TENTH EDITION

CRSI®

# DESIGN HANDBOOK 2008

CRSI® CONCRETE REINFORCING STEEL INSTITUTE

# CRSI

# DESIGN HANDBOOK

# 2008

*Based upon the 2008 ACI BUILDING CODE*

Prepared under the Direction of the CRSI Engineering Practice Committee by
The Committee on Design Aids


Donald F. Meinheit, Chairman ..... Wiss, Janney, Elstner Associates, Inc.
Stephen D. Disch ..... Walker Restoration Consultants
Robert W. Hall ..... CMC Rebar Virginia
David F. Horton ..... CMC Rebar Virginia
Michael D. Hunter ..... CMC South Carolina Steel
Saru Poch ..... CMC Fontana Steel
William Sebastian ..... Barker Steel LLC
Lyle Sieg ..... Harris Salinas Rebar
Robert G. Smith ..... ERICO International Corp.
Anthony L. Felder ..... Concrete Reinforcing Steel Institute
Scott R. Humphreys ..... Concrete Reinforcing Steel Institute
Mike Mota ..... Concrete Reinforcing Steel Institute



CRSI®

**CONCRETE REINFORCING STEEL INSTITUTE**

933 North Plum Grove Road
Schaumburg, Illinois 60173-4758
847-517-1200 • www.crsi.org

# FOREWORD

The Concrete Reinforcing Steel Institute (CRSI) was organized in 1924 as a cooperative, non-profit organization of producers and fabricators of reinforcing bars and accessories, together with persons or entities otherwise involved in reinforced concrete construction. The Institute has a "Professional Member" classification which opens CRSI activities to designers, specifiers, educators and research personnel actively engaged in reinforced concrete design and construction.

A major objective of the Concrete Reinforcing Steel Institute is to disseminate helpful structural design information for economical and efficient use of materials, and to save designers' time. CRSI has published Design Handbooks since 1952.

This new *CRSI Design Handbook*, 10th Edition, 2008, follows the long-established tradition of providing completed, tabulated designs of common reinforced concrete structural members. The tabulated designs are for normally encountered conditions, and are based on the latest applicable code provisions and materials specifications. All of the tabulated designs in this *Handbook* are prepared in accordance with "Building Code Requirements for Structural Concrete (ACI 318-08)." The majority of the notation used in this *Handbook* follows ACI 318-08. In those instances where other notation had to be introduced, the symbols are defined or shown on figures. Inch-pound units are used throughout this *Handbook*. The reader is encouraged to review the information about soft metric reinforcing bars on Page 1-5.

Since the first *CRSI Design Handbook* in 1952, users of these Handbooks have been cooperative in suggesting to the Design Aids Committee and CRSI Staff, many improvements, clarifications and additional design short-cuts. This professional assistance is very helpful, and is appreciated. Comments regarding this *Handbook* are welcome so that future Handbooks can be further improved. Direct comments to Neal S. Anderson, CRSI Vice President of Engineering.

# ACKNOWLEDGEMENTS

A sincere note of appreciation goes to Dr. David P. Gustafson for his tireless efforts on the *Design Handbook,* both for past editions as Vice President of Engineering for CRSI and as Technical Consultant for this 10th edition. The Handbook would not be what it is today were it not for Dr. Gustafson's expertise in reinforced concrete design and construction and his attention to detail.

Also, a note of appreciation to Nicholas Gouwens for his expert assistance in typesetting and reviewing the Handbook manuscript and to Kurt S. Lepinski for his work in updating the Handbook computer programs.

**Tenth Edition, 2008**

© Concrete Reinforcing Steel Institute, 2008

**PRINTED IN THE UNITED STATES OF AMERICA**

This book or any part thereof may not be reproduced in any form
without permission of the Concrete Reinforcing Steel Institute.

# CONTENTS


**CHAPTER 1** – Basis and Use of Tabulated Designs

**CHAPTER 2** – Strength Design of Columns

**CHAPTER 3** – Square and Rectangular Columns

**CHAPTER 4** – Round-Tied Columns

**CHAPTER 5** – Strength Design of Flexural Members and Development and Splice Design Data for Reinforcing Bars

**CHAPTER 6** – Serviceability Requirements

**CHAPTER 7** – One-Way Slabs

**CHAPTER 8** – One-Way Concrete Joist Construction

**CHAPTER 9** – Solid Two-Way Flat Plates — Square Panels

**CHAPTER 10** – Two-Way Solid Flat Slabs — Square Panels with Drops

**CHAPTER 11** – Waffle Flat Slabs — Square Panels

**CHAPTER 12** – Beams

**CHAPTER 13** – Square Spread Footings, Pile Caps and Drilled Piers

**CHAPTER 14** – Cantilevered Retaining Walls

**EXPANDED COLUMN TABLES** – Chapter 3 and Chapter 4

# CHAPTER 1 – BASIS AND USE OF TABULATED DESIGNS



## CHAPTERS 2, 3, AND 4

**Columns.** The purpose of Chapters 2, 3, and 4 is to provide designs of "short" columns in reinforced concrete by giving column dimensions, and sizes and quantities of reinforcement in accordance with the strength design method of "Building Code Requirements for Structural Concrete (ACI 318-08)." Selecting completed designs of columns from the tabulated designs in Chapters 3 and 4 eliminates the need for charts and diagrams. The appropriate table is entered with values of the factored load and moment, and the column dimensions and reinforcing steel are obtained.

The column tables provide capacities for bending about both major and minor axes. These data permit adjustment for the effects of slenderness in one or both directions, as well as simultaneous bending in both axes.

**Load-Moment Tables Instead of Coefficients and Charts.** It is extravagant to continually repeat computations to determine the nominal design strength of an assumed section, when a computer program can tabulate the same results for ready reference. Use of these tables eliminates routine calculations and helps prevent the oversight of one or more applicable criteria. However, no handbook can replace the judgment of an experienced Engineer.

**Load and Strength-Reduction Factors.** The strength design method makes use of two sets of factors. Load factors provide for variable conditions that lead to possible load variances. Strength-reduction factors, or $\phi$-factors, provide for variable conditions that lead to possible understrengths. Because different load factors are prescribed for dead, live, wind and earthquake effects, and the factors vary with different combinations of such effects, it is only possible to tabulate nominal design strength in this Handbook. Appropriate load factors must be applied to each effect for as many combinations as circumstances require. Then these tables can be entered with the maximum of the total factored load effects and compared with the design strength.

Since the $\phi$-factors are standardized (0.65 for tied columns, and 0.90 for flexure), they were incorporated into the tabulated designs. Hence the tabulated values are the nominal design strength for each column, i.e., the design axial load and moment strengths ($\phi P_n$ and $\phi M_n$).

**Basis and Scope of Tabulated Designs.** These tables give the nominal design strength (with $\phi$-factors included) for the usual range of sizes of square, rectangular, and round tied "short" columns—using "short" in the Code sense of a column that does not require reduction in capacity for slenderness effects (ACI 10.10).*

Designs are tabulated for Grade 60 (minimum $f_y$ = 60,000 psi) reinforcing bars for the usual range of concrete strengths ($f'_c$). For the higher concrete strengths now available, designs are also tabulated for Grades 60 and 75. The tabulated designs for Grade 75 (minimum $f_y$ = 75,000 psi) are limited to the use of the large size bars (#11, #14, and #18). Lower strength grades for these sizes are not recommended (by CRSI) for economy. The percentages of longitudinal reinforcement in the tabulated designs vary from one percent, the minimum allowed, to the maximum that can be fitted as single bars at minimum spacings in one layer or ring, but not more than eight percent, the maximum allowed (ACI 10.9.1).

## CHAPTERS 5 THROUGH 14

Strength design of flexural members is discussed in Chapter 5. Also included in Chapter 5 is development of reinforcement and lap splices for reinforcing bars.

Strength design consists of two steps—first, a member is proportioned to ensure its strength with the appropriate safety factors, and second, the member must be checked to ensure that deflection and cracking at service load conditions will be controlled. These two design phases—strength and serviceability—are described in Chapters 5 and 6, respectively.

Chapter 7 covers design of one-way solid slabs. Tabulated designs are presented for single spans simply supported, end spans of continuous members simply supported at one end and continuous at the other, and interior spans continuous at both ends.

Chapters 8 through 14 provide designs of reinforced concrete floor systems, footings, pile caps and cantilevered retaining walls. Tabulated designs are given which indicate member dimensions and reinforcement for various span and load conditions. The empirical moment coefficients (ACI 8.3.3) for one-way slab systems and the Direct Design Method (ACI 13.6) for two-way systems are used.

*All references in this *Handbook* to "Building Code Requirements for Structural Concrete (ACI 318-08)" are given as "ACI" followed by appropriate section number.

The tabulated designs in Chapters 7, 8, 9, 10 and 11 give the factored usable superimposed loads (reduced by the proper $\phi$-factors) of practical sizes of slabs, joists, flat plates, flat slabs, and waffle flat slabs, with a range of spans and loads, and required reinforcement.

**Materials.** The tabulated designs are based on a specified concrete compressive strength $f'_c$ = 3,000 psi for footings and retaining walls, and on $f'_c$ = 4,000 psi for one-way solid slabs, beams, joists, flat plates, flat slabs with drop panels, and waffle flat slabs. All designs for flexural members are based on Grade 60 reinforcing bars.

Except for Chapter 12—Beams, the tabulated designs in this *Handbook* give "factored usable superimposed loads" because different load factors are prescribed for different types of loads. The total factored load varies with different combinations of such effects.

Since $\phi$-factors are standardized, all tabulated loads have been reduced by the appropriate $\phi$-factor. Also, for floor systems, 1.2 times the dead weight of the floor system—based on a conservative unit weight of concrete of 150 pounds per cubic foot—was deducted in tabulating net usable superimposed loads. When transferring total floor loads onto supporting members, the augmented weight of the floor system must be included.

**Supplementary References.** The following references are recommended to the reader to supplement this *Handbook* and to ensure that the design, detailing and construction techniques meet standards and accepted practices.

1. *ACI Detailing Manual,* (SP-66).*
2. *Manual of Standard Practice,* CRSI**
3. *Reinforcing Bars: Anchorages and Splices,* CRSI.**

## STRUCTURAL INTEGRITY

Requirements for "structural integrity" are included in the ACI Building Code (ACI 7.13 and 13.3.8.5). To comply with the provisions, members of a structure must be effectively tied together. The objective of structural integrity is: If a structure or a part of the structure is subjected to an abnormal loading condition, or if a primary supporting element sustains damage from an unanticipated event, tying the members together should result in confining the resulting damage to a relatively small area.

The Code requirements for achieving structural integrity in reinforced concrete construction focus on the structural detailing of reinforcement. Basically, prescribed amounts of longitudinal reinforcement must be continuous over supports or reinforcing bars that terminate at discontinuous ends of a member have to be anchored with standard hooks or headed bars.

Cast-in-place structural concrete members and systems which are affected by the structural integrity provisions are:

**One-Way Joists (ACI 8.13).** At least one reinforcing bar in the bottom of a rib has to be continuous over supports or the bar must be spliced with a Class B tension lap splice or a mechanical or welded splice to a bar in the adjacent span. At discontinuous ends of joists, anchorage of at least one bottom bar must be provided with a standard hook or headed bar. Fig. 1-1 shows the structural integrity reinforcement requirements for joist construction.

*American Concrete Institute, P.O. Box 9094, Farmington Hills, Michigan 48333.
**Concrete Reinforcing Steel Institute, 933 North Plum Grove Road, Schaumburg, Illinois 60173.

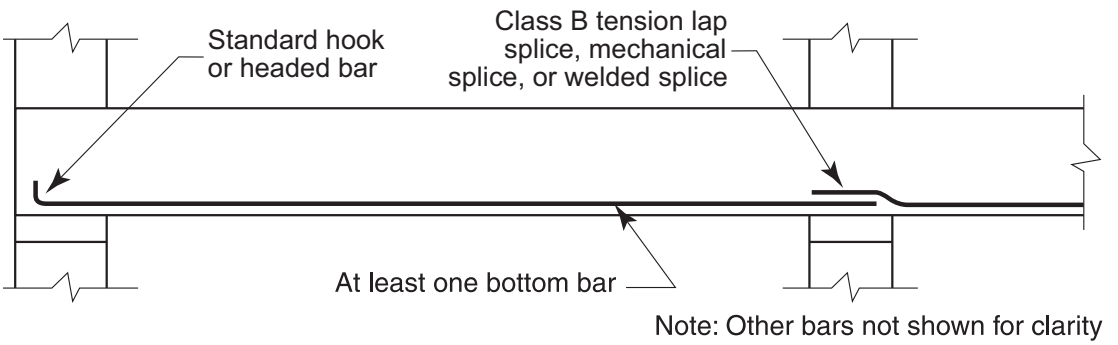



**Figure 1-1 Structural Integrity Reinforcement for One-Way Joist Construction**

**Beams.** Beams are categorized as either "perimeter" beams or "non-perimeter" beams. A spandrel beam would be a perimeter beam.

The detailing of top and bottom bars, and stirrups in perimeter beams, is impacted by the structural integrity provisions. At least one-sixth of the $-A_s$ required for negative factored moment at the face of supports (minimum of 2 bars) and one-quarter of the $+A_s$ required for positive factored moment at midspan (minimum of 2 bars) have to be made continuous around the perimeter of the structure. Closed stirrups are also required in perimeter beams. It is not necessary to place closed stirrups within the joints at columns or other supporting girders. It is permissible to provide continuity of the top and bottom bars by splicing the top bars at midspan and the bottom bars at or near the supports. Splicing with Class B tension lap splices, or mechanical or welded splices, is required. See Fig. 1-2.

For non-perimeter beams, the Engineer has two choices to satisfy the structural integrity requirements: (1) provide closed stirrups, or (2) make at least one-quarter of the $+A_s$ required for positive factored moment at midspan continuous (minimum of 2 bars). Splicing the prescribed number of bottom bars over the supports with Class B tension lap splices, mechanical or welded splices, is acceptable. At discontinuous ends of non-perimeter beams, the bottom bars must be anchored with standard hooks or headed bars. See Fig. 1-3.

**Two-Way Slabs.** In two-way slab construction, all bottom bars within the column strip, in each direction, must be spliced with Class B tension lap splices, mechanical or welded splices. Fig. 13.3.8 in the ACI Building Code shows the locations where the lap splices are permitted. At least two of the bottom bars in the column strip must

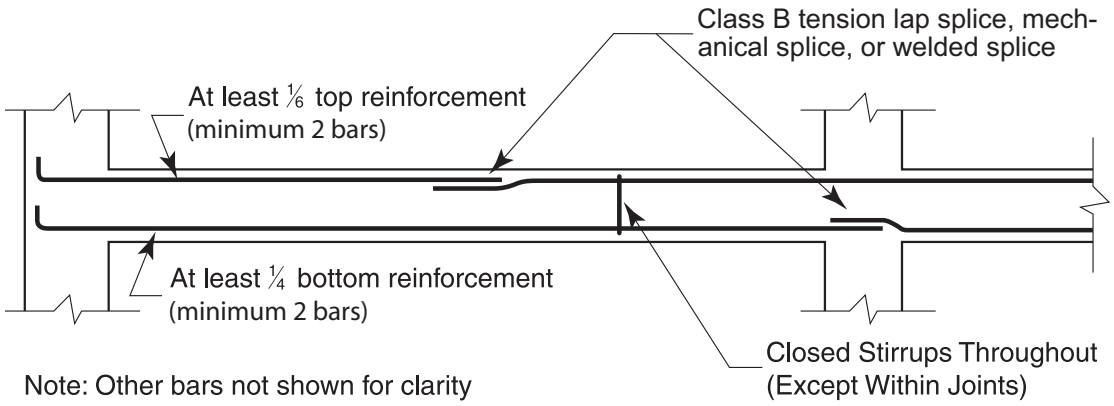



**Figure 1-2 Structural Integrity Reinforcement for Perimeter Beams**

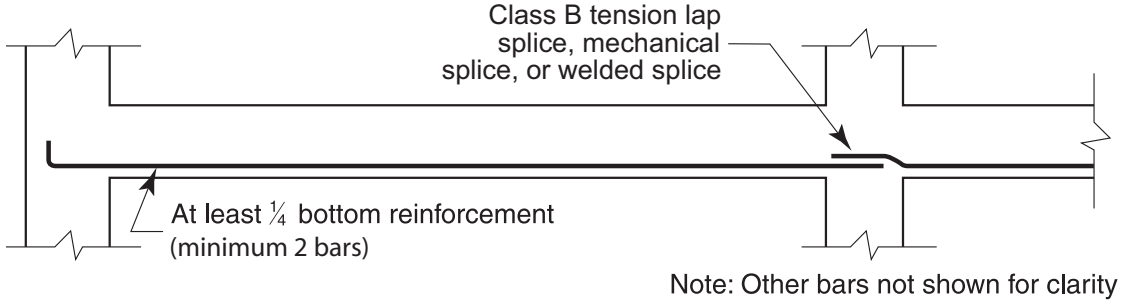



**Figure 1-3 Structural Integrity Reinforcement for Non-Perimeter Beams**

pass within the core of the columns and be anchored with a hook or headed bar at exterior supports. See Fig. 1-4.

The structural integrity requirements of the ACI Building Code were not incorporated into the various tabulated designs of this *Handbook.* One reason for this exclusion was due to the inability to determine where the bars would be truly continuous (i.e., one piece) and where the bars would be spliced.

As an example, consider a relatively short 14-foot span one-way joist system. Since stock lengths of reinforcing bars from steel mills vary from 40 to 60 feet, this would result in lap splicing the bottom bars within either every two or every three spans. Although the bars could have been assumed to be lap spliced at every support or at midspan, such details were felt to be unrealistic.

Another reason, which applies only to the tabulated designs of beams in Chapter 12, is that the structural integrity requirements are quite different for perimeter and non-perimeter beams. This would have necessitated preparation and printing of two sets of tables: one set for perimeter beams and another set for non-perimeter beams.

Therefore, the tabulated designs in this *Handbook* do not include the structural integrity requirements in order to make them as general as possible. The Engineer using this *Handbook* must evaluate the issue of structural integrity on a case-by-case basis.

## NOTICE

The Institute does not prepare project drawings and project specifications. While every precaution is taken to ensure that all data and information furnished are as accurate as possible, the Institute cannot assume responsibility for errors or oversights in the use of such information or in the preparation of project drawings and project specifications. The information given in the tabulated designs should prove useful in preliminary design, in preliminary estimating of quantities of materials, for establishing sizes and clearances, and for comparing different types of construction. Obviously, the tabulated designs apply only to the particular condition of span, loading and material strengths specified. The information in this *Handbook* should not replace the judgment of an experienced structural engineer when selecting types of structural concrete members and systems, proper loads, providing proper stiffness and in obtaining the most economical design.

Tabulated solutions for common structural concrete members and systems are presented in this *Handbook* with examples to illustrate the application of ACI Building Code requirements. It is not possible to prepare tabulated solutions for connections of these members and systems in general. Structural integrity for the completed structure can be provided only by the Engineer familiar with the overall requirements involved.

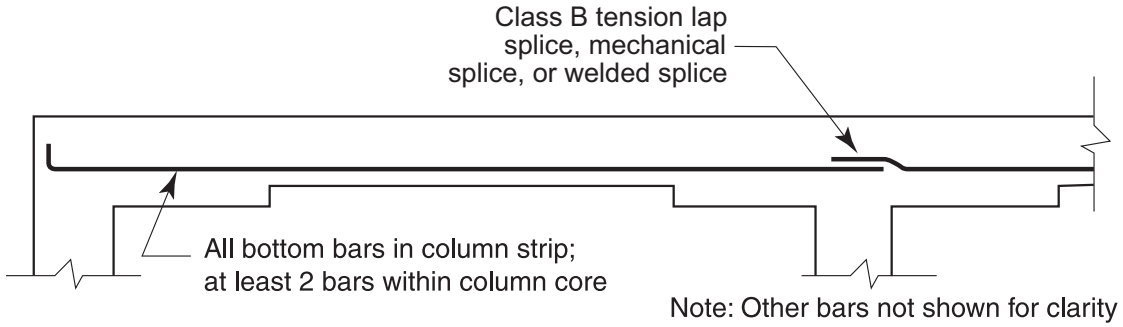



**Figure 1-4 Structural Integrity Reinforcement for Two-Way Slab Construction**

## SOFT METRIC REINFORCING BARS

The tabulated designs in this *Handbook* are based on requirements in the inch-pound version of the ACI Building Code. Consequently, inch-pound units, including the designations for the sizes of reinforcing bars, are used throughout this *Handbook*. Space limitations precluded inclusion of companion tabulated designs in metric units, which would be based on ACI 318M.

It is important for users of this *Handbook* to be aware of current industry practice regarding soft metric reinforcing bars. The term "soft metric" is used in the context of bar sizes and bar size designations. "Soft metric conversion" means describing the nominal dimensions of inch-pound reinforcing bars in metric units, but not physically changing the bar sizes. In 1997, producers of reinforcing bars (the steel mills) began to phase in the production of soft metric bars. Within a few years, the shift to exclusive production of soft metric reinforcing bars was essentially achieved. Virtually all reinforcing bars currently produced and used in the USA are soft metric. The steel mills' initiative of soft metric conversion enables the industry to furnish the same reinforcing bars to inch-pound construction projects as well as to metric construction projects, and eliminates the need for the steel mills and fabricators to maintain a dual inventory. Thus, USA-produced reinforcing bars furnished to any construction project most likely will be soft metric.

**Designations of Bar Sizes.** The sizes of soft metric reinforcing bars are physically the same as the corresponding sizes of inch-pound bars. Soft metric bar sizes, which are designated #10, #13, #16, and so on, correspond to inch-pound bar sizes #3, #4, #5, and so on. The metric bar designations are simply a re-labeling of the inch-pound bar designations. The following table shows the one-to-one correspondence of the soft metric bar sizes to the inch-pound bar sizes.

### Soft Metric Bar Sizes vs. Inch-Pound Bar Sizes

| Soft Metric Bar Size Designation | Inch-Pound Bar Size Designation |
|---|---|
| #10 | #3 |
| #13 | #4 |
| #16 | #5 |
| #19 | #6 |
| #22 | #7 |
| #25 | #8 |
| #29 | #9 |
| #32 | #10 |
| #36 | #11 |
| #43 | #14 |
| #57 | #18 |

**Minimum Yield Strengths or Grades.** Virtually all steel mills in the USA are producing reinforcing bars to meet the metric requirements of the ASTM specifications. Minimum yield strengths in metric units are 280, 350, 420 and 520 MPa (megapascals), which are equivalent to 40,000, 50,000, 60,000 and 75,000 psi, respectively. Metric Grade 420 is the counterpart of standard Grade 60.

**Bar Marking.** Soft metric reinforcing bars are required to be identified with the Producer's mill designation, bar size, type of steel, and minimum yield strength or grade. For example, consider the marking requirements for a #25, Grade 420 metric bar, which is the counterpart of an inch-pound #8, Grade 60 bar. Regarding the bar size and grade, the ASTM specifications require the number "25" to be rolled onto the surface of the metric bar to indicate its size. For identifying or designating the yield strength or grade, the ASTM specifications provide an option. A mill can choose to roll a "4" (the first digit in the grade number) onto the bar, or roll an additional longitudinal rib or grade line to indicate Grade 420.

Chapter 1 in the CRSI *Manual of Standard Practice* includes a detailed presentation of the inch-pound and metric requirements in the ASTM specifications for reinforcing bars. Appendix A in the *Manual* shows the bar marks used by USA producers to identify Grade 420 soft metric bars. More information about soft metric reinforcing bars is given in Engineering Data Report No. 42, "Using Soft Metric Reinforcing Bars in Non-Metric Construction Projects". EDR No. 42 can be found on CRSI's Website at **www.crsi.org**.

Users of this *Handbook* are also encouraged to visit the CRSI Website for:

- Descriptions of CRSI publications and software, and ordering information
- Institute documents available for downloading
- Technical information on epoxy-coated reinforcing bars
- Technical information on continuously reinforced concrete pavement
- Membership in CRSI and member web links
- General information on the CRSI Foundation
- Information on the CRSI Design Awards competition

# CHAPTER 2 – STRENGTH DESIGN OF COLUMNS



**General**

Strength design of reinforced concrete columns is a complete design since there are no further serviceability requirements to be satisfied. Strength design of columns consists of determining the critical load combinations and resulting factored loadings for each; selecting a column cross section satisfying all design assumptions for the materials used under loads and moments equal to or larger than the factored loads and moments; and ensuring that slenderness effects do not reduce capacity.

Since the reduction in capacity for slenderness is dependent on the cross-sectional properties, including reinforcement of the column selected, and the factored moments are also dependent on the gross cross section, strength design of columns is in reality a two-stage review of a trial design. The manual calculations for such a review are formidable and become increasingly onerous if several trials are required. The column capacity tables in this *Handbook* can be used to avoid the need to make several trials since the tables cover most of the practicable range encountered in ordinary structures.

**Load and Strength-Reduction Factors**

The ACI Building Code provides seven principal load combinations with appropriate load factors for each to compute the factored load effects, axial load and moment. When these combinations are simplified by only concerning $D$ (dead), $L$ (live), and $W$ (wind) loads, they result in the following three combinations:

$U = 1.4D$

$U = 1.2D + 1.6L$

$U = 1.2D + 1.0L + 1.6W$ (use whichever of the three is largest)

Use of the column capacity tables in this *Handbook* requires computation for the maximum effects, axial load and moment for the factored (augmented) load above. The load capacities tabulated in Chapters 3 and 4 have been computed for the stated concrete compressive strengths and Grade 60 bars ($f_y$ = 60,000 psi) and Grade 75 bars ($f_y$ = 75,000 psi), reduced by strength- reduction factors $\phi = 0.65$ for compression, and $\phi = 0.90$ for pure flexure only. The capacities tabulated are, therefore, the maximum usable design capacities for short columns. "Short" columns are those for which no reduction in load capacity for the effect of slenderness need be made.

**Design Assumptions**

The general assumptions prescribed in the ACI Building Code for strength design of reinforced concrete columns are given as follows:

10.2 – Design assumptions.

10.2.1 – Strength design of members for flexure and axial loads shall be based on the assumptions given in 10.2.2 through 10.2.7, and on satisfaction of applicable conditions of equilibrium and compatibility of strains.

10.2.2 – Strain in reinforcement and concrete shall be assumed directly proportional to the distance from the neutral axis . . .

10.2.3 – Maximum usable strain at extreme concrete compression fiber shall be assumed equal to 0.003.

10.2.4 – Stress in reinforcement below $f_y$ shall be taken as $E_s$ times steel strain. For strains greater than that corresponding to $f_y$, stress in reinforcement shall be considered independent of strain and equal to $f_y$.

10.2.5 – Tensile strength of concrete shall be neglected in axial and flexural calculations of reinforced concrete . . .

10.2.6 – The relationship between concrete compressive stress distribution and concrete strain shall be assumed to be rectangular, trapezoidal, parabolic, or any other shape that results in prediction of strength in substantial agreement with results of comprehensive tests.

10.2.7 – Requirements of 10.2.6 are satisfied by an equivalent rectangular concrete stress distribution defined by the following:

10.2.7.1 – Concrete stress of 0.85 $f'_c$ shall be assumed uniformly distributed over an equivalent compression zone bounded by edges of the cross section and a straight line located parallel to the neutral axis at a distance $a = \beta_1 c$ from the fiber of maximum compressive strain.

10.2.7.2 – Distance from the fiber of maximum strain to the neutral axis, $c$, shall be measured in a direction perpendicular to the neutral axis.

10.2.7.3 – For $f'_c$ between 2,500 and 4,000 psi, $\beta_1$ shall be taken as 0.85. For $f'_c$ above 4,000 psi, $\beta_1$ shall be reduced linearly at a rate of 0.05 for each 1,000 psi of strength in excess of 4,000 psi, but $\beta_1$ shall not be taken less than 0.65."

The computer program used for the preparation of the column capacity tables in this *Handbook* followed

all design assumptions required. An equivalent rectangular stress block for compressive stress distribution in concrete as specifically prescribed was used (ACI 10.2.7). The area of concrete displaced by vertical reinforcing bars was deducted from the total compression on concrete. Where the vertical reinforcing bars are located at varying distances from the neutral axis, such as bars in circular patterns for round columns, or in the sides parallel to the direction of bending for square or rectangular columns, actual bar area and location were considered for each bar.

**Load-Moment Interaction Diagrams**

Even with the advantage of tabulated load capacities at various control points as provided by this *Handbook*, it is frequently helpful to construct a load-moment interaction diagram. Such a diagram is particularly useful in the evaluation of load effects for the three different load combinations prescribed. The various load-moment capacities can be located conveniently on an interaction diagram, and the effect of changing bar size, or the number of bars, or their arrangement, can be quickly determined. Also, the increase in factored moment as an effect of slenderness may be added.

The intervals, or control points, at which design axial load strengths and moment strengths are tabulated were selected to permit convenient construction of interaction curves, complete from maximum design axial load strength to pure flexure. Sample interaction curves prepared from the load tables in Chapters 3 and 4 are discussed and shown. In the sample interaction curves that follow, attention is particularly directed to these considerations:

**1. "Major" versus "minor" axes (MA and MI) capacities.** Note that for a square column, if the unbraced height and end restraint conditions are equivalent in both directions, the *minor* axis capacity, except for 4-bar columns, will be smaller and will control the maximum load allowed. Maximum design axial load strength will be equal in both directions for a square column. See Fig. 2-1.

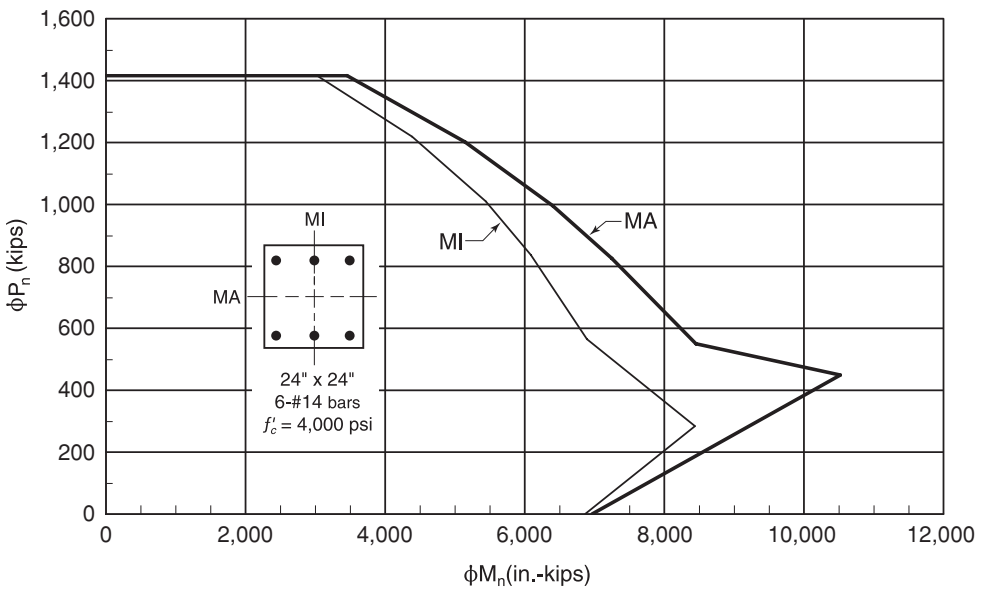



**Figure 2-1 Major Axis vs. Minor Axis**

**2. Round-tied columns versus square.** The round-tied column (or circular bar pattern) is less efficient for moment resistance. For equivalent areas of vertical reinforcing bars and concrete, the square column has more capacity than the round-tied column. At the point of maximum design axial load strength, the capacities of the two columns are the same. See Fig. 2-2.

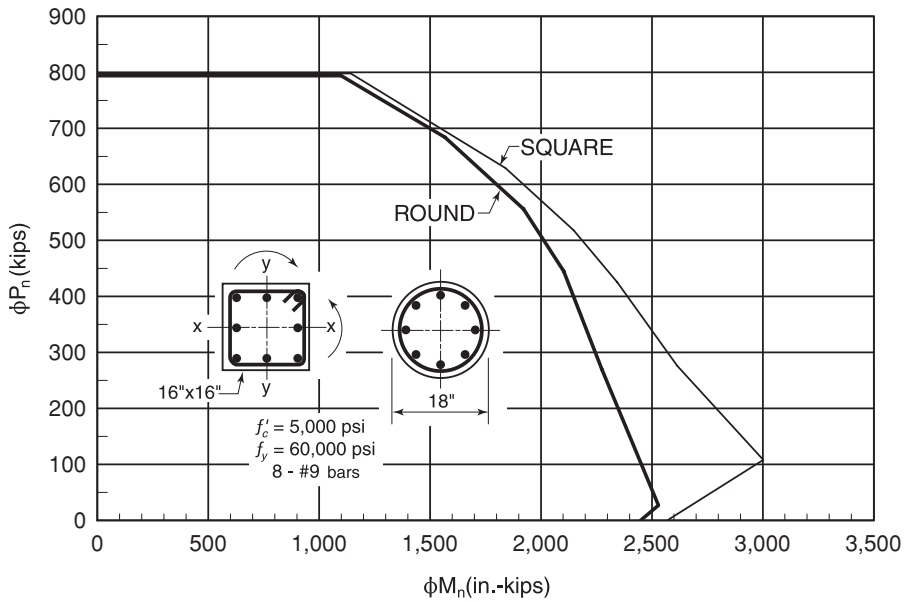



**Figure 2-2 Round-Tied vs. Square**

**3. Grade 60 versus Grade 75 reinforcing bars.** Tabulated capacities of columns reinforced with Grade 75 bars have been included in this *Handbook* (in bar sizes #11, #14, and #18). Load-moment interaction curve comparisons for a square column reinforced with Grade 60 and Grade 75 bars are shown in Fig. 2-3.

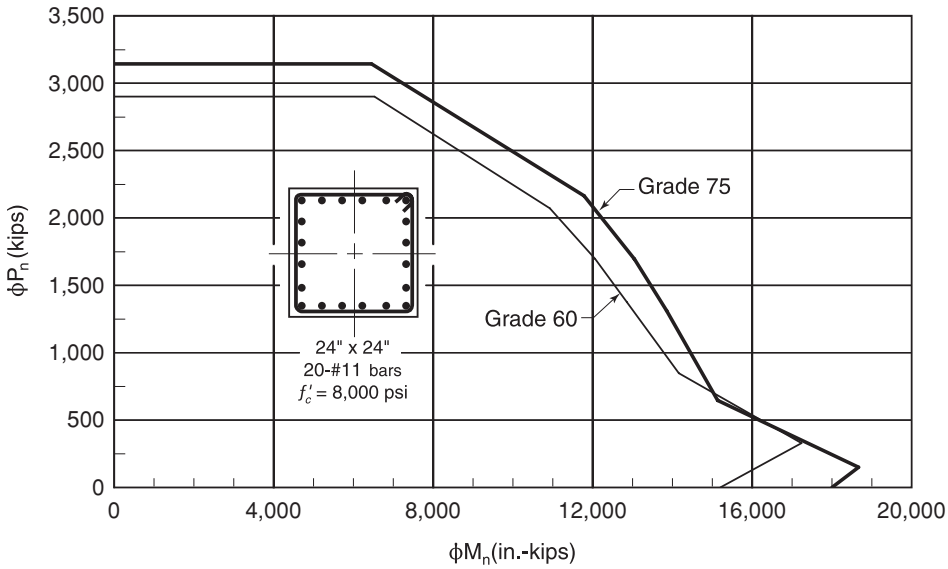



**Figure 2-3 Grade 60 vs. Grade 75 Reinforcing Bars**

**Splices**

See Chapter 5 for dowel embedment and lap splices in compression. Tables for tension development lengths and tension lap splice lengths are also provided in Chapter 5. For footing dowel design, see Chapter 13 – Footings.

Special requirements for splices in columns are prescribed by the Code (ACI 12.17). Selection of the tabulated combinations of design axial load and moment strengths in Chapters 3 and 4—the control points on the load-moment interaction diagram—was influenced by the splice provisions.

A point often overlooked in design for lap splices of offset column vertical bars is the reduction in effective depth of the offset bars. This effect can usually be safely neglected when the stress is always compressive with low reinforcement ratios. Particularly with reinforcement ratios in excess of 0.04 and large factored moments, however, nominal moment capacity should be reduced. An approximation for this reduction is:

$$R = (X - X_o)/X$$

where $R$ = reduction of moment capacity
$X_o = 0.5h - d'_c$ for offset bar, and
$X = 0.5h - d_c$ for straight bar

See Fig. 2-4 for a sketch of an offset detail and definition of terms.

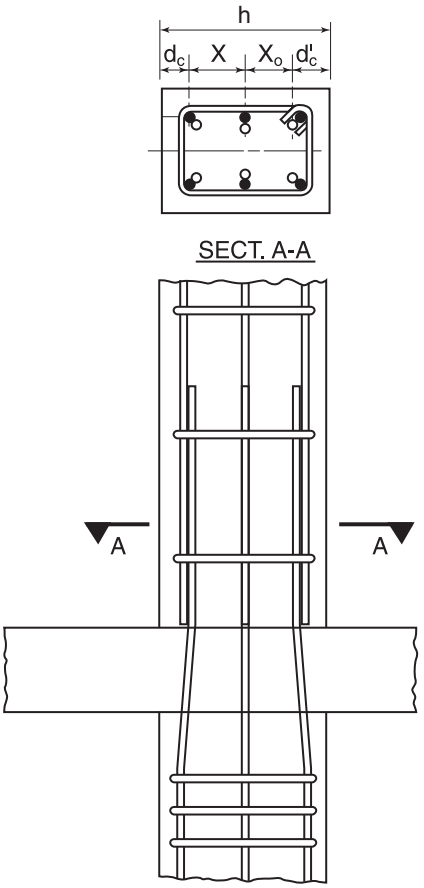



**Figure 2-4 Offset Bar Lap Splices – Columns with Bending Moments, #11 Bars and Smaller**

# CHAPTER 3 – SQUARE AND RECTANGULAR COLUMNS

**General.** The variety of cross-sectional shapes used for reinforced concrete columns is unlimited, but many columns are square or rectangular because of practical requirements in layout of walls and partitions and ease of forming. In this Chapter, design strength tables for the three most used types of columns are furnished:

1. Square cross section with symmetrical groupings of reinforcing bars in four faces (4F).
2. Square cross section with symmetrical groups of reinforcing bars in two faces (2F).
3. Rectangular cross section with reinforcing bars in all faces; symmetrical groups of reinforcing bars in opposite faces.

Design strengths for the latter two types are tabulated for bending about each axis of symmetry. The major axis (MA) for the square sections (2F) is the axis equidistant from each parallel line through reinforcing bar centers. The minor axis (MI) is the axis through the center of the section at 90º to the major axis. For most (not all) combinations of column size, concrete cover, size and number of reinforcing bars, this type of column will have maximum design moment strength, $\phi M_n$, bending about the major axis (MA). For the rectangular columns, the major axis is a line parallel to the short sides passing through the center of the section. See Fig. 3-1.

Two separate tables for square columns are presented. Output and resulting format for the two tables are different. The square columns with symmetrical groupings of reinforcing bars in four faces provide the same design moment strength in each direction and require one line in the tables (Pages 3-12 through 3-15). Square columns with reinforcing bars in two faces only provide a different bending resistance in each direction. *Both directions must be evaluated separately for slenderness effects*, particularly when effective length differs due to different lateral bracing in the two directions. Since the same format was used for square columns with reinforcing bars in two faces and all rectangular columns, this type of square column design was tabulated at the beginning of each rectangular column design strength table.

**Scope.** The tabulated column designs presented on Pages 3-12 through 3-106 are for a concrete compressive strength, $f'_c$, of 4,000 psi and Grade 60 ($f_y$ = 60,000 psi) reinforcing bars. Tabulated designs for concrete compressive strengths of 5,000, 6,000 and 8,000 psi in combination with Grade 60 bars are provided on the enclosed CD-ROM. Also included in the enclosed CD-ROM are tabulated designs for concrete strengths of 6,000, 8,000, and 10,000 psi in combination with Grade 75 ($f_y$ = 75,000 psi) reinforcing bars.

CRSI recommends use of Grade 60 reinforcing bars as the standard grade for economy in the majority of structures. The ASTM A615 Specification for carbon-steel reinforcing bars includes Grade 75 bars in bar sizes #3 through #18. For example, Grade 75 could provide cost savings and other possible advantages in high-rise construction especially when combined with higher strength concretes. CRSI recommends that the availability of Grade 75 bars in any size should be investigated before the higher grade is specified. The ASTM A706 Specification covers low-alloy steel reinforcing bars in a single grade, i.e., Grade 60 ($f_y$ = 60,000 psi).

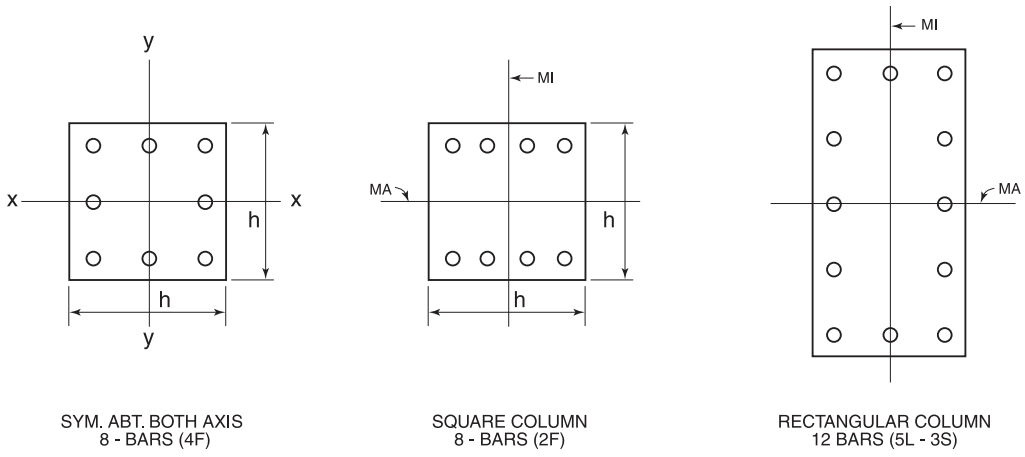



**Figure 3-1 Bar Pattern Designation – Major and Minor Axis**

Column sizes using Grade 60 reinforcing bars are shown for minimum size sides, 10 inches. For rectangular columns of each width, increasing depth increments up to depth = 2 times width are presented, maximum of 48 inches. Design strengths and reinforcement for various size combinations of rectangular columns with proportions exceeding 2:1 can be determined as fractions of strengths given. For bars in the two short faces only, 10 × 40 equals half the (MA) design moment strength of 20 × 40 if concrete cover and spacing permit use of half the number of bars. Similarly, 20 × 80 will provide twice the (MI) design moment strength of 20 × 40 for bars in long faces only.

Vertical reinforcing bar combinations are shown to provide reinforcing steel to concrete cross section ratios from 1 to 8 percent. Sizes of Grade 60 bars begin with #5 in smaller size columns and continue up to the largest size practicable for each size column. Not all bar combinations possible between 1 and 8 percent are shown. As column size increases, minimum bar size is increased to avoid designs with excessive numbers of vertical bars with equally excessive tie requirements. For Grade 75 bars, only the largest sizes, #11, #14 and #18, are used in the tabulated designs on the enclosed CD-ROM.

**ACI Building Code Requirements.** A number of Code requirements apply to square and rectangular columns.

1. *Design Assumptions.* See Chapter 2.
2. *Load Factors.* Three principal load factor combinations are prescribed for the required strength:

$U = 1.4D$
$U = 1.2D + 1.6L$
$U = 1.2D + 1.0L + 1.6W$

Column design must provide strength equal or larger than the largest value of $U$, determined by the three combinations above, or five in seismic design categories. Other factors apply for various special conditions.

In practice, the second load combination above will control most column designs, except in high-rise buildings, narrow buildings with few columns and no other lateral bracing greatly stiffer than the columns. For this reason, and for concise examples only, the final values of the required strength, $U$, (expressed as $\phi P_n$, $\phi M_n$) will be used in the examples in this Chapter. The required factored loads and factored moments ($P_u$, $M_u$) must be determined for the conditions of the structure to enter the column tables.

3. *Slenderness effects.* All design strengths tabulated in Chapters 3 and 4 are for "short" columns. Slenderness effects are not considered in the tabulated designs in Chapters 3 and 4.
4. *Biaxial Bending.* Column design strengths ($\phi P_n$, $\phi M_n$) are tabulated for uniaxial bending, with eccentricities in the direction of major (MA) and minor (MI) axis. A single value suffices for the table of square columns symmetrically reinforced where design axial load and moment strengths, MA and MI, are equal. Corner columns and any other columns subjected to known factored moments simultaneously about each axis must be designed for biaxial bending (ACI Commentary R10.3.6 and R10.3.7).
5. *Splices.* Special requirements for splices in columns are prescribed by the Code (ACI 12.17). Consideration of the splice requirements was made in the selection of the tabulated combinations of design axial load and moment strengths – the control or key points on the $\phi P_n - \phi M_n$ interaction diagram.
6. *Ties and Concrete Cover.* Recommended typical tie arrangements, suitable for prefabricated column cages or in-place free-standing erection, are shown in the *ACI Detailing Manual*. Each corner bar and alternate interior bars (with clear spacings equal or less than 6 inches) must have lateral support of a tie corner within an included angle not larger than 135º, (ACI 7.10.5.3). For cast-in-place columns, minimum concrete cover to ties is 1½ inches (ACI 7.7.1). Minimum sizes of ties are #3 for vertical (longitudinal) bars up to #10, and #4 for #11, #14, or #18 vertical bars. The calculated design strengths are based on depths, $d'$, from the nearest face to the center of bars as shown in Table 3-1.

No column designs using mixed bar sizes are tabulated in this Chapter. If such designs are attempted, the largest bar size in the column face will establish depth, $d'$.

**Table 3-1 Depth from Nearest Face to Center of Vertical Bars***

| Bar Size | #5 | #6 | #7 | #8 | #9 | #10 | #11 | #14 | #18 |
|---|---|---|---|---|---|---|---|---|---|
| Depth, $d'$ (in.) | 2.19 | 2.25 | 2.31 | 2.38 | 2.44 | 2.51 | 2.71 | 2.85 | 3.12 |

* Based on 1-1/2 in. concrete cover to the tie.

7. *Limiting Vertical (Longitudinal) Reinforcement.* The minimum number of vertical reinforcing bars is four in tied columns. The minimum area of vertical reinforcing bars is 0.01 and maximum 0.08 times the gross area of the column cross section (ACI 10.9.1). Where columns are larger than required for loadings,

the minimum limiting area of vertical bars can be reduced to 0.005 times the gross area. When the vertical bar area is reduced below 0.01 times gross area, computations for the design axial load strength, design moment strength, and minimum bar area must be based on an *effective gross area* reduced proportionately (ACI 10.8.4). This provision avoids waste of reinforcing steel for upper floors of a multi-story column made to a uniform size for form reuse from bottom to top. See Design from Tables Section in this Chapter. For lower floors in high-rise construction, the use of Grade 75 reinforcing bars in combination with maximum available concrete strength often can reduce congestion of vertical bars where compression controls design.

Costs for each item in reinforced concrete column construction vary in different localities. A few general principles for economy of column design are applicable, however, throughout the industry.

1. Form reuse through utilization of the same cross section over an entire floor and for all stories in a multi-story column saves form costs and erection time.
2. High placing costs of reinforcing steel can be reduced by designing for the fewest (or largest practicable size) reinforcing bars.
3. High cost per pound of ties versus vertical (longitudinal) bars can be reduced by using the least number of largest practicable size vertical bars.
4. Concrete costs can be reduced for both material and placing if interfering interior ties are eliminated as in 4-, 6-, or 8-bar columns requiring only one tie per set. Faster placing and easier consolidation with lower slump (less expensive) concrete will result.
5. Lap splices are least expensive where the required lap length is practicable, and where required design moment strength can be developed. #14 and #18 bars cannot be lap spliced except in compression to #11 or smaller bars; also for compression-only applications, staggered end-bearing mechanical splices offer economy. Partial lap splices in bundled bars staggered for one-half or two-thirds tensile capacity require no additional reinforcing steel. Two-story lengths for large bars eliminate one-half the required number of butt splices.

The design strength tables in this Chapter follow these principles for economy. No mixed bar size designs were used. The minimum size bar was gradually increased so that all practicable combinations for minimum numbers of bars are presented. The tables include design load and moment strengths at zero and 50 percent tension in the bars on the tension (convex) side of the columns. These values provide guidance to prescribe the most economical splicing arrangements without tedious calculations of critical tension. Bundled bar designs, as such, were not feasible for tabulation, but the design strengths shown for eight or more bars, #11 or less in size, can be applied where tabulated bars are arranged in bundles. In most cases, the bundled arrangement can be devised to increase the design moment strength above that tabulated in at least one, sometimes both directions.



Table 3-2 Maximum Spacing of Column Ties (ACI 7.10.5.2)*

| Vertical bar size | Size and spacing of ties, (inches) | | |
|---|---|---|---|
| | #3 | #4 | #5 |
| #5 | 10 | – | – |
| #6 | 12 | – | – |
| #7 | 14 | – | – |
| #8 | 16 | 16 | – |
| #9 | 18 | 18 | – |
| #10 | 18 | 20 | – |
| #11 | ** | 22 | 22 |
| #14 | ** | 24 | 27 |
| #18 | ** | 24 | 30 |

* Maximum spacing not to exceed least column dimension.
** Not allowed.

## DESIGN FROM TABLES

Select interior rectangular columns for the conditions in Fig. 3-2, maintaining a uniform size for form reuse and a maximum width, not to exceed 16 in. Use $f'_c$ = 4,000 psi, if possible. First floor story height is 16′-0″ and the unbraced length, $\ell_u$, is 13′-3″. For all other floors, story height is 11′-6″ and the unbraced length, $\ell_u$, from finished floor to the bottom of the beam is 8′-9″.

Assume the structure is braced (non-sway columns). For these conditions, the load factor combination of $1.2D + 1.6L$ will control the design, 1.2 times the dead load and dead load moment, if any, plus 1.6 times live load and unbalanced live load moments. See Fig. 3-2. Note that the factored moments are so small that it is unnecessary to consider separately the full load and partial load for unbalanced moment. Maximum $P_u \leq 0.80(0.65)[0.85f'_c\,(A_g - A_{st}) + f_y\,A_{st}]$(ACI 10.3.6.2) will control this column design for all floors if slenderness effects may be neglected.

Make a preliminary evaluation whether slenderness effects must be considered. For members braced against sidesway, slenderness effects can be neglected if $k\ell_u/r < 34 - 12\,M_1/M_2$ . . . (ACI 10.10.1)

Take $k = 1.0$ and $r = 0.30\ (16) = 4.8$ in.

$k\ell_u/r = (1)(105)/(4.8) = 22$

Roof: $34 - 12(91/262) = 30 > 22$

Intermediate Floors: $34 - 12(262/262) = 22$

First Floor: $k\ell_u/r = (1)(159)/(4.8) = 33$

First F1oor: 34  12(0/262) = 34 > 33

Slenderness effects can be neglected for this column stack. Final designs may, therefore, be selected directly from the tables. As a quick check for design strengths, find maximum design axial load strength $\phi P_n$ and corresponding value of design moment strengths $\phi M_n$ for comparison to maximum factored loads and moments $P_u$ and $M_u$.

For $f'_c$ = 4,000 psi and column size 16″ x 20″, enter table on Pages 3-28 and 3-29 for rectangular columns and read maximum $\phi P_n$ and corresponding value of $\phi M_n$:

| Location | Bars | $\phi P_n$ (kips) | $\phi M_n$ (in.-kips) |
|---|---|---|---|
| 1st Floor | 14-#10<br>5L-4S | 1,089<br>($>P_u$ = 1,036) | 1,797<br>($>M_u$ = 262) |
| 2nd Floor | 8-#11<br>3E | 933<br>($>P_u$ = 816) | 1,614<br>($>M_u$ = 262) |
| 3rd Floor | 6-#8<br>2L-3S | 705<br>($>P_u$ = 596) | 1,438<br>($>M_u$ = 262) |
| 4th Floor | 4-#9<br>2E | 683<br>($>P_u$ = 375) | 1,389<br>($>M_u$ = 262) |

Note that $P_u$ at the 4th floor level is only 375 kips. Read design strengths for 4-bar arrangements with rho nearest to 1.00% to apply oversize column reduction (ACI 10.8.4):

Calculate the ratio: $P_u/\phi P_n = 375/683 = 0.55$
For 4–#9 bars, $A_s = 4.00$ in.$^2$
Reduce $A_s$ by ratio 0.55; $(0.55)(4.00) = 2.20$ in.$^2$
$\phi M_n \approx 0.55(1{,}389) = 764$ in.-kips > 262
Use 4–#7 bars; $A_s = (4)(0.60) = 2.40$ in.$^2$

Apply same procedure to roof column.

*Roof:* 155/683 < 0.5, use minimum $A_s = 0.005A_g$
Minimum $A_s = (0.005)(16 \times 20) = 1.60$ in.$^2$
$\phi M_n \approx 0.5(1{,}389) = 695$ in.-kips > 91
Use 4-#6 bars; $A_s = (4)(0.44) = 1.76$ in.$^2$ > 1.60

Select minimum sizes and maximum spacings for ties from Table 3-2. See Fig. 3-3 for details.

*Splices.* All vertical (longitudinal) bars are in compression only. Select lap splice lengths as follows from Chapter 5, noting that the beam is 33-in. deep.

*5th Floor:* minimum standard lap splice length (Table 5-1) for #6 bars above = 23 in. Use lap length = 23 in.

*4th Floor:* minimum standard lap splice length (Table 5-1) for #7 is bars 27 in.; compression embedment length for #8 bars below is 22 in. Use lap length = 27 in.; cut off discontinued bars at 2 in. below finished floor. Extend 4-#8 bars.

*3rd Floor:* minimum standard lap splice length (Table 5-1) for #8 bars is 30 in.; minimum compression embedment length for #11 bars below is 31 in. Use lap length = 31 in.; cut off bars at 2 in. below finished floor. Extend 6-#11 bars.

*2nd Floor:* minimum standard lap splice length (Table 5-1) length for #11 bar is 43 in.; minimum compression embedment for #11 below is 31 in. Use lap length = 43 in.; cut-off bars at 2 in. below finished floor. Extend 8-#11 bars.

*Footing.* Design bearing strength of column (ACI 10.14.1) = $\phi(0.85f'_cA_1) = 0.65(0.85)(4)(16 \times 20) = 707$ kips. Excess compression on base of the column = 1,036 – 707 = 329 kips. Assuming the footing $f'_c$ is at least equal to 3,000 psi and $\sqrt{A_2/A_1} = 2$, the design bearing strength of the footing = $(2)(0.60)(0.85)(3)(16 \times 20) = 1{,}061$ kips. Dowels must provide (ACI 15.8.2.1) $A_s = (0.005)(16 \times 20) = 1.60$ in.$^2$; and transfer (ACI 15.8.1.2) 329 kips by compression embedment.

Use 6– #10 dowels, 2L-3S; from Table 5-1, the required embedment length for $f_y$ = 60 ksi is 28 in. For transferring 329 kips, the required embedment =

$$\frac{329(28)}{6(1.27)(60)} = (0.72)(28) = 20 \text{ in.}$$

Length of compression lap splice of #10 dowels to #10 column bars; from Table 5-1, the required lap length for $f_y$ = 60 ksi is 38 in. For transferring 329 kips, the required lap length = 0.72(38) = 28 in.

See Figs. 3-2 and 3-3 for details of splice arrangements.

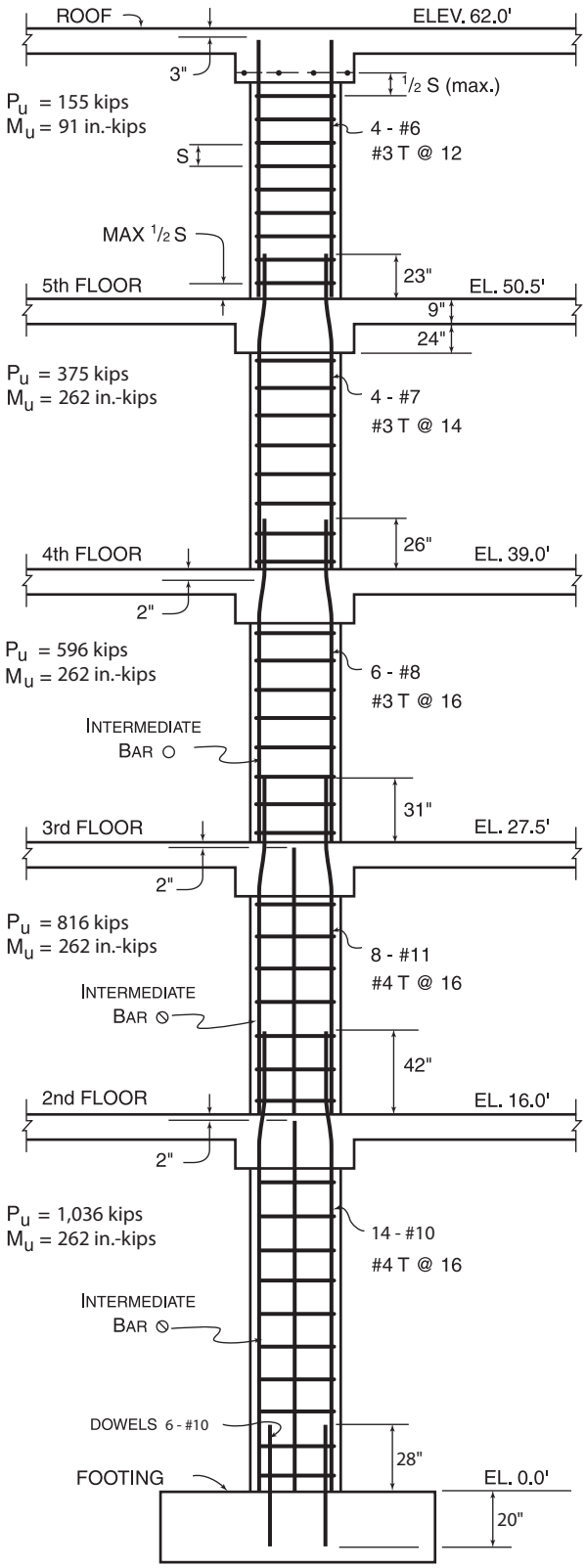



**Figure 3-2 Lap Splices and Cut-off Details**

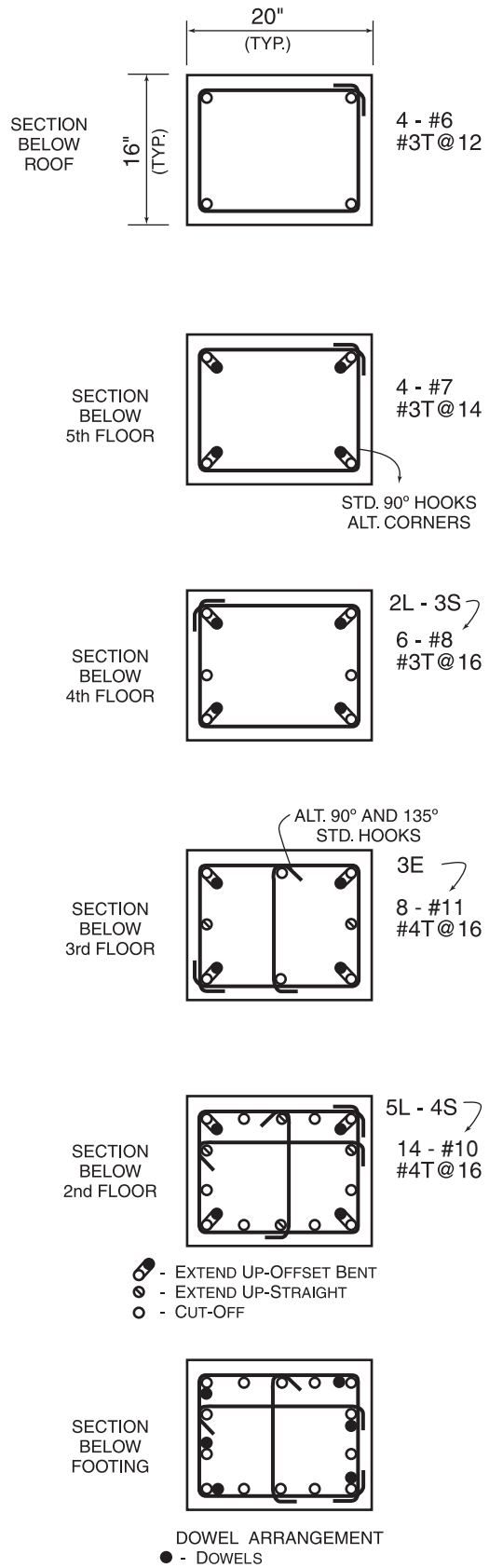



**Figure 3-3 Multi-Story Column—Plan Sections**

## MANUAL EXAMPLE

Review a rectangular column 12″ × 24″ with $f'_c$ = 6,000 psi and 10-#14 Grade 60 vertical (longitudinal) reinforcing bars. Compute values of $\phi P_n$ and $\phi M_n$ at control points ($\phi M_n$ about major axis, MA). Compare computed values versus the tabulated values printed out for 10-#14, 5L-2S from the enclosed CD-ROM. The printed-out values are displayed in Table 3-3.

The dimensions in Fig. 3-4 are based on 1½ inches of concrete cover to the #4 ties. For $f'_c$ = 6,000 psi, $\beta_1$ = 0.75 (ACI 10.2.7.3). $E_s$ = 29 × $10^6$ psi (ACI 8.5.2). Strength-reduction factors: $\phi$ = 0.65 for compression and $\phi$ = 0.90 for flexure (ACI 9.3.2).

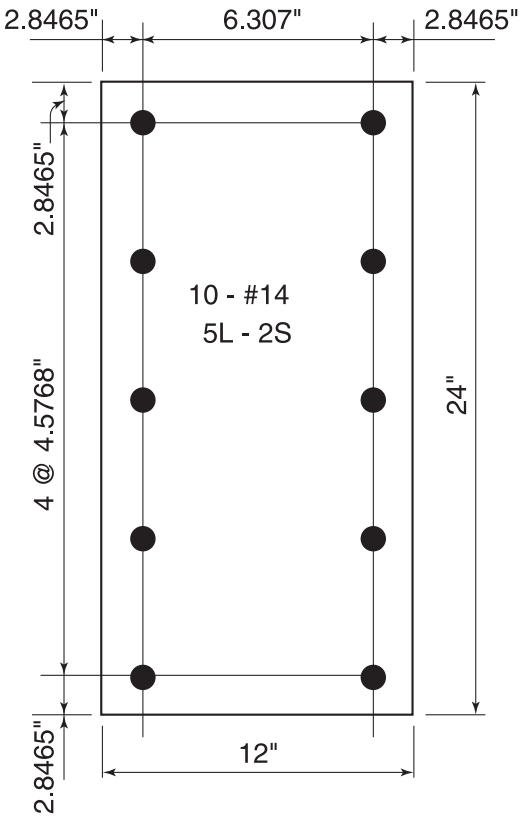



**Figure 3-4 Dimensions – Manual Example**

In the general case, (Fig. 3-5), the distance from the extreme compression fiber to the neutral axis, $c$, has to be determined by iteration. The distance, $c$, can be expressed in terms of the tensile strain, $\varepsilon_s = f_s/E_s$, in the outermost bars:

$$c = \frac{d_{sn}}{1 + f_s/(E_s \varepsilon_c)}$$

Where:

$d_{sn}$ = maximum distance to bars from extreme compression surface. Maximum distance is $d_{s5}$ in Fig. 3-5.

$f_s$ = tensile stress in outermost bars.

$\varepsilon_c$ = maximum compressive strain in concrete = 0.003 (ACI 10.2.3).

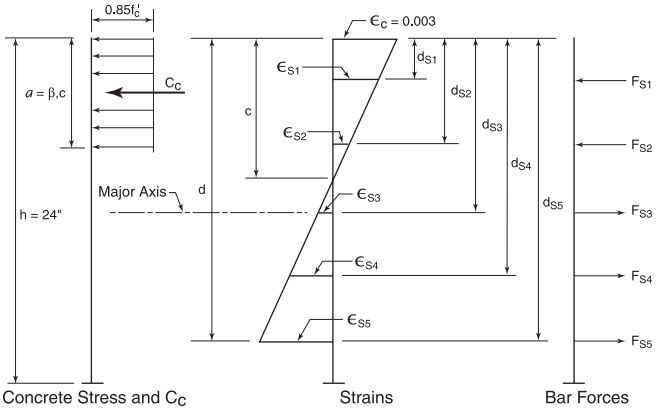



**Figure 3-5 General Case**

For bars located in the compression zone, i.e., $d_{si} < \beta_1 c$, the compressive force must be reduced by $0.85 f'_c A_b$ to subtract the force from the concrete resisting compression. In this example, the force reduction for 2-#14 bars in a row (stress = 0.85(6) = 5.1 ksi) = 0.85(6)(4.5) = 22.95 kips.

### 1. $\phi P_{n(max)}$ and $\phi M_n$

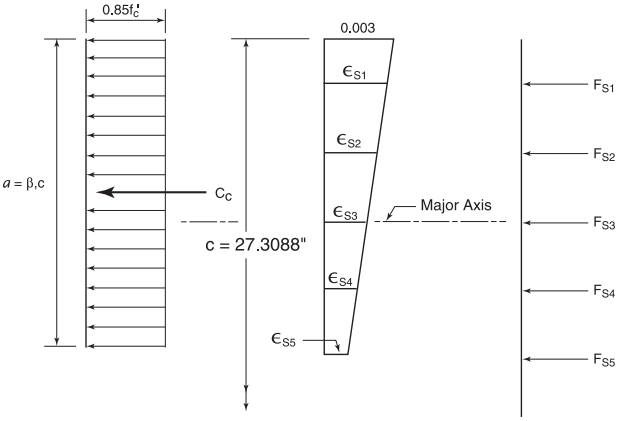



**Figure 3-6 $\phi P_{n(max)}$ and $\phi M_n$**

The value of $\phi P_{n(max)}$ can be solved directly by ACI Eq. 10-2:

$$\phi P_{n(max)} = 0.80\ \phi[0.85 f'_c\ (A_g - A_{st}) + f_y A_{st}]$$

$$\phi P_{n(max)} = 0.80(0.65)[0.85(6)(288 - 22.5) + 60(22.5)]$$

$$= 1{,}406 \text{ kips (tabulated = 1,406)}$$

Note that $\phi P_{n(max)}$ was calculated as 1,406.106 kips; then $P_n$ = 1,406.106/$\phi$ = 1,406.106/0.65 = 2,163.240 kips.

For this condition, the exact value of strain in the outermost bars (Row 5) is not evident (Fig. 3-6). The entire cross section will be in compression so $c > h$. Expressing the bar forces and the compression resultant in the concrete, $C_c$, in terms of $c$, and equating the sum of forces to 2,163.240 kips:

$C_c = 0.85 f'_c ab$
$C_c = 0.85(6)(0.75c)(12) = 45.90c$
$\Sigma$ Bar Forces (Rows 1 through 5) + $45.90c$
= 2,163.240 kips
Solving, $c$ = 27.3088 in.

From Fig. 3-5, the bar (row) strains, stresses, forces, and moments of the forces about the major axis of the column can be expressed:

$\varepsilon_{si} = \varepsilon_c(1 - d_{si}/c)$

$f_{si} = E_s \varepsilon_{si}$ ($\leq$ 60 ksi)

$F_{si} = f_{si} A_s$ (in this example. $A_s$ = 4.5 in.$^2$ for 2-#14 bars in a row)

General equation for force $F_{si}$ in row $i$:

$$F_{si} = \left[(c\text{-}d_{si})\left(\frac{0.003}{c}\right)(E_s) - \beta f'_c\right] A_b \leq f_y A_b$$

where the $\beta f'_c$ term only applies if $d_{si} < \beta c$

$M_{si} = F_{si}(h/2 - d_{si})$

Bars (compression forces and moments about major axis):

| Row | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 2.8465 | 0.0026873 | 60.000 | 247.050* | 2,261.372 |
| 2 | 7.4233 | 0.0021845 | 60.000 | 247.050* | 1,130.674 |
| 3 | 12.0000 | 0.0016817 | 48.769 | 196.510* | 0 |
| 4 | 16.5768 | 0.0011790 | 34.191 | 130.909* | −599.144 |
| 5 | 21.1535 | 0.0006762 | 19.610 | 88.245 | −807.751 |
| | | | | 909.764 | 1,985.151 |

*$F_{si}$ reduced by 22.95 kips/row.

Compute the concrete compression resultant, $C_c$, and moment, $M_c$, about the major axis.

The depth of the equivalent rectangular stress block:

$a = \beta_1 c = 0.75(27.3088) = 20.4816$ in.
$C_c = 0.85(6)(20.4816)(12) = 1,253.474$ kips
$M_c = 1,253.474(12 - 20.4816/2) = 2,205.111$ in.-kips

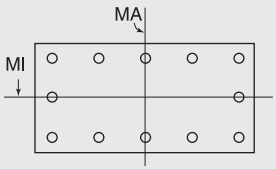
$\Sigma$Forces = 0
$-P_n + 909.764 + 1,253.474 = 0$
$P_n = 2,163.238$ kips
$\phi P_{n(max)} = (0.65)(2,163.238) = 1,406$ kips
(tabulated = 1,406)

$\Sigma M_{MA} = 0$
$-M_n + 1,985.151 + 2,205.111 = 0$
$M_n = 4,190.262$ in.-kips
$\phi M_n = (0.65)(4,190.262) = 2,724$ in.-kips
(tabulated = 2,724)

**Table 3-3 Print-Out from Enclosed CD-ROM – Values of $\phi P_n$ and $\phi M_n$ at Control Points**

## RECTANGULAR TIED COLUMNS 12″ X 24″

Short Columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in.-kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | $\phi P_n$ = 0 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 7.81 | MA | 2724 | 1406 | 4473 | 1092 | 5212 | 881 | 5746 | 708 | 6588 | 375 | 8276 | -111 | 8125 |
| 5L-2S | | MI | 1370 | 1406 | 2667 | 947 | 2934 | 723 | 3142 | 520 | 3501 | 149 | 3727 | -174 | 3599 |

**2. $\phi P_{ot}$ and $\phi M_{ot}$ (Point of Zero Tension in Extreme Bars)**

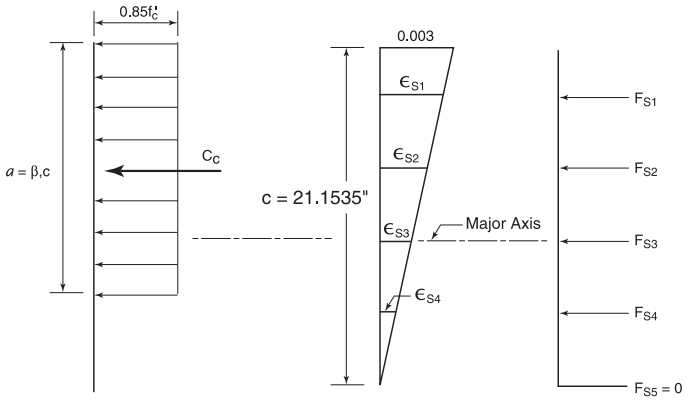



**Figure 3-7 $\phi P_{ot}$ and $\phi M_{ot}$ (Point of Zero Tension)**

For this condition, the $c$ distance is easily determined by inspection from Fig. 3-7 because $\epsilon_{s5} = f_{s5}/E_s = 0$; hence, $c = 24 - 2.8465 = 21.1535$ in., or by the equation:

$$c = \frac{d_{sn}}{1 + f_s/(E_s \epsilon_c)}$$

$$c = \frac{21.1535}{1 + 0/(29{,}000 \times 0.003)} = 21.1535 \text{ in.}$$

Note that the point of "zero tension" is defined, in this Chapter, as the load/moment combination resulting in zero strain at the center of the vertical bars on the tension face. The diameter of the bar is neglected because the stress in the bar on either side of its center reverses sign and totals zero. Where two layers of bars are used, as with bundled bars, the same definition (to centroid of bundle) is satisfactory for practical use in designing splices.

Bars (compression forces and moments about major axis):

| Row | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 2.8465 | 0.0025963 | 60.000 | 247.050* | 2,261.372 |
| 2 | 7.4233 | 0.0019472 | 56.469 | 231.161* | 1,057.955 |
| 3 | 12.0000 | 0.0012981 | 37.646 | 146.457* | 0 |
| 4 | 16.5768 | 0.0006491 | 18.823 | 84.703* | –387.669 |
| 5 | 21.1535 | 0 | 0 | 0 | 0 |
| | | | | 709.371 | 2,931.658 |

*$F_{si}$ reduced by 22.95 kips/row.

Compute the concrete compression resultant, $C_c$, and moment, $M_c$, about the major axis:

$a = 0.75\ (21.1535) = 15.8651$ in.
$C_c = 0.85 f'_c ab = 0.85(6)(15.8651)(12) = 970.944$ kips
$M_c = 970.944\ (12 - 15.8651/2) = 3{,}949.266$ in.-kips

$\Sigma$Forces = 0
$-P_n + 709.371 + 970.944 = 0$
$P_n = 1{,}680.351$ kips
$\phi P_n = (0.65)(1{,}680.315) = 1{,}092$ kips
(tabulated = 1,092)

$\Sigma M_{MA} = 0$
$-M_n + 2{,}931.658 + 3{,}949.266 = 0$
$M_n = 6{,}880.924$ in.-kips
$\phi M_n = (0.65)(6{,}880.924) = 4{,}473$ in.-kips
(tabulated = 4,473)

**3. 25% Tension**

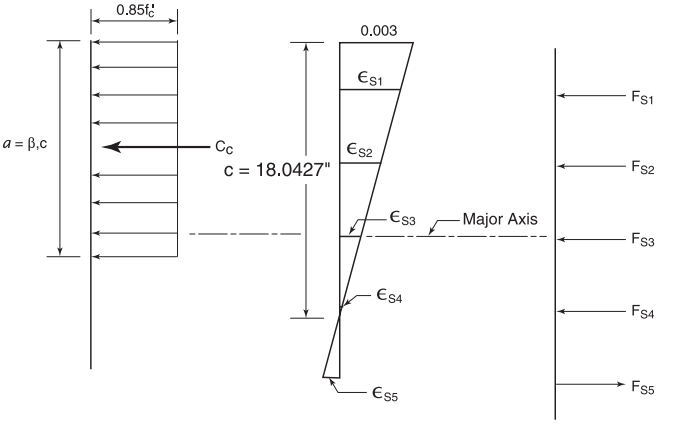



**Figure 3-8 25% Tension**

The tensile stress in the Row 5 bars = 0.25(60) = 15 ksi. The distance:

$$c = \frac{21.1535}{1 + 15/(29{,}000 \times 0.003)} = 18.0427 \text{ in.}$$

Bars (forces and moments about major axis):

| Row | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 2.8465 | 0.0025267 | 60.000 | 247.050* | 2,261.372 |
| 2 | 7.4233 | 0.0017657 | 51.205 | 207.472* | 949.537 |
| 3 | 12.0000 | 0.0010047 | 29.136 | 108.162* | 0 |
| 4 | 16.5768 | 0.0002437 | 7.067 | 31.801* | –145.547 |
| 5 | 21.1535 | –0.0005172 | –15.000 | –67.500 | 617.861 |
| | | | | 526.985 | 3,683.223 |

*$F_{si}$ reduced by 22.95 kips/row.

Compute the concrete compression resultant, $C_c$, and moment, $M_c$, about the major axis:

$a = 0.75(18.0472) = 13.5320$ in.
$C_c = 0.85(6)(13.5320)(12) = 828.158$ kips
$M_c = 828.158(12 - 13.5320/2) = 4{,}334.579$ in.-kips

ΣForces = 0
$-P_n + 526.985 + 828.158 = 0$
$P_n = 1{,}355.143$ kips
$\phi P_n = (0.65)(1{,}355.143) = 881$ kips (tabulated = 881)

$\Sigma M_{MA} = 0$
$-M_n + 3{,}683.223 + 4{,}334.579 = 0$
$M_n = 8{,}017.802$ in.-kips
$\phi M_n = (0.65)(8{,}017.802) = 5{,}212$ in.-kips
(tabulated = 5,212)

**4. 50% Tension**

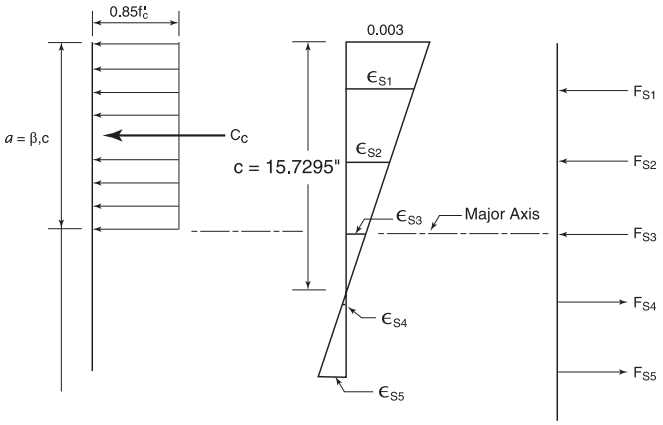



**Figure 3-9 50% Tension**

The tensile stress in the Row 5 bars = 0.50(60) = 30 ksi. The distance:

$$c = \frac{21.1535}{1 + 30/(29.000 \times 0.003)} = 15.7295 \text{ in.}$$

Bars (forces and moments about major axis):

| Row | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 2.8465 | 0.0024571 | 60.000 | 247.050* | 2,261.372 |
| 2 | 7.4233 | 0.0015842 | 45.942 | 183.789* | 841.147 |
| 3 | 12.0000 | 0.0007113 | 20.628 | 92.826 | 0 |
| 4 | 16.5768 | –0.0001616 | –4.686 | –21.087 | 96.511 |
| 5 | 21.1535 | –0.0010345 | –30.000 | –135.000 | 1,235.723 |
| | | | | 367.587 | 4,434.753 |

*$F_{si}$ reduced by 22.95 kips/row.

Compute the concrete compression resultant, $C_c$, and moment, $M_c$, about the major axis:

$a = 0.75\ (15.7295) = 11.7971$ in.
$C_c = 0.85(6)\ (11.7971)(12) = 721.983$ kips
$M_c = 721.983\ (12 - 11.7971/2) = 4{,}405.143$ in.-kips

ΣForces = 0
$-P_n + 367.578 + 721.983 = 0$
$P_n = 1{,}089.561$ kips
$\phi P_n = (0.65)(1{,}089.561) = 708$ kips (tabulated = 708)

$\Sigma M_{MA} = 0$
$-M_n + 4{,}434.753 + 4{,}405.143 = 0$
$M_n = 8{,}839.896$ in.-kips
$\phi M_n = (0.65)(8{,}839.896) = 5{,}746$ in.-kips
(tabulated = 5,746)

**5. 100% $f_y$ ($\phi P_b$ and $\phi M_b$, Balance Point on Interaction Diagram)**

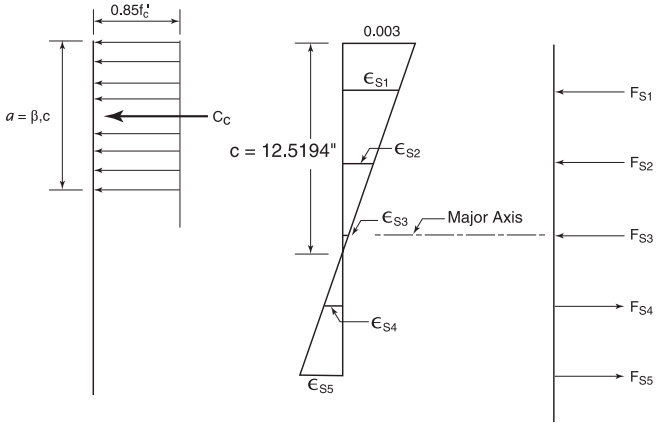



**Figure 3-10 100% $f_y$ ($\phi P_b$ and $\phi M_b$ Balance)**

The tensile stress in the Row 5 bars = $f_y$ = 60 ksi. The distance:

$$c = \frac{21.1535}{1 + 60/(29.000 \times 0.003)} = 12.5194 \text{ in.}$$

Bars (forces and moments about major axis):

| Row | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 2.8465 | 0.0023179 | 60.000 | 247.050* | 2,261.372 |
| 2 | 7.4233 | 0.0012212 | 35.415 | 136.417* | 624.340 |
| 3 | 12.0000 | 0.0001245 | 3.610 | 16.245 | 0 |
| 4 | 16.5768 | –0.0009723 | –28.197 | –126.886 | 580.732 |
| 5 | 21.1535 | –0.0020690 | –60.000 | –270.000 | 2,471.445 |
| | | | | 2.826 | 5,937.890 |

*$F_{si}$ reduced by 22.95 kips/row.

Compute the concrete compression resultant, $C_c$, and moment, $M_c$, about the major axis:

$a = 0.75(12.5194) = 9.3895$ in.
$C_c = 0.85(6)(9.3895)(12) = 574.637$ kips
$M_c = 574.637(12 - 9.3895/2) = 4{,}197.867$ in.-kips

$\Sigma$Forces = 0

$-P_n + 2.826 + 574.637 = 0$

$P_n = 577.463$ kips

$\phi P_n = 0.65(577.463) = 375$ kips (tabulated = 375)

$\Sigma M_{MA} = 0$

$-M_n + 5{,}937.890 + 4{,}197.867 = 0$

$M_n = 10{,}135.757$ in.-kips

$\phi M_n = (0.65)(10{,}135.757) = 6{,}588$ in.-kips (tabulated = 6,588)

### 6. $\phi P_n$, $\phi M_n$ ($\varepsilon_t = 0.005$)

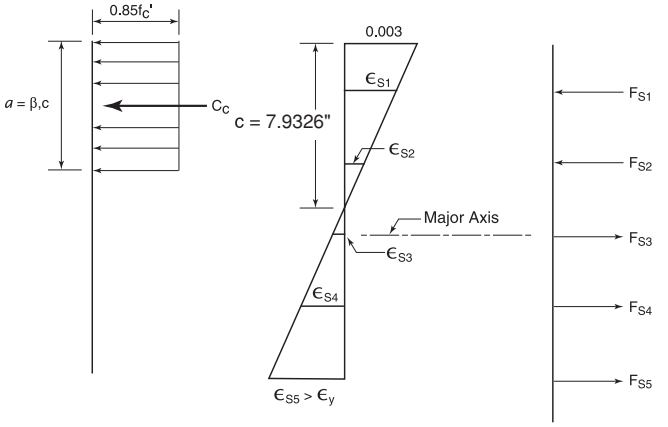



**Figure 3-11 $\phi P_n$, $\phi M_n$ ($\varepsilon_t = 0.005$)**

For this condition, the tensile strain in the outermost bars (Row 5) is 0.005. The value of $c$ can be solved for directly:

$c = d_{sn}(0.003)/(0.003 + 0.005)$

$= 21.1535(0.003)/(0.003 + 0.005)$

$= 7.9326$ in.

Bars (forces and moments about major axis):

| Row | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 2.8465 | 0.0019235 | 55.781 | 228.065* | 2,087.595 |
| 2 | 7.4233 | 0.0001926 | 5.586 | 25.136* | 115.043 |
| 3 | 12.0000 | –0.0015383 | –44.609 | –200.742 | 0 |
| 4 | 16.5768 | –0.0032691 | –60.000 | –270.000 | 1,235.722 |
| 5 | 21.1535 | –0.0050000 | –60.000 | –270.000 | 2,471.445 |
| | | | | –487.541 | 5,909.805 |

*$F_{si}$ reduced by 22.95 kips/row.

Compute the concrete compression resultant, $C_c$, and moment, $M_c$, about the major axis:

$a = 0.75(7.9326) = 5.9494$ in.

$C_c = 0.85(6)(5.9494)(12) = 364.105$ kips

$M_c = 364.105(12 - 5.9494/2) = 3{,}286.150$ in.-kips

$\Sigma$Forces = 0

$-P_n - 487.541 + 364.105 = 0$

$P_n = 123.436$ kips

$\phi P_n = (0.9)(-123.436) = -111$ kips (tabulated = –111)

$\Sigma M_{MA} = 0$

$-M_n + 5{,}909.805 + 3{,}286.150 = 0$

$M_n = 9{,}195.955$ in.-kips

$\phi M_n = (0.9)(9{,}195.955) = 8{,}276$ in.-kips (tabulated = 8,276)

### 7. $\phi M_n$ ($\phi P_n = 0$)

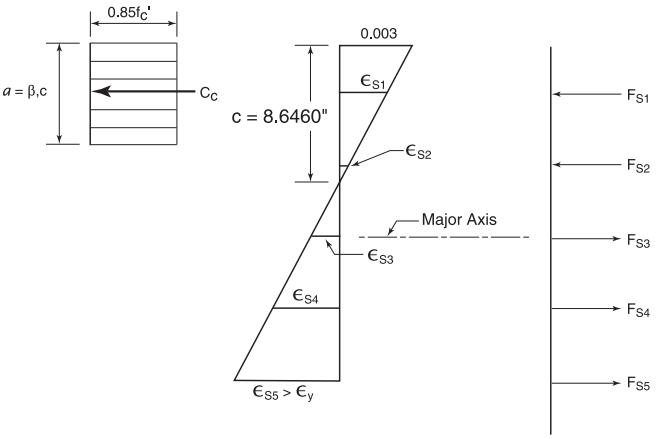



**Figure 3-12 $\phi M_n$ ($\phi P_n = 0$)**

For this condition, the tensile stress in the outermost bars (Row 5) is 60 ksi, but the exact value of the strain is not evident: $\varepsilon_{s5} > \varepsilon_y$ (Fig. 3-12). *A trial-and-error solution is required.* After several trials (manually), the neutral axis is determined to be located between Row 2 and Row 3. Expressing the bar forces and the concrete compression resultant, $C_c$, in terms of $c$ and summing forces:

$$[(c - 2.8465)\left(\frac{0.003}{c}\right)(29{,}000 - 5.1](4.5) +$$

$$(c - 7.4233)\left(\frac{0.003}{c}\right)(29{,}000)(4.5) + 0.85\,(6)(0.75c)(12)]$$

$$= (12 - c)\left(\frac{0.003}{c}\right)(29{,}000)(4.5) + 270 + 270$$

Solving, $c = 8.6460$ in.

Bars (forces and moments about major axis):

| Row | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 2.8465 | 0.0020123 | 58.357 | 239.656* | 2,193.691 |
| 2 | 7.4233 | 0.0004242 | 12.302 | 55.359 | 253.361 |
| 3 | 12.0000 | –0.0011638 | –33.750 | –151.875 | 0 |
| 4 | 16.5768 | –0.0027518 | –60.000 | –270.000 | –1,235.736 |
| 5 | 21.1535 | –0.0043399 | –60.000 | –270.000 | 2,471.445 |
| | | | | –396.860 | 6,154.233 |

*$F_{si}$ reduced by 22.95 kips/row.

Compute the concrete compression resultant, $C_c$, and moment, $M_c$, about the major axis:

$a = 0.75(8.6460) = 6.4845$ in.
$C_c = 0.85(6)\ (6.4845)(12) = 396.851$ kips
$M_c = 396.851(12 - 6.4845/2) = 3,475.522$ in.-kips

Because $\varepsilon_t = 0.00434 > 0.00207$ and $\varepsilon_t < 0.005$, $\phi$ must be determined:

$$\phi = 0.65 + \frac{(0.9 - 0.65)}{(0.005 - 0.00207)}(\varepsilon_t - 0.00207)$$

$$\phi = 0.65 + 85.324(0.00434 - 0.00207)$$
$$= 0.8437$$

$\Sigma$Forces = 0
$-P_n - 396.860 + 396.851 = 0$
$P_n = 0$; hence, $\phi P_n = 0$ (tabulated = 0)

$\Sigma M_{MA} = 0$
$-M_n + 6,154.233 + 3,475.522 = 0$
$M_n = 9,629.755$ in.-kips
$\phi M_n = (0.8437)(9,629.755) = 8,125$ in.-kips
(tabulated = 8,125)

## SQUARE TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#5 | 1.24 | 200 | 213 | 311 | 170 | 351 | 141 | 368 | 118 | 380 | 80 | 410 | 53 | 254 |
| 4-#6 | 1.76 | 207 | 229 | 337 | 178 | 381 | 146 | 401 | 119 | 422 | 75 | 451 | 41 | 335 |
| 4-#7 | 2.40 | 216 | 247 | 369 | 189 | 415 | 153 | 440 | 122 | 470 | 69 | 497 | 25 | 429 |
| 4-#8 | 3.16 | 227 | 270 | 404 | 201 | 453 | 160 | 484 | 124 | 525 | 62 | 548 | 5 | 534 |
| 4-#9 | 4.00 | 237 | 295 | 439 | 214 | 492 | 168 | 528 | 126 | 581 | 53 | 613 | -12 | 602 |
| 4-#10 | 5.08 | 250 | 326 | 479 | 231 | 539 | 177 | 581 | 128 | 647 | 41 | 672 | -43 | 665 |
| 4-#11 | 6.24 | 257 | 360 | 499 | 241 | 558 | 179 | 601 | 123 | 671 | 18 | 666 | -95 | 677 |
| 8-#5 | 2.48 | 204 | 250 | 343 | 192 | 390 | 157 | 414 | 127 | 438 | 73 | 471 | 8 | 450 |
| 8-#6 | 3.52 | 214 | 280 | 382 | 210 | 435 | 168 | 464 | 132 | 501 | 65 | 534 | -24 | 532 |
| 8-#7 | 4.80 | 226 | 318 | 428 | 232 | 486 | 181 | 523 | 137 | 575 | 55 | 604 | -65 | 601 |

## SQUARE TIED COLUMNS 12" x 12"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.22 | 353 | 306 | 529 | 252 | 616 | 211 | 663 | 179 | 697 | 124 | 775 | 90 | 442 |
| 4-#7 | 1.67 | 367 | 325 | 574 | 263 | 669 | 219 | 724 | 182 | 773 | 120 | 857 | 79 | 573 |
| 4-#8 | 2.19 | 383 | 348 | 625 | 275 | 731 | 228 | 793 | 187 | 859 | 115 | 948 | 65 | 721 |
| 4-#9 | 2.78 | 399 | 372 | 679 | 289 | 797 | 238 | 865 | 191 | 950 | 109 | 1042 | 48 | 878 |
| 4-#10 | 3.53 | 419 | 404 | 747 | 307 | 880 | 251 | 954 | 196 | 1061 | 101 | 1155 | 25 | 1072 |
| 4-#11 | 4.33 | 431 | 438 | 808 | 324 | 931 | 258 | 1009 | 195 | 1128 | 85 | 1196 | -15 | 1197 |
| 4-#14 | 6.25 | 474 | 519 | 957 | 372 | 1089 | 284 | 1189 | 204 | 1354 | 57 | 1399 | -89 | 1404 |
| 8-#5 | 1.72 | 348 | 328 | 535 | 268 | 626 | 222 | 676 | 185 | 718 | 124 | 803 | 61 | 598 |
| 8-#6 | 2.44 | 364 | 358 | 590 | 286 | 693 | 235 | 756 | 193 | 814 | 119 | 909 | 34 | 803 |
| 8-#7 | 3.33 | 383 | 396 | 655 | 308 | 772 | 251 | 847 | 201 | 929 | 113 | 1032 | 1 | 1031 |
| 8-#8 | 4.39 | 405 | 441 | 730 | 334 | 865 | 270 | 950 | 210 | 1059 | 104 | 1171 | -41 | 1157 |
| 8-#9 | 5.56 | 429 | 490 | 810 | 364 | 963 | 290 | 1059 | 220 | 1195 | 94 | 1313 | -90 | 1283 |
| 8-#10 | 7.06 | 459 | 554 | 910 | 401 | 1086 | 317 | 1192 | 237 | 1363 | 79 | 1483 | -155 | 1435 |

## SQUARE TIED COLUMNS 14" x 14"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.22 | 571 | 417 | 832 | 352 | 986 | 295 | 1072 | 249 | 1157 | 178 | 1314 | 136 | 716 |
| 4-#8 | 1.61 | 594 | 440 | 898 | 364 | 1067 | 303 | 1168 | 255 | 1277 | 174 | 1450 | 125 | 907 |
| 4-#9 | 2.04 | 617 | 464 | 970 | 378 | 1153 | 313 | 1270 | 261 | 1404 | 170 | 1591 | 112 | 1112 |
| 4-#10 | 2.59 | 645 | 496 | 1059 | 396 | 1261 | 326 | 1399 | 269 | 1561 | 165 | 1765 | 95 | 1367 |
| 4-#11 | 3.18 | 665 | 530 | 1146 | 412 | 1360 | 338 | 1503 | 273 | 1675 | 152 | 1864 | 64 | 1603 |
| 4-#14 | 4.59 | 725 | 611 | 1350 | 459 | 1610 | 372 | 1775 | 288 | 2017 | 133 | 2215 | 8 | 2183 |
| 8-#5 | 1.27 | 545 | 420 | 780 | 358 | 928 | 299 | 1007 | 253 | 1079 | 182 | 1231 | 117 | 745 |
| 8-#6 | 1.80 | 568 | 450 | 851 | 376 | 1014 | 312 | 1108 | 261 | 1210 | 179 | 1382 | 95 | 1011 |
| 8-#7 | 2.45 | 594 | 488 | 935 | 398 | 1117 | 328 | 1231 | 270 | 1367 | 175 | 1562 | 67 | 1323 |
| 8-#8 | 3.22 | 624 | 533 | 1033 | 425 | 1237 | 348 | 1373 | 282 | 1547 | 169 | 1766 | 33 | 1677 |
| 8-#9 | 4.08 | 656 | 582 | 1138 | 455 | 1365 | 369 | 1527 | 295 | 1738 | 163 | 1980 | -7 | 1975 |
| 8-#10 | 5.18 | 697 | 646 | 1269 | 493 | 1527 | 396 | 1720 | 311 | 1975 | 154 | 2242 | -60 | 2200 |
| 8-#11 | 6.37 | 727 | 714 | 1393 | 529 | 1672 | 421 | 1876 | 321 | 2147 | 132 | 2395 | -140 | 2318 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.23 | 866 | 546 | 1232 | 468 | 1483 | 392 | 1625 | 332 | 1782 | 239 | 2064 | 189 | 1092 |
| 4-#9 | 1.56 | 898 | 570 | 1321 | 481 | 1590 | 402 | 1752 | 338 | 1950 | 237 | 2255 | 179 | 1344 |
| 4-#10 | 1.98 | 936 | 602 | 1432 | 499 | 1724 | 415 | 1912 | 345 | 2159 | 234 | 2492 | 166 | 1660 |
| 4-#11 | 2.44 | 963 | 636 | 1547 | 514 | 1853 | 425 | 2059 | 351 | 2322 | 224 | 2653 | 141 | 1963 |
| 4-#14 | 3.52 | 1044 | 717 | 1806 | 561 | 2169 | 459 | 2435 | 372 | 2783 | 210 | 3161 | 98 | 2698 |
| 4-#18 | 6.25 | 1225 | 924 | 2412 | 681 | 2914 | 546 | 3289 | 419 | 3823 | 166 | 4254 | -35 | 4222 |
| 8-#6 | 1.38 | 831 | 556 | 1170 | 481 | 1416 | 402 | 1550 | 339 | 1686 | 243 | 1968 | 160 | 1217 |
| 8-#7 | 1.88 | 867 | 594 | 1275 | 503 | 1543 | 418 | 1700 | 349 | 1885 | 240 | 2205 | 136 | 1602 |
| 8-#8 | 2.47 | 907 | 639 | 1395 | 530 | 1690 | 438 | 1875 | 361 | 2119 | 238 | 2477 | 107 | 2043 |
| 8-#9 | 3.13 | 949 | 688 | 1525 | 560 | 1849 | 459 | 2065 | 374 | 2371 | 235 | 2765 | 73 | 2513 |
| 8-#10 | 3.97 | 1001 | 752 | 1689 | 598 | 2049 | 487 | 2304 | 391 | 2686 | 230 | 3122 | 28 | 3056 |
| 8-#11 | 4.88 | 1041 | 820 | 1851 | 635 | 2237 | 512 | 2524 | 405 | 2932 | 214 | 3370 | -40 | 3332 |
| 8-#14 | 7.03 | 1164 | 982 | 2232 | 733 | 2709 | 583 | 3088 | 447 | 3625 | 191 | 4136 | -175 | 3976 |
| 12-#10 | 5.95 | 1138 | 901 | 2016 | 698 | 2447 | 565 | 2782 | 442 | 3323 | 221 | 3924 | -60 | 3852 |

## SQUARE TIED COLUMNS 18" x 18"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.23 | 1248 | 691 | 1738 | 600 | 2118 | 503 | 2336 | 426 | 2578 | 307 | 3048 | 250 | 1576 |
| 4-#10 | 1.57 | 1297 | 722 | 1872 | 617 | 2279 | 515 | 2527 | 433 | 2831 | 304 | 3349 | 240 | 1952 |
| 4-#11 | 1.93 | 1335 | 756 | 2015 | 632 | 2438 | 525 | 2708 | 439 | 3066 | 299 | 3575 | 220 | 2322 |
| 4-#14 | 2.78 | 1438 | 838 | 2330 | 678 | 2821 | 559 | 3163 | 459 | 3661 | 292 | 4245 | 185 | 3211 |
| 4-#18 | 4.94 | 1669 | 1044 | 3076 | 797 | 3734 | 645 | 4252 | 512 | 5005 | 260 | 5738 | 80 | 5313 |
| 8-#6 | 1.09 | 1165 | 676 | 1556 | 601 | 1909 | 504 | 2095 | 428 | 2263 | 314 | 2680 | 229 | 1421 |
| 8-#7 | 1.48 | 1208 | 714 | 1680 | 623 | 2059 | 521 | 2272 | 438 | 2499 | 312 | 2975 | 208 | 1880 |
| 8-#8 | 1.95 | 1257 | 759 | 1824 | 650 | 2234 | 540 | 2480 | 450 | 2775 | 310 | 3317 | 183 | 2407 |
| 8-#9 | 2.47 | 1312 | 808 | 1980 | 680 | 2424 | 562 | 2705 | 464 | 3076 | 307 | 3681 | 154 | 2973 |
| 8-#10 | 3.14 | 1378 | 872 | 2176 | 719 | 2663 | 590 | 2991 | 481 | 3456 | 304 | 4135 | 115 | 3677 |
| 8-#11 | 3.85 | 1429 | 940 | 2377 | 755 | 2895 | 615 | 3261 | 495 | 3810 | 297 | 4482 | 56 | 4332 |
| 8-#14 | 5.56 | 1581 | 1103 | 2840 | 854 | 3466 | 687 | 3943 | 539 | 4705 | 285 | 5491 | -61 | 5407 |
| 12-#10 | 4.70 | 1543 | 1021 | 2566 | 820 | 3148 | 664 | 3559 | 534 | 4215 | 298 | 5142 | 36 | 4997 |
| 12-#11 | 5.78 | 1625 | 1124 | 2839 | 878 | 3457 | 712 | 3935 | 559 | 4711 | 287 | 5638 | -48 | 5566 |

## SQUARE TIED COLUMNS 20" x 20"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.00 | 1675 | 825 | 2230 | 733 | 2749 | 617 | 3035 | 525 | 3326 | 386 | 3983 | 327 | 1808 |
| 4-#10 | 1.27 | 1735 | 857 | 2387 | 751 | 2937 | 629 | 3256 | 533 | 3620 | 383 | 4349 | 319 | 2244 |
| 4-#11 | 1.56 | 1785 | 891 | 2559 | 765 | 3127 | 639 | 3472 | 537 | 3898 | 378 | 4642 | 302 | 2680 |
| 4-#14 | 2.25 | 1915 | 972 | 2931 | 810 | 3577 | 671 | 4006 | 557 | 4608 | 371 | 5476 | 274 | 3723 |
| 4-#18 | 4.00 | 2200 | 1178 | 3816 | 928 | 4658 | 757 | 5295 | 610 | 6317 | 356 | 7382 | 189 | 6213 |
| 8-#7 | 1.20 | 1627 | 848 | 2159 | 758 | 2678 | 636 | 2958 | 539 | 3232 | 392 | 3888 | 286 | 2156 |
| 8-#8 | 1.58 | 1687 | 893 | 2326 | 785 | 2880 | 655 | 3199 | 551 | 3551 | 390 | 4299 | 264 | 2770 |
| 8-#9 | 2.00 | 1751 | 943 | 2508 | 814 | 3101 | 677 | 3460 | 565 | 3899 | 388 | 4741 | 238 | 3430 |
| 8-#10 | 2.54 | 1830 | 1006 | 2736 | 853 | 3379 | 705 | 3792 | 582 | 4341 | 385 | 5294 | 204 | 4258 |
| 8-#11 | 3.12 | 1899 | 1075 | 2978 | 889 | 3656 | 731 | 4113 | 596 | 4760 | 378 | 5741 | 152 | 5061 |
| 8-#14 | 4.50 | 2082 | 1237 | 3523 | 989 | 4326 | 803 | 4912 | 641 | 5828 | 370 | 6999 | 49 | 6859 |
| 8-#18 | 8.00 | 2524 | 1649 | 4827 | 1242 | 5938 | 985 | 6842 | 753 | 8395 | 346 | 9870 | -244 | 9447 |
| 12-#10 | 3.81 | 2031 | 1156 | 3189 | 956 | 3942 | 781 | 4451 | 637 | 5221 | 382 | 6509 | 131 | 5898 |
| 12-#11 | 4.68 | 2131 | 1258 | 3517 | 1014 | 4328 | 823 | 4899 | 663 | 5810 | 372 | 7151 | 57 | 6893 |
| 12-#14 | 6.75 | 2418 | 1502 | 4284 | 1168 | 5273 | 934 | 6022 | 735 | 7309 | 359 | 8946 | -94 | 8749 |
| 16-#10 | 5.08 | 2226 | 1305 | 3667 | 1058 | 4514 | 863 | 5151 | 687 | 6151 | 384 | 7731 | 53 | 7539 |

## SQUARE TIED COLUMNS 22" x 22"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.05 | 2261 | 1005 | 2982 | 899 | 3707 | 756 | 4113 | 643 | 4541 | 471 | 5508 | 404 | 2535 |
| 4-#11 | 1.29 | 2321 | 1039 | 3185 | 912 | 3929 | 765 | 4364 | 647 | 4862 | 465 | 5868 | 389 | 3038 |
| 4-#14 | 1.86 | 2480 | 1121 | 3614 | 957 | 4447 | 797 | 4977 | 666 | 5677 | 459 | 6870 | 367 | 4235 |
| 4-#18 | 3.31 | 2827 | 1327 | 4641 | 1074 | 5697 | 882 | 6465 | 718 | 7659 | 444 | 9195 | 298 | 7112 |
| 8-#8 | 1.31 | 2204 | 1042 | 2909 | 934 | 3640 | 783 | 4044 | 663 | 4460 | 479 | 5440 | 350 | 3131 |
| 8-#9 | 1.65 | 2279 | 1091 | 3117 | 964 | 3891 | 805 | 4342 | 676 | 4855 | 477 | 5959 | 327 | 3886 |
| 8-#10 | 2.10 | 2373 | 1155 | 3378 | 1003 | 4209 | 833 | 4720 | 694 | 5358 | 475 | 6612 | 296 | 4836 |
| 8-#11 | 2.58 | 2452 | 1223 | 3661 | 1039 | 4531 | 858 | 5092 | 708 | 5843 | 468 | 7162 | 249 | 5772 |
| 8-#14 | 3.72 | 2674 | 1385 | 4288 | 1138 | 5300 | 931 | 6010 | 753 | 7067 | 461 | 8671 | 158 | 8018 |
| 8-#18 | 6.61 | 3191 | 1798 | 5799 | 1392 | 7163 | 1115 | 8238 | 867 | 10045 | 442 | 12175 | -103 | 11941 |
| 12-#10 | 3.15 | 2599 | 1304 | 3893 | 1106 | 4849 | 910 | 5470 | 750 | 6359 | 473 | 8037 | 229 | 6833 |
| 12-#11 | 3.87 | 2728 | 1407 | 4277 | 1165 | 5297 | 952 | 5989 | 776 | 7041 | 464 | 8828 | 162 | 7998 |
| 12-#14 | 5.58 | 3062 | 1650 | 5160 | 1319 | 6384 | 1065 | 7279 | 850 | 8762 | 454 | 10987 | 26 | 10859 |
| 16-#10 | 4.20 | 2832 | 1454 | 4437 | 1210 | 5500 | 993 | 6267 | 801 | 7418 | 477 | 9465 | 160 | 8756 |
| 16-#11 | 5.16 | 2993 | 1590 | 4927 | 1291 | 6076 | 1053 | 6943 | 838 | 8307 | 467 | 10502 | 69 | 10231 |

## SQUARE TIED COLUMNS 24" x 24"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.08 | 2953 | 1202 | 3899 | 1075 | 4855 | 903 | 5395 | 768 | 5973 | 561 | 7269 | 482 | 3395 |
| 4-#14 | 1.56 | 3140 | 1283 | 4386 | 1119 | 5441 | 935 | 6088 | 787 | 6892 | 554 | 8439 | 464 | 4746 |
| 4-#18 | 2.78 | 3555 | 1489 | 5556 | 1235 | 6862 | 1019 | 7776 | 838 | 9138 | 539 | 11189 | 408 | 8010 |
| 8-#8 | 1.10 | 2815 | 1204 | 3578 | 1098 | 4522 | 923 | 5029 | 785 | 5514 | 577 | 6724 | 440 | 3491 |
| 8-#9 | 1.39 | 2902 | 1254 | 3813 | 1128 | 4804 | 945 | 5363 | 799 | 5957 | 575 | 7332 | 420 | 4341 |
| 8-#10 | 1.76 | 3011 | 1317 | 4108 | 1167 | 5162 | 973 | 5788 | 816 | 6522 | 573 | 8105 | 394 | 5412 |
| 8-#11 | 2.17 | 3105 | 1386 | 4432 | 1202 | 5530 | 998 | 6211 | 831 | 7072 | 566 | 8758 | 351 | 6481 |
| 8-#14 | 3.13 | 3366 | 1548 | 5143 | 1302 | 6399 | 1071 | 7247 | 876 | 8453 | 560 | 10522 | 268 | 9039 |
| 8-#18 | 5.56 | 3962 | 1960 | 6861 | 1557 | 8513 | 1257 | 9774 | 992 | 11828 | 543 | 14664 | 34 | 14554 |
| 12-#10 | 2.65 | 3270 | 1467 | 4685 | 1271 | 5879 | 1052 | 6628 | 874 | 7643 | 573 | 9742 | 331 | 7804 |
| 12-#11 | 3.25 | 3411 | 1569 | 5125 | 1330 | 6391 | 1094 | 7220 | 900 | 8418 | 564 | 10683 | 269 | 9143 |
| 12-#14 | 4.69 | 3807 | 1813 | 6125 | 1485 | 7620 | 1207 | 8677 | 975 | 10362 | 556 | 13209 | 145 | 12407 |
| 16-#10 | 3.53 | 3525 | 1616 | 5295 | 1376 | 6610 | 1136 | 7523 | 926 | 8831 | 578 | 11377 | 268 | 9907 |
| 16-#11 | 4.33 | 3723 | 1753 | 5857 | 1457 | 7267 | 1196 | 8293 | 963 | 9842 | 569 | 12610 | 185 | 11733 |
| 16-#14 | 6.25 | 4219 | 2078 | 7163 | 1668 | 8862 | 1353 | 10198 | 1065 | 12381 | 561 | 15904 | 17 | 15833 |
| 20-#10 | 4.41 | 3760 | 1766 | 5906 | 1478 | 7377 | 1214 | 8428 | 984 | 10033 | 578 | 13044 | 190 | 12009 |
| 20-#11 | 5.42 | 3990 | 1937 | 6597 | 1583 | 8187 | 1291 | 9379 | 1033 | 11285 | 568 | 14570 | 84 | 14122 |

## SQUARE TIED COLUMNS 26" x 26"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.33 | 3904 | 1460 | 5254 | 1296 | 6570 | 1086 | 7351 | 919 | 8266 | 659 | 10199 | 567 | 5256 |
| 4-#18 | 2.37 | 4392 | 1666 | 6569 | 1411 | 8162 | 1169 | 9240 | 969 | 10777 | 643 | 13377 | 521 | 8908 |
| 8-#9 | 1.18 | 3629 | 1431 | 4602 | 1307 | 5851 | 1098 | 6536 | 932 | 7219 | 682 | 8849 | 515 | 4795 |
| 8-#10 | 1.50 | 3754 | 1494 | 4931 | 1346 | 6249 | 1126 | 7007 | 950 | 7844 | 680 | 9708 | 489 | 5987 |
| 8-#11 | 1.85 | 3863 | 1562 | 5299 | 1381 | 6663 | 1151 | 7482 | 964 | 8460 | 673 | 10543 | 457 | 7188 |
| 8-#14 | 2.66 | 4150 | 1725 | 6095 | 1481 | 7633 | 1224 | 8637 | 1010 | 9997 | 667 | 12565 | 382 | 10057 |
| 8-#18 | 4.73 | 4845 | 2137 | 8022 | 1736 | 10000 | 1411 | 11462 | 1127 | 13769 | 653 | 17352 | 169 | 16742 |
| 12-#10 | 2.25 | 4046 | 1644 | 5571 | 1451 | 7044 | 1206 | 7938 | 1009 | 9087 | 681 | 11531 | 427 | 8730 |
| 12-#11 | 2.77 | 4209 | 1746 | 6068 | 1509 | 7620 | 1247 | 8602 | 1035 | 9955 | 673 | 12726 | 380 | 10326 |
| 12-#14 | 3.99 | 4661 | 1990 | 7187 | 1665 | 8992 | 1362 | 10227 | 1111 | 12120 | 666 | 15625 | 266 | 14002 |
| 12-#18 | 7.10 | 5724 | 2608 | 9903 | 2061 | 12340 | 1652 | 14203 | 1303 | 17427 | 644 | 22477 | -52 | 22269 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 3.01 | 4332 | 1793 | 6248 | 1556 | 7854 | 1290 | 8930 | 1062 | 10403 | 687 | 13348 | 368 | 11080 |
| 16-#11 | 3.69 | 4547 | 1930 | 6882 | 1638 | 8593 | 1351 | 9794 | 1099 | 11537 | 679 | 14908 | 304 | 13141 |
| 16-#14 | 5.33 | 5121 | 2255 | 8342 | 1850 | 10373 | 1510 | 11920 | 1202 | 14367 | 674 | 18687 | 150 | 17993 |
| 20-#10 | 3.76 | 4581 | 1943 | 6918 | 1658 | 8705 | 1370 | 9934 | 1121 | 11736 | 688 | 15204 | 291 | 13524 |
| 20-#11 | 4.62 | 4861 | 2113 | 7695 | 1763 | 9616 | 1447 | 11001 | 1170 | 13140 | 679 | 17131 | 207 | 15913 |

## SQUARE TIED COLUMNS 28" x 28"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.15 | 4781 | 1651 | 6225 | 1489 | 7845 | 1250 | 8778 | 1062 | 9812 | 773 | 12130 | 673 | 5765 |
| 4-#18 | 2.04 | 5340 | 1857 | 7686 | 1603 | 9609 | 1332 | 10868 | 1111 | 12587 | 757 | 15773 | 639 | 9805 |
| 8-#9 | 1.02 | 4467 | 1622 | 5493 | 1502 | 7043 | 1264 | 7873 | 1077 | 8653 | 798 | 10569 | 617 | 5247 |
| 8-#10 | 1.30 | 4608 | 1685 | 5856 | 1540 | 7481 | 1292 | 8391 | 1095 | 9339 | 795 | 11512 | 592 | 6560 |
| 8-#11 | 1.59 | 4733 | 1753 | 6268 | 1575 | 7942 | 1316 | 8918 | 1108 | 10020 | 789 | 12434 | 560 | 7894 |
| 8-#14 | 2.30 | 5059 | 1916 | 7149 | 1674 | 9013 | 1389 | 10191 | 1155 | 11714 | 783 | 14764 | 496 | 11073 |
| 8-#18 | 4.08 | 5846 | 2328 | 9286 | 1930 | 11633 | 1576 | 13316 | 1272 | 15883 | 770 | 20251 | 305 | 18709 |
| 12-#10 | 1.94 | 4935 | 1835 | 6558 | 1646 | 8354 | 1372 | 9413 | 1154 | 10703 | 797 | 13520 | 531 | 9594 |
| 12-#11 | 2.39 | 5121 | 1937 | 7114 | 1704 | 8994 | 1414 | 10149 | 1181 | 11664 | 790 | 14844 | 484 | 11505 |
| 12-#14 | 3.44 | 5607 | 2181 | 8352 | 1860 | 10509 | 1529 | 11942 | 1257 | 14052 | 783 | 18183 | 385 | 15643 |
| 12-#18 | 6.12 | 6819 | 2799 | 11364 | 2257 | 14217 | 1821 | 16342 | 1452 | 19922 | 765 | 26039 | 96 | 25430 |
| 16-#10 | 2.59 | 5253 | 1984 | 7302 | 1752 | 9243 | 1457 | 10501 | 1208 | 12147 | 805 | 15518 | 474 | 12275 |
| 16-#11 | 3.18 | 5496 | 2121 | 8010 | 1833 | 10065 | 1518 | 11461 | 1246 | 13404 | 798 | 17248 | 411 | 14573 |
| 16-#14 | 4.59 | 6141 | 2446 | 9624 | 2046 | 12031 | 1678 | 13807 | 1350 | 16526 | 794 | 21596 | 277 | 20121 |
| 20-#10 | 3.24 | 5530 | 2134 | 8031 | 1853 | 10177 | 1537 | 11604 | 1268 | 13611 | 807 | 17562 | 397 | 15028 |
| 20-#11 | 3.98 | 5826 | 2304 | 8895 | 1958 | 11190 | 1615 | 12788 | 1318 | 15167 | 799 | 19702 | 316 | 17757 |
| 20-#14 | 5.74 | 6621 | 2711 | 10892 | 2226 | 13630 | 1817 | 15694 | 1453 | 19033 | 794 | 25077 | 138 | 24263 |
| 24-#10 | 3.89 | 5845 | 2283 | 8762 | 1955 | 11103 | 1615 | 12723 | 1322 | 15095 | 814 | 19618 | 349 | 17588 |
| 24-#11 | 4.78 | 6230 | 2488 | 9726 | 2089 | 12315 | 1710 | 14137 | 1383 | 16955 | 807 | 22173 | 253 | 20858 |

## SQUARE TIED COLUMNS 30" x 30"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.00 | 5779 | 1856 | 7306 | 1696 | 9276 | 1427 | 10382 | 1216 | 11544 | 896 | 14219 | 781 | 6273 |
| 4-#18 | 1.78 | 6411 | 2062 | 8915 | 1809 | 11213 | 1508 | 12674 | 1264 | 14584 | 879 | 18392 | 762 | 10702 |
| 8-#10 | 1.13 | 5582 | 1890 | 6889 | 1749 | 8868 | 1471 | 9950 | 1250 | 11020 | 920 | 13535 | 702 | 7133 |
| 8-#11 | 1.39 | 5724 | 1959 | 7346 | 1783 | 9376 | 1494 | 10530 | 1264 | 11766 | 913 | 14544 | 671 | 8598 |
| 8-#14 | 2.00 | 6089 | 2121 | 8312 | 1883 | 10549 | 1567 | 11922 | 1310 | 13617 | 908 | 17089 | 607 | 12086 |
| 8-#18 | 3.56 | 6974 | 2533 | 10662 | 2138 | 13423 | 1755 | 15347 | 1429 | 18183 | 895 | 23375 | 443 | 20510 |
| 12-#10 | 1.69 | 5946 | 2040 | 7654 | 1855 | 9818 | 1551 | 11064 | 1311 | 12505 | 922 | 15729 | 642 | 10455 |
| 12-#11 | 2.08 | 6154 | 2142 | 8269 | 1913 | 10524 | 1592 | 11873 | 1337 | 13559 | 915 | 17182 | 595 | 12566 |
| 12-#14 | 3.00 | 6695 | 2386 | 9626 | 2069 | 12182 | 1708 | 13834 | 1414 | 16169 | 910 | 20835 | 497 | 17331 |
| 12-#18 | 5.33 | 8044 | 3004 | 12936 | 2467 | 16251 | 2002 | 18659 | 1611 | 22603 | 895 | 29830 | 245 | 28145 |
| 16-#10 | 2.26 | 6296 | 2189 | 8464 | 1962 | 10787 | 1637 | 12249 | 1365 | 14078 | 931 | 17860 | 579 | 13491 |
| 16-#11 | 2.77 | 6569 | 2326 | 9246 | 2043 | 11692 | 1697 | 13304 | 1403 | 15457 | 924 | 19808 | 526 | 16029 |
| 16-#14 | 4.00 | 7263 | 2651 | 11017 | 2256 | 13845 | 1858 | 15870 | 1509 | 18871 | 922 | 24569 | 394 | 22135 |
| 16-#18 | 7.11 | 8967 | 3475 | 15342 | 2797 | 19129 | 2266 | 22184 | 1775 | 27280 | 911 | 36279 | 50 | 36023 |
| 20-#10 | 2.82 | 6603 | 2339 | 9252 | 2063 | 11805 | 1718 | 13450 | 1425 | 15672 | 934 | 20141 | 511 | 16462 |
| 20-#11 | 3.47 | 6933 | 2509 | 10204 | 2167 | 12920 | 1795 | 14752 | 1476 | 17380 | 926 | 22494 | 431 | 19652 |
| 20-#14 | 5.00 | 7815 | 2916 | 12389 | 2436 | 15592 | 1999 | 17932 | 1613 | 21609 | 924 | 28383 | 257 | 26829 |
| 24-#10 | 3.39 | 6950 | 2488 | 10048 | 2165 | 12805 | 1794 | 14670 | 1480 | 17289 | 942 | 22384 | 465 | 19355 |
| 24-#11 | 4.16 | 7348 | 2693 | 11166 | 2292 | 14137 | 1890 | 16224 | 1542 | 19331 | 935 | 25195 | 371 | 22969 |

## SQUARE TIED COLUMNS 32" x 32"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.56 | 7613 | 2281 | 10261 | 2030 | 12984 | 1697 | 14670 | 1429 | 16779 | 1009 | 21078 | 877 | 11598 |
| 8-#11 | 1.22 | 6844 | 2178 | 8540 | 2006 | 10977 | 1685 | 12331 | 1430 | 13711 | 1045 | 16890 | 789 | 9300 |
| 8-#14 | 1.76 | 7249 | 2340 | 9592 | 2106 | 12251 | 1758 | 13842 | 1477 | 15718 | 1041 | 19648 | 726 | 13098 |
| 8-#18 | 3.13 | 8202 | 2752 | 12155 | 2361 | 15381 | 1946 | 17568 | 1596 | 20682 | 1029 | 26481 | 565 | 22307 |
| 12-#10 | 1.49 | 7085 | 2259 | 8864 | 2080 | 11449 | 1743 | 12903 | 1478 | 14506 | 1056 | 18173 | 760 | 11314 |
| 12-#11 | 1.83 | 7318 | 2361 | 9540 | 2137 | 12220 | 1784 | 13786 | 1504 | 15653 | 1049 | 19756 | 714 | 13624 |
| 12-#14 | 2.64 | 7916 | 2605 | 11017 | 2293 | 14022 | 1900 | 15915 | 1582 | 18485 | 1044 | 23723 | 617 | 19066 |
| 12-#18 | 4.69 | 9405 | 3223 | 14626 | 2692 | 18453 | 2195 | 21166 | 1780 | 25483 | 1032 | 33518 | 369 | 30922 |
| 16-#10 | 1.98 | 7470 | 2408 | 9740 | 2187 | 12497 | 1829 | 14186 | 1533 | 16207 | 1065 | 20482 | 700 | 14729 |
| 16-#11 | 2.44 | 7772 | 2545 | 10598 | 2267 | 13486 | 1890 | 15336 | 1571 | 17709 | 1059 | 22604 | 647 | 17509 |
| 16-#14 | 3.52 | 8537 | 2870 | 12525 | 2481 | 15826 | 2051 | 18124 | 1678 | 21415 | 1058 | 27778 | 518 | 24178 |
| 16-#18 | 6.25 | 10411 | 3694 | 17242 | 3023 | 21581 | 2461 | 24996 | 1947 | 30565 | 1052 | 40537 | 182 | 39775 |
| 20-#10 | 2.48 | 7807 | 2558 | 10587 | 2287 | 13599 | 1910 | 15485 | 1594 | 17932 | 1069 | 22956 | 631 | 17910 |
| 20-#11 | 3.05 | 8172 | 2729 | 11629 | 2392 | 14817 | 1988 | 16905 | 1645 | 19793 | 1062 | 25522 | 553 | 21407 |
| 20-#14 | 4.39 | 9105 | 3135 | 14002 | 2660 | 17722 | 2193 | 20360 | 1783 | 24384 | 1061 | 31926 | 381 | 29452 |
| 24-#10 | 2.98 | 8186 | 2708 | 11448 | 2390 | 14673 | 1987 | 16805 | 1649 | 19682 | 1078 | 25386 | 587 | 21157 |
| 24-#11 | 3.66 | 8625 | 2912 | 12671 | 2517 | 16125 | 2083 | 18500 | 1712 | 21906 | 1072 | 28453 | 496 | 25118 |
| 24-#14 | 5.27 | 9801 | 3400 | 15487 | 2840 | 19597 | 2330 | 22631 | 1879 | 27395 | 1075 | 36096 | 296 | 34630 |

## SQUARE TIED COLUMNS 34" x 34"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.38 | 8954 | 2515 | 11732 | 2266 | 14934 | 1898 | 16867 | 1604 | 19187 | 1149 | 24013 | 999 | 12493 |
| 8-#11 | 1.08 | 8101 | 2411 | 9856 | 2245 | 12755 | 1889 | 14333 | 1608 | 15869 | 1187 | 19487 | 914 | 10002 |
| 8-#14 | 1.56 | 8548 | 2574 | 10996 | 2344 | 14132 | 1961 | 15963 | 1654 | 18032 | 1183 | 22459 | 852 | 14107 |
| 8-#18 | 2.77 | 9598 | 2986 | 13774 | 2599 | 17517 | 2149 | 19991 | 1773 | 23392 | 1172 | 29835 | 694 | 24101 |
| 12-#10 | 1.32 | 8362 | 2492 | 10195 | 2319 | 13256 | 1947 | 14944 | 1656 | 16719 | 1199 | 20870 | 886 | 12170 |
| 12-#11 | 1.62 | 8620 | 2595 | 10932 | 2376 | 14093 | 1988 | 15900 | 1682 | 17959 | 1191 | 22581 | 840 | 14680 |
| 12-#14 | 2.34 | 9276 | 2838 | 12531 | 2532 | 16040 | 2104 | 18198 | 1761 | 21013 | 1187 | 26862 | 745 | 20632 |
| 12-#18 | 4.15 | 10853 | 3457 | 16441 | 2932 | 20833 | 2400 | 23875 | 1960 | 28575 | 1177 | 37455 | 500 | 33762 |
| 16-#10 | 1.76 | 8781 | 2642 | 11138 | 2426 | 14384 | 2034 | 16324 | 1712 | 18549 | 1209 | 23356 | 827 | 15957 |
| 16-#11 | 2.16 | 9115 | 2778 | 12073 | 2507 | 15457 | 2094 | 17569 | 1750 | 20173 | 1202 | 25584 | 766 | 19013 |
| 16-#14 | 3.11 | 9953 | 3103 | 14157 | 2721 | 17985 | 2256 | 20579 | 1857 | 24171 | 1202 | 31141 | 635 | 26250 |
| 16-#18 | 5.54 | 12002 | 3927 | 19266 | 3264 | 24211 | 2668 | 28011 | 2129 | 34063 | 1199 | 45045 | 319 | 43594 |
| 20-#10 | 2.20 | 9149 | 2791 | 12044 | 2527 | 15567 | 2115 | 17738 | 1768 | 20405 | 1213 | 26019 | 760 | 19372 |
| 20-#11 | 2.70 | 9552 | 2962 | 13177 | 2631 | 16890 | 2194 | 19260 | 1824 | 22418 | 1206 | 28801 | 682 | 23174 |
| 20-#14 | 3.89 | 10570 | 3368 | 15739 | 2900 | 20028 | 2399 | 22989 | 1964 | 27372 | 1207 | 35720 | 513 | 32137 |
| 24-#10 | 2.64 | 9562 | 2941 | 12970 | 2630 | 16718 | 2192 | 19142 | 1829 | 22287 | 1223 | 28640 | 717 | 22946 |
| 24-#11 | 3.24 | 10044 | 3146 | 14297 | 2756 | 18291 | 2287 | 20977 | 1892 | 24694 | 1217 | 31962 | 627 | 27305 |
| 24-#14 | 4.67 | 11274 | 3633 | 17338 | 3080 | 22036 | 2535 | 25438 | 2061 | 30618 | 1222 | 40223 | 431 | 37644 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 36" x 36"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.23 | 10442 | 2762 | 13335 | 2517 | 17073 | 2112 | 19279 | 1791 | 21820 | 1298 | 27214 | 1130 | 13388 |
| 8-#14 | 1.39 | 9993 | 2821 | 12529 | 2597 | 16200 | 2177 | 18299 | 1843 | 20571 | 1333 | 25537 | 986 | 15116 |
| 8-#18 | 2.47 | 11143 | 3233 | 15523 | 2851 | 19841 | 2365 | 22627 | 1962 | 26329 | 1323 | 33457 | 829 | 25891 |
| 12-#10 | 1.18 | 9784 | 2740 | 11655 | 2573 | 15250 | 2164 | 17198 | 1846 | 19157 | 1350 | 23834 | 1019 | 13025 |
| 12-#11 | 1.44 | 10067 | 2842 | 12455 | 2629 | 16154 | 2205 | 18228 | 1872 | 20490 | 1342 | 25673 | 973 | 15732 |
| 12-#14 | 2.08 | 10784 | 3086 | 14175 | 2786 | 18246 | 2321 | 20695 | 1950 | 23767 | 1339 | 30269 | 879 | 22154 |
| 12-#18 | 3.70 | 12501 | 3704 | 18388 | 3186 | 23403 | 2617 | 26798 | 2150 | 31893 | 1330 | 41660 | 637 | 36664 |
| 16-#10 | 1.57 | 10239 | 2889 | 12660 | 2680 | 16457 | 2252 | 18675 | 1902 | 21117 | 1360 | 26497 | 962 | 17103 |
| 16-#11 | 1.93 | 10605 | 3026 | 13677 | 2761 | 17616 | 2311 | 20016 | 1940 | 22863 | 1354 | 28894 | 901 | 20542 |
| 16-#14 | 2.78 | 11517 | 3351 | 15919 | 2975 | 20331 | 2474 | 23247 | 2048 | 27153 | 1355 | 34861 | 772 | 28351 |
| 16-#18 | 4.94 | 13750 | 4175 | 21422 | 3520 | 27031 | 2887 | 31240 | 2321 | 37786 | 1355 | 49820 | 462 | 47245 |
| 20-#10 | 1.96 | 10639 | 3039 | 13629 | 2781 | 17719 | 2333 | 20189 | 1958 | 23103 | 1365 | 29351 | 896 | 20849 |
| 20-#11 | 2.41 | 11079 | 3210 | 14853 | 2885 | 19152 | 2411 | 21828 | 2015 | 25268 | 1359 | 32346 | 818 | 24957 |
| 20-#14 | 3.47 | 12185 | 3616 | 17606 | 3154 | 22523 | 2618 | 25832 | 2155 | 30586 | 1361 | 39782 | 651 | 34777 |
| 20-#18 | 6.17 | 14937 | 4646 | 24386 | 3838 | 30844 | 3140 | 35737 | 2510 | 43758 | 1363 | 58171 | 220 | 56740 |
| 24-#10 | 2.35 | 11087 | 3188 | 14620 | 2884 | 18949 | 2409 | 21689 | 2020 | 25118 | 1375 | 32162 | 853 | 24661 |
| 24-#11 | 2.89 | 11613 | 3393 | 16053 | 3011 | 20643 | 2505 | 23669 | 2083 | 27707 | 1371 | 35740 | 765 | 29532 |
| 24-#14 | 4.17 | 12944 | 3881 | 19319 | 3335 | 24663 | 2753 | 28459 | 2253 | 34066 | 1377 | 44617 | 572 | 40726 |

## SQUARE TIED COLUMNS 38" x 38"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.11 | 12085 | 3024 | 15075 | 2784 | 19411 | 2339 | 21917 | 1989 | 24692 | 1456 | 30698 | 1268 | 14282 |
| 8-#14 | 1.25 | 11592 | 3083 | 14199 | 2865 | 18466 | 2406 | 20861 | 2042 | 23350 | 1492 | 28898 | 1127 | 16122 |
| 8-#18 | 2.22 | 12844 | 3495 | 17411 | 3119 | 22365 | 2593 | 25491 | 2162 | 29504 | 1483 | 37361 | 972 | 27679 |
| 12-#10 | 1.06 | 11360 | 3002 | 13249 | 2843 | 17442 | 2394 | 19677 | 2046 | 21834 | 1510 | 27081 | 1160 | 13879 |
| 12-#11 | 1.30 | 11669 | 3104 | 14113 | 2898 | 18414 | 2434 | 20782 | 2072 | 23261 | 1502 | 29049 | 1114 | 16783 |
| 12-#14 | 1.87 | 12447 | 3348 | 15956 | 3054 | 20650 | 2550 | 23418 | 2151 | 26760 | 1499 | 33958 | 1021 | 23672 |
| 12-#18 | 3.32 | 14307 | 3966 | 20473 | 3454 | 26171 | 2847 | 29948 | 2352 | 35449 | 1492 | 46148 | 781 | 39628 |
| 16-#10 | 1.41 | 11851 | 3151 | 14317 | 2949 | 18729 | 2482 | 21252 | 2103 | 23923 | 1521 | 29922 | 1104 | 18245 |
| 16-#11 | 1.73 | 12250 | 3288 | 15413 | 3030 | 19973 | 2541 | 22690 | 2141 | 25792 | 1515 | 32488 | 1044 | 22018 |
| 16-#14 | 2.49 | 13240 | 3613 | 17818 | 3244 | 22876 | 2704 | 26143 | 2249 | 30374 | 1517 | 38866 | 917 | 30482 |
| 16-#18 | 4.43 | 15596 | 4437 | 23716 | 3790 | 30050 | 3119 | 34695 | 2524 | 41748 | 1519 | 54684 | 587 | 50807 |
| 20-#10 | 1.76 | 12284 | 3301 | 15349 | 3051 | 20067 | 2563 | 22865 | 2160 | 26040 | 1526 | 32965 | 1040 | 22340 |
| 20-#11 | 2.16 | 12763 | 3471 | 16665 | 3153 | 21604 | 2641 | 24645 | 2209 | 28357 | 1520 | 36172 | 963 | 26756 |
| 20-#14 | 3.12 | 13960 | 3877 | 19609 | 3422 | 25216 | 2848 | 28902 | 2357 | 34038 | 1524 | 44124 | 797 | 37296 |
| 20-#18 | 5.54 | 16931 | 4908 | 26866 | 4108 | 34126 | 3373 | 39503 | 2714 | 48132 | 1528 | 63824 | 371 | 61211 |
| 24-#10 | 2.11 | 12767 | 3450 | 16405 | 3154 | 21379 | 2640 | 24457 | 2221 | 28187 | 1537 | 35968 | 997 | 26385 |
| 24-#11 | 2.59 | 13338 | 3655 | 17945 | 3280 | 23194 | 2735 | 26586 | 2285 | 30959 | 1533 | 39801 | 910 | 31689 |
| 24-#14 | 3.74 | 14775 | 4142 | 21437 | 3604 | 27488 | 2983 | 31706 | 2456 | 37754 | 1541 | 49295 | 720 | 43833 |

## SQUARE TIED COLUMNS 40" x 40"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#18 | 1.00 | 13891 | 3300 | 16961 | 3065 | 21959 | 2579 | 24795 | 2198 | 27816 | 1622 | 34481 | 1414 | 15175 |
| 8-#14 | 1.13 | 13354 | 3359 | 16012 | 3148 | 20942 | 2648 | 23661 | 2253 | 26380 | 1660 | 32558 | 1275 | 17128 |
| 8-#18 | 2.00 | 14711 | 3771 | 19444 | 3401 | 25099 | 2835 | 28594 | 2372 | 32931 | 1651 | 41563 | 1122 | 29465 |
| 12-#11 | 1.17 | 13434 | 3380 | 15914 | 3182 | 20881 | 2676 | 23574 | 2283 | 26283 | 1671 | 32724 | 1263 | 17832 |
| 12-#14 | 1.69 | 14274 | 3623 | 17880 | 3338 | 23263 | 2792 | 26379 | 2362 | 30005 | 1668 | 37947 | 1170 | 25188 |
| 12-#18 | 3.00 | 16281 | 4242 | 22703 | 3738 | 29150 | 3090 | 33337 | 2564 | 39258 | 1662 | 50935 | 933 | 42654 |
| 16-#10 | 1.27 | 13626 | 3427 | 16115 | 3233 | 21208 | 2725 | 24067 | 2315 | 26981 | 1690 | 33647 | 1254 | 19385 |
| 16-#11 | 1.56 | 14059 | 3563 | 17290 | 3313 | 22538 | 2784 | 25601 | 2352 | 28972 | 1684 | 36381 | 1194 | 23423 |
| 16-#14 | 2.25 | 15127 | 3888 | 19853 | 3528 | 25631 | 2947 | 29276 | 2461 | 33847 | 1686 | 43169 | 1068 | 32642 |
| 16-#18 | 4.00 | 17665 | 4712 | 26156 | 4074 | 33279 | 3363 | 38391 | 2738 | 45962 | 1691 | 60030 | 744 | 54392 |
| 20-#10 | 1.59 | 14092 | 3576 | 17211 | 3335 | 22624 | 2805 | 25780 | 2372 | 29229 | 1696 | 36880 | 1191 | 23846 |
| 20-#11 | 1.95 | 14611 | 3747 | 18621 | 3437 | 24265 | 2883 | 27679 | 2422 | 31699 | 1690 | 40298 | 1114 | 28571 |
| 20-#14 | 2.81 | 15900 | 4153 | 21756 | 3706 | 28108 | 3091 | 32245 | 2560 | 37743 | 1695 | 48763 | 951 | 39834 |
| 20-#18 | 5.00 | 19099 | 5183 | 29492 | 4392 | 37619 | 3618 | 43509 | 2929 | 52758 | 1702 | 69776 | 529 | 65819 |
| 24-#10 | 1.90 | 14611 | 3726 | 18331 | 3438 | 24016 | 2883 | 27463 | 2433 | 31509 | 1707 | 40073 | 1149 | 28119 |
| 24-#11 | 2.34 | 15229 | 3931 | 19980 | 3564 | 25954 | 2978 | 29732 | 2497 | 34463 | 1703 | 44161 | 1062 | 33795 |
| 24-#14 | 3.38 | 16773 | 4418 | 23699 | 3889 | 30522 | 3226 | 35191 | 2670 | 41693 | 1713 | 54272 | 875 | 46983 |

## SQUARE TIED COLUMNS 42" x 42"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#14 | 1.02 | 15286 | 3649 | 17976 | 3445 | 23638 | 2902 | 26713 | 2475 | 29675 | 1837 | 36533 | 1432 | 18133 |
| 8-#18 | 1.81 | 16751 | 4061 | 21628 | 3699 | 28054 | 3088 | 31948 | 2594 | 36624 | 1828 | 46080 | 1280 | 31248 |
| 12-#11 | 1.06 | 15369 | 3670 | 17864 | 3480 | 23569 | 2931 | 26617 | 2506 | 29571 | 1848 | 36714 | 1419 | 18879 |
| 12-#14 | 1.53 | 16273 | 3913 | 19954 | 3636 | 26097 | 3047 | 29592 | 2585 | 33515 | 1846 | 42251 | 1327 | 26700 |
| 12-#18 | 2.72 | 18430 | 4531 | 25084 | 4036 | 32349 | 3345 | 36977 | 2787 | 43332 | 1841 | 56036 | 1091 | 45710 |
| 16-#10 | 1.15 | 15571 | 3717 | 18062 | 3532 | 23906 | 2980 | 27132 | 2538 | 30304 | 1868 | 37687 | 1411 | 20522 |
| 16-#11 | 1.41 | 16039 | 3853 | 19317 | 3611 | 25323 | 3039 | 28764 | 2575 | 32418 | 1862 | 40590 | 1352 | 24824 |
| 16-#14 | 2.04 | 17187 | 4178 | 22039 | 3826 | 28605 | 3202 | 32661 | 2684 | 37586 | 1865 | 47787 | 1227 | 34831 |
| 16-#18 | 3.63 | 19912 | 5002 | 28747 | 4374 | 36729 | 3619 | 42337 | 2962 | 50442 | 1872 | 65690 | 907 | 58016 |
| 20-#10 | 1.44 | 16071 | 3866 | 19221 | 3634 | 25400 | 3061 | 28946 | 2595 | 32683 | 1874 | 41110 | 1349 | 25367 |
| 20-#11 | 1.77 | 16632 | 4037 | 20725 | 3736 | 27146 | 3138 | 30964 | 2645 | 35305 | 1869 | 44740 | 1273 | 30402 |
| 20-#14 | 2.55 | 18015 | 4443 | 24053 | 4005 | 31220 | 3346 | 35806 | 2784 | 41713 | 1874 | 53717 | 1112 | 42390 |
| 20-#18 | 4.54 | 21339 | 5473 | 32269 | 4690 | 41330 | 3875 | 47766 | 3155 | 57649 | 1884 | 76035 | 695 | 70455 |
| 24-#10 | 1.73 | 16626 | 4016 | 20406 | 3738 | 26872 | 3138 | 30720 | 2656 | 35096 | 1886 | 44494 | 1307 | 29863 |
| 24-#11 | 2.12 | 17293 | 4221 | 22164 | 3863 | 28933 | 3233 | 33129 | 2720 | 38233 | 1883 | 48837 | 1222 | 35912 |
| 24-#14 | 3.06 | 18947 | 4708 | 26111 | 4188 | 33776 | 3482 | 38915 | 2893 | 45898 | 1893 | 59564 | 1037 | 50174 |
| 24-#18 | 5.44 | 23092 | 5944 | 35865 | 5014 | 45798 | 4115 | 53282 | 3330 | 64958 | 1915 | 86208 | 558 | 82582 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 8-#18 | 1.65 | 18971 | 4365 | 23971 | 4011 | 31240 | 3355 | 35565 | 2827 | 40595 | 2014 | 50928 | 1445 | 33029 |
| 12-#14 | 1.39 | 18452 | 4218 | 22186 | 3950 | 29160 | 3315 | 33068 | 2818 | 37303 | 2033 | 46886 | 1491 | 28210 |
| 12-#18 | 2.48 | 20762 | 4836 | 27624 | 4349 | 35780 | 3612 | 40881 | 3021 | 47685 | 2028 | 61469 | 1257 | 48409 |
| 16-#10 | 1.05 | 17696 | 4021 | 20165 | 3846 | 26834 | 3249 | 30461 | 2772 | 33906 | 2055 | 42059 | 1576 | 21657 |
| 16-#11 | 1.29 | 18198 | 4157 | 21501 | 3925 | 28338 | 3307 | 32189 | 2809 | 36143 | 2049 | 45129 | 1517 | 26223 |
| 16-#14 | 1.86 | 19428 | 4482 | 24381 | 4139 | 31809 | 3471 | 36309 | 2919 | 41602 | 2052 | 52737 | 1394 | 37025 |
| 16-#18 | 3.31 | 22344 | 5306 | 31484 | 4686 | 40410 | 3888 | 46547 | 3197 | 55200 | 2060 | 71682 | 1077 | 61680 |
| 20-#10 | 1.31 | 18230 | 4170 | 21387 | 3948 | 28405 | 3329 | 32374 | 2830 | 36416 | 2061 | 45671 | 1515 | 26794 |
| 20-#11 | 1.61 | 18832 | 4341 | 22986 | 4050 | 30256 | 3406 | 34512 | 2879 | 39190 | 2056 | 49512 | 1440 | 32249 |
| 20-#14 | 2.32 | 20313 | 4747 | 26507 | 4318 | 34562 | 3614 | 39631 | 3019 | 45961 | 2062 | 59003 | 1281 | 44966 |
| 20-#18 | 4.13 | 23859 | 5777 | 35205 | 5004 | 45255 | 4143 | 52353 | 3374 | 62819 | 2075 | 82623 | 869 | 75174 |
| 24-#10 | 1.57 | 18823 | 4320 | 22637 | 4052 | 29957 | 3407 | 34239 | 2890 | 38962 | 2073 | 49247 | 1473 | 31617 |
| 24-#11 | 1.93 | 19537 | 4525 | 24504 | 4177 | 32142 | 3501 | 36790 | 2954 | 42281 | 2070 | 53844 | 1388 | 38040 |
| 24-#14 | 2.79 | 21305 | 5012 | 28679 | 4502 | 37260 | 3750 | 42902 | 3127 | 50382 | 2082 | 65188 | 1206 | 53323 |
| 24-#18 | 4.96 | 25584 | 6248 | 39005 | 5328 | 49976 | 4384 | 58116 | 3567 | 70546 | 2107 | 93398 | 733 | 87917 |

## SQUARE TIED COLUMNS 46" x 46"

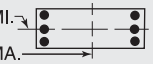
| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#18 | 1.51 | 21381 | 4683 | 26479 | 4338 | 34667 | 3634 | 39459 | 3070 | 44857 | 2208 | 56122 | 1617 | 34809 |
| 12-#14 | 1.28 | 20819 | 4536 | 24581 | 4278 | 32464 | 3595 | 36819 | 3063 | 41384 | 2228 | 51868 | 1663 | 29717 |
| 12-#18 | 2.27 | 23285 | 5154 | 30330 | 4677 | 39452 | 3893 | 45061 | 3266 | 52329 | 2224 | 67248 | 1431 | 51102 |
| 16-#11 | 1.18 | 20546 | 4476 | 23847 | 4253 | 31593 | 3588 | 35890 | 3054 | 40159 | 2244 | 50016 | 1690 | 27620 |
| 16-#14 | 1.70 | 21859 | 4801 | 26887 | 4467 | 35255 | 3751 | 40233 | 3164 | 45911 | 2248 | 58034 | 1568 | 39047 |
| 16-#18 | 3.02 | 24969 | 5625 | 34386 | 5014 | 44332 | 4169 | 51033 | 3443 | 60251 | 2258 | 78020 | 1253 | 65383 |
| 20-#10 | 1.20 | 20577 | 4489 | 23714 | 4277 | 31650 | 3610 | 36077 | 3075 | 40441 | 2257 | 50580 | 1688 | 28216 |
| 20-#11 | 1.47 | 21222 | 4659 | 25410 | 4378 | 33606 | 3687 | 38336 | 3125 | 43368 | 2252 | 54632 | 1614 | 34113 |
| 20-#14 | 2.13 | 22800 | 5066 | 29124 | 4647 | 38144 | 3894 | 43732 | 3265 | 50502 | 2258 | 64635 | 1456 | 47562 |
| 20-#18 | 3.78 | 26575 | 6096 | 38305 | 5332 | 49422 | 4424 | 57154 | 3621 | 68282 | 2273 | 89558 | 1049 | 79977 |
| 24-#10 | 1.44 | 21207 | 4638 | 25029 | 4382 | 33283 | 3688 | 38034 | 3136 | 43119 | 2270 | 54347 | 1647 | 33382 |
| 24-#11 | 1.77 | 21971 | 4843 | 27008 | 4506 | 35591 | 3782 | 40725 | 3199 | 46621 | 2267 | 59199 | 1563 | 40179 |
| 24-#14 | 2.55 | 23853 | 5330 | 31412 | 4830 | 40985 | 4031 | 47164 | 3373 | 55158 | 2279 | 71159 | 1382 | 56342 |
| 24-#18 | 4.54 | 28398 | 6567 | 42310 | 5657 | 54396 | 4666 | 63204 | 3814 | 76426 | 2307 | 100935 | 914 | 93282 |

## SQUARE TIED COLUMNS 48" x 48"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#18 | 1.39 | 23988 | 5015 | 29159 | 4680 | 38346 | 3926 | 43641 | 3325 | 49425 | 2412 | 61679 | 1797 | 36587 |
| 12-#14 | 1.17 | 23382 | 4868 | 27147 | 4621 | 36020 | 3888 | 40858 | 3318 | 45769 | 2432 | 57213 | 1843 | 31222 |
| 12-#18 | 2.08 | 26006 | 5486 | 33207 | 5020 | 43376 | 4186 | 49530 | 3521 | 57279 | 2429 | 73389 | 1612 | 53790 |
| 16-#11 | 1.08 | 23090 | 4808 | 26363 | 4597 | 35100 | 3881 | 39879 | 3310 | 44481 | 2448 | 55266 | 1870 | 29014 |
| 16-#14 | 1.56 | 24487 | 5133 | 29563 | 4810 | 38951 | 4045 | 44444 | 3420 | 50525 | 2453 | 63693 | 1749 | 41065 |
| 16-#18 | 2.78 | 27796 | 5957 | 37460 | 5356 | 48507 | 4463 | 55808 | 3700 | 65606 | 2463 | 84721 | 1438 | 69126 |
| 20-#10 | 1.10 | 23121 | 4821 | 26210 | 4622 | 35145 | 3903 | 40067 | 3332 | 44771 | 2462 | 55852 | 1869 | 29635 |
| 20-#11 | 1.35 | 23808 | 4992 | 28003 | 4722 | 37208 | 3980 | 42447 | 3381 | 47850 | 2457 | 60115 | 1795 | 35893 |
| 20-#14 | 1.95 | 25486 | 5398 | 31913 | 4990 | 41978 | 4187 | 48120 | 3521 | 55348 | 2464 | 70631 | 1639 | 50177 |
| 20-#18 | 3.47 | 29494 | 6428 | 41578 | 5675 | 53841 | 4717 | 62243 | 3878 | 74049 | 2480 | 96856 | 1236 | 84500 |
| 24-#10 | 1.32 | 23788 | 4971 | 27590 | 4726 | 36858 | 3982 | 42115 | 3392 | 47581 | 2475 | 59810 | 1828 | 35156 |
| 24-#11 | 1.63 | 24603 | 5175 | 29681 | 4850 | 39291 | 4075 | 44949 | 3455 | 51267 | 2472 | 64917 | 1744 | 42329 |
| 24-#14 | 2.34 | 26602 | 5663 | 34315 | 5174 | 44962 | 4325 | 51714 | 3629 | 60238 | 2485 | 77494 | 1565 | 59374 |
| 24-#18 | 4.17 | 31418 | 6899 | 45787 | 6001 | 59069 | 4960 | 68581 | 4071 | 82611 | 2515 | 108834 | 1103 | 98711 |

## RECTANGULAR TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.86 | MA | 210 | 232 | 343 | 181 | 390 | 149 | 414 | 122 | 438 | 76 | 471 | 42 | 353 |
| 2L-3S | | MI | 192 | 232 | 311 | 181 | 351 | 149 | 368 | 122 | 380 | 77 | 410 | 20 | 355 |
| 6-#6 | 2.64 | MA | 222 | 254 | 382 | 194 | 435 | 158 | 464 | 125 | 501 | 70 | 534 | 24 | 469 |
| 2L-3S | | MI | 198 | 255 | 337 | 194 | 381 | 157 | 401 | 126 | 422 | 71 | 451 | -7 | 450 |
| 6-#7 | 3.60 | MA | 236 | 283 | 428 | 211 | 486 | 168 | 523 | 129 | 575 | 61 | 604 | 0 | 604 |
| 2L-3S | | MI | 205 | 283 | 369 | 210 | 415 | 166 | 440 | 130 | 470 | 63 | 497 | -40 | 496 |

## RECTANGULAR TIED COLUMNS 10" x 12"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#5 | 1.03 | MA | 289 | 249 | 424 | 207 | 494 | 174 | 530 | 148 | 556 | 105 | 620 | 80 | 321 |
| 2E | | MI | 235 | 249 | 360 | 199 | 405 | 166 | 423 | 139 | 432 | 97 | 467 | 68 | 264 |
| 4-#6 | 1.47 | MA | 302 | 264 | 461 | 216 | 539 | 180 | 583 | 151 | 620 | 102 | 690 | 71 | 430 |
| 2E | | MI | 243 | 264 | 387 | 207 | 435 | 171 | 457 | 141 | 474 | 92 | 508 | 56 | 347 |
| 4-#7 | 2.00 | MA | 316 | 283 | 505 | 226 | 592 | 188 | 644 | 155 | 696 | 99 | 772 | 60 | 558 |
| 2E | | MI | 252 | 283 | 419 | 217 | 470 | 177 | 496 | 143 | 523 | 86 | 554 | 40 | 443 |
| 4-#8 | 2.63 | MA | 331 | 305 | 556 | 239 | 654 | 197 | 713 | 160 | 783 | 94 | 864 | 46 | 705 |
| 2E | | MI | 262 | 305 | 455 | 230 | 508 | 184 | 539 | 145 | 577 | 79 | 604 | 20 | 550 |
| 4-#9 | 3.33 | MA | 347 | 330 | 610 | 253 | 720 | 207 | 785 | 164 | 873 | 88 | 959 | 29 | 860 |
| 2E | | MI | 273 | 330 | 489 | 243 | 547 | 192 | 583 | 147 | 633 | 70 | 668 | 2 | 662 |
| 4-#10 | 4.23 | MA | 367 | 362 | 677 | 272 | 802 | 221 | 874 | 170 | 985 | 80 | 1071 | 6 | 1051 |
| 2E | | MI | 285 | 362 | 531 | 259 | 594 | 201 | 636 | 149 | 699 | 58 | 728 | -28 | 719 |
| 4-#11 | 5.20 | MA | 380 | 396 | 736 | 289 | 852 | 228 | 929 | 169 | 1052 | 64 | 1114 | -33 | 1113 |
| 2E | | MI | 292 | 396 | 551 | 269 | 613 | 203 | 656 | 143 | 723 | 35 | 721 | -80 | 731 |
| 6-#5 | 1.55 | MA | 306 | 267 | 468 | 219 | 549 | 182 | 597 | 153 | 641 | 104 | 718 | 72 | 453 |
| 2L-3S | | MI | 227 | 267 | 360 | 210 | 405 | 174 | 423 | 144 | 432 | 94 | 467 | 35 | 368 |
| 6-#5 | 1.55 | MA | 280 | 267 | 424 | 219 | 494 | 183 | 530 | 153 | 556 | 104 | 620 | 49 | 456 |
| 3L-2S | | MI | 246 | 267 | 392 | 210 | 445 | 174 | 469 | 144 | 490 | 94 | 528 | 57 | 365 |
| 6-#6 | 2.20 | MA | 323 | 290 | 522 | 232 | 616 | 192 | 676 | 159 | 737 | 100 | 824 | 60 | 612 |
| 2L-3S | | MI | 233 | 290 | 387 | 223 | 435 | 181 | 457 | 148 | 474 | 88 | 508 | 9 | 485 |
| 6-#6 | 2.20 | MA | 290 | 290 | 461 | 233 | 539 | 192 | 583 | 158 | 620 | 101 | 690 | 27 | 610 |
| 3L-2S | | MI | 258 | 290 | 432 | 223 | 489 | 182 | 519 | 147 | 554 | 87 | 591 | 39 | 483 |
| 6-#7 | 3.00 | MA | 344 | 318 | 587 | 248 | 695 | 204 | 767 | 165 | 852 | 94 | 948 | 43 | 798 |
| 2L-3S | | MI | 240 | 318 | 419 | 239 | 470 | 191 | 496 | 152 | 523 | 80 | 554 | -25 | 553 |
| 6-#7 | 3.00 | MA | 302 | 318 | 505 | 249 | 592 | 204 | 644 | 164 | 696 | 96 | 772 | -1 | 772 |
| 3L-2S | | MI | 271 | 318 | 478 | 240 | 541 | 192 | 578 | 150 | 627 | 78 | 661 | 15 | 620 |
| 6-#8 | 3.95 | MA | 315 | 352 | 556 | 269 | 654 | 217 | 713 | 171 | 783 | 89 | 864 | -36 | 854 |
| 3L-2S | | MI | 286 | 352 | 531 | 259 | 598 | 203 | 643 | 154 | 709 | 68 | 737 | -15 | 740 |
| 6-#9 | 5.00 | MA | 330 | 389 | 610 | 291 | 720 | 233 | 785 | 178 | 873 | 81 | 959 | -76 | 937 |
| 3L-2S | | MI | 302 | 389 | 582 | 279 | 657 | 215 | 710 | 158 | 793 | 54 | 835 | -41 | 821 |
| 6-#10 | 6.35 | MA | 350 | 436 | 677 | 319 | 802 | 252 | 874 | 191 | 985 | 70 | 1071 | -130 | 1038 |
| 3L-2S | | MI | 322 | 436 | 642 | 304 | 726 | 229 | 789 | 161 | 893 | 36 | 925 | -86 | 913 |

## RECTANGULAR TIED COLUMNS 10" x 14"

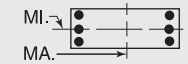
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.26 | MA | 411 | 299 | 597 | 253 | 710 | 212 | 775 | 179 | 842 | 128 | 961 | 98 | 525 |
| 2E | | MI | 279 | 299 | 437 | 236 | 489 | 196 | 512 | 163 | 527 | 110 | 564 | 71 | 358 |
| 4-#7 | 1.71 | MA | 431 | 318 | 653 | 264 | 779 | 220 | 856 | 184 | 946 | 126 | 1080 | 90 | 688 |
| 2E | | MI | 288 | 318 | 469 | 246 | 524 | 202 | 551 | 165 | 575 | 104 | 610 | 55 | 456 |
| 4-#8 | 2.26 | MA | 453 | 341 | 719 | 277 | 859 | 229 | 951 | 190 | 1066 | 123 | 1216 | 80 | 875 |
| 2E | | MI | 298 | 341 | 505 | 259 | 563 | 209 | 594 | 167 | 629 | 96 | 660 | 35 | 566 |
| 4-#9 | 2.86 | MA | 475 | 365 | 789 | 291 | 945 | 239 | 1054 | 196 | 1194 | 119 | 1359 | 67 | 1076 |
| 2E | | MI | 308 | 365 | 540 | 271 | 602 | 216 | 639 | 168 | 685 | 87 | 724 | 17 | 680 |
| 4-#10 | 3.63 | MA | 503 | 397 | 876 | 309 | 1053 | 253 | 1183 | 204 | 1351 | 114 | 1533 | 50 | 1325 |
| 2E | | MI | 321 | 397 | 582 | 287 | 649 | 225 | 691 | 170 | 751 | 74 | 783 | -14 | 772 |
| 4-#11 | 4.46 | MA | 522 | 431 | 960 | 327 | 1149 | 265 | 1287 | 210 | 1466 | 102 | 1635 | 20 | 1553 |
| 2E | | MI | 327 | 431 | 603 | 296 | 668 | 226 | 711 | 163 | 774 | 51 | 775 | -66 | 784 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 10" x 14"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

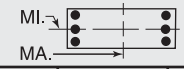
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.33 | MA | 417 | 302 | 604 | 256 | 723 | 214 | 791 | 181 | 868 | 129 | 995 | 99 | 554 |
| 2L-3S | | MI | 263 | 302 | 409 | 240 | 459 | 199 | 478 | 166 | 485 | 112 | 524 | 50 | 380 |
| 6-#5 | 1.33 | MA | 383 | 302 | 549 | 258 | 653 | 215 | 707 | 181 | 755 | 130 | 860 | 76 | 556 |
| 3L-2S | | MI | 282 | 302 | 441 | 240 | 499 | 199 | 524 | 165 | 543 | 111 | 586 | 72 | 376 |
| 6-#6 | 1.89 | MA | 441 | 325 | 674 | 269 | 808 | 224 | 892 | 187 | 999 | 127 | 1147 | 90 | 754 |
| 2L-3S | | MI | 268 | 325 | 437 | 252 | 489 | 206 | 512 | 169 | 527 | 105 | 564 | 24 | 500 |
| 6-#6 | 1.89 | MA | 397 | 325 | 597 | 271 | 710 | 225 | 775 | 187 | 842 | 128 | 961 | 58 | 753 |
| 3L-2S | | MI | 293 | 325 | 481 | 252 | 544 | 207 | 574 | 168 | 606 | 104 | 648 | 54 | 496 |
| 6-#7 | 2.57 | MA | 469 | 353 | 757 | 286 | 910 | 236 | 1015 | 194 | 1156 | 124 | 1328 | 78 | 993 |
| 2L-3S | | MI | 275 | 353 | 469 | 267 | 524 | 215 | 551 | 173 | 575 | 97 | 610 | -10 | 610 |
| 6-#7 | 2.57 | MA | 414 | 353 | 653 | 288 | 779 | 237 | 856 | 195 | 946 | 125 | 1080 | 34 | 982 |
| 3L-2S | | MI | 307 | 353 | 528 | 268 | 595 | 217 | 633 | 172 | 679 | 96 | 718 | 30 | 636 |
| 6-#8 | 3.39 | MA | 433 | 387 | 719 | 309 | 859 | 252 | 951 | 203 | 1066 | 121 | 1216 | 5 | 1208 |
| 3L-2S | | MI | 322 | 387 | 581 | 288 | 653 | 228 | 698 | 176 | 761 | 85 | 794 | 0 | 793 |
| 6-#9 | 4.29 | MA | 454 | 424 | 789 | 331 | 945 | 268 | 1054 | 213 | 1194 | 116 | 1359 | -29 | 1341 |
| 3L-2S | | MI | 338 | 424 | 633 | 307 | 711 | 239 | 765 | 179 | 845 | 71 | 891 | -26 | 876 |
| 6-#10 | 5.44 | MA | 481 | 472 | 876 | 360 | 1053 | 288 | 1183 | 225 | 1351 | 109 | 1533 | -74 | 1489 |
| 3L-2S | | MI | 357 | 472 | 694 | 332 | 781 | 253 | 844 | 182 | 945 | 53 | 981 | -72 | 970 |
| 6-#11 | 6.69 | MA | 500 | 523 | 960 | 387 | 1149 | 307 | 1287 | 232 | 1466 | 94 | 1635 | -139 | 1570 |
| 3L-2S | | MI | 368 | 523 | 723 | 348 | 810 | 257 | 875 | 174 | 981 | 20 | 972 | -149 | 988 |
| 8-#5 | 1.77 | MA | 407 | 321 | 604 | 269 | 723 | 224 | 791 | 187 | 868 | 129 | 995 | 71 | 717 |
| 3E | | MI | 274 | 321 | 441 | 251 | 499 | 207 | 524 | 170 | 543 | 108 | 586 | 39 | 477 |
| 8-#5 | 1.77 | MA | 387 | 321 | 564 | 271 | 669 | 226 | 725 | 189 | 778 | 128 | 897 | 60 | 707 |
| 4L-2S | | MI | 292 | 321 | 473 | 251 | 539 | 208 | 570 | 170 | 601 | 107 | 647 | 61 | 475 |
| 8-#6 | 2.51 | MA | 429 | 351 | 674 | 287 | 808 | 237 | 892 | 195 | 999 | 126 | 1147 | 49 | 974 |
| 3E | | MI | 284 | 351 | 481 | 268 | 544 | 217 | 574 | 175 | 606 | 100 | 648 | 6 | 631 |
| 8-#6 | 2.51 | MA | 403 | 351 | 618 | 289 | 732 | 240 | 800 | 197 | 875 | 125 | 1011 | 35 | 908 |
| 4L-2S | | MI | 308 | 351 | 526 | 269 | 598 | 218 | 637 | 174 | 685 | 99 | 731 | 37 | 630 |
| 8-#7 | 3.43 | MA | 455 | 389 | 757 | 310 | 910 | 253 | 1015 | 205 | 1156 | 123 | 1328 | 22 | 1276 |
| 3E | | MI | 296 | 389 | 528 | 289 | 595 | 230 | 633 | 180 | 679 | 89 | 718 | -35 | 717 |
| 8-#7 | 3.43 | MA | 422 | 389 | 682 | 313 | 808 | 257 | 890 | 208 | 990 | 121 | 1146 | 2 | 1139 |
| 4L-2S | | MI | 326 | 389 | 588 | 290 | 666 | 232 | 715 | 179 | 784 | 87 | 825 | 5 | 811 |
| 8-#8 | 4.51 | MA | 446 | 434 | 755 | 341 | 896 | 278 | 995 | 220 | 1123 | 116 | 1300 | -37 | 1287 |
| 4L-2S | | MI | 346 | 434 | 657 | 317 | 743 | 247 | 802 | 184 | 893 | 73 | 927 | -34 | 932 |
| 8-#9 | 5.71 | MA | 473 | 483 | 834 | 371 | 991 | 301 | 1108 | 234 | 1263 | 109 | 1460 | -82 | 1422 |
| 4L-2S | | MI | 368 | 483 | 725 | 343 | 821 | 262 | 891 | 189 | 1005 | 56 | 1057 | -69 | 1037 |

## RECTANGULAR TIED COLUMNS 10" x 16"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.10 | MA | 536 | 335 | 743 | 291 | 900 | 244 | 987 | 207 | 1078 | 151 | 1260 | 123 | 620 |
| 2E | | MI | 314 | 335 | 486 | 265 | 544 | 221 | 567 | 184 | 579 | 127 | 621 | 86 | 369 |
| 4-#7 | 1.50 | MA | 562 | 354 | 812 | 301 | 984 | 252 | 1087 | 212 | 1211 | 150 | 1418 | 117 | 818 |
| 2E | | MI | 323 | 354 | 519 | 275 | 579 | 227 | 606 | 186 | 628 | 121 | 667 | 70 | 469 |
| 4-#8 | 1.98 | MA | 590 | 376 | 892 | 314 | 1082 | 261 | 1203 | 218 | 1366 | 148 | 1600 | 109 | 1046 |
| 2E | | MI | 333 | 376 | 556 | 287 | 617 | 233 | 649 | 188 | 682 | 113 | 717 | 50 | 580 |
| 4-#9 | 2.50 | MA | 620 | 401 | 979 | 328 | 1188 | 271 | 1330 | 224 | 1535 | 146 | 1792 | 100 | 1292 |
| 2E | | MI | 344 | 401 | 591 | 299 | 657 | 240 | 694 | 190 | 737 | 104 | 780 | 32 | 696 |
| 4-#10 | 3.17 | MA | 656 | 432 | 1087 | 347 | 1321 | 285 | 1489 | 232 | 1745 | 144 | 2030 | 87 | 1600 |
| 2E | | MI | 356 | 432 | 633 | 315 | 704 | 249 | 747 | 191 | 803 | 91 | 839 | 1 | 837 |
| 4-#11 | 3.90 | MA | 683 | 467 | 1195 | 365 | 1446 | 297 | 1635 | 240 | 1909 | 135 | 2196 | 63 | 1890 |
| 2E | | MI | 362 | 467 | 655 | 323 | 723 | 249 | 766 | 184 | 825 | 67 | 830 | -52 | 835 |
| 6-#5 | 1.16 | MA | 542 | 338 | 751 | 294 | 914 | 246 | 1006 | 209 | 1105 | 152 | 1301 | 124 | 654 |
| 2L-3S | | MI | 298 | 338 | 459 | 269 | 514 | 224 | 534 | 188 | 538 | 129 | 581 | 65 | 390 |
| 6-#5 | 1.16 | MA | 500 | 338 | 685 | 296 | 830 | 248 | 904 | 210 | 968 | 153 | 1128 | 101 | 657 |
| 3L-2S | | MI | 317 | 338 | 491 | 269 | 553 | 224 | 579 | 187 | 596 | 128 | 643 | 87 | 386 |
| 6-#6 | 1.65 | MA | 574 | 361 | 836 | 307 | 1018 | 256 | 1129 | 215 | 1269 | 150 | 1501 | 117 | 897 |
| 2L-3S | | MI | 303 | 361 | 486 | 281 | 544 | 231 | 567 | 191 | 579 | 122 | 621 | 39 | 513 |
| 6-#6 | 1.65 | MA | 519 | 361 | 743 | 310 | 900 | 258 | 987 | 216 | 1078 | 152 | 1260 | 85 | 895 |
| 3L-2S | | MI | 329 | 361 | 531 | 281 | 598 | 232 | 630 | 190 | 659 | 121 | 704 | 69 | 509 |

## RECTANGULAR TIED COLUMNS 10" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#7 | 2.25 | MA | 611 | 389 | 938 | 323 | 1143 | 268 | 1279 | 222 | 1469 | 148 | 1739 | 108 | 1187 |
| 2L-3S | | MI | 310 | 389 | 519 | 296 | 579 | 240 | 606 | 195 | 628 | 114 | 667 | 5 | 653 |
| 6-#7 | 2.25 | MA | 541 | 389 | 812 | 327 | 984 | 270 | 1087 | 224 | 1211 | 150 | 1418 | 64 | 1176 |
| 3L-2S | | MI | 342 | 389 | 578 | 297 | 650 | 241 | 688 | 193 | 732 | 113 | 774 | 45 | 651 |
| 6-#8 | 2.96 | MA | 567 | 422 | 892 | 347 | 1082 | 285 | 1203 | 233 | 1366 | 149 | 1600 | 39 | 1494 |
| 3L-2S | | MI | 358 | 422 | 632 | 316 | 707 | 252 | 753 | 197 | 814 | 101 | 850 | 15 | 810 |
| 6-#9 | 3.75 | MA | 594 | 459 | 979 | 370 | 1188 | 302 | 1330 | 243 | 1535 | 147 | 1792 | 10 | 1772 |
| 3L-2S | | MI | 373 | 459 | 683 | 336 | 766 | 263 | 820 | 200 | 897 | 88 | 947 | -11 | 929 |
| 6-#10 | 4.76 | MA | 629 | 507 | 1087 | 400 | 1321 | 323 | 1489 | 256 | 1745 | 143 | 2030 | -29 | 2002 |
| 3L-2S | | MI | 393 | 507 | 745 | 360 | 836 | 277 | 899 | 203 | 997 | 70 | 1036 | -57 | 1025 |
| 6-#11 | 5.85 | MA | 656 | 558 | 1195 | 428 | 1446 | 342 | 1635 | 266 | 1909 | 132 | 2196 | -84 | 2125 |
| 3L-2S | | MI | 403 | 558 | 775 | 375 | 865 | 281 | 930 | 194 | 1033 | 36 | 1026 | -135 | 1043 |
| 8-#5 | 1.55 | MA | 530 | 356 | 751 | 307 | 914 | 256 | 1006 | 215 | 1105 | 152 | 1301 | 97 | 851 |
| 3E | | MI | 310 | 356 | 491 | 280 | 553 | 232 | 579 | 192 | 596 | 126 | 643 | 54 | 490 |
| 8-#5 | 1.55 | MA | 505 | 356 | 704 | 309 | 852 | 258 | 927 | 218 | 998 | 152 | 1177 | 86 | 846 |
| 4L-2S | | MI | 328 | 356 | 523 | 280 | 593 | 233 | 625 | 191 | 654 | 125 | 705 | 76 | 486 |
| 8-#6 | 2.20 | MA | 560 | 386 | 836 | 326 | 1018 | 270 | 1129 | 224 | 1269 | 151 | 1501 | 79 | 1164 |
| 3E | | MI | 319 | 386 | 531 | 297 | 598 | 242 | 630 | 197 | 659 | 117 | 704 | 21 | 647 |
| 8-#6 | 2.20 | MA | 526 | 386 | 770 | 328 | 931 | 272 | 1019 | 227 | 1119 | 151 | 1327 | 63 | 1107 |
| 4L-2S | | MI | 344 | 386 | 576 | 298 | 652 | 243 | 692 | 196 | 738 | 116 | 787 | 52 | 644 |
| 8-#7 | 3.00 | MA | 594 | 424 | 938 | 349 | 1143 | 287 | 1279 | 234 | 1469 | 149 | 1739 | 56 | 1535 |
| 3E | | MI | 330 | 424 | 578 | 318 | 650 | 255 | 688 | 202 | 732 | 106 | 774 | -20 | 774 |
| 8-#7 | 3.00 | MA | 554 | 424 | 848 | 352 | 1026 | 289 | 1130 | 238 | 1266 | 149 | 1507 | 34 | 1393 |
| 4L-2S | | MI | 362 | 424 | 638 | 319 | 721 | 256 | 770 | 201 | 836 | 105 | 881 | 20 | 827 |
| 8-#8 | 3.95 | MA | 585 | 469 | 939 | 381 | 1136 | 310 | 1259 | 252 | 1438 | 146 | 1714 | -1 | 1713 |
| 4L-2S | | MI | 382 | 469 | 708 | 345 | 797 | 271 | 857 | 206 | 945 | 90 | 983 | -19 | 987 |
| 8-#9 | 5.00 | MA | 620 | 518 | 1036 | 412 | 1247 | 337 | 1399 | 266 | 1623 | 143 | 1932 | -41 | 1903 |
| 4L-2S | | MI | 403 | 518 | 776 | 372 | 875 | 287 | 946 | 210 | 1057 | 73 | 1113 | -54 | 1094 |
| 8-#10 | 6.35 | MA | 665 | 582 | 1159 | 453 | 1395 | 367 | 1575 | 285 | 1855 | 138 | 2201 | -94 | 2123 |
| 4L-2S | | MI | 430 | 582 | 857 | 405 | 968 | 306 | 1052 | 215 | 1191 | 48 | 1233 | -115 | 1217 |

## RECTANGULAR TIED COLUMNS 10" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#7 | 1.33 | MA | 707 | 389 | 983 | 339 | 1206 | 284 | 1338 | 240 | 1490 | 172 | 1785 | 142 | 947 |
| 2E | | MI | 359 | 389 | 569 | 304 | 633 | 251 | 661 | 208 | 680 | 138 | 724 | 85 | 481 |
| 4-#8 | 1.76 | MA | 743 | 411 | 1078 | 352 | 1322 | 293 | 1476 | 246 | 1674 | 170 | 2013 | 136 | 1217 |
| 2E | | MI | 369 | 411 | 606 | 316 | 672 | 258 | 705 | 209 | 734 | 130 | 773 | 65 | 594 |
| 4-#9 | 2.22 | MA | 780 | 436 | 1180 | 366 | 1448 | 303 | 1626 | 252 | 1874 | 169 | 2256 | 129 | 1508 |
| 2E | | MI | 379 | 436 | 642 | 328 | 711 | 264 | 749 | 211 | 789 | 120 | 836 | 47 | 712 |
| 4-#10 | 2.82 | MA | 825 | 468 | 1310 | 384 | 1607 | 317 | 1816 | 260 | 2128 | 167 | 2560 | 119 | 1874 |
| 2E | | MI | 392 | 468 | 684 | 343 | 758 | 273 | 802 | 212 | 855 | 108 | 895 | 15 | 855 |
| 4-#11 | 3.47 | MA | 861 | 502 | 1441 | 402 | 1761 | 329 | 1996 | 268 | 2365 | 163 | 2792 | 100 | 2227 |
| 2E | | MI | 397 | 502 | 708 | 351 | 778 | 273 | 821 | 204 | 877 | 83 | 884 | -38 | 902 |
| 6-#5 | 1.03 | MA | 682 | 373 | 910 | 331 | 1123 | 279 | 1241 | 237 | 1363 | 174 | 1635 | 147 | 755 |
| 2L-3S | | MI | 333 | 373 | 508 | 298 | 568 | 249 | 589 | 210 | 591 | 146 | 638 | 81 | 400 |
| 6-#5 | 1.03 | MA | 632 | 373 | 833 | 334 | 1025 | 280 | 1122 | 238 | 1203 | 176 | 1423 | 124 | 757 |
| 3L-2S | | MI | 353 | 373 | 540 | 298 | 608 | 250 | 635 | 209 | 649 | 146 | 700 | 103 | 396 |
| 6-#6 | 1.47 | MA | 722 | 396 | 1010 | 344 | 1245 | 288 | 1387 | 243 | 1558 | 172 | 1883 | 142 | 1039 |
| 2L-3S | | MI | 338 | 396 | 536 | 310 | 598 | 256 | 622 | 213 | 632 | 140 | 678 | 54 | 526 |
| 6-#6 | 1.47 | MA | 655 | 396 | 901 | 348 | 1107 | 291 | 1219 | 245 | 1332 | 175 | 1587 | 110 | 1038 |
| 3L-2S | | MI | 364 | 396 | 581 | 311 | 652 | 257 | 685 | 212 | 711 | 139 | 761 | 84 | 521 |
| 6-#7 | 2.00 | MA | 768 | 424 | 1130 | 361 | 1393 | 300 | 1563 | 250 | 1794 | 170 | 2180 | 136 | 1382 |
| 2L-3S | | MI | 345 | 424 | 569 | 325 | 633 | 265 | 661 | 216 | 680 | 131 | 724 | 20 | 669 |
| 6-#7 | 2.00 | MA | 682 | 424 | 983 | 365 | 1206 | 303 | 1338 | 253 | 1490 | 174 | 1785 | 92 | 1370 |
| 3L-2S | | MI | 378 | 424 | 628 | 326 | 704 | 266 | 743 | 215 | 784 | 130 | 831 | 60 | 665 |
| 6-#8 | 2.63 | MA | 716 | 458 | 1078 | 386 | 1322 | 319 | 1476 | 262 | 1674 | 173 | 2013 | 70 | 1750 |
| 3L-2S | | MI | 393 | 458 | 682 | 345 | 762 | 277 | 809 | 218 | 866 | 118 | 906 | 30 | 826 |
| 6-#9 | 3.33 | MA | 750 | 495 | 1180 | 409 | 1448 | 335 | 1626 | 273 | 1874 | 171 | 2256 | 44 | 2152 |
| 3L-2S | | MI | 409 | 495 | 734 | 364 | 821 | 288 | 875 | 221 | 949 | 105 | 1003 | 4 | 994 |

## RECTANGULAR TIED COLUMNS 10" x 18"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#10 | 4.23 | MA | 793 | 543 | 1310 | 439 | 1607 | 357 | 1816 | 286 | 2128 | 169 | 2560 | 10 | 2538 |
| 3L-2S | | MI | 428 | 543 | 796 | 388 | 891 | 301 | 955 | 224 | 1049 | 86 | 1092 | -43 | 1079 |
| 6-#11 | 5.20 | MA | 828 | 594 | 1441 | 468 | 1761 | 377 | 1996 | 298 | 2365 | 164 | 2792 | -39 | 2743 |
| 3L-2S | | MI | 437 | 594 | 827 | 403 | 920 | 304 | 984 | 214 | 1084 | 52 | 1081 | -121 | 1097 |
| 8-#5 | 1.38 | MA | 668 | 391 | 910 | 345 | 1123 | 289 | 1241 | 244 | 1363 | 175 | 1635 | 122 | 985 |
| 3E | | MI | 345 | 391 | 540 | 310 | 608 | 257 | 635 | 214 | 649 | 143 | 700 | 69 | 501 |
| 8-#5 | 1.38 | MA | 639 | 391 | 855 | 347 | 1051 | 291 | 1150 | 247 | 1239 | 176 | 1484 | 109 | 980 |
| 4L-2S | | MI | 364 | 391 | 572 | 310 | 647 | 258 | 680 | 213 | 707 | 142 | 762 | 91 | 497 |
| 8-#6 | 1.96 | MA | 704 | 422 | 1010 | 364 | 1245 | 303 | 1387 | 252 | 1558 | 174 | 1883 | 106 | 1354 |
| 3E | | MI | 354 | 422 | 581 | 326 | 652 | 267 | 685 | 218 | 711 | 134 | 761 | 37 | 661 |
| 8-#6 | 1.96 | MA | 665 | 422 | 933 | 367 | 1144 | 305 | 1258 | 256 | 1382 | 175 | 1672 | 89 | 1312 |
| 4L-2S | | MI | 379 | 422 | 625 | 327 | 707 | 268 | 748 | 217 | 791 | 133 | 844 | 67 | 657 |
| 8-#7 | 2.67 | MA | 748 | 460 | 1130 | 387 | 1393 | 320 | 1563 | 263 | 1794 | 173 | 2180 | 86 | 1795 |
| 3E | | MI | 365 | 460 | 628 | 347 | 704 | 280 | 743 | 223 | 784 | 123 | 831 | -5 | 831 |
| 8-#7 | 2.67 | MA | 698 | 460 | 1026 | 391 | 1257 | 323 | 1389 | 268 | 1556 | 173 | 1898 | 63 | 1655 |
| 4L-2S | | MI | 397 | 460 | 688 | 348 | 775 | 281 | 826 | 222 | 888 | 122 | 938 | 35 | 843 |
| 8-#8 | 3.51 | MA | 739 | 504 | 1133 | 420 | 1388 | 344 | 1543 | 282 | 1761 | 172 | 2158 | 31 | 2043 |
| 4L-2S | | MI | 417 | 504 | 758 | 374 | 852 | 296 | 913 | 227 | 998 | 107 | 1039 | -5 | 1040 |
| 8-#9 | 4.44 | MA | 782 | 554 | 1250 | 452 | 1530 | 367 | 1710 | 298 | 1982 | 169 | 2435 | -5 | 2429 |
| 4L-2S | | MI | 439 | 554 | 827 | 400 | 930 | 311 | 1001 | 231 | 1109 | 89 | 1169 | -39 | 1149 |
| 8-#10 | 5.64 | MA | 838 | 617 | 1396 | 494 | 1709 | 397 | 1921 | 317 | 2263 | 166 | 2780 | -53 | 2721 |
| 4L-2S | | MI | 465 | 617 | 908 | 433 | 1023 | 330 | 1107 | 236 | 1243 | 65 | 1289 | -101 | 1274 |
| 8-#11 | 6.93 | MA | 883 | 686 | 1542 | 534 | 1866 | 432 | 2118 | 334 | 2522 | 158 | 3041 | -118 | 2911 |
| 4L-2S | | MI | 479 | 686 | 946 | 455 | 1061 | 335 | 1148 | 225 | 1291 | 21 | 1277 | -203 | 1299 |
| 10-#10 | 7.06 | MA | 888 | 692 | 1505 | 548 | 1818 | 443 | 2060 | 343 | 2440 | 169 | 3011 | -125 | 2872 |
| 5L-2S | | MI | 502 | 692 | 1020 | 478 | 1156 | 358 | 1260 | 248 | 1437 | 44 | 1486 | -159 | 1462 |

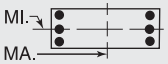
## RECTANGULAR TIED COLUMNS 10" x 20"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#7 | 1.20 | MA | 867 | 424 | 1164 | 376 | 1446 | 316 | 1609 | 268 | 1791 | 194 | 2179 | 165 | 1077 |
| 2E | | MI | 394 | 424 | 619 | 333 | 688 | 276 | 716 | 229 | 732 | 155 | 780 | 100 | 492 |
| 4-#8 | 1.58 | MA | 910 | 447 | 1274 | 389 | 1580 | 325 | 1769 | 274 | 2004 | 192 | 2454 | 161 | 1387 |
| 2E | | MI | 404 | 447 | 656 | 344 | 726 | 282 | 760 | 231 | 786 | 147 | 829 | 80 | 608 |
| 4-#9 | 2.00 | MA | 956 | 471 | 1393 | 403 | 1726 | 335 | 1943 | 280 | 2236 | 191 | 2749 | 156 | 1724 |
| 2E | | MI | 415 | 471 | 692 | 356 | 766 | 289 | 804 | 232 | 841 | 137 | 892 | 61 | 728 |
| 4-#10 | 2.54 | MA | 1011 | 503 | 1543 | 422 | 1911 | 349 | 2164 | 288 | 2531 | 189 | 3119 | 148 | 2148 |
| 2E | | MI | 427 | 503 | 735 | 371 | 813 | 297 | 857 | 233 | 907 | 124 | 950 | 30 | 872 |
| 4-#11 | 3.12 | MA | 1056 | 537 | 1698 | 440 | 2093 | 361 | 2377 | 296 | 2811 | 185 | 3420 | 133 | 2564 |
| 2E | | MI | 432 | 537 | 760 | 378 | 834 | 296 | 876 | 225 | 928 | 100 | 939 | -23 | 951 |
| 6-#6 | 1.32 | MA | 884 | 431 | 1195 | 382 | 1490 | 320 | 1664 | 271 | 1868 | 194 | 2293 | 166 | 1182 |
| 2L-3S | | MI | 374 | 431 | 586 | 339 | 653 | 281 | 678 | 234 | 684 | 157 | 735 | 69 | 538 |
| 6-#6 | 1.32 | MA | 806 | 431 | 1070 | 386 | 1331 | 323 | 1472 | 273 | 1609 | 198 | 1942 | 134 | 1180 |
| 3L-2S | | MI | 400 | 431 | 630 | 340 | 707 | 282 | 740 | 233 | 764 | 156 | 818 | 99 | 532 |
| 6-#7 | 1.80 | MA | 940 | 460 | 1334 | 398 | 1661 | 332 | 1869 | 278 | 2140 | 193 | 2649 | 162 | 1576 |
| 2L-3S | | MI | 380 | 460 | 619 | 354 | 688 | 289 | 716 | 238 | 732 | 148 | 780 | 35 | 684 |
| 6-#7 | 1.80 | MA | 839 | 460 | 1164 | 403 | 1446 | 336 | 1609 | 281 | 1791 | 197 | 2179 | 118 | 1565 |
| 3L-2S | | MI | 414 | 460 | 678 | 355 | 759 | 291 | 799 | 236 | 837 | 147 | 887 | 75 | 678 |
| 6-#8 | 2.37 | MA | 877 | 493 | 1274 | 424 | 1580 | 352 | 1769 | 291 | 2004 | 196 | 2454 | 98 | 2006 |
| 3L-2S | | MI | 429 | 493 | 732 | 374 | 817 | 301 | 864 | 239 | 918 | 135 | 962 | 45 | 841 |
| 6-#9 | 3.00 | MA | 917 | 530 | 1393 | 448 | 1726 | 369 | 1943 | 302 | 2236 | 195 | 2749 | 75 | 2476 |
| 3L-2S | | MI | 444 | 530 | 785 | 392 | 875 | 312 | 930 | 242 | 1001 | 122 | 1059 | 18 | 1011 |
| 6-#10 | 3.81 | MA | 973 | 578 | 1543 | 478 | 1911 | 391 | 2164 | 316 | 2531 | 194 | 3119 | 44 | 3012 |
| 3L-2S | | MI | 463 | 578 | 847 | 416 | 946 | 325 | 1010 | 245 | 1101 | 103 | 1147 | -28 | 1132 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 10" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 4.68 | MA | 1017 | 629 | 1698 | 507 | 2093 | 411 | 2377 | 328 | 2811 | 189 | 3420 | 1 | 3419 |
| 3L-2S | | MI | 472 | 629 | 879 | 430 | 975 | 327 | 1039 | 235 | 1135 | 68 | 1135 | -106 | 1150 |
| 8-#5 | 1.24 | MA | 821 | 427 | 1080 | 383 | 1349 | 321 | 1496 | 272 | 1644 | 198 | 1997 | 146 | 1119 |
| 3E | | MI | 380 | 427 | 589 | 339 | 662 | 282 | 690 | 236 | 701 | 160 | 757 | 84 | 512 |
| 8-#5 | 1.24 | MA | 787 | 427 | 1018 | 385 | 1268 | 323 | 1392 | 275 | 1502 | 199 | 1820 | 132 | 1114 |
| 4L-2S | | MI | 399 | 427 | 621 | 339 | 702 | 283 | 736 | 235 | 759 | 160 | 819 | 106 | 508 |
| 8-#6 | 1.76 | MA | 864 | 457 | 1195 | 402 | 1490 | 335 | 1664 | 281 | 1868 | 197 | 2293 | 132 | 1545 |
| 3E | | MI | 390 | 457 | 630 | 355 | 707 | 292 | 740 | 240 | 764 | 151 | 818 | 52 | 674 |
| 8-#6 | 1.76 | MA | 819 | 457 | 1107 | 405 | 1375 | 338 | 1518 | 285 | 1667 | 198 | 2045 | 113 | 1520 |
| 4L-2S | | MI | 415 | 457 | 675 | 356 | 761 | 293 | 803 | 239 | 843 | 150 | 901 | 82 | 670 |
| 8-#7 | 2.40 | MA | 915 | 495 | 1334 | 425 | 1661 | 352 | 1869 | 292 | 2140 | 196 | 2649 | 114 | 2054 |
| 3E | | MI | 401 | 495 | 678 | 376 | 759 | 304 | 799 | 245 | 837 | 140 | 887 | 10 | 860 |
| 8-#7 | 2.40 | MA | 858 | 495 | 1215 | 430 | 1505 | 356 | 1670 | 298 | 1869 | 197 | 2316 | 89 | 1924 |
| 4L-2S | | MI | 433 | 495 | 738 | 377 | 830 | 305 | 881 | 243 | 941 | 139 | 995 | 50 | 858 |
| 8-#8 | 3.16 | MA | 904 | 540 | 1340 | 460 | 1657 | 378 | 1848 | 312 | 2106 | 196 | 2631 | 60 | 2378 |
| 4L-2S | | MI | 453 | 540 | 809 | 403 | 907 | 320 | 968 | 248 | 1050 | 124 | 1096 | 10 | 1068 |
| 8-#9 | 4.00 | MA | 960 | 589 | 1475 | 492 | 1822 | 402 | 2042 | 328 | 2363 | 195 | 2968 | 27 | 2859 |
| 4L-2S | | MI | 474 | 589 | 877 | 428 | 985 | 335 | 1057 | 252 | 1161 | 106 | 1225 | -25 | 1203 |
| 8-#10 | 5.08 | MA | 1027 | 653 | 1646 | 534 | 2031 | 432 | 2287 | 349 | 2690 | 193 | 3390 | -17 | 3364 |
| 4L-2S | | MI | 500 | 653 | 959 | 461 | 1078 | 354 | 1163 | 257 | 1295 | 82 | 1345 | -86 | 1330 |
| 8-#11 | 6.24 | MA | 1083 | 721 | 1819 | 575 | 2234 | 461 | 2522 | 367 | 2998 | 187 | 3731 | -76 | 3621 |
| 4L-2S | | MI | 514 | 721 | 999 | 482 | 1116 | 359 | 1203 | 245 | 1343 | 37 | 1332 | -189 | 1354 |
| 10-#10 | 6.35 | MA | 1080 | 727 | 1774 | 590 | 2160 | 480 | 2452 | 377 | 2899 | 198 | 3667 | -84 | 3532 |
| 5L-2S | | MI | 537 | 727 | 1071 | 506 | 1210 | 382 | 1315 | 269 | 1489 | 61 | 1542 | -144 | 1521 |

## RECTANGULAR TIED COLUMNS 12" x 12"

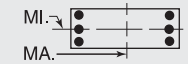
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.29 | MA | 357 | 309 | 535 | 255 | 626 | 214 | 676 | 181 | 718 | 125 | 803 | 91 | 465 |
| 2L-3S | | MI | 331 | 309 | 492 | 256 | 571 | 214 | 610 | 180 | 633 | 126 | 705 | 69 | 469 |
| 6-#6 | 1.83 | MA | 375 | 332 | 590 | 268 | 693 | 223 | 756 | 186 | 814 | 121 | 909 | 79 | 626 |
| 2L-3S | | MI | 341 | 332 | 529 | 269 | 616 | 223 | 663 | 185 | 697 | 122 | 775 | 46 | 627 |
| 6-#7 | 2.50 | MA | 396 | 361 | 655 | 285 | 772 | 235 | 847 | 192 | 929 | 116 | 1032 | 62 | 815 |
| 2L-3S | | MI | 352 | 361 | 574 | 286 | 669 | 235 | 724 | 191 | 773 | 117 | 857 | 18 | 810 |
| 6-#8 | 3.29 | MA | 419 | 394 | 730 | 304 | 865 | 249 | 950 | 199 | 1059 | 109 | 1171 | 41 | 1031 |
| 2L-3S | | MI | 365 | 394 | 625 | 305 | 731 | 248 | 793 | 198 | 859 | 111 | 948 | -17 | 944 |
| 6-#9 | 4.17 | MA | 443 | 431 | 810 | 326 | 963 | 265 | 1059 | 207 | 1195 | 100 | 1313 | 16 | 1259 |
| 2L-3S | | MI | 380 | 431 | 679 | 327 | 797 | 263 | 865 | 204 | 950 | 103 | 1042 | -58 | 1027 |
| 6-#10 | 5.29 | MA | 473 | 479 | 910 | 354 | 1086 | 285 | 1192 | 215 | 1363 | 89 | 1483 | -18 | 1477 |
| 2L-3S | | MI | 398 | 479 | 747 | 355 | 880 | 283 | 954 | 218 | 1061 | 92 | 1155 | -112 | 1128 |

## RECTANGULAR TIED COLUMNS 12" x 14"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.05 | MA | 481 | 349 | 685 | 297 | 814 | 250 | 883 | 212 | 948 | 154 | 1078 | 121 | 537 |
| 2E | | MI | 404 | 349 | 597 | 289 | 693 | 243 | 742 | 206 | 774 | 146 | 859 | 109 | 453 |
| 4-#7 | 1.43 | MA | 501 | 368 | 743 | 308 | 883 | 257 | 964 | 217 | 1052 | 152 | 1197 | 113 | 702 |
| 2E | | MI | 419 | 368 | 642 | 299 | 747 | 250 | 803 | 209 | 849 | 142 | 941 | 98 | 586 |
| 4-#8 | 1.88 | MA | 523 | 390 | 809 | 320 | 963 | 266 | 1059 | 222 | 1172 | 148 | 1333 | 102 | 892 |
| 2E | | MI | 435 | 390 | 694 | 311 | 809 | 259 | 872 | 214 | 936 | 137 | 1032 | 84 | 737 |
| 4-#9 | 2.38 | MA | 546 | 415 | 879 | 334 | 1049 | 276 | 1162 | 228 | 1299 | 145 | 1475 | 90 | 1094 |
| 2E | | MI | 451 | 415 | 749 | 325 | 875 | 269 | 945 | 218 | 1026 | 131 | 1126 | 67 | 896 |
| 4-#10 | 3.02 | MA | 574 | 447 | 968 | 352 | 1157 | 290 | 1291 | 237 | 1456 | 139 | 1649 | 73 | 1346 |
| 2E | | MI | 471 | 447 | 817 | 343 | 957 | 282 | 1033 | 223 | 1137 | 122 | 1238 | 43 | 1092 |
| 4-#11 | 3.71 | MA | 594 | 481 | 1053 | 369 | 1255 | 302 | 1395 | 241 | 1571 | 127 | 1749 | 42 | 1579 |
| 2E | | MI | 483 | 481 | 879 | 359 | 1009 | 287 | 1088 | 221 | 1204 | 106 | 1277 | 4 | 1266 |
| 4-#14 | 5.36 | MA | 654 | 562 | 1256 | 417 | 1504 | 336 | 1667 | 256 | 1913 | 108 | 2101 | -14 | 2095 |
| 2E | | MI | 525 | 562 | 1029 | 406 | 1168 | 313 | 1268 | 229 | 1430 | 78 | 1480 | -72 | 1489 |
| 6-#5 | 1.11 | MA | 486 | 352 | 692 | 300 | 826 | 252 | 899 | 214 | 973 | 155 | 1113 | 122 | 566 |
| 2L-3S | | MI | 382 | 352 | 559 | 293 | 648 | 245 | 689 | 207 | 710 | 148 | 790 | 88 | 480 |

## RECTANGULAR TIED COLUMNS 12" x 14"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

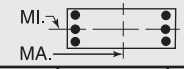
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.11 | MA | 452 | 352 | 637 | 302 | 756 | 253 | 815 | 214 | 861 | 156 | 978 | 99 | 569 |
| 3L-2S | | MI | 408 | 352 | 603 | 292 | 703 | 245 | 756 | 208 | 795 | 147 | 888 | 110 | 476 |
| 6-#6 | 1.57 | MA | 512 | 375 | 762 | 313 | 911 | 262 | 1000 | 220 | 1105 | 153 | 1265 | 113 | 768 |
| 2L-3S | | MI | 391 | 375 | 597 | 306 | 693 | 254 | 742 | 213 | 774 | 144 | 859 | 65 | 642 |
| 6-#6 | 1.57 | MA | 467 | 375 | 685 | 315 | 814 | 263 | 883 | 220 | 948 | 154 | 1078 | 80 | 770 |
| 3L-2S | | MI | 427 | 375 | 658 | 305 | 770 | 254 | 835 | 213 | 891 | 143 | 993 | 98 | 639 |
| 6-#7 | 2.14 | MA | 540 | 403 | 846 | 330 | 1014 | 273 | 1123 | 227 | 1261 | 150 | 1445 | 101 | 1009 |
| 2L-3S | | MI | 403 | 403 | 642 | 322 | 747 | 266 | 803 | 218 | 849 | 139 | 941 | 37 | 830 |
| 6-#7 | 2.14 | MA | 483 | 403 | 743 | 332 | 883 | 275 | 964 | 227 | 1052 | 151 | 1197 | 57 | 1004 |
| 3L-2S | | MI | 448 | 403 | 724 | 321 | 850 | 266 | 926 | 219 | 1005 | 137 | 1116 | 81 | 830 |
| 6-#8 | 2.82 | MA | 572 | 437 | 943 | 349 | 1133 | 288 | 1265 | 236 | 1441 | 145 | 1649 | 85 | 1287 |
| 2L-3S | | MI | 415 | 437 | 694 | 341 | 809 | 279 | 872 | 225 | 936 | 132 | 1032 | 2 | 1029 |
| 6-#8 | 2.82 | MA | 502 | 437 | 809 | 352 | 963 | 289 | 1059 | 236 | 1172 | 147 | 1333 | 27 | 1268 |
| 3L-2S | | MI | 471 | 437 | 799 | 340 | 942 | 280 | 1030 | 226 | 1136 | 130 | 1255 | 60 | 1049 |
| 6-#9 | 3.57 | MA | 606 | 474 | 1047 | 371 | 1261 | 303 | 1419 | 246 | 1632 | 140 | 1864 | 67 | 1583 |
| 2L-3S | | MI | 429 | 474 | 749 | 363 | 875 | 294 | 945 | 231 | 1026 | 124 | 1126 | -39 | 1116 |
| 6-#9 | 3.57 | MA | 522 | 474 | 879 | 374 | 1049 | 305 | 1162 | 245 | 1299 | 142 | 1475 | -7 | 1471 |
| 3L-2S | | MI | 495 | 474 | 880 | 362 | 1041 | 296 | 1138 | 233 | 1272 | 122 | 1396 | 34 | 1280 |
| 6-#10 | 4.54 | MA | 647 | 521 | 1178 | 399 | 1422 | 324 | 1612 | 258 | 1870 | 132 | 2126 | 42 | 1954 |
| 2L-3S | | MI | 447 | 521 | 817 | 390 | 957 | 313 | 1033 | 244 | 1137 | 113 | 1238 | -93 | 1217 |
| 6-#10 | 4.54 | MA | 548 | 521 | 968 | 403 | 1157 | 325 | 1291 | 257 | 1456 | 135 | 1649 | -52 | 1620 |
| 3L-2S | | MI | 525 | 521 | 980 | 390 | 1164 | 316 | 1271 | 242 | 1439 | 110 | 1566 | 0 | 1565 |
| 6-#11 | 5.57 | MA | 566 | 573 | 1053 | 430 | 1255 | 343 | 1395 | 264 | 1571 | 119 | 1749 | -117 | 1698 |
| 3L-2S | | MI | 544 | 573 | 1068 | 417 | 1239 | 327 | 1354 | 241 | 1540 | 86 | 1629 | -58 | 1626 |
| 8-#5 | 1.48 | MA | 508 | 370 | 747 | 312 | 895 | 261 | 983 | 219 | 1086 | 155 | 1248 | 117 | 730 |
| 2L-4S | | MI | 383 | 370 | 571 | 305 | 660 | 255 | 703 | 214 | 727 | 145 | 815 | 71 | 613 |
| 8-#5 | 1.48 | MA | 476 | 370 | 692 | 313 | 826 | 262 | 899 | 220 | 973 | 155 | 1113 | 94 | 732 |
| 3E | | MI | 399 | 370 | 603 | 305 | 703 | 254 | 756 | 213 | 795 | 146 | 888 | 80 | 611 |
| 8-#5 | 1.48 | MA | 455 | 370 | 652 | 315 | 772 | 264 | 833 | 222 | 884 | 155 | 1014 | 83 | 731 |
| 4L-2S | | MI | 425 | 370 | 646 | 304 | 758 | 254 | 822 | 213 | 880 | 145 | 985 | 103 | 609 |
| 8-#6 | 2.10 | MA | 541 | 401 | 839 | 330 | 1008 | 274 | 1118 | 227 | 1261 | 152 | 1451 | 105 | 996 |
| 2L-4S | | MI | 393 | 401 | 613 | 323 | 709 | 268 | 761 | 221 | 798 | 140 | 893 | 41 | 788 |
| 8-#6 | 2.10 | MA | 498 | 401 | 762 | 332 | 911 | 275 | 1000 | 228 | 1105 | 153 | 1265 | 72 | 994 |
| 3E | | MI | 415 | 401 | 658 | 322 | 770 | 266 | 835 | 220 | 891 | 141 | 993 | 53 | 821 |
| 8-#6 | 2.10 | MA | 471 | 401 | 706 | 334 | 836 | 278 | 908 | 230 | 980 | 152 | 1128 | 58 | 953 |
| 4L-2S | | MI | 448 | 401 | 719 | 321 | 846 | 266 | 928 | 221 | 1009 | 140 | 1127 | 86 | 820 |
| 8-#7 | 2.86 | MA | 525 | 438 | 846 | 354 | 1014 | 291 | 1123 | 238 | 1261 | 149 | 1445 | 45 | 1301 |
| 3E | | MI | 434 | 438 | 724 | 344 | 850 | 282 | 926 | 228 | 1005 | 134 | 1116 | 20 | 1064 |
| 8-#7 | 2.86 | MA | 490 | 438 | 771 | 357 | 912 | 295 | 998 | 240 | 1096 | 147 | 1263 | 25 | 1190 |
| 4L-2S | | MI | 476 | 438 | 805 | 343 | 953 | 282 | 1050 | 229 | 1161 | 133 | 1292 | 64 | 1070 |
| 8-#8 | 3.76 | MA | 555 | 483 | 943 | 381 | 1133 | 310 | 1265 | 249 | 1441 | 144 | 1649 | 10 | 1628 |
| 3E | | MI | 455 | 483 | 799 | 370 | 942 | 301 | 1030 | 237 | 1136 | 126 | 1255 | -22 | 1248 |
| 8-#8 | 3.76 | MA | 513 | 483 | 845 | 384 | 1000 | 315 | 1103 | 253 | 1228 | 142 | 1417 | -14 | 1413 |
| 4L-2S | | MI | 507 | 483 | 905 | 369 | 1075 | 301 | 1188 | 239 | 1335 | 124 | 1477 | 36 | 1355 |
| 8-#9 | 4.76 | MA | 588 | 532 | 1047 | 411 | 1261 | 332 | 1419 | 262 | 1632 | 137 | 1864 | -29 | 1842 |
| 3E | | MI | 478 | 532 | 880 | 400 | 1041 | 321 | 1138 | 247 | 1272 | 115 | 1396 | -71 | 1374 |
| 8-#9 | 4.76 | MA | 538 | 532 | 925 | 415 | 1095 | 338 | 1216 | 266 | 1368 | 135 | 1576 | -60 | 1558 |
| 4L-2S | | MI | 539 | 532 | 1011 | 399 | 1206 | 323 | 1332 | 249 | 1517 | 113 | 1667 | 2 | 1658 |
| 8-#10 | 6.05 | MA | 630 | 596 | 1178 | 450 | 1422 | 359 | 1612 | 279 | 1870 | 128 | 2126 | -83 | 2065 |
| 3E | | MI | 508 | 596 | 980 | 437 | 1164 | 347 | 1271 | 263 | 1439 | 100 | 1566 | -136 | 1527 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#7 | 1.25 | MA | 653 | 410 | 925 | 353 | 1117 | 296 | 1227 | 250 | 1349 | 180 | 1573 | 143 | 832 |
| 2E | | MI | 470 | 410 | 711 | 335 | 824 | 281 | 883 | 237 | 926 | 163 | 1025 | 117 | 599 |
| 4-#8 | 1.65 | MA | 683 | 432 | 1006 | 365 | 1215 | 305 | 1344 | 256 | 1505 | 178 | 1755 | 136 | 1062 |
| 2E | | MI | 486 | 432 | 763 | 347 | 886 | 289 | 952 | 241 | 1012 | 158 | 1116 | 102 | 751 |
| 4-#9 | 2.08 | MA | 713 | 457 | 1093 | 379 | 1322 | 315 | 1470 | 262 | 1673 | 176 | 1946 | 126 | 1310 |
| 2E | | MI | 503 | 457 | 819 | 361 | 953 | 299 | 1024 | 245 | 1103 | 152 | 1209 | 85 | 912 |
| 4-#10 | 2.65 | MA | 750 | 489 | 1202 | 398 | 1456 | 328 | 1630 | 270 | 1883 | 174 | 2184 | 113 | 1621 |
| 2E | | MI | 523 | 489 | 887 | 379 | 1035 | 312 | 1113 | 249 | 1213 | 144 | 1321 | 62 | 1111 |
| 4-#11 | 3.25 | MA | 777 | 523 | 1312 | 414 | 1582 | 340 | 1776 | 277 | 2047 | 165 | 2348 | 89 | 1916 |
| 2E | | MI | 534 | 523 | 951 | 394 | 1087 | 317 | 1168 | 247 | 1279 | 126 | 1359 | 22 | 1289 |
| 4-#14 | 4.69 | MA | 856 | 604 | 1568 | 462 | 1897 | 375 | 2153 | 298 | 2508 | 151 | 2858 | 46 | 2640 |
| 2E | | MI | 576 | 604 | 1102 | 441 | 1246 | 343 | 1348 | 255 | 1505 | 98 | 1561 | -54 | 1571 |
| 6-#6 | 1.38 | MA | 666 | 417 | 948 | 359 | 1150 | 300 | 1270 | 253 | 1408 | 181 | 1656 | 144 | 911 |
| 2L-3S | | MI | 442 | 417 | 665 | 343 | 770 | 286 | 822 | 240 | 851 | 166 | 944 | 84 | 656 |
| 6-#6 | 1.38 | MA | 609 | 417 | 854 | 361 | 1033 | 302 | 1127 | 255 | 1217 | 182 | 1416 | 112 | 913 |
| 3L-2S | | MI | 478 | 417 | 726 | 342 | 847 | 286 | 915 | 241 | 968 | 165 | 1078 | 117 | 651 |
| 6-#7 | 1.88 | MA | 704 | 445 | 1050 | 375 | 1276 | 312 | 1419 | 261 | 1608 | 179 | 1894 | 135 | 1204 |
| 2L-3S | | MI | 453 | 445 | 711 | 358 | 824 | 297 | 883 | 245 | 926 | 160 | 1025 | 56 | 848 |
| 6-#7 | 1.88 | MA | 631 | 445 | 925 | 378 | 1117 | 314 | 1227 | 262 | 1349 | 181 | 1573 | 91 | 1199 |
| 3L-2S | | MI | 499 | 445 | 792 | 357 | 927 | 297 | 1006 | 247 | 1082 | 159 | 1201 | 100 | 845 |
| 6-#8 | 2.47 | MA | 746 | 479 | 1169 | 394 | 1422 | 326 | 1594 | 269 | 1842 | 177 | 2167 | 124 | 1543 |
| 2L-3S | | MI | 466 | 479 | 763 | 378 | 886 | 310 | 952 | 251 | 1012 | 153 | 1116 | 20 | 1060 |
| 6-#8 | 2.47 | MA | 657 | 479 | 1006 | 399 | 1215 | 329 | 1344 | 271 | 1505 | 179 | 1755 | 66 | 1524 |
| 3L-2S | | MI | 523 | 479 | 868 | 376 | 1019 | 311 | 1110 | 253 | 1212 | 152 | 1339 | 78 | 1065 |
| 6-#9 | 3.13 | MA | 789 | 516 | 1297 | 416 | 1581 | 342 | 1783 | 279 | 2095 | 174 | 2456 | 110 | 1907 |
| 2L-3S | | MI | 479 | 516 | 819 | 399 | 953 | 325 | 1024 | 258 | 1103 | 145 | 1209 | -20 | 1205 |
| 6-#9 | 3.13 | MA | 684 | 516 | 1093 | 421 | 1322 | 345 | 1470 | 281 | 1673 | 177 | 1946 | 36 | 1866 |
| 3L-2S | | MI | 547 | 516 | 950 | 398 | 1118 | 326 | 1218 | 260 | 1348 | 143 | 1480 | 53 | 1299 |
| 6-#10 | 3.97 | MA | 842 | 564 | 1459 | 444 | 1780 | 362 | 2022 | 292 | 2410 | 171 | 2814 | 91 | 2366 |
| 2L-3S | | MI | 496 | 564 | 887 | 426 | 1035 | 344 | 1113 | 271 | 1213 | 134 | 1321 | -75 | 1306 |
| 6-#10 | 3.97 | MA | 718 | 564 | 1202 | 450 | 1456 | 366 | 1630 | 294 | 1883 | 173 | 2184 | -2 | 2182 |
| 3L-2S | | MI | 577 | 564 | 1050 | 425 | 1242 | 346 | 1351 | 268 | 1515 | 131 | 1649 | 19 | 1587 |
| 6-#11 | 4.88 | MA | 744 | 615 | 1312 | 478 | 1582 | 385 | 1776 | 304 | 2047 | 162 | 2348 | -58 | 2302 |
| 3L-2S | | MI | 596 | 615 | 1140 | 452 | 1318 | 357 | 1434 | 267 | 1616 | 107 | 1711 | -40 | 1712 |
| 6-#14 | 7.03 | MA | 825 | 737 | 1568 | 552 | 1897 | 438 | 2153 | 335 | 2508 | 144 | 2858 | -173 | 2729 |
| 3L-2S | | MI | 661 | 737 | 1363 | 523 | 1555 | 396 | 1704 | 280 | 1956 | 66 | 2018 | -152 | 2018 |
| 8-#5 | 1.29 | MA | 661 | 412 | 928 | 357 | 1130 | 299 | 1247 | 253 | 1380 | 182 | 1631 | 147 | 864 |
| 2L-4S | | MI | 433 | 412 | 638 | 342 | 736 | 287 | 783 | 241 | 805 | 167 | 900 | 90 | 627 |
| 8-#5 | 1.29 | MA | 621 | 412 | 862 | 359 | 1046 | 301 | 1146 | 254 | 1244 | 183 | 1457 | 124 | 866 |
| 3E | | MI | 450 | 412 | 670 | 341 | 780 | 285 | 835 | 240 | 872 | 168 | 973 | 99 | 624 |
| 8-#5 | 1.29 | MA | 595 | 412 | 815 | 361 | 985 | 302 | 1067 | 256 | 1137 | 183 | 1333 | 113 | 865 |
| 4L-2S | | MI | 476 | 412 | 714 | 341 | 835 | 285 | 902 | 241 | 957 | 167 | 1070 | 122 | 620 |
| 8-#6 | 1.83 | MA | 704 | 443 | 1041 | 375 | 1268 | 312 | 1412 | 261 | 1600 | 180 | 1897 | 138 | 1186 |
| 2L-4S | | MI | 443 | 443 | 681 | 360 | 786 | 300 | 841 | 248 | 875 | 162 | 978 | 60 | 821 |
| 8-#6 | 1.83 | MA | 650 | 443 | 948 | 377 | 1150 | 314 | 1270 | 262 | 1408 | 181 | 1656 | 106 | 1184 |
| 3E | | MI | 466 | 443 | 726 | 359 | 847 | 298 | 915 | 247 | 968 | 163 | 1078 | 72 | 837 |
| 8-#6 | 1.83 | MA | 616 | 443 | 881 | 380 | 1064 | 316 | 1159 | 265 | 1258 | 181 | 1483 | 90 | 1160 |
| 4L-2S | | MI | 500 | 443 | 787 | 358 | 923 | 298 | 1008 | 248 | 1086 | 162 | 1211 | 105 | 834 |
| 8-#7 | 2.50 | MA | 685 | 481 | 1050 | 400 | 1276 | 331 | 1419 | 272 | 1608 | 179 | 1894 | 82 | 1560 |
| 3E | | MI | 484 | 481 | 792 | 381 | 927 | 313 | 1006 | 255 | 1082 | 156 | 1201 | 38 | 1084 |
| 8-#7 | 2.50 | MA | 643 | 481 | 960 | 404 | 1159 | 333 | 1270 | 277 | 1405 | 179 | 1663 | 61 | 1454 |
| 4L-2S | | MI | 528 | 481 | 874 | 379 | 1030 | 313 | 1129 | 257 | 1238 | 154 | 1376 | 83 | 1086 |
| 8-#8 | 3.29 | MA | 725 | 525 | 1169 | 428 | 1422 | 350 | 1594 | 285 | 1842 | 177 | 2167 | 54 | 1991 |
| 3E | | MI | 506 | 525 | 868 | 407 | 1019 | 331 | 1110 | 264 | 1212 | 147 | 1339 | -4 | 1338 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

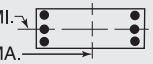
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 8-#8 | 3.29 | MA | 673 | 525 | 1052 | 432 | 1270 | 353 | 1399 | 290 | 1576 | 176 | 1869 | 26 | 1784 |
| 4L-2S | | MI | 559 | 525 | 974 | 406 | 1153 | 332 | 1267 | 266 | 1412 | 145 | 1561 | 55 | 1374 |
| 8-#9 | 4.17 | MA | 767 | 575 | 1297 | 458 | 1581 | 372 | 1783 | 298 | 2095 | 175 | 2456 | 20 | 2409 |
| 3E | | MI | 528 | 575 | 950 | 435 | 1118 | 352 | 1218 | 273 | 1348 | 136 | 1480 | -52 | 1465 |
| 8-#9 | 4.17 | MA | 707 | 575 | 1150 | 463 | 1381 | 380 | 1539 | 304 | 1762 | 173 | 2086 | -15 | 2077 |
| 4L-2S | | MI | 591 | 575 | 1081 | 435 | 1284 | 353 | 1412 | 275 | 1594 | 134 | 1750 | 21 | 1679 |
| 8-#10 | 5.29 | MA | 821 | 638 | 1459 | 497 | 1780 | 401 | 2022 | 315 | 2410 | 170 | 2814 | -25 | 2784 |
| 3E | | MI | 557 | 638 | 1050 | 473 | 1242 | 378 | 1351 | 290 | 1515 | 121 | 1649 | -118 | 1618 |
| 8-#10 | 5.29 | MA | 750 | 638 | 1274 | 503 | 1529 | 410 | 1716 | 323 | 1993 | 168 | 2355 | -68 | 2311 |
| 4L-2S | | MI | 631 | 638 | 1213 | 472 | 1448 | 381 | 1589 | 287 | 1817 | 118 | 1977 | -25 | 1970 |
| 10-#10 | 6.61 | MA | 859 | 713 | 1530 | 550 | 1853 | 444 | 2108 | 345 | 2520 | 164 | 2985 | -90 | 2888 |
| 4L-3S | | MI | 616 | 713 | 1213 | 519 | 1448 | 412 | 1589 | 308 | 1817 | 109 | 1977 | -161 | 1924 |

## RECTANGULAR TIED COLUMNS 12" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#7 | 1.11 | MA | 823 | 453 | 1120 | 398 | 1373 | 334 | 1515 | 284 | 1666 | 207 | 1984 | 172 | 961 |
| 2E | | MI | 521 | 453 | 780 | 372 | 901 | 312 | 962 | 264 | 1003 | 185 | 1109 | 136 | 611 |
| 4-#8 | 1.46 | MA | 860 | 475 | 1216 | 410 | 1489 | 343 | 1653 | 289 | 1850 | 205 | 2211 | 166 | 1233 |
| 2E | | MI | 537 | 475 | 832 | 384 | 964 | 320 | 1031 | 267 | 1089 | 180 | 1200 | 121 | 765 |
| 4-#9 | 1.85 | MA | 898 | 500 | 1320 | 424 | 1616 | 353 | 1803 | 295 | 2050 | 203 | 2454 | 159 | 1526 |
| 2E | | MI | 554 | 500 | 888 | 397 | 1030 | 330 | 1104 | 271 | 1179 | 173 | 1292 | 104 | 928 |
| 4-#10 | 2.35 | MA | 944 | 531 | 1450 | 443 | 1775 | 367 | 1994 | 304 | 2304 | 201 | 2757 | 149 | 1895 |
| 2E | | MI | 574 | 531 | 957 | 414 | 1113 | 342 | 1192 | 276 | 1290 | 165 | 1404 | 80 | 1129 |
| 4-#11 | 2.89 | MA | 980 | 566 | 1584 | 460 | 1930 | 378 | 2174 | 310 | 2540 | 197 | 2988 | 130 | 2252 |
| 2E | | MI | 586 | 566 | 1022 | 429 | 1166 | 347 | 1247 | 273 | 1355 | 147 | 1441 | 40 | 1311 |
| 4-#14 | 4.17 | MA | 1080 | 647 | 1893 | 507 | 2310 | 413 | 2628 | 332 | 3137 | 190 | 3661 | 96 | 3126 |
| 2E | | MI | 628 | 647 | 1175 | 475 | 1325 | 372 | 1427 | 281 | 1580 | 118 | 1642 | -36 | 1651 |
| 4-#18 | 7.41 | MA | 1310 | 853 | 2626 | 630 | 3218 | 502 | 3716 | 388 | 4484 | 160 | 5161 | -7 | 5146 |
| 2E | | MI | 721 | 853 | 1459 | 575 | 1648 | 426 | 1793 | 287 | 2039 | 31 | 2062 | -239 | 2057 |
| 6-#6 | 1.22 | MA | 838 | 460 | 1147 | 404 | 1411 | 339 | 1564 | 287 | 1734 | 207 | 2082 | 173 | 1053 |
| 2L-3S | | MI | 493 | 460 | 733 | 379 | 847 | 317 | 901 | 267 | 927 | 187 | 1029 | 103 | 669 |
| 6-#6 | 1.22 | MA | 770 | 460 | 1037 | 407 | 1273 | 341 | 1396 | 289 | 1509 | 210 | 1787 | 141 | 1055 |
| 3L-2S | | MI | 529 | 460 | 794 | 378 | 924 | 317 | 994 | 268 | 1045 | 186 | 1162 | 136 | 663 |
| 6-#7 | 1.67 | MA | 885 | 488 | 1268 | 420 | 1560 | 350 | 1741 | 294 | 1970 | 205 | 2379 | 166 | 1398 |
| 2L-3S | | MI | 504 | 488 | 780 | 395 | 901 | 328 | 962 | 272 | 1003 | 182 | 1109 | 75 | 864 |
| 6-#7 | 1.67 | MA | 797 | 488 | 1120 | 424 | 1373 | 354 | 1515 | 297 | 1666 | 209 | 1984 | 122 | 1393 |
| 3L-2S | | MI | 551 | 488 | 861 | 394 | 1004 | 328 | 1085 | 274 | 1159 | 180 | 1285 | 119 | 859 |
| 6-#8 | 2.19 | MA | 938 | 521 | 1409 | 439 | 1733 | 365 | 1948 | 303 | 2247 | 203 | 2721 | 158 | 1799 |
| 2L-3S | | MI | 516 | 521 | 832 | 414 | 964 | 341 | 1031 | 278 | 1089 | 175 | 1200 | 39 | 1081 |
| 6-#8 | 2.19 | MA | 828 | 521 | 1216 | 445 | 1489 | 369 | 1653 | 306 | 1850 | 207 | 2211 | 100 | 1780 |
| 3L-2S | | MI | 574 | 521 | 937 | 413 | 1097 | 342 | 1189 | 280 | 1289 | 173 | 1422 | 97 | 1082 |
| 6-#9 | 2.78 | MA | 992 | 558 | 1561 | 461 | 1921 | 380 | 2173 | 313 | 2548 | 201 | 3087 | 148 | 2231 |
| 2L-3S | | MI | 530 | 558 | 888 | 435 | 1030 | 355 | 1104 | 285 | 1179 | 166 | 1292 | -2 | 1292 |
| 6-#9 | 2.78 | MA | 864 | 558 | 1320 | 468 | 1616 | 385 | 1803 | 316 | 2050 | 206 | 2454 | 74 | 2190 |
| 3L-2S | | MI | 599 | 558 | 1019 | 434 | 1196 | 357 | 1298 | 287 | 1425 | 164 | 1563 | 72 | 1318 |
| 6-#10 | 3.53 | MA | 1058 | 606 | 1754 | 489 | 2159 | 401 | 2458 | 326 | 2929 | 198 | 3543 | 133 | 2777 |
| 2L-3S | | MI | 546 | 606 | 957 | 462 | 1113 | 374 | 1192 | 298 | 1290 | 155 | 1404 | -56 | 1393 |
| 6-#10 | 3.53 | MA | 907 | 606 | 1450 | 497 | 1775 | 407 | 1994 | 329 | 2304 | 204 | 2757 | 40 | 2666 |
| 3L-2S | | MI | 629 | 606 | 1120 | 461 | 1319 | 377 | 1430 | 295 | 1591 | 152 | 1732 | 37 | 1608 |
| 6-#11 | 4.33 | MA | 941 | 657 | 1584 | 525 | 1930 | 426 | 2174 | 340 | 2540 | 198 | 2988 | -9 | 2977 |
| 3L-2S | | MI | 647 | 657 | 1212 | 486 | 1396 | 386 | 1513 | 293 | 1692 | 128 | 1793 | -22 | 1795 |
| 6-#14 | 6.25 | MA | 1043 | 779 | 1893 | 601 | 2310 | 480 | 2628 | 373 | 3137 | 190 | 3661 | -109 | 3534 |
| 3L-2S | | MI | 712 | 779 | 1435 | 558 | 1633 | 426 | 1783 | 306 | 2032 | 86 | 2099 | -134 | 2106 |
| 8-#5 | 1.15 | MA | 832 | 455 | 1123 | 402 | 1387 | 338 | 1536 | 286 | 1700 | 208 | 2047 | 176 | 998 |
| 2L-4S | | MI | 484 | 455 | 706 | 379 | 813 | 318 | 862 | 269 | 882 | 189 | 985 | 109 | 639 |
| 8-#5 | 1.15 | MA | 783 | 455 | 1046 | 404 | 1288 | 339 | 1418 | 288 | 1540 | 210 | 1835 | 153 | 1000 |
| 3E | | MI | 501 | 455 | 738 | 378 | 856 | 317 | 915 | 268 | 949 | 190 | 1057 | 118 | 635 |

## RECTANGULAR TIED COLUMNS 12" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#5 | 1.15 | MA | 753 | 455 | 991 | 407 | 1217 | 341 | 1326 | 291 | 1415 | 211 | 1684 | 140 | 999 |
| 4L-2S | | MI | 528 | 455 | 781 | 377 | 911 | 317 | 981 | 268 | 1034 | 189 | 1155 | 141 | 631 |
| 8-#6 | 1.63 | MA | 885 | 485 | 1256 | 420 | 1549 | 350 | 1731 | 294 | 1959 | 206 | 2377 | 169 | 1376 |
| 2L-4S | | MI | 494 | 485 | 749 | 396 | 863 | 331 | 920 | 276 | 952 | 183 | 1062 | 79 | 852 |
| 8-#6 | 1.63 | MA | 819 | 485 | 1147 | 423 | 1411 | 353 | 1564 | 296 | 1734 | 209 | 2082 | 137 | 1374 |
| 3E | | MI | 517 | 485 | 794 | 395 | 924 | 329 | 994 | 275 | 1045 | 184 | 1162 | 91 | 851 |
| 8-#6 | 1.63 | MA | 779 | 485 | 1069 | 426 | 1310 | 356 | 1435 | 300 | 1559 | 210 | 1872 | 119 | 1359 |
| 4L-2S | | MI | 552 | 485 | 855 | 394 | 1000 | 329 | 1087 | 276 | 1163 | 183 | 1296 | 124 | 847 |
| 8-#7 | 2.22 | MA | 862 | 523 | 1268 | 446 | 1560 | 370 | 1741 | 307 | 1970 | 207 | 2379 | 117 | 1819 |
| 3E | | MI | 535 | 523 | 861 | 417 | 1004 | 344 | 1085 | 282 | 1159 | 177 | 1285 | 57 | 1102 |
| 8-#7 | 2.22 | MA | 811 | 523 | 1163 | 450 | 1423 | 373 | 1567 | 312 | 1733 | 208 | 2096 | 93 | 1726 |
| 4L-2S | | MI | 580 | 523 | 942 | 416 | 1107 | 344 | 1209 | 284 | 1315 | 176 | 1461 | 101 | 1102 |
| 8-#8 | 2.93 | MA | 913 | 568 | 1409 | 474 | 1733 | 390 | 1948 | 320 | 2247 | 206 | 2721 | 92 | 2332 |
| 3E | | MI | 556 | 568 | 937 | 443 | 1097 | 362 | 1189 | 291 | 1289 | 168 | 1422 | 15 | 1384 |
| 8-#8 | 2.93 | MA | 848 | 568 | 1272 | 479 | 1555 | 394 | 1720 | 326 | 1937 | 206 | 2356 | 61 | 2122 |
| 4L-2S | | MI | 611 | 568 | 1043 | 442 | 1230 | 363 | 1347 | 293 | 1488 | 167 | 1645 | 73 | 1392 |
| 8-#9 | 3.70 | MA | 966 | 617 | 1561 | 504 | 1921 | 412 | 2173 | 333 | 2548 | 204 | 3087 | 63 | 2880 |
| 3E | | MI | 578 | 617 | 1019 | 471 | 1196 | 382 | 1298 | 300 | 1425 | 157 | 1563 | -34 | 1554 |
| 8-#9 | 3.70 | MA | 893 | 617 | 1389 | 511 | 1697 | 417 | 1887 | 341 | 2158 | 204 | 2633 | 25 | 2541 |
| 4L-2S | | MI | 643 | 617 | 1150 | 470 | 1362 | 384 | 1491 | 302 | 1670 | 155 | 1834 | 40 | 1700 |
| 8-#10 | 4.70 | MA | 1032 | 681 | 1754 | 544 | 2159 | 441 | 2458 | 351 | 2929 | 201 | 3543 | 24 | 3482 |
| 3E | | MI | 607 | 681 | 1120 | 508 | 1319 | 408 | 1430 | 316 | 1591 | 142 | 1732 | -99 | 1708 |
| 8-#10 | 4.70 | MA | 947 | 681 | 1537 | 552 | 1877 | 447 | 2098 | 361 | 2439 | 201 | 2977 | -23 | 2955 |
| 4L-2S | | MI | 683 | 681 | 1283 | 508 | 1526 | 411 | 1669 | 313 | 1893 | 139 | 2060 | -6 | 2059 |
| 8-#11 | 5.78 | MA | 990 | 749 | 1686 | 591 | 2035 | 481 | 2296 | 377 | 2697 | 192 | 3237 | -88 | 3154 |
| 4L-2S | | MI | 709 | 749 | 1401 | 544 | 1626 | 426 | 1779 | 313 | 2029 | 108 | 2145 | -83 | 2139 |
| 10-#10 | 5.88 | MA | 1080 | 756 | 1840 | 598 | 2261 | 481 | 2562 | 383 | 3063 | 198 | 3764 | -39 | 3703 |
| 4L-3S | | MI | 666 | 756 | 1283 | 555 | 1526 | 443 | 1669 | 335 | 1893 | 130 | 2060 | -142 | 2017 |
| 10-#10 | 5.88 | MA | 998 | 756 | 1646 | 606 | 1986 | 493 | 2238 | 387 | 2616 | 203 | 3208 | -95 | 3131 |
| 5L-2S | | MI | 737 | 756 | 1446 | 555 | 1732 | 445 | 1907 | 332 | 2195 | 127 | 2388 | -49 | 2370 |
| 12-#10 | 7.06 | MA | 1127 | 830 | 1949 | 653 | 2370 | 527 | 2702 | 409 | 3241 | 200 | 3994 | -111 | 3861 |
| 5L-3S | | MI | 724 | 830 | 1446 | 602 | 1732 | 477 | 1907 | 354 | 2195 | 117 | 2388 | -186 | 2321 |

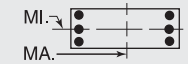
## RECTANGULAR TIED COLUMNS 12" x 20"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.00 | MA | 1010 | 495 | 1329 | 443 | 1650 | 373 | 1827 | 317 | 2009 | 233 | 2427 | 200 | 1091 |
| 2E | | MI | 572 | 495 | 848 | 408 | 978 | 343 | 1042 | 291 | 1080 | 206 | 1193 | 155 | 622 |
| 4-#8 | 1.32 | MA | 1054 | 517 | 1440 | 455 | 1784 | 382 | 1987 | 323 | 2222 | 232 | 2701 | 195 | 1404 |
| 2E | | MI | 589 | 517 | 901 | 420 | 1041 | 351 | 1111 | 294 | 1166 | 201 | 1284 | 140 | 778 |
| 4-#9 | 1.67 | MA | 1101 | 542 | 1560 | 469 | 1931 | 392 | 2161 | 329 | 2454 | 230 | 2996 | 190 | 1742 |
| 2E | | MI | 605 | 542 | 958 | 433 | 1108 | 360 | 1183 | 298 | 1255 | 195 | 1376 | 122 | 944 |
| 4-#10 | 2.12 | MA | 1158 | 574 | 1712 | 488 | 2116 | 405 | 2382 | 337 | 2749 | 228 | 3365 | 183 | 2169 |
| 2E | | MI | 626 | 574 | 1027 | 450 | 1191 | 373 | 1272 | 303 | 1366 | 186 | 1487 | 99 | 1147 |
| 4-#11 | 2.60 | MA | 1203 | 608 | 1870 | 505 | 2300 | 417 | 2596 | 344 | 3029 | 224 | 3665 | 167 | 2589 |
| 2E | | MI | 637 | 608 | 1094 | 464 | 1244 | 377 | 1327 | 299 | 1431 | 168 | 1523 | 58 | 1333 |
| 4-#14 | 3.75 | MA | 1325 | 689 | 2232 | 552 | 2745 | 451 | 3129 | 365 | 3741 | 219 | 4504 | 140 | 3612 |
| 2E | | MI | 679 | 689 | 1247 | 509 | 1404 | 401 | 1507 | 306 | 1655 | 139 | 1723 | -18 | 1729 |
| 4-#18 | 6.67 | MA | 1603 | 895 | 3099 | 675 | 3818 | 541 | 4415 | 421 | 5453 | 206 | 6420 | 58 | 6065 |
| 2E | | MI | 771 | 895 | 1533 | 608 | 1727 | 454 | 1872 | 312 | 2114 | 50 | 2141 | -222 | 2140 |
| 6-#6 | 1.10 | MA | 1028 | 502 | 1359 | 449 | 1693 | 377 | 1882 | 320 | 2086 | 234 | 2541 | 201 | 1196 |
| 2L-3S | | MI | 544 | 502 | 801 | 416 | 924 | 348 | 981 | 294 | 1004 | 209 | 1113 | 122 | 680 |
| 6-#6 | 1.10 | MA | 948 | 502 | 1234 | 452 | 1534 | 380 | 1690 | 323 | 1828 | 237 | 2191 | 169 | 1198 |
| 3L-2S | | MI | 581 | 502 | 862 | 415 | 1001 | 348 | 1074 | 295 | 1122 | 208 | 1247 | 155 | 675 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 1.50 | MA | 1085 | 530 | 1499 | 465 | 1864 | 389 | 2086 | 328 | 2359 | 232 | 2897 | 196 | 1592 |
| 2L-3S | | MI | 555 | 530 | 848 | 431 | 978 | 359 | 1042 | 299 | 1080 | 203 | 1193 | 93 | 878 |
| 6-#7 | 1.50 | MA | 981 | 530 | 1329 | 470 | 1650 | 393 | 1827 | 331 | 2009 | 236 | 2427 | 152 | 1588 |
| 3L-2S | | MI | 602 | 530 | 929 | 430 | 1081 | 359 | 1165 | 301 | 1236 | 202 | 1369 | 137 | 872 |
| 6-#8 | 1.98 | MA | 1148 | 564 | 1662 | 484 | 2065 | 403 | 2326 | 336 | 2679 | 230 | 3311 | 190 | 2054 |
| 2L-3S | | MI | 567 | 564 | 901 | 450 | 1041 | 372 | 1111 | 305 | 1166 | 196 | 1284 | 58 | 1100 |
| 6-#8 | 1.98 | MA | 1018 | 564 | 1440 | 491 | 1784 | 408 | 1987 | 340 | 2222 | 235 | 2701 | 132 | 2036 |
| 3L-2S | | MI | 626 | 564 | 1007 | 449 | 1174 | 373 | 1269 | 307 | 1365 | 194 | 1506 | 116 | 1097 |
| 6-#9 | 2.50 | MA | 1214 | 601 | 1839 | 506 | 2283 | 419 | 2587 | 346 | 3027 | 228 | 3754 | 182 | 2555 |
| 2L-3S | | MI | 580 | 601 | 958 | 470 | 1108 | 386 | 1183 | 311 | 1255 | 188 | 1376 | 17 | 1329 |
| 6-#9 | 2.50 | MA | 1059 | 601 | 1560 | 514 | 1931 | 425 | 2161 | 351 | 2454 | 234 | 2996 | 109 | 2514 |
| 3L-2S | | MI | 651 | 601 | 1089 | 470 | 1274 | 388 | 1377 | 313 | 1501 | 185 | 1647 | 90 | 1335 |
| 6-#10 | 3.17 | MA | 1294 | 649 | 2062 | 534 | 2559 | 439 | 2918 | 359 | 3470 | 225 | 4309 | 171 | 3189 |
| 2L-3S | | MI | 596 | 649 | 1027 | 497 | 1191 | 404 | 1272 | 324 | 1366 | 176 | 1487 | -38 | 1480 |
| 6-#10 | 3.17 | MA | 1114 | 649 | 1712 | 544 | 2116 | 447 | 2382 | 365 | 2749 | 233 | 3365 | 78 | 3108 |
| 3L-2S | | MI | 680 | 649 | 1190 | 497 | 1397 | 407 | 1510 | 321 | 1667 | 173 | 1815 | 56 | 1628 |
| 6-#11 | 3.90 | MA | 1157 | 700 | 1870 | 572 | 2300 | 467 | 2596 | 376 | 3029 | 228 | 3665 | 34 | 3581 |
| 3L-2S | | MI | 699 | 700 | 1283 | 521 | 1474 | 416 | 1593 | 319 | 1767 | 148 | 1875 | -4 | 1876 |
| 6-#14 | 5.63 | MA | 1280 | 822 | 2232 | 648 | 2745 | 522 | 3129 | 410 | 3741 | 223 | 4504 | -55 | 4416 |
| 3L-2S | | MI | 762 | 822 | 1508 | 592 | 1712 | 455 | 1863 | 331 | 2107 | 107 | 2180 | -116 | 2191 |
| 8-#5 | 1.03 | MA | 1020 | 497 | 1332 | 447 | 1664 | 376 | 1850 | 320 | 2046 | 235 | 2497 | 203 | 1132 |
| 2L-4S | | MI | 535 | 497 | 773 | 416 | 890 | 350 | 942 | 296 | 959 | 211 | 1070 | 128 | 650 |
| 8-#5 | 1.03 | MA | 963 | 497 | 1243 | 450 | 1552 | 378 | 1714 | 322 | 1862 | 237 | 2246 | 180 | 1134 |
| 3E | | MI | 552 | 497 | 805 | 415 | 933 | 348 | 994 | 295 | 1026 | 211 | 1142 | 137 | 646 |
| 8-#5 | 1.03 | MA | 929 | 497 | 1180 | 452 | 1470 | 380 | 1610 | 325 | 1720 | 239 | 2068 | 167 | 1133 |
| 4L-2S | | MI | 579 | 497 | 848 | 414 | 988 | 348 | 1061 | 296 | 1111 | 211 | 1240 | 160 | 642 |
| 8-#6 | 1.47 | MA | 1083 | 528 | 1485 | 465 | 1852 | 389 | 2074 | 328 | 2345 | 233 | 2892 | 199 | 1566 |
| 2L-4S | | MI | 544 | 528 | 817 | 433 | 940 | 362 | 1000 | 303 | 1029 | 205 | 1147 | 98 | 868 |
| 8-#6 | 1.47 | MA | 1007 | 528 | 1359 | 468 | 1693 | 392 | 1882 | 330 | 2086 | 236 | 2541 | 166 | 1564 |
| 3E | | MI | 568 | 528 | 862 | 432 | 1001 | 360 | 1074 | 302 | 1122 | 206 | 1247 | 110 | 865 |
| 8-#6 | 1.47 | MA | 960 | 528 | 1271 | 472 | 1578 | 395 | 1735 | 335 | 1886 | 238 | 2293 | 148 | 1549 |
| 4L-2S | | MI | 603 | 528 | 923 | 431 | 1078 | 360 | 1167 | 303 | 1240 | 205 | 1381 | 143 | 860 |
| 8-#7 | 2.00 | MA | 1058 | 566 | 1499 | 492 | 1864 | 409 | 2086 | 341 | 2359 | 235 | 2897 | 148 | 2078 |
| 3E | | MI | 586 | 566 | 929 | 453 | 1081 | 375 | 1165 | 309 | 1236 | 199 | 1369 | 76 | 1119 |
| 8-#7 | 2.00 | MA | 999 | 566 | 1380 | 497 | 1709 | 413 | 1888 | 347 | 2087 | 237 | 2564 | 124 | 2006 |
| 4L-2S | | MI | 631 | 566 | 1011 | 452 | 1184 | 375 | 1288 | 311 | 1392 | 197 | 1545 | 120 | 1117 |
| 8-#8 | 2.63 | MA | 1117 | 610 | 1662 | 520 | 2065 | 429 | 2326 | 354 | 2679 | 234 | 3311 | 126 | 2673 |
| 3E | | MI | 607 | 610 | 1007 | 479 | 1174 | 393 | 1269 | 318 | 1365 | 190 | 1506 | 34 | 1405 |
| 8-#8 | 2.63 | MA | 1044 | 610 | 1506 | 526 | 1861 | 434 | 2066 | 362 | 2324 | 236 | 2878 | 94 | 2469 |
| 4L-2S | | MI | 662 | 610 | 1112 | 478 | 1308 | 394 | 1426 | 320 | 1565 | 188 | 1729 | 92 | 1410 |
| 8-#9 | 3.33 | MA | 1183 | 660 | 1839 | 551 | 2283 | 452 | 2587 | 368 | 3027 | 232 | 3754 | 101 | 3312 |
| 3E | | MI | 629 | 660 | 1089 | 507 | 1274 | 413 | 1377 | 327 | 1501 | 179 | 1647 | -15 | 1643 |
| 8-#9 | 3.33 | MA | 1093 | 660 | 1642 | 558 | 2027 | 458 | 2260 | 377 | 2581 | 234 | 3215 | 61 | 2960 |
| 4L-2S | | MI | 695 | 660 | 1220 | 506 | 1439 | 415 | 1571 | 329 | 1747 | 176 | 1917 | 58 | 1719 |
| 8-#10 | 4.23 | MA | 1262 | 723 | 2062 | 590 | 2559 | 481 | 2918 | 387 | 3470 | 230 | 4309 | 67 | 4111 |
| 3E | | MI | 656 | 723 | 1190 | 544 | 1397 | 439 | 1510 | 343 | 1667 | 163 | 1815 | -81 | 1797 |
| 8-#10 | 4.23 | MA | 1164 | 723 | 1814 | 600 | 2236 | 488 | 2506 | 398 | 2908 | 232 | 3636 | 17 | 3568 |
| 4L-2S | | MI | 735 | 723 | 1353 | 543 | 1604 | 441 | 1748 | 340 | 1969 | 161 | 2143 | 12 | 2102 |
| 8-#11 | 5.20 | MA | 1218 | 792 | 1991 | 640 | 2441 | 517 | 2741 | 415 | 3216 | 225 | 3975 | -42 | 3921 |
| 4L-2S | | MI | 760 | 792 | 1472 | 579 | 1705 | 456 | 1858 | 339 | 2104 | 129 | 2227 | -65 | 2226 |
| 8-#14 | 7.50 | MA | 1379 | 954 | 2401 | 745 | 2943 | 593 | 3332 | 465 | 4002 | 217 | 4929 | -167 | 4687 |
| 4L-2S | | MI | 847 | 954 | 1769 | 675 | 2020 | 509 | 2219 | 356 | 2558 | 74 | 2636 | -215 | 2631 |
| 10-#10 | 5.29 | MA | 1319 | 798 | 2164 | 646 | 2679 | 523 | 3041 | 420 | 3629 | 229 | 4580 | 6 | 4556 |
| 4L-3S | | MI | 715 | 798 | 1353 | 591 | 1604 | 473 | 1748 | 361 | 1969 | 151 | 2143 | -124 | 2108 |
| 10-#10 | 5.29 | MA | 1218 | 798 | 1942 | 655 | 2365 | 536 | 2671 | 425 | 3117 | 237 | 3913 | -50 | 3859 |
| 5L-2S | | MI | 788 | 798 | 1517 | 590 | 1810 | 476 | 1986 | 359 | 2271 | 148 | 2471 | -31 | 2462 |
| 12-#10 | 6.35 | MA | 1369 | 873 | 2292 | 702 | 2808 | 570 | 3206 | 447 | 3838 | 234 | 4858 | -61 | 4760 |
| 5L-3S | | MI | 774 | 873 | 1517 | 637 | 1810 | 507 | 1986 | 380 | 2271 | 138 | 2471 | -167 | 2415 |

## RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#8 | 1.20 | MA | 1267 | 560 | 1678 | 501 | 2101 | 420 | 2345 | 356 | 2620 | 258 | 3225 | 223 | 1574 |
| 2E | | MI | 640 | 560 | 970 | 456 | 1118 | 382 | 1190 | 321 | 1242 | 222 | 1368 | 159 | 791 |
| 4-#9 | 1.52 | MA | 1322 | 584 | 1815 | 515 | 2267 | 430 | 2544 | 362 | 2884 | 257 | 3572 | 219 | 1958 |
| 2E | | MI | 657 | 584 | 1027 | 469 | 1186 | 391 | 1263 | 325 | 1332 | 216 | 1459 | 141 | 958 |
| 4-#10 | 1.92 | MA | 1389 | 616 | 1987 | 533 | 2478 | 443 | 2795 | 371 | 3220 | 254 | 4008 | 214 | 2444 |
| 2E | | MI | 677 | 616 | 1097 | 486 | 1269 | 403 | 1351 | 329 | 1442 | 207 | 1570 | 117 | 1164 |
| 4-#11 | 2.36 | MA | 1446 | 650 | 2170 | 550 | 2690 | 455 | 3042 | 377 | 3544 | 251 | 4377 | 201 | 2926 |
| 2E | | MI | 689 | 650 | 1166 | 499 | 1322 | 407 | 1406 | 325 | 1506 | 188 | 1605 | 76 | 1353 |
| 4-#14 | 3.41 | MA | 1590 | 732 | 2585 | 597 | 3202 | 490 | 3654 | 399 | 4361 | 246 | 5385 | 180 | 4098 |
| 2E | | MI | 730 | 732 | 1320 | 544 | 1482 | 431 | 1586 | 332 | 1731 | 159 | 1805 | 0 | 1805 |
| 4-#18 | 6.06 | MA | 1918 | 938 | 3584 | 720 | 4440 | 579 | 5138 | 455 | 6347 | 234 | 7724 | 114 | 6929 |
| 2E | | MI | 821 | 938 | 1608 | 642 | 1806 | 482 | 1952 | 337 | 2188 | 70 | 2221 | -204 | 2222 |
| 6-#6 | 1.00 | MA | 1236 | 544 | 1585 | 494 | 1996 | 415 | 2225 | 354 | 2465 | 261 | 3027 | 227 | 1338 |
| 2L-3S | | MI | 595 | 544 | 869 | 453 | 1001 | 379 | 1060 | 321 | 1081 | 231 | 1198 | 141 | 691 |
| 6-#6 | 1.00 | MA | 1143 | 544 | 1444 | 498 | 1817 | 419 | 2009 | 357 | 2173 | 264 | 2623 | 195 | 1340 |
| 3L-2S | | MI | 632 | 544 | 930 | 452 | 1078 | 379 | 1153 | 322 | 1199 | 230 | 1331 | 174 | 686 |
| 6-#7 | 1.36 | MA | 1302 | 573 | 1744 | 510 | 2190 | 427 | 2457 | 361 | 2774 | 259 | 3449 | 225 | 1787 |
| 2L-3S | | MI | 605 | 573 | 917 | 468 | 1056 | 390 | 1121 | 326 | 1156 | 225 | 1278 | 112 | 892 |
| 6-#7 | 1.36 | MA | 1182 | 573 | 1552 | 515 | 1948 | 432 | 2164 | 365 | 2379 | 264 | 2903 | 180 | 1782 |
| 3L-2S | | MI | 654 | 573 | 998 | 467 | 1159 | 390 | 1244 | 328 | 1312 | 224 | 1453 | 156 | 885 |
| 6-#8 | 1.80 | MA | 1376 | 606 | 1929 | 530 | 2418 | 441 | 2729 | 370 | 3137 | 257 | 3934 | 220 | 2310 |
| 2L-3S | | MI | 618 | 606 | 970 | 486 | 1118 | 403 | 1190 | 332 | 1242 | 218 | 1368 | 77 | 1118 |
| 6-#8 | 1.80 | MA | 1226 | 606 | 1678 | 536 | 2101 | 447 | 2345 | 375 | 2620 | 263 | 3225 | 162 | 2292 |
| 3L-2S | | MI | 678 | 606 | 1076 | 485 | 1252 | 403 | 1348 | 334 | 1442 | 216 | 1590 | 135 | 1112 |
| 6-#9 | 2.27 | MA | 1454 | 643 | 2130 | 551 | 2666 | 457 | 3026 | 380 | 3533 | 254 | 4455 | 215 | 2879 |
| 2L-3S | | MI | 630 | 643 | 1027 | 506 | 1186 | 417 | 1263 | 338 | 1332 | 209 | 1459 | 36 | 1351 |
| 6-#9 | 2.27 | MA | 1274 | 643 | 1815 | 560 | 2267 | 464 | 2544 | 386 | 2884 | 262 | 3572 | 141 | 2838 |
| 3L-2S | | MI | 702 | 643 | 1158 | 505 | 1351 | 418 | 1457 | 340 | 1577 | 207 | 1730 | 109 | 1352 |
| 6-#10 | 2.89 | MA | 1549 | 691 | 2384 | 580 | 2980 | 478 | 3402 | 393 | 4037 | 252 | 5111 | 207 | 3600 |
| 2L-3S | | MI | 646 | 691 | 1097 | 533 | 1269 | 435 | 1351 | 351 | 1442 | 197 | 1570 | -19 | 1567 |
| 6-#10 | 2.89 | MA | 1334 | 691 | 1987 | 590 | 2478 | 486 | 2795 | 400 | 3220 | 261 | 4008 | 113 | 3520 |
| 3L-2S | | MI | 732 | 691 | 1261 | 532 | 1475 | 438 | 1590 | 348 | 1744 | 194 | 1898 | 74 | 1648 |
| 6-#11 | 3.55 | MA | 1391 | 742 | 2170 | 619 | 2690 | 507 | 3042 | 412 | 3544 | 257 | 4377 | 74 | 4177 |
| 3L-2S | | MI | 750 | 742 | 1355 | 556 | 1553 | 446 | 1672 | 345 | 1843 | 169 | 1957 | 14 | 1911 |
| 6-#14 | 5.11 | MA | 1536 | 864 | 2585 | 696 | 3202 | 563 | 3654 | 447 | 4361 | 253 | 5385 | -7 | 5370 |
| 3L-2S | | MI | 814 | 864 | 1580 | 626 | 1791 | 484 | 1942 | 357 | 2182 | 127 | 2261 | -98 | 2275 |
| 8-#6 | 1.33 | MA | 1300 | 570 | 1727 | 510 | 2175 | 427 | 2442 | 361 | 2757 | 260 | 3431 | 226 | 1756 |
| 2L-4S | | MI | 595 | 570 | 885 | 470 | 1017 | 393 | 1079 | 330 | 1106 | 227 | 1231 | 117 | 882 |
| 8-#6 | 1.33 | MA | 1211 | 570 | 1585 | 514 | 1996 | 431 | 2225 | 364 | 2465 | 264 | 3027 | 194 | 1754 |
| 3E | | MI | 619 | 570 | 930 | 469 | 1078 | 391 | 1153 | 329 | 1199 | 228 | 1331 | 129 | 877 |
| 8-#6 | 1.33 | MA | 1159 | 570 | 1486 | 518 | 1867 | 434 | 2061 | 369 | 2240 | 265 | 2743 | 175 | 1740 |
| 4L-2S | | MI | 655 | 570 | 991 | 468 | 1155 | 391 | 1246 | 330 | 1317 | 227 | 1465 | 162 | 873 |
| 8-#7 | 1.82 | MA | 1271 | 608 | 1744 | 537 | 2190 | 448 | 2457 | 375 | 2774 | 262 | 3449 | 178 | 2338 |
| 3E | | MI | 637 | 608 | 998 | 490 | 1159 | 406 | 1244 | 336 | 1312 | 220 | 1453 | 95 | 1135 |
| 8-#7 | 1.82 | MA | 1204 | 608 | 1610 | 543 | 2015 | 452 | 2234 | 382 | 2469 | 265 | 3064 | 153 | 2293 |
| 4L-2S | | MI | 683 | 608 | 1079 | 489 | 1262 | 406 | 1368 | 338 | 1469 | 219 | 1629 | 139 | 1131 |
| 8-#8 | 2.39 | MA | 1341 | 653 | 1929 | 565 | 2418 | 469 | 2729 | 388 | 3137 | 261 | 3934 | 159 | 3015 |
| 3E | | MI | 658 | 653 | 1076 | 515 | 1252 | 424 | 1348 | 345 | 1442 | 211 | 1590 | 53 | 1425 |
| 8-#8 | 2.39 | MA | 1257 | 653 | 1753 | 572 | 2189 | 474 | 2437 | 397 | 2738 | 264 | 3433 | 125 | 2825 |
| 4L-2S | | MI | 714 | 653 | 1181 | 514 | 1385 | 425 | 1506 | 347 | 1642 | 209 | 1813 | 111 | 1426 |
| 8-#9 | 3.03 | MA | 1414 | 702 | 2130 | 596 | 2666 | 491 | 3026 | 403 | 3533 | 260 | 4455 | 136 | 3744 |
| 3E | | MI | 679 | 702 | 1158 | 543 | 1351 | 444 | 1457 | 353 | 1577 | 200 | 1730 | 4 | 1723 |
| 8-#9 | 3.03 | MA | 1315 | 702 | 1909 | 605 | 2377 | 498 | 2658 | 413 | 3031 | 263 | 3831 | 94 | 3389 |
| 4L-2S | | MI | 747 | 702 | 1289 | 542 | 1517 | 445 | 1651 | 356 | 1823 | 198 | 2001 | 77 | 1738 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.



## RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

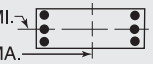
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 8-#10 | 3.85 | MA | 1512 | 766 | 2384 | 636 | 2980 | 521 | 3402 | 422 | 4037 | 258 | 5111 | 106 | 4660 |
| 3E | | MI | 706 | 766 | 1261 | 580 | 1475 | 469 | 1590 | 369 | 1744 | 184 | 1898 | -62 | 1885 |
| 8-#10 | 3.85 | MA | 1398 | 766 | 2105 | 647 | 2617 | 529 | 2938 | 434 | 3403 | 262 | 4330 | 53 | 4088 |
| 4L-2S | | MI | 786 | 766 | 1424 | 579 | 1681 | 472 | 1828 | 366 | 2045 | 182 | 2226 | 31 | 2123 |
| 8-#11 | 4.73 | MA | 1463 | 834 | 2310 | 688 | 2854 | 559 | 3211 | 453 | 3761 | 257 | 4749 | -1 | 4747 |
| 4L-2S | | MI | 811 | 834 | 1544 | 614 | 1783 | 485 | 1938 | 365 | 2180 | 150 | 2309 | -47 | 2310 |
| 8-#14 | 6.82 | MA | 1652 | 997 | 2781 | 794 | 3432 | 636 | 3890 | 505 | 4665 | 251 | 5899 | -117 | 5685 |
| 4L-2S | | MI | 898 | 997 | 1841 | 709 | 2099 | 538 | 2299 | 382 | 2634 | 95 | 2717 | -197 | 2720 |
| 10-#10 | 4.81 | MA | 1578 | 841 | 2502 | 693 | 3118 | 564 | 3545 | 456 | 4221 | 259 | 5433 | 46 | 5213 |
| 4L-3S | | MI | 765 | 841 | 1424 | 626 | 1681 | 503 | 1828 | 388 | 2045 | 172 | 2226 | -105 | 2199 |
| 10-#10 | 4.81 | MA | 1455 | 841 | 2253 | 704 | 2766 | 578 | 3129 | 463 | 3645 | 269 | 4654 | -9 | 4642 |
| 5L-2S | | MI | 840 | 841 | 1587 | 626 | 1888 | 506 | 2066 | 385 | 2347 | 169 | 2554 | -12 | 2551 |
| 10-#11 | 5.91 | MA | 1535 | 926 | 2484 | 757 | 3031 | 617 | 3437 | 487 | 4047 | 263 | 5129 | -82 | 5022 |
| 5L-2S | | MI | 873 | 926 | 1733 | 671 | 2013 | 525 | 2204 | 385 | 2517 | 130 | 2661 | -109 | 2652 |
| 12-#10 | 5.77 | MA | 1630 | 915 | 2649 | 750 | 3268 | 612 | 3736 | 485 | 4462 | 266 | 5758 | -16 | 5725 |
| 5L-3S | | MI | 823 | 915 | 1587 | 673 | 1888 | 538 | 2066 | 407 | 2347 | 159 | 2554 | -149 | 2508 |
| 12-#10 | 5.77 | MA | 1489 | 915 | 2407 | 760 | 2948 | 621 | 3329 | 498 | 3900 | 270 | 5002 | -84 | 4879 |
| 6L-2S | | MI | 894 | 915 | 1750 | 673 | 2094 | 541 | 2304 | 404 | 2649 | 156 | 2882 | -55 | 2863 |
| 14-#10 | 6.73 | MA | 1669 | 990 | 2803 | 806 | 3450 | 655 | 3936 | 520 | 4717 | 267 | 6106 | -92 | 5925 |
| 6L-3S | | MI | 881 | 990 | 1750 | 720 | 2094 | 572 | 2304 | 425 | 2649 | 147 | 2882 | -192 | 2813 |

## RECTANGULAR TIED COLUMNS 12" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#8 | 1.10 | MA | 1497 | 602 | 1929 | 546 | 2438 | 459 | 2729 | 390 | 3045 | 285 | 3761 | 248 | 1745 |
| 2E | | MI | 691 | 602 | 1039 | 492 | 1196 | 413 | 1270 | 348 | 1319 | 244 | 1451 | 177 | 804 |
| 4-#9 | 1.39 | MA | 1560 | 627 | 2082 | 560 | 2624 | 469 | 2951 | 396 | 3341 | 283 | 4168 | 246 | 2174 |
| 2E | | MI | 708 | 627 | 1097 | 505 | 1263 | 422 | 1342 | 351 | 1408 | 237 | 1543 | 160 | 973 |
| 4-#10 | 1.76 | MA | 1638 | 659 | 2276 | 578 | 2861 | 482 | 3233 | 404 | 3718 | 281 | 4684 | 244 | 2718 |
| 2E | | MI | 729 | 659 | 1168 | 521 | 1347 | 434 | 1431 | 356 | 1518 | 228 | 1653 | 136 | 1180 |
| 4-#11 | 2.17 | MA | 1705 | 693 | 2483 | 595 | 3102 | 494 | 3514 | 411 | 4085 | 277 | 5124 | 233 | 3263 |
| 2E | | MI | 740 | 693 | 1237 | 534 | 1401 | 436 | 1486 | 351 | 1582 | 209 | 1687 | 94 | 1373 |
| 4-#14 | 3.13 | MA | 1875 | 774 | 2951 | 642 | 3679 | 528 | 4203 | 432 | 5007 | 272 | 6303 | 217 | 4584 |
| 2E | | MI | 781 | 774 | 1392 | 578 | 1561 | 460 | 1666 | 357 | 1806 | 180 | 1886 | 18 | 1830 |
| 4-#18 | 5.56 | MA | 2256 | 980 | 4083 | 765 | 5082 | 618 | 5886 | 488 | 7259 | 261 | 9070 | 164 | 7793 |
| 2E | | MI | 872 | 980 | 1682 | 675 | 1885 | 511 | 2031 | 362 | 2262 | 90 | 2300 | -187 | 2302 |
| 6-#7 | 1.25 | MA | 1537 | 615 | 2002 | 555 | 2537 | 466 | 2852 | 395 | 3215 | 285 | 3999 | 248 | 1981 |
| 2L-3S | | MI | 656 | 615 | 985 | 504 | 1133 | 421 | 1201 | 353 | 1233 | 246 | 1362 | 131 | 905 |
| 6-#7 | 1.25 | MA | 1401 | 615 | 1788 | 561 | 2267 | 471 | 2525 | 399 | 2775 | 291 | 3389 | 205 | 1976 |
| 3L-2S | | MI | 705 | 615 | 1067 | 503 | 1236 | 421 | 1324 | 355 | 1389 | 245 | 1538 | 175 | 898 |
| 6-#8 | 1.65 | MA | 1622 | 649 | 2209 | 575 | 2792 | 480 | 3157 | 403 | 3622 | 283 | 4559 | 246 | 2566 |
| 2L-3S | | MI | 668 | 649 | 1039 | 522 | 1196 | 433 | 1270 | 359 | 1319 | 239 | 1451 | 96 | 1134 |
| 6-#8 | 1.65 | MA | 1452 | 649 | 1929 | 582 | 2438 | 486 | 2729 | 409 | 3045 | 291 | 3761 | 189 | 2548 |
| 3L-2S | | MI | 729 | 649 | 1145 | 521 | 1329 | 434 | 1428 | 361 | 1519 | 237 | 1674 | 154 | 1127 |
| 6-#9 | 2.08 | MA | 1712 | 686 | 2434 | 596 | 3069 | 496 | 3489 | 413 | 4066 | 281 | 5171 | 243 | 3203 |
| 2L-3S | | MI | 681 | 686 | 1097 | 542 | 1263 | 447 | 1342 | 365 | 1408 | 230 | 1543 | 54 | 1371 |
| 6-#9 | 2.08 | MA | 1507 | 686 | 2082 | 605 | 2624 | 504 | 2951 | 420 | 3341 | 290 | 4168 | 170 | 3162 |
| 3L-2S | | MI | 754 | 686 | 1228 | 541 | 1429 | 449 | 1536 | 367 | 1654 | 228 | 1813 | 128 | 1369 |
| 6-#10 | 2.65 | MA | 1823 | 733 | 2719 | 625 | 3422 | 516 | 3911 | 426 | 4631 | 278 | 5948 | 240 | 4012 |
| 2L-3S | | MI | 697 | 733 | 1168 | 569 | 1347 | 465 | 1431 | 377 | 1518 | 218 | 1653 | -1 | 1653 |
| 6-#10 | 2.65 | MA | 1576 | 733 | 2276 | 636 | 2861 | 526 | 3233 | 434 | 3718 | 289 | 4684 | 146 | 3931 |
| 3L-2S | | MI | 784 | 733 | 1331 | 568 | 1553 | 468 | 1669 | 374 | 1820 | 215 | 1981 | 93 | 1667 |
| 6-#11 | 3.25 | MA | 1637 | 785 | 2483 | 665 | 3102 | 547 | 3514 | 447 | 4085 | 286 | 5124 | 110 | 4685 |
| 3L-2S | | MI | 802 | 785 | 1426 | 591 | 1631 | 476 | 1752 | 371 | 1919 | 190 | 2039 | 33 | 1934 |
| 6-#14 | 4.69 | MA | 1811 | 907 | 2951 | 743 | 3679 | 604 | 4203 | 483 | 5007 | 283 | 6303 | 36 | 6204 |
| 3L-2S | | MI | 865 | 907 | 1653 | 661 | 1869 | 514 | 2022 | 382 | 2257 | 147 | 2342 | -81 | 2356 |

## RECTANGULAR TIED COLUMNS 12" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

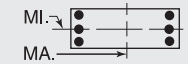
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#6 | 1.22 | MA | 1534 | 613 | 1983 | 555 | 2520 | 466 | 2835 | 395 | 3195 | 286 | 3973 | 249 | 1946 |
| 2L-4S | | MI | 646 | 613 | 953 | 506 | 1094 | 424 | 1159 | 357 | 1183 | 248 | 1316 | 136 | 895 |
| 8-#6 | 1.22 | MA | 1434 | 613 | 1825 | 559 | 2320 | 470 | 2593 | 398 | 2870 | 291 | 3523 | 218 | 1944 |
| 3E | | MI | 670 | 613 | 998 | 505 | 1155 | 423 | 1233 | 356 | 1276 | 249 | 1416 | 149 | 889 |
| 8-#6 | 1.22 | MA | 1374 | 613 | 1715 | 563 | 2177 | 473 | 2411 | 404 | 2620 | 293 | 3211 | 199 | 1930 |
| 4L-2S | | MI | 706 | 613 | 1059 | 504 | 1232 | 423 | 1326 | 357 | 1393 | 248 | 1550 | 181 | 884 |
| 8-#7 | 1.67 | MA | 1503 | 650 | 2002 | 583 | 2537 | 487 | 2852 | 409 | 3215 | 290 | 3999 | 204 | 2597 |
| 3E | | MI | 688 | 650 | 1067 | 526 | 1236 | 437 | 1324 | 363 | 1389 | 242 | 1538 | 114 | 1150 |
| 8-#7 | 1.67 | MA | 1426 | 650 | 1853 | 588 | 2343 | 492 | 2604 | 416 | 2876 | 293 | 3574 | 178 | 2552 |
| 4L-2S | | MI | 734 | 650 | 1148 | 525 | 1339 | 437 | 1447 | 365 | 1545 | 241 | 1713 | 158 | 1145 |
| 8-#8 | 2.19 | MA | 1582 | 695 | 2209 | 611 | 2792 | 508 | 3157 | 423 | 3622 | 289 | 4559 | 187 | 3356 |
| 3E | | MI | 708 | 695 | 1145 | 551 | 1329 | 455 | 1428 | 372 | 1519 | 233 | 1674 | 72 | 1444 |
| 8-#8 | 2.19 | MA | 1488 | 695 | 2014 | 618 | 2538 | 514 | 2832 | 432 | 3178 | 293 | 4001 | 153 | 3189 |
| 4L-2S | | MI | 766 | 695 | 1250 | 550 | 1462 | 456 | 1585 | 373 | 1718 | 231 | 1897 | 130 | 1442 |
| 8-#9 | 2.78 | MA | 1667 | 745 | 2434 | 642 | 3069 | 531 | 3489 | 437 | 4066 | 288 | 5171 | 167 | 4176 |
| 3E | | MI | 730 | 745 | 1228 | 579 | 1429 | 474 | 1536 | 380 | 1654 | 221 | 1813 | 22 | 1749 |
| 8-#9 | 2.78 | MA | 1555 | 745 | 2189 | 651 | 2749 | 538 | 3080 | 448 | 3507 | 292 | 4467 | 124 | 3826 |
| 4L-2S | | MI | 799 | 745 | 1359 | 578 | 1595 | 476 | 1730 | 382 | 1899 | 219 | 2084 | 96 | 1757 |
| 8-#10 | 3.53 | MA | 1780 | 808 | 2719 | 682 | 3422 | 560 | 3911 | 456 | 4631 | 286 | 5948 | 142 | 5209 |
| 3E | | MI | 757 | 808 | 1331 | 615 | 1553 | 500 | 1669 | 396 | 1820 | 206 | 1981 | -44 | 1973 |
| 8-#10 | 3.53 | MA | 1641 | 808 | 2409 | 694 | 3018 | 570 | 3395 | 470 | 3926 | 292 | 5057 | 87 | 4618 |
| 4L-2S | | MI | 838 | 808 | 1494 | 615 | 1759 | 502 | 1907 | 393 | 2122 | 203 | 2309 | 50 | 2144 |
| 8-#11 | 4.33 | MA | 1727 | 876 | 2642 | 735 | 3289 | 600 | 3706 | 489 | 4333 | 287 | 5559 | 36 | 5382 |
| 4L-2S | | MI | 863 | 876 | 1615 | 649 | 1861 | 515 | 2017 | 391 | 2256 | 170 | 2391 | -29 | 2393 |
| 8-#14 | 6.25 | MA | 1945 | 1039 | 3175 | 843 | 3941 | 679 | 4474 | 543 | 5355 | 283 | 6906 | -71 | 6747 |
| 4L-2S | | MI | 949 | 1039 | 1914 | 743 | 2178 | 568 | 2378 | 408 | 2709 | 115 | 2798 | -179 | 2807 |
| 10-#10 | 4.41 | MA | 1856 | 883 | 2853 | 740 | 3579 | 604 | 4074 | 492 | 4839 | 289 | 6321 | 83 | 5882 |
| 4L-3S | | MI | 816 | 883 | 1494 | 662 | 1759 | 534 | 1907 | 414 | 2122 | 193 | 2309 | -87 | 2288 |
| 10-#10 | 4.41 | MA | 1704 | 883 | 2577 | 751 | 3188 | 619 | 3611 | 500 | 4199 | 300 | 5429 | 29 | 5328 |
| 5L-2S | | MI | 892 | 883 | 1657 | 661 | 1966 | 537 | 2145 | 412 | 2423 | 190 | 2637 | 6 | 2616 |
| 10-#11 | 5.42 | MA | 1803 | 968 | 2841 | 805 | 3490 | 660 | 3963 | 525 | 4658 | 296 | 5997 | -39 | 5933 |
| 5L-2S | | MI | 924 | 968 | 1804 | 706 | 2092 | 555 | 2283 | 411 | 2593 | 151 | 2743 | -91 | 2739 |
| 10-#14 | 7.81 | MA | 2051 | 1171 | 3455 | 943 | 4224 | 764 | 4835 | 594 | 5813 | 294 | 7518 | -184 | 7104 |
| 5L-2S | | MI | 1034 | 1171 | 2175 | 826 | 2486 | 622 | 2734 | 433 | 3160 | 83 | 3255 | -277 | 3243 |
| 12-#10 | 5.29 | MA | 1910 | 958 | 3020 | 798 | 3748 | 654 | 4290 | 522 | 5113 | 297 | 6693 | 25 | 6600 |
| 5L-3S | | MI | 874 | 958 | 1657 | 709 | 1966 | 568 | 2145 | 433 | 2423 | 180 | 2637 | -130 | 2600 |
| 12-#10 | 5.29 | MA | 1750 | 958 | 2743 | 807 | 3394 | 663 | 3838 | 536 | 4489 | 302 | 5832 | -46 | 5718 |
| 6L-2S | | MI | 946 | 958 | 1820 | 708 | 2172 | 571 | 2383 | 430 | 2725 | 178 | 2965 | -37 | 2954 |
| 12-#11 | 6.50 | MA | 1853 | 1060 | 3047 | 874 | 3735 | 713 | 4232 | 568 | 5002 | 297 | 6467 | -132 | 6223 |
| 6L-2S | | MI | 986 | 1060 | 1994 | 763 | 2322 | 594 | 2549 | 431 | 2929 | 131 | 3095 | -152 | 3075 |
| 14-#10 | 6.17 | MA | 1954 | 1032 | 3187 | 853 | 3955 | 698 | 4516 | 558 | 5402 | 300 | 7096 | -50 | 6920 |
| 6L-3S | | MI | 931 | 1032 | 1820 | 755 | 2172 | 603 | 2383 | 452 | 2725 | 168 | 2965 | -173 | 2907 |

## RECTANGULAR TIED COLUMNS 14" x 14"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#6 | 1.35 | MA | 582 | 424 | 851 | 358 | 1014 | 299 | 1108 | 253 | 1210 | 179 | 1382 | 136 | 781 |
| 2L-3S | | MI | 535 | 424 | 774 | 360 | 917 | 300 | 991 | 253 | 1053 | 180 | 1196 | 103 | 785 |
| 6-#7 | 1.84 | MA | 611 | 452 | 935 | 374 | 1117 | 311 | 1231 | 260 | 1367 | 175 | 1562 | 123 | 1025 |
| 2L-3S | | MI | 552 | 452 | 832 | 376 | 986 | 312 | 1072 | 260 | 1157 | 177 | 1314 | 79 | 1024 |
| 6-#8 | 2.42 | MA | 644 | 486 | 1033 | 393 | 1237 | 325 | 1373 | 268 | 1547 | 171 | 1766 | 108 | 1305 |
| 2L-3S | | MI | 571 | 486 | 898 | 396 | 1067 | 326 | 1168 | 268 | 1277 | 173 | 1450 | 50 | 1294 |
| 6-#9 | 3.06 | MA | 677 | 523 | 1138 | 414 | 1365 | 340 | 1527 | 278 | 1738 | 165 | 1980 | 89 | 1604 |
| 2L-3S | | MI | 591 | 523 | 970 | 418 | 1153 | 342 | 1270 | 277 | 1404 | 168 | 1591 | 16 | 1562 |
| 6-#10 | 3.89 | MA | 719 | 571 | 1269 | 442 | 1527 | 361 | 1720 | 291 | 1975 | 158 | 2242 | 64 | 1977 |
| 2L-3S | | MI | 616 | 571 | 1059 | 446 | 1261 | 362 | 1399 | 289 | 1561 | 161 | 1765 | -29 | 1749 |
| 6-#11 | 4.78 | MA | 748 | 622 | 1393 | 469 | 1672 | 380 | 1876 | 299 | 2147 | 141 | 2395 | 20 | 2317 |
| 2L-3S | | MI | 633 | 622 | 1146 | 472 | 1360 | 379 | 1503 | 295 | 1675 | 144 | 1864 | -95 | 1824 |

## RECTANGULAR TIED COLUMNS 14" x 14"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#6 | 1.80 | MA | 612 | 450 | 928 | 374 | 1111 | 311 | 1226 | 260 | 1367 | 178 | 1569 | 127 | 1010 |
| 2L-4S | | MI | 540 | 450 | 795 | 378 | 939 | 315 | 1016 | 263 | 1086 | 178 | 1246 | 81 | 994 |
| 8-#7 | 2.45 | MA | 649 | 488 | 1039 | 396 | 1248 | 327 | 1389 | 270 | 1576 | 173 | 1809 | 111 | 1329 |
| 2L-4S | | MI | 558 | 488 | 860 | 401 | 1015 | 332 | 1106 | 273 | 1201 | 173 | 1380 | 48 | 1238 |
| 8-#8 | 3.22 | MA | 692 | 533 | 1167 | 422 | 1407 | 346 | 1579 | 282 | 1816 | 168 | 2082 | 91 | 1697 |
| 2L-4S | | MI | 581 | 533 | 935 | 428 | 1104 | 353 | 1211 | 285 | 1333 | 168 | 1533 | 8 | 1509 |
| 8-#9 | 4.08 | MA | 736 | 582 | 1306 | 451 | 1578 | 367 | 1784 | 295 | 2071 | 161 | 2368 | 67 | 2090 |
| 2L-4S | | MI | 605 | 582 | 1015 | 458 | 1199 | 375 | 1324 | 298 | 1474 | 161 | 1693 | -37 | 1683 |

## RECTANGULAR TIED COLUMNS 14" x 16"

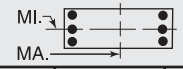
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.07 | MA | 745 | 467 | 1037 | 404 | 1250 | 339 | 1368 | 288 | 1488 | 210 | 1729 | 170 | 845 |
| 2E | | MI | 641 | 467 | 921 | 395 | 1090 | 332 | 1180 | 282 | 1263 | 204 | 1432 | 158 | 728 |
| 4-#8 | 1.41 | MA | 775 | 489 | 1119 | 416 | 1349 | 348 | 1485 | 294 | 1643 | 209 | 1910 | 162 | 1078 |
| 2E | | MI | 664 | 489 | 988 | 408 | 1170 | 341 | 1276 | 287 | 1382 | 200 | 1567 | 148 | 922 |
| 4-#9 | 1.79 | MA | 806 | 514 | 1207 | 430 | 1456 | 358 | 1611 | 300 | 1812 | 207 | 2101 | 153 | 1328 |
| 2E | | MI | 688 | 514 | 1061 | 421 | 1257 | 350 | 1378 | 293 | 1509 | 196 | 1708 | 135 | 1128 |
| 4-#10 | 2.27 | MA | 843 | 546 | 1317 | 448 | 1590 | 371 | 1771 | 308 | 2021 | 204 | 2338 | 139 | 1641 |
| 2E | | MI | 716 | 546 | 1151 | 439 | 1366 | 363 | 1507 | 301 | 1666 | 190 | 1881 | 117 | 1386 |
| 4-#11 | 2.79 | MA | 870 | 580 | 1429 | 464 | 1717 | 383 | 1917 | 314 | 2184 | 194 | 2501 | 115 | 1940 |
| 2E | | MI | 735 | 580 | 1240 | 454 | 1465 | 374 | 1611 | 304 | 1780 | 177 | 1978 | 87 | 1626 |
| 4-#14 | 4.02 | MA | 950 | 661 | 1687 | 511 | 2033 | 417 | 2294 | 335 | 2646 | 181 | 3010 | 72 | 2669 |
| 2E | | MI | 796 | 661 | 1445 | 501 | 1715 | 408 | 1884 | 319 | 2121 | 158 | 2329 | 30 | 2212 |
| 4-#18 | 7.14 | MA | 1132 | 867 | 2290 | 633 | 2776 | 505 | 3147 | 383 | 3687 | 137 | 4104 | -60 | 4042 |
| 2E | | MI | 932 | 867 | 1917 | 621 | 2247 | 483 | 2475 | 347 | 2864 | 96 | 3035 | -141 | 3001 |
| 6-#6 | 1.18 | MA | 758 | 474 | 1059 | 410 | 1283 | 344 | 1410 | 292 | 1547 | 211 | 1812 | 171 | 924 |
| 2L-3S | | MI | 604 | 474 | 862 | 404 | 1020 | 338 | 1098 | 286 | 1159 | 206 | 1313 | 126 | 799 |
| 6-#6 | 1.18 | MA | 700 | 474 | 966 | 413 | 1166 | 346 | 1268 | 293 | 1355 | 213 | 1572 | 138 | 928 |
| 3L-2S | | MI | 652 | 474 | 939 | 402 | 1117 | 337 | 1216 | 285 | 1316 | 205 | 1500 | 159 | 794 |
| 6-#7 | 1.61 | MA | 796 | 502 | 1162 | 426 | 1409 | 356 | 1560 | 299 | 1747 | 209 | 2049 | 162 | 1219 |
| 2L-3S | | MI | 621 | 502 | 921 | 420 | 1090 | 350 | 1180 | 293 | 1263 | 203 | 1432 | 102 | 1042 |
| 6-#7 | 1.61 | MA | 721 | 502 | 1037 | 430 | 1250 | 358 | 1368 | 300 | 1488 | 211 | 1729 | 118 | 1219 |
| 3L-2S | | MI | 682 | 502 | 1025 | 418 | 1221 | 348 | 1339 | 292 | 1472 | 201 | 1679 | 146 | 1039 |
| 6-#8 | 2.12 | MA | 839 | 536 | 1282 | 446 | 1556 | 370 | 1735 | 307 | 1980 | 207 | 2322 | 150 | 1561 |
| 2L-3S | | MI | 640 | 536 | 988 | 440 | 1170 | 364 | 1276 | 301 | 1382 | 199 | 1567 | 73 | 1316 |
| 6-#8 | 2.12 | MA | 747 | 536 | 1119 | 450 | 1349 | 373 | 1485 | 309 | 1643 | 209 | 1910 | 92 | 1550 |
| 3L-2S | | MI | 715 | 536 | 1123 | 437 | 1340 | 362 | 1481 | 301 | 1652 | 197 | 1883 | 131 | 1321 |
| 6-#9 | 2.68 | MA | 883 | 573 | 1411 | 467 | 1715 | 385 | 1924 | 317 | 2233 | 204 | 2611 | 136 | 1928 |
| 2L-3S | | MI | 659 | 573 | 1061 | 461 | 1257 | 379 | 1378 | 310 | 1509 | 193 | 1708 | 39 | 1604 |
| 6-#9 | 2.68 | MA | 774 | 573 | 1207 | 472 | 1456 | 389 | 1611 | 319 | 1812 | 207 | 2101 | 63 | 1899 |
| 3L-2S | | MI | 749 | 573 | 1228 | 458 | 1469 | 377 | 1635 | 310 | 1843 | 191 | 2096 | 112 | 1623 |
| 6-#10 | 3.40 | MA | 937 | 620 | 1574 | 495 | 1915 | 406 | 2163 | 330 | 2548 | 201 | 2968 | 117 | 2388 |
| 2L-3S | | MI | 684 | 620 | 1151 | 489 | 1366 | 399 | 1507 | 321 | 1666 | 186 | 1881 | -7 | 1877 |
| 6-#10 | 3.40 | MA | 808 | 620 | 1317 | 501 | 1590 | 409 | 1771 | 331 | 2021 | 203 | 2338 | 24 | 2289 |
| 3L-2S | | MI | 790 | 620 | 1360 | 486 | 1631 | 398 | 1828 | 323 | 2080 | 183 | 2357 | 86 | 1999 |
| 6-#11 | 4.18 | MA | 977 | 672 | 1733 | 522 | 2102 | 425 | 2382 | 341 | 2795 | 188 | 3218 | 82 | 2822 |
| 2L-3S | | MI | 700 | 672 | 1240 | 514 | 1465 | 415 | 1611 | 327 | 1780 | 169 | 1978 | -73 | 1949 |
| 6-#11 | 4.18 | MA | 832 | 672 | 1429 | 528 | 1717 | 428 | 1917 | 341 | 2184 | 191 | 2501 | -32 | 2476 |
| 3L-2S | | MI | 819 | 672 | 1486 | 512 | 1777 | 416 | 1984 | 330 | 2252 | 166 | 2509 | 42 | 2343 |
| 6-#14 | 6.03 | MA | 911 | 793 | 1687 | 601 | 2033 | 480 | 2294 | 371 | 2646 | 174 | 3010 | -147 | 2904 |
| 3L-2S | | MI | 910 | 793 | 1789 | 584 | 2150 | 468 | 2392 | 353 | 2765 | 137 | 3038 | -42 | 3014 |
| 8-#6 | 1.57 | MA | 796 | 500 | 1152 | 426 | 1401 | 356 | 1552 | 299 | 1739 | 210 | 2053 | 165 | 1200 |
| 2L-4S | | MI | 609 | 500 | 884 | 422 | 1042 | 353 | 1124 | 296 | 1192 | 204 | 1364 | 104 | 1024 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 8-#6 | 1.57 | MA | 741 | 500 | 1059 | 429 | 1283 | 358 | 1410 | 301 | 1547 | 212 | 1812 | 133 | 1201 |
| 3E | | MI | 637 | 500 | 939 | 420 | 1117 | 350 | 1216 | 293 | 1316 | 205 | 1500 | 118 | 1027 |
| 8-#6 | 1.57 | MA | 706 | 500 | 992 | 432 | 1197 | 360 | 1300 | 304 | 1397 | 212 | 1639 | 116 | 1193 |
| 4L-2S | | MI | 682 | 500 | 1016 | 418 | 1215 | 349 | 1334 | 293 | 1473 | 204 | 1686 | 150 | 1024 |
| 8-#7 | 2.14 | MA | 846 | 537 | 1288 | 448 | 1568 | 372 | 1752 | 309 | 2005 | 208 | 2370 | 153 | 1589 |
| 2L-4S | | MI | 627 | 537 | 949 | 445 | 1119 | 370 | 1214 | 306 | 1307 | 199 | 1498 | 71 | 1283 |
| 8-#7 | 2.14 | MA | 776 | 537 | 1162 | 452 | 1409 | 374 | 1560 | 311 | 1747 | 210 | 2049 | 109 | 1582 |
| 3E | | MI | 664 | 537 | 1025 | 442 | 1221 | 366 | 1339 | 303 | 1472 | 201 | 1679 | 90 | 1343 |
| 8-#7 | 2.14 | MA | 731 | 537 | 1072 | 455 | 1292 | 377 | 1411 | 315 | 1543 | 209 | 1818 | 87 | 1510 |
| 4L-2S | | MI | 720 | 537 | 1128 | 440 | 1352 | 365 | 1497 | 303 | 1682 | 199 | 1926 | 134 | 1346 |
| 8-#8 | 2.82 | MA | 900 | 582 | 1446 | 475 | 1763 | 391 | 1985 | 321 | 2317 | 205 | 2735 | 138 | 2038 |
| 2L-4S | | MI | 648 | 582 | 1025 | 472 | 1208 | 390 | 1319 | 318 | 1439 | 194 | 1650 | 31 | 1560 |
| 8-#8 | 2.82 | MA | 816 | 582 | 1282 | 479 | 1556 | 394 | 1735 | 323 | 1980 | 208 | 2322 | 80 | 2018 |
| 3E | | MI | 693 | 582 | 1123 | 469 | 1340 | 385 | 1481 | 314 | 1652 | 195 | 1883 | 56 | 1702 |
| 8-#8 | 2.82 | MA | 762 | 582 | 1165 | 483 | 1403 | 397 | 1540 | 328 | 1715 | 206 | 2023 | 52 | 1848 |
| 4L-2S | | MI | 763 | 582 | 1257 | 466 | 1510 | 383 | 1687 | 314 | 1922 | 194 | 2199 | 114 | 1715 |
| 8-#9 | 3.57 | MA | 958 | 631 | 1616 | 504 | 1973 | 412 | 2237 | 334 | 2654 | 202 | 3121 | 120 | 2522 |
| 2L-4S | | MI | 672 | 631 | 1106 | 501 | 1303 | 412 | 1432 | 331 | 1579 | 186 | 1809 | -15 | 1806 |
| 8-#9 | 3.57 | MA | 858 | 631 | 1411 | 509 | 1715 | 416 | 1924 | 336 | 2233 | 205 | 2611 | 46 | 2482 |
| 3E | | MI | 725 | 631 | 1228 | 498 | 1469 | 406 | 1635 | 327 | 1843 | 189 | 2096 | 16 | 2063 |
| 8-#9 | 3.57 | MA | 795 | 631 | 1264 | 514 | 1515 | 424 | 1680 | 342 | 1900 | 203 | 2241 | 12 | 2202 |
| 4L-2S | | MI | 808 | 631 | 1396 | 495 | 1682 | 405 | 1892 | 328 | 2177 | 186 | 2485 | 89 | 2111 |
| 8-#10 | 4.54 | MA | 911 | 695 | 1574 | 548 | 1915 | 444 | 2163 | 353 | 2548 | 200 | 2968 | 1 | 2965 |
| 3E | | MI | 766 | 695 | 1360 | 536 | 1631 | 433 | 1828 | 343 | 2080 | 179 | 2357 | -38 | 2333 |
| 8-#10 | 4.54 | MA | 836 | 695 | 1389 | 554 | 1663 | 453 | 1856 | 360 | 2131 | 198 | 2509 | -41 | 2485 |
| 4L-2S | | MI | 862 | 695 | 1570 | 532 | 1897 | 432 | 2149 | 345 | 2493 | 176 | 2834 | 56 | 2606 |
| 8-#11 | 5.57 | MA | 952 | 763 | 1733 | 585 | 2102 | 470 | 2382 | 368 | 2795 | 185 | 3218 | -66 | 3152 |
| 3E | | MI | 794 | 763 | 1486 | 572 | 1777 | 457 | 1984 | 353 | 2252 | 157 | 2509 | -118 | 2449 |
| 10-#10 | 5.67 | MA | 945 | 770 | 1645 | 601 | 1988 | 488 | 2249 | 382 | 2658 | 194 | 3139 | -64 | 3078 |
| 4L-3S | | MI | 845 | 770 | 1570 | 583 | 1897 | 467 | 2149 | 365 | 2493 | 172 | 2834 | -69 | 2779 |

## RECTANGULAR TIED COLUMNS 14" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#8 | 1.25 | MA | 976 | 539 | 1355 | 469 | 1656 | 393 | 1830 | 333 | 2026 | 240 | 2410 | 197 | 1248 |
| 2E | | MI | 734 | 539 | 1078 | 451 | 1274 | 378 | 1384 | 320 | 1488 | 226 | 1683 | 170 | 936 |
| 4-#9 | 1.59 | MA | 1015 | 563 | 1459 | 483 | 1783 | 403 | 1981 | 339 | 2226 | 238 | 2652 | 190 | 1544 |
| 2E | | MI | 758 | 563 | 1151 | 464 | 1361 | 388 | 1486 | 325 | 1614 | 222 | 1824 | 157 | 1144 |
| 4-#10 | 2.02 | MA | 1063 | 595 | 1591 | 501 | 1943 | 416 | 2171 | 347 | 2480 | 235 | 2954 | 180 | 1915 |
| 2E | | MI | 787 | 595 | 1242 | 482 | 1470 | 400 | 1615 | 333 | 1771 | 216 | 1996 | 140 | 1404 |
| 4-#11 | 2.48 | MA | 1099 | 629 | 1728 | 517 | 2100 | 427 | 2352 | 353 | 2715 | 231 | 3184 | 160 | 2277 |
| 2E | | MI | 806 | 629 | 1333 | 497 | 1570 | 410 | 1720 | 336 | 1884 | 202 | 2093 | 109 | 1648 |
| 4-#14 | 3.57 | MA | 1200 | 710 | 2039 | 564 | 2481 | 462 | 2807 | 374 | 3311 | 224 | 3855 | 126 | 3155 |
| 2E | | MI | 866 | 710 | 1540 | 543 | 1821 | 443 | 1992 | 350 | 2225 | 182 | 2442 | 52 | 2239 |
| 4-#18 | 6.35 | MA | 1429 | 916 | 2776 | 685 | 3390 | 550 | 3895 | 429 | 4658 | 193 | 5354 | 22 | 5239 |
| 2E | | MI | 1002 | 916 | 2014 | 662 | 2353 | 518 | 2583 | 377 | 2967 | 120 | 3147 | -120 | 3126 |
| 6-#6 | 1.05 | MA | 954 | 523 | 1283 | 463 | 1577 | 389 | 1741 | 331 | 1910 | 242 | 2282 | 204 | 1066 |
| 2L-3S | | MI | 674 | 523 | 951 | 448 | 1123 | 376 | 1206 | 319 | 1265 | 232 | 1431 | 149 | 811 |
| 6-#6 | 1.05 | MA | 884 | 523 | 1174 | 466 | 1439 | 392 | 1573 | 333 | 1685 | 245 | 1986 | 171 | 1070 |
| 3L-2S | | MI | 722 | 523 | 1028 | 446 | 1221 | 375 | 1324 | 318 | 1422 | 231 | 1617 | 182 | 806 |
| 6-#7 | 1.43 | MA | 1002 | 551 | 1405 | 479 | 1726 | 401 | 1918 | 338 | 2146 | 240 | 2578 | 197 | 1413 |
| 2L-3S | | MI | 690 | 551 | 1010 | 464 | 1193 | 387 | 1288 | 325 | 1368 | 229 | 1549 | 125 | 1058 |
| 6-#7 | 1.43 | MA | 912 | 551 | 1258 | 483 | 1539 | 404 | 1692 | 340 | 1842 | 244 | 2183 | 153 | 1413 |
| 3L-2S | | MI | 752 | 551 | 1114 | 461 | 1324 | 386 | 1447 | 325 | 1578 | 227 | 1796 | 169 | 1053 |
| 6-#8 | 1.88 | MA | 1056 | 585 | 1547 | 498 | 1900 | 415 | 2125 | 347 | 2423 | 238 | 2920 | 188 | 1817 |
| 2L-3S | | MI | 709 | 585 | 1078 | 483 | 1274 | 401 | 1384 | 333 | 1488 | 224 | 1683 | 95 | 1337 |
| 6-#8 | 1.88 | MA | 943 | 585 | 1355 | 503 | 1656 | 419 | 1830 | 350 | 2026 | 242 | 2410 | 130 | 1806 |
| 3L-2S | | MI | 785 | 585 | 1213 | 480 | 1444 | 399 | 1589 | 333 | 1757 | 223 | 2000 | 153 | 1338 |
| 6-#9 | 2.38 | MA | 1111 | 622 | 1701 | 520 | 2089 | 430 | 2350 | 356 | 2724 | 236 | 3285 | 178 | 2252 |
| 2L-3S | | MI | 728 | 622 | 1151 | 505 | 1361 | 416 | 1486 | 342 | 1614 | 219 | 1824 | 61 | 1630 |

## RECTANGULAR TIED COLUMNS 14" x 18"

Short columns – no sidesway
Bending on major or minor axis

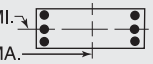
$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#9 | 2.38 | MA | 979 | 622 | 1459 | 526 | 1783 | 435 | 1981 | 360 | 2226 | 240 | 2652 | 105 | 2223 |
| 3L-2S | | MI | 820 | 622 | 1319 | 501 | 1573 | 415 | 1743 | 343 | 1948 | 217 | 2212 | 135 | 1642 |
| 6-#10 | 3.02 | MA | 1178 | 670 | 1894 | 548 | 2327 | 450 | 2635 | 369 | 3105 | 233 | 3741 | 164 | 2800 |
| 2L-3S | | MI | 753 | 670 | 1242 | 532 | 1470 | 435 | 1615 | 353 | 1771 | 212 | 1996 | 16 | 1967 |
| 6-#10 | 3.02 | MA | 1021 | 670 | 1591 | 555 | 1943 | 456 | 2171 | 373 | 2480 | 238 | 2954 | 70 | 2739 |
| 3L-2S | | MI | 861 | 670 | 1452 | 529 | 1736 | 434 | 1936 | 355 | 2185 | 209 | 2473 | 109 | 2020 |
| 6-#11 | 3.71 | MA | 1231 | 721 | 2089 | 574 | 2557 | 470 | 2905 | 380 | 3460 | 228 | 4090 | 135 | 3327 |
| 2L-3S | | MI | 768 | 721 | 1333 | 557 | 1570 | 451 | 1720 | 358 | 1884 | 194 | 2093 | -51 | 2074 |
| 6-#11 | 3.71 | MA | 1054 | 721 | 1728 | 583 | 2100 | 475 | 2352 | 383 | 2715 | 232 | 3184 | 21 | 3137 |
| 3L-2S | | MI | 890 | 721 | 1580 | 554 | 1882 | 452 | 2092 | 362 | 2356 | 191 | 2624 | 64 | 2368 |
| 6-#14 | 5.36 | MA | 1153 | 843 | 2039 | 657 | 2481 | 529 | 2807 | 415 | 3311 | 223 | 3855 | -80 | 3766 |
| 3L-2S | | MI | 981 | 843 | 1884 | 625 | 2256 | 504 | 2501 | 385 | 2869 | 162 | 3152 | -21 | 3142 |
| 8-#6 | 1.40 | MA | 1001 | 549 | 1392 | 479 | 1715 | 401 | 1908 | 338 | 2136 | 241 | 2577 | 200 | 1390 |
| 2L-4S | | MI | 677 | 549 | 972 | 466 | 1145 | 391 | 1232 | 328 | 1298 | 230 | 1481 | 126 | 1042 |
| 8-#6 | 1.40 | MA | 934 | 549 | 1283 | 482 | 1577 | 403 | 1741 | 340 | 1910 | 244 | 2282 | 168 | 1391 |
| 3E | | MI | 707 | 549 | 1028 | 464 | 1221 | 388 | 1324 | 326 | 1422 | 231 | 1617 | 141 | 1041 |
| 8-#6 | 1.40 | MA | 894 | 549 | 1206 | 485 | 1477 | 406 | 1612 | 344 | 1735 | 245 | 2071 | 150 | 1384 |
| 4L-2S | | MI | 752 | 549 | 1105 | 462 | 1318 | 386 | 1442 | 326 | 1578 | 230 | 1804 | 173 | 1038 |
| 8-#7 | 1.90 | MA | 1063 | 587 | 1553 | 501 | 1913 | 417 | 2144 | 348 | 2450 | 239 | 2973 | 191 | 1848 |
| 2L-4S | | MI | 696 | 587 | 1039 | 488 | 1222 | 407 | 1322 | 338 | 1412 | 225 | 1615 | 94 | 1326 |
| 8-#7 | 1.90 | MA | 977 | 587 | 1405 | 505 | 1726 | 420 | 1918 | 351 | 2146 | 242 | 2578 | 147 | 1841 |
| 3E | | MI | 733 | 587 | 1114 | 486 | 1324 | 403 | 1447 | 336 | 1578 | 227 | 1796 | 113 | 1361 |
| 8-#7 | 1.90 | MA | 925 | 587 | 1301 | 509 | 1590 | 423 | 1744 | 356 | 1909 | 243 | 2295 | 124 | 1792 |
| 4L-2S | | MI | 791 | 587 | 1217 | 483 | 1455 | 402 | 1605 | 335 | 1787 | 225 | 2043 | 157 | 1361 |
| 8-#8 | 2.51 | MA | 1132 | 632 | 1740 | 527 | 2144 | 436 | 2420 | 360 | 2820 | 236 | 3430 | 180 | 2379 |
| 2L-4S | | MI | 717 | 632 | 1115 | 515 | 1312 | 427 | 1427 | 350 | 1544 | 219 | 1767 | 54 | 1609 |
| 8-#8 | 2.51 | MA | 1029 | 632 | 1547 | 533 | 1900 | 440 | 2125 | 363 | 2423 | 240 | 2920 | 122 | 2360 |
| 3E | | MI | 763 | 632 | 1213 | 512 | 1444 | 422 | 1589 | 347 | 1757 | 221 | 2000 | 78 | 1725 |
| 8-#8 | 2.51 | MA | 962 | 632 | 1410 | 538 | 1722 | 444 | 1898 | 370 | 2113 | 241 | 2554 | 92 | 2197 |
| 4L-2S | | MI | 834 | 632 | 1347 | 509 | 1614 | 421 | 1795 | 347 | 2027 | 219 | 2316 | 136 | 1734 |
| 8-#9 | 3.17 | MA | 1203 | 681 | 1942 | 556 | 2394 | 457 | 2720 | 373 | 3221 | 233 | 3918 | 167 | 2954 |
| 2L-4S | | MI | 740 | 681 | 1196 | 545 | 1407 | 449 | 1540 | 363 | 1684 | 212 | 1925 | 8 | 1903 |
| 8-#9 | 3.17 | MA | 1081 | 681 | 1701 | 563 | 2089 | 462 | 2350 | 377 | 2724 | 238 | 3285 | 93 | 2914 |
| 3E | | MI | 795 | 681 | 1319 | 541 | 1573 | 443 | 1743 | 359 | 1948 | 214 | 2212 | 38 | 2109 |
| 8-#9 | 3.17 | MA | 1006 | 681 | 1529 | 569 | 1865 | 467 | 2065 | 385 | 2334 | 239 | 2831 | 55 | 2623 |
| 4L-2S | | MI | 879 | 681 | 1487 | 538 | 1786 | 442 | 2000 | 360 | 2282 | 212 | 2601 | 112 | 2132 |
| 8-#10 | 4.03 | MA | 1147 | 745 | 1894 | 602 | 2327 | 491 | 2635 | 395 | 3105 | 235 | 3741 | 54 | 3597 |
| 3E | | MI | 834 | 745 | 1452 | 579 | 1736 | 470 | 1936 | 375 | 2185 | 205 | 2473 | -15 | 2464 |
| 8-#10 | 4.03 | MA | 1058 | 745 | 1678 | 610 | 2045 | 497 | 2276 | 404 | 2614 | 235 | 3175 | 7 | 3149 |
| 4L-2S | | MI | 934 | 745 | 1662 | 575 | 2001 | 469 | 2257 | 377 | 2598 | 202 | 2950 | 78 | 2628 |
| 8-#11 | 4.95 | MA | 1200 | 813 | 2089 | 640 | 2557 | 517 | 2905 | 410 | 3460 | 229 | 4090 | -4 | 4085 |
| 3E | | MI | 862 | 813 | 1580 | 614 | 1882 | 494 | 2092 | 384 | 2356 | 182 | 2624 | -96 | 2577 |
| 8-#11 | 4.95 | MA | 1099 | 813 | 1830 | 648 | 2204 | 530 | 2474 | 420 | 2872 | 226 | 3433 | -58 | 3385 |
| 4L-2S | | MI | 974 | 813 | 1826 | 611 | 2194 | 494 | 2465 | 388 | 2828 | 179 | 3155 | 19 | 3080 |
| 10-#10 | 5.04 | MA | 1191 | 819 | 1981 | 657 | 2429 | 531 | 2740 | 426 | 3239 | 232 | 3961 | -9 | 3949 |
| 4L-3S | | MI | 913 | 819 | 1662 | 626 | 2001 | 504 | 2257 | 397 | 2598 | 198 | 2950 | -46 | 2915 |
| 10-#10 | 5.04 | MA | 1110 | 819 | 1786 | 665 | 2154 | 542 | 2416 | 430 | 2792 | 238 | 3405 | -65 | 3356 |
| 5L-2S | | MI | 1006 | 819 | 1871 | 622 | 2266 | 503 | 2578 | 399 | 3011 | 195 | 3427 | 47 | 3234 |
| 10-#11 | 6.19 | MA | 1254 | 905 | 2191 | 706 | 2661 | 572 | 3027 | 447 | 3617 | 223 | 4339 | -83 | 4232 |
| 4L-3S | | MI | 953 | 905 | 1826 | 672 | 2194 | 536 | 2465 | 410 | 2828 | 171 | 3155 | -141 | 3071 |
| 12-#10 | 6.05 | MA | 1239 | 894 | 2090 | 711 | 2538 | 577 | 2880 | 452 | 3416 | 235 | 4192 | -81 | 4100 |
| 5L-3S | | MI | 991 | 894 | 1871 | 673 | 2266 | 539 | 2578 | 419 | 3011 | 191 | 3427 | -77 | 3359 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis



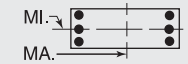

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.13 | MA | 1198 | 588 | 1606 | 522 | 1988 | 438 | 2205 | 372 | 2440 | 271 | 2949 | 230 | 1419 |
| 2E | | MI | 804 | 588 | 1168 | 495 | 1378 | 415 | 1492 | 352 | 1593 | 252 | 1800 | 193 | 949 |
| 4-#9 | 1.43 | MA | 1245 | 613 | 1728 | 535 | 2135 | 448 | 2380 | 378 | 2672 | 269 | 3243 | 224 | 1760 |
| 2E | | MI | 828 | 613 | 1242 | 508 | 1465 | 425 | 1594 | 358 | 1719 | 247 | 1940 | 180 | 1160 |
| 4-#10 | 1.81 | MA | 1303 | 645 | 1881 | 553 | 2321 | 461 | 2601 | 386 | 2967 | 267 | 3611 | 217 | 2189 |
| 2E | | MI | 857 | 645 | 1333 | 525 | 1575 | 437 | 1723 | 365 | 1876 | 241 | 2112 | 162 | 1421 |
| 4-#11 | 2.23 | MA | 1350 | 679 | 2043 | 570 | 2507 | 472 | 2815 | 392 | 3246 | 262 | 3909 | 201 | 2614 |
| 2E | | MI | 876 | 679 | 1426 | 539 | 1675 | 446 | 1828 | 367 | 1989 | 228 | 2208 | 131 | 1669 |
| 4-#14 | 3.21 | MA | 1474 | 760 | 2407 | 617 | 2953 | 506 | 3348 | 413 | 3958 | 257 | 4747 | 174 | 3641 |
| 2E | | MI | 937 | 760 | 1635 | 585 | 1927 | 479 | 2100 | 381 | 2329 | 207 | 2556 | 73 | 2265 |
| 4-#18 | 5.71 | MA | 1753 | 966 | 3278 | 738 | 4028 | 595 | 4635 | 468 | 5669 | 244 | 6661 | 91 | 6103 |
| 2E | | MI | 1072 | 966 | 2111 | 703 | 2460 | 552 | 2692 | 407 | 3070 | 144 | 3259 | -99 | 3248 |
| 6-#7 | 1.29 | MA | 1229 | 601 | 1664 | 531 | 2068 | 445 | 2304 | 377 | 2577 | 271 | 3145 | 231 | 1608 |
| 2L-3S | | MI | 760 | 601 | 1100 | 508 | 1297 | 425 | 1396 | 358 | 1474 | 255 | 1666 | 148 | 1073 |
| 6-#7 | 1.29 | MA | 1122 | 601 | 1494 | 536 | 1853 | 449 | 2045 | 380 | 2227 | 276 | 2675 | 187 | 1607 |
| 3L-2S | | MI | 822 | 601 | 1203 | 505 | 1428 | 423 | 1555 | 358 | 1683 | 253 | 1913 | 192 | 1067 |
| 6-#8 | 1.69 | MA | 1293 | 635 | 1828 | 551 | 2269 | 459 | 2544 | 386 | 2897 | 269 | 3558 | 224 | 2072 |
| 2L-3S | | MI | 778 | 635 | 1168 | 527 | 1378 | 438 | 1492 | 366 | 1593 | 250 | 1800 | 118 | 1356 |
| 6-#8 | 1.69 | MA | 1160 | 635 | 1606 | 557 | 1988 | 465 | 2205 | 390 | 2440 | 275 | 2949 | 166 | 2061 |
| 3L-2S | | MI | 856 | 635 | 1303 | 524 | 1548 | 437 | 1697 | 366 | 1863 | 249 | 2116 | 176 | 1353 |
| 6-#9 | 2.14 | MA | 1361 | 672 | 2006 | 572 | 2487 | 475 | 2805 | 395 | 3245 | 267 | 4001 | 217 | 2576 |
| 2L-3S | | MI | 797 | 672 | 1242 | 548 | 1465 | 453 | 1594 | 374 | 1719 | 245 | 1940 | 84 | 1653 |
| 6-#9 | 2.14 | MA | 1201 | 672 | 1728 | 580 | 2135 | 481 | 2380 | 400 | 2672 | 273 | 3243 | 143 | 2547 |
| 3L-2S | | MI | 890 | 672 | 1410 | 545 | 1678 | 452 | 1851 | 375 | 2053 | 243 | 2329 | 157 | 1659 |
| 6-#10 | 2.72 | MA | 1443 | 719 | 2230 | 600 | 2764 | 495 | 3136 | 408 | 3687 | 264 | 4556 | 206 | 3211 |
| 2L-3S | | MI | 821 | 719 | 1333 | 576 | 1575 | 472 | 1723 | 385 | 1876 | 237 | 2112 | 38 | 2016 |
| 6-#10 | 2.72 | MA | 1252 | 719 | 1881 | 609 | 2321 | 503 | 2601 | 414 | 2967 | 271 | 3611 | 112 | 3151 |
| 3L-2S | | MI | 932 | 719 | 1543 | 572 | 1840 | 471 | 2044 | 387 | 2290 | 234 | 2589 | 131 | 2040 |
| 6-#11 | 3.34 | MA | 1509 | 771 | 2461 | 627 | 3036 | 514 | 3455 | 419 | 4108 | 259 | 5008 | 183 | 3833 |
| 2L-3S | | MI | 836 | 771 | 1426 | 599 | 1675 | 488 | 1828 | 390 | 1989 | 219 | 2208 | -29 | 2197 |
| 6-#11 | 3.34 | MA | 1297 | 771 | 2043 | 637 | 2507 | 522 | 2815 | 425 | 3246 | 266 | 3909 | 68 | 3731 |
| 3L-2S | | MI | 961 | 771 | 1673 | 597 | 1987 | 488 | 2201 | 393 | 2461 | 216 | 2738 | 86 | 2392 |
| 6-#14 | 4.82 | MA | 1418 | 892 | 2407 | 713 | 2953 | 577 | 3348 | 458 | 3958 | 261 | 4747 | -22 | 4714 |
| 3L-2S | | MI | 1052 | 892 | 1978 | 667 | 2362 | 540 | 2609 | 416 | 2973 | 187 | 3266 | 1 | 3261 |
| 8-#6 | 1.26 | MA | 1227 | 599 | 1648 | 532 | 2054 | 446 | 2292 | 378 | 2563 | 272 | 3140 | 233 | 1581 |
| 2L-4S | | MI | 746 | 599 | 1061 | 510 | 1248 | 428 | 1340 | 361 | 1403 | 256 | 1599 | 149 | 1058 |
| 8-#6 | 1.26 | MA | 1149 | 599 | 1523 | 535 | 1896 | 449 | 2100 | 380 | 2305 | 276 | 2789 | 201 | 1581 |
| 3E | | MI | 776 | 599 | 1116 | 508 | 1324 | 425 | 1432 | 359 | 1527 | 257 | 1735 | 164 | 1055 |
| 8-#6 | 1.26 | MA | 1101 | 599 | 1435 | 539 | 1781 | 452 | 1953 | 385 | 2104 | 277 | 2541 | 182 | 1574 |
| 4L-2S | | MI | 823 | 599 | 1193 | 506 | 1421 | 424 | 1549 | 359 | 1684 | 256 | 1921 | 196 | 1050 |
| 8-#7 | 1.71 | MA | 1301 | 636 | 1834 | 553 | 2282 | 462 | 2564 | 387 | 2927 | 270 | 3615 | 227 | 2107 |
| 2L-4S | | MI | 764 | 636 | 1128 | 532 | 1326 | 445 | 1430 | 371 | 1518 | 251 | 1732 | 116 | 1367 |
| 8-#7 | 1.71 | MA | 1200 | 636 | 1664 | 558 | 2068 | 466 | 2304 | 391 | 2577 | 274 | 3145 | 183 | 2100 |
| 3E | | MI | 803 | 636 | 1203 | 530 | 1428 | 441 | 1555 | 368 | 1683 | 253 | 1913 | 136 | 1379 |
| 8-#7 | 1.71 | MA | 1139 | 636 | 1545 | 563 | 1912 | 470 | 2106 | 397 | 2306 | 276 | 2812 | 158 | 2070 |
| 4L-2S | | MI | 862 | 636 | 1306 | 527 | 1558 | 439 | 1713 | 368 | 1893 | 251 | 2160 | 180 | 1376 |
| 8-#8 | 2.26 | MA | 1385 | 681 | 2050 | 580 | 2549 | 481 | 2883 | 399 | 3353 | 267 | 4167 | 219 | 2721 |
| 2L-4S | | MI | 785 | 681 | 1205 | 559 | 1415 | 464 | 1535 | 383 | 1649 | 245 | 1883 | 76 | 1655 |
| 8-#8 | 2.26 | MA | 1260 | 681 | 1828 | 586 | 2269 | 486 | 2544 | 403 | 2897 | 273 | 3558 | 161 | 2701 |
| 3E | | MI | 832 | 681 | 1303 | 556 | 1548 | 459 | 1697 | 379 | 1863 | 247 | 2116 | 101 | 1746 |
| 8-#8 | 2.26 | MA | 1184 | 681 | 1672 | 592 | 2065 | 491 | 2284 | 411 | 2542 | 275 | 3125 | 129 | 2555 |
| 4L-2S | | MI | 905 | 681 | 1437 | 553 | 1718 | 458 | 1903 | 379 | 2132 | 245 | 2433 | 159 | 1751 |
| 8-#9 | 2.86 | MA | 1471 | 730 | 2284 | 609 | 2839 | 502 | 3231 | 413 | 3818 | 264 | 4759 | 209 | 3386 |
| 2L-4S | | MI | 807 | 730 | 1287 | 588 | 1512 | 486 | 1648 | 395 | 1789 | 238 | 2042 | 31 | 1954 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

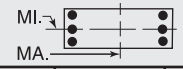
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 2.86 | MA | 1326 | 730 | 2006 | 616 | 2487 | 508 | 2805 | 417 | 3245 | 271 | 4001 | 135 | 3346 |
| 3E | | MI | 864 | 730 | 1410 | 585 | 1678 | 480 | 1851 | 391 | 2053 | 240 | 2329 | 61 | 2134 |
| 8-#9 | 2.86 | MA | 1233 | 730 | 1810 | 624 | 2231 | 514 | 2478 | 427 | 2799 | 273 | 3461 | 95 | 3055 |
| 4L-2S | | MI | 951 | 730 | 1577 | 582 | 1890 | 479 | 2108 | 392 | 2387 | 238 | 2717 | 134 | 2151 |
| 8-#10 | 3.63 | MA | 1405 | 794 | 2230 | 656 | 2764 | 537 | 3136 | 435 | 3687 | 269 | 4556 | 101 | 4154 |
| 3E | | MI | 903 | 794 | 1543 | 622 | 1840 | 507 | 2044 | 407 | 2290 | 230 | 2589 | 7 | 2574 |
| 8-#10 | 3.63 | MA | 1302 | 794 | 1983 | 665 | 2441 | 544 | 2724 | 447 | 3126 | 271 | 3882 | 51 | 3672 |
| 4L-2S | | MI | 1006 | 794 | 1753 | 619 | 2105 | 506 | 2365 | 409 | 2703 | 227 | 3066 | 100 | 2650 |
| 8-#11 | 4.46 | MA | 1472 | 862 | 2461 | 695 | 3036 | 564 | 3455 | 451 | 4108 | 263 | 5008 | 50 | 4864 |
| 3E | | MI | 930 | 862 | 1673 | 657 | 1987 | 530 | 2201 | 416 | 2461 | 208 | 2738 | -74 | 2704 |
| 8-#11 | 4.46 | MA | 1354 | 862 | 2163 | 705 | 2648 | 572 | 2960 | 464 | 3433 | 264 | 4219 | -9 | 4209 |
| 4L-2S | | MI | 1045 | 862 | 1919 | 654 | 2299 | 531 | 2573 | 419 | 2933 | 204 | 3269 | 41 | 3106 |
| 8-#14 | 6.43 | MA | 1510 | 1025 | 2575 | 809 | 3151 | 648 | 3551 | 513 | 4219 | 255 | 5172 | -134 | 4994 |
| 4L-2S | | MI | 1166 | 1025 | 2322 | 750 | 2797 | 601 | 3118 | 450 | 3618 | 167 | 3975 | -71 | 3932 |
| 10-#10 | 4.54 | MA | 1458 | 869 | 2333 | 712 | 2884 | 579 | 3260 | 469 | 3846 | 268 | 4827 | 40 | 4654 |
| 4L-3S | | MI | 982 | 869 | 1753 | 669 | 2105 | 541 | 2365 | 429 | 2703 | 223 | 3066 | -24 | 3049 |
| 10-#10 | 4.54 | MA | 1357 | 869 | 2111 | 721 | 2570 | 592 | 2889 | 474 | 3335 | 276 | 4159 | -16 | 4143 |
| 5L-2S | | MI | 1078 | 869 | 1963 | 665 | 2371 | 540 | 2686 | 431 | 3116 | 220 | 3543 | 69 | 3257 |
| 10-#11 | 5.57 | MA | 1537 | 954 | 2582 | 762 | 3178 | 614 | 3601 | 491 | 4295 | 260 | 5319 | -27 | 5271 |
| 4L-3S | | MI | 1021 | 954 | 1919 | 714 | 2299 | 572 | 2573 | 442 | 2933 | 196 | 3269 | -119 | 3202 |
| 12-#10 | 5.44 | MA | 1509 | 944 | 2461 | 768 | 3013 | 626 | 3425 | 496 | 4056 | 273 | 5104 | -27 | 5063 |
| 5L-3S | | MI | 1060 | 944 | 1963 | 716 | 2371 | 575 | 2686 | 451 | 3116 | 216 | 3543 | -55 | 3497 |

## RECTANGULAR TIED COLUMNS 14" x 22"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.03 | MA | 1441 | 638 | 1874 | 574 | 2345 | 483 | 2608 | 411 | 2885 | 302 | 3527 | 262 | 1590 |
| 2E | | MI | 874 | 638 | 1258 | 539 | 1482 | 452 | 1600 | 385 | 1698 | 278 | 1917 | 216 | 962 |
| 4-#9 | 1.30 | MA | 1496 | 662 | 2012 | 588 | 2512 | 493 | 2807 | 417 | 3149 | 300 | 3873 | 258 | 1976 |
| 2E | | MI | 898 | 662 | 1333 | 551 | 1569 | 462 | 1702 | 390 | 1825 | 273 | 2057 | 202 | 1174 |
| 4-#10 | 1.65 | MA | 1564 | 694 | 2186 | 606 | 2724 | 506 | 3059 | 425 | 3484 | 298 | 4308 | 252 | 2464 |
| 2E | | MI | 927 | 694 | 1425 | 568 | 1679 | 474 | 1831 | 397 | 1981 | 267 | 2228 | 185 | 1438 |
| 4-#11 | 2.03 | MA | 1622 | 728 | 2373 | 622 | 2938 | 517 | 3307 | 431 | 3807 | 293 | 4675 | 238 | 2951 |
| 2E | | MI | 947 | 728 | 1520 | 582 | 1780 | 483 | 1936 | 399 | 2093 | 253 | 2322 | 153 | 1690 |
| 4-#14 | 2.92 | MA | 1771 | 809 | 2790 | 669 | 3451 | 551 | 3918 | 452 | 4624 | 288 | 5682 | 217 | 4127 |
| 2E | | MI | 1008 | 809 | 1729 | 626 | 2032 | 515 | 2208 | 412 | 2433 | 232 | 2670 | 95 | 2291 |
| 4-#18 | 5.19 | MA | 2102 | 1015 | 3796 | 791 | 4691 | 640 | 5403 | 507 | 6609 | 276 | 8018 | 151 | 6967 |
| 2E | | MI | 1142 | 1015 | 2209 | 744 | 2566 | 587 | 2800 | 438 | 3174 | 169 | 3371 | -77 | 3366 |
| 6-#7 | 1.17 | MA | 1476 | 650 | 1938 | 584 | 2434 | 490 | 2720 | 416 | 3038 | 302 | 3751 | 263 | 1802 |
| 2L-3S | | MI | 828 | 650 | 1189 | 552 | 1400 | 462 | 1504 | 390 | 1579 | 281 | 1783 | 171 | 1087 |
| 6-#7 | 1.17 | MA | 1354 | 650 | 1747 | 589 | 2191 | 495 | 2426 | 420 | 2643 | 308 | 3205 | 219 | 1802 |
| 3L-2S | | MI | 892 | 650 | 1292 | 549 | 1531 | 461 | 1662 | 390 | 1789 | 279 | 2030 | 215 | 1080 |
| 6-#8 | 1.54 | MA | 1552 | 684 | 2125 | 603 | 2662 | 504 | 2992 | 425 | 3401 | 300 | 4235 | 258 | 2328 |
| 2L-3S | | MI | 847 | 684 | 1258 | 571 | 1482 | 475 | 1600 | 398 | 1698 | 276 | 1917 | 141 | 1374 |
| 6-#8 | 1.54 | MA | 1398 | 684 | 1874 | 610 | 2345 | 510 | 2608 | 430 | 2885 | 307 | 3527 | 200 | 2317 |
| 3L-2S | | MI | 926 | 684 | 1393 | 568 | 1652 | 474 | 1805 | 398 | 1968 | 274 | 2233 | 199 | 1368 |
| 6-#9 | 1.95 | MA | 1631 | 721 | 2327 | 625 | 2911 | 520 | 3289 | 434 | 3798 | 298 | 4756 | 253 | 2900 |
| 2L-3S | | MI | 866 | 721 | 1333 | 592 | 1569 | 490 | 1702 | 406 | 1825 | 271 | 2057 | 106 | 1675 |
| 6-#9 | 1.95 | MA | 1446 | 721 | 2012 | 633 | 2512 | 527 | 2807 | 440 | 3149 | 306 | 3873 | 179 | 2871 |
| 3L-2S | | MI | 961 | 721 | 1500 | 588 | 1782 | 489 | 1959 | 407 | 2158 | 268 | 2445 | 180 | 1676 |
| 6-#10 | 2.47 | MA | 1729 | 769 | 2583 | 653 | 3226 | 540 | 3666 | 447 | 4301 | 295 | 5412 | 245 | 3623 |
| 2L-3S | | MI | 890 | 769 | 1425 | 619 | 1679 | 509 | 1831 | 417 | 1981 | 263 | 2228 | 60 | 2043 |
| 6-#10 | 2.47 | MA | 1506 | 769 | 2186 | 663 | 2724 | 549 | 3059 | 454 | 3484 | 304 | 4308 | 151 | 3562 |
| 3L-2S | | MI | 1003 | 769 | 1634 | 615 | 1944 | 508 | 2152 | 419 | 2395 | 260 | 2705 | 154 | 2060 |
| 6-#11 | 3.04 | MA | 1810 | 820 | 2849 | 680 | 3540 | 559 | 4035 | 458 | 4788 | 290 | 5969 | 226 | 4338 |
| 2L-3S | | MI | 904 | 820 | 1520 | 642 | 1780 | 524 | 1936 | 421 | 2093 | 244 | 2322 | -7 | 2320 |
| 6-#11 | 3.04 | MA | 1562 | 820 | 2373 | 691 | 2938 | 569 | 3307 | 466 | 3807 | 300 | 4675 | 111 | 4236 |
| 3L-2S | | MI | 1032 | 820 | 1766 | 639 | 2092 | 525 | 2309 | 425 | 2565 | 241 | 2853 | 108 | 2416 |
| 6-#14 | 4.38 | MA | 1705 | 942 | 2790 | 768 | 3451 | 625 | 3918 | 500 | 4624 | 296 | 5682 | 30 | 5604 |
| 3L-2S | | MI | 1123 | 942 | 2073 | 709 | 2467 | 576 | 2717 | 447 | 3077 | 212 | 3379 | 23 | 3289 |

## RECTANGULAR TIED COLUMNS 14" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#18 | 7.79 | MA | 2059 | 1251 | 3796 | 962 | 4691 | 765 | 5403 | 587 | 6609 | 283 | 8018 | -197 | 7650 |
| 3L-2S | | MI | 1329 | 1251 | 2778 | 891 | 3263 | 689 | 3605 | 490 | 4193 | 120 | 4442 | -233 | 4373 |
| 8-#6 | 1.14 | MA | 1474 | 648 | 1920 | 584 | 2418 | 491 | 2705 | 417 | 3022 | 304 | 3734 | 264 | 1771 |
| 2L-4S | | MI | 815 | 648 | 1149 | 554 | 1351 | 466 | 1448 | 394 | 1509 | 282 | 1716 | 172 | 1072 |
| 8-#6 | 1.14 | MA | 1384 | 648 | 1779 | 588 | 2239 | 494 | 2488 | 420 | 2730 | 307 | 3330 | 232 | 1771 |
| 3E | | MI | 845 | 648 | 1205 | 552 | 1427 | 463 | 1540 | 392 | 1633 | 283 | 1852 | 187 | 1067 |
| 8-#6 | 1.14 | MA | 1329 | 648 | 1680 | 592 | 2110 | 497 | 2323 | 424 | 2505 | 309 | 3046 | 213 | 1764 |
| 4L-2S | | MI | 893 | 648 | 1282 | 550 | 1524 | 462 | 1657 | 392 | 1790 | 282 | 2039 | 219 | 1063 |
| 8-#7 | 1.56 | MA | 1561 | 686 | 2130 | 606 | 2676 | 507 | 3013 | 426 | 3434 | 301 | 4297 | 261 | 2366 |
| 2L-4S | | MI | 833 | 686 | 1217 | 576 | 1429 | 482 | 1538 | 404 | 1623 | 277 | 1849 | 139 | 1392 |
| 8-#7 | 1.56 | MA | 1444 | 686 | 1938 | 611 | 2434 | 511 | 2720 | 430 | 3038 | 306 | 3751 | 217 | 2360 |
| 3E | | MI | 872 | 686 | 1292 | 574 | 1531 | 478 | 1662 | 401 | 1789 | 279 | 2030 | 159 | 1395 |
| 8-#7 | 1.56 | MA | 1374 | 686 | 1805 | 616 | 2259 | 516 | 2497 | 437 | 2733 | 309 | 3366 | 191 | 2330 |
| 4L-2S | | MI | 932 | 686 | 1396 | 571 | 1662 | 477 | 1821 | 401 | 1998 | 277 | 2278 | 203 | 1391 |
| 8-#8 | 2.05 | MA | 1659 | 731 | 2375 | 632 | 2979 | 526 | 3376 | 438 | 3918 | 298 | 4943 | 255 | 3062 |
| 2L-4S | | MI | 854 | 731 | 1295 | 603 | 1519 | 502 | 1643 | 415 | 1755 | 271 | 2000 | 99 | 1700 |
| 8-#8 | 2.05 | MA | 1514 | 731 | 2125 | 639 | 2662 | 531 | 2992 | 443 | 3401 | 305 | 4235 | 197 | 3042 |
| 3E | | MI | 902 | 731 | 1393 | 600 | 1652 | 497 | 1805 | 412 | 1968 | 273 | 2233 | 124 | 1766 |
| 8-#8 | 2.05 | MA | 1427 | 731 | 1949 | 646 | 2433 | 537 | 2700 | 452 | 3002 | 308 | 3735 | 163 | 2923 |
| 4L-2S | | MI | 976 | 731 | 1527 | 597 | 1822 | 495 | 2011 | 412 | 2238 | 271 | 2549 | 182 | 1767 |
| 8-#9 | 2.60 | MA | 1761 | 780 | 2642 | 662 | 3309 | 547 | 3771 | 452 | 4446 | 296 | 5640 | 248 | 3818 |
| 2L-4S | | MI | 875 | 780 | 1378 | 632 | 1616 | 523 | 1756 | 427 | 1894 | 263 | 2158 | 53 | 2003 |
| 8-#9 | 2.60 | MA | 1588 | 780 | 2327 | 670 | 2911 | 554 | 3289 | 458 | 3798 | 303 | 4756 | 174 | 3778 |
| 3E | | MI | 933 | 780 | 1500 | 628 | 1782 | 517 | 1959 | 424 | 2158 | 266 | 2445 | 83 | 2158 |
| 8-#9 | 2.60 | MA | 1485 | 780 | 2106 | 678 | 2623 | 561 | 2921 | 468 | 3295 | 307 | 4131 | 132 | 3497 |
| 4L-2S | | MI | 1022 | 780 | 1668 | 625 | 1994 | 516 | 2216 | 424 | 2492 | 263 | 2834 | 157 | 2170 |
| 8-#10 | 3.30 | MA | 1686 | 844 | 2583 | 710 | 3226 | 583 | 3666 | 476 | 4301 | 302 | 5412 | 144 | 4702 |
| 3E | | MI | 972 | 844 | 1634 | 666 | 1944 | 543 | 2152 | 439 | 2395 | 256 | 2705 | 29 | 2641 |
| 8-#10 | 3.30 | MA | 1558 | 844 | 2304 | 720 | 2862 | 592 | 3202 | 489 | 3668 | 305 | 4630 | 91 | 4207 |
| 4L-2S | | MI | 1077 | 844 | 1844 | 662 | 2210 | 542 | 2473 | 441 | 2808 | 253 | 3182 | 123 | 2672 |
| 8-#11 | 4.05 | MA | 1765 | 912 | 2849 | 749 | 3540 | 611 | 4035 | 493 | 4788 | 296 | 5969 | 99 | 5601 |
| 3E | | MI | 998 | 912 | 1766 | 699 | 2092 | 566 | 2309 | 447 | 2565 | 233 | 2853 | -52 | 2830 |
| 8-#11 | 4.05 | MA | 1629 | 912 | 2513 | 760 | 3102 | 620 | 3476 | 507 | 4025 | 299 | 5048 | 36 | 4885 |
| 4L-2S | | MI | 1116 | 912 | 2013 | 696 | 2404 | 567 | 2682 | 451 | 3037 | 229 | 3384 | 63 | 3132 |
| 8-#14 | 5.84 | MA | 1813 | 1074 | 2987 | 866 | 3681 | 698 | 4155 | 558 | 4928 | 293 | 6196 | -79 | 6064 |
| 4L-2S | | MI | 1237 | 1074 | 2417 | 792 | 2902 | 637 | 3226 | 482 | 3722 | 191 | 4089 | -49 | 4062 |
| 10-#10 | 4.12 | MA | 1748 | 918 | 2701 | 767 | 3364 | 626 | 3809 | 511 | 4485 | 303 | 5733 | 84 | 5325 |
| 4L-3S | | MI | 1051 | 918 | 1844 | 712 | 2210 | 578 | 2473 | 461 | 2808 | 249 | 3182 | -1 | 3181 |
| 10-#10 | 4.12 | MA | 1625 | 918 | 2451 | 777 | 3011 | 640 | 3392 | 518 | 3909 | 312 | 4954 | 29 | 4859 |
| 5L-2S | | MI | 1150 | 918 | 2054 | 708 | 2475 | 577 | 2794 | 463 | 3221 | 246 | 3659 | 92 | 3280 |
| 10-#11 | 5.06 | MA | 1843 | 1004 | 2989 | 818 | 3704 | 663 | 4204 | 534 | 5005 | 296 | 6341 | 24 | 6229 |
| 4L-3S | | MI | 1089 | 1004 | 2013 | 757 | 2404 | 608 | 2682 | 473 | 3037 | 221 | 3384 | -97 | 3332 |
| 10-#11 | 5.06 | MA | 1702 | 1004 | 2687 | 829 | 3278 | 679 | 3701 | 541 | 4310 | 306 | 5428 | -44 | 5373 |
| 5L-2S | | MI | 1199 | 1004 | 2259 | 754 | 2716 | 609 | 3054 | 477 | 3509 | 217 | 3915 | 18 | 3843 |
| 12-#10 | 4.95 | MA | 1801 | 993 | 2848 | 824 | 3513 | 675 | 3999 | 540 | 4726 | 309 | 6058 | 22 | 5982 |
| 5L-3S | | MI | 1129 | 993 | 2054 | 759 | 2475 | 612 | 2794 | 483 | 3221 | 242 | 3659 | -32 | 3633 |
| 12-#10 | 4.95 | MA | 1654 | 993 | 2605 | 833 | 3194 | 683 | 3592 | 552 | 4164 | 313 | 5302 | -46 | 5238 |
| 6L-2S | | MI | 1222 | 993 | 2264 | 755 | 2740 | 611 | 3115 | 485 | 3634 | 239 | 4136 | 61 | 3886 |
| 12-#11 | 6.08 | MA | 1909 | 1096 | 3163 | 886 | 3881 | 721 | 4429 | 568 | 5291 | 303 | 6721 | -57 | 6619 |
| 5L-3S | | MI | 1179 | 1096 | 2259 | 814 | 2716 | 650 | 3054 | 499 | 3509 | 209 | 3915 | -141 | 3826 |
| 14-#10 | 5.77 | MA | 1835 | 1068 | 3002 | 880 | 3695 | 718 | 4199 | 574 | 4981 | 310 | 6406 | -54 | 6303 |
| 6L-3S | | MI | 1206 | 1068 | 2264 | 806 | 2740 | 646 | 3115 | 505 | 3634 | 235 | 4136 | -63 | 4078 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 24"

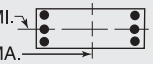
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#9 | 1.19 | MA | 1768 | 712 | 2312 | 641 | 2914 | 538 | 3263 | 456 | 3656 | 331 | 4528 | 288 | 2192 |
| 2E | | MI | 968 | 712 | 1423 | 595 | 1673 | 499 | 1810 | 422 | 1930 | 299 | 2173 | 225 | 1189 |
| 4-#10 | 1.51 | MA | 1847 | 744 | 2507 | 659 | 3151 | 551 | 3546 | 464 | 4033 | 329 | 5044 | 285 | 2738 |
| 2E | | MI | 998 | 744 | 1516 | 611 | 1783 | 511 | 1940 | 429 | 2086 | 293 | 2344 | 207 | 1454 |
| 4-#11 | 1.86 | MA | 1915 | 778 | 2719 | 675 | 3394 | 562 | 3827 | 470 | 4400 | 325 | 5481 | 274 | 3288 |
| 2E | | MI | 1017 | 778 | 1613 | 624 | 1886 | 519 | 2044 | 431 | 2198 | 278 | 2437 | 175 | 1710 |
| 4-#14 | 2.68 | MA | 2090 | 859 | 3190 | 722 | 3973 | 596 | 4517 | 491 | 5321 | 319 | 6659 | 258 | 4613 |
| 2E | | MI | 1078 | 859 | 1824 | 668 | 2138 | 551 | 2317 | 443 | 2537 | 257 | 2783 | 117 | 2316 |
| 4-#18 | 4.76 | MA | 2476 | 1065 | 4329 | 843 | 5379 | 684 | 6201 | 546 | 7572 | 307 | 9423 | 205 | 7831 |
| 2E | | MI | 1212 | 1065 | 2306 | 784 | 2673 | 622 | 2908 | 468 | 3277 | 193 | 3482 | -56 | 3482 |
| 6-#7 | 1.07 | MA | 1744 | 700 | 2229 | 637 | 2825 | 535 | 3164 | 455 | 3531 | 334 | 4360 | 291 | 1997 |
| 2L-3S | | MI | 898 | 700 | 1278 | 596 | 1504 | 499 | 1612 | 423 | 1685 | 307 | 1900 | 193 | 1100 |
| 6-#7 | 1.07 | MA | 1605 | 700 | 2015 | 642 | 2554 | 540 | 2837 | 460 | 3090 | 339 | 3750 | 248 | 1996 |
| 3L-2S | | MI | 962 | 700 | 1382 | 593 | 1635 | 498 | 1770 | 423 | 1894 | 305 | 2147 | 237 | 1092 |
| 6-#8 | 1.41 | MA | 1831 | 734 | 2437 | 656 | 3080 | 549 | 3469 | 464 | 3937 | 331 | 4920 | 288 | 2584 |
| 2L-3S | | MI | 916 | 734 | 1348 | 614 | 1585 | 513 | 1708 | 431 | 1804 | 302 | 2033 | 163 | 1390 |
| 6-#8 | 1.41 | MA | 1656 | 734 | 2157 | 663 | 2726 | 556 | 3041 | 469 | 3361 | 339 | 4122 | 231 | 2573 |
| 3L-2S | | MI | 996 | 734 | 1483 | 611 | 1756 | 511 | 1913 | 431 | 2073 | 300 | 2350 | 221 | 1383 |
| 6-#9 | 1.79 | MA | 1923 | 771 | 2664 | 677 | 3359 | 565 | 3801 | 474 | 4381 | 329 | 5531 | 285 | 3224 |
| 2L-3S | | MI | 936 | 771 | 1423 | 635 | 1673 | 527 | 1810 | 439 | 1930 | 296 | 2173 | 129 | 1695 |
| 6-#9 | 1.79 | MA | 1712 | 771 | 2312 | 686 | 2914 | 573 | 3263 | 480 | 3656 | 338 | 4528 | 212 | 3195 |
| 3L-2S | | MI | 1031 | 771 | 1591 | 632 | 1886 | 526 | 2067 | 439 | 2264 | 294 | 2561 | 202 | 1693 |
| 6-#10 | 2.27 | MA | 2035 | 818 | 2950 | 705 | 3712 | 585 | 4224 | 486 | 4946 | 326 | 6307 | 281 | 4034 |
| 2L-3S | | MI | 959 | 818 | 1516 | 662 | 1783 | 546 | 1940 | 449 | 2086 | 288 | 2344 | 83 | 2069 |
| 6-#10 | 2.27 | MA | 1781 | 818 | 2507 | 716 | 3151 | 595 | 3546 | 494 | 4033 | 337 | 5044 | 188 | 3974 |
| 3L-2S | | MI | 1074 | 818 | 1726 | 658 | 2049 | 545 | 2261 | 451 | 2500 | 285 | 2821 | 176 | 2078 |
| 6-#11 | 2.79 | MA | 2133 | 870 | 3252 | 732 | 4069 | 604 | 4643 | 497 | 5499 | 321 | 6971 | 266 | 4844 |
| 2L-3S | | MI | 973 | 870 | 1613 | 684 | 1886 | 560 | 2044 | 453 | 2198 | 270 | 2437 | 15 | 2408 |
| 6-#11 | 2.79 | MA | 1841 | 870 | 2719 | 745 | 3394 | 615 | 3827 | 506 | 4400 | 333 | 5481 | 151 | 4741 |
| 3L-2S | | MI | 1103 | 870 | 1860 | 681 | 2197 | 561 | 2417 | 456 | 2670 | 266 | 2968 | 130 | 2439 |
| 6-#14 | 4.02 | MA | 2014 | 991 | 3190 | 822 | 3973 | 671 | 4517 | 542 | 5321 | 330 | 6659 | 77 | 6439 |
| 3L-2S | | MI | 1194 | 991 | 2168 | 751 | 2573 | 611 | 2825 | 478 | 3182 | 237 | 3493 | 45 | 3318 |
| 6-#18 | 7.14 | MA | 2422 | 1300 | 4329 | 1018 | 5379 | 814 | 6201 | 631 | 7572 | 320 | 9423 | -129 | 9117 |
| 3L-2S | | MI | 1398 | 1300 | 2876 | 932 | 3370 | 724 | 3713 | 520 | 4296 | 144 | 4553 | -212 | 4501 |
| 8-#6 | 1.05 | MA | 1741 | 698 | 2208 | 637 | 2807 | 535 | 3146 | 456 | 3511 | 335 | 4335 | 292 | 1961 |
| 2L-4S | | MI | 884 | 698 | 1238 | 598 | 1455 | 504 | 1555 | 427 | 1615 | 308 | 1834 | 195 | 1085 |
| 8-#6 | 1.05 | MA | 1639 | 698 | 2050 | 641 | 2607 | 539 | 2905 | 459 | 3186 | 339 | 3885 | 260 | 1961 |
| 3E | | MI | 915 | 698 | 1293 | 596 | 1530 | 501 | 1648 | 425 | 1739 | 309 | 1970 | 210 | 1080 |
| 8-#6 | 1.05 | MA | 1578 | 698 | 1941 | 645 | 2464 | 543 | 2722 | 464 | 2936 | 341 | 3573 | 242 | 1954 |
| 4L-2S | | MI | 963 | 698 | 1370 | 594 | 1627 | 499 | 1765 | 424 | 1895 | 308 | 2156 | 242 | 1074 |
| 8-#7 | 1.43 | MA | 1841 | 735 | 2443 | 659 | 3095 | 551 | 3491 | 466 | 3971 | 332 | 4970 | 289 | 2625 |
| 2L-4S | | MI | 902 | 735 | 1306 | 620 | 1533 | 520 | 1646 | 436 | 1729 | 303 | 1966 | 162 | 1411 |
| 8-#7 | 1.43 | MA | 1708 | 735 | 2229 | 664 | 2825 | 556 | 3164 | 470 | 3531 | 338 | 4360 | 246 | 2619 |
| 3E | | MI | 942 | 735 | 1382 | 618 | 1635 | 516 | 1770 | 433 | 1894 | 305 | 2147 | 181 | 1410 |
| 8-#7 | 1.43 | MA | 1630 | 735 | 2080 | 670 | 2631 | 561 | 2916 | 477 | 3192 | 341 | 3936 | 220 | 2589 |
| 4L-2S | | MI | 1003 | 735 | 1485 | 615 | 1765 | 514 | 1929 | 433 | 2104 | 303 | 2395 | 225 | 1405 |
| 8-#8 | 1.88 | MA | 1953 | 780 | 2717 | 685 | 3434 | 571 | 3897 | 478 | 4513 | 330 | 5718 | 286 | 3403 |
| 2L-4S | | MI | 922 | 780 | 1385 | 646 | 1623 | 539 | 1751 | 448 | 1860 | 297 | 2117 | 122 | 1742 |
| 8-#8 | 1.88 | MA | 1788 | 780 | 2437 | 692 | 3080 | 577 | 3469 | 483 | 3937 | 337 | 4920 | 229 | 3383 |
| 3E | | MI | 971 | 780 | 1483 | 643 | 1756 | 534 | 1913 | 444 | 2073 | 299 | 2350 | 146 | 1785 |
| 8-#8 | 1.88 | MA | 1691 | 780 | 2242 | 699 | 2826 | 583 | 3144 | 492 | 3493 | 341 | 4362 | 195 | 3300 |
| 4L-2S | | MI | 1047 | 780 | 1617 | 640 | 1926 | 532 | 2119 | 444 | 2343 | 297 | 2666 | 204 | 1783 |
| 8-#9 | 2.38 | MA | 2071 | 830 | 3015 | 714 | 3804 | 592 | 4339 | 491 | 5106 | 327 | 6535 | 282 | 4250 |
| 2L-4S | | MI | 944 | 830 | 1468 | 675 | 1720 | 560 | 1865 | 460 | 2000 | 289 | 2274 | 76 | 2051 |
| 8-#9 | 2.38 | MA | 1874 | 830 | 2664 | 723 | 3359 | 600 | 3801 | 498 | 4381 | 336 | 5531 | 209 | 4210 |
| 3E | | MI | 1002 | 830 | 1591 | 672 | 1886 | 554 | 2067 | 456 | 2264 | 291 | 2561 | 106 | 2181 |
| 8-#9 | 2.38 | MA | 1757 | 830 | 2418 | 732 | 3039 | 607 | 3392 | 509 | 3822 | 340 | 4827 | 166 | 3949 |
| 4L-2S | | MI | 1093 | 830 | 1759 | 668 | 2098 | 553 | 2324 | 457 | 2597 | 289 | 2950 | 179 | 2189 |

## RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

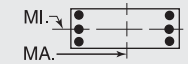
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 3.02 | MA | 1981 | 893 | 2950 | 763 | 3712 | 629 | 4224 | 516 | 4946 | 334 | 6307 | 184 | 5251 |
| 3E | | MI | 1041 | 893 | 1726 | 709 | 2049 | 580 | 2261 | 471 | 2500 | 281 | 2821 | 52 | 2669 |
| 8-#10 | 3.02 | MA | 1842 | 893 | 2641 | 774 | 3308 | 639 | 3708 | 530 | 4241 | 339 | 5417 | 129 | 4753 |
| 4L-2S | | MI | 1148 | 893 | 1936 | 705 | 2314 | 579 | 2582 | 473 | 2913 | 278 | 3298 | 145 | 2693 |
| 8-#11 | 3.71 | MA | 2081 | 961 | 3252 | 802 | 4069 | 657 | 4643 | 533 | 5499 | 330 | 6971 | 143 | 6275 |
| 3E | | MI | 1067 | 961 | 1860 | 742 | 2197 | 602 | 2417 | 479 | 2670 | 258 | 2968 | -30 | 2955 |
| 8-#11 | 3.71 | MA | 1916 | 961 | 2878 | 815 | 3581 | 668 | 4020 | 549 | 4647 | 335 | 5917 | 78 | 5529 |
| 4L-2S | | MI | 1187 | 961 | 2106 | 739 | 2509 | 603 | 2790 | 482 | 3142 | 254 | 3498 | 85 | 3157 |
| 8-#14 | 5.36 | MA | 2139 | 1124 | 3414 | 922 | 4235 | 747 | 4788 | 602 | 5669 | 330 | 7262 | -30 | 7200 |
| 4L-2S | | MI | 1308 | 1124 | 2512 | 834 | 3008 | 672 | 3334 | 513 | 3826 | 216 | 4203 | -27 | 4190 |
| 10-#10 | 3.78 | MA | 2048 | 968 | 3084 | 821 | 3869 | 673 | 4386 | 552 | 5154 | 337 | 6681 | 125 | 6009 |
| 4L-3S | | MI | 1121 | 968 | 1936 | 755 | 2314 | 615 | 2582 | 493 | 2913 | 274 | 3298 | 21 | 3248 |
| 10-#10 | 3.78 | MA | 1906 | 968 | 2808 | 832 | 3477 | 688 | 3924 | 560 | 4515 | 348 | 5789 | 71 | 5534 |
| 5L-2S | | MI | 1221 | 968 | 2145 | 752 | 2579 | 614 | 2903 | 495 | 3326 | 271 | 3775 | 114 | 3302 |
| 10-#11 | 4.64 | MA | 2170 | 1053 | 3411 | 872 | 4256 | 710 | 4836 | 576 | 5746 | 331 | 7406 | 70 | 7042 |
| 4L-3S | | MI | 1158 | 1053 | 2106 | 799 | 2509 | 644 | 2790 | 505 | 3142 | 246 | 3498 | -75 | 3460 |
| 10-#11 | 4.64 | MA | 2003 | 1053 | 3077 | 885 | 3782 | 728 | 4276 | 585 | 4973 | 343 | 6354 | 2 | 6346 |
| 5L-2S | | MI | 1270 | 1053 | 2353 | 796 | 2821 | 645 | 3163 | 508 | 3614 | 243 | 4029 | 40 | 3870 |
| 10-#14 | 6.70 | MA | 2247 | 1256 | 3694 | 1022 | 4518 | 832 | 5150 | 653 | 6127 | 341 | 7874 | -143 | 7565 |
| 5L-2S | | MI | 1423 | 1256 | 2855 | 917 | 3443 | 733 | 3843 | 548 | 4470 | 196 | 4913 | -99 | 4848 |
| 12-#10 | 4.54 | MA | 2115 | 1043 | 3251 | 879 | 4038 | 723 | 4602 | 582 | 5428 | 345 | 7052 | 67 | 6798 |
| 5L-3S | | MI | 1199 | 1043 | 2145 | 802 | 2579 | 649 | 2903 | 515 | 3326 | 267 | 3775 | -10 | 3767 |
| 12-#10 | 4.54 | MA | 1938 | 1043 | 2975 | 887 | 3684 | 732 | 4151 | 596 | 4804 | 350 | 6191 | -4 | 6184 |
| 6L-2S | | MI | 1294 | 1043 | 2355 | 798 | 2845 | 648 | 3224 | 517 | 3739 | 264 | 4251 | 83 | 3909 |
| 12-#11 | 5.57 | MA | 2240 | 1145 | 3610 | 943 | 4457 | 770 | 5093 | 612 | 6072 | 340 | 7844 | -6 | 7831 |
| 5L-3S | | MI | 1247 | 1145 | 2353 | 856 | 2821 | 687 | 3163 | 531 | 3614 | 234 | 4029 | -119 | 3958 |
| 12-#11 | 5.57 | MA | 2048 | 1145 | 3283 | 954 | 4027 | 781 | 4546 | 628 | 5316 | 345 | 6825 | -90 | 6680 |
| 6L-2S | | MI | 1353 | 1145 | 2599 | 854 | 3133 | 687 | 3535 | 534 | 4086 | 231 | 4560 | -5 | 4557 |
| 14-#10 | 5.29 | MA | 2154 | 1117 | 3418 | 934 | 4245 | 767 | 4829 | 618 | 5717 | 347 | 7455 | -8 | 7428 |
| 6L-3S | | MI | 1275 | 1117 | 2355 | 849 | 2845 | 683 | 3224 | 537 | 3739 | 260 | 4251 | -41 | 4216 |
| 14-#11 | 6.50 | MA | 2291 | 1237 | 3816 | 1011 | 4702 | 823 | 5362 | 654 | 6415 | 341 | 8314 | -99 | 8099 |
| 6L-3S | | MI | 1336 | 1237 | 2599 | 914 | 3133 | 729 | 3535 | 557 | 4086 | 222 | 4560 | -164 | 4448 |

## RECTANGULAR TIED COLUMNS 14" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.10 | MA | 2060 | 761 | 2628 | 693 | 3340 | 583 | 3748 | 495 | 4195 | 362 | 5191 | 316 | 2408 |
| 2E | | MI | 1038 | 761 | 1514 | 638 | 1777 | 536 | 1919 | 454 | 2035 | 325 | 2289 | 248 | 1202 |
| 4-#10 | 1.40 | MA | 2150 | 793 | 2844 | 711 | 3603 | 596 | 4061 | 503 | 4612 | 360 | 5765 | 313 | 3012 |
| 2E | | MI | 1068 | 793 | 1607 | 655 | 1888 | 547 | 2048 | 461 | 2191 | 318 | 2460 | 229 | 1470 |
| 4-#11 | 1.71 | MA | 2229 | 827 | 3081 | 727 | 3875 | 607 | 4377 | 509 | 5023 | 356 | 6325 | 309 | 3625 |
| 2E | | MI | 1087 | 827 | 1706 | 666 | 1991 | 555 | 2153 | 462 | 2302 | 303 | 2551 | 197 | 1729 |
| 4-#14 | 2.47 | MA | 2430 | 908 | 3605 | 774 | 4519 | 641 | 5145 | 531 | 6049 | 350 | 7676 | 296 | 5099 |
| 2E | | MI | 1148 | 908 | 1919 | 710 | 2244 | 586 | 2425 | 475 | 2641 | 282 | 2897 | 139 | 2340 |
| 4-#18 | 4.40 | MA | 2874 | 1114 | 4878 | 896 | 6091 | 729 | 7027 | 586 | 8565 | 338 | 10873 | 254 | 8695 |
| 2E | | MI | 1282 | 1114 | 2403 | 825 | 2780 | 657 | 3016 | 498 | 3380 | 217 | 3594 | -35 | 3596 |
| 6-#8 | 1.30 | MA | 2131 | 783 | 2765 | 709 | 3523 | 594 | 3974 | 503 | 4504 | 362 | 5622 | 315 | 2840 |
| 2L-3S | | MI | 986 | 783 | 1438 | 658 | 1689 | 550 | 1816 | 463 | 1909 | 328 | 2150 | 186 | 1405 |
| 6-#8 | 1.30 | MA | 1935 | 783 | 2456 | 716 | 3132 | 601 | 3502 | 509 | 3868 | 371 | 4741 | 260 | 2829 |
| 3L-2S | | MI | 1066 | 783 | 1573 | 655 | 1859 | 548 | 2021 | 463 | 2179 | 326 | 2466 | 244 | 1397 |
| 6-#9 | 1.65 | MA | 2235 | 820 | 3016 | 730 | 3831 | 610 | 4343 | 513 | 4995 | 360 | 6299 | 313 | 3548 |
| 2L-3S | | MI | 1005 | 820 | 1514 | 678 | 1777 | 564 | 1919 | 471 | 2035 | 322 | 2289 | 151 | 1714 |
| 6-#9 | 1.65 | MA | 1998 | 820 | 2628 | 739 | 3340 | 618 | 3748 | 520 | 4195 | 370 | 5191 | 242 | 3519 |
| 3L-2S | | MI | 1102 | 820 | 1682 | 675 | 1990 | 563 | 2175 | 472 | 2369 | 320 | 2678 | 225 | 1709 |
| 6-#10 | 2.09 | MA | 2363 | 868 | 3334 | 758 | 4223 | 630 | 4811 | 525 | 5622 | 357 | 7163 | 309 | 4446 |
| 2L-3S | | MI | 1028 | 868 | 1607 | 705 | 1888 | 583 | 2048 | 482 | 2191 | 314 | 2460 | 105 | 2092 |
| 6-#10 | 2.09 | MA | 2077 | 868 | 2844 | 770 | 3603 | 640 | 4061 | 534 | 4612 | 369 | 5765 | 218 | 4385 |
| 3L-2S | | MI | 1145 | 868 | 1817 | 701 | 2153 | 582 | 2369 | 483 | 2605 | 311 | 2937 | 199 | 2097 |

## RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

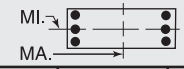
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 2.57 | MA | 2477 | 919 | 3672 | 785 | 4623 | 649 | 5281 | 536 | 6241 | 352 | 8010 | 304 | 5349 |
| 2L-3S | | MI | 1042 | 919 | 1706 | 727 | 1991 | 596 | 2153 | 485 | 2302 | 295 | 2551 | 37 | 2444 |
| 6-#11 | 2.57 | MA | 2147 | 919 | 3081 | 798 | 3875 | 661 | 4377 | 547 | 5023 | 366 | 6325 | 189 | 5247 |
| 3L-2S | | MI | 1174 | 919 | 1953 | 724 | 2303 | 597 | 2525 | 488 | 2774 | 291 | 3082 | 152 | 2462 |
| 6-#14 | 3.71 | MA | 2345 | 1041 | 3605 | 876 | 4519 | 718 | 5145 | 583 | 6049 | 363 | 7676 | 121 | 7289 |
| 3L-2S | | MI | 1264 | 1041 | 2262 | 793 | 2679 | 647 | 2934 | 509 | 3286 | 261 | 3607 | 67 | 3345 |
| 6-#18 | 6.59 | MA | 2808 | 1350 | 4878 | 1073 | 6091 | 863 | 7027 | 674 | 8565 | 356 | 10873 | -69 | 10674 |
| 3L-2S | | MI | 1468 | 1350 | 2973 | 972 | 3477 | 759 | 3821 | 550 | 4399 | 168 | 4665 | -190 | 4627 |
| 8-#7 | 1.32 | MA | 2142 | 785 | 2771 | 711 | 3539 | 596 | 3998 | 505 | 4540 | 363 | 5676 | 316 | 2885 |
| 2L-4S | | MI | 970 | 785 | 1396 | 664 | 1636 | 557 | 1754 | 469 | 1834 | 329 | 2083 | 185 | 1428 |
| 8-#7 | 1.32 | MA | 1993 | 785 | 2535 | 717 | 3240 | 602 | 3637 | 509 | 4054 | 370 | 5003 | 274 | 2878 |
| 3E | | MI | 1011 | 785 | 1471 | 662 | 1738 | 553 | 1878 | 466 | 2000 | 331 | 2265 | 204 | 1424 |
| 8-#7 | 1.32 | MA | 1905 | 785 | 2372 | 723 | 3027 | 607 | 3365 | 517 | 3682 | 373 | 4540 | 249 | 2848 |
| 4L-2S | | MI | 1073 | 785 | 1574 | 659 | 1869 | 552 | 2037 | 466 | 2209 | 329 | 2512 | 248 | 1418 |
| 8-#8 | 1.74 | MA | 2269 | 830 | 3074 | 738 | 3913 | 615 | 4447 | 517 | 5140 | 361 | 6503 | 313 | 3744 |
| 2L-4S | | MI | 991 | 830 | 1475 | 690 | 1727 | 576 | 1859 | 480 | 1965 | 323 | 2234 | 144 | 1784 |
| 8-#8 | 1.74 | MA | 2084 | 830 | 2765 | 745 | 3523 | 622 | 3974 | 523 | 4504 | 369 | 5622 | 258 | 3725 |
| 3E | | MI | 1041 | 830 | 1573 | 687 | 1859 | 571 | 2021 | 477 | 2179 | 325 | 2466 | 169 | 1803 |
| 8-#8 | 1.74 | MA | 1974 | 830 | 2551 | 753 | 3243 | 629 | 3617 | 532 | 4015 | 373 | 5013 | 224 | 3651 |
| 4L-2S | | MI | 1117 | 830 | 1707 | 684 | 2029 | 570 | 2227 | 477 | 2449 | 323 | 2783 | 227 | 1799 |
| 8-#9 | 2.20 | MA | 2403 | 879 | 3405 | 767 | 4323 | 637 | 4937 | 530 | 5796 | 358 | 7407 | 309 | 4682 |
| 2L-4S | | MI | 1012 | 879 | 1559 | 719 | 1824 | 597 | 1973 | 492 | 2105 | 315 | 2391 | 98 | 2097 |
| 8-#9 | 2.20 | MA | 2181 | 879 | 3016 | 776 | 3831 | 645 | 4343 | 537 | 4995 | 368 | 6299 | 239 | 4642 |
| 3E | | MI | 1072 | 879 | 1682 | 715 | 1990 | 591 | 2175 | 488 | 2369 | 317 | 2678 | 129 | 2203 |
| 8-#9 | 2.20 | MA | 2050 | 879 | 2747 | 786 | 3479 | 654 | 3892 | 549 | 4380 | 373 | 5531 | 196 | 4410 |
| 4L-2S | | MI | 1164 | 879 | 1849 | 712 | 2202 | 590 | 2432 | 489 | 2703 | 315 | 3066 | 202 | 2206 |
| 8-#10 | 2.79 | MA | 2302 | 943 | 3334 | 816 | 4223 | 675 | 4811 | 556 | 5622 | 367 | 7163 | 214 | 5800 |
| 3E | | MI | 1110 | 943 | 1817 | 752 | 2153 | 617 | 2369 | 504 | 2605 | 307 | 2937 | 74 | 2695 |
| 8-#10 | 2.79 | MA | 2146 | 943 | 2993 | 828 | 3779 | 685 | 4243 | 571 | 4845 | 373 | 6190 | 160 | 5310 |
| 4L-2S | | MI | 1220 | 943 | 2027 | 748 | 2418 | 616 | 2690 | 505 | 3018 | 304 | 3414 | 168 | 2713 |
| 8-#11 | 3.43 | MA | 2410 | 1011 | 3672 | 856 | 4623 | 703 | 5281 | 574 | 6241 | 362 | 8010 | 185 | 6949 |
| 3E | | MI | 1135 | 1011 | 1953 | 784 | 2303 | 638 | 2525 | 511 | 2774 | 283 | 3082 | -8 | 3079 |
| 8-#11 | 3.43 | MA | 2232 | 1011 | 3259 | 870 | 4084 | 715 | 4593 | 591 | 5301 | 369 | 6823 | 117 | 6184 |
| 4L-2S | | MI | 1258 | 1011 | 2199 | 781 | 2614 | 639 | 2898 | 514 | 3246 | 279 | 3613 | 107 | 3182 |
| 8-#14 | 4.95 | MA | 2486 | 1173 | 3857 | 978 | 4814 | 795 | 5450 | 645 | 6441 | 367 | 8370 | 15 | 8290 |
| 4L-2S | | MI | 1379 | 1173 | 2606 | 876 | 3114 | 708 | 3442 | 544 | 3930 | 241 | 4316 | -6 | 4314 |
| 10-#10 | 3.49 | MA | 2378 | 1017 | 3484 | 875 | 4399 | 720 | 4993 | 593 | 5855 | 370 | 7588 | 156 | 6703 |
| 4L-3S | | MI | 1190 | 1017 | 2027 | 799 | 2418 | 651 | 2690 | 525 | 3018 | 300 | 3414 | 43 | 3294 |
| 10-#10 | 3.49 | MA | 2214 | 1017 | 3180 | 887 | 3968 | 736 | 4484 | 602 | 5151 | 382 | 6609 | 105 | 6227 |
| 5L-2S | | MI | 1293 | 1017 | 2237 | 795 | 2684 | 650 | 3011 | 527 | 3431 | 297 | 3890 | 137 | 3324 |
| 10-#11 | 4.29 | MA | 2519 | 1103 | 3850 | 927 | 4832 | 757 | 5497 | 618 | 6518 | 365 | 8509 | 112 | 7866 |
| 4L-3S | | MI | 1226 | 1103 | 2199 | 841 | 2614 | 681 | 2898 | 536 | 3246 | 271 | 3613 | -52 | 3588 |
| 10-#11 | 4.29 | MA | 2315 | 1103 | 3482 | 941 | 4310 | 776 | 4881 | 628 | 5666 | 379 | 7319 | 46 | 7148 |
| 5L-2S | | MI | 1342 | 1103 | 2446 | 839 | 2926 | 681 | 3271 | 540 | 3718 | 268 | 4144 | 62 | 3896 |
| 10-#14 | 6.18 | MA | 2599 | 1306 | 4172 | 1079 | 5133 | 882 | 5856 | 698 | 6956 | 380 | 9066 | -91 | 8758 |
| 5L-2S | | MI | 1494 | 1306 | 2950 | 959 | 3549 | 769 | 3951 | 579 | 4574 | 221 | 5026 | -78 | 4981 |
| 12-#10 | 4.19 | MA | 2439 | 1092 | 3670 | 934 | 4588 | 770 | 5234 | 624 | 6161 | 380 | 8007 | 101 | 7633 |
| 5L-3S | | MI | 1268 | 1092 | 2237 | 845 | 2684 | 686 | 3011 | 547 | 3431 | 293 | 3890 | 12 | 3859 |
| 12-#10 | 4.19 | MA | 2251 | 1092 | 3360 | 942 | 4199 | 781 | 4738 | 639 | 5475 | 386 | 7067 | 31 | 6925 |
| 6L-2S | | MI | 1365 | 1092 | 2447 | 842 | 2949 | 685 | 3332 | 549 | 3844 | 290 | 4367 | 106 | 3931 |
| 12-#11 | 5.14 | MA | 2592 | 1195 | 4073 | 998 | 5058 | 818 | 5785 | 655 | 6883 | 376 | 9005 | 41 | 8842 |
| 5L-3S | | MI | 1316 | 1195 | 2446 | 899 | 2926 | 723 | 3271 | 562 | 3718 | 259 | 4144 | -97 | 4088 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 12-#11 | 5.14 | MA | 2376 | 1195 | 3704 | 1009 | 4586 | 830 | 5183 | 672 | 6052 | 382 | 7857 | -46 | 7730 |
| 6L-2S | | MI | 1425 | 1195 | 2692 | 896 | 3238 | 724 | 3643 | 566 | 4190 | 256 | 4675 | 17 | 4606 |
| 14-#10 | 4.88 | MA | 2480 | 1167 | 3850 | 988 | 4819 | 815 | 5488 | 661 | 6484 | 383 | 8465 | 27 | 8341 |
| 6L-3S | | MI | 1345 | 1167 | 2447 | 892 | 2949 | 720 | 3332 | 569 | 3844 | 286 | 4367 | -19 | 4352 |
| 14-#10 | 4.88 | MA | 2324 | 1167 | 3497 | 1002 | 4430 | 824 | 5008 | 670 | 5817 | 395 | 7537 | -16 | 7499 |
| 7L-2S | | MI | 1437 | 1167 | 2656 | 888 | 3215 | 719 | 3653 | 571 | 4258 | 283 | 4844 | 75 | 4537 |
| 14-#11 | 6.00 | MA | 2649 | 1286 | 4295 | 1066 | 5333 | 872 | 6087 | 699 | 7269 | 379 | 9542 | -51 | 9342 |
| 6L-3S | | MI | 1405 | 1286 | 2692 | 956 | 3238 | 765 | 3643 | 588 | 4190 | 248 | 4675 | -142 | 4582 |
| 16-#10 | 5.58 | MA | 2572 | 1242 | 3988 | 1048 | 5050 | 858 | 5758 | 692 | 6826 | 393 | 8935 | -20 | 8866 |
| 7L-3S | | MI | 1421 | 1242 | 2656 | 939 | 3215 | 754 | 3653 | 591 | 4258 | 279 | 4844 | -50 | 4798 |

## RECTANGULAR TIED COLUMNS 14" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#9 | 1.02 | MA | 2372 | 811 | 2959 | 746 | 3791 | 627 | 4262 | 534 | 4764 | 393 | 5891 | 343 | 2624 |
| 2E | | MI | 1108 | 811 | 1604 | 682 | 1882 | 573 | 2027 | 487 | 2140 | 350 | 2406 | 270 | 1216 |
| 4-#10 | 1.30 | MA | 2473 | 843 | 3197 | 764 | 4080 | 640 | 4606 | 542 | 5223 | 391 | 6522 | 340 | 3287 |
| 2E | | MI | 1138 | 843 | 1699 | 698 | 1992 | 584 | 2156 | 493 | 2296 | 344 | 2576 | 252 | 1485 |
| 4-#11 | 1.59 | MA | 2564 | 877 | 3458 | 780 | 4381 | 652 | 4955 | 549 | 5678 | 387 | 7141 | 336 | 3962 |
| 2E | | MI | 1157 | 877 | 1800 | 709 | 2096 | 591 | 2261 | 494 | 2406 | 328 | 2666 | 219 | 1748 |
| 4-#14 | 2.30 | MA | 2791 | 958 | 4036 | 827 | 5090 | 686 | 5802 | 570 | 6808 | 382 | 8699 | 330 | 5585 |
| 2E | | MI | 1219 | 958 | 2013 | 752 | 2349 | 622 | 2533 | 506 | 2745 | 306 | 3010 | 160 | 2363 |
| 4-#18 | 4.08 | MA | 3297 | 1164 | 5443 | 948 | 6828 | 774 | 7882 | 625 | 9589 | 369 | 12365 | 299 | 9559 |
| 2E | | MI | 1352 | 1164 | 2500 | 866 | 2886 | 692 | 3125 | 529 | 3483 | 241 | 3706 | -14 | 3707 |
| 6-#8 | 1.21 | MA | 2452 | 833 | 3109 | 761 | 3990 | 639 | 4508 | 542 | 5101 | 394 | 6361 | 343 | 3096 |
| 2L-3S | | MI | 1055 | 833 | 1528 | 702 | 1793 | 587 | 1924 | 495 | 2014 | 354 | 2267 | 209 | 1420 |
| 6-#8 | 1.21 | MA | 2234 | 833 | 2771 | 769 | 3563 | 646 | 3991 | 549 | 4405 | 402 | 5397 | 289 | 3085 |
| 3L-2S | | MI | 1136 | 833 | 1662 | 699 | 1963 | 586 | 2129 | 496 | 2284 | 352 | 2583 | 267 | 1410 |
| 6-#9 | 1.53 | MA | 2569 | 870 | 3384 | 783 | 4329 | 654 | 4913 | 552 | 5641 | 391 | 7104 | 340 | 3872 |
| 2L-3S | | MI | 1074 | 870 | 1604 | 722 | 1882 | 601 | 2027 | 503 | 2140 | 348 | 2406 | 174 | 1732 |
| 6-#9 | 1.53 | MA | 2305 | 870 | 2959 | 793 | 3791 | 664 | 4262 | 560 | 4764 | 402 | 5891 | 271 | 3843 |
| 3L-2S | | MI | 1172 | 870 | 1772 | 718 | 2094 | 600 | 2283 | 504 | 2474 | 345 | 2794 | 247 | 1724 |
| 6-#10 | 1.94 | MA | 2712 | 917 | 3733 | 811 | 4759 | 675 | 5427 | 564 | 6329 | 388 | 8053 | 336 | 4857 |
| 2L-3S | | MI | 1097 | 917 | 1699 | 748 | 1992 | 620 | 2156 | 514 | 2296 | 339 | 2576 | 128 | 2115 |
| 6-#10 | 1.94 | MA | 2393 | 917 | 3197 | 823 | 4080 | 686 | 4606 | 574 | 5223 | 401 | 6522 | 248 | 4797 |
| 3L-2S | | MI | 1215 | 917 | 1909 | 745 | 2257 | 618 | 2477 | 515 | 2710 | 337 | 3053 | 221 | 2114 |
| 6-#11 | 2.39 | MA | 2842 | 969 | 4106 | 837 | 5201 | 694 | 5947 | 576 | 7013 | 383 | 8990 | 331 | 5855 |
| 2L-3S | | MI | 1110 | 969 | 1800 | 769 | 2096 | 632 | 2261 | 516 | 2406 | 320 | 2666 | 59 | 2473 |
| 6-#11 | 2.39 | MA | 2473 | 969 | 3458 | 852 | 4381 | 707 | 4955 | 587 | 5678 | 398 | 7141 | 220 | 5752 |
| 3L-2S | | MI | 1244 | 969 | 2046 | 766 | 2408 | 633 | 2634 | 520 | 2879 | 316 | 3197 | 174 | 2483 |
| 6-#14 | 3.44 | MA | 2683 | 1090 | 4036 | 930 | 5090 | 764 | 5802 | 624 | 6808 | 397 | 8699 | 159 | 8018 |
| 3L-2S | | MI | 1335 | 1090 | 2357 | 835 | 2784 | 683 | 3042 | 540 | 3390 | 286 | 3720 | 88 | 3372 |
| 6-#18 | 6.12 | MA | 3216 | 1399 | 5443 | 1128 | 6828 | 910 | 7882 | 717 | 9589 | 392 | 12365 | -14 | 12316 |
| 3L-2S | | MI | 1538 | 1399 | 3070 | 1013 | 3583 | 794 | 3929 | 581 | 4502 | 193 | 4777 | -169 | 4750 |
| 8-#7 | 1.22 | MA | 2463 | 834 | 3115 | 764 | 4007 | 641 | 4534 | 544 | 5140 | 395 | 6418 | 343 | 3144 |
| 2L-4S | | MI | 1039 | 834 | 1485 | 708 | 1740 | 595 | 1862 | 502 | 1940 | 355 | 2200 | 208 | 1443 |
| 8-#7 | 1.22 | MA | 2298 | 834 | 2857 | 770 | 3681 | 647 | 4139 | 549 | 4609 | 401 | 5682 | 303 | 3137 |
| 3E | | MI | 1080 | 834 | 1560 | 706 | 1842 | 591 | 1986 | 499 | 2105 | 357 | 2382 | 227 | 1438 |
| 8-#7 | 1.22 | MA | 2201 | 834 | 2679 | 776 | 3448 | 652 | 3842 | 557 | 4202 | 405 | 5181 | 278 | 3107 |
| 4L-2S | | MI | 1143 | 834 | 1664 | 703 | 1972 | 589 | 2145 | 499 | 2315 | 355 | 2629 | 271 | 1431 |
| 8-#8 | 1.61 | MA | 2606 | 879 | 3447 | 790 | 4418 | 660 | 5025 | 556 | 5797 | 392 | 7325 | 340 | 4086 |
| 2L-4S | | MI | 1060 | 879 | 1565 | 734 | 1830 | 613 | 1967 | 512 | 2071 | 349 | 2350 | 167 | 1816 |
| 8-#8 | 1.61 | MA | 2400 | 879 | 3109 | 798 | 3990 | 668 | 4508 | 562 | 5101 | 400 | 6361 | 286 | 4066 |
| 3E | | MI | 1110 | 879 | 1662 | 731 | 1963 | 608 | 2129 | 509 | 2284 | 350 | 2583 | 192 | 1819 |
| 8-#8 | 1.61 | MA | 2278 | 879 | 2876 | 806 | 3685 | 675 | 4119 | 572 | 4569 | 406 | 5702 | 253 | 3992 |
| 4L-2S | | MI | 1188 | 879 | 1797 | 728 | 2133 | 607 | 2335 | 509 | 2554 | 349 | 2900 | 250 | 1814 |
| 8-#9 | 2.04 | MA | 2756 | 929 | 3810 | 819 | 4867 | 682 | 5563 | 569 | 6517 | 389 | 8318 | 337 | 5114 |
| 2L-4S | | MI | 1081 | 929 | 1650 | 762 | 1928 | 634 | 2081 | 524 | 2210 | 341 | 2507 | 121 | 2142 |

## RECTANGULAR TIED COLUMNS 14" x 28"

Short columns – no sidesway
Bending on major or minor axis

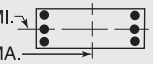
$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 8-#9 | 2.04 | MA | 2508 | 929 | 3384 | 829 | 4329 | 691 | 4913 | 577 | 5641 | 400 | 7104 | 268 | 5074 |
| 3E | | MI | 1141 | 929 | 1772 | 759 | 2094 | 628 | 2283 | 521 | 2474 | 343 | 2794 | 151 | 2223 |
| 8-#9 | 2.04 | MA | 2363 | 929 | 3091 | 839 | 3945 | 700 | 4421 | 590 | 4969 | 406 | 6272 | 226 | 4881 |
| 4L-2S | | MI | 1234 | 929 | 1940 | 755 | 2306 | 627 | 2540 | 521 | 2808 | 341 | 3183 | 224 | 2224 |
| 8-#10 | 2.59 | MA | 2644 | 992 | 3733 | 870 | 4759 | 720 | 5427 | 596 | 6329 | 399 | 8053 | 244 | 6348 |
| 3E | | MI | 1180 | 992 | 1909 | 795 | 2257 | 654 | 2477 | 536 | 2710 | 332 | 3053 | 97 | 2720 |
| 8-#10 | 2.59 | MA | 2471 | 992 | 3362 | 882 | 4274 | 732 | 4807 | 612 | 5480 | 406 | 6998 | 190 | 5876 |
| 4L-2S | | MI | 1291 | 992 | 2118 | 791 | 2523 | 653 | 2798 | 537 | 3123 | 330 | 3529 | 190 | 2733 |
| 8-#11 | 3.18 | MA | 2767 | 1060 | 4106 | 909 | 5201 | 749 | 5947 | 614 | 7013 | 395 | 8990 | 215 | 7623 |
| 3E | | MI | 1204 | 1060 | 2046 | 826 | 2408 | 675 | 2634 | 542 | 2879 | 308 | 3197 | 14 | 3165 |
| 8-#11 | 3.18 | MA | 2568 | 1060 | 3656 | 924 | 4613 | 762 | 5195 | 632 | 5986 | 403 | 7703 | 148 | 6850 |
| 4L-2S | | MI | 1329 | 1060 | 2293 | 824 | 2720 | 675 | 3006 | 546 | 3351 | 305 | 3728 | 129 | 3206 |
| 8-#14 | 4.59 | MA | 2834 | 1223 | 4316 | 1033 | 5418 | 843 | 6141 | 688 | 7244 | 402 | 9484 | 55 | 9188 |
| 4L-2S | | MI | 1450 | 1223 | 2701 | 918 | 3219 | 744 | 3551 | 575 | 4034 | 266 | 4430 | 16 | 4367 |
| 10-#10 | 3.24 | MA | 2728 | 1067 | 3899 | 929 | 4953 | 766 | 5628 | 634 | 6586 | 403 | 8530 | 187 | 7408 |
| 4L-3S | | MI | 1260 | 1067 | 2118 | 842 | 2523 | 688 | 2798 | 558 | 3123 | 325 | 3529 | 66 | 3321 |
| 10-#10 | 3.24 | MA | 2543 | 1067 | 3569 | 941 | 4484 | 783 | 5074 | 644 | 5819 | 417 | 7465 | 138 | 6879 |
| 5L-2S | | MI | 1364 | 1067 | 2328 | 838 | 2788 | 687 | 3119 | 559 | 3536 | 323 | 4006 | 159 | 3345 |
| 10-#11 | 3.98 | MA | 2872 | 1152 | 4304 | 981 | 5433 | 804 | 6186 | 659 | 7321 | 399 | 9552 | 143 | 8703 |
| 4L-3S | | MI | 1295 | 1152 | 2293 | 884 | 2720 | 717 | 3006 | 568 | 3351 | 296 | 3728 | -30 | 3714 |
| 10-#11 | 3.98 | MA | 2657 | 1152 | 3903 | 996 | 4864 | 824 | 5514 | 670 | 6391 | 414 | 8258 | 80 | 7969 |
| 5L-2S | | MI | 1413 | 1152 | 2539 | 881 | 3031 | 718 | 3379 | 571 | 3823 | 293 | 4258 | 84 | 3921 |
| 10-#14 | 5.74 | MA | 2973 | 1355 | 4665 | 1136 | 5773 | 931 | 6592 | 742 | 7816 | 417 | 10264 | -46 | 10107 |
| 5L-2S | | MI | 1564 | 1355 | 3045 | 1001 | 3654 | 805 | 4059 | 610 | 4678 | 245 | 5140 | -56 | 5110 |
| 12-#10 | 3.89 | MA | 2793 | 1142 | 4105 | 988 | 5163 | 817 | 5895 | 666 | 6925 | 414 | 8997 | 134 | 8437 |
| 5L-3S | | MI | 1338 | 1142 | 2328 | 888 | 2788 | 723 | 3119 | 580 | 3536 | 318 | 4006 | 35 | 3918 |
| 12-#10 | 3.89 | MA | 2585 | 1142 | 3760 | 996 | 4739 | 828 | 5355 | 681 | 6177 | 421 | 7978 | 65 | 7654 |
| 6L-2S | | MI | 1437 | 1142 | 2538 | 885 | 3054 | 722 | 3440 | 581 | 3949 | 316 | 4483 | 128 | 3954 |
| 12-#11 | 4.78 | MA | 2965 | 1244 | 4551 | 1053 | 5684 | 866 | 6506 | 697 | 7726 | 411 | 10107 | 76 | 9836 |
| 5L-3S | | MI | 1385 | 1244 | 2539 | 941 | 3031 | 759 | 3379 | 594 | 3823 | 284 | 4258 | -75 | 4217 |
| 12-#11 | 4.78 | MA | 2710 | 1244 | 4140 | 1063 | 5169 | 879 | 5850 | 715 | 6818 | 419 | 8863 | -10 | 8828 |
| 6L-2S | | MI | 1496 | 1244 | 2786 | 938 | 3343 | 760 | 3752 | 597 | 4295 | 281 | 4789 | 39 | 4633 |
| 12-#14 | 6.89 | MA | 3071 | 1488 | 5009 | 1234 | 6204 | 1010 | 7067 | 806 | 8421 | 422 | 11111 | -178 | 10563 |
| 6L-2S | | MI | 1679 | 1488 | 3389 | 1083 | 4089 | 865 | 4568 | 645 | 5323 | 225 | 5850 | -128 | 5764 |
| 14-#10 | 4.54 | MA | 2839 | 1216 | 4297 | 1043 | 5418 | 863 | 6176 | 703 | 7283 | 418 | 9509 | 61 | 9205 |
| 6L-3S | | MI | 1415 | 1216 | 2538 | 935 | 3054 | 757 | 3440 | 601 | 3949 | 311 | 4483 | 4 | 4473 |
| 14-#10 | 4.54 | MA | 2665 | 1216 | 3955 | 1051 | 4985 | 871 | 5653 | 713 | 6555 | 432 | 8502 | 20 | 8423 |
| 7L-2S | | MI | 1509 | 1216 | 2748 | 931 | 3319 | 756 | 3761 | 603 | 4363 | 308 | 4960 | 97 | 4560 |
| 14-#11 | 5.57 | MA | 3028 | 1336 | 4789 | 1121 | 5989 | 921 | 6842 | 742 | 8154 | 415 | 10712 | -15 | 10639 |
| 6L-3S | | MI | 1473 | 1336 | 2786 | 999 | 3343 | 801 | 3752 | 620 | 4295 | 273 | 4789 | -120 | 4714 |
| 14-#11 | 5.57 | MA | 2828 | 1336 | 4323 | 1137 | 5474 | 932 | 6206 | 753 | 7271 | 430 | 9485 | -69 | 9304 |
| 7L-2S | | MI | 1579 | 1336 | 3032 | 996 | 3655 | 802 | 4124 | 623 | 4767 | 269 | 5320 | -6 | 5316 |
| 16-#10 | 5.18 | MA | 2923 | 1291 | 4492 | 1097 | 5664 | 905 | 6475 | 735 | 7661 | 429 | 10034 | 16 | 9970 |
| 7L-3S | | MI | 1491 | 1291 | 2748 | 982 | 3319 | 791 | 3761 | 623 | 4363 | 304 | 4960 | -27 | 4936 |
| 16-#10 | 5.18 | MA | 2767 | 1291 | 4115 | 1112 | 5200 | 919 | 5956 | 745 | 6935 | 436 | 9064 | -38 | 8969 |
| 8L-2S | | MI | 1581 | 1291 | 2958 | 978 | 3584 | 790 | 4082 | 625 | 4776 | 301 | 5437 | 66 | 5165 |
| 16-#11 | 6.37 | MA | 3138 | 1428 | 4971 | 1194 | 6294 | 974 | 7198 | 780 | 8606 | 427 | 11334 | -73 | 11051 |
| 7L-3S | | MI | 1561 | 1428 | 3032 | 1056 | 3655 | 843 | 4124 | 646 | 4767 | 261 | 5320 | -165 | 5205 |
| 18-#10 | 5.83 | MA | 3035 | 1366 | 4652 | 1159 | 5880 | 953 | 6777 | 766 | 8041 | 434 | 10595 | -42 | 10452 |
| 8L-3S | | MI | 1566 | 1366 | 2958 | 1029 | 3584 | 826 | 4082 | 645 | 4776 | 297 | 5437 | -58 | 5380 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

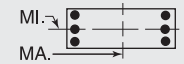
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 1.41 | MA | 888 | 559 | 1275 | 478 | 1543 | 400 | 1700 | 337 | 1885 | 239 | 2205 | 188 | 1234 |
| 2L-3S | | MI | 812 | 559 | 1149 | 481 | 1384 | 402 | 1508 | 339 | 1627 | 242 | 1884 | 144 | 1236 |
| 6-#8 | 1.85 | MA | 932 | 592 | 1395 | 497 | 1690 | 413 | 1875 | 345 | 2119 | 237 | 2477 | 177 | 1577 |
| 2L-3S | | MI | 836 | 592 | 1232 | 501 | 1483 | 416 | 1625 | 347 | 1782 | 240 | 2064 | 119 | 1572 |
| 6-#9 | 2.34 | MA | 976 | 629 | 1525 | 518 | 1849 | 429 | 2065 | 355 | 2371 | 235 | 2765 | 163 | 1947 |
| 2L-3S | | MI | 864 | 629 | 1321 | 523 | 1590 | 432 | 1752 | 357 | 1950 | 237 | 2255 | 89 | 1928 |
| 6-#10 | 2.98 | MA | 1031 | 677 | 1689 | 546 | 2049 | 449 | 2304 | 367 | 2686 | 231 | 3122 | 143 | 2410 |
| 2L-3S | | MI | 897 | 677 | 1432 | 552 | 1724 | 453 | 1912 | 369 | 2159 | 233 | 2492 | 50 | 2365 |
| 6-#11 | 3.66 | MA | 1071 | 728 | 1851 | 572 | 2237 | 467 | 2524 | 378 | 2932 | 217 | 3370 | 108 | 2848 |
| 2L-3S | | MI | 921 | 728 | 1547 | 578 | 1853 | 470 | 2059 | 378 | 2322 | 221 | 2653 | -6 | 2649 |
| 6-#14 | 5.27 | MA | 1191 | 850 | 2232 | 644 | 2709 | 520 | 3088 | 411 | 3625 | 198 | 4136 | 44 | 3930 |
| 2L-3S | | MI | 998 | 850 | 1806 | 651 | 2169 | 522 | 2435 | 408 | 2783 | 203 | 3161 | -122 | 3077 |
| 8-#7 | 1.88 | MA | 939 | 594 | 1400 | 500 | 1701 | 416 | 1892 | 347 | 2144 | 238 | 2525 | 180 | 1605 |
| 2L-4S | | MI | 820 | 594 | 1185 | 507 | 1426 | 421 | 1551 | 353 | 1682 | 240 | 1973 | 114 | 1564 |
| 8-#8 | 2.47 | MA | 994 | 639 | 1559 | 526 | 1896 | 435 | 2125 | 359 | 2455 | 235 | 2890 | 165 | 2057 |
| 2L-4S | | MI | 851 | 639 | 1278 | 534 | 1537 | 441 | 1681 | 366 | 1853 | 237 | 2178 | 79 | 1908 |
| 8-#9 | 3.13 | MA | 1052 | 688 | 1730 | 555 | 2107 | 456 | 2378 | 372 | 2793 | 232 | 3275 | 146 | 2543 |
| 2L-4S | | MI | 883 | 688 | 1378 | 565 | 1649 | 467 | 1821 | 380 | 2039 | 233 | 2395 | 38 | 2268 |
| 8-#10 | 3.97 | MA | 1123 | 752 | 1945 | 592 | 2373 | 483 | 2697 | 389 | 3213 | 228 | 3752 | 121 | 3154 |
| 2L-4S | | MI | 924 | 752 | 1503 | 605 | 1798 | 496 | 1997 | 398 | 2269 | 228 | 2663 | -15 | 2655 |

## RECTANGULAR TIED COLUMNS 16" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.10 | MA | 1092 | 602 | 1493 | 528 | 1823 | 443 | 2008 | 377 | 2202 | 274 | 2608 | 227 | 1263 |
| 2E | | MI | 958 | 602 | 1345 | 519 | 1616 | 436 | 1766 | 370 | 1920 | 269 | 2219 | 215 | 1106 |
| 4-#9 | 1.39 | MA | 1132 | 627 | 1599 | 541 | 1951 | 453 | 2158 | 382 | 2402 | 272 | 2850 | 220 | 1560 |
| 2E | | MI | 990 | 627 | 1435 | 532 | 1724 | 445 | 1893 | 376 | 2088 | 267 | 2410 | 205 | 1360 |
| 4-#10 | 1.76 | MA | 1180 | 659 | 1732 | 559 | 2111 | 466 | 2349 | 390 | 2656 | 270 | 3152 | 210 | 1934 |
| 2E | | MI | 1028 | 659 | 1547 | 550 | 1859 | 458 | 2052 | 383 | 2297 | 264 | 2646 | 192 | 1678 |
| 4-#11 | 2.17 | MA | 1217 | 693 | 1872 | 574 | 2269 | 476 | 2530 | 396 | 2890 | 265 | 3379 | 190 | 2300 |
| 2E | | MI | 1056 | 693 | 1664 | 564 | 1988 | 468 | 2200 | 388 | 2460 | 253 | 2806 | 167 | 1985 |
| 4-#14 | 3.13 | MA | 1319 | 774 | 2185 | 621 | 2651 | 510 | 2985 | 416 | 3486 | 258 | 4050 | 156 | 3184 |
| 2E | | MI | 1137 | 774 | 1925 | 610 | 2305 | 501 | 2576 | 409 | 2920 | 239 | 3313 | 123 | 2725 |
| 4-#18 | 5.56 | MA | 1549 | 980 | 2926 | 741 | 3562 | 598 | 4073 | 471 | 4831 | 226 | 5546 | 51 | 5276 |
| 2E | | MI | 1318 | 980 | 2535 | 730 | 3051 | 588 | 3430 | 454 | 3959 | 195 | 4403 | -10 | 4395 |
| 6-#7 | 1.25 | MA | 1118 | 615 | 1543 | 538 | 1893 | 451 | 2095 | 382 | 2323 | 275 | 2776 | 228 | 1428 |
| 2L-3S | | MI | 902 | 615 | 1261 | 533 | 1517 | 446 | 1649 | 377 | 1766 | 272 | 2040 | 171 | 1252 |
| 6-#7 | 1.25 | MA | 1026 | 615 | 1395 | 542 | 1706 | 454 | 1869 | 384 | 2019 | 278 | 2381 | 184 | 1431 |
| 3L-2S | | MI | 980 | 615 | 1387 | 529 | 1676 | 443 | 1841 | 375 | 2024 | 270 | 2360 | 215 | 1248 |
| 6-#8 | 1.65 | MA | 1173 | 649 | 1686 | 557 | 2067 | 465 | 2302 | 390 | 2599 | 273 | 3118 | 219 | 1833 |
| 2L-3S | | MI | 927 | 649 | 1345 | 552 | 1616 | 460 | 1766 | 385 | 1920 | 270 | 2219 | 145 | 1593 |
| 6-#8 | 1.65 | MA | 1057 | 649 | 1493 | 562 | 1823 | 469 | 2008 | 393 | 2202 | 277 | 2608 | 161 | 1828 |
| 3L-2S | | MI | 1024 | 649 | 1508 | 548 | 1823 | 457 | 2016 | 384 | 2257 | 267 | 2632 | 203 | 1594 |
| 6-#9 | 2.08 | MA | 1230 | 686 | 1840 | 578 | 2256 | 480 | 2528 | 400 | 2900 | 270 | 3483 | 208 | 2271 |
| 2L-3S | | MI | 955 | 686 | 1435 | 574 | 1724 | 476 | 1893 | 394 | 2088 | 267 | 2410 | 116 | 1954 |
| 6-#9 | 2.08 | MA | 1091 | 686 | 1599 | 585 | 1951 | 485 | 2158 | 403 | 2402 | 275 | 2850 | 135 | 2252 |
| 3L-2S | | MI | 1069 | 686 | 1639 | 569 | 1983 | 472 | 2206 | 393 | 2510 | 265 | 2920 | 189 | 1966 |
| 6-#10 | 2.65 | MA | 1298 | 733 | 2035 | 606 | 2495 | 500 | 2813 | 412 | 3280 | 267 | 3938 | 194 | 2822 |
| 2L-3S | | MI | 988 | 733 | 1547 | 602 | 1859 | 496 | 2052 | 407 | 2297 | 263 | 2646 | 76 | 2398 |
| 6-#10 | 2.65 | MA | 1135 | 733 | 1732 | 614 | 2111 | 506 | 2349 | 416 | 2656 | 273 | 3152 | 100 | 2776 |
| 3L-2S | | MI | 1124 | 733 | 1803 | 596 | 2183 | 492 | 2445 | 405 | 2824 | 261 | 3276 | 170 | 2431 |
| 6-#11 | 3.25 | MA | 1351 | 785 | 2233 | 632 | 2726 | 519 | 3083 | 423 | 3635 | 262 | 4286 | 165 | 3353 |
| 2L-3S | | MI | 1011 | 785 | 1664 | 628 | 1988 | 513 | 2200 | 415 | 2460 | 250 | 2806 | 19 | 2765 |
| 6-#11 | 3.25 | MA | 1167 | 785 | 1872 | 640 | 2269 | 524 | 2530 | 426 | 2890 | 266 | 3379 | 51 | 3261 |
| 3L-2S | | MI | 1165 | 785 | 1968 | 622 | 2373 | 510 | 2665 | 415 | 3070 | 247 | 3523 | 134 | 2873 |
| 6-#14 | 4.69 | MA | 1500 | 907 | 2694 | 704 | 3295 | 571 | 3764 | 455 | 4530 | 252 | 5296 | 115 | 4659 |
| 2L-3S | | MI | 1086 | 907 | 1925 | 700 | 2305 | 564 | 2576 | 445 | 2920 | 232 | 3313 | -96 | 3249 |
| 6-#14 | 4.69 | MA | 1265 | 907 | 2185 | 714 | 2651 | 577 | 2985 | 458 | 3486 | 257 | 4050 | -50 | 3996 |
| 3L-2S | | MI | 1285 | 907 | 2352 | 693 | 2845 | 562 | 3229 | 447 | 3763 | 227 | 4287 | 69 | 3960 |

## RECTANGULAR TIED COLUMNS 16" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#7 | 1.67 | MA | 1180 | 650 | 1690 | 560 | 2079 | 467 | 2321 | 392 | 2627 | 274 | 3172 | 222 | 1864 |
| 2L-4S | | MI | 910 | 650 | 1297 | 558 | 1559 | 465 | 1692 | 391 | 1821 | 270 | 2129 | 141 | 1608 |
| 8-#7 | 1.67 | MA | 1093 | 650 | 1543 | 564 | 1893 | 470 | 2095 | 395 | 2323 | 277 | 2776 | 178 | 1861 |
| 3E | | MI | 957 | 650 | 1387 | 555 | 1676 | 462 | 1841 | 387 | 2024 | 271 | 2360 | 163 | 1621 |
| 8-#7 | 1.67 | MA | 1039 | 650 | 1438 | 568 | 1756 | 474 | 1921 | 400 | 2085 | 278 | 2494 | 154 | 1842 |
| 4L-2S | | MI | 1031 | 650 | 1512 | 551 | 1835 | 460 | 2033 | 386 | 2283 | 269 | 2681 | 207 | 1620 |
| 8-#8 | 2.19 | MA | 1251 | 695 | 1878 | 586 | 2311 | 486 | 2597 | 404 | 2996 | 271 | 3629 | 211 | 2398 |
| 2L-4S | | MI | 941 | 695 | 1391 | 586 | 1670 | 484 | 1821 | 404 | 1992 | 267 | 2333 | 105 | 1965 |
| 8-#8 | 2.19 | MA | 1142 | 695 | 1686 | 591 | 2067 | 490 | 2302 | 407 | 2599 | 275 | 3118 | 153 | 2384 |
| 3E | | MI | 998 | 695 | 1508 | 581 | 1823 | 481 | 2016 | 399 | 2257 | 268 | 2632 | 133 | 2066 |
| 8-#8 | 2.19 | MA | 1075 | 695 | 1549 | 597 | 1889 | 494 | 2075 | 413 | 2289 | 276 | 2753 | 122 | 2267 |
| 4L-2S | | MI | 1088 | 695 | 1672 | 577 | 2030 | 478 | 2266 | 397 | 2594 | 266 | 3045 | 191 | 2075 |
| 8-#9 | 2.78 | MA | 1323 | 745 | 2082 | 615 | 2561 | 507 | 2897 | 417 | 3397 | 268 | 4116 | 197 | 2975 |
| 2L-4S | | MI | 972 | 745 | 1492 | 616 | 1783 | 511 | 1961 | 418 | 2177 | 263 | 2549 | 65 | 2332 |
| 8-#9 | 2.78 | MA | 1197 | 745 | 1840 | 621 | 2256 | 512 | 2528 | 420 | 2900 | 273 | 3483 | 123 | 2945 |
| 3E | | MI | 1039 | 745 | 1639 | 611 | 1983 | 503 | 2206 | 412 | 2510 | 265 | 2920 | 99 | 2541 |
| 8-#9 | 2.78 | MA | 1118 | 745 | 1668 | 628 | 2032 | 517 | 2242 | 428 | 2510 | 273 | 3029 | 86 | 2700 |
| 4L-2S | | MI | 1146 | 745 | 1844 | 606 | 2241 | 499 | 2519 | 410 | 2931 | 263 | 3430 | 173 | 2564 |
| 8-#10 | 3.53 | MA | 1411 | 808 | 2338 | 652 | 2879 | 534 | 3277 | 434 | 3905 | 264 | 4724 | 178 | 3703 |
| 2L-4S | | MI | 1012 | 808 | 1618 | 655 | 1932 | 540 | 2138 | 436 | 2408 | 258 | 2817 | 11 | 2781 |
| 8-#10 | 3.53 | MA | 1262 | 808 | 2035 | 660 | 2495 | 540 | 2813 | 438 | 3280 | 270 | 3938 | 84 | 3643 |
| 3E | | MI | 1092 | 808 | 1803 | 649 | 2183 | 530 | 2445 | 429 | 2824 | 260 | 3276 | 54 | 3129 |
| 8-#10 | 3.53 | MA | 1170 | 808 | 1818 | 668 | 2213 | 546 | 2454 | 447 | 2790 | 270 | 3372 | 37 | 3234 |
| 4L-2S | | MI | 1217 | 808 | 2060 | 643 | 2508 | 526 | 2837 | 427 | 3351 | 258 | 3906 | 147 | 3177 |
| 8-#11 | 4.33 | MA | 1314 | 876 | 2233 | 698 | 2726 | 566 | 3083 | 453 | 3635 | 263 | 4286 | 26 | 4217 |
| 3E | | MI | 1131 | 876 | 1968 | 685 | 2373 | 555 | 2665 | 442 | 3070 | 244 | 3523 | -14 | 3510 |
| 8-#11 | 4.33 | MA | 1209 | 876 | 1973 | 706 | 2374 | 579 | 2652 | 463 | 3048 | 260 | 3629 | -28 | 3608 |
| 4L-2S | | MI | 1272 | 876 | 2272 | 679 | 2757 | 552 | 3130 | 442 | 3680 | 240 | 4239 | 101 | 3754 |
| 8-#14 | 6.25 | MA | 1468 | 1039 | 2694 | 797 | 3295 | 638 | 3764 | 497 | 4530 | 251 | 5296 | -91 | 5168 |
| 3E | | MI | 1252 | 1039 | 2352 | 783 | 2845 | 625 | 3229 | 484 | 3763 | 220 | 4287 | -150 | 4156 |
| 10-#10 | 4.41 | MA | 1384 | 883 | 2338 | 707 | 2879 | 575 | 3277 | 460 | 3905 | 267 | 4724 | 68 | 4511 |
| 3L-4S | | MI | 1121 | 883 | 1875 | 702 | 2257 | 574 | 2530 | 458 | 2934 | 254 | 3447 | -11 | 3438 |
| 10-#10 | 4.41 | MA | 1303 | 883 | 2122 | 715 | 2597 | 580 | 2917 | 469 | 3415 | 267 | 4159 | 21 | 4076 |
| 4L-3S | | MI | 1192 | 883 | 2060 | 696 | 2508 | 565 | 2837 | 450 | 3351 | 257 | 3906 | 32 | 3823 |
| 10-#10 | 4.41 | MA | 1222 | 883 | 1927 | 723 | 2322 | 592 | 2593 | 473 | 2967 | 272 | 3603 | -35 | 3578 |
| 5L-2S | | MI | 1308 | 883 | 2317 | 690 | 2832 | 561 | 3230 | 449 | 3878 | 254 | 4537 | 125 | 3920 |
| 10-#11 | 5.42 | MA | 1364 | 968 | 2335 | 763 | 2831 | 621 | 3205 | 489 | 3792 | 257 | 4535 | -53 | 4472 |
| 4L-3S | | MI | 1247 | 968 | 2272 | 742 | 2757 | 597 | 3130 | 469 | 3680 | 238 | 4239 | -47 | 4187 |
| 12-#10 | 5.29 | MA | 1430 | 958 | 2425 | 762 | 2980 | 615 | 3381 | 491 | 4040 | 264 | 4945 | 5 | 4923 |
| 4E | | MI | 1226 | 958 | 2131 | 749 | 2581 | 608 | 2923 | 480 | 3461 | 251 | 4077 | -33 | 4041 |
| 12-#10 | 5.29 | MA | 1352 | 958 | 2230 | 769 | 2706 | 626 | 3057 | 495 | 3592 | 269 | 4389 | -51 | 4334 |
| 5L-3S | | MI | 1290 | 958 | 2317 | 743 | 2832 | 599 | 3230 | 472 | 3878 | 254 | 4537 | 9 | 4510 |

## RECTANGULAR TIED COLUMNS 16" x 20"

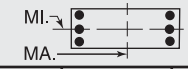
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.25 | MA | 1389 | 683 | 1895 | 601 | 2340 | 504 | 2598 | 427 | 2890 | 308 | 3489 | 259 | 1776 |
| 2E | | MI | 1081 | 683 | 1549 | 583 | 1858 | 489 | 2033 | 413 | 2227 | 297 | 2564 | 232 | 1376 |
| 4-#10 | 1.59 | MA | 1448 | 715 | 2049 | 619 | 2526 | 517 | 2819 | 435 | 3184 | 306 | 3857 | 251 | 2208 |
| 2E | | MI | 1120 | 715 | 1662 | 600 | 1993 | 501 | 2193 | 421 | 2436 | 294 | 2800 | 218 | 1695 |
| 4-#11 | 1.95 | MA | 1496 | 749 | 2215 | 635 | 2713 | 528 | 3034 | 440 | 3463 | 301 | 4153 | 234 | 2637 |
| 2E | | MI | 1148 | 749 | 1781 | 614 | 2124 | 510 | 2341 | 425 | 2597 | 283 | 2959 | 193 | 2006 |
| 4-#14 | 2.81 | MA | 1622 | 831 | 2581 | 681 | 3161 | 561 | 3567 | 461 | 4175 | 295 | 4990 | 207 | 3670 |
| 2E | | MI | 1230 | 831 | 2044 | 660 | 2442 | 543 | 2718 | 445 | 3057 | 268 | 3464 | 149 | 2751 |
| 4-#18 | 5.00 | MA | 1903 | 1037 | 3457 | 801 | 4238 | 649 | 4855 | 515 | 5885 | 281 | 6901 | 123 | 6140 |
| 2E | | MI | 1411 | 1037 | 2657 | 778 | 3189 | 629 | 3571 | 490 | 4096 | 223 | 4553 | 15 | 4485 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis

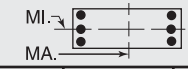



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#7 | 1.13 | MA | 1372 | 672 | 1829 | 598 | 2271 | 502 | 2522 | 426 | 2795 | 311 | 3393 | 265 | 1623 |
| 2L-3S | | MI | 993 | 672 | 1374 | 584 | 1650 | 490 | 1789 | 415 | 1904 | 303 | 2195 | 198 | 1267 |
| 6-#7 | 1.13 | MA | 1264 | 672 | 1659 | 603 | 2056 | 506 | 2263 | 430 | 2446 | 315 | 2923 | 221 | 1625 |
| 3L-2S | | MI | 1071 | 672 | 1499 | 580 | 1809 | 487 | 1981 | 414 | 2163 | 300 | 2516 | 242 | 1261 |
| 6-#8 | 1.48 | MA | 1438 | 705 | 1994 | 617 | 2473 | 516 | 2762 | 435 | 3115 | 308 | 3805 | 259 | 2089 |
| 2L-3S | | MI | 1017 | 705 | 1458 | 603 | 1750 | 504 | 1906 | 423 | 2059 | 300 | 2374 | 172 | 1612 |
| 6-#8 | 1.48 | MA | 1302 | 705 | 1773 | 623 | 2192 | 521 | 2423 | 439 | 2658 | 314 | 3196 | 201 | 2084 |
| 3L-2S | | MI | 1116 | 705 | 1621 | 599 | 1957 | 501 | 2157 | 422 | 2396 | 298 | 2787 | 230 | 1609 |
| 6-#9 | 1.88 | MA | 1506 | 742 | 2173 | 638 | 2692 | 531 | 3023 | 444 | 3463 | 306 | 4247 | 251 | 2595 |
| 2L-3S | | MI | 1045 | 742 | 1549 | 625 | 1858 | 519 | 2033 | 432 | 2227 | 297 | 2564 | 142 | 1977 |
| 6-#9 | 1.88 | MA | 1342 | 742 | 1895 | 646 | 2340 | 537 | 2598 | 449 | 2890 | 312 | 3489 | 177 | 2576 |
| 3L-2S | | MI | 1162 | 742 | 1753 | 620 | 2117 | 516 | 2346 | 431 | 2648 | 295 | 3074 | 216 | 1983 |
| 6-#10 | 2.38 | MA | 1590 | 790 | 2399 | 666 | 2969 | 551 | 3355 | 457 | 3905 | 303 | 4802 | 240 | 3233 |
| 2L-3S | | MI | 1078 | 790 | 1662 | 653 | 1993 | 539 | 2193 | 444 | 2436 | 293 | 2800 | 103 | 2428 |
| 6-#10 | 2.38 | MA | 1393 | 790 | 2049 | 675 | 2526 | 559 | 2819 | 462 | 3184 | 310 | 3857 | 146 | 3188 |
| 3L-2S | | MI | 1218 | 790 | 1918 | 647 | 2318 | 535 | 2586 | 443 | 2962 | 291 | 3430 | 196 | 2451 |
| 6-#11 | 2.92 | MA | 1657 | 841 | 2633 | 692 | 3243 | 570 | 3674 | 467 | 4326 | 297 | 5252 | 216 | 3859 |
| 2L-3S | | MI | 1100 | 841 | 1781 | 678 | 2124 | 555 | 2341 | 452 | 2597 | 280 | 2959 | 45 | 2851 |
| 6-#11 | 2.92 | MA | 1439 | 841 | 2215 | 702 | 2713 | 578 | 3034 | 473 | 3463 | 305 | 4153 | 102 | 3779 |
| 3L-2S | | MI | 1259 | 841 | 2085 | 672 | 2508 | 553 | 2806 | 452 | 3208 | 276 | 3675 | 160 | 2898 |
| 6-#14 | 4.22 | MA | 1838 | 963 | 3174 | 764 | 3910 | 622 | 4473 | 500 | 5394 | 290 | 6513 | 177 | 5388 |
| 2L-3S | | MI | 1175 | 963 | 2044 | 749 | 2442 | 606 | 2718 | 482 | 3057 | 261 | 3464 | -70 | 3419 |
| 6-#14 | 4.22 | MA | 1558 | 963 | 2581 | 777 | 3161 | 632 | 3567 | 506 | 4175 | 299 | 4990 | 12 | 4961 |
| 3L-2S | | MI | 1379 | 963 | 2471 | 743 | 2981 | 604 | 3370 | 484 | 3900 | 256 | 4439 | 95 | 3990 |
| 6-#18 | 7.50 | MA | 1851 | 1272 | 3457 | 968 | 4238 | 769 | 4855 | 589 | 5885 | 280 | 6901 | -240 | 6572 |
| 3L-2S | | MI | 1652 | 1272 | 3374 | 925 | 4096 | 737 | 4650 | 556 | 5462 | 192 | 6082 | -103 | 5971 |
| 8-#7 | 1.50 | MA | 1446 | 707 | 1999 | 620 | 2486 | 518 | 2782 | 437 | 3145 | 309 | 3863 | 261 | 2123 |
| 2L-4S | | MI | 1001 | 707 | 1409 | 609 | 1692 | 508 | 1832 | 430 | 1959 | 301 | 2284 | 168 | 1631 |
| 8-#7 | 1.50 | MA | 1343 | 707 | 1829 | 625 | 2271 | 522 | 2522 | 440 | 2795 | 314 | 3393 | 217 | 2120 |
| 3E | | MI | 1048 | 707 | 1499 | 606 | 1809 | 506 | 1981 | 425 | 2163 | 301 | 2516 | 189 | 1638 |
| 8-#7 | 1.50 | MA | 1280 | 707 | 1710 | 629 | 2115 | 526 | 2324 | 446 | 2524 | 315 | 3059 | 193 | 2101 |
| 4L-2S | | MI | 1123 | 707 | 1625 | 603 | 1968 | 504 | 2173 | 424 | 2421 | 299 | 2836 | 233 | 1635 |
| 8-#8 | 1.98 | MA | 1531 | 752 | 2216 | 646 | 2753 | 537 | 3101 | 449 | 3571 | 307 | 4414 | 253 | 2739 |
| 2L-4S | | MI | 1028 | 752 | 1504 | 637 | 1804 | 528 | 1962 | 442 | 2130 | 297 | 2488 | 132 | 2020 |
| 8-#8 | 1.98 | MA | 1402 | 752 | 1994 | 652 | 2473 | 542 | 2762 | 453 | 3115 | 312 | 3805 | 195 | 2726 |
| 3E | | MI | 1089 | 752 | 1621 | 632 | 1957 | 525 | 2157 | 437 | 2396 | 298 | 2787 | 160 | 2087 |
| 8-#8 | 1.98 | MA | 1325 | 752 | 1838 | 658 | 2269 | 547 | 2502 | 460 | 2760 | 314 | 3372 | 163 | 2637 |
| 4L-2S | | MI | 1181 | 752 | 1785 | 628 | 2164 | 522 | 2407 | 435 | 2733 | 296 | 3199 | 218 | 2092 |
| 8-#9 | 2.50 | MA | 1619 | 801 | 2452 | 675 | 3044 | 558 | 3449 | 462 | 4036 | 304 | 5005 | 243 | 3407 |
| 2L-4S | | MI | 1061 | 801 | 1606 | 667 | 1917 | 554 | 2102 | 456 | 2315 | 293 | 2704 | 91 | 2392 |
| 8-#9 | 2.50 | MA | 1466 | 801 | 2173 | 682 | 2692 | 564 | 3023 | 466 | 3463 | 310 | 4247 | 170 | 3377 |
| 3E | | MI | 1130 | 801 | 1753 | 662 | 2117 | 546 | 2346 | 450 | 2648 | 295 | 3074 | 126 | 2566 |
| 8-#9 | 2.50 | MA | 1373 | 801 | 1977 | 690 | 2436 | 571 | 2697 | 476 | 3017 | 312 | 3708 | 129 | 3144 |
| 4L-2S | | MI | 1240 | 801 | 1958 | 657 | 2375 | 543 | 2659 | 448 | 3070 | 293 | 3584 | 199 | 2583 |
| 8-#10 | 3.17 | MA | 1725 | 865 | 2749 | 713 | 3412 | 586 | 3890 | 479 | 4626 | 300 | 5746 | 229 | 4252 |
| 2L-4S | | MI | 1100 | 865 | 1733 | 706 | 2067 | 583 | 2279 | 473 | 2546 | 288 | 2971 | 38 | 2848 |
| 8-#10 | 3.17 | MA | 1549 | 865 | 2399 | 722 | 2969 | 593 | 3355 | 484 | 3905 | 308 | 4802 | 135 | 4192 |
| 3E | | MI | 1182 | 865 | 1918 | 700 | 2318 | 573 | 2586 | 466 | 2962 | 290 | 3430 | 80 | 3160 |
| 8-#10 | 3.17 | MA | 1434 | 865 | 2152 | 731 | 2646 | 601 | 2943 | 496 | 3343 | 310 | 4128 | 85 | 3770 |
| 4L-2S | | MI | 1312 | 865 | 2175 | 694 | 2642 | 570 | 2978 | 465 | 3489 | 288 | 4060 | 174 | 3199 |
| 8-#11 | 3.90 | MA | 1614 | 933 | 2633 | 760 | 3243 | 620 | 3674 | 500 | 4326 | 301 | 5252 | 84 | 4976 |
| 3E | | MI | 1221 | 933 | 2085 | 735 | 2508 | 598 | 2806 | 479 | 3208 | 273 | 3675 | 12 | 3646 |
| 8-#11 | 3.90 | MA | 1491 | 933 | 2335 | 770 | 2855 | 628 | 3179 | 512 | 3650 | 302 | 4464 | 25 | 4362 |
| 4L-2S | | MI | 1366 | 933 | 2389 | 729 | 2893 | 595 | 3271 | 479 | 3818 | 270 | 4392 | 127 | 3780 |
| 8-#14 | 5.63 | MA | 1799 | 1096 | 3174 | 860 | 3910 | 693 | 4473 | 545 | 5394 | 294 | 6513 | -18 | 6477 |
| 3E | | MI | 1340 | 1096 | 2471 | 832 | 2981 | 667 | 3370 | 521 | 3900 | 249 | 4439 | -124 | 4334 |
| 8-#14 | 5.63 | MA | 1643 | 1096 | 2750 | 873 | 3359 | 703 | 3771 | 561 | 4436 | 293 | 5415 | -100 | 5297 |
| 4L-2S | | MI | 1525 | 1096 | 2897 | 825 | 3521 | 665 | 4023 | 523 | 4742 | 244 | 5413 | 41 | 5220 |

## RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 10-#10 | 3.97 | MA | 1693 | 940 | 2749 | 768 | 3412 | 627 | 3890 | 506 | 4626 | 305 | 5746 | 124 | 5197 |
| 3L-4S | | MI | 1209 | 940 | 1990 | 753 | 2391 | 617 | 2671 | 495 | 3073 | 284 | 3601 | 15 | 3549 |
| 10-#10 | 3.97 | MA | 1598 | 940 | 2502 | 778 | 3089 | 635 | 3478 | 518 | 4064 | 307 | 5073 | 74 | 4747 |
| 4L-3S | | MI | 1283 | 940 | 2175 | 747 | 2642 | 608 | 2978 | 488 | 3489 | 287 | 4060 | 58 | 3893 |
| 10-#10 | 3.97 | MA | 1497 | 940 | 2280 | 787 | 2775 | 648 | 3108 | 523 | 3553 | 315 | 4405 | 18 | 4351 |
| 5L-2S | | MI | 1403 | 940 | 2431 | 740 | 2967 | 604 | 3371 | 487 | 4016 | 284 | 4691 | 151 | 3943 |
| 10-#11 | 4.88 | MA | 1675 | 1025 | 2754 | 827 | 3384 | 670 | 3820 | 539 | 4513 | 299 | 5563 | 7 | 5532 |
| 4L-3S | | MI | 1337 | 1025 | 2389 | 792 | 2893 | 640 | 3271 | 506 | 3818 | 267 | 4392 | -21 | 4370 |
| 10-#14 | 7.03 | MA | 1900 | 1228 | 3342 | 956 | 4108 | 763 | 4677 | 600 | 5656 | 288 | 6937 | -131 | 6702 |
| 4L-3S | | MI | 1501 | 1228 | 2897 | 915 | 3521 | 728 | 4023 | 559 | 4742 | 237 | 5413 | -178 | 5231 |
| 12-#10 | 4.76 | MA | 1749 | 1014 | 2852 | 824 | 3532 | 669 | 4014 | 539 | 4785 | 304 | 6017 | 63 | 5730 |
| 4E | | MI | 1315 | 1014 | 2246 | 799 | 2716 | 652 | 3064 | 517 | 3599 | 281 | 4231 | -7 | 4224 |
| 12-#10 | 4.76 | MA | 1650 | 1014 | 2630 | 834 | 3218 | 682 | 3643 | 545 | 4274 | 312 | 5350 | 7 | 5326 |
| 5L-3S | | MI | 1381 | 1014 | 2431 | 793 | 2967 | 642 | 3371 | 510 | 4016 | 284 | 4691 | 36 | 4589 |
| 14-#10 | 5.56 | MA | 1797 | 1089 | 2979 | 880 | 3661 | 717 | 4179 | 567 | 4994 | 309 | 6294 | -4 | 6287 |
| 5L-4S | | MI | 1417 | 1089 | 2503 | 846 | 3040 | 686 | 3456 | 539 | 4126 | 278 | 4862 | -30 | 4824 |

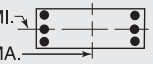
## RECTANGULAR TIED COLUMNS 16" x 22"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#9 | 1.14 | MA | 1670 | 740 | 2209 | 662 | 2757 | 556 | 3070 | 472 | 3413 | 344 | 4173 | 296 | 1992 |
| 2E | | MI | 1173 | 740 | 1663 | 634 | 1992 | 532 | 2174 | 451 | 2365 | 327 | 2719 | 258 | 1390 |
| 4-#10 | 1.44 | MA | 1739 | 772 | 2385 | 679 | 2970 | 568 | 3322 | 480 | 3748 | 341 | 4608 | 290 | 2483 |
| 2E | | MI | 1212 | 772 | 1777 | 651 | 2128 | 544 | 2334 | 458 | 2574 | 324 | 2954 | 245 | 1712 |
| 4-#11 | 1.77 | MA | 1798 | 806 | 2576 | 695 | 3186 | 579 | 3571 | 485 | 4071 | 336 | 4974 | 276 | 2974 |
| 2E | | MI | 1240 | 806 | 1899 | 664 | 2259 | 553 | 2482 | 463 | 2735 | 312 | 3111 | 219 | 2027 |
| 4-#14 | 2.56 | MA | 1950 | 887 | 2996 | 741 | 3700 | 613 | 4183 | 506 | 4887 | 331 | 5979 | 255 | 4156 |
| 2E | | MI | 1323 | 887 | 2163 | 709 | 2578 | 585 | 2859 | 482 | 3194 | 298 | 3616 | 174 | 2777 |
| 4-#18 | 4.55 | MA | 2285 | 1093 | 4007 | 862 | 4943 | 700 | 5669 | 560 | 6872 | 318 | 8313 | 188 | 7004 |
| 2E | | MI | 1504 | 1093 | 2779 | 826 | 3326 | 670 | 3713 | 526 | 4232 | 252 | 4702 | 40 | 4520 |
| 6-#7 | 1.02 | MA | 1649 | 728 | 2133 | 658 | 2678 | 553 | 2983 | 471 | 3303 | 346 | 4053 | 301 | 1817 |
| 2L-3S | | MI | 1083 | 728 | 1486 | 635 | 1784 | 534 | 1930 | 453 | 2043 | 333 | 2350 | 224 | 1281 |
| 6-#7 | 1.02 | MA | 1525 | 728 | 1941 | 663 | 2435 | 558 | 2689 | 475 | 2908 | 351 | 3507 | 257 | 1820 |
| 3L-2S | | MI | 1163 | 728 | 1611 | 632 | 1942 | 531 | 2122 | 452 | 2302 | 331 | 2671 | 268 | 1274 |
| 6-#8 | 1.35 | MA | 1726 | 762 | 2321 | 677 | 2906 | 567 | 3255 | 480 | 3666 | 344 | 4536 | 297 | 2345 |
| 2L-3S | | MI | 1108 | 762 | 1571 | 655 | 1884 | 547 | 2047 | 461 | 2198 | 330 | 2529 | 198 | 1629 |
| 6-#8 | 1.35 | MA | 1570 | 762 | 2070 | 684 | 2589 | 573 | 2872 | 484 | 3150 | 350 | 3828 | 239 | 2340 |
| 3L-2S | | MI | 1208 | 762 | 1735 | 650 | 2091 | 544 | 2297 | 460 | 2534 | 328 | 2942 | 256 | 1624 |
| 6-#9 | 1.70 | MA | 1807 | 799 | 2524 | 698 | 3156 | 583 | 3552 | 489 | 4062 | 341 | 5057 | 291 | 2919 |
| 2L-3S | | MI | 1134 | 799 | 1663 | 676 | 1992 | 563 | 2174 | 470 | 2365 | 328 | 2719 | 169 | 1999 |
| 6-#9 | 1.70 | MA | 1618 | 799 | 2209 | 707 | 2757 | 590 | 3070 | 495 | 3413 | 349 | 4173 | 217 | 2900 |
| 3L-2S | | MI | 1255 | 799 | 1867 | 671 | 2251 | 559 | 2487 | 469 | 2787 | 325 | 3229 | 242 | 2000 |
| 6-#10 | 2.16 | MA | 1906 | 847 | 2781 | 726 | 3471 | 603 | 3929 | 501 | 4566 | 338 | 5712 | 283 | 3644 |
| 2L-3S | | MI | 1168 | 847 | 1777 | 704 | 2128 | 582 | 2334 | 482 | 2574 | 323 | 2954 | 129 | 2455 |
| 6-#10 | 2.16 | MA | 1678 | 847 | 2385 | 736 | 2970 | 611 | 3322 | 509 | 3748 | 348 | 4608 | 189 | 3599 |
| 3L-2S | | MI | 1311 | 847 | 2033 | 698 | 2452 | 579 | 2727 | 480 | 3101 | 321 | 3584 | 222 | 2471 |
| 6-#11 | 2.66 | MA | 1990 | 898 | 3052 | 752 | 3788 | 621 | 4299 | 512 | 5052 | 333 | 6267 | 264 | 4364 |
| 2L-3S | | MI | 1190 | 898 | 1899 | 728 | 2259 | 598 | 2482 | 489 | 2735 | 309 | 3111 | 71 | 2886 |
| 6-#11 | 2.66 | MA | 1728 | 898 | 2576 | 764 | 3186 | 631 | 3571 | 519 | 4071 | 343 | 4974 | 149 | 4285 |
| 3L-2S | | MI | 1352 | 898 | 2203 | 722 | 2644 | 595 | 2947 | 489 | 3345 | 306 | 3828 | 186 | 2922 |
| 6-#14 | 3.84 | MA | 2204 | 1020 | 3671 | 824 | 4553 | 674 | 5216 | 545 | 6278 | 326 | 7781 | 233 | 6117 |
| 2L-3S | | MI | 1263 | 1020 | 2163 | 799 | 2578 | 648 | 2859 | 518 | 3194 | 291 | 3616 | -45 | 3588 |
| 6-#14 | 3.84 | MA | 1875 | 1020 | 2996 | 840 | 3700 | 686 | 4183 | 554 | 4887 | 338 | 5979 | 68 | 5798 |
| 3L-2S | | MI | 1472 | 1020 | 2590 | 792 | 3117 | 646 | 3512 | 521 | 4037 | 286 | 4590 | 121 | 4018 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis



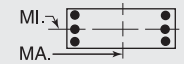

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 6.82 | MA | 2222 | 1329 | 4007 | 1033 | 4943 | 826 | 5669 | 640 | 6872 | 325 | 8313 | -160 | 8021 |
| 3L-2S | | MI | 1745 | 1329 | 3496 | 973 | 4233 | 778 | 4791 | 592 | 5598 | 220 | 6231 | -78 | 6154 |
| 8-#7 | 1.36 | MA | 1736 | 764 | 2325 | 680 | 2920 | 570 | 3276 | 481 | 3698 | 345 | 4599 | 299 | 2382 |
| 2L-4S | | MI | 1091 | 764 | 1521 | 661 | 1825 | 552 | 1973 | 468 | 2098 | 331 | 2439 | 194 | 1651 |
| 8-#7 | 1.36 | MA | 1617 | 764 | 2133 | 685 | 2678 | 574 | 2983 | 485 | 3303 | 350 | 4053 | 255 | 2380 |
| 3E | | MI | 1138 | 764 | 1611 | 657 | 1942 | 550 | 2122 | 464 | 2302 | 332 | 2671 | 216 | 1654 |
| 8-#7 | 1.36 | MA | 1545 | 764 | 1999 | 690 | 2503 | 579 | 2759 | 492 | 2998 | 352 | 3668 | 229 | 2360 |
| 4L-2S | | MI | 1215 | 764 | 1737 | 654 | 2101 | 547 | 2314 | 462 | 2560 | 329 | 2992 | 260 | 1650 |
| 8-#8 | 1.80 | MA | 1835 | 808 | 2571 | 706 | 3223 | 589 | 3639 | 493 | 4182 | 342 | 5245 | 294 | 3081 |
| 2L-4S | | MI | 1118 | 808 | 1617 | 688 | 1938 | 572 | 2102 | 480 | 2269 | 328 | 2643 | 159 | 2073 |
| 8-#8 | 1.80 | MA | 1686 | 808 | 2321 | 713 | 2906 | 594 | 3255 | 498 | 3666 | 349 | 4536 | 236 | 3067 |
| 3E | | MI | 1178 | 808 | 1735 | 684 | 2091 | 569 | 2297 | 475 | 2534 | 329 | 2942 | 186 | 2107 |
| 8-#8 | 1.80 | MA | 1598 | 808 | 2145 | 720 | 2678 | 600 | 2963 | 506 | 3267 | 352 | 4036 | 202 | 3012 |
| 4L-2S | | MI | 1273 | 808 | 1898 | 679 | 2297 | 566 | 2547 | 473 | 2871 | 326 | 3354 | 244 | 2109 |
| 8-#9 | 2.27 | MA | 1939 | 858 | 2839 | 735 | 3554 | 610 | 4034 | 506 | 4711 | 339 | 5940 | 286 | 3839 |
| 2L-4S | | MI | 1151 | 858 | 1720 | 718 | 2051 | 597 | 2243 | 494 | 2454 | 324 | 2858 | 118 | 2451 |
| 8-#9 | 2.27 | MA | 1761 | 858 | 2524 | 743 | 3156 | 617 | 3552 | 512 | 4062 | 347 | 5057 | 213 | 3809 |
| 3E | | MI | 1221 | 858 | 1867 | 713 | 2251 | 590 | 2487 | 488 | 2787 | 325 | 3229 | 152 | 2590 |
| 8-#9 | 2.27 | MA | 1654 | 858 | 2304 | 752 | 2868 | 624 | 3184 | 522 | 3560 | 350 | 4432 | 170 | 3599 |
| 4L-2S | | MI | 1333 | 858 | 2072 | 708 | 2510 | 586 | 2800 | 486 | 3208 | 323 | 3739 | 226 | 2602 |
| 8-#10 | 2.89 | MA | 2066 | 921 | 3178 | 773 | 3973 | 637 | 4536 | 523 | 5383 | 335 | 6815 | 275 | 4800 |
| 2L-4S | | MI | 1189 | 921 | 1848 | 757 | 2201 | 626 | 2420 | 511 | 2684 | 318 | 3125 | 64 | 2912 |
| 8-#10 | 2.89 | MA | 1854 | 921 | 2781 | 783 | 3471 | 646 | 3929 | 530 | 4566 | 345 | 5712 | 182 | 4740 |
| 3E | | MI | 1273 | 921 | 2033 | 751 | 2452 | 617 | 2727 | 504 | 3101 | 320 | 3584 | 107 | 3190 |
| 8-#10 | 2.89 | MA | 1727 | 921 | 2503 | 793 | 3108 | 654 | 3465 | 543 | 3932 | 349 | 4930 | 129 | 4320 |
| 4L-2S | | MI | 1405 | 921 | 2290 | 744 | 2777 | 613 | 3119 | 502 | 3627 | 318 | 4214 | 200 | 3220 |
| 8-#11 | 3.55 | MA | 1939 | 990 | 3052 | 821 | 3788 | 673 | 4299 | 546 | 5052 | 339 | 6267 | 136 | 5650 |
| 3E | | MI | 1311 | 990 | 2203 | 785 | 2644 | 640 | 2947 | 516 | 3345 | 303 | 3828 | 38 | 3735 |
| 8-#11 | 3.55 | MA | 1797 | 990 | 2716 | 833 | 3350 | 682 | 3740 | 561 | 4288 | 342 | 5346 | 74 | 5009 |
| 4L-2S | | MI | 1460 | 990 | 2507 | 779 | 3028 | 637 | 3412 | 516 | 3956 | 300 | 4544 | 153 | 3806 |
| 8-#14 | 5.11 | MA | 2156 | 1152 | 3671 | 922 | 4553 | 747 | 5216 | 593 | 6278 | 333 | 7781 | 46 | 7642 |
| 3E | | MI | 1429 | 1152 | 2590 | 882 | 3117 | 709 | 3512 | 557 | 4037 | 279 | 4590 | -98 | 4510 |
| 8-#14 | 5.11 | MA | 1977 | 1152 | 3192 | 938 | 3930 | 759 | 4420 | 612 | 5192 | 336 | 6493 | -42 | 6428 |
| 4L-2S | | MI | 1619 | 1152 | 3016 | 875 | 3657 | 707 | 4164 | 560 | 4880 | 274 | 5565 | 67 | 5251 |
| 10-#10 | 3.61 | MA | 2028 | 996 | 3178 | 830 | 3973 | 680 | 4536 | 552 | 5383 | 342 | 6815 | 175 | 5882 |
| 3L-4S | | MI | 1298 | 996 | 2105 | 803 | 2526 | 660 | 2812 | 533 | 3211 | 314 | 3755 | 42 | 3611 |
| 10-#10 | 3.61 | MA | 1918 | 996 | 2900 | 840 | 3610 | 689 | 4072 | 565 | 4749 | 346 | 6034 | 122 | 5432 |
| 4L-3S | | MI | 1374 | 996 | 2290 | 797 | 2777 | 651 | 3119 | 526 | 3627 | 317 | 4214 | 84 | 3923 |
| 10-#10 | 3.61 | MA | 1788 | 996 | 2650 | 850 | 3257 | 703 | 3656 | 572 | 4173 | 355 | 5254 | 67 | 5030 |
| 5L-2S | | MI | 1498 | 996 | 2546 | 791 | 3101 | 647 | 3511 | 524 | 4154 | 314 | 4845 | 178 | 3966 |
| 10-#11 | 4.43 | MA | 2011 | 1081 | 3192 | 890 | 3952 | 724 | 4468 | 588 | 5269 | 339 | 6640 | 61 | 6346 |
| 4L-3S | | MI | 1427 | 1081 | 2507 | 842 | 3028 | 682 | 3412 | 543 | 3956 | 297 | 4544 | 5 | 4531 |
| 10-#11 | 4.43 | MA | 1871 | 1081 | 2890 | 902 | 3526 | 741 | 3965 | 595 | 4574 | 349 | 5726 | -7 | 5718 |
| 5L-2S | | MI | 1566 | 1081 | 2810 | 836 | 3413 | 680 | 3877 | 543 | 4566 | 293 | 5261 | 120 | 4686 |
| 10-#14 | 6.39 | MA | 2275 | 1285 | 3867 | 1021 | 4783 | 820 | 5453 | 651 | 6582 | 331 | 8294 | -64 | 8144 |
| 4L-3S | | MI | 1590 | 1285 | 3016 | 964 | 3657 | 770 | 4164 | 596 | 4880 | 267 | 5565 | -152 | 5414 |
| 12-#10 | 4.33 | MA | 2092 | 1071 | 3296 | 887 | 4112 | 723 | 4679 | 587 | 5566 | 343 | 7137 | 115 | 6551 |
| 4E | | MI | 1404 | 1071 | 2361 | 850 | 2850 | 695 | 3205 | 555 | 3738 | 311 | 4385 | 19 | 4317 |
| 12-#10 | 4.33 | MA | 1973 | 1071 | 3047 | 897 | 3759 | 737 | 4263 | 594 | 4991 | 353 | 6358 | 60 | 6146 |
| 5L-3S | | MI | 1473 | 1071 | 2546 | 844 | 3101 | 685 | 3511 | 548 | 4154 | 314 | 4845 | 62 | 4657 |
| 12-#10 | 4.33 | MA | 1821 | 1071 | 2804 | 906 | 3439 | 746 | 3856 | 607 | 4428 | 356 | 5602 | -8 | 5592 |
| 6L-2S | | MI | 1589 | 1071 | 2803 | 838 | 3426 | 682 | 3904 | 546 | 4681 | 311 | 5475 | 155 | 4709 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

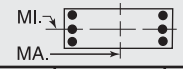
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 5.32 | MA | 2079 | 1173 | 3366 | 959 | 4128 | 783 | 4694 | 622 | 5555 | 345 | 7020 | -19 | 6987 |
| 5L-3S | | MI | 1541 | 1173 | 2810 | 900 | 3413 | 725 | 3877 | 570 | 4566 | 290 | 5261 | -28 | 5228 |
| 14-#10 | 5.05 | MA | 2143 | 1146 | 3444 | 944 | 4261 | 772 | 4870 | 616 | 5808 | 350 | 7461 | 53 | 7265 |
| 5L-4S | | MI | 1507 | 1146 | 2618 | 897 | 3175 | 729 | 3597 | 577 | 4264 | 308 | 5016 | -3 | 5012 |
| 14-#10 | 5.05 | MA | 2003 | 1146 | 3201 | 953 | 3941 | 780 | 4463 | 629 | 5246 | 354 | 6706 | -16 | 6677 |
| 6L-3S | | MI | 1569 | 1146 | 2803 | 891 | 3426 | 720 | 3904 | 570 | 4681 | 311 | 5475 | 40 | 5355 |
| 16-#10 | 5.77 | MA | 2178 | 1220 | 3598 | 999 | 4443 | 815 | 5070 | 651 | 6063 | 351 | 7810 | -23 | 7754 |
| 6L-4S | | MI | 1607 | 1220 | 2874 | 944 | 3499 | 763 | 3990 | 599 | 4791 | 305 | 5646 | -26 | 5609 |

## RECTANGULAR TIED COLUMNS 16" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.04 | MA | 1975 | 797 | 2542 | 722 | 3203 | 607 | 3575 | 516 | 3972 | 379 | 4888 | 330 | 2208 |
| 2E | | MI | 1264 | 797 | 1777 | 685 | 2126 | 576 | 2315 | 489 | 2503 | 357 | 2873 | 285 | 1405 |
| 4-#10 | 1.32 | MA | 2055 | 828 | 2738 | 739 | 3441 | 620 | 3858 | 524 | 4348 | 377 | 5403 | 327 | 2757 |
| 2E | | MI | 1304 | 828 | 1892 | 702 | 2262 | 587 | 2475 | 496 | 2712 | 354 | 3108 | 271 | 1729 |
| 4-#11 | 1.63 | MA | 2124 | 863 | 2955 | 755 | 3687 | 630 | 4141 | 530 | 4715 | 372 | 5839 | 316 | 3311 |
| 2E | | MI | 1332 | 863 | 2016 | 714 | 2395 | 596 | 2623 | 500 | 2872 | 342 | 3264 | 245 | 2047 |
| 4-#14 | 2.34 | MA | 2303 | 944 | 3429 | 801 | 4266 | 664 | 4831 | 551 | 5635 | 366 | 7015 | 299 | 4642 |
| 2E | | MI | 1415 | 944 | 2282 | 759 | 2714 | 627 | 3000 | 519 | 3332 | 327 | 3767 | 200 | 2802 |
| 4-#18 | 4.17 | MA | 2694 | 1150 | 4574 | 922 | 5676 | 751 | 6516 | 605 | 7885 | 354 | 9776 | 245 | 7868 |
| 2E | | MI | 1597 | 1150 | 2902 | 875 | 3464 | 711 | 3854 | 562 | 4368 | 280 | 4851 | 65 | 4554 |
| 6-#8 | 1.23 | MA | 2039 | 818 | 2665 | 737 | 3368 | 618 | 3781 | 524 | 4253 | 379 | 5280 | 330 | 2601 |
| 2L-3S | | MI | 1198 | 818 | 1684 | 706 | 2017 | 591 | 2188 | 499 | 2336 | 361 | 2684 | 225 | 1646 |
| 6-#8 | 1.23 | MA | 1861 | 818 | 2385 | 744 | 3014 | 625 | 3353 | 530 | 3676 | 387 | 4483 | 273 | 2596 |
| 3L-2S | | MI | 1300 | 818 | 1848 | 701 | 2224 | 588 | 2438 | 498 | 2673 | 358 | 3097 | 283 | 1639 |
| 6-#9 | 1.56 | MA | 2132 | 856 | 2893 | 758 | 3648 | 634 | 4114 | 534 | 4696 | 377 | 5892 | 327 | 3243 |
| 2L-3S | | MI | 1224 | 856 | 1777 | 727 | 2126 | 606 | 2315 | 508 | 2503 | 358 | 2873 | 195 | 2019 |
| 6-#9 | 1.56 | MA | 1916 | 856 | 2542 | 767 | 3203 | 642 | 3575 | 540 | 3972 | 386 | 4888 | 255 | 3224 |
| 3L-2S | | MI | 1347 | 856 | 1981 | 722 | 2385 | 603 | 2628 | 506 | 2925 | 355 | 3383 | 269 | 2017 |
| 6-#10 | 1.98 | MA | 2246 | 903 | 3182 | 786 | 4002 | 654 | 4537 | 546 | 5261 | 374 | 6667 | 323 | 4056 |
| 2L-3S | | MI | 1258 | 903 | 1892 | 754 | 2262 | 626 | 2475 | 520 | 2712 | 353 | 3108 | 155 | 2480 |
| 6-#10 | 1.98 | MA | 1986 | 903 | 2738 | 797 | 3441 | 664 | 3858 | 554 | 4348 | 385 | 5403 | 230 | 4011 |
| 3L-2S | | MI | 1403 | 903 | 2148 | 748 | 2587 | 622 | 2867 | 518 | 3239 | 351 | 3738 | 249 | 2490 |
| 6-#11 | 2.44 | MA | 2346 | 954 | 3488 | 812 | 4361 | 672 | 4957 | 557 | 5814 | 368 | 7328 | 308 | 4870 |
| 2L-3S | | MI | 1280 | 954 | 2016 | 778 | 2395 | 641 | 2623 | 526 | 2872 | 339 | 3264 | 97 | 2919 |
| 6-#11 | 2.44 | MA | 2045 | 954 | 2955 | 825 | 3687 | 683 | 4141 | 566 | 4715 | 380 | 5839 | 193 | 4790 |
| 3L-2S | | MI | 1445 | 954 | 2320 | 772 | 2779 | 638 | 3088 | 527 | 3483 | 336 | 3980 | 212 | 2945 |
| 6-#14 | 3.52 | MA | 2596 | 1076 | 4187 | 884 | 5225 | 725 | 5991 | 589 | 7196 | 361 | 9098 | 284 | 6846 |
| 2L-3S | | MI | 1352 | 1076 | 2282 | 848 | 2714 | 691 | 3000 | 555 | 3332 | 320 | 3767 | -19 | 3756 |
| 6-#14 | 3.52 | MA | 2218 | 1076 | 3429 | 902 | 4266 | 739 | 4831 | 601 | 5635 | 377 | 7015 | 119 | 6637 |
| 3L-2S | | MI | 1566 | 1076 | 2709 | 841 | 3254 | 688 | 3653 | 558 | 4174 | 315 | 4742 | 146 | 4047 |
| 6-#18 | 6.25 | MA | 2619 | 1385 | 4574 | 1096 | 5676 | 881 | 6516 | 690 | 7885 | 366 | 9776 | -89 | 9572 |
| 3L-2S | | MI | 1838 | 1385 | 3619 | 1022 | 4371 | 819 | 4933 | 628 | 5734 | 249 | 6381 | -53 | 6333 |
| 8-#7 | 1.25 | MA | 2049 | 820 | 2669 | 740 | 3383 | 621 | 3803 | 526 | 4287 | 380 | 5331 | 331 | 2642 |
| 2L-4S | | MI | 1181 | 820 | 1634 | 712 | 1959 | 596 | 2113 | 506 | 2237 | 362 | 2595 | 221 | 1670 |
| 8-#7 | 1.25 | MA | 1914 | 820 | 2455 | 746 | 3112 | 626 | 3476 | 531 | 3847 | 386 | 4722 | 288 | 2639 |
| 3E | | MI | 1229 | 820 | 1724 | 709 | 2076 | 594 | 2262 | 502 | 2440 | 362 | 2826 | 243 | 1669 |
| 8-#7 | 1.25 | MA | 1833 | 820 | 2307 | 751 | 2918 | 631 | 3228 | 538 | 3508 | 389 | 4297 | 263 | 2619 |
| 4L-2S | | MI | 1307 | 820 | 1849 | 705 | 2234 | 591 | 2454 | 500 | 2699 | 360 | 3147 | 287 | 1664 |
| 8-#8 | 1.65 | MA | 2163 | 865 | 2945 | 766 | 3722 | 640 | 4209 | 538 | 4829 | 378 | 6078 | 328 | 3422 |
| 2L-4S | | MI | 1208 | 865 | 1730 | 739 | 2071 | 615 | 2243 | 518 | 2407 | 358 | 2798 | 185 | 2112 |
| 8-#8 | 1.65 | MA | 1994 | 865 | 2665 | 773 | 3368 | 646 | 3781 | 543 | 4253 | 385 | 5280 | 271 | 3408 |
| 3E | | MI | 1269 | 865 | 1848 | 735 | 2224 | 612 | 2438 | 513 | 2673 | 359 | 3097 | 213 | 2126 |
| 8-#8 | 1.65 | MA | 1894 | 865 | 2471 | 781 | 3114 | 653 | 3456 | 552 | 3809 | 389 | 4723 | 237 | 3354 |
| 4L-2S | | MI | 1366 | 865 | 2011 | 731 | 2431 | 609 | 2688 | 511 | 3010 | 357 | 3509 | 271 | 2125 |
| 8-#9 | 2.08 | MA | 2283 | 914 | 3245 | 795 | 4093 | 661 | 4652 | 551 | 5421 | 375 | 6895 | 324 | 4271 |
| 2L-4S | | MI | 1240 | 914 | 1834 | 769 | 2185 | 641 | 2384 | 532 | 2592 | 354 | 3013 | 144 | 2507 |

## RECTANGULAR TIED COLUMNS 16" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 8-#9 | 2.08 | MA | 2080 | 914 | 2893 | 804 | 3648 | 669 | 4114 | 558 | 4696 | 384 | 5892 | 251 | 4241 |
| 3E | | MI | 1312 | 914 | 1981 | 764 | 2385 | 633 | 2628 | 525 | 2925 | 356 | 3383 | 179 | 2613 |
| 8-#9 | 2.08 | MA | 1960 | 914 | 2648 | 813 | 3328 | 677 | 3705 | 569 | 4138 | 388 | 5187 | 208 | 4065 |
| 4L-2S | | MI | 1426 | 914 | 2186 | 759 | 2644 | 630 | 2941 | 524 | 3346 | 353 | 3893 | 252 | 2621 |
| 8-#10 | 2.65 | MA | 2430 | 978 | 3625 | 833 | 4563 | 688 | 5215 | 568 | 6175 | 371 | 7931 | 319 | 5349 |
| 2L-4S | | MI | 1278 | 978 | 1963 | 807 | 2336 | 669 | 2561 | 549 | 2822 | 348 | 3279 | 90 | 2975 |
| 8-#10 | 2.65 | MA | 2187 | 978 | 3182 | 844 | 4002 | 698 | 4537 | 576 | 5261 | 382 | 6667 | 226 | 5289 |
| 3E | | MI | 1364 | 978 | 2148 | 801 | 2587 | 660 | 2867 | 542 | 3239 | 350 | 3738 | 133 | 3217 |
| 8-#10 | 2.65 | MA | 2043 | 978 | 2872 | 855 | 3598 | 708 | 4021 | 590 | 4556 | 387 | 5776 | 171 | 4881 |
| 4L-2S | | MI | 1499 | 978 | 2405 | 795 | 2911 | 656 | 3260 | 540 | 3766 | 348 | 4368 | 226 | 3241 |
| 8-#11 | 3.25 | MA | 2289 | 1046 | 3488 | 882 | 4361 | 725 | 4957 | 593 | 5814 | 377 | 7328 | 185 | 6324 |
| 3E | | MI | 1401 | 1046 | 2320 | 835 | 2779 | 683 | 3088 | 553 | 3483 | 333 | 3980 | 64 | 3786 |
| 8-#11 | 3.25 | MA | 2116 | 1046 | 3114 | 895 | 3873 | 736 | 4333 | 608 | 4962 | 382 | 6274 | 119 | 5668 |
| 4L-2S | | MI | 1554 | 1046 | 2624 | 829 | 3164 | 680 | 3553 | 554 | 4093 | 329 | 4697 | 179 | 3831 |
| 8-#14 | 4.69 | MA | 2540 | 1209 | 4187 | 984 | 5225 | 800 | 5991 | 640 | 7196 | 372 | 9098 | 103 | 8754 |
| 3E | | MI | 1518 | 1209 | 2709 | 931 | 3254 | 751 | 3653 | 594 | 4174 | 308 | 4742 | -73 | 4684 |
| 8-#14 | 4.69 | MA | 2335 | 1209 | 3653 | 1002 | 4529 | 815 | 5102 | 661 | 5983 | 378 | 7618 | 11 | 7565 |
| 4L-2S | | MI | 1713 | 1209 | 3135 | 924 | 3793 | 749 | 4305 | 597 | 5017 | 303 | 5716 | 92 | 5281 |
| 10-#10 | 3.31 | MA | 2380 | 1053 | 3625 | 891 | 4563 | 732 | 5215 | 598 | 6175 | 379 | 7931 | 222 | 6568 |
| 3L-4S | | MI | 1388 | 1053 | 2219 | 854 | 2660 | 704 | 2953 | 571 | 3349 | 344 | 3909 | 68 | 3671 |
| 10-#10 | 3.31 | MA | 2251 | 1053 | 3316 | 902 | 4159 | 742 | 4699 | 612 | 5470 | 384 | 7040 | 167 | 6130 |
| 4L-3S | | MI | 1466 | 1053 | 2405 | 848 | 2911 | 694 | 3260 | 564 | 3766 | 347 | 4368 | 111 | 3952 |
| 10-#10 | 3.31 | MA | 2109 | 1053 | 3039 | 913 | 3767 | 757 | 4237 | 620 | 4830 | 395 | 6148 | 113 | 5730 |
| 5L-2S | | MI | 1592 | 1053 | 2661 | 842 | 3236 | 690 | 3652 | 562 | 4292 | 344 | 4998 | 204 | 3988 |
| 10-#11 | 4.06 | MA | 2372 | 1138 | 3647 | 952 | 4548 | 778 | 5149 | 635 | 6061 | 378 | 7764 | 111 | 7174 |
| 4L-3S | | MI | 1518 | 1138 | 2624 | 892 | 3164 | 725 | 3553 | 580 | 4093 | 326 | 4697 | 31 | 4614 |
| 10-#11 | 4.06 | MA | 2196 | 1138 | 3313 | 965 | 4074 | 796 | 4590 | 644 | 5287 | 390 | 6712 | 44 | 6556 |
| 5L-2S | | MI | 1660 | 1138 | 2928 | 886 | 3548 | 722 | 4018 | 581 | 4704 | 323 | 5414 | 146 | 4712 |
| 10-#14 | 5.86 | MA | 2675 | 1341 | 4411 | 1084 | 5487 | 875 | 6262 | 700 | 7544 | 373 | 9701 | -4 | 9689 |
| 4L-3S | | MI | 1679 | 1341 | 3135 | 1014 | 3793 | 812 | 4305 | 633 | 5017 | 296 | 5716 | -127 | 5595 |
| 10-#14 | 5.86 | MA | 2446 | 1341 | 3933 | 1102 | 4811 | 900 | 5464 | 712 | 6441 | 388 | 8230 | -102 | 8075 |
| 5L-2S | | MI | 1859 | 1341 | 3562 | 1007 | 4333 | 810 | 4958 | 635 | 5859 | 291 | 6691 | 39 | 6510 |
| 12-#10 | 3.97 | MA | 2461 | 1127 | 3759 | 948 | 4720 | 776 | 5377 | 634 | 6383 | 382 | 8304 | 163 | 7385 |
| 4E | | MI | 1494 | 1127 | 2476 | 901 | 2985 | 738 | 3345 | 593 | 3876 | 341 | 4539 | 45 | 4375 |
| 12-#10 | 3.97 | MA | 2311 | 1127 | 3483 | 960 | 4328 | 792 | 4915 | 642 | 5743 | 393 | 7412 | 109 | 6987 |
| 5L-3S | | MI | 1565 | 1127 | 2661 | 895 | 3236 | 729 | 3652 | 585 | 4292 | 344 | 4998 | 88 | 4687 |
| 12-#10 | 3.97 | MA | 2138 | 1127 | 3206 | 968 | 3974 | 801 | 4463 | 656 | 5119 | 398 | 6551 | 38 | 6374 |
| 6L-2S | | MI | 1684 | 1127 | 2918 | 889 | 3560 | 725 | 4045 | 584 | 4819 | 341 | 5629 | 182 | 4732 |
| 12-#11 | 4.88 | MA | 2443 | 1230 | 3846 | 1023 | 4749 | 838 | 5406 | 671 | 6386 | 387 | 8201 | 36 | 8067 |
| 5L-3S | | MI | 1632 | 1230 | 2928 | 950 | 3548 | 767 | 4018 | 607 | 4704 | 320 | 5414 | -2 | 5411 |
| 12-#11 | 4.88 | MA | 2245 | 1230 | 3519 | 1034 | 4319 | 849 | 4860 | 687 | 5631 | 392 | 7183 | -49 | 7108 |
| 6L-2S | | MI | 1766 | 1230 | 3232 | 944 | 3933 | 764 | 4483 | 608 | 5314 | 316 | 6130 | 112 | 5590 |
| 12-#14 | 7.03 | MA | 2775 | 1474 | 4691 | 1185 | 5770 | 961 | 6623 | 751 | 8002 | 383 | 10313 | -117 | 10056 |
| 5L-3S | | MI | 1837 | 1474 | 3562 | 1097 | 4333 | 873 | 4958 | 672 | 5859 | 284 | 6691 | -181 | 6491 |
| 14-#10 | 4.63 | MA | 2514 | 1202 | 3926 | 1006 | 4889 | 826 | 5593 | 664 | 6657 | 390 | 8676 | 105 | 8247 |
| 5L-4S | | MI | 1596 | 1202 | 2732 | 947 | 3309 | 772 | 3738 | 615 | 4403 | 338 | 5170 | 23 | 5084 |
| 14-#10 | 4.63 | MA | 2354 | 1202 | 3650 | 1015 | 4535 | 836 | 5142 | 678 | 6032 | 395 | 7815 | 34 | 7651 |
| 6L-3S | | MI | 1662 | 1202 | 2918 | 941 | 3560 | 763 | 4045 | 607 | 4819 | 341 | 5629 | 66 | 5421 |
| 14-#11 | 5.69 | MA | 2489 | 1322 | 4052 | 1091 | 4994 | 891 | 5676 | 714 | 6730 | 388 | 8672 | -57 | 8550 |
| 6L-3S | | MI | 1745 | 1322 | 3232 | 1007 | 3933 | 809 | 4483 | 634 | 5314 | 313 | 6130 | -35 | 6085 |
| 16-#10 | 5.29 | MA | 2553 | 1277 | 4093 | 1062 | 5096 | 870 | 5820 | 700 | 6946 | 392 | 9078 | 30 | 8929 |
| 6L-4S | | MI | 1697 | 1277 | 2989 | 994 | 3634 | 807 | 4130 | 637 | 4929 | 335 | 5800 | 1 | 5797 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 26"

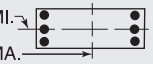
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#10 | 1.22 | MA | 2394 | 885 | 3110 | 799 | 3941 | 671 | 4427 | 569 | 4983 | 412 | 6189 | 359 | 3031 |
| 2E | | MI | 1395 | 885 | 2007 | 752 | 2397 | 631 | 2616 | 534 | 2850 | 384 | 3262 | 297 | 1744 |
| 4-#11 | 1.50 | MA | 2474 | 919 | 3352 | 815 | 4215 | 682 | 4743 | 575 | 5393 | 407 | 6747 | 354 | 3648 |
| 2E | | MI | 1424 | 919 | 2133 | 764 | 2530 | 638 | 2764 | 537 | 3010 | 372 | 3416 | 271 | 2066 |
| 4-#14 | 2.16 | MA | 2678 | 1000 | 3880 | 861 | 4861 | 715 | 5513 | 595 | 6418 | 402 | 8096 | 341 | 5128 |
| 2E | | MI | 1508 | 1000 | 2401 | 808 | 2850 | 670 | 3141 | 556 | 3469 | 356 | 3919 | 226 | 2826 |
| 4-#18 | 3.85 | MA | 3131 | 1206 | 5160 | 982 | 6436 | 803 | 7396 | 649 | 8934 | 389 | 11290 | 298 | 8732 |
| 2E | | MI | 1690 | 1206 | 3024 | 923 | 3602 | 753 | 3996 | 598 | 4504 | 309 | 5001 | 90 | 4588 |
| 6-#8 | 1.14 | MA | 2375 | 875 | 3028 | 797 | 3859 | 670 | 4339 | 569 | 4874 | 415 | 6047 | 361 | 2857 |
| 2L-3S | | MI | 1289 | 875 | 1797 | 757 | 2151 | 635 | 2328 | 537 | 2475 | 391 | 2839 | 252 | 1661 |
| 6-#8 | 1.14 | MA | 2175 | 875 | 2719 | 805 | 3468 | 677 | 3867 | 575 | 4238 | 423 | 5166 | 306 | 2852 |
| 3L-2S | | MI | 1391 | 875 | 1961 | 753 | 2358 | 632 | 2578 | 536 | 2811 | 389 | 3252 | 310 | 1653 |
| 6-#9 | 1.44 | MA | 2481 | 912 | 3281 | 819 | 4168 | 685 | 4708 | 578 | 5366 | 412 | 6724 | 359 | 3567 |
| 2L-3S | | MI | 1315 | 912 | 1891 | 778 | 2260 | 649 | 2455 | 546 | 2642 | 388 | 3028 | 222 | 2038 |
| 6-#9 | 1.44 | MA | 2238 | 912 | 2892 | 828 | 3676 | 694 | 4114 | 586 | 4565 | 422 | 5616 | 288 | 3548 |
| 3L-2S | | MI | 1439 | 912 | 2095 | 773 | 2519 | 646 | 2768 | 544 | 3063 | 385 | 3538 | 295 | 2033 |
| 6-#10 | 1.83 | MA | 2611 | 960 | 3600 | 846 | 4561 | 705 | 5177 | 591 | 5992 | 409 | 7587 | 355 | 4467 |
| 2L-3S | | MI | 1349 | 960 | 2007 | 805 | 2397 | 669 | 2616 | 557 | 2850 | 383 | 3262 | 182 | 2504 |
| 6-#10 | 1.83 | MA | 2317 | 960 | 3110 | 858 | 3941 | 716 | 4427 | 600 | 4983 | 422 | 6189 | 264 | 4422 |
| 3L-2S | | MI | 1496 | 960 | 2263 | 799 | 2721 | 665 | 3008 | 556 | 3377 | 381 | 3892 | 275 | 2508 |
| 6-#11 | 2.25 | MA | 2726 | 1011 | 3943 | 872 | 4963 | 724 | 5647 | 602 | 6611 | 404 | 8432 | 349 | 5375 |
| 2L-3S | | MI | 1370 | 1011 | 2133 | 827 | 2530 | 683 | 2764 | 564 | 3010 | 369 | 3416 | 123 | 2949 |
| 6-#11 | 2.25 | MA | 2387 | 1011 | 3352 | 886 | 4215 | 736 | 4743 | 612 | 5393 | 418 | 6747 | 235 | 5296 |
| 3L-2S | | MI | 1538 | 1011 | 2437 | 822 | 2915 | 680 | 3229 | 564 | 3621 | 365 | 4133 | 238 | 2967 |
| 6-#14 | 3.25 | MA | 3015 | 1133 | 4720 | 944 | 5924 | 776 | 6799 | 634 | 8150 | 397 | 10462 | 331 | 7575 |
| 2L-3S | | MI | 1442 | 1133 | 2401 | 898 | 2850 | 733 | 3141 | 592 | 3469 | 349 | 3919 | 7 | 3905 |
| 6-#14 | 3.25 | MA | 2573 | 1133 | 3880 | 963 | 4861 | 792 | 5513 | 648 | 6418 | 415 | 8096 | 166 | 7366 |
| 3L-2S | | MI | 1659 | 1133 | 2828 | 891 | 3390 | 730 | 3794 | 594 | 4311 | 344 | 4893 | 172 | 4074 |
| 6-#18 | 5.77 | MA | 3042 | 1442 | 5160 | 1159 | 6436 | 936 | 7396 | 738 | 8934 | 407 | 11290 | -25 | 11221 |
| 3L-2S | | MI | 1931 | 1442 | 3741 | 1070 | 4508 | 861 | 5074 | 664 | 5871 | 277 | 6530 | -28 | 6507 |
| 8-#7 | 1.15 | MA | 2385 | 877 | 3032 | 800 | 3874 | 672 | 4363 | 571 | 4911 | 416 | 6102 | 362 | 2901 |
| 2L-4S | | MI | 1271 | 877 | 1746 | 764 | 2092 | 640 | 2254 | 544 | 2375 | 392 | 2750 | 248 | 1687 |
| 8-#7 | 1.15 | MA | 2234 | 877 | 2796 | 806 | 3575 | 677 | 4002 | 576 | 4425 | 422 | 5429 | 321 | 2898 |
| 3E | | MI | 1320 | 877 | 1836 | 760 | 2209 | 638 | 2403 | 540 | 2579 | 393 | 2982 | 269 | 1683 |
| 8-#7 | 1.15 | MA | 2144 | 877 | 2633 | 812 | 3362 | 683 | 3729 | 583 | 4053 | 426 | 4966 | 295 | 2878 |
| 4L-2S | | MI | 1398 | 877 | 1961 | 757 | 2368 | 635 | 2595 | 539 | 2838 | 390 | 3302 | 313 | 1677 |
| 8-#8 | 1.52 | MA | 2515 | 921 | 3337 | 826 | 4249 | 691 | 4812 | 583 | 5511 | 413 | 6928 | 359 | 3763 |
| 2L-4S | | MI | 1298 | 921 | 1843 | 790 | 2205 | 659 | 2384 | 556 | 2546 | 388 | 2953 | 212 | 2136 |
| 8-#8 | 1.52 | MA | 2325 | 921 | 3028 | 834 | 3859 | 698 | 4339 | 589 | 4874 | 421 | 6047 | 304 | 3750 |
| 3E | | MI | 1360 | 921 | 1961 | 786 | 2358 | 656 | 2578 | 551 | 2811 | 389 | 3252 | 240 | 2144 |
| 8-#8 | 1.52 | MA | 2213 | 921 | 2814 | 842 | 3579 | 705 | 3982 | 598 | 4386 | 426 | 5439 | 270 | 3695 |
| 4L-2S | | MI | 1458 | 921 | 2124 | 782 | 2565 | 653 | 2829 | 549 | 3148 | 387 | 3664 | 298 | 2140 |
| 8-#9 | 1.92 | MA | 2652 | 971 | 3669 | 855 | 4659 | 712 | 5303 | 596 | 6166 | 410 | 7832 | 355 | 4703 |
| 2L-4S | | MI | 1327 | 971 | 1948 | 820 | 2319 | 684 | 2524 | 569 | 2730 | 384 | 3167 | 171 | 2561 |
| 8-#9 | 1.92 | MA | 2423 | 971 | 3281 | 865 | 4168 | 721 | 4708 | 603 | 5366 | 420 | 6724 | 285 | 4673 |
| 3E | | MI | 1403 | 971 | 2095 | 815 | 2519 | 677 | 2768 | 563 | 3063 | 386 | 3538 | 205 | 2635 |
| 8-#9 | 1.92 | MA | 2288 | 971 | 3011 | 874 | 3816 | 729 | 4258 | 615 | 4751 | 426 | 5956 | 242 | 4541 |
| 4L-2S | | MI | 1519 | 971 | 2300 | 809 | 2778 | 673 | 3081 | 562 | 3485 | 383 | 4047 | 279 | 2638 |
| 8-#10 | 2.44 | MA | 2819 | 1035 | 4090 | 893 | 5181 | 740 | 5927 | 613 | 7002 | 407 | 8985 | 351 | 5898 |
| 2L-4S | | MI | 1367 | 1035 | 2078 | 858 | 2470 | 713 | 2701 | 586 | 2960 | 378 | 3433 | 117 | 3035 |
| 8-#10 | 2.44 | MA | 2544 | 1035 | 3600 | 905 | 4561 | 750 | 5177 | 622 | 5992 | 419 | 7587 | 260 | 5837 |
| 3E | | MI | 1455 | 1035 | 2263 | 852 | 2721 | 703 | 3008 | 579 | 3377 | 380 | 3892 | 159 | 3244 |
| 8-#10 | 2.44 | MA | 2383 | 1035 | 3260 | 917 | 4116 | 761 | 4609 | 637 | 5216 | 425 | 6614 | 206 | 5453 |
| 4L-2S | | MI | 1592 | 1035 | 2520 | 846 | 3046 | 699 | 3401 | 578 | 3904 | 378 | 4522 | 253 | 3262 |
| 8-#11 | 3.00 | MA | 2653 | 1103 | 3943 | 943 | 4963 | 778 | 5647 | 639 | 6611 | 414 | 8432 | 230 | 6998 |
| 3E | | MI | 1492 | 1103 | 2437 | 885 | 2915 | 725 | 3229 | 591 | 3621 | 362 | 4133 | 90 | 3819 |
| 8-#11 | 3.00 | MA | 2468 | 1103 | 3530 | 957 | 4425 | 790 | 4960 | 656 | 5671 | 421 | 7245 | 162 | 6341 |
| 4L-2S | | MI | 1647 | 1103 | 2741 | 879 | 3299 | 723 | 3694 | 591 | 4231 | 359 | 4849 | 205 | 3856 |

## RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis



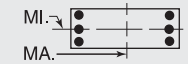

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 4.33 | MA | 2949 | 1265 | 4720 | 1046 | 5924 | 853 | 6799 | 687 | 8150 | 410 | 10462 | 156 | 9788 |
| 3E | | MI | 1608 | 1265 | 2828 | 981 | 3390 | 794 | 3794 | 631 | 4311 | 337 | 4893 | -47 | 4857 |
| 8-#14 | 4.33 | MA | 2718 | 1265 | 4132 | 1065 | 5156 | 869 | 5818 | 710 | 6810 | 418 | 8790 | 61 | 8469 |
| 4L-2S | | MI | 1807 | 1265 | 3254 | 974 | 3930 | 791 | 4447 | 633 | 5154 | 332 | 5868 | 118 | 5310 |
| 8-#18 | 7.69 | MA | 3318 | 1677 | 5588 | 1337 | 6939 | 1069 | 7914 | 845 | 9599 | 407 | 12439 | -216 | 11879 |
| 4L-2S | | MI | 2172 | 1677 | 4458 | 1217 | 5415 | 969 | 6153 | 729 | 7237 | 246 | 8060 | -146 | 7899 |
| 10-#10 | 3.05 | MA | 2762 | 1109 | 4090 | 951 | 5181 | 784 | 5927 | 644 | 7002 | 416 | 8985 | 256 | 7254 |
| 3L-4S | | MI | 1477 | 1109 | 2334 | 905 | 2794 | 747 | 3094 | 608 | 3487 | 374 | 4063 | 94 | 3730 |
| 10-#10 | 3.05 | MA | 2617 | 1109 | 3750 | 963 | 4736 | 795 | 5359 | 659 | 6225 | 422 | 8012 | 202 | 6839 |
| 4L-3S | | MI | 1557 | 1109 | 2520 | 899 | 3046 | 737 | 3401 | 601 | 3904 | 377 | 4522 | 137 | 3980 |
| 10-#10 | 3.05 | MA | 2453 | 1109 | 3447 | 975 | 4306 | 811 | 4850 | 668 | 5522 | 435 | 7033 | 151 | 6370 |
| 5L-2S | | MI | 1686 | 1109 | 2776 | 892 | 3370 | 734 | 3793 | 600 | 4431 | 374 | 5152 | 230 | 4010 |
| 10-#11 | 3.75 | MA | 2742 | 1195 | 4121 | 1014 | 5172 | 832 | 5864 | 683 | 6888 | 417 | 8931 | 157 | 8015 |
| 4L-3S | | MI | 1609 | 1195 | 2741 | 942 | 3299 | 768 | 3694 | 617 | 4231 | 356 | 4849 | 57 | 4686 |
| 10-#11 | 3.75 | MA | 2553 | 1195 | 3753 | 1028 | 4651 | 851 | 5248 | 693 | 6036 | 431 | 7741 | 91 | 7388 |
| 5L-2S | | MI | 1755 | 1195 | 3045 | 936 | 3684 | 765 | 4159 | 618 | 4841 | 352 | 5566 | 171 | 4738 |
| 10-#14 | 5.41 | MA | 3101 | 1398 | 4972 | 1148 | 6219 | 930 | 7104 | 749 | 8542 | 413 | 11157 | 51 | 10873 |
| 4L-3S | | MI | 1769 | 1398 | 3254 | 1063 | 3930 | 854 | 4447 | 670 | 5154 | 325 | 5868 | -101 | 5775 |
| 10-#14 | 5.41 | MA | 2834 | 1398 | 4446 | 1166 | 5475 | 956 | 6224 | 762 | 7325 | 431 | 9486 | -46 | 9402 |
| 5L-2S | | MI | 1953 | 1398 | 3681 | 1056 | 4469 | 852 | 5099 | 672 | 5997 | 320 | 6842 | 64 | 6541 |
| 12-#10 | 3.66 | MA | 2840 | 1184 | 4240 | 1010 | 5356 | 829 | 6109 | 681 | 7235 | 420 | 9410 | 198 | 8231 |
| 4E | | MI | 1583 | 1184 | 2591 | 951 | 3119 | 781 | 3486 | 630 | 4014 | 371 | 4693 | 72 | 4432 |
| 12-#10 | 3.66 | MA | 2680 | 1184 | 3937 | 1022 | 4926 | 845 | 5600 | 690 | 6531 | 432 | 8432 | 147 | 7782 |
| 5L-3S | | MI | 1656 | 1184 | 2776 | 945 | 3370 | 772 | 3793 | 623 | 4431 | 374 | 5152 | 115 | 4716 |
| 12-#10 | 3.66 | MA | 2487 | 1184 | 3626 | 1030 | 4537 | 856 | 5104 | 705 | 5845 | 438 | 7491 | 77 | 7126 |
| 6L-2S | | MI | 1779 | 1184 | 3033 | 939 | 3695 | 768 | 4186 | 622 | 4957 | 371 | 5783 | 208 | 4754 |
| 12-#11 | 4.50 | MA | 2832 | 1286 | 4344 | 1086 | 5398 | 893 | 6152 | 720 | 7253 | 427 | 9427 | 86 | 9072 |
| 5L-3S | | MI | 1724 | 1286 | 3045 | 1000 | 3684 | 810 | 4159 | 644 | 4841 | 349 | 5566 | 24 | 5498 |
| 12-#11 | 4.50 | MA | 2596 | 1286 | 3975 | 1096 | 4926 | 905 | 5550 | 737 | 6422 | 434 | 8279 | -1 | 8277 |
| 6L-2S | | MI | 1860 | 1286 | 3349 | 994 | 4068 | 807 | 4624 | 645 | 5452 | 346 | 6283 | 138 | 5617 |
| 12-#14 | 6.49 | MA | 3205 | 1530 | 5287 | 1249 | 6538 | 1017 | 7510 | 801 | 9057 | 426 | 11852 | -56 | 11704 |
| 5L-3S | | MI | 1926 | 1530 | 3681 | 1146 | 4469 | 915 | 5099 | 709 | 5997 | 313 | 6842 | -155 | 6676 |
| 14-#10 | 4.27 | MA | 2899 | 1259 | 4427 | 1069 | 5546 | 880 | 6350 | 712 | 7541 | 429 | 9830 | 143 | 9197 |
| 5L-4S | | MI | 1686 | 1259 | 2847 | 998 | 3443 | 816 | 3879 | 652 | 4541 | 368 | 5323 | 49 | 5139 |
| 14-#10 | 4.27 | MA | 2717 | 1259 | 4116 | 1077 | 5157 | 890 | 5854 | 727 | 6855 | 435 | 8889 | 73 | 8543 |
| 6L-3S | | MI | 1754 | 1259 | 3033 | 992 | 3695 | 806 | 4186 | 645 | 4957 | 371 | 5783 | 92 | 5450 |
| 14-#10 | 4.27 | MA | 2556 | 1259 | 3764 | 1090 | 4767 | 899 | 5374 | 736 | 6187 | 448 | 7961 | 30 | 7852 |
| 7L-2S | | MI | 1870 | 1259 | 3289 | 986 | 4019 | 802 | 4578 | 644 | 5484 | 368 | 6413 | 186 | 5497 |
| 14-#11 | 5.25 | MA | 2883 | 1378 | 4566 | 1154 | 5673 | 947 | 6454 | 764 | 7639 | 431 | 9964 | -5 | 9941 |
| 6L-3S | | MI | 1836 | 1378 | 3349 | 1057 | 4068 | 852 | 4624 | 671 | 5452 | 343 | 6283 | -9 | 6271 |
| 16-#10 | 4.88 | MA | 2954 | 1334 | 4606 | 1123 | 5777 | 924 | 6604 | 749 | 7864 | 433 | 10287 | 69 | 9961 |
| 6L-4S | | MI | 1787 | 1334 | 3104 | 1045 | 3768 | 850 | 4271 | 674 | 5068 | 365 | 5954 | 27 | 5851 |
| 16-#10 | 4.88 | MA | 2789 | 1334 | 4254 | 1137 | 5387 | 933 | 6124 | 758 | 7197 | 445 | 9359 | 26 | 9264 |
| 7L-3S | | MI | 1850 | 1334 | 3289 | 1039 | 4019 | 841 | 4578 | 667 | 5484 | 368 | 6413 | 70 | 6185 |
| 18-#10 | 5.50 | MA | 3033 | 1408 | 4744 | 1183 | 6008 | 968 | 6874 | 780 | 8206 | 442 | 10757 | 22 | 10676 |
| 7L-4S | | MI | 1887 | 1408 | 3360 | 1092 | 4092 | 884 | 4664 | 696 | 5594 | 362 | 6584 | 5 | 6566 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis

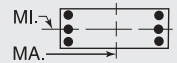



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.13 | MA | 2756 | 942 | 3500 | 860 | 4469 | 722 | 5029 | 614 | 5653 | 448 | 7016 | 390 | 3306 |
| 2E | | MI | 1487 | 942 | 2121 | 803 | 2531 | 674 | 2757 | 572 | 2988 | 414 | 3416 | 324 | 1760 |
| 4-#11 | 1.39 | MA | 2848 | 976 | 3767 | 875 | 4773 | 733 | 5379 | 619 | 6107 | 443 | 7633 | 385 | 3985 |
| 2E | | MI | 1516 | 976 | 2251 | 814 | 2666 | 681 | 2905 | 574 | 3148 | 401 | 3569 | 297 | 2085 |
| 4-#14 | 2.01 | MA | 3079 | 1057 | 4349 | 922 | 5484 | 767 | 6227 | 640 | 7237 | 437 | 9189 | 379 | 5614 |
| 2E | | MI | 1600 | 1057 | 2520 | 857 | 2986 | 712 | 3283 | 592 | 3606 | 385 | 4070 | 251 | 2849 |
| 4-#18 | 3.57 | MA | 3595 | 1263 | 5763 | 1042 | 7226 | 854 | 8309 | 694 | 10018 | 425 | 12851 | 348 | 9596 |
| 2E | | MI | 1783 | 1263 | 3146 | 971 | 3739 | 794 | 4137 | 634 | 4641 | 338 | 5150 | 115 | 4621 |
| 6-#8 | 1.06 | MA | 2734 | 932 | 3408 | 857 | 4377 | 721 | 4931 | 614 | 5532 | 451 | 6857 | 393 | 3113 |
| 2L-3S | | MI | 1380 | 932 | 1910 | 808 | 2285 | 678 | 2469 | 576 | 2613 | 421 | 2994 | 278 | 1675 |
| 6-#8 | 1.06 | MA | 2512 | 932 | 3071 | 865 | 3950 | 728 | 4414 | 620 | 4836 | 459 | 5893 | 339 | 3108 |
| 3L-2S | | MI | 1482 | 932 | 2074 | 804 | 2491 | 675 | 2719 | 574 | 2950 | 419 | 3407 | 336 | 1666 |
| 6-#9 | 1.34 | MA | 2853 | 969 | 3686 | 879 | 4716 | 736 | 5335 | 623 | 6071 | 448 | 7599 | 390 | 3891 |
| 2L-3S | | MI | 1405 | 969 | 2004 | 829 | 2394 | 693 | 2596 | 584 | 2780 | 418 | 3182 | 248 | 2056 |
| 6-#9 | 1.34 | MA | 2583 | 969 | 3260 | 889 | 4178 | 745 | 4685 | 631 | 5195 | 459 | 6386 | 321 | 3872 |
| 3L-2S | | MI | 1530 | 969 | 2209 | 824 | 2653 | 690 | 2909 | 582 | 3202 | 416 | 3692 | 321 | 2048 |
| 6-#10 | 1.70 | MA | 2999 | 1016 | 4037 | 906 | 5148 | 756 | 5851 | 636 | 6759 | 445 | 8547 | 386 | 4879 |
| 2L-3S | | MI | 1439 | 1016 | 2121 | 856 | 2531 | 712 | 2757 | 595 | 2988 | 413 | 3416 | 208 | 2526 |
| 6-#10 | 1.70 | MA | 2672 | 1016 | 3500 | 919 | 4469 | 768 | 5029 | 646 | 5653 | 458 | 7016 | 298 | 4834 |
| 3L-2S | | MI | 1588 | 1016 | 2378 | 850 | 2856 | 708 | 3149 | 593 | 3515 | 411 | 4046 | 301 | 2526 |
| 6-#11 | 2.09 | MA | 3130 | 1068 | 4415 | 932 | 5593 | 775 | 6371 | 646 | 7443 | 440 | 9482 | 380 | 5881 |
| 2L-3S | | MI | 1461 | 1068 | 2251 | 877 | 2666 | 726 | 2905 | 601 | 3148 | 398 | 3569 | 149 | 2978 |
| 6-#11 | 2.09 | MA | 2751 | 1068 | 3767 | 947 | 4773 | 788 | 5379 | 657 | 6107 | 454 | 7633 | 269 | 5801 |
| 3L-2S | | MI | 1630 | 1068 | 2555 | 871 | 3050 | 723 | 3370 | 601 | 3758 | 395 | 4285 | 264 | 2989 |
| 6-#14 | 3.01 | MA | 3459 | 1189 | 5272 | 1004 | 6652 | 827 | 7639 | 679 | 9139 | 433 | 11823 | 372 | 8304 |
| 2L-3S | | MI | 1531 | 1189 | 2520 | 947 | 2986 | 775 | 3283 | 629 | 3606 | 378 | 4070 | 32 | 4001 |
| 6-#14 | 3.01 | MA | 2961 | 1189 | 4349 | 1024 | 5484 | 845 | 6227 | 694 | 7237 | 453 | 9189 | 208 | 8095 |
| 3L-2S | | MI | 1752 | 1189 | 2947 | 940 | 3526 | 773 | 3935 | 631 | 4449 | 373 | 5045 | 198 | 4101 |
| 6-#18 | 5.36 | MA | 3490 | 1498 | 5763 | 1222 | 7226 | 990 | 8309 | 786 | 10018 | 447 | 12851 | 34 | 12748 |
| 3L-2S | | MI | 2024 | 1498 | 3863 | 1118 | 4646 | 902 | 5216 | 700 | 6007 | 306 | 6679 | -3 | 6677 |
| 8-#7 | 1.07 | MA | 2745 | 933 | 3412 | 860 | 4393 | 723 | 4956 | 616 | 5571 | 452 | 6915 | 394 | 3160 |
| 2L-4S | | MI | 1362 | 933 | 1858 | 815 | 2225 | 684 | 2394 | 582 | 2514 | 422 | 2905 | 274 | 1702 |
| 8-#7 | 1.07 | MA | 2577 | 933 | 3154 | 867 | 4066 | 729 | 4561 | 621 | 5039 | 458 | 6179 | 353 | 3157 |
| 3E | | MI | 1411 | 933 | 1948 | 812 | 2342 | 681 | 2543 | 578 | 2718 | 423 | 3137 | 296 | 1697 |
| 8-#7 | 1.07 | MA | 2478 | 933 | 2976 | 873 | 3834 | 735 | 4264 | 628 | 4633 | 462 | 5677 | 328 | 3138 |
| 4L-2S | | MI | 1489 | 933 | 2074 | 808 | 2501 | 679 | 2735 | 577 | 2976 | 421 | 3458 | 340 | 1690 |
| 8-#8 | 1.41 | MA | 2891 | 978 | 3746 | 886 | 4804 | 742 | 5448 | 627 | 6228 | 449 | 7820 | 390 | 4104 |
| 2L-4S | | MI | 1388 | 978 | 1956 | 842 | 2339 | 703 | 2524 | 594 | 2684 | 419 | 3108 | 238 | 2157 |
| 8-#8 | 1.41 | MA | 2680 | 978 | 3408 | 894 | 4377 | 750 | 4931 | 634 | 5532 | 457 | 6857 | 336 | 4091 |
| 3E | | MI | 1451 | 978 | 2074 | 837 | 2491 | 700 | 2719 | 589 | 2950 | 420 | 3407 | 266 | 2161 |
| 8-#8 | 1.41 | MA | 2556 | 978 | 3175 | 902 | 4072 | 757 | 4541 | 644 | 4999 | 463 | 6198 | 303 | 4036 |
| 4L-2S | | MI | 1550 | 978 | 2237 | 833 | 2698 | 697 | 2969 | 588 | 3287 | 417 | 3819 | 324 | 2156 |
| 8-#9 | 1.79 | MA | 3044 | 1028 | 4111 | 915 | 5254 | 763 | 5986 | 640 | 6947 | 446 | 8812 | 387 | 5135 |
| 2L-4S | | MI | 1417 | 1028 | 2062 | 871 | 2453 | 728 | 2665 | 607 | 2869 | 414 | 3322 | 197 | 2614 |
| 8-#9 | 1.79 | MA | 2789 | 1028 | 3686 | 925 | 4716 | 772 | 5335 | 649 | 6071 | 456 | 7599 | 318 | 5105 |
| 3E | | MI | 1494 | 1028 | 2209 | 866 | 2653 | 720 | 2909 | 601 | 3202 | 416 | 3692 | 232 | 2655 |
| 8-#9 | 1.79 | MA | 2640 | 1028 | 3392 | 935 | 4332 | 781 | 4844 | 661 | 5400 | 463 | 6767 | 276 | 4992 |
| 4L-2S | | MI | 1611 | 1028 | 2414 | 860 | 2912 | 717 | 3222 | 600 | 3623 | 413 | 4202 | 305 | 2656 |
| 8-#10 | 2.27 | MA | 3232 | 1091 | 4574 | 953 | 5827 | 791 | 6672 | 658 | 7865 | 442 | 10078 | 382 | 6446 |
| 2L-4S | | MI | 1457 | 1091 | 2193 | 909 | 2604 | 756 | 2842 | 624 | 3098 | 408 | 3587 | 143 | 3094 |
| 8-#10 | 2.27 | MA | 2926 | 1091 | 4037 | 965 | 5148 | 802 | 5851 | 667 | 6759 | 455 | 8547 | 294 | 6386 |
| 3E | | MI | 1546 | 1091 | 2378 | 903 | 2856 | 746 | 3149 | 617 | 3515 | 410 | 4046 | 186 | 3268 |
| 8-#10 | 2.27 | MA | 2747 | 1091 | 3665 | 978 | 4662 | 813 | 5230 | 683 | 5911 | 463 | 7492 | 240 | 6036 |
| 4L-2S | | MI | 1686 | 1091 | 2634 | 896 | 3180 | 743 | 3541 | 615 | 4042 | 408 | 4676 | 279 | 3282 |
| 8-#11 | 2.79 | MA | 3049 | 1159 | 4415 | 1004 | 5593 | 830 | 6371 | 684 | 7443 | 451 | 9482 | 264 | 7672 |
| 3E | | MI | 1582 | 1159 | 2555 | 935 | 3050 | 768 | 3370 | 628 | 3758 | 392 | 4285 | 116 | 3850 |
| 8-#11 | 2.79 | MA | 2843 | 1159 | 3965 | 1019 | 5004 | 843 | 5619 | 703 | 6416 | 459 | 8195 | 197 | 7025 |
| 4L-2S | | MI | 1740 | 1159 | 2859 | 929 | 3435 | 765 | 3835 | 628 | 4369 | 388 | 5002 | 231 | 3880 |

## RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis



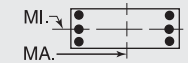

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 4.02 | MA | 3383 | 1322 | 5272 | 1107 | 6652 | 906 | 7639 | 733 | 9139 | 448 | 11823 | 201 | 10760 |
| 3E | | MI | 1697 | 1322 | 2947 | 1030 | 3526 | 836 | 3935 | 668 | 4449 | 366 | 5045 | -22 | 5029 |
| 8-#14 | 4.02 | MA | 3105 | 1322 | 4628 | 1127 | 5812 | 923 | 6566 | 758 | 7673 | 458 | 9974 | 104 | 9388 |
| 4L-2S | | MI | 1901 | 1322 | 3374 | 1023 | 4066 | 833 | 4588 | 670 | 5291 | 361 | 6019 | 144 | 5339 |
| 8-#18 | 7.14 | MA | 3798 | 1734 | 6241 | 1402 | 7786 | 1126 | 8887 | 896 | 10761 | 451 | 14162 | -155 | 13580 |
| 4L-2S | | MI | 2265 | 1734 | 4580 | 1266 | 5553 | 1010 | 6294 | 765 | 7373 | 275 | 8209 | -121 | 8084 |
| 10-#10 | 2.83 | MA | 3168 | 1166 | 4574 | 1012 | 5827 | 836 | 6672 | 689 | 7865 | 453 | 10078 | 290 | 7940 |
| 3L-4S | | MI | 1567 | 1166 | 2449 | 955 | 2929 | 790 | 3235 | 646 | 3625 | 404 | 4217 | 120 | 3787 |
| 10-#10 | 2.83 | MA | 3006 | 1166 | 4202 | 1025 | 5342 | 848 | 6052 | 705 | 7016 | 460 | 9024 | 236 | 7560 |
| 4L-3S | | MI | 1648 | 1166 | 2634 | 949 | 3180 | 781 | 3541 | 639 | 4042 | 407 | 4676 | 163 | 4007 |
| 10-#10 | 2.83 | MA | 2820 | 1166 | 3872 | 1037 | 4872 | 864 | 5497 | 715 | 6249 | 473 | 7960 | 188 | 7017 |
| 5L-2S | | MI | 1780 | 1166 | 2891 | 943 | 3505 | 777 | 3934 | 637 | 4569 | 404 | 5306 | 257 | 4031 |
| 10-#11 | 3.48 | MA | 3149 | 1251 | 4613 | 1076 | 5824 | 885 | 6611 | 730 | 7751 | 456 | 10044 | 193 | 8868 |
| 4L-3S | | MI | 1700 | 1251 | 2859 | 992 | 3435 | 810 | 3835 | 655 | 4369 | 385 | 5002 | 83 | 4719 |
| 10-#11 | 3.48 | MA | 2933 | 1251 | 4212 | 1091 | 5255 | 905 | 5939 | 741 | 6820 | 470 | 8750 | 130 | 8240 |
| 5L-2S | | MI | 1848 | 1251 | 3163 | 986 | 3819 | 807 | 4300 | 655 | 4979 | 382 | 5719 | 197 | 4764 |
| 10-#14 | 5.02 | MA | 3552 | 1454 | 5552 | 1210 | 6980 | 984 | 7979 | 797 | 9575 | 453 | 12608 | 97 | 12039 |
| 4L-3S | | MI | 1858 | 1454 | 3374 | 1113 | 4066 | 897 | 4588 | 706 | 5291 | 354 | 6019 | -75 | 5952 |
| 10-#14 | 5.02 | MA | 3230 | 1454 | 4978 | 1230 | 6166 | 1012 | 7018 | 812 | 8245 | 473 | 10754 | 3 | 10745 |
| 5L-2S | | MI | 2047 | 1454 | 3800 | 1106 | 4605 | 894 | 5241 | 709 | 6134 | 349 | 6994 | 90 | 6571 |
| 12-#10 | 3.40 | MA | 3255 | 1241 | 4739 | 1071 | 6021 | 882 | 6873 | 727 | 8122 | 457 | 10555 | 232 | 9089 |
| 4E | | MI | 1673 | 1241 | 2706 | 1002 | 3253 | 824 | 3627 | 668 | 4152 | 401 | 4847 | 98 | 4487 |
| 12-#10 | 3.40 | MA | 3073 | 1241 | 4409 | 1084 | 5552 | 899 | 6319 | 737 | 7355 | 470 | 9491 | 184 | 8567 |
| 5L-3S | | MI | 1748 | 1241 | 2891 | 996 | 3505 | 815 | 3934 | 661 | 4569 | 404 | 5306 | 141 | 4743 |
| 12-#10 | 3.40 | MA | 2859 | 1241 | 4064 | 1092 | 5128 | 910 | 5778 | 753 | 6607 | 478 | 8472 | 114 | 7895 |
| 6L-2S | | MI | 1873 | 1241 | 3147 | 990 | 3829 | 811 | 4326 | 659 | 5096 | 401 | 5937 | 234 | 4777 |
| 12-#11 | 4.18 | MA | 3231 | 1343 | 4860 | 1148 | 6075 | 947 | 6930 | 768 | 8156 | 467 | 10599 | 125 | 10100 |
| 5L-3S | | MI | 1815 | 1343 | 3163 | 1050 | 3819 | 852 | 4300 | 682 | 4979 | 379 | 5719 | 50 | 5575 |
| 12-#11 | 4.18 | MA | 2982 | 1343 | 4449 | 1158 | 5560 | 960 | 6274 | 786 | 7248 | 475 | 9355 | 39 | 9164 |
| 6L-2S | | MI | 1955 | 1343 | 3466 | 1044 | 4204 | 850 | 4765 | 682 | 5589 | 375 | 6435 | 164 | 5644 |
| 12-#14 | 6.03 | MA | 3660 | 1587 | 5901 | 1313 | 7334 | 1073 | 8430 | 851 | 10147 | 468 | 13388 | -4 | 13368 |
| 5L-3S | | MI | 2016 | 1587 | 3800 | 1195 | 4605 | 957 | 5241 | 745 | 6134 | 342 | 6994 | -129 | 6860 |
| 12-#14 | 6.03 | MA | 3336 | 1587 | 5322 | 1328 | 6598 | 1090 | 7492 | 876 | 8850 | 478 | 11602 | -129 | 11210 |
| 6L-2S | | MI | 2193 | 1587 | 4227 | 1189 | 5145 | 955 | 5893 | 748 | 6976 | 337 | 7969 | 36 | 7800 |
| 14-#10 | 3.97 | MA | 3316 | 1315 | 4946 | 1130 | 6231 | 933 | 7140 | 759 | 8461 | 468 | 11022 | 180 | 10120 |
| 5L-4S | | MI | 1777 | 1315 | 2962 | 1049 | 3578 | 859 | 4020 | 690 | 4679 | 398 | 5477 | 76 | 5193 |
| 14-#10 | 3.97 | MA | 3114 | 1315 | 4601 | 1138 | 5807 | 944 | 6599 | 775 | 7713 | 475 | 10004 | 110 | 9447 |
| 6L-3S | | MI | 1846 | 1315 | 3147 | 1043 | 3829 | 849 | 4326 | 683 | 5096 | 401 | 5937 | 119 | 5479 |
| 14-#10 | 3.97 | MA | 2936 | 1315 | 4259 | 1146 | 5374 | 953 | 6076 | 784 | 6985 | 488 | 8996 | 70 | 8712 |
| 7L-2S | | MI | 1965 | 1315 | 3404 | 1037 | 4154 | 846 | 4719 | 681 | 5622 | 398 | 6567 | 212 | 5520 |
| 14-#11 | 4.88 | MA | 3302 | 1435 | 5098 | 1216 | 6380 | 1002 | 7266 | 813 | 8583 | 472 | 11204 | 34 | 11036 |
| 6L-3S | | MI | 1927 | 1435 | 3466 | 1107 | 4204 | 895 | 4765 | 709 | 5589 | 373 | 6435 | 17 | 6385 |
| 14-#11 | 4.88 | MA | 3078 | 1435 | 4631 | 1232 | 5866 | 1013 | 6631 | 824 | 7700 | 486 | 9977 | -19 | 9928 |
| 7L-2S | | MI | 2060 | 1435 | 3770 | 1101 | 4588 | 892 | 5230 | 709 | 6200 | 369 | 7152 | 131 | 6522 |
| 14-#14 | 7.03 | MA | 3762 | 1719 | 6245 | 1411 | 7766 | 1151 | 8905 | 915 | 10752 | 473 | 14235 | -136 | 13655 |
| 6L-3S | | MI | 2172 | 1719 | 4227 | 1278 | 5145 | 1018 | 5893 | 784 | 6976 | 330 | 7969 | -183 | 7754 |
| 16-#10 | 4.54 | MA | 3362 | 1390 | 5137 | 1185 | 6486 | 979 | 7421 | 796 | 8819 | 472 | 11535 | 107 | 10999 |
| 6L-4S | | MI | 1878 | 1390 | 3219 | 1096 | 3902 | 893 | 4412 | 712 | 5206 | 395 | 6108 | 53 | 5903 |
| 16-#10 | 4.54 | MA | 3195 | 1390 | 4795 | 1193 | 6053 | 987 | 6898 | 806 | 8091 | 485 | 10528 | 66 | 10259 |
| 7L-3S | | MI | 1942 | 1390 | 3404 | 1089 | 4154 | 884 | 4719 | 705 | 5622 | 398 | 6567 | 96 | 6214 |
| 16-#10 | 4.54 | MA | 3038 | 1390 | 4419 | 1208 | 5589 | 1000 | 6379 | 816 | 7365 | 493 | 9558 | 12 | 9521 |
| 8L-2S | | MI | 2055 | 1390 | 3660 | 1083 | 4478 | 880 | 5111 | 703 | 6149 | 395 | 7197 | 189 | 6263 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 5.57 | MA | 3406 | 1527 | 5280 | 1289 | 6686 | 1055 | 7623 | 851 | 9036 | 483 | 11826 | -24 | 11737 |
| 7L-3S | | MI | 2039 | 1527 | 3770 | 1164 | 4588 | 937 | 5230 | 736 | 6200 | 366 | 7152 | -17 | 7130 |
| 18-#10 | 5.10 | MA | 3466 | 1465 | 5332 | 1240 | 6732 | 1021 | 7719 | 828 | 9197 | 483 | 12059 | 62 | 11807 |
| 7L-4S | | MI | 1977 | 1465 | 3475 | 1142 | 4227 | 928 | 4805 | 734 | 5733 | 392 | 6738 | 31 | 6617 |
| 18-#10 | 5.10 | MA | 3292 | 1465 | 4955 | 1255 | 6268 | 1035 | 7201 | 838 | 8471 | 490 | 11089 | 8 | 11064 |
| 8L-3S | | MI | 2037 | 1465 | 3660 | 1136 | 4478 | 918 | 5111 | 727 | 6149 | 395 | 7197 | 74 | 6950 |
| 20-#10 | 5.67 | MA | 3557 | 1540 | 5492 | 1301 | 6947 | 1069 | 8022 | 860 | 9577 | 487 | 12620 | 4 | 12608 |
| 8L-4S | | MI | 2075 | 1540 | 3732 | 1189 | 4551 | 962 | 5197 | 756 | 6260 | 389 | 7368 | 9 | 7334 |

## RECTANGULAR TIED COLUMNS 16" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.06 | MA | 3142 | 998 | 3908 | 920 | 5025 | 773 | 5664 | 658 | 6358 | 483 | 7885 | 421 | 3580 |
| 2E | | MI | 1578 | 998 | 2236 | 854 | 2666 | 717 | 2897 | 609 | 3126 | 444 | 3570 | 350 | 1775 |
| 4-#11 | 1.30 | MA | 3245 | 1032 | 4200 | 935 | 5358 | 784 | 6048 | 664 | 6857 | 479 | 8562 | 416 | 4322 |
| 2E | | MI | 1608 | 1032 | 2368 | 864 | 2801 | 723 | 3046 | 611 | 3285 | 431 | 3721 | 323 | 2103 |
| 4-#14 | 1.88 | MA | 3503 | 1114 | 4836 | 982 | 6135 | 818 | 6974 | 685 | 8091 | 473 | 10262 | 410 | 6100 |
| 2E | | MI | 1692 | 1114 | 2639 | 907 | 3123 | 754 | 3424 | 629 | 3743 | 415 | 4222 | 277 | 2871 |
| 4-#18 | 3.33 | MA | 4085 | 1320 | 6385 | 1102 | 8043 | 905 | 9254 | 739 | 11137 | 460 | 14460 | 395 | 10460 |
| 2E | | MI | 1875 | 1320 | 3269 | 1020 | 3877 | 835 | 4278 | 670 | 4777 | 366 | 5299 | 141 | 4654 |
| 6-#9 | 1.25 | MA | 3248 | 1025 | 4109 | 939 | 5293 | 788 | 5996 | 668 | 6811 | 484 | 8517 | 421 | 4215 |
| 2L-3S | | MI | 1496 | 1025 | 2118 | 880 | 2528 | 736 | 2737 | 622 | 2919 | 448 | 3337 | 274 | 2073 |
| 6-#9 | 1.25 | MA | 2951 | 1025 | 3647 | 949 | 4708 | 797 | 5289 | 676 | 5859 | 495 | 7199 | 353 | 4196 |
| 3L-2S | | MI | 1622 | 1025 | 2323 | 875 | 2787 | 733 | 3050 | 620 | 3340 | 446 | 3846 | 348 | 2063 |
| 6-#10 | 1.59 | MA | 3411 | 1073 | 4491 | 966 | 5763 | 808 | 6557 | 680 | 7560 | 481 | 9549 | 417 | 5290 |
| 2L-3S | | MI | 1528 | 1073 | 2236 | 907 | 2666 | 755 | 2897 | 633 | 3126 | 443 | 3570 | 234 | 2547 |
| 6-#10 | 1.59 | MA | 3050 | 1073 | 3908 | 979 | 5025 | 820 | 5664 | 691 | 6358 | 495 | 7885 | 331 | 5245 |
| 3L-2S | | MI | 1680 | 1073 | 2493 | 900 | 2990 | 751 | 3290 | 631 | 3653 | 441 | 4200 | 328 | 2543 |
| 6-#11 | 1.95 | MA | 3559 | 1124 | 4906 | 993 | 6250 | 826 | 7127 | 691 | 8311 | 475 | 10575 | 412 | 6386 |
| 2L-3S | | MI | 1551 | 1124 | 2368 | 927 | 2801 | 768 | 3046 | 638 | 3285 | 428 | 3721 | 175 | 3005 |
| 6-#11 | 1.95 | MA | 3140 | 1124 | 4200 | 1008 | 5358 | 840 | 6048 | 703 | 6857 | 491 | 8562 | 303 | 6307 |
| 3L-2S | | MI | 1722 | 1124 | 2672 | 921 | 3186 | 766 | 3511 | 638 | 3896 | 424 | 4438 | 290 | 3010 |
| 6-#14 | 2.81 | MA | 3926 | 1246 | 5842 | 1064 | 7408 | 879 | 8513 | 724 | 10164 | 468 | 13131 | 403 | 9033 |
| 2L-3S | | MI | 1621 | 1246 | 2639 | 997 | 3123 | 817 | 3424 | 665 | 3743 | 408 | 4222 | 58 | 4072 |
| 6-#14 | 2.81 | MA | 3373 | 1246 | 4836 | 1086 | 6135 | 898 | 6974 | 740 | 8091 | 490 | 10262 | 243 | 8824 |
| 3L-2S | | MI | 1845 | 1246 | 3066 | 990 | 3662 | 815 | 4076 | 668 | 4586 | 403 | 5196 | 223 | 4127 |
| 6-#18 | 5.00 | MA | 3963 | 1555 | 6385 | 1284 | 8043 | 1044 | 9254 | 834 | 11137 | 486 | 14460 | 89 | 14171 |
| 3L-2S | | MI | 2117 | 1555 | 3986 | 1167 | 4783 | 943 | 5357 | 736 | 6143 | 335 | 6829 | 23 | 6727 |
| 8-#7 | 1.00 | MA | 3128 | 990 | 3811 | 920 | 4940 | 775 | 5582 | 660 | 6266 | 487 | 7770 | 425 | 3419 |
| 2L-4S | | MI | 1452 | 990 | 1970 | 867 | 2358 | 728 | 2535 | 621 | 2653 | 453 | 3061 | 301 | 1717 |
| 8-#7 | 1.00 | MA | 2943 | 990 | 3530 | 927 | 4586 | 781 | 5153 | 666 | 5689 | 494 | 6971 | 385 | 3416 |
| 3E | | MI | 1502 | 990 | 2060 | 863 | 2475 | 725 | 2684 | 617 | 2856 | 453 | 3292 | 323 | 1710 |
| 8-#7 | 1.00 | MA | 2835 | 990 | 3338 | 933 | 4334 | 786 | 4831 | 674 | 5249 | 499 | 6432 | 360 | 3397 |
| 4L-2S | | MI | 1581 | 990 | 2186 | 860 | 2634 | 723 | 2876 | 615 | 3115 | 451 | 3613 | 367 | 1703 |
| 8-#8 | 1.32 | MA | 3290 | 1035 | 4174 | 947 | 5388 | 794 | 6117 | 672 | 6980 | 484 | 8755 | 421 | 4446 |
| 2L-4S | | MI | 1479 | 1035 | 2070 | 893 | 2472 | 746 | 2665 | 632 | 2823 | 449 | 3263 | 265 | 2177 |
| 8-#8 | 1.32 | MA | 3057 | 1035 | 3807 | 955 | 4924 | 801 | 5555 | 679 | 6224 | 494 | 7709 | 368 | 4432 |
| 3E | | MI | 1541 | 1035 | 2187 | 888 | 2625 | 743 | 2860 | 627 | 3088 | 450 | 3561 | 293 | 2177 |
| 8-#8 | 1.32 | MA | 2921 | 1035 | 3555 | 963 | 4594 | 809 | 5133 | 689 | 5647 | 499 | 6999 | 336 | 4377 |
| 4L-2S | | MI | 1641 | 1035 | 2350 | 884 | 2832 | 740 | 3110 | 626 | 3425 | 447 | 3974 | 351 | 2170 |
| 8-#9 | 1.67 | MA | 3460 | 1084 | 4571 | 976 | 5878 | 815 | 6703 | 685 | 7763 | 481 | 9835 | 418 | 5567 |
| 2L-4S | | MI | 1507 | 1084 | 2176 | 922 | 2587 | 771 | 2806 | 645 | 3007 | 444 | 3476 | 224 | 2658 |
| 8-#9 | 1.67 | MA | 3179 | 1084 | 4109 | 986 | 5293 | 824 | 5996 | 694 | 6811 | 493 | 8517 | 350 | 5537 |
| 3E | | MI | 1585 | 1084 | 2323 | 917 | 2787 | 763 | 3050 | 639 | 3340 | 446 | 3846 | 258 | 2675 |
| 8-#9 | 1.67 | MA | 3015 | 1084 | 3791 | 996 | 4877 | 834 | 5464 | 707 | 6084 | 500 | 7621 | 309 | 5424 |
| 4L-2S | | MI | 1704 | 1084 | 2528 | 911 | 3046 | 760 | 3363 | 637 | 3761 | 443 | 4356 | 332 | 2672 |
| 8-#10 | 2.12 | MA | 3669 | 1148 | 5075 | 1013 | 6501 | 842 | 7450 | 702 | 8763 | 478 | 11214 | 413 | 6995 |
| 2L-4S | | MI | 1546 | 1148 | 2308 | 959 | 2739 | 799 | 2983 | 662 | 3237 | 438 | 3741 | 169 | 3151 |

## RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 2.12 | MA | 3330 | 1148 | 4491 | 1026 | 5763 | 854 | 6557 | 713 | 7560 | 492 | 9549 | 327 | 6935 |
| 3E | | MI | 1637 | 1148 | 2493 | 953 | 2990 | 790 | 3290 | 655 | 3653 | 440 | 4200 | 212 | 3292 |
| 8-#10 | 2.12 | MA | 3133 | 1148 | 4089 | 1039 | 5237 | 866 | 5884 | 729 | 6641 | 500 | 8413 | 274 | 6630 |
| 4L-2S | | MI | 1778 | 1148 | 2749 | 947 | 3315 | 786 | 3682 | 653 | 4180 | 438 | 4830 | 305 | 3301 |
| 8-#11 | 2.60 | MA | 3469 | 1216 | 4906 | 1065 | 6250 | 882 | 7127 | 730 | 8311 | 488 | 10575 | 298 | 8346 |
| 3E | | MI | 1673 | 1216 | 2672 | 985 | 3186 | 811 | 3511 | 665 | 3896 | 421 | 4438 | 142 | 3880 |
| 8-#11 | 2.60 | MA | 3242 | 1216 | 4417 | 1080 | 5612 | 896 | 6311 | 749 | 7196 | 497 | 9187 | 232 | 7721 |
| 4L-2S | | MI | 1834 | 1216 | 2976 | 979 | 3570 | 808 | 3976 | 665 | 4506 | 418 | 5154 | 256 | 3903 |
| 8-#14 | 3.75 | MA | 3825 | 1378 | 5842 | 1168 | 7408 | 958 | 8513 | 779 | 10164 | 485 | 13131 | 236 | 11732 |
| 3E | | MI | 1787 | 1378 | 3066 | 1079 | 3662 | 878 | 4076 | 704 | 4586 | 396 | 5196 | 4 | 5186 |
| 8-#14 | 3.75 | MA | 3533 | 1378 | 5143 | 1190 | 6496 | 977 | 7347 | 806 | 8571 | 497 | 11139 | 140 | 10321 |
| 4L-2S | | MI | 1994 | 1378 | 3493 | 1072 | 4202 | 876 | 4729 | 707 | 5428 | 391 | 6171 | 169 | 5367 |
| 8-#18 | 6.67 | MA | 4303 | 1790 | 6912 | 1466 | 8661 | 1182 | 9893 | 947 | 11958 | 494 | 15932 | -97 | 15343 |
| 4L-2S | | MI | 2358 | 1790 | 4702 | 1314 | 5690 | 1051 | 6436 | 801 | 7510 | 303 | 8358 | -96 | 8266 |
| 10-#10 | 2.65 | MA | 3598 | 1222 | 5075 | 1073 | 6501 | 888 | 7450 | 735 | 8763 | 489 | 11214 | 323 | 8626 |
| 3L-4S | | MI | 1657 | 1222 | 2564 | 1006 | 3063 | 833 | 3375 | 684 | 3764 | 434 | 4371 | 147 | 3842 |
| 10-#10 | 2.65 | MA | 3420 | 1222 | 4672 | 1086 | 5975 | 900 | 6777 | 751 | 7843 | 497 | 10078 | 270 | 8292 |
| 4L-3S | | MI | 1740 | 1222 | 2749 | 1000 | 3315 | 824 | 3682 | 677 | 4180 | 437 | 4830 | 190 | 4032 |
| 10-#10 | 2.65 | MA | 3211 | 1222 | 4315 | 1099 | 5467 | 917 | 6177 | 762 | 7012 | 511 | 8880 | 216 | 7670 |
| 5L-2S | | MI | 1874 | 1222 | 3006 | 994 | 3639 | 820 | 4075 | 675 | 4707 | 434 | 5460 | 283 | 4052 |
| 10-#11 | 3.25 | MA | 3580 | 1308 | 5123 | 1138 | 6505 | 938 | 7391 | 776 | 8649 | 494 | 11200 | 227 | 9734 |
| 4L-3S | | MI | 1791 | 1308 | 2976 | 1042 | 3570 | 853 | 3976 | 692 | 4506 | 415 | 5154 | 109 | 4751 |
| 10-#11 | 3.25 | MA | 3337 | 1308 | 4689 | 1153 | 5888 | 959 | 6662 | 788 | 7640 | 510 | 9801 | 167 | 9041 |
| 5L-2S | | MI | 1942 | 1308 | 3280 | 1036 | 3955 | 850 | 4441 | 692 | 5117 | 411 | 5871 | 223 | 4789 |
| 10-#14 | 4.69 | MA | 4027 | 1511 | 6149 | 1272 | 7768 | 1038 | 8887 | 844 | 10643 | 492 | 14008 | 134 | 13219 |
| 4L-3S | | MI | 1949 | 1511 | 3493 | 1162 | 4202 | 939 | 4729 | 743 | 5428 | 384 | 6171 | -50 | 6128 |
| 10-#14 | 4.69 | MA | 3664 | 1511 | 5528 | 1294 | 6886 | 1067 | 7844 | 861 | 9200 | 514 | 12003 | 44 | 11842 |
| 5L-2S | | MI | 2141 | 1511 | 3919 | 1155 | 4742 | 936 | 5382 | 746 | 6271 | 379 | 7145 | 115 | 6601 |
| 12-#10 | 3.17 | MA | 3694 | 1297 | 5256 | 1132 | 6714 | 934 | 7670 | 773 | 9045 | 495 | 11743 | 266 | 9959 |
| 4E | | MI | 1763 | 1297 | 2821 | 1053 | 3388 | 868 | 3768 | 706 | 4290 | 431 | 5001 | 124 | 4541 |
| 12-#10 | 3.17 | MA | 3490 | 1297 | 4899 | 1145 | 6206 | 952 | 7070 | 784 | 8214 | 509 | 10545 | 212 | 9359 |
| 5L-3S | | MI | 1840 | 1297 | 3006 | 1047 | 3639 | 858 | 4075 | 699 | 4707 | 434 | 5460 | 167 | 4770 |
| 12-#10 | 3.17 | MA | 3254 | 1297 | 4520 | 1153 | 5747 | 964 | 6485 | 800 | 7404 | 517 | 9497 | 151 | 8661 |
| 6L-2S | | MI | 1967 | 1297 | 3262 | 1041 | 3963 | 854 | 4467 | 697 | 5234 | 431 | 6091 | 261 | 4799 |
| 12-#11 | 3.90 | MA | 3665 | 1400 | 5394 | 1210 | 6781 | 1001 | 7742 | 815 | 9094 | 506 | 11813 | 162 | 11088 |
| 5L-3S | | MI | 1906 | 1400 | 3280 | 1100 | 3955 | 895 | 4441 | 719 | 5117 | 408 | 5871 | 76 | 5620 |
| 12-#11 | 3.90 | MA | 3391 | 1400 | 4942 | 1220 | 6223 | 1014 | 7031 | 834 | 8110 | 515 | 10473 | 77 | 10059 |
| 6L-2S | | MI | 2049 | 1400 | 3584 | 1094 | 4339 | 892 | 4906 | 719 | 5727 | 405 | 6588 | 190 | 5670 |
| 12-#14 | 5.63 | MA | 4139 | 1643 | 6534 | 1376 | 8159 | 1128 | 9384 | 900 | 11273 | 509 | 14873 | 37 | 14737 |
| 5L-3S | | MI | 2107 | 1643 | 3919 | 1245 | 4742 | 1000 | 5382 | 782 | 6271 | 372 | 7145 | -104 | 7041 |
| 12-#14 | 5.63 | MA | 3782 | 1643 | 5894 | 1391 | 7361 | 1147 | 8366 | 926 | 9866 | 521 | 12948 | -87 | 12657 |
| 6L-2S | | MI | 2287 | 1643 | 4346 | 1238 | 5281 | 997 | 6035 | 785 | 7113 | 367 | 8120 | 62 | 7831 |
| 14-#10 | 3.70 | MA | 3758 | 1372 | 5482 | 1192 | 6944 | 986 | 7963 | 806 | 9416 | 506 | 12209 | 208 | 11050 |
| 5L-4S | | MI | 1867 | 1372 | 3077 | 1100 | 3712 | 902 | 4160 | 728 | 4817 | 428 | 5631 | 102 | 5245 |
| 14-#10 | 3.70 | MA | 3536 | 1372 | 5103 | 1200 | 6485 | 998 | 7378 | 822 | 8606 | 514 | 11161 | 147 | 10348 |
| 6L-3S | | MI | 1938 | 1372 | 3262 | 1093 | 3963 | 893 | 4467 | 721 | 5234 | 431 | 6091 | 145 | 5507 |
| 14-#10 | 3.70 | MA | 3339 | 1372 | 4732 | 1208 | 6009 | 1006 | 6812 | 833 | 7818 | 528 | 10075 | 109 | 9591 |
| 7L-2S | | MI | 2059 | 1372 | 3519 | 1087 | 4288 | 889 | 4860 | 719 | 5761 | 428 | 6721 | 238 | 5543 |
| 14-#11 | 4.55 | MA | 3725 | 1491 | 5647 | 1277 | 7116 | 1057 | 8111 | 861 | 9564 | 512 | 12486 | 72 | 12098 |
| 6L-3S | | MI | 2019 | 1491 | 3584 | 1157 | 4339 | 937 | 4906 | 746 | 5727 | 402 | 6588 | 42 | 6458 |
| 14-#11 | 4.55 | MA | 3497 | 1491 | 5198 | 1287 | 6548 | 1067 | 7423 | 873 | 8607 | 528 | 11162 | 22 | 11068 |
| 7L-2S | | MI | 2155 | 1491 | 3888 | 1151 | 4724 | 934 | 5371 | 746 | 6338 | 399 | 7304 | 157 | 6549 |
| 14-#14 | 6.56 | MA | 4251 | 1776 | 6900 | 1474 | 8634 | 1207 | 9906 | 965 | 11938 | 516 | 15817 | -94 | 15378 |
| 6L-3S | | MI | 2262 | 1776 | 4346 | 1328 | 5281 | 1060 | 6035 | 821 | 7113 | 360 | 8120 | -157 | 7941 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

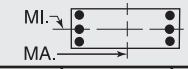
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 4.23 | MA | 3808 | 1447 | 5687 | 1246 | 7224 | 1032 | 8271 | 844 | 9808 | 511 | 12826 | 143 | 12035 |
| 6L-4S | | MI | 1968 | 1447 | 3334 | 1146 | 4037 | 936 | 4553 | 750 | 5344 | 425 | 6262 | 80 | 5954 |
| 16-#10 | 4.23 | MA | 3624 | 1447 | 5316 | 1255 | 6747 | 1040 | 7705 | 855 | 9021 | 525 | 11739 | 105 | 11273 |
| 7L-3S | | MI | 2035 | 1447 | 3519 | 1140 | 4288 | 927 | 4860 | 742 | 5761 | 428 | 6721 | 123 | 6243 |
| 16-#10 | 4.23 | MA | 3449 | 1447 | 4908 | 1270 | 6244 | 1054 | 7133 | 863 | 8236 | 534 | 10693 | 53 | 10501 |
| 8L-2S | | MI | 2150 | 1447 | 3775 | 1134 | 4612 | 923 | 5252 | 741 | 6287 | 425 | 7351 | 216 | 6286 |
| 16-#11 | 5.20 | MA | 3835 | 1583 | 5903 | 1345 | 7441 | 1109 | 8503 | 900 | 10060 | 524 | 13174 | 17 | 13101 |
| 7L-3S | | MI | 2131 | 1583 | 3888 | 1214 | 4724 | 979 | 5371 | 773 | 6338 | 396 | 7304 | 9 | 7275 |
| 18-#10 | 4.76 | MA | 3900 | 1521 | 5900 | 1302 | 7485 | 1075 | 8598 | 877 | 10223 | 523 | 13404 | 101 | 12955 |
| 7L-4S | | MI | 2068 | 1521 | 3590 | 1193 | 4361 | 971 | 4945 | 772 | 5871 | 422 | 6892 | 57 | 6667 |
| 18-#10 | 4.76 | MA | 3728 | 1521 | 5491 | 1317 | 6983 | 1088 | 8026 | 885 | 9438 | 531 | 12357 | 49 | 12186 |
| 8L-3S | | MI | 2130 | 1521 | 3775 | 1187 | 4612 | 961 | 5252 | 764 | 6287 | 425 | 7351 | 100 | 6978 |
| 20-#10 | 5.29 | MA | 3999 | 1596 | 6075 | 1364 | 7721 | 1123 | 8919 | 907 | 10640 | 528 | 14022 | 45 | 13864 |
| 8L-4S | | MI | 2166 | 1596 | 3847 | 1240 | 4686 | 1005 | 5338 | 794 | 6398 | 419 | 7522 | 35 | 7383 |

## RECTANGULAR TIED COLUMNS 16" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.22 | MA | 3666 | 1089 | 4651 | 995 | 5971 | 835 | 6749 | 709 | 7642 | 514 | 9533 | 448 | 4659 |
| 2E | | MI | 1699 | 1089 | 2486 | 914 | 2937 | 766 | 3187 | 648 | 3423 | 460 | 3874 | 349 | 2121 |
| 4-#14 | 1.76 | MA | 3952 | 1170 | 5341 | 1042 | 6814 | 869 | 7754 | 729 | 8981 | 509 | 11377 | 441 | 6586 |
| 2E | | MI | 1784 | 1170 | 2759 | 956 | 3259 | 796 | 3565 | 666 | 3881 | 444 | 4373 | 303 | 2893 |
| 4-#18 | 3.13 | MA | 4600 | 1376 | 7025 | 1162 | 8888 | 956 | 10233 | 784 | 12292 | 496 | 15942 | 426 | 11324 |
| 2E | | MI | 1968 | 1376 | 3391 | 1068 | 4014 | 876 | 4420 | 706 | 4913 | 395 | 5449 | 166 | 4686 |
| 6-#9 | 1.17 | MA | 3667 | 1082 | 4550 | 999 | 5898 | 839 | 6689 | 713 | 7587 | 519 | 9477 | 452 | 4539 |
| 2L-3S | | MI | 1586 | 1082 | 2232 | 931 | 2662 | 780 | 2878 | 660 | 3057 | 478 | 3491 | 301 | 2089 |
| 6-#9 | 1.17 | MA | 3342 | 1082 | 4051 | 1010 | 5267 | 849 | 5925 | 722 | 6559 | 531 | 8054 | 386 | 4520 |
| 3L-2S | | MI | 1713 | 1082 | 2437 | 926 | 2921 | 776 | 3191 | 658 | 3478 | 476 | 4001 | 374 | 2078 |
| 6-#10 | 1.49 | MA | 3847 | 1129 | 4964 | 1027 | 6406 | 859 | 7296 | 725 | 8397 | 516 | 10594 | 449 | 5702 |
| 2L-3S | | MI | 1618 | 1129 | 2351 | 957 | 2800 | 798 | 3038 | 670 | 3265 | 473 | 3724 | 261 | 2567 |
| 6-#10 | 1.49 | MA | 3452 | 1129 | 4333 | 1040 | 5609 | 871 | 6332 | 736 | 7099 | 531 | 8796 | 364 | 5657 |
| 3L-2S | | MI | 1772 | 1129 | 2608 | 951 | 3124 | 795 | 3431 | 669 | 3791 | 471 | 4354 | 354 | 2560 |
| 6-#11 | 1.83 | MA | 4012 | 1181 | 5415 | 1053 | 6937 | 878 | 7917 | 736 | 9214 | 511 | 11710 | 443 | 6892 |
| 2L-3S | | MI | 1641 | 1181 | 2486 | 977 | 2937 | 811 | 3187 | 675 | 3423 | 457 | 3874 | 201 | 3031 |
| 6-#11 | 1.83 | MA | 3551 | 1181 | 4651 | 1068 | 5971 | 892 | 6749 | 749 | 7642 | 528 | 9533 | 336 | 6812 |
| 3L-2S | | MI | 1815 | 1181 | 2789 | 971 | 3321 | 808 | 3652 | 675 | 4033 | 454 | 4590 | 316 | 3030 |
| 6-#14 | 2.64 | MA | 4417 | 1303 | 6429 | 1125 | 8192 | 930 | 9420 | 768 | 11224 | 504 | 14483 | 434 | 9762 |
| 2L-3S | | MI | 1711 | 1303 | 2759 | 1046 | 3259 | 859 | 3565 | 702 | 3881 | 437 | 4373 | 84 | 4109 |
| 6-#14 | 2.64 | MA | 3809 | 1303 | 5341 | 1147 | 6814 | 950 | 7754 | 786 | 8981 | 527 | 11377 | 278 | 9553 |
| 3L-2S | | MI | 1938 | 1303 | 3185 | 1039 | 3799 | 857 | 4218 | 705 | 4723 | 432 | 5348 | 249 | 4153 |
| 6-#18 | 4.69 | MA | 4461 | 1612 | 7025 | 1346 | 8888 | 1097 | 10233 | 881 | 12292 | 525 | 15942 | 127 | 15626 |
| 3L-2S | | MI | 2210 | 1612 | 4108 | 1215 | 4921 | 984 | 5498 | 772 | 6280 | 363 | 6978 | 48 | 6762 |
| 8-#8 | 1.23 | MA | 3713 | 1091 | 4620 | 1007 | 5999 | 845 | 6818 | 717 | 7768 | 520 | 9733 | 453 | 4787 |
| 2L-4S | | MI | 1569 | 1091 | 2183 | 944 | 2606 | 790 | 2806 | 670 | 2962 | 479 | 3418 | 291 | 2196 |
| 8-#8 | 1.23 | MA | 3458 | 1091 | 4224 | 1015 | 5498 | 853 | 6213 | 724 | 6952 | 530 | 8603 | 401 | 4773 |
| 3E | | MI | 1632 | 1091 | 2300 | 940 | 2759 | 787 | 3000 | 665 | 3227 | 480 | 3716 | 319 | 2192 |
| 8-#8 | 1.23 | MA | 3309 | 1091 | 3952 | 1024 | 5143 | 861 | 5758 | 735 | 6331 | 536 | 7843 | 368 | 4719 |
| 4L-2S | | MI | 1733 | 1091 | 2463 | 935 | 2966 | 784 | 3250 | 664 | 3564 | 478 | 4129 | 377 | 2185 |
| 8-#9 | 1.56 | MA | 3900 | 1141 | 5049 | 1036 | 6529 | 866 | 7452 | 730 | 8615 | 517 | 10900 | 449 | 5999 |
| 2L-4S | | MI | 1597 | 1141 | 2290 | 973 | 2721 | 815 | 2946 | 683 | 3146 | 474 | 3631 | 250 | 2683 |
| 8-#9 | 1.56 | MA | 3592 | 1141 | 4550 | 1046 | 5898 | 876 | 6689 | 739 | 7587 | 529 | 9477 | 383 | 5969 |
| 3E | | MI | 1674 | 1141 | 2437 | 968 | 2921 | 807 | 3191 | 677 | 3478 | 476 | 4001 | 285 | 2694 |
| 8-#9 | 1.56 | MA | 3412 | 1141 | 4208 | 1057 | 5450 | 886 | 6116 | 752 | 6803 | 536 | 8517 | 342 | 5856 |
| 4L-2S | | MI | 1796 | 1141 | 2642 | 962 | 3180 | 803 | 3504 | 675 | 3900 | 474 | 4511 | 358 | 2689 |
| 8-#10 | 1.98 | MA | 4130 | 1204 | 5594 | 1073 | 7204 | 893 | 8260 | 747 | 9696 | 513 | 12392 | 445 | 7544 |
| 2L-4S | | MI | 1636 | 1204 | 2422 | 1010 | 2873 | 842 | 3124 | 699 | 3375 | 468 | 3895 | 195 | 3206 |
| 8-#10 | 1.98 | MA | 3759 | 1204 | 4964 | 1087 | 6406 | 906 | 7296 | 758 | 8397 | 528 | 10594 | 360 | 7483 |
| 3E | | MI | 1728 | 1204 | 2608 | 1004 | 3124 | 833 | 3431 | 692 | 3791 | 470 | 4354 | 238 | 3315 |

## RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis

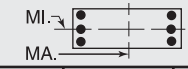



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.98 | MA | 3543 | 1204 | 4530 | 1100 | 5840 | 918 | 6571 | 775 | 7407 | 537 | 9377 | 307 | 7233 |
| 4L-2S | | MI | 1871 | 1204 | 2864 | 998 | 3449 | 829 | 3823 | 691 | 4318 | 468 | 4984 | 332 | 3320 |
| 8-#11 | 2.44 | MA | 3913 | 1273 | 5415 | 1126 | 6937 | 934 | 7917 | 776 | 9214 | 524 | 11710 | 331 | 9019 |
| 3E | | MI | 1764 | 1273 | 2789 | 1035 | 3321 | 853 | 3652 | 702 | 4033 | 451 | 4590 | 168 | 3909 |
| 8-#11 | 2.44 | MA | 3664 | 1273 | 4888 | 1142 | 6249 | 948 | 7037 | 795 | 8011 | 535 | 10223 | 266 | 8428 |
| 4L-2S | | MI | 1926 | 1273 | 3093 | 1029 | 3706 | 850 | 4117 | 702 | 4644 | 447 | 5307 | 282 | 3926 |
| 8-#14 | 3.52 | MA | 4305 | 1435 | 6429 | 1229 | 8192 | 1011 | 9420 | 825 | 11224 | 522 | 14483 | 271 | 12704 |
| 3E | | MI | 1877 | 1435 | 3185 | 1129 | 3799 | 920 | 4218 | 741 | 4723 | 425 | 5348 | 30 | 5275 |
| 8-#14 | 3.52 | MA | 3984 | 1435 | 5676 | 1252 | 7208 | 1031 | 8162 | 853 | 9504 | 536 | 12346 | 176 | 11267 |
| 4L-2S | | MI | 2088 | 1435 | 3612 | 1122 | 4338 | 918 | 4870 | 744 | 5566 | 420 | 6322 | 195 | 5395 |
| 8-#18 | 6.25 | MA | 4832 | 1847 | 7602 | 1530 | 9565 | 1238 | 10933 | 996 | 13191 | 536 | 17576 | -57 | 17203 |
| 4L-2S | | MI | 2451 | 1847 | 4825 | 1362 | 5828 | 1093 | 6577 | 837 | 7646 | 332 | 8508 | -70 | 8444 |
| 10-#10 | 2.48 | MA | 4052 | 1279 | 5594 | 1133 | 7204 | 940 | 8260 | 780 | 9696 | 525 | 12392 | 356 | 9311 |
| 3L-4S | | MI | 1746 | 1279 | 2679 | 1057 | 3198 | 877 | 3516 | 721 | 3902 | 464 | 4525 | 173 | 3896 |
| 10-#10 | 2.48 | MA | 3857 | 1279 | 5161 | 1147 | 6637 | 952 | 7536 | 797 | 8705 | 534 | 11175 | 303 | 9034 |
| 4L-3S | | MI | 1831 | 1279 | 2864 | 1051 | 3449 | 867 | 3823 | 714 | 4318 | 467 | 4984 | 216 | 4057 |
| 10-#10 | 2.48 | MA | 3626 | 1279 | 4777 | 1160 | 6091 | 970 | 6890 | 808 | 7810 | 549 | 9888 | 251 | 8330 |
| 5L-2S | | MI | 1967 | 1279 | 3121 | 1045 | 3773 | 863 | 4216 | 713 | 4845 | 464 | 5614 | 309 | 4072 |
| 10-#11 | 3.05 | MA | 4034 | 1364 | 5651 | 1199 | 7214 | 991 | 8204 | 822 | 9583 | 531 | 12399 | 261 | 10612 |
| 4L-3S | | MI | 1882 | 1364 | 3093 | 1092 | 3706 | 895 | 4117 | 729 | 4644 | 444 | 5307 | 135 | 4782 |
| 10-#11 | 3.05 | MA | 3764 | 1364 | 5184 | 1215 | 6550 | 1012 | 7419 | 835 | 8495 | 548 | 10895 | 204 | 9827 |
| 5L-2S | | MI | 2036 | 1364 | 3397 | 1086 | 4090 | 893 | 4582 | 729 | 5254 | 441 | 6024 | 249 | 4813 |
| 10-#14 | 4.39 | MA | 4498 | 1567 | 6765 | 1334 | 8585 | 1091 | 9827 | 892 | 11747 | 531 | 15452 | 169 | 14413 |
| 4L-3S | | MI | 2039 | 1567 | 3612 | 1212 | 4338 | 981 | 4870 | 780 | 5566 | 413 | 6322 | -24 | 6302 |
| 10-#14 | 4.39 | MA | 4122 | 1567 | 6096 | 1356 | 7634 | 1121 | 8704 | 909 | 10191 | 554 | 13295 | 84 | 12961 |
| 5L-2S | | MI | 2235 | 1567 | 4038 | 1205 | 4878 | 979 | 5523 | 782 | 6408 | 408 | 7297 | 141 | 6630 |
| 10-#18 | 7.81 | MA | 5057 | 2082 | 8323 | 1714 | 10296 | 1396 | 11865 | 1094 | 14371 | 565 | 19192 | -232 | 17959 |
| 5L-2S | | MI | 2692 | 2082 | 5542 | 1510 | 6735 | 1201 | 7656 | 902 | 9012 | 300 | 10037 | -188 | 9827 |
| 12-#10 | 2.98 | MA | 4157 | 1354 | 5791 | 1193 | 7435 | 987 | 8500 | 819 | 10003 | 532 | 12973 | 300 | 10839 |
| 4E | | MI | 1853 | 1354 | 2935 | 1103 | 3522 | 911 | 3909 | 743 | 4429 | 461 | 5155 | 151 | 4593 |
| 12-#10 | 2.98 | MA | 3930 | 1354 | 5407 | 1207 | 6888 | 1005 | 7854 | 830 | 9108 | 546 | 11686 | 247 | 10157 |
| 5L-3S | | MI | 1932 | 1354 | 3121 | 1097 | 3773 | 902 | 4216 | 736 | 4845 | 464 | 5614 | 194 | 4796 |
| 12-#10 | 2.98 | MA | 3673 | 1354 | 4993 | 1214 | 6395 | 1017 | 7225 | 847 | 8237 | 556 | 10564 | 187 | 9438 |
| 6L-2S | | MI | 2061 | 1354 | 3377 | 1091 | 4098 | 898 | 4608 | 735 | 5372 | 461 | 6245 | 287 | 4820 |
| 12-#11 | 3.66 | MA | 4124 | 1456 | 5947 | 1272 | 7515 | 1054 | 8587 | 862 | 10067 | 545 | 13071 | 199 | 12040 |
| 5L-3S | | MI | 1997 | 1456 | 3397 | 1150 | 4090 | 938 | 4582 | 756 | 5254 | 438 | 6024 | 102 | 5652 |
| 12-#11 | 3.66 | MA | 3824 | 1456 | 5452 | 1282 | 6915 | 1069 | 7821 | 882 | 9007 | 555 | 11635 | 115 | 10968 |
| 6L-2S | | MI | 2143 | 1456 | 3701 | 1144 | 4475 | 935 | 5047 | 756 | 5865 | 435 | 6740 | 216 | 5696 |
| 12-#14 | 5.27 | MA | 4644 | 1700 | 7185 | 1439 | 9012 | 1182 | 10370 | 948 | 12434 | 549 | 16401 | 77 | 16095 |
| 5L-3S | | MI | 2197 | 1700 | 4038 | 1294 | 4878 | 1042 | 5523 | 819 | 6408 | 401 | 7297 | -78 | 7221 |
| 12-#14 | 5.27 | MA | 4225 | 1700 | 6484 | 1453 | 8152 | 1202 | 9274 | 976 | 10917 | 563 | 14337 | -46 | 14168 |
| 6L-2S | | MI | 2381 | 1700 | 4465 | 1287 | 5417 | 1039 | 6176 | 821 | 7251 | 396 | 8272 | 87 | 7861 |
| 14-#10 | 3.47 | MA | 4224 | 1429 | 6037 | 1254 | 7685 | 1039 | 8819 | 852 | 10407 | 544 | 13483 | 243 | 11986 |
| 5L-4S | | MI | 1957 | 1429 | 3192 | 1150 | 3847 | 945 | 4301 | 765 | 4955 | 458 | 5785 | 128 | 5297 |
| 14-#10 | 3.47 | MA | 3981 | 1429 | 5624 | 1261 | 7192 | 1051 | 8189 | 869 | 9535 | 553 | 12362 | 183 | 11261 |
| 6L-3S | | MI | 2030 | 1429 | 3377 | 1144 | 4098 | 936 | 4608 | 758 | 5372 | 461 | 6245 | 171 | 5533 |
| 14-#10 | 3.47 | MA | 3766 | 1429 | 5224 | 1270 | 6672 | 1059 | 7580 | 880 | 8687 | 568 | 11196 | 146 | 10487 |
| 7L-2S | | MI | 2154 | 1429 | 3634 | 1138 | 4422 | 932 | 5001 | 757 | 5899 | 458 | 6875 | 264 | 5565 |
| 14-#11 | 4.27 | MA | 4189 | 1548 | 6215 | 1339 | 7880 | 1111 | 8989 | 909 | 10579 | 551 | 13812 | 110 | 13173 |
| 6L-3S | | MI | 2111 | 1548 | 3701 | 1207 | 4475 | 980 | 5047 | 783 | 5865 | 432 | 6740 | 68 | 6521 |
| 14-#11 | 4.27 | MA | 3940 | 1548 | 5730 | 1349 | 7258 | 1121 | 8248 | 922 | 9549 | 568 | 12390 | 62 | 12104 |
| 7L-2S | | MI | 2249 | 1548 | 4005 | 1201 | 4859 | 977 | 5512 | 783 | 6475 | 428 | 7457 | 183 | 6576 |
| 14-#14 | 6.15 | MA | 4764 | 1832 | 7573 | 1536 | 9530 | 1263 | 10940 | 1015 | 13160 | 558 | 17443 | -53 | 17171 |
| 6L-3S | | MI | 2353 | 1832 | 4465 | 1377 | 5417 | 1103 | 6176 | 858 | 7251 | 389 | 8272 | -132 | 8126 |
| 14-#14 | 6.15 | MA | 4438 | 1832 | 6880 | 1550 | 8651 | 1278 | 9880 | 1033 | 11685 | 581 | 15402 | -125 | 14996 |
| 7L-2S | | MI | 2527 | 1832 | 4892 | 1370 | 5957 | 1100 | 6828 | 860 | 8093 | 384 | 9246 | 33 | 9089 |

## RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

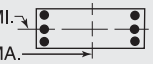
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 3.97 | MA | 4278 | 1503 | 6254 | 1308 | 7990 | 1086 | 9153 | 891 | 10833 | 550 | 14159 | 179 | 13084 |
| 6L-4S | | MI | 2059 | 1503 | 3449 | 1197 | 4171 | 980 | 4694 | 787 | 5482 | 455 | 6416 | 106 | 6005 |
| 16-#10 | 3.97 | MA | 4077 | 1503 | 5855 | 1317 | 7469 | 1093 | 8545 | 902 | 9986 | 565 | 12994 | 142 | 12304 |
| 7L-3S | | MI | 2127 | 1503 | 3634 | 1191 | 4422 | 970 | 5001 | 780 | 5899 | 458 | 6875 | 149 | 6270 |
| 16-#10 | 3.97 | MA | 3883 | 1503 | 5415 | 1332 | 6928 | 1108 | 7920 | 911 | 9141 | 574 | 11870 | 92 | 11446 |
| 8L-2S | | MI | 2245 | 1503 | 3890 | 1185 | 4747 | 966 | 5393 | 779 | 6426 | 455 | 7505 | 242 | 6309 |
| 16-#11 | 4.88 | MA | 4310 | 1640 | 6493 | 1407 | 8224 | 1163 | 9416 | 949 | 11121 | 565 | 14566 | 57 | 14302 |
| 7L-3S | | MI | 2222 | 1640 | 4005 | 1264 | 4859 | 1022 | 5512 | 810 | 6475 | 425 | 7457 | 35 | 7345 |
| 16-#11 | 4.88 | MA | 4082 | 1640 | 5959 | 1426 | 7566 | 1180 | 8670 | 960 | 10093 | 575 | 13196 | -7 | 13176 |
| 8L-2S | | MI | 2354 | 1640 | 4309 | 1258 | 5244 | 1019 | 5977 | 810 | 7086 | 422 | 8174 | 150 | 7454 |
| 16-#14 | 7.03 | MA | 4962 | 1965 | 7968 | 1633 | 10028 | 1339 | 11546 | 1072 | 13928 | 576 | 18508 | -131 | 17887 |
| 7L-3S | | MI | 2507 | 1965 | 4892 | 1460 | 5957 | 1163 | 6828 | 897 | 8093 | 377 | 9246 | -186 | 9019 |
| 18-#10 | 4.46 | MA | 4378 | 1578 | 6485 | 1363 | 8267 | 1128 | 9509 | 924 | 11284 | 562 | 14792 | 139 | 14121 |
| 7L-4S | | MI | 2159 | 1578 | 3705 | 1244 | 4496 | 1014 | 5086 | 809 | 6009 | 452 | 7046 | 84 | 6717 |
| 18-#10 | 4.46 | MA | 4188 | 1578 | 6045 | 1379 | 7725 | 1142 | 8885 | 933 | 10440 | 571 | 13668 | 88 | 13266 |
| 8L-3S | | MI | 2223 | 1578 | 3890 | 1238 | 4747 | 1005 | 5393 | 802 | 6426 | 455 | 7505 | 126 | 7006 |
| 18-#10 | 4.46 | MA | 3952 | 1578 | 5667 | 1390 | 7222 | 1152 | 8243 | 946 | 9606 | 586 | 12506 | 34 | 12357 |
| 9L-2S | | MI | 2336 | 1578 | 4147 | 1231 | 5071 | 1001 | 5785 | 801 | 6952 | 452 | 8135 | 220 | 7051 |
| 18-#11 | 5.48 | MA | 4444 | 1732 | 6722 | 1483 | 8531 | 1222 | 9837 | 987 | 11665 | 572 | 15373 | -12 | 15326 |
| 8L-3S | | MI | 2333 | 1732 | 4309 | 1322 | 5244 | 1064 | 5977 | 837 | 7086 | 419 | 8174 | 2 | 8166 |
| 20-#10 | 4.96 | MA | 4484 | 1653 | 6675 | 1426 | 8522 | 1176 | 9849 | 955 | 11738 | 568 | 15466 | 84 | 15087 |
| 8L-4S | | MI | 2258 | 1653 | 3962 | 1290 | 4820 | 1048 | 5479 | 831 | 6536 | 449 | 7676 | 61 | 7431 |
| 20-#10 | 4.96 | MA | 4259 | 1653 | 6297 | 1437 | 8019 | 1186 | 9207 | 968 | 10905 | 583 | 14304 | 30 | 14174 |
| 9L-3S | | MI | 2317 | 1653 | 4147 | 1284 | 5071 | 1039 | 5785 | 824 | 6952 | 452 | 8135 | 104 | 7743 |
| 22-#10 | 5.46 | MA | 4558 | 1728 | 6927 | 1484 | 8816 | 1220 | 10172 | 990 | 12203 | 580 | 16102 | 26 | 15990 |
| 9L-4S | | MI | 2355 | 1728 | 4218 | 1337 | 5145 | 1083 | 5871 | 853 | 7063 | 446 | 8306 | 39 | 8149 |

## RECTANGULAR TIED COLUMNS 18" x 18"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#8 | 1.46 | MA | 1290 | 712 | 1824 | 616 | 2234 | 515 | 2480 | 434 | 2775 | 307 | 3317 | 249 | 1850 |
| 2L-3S | | MI | 1172 | 712 | 1632 | 621 | 1990 | 519 | 2185 | 437 | 2379 | 312 | 2806 | 191 | 1849 |
| 6-#9 | 1.85 | MA | 1348 | 749 | 1980 | 637 | 2424 | 530 | 2705 | 443 | 3076 | 305 | 3681 | 239 | 2290 |
| 2L-3S | | MI | 1205 | 749 | 1738 | 643 | 2118 | 535 | 2336 | 447 | 2578 | 310 | 3048 | 165 | 2278 |
| 6-#10 | 2.35 | MA | 1416 | 797 | 2176 | 664 | 2663 | 550 | 2991 | 455 | 3456 | 302 | 4135 | 224 | 2843 |
| 2L-3S | | MI | 1250 | 797 | 1872 | 672 | 2279 | 556 | 2527 | 459 | 2831 | 307 | 3349 | 131 | 2809 |
| 6-#11 | 2.89 | MA | 1470 | 848 | 2377 | 689 | 2895 | 568 | 3261 | 465 | 3810 | 296 | 4482 | 195 | 3379 |
| 2L-3S | | MI | 1281 | 848 | 2015 | 698 | 2438 | 573 | 2708 | 468 | 3066 | 300 | 3575 | 81 | 3317 |
| 6-#14 | 4.17 | MA | 1621 | 970 | 2840 | 761 | 3466 | 620 | 3943 | 498 | 4705 | 286 | 5491 | 145 | 4689 |
| 2L-3S | | MI | 1378 | 970 | 2330 | 771 | 2821 | 626 | 3163 | 500 | 3661 | 291 | 4245 | -21 | 4223 |
| 6-#18 | 7.41 | MA | 1964 | 1279 | 3940 | 944 | 4827 | 753 | 5574 | 581 | 6726 | 240 | 7742 | -11 | 7718 |
| 2L-3S | | MI | 1613 | 1279 | 3076 | 958 | 3734 | 759 | 4252 | 579 | 5005 | 249 | 5738 | -305 | 5458 |
| 8-#8 | 1.95 | MA | 1369 | 759 | 2017 | 645 | 2478 | 536 | 2774 | 447 | 3172 | 306 | 3827 | 241 | 2416 |
| 2L-4S | | MI | 1189 | 759 | 1687 | 655 | 2056 | 544 | 2252 | 457 | 2465 | 310 | 2951 | 153 | 2334 |
| 8-#9 | 2.47 | MA | 1442 | 808 | 2221 | 673 | 2729 | 557 | 3074 | 460 | 3573 | 303 | 4314 | 227 | 2996 |
| 2L-4S | | MI | 1228 | 808 | 1808 | 686 | 2200 | 567 | 2420 | 472 | 2686 | 308 | 3227 | 116 | 2774 |
| 8-#10 | 3.14 | MA | 1531 | 872 | 2479 | 711 | 3047 | 584 | 3454 | 477 | 4081 | 299 | 4922 | 208 | 3726 |
| 2L-4S | | MI | 1282 | 872 | 1959 | 726 | 2381 | 596 | 2631 | 491 | 2966 | 304 | 3570 | 68 | 3315 |
| 8-#11 | 3.85 | MA | 1602 | 940 | 2738 | 747 | 3352 | 610 | 3813 | 492 | 4554 | 292 | 5388 | 171 | 4428 |
| 2L-4S | | MI | 1320 | 940 | 2117 | 763 | 2543 | 628 | 2830 | 505 | 3223 | 294 | 3825 | 1 | 3819 |
| 10-#10 | 3.92 | MA | 1642 | 947 | 2782 | 757 | 3430 | 618 | 3918 | 499 | 4706 | 296 | 5708 | 192 | 4606 |
| 2L-5S | | MI | 1335 | 947 | 2068 | 781 | 2490 | 642 | 2771 | 516 | 3143 | 307 | 3800 | -5 | 3797 |
| 10-#10 | 3.92 | MA | 1500 | 947 | 2479 | 765 | 3047 | 624 | 3454 | 503 | 4081 | 301 | 4922 | 99 | 4546 |
| 3L-4S | | MI | 1415 | 947 | 2262 | 773 | 2765 | 630 | 3095 | 513 | 3591 | 301 | 4356 | 52 | 4153 |
| 10-#11 | 4.81 | MA | 1571 | 1032 | 2738 | 812 | 3352 | 658 | 3813 | 522 | 4554 | 293 | 5388 | 32 | 5296 |
| 3L-4S | | MI | 1476 | 1032 | 2478 | 821 | 3000 | 670 | 3383 | 532 | 3967 | 291 | 4731 | -23 | 4705 |

## RECTANGULAR TIED COLUMNS 18" x 20"

Short columns – no sidesway
Bending on major or minor axis



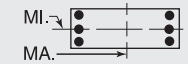

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.11 | MA | 1532 | 754 | 2063 | 667 | 2544 | 561 | 2816 | 476 | 3108 | 347 | 3736 | 293 | 1792 |
| 2E | | MI | 1364 | 754 | 1878 | 658 | 2286 | 553 | 2513 | 469 | 2754 | 342 | 3246 | 281 | 1592 |
| 4-#10 | 1.41 | MA | 1592 | 786 | 2218 | 685 | 2732 | 573 | 3038 | 484 | 3402 | 344 | 4103 | 285 | 2227 |
| 2E | | MI | 1413 | 786 | 2013 | 675 | 2447 | 565 | 2704 | 477 | 3007 | 339 | 3546 | 270 | 1970 |
| 4-#11 | 1.73 | MA | 1641 | 820 | 2387 | 700 | 2920 | 583 | 3253 | 489 | 3680 | 339 | 4398 | 268 | 2659 |
| 2E | | MI | 1452 | 820 | 2159 | 689 | 2608 | 574 | 2886 | 481 | 3241 | 333 | 3771 | 249 | 2343 |
| 4-#14 | 2.50 | MA | 1768 | 901 | 2756 | 746 | 3369 | 616 | 3787 | 509 | 4391 | 333 | 5233 | 241 | 3697 |
| 2E | | MI | 1556 | 901 | 2476 | 735 | 2992 | 607 | 3341 | 501 | 3836 | 325 | 4439 | 215 | 3237 |
| 4-#18 | 4.44 | MA | 2052 | 1107 | 3637 | 865 | 4448 | 703 | 5075 | 563 | 6101 | 319 | 7142 | 156 | 6177 |
| 2E | | MI | 1788 | 1107 | 3225 | 853 | 3906 | 693 | 4431 | 554 | 5179 | 293 | 5931 | 109 | 5349 |
| 6-#8 | 1.32 | MA | 1582 | 776 | 2160 | 683 | 2677 | 572 | 2980 | 484 | 3333 | 347 | 4052 | 293 | 2105 |
| 2L-3S | | MI | 1287 | 776 | 1770 | 680 | 2157 | 569 | 2362 | 480 | 2555 | 346 | 3005 | 222 | 1868 |
| 6-#8 | 1.32 | MA | 1444 | 776 | 1939 | 689 | 2396 | 577 | 2641 | 488 | 2877 | 353 | 3443 | 235 | 2105 |
| 3L-2S | | MI | 1406 | 776 | 1963 | 674 | 2401 | 565 | 2657 | 477 | 2951 | 342 | 3515 | 280 | 1865 |
| 6-#9 | 1.67 | MA | 1651 | 813 | 2341 | 704 | 2896 | 588 | 3242 | 493 | 3681 | 345 | 4494 | 285 | 2614 |
| 2L-3S | | MI | 1320 | 813 | 1878 | 701 | 2286 | 585 | 2513 | 490 | 2754 | 344 | 3246 | 196 | 2301 |
| 6-#9 | 1.67 | MA | 1484 | 813 | 2063 | 712 | 2544 | 594 | 2816 | 498 | 3108 | 351 | 3736 | 212 | 2602 |
| 3L-2S | | MI | 1464 | 813 | 2119 | 695 | 2591 | 580 | 2883 | 487 | 3252 | 339 | 3879 | 269 | 2307 |
| 6-#10 | 2.12 | MA | 1737 | 861 | 2568 | 732 | 3174 | 607 | 3573 | 506 | 4123 | 342 | 5048 | 274 | 3254 |
| 2L-3S | | MI | 1361 | 861 | 2013 | 730 | 2447 | 605 | 2704 | 502 | 3007 | 341 | 3546 | 161 | 2839 |
| 6-#10 | 2.12 | MA | 1535 | 861 | 2218 | 741 | 2732 | 615 | 3038 | 511 | 3402 | 349 | 4103 | 181 | 3221 |
| 3L-2S | | MI | 1535 | 861 | 2316 | 722 | 2831 | 599 | 3168 | 499 | 3632 | 336 | 4333 | 254 | 2863 |
| 6-#11 | 2.60 | MA | 1805 | 912 | 2806 | 757 | 3450 | 625 | 3894 | 516 | 4543 | 336 | 5497 | 250 | 3884 |
| 2L-3S | | MI | 1396 | 912 | 2159 | 755 | 2608 | 622 | 2886 | 511 | 3241 | 334 | 3771 | 110 | 3356 |
| 6-#11 | 2.60 | MA | 1580 | 912 | 2387 | 767 | 2920 | 633 | 3253 | 521 | 3680 | 343 | 4398 | 136 | 3823 |
| 3L-2S | | MI | 1589 | 912 | 2520 | 747 | 3065 | 617 | 3439 | 508 | 3985 | 330 | 4678 | 225 | 3403 |
| 6-#14 | 3.75 | MA | 1988 | 1034 | 3348 | 828 | 4118 | 677 | 4693 | 548 | 5611 | 328 | 6756 | 211 | 5418 |
| 2L-3S | | MI | 1491 | 1034 | 2476 | 828 | 2992 | 675 | 3341 | 542 | 3836 | 324 | 4439 | 9 | 4419 |
| 6-#14 | 3.75 | MA | 1698 | 1034 | 2756 | 842 | 3369 | 687 | 3787 | 554 | 4391 | 337 | 5233 | 45 | 5121 |
| 3L-2S | | MI | 1741 | 1034 | 2985 | 818 | 3636 | 668 | 4121 | 540 | 4880 | 319 | 5686 | 174 | 4719 |
| 6-#18 | 6.67 | MA | 2404 | 1343 | 4648 | 1012 | 5728 | 811 | 6622 | 632 | 8179 | 309 | 9630 | 86 | 9097 |
| 2L-3S | | MI | 1722 | 1343 | 3225 | 1014 | 3906 | 807 | 4431 | 620 | 5179 | 282 | 5931 | -276 | 5683 |
| 6-#18 | 6.67 | MA | 1986 | 1343 | 3637 | 1031 | 4448 | 823 | 5075 | 637 | 6101 | 318 | 7142 | -207 | 6864 |
| 3L-2S | | MI | 2084 | 1343 | 4089 | 1000 | 4999 | 801 | 5753 | 623 | 6899 | 274 | 7934 | 18 | 7839 |
| 8-#8 | 1.76 | MA | 1676 | 822 | 2382 | 712 | 2957 | 594 | 3319 | 498 | 3790 | 346 | 4661 | 288 | 2757 |
| 2L-4S | | MI | 1303 | 822 | 1826 | 714 | 2223 | 594 | 2430 | 501 | 2641 | 345 | 3150 | 183 | 2398 |
| 8-#8 | 1.76 | MA | 1545 | 822 | 2160 | 718 | 2677 | 599 | 2980 | 502 | 3333 | 351 | 4052 | 230 | 2749 |
| 3E | | MI | 1372 | 822 | 1963 | 709 | 2401 | 590 | 2657 | 494 | 2951 | 345 | 3515 | 214 | 2429 |
| 8-#8 | 1.76 | MA | 1465 | 822 | 2004 | 724 | 2473 | 604 | 2721 | 509 | 2978 | 353 | 3620 | 197 | 2708 |
| 4L-2S | | MI | 1486 | 822 | 2155 | 703 | 2645 | 586 | 2952 | 491 | 3348 | 340 | 4025 | 272 | 2433 |
| 8-#9 | 2.22 | MA | 1766 | 872 | 2619 | 741 | 3248 | 615 | 3667 | 511 | 4254 | 343 | 5252 | 277 | 3428 |
| 2L-4S | | MI | 1341 | 872 | 1948 | 745 | 2367 | 617 | 2597 | 515 | 2862 | 342 | 3424 | 146 | 2845 |
| 8-#9 | 2.22 | MA | 1608 | 872 | 2341 | 748 | 2896 | 621 | 3242 | 515 | 3681 | 349 | 4494 | 204 | 3405 |
| 3E | | MI | 1428 | 872 | 2119 | 738 | 2591 | 612 | 2883 | 507 | 3252 | 342 | 3879 | 184 | 2998 |
| 8-#9 | 2.22 | MA | 1513 | 872 | 2144 | 756 | 2640 | 627 | 2915 | 525 | 3235 | 351 | 3955 | 164 | 3230 |
| 4L-2S | | MI | 1561 | 872 | 2361 | 732 | 2896 | 607 | 3252 | 504 | 3749 | 337 | 4512 | 258 | 3015 |
| 8-#10 | 2.82 | MA | 1874 | 936 | 2918 | 778 | 3617 | 642 | 4109 | 528 | 4844 | 339 | 5992 | 263 | 4274 |
| 2L-4S | | MI | 1395 | 936 | 2100 | 785 | 2549 | 645 | 2809 | 534 | 3142 | 338 | 3767 | 98 | 3394 |
| 8-#10 | 2.82 | MA | 1692 | 936 | 2568 | 787 | 3174 | 649 | 3573 | 533 | 4123 | 346 | 5048 | 169 | 4226 |
| 3E | | MI | 1493 | 936 | 2316 | 777 | 2831 | 640 | 3168 | 524 | 3632 | 339 | 4333 | 145 | 3709 |
| 8-#10 | 2.82 | MA | 1573 | 936 | 2320 | 797 | 2852 | 657 | 3161 | 544 | 3561 | 349 | 4374 | 119 | 3865 |
| 4L-2S | | MI | 1651 | 936 | 2619 | 769 | 3215 | 634 | 3632 | 521 | 4257 | 333 | 5119 | 238 | 3748 |
| 8-#11 | 3.47 | MA | 1962 | 1004 | 3224 | 814 | 3979 | 668 | 4534 | 543 | 5405 | 332 | 6596 | 232 | 5102 |
| 2L-4S | | MI | 1432 | 1004 | 2261 | 821 | 2712 | 677 | 3008 | 548 | 3398 | 328 | 4020 | 31 | 3906 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 3.47 | MA | 1757 | 1004 | 2806 | 824 | 3450 | 675 | 3894 | 548 | 4543 | 340 | 5497 | 118 | 5020 |
| 3E | | MI | 1544 | 1004 | 2520 | 813 | 3065 | 664 | 3439 | 538 | 3985 | 331 | 4678 | 86 | 4387 |
| 8-#11 | 3.47 | MA | 1629 | 1004 | 2507 | 835 | 3062 | 683 | 3398 | 560 | 3867 | 340 | 4708 | 59 | 4466 |
| 4L-2S | | MI | 1722 | 1004 | 2882 | 804 | 3522 | 659 | 3991 | 535 | 4730 | 326 | 5584 | 200 | 4454 |
| 8-#14 | 5.00 | MA | 1940 | 1166 | 3348 | 925 | 4118 | 748 | 4693 | 593 | 5611 | 332 | 6756 | 15 | 6713 |
| 3E | | MI | 1694 | 1166 | 2985 | 911 | 3636 | 735 | 4121 | 581 | 4880 | 318 | 5686 | -31 | 5644 |
| 8-#14 | 5.00 | MA | 1778 | 1166 | 2925 | 938 | 3567 | 758 | 3990 | 609 | 4653 | 331 | 5658 | -67 | 5585 |
| 4L-2S | | MI | 1920 | 1166 | 3495 | 900 | 4280 | 729 | 4900 | 579 | 5923 | 313 | 6932 | 134 | 6192 |
| 10-#10 | 3.53 | MA | 2007 | 1010 | 3268 | 825 | 4060 | 676 | 4644 | 550 | 5565 | 336 | 6936 | 252 | 5292 |
| 2L-5S | | MI | 1448 | 1010 | 2208 | 839 | 2658 | 691 | 2949 | 560 | 3319 | 341 | 3997 | 26 | 3928 |
| 10-#10 | 3.53 | MA | 1837 | 1010 | 2918 | 834 | 3617 | 684 | 4109 | 555 | 4844 | 344 | 5992 | 158 | 5232 |
| 3L-4S | | MI | 1529 | 1010 | 2403 | 831 | 2933 | 680 | 3273 | 556 | 3766 | 336 | 4553 | 82 | 4228 |
| 10-#10 | 3.53 | MA | 1738 | 1010 | 2670 | 843 | 3294 | 691 | 3697 | 566 | 4282 | 346 | 5319 | 108 | 4837 |
| 4L-3S | | MI | 1617 | 1010 | 2619 | 823 | 3215 | 674 | 3632 | 546 | 4257 | 336 | 5119 | 129 | 4578 |
| 10-#10 | 3.53 | MA | 1632 | 1010 | 2448 | 853 | 2981 | 704 | 3327 | 572 | 3770 | 353 | 4652 | 53 | 4492 |
| 5L-2S | | MI | 1763 | 1010 | 2923 | 816 | 3598 | 668 | 4096 | 543 | 4881 | 330 | 5905 | 222 | 4629 |
| 10-#11 | 4.33 | MA | 1926 | 1096 | 3224 | 882 | 3979 | 717 | 4534 | 575 | 5405 | 336 | 6596 | 100 | 6220 |
| 3L-4S | | MI | 1587 | 1096 | 2622 | 878 | 3169 | 719 | 3561 | 575 | 4142 | 325 | 4927 | 7 | 4901 |
| 10-#11 | 4.33 | MA | 1814 | 1096 | 2926 | 892 | 3591 | 725 | 4039 | 587 | 4730 | 337 | 5807 | 41 | 5630 |
| 4L-3S | | MI | 1687 | 1096 | 2882 | 870 | 3522 | 707 | 3991 | 565 | 4730 | 327 | 5584 | 61 | 5402 |
| 10-#14 | 6.25 | MA | 2035 | 1299 | 3517 | 1021 | 4316 | 818 | 4896 | 648 | 5873 | 326 | 7181 | -97 | 7016 |
| 4L-3S | | MI | 1891 | 1299 | 3495 | 994 | 4280 | 796 | 4900 | 620 | 5923 | 313 | 6932 | -72 | 6816 |
| 12-#10 | 4.23 | MA | 1978 | 1085 | 3268 | 881 | 4060 | 718 | 4644 | 577 | 5565 | 341 | 6936 | 147 | 6238 |
| 3L-5S | | MI | 1579 | 1085 | 2511 | 886 | 3042 | 726 | 3413 | 582 | 3944 | 338 | 4784 | 10 | 4756 |
| 12-#10 | 4.23 | MA | 1890 | 1085 | 3020 | 890 | 3737 | 725 | 4232 | 588 | 5003 | 343 | 6263 | 97 | 5815 |
| 4E | | MI | 1657 | 1085 | 2706 | 878 | 3316 | 714 | 3737 | 578 | 4391 | 333 | 5340 | 66 | 5069 |
| 12-#10 | 4.23 | MA | 1791 | 1085 | 2798 | 899 | 3423 | 738 | 3862 | 594 | 4491 | 351 | 5596 | 42 | 5462 |
| 5L-3S | | MI | 1736 | 1085 | 2923 | 870 | 3598 | 708 | 4096 | 568 | 4881 | 333 | 5905 | 113 | 5448 |
| 12-#11 | 5.20 | MA | 1991 | 1187 | 3345 | 949 | 4121 | 767 | 4680 | 614 | 5593 | 334 | 6907 | 23 | 6802 |
| 4E | | MI | 1737 | 1187 | 2983 | 936 | 3626 | 761 | 4114 | 602 | 4887 | 321 | 5833 | -18 | 5809 |
| 14-#10 | 4.94 | MA | 2036 | 1160 | 3370 | 937 | 4180 | 760 | 4768 | 610 | 5724 | 340 | 7207 | 86 | 6799 |
| 4L-5S | | MI | 1705 | 1160 | 2815 | 933 | 3425 | 760 | 3877 | 604 | 4568 | 335 | 5570 | -6 | 5562 |
| 14-#10 | 4.94 | MA | 1939 | 1160 | 3148 | 946 | 3866 | 773 | 4397 | 616 | 5212 | 348 | 6540 | 30 | 6437 |
| 5L-4S | | MI | 1782 | 1160 | 3009 | 925 | 3700 | 748 | 4201 | 600 | 5016 | 330 | 6126 | 50 | 5915 |

## RECTANGULAR TIED COLUMNS 18" x 22"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.01 | MA | 1843 | 818 | 2407 | 735 | 3002 | 618 | 3334 | 526 | 3678 | 387 | 4474 | 334 | 2008 |
| 2E | | MI | 1479 | 818 | 2018 | 717 | 2453 | 603 | 2691 | 513 | 2930 | 376 | 3444 | 311 | 1606 |
| 4-#10 | 1.28 | MA | 1913 | 850 | 2584 | 752 | 3215 | 631 | 3586 | 534 | 4013 | 384 | 4908 | 328 | 2501 |
| 2E | | MI | 1529 | 850 | 2154 | 734 | 2615 | 615 | 2882 | 520 | 3183 | 373 | 3744 | 300 | 1987 |
| 4-#11 | 1.58 | MA | 1973 | 884 | 2779 | 767 | 3433 | 641 | 3835 | 539 | 4335 | 379 | 5272 | 314 | 2996 |
| 2E | | MI | 1568 | 884 | 2303 | 747 | 2777 | 624 | 3064 | 524 | 3416 | 367 | 3967 | 279 | 2364 |
| 4-#14 | 2.27 | MA | 2128 | 965 | 3202 | 813 | 3949 | 674 | 4448 | 559 | 5150 | 373 | 6276 | 292 | 4183 |
| 2E | | MI | 1674 | 965 | 2622 | 792 | 3162 | 656 | 3520 | 543 | 4011 | 359 | 4634 | 244 | 3263 |
| 4-#18 | 4.04 | MA | 2466 | 1171 | 4218 | 932 | 5194 | 761 | 5934 | 613 | 7134 | 360 | 8607 | 224 | 7041 |
| 2E | | MI | 1907 | 1171 | 3375 | 909 | 4078 | 741 | 4609 | 595 | 5353 | 326 | 6123 | 138 | 5384 |
| 6-#8 | 1.20 | MA | 1901 | 840 | 2517 | 751 | 3151 | 630 | 3518 | 534 | 3931 | 387 | 4838 | 335 | 2361 |
| 2L-3S | | MI | 1402 | 840 | 1909 | 738 | 2325 | 619 | 2540 | 524 | 2731 | 381 | 3203 | 252 | 1885 |
| 6-#8 | 1.20 | MA | 1742 | 840 | 2266 | 757 | 2834 | 636 | 3135 | 539 | 3414 | 394 | 4129 | 277 | 2361 |
| 3L-2S | | MI | 1522 | 840 | 2101 | 733 | 2568 | 615 | 2834 | 521 | 3128 | 377 | 3714 | 310 | 1880 |
| 6-#9 | 1.52 | MA | 1982 | 877 | 2722 | 772 | 3401 | 645 | 3815 | 544 | 4326 | 385 | 5358 | 329 | 2938 |
| 2L-3S | | MI | 1435 | 877 | 2018 | 760 | 2453 | 635 | 2691 | 533 | 2930 | 379 | 3444 | 226 | 2323 |
| 6-#9 | 1.52 | MA | 1789 | 877 | 2407 | 780 | 3002 | 652 | 3334 | 550 | 3678 | 393 | 4474 | 256 | 2926 |
| 3L-2S | | MI | 1581 | 877 | 2259 | 753 | 2759 | 630 | 3060 | 530 | 3428 | 374 | 4077 | 299 | 2324 |
| 6-#10 | 1.92 | MA | 2083 | 924 | 2980 | 799 | 3717 | 665 | 4193 | 556 | 4830 | 382 | 6012 | 321 | 3665 |
| 2L-3S | | MI | 1476 | 924 | 2154 | 788 | 2615 | 655 | 2882 | 546 | 3183 | 376 | 3744 | 191 | 2866 |

## RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 1.92 | MA | 1849 | 924 | 2584 | 809 | 3215 | 674 | 3586 | 563 | 4013 | 391 | 4908 | 227 | 3632 |
| 3L-2S | | MI | 1653 | 924 | 2457 | 780 | 2999 | 649 | 3346 | 542 | 3808 | 370 | 4530 | 284 | 2882 |
| 6-#11 | 2.36 | MA | 2168 | 976 | 3255 | 825 | 4036 | 683 | 4563 | 566 | 5316 | 376 | 6565 | 301 | 4390 |
| 2L-3S | | MI | 1510 | 976 | 2303 | 813 | 2777 | 671 | 3064 | 554 | 3416 | 368 | 3967 | 140 | 3392 |
| 6-#11 | 2.36 | MA | 1899 | 976 | 2779 | 836 | 3433 | 692 | 3835 | 573 | 4335 | 386 | 5272 | 187 | 4328 |
| 3L-2S | | MI | 1708 | 976 | 2664 | 804 | 3234 | 666 | 3617 | 551 | 4160 | 364 | 4873 | 255 | 3427 |
| 6-#14 | 3.41 | MA | 2385 | 1097 | 3877 | 896 | 4802 | 735 | 5480 | 598 | 6541 | 368 | 8078 | 270 | 6147 |
| 2L-3S | | MI | 1604 | 1097 | 2622 | 885 | 3162 | 723 | 3520 | 585 | 4011 | 358 | 4634 | 39 | 4545 |
| 6-#14 | 3.41 | MA | 2046 | 1097 | 3202 | 912 | 3949 | 747 | 4448 | 607 | 5150 | 381 | 6276 | 105 | 5974 |
| 3L-2S | | MI | 1860 | 1097 | 3131 | 875 | 3806 | 717 | 4299 | 582 | 5054 | 353 | 5880 | 204 | 4747 |
| 6-#18 | 6.06 | MA | 2878 | 1406 | 5376 | 1080 | 6660 | 869 | 7707 | 682 | 9521 | 351 | 11586 | 171 | 10393 |
| 2L-3S | | MI | 1831 | 1406 | 3375 | 1070 | 4078 | 854 | 4609 | 662 | 5353 | 315 | 6123 | -247 | 5907 |
| 6-#18 | 6.06 | MA | 2387 | 1406 | 4218 | 1103 | 5194 | 886 | 5934 | 693 | 7134 | 367 | 8607 | -123 | 8387 |
| 3L-2S | | MI | 2204 | 1406 | 4239 | 1056 | 5171 | 849 | 5931 | 664 | 7073 | 307 | 8127 | 47 | 7877 |
| 8-#8 | 1.60 | MA | 2011 | 886 | 2767 | 780 | 3468 | 651 | 3902 | 548 | 4447 | 386 | 5546 | 332 | 3099 |
| 2L-4S | | MI | 1417 | 886 | 1964 | 773 | 2390 | 645 | 2607 | 544 | 2817 | 380 | 3348 | 214 | 2428 |
| 8-#8 | 1.60 | MA | 1859 | 886 | 2517 | 787 | 3151 | 657 | 3518 | 553 | 3931 | 392 | 4838 | 274 | 3090 |
| 3E | | MI | 1488 | 886 | 2101 | 767 | 2568 | 640 | 2834 | 538 | 3128 | 379 | 3714 | 244 | 2449 |
| 8-#8 | 1.60 | MA | 1768 | 886 | 2341 | 793 | 2922 | 663 | 3226 | 561 | 3531 | 395 | 4338 | 240 | 3050 |
| 4L-2S | | MI | 1603 | 886 | 2294 | 762 | 2812 | 636 | 3129 | 535 | 3524 | 375 | 4224 | 302 | 2450 |
| 8-#9 | 2.02 | MA | 2116 | 936 | 3037 | 809 | 3799 | 672 | 4297 | 561 | 4975 | 383 | 6241 | 324 | 3860 |
| 2L-4S | | MI | 1455 | 936 | 2087 | 803 | 2535 | 667 | 2775 | 559 | 3038 | 377 | 3622 | 177 | 2913 |
| 8-#9 | 2.02 | MA | 1934 | 936 | 2722 | 817 | 3401 | 679 | 3815 | 567 | 4326 | 390 | 5358 | 251 | 3837 |
| 3E | | MI | 1540 | 936 | 2259 | 797 | 2759 | 662 | 3060 | 551 | 3428 | 377 | 4077 | 215 | 3022 |
| 8-#9 | 2.02 | MA | 1825 | 936 | 2501 | 825 | 3113 | 686 | 3448 | 577 | 3824 | 394 | 4733 | 209 | 3697 |
| 4L-2S | | MI | 1679 | 936 | 2500 | 790 | 3064 | 657 | 3429 | 547 | 3925 | 372 | 4710 | 288 | 3034 |
| 8-#10 | 2.57 | MA | 2246 | 999 | 3377 | 846 | 4219 | 699 | 4800 | 578 | 5647 | 379 | 7115 | 313 | 4823 |
| 2L-4S | | MI | 1503 | 999 | 2240 | 843 | 2717 | 695 | 2986 | 577 | 3318 | 373 | 3964 | 128 | 3469 |
| 8-#10 | 2.57 | MA | 2027 | 999 | 2980 | 856 | 3717 | 708 | 4193 | 585 | 4830 | 388 | 6012 | 220 | 4775 |
| 3E | | MI | 1609 | 999 | 2457 | 835 | 2999 | 689 | 3346 | 568 | 3808 | 373 | 4530 | 175 | 3738 |
| 8-#10 | 2.57 | MA | 1896 | 999 | 2702 | 866 | 3354 | 717 | 3729 | 598 | 4196 | 392 | 5230 | 167 | 4427 |
| 4L-2S | | MI | 1770 | 999 | 2760 | 827 | 3383 | 683 | 3810 | 564 | 4432 | 368 | 5316 | 268 | 3769 |
| 8-#11 | 3.15 | MA | 2353 | 1067 | 3731 | 882 | 4638 | 725 | 5292 | 593 | 6296 | 372 | 7859 | 289 | 5776 |
| 2L-4S | | MI | 1544 | 1067 | 2404 | 878 | 2882 | 726 | 3186 | 591 | 3573 | 362 | 4216 | 61 | 3989 |
| 8-#11 | 3.15 | MA | 2112 | 1067 | 3255 | 894 | 4036 | 735 | 4563 | 600 | 5316 | 382 | 6565 | 174 | 5694 |
| 3E | | MI | 1659 | 1067 | 2664 | 870 | 3234 | 714 | 3617 | 581 | 4160 | 365 | 4873 | 116 | 4424 |
| 8-#11 | 3.15 | MA | 1956 | 1067 | 2918 | 905 | 3597 | 744 | 4004 | 615 | 4552 | 385 | 5644 | 111 | 5127 |
| 4L-2S | | MI | 1841 | 1067 | 3025 | 862 | 3691 | 708 | 4169 | 578 | 4905 | 360 | 5780 | 230 | 4480 |
| 8-#14 | 4.55 | MA | 2329 | 1230 | 3877 | 994 | 4802 | 808 | 5480 | 646 | 6541 | 376 | 8078 | 83 | 7819 |
| 3E | | MI | 1808 | 1230 | 3131 | 968 | 3806 | 784 | 4299 | 624 | 5054 | 352 | 5880 | -2 | 5878 |
| 8-#14 | 4.55 | MA | 2142 | 1230 | 3398 | 1010 | 4179 | 820 | 4685 | 665 | 5455 | 378 | 6790 | -5 | 6783 |
| 4L-2S | | MI | 2041 | 1230 | 3641 | 957 | 4451 | 778 | 5078 | 621 | 6098 | 347 | 7127 | 163 | 6223 |
| 10-#10 | 3.21 | MA | 2401 | 1074 | 3774 | 893 | 4721 | 734 | 5407 | 600 | 6464 | 376 | 8219 | 306 | 5977 |
| 2L-5S | | MI | 1559 | 1074 | 2349 | 897 | 2826 | 741 | 3126 | 603 | 3495 | 376 | 4195 | 56 | 4040 |
| 10-#10 | 3.21 | MA | 2203 | 1074 | 3377 | 903 | 4219 | 742 | 4800 | 607 | 5647 | 385 | 7115 | 213 | 5917 |
| 3L-4S | | MI | 1642 | 1074 | 2544 | 889 | 3101 | 729 | 3450 | 599 | 3942 | 370 | 4751 | 112 | 4300 |
| 10-#10 | 3.21 | MA | 2079 | 1074 | 3098 | 913 | 3856 | 751 | 4336 | 620 | 5013 | 389 | 6334 | 160 | 5535 |
| 4L-3S | | MI | 1733 | 1074 | 2760 | 882 | 3383 | 724 | 3810 | 590 | 4432 | 370 | 5316 | 159 | 4609 |
| 10-#10 | 3.21 | MA | 1959 | 1074 | 2849 | 923 | 3503 | 765 | 3919 | 627 | 4438 | 399 | 5554 | 105 | 5194 |
| 5L-2S | | MI | 1884 | 1074 | 3063 | 874 | 3766 | 718 | 4274 | 586 | 5057 | 365 | 6103 | 252 | 4651 |
| 10-#11 | 3.94 | MA | 2309 | 1159 | 3731 | 951 | 4638 | 777 | 5292 | 627 | 6296 | 379 | 7859 | 162 | 7062 |
| 3L-4S | | MI | 1700 | 1159 | 2765 | 936 | 3339 | 768 | 3739 | 618 | 4318 | 359 | 5123 | 37 | 4980 |
| 10-#11 | 3.94 | MA | 2180 | 1159 | 3395 | 963 | 4200 | 786 | 4732 | 641 | 5533 | 382 | 6938 | 99 | 6458 |
| 4L-3S | | MI | 1803 | 1159 | 3025 | 927 | 3691 | 756 | 4169 | 608 | 4905 | 361 | 5780 | 91 | 5457 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

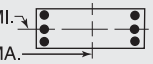
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 3.94 | MA | 2040 | 1159 | 3093 | 974 | 3774 | 803 | 4230 | 649 | 4838 | 392 | 6024 | 31 | 5923 |
| 5L-2S | | MI | 1972 | 1159 | 3386 | 919 | 4148 | 750 | 4722 | 605 | 5649 | 357 | 6686 | 206 | 5528 |
| 10-#14 | 5.68 | MA | 2440 | 1362 | 4073 | 1093 | 5032 | 881 | 5717 | 704 | 6845 | 374 | 8591 | -27 | 8532 |
| 4L-3S | | MI | 2005 | 1362 | 3641 | 1051 | 4451 | 845 | 5078 | 663 | 6098 | 346 | 7127 | -42 | 7060 |
| 12-#10 | 3.85 | MA | 2367 | 1149 | 3774 | 950 | 4721 | 777 | 5407 | 629 | 6464 | 383 | 8219 | 206 | 7061 |
| 3L-5S | | MI | 1693 | 1149 | 2652 | 944 | 3210 | 775 | 3590 | 625 | 4119 | 373 | 4981 | 40 | 4864 |
| 12-#10 | 3.85 | MA | 2264 | 1149 | 3495 | 960 | 4357 | 785 | 4943 | 641 | 5831 | 387 | 7437 | 153 | 6648 |
| 4E | | MI | 1771 | 1149 | 2847 | 936 | 3484 | 764 | 3914 | 621 | 4567 | 367 | 5537 | 96 | 5138 |
| 12-#10 | 3.85 | MA | 2144 | 1149 | 3246 | 970 | 4005 | 800 | 4526 | 649 | 5255 | 396 | 6658 | 98 | 6304 |
| 5L-3S | | MI | 1853 | 1149 | 3063 | 928 | 3766 | 758 | 4274 | 612 | 5057 | 367 | 6103 | 143 | 5480 |
| 12-#10 | 3.85 | MA | 1981 | 1149 | 3003 | 979 | 3685 | 808 | 4119 | 661 | 4693 | 400 | 5903 | 30 | 5777 |
| 6L-2S | | MI | 1995 | 1149 | 3367 | 920 | 4150 | 752 | 4738 | 608 | 5682 | 362 | 6889 | 236 | 5532 |
| 12-#11 | 4.73 | MA | 2386 | 1251 | 3871 | 1020 | 4802 | 828 | 5461 | 668 | 6514 | 378 | 8232 | 86 | 7796 |
| 4E | | MI | 1850 | 1251 | 3127 | 993 | 3796 | 810 | 4292 | 645 | 5062 | 355 | 6029 | 12 | 5980 |
| 12-#11 | 4.73 | MA | 2249 | 1251 | 3569 | 1031 | 4376 | 845 | 4958 | 676 | 5819 | 388 | 7318 | 19 | 7253 |
| 5L-3S | | MI | 1942 | 1251 | 3386 | 985 | 4148 | 798 | 4722 | 635 | 5649 | 358 | 6686 | 67 | 6473 |
| 14-#10 | 4.49 | MA | 2434 | 1223 | 3892 | 1007 | 4859 | 820 | 5550 | 663 | 6648 | 384 | 8541 | 146 | 7767 |
| 4L-5S | | MI | 1820 | 1223 | 2955 | 991 | 3593 | 810 | 4054 | 647 | 4744 | 370 | 5767 | 24 | 5694 |
| 14-#10 | 4.49 | MA | 2316 | 1223 | 3643 | 1017 | 4507 | 834 | 5133 | 670 | 6072 | 393 | 7762 | 91 | 7418 |
| 5L-4S | | MI | 1896 | 1223 | 3150 | 983 | 3868 | 798 | 4378 | 643 | 5192 | 364 | 6323 | 80 | 5982 |
| 14-#10 | 4.49 | MA | 2171 | 1223 | 3400 | 1026 | 4187 | 843 | 4726 | 683 | 5510 | 397 | 7006 | 22 | 6907 |
| 6L-3S | | MI | 1971 | 1223 | 3367 | 975 | 4150 | 792 | 4738 | 634 | 5682 | 365 | 6889 | 127 | 6351 |
| 14-#11 | 5.52 | MA | 2451 | 1343 | 4045 | 1089 | 4978 | 887 | 5686 | 703 | 6799 | 385 | 8611 | 6 | 8589 |
| 5L-4S | | MI | 1995 | 1343 | 3488 | 1051 | 4253 | 853 | 4844 | 672 | 5806 | 352 | 6936 | -12 | 6915 |
| 16-#10 | 5.13 | MA | 2483 | 1298 | 4039 | 1063 | 5008 | 868 | 5740 | 692 | 6889 | 390 | 8865 | 84 | 8535 |
| 5E | | MI | 1943 | 1298 | 3259 | 1037 | 3977 | 844 | 4518 | 669 | 5369 | 367 | 6554 | 8 | 6529 |
| 16-#10 | 5.13 | MA | 2347 | 1298 | 3797 | 1073 | 4689 | 877 | 5333 | 705 | 6327 | 394 | 8110 | 15 | 8040 |
| 6L-4S | | MI | 2018 | 1298 | 3453 | 1030 | 4252 | 832 | 4842 | 665 | 5816 | 362 | 7110 | 64 | 6830 |

## RECTANGULAR TIED COLUMNS 18" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.18 | MA | 2262 | 913 | 2970 | 820 | 3731 | 688 | 4171 | 584 | 4663 | 424 | 5763 | 369 | 2775 |
| 2E | | MI | 1645 | 913 | 2294 | 792 | 2783 | 664 | 3059 | 563 | 3359 | 408 | 3941 | 331 | 2003 |
| 4-#11 | 1.44 | MA | 2332 | 947 | 3191 | 835 | 3979 | 699 | 4454 | 589 | 5029 | 419 | 6196 | 357 | 3333 |
| 2E | | MI | 1685 | 947 | 2446 | 804 | 2946 | 673 | 3242 | 567 | 3591 | 401 | 4163 | 309 | 2384 |
| 4-#14 | 2.08 | MA | 2513 | 1029 | 3668 | 881 | 4560 | 732 | 5145 | 610 | 5949 | 413 | 7371 | 341 | 4669 |
| 2E | | MI | 1792 | 1029 | 2768 | 849 | 3332 | 704 | 3698 | 586 | 4185 | 393 | 4829 | 274 | 3288 |
| 4-#18 | 3.70 | MA | 2911 | 1235 | 4820 | 1000 | 5972 | 818 | 6831 | 663 | 8198 | 400 | 10129 | 286 | 7905 |
| 2E | | MI | 2026 | 1235 | 3525 | 965 | 4250 | 788 | 4788 | 637 | 5527 | 359 | 6315 | 167 | 5418 |
| 6-#8 | 1.10 | MA | 2246 | 903 | 2893 | 818 | 3657 | 688 | 4093 | 585 | 4568 | 428 | 5641 | 372 | 2617 |
| 2L-3S | | MI | 1516 | 903 | 2047 | 797 | 2492 | 669 | 2717 | 568 | 2907 | 416 | 3402 | 283 | 1902 |
| 6-#8 | 1.10 | MA | 2065 | 903 | 2614 | 826 | 3303 | 694 | 3665 | 590 | 3992 | 435 | 4843 | 315 | 2617 |
| 3L-2S | | MI | 1638 | 903 | 2240 | 792 | 2735 | 665 | 3012 | 565 | 3304 | 412 | 3912 | 341 | 1895 |
| 6-#9 | 1.39 | MA | 2340 | 940 | 3123 | 839 | 3937 | 703 | 4426 | 594 | 5012 | 425 | 6252 | 369 | 3262 |
| 2L-3S | | MI | 1549 | 940 | 2157 | 818 | 2621 | 684 | 2868 | 577 | 3106 | 413 | 3641 | 256 | 2343 |
| 6-#9 | 1.39 | MA | 2121 | 940 | 2771 | 848 | 3492 | 711 | 3888 | 601 | 4287 | 434 | 5248 | 297 | 3250 |
| 3L-2S | | MI | 1697 | 940 | 2398 | 812 | 2926 | 680 | 3238 | 574 | 3603 | 409 | 4275 | 330 | 2341 |
| 6-#10 | 1.76 | MA | 2456 | 988 | 3413 | 867 | 4292 | 723 | 4850 | 606 | 5576 | 422 | 7026 | 365 | 4077 |
| 2L-3S | | MI | 1590 | 988 | 2294 | 846 | 2783 | 705 | 3059 | 589 | 3359 | 410 | 3941 | 221 | 2892 |
| 6-#10 | 1.76 | MA | 2190 | 988 | 2970 | 878 | 3731 | 732 | 4171 | 614 | 4663 | 433 | 5763 | 272 | 4044 |
| 3L-2S | | MI | 1770 | 988 | 2597 | 839 | 3167 | 699 | 3523 | 585 | 3983 | 405 | 4727 | 315 | 2901 |
| 6-#11 | 2.17 | MA | 2557 | 1039 | 3724 | 892 | 4653 | 741 | 5270 | 616 | 6128 | 416 | 7686 | 349 | 4895 |
| 2L-3S | | MI | 1624 | 1039 | 2446 | 870 | 2946 | 720 | 3242 | 597 | 3591 | 402 | 4163 | 170 | 3424 |
| 6-#11 | 2.17 | MA | 2250 | 1039 | 3191 | 905 | 3979 | 751 | 4454 | 625 | 5029 | 428 | 6196 | 235 | 4834 |
| 3L-2S | | MI | 1825 | 1039 | 2807 | 862 | 3403 | 715 | 3795 | 594 | 4336 | 398 | 5069 | 285 | 3450 |
| 6-#14 | 3.13 | MA | 2813 | 1161 | 4426 | 964 | 5518 | 793 | 6305 | 649 | 7510 | 408 | 9454 | 325 | 6876 |
| 2L-3S | | MI | 1718 | 1161 | 2768 | 942 | 3332 | 772 | 3698 | 627 | 4185 | 392 | 4829 | 68 | 4668 |

## RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis



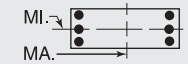

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 3.13 | MA | 2422 | 1161 | 3668 | 981 | 4560 | 807 | 5145 | 660 | 5949 | 424 | 7371 | 160 | 6703 |
| 3L-2S | | MI | 1979 | 1161 | 3277 | 932 | 3977 | 765 | 4477 | 625 | 5229 | 387 | 6075 | 233 | 4776 |
| 6-#18 | 5.56 | MA | 3384 | 1470 | 6125 | 1147 | 7624 | 926 | 8828 | 732 | 10888 | 391 | 13605 | 246 | 11689 |
| 2L-3S | | MI | 1941 | 1470 | 3525 | 1126 | 4250 | 902 | 4788 | 703 | 5527 | 349 | 6315 | -218 | 6129 |
| 6-#18 | 5.56 | MA | 2818 | 1470 | 4820 | 1175 | 5972 | 948 | 6831 | 748 | 8198 | 413 | 10129 | -48 | 10021 |
| 3L-2S | | MI | 2324 | 1470 | 4389 | 1112 | 5343 | 896 | 6110 | 706 | 7247 | 340 | 8319 | 76 | 7914 |
| 8-#8 | 1.46 | MA | 2372 | 950 | 3173 | 847 | 4011 | 709 | 4521 | 598 | 5144 | 426 | 6439 | 370 | 3440 |
| 2L-4S | | MI | 1531 | 950 | 2103 | 831 | 2557 | 695 | 2784 | 588 | 2994 | 415 | 3547 | 244 | 2454 |
| 8-#8 | 1.46 | MA | 2200 | 950 | 2893 | 855 | 3657 | 715 | 4093 | 604 | 4568 | 433 | 5641 | 313 | 3431 |
| 3E | | MI | 1603 | 950 | 2240 | 826 | 2735 | 690 | 3012 | 581 | 3304 | 414 | 3912 | 275 | 2467 |
| 8-#8 | 1.46 | MA | 2097 | 950 | 2699 | 862 | 3403 | 722 | 3768 | 613 | 4124 | 437 | 5084 | 279 | 3391 |
| 4L-2S | | MI | 1719 | 950 | 2432 | 821 | 2979 | 686 | 3306 | 578 | 3700 | 410 | 4422 | 333 | 2466 |
| 8-#9 | 1.85 | MA | 2494 | 999 | 3475 | 876 | 4382 | 730 | 4964 | 611 | 5736 | 423 | 7255 | 366 | 4292 |
| 2L-4S | | MI | 1569 | 999 | 2227 | 862 | 2702 | 716 | 2952 | 602 | 3214 | 412 | 3820 | 207 | 2979 |
| 8-#9 | 1.85 | MA | 2286 | 999 | 3123 | 885 | 3937 | 738 | 4426 | 618 | 5012 | 432 | 6252 | 294 | 4269 |
| 3E | | MI | 1655 | 999 | 2398 | 855 | 2926 | 711 | 3238 | 594 | 3603 | 411 | 4275 | 245 | 3045 |
| 8-#9 | 1.85 | MA | 2162 | 999 | 2878 | 894 | 3617 | 746 | 4017 | 629 | 4453 | 436 | 5548 | 250 | 4175 |
| 4L-2S | | MI | 1797 | 999 | 2640 | 849 | 3231 | 707 | 3607 | 591 | 4101 | 406 | 4908 | 318 | 3053 |
| 8-#10 | 2.35 | MA | 2643 | 1063 | 3857 | 914 | 4853 | 757 | 5528 | 628 | 6490 | 419 | 8290 | 361 | 5372 |
| 2L-4S | | MI | 1617 | 1063 | 2381 | 901 | 2885 | 745 | 3164 | 620 | 3493 | 407 | 4162 | 158 | 3542 |
| 8-#10 | 2.35 | MA | 2393 | 1063 | 3413 | 925 | 4292 | 767 | 4850 | 636 | 5576 | 430 | 7026 | 268 | 5323 |
| 3E | | MI | 1724 | 1063 | 2597 | 893 | 3167 | 739 | 3523 | 611 | 3983 | 408 | 4727 | 205 | 3766 |
| 8-#10 | 2.35 | MA | 2246 | 1063 | 3104 | 936 | 3888 | 776 | 4333 | 650 | 4871 | 435 | 6136 | 213 | 5003 |
| 4L-2S | | MI | 1889 | 1063 | 2901 | 885 | 3551 | 733 | 3987 | 607 | 4608 | 402 | 5514 | 299 | 3790 |
| 8-#11 | 2.89 | MA | 2772 | 1131 | 4258 | 950 | 5328 | 783 | 6087 | 643 | 7227 | 412 | 9175 | 341 | 6449 |
| 2L-4S | | MI | 1657 | 1131 | 2548 | 936 | 3051 | 775 | 3364 | 633 | 3749 | 396 | 4412 | 91 | 4069 |
| 8-#11 | 2.89 | MA | 2487 | 1131 | 3724 | 962 | 4653 | 794 | 5270 | 652 | 6128 | 424 | 7686 | 226 | 6368 |
| 3E | | MI | 1774 | 1131 | 2807 | 927 | 3403 | 763 | 3795 | 624 | 4336 | 399 | 5069 | 146 | 4459 |
| 8-#11 | 2.89 | MA | 2317 | 1131 | 3350 | 975 | 4165 | 804 | 4647 | 668 | 5277 | 429 | 6632 | 161 | 5802 |
| 4L-2S | | MI | 1961 | 1131 | 3169 | 919 | 3861 | 757 | 4347 | 621 | 5080 | 394 | 5976 | 260 | 4505 |
| 8-#14 | 4.17 | MA | 2746 | 1294 | 4426 | 1064 | 5518 | 868 | 6305 | 699 | 7510 | 419 | 9454 | 144 | 8879 |
| 3E | | MI | 1923 | 1294 | 3277 | 1025 | 3977 | 833 | 4477 | 666 | 5229 | 386 | 6075 | 28 | 6002 |
| 8-#14 | 4.17 | MA | 2533 | 1294 | 3892 | 1081 | 4822 | 882 | 5416 | 720 | 6297 | 425 | 7974 | 52 | 7718 |
| 4L-2S | | MI | 2161 | 1294 | 3786 | 1014 | 4621 | 826 | 5257 | 664 | 6273 | 381 | 7321 | 193 | 6253 |
| 8-#18 | 7.41 | MA | 3354 | 1706 | 6125 | 1322 | 7624 | 1056 | 8828 | 817 | 10888 | 404 | 13605 | -88 | 13339 |
| 3E | | MI | 2278 | 1706 | 4389 | 1273 | 5343 | 1010 | 6110 | 773 | 7247 | 329 | 8319 | -309 | 7972 |
| 8-#18 | 7.41 | MA | 3050 | 1706 | 5199 | 1349 | 6417 | 1078 | 7288 | 851 | 8787 | 408 | 11119 | -243 | 10620 |
| 4L-2S | | MI | 2619 | 1706 | 5253 | 1259 | 6436 | 1005 | 7432 | 775 | 8967 | 321 | 10323 | -15 | 10291 |
| 10-#10 | 2.94 | MA | 2824 | 1138 | 4300 | 960 | 5414 | 791 | 6206 | 650 | 7403 | 416 | 9554 | 357 | 6663 |
| 2L-5S | | MI | 1671 | 1138 | 2489 | 956 | 2994 | 790 | 3304 | 646 | 3671 | 410 | 4392 | 86 | 4145 |
| 10-#10 | 2.94 | MA | 2589 | 1138 | 3857 | 971 | 4853 | 801 | 5528 | 658 | 6490 | 427 | 8290 | 264 | 6603 |
| 3L-4S | | MI | 1756 | 1138 | 2684 | 948 | 3269 | 779 | 3628 | 642 | 4118 | 405 | 4948 | 142 | 4370 |
| 10-#10 | 2.94 | MA | 2454 | 1138 | 3547 | 982 | 4449 | 811 | 5012 | 672 | 5785 | 432 | 7400 | 209 | 6246 |
| 4L-3S | | MI | 1849 | 1138 | 2901 | 940 | 3551 | 773 | 3987 | 633 | 4608 | 405 | 5514 | 189 | 4638 |
| 10-#10 | 2.94 | MA | 2312 | 1138 | 3271 | 994 | 4057 | 826 | 4549 | 680 | 5145 | 443 | 6508 | 155 | 5838 |
| 5L-2S | | MI | 2004 | 1138 | 3204 | 932 | 3934 | 767 | 4451 | 629 | 5233 | 399 | 6300 | 283 | 4674 |
| 10-#11 | 3.61 | MA | 2722 | 1223 | 4258 | 1020 | 5328 | 836 | 6087 | 679 | 7227 | 421 | 9175 | 218 | 7904 |
| 3L-4S | | MI | 1813 | 1223 | 2909 | 993 | 3508 | 817 | 3917 | 660 | 4493 | 393 | 5318 | 66 | 5058 |
| 10-#11 | 3.61 | MA | 2562 | 1223 | 3883 | 1032 | 4840 | 847 | 5463 | 695 | 6376 | 426 | 8121 | 153 | 7300 |
| 4L-3S | | MI | 1918 | 1223 | 3169 | 985 | 3861 | 805 | 4347 | 651 | 5080 | 395 | 5976 | 121 | 5493 |
| 10-#11 | 3.61 | MA | 2399 | 1223 | 3549 | 1045 | 4366 | 864 | 4904 | 704 | 5602 | 438 | 7069 | 85 | 6759 |
| 5L-2S | | MI | 2092 | 1223 | 3530 | 977 | 4318 | 799 | 4900 | 648 | 5824 | 391 | 6882 | 236 | 5554 |
| 10-#14 | 5.21 | MA | 2874 | 1426 | 4650 | 1164 | 5781 | 943 | 6576 | 759 | 7858 | 420 | 10058 | 37 | 9867 |
| 4L-3S | | MI | 2120 | 1426 | 3786 | 1108 | 4621 | 893 | 5257 | 705 | 6273 | 380 | 7321 | -13 | 7302 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

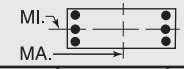
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 5.21 | MA | 2645 | 1426 | 4172 | 1181 | 5105 | 968 | 5778 | 771 | 6755 | 435 | 8586 | -61 | 8498 |
| 5L-2S | | MI | 2339 | 1426 | 4296 | 1097 | 5265 | 887 | 6036 | 703 | 7317 | 375 | 8568 | 152 | 7725 |
| 12-#10 | 3.53 | MA | 2784 | 1212 | 4300 | 1018 | 5414 | 835 | 6206 | 680 | 7403 | 424 | 9554 | 260 | 7884 |
| 3L-5S | | MI | 1808 | 1212 | 2793 | 1002 | 3378 | 825 | 3768 | 668 | 4295 | 407 | 5178 | 70 | 4969 |
| 12-#10 | 3.53 | MA | 2655 | 1212 | 3990 | 1029 | 5010 | 845 | 5690 | 694 | 6698 | 429 | 8663 | 205 | 7495 |
| 4E | | MI | 1885 | 1212 | 2987 | 994 | 3652 | 813 | 4092 | 664 | 4743 | 402 | 5734 | 126 | 5206 |
| 12-#10 | 3.53 | MA | 2515 | 1212 | 3714 | 1040 | 4618 | 860 | 5228 | 702 | 6058 | 440 | 7771 | 151 | 7106 |
| 5L-3S | | MI | 1970 | 1212 | 3204 | 987 | 3934 | 808 | 4451 | 655 | 5233 | 402 | 6300 | 173 | 5510 |
| 12-#10 | 3.53 | MA | 2339 | 1212 | 3438 | 1049 | 4264 | 870 | 4776 | 716 | 5434 | 446 | 6910 | 80 | 6540 |
| 6L-2S | | MI | 2116 | 1212 | 3507 | 979 | 4318 | 802 | 4915 | 651 | 5858 | 396 | 7086 | 267 | 5555 |
| 12-#11 | 4.33 | MA | 2809 | 1315 | 4417 | 1090 | 5515 | 889 | 6279 | 722 | 7474 | 422 | 9610 | 144 | 8806 |
| 4E | | MI | 1963 | 1315 | 3270 | 1051 | 3965 | 859 | 4470 | 687 | 5237 | 389 | 6225 | 42 | 6055 |
| 12-#11 | 4.33 | MA | 2647 | 1315 | 4082 | 1103 | 5041 | 907 | 5720 | 731 | 6701 | 434 | 8559 | 77 | 8262 |
| 5L-3S | | MI | 2058 | 1315 | 3530 | 1042 | 4318 | 847 | 4900 | 678 | 5824 | 392 | 6882 | 97 | 6528 |
| 12-#11 | 4.33 | MA | 2433 | 1315 | 3755 | 1114 | 4612 | 917 | 5173 | 746 | 5945 | 439 | 7540 | -7 | 7530 |
| 6L-2S | | MI | 2222 | 1315 | 3891 | 1034 | 4775 | 841 | 5453 | 675 | 6569 | 387 | 7789 | 211 | 6601 |
| 12-#14 | 6.25 | MA | 2976 | 1558 | 4930 | 1264 | 6064 | 1028 | 6937 | 810 | 8316 | 430 | 10669 | -76 | 10508 |
| 5L-3S | | MI | 2313 | 1558 | 4296 | 1190 | 5265 | 954 | 6036 | 744 | 7317 | 374 | 8568 | -53 | 8474 |
| 14-#10 | 4.12 | MA | 2860 | 1287 | 4434 | 1076 | 5571 | 879 | 6369 | 716 | 7612 | 427 | 9927 | 201 | 8750 |
| 4L-5S | | MI | 1935 | 1287 | 3096 | 1049 | 3761 | 859 | 4232 | 690 | 4920 | 404 | 5965 | 54 | 5796 |
| 14-#10 | 4.12 | MA | 2721 | 1287 | 4158 | 1087 | 5179 | 895 | 5906 | 724 | 6972 | 438 | 9035 | 147 | 8378 |
| 5L-4S | | MI | 2011 | 1287 | 3291 | 1041 | 4036 | 848 | 4556 | 686 | 5367 | 399 | 6521 | 110 | 6047 |
| 14-#10 | 4.12 | MA | 2545 | 1287 | 3881 | 1096 | 4825 | 904 | 5455 | 738 | 6347 | 443 | 8174 | 76 | 7808 |
| 6L-3S | | MI | 2088 | 1287 | 3507 | 1033 | 4318 | 842 | 4915 | 677 | 5858 | 399 | 7086 | 157 | 6381 |
| 14-#11 | 5.06 | MA | 2877 | 1407 | 4616 | 1160 | 5716 | 949 | 6536 | 758 | 7800 | 431 | 10048 | 69 | 9769 |
| 5L-4S | | MI | 2109 | 1407 | 3632 | 1108 | 4422 | 902 | 5022 | 714 | 5981 | 386 | 7132 | 18 | 7058 |
| 14-#11 | 5.06 | MA | 2688 | 1407 | 4288 | 1171 | 5286 | 960 | 5989 | 773 | 7044 | 436 | 9029 | -15 | 8997 |
| 6L-3S | | MI | 2196 | 1407 | 3891 | 1100 | 4775 | 889 | 5453 | 705 | 6569 | 388 | 7789 | 72 | 7544 |
| 16-#10 | 4.70 | MA | 2911 | 1362 | 4601 | 1134 | 5740 | 929 | 6585 | 746 | 7885 | 435 | 10299 | 143 | 9652 |
| 5E | | MI | 2058 | 1362 | 3399 | 1096 | 4145 | 894 | 4696 | 712 | 5545 | 402 | 6751 | 38 | 6627 |
| 16-#10 | 4.70 | MA | 2757 | 1362 | 4324 | 1142 | 5385 | 939 | 6133 | 760 | 7261 | 440 | 9438 | 72 | 9075 |
| 6L-4S | | MI | 2133 | 1362 | 3594 | 1088 | 4420 | 882 | 5020 | 708 | 5992 | 396 | 7307 | 94 | 6894 |
| 16-#11 | 5.78 | MA | 2924 | 1498 | 4822 | 1229 | 5961 | 1002 | 6806 | 800 | 8143 | 432 | 10519 | -24 | 10454 |
| 6L-4S | | MI | 2252 | 1498 | 3993 | 1165 | 4879 | 944 | 5575 | 741 | 6726 | 383 | 8038 | -7 | 8025 |
| 18-#10 | 5.29 | MA | 2951 | 1437 | 4768 | 1189 | 5946 | 973 | 6811 | 782 | 8174 | 437 | 10702 | 68 | 10349 |
| 6L-5S | | MI | 2179 | 1437 | 3702 | 1142 | 4529 | 928 | 5160 | 734 | 6169 | 399 | 7538 | 22 | 7463 |

## RECTANGULAR TIED COLUMNS 18" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.09 | MA | 2637 | 977 | 3376 | 888 | 4278 | 746 | 4793 | 635 | 5353 | 464 | 6613 | 405 | 3050 |
| 2E | | MI | 1761 | 977 | 2435 | 850 | 2951 | 714 | 3237 | 606 | 3535 | 442 | 4138 | 361 | 2019 |
| 4-#11 | 1.33 | MA | 2718 | 1011 | 3623 | 902 | 4555 | 756 | 5110 | 640 | 5763 | 459 | 7169 | 399 | 3670 |
| 2E | | MI | 1801 | 1011 | 2590 | 862 | 3116 | 722 | 3420 | 609 | 3767 | 435 | 4358 | 339 | 2403 |
| 4-#14 | 1.92 | MA | 2925 | 1092 | 4155 | 948 | 5203 | 789 | 5880 | 660 | 6788 | 453 | 8517 | 387 | 5155 |
| 2E | | MI | 1909 | 1092 | 2913 | 906 | 3503 | 753 | 3876 | 628 | 4360 | 426 | 5023 | 303 | 3312 |
| 4-#18 | 3.42 | MA | 3387 | 1298 | 5442 | 1068 | 6782 | 876 | 7765 | 713 | 9302 | 440 | 11707 | 343 | 8769 |
| 2E | | MI | 2144 | 1298 | 3674 | 1021 | 4422 | 836 | 4967 | 678 | 5701 | 392 | 6508 | 196 | 5452 |
| 6-#8 | 1.01 | MA | 2617 | 967 | 3290 | 886 | 4194 | 745 | 4705 | 635 | 5245 | 468 | 6473 | 408 | 2873 |
| 2L-3S | | MI | 1631 | 967 | 2186 | 856 | 2659 | 719 | 2894 | 611 | 3083 | 451 | 3600 | 313 | 1917 |
| 6-#8 | 1.01 | MA | 2415 | 967 | 2982 | 894 | 3804 | 752 | 4232 | 641 | 4609 | 476 | 5592 | 352 | 2873 |
| 3L-2S | | MI | 1754 | 967 | 2378 | 850 | 2902 | 715 | 3189 | 608 | 3480 | 446 | 4110 | 371 | 1909 |
| 6-#9 | 1.28 | MA | 2725 | 1004 | 3545 | 907 | 4505 | 761 | 5074 | 644 | 5736 | 465 | 7149 | 404 | 3586 |
| 2L-3S | | MI | 1664 | 1004 | 2297 | 877 | 2788 | 734 | 3046 | 620 | 3282 | 448 | 3839 | 287 | 2362 |
| 6-#9 | 1.28 | MA | 2478 | 1004 | 3156 | 917 | 4013 | 769 | 4479 | 652 | 4936 | 475 | 6041 | 334 | 3574 |
| 3L-2S | | MI | 1813 | 1004 | 2538 | 870 | 3094 | 729 | 3415 | 617 | 3779 | 443 | 4473 | 360 | 2357 |

## RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis



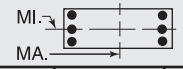

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#10 | 1.63 | MA | 2857 | 1052 | 3866 | 934 | 4898 | 780 | 5543 | 656 | 6363 | 462 | 8011 | 401 | 4488 |
| 2L-3S | | MI | 1705 | 1052 | 2435 | 905 | 2951 | 754 | 3237 | 632 | 3535 | 445 | 4138 | 252 | 2915 |
| 6-#10 | 1.63 | MA | 2557 | 1052 | 3376 | 946 | 4278 | 791 | 4793 | 666 | 5353 | 474 | 6613 | 310 | 4455 |
| 3L-2S | | MI | 1887 | 1052 | 2738 | 897 | 3335 | 748 | 3701 | 628 | 4159 | 439 | 4925 | 345 | 2919 |
| 6-#11 | 2.00 | MA | 2974 | 1103 | 4214 | 960 | 5303 | 798 | 6014 | 667 | 6980 | 456 | 8854 | 395 | 5400 |
| 2L-3S | | MI | 1739 | 1103 | 2590 | 928 | 3116 | 769 | 3420 | 639 | 3767 | 436 | 4358 | 200 | 3455 |
| 6-#11 | 2.00 | MA | 2627 | 1103 | 3623 | 974 | 4555 | 810 | 5110 | 677 | 5763 | 469 | 7169 | 280 | 5339 |
| 3L-2S | | MI | 1943 | 1103 | 2951 | 919 | 3573 | 764 | 3973 | 636 | 4511 | 432 | 5265 | 314 | 3473 |
| 6-#14 | 2.88 | MA | 3269 | 1225 | 4995 | 1031 | 6266 | 850 | 7166 | 699 | 8519 | 448 | 10883 | 377 | 7605 |
| 2L-3S | | MI | 1831 | 1225 | 2913 | 999 | 3503 | 820 | 3876 | 669 | 4360 | 425 | 5023 | 98 | 4721 |
| 6-#14 | 2.88 | MA | 2812 | 1225 | 4155 | 1050 | 5203 | 866 | 5880 | 712 | 6788 | 466 | 8517 | 211 | 7432 |
| 3L-2S | | MI | 2098 | 1225 | 3423 | 988 | 4147 | 814 | 4656 | 667 | 5404 | 420 | 6270 | 263 | 4803 |
| 6-#18 | 5.13 | MA | 3923 | 1534 | 6894 | 1215 | 8619 | 984 | 9987 | 783 | 12295 | 431 | 15683 | 314 | 12985 |
| 2L-3S | | MI | 2052 | 1534 | 3674 | 1182 | 4422 | 950 | 4967 | 745 | 5701 | 382 | 6508 | -189 | 6350 |
| 6-#18 | 5.13 | MA | 3277 | 1534 | 5442 | 1245 | 6782 | 1009 | 7765 | 802 | 9302 | 458 | 11707 | 20 | 11650 |
| 3L-2S | | MI | 2443 | 1534 | 4538 | 1168 | 5515 | 944 | 6289 | 748 | 7421 | 373 | 8511 | 105 | 7951 |
| 8-#8 | 1.35 | MA | 2760 | 1013 | 3599 | 915 | 4585 | 767 | 5177 | 649 | 5881 | 466 | 7354 | 405 | 3781 |
| 2L-4S | | MI | 1645 | 1013 | 2241 | 890 | 2724 | 745 | 2962 | 632 | 3170 | 449 | 3745 | 275 | 2477 |
| 8-#8 | 1.35 | MA | 2566 | 1013 | 3290 | 923 | 4194 | 774 | 4705 | 655 | 5245 | 474 | 6473 | 350 | 3773 |
| 3E | | MI | 1718 | 1013 | 2378 | 885 | 2902 | 741 | 3189 | 625 | 3480 | 449 | 4110 | 305 | 2485 |
| 8-#8 | 1.35 | MA | 2452 | 1013 | 3077 | 930 | 3915 | 781 | 4347 | 664 | 4757 | 478 | 5865 | 316 | 3732 |
| 4L-2S | | MI | 1836 | 1013 | 2571 | 879 | 3146 | 736 | 3484 | 622 | 3876 | 445 | 4621 | 363 | 2482 |
| 8-#9 | 1.71 | MA | 2898 | 1063 | 3933 | 944 | 4996 | 788 | 5668 | 662 | 6537 | 463 | 8257 | 401 | 4724 |
| 2L-4S | | MI | 1683 | 1063 | 2366 | 920 | 2870 | 766 | 3130 | 646 | 3390 | 446 | 4018 | 237 | 3035 |
| 8-#9 | 1.71 | MA | 2665 | 1063 | 3545 | 953 | 4505 | 796 | 5074 | 669 | 5736 | 473 | 7149 | 331 | 4701 |
| 3E | | MI | 1771 | 1063 | 2538 | 914 | 3094 | 761 | 3415 | 638 | 3779 | 446 | 4473 | 275 | 3067 |
| 8-#9 | 1.71 | MA | 2526 | 1063 | 3275 | 963 | 4153 | 805 | 4624 | 681 | 5122 | 478 | 6381 | 288 | 4613 |
| 4L-2S | | MI | 1913 | 1063 | 2779 | 907 | 3399 | 756 | 3784 | 634 | 4277 | 441 | 5106 | 349 | 3070 |
| 8-#10 | 2.17 | MA | 3068 | 1126 | 4357 | 981 | 5518 | 815 | 6293 | 678 | 7372 | 459 | 9410 | 397 | 5920 |
| 2L-4S | | MI | 1730 | 1126 | 2522 | 959 | 3053 | 794 | 3342 | 664 | 3669 | 442 | 4359 | 188 | 3612 |
| 8-#10 | 2.17 | MA | 2787 | 1126 | 3866 | 993 | 4898 | 825 | 5543 | 688 | 6363 | 471 | 8011 | 306 | 5872 |
| 3E | | MI | 1836 | 1126 | 2738 | 951 | 3335 | 788 | 3701 | 654 | 4159 | 442 | 4925 | 236 | 3792 |
| 8-#10 | 2.17 | MA | 2621 | 1126 | 3526 | 1005 | 4454 | 836 | 4975 | 702 | 5586 | 477 | 7038 | 252 | 5590 |
| 4L-2S | | MI | 2007 | 1126 | 3041 | 943 | 3719 | 783 | 4165 | 650 | 4784 | 437 | 5711 | 329 | 3810 |
| 8-#11 | 2.67 | MA | 3219 | 1195 | 4805 | 1017 | 6050 | 841 | 6918 | 694 | 8198 | 452 | 10540 | 390 | 7123 |
| 2L-4S | | MI | 1769 | 1195 | 2691 | 993 | 3220 | 824 | 3542 | 676 | 3924 | 430 | 4608 | 121 | 4147 |
| 8-#11 | 2.67 | MA | 2895 | 1195 | 4214 | 1031 | 5303 | 852 | 6014 | 704 | 6980 | 466 | 8854 | 275 | 7042 |
| 3E | | MI | 1889 | 1195 | 2951 | 985 | 3573 | 812 | 3973 | 666 | 4511 | 433 | 5265 | 175 | 4493 |
| 8-#11 | 2.67 | MA | 2704 | 1195 | 3802 | 1045 | 4765 | 864 | 5327 | 721 | 6041 | 473 | 7667 | 208 | 6491 |
| 4L-2S | | MI | 2079 | 1195 | 3312 | 977 | 4030 | 806 | 4525 | 663 | 5255 | 428 | 6172 | 290 | 4530 |
| 8-#14 | 3.85 | MA | 3192 | 1357 | 4995 | 1133 | 6266 | 927 | 7166 | 751 | 8519 | 461 | 10883 | 201 | 9851 |
| 3E | | MI | 2037 | 1357 | 3423 | 1082 | 4147 | 881 | 4656 | 708 | 5404 | 420 | 6270 | 57 | 6116 |
| 8-#14 | 3.85 | MA | 2934 | 1357 | 4407 | 1152 | 5498 | 943 | 6185 | 775 | 7180 | 470 | 9211 | 106 | 8642 |
| 4L-2S | | MI | 2281 | 1357 | 3932 | 1071 | 4791 | 875 | 5435 | 706 | 6448 | 415 | 7516 | 222 | 6282 |
| 8-#18 | 6.84 | MA | 3882 | 1769 | 6894 | 1392 | 8619 | 1117 | 9987 | 871 | 12295 | 449 | 15683 | -9 | 15648 |
| 3E | | MI | 2389 | 1769 | 4538 | 1329 | 5515 | 1058 | 6289 | 814 | 7421 | 363 | 8511 | -280 | 8204 |
| 8-#18 | 6.84 | MA | 3541 | 1769 | 5870 | 1423 | 7284 | 1142 | 8282 | 909 | 9968 | 458 | 12857 | -172 | 12432 |
| 4L-2S | | MI | 2739 | 1769 | 5403 | 1315 | 6608 | 1052 | 7611 | 817 | 9141 | 354 | 10515 | 14 | 10440 |
| 10-#10 | 2.71 | MA | 3272 | 1201 | 4847 | 1028 | 6138 | 849 | 7043 | 700 | 8382 | 456 | 10808 | 393 | 7349 |
| 2L-5S | | MI | 1778 | 1201 | 2630 | 1014 | 3162 | 840 | 3482 | 689 | 3846 | 444 | 4589 | 116 | 4209 |
| 10-#10 | 2.71 | MA | 3007 | 1201 | 4357 | 1040 | 5518 | 860 | 6293 | 710 | 7372 | 468 | 9410 | 302 | 7289 |
| 3L-4S | | MI | 1870 | 1201 | 2825 | 1006 | 3437 | 829 | 3806 | 686 | 4294 | 439 | 5145 | 172 | 4438 |
| 10-#10 | 2.71 | MA | 2856 | 1201 | 4016 | 1051 | 5074 | 870 | 5725 | 724 | 6596 | 475 | 8436 | 248 | 6969 |
| 4L-3S | | MI | 1965 | 1201 | 3041 | 998 | 3719 | 823 | 4165 | 676 | 4784 | 439 | 5711 | 220 | 4666 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis

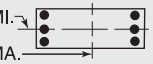



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 10-#10 | 2.71 | MA | 2692 | 1201 | 3713 | 1063 | 4643 | 886 | 5216 | 733 | 5892 | 487 | 7458 | 197 | 6488 |
| 5L-2S | | MI | 2123 | 1201 | 3345 | 990 | 4102 | 817 | 4629 | 672 | 5409 | 434 | 6497 | 313 | 4695 |
| 10-#11 | 3.33 | MA | 3153 | 1287 | 4805 | 1088 | 6050 | 895 | 6918 | 731 | 8198 | 462 | 10540 | 271 | 8747 |
| 3L-4S | | MI | 1926 | 1287 | 3053 | 1051 | 3677 | 866 | 4095 | 703 | 4668 | 427 | 5514 | 96 | 5133 |
| 10-#11 | 3.33 | MA | 2981 | 1287 | 4392 | 1102 | 5512 | 907 | 6231 | 748 | 7258 | 469 | 9353 | 203 | 8157 |
| 4L-3S | | MI | 2034 | 1287 | 3312 | 1042 | 4030 | 854 | 4525 | 693 | 5255 | 429 | 6172 | 151 | 5528 |
| 10-#11 | 3.33 | MA | 2791 | 1287 | 4025 | 1116 | 4991 | 925 | 5615 | 758 | 6406 | 483 | 8163 | 136 | 7619 |
| 5L-2S | | MI | 2212 | 1287 | 3674 | 1034 | 4487 | 848 | 5078 | 690 | 6000 | 425 | 7078 | 266 | 5581 |
| 10-#14 | 4.81 | MA | 3336 | 1490 | 5247 | 1235 | 6561 | 1004 | 7471 | 814 | 8911 | 465 | 11577 | 96 | 11035 |
| 4L-3S | | MI | 2235 | 1490 | 3932 | 1165 | 4791 | 942 | 5435 | 747 | 6448 | 414 | 7516 | 17 | 7467 |
| 10-#14 | 4.81 | MA | 3070 | 1490 | 4721 | 1253 | 5816 | 1030 | 6592 | 827 | 7695 | 483 | 9907 | -1 | 9905 |
| 5L-2S | | MI | 2460 | 1490 | 4441 | 1154 | 5436 | 935 | 6214 | 745 | 7492 | 409 | 8762 | 182 | 7756 |
| 12-#10 | 3.26 | MA | 3220 | 1276 | 4847 | 1086 | 6138 | 894 | 7043 | 732 | 8382 | 465 | 10808 | 298 | 8707 |
| 3L-5S | | MI | 1921 | 1276 | 2933 | 1060 | 3546 | 874 | 3945 | 711 | 4471 | 442 | 5376 | 100 | 5057 |
| 12-#10 | 3.26 | MA | 3082 | 1276 | 4506 | 1098 | 5694 | 904 | 6475 | 746 | 7605 | 472 | 9834 | 244 | 8355 |
| 4E | | MI | 2000 | 1276 | 3128 | 1053 | 3820 | 863 | 4270 | 708 | 4918 | 436 | 5932 | 156 | 5272 |
| 12-#10 | 3.26 | MA | 2921 | 1276 | 4203 | 1110 | 5263 | 921 | 5966 | 755 | 6902 | 484 | 8856 | 193 | 7894 |
| 5L-3S | | MI | 2087 | 1276 | 3345 | 1045 | 4102 | 857 | 4629 | 698 | 5409 | 436 | 6497 | 204 | 5538 |
| 12-#10 | 3.26 | MA | 2723 | 1276 | 3892 | 1118 | 4874 | 931 | 5470 | 770 | 6215 | 491 | 7915 | 123 | 7312 |
| 6L-2S | | MI | 2236 | 1276 | 3648 | 1037 | 4486 | 851 | 5093 | 694 | 6033 | 431 | 7284 | 297 | 5577 |
| 12-#11 | 4.00 | MA | 3261 | 1378 | 4983 | 1159 | 6260 | 949 | 7135 | 775 | 8475 | 466 | 11038 | 198 | 9830 |
| 4E | | MI | 2076 | 1378 | 3414 | 1108 | 4135 | 908 | 4648 | 730 | 5412 | 423 | 6421 | 72 | 6127 |
| 12-#11 | 4.00 | MA | 3060 | 1378 | 4615 | 1173 | 5738 | 968 | 6519 | 785 | 7623 | 479 | 9849 | 132 | 9295 |
| 5L-3S | | MI | 2175 | 1378 | 3674 | 1100 | 4487 | 896 | 5078 | 720 | 6000 | 426 | 7078 | 126 | 6563 |
| 12-#11 | 4.00 | MA | 2831 | 1378 | 4246 | 1184 | 5266 | 980 | 5917 | 802 | 6791 | 486 | 8701 | 45 | 8478 |
| 6L-2S | | MI | 2342 | 1378 | 4035 | 1091 | 4944 | 890 | 5631 | 717 | 6744 | 421 | 7985 | 241 | 6628 |
| 12-#14 | 5.77 | MA | 3443 | 1622 | 5562 | 1336 | 6880 | 1091 | 7878 | 866 | 9426 | 478 | 12273 | -11 | 12245 |
| 5L-3S | | MI | 2428 | 1622 | 4441 | 1247 | 5436 | 1003 | 6214 | 786 | 7492 | 408 | 8762 | -24 | 8722 |
| 14-#10 | 3.80 | MA | 3300 | 1351 | 4996 | 1145 | 6314 | 939 | 7225 | 768 | 8615 | 469 | 11232 | 240 | 9746 |
| 4L-5S | | MI | 2050 | 1351 | 3237 | 1107 | 3929 | 909 | 4409 | 733 | 5096 | 439 | 6162 | 84 | 5895 |
| 14-#10 | 3.80 | MA | 3141 | 1351 | 4693 | 1157 | 5883 | 955 | 6716 | 777 | 7911 | 481 | 10254 | 189 | 9303 |
| 5L-4S | | MI | 2126 | 1351 | 3431 | 1099 | 4204 | 897 | 4734 | 730 | 5543 | 433 | 6718 | 140 | 6111 |
| 14-#10 | 3.80 | MA | 2954 | 1351 | 4382 | 1165 | 5494 | 965 | 6220 | 792 | 7225 | 488 | 9313 | 119 | 8720 |
| 6L-3S | | MI | 2206 | 1351 | 3648 | 1091 | 4486 | 892 | 5093 | 720 | 6033 | 434 | 7284 | 188 | 6411 |
| 14-#10 | 3.80 | MA | 2789 | 1351 | 4030 | 1178 | 5105 | 974 | 5740 | 801 | 6557 | 500 | 8385 | 75 | 8098 |
| 7L-2S | | MI | 2348 | 1351 | 3951 | 1084 | 4869 | 886 | 5557 | 716 | 6658 | 428 | 8070 | 281 | 6457 |
| 14-#11 | 4.67 | MA | 3331 | 1470 | 5206 | 1230 | 6485 | 1010 | 7423 | 812 | 8840 | 476 | 11534 | 127 | 10975 |
| 5L-4S | | MI | 2223 | 1470 | 3775 | 1165 | 4592 | 951 | 5200 | 757 | 6157 | 420 | 7327 | 47 | 7128 |
| 14-#11 | 4.67 | MA | 3119 | 1470 | 4837 | 1241 | 6013 | 1022 | 6821 | 829 | 8009 | 482 | 10386 | 40 | 10180 |
| 6L-3S | | MI | 2313 | 1470 | 4035 | 1157 | 4944 | 938 | 5631 | 747 | 6744 | 422 | 7985 | 102 | 7599 |
| 16-#10 | 4.34 | MA | 3367 | 1425 | 5183 | 1203 | 6503 | 989 | 7466 | 799 | 8921 | 478 | 11652 | 185 | 10715 |
| 5E | | MI | 2174 | 1425 | 3540 | 1154 | 4313 | 943 | 4873 | 755 | 5720 | 436 | 6949 | 68 | 6724 |
| 16-#10 | 4.34 | MA | 3179 | 1425 | 4872 | 1212 | 6114 | 1000 | 6970 | 814 | 8235 | 485 | 10711 | 115 | 10131 |
| 6L-4S | | MI | 2249 | 1425 | 3735 | 1146 | 4588 | 932 | 5198 | 752 | 6168 | 431 | 7504 | 125 | 6955 |
| 16-#10 | 4.34 | MA | 3023 | 1425 | 4520 | 1225 | 5725 | 1009 | 6490 | 823 | 7567 | 497 | 9784 | 72 | 9511 |
| 7L-3S | | MI | 2323 | 1425 | 3951 | 1138 | 4869 | 926 | 5557 | 742 | 6658 | 431 | 8070 | 172 | 7283 |
| 16-#11 | 5.33 | MA | 3384 | 1562 | 5428 | 1298 | 6761 | 1064 | 7725 | 856 | 9226 | 479 | 12072 | 35 | 11884 |
| 6L-4S | | MI | 2366 | 1562 | 4137 | 1223 | 5049 | 993 | 5753 | 784 | 6901 | 417 | 8234 | 23 | 8136 |
| 18-#10 | 4.88 | MA | 3412 | 1500 | 5363 | 1258 | 6734 | 1034 | 7720 | 836 | 9244 | 482 | 12109 | 111 | 11543 |
| 6L-5S | | MI | 2295 | 1500 | 3843 | 1201 | 4697 | 977 | 5337 | 777 | 6345 | 433 | 7735 | 52 | 7557 |
| 18-#10 | 4.88 | MA | 3251 | 1500 | 5010 | 1272 | 6345 | 1043 | 7240 | 845 | 8577 | 494 | 11182 | 68 | 10924 |
| 7L-4S | | MI | 2369 | 1500 | 4038 | 1193 | 4971 | 966 | 5661 | 773 | 6793 | 428 | 8291 | 109 | 7803 |
| 20-#10 | 5.43 | MA | 3491 | 1575 | 5500 | 1318 | 6965 | 1077 | 7990 | 867 | 9586 | 491 | 12580 | 64 | 12337 |
| 7L-5S | | MI | 2414 | 1575 | 4146 | 1247 | 5080 | 1012 | 5801 | 799 | 6970 | 430 | 8521 | 36 | 8394 |

## RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis



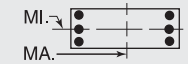

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.01 | MA | 3038 | 1041 | 3803 | 955 | 4857 | 804 | 5453 | 685 | 6083 | 504 | 7510 | 440 | 3324 |
| 2E | | MI | 1876 | 1041 | 2575 | 908 | 3119 | 764 | 3415 | 650 | 3710 | 477 | 4336 | 391 | 2034 |
| 4-#11 | 1.24 | MA | 3131 | 1075 | 4076 | 970 | 5164 | 814 | 5804 | 690 | 6537 | 499 | 8125 | 435 | 4007 |
| 2E | | MI | 1917 | 1075 | 2733 | 919 | 3285 | 771 | 3598 | 652 | 3942 | 469 | 4554 | 369 | 2422 |
| 4-#14 | 1.79 | MA | 3365 | 1156 | 4662 | 1016 | 5877 | 847 | 6652 | 710 | 7666 | 493 | 9679 | 428 | 5641 |
| 2E | | MI | 2026 | 1156 | 3059 | 963 | 3673 | 802 | 4055 | 670 | 4535 | 460 | 5218 | 333 | 3335 |
| 4-#18 | 3.17 | MA | 3891 | 1362 | 6084 | 1135 | 7623 | 934 | 8735 | 764 | 10446 | 480 | 13338 | 396 | 9633 |
| 2E | | MI | 2262 | 1362 | 3824 | 1077 | 4594 | 884 | 5145 | 720 | 5875 | 425 | 6700 | 225 | 5485 |
| 6-#9 | 1.19 | MA | 3136 | 1068 | 3987 | 975 | 5104 | 818 | 5758 | 695 | 6501 | 505 | 8094 | 440 | 3910 |
| 2L-3S | | MI | 1779 | 1068 | 2436 | 935 | 2956 | 784 | 3223 | 664 | 3458 | 483 | 4037 | 317 | 2380 |
| 6-#9 | 1.19 | MA | 2862 | 1068 | 3562 | 985 | 4566 | 827 | 5108 | 703 | 5625 | 516 | 6881 | 371 | 3898 |
| 3L-2S | | MI | 1929 | 1068 | 2677 | 929 | 3261 | 779 | 3593 | 660 | 3955 | 478 | 4671 | 391 | 2372 |
| 6-#10 | 1.51 | MA | 3284 | 1115 | 4340 | 1002 | 5537 | 838 | 6274 | 707 | 7189 | 502 | 9041 | 436 | 4900 |
| 2L-3S | | MI | 1820 | 1115 | 2575 | 963 | 3119 | 804 | 3415 | 676 | 3710 | 479 | 4336 | 282 | 2938 |
| 6-#10 | 1.51 | MA | 2951 | 1115 | 3803 | 1014 | 4857 | 849 | 5453 | 717 | 6083 | 515 | 7510 | 347 | 4867 |
| 3L-2S | | MI | 2003 | 1115 | 2879 | 955 | 3503 | 798 | 3879 | 672 | 4335 | 474 | 5122 | 375 | 2937 |
| 6-#11 | 1.86 | MA | 3418 | 1167 | 4724 | 1027 | 5984 | 856 | 6795 | 717 | 7872 | 496 | 9974 | 430 | 5906 |
| 2L-3S | | MI | 1853 | 1167 | 2733 | 985 | 3285 | 818 | 3598 | 682 | 3942 | 470 | 4554 | 230 | 3484 |
| 6-#11 | 1.86 | MA | 3030 | 1167 | 4076 | 1042 | 5164 | 869 | 5804 | 728 | 6537 | 511 | 8125 | 318 | 5844 |
| 3L-2S | | MI | 2060 | 1167 | 3095 | 977 | 3742 | 813 | 4151 | 679 | 4686 | 466 | 5461 | 344 | 3494 |
| 6-#14 | 2.68 | MA | 3751 | 1288 | 5585 | 1099 | 7045 | 908 | 8065 | 749 | 9568 | 488 | 12313 | 421 | 8334 |
| 2L-3S | | MI | 1945 | 1288 | 3059 | 1056 | 3673 | 869 | 4055 | 712 | 4535 | 459 | 5218 | 127 | 4762 |
| 6-#14 | 2.68 | MA | 3240 | 1288 | 4662 | 1119 | 5877 | 926 | 6652 | 764 | 7666 | 509 | 9679 | 257 | 8161 |
| 3L-2S | | MI | 2216 | 1288 | 3568 | 1045 | 4317 | 862 | 4834 | 709 | 5579 | 454 | 6464 | 292 | 4830 |
| 6-#18 | 4.76 | MA | 4493 | 1597 | 7684 | 1282 | 9647 | 1042 | 11183 | 833 | 13742 | 471 | 17816 | 376 | 14281 |
| 2L-3S | | MI | 2163 | 1597 | 3824 | 1237 | 4594 | 997 | 5145 | 786 | 5875 | 415 | 6700 | -160 | 6569 |
| 6-#18 | 4.76 | MA | 3765 | 1597 | 6084 | 1315 | 7623 | 1070 | 8735 | 856 | 10446 | 502 | 13338 | 83 | 13081 |
| 3L-2S | | MI | 2563 | 1597 | 4688 | 1224 | 5687 | 992 | 6467 | 789 | 7595 | 406 | 8704 | 134 | 7987 |
| 8-#8 | 1.25 | MA | 3175 | 1077 | 4046 | 983 | 5191 | 824 | 5870 | 699 | 6658 | 506 | 8316 | 440 | 4123 |
| 2L-4S | | MI | 1759 | 1077 | 2380 | 949 | 2891 | 795 | 3139 | 675 | 3346 | 484 | 3943 | 305 | 2498 |
| 8-#8 | 1.25 | MA | 2959 | 1077 | 3708 | 991 | 4764 | 832 | 5353 | 705 | 5962 | 514 | 7352 | 386 | 4114 |
| 3E | | MI | 1833 | 1077 | 2517 | 943 | 3069 | 791 | 3366 | 669 | 3656 | 484 | 4309 | 336 | 2502 |
| 8-#8 | 1.25 | MA | 2833 | 1077 | 3475 | 999 | 4459 | 839 | 4964 | 716 | 5429 | 520 | 6694 | 353 | 4074 |
| 4L-2S | | MI | 1952 | 1077 | 2709 | 938 | 3313 | 786 | 3661 | 666 | 4053 | 479 | 4819 | 394 | 2497 |
| 8-#9 | 1.59 | MA | 3330 | 1127 | 4412 | 1011 | 5642 | 845 | 6409 | 712 | 7377 | 503 | 9307 | 437 | 5156 |
| 2L-4S | | MI | 1797 | 1127 | 2506 | 979 | 3037 | 816 | 3307 | 689 | 3566 | 481 | 4216 | 268 | 3064 |
| 8-#9 | 1.59 | MA | 3070 | 1127 | 3987 | 1021 | 5104 | 854 | 5758 | 720 | 6501 | 513 | 8094 | 367 | 5133 |
| 3E | | MI | 1886 | 1127 | 2677 | 972 | 3261 | 811 | 3593 | 681 | 3955 | 480 | 4671 | 306 | 3087 |
| 8-#9 | 1.59 | MA | 2917 | 1127 | 3693 | 1031 | 4720 | 863 | 5267 | 732 | 5830 | 520 | 7262 | 325 | 5045 |
| 4L-2S | | MI | 2030 | 1127 | 2919 | 966 | 3566 | 806 | 3962 | 678 | 4453 | 476 | 5304 | 379 | 3088 |
| 8-#10 | 2.02 | MA | 3521 | 1190 | 4877 | 1049 | 6216 | 873 | 7095 | 729 | 8295 | 499 | 10573 | 432 | 6469 |
| 2L-4S | | MI | 1844 | 1190 | 2662 | 1017 | 3221 | 844 | 3519 | 707 | 3845 | 476 | 4556 | 219 | 3681 |
| 8-#10 | 2.02 | MA | 3207 | 1190 | 4340 | 1061 | 5537 | 884 | 6274 | 739 | 7189 | 512 | 9041 | 343 | 6420 |
| 3E | | MI | 1951 | 1190 | 2879 | 1009 | 3503 | 838 | 3879 | 697 | 4335 | 476 | 5122 | 266 | 3817 |
| 8-#10 | 2.02 | MA | 3023 | 1190 | 3968 | 1074 | 5051 | 895 | 5653 | 754 | 6341 | 520 | 7987 | 290 | 6189 |
| 4L-2S | | MI | 2125 | 1190 | 3182 | 1002 | 3887 | 832 | 4343 | 694 | 4960 | 471 | 5908 | 359 | 3830 |
| 8-#11 | 2.48 | MA | 3692 | 1258 | 5372 | 1085 | 6804 | 898 | 7787 | 744 | 9208 | 492 | 11823 | 425 | 7797 |
| 2L-4S | | MI | 1882 | 1258 | 2835 | 1051 | 3390 | 873 | 3720 | 719 | 4099 | 464 | 4804 | 151 | 4223 |
| 8-#11 | 2.48 | MA | 3330 | 1258 | 4724 | 1099 | 5984 | 911 | 6795 | 755 | 7872 | 507 | 9974 | 314 | 7716 |
| 3E | | MI | 2005 | 1258 | 3095 | 1042 | 3742 | 861 | 4151 | 709 | 4686 | 467 | 5461 | 205 | 4524 |
| 8-#11 | 2.48 | MA | 3118 | 1258 | 4274 | 1114 | 5396 | 924 | 6044 | 773 | 6845 | 515 | 8687 | 247 | 7192 |
| 4L-2S | | MI | 2198 | 1258 | 3456 | 1034 | 4199 | 855 | 4703 | 706 | 5430 | 462 | 6367 | 320 | 4554 |
| 8-#14 | 3.57 | MA | 3652 | 1421 | 5585 | 1202 | 7045 | 986 | 8065 | 803 | 9568 | 504 | 12313 | 250 | 10823 |
| 3E | | MI | 2152 | 1421 | 3568 | 1139 | 4317 | 930 | 4834 | 751 | 5579 | 453 | 6464 | 87 | 6213 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis

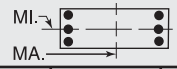



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 3.57 | MA | 3377 | 1421 | 4941 | 1222 | 6205 | 1004 | 6991 | 828 | 8102 | 514 | 10465 | 153 | 9581 |
| 4L-2S | | MI | 2400 | 1421 | 4078 | 1128 | 4962 | 923 | 5613 | 748 | 6623 | 448 | 7711 | 252 | 6311 |
| 8-#18 | 6.35 | MA | 4440 | 1833 | 7684 | 1463 | 9647 | 1178 | 11183 | 925 | 13742 | 493 | 17816 | 63 | 17591 |
| 3E | | MI | 2500 | 1833 | 4688 | 1385 | 5687 | 1105 | 6467 | 856 | 7595 | 396 | 8704 | -251 | 8435 |
| 8-#18 | 6.35 | MA | 4059 | 1833 | 6562 | 1495 | 8183 | 1206 | 9314 | 966 | 11189 | 507 | 14649 | -106 | 14333 |
| 4L-2S | | MI | 2859 | 1833 | 5552 | 1371 | 6780 | 1100 | 7789 | 858 | 9315 | 387 | 10708 | 43 | 10477 |
| 10-#10 | 2.52 | MA | 3749 | 1265 | 5414 | 1096 | 6895 | 907 | 7917 | 751 | 9401 | 496 | 12104 | 428 | 8035 |
| 2L-5S | | MI | 1890 | 1265 | 2771 | 1072 | 3330 | 890 | 3659 | 733 | 4022 | 479 | 4787 | 146 | 4271 |
| 10-#10 | 2.52 | MA | 3452 | 1265 | 4877 | 1108 | 6216 | 918 | 7095 | 761 | 8295 | 509 | 10573 | 340 | 7975 |
| 3L-4S | | MI | 1984 | 1265 | 2966 | 1064 | 3605 | 878 | 3983 | 729 | 4470 | 473 | 5343 | 203 | 4504 |
| 10-#10 | 2.52 | MA | 3284 | 1265 | 4505 | 1120 | 5730 | 929 | 6475 | 776 | 7447 | 517 | 9518 | 286 | 7705 |
| 4L-3S | | MI | 2081 | 1265 | 3182 | 1056 | 3887 | 872 | 4343 | 719 | 4960 | 474 | 5908 | 250 | 4692 |
| 10-#10 | 2.52 | MA | 3098 | 1265 | 4175 | 1133 | 5261 | 946 | 5921 | 786 | 6679 | 530 | 8454 | 237 | 7146 |
| 5L-2S | | MI | 2242 | 1265 | 3485 | 1048 | 4270 | 867 | 4807 | 716 | 5584 | 468 | 6695 | 343 | 4717 |
| 10-#11 | 3.10 | MA | 3618 | 1350 | 5372 | 1157 | 6804 | 953 | 7787 | 782 | 9208 | 504 | 11823 | 309 | 9589 |
| 3L-4S | | MI | 2039 | 1350 | 3196 | 1108 | 3847 | 915 | 4273 | 746 | 4843 | 461 | 5710 | 126 | 5206 |
| 10-#11 | 3.10 | MA | 3426 | 1350 | 4922 | 1171 | 6216 | 966 | 7035 | 800 | 8181 | 512 | 10536 | 242 | 9027 |
| 4L-3S | | MI | 2150 | 1350 | 3456 | 1100 | 4199 | 903 | 4703 | 736 | 5430 | 463 | 6367 | 181 | 5561 |
| 10-#11 | 3.10 | MA | 3210 | 1350 | 4521 | 1186 | 5647 | 986 | 6363 | 811 | 7250 | 527 | 9241 | 179 | 8407 |
| 5L-2S | | MI | 2332 | 1350 | 3817 | 1091 | 4656 | 897 | 5256 | 733 | 6175 | 459 | 7274 | 295 | 5606 |
| 10-#14 | 4.46 | MA | 3827 | 1553 | 5864 | 1305 | 7373 | 1065 | 8404 | 867 | 10004 | 509 | 13098 | 146 | 12219 |
| 4L-3S | | MI | 2350 | 1553 | 4078 | 1222 | 4962 | 991 | 5613 | 790 | 6623 | 447 | 7711 | 46 | 7574 |
| 10-#14 | 4.46 | MA | 3505 | 1553 | 5291 | 1325 | 6560 | 1092 | 7443 | 882 | 8674 | 529 | 11245 | 52 | 11056 |
| 5L-2S | | MI | 2581 | 1553 | 4587 | 1211 | 5606 | 984 | 6393 | 787 | 7667 | 442 | 8957 | 212 | 7786 |
| 10-#18 | 7.94 | MA | 4779 | 2068 | 8162 | 1643 | 10207 | 1314 | 11761 | 1035 | 14485 | 498 | 19127 | -126 | 18528 |
| 4L-3S | | MI | 2828 | 2068 | 5552 | 1532 | 6780 | 1214 | 7789 | 925 | 9315 | 377 | 10708 | -341 | 10263 |
| 12-#10 | 3.02 | MA | 3689 | 1340 | 5414 | 1155 | 6895 | 952 | 7917 | 783 | 9401 | 506 | 12104 | 336 | 9530 |
| 3L-5S | | MI | 2034 | 1340 | 3074 | 1119 | 3714 | 924 | 4123 | 755 | 4647 | 476 | 5573 | 130 | 5117 |
| 12-#10 | 3.02 | MA | 3536 | 1340 | 5042 | 1167 | 6410 | 964 | 7296 | 798 | 8553 | 514 | 11049 | 282 | 9228 |
| 4E | | MI | 2114 | 1340 | 3269 | 1111 | 3988 | 913 | 4447 | 751 | 5094 | 471 | 6129 | 187 | 5335 |
| 12-#10 | 3.02 | MA | 3353 | 1340 | 4712 | 1179 | 5940 | 980 | 6742 | 808 | 7785 | 527 | 9985 | 233 | 8689 |
| 5L-3S | | MI | 2204 | 1340 | 3485 | 1103 | 4270 | 907 | 4807 | 741 | 5584 | 471 | 6695 | 234 | 5566 |
| 12-#10 | 3.02 | MA | 3134 | 1340 | 4367 | 1187 | 5517 | 992 | 6201 | 824 | 7037 | 535 | 8966 | 164 | 8098 |
| 6L-2S | | MI | 2356 | 1340 | 3788 | 1095 | 4654 | 901 | 5271 | 738 | 6209 | 465 | 7481 | 327 | 5600 |
| 12-#11 | 3.71 | MA | 3722 | 1442 | 5570 | 1229 | 7036 | 1008 | 8027 | 827 | 9516 | 508 | 12385 | 237 | 10868 |
| 4E | | MI | 2190 | 1442 | 3558 | 1165 | 4304 | 957 | 4826 | 773 | 5588 | 457 | 6617 | 102 | 6198 |
| 12-#11 | 3.71 | MA | 3510 | 1442 | 5169 | 1243 | 6467 | 1028 | 7355 | 838 | 8585 | 523 | 11091 | 174 | 10276 |
| 5L-3S | | MI | 2292 | 1442 | 3817 | 1157 | 4656 | 945 | 5256 | 763 | 6175 | 460 | 7274 | 156 | 6598 |
| 12-#11 | 3.71 | MA | 3255 | 1442 | 4758 | 1253 | 5952 | 1041 | 6699 | 857 | 7678 | 531 | 9847 | 88 | 9399 |
| 6L-2S | | MI | 2463 | 1442 | 4179 | 1149 | 5113 | 939 | 5809 | 760 | 6919 | 455 | 8180 | 271 | 6655 |
| 12-#14 | 5.36 | MA | 3937 | 1686 | 6214 | 1408 | 7728 | 1153 | 8855 | 921 | 10576 | 524 | 13878 | 45 | 13715 |
| 5L-3S | | MI | 2544 | 1686 | 4587 | 1304 | 5606 | 1051 | 6393 | 828 | 7667 | 441 | 8957 | 6 | 8938 |
| 12-#14 | 5.36 | MA | 3604 | 1686 | 5635 | 1423 | 6991 | 1171 | 7917 | 946 | 9279 | 534 | 12092 | -80 | 11851 |
| 6L-2S | | MI | 2759 | 1686 | 5096 | 1294 | 6250 | 1045 | 7172 | 826 | 8710 | 437 | 10203 | 171 | 9258 |
| 14-#10 | 3.53 | MA | 3779 | 1414 | 5579 | 1214 | 7089 | 998 | 8118 | 820 | 9658 | 511 | 12580 | 278 | 10755 |
| 4L-5S | | MI | 2165 | 1414 | 3377 | 1165 | 4097 | 958 | 4587 | 777 | 5272 | 473 | 6360 | 114 | 5967 |
| 14-#10 | 3.53 | MA | 3598 | 1414 | 5249 | 1226 | 6620 | 1015 | 7563 | 830 | 8891 | 524 | 11516 | 230 | 10236 |
| 5L-4S | | MI | 2241 | 1414 | 3572 | 1157 | 4372 | 947 | 4911 | 773 | 5719 | 468 | 6915 | 171 | 6173 |
| 14-#10 | 3.53 | MA | 3391 | 1414 | 4904 | 1234 | 6196 | 1026 | 7023 | 846 | 8143 | 532 | 10498 | 160 | 9647 |
| 6L-3S | | MI | 2324 | 1414 | 3788 | 1150 | 4654 | 941 | 5271 | 763 | 6209 | 468 | 7481 | 218 | 6439 |
| 14-#10 | 3.53 | MA | 3207 | 1414 | 4562 | 1242 | 5763 | 1034 | 6500 | 856 | 7415 | 545 | 9491 | 120 | 8989 |
| 7L-2S | | MI | 2468 | 1414 | 4092 | 1142 | 5037 | 935 | 5735 | 760 | 6834 | 463 | 8268 | 311 | 6480 |
| 14-#11 | 4.33 | MA | 3814 | 1534 | 5817 | 1301 | 7287 | 1070 | 8347 | 865 | 9921 | 520 | 12940 | 169 | 12148 |
| 5L-4S | | MI | 2337 | 1534 | 3919 | 1223 | 4761 | 1000 | 5378 | 800 | 6332 | 454 | 7523 | 77 | 7197 |
| 14-#11 | 4.33 | MA | 3559 | 1534 | 5406 | 1311 | 6772 | 1083 | 7690 | 884 | 9013 | 528 | 11696 | 83 | 11273 |
| 6L-3S | | MI | 2430 | 1534 | 4179 | 1215 | 5113 | 987 | 5809 | 790 | 6919 | 456 | 8180 | 132 | 7634 |
| 14-#11 | 4.33 | MA | 3347 | 1534 | 4940 | 1327 | 6257 | 1094 | 7055 | 895 | 8130 | 543 | 10468 | 30 | 10349 |
| 7L-2S | | MI | 2592 | 1534 | 4540 | 1206 | 5570 | 981 | 6362 | 787 | 7663 | 452 | 9087 | 246 | 7701 |

## RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 6.25 | MA | 4031 | 1818 | 6558 | 1505 | 8159 | 1232 | 9330 | 985 | 11181 | 529 | 14725 | -87 | 14355 |
| 6L-3S | | MI | 2734 | 1818 | 5096 | 1387 | 6250 | 1112 | 7172 | 867 | 8710 | 436 | 10203 | -35 | 10139 |
| 16-#10 | 4.03 | MA | 3837 | 1489 | 5786 | 1273 | 7299 | 1049 | 8385 | 852 | 9997 | 521 | 13048 | 226 | 11785 |
| 5E | | MI | 2289 | 1489 | 3680 | 1212 | 4481 | 993 | 5051 | 799 | 5896 | 470 | 7146 | 98 | 6818 |
| 16-#10 | 4.03 | MA | 3640 | 1489 | 5441 | 1281 | 6875 | 1060 | 7844 | 868 | 9249 | 529 | 12029 | 156 | 11198 |
| 6L-4S | | MI | 2364 | 1489 | 3875 | 1204 | 4756 | 981 | 5375 | 795 | 6344 | 465 | 7702 | 155 | 7015 |
| 16-#10 | 4.03 | MA | 3468 | 1489 | 5099 | 1289 | 6442 | 1069 | 7321 | 878 | 8521 | 542 | 11022 | 116 | 10537 |
| 7L-3S | | MI | 2441 | 1489 | 4092 | 1196 | 5037 | 975 | 5735 | 785 | 6834 | 465 | 8268 | 202 | 7312 |
| 16-#10 | 4.03 | MA | 3307 | 1489 | 4722 | 1304 | 5978 | 1082 | 6803 | 887 | 7796 | 550 | 10052 | 61 | 9818 |
| 8L-2S | | MI | 2579 | 1489 | 4395 | 1189 | 5421 | 970 | 6198 | 782 | 7458 | 460 | 9054 | 295 | 7360 |
| 16-#11 | 4.95 | MA | 3872 | 1626 | 6055 | 1368 | 7592 | 1125 | 8682 | 911 | 10348 | 524 | 13545 | 79 | 13150 |
| 6L-4S | | MI | 2480 | 1626 | 4280 | 1280 | 5218 | 1042 | 5931 | 827 | 7076 | 451 | 8430 | 53 | 8202 |
| 16-#11 | 4.95 | MA | 3676 | 1626 | 5588 | 1384 | 7078 | 1136 | 8047 | 922 | 9465 | 539 | 12317 | 25 | 12217 |
| 7L-3S | | MI | 2566 | 1626 | 4540 | 1272 | 5570 | 1029 | 6362 | 817 | 7663 | 453 | 9087 | 107 | 8670 |
| 18-#10 | 4.54 | MA | 3882 | 1564 | 5978 | 1328 | 7554 | 1095 | 8666 | 890 | 10355 | 526 | 13560 | 152 | 12750 |
| 6L-5S | | MI | 2411 | 1564 | 3984 | 1259 | 4865 | 1027 | 5515 | 821 | 6521 | 468 | 7932 | 82 | 7649 |
| 18-#10 | 4.54 | MA | 3720 | 1564 | 5636 | 1336 | 7121 | 1103 | 8143 | 900 | 9627 | 539 | 12553 | 112 | 12085 |
| 7L-4S | | MI | 2485 | 1564 | 4178 | 1251 | 5139 | 1016 | 5839 | 817 | 6968 | 462 | 8488 | 139 | 7862 |
| 18-#10 | 4.54 | MA | 3567 | 1564 | 5259 | 1351 | 6657 | 1116 | 7624 | 909 | 8902 | 547 | 11583 | 57 | 11369 |
| 8L-3S | | MI | 2556 | 1564 | 4395 | 1243 | 5421 | 1010 | 6198 | 807 | 7458 | 462 | 9054 | 186 | 8184 |
| 18-#11 | 5.57 | MA | 3977 | 1718 | 6237 | 1442 | 7898 | 1179 | 9039 | 949 | 10801 | 536 | 14167 | 21 | 14085 |
| 7L-4S | | MI | 2621 | 1718 | 4641 | 1338 | 5675 | 1084 | 6484 | 854 | 7820 | 447 | 9336 | 28 | 9212 |
| 20-#10 | 5.04 | MA | 3987 | 1639 | 6172 | 1382 | 7800 | 1137 | 8964 | 922 | 10733 | 537 | 14085 | 108 | 13633 |
| 7L-5S | | MI | 2530 | 1639 | 4287 | 1306 | 5248 | 1061 | 5979 | 843 | 7146 | 465 | 8719 | 66 | 8483 |
| 20-#10 | 5.04 | MA | 3815 | 1639 | 5796 | 1397 | 7336 | 1151 | 8445 | 931 | 10007 | 544 | 13115 | 53 | 12919 |
| 8L-4S | | MI | 2604 | 1639 | 4482 | 1298 | 5523 | 1050 | 6303 | 839 | 7593 | 459 | 9274 | 123 | 8712 |
| 22-#10 | 5.54 | MA | 4076 | 1713 | 6332 | 1444 | 8015 | 1185 | 9267 | 953 | 11113 | 541 | 14646 | 50 | 14470 |
| 8L-5S | | MI | 2648 | 1713 | 4590 | 1352 | 5632 | 1096 | 6443 | 864 | 7770 | 462 | 9505 | 51 | 9322 |

## RECTANGULAR TIED COLUMNS 18" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.16 | MA | 3570 | 1138 | 4549 | 1038 | 5804 | 872 | 6534 | 740 | 7351 | 539 | 9129 | 470 | 4344 |
| 2E | | MI | 2032 | 1138 | 2877 | 977 | 3455 | 820 | 3776 | 695 | 4117 | 503 | 4750 | 399 | 2440 |
| 4-#14 | 1.67 | MA | 3831 | 1220 | 5189 | 1084 | 6584 | 905 | 7461 | 761 | 8585 | 533 | 10827 | 463 | 6127 |
| 2E | | MI | 2143 | 1220 | 3205 | 1020 | 3843 | 850 | 4233 | 713 | 4710 | 494 | 5412 | 362 | 3357 |
| 4-#18 | 2.96 | MA | 4425 | 1426 | 6746 | 1203 | 8496 | 991 | 9743 | 814 | 11629 | 520 | 15022 | 447 | 10497 |
| 2E | | MI | 2380 | 1426 | 3974 | 1132 | 4766 | 931 | 5324 | 762 | 6049 | 458 | 6892 | 254 | 5518 |
| 6-#9 | 1.11 | MA | 3573 | 1131 | 4449 | 1042 | 5735 | 876 | 6480 | 745 | 7306 | 545 | 9087 | 475 | 4234 |
| 2L-3S | | MI | 1893 | 1131 | 2576 | 994 | 3123 | 834 | 3401 | 707 | 3634 | 517 | 4235 | 347 | 2397 |
| 6-#9 | 1.11 | MA | 3271 | 1131 | 3987 | 1053 | 5151 | 885 | 5773 | 753 | 6354 | 556 | 7769 | 407 | 4222 |
| 3L-2S | | MI | 2045 | 1131 | 2817 | 987 | 3429 | 829 | 3770 | 704 | 4131 | 512 | 4868 | 421 | 2387 |
| 6-#10 | 1.41 | MA | 3738 | 1179 | 4834 | 1070 | 6206 | 896 | 7042 | 757 | 8055 | 542 | 10119 | 471 | 5311 |
| 2L-3S | | MI | 1934 | 1179 | 2716 | 1021 | 3287 | 853 | 3592 | 719 | 3886 | 514 | 4533 | 312 | 2959 |
| 6-#10 | 1.41 | MA | 3370 | 1179 | 4250 | 1083 | 5468 | 908 | 6149 | 768 | 6852 | 556 | 8454 | 384 | 5278 |
| 3L-2S | | MI | 2120 | 1179 | 3019 | 1013 | 3671 | 848 | 4056 | 715 | 4511 | 508 | 5319 | 405 | 2955 |
| 6-#11 | 1.73 | MA | 3888 | 1230 | 5255 | 1095 | 6697 | 914 | 7613 | 767 | 8804 | 536 | 11142 | 465 | 6411 |
| 2L-3S | | MI | 1965 | 1230 | 2877 | 1042 | 3455 | 867 | 3776 | 725 | 4117 | 504 | 4750 | 260 | 3511 |
| 6-#11 | 1.73 | MA | 3460 | 1230 | 4549 | 1110 | 5804 | 927 | 6534 | 779 | 7351 | 552 | 9129 | 356 | 6350 |
| 3L-2S | | MI | 2178 | 1230 | 3238 | 1034 | 3912 | 862 | 4329 | 722 | 4861 | 500 | 5657 | 374 | 3515 |
| 6-#14 | 2.50 | MA | 4261 | 1352 | 6195 | 1166 | 7856 | 966 | 9000 | 799 | 10657 | 528 | 13697 | 456 | 9063 |
| 2L-3S | | MI | 2060 | 1352 | 3205 | 1113 | 3843 | 917 | 4233 | 754 | 4710 | 493 | 5412 | 157 | 4801 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 30"

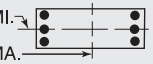
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 2.50 | MA | 3693 | 1352 | 5189 | 1188 | 6584 | 985 | 7461 | 816 | 8585 | 550 | 10827 | 296 | 8890 |
| 3L-2S | | MI | 2334 | 1352 | 3714 | 1102 | 4487 | 911 | 5012 | 752 | 5754 | 488 | 6659 | 322 | 4856 |
| 6-#18 | 4.44 | MA | 5093 | 1661 | 8493 | 1350 | 10706 | 1099 | 12416 | 883 | 15228 | 511 | 20004 | 435 | 15577 |
| 2L-3S | | MI | 2275 | 1661 | 3974 | 1293 | 4766 | 1045 | 5324 | 828 | 6049 | 448 | 6892 | -131 | 6788 |
| 6-#18 | 4.44 | MA | 4281 | 1661 | 6746 | 1385 | 8496 | 1130 | 9743 | 909 | 11629 | 546 | 15022 | 141 | 14547 |
| 3L-2S | | MI | 2682 | 1661 | 4838 | 1280 | 5859 | 1039 | 6646 | 831 | 7769 | 439 | 8896 | 163 | 8023 |
| 8-#8 | 1.17 | MA | 3615 | 1141 | 4512 | 1050 | 5829 | 882 | 6601 | 749 | 7475 | 546 | 9326 | 475 | 4464 |
| 2L-4S | | MI | 1874 | 1141 | 2518 | 1007 | 3058 | 845 | 3316 | 719 | 3522 | 519 | 4142 | 336 | 2518 |
| 8-#8 | 1.17 | MA | 3378 | 1141 | 4145 | 1059 | 5365 | 890 | 6039 | 756 | 6719 | 555 | 8280 | 422 | 4455 |
| 3E | | MI | 1948 | 1141 | 2655 | 1002 | 3236 | 841 | 3544 | 712 | 3832 | 518 | 4507 | 366 | 2518 |
| 8-#8 | 1.17 | MA | 3239 | 1141 | 3893 | 1067 | 5035 | 897 | 5617 | 767 | 6142 | 561 | 7570 | 390 | 4415 |
| 4L-2S | | MI | 2068 | 1141 | 2848 | 997 | 3480 | 837 | 3838 | 709 | 4229 | 514 | 5018 | 424 | 2512 |
| 8-#9 | 1.48 | MA | 3788 | 1190 | 4911 | 1079 | 6320 | 903 | 7187 | 762 | 8258 | 543 | 10405 | 472 | 5588 |
| 2L-4S | | MI | 1911 | 1190 | 2645 | 1037 | 3205 | 866 | 3484 | 733 | 3742 | 515 | 4414 | 298 | 3090 |
| 8-#9 | 1.48 | MA | 3501 | 1190 | 4449 | 1089 | 5735 | 913 | 6480 | 771 | 7306 | 554 | 9087 | 404 | 5565 |
| 3E | | MI | 2001 | 1190 | 2817 | 1031 | 3429 | 861 | 3770 | 725 | 4131 | 515 | 4868 | 336 | 3107 |
| 8-#9 | 1.48 | MA | 3333 | 1190 | 4131 | 1100 | 5319 | 922 | 5948 | 784 | 6578 | 561 | 8191 | 363 | 5477 |
| 4L-2S | | MI | 2147 | 1190 | 3058 | 1024 | 3734 | 856 | 4139 | 721 | 4629 | 510 | 5502 | 409 | 3104 |
| 8-#10 | 1.88 | MA | 4000 | 1254 | 5417 | 1116 | 6945 | 930 | 7935 | 779 | 9257 | 539 | 11783 | 467 | 7018 |
| 2L-4S | | MI | 1957 | 1254 | 2803 | 1076 | 3389 | 894 | 3697 | 750 | 4021 | 511 | 4754 | 249 | 3747 |
| 8-#10 | 1.88 | MA | 3653 | 1254 | 4834 | 1129 | 6206 | 942 | 7042 | 790 | 8055 | 553 | 10119 | 380 | 6969 |
| 3E | | MI | 2067 | 1254 | 3019 | 1068 | 3671 | 888 | 4056 | 741 | 4511 | 511 | 5319 | 296 | 3841 |
| 8-#10 | 1.88 | MA | 3451 | 1254 | 4431 | 1142 | 5681 | 954 | 6369 | 806 | 7135 | 561 | 8983 | 328 | 6793 |
| 4L-2S | | MI | 2243 | 1254 | 3323 | 1060 | 4055 | 882 | 4520 | 737 | 5136 | 505 | 6106 | 389 | 3850 |
| 8-#11 | 2.31 | MA | 4193 | 1322 | 5960 | 1152 | 7590 | 956 | 8693 | 794 | 10258 | 532 | 13155 | 460 | 8471 |
| 2L-4S | | MI | 1996 | 1322 | 2979 | 1108 | 3559 | 922 | 3898 | 762 | 4274 | 498 | 4999 | 180 | 4297 |
| 8-#11 | 2.31 | MA | 3792 | 1322 | 5255 | 1168 | 6697 | 970 | 7613 | 806 | 8804 | 548 | 11142 | 351 | 8390 |
| 3E | | MI | 2120 | 1322 | 3238 | 1100 | 3912 | 910 | 4329 | 752 | 4861 | 501 | 5657 | 235 | 4554 |
| 8-#11 | 2.31 | MA | 3558 | 1322 | 4766 | 1183 | 6059 | 983 | 6797 | 825 | 7689 | 558 | 9754 | 285 | 7906 |
| 4L-2S | | MI | 2316 | 1322 | 3600 | 1092 | 4369 | 904 | 4882 | 749 | 5606 | 496 | 6563 | 350 | 4577 |
| 8-#14 | 3.33 | MA | 4150 | 1484 | 6195 | 1270 | 7856 | 1045 | 9000 | 855 | 10657 | 545 | 13697 | 289 | 11795 |
| 3E | | MI | 2266 | 1484 | 3714 | 1196 | 4487 | 978 | 5012 | 793 | 5754 | 487 | 6659 | 116 | 6254 |
| 8-#14 | 3.33 | MA | 3846 | 1484 | 5496 | 1292 | 6944 | 1064 | 7834 | 881 | 9064 | 557 | 11704 | 193 | 10534 |
| 4L-2S | | MI | 2520 | 1484 | 4223 | 1185 | 5132 | 972 | 5792 | 791 | 6798 | 482 | 7905 | 282 | 6339 |
| 8-#18 | 5.93 | MA | 5027 | 1897 | 8493 | 1532 | 10706 | 1238 | 12416 | 978 | 15228 | 537 | 20004 | 129 | 19507 |
| 3E | | MI | 2612 | 1897 | 4838 | 1440 | 5859 | 1153 | 6646 | 897 | 7769 | 429 | 8896 | -222 | 8663 |
| 8-#18 | 5.93 | MA | 4606 | 1897 | 7274 | 1567 | 9114 | 1269 | 10382 | 1022 | 12450 | 554 | 16494 | -45 | 16233 |
| 4L-2S | | MI | 2978 | 1897 | 5702 | 1427 | 6952 | 1147 | 7968 | 900 | 9489 | 420 | 10900 | 72 | 10515 |
| 10-#10 | 2.35 | MA | 4253 | 1329 | 6001 | 1163 | 7683 | 965 | 8827 | 801 | 10459 | 536 | 13448 | 463 | 8721 |
| 2L-5S | | MI | 2003 | 1329 | 2911 | 1130 | 3498 | 939 | 3837 | 776 | 4198 | 513 | 4984 | 177 | 4330 |
| 10-#10 | 2.35 | MA | 3924 | 1329 | 5417 | 1176 | 6945 | 976 | 7935 | 812 | 9257 | 550 | 11783 | 377 | 8661 |
| 3L-4S | | MI | 2093 | 1329 | 3106 | 1122 | 3773 | 928 | 4161 | 772 | 4645 | 508 | 5540 | 233 | 4568 |
| 10-#10 | 2.35 | MA | 3739 | 1329 | 5015 | 1189 | 6419 | 988 | 7262 | 828 | 8337 | 559 | 10647 | 324 | 8453 |
| 4L-3S | | MI | 2198 | 1329 | 3323 | 1114 | 4055 | 922 | 4520 | 763 | 5136 | 508 | 6106 | 280 | 4718 |
| 10-#10 | 2.35 | MA | 3531 | 1329 | 4658 | 1202 | 5911 | 1006 | 6662 | 839 | 7506 | 573 | 9449 | 269 | 7811 |
| 5L-2S | | MI | 2361 | 1329 | 3626 | 1107 | 4438 | 916 | 4984 | 759 | 5760 | 503 | 6892 | 373 | 4738 |
| 10-#11 | 2.89 | MA | 4110 | 1414 | 5960 | 1225 | 7590 | 1012 | 8693 | 833 | 10258 | 545 | 13155 | 346 | 10432 |
| 3L-4S | | MI | 2153 | 1414 | 3340 | 1166 | 4016 | 964 | 4451 | 789 | 5019 | 495 | 5906 | 156 | 5277 |
| 10-#11 | 2.89 | MA | 3899 | 1414 | 5472 | 1240 | 6952 | 1025 | 7877 | 852 | 9143 | 554 | 11767 | 281 | 9910 |
| 4L-3S | | MI | 2266 | 1414 | 3600 | 1157 | 4369 | 952 | 4882 | 779 | 5606 | 497 | 6563 | 211 | 5593 |
| 10-#11 | 2.89 | MA | 3655 | 1414 | 5037 | 1255 | 6335 | 1046 | 7148 | 865 | 8134 | 570 | 10368 | 220 | 9200 |
| 5L-2S | | MI | 2451 | 1414 | 3961 | 1149 | 4826 | 946 | 5434 | 776 | 6350 | 493 | 7470 | 325 | 5631 |
| 10-#14 | 4.17 | MA | 4318 | 1617 | 6502 | 1374 | 8217 | 1125 | 9373 | 920 | 11137 | 552 | 14574 | 187 | 13419 |
| 4L-3S | | MI | 2466 | 1617 | 4223 | 1278 | 5132 | 1039 | 5792 | 832 | 6798 | 481 | 7905 | 76 | 7678 |
| 10-#14 | 4.17 | MA | 3980 | 1617 | 5881 | 1396 | 7335 | 1154 | 8331 | 937 | 9694 | 574 | 12569 | 97 | 12201 |
| 5L-2S | | MI | 2701 | 1617 | 4733 | 1268 | 5776 | 1033 | 6571 | 830 | 7841 | 476 | 9151 | 241 | 7816 |
| 10-#18 | 7.41 | MA | 5399 | 2132 | 9021 | 1714 | 11324 | 1377 | 13055 | 1091 | 16049 | 545 | 21476 | -57 | 20962 |
| 4L-3S | | MI | 2939 | 2132 | 5702 | 1588 | 6952 | 1261 | 7968 | 966 | 9489 | 410 | 10900 | -312 | 10502 |

## RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis



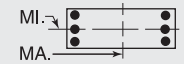

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 7.41 | MA | 4826 | 2132 | 7933 | 1749 | 9782 | 1425 | 11233 | 1117 | 13529 | 579 | 17960 | -228 | 16869 |
| 5L-2S | | MI | 3274 | 2132 | 6566 | 1574 | 8045 | 1256 | 9290 | 969 | 11209 | 401 | 12904 | -19 | 12864 |
| 12-#10 | 2.82 | MA | 4186 | 1403 | 6001 | 1223 | 7683 | 1011 | 8827 | 834 | 10459 | 547 | 13448 | 373 | 10353 |
| 3L-5S | | MI | 2147 | 1403 | 3215 | 1177 | 3882 | 974 | 4301 | 798 | 4823 | 510 | 5770 | 161 | 5175 |
| 12-#10 | 2.82 | MA | 4016 | 1403 | 5598 | 1236 | 7157 | 1022 | 8155 | 850 | 9539 | 556 | 12312 | 320 | 10112 |
| 4E | | MI | 2229 | 1403 | 3409 | 1169 | 4156 | 962 | 4625 | 794 | 5270 | 505 | 6326 | 217 | 5398 |
| 12-#10 | 2.82 | MA | 3812 | 1403 | 5241 | 1249 | 6649 | 1040 | 7555 | 861 | 8708 | 570 | 11114 | 266 | 9492 |
| 5L-3S | | MI | 2321 | 1403 | 3626 | 1161 | 4438 | 956 | 4984 | 785 | 5760 | 505 | 6892 | 264 | 5593 |
| 12-#10 | 2.82 | MA | 3570 | 1403 | 4862 | 1256 | 6191 | 1052 | 6970 | 877 | 7898 | 578 | 10066 | 205 | 8899 |
| 6L-2S | | MI | 2476 | 1403 | 3929 | 1153 | 4822 | 951 | 5448 | 781 | 6385 | 500 | 7679 | 357 | 5621 |
| 12-#11 | 3.47 | MA | 4225 | 1506 | 6177 | 1298 | 7844 | 1068 | 8957 | 879 | 10597 | 551 | 13780 | 276 | 11920 |
| 4E | | MI | 2304 | 1506 | 3701 | 1223 | 4473 | 1006 | 5004 | 816 | 5763 | 491 | 6812 | 132 | 6266 |
| 12-#11 | 3.47 | MA | 3986 | 1506 | 5743 | 1313 | 7227 | 1088 | 8228 | 892 | 9587 | 567 | 12381 | 216 | 11239 |
| 5L-3S | | MI | 2408 | 1506 | 3961 | 1215 | 4826 | 994 | 5434 | 806 | 6350 | 494 | 7470 | 186 | 6631 |
| 12-#11 | 3.47 | MA | 3706 | 1506 | 5290 | 1323 | 6670 | 1102 | 7517 | 911 | 8604 | 576 | 11041 | 130 | 10340 |
| 6L-2S | | MI | 2583 | 1506 | 4322 | 1206 | 5283 | 988 | 5987 | 803 | 7094 | 489 | 8376 | 301 | 6681 |
| 12-#14 | 5.00 | MA | 4459 | 1749 | 6887 | 1478 | 8607 | 1215 | 9870 | 976 | 11766 | 569 | 15438 | 90 | 15097 |
| 5L-3S | | MI | 2660 | 1749 | 4733 | 1361 | 5776 | 1100 | 6571 | 871 | 7841 | 475 | 9151 | 35 | 9039 |
| 12-#14 | 5.00 | MA | 4068 | 1749 | 6247 | 1493 | 7810 | 1234 | 8853 | 1002 | 10359 | 581 | 13513 | -34 | 13398 |
| 6L-2S | | MI | 2880 | 1749 | 5242 | 1351 | 6421 | 1093 | 7350 | 868 | 8885 | 470 | 10398 | 201 | 9289 |
| 14-#10 | 3.29 | MA | 4284 | 1478 | 6182 | 1282 | 7895 | 1057 | 9048 | 872 | 10742 | 553 | 13977 | 316 | 11777 |
| 4L-5S | | MI | 2280 | 1478 | 3518 | 1224 | 4265 | 1008 | 4765 | 820 | 5447 | 508 | 6557 | 145 | 6023 |
| 14-#10 | 3.29 | MA | 4082 | 1478 | 5825 | 1295 | 7387 | 1074 | 8448 | 882 | 9910 | 567 | 12779 | 262 | 11176 |
| 5L-4S | | MI | 2356 | 1478 | 3713 | 1216 | 4540 | 997 | 5089 | 816 | 5895 | 502 | 7113 | 201 | 6233 |
| 14-#10 | 3.29 | MA | 3854 | 1478 | 5446 | 1303 | 6929 | 1086 | 7863 | 899 | 9100 | 575 | 11731 | 201 | 10588 |
| 6L-3S | | MI | 2441 | 1478 | 3929 | 1208 | 4822 | 991 | 5448 | 807 | 6385 | 502 | 7679 | 248 | 6467 |
| 14-#10 | 3.29 | MA | 3652 | 1478 | 5075 | 1311 | 6453 | 1094 | 7297 | 909 | 8313 | 589 | 10644 | 162 | 9900 |
| 7L-2S | | MI | 2589 | 1478 | 4232 | 1200 | 5205 | 985 | 5912 | 803 | 7010 | 497 | 8465 | 341 | 6503 |
| 14-#11 | 4.04 | MA | 4305 | 1598 | 6449 | 1370 | 8120 | 1130 | 9308 | 918 | 11041 | 563 | 14393 | 211 | 13280 |
| 5L-4S | | MI | 2451 | 1598 | 4063 | 1280 | 4930 | 1049 | 5556 | 843 | 6507 | 488 | 7719 | 107 | 7264 |
| 14-#11 | 4.04 | MA | 4041 | 1598 | 5996 | 1380 | 7563 | 1144 | 8597 | 938 | 10057 | 573 | 13053 | 126 | 12380 |
| 6L-3S | | MI | 2547 | 1598 | 4322 | 1272 | 5283 | 1036 | 5987 | 833 | 7094 | 490 | 8376 | 162 | 7668 |
| 14-#11 | 4.04 | MA | 3807 | 1598 | 5546 | 1390 | 6995 | 1155 | 7909 | 950 | 9100 | 589 | 11729 | 75 | 11401 |
| 7L-2S | | MI | 2713 | 1598 | 4684 | 1264 | 5740 | 1030 | 6540 | 830 | 7839 | 486 | 9283 | 276 | 7728 |
| 14-#14 | 5.83 | MA | 4562 | 1882 | 7253 | 1576 | 9082 | 1294 | 10393 | 1041 | 12432 | 576 | 16383 | -41 | 16187 |
| 6L-3S | | MI | 2850 | 1882 | 5242 | 1444 | 6421 | 1161 | 7350 | 910 | 8885 | 469 | 10398 | -5 | 10389 |
| 16-#10 | 3.76 | MA | 4345 | 1553 | 6408 | 1342 | 8126 | 1109 | 9341 | 904 | 11113 | 564 | 14443 | 258 | 12863 |
| 5E | | MI | 2405 | 1553 | 3821 | 1270 | 4649 | 1042 | 5229 | 842 | 6072 | 505 | 7343 | 129 | 6876 |
| 16-#10 | 3.76 | MA | 4128 | 1553 | 6029 | 1350 | 7667 | 1120 | 8755 | 921 | 10303 | 573 | 13395 | 197 | 12276 |
| 6L-4S | | MI | 2480 | 1553 | 4016 | 1262 | 4924 | 1031 | 5553 | 838 | 6519 | 499 | 7899 | 185 | 7074 |
| 16-#10 | 3.76 | MA | 3939 | 1553 | 5659 | 1358 | 7191 | 1128 | 8190 | 931 | 9515 | 587 | 12309 | 158 | 11583 |
| 7L-3S | | MI | 2559 | 1553 | 4232 | 1255 | 5205 | 1025 | 5912 | 829 | 7010 | 500 | 8465 | 232 | 7340 |
| 16-#10 | 3.76 | MA | 3762 | 1553 | 5250 | 1374 | 6688 | 1142 | 7618 | 940 | 8730 | 595 | 11262 | 106 | 10775 |
| 8L-2S | | MI | 2700 | 1553 | 4536 | 1247 | 5589 | 1019 | 6376 | 825 | 7634 | 494 | 9251 | 325 | 7383 |
| 16-#11 | 4.62 | MA | 4365 | 1689 | 6701 | 1437 | 8455 | 1186 | 9676 | 965 | 11511 | 569 | 15066 | 121 | 14403 |
| 6L-4S | | MI | 2595 | 1689 | 4424 | 1338 | 5387 | 1091 | 6109 | 870 | 7251 | 485 | 8625 | 83 | 8267 |
| 16-#11 | 4.62 | MA | 4147 | 1689 | 6252 | 1447 | 7887 | 1197 | 8989 | 977 | 10554 | 585 | 13741 | 71 | 13434 |
| 7L-3S | | MI | 2683 | 1689 | 4684 | 1329 | 5740 | 1078 | 6540 | 860 | 7839 | 487 | 9283 | 137 | 8704 |
| 18-#10 | 4.23 | MA | 4395 | 1628 | 6613 | 1396 | 8405 | 1155 | 9648 | 943 | 11505 | 570 | 15060 | 193 | 13964 |
| 6L-5S | | MI | 2527 | 1628 | 4124 | 1317 | 5033 | 1077 | 5693 | 864 | 6697 | 502 | 8130 | 113 | 7731 |
| 18-#10 | 4.23 | MA | 4216 | 1628 | 6242 | 1405 | 7929 | 1163 | 9082 | 953 | 10717 | 584 | 13973 | 154 | 13265 |
| 7L-4S | | MI | 2601 | 1628 | 4319 | 1309 | 5307 | 1065 | 6017 | 860 | 7144 | 497 | 8685 | 169 | 7920 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

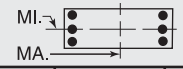
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 4.23 | MA | 4044 | 1628 | 5834 | 1420 | 7426 | 1177 | 8511 | 962 | 9932 | 592 | 12927 | 102 | 12461 |
| 8L-3S | | MI | 2675 | 1628 | 4536 | 1301 | 5589 | 1059 | 6376 | 851 | 7634 | 497 | 9251 | 216 | 8213 |
| 18-#11 | 5.20 | MA | 4503 | 1781 | 6958 | 1505 | 8780 | 1239 | 10068 | 1004 | 12008 | 582 | 15754 | 66 | 15468 |
| 7L-4S | | MI | 2736 | 1781 | 4785 | 1395 | 5844 | 1133 | 6662 | 896 | 7996 | 481 | 9532 | 58 | 9275 |
| 20-#10 | 4.70 | MA | 4487 | 1702 | 6826 | 1452 | 8667 | 1197 | 9975 | 975 | 11919 | 581 | 15638 | 151 | 14948 |
| 7L-5S | | MI | 2647 | 1702 | 4428 | 1364 | 5416 | 1111 | 6157 | 886 | 7321 | 499 | 8916 | 97 | 8571 |
| 20-#10 | 4.70 | MA | 4317 | 1702 | 6417 | 1467 | 8164 | 1211 | 9404 | 984 | 11134 | 589 | 14591 | 98 | 14147 |
| 8L-4S | | MI | 2721 | 1702 | 4622 | 1356 | 5691 | 1100 | 6481 | 882 | 7769 | 494 | 9472 | 153 | 8768 |
| 22-#10 | 5.17 | MA | 4584 | 1777 | 7001 | 1514 | 8903 | 1245 | 10297 | 1006 | 12336 | 587 | 16256 | 94 | 15833 |
| 8L-5S | | MI | 2765 | 1777 | 4731 | 1410 | 5800 | 1145 | 6621 | 908 | 7946 | 496 | 9702 | 81 | 9407 |

## RECTANGULAR TIED COLUMNS 18" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.08 | MA | 4035 | 1202 | 5042 | 1105 | 6476 | 929 | 7301 | 791 | 8204 | 579 | 10181 | 505 | 4681 |
| 2E | | MI | 2148 | 1202 | 3021 | 1034 | 3624 | 869 | 3954 | 738 | 4292 | 537 | 4946 | 428 | 2458 |
| 4-#14 | 1.56 | MA | 4325 | 1283 | 5736 | 1151 | 7322 | 962 | 8307 | 811 | 9543 | 573 | 12023 | 498 | 6613 |
| 2E | | MI | 2259 | 1283 | 3350 | 1076 | 4013 | 899 | 4411 | 755 | 4885 | 527 | 5607 | 392 | 3379 |
| 4-#18 | 2.78 | MA | 4984 | 1489 | 7429 | 1271 | 9400 | 1049 | 10788 | 864 | 12853 | 560 | 16584 | 482 | 11361 |
| 2E | | MI | 2498 | 1489 | 4124 | 1188 | 4938 | 979 | 5503 | 803 | 6223 | 491 | 7085 | 283 | 5550 |
| 6-#9 | 1.04 | MA | 4036 | 1195 | 4932 | 1110 | 6398 | 934 | 7239 | 795 | 8150 | 585 | 10128 | 510 | 4558 |
| 2L-3S | | MI | 2008 | 1195 | 2715 | 1052 | 3291 | 884 | 3578 | 751 | 3810 | 552 | 4433 | 378 | 2413 |
| 6-#9 | 1.04 | MA | 3706 | 1195 | 4433 | 1121 | 5767 | 944 | 6475 | 804 | 7122 | 597 | 8705 | 443 | 4546 |
| 3L-2S | | MI | 2161 | 1195 | 2957 | 1046 | 3596 | 879 | 3947 | 747 | 4307 | 547 | 5066 | 451 | 2402 |
| 6-#10 | 1.32 | MA | 4219 | 1243 | 5348 | 1137 | 6908 | 954 | 7846 | 807 | 8960 | 582 | 11244 | 506 | 5723 |
| 2L-3S | | MI | 2049 | 1243 | 2857 | 1079 | 3455 | 903 | 3770 | 762 | 4062 | 548 | 4730 | 342 | 2979 |
| 6-#10 | 1.32 | MA | 3816 | 1243 | 4717 | 1151 | 6111 | 966 | 6882 | 819 | 7662 | 596 | 9446 | 421 | 5690 |
| 3L-2S | | MI | 2236 | 1243 | 3160 | 1071 | 3839 | 897 | 4234 | 758 | 4687 | 543 | 5517 | 435 | 2972 |
| 6-#11 | 1.63 | MA | 4386 | 1294 | 5805 | 1163 | 7442 | 971 | 8468 | 817 | 9776 | 576 | 12357 | 500 | 6917 |
| 2L-3S | | MI | 2079 | 1294 | 3021 | 1100 | 3624 | 916 | 3954 | 768 | 4292 | 538 | 4946 | 289 | 3536 |
| 6-#11 | 1.63 | MA | 3916 | 1294 | 5042 | 1179 | 6476 | 986 | 7301 | 830 | 8204 | 593 | 10181 | 393 | 6855 |
| 3L-2S | | MI | 2294 | 1294 | 3382 | 1092 | 4081 | 911 | 4507 | 765 | 5037 | 534 | 5852 | 404 | 3536 |
| 6-#14 | 2.34 | MA | 4798 | 1416 | 6825 | 1234 | 8699 | 1023 | 9973 | 850 | 11786 | 568 | 15128 | 491 | 9792 |
| 2L-3S | | MI | 2174 | 1416 | 3350 | 1170 | 4013 | 966 | 4411 | 796 | 4885 | 526 | 5607 | 186 | 4838 |
| 6-#14 | 2.34 | MA | 4174 | 1416 | 5736 | 1256 | 7322 | 1043 | 8307 | 868 | 9543 | 592 | 12023 | 335 | 9619 |
| 3L-2S | | MI | 2452 | 1416 | 3860 | 1159 | 4658 | 959 | 5190 | 794 | 5929 | 522 | 6853 | 352 | 4882 |
| 6-#18 | 4.17 | MA | 5725 | 1725 | 9323 | 1418 | 11797 | 1157 | 13686 | 933 | 16755 | 551 | 21987 | 470 | 16873 |
| 2L-3S | | MI | 2387 | 1725 | 4124 | 1349 | 4938 | 1093 | 5503 | 870 | 6223 | 481 | 7085 | -102 | 7005 |
| 6-#18 | 4.17 | MA | 4797 | 1725 | 7429 | 1455 | 9400 | 1190 | 10788 | 962 | 12853 | 589 | 16584 | 183 | 16047 |
| 3L-2S | | MI | 2801 | 1725 | 4988 | 1335 | 6031 | 1087 | 6825 | 872 | 7943 | 472 | 9088 | 192 | 8058 |
| 8-#8 | 1.10 | MA | 4082 | 1204 | 4999 | 1118 | 6499 | 940 | 7368 | 799 | 8331 | 586 | 10384 | 510 | 4805 |
| 2L-4S | | MI | 1988 | 1204 | 2657 | 1066 | 3225 | 895 | 3494 | 763 | 3698 | 554 | 4340 | 366 | 2537 |
| 8-#8 | 1.10 | MA | 3823 | 1204 | 4603 | 1127 | 5998 | 948 | 6762 | 807 | 7515 | 595 | 9255 | 458 | 4796 |
| 3E | | MI | 2063 | 1204 | 2794 | 1061 | 3403 | 891 | 3721 | 756 | 4008 | 553 | 4706 | 396 | 2534 |
| 8-#8 | 1.10 | MA | 3672 | 1204 | 4332 | 1135 | 5643 | 956 | 6307 | 818 | 6894 | 601 | 8495 | 426 | 4756 |
| 4L-2S | | MI | 2184 | 1204 | 2986 | 1056 | 3647 | 887 | 4015 | 753 | 4405 | 549 | 5216 | 455 | 2526 |
| 8-#9 | 1.39 | MA | 4272 | 1254 | 5431 | 1147 | 7030 | 961 | 8002 | 812 | 9178 | 583 | 11551 | 507 | 6020 |
| 2L-4S | | MI | 2025 | 1254 | 2785 | 1096 | 3372 | 916 | 3662 | 776 | 3918 | 550 | 4612 | 328 | 3115 |
| 8-#9 | 1.39 | MA | 3958 | 1254 | 4932 | 1157 | 6398 | 971 | 7239 | 821 | 8150 | 595 | 10128 | 440 | 5997 |
| 3E | | MI | 2116 | 1254 | 2957 | 1089 | 3596 | 911 | 3947 | 768 | 4307 | 550 | 5066 | 366 | 3126 |
| 8-#9 | 1.39 | MA | 3774 | 1254 | 4589 | 1168 | 5951 | 980 | 6666 | 835 | 7366 | 602 | 9168 | 399 | 5909 |
| 4L-2S | | MI | 2263 | 1254 | 3198 | 1083 | 3901 | 906 | 4317 | 765 | 4805 | 545 | 5700 | 440 | 3121 |
| 8-#10 | 1.76 | MA | 4506 | 1317 | 5978 | 1184 | 7705 | 988 | 8811 | 829 | 10259 | 579 | 13042 | 502 | 7566 |
| 2L-4S | | MI | 2071 | 1317 | 2944 | 1134 | 3557 | 943 | 3875 | 793 | 4196 | 545 | 4951 | 279 | 3811 |
| 8-#10 | 1.76 | MA | 4126 | 1317 | 5348 | 1197 | 6908 | 1000 | 7846 | 841 | 8960 | 594 | 11244 | 417 | 7518 |
| 3E | | MI | 2182 | 1317 | 3160 | 1126 | 3839 | 937 | 4234 | 784 | 4687 | 545 | 5517 | 326 | 3863 |
| 8-#10 | 1.76 | MA | 3905 | 1317 | 4914 | 1211 | 6342 | 1012 | 7122 | 857 | 7969 | 603 | 10027 | 365 | 7341 |
| 4L-2S | | MI | 2360 | 1317 | 3463 | 1118 | 4223 | 932 | 4698 | 780 | 5311 | 540 | 6303 | 419 | 3868 |

## RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 8-#11 | 2.17 | MA | 4721 | 1386 | 6568 | 1220 | 8407 | 1014 | 9636 | 844 | 11348 | 572 | 14534 | 495 | 9145 |
| 2L-4S | | MI | 2109 | 1386 | 3122 | 1166 | 3729 | 971 | 4076 | 804 | 4450 | 532 | 5195 | 210 | 4368 |
| 8-#11 | 2.17 | MA | 4281 | 1386 | 5805 | 1236 | 7442 | 1028 | 8468 | 857 | 9776 | 590 | 12357 | 388 | 9064 |
| 3E | | MI | 2235 | 1386 | 3382 | 1157 | 4081 | 959 | 4507 | 795 | 5037 | 535 | 5852 | 265 | 4583 |
| 8-#11 | 2.17 | MA | 4025 | 1386 | 5279 | 1252 | 6754 | 1042 | 7588 | 877 | 8573 | 600 | 10870 | 323 | 8632 |
| 4L-2S | | MI | 2434 | 1386 | 3743 | 1149 | 4538 | 953 | 5060 | 792 | 5781 | 530 | 6759 | 379 | 4600 |
| 8-#14 | 3.13 | MA | 4675 | 1548 | 6825 | 1339 | 8699 | 1104 | 9973 | 906 | 11786 | 587 | 15128 | 328 | 12767 |
| 3E | | MI | 2381 | 1548 | 3860 | 1253 | 4658 | 1027 | 5190 | 835 | 5929 | 521 | 6853 | 146 | 6294 |
| 8-#14 | 3.13 | MA | 4342 | 1548 | 6072 | 1361 | 7715 | 1124 | 8714 | 934 | 10066 | 601 | 12992 | 233 | 11502 |
| 4L-2S | | MI | 2639 | 1548 | 4369 | 1242 | 5302 | 1020 | 5970 | 833 | 6972 | 516 | 8100 | 311 | 6367 |
| 8-#18 | 5.56 | MA | 5643 | 1960 | 9323 | 1602 | 11797 | 1298 | 13686 | 1031 | 16755 | 580 | 21987 | 171 | 21459 |
| 3E | | MI | 2724 | 1960 | 4988 | 1496 | 6031 | 1201 | 6825 | 939 | 7943 | 462 | 9088 | -193 | 8891 |
| 8-#18 | 5.56 | MA | 5179 | 1960 | 8006 | 1639 | 10077 | 1331 | 11488 | 1077 | 13752 | 600 | 18218 | -1 | 18214 |
| 4L-2S | | MI | 3098 | 1960 | 5852 | 1483 | 7124 | 1195 | 8147 | 941 | 9663 | 453 | 11092 | 101 | 10552 |
| 10-#10 | 2.20 | MA | 4784 | 1392 | 6608 | 1231 | 8503 | 1022 | 9775 | 851 | 11557 | 576 | 14840 | 498 | 9406 |
| 2L-5S | | MI | 2116 | 1392 | 3052 | 1188 | 3666 | 989 | 4014 | 819 | 4374 | 548 | 5181 | 207 | 4388 |
| 10-#10 | 2.20 | MA | 4424 | 1392 | 5978 | 1244 | 7705 | 1035 | 8811 | 863 | 10259 | 591 | 13042 | 413 | 9346 |
| 3L-4S | | MI | 2207 | 1392 | 3247 | 1180 | 3941 | 978 | 4339 | 815 | 4821 | 542 | 5737 | 263 | 4631 |
| 10-#10 | 2.20 | MA | 4221 | 1392 | 5545 | 1258 | 7139 | 1047 | 8086 | 879 | 9268 | 600 | 11825 | 361 | 9165 |
| 4L-3S | | MI | 2313 | 1392 | 3463 | 1173 | 4223 | 972 | 4698 | 806 | 5311 | 542 | 6303 | 310 | 4742 |
| 10-#10 | 2.20 | MA | 3989 | 1392 | 5161 | 1271 | 6592 | 1065 | 7440 | 891 | 8373 | 615 | 10538 | 309 | 8482 |
| 5L-2S | | MI | 2479 | 1392 | 3766 | 1165 | 4606 | 966 | 5162 | 802 | 5936 | 537 | 7090 | 404 | 4758 |
| 10-#11 | 2.71 | MA | 4630 | 1478 | 6568 | 1293 | 8407 | 1070 | 9636 | 884 | 11348 | 586 | 14534 | 384 | 11274 |
| 3L-4S | | MI | 2266 | 1478 | 3484 | 1223 | 4186 | 1013 | 4629 | 831 | 5194 | 529 | 6102 | 186 | 5346 |
| 10-#11 | 2.71 | MA | 4398 | 1478 | 6042 | 1309 | 7719 | 1085 | 8756 | 904 | 10145 | 596 | 13047 | 319 | 10805 |
| 4L-3S | | MI | 2382 | 1478 | 3743 | 1215 | 4538 | 1001 | 5060 | 821 | 5781 | 531 | 6759 | 240 | 5624 |
| 10-#11 | 2.71 | MA | 4127 | 1478 | 5574 | 1325 | 7055 | 1106 | 7971 | 917 | 9057 | 613 | 11542 | 261 | 10001 |
| 5L-2S | | MI | 2570 | 1478 | 4105 | 1206 | 4995 | 995 | 5612 | 819 | 6525 | 527 | 7665 | 355 | 5656 |
| 10-#14 | 3.91 | MA | 4859 | 1681 | 7160 | 1444 | 9093 | 1185 | 10380 | 973 | 12309 | 596 | 16097 | 226 | 14634 |
| 4L-3S | | MI | 2581 | 1681 | 4369 | 1335 | 5302 | 1088 | 5970 | 874 | 6972 | 515 | 8100 | 105 | 7748 |
| 10-#14 | 3.91 | MA | 4483 | 1681 | 6491 | 1466 | 8142 | 1215 | 9257 | 991 | 10753 | 619 | 13941 | 140 | 13359 |
| 5L-2S | | MI | 2821 | 1681 | 4879 | 1325 | 5946 | 1081 | 6749 | 872 | 8016 | 510 | 9346 | 271 | 7845 |
| 10-#18 | 6.94 | MA | 6048 | 2196 | 9900 | 1786 | 12473 | 1439 | 14386 | 1146 | 17654 | 591 | 23621 | -13 | 23495 |
| 4L-3S | | MI | 3052 | 2196 | 5852 | 1644 | 7124 | 1309 | 8147 | 1008 | 9663 | 443 | 11092 | -283 | 10739 |
| 10-#18 | 6.94 | MA | 5408 | 2196 | 8727 | 1823 | 10808 | 1489 | 12419 | 1175 | 14932 | 629 | 19834 | -176 | 18857 |
| 5L-2S | | MI | 3394 | 2196 | 6716 | 1630 | 8217 | 1303 | 9469 | 1011 | 11383 | 434 | 13096 | 10 | 13040 |
| 12-#10 | 2.65 | MA | 4711 | 1467 | 6608 | 1291 | 8503 | 1069 | 9775 | 884 | 11557 | 588 | 14840 | 409 | 11176 |
| 3L-5S | | MI | 2260 | 1467 | 3355 | 1235 | 4050 | 1023 | 4478 | 841 | 4998 | 545 | 5968 | 191 | 5231 |
| 12-#10 | 2.65 | MA | 4524 | 1467 | 6175 | 1304 | 7936 | 1081 | 9050 | 901 | 10566 | 597 | 13623 | 357 | 10992 |
| 4E | | MI | 2344 | 1467 | 3550 | 1227 | 4324 | 1012 | 4802 | 837 | 5446 | 539 | 6524 | 247 | 5458 |
| 12-#10 | 2.65 | MA | 4297 | 1467 | 5791 | 1318 | 7390 | 1099 | 8405 | 913 | 9671 | 612 | 12336 | 305 | 10301 |
| 5L-3S | | MI | 2437 | 1467 | 3766 | 1219 | 4606 | 1006 | 5162 | 828 | 5936 | 540 | 7090 | 294 | 5619 |
| 12-#10 | 2.65 | MA | 4033 | 1467 | 5377 | 1325 | 6897 | 1111 | 7775 | 929 | 8799 | 621 | 11214 | 244 | 9701 |
| 6L-2S | | MI | 2595 | 1467 | 4070 | 1211 | 4990 | 1000 | 5626 | 824 | 6561 | 534 | 7876 | 388 | 5643 |
| 12-#11 | 3.25 | MA | 4756 | 1569 | 6805 | 1366 | 8684 | 1127 | 9923 | 931 | 11717 | 593 | 15223 | 314 | 12984 |
| 4E | | MI | 2418 | 1569 | 3845 | 1280 | 4643 | 1055 | 5182 | 858 | 5938 | 525 | 7008 | 161 | 6334 |
| 12-#11 | 3.25 | MA | 4490 | 1569 | 6337 | 1382 | 8020 | 1148 | 9138 | 944 | 10629 | 610 | 13719 | 256 | 12209 |
| 5L-3S | | MI | 2525 | 1569 | 4105 | 1272 | 4995 | 1043 | 5612 | 848 | 6525 | 528 | 7665 | 216 | 6663 |
| 12-#11 | 3.25 | MA | 4183 | 1569 | 5842 | 1392 | 7420 | 1162 | 8373 | 964 | 9570 | 620 | 12283 | 172 | 11275 |
| 6L-2S | | MI | 2702 | 1569 | 4466 | 1264 | 5452 | 1037 | 6165 | 846 | 7270 | 523 | 8572 | 331 | 6707 |
| 12-#14 | 4.69 | MA | 4985 | 1813 | 7580 | 1549 | 9519 | 1276 | 10923 | 1030 | 12996 | 614 | 17047 | 134 | 16494 |
| 5L-3S | | MI | 2775 | 1813 | 4879 | 1418 | 5946 | 1148 | 6749 | 913 | 8016 | 509 | 9346 | 65 | 9138 |
| 12-#14 | 4.69 | MA | 4579 | 1813 | 6879 | 1563 | 8660 | 1296 | 9827 | 1058 | 11479 | 628 | 14983 | 11 | 14923 |
| 6L-2S | | MI | 3000 | 1813 | 5388 | 1408 | 6591 | 1142 | 7528 | 911 | 9060 | 504 | 10592 | 230 | 9319 |
| 14-#10 | 3.09 | MA | 4817 | 1542 | 6805 | 1351 | 8734 | 1116 | 10015 | 923 | 11865 | 594 | 15421 | 353 | 12810 |
| 4L-5S | | MI | 2395 | 1542 | 3659 | 1282 | 4433 | 1058 | 4942 | 863 | 5623 | 542 | 6754 | 175 | 6078 |
| 14-#10 | 3.09 | MA | 4593 | 1542 | 6421 | 1364 | 8187 | 1133 | 9369 | 935 | 10970 | 609 | 14134 | 301 | 12124 |
| 5L-4S | | MI | 2471 | 1542 | 3853 | 1274 | 4708 | 1046 | 5266 | 859 | 6071 | 537 | 7310 | 231 | 6293 |

## RECTANGULAR TIED COLUMNS 18" x 32"

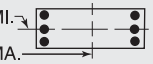
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 14-#10 | 3.09 | MA | 4344 | 1542 | 6008 | 1372 | 7694 | 1146 | 8739 | 951 | 10098 | 618 | 13012 | 240 | 11525 |
| 6L-3S | | MI | 2558 | 1542 | 4070 | 1266 | 4990 | 1040 | 5626 | 850 | 6561 | 537 | 7876 | 278 | 6493 |
| 14-#10 | 3.09 | MA | 4123 | 1542 | 5608 | 1381 | 7174 | 1154 | 8131 | 963 | 9250 | 633 | 11846 | 204 | 10777 |
| 7L-2S | | MI | 2709 | 1542 | 4373 | 1258 | 5373 | 1035 | 6090 | 846 | 7185 | 531 | 8662 | 372 | 6525 |
| 14-#11 | 3.79 | MA | 4839 | 1661 | 7100 | 1440 | 8985 | 1190 | 10306 | 971 | 12201 | 606 | 15895 | 252 | 14420 |
| 5L-4S | | MI | 2566 | 1661 | 4206 | 1338 | 5100 | 1098 | 5734 | 885 | 6682 | 522 | 7915 | 137 | 7329 |
| 14-#11 | 3.79 | MA | 4550 | 1661 | 6605 | 1449 | 8385 | 1205 | 9540 | 991 | 11141 | 617 | 14459 | 167 | 13481 |
| 6L-3S | | MI | 2664 | 1661 | 4466 | 1329 | 5452 | 1085 | 6165 | 875 | 7270 | 524 | 8572 | 192 | 7701 |
| 14-#11 | 3.79 | MA | 4294 | 1661 | 6121 | 1459 | 7763 | 1215 | 8800 | 1004 | 10111 | 634 | 13037 | 119 | 12473 |
| 7L-2S | | MI | 2833 | 1661 | 4827 | 1321 | 5909 | 1079 | 6718 | 872 | 8014 | 520 | 9478 | 306 | 7755 |
| 14-#14 | 5.47 | MA | 5120 | 1945 | 7968 | 1645 | 10037 | 1356 | 11493 | 1096 | 13722 | 623 | 18089 | 4 | 18067 |
| 6L-3S | | MI | 2966 | 1945 | 5388 | 1501 | 6591 | 1209 | 7528 | 952 | 9060 | 503 | 10592 | 25 | 10510 |
| 14-#14 | 5.47 | MA | 4755 | 1945 | 7275 | 1660 | 9158 | 1371 | 10432 | 1114 | 12247 | 646 | 16048 | -68 | 15834 |
| 7L-2S | | MI | 3178 | 1945 | 5897 | 1490 | 7235 | 1203 | 8308 | 950 | 10104 | 498 | 11839 | 190 | 10790 |
| 16-#10 | 3.53 | MA | 4881 | 1616 | 7052 | 1411 | 8985 | 1168 | 10333 | 957 | 12268 | 606 | 15931 | 297 | 13948 |
| 5E | | MI | 2521 | 1616 | 3962 | 1328 | 4817 | 1092 | 5406 | 885 | 6248 | 539 | 7541 | 159 | 6929 |
| 16-#10 | 3.53 | MA | 4643 | 1616 | 6638 | 1418 | 8491 | 1180 | 9704 | 973 | 11396 | 616 | 14809 | 236 | 13348 |
| 6L-4S | | MI | 2596 | 1616 | 4157 | 1321 | 5092 | 1081 | 5730 | 881 | 6695 | 534 | 8096 | 215 | 7132 |
| 16-#10 | 3.53 | MA | 4436 | 1616 | 6239 | 1427 | 7971 | 1188 | 9095 | 985 | 10549 | 630 | 13644 | 200 | 12602 |
| 7L-3S | | MI | 2677 | 1616 | 4373 | 1313 | 5373 | 1075 | 6090 | 872 | 7185 | 534 | 8662 | 262 | 7367 |
| 16-#10 | 3.53 | MA | 4242 | 1616 | 5799 | 1443 | 7429 | 1202 | 8471 | 993 | 9704 | 639 | 12520 | 150 | 11747 |
| 8L-2S | | MI | 2821 | 1616 | 4676 | 1305 | 5757 | 1069 | 6554 | 868 | 7810 | 529 | 9449 | 356 | 7406 |
| 16-#11 | 4.33 | MA | 4905 | 1753 | 7369 | 1506 | 9350 | 1247 | 10708 | 1018 | 12713 | 613 | 16636 | 162 | 15687 |
| 6L-4S | | MI | 2710 | 1753 | 4567 | 1395 | 5557 | 1140 | 6287 | 912 | 7427 | 519 | 8821 | 112 | 8331 |
| 16-#11 | 4.33 | MA | 4666 | 1753 | 6884 | 1517 | 8729 | 1257 | 9967 | 1031 | 11683 | 630 | 15214 | 115 | 14672 |
| 7L-3S | | MI | 2801 | 1753 | 4827 | 1387 | 5909 | 1127 | 6718 | 902 | 8014 | 521 | 9478 | 167 | 8738 |
| 16-#11 | 4.33 | MA | 4438 | 1753 | 6349 | 1536 | 8071 | 1274 | 9222 | 1042 | 10656 | 640 | 13844 | 50 | 13657 |
| 8L-2S | | MI | 2962 | 1753 | 5188 | 1379 | 6366 | 1122 | 7271 | 899 | 8758 | 517 | 10385 | 282 | 8802 |
| 16-#14 | 6.25 | MA | 5310 | 2078 | 8364 | 1743 | 10536 | 1432 | 12098 | 1153 | 14490 | 641 | 19154 | -75 | 18812 |
| 7L-3S | | MI | 3154 | 2078 | 5897 | 1584 | 7235 | 1270 | 8308 | 991 | 10104 | 497 | 11839 | -16 | 11808 |
| 18-#10 | 3.97 | MA | 4935 | 1691 | 7268 | 1465 | 9289 | 1214 | 10668 | 995 | 12695 | 613 | 16607 | 233 | 15171 |
| 6L-5S | | MI | 2643 | 1691 | 4265 | 1375 | 5201 | 1126 | 5870 | 907 | 6872 | 537 | 8327 | 143 | 7783 |
| 18-#10 | 3.97 | MA | 4739 | 1691 | 6869 | 1474 | 8769 | 1222 | 10060 | 1007 | 11847 | 627 | 15442 | 196 | 14428 |
| 7L-4S | | MI | 2718 | 1691 | 4460 | 1367 | 5475 | 1115 | 6194 | 903 | 7320 | 531 | 8883 | 199 | 7976 |
| 18-#10 | 3.97 | MA | 4549 | 1691 | 6429 | 1490 | 8227 | 1236 | 9435 | 1015 | 11002 | 637 | 14318 | 146 | 13569 |
| 8L-3S | | MI | 2793 | 1691 | 4676 | 1359 | 5757 | 1109 | 6554 | 894 | 7810 | 531 | 9449 | 246 | 8241 |
| 18-#10 | 3.97 | MA | 4308 | 1691 | 6051 | 1501 | 7724 | 1246 | 8793 | 1029 | 10169 | 651 | 13156 | 91 | 12716 |
| 9L-2S | | MI | 2932 | 1691 | 4979 | 1352 | 6141 | 1103 | 7018 | 890 | 8435 | 526 | 10235 | 340 | 8286 |
| 18-#11 | 4.88 | MA | 5026 | 1845 | 7647 | 1574 | 9694 | 1299 | 11135 | 1058 | 13255 | 627 | 17390 | 110 | 16872 |
| 7L-4S | | MI | 2852 | 1845 | 4929 | 1453 | 6014 | 1182 | 6840 | 939 | 8171 | 515 | 9728 | 88 | 9338 |
| 18-#11 | 4.88 | MA | 4802 | 1845 | 7112 | 1593 | 9036 | 1316 | 10389 | 1069 | 12228 | 637 | 16020 | 45 | 15851 |
| 8L-3S | | MI | 2936 | 1845 | 5188 | 1444 | 6366 | 1169 | 7271 | 929 | 8758 | 518 | 10385 | 143 | 9775 |
| 20-#10 | 4.41 | MA | 5035 | 1766 | 7499 | 1521 | 9566 | 1257 | 11024 | 1029 | 13145 | 625 | 17240 | 192 | 16254 |
| 7L-5S | | MI | 2764 | 1766 | 4568 | 1422 | 5584 | 1161 | 6334 | 929 | 7497 | 534 | 9113 | 127 | 8640 |
| 20-#10 | 4.41 | MA | 4847 | 1766 | 7059 | 1537 | 9024 | 1271 | 10399 | 1037 | 12301 | 634 | 16116 | 142 | 15390 |
| 8L-4S | | MI | 2837 | 1766 | 4763 | 1414 | 5859 | 1149 | 6658 | 925 | 7945 | 528 | 9669 | 183 | 8823 |
| 20-#10 | 4.41 | MA | 4617 | 1766 | 6681 | 1548 | 8521 | 1280 | 9758 | 1051 | 11468 | 649 | 14954 | 88 | 14534 |
| 9L-3S | | MI | 2908 | 1766 | 4979 | 1406 | 6141 | 1143 | 7018 | 916 | 8435 | 528 | 10235 | 230 | 9114 |
| 20-#11 | 5.42 | MA | 5156 | 1937 | 7876 | 1650 | 10001 | 1358 | 11556 | 1096 | 13799 | 633 | 18197 | 41 | 18045 |
| 8L-4S | | MI | 2991 | 1937 | 5290 | 1510 | 6471 | 1224 | 7393 | 966 | 8915 | 512 | 10634 | 63 | 10348 |
| 22-#10 | 4.85 | MA | 5138 | 1841 | 7690 | 1583 | 9821 | 1305 | 11364 | 1059 | 13599 | 631 | 17914 | 138 | 17211 |
| 8L-5S | | MI | 2882 | 1841 | 4871 | 1469 | 5968 | 1195 | 6798 | 951 | 8122 | 531 | 9900 | 111 | 9491 |
| 22-#10 | 4.85 | MA | 4917 | 1841 | 7311 | 1594 | 9318 | 1315 | 10722 | 1073 | 12766 | 646 | 16752 | 84 | 16351 |
| 9L-4S | | MI | 2956 | 1841 | 5066 | 1461 | 6242 | 1184 | 7122 | 947 | 8569 | 525 | 10456 | 167 | 9674 |
| 24-#10 | 5.29 | MA | 5211 | 1915 | 7942 | 1641 | 10116 | 1349 | 11686 | 1095 | 14064 | 643 | 18550 | 80 | 18168 |
| 9L-5S | | MI | 2999 | 1915 | 5175 | 1515 | 6351 | 1229 | 7262 | 973 | 8747 | 528 | 10686 | 95 | 10329 |

## RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis



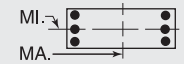

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.02 | MA | 4526 | 1266 | 5556 | 1173 | 7180 | 987 | 8105 | 841 | 9097 | 619 | 11280 | 540 | 5018 |
| 2E | | MI | 2264 | 1266 | 3164 | 1092 | 3793 | 918 | 4132 | 780 | 4468 | 571 | 5142 | 458 | 2475 |
| 4-#14 | 1.47 | MA | 4845 | 1347 | 6304 | 1219 | 8092 | 1020 | 9189 | 861 | 10540 | 613 | 13266 | 533 | 7099 |
| 2E | | MI | 2375 | 1347 | 3496 | 1133 | 4184 | 947 | 4589 | 797 | 5060 | 561 | 5802 | 422 | 3401 |
| 4-#18 | 2.61 | MA | 5570 | 1553 | 8132 | 1338 | 10337 | 1107 | 11869 | 915 | 14116 | 600 | 18193 | 518 | 12225 |
| 2E | | MI | 2616 | 1553 | 4273 | 1244 | 5110 | 1026 | 5681 | 845 | 6397 | 524 | 7277 | 312 | 5581 |
| 6-#10 | 1.25 | MA | 4725 | 1306 | 5882 | 1205 | 7641 | 1011 | 8688 | 858 | 9906 | 622 | 12417 | 541 | 6134 |
| 2L-3S | | MI | 2164 | 1306 | 2997 | 1137 | 3623 | 953 | 3948 | 805 | 4238 | 583 | 4928 | 372 | 2998 |
| 6-#10 | 1.25 | MA | 4287 | 1306 | 5205 | 1219 | 6785 | 1024 | 7652 | 869 | 8511 | 637 | 10486 | 458 | 6101 |
| 3L-2S | | MI | 2352 | 1306 | 3301 | 1130 | 4007 | 947 | 4412 | 802 | 4862 | 577 | 5714 | 466 | 2988 |
| 6-#11 | 1.53 | MA | 4910 | 1357 | 6376 | 1230 | 8218 | 1029 | 9360 | 868 | 10787 | 616 | 13621 | 535 | 7422 |
| 2L-3S | | MI | 2194 | 1358 | 3164 | 1157 | 3793 | 965 | 4132 | 810 | 4468 | 572 | 5142 | 319 | 3561 |
| 6-#11 | 1.53 | MA | 4398 | 1357 | 5556 | 1247 | 7180 | 1044 | 8105 | 881 | 9097 | 634 | 11280 | 430 | 7361 |
| 3L-2S | | MI | 2411 | 1357 | 3526 | 1149 | 4250 | 960 | 4685 | 807 | 5212 | 568 | 6048 | 434 | 3556 |
| 6-#14 | 2.21 | MA | 5362 | 1479 | 7475 | 1302 | 9574 | 1081 | 10982 | 900 | 12954 | 609 | 16608 | 526 | 10521 |
| 2L-3S | | MI | 2288 | 1479 | 3496 | 1227 | 4184 | 1015 | 4589 | 839 | 5060 | 560 | 5802 | 216 | 4873 |
| 6-#14 | 2.21 | MA | 4681 | 1479 | 6304 | 1325 | 8092 | 1102 | 9189 | 919 | 10540 | 633 | 13266 | 373 | 10348 |
| 3L-2S | | MI | 2570 | 1479 | 4006 | 1216 | 4828 | 1008 | 5369 | 836 | 6103 | 555 | 7048 | 381 | 4907 |
| 6-#18 | 3.92 | MA | 6385 | 1788 | 10174 | 1485 | 12919 | 1215 | 14993 | 984 | 18321 | 591 | 24015 | 505 | 18169 |
| 2L-3S | | MI | 2499 | 1788 | 4273 | 1405 | 5110 | 1140 | 5681 | 911 | 6397 | 514 | 7277 | -73 | 7221 |
| 6-#18 | 3.92 | MA | 5363 | 1788 | 8132 | 1524 | 10337 | 1249 | 11869 | 1014 | 14116 | 632 | 18193 | 224 | 17490 |
| 3L-2S | | MI | 2920 | 1788 | 5137 | 1391 | 6203 | 1135 | 7003 | 914 | 8117 | 505 | 9281 | 221 | 8093 |
| 8-#8 | 1.03 | MA | 4575 | 1268 | 5506 | 1186 | 7200 | 998 | 8172 | 850 | 9227 | 626 | 11490 | 546 | 5146 |
| 2L-4S | | MI | 2102 | 1268 | 2795 | 1125 | 3392 | 945 | 3671 | 806 | 3874 | 588 | 4539 | 397 | 2554 |
| 8-#8 | 1.03 | MA | 4294 | 1268 | 5081 | 1194 | 6662 | 1006 | 7522 | 857 | 8352 | 636 | 10278 | 494 | 5138 |
| 3E | | MI | 2178 | 1268 | 2932 | 1120 | 3570 | 941 | 3898 | 800 | 4184 | 588 | 4904 | 427 | 2548 |
| 8-#8 | 1.03 | MA | 4130 | 1268 | 4791 | 1203 | 6282 | 1014 | 7035 | 868 | 7686 | 642 | 9468 | 462 | 5097 |
| 4L-2S | | MI | 2300 | 1268 | 3125 | 1114 | 3814 | 937 | 4193 | 797 | 4581 | 584 | 5414 | 485 | 2540 |
| 8-#9 | 1.31 | MA | 4783 | 1317 | 5970 | 1214 | 7771 | 1018 | 8854 | 863 | 10137 | 623 | 12745 | 542 | 6452 |
| 2L-4S | | MI | 2139 | 1317 | 2924 | 1154 | 3540 | 966 | 3839 | 819 | 4094 | 585 | 4810 | 359 | 3137 |
| 8-#9 | 1.31 | MA | 4441 | 1317 | 5435 | 1225 | 7093 | 1029 | 8034 | 872 | 9034 | 635 | 11217 | 477 | 6429 |
| 3E | | MI | 2231 | 1317 | 3096 | 1148 | 3764 | 961 | 4125 | 812 | 4483 | 584 | 5264 | 397 | 3143 |
| 8-#9 | 1.31 | MA | 4242 | 1317 | 5068 | 1236 | 6613 | 1039 | 7420 | 886 | 8194 | 643 | 10193 | 436 | 6341 |
| 4L-2S | | MI | 2379 | 1317 | 3337 | 1141 | 4069 | 956 | 4494 | 808 | 4981 | 579 | 5897 | 470 | 3137 |
| 8-#10 | 1.66 | MA | 5039 | 1381 | 6559 | 1252 | 8498 | 1046 | 9724 | 880 | 11300 | 619 | 14349 | 537 | 8115 |
| 2L-4S | | MI | 2185 | 1381 | 3084 | 1192 | 3725 | 993 | 4052 | 837 | 4372 | 580 | 5148 | 309 | 3853 |
| 8-#10 | 1.66 | MA | 4625 | 1381 | 5882 | 1265 | 7641 | 1058 | 8688 | 891 | 9906 | 634 | 12417 | 454 | 8066 |
| 3E | | MI | 2297 | 1381 | 3301 | 1184 | 4007 | 987 | 4412 | 827 | 4862 | 580 | 5714 | 356 | 3885 |
| 8-#10 | 1.66 | MA | 4385 | 1381 | 5418 | 1279 | 7035 | 1071 | 7911 | 909 | 8843 | 644 | 11119 | 402 | 7890 |
| 4L-2S | | MI | 2477 | 1381 | 3604 | 1176 | 4391 | 981 | 4876 | 823 | 5487 | 574 | 6501 | 450 | 3887 |
| 8-#11 | 2.04 | MA | 5276 | 1449 | 7197 | 1288 | 9256 | 1071 | 10616 | 895 | 12477 | 612 | 15961 | 530 | 9819 |
| 2L-4S | | MI | 2223 | 1449 | 3266 | 1223 | 3898 | 1020 | 4254 | 847 | 4625 | 566 | 5391 | 240 | 4438 |
| 8-#11 | 2.04 | MA | 4796 | 1449 | 6376 | 1304 | 8218 | 1086 | 9360 | 908 | 10787 | 630 | 13621 | 426 | 9738 |
| 3E | | MI | 2350 | 1449 | 3526 | 1215 | 4250 | 1008 | 4685 | 837 | 5212 | 569 | 6048 | 295 | 4610 |
| 8-#11 | 2.04 | MA | 4517 | 1449 | 5812 | 1320 | 7480 | 1101 | 8416 | 929 | 9497 | 641 | 12034 | 361 | 9368 |
| 4L-2S | | MI | 2552 | 1449 | 3887 | 1206 | 4707 | 1002 | 5238 | 834 | 5956 | 564 | 6955 | 409 | 4623 |
| 8-#14 | 2.94 | MA | 5227 | 1612 | 7475 | 1407 | 9574 | 1163 | 10982 | 958 | 12954 | 628 | 16608 | 366 | 13739 |
| 3E | | MI | 2496 | 1612 | 4006 | 1310 | 4828 | 1075 | 5369 | 878 | 6103 | 554 | 7048 | 175 | 6331 |
| 8-#14 | 2.94 | MA | 4865 | 1612 | 6667 | 1430 | 8518 | 1184 | 9631 | 987 | 11108 | 643 | 14327 | 272 | 12484 |
| 4L-2S | | MI | 2758 | 1612 | 4515 | 1299 | 5472 | 1069 | 6148 | 875 | 7147 | 549 | 8294 | 341 | 6395 |
| 8-#18 | 5.23 | MA | 6289 | 2024 | 10174 | 1671 | 12919 | 1357 | 14993 | 1083 | 18321 | 623 | 24015 | 212 | 23435 |
| 3E | | MI | 2837 | 2024 | 5137 | 1552 | 6203 | 1248 | 7003 | 980 | 8117 | 495 | 9281 | -164 | 9116 |
| 8-#18 | 5.23 | MA | 5733 | 2024 | 8759 | 1709 | 11071 | 1392 | 12630 | 1132 | 15093 | 645 | 19990 | 42 | 19745 |
| 4L-2S | | MI | 3218 | 2024 | 6001 | 1538 | 7296 | 1243 | 8325 | 983 | 9837 | 486 | 11285 | 130 | 10589 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis

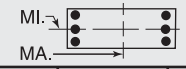



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.08 | MA | 5342 | 1456 | 7236 | 1298 | 9354 | 1080 | 10760 | 902 | 12695 | 616 | 16280 | 533 | 10092 |
| 2L-5S | | MI | 2229 | 1456 | 3193 | 1246 | 3834 | 1039 | 4192 | 863 | 4550 | 582 | 5379 | 237 | 4443 |
| 10-#10 | 2.08 | MA | 4949 | 1456 | 6559 | 1312 | 8498 | 1093 | 9724 | 913 | 11300 | 632 | 14349 | 450 | 10032 |
| 3L-4S | | MI | 2321 | 1456 | 3387 | 1239 | 4109 | 1027 | 4516 | 859 | 4997 | 577 | 5935 | 293 | 4692 |
| 10-#10 | 2.08 | MA | 4728 | 1456 | 6095 | 1326 | 7891 | 1105 | 8947 | 931 | 10238 | 641 | 13051 | 398 | 9851 |
| 4L-3S | | MI | 2426 | 1456 | 3604 | 1231 | 4391 | 1021 | 4876 | 849 | 5487 | 577 | 6501 | 340 | 4766 |
| 10-#10 | 2.08 | MA | 4474 | 1456 | 5683 | 1340 | 7306 | 1124 | 8256 | 943 | 9279 | 657 | 11674 | 347 | 9160 |
| 5L-2S | | MI | 2597 | 1456 | 3907 | 1223 | 4774 | 1016 | 5339 | 845 | 6112 | 571 | 7287 | 434 | 4778 |
| 10-#11 | 2.55 | MA | 5176 | 1541 | 7197 | 1361 | 9256 | 1128 | 10616 | 935 | 12477 | 627 | 15961 | 421 | 12116 |
| 3L-4S | | MI | 2380 | 1541 | 3627 | 1280 | 4355 | 1062 | 4807 | 874 | 5369 | 563 | 6297 | 216 | 5414 |
| 10-#11 | 2.55 | MA | 4923 | 1541 | 6632 | 1378 | 8518 | 1143 | 9672 | 956 | 11187 | 638 | 14374 | 356 | 11712 |
| 4L-3S | | MI | 2498 | 1541 | 3887 | 1272 | 4707 | 1050 | 5238 | 864 | 5956 | 565 | 6955 | 270 | 5654 |
| 10-#11 | 2.55 | MA | 4625 | 1541 | 6132 | 1394 | 7806 | 1165 | 8830 | 970 | 10021 | 656 | 12697 | 291 | 10808 |
| 5L-2S | | MI | 2688 | 1541 | 4248 | 1264 | 5164 | 1044 | 5790 | 861 | 6700 | 561 | 7861 | 385 | 5680 |
| 10-#14 | 3.68 | MA | 5427 | 1744 | 7839 | 1513 | 10000 | 1244 | 11424 | 1026 | 13521 | 638 | 17669 | 265 | 15863 |
| 4L-3S | | MI | 2696 | 1744 | 4515 | 1392 | 5472 | 1136 | 6148 | 917 | 7147 | 548 | 8294 | 135 | 7787 |
| 10-#14 | 3.68 | MA | 5012 | 1744 | 7122 | 1536 | 8981 | 1275 | 10219 | 1044 | 11852 | 663 | 15264 | 169 | 14540 |
| 5L-2S | | MI | 2941 | 1744 | 5024 | 1382 | 6117 | 1130 | 6927 | 914 | 8191 | 543 | 9541 | 300 | 7874 |
| 10-#18 | 6.54 | MA | 6726 | 2259 | 10800 | 1857 | 13654 | 1500 | 15754 | 1201 | 19298 | 637 | 25813 | 30 | 25639 |
| 4L-3S | | MI | 3164 | 2259 | 6001 | 1699 | 7296 | 1357 | 8325 | 1049 | 9837 | 476 | 11285 | -254 | 10974 |
| 10-#18 | 6.54 | MA | 6018 | 2259 | 9542 | 1895 | 11867 | 1552 | 13643 | 1231 | 16375 | 677 | 21757 | -126 | 20921 |
| 5L-2S | | MI | 3513 | 2259 | 6865 | 1686 | 8389 | 1351 | 9647 | 1052 | 11557 | 467 | 13288 | 39 | 13078 |
| 12-#10 | 2.49 | MA | 5262 | 1531 | 7236 | 1359 | 9354 | 1127 | 10760 | 935 | 12695 | 629 | 16280 | 446 | 11999 |
| 3L-5S | | MI | 2367 | 1531 | 3496 | 1293 | 4218 | 1073 | 4656 | 885 | 5174 | 579 | 6165 | 221 | 5285 |
| 12-#10 | 2.49 | MA | 5058 | 1531 | 6772 | 1373 | 8747 | 1140 | 9983 | 953 | 11633 | 639 | 14982 | 394 | 11815 |
| 4E | | MI | 2458 | 1531 | 3691 | 1285 | 4492 | 1062 | 4980 | 881 | 5622 | 574 | 6721 | 277 | 5518 |
| 12-#10 | 2.49 | MA | 4808 | 1531 | 6360 | 1386 | 8162 | 1158 | 9291 | 964 | 10674 | 654 | 13605 | 343 | 11118 |
| 5L-3S | | MI | 2554 | 1531 | 3907 | 1278 | 4774 | 1056 | 5339 | 871 | 6112 | 574 | 7287 | 324 | 5644 |
| 12-#10 | 2.49 | MA | 4522 | 1531 | 5913 | 1393 | 7633 | 1171 | 8634 | 976 | 9740 | 664 | 12407 | 284 | 10515 |
| 6L-2S | | MI | 2714 | 1531 | 4210 | 1270 | 5158 | 1050 | 5803 | 867 | 6736 | 569 | 8073 | 418 | 5664 |
| 12-#11 | 3.06 | MA | 5313 | 1633 | 7453 | 1435 | 9556 | 1186 | 10927 | 983 | 12877 | 635 | 16714 | 351 | 14061 |
| 4E | | MI | 2532 | 1633 | 3989 | 1338 | 4812 | 1104 | 5360 | 901 | 6113 | 559 | 7204 | 191 | 6400 |
| 12-#11 | 3.06 | MA | 5020 | 1633 | 6952 | 1451 | 8844 | 1208 | 10086 | 997 | 11711 | 653 | 15037 | 287 | 13186 |
| 5L-3S | | MI | 2641 | 1633 | 4248 | 1330 | 5164 | 1092 | 5790 | 891 | 6700 | 562 | 7861 | 246 | 6694 |
| 12-#11 | 3.06 | MA | 4686 | 1633 | 6415 | 1460 | 8202 | 1223 | 9266 | 1017 | 10575 | 664 | 13574 | 212 | 12224 |
| 6L-2S | | MI | 2822 | 1633 | 4610 | 1321 | 5621 | 1086 | 6343 | 888 | 7445 | 557 | 8768 | 360 | 6732 |
| 12-#14 | 4.41 | MA | 5558 | 1877 | 8293 | 1619 | 10463 | 1336 | 12012 | 1083 | 14266 | 658 | 18606 | 162 | 17913 |
| 5L-3S | | MI | 2891 | 1877 | 5024 | 1475 | 6117 | 1197 | 6927 | 955 | 8191 | 543 | 9541 | 95 | 9235 |
| 12-#14 | 4.41 | MA | 5116 | 1877 | 7532 | 1632 | 9542 | 1357 | 10837 | 1112 | 12639 | 673 | 16502 | 54 | 16179 |
| 6L-2S | | MI | 3121 | 1877 | 5534 | 1465 | 6761 | 1191 | 7707 | 953 | 9235 | 538 | 10787 | 260 | 9349 |
| 12-#18 | 7.84 | MA | 6932 | 2495 | 11584 | 2042 | 14449 | 1660 | 16766 | 1300 | 20581 | 668 | 27579 | -138 | 26339 |
| 5L-3S | | MI | 3485 | 2495 | 6865 | 1847 | 8389 | 1465 | 9647 | 1119 | 11557 | 457 | 13288 | -345 | 12801 |
| 14-#10 | 2.91 | MA | 5377 | 1605 | 7449 | 1419 | 9604 | 1174 | 11019 | 975 | 13028 | 636 | 16913 | 390 | 13781 |
| 4L-5S | | MI | 2508 | 1605 | 3799 | 1340 | 4601 | 1107 | 5120 | 906 | 5799 | 577 | 6952 | 205 | 6131 |
| 14-#10 | 2.91 | MA | 5131 | 1605 | 7037 | 1433 | 9019 | 1192 | 10327 | 986 | 12069 | 651 | 15537 | 340 | 13078 |
| 5L-4S | | MI | 2586 | 1605 | 3994 | 1332 | 4876 | 1096 | 5444 | 903 | 6246 | 571 | 7507 | 261 | 6350 |
| 14-#10 | 2.91 | MA | 4859 | 1605 | 6590 | 1440 | 8490 | 1205 | 9670 | 998 | 11135 | 661 | 14338 | 280 | 12474 |
| 6L-3S | | MI | 2676 | 1605 | 4210 | 1324 | 5158 | 1090 | 5803 | 893 | 6736 | 571 | 8073 | 308 | 6519 |
| 14-#10 | 2.91 | MA | 4620 | 1605 | 6162 | 1450 | 7927 | 1213 | 9002 | 1016 | 10228 | 676 | 13096 | 245 | 11651 |
| 7L-2S | | MI | 2829 | 1605 | 4514 | 1316 | 5541 | 1084 | 6267 | 889 | 7361 | 566 | 8860 | 402 | 6548 |
| 14-#11 | 3.57 | MA | 5400 | 1725 | 7773 | 1509 | 9882 | 1250 | 11341 | 1024 | 13401 | 649 | 17377 | 282 | 15568 |
| 5L-4S | | MI | 2680 | 1725 | 4350 | 1395 | 5269 | 1147 | 5912 | 928 | 6858 | 556 | 8111 | 167 | 7394 |
| 14-#11 | 3.57 | MA | 5085 | 1725 | 7235 | 1518 | 9239 | 1265 | 10521 | 1044 | 12266 | 660 | 15914 | 207 | 14597 |
| 6L-3S | | MI | 2781 | 1725 | 4610 | 1387 | 5621 | 1134 | 6343 | 918 | 7445 | 558 | 8768 | 221 | 7733 |
| 14-#11 | 3.57 | MA | 4807 | 1725 | 6715 | 1529 | 8564 | 1274 | 9728 | 1058 | 11161 | 678 | 14395 | 162 | 13566 |
| 7L-2S | | MI | 2953 | 1725 | 4971 | 1379 | 6078 | 1128 | 6896 | 915 | 8189 | 554 | 9674 | 336 | 7781 |
| 14-#14 | 5.15 | MA | 5671 | 2009 | 8704 | 1715 | 11024 | 1418 | 12630 | 1151 | 15053 | 668 | 19843 | 47 | 19562 |
| 6L-3S | | MI | 3083 | 2009 | 5534 | 1558 | 6761 | 1258 | 7707 | 994 | 9235 | 537 | 10787 | 54 | 10604 |

## RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis



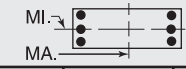

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 5.15 | MA | 5307 | 2009 | 7960 | 1730 | 10068 | 1432 | 11494 | 1170 | 13472 | 693 | 17662 | -21 | 17591 |
| 7L-2S | | MI | 3299 | 2009 | 6043 | 1547 | 7405 | 1251 | 8486 | 992 | 10279 | 532 | 12033 | 219 | 10821 |
| 16-#10 | 3.32 | MA | 5444 | 1680 | 7714 | 1480 | 9875 | 1227 | 11363 | 1008 | 13463 | 648 | 17468 | 336 | 15040 |
| 5E | | MI | 2636 | 1680 | 4102 | 1387 | 4985 | 1142 | 5584 | 928 | 6424 | 574 | 7738 | 189 | 6981 |
| 16-#10 | 3.32 | MA | 5185 | 1680 | 7267 | 1487 | 9346 | 1239 | 10706 | 1020 | 12530 | 658 | 16269 | 277 | 14432 |
| 6L-4S | | MI | 2711 | 1680 | 4297 | 1379 | 5260 | 1130 | 5908 | 925 | 6871 | 568 | 8294 | 245 | 7189 |
| 16-#10 | 3.32 | MA | 4960 | 1680 | 6839 | 1496 | 8783 | 1247 | 10038 | 1038 | 11622 | 674 | 15027 | 241 | 13613 |
| 7L-3S | | MI | 2795 | 1680 | 4514 | 1371 | 5541 | 1124 | 6267 | 915 | 7361 | 569 | 8860 | 292 | 7394 |
| 16-#10 | 3.32 | MA | 4746 | 1680 | 6368 | 1512 | 8203 | 1262 | 9360 | 1046 | 10718 | 683 | 13827 | 192 | 12735 |
| 8L-2S | | MI | 2942 | 1680 | 4817 | 1363 | 5925 | 1119 | 6731 | 911 | 7986 | 563 | 9646 | 386 | 7429 |
| 16-#11 | 4.08 | MA | 5471 | 1817 | 8056 | 1575 | 10277 | 1307 | 11776 | 1071 | 13956 | 657 | 18254 | 203 | 16969 |
| 6L-4S | | MI | 2825 | 1817 | 4711 | 1453 | 5726 | 1189 | 6465 | 955 | 7602 | 553 | 9017 | 142 | 8394 |
| 16-#11 | 4.08 | MA | 5211 | 1817 | 7536 | 1586 | 9602 | 1316 | 10983 | 1085 | 12852 | 675 | 16735 | 157 | 15931 |
| 7L-3S | | MI | 2918 | 1817 | 4971 | 1444 | 6078 | 1176 | 6896 | 945 | 8189 | 555 | 9674 | 197 | 8771 |
| 16-#11 | 4.08 | MA | 4960 | 1817 | 6963 | 1606 | 8896 | 1334 | 10172 | 1095 | 11751 | 686 | 15270 | 95 | 14826 |
| 8L-2S | | MI | 3083 | 1817 | 5332 | 1436 | 6535 | 1171 | 7449 | 942 | 8933 | 551 | 10581 | 311 | 8829 |
| 16-#14 | 5.88 | MA | 5871 | 2142 | 9131 | 1813 | 11550 | 1493 | 13286 | 1209 | 15885 | 688 | 21004 | -28 | 20867 |
| 7L-3S | | MI | 3271 | 2142 | 6043 | 1641 | 7405 | 1319 | 8486 | 1033 | 10279 | 531 | 12033 | 14 | 11986 |
| 18-#10 | 3.74 | MA | 5502 | 1755 | 7944 | 1534 | 10202 | 1274 | 11741 | 1042 | 13925 | 655 | 18200 | 273 | 16391 |
| 6L-5S | | MI | 2760 | 1755 | 4406 | 1433 | 5369 | 1176 | 6048 | 950 | 7048 | 571 | 8524 | 173 | 7834 |
| 18-#10 | 3.74 | MA | 5289 | 1755 | 7516 | 1543 | 9640 | 1281 | 11074 | 1060 | 13017 | 671 | 16959 | 237 | 15575 |
| 7L-4S | | MI | 2834 | 1755 | 4600 | 1426 | 5643 | 1165 | 6372 | 947 | 7496 | 566 | 9080 | 229 | 8031 |
| 18-#10 | 3.74 | MA | 5080 | 1755 | 7045 | 1559 | 9059 | 1296 | 10396 | 1068 | 12113 | 681 | 15758 | 188 | 14691 |
| 8L-3S | | MI | 2912 | 1755 | 4817 | 1418 | 5925 | 1159 | 6731 | 937 | 7986 | 566 | 9646 | 276 | 8268 |
| 18-#10 | 3.74 | MA | 4817 | 1755 | 6639 | 1571 | 8520 | 1306 | 9709 | 1082 | 11221 | 696 | 14520 | 134 | 13815 |
| 9L-2S | | MI | 3053 | 1755 | 5120 | 1410 | 6309 | 1153 | 7195 | 933 | 8611 | 560 | 10432 | 370 | 8309 |
| 18-#11 | 4.59 | MA | 5602 | 1908 | 8356 | 1644 | 10640 | 1359 | 12239 | 1112 | 14542 | 671 | 19075 | 153 | 18296 |
| 7L-4S | | MI | 2967 | 1908 | 5072 | 1510 | 6183 | 1231 | 7018 | 982 | 8346 | 549 | 9924 | 118 | 9399 |
| 18-#11 | 4.59 | MA | 5355 | 1908 | 7783 | 1663 | 9934 | 1376 | 11428 | 1122 | 13441 | 682 | 17611 | 90 | 17196 |
| 8L-3S | | MI | 3054 | 1908 | 5332 | 1502 | 6535 | 1218 | 7449 | 972 | 8933 | 552 | 10581 | 172 | 9809 |
| 20-#10 | 4.15 | MA | 5610 | 1830 | 8193 | 1590 | 10496 | 1316 | 12110 | 1081 | 14412 | 668 | 18890 | 233 | 17536 |
| 7L-5S | | MI | 2880 | 1830 | 4709 | 1480 | 5752 | 1210 | 6512 | 972 | 7673 | 568 | 9311 | 157 | 8690 |
| 20-#10 | 4.15 | MA | 5403 | 1830 | 7722 | 1606 | 9916 | 1330 | 11432 | 1089 | 13507 | 678 | 17690 | 184 | 16648 |
| 8L-4S | | MI | 2954 | 1830 | 4904 | 1472 | 6027 | 1199 | 6836 | 969 | 8120 | 563 | 9867 | 213 | 8877 |
| 20-#10 | 4.15 | MA | 5153 | 1830 | 7316 | 1617 | 9377 | 1340 | 10744 | 1104 | 12615 | 693 | 16452 | 131 | 15767 |
| 9L-3S | | MI | 3027 | 1830 | 5120 | 1464 | 6309 | 1193 | 7195 | 959 | 8611 | 563 | 10432 | 260 | 9142 |
| 20-#10 | 4.15 | MA | 4919 | 1830 | 6890 | 1625 | 8848 | 1351 | 10082 | 1113 | 11718 | 703 | 15248 | 88 | 14852 |
| 10L-2S | | MI | 3163 | 1830 | 5423 | 1457 | 6692 | 1187 | 7659 | 955 | 9235 | 557 | 11219 | 354 | 9188 |
| 20-#11 | 5.10 | MA | 5739 | 2000 | 8604 | 1720 | 10972 | 1418 | 12683 | 1149 | 15131 | 679 | 19951 | 86 | 19565 |
| 8L-4S | | MI | 3107 | 2000 | 5434 | 1567 | 6640 | 1273 | 7571 | 1009 | 9090 | 546 | 10830 | 93 | 10408 |
| 22-#10 | 4.57 | MA | 5719 | 1904 | 8399 | 1653 | 10772 | 1365 | 12468 | 1111 | 14902 | 675 | 19621 | 181 | 18604 |
| 8L-5S | | MI | 2999 | 1904 | 5012 | 1527 | 6136 | 1245 | 6976 | 994 | 8298 | 565 | 10097 | 141 | 9548 |
| 22-#10 | 4.57 | MA | 5479 | 1904 | 7993 | 1664 | 10233 | 1375 | 11780 | 1126 | 14010 | 690 | 18383 | 127 | 17719 |
| 9L-4S | | MI | 3073 | 1904 | 5207 | 1519 | 6410 | 1233 | 7300 | 990 | 8745 | 560 | 10653 | 197 | 9727 |
| 22-#10 | 4.57 | MA | 5256 | 1904 | 7567 | 1672 | 9705 | 1385 | 11118 | 1135 | 13113 | 700 | 17179 | 84 | 16801 |
| 10L-3S | | MI | 3141 | 1904 | 5423 | 1511 | 6692 | 1227 | 7659 | 981 | 9235 | 560 | 11219 | 244 | 10016 |
| 24-#10 | 4.98 | MA | 5798 | 1979 | 8670 | 1711 | 11090 | 1409 | 12816 | 1148 | 15405 | 688 | 20314 | 123 | 19672 |
| 9L-5S | | MI | 3117 | 1979 | 5315 | 1574 | 6519 | 1279 | 7440 | 1016 | 8922 | 563 | 10883 | 125 | 10407 |
| 24-#10 | 4.98 | MA | 5585 | 1979 | 8244 | 1719 | 10561 | 1420 | 12153 | 1157 | 14507 | 697 | 19110 | 80 | 18750 |
| 10L-4S | | MI | 3190 | 1979 | 5510 | 1566 | 6794 | 1268 | 7764 | 1012 | 9370 | 557 | 11439 | 181 | 10579 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis

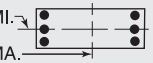



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.39 | MA | 5391 | 1411 | 6892 | 1287 | 8893 | 1078 | 10109 | 911 | 11578 | 654 | 14558 | 568 | 7585 |
| 2E | | MI | 2492 | 1411 | 3642 | 1190 | 4354 | 996 | 4768 | 840 | 5234 | 595 | 5996 | 451 | 3422 |
| 4-#18 | 2.47 | MA | 6184 | 1617 | 8856 | 1406 | 11305 | 1164 | 12988 | 965 | 15419 | 640 | 19850 | 553 | 13089 |
| 2E | | MI | 2733 | 1617 | 4423 | 1300 | 5282 | 1074 | 5860 | 886 | 6571 | 557 | 7469 | 341 | 5612 |
| 6-#10 | 1.18 | MA | 5258 | 1370 | 6437 | 1273 | 8407 | 1069 | 9567 | 908 | 10891 | 662 | 13638 | 576 | 6546 |
| 2L-3S | | MI | 2278 | 1370 | 3138 | 1196 | 3792 | 1002 | 4125 | 849 | 4414 | 617 | 5125 | 403 | 3016 |
| 6-#10 | 1.18 | MA | 4784 | 1370 | 5713 | 1287 | 7491 | 1082 | 8460 | 920 | 9400 | 678 | 11574 | 494 | 6513 |
| 3L-2S | | MI | 2468 | 1370 | 3441 | 1188 | 4175 | 997 | 4589 | 845 | 5038 | 612 | 5912 | 496 | 3004 |
| 6-#11 | 1.44 | MA | 5461 | 1421 | 6967 | 1298 | 9026 | 1087 | 10289 | 918 | 11838 | 656 | 14932 | 570 | 7928 |
| 2L-3S | | MI | 2308 | 1421 | 3308 | 1215 | 3963 | 1014 | 4310 | 853 | 4643 | 606 | 5337 | 349 | 3585 |
| 6-#11 | 1.44 | MA | 4906 | 1421 | 6090 | 1315 | 7916 | 1102 | 8946 | 932 | 10030 | 675 | 12428 | 467 | 7866 |
| 3L-2S | | MI | 2527 | 1421 | 3669 | 1207 | 4420 | 1009 | 4863 | 850 | 5387 | 602 | 6244 | 464 | 3576 |
| 6-#14 | 2.08 | MA | 5954 | 1543 | 8146 | 1369 | 10480 | 1139 | 12028 | 950 | 14162 | 649 | 18136 | 561 | 11250 |
| 2L-3S | | MI | 2402 | 1543 | 3642 | 1284 | 4354 | 1063 | 4768 | 881 | 5234 | 594 | 5996 | 245 | 4906 |
| 6-#14 | 2.08 | MA | 5214 | 1543 | 6892 | 1393 | 8893 | 1160 | 10109 | 970 | 11578 | 675 | 14558 | 411 | 11077 |
| 3L-2S | | MI | 2687 | 1543 | 4151 | 1273 | 4998 | 1057 | 5547 | 879 | 6278 | 589 | 7243 | 411 | 4932 |
| 6-#18 | 3.70 | MA | 7076 | 1852 | 11044 | 1553 | 14073 | 1273 | 16336 | 1034 | 19927 | 631 | 26092 | 540 | 19465 |
| 2L-3S | | MI | 2612 | 1852 | 4423 | 1461 | 5282 | 1188 | 5860 | 953 | 6571 | 547 | 7469 | -44 | 7436 |
| 6-#18 | 3.70 | MA | 5956 | 1852 | 8856 | 1593 | 11305 | 1309 | 12988 | 1066 | 15419 | 674 | 19850 | 264 | 18786 |
| 3L-2S | | MI | 3039 | 1852 | 5287 | 1447 | 6375 | 1182 | 7182 | 955 | 8291 | 538 | 9473 | 250 | 8128 |
| 8-#9 | 1.23 | MA | 5320 | 1381 | 6530 | 1282 | 8544 | 1076 | 9743 | 913 | 11137 | 663 | 13986 | 577 | 6884 |
| 2L-4S | | MI | 2253 | 1381 | 3064 | 1212 | 3707 | 1016 | 4017 | 863 | 4270 | 619 | 5008 | 389 | 3159 |
| 8-#9 | 1.23 | MA | 4950 | 1381 | 5958 | 1293 | 7820 | 1087 | 8867 | 923 | 9958 | 676 | 12353 | 513 | 6861 |
| 3E | | MI | 2346 | 1381 | 3236 | 1206 | 3931 | 1011 | 4302 | 855 | 4659 | 619 | 5462 | 427 | 3160 |
| 8-#9 | 1.23 | MA | 4736 | 1381 | 5567 | 1304 | 7308 | 1097 | 8212 | 937 | 9062 | 684 | 11266 | 472 | 6773 |
| 4L-2S | | MI | 2495 | 1381 | 3477 | 1199 | 4236 | 1006 | 4672 | 852 | 5157 | 614 | 6095 | 500 | 3153 |
| 8-#10 | 1.57 | MA | 5599 | 1445 | 7160 | 1319 | 9322 | 1103 | 10674 | 930 | 12382 | 659 | 15703 | 572 | 8663 |
| 2L-4S | | MI | 2299 | 1445 | 3225 | 1250 | 3893 | 1043 | 4230 | 880 | 4548 | 614 | 5346 | 340 | 3881 |
| 8-#10 | 1.57 | MA | 5150 | 1445 | 6437 | 1333 | 8407 | 1116 | 9567 | 942 | 10891 | 675 | 13638 | 490 | 8615 |
| 3E | | MI | 2412 | 1445 | 3441 | 1242 | 4175 | 1037 | 4589 | 871 | 5038 | 614 | 5912 | 387 | 3906 |
| 8-#10 | 1.57 | MA | 4891 | 1445 | 5942 | 1347 | 7759 | 1130 | 8738 | 960 | 9757 | 685 | 12260 | 439 | 8438 |
| 4L-2S | | MI | 2593 | 1445 | 3745 | 1234 | 4559 | 1031 | 5053 | 867 | 5663 | 609 | 6698 | 480 | 3905 |
| 8-#11 | 1.93 | MA | 5859 | 1513 | 7845 | 1355 | 10137 | 1129 | 11632 | 945 | 13647 | 653 | 17436 | 565 | 10493 |
| 2L-4S | | MI | 2331 | 1513 | 3410 | 1281 | 4067 | 1069 | 4432 | 890 | 4800 | 600 | 5587 | 270 | 4507 |
| 8-#11 | 1.93 | MA | 5337 | 1513 | 6967 | 1372 | 9026 | 1145 | 10289 | 959 | 11838 | 671 | 14932 | 462 | 10411 |
| 3E | | MI | 2465 | 1513 | 3669 | 1272 | 4420 | 1057 | 4863 | 880 | 5387 | 603 | 6244 | 325 | 4637 |
| 8-#11 | 1.93 | MA | 5036 | 1513 | 6365 | 1389 | 8239 | 1160 | 9282 | 981 | 10460 | 683 | 13245 | 398 | 10115 |
| 4L-2S | | MI | 2669 | 1513 | 4031 | 1264 | 4877 | 1051 | 5416 | 877 | 6131 | 598 | 7151 | 439 | 4644 |
| 8-#14 | 2.78 | MA | 5806 | 1675 | 8146 | 1476 | 10480 | 1221 | 12028 | 1009 | 14162 | 670 | 18136 | 404 | 14711 |
| 3E | | MI | 2611 | 1675 | 4151 | 1366 | 4998 | 1124 | 5547 | 920 | 6278 | 588 | 7243 | 205 | 6368 |
| 8-#14 | 2.78 | MA | 5413 | 1675 | 7283 | 1499 | 9352 | 1243 | 10586 | 1039 | 12189 | 686 | 15711 | 311 | 13478 |
| 4L-2S | | MI | 2876 | 1675 | 4661 | 1356 | 5643 | 1117 | 6326 | 918 | 7322 | 583 | 8489 | 370 | 6422 |
| 8-#18 | 4.94 | MA | 6962 | 2087 | 11044 | 1740 | 14073 | 1417 | 16336 | 1136 | 19927 | 665 | 26092 | 252 | 25163 |
| 3E | | MI | 2950 | 2087 | 5287 | 1608 | 6375 | 1296 | 7182 | 1022 | 8291 | 528 | 9473 | -135 | 9341 |
| 8-#18 | 4.94 | MA | 6356 | 2087 | 9532 | 1780 | 12098 | 1453 | 13810 | 1186 | 16474 | 690 | 21811 | 84 | 21283 |
| 4L-2S | | MI | 3337 | 2087 | 6151 | 1594 | 7468 | 1290 | 8504 | 1024 | 10011 | 519 | 11477 | 159 | 10625 |
| 10-#10 | 1.96 | MA | 5928 | 1519 | 7884 | 1366 | 10238 | 1138 | 11782 | 952 | 13873 | 656 | 17767 | 569 | 10778 |
| 2L-5S | | MI | 2342 | 1519 | 3333 | 1305 | 4002 | 1088 | 4370 | 906 | 4725 | 617 | 5576 | 267 | 4497 |
| 10-#10 | 1.96 | MA | 5501 | 1519 | 7160 | 1380 | 9322 | 1151 | 10674 | 964 | 12382 | 672 | 15703 | 486 | 10718 |
| 3L-4S | | MI | 2435 | 1519 | 3528 | 1297 | 4277 | 1077 | 4694 | 902 | 5173 | 611 | 6132 | 324 | 4751 |
| 10-#10 | 1.96 | MA | 5262 | 1519 | 6665 | 1394 | 8675 | 1164 | 9845 | 982 | 11248 | 683 | 14324 | 435 | 10537 |
| 4L-3S | | MI | 2541 | 1519 | 3745 | 1289 | 4559 | 1071 | 5053 | 893 | 5663 | 611 | 6698 | 371 | 4789 |
| 10-#10 | 1.96 | MA | 4984 | 1519 | 6223 | 1408 | 8051 | 1183 | 9108 | 994 | 10226 | 699 | 12859 | 386 | 9844 |
| 5L-2S | | MI | 2715 | 1519 | 4048 | 1281 | 4942 | 1065 | 5517 | 889 | 6288 | 606 | 7484 | 464 | 4798 |
| 10-#11 | 2.41 | MA | 5750 | 1605 | 7845 | 1430 | 10137 | 1187 | 11632 | 986 | 13647 | 668 | 17436 | 458 | 12959 |
| 3L-4S | | MI | 2494 | 1605 | 3771 | 1338 | 4524 | 1111 | 4985 | 917 | 5544 | 597 | 6493 | 245 | 5480 |
| 10-#11 | 2.41 | MA | 5475 | 1605 | 7243 | 1446 | 9349 | 1202 | 10625 | 1007 | 12269 | 680 | 15749 | 394 | 12630 |
| 4L-3S | | MI | 2613 | 1605 | 4031 | 1330 | 4877 | 1099 | 5416 | 907 | 6131 | 599 | 7151 | 300 | 5682 |

## RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis

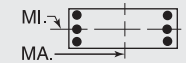



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.41 | MA | 5149 | 1605 | 6709 | 1463 | 8590 | 1225 | 9727 | 1022 | 11025 | 698 | 13962 | 331 | 11622 |
| 5L-2S | | MI | 2807 | 1605 | 4392 | 1321 | 5334 | 1093 | 5968 | 904 | 6876 | 595 | 8057 | 415 | 5704 |
| 10-#14 | 3.47 | MA | 6022 | 1808 | 8538 | 1582 | 10939 | 1304 | 12505 | 1078 | 14773 | 681 | 19289 | 304 | 17106 |
| 4L-3S | | MI | 2812 | 1808 | 4661 | 1449 | 5643 | 1185 | 6326 | 959 | 7322 | 582 | 8489 | 165 | 7825 |
| 10-#14 | 3.47 | MA | 5568 | 1808 | 7773 | 1606 | 9851 | 1335 | 11219 | 1098 | 12991 | 707 | 16726 | 211 | 15719 |
| 5L-2S | | MI | 3060 | 1808 | 5170 | 1439 | 6287 | 1178 | 7106 | 957 | 8366 | 577 | 9735 | 330 | 7903 |
| 10-#18 | 6.17 | MA | 7431 | 2323 | 11721 | 1927 | 14866 | 1561 | 17158 | 1255 | 20982 | 681 | 28053 | 72 | 27603 |
| 4L-3S | | MI | 3277 | 2323 | 6151 | 1755 | 7468 | 1404 | 8504 | 1091 | 10011 | 509 | 11477 | -225 | 11208 |
| 10-#18 | 6.17 | MA | 6655 | 2323 | 10378 | 1967 | 12958 | 1615 | 14903 | 1287 | 17859 | 724 | 23728 | -78 | 23059 |
| 5L-2S | | MI | 3633 | 2323 | 7015 | 1742 | 8561 | 1399 | 9826 | 1094 | 11731 | 500 | 13481 | 68 | 13116 |
| 12-#10 | 2.35 | MA | 5840 | 1594 | 7884 | 1427 | 10238 | 1185 | 11782 | 986 | 13873 | 669 | 17767 | 482 | 12822 |
| 3L-5S | | MI | 2481 | 1594 | 3637 | 1351 | 4386 | 1123 | 4834 | 928 | 5350 | 614 | 6363 | 251 | 5338 |
| 12-#10 | 2.35 | MA | 5619 | 1594 | 7389 | 1441 | 9590 | 1198 | 10953 | 1004 | 12739 | 680 | 16388 | 431 | 12638 |
| 4E | | MI | 2573 | 1594 | 3831 | 1344 | 4660 | 1111 | 5158 | 924 | 5797 | 608 | 6918 | 308 | 5576 |
| 12-#10 | 2.35 | MA | 5346 | 1594 | 6947 | 1454 | 8966 | 1217 | 10215 | 1016 | 11717 | 696 | 14923 | 382 | 11940 |
| 5L-3S | | MI | 2670 | 1594 | 4048 | 1336 | 4942 | 1105 | 5517 | 915 | 6288 | 609 | 7484 | 355 | 5668 |
| 12-#10 | 2.35 | MA | 5037 | 1594 | 6469 | 1462 | 8397 | 1229 | 9515 | 1028 | 10721 | 706 | 13648 | 324 | 11341 |
| 6L-2S | | MI | 2833 | 1594 | 4351 | 1328 | 5326 | 1100 | 5981 | 911 | 6912 | 603 | 8271 | 448 | 5685 |
| 12-#11 | 2.89 | MA | 5897 | 1697 | 8121 | 1504 | 10460 | 1244 | 11968 | 1034 | 14077 | 676 | 18253 | 389 | 15150 |
| 4E | | MI | 2647 | 1697 | 4132 | 1395 | 4981 | 1153 | 5538 | 944 | 6289 | 594 | 7400 | 221 | 6464 |
| 12-#11 | 2.89 | MA | 5576 | 1697 | 7587 | 1520 | 9700 | 1267 | 11070 | 1049 | 12833 | 695 | 16466 | 326 | 14171 |
| 5L-3S | | MI | 2757 | 1697 | 4392 | 1387 | 5334 | 1141 | 5968 | 934 | 6876 | 596 | 8057 | 276 | 6724 |
| 12-#11 | 2.89 | MA | 5216 | 1697 | 7008 | 1529 | 9015 | 1282 | 10196 | 1070 | 11621 | 707 | 14910 | 253 | 13187 |
| 6L-2S | | MI | 2941 | 1697 | 4753 | 1379 | 5791 | 1135 | 6521 | 931 | 7620 | 591 | 8964 | 390 | 6757 |
| 12-#14 | 4.17 | MA | 6158 | 1940 | 9027 | 1688 | 11438 | 1396 | 13138 | 1136 | 15576 | 702 | 20304 | 204 | 19354 |
| 5L-3S | | MI | 3008 | 1940 | 5170 | 1532 | 6287 | 1246 | 7106 | 998 | 8366 | 576 | 9735 | 124 | 9282 |
| 12-#14 | 4.17 | MA | 5680 | 1940 | 8205 | 1701 | 10456 | 1418 | 11885 | 1166 | 13840 | 718 | 18069 | 97 | 17450 |
| 6L-2S | | MI | 3241 | 1940 | 5679 | 1521 | 6931 | 1239 | 7885 | 995 | 9410 | 571 | 10982 | 289 | 9379 |
| 12-#18 | 7.41 | MA | 7643 | 2558 | 12566 | 2114 | 15726 | 1723 | 18252 | 1356 | 22367 | 715 | 29970 | -90 | 28979 |
| 5L-3S | | MI | 3598 | 2558 | 7015 | 1902 | 8561 | 1512 | 9826 | 1160 | 11731 | 490 | 13481 | -316 | 13043 |
| 12-#18 | 7.41 | MA | 6923 | 2558 | 11153 | 2138 | 14002 | 1759 | 16052 | 1406 | 19323 | 740 | 25836 | -308 | 24511 |
| 6L-2S | | MI | 3929 | 2558 | 7879 | 1889 | 9654 | 1507 | 11148 | 1163 | 13451 | 481 | 15484 | -22 | 15437 |
| 14-#10 | 2.74 | MA | 5964 | 1669 | 8113 | 1488 | 10506 | 1233 | 12060 | 1026 | 14230 | 677 | 18453 | 427 | 14742 |
| 4L-5S | | MI | 2622 | 1669 | 3940 | 1398 | 4769 | 1157 | 5298 | 950 | 5975 | 611 | 7149 | 235 | 6183 |
| 14-#10 | 2.74 | MA | 5695 | 1669 | 7670 | 1501 | 9882 | 1251 | 11323 | 1038 | 13208 | 693 | 16988 | 378 | 14039 |
| 5L-4S | | MI | 2702 | 1669 | 4135 | 1390 | 5044 | 1146 | 5622 | 946 | 6422 | 606 | 7705 | 292 | 6407 |
| 14-#10 | 2.74 | MA | 5402 | 1669 | 7193 | 1509 | 9312 | 1264 | 10622 | 1050 | 12212 | 703 | 15712 | 320 | 13435 |
| 6L-3S | | MI | 2793 | 1669 | 4351 | 1382 | 5326 | 1140 | 5981 | 936 | 6912 | 606 | 8271 | 339 | 6545 |
| 14-#10 | 2.74 | MA | 5143 | 1669 | 6736 | 1518 | 8712 | 1272 | 9907 | 1068 | 11245 | 719 | 14395 | 285 | 12536 |
| 7L-2S | | MI | 2948 | 1669 | 4654 | 1375 | 5709 | 1134 | 6445 | 933 | 7537 | 600 | 9057 | 432 | 6569 |
| 14-#11 | 3.37 | MA | 5988 | 1788 | 8465 | 1578 | 10811 | 1309 | 12413 | 1076 | 14641 | 691 | 18970 | 321 | 16723 |
| 5L-4S | | MI | 2795 | 1788 | 4493 | 1453 | 5438 | 1196 | 6091 | 971 | 7033 | 590 | 8306 | 197 | 7457 |
| 14-#11 | 3.37 | MA | 5647 | 1788 | 7886 | 1587 | 10126 | 1325 | 11539 | 1097 | 13430 | 703 | 17414 | 248 | 15725 |
| 6L-3S | | MI | 2898 | 1788 | 4753 | 1444 | 5791 | 1183 | 6521 | 961 | 7620 | 592 | 8964 | 251 | 7764 |
| 14-#11 | 3.37 | MA | 5347 | 1788 | 7330 | 1598 | 9396 | 1334 | 10693 | 1111 | 12252 | 722 | 15800 | 204 | 14678 |
| 7L-2S | | MI | 3073 | 1788 | 5114 | 1436 | 6248 | 1178 | 7074 | 958 | 8364 | 588 | 9870 | 366 | 7808 |
| 14-#14 | 4.86 | MA | 6280 | 2073 | 9460 | 1784 | 12043 | 1479 | 13804 | 1205 | 16424 | 713 | 21647 | 90 | 21072 |
| 6L-3S | | MI | 3199 | 2073 | 5679 | 1615 | 6931 | 1306 | 7885 | 1037 | 9410 | 570 | 10982 | 84 | 10697 |
| 14-#14 | 4.86 | MA | 5886 | 2073 | 8665 | 1800 | 11009 | 1493 | 12592 | 1225 | 14736 | 739 | 19325 | 25 | 19201 |
| 7L-2S | | MI | 3420 | 2073 | 6189 | 1604 | 7576 | 1300 | 8664 | 1034 | 10454 | 565 | 12228 | 249 | 10852 |
| 16-#10 | 3.14 | MA | 6034 | 1744 | 8394 | 1548 | 10797 | 1286 | 12430 | 1060 | 14699 | 690 | 19052 | 374 | 16139 |
| 5E | | MI | 2752 | 1744 | 4243 | 1445 | 5153 | 1191 | 5762 | 972 | 6599 | 608 | 7935 | 219 | 7032 |
| 16-#10 | 3.14 | MA | 5754 | 1744 | 7916 | 1555 | 10228 | 1298 | 11729 | 1072 | 13703 | 701 | 17776 | 316 | 15529 |
| 6L-4S | | MI | 2827 | 1744 | 4438 | 1437 | 5428 | 1180 | 6086 | 968 | 7047 | 603 | 8491 | 276 | 7244 |
| 16-#10 | 3.14 | MA | 5510 | 1744 | 7460 | 1565 | 9627 | 1306 | 11014 | 1090 | 12736 | 717 | 16459 | 281 | 14633 |
| 7L-3S | | MI | 2912 | 1744 | 4654 | 1429 | 5709 | 1174 | 6445 | 958 | 7537 | 603 | 9057 | 323 | 7420 |
| 16-#10 | 3.14 | MA | 5277 | 1744 | 6957 | 1582 | 9008 | 1321 | 10287 | 1098 | 11772 | 727 | 15182 | 234 | 13736 |
| 8L-2S | | MI | 3062 | 1744 | 4957 | 1421 | 6093 | 1168 | 6909 | 955 | 8162 | 598 | 9843 | 416 | 7451 |

## RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 3.85 | MA | 6064 | 1880 | 8764 | 1644 | 11236 | 1367 | 12882 | 1124 | 15238 | 700 | 19918 | 243 | 18264 |
| 6L-4S | | MI | 2940 | 1880 | 4855 | 1510 | 5895 | 1238 | 6643 | 998 | 7777 | 587 | 9213 | 172 | 8455 |
| 16-#11 | 3.85 | MA | 5783 | 1880 | 8208 | 1655 | 10507 | 1376 | 12036 | 1138 | 14060 | 718 | 18304 | 199 | 17208 |
| 7L-3S | | MI | 3036 | 1880 | 5114 | 1502 | 6248 | 1225 | 7074 | 988 | 8364 | 589 | 9870 | 227 | 8803 |
| 16-#11 | 3.85 | MA | 5508 | 1880 | 7597 | 1675 | 9753 | 1394 | 11160 | 1148 | 12887 | 730 | 16745 | 139 | 15995 |
| 8L-2S | | MI | 3203 | 1880 | 5476 | 1493 | 6705 | 1220 | 7627 | 985 | 9109 | 585 | 10777 | 341 | 8855 |
| 16-#14 | 5.56 | MA | 6494 | 2205 | 9919 | 1883 | 12596 | 1553 | 14511 | 1264 | 17320 | 734 | 22903 | 18 | 22814 |
| 7L-3S | | MI | 3388 | 2205 | 6189 | 1698 | 7576 | 1367 | 8664 | 1076 | 10454 | 565 | 12228 | 43 | 12075 |
| 16-#14 | 5.56 | MA | 6110 | 2205 | 9043 | 1911 | 11517 | 1579 | 13270 | 1279 | 15638 | 750 | 20666 | -72 | 20417 |
| 8L-2S | | MI | 3598 | 2205 | 6698 | 1687 | 8220 | 1361 | 9444 | 1073 | 11497 | 560 | 13474 | 208 | 12323 |
| 18-#10 | 3.53 | MA | 6096 | 1818 | 8640 | 1602 | 11143 | 1332 | 12837 | 1094 | 15194 | 698 | 19841 | 312 | 17623 |
| 6L-5S | | MI | 2876 | 1818 | 4546 | 1492 | 5537 | 1226 | 6225 | 994 | 7224 | 605 | 8722 | 203 | 7884 |
| 18-#10 | 3.53 | MA | 5865 | 1818 | 8183 | 1612 | 10543 | 1340 | 12122 | 1112 | 14227 | 714 | 18523 | 277 | 16730 |
| 7L-4S | | MI | 2950 | 1818 | 4741 | 1484 | 5811 | 1214 | 6550 | 990 | 7671 | 600 | 9278 | 260 | 8085 |
| 18-#10 | 3.53 | MA | 5637 | 1818 | 7681 | 1628 | 9923 | 1355 | 11394 | 1120 | 13263 | 724 | 17247 | 230 | 15828 |
| 8L-3S | | MI | 3030 | 1818 | 4957 | 1476 | 6093 | 1208 | 6909 | 980 | 8162 | 600 | 9843 | 307 | 8295 |
| 18-#10 | 3.53 | MA | 5354 | 1818 | 7244 | 1639 | 9349 | 1366 | 10661 | 1134 | 12312 | 740 | 15933 | 176 | 14932 |
| 9L-2S | | MI | 3174 | 1818 | 5261 | 1468 | 6477 | 1203 | 7373 | 977 | 8786 | 595 | 10630 | 400 | 8332 |
| 18-#11 | 4.33 | MA | 6205 | 1972 | 9086 | 1713 | 11617 | 1418 | 13379 | 1165 | 15869 | 715 | 20808 | 195 | 19739 |
| 7L-4S | | MI | 3083 | 1972 | 5216 | 1568 | 6352 | 1280 | 7196 | 1025 | 8521 | 583 | 10119 | 148 | 9459 |
| 18-#11 | 4.33 | MA | 5936 | 1972 | 8474 | 1733 | 10864 | 1436 | 12503 | 1175 | 14695 | 727 | 19249 | 134 | 18531 |
| 8L-3S | | MI | 3172 | 1972 | 5476 | 1559 | 6705 | 1268 | 7627 | 1015 | 9109 | 586 | 10777 | 202 | 9841 |
| 18-#11 | 4.33 | MA | 5606 | 1972 | 7949 | 1746 | 10165 | 1448 | 11611 | 1192 | 13537 | 746 | 17640 | 68 | 17289 |
| 9L-2S | | MI | 3332 | 1972 | 5837 | 1551 | 7162 | 1262 | 8179 | 1012 | 9853 | 581 | 11683 | 317 | 9902 |
| 18-#14 | 6.25 | MA | 6705 | 2338 | 10298 | 1994 | 13104 | 1639 | 15189 | 1318 | 18223 | 745 | 24244 | -79 | 23871 |
| 8L-3S | | MI | 3575 | 2338 | 6698 | 1780 | 8220 | 1428 | 9444 | 1115 | 11497 | 559 | 13474 | 3 | 13465 |
| 20-#10 | 3.92 | MA | 6211 | 1893 | 8907 | 1658 | 11458 | 1375 | 13229 | 1134 | 15718 | 711 | 20588 | 273 | 18828 |
| 7L-5S | | MI | 2997 | 1893 | 4850 | 1538 | 5920 | 1260 | 6689 | 1016 | 7849 | 603 | 9508 | 187 | 8739 |
| 20-#10 | 3.92 | MA | 5986 | 1893 | 8404 | 1675 | 10839 | 1390 | 12501 | 1142 | 14754 | 721 | 19311 | 226 | 17920 |
| 8L-4S | | MI | 3071 | 1893 | 5044 | 1530 | 6195 | 1249 | 7014 | 1012 | 8296 | 597 | 10064 | 244 | 8931 |
| 20-#10 | 3.92 | MA | 5715 | 1893 | 7968 | 1686 | 10264 | 1400 | 11768 | 1156 | 13803 | 737 | 17998 | 173 | 17020 |
| 9L-3S | | MI | 3146 | 1893 | 5261 | 1523 | 6477 | 1243 | 7373 | 1002 | 8786 | 597 | 10630 | 291 | 9169 |
| 20-#10 | 3.92 | MA | 5462 | 1893 | 7513 | 1695 | 9701 | 1411 | 11062 | 1166 | 12834 | 746 | 16717 | 131 | 16059 |
| 10L-2S | | MI | 3284 | 1893 | 5564 | 1515 | 6860 | 1237 | 7837 | 999 | 9411 | 592 | 11416 | 384 | 9211 |
| 20-#11 | 4.81 | MA | 6350 | 2064 | 9352 | 1790 | 11974 | 1478 | 13846 | 1202 | 16503 | 723 | 21753 | 129 | 21067 |
| 8L-4S | | MI | 3223 | 2064 | 5577 | 1625 | 6809 | 1322 | 7749 | 1052 | 9266 | 580 | 11026 | 123 | 10467 |
| 20-#11 | 4.81 | MA | 6036 | 2064 | 8826 | 1804 | 11275 | 1490 | 12954 | 1219 | 15346 | 742 | 20144 | 63 | 19819 |
| 9L-3S | | MI | 3306 | 2064 | 5837 | 1617 | 7162 | 1310 | 8179 | 1042 | 9853 | 582 | 11683 | 178 | 10880 |
| 22-#10 | 4.31 | MA | 6327 | 1968 | 9128 | 1722 | 11755 | 1424 | 13609 | 1164 | 16245 | 718 | 21376 | 222 | 20012 |
| 8L-5S | | MI | 3117 | 1968 | 5153 | 1585 | 6304 | 1294 | 7153 | 1038 | 8473 | 600 | 10294 | 171 | 9596 |
| 22-#10 | 4.31 | MA | 6067 | 1968 | 8692 | 1733 | 11180 | 1435 | 12876 | 1178 | 15294 | 734 | 20062 | 169 | 19107 |
| 9L-4S | | MI | 3190 | 1968 | 5348 | 1577 | 6578 | 1283 | 7478 | 1034 | 8921 | 594 | 10850 | 228 | 9779 |
| 22-#10 | 4.31 | MA | 5826 | 1968 | 8237 | 1741 | 10617 | 1446 | 12169 | 1188 | 14325 | 743 | 18782 | 127 | 18149 |
| 10L-3S | | MI | 3260 | 1968 | 5564 | 1569 | 6860 | 1277 | 7837 | 1024 | 9411 | 595 | 11416 | 275 | 10043 |
| 22-#11 | 5.30 | MA | 6455 | 2156 | 9704 | 1861 | 12385 | 1533 | 14297 | 1246 | 17154 | 739 | 22648 | 58 | 22349 |
| 9L-4S | | MI | 3361 | 2156 | 5939 | 1682 | 7267 | 1364 | 8302 | 1079 | 10010 | 576 | 11932 | 99 | 11479 |
| 24-#10 | 4.70 | MA | 6411 | 2043 | 9415 | 1780 | 12095 | 1469 | 13983 | 1200 | 16785 | 732 | 22126 | 165 | 21194 |
| 9L-5S | | MI | 3234 | 2043 | 5456 | 1632 | 6687 | 1329 | 7617 | 1060 | 9098 | 597 | 11081 | 155 | 10455 |
| 24-#10 | 4.70 | MA | 6181 | 2043 | 8961 | 1788 | 11532 | 1480 | 13276 | 1210 | 15816 | 741 | 20846 | 123 | 20239 |
| 10L-4S | | MI | 3307 | 2043 | 5651 | 1624 | 6962 | 1317 | 7941 | 1056 | 9546 | 592 | 11637 | 212 | 10630 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 20"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#8 | 1.19 | MA | 1725 | 847 | 2326 | 749 | 2880 | 629 | 3199 | 533 | 3551 | 387 | 4299 | 327 | 2121 |
| 2L-3S | | MI | 1585 | 847 | 2105 | 755 | 2600 | 634 | 2859 | 537 | 3095 | 392 | 3690 | 269 | 2124 |
| 6-#9 | 1.50 | MA | 1796 | 884 | 2508 | 770 | 3101 | 644 | 3460 | 542 | 3899 | 384 | 4741 | 319 | 2631 |
| 2L-3S | | MI | 1626 | 884 | 2230 | 778 | 2749 | 650 | 3035 | 547 | 3326 | 390 | 3983 | 246 | 2625 |
| 6-#10 | 1.90 | MA | 1882 | 931 | 2736 | 797 | 3379 | 663 | 3792 | 554 | 4341 | 380 | 5294 | 308 | 3274 |
| 2L-3S | | MI | 1676 | 931 | 2387 | 806 | 2937 | 671 | 3256 | 560 | 3620 | 388 | 4349 | 215 | 3251 |
| 6-#11 | 2.34 | MA | 1952 | 983 | 2978 | 822 | 3656 | 681 | 4113 | 564 | 4760 | 374 | 5741 | 284 | 3909 |
| 2L-3S | | MI | 1717 | 983 | 2559 | 832 | 3127 | 689 | 3472 | 569 | 3898 | 382 | 4642 | 169 | 3862 |
| 6-#14 | 3.38 | MA | 2137 | 1105 | 3523 | 893 | 4326 | 732 | 4912 | 596 | 5828 | 366 | 6999 | 244 | 5448 |
| 2L-3S | | MI | 1838 | 1105 | 2931 | 906 | 3577 | 742 | 4006 | 602 | 4608 | 375 | 5476 | 79 | 5275 |
| 6-#18 | 6.00 | MA | 2554 | 1414 | 4827 | 1075 | 5938 | 865 | 6842 | 679 | 8395 | 347 | 9870 | 119 | 9135 |
| 2L-3S | | MI | 2121 | 1414 | 3816 | 1095 | 4658 | 877 | 5295 | 684 | 6317 | 355 | 7382 | -174 | 7154 |
| 8-#8 | 1.58 | MA | 1821 | 893 | 2548 | 778 | 3161 | 650 | 3538 | 547 | 4008 | 385 | 4909 | 322 | 2775 |
| 2L-4S | | MI | 1606 | 893 | 2170 | 791 | 2677 | 660 | 2939 | 559 | 3196 | 392 | 3867 | 232 | 2741 |
| 8-#9 | 2.00 | MA | 1912 | 943 | 2786 | 807 | 3453 | 671 | 3886 | 560 | 4472 | 382 | 5499 | 312 | 3447 |
| 2L-4S | | MI | 1653 | 943 | 2312 | 822 | 2845 | 683 | 3133 | 574 | 3453 | 390 | 4201 | 198 | 3311 |
| 8-#10 | 2.54 | MA | 2022 | 1006 | 3086 | 844 | 3822 | 698 | 4327 | 576 | 5062 | 378 | 6238 | 297 | 4296 |
| 2L-4S | | MI | 1713 | 1006 | 2489 | 862 | 3057 | 713 | 3380 | 593 | 3779 | 387 | 4620 | 153 | 3955 |
| 8-#11 | 3.12 | MA | 2111 | 1075 | 3396 | 879 | 4186 | 723 | 4753 | 591 | 5623 | 371 | 6840 | 266 | 5128 |
| 2L-4S | | MI | 1768 | 1075 | 2680 | 900 | 3268 | 738 | 3617 | 609 | 4085 | 379 | 4953 | 92 | 4565 |
| 8-#14 | 4.50 | MA | 2351 | 1237 | 4115 | 976 | 5075 | 793 | 5818 | 635 | 7048 | 362 | 8521 | 214 | 7164 |
| 2L-4S | | MI | 1914 | 1237 | 3099 | 1002 | 3775 | 813 | 4210 | 657 | 4870 | 369 | 5901 | -34 | 5868 |
| 10-#10 | 3.17 | MA | 2156 | 1081 | 3436 | 891 | 4265 | 732 | 4863 | 598 | 5783 | 375 | 7182 | 286 | 5315 |
| 2L-5S | | MI | 1772 | 1081 | 2617 | 918 | 3186 | 760 | 3545 | 621 | 3988 | 392 | 4898 | 87 | 4628 |
| 10-#10 | 3.17 | MA | 1982 | 1081 | 3086 | 900 | 3822 | 740 | 4327 | 604 | 5062 | 383 | 6238 | 193 | 5264 |
| 3L-4S | | MI | 1879 | 1081 | 2839 | 909 | 3499 | 747 | 3915 | 615 | 4500 | 385 | 5565 | 142 | 4923 |
| 10-#11 | 3.90 | MA | 2070 | 1166 | 3396 | 947 | 4186 | 773 | 4753 | 623 | 5623 | 375 | 6840 | 134 | 6261 |
| 3L-4S | | MI | 1953 | 1166 | 3098 | 957 | 3798 | 781 | 4258 | 636 | 4947 | 375 | 6052 | 75 | 5725 |
| 10-#14 | 5.63 | MA | 2315 | 1369 | 4115 | 1072 | 5075 | 864 | 5818 | 680 | 7048 | 365 | 8521 | 19 | 8463 |
| 3L-4S | | MI | 2171 | 1369 | 3691 | 1085 | 4524 | 873 | 5116 | 696 | 6089 | 364 | 7424 | -64 | 7322 |

## RECTANGULAR TIED COLUMNS 20" x 22"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#10 | 1.15 | MA | 2087 | 927 | 2783 | 826 | 3461 | 693 | 3850 | 588 | 4277 | 428 | 5208 | 366 | 2518 |
| 2E | | MI | 1879 | 927 | 2555 | 816 | 3142 | 685 | 3475 | 581 | 3838 | 422 | 4596 | 353 | 2261 |
| 4-#11 | 1.42 | MA | 2147 | 962 | 2982 | 840 | 3681 | 703 | 4099 | 593 | 4599 | 422 | 5570 | 351 | 3017 |
| 2E | | MI | 1928 | 962 | 2731 | 830 | 3334 | 694 | 3691 | 585 | 4115 | 416 | 4887 | 335 | 2701 |
| 4-#14 | 2.05 | MA | 2304 | 1043 | 3408 | 885 | 4198 | 735 | 4712 | 613 | 5414 | 416 | 6573 | 330 | 4209 |
| 2E | | MI | 2060 | 1043 | 3105 | 874 | 3785 | 726 | 4226 | 605 | 4825 | 410 | 5720 | 308 | 3749 |
| 4-#18 | 3.64 | MA | 2647 | 1249 | 4429 | 1003 | 5446 | 821 | 6200 | 666 | 7397 | 402 | 8901 | 261 | 7077 |
| 2E | | MI | 2348 | 1249 | 3995 | 992 | 4868 | 811 | 5515 | 657 | 6532 | 394 | 7623 | 222 | 6248 |
| 6-#8 | 1.08 | MA | 2074 | 917 | 2713 | 825 | 3395 | 693 | 3781 | 589 | 4195 | 431 | 5139 | 373 | 2377 |
| 2L-3S | | MI | 1727 | 917 | 2271 | 822 | 2804 | 690 | 3078 | 587 | 3313 | 431 | 3938 | 304 | 2141 |
| 6-#8 | 1.08 | MA | 1913 | 917 | 2462 | 831 | 3078 | 699 | 3398 | 594 | 3679 | 438 | 4431 | 315 | 2380 |
| 3L-2S | | MI | 1869 | 917 | 2493 | 816 | 3084 | 685 | 3417 | 583 | 3769 | 426 | 4547 | 362 | 2136 |
| 6-#9 | 1.36 | MA | 2157 | 955 | 2919 | 845 | 3646 | 708 | 4079 | 598 | 4591 | 428 | 5658 | 367 | 2955 |
| 2L-3S | | MI | 1768 | 955 | 2397 | 844 | 2953 | 706 | 3253 | 596 | 3544 | 429 | 4229 | 280 | 2647 |
| 6-#9 | 1.36 | MA | 1961 | 955 | 2604 | 854 | 3247 | 715 | 3597 | 604 | 3942 | 436 | 4775 | 294 | 2949 |
| 3L-2S | | MI | 1940 | 955 | 2675 | 836 | 3305 | 700 | 3678 | 592 | 4117 | 423 | 4987 | 354 | 2648 |
| 6-#10 | 1.73 | MA | 2259 | 1002 | 3179 | 872 | 3963 | 728 | 4456 | 610 | 5094 | 425 | 6312 | 359 | 3686 |
| 2L-3S | | MI | 1818 | 1002 | 2555 | 872 | 3142 | 727 | 3475 | 609 | 3838 | 427 | 4596 | 249 | 3278 |
| 6-#10 | 1.73 | MA | 2021 | 1002 | 2783 | 883 | 3461 | 736 | 3850 | 617 | 4277 | 434 | 5208 | 265 | 3662 |
| 3L-2S | | MI | 2027 | 1002 | 2905 | 863 | 3584 | 720 | 4010 | 603 | 4559 | 419 | 5540 | 342 | 3294 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 22"

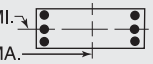
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#11 | 2.13 | MA | 2345 | 1053 | 3458 | 897 | 4283 | 745 | 4828 | 620 | 5579 | 419 | 6864 | 339 | 4414 |
| 2L-3S | | MI | 1858 | 1053 | 2731 | 897 | 3334 | 744 | 3691 | 618 | 4115 | 420 | 4887 | 203 | 3897 |
| 6-#11 | 2.13 | MA | 2071 | 1053 | 2982 | 909 | 3681 | 754 | 4099 | 627 | 4599 | 429 | 5570 | 224 | 4367 |
| 3L-2S | | MI | 2098 | 1053 | 3150 | 887 | 3863 | 736 | 4332 | 612 | 4977 | 413 | 5986 | 318 | 3932 |
| 6-#14 | 3.07 | MA | 2566 | 1175 | 4083 | 968 | 5051 | 796 | 5745 | 652 | 6804 | 411 | 8374 | 308 | 6177 |
| 2L-3S | | MI | 1979 | 1175 | 3105 | 971 | 3785 | 797 | 4226 | 650 | 4825 | 413 | 5720 | 112 | 5357 |
| 6-#14 | 3.07 | MA | 2217 | 1175 | 3408 | 984 | 4198 | 809 | 4712 | 661 | 5414 | 423 | 6573 | 142 | 6033 |
| 3L-2S | | MI | 2285 | 1175 | 3697 | 957 | 4534 | 787 | 5132 | 644 | 6045 | 405 | 7242 | 278 | 5476 |
| 6-#18 | 5.45 | MA | 3061 | 1484 | 5588 | 1150 | 6911 | 929 | 7972 | 735 | 9783 | 393 | 11880 | 208 | 10431 |
| 2L-3S | | MI | 2258 | 1484 | 3995 | 1158 | 4868 | 931 | 5515 | 731 | 6532 | 393 | 7623 | -141 | 7442 |
| 6-#18 | 5.45 | MA | 2554 | 1484 | 4429 | 1174 | 5446 | 947 | 6200 | 746 | 7397 | 409 | 8901 | -86 | 8751 |
| 3L-2S | | MI | 2704 | 1484 | 5007 | 1139 | 6148 | 919 | 7062 | 726 | 8611 | 384 | 10111 | 152 | 9173 |
| 8-#8 | 1.44 | MA | 2186 | 964 | 2963 | 854 | 3712 | 714 | 4165 | 603 | 4712 | 429 | 5848 | 370 | 3116 |
| 2L-4S | | MI | 1747 | 964 | 2337 | 857 | 2881 | 717 | 3157 | 608 | 3415 | 431 | 4114 | 266 | 2769 |
| 8-#8 | 1.44 | MA | 2031 | 964 | 2713 | 860 | 3395 | 720 | 3781 | 608 | 4195 | 436 | 5139 | 312 | 3111 |
| 3E | | MI | 1830 | 964 | 2493 | 851 | 3084 | 712 | 3417 | 600 | 3769 | 430 | 4547 | 298 | 2790 |
| 8-#8 | 1.44 | MA | 1939 | 964 | 2537 | 867 | 3166 | 726 | 3489 | 616 | 3796 | 439 | 4639 | 278 | 3082 |
| 4L-2S | | MI | 1965 | 964 | 2714 | 845 | 3365 | 707 | 3756 | 596 | 4226 | 424 | 5156 | 356 | 2791 |
| 8-#9 | 1.82 | MA | 2293 | 1013 | 3234 | 882 | 4044 | 735 | 4561 | 616 | 5240 | 426 | 6542 | 362 | 3879 |
| 2L-4S | | MI | 1794 | 1013 | 2479 | 888 | 3049 | 739 | 3352 | 623 | 3671 | 429 | 4448 | 232 | 3390 |
| 8-#9 | 1.82 | MA | 2106 | 1013 | 2919 | 890 | 3646 | 742 | 4079 | 621 | 4591 | 434 | 5658 | 289 | 3862 |
| 3E | | MI | 1893 | 1013 | 2675 | 880 | 3305 | 733 | 3678 | 614 | 4117 | 427 | 4987 | 272 | 3454 |
| 8-#9 | 1.82 | MA | 1995 | 1013 | 2698 | 899 | 3358 | 749 | 3711 | 632 | 4089 | 437 | 5034 | 247 | 3790 |
| 4L-2S | | MI | 2057 | 1013 | 2954 | 873 | 3657 | 727 | 4104 | 609 | 4690 | 421 | 5745 | 346 | 3466 |
| 8-#10 | 2.31 | MA | 2424 | 1077 | 3576 | 919 | 4465 | 762 | 5063 | 632 | 5911 | 422 | 7415 | 351 | 4845 |
| 2L-4S | | MI | 1853 | 1077 | 2658 | 928 | 3262 | 769 | 3599 | 642 | 3997 | 426 | 4866 | 187 | 4042 |
| 8-#10 | 2.31 | MA | 2200 | 1077 | 3179 | 929 | 3963 | 771 | 4456 | 639 | 5094 | 432 | 6312 | 258 | 4806 |
| 3E | | MI | 1973 | 1077 | 2905 | 919 | 3584 | 761 | 4010 | 631 | 4559 | 424 | 5540 | 238 | 4287 |
| 8-#10 | 2.31 | MA | 2066 | 1077 | 2901 | 940 | 3600 | 779 | 3992 | 652 | 4460 | 435 | 5530 | 205 | 4530 |
| 4L-2S | | MI | 2169 | 1077 | 3255 | 910 | 4027 | 754 | 4546 | 625 | 5280 | 417 | 6484 | 331 | 4318 |
| 8-#11 | 2.84 | MA | 2533 | 1145 | 3934 | 954 | 4886 | 787 | 5556 | 647 | 6560 | 415 | 8157 | 326 | 5802 |
| 2L-4S | | MI | 1907 | 1145 | 2852 | 965 | 3475 | 794 | 3837 | 657 | 4302 | 417 | 5197 | 126 | 4661 |
| 8-#11 | 2.84 | MA | 2285 | 1145 | 3458 | 966 | 4283 | 796 | 4828 | 654 | 5579 | 425 | 6864 | 212 | 5735 |
| 3E | | MI | 2042 | 1145 | 3150 | 954 | 3863 | 786 | 4332 | 645 | 4977 | 417 | 5986 | 185 | 5098 |
| 8-#11 | 2.84 | MA | 2125 | 1145 | 3121 | 978 | 3845 | 806 | 4268 | 668 | 4816 | 428 | 5943 | 149 | 5240 |
| 4L-2S | | MI | 2259 | 1145 | 3569 | 944 | 4393 | 778 | 4972 | 639 | 5840 | 409 | 7085 | 300 | 5154 |
| 8-#14 | 4.09 | MA | 2817 | 1308 | 4758 | 1051 | 5905 | 857 | 6778 | 691 | 8195 | 406 | 10176 | 286 | 8136 |
| 2L-4S | | MI | 2051 | 1308 | 3274 | 1067 | 3983 | 868 | 4429 | 705 | 5086 | 407 | 6144 | 0 | 6144 |
| 8-#14 | 4.09 | MA | 2501 | 1308 | 4083 | 1066 | 5051 | 869 | 5745 | 700 | 6804 | 419 | 8374 | 120 | 7965 |
| 3E | | MI | 2224 | 1308 | 3697 | 1053 | 4534 | 858 | 5132 | 689 | 6045 | 408 | 7242 | 82 | 7002 |
| 8-#14 | 4.09 | MA | 2308 | 1308 | 3604 | 1082 | 4428 | 882 | 4949 | 719 | 5718 | 421 | 7087 | 33 | 6941 |
| 4L-2S | | MI | 2501 | 1308 | 4290 | 1040 | 5283 | 848 | 6038 | 683 | 7265 | 400 | 8764 | 247 | 7195 |
| 8-#18 | 7.27 | MA | 3023 | 1720 | 5588 | 1322 | 6911 | 1055 | 7972 | 815 | 9783 | 400 | 11880 | -140 | 11556 |
| 3E | | MI | 2661 | 1720 | 5007 | 1305 | 6148 | 1040 | 7062 | 800 | 8611 | 383 | 10111 | -211 | 9754 |
| 10-#10 | 2.89 | MA | 2582 | 1152 | 3973 | 966 | 4967 | 796 | 5670 | 654 | 6728 | 419 | 8519 | 344 | 6000 |
| 2L-5S | | MI | 1913 | 1152 | 2786 | 984 | 3391 | 816 | 3764 | 670 | 4206 | 431 | 5144 | 121 | 4721 |
| 10-#10 | 2.89 | MA | 2378 | 1152 | 3576 | 976 | 4465 | 805 | 5063 | 661 | 5911 | 429 | 7415 | 251 | 5950 |
| 3L-4S | | MI | 2012 | 1152 | 3008 | 975 | 3705 | 803 | 4134 | 664 | 4718 | 423 | 5811 | 176 | 5006 |
| 10-#10 | 2.89 | MA | 2250 | 1152 | 3297 | 986 | 4101 | 814 | 4599 | 674 | 5278 | 433 | 6634 | 198 | 5633 |
| 4L-3S | | MI | 2126 | 1152 | 3255 | 966 | 4027 | 796 | 4546 | 653 | 5280 | 421 | 6484 | 227 | 5295 |
| 10-#10 | 2.89 | MA | 2129 | 1152 | 3048 | 997 | 3749 | 828 | 4183 | 681 | 4702 | 442 | 5855 | 143 | 5287 |
| 5L-2S | | MI | 2305 | 1152 | 3605 | 956 | 4470 | 788 | 5081 | 647 | 6001 | 414 | 7429 | 320 | 5337 |
| 10-#11 | 3.55 | MA | 2484 | 1237 | 3934 | 1023 | 4886 | 839 | 5556 | 681 | 6560 | 422 | 8157 | 199 | 7103 |
| 3L-4S | | MI | 2093 | 1237 | 3270 | 1022 | 4005 | 836 | 4477 | 684 | 5165 | 414 | 6296 | 108 | 5816 |
| 10-#11 | 3.55 | MA | 2350 | 1237 | 3598 | 1035 | 4447 | 848 | 4997 | 695 | 5797 | 425 | 7236 | 137 | 6565 |
| 4L-3S | | MI | 2213 | 1237 | 3569 | 1012 | 4393 | 828 | 4972 | 672 | 5840 | 413 | 7085 | 168 | 6299 |
| 10-#11 | 3.55 | MA | 2203 | 1237 | 3296 | 1047 | 4021 | 864 | 4494 | 703 | 5102 | 435 | 6323 | 69 | 6093 |
| 5L-2S | | MI | 2416 | 1237 | 3987 | 1002 | 4922 | 821 | 5613 | 666 | 6702 | 406 | 8184 | 282 | 6370 |

## RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

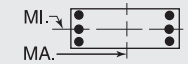
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 5.11 | MA | 2774 | 1440 | 4758 | 1149 | 5905 | 930 | 6778 | 739 | 8195 | 414 | 10176 | 98 | 9835 |
| 3L-4S | | MI | 2308 | 1440 | 3866 | 1150 | 4732 | 928 | 5335 | 744 | 6306 | 402 | 7667 | -30 | 7621 |
| 10-#14 | 5.11 | MA | 2607 | 1440 | 4279 | 1165 | 5281 | 943 | 5982 | 758 | 7109 | 416 | 8888 | 11 | 8838 |
| 4L-3S | | MI | 2458 | 1440 | 4290 | 1136 | 5283 | 919 | 6038 | 728 | 7265 | 403 | 8764 | 52 | 8599 |
| 12-#10 | 3.46 | MA | 2544 | 1226 | 3973 | 1023 | 4967 | 839 | 5670 | 683 | 6728 | 426 | 8519 | 244 | 7094 |
| 3L-5S | | MI | 2074 | 1226 | 3136 | 1031 | 3834 | 850 | 4299 | 692 | 4927 | 428 | 6088 | 110 | 5709 |
| 12-#10 | 3.46 | MA | 2436 | 1226 | 3694 | 1033 | 4603 | 848 | 5206 | 696 | 6095 | 430 | 7737 | 191 | 6742 |
| 4E | | MI | 2173 | 1226 | 3357 | 1021 | 4147 | 837 | 4669 | 686 | 5439 | 421 | 6755 | 165 | 5978 |
| 12-#10 | 3.46 | MA | 2308 | 1226 | 3445 | 1043 | 4251 | 862 | 4790 | 703 | 5519 | 439 | 6958 | 136 | 6414 |
| 5L-3S | | MI | 2269 | 1226 | 3605 | 1012 | 4470 | 830 | 5081 | 675 | 6001 | 419 | 7429 | 216 | 6303 |
| 12-#10 | 3.46 | MA | 2149 | 1226 | 3202 | 1052 | 3931 | 871 | 4383 | 716 | 4957 | 443 | 6203 | 68 | 5916 |
| 6L-2S | | MI | 2438 | 1226 | 3955 | 1003 | 4913 | 823 | 5617 | 669 | 6722 | 411 | 8373 | 309 | 6355 |
| 12-#11 | 4.25 | MA | 2557 | 1329 | 4074 | 1092 | 5050 | 890 | 5725 | 722 | 6777 | 421 | 8530 | 124 | 7899 |
| 4E | | MI | 2271 | 1329 | 3689 | 1079 | 4534 | 878 | 5118 | 711 | 6027 | 410 | 7395 | 91 | 6980 |
| 12-#11 | 4.25 | MA | 2420 | 1329 | 3772 | 1104 | 4624 | 907 | 5222 | 730 | 6082 | 431 | 7616 | 56 | 7417 |
| 5L-3S | | MI | 2379 | 1329 | 3987 | 1069 | 4922 | 870 | 5613 | 699 | 6702 | 410 | 8184 | 150 | 7501 |
| 12-#14 | 6.14 | MA | 2893 | 1573 | 4954 | 1247 | 6135 | 1004 | 7015 | 797 | 8499 | 411 | 10690 | -11 | 10659 |
| 4E | | MI | 2555 | 1573 | 4458 | 1232 | 5481 | 989 | 6241 | 783 | 7526 | 397 | 9189 | -60 | 9068 |
| 14-#10 | 4.04 | MA | 2607 | 1301 | 4091 | 1080 | 5105 | 882 | 5813 | 718 | 6912 | 427 | 8841 | 184 | 7857 |
| 4L-5S | | MI | 2224 | 1301 | 3485 | 1077 | 4276 | 885 | 4835 | 714 | 5648 | 426 | 7032 | 99 | 6688 |
| 14-#10 | 4.04 | MA | 2489 | 1301 | 3842 | 1090 | 4752 | 896 | 5397 | 725 | 6336 | 437 | 8062 | 129 | 7545 |
| 5L-4S | | MI | 2321 | 1301 | 3707 | 1068 | 4590 | 872 | 5205 | 708 | 6160 | 418 | 7699 | 154 | 6955 |
| 14-#10 | 4.04 | MA | 2341 | 1301 | 3599 | 1099 | 4433 | 905 | 4990 | 738 | 5774 | 440 | 7306 | 61 | 7040 |
| 6L-3S | | MI | 2409 | 1301 | 3955 | 1059 | 4913 | 864 | 5617 | 697 | 6722 | 416 | 8373 | 204 | 7311 |
| 14-#11 | 4.96 | MA | 2623 | 1421 | 4248 | 1161 | 5226 | 949 | 5951 | 757 | 7063 | 428 | 8910 | 44 | 8747 |
| 5L-4S | | MI | 2444 | 1421 | 4108 | 1137 | 5064 | 920 | 5758 | 738 | 6890 | 407 | 8494 | 73 | 8151 |
| 16-#10 | 4.62 | MA | 2657 | 1376 | 4238 | 1137 | 5254 | 931 | 6004 | 747 | 7153 | 434 | 9165 | 122 | 8679 |
| 5E | | MI | 2370 | 1376 | 3835 | 1124 | 4719 | 919 | 5370 | 736 | 6369 | 423 | 7977 | 88 | 7658 |
| 16-#10 | 4.62 | MA | 2517 | 1376 | 3996 | 1146 | 4934 | 939 | 5597 | 760 | 6591 | 438 | 8410 | 53 | 8167 |
| 6L-4S | | MI | 2465 | 1376 | 4057 | 1115 | 5033 | 906 | 5740 | 730 | 6881 | 415 | 8644 | 143 | 7937 |

## RECTANGULAR TIED COLUMNS 20" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.06 | MA | 2468 | 998 | 3201 | 901 | 4021 | 757 | 4484 | 644 | 4978 | 472 | 6122 | 411 | 2793 |
| 2E | | MI | 2022 | 998 | 2724 | 882 | 3347 | 741 | 3693 | 630 | 4056 | 461 | 4842 | 387 | 2277 |
| 4-#11 | 1.30 | MA | 2540 | 1032 | 3427 | 915 | 4271 | 767 | 4768 | 649 | 5344 | 467 | 6554 | 399 | 3354 |
| 2E | | MI | 2072 | 1032 | 2903 | 895 | 3540 | 749 | 3910 | 634 | 4332 | 455 | 5131 | 369 | 2721 |
| 4-#14 | 1.88 | MA | 2723 | 1114 | 3907 | 960 | 4853 | 800 | 5460 | 669 | 6263 | 460 | 7727 | 382 | 4695 |
| 2E | | MI | 2206 | 1114 | 3280 | 939 | 3993 | 781 | 4445 | 653 | 5042 | 448 | 5963 | 341 | 3774 |
| 4-#18 | 3.33 | MA | 3127 | 1320 | 5065 | 1078 | 6269 | 885 | 7146 | 721 | 8512 | 446 | 10483 | 327 | 7941 |
| 2E | | MI | 2496 | 1320 | 4175 | 1055 | 5078 | 865 | 5735 | 704 | 6748 | 431 | 7864 | 255 | 6282 |
| 6-#9 | 1.25 | MA | 2548 | 1025 | 3353 | 920 | 4226 | 772 | 4738 | 654 | 5327 | 473 | 6612 | 411 | 3279 |
| 2L-3S | | MI | 1909 | 1025 | 2565 | 910 | 3158 | 763 | 3471 | 645 | 3762 | 468 | 4476 | 314 | 2667 |
| 6-#9 | 1.25 | MA | 2325 | 1025 | 3001 | 929 | 3781 | 780 | 4200 | 661 | 4602 | 482 | 5609 | 339 | 3273 |
| 3L-2S | | MI | 2083 | 1025 | 2843 | 902 | 3510 | 756 | 3897 | 641 | 4335 | 462 | 5234 | 388 | 2665 |
| 6-#10 | 1.59 | MA | 2666 | 1073 | 3645 | 948 | 4582 | 792 | 5162 | 666 | 5891 | 469 | 7386 | 407 | 4097 |
| 2L-3S | | MI | 1960 | 1073 | 2724 | 938 | 3347 | 783 | 3693 | 658 | 4056 | 466 | 4842 | 283 | 3303 |
| 6-#10 | 1.59 | MA | 2395 | 1073 | 3201 | 959 | 4021 | 801 | 4484 | 674 | 4978 | 480 | 6122 | 314 | 4074 |
| 3L-2S | | MI | 2171 | 1073 | 3074 | 929 | 3790 | 776 | 4229 | 652 | 4777 | 458 | 5786 | 376 | 3313 |
| 6-#11 | 1.95 | MA | 2768 | 1124 | 3960 | 972 | 4946 | 809 | 5584 | 676 | 6443 | 463 | 8043 | 391 | 4920 |
| 2L-3S | | MI | 2000 | 1124 | 2903 | 962 | 3540 | 799 | 3910 | 666 | 4332 | 459 | 5131 | 237 | 3930 |
| 6-#11 | 1.95 | MA | 2454 | 1124 | 3427 | 985 | 4271 | 820 | 4768 | 685 | 5344 | 475 | 6554 | 276 | 4872 |
| 3L-2S | | MI | 2244 | 1124 | 3322 | 952 | 4070 | 792 | 4551 | 661 | 5195 | 451 | 6230 | 351 | 3956 |
| 6-#14 | 2.81 | MA | 3028 | 1246 | 4665 | 1043 | 5812 | 860 | 6619 | 708 | 7824 | 455 | 9810 | 366 | 6906 |
| 2L-3S | | MI | 2120 | 1246 | 3280 | 1035 | 3993 | 852 | 4445 | 698 | 5042 | 452 | 5963 | 146 | 5405 |
| 6-#14 | 2.81 | MA | 2616 | 1246 | 3907 | 1060 | 4853 | 875 | 5460 | 719 | 6263 | 471 | 7727 | 201 | 6762 |
| 3L-2S | | MI | 2432 | 1246 | 3872 | 1022 | 4742 | 842 | 5351 | 692 | 6262 | 443 | 7485 | 311 | 5505 |

## RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

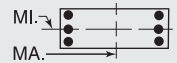
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 5.00 | MA | 3604 | 1555 | 6371 | 1226 | 7920 | 993 | 9144 | 791 | 11201 | 438 | 13958 | 286 | 11727 |
| 2L-3S | | MI | 2396 | 1555 | 4175 | 1222 | 5078 | 985 | 5735 | 778 | 6748 | 430 | 7864 | -109 | 7728 |
| 6-#18 | 5.00 | MA | 3018 | 1555 | 5065 | 1253 | 6269 | 1015 | 7146 | 806 | 8512 | 459 | 10483 | -7 | 10467 |
| 3L-2S | | MI | 2854 | 1555 | 5186 | 1202 | 6357 | 973 | 7282 | 773 | 8827 | 422 | 10352 | 185 | 9210 |
| 8-#8 | 1.32 | MA | 2580 | 1035 | 3401 | 929 | 4299 | 778 | 4833 | 659 | 5460 | 474 | 6800 | 412 | 3457 |
| 2L-4S | | MI | 1888 | 1035 | 2503 | 923 | 3085 | 773 | 3375 | 657 | 3633 | 471 | 4361 | 300 | 2795 |
| 8-#8 | 1.32 | MA | 2405 | 1035 | 3122 | 936 | 3945 | 785 | 4405 | 664 | 4883 | 481 | 6002 | 355 | 3452 |
| 3E | | MI | 1972 | 1035 | 2659 | 917 | 3288 | 768 | 3635 | 650 | 3988 | 469 | 4794 | 333 | 2809 |
| 8-#8 | 1.32 | MA | 2300 | 1035 | 2927 | 943 | 3691 | 791 | 4080 | 673 | 4440 | 485 | 5445 | 321 | 3423 |
| 4L-2S | | MI | 2109 | 1035 | 2880 | 911 | 3569 | 763 | 3974 | 645 | 4444 | 463 | 5403 | 391 | 2807 |
| 8-#9 | 1.67 | MA | 2703 | 1084 | 3705 | 957 | 4671 | 799 | 5277 | 672 | 6052 | 471 | 7615 | 408 | 4311 |
| 2L-4S | | MI | 1935 | 1084 | 2646 | 954 | 3254 | 796 | 3570 | 672 | 3889 | 468 | 4695 | 266 | 3436 |
| 8-#9 | 1.67 | MA | 2492 | 1084 | 3353 | 966 | 4226 | 807 | 4738 | 678 | 5327 | 480 | 6612 | 336 | 4294 |
| 3E | | MI | 2036 | 1084 | 2843 | 946 | 3510 | 790 | 3897 | 663 | 4335 | 466 | 5234 | 307 | 3477 |
| 8-#9 | 1.67 | MA | 2366 | 1084 | 3108 | 975 | 3906 | 815 | 4329 | 689 | 4768 | 484 | 5908 | 292 | 4226 |
| 4L-2S | | MI | 2202 | 1084 | 3121 | 939 | 3862 | 783 | 4322 | 658 | 4908 | 460 | 5992 | 380 | 3485 |
| 8-#10 | 2.12 | MA | 2855 | 1148 | 4088 | 994 | 5143 | 826 | 5841 | 688 | 6805 | 467 | 8650 | 403 | 5394 |
| 2L-4S | | MI | 1994 | 1148 | 2826 | 994 | 3467 | 825 | 3817 | 691 | 4215 | 465 | 5113 | 221 | 4126 |
| 8-#10 | 2.12 | MA | 2600 | 1148 | 3645 | 1005 | 4582 | 836 | 5162 | 696 | 5891 | 478 | 7386 | 310 | 5355 |
| 3E | | MI | 2115 | 1148 | 3074 | 985 | 3790 | 817 | 4229 | 680 | 4777 | 463 | 5786 | 272 | 4315 |
| 8-#10 | 2.12 | MA | 2448 | 1148 | 3335 | 1016 | 4178 | 845 | 4646 | 710 | 5186 | 483 | 6495 | 255 | 5119 |
| 4L-2S | | MI | 2316 | 1148 | 3424 | 975 | 4232 | 810 | 4764 | 674 | 5497 | 455 | 6730 | 365 | 4339 |
| 8-#11 | 2.60 | MA | 2987 | 1216 | 4494 | 1030 | 5620 | 851 | 6400 | 703 | 7542 | 460 | 9533 | 382 | 6476 |
| 2L-4S | | MI | 2040 | 1216 | 3024 | 1030 | 3682 | 849 | 4056 | 705 | 4519 | 456 | 5441 | 160 | 4753 |
| 8-#11 | 2.60 | MA | 2693 | 1216 | 3960 | 1042 | 4946 | 862 | 5584 | 712 | 6443 | 472 | 8043 | 268 | 6408 |
| 3E | | MI | 2185 | 1216 | 3322 | 1019 | 4070 | 842 | 4551 | 693 | 5195 | 455 | 6230 | 219 | 5133 |
| 8-#11 | 2.60 | MA | 2518 | 1216 | 3586 | 1055 | 4457 | 873 | 4960 | 727 | 5591 | 477 | 6989 | 202 | 5930 |
| 4L-2S | | MI | 2407 | 1216 | 3741 | 1009 | 4600 | 834 | 5191 | 688 | 6057 | 448 | 7329 | 334 | 5179 |
| 8-#14 | 3.75 | MA | 3316 | 1378 | 5423 | 1126 | 6770 | 921 | 7778 | 747 | 9385 | 450 | 11893 | 351 | 9108 |
| 2L-4S | | MI | 2188 | 1378 | 3449 | 1131 | 4191 | 923 | 4648 | 753 | 5303 | 445 | 6388 | 33 | 6252 |
| 8-#14 | 3.75 | MA | 2953 | 1378 | 4665 | 1143 | 5812 | 936 | 6619 | 758 | 7824 | 466 | 9810 | 186 | 8937 |
| 3E | | MI | 2366 | 1378 | 3872 | 1118 | 4742 | 913 | 5351 | 737 | 6262 | 447 | 7485 | 116 | 7095 |
| 8-#14 | 3.75 | MA | 2732 | 1378 | 4131 | 1161 | 5116 | 950 | 5730 | 779 | 6612 | 472 | 8330 | 94 | 7866 |
| 4L-2S | | MI | 2650 | 1378 | 4464 | 1104 | 5491 | 903 | 6257 | 731 | 7482 | 438 | 9008 | 281 | 7225 |
| 8-#18 | 6.67 | MA | 3555 | 1790 | 6371 | 1400 | 7920 | 1123 | 9144 | 875 | 11201 | 450 | 13958 | -48 | 13818 |
| 3E | | MI | 2799 | 1790 | 5186 | 1369 | 6357 | 1094 | 7282 | 847 | 8827 | 421 | 10352 | -178 | 10057 |
| 8-#18 | 6.67 | MA | 3240 | 1790 | 5444 | 1428 | 6713 | 1145 | 7604 | 909 | 9100 | 455 | 11472 | -203 | 11078 |
| 4L-2S | | MI | 3205 | 1790 | 6197 | 1349 | 7637 | 1081 | 8829 | 842 | 10906 | 412 | 12840 | 115 | 12130 |
| 10-#10 | 2.65 | MA | 3038 | 1222 | 4532 | 1041 | 5704 | 860 | 6519 | 710 | 7718 | 464 | 9913 | 399 | 6686 |
| 2L-5S | | MI | 2054 | 1222 | 2954 | 1050 | 3596 | 872 | 3982 | 719 | 4424 | 470 | 5390 | 155 | 4796 |
| 10-#10 | 2.65 | MA | 2797 | 1222 | 4088 | 1052 | 5143 | 870 | 5841 | 718 | 6805 | 475 | 8650 | 306 | 6636 |
| 3L-4S | | MI | 2153 | 1222 | 3176 | 1040 | 3910 | 859 | 4353 | 713 | 4936 | 462 | 6057 | 210 | 5087 |
| 10-#10 | 2.65 | MA | 2658 | 1222 | 3779 | 1063 | 4739 | 880 | 5324 | 732 | 6100 | 480 | 7759 | 251 | 6357 |
| 4L-3S | | MI | 2270 | 1222 | 3424 | 1031 | 4232 | 852 | 4764 | 702 | 5497 | 460 | 6730 | 261 | 5324 |
| 10-#10 | 2.65 | MA | 2516 | 1222 | 3502 | 1074 | 4347 | 895 | 4862 | 740 | 5460 | 491 | 6867 | 197 | 5939 |
| 5L-2S | | MI | 2454 | 1222 | 3774 | 1022 | 4675 | 844 | 5300 | 696 | 6218 | 453 | 7675 | 354 | 5359 |
| 10-#11 | 3.25 | MA | 2931 | 1308 | 4494 | 1100 | 5620 | 904 | 6400 | 739 | 7542 | 468 | 9533 | 260 | 7946 |
| 3L-4S | | MI | 2233 | 1308 | 3443 | 1087 | 4211 | 891 | 4696 | 732 | 5382 | 452 | 6541 | 142 | 5905 |
| 10-#11 | 3.25 | MA | 2765 | 1308 | 4119 | 1112 | 5132 | 915 | 5777 | 754 | 6690 | 473 | 8479 | 194 | 7422 |
| 4L-3S | | MI | 2357 | 1308 | 3741 | 1077 | 4600 | 884 | 5191 | 720 | 6057 | 452 | 7329 | 201 | 6336 |
| 10-#11 | 3.25 | MA | 2601 | 1308 | 3785 | 1125 | 4658 | 933 | 5217 | 763 | 5916 | 485 | 7427 | 127 | 6955 |
| 5L-2S | | MI | 2565 | 1308 | 4159 | 1067 | 5129 | 876 | 5832 | 715 | 6920 | 444 | 8428 | 316 | 6397 |
| 10-#14 | 4.69 | MA | 3265 | 1511 | 5423 | 1226 | 6770 | 997 | 7778 | 797 | 9385 | 461 | 11893 | 170 | 11117 |
| 3L-4S | | MI | 2446 | 1511 | 4041 | 1214 | 4940 | 983 | 5554 | 792 | 6523 | 440 | 7910 | 3 | 7896 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 4.69 | MA | 3074 | 1511 | 4889 | 1243 | 6075 | 1011 | 6890 | 818 | 8173 | 467 | 10414 | 78 | 10006 |
| 4L-3S | | MI | 2602 | 1511 | 4464 | 1201 | 5491 | 974 | 6257 | 776 | 7482 | 442 | 9008 | 85 | 8731 |
| 10-#14 | 4.69 | MA | 2846 | 1511 | 4411 | 1261 | 5399 | 1035 | 6092 | 830 | 7069 | 482 | 8942 | -19 | 8915 |
| 5L-2S | | MI | 2863 | 1511 | 5056 | 1187 | 6240 | 964 | 7163 | 770 | 8702 | 433 | 10530 | 251 | 8940 |
| 12-#10 | 3.17 | MA | 2987 | 1297 | 4532 | 1099 | 5704 | 904 | 6519 | 740 | 7718 | 472 | 9913 | 302 | 7917 |
| 3L-5S | | MI | 2210 | 1297 | 3304 | 1096 | 4039 | 906 | 4518 | 741 | 5145 | 467 | 6334 | 144 | 5781 |
| 12-#10 | 3.17 | MA | 2860 | 1297 | 4222 | 1110 | 5300 | 914 | 6003 | 754 | 7013 | 477 | 9023 | 247 | 7601 |
| 4E | | MI | 2315 | 1297 | 3526 | 1087 | 4352 | 893 | 4888 | 735 | 5656 | 460 | 7001 | 199 | 6055 |
| 12-#10 | 3.17 | MA | 2720 | 1297 | 3946 | 1121 | 4908 | 929 | 5540 | 762 | 6373 | 488 | 8131 | 193 | 7203 |
| 5L-3S | | MI | 2414 | 1297 | 3774 | 1078 | 4675 | 886 | 5300 | 724 | 6218 | 458 | 7675 | 250 | 6333 |
| 12-#10 | 3.17 | MA | 2540 | 1297 | 3669 | 1130 | 4554 | 939 | 5089 | 776 | 5749 | 493 | 7270 | 122 | 6691 |
| 6L-2S | | MI | 2588 | 1297 | 4124 | 1069 | 5118 | 879 | 5835 | 718 | 6939 | 450 | 8619 | 343 | 6378 |
| 12-#11 | 3.90 | MA | 3014 | 1400 | 4653 | 1170 | 5807 | 957 | 6593 | 781 | 7789 | 470 | 9968 | 186 | 8922 |
| 4E | | MI | 2412 | 1400 | 3861 | 1144 | 4741 | 934 | 5337 | 759 | 6244 | 449 | 7640 | 124 | 7065 |
| 12-#11 | 3.90 | MA | 2841 | 1400 | 4318 | 1183 | 5333 | 975 | 6033 | 790 | 7015 | 482 | 8916 | 119 | 8451 |
| 5L-3S | | MI | 2524 | 1400 | 4159 | 1134 | 5129 | 926 | 5832 | 747 | 6920 | 448 | 8428 | 183 | 7539 |
| 12-#11 | 3.90 | MA | 2633 | 1400 | 3991 | 1194 | 4904 | 986 | 5487 | 806 | 6260 | 487 | 7898 | 34 | 7739 |
| 6L-2S | | MI | 2719 | 1400 | 4578 | 1124 | 5659 | 918 | 6473 | 742 | 7782 | 441 | 9527 | 298 | 7612 |
| 12-#14 | 5.63 | MA | 3401 | 1643 | 5647 | 1326 | 7033 | 1072 | 8049 | 857 | 9733 | 462 | 12497 | 63 | 12155 |
| 4E | | MI | 2693 | 1643 | 4633 | 1297 | 5689 | 1044 | 6460 | 831 | 7743 | 435 | 9433 | -27 | 9381 |
| 12-#14 | 5.63 | MA | 3178 | 1643 | 5169 | 1344 | 6357 | 1096 | 7251 | 869 | 8630 | 477 | 11026 | -35 | 10954 |
| 5L-3S | | MI | 2831 | 1643 | 5056 | 1283 | 6240 | 1034 | 7163 | 815 | 8702 | 437 | 10530 | 55 | 10339 |
| 14-#10 | 3.70 | MA | 3067 | 1372 | 4665 | 1157 | 5861 | 948 | 6681 | 776 | 7927 | 474 | 10287 | 243 | 8852 |
| 4L-5S | | MI | 2367 | 1372 | 3654 | 1143 | 4481 | 941 | 5053 | 763 | 5866 | 464 | 7278 | 133 | 6770 |
| 14-#10 | 3.70 | MA | 2918 | 1372 | 4389 | 1168 | 5469 | 964 | 6219 | 784 | 7287 | 485 | 9395 | 189 | 8470 |
| 5L-4S | | MI | 2464 | 1372 | 3876 | 1134 | 4795 | 928 | 5423 | 757 | 6377 | 457 | 7946 | 188 | 7030 |
| 14-#10 | 3.70 | MA | 2747 | 1372 | 4113 | 1176 | 5114 | 973 | 5767 | 798 | 6663 | 491 | 8534 | 118 | 7954 |
| 6L-3S | | MI | 2555 | 1372 | 4124 | 1125 | 5118 | 920 | 5835 | 746 | 6939 | 455 | 8619 | 239 | 7341 |
| 14-#11 | 4.55 | MA | 3083 | 1491 | 4852 | 1240 | 6008 | 1017 | 6849 | 817 | 8114 | 478 | 10406 | 111 | 9951 |
| 5L-4S | | MI | 2586 | 1491 | 4280 | 1202 | 5271 | 976 | 5977 | 786 | 7107 | 445 | 8739 | 107 | 8233 |
| 14-#11 | 4.55 | MA | 2889 | 1491 | 4524 | 1251 | 5579 | 1028 | 6303 | 833 | 7359 | 483 | 9387 | 26 | 9262 |
| 6L-3S | | MI | 2687 | 1491 | 4578 | 1192 | 5659 | 968 | 6473 | 774 | 7782 | 445 | 9527 | 166 | 8742 |
| 14-#14 | 6.56 | MA | 3498 | 1776 | 5927 | 1426 | 7316 | 1157 | 8410 | 908 | 10191 | 472 | 13109 | -50 | 12976 |
| 5L-4S | | MI | 2934 | 1776 | 5225 | 1380 | 6438 | 1105 | 7366 | 870 | 8963 | 431 | 10955 | -57 | 10822 |
| 16-#10 | 4.23 | MA | 3119 | 1447 | 4833 | 1214 | 6030 | 998 | 6897 | 806 | 8200 | 483 | 10658 | 185 | 9741 |
| 5E | | MI | 2513 | 1447 | 4004 | 1190 | 4924 | 975 | 5589 | 784 | 6587 | 462 | 8223 | 122 | 7762 |
| 16-#10 | 4.23 | MA | 2960 | 1447 | 4556 | 1223 | 5675 | 1008 | 6446 | 820 | 7576 | 488 | 9797 | 114 | 9220 |
| 6L-4S | | MI | 2609 | 1447 | 4226 | 1181 | 5238 | 962 | 5959 | 779 | 7098 | 454 | 8890 | 177 | 8009 |
| 16-#11 | 5.20 | MA | 3126 | 1583 | 5058 | 1309 | 6253 | 1070 | 7119 | 860 | 8458 | 480 | 10876 | 18 | 10788 |
| 6L-4S | | MI | 2755 | 1583 | 4699 | 1259 | 5800 | 1018 | 6618 | 813 | 7969 | 442 | 9838 | 89 | 9407 |
| 18-#10 | 4.76 | MA | 3156 | 1521 | 4999 | 1270 | 6236 | 1042 | 7124 | 842 | 8489 | 485 | 11061 | 110 | 10488 |
| 6L-5S | | MI | 2656 | 1521 | 4354 | 1237 | 5367 | 1009 | 6124 | 806 | 7308 | 459 | 9167 | 111 | 8746 |

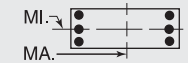
## RECTANGULAR TIED COLUMNS 20" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.20 | MA | 2961 | 1103 | 3894 | 990 | 4896 | 831 | 5477 | 705 | 6133 | 511 | 7591 | 445 | 3691 |
| 2E | | MI | 2215 | 1103 | 3076 | 959 | 3747 | 805 | 4129 | 682 | 4549 | 493 | 5375 | 403 | 2740 |
| 4-#14 | 1.73 | MA | 3171 | 1184 | 4430 | 1035 | 5545 | 864 | 6248 | 725 | 7157 | 505 | 8937 | 432 | 5181 |
| 2E | | MI | 2351 | 1184 | 3455 | 1003 | 4201 | 836 | 4665 | 701 | 5259 | 486 | 6206 | 375 | 3798 |
| 4-#18 | 3.08 | MA | 3640 | 1390 | 5723 | 1154 | 7127 | 949 | 8133 | 777 | 9671 | 491 | 12125 | 388 | 8805 |
| 2E | | MI | 2643 | 1390 | 4354 | 1118 | 5288 | 919 | 5955 | 751 | 6964 | 469 | 8104 | 288 | 6316 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis

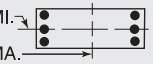



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#9 | 1.15 | MA | 2968 | 1096 | 3809 | 996 | 4841 | 836 | 5439 | 710 | 6107 | 517 | 7574 | 450 | 3603 |
| 2L-3S | | MI | 2051 | 1096 | 2732 | 976 | 3362 | 819 | 3689 | 694 | 3980 | 507 | 4723 | 349 | 2686 |
| 6-#9 | 1.15 | MA | 2718 | 1096 | 3421 | 1005 | 4350 | 845 | 4845 | 718 | 5307 | 527 | 6466 | 380 | 3597 |
| 3L-2S | | MI | 2227 | 1096 | 3010 | 968 | 3714 | 813 | 4115 | 690 | 4553 | 501 | 5481 | 422 | 2681 |
| 6-#10 | 1.47 | MA | 3102 | 1144 | 4133 | 1023 | 5236 | 856 | 5909 | 722 | 6733 | 514 | 8436 | 447 | 4509 |
| 2L-3S | | MI | 2101 | 1144 | 2893 | 1004 | 3552 | 839 | 3912 | 707 | 4273 | 505 | 5088 | 317 | 3327 |
| 6-#10 | 1.47 | MA | 2798 | 1144 | 3643 | 1034 | 4616 | 866 | 5159 | 731 | 5723 | 526 | 7038 | 356 | 4485 |
| 3L-2S | | MI | 2315 | 1144 | 3242 | 994 | 3995 | 832 | 4447 | 701 | 4994 | 497 | 6032 | 410 | 3331 |
| 6-#11 | 1.80 | MA | 3221 | 1195 | 4485 | 1047 | 5643 | 873 | 6381 | 732 | 7350 | 508 | 9277 | 440 | 5425 |
| 2L-3S | | MI | 2141 | 1195 | 3076 | 1027 | 3747 | 855 | 4129 | 714 | 4549 | 497 | 5375 | 271 | 3960 |
| 6-#11 | 1.80 | MA | 2867 | 1195 | 3894 | 1061 | 4896 | 885 | 5477 | 742 | 6133 | 521 | 7591 | 326 | 5378 |
| 3L-2S | | MI | 2389 | 1195 | 3494 | 1017 | 4277 | 847 | 4770 | 709 | 5412 | 490 | 6474 | 385 | 3978 |
| 6-#14 | 2.60 | MA | 3520 | 1317 | 5270 | 1118 | 6608 | 924 | 7534 | 764 | 8889 | 500 | 11303 | 422 | 7635 |
| 2L-3S | | MI | 2261 | 1317 | 3455 | 1100 | 4201 | 907 | 4665 | 746 | 5259 | 490 | 6206 | 179 | 5450 |
| 6-#14 | 2.60 | MA | 3052 | 1317 | 4430 | 1137 | 5545 | 941 | 6248 | 777 | 7157 | 518 | 8937 | 257 | 7491 |
| 3L-2S | | MI | 2579 | 1317 | 4047 | 1086 | 4950 | 897 | 5571 | 740 | 6479 | 481 | 7728 | 344 | 5532 |
| 6-#18 | 4.62 | MA | 4182 | 1626 | 7176 | 1301 | 8964 | 1057 | 10356 | 846 | 12663 | 482 | 16100 | 358 | 13023 |
| 2L-3S | | MI | 2534 | 1626 | 4354 | 1285 | 5288 | 1040 | 5955 | 825 | 6964 | 468 | 8104 | -76 | 8012 |
| 6-#18 | 4.62 | MA | 3514 | 1626 | 5723 | 1331 | 7127 | 1082 | 8133 | 866 | 9671 | 509 | 12125 | 65 | 11933 |
| 3L-2S | | MI | 3003 | 1626 | 5365 | 1266 | 6567 | 1027 | 7502 | 820 | 9043 | 459 | 10592 | 218 | 9247 |
| 8-#8 | 1.22 | MA | 3004 | 1105 | 3862 | 1004 | 4921 | 843 | 5542 | 715 | 6252 | 518 | 7779 | 451 | 3799 |
| 2L-4S | | MI | 2030 | 1105 | 2669 | 989 | 3289 | 830 | 3593 | 706 | 3851 | 510 | 4609 | 335 | 2818 |
| 8-#8 | 1.22 | MA | 2807 | 1105 | 3553 | 1011 | 4530 | 849 | 5070 | 721 | 5616 | 526 | 6898 | 396 | 3794 |
| 3E | | MI | 2114 | 1105 | 2825 | 983 | 3492 | 825 | 3853 | 699 | 4206 | 508 | 5041 | 367 | 2827 |
| 8-#8 | 1.22 | MA | 2691 | 1105 | 3339 | 1019 | 4251 | 856 | 4713 | 730 | 5128 | 531 | 6290 | 362 | 3765 |
| 4L-2S | | MI | 2253 | 1105 | 3047 | 977 | 3773 | 820 | 4192 | 695 | 4662 | 502 | 5650 | 425 | 2823 |
| 8-#9 | 1.54 | MA | 3144 | 1155 | 4198 | 1032 | 5333 | 863 | 6034 | 727 | 6907 | 515 | 8682 | 447 | 4743 |
| 2L-4S | | MI | 2076 | 1155 | 2814 | 1020 | 3458 | 852 | 3788 | 721 | 4107 | 507 | 4941 | 301 | 3467 |
| 8-#9 | 1.54 | MA | 2906 | 1155 | 3809 | 1042 | 4841 | 872 | 5439 | 735 | 6107 | 525 | 7574 | 377 | 4726 |
| 3E | | MI | 2178 | 1155 | 3010 | 1012 | 3714 | 846 | 4115 | 712 | 4553 | 505 | 5481 | 341 | 3499 |
| 8-#9 | 1.54 | MA | 2765 | 1155 | 3540 | 1051 | 4489 | 880 | 4989 | 747 | 5492 | 530 | 6806 | 334 | 4658 |
| 4L-2S | | MI | 2346 | 1155 | 3288 | 1005 | 4066 | 840 | 4541 | 707 | 5126 | 499 | 6239 | 414 | 3502 |
| 8-#10 | 1.95 | MA | 3316 | 1218 | 4623 | 1069 | 5856 | 890 | 6659 | 744 | 7743 | 511 | 9834 | 443 | 5942 |
| 2L-4S | | MI | 2134 | 1218 | 2995 | 1059 | 3672 | 881 | 4036 | 740 | 4432 | 504 | 5359 | 256 | 4207 |
| 8-#10 | 1.95 | MA | 3029 | 1218 | 4133 | 1081 | 5236 | 901 | 5909 | 753 | 6733 | 523 | 8436 | 352 | 5903 |
| 3E | | MI | 2258 | 1218 | 3242 | 1050 | 3995 | 873 | 4447 | 729 | 4994 | 502 | 6032 | 306 | 4341 |
| 8-#10 | 1.95 | MA | 2859 | 1218 | 3792 | 1093 | 4791 | 911 | 5341 | 768 | 5956 | 530 | 7462 | 298 | 5721 |
| 4L-2S | | MI | 2461 | 1218 | 3592 | 1041 | 4437 | 866 | 4983 | 723 | 5715 | 494 | 6976 | 399 | 4359 |
| 8-#11 | 2.40 | MA | 3469 | 1287 | 5076 | 1105 | 6390 | 915 | 7285 | 759 | 8567 | 504 | 10962 | 435 | 7150 |
| 2L-4S | | MI | 2180 | 1287 | 3196 | 1095 | 3889 | 905 | 4275 | 754 | 4737 | 494 | 5686 | 194 | 4843 |
| 8-#11 | 2.40 | MA | 3138 | 1287 | 4485 | 1118 | 5643 | 927 | 6381 | 769 | 7350 | 518 | 9277 | 321 | 7082 |
| 3E | | MI | 2327 | 1287 | 3494 | 1084 | 4277 | 897 | 4770 | 741 | 5412 | 494 | 6474 | 253 | 5167 |
| 8-#11 | 2.40 | MA | 2942 | 1287 | 4073 | 1132 | 5105 | 939 | 5694 | 786 | 6411 | 524 | 8089 | 253 | 6635 |
| 4L-2S | | MI | 2554 | 1287 | 3913 | 1074 | 4806 | 889 | 5410 | 736 | 6275 | 486 | 7574 | 367 | 5203 |
| 8-#14 | 3.46 | MA | 3849 | 1449 | 6111 | 1201 | 7671 | 985 | 8820 | 802 | 10620 | 495 | 13669 | 412 | 10080 |
| 2L-4S | | MI | 2326 | 1449 | 3623 | 1196 | 4398 | 977 | 4868 | 801 | 5520 | 484 | 6631 | 67 | 6356 |
| 8-#14 | 3.46 | MA | 3435 | 1449 | 5270 | 1220 | 6608 | 1001 | 7534 | 816 | 8889 | 513 | 11303 | 247 | 9909 |
| 3E | | MI | 2508 | 1449 | 4047 | 1182 | 4950 | 968 | 5571 | 785 | 6479 | 485 | 7728 | 149 | 7141 |
| 8-#14 | 3.46 | MA | 3169 | 1449 | 4681 | 1239 | 5840 | 1018 | 6553 | 839 | 7549 | 521 | 9631 | 151 | 8808 |
| 4L-2S | | MI | 2799 | 1449 | 4639 | 1169 | 5699 | 958 | 6477 | 779 | 7698 | 476 | 9251 | 314 | 7254 |
| 8-#18 | 6.15 | MA | 4121 | 1861 | 7176 | 1478 | 8964 | 1191 | 10356 | 935 | 12663 | 500 | 16100 | 35 | 15979 |
| 3E | | MI | 2938 | 1861 | 5365 | 1432 | 6567 | 1148 | 7502 | 894 | 9043 | 458 | 10592 | -146 | 10357 |
| 8-#18 | 6.15 | MA | 3766 | 1861 | 6152 | 1509 | 7629 | 1216 | 8651 | 973 | 10336 | 509 | 13274 | -127 | 12976 |
| 4L-2S | | MI | 3356 | 1861 | 6376 | 1413 | 7847 | 1135 | 9049 | 889 | 11121 | 450 | 13080 | 148 | 12168 |
| 10-#10 | 2.44 | MA | 3523 | 1293 | 5113 | 1116 | 6476 | 924 | 7409 | 766 | 8752 | 508 | 11232 | 439 | 7372 |
| 2L-5S | | MI | 2194 | 1293 | 3123 | 1115 | 3801 | 928 | 4201 | 767 | 4642 | 509 | 5636 | 189 | 4868 |
| 10-#10 | 2.44 | MA | 3251 | 1293 | 4623 | 1128 | 5856 | 935 | 6659 | 775 | 7743 | 520 | 9834 | 348 | 7322 |
| 3L-4S | | MI | 2294 | 1293 | 3345 | 1106 | 4115 | 915 | 4571 | 762 | 5153 | 501 | 6303 | 244 | 5165 |

## RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis



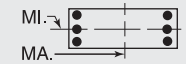

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.44 | MA | 3095 | 1293 | 4282 | 1140 | 5411 | 945 | 6091 | 790 | 6966 | 527 | 8860 | 294 | 7094 |
| 4L-3S | | MI | 2409 | 1293 | 3592 | 1097 | 4437 | 908 | 4983 | 751 | 5715 | 499 | 6976 | 295 | 5352 |
| 10-#10 | 2.44 | MA | 2931 | 1293 | 3979 | 1152 | 4981 | 962 | 5582 | 799 | 6262 | 539 | 7882 | 242 | 6600 |
| 5L-2S | | MI | 2601 | 1293 | 3942 | 1088 | 4880 | 900 | 5518 | 745 | 6436 | 492 | 7921 | 388 | 5381 |
| 10-#11 | 3.00 | MA | 3397 | 1378 | 5076 | 1176 | 6390 | 969 | 7285 | 796 | 8567 | 514 | 10962 | 316 | 8788 |
| 3L-4S | | MI | 2374 | 1378 | 3615 | 1152 | 4418 | 947 | 4915 | 781 | 5599 | 491 | 6785 | 176 | 5991 |
| 10-#11 | 3.00 | MA | 3219 | 1378 | 4664 | 1190 | 5852 | 981 | 6598 | 813 | 7628 | 521 | 9775 | 248 | 8293 |
| 4L-3S | | MI | 2501 | 1378 | 3913 | 1142 | 4806 | 939 | 5410 | 768 | 6275 | 490 | 7574 | 235 | 6371 |
| 10-#11 | 3.00 | MA | 3030 | 1378 | 4296 | 1203 | 5331 | 1000 | 5982 | 823 | 6776 | 534 | 8586 | 182 | 7750 |
| 5L-2S | | MI | 2713 | 1378 | 4332 | 1132 | 5336 | 931 | 6051 | 763 | 7137 | 483 | 8673 | 350 | 6423 |
| 10-#14 | 4.33 | MA | 3788 | 1582 | 6111 | 1303 | 7671 | 1062 | 8820 | 855 | 10620 | 508 | 13669 | 237 | 12332 |
| 3L-4S | | MI | 2584 | 1582 | 4215 | 1278 | 5147 | 1038 | 5774 | 840 | 6740 | 479 | 8153 | 37 | 7995 |
| 10-#14 | 4.33 | MA | 3573 | 1582 | 5522 | 1322 | 6903 | 1079 | 7839 | 878 | 9281 | 516 | 11998 | 141 | 11191 |
| 4L-3S | | MI | 2745 | 1582 | 4639 | 1265 | 5699 | 1029 | 6477 | 824 | 7698 | 480 | 9251 | 119 | 8835 |
| 10-#14 | 4.33 | MA | 3292 | 1582 | 4996 | 1340 | 6158 | 1105 | 6959 | 892 | 8064 | 534 | 10327 | 44 | 10159 |
| 5L-2S | | MI | 3014 | 1582 | 5231 | 1252 | 6448 | 1019 | 7383 | 817 | 8918 | 471 | 10773 | 284 | 8971 |
| 10-#18 | 7.69 | MA | 4413 | 2097 | 7605 | 1656 | 9467 | 1324 | 10874 | 1042 | 13329 | 500 | 17249 | -156 | 16707 |
| 4L-3S | | MI | 3328 | 2097 | 6376 | 1579 | 7847 | 1256 | 9049 | 963 | 11121 | 449 | 13080 | -215 | 12657 |
| 12-#10 | 2.93 | MA | 3466 | 1368 | 5113 | 1175 | 6476 | 969 | 7409 | 797 | 8752 | 518 | 11232 | 344 | 8740 |
| 3L-5S | | MI | 2351 | 1368 | 3473 | 1162 | 4244 | 962 | 4736 | 789 | 5363 | 506 | 6580 | 178 | 5850 |
| 12-#10 | 2.93 | MA | 3323 | 1368 | 4772 | 1186 | 6031 | 980 | 6841 | 812 | 7976 | 524 | 10258 | 290 | 8475 |
| 4E | | MI | 2457 | 1368 | 3695 | 1153 | 4557 | 949 | 5107 | 784 | 5874 | 498 | 7247 | 233 | 6130 |
| 12-#10 | 2.93 | MA | 3161 | 1368 | 4469 | 1198 | 5601 | 996 | 6332 | 821 | 7272 | 536 | 9280 | 239 | 8000 |
| 5L-3S | | MI | 2559 | 1368 | 3942 | 1144 | 4880 | 942 | 5518 | 773 | 6436 | 496 | 7921 | 284 | 6361 |
| 12-#10 | 2.93 | MA | 2960 | 1368 | 4158 | 1207 | 5212 | 1006 | 5836 | 836 | 6586 | 543 | 8339 | 169 | 7482 |
| 6L-2S | | MI | 2737 | 1368 | 4292 | 1135 | 5323 | 935 | 6054 | 767 | 7157 | 489 | 8865 | 377 | 6400 |
| 12-#11 | 3.60 | MA | 3487 | 1470 | 5255 | 1247 | 6600 | 1023 | 7502 | 840 | 8845 | 517 | 11460 | 244 | 9960 |
| 4E | | MI | 2554 | 1470 | 4034 | 1209 | 4948 | 989 | 5556 | 808 | 6462 | 487 | 7884 | 158 | 7148 |
| 12-#11 | 3.60 | MA | 3300 | 1470 | 4887 | 1261 | 6078 | 1042 | 6886 | 850 | 7993 | 531 | 10271 | 177 | 9442 |
| 5L-3S | | MI | 2669 | 1470 | 4332 | 1199 | 5336 | 981 | 6051 | 795 | 7137 | 487 | 8673 | 217 | 7574 |
| 12-#11 | 3.60 | MA | 3066 | 1470 | 4518 | 1271 | 5606 | 1054 | 6284 | 867 | 7161 | 538 | 9123 | 90 | 8674 |
| 6L-2S | | MI | 2869 | 1470 | 4750 | 1189 | 5866 | 974 | 6692 | 790 | 8000 | 479 | 9772 | 332 | 7639 |
| 12-#14 | 5.19 | MA | 3942 | 1714 | 6362 | 1404 | 7966 | 1139 | 9125 | 917 | 11012 | 511 | 14364 | 131 | 13584 |
| 4E | | MI | 2832 | 1714 | 4808 | 1361 | 5897 | 1099 | 6680 | 879 | 7960 | 474 | 9676 | 7 | 9646 |
| 12-#14 | 5.19 | MA | 3681 | 1714 | 5837 | 1423 | 7221 | 1165 | 8245 | 931 | 9796 | 529 | 12693 | 34 | 12555 |
| 5L-3S | | MI | 2975 | 1714 | 5231 | 1348 | 6448 | 1089 | 7383 | 863 | 8918 | 475 | 10773 | 89 | 10463 |
| 14-#10 | 3.42 | MA | 3543 | 1443 | 5263 | 1233 | 6651 | 1014 | 7591 | 834 | 8985 | 521 | 11656 | 286 | 9860 |
| 4L-5S | | MI | 2509 | 1443 | 3823 | 1209 | 4686 | 997 | 5272 | 811 | 6083 | 503 | 7525 | 167 | 6837 |
| 14-#10 | 3.42 | MA | 3384 | 1443 | 4959 | 1245 | 6221 | 1030 | 7082 | 843 | 8282 | 533 | 10678 | 235 | 9405 |
| 5L-4S | | MI | 2606 | 1443 | 4045 | 1200 | 5000 | 984 | 5642 | 806 | 6595 | 496 | 8192 | 222 | 7102 |
| 14-#10 | 3.42 | MA | 3193 | 1443 | 4649 | 1253 | 5832 | 1041 | 6586 | 858 | 7595 | 540 | 9737 | 165 | 8885 |
| 6L-3S | | MI | 2701 | 1443 | 4292 | 1190 | 5323 | 976 | 6054 | 795 | 7157 | 494 | 8865 | 273 | 7371 |
| 14-#10 | 3.42 | MA | 3023 | 1443 | 4296 | 1266 | 5443 | 1050 | 6106 | 867 | 6928 | 552 | 8810 | 121 | 8326 |
| 7L-2S | | MI | 2869 | 1443 | 4642 | 1181 | 5766 | 969 | 6589 | 789 | 7878 | 486 | 9809 | 366 | 7417 |
| 14-#11 | 4.20 | MA | 3574 | 1562 | 5478 | 1318 | 6826 | 1084 | 7790 | 877 | 9210 | 527 | 11956 | 172 | 11139 |
| 5L-4S | | MI | 2728 | 1562 | 4452 | 1267 | 5477 | 1031 | 6197 | 835 | 7324 | 484 | 8983 | 140 | 8313 |
| 14-#11 | 4.20 | MA | 3341 | 1562 | 5109 | 1329 | 6353 | 1096 | 7188 | 894 | 8379 | 534 | 10809 | 85 | 10359 |
| 6L-3S | | MI | 2833 | 1562 | 4750 | 1257 | 5866 | 1024 | 6692 | 822 | 8000 | 483 | 9772 | 199 | 8778 |
| 14-#14 | 6.06 | MA | 4041 | 1846 | 6677 | 1506 | 8285 | 1226 | 9531 | 970 | 11527 | 524 | 15059 | 24 | 14955 |
| 5L-4S | | MI | 3073 | 1846 | 5400 | 1444 | 6646 | 1160 | 7586 | 917 | 9180 | 469 | 11198 | -24 | 11145 |
| 16-#10 | 3.91 | MA | 3600 | 1517 | 5449 | 1292 | 6841 | 1065 | 7832 | 865 | 9291 | 531 | 12076 | 231 | 10812 |
| 5E | | MI | 2657 | 1517 | 4173 | 1256 | 5129 | 1031 | 5807 | 833 | 6804 | 501 | 8469 | 156 | 7827 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

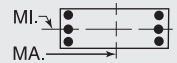
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 3.91 | MA | 3418 | 1517 | 5139 | 1300 | 6452 | 1075 | 7336 | 880 | 8605 | 537 | 11135 | 161 | 10289 |
| 6L-4S | | MI | 2752 | 1517 | 4395 | 1246 | 5443 | 1018 | 6177 | 828 | 7316 | 493 | 9136 | 211 | 8080 |
| 16-#10 | 3.91 | MA | 3259 | 1517 | 4786 | 1313 | 6063 | 1084 | 6856 | 889 | 7937 | 549 | 10208 | 117 | 9738 |
| 7L-3S | | MI | 2839 | 1517 | 4642 | 1237 | 5766 | 1011 | 6589 | 816 | 7878 | 491 | 9809 | 262 | 8380 |
| 16-#11 | 4.80 | MA | 3623 | 1654 | 5699 | 1386 | 7101 | 1139 | 8092 | 921 | 9596 | 531 | 12494 | 81 | 12056 |
| 6L-4S | | MI | 2898 | 1654 | 4871 | 1324 | 6007 | 1073 | 6837 | 862 | 8187 | 480 | 10082 | 122 | 9484 |
| 18-#10 | 4.40 | MA | 3638 | 1592 | 5629 | 1347 | 7072 | 1109 | 8086 | 902 | 9615 | 534 | 12534 | 157 | 11696 |
| 6L-5S | | MI | 2800 | 1592 | 4523 | 1302 | 5572 | 1065 | 6343 | 855 | 7525 | 498 | 9413 | 145 | 8820 |
| 18-#10 | 4.40 | MA | 3487 | 1592 | 5276 | 1360 | 6683 | 1118 | 7606 | 911 | 8947 | 546 | 11606 | 114 | 11150 |
| 7L-4S | | MI | 2895 | 1592 | 4745 | 1293 | 5886 | 1052 | 6713 | 850 | 8037 | 490 | 10080 | 200 | 9061 |
| 20-#10 | 4.88 | MA | 3729 | 1667 | 5766 | 1407 | 7303 | 1153 | 8356 | 933 | 9957 | 544 | 13004 | 110 | 12564 |
| 7L-5S | | MI | 2941 | 1667 | 4873 | 1349 | 6015 | 1100 | 6878 | 877 | 8246 | 495 | 10358 | 134 | 9816 |

## RECTANGULAR TIED COLUMNS 20" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.11 | MA | 3413 | 1174 | 4385 | 1065 | 5556 | 895 | 6228 | 761 | 6967 | 556 | 8617 | 484 | 4028 |
| 2E | | MI | 2358 | 1174 | 3248 | 1024 | 3954 | 860 | 4348 | 730 | 4767 | 531 | 5620 | 437 | 2759 |
| 4-#14 | 1.61 | MA | 3650 | 1255 | 4974 | 1111 | 6271 | 928 | 7077 | 781 | 8096 | 549 | 10169 | 477 | 5667 |
| 2E | | MI | 2494 | 1255 | 3629 | 1068 | 4409 | 891 | 4884 | 749 | 5476 | 524 | 6449 | 408 | 3821 |
| 4-#18 | 2.86 | MA | 4185 | 1461 | 6404 | 1229 | 8020 | 1013 | 9162 | 833 | 10874 | 535 | 13825 | 445 | 9669 |
| 2E | | MI | 2789 | 1461 | 4533 | 1182 | 5498 | 973 | 6175 | 798 | 7180 | 506 | 8345 | 321 | 6349 |
| 6-#9 | 1.07 | MA | 3418 | 1167 | 4288 | 1071 | 5492 | 900 | 6181 | 766 | 6931 | 562 | 8589 | 489 | 3927 |
| 2L-3S | | MI | 2193 | 1167 | 2899 | 1042 | 3567 | 875 | 3908 | 743 | 4198 | 547 | 4970 | 383 | 2704 |
| 6-#9 | 1.07 | MA | 3140 | 1167 | 3863 | 1081 | 4954 | 909 | 5530 | 774 | 6055 | 572 | 7376 | 420 | 3921 |
| 3L-2S | | MI | 2370 | 1167 | 3177 | 1034 | 3919 | 869 | 4333 | 739 | 4771 | 540 | 5727 | 456 | 2696 |
| 6-#10 | 1.36 | MA | 3568 | 1214 | 4643 | 1098 | 5925 | 920 | 6697 | 778 | 7619 | 558 | 9535 | 486 | 4920 |
| 2L-3S | | MI | 2243 | 1214 | 3061 | 1069 | 3757 | 895 | 4130 | 756 | 4491 | 544 | 5334 | 351 | 3349 |
| 6-#10 | 1.36 | MA | 3229 | 1214 | 4106 | 1110 | 5246 | 931 | 5876 | 788 | 6513 | 572 | 8004 | 397 | 4896 |
| 3L-2S | | MI | 2459 | 1214 | 3411 | 1060 | 4200 | 888 | 4666 | 750 | 5212 | 536 | 6278 | 444 | 3349 |
| 6-#11 | 1.67 | MA | 3703 | 1266 | 5033 | 1123 | 6376 | 937 | 7220 | 788 | 8302 | 552 | 10466 | 479 | 5930 |
| 2L-3S | | MI | 2283 | 1266 | 3248 | 1092 | 3954 | 910 | 4348 | 763 | 4767 | 536 | 5620 | 304 | 3989 |
| 6-#11 | 1.67 | MA | 3309 | 1266 | 4385 | 1137 | 5556 | 950 | 6228 | 799 | 6967 | 567 | 8617 | 368 | 5883 |
| 3L-2S | | MI | 2533 | 1266 | 3666 | 1082 | 4483 | 902 | 4989 | 757 | 5629 | 528 | 6719 | 419 | 4000 |
| 6-#14 | 2.41 | MA | 4042 | 1387 | 5898 | 1193 | 7439 | 989 | 8490 | 819 | 9997 | 544 | 12803 | 470 | 8364 |
| 2L-3S | | MI | 2403 | 1387 | 3629 | 1164 | 4409 | 962 | 4884 | 794 | 5476 | 528 | 6449 | 213 | 5491 |
| 6-#14 | 2.41 | MA | 3518 | 1387 | 4974 | 1213 | 6271 | 1006 | 7077 | 835 | 8096 | 565 | 10169 | 306 | 8220 |
| 3L-2S | | MI | 2726 | 1387 | 4221 | 1151 | 5158 | 952 | 5790 | 788 | 6695 | 519 | 7971 | 378 | 5559 |
| 6-#18 | 4.29 | MA | 4795 | 1696 | 8004 | 1376 | 10044 | 1121 | 11610 | 902 | 14170 | 527 | 18303 | 425 | 14319 |
| 2L-3S | | MI | 2673 | 1696 | 4533 | 1348 | 5498 | 1094 | 6175 | 872 | 7180 | 506 | 8345 | -43 | 8294 |
| 6-#18 | 4.29 | MA | 4041 | 1696 | 6404 | 1409 | 8020 | 1149 | 9162 | 925 | 10874 | 557 | 13825 | 131 | 13404 |
| 3L-2S | | MI | 3152 | 1696 | 5545 | 1329 | 6777 | 1081 | 7722 | 867 | 9259 | 497 | 10833 | 251 | 9283 |
| 8-#8 | 1.13 | MA | 3457 | 1176 | 4345 | 1079 | 5578 | 907 | 6293 | 771 | 7089 | 563 | 8812 | 490 | 4140 |
| 2L-4S | | MI | 2171 | 1176 | 2835 | 1055 | 3493 | 886 | 3811 | 756 | 4069 | 549 | 4856 | 369 | 2840 |
| 8-#8 | 1.13 | MA | 3239 | 1176 | 4007 | 1087 | 5151 | 914 | 5776 | 777 | 6393 | 571 | 7848 | 436 | 4135 |
| 3E | | MI | 2256 | 1176 | 2991 | 1049 | 3696 | 881 | 4071 | 748 | 4424 | 547 | 5288 | 402 | 2843 |
| 8-#8 | 1.13 | MA | 3110 | 1176 | 3774 | 1095 | 4846 | 921 | 5386 | 787 | 5860 | 577 | 7189 | 403 | 4106 |
| 4L-2S | | MI | 2396 | 1176 | 3213 | 1043 | 3977 | 876 | 4410 | 744 | 4880 | 542 | 5897 | 460 | 2838 |
| 8-#9 | 1.43 | MA | 3615 | 1226 | 4713 | 1107 | 6030 | 927 | 6832 | 783 | 7808 | 560 | 9802 | 486 | 5175 |
| 2L-4S | | MI | 2217 | 1226 | 2981 | 1086 | 3663 | 908 | 4007 | 770 | 4325 | 546 | 5188 | 335 | 3496 |
| 8-#9 | 1.43 | MA | 3350 | 1226 | 4288 | 1117 | 5492 | 936 | 6181 | 791 | 6931 | 570 | 8589 | 417 | 5158 |
| 3E | | MI | 2320 | 1226 | 3177 | 1078 | 3919 | 902 | 4333 | 761 | 4771 | 544 | 5727 | 375 | 3519 |
| 8-#9 | 1.43 | MA | 3194 | 1226 | 3994 | 1127 | 5108 | 945 | 5690 | 804 | 6260 | 576 | 7757 | 375 | 5090 |
| 4L-2S | | MI | 2490 | 1226 | 3456 | 1071 | 4271 | 896 | 4759 | 756 | 5344 | 538 | 6485 | 449 | 3520 |
| 8-#10 | 1.81 | MA | 3808 | 1289 | 5180 | 1145 | 6604 | 954 | 7519 | 800 | 8725 | 556 | 11067 | 482 | 6491 |
| 2L-4S | | MI | 2275 | 1289 | 3164 | 1125 | 3877 | 937 | 4254 | 789 | 4650 | 543 | 5605 | 290 | 4285 |
| 8-#10 | 1.81 | MA | 3488 | 1289 | 4643 | 1157 | 5925 | 965 | 6697 | 810 | 7619 | 569 | 9535 | 393 | 6452 |
| 3E | | MI | 2400 | 1289 | 3411 | 1116 | 4200 | 929 | 4666 | 778 | 5212 | 541 | 6278 | 340 | 4366 |

## RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis



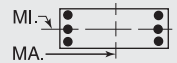

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 8-#10 | 1.81 | MA | 3300 | 1289 | 4272 | 1169 | 5440 | 977 | 6077 | 825 | 6771 | 576 | 8481 | 340 | 6308 |
| 4L-2S | | MI | 2606 | 1289 | 3761 | 1107 | 4643 | 922 | 5201 | 772 | 5933 | 533 | 7222 | 433 | 4379 |
| 8-#11 | 2.23 | MA | 3982 | 1357 | 5681 | 1180 | 7196 | 979 | 8212 | 815 | 9637 | 549 | 12315 | 474 | 7824 |
| 2L-4S | | MI | 2320 | 1357 | 3368 | 1160 | 4095 | 960 | 4494 | 802 | 4954 | 533 | 5930 | 227 | 4930 |
| 8-#11 | 2.23 | MA | 3612 | 1357 | 5033 | 1194 | 6376 | 992 | 7220 | 826 | 8302 | 564 | 10466 | 363 | 7756 |
| 3E | | MI | 2465 | 1357 | 3666 | 1149 | 4483 | 952 | 4989 | 790 | 5629 | 532 | 6719 | 287 | 5198 |
| 8-#11 | 2.23 | MA | 3394 | 1357 | 4582 | 1209 | 5787 | 1005 | 6468 | 844 | 7275 | 572 | 9179 | 296 | 7352 |
| 4L-2S | | MI | 2700 | 1357 | 4085 | 1139 | 5013 | 945 | 5630 | 784 | 6492 | 525 | 7818 | 401 | 5228 |
| 8-#14 | 3.21 | MA | 4415 | 1520 | 6821 | 1276 | 8607 | 1049 | 9902 | 858 | 11899 | 539 | 15437 | 463 | 11052 |
| 2L-4S | | MI | 2465 | 1520 | 3798 | 1260 | 4606 | 1032 | 5087 | 849 | 5737 | 522 | 6874 | 100 | 6457 |
| 8-#14 | 3.21 | MA | 3934 | 1520 | 5898 | 1296 | 7439 | 1067 | 8490 | 873 | 9997 | 560 | 12803 | 299 | 10881 |
| 3E | | MI | 2651 | 1520 | 4221 | 1247 | 5158 | 1023 | 5790 | 833 | 6695 | 523 | 7971 | 183 | 7185 |
| 8-#14 | 3.21 | MA | 3650 | 1520 | 5254 | 1316 | 6599 | 1085 | 7416 | 899 | 8531 | 570 | 10955 | 202 | 9766 |
| 4L-2S | | MI | 2948 | 1520 | 4813 | 1233 | 5907 | 1013 | 6696 | 827 | 7915 | 514 | 9494 | 348 | 7283 |
| 8-#18 | 5.71 | MA | 4720 | 1932 | 8004 | 1556 | 10044 | 1258 | 11610 | 995 | 14170 | 549 | 18303 | 111 | 17894 |
| 3E | | MI | 3078 | 1932 | 5545 | 1495 | 6777 | 1202 | 7722 | 941 | 9259 | 496 | 10833 | -113 | 10655 |
| 8-#18 | 5.71 | MA | 4323 | 1932 | 6882 | 1589 | 8580 | 1286 | 9740 | 1035 | 11617 | 562 | 15135 | -57 | 14976 |
| 4L-2S | | MI | 3506 | 1932 | 6556 | 1476 | 8057 | 1190 | 9269 | 937 | 11337 | 487 | 13321 | 181 | 12205 |
| 10-#10 | 2.27 | MA | 4040 | 1364 | 5717 | 1191 | 7284 | 989 | 8340 | 822 | 9831 | 553 | 12598 | 478 | 8058 |
| 2L-5S | | MI | 2333 | 1364 | 3292 | 1181 | 4006 | 984 | 4419 | 816 | 4859 | 548 | 5882 | 223 | 4937 |
| 10-#10 | 2.27 | MA | 3736 | 1364 | 5180 | 1204 | 6604 | 1000 | 7519 | 832 | 8725 | 566 | 11067 | 389 | 8007 |
| 3L-4S | | MI | 2435 | 1364 | 3514 | 1172 | 4320 | 971 | 4790 | 811 | 5371 | 540 | 6549 | 279 | 5240 |
| 10-#10 | 2.27 | MA | 3563 | 1364 | 4809 | 1216 | 6119 | 1011 | 6898 | 847 | 7877 | 573 | 10012 | 336 | 7844 |
| 4L-3S | | MI | 2552 | 1364 | 3761 | 1163 | 4643 | 964 | 5201 | 799 | 5933 | 538 | 7222 | 329 | 5378 |
| 10-#10 | 2.27 | MA | 3376 | 1364 | 4478 | 1229 | 5650 | 1028 | 6344 | 857 | 7109 | 587 | 8948 | 287 | 7268 |
| 5L-2S | | MI | 2749 | 1364 | 4111 | 1154 | 5085 | 956 | 5737 | 794 | 6654 | 530 | 8167 | 422 | 5402 |
| 10-#11 | 2.79 | MA | 3902 | 1449 | 5681 | 1252 | 7196 | 1034 | 8212 | 853 | 9637 | 560 | 12315 | 358 | 9630 |
| 3L-4S | | MI | 2514 | 1449 | 3787 | 1217 | 4625 | 1002 | 5134 | 829 | 5816 | 529 | 7029 | 210 | 6074 |
| 10-#11 | 2.79 | MA | 3704 | 1449 | 5231 | 1266 | 6608 | 1047 | 7460 | 871 | 8610 | 568 | 11028 | 291 | 9179 |
| 4L-3S | | MI | 2645 | 1449 | 4085 | 1207 | 5013 | 995 | 5630 | 817 | 6492 | 529 | 7818 | 269 | 6404 |
| 10-#11 | 2.79 | MA | 3487 | 1449 | 4830 | 1281 | 6038 | 1067 | 6787 | 882 | 7679 | 583 | 9733 | 228 | 8546 |
| 5L-2S | | MI | 2861 | 1449 | 4504 | 1197 | 5543 | 987 | 6270 | 811 | 7354 | 521 | 8917 | 383 | 6448 |
| 10-#14 | 4.02 | MA | 4343 | 1652 | 6821 | 1379 | 8607 | 1128 | 9902 | 912 | 11899 | 555 | 15437 | 293 | 13547 |
| 3L-4S | | MI | 2723 | 1652 | 4390 | 1343 | 5355 | 1093 | 5993 | 888 | 6957 | 517 | 8396 | 70 | 8092 |
| 10-#14 | 4.02 | MA | 4080 | 1652 | 6177 | 1399 | 7767 | 1146 | 8829 | 937 | 10433 | 565 | 13588 | 195 | 12394 |
| 4L-3S | | MI | 2888 | 1652 | 4813 | 1330 | 5907 | 1084 | 6696 | 872 | 7915 | 518 | 9494 | 152 | 8880 |
| 10-#14 | 4.02 | MA | 3780 | 1652 | 5604 | 1419 | 6953 | 1173 | 7868 | 953 | 9103 | 585 | 11735 | 101 | 11338 |
| 5L-2S | | MI | 3164 | 1652 | 5406 | 1316 | 6656 | 1074 | 7602 | 865 | 9135 | 509 | 11016 | 318 | 9001 |
| 10-#18 | 7.14 | MA | 5044 | 2167 | 8482 | 1736 | 10604 | 1394 | 12188 | 1104 | 14913 | 553 | 19613 | -78 | 19294 |
| 4L-3S | | MI | 3468 | 2167 | 6556 | 1643 | 8057 | 1310 | 9269 | 1011 | 11337 | 486 | 13321 | -183 | 12970 |
| 12-#10 | 2.72 | MA | 3975 | 1439 | 5717 | 1250 | 7284 | 1034 | 8340 | 854 | 9831 | 563 | 12598 | 385 | 9563 |
| 3L-5S | | MI | 2493 | 1439 | 3641 | 1228 | 4449 | 1019 | 4955 | 838 | 5580 | 545 | 6826 | 212 | 5917 |
| 12-#10 | 2.72 | MA | 3816 | 1439 | 5345 | 1263 | 6798 | 1045 | 7720 | 869 | 8983 | 571 | 11543 | 332 | 9361 |
| 4E | | MI | 2591 | 1439 | 3863 | 1219 | 4763 | 1005 | 5325 | 833 | 6092 | 537 | 7493 | 268 | 6203 |
| 12-#10 | 2.72 | MA | 3633 | 1439 | 5015 | 1275 | 6329 | 1062 | 7165 | 879 | 8215 | 584 | 10479 | 283 | 8805 |
| 5L-3S | | MI | 2704 | 1439 | 4111 | 1209 | 5085 | 998 | 5737 | 821 | 6654 | 535 | 8167 | 318 | 6389 |
| 12-#10 | 2.72 | MA | 3409 | 1439 | 4670 | 1283 | 5905 | 1073 | 6625 | 895 | 7467 | 591 | 9461 | 214 | 8289 |
| 6L-2S | | MI | 2885 | 1439 | 4461 | 1200 | 5528 | 991 | 6272 | 816 | 7375 | 528 | 9111 | 411 | 6423 |
| 12-#11 | 3.34 | MA | 4002 | 1541 | 5879 | 1324 | 7428 | 1089 | 8452 | 898 | 9946 | 565 | 12877 | 287 | 11013 |
| 4E | | MI | 2695 | 1541 | 4206 | 1274 | 5155 | 1045 | 5775 | 856 | 6679 | 526 | 8128 | 192 | 7229 |
| 12-#11 | 3.34 | MA | 3789 | 1541 | 5478 | 1338 | 6858 | 1109 | 7779 | 909 | 9015 | 580 | 11582 | 224 | 10407 |
| 5L-3S | | MI | 2814 | 1541 | 4504 | 1264 | 5543 | 1037 | 6270 | 844 | 7354 | 525 | 8917 | 251 | 7609 |
| 12-#11 | 3.34 | MA | 3529 | 1541 | 5067 | 1348 | 6344 | 1122 | 7123 | 927 | 8107 | 588 | 10338 | 138 | 9617 |
| 6L-2S | | MI | 3018 | 1541 | 4922 | 1254 | 6072 | 1029 | 6911 | 838 | 8217 | 518 | 10016 | 365 | 7666 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis

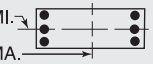



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 12-#14 | 4.82 | MA | 4514 | 1785 | 7100 | 1482 | 8935 | 1206 | 10242 | 976 | 12335 | 560 | 16222 | 188 | 15030 |
| 4E | | MI | 2972 | 1785 | 4982 | 1426 | 6104 | 1154 | 6899 | 926 | 8177 | 512 | 9919 | 40 | 9739 |
| 12-#14 | 4.82 | MA | 4216 | 1785 | 6527 | 1502 | 8121 | 1234 | 9281 | 992 | 11005 | 580 | 14368 | 94 | 13986 |
| 5L-3S | | MI | 3119 | 1785 | 5406 | 1412 | 6656 | 1144 | 7602 | 910 | 9135 | 513 | 11016 | 122 | 10576 |
| 12-#14 | 4.82 | MA | 3853 | 1785 | 5947 | 1517 | 7385 | 1252 | 8342 | 1017 | 9708 | 590 | 12582 | -31 | 12487 |
| 6L-2S | | MI | 3376 | 1785 | 5998 | 1399 | 7405 | 1135 | 8508 | 904 | 10355 | 504 | 12539 | 287 | 10716 |
| 14-#10 | 3.17 | MA | 4061 | 1513 | 5882 | 1310 | 7477 | 1080 | 8541 | 891 | 10089 | 568 | 13075 | 328 | 10883 |
| 4L-5S | | MI | 2652 | 1513 | 3991 | 1275 | 4892 | 1053 | 5490 | 860 | 6301 | 542 | 7771 | 201 | 6902 |
| 14-#10 | 3.17 | MA | 3880 | 1513 | 5552 | 1322 | 7008 | 1096 | 7987 | 901 | 9321 | 581 | 12010 | 279 | 10347 |
| 5L-4S | | MI | 2749 | 1513 | 4213 | 1265 | 5205 | 1040 | 5861 | 855 | 6813 | 535 | 8438 | 256 | 7173 |
| 14-#10 | 3.17 | MA | 3668 | 1513 | 5207 | 1330 | 6584 | 1108 | 7446 | 917 | 8573 | 588 | 10992 | 210 | 9831 |
| 6L-3S | | MI | 2847 | 1513 | 4461 | 1256 | 5528 | 1032 | 6272 | 843 | 7375 | 532 | 9111 | 307 | 7399 |
| 14-#10 | 3.17 | MA | 3480 | 1513 | 4865 | 1338 | 6152 | 1116 | 6923 | 927 | 7845 | 602 | 9985 | 169 | 9246 |
| 7L-2S | | MI | 3019 | 1513 | 4811 | 1247 | 5971 | 1025 | 6808 | 838 | 8096 | 525 | 10055 | 400 | 7441 |
| 14-#11 | 3.90 | MA | 4080 | 1633 | 6126 | 1396 | 7678 | 1151 | 8771 | 936 | 10350 | 576 | 13431 | 219 | 12273 |
| 5L-4S | | MI | 2870 | 1633 | 4624 | 1332 | 5684 | 1087 | 6416 | 883 | 7541 | 522 | 9228 | 174 | 8391 |
| 14-#11 | 3.90 | MA | 3835 | 1633 | 5715 | 1406 | 7164 | 1164 | 8115 | 954 | 9443 | 584 | 12188 | 133 | 11482 |
| 6L-3S | | MI | 2979 | 1633 | 4922 | 1322 | 6072 | 1079 | 6911 | 871 | 8217 | 522 | 10016 | 233 | 8813 |
| 14-#11 | 3.90 | MA | 3617 | 1633 | 5249 | 1422 | 6649 | 1175 | 7480 | 965 | 8559 | 599 | 10960 | 79 | 10636 |
| 7L-2S | | MI | 3172 | 1633 | 5341 | 1311 | 6602 | 1071 | 7551 | 865 | 9079 | 514 | 11115 | 348 | 8881 |
| 14-#14 | 5.63 | MA | 4617 | 1917 | 7450 | 1585 | 9289 | 1295 | 10693 | 1030 | 12907 | 575 | 17002 | 87 | 16638 |
| 5L-4S | | MI | 3213 | 1917 | 5574 | 1508 | 6854 | 1215 | 7805 | 965 | 9397 | 507 | 11441 | 10 | 11396 |
| 14-#14 | 5.63 | MA | 4302 | 1917 | 6871 | 1600 | 8553 | 1312 | 9755 | 1056 | 11610 | 585 | 15216 | -38 | 15047 |
| 6L-3S | | MI | 3345 | 1917 | 5998 | 1495 | 7405 | 1205 | 8508 | 949 | 10355 | 508 | 12539 | 92 | 12197 |
| 16-#10 | 3.63 | MA | 4121 | 1588 | 6089 | 1369 | 7687 | 1131 | 8808 | 923 | 10427 | 578 | 13542 | 275 | 11891 |
| 5E | | MI | 2800 | 1588 | 4341 | 1321 | 5334 | 1087 | 6026 | 882 | 7022 | 539 | 8715 | 190 | 7890 |
| 16-#10 | 3.63 | MA | 3919 | 1588 | 5744 | 1377 | 7264 | 1142 | 8267 | 939 | 9679 | 586 | 12523 | 206 | 11375 |
| 6L-4S | | MI | 2896 | 1588 | 4563 | 1312 | 5648 | 1074 | 6396 | 877 | 7534 | 532 | 9382 | 245 | 8148 |
| 16-#10 | 3.63 | MA | 3742 | 1588 | 5402 | 1385 | 6831 | 1150 | 7744 | 949 | 8951 | 599 | 11516 | 165 | 10802 |
| 7L-3S | | MI | 2986 | 1588 | 4811 | 1303 | 5971 | 1067 | 6808 | 865 | 8096 | 530 | 10055 | 296 | 8409 |
| 16-#10 | 3.63 | MA | 3577 | 1588 | 5025 | 1400 | 6367 | 1164 | 7226 | 958 | 8226 | 606 | 10546 | 111 | 10055 |
| 8L-2S | | MI | 3150 | 1588 | 5161 | 1294 | 6413 | 1059 | 7343 | 860 | 8817 | 522 | 11000 | 389 | 8457 |
| 16-#11 | 4.46 | MA | 4150 | 1725 | 6363 | 1463 | 7984 | 1206 | 9107 | 981 | 10778 | 581 | 14037 | 128 | 13349 |
| 6L-4S | | MI | 3041 | 1725 | 5043 | 1389 | 6214 | 1129 | 7056 | 910 | 8404 | 519 | 10327 | 156 | 9559 |
| 16-#11 | 4.46 | MA | 3927 | 1725 | 5897 | 1479 | 7469 | 1217 | 8472 | 992 | 9895 | 595 | 12809 | 75 | 12505 |
| 7L-3S | | MI | 3140 | 1725 | 5341 | 1379 | 6602 | 1121 | 7551 | 898 | 9079 | 518 | 11115 | 215 | 10018 |
| 16-#14 | 6.43 | MA | 4715 | 2050 | 7794 | 1683 | 9721 | 1373 | 11168 | 1094 | 13512 | 580 | 17849 | -45 | 17593 |
| 6L-4S | | MI | 3449 | 2050 | 6166 | 1591 | 7603 | 1276 | 8711 | 1004 | 10616 | 502 | 12964 | -20 | 12913 |
| 18-#10 | 4.08 | MA | 4163 | 1663 | 6281 | 1423 | 7943 | 1176 | 9089 | 961 | 10785 | 583 | 14055 | 202 | 12922 |
| 6L-5S | | MI | 2945 | 1663 | 4691 | 1368 | 5777 | 1122 | 6561 | 904 | 7743 | 537 | 9659 | 179 | 8882 |
| 18-#10 | 4.08 | MA | 3996 | 1663 | 5939 | 1431 | 7510 | 1185 | 8566 | 971 | 10057 | 596 | 13047 | 161 | 12353 |
| 7L-4S | | MI | 3039 | 1663 | 4913 | 1359 | 6091 | 1109 | 6931 | 899 | 8255 | 529 | 10326 | 234 | 9128 |
| 18-#10 | 4.08 | MA | 3841 | 1663 | 5562 | 1446 | 7046 | 1198 | 8047 | 980 | 9332 | 604 | 12077 | 107 | 11606 |
| 8L-3S | | MI | 3123 | 1663 | 5161 | 1350 | 6413 | 1101 | 7343 | 887 | 8817 | 527 | 11000 | 285 | 9419 |
| 18-#11 | 5.01 | MA | 4250 | 1817 | 6546 | 1537 | 8289 | 1260 | 9463 | 1019 | 11230 | 592 | 14658 | 70 | 14374 |
| 7L-4S | | MI | 3208 | 1817 | 5462 | 1446 | 6743 | 1171 | 7697 | 937 | 9266 | 515 | 11426 | 138 | 10733 |
| 20-#10 | 4.54 | MA | 4243 | 1738 | 6476 | 1478 | 8189 | 1219 | 9387 | 993 | 11163 | 593 | 14579 | 158 | 13901 |
| 7L-5S | | MI | 3086 | 1738 | 5041 | 1415 | 6220 | 1156 | 7096 | 926 | 8464 | 534 | 10604 | 168 | 9876 |
| 20-#10 | 4.54 | MA | 4092 | 1738 | 6099 | 1493 | 7725 | 1232 | 8869 | 1002 | 10438 | 601 | 13609 | 103 | 13157 |
| 8L-4S | | MI | 3180 | 1738 | 5263 | 1406 | 6533 | 1143 | 7467 | 920 | 8976 | 526 | 11271 | 223 | 10111 |
| 22-#10 | 4.99 | MA | 4355 | 1812 | 6636 | 1540 | 8404 | 1267 | 9690 | 1024 | 11544 | 598 | 15140 | 99 | 14709 |
| 8L-5S | | MI | 3225 | 1812 | 5391 | 1461 | 6662 | 1190 | 7632 | 948 | 9185 | 531 | 11548 | 157 | 10872 |

## RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis



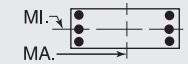

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.04 | MA | 3893 | 1244 | 4898 | 1140 | 6251 | 959 | 7020 | 816 | 7844 | 600 | 9696 | 523 | 4365 |
| 2E | | MI | 2501 | 1244 | 3420 | 1089 | 4161 | 916 | 4567 | 779 | 4984 | 570 | 5864 | 470 | 2777 |
| 4-#14 | 1.50 | MA | 4158 | 1326 | 5542 | 1186 | 7032 | 992 | 7948 | 836 | 9078 | 594 | 11392 | 516 | 6153 |
| 2E | | MI | 2638 | 1326 | 3804 | 1132 | 4616 | 946 | 5104 | 797 | 5692 | 562 | 6692 | 442 | 3843 |
| 4-#18 | 2.67 | MA | 4760 | 1532 | 7108 | 1304 | 8949 | 1077 | 10231 | 889 | 12122 | 580 | 15583 | 500 | 10533 |
| 2E | | MI | 2936 | 1532 | 4713 | 1245 | 5708 | 1027 | 6395 | 845 | 7396 | 544 | 8586 | 354 | 6382 |
| 6-#9 | 1.00 | MA | 3897 | 1237 | 4789 | 1146 | 6178 | 964 | 6964 | 822 | 7800 | 606 | 9658 | 528 | 4251 |
| 2L-3S | | MI | 2334 | 1237 | 3067 | 1108 | 3771 | 931 | 4126 | 793 | 4416 | 586 | 5216 | 417 | 2721 |
| 6-#9 | 1.00 | MA | 3591 | 1237 | 4327 | 1156 | 5593 | 974 | 6257 | 830 | 6848 | 618 | 8339 | 461 | 4245 |
| 3L-2S | | MI | 2513 | 1237 | 3345 | 1100 | 4123 | 925 | 4552 | 788 | 4989 | 579 | 5974 | 491 | 2711 |
| 6-#10 | 1.27 | MA | 4064 | 1285 | 5176 | 1173 | 6650 | 984 | 7526 | 834 | 8549 | 603 | 10688 | 525 | 5332 |
| 2L-3S | | MI | 2385 | 1285 | 3230 | 1135 | 3962 | 951 | 4349 | 804 | 4709 | 583 | 5580 | 385 | 3370 |
| 6-#10 | 1.27 | MA | 3690 | 1285 | 4593 | 1186 | 5912 | 996 | 6634 | 845 | 7347 | 617 | 9024 | 438 | 5308 |
| 3L-2S | | MI | 2603 | 1285 | 3580 | 1126 | 4405 | 944 | 4884 | 799 | 5430 | 575 | 6524 | 479 | 3366 |
| 6-#11 | 1.56 | MA | 4216 | 1336 | 5603 | 1198 | 7144 | 1001 | 8099 | 843 | 9298 | 597 | 11709 | 518 | 6436 |
| 2L-3S | | MI | 2424 | 1336 | 3420 | 1157 | 4161 | 966 | 4567 | 811 | 4984 | 574 | 5864 | 338 | 4016 |
| 6-#11 | 1.56 | MA | 3780 | 1336 | 4898 | 1213 | 6251 | 1015 | 7020 | 856 | 7844 | 613 | 9696 | 409 | 6389 |
| 3L-2S | | MI | 2677 | 1336 | 3839 | 1147 | 4690 | 958 | 5208 | 806 | 5847 | 566 | 6963 | 453 | 4021 |
| 6-#14 | 2.25 | MA | 4594 | 1458 | 6548 | 1268 | 8305 | 1053 | 9487 | 875 | 11150 | 589 | 14262 | 509 | 9093 |
| 2L-3S | | MI | 2544 | 1458 | 3804 | 1228 | 4616 | 1017 | 5104 | 842 | 5692 | 566 | 6692 | 246 | 5530 |
| 6-#14 | 2.25 | MA | 4014 | 1458 | 5542 | 1290 | 7032 | 1072 | 7948 | 892 | 9078 | 611 | 11392 | 349 | 8949 |
| 3L-2S | | MI | 2872 | 1458 | 4396 | 1215 | 5365 | 1007 | 6010 | 836 | 6912 | 557 | 8215 | 411 | 5585 |
| 6-#18 | 4.00 | MA | 5440 | 1767 | 8855 | 1451 | 11159 | 1186 | 12904 | 958 | 15721 | 571 | 20566 | 487 | 15615 |
| 2L-3S | | MI | 2813 | 1767 | 4713 | 1412 | 5708 | 1148 | 6395 | 919 | 7396 | 543 | 8586 | -10 | 8574 |
| 6-#18 | 4.00 | MA | 4600 | 1767 | 7108 | 1486 | 8949 | 1216 | 10231 | 984 | 12122 | 606 | 15583 | 194 | 14912 |
| 3L-2S | | MI | 3300 | 1767 | 5724 | 1392 | 6987 | 1135 | 7942 | 914 | 9475 | 534 | 11074 | 284 | 9319 |
| 8-#8 | 1.05 | MA | 3939 | 1247 | 4851 | 1154 | 6270 | 971 | 7084 | 826 | 7969 | 607 | 9897 | 529 | 4481 |
| 2L-4S | | MI | 2312 | 1247 | 3001 | 1122 | 3697 | 943 | 4029 | 805 | 4287 | 588 | 5103 | 404 | 2860 |
| 8-#8 | 1.05 | MA | 3699 | 1247 | 4484 | 1162 | 5806 | 978 | 6523 | 833 | 7213 | 616 | 8851 | 476 | 4476 |
| 3E | | MI | 2398 | 1247 | 3157 | 1116 | 3900 | 938 | 4289 | 797 | 4642 | 586 | 5536 | 436 | 2859 |
| 8-#8 | 1.05 | MA | 3558 | 1247 | 4231 | 1171 | 5476 | 986 | 6101 | 844 | 6636 | 622 | 8141 | 444 | 4447 |
| 4L-2S | | MI | 2539 | 1247 | 3379 | 1110 | 4181 | 933 | 4628 | 793 | 5099 | 581 | 6145 | 494 | 2853 |
| 8-#9 | 1.33 | MA | 4114 | 1296 | 5252 | 1183 | 6762 | 991 | 7671 | 839 | 8752 | 604 | 10976 | 525 | 5607 |
| 2L-4S | | MI | 2358 | 1296 | 3148 | 1152 | 3867 | 965 | 4225 | 819 | 4543 | 585 | 5435 | 369 | 3522 |
| 8-#9 | 1.33 | MA | 3822 | 1296 | 4789 | 1193 | 6178 | 1001 | 6964 | 848 | 7800 | 615 | 9658 | 458 | 5590 |
| 3E | | MI | 2463 | 1296 | 3345 | 1144 | 4123 | 958 | 4552 | 810 | 4989 | 583 | 5974 | 409 | 3539 |
| 8-#9 | 1.33 | MA | 3651 | 1296 | 4471 | 1203 | 5762 | 1010 | 6432 | 861 | 7073 | 622 | 8761 | 416 | 5522 |
| 4L-2S | | MI | 2634 | 1296 | 3623 | 1137 | 4475 | 952 | 4977 | 805 | 5562 | 577 | 6732 | 483 | 3536 |
| 8-#10 | 1.69 | MA | 4330 | 1360 | 5760 | 1220 | 7388 | 1018 | 8419 | 856 | 9751 | 600 | 12353 | 521 | 7040 |
| 2L-4S | | MI | 2416 | 1360 | 3332 | 1191 | 4082 | 993 | 4473 | 838 | 4868 | 582 | 5851 | 324 | 4338 |
| 8-#10 | 1.69 | MA | 3976 | 1360 | 5176 | 1233 | 6650 | 1030 | 7526 | 866 | 8549 | 614 | 10688 | 434 | 7001 |
| 3E | | MI | 2543 | 1360 | 3580 | 1182 | 4405 | 985 | 4884 | 826 | 5430 | 580 | 6524 | 374 | 4389 |
| 8-#10 | 1.69 | MA | 3769 | 1360 | 4774 | 1246 | 6124 | 1042 | 6854 | 883 | 7629 | 622 | 9552 | 381 | 6857 |
| 4L-2S | | MI | 2751 | 1360 | 3930 | 1173 | 4848 | 978 | 5420 | 821 | 6151 | 572 | 7469 | 467 | 4398 |
| 8-#11 | 2.08 | MA | 4525 | 1428 | 6309 | 1255 | 8036 | 1043 | 9179 | 870 | 10752 | 593 | 13722 | 513 | 8498 |
| 2L-4S | | MI | 2460 | 1428 | 3540 | 1224 | 4302 | 1016 | 4713 | 850 | 5171 | 571 | 6175 | 261 | 5015 |
| 8-#11 | 2.08 | MA | 4115 | 1428 | 5603 | 1270 | 7144 | 1057 | 8099 | 883 | 9298 | 609 | 11709 | 404 | 8430 |
| 3E | | MI | 2607 | 1428 | 3839 | 1214 | 4690 | 1008 | 5208 | 838 | 5847 | 571 | 6963 | 320 | 5228 |
| 8-#11 | 2.08 | MA | 3875 | 1428 | 5115 | 1285 | 6506 | 1071 | 7284 | 902 | 8183 | 618 | 10321 | 339 | 8083 |
| 4L-2S | | MI | 2846 | 1428 | 4257 | 1204 | 5220 | 1000 | 5849 | 833 | 6709 | 563 | 8062 | 435 | 5251 |
| 8-#14 | 3.00 | MA | 5010 | 1591 | 7554 | 1351 | 9578 | 1113 | 11026 | 914 | 13223 | 584 | 17132 | 502 | 12024 |
| 2L-4S | | MI | 2604 | 1591 | 3972 | 1325 | 4814 | 1087 | 5307 | 897 | 5954 | 560 | 7117 | 134 | 6556 |
| 8-#14 | 3.00 | MA | 4474 | 1591 | 6548 | 1372 | 8305 | 1132 | 9487 | 931 | 11150 | 606 | 14262 | 342 | 11853 |
| 3E | | MI | 2793 | 1591 | 4396 | 1311 | 5365 | 1078 | 6010 | 881 | 6912 | 561 | 8215 | 216 | 7226 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 3.00 | MA | 4161 | 1591 | 5849 | 1394 | 7393 | 1151 | 8321 | 957 | 9557 | 618 | 12269 | 246 | 10739 |
| 4L-2S | | MI | 3096 | 1591 | 4988 | 1298 | 6115 | 1068 | 6916 | 874 | 8132 | 552 | 9737 | 381 | 7311 |
| 8-#18 | 5.33 | MA | 5351 | 2003 | 8855 | 1633 | 11159 | 1324 | 12904 | 1053 | 15721 | 597 | 20566 | 181 | 19850 |
| 3E | | MI | 3217 | 2003 | 5724 | 1559 | 6987 | 1256 | 7942 | 989 | 9475 | 534 | 11074 | -80 | 10950 |
| 8-#18 | 5.33 | MA | 4911 | 2003 | 7635 | 1668 | 9567 | 1355 | 10871 | 1097 | 12943 | 614 | 17055 | 8 | 17010 |
| 4L-2S | | MI | 3655 | 2003 | 6735 | 1539 | 8267 | 1244 | 9489 | 984 | 11553 | 525 | 13562 | 214 | 12243 |
| 10-#10 | 2.12 | MA | 4586 | 1435 | 6343 | 1266 | 8126 | 1053 | 9312 | 878 | 10953 | 597 | 14017 | 517 | 8744 |
| 2L-5S | | MI | 2473 | 1435 | 3460 | 1247 | 4211 | 1040 | 4638 | 865 | 5077 | 587 | 6128 | 257 | 5003 |
| 10-#10 | 2.12 | MA | 4250 | 1435 | 5760 | 1279 | 7388 | 1064 | 8419 | 888 | 9751 | 611 | 12353 | 430 | 8693 |
| 3L-4S | | MI | 2577 | 1435 | 3682 | 1238 | 4525 | 1027 | 5008 | 860 | 5589 | 579 | 6795 | 313 | 5314 |
| 10-#10 | 2.12 | MA | 4059 | 1435 | 5357 | 1292 | 6862 | 1076 | 7747 | 905 | 8832 | 620 | 11217 | 377 | 8542 |
| 4L-3S | | MI | 2695 | 1435 | 3930 | 1228 | 4848 | 1020 | 5420 | 848 | 6151 | 577 | 7469 | 363 | 5404 |
| 10-#10 | 2.12 | MA | 3850 | 1435 | 5000 | 1305 | 6355 | 1094 | 7147 | 915 | 8000 | 634 | 10019 | 323 | 7943 |
| 5L-2S | | MI | 2894 | 1435 | 4280 | 1219 | 5290 | 1012 | 5955 | 843 | 6872 | 569 | 8413 | 456 | 5423 |
| 10-#11 | 2.60 | MA | 4437 | 1520 | 6309 | 1328 | 8036 | 1099 | 9179 | 910 | 10752 | 606 | 13722 | 400 | 10473 |
| 3L-4S | | MI | 2655 | 1520 | 3959 | 1282 | 4832 | 1058 | 5353 | 877 | 6034 | 568 | 7274 | 243 | 6156 |
| 10-#11 | 2.60 | MA | 4218 | 1520 | 5820 | 1343 | 7398 | 1113 | 8363 | 929 | 9637 | 615 | 12334 | 334 | 10078 |
| 4L-3S | | MI | 2788 | 1520 | 4257 | 1272 | 5220 | 1050 | 5849 | 865 | 6709 | 567 | 8062 | 302 | 6436 |
| 10-#11 | 2.60 | MA | 3974 | 1520 | 5386 | 1358 | 6781 | 1134 | 7634 | 941 | 8627 | 631 | 10935 | 274 | 9351 |
| 5L-2S | | MI | 3008 | 1520 | 4676 | 1262 | 5749 | 1042 | 6489 | 860 | 7572 | 560 | 9161 | 417 | 6474 |
| 10-#14 | 3.75 | MA | 4930 | 1723 | 7554 | 1455 | 9578 | 1193 | 11026 | 970 | 13223 | 601 | 17132 | 335 | 14762 |
| 3L-4S | | MI | 2863 | 1723 | 4565 | 1407 | 5563 | 1148 | 6213 | 936 | 7174 | 555 | 8639 | 104 | 8186 |
| 10-#14 | 3.75 | MA | 4636 | 1723 | 6855 | 1476 | 8666 | 1212 | 9860 | 996 | 11630 | 613 | 15139 | 240 | 13612 |
| 4L-3S | | MI | 3032 | 1723 | 4988 | 1394 | 6115 | 1138 | 6916 | 919 | 8132 | 556 | 9737 | 186 | 8922 |
| 10-#14 | 3.75 | MA | 4297 | 1723 | 6234 | 1498 | 7784 | 1241 | 8818 | 1013 | 10187 | 635 | 13134 | 150 | 12544 |
| 5L-2S | | MI | 3313 | 1723 | 5580 | 1381 | 6864 | 1129 | 7822 | 913 | 9352 | 547 | 11260 | 351 | 9031 |
| 10-#18 | 6.67 | MA | 5707 | 2238 | 9382 | 1815 | 11777 | 1463 | 13544 | 1166 | 16542 | 605 | 22038 | -5 | 21999 |
| 4L-3S | | MI | 3608 | 2238 | 6735 | 1706 | 8267 | 1364 | 9489 | 1058 | 11553 | 524 | 13562 | -150 | 13280 |
| 10-#18 | 6.67 | MA | 5135 | 2238 | 8294 | 1850 | 10235 | 1511 | 11722 | 1192 | 14021 | 639 | 18521 | -175 | 17644 |
| 5L-2S | | MI | 4007 | 2238 | 7746 | 1687 | 9546 | 1352 | 11036 | 1053 | 13632 | 515 | 16050 | 144 | 15162 |
| 12-#10 | 2.54 | MA | 4515 | 1509 | 6343 | 1326 | 8126 | 1099 | 9312 | 910 | 10953 | 608 | 14017 | 426 | 10386 |
| 3L-5S | | MI | 2635 | 1509 | 3810 | 1294 | 4654 | 1075 | 5173 | 887 | 5798 | 584 | 7072 | 246 | 5981 |
| 12-#10 | 2.54 | MA | 4339 | 1509 | 5941 | 1339 | 7601 | 1111 | 8640 | 927 | 10034 | 617 | 12881 | 373 | 10229 |
| 4E | | MI | 2733 | 1509 | 4032 | 1284 | 4968 | 1062 | 5544 | 882 | 6310 | 576 | 7739 | 302 | 6275 |
| 12-#10 | 2.54 | MA | 4133 | 1509 | 5584 | 1352 | 7093 | 1128 | 8040 | 937 | 9202 | 631 | 11683 | 319 | 9618 |
| 5L-3S | | MI | 2844 | 1509 | 4280 | 1275 | 5290 | 1054 | 5955 | 870 | 6872 | 574 | 8413 | 352 | 6416 |
| 12-#10 | 2.54 | MA | 3887 | 1509 | 5205 | 1359 | 6634 | 1140 | 7454 | 954 | 8392 | 639 | 10635 | 258 | 9110 |
| 6L-2S | | MI | 3033 | 1509 | 4630 | 1266 | 5733 | 1047 | 6491 | 865 | 7593 | 567 | 9357 | 445 | 6444 |
| 12-#11 | 3.12 | MA | 4547 | 1612 | 6526 | 1400 | 8291 | 1155 | 9443 | 956 | 11090 | 611 | 14347 | 329 | 12080 |
| 4E | | MI | 2836 | 1612 | 4378 | 1339 | 5361 | 1100 | 5994 | 904 | 6896 | 564 | 8373 | 226 | 7307 |
| 12-#11 | 3.12 | MA | 4308 | 1612 | 6092 | 1415 | 7674 | 1176 | 8714 | 968 | 10081 | 627 | 12948 | 269 | 11381 |
| 5L-3S | | MI | 2958 | 1612 | 4676 | 1329 | 5749 | 1092 | 6489 | 892 | 7572 | 564 | 9161 | 285 | 7642 |
| 12-#11 | 3.12 | MA | 4021 | 1612 | 5639 | 1425 | 7117 | 1189 | 8003 | 987 | 9097 | 637 | 11608 | 184 | 10577 |
| 6L-2S | | MI | 3167 | 1612 | 5095 | 1319 | 6279 | 1084 | 7130 | 887 | 8434 | 556 | 10261 | 399 | 7692 |
| 12-#14 | 4.50 | MA | 5117 | 1855 | 7861 | 1559 | 9938 | 1273 | 11400 | 1035 | 13702 | 608 | 18009 | 233 | 16494 |
| 4E | | MI | 3112 | 1855 | 5157 | 1490 | 6312 | 1209 | 7119 | 974 | 8394 | 550 | 10162 | 73 | 9829 |
| 12-#14 | 4.50 | MA | 4758 | 1855 | 7240 | 1580 | 9056 | 1302 | 10357 | 1052 | 12259 | 630 | 16003 | 143 | 15444 |
| 5L-3S | | MI | 3263 | 1855 | 5580 | 1477 | 6864 | 1199 | 7822 | 958 | 9352 | 551 | 11260 | 156 | 10619 |
| 12-#14 | 4.50 | MA | 4379 | 1855 | 6600 | 1595 | 8258 | 1321 | 9340 | 1078 | 10852 | 642 | 14078 | 19 | 13979 |
| 6L-2S | | MI | 3526 | 1855 | 6172 | 1463 | 7613 | 1190 | 8728 | 952 | 10572 | 542 | 12782 | 321 | 10747 |
| 12-#18 | 8.00 | MA | 5906 | 2474 | 10041 | 1998 | 12445 | 1619 | 14395 | 1261 | 17620 | 630 | 23504 | -188 | 22195 |
| 5L-3S | | MI | 3990 | 2474 | 7746 | 1853 | 9546 | 1472 | 11036 | 1127 | 13632 | 514 | 16050 | -220 | 15571 |
| 14-#10 | 2.96 | MA | 4609 | 1584 | 6525 | 1386 | 8339 | 1145 | 9533 | 949 | 11236 | 614 | 14546 | 369 | 11918 |
| 4L-5S | | MI | 2788 | 1584 | 4160 | 1340 | 5097 | 1109 | 5709 | 909 | 6519 | 581 | 8017 | 235 | 6964 |
| 14-#10 | 2.96 | MA | 4406 | 1584 | 6167 | 1399 | 7831 | 1162 | 8932 | 959 | 10405 | 628 | 13348 | 315 | 11297 |
| 5L-4S | | MI | 2892 | 1584 | 4382 | 1331 | 5410 | 1096 | 6079 | 903 | 7031 | 573 | 8684 | 291 | 7242 |
| 14-#10 | 2.96 | MA | 4173 | 1584 | 5788 | 1406 | 7372 | 1174 | 8347 | 976 | 9595 | 636 | 12300 | 254 | 10793 |
| 6L-3S | | MI | 2992 | 1584 | 4630 | 1322 | 5733 | 1088 | 6491 | 892 | 7593 | 571 | 9357 | 341 | 7427 |

## RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.96 | MA | 3966 | 1584 | 5418 | 1415 | 6896 | 1182 | 7781 | 986 | 8807 | 650 | 11214 | 216 | 10119 |
| 7L-2S | | MI | 3168 | 1584 | 4980 | 1313 | 6176 | 1081 | 7026 | 887 | 8314 | 564 | 10302 | 434 | 7463 |
| 14-#11 | 3.64 | MA | 4629 | 1704 | 6797 | 1473 | 8567 | 1218 | 9794 | 995 | 11535 | 624 | 14960 | 264 | 13415 |
| 5L-4S | | MI | 3012 | 1704 | 4797 | 1397 | 5891 | 1142 | 6635 | 931 | 7759 | 561 | 9472 | 208 | 8467 |
| 14-#11 | 3.64 | MA | 4358 | 1704 | 6344 | 1482 | 8009 | 1232 | 9083 | 1014 | 10551 | 633 | 13620 | 179 | 12615 |
| 6L-3S | | MI | 3124 | 1704 | 5095 | 1387 | 6279 | 1134 | 7130 | 919 | 8434 | 560 | 10261 | 267 | 8847 |
| 14-#11 | 3.64 | MA | 4119 | 1704 | 5895 | 1492 | 7441 | 1242 | 8395 | 1026 | 9594 | 649 | 12296 | 129 | 11722 |
| 7L-2S | | MI | 3322 | 1704 | 5513 | 1376 | 6809 | 1127 | 7770 | 914 | 9297 | 553 | 11360 | 381 | 8908 |
| 14-#14 | 5.25 | MA | 5223 | 1988 | 8246 | 1663 | 10329 | 1363 | 11897 | 1091 | 14332 | 625 | 18873 | 136 | 18341 |
| 5L-4S | | MI | 3354 | 1988 | 5749 | 1573 | 7061 | 1270 | 8025 | 1013 | 9613 | 545 | 11684 | 43 | 11483 |
| 14-#14 | 5.25 | MA | 4875 | 1988 | 7606 | 1678 | 9531 | 1381 | 10880 | 1117 | 12925 | 637 | 16948 | 12 | 16884 |
| 6L-3S | | MI | 3490 | 1988 | 6172 | 1560 | 7613 | 1260 | 8728 | 997 | 10572 | 546 | 12782 | 126 | 12311 |
| 16-#10 | 3.39 | MA | 4672 | 1659 | 6751 | 1445 | 8569 | 1197 | 9825 | 981 | 11607 | 625 | 15013 | 311 | 12978 |
| 5E | | MI | 2944 | 1659 | 4510 | 1387 | 5539 | 1143 | 6244 | 931 | 7240 | 578 | 8961 | 224 | 7951 |
| 16-#10 | 3.39 | MA | 4449 | 1659 | 6372 | 1453 | 8111 | 1208 | 9240 | 998 | 10797 | 634 | 13965 | 250 | 12477 |
| 6L-4S | | MI | 3039 | 1659 | 4732 | 1378 | 5853 | 1130 | 6614 | 925 | 7752 | 571 | 9628 | 279 | 8216 |
| 16-#10 | 3.39 | MA | 4254 | 1659 | 6001 | 1461 | 7634 | 1217 | 8674 | 1008 | 10009 | 648 | 12878 | 212 | 11810 |
| 7L-3S | | MI | 3132 | 1659 | 4980 | 1369 | 6176 | 1123 | 7026 | 914 | 8314 | 569 | 10302 | 330 | 8437 |
| 16-#10 | 3.39 | MA | 4073 | 1659 | 5593 | 1477 | 7131 | 1230 | 8103 | 1017 | 9224 | 656 | 11831 | 160 | 11037 |
| 8L-2S | | MI | 3301 | 1659 | 5330 | 1359 | 6618 | 1115 | 7562 | 909 | 9035 | 561 | 11246 | 423 | 8480 |
| 16-#11 | 4.16 | MA | 4685 | 1795 | 7050 | 1540 | 8902 | 1274 | 10163 | 1041 | 12005 | 630 | 15633 | 174 | 14654 |
| 6L-4S | | MI | 3183 | 1795 | 5215 | 1454 | 6421 | 1184 | 7275 | 958 | 8621 | 557 | 10571 | 190 | 9633 |
| 16-#11 | 4.16 | MA | 4460 | 1795 | 6601 | 1550 | 8334 | 1284 | 9475 | 1053 | 11048 | 646 | 14308 | 124 | 13756 |
| 7L-3S | | MI | 3287 | 1795 | 5513 | 1444 | 6809 | 1177 | 7770 | 946 | 9297 | 557 | 11360 | 249 | 10052 |
| 16-#14 | 6.00 | MA | 5330 | 2120 | 8612 | 1760 | 10804 | 1442 | 12419 | 1156 | 14997 | 632 | 19818 | 5 | 19789 |
| 6L-4S | | MI | 3590 | 2120 | 6341 | 1656 | 7810 | 1331 | 8931 | 1052 | 10833 | 540 | 13207 | 13 | 13144 |
| 18-#10 | 3.81 | MA | 4718 | 1734 | 6955 | 1500 | 8849 | 1243 | 10133 | 1019 | 11999 | 631 | 15629 | 246 | 14163 |
| 6L-5S | | MI | 3089 | 1734 | 4860 | 1434 | 5982 | 1178 | 6780 | 953 | 7961 | 576 | 9905 | 213 | 8941 |
| 18-#10 | 3.81 | MA | 4534 | 1734 | 6585 | 1508 | 8373 | 1251 | 9567 | 1030 | 11211 | 645 | 14543 | 208 | 13501 |
| 7L-4S | | MI | 3183 | 1734 | 5082 | 1425 | 6296 | 1165 | 7150 | 947 | 8473 | 568 | 10572 | 268 | 9193 |
| 18-#10 | 3.81 | MA | 4362 | 1734 | 6176 | 1524 | 7870 | 1265 | 8996 | 1039 | 10426 | 653 | 13496 | 156 | 12724 |
| 8L-3S | | MI | 3270 | 1734 | 5330 | 1415 | 6618 | 1157 | 7562 | 936 | 9035 | 566 | 11246 | 319 | 9447 |
| 18-#11 | 4.68 | MA | 4791 | 1887 | 7306 | 1607 | 9226 | 1326 | 10554 | 1080 | 12501 | 642 | 16321 | 119 | 15790 |
| 7L-4S | | MI | 3351 | 1887 | 5634 | 1511 | 6950 | 1226 | 7916 | 985 | 9484 | 554 | 11670 | 172 | 10805 |
| 20-#10 | 4.23 | MA | 4806 | 1808 | 7168 | 1555 | 9111 | 1285 | 10460 | 1052 | 12413 | 642 | 16207 | 204 | 15192 |
| 7L-5S | | MI | 3231 | 1808 | 5210 | 1480 | 6425 | 1212 | 7315 | 975 | 8682 | 573 | 10850 | 202 | 9934 |
| 20-#10 | 4.23 | MA | 4636 | 1808 | 6760 | 1570 | 8608 | 1299 | 9889 | 1061 | 11628 | 650 | 15161 | 152 | 14411 |
| 8L-4S | | MI | 3325 | 1808 | 5432 | 1471 | 6739 | 1199 | 7685 | 969 | 9194 | 565 | 11517 | 257 | 10175 |
| 22-#10 | 4.66 | MA | 4905 | 1883 | 7343 | 1617 | 9346 | 1333 | 10781 | 1083 | 12831 | 648 | 16825 | 148 | 16097 |
| 8L-5S | | MI | 3371 | 1883 | 5560 | 1527 | 6868 | 1246 | 7850 | 997 | 9403 | 570 | 11794 | 191 | 10928 |

## RECTANGULAR TIED COLUMNS 20" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.41 | MA | 4696 | 1396 | 6131 | 1261 | 7829 | 1056 | 8859 | 892 | 10104 | 638 | 12668 | 555 | 6639 |
| 2E | | MI | 2782 | 1396 | 3978 | 1197 | 4824 | 1001 | 5323 | 845 | 5909 | 600 | 6935 | 475 | 3865 |
| 4-#18 | 2.50 | MA | 5364 | 1602 | 7834 | 1379 | 9912 | 1142 | 11342 | 945 | 13414 | 624 | 17226 | 539 | 11397 |
| 2E | | MI | 3082 | 1602 | 4892 | 1308 | 5918 | 1081 | 6615 | 892 | 7612 | 581 | 8826 | 387 | 6414 |
| 6-#10 | 1.19 | MA | 4589 | 1356 | 5732 | 1248 | 7410 | 1048 | 8397 | 890 | 9523 | 647 | 11894 | 564 | 5743 |
| 2L-3S | | MI | 2526 | 1356 | 3398 | 1201 | 4167 | 1007 | 4568 | 853 | 4927 | 621 | 5826 | 419 | 3390 |
| 6-#10 | 1.19 | MA | 4180 | 1356 | 5102 | 1261 | 6613 | 1060 | 7432 | 901 | 8225 | 662 | 10096 | 479 | 5719 |
| 3L-2S | | MI | 2746 | 1356 | 3748 | 1192 | 4610 | 1000 | 5103 | 848 | 5648 | 614 | 6770 | 513 | 3383 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 32"

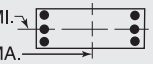
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.46 | MA | 4758 | 1407 | 6196 | 1273 | 7947 | 1065 | 9020 | 899 | 10338 | 641 | 13005 | 557 | 6941 |
| 2L-3S | | MI | 2566 | 1407 | 3592 | 1222 | 4367 | 1021 | 4787 | 859 | 5201 | 612 | 6108 | 372 | 4042 |
| 6-#11 | 1.46 | MA | 4280 | 1407 | 5433 | 1289 | 6982 | 1080 | 7853 | 912 | 8766 | 658 | 10828 | 450 | 6894 |
| 3L-2S | | MI | 2821 | 1407 | 4011 | 1212 | 4897 | 1013 | 5427 | 854 | 6064 | 605 | 7208 | 486 | 4041 |
| 6-#14 | 2.11 | MA | 5176 | 1529 | 7220 | 1344 | 9207 | 1117 | 10525 | 931 | 12347 | 633 | 15774 | 548 | 9822 |
| 2L-3S | | MI | 2680 | 1529 | 3978 | 1293 | 4824 | 1072 | 5323 | 890 | 5909 | 604 | 6935 | 280 | 5567 |
| 6-#14 | 2.11 | MA | 4539 | 1529 | 6131 | 1366 | 7829 | 1137 | 8859 | 949 | 10104 | 657 | 12668 | 392 | 9678 |
| 3L-2S | | MI | 3018 | 1529 | 4571 | 1279 | 5573 | 1062 | 6229 | 883 | 7129 | 595 | 8458 | 445 | 5611 |
| 6-#18 | 3.75 | MA | 6119 | 1838 | 9728 | 1526 | 12309 | 1250 | 14240 | 1014 | 17316 | 615 | 22629 | 526 | 16911 |
| 2L-3S | | MI | 2952 | 1838 | 4892 | 1475 | 5918 | 1202 | 6615 | 967 | 7612 | 581 | 8826 | 23 | 8768 |
| 6-#18 | 3.75 | MA | 5160 | 1838 | 7834 | 1563 | 9912 | 1282 | 11342 | 1042 | 13414 | 653 | 17226 | 239 | 16319 |
| 3L-2S | | MI | 3448 | 1838 | 5903 | 1456 | 7197 | 1190 | 8162 | 962 | 9691 | 572 | 11314 | 317 | 9354 |
| 8-#9 | 1.25 | MA | 4643 | 1367 | 5812 | 1258 | 7530 | 1055 | 8552 | 895 | 9741 | 648 | 12202 | 564 | 6039 |
| 2L-4S | | MI | 2499 | 1367 | 3316 | 1218 | 4072 | 1021 | 4443 | 868 | 4761 | 624 | 5682 | 403 | 3547 |
| 8-#9 | 1.25 | MA | 4324 | 1367 | 5313 | 1268 | 6899 | 1065 | 7788 | 904 | 8713 | 660 | 10779 | 498 | 6022 |
| 3E | | MI | 2605 | 1367 | 3512 | 1210 | 4328 | 1015 | 4770 | 859 | 5207 | 622 | 6221 | 444 | 3558 |
| 8-#9 | 1.25 | MA | 4137 | 1367 | 4971 | 1279 | 6451 | 1075 | 7215 | 918 | 7929 | 668 | 9819 | 457 | 5954 |
| 4L-2S | | MI | 2778 | 1367 | 3790 | 1203 | 4680 | 1009 | 5196 | 854 | 5780 | 616 | 6979 | 517 | 3553 |
| 8-#10 | 1.59 | MA | 4881 | 1431 | 6362 | 1295 | 8207 | 1082 | 9361 | 912 | 10821 | 644 | 13692 | 560 | 7588 |
| 2L-4S | | MI | 2557 | 1431 | 3501 | 1257 | 4287 | 1049 | 4691 | 886 | 5086 | 621 | 6097 | 358 | 4371 |
| 8-#10 | 1.59 | MA | 4493 | 1431 | 5732 | 1308 | 7410 | 1095 | 8397 | 923 | 9523 | 659 | 11894 | 475 | 7549 |
| 3E | | MI | 2685 | 1431 | 3748 | 1247 | 4610 | 1042 | 5103 | 875 | 5648 | 619 | 6770 | 408 | 4412 |
| 8-#10 | 1.59 | MA | 4267 | 1431 | 5299 | 1322 | 6843 | 1107 | 7672 | 940 | 8532 | 668 | 10677 | 422 | 7406 |
| 4L-2S | | MI | 2895 | 1431 | 4098 | 1238 | 5053 | 1034 | 5638 | 870 | 6369 | 611 | 7715 | 502 | 4417 |
| 8-#11 | 1.95 | MA | 5098 | 1499 | 6959 | 1330 | 8912 | 1107 | 10188 | 926 | 11910 | 638 | 15181 | 552 | 9171 |
| 2L-4S | | MI | 2600 | 1499 | 3713 | 1289 | 4509 | 1071 | 4932 | 899 | 5388 | 610 | 6419 | 295 | 5097 |
| 8-#11 | 1.95 | MA | 4648 | 1499 | 6196 | 1346 | 7947 | 1122 | 9020 | 939 | 10338 | 655 | 13005 | 446 | 9104 |
| 3E | | MI | 2750 | 1499 | 4011 | 1279 | 4897 | 1063 | 5427 | 886 | 6064 | 609 | 7208 | 354 | 5257 |
| 8-#11 | 1.95 | MA | 4386 | 1499 | 5669 | 1362 | 7259 | 1136 | 8140 | 959 | 9135 | 665 | 11518 | 380 | 8826 |
| 4L-2S | | MI | 2992 | 1499 | 4429 | 1269 | 5427 | 1055 | 6068 | 881 | 6926 | 602 | 8307 | 469 | 5274 |
| 8-#14 | 2.81 | MA | 5634 | 1661 | 8309 | 1426 | 10584 | 1178 | 12191 | 970 | 14590 | 628 | 18880 | 541 | 12996 |
| 2L-4S | | MI | 2743 | 1661 | 4147 | 1389 | 5022 | 1142 | 5526 | 945 | 6171 | 598 | 7360 | 167 | 6653 |
| 8-#14 | 2.81 | MA | 5044 | 1661 | 7220 | 1448 | 9207 | 1198 | 10525 | 988 | 12347 | 652 | 15774 | 385 | 12825 |
| 3E | | MI | 2935 | 1661 | 4571 | 1376 | 5573 | 1133 | 6229 | 928 | 7129 | 599 | 8458 | 249 | 7266 |
| 8-#14 | 2.81 | MA | 4701 | 1661 | 6467 | 1471 | 8223 | 1217 | 9267 | 1016 | 10628 | 665 | 13637 | 290 | 11728 |
| 4L-2S | | MI | 3243 | 1661 | 5163 | 1362 | 6322 | 1123 | 7135 | 922 | 8349 | 590 | 9980 | 415 | 7339 |
| 8-#18 | 5.00 | MA | 6014 | 2073 | 9728 | 1710 | 12309 | 1390 | 14240 | 1112 | 17316 | 644 | 22629 | 227 | 21816 |
| 3E | | MI | 3358 | 2073 | 5903 | 1622 | 7197 | 1310 | 8162 | 1036 | 9691 | 571 | 11314 | -47 | 11243 |
| 8-#18 | 5.00 | MA | 5487 | 2073 | 8411 | 1747 | 10589 | 1423 | 12042 | 1158 | 14313 | 664 | 18860 | 56 | 18555 |
| 4L-2S | | MI | 3805 | 2073 | 6915 | 1603 | 8477 | 1298 | 9709 | 1031 | 11769 | 562 | 13802 | 247 | 12280 |
| 10-#10 | 1.98 | MA | 5163 | 1505 | 6992 | 1342 | 9005 | 1117 | 10326 | 934 | 12120 | 642 | 15490 | 556 | 9429 |
| 2L-5S | | MI | 2613 | 1505 | 3629 | 1313 | 4416 | 1096 | 4856 | 914 | 5295 | 626 | 6374 | 291 | 5067 |
| 10-#10 | 1.98 | MA | 4794 | 1505 | 6362 | 1355 | 8207 | 1129 | 9361 | 945 | 10821 | 656 | 13692 | 471 | 9379 |
| 3L-4S | | MI | 2718 | 1505 | 3851 | 1303 | 4730 | 1083 | 5227 | 908 | 5807 | 618 | 7041 | 347 | 5373 |
| 10-#10 | 1.98 | MA | 4585 | 1505 | 5929 | 1368 | 7641 | 1141 | 8636 | 962 | 9831 | 666 | 12475 | 418 | 9228 |
| 4L-3S | | MI | 2838 | 1505 | 4098 | 1294 | 5053 | 1076 | 5638 | 897 | 6369 | 616 | 7715 | 397 | 5428 |
| 10-#10 | 1.98 | MA | 4353 | 1505 | 5545 | 1382 | 7094 | 1159 | 7991 | 973 | 8936 | 680 | 11188 | 366 | 8625 |
| 5L-2S | | MI | 3040 | 1505 | 4448 | 1285 | 5495 | 1068 | 6174 | 892 | 7090 | 608 | 8659 | 490 | 5444 |
| 10-#11 | 2.44 | MA | 5001 | 1591 | 6959 | 1403 | 8912 | 1164 | 10188 | 966 | 11910 | 651 | 15181 | 441 | 11315 |
| 3L-4S | | MI | 2788 | 1591 | 4131 | 1347 | 5038 | 1113 | 5573 | 926 | 6251 | 606 | 7518 | 277 | 6235 |
| 10-#11 | 2.44 | MA | 4762 | 1591 | 6432 | 1419 | 8224 | 1178 | 9308 | 986 | 10707 | 661 | 13694 | 376 | 10990 |
| 4L-3S | | MI | 2932 | 1591 | 4429 | 1337 | 5427 | 1105 | 6068 | 913 | 6926 | 606 | 8307 | 336 | 6466 |
| 10-#11 | 2.44 | MA | 4490 | 1591 | 5965 | 1435 | 7560 | 1200 | 8523 | 999 | 9620 | 678 | 12190 | 318 | 10163 |
| 5L-2S | | MI | 3156 | 1591 | 4848 | 1327 | 5956 | 1098 | 6708 | 908 | 7789 | 598 | 9406 | 451 | 6498 |
| 10-#14 | 3.52 | MA | 5526 | 1794 | 8309 | 1531 | 10584 | 1258 | 12191 | 1027 | 14590 | 647 | 18880 | 378 | 15977 |
| 3L-4S | | MI | 3003 | 1794 | 4739 | 1472 | 5771 | 1203 | 6432 | 983 | 7390 | 593 | 8883 | 137 | 8279 |
| 10-#14 | 3.52 | MA | 5221 | 1794 | 7556 | 1553 | 9600 | 1278 | 10933 | 1055 | 12871 | 660 | 16743 | 283 | 14847 |
| 4L-3S | | MI | 3175 | 1794 | 5163 | 1458 | 6322 | 1193 | 7135 | 967 | 8349 | 594 | 9980 | 219 | 8963 |

## RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis

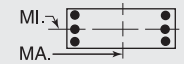



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 3.52 | MA | 4845 | 1794 | 6886 | 1575 | 8649 | 1308 | 9809 | 1072 | 11315 | 684 | 14587 | 197 | 13744 |
| 5L-2S | | MI | 3462 | 1794 | 5755 | 1445 | 7072 | 1184 | 8041 | 961 | 9569 | 585 | 11503 | 385 | 9060 |
| 10-#18 | 6.25 | MA | 6402 | 2309 | 10305 | 1894 | 12985 | 1531 | 14940 | 1227 | 18215 | 655 | 24263 | 43 | 24025 |
| 4L-3S | | MI | 3749 | 2309 | 6915 | 1769 | 8477 | 1418 | 9709 | 1105 | 11769 | 562 | 13802 | -117 | 13587 |
| 10-#18 | 6.25 | MA | 5762 | 2309 | 9132 | 1931 | 11320 | 1582 | 12974 | 1255 | 15493 | 693 | 20476 | -120 | 19743 |
| 5L-2S | | MI | 4157 | 2309 | 7926 | 1750 | 9756 | 1406 | 11256 | 1100 | 13848 | 553 | 16290 | 177 | 15200 |
| 12-#10 | 2.38 | MA | 5084 | 1580 | 6992 | 1402 | 9005 | 1163 | 10326 | 967 | 12120 | 654 | 15490 | 467 | 11209 |
| 3L-5S | | MI | 2777 | 1580 | 3979 | 1359 | 4859 | 1131 | 5392 | 936 | 6016 | 623 | 7318 | 280 | 6044 |
| 12-#10 | 2.38 | MA | 4891 | 1580 | 6559 | 1415 | 8438 | 1176 | 9601 | 984 | 11129 | 663 | 14273 | 415 | 11052 |
| 4E | | MI | 2874 | 1580 | 4201 | 1350 | 5173 | 1118 | 5762 | 930 | 6528 | 615 | 7986 | 336 | 6344 |
| 12-#10 | 2.38 | MA | 4663 | 1580 | 6175 | 1428 | 7892 | 1194 | 8955 | 995 | 10234 | 678 | 12986 | 362 | 10438 |
| 5L-3S | | MI | 2988 | 1580 | 4448 | 1341 | 5495 | 1110 | 6174 | 919 | 7090 | 613 | 8659 | 386 | 6442 |
| 12-#10 | 2.38 | MA | 4394 | 1580 | 5762 | 1436 | 7398 | 1206 | 8325 | 1012 | 9362 | 687 | 11864 | 302 | 9946 |
| 6L-2S | | MI | 3180 | 1580 | 4798 | 1332 | 5938 | 1103 | 6709 | 914 | 7811 | 605 | 9603 | 479 | 6466 |
| 12-#11 | 2.92 | MA | 5122 | 1682 | 7195 | 1477 | 9189 | 1221 | 10475 | 1013 | 12279 | 658 | 15871 | 371 | 13161 |
| 4E | | MI | 2978 | 1682 | 4550 | 1404 | 5568 | 1155 | 6213 | 953 | 7113 | 603 | 8617 | 259 | 7384 |
| 12-#11 | 2.92 | MA | 4856 | 1682 | 6728 | 1492 | 8525 | 1242 | 9690 | 1026 | 11192 | 675 | 14366 | 313 | 12363 |
| 5L-3S | | MI | 3103 | 1682 | 4848 | 1394 | 5956 | 1148 | 6708 | 940 | 7789 | 602 | 9406 | 318 | 7674 |
| 12-#11 | 2.92 | MA | 4542 | 1682 | 6233 | 1502 | 7925 | 1256 | 8925 | 1046 | 10132 | 685 | 12930 | 229 | 11551 |
| 6L-2S | | MI | 3315 | 1682 | 5267 | 1384 | 6486 | 1140 | 7349 | 935 | 8651 | 595 | 10505 | 433 | 7718 |
| 12-#14 | 4.22 | MA | 5719 | 1926 | 8645 | 1636 | 10978 | 1339 | 12599 | 1093 | 15114 | 655 | 19849 | 276 | 17974 |
| 4E | | MI | 3252 | 1926 | 5331 | 1555 | 6520 | 1264 | 7338 | 1022 | 8610 | 588 | 10405 | 107 | 9918 |
| 12-#14 | 4.22 | MA | 5350 | 1926 | 7975 | 1658 | 10027 | 1369 | 11475 | 1111 | 13558 | 679 | 17692 | 190 | 16879 |
| 5L-3S | | MI | 3408 | 1926 | 5755 | 1541 | 7072 | 1254 | 8041 | 1006 | 9569 | 589 | 11503 | 189 | 10661 |
| 12-#14 | 4.22 | MA | 4934 | 1926 | 7275 | 1672 | 9167 | 1389 | 10379 | 1139 | 12041 | 692 | 15629 | 68 | 15247 |
| 6L-2S | | MI | 3677 | 1926 | 6347 | 1528 | 7821 | 1245 | 8947 | 1000 | 10789 | 580 | 13025 | 354 | 10777 |
| 12-#18 | 7.50 | MA | 6606 | 2544 | 11026 | 2078 | 13717 | 1690 | 15872 | 1324 | 19395 | 684 | 25879 | -132 | 24790 |
| 5L-3S | | MI | 4131 | 2544 | 7926 | 1917 | 9756 | 1526 | 11256 | 1174 | 13848 | 552 | 16290 | -187 | 15892 |
| 14-#10 | 2.78 | MA | 5187 | 1655 | 7189 | 1462 | 9235 | 1210 | 10565 | 1006 | 12427 | 660 | 16071 | 411 | 12879 |
| 4L-5S | | MI | 2931 | 1655 | 4329 | 1406 | 5302 | 1165 | 5927 | 958 | 6737 | 620 | 8263 | 269 | 7025 |
| 14-#10 | 2.78 | MA | 4962 | 1655 | 6805 | 1475 | 8689 | 1228 | 9919 | 1017 | 11532 | 675 | 14784 | 358 | 12254 |
| 5L-4S | | MI | 3027 | 1655 | 4551 | 1397 | 5616 | 1152 | 6298 | 952 | 7249 | 612 | 8930 | 325 | 7310 |
| 14-#10 | 2.78 | MA | 4707 | 1655 | 6392 | 1482 | 8196 | 1240 | 9290 | 1034 | 10661 | 684 | 13662 | 298 | 11769 |
| 6L-3S | | MI | 3137 | 1655 | 4798 | 1388 | 5938 | 1145 | 6709 | 941 | 7811 | 610 | 9603 | 375 | 7454 |
| 14-#10 | 2.78 | MA | 4481 | 1655 | 5992 | 1491 | 7676 | 1248 | 8681 | 1045 | 9813 | 699 | 12496 | 261 | 11003 |
| 7L-2S | | MI | 3317 | 1655 | 5148 | 1378 | 6381 | 1137 | 7245 | 935 | 8532 | 603 | 10548 | 468 | 7486 |
| 14-#11 | 3.41 | MA | 5208 | 1774 | 7491 | 1550 | 9490 | 1284 | 10858 | 1053 | 12763 | 672 | 16543 | 309 | 14567 |
| 5L-4S | | MI | 3154 | 1774 | 4969 | 1462 | 6098 | 1198 | 6854 | 980 | 7976 | 599 | 9716 | 241 | 8542 |
| 14-#11 | 3.41 | MA | 4912 | 1774 | 6996 | 1559 | 8890 | 1298 | 10092 | 1073 | 11704 | 682 | 15107 | 224 | 13758 |
| 6L-3S | | MI | 3269 | 1774 | 5267 | 1452 | 6486 | 1190 | 7349 | 967 | 8651 | 599 | 10505 | 301 | 8880 |
| 14-#11 | 3.41 | MA | 4650 | 1774 | 6511 | 1570 | 8269 | 1308 | 9352 | 1086 | 10673 | 699 | 13685 | 177 | 12829 |
| 7L-2S | | MI | 3471 | 1774 | 5685 | 1441 | 7016 | 1182 | 7989 | 962 | 9514 | 591 | 11604 | 415 | 8934 |
| 14-#14 | 4.92 | MA | 5861 | 2059 | 9064 | 1741 | 11404 | 1430 | 13141 | 1150 | 15801 | 674 | 20798 | 183 | 20015 |
| 5L-4S | | MI | 3494 | 2059 | 5924 | 1637 | 7269 | 1325 | 8244 | 1061 | 9830 | 583 | 11928 | 77 | 11568 |
| 14-#14 | 4.92 | MA | 5448 | 2059 | 8364 | 1755 | 10545 | 1450 | 12045 | 1178 | 14284 | 687 | 18734 | 61 | 18392 |
| 6L-3S | | MI | 3635 | 2059 | 6347 | 1624 | 7821 | 1315 | 8947 | 1045 | 10789 | 584 | 13025 | 159 | 12360 |
| 14-#14 | 4.92 | MA | 5104 | 2059 | 7670 | 1769 | 9666 | 1465 | 10985 | 1196 | 12809 | 711 | 16694 | -11 | 16660 |
| 7L-2S | | MI | 3888 | 2059 | 6939 | 1611 | 8570 | 1305 | 9853 | 1039 | 12009 | 575 | 14548 | 324 | 12491 |
| 16-#10 | 3.17 | MA | 5253 | 1730 | 7436 | 1522 | 9486 | 1262 | 10884 | 1039 | 12831 | 672 | 16581 | 354 | 14073 |
| 5E | | MI | 3087 | 1730 | 4679 | 1453 | 5745 | 1199 | 6463 | 980 | 7458 | 617 | 9207 | 258 | 8010 |
| 16-#10 | 3.17 | MA | 5009 | 1730 | 7022 | 1529 | 8993 | 1275 | 10254 | 1056 | 11959 | 681 | 15459 | 294 | 13594 |
| 6L-4S | | MI | 3183 | 1730 | 4901 | 1443 | 6058 | 1186 | 6833 | 974 | 7970 | 610 | 9874 | 314 | 8281 |
| 16-#10 | 3.17 | MA | 4796 | 1730 | 6623 | 1538 | 8473 | 1282 | 9646 | 1067 | 11111 | 696 | 14294 | 258 | 12829 |
| 7L-3S | | MI | 3278 | 1730 | 5148 | 1434 | 6381 | 1179 | 7245 | 963 | 8532 | 607 | 10548 | 364 | 8465 |
| 16-#10 | 3.17 | MA | 4598 | 1730 | 6183 | 1554 | 7931 | 1297 | 9021 | 1075 | 10267 | 705 | 13171 | 207 | 12036 |
| 8L-2S | | MI | 3450 | 1730 | 5498 | 1425 | 6824 | 1171 | 7780 | 957 | 9252 | 600 | 11492 | 457 | 8503 |
| 16-#11 | 3.90 | MA | 5269 | 1866 | 7759 | 1616 | 9856 | 1341 | 11260 | 1100 | 13276 | 678 | 17283 | 219 | 15965 |
| 6L-4S | | MI | 3326 | 1866 | 5387 | 1519 | 6627 | 1240 | 7494 | 1006 | 8838 | 596 | 10816 | 224 | 9706 |

## RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 3.90 | MA | 5023 | 1866 | 7274 | 1627 | 9234 | 1351 | 10519 | 1113 | 12245 | 695 | 15861 | 172 | 15029 |
| 7L-3S | | MI | 3433 | 1866 | 5685 | 1509 | 7016 | 1232 | 7989 | 994 | 9514 | 595 | 11604 | 283 | 10086 |
| 16-#11 | 3.90 | MA | 4794 | 1866 | 6740 | 1646 | 8576 | 1367 | 9773 | 1124 | 11218 | 705 | 14491 | 107 | 13988 |
| 8L-2S | | MI | 3625 | 1866 | 6104 | 1499 | 7545 | 1224 | 8630 | 989 | 10376 | 588 | 12703 | 397 | 10149 |
| 16-#14 | 5.63 | MA | 5976 | 2191 | 9452 | 1838 | 11922 | 1511 | 13711 | 1217 | 16527 | 682 | 21840 | 54 | 21537 |
| 6L-4S | | MI | 3731 | 2191 | 6516 | 1720 | 8018 | 1386 | 9150 | 1100 | 11050 | 578 | 13450 | 47 | 13226 |
| 16-#14 | 5.63 | MA | 5661 | 2191 | 8759 | 1852 | 11043 | 1526 | 12651 | 1235 | 15052 | 706 | 19799 | -18 | 19720 |
| 7L-3S | | MI | 3859 | 2191 | 6939 | 1707 | 8570 | 1376 | 9853 | 1084 | 12009 | 579 | 14548 | 129 | 14041 |
| 18-#10 | 3.57 | MA | 5303 | 1804 | 7652 | 1576 | 9790 | 1309 | 11219 | 1078 | 13257 | 678 | 17257 | 290 | 15421 |
| 6L-5S | | MI | 3233 | 1804 | 5029 | 1499 | 6187 | 1234 | 6998 | 1002 | 8179 | 614 | 10151 | 247 | 8999 |
| 18-#10 | 3.57 | MA | 5101 | 1804 | 7253 | 1585 | 9270 | 1317 | 10610 | 1089 | 12410 | 693 | 16092 | 254 | 14656 |
| 7L-4S | | MI | 3328 | 1804 | 5251 | 1490 | 6501 | 1221 | 7368 | 996 | 8690 | 607 | 10819 | 303 | 9257 |
| 18-#10 | 3.57 | MA | 4911 | 1804 | 6813 | 1601 | 8729 | 1331 | 9985 | 1097 | 11565 | 702 | 14968 | 203 | 13858 |
| 8L-3S | | MI | 3417 | 1804 | 5498 | 1481 | 6824 | 1213 | 7780 | 985 | 9252 | 605 | 11492 | 353 | 9475 |
| 18-#10 | 3.57 | MA | 4664 | 1804 | 6435 | 1612 | 8225 | 1341 | 9344 | 1111 | 10732 | 717 | 13806 | 149 | 13063 |
| 9L-2S | | MI | 3582 | 1804 | 5848 | 1472 | 7266 | 1206 | 8316 | 979 | 9973 | 597 | 12436 | 446 | 9520 |
| 18-#11 | 4.39 | MA | 5385 | 1958 | 8037 | 1684 | 10199 | 1393 | 11687 | 1140 | 13817 | 692 | 18038 | 167 | 17229 |
| 7L-4S | | MI | 3495 | 1958 | 5806 | 1576 | 7157 | 1282 | 8135 | 1033 | 9701 | 592 | 11915 | 206 | 10876 |
| 18-#11 | 4.39 | MA | 5162 | 1958 | 7503 | 1703 | 9541 | 1410 | 10941 | 1151 | 12790 | 702 | 16668 | 102 | 16193 |
| 8L-3S | | MI | 3593 | 1958 | 6104 | 1566 | 7545 | 1274 | 8630 | 1021 | 10376 | 592 | 12703 | 265 | 11292 |
| 18-#14 | 6.33 | MA | 6170 | 2324 | 9848 | 1935 | 12421 | 1587 | 14317 | 1274 | 17295 | 701 | 22905 | -25 | 22761 |
| 7L-4S | | MI | 3963 | 2324 | 7108 | 1803 | 8767 | 1447 | 10056 | 1139 | 12270 | 573 | 14973 | 16 | 14892 |
| 20-#10 | 3.97 | MA | 5399 | 1879 | 7883 | 1632 | 10068 | 1351 | 11574 | 1111 | 13708 | 690 | 17890 | 250 | 16483 |
| 7L-5S | | MI | 3376 | 1879 | 5379 | 1546 | 6630 | 1268 | 7534 | 1024 | 8900 | 612 | 11096 | 236 | 9990 |
| 20-#10 | 3.97 | MA | 5211 | 1879 | 7443 | 1647 | 9526 | 1365 | 10950 | 1119 | 12864 | 699 | 16766 | 199 | 15680 |
| 8L-4S | | MI | 3470 | 1879 | 5601 | 1537 | 6944 | 1255 | 7904 | 1018 | 9411 | 604 | 11763 | 291 | 10238 |
| 20-#10 | 3.97 | MA | 4975 | 1879 | 7065 | 1658 | 9023 | 1375 | 10308 | 1133 | 12030 | 714 | 15604 | 145 | 14881 |
| 9L-3S | | MI | 3553 | 1879 | 5848 | 1528 | 7266 | 1248 | 8316 | 1007 | 9973 | 602 | 12436 | 342 | 10486 |
| 20-#11 | 4.88 | MA | 5517 | 2050 | 8266 | 1761 | 10506 | 1452 | 12108 | 1178 | 14362 | 699 | 18844 | 98 | 18397 |
| 8L-4S | | MI | 3660 | 2050 | 6225 | 1634 | 7687 | 1324 | 8776 | 1060 | 10563 | 589 | 13014 | 188 | 12050 |
| 22-#10 | 4.37 | MA | 5504 | 1954 | 8074 | 1694 | 10323 | 1400 | 11914 | 1141 | 14162 | 697 | 18564 | 196 | 17502 |
| 8L-5S | | MI | 3517 | 1954 | 5729 | 1593 | 7073 | 1302 | 8069 | 1046 | 9621 | 609 | 12040 | 225 | 10984 |
| 22-#10 | 4.37 | MA | 5278 | 1954 | 7695 | 1705 | 9820 | 1409 | 11272 | 1155 | 13329 | 711 | 17402 | 141 | 16698 |
| 9L-4S | | MI | 3610 | 1954 | 5951 | 1584 | 7386 | 1289 | 8439 | 1040 | 10132 | 601 | 12707 | 280 | 11221 |
| 24-#10 | 4.76 | MA | 5573 | 2029 | 8326 | 1752 | 10617 | 1444 | 12237 | 1177 | 14627 | 709 | 19200 | 137 | 18516 |
| 9L-5S | | MI | 3655 | 2029 | 6079 | 1640 | 7515 | 1337 | 8604 | 1068 | 10342 | 606 | 12984 | 214 | 11979 |

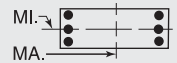
## RECTANGULAR TIED COLUMNS 20" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.32 | MA | 5264 | 1467 | 6744 | 1336 | 8661 | 1120 | 9812 | 948 | 11175 | 683 | 13998 | 594 | 7125 |
| 2E | | MI | 2925 | 1467 | 4153 | 1261 | 5032 | 1056 | 5542 | 892 | 6126 | 638 | 7178 | 509 | 3887 |
| 4-#18 | 2.35 | MA | 5999 | 1673 | 8582 | 1454 | 10911 | 1206 | 12494 | 1001 | 14750 | 669 | 18920 | 578 | 12261 |
| 2E | | MI | 3227 | 1673 | 5072 | 1372 | 6128 | 1135 | 6835 | 940 | 7828 | 619 | 9067 | 420 | 6445 |
| 6-#10 | 1.12 | MA | 5143 | 1427 | 6310 | 1323 | 8205 | 1112 | 9308 | 946 | 10541 | 692 | 13153 | 603 | 6155 |
| 2L-3S | | MI | 2668 | 1427 | 3567 | 1266 | 4373 | 1063 | 4786 | 902 | 5145 | 660 | 6072 | 454 | 3409 |
| 6-#10 | 1.12 | MA | 4698 | 1427 | 5633 | 1337 | 7349 | 1125 | 8272 | 957 | 9147 | 707 | 11222 | 519 | 6131 |
| 3L-2S | | MI | 2889 | 1427 | 3917 | 1257 | 4815 | 1056 | 5322 | 897 | 5866 | 653 | 7016 | 547 | 3400 |
| 6-#11 | 1.38 | MA | 5330 | 1478 | 6811 | 1348 | 8785 | 1129 | 9982 | 955 | 11422 | 686 | 14354 | 596 | 7447 |
| 2L-3S | | MI | 2707 | 1478 | 3764 | 1287 | 4574 | 1076 | 5006 | 908 | 5419 | 651 | 6353 | 406 | 4066 |
| 6-#11 | 1.38 | MA | 4809 | 1478 | 5991 | 1364 | 7747 | 1144 | 8727 | 969 | 9732 | 703 | 12014 | 491 | 7400 |
| 3L-2S | | MI | 2964 | 1478 | 4183 | 1277 | 5104 | 1069 | 5646 | 902 | 6281 | 643 | 7452 | 520 | 4061 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

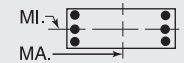
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#14 | 1.99 | MA | 5789 | 1600 | 7915 | 1419 | 10143 | 1181 | 11605 | 987 | 13589 | 678 | 17340 | 587 | 10551 |
| 2L-3S | | MI | 2821 | 1600 | 4153 | 1357 | 5032 | 1127 | 5542 | 937 | 6126 | 642 | 7178 | 313 | 5602 |
| 6-#14 | 1.99 | MA | 5093 | 1600 | 6744 | 1442 | 8661 | 1202 | 9812 | 1006 | 11175 | 703 | 13998 | 434 | 10407 |
| 3L-2S | | MI | 3163 | 1600 | 4745 | 1344 | 5781 | 1117 | 6448 | 931 | 7346 | 633 | 8701 | 478 | 5636 |
| 6-#18 | 3.53 | MA | 6831 | 1909 | 10624 | 1601 | 13494 | 1314 | 15617 | 1070 | 18955 | 660 | 24743 | 566 | 18207 |
| 2L-3S | | MI | 3092 | 1909 | 5072 | 1538 | 6128 | 1256 | 6835 | 1014 | 7828 | 618 | 9067 | 56 | 8924 |
| 6-#18 | 3.53 | MA | 5774 | 1909 | 8582 | 1640 | 10911 | 1348 | 12494 | 1100 | 14750 | 700 | 18920 | 284 | 17615 |
| 3L-2S | | MI | 3596 | 1909 | 6083 | 1519 | 7407 | 1244 | 8382 | 1009 | 9907 | 609 | 11555 | 350 | 9389 |
| 8-#9 | 1.18 | MA | 5201 | 1438 | 6396 | 1333 | 8333 | 1120 | 9473 | 951 | 10773 | 693 | 13482 | 603 | 6471 |
| 2L-4S | | MI | 2640 | 1438 | 3483 | 1284 | 4276 | 1077 | 4662 | 917 | 4979 | 664 | 5928 | 438 | 3569 |
| 8-#9 | 1.18 | MA | 4854 | 1438 | 5860 | 1344 | 7655 | 1130 | 8654 | 960 | 9670 | 705 | 11954 | 538 | 6454 |
| 3E | | MI | 2747 | 1438 | 3680 | 1276 | 4532 | 1071 | 4988 | 908 | 5425 | 661 | 6468 | 478 | 3575 |
| 8-#9 | 1.18 | MA | 4651 | 1438 | 5493 | 1355 | 7176 | 1140 | 8040 | 974 | 8830 | 713 | 10930 | 497 | 6386 |
| 4L-2S | | MI | 2921 | 1438 | 3958 | 1269 | 4884 | 1065 | 5414 | 903 | 5998 | 655 | 7225 | 551 | 3569 |
| 8-#10 | 1.49 | MA | 5461 | 1501 | 6987 | 1370 | 9061 | 1146 | 10344 | 968 | 11936 | 689 | 15085 | 599 | 8137 |
| 2L-4S | | MI | 2697 | 1501 | 3670 | 1322 | 4493 | 1105 | 4910 | 935 | 5304 | 660 | 6343 | 392 | 4401 |
| 8-#10 | 1.49 | MA | 5039 | 1501 | 6310 | 1384 | 8205 | 1159 | 9308 | 979 | 10541 | 704 | 13153 | 515 | 8098 |
| 3E | | MI | 2827 | 1501 | 3917 | 1313 | 4815 | 1098 | 5322 | 924 | 5866 | 658 | 7016 | 442 | 4434 |
| 8-#10 | 1.49 | MA | 4794 | 1501 | 5846 | 1397 | 7598 | 1172 | 8531 | 997 | 9479 | 714 | 11855 | 463 | 7954 |
| 4L-2S | | MI | 3039 | 1501 | 4267 | 1304 | 5258 | 1090 | 5857 | 918 | 6587 | 650 | 7961 | 536 | 4435 |
| 8-#11 | 1.84 | MA | 5702 | 1570 | 7632 | 1405 | 9823 | 1172 | 11237 | 982 | 13113 | 682 | 16694 | 591 | 9845 |
| 2L-4S | | MI | 2741 | 1570 | 3885 | 1354 | 4716 | 1126 | 5151 | 947 | 5606 | 648 | 6663 | 329 | 5177 |
| 8-#11 | 1.84 | MA | 5211 | 1570 | 6811 | 1422 | 8785 | 1187 | 9982 | 996 | 11422 | 700 | 14354 | 487 | 9778 |
| 3E | | MI | 2892 | 1570 | 4183 | 1344 | 5104 | 1119 | 5646 | 935 | 6281 | 647 | 7452 | 388 | 5284 |
| 8-#11 | 1.84 | MA | 4925 | 1570 | 6247 | 1438 | 8048 | 1202 | 9038 | 1016 | 10132 | 711 | 12767 | 422 | 9533 |
| 4L-2S | | MI | 3137 | 1570 | 4602 | 1334 | 5633 | 1111 | 6287 | 929 | 7144 | 640 | 8551 | 502 | 5297 |
| 8-#14 | 2.65 | MA | 6290 | 1732 | 9087 | 1502 | 11626 | 1242 | 13397 | 1026 | 16002 | 673 | 20681 | 580 | 13968 |
| 2L-4S | | MI | 2882 | 1732 | 4322 | 1453 | 5230 | 1197 | 5746 | 992 | 6387 | 636 | 7603 | 201 | 6747 |
| 8-#14 | 2.65 | MA | 5644 | 1732 | 7915 | 1524 | 10143 | 1263 | 11605 | 1045 | 13589 | 698 | 17340 | 427 | 13797 |
| 3E | | MI | 3078 | 1732 | 4745 | 1440 | 5781 | 1188 | 6448 | 976 | 7346 | 637 | 8701 | 283 | 7303 |
| 8-#14 | 2.65 | MA | 5271 | 1732 | 7107 | 1547 | 9088 | 1283 | 10254 | 1074 | 11743 | 713 | 15059 | 333 | 12731 |
| 4L-2S | | MI | 3390 | 1732 | 5337 | 1427 | 6530 | 1178 | 7354 | 970 | 8566 | 629 | 10223 | 448 | 7367 |
| 8-#18 | 4.71 | MA | 6708 | 2144 | 10624 | 1787 | 13494 | 1456 | 15617 | 1170 | 18955 | 691 | 24743 | 272 | 23544 |
| 3E | | MI | 3498 | 2144 | 6083 | 1686 | 7407 | 1364 | 8382 | 1083 | 9907 | 609 | 11555 | -14 | 11534 |
| 8-#18 | 4.71 | MA | 6130 | 2144 | 9209 | 1825 | 11646 | 1491 | 13255 | 1218 | 15727 | 714 | 20718 | 102 | 20108 |
| 4L-2S | | MI | 3954 | 2144 | 7094 | 1666 | 8687 | 1352 | 9929 | 1078 | 11985 | 600 | 14043 | 280 | 12317 |
| 10-#10 | 1.87 | MA | 5769 | 1576 | 7664 | 1417 | 9918 | 1181 | 11380 | 990 | 13331 | 686 | 17016 | 595 | 10115 |
| 2L-5S | | MI | 2753 | 1576 | 3798 | 1378 | 4622 | 1152 | 5075 | 963 | 5513 | 665 | 6620 | 326 | 5129 |
| 10-#10 | 1.87 | MA | 5367 | 1576 | 6987 | 1430 | 9061 | 1194 | 10344 | 1001 | 11936 | 702 | 15085 | 511 | 10065 |
| 3L-4S | | MI | 2859 | 1576 | 4019 | 1369 | 4935 | 1139 | 5445 | 957 | 6025 | 657 | 7287 | 381 | 5406 |
| 10-#10 | 1.87 | MA | 5140 | 1576 | 6523 | 1444 | 8455 | 1206 | 9567 | 1019 | 10874 | 711 | 13787 | 459 | 9913 |
| 4L-3S | | MI | 2981 | 1576 | 4267 | 1360 | 5258 | 1132 | 5857 | 946 | 6587 | 655 | 7961 | 431 | 5452 |
| 10-#10 | 1.87 | MA | 4884 | 1576 | 6111 | 1458 | 7869 | 1225 | 8876 | 1030 | 9915 | 727 | 12410 | 409 | 9315 |
| 5L-2S | | MI | 3185 | 1576 | 4617 | 1351 | 5701 | 1124 | 6392 | 940 | 7307 | 647 | 8905 | 525 | 5464 |
| 10-#11 | 2.29 | MA | 5596 | 1661 | 7632 | 1479 | 9823 | 1229 | 11237 | 1023 | 13113 | 697 | 16694 | 482 | 12158 |
| 3L-4S | | MI | 2929 | 1661 | 4303 | 1412 | 5245 | 1169 | 5792 | 974 | 6468 | 645 | 7762 | 311 | 6313 |
| 10-#11 | 2.29 | MA | 5334 | 1661 | 7067 | 1495 | 9085 | 1244 | 10293 | 1043 | 11822 | 708 | 15107 | 417 | 11907 |
| 4L-3S | | MI | 3075 | 1661 | 4602 | 1402 | 5633 | 1161 | 6287 | 962 | 7144 | 644 | 8551 | 370 | 6496 |
| 10-#11 | 2.29 | MA | 5035 | 1661 | 6567 | 1512 | 8373 | 1266 | 9452 | 1057 | 10656 | 726 | 13430 | 353 | 10983 |
| 5L-2S | | MI | 3302 | 1661 | 5020 | 1392 | 6163 | 1153 | 6927 | 956 | 8006 | 637 | 9650 | 484 | 6522 |
| 10-#14 | 3.31 | MA | 6170 | 1864 | 9087 | 1607 | 11626 | 1323 | 13397 | 1084 | 16002 | 693 | 20681 | 420 | 17192 |
| 3L-4S | | MI | 3143 | 1864 | 4914 | 1536 | 5979 | 1258 | 6652 | 1031 | 7607 | 631 | 9126 | 171 | 8369 |
| 10-#14 | 3.31 | MA | 5837 | 1864 | 8279 | 1630 | 10570 | 1344 | 12047 | 1113 | 14156 | 708 | 18401 | 326 | 16097 |
| 4L-3S | | MI | 3319 | 1864 | 5337 | 1523 | 6530 | 1248 | 7354 | 1015 | 8566 | 632 | 10223 | 253 | 9002 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.



## RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis

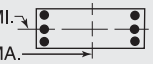



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 10-#14 | 3.31 | MA | 5421 | 1864 | 7562 | 1653 | 9550 | 1375 | 10842 | 1131 | 12487 | 732 | 15995 | 230 | 14870 |
| 5L-2S | | MI | 3611 | 1864 | 5929 | 1509 | 7279 | 1239 | 8260 | 1009 | 9786 | 624 | 11746 | 418 | 9089 |
| 10-#18 | 5.88 | MA | 7127 | 2380 | 11250 | 1973 | 14228 | 1599 | 16378 | 1287 | 19932 | 705 | 26540 | 90 | 26005 |
| 4L-3S | | MI | 3890 | 2380 | 7094 | 1833 | 8687 | 1472 | 9929 | 1152 | 11985 | 599 | 14043 | -84 | 13891 |
| 10-#18 | 5.88 | MA | 6420 | 2380 | 9992 | 2011 | 12442 | 1651 | 14267 | 1318 | 17009 | 745 | 22484 | -66 | 21924 |
| 5L-2S | | MI | 4307 | 2380 | 8105 | 1813 | 9966 | 1460 | 11476 | 1147 | 14064 | 590 | 16531 | 210 | 15238 |
| 12-#10 | 2.24 | MA | 5683 | 1651 | 7664 | 1477 | 9918 | 1228 | 11380 | 1023 | 13331 | 699 | 17016 | 507 | 12032 |
| 3L-5S | | MI | 2917 | 1651 | 4147 | 1425 | 5064 | 1187 | 5610 | 985 | 6234 | 662 | 7565 | 314 | 6104 |
| 12-#10 | 2.24 | MA | 5473 | 1651 | 7200 | 1491 | 9311 | 1241 | 10603 | 1041 | 12269 | 709 | 15718 | 456 | 11875 |
| 4E | | MI | 3016 | 1651 | 4369 | 1416 | 5378 | 1174 | 5981 | 979 | 6745 | 654 | 8232 | 370 | 6410 |
| 12-#10 | 2.24 | MA | 5222 | 1651 | 6788 | 1505 | 8726 | 1259 | 9912 | 1052 | 11310 | 724 | 14341 | 405 | 11265 |
| 5L-3S | | MI | 3131 | 1651 | 4617 | 1407 | 5701 | 1166 | 6392 | 968 | 7307 | 652 | 8905 | 420 | 6467 |
| 12-#10 | 2.24 | MA | 4930 | 1651 | 6341 | 1512 | 8197 | 1272 | 9254 | 1064 | 10376 | 734 | 13143 | 346 | 10752 |
| 6L-2S | | MI | 3327 | 1651 | 4967 | 1397 | 6143 | 1159 | 6928 | 962 | 8028 | 644 | 9849 | 514 | 6487 |
| 12-#11 | 2.75 | MA | 5727 | 1753 | 7888 | 1553 | 10123 | 1286 | 11549 | 1070 | 13512 | 704 | 17447 | 413 | 14255 |
| 4E | | MI | 3120 | 1753 | 4722 | 1469 | 5775 | 1211 | 6432 | 1001 | 7331 | 641 | 8862 | 293 | 7459 |
| 12-#11 | 2.75 | MA | 5433 | 1753 | 7387 | 1569 | 9411 | 1308 | 10707 | 1084 | 12346 | 722 | 15770 | 348 | 13353 |
| 5L-3S | | MI | 3247 | 1753 | 5020 | 1459 | 6163 | 1203 | 6927 | 989 | 8006 | 641 | 9650 | 352 | 7705 |
| 12-#11 | 2.75 | MA | 5093 | 1753 | 6850 | 1578 | 8769 | 1323 | 9887 | 1105 | 11211 | 733 | 14307 | 273 | 12526 |
| 6L-2S | | MI | 3463 | 1753 | 5439 | 1449 | 6693 | 1195 | 7568 | 983 | 8869 | 633 | 10749 | 467 | 7743 |
| 12-#14 | 3.97 | MA | 6379 | 1997 | 9451 | 1713 | 12052 | 1405 | 13839 | 1151 | 16570 | 703 | 21742 | 319 | 19470 |
| 4E | | MI | 3393 | 1997 | 5506 | 1619 | 6728 | 1319 | 7558 | 1070 | 8827 | 626 | 10648 | 140 | 10005 |
| 12-#14 | 3.97 | MA | 5971 | 1997 | 8733 | 1736 | 11032 | 1436 | 12635 | 1170 | 14901 | 727 | 19337 | 223 | 18267 |
| 5L-3S | | MI | 3552 | 1997 | 5929 | 1606 | 7279 | 1309 | 8260 | 1054 | 9786 | 627 | 11746 | 223 | 10701 |
| 12-#14 | 3.97 | MA | 5519 | 1997 | 7972 | 1749 | 10112 | 1457 | 11460 | 1199 | 13274 | 742 | 17233 | 115 | 16533 |
| 6L-2S | | MI | 3826 | 1997 | 6522 | 1592 | 8028 | 1300 | 9166 | 1048 | 11006 | 619 | 13268 | 388 | 10807 |
| 12-#18 | 7.06 | MA | 7338 | 2615 | 12034 | 2158 | 15024 | 1759 | 17391 | 1387 | 21215 | 737 | 28307 | -78 | 27478 |
| 5L-3S | | MI | 4273 | 2615 | 8105 | 1980 | 9966 | 1580 | 11476 | 1221 | 14064 | 590 | 16531 | -154 | 16209 |
| 14-#10 | 2.61 | MA | 5795 | 1726 | 7877 | 1538 | 10167 | 1275 | 11639 | 1063 | 13663 | 706 | 17649 | 452 | 13839 |
| 4L-5S | | MI | 3073 | 1726 | 4497 | 1472 | 5507 | 1221 | 6146 | 1007 | 6955 | 659 | 8509 | 303 | 7084 |
| 14-#10 | 2.61 | MA | 5548 | 1726 | 7465 | 1551 | 9582 | 1293 | 10947 | 1074 | 12704 | 721 | 16273 | 401 | 13219 |
| 5L-4S | | MI | 3169 | 1726 | 4719 | 1462 | 5821 | 1208 | 6516 | 1001 | 7466 | 651 | 9176 | 359 | 7376 |
| 14-#10 | 2.61 | MA | 5270 | 1726 | 7018 | 1558 | 9053 | 1306 | 10290 | 1086 | 11771 | 731 | 15074 | 342 | 12720 |
| 6L-3S | | MI | 3282 | 1726 | 4967 | 1453 | 6143 | 1201 | 6928 | 990 | 8028 | 649 | 9849 | 409 | 7480 |
| 14-#10 | 2.61 | MA | 5025 | 1726 | 6590 | 1568 | 8490 | 1314 | 9622 | 1104 | 10863 | 746 | 13832 | 306 | 11896 |
| 7L-2S | | MI | 3465 | 1726 | 5317 | 1444 | 6586 | 1193 | 7463 | 984 | 8749 | 641 | 10794 | 502 | 7508 |
| 14-#11 | 3.21 | MA | 5817 | 1845 | 8208 | 1626 | 10449 | 1350 | 11963 | 1111 | 14037 | 719 | 18110 | 343 | 15726 |
| 5L-4S | | MI | 3297 | 1845 | 5141 | 1527 | 6304 | 1253 | 7073 | 1028 | 8193 | 638 | 9961 | 275 | 8615 |
| 14-#11 | 3.21 | MA | 5495 | 1845 | 7670 | 1635 | 9807 | 1365 | 11143 | 1132 | 12901 | 730 | 16647 | 269 | 14899 |
| 6L-3S | | MI | 3415 | 1845 | 5439 | 1516 | 6693 | 1245 | 7568 | 1016 | 8869 | 637 | 10749 | 334 | 8912 |
| 14-#11 | 3.21 | MA | 5210 | 1845 | 7150 | 1646 | 9131 | 1375 | 10350 | 1145 | 11797 | 748 | 15128 | 223 | 13937 |
| 7L-2S | | MI | 3620 | 1845 | 5858 | 1506 | 7222 | 1237 | 8209 | 1010 | 9731 | 630 | 11849 | 449 | 8961 |
| 14-#14 | 4.63 | MA | 6500 | 2129 | 9905 | 1819 | 12514 | 1497 | 14427 | 1209 | 17314 | 722 | 22679 | 216 | 21664 |
| 5L-4S | | MI | 3636 | 2129 | 6098 | 1702 | 7477 | 1380 | 8464 | 1109 | 10047 | 621 | 12171 | 110 | 11652 |
| 14-#14 | 4.63 | MA | 6077 | 2129 | 9144 | 1832 | 11594 | 1518 | 13252 | 1238 | 15688 | 737 | 20575 | 108 | 19917 |
| 6L-3S | | MI | 3780 | 2129 | 6522 | 1688 | 8028 | 1370 | 9166 | 1093 | 11006 | 622 | 13268 | 192 | 12401 |
| 14-#14 | 4.63 | MA | 5703 | 2129 | 8400 | 1847 | 10638 | 1532 | 12116 | 1257 | 14106 | 762 | 18394 | 40 | 18202 |
| 7L-2S | | MI | 4039 | 2129 | 7114 | 1675 | 8778 | 1360 | 10072 | 1087 | 12225 | 614 | 14791 | 358 | 12522 |
| 16-#10 | 2.99 | MA | 5864 | 1800 | 8142 | 1598 | 10439 | 1328 | 11983 | 1096 | 14099 | 718 | 18204 | 397 | 15175 |
| 5E | | MI | 3230 | 1800 | 4847 | 1518 | 5950 | 1255 | 6681 | 1029 | 7676 | 656 | 9453 | 292 | 8068 |
| 16-#10 | 2.99 | MA | 5599 | 1800 | 7695 | 1605 | 9910 | 1340 | 11326 | 1108 | 13166 | 728 | 17005 | 338 | 14689 |
| 6L-4S | | MI | 3326 | 1800 | 5069 | 1509 | 6263 | 1242 | 7052 | 1023 | 8187 | 648 | 10120 | 348 | 8346 |
| 16-#10 | 2.99 | MA | 5367 | 1800 | 7267 | 1615 | 9347 | 1348 | 10658 | 1126 | 12258 | 744 | 15763 | 302 | 13859 |
| 7L-3S | | MI | 3424 | 1800 | 5317 | 1500 | 6586 | 1235 | 7463 | 1012 | 8749 | 646 | 10794 | 398 | 8491 |
| 16-#10 | 2.99 | MA | 5152 | 1800 | 6796 | 1631 | 8766 | 1363 | 9980 | 1134 | 11354 | 753 | 14563 | 254 | 13051 |
| 8L-2S | | MI | 3599 | 1800 | 5667 | 1491 | 7029 | 1228 | 7999 | 1006 | 9470 | 639 | 11738 | 491 | 8526 |
| 16-#11 | 3.67 | MA | 5884 | 1937 | 8491 | 1693 | 10845 | 1407 | 12398 | 1159 | 14591 | 726 | 18987 | 264 | 17272 |
| 6L-4S | | MI | 3469 | 1937 | 5560 | 1584 | 6834 | 1295 | 7713 | 1055 | 9056 | 634 | 11060 | 257 | 9777 |

## RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

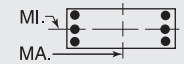
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 3.67 | MA | 5616 | 1937 | 7971 | 1704 | 10169 | 1417 | 11605 | 1172 | 13487 | 744 | 17468 | 218 | 16314 |
| 7L-3S | | MI | 3579 | 1937 | 5858 | 1574 | 7222 | 1287 | 8209 | 1043 | 9731 | 634 | 11849 | 316 | 10119 |
| 16-#11 | 3.67 | MA | 5365 | 1937 | 7398 | 1723 | 9463 | 1434 | 10794 | 1183 | 12386 | 755 | 16004 | 156 | 15172 |
| 8L-2S | | MI | 3775 | 1937 | 6276 | 1564 | 7752 | 1280 | 8849 | 1037 | 10594 | 626 | 12948 | 431 | 10176 |
| 16-#14 | 5.29 | MA | 6616 | 2262 | 10315 | 1915 | 13076 | 1579 | 15045 | 1277 | 18101 | 732 | 23917 | 101 | 23302 |
| 6L-4S | | MI | 3873 | 2262 | 6690 | 1785 | 8226 | 1441 | 9370 | 1148 | 11267 | 616 | 13693 | 80 | 13307 |
| 16-#14 | 5.29 | MA | 6269 | 2262 | 9571 | 1930 | 12120 | 1593 | 13909 | 1296 | 16520 | 757 | 21736 | 33 | 21577 |
| 7L-3S | | MI | 4004 | 2262 | 7114 | 1771 | 8778 | 1431 | 10072 | 1132 | 12225 | 617 | 14791 | 162 | 14101 |
| 18-#10 | 3.36 | MA | 5918 | 1875 | 8372 | 1652 | 10766 | 1375 | 12361 | 1130 | 14560 | 725 | 18936 | 334 | 16657 |
| 6L-5S | | MI | 3377 | 1875 | 5197 | 1565 | 6392 | 1290 | 7217 | 1051 | 8397 | 653 | 10398 | 281 | 9055 |
| 18-#10 | 3.36 | MA | 5699 | 1875 | 7944 | 1661 | 10203 | 1382 | 11694 | 1147 | 13653 | 741 | 17695 | 298 | 15821 |
| 7L-4S | | MI | 3472 | 1875 | 5419 | 1556 | 6706 | 1277 | 7587 | 1045 | 8908 | 646 | 11065 | 337 | 9320 |
| 18-#10 | 3.36 | MA | 5489 | 1875 | 7473 | 1678 | 9623 | 1397 | 11016 | 1155 | 12748 | 751 | 16494 | 250 | 15008 |
| 8L-3S | | MI | 3564 | 1875 | 5667 | 1547 | 7029 | 1269 | 7999 | 1034 | 9470 | 644 | 11738 | 387 | 9503 |
| 18-#10 | 3.36 | MA | 5221 | 1875 | 7067 | 1689 | 9084 | 1407 | 10329 | 1170 | 11856 | 766 | 15256 | 196 | 14196 |
| 9L-2S | | MI | 3732 | 1875 | 6017 | 1538 | 7471 | 1262 | 8534 | 1028 | 10191 | 636 | 12682 | 480 | 9543 |
| 18-#11 | 4.13 | MA | 6009 | 2029 | 8791 | 1761 | 11207 | 1459 | 12860 | 1199 | 15177 | 741 | 19808 | 214 | 18689 |
| 7L-4S | | MI | 3638 | 2029 | 5978 | 1641 | 7364 | 1337 | 8354 | 1082 | 9918 | 631 | 12159 | 240 | 10945 |
| 18-#11 | 4.13 | MA | 5763 | 2029 | 8218 | 1781 | 10501 | 1476 | 12049 | 1210 | 14077 | 752 | 18344 | 151 | 17542 |
| 8L-3S | | MI | 3740 | 2029 | 6276 | 1631 | 7752 | 1330 | 8849 | 1070 | 10594 | 630 | 12948 | 299 | 11325 |
| 18-#14 | 5.96 | MA | 6862 | 2394 | 10743 | 2013 | 13602 | 1654 | 15702 | 1335 | 18933 | 752 | 25077 | 26 | 24952 |
| 7L-4S | | MI | 4105 | 2394 | 7282 | 1867 | 8975 | 1502 | 10276 | 1187 | 12487 | 611 | 15216 | 50 | 14970 |
| 20-#10 | 3.74 | MA | 6022 | 1950 | 8621 | 1708 | 11060 | 1417 | 12730 | 1169 | 15047 | 738 | 19626 | 295 | 17783 |
| 7L-5S | | MI | 3521 | 1950 | 5547 | 1612 | 6835 | 1324 | 7752 | 1073 | 9118 | 650 | 11342 | 270 | 10045 |
| 20-#10 | 3.74 | MA | 5815 | 1950 | 8150 | 1724 | 10479 | 1431 | 12052 | 1177 | 14143 | 748 | 18426 | 246 | 16965 |
| 8L-4S | | MI | 3615 | 1950 | 5769 | 1603 | 7149 | 1311 | 8122 | 1067 | 9629 | 643 | 12009 | 326 | 10299 |
| 20-#10 | 3.74 | MA | 5559 | 1950 | 7744 | 1736 | 9940 | 1441 | 11364 | 1192 | 13251 | 763 | 17188 | 192 | 16149 |
| 9L-3S | | MI | 3701 | 1950 | 6017 | 1593 | 7471 | 1304 | 8534 | 1056 | 10191 | 641 | 12682 | 376 | 10514 |
| 20-#10 | 3.74 | MA | 5319 | 1950 | 7318 | 1744 | 9412 | 1452 | 10702 | 1201 | 12354 | 773 | 15984 | 149 | 15238 |
| 10L-2S | | MI | 3863 | 1950 | 6367 | 1584 | 7914 | 1296 | 9070 | 1050 | 10912 | 633 | 13627 | 469 | 10560 |
| 20-#11 | 4.59 | MA | 6149 | 2121 | 9039 | 1838 | 11539 | 1519 | 13304 | 1237 | 15767 | 748 | 20684 | 147 | 19913 |
| 8L-4S | | MI | 3804 | 2121 | 6397 | 1699 | 7893 | 1380 | 8995 | 1109 | 10781 | 627 | 13258 | 222 | 12118 |
| 22-#10 | 4.11 | MA | 6133 | 2025 | 8827 | 1771 | 11336 | 1466 | 13088 | 1199 | 15538 | 745 | 20357 | 242 | 18923 |
| 8L-5S | | MI | 3662 | 2025 | 5897 | 1659 | 7278 | 1358 | 8288 | 1095 | 9838 | 648 | 12286 | 259 | 11038 |
| 22-#10 | 4.11 | MA | 5887 | 2025 | 8421 | 1782 | 10797 | 1476 | 12400 | 1214 | 14646 | 760 | 19119 | 188 | 18102 |
| 9L-4S | | MI | 3755 | 2025 | 6119 | 1649 | 7591 | 1345 | 8658 | 1089 | 10350 | 640 | 12953 | 314 | 11281 |
| 22-#10 | 4.11 | MA | 5658 | 2025 | 7995 | 1791 | 10268 | 1486 | 11738 | 1223 | 13748 | 770 | 17915 | 145 | 17194 |
| 10L-3S | | MI | 3836 | 2025 | 6367 | 1640 | 7914 | 1338 | 9070 | 1078 | 10912 | 638 | 13627 | 365 | 11524 |
| 24-#10 | 4.48 | MA | 6208 | 2099 | 9098 | 1829 | 11653 | 1510 | 13436 | 1236 | 16041 | 758 | 21050 | 184 | 20055 |
| 9L-5S | | MI | 3801 | 2099 | 6247 | 1705 | 7720 | 1393 | 8823 | 1117 | 10559 | 645 | 13231 | 248 | 12032 |
| 24-#10 | 4.48 | MA | 5989 | 2099 | 8672 | 1837 | 11125 | 1521 | 12774 | 1245 | 15143 | 767 | 19846 | 141 | 19150 |
| 10L-4S | | MI | 3894 | 2099 | 6469 | 1696 | 8034 | 1380 | 9193 | 1111 | 11071 | 637 | 13898 | 303 | 12266 |

## RECTANGULAR TIED COLUMNS 20" x 36"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.25 | MA | 5860 | 1538 | 7379 | 1411 | 9529 | 1184 | 10806 | 1004 | 12290 | 727 | 15380 | 633 | 7611 |
| 2E | | MI | 3068 | 1538 | 4328 | 1326 | 5240 | 1111 | 5762 | 940 | 6343 | 677 | 7422 | 542 | 3908 |
| 4-#18 | 2.22 | MA | 6665 | 1744 | 9353 | 1529 | 11946 | 1270 | 13687 | 1057 | 16130 | 713 | 20668 | 617 | 13125 |
| 2E | | MI | 3373 | 1744 | 5251 | 1435 | 6338 | 1189 | 7055 | 987 | 8044 | 656 | 9307 | 453 | 6476 |
| 6-#10 | 1.06 | MA | 5725 | 1497 | 6911 | 1398 | 9035 | 1176 | 10261 | 1001 | 11604 | 736 | 14466 | 642 | 6566 |
| 2L-3S | | MI | 2810 | 1497 | 3736 | 1332 | 4578 | 1119 | 5005 | 951 | 5362 | 699 | 6318 | 488 | 3427 |
| 6-#10 | 1.06 | MA | 5245 | 1497 | 6187 | 1412 | 8120 | 1189 | 9153 | 1014 | 10113 | 752 | 12401 | 559 | 6542 |
| 3L-2S | | MI | 3033 | 1497 | 4086 | 1323 | 5020 | 1112 | 5540 | 945 | 6083 | 692 | 7262 | 581 | 3416 |
| 6-#11 | 1.30 | MA | 5931 | 1548 | 7449 | 1423 | 9659 | 1193 | 10985 | 1011 | 12551 | 730 | 15756 | 635 | 7952 |
| 2L-3S | | MI | 2849 | 1548 | 3936 | 1352 | 4781 | 1132 | 5225 | 956 | 5636 | 689 | 6597 | 439 | 4090 |

## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

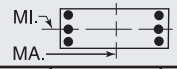
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.30 | MA | 5367 | 1548 | 6571 | 1440 | 8548 | 1209 | 9642 | 1025 | 10743 | 749 | 13252 | 532 | 7905 |
| 3L-2S | | MI | 3108 | 1548 | 4355 | 1342 | 5310 | 1124 | 5865 | 951 | 6498 | 682 | 7696 | 554 | 4081 |
| 6-#14 | 1.88 | MA | 6432 | 1670 | 8633 | 1494 | 11116 | 1245 | 12725 | 1043 | 14874 | 722 | 18958 | 626 | 11280 |
| 2L-3S | | MI | 2962 | 1670 | 4328 | 1422 | 5240 | 1182 | 5762 | 985 | 6343 | 680 | 7422 | 347 | 5635 |
| 6-#14 | 1.88 | MA | 5676 | 1670 | 7379 | 1518 | 9529 | 1267 | 10806 | 1063 | 12290 | 748 | 15380 | 475 | 11136 |
| 3L-2S | | MI | 3309 | 1670 | 4920 | 1408 | 5989 | 1172 | 6668 | 979 | 7563 | 672 | 8944 | 512 | 5661 |
| 6-#18 | 3.33 | MA | 7574 | 1979 | 11542 | 1676 | 14714 | 1378 | 17035 | 1126 | 20638 | 704 | 26910 | 605 | 19503 |
| 2L-3S | | MI | 3232 | 1979 | 5251 | 1602 | 6338 | 1310 | 7055 | 1061 | 8044 | 656 | 9307 | 89 | 9078 |
| 6-#18 | 3.33 | MA | 6418 | 1979 | 9353 | 1716 | 11946 | 1414 | 13687 | 1158 | 16130 | 747 | 20668 | 328 | 18911 |
| 3L-2S | | MI | 3743 | 1979 | 6262 | 1582 | 7617 | 1298 | 8602 | 1056 | 10123 | 647 | 11795 | 383 | 9424 |
| 8-#9 | 1.11 | MA | 5789 | 1508 | 7001 | 1408 | 9171 | 1184 | 10436 | 1007 | 11850 | 737 | 14815 | 642 | 6903 |
| 2L-4S | | MI | 2781 | 1508 | 3651 | 1350 | 4481 | 1133 | 4880 | 966 | 5197 | 703 | 6175 | 472 | 3591 |
| 8-#9 | 1.11 | MA | 5413 | 1508 | 6429 | 1419 | 8447 | 1194 | 9560 | 1017 | 10671 | 750 | 13182 | 578 | 6886 |
| 3E | | MI | 2889 | 1508 | 3847 | 1342 | 4737 | 1127 | 5207 | 957 | 5643 | 701 | 6714 | 512 | 3592 |
| 8-#9 | 1.11 | MA | 5194 | 1508 | 6038 | 1431 | 7935 | 1205 | 8905 | 1031 | 9775 | 759 | 12094 | 538 | 6818 |
| 4L-2S | | MI | 3065 | 1508 | 4125 | 1335 | 5089 | 1121 | 5632 | 952 | 6216 | 694 | 7472 | 586 | 3585 |
| 8-#10 | 1.41 | MA | 6071 | 1572 | 7634 | 1445 | 9951 | 1211 | 11368 | 1023 | 13095 | 733 | 16530 | 638 | 8685 |
| 2L-4S | | MI | 2838 | 1572 | 3838 | 1388 | 4698 | 1161 | 5128 | 984 | 5521 | 699 | 6589 | 426 | 4430 |
| 8-#10 | 1.41 | MA | 5614 | 1572 | 6911 | 1459 | 9035 | 1224 | 10261 | 1036 | 11604 | 749 | 14466 | 555 | 8647 |
| 3E | | MI | 2969 | 1572 | 4086 | 1379 | 5020 | 1154 | 5540 | 973 | 6083 | 696 | 7262 | 477 | 4455 |
| 8-#10 | 1.41 | MA | 5349 | 1572 | 6416 | 1473 | 8388 | 1237 | 9432 | 1054 | 10470 | 760 | 13087 | 504 | 8503 |
| 4L-2S | | MI | 3183 | 1572 | 4436 | 1370 | 5463 | 1146 | 6076 | 967 | 6804 | 689 | 8207 | 570 | 4453 |
| 8-#11 | 1.73 | MA | 6335 | 1640 | 8327 | 1480 | 10769 | 1236 | 12328 | 1038 | 14359 | 727 | 18260 | 630 | 10519 |
| 2L-4S | | MI | 2882 | 1640 | 4057 | 1419 | 4922 | 1182 | 5370 | 995 | 5823 | 687 | 6908 | 362 | 5253 |
| 8-#11 | 1.73 | MA | 5802 | 1640 | 7449 | 1497 | 9659 | 1251 | 10985 | 1052 | 12551 | 745 | 15756 | 527 | 10452 |
| 3E | | MI | 3034 | 1640 | 4355 | 1409 | 5310 | 1174 | 5865 | 983 | 6498 | 686 | 7696 | 421 | 5311 |
| 8-#11 | 1.73 | MA | 5494 | 1640 | 6847 | 1514 | 8871 | 1267 | 9977 | 1074 | 11173 | 757 | 14070 | 463 | 10207 |
| 4L-2S | | MI | 3281 | 1640 | 4774 | 1399 | 5840 | 1166 | 6506 | 978 | 7361 | 678 | 8795 | 536 | 5318 |
| 8-#14 | 2.50 | MA | 6976 | 1803 | 9887 | 1577 | 12702 | 1306 | 14644 | 1082 | 17458 | 717 | 22536 | 619 | 14940 |
| 2L-4S | | MI | 3022 | 1803 | 4496 | 1518 | 5438 | 1252 | 5965 | 1040 | 6604 | 674 | 7846 | 234 | 6839 |
| 8-#14 | 2.50 | MA | 6274 | 1803 | 8633 | 1600 | 11116 | 1327 | 12725 | 1102 | 14874 | 743 | 18958 | 468 | 14769 |
| 3E | | MI | 3220 | 1803 | 4920 | 1505 | 5989 | 1243 | 6668 | 1024 | 7563 | 675 | 8944 | 316 | 7340 |
| 8-#14 | 2.50 | MA | 5870 | 1803 | 7770 | 1624 | 9988 | 1349 | 11282 | 1131 | 12902 | 759 | 16534 | 375 | 13747 |
| 4L-2S | | MI | 3537 | 1803 | 5512 | 1491 | 6738 | 1233 | 7574 | 1018 | 8783 | 667 | 10466 | 482 | 7394 |
| 8-#18 | 4.44 | MA | 7434 | 2215 | 11542 | 1863 | 14714 | 1522 | 17035 | 1227 | 20638 | 738 | 26910 | 316 | 25272 |
| 3E | | MI | 3639 | 2215 | 6262 | 1749 | 7617 | 1418 | 8602 | 1130 | 10123 | 646 | 11795 | 19 | 11740 |
| 8-#18 | 4.44 | MA | 6803 | 2215 | 10030 | 1903 | 12739 | 1558 | 14509 | 1277 | 17185 | 763 | 22629 | 148 | 21678 |
| 4L-2S | | MI | 4103 | 2215 | 7273 | 1730 | 8897 | 1406 | 10149 | 1125 | 12201 | 637 | 14284 | 313 | 12353 |
| 10-#10 | 1.76 | MA | 6405 | 1647 | 8358 | 1492 | 10866 | 1245 | 12475 | 1045 | 14586 | 731 | 18595 | 634 | 10801 |
| 2L-5S | | MI | 2893 | 1647 | 3966 | 1444 | 4827 | 1208 | 5293 | 1012 | 5731 | 703 | 6866 | 360 | 5190 |
| 10-#10 | 1.76 | MA | 5969 | 1647 | 7634 | 1506 | 9951 | 1258 | 11368 | 1058 | 13095 | 747 | 16530 | 552 | 10751 |
| 3L-4S | | MI | 3001 | 1647 | 4188 | 1435 | 5140 | 1195 | 5664 | 1006 | 6242 | 696 | 7533 | 415 | 5436 |
| 10-#10 | 1.76 | MA | 5723 | 1647 | 7139 | 1520 | 9304 | 1271 | 10539 | 1075 | 11961 | 757 | 15151 | 500 | 10599 |
| 4L-3S | | MI | 3124 | 1647 | 4436 | 1426 | 5463 | 1188 | 6076 | 995 | 6804 | 694 | 8207 | 465 | 5475 |
| 10-#10 | 1.76 | MA | 5445 | 1647 | 6697 | 1534 | 8680 | 1290 | 9802 | 1088 | 10939 | 773 | 13686 | 451 | 10011 |
| 5L-2S | | MI | 3330 | 1647 | 4786 | 1416 | 5906 | 1181 | 6611 | 989 | 7525 | 686 | 9151 | 559 | 5484 |
| 10-#11 | 2.17 | MA | 6220 | 1732 | 8327 | 1555 | 10769 | 1293 | 12328 | 1079 | 14359 | 742 | 18260 | 523 | 13000 |
| 3L-4S | | MI | 3070 | 1732 | 4476 | 1477 | 5452 | 1224 | 6011 | 1022 | 6685 | 683 | 8007 | 345 | 6389 |
| 10-#11 | 2.17 | MA | 5937 | 1732 | 7724 | 1571 | 9982 | 1309 | 11320 | 1100 | 12981 | 754 | 16574 | 459 | 12750 |
| 4L-3S | | MI | 3213 | 1732 | 4774 | 1467 | 5840 | 1216 | 6506 | 1010 | 7361 | 682 | 8795 | 404 | 6525 |
| 10-#11 | 2.17 | MA | 5609 | 1732 | 7191 | 1588 | 9222 | 1331 | 10423 | 1115 | 11737 | 772 | 14787 | 396 | 11811 |
| 5L-2S | | MI | 3448 | 1732 | 5192 | 1457 | 6370 | 1209 | 7146 | 1005 | 8223 | 675 | 9895 | 518 | 6546 |
| 10-#14 | 3.13 | MA | 6844 | 1935 | 9887 | 1683 | 12702 | 1388 | 14644 | 1141 | 17458 | 738 | 22536 | 461 | 18407 |
| 3L-4S | | MI | 3283 | 1935 | 5089 | 1601 | 6187 | 1313 | 6871 | 1079 | 7824 | 669 | 9369 | 204 | 8457 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 3.13 | MA | 6483 | 1935 | 9025 | 1707 | 11575 | 1410 | 13202 | 1170 | 15486 | 754 | 20112 | 368 | 17361 |
| 4L-3S | | MI | 3462 | 1935 | 5512 | 1587 | 6738 | 1303 | 7574 | 1063 | 8783 | 670 | 10466 | 286 | 9040 |
| 10-#14 | 3.13 | MA | 6027 | 1935 | 8260 | 1730 | 10487 | 1442 | 11916 | 1190 | 13704 | 780 | 17548 | 275 | 15989 |
| 5L-2S | | MI | 3759 | 1935 | 6104 | 1574 | 7487 | 1294 | 8480 | 1057 | 10003 | 662 | 11989 | 451 | 9118 |
| 10-#18 | 5.56 | MA | 7884 | 2450 | 12218 | 2050 | 15507 | 1666 | 17857 | 1347 | 21694 | 754 | 28871 | 136 | 28001 |
| 4L-3S | | MI | 4032 | 2450 | 7273 | 1896 | 8897 | 1526 | 10149 | 1199 | 12201 | 637 | 14284 | -51 | 14193 |
| 10-#18 | 5.56 | MA | 7065 | 2450 | 10875 | 2090 | 13599 | 1720 | 15602 | 1379 | 18570 | 797 | 24546 | -14 | 24186 |
| 5L-2S | | MI | 4457 | 2450 | 8285 | 1877 | 10176 | 1514 | 11696 | 1194 | 14280 | 628 | 16772 | 243 | 15276 |
| 12-#10 | 2.12 | MA | 6312 | 1722 | 8358 | 1553 | 10866 | 1292 | 12475 | 1080 | 14586 | 744 | 18595 | 548 | 12855 |
| 3L-5S | | MI | 3058 | 1722 | 4316 | 1491 | 5269 | 1243 | 5829 | 1034 | 6452 | 701 | 7811 | 349 | 6163 |
| 12-#10 | 2.12 | MA | 6083 | 1722 | 7863 | 1567 | 10219 | 1306 | 11647 | 1097 | 13452 | 754 | 17216 | 496 | 12698 |
| 4E | | MI | 3158 | 1722 | 4538 | 1481 | 5583 | 1230 | 6199 | 1028 | 6963 | 693 | 8478 | 404 | 6442 |
| 12-#10 | 2.12 | MA | 5810 | 1722 | 7421 | 1580 | 9595 | 1324 | 10909 | 1110 | 12430 | 770 | 15750 | 447 | 12099 |
| 5L-3S | | MI | 3275 | 1722 | 4786 | 1472 | 5906 | 1222 | 6611 | 1017 | 7525 | 691 | 9151 | 454 | 6491 |
| 12-#10 | 2.12 | MA | 5495 | 1722 | 6943 | 1588 | 9025 | 1337 | 10208 | 1122 | 11434 | 781 | 14475 | 389 | 11533 |
| 6L-2S | | MI | 3473 | 1722 | 5136 | 1463 | 6348 | 1215 | 7146 | 1011 | 8246 | 683 | 10095 | 548 | 6508 |
| 12-#11 | 2.60 | MA | 6362 | 1824 | 8602 | 1629 | 11092 | 1351 | 12663 | 1127 | 14790 | 750 | 19078 | 454 | 15297 |
| 4E | | MI | 3262 | 1824 | 4894 | 1534 | 5982 | 1266 | 6651 | 1049 | 7548 | 680 | 9106 | 327 | 7533 |
| 12-#11 | 2.60 | MA | 6040 | 1824 | 8069 | 1646 | 10333 | 1374 | 11766 | 1142 | 13546 | 769 | 17291 | 391 | 14350 |
| 5L-3S | | MI | 3391 | 1824 | 5192 | 1524 | 6370 | 1258 | 7146 | 1037 | 8223 | 679 | 9895 | 386 | 7735 |
| 12-#11 | 2.60 | MA | 5672 | 1824 | 7489 | 1654 | 9648 | 1389 | 10891 | 1163 | 12334 | 781 | 15735 | 318 | 13515 |
| 6L-2S | | MI | 3610 | 1824 | 5611 | 1514 | 6899 | 1251 | 7787 | 1032 | 9086 | 672 | 10994 | 500 | 7768 |
| 12-#14 | 3.75 | MA | 7069 | 2068 | 10279 | 1789 | 13162 | 1471 | 15121 | 1209 | 18070 | 749 | 23689 | 362 | 20981 |
| 4E | | MI | 3534 | 2068 | 5681 | 1683 | 6936 | 1374 | 7777 | 1118 | 9044 | 664 | 10891 | 174 | 10090 |
| 12-#14 | 3.75 | MA | 6622 | 2068 | 9514 | 1813 | 12073 | 1503 | 13835 | 1229 | 16288 | 775 | 21126 | 268 | 19627 |
| 5L-3S | | MI | 3697 | 2068 | 6104 | 1670 | 7487 | 1364 | 8480 | 1102 | 10003 | 665 | 11989 | 256 | 10740 |
| 12-#14 | 3.75 | MA | 6133 | 2068 | 8692 | 1826 | 11091 | 1524 | 12582 | 1259 | 14552 | 791 | 18891 | 161 | 17835 |
| 6L-2S | | MI | 3976 | 2068 | 6696 | 1657 | 8236 | 1354 | 9386 | 1096 | 11222 | 657 | 13511 | 421 | 10837 |
| 12-#18 | 6.67 | MA | 8101 | 2686 | 13064 | 2237 | 16367 | 1828 | 18951 | 1448 | 23078 | 788 | 30789 | -26 | 30258 |
| 5L-3S | | MI | 4414 | 2686 | 8285 | 2043 | 10176 | 1634 | 11696 | 1268 | 14280 | 627 | 16772 | -121 | 16523 |
| 12-#18 | 6.67 | MA | 7360 | 2686 | 11650 | 2262 | 14643 | 1864 | 16751 | 1498 | 20034 | 813 | 26655 | -244 | 25619 |
| 6L-2S | | MI | 4808 | 2686 | 9296 | 2024 | 11455 | 1622 | 13244 | 1263 | 16358 | 618 | 19260 | 173 | 18195 |
| 14-#10 | 2.47 | MA | 6432 | 1796 | 8587 | 1613 | 11135 | 1340 | 12754 | 1119 | 14943 | 751 | 19280 | 492 | 14800 |
| 4L-5S | | MI | 3215 | 1796 | 4666 | 1537 | 5712 | 1277 | 6364 | 1056 | 7173 | 698 | 8755 | 338 | 7141 |
| 14-#10 | 2.47 | MA | 6162 | 1796 | 8144 | 1627 | 10511 | 1359 | 12017 | 1132 | 13921 | 767 | 17815 | 443 | 14191 |
| 5L-4S | | MI | 3312 | 1796 | 4888 | 1528 | 6026 | 1264 | 6735 | 1050 | 7684 | 690 | 9422 | 393 | 7440 |
| 14-#10 | 2.47 | MA | 5862 | 1796 | 7667 | 1634 | 9941 | 1371 | 11316 | 1144 | 12925 | 778 | 16539 | 385 | 13638 |
| 6L-3S | | MI | 3422 | 1796 | 5136 | 1519 | 6348 | 1257 | 7146 | 1039 | 8246 | 688 | 10095 | 443 | 7505 |
| 14-#10 | 2.47 | MA | 5598 | 1796 | 7210 | 1644 | 9341 | 1379 | 10601 | 1161 | 11958 | 794 | 15222 | 350 | 12800 |
| 7L-2S | | MI | 3612 | 1796 | 5486 | 1510 | 6791 | 1249 | 7682 | 1033 | 8967 | 680 | 11040 | 537 | 7529 |
| 14-#11 | 3.03 | MA | 6456 | 1916 | 8947 | 1703 | 11443 | 1416 | 13109 | 1169 | 15354 | 765 | 19795 | 386 | 16893 |
| 5L-4S | | MI | 3439 | 1916 | 5313 | 1592 | 6511 | 1308 | 7292 | 1076 | 8410 | 676 | 10205 | 309 | 8686 |
| 14-#11 | 3.03 | MA | 6107 | 1916 | 8367 | 1712 | 10758 | 1431 | 12234 | 1190 | 14142 | 777 | 18239 | 313 | 16054 |
| 6L-3S | | MI | 3560 | 1916 | 5611 | 1581 | 6899 | 1301 | 7787 | 1064 | 9086 | 676 | 10994 | 368 | 8943 |
| 14-#11 | 3.03 | MA | 5799 | 1916 | 7812 | 1723 | 10029 | 1440 | 11389 | 1204 | 12964 | 796 | 16625 | 269 | 15004 |
| 7L-2S | | MI | 3769 | 1916 | 6030 | 1571 | 7429 | 1293 | 8428 | 1059 | 9948 | 668 | 12093 | 483 | 8987 |
| 14-#14 | 4.38 | MA | 7195 | 2200 | 10769 | 1896 | 13660 | 1563 | 15754 | 1268 | 18872 | 770 | 24704 | 262 | 23264 |
| 5L-4S | | MI | 3777 | 2200 | 6273 | 1766 | 7685 | 1435 | 8683 | 1157 | 10264 | 659 | 12414 | 144 | 11734 |
| 14-#14 | 4.38 | MA | 6737 | 2200 | 9947 | 1909 | 12678 | 1585 | 14501 | 1298 | 17136 | 786 | 22469 | 154 | 21459 |
| 6L-3S | | MI | 3926 | 2200 | 6696 | 1753 | 8236 | 1425 | 9386 | 1141 | 11222 | 661 | 13511 | 226 | 12440 |
| 14-#14 | 4.38 | MA | 6331 | 2200 | 9152 | 1925 | 11644 | 1599 | 13289 | 1318 | 15448 | 812 | 20148 | 89 | 19687 |
| 7L-2S | | MI | 4189 | 2200 | 7288 | 1739 | 8985 | 1415 | 10292 | 1135 | 12442 | 652 | 15034 | 391 | 12553 |
| 14-#18 | 7.78 | MA | 8384 | 2921 | 13839 | 2409 | 17411 | 1973 | 20100 | 1567 | 24542 | 804 | 32897 | -256 | 31393 |
| 6L-3S | | MI | 4791 | 2921 | 9296 | 2190 | 11455 | 1742 | 13244 | 1337 | 16358 | 618 | 19260 | -191 | 18819 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 36"

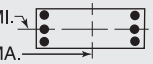
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.82 | MA | 6505 | 1871 | 8868 | 1674 | 11426 | 1393 | 13124 | 1154 | 15412 | 765 | 19879 | 439 | 16285 |
| 5E | | MI | 3367 | 1871 | 5016 | 1584 | 6155 | 1311 | 6900 | 1078 | 7893 | 695 | 9699 | 326 | 8124 |
| 16-#10 | 2.82 | MA | 6218 | 1871 | 8390 | 1681 | 10857 | 1405 | 12423 | 1166 | 14416 | 775 | 18604 | 382 | 15743 |
| 6L-4S | | MI | 3470 | 1871 | 5238 | 1575 | 6468 | 1298 | 7270 | 1072 | 8405 | 687 | 10366 | 382 | 8408 |
| 16-#10 | 2.82 | MA | 5967 | 1871 | 7934 | 1691 | 10256 | 1413 | 11708 | 1183 | 13449 | 791 | 17286 | 346 | 14898 |
| 7L-3S | | MI | 3570 | 1871 | 5486 | 1566 | 6791 | 1291 | 7682 | 1061 | 8967 | 685 | 11040 | 432 | 8518 |
| 16-#10 | 2.82 | MA | 5734 | 1871 | 7431 | 1707 | 9637 | 1428 | 10980 | 1191 | 12485 | 801 | 16010 | 299 | 14081 |
| 8L-2S | | MI | 3748 | 1871 | 5836 | 1557 | 7234 | 1284 | 8217 | 1055 | 9688 | 678 | 11984 | 525 | 8549 |
| 16-#11 | 3.47 | MA | 6528 | 2008 | 9245 | 1769 | 11869 | 1473 | 13577 | 1217 | 15951 | 774 | 20742 | 308 | 18593 |
| 6L-4S | | MI | 3612 | 2008 | 5732 | 1649 | 7041 | 1351 | 7933 | 1103 | 9273 | 673 | 11304 | 291 | 9847 |
| 16-#11 | 3.47 | MA | 6238 | 2008 | 8690 | 1780 | 11140 | 1483 | 12732 | 1231 | 14773 | 793 | 19128 | 264 | 17547 |
| 7L-3S | | MI | 3725 | 2008 | 6030 | 1639 | 7429 | 1343 | 8428 | 1091 | 9948 | 672 | 12093 | 350 | 10151 |
| 16-#11 | 3.47 | MA | 5963 | 2008 | 8078 | 1800 | 10386 | 1501 | 11856 | 1241 | 13599 | 804 | 17570 | 204 | 16372 |
| 8L-2S | | MI | 3925 | 2008 | 6448 | 1629 | 7959 | 1335 | 9068 | 1085 | 10811 | 665 | 13192 | 465 | 10203 |
| 16-#14 | 5.00 | MA | 7319 | 2333 | 11201 | 1992 | 14265 | 1646 | 16420 | 1337 | 19720 | 782 | 26047 | 147 | 25084 |
| 6L-4S | | MI | 4015 | 2333 | 6865 | 1849 | 8434 | 1496 | 9589 | 1196 | 11484 | 654 | 13936 | 114 | 13387 |
| 16-#14 | 5.00 | MA | 6943 | 2333 | 10406 | 2007 | 13231 | 1660 | 15208 | 1356 | 18032 | 808 | 23726 | 82 | 23301 |
| 7L-3S | | MI | 4150 | 2333 | 7288 | 1836 | 8985 | 1486 | 10292 | 1180 | 12442 | 656 | 15034 | 196 | 14141 |
| 16-#14 | 5.00 | MA | 6559 | 2333 | 9530 | 2035 | 12153 | 1685 | 13967 | 1371 | 16351 | 824 | 21488 | -7 | 21464 |
| 8L-2S | | MI | 4401 | 2333 | 7881 | 1822 | 9735 | 1476 | 11198 | 1174 | 13662 | 647 | 16556 | 361 | 14267 |
| 18-#10 | 3.17 | MA | 6563 | 1946 | 9114 | 1728 | 11772 | 1440 | 13530 | 1188 | 15907 | 772 | 20668 | 378 | 17847 |
| 6L-5S | | MI | 3521 | 1946 | 5366 | 1631 | 6598 | 1346 | 7435 | 1100 | 8614 | 692 | 10644 | 315 | 9110 |
| 18-#10 | 3.17 | MA | 6325 | 1946 | 8657 | 1738 | 11172 | 1448 | 12816 | 1205 | 14940 | 788 | 19351 | 342 | 16996 |
| 7L-4S | | MI | 3616 | 1946 | 5588 | 1622 | 6911 | 1333 | 7806 | 1094 | 9126 | 684 | 11311 | 371 | 9382 |
| 18-#10 | 3.17 | MA | 6096 | 1946 | 8155 | 1754 | 10552 | 1463 | 12088 | 1213 | 13976 | 799 | 18074 | 295 | 16173 |
| 8L-3S | | MI | 3710 | 1946 | 5836 | 1612 | 7234 | 1325 | 8217 | 1083 | 9688 | 682 | 11984 | 421 | 9529 |
| 18-#10 | 3.17 | MA | 5807 | 1946 | 7718 | 1765 | 9978 | 1473 | 11355 | 1228 | 13025 | 815 | 16760 | 242 | 15328 |
| 9L-2S | | MI | 3881 | 1946 | 6186 | 1603 | 7677 | 1318 | 8753 | 1077 | 10409 | 675 | 12928 | 514 | 9566 |
| 18-#11 | 3.90 | MA | 6663 | 2099 | 9567 | 1838 | 12250 | 1525 | 14075 | 1258 | 16581 | 789 | 21632 | 259 | 20090 |
| 7L-4S | | MI | 3782 | 2099 | 6150 | 1706 | 7570 | 1393 | 8573 | 1130 | 10135 | 669 | 12403 | 273 | 11013 |
| 18-#11 | 3.90 | MA | 6393 | 2099 | 8956 | 1858 | 11497 | 1543 | 13199 | 1268 | 15408 | 801 | 20074 | 199 | 18909 |
| 8L-3S | | MI | 3887 | 2099 | 6448 | 1696 | 7959 | 1385 | 9068 | 1118 | 10811 | 669 | 13192 | 332 | 11358 |
| 18-#11 | 3.90 | MA | 6056 | 2099 | 8430 | 1872 | 10797 | 1555 | 12307 | 1285 | 14250 | 820 | 18465 | 133 | 17738 |
| 9L-2S | | MI | 4078 | 2099 | 6867 | 1686 | 8488 | 1377 | 9709 | 1112 | 11673 | 661 | 14291 | 447 | 11418 |
| 18-#14 | 5.63 | MA | 7584 | 2465 | 11660 | 2090 | 14818 | 1721 | 17127 | 1395 | 20616 | 803 | 27304 | 76 | 26915 |
| 7L-4S | | MI | 4248 | 2465 | 7457 | 1932 | 9183 | 1557 | 10495 | 1235 | 12704 | 649 | 15459 | 83 | 15048 |
| 18-#14 | 5.63 | MA | 7157 | 2465 | 10785 | 2118 | 13740 | 1746 | 15886 | 1410 | 18935 | 819 | 25066 | -14 | 25001 |
| 8L-3S | | MI | 4372 | 2465 | 7881 | 1918 | 9735 | 1547 | 11198 | 1219 | 13662 | 651 | 16556 | 166 | 15843 |
| 20-#10 | 3.53 | MA | 6674 | 2021 | 9381 | 1784 | 12087 | 1482 | 13923 | 1227 | 16431 | 785 | 21415 | 339 | 19094 |
| 7L-5S | | MI | 3666 | 2021 | 5716 | 1678 | 7040 | 1380 | 7971 | 1122 | 9335 | 689 | 11588 | 304 | 10099 |
| 20-#10 | 3.53 | MA | 6449 | 2021 | 8878 | 1801 | 11468 | 1497 | 13195 | 1235 | 15467 | 796 | 20138 | 291 | 18266 |
| 8L-4S | | MI | 3760 | 2021 | 5938 | 1668 | 7354 | 1367 | 8341 | 1116 | 9847 | 682 | 12255 | 360 | 10359 |
| 20-#10 | 3.53 | MA | 6171 | 2021 | 8442 | 1812 | 10893 | 1508 | 12462 | 1250 | 14516 | 812 | 18825 | 238 | 17423 |
| 9L-3S | | MI | 3848 | 2021 | 6186 | 1659 | 7677 | 1360 | 8753 | 1105 | 10409 | 680 | 12928 | 410 | 10541 |
| 20-#10 | 3.53 | MA | 5913 | 2021 | 7987 | 1821 | 10330 | 1519 | 11755 | 1260 | 13547 | 821 | 17545 | 197 | 16453 |
| 10L-2S | | MI | 4013 | 2021 | 6535 | 1650 | 8119 | 1352 | 9288 | 1099 | 11130 | 672 | 13873 | 503 | 10583 |
| 20-#11 | 4.33 | MA | 6811 | 2191 | 9834 | 1915 | 12607 | 1585 | 14542 | 1295 | 17216 | 797 | 22578 | 194 | 21445 |
| 8L-4S | | MI | 3949 | 2191 | 6569 | 1764 | 8100 | 1435 | 9214 | 1157 | 10998 | 666 | 13503 | 256 | 12184 |
| 20-#11 | 4.33 | MA | 6489 | 2191 | 9308 | 1929 | 11908 | 1597 | 13650 | 1312 | 16058 | 816 | 20969 | 128 | 20270 |
| 9L-3S | | MI | 4046 | 2191 | 6867 | 1754 | 8488 | 1427 | 9709 | 1145 | 11673 | 665 | 14291 | 315 | 12564 |
| 20-#14 | 6.25 | MA | 7782 | 2597 | 12039 | 2201 | 15326 | 1807 | 17805 | 1449 | 21519 | 814 | 28644 | -21 | 28522 |
| 8L-4S | | MI | 4477 | 2597 | 8049 | 2015 | 9932 | 1617 | 11401 | 1274 | 13924 | 644 | 16981 | 53 | 16715 |
| 22-#10 | 3.88 | MA | 6792 | 2095 | 9602 | 1848 | 12383 | 1531 | 14303 | 1257 | 16958 | 793 | 22203 | 287 | 20358 |
| 8L-5S | | MI | 3808 | 2095 | 6066 | 1724 | 7483 | 1414 | 8506 | 1144 | 10056 | 687 | 12532 | 293 | 11091 |
| 22-#10 | 3.88 | MA | 6526 | 2095 | 9166 | 1859 | 11809 | 1542 | 13569 | 1272 | 16007 | 809 | 20889 | 234 | 19518 |
| 9L-4S | | MI | 3901 | 2095 | 6288 | 1715 | 7797 | 1401 | 8876 | 1138 | 10568 | 679 | 13199 | 349 | 11340 |
| 22-#10 | 3.88 | MA | 6279 | 2095 | 8711 | 1867 | 11245 | 1553 | 12863 | 1282 | 15038 | 818 | 19609 | 193 | 18544 |
| 10L-3S | | MI | 3984 | 2095 | 6535 | 1706 | 8119 | 1394 | 9288 | 1127 | 11130 | 677 | 13873 | 399 | 11552 |

## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 4.77 | MA | 6910 | 2283 | 10186 | 1986 | 13018 | 1639 | 14993 | 1339 | 17867 | 813 | 23473 | 123 | 22801 |
| 9L-4S | | MI | 4113 | 2283 | 6988 | 1821 | 8630 | 1477 | 9854 | 1184 | 11860 | 662 | 14602 | 238 | 13359 |
| 24-#10 | 4.23 | MA | 6872 | 2170 | 9889 | 1905 | 12724 | 1576 | 14677 | 1294 | 17498 | 806 | 22954 | 230 | 21612 |
| 9L-5S | | MI | 3947 | 2170 | 6416 | 1771 | 7926 | 1449 | 9042 | 1165 | 10777 | 684 | 13477 | 282 | 12084 |
| 24-#10 | 4.23 | MA | 6636 | 2170 | 9435 | 1914 | 12161 | 1587 | 13970 | 1304 | 16529 | 815 | 21673 | 189 | 20621 |
| 10L-4S | | MI | 4040 | 2170 | 6638 | 1762 | 8239 | 1436 | 9412 | 1160 | 11289 | 676 | 14144 | 338 | 12324 |

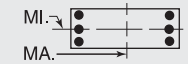
## RECTANGULAR TIED COLUMNS 20" x 38"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.18 | MA | 6486 | 1609 | 8036 | 1486 | 10431 | 1248 | 11841 | 1060 | 13449 | 772 | 16816 | 672 | 8097 |
| 2E | | MI | 3211 | 1609 | 4502 | 1390 | 5448 | 1166 | 5981 | 988 | 6560 | 715 | 7665 | 575 | 3929 |
| 4-#18 | 2.11 | MA | 7360 | 1815 | 10147 | 1604 | 13015 | 1334 | 14921 | 1113 | 17554 | 758 | 22469 | 656 | 13989 |
| 2E | | MI | 3518 | 1815 | 5430 | 1499 | 6548 | 1244 | 7275 | 1034 | 8260 | 694 | 9548 | 486 | 6506 |
| 6-#10 | 1.00 | MA | 6337 | 1568 | 7534 | 1474 | 9901 | 1240 | 11254 | 1057 | 12711 | 781 | 15831 | 681 | 6978 |
| 2L-3S | | MI | 2951 | 1568 | 3904 | 1398 | 4783 | 1175 | 5223 | 1000 | 5580 | 738 | 6564 | 522 | 3445 |
| 6-#10 | 1.00 | MA | 5820 | 1568 | 6763 | 1488 | 8926 | 1254 | 10076 | 1070 | 11123 | 797 | 13634 | 600 | 6954 |
| 3L-2S | | MI | 3175 | 1568 | 4254 | 1389 | 5225 | 1168 | 5759 | 994 | 6301 | 730 | 7509 | 615 | 3432 |
| 6-#11 | 1.23 | MA | 6561 | 1619 | 8109 | 1498 | 10568 | 1258 | 12029 | 1067 | 13724 | 774 | 17212 | 674 | 8458 |
| 2L-3S | | MI | 2991 | 1619 | 4109 | 1417 | 4988 | 1187 | 5444 | 1004 | 5853 | 728 | 6842 | 473 | 4112 |
| 6-#11 | 1.23 | MA | 5953 | 1619 | 7174 | 1515 | 9385 | 1274 | 10598 | 1082 | 11797 | 794 | 14544 | 573 | 8410 |
| 3L-2S | | MI | 3251 | 1619 | 4527 | 1407 | 5517 | 1180 | 6084 | 999 | 6716 | 720 | 7941 | 588 | 4100 |
| 6-#14 | 1.78 | MA | 7104 | 1741 | 9373 | 1569 | 12123 | 1309 | 13887 | 1099 | 16204 | 767 | 20630 | 665 | 12009 |
| 2L-3S | | MI | 3104 | 1741 | 4502 | 1486 | 5448 | 1237 | 5981 | 1033 | 6560 | 719 | 7665 | 380 | 5667 |
| 6-#14 | 1.78 | MA | 6289 | 1741 | 8036 | 1593 | 10431 | 1331 | 11841 | 1119 | 13449 | 794 | 16816 | 516 | 11865 |
| 3L-2S | | MI | 3453 | 1741 | 5094 | 1473 | 6197 | 1227 | 6887 | 1027 | 7780 | 710 | 9187 | 545 | 5684 |
| 6-#18 | 3.16 | MA | 8344 | 2050 | 12483 | 1752 | 15970 | 1442 | 18495 | 1182 | 22366 | 749 | 29131 | 644 | 20799 |
| 2L-3S | | MI | 3373 | 2050 | 5430 | 1665 | 6548 | 1364 | 7275 | 1108 | 8260 | 693 | 9548 | 122 | 9229 |
| 6-#18 | 3.16 | MA | 7092 | 2050 | 10147 | 1793 | 13015 | 1480 | 14921 | 1216 | 17554 | 794 | 22469 | 372 | 20207 |
| 3L-2S | | MI | 3891 | 2050 | 6441 | 1646 | 7827 | 1352 | 8822 | 1103 | 10339 | 684 | 12036 | 416 | 9458 |
| 8-#9 | 1.05 | MA | 6405 | 1579 | 7630 | 1483 | 10045 | 1248 | 11440 | 1063 | 12971 | 782 | 16200 | 681 | 7335 |
| 2L-4S | | MI | 2923 | 1579 | 3818 | 1416 | 4685 | 1190 | 5098 | 1015 | 5415 | 742 | 6422 | 506 | 3611 |
| 8-#9 | 1.05 | MA | 6001 | 1579 | 7020 | 1495 | 9274 | 1259 | 10508 | 1073 | 11716 | 795 | 14463 | 618 | 7318 |
| 3E | | MI | 3031 | 1579 | 4014 | 1408 | 4941 | 1184 | 5425 | 1006 | 5861 | 740 | 6961 | 546 | 3609 |
| 8-#9 | 1.05 | MA | 5766 | 1579 | 6605 | 1506 | 8730 | 1269 | 9812 | 1087 | 10764 | 804 | 13311 | 578 | 7250 |
| 4L-2S | | MI | 3208 | 1579 | 4292 | 1401 | 5293 | 1177 | 5851 | 1001 | 6434 | 733 | 7719 | 620 | 3600 |
| 8-#10 | 1.34 | MA | 6710 | 1643 | 8304 | 1520 | 10876 | 1275 | 12433 | 1079 | 14298 | 778 | 18029 | 677 | 9234 |
| 2L-4S | | MI | 2980 | 1643 | 4007 | 1454 | 4903 | 1217 | 5347 | 1033 | 5739 | 737 | 6835 | 460 | 4457 |
| 8-#10 | 1.34 | MA | 6218 | 1643 | 7534 | 1535 | 9901 | 1288 | 11254 | 1092 | 12711 | 794 | 15831 | 596 | 9195 |
| 3E | | MI | 3111 | 1643 | 4254 | 1445 | 5225 | 1210 | 5759 | 1022 | 6301 | 735 | 7509 | 511 | 4475 |
| 8-#10 | 1.34 | MA | 5933 | 1643 | 7008 | 1549 | 9213 | 1302 | 10374 | 1110 | 11506 | 805 | 14371 | 544 | 9052 |
| 4L-2S | | MI | 3327 | 1643 | 4604 | 1435 | 5668 | 1202 | 6294 | 1016 | 7022 | 728 | 8453 | 604 | 4471 |
| 8-#11 | 1.64 | MA | 6997 | 1711 | 9044 | 1556 | 11751 | 1300 | 13460 | 1094 | 15650 | 771 | 19879 | 669 | 11193 |
| 2L-4S | | MI | 3022 | 1711 | 4229 | 1484 | 5129 | 1237 | 5589 | 1044 | 6040 | 725 | 7152 | 396 | 5290 |
| 8-#11 | 1.64 | MA | 6423 | 1711 | 8109 | 1573 | 10568 | 1316 | 12029 | 1109 | 13724 | 790 | 17212 | 568 | 11126 |
| 3E | | MI | 3176 | 1711 | 4527 | 1474 | 5517 | 1229 | 6084 | 1031 | 6716 | 724 | 7941 | 455 | 5336 |
| 8-#11 | 1.64 | MA | 6091 | 1711 | 7469 | 1590 | 9731 | 1332 | 10957 | 1130 | 12258 | 803 | 15426 | 504 | 10881 |
| 4L-2S | | MI | 3425 | 1711 | 4946 | 1464 | 6047 | 1222 | 6725 | 1026 | 7578 | 717 | 9040 | 570 | 5340 |
| 8-#14 | 2.37 | MA | 7692 | 1873 | 10710 | 1652 | 13814 | 1370 | 15933 | 1138 | 18958 | 762 | 24444 | 658 | 15912 |
| 2L-4S | | MI | 3153 | 1873 | 4671 | 1582 | 5646 | 1307 | 6184 | 1088 | 6821 | 712 | 8090 | 268 | 6929 |
| 8-#14 | 2.37 | MA | 6933 | 1873 | 9373 | 1676 | 12123 | 1392 | 13887 | 1158 | 16204 | 789 | 20630 | 510 | 15741 |
| 3E | | MI | 3363 | 1873 | 5094 | 1569 | 6197 | 1298 | 6887 | 1072 | 7780 | 714 | 9187 | 350 | 7374 |
| 8-#14 | 2.37 | MA | 6497 | 1873 | 8456 | 1700 | 10923 | 1415 | 12352 | 1189 | 14105 | 806 | 18062 | 417 | 14777 |
| 4L-2S | | MI | 3683 | 1873 | 5687 | 1556 | 6946 | 1288 | 7793 | 1066 | 9000 | 705 | 10710 | 515 | 7421 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

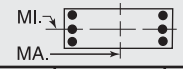



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 4.21 | MA | 8150 | 2286 | 12483 | 1940 | 15970 | 1588 | 18495 | 1285 | 22366 | 785 | 29131 | 360 | 27000 |
| 3E | | MI | 3780 | 2286 | 6441 | 1812 | 7827 | 1472 | 8822 | 1177 | 10339 | 684 | 12036 | 52 | 11884 |
| 8-#18 | 4.21 | MA | 7506 | 2286 | 10873 | 1981 | 13867 | 1625 | 15804 | 1337 | 18688 | 812 | 24594 | 193 | 23265 |
| 4L-2S | | MI | 4252 | 2286 | 7453 | 1793 | 9107 | 1460 | 10369 | 1172 | 12417 | 675 | 14524 | 346 | 12390 |
| 10-#10 | 1.67 | MA | 7071 | 1717 | 9075 | 1567 | 11850 | 1309 | 13612 | 1101 | 15885 | 775 | 20227 | 673 | 11487 |
| 2L-5S | | MI | 3034 | 1717 | 4135 | 1510 | 5032 | 1264 | 5512 | 1061 | 5948 | 742 | 7112 | 394 | 5248 |
| 10-#10 | 1.67 | MA | 6601 | 1717 | 8304 | 1581 | 10876 | 1323 | 12433 | 1114 | 14298 | 792 | 18029 | 592 | 11436 |
| 3L-4S | | MI | 3142 | 1717 | 4357 | 1500 | 5345 | 1251 | 5882 | 1055 | 6460 | 735 | 7779 | 449 | 5465 |
| 10-#10 | 1.67 | MA | 6336 | 1717 | 7778 | 1596 | 10188 | 1336 | 11552 | 1132 | 13093 | 803 | 16569 | 541 | 11285 |
| 4L-3S | | MI | 3267 | 1717 | 4604 | 1491 | 5668 | 1244 | 6294 | 1044 | 7022 | 733 | 8453 | 500 | 5497 |
| 10-#10 | 1.67 | MA | 6034 | 1717 | 7305 | 1609 | 9525 | 1355 | 10769 | 1145 | 12007 | 819 | 15015 | 493 | 10713 |
| 5L-2S | | MI | 3474 | 1717 | 4954 | 1482 | 6111 | 1237 | 6830 | 1038 | 7743 | 725 | 9397 | 593 | 5503 |
| 10-#11 | 2.05 | MA | 6873 | 1803 | 9044 | 1630 | 11751 | 1358 | 13460 | 1136 | 15650 | 787 | 19879 | 563 | 13842 |
| 3L-4S | | MI | 3211 | 1803 | 4648 | 1542 | 5659 | 1279 | 6230 | 1071 | 6903 | 722 | 8251 | 378 | 6463 |
| 10-#11 | 2.05 | MA | 6568 | 1803 | 8404 | 1647 | 10914 | 1374 | 12388 | 1157 | 14185 | 799 | 18093 | 500 | 13592 |
| 4L-3S | | MI | 3356 | 1803 | 4946 | 1532 | 6047 | 1272 | 6725 | 1058 | 7578 | 721 | 9040 | 437 | 6552 |
| 10-#11 | 2.05 | MA | 6212 | 1803 | 7834 | 1664 | 10107 | 1397 | 11434 | 1172 | 12862 | 819 | 16197 | 439 | 12645 |
| 5L-2S | | MI | 3594 | 1803 | 5365 | 1522 | 6577 | 1264 | 7366 | 1053 | 8441 | 713 | 10139 | 552 | 6570 |
| 10-#14 | 2.96 | MA | 7549 | 2006 | 10710 | 1759 | 13814 | 1453 | 15933 | 1197 | 18958 | 784 | 24444 | 503 | 19622 |
| 3L-4S | | MI | 3423 | 2006 | 5263 | 1665 | 6395 | 1368 | 7090 | 1127 | 8041 | 707 | 9612 | 237 | 8544 |
| 10-#14 | 2.96 | MA | 7158 | 2006 | 9793 | 1783 | 12615 | 1476 | 14398 | 1228 | 16859 | 801 | 21876 | 411 | 18639 |
| 4L-3S | | MI | 3606 | 2006 | 5687 | 1652 | 6946 | 1358 | 7793 | 1111 | 9000 | 709 | 10710 | 320 | 9077 |
| 10-#14 | 2.96 | MA | 6662 | 2006 | 8981 | 1807 | 11458 | 1508 | 13031 | 1249 | 14965 | 828 | 19155 | 320 | 17115 |
| 5L-2S | | MI | 3906 | 2006 | 6279 | 1638 | 7695 | 1349 | 8699 | 1105 | 10219 | 700 | 12232 | 485 | 9146 |
| 10-#18 | 5.26 | MA | 8608 | 2521 | 13209 | 2128 | 16821 | 1733 | 19378 | 1406 | 23500 | 803 | 31256 | 181 | 30013 |
| 4L-3S | | MI | 4173 | 2521 | 7453 | 1960 | 9107 | 1580 | 10369 | 1246 | 12417 | 674 | 14524 | -18 | 14493 |
| 10-#18 | 5.26 | MA | 7778 | 2521 | 11781 | 2169 | 14791 | 1789 | 16978 | 1440 | 20175 | 848 | 26468 | 12 | 26497 |
| 5L-2S | | MI | 4607 | 2521 | 8464 | 1940 | 10386 | 1568 | 11916 | 1241 | 14496 | 665 | 17012 | 276 | 15313 |
| 12-#10 | 2.01 | MA | 6970 | 1792 | 9075 | 1628 | 11850 | 1357 | 13612 | 1136 | 15885 | 789 | 20227 | 588 | 13678 |
| 3L-5S | | MI | 3198 | 1792 | 4485 | 1556 | 5475 | 1299 | 6047 | 1083 | 6669 | 739 | 8057 | 383 | 6220 |
| 12-#10 | 2.01 | MA | 6724 | 1792 | 8549 | 1643 | 11162 | 1370 | 12731 | 1154 | 14680 | 800 | 18767 | 537 | 13521 |
| 4E | | MI | 3300 | 1792 | 4707 | 1547 | 5788 | 1286 | 6418 | 1077 | 7181 | 732 | 8724 | 438 | 6472 |
| 12-#10 | 2.01 | MA | 6427 | 1792 | 8075 | 1656 | 10500 | 1390 | 11948 | 1167 | 13594 | 816 | 17213 | 489 | 12940 |
| 5L-3S | | MI | 3418 | 1792 | 4954 | 1538 | 6111 | 1278 | 6830 | 1066 | 7743 | 730 | 9397 | 489 | 6515 |
| 12-#10 | 2.01 | MA | 6089 | 1792 | 7567 | 1664 | 9890 | 1402 | 11204 | 1179 | 12537 | 827 | 15860 | 432 | 12318 |
| 6L-2S | | MI | 3619 | 1792 | 5304 | 1529 | 6554 | 1271 | 7365 | 1060 | 8464 | 722 | 10342 | 582 | 6528 |
| 12-#11 | 2.46 | MA | 7026 | 1895 | 9339 | 1705 | 12097 | 1416 | 13819 | 1184 | 16111 | 796 | 20761 | 495 | 16308 |
| 4E | | MI | 3403 | 1895 | 5066 | 1599 | 6188 | 1322 | 6870 | 1097 | 7765 | 718 | 9350 | 361 | 7605 |
| 12-#11 | 2.46 | MA | 6677 | 1895 | 8769 | 1721 | 11290 | 1439 | 12865 | 1199 | 14789 | 815 | 18865 | 434 | 15355 |
| 5L-3S | | MI | 3535 | 1895 | 5365 | 1589 | 6577 | 1314 | 7366 | 1085 | 8441 | 717 | 10139 | 420 | 7764 |
| 12-#11 | 2.46 | MA | 6281 | 1895 | 8151 | 1730 | 10555 | 1454 | 11959 | 1214 | 13501 | 828 | 17214 | 362 | 14518 |
| 6L-2S | | MI | 3757 | 1895 | 5783 | 1579 | 7106 | 1306 | 8006 | 1080 | 9303 | 710 | 11238 | 534 | 7793 |
| 12-#14 | 3.55 | MA | 7789 | 2138 | 11130 | 1866 | 14306 | 1536 | 16444 | 1267 | 19614 | 796 | 25690 | 404 | 22506 |
| 4E | | MI | 3675 | 2138 | 5855 | 1748 | 7144 | 1429 | 7996 | 1166 | 9261 | 702 | 11135 | 207 | 10174 |
| 12-#14 | 3.55 | MA | 7303 | 2138 | 10318 | 1890 | 13150 | 1569 | 15077 | 1287 | 17719 | 823 | 22969 | 313 | 20994 |
| 5L-3S | | MI | 3841 | 2138 | 6279 | 1735 | 7695 | 1419 | 8699 | 1150 | 10219 | 704 | 12232 | 290 | 10778 |
| 12-#14 | 3.55 | MA | 6776 | 2138 | 9435 | 1903 | 12107 | 1591 | 13745 | 1318 | 15874 | 840 | 20599 | 208 | 19154 |
| 6L-2S | | MI | 4125 | 2138 | 6871 | 1721 | 8444 | 1409 | 9605 | 1144 | 11439 | 695 | 13755 | 455 | 10866 |
| 12-#18 | 6.32 | MA | 8895 | 2756 | 14117 | 2316 | 17745 | 1897 | 20552 | 1509 | 24987 | 839 | 33130 | 0 | 33215 |
| 5L-3S | | MI | 4557 | 2756 | 8464 | 2107 | 10386 | 1688 | 11916 | 1315 | 14496 | 665 | 17012 | -88 | 16835 |
| 12-#18 | 6.32 | MA | 8037 | 2756 | 12595 | 2340 | 15912 | 1934 | 18213 | 1561 | 21747 | 866 | 28945 | -192 | 28072 |
| 6L-2S | | MI | 4958 | 2756 | 9475 | 2087 | 11665 | 1676 | 13464 | 1310 | 16574 | 656 | 19500 | 206 | 18233 |
| 14-#10 | 2.34 | MA | 7099 | 1867 | 9319 | 1689 | 12137 | 1405 | 13910 | 1176 | 16268 | 797 | 20965 | 533 | 15760 |
| 4L-5S | | MI | 3358 | 1867 | 4835 | 1603 | 5917 | 1333 | 6583 | 1105 | 7390 | 737 | 9001 | 372 | 7197 |
| 14-#10 | 2.34 | MA | 6806 | 1867 | 8846 | 1703 | 11475 | 1424 | 13127 | 1189 | 15181 | 813 | 19410 | 485 | 15169 |
| 5L-4S | | MI | 3454 | 1867 | 5057 | 1594 | 6231 | 1320 | 6953 | 1099 | 7902 | 729 | 9668 | 427 | 7478 |
| 14-#10 | 2.34 | MA | 6484 | 1867 | 8338 | 1710 | 10864 | 1436 | 12383 | 1201 | 14124 | 824 | 18058 | 428 | 14559 |
| 6L-3S | | MI | 3567 | 1867 | 5304 | 1585 | 6554 | 1313 | 7365 | 1088 | 8464 | 727 | 10342 | 477 | 7530 |

## RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis



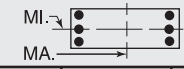

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.34 | MA | 6199 | 1867 | 7852 | 1720 | 10226 | 1444 | 11616 | 1219 | 13097 | 841 | 16665 | 394 | 13725 |
| 7L-2S | | MI | 3760 | 1867 | 5654 | 1576 | 6996 | 1305 | 7900 | 1082 | 9185 | 719 | 11286 | 571 | 7551 |
| 14-#11 | 2.87 | MA | 7125 | 1986 | 9704 | 1779 | 12473 | 1481 | 14296 | 1226 | 16715 | 812 | 21532 | 429 | 18067 |
| 5L-4S | | MI | 3582 | 1986 | 5485 | 1657 | 6718 | 1364 | 7511 | 1124 | 8628 | 715 | 10450 | 343 | 8756 |
| 14-#11 | 2.87 | MA | 6749 | 1986 | 9087 | 1788 | 11739 | 1497 | 13390 | 1241 | 15428 | 824 | 19882 | 357 | 17223 |
| 6L-3S | | MI | 3705 | 1986 | 5783 | 1646 | 7106 | 1356 | 8006 | 1112 | 9303 | 714 | 11238 | 402 | 8974 |
| 14-#11 | 2.87 | MA | 6417 | 1986 | 8496 | 1800 | 10962 | 1506 | 12468 | 1263 | 14177 | 844 | 18175 | 314 | 16080 |
| 7L-2S | | MI | 3917 | 1986 | 6202 | 1636 | 7636 | 1348 | 8647 | 1107 | 10166 | 707 | 12337 | 516 | 9013 |
| 14-#14 | 4.14 | MA | 7920 | 2271 | 11655 | 1973 | 14841 | 1630 | 17122 | 1326 | 20474 | 818 | 26783 | 306 | 24873 |
| 5L-4S | | MI | 3919 | 2271 | 6447 | 1831 | 7893 | 1490 | 8902 | 1205 | 10481 | 698 | 12657 | 177 | 11815 |
| 14-#14 | 4.14 | MA | 7426 | 2271 | 10772 | 1985 | 13798 | 1652 | 15790 | 1357 | 18628 | 835 | 24413 | 201 | 23018 |
| 6L-3S | | MI | 4071 | 2271 | 6871 | 1817 | 8444 | 1480 | 9605 | 1189 | 11439 | 699 | 13755 | 259 | 12479 |
| 14-#14 | 4.14 | MA | 6989 | 2271 | 9926 | 2002 | 12687 | 1665 | 14503 | 1378 | 16835 | 862 | 21955 | 138 | 21196 |
| 7L-2S | | MI | 4339 | 2271 | 7463 | 1804 | 9193 | 1470 | 10511 | 1183 | 12659 | 690 | 15277 | 425 | 12583 |
| 14-#18 | 7.37 | MA | 9195 | 2992 | 14931 | 2487 | 18867 | 2043 | 21786 | 1630 | 26559 | 857 | 35607 | -204 | 34328 |
| 6L-3S | | MI | 4934 | 2992 | 9475 | 2254 | 11665 | 1797 | 13464 | 1385 | 16574 | 655 | 19500 | -158 | 19142 |
| 16-#10 | 2.67 | MA | 7175 | 1942 | 9616 | 1749 | 12449 | 1458 | 14306 | 1211 | 16769 | 811 | 21608 | 481 | 17401 |
| 5E | | MI | 3510 | 1942 | 5185 | 1650 | 6360 | 1367 | 7118 | 1127 | 8111 | 734 | 9945 | 361 | 8179 |
| 16-#10 | 2.67 | MA | 6866 | 1942 | 9108 | 1757 | 11839 | 1470 | 13562 | 1223 | 15711 | 822 | 20256 | 425 | 16801 |
| 6L-4S | | MI | 3605 | 1942 | 5407 | 1641 | 6674 | 1354 | 7489 | 1121 | 8623 | 726 | 10612 | 416 | 8470 |
| 16-#10 | 2.67 | MA | 6596 | 1942 | 8623 | 1767 | 11201 | 1479 | 12795 | 1241 | 14684 | 838 | 18863 | 390 | 15959 |
| 7L-3S | | MI | 3716 | 1942 | 5654 | 1631 | 6996 | 1347 | 7900 | 1110 | 9185 | 724 | 11286 | 466 | 8543 |
| 16-#10 | 2.67 | MA | 6343 | 1942 | 8089 | 1784 | 10542 | 1494 | 12022 | 1249 | 13661 | 849 | 17510 | 344 | 15125 |
| 8L-2S | | MI | 3896 | 1942 | 6004 | 1622 | 7439 | 1340 | 8436 | 1104 | 9906 | 716 | 12230 | 560 | 8571 |
| 16-#11 | 3.28 | MA | 7201 | 2078 | 10022 | 1845 | 12922 | 1539 | 14820 | 1268 | 17355 | 821 | 22549 | 353 | 19929 |
| 6L-4S | | MI | 3756 | 2078 | 5904 | 1714 | 7248 | 1406 | 8152 | 1151 | 9490 | 711 | 11549 | 325 | 9915 |
| 16-#11 | 3.28 | MA | 6889 | 2078 | 9431 | 1857 | 12145 | 1548 | 13899 | 1290 | 16103 | 840 | 20842 | 309 | 18790 |
| 7L-3S | | MI | 3870 | 2078 | 6202 | 1704 | 7636 | 1398 | 8647 | 1139 | 10166 | 711 | 12337 | 384 | 10182 |
| 16-#11 | 3.28 | MA | 6591 | 2078 | 8781 | 1877 | 11344 | 1567 | 12958 | 1299 | 14857 | 853 | 19190 | 251 | 17589 |
| 8L-2S | | MI | 4074 | 2078 | 6621 | 1694 | 8165 | 1390 | 9287 | 1134 | 11028 | 703 | 13436 | 499 | 10230 |
| 16-#14 | 4.74 | MA | 8052 | 2403 | 12109 | 2068 | 15490 | 1713 | 17836 | 1396 | 21383 | 830 | 28227 | 194 | 26882 |
| 6L-4S | | MI | 4157 | 2403 | 7040 | 1913 | 8642 | 1551 | 9808 | 1244 | 11701 | 693 | 14179 | 147 | 13466 |
| 16-#14 | 4.74 | MA | 7647 | 2403 | 11263 | 2085 | 14378 | 1726 | 16549 | 1416 | 19589 | 857 | 25770 | 131 | 25048 |
| 7L-3S | | MI | 4296 | 2403 | 7463 | 1900 | 9193 | 1541 | 10511 | 1228 | 12659 | 694 | 15277 | 229 | 14180 |
| 16-#14 | 4.74 | MA | 7229 | 2403 | 10332 | 2113 | 13231 | 1752 | 15213 | 1431 | 17802 | 874 | 23396 | 44 | 23207 |
| 8L-2S | | MI | 4551 | 2403 | 8055 | 1887 | 9942 | 1531 | 11417 | 1222 | 13879 | 685 | 16800 | 394 | 14298 |
| 18-#10 | 3.01 | MA | 7238 | 2016 | 9879 | 1804 | 12813 | 1505 | 14741 | 1245 | 17299 | 819 | 22453 | 421 | 19042 |
| 6L-5S | | MI | 3665 | 2016 | 5535 | 1697 | 6803 | 1402 | 7654 | 1148 | 8832 | 731 | 10890 | 349 | 9164 |
| 18-#10 | 3.01 | MA | 6981 | 2016 | 9393 | 1814 | 12175 | 1513 | 13974 | 1263 | 16271 | 835 | 21060 | 386 | 18193 |
| 7L-4S | | MI | 3760 | 2016 | 5757 | 1687 | 7116 | 1389 | 8024 | 1143 | 9344 | 723 | 11557 | 405 | 9442 |
| 18-#10 | 3.01 | MA | 6733 | 2016 | 8859 | 1831 | 11517 | 1528 | 13201 | 1271 | 15248 | 846 | 19707 | 340 | 17353 |
| 8L-3S | | MI | 3857 | 2016 | 6004 | 1678 | 7439 | 1381 | 8436 | 1132 | 9906 | 721 | 12230 | 455 | 9556 |
| 18-#10 | 3.01 | MA | 6422 | 2016 | 8392 | 1842 | 10907 | 1539 | 12422 | 1286 | 14239 | 863 | 18318 | 287 | 16433 |
| 9L-2S | | MI | 4031 | 2016 | 6354 | 1669 | 7882 | 1374 | 8971 | 1126 | 10627 | 714 | 13175 | 549 | 9589 |
| 18-#11 | 3.69 | MA | 7346 | 2170 | 10366 | 1914 | 13328 | 1591 | 15330 | 1317 | 18030 | 837 | 23510 | 304 | 21500 |
| 7L-4S | | MI | 3926 | 2170 | 6323 | 1771 | 7777 | 1448 | 8792 | 1178 | 10353 | 708 | 12648 | 307 | 11080 |
| 18-#11 | 3.69 | MA | 7053 | 2170 | 9716 | 1935 | 12527 | 1609 | 14389 | 1326 | 16783 | 849 | 21857 | 246 | 20291 |
| 8L-3S | | MI | 4033 | 2170 | 6621 | 1761 | 8165 | 1440 | 9287 | 1166 | 11028 | 707 | 13436 | 366 | 11389 |
| 18-#11 | 3.69 | MA | 6690 | 2170 | 9153 | 1948 | 11784 | 1621 | 13441 | 1344 | 15553 | 869 | 20155 | 180 | 19093 |
| 9L-2S | | MI | 4228 | 2170 | 7039 | 1751 | 8695 | 1433 | 9928 | 1161 | 11891 | 700 | 14536 | 481 | 11445 |
| 18-#14 | 5.33 | MA | 8282 | 2536 | 12600 | 2167 | 16070 | 1787 | 18595 | 1455 | 22344 | 852 | 29584 | 124 | 28901 |
| 7L-4S | | MI | 4390 | 2536 | 7632 | 1996 | 9391 | 1611 | 10714 | 1283 | 12921 | 688 | 15702 | 117 | 15124 |
| 18-#14 | 5.33 | MA | 7872 | 2536 | 11669 | 2196 | 14922 | 1813 | 17259 | 1470 | 20557 | 869 | 27210 | 37 | 27051 |
| 8L-3S | | MI | 4518 | 2536 | 8055 | 1983 | 9942 | 1602 | 11417 | 1267 | 13879 | 689 | 16800 | 199 | 15883 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

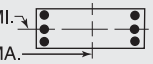
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 3.34 | MA | 7356 | 2091 | 10164 | 1860 | 13150 | 1547 | 15153 | 1285 | 17859 | 832 | 23258 | 382 | 20427 |
| 7L-5S | | MI | 3810 | 2091 | 5885 | 1743 | 7245 | 1436 | 8189 | 1170 | 9553 | 728 | 11834 | 338 | 10152 |
| 20-#10 | 3.34 | MA | 7112 | 2091 | 9630 | 1877 | 12492 | 1563 | 14380 | 1293 | 16835 | 843 | 21905 | 336 | 19581 |
| 8L-4S | | MI | 3904 | 2091 | 6107 | 1734 | 7559 | 1423 | 8560 | 1165 | 10065 | 721 | 12501 | 394 | 10418 |
| 20-#10 | 3.34 | MA | 6813 | 2091 | 9162 | 1888 | 11881 | 1573 | 13601 | 1308 | 15826 | 860 | 20516 | 283 | 18664 |
| 9L-3S | | MI | 3995 | 2091 | 6354 | 1725 | 7882 | 1416 | 8971 | 1154 | 10627 | 719 | 13175 | 444 | 10567 |
| 20-#10 | 3.34 | MA | 6535 | 2091 | 8679 | 1897 | 11283 | 1585 | 12850 | 1318 | 14786 | 868 | 19159 | 243 | 17671 |
| 10L-2S | | MI | 4163 | 2091 | 6704 | 1716 | 8324 | 1408 | 9507 | 1148 | 11348 | 711 | 14119 | 537 | 10606 |
| 20-#11 | 4.11 | MA | 7502 | 2262 | 10651 | 1992 | 13710 | 1651 | 15820 | 1353 | 18710 | 846 | 24525 | 241 | 22994 |
| 8L-4S | | MI | 4093 | 2262 | 6741 | 1829 | 8307 | 1490 | 9433 | 1205 | 11215 | 704 | 13747 | 289 | 12250 |
| 20-#11 | 4.11 | MA | 7156 | 2262 | 10089 | 2006 | 12967 | 1664 | 14872 | 1371 | 17480 | 865 | 22823 | 175 | 21790 |
| 9L-3S | | MI | 4193 | 2262 | 7039 | 1819 | 8695 | 1483 | 9928 | 1193 | 11891 | 704 | 14536 | 348 | 12597 |
| 20-#11 | 4.11 | MA | 6832 | 2262 | 9501 | 2016 | 12239 | 1677 | 13958 | 1383 | 16232 | 877 | 21166 | 124 | 20539 |
| 10L-2S | | MI | 4381 | 2262 | 7458 | 1808 | 9225 | 1475 | 10568 | 1188 | 12753 | 696 | 15635 | 463 | 12659 |
| 20-#14 | 5.92 | MA | 8496 | 2668 | 13006 | 2279 | 16614 | 1874 | 19305 | 1509 | 23311 | 864 | 31024 | 30 | 30895 |
| 8L-4S | | MI | 4620 | 2668 | 8224 | 2079 | 10140 | 1672 | 11620 | 1322 | 14140 | 683 | 17224 | 87 | 16789 |
| 22-#10 | 3.68 | MA | 7481 | 2166 | 10400 | 1924 | 13466 | 1597 | 15559 | 1315 | 18423 | 840 | 24103 | 332 | 21809 |
| 8L-5S | | MI | 3953 | 2166 | 6235 | 1790 | 7688 | 1470 | 8725 | 1192 | 10274 | 725 | 12778 | 327 | 11143 |
| 22-#10 | 3.68 | MA | 7194 | 2166 | 9933 | 1935 | 12856 | 1608 | 14780 | 1330 | 17413 | 857 | 22713 | 279 | 20894 |
| 9L-4S | | MI | 4046 | 2166 | 6457 | 1781 | 8002 | 1457 | 9095 | 1187 | 10786 | 718 | 13445 | 383 | 11398 |
| 22-#10 | 3.68 | MA | 6928 | 2166 | 9450 | 1944 | 12258 | 1619 | 14029 | 1340 | 16373 | 866 | 21357 | 239 | 19897 |
| 10L-3S | | MI | 4132 | 2166 | 6704 | 1772 | 8324 | 1450 | 9507 | 1176 | 11348 | 716 | 14119 | 433 | 11579 |
| 22-#10 | 3.68 | MA | 6674 | 2166 | 8976 | 1954 | 11655 | 1630 | 13290 | 1351 | 15337 | 880 | 20040 | 191 | 18879 |
| 11L-2S | | MI | 4294 | 2166 | 7054 | 1762 | 8767 | 1443 | 10042 | 1170 | 12069 | 708 | 15063 | 526 | 11623 |
| 22-#11 | 4.52 | MA | 7608 | 2354 | 11024 | 2063 | 14150 | 1706 | 16303 | 1398 | 19407 | 862 | 25491 | 170 | 24487 |
| 9L-4S | | MI | 4258 | 2354 | 7160 | 1886 | 8836 | 1533 | 10073 | 1232 | 12078 | 701 | 14846 | 271 | 13424 |
| 22-#11 | 4.52 | MA | 7300 | 2354 | 10436 | 2073 | 13422 | 1719 | 15389 | 1410 | 18159 | 873 | 23833 | 119 | 23231 |
| 10L-3S | | MI | 4352 | 2354 | 7458 | 1876 | 9225 | 1525 | 10568 | 1220 | 12753 | 700 | 15635 | 331 | 13804 |
| 24-#10 | 4.01 | MA | 7566 | 2241 | 10703 | 1982 | 13831 | 1642 | 15958 | 1352 | 19000 | 854 | 24911 | 275 | 23125 |
| 9L-5S | | MI | 4093 | 2241 | 6585 | 1837 | 8131 | 1505 | 9260 | 1214 | 10995 | 723 | 13723 | 316 | 12135 |
| 24-#10 | 4.01 | MA | 7311 | 2241 | 10220 | 1991 | 13232 | 1654 | 15208 | 1362 | 17960 | 863 | 23554 | 235 | 22123 |
| 10L-4S | | MI | 4186 | 2241 | 6807 | 1828 | 8444 | 1492 | 9630 | 1209 | 11507 | 715 | 14390 | 372 | 12381 |
| 24-#10 | 4.01 | MA | 7069 | 2241 | 9747 | 2000 | 12630 | 1664 | 14469 | 1373 | 16924 | 877 | 22237 | 187 | 21101 |
| 11L-3S | | MI | 4267 | 2241 | 7054 | 1818 | 8767 | 1484 | 10042 | 1197 | 12069 | 713 | 15063 | 422 | 12590 |
| 24-#11 | 4.93 | MA | 7756 | 2446 | 11371 | 2131 | 14605 | 1761 | 16820 | 1437 | 20085 | 870 | 26501 | 114 | 25923 |
| 10L-4S | | MI | 4420 | 2446 | 7579 | 1944 | 9366 | 1575 | 10714 | 1259 | 12940 | 697 | 15945 | 254 | 14601 |

## RECTANGULAR TIED COLUMNS 20" x 40"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.13 | MA | 7141 | 1679 | 8716 | 1561 | 11369 | 1312 | 12917 | 1116 | 14652 | 816 | 18304 | 711 | 8583 |
| 2E | | MI | 3354 | 1679 | 4677 | 1454 | 5656 | 1221 | 6201 | 1036 | 6777 | 753 | 7908 | 609 | 3949 |
| 4-#18 | 2.00 | MA | 8086 | 1885 | 10963 | 1680 | 14120 | 1398 | 16196 | 1168 | 19023 | 802 | 24323 | 695 | 14853 |
| 2E | | MI | 3663 | 1885 | 5610 | 1562 | 6758 | 1298 | 7495 | 1081 | 8476 | 731 | 9789 | 518 | 6535 |
| 6-#11 | 1.17 | MA | 7220 | 1690 | 8792 | 1573 | 11512 | 1322 | 13114 | 1123 | 14941 | 819 | 18720 | 713 | 8963 |
| 2L-3S | | MI | 3132 | 1690 | 4281 | 1482 | 5194 | 1243 | 5663 | 1053 | 6070 | 766 | 7086 | 507 | 4134 |
| 6-#11 | 1.17 | MA | 6569 | 1690 | 7800 | 1591 | 10256 | 1338 | 11595 | 1138 | 12896 | 839 | 15889 | 613 | 8916 |
| 3L-2S | | MI | 3394 | 1690 | 4699 | 1472 | 5724 | 1235 | 6303 | 1047 | 6933 | 759 | 8185 | 621 | 4119 |
| 6-#14 | 1.69 | MA | 7806 | 1812 | 10136 | 1644 | 13165 | 1373 | 15090 | 1155 | 17578 | 811 | 22354 | 704 | 12738 |
| 2L-3S | | MI | 3245 | 1812 | 4677 | 1551 | 5656 | 1292 | 6201 | 1081 | 6777 | 757 | 7908 | 413 | 5698 |
| 6-#14 | 1.69 | MA | 6930 | 1812 | 8716 | 1669 | 11369 | 1396 | 12917 | 1176 | 14652 | 839 | 18304 | 558 | 12594 |
| 3L-2S | | MI | 3598 | 1812 | 5269 | 1537 | 6405 | 1282 | 7107 | 1075 | 7997 | 748 | 9430 | 579 | 5708 |
| 6-#18 | 3.00 | MA | 9145 | 2121 | 13446 | 1827 | 17261 | 1506 | 19995 | 1238 | 24138 | 793 | 31405 | 683 | 22095 |
| 2L-3S | | MI | 3513 | 2121 | 5610 | 1729 | 6758 | 1418 | 7495 | 1155 | 8476 | 731 | 9789 | 155 | 9310 |
| 6-#18 | 3.00 | MA | 7796 | 2121 | 10963 | 1869 | 14120 | 1545 | 16196 | 1273 | 19023 | 840 | 24323 | 415 | 21503 |
| 3L-2S | | MI | 4037 | 2121 | 6621 | 1709 | 8037 | 1406 | 9042 | 1150 | 10555 | 722 | 12277 | 449 | 9491 |
| 8-#9 | 1.00 | MA | 7050 | 1650 | 8281 | 1558 | 10953 | 1312 | 12485 | 1118 | 14137 | 826 | 17640 | 720 | 7767 |
| 2L-4S | | MI | 3064 | 1650 | 3985 | 1482 | 4890 | 1246 | 5317 | 1064 | 5633 | 781 | 6668 | 540 | 3630 |

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

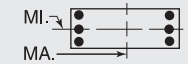
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.00 | MA | 6617 | 1650 | 7634 | 1570 | 10136 | 1323 | 11496 | 1129 | 12806 | 840 | 15797 | 658 | 7750 |
| 3E | | MI | 3173 | 1650 | 4182 | 1474 | 5146 | 1240 | 5643 | 1055 | 6079 | 779 | 7208 | 581 | 3625 |
| 8-#9 | 1.00 | MA | 6366 | 1650 | 7195 | 1582 | 9561 | 1334 | 10759 | 1144 | 11798 | 849 | 14582 | 618 | 7682 |
| 4L-2S | | MI | 3351 | 1650 | 4460 | 1467 | 5498 | 1234 | 6069 | 1050 | 6652 | 772 | 7966 | 654 | 3615 |
| 8-#10 | 1.27 | MA | 7379 | 1713 | 8997 | 1595 | 11836 | 1339 | 13539 | 1135 | 15545 | 822 | 19581 | 716 | 9783 |
| 2L-4S | | MI | 3121 | 1713 | 4176 | 1519 | 5108 | 1273 | 5565 | 1082 | 5957 | 776 | 7081 | 494 | 4482 |
| 8-#10 | 1.27 | MA | 6851 | 1713 | 8180 | 1610 | 10802 | 1353 | 12289 | 1148 | 13862 | 839 | 17250 | 636 | 9744 |
| 3E | | MI | 3254 | 1713 | 4423 | 1510 | 5431 | 1266 | 5977 | 1071 | 6519 | 774 | 7755 | 545 | 4495 |
| 8-#10 | 1.27 | MA | 6546 | 1713 | 7623 | 1625 | 10073 | 1366 | 11356 | 1167 | 12586 | 851 | 15709 | 585 | 9600 |
| 4L-2S | | MI | 3470 | 1713 | 4773 | 1501 | 5873 | 1258 | 6513 | 1065 | 7240 | 767 | 8699 | 638 | 4488 |
| 8-#11 | 1.56 | MA | 7690 | 1782 | 9785 | 1631 | 12768 | 1364 | 14633 | 1150 | 16985 | 815 | 21551 | 708 | 11867 |
| 2L-4S | | MI | 3163 | 1782 | 4401 | 1549 | 5336 | 1293 | 5808 | 1092 | 6257 | 763 | 7397 | 430 | 5324 |
| 8-#11 | 1.56 | MA | 7073 | 1782 | 8792 | 1648 | 11512 | 1380 | 13114 | 1165 | 14941 | 835 | 18720 | 608 | 11800 |
| 3E | | MI | 3318 | 1782 | 4699 | 1539 | 5724 | 1285 | 6303 | 1080 | 6933 | 763 | 8185 | 489 | 5361 |
| 8-#11 | 1.56 | MA | 6717 | 1782 | 8114 | 1666 | 10625 | 1397 | 11979 | 1187 | 13387 | 849 | 16835 | 545 | 11555 |
| 4L-2S | | MI | 3569 | 1782 | 5118 | 1529 | 6254 | 1277 | 6944 | 1074 | 7795 | 755 | 9284 | 604 | 5361 |
| 8-#14 | 2.25 | MA | 8439 | 1944 | 11556 | 1727 | 14962 | 1434 | 17262 | 1194 | 20503 | 806 | 26405 | 697 | 16884 |
| 2L-4S | | MI | 3293 | 1944 | 4846 | 1647 | 5854 | 1362 | 6404 | 1136 | 7038 | 751 | 8333 | 301 | 7017 |
| 8-#14 | 2.25 | MA | 7622 | 1944 | 10136 | 1752 | 13165 | 1457 | 15090 | 1215 | 17578 | 834 | 22354 | 551 | 16713 |
| 3E | | MI | 3505 | 1944 | 5269 | 1633 | 6405 | 1352 | 7107 | 1120 | 7997 | 752 | 9430 | 383 | 7408 |
| 8-#14 | 2.25 | MA | 7154 | 1944 | 9164 | 1777 | 11894 | 1480 | 13462 | 1246 | 15352 | 852 | 19643 | 459 | 15820 |
| 4L-2S | | MI | 3829 | 1944 | 5861 | 1620 | 7154 | 1343 | 8013 | 1114 | 9216 | 743 | 10953 | 549 | 7447 |
| 8-#18 | 4.00 | MA | 8932 | 2356 | 13446 | 2016 | 17261 | 1653 | 19995 | 1342 | 24138 | 831 | 31405 | 403 | 28728 |
| 3E | | MI | 3922 | 2356 | 6621 | 1876 | 8037 | 1526 | 9042 | 1224 | 10555 | 721 | 12277 | 85 | 12025 |
| 8-#18 | 4.00 | MA | 8239 | 2356 | 11739 | 2058 | 15030 | 1692 | 17141 | 1395 | 20235 | 860 | 26612 | 238 | 24867 |
| 4L-2S | | MI | 4400 | 2356 | 7632 | 1856 | 9317 | 1514 | 10589 | 1219 | 12633 | 712 | 14765 | 379 | 12425 |
| 10-#10 | 1.59 | MA | 7766 | 1788 | 9814 | 1642 | 12869 | 1373 | 14790 | 1157 | 17229 | 820 | 21912 | 712 | 12173 |
| 2L-5S | | MI | 3174 | 1788 | 4303 | 1575 | 5237 | 1320 | 5731 | 1109 | 6166 | 781 | 7358 | 428 | 5305 |
| 10-#10 | 1.59 | MA | 7261 | 1788 | 8997 | 1657 | 11836 | 1387 | 13539 | 1170 | 15545 | 837 | 19581 | 632 | 12122 |
| 3L-4S | | MI | 3284 | 1788 | 4525 | 1566 | 5551 | 1307 | 6101 | 1104 | 6678 | 774 | 8026 | 483 | 5493 |
| 10-#10 | 1.59 | MA | 6977 | 1788 | 8440 | 1671 | 11107 | 1401 | 12607 | 1189 | 14269 | 848 | 18040 | 581 | 11971 |
| 4L-3S | | MI | 3410 | 1788 | 4773 | 1557 | 5873 | 1300 | 6513 | 1093 | 7240 | 771 | 8699 | 534 | 5519 |
| 10-#10 | 1.59 | MA | 6651 | 1788 | 7936 | 1685 | 10406 | 1420 | 11778 | 1202 | 13119 | 865 | 16397 | 534 | 11421 |
| 5L-2S | | MI | 3619 | 1788 | 5123 | 1548 | 6316 | 1293 | 7048 | 1087 | 7961 | 764 | 9643 | 627 | 5521 |
| 10-#11 | 1.95 | MA | 7556 | 1874 | 9785 | 1706 | 12768 | 1422 | 14633 | 1192 | 16985 | 832 | 21551 | 603 | 14685 |
| 3L-4S | | MI | 3353 | 1874 | 4820 | 1607 | 5865 | 1335 | 6449 | 1119 | 7120 | 760 | 8496 | 412 | 6524 |
| 10-#11 | 1.95 | MA | 7228 | 1874 | 9107 | 1723 | 11881 | 1439 | 13497 | 1214 | 15432 | 845 | 19666 | 540 | 14435 |
| 4L-3S | | MI | 3499 | 1874 | 5118 | 1597 | 6254 | 1327 | 6944 | 1107 | 7795 | 759 | 9284 | 471 | 6579 |
| 10-#11 | 1.95 | MA | 6843 | 1874 | 8498 | 1740 | 11026 | 1462 | 12487 | 1230 | 14032 | 865 | 17661 | 481 | 13487 |
| 5L-2S | | MI | 3740 | 1874 | 5537 | 1587 | 6783 | 1319 | 7585 | 1101 | 8658 | 752 | 10383 | 586 | 6593 |
| 10-#14 | 2.81 | MA | 8283 | 2077 | 11556 | 1835 | 14962 | 1518 | 17262 | 1254 | 20503 | 829 | 26405 | 544 | 20837 |
| 3L-4S | | MI | 3564 | 2077 | 5438 | 1730 | 6603 | 1423 | 7310 | 1175 | 8258 | 746 | 9855 | 271 | 8629 |
| 10-#14 | 2.81 | MA | 7862 | 2077 | 10584 | 1859 | 13690 | 1541 | 15635 | 1285 | 18277 | 847 | 23693 | 452 | 19930 |
| 4L-3S | | MI | 3749 | 2077 | 5861 | 1716 | 7154 | 1413 | 8013 | 1159 | 9216 | 747 | 10953 | 353 | 9113 |
| 10-#14 | 2.81 | MA | 7326 | 2077 | 9717 | 1883 | 12465 | 1574 | 14187 | 1307 | 16270 | 875 | 20815 | 364 | 18250 |
| 5L-2S | | MI | 4054 | 2077 | 6453 | 1703 | 7903 | 1404 | 8919 | 1153 | 10436 | 738 | 12475 | 518 | 9174 |
| 10-#18 | 5.00 | MA | 9419 | 2592 | 14222 | 2205 | 18171 | 1800 | 20939 | 1465 | 25350 | 851 | 33694 | 226 | 32041 |
| 4L-3S | | MI | 4315 | 2592 | 7632 | 2023 | 9317 | 1634 | 10589 | 1293 | 12633 | 712 | 14765 | 15 | 14717 |
| 10-#18 | 5.00 | MA | 8521 | 2592 | 12710 | 2248 | 16018 | 1857 | 18395 | 1500 | 21824 | 898 | 28625 | 61 | 28417 |
| 5L-2S | | MI | 4756 | 2592 | 8643 | 2004 | 10596 | 1622 | 12136 | 1288 | 14712 | 703 | 17253 | 309 | 15350 |
| 12-#10 | 1.90 | MA | 7658 | 1863 | 9814 | 1704 | 12869 | 1421 | 14790 | 1192 | 17229 | 834 | 21912 | 628 | 14501 |
| 3L-5S | | MI | 3339 | 1863 | 4653 | 1622 | 5680 | 1355 | 6266 | 1131 | 6887 | 778 | 8303 | 417 | 6276 |
| 12-#10 | 1.90 | MA | 7393 | 1863 | 9257 | 1718 | 12141 | 1435 | 13857 | 1211 | 15952 | 845 | 20371 | 577 | 14344 |
| 4E | | MI | 3442 | 1863 | 4875 | 1613 | 5993 | 1342 | 6636 | 1126 | 7399 | 771 | 8970 | 472 | 6501 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis

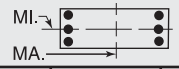



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.90 | MA | 7073 | 1863 | 8753 | 1731 | 11440 | 1455 | 13028 | 1224 | 14803 | 862 | 18728 | 530 | 13787 |
| 5L-3S | | MI | 3562 | 1863 | 5123 | 1604 | 6316 | 1334 | 7048 | 1115 | 7961 | 769 | 9643 | 523 | 6538 |
| 12-#10 | 1.90 | MA | 6711 | 1863 | 8214 | 1739 | 10789 | 1467 | 12241 | 1237 | 13684 | 873 | 17299 | 475 | 13108 |
| 6L-2S | | MI | 3764 | 1863 | 5473 | 1595 | 6759 | 1327 | 7584 | 1109 | 8682 | 761 | 10588 | 616 | 6549 |
| 12-#11 | 2.34 | MA | 7719 | 1965 | 10099 | 1781 | 13136 | 1481 | 15016 | 1241 | 17477 | 842 | 22498 | 536 | 17318 |
| 4E | | MI | 3537 | 1965 | 5239 | 1664 | 6395 | 1377 | 7090 | 1146 | 7982 | 757 | 9595 | 394 | 7676 |
| 12-#11 | 2.34 | MA | 7342 | 1965 | 9491 | 1797 | 12282 | 1504 | 14006 | 1257 | 16076 | 862 | 20492 | 476 | 16367 |
| 5L-3S | | MI | 3679 | 1965 | 5537 | 1654 | 6783 | 1369 | 7585 | 1134 | 8658 | 756 | 10383 | 453 | 7793 |
| 12-#11 | 2.34 | MA | 6918 | 1965 | 8836 | 1806 | 11498 | 1519 | 13046 | 1272 | 14713 | 875 | 18747 | 406 | 15534 |
| 6L-2S | | MI | 3904 | 1965 | 5955 | 1644 | 7313 | 1362 | 8225 | 1128 | 9520 | 748 | 11483 | 568 | 7817 |
| 12-#14 | 3.38 | MA | 8539 | 2209 | 12004 | 1942 | 15487 | 1602 | 17807 | 1324 | 21203 | 842 | 27743 | 445 | 24045 |
| 4E | | MI | 3816 | 2209 | 6030 | 1812 | 7352 | 1484 | 8216 | 1214 | 9478 | 741 | 11378 | 241 | 10256 |
| 12-#14 | 3.38 | MA | 8014 | 2209 | 11137 | 1966 | 14262 | 1635 | 16359 | 1346 | 19195 | 870 | 24865 | 357 | 22369 |
| 5L-3S | | MI | 3985 | 2209 | 6453 | 1799 | 7903 | 1474 | 8919 | 1198 | 10436 | 742 | 12475 | 323 | 10815 |
| 12-#14 | 3.38 | MA | 7449 | 2209 | 10200 | 1979 | 13147 | 1657 | 14983 | 1367 | 17240 | 888 | 22358 | 254 | 20488 |
| 6L-2S | | MI | 4273 | 2209 | 7046 | 1786 | 8652 | 1464 | 9825 | 1192 | 11656 | 733 | 13998 | 488 | 10896 |
| 12-#18 | 6.00 | MA | 9720 | 2827 | 15192 | 2395 | 19159 | 1965 | 22194 | 1569 | 26939 | 889 | 35707 | 49 | 35558 |
| 5L-3S | | MI | 4699 | 2827 | 8643 | 2170 | 10596 | 1742 | 12136 | 1363 | 14712 | 702 | 17253 | -55 | 17144 |
| 12-#18 | 6.00 | MA | 8796 | 2827 | 13563 | 2418 | 17217 | 2004 | 19715 | 1623 | 23505 | 918 | 31289 | -142 | 30605 |
| 6L-2S | | MI | 5109 | 2827 | 9654 | 2151 | 11875 | 1730 | 13684 | 1358 | 16790 | 693 | 19741 | 239 | 18270 |
| 14-#10 | 2.22 | MA | 7795 | 1938 | 10074 | 1765 | 13175 | 1469 | 15107 | 1233 | 17636 | 842 | 22702 | 573 | 16720 |
| 4L-5S | | MI | 3499 | 1938 | 5003 | 1669 | 6122 | 1389 | 6801 | 1153 | 7608 | 776 | 9247 | 406 | 7252 |
| 14-#10 | 2.22 | MA | 7480 | 1938 | 9570 | 1778 | 12474 | 1489 | 14278 | 1246 | 16486 | 859 | 21059 | 526 | 16154 |
| 5L-4S | | MI | 3597 | 1938 | 5225 | 1660 | 6436 | 1376 | 7172 | 1148 | 8120 | 768 | 9914 | 461 | 7508 |
| 14-#10 | 2.22 | MA | 7134 | 1938 | 9032 | 1786 | 11823 | 1501 | 13491 | 1259 | 15367 | 871 | 19630 | 471 | 15485 |
| 6L-3S | | MI | 3710 | 1938 | 5473 | 1650 | 6759 | 1369 | 7584 | 1137 | 8682 | 766 | 10588 | 512 | 7554 |
| 14-#10 | 2.22 | MA | 6830 | 1938 | 8517 | 1796 | 11146 | 1509 | 12673 | 1276 | 14280 | 888 | 18161 | 437 | 14648 |
| 7L-2S | | MI | 3906 | 1938 | 5823 | 1641 | 7201 | 1361 | 8119 | 1131 | 9403 | 758 | 11532 | 605 | 7572 |
| 14-#11 | 2.73 | MA | 7823 | 2057 | 10483 | 1854 | 13538 | 1547 | 15525 | 1284 | 18121 | 858 | 23324 | 471 | 19249 |
| 5L-4S | | MI | 3724 | 2057 | 5657 | 1722 | 6925 | 1419 | 7730 | 1173 | 8845 | 753 | 10694 | 376 | 8825 |
| 14-#11 | 2.73 | MA | 7419 | 2057 | 9828 | 1864 | 12753 | 1562 | 14565 | 1299 | 16758 | 871 | 21578 | 401 | 18406 |
| 6L-3S | | MI | 3849 | 2057 | 5955 | 1711 | 7313 | 1411 | 8225 | 1161 | 9520 | 752 | 11483 | 436 | 9003 |
| 14-#11 | 2.73 | MA | 7064 | 2057 | 9203 | 1876 | 11931 | 1572 | 13581 | 1320 | 15433 | 891 | 19778 | 358 | 17168 |
| 7L-2S | | MI | 4064 | 2057 | 6374 | 1701 | 7843 | 1404 | 8866 | 1155 | 10383 | 745 | 12582 | 550 | 9038 |
| 14-#14 | 3.94 | MA | 8675 | 2342 | 12557 | 2049 | 16058 | 1696 | 18532 | 1384 | 22120 | 865 | 28915 | 350 | 26489 |
| 5L-4S | | MI | 4060 | 2342 | 6622 | 1895 | 8101 | 1545 | 9122 | 1253 | 10698 | 736 | 12900 | 211 | 11895 |
| 14-#14 | 3.94 | MA | 8144 | 2342 | 11620 | 2062 | 14943 | 1718 | 17155 | 1406 | 20165 | 883 | 26409 | 247 | 24592 |
| 6L-3S | | MI | 4216 | 2342 | 7046 | 1882 | 8652 | 1535 | 9825 | 1237 | 11656 | 737 | 13998 | 293 | 12517 |
| 14-#14 | 3.94 | MA | 7676 | 2342 | 10723 | 2079 | 13764 | 1732 | 15757 | 1437 | 18265 | 911 | 23817 | 185 | 22727 |
| 7L-2S | | MI | 4489 | 2342 | 7638 | 1868 | 9401 | 1525 | 10731 | 1231 | 12876 | 728 | 15520 | 458 | 12613 |
| 14-#18 | 7.00 | MA | 10037 | 3063 | 16046 | 2565 | 20358 | 2112 | 23514 | 1692 | 28620 | 909 | 38371 | -154 | 37353 |
| 6L-3S | | MI | 5076 | 3063 | 9654 | 2317 | 11875 | 1851 | 13684 | 1432 | 16790 | 693 | 19741 | -125 | 19462 |
| 16-#10 | 2.54 | MA | 7875 | 2012 | 10387 | 1825 | 13507 | 1523 | 15529 | 1268 | 18170 | 856 | 23390 | 523 | 18525 |
| 5E | | MI | 3652 | 2012 | 5353 | 1716 | 6565 | 1423 | 7337 | 1175 | 8329 | 773 | 10191 | 395 | 8232 |
| 16-#10 | 2.54 | MA | 7543 | 2012 | 9849 | 1833 | 12856 | 1535 | 14742 | 1281 | 17051 | 868 | 21961 | 467 | 17863 |
| 6L-4S | | MI | 3748 | 2012 | 5575 | 1706 | 6879 | 1410 | 7707 | 1170 | 8841 | 765 | 10859 | 450 | 8515 |
| 16-#10 | 2.54 | MA | 7254 | 2012 | 9335 | 1843 | 12180 | 1544 | 13924 | 1298 | 15964 | 885 | 20492 | 433 | 17018 |
| 7L-3S | | MI | 3861 | 2012 | 5823 | 1697 | 7201 | 1403 | 8119 | 1159 | 9403 | 763 | 11532 | 500 | 8568 |
| 16-#10 | 2.54 | MA | 6981 | 2012 | 8769 | 1860 | 11483 | 1560 | 13105 | 1306 | 14881 | 896 | 19063 | 388 | 16184 |
| 8L-2S | | MI | 4044 | 2012 | 6173 | 1688 | 7644 | 1396 | 8654 | 1153 | 10124 | 755 | 12476 | 594 | 8593 |
| 16-#11 | 3.12 | MA | 7904 | 2149 | 10821 | 1921 | 14009 | 1604 | 16084 | 1326 | 18803 | 868 | 24409 | 397 | 21277 |
| 6L-4S | | MI | 3899 | 2149 | 6076 | 1779 | 7454 | 1461 | 8371 | 1200 | 9707 | 750 | 11793 | 359 | 9982 |
| 16-#11 | 3.12 | MA | 7569 | 2149 | 10195 | 1933 | 13186 | 1614 | 15099 | 1347 | 17478 | 888 | 22610 | 354 | 20044 |
| 7L-3S | | MI | 4016 | 2149 | 6374 | 1769 | 7843 | 1454 | 8866 | 1187 | 10383 | 749 | 12582 | 418 | 10213 |
| 16-#11 | 3.12 | MA | 7247 | 2149 | 9506 | 1954 | 12338 | 1633 | 14102 | 1357 | 16158 | 901 | 20863 | 297 | 18821 |
| 8L-2S | | MI | 4222 | 2149 | 6793 | 1759 | 8372 | 1446 | 9506 | 1182 | 11245 | 742 | 13681 | 532 | 10256 |
| 16-#14 | 4.50 | MA | 8815 | 2474 | 13040 | 2145 | 16739 | 1779 | 19328 | 1445 | 23090 | 878 | 30459 | 240 | 28696 |
| 6L-4S | | MI | 4299 | 2474 | 7214 | 1978 | 8850 | 1606 | 10028 | 1292 | 11917 | 731 | 14423 | 180 | 13543 |

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis

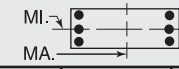



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 4.50 | MA | 8380 | 2474 | 12143 | 2162 | 15560 | 1792 | 17929 | 1476 | 21191 | 906 | 27867 | 178 | 26819 |
| 7L-3S | | MI | 4442 | 2474 | 7638 | 1965 | 9401 | 1596 | 10731 | 1276 | 12876 | 732 | 15520 | 263 | 14219 |
| 16-#14 | 4.50 | MA | 7928 | 2474 | 11156 | 2191 | 14344 | 1819 | 16501 | 1490 | 19298 | 924 | 25358 | 93 | 24927 |
| 8L-2S | | MI | 4702 | 2474 | 8230 | 1951 | 10150 | 1586 | 11637 | 1270 | 14096 | 723 | 17043 | 428 | 14329 |
| 18-#10 | 2.86 | MA | 7942 | 2087 | 10666 | 1880 | 13890 | 1570 | 15992 | 1303 | 18734 | 865 | 24292 | 463 | 20240 |
| 6L-5S | | MI | 3802 | 2087 | 5703 | 1762 | 7008 | 1458 | 7872 | 1197 | 9050 | 770 | 11136 | 384 | 9217 |
| 18-#10 | 2.86 | MA | 7667 | 2087 | 10152 | 1890 | 13214 | 1578 | 15174 | 1320 | 17647 | 882 | 22823 | 429 | 19388 |
| 7L-4S | | MI | 3904 | 2087 | 5925 | 1753 | 7321 | 1445 | 8243 | 1192 | 9562 | 762 | 11803 | 439 | 9501 |
| 18-#10 | 2.86 | MA | 7399 | 2087 | 9586 | 1907 | 12517 | 1594 | 14355 | 1328 | 16564 | 893 | 21394 | 384 | 18547 |
| 8L-3S | | MI | 4003 | 2087 | 6173 | 1744 | 7644 | 1437 | 8654 | 1180 | 10124 | 760 | 12476 | 489 | 9581 |
| 18-#10 | 2.86 | MA | 7066 | 2087 | 9088 | 1918 | 11871 | 1605 | 13530 | 1344 | 15496 | 910 | 19929 | 331 | 17551 |
| 9L-2S | | MI | 4179 | 2087 | 6523 | 1735 | 8087 | 1430 | 9190 | 1175 | 10845 | 753 | 13421 | 583 | 9612 |
| 18-#11 | 3.51 | MA | 8059 | 2241 | 11188 | 1991 | 14442 | 1656 | 16618 | 1374 | 19523 | 885 | 25441 | 349 | 22920 |
| 7L-4S | | MI | 4069 | 2241 | 6495 | 1836 | 7984 | 1504 | 9011 | 1227 | 10570 | 746 | 12892 | 341 | 11146 |
| 18-#11 | 3.51 | MA | 7742 | 2241 | 10499 | 2011 | 13593 | 1675 | 15621 | 1384 | 18203 | 898 | 23695 | 292 | 21690 |
| 8L-3S | | MI | 4179 | 2241 | 6793 | 1826 | 8372 | 1496 | 9506 | 1214 | 11245 | 746 | 13681 | 400 | 11421 |
| 18-#11 | 3.51 | MA | 7353 | 2241 | 9898 | 2025 | 12806 | 1688 | 14617 | 1403 | 16901 | 918 | 21900 | 226 | 20469 |
| 9L-2S | | MI | 4378 | 2241 | 7211 | 1816 | 8902 | 1488 | 10147 | 1209 | 12108 | 738 | 14780 | 514 | 11472 |
| 18-#14 | 5.06 | MA | 9060 | 2606 | 13563 | 2244 | 17357 | 1853 | 20102 | 1515 | 24116 | 901 | 31917 | 171 | 30910 |
| 7L-4S | | MI | 4533 | 2606 | 7806 | 2061 | 9599 | 1666 | 10934 | 1331 | 13137 | 726 | 15945 | 150 | 15199 |
| 18-#14 | 5.06 | MA | 8617 | 2606 | 12576 | 2273 | 16141 | 1880 | 18673 | 1529 | 22223 | 919 | 29408 | 86 | 29009 |
| 8L-3S | | MI | 4665 | 2606 | 8230 | 2047 | 10150 | 1657 | 11637 | 1315 | 14096 | 727 | 17043 | 232 | 15921 |
| 18-#14 | 5.06 | MA | 8102 | 2606 | 11721 | 2293 | 15012 | 1898 | 17234 | 1554 | 20356 | 947 | 26824 | -9 | 26792 |
| 9L-2S | | MI | 4913 | 2606 | 8822 | 2034 | 10899 | 1647 | 12543 | 1309 | 15316 | 718 | 18565 | 398 | 16043 |
| 20-#10 | 3.17 | MA | 8068 | 2162 | 10969 | 1936 | 14248 | 1612 | 16424 | 1342 | 19331 | 879 | 25154 | 425 | 21757 |
| 7L-5S | | MI | 3955 | 2162 | 6053 | 1809 | 7450 | 1492 | 8408 | 1219 | 9771 | 767 | 12080 | 373 | 10204 |
| 20-#10 | 3.17 | MA | 7804 | 2162 | 10403 | 1954 | 13551 | 1628 | 15605 | 1350 | 18248 | 891 | 23725 | 380 | 20911 |
| 8L-4S | | MI | 4049 | 2162 | 6275 | 1800 | 7764 | 1479 | 8778 | 1214 | 10283 | 759 | 12747 | 428 | 10476 |
| 20-#10 | 3.17 | MA | 7484 | 2162 | 9905 | 1964 | 12905 | 1639 | 14781 | 1366 | 17180 | 907 | 22260 | 328 | 19917 |
| 9L-3S | | MI | 4142 | 2162 | 6523 | 1791 | 8087 | 1472 | 9190 | 1202 | 10845 | 757 | 13421 | 478 | 10594 |
| 20-#10 | 3.17 | MA | 7186 | 2162 | 9394 | 1973 | 12272 | 1651 | 13986 | 1376 | 16068 | 916 | 20827 | 289 | 18905 |
| 10L-2S | | MI | 4313 | 2162 | 6873 | 1781 | 8530 | 1464 | 9725 | 1197 | 11566 | 750 | 14365 | 572 | 10629 |
| 20-#11 | 3.90 | MA | 8223 | 2333 | 11492 | 2069 | 14849 | 1717 | 17140 | 1411 | 20248 | 894 | 26526 | 287 | 24559 |
| 8L-4S | | MI | 4237 | 2333 | 6913 | 1894 | 8514 | 1546 | 9652 | 1254 | 11432 | 743 | 13991 | 323 | 12314 |
| 20-#11 | 3.90 | MA | 7852 | 2333 | 10891 | 2082 | 14062 | 1730 | 16135 | 1430 | 18946 | 914 | 24731 | 222 | 23332 |
| 9L-3S | | MI | 4340 | 2333 | 7211 | 1884 | 8902 | 1538 | 10147 | 1241 | 12108 | 742 | 14780 | 382 | 12628 |
| 20-#11 | 3.90 | MA | 7504 | 2333 | 10268 | 2093 | 13290 | 1744 | 15168 | 1442 | 17610 | 925 | 22980 | 172 | 22009 |
| 10L-2S | | MI | 4532 | 2333 | 7630 | 1873 | 9431 | 1530 | 10788 | 1236 | 12970 | 735 | 15879 | 497 | 12687 |
| 20-#14 | 5.63 | MA | 9284 | 2739 | 13996 | 2356 | 17937 | 1941 | 20846 | 1568 | 25148 | 914 | 33459 | 79 | 33091 |
| 8L-4S | | MI | 4763 | 2739 | 8399 | 2143 | 10348 | 1727 | 11840 | 1370 | 14357 | 721 | 17468 | 120 | 16862 |
| 20-#14 | 5.63 | MA | 8797 | 2739 | 13141 | 2376 | 16808 | 1959 | 19406 | 1593 | 23281 | 942 | 30875 | -15 | 30793 |
| 9L-3S | | MI | 4885 | 2739 | 8822 | 2130 | 10899 | 1718 | 12543 | 1354 | 15316 | 722 | 18565 | 202 | 17624 |
| 22-#10 | 3.49 | MA | 8199 | 2237 | 11221 | 2000 | 14585 | 1663 | 16856 | 1372 | 19931 | 888 | 26056 | 376 | 23274 |
| 8L-5S | | MI | 4098 | 2237 | 6403 | 1856 | 7893 | 1526 | 8943 | 1241 | 10492 | 764 | 13024 | 361 | 11194 |
| 22-#10 | 3.49 | MA | 7892 | 2237 | 10723 | 2011 | 13938 | 1674 | 16031 | 1388 | 18863 | 905 | 24591 | 324 | 22283 |
| 9L-4S | | MI | 4191 | 2237 | 6625 | 1847 | 8207 | 1513 | 9314 | 1236 | 11004 | 757 | 13692 | 417 | 11455 |
| 22-#10 | 3.49 | MA | 7606 | 2237 | 10211 | 2020 | 13305 | 1685 | 15237 | 1398 | 17751 | 913 | 23158 | 285 | 21266 |
| 10L-3S | | MI | 4279 | 2237 | 6873 | 1837 | 8530 | 1506 | 9725 | 1224 | 11566 | 755 | 14365 | 467 | 11606 |
| 22-#10 | 3.49 | MA | 7335 | 2237 | 9709 | 2030 | 12663 | 1695 | 14454 | 1409 | 16655 | 927 | 21767 | 238 | 20227 |
| 11L-2S | | MI | 4444 | 2237 | 7223 | 1828 | 8972 | 1499 | 10261 | 1219 | 12287 | 747 | 15309 | 560 | 11646 |
| 22-#11 | 4.29 | MA | 8336 | 2425 | 11884 | 2140 | 15317 | 1772 | 17654 | 1457 | 20991 | 911 | 27562 | 217 | 26194 |
| 9L-4S | | MI | 4403 | 2425 | 7332 | 1951 | 9043 | 1588 | 10292 | 1281 | 12295 | 739 | 15090 | 305 | 13487 |
| 22-#11 | 4.29 | MA | 8005 | 2425 | 11261 | 2150 | 14546 | 1786 | 16686 | 1469 | 19655 | 921 | 25811 | 167 | 24876 |
| 10L-3S | | MI | 4499 | 2425 | 7630 | 1941 | 9431 | 1580 | 10788 | 1268 | 12970 | 739 | 15879 | 364 | 13836 |
| 22-#14 | 6.19 | MA | 9472 | 2871 | 14561 | 2459 | 18604 | 2020 | 21579 | 1632 | 26206 | 938 | 34925 | -22 | 34774 |
| 9L-4S | | MI | 4991 | 2871 | 8991 | 2226 | 11097 | 1788 | 12746 | 1409 | 15577 | 716 | 18990 | 90 | 18530 |

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis



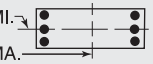

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#10 | 3.81 | MA | 8290 | 2311 | 11540 | 2058 | 14972 | 1708 | 17281 | 1410 | 20547 | 902 | 26922 | 320 | 24649 |
| 9L-5S | | MI | 4239 | 2311 | 6753 | 1902 | 8336 | 1561 | 9479 | 1263 | 11213 | 762 | 13969 | 350 | 12186 |
| 24-#10 | 3.81 | MA | 8016 | 2311 | 11028 | 2067 | 14339 | 1720 | 16487 | 1420 | 19435 | 910 | 25489 | 281 | 23628 |
| 10L-4S | | MI | 4332 | 2311 | 6975 | 1893 | 8650 | 1548 | 9849 | 1258 | 11725 | 754 | 14636 | 406 | 12437 |
| 24-#10 | 3.81 | MA | 7757 | 2311 | 10527 | 2077 | 13696 | 1730 | 15705 | 1431 | 18338 | 925 | 24098 | 234 | 22585 |
| 11L-3S | | MI | 4415 | 2311 | 7223 | 1884 | 8972 | 1540 | 10261 | 1246 | 12287 | 752 | 15309 | 456 | 12617 |
| 24-#11 | 4.68 | MA | 8493 | 2516 | 12253 | 2208 | 15802 | 1828 | 18205 | 1496 | 21700 | 918 | 28642 | 162 | 27743 |
| 10L-4S | | MI | 4566 | 2516 | 7751 | 2009 | 9573 | 1630 | 10933 | 1308 | 13157 | 736 | 16190 | 287 | 14663 |
| **RECTANGULAR TIED COLUMNS 22" x 22"** | | | | | | | | | | | | | | | |
| 6-#9 | 1.24 | MA | 2331 | 1032 | 3117 | 919 | 3891 | 771 | 4342 | 653 | 4855 | 472 | 5959 | 405 | 2972 |
| 2L-3S | | MI | 2133 | 1032 | 2802 | 927 | 3492 | 778 | 3860 | 659 | 4206 | 480 | 5076 | 332 | 2971 |
| 6-#10 | 1.57 | MA | 2434 | 1080 | 3378 | 946 | 4209 | 790 | 4720 | 665 | 5358 | 468 | 6612 | 397 | 3705 |
| 2L-3S | | MI | 2192 | 1080 | 2982 | 956 | 3707 | 799 | 4113 | 672 | 4541 | 478 | 5508 | 303 | 3689 |
| 6-#11 | 1.93 | MA | 2521 | 1131 | 3661 | 970 | 4531 | 807 | 5092 | 674 | 5843 | 462 | 7162 | 376 | 4438 |
| 2L-3S | | MI | 2242 | 1131 | 3185 | 981 | 3929 | 816 | 4364 | 681 | 4862 | 472 | 5868 | 262 | 4402 |
| 6-#14 | 2.79 | MA | 2746 | 1253 | 4288 | 1040 | 5300 | 858 | 6010 | 705 | 7067 | 454 | 8671 | 345 | 6205 |
| 2L-3S | | MI | 2388 | 1253 | 3614 | 1055 | 4447 | 870 | 4977 | 714 | 5677 | 466 | 6870 | 180 | 6086 |
| 6-#18 | 4.96 | MA | 3244 | 1562 | 5799 | 1221 | 7163 | 990 | 8238 | 787 | 10045 | 435 | 12175 | 244 | 10469 |
| 2L-3S | | MI | 2721 | 1562 | 4641 | 1245 | 5697 | 1007 | 6465 | 798 | 7659 | 451 | 9195 | -49 | 9111 |
| 8-#8 | 1.31 | MA | 2360 | 1042 | 3160 | 927 | 3957 | 777 | 4428 | 658 | 4976 | 473 | 6149 | 408 | 3133 |
| 2L-4S | | MI | 2110 | 1042 | 2733 | 941 | 3411 | 789 | 3752 | 671 | 4061 | 482 | 4940 | 317 | 3111 |
| 8-#9 | 1.65 | MA | 2468 | 1091 | 3432 | 956 | 4289 | 798 | 4824 | 670 | 5504 | 470 | 6843 | 401 | 3898 |
| 2L-4S | | MI | 2165 | 1091 | 2896 | 972 | 3603 | 812 | 3974 | 686 | 4353 | 481 | 5334 | 285 | 3833 |
| 8-#10 | 2.10 | MA | 2601 | 1155 | 3775 | 992 | 4711 | 824 | 5327 | 687 | 6176 | 465 | 7716 | 390 | 4866 |
| 2L-4S | | MI | 2236 | 1155 | 3100 | 1013 | 3845 | 842 | 4256 | 706 | 4725 | 479 | 5830 | 243 | 4630 |
| 8-#11 | 2.58 | MA | 2713 | 1223 | 4137 | 1027 | 5133 | 849 | 5820 | 701 | 6824 | 458 | 8456 | 364 | 5828 |
| 2L-4S | | MI | 2294 | 1223 | 3324 | 1050 | 4093 | 868 | 4533 | 722 | 5079 | 471 | 6241 | 187 | 5349 |
| 8-#14 | 3.72 | MA | 2999 | 1385 | 4963 | 1123 | 6154 | 919 | 7042 | 744 | 8458 | 449 | 10473 | 323 | 8167 |
| 2L-4S | | MI | 2474 | 1385 | 3810 | 1154 | 4677 | 943 | 5214 | 772 | 5982 | 464 | 7384 | 70 | 7067 |
| 10-#10 | 2.62 | MA | 2762 | 1229 | 4172 | 1039 | 5212 | 859 | 5934 | 709 | 6993 | 463 | 8819 | 382 | 6023 |
| 2L-5S | | MI | 2300 | 1229 | 3247 | 1070 | 3994 | 890 | 4446 | 735 | 4966 | 485 | 6155 | 181 | 5374 |
| 10-#10 | 2.62 | MA | 2546 | 1229 | 3775 | 1049 | 4711 | 867 | 5327 | 716 | 6176 | 472 | 7716 | 289 | 5981 |
| 3L-4S | | MI | 2421 | 1229 | 3496 | 1060 | 4347 | 876 | 4863 | 728 | 5542 | 476 | 6934 | 236 | 5728 |
| 10-#11 | 3.22 | MA | 2896 | 1315 | 4613 | 1084 | 5736 | 891 | 6549 | 728 | 7805 | 455 | 9749 | 351 | 7213 |
| 2L-5S | | MI | 2373 | 1315 | 3499 | 1119 | 4269 | 926 | 4758 | 757 | 5365 | 478 | 6621 | 106 | 6258 |
| 10-#11 | 3.22 | MA | 2659 | 1315 | 4137 | 1096 | 5133 | 900 | 5820 | 735 | 6824 | 465 | 8456 | 237 | 7142 |
| 3L-4S | | MI | 2520 | 1315 | 3800 | 1107 | 4695 | 910 | 5261 | 749 | 6060 | 468 | 7535 | 174 | 6669 |
| 10-#14 | 4.65 | MA | 2948 | 1518 | 4963 | 1221 | 6154 | 992 | 7042 | 792 | 8458 | 456 | 10473 | 136 | 9954 |
| 3L-4S | | MI | 2775 | 1518 | 4485 | 1237 | 5530 | 1004 | 6247 | 811 | 7372 | 459 | 9185 | 48 | 8957 |
| **RECTANGULAR TIED COLUMNS 22" x 24"** | | | | | | | | | | | | | | | |
| 4-#11 | 1.18 | MA | 2747 | 1117 | 3663 | 995 | 4563 | 835 | 5081 | 708 | 5658 | 514 | 6911 | 440 | 3375 |
| 2E | | MI | 2495 | 1117 | 3388 | 985 | 4176 | 826 | 4628 | 701 | 5126 | 508 | 6167 | 427 | 3058 |
| 4-#14 | 1.70 | MA | 2931 | 1198 | 4147 | 1040 | 5147 | 867 | 5774 | 728 | 6578 | 507 | 8083 | 423 | 4721 |
| 2E | | MI | 2655 | 1198 | 3819 | 1029 | 4696 | 858 | 5242 | 720 | 5940 | 501 | 7167 | 404 | 4260 |
| 4-#18 | 3.03 | MA | 3342 | 1404 | 5311 | 1157 | 6565 | 952 | 7461 | 780 | 8825 | 493 | 10836 | 367 | 7976 |
| 2E | | MI | 3006 | 1404 | 4852 | 1145 | 5949 | 942 | 6731 | 771 | 7921 | 486 | 9489 | 335 | 7146 |
| 6-#9 | 1.14 | MA | 2755 | 1110 | 3583 | 1001 | 4515 | 841 | 5051 | 714 | 5642 | 521 | 6972 | 453 | 3296 |
| 2L-3S | | MI | 2304 | 1110 | 2999 | 1001 | 3737 | 840 | 4123 | 713 | 4471 | 523 | 5376 | 370 | 2991 |
| 6-#9 | 1.14 | MA | 2529 | 1110 | 3231 | 1010 | 4070 | 849 | 4513 | 721 | 4918 | 530 | 5969 | 381 | 3295 |
| 3L-2S | | MI | 2505 | 1110 | 3314 | 992 | 4136 | 833 | 4605 | 708 | 5120 | 515 | 6260 | 444 | 2989 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis



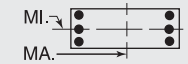

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 1.44 | MA | 2874 | 1158 | 3876 | 1028 | 4872 | 861 | 5475 | 726 | 6207 | 517 | 7745 | 449 | 4117 |
| 2L-3S | | MI | 2364 | 1158 | 3181 | 1029 | 3953 | 861 | 4377 | 726 | 4805 | 521 | 5809 | 341 | 3715 |
| 6-#10 | 1.44 | MA | 2599 | 1158 | 3433 | 1039 | 4311 | 870 | 4797 | 734 | 5293 | 528 | 6482 | 356 | 4101 |
| 3L-2S | | MI | 2609 | 1158 | 3577 | 1019 | 4454 | 852 | 4984 | 719 | 5623 | 512 | 6912 | 435 | 3724 |
| 6-#11 | 1.77 | MA | 2977 | 1209 | 4196 | 1052 | 5238 | 877 | 5898 | 735 | 6757 | 511 | 8401 | 432 | 4943 |
| 2L-3S | | MI | 2414 | 1209 | 3388 | 1054 | 4176 | 878 | 4628 | 735 | 5126 | 514 | 6167 | 300 | 4435 |
| 6-#11 | 1.77 | MA | 2658 | 1209 | 3663 | 1065 | 4563 | 888 | 5081 | 744 | 5658 | 522 | 6911 | 318 | 4908 |
| 3L-2S | | MI | 2697 | 1209 | 3864 | 1042 | 4779 | 869 | 5356 | 728 | 6107 | 504 | 7460 | 414 | 4461 |
| 6-#14 | 2.56 | MA | 3242 | 1331 | 4904 | 1123 | 6106 | 928 | 6933 | 767 | 8139 | 502 | 10166 | 408 | 6934 |
| 2L-3S | | MI | 2551 | 1331 | 3819 | 1127 | 4696 | 931 | 5242 | 768 | 5940 | 509 | 7167 | 217 | 6134 |
| 6-#14 | 2.56 | MA | 2820 | 1331 | 4147 | 1140 | 5147 | 943 | 5774 | 778 | 6578 | 518 | 8083 | 242 | 6815 |
| 3L-2S | | MI | 2924 | 1331 | 4494 | 1112 | 5549 | 919 | 6274 | 759 | 7331 | 496 | 8968 | 382 | 6234 |
| 6-#18 | 4.55 | MA | 3823 | 1640 | 6616 | 1304 | 8217 | 1060 | 9459 | 849 | 11514 | 484 | 14311 | 327 | 11765 |
| 2L-3S | | MI | 2890 | 1640 | 4852 | 1316 | 5949 | 1068 | 6731 | 851 | 7921 | 493 | 9489 | -12 | 9469 |
| 6-#18 | 4.55 | MA | 3219 | 1640 | 5311 | 1331 | 6565 | 1082 | 7461 | 865 | 8825 | 506 | 10836 | 33 | 10743 |
| 3L-2S | | MI | 3427 | 1640 | 6010 | 1292 | 7414 | 1050 | 8503 | 840 | 10308 | 477 | 12469 | 281 | 10506 |
| 8-#8 | 1.20 | MA | 2788 | 1120 | 3630 | 1010 | 4587 | 848 | 5145 | 719 | 5775 | 522 | 7161 | 454 | 3474 |
| 2L-4S | | MI | 2281 | 1120 | 2930 | 1014 | 3655 | 852 | 4015 | 726 | 4325 | 526 | 5242 | 355 | 3136 |
| 8-#8 | 1.20 | MA | 2610 | 1120 | 3350 | 1017 | 4233 | 854 | 4717 | 725 | 5199 | 529 | 6363 | 397 | 3472 |
| 3E | | MI | 2376 | 1120 | 3105 | 1008 | 3884 | 846 | 4307 | 717 | 4724 | 523 | 5742 | 389 | 3150 |
| 8-#8 | 1.20 | MA | 2504 | 1120 | 3155 | 1024 | 3979 | 860 | 4392 | 734 | 4755 | 533 | 5805 | 363 | 3452 |
| 4L-2S | | MI | 2534 | 1120 | 3356 | 1001 | 4201 | 840 | 4691 | 713 | 5241 | 517 | 6450 | 447 | 3149 |
| 8-#9 | 1.52 | MA | 2912 | 1169 | 3935 | 1038 | 4960 | 868 | 5589 | 732 | 6367 | 519 | 7975 | 450 | 4330 |
| 2L-4S | | MI | 2336 | 1169 | 3093 | 1046 | 3848 | 875 | 4237 | 741 | 4617 | 524 | 5635 | 323 | 3868 |
| 8-#9 | 1.52 | MA | 2697 | 1169 | 3583 | 1047 | 4515 | 876 | 5051 | 738 | 5642 | 527 | 6972 | 378 | 4318 |
| 3E | | MI | 2452 | 1169 | 3314 | 1037 | 4136 | 867 | 4605 | 731 | 5120 | 521 | 6260 | 365 | 3909 |
| 8-#9 | 1.52 | MA | 2569 | 1169 | 3338 | 1056 | 4195 | 884 | 4642 | 750 | 5084 | 532 | 6268 | 334 | 4265 |
| 4L-2S | | MI | 2643 | 1169 | 3629 | 1029 | 4534 | 860 | 5087 | 725 | 5769 | 513 | 7144 | 439 | 3917 |
| 8-#10 | 1.92 | MA | 3065 | 1233 | 4320 | 1075 | 5433 | 895 | 6153 | 748 | 7120 | 514 | 9009 | 445 | 5415 |
| 2L-4S | | MI | 2406 | 1233 | 3299 | 1086 | 4091 | 904 | 4520 | 761 | 4989 | 522 | 6130 | 281 | 4725 |
| 8-#10 | 1.92 | MA | 2806 | 1233 | 3876 | 1086 | 4872 | 905 | 5475 | 756 | 6207 | 525 | 7745 | 352 | 5384 |
| 3E | | MI | 2546 | 1233 | 3577 | 1076 | 4454 | 895 | 4984 | 748 | 5623 | 518 | 6912 | 334 | 4863 |
| 8-#10 | 1.92 | MA | 2651 | 1233 | 3567 | 1097 | 4468 | 914 | 4959 | 770 | 5501 | 531 | 6855 | 297 | 5231 |
| 4L-2S | | MI | 2777 | 1233 | 3974 | 1066 | 4956 | 887 | 5591 | 741 | 6440 | 509 | 8016 | 428 | 4887 |
| 8-#11 | 2.36 | MA | 3199 | 1301 | 4730 | 1110 | 5913 | 919 | 6714 | 762 | 7856 | 507 | 9890 | 424 | 6502 |
| 2L-4S | | MI | 2464 | 1301 | 3527 | 1123 | 4340 | 930 | 4797 | 776 | 5343 | 514 | 6539 | 224 | 5455 |
| 8-#11 | 2.36 | MA | 2899 | 1301 | 4196 | 1122 | 5238 | 930 | 5898 | 771 | 6757 | 519 | 8401 | 309 | 6446 |
| 3E | | MI | 2625 | 1301 | 3864 | 1111 | 4779 | 920 | 5356 | 762 | 6107 | 511 | 7460 | 287 | 5807 |
| 8-#11 | 2.36 | MA | 2720 | 1301 | 3822 | 1135 | 4749 | 941 | 5274 | 787 | 5906 | 524 | 7347 | 244 | 6054 |
| 4L-2S | | MI | 2891 | 1301 | 4340 | 1099 | 5381 | 911 | 6085 | 755 | 7088 | 501 | 8754 | 402 | 5853 |
| 8-#14 | 3.41 | MA | 3534 | 1463 | 5662 | 1205 | 7064 | 989 | 8092 | 806 | 9699 | 497 | 12249 | 392 | 9139 |
| 2L-4S | | MI | 2642 | 1463 | 4016 | 1226 | 4926 | 1005 | 5479 | 826 | 6245 | 506 | 7681 | 107 | 7189 |
| 8-#14 | 3.41 | MA | 3160 | 1463 | 4904 | 1223 | 6106 | 1003 | 6933 | 817 | 8139 | 513 | 10166 | 227 | 8990 |
| 3E | | MI | 2847 | 1463 | 4494 | 1210 | 5549 | 992 | 6274 | 807 | 7331 | 504 | 8968 | 195 | 8067 |
| 8-#14 | 3.41 | MA | 2917 | 1463 | 4371 | 1240 | 5410 | 1018 | 6045 | 839 | 6926 | 519 | 8687 | 135 | 8009 |
| 4L-2S | | MI | 3181 | 1463 | 5169 | 1195 | 6403 | 980 | 7307 | 798 | 8721 | 491 | 10770 | 360 | 8197 |
| 8-#18 | 6.06 | MA | 3759 | 1875 | 6616 | 1479 | 8217 | 1190 | 9459 | 934 | 11514 | 497 | 14311 | -7 | 14292 |
| 3E | | MI | 3361 | 1875 | 6010 | 1463 | 7414 | 1176 | 8503 | 920 | 10308 | 484 | 12469 | -66 | 12322 |
| 8-#18 | 6.06 | MA | 3431 | 1875 | 5690 | 1506 | 7010 | 1212 | 7919 | 967 | 9413 | 501 | 11825 | -162 | 11531 |
| 4L-2S | | MI | 3837 | 1875 | 7169 | 1439 | 8880 | 1158 | 10275 | 909 | 12694 | 468 | 15448 | 228 | 13858 |
| 10-#10 | 2.41 | MA | 3251 | 1307 | 4763 | 1122 | 5994 | 929 | 6832 | 770 | 8033 | 512 | 10273 | 441 | 6709 |
| 2L-5S | | MI | 2471 | 1307 | 3446 | 1143 | 4240 | 953 | 4710 | 790 | 5230 | 529 | 6455 | 219 | 5457 |
| 10-#10 | 2.41 | MA | 3004 | 1307 | 4320 | 1133 | 5433 | 939 | 6153 | 778 | 7120 | 523 | 9009 | 348 | 6666 |
| 3L-4S | | MI | 2592 | 1307 | 3695 | 1133 | 4593 | 938 | 5126 | 783 | 5806 | 519 | 7234 | 274 | 5819 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis

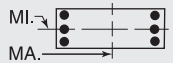



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.41 | MA | 2862 | 1307 | 4010 | 1144 | 5029 | 949 | 5637 | 792 | 6415 | 528 | 8119 | 293 | 6464 |
| 4L-3S | | MI | 2720 | 1307 | 3974 | 1123 | 4956 | 930 | 5591 | 770 | 6440 | 515 | 8016 | 327 | 6010 |
| 10-#10 | 2.41 | MA | 2719 | 1307 | 3734 | 1155 | 4637 | 964 | 5175 | 800 | 5775 | 539 | 7227 | 239 | 6035 |
| 5L-2S | | MI | 2941 | 1307 | 4371 | 1112 | 5458 | 921 | 6197 | 763 | 7257 | 506 | 9119 | 420 | 6045 |
| 10-#11 | 2.95 | MA | 3411 | 1393 | 5263 | 1167 | 6587 | 962 | 7530 | 789 | 8955 | 504 | 11380 | 416 | 8055 |
| 2L-5S | | MI | 2543 | 1393 | 3702 | 1192 | 4517 | 988 | 5022 | 810 | 5629 | 520 | 6919 | 144 | 6378 |
| 10-#11 | 2.95 | MA | 3131 | 1393 | 4730 | 1180 | 5913 | 972 | 6714 | 798 | 7856 | 516 | 9890 | 301 | 7984 |
| 3L-4S | | MI | 2680 | 1393 | 4003 | 1180 | 4943 | 972 | 5525 | 803 | 6324 | 511 | 7833 | 212 | 6770 |
| 10-#11 | 2.95 | MA | 2968 | 1393 | 4355 | 1192 | 5424 | 983 | 6090 | 814 | 7005 | 521 | 8836 | 236 | 7539 |
| 4L-3S | | MI | 2834 | 1393 | 4340 | 1168 | 5381 | 962 | 6085 | 789 | 7088 | 508 | 8754 | 274 | 7178 |
| 10-#11 | 2.95 | MA | 2804 | 1393 | 4021 | 1205 | 4950 | 1001 | 5531 | 823 | 6231 | 532 | 7784 | 169 | 7072 |
| 5L-2S | | MI | 3076 | 1393 | 4816 | 1157 | 5983 | 953 | 6813 | 782 | 8068 | 498 | 10048 | 389 | 7239 |
| 10-#14 | 4.26 | MA | 3473 | 1596 | 5662 | 1305 | 7064 | 1064 | 8092 | 856 | 9699 | 508 | 12249 | 212 | 11169 |
| 3L-4S | | MI | 2943 | 1596 | 4691 | 1309 | 5779 | 1065 | 6511 | 865 | 7635 | 501 | 9482 | 85 | 9073 |
| 10-#14 | 4.26 | MA | 3276 | 1596 | 5128 | 1323 | 6368 | 1079 | 7204 | 877 | 8487 | 514 | 10770 | 119 | 10140 |
| 4L-3S | | MI | 3123 | 1596 | 5169 | 1293 | 6403 | 1053 | 7307 | 846 | 8721 | 499 | 10770 | 173 | 10003 |
| 10-#14 | 4.26 | MA | 3047 | 1596 | 4651 | 1340 | 5692 | 1103 | 6406 | 889 | 7384 | 529 | 9299 | 22 | 9221 |
| 5L-2S | | MI | 3430 | 1596 | 5844 | 1277 | 7257 | 1041 | 8340 | 837 | 10112 | 486 | 12572 | 338 | 10155 |
| 10-#18 | 7.58 | MA | 4005 | 2111 | 6995 | 1653 | 8661 | 1320 | 9916 | 1036 | 12103 | 492 | 15301 | -202 | 14752 |
| 4L-3S | | MI | 3814 | 2111 | 7169 | 1610 | 8880 | 1284 | 10275 | 989 | 12694 | 475 | 15448 | -119 | 15125 |
| 12-#10 | 2.89 | MA | 3432 | 1382 | 5206 | 1168 | 6555 | 964 | 7510 | 792 | 8947 | 509 | 11537 | 437 | 8000 |
| 2L-6S | | MI | 2488 | 1382 | 3600 | 1199 | 4422 | 996 | 4910 | 825 | 5485 | 530 | 6803 | 144 | 6170 |
| 12-#10 | 2.89 | MA | 3197 | 1382 | 4763 | 1180 | 5994 | 973 | 6832 | 800 | 8033 | 520 | 10273 | 344 | 7949 |
| 3L-5S | | MI | 2652 | 1382 | 3843 | 1190 | 4742 | 987 | 5317 | 812 | 6048 | 526 | 7558 | 212 | 6577 |
| 12-#10 | 2.89 | MA | 3065 | 1382 | 4453 | 1191 | 5590 | 983 | 6316 | 814 | 7328 | 525 | 9382 | 289 | 7704 |
| 4E | | MI | 2770 | 1382 | 4092 | 1179 | 5095 | 973 | 5733 | 805 | 6623 | 517 | 8338 | 267 | 6921 |
| 12-#10 | 2.89 | MA | 2925 | 1382 | 4177 | 1202 | 5198 | 998 | 5853 | 822 | 6689 | 536 | 8490 | 235 | 7295 |
| 5L-3S | | MI | 2896 | 1382 | 4371 | 1169 | 5458 | 964 | 6197 | 792 | 7257 | 513 | 9119 | 320 | 7156 |
| 12-#10 | 2.89 | MA | 2742 | 1382 | 3901 | 1210 | 4843 | 1008 | 5402 | 836 | 6064 | 541 | 7629 | 164 | 6837 |
| 6L-2S | | MI | 3098 | 1382 | 4767 | 1159 | 5960 | 956 | 6804 | 785 | 8074 | 503 | 10223 | 413 | 7201 |
| 12-#11 | 3.55 | MA | 3361 | 1484 | 5263 | 1237 | 6587 | 1015 | 7530 | 825 | 8955 | 512 | 11380 | 293 | 9523 |
| 3L-5S | | MI | 2763 | 1484 | 4178 | 1249 | 5119 | 1030 | 5751 | 837 | 6610 | 517 | 8213 | 131 | 7725 |
| 12-#11 | 3.55 | MA | 3219 | 1484 | 4889 | 1250 | 6099 | 1025 | 6906 | 841 | 8104 | 517 | 10325 | 227 | 9034 |
| 4E | | MI | 2900 | 1484 | 4479 | 1237 | 5545 | 1014 | 6254 | 830 | 7305 | 507 | 9126 | 199 | 8095 |
| 12-#11 | 3.55 | MA | 3046 | 1484 | 4554 | 1263 | 5625 | 1043 | 6347 | 850 | 7330 | 529 | 9274 | 160 | 8590 |
| 5L-3S | | MI | 3029 | 1484 | 4816 | 1226 | 5983 | 1004 | 6813 | 816 | 8068 | 504 | 10048 | 262 | 8549 |
| 12-#11 | 3.55 | MA | 2833 | 1484 | 4227 | 1274 | 5196 | 1054 | 5800 | 865 | 6575 | 534 | 8255 | 76 | 7907 |
| 6L-2S | | MI | 3257 | 1484 | 5292 | 1214 | 6585 | 995 | 7541 | 809 | 9049 | 494 | 11341 | 376 | 8623 |
| 12-#14 | 5.11 | MA | 3604 | 1728 | 5886 | 1406 | 7327 | 1140 | 8363 | 916 | 10048 | 509 | 12853 | 104 | 12283 |
| 4E | | MI | 3231 | 1728 | 5365 | 1391 | 6633 | 1126 | 7544 | 904 | 9026 | 496 | 11284 | 63 | 10969 |
| 12-#14 | 5.11 | MA | 3381 | 1728 | 5408 | 1423 | 6651 | 1164 | 7565 | 928 | 8945 | 524 | 11382 | 7 | 11357 |
| 5L-3S | | MI | 3389 | 1728 | 5844 | 1376 | 7257 | 1114 | 8340 | 885 | 10112 | 494 | 12572 | 151 | 11943 |
| 14-#10 | 3.37 | MA | 3391 | 1457 | 5206 | 1226 | 6555 | 1008 | 7510 | 822 | 8947 | 517 | 11537 | 340 | 9231 |
| 3L-6S | | MI | 2671 | 1457 | 3997 | 1246 | 4924 | 1030 | 5517 | 846 | 6303 | 527 | 7907 | 137 | 7285 |
| 14-#10 | 3.37 | MA | 3262 | 1457 | 4897 | 1237 | 6150 | 1017 | 6994 | 836 | 8242 | 522 | 10646 | 285 | 8950 |
| 4L-5S | | MI | 2827 | 1457 | 4240 | 1236 | 5244 | 1021 | 5924 | 834 | 6865 | 523 | 8662 | 205 | 7702 |
| 14-#10 | 3.37 | MA | 3124 | 1457 | 4621 | 1248 | 5759 | 1032 | 6532 | 844 | 7602 | 533 | 9754 | 231 | 8559 |
| 5L-4S | | MI | 2954 | 1457 | 4489 | 1226 | 5597 | 1007 | 6340 | 827 | 7441 | 514 | 9441 | 260 | 8030 |
| 14-#10 | 3.37 | MA | 2950 | 1457 | 4344 | 1257 | 5404 | 1042 | 6080 | 858 | 6978 | 538 | 8893 | 160 | 8095 |
| 6L-3S | | MI | 3060 | 1457 | 4767 | 1216 | 5960 | 998 | 6804 | 814 | 8074 | 510 | 10223 | 313 | 8301 |
| 14-#11 | 4.14 | MA | 3449 | 1576 | 5422 | 1307 | 6774 | 1067 | 7722 | 868 | 9203 | 514 | 11815 | 219 | 10536 |
| 4L-5S | | MI | 2968 | 1576 | 4654 | 1306 | 5721 | 1072 | 6479 | 864 | 7590 | 514 | 9506 | 119 | 9051 |
| 14-#11 | 4.14 | MA | 3289 | 1576 | 5088 | 1320 | 6300 | 1085 | 7163 | 877 | 8429 | 525 | 10763 | 152 | 10113 |
| 5L-4S | | MI | 3102 | 1576 | 4956 | 1295 | 6147 | 1056 | 6982 | 857 | 8285 | 504 | 10420 | 187 | 9427 |
| 14-#11 | 4.14 | MA | 3091 | 1576 | 4760 | 1331 | 5871 | 1096 | 6616 | 892 | 7674 | 530 | 9744 | 68 | 9422 |
| 6L-3S | | MI | 3219 | 1576 | 5292 | 1283 | 6585 | 1047 | 7541 | 843 | 9049 | 501 | 11341 | 249 | 9921 |
| 14-#14 | 5.97 | MA | 3702 | 1861 | 6166 | 1506 | 7609 | 1225 | 8725 | 967 | 10505 | 519 | 13465 | -9 | 13442 |
| 5L-4S | | MI | 3510 | 1861 | 6040 | 1474 | 7487 | 1187 | 8577 | 943 | 10416 | 491 | 13086 | 41 | 12873 |

## RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 3.85 | MA | 3465 | 1532 | 5340 | 1284 | 6711 | 1052 | 7672 | 858 | 9155 | 519 | 11910 | 281 | 10202 |
| 4L-6S | | MI | 2859 | 1532 | 4394 | 1292 | 5426 | 1064 | 6124 | 868 | 7120 | 524 | 9010 | 129 | 8403 |
| 16-#10 | 3.85 | MA | 3328 | 1532 | 5064 | 1295 | 6320 | 1067 | 7210 | 866 | 8515 | 530 | 11018 | 227 | 9826 |
| 5E | | MI | 3006 | 1532 | 4636 | 1283 | 5746 | 1056 | 6531 | 856 | 7682 | 520 | 9766 | 198 | 8830 |
| 16-#10 | 3.85 | MA | 3152 | 1532 | 4787 | 1304 | 5965 | 1076 | 6758 | 880 | 7891 | 536 | 10157 | 156 | 9356 |
| 6L-4S | | MI | 3122 | 1532 | 4885 | 1273 | 6098 | 1041 | 6947 | 849 | 8258 | 511 | 10545 | 253 | 9143 |
| 16-#11 | 4.73 | MA | 3515 | 1668 | 5621 | 1377 | 6975 | 1127 | 7979 | 904 | 9528 | 522 | 12253 | 144 | 11628 |
| 5E | | MI | 3166 | 1668 | 5130 | 1364 | 6323 | 1115 | 7208 | 891 | 8571 | 510 | 10800 | 106 | 10376 |
| 16-#11 | 4.73 | MA | 3329 | 1668 | 5294 | 1389 | 6545 | 1138 | 7433 | 919 | 8773 | 527 | 11234 | 59 | 10936 |
| 6L-4S | | MI | 3298 | 1668 | 5432 | 1352 | 6749 | 1098 | 7710 | 884 | 9266 | 500 | 11714 | 174 | 10766 |
| 18-#10 | 4.33 | MA | 3516 | 1606 | 5507 | 1342 | 6881 | 1101 | 7888 | 888 | 9429 | 528 | 12281 | 223 | 11095 |
| 5L-6S | | MI | 3033 | 1606 | 4790 | 1339 | 5928 | 1099 | 6731 | 890 | 7937 | 521 | 10114 | 122 | 9525 |
| 18-#10 | 4.33 | MA | 3361 | 1606 | 5231 | 1351 | 6526 | 1111 | 7437 | 902 | 8805 | 533 | 11420 | 152 | 10619 |
| 6L-5S | | MI | 3172 | 1606 | 5033 | 1330 | 6247 | 1090 | 7138 | 878 | 8499 | 518 | 10869 | 191 | 9961 |
| 18-#11 | 5.32 | MA | 3560 | 1760 | 5827 | 1446 | 7220 | 1180 | 8249 | 946 | 9872 | 524 | 12723 | 51 | 12460 |
| 6L-5S | | MI | 3360 | 1760 | 5606 | 1421 | 6926 | 1157 | 7936 | 918 | 9552 | 507 | 12094 | 94 | 11706 |

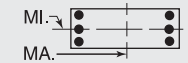
## RECTANGULAR TIED COLUMNS 22" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.09 | MA | 3204 | 1195 | 4166 | 1077 | 5236 | 906 | 5844 | 770 | 6503 | 563 | 8013 | 490 | 3712 |
| 2E | | MI | 2668 | 1195 | 3590 | 1057 | 4424 | 888 | 4892 | 755 | 5390 | 551 | 6465 | 464 | 3077 |
| 4-#14 | 1.57 | MA | 3416 | 1276 | 4704 | 1122 | 5886 | 938 | 6615 | 789 | 7527 | 556 | 9358 | 477 | 5207 |
| 2E | | MI | 2829 | 1276 | 4025 | 1101 | 4945 | 920 | 5507 | 773 | 6204 | 544 | 7464 | 442 | 4284 |
| 4-#18 | 2.80 | MA | 3892 | 1482 | 6005 | 1240 | 7472 | 1023 | 8502 | 841 | 10039 | 542 | 12542 | 432 | 8840 |
| 2E | | MI | 3184 | 1482 | 5063 | 1216 | 6200 | 1002 | 6996 | 824 | 8184 | 528 | 9784 | 372 | 7180 |
| 6-#9 | 1.05 | MA | 3211 | 1188 | 4074 | 1084 | 5178 | 912 | 5805 | 776 | 6478 | 570 | 7999 | 496 | 3620 |
| 2L-3S | | MI | 2476 | 1188 | 3197 | 1074 | 3982 | 903 | 4387 | 768 | 4735 | 567 | 5677 | 408 | 3010 |
| 6-#9 | 1.05 | MA | 2958 | 1188 | 3685 | 1094 | 4686 | 920 | 5210 | 783 | 5677 | 580 | 6891 | 426 | 3619 |
| 3L-2S | | MI | 2678 | 1188 | 3512 | 1066 | 4381 | 896 | 4869 | 762 | 5384 | 559 | 6561 | 482 | 3005 |
| 6-#10 | 1.33 | MA | 3347 | 1236 | 4399 | 1111 | 5574 | 931 | 6275 | 788 | 7103 | 566 | 8860 | 492 | 4528 |
| 2L-3S | | MI | 2536 | 1236 | 3379 | 1102 | 4198 | 924 | 4640 | 781 | 5070 | 564 | 6109 | 379 | 3738 |
| 6-#10 | 1.33 | MA | 3038 | 1236 | 3909 | 1123 | 4954 | 942 | 5525 | 797 | 6094 | 578 | 7462 | 402 | 4512 |
| 3L-2S | | MI | 2783 | 1236 | 3776 | 1092 | 4700 | 915 | 5247 | 774 | 5887 | 555 | 7212 | 473 | 3742 |
| 6-#11 | 1.64 | MA | 3466 | 1287 | 4757 | 1135 | 5983 | 948 | 6748 | 797 | 7720 | 559 | 9699 | 486 | 5449 |
| 2L-3S | | MI | 2585 | 1287 | 3590 | 1126 | 4424 | 940 | 4892 | 789 | 5390 | 557 | 6465 | 337 | 4466 |
| 6-#11 | 1.64 | MA | 3107 | 1287 | 4166 | 1149 | 5236 | 960 | 5844 | 807 | 6503 | 573 | 8013 | 371 | 5413 |
| 3L-2S | | MI | 2872 | 1287 | 4067 | 1115 | 5026 | 930 | 5620 | 782 | 6370 | 547 | 7759 | 452 | 4483 |
| 6-#14 | 2.36 | MA | 3769 | 1409 | 5545 | 1205 | 6950 | 999 | 7901 | 828 | 9258 | 551 | 11724 | 467 | 7663 |
| 2L-3S | | MI | 2723 | 1409 | 4025 | 1199 | 4945 | 993 | 5507 | 821 | 6204 | 551 | 7464 | 254 | 6179 |
| 6-#14 | 2.36 | MA | 3292 | 1409 | 4704 | 1224 | 5886 | 1015 | 6615 | 842 | 7527 | 569 | 9358 | 302 | 7544 |
| 3L-2S | | MI | 3103 | 1409 | 4700 | 1184 | 5798 | 980 | 6539 | 812 | 7594 | 539 | 9265 | 420 | 6261 |
| 6-#18 | 4.20 | MA | 4440 | 1718 | 7458 | 1387 | 9310 | 1131 | 10725 | 910 | 13032 | 533 | 16517 | 403 | 13061 |
| 2L-3S | | MI | 3059 | 1718 | 5063 | 1387 | 6200 | 1128 | 6996 | 904 | 8184 | 535 | 9784 | 24 | 9719 |
| 6-#18 | 4.20 | MA | 3752 | 1718 | 6005 | 1417 | 7472 | 1156 | 8502 | 930 | 10039 | 560 | 12542 | 109 | 12210 |
| 3L-2S | | MI | 3609 | 1718 | 6221 | 1363 | 7666 | 1111 | 8769 | 893 | 10570 | 519 | 12763 | 318 | 10543 |
| 8-#8 | 1.10 | MA | 3247 | 1197 | 4125 | 1093 | 5257 | 918 | 5908 | 781 | 6623 | 571 | 8205 | 497 | 3815 |
| 2L-4S | | MI | 2452 | 1197 | 3126 | 1088 | 3899 | 915 | 4278 | 781 | 4590 | 570 | 5543 | 393 | 3160 |
| 8-#8 | 1.10 | MA | 3048 | 1197 | 3816 | 1100 | 4866 | 925 | 5435 | 787 | 5987 | 579 | 7324 | 442 | 3814 |
| 3E | | MI | 2548 | 1197 | 3301 | 1081 | 4128 | 909 | 4570 | 772 | 4989 | 567 | 6043 | 427 | 3168 |
| 8-#8 | 1.10 | MA | 2930 | 1197 | 3602 | 1108 | 4587 | 932 | 5078 | 796 | 5498 | 583 | 6716 | 408 | 3793 |
| 4L-2S | | MI | 2708 | 1197 | 3552 | 1075 | 4445 | 903 | 4954 | 767 | 5505 | 560 | 6752 | 485 | 3164 |
| 8-#9 | 1.40 | MA | 3389 | 1247 | 4462 | 1121 | 5669 | 939 | 6399 | 793 | 7278 | 567 | 9107 | 493 | 4762 |
| 2L-4S | | MI | 2507 | 1247 | 3291 | 1119 | 4093 | 937 | 4501 | 796 | 4882 | 568 | 5936 | 361 | 3899 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis

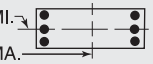



$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.40 | MA | 3147 | 1247 | 4074 | 1130 | 5178 | 947 | 5805 | 801 | 6478 | 577 | 7999 | 423 | 4750 |
| 3E | | MI | 2624 | 1247 | 3512 | 1111 | 4381 | 930 | 4869 | 785 | 5384 | 564 | 6561 | 403 | 3931 |
| 8-#9 | 1.40 | MA | 3004 | 1247 | 3804 | 1140 | 4826 | 956 | 5355 | 813 | 5863 | 583 | 7231 | 380 | 4697 |
| 4L-2S | | MI | 2818 | 1247 | 3827 | 1103 | 4779 | 923 | 5351 | 780 | 6033 | 557 | 7444 | 477 | 3934 |
| 8-#10 | 1.78 | MA | 3563 | 1310 | 4889 | 1158 | 6194 | 965 | 7025 | 810 | 8113 | 563 | 10258 | 489 | 5964 |
| 2L-4S | | MI | 2577 | 1310 | 3498 | 1159 | 4337 | 967 | 4783 | 815 | 5253 | 565 | 6431 | 319 | 4811 |
| 8-#10 | 1.78 | MA | 3271 | 1310 | 4399 | 1169 | 5574 | 976 | 6275 | 819 | 7103 | 575 | 8860 | 398 | 5933 |
| 3E | | MI | 2718 | 1310 | 3776 | 1149 | 4700 | 958 | 5247 | 803 | 5887 | 562 | 7212 | 372 | 4889 |
| 8-#10 | 1.78 | MA | 3098 | 1310 | 4058 | 1181 | 5129 | 986 | 5707 | 834 | 6327 | 582 | 7887 | 343 | 5815 |
| 4L-2S | | MI | 2953 | 1310 | 4173 | 1139 | 5202 | 949 | 5854 | 796 | 6704 | 552 | 8316 | 466 | 4908 |
| 8-#11 | 2.18 | MA | 3718 | 1379 | 5347 | 1192 | 6731 | 990 | 7652 | 824 | 8937 | 556 | 11384 | 481 | 7175 |
| 2L-4S | | MI | 2633 | 1379 | 3730 | 1195 | 4588 | 991 | 5061 | 830 | 5607 | 557 | 6838 | 262 | 5557 |
| 8-#11 | 2.18 | MA | 3380 | 1379 | 4757 | 1206 | 5983 | 1002 | 6748 | 834 | 7720 | 569 | 9699 | 366 | 7120 |
| 3E | | MI | 2797 | 1379 | 4067 | 1184 | 5026 | 982 | 5620 | 816 | 6370 | 554 | 7759 | 325 | 5840 |
| 8-#11 | 2.18 | MA | 3179 | 1379 | 4344 | 1220 | 5445 | 1014 | 6060 | 851 | 6781 | 576 | 8511 | 299 | 6773 |
| 4L-2S | | MI | 3069 | 1379 | 4543 | 1172 | 5629 | 973 | 6349 | 809 | 7351 | 544 | 9052 | 439 | 5877 |
| 8-#14 | 3.15 | MA | 4105 | 1541 | 6385 | 1288 | 8013 | 1060 | 9187 | 867 | 10990 | 546 | 14090 | 457 | 10111 |
| 2L-4S | | MI | 2810 | 1541 | 4221 | 1298 | 5175 | 1066 | 5743 | 879 | 6508 | 549 | 7977 | 145 | 7308 |
| 8-#14 | 3.15 | MA | 3666 | 1541 | 5545 | 1307 | 6950 | 1076 | 7901 | 881 | 9258 | 564 | 11724 | 292 | 9962 |
| 3E | | MI | 3020 | 1541 | 4700 | 1282 | 5798 | 1054 | 6539 | 860 | 7594 | 546 | 9265 | 232 | 8113 |
| 8-#14 | 3.15 | MA | 3404 | 1541 | 4956 | 1326 | 6182 | 1092 | 6920 | 904 | 7919 | 573 | 10052 | 196 | 8968 |
| 4L-2S | | MI | 3361 | 1541 | 5375 | 1267 | 6652 | 1041 | 7572 | 851 | 8984 | 534 | 11067 | 398 | 8226 |
| 8-#18 | 5.59 | MA | 4362 | 1953 | 7458 | 1564 | 9310 | 1264 | 10725 | 999 | 13032 | 551 | 16517 | 80 | 16239 |
| 3E | | MI | 3531 | 1953 | 6221 | 1534 | 7666 | 1236 | 8769 | 973 | 10570 | 526 | 12763 | -29 | 12700 |
| 8-#18 | 5.59 | MA | 3993 | 1953 | 6434 | 1595 | 7974 | 1289 | 9020 | 1037 | 10705 | 560 | 13691 | -83 | 13507 |
| 4L-2S | | MI | 4021 | 1953 | 7380 | 1510 | 9131 | 1219 | 10541 | 962 | 12956 | 510 | 15742 | 265 | 13896 |
| 10-#10 | 2.22 | MA | 3773 | 1385 | 5379 | 1204 | 6814 | 1000 | 7775 | 832 | 9123 | 561 | 11656 | 485 | 7395 |
| 2L-5S | | MI | 2642 | 1385 | 3645 | 1216 | 4486 | 1015 | 4974 | 844 | 5495 | 572 | 6755 | 257 | 5537 |
| 10-#10 | 2.22 | MA | 3495 | 1385 | 4889 | 1216 | 6194 | 1010 | 7025 | 841 | 8113 | 573 | 10258 | 394 | 7352 |
| 3L-4S | | MI | 2763 | 1385 | 3894 | 1206 | 4839 | 1001 | 5390 | 837 | 6070 | 563 | 7534 | 312 | 5908 |
| 10-#10 | 2.22 | MA | 3335 | 1385 | 4548 | 1228 | 5749 | 1021 | 6457 | 856 | 7336 | 579 | 9285 | 340 | 7214 |
| 4L-3S | | MI | 2894 | 1385 | 4173 | 1196 | 5202 | 992 | 5854 | 825 | 6704 | 559 | 8316 | 365 | 6038 |
| 10-#10 | 2.22 | MA | 3171 | 1385 | 4245 | 1240 | 5319 | 1037 | 5948 | 865 | 6633 | 591 | 8306 | 288 | 6705 |
| 5L-2S | | MI | 3118 | 1385 | 4570 | 1186 | 5704 | 984 | 6461 | 818 | 7521 | 549 | 9419 | 458 | 6067 |
| 10-#11 | 2.73 | MA | 3961 | 1470 | 5938 | 1250 | 7478 | 1032 | 8556 | 851 | 10154 | 553 | 13069 | 476 | 8898 |
| 2L-5S | | MI | 2714 | 1470 | 3905 | 1264 | 4764 | 1050 | 5287 | 864 | 5893 | 563 | 7217 | 182 | 6469 |
| 10-#11 | 2.73 | MA | 3642 | 1470 | 5347 | 1263 | 6731 | 1044 | 7652 | 861 | 8937 | 566 | 11384 | 362 | 8827 |
| 3L-4S | | MI | 2851 | 1470 | 4206 | 1252 | 5190 | 1034 | 5789 | 857 | 6588 | 553 | 8131 | 250 | 6868 |
| 10-#11 | 2.73 | MA | 3458 | 1470 | 4935 | 1277 | 6192 | 1056 | 6964 | 878 | 7998 | 573 | 10197 | 294 | 8425 |
| 4L-3S | | MI | 3008 | 1470 | 4543 | 1241 | 5629 | 1024 | 6349 | 843 | 7351 | 550 | 9052 | 312 | 7213 |
| 10-#11 | 2.73 | MA | 3268 | 1470 | 4567 | 1291 | 5671 | 1075 | 6349 | 888 | 7146 | 586 | 9008 | 227 | 7870 |
| 5L-2S | | MI | 3256 | 1470 | 5019 | 1229 | 6231 | 1015 | 7077 | 836 | 8332 | 541 | 10346 | 427 | 7265 |
| 10-#14 | 3.93 | MA | 4034 | 1674 | 6385 | 1390 | 8013 | 1137 | 9187 | 920 | 10990 | 559 | 14090 | 282 | 12384 |
| 3L-4S | | MI | 3112 | 1674 | 4896 | 1381 | 6028 | 1127 | 6776 | 918 | 7899 | 544 | 9779 | 123 | 9186 |
| 10-#14 | 3.93 | MA | 3810 | 1674 | 5797 | 1408 | 7245 | 1153 | 8206 | 943 | 9650 | 568 | 12418 | 186 | 11342 |
| 4L-3S | | MI | 3297 | 1674 | 5375 | 1365 | 6652 | 1114 | 7572 | 899 | 8984 | 541 | 11067 | 210 | 10050 |
| 10-#14 | 3.93 | MA | 3529 | 1674 | 5271 | 1427 | 6500 | 1179 | 7327 | 956 | 8434 | 586 | 10748 | 90 | 10402 |
| 5L-2S | | MI | 3612 | 1674 | 6050 | 1349 | 7506 | 1102 | 8604 | 890 | 10375 | 529 | 12869 | 376 | 10186 |
| 10-#18 | 6.99 | MA | 4641 | 2189 | 7886 | 1742 | 9812 | 1397 | 11243 | 1106 | 13698 | 551 | 17667 | -112 | 17294 |
| 4L-3S | | MI | 3985 | 2189 | 7380 | 1681 | 9131 | 1344 | 10541 | 1042 | 12956 | 517 | 15742 | -83 | 15524 |
| 12-#10 | 2.66 | MA | 3977 | 1460 | 5869 | 1251 | 7434 | 1034 | 8525 | 854 | 10133 | 558 | 13054 | 481 | 8823 |
| 2L-6S | | MI | 2657 | 1460 | 3799 | 1272 | 4668 | 1058 | 5174 | 879 | 5750 | 573 | 7103 | 182 | 6290 |
| 12-#10 | 2.66 | MA | 3712 | 1460 | 5379 | 1263 | 6814 | 1045 | 7775 | 863 | 9123 | 570 | 11656 | 390 | 8772 |
| 3L-5S | | MI | 2824 | 1460 | 4042 | 1263 | 4988 | 1049 | 5581 | 866 | 6312 | 569 | 7859 | 250 | 6654 |
| 12-#10 | 2.66 | MA | 3564 | 1460 | 5039 | 1275 | 6369 | 1055 | 7207 | 878 | 8346 | 576 | 10683 | 336 | 8590 |
| 4E | | MI | 2942 | 1460 | 4291 | 1253 | 5340 | 1035 | 5997 | 859 | 6888 | 560 | 8638 | 305 | 7007 |
| 12-#10 | 2.66 | MA | 3402 | 1460 | 4735 | 1287 | 5939 | 1071 | 6698 | 887 | 7642 | 588 | 9704 | 284 | 8101 |
| 5L-3S | | MI | 3065 | 1460 | 4570 | 1242 | 5704 | 1027 | 6461 | 847 | 7521 | 556 | 9419 | 358 | 7184 |

## RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis

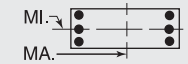



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 2.66 | MA | 3197 | 1460 | 4425 | 1295 | 5549 | 1082 | 6202 | 901 | 6956 | 595 | 8764 | 214 | 7647 |
| 6L-2S | | MI | 3279 | 1460 | 4966 | 1232 | 6206 | 1018 | 7068 | 840 | 8338 | 547 | 10523 | 451 | 7223 |
| 12-#11 | 3.27 | MA | 3895 | 1562 | 5938 | 1321 | 7478 | 1086 | 8556 | 888 | 10154 | 563 | 13069 | 357 | 10534 |
| 3L-5S | | MI | 2935 | 1562 | 4381 | 1321 | 5367 | 1092 | 6015 | 891 | 6873 | 560 | 8511 | 169 | 7812 |
| 12-#11 | 3.27 | MA | 3727 | 1562 | 5526 | 1334 | 6940 | 1098 | 7869 | 905 | 9215 | 569 | 11882 | 289 | 10086 |
| 4E | | MI | 3071 | 1562 | 4682 | 1310 | 5793 | 1076 | 6518 | 884 | 7568 | 550 | 9425 | 237 | 8189 |
| 12-#11 | 3.27 | MA | 3541 | 1562 | 5158 | 1348 | 6418 | 1117 | 7253 | 915 | 8363 | 583 | 10693 | 223 | 9557 |
| 5L-3S | | MI | 3205 | 1562 | 5019 | 1298 | 6231 | 1066 | 7077 | 870 | 8332 | 547 | 10346 | 300 | 8585 |
| 12-#11 | 3.27 | MA | 3302 | 1562 | 4789 | 1359 | 5946 | 1129 | 6651 | 932 | 7531 | 589 | 9545 | 136 | 8853 |
| 6L-2S | | MI | 3439 | 1562 | 5495 | 1287 | 6833 | 1057 | 7806 | 863 | 9313 | 537 | 11639 | 414 | 8650 |
| 12-#14 | 4.72 | MA | 4181 | 1806 | 6637 | 1491 | 8308 | 1214 | 9492 | 982 | 11382 | 563 | 14784 | 176 | 13727 |
| 4E | | MI | 3401 | 1806 | 5571 | 1463 | 6882 | 1188 | 7809 | 957 | 9289 | 539 | 11581 | 101 | 11076 |
| 12-#14 | 4.72 | MA | 3921 | 1806 | 6111 | 1510 | 7563 | 1240 | 8613 | 995 | 10165 | 581 | 13114 | 80 | 12787 |
| 5L-3S | | MI | 3565 | 1806 | 6050 | 1448 | 7506 | 1175 | 8604 | 938 | 10375 | 536 | 12869 | 188 | 11990 |
| 14-#10 | 3.11 | MA | 3923 | 1535 | 5869 | 1310 | 7434 | 1079 | 8525 | 885 | 10133 | 567 | 13054 | 386 | 10191 |
| 3L-6S | | MI | 2841 | 1535 | 4196 | 1319 | 5170 | 1092 | 5781 | 901 | 6567 | 570 | 8207 | 175 | 7401 |
| 14-#10 | 3.11 | MA | 3786 | 1535 | 5529 | 1321 | 6989 | 1089 | 7956 | 899 | 9356 | 574 | 12081 | 332 | 9971 |
| 4L-5S | | MI | 3000 | 1535 | 4438 | 1310 | 5490 | 1084 | 6187 | 888 | 7129 | 567 | 8962 | 243 | 7776 |
| 14-#10 | 3.11 | MA | 3626 | 1535 | 5226 | 1333 | 6559 | 1105 | 7448 | 909 | 8652 | 586 | 11102 | 281 | 9501 |
| 5L-4S | | MI | 3127 | 1535 | 4688 | 1299 | 5842 | 1070 | 6604 | 881 | 7705 | 557 | 9741 | 298 | 8112 |
| 14-#10 | 3.11 | MA | 3431 | 1535 | 4915 | 1341 | 6169 | 1116 | 6952 | 923 | 7966 | 592 | 10162 | 211 | 9043 |
| 6L-3S | | MI | 3237 | 1535 | 4966 | 1289 | 6206 | 1061 | 7068 | 869 | 8338 | 553 | 10523 | 351 | 8331 |
| 14-#10 | 3.11 | MA | 3259 | 1535 | 4562 | 1355 | 5780 | 1125 | 6472 | 933 | 7298 | 604 | 9234 | 167 | 8531 |
| 7L-2S | | MI | 3434 | 1535 | 5363 | 1279 | 6707 | 1052 | 7675 | 862 | 9156 | 544 | 11627 | 444 | 8378 |
| 14-#11 | 3.82 | MA | 4003 | 1654 | 6117 | 1392 | 7687 | 1140 | 8773 | 932 | 10432 | 566 | 13568 | 284 | 11754 |
| 4L-5S | | MI | 3140 | 1654 | 4857 | 1379 | 5969 | 1134 | 6743 | 918 | 7854 | 556 | 9805 | 157 | 9161 |
| 14-#11 | 3.82 | MA | 3804 | 1654 | 5749 | 1406 | 7166 | 1159 | 8157 | 942 | 9580 | 579 | 12378 | 218 | 11248 |
| 5L-4S | | MI | 3274 | 1654 | 5158 | 1367 | 6395 | 1118 | 7246 | 911 | 8549 | 547 | 10718 | 224 | 9518 |
| 14-#11 | 3.82 | MA | 3578 | 1654 | 5380 | 1416 | 6693 | 1171 | 7555 | 959 | 8748 | 586 | 11231 | 131 | 10539 |
| 6L-3S | | MI | 3396 | 1654 | 5495 | 1356 | 6833 | 1109 | 7806 | 897 | 9313 | 544 | 11639 | 287 | 9957 |
| 14-#14 | 5.51 | MA | 4283 | 1938 | 6952 | 1593 | 8627 | 1301 | 9899 | 1034 | 11897 | 576 | 15480 | 70 | 15179 |
| 5L-4S | | MI | 3681 | 1938 | 6246 | 1546 | 7736 | 1248 | 8841 | 996 | 10679 | 534 | 13383 | 79 | 12976 |
| 16-#10 | 3.55 | MA | 4002 | 1609 | 6019 | 1368 | 7609 | 1124 | 8706 | 921 | 10366 | 571 | 13479 | 328 | 11357 |
| 4L-6S | | MI | 3031 | 1609 | 4592 | 1366 | 5672 | 1127 | 6388 | 923 | 7384 | 568 | 9310 | 167 | 8516 |
| 16-#10 | 3.55 | MA | 3844 | 1609 | 5716 | 1380 | 7179 | 1140 | 8198 | 931 | 9662 | 583 | 12500 | 277 | 10905 |
| 5E | | MI | 3180 | 1609 | 4835 | 1356 | 5991 | 1118 | 6794 | 910 | 7946 | 564 | 10066 | 236 | 8901 |
| 16-#10 | 3.55 | MA | 3658 | 1609 | 5405 | 1388 | 6789 | 1150 | 7702 | 945 | 8976 | 589 | 11560 | 207 | 10442 |
| 6L-4S | | MI | 3297 | 1609 | 5084 | 1346 | 6344 | 1104 | 7211 | 903 | 8522 | 554 | 10845 | 291 | 9223 |
| 16-#10 | 3.55 | MA | 3495 | 1609 | 5052 | 1401 | 6400 | 1159 | 7222 | 955 | 8308 | 602 | 10632 | 163 | 9945 |
| 7L-3S | | MI | 3398 | 1609 | 5363 | 1336 | 6707 | 1095 | 7675 | 891 | 9156 | 550 | 11627 | 344 | 9477 |
| 16-#11 | 4.36 | MA | 4072 | 1746 | 6340 | 1463 | 7913 | 1201 | 9061 | 969 | 10797 | 576 | 14064 | 213 | 12943 |
| 5E | | MI | 3340 | 1746 | 5333 | 1436 | 6571 | 1176 | 7472 | 945 | 8835 | 553 | 11098 | 144 | 10513 |
| 16-#11 | 4.36 | MA | 3862 | 1746 | 5971 | 1474 | 7441 | 1213 | 8459 | 986 | 9966 | 582 | 12916 | 126 | 12228 |
| 6L-4S | | MI | 3472 | 1746 | 5635 | 1425 | 6997 | 1160 | 7975 | 938 | 9530 | 543 | 12012 | 212 | 10853 |
| 18-#10 | 4.00 | MA | 4057 | 1684 | 6206 | 1427 | 7799 | 1174 | 8948 | 953 | 10672 | 580 | 13898 | 273 | 12311 |
| 5L-6S | | MI | 3205 | 1684 | 4989 | 1412 | 6174 | 1161 | 6994 | 945 | 8201 | 565 | 10414 | 160 | 9635 |
| 18-#10 | 4.00 | MA | 3879 | 1684 | 5895 | 1435 | 7409 | 1185 | 8452 | 967 | 9985 | 587 | 12958 | 203 | 11844 |
| 6L-5S | | MI | 3347 | 1684 | 5232 | 1403 | 6493 | 1153 | 7401 | 932 | 8763 | 561 | 11169 | 229 | 10030 |
| 18-#10 | 4.00 | MA | 3725 | 1684 | 5543 | 1448 | 7020 | 1194 | 7972 | 977 | 9318 | 599 | 12030 | 159 | 11354 |
| 7L-4S | | MI | 3462 | 1684 | 5481 | 1393 | 6846 | 1138 | 7818 | 925 | 9339 | 551 | 11948 | 283 | 10338 |
| 18-#11 | 4.91 | MA | 4122 | 1838 | 6562 | 1531 | 8188 | 1255 | 9363 | 1013 | 11183 | 579 | 14601 | 121 | 13921 |
| 6L-5S | | MI | 3535 | 1838 | 5809 | 1494 | 7173 | 1219 | 8200 | 972 | 9816 | 550 | 12392 | 131 | 11843 |
| 20-#10 | 4.44 | MA | 4111 | 1759 | 6385 | 1482 | 8029 | 1219 | 9202 | 989 | 10995 | 584 | 14356 | 199 | 13248 |
| 6E | | MI | 3375 | 1759 | 5386 | 1459 | 6675 | 1195 | 7601 | 967 | 9018 | 562 | 11517 | 153 | 10756 |
| 20-#10 | 4.44 | MA | 3948 | 1759 | 6033 | 1495 | 7640 | 1228 | 8722 | 998 | 10327 | 596 | 13428 | 155 | 12763 |
| 7L-5S | | MI | 3511 | 1759 | 5628 | 1450 | 6995 | 1187 | 8008 | 954 | 9581 | 558 | 12273 | 221 | 11161 |

## RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

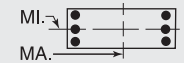
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.01 | MA | 3694 | 1273 | 4694 | 1160 | 5947 | 976 | 6652 | 831 | 7396 | 612 | 9109 | 533 | 4049 |
| 2E | | MI | 2841 | 1273 | 3793 | 1130 | 4672 | 950 | 5156 | 809 | 5653 | 594 | 6763 | 502 | 3096 |
| 4-#14 | 1.46 | MA | 3934 | 1354 | 5287 | 1205 | 6664 | 1008 | 7502 | 851 | 8525 | 605 | 10660 | 526 | 5693 |
| 2E | | MI | 3004 | 1354 | 4231 | 1173 | 5194 | 981 | 5771 | 827 | 6467 | 586 | 7761 | 479 | 4307 |
| 4-#18 | 2.60 | MA | 4478 | 1560 | 6725 | 1322 | 8417 | 1093 | 9588 | 903 | 11303 | 591 | 14312 | 494 | 9704 |
| 2E | | MI | 3362 | 1560 | 5274 | 1287 | 6452 | 1063 | 7262 | 876 | 8446 | 570 | 10078 | 408 | 7213 |
| 6-#10 | 1.24 | MA | 3852 | 1313 | 4946 | 1194 | 6314 | 1002 | 7121 | 849 | 8049 | 615 | 10029 | 535 | 4940 |
| 2L-3S | | MI | 2707 | 1313 | 3578 | 1176 | 4444 | 986 | 4904 | 835 | 5334 | 608 | 6409 | 417 | 3761 |
| 6-#10 | 1.24 | MA | 3508 | 1313 | 4410 | 1206 | 5635 | 1013 | 6299 | 859 | 6943 | 628 | 8498 | 447 | 4924 |
| 3L-2S | | MI | 2957 | 1313 | 3975 | 1165 | 4946 | 977 | 5511 | 828 | 6151 | 598 | 7512 | 511 | 3760 |
| 6-#11 | 1.52 | MA | 3988 | 1365 | 5342 | 1218 | 6767 | 1018 | 7644 | 858 | 8732 | 608 | 10958 | 528 | 5954 |
| 2L-3S | | MI | 2756 | 1365 | 3793 | 1199 | 4672 | 1002 | 5156 | 843 | 5653 | 600 | 6763 | 375 | 4494 |
| 6-#11 | 1.52 | MA | 3587 | 1365 | 4694 | 1232 | 5947 | 1031 | 6652 | 869 | 7396 | 623 | 9109 | 417 | 5919 |
| 3L-2S | | MI | 3047 | 1365 | 4269 | 1187 | 5274 | 992 | 5885 | 836 | 6634 | 590 | 8057 | 489 | 4505 |
| 6-#14 | 2.19 | MA | 4330 | 1486 | 6210 | 1288 | 7832 | 1069 | 8915 | 890 | 10427 | 600 | 13293 | 519 | 8392 |
| 2L-3S | | MI | 2894 | 1486 | 4231 | 1271 | 5194 | 1054 | 5771 | 875 | 6467 | 594 | 7761 | 292 | 6220 |
| 6-#14 | 2.19 | MA | 3797 | 1486 | 5287 | 1308 | 6664 | 1087 | 7502 | 905 | 8525 | 620 | 10660 | 355 | 8273 |
| 3L-2S | | MI | 3280 | 1486 | 4906 | 1256 | 6047 | 1042 | 6804 | 866 | 7857 | 581 | 9562 | 457 | 6288 |
| 6-#18 | 3.90 | MA | 5094 | 1795 | 8325 | 1469 | 10441 | 1201 | 12036 | 972 | 14598 | 582 | 18790 | 473 | 14357 |
| 2L-3S | | MI | 3228 | 1795 | 5274 | 1458 | 6452 | 1189 | 7262 | 956 | 8446 | 577 | 10078 | 61 | 9913 |
| 6-#18 | 3.90 | MA | 4319 | 1795 | 6725 | 1502 | 8417 | 1229 | 9588 | 995 | 11303 | 613 | 14312 | 180 | 13718 |
| 3L-2S | | MI | 3790 | 1795 | 6433 | 1434 | 7917 | 1171 | 9034 | 946 | 10832 | 561 | 13057 | 355 | 10579 |
| 8-#8 | 1.03 | MA | 3739 | 1275 | 4644 | 1175 | 5965 | 989 | 6715 | 842 | 7519 | 620 | 9307 | 540 | 4156 |
| 2L-4S | | MI | 2623 | 1275 | 3322 | 1162 | 4144 | 977 | 4541 | 835 | 4854 | 613 | 5844 | 431 | 3181 |
| 8-#8 | 1.03 | MA | 3518 | 1275 | 4306 | 1183 | 5537 | 996 | 6198 | 849 | 6823 | 628 | 8344 | 486 | 4155 |
| 3E | | MI | 2720 | 1275 | 3497 | 1155 | 4373 | 972 | 4833 | 827 | 5254 | 610 | 6345 | 465 | 3185 |
| 8-#8 | 1.03 | MA | 3387 | 1275 | 4073 | 1191 | 5233 | 1003 | 5809 | 859 | 6290 | 634 | 7685 | 453 | 4135 |
| 4L-2S | | MI | 2881 | 1275 | 3748 | 1148 | 4690 | 966 | 5217 | 822 | 5770 | 604 | 7053 | 523 | 3179 |
| 8-#9 | 1.30 | MA | 3898 | 1325 | 5015 | 1204 | 6418 | 1009 | 7255 | 855 | 8238 | 616 | 10297 | 536 | 5194 |
| 2L-4S | | MI | 2678 | 1325 | 3488 | 1193 | 4338 | 1000 | 4764 | 850 | 5146 | 611 | 6237 | 399 | 3928 |
| 8-#9 | 1.30 | MA | 3629 | 1325 | 4589 | 1213 | 5880 | 1018 | 6604 | 863 | 7362 | 627 | 9084 | 467 | 5182 |
| 3E | | MI | 2796 | 1325 | 3709 | 1184 | 4626 | 993 | 5132 | 840 | 5649 | 608 | 6862 | 442 | 3951 |
| 8-#9 | 1.30 | MA | 3471 | 1325 | 4295 | 1223 | 5496 | 1027 | 6113 | 875 | 6691 | 633 | 8252 | 425 | 5129 |
| 4L-2S | | MI | 2992 | 1325 | 4024 | 1176 | 5024 | 986 | 5614 | 834 | 6297 | 600 | 7745 | 515 | 3952 |
| 8-#10 | 1.65 | MA | 4094 | 1388 | 5483 | 1240 | 6993 | 1036 | 7942 | 871 | 9155 | 612 | 11561 | 531 | 6512 |
| 2L-4S | | MI | 2747 | 1388 | 3696 | 1232 | 4583 | 1029 | 5047 | 870 | 5517 | 609 | 6731 | 357 | 4850 |
| 8-#10 | 1.65 | MA | 3768 | 1388 | 4946 | 1253 | 6314 | 1047 | 7121 | 881 | 8049 | 625 | 10029 | 443 | 6482 |
| 3E | | MI | 2891 | 1388 | 3975 | 1222 | 4946 | 1020 | 5511 | 857 | 6151 | 605 | 7512 | 410 | 4914 |
| 8-#10 | 1.65 | MA | 3576 | 1388 | 4575 | 1265 | 5829 | 1058 | 6500 | 897 | 7201 | 633 | 8975 | 389 | 6364 |
| 4L-2S | | MI | 3129 | 1388 | 4372 | 1212 | 5448 | 1012 | 6118 | 850 | 6968 | 595 | 8616 | 504 | 4928 |
| 8-#11 | 2.03 | MA | 4270 | 1456 | 5990 | 1275 | 7587 | 1060 | 8636 | 885 | 10067 | 605 | 12807 | 524 | 7849 |
| 2L-4S | | MI | 2803 | 1456 | 3933 | 1268 | 4836 | 1053 | 5325 | 884 | 5871 | 600 | 7136 | 300 | 5656 |
| 8-#11 | 2.03 | MA | 3893 | 1456 | 5342 | 1289 | 6767 | 1073 | 7644 | 896 | 8732 | 620 | 10958 | 412 | 7794 |
| 3E | | MI | 2970 | 1456 | 4269 | 1256 | 5274 | 1044 | 5885 | 870 | 6634 | 597 | 8057 | 362 | 5872 |
| 8-#11 | 2.03 | MA | 3670 | 1456 | 4891 | 1304 | 6179 | 1086 | 6892 | 915 | 7704 | 628 | 9671 | 345 | 7506 |
| 4L-2S | | MI | 3245 | 1456 | 4746 | 1244 | 5876 | 1034 | 6613 | 863 | 7615 | 587 | 9350 | 477 | 5901 |
| 8-#14 | 2.92 | MA | 4710 | 1619 | 7134 | 1371 | 9000 | 1130 | 10328 | 929 | 12329 | 595 | 15927 | 512 | 11083 |
| 2L-4S | | MI | 2967 | 1619 | 4427 | 1370 | 5424 | 1127 | 6008 | 933 | 6772 | 591 | 8274 | 182 | 7424 |
| 8-#14 | 2.92 | MA | 4215 | 1619 | 6210 | 1391 | 7832 | 1148 | 8915 | 944 | 10427 | 615 | 13293 | 348 | 10934 |
| 3E | | MI | 3193 | 1619 | 4906 | 1354 | 6047 | 1115 | 6804 | 914 | 7857 | 589 | 9562 | 270 | 8157 |
| 8-#14 | 2.92 | MA | 3924 | 1619 | 5567 | 1411 | 6992 | 1165 | 7842 | 969 | 8960 | 626 | 11445 | 251 | 9944 |
| 4L-2S | | MI | 3541 | 1619 | 5581 | 1339 | 6901 | 1103 | 7837 | 905 | 9248 | 576 | 11364 | 435 | 8255 |
| 8-#18 | 5.19 | MA | 5001 | 2031 | 8325 | 1649 | 10441 | 1337 | 12036 | 1064 | 14598 | 604 | 18790 | 160 | 18190 |
| 3E | | MI | 3702 | 2031 | 6433 | 1605 | 7917 | 1297 | 9034 | 1026 | 10832 | 568 | 13057 | 8 | 13034 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis

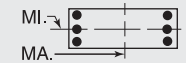



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 5.19 | MA | 4589 | 2031 | 7203 | 1682 | 8977 | 1365 | 10167 | 1105 | 12046 | 617 | 15622 | -9 | 15599 |
| 4L-2S | | MI | 4204 | 2031 | 7591 | 1581 | 9383 | 1279 | 10806 | 1015 | 13219 | 552 | 16037 | 301 | 13933 |
| 10-#10 | 2.06 | MA | 4329 | 1463 | 6020 | 1287 | 7672 | 1070 | 8763 | 893 | 10261 | 609 | 13092 | 528 | 8081 |
| 2L-5S | | MI | 2813 | 1463 | 3844 | 1289 | 4732 | 1078 | 5237 | 899 | 5759 | 615 | 7055 | 295 | 5613 |
| 10-#10 | 2.06 | MA | 4018 | 1463 | 5483 | 1299 | 6993 | 1081 | 7942 | 903 | 9155 | 623 | 11561 | 439 | 8038 |
| 3L-4S | | MI | 2934 | 1463 | 4093 | 1279 | 5084 | 1063 | 5654 | 892 | 6335 | 606 | 7834 | 350 | 5987 |
| 10-#10 | 2.06 | MA | 3841 | 1463 | 5112 | 1312 | 6508 | 1093 | 7321 | 919 | 8307 | 630 | 10506 | 385 | 7911 |
| 4L-3S | | MI | 3068 | 1463 | 4372 | 1269 | 5448 | 1055 | 6118 | 879 | 6968 | 602 | 8616 | 403 | 6064 |
| 10-#10 | 2.06 | MA | 3654 | 1463 | 4782 | 1324 | 6039 | 1109 | 6767 | 929 | 7539 | 643 | 9442 | 337 | 7383 |
| 5L-2S | | MI | 3295 | 1463 | 4768 | 1259 | 5950 | 1046 | 6725 | 872 | 7785 | 593 | 9720 | 496 | 6088 |
| 10-#11 | 2.53 | MA | 4542 | 1548 | 6638 | 1332 | 8407 | 1103 | 9628 | 912 | 11402 | 601 | 14656 | 519 | 9740 |
| 2L-5S | | MI | 2884 | 1548 | 4108 | 1337 | 5012 | 1112 | 5551 | 918 | 6156 | 606 | 7516 | 219 | 6557 |
| 10-#11 | 2.53 | MA | 4185 | 1548 | 5990 | 1347 | 7587 | 1115 | 8636 | 923 | 10067 | 616 | 12807 | 407 | 9669 |
| 3L-4S | | MI | 3022 | 1548 | 4409 | 1325 | 5438 | 1095 | 6054 | 911 | 6851 | 596 | 8429 | 287 | 6963 |
| 10-#11 | 2.53 | MA | 3982 | 1548 | 5540 | 1361 | 6999 | 1128 | 7884 | 942 | 9040 | 624 | 11520 | 341 | 9325 |
| 4L-3S | | MI | 3183 | 1548 | 4746 | 1313 | 5876 | 1086 | 6613 | 897 | 7615 | 593 | 9350 | 350 | 7246 |
| 10-#11 | 2.53 | MA | 3765 | 1548 | 5138 | 1376 | 6430 | 1148 | 7212 | 953 | 8109 | 639 | 10225 | 278 | 8678 |
| 5L-2S | | MI | 3435 | 1548 | 5222 | 1302 | 6479 | 1077 | 7342 | 890 | 8596 | 583 | 10644 | 464 | 7291 |
| 10-#14 | 3.65 | MA | 4629 | 1751 | 7134 | 1474 | 9000 | 1208 | 10328 | 983 | 12329 | 610 | 15927 | 342 | 13599 |
| 3L-4S | | MI | 3281 | 1751 | 5102 | 1453 | 6277 | 1188 | 7041 | 972 | 8162 | 586 | 10076 | 160 | 9296 |
| 10-#14 | 3.65 | MA | 4356 | 1751 | 6490 | 1494 | 8160 | 1226 | 9254 | 1008 | 10862 | 621 | 14079 | 244 | 12562 |
| 4L-3S | | MI | 3472 | 1751 | 5581 | 1437 | 6901 | 1176 | 7837 | 953 | 9248 | 584 | 11364 | 248 | 10095 |
| 10-#14 | 3.65 | MA | 4056 | 1751 | 5916 | 1514 | 7347 | 1254 | 8293 | 1023 | 9532 | 641 | 12225 | 150 | 11612 |
| 5L-2S | | MI | 3794 | 1751 | 6256 | 1421 | 7755 | 1163 | 8869 | 944 | 10638 | 571 | 13166 | 413 | 10216 |
| 10-#18 | 6.49 | MA | 5312 | 2266 | 8802 | 1829 | 11001 | 1474 | 12615 | 1174 | 15341 | 608 | 20100 | -29 | 19985 |
| 4L-3S | | MI | 4157 | 2266 | 7591 | 1752 | 9383 | 1405 | 10806 | 1095 | 13219 | 559 | 16037 | -46 | 15918 |
| 12-#10 | 2.47 | MA | 4557 | 1538 | 6557 | 1334 | 8352 | 1105 | 9585 | 915 | 11367 | 607 | 14623 | 524 | 9646 |
| 2L-6S | | MI | 2827 | 1538 | 3998 | 1345 | 4914 | 1121 | 5437 | 933 | 6014 | 617 | 7403 | 220 | 6407 |
| 12-#10 | 2.47 | MA | 4261 | 1538 | 6020 | 1346 | 7672 | 1116 | 8763 | 925 | 10261 | 620 | 13092 | 435 | 9594 |
| 3L-5S | | MI | 2996 | 1538 | 4241 | 1336 | 5234 | 1112 | 5844 | 921 | 6576 | 613 | 8159 | 288 | 6728 |
| 12-#10 | 2.47 | MA | 4096 | 1538 | 5649 | 1359 | 7187 | 1127 | 8143 | 941 | 9413 | 627 | 12037 | 382 | 9460 |
| 4E | | MI | 3114 | 1538 | 4490 | 1326 | 5586 | 1098 | 6261 | 914 | 7152 | 603 | 8938 | 343 | 7090 |
| 12-#10 | 2.47 | MA | 3912 | 1538 | 5318 | 1371 | 6718 | 1144 | 7589 | 951 | 8645 | 640 | 10973 | 333 | 8916 |
| 5L-3S | | MI | 3240 | 1538 | 4768 | 1316 | 5950 | 1089 | 6725 | 901 | 7785 | 599 | 9720 | 396 | 7212 |
| 12-#10 | 2.47 | MA | 3685 | 1538 | 4974 | 1379 | 6294 | 1155 | 7048 | 966 | 7897 | 648 | 9955 | 264 | 8472 |
| 6L-2S | | MI | 3458 | 1538 | 5165 | 1305 | 6451 | 1080 | 7332 | 894 | 8603 | 590 | 10823 | 489 | 7246 |
| 12-#11 | 3.04 | MA | 4469 | 1640 | 6638 | 1404 | 8407 | 1158 | 9628 | 950 | 11402 | 613 | 14656 | 403 | 11545 |
| 3L-5S | | MI | 3098 | 1640 | 4584 | 1394 | 5614 | 1154 | 6279 | 945 | 7137 | 603 | 8809 | 207 | 7897 |
| 12-#11 | 3.04 | MA | 4281 | 1640 | 6188 | 1419 | 7819 | 1170 | 8876 | 969 | 10375 | 621 | 13369 | 336 | 11153 |
| 4E | | MI | 3243 | 1640 | 4885 | 1382 | 6040 | 1138 | 6782 | 938 | 7832 | 593 | 9723 | 275 | 8280 |
| 12-#11 | 3.04 | MA | 4068 | 1640 | 5787 | 1433 | 7250 | 1190 | 8204 | 980 | 9444 | 636 | 12074 | 273 | 10533 |
| 5L-3S | | MI | 3381 | 1640 | 5222 | 1371 | 6479 | 1128 | 7342 | 924 | 8596 | 590 | 10644 | 337 | 8619 |
| 12-#11 | 3.04 | MA | 3804 | 1640 | 5376 | 1443 | 6735 | 1203 | 7547 | 998 | 8537 | 644 | 10830 | 187 | 9817 |
| 6L-2S | | MI | 3619 | 1640 | 5698 | 1359 | 7081 | 1119 | 8070 | 916 | 9576 | 580 | 11938 | 452 | 8677 |
| 12-#14 | 4.38 | MA | 4793 | 1884 | 7413 | 1576 | 9328 | 1287 | 10667 | 1047 | 12764 | 616 | 16712 | 237 | 15190 |
| 4E | | MI | 3571 | 1884 | 5777 | 1535 | 7131 | 1249 | 8073 | 1011 | 9552 | 581 | 11878 | 138 | 11181 |
| 12-#14 | 4.38 | MA | 4475 | 1884 | 6840 | 1597 | 8515 | 1315 | 9706 | 1062 | 11434 | 636 | 14859 | 143 | 14249 |
| 5L-3S | | MI | 3741 | 1884 | 6256 | 1520 | 7755 | 1237 | 8869 | 992 | 10638 | 579 | 13166 | 226 | 12034 |
| 12-#14 | 4.38 | MA | 4124 | 1884 | 6260 | 1612 | 7778 | 1332 | 8768 | 1087 | 10137 | 646 | 13072 | 18 | 12984 |
| 6L-2S | | MI | 4042 | 1884 | 6931 | 1504 | 8609 | 1224 | 9902 | 983 | 12028 | 566 | 14967 | 391 | 12174 |
| 14-#10 | 2.89 | MA | 4496 | 1612 | 6557 | 1393 | 8352 | 1150 | 9585 | 947 | 11367 | 617 | 14623 | 431 | 11151 |
| 3L-6S | | MI | 3012 | 1612 | 4395 | 1392 | 5416 | 1155 | 6044 | 955 | 6831 | 614 | 8507 | 213 | 7515 |
| 14-#10 | 2.89 | MA | 4343 | 1612 | 6186 | 1405 | 7866 | 1161 | 8964 | 963 | 10519 | 624 | 13569 | 378 | 11006 |
| 4L-5S | | MI | 3173 | 1612 | 4637 | 1383 | 5735 | 1146 | 6451 | 943 | 7393 | 610 | 9262 | 281 | 7848 |
| 14-#10 | 2.89 | MA | 4162 | 1612 | 5855 | 1418 | 7397 | 1178 | 8410 | 973 | 9751 | 638 | 12505 | 329 | 10453 |
| 5L-4S | | MI | 3290 | 1612 | 4886 | 1373 | 6088 | 1132 | 6867 | 936 | 7969 | 600 | 10041 | 336 | 8192 |
| 14-#10 | 2.89 | MA | 3945 | 1612 | 5510 | 1426 | 6973 | 1189 | 7869 | 988 | 9003 | 645 | 11486 | 260 | 10008 |
| 6L-3S | | MI | 3414 | 1612 | 5165 | 1362 | 6451 | 1123 | 7332 | 923 | 8603 | 597 | 10823 | 389 | 8359 |

## RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis

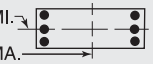



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.89 | MA | 3754 | 1612 | 5168 | 1434 | 6541 | 1198 | 7346 | 998 | 8275 | 658 | 10479 | 219 | 9417 |
| 7L-2S | | MI | 3615 | 1612 | 5562 | 1352 | 6953 | 1115 | 7938 | 916 | 9420 | 587 | 11927 | 482 | 8401 |
| 14-#11 | 3.55 | MA | 4572 | 1732 | 6836 | 1476 | 8639 | 1213 | 9868 | 996 | 11711 | 617 | 15218 | 331 | 12988 |
| 4L-5S | | MI | 3313 | 1732 | 5060 | 1451 | 6217 | 1196 | 7008 | 972 | 8118 | 599 | 10103 | 194 | 9242 |
| 14-#11 | 3.55 | MA | 4362 | 1732 | 6435 | 1491 | 8070 | 1232 | 9195 | 1007 | 10780 | 632 | 13923 | 268 | 12392 |
| 5L-4S | | MI | 3447 | 1732 | 5361 | 1440 | 6642 | 1180 | 7511 | 965 | 8813 | 589 | 11017 | 262 | 9606 |
| 14-#11 | 3.55 | MA | 4111 | 1732 | 6024 | 1501 | 7555 | 1245 | 8539 | 1025 | 9872 | 640 | 12679 | 182 | 11675 |
| 6L-3S | | MI | 3573 | 1732 | 5698 | 1428 | 7081 | 1170 | 8070 | 951 | 9576 | 586 | 11938 | 325 | 9992 |
| 14-#11 | 3.55 | MA | 3889 | 1732 | 5558 | 1517 | 7041 | 1256 | 7904 | 1036 | 8989 | 655 | 11452 | 129 | 10909 |
| 7L-2S | | MI | 3800 | 1732 | 6174 | 1417 | 7683 | 1161 | 8798 | 943 | 10557 | 577 | 13231 | 439 | 10060 |
| 14-#14 | 5.11 | MA | 4898 | 2016 | 7763 | 1679 | 9683 | 1375 | 11118 | 1101 | 13336 | 631 | 17492 | 136 | 16891 |
| 5L-4S | | MI | 3852 | 2016 | 6452 | 1618 | 7985 | 1310 | 9106 | 1050 | 10943 | 577 | 13679 | 116 | 13076 |
| 14-#14 | 5.11 | MA | 4575 | 2016 | 7183 | 1694 | 8946 | 1393 | 10180 | 1126 | 12039 | 641 | 15706 | 11 | 15651 |
| 6L-3S | | MI | 4004 | 2016 | 6931 | 1602 | 8609 | 1298 | 9902 | 1031 | 12028 | 574 | 14967 | 204 | 13976 |
| 16-#10 | 3.30 | MA | 4584 | 1687 | 6722 | 1452 | 8545 | 1196 | 9786 | 985 | 11625 | 622 | 15100 | 374 | 12528 |
| 4L-6S | | MI | 3191 | 1687 | 4791 | 1439 | 5917 | 1189 | 6651 | 977 | 7648 | 611 | 9610 | 205 | 8626 |
| 16-#10 | 3.30 | MA | 4405 | 1687 | 6392 | 1464 | 8076 | 1212 | 9231 | 995 | 10857 | 635 | 14036 | 325 | 11992 |
| 5E | | MI | 3355 | 1687 | 5034 | 1430 | 6237 | 1181 | 7058 | 965 | 8210 | 607 | 10366 | 274 | 8971 |
| 16-#10 | 3.30 | MA | 4198 | 1687 | 6047 | 1472 | 7652 | 1224 | 8691 | 1010 | 10109 | 642 | 13017 | 256 | 11547 |
| 6L-4S | | MI | 3471 | 1687 | 5283 | 1419 | 6590 | 1166 | 7474 | 958 | 8786 | 598 | 11145 | 329 | 9301 |
| 16-#10 | 3.30 | MA | 4017 | 1687 | 5705 | 1480 | 7220 | 1232 | 8168 | 1020 | 9381 | 656 | 12010 | 215 | 10971 |
| 7L-3S | | MI | 3576 | 1687 | 5562 | 1409 | 6953 | 1158 | 7938 | 945 | 9420 | 594 | 11927 | 382 | 9506 |
| 16-#10 | 3.30 | MA | 3848 | 1687 | 5328 | 1495 | 6756 | 1245 | 7649 | 1029 | 8656 | 663 | 11040 | 161 | 10282 |
| 8L-2S | | MI | 3768 | 1687 | 5958 | 1399 | 7455 | 1149 | 8545 | 938 | 10237 | 584 | 13030 | 475 | 9554 |
| 16-#11 | 4.05 | MA | 4663 | 1824 | 7083 | 1548 | 8890 | 1275 | 10187 | 1034 | 12115 | 629 | 15772 | 263 | 14255 |
| 5E | | MI | 3514 | 1824 | 5536 | 1509 | 6819 | 1238 | 7736 | 999 | 9099 | 596 | 11396 | 182 | 10592 |
| 16-#11 | 4.05 | MA | 4408 | 1824 | 6672 | 1558 | 8375 | 1287 | 9531 | 1052 | 11208 | 637 | 14528 | 177 | 13535 |
| 6L-4S | | MI | 3646 | 1824 | 5838 | 1497 | 7245 | 1222 | 8239 | 992 | 9794 | 586 | 12310 | 250 | 10939 |
| 16-#11 | 4.05 | MA | 4199 | 1824 | 6206 | 1574 | 7861 | 1298 | 8896 | 1063 | 10324 | 652 | 13301 | 124 | 12778 |
| 7L-3S | | MI | 3761 | 1824 | 6174 | 1486 | 7683 | 1213 | 8798 | 978 | 10557 | 583 | 13231 | 312 | 11366 |
| 16-#14 | 5.84 | MA | 4989 | 2149 | 8107 | 1777 | 10114 | 1454 | 11593 | 1165 | 13941 | 636 | 18339 | 5 | 18317 |
| 6L-4S | | MI | 4125 | 2149 | 7127 | 1701 | 8839 | 1371 | 10139 | 1088 | 12333 | 572 | 15481 | 94 | 14980 |
| 18-#10 | 3.71 | MA | 4641 | 1762 | 6929 | 1511 | 8755 | 1247 | 10053 | 1016 | 11963 | 632 | 15567 | 321 | 13535 |
| 5L-6S | | MI | 3377 | 1762 | 5188 | 1486 | 6419 | 1224 | 7258 | 999 | 8465 | 608 | 10714 | 198 | 9741 |
| 18-#10 | 3.71 | MA | 4443 | 1762 | 6584 | 1519 | 8331 | 1258 | 9512 | 1032 | 11215 | 640 | 14549 | 252 | 13087 |
| 6L-5S | | MI | 3523 | 1762 | 5431 | 1476 | 6739 | 1215 | 7665 | 987 | 9028 | 604 | 11469 | 267 | 10097 |
| 18-#10 | 3.71 | MA | 4272 | 1762 | 6242 | 1527 | 7899 | 1266 | 8989 | 1042 | 10487 | 653 | 13542 | 211 | 12526 |
| 7L-4S | | MI | 3638 | 1762 | 5680 | 1466 | 7092 | 1201 | 8081 | 980 | 9603 | 595 | 12249 | 321 | 10414 |
| 18-#10 | 3.71 | MA | 4113 | 1762 | 5865 | 1542 | 7435 | 1280 | 8471 | 1051 | 9762 | 660 | 12571 | 157 | 11834 |
| 8L-3S | | MI | 3735 | 1762 | 5958 | 1456 | 7455 | 1192 | 8545 | 967 | 10237 | 591 | 13030 | 374 | 10653 |
| 18-#11 | 4.56 | MA | 4718 | 1916 | 7321 | 1616 | 9195 | 1330 | 10523 | 1079 | 12543 | 633 | 16378 | 173 | 15398 |
| 6L-5S | | MI | 3710 | 1916 | 6012 | 1566 | 7421 | 1280 | 8464 | 1026 | 10079 | 593 | 12690 | 169 | 11946 |
| 18-#11 | 4.56 | MA | 4501 | 1916 | 6854 | 1632 | 8681 | 1341 | 9888 | 1090 | 11660 | 648 | 15150 | 119 | 14649 |
| 7L-4S | | MI | 3840 | 1916 | 6314 | 1555 | 7847 | 1264 | 8967 | 1019 | 10774 | 583 | 13604 | 237 | 12277 |
| 20-#10 | 4.12 | MA | 4683 | 1837 | 7121 | 1566 | 9011 | 1292 | 10334 | 1054 | 12321 | 637 | 16080 | 248 | 14630 |
| 6E | | MI | 3548 | 1837 | 5585 | 1532 | 6921 | 1258 | 7865 | 1021 | 9283 | 605 | 11817 | 191 | 10860 |
| 20-#10 | 4.12 | MA | 4520 | 1837 | 6779 | 1574 | 8578 | 1301 | 9811 | 1064 | 11593 | 650 | 15073 | 207 | 14082 |
| 7L-5S | | MI | 3687 | 1837 | 5827 | 1523 | 7241 | 1249 | 8272 | 1009 | 9845 | 601 | 12573 | 260 | 11227 |
| 20-#10 | 4.12 | MA | 4369 | 1837 | 6402 | 1589 | 8114 | 1314 | 9292 | 1073 | 10868 | 657 | 14103 | 153 | 13386 |
| 8L-4S | | MI | 3801 | 1837 | 6077 | 1513 | 7593 | 1235 | 8688 | 1002 | 10421 | 592 | 13352 | 314 | 11531 |
| 20-#11 | 5.06 | MA | 4820 | 2007 | 7503 | 1689 | 9501 | 1383 | 10880 | 1117 | 12995 | 645 | 16999 | 115 | 16522 |
| 7L-5S | | MI | 3901 | 2007 | 6488 | 1623 | 8023 | 1323 | 9193 | 1053 | 11060 | 589 | 13984 | 157 | 13303 |
| 22-#10 | 4.54 | MA | 4764 | 1911 | 7316 | 1621 | 9257 | 1335 | 10632 | 1086 | 12699 | 647 | 16604 | 203 | 15639 |
| 7L-6S | | MI | 3716 | 1911 | 5981 | 1579 | 7423 | 1292 | 8472 | 1043 | 10100 | 602 | 12921 | 184 | 11981 |
| 22-#10 | 4.54 | MA | 4614 | 1911 | 6939 | 1636 | 8793 | 1348 | 10113 | 1095 | 11974 | 655 | 15634 | 149 | 14938 |
| 8L-5S | | MI | 3848 | 1911 | 6224 | 1570 | 7743 | 1284 | 8879 | 1031 | 10662 | 599 | 13676 | 252 | 12359 |

## RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis

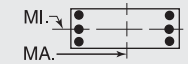



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#14 | 1.36 | MA | 4484 | 1432 | 5895 | 1288 | 7481 | 1079 | 8435 | 912 | 9571 | 654 | 11958 | 569 | 6179 |
| 2E | | MI | 3178 | 1432 | 4437 | 1245 | 5443 | 1042 | 6036 | 880 | 6730 | 629 | 8058 | 516 | 4329 |
| 4-#18 | 2.42 | MA | 5093 | 1638 | 7469 | 1405 | 9401 | 1164 | 10720 | 964 | 12614 | 640 | 16145 | 552 | 10568 |
| 2E | | MI | 3540 | 1638 | 5486 | 1358 | 6703 | 1123 | 7527 | 929 | 8709 | 612 | 10372 | 445 | 7246 |
| 6-#10 | 1.15 | MA | 4389 | 1391 | 5519 | 1276 | 7094 | 1072 | 8011 | 911 | 9043 | 664 | 11258 | 578 | 5351 |
| 2L-3S | | MI | 2879 | 1391 | 3777 | 1249 | 4690 | 1048 | 5167 | 890 | 5598 | 651 | 6709 | 456 | 3782 |
| 6-#10 | 1.15 | MA | 4010 | 1391 | 4935 | 1289 | 6355 | 1084 | 7118 | 921 | 7841 | 678 | 9593 | 492 | 5335 |
| 3L-2S | | MI | 3131 | 1391 | 4174 | 1239 | 5192 | 1040 | 5774 | 883 | 6415 | 642 | 7813 | 549 | 3778 |
| 6-#11 | 1.42 | MA | 4543 | 1442 | 5952 | 1300 | 7590 | 1089 | 8585 | 920 | 9792 | 657 | 12276 | 571 | 6460 |
| 2L-3S | | MI | 2928 | 1442 | 3996 | 1271 | 4919 | 1063 | 5421 | 897 | 5917 | 643 | 7062 | 412 | 4522 |
| 6-#11 | 1.42 | MA | 4100 | 1442 | 5246 | 1315 | 6698 | 1102 | 7506 | 932 | 8338 | 673 | 10263 | 462 | 6424 |
| 3L-2S | | MI | 3221 | 1442 | 4472 | 1260 | 5522 | 1054 | 6149 | 889 | 6898 | 633 | 8355 | 527 | 4526 |
| 6-#14 | 2.05 | MA | 4925 | 1564 | 6901 | 1371 | 8754 | 1140 | 9974 | 951 | 11644 | 649 | 14827 | 562 | 9121 |
| 2L-3S | | MI | 3065 | 1564 | 4437 | 1343 | 5443 | 1116 | 6036 | 928 | 6730 | 636 | 8058 | 329 | 6259 |
| 6-#14 | 2.05 | MA | 4334 | 1564 | 5895 | 1392 | 7481 | 1159 | 8435 | 968 | 9571 | 671 | 11958 | 402 | 9002 |
| 3L-2S | | MI | 3456 | 1564 | 5112 | 1328 | 6296 | 1103 | 7069 | 919 | 8121 | 624 | 9859 | 494 | 6314 |
| 6-#18 | 3.64 | MA | 5785 | 1873 | 9216 | 1552 | 11611 | 1272 | 13393 | 1033 | 16213 | 631 | 21128 | 540 | 15653 |
| 2L-3S | | MI | 3398 | 1873 | 5486 | 1529 | 6703 | 1249 | 7527 | 1009 | 8709 | 619 | 10372 | 98 | 10103 |
| 6-#18 | 3.64 | MA | 4894 | 1873 | 7469 | 1587 | 9401 | 1302 | 10720 | 1059 | 12614 | 665 | 16145 | 246 | 15133 |
| 3L-2S | | MI | 3970 | 1873 | 6644 | 1505 | 8169 | 1232 | 9300 | 998 | 11095 | 603 | 13352 | 392 | 10615 |
| 8-#9 | 1.21 | MA | 4440 | 1402 | 5592 | 1286 | 7205 | 1080 | 8156 | 916 | 9246 | 665 | 11546 | 579 | 5626 |
| 2L-4S | | MI | 2849 | 1402 | 3686 | 1266 | 4583 | 1063 | 5027 | 905 | 5411 | 655 | 6538 | 437 | 3954 |
| 8-#9 | 1.21 | MA | 4143 | 1402 | 5130 | 1297 | 6620 | 1089 | 7449 | 925 | 8294 | 677 | 10228 | 512 | 5614 |
| 3E | | MI | 2968 | 1402 | 3906 | 1258 | 4871 | 1055 | 5395 | 895 | 5913 | 651 | 7162 | 480 | 3971 |
| 8-#9 | 1.21 | MA | 3969 | 1402 | 4812 | 1307 | 6204 | 1099 | 6916 | 938 | 7567 | 683 | 9332 | 470 | 5561 |
| 4L-2S | | MI | 3166 | 1402 | 4221 | 1250 | 5269 | 1048 | 5877 | 889 | 6562 | 644 | 8046 | 553 | 3968 |
| 8-#10 | 1.54 | MA | 4658 | 1466 | 6102 | 1323 | 7832 | 1106 | 8904 | 933 | 10245 | 661 | 12922 | 574 | 7061 |
| 2L-4S | | MI | 2918 | 1466 | 3895 | 1306 | 4828 | 1091 | 5310 | 924 | 5782 | 652 | 7031 | 395 | 4886 |
| 8-#10 | 1.54 | MA | 4298 | 1466 | 5519 | 1336 | 7094 | 1118 | 8011 | 943 | 9043 | 675 | 11258 | 488 | 7030 |
| 3E | | MI | 3063 | 1466 | 4174 | 1295 | 5192 | 1083 | 5774 | 912 | 6415 | 648 | 7813 | 448 | 4938 |
| 8-#10 | 1.54 | MA | 4087 | 1466 | 5116 | 1349 | 6568 | 1130 | 7339 | 960 | 8124 | 684 | 10122 | 435 | 6913 |
| 4L-2S | | MI | 3304 | 1466 | 4571 | 1285 | 5694 | 1074 | 6381 | 905 | 7233 | 639 | 8916 | 542 | 4947 |
| 8-#11 | 1.89 | MA | 4855 | 1534 | 6657 | 1358 | 8483 | 1131 | 9665 | 947 | 11245 | 654 | 14289 | 567 | 8523 |
| 2L-4S | | MI | 2973 | 1534 | 4136 | 1340 | 5083 | 1115 | 5590 | 938 | 6134 | 643 | 7434 | 337 | 5752 |
| 8-#11 | 1.89 | MA | 4438 | 1534 | 5952 | 1373 | 7590 | 1145 | 8585 | 959 | 9792 | 670 | 12276 | 458 | 8468 |
| 3E | | MI | 3142 | 1534 | 4472 | 1329 | 5522 | 1106 | 6149 | 924 | 6898 | 640 | 8355 | 400 | 5902 |
| 8-#11 | 1.89 | MA | 4193 | 1534 | 5463 | 1388 | 6952 | 1158 | 7770 | 978 | 8677 | 679 | 10889 | 392 | 8253 |
| 4L-2S | | MI | 3420 | 1534 | 4949 | 1317 | 6124 | 1096 | 6877 | 916 | 7879 | 630 | 9649 | 514 | 5925 |
| 8-#14 | 2.73 | MA | 5346 | 1697 | 7907 | 1453 | 10026 | 1201 | 11513 | 990 | 13716 | 644 | 17697 | 555 | 12055 |
| 2L-4S | | MI | 3136 | 1697 | 4633 | 1442 | 5673 | 1189 | 6273 | 986 | 7035 | 634 | 8571 | 219 | 7536 |
| 8-#14 | 2.73 | MA | 4797 | 1697 | 6901 | 1474 | 8754 | 1219 | 9974 | 1007 | 11644 | 666 | 14827 | 395 | 11906 |
| 3E | | MI | 3366 | 1697 | 5112 | 1426 | 6296 | 1176 | 7069 | 967 | 8121 | 631 | 9859 | 307 | 8198 |
| 8-#14 | 2.73 | MA | 4477 | 1697 | 6202 | 1496 | 7842 | 1238 | 8808 | 1033 | 10051 | 678 | 12835 | 299 | 10937 |
| 4L-2S | | MI | 3720 | 1697 | 5787 | 1411 | 7150 | 1164 | 8101 | 958 | 9511 | 619 | 11661 | 472 | 8283 |
| 8-#18 | 4.85 | MA | 5675 | 2109 | 9216 | 1734 | 11611 | 1410 | 13393 | 1128 | 16213 | 656 | 21128 | 234 | 20185 |
| 3E | | MI | 3873 | 2109 | 6644 | 1676 | 8169 | 1357 | 9300 | 1078 | 11095 | 610 | 13352 | 44 | 13213 |
| 8-#18 | 4.85 | MA | 5219 | 2109 | 7997 | 1769 | 10020 | 1441 | 11359 | 1172 | 13435 | 673 | 17617 | 60 | 17254 |
| 4L-2S | | MI | 4387 | 2109 | 7802 | 1652 | 9634 | 1340 | 11072 | 1067 | 13481 | 594 | 16331 | 338 | 13971 |
| 10-#10 | 1.92 | MA | 4917 | 1541 | 6686 | 1370 | 8570 | 1141 | 9797 | 955 | 11447 | 658 | 14587 | 570 | 8766 |
| 2L-5S | | MI | 2984 | 1541 | 4043 | 1363 | 4978 | 1140 | 5501 | 953 | 6023 | 659 | 7355 | 333 | 5687 |
| 10-#10 | 1.92 | MA | 4574 | 1541 | 6102 | 1383 | 7832 | 1153 | 8904 | 965 | 10245 | 672 | 12922 | 484 | 8724 |
| 3L-4S | | MI | 3105 | 1541 | 4292 | 1352 | 5330 | 1126 | 5917 | 946 | 6599 | 649 | 8134 | 388 | 6024 |
| 10-#10 | 1.92 | MA | 4379 | 1541 | 5700 | 1396 | 7306 | 1164 | 8232 | 982 | 9326 | 681 | 11786 | 431 | 8597 |
| 4L-3S | | MI | 3241 | 1541 | 4571 | 1342 | 5694 | 1117 | 6381 | 934 | 7233 | 645 | 8916 | 441 | 6090 |
| 10-#10 | 1.92 | MA | 4169 | 1541 | 5343 | 1408 | 6798 | 1182 | 7631 | 992 | 8494 | 695 | 10588 | 377 | 8069 |
| 5L-2S | | MI | 3471 | 1541 | 4967 | 1332 | 6195 | 1109 | 6988 | 927 | 8050 | 636 | 10020 | 534 | 6109 |
| 10-#11 | 2.36 | MA | 5158 | 1626 | 7363 | 1415 | 9375 | 1173 | 10745 | 974 | 12699 | 650 | 16302 | 562 | 10582 |
| 2L-5S | | MI | 3055 | 1626 | 4311 | 1409 | 5260 | 1174 | 5815 | 972 | 6420 | 649 | 7814 | 257 | 6642 |

## RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

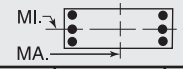
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 10-#11 | 2.36 | MA | 4762 | 1626 | 6657 | 1430 | 8483 | 1187 | 9665 | 986 | 11245 | 666 | 14289 | 453 | 10511 |
| 3L-4S | | MI | 3192 | 1626 | 4612 | 1397 | 5686 | 1157 | 6318 | 965 | 7115 | 639 | 8728 | 325 | 7055 |
| 10-#11 | 2.36 | MA | 4537 | 1626 | 6169 | 1445 | 7845 | 1200 | 8849 | 1005 | 10130 | 676 | 12901 | 387 | 10240 |
| 4L-3S | | MI | 3349 | 1626 | 4949 | 1386 | 6124 | 1148 | 6877 | 951 | 7879 | 636 | 9649 | 387 | 7278 |
| 10-#11 | 2.36 | MA | 4293 | 1626 | 5735 | 1461 | 7228 | 1221 | 8120 | 1017 | 9121 | 692 | 11502 | 327 | 9493 |
| 5L-2S | | MI | 3614 | 1626 | 5425 | 1374 | 6726 | 1138 | 7606 | 943 | 8859 | 626 | 10942 | 502 | 7316 |
| 10-#14 | 3.41 | MA | 5241 | 1829 | 7907 | 1557 | 10026 | 1280 | 11513 | 1046 | 13716 | 661 | 17697 | 388 | 14814 |
| 3L-4S | | MI | 3451 | 1829 | 5308 | 1524 | 6526 | 1250 | 7306 | 1025 | 8425 | 629 | 10373 | 197 | 9403 |
| 10-#14 | 3.41 | MA | 4953 | 1829 | 7208 | 1578 | 9114 | 1299 | 10347 | 1072 | 12123 | 673 | 15704 | 292 | 13799 |
| 4L-3S | | MI | 3646 | 1829 | 5787 | 1509 | 7150 | 1237 | 8101 | 1006 | 9511 | 626 | 11661 | 285 | 10137 |
| 10-#14 | 3.41 | MA | 4615 | 1829 | 6587 | 1600 | 8232 | 1328 | 9305 | 1089 | 10680 | 695 | 13699 | 203 | 12843 |
| 5L-2S | | MI | 3976 | 1829 | 6461 | 1493 | 8004 | 1225 | 9134 | 997 | 10901 | 614 | 13463 | 450 | 10246 |
| 10-#18 | 6.06 | MA | 6017 | 2344 | 9744 | 1916 | 12230 | 1549 | 14032 | 1241 | 17034 | 664 | 22600 | 48 | 22294 |
| 4L-3S | | MI | 4329 | 2344 | 7802 | 1823 | 9634 | 1465 | 11072 | 1148 | 13481 | 601 | 16331 | -9 | 16308 |
| 10-#18 | 6.06 | MA | 5446 | 2344 | 8656 | 1951 | 10687 | 1597 | 12211 | 1267 | 14514 | 699 | 19083 | -123 | 18409 |
| 5L-2S | | MI | 4796 | 2344 | 8961 | 1799 | 11100 | 1448 | 12844 | 1137 | 15868 | 585 | 19310 | 285 | 17322 |
| 12-#10 | 2.31 | MA | 5170 | 1615 | 7270 | 1416 | 9308 | 1175 | 10690 | 977 | 12650 | 656 | 16251 | 567 | 10469 |
| 2L-6S | | MI | 2997 | 1615 | 4197 | 1419 | 5160 | 1183 | 5701 | 988 | 6278 | 660 | 7703 | 258 | 6521 |
| 12-#10 | 2.31 | MA | 4842 | 1615 | 6686 | 1429 | 8570 | 1187 | 9797 | 987 | 11447 | 670 | 14587 | 480 | 10417 |
| 3L-5S | | MI | 3168 | 1615 | 4440 | 1409 | 5479 | 1174 | 6108 | 975 | 6840 | 656 | 8459 | 326 | 6799 |
| 12-#10 | 2.31 | MA | 4660 | 1615 | 6284 | 1442 | 8044 | 1199 | 9124 | 1003 | 10528 | 678 | 13451 | 427 | 10283 |
| 4E | | MI | 3286 | 1615 | 4689 | 1399 | 5832 | 1160 | 6524 | 968 | 7416 | 647 | 9238 | 381 | 7163 |
| 12-#10 | 2.31 | MA | 4454 | 1615 | 5926 | 1455 | 7536 | 1216 | 8524 | 1014 | 9697 | 692 | 12253 | 373 | 9738 |
| 5L-3S | | MI | 3414 | 1615 | 4967 | 1389 | 6195 | 1152 | 6988 | 956 | 8050 | 643 | 10020 | 434 | 7239 |
| 12-#10 | 2.31 | MA | 4204 | 1615 | 5547 | 1463 | 7078 | 1228 | 7939 | 1030 | 8887 | 700 | 11205 | 312 | 9313 |
| 6L-2S | | MI | 3635 | 1615 | 5364 | 1379 | 6697 | 1143 | 7595 | 948 | 8867 | 633 | 11123 | 527 | 7267 |
| 12-#11 | 2.84 | MA | 5076 | 1718 | 7363 | 1488 | 9375 | 1229 | 10745 | 1013 | 12699 | 663 | 16302 | 448 | 12556 |
| 3L-5S | | MI | 3269 | 1718 | 4787 | 1466 | 5862 | 1216 | 6543 | 999 | 7401 | 646 | 9108 | 244 | 7978 |
| 12-#11 | 2.84 | MA | 4869 | 1718 | 6875 | 1503 | 8737 | 1243 | 9929 | 1032 | 11584 | 672 | 14914 | 382 | 12235 |
| 4E | | MI | 3415 | 1718 | 5088 | 1455 | 6288 | 1199 | 7046 | 992 | 8096 | 636 | 10021 | 312 | 8370 |
| 12-#11 | 2.84 | MA | 4629 | 1718 | 6440 | 1518 | 8121 | 1263 | 9200 | 1044 | 10575 | 688 | 13515 | 322 | 11517 |
| 5L-3S | | MI | 3556 | 1718 | 5425 | 1443 | 6726 | 1190 | 7606 | 978 | 8859 | 633 | 10942 | 375 | 8653 |
| 12-#11 | 2.84 | MA | 4337 | 1718 | 5987 | 1528 | 7563 | 1277 | 8489 | 1063 | 9591 | 697 | 12175 | 237 | 10799 |
| 6L-2S | | MI | 3800 | 1718 | 5901 | 1432 | 7328 | 1181 | 8334 | 970 | 9840 | 623 | 12236 | 489 | 8703 |
| 12-#14 | 4.09 | MA | 5411 | 1962 | 8214 | 1661 | 10387 | 1360 | 11887 | 1111 | 14196 | 668 | 18574 | 286 | 16671 |
| 4E | | MI | 3742 | 1962 | 5983 | 1607 | 7380 | 1310 | 8338 | 1064 | 9816 | 624 | 12175 | 175 | 11283 |
| 12-#14 | 4.09 | MA | 5079 | 1962 | 7593 | 1682 | 9505 | 1389 | 10844 | 1128 | 12753 | 690 | 16569 | 196 | 15741 |
| 5L-3S | | MI | 3917 | 1962 | 6461 | 1592 | 8004 | 1298 | 9134 | 1045 | 10901 | 622 | 13463 | 263 | 12077 |
| 12-#14 | 4.09 | MA | 4692 | 1962 | 6953 | 1697 | 8707 | 1408 | 9827 | 1154 | 11346 | 702 | 14644 | 72 | 14262 |
| 6L-2S | | MI | 4225 | 1962 | 7136 | 1576 | 8858 | 1286 | 10167 | 1036 | 12292 | 609 | 15264 | 428 | 12205 |
| 12-#18 | 7.27 | MA | 6219 | 2580 | 10403 | 2099 | 12897 | 1705 | 14883 | 1336 | 18113 | 690 | 24066 | -135 | 23063 |
| 5L-3S | | MI | 4773 | 2580 | 8961 | 1970 | 11100 | 1573 | 12844 | 1217 | 15868 | 592 | 19310 | -63 | 19126 |
| 14-#10 | 2.69 | MA | 5102 | 1690 | 7270 | 1476 | 9308 | 1221 | 10690 | 1009 | 12650 | 667 | 16251 | 476 | 12111 |
| 3L-6S | | MI | 3182 | 1690 | 4594 | 1465 | 5661 | 1217 | 6308 | 1010 | 7095 | 657 | 8807 | 251 | 7625 |
| 14-#10 | 2.69 | MA | 4933 | 1690 | 6867 | 1489 | 8782 | 1233 | 10017 | 1025 | 11730 | 675 | 15115 | 423 | 11971 |
| 4L-5S | | MI | 3346 | 1690 | 4836 | 1456 | 5981 | 1209 | 6715 | 997 | 7658 | 653 | 9562 | 319 | 7917 |
| 14-#10 | 2.69 | MA | 4730 | 1690 | 6510 | 1502 | 8275 | 1250 | 9417 | 1036 | 10899 | 689 | 13917 | 369 | 11412 |
| 5L-4S | | MI | 3463 | 1690 | 5085 | 1446 | 6334 | 1194 | 7131 | 990 | 8233 | 644 | 10342 | 374 | 8271 |
| 14-#10 | 2.69 | MA | 4492 | 1690 | 6131 | 1509 | 7816 | 1262 | 8832 | 1052 | 10089 | 698 | 12869 | 308 | 10989 |
| 6L-3S | | MI | 3583 | 1690 | 5364 | 1436 | 6697 | 1186 | 7595 | 977 | 8867 | 640 | 11123 | 427 | 8387 |
| 14-#10 | 2.69 | MA | 4281 | 1690 | 5760 | 1518 | 7340 | 1270 | 8266 | 1063 | 9301 | 712 | 11783 | 269 | 10315 |
| 7L-2S | | MI | 3795 | 1690 | 5761 | 1425 | 7199 | 1177 | 8202 | 970 | 9684 | 630 | 12227 | 520 | 8423 |
| 14-#11 | 3.31 | MA | 5190 | 1810 | 7580 | 1560 | 9630 | 1285 | 11009 | 1059 | 13038 | 669 | 16927 | 377 | 14238 |
| 4L-5S | | MI | 3486 | 1810 | 5263 | 1524 | 6464 | 1258 | 7272 | 1026 | 8382 | 642 | 10401 | 232 | 9321 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 3.31 | MA | 4953 | 1810 | 7146 | 1575 | 9013 | 1305 | 10280 | 1071 | 12028 | 685 | 15527 | 317 | 13545 |
| 5L-4S | | MI | 3620 | 1810 | 5564 | 1512 | 6890 | 1242 | 7775 | 1019 | 9077 | 632 | 11315 | 300 | 9692 |
| 14-#11 | 3.31 | MA | 4676 | 1810 | 6693 | 1585 | 8456 | 1319 | 9569 | 1090 | 11045 | 694 | 14187 | 232 | 12828 |
| 6L-3S | | MI | 3750 | 1810 | 5901 | 1501 | 7328 | 1232 | 8334 | 1005 | 9840 | 629 | 12236 | 362 | 10026 |
| 14-#11 | 3.31 | MA | 4432 | 1810 | 6243 | 1595 | 7888 | 1330 | 8881 | 1102 | 10088 | 710 | 12863 | 182 | 12032 |
| 7L-2S | | MI | 3981 | 1810 | 6377 | 1489 | 7931 | 1223 | 9063 | 997 | 10821 | 619 | 13530 | 477 | 10087 |
| 14-#14 | 4.77 | MA | 5548 | 2094 | 8599 | 1765 | 10778 | 1450 | 12384 | 1166 | 14825 | 685 | 19438 | 189 | 18635 |
| 5L-4S | | MI | 4023 | 2094 | 6658 | 1690 | 8234 | 1371 | 9371 | 1103 | 11206 | 619 | 13976 | 153 | 13174 |
| 14-#14 | 4.77 | MA | 5163 | 2094 | 7959 | 1780 | 9980 | 1468 | 11366 | 1193 | 13418 | 697 | 17513 | 65 | 17168 |
| 6L-3S | | MI | 4181 | 2094 | 7136 | 1674 | 8858 | 1359 | 10167 | 1084 | 12292 | 617 | 15264 | 241 | 14019 |
| 16-#10 | 3.08 | MA | 5199 | 1765 | 7451 | 1536 | 9521 | 1267 | 10910 | 1047 | 12932 | 672 | 16780 | 419 | 13662 |
| 4L-6S | | MI | 3362 | 1765 | 4990 | 1512 | 6163 | 1252 | 6915 | 1032 | 7912 | 654 | 9910 | 243 | 8733 |
| 16-#10 | 3.08 | MA | 4998 | 1765 | 7094 | 1549 | 9013 | 1285 | 10310 | 1058 | 12101 | 686 | 15582 | 365 | 13089 |
| 5E | | MI | 3519 | 1765 | 5233 | 1503 | 6483 | 1243 | 7322 | 1019 | 8475 | 650 | 10666 | 312 | 9038 |
| 16-#10 | 3.08 | MA | 4770 | 1765 | 6714 | 1556 | 8554 | 1297 | 9725 | 1074 | 11291 | 695 | 14534 | 304 | 12667 |
| 6L-4S | | MI | 3646 | 1765 | 5482 | 1493 | 6836 | 1229 | 7738 | 1012 | 9051 | 641 | 11445 | 367 | 9377 |
| 16-#10 | 3.08 | MA | 4571 | 1765 | 6344 | 1565 | 8078 | 1305 | 9159 | 1085 | 10503 | 709 | 13448 | 266 | 12008 |
| 7L-3S | | MI | 3753 | 1765 | 5761 | 1482 | 7199 | 1220 | 8202 | 999 | 9684 | 637 | 12227 | 420 | 9534 |
| 16-#10 | 3.08 | MA | 4386 | 1765 | 5935 | 1580 | 7575 | 1318 | 8588 | 1094 | 9718 | 717 | 12401 | 213 | 11290 |
| 8L-2S | | MI | 3950 | 1765 | 6157 | 1472 | 7701 | 1212 | 8809 | 992 | 10501 | 628 | 13330 | 513 | 9578 |
| 16-#11 | 3.78 | MA | 5268 | 1902 | 7852 | 1633 | 9906 | 1348 | 11359 | 1098 | 13482 | 681 | 17540 | 313 | 15577 |
| 5E | | MI | 3688 | 1902 | 5739 | 1581 | 7066 | 1300 | 8000 | 1053 | 9362 | 639 | 11695 | 219 | 10669 |
| 16-#11 | 3.78 | MA | 5005 | 1902 | 7399 | 1642 | 9348 | 1361 | 10649 | 1117 | 12498 | 690 | 16200 | 227 | 14860 |
| 6L-4S | | MI | 3820 | 1902 | 6040 | 1570 | 7492 | 1284 | 8503 | 1046 | 10057 | 629 | 12609 | 287 | 11022 |
| 16-#11 | 3.78 | MA | 4775 | 1902 | 6949 | 1652 | 8780 | 1372 | 9961 | 1129 | 11541 | 707 | 14875 | 177 | 14067 |
| 7L-3S | | MI | 3939 | 1902 | 6377 | 1558 | 7931 | 1274 | 9063 | 1032 | 10821 | 626 | 13530 | 350 | 11400 |
| 16-#14 | 5.45 | MA | 5647 | 2226 | 8965 | 1862 | 11252 | 1529 | 12906 | 1232 | 15491 | 692 | 20383 | 58 | 20075 |
| 6L-4S | | MI | 4298 | 2226 | 7333 | 1773 | 9088 | 1432 | 10403 | 1142 | 12596 | 614 | 15778 | 131 | 15074 |
| 18-#10 | 3.46 | MA | 5259 | 1840 | 7677 | 1595 | 9751 | 1319 | 11203 | 1080 | 13303 | 684 | 17247 | 361 | 14768 |
| 5L-6S | | MI | 3550 | 1840 | 5387 | 1559 | 6665 | 1286 | 7522 | 1054 | 8730 | 651 | 11014 | 236 | 9845 |
| 18-#10 | 3.46 | MA | 5041 | 1840 | 7298 | 1603 | 9292 | 1331 | 10618 | 1096 | 12493 | 692 | 16199 | 300 | 14348 |
| 6L-5S | | MI | 3698 | 1840 | 5630 | 1550 | 6985 | 1277 | 7928 | 1041 | 9292 | 648 | 11769 | 305 | 10163 |
| 18-#10 | 3.46 | MA | 4852 | 1840 | 6927 | 1612 | 8816 | 1339 | 10052 | 1107 | 11705 | 706 | 15112 | 262 | 13700 |
| 7L-4S | | MI | 3813 | 1840 | 5879 | 1539 | 7337 | 1263 | 8345 | 1034 | 9868 | 638 | 12549 | 359 | 10488 |
| 18-#10 | 3.46 | MA | 4677 | 1840 | 6519 | 1627 | 8313 | 1353 | 9481 | 1116 | 10920 | 714 | 14065 | 209 | 12977 |
| 8L-3S | | MI | 3914 | 1840 | 6157 | 1529 | 7701 | 1255 | 8809 | 1021 | 10501 | 634 | 13330 | 412 | 10682 |
| 18-#11 | 4.25 | MA | 5324 | 1993 | 8104 | 1700 | 10241 | 1403 | 11728 | 1144 | 13952 | 687 | 18213 | 223 | 16895 |
| 6L-5S | | MI | 3884 | 1993 | 6215 | 1639 | 7669 | 1342 | 8729 | 1080 | 10343 | 635 | 12988 | 207 | 12020 |
| 18-#11 | 4.25 | MA | 5107 | 1993 | 7655 | 1710 | 9673 | 1414 | 11040 | 1156 | 12995 | 703 | 16888 | 172 | 16102 |
| 7L-4S | | MI | 4015 | 1993 | 6517 | 1627 | 8095 | 1326 | 9232 | 1073 | 11038 | 625 | 13902 | 275 | 12358 |
| 20-#10 | 3.85 | MA | 5305 | 1914 | 7881 | 1650 | 10031 | 1365 | 11511 | 1118 | 13695 | 689 | 17863 | 296 | 16030 |
| 6E | | MI | 3721 | 1914 | 5784 | 1605 | 7167 | 1320 | 8129 | 1076 | 9547 | 649 | 12118 | 229 | 10961 |
| 20-#10 | 3.85 | MA | 5126 | 1914 | 7511 | 1658 | 9554 | 1373 | 10945 | 1129 | 12908 | 703 | 16777 | 258 | 15391 |
| 7L-5S | | MI | 3863 | 1914 | 6026 | 1596 | 7487 | 1312 | 8535 | 1063 | 10109 | 645 | 12873 | 298 | 11290 |
| 20-#10 | 3.85 | MA | 4956 | 1914 | 7102 | 1674 | 9051 | 1387 | 10373 | 1138 | 12123 | 712 | 15730 | 206 | 14664 |
| 8L-4S | | MI | 3977 | 1914 | 6275 | 1586 | 7839 | 1298 | 8952 | 1056 | 10685 | 635 | 13652 | 352 | 11603 |
| 20-#11 | 4.73 | MA | 5431 | 2085 | 8360 | 1767 | 10566 | 1456 | 12120 | 1183 | 14449 | 700 | 18901 | 168 | 18137 |
| 7L-5S | | MI | 4077 | 2085 | 6691 | 1696 | 8271 | 1384 | 9457 | 1107 | 11324 | 632 | 14282 | 194 | 13375 |
| 22-#10 | 4.23 | MA | 5393 | 1989 | 8094 | 1705 | 10293 | 1408 | 11838 | 1151 | 14110 | 700 | 18441 | 254 | 17083 |
| 7L-6S | | MI | 3890 | 1989 | 6180 | 1652 | 7669 | 1355 | 8735 | 1098 | 10364 | 646 | 13221 | 222 | 12079 |
| 22-#10 | 4.23 | MA | 5226 | 1989 | 7686 | 1720 | 9790 | 1421 | 11266 | 1160 | 13325 | 709 | 17395 | 202 | 16351 |
| 8L-5S | | MI | 4025 | 1989 | 6423 | 1643 | 7988 | 1346 | 9142 | 1085 | 10926 | 642 | 13977 | 290 | 12421 |
| 24-#10 | 4.62 | MA | 5490 | 2064 | 8270 | 1767 | 10528 | 1456 | 12159 | 1182 | 14527 | 706 | 19059 | 198 | 18038 |
| 8L-6S | | MI | 4055 | 2064 | 6577 | 1699 | 8170 | 1389 | 9342 | 1120 | 11181 | 643 | 14325 | 215 | 13200 |

## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

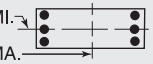
$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.28 | MA | 5066 | 1510 | 6527 | 1370 | 8337 | 1149 | 9412 | 974 | 10666 | 703 | 13314 | 612 | 6665 |
| 2E | | MI | 3351 | 1510 | 4642 | 1317 | 5692 | 1104 | 6301 | 934 | 6994 | 671 | 8354 | 554 | 4351 |
| 4-#18 | 2.27 | MA | 5743 | 1716 | 8238 | 1487 | 10424 | 1234 | 11897 | 1026 | 13975 | 688 | 17868 | 595 | 11432 |
| 2E | | MI | 3716 | 1716 | 5697 | 1429 | 6955 | 1184 | 7793 | 982 | 8971 | 654 | 10666 | 482 | 7278 |
| 6-#10 | 1.08 | MA | 4958 | 1469 | 6116 | 1359 | 7912 | 1143 | 8947 | 972 | 10086 | 713 | 12544 | 621 | 5763 |
| 2L-3S | | MI | 3050 | 1469 | 3976 | 1322 | 4936 | 1111 | 5431 | 944 | 5862 | 694 | 7009 | 494 | 3802 |
| 6-#10 | 1.08 | MA | 4544 | 1469 | 5486 | 1372 | 7114 | 1155 | 7983 | 983 | 8787 | 728 | 10746 | 536 | 5747 |
| 3L-2S | | MI | 3304 | 1469 | 4373 | 1312 | 5438 | 1102 | 6038 | 937 | 6680 | 685 | 8113 | 587 | 3794 |
| 6-#11 | 1.33 | MA | 5129 | 1520 | 6587 | 1383 | 8452 | 1159 | 9572 | 981 | 10900 | 706 | 13652 | 614 | 6965 |
| 2L-3S | | MI | 3099 | 1520 | 4199 | 1344 | 5167 | 1125 | 5685 | 951 | 6181 | 686 | 7360 | 450 | 4547 |
| 6-#11 | 1.33 | MA | 4644 | 1520 | 5824 | 1399 | 7487 | 1174 | 8404 | 994 | 9328 | 723 | 11476 | 508 | 6930 |
| 3L-2S | | MI | 3395 | 1520 | 4675 | 1332 | 5769 | 1116 | 6413 | 943 | 7162 | 676 | 8653 | 565 | 4547 |
| 6-#14 | 1.92 | MA | 5553 | 1642 | 7616 | 1453 | 9714 | 1210 | 11078 | 1013 | 12909 | 698 | 16420 | 605 | 9850 |
| 2L-3S | | MI | 3236 | 1642 | 4642 | 1415 | 5692 | 1177 | 6301 | 982 | 6994 | 679 | 8354 | 366 | 6296 |
| 6-#14 | 1.92 | MA | 4903 | 1642 | 6527 | 1475 | 8337 | 1230 | 9412 | 1030 | 10666 | 722 | 13314 | 448 | 9731 |
| 3L-2S | | MI | 3632 | 1642 | 5317 | 1400 | 6545 | 1165 | 7333 | 973 | 8384 | 666 | 10156 | 532 | 6340 |
| 6-#18 | 3.41 | MA | 6511 | 1951 | 10133 | 1635 | 12821 | 1342 | 14795 | 1095 | 17877 | 680 | 23271 | 583 | 16949 |
| 2L-3S | | MI | 3568 | 1951 | 5697 | 1600 | 6955 | 1309 | 7793 | 1062 | 8971 | 661 | 10666 | 135 | 10290 |
| 6-#18 | 3.41 | MA | 5523 | 1951 | 8238 | 1672 | 10424 | 1375 | 11897 | 1123 | 13975 | 717 | 17868 | 296 | 16429 |
| 3L-2S | | MI | 4150 | 1951 | 6855 | 1576 | 8420 | 1292 | 9565 | 1051 | 11357 | 645 | 13646 | 429 | 10650 |
| 8-#9 | 1.14 | MA | 5013 | 1480 | 6194 | 1369 | 8031 | 1150 | 9102 | 978 | 10304 | 714 | 12853 | 622 | 6058 |
| 2L-4S | | MI | 3020 | 1480 | 3883 | 1340 | 4828 | 1125 | 5291 | 960 | 5675 | 698 | 6838 | 476 | 3979 |
| 8-#9 | 1.14 | MA | 4689 | 1480 | 5695 | 1380 | 7400 | 1160 | 8338 | 987 | 9276 | 726 | 11430 | 556 | 6046 |
| 3E | | MI | 3140 | 1480 | 4104 | 1331 | 5116 | 1118 | 5659 | 949 | 6178 | 695 | 7463 | 518 | 3990 |
| 8-#9 | 1.14 | MA | 4499 | 1480 | 5353 | 1390 | 6952 | 1170 | 7765 | 1000 | 8492 | 734 | 10470 | 515 | 5993 |
| 4L-2S | | MI | 3340 | 1480 | 4419 | 1323 | 5514 | 1111 | 6140 | 944 | 6826 | 687 | 8347 | 591 | 3985 |
| 8-#10 | 1.44 | MA | 5253 | 1544 | 6746 | 1406 | 8709 | 1177 | 9912 | 994 | 11384 | 710 | 14342 | 617 | 7610 |
| 2L-4S | | MI | 3088 | 1544 | 4094 | 1379 | 5074 | 1154 | 5574 | 979 | 6046 | 695 | 7331 | 433 | 4919 |
| 8-#10 | 1.44 | MA | 4859 | 1544 | 6116 | 1419 | 7912 | 1189 | 8947 | 1005 | 10086 | 725 | 12544 | 532 | 7579 |
| 3E | | MI | 3235 | 1544 | 4373 | 1369 | 5438 | 1145 | 6038 | 966 | 6680 | 692 | 8113 | 486 | 4961 |
| 8-#10 | 1.44 | MA | 4629 | 1544 | 5683 | 1432 | 7345 | 1202 | 8222 | 1022 | 9095 | 734 | 11327 | 480 | 7461 |
| 4L-2S | | MI | 3478 | 1544 | 4770 | 1358 | 5939 | 1137 | 6645 | 959 | 7497 | 682 | 9216 | 580 | 4966 |
| 8-#11 | 1.77 | MA | 5474 | 1612 | 7350 | 1440 | 9417 | 1201 | 10739 | 1008 | 12472 | 703 | 15829 | 610 | 9197 |
| 2L-4S | | MI | 3144 | 1612 | 4339 | 1413 | 5331 | 1177 | 5854 | 992 | 6398 | 686 | 7732 | 375 | 5845 |
| 8-#11 | 1.77 | MA | 5015 | 1612 | 6587 | 1456 | 8452 | 1216 | 9572 | 1021 | 10900 | 720 | 13652 | 503 | 9142 |
| 3E | | MI | 3315 | 1612 | 4675 | 1401 | 5769 | 1167 | 6413 | 978 | 7162 | 683 | 8653 | 438 | 5931 |
| 8-#11 | 1.77 | MA | 4747 | 1612 | 6060 | 1472 | 7764 | 1230 | 8692 | 1041 | 9698 | 730 | 12165 | 438 | 8937 |
| 4L-2S | | MI | 3596 | 1612 | 5151 | 1389 | 6372 | 1158 | 7142 | 970 | 8142 | 673 | 9947 | 552 | 5948 |
| 8-#14 | 2.56 | MA | 6017 | 1774 | 8704 | 1536 | 11092 | 1271 | 12744 | 1052 | 15152 | 693 | 19526 | 598 | 13027 |
| 2L-4S | | MI | 3305 | 1774 | 4839 | 1514 | 5922 | 1250 | 6538 | 1040 | 7298 | 677 | 8868 | 257 | 7646 |
| 8-#14 | 2.56 | MA | 5413 | 1774 | 7616 | 1558 | 9714 | 1291 | 11078 | 1069 | 12909 | 717 | 16420 | 442 | 12878 |
| 3E | | MI | 3531 | 1774 | 5317 | 1498 | 6545 | 1238 | 7333 | 1021 | 8384 | 674 | 10156 | 344 | 8238 |
| 8-#14 | 2.56 | MA | 5061 | 1774 | 6862 | 1580 | 8730 | 1311 | 9820 | 1097 | 11190 | 730 | 14283 | 347 | 11945 |
| 4L-2S | | MI | 3899 | 1774 | 5992 | 1482 | 7399 | 1225 | 8366 | 1012 | 9774 | 662 | 11958 | 510 | 8311 |
| 8-#18 | 4.55 | MA | 6384 | 2186 | 10133 | 1819 | 12821 | 1483 | 14795 | 1192 | 17877 | 708 | 23271 | 284 | 21914 |
| 3E | | MI | 4044 | 2186 | 6855 | 1747 | 8420 | 1418 | 9565 | 1131 | 11357 | 652 | 13646 | 81 | 13390 |
| 8-#18 | 4.55 | MA | 5839 | 2186 | 8815 | 1856 | 11101 | 1516 | 12597 | 1238 | 14874 | 728 | 19502 | 112 | 18856 |
| 4L-2S | | MI | 4569 | 2186 | 8014 | 1723 | 9886 | 1400 | 11338 | 1120 | 13744 | 636 | 16625 | 375 | 14008 |
| 10-#10 | 1.80 | MA | 5539 | 1618 | 7377 | 1452 | 9506 | 1211 | 10876 | 1016 | 12683 | 707 | 16140 | 613 | 9452 |
| 2L-5S | | MI | 3155 | 1618 | 4242 | 1436 | 5223 | 1203 | 5764 | 1008 | 6287 | 702 | 7655 | 371 | 5758 |
| 10-#10 | 1.80 | MA | 5163 | 1618 | 6746 | 1466 | 8709 | 1224 | 9912 | 1027 | 11384 | 722 | 14342 | 528 | 9410 |
| 3L-4S | | MI | 3276 | 1618 | 4491 | 1426 | 5576 | 1188 | 6181 | 1001 | 6863 | 693 | 8435 | 426 | 6059 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis



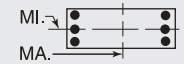

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.80 | MA | 4949 | 1618 | 6313 | 1479 | 8143 | 1236 | 9187 | 1044 | 10393 | 731 | 13125 | 476 | 9282 |
| 4L-3S | | MI | 3414 | 1618 | 4770 | 1415 | 5939 | 1180 | 6645 | 988 | 7497 | 689 | 9216 | 479 | 6114 |
| 10-#10 | 1.80 | MA | 4716 | 1618 | 5929 | 1492 | 7596 | 1254 | 8541 | 1055 | 9498 | 746 | 11838 | 424 | 8761 |
| 5L-2S | | MI | 3647 | 1618 | 5166 | 1405 | 6441 | 1171 | 7252 | 981 | 8314 | 679 | 10320 | 572 | 6130 |
| 10-#11 | 2.22 | MA | 5807 | 1704 | 8113 | 1498 | 10382 | 1244 | 11907 | 1035 | 14044 | 699 | 18005 | 605 | 11425 |
| 2L-5S | | MI | 3224 | 1704 | 4514 | 1482 | 5507 | 1235 | 6079 | 1026 | 6684 | 692 | 8112 | 295 | 6723 |
| 10-#11 | 2.22 | MA | 5372 | 1704 | 7350 | 1513 | 9417 | 1258 | 10739 | 1048 | 12472 | 716 | 15829 | 498 | 11354 |
| 3L-4S | | MI | 3363 | 1704 | 4815 | 1470 | 5933 | 1219 | 6582 | 1019 | 7379 | 682 | 9026 | 362 | 7145 |
| 10-#11 | 2.22 | MA | 5125 | 1704 | 6823 | 1529 | 8729 | 1272 | 9859 | 1068 | 11269 | 727 | 14342 | 433 | 11140 |
| 4L-3S | | MI | 3523 | 1704 | 5151 | 1458 | 6372 | 1210 | 7142 | 1005 | 8142 | 679 | 9947 | 425 | 7309 |
| 10-#11 | 2.22 | MA | 4853 | 1704 | 6356 | 1545 | 8065 | 1294 | 9074 | 1081 | 10182 | 744 | 12837 | 375 | 10318 |
| 5L-2S | | MI | 3792 | 1704 | 5628 | 1447 | 6974 | 1200 | 7870 | 997 | 9123 | 669 | 11241 | 540 | 7341 |
| 10-#14 | 3.20 | MA | 5899 | 1907 | 8704 | 1641 | 11092 | 1352 | 12744 | 1108 | 15152 | 712 | 19526 | 435 | 16029 |
| 3L-4S | | MI | 3621 | 1907 | 5514 | 1596 | 6775 | 1311 | 7570 | 1079 | 8689 | 672 | 10670 | 235 | 9508 |
| 10-#14 | 3.20 | MA | 5584 | 1907 | 7951 | 1663 | 10108 | 1372 | 11486 | 1136 | 13433 | 725 | 17389 | 340 | 15053 |
| 4L-3S | | MI | 3821 | 1907 | 5992 | 1581 | 7399 | 1299 | 8366 | 1060 | 9774 | 669 | 11958 | 322 | 10178 |
| 10-#14 | 3.20 | MA | 5207 | 1907 | 7282 | 1685 | 9157 | 1402 | 10362 | 1154 | 11877 | 749 | 15232 | 254 | 13971 |
| 5L-2S | | MI | 4156 | 1907 | 6667 | 1565 | 8253 | 1286 | 9399 | 1051 | 11165 | 657 | 13760 | 488 | 10275 |
| 10-#18 | 5.68 | MA | 6757 | 2422 | 10709 | 2003 | 13497 | 1624 | 15495 | 1308 | 18776 | 720 | 24905 | 100 | 24338 |
| 4L-3S | | MI | 4501 | 2422 | 8014 | 1894 | 9886 | 1526 | 11338 | 1200 | 13744 | 643 | 16625 | 28 | 16529 |
| 10-#18 | 5.68 | MA | 6118 | 2422 | 9536 | 2040 | 11832 | 1674 | 13529 | 1336 | 16054 | 757 | 21118 | -63 | 20868 |
| 5L-2S | | MI | 4980 | 2422 | 9172 | 1870 | 11351 | 1508 | 13110 | 1189 | 16130 | 627 | 19605 | 322 | 17360 |
| 12-#10 | 2.16 | MA | 5817 | 1693 | 8007 | 1499 | 10304 | 1246 | 11840 | 1038 | 13981 | 704 | 17938 | 609 | 11292 |
| 2L-6S | | MI | 3167 | 1693 | 4396 | 1492 | 5405 | 1246 | 5964 | 1042 | 6542 | 703 | 8003 | 296 | 6632 |
| 12-#10 | 2.16 | MA | 5456 | 1693 | 7377 | 1512 | 9506 | 1258 | 10876 | 1049 | 12683 | 719 | 16140 | 525 | 11240 |
| 3L-5S | | MI | 3339 | 1693 | 4639 | 1483 | 5725 | 1237 | 6371 | 1030 | 7105 | 699 | 8759 | 364 | 6868 |
| 12-#10 | 2.16 | MA | 5257 | 1693 | 6943 | 1526 | 8940 | 1270 | 10151 | 1066 | 11692 | 728 | 14923 | 472 | 11106 |
| 4E | | MI | 3458 | 1693 | 4888 | 1472 | 6078 | 1223 | 6788 | 1023 | 7680 | 690 | 9538 | 419 | 7199 |
| 12-#10 | 2.16 | MA | 5029 | 1693 | 6559 | 1539 | 8393 | 1288 | 9505 | 1077 | 10797 | 743 | 13636 | 420 | 10568 |
| 5L-3S | | MI | 3588 | 1693 | 5166 | 1462 | 6441 | 1214 | 7252 | 1010 | 8314 | 686 | 10320 | 472 | 7265 |
| 12-#10 | 2.16 | MA | 4756 | 1693 | 6146 | 1546 | 7900 | 1300 | 8876 | 1094 | 9925 | 752 | 12514 | 359 | 10106 |
| 6L-2S | | MI | 3813 | 1693 | 5563 | 1452 | 6943 | 1205 | 7859 | 1003 | 9131 | 677 | 11423 | 565 | 7289 |
| 12-#11 | 2.66 | MA | 5716 | 1796 | 8113 | 1571 | 10382 | 1300 | 11907 | 1075 | 14044 | 713 | 18005 | 493 | 13567 |
| 3L-5S | | MI | 3441 | 1796 | 4990 | 1539 | 6110 | 1278 | 6808 | 1053 | 7665 | 689 | 9406 | 282 | 8057 |
| 12-#11 | 2.66 | MA | 5489 | 1796 | 7586 | 1587 | 9695 | 1314 | 11027 | 1095 | 12841 | 723 | 16518 | 428 | 13332 |
| 4E | | MI | 3576 | 1796 | 5291 | 1527 | 6536 | 1261 | 7311 | 1046 | 8360 | 679 | 10320 | 350 | 8457 |
| 12-#11 | 2.66 | MA | 5222 | 1796 | 7119 | 1602 | 9030 | 1336 | 10242 | 1108 | 11754 | 740 | 15014 | 371 | 12510 |
| 5L-3S | | MI | 3731 | 1796 | 5628 | 1516 | 6974 | 1252 | 7870 | 1032 | 9123 | 676 | 11241 | 412 | 8685 |
| 12-#11 | 2.66 | MA | 4903 | 1796 | 6624 | 1612 | 8430 | 1350 | 9476 | 1128 | 10694 | 750 | 13578 | 286 | 11797 |
| 6L-2S | | MI | 3979 | 1796 | 6104 | 1504 | 7576 | 1242 | 8598 | 1024 | 10104 | 666 | 12534 | 527 | 8729 |
| 12-#14 | 3.84 | MA | 6085 | 2039 | 9040 | 1746 | 11485 | 1433 | 13152 | 1175 | 15676 | 720 | 20495 | 333 | 18169 |
| 4E | | MI | 3913 | 2039 | 6189 | 1679 | 7629 | 1372 | 8603 | 1118 | 10079 | 667 | 12472 | 213 | 11384 |
| 12-#14 | 3.84 | MA | 5715 | 2039 | 8371 | 1768 | 10534 | 1462 | 12028 | 1193 | 14120 | 744 | 18338 | 247 | 17131 |
| 5L-3S | | MI | 4093 | 2039 | 6667 | 1664 | 8253 | 1359 | 9399 | 1099 | 11165 | 664 | 13760 | 300 | 12119 |
| 12-#14 | 3.84 | MA | 5291 | 2039 | 7670 | 1782 | 9675 | 1482 | 10932 | 1220 | 12603 | 757 | 16274 | 125 | 15558 |
| 6L-2S | | MI | 4408 | 2039 | 7342 | 1648 | 9107 | 1347 | 10431 | 1090 | 12555 | 652 | 15561 | 466 | 12235 |
| 12-#18 | 6.82 | MA | 6966 | 2657 | 11431 | 2187 | 14229 | 1782 | 16427 | 1405 | 19956 | 748 | 26521 | -75 | 26076 |
| 5L-3S | | MI | 4946 | 2657 | 9172 | 2041 | 11351 | 1634 | 13110 | 1269 | 16130 | 634 | 19605 | -26 | 19530 |
| 14-#10 | 2.53 | MA | 5742 | 1768 | 8007 | 1559 | 10304 | 1292 | 11840 | 1071 | 13981 | 716 | 17938 | 521 | 13071 |
| 3L-6S | | MI | 3353 | 1768 | 4793 | 1539 | 5907 | 1280 | 6571 | 1064 | 7360 | 700 | 9107 | 289 | 7733 |
| 14-#10 | 2.53 | MA | 5556 | 1768 | 7574 | 1573 | 9737 | 1305 | 11116 | 1088 | 12990 | 726 | 16721 | 468 | 12932 |
| 4L-5S | | MI | 3518 | 1768 | 5035 | 1529 | 6227 | 1271 | 6978 | 1052 | 7922 | 697 | 9862 | 357 | 7984 |
| 14-#10 | 2.53 | MA | 5331 | 1768 | 7189 | 1586 | 9191 | 1322 | 10470 | 1099 | 12095 | 740 | 15434 | 416 | 12379 |
| 5L-4S | | MI | 3636 | 1768 | 5284 | 1519 | 6580 | 1257 | 7395 | 1045 | 8498 | 687 | 10642 | 412 | 8339 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.53 | MA | 5070 | 1768 | 6776 | 1593 | 8698 | 1335 | 9840 | 1116 | 11223 | 749 | 14312 | 355 | 11934 |
| 6L-3S | | MI | 3758 | 1768 | 5563 | 1509 | 6943 | 1248 | 7859 | 1032 | 9131 | 683 | 11423 | 465 | 8414 |
| 14-#10 | 2.53 | MA | 4840 | 1768 | 6377 | 1602 | 8177 | 1343 | 9232 | 1127 | 10376 | 764 | 13146 | 319 | 11228 |
| 7L-2S | | MI | 3975 | 1768 | 5960 | 1499 | 7445 | 1240 | 8466 | 1025 | 9948 | 674 | 12527 | 558 | 8446 |
| 14-#11 | 3.10 | MA | 5840 | 1887 | 8349 | 1644 | 10660 | 1357 | 12194 | 1122 | 14413 | 720 | 18695 | 423 | 15502 |
| 4L-5S | | MI | 3659 | 1887 | 5466 | 1596 | 6712 | 1320 | 7536 | 1080 | 8645 | 685 | 10699 | 269 | 9398 |
| 14-#11 | 3.10 | MA | 5577 | 1887 | 7882 | 1660 | 9995 | 1378 | 11409 | 1135 | 13326 | 737 | 17190 | 366 | 14707 |
| 5L-4S | | MI | 3793 | 1887 | 5767 | 1585 | 7138 | 1303 | 8039 | 1073 | 9340 | 675 | 11613 | 337 | 9777 |
| 14-#11 | 3.10 | MA | 5274 | 1887 | 7387 | 1669 | 9395 | 1392 | 10644 | 1155 | 12266 | 747 | 15754 | 281 | 13999 |
| 6L-3S | | MI | 3926 | 1887 | 6104 | 1573 | 7576 | 1294 | 8598 | 1059 | 10104 | 672 | 12534 | 400 | 10059 |
| 14-#11 | 3.10 | MA | 5007 | 1887 | 6902 | 1680 | 8774 | 1402 | 9903 | 1168 | 11235 | 764 | 14332 | 234 | 13124 |
| 7L-2S | | MI | 4162 | 1887 | 6580 | 1562 | 8178 | 1285 | 9327 | 1051 | 11085 | 662 | 13828 | 515 | 10114 |
| 14-#14 | 4.47 | MA | 6205 | 2172 | 9459 | 1851 | 11911 | 1523 | 13694 | 1232 | 16363 | 739 | 21444 | 240 | 20295 |
| 5L-4S | | MI | 4195 | 2172 | 6864 | 1762 | 8483 | 1433 | 9636 | 1157 | 11469 | 662 | 14273 | 191 | 13271 |
| 14-#14 | 4.47 | MA | 5807 | 2172 | 8759 | 1864 | 11052 | 1543 | 12598 | 1259 | 14846 | 752 | 19380 | 118 | 18704 |
| 6L-3S | | MI | 4358 | 2172 | 7342 | 1746 | 9107 | 1420 | 10431 | 1138 | 12555 | 659 | 15561 | 278 | 14061 |
| 14-#14 | 4.47 | MA | 5455 | 2172 | 8066 | 1879 | 10173 | 1558 | 11538 | 1277 | 13371 | 776 | 17339 | 46 | 17131 |
| 7L-2S | | MI | 4655 | 2172 | 8017 | 1731 | 9961 | 1408 | 11464 | 1128 | 13945 | 647 | 17363 | 444 | 14192 |
| 16-#10 | 2.89 | MA | 5847 | 1843 | 8204 | 1619 | 10535 | 1339 | 12080 | 1110 | 14289 | 723 | 18519 | 464 | 14759 |
| 4L-6S | | MI | 3534 | 1843 | 5189 | 1585 | 6409 | 1314 | 7178 | 1086 | 8177 | 698 | 10211 | 281 | 8838 |
| 16-#10 | 2.89 | MA | 5624 | 1843 | 7820 | 1633 | 9988 | 1357 | 11434 | 1121 | 13394 | 738 | 17232 | 412 | 14193 |
| 5E | | MI | 3693 | 1843 | 5432 | 1576 | 6729 | 1306 | 7585 | 1074 | 8739 | 694 | 10966 | 350 | 9103 |
| 16-#10 | 2.89 | MA | 5375 | 1843 | 7406 | 1640 | 9495 | 1369 | 10805 | 1138 | 12522 | 747 | 16110 | 352 | 13763 |
| 6L-4S | | MI | 3809 | 1843 | 5681 | 1566 | 7081 | 1291 | 8002 | 1067 | 9315 | 684 | 11745 | 405 | 9451 |
| 16-#10 | 2.89 | MA | 5157 | 1843 | 7007 | 1649 | 8975 | 1377 | 10196 | 1149 | 11674 | 761 | 14944 | 315 | 13044 |
| 7L-3S | | MI | 3931 | 1843 | 5960 | 1556 | 7445 | 1283 | 8466 | 1054 | 9948 | 680 | 12527 | 458 | 9562 |
| 16-#10 | 2.89 | MA | 4955 | 1843 | 6567 | 1665 | 8433 | 1391 | 9571 | 1158 | 10829 | 771 | 13821 | 265 | 12314 |
| 8L-2S | | MI | 4131 | 1843 | 6356 | 1545 | 7947 | 1274 | 9073 | 1047 | 10766 | 671 | 13630 | 551 | 9601 |
| 16-#11 | 3.55 | MA | 5922 | 1979 | 8645 | 1717 | 10961 | 1420 | 12577 | 1162 | 14898 | 733 | 19367 | 361 | 16907 |
| 5E | | MI | 3862 | 1979 | 5942 | 1654 | 7314 | 1362 | 8265 | 1107 | 9626 | 682 | 11993 | 257 | 10743 |
| 16-#11 | 3.55 | MA | 5634 | 1979 | 8150 | 1727 | 10361 | 1435 | 11811 | 1182 | 13838 | 743 | 17931 | 277 | 16203 |
| 6L-4S | | MI | 3994 | 1979 | 6243 | 1642 | 7740 | 1346 | 8767 | 1100 | 10321 | 672 | 12907 | 325 | 11104 |
| 16-#11 | 3.55 | MA | 5382 | 1979 | 7665 | 1737 | 9739 | 1445 | 11071 | 1195 | 12807 | 760 | 16509 | 229 | 15335 |
| 7L-3S | | MI | 4117 | 1979 | 6580 | 1631 | 8178 | 1336 | 9327 | 1086 | 11085 | 669 | 13828 | 387 | 11434 |
| 16-#11 | 3.55 | MA | 5148 | 1979 | 7131 | 1756 | 9081 | 1461 | 10325 | 1206 | 11780 | 771 | 15139 | 164 | 14292 |
| 8L-2S | | MI | 4342 | 1979 | 7056 | 1619 | 8781 | 1327 | 10055 | 1078 | 12065 | 659 | 15121 | 502 | 11497 |
| 16-#14 | 5.11 | MA | 6339 | 2304 | 9848 | 1947 | 12429 | 1604 | 14264 | 1298 | 17089 | 747 | 22486 | 111 | 21851 |
| 6L-4S | | MI | 4471 | 2304 | 7538 | 1845 | 9337 | 1493 | 10668 | 1195 | 12860 | 657 | 16075 | 169 | 15167 |
| 16-#14 | 5.11 | MA | 5978 | 2304 | 9155 | 1962 | 11551 | 1619 | 13204 | 1316 | 15614 | 771 | 20445 | 39 | 20268 |
| 7L-3S | | MI | 4618 | 2304 | 8017 | 1829 | 9961 | 1481 | 11464 | 1176 | 13945 | 654 | 17363 | 256 | 16004 |
| 18-#10 | 3.25 | MA | 5910 | 1917 | 8450 | 1679 | 10785 | 1391 | 12398 | 1143 | 14692 | 735 | 19029 | 408 | 16009 |
| 5L-6S | | MI | 3710 | 1917 | 5586 | 1632 | 6911 | 1349 | 7785 | 1108 | 8994 | 695 | 11314 | 274 | 9947 |
| 18-#10 | 3.25 | MA | 5671 | 1917 | 8037 | 1687 | 10292 | 1403 | 11769 | 1160 | 13820 | 744 | 17907 | 348 | 15593 |
| 6L-5S | | MI | 3873 | 1917 | 5829 | 1623 | 7231 | 1340 | 8192 | 1096 | 9556 | 691 | 12070 | 343 | 10226 |
| 18-#10 | 3.25 | MA | 5464 | 1917 | 7637 | 1696 | 9772 | 1411 | 11160 | 1171 | 12973 | 759 | 16742 | 311 | 14872 |
| 7L-4S | | MI | 3989 | 1917 | 6078 | 1613 | 7583 | 1326 | 8608 | 1089 | 10132 | 681 | 12849 | 397 | 10560 |
| 18-#10 | 3.25 | MA | 5273 | 1917 | 7197 | 1711 | 9230 | 1425 | 10536 | 1180 | 12128 | 768 | 15618 | 261 | 14136 |
| 8L-3S | | MI | 4092 | 1917 | 6356 | 1602 | 7947 | 1317 | 9073 | 1076 | 10766 | 678 | 13630 | 450 | 10710 |
| 18-#10 | 3.25 | MA | 5022 | 1917 | 6819 | 1723 | 8727 | 1435 | 9894 | 1193 | 11295 | 783 | 14456 | 206 | 13397 |
| 9L-2S | | MI | 4285 | 1917 | 6753 | 1592 | 8448 | 1308 | 9679 | 1069 | 11583 | 668 | 14734 | 544 | 10755 |
| 18-#11 | 3.99 | MA | 5984 | 2071 | 8913 | 1784 | 11326 | 1477 | 12979 | 1209 | 15410 | 740 | 20107 | 272 | 18410 |
| 6L-5S | | MI | 4059 | 2071 | 6418 | 1711 | 7916 | 1404 | 8993 | 1134 | 10607 | 678 | 13287 | 244 | 12092 |
| 18-#11 | 3.99 | MA | 5746 | 2071 | 8428 | 1794 | 10704 | 1487 | 12238 | 1222 | 14379 | 757 | 18685 | 224 | 17545 |
| 7L-4S | | MI | 4190 | 2071 | 6719 | 1700 | 8342 | 1388 | 9496 | 1127 | 11302 | 668 | 14200 | 312 | 12437 |
| 18-#11 | 3.99 | MA | 5522 | 2071 | 7894 | 1813 | 10046 | 1504 | 11493 | 1233 | 13352 | 767 | 17315 | 160 | 16497 |
| 8L-3S | | MI | 4304 | 2071 | 7056 | 1688 | 8781 | 1378 | 10055 | 1113 | 12065 | 665 | 15121 | 375 | 12808 |
| 18-#14 | 5.75 | MA | 6525 | 2437 | 10243 | 2044 | 12928 | 1680 | 14870 | 1355 | 17857 | 766 | 23551 | 32 | 23405 |
| 7L-4S | | MI | 4740 | 2437 | 8213 | 1928 | 10191 | 1554 | 11701 | 1234 | 14250 | 652 | 17877 | 147 | 17071 |

## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 20-#10 | 3.61 | MA | 5960 | 1992 | 8667 | 1733 | 11090 | 1438 | 12733 | 1182 | 15119 | 741 | 19705 | 344 | 17425 |
| 6E | | MI | 3895 | 1992 | 5983 | 1679 | 7413 | 1383 | 8392 | 1130 | 9811 | 692 | 12418 | 267 | 11060 |
| 20-#10 | 3.61 | MA | 5764 | 1992 | 8267 | 1742 | 10569 | 1446 | 12125 | 1193 | 14271 | 756 | 18540 | 307 | 16699 |
| 7L-5S | | MI | 4039 | 1992 | 6225 | 1670 | 7732 | 1374 | 8799 | 1118 | 10373 | 688 | 13173 | 336 | 11353 |
| 20-#10 | 3.61 | MA | 5575 | 1992 | 7828 | 1758 | 10028 | 1460 | 11500 | 1202 | 13426 | 765 | 17416 | 257 | 15959 |
| 8L-4S | | MI | 4154 | 1992 | 6474 | 1659 | 8085 | 1360 | 9215 | 1110 | 10949 | 679 | 13952 | 390 | 11673 |
| 20-#10 | 3.61 | MA | 5334 | 1992 | 7449 | 1769 | 9524 | 1469 | 10858 | 1215 | 12593 | 780 | 16254 | 203 | 15216 |
| 9L-3S | | MI | 4250 | 1992 | 6753 | 1649 | 8448 | 1351 | 9679 | 1098 | 11583 | 675 | 14734 | 443 | 11857 |
| 20-#11 | 4.43 | MA | 6100 | 2163 | 9191 | 1852 | 11669 | 1529 | 13406 | 1249 | 15951 | 754 | 20862 | 219 | 19756 |
| 7L-5S | | MI | 4253 | 2163 | 6894 | 1768 | 8519 | 1446 | 9721 | 1161 | 11588 | 675 | 14580 | 232 | 13445 |
| 20-#11 | 4.43 | MA | 5880 | 2163 | 8657 | 1871 | 11012 | 1546 | 12660 | 1260 | 14924 | 764 | 19492 | 155 | 18702 |
| 8L-4S | | MI | 4382 | 2163 | 7196 | 1757 | 8944 | 1430 | 10224 | 1154 | 12282 | 665 | 15494 | 300 | 13775 |
| 22-#10 | 3.97 | MA | 6056 | 2067 | 8898 | 1789 | 11367 | 1480 | 13089 | 1215 | 15569 | 753 | 20338 | 303 | 18527 |
| 7L-6S | | MI | 4064 | 2067 | 6379 | 1725 | 7914 | 1417 | 8999 | 1152 | 10628 | 689 | 13521 | 260 | 12176 |
| 22-#10 | 3.97 | MA | 5870 | 2067 | 8458 | 1805 | 10825 | 1494 | 12464 | 1224 | 14725 | 762 | 19214 | 253 | 17781 |
| 8L-5S | | MI | 4202 | 2067 | 6622 | 1716 | 8234 | 1409 | 9406 | 1139 | 11191 | 685 | 14277 | 328 | 12481 |
| 22-#10 | 3.97 | MA | 5639 | 2067 | 8079 | 1816 | 10322 | 1504 | 11823 | 1237 | 13892 | 777 | 18052 | 199 | 17034 |
| 9L-4S | | MI | 4316 | 2067 | 6871 | 1706 | 8587 | 1394 | 9822 | 1132 | 11766 | 676 | 15056 | 383 | 12790 |
| 22-#11 | 4.88 | MA | 6229 | 2255 | 9420 | 1928 | 11977 | 1588 | 13828 | 1287 | 16496 | 760 | 21668 | 150 | 20907 |
| 8L-5S | | MI | 4443 | 2255 | 7370 | 1826 | 9121 | 1488 | 10450 | 1188 | 12568 | 671 | 15874 | 219 | 14801 |
| 24-#10 | 4.33 | MA | 6159 | 2142 | 9088 | 1852 | 11622 | 1528 | 13429 | 1246 | 16023 | 759 | 21012 | 249 | 19604 |
| 8L-6S | | MI | 4230 | 2142 | 6776 | 1772 | 8416 | 1452 | 9606 | 1174 | 11445 | 686 | 14625 | 253 | 13295 |
| 24-#10 | 4.33 | MA | 5936 | 2142 | 8710 | 1863 | 11119 | 1538 | 12787 | 1259 | 15190 | 774 | 19850 | 195 | 18853 |
| 9L-5S | | MI | 4363 | 2142 | 7019 | 1763 | 8736 | 1443 | 10013 | 1161 | 12008 | 682 | 15380 | 321 | 13612 |

## RECTANGULAR TIED COLUMNS 22" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#14 | 1.20 | MA | 5681 | 1587 | 7184 | 1453 | 9231 | 1220 | 10435 | 1035 | 11810 | 752 | 14729 | 655 | 7151 |
| 2E | | MI | 3525 | 1587 | 4848 | 1389 | 5941 | 1165 | 6565 | 987 | 7257 | 714 | 8651 | 591 | 4373 |
| 4-#18 | 2.14 | MA | 6426 | 1793 | 9032 | 1570 | 11486 | 1305 | 13119 | 1087 | 15384 | 737 | 19648 | 638 | 12296 |
| 2E | | MI | 3893 | 1793 | 5908 | 1500 | 7206 | 1244 | 8058 | 1035 | 9233 | 696 | 10961 | 519 | 7309 |
| 6-#10 | 1.02 | MA | 5559 | 1547 | 6738 | 1442 | 8769 | 1213 | 9928 | 1034 | 11177 | 762 | 13889 | 664 | 6174 |
| 2L-3S | | MI | 3222 | 1547 | 4175 | 1395 | 5181 | 1173 | 5695 | 999 | 6127 | 738 | 7309 | 532 | 3821 |
| 6-#10 | 1.02 | MA | 5109 | 1547 | 6061 | 1455 | 7912 | 1226 | 8892 | 1045 | 9782 | 777 | 11958 | 581 | 6158 |
| 3L-2S | | MI | 3477 | 1547 | 4572 | 1385 | 5683 | 1165 | 6301 | 992 | 6944 | 728 | 8413 | 625 | 3811 |
| 6-#11 | 1.25 | MA | 5748 | 1598 | 7246 | 1466 | 9352 | 1230 | 10604 | 1043 | 12058 | 755 | 15087 | 657 | 7471 |
| 2L-3S | | MI | 3271 | 1598 | 4402 | 1416 | 5415 | 1187 | 5949 | 1005 | 6445 | 729 | 7658 | 488 | 4572 |
| 6-#11 | 1.25 | MA | 5220 | 1598 | 6426 | 1482 | 8315 | 1245 | 9348 | 1056 | 10367 | 773 | 12747 | 552 | 7435 |
| 3L-2S | | MI | 3569 | 1598 | 4878 | 1405 | 6017 | 1178 | 6677 | 997 | 7425 | 719 | 8952 | 602 | 4567 |
| 6-#14 | 1.80 | MA | 6213 | 1720 | 8355 | 1536 | 10713 | 1281 | 12227 | 1074 | 14223 | 747 | 18071 | 648 | 10579 |
| 2L-3S | | MI | 3408 | 1720 | 4848 | 1487 | 5941 | 1238 | 6565 | 1035 | 7257 | 722 | 8651 | 404 | 6331 |
| 6-#14 | 1.80 | MA | 5505 | 1720 | 7184 | 1559 | 9231 | 1302 | 10435 | 1093 | 11810 | 772 | 14729 | 494 | 10460 |
| 3L-2S | | MI | 3807 | 1720 | 5523 | 1472 | 6794 | 1226 | 7598 | 1026 | 8647 | 709 | 10453 | 569 | 6365 |
| 6-#18 | 3.21 | MA | 7272 | 2029 | 11074 | 1717 | 14068 | 1413 | 16242 | 1156 | 19589 | 729 | 25470 | 626 | 18245 |
| 2L-3S | | MI | 3738 | 2029 | 5908 | 1671 | 7206 | 1370 | 8058 | 1115 | 9233 | 703 | 10961 | 172 | 10429 |
| 6-#18 | 3.21 | MA | 6185 | 2029 | 9032 | 1756 | 11486 | 1447 | 13119 | 1187 | 15384 | 769 | 19648 | 345 | 17725 |
| 3L-2S | | MI | 4330 | 2029 | 7066 | 1647 | 8672 | 1353 | 9831 | 1104 | 11620 | 687 | 13940 | 465 | 10685 |
| 8-#9 | 1.07 | MA | 5618 | 1558 | 6821 | 1451 | 8895 | 1221 | 10093 | 1039 | 11409 | 763 | 14219 | 665 | 6490 |
| 2L-4S | | MI | 3190 | 1558 | 4081 | 1413 | 5073 | 1188 | 5554 | 1014 | 5940 | 742 | 7139 | 514 | 4001 |
| 8-#9 | 1.07 | MA | 5266 | 1558 | 6285 | 1462 | 8218 | 1231 | 9273 | 1049 | 10306 | 775 | 12691 | 600 | 6478 |
| 3E | | MI | 3312 | 1558 | 4301 | 1405 | 5361 | 1181 | 5922 | 1004 | 6442 | 738 | 7764 | 556 | 4007 |
| 8-#9 | 1.07 | MA | 5060 | 1558 | 5918 | 1473 | 7738 | 1241 | 8659 | 1062 | 9466 | 783 | 11667 | 559 | 6425 |
| 4L-2S | | MI | 3513 | 1558 | 4616 | 1397 | 5759 | 1174 | 6404 | 998 | 7091 | 731 | 8647 | 630 | 4001 |
| 8-#10 | 1.36 | MA | 5881 | 1621 | 7415 | 1488 | 9625 | 1247 | 10964 | 1056 | 12572 | 759 | 15821 | 660 | 8158 |
| 2L-4S | | MI | 3259 | 1621 | 4293 | 1452 | 5320 | 1216 | 5837 | 1033 | 6310 | 739 | 7631 | 471 | 4950 |
| 8-#10 | 1.36 | MA | 5452 | 1621 | 6738 | 1502 | 8769 | 1260 | 9928 | 1067 | 11177 | 774 | 13889 | 577 | 8127 |
| 3E | | MI | 3408 | 1621 | 4572 | 1442 | 5683 | 1208 | 6301 | 1021 | 6944 | 735 | 8413 | 524 | 4982 |

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis

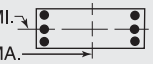
$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 8-#10 | 1.36 | MA | 5203 | 1621 | 6274 | 1516 | 8162 | 1273 | 9152 | 1085 | 10115 | 784 | 12591 | 525 | 8010 |
| 4L-2S | | MI | 3653 | 1621 | 4969 | 1432 | 6185 | 1199 | 6908 | 1013 | 7761 | 725 | 9516 | 618 | 4984 |
| 8-#11 | 1.67 | MA | 6125 | 1690 | 8067 | 1523 | 10390 | 1272 | 11859 | 1070 | 13748 | 752 | 17427 | 652 | 9871 |
| 2L-4S | | MI | 3314 | 1690 | 4542 | 1485 | 5579 | 1239 | 6118 | 1046 | 6662 | 729 | 8031 | 413 | 5888 |
| 8-#11 | 1.67 | MA | 5625 | 1690 | 7246 | 1539 | 9352 | 1287 | 10604 | 1083 | 12058 | 770 | 15087 | 548 | 9816 |
| 3E | | MI | 3487 | 1690 | 4878 | 1473 | 6017 | 1229 | 6677 | 1032 | 7425 | 725 | 8952 | 475 | 5958 |
| 8-#11 | 1.67 | MA | 5334 | 1690 | 6682 | 1556 | 8615 | 1302 | 9660 | 1104 | 10767 | 781 | 13500 | 483 | 9611 |
| 4L-2S | | MI | 3771 | 1690 | 5354 | 1462 | 6619 | 1220 | 7406 | 1024 | 8406 | 716 | 10245 | 590 | 5971 |
| 8-#14 | 2.41 | MA | 6721 | 1852 | 9527 | 1619 | 12195 | 1342 | 14020 | 1113 | 16637 | 742 | 21413 | 641 | 13999 |
| 2L-4S | | MI | 3474 | 1852 | 5045 | 1586 | 6171 | 1311 | 6802 | 1093 | 7561 | 719 | 9165 | 294 | 7753 |
| 8-#14 | 2.41 | MA | 6060 | 1852 | 8355 | 1641 | 10713 | 1362 | 12227 | 1132 | 14223 | 767 | 18071 | 487 | 13850 |
| 3E | | MI | 3703 | 1852 | 5523 | 1570 | 6794 | 1299 | 7598 | 1074 | 8647 | 717 | 10453 | 382 | 8275 |
| 8-#14 | 2.41 | MA | 5678 | 1852 | 7547 | 1664 | 9657 | 1383 | 10877 | 1161 | 12377 | 782 | 15790 | 394 | 12968 |
| 4L-2S | | MI | 4077 | 1852 | 6198 | 1554 | 7648 | 1287 | 8631 | 1065 | 10038 | 704 | 12255 | 547 | 8339 |
| 8-#18 | 4.28 | MA | 7128 | 2264 | 11074 | 1903 | 14068 | 1555 | 16242 | 1256 | 19589 | 760 | 25470 | 332 | 23642 |
| 3E | | MI | 4216 | 2264 | 7066 | 1818 | 8672 | 1478 | 9831 | 1184 | 11620 | 694 | 13940 | 118 | 13563 |
| 8-#18 | 4.28 | MA | 6530 | 2264 | 9659 | 1941 | 12221 | 1590 | 13880 | 1304 | 16361 | 783 | 21445 | 163 | 20457 |
| 4L-2S | | MI | 4751 | 2264 | 8225 | 1794 | 10137 | 1461 | 11603 | 1173 | 14006 | 678 | 16919 | 412 | 14045 |
| 10-#10 | 1.70 | MA | 6193 | 1696 | 8092 | 1535 | 10481 | 1282 | 12000 | 1077 | 13967 | 756 | 17752 | 656 | 10138 |
| 2L-5S | | MI | 3326 | 1696 | 4441 | 1509 | 5469 | 1265 | 6028 | 1062 | 6552 | 745 | 7955 | 409 | 5827 |
| 10-#10 | 1.70 | MA | 5783 | 1696 | 7415 | 1549 | 9625 | 1294 | 10964 | 1089 | 12572 | 772 | 15821 | 573 | 10095 |
| 3L-4S | | MI | 3448 | 1696 | 4690 | 1499 | 5822 | 1251 | 6444 | 1055 | 7127 | 736 | 8735 | 464 | 6092 |
| 10-#10 | 1.70 | MA | 5551 | 1696 | 6951 | 1563 | 9018 | 1307 | 10187 | 1107 | 11510 | 781 | 14523 | 521 | 9968 |
| 4L-3S | | MI | 3587 | 1696 | 4969 | 1489 | 6185 | 1242 | 6908 | 1042 | 7761 | 732 | 9516 | 517 | 6138 |
| 10-#10 | 1.70 | MA | 5295 | 1696 | 6539 | 1576 | 8433 | 1326 | 9496 | 1118 | 10551 | 797 | 13146 | 470 | 9461 |
| 5L-2S | | MI | 3823 | 1696 | 5365 | 1478 | 6687 | 1233 | 7515 | 1035 | 8578 | 723 | 10620 | 610 | 6150 |
| 10-#11 | 2.09 | MA | 6489 | 1782 | 8887 | 1580 | 11428 | 1314 | 13114 | 1097 | 15438 | 748 | 19768 | 648 | 12267 |
| 2L-5S | | MI | 3393 | 1782 | 4717 | 1554 | 5755 | 1297 | 6344 | 1080 | 6948 | 735 | 8411 | 332 | 6802 |
| 10-#11 | 2.09 | MA | 6014 | 1782 | 8067 | 1597 | 10390 | 1329 | 11859 | 1110 | 13748 | 766 | 17427 | 543 | 12196 |
| 3L-4S | | MI | 3534 | 1782 | 5018 | 1542 | 6181 | 1281 | 6846 | 1073 | 7643 | 725 | 9324 | 400 | 7233 |
| 10-#11 | 2.09 | MA | 5745 | 1782 | 7502 | 1613 | 9653 | 1344 | 10915 | 1131 | 12457 | 777 | 15841 | 478 | 11983 |
| 4L-3S | | MI | 3696 | 1782 | 5354 | 1531 | 6619 | 1271 | 7406 | 1059 | 8406 | 722 | 10245 | 463 | 7338 |
| 10-#11 | 2.09 | MA | 5445 | 1782 | 7002 | 1629 | 8941 | 1366 | 10074 | 1144 | 11291 | 795 | 14163 | 414 | 11150 |
| 5L-2S | | MI | 3968 | 1782 | 5830 | 1519 | 7222 | 1262 | 8134 | 1051 | 9387 | 712 | 11539 | 577 | 7365 |
| 10-#14 | 3.01 | MA | 6592 | 1985 | 9527 | 1724 | 12195 | 1423 | 14020 | 1171 | 16637 | 762 | 21413 | 481 | 17244 |
| 3L-4S | | MI | 3791 | 1985 | 5719 | 1668 | 7024 | 1372 | 7835 | 1132 | 8952 | 714 | 10967 | 272 | 9610 |
| 10-#14 | 3.01 | MA | 6247 | 1985 | 8719 | 1747 | 11140 | 1444 | 12669 | 1200 | 14791 | 777 | 19132 | 387 | 16322 |
| 4L-3S | | MI | 3995 | 1985 | 6198 | 1653 | 7648 | 1360 | 8631 | 1113 | 10038 | 712 | 12255 | 360 | 10217 |
| 10-#14 | 3.01 | MA | 5831 | 1985 | 8002 | 1770 | 10120 | 1475 | 11465 | 1218 | 13122 | 802 | 16727 | 291 | 15107 |
| 5L-2S | | MI | 4337 | 1985 | 6873 | 1637 | 8502 | 1348 | 9663 | 1104 | 11428 | 699 | 14056 | 525 | 10304 |
| 10-#18 | 5.35 | MA | 7531 | 2500 | 11700 | 2089 | 14803 | 1698 | 17003 | 1373 | 20566 | 774 | 27268 | 150 | 26356 |
| 4L-3S | | MI | 4674 | 2500 | 8225 | 1965 | 10137 | 1586 | 11603 | 1253 | 14006 | 685 | 16919 | 65 | 16694 |
| 10-#18 | 5.35 | MA | 6785 | 2500 | 10442 | 2127 | 13016 | 1750 | 14892 | 1404 | 17643 | 814 | 23212 | -6 | 23188 |
| 5L-2S | | MI | 5163 | 2500 | 9383 | 1941 | 11603 | 1569 | 13375 | 1242 | 16392 | 669 | 19899 | 358 | 17398 |
| 12-#10 | 2.04 | MA | 6496 | 1771 | 8769 | 1582 | 11338 | 1316 | 13036 | 1099 | 15361 | 753 | 19683 | 652 | 12115 |
| 2L-6S | | MI | 3338 | 1771 | 4595 | 1565 | 5651 | 1308 | 6228 | 1097 | 6807 | 747 | 8304 | 334 | 6707 |
| 12-#10 | 2.04 | MA | 6103 | 1771 | 8092 | 1595 | 10481 | 1329 | 12000 | 1111 | 13967 | 769 | 17752 | 569 | 12063 |
| 3L-5S | | MI | 3511 | 1771 | 4837 | 1556 | 5971 | 1299 | 6635 | 1084 | 7369 | 743 | 9059 | 402 | 6935 |
| 12-#10 | 2.04 | MA | 5886 | 1771 | 7628 | 1609 | 9875 | 1342 | 11223 | 1129 | 12904 | 779 | 16454 | 517 | 11929 |
| 4E | | MI | 3630 | 1771 | 5087 | 1546 | 6323 | 1285 | 7051 | 1077 | 7945 | 733 | 9838 | 457 | 7233 |
| 12-#10 | 2.04 | MA | 5635 | 1771 | 7216 | 1623 | 9289 | 1360 | 10532 | 1140 | 11946 | 794 | 15077 | 466 | 11406 |
| 5L-3S | | MI | 3762 | 1771 | 5365 | 1535 | 6687 | 1276 | 7515 | 1064 | 8578 | 729 | 10620 | 510 | 7290 |
| 12-#10 | 2.04 | MA | 5339 | 1771 | 6769 | 1630 | 8760 | 1373 | 9874 | 1152 | 11012 | 804 | 13879 | 407 | 10895 |
| 6L-2S | | MI | 3989 | 1771 | 5762 | 1525 | 7189 | 1268 | 8122 | 1057 | 9395 | 720 | 11723 | 603 | 7310 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis



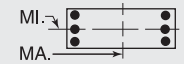

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.50 | MA | 6389 | 1873 | 8887 | 1654 | 11428 | 1371 | 13114 | 1137 | 15438 | 763 | 19768 | 538 | 14577 |
| 3L-5S | | MI | 3613 | 1873 | 5193 | 1611 | 6357 | 1339 | 7072 | 1107 | 7928 | 732 | 9704 | 320 | 8134 |
| 12-#11 | 2.50 | MA | 6141 | 1873 | 8323 | 1670 | 10690 | 1386 | 12170 | 1158 | 14147 | 774 | 18181 | 474 | 14358 |
| 4E | | MI | 3748 | 1873 | 5494 | 1600 | 6783 | 1323 | 7575 | 1100 | 8623 | 722 | 10618 | 388 | 8542 |
| 12-#11 | 2.50 | MA | 5847 | 1873 | 7822 | 1687 | 9978 | 1408 | 11329 | 1171 | 12982 | 792 | 16503 | 409 | 13511 |
| 5L-3S | | MI | 3906 | 1873 | 5830 | 1588 | 7222 | 1314 | 8134 | 1085 | 9387 | 719 | 11539 | 450 | 8716 |
| 12-#11 | 2.50 | MA | 5500 | 1873 | 7285 | 1696 | 9336 | 1423 | 10509 | 1192 | 11846 | 803 | 15040 | 334 | 12811 |
| 6L-2S | | MI | 4158 | 1873 | 6307 | 1577 | 7824 | 1304 | 8863 | 1078 | 10368 | 709 | 12833 | 565 | 8754 |
| 12-#14 | 3.61 | MA | 6793 | 2117 | 9891 | 1830 | 12622 | 1505 | 14462 | 1238 | 17204 | 772 | 22474 | 380 | 19684 |
| 4E | | MI | 4084 | 2117 | 6394 | 1751 | 7878 | 1433 | 8868 | 1171 | 10342 | 709 | 12769 | 250 | 11482 |
| 12-#14 | 3.61 | MA | 6384 | 2117 | 9174 | 1853 | 11602 | 1536 | 13257 | 1257 | 15535 | 797 | 20069 | 284 | 18506 |
| 5L-3S | | MI | 4268 | 2117 | 6873 | 1736 | 8502 | 1421 | 9663 | 1152 | 11428 | 707 | 14056 | 338 | 12159 |
| 12-#14 | 3.61 | MA | 5923 | 2117 | 8412 | 1866 | 10681 | 1557 | 12083 | 1286 | 13909 | 812 | 17964 | 176 | 16873 |
| 6L-2S | | MI | 4590 | 2117 | 7548 | 1720 | 9356 | 1408 | 10696 | 1143 | 12818 | 694 | 15858 | 503 | 12265 |
| 12-#18 | 6.42 | MA | 7746 | 2735 | 12484 | 2274 | 15599 | 1858 | 18015 | 1473 | 21849 | 805 | 29034 | -18 | 28921 |
| 5L-3S | | MI | 5120 | 2735 | 9383 | 2112 | 11603 | 1694 | 13375 | 1322 | 16392 | 676 | 19899 | 11 | 19857 |
| 14-#10 | 2.38 | MA | 6414 | 1846 | 8769 | 1642 | 11338 | 1363 | 13036 | 1133 | 15361 | 766 | 19683 | 565 | 14032 |
| 3L-6S | | MI | 3524 | 1846 | 4991 | 1612 | 6153 | 1342 | 6835 | 1119 | 7624 | 744 | 9407 | 327 | 7830 |
| 14-#10 | 2.38 | MA | 6212 | 1846 | 8305 | 1656 | 10731 | 1376 | 12259 | 1151 | 14299 | 776 | 18385 | 513 | 13892 |
| 4L-5S | | MI | 3691 | 1846 | 5234 | 1603 | 6473 | 1334 | 7242 | 1106 | 8186 | 740 | 10163 | 395 | 8049 |
| 14-#10 | 2.38 | MA | 5964 | 1846 | 7893 | 1670 | 10146 | 1394 | 11567 | 1162 | 13340 | 791 | 17009 | 462 | 13354 |
| 5L-4S | | MI | 3809 | 1846 | 5483 | 1592 | 6825 | 1319 | 7658 | 1099 | 8762 | 730 | 10942 | 450 | 8374 |
| 14-#10 | 2.38 | MA | 5681 | 1846 | 7446 | 1677 | 9617 | 1407 | 10910 | 1174 | 12407 | 801 | 15810 | 403 | 12860 |
| 6L-3S | | MI | 3933 | 1846 | 5762 | 1582 | 7189 | 1311 | 8122 | 1086 | 9395 | 727 | 11723 | 503 | 8440 |
| 14-#10 | 2.38 | MA | 5431 | 1846 | 7018 | 1686 | 9054 | 1415 | 10242 | 1192 | 11499 | 816 | 14568 | 368 | 12139 |
| 7L-2S | | MI | 4153 | 1846 | 6159 | 1572 | 7690 | 1302 | 8729 | 1079 | 10213 | 717 | 12827 | 596 | 8468 |
| 14-#11 | 2.92 | MA | 6524 | 1965 | 9143 | 1728 | 11728 | 1428 | 13426 | 1185 | 15838 | 770 | 20521 | 469 | 16737 |
| 4L-5S | | MI | 3822 | 1965 | 5669 | 1669 | 6960 | 1382 | 7800 | 1134 | 8909 | 728 | 10998 | 307 | 9472 |
| 14-#11 | 2.92 | MA | 6234 | 1965 | 8643 | 1744 | 11016 | 1450 | 12584 | 1198 | 14672 | 788 | 18844 | 404 | 15877 |
| 5L-4S | | MI | 3966 | 1965 | 5970 | 1657 | 7385 | 1365 | 8303 | 1127 | 9604 | 718 | 11911 | 375 | 9859 |
| 14-#11 | 2.92 | MA | 5905 | 1965 | 8105 | 1753 | 10374 | 1465 | 11764 | 1219 | 13536 | 799 | 17380 | 330 | 15186 |
| 6L-3S | | MI | 4103 | 1965 | 6307 | 1646 | 7824 | 1356 | 8863 | 1112 | 10368 | 715 | 12833 | 438 | 10091 |
| 14-#11 | 2.92 | MA | 5614 | 1965 | 7585 | 1764 | 9698 | 1475 | 10971 | 1233 | 12432 | 817 | 15861 | 284 | 14199 |
| 7L-2S | | MI | 4343 | 1965 | 6783 | 1634 | 8426 | 1346 | 9591 | 1105 | 11348 | 705 | 14126 | 552 | 10140 |
| 14-#14 | 4.21 | MA | 6917 | 2250 | 10345 | 1936 | 13084 | 1597 | 15050 | 1296 | 17949 | 792 | 23410 | 277 | 21905 |
| 5L-4S | | MI | 4368 | 2250 | 7069 | 1834 | 8732 | 1494 | 9900 | 1210 | 11733 | 704 | 14570 | 228 | 13366 |
| 14-#14 | 4.21 | MA | 6484 | 2250 | 9584 | 1949 | 12164 | 1618 | 13875 | 1325 | 16323 | 807 | 21306 | 169 | 20259 |
| 6L-3S | | MI | 4535 | 2250 | 7548 | 1818 | 9356 | 1482 | 10696 | 1191 | 12818 | 702 | 15858 | 316 | 14102 |
| 14-#14 | 4.21 | MA | 6101 | 2250 | 8840 | 1964 | 11207 | 1632 | 12739 | 1344 | 14741 | 831 | 19125 | 101 | 18632 |
| 7L-2S | | MI | 4838 | 2250 | 8223 | 1803 | 10210 | 1469 | 11729 | 1182 | 14209 | 689 | 17660 | 481 | 14223 |
| 16-#10 | 2.72 | MA | 6528 | 1921 | 8982 | 1703 | 11587 | 1410 | 13295 | 1173 | 15694 | 773 | 20316 | 509 | 15856 |
| 4L-6S | | MI | 3705 | 1921 | 5388 | 1658 | 6655 | 1377 | 7442 | 1141 | 8441 | 741 | 10511 | 319 | 8940 |
| 16-#10 | 2.72 | MA | 6283 | 1921 | 8570 | 1716 | 11002 | 1429 | 12603 | 1184 | 14735 | 788 | 18940 | 459 | 15305 |
| 5E | | MI | 3866 | 1921 | 5631 | 1649 | 6974 | 1368 | 7849 | 1128 | 9003 | 737 | 11266 | 388 | 9167 |
| 16-#10 | 2.72 | MA | 6012 | 1921 | 8123 | 1724 | 10473 | 1441 | 11946 | 1196 | 13801 | 798 | 17741 | 399 | 14827 |
| 6L-4S | | MI | 3983 | 1921 | 5880 | 1639 | 7327 | 1354 | 8265 | 1121 | 9579 | 728 | 12045 | 443 | 9515 |
| 16-#10 | 2.72 | MA | 5775 | 1921 | 7695 | 1733 | 9911 | 1449 | 11278 | 1214 | 12894 | 814 | 16499 | 364 | 14102 |
| 7L-3S | | MI | 4108 | 1921 | 6159 | 1629 | 7690 | 1345 | 8729 | 1108 | 10213 | 724 | 12827 | 496 | 9589 |
| 16-#10 | 2.72 | MA | 5556 | 1921 | 7223 | 1749 | 9330 | 1464 | 10600 | 1222 | 11989 | 823 | 15299 | 315 | 13354 |
| 8L-2S | | MI | 4312 | 1921 | 6555 | 1619 | 8192 | 1336 | 9336 | 1101 | 11030 | 714 | 13931 | 589 | 9623 |
| 16-#11 | 3.34 | MA | 6610 | 2057 | 9463 | 1801 | 12054 | 1492 | 13839 | 1225 | 16362 | 785 | 21184 | 399 | 18246 |
| 5E | | MI | 4035 | 2057 | 6145 | 1726 | 7562 | 1424 | 8529 | 1161 | 9890 | 725 | 12291 | 295 | 10815 |
| 16-#11 | 3.34 | MA | 6296 | 2057 | 8926 | 1810 | 11412 | 1507 | 13019 | 1246 | 15226 | 796 | 19721 | 325 | 17562 |
| 6L-4S | | MI | 4168 | 2057 | 6446 | 1715 | 7988 | 1407 | 9032 | 1154 | 10585 | 715 | 13205 | 362 | 11184 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis

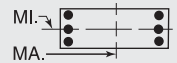



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 3.34 | MA | 6022 | 2057 | 8406 | 1821 | 10736 | 1517 | 12226 | 1260 | 14122 | 814 | 18201 | 280 | 16577 |
| 7L-3S | | MI | 4294 | 2057 | 6783 | 1703 | 8426 | 1398 | 9591 | 1139 | 11348 | 712 | 14126 | 425 | 11466 |
| 16-#11 | 3.34 | MA | 5767 | 2057 | 7833 | 1841 | 10031 | 1534 | 11415 | 1270 | 13022 | 825 | 16737 | 217 | 15504 |
| 8L-2S | | MI | 4524 | 2057 | 7259 | 1691 | 9028 | 1389 | 10320 | 1132 | 12329 | 702 | 15420 | 540 | 11524 |
| 16-#14 | 4.81 | MA | 7026 | 2382 | 10756 | 2032 | 13646 | 1678 | 15668 | 1364 | 18736 | 802 | 24648 | 162 | 23645 |
| 6L-4S | | MI | 4644 | 2382 | 7744 | 1917 | 9586 | 1555 | 10933 | 1249 | 13123 | 699 | 16372 | 206 | 15259 |
| 16-#14 | 4.81 | MA | 6670 | 2382 | 10011 | 2047 | 12689 | 1693 | 14532 | 1383 | 17155 | 826 | 22467 | 94 | 22008 |
| 7L-3S | | MI | 4796 | 2382 | 8223 | 1901 | 10210 | 1542 | 11729 | 1230 | 14209 | 697 | 17660 | 294 | 16045 |
| 18-#10 | 3.06 | MA | 6594 | 1995 | 9247 | 1763 | 11859 | 1463 | 13639 | 1206 | 16130 | 786 | 20871 | 455 | 17258 |
| 5L-6S | | MI | 3882 | 1995 | 5785 | 1705 | 7157 | 1411 | 8049 | 1163 | 9258 | 738 | 11614 | 312 | 10047 |
| 18-#10 | 3.06 | MA | 6334 | 1995 | 8800 | 1770 | 11330 | 1476 | 12982 | 1218 | 15196 | 795 | 19672 | 395 | 16796 |
| 6L-5S | | MI | 4038 | 1995 | 6028 | 1696 | 7476 | 1402 | 8456 | 1150 | 9820 | 734 | 12370 | 381 | 10288 |
| 18-#10 | 3.06 | MA | 6109 | 1995 | 8372 | 1780 | 10767 | 1483 | 12314 | 1235 | 14288 | 811 | 18431 | 360 | 16066 |
| 7L-4S | | MI | 4164 | 1995 | 6277 | 1686 | 7829 | 1388 | 8872 | 1143 | 10396 | 725 | 13149 | 436 | 10631 |
| 18-#10 | 3.06 | MA | 5899 | 1995 | 7900 | 1796 | 10186 | 1498 | 11636 | 1243 | 13384 | 821 | 17230 | 311 | 15312 |
| 8L-3S | | MI | 4270 | 1995 | 6555 | 1676 | 8192 | 1379 | 9336 | 1130 | 11030 | 721 | 13931 | 488 | 10737 |
| 18-#10 | 3.06 | MA | 5626 | 1995 | 7495 | 1807 | 9647 | 1508 | 10949 | 1258 | 12492 | 836 | 15992 | 257 | 14514 |
| 9L-2S | | MI | 4466 | 1995 | 6952 | 1665 | 8694 | 1371 | 9943 | 1123 | 11847 | 711 | 15034 | 582 | 10778 |
| 18-#11 | 3.75 | MA | 6677 | 2149 | 9746 | 1868 | 12450 | 1550 | 14275 | 1273 | 16916 | 792 | 22061 | 320 | 19936 |
| 6L-5S | | MI | 4234 | 2149 | 6621 | 1784 | 8164 | 1466 | 9257 | 1188 | 10870 | 721 | 13585 | 282 | 12163 |
| 18-#11 | 3.75 | MA | 6418 | 2149 | 9226 | 1879 | 11774 | 1559 | 13482 | 1287 | 15812 | 810 | 20542 | 275 | 18954 |
| 7L-4S | | MI | 4365 | 2149 | 6922 | 1772 | 8590 | 1450 | 9760 | 1181 | 11565 | 711 | 14499 | 350 | 12515 |
| 18-#11 | 3.75 | MA | 6171 | 2149 | 8653 | 1898 | 11068 | 1577 | 12671 | 1297 | 14712 | 821 | 19077 | 212 | 17876 |
| 8L-3S | | MI | 4482 | 2149 | 7259 | 1760 | 9028 | 1440 | 10320 | 1166 | 12329 | 708 | 15420 | 413 | 12841 |
| 18-#14 | 5.41 | MA | 7220 | 2514 | 11183 | 2130 | 14171 | 1754 | 16324 | 1422 | 19568 | 821 | 25809 | 87 | 25383 |
| 7L-4S | | MI | 4914 | 2514 | 8419 | 2000 | 10440 | 1616 | 11966 | 1288 | 14513 | 694 | 18174 | 184 | 17159 |
| 20-#10 | 3.40 | MA | 6649 | 2070 | 9477 | 1817 | 12186 | 1510 | 14017 | 1240 | 16591 | 793 | 21603 | 392 | 18765 |
| 6E | | MI | 4068 | 2070 | 6182 | 1752 | 7658 | 1445 | 8656 | 1185 | 10075 | 735 | 12718 | 305 | 11157 |
| 20-#10 | 3.40 | MA | 6434 | 2070 | 9049 | 1826 | 11623 | 1518 | 13350 | 1257 | 15683 | 808 | 20362 | 356 | 18029 |
| 7L-5S | | MI | 4215 | 2070 | 6424 | 1743 | 7978 | 1437 | 9063 | 1172 | 10638 | 731 | 13473 | 374 | 11413 |
| 20-#10 | 3.40 | MA | 6227 | 2070 | 8577 | 1843 | 11043 | 1532 | 12672 | 1265 | 14779 | 818 | 19162 | 307 | 17270 |
| 8L-4S | | MI | 4330 | 2070 | 6673 | 1733 | 8331 | 1422 | 9479 | 1165 | 11213 | 722 | 14252 | 428 | 11742 |
| 20-#10 | 3.40 | MA | 5965 | 2070 | 8172 | 1854 | 10504 | 1542 | 11985 | 1280 | 13887 | 833 | 17924 | 253 | 16474 |
| 9L-3S | | MI | 4429 | 2070 | 6952 | 1722 | 8694 | 1414 | 9943 | 1152 | 11847 | 718 | 15034 | 481 | 11885 |
| 20-#10 | 3.40 | MA | 5721 | 2070 | 7746 | 1862 | 9975 | 1553 | 11322 | 1289 | 12989 | 843 | 16720 | 211 | 15586 |
| 10L-2S | | MI | 4619 | 2070 | 7349 | 1712 | 9196 | 1405 | 10550 | 1145 | 12664 | 709 | 16138 | 575 | 11931 |
| 20-#11 | 4.17 | MA | 6803 | 2241 | 10047 | 1936 | 12812 | 1601 | 14737 | 1314 | 17502 | 807 | 22882 | 270 | 21331 |
| 7L-5S | | MI | 4428 | 2241 | 7097 | 1841 | 8766 | 1508 | 9986 | 1215 | 11851 | 718 | 14879 | 270 | 13514 |
| 20-#11 | 4.17 | MA | 6560 | 2241 | 9474 | 1955 | 12106 | 1619 | 13926 | 1324 | 16402 | 818 | 21417 | 208 | 20247 |
| 8L-4S | | MI | 4558 | 2241 | 7399 | 1829 | 9192 | 1492 | 10488 | 1208 | 12546 | 708 | 15792 | 337 | 13851 |
| 22-#10 | 3.74 | MA | 6752 | 2145 | 9726 | 1873 | 12480 | 1552 | 14386 | 1279 | 17078 | 805 | 22293 | 352 | 19992 |
| 7L-6S | | MI | 4238 | 2145 | 6578 | 1799 | 8160 | 1480 | 9263 | 1207 | 10893 | 732 | 13821 | 298 | 12271 |
| 22-#10 | 3.74 | MA | 6548 | 2145 | 9255 | 1889 | 11899 | 1567 | 13708 | 1287 | 16174 | 815 | 21093 | 303 | 19228 |
| 8L-5S | | MI | 4379 | 2145 | 6821 | 1789 | 8480 | 1471 | 9669 | 1194 | 11455 | 729 | 14577 | 366 | 12540 |
| 22-#10 | 3.74 | MA | 6296 | 2145 | 8849 | 1901 | 11360 | 1577 | 13020 | 1302 | 15282 | 830 | 19855 | 249 | 18434 |
| 9L-4S | | MI | 4493 | 2145 | 7070 | 1779 | 8833 | 1457 | 10086 | 1187 | 12031 | 719 | 15356 | 421 | 12857 |
| 22-#10 | 3.74 | MA | 6062 | 2145 | 8423 | 1909 | 10832 | 1587 | 12358 | 1311 | 14384 | 840 | 18651 | 207 | 17542 |
| 10L-3S | | MI | 4587 | 2145 | 7349 | 1769 | 9196 | 1448 | 10550 | 1174 | 12664 | 715 | 16138 | 474 | 13033 |
| 22-#11 | 4.59 | MA | 6939 | 2333 | 10294 | 2013 | 13144 | 1661 | 15181 | 1351 | 18092 | 814 | 23758 | 203 | 22618 |
| 8L-5S | | MI | 4619 | 2333 | 7573 | 1898 | 9368 | 1550 | 10714 | 1242 | 12832 | 714 | 16172 | 257 | 14868 |
| 24-#10 | 4.07 | MA | 6861 | 2220 | 9932 | 1936 | 12756 | 1601 | 14744 | 1309 | 17568 | 812 | 23024 | 299 | 21186 |
| 8L-6S | | MI | 4405 | 2220 | 6975 | 1845 | 8662 | 1514 | 9870 | 1229 | 11710 | 730 | 14925 | 291 | 13387 |
| 24-#10 | 4.07 | MA | 6619 | 2220 | 9526 | 1947 | 12217 | 1611 | 14056 | 1324 | 16676 | 828 | 21786 | 246 | 20394 |
| 9L-5S | | MI | 4541 | 2220 | 7218 | 1836 | 8982 | 1505 | 10276 | 1216 | 12272 | 726 | 15680 | 359 | 13670 |
| 24-#10 | 4.07 | MA | 6395 | 2220 | 9100 | 1956 | 11688 | 1622 | 13394 | 1333 | 15779 | 837 | 20582 | 203 | 19499 |
| 10L-4S | | MI | 4653 | 2220 | 7467 | 1826 | 9334 | 1491 | 10693 | 1209 | 12848 | 716 | 16460 | 414 | 13976 |

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis

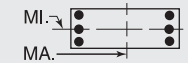



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.14 | MA | 6328 | 1665 | 7866 | 1536 | 10164 | 1290 | 11503 | 1097 | 13002 | 801 | 16202 | 698 | 7637 |
| 2E | | MI | 3698 | 1665 | 5054 | 1461 | 6190 | 1226 | 6830 | 1041 | 7520 | 757 | 8948 | 628 | 4394 |
| 4-#18 | 2.02 | MA | 7142 | 1871 | 9851 | 1653 | 12587 | 1375 | 14386 | 1148 | 16841 | 786 | 21486 | 681 | 13160 |
| 2E | | MI | 4069 | 1871 | 6119 | 1571 | 7458 | 1305 | 8324 | 1087 | 9496 | 738 | 11255 | 556 | 7340 |
| 6-#11 | 1.18 | MA | 6399 | 1676 | 7930 | 1548 | 10292 | 1300 | 11680 | 1104 | 13264 | 804 | 16581 | 700 | 7976 |
| 2L-3S | | MI | 3442 | 1676 | 4605 | 1489 | 5662 | 1249 | 6213 | 1058 | 6708 | 772 | 7956 | 525 | 4595 |
| 6-#11 | 1.18 | MA | 5828 | 1676 | 7053 | 1565 | 9181 | 1316 | 10337 | 1118 | 11455 | 823 | 14077 | 597 | 7941 |
| 3L-2S | | MI | 3742 | 1676 | 5081 | 1477 | 6265 | 1240 | 6942 | 1051 | 7689 | 762 | 9250 | 640 | 4586 |
| 6-#14 | 1.70 | MA | 6907 | 1798 | 9120 | 1618 | 11751 | 1351 | 13422 | 1136 | 15586 | 796 | 19780 | 691 | 11308 |
| 2L-3S | | MI | 3579 | 1798 | 5054 | 1559 | 6190 | 1300 | 6830 | 1089 | 7520 | 764 | 8948 | 441 | 6364 |
| 6-#14 | 1.70 | MA | 6138 | 1798 | 7866 | 1642 | 10164 | 1373 | 11503 | 1155 | 13002 | 822 | 16202 | 540 | 11189 |
| 3L-2S | | MI | 3982 | 1798 | 5729 | 1544 | 7043 | 1287 | 7863 | 1080 | 8910 | 752 | 10750 | 606 | 6390 |
| 6-#18 | 3.03 | MA | 8063 | 2107 | 12040 | 1800 | 15355 | 1483 | 17734 | 1218 | 21350 | 777 | 27729 | 669 | 19541 |
| 2L-3S | | MI | 3909 | 2107 | 6119 | 1742 | 7458 | 1430 | 8324 | 1167 | 9496 | 744 | 11255 | 208 | 10491 |
| 6-#18 | 3.03 | MA | 6880 | 2107 | 9851 | 1840 | 12587 | 1519 | 14386 | 1250 | 16841 | 820 | 21486 | 393 | 19021 |
| 3L-2S | | MI | 4509 | 2107 | 7278 | 1718 | 8923 | 1413 | 10096 | 1156 | 11882 | 729 | 14234 | 502 | 10720 |
| 8-#9 | 1.01 | MA | 6255 | 1636 | 7472 | 1534 | 9799 | 1291 | 11129 | 1101 | 12564 | 812 | 15643 | 708 | 6922 |
| 2L-4S | | MI | 3361 | 1636 | 4278 | 1487 | 5318 | 1251 | 5817 | 1069 | 6204 | 785 | 7440 | 552 | 4023 |
| 8-#9 | 1.01 | MA | 5875 | 1636 | 6900 | 1545 | 9074 | 1302 | 10253 | 1110 | 11384 | 825 | 14010 | 644 | 6910 |
| 3E | | MI | 3484 | 1636 | 4499 | 1478 | 5606 | 1244 | 6185 | 1059 | 6706 | 782 | 8065 | 594 | 4024 |
| 8-#9 | 1.01 | MA | 5653 | 1636 | 6509 | 1557 | 8563 | 1312 | 9598 | 1125 | 10488 | 833 | 12922 | 603 | 6857 |
| 4L-2S | | MI | 3687 | 1636 | 4814 | 1470 | 6004 | 1236 | 6667 | 1053 | 7355 | 774 | 8948 | 668 | 4017 |
| 8-#10 | 1.28 | MA | 6542 | 1699 | 8108 | 1571 | 10580 | 1318 | 12062 | 1117 | 13808 | 808 | 17357 | 703 | 8707 |
| 2L-4S | | MI | 3430 | 1699 | 4492 | 1525 | 5566 | 1279 | 6101 | 1088 | 6574 | 782 | 7931 | 509 | 4979 |
| 8-#10 | 1.28 | MA | 6078 | 1699 | 7385 | 1585 | 9664 | 1331 | 10955 | 1129 | 12317 | 824 | 15293 | 621 | 8676 |
| 3E | | MI | 3580 | 1699 | 4771 | 1515 | 5929 | 1270 | 6565 | 1075 | 7208 | 778 | 8713 | 562 | 5004 |
| 8-#10 | 1.28 | MA | 5808 | 1699 | 6890 | 1599 | 9017 | 1344 | 10126 | 1147 | 11183 | 834 | 13914 | 569 | 8559 |
| 4L-2S | | MI | 3827 | 1699 | 5167 | 1505 | 6431 | 1262 | 7172 | 1068 | 8025 | 769 | 9816 | 656 | 5002 |
| 8-#11 | 1.58 | MA | 6809 | 1768 | 8808 | 1606 | 11402 | 1342 | 13024 | 1131 | 15072 | 801 | 19085 | 695 | 10545 |
| 2L-4S | | MI | 3485 | 1768 | 4745 | 1558 | 5826 | 1301 | 6382 | 1100 | 6925 | 771 | 8329 | 450 | 5927 |
| 8-#11 | 1.58 | MA | 6267 | 1768 | 7930 | 1622 | 10292 | 1358 | 11680 | 1145 | 13264 | 819 | 16581 | 592 | 10490 |
| 3E | | MI | 3659 | 1768 | 5081 | 1546 | 6265 | 1291 | 6942 | 1085 | 7689 | 768 | 9250 | 513 | 5985 |
| 8-#11 | 1.58 | MA | 5952 | 1768 | 7328 | 1639 | 9504 | 1373 | 10673 | 1167 | 11885 | 831 | 14894 | 528 | 10285 |
| 4L-2S | | MI | 3946 | 1768 | 5557 | 1534 | 6867 | 1282 | 7670 | 1078 | 8670 | 758 | 10544 | 627 | 5992 |
| 8-#14 | 2.27 | MA | 7459 | 1930 | 10374 | 1701 | 13338 | 1412 | 15341 | 1174 | 18170 | 791 | 23358 | 684 | 14971 |
| 2L-4S | | MI | 3644 | 1930 | 5250 | 1658 | 6420 | 1373 | 7067 | 1147 | 7825 | 762 | 9462 | 332 | 7857 |
| 8-#14 | 2.27 | MA | 6741 | 1930 | 9120 | 1725 | 11751 | 1434 | 13422 | 1194 | 15586 | 817 | 19780 | 533 | 14822 |
| 3E | | MI | 3876 | 1930 | 5729 | 1642 | 7043 | 1360 | 7863 | 1128 | 8910 | 759 | 10750 | 419 | 8312 |
| 8-#14 | 2.27 | MA | 6326 | 1930 | 8257 | 1748 | 10623 | 1455 | 11979 | 1224 | 13614 | 833 | 17356 | 440 | 14006 |
| 4L-2S | | MI | 4255 | 1930 | 6404 | 1626 | 7897 | 1348 | 8895 | 1119 | 10301 | 747 | 12552 | 584 | 8366 |
| 8-#18 | 4.04 | MA | 7868 | 2342 | 12040 | 1987 | 15355 | 1627 | 17734 | 1319 | 21350 | 811 | 27729 | 380 | 25370 |
| 3E | | MI | 4388 | 2342 | 7278 | 1889 | 8923 | 1539 | 10096 | 1237 | 11882 | 736 | 14234 | 155 | 13734 |
| 8-#18 | 4.04 | MA | 7253 | 2342 | 10528 | 2027 | 13380 | 1664 | 15208 | 1369 | 17896 | 836 | 23447 | 212 | 22058 |
| 4L-2S | | MI | 4932 | 2342 | 8436 | 1865 | 10389 | 1521 | 11869 | 1226 | 14268 | 720 | 17214 | 449 | 14081 |
| 10-#10 | 1.60 | MA | 6880 | 1774 | 8832 | 1618 | 11495 | 1352 | 13169 | 1139 | 15299 | 805 | 19422 | 699 | 10824 |
| 2L-5S | | MI | 3497 | 1774 | 4640 | 1582 | 5715 | 1327 | 6291 | 1117 | 6816 | 789 | 8256 | 447 | 5894 |
| 10-#10 | 1.60 | MA | 6436 | 1774 | 8108 | 1632 | 10580 | 1365 | 12062 | 1151 | 13808 | 821 | 17357 | 617 | 10781 |
| 3L-4S | | MI | 3619 | 1774 | 4889 | 1572 | 6067 | 1313 | 6708 | 1110 | 7392 | 779 | 9035 | 502 | 6122 |
| 10-#10 | 1.60 | MA | 6184 | 1774 | 7613 | 1646 | 9932 | 1379 | 11233 | 1169 | 12674 | 831 | 15978 | 565 | 10654 |
| 4L-3S | | MI | 3760 | 1774 | 5167 | 1562 | 6431 | 1305 | 7172 | 1097 | 8025 | 775 | 9816 | 555 | 6161 |
| 10-#10 | 1.60 | MA | 5905 | 1774 | 7171 | 1659 | 9308 | 1397 | 10496 | 1181 | 11652 | 847 | 14513 | 516 | 10168 |
| 5L-2S | | MI | 3998 | 1774 | 5564 | 1552 | 6933 | 1296 | 7779 | 1090 | 8842 | 766 | 10920 | 648 | 6169 |
| 10-#11 | 1.97 | MA | 7204 | 1859 | 9686 | 1663 | 12513 | 1385 | 14367 | 1158 | 16880 | 797 | 21588 | 691 | 13110 |
| 2L-5S | | MI | 3563 | 1859 | 4920 | 1626 | 6003 | 1359 | 6608 | 1134 | 7211 | 778 | 8709 | 370 | 6879 |
| 10-#11 | 1.97 | MA | 6688 | 1859 | 8808 | 1680 | 11402 | 1400 | 13024 | 1172 | 15072 | 816 | 19085 | 587 | 13039 |
| 3L-4S | | MI | 3705 | 1859 | 5221 | 1615 | 6429 | 1343 | 7111 | 1127 | 7906 | 768 | 9623 | 438 | 7292 |
| 10-#11 | 1.97 | MA | 6398 | 1859 | 8206 | 1696 | 10615 | 1416 | 12016 | 1194 | 13694 | 828 | 17398 | 524 | 12825 |
| 4L-3S | | MI | 3869 | 1859 | 5557 | 1603 | 6867 | 1333 | 7670 | 1112 | 8670 | 765 | 10544 | 500 | 7367 |

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis



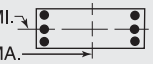

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.97 | MA | 6069 | 1859 | 7672 | 1713 | 9855 | 1438 | 11118 | 1208 | 12450 | 846 | 15611 | 461 | 11989 |
| 5L-2S | | MI | 4144 | 1859 | 6033 | 1592 | 7469 | 1324 | 8399 | 1105 | 9651 | 755 | 11837 | 615 | 7389 |
| 10-#14 | 2.84 | MA | 7317 | 2062 | 10374 | 1808 | 13338 | 1495 | 15341 | 1233 | 18170 | 812 | 23358 | 526 | 18459 |
| 3L-4S | | MI | 3948 | 2062 | 5925 | 1740 | 7273 | 1434 | 8100 | 1186 | 9215 | 757 | 11264 | 310 | 9710 |
| 10-#14 | 2.84 | MA | 6943 | 2062 | 9512 | 1831 | 12210 | 1516 | 13898 | 1263 | 16198 | 828 | 20934 | 433 | 17606 |
| 4L-3S | | MI | 4169 | 2062 | 6404 | 1725 | 7897 | 1421 | 8895 | 1167 | 10301 | 754 | 12552 | 397 | 10255 |
| 10-#14 | 2.84 | MA | 6487 | 2062 | 8747 | 1855 | 11122 | 1548 | 12612 | 1283 | 14416 | 854 | 18371 | 340 | 16242 |
| 5L-2S | | MI | 4516 | 2062 | 7079 | 1709 | 8751 | 1409 | 9928 | 1158 | 11691 | 742 | 14353 | 562 | 10333 |
| 10-#18 | 5.05 | MA | 8281 | 2578 | 12716 | 2174 | 16148 | 1772 | 18556 | 1438 | 22405 | 827 | 29690 | 200 | 28383 |
| 4L-3S | | MI | 4847 | 2578 | 8436 | 2036 | 10389 | 1647 | 11869 | 1306 | 14268 | 727 | 17214 | 101 | 16857 |
| 10-#18 | 5.05 | MA | 7519 | 2578 | 11373 | 2214 | 14239 | 1826 | 16301 | 1471 | 19281 | 870 | 25364 | 50 | 25147 |
| 5L-2S | | MI | 5346 | 2578 | 9594 | 2012 | 11854 | 1629 | 13641 | 1295 | 16655 | 711 | 20193 | 395 | 17436 |
| 12-#10 | 1.92 | MA | 7209 | 1849 | 9556 | 1664 | 12411 | 1387 | 14277 | 1161 | 16790 | 802 | 21486 | 695 | 12938 |
| 2L-6S | | MI | 3508 | 1849 | 4794 | 1638 | 5897 | 1370 | 6491 | 1151 | 7071 | 790 | 8604 | 372 | 6772 |
| 12-#10 | 1.92 | MA | 6783 | 1849 | 8832 | 1678 | 11495 | 1400 | 13169 | 1173 | 15299 | 818 | 19422 | 613 | 12886 |
| 3L-5S | | MI | 3683 | 1849 | 5036 | 1629 | 6217 | 1362 | 6898 | 1139 | 7633 | 786 | 9359 | 440 | 7000 |
| 12-#10 | 1.92 | MA | 6547 | 1849 | 8337 | 1693 | 10848 | 1413 | 12341 | 1191 | 14165 | 829 | 18043 | 562 | 12752 |
| 4E | | MI | 3802 | 1849 | 5286 | 1619 | 6569 | 1348 | 7315 | 1132 | 8209 | 777 | 10138 | 495 | 7265 |
| 12-#10 | 1.92 | MA | 6273 | 1849 | 7895 | 1706 | 10224 | 1432 | 11603 | 1203 | 13143 | 845 | 16578 | 512 | 12250 |
| 5L-3S | | MI | 3936 | 1849 | 5564 | 1609 | 6933 | 1339 | 7779 | 1119 | 8842 | 773 | 10920 | 548 | 7314 |
| 12-#10 | 1.92 | MA | 5953 | 1849 | 7417 | 1714 | 9654 | 1444 | 10902 | 1215 | 12148 | 855 | 15302 | 455 | 11689 |
| 6L-2S | | MI | 4166 | 1849 | 5961 | 1598 | 7434 | 1330 | 8386 | 1112 | 9660 | 763 | 12024 | 641 | 7331 |
| 12-#11 | 2.36 | MA | 7095 | 1951 | 9686 | 1737 | 12513 | 1442 | 14367 | 1199 | 16880 | 812 | 21588 | 583 | 15588 |
| 3L-5S | | MI | 3784 | 1951 | 5396 | 1684 | 6605 | 1401 | 7336 | 1161 | 8192 | 774 | 10002 | 357 | 8208 |
| 12-#11 | 2.36 | MA | 6826 | 1951 | 9084 | 1754 | 11725 | 1458 | 13359 | 1220 | 15502 | 824 | 19902 | 519 | 15369 |
| 4E | | MI | 3919 | 1951 | 5697 | 1672 | 7031 | 1385 | 7839 | 1154 | 8887 | 765 | 10916 | 425 | 8625 |
| 12-#11 | 2.36 | MA | 6504 | 1951 | 8550 | 1771 | 10966 | 1480 | 12461 | 1235 | 14258 | 843 | 18115 | 456 | 14520 |
| 5L-3S | | MI | 4073 | 1951 | 6033 | 1661 | 7469 | 1375 | 8399 | 1139 | 9651 | 761 | 11837 | 488 | 8746 |
| 12-#11 | 2.36 | MA | 6130 | 1951 | 7971 | 1779 | 10281 | 1496 | 11587 | 1256 | 13046 | 855 | 16559 | 383 | 13829 |
| 6L-2S | | MI | 4337 | 1951 | 6509 | 1649 | 8071 | 1366 | 9127 | 1132 | 10631 | 752 | 13131 | 602 | 8779 |
| 12-#14 | 3.41 | MA | 7534 | 2195 | 10766 | 1914 | 13797 | 1577 | 15818 | 1302 | 18782 | 823 | 24512 | 426 | 21214 |
| 4E | | MI | 4255 | 2195 | 6600 | 1823 | 8127 | 1495 | 9132 | 1225 | 10606 | 752 | 13066 | 287 | 11579 |
| 12-#14 | 3.41 | MA | 7086 | 2195 | 10001 | 1938 | 12709 | 1609 | 14532 | 1322 | 17000 | 849 | 21949 | 333 | 19881 |
| 5L-3S | | MI | 4444 | 2195 | 7079 | 1808 | 8751 | 1482 | 9928 | 1206 | 11691 | 749 | 14353 | 375 | 12198 |
| 12-#14 | 3.41 | MA | 6587 | 2195 | 9179 | 1951 | 11727 | 1630 | 13278 | 1351 | 15264 | 865 | 19713 | 226 | 18206 |
| 6L-2S | | MI | 4771 | 2195 | 7754 | 1792 | 9605 | 1470 | 10961 | 1197 | 13082 | 737 | 16155 | 540 | 12295 |
| 12-#18 | 6.06 | MA | 8561 | 2813 | 13562 | 2361 | 17008 | 1934 | 19650 | 1540 | 23790 | 861 | 31607 | 38 | 31443 |
| 5L-3S | | MI | 5294 | 2813 | 9594 | 2183 | 11854 | 1755 | 13641 | 1375 | 16655 | 718 | 20193 | 48 | 20012 |
| 12-#18 | 6.06 | MA | 7749 | 2813 | 12148 | 2385 | 15284 | 1970 | 17450 | 1590 | 20745 | 886 | 27473 | -180 | 26718 |
| 6L-2S | | MI | 5755 | 2813 | 10753 | 2159 | 13319 | 1737 | 15413 | 1364 | 19041 | 702 | 23172 | 342 | 20787 |
| 14-#10 | 2.24 | MA | 7120 | 1924 | 9556 | 1725 | 12411 | 1434 | 14277 | 1195 | 16790 | 815 | 21486 | 609 | 14992 |
| 3L-6S | | MI | 3695 | 1924 | 5190 | 1685 | 6399 | 1405 | 7098 | 1173 | 7888 | 787 | 9707 | 365 | 7894 |
| 14-#10 | 2.24 | MA | 6899 | 1924 | 9061 | 1739 | 11763 | 1447 | 13448 | 1213 | 15656 | 826 | 20107 | 558 | 14852 |
| 4L-5S | | MI | 3863 | 1924 | 5433 | 1676 | 6718 | 1396 | 7505 | 1161 | 8450 | 783 | 10463 | 433 | 8112 |
| 14-#10 | 2.24 | MA | 6629 | 1924 | 8618 | 1753 | 11140 | 1466 | 12710 | 1225 | 14634 | 842 | 18642 | 508 | 14336 |
| 5L-4S | | MI | 3981 | 1924 | 5682 | 1666 | 7071 | 1382 | 7922 | 1153 | 9026 | 774 | 11242 | 488 | 8407 |
| 14-#10 | 2.24 | MA | 6323 | 1924 | 8141 | 1760 | 10570 | 1478 | 12010 | 1237 | 13639 | 852 | 17367 | 451 | 13792 |
| 6L-3S | | MI | 4108 | 1924 | 5961 | 1655 | 7434 | 1373 | 8386 | 1141 | 9660 | 770 | 12024 | 541 | 8465 |
| 14-#10 | 2.24 | MA | 6054 | 1924 | 7684 | 1770 | 9969 | 1486 | 11295 | 1255 | 12671 | 868 | 16049 | 416 | 13061 |
| 7L-2S | | MI | 4330 | 1924 | 6358 | 1645 | 7936 | 1365 | 8993 | 1134 | 10477 | 760 | 13127 | 634 | 8489 |
| 14-#11 | 2.76 | MA | 7241 | 2043 | 9962 | 1811 | 12836 | 1500 | 14702 | 1247 | 17311 | 821 | 22406 | 514 | 17916 |
| 4L-5S | | MI | 3994 | 2043 | 5872 | 1741 | 7207 | 1443 | 8065 | 1188 | 9173 | 771 | 11296 | 345 | 9544 |
| 14-#11 | 2.76 | MA | 6923 | 2043 | 9428 | 1828 | 12076 | 1522 | 13804 | 1262 | 16066 | 839 | 20619 | 451 | 17055 |
| 5L-4S | | MI | 4139 | 2043 | 6173 | 1730 | 7633 | 1427 | 8568 | 1181 | 9868 | 761 | 12210 | 413 | 9940 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis



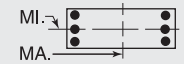

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.76 | MA | 6567 | 2043 | 8849 | 1837 | 11391 | 1538 | 12930 | 1283 | 14855 | 851 | 19063 | 378 | 16369 |
| 6L-3S | | MI | 4278 | 2043 | 6509 | 1718 | 8071 | 1418 | 9127 | 1166 | 10631 | 758 | 13131 | 475 | 10123 |
| 14-#11 | 2.76 | MA | 6253 | 2043 | 8293 | 1848 | 10662 | 1547 | 12084 | 1297 | 13677 | 870 | 17449 | 334 | 15286 |
| 7L-2S | | MI | 4523 | 2043 | 6986 | 1707 | 8674 | 1408 | 9855 | 1159 | 11612 | 748 | 14424 | 590 | 10166 |
| 14-#14 | 3.98 | MA | 7663 | 2327 | 11256 | 2020 | 14296 | 1670 | 16451 | 1361 | 19584 | 844 | 25527 | 326 | 23521 |
| 5L-4S | | MI | 4540 | 2327 | 7275 | 1906 | 8981 | 1555 | 10165 | 1264 | 11996 | 747 | 14867 | 265 | 13459 |
| 14-#14 | 3.98 | MA | 7194 | 2327 | 10434 | 2033 | 13314 | 1691 | 15198 | 1390 | 17848 | 860 | 23291 | 219 | 21831 |
| 6L-3S | | MI | 4711 | 2327 | 7754 | 1890 | 9605 | 1543 | 10961 | 1245 | 13082 | 744 | 16155 | 353 | 14141 |
| 14-#14 | 3.98 | MA | 6779 | 2327 | 9639 | 2049 | 12280 | 1705 | 13986 | 1410 | 16160 | 886 | 20970 | 154 | 20158 |
| 7L-2S | | MI | 5021 | 2327 | 8429 | 1875 | 10459 | 1531 | 11993 | 1235 | 14472 | 732 | 17957 | 518 | 14254 |
| 14-#18 | 7.07 | MA | 8828 | 3048 | 14337 | 2532 | 18052 | 2078 | 20799 | 1659 | 25254 | 877 | 33715 | -192 | 32600 |
| 6L-3S | | MI | 5732 | 3048 | 10753 | 2330 | 13319 | 1863 | 15413 | 1444 | 19041 | 709 | 23172 | -6 | 23155 |
| 16-#10 | 2.57 | MA | 7242 | 1998 | 9784 | 1786 | 12679 | 1482 | 14555 | 1235 | 17147 | 823 | 22172 | 554 | 16954 |
| 4L-6S | | MI | 3877 | 1998 | 5587 | 1732 | 6900 | 1439 | 7705 | 1195 | 8705 | 784 | 10811 | 357 | 9019 |
| 16-#10 | 2.57 | MA | 6974 | 1998 | 9342 | 1800 | 12055 | 1500 | 13818 | 1247 | 16125 | 839 | 20706 | 505 | 16424 |
| 5E | | MI | 4040 | 1998 | 5830 | 1723 | 7220 | 1430 | 8112 | 1182 | 9267 | 780 | 11566 | 426 | 9229 |
| 16-#10 | 2.57 | MA | 6681 | 1998 | 8864 | 1807 | 11485 | 1513 | 13117 | 1259 | 15129 | 849 | 19431 | 447 | 15897 |
| 6L-4S | | MI | 4156 | 1998 | 6079 | 1712 | 7573 | 1416 | 8529 | 1175 | 9843 | 771 | 12345 | 481 | 9549 |
| 16-#10 | 2.57 | MA | 6425 | 1998 | 8408 | 1817 | 10885 | 1521 | 12402 | 1277 | 14162 | 865 | 18114 | 412 | 15160 |
| 7L-3S | | MI | 4277 | 1998 | 6358 | 1702 | 7936 | 1408 | 8993 | 1163 | 10477 | 767 | 13127 | 534 | 9615 |
| 16-#10 | 2.57 | MA | 6188 | 1998 | 7905 | 1833 | 10266 | 1536 | 11674 | 1285 | 13198 | 876 | 16837 | 364 | 14411 |
| 8L-2S | | MI | 4492 | 1998 | 6754 | 1692 | 8438 | 1399 | 9600 | 1156 | 11294 | 758 | 14231 | 627 | 9646 |
| 16-#11 | 3.15 | MA | 7331 | 2135 | 10306 | 1885 | 13187 | 1565 | 15147 | 1289 | 17875 | 836 | 23123 | 446 | 19594 |
| 5E | | MI | 4209 | 2135 | 6348 | 1799 | 7809 | 1486 | 8793 | 1215 | 10153 | 768 | 12590 | 332 | 10886 |
| 16-#11 | 3.15 | MA | 6991 | 2135 | 9727 | 1894 | 12502 | 1580 | 14273 | 1310 | 16663 | 848 | 21567 | 373 | 18909 |
| 6L-4S | | MI | 4342 | 2135 | 6649 | 1787 | 8235 | 1469 | 9296 | 1208 | 10848 | 758 | 13503 | 400 | 11262 |
| 16-#11 | 3.15 | MA | 6694 | 2135 | 9171 | 1906 | 11772 | 1589 | 13427 | 1324 | 15485 | 867 | 19953 | 329 | 17830 |
| 7L-3S | | MI | 4471 | 2135 | 6986 | 1776 | 8674 | 1460 | 9855 | 1193 | 11612 | 755 | 14424 | 463 | 11498 |
| 16-#11 | 3.15 | MA | 6419 | 2135 | 8560 | 1925 | 11019 | 1607 | 12551 | 1334 | 14312 | 878 | 18394 | 269 | 16734 |
| 8L-2S | | MI | 4705 | 2135 | 7462 | 1764 | 9276 | 1450 | 10584 | 1186 | 12593 | 745 | 15718 | 577 | 11551 |
| 16-#14 | 4.55 | MA | 7780 | 2460 | 11688 | 2116 | 14901 | 1752 | 17117 | 1429 | 20432 | 855 | 26869 | 212 | 25456 |
| 6L-4S | | MI | 4817 | 2460 | 7950 | 1989 | 9835 | 1616 | 11198 | 1302 | 13386 | 742 | 16669 | 243 | 15349 |
| 16-#14 | 4.55 | MA | 7394 | 2460 | 10893 | 2132 | 13867 | 1766 | 15905 | 1449 | 18745 | 881 | 24548 | 147 | 23773 |
| 7L-3S | | MI | 4974 | 2460 | 8429 | 1973 | 10459 | 1604 | 11993 | 1283 | 14472 | 739 | 17957 | 331 | 16085 |
| 16-#14 | 4.55 | MA | 7009 | 2460 | 10017 | 2160 | 12788 | 1791 | 14664 | 1464 | 17063 | 897 | 22310 | 58 | 22072 |
| 8L-2S | | MI | 5267 | 2460 | 9104 | 1957 | 11312 | 1592 | 13026 | 1274 | 15862 | 727 | 19758 | 496 | 16211 |
| 18-#10 | 2.89 | MA | 7311 | 2073 | 10066 | 1846 | 12971 | 1535 | 14925 | 1269 | 17616 | 836 | 22771 | 501 | 18515 |
| 5L-6S | | MI | 4055 | 2073 | 5984 | 1778 | 7402 | 1473 | 8312 | 1217 | 9522 | 781 | 11914 | 350 | 10144 |
| 18-#10 | 2.89 | MA | 7030 | 2073 | 9588 | 1854 | 12401 | 1547 | 14224 | 1281 | 16620 | 847 | 21495 | 443 | 18003 |
| 6L-5S | | MI | 4212 | 2073 | 6226 | 1769 | 7722 | 1465 | 8719 | 1204 | 10085 | 778 | 12670 | 419 | 10349 |
| 18-#10 | 2.89 | MA | 6786 | 2073 | 9131 | 1863 | 11801 | 1555 | 13509 | 1299 | 15653 | 863 | 20178 | 408 | 17259 |
| 7L-4S | | MI | 4328 | 2073 | 6476 | 1759 | 8075 | 1451 | 9136 | 1197 | 10660 | 768 | 13449 | 474 | 10692 |
| 18-#10 | 2.89 | MA | 6556 | 2073 | 8629 | 1880 | 11181 | 1570 | 12782 | 1307 | 14689 | 873 | 18901 | 361 | 16504 |
| 8L-3S | | MI | 4448 | 2073 | 6754 | 1749 | 8438 | 1442 | 9600 | 1185 | 11294 | 764 | 14231 | 527 | 10764 |
| 18-#10 | 2.89 | MA | 6262 | 2073 | 8192 | 1891 | 10606 | 1581 | 12049 | 1322 | 13739 | 889 | 17588 | 307 | 15630 |
| 9L-2S | | MI | 4648 | 2073 | 7151 | 1739 | 8940 | 1433 | 10207 | 1178 | 12111 | 755 | 15334 | 620 | 10801 |
| 18-#11 | 3.55 | MA | 7402 | 2227 | 10604 | 1952 | 13612 | 1622 | 15616 | 1337 | 18472 | 844 | 24071 | 368 | 21449 |
| 6L-5S | | MI | 4409 | 2227 | 6824 | 1856 | 8412 | 1528 | 9521 | 1242 | 11134 | 764 | 13883 | 320 | 12231 |
| 18-#11 | 3.55 | MA | 7122 | 2227 | 10049 | 1963 | 12883 | 1632 | 14770 | 1351 | 17294 | 863 | 22457 | 324 | 20374 |
| 7L-4S | | MI | 4539 | 2227 | 7125 | 1845 | 8838 | 1511 | 10024 | 1235 | 11829 | 754 | 14797 | 388 | 12592 |
| 18-#11 | 3.55 | MA | 6852 | 2227 | 9437 | 1983 | 12129 | 1649 | 13894 | 1361 | 16120 | 875 | 20898 | 264 | 19272 |
| 8L-3S | | MI | 4661 | 2227 | 7462 | 1833 | 9276 | 1502 | 10584 | 1220 | 12593 | 751 | 15718 | 450 | 12874 |
| 18-#11 | 3.55 | MA | 6508 | 2227 | 8912 | 1997 | 11430 | 1662 | 13002 | 1378 | 14963 | 894 | 19289 | 198 | 18174 |
| 9L-2S | | MI | 4885 | 2227 | 7938 | 1821 | 9878 | 1493 | 11312 | 1213 | 13573 | 741 | 17012 | 565 | 12934 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

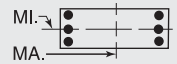
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 5.11 | MA | 7988 | 2592 | 12147 | 2215 | 15454 | 1827 | 17824 | 1488 | 21329 | 876 | 28126 | 140 | 27388 |
| 7L-4S | | MI | 5088 | 2592 | 8625 | 2071 | 10689 | 1677 | 12230 | 1341 | 14777 | 737 | 18471 | 221 | 17246 |
| 18-#14 | 5.11 | MA | 7611 | 2592 | 11272 | 2243 | 14375 | 1852 | 16583 | 1503 | 19647 | 892 | 25888 | 51 | 25678 |
| 8L-3S | | MI | 5231 | 2592 | 9104 | 2056 | 11312 | 1665 | 13026 | 1322 | 15862 | 734 | 19758 | 309 | 18030 |
| 20-#10 | 3.21 | MA | 7370 | 2148 | 10312 | 1900 | 13317 | 1581 | 15332 | 1303 | 18111 | 844 | 23560 | 439 | 20111 |
| 6E | | MI | 4229 | 2148 | 6380 | 1825 | 7904 | 1508 | 8919 | 1239 | 10340 | 779 | 13018 | 343 | 11252 |
| 20-#10 | 3.21 | MA | 7137 | 2148 | 9855 | 1910 | 12716 | 1589 | 14617 | 1321 | 17144 | 860 | 22242 | 404 | 19358 |
| 7L-5S | | MI | 4391 | 2148 | 6623 | 1816 | 8224 | 1499 | 9326 | 1226 | 10902 | 775 | 13773 | 412 | 11472 |
| 20-#10 | 3.21 | MA | 6911 | 2148 | 9352 | 1927 | 12097 | 1604 | 13889 | 1329 | 16180 | 870 | 20966 | 357 | 18597 |
| 8L-4S | | MI | 4506 | 2148 | 6872 | 1806 | 8576 | 1485 | 9743 | 1219 | 11478 | 765 | 14553 | 466 | 11810 |
| 20-#10 | 3.21 | MA | 6628 | 2148 | 8916 | 1938 | 11522 | 1615 | 13156 | 1344 | 15230 | 886 | 19652 | 303 | 17726 |
| 9L-3S | | MI | 4608 | 2148 | 7151 | 1795 | 8940 | 1476 | 10207 | 1207 | 12111 | 761 | 15334 | 519 | 11912 |
| 20-#10 | 3.21 | MA | 6364 | 2148 | 8461 | 1946 | 10959 | 1626 | 12449 | 1353 | 14261 | 895 | 18372 | 262 | 16817 |
| 10L-2S | | MI | 4801 | 2148 | 7548 | 1785 | 9442 | 1468 | 10814 | 1200 | 12928 | 752 | 16438 | 613 | 11955 |
| 20-#11 | 3.94 | MA | 7538 | 2319 | 10927 | 2020 | 13993 | 1674 | 16114 | 1378 | 19102 | 860 | 24961 | 320 | 22918 |
| 7L-5S | | MI | 4604 | 2319 | 7300 | 1913 | 9014 | 1570 | 10250 | 1269 | 12115 | 761 | 15177 | 307 | 13581 |
| 20-#11 | 3.94 | MA | 7272 | 2319 | 10315 | 2040 | 13240 | 1692 | 15237 | 1388 | 17929 | 871 | 23402 | 259 | 21809 |
| 8L-4S | | MI | 4734 | 2319 | 7601 | 1902 | 9440 | 1554 | 10753 | 1261 | 12810 | 751 | 16091 | 375 | 13926 |
| 20-#11 | 3.94 | MA | 6943 | 2319 | 9790 | 2054 | 12540 | 1704 | 14345 | 1405 | 16771 | 890 | 21793 | 193 | 20705 |
| 9L-3S | | MI | 4847 | 2319 | 7938 | 1890 | 9878 | 1544 | 11312 | 1247 | 13573 | 748 | 17012 | 438 | 14249 |
| 20-#14 | 5.68 | MA | 8195 | 2725 | 12526 | 2326 | 15962 | 1913 | 18502 | 1542 | 22231 | 887 | 29466 | 44 | 29285 |
| 8L-4S | | MI | 5354 | 2725 | 9300 | 2154 | 11542 | 1738 | 13263 | 1380 | 16167 | 732 | 20272 | 199 | 19151 |
| 22-#10 | 3.53 | MA | 7481 | 2223 | 10579 | 1957 | 13632 | 1624 | 15724 | 1343 | 18635 | 857 | 24307 | 400 | 21457 |
| 7L-6S | | MI | 4412 | 2223 | 6777 | 1872 | 8406 | 1542 | 9526 | 1261 | 11157 | 776 | 14122 | 336 | 12363 |
| 22-#10 | 3.53 | MA | 7257 | 2223 | 10076 | 1973 | 13012 | 1639 | 14996 | 1351 | 17671 | 867 | 23030 | 353 | 20691 |
| 8L-5S | | MI | 4556 | 2223 | 7020 | 1863 | 8726 | 1533 | 9933 | 1248 | 11719 | 772 | 14877 | 404 | 12598 |
| 22-#10 | 3.53 | MA | 6985 | 2223 | 9640 | 1985 | 12438 | 1649 | 14263 | 1365 | 16720 | 883 | 21716 | 299 | 19822 |
| 9L-4S | | MI | 4670 | 2223 | 7269 | 1852 | 9078 | 1519 | 10349 | 1241 | 12295 | 763 | 15656 | 459 | 12924 |
| 22-#10 | 3.53 | MA | 6732 | 2223 | 9185 | 1993 | 11874 | 1660 | 13557 | 1375 | 15752 | 892 | 20436 | 258 | 18909 |
| 10L-3S | | MI | 4766 | 2223 | 7548 | 1842 | 9442 | 1511 | 10814 | 1229 | 12928 | 759 | 16438 | 512 | 13061 |
| 22-#11 | 4.33 | MA | 7682 | 2410 | 11193 | 2098 | 14350 | 1734 | 16580 | 1415 | 19737 | 868 | 25906 | 255 | 24346 |
| 8L-5S | | MI | 4796 | 2410 | 7776 | 1971 | 9616 | 1612 | 10978 | 1296 | 13096 | 757 | 16470 | 295 | 14934 |
| 22-#11 | 4.33 | MA | 7367 | 2410 | 10667 | 2111 | 13651 | 1746 | 15688 | 1432 | 18579 | 887 | 24297 | 188 | 23237 |
| 9L-4S | | MI | 4925 | 2410 | 8078 | 1959 | 10042 | 1596 | 11481 | 1288 | 13791 | 747 | 17384 | 363 | 15265 |
| 24-#10 | 3.85 | MA | 7596 | 2297 | 10800 | 2020 | 13928 | 1673 | 16104 | 1373 | 19162 | 865 | 25095 | 349 | 22784 |
| 8L-6S | | MI | 4580 | 2297 | 7174 | 1919 | 8908 | 1576 | 10133 | 1283 | 11974 | 773 | 15225 | 329 | 13478 |
| 24-#10 | 3.85 | MA | 7334 | 2297 | 10363 | 2031 | 13353 | 1684 | 15371 | 1387 | 18211 | 881 | 23781 | 295 | 21917 |
| 9L-5S | | MI | 4718 | 2297 | 7416 | 1909 | 9227 | 1568 | 10540 | 1270 | 12536 | 769 | 15981 | 397 | 13727 |
| 24-#10 | 3.85 | MA | 7091 | 2297 | 9909 | 2040 | 12790 | 1695 | 14664 | 1397 | 17242 | 890 | 22501 | 254 | 21000 |
| 10L-4S | | MI | 4831 | 2297 | 7666 | 1899 | 9580 | 1554 | 10956 | 1263 | 13112 | 760 | 16760 | 452 | 14041 |
| 24-#11 | 4.73 | MA | 7781 | 2502 | 11545 | 2169 | 14761 | 1788 | 17032 | 1459 | 20388 | 883 | 26801 | 183 | 25769 |
| 9L-5S | | MI | 4985 | 2502 | 8252 | 2028 | 10218 | 1654 | 11707 | 1323 | 14076 | 754 | 17764 | 282 | 16289 |

## RECTANGULAR TIED COLUMNS 22" x 38"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.08 | MA | 7007 | 1743 | 8572 | 1618 | 11136 | 1361 | 12616 | 1158 | 14243 | 850 | 17734 | 741 | 8123 |
| 2E | | MI | 3871 | 1743 | 5260 | 1533 | 6439 | 1288 | 7095 | 1094 | 7783 | 799 | 9245 | 666 | 4415 |
| 4-#18 | 1.91 | MA | 7892 | 1949 | 10695 | 1735 | 13726 | 1446 | 15698 | 1210 | 18347 | 835 | 23383 | 724 | 14024 |
| 2E | | MI | 4245 | 1949 | 6331 | 1641 | 7710 | 1365 | 8589 | 1140 | 9758 | 780 | 11549 | 592 | 7370 |
| 6-#11 | 1.12 | MA | 7082 | 1754 | 8640 | 1631 | 11270 | 1371 | 12803 | 1166 | 14518 | 853 | 18132 | 743 | 8481 |
| 2L-3S | | MI | 3614 | 1754 | 4808 | 1561 | 5910 | 1311 | 6478 | 1112 | 6972 | 815 | 8255 | 563 | 4618 |
| 6-#11 | 1.12 | MA | 6467 | 1754 | 7704 | 1648 | 10087 | 1387 | 11372 | 1180 | 12591 | 872 | 15465 | 641 | 8446 |
| 3L-2S | | MI | 3915 | 1754 | 5284 | 1550 | 6512 | 1301 | 7206 | 1105 | 7953 | 805 | 9548 | 678 | 4606 |
| 6-#14 | 1.61 | MA | 7633 | 1875 | 9909 | 1701 | 12828 | 1422 | 14662 | 1197 | 16998 | 845 | 21548 | 734 | 12037 |
| 2L-3S | | MI | 3750 | 1875 | 5260 | 1631 | 6439 | 1361 | 7095 | 1142 | 7783 | 807 | 9245 | 479 | 6396 |
| 6-#14 | 1.61 | MA | 6803 | 1875 | 8572 | 1725 | 11136 | 1444 | 12616 | 1218 | 14243 | 872 | 17734 | 585 | 11918 |
| 3L-2S | | MI | 4157 | 1875 | 5935 | 1616 | 7292 | 1349 | 8127 | 1133 | 9174 | 794 | 11047 | 644 | 6413 |

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

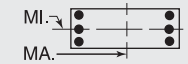



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#18 | 2.87 | MA | 8889 | 2184 | 13030 | 1883 | 16681 | 1554 | 19272 | 1279 | 23159 | 826 | 30045 | 712 | 20837 |
| 2L-3S | | MI | 4079 | 2184 | 6331 | 1812 | 7710 | 1491 | 8589 | 1220 | 9758 | 786 | 11549 | 245 | 10550 |
| 6-#18 | 2.87 | MA | 7607 | 2184 | 10695 | 1924 | 13726 | 1591 | 15698 | 1313 | 18347 | 871 | 23383 | 440 | 20317 |
| 3L-2S | | MI | 4687 | 2184 | 7489 | 1789 | 9175 | 1473 | 10362 | 1209 | 12144 | 771 | 14528 | 539 | 10754 |
| 8-#10 | 1.22 | MA | 7234 | 1777 | 8827 | 1654 | 11573 | 1388 | 13205 | 1178 | 15093 | 857 | 18953 | 746 | 9255 |
| 2L-4S | | MI | 3601 | 1777 | 4691 | 1599 | 5811 | 1341 | 6365 | 1142 | 6839 | 825 | 8231 | 547 | 5005 |
| 8-#10 | 1.22 | MA | 6734 | 1777 | 8056 | 1668 | 10599 | 1402 | 12026 | 1191 | 13506 | 873 | 16755 | 665 | 9225 |
| 3E | | MI | 3752 | 1777 | 4970 | 1588 | 6175 | 1333 | 6829 | 1129 | 7472 | 822 | 9013 | 600 | 5024 |
| 8-#10 | 1.22 | MA | 6444 | 1777 | 7530 | 1682 | 9911 | 1415 | 11145 | 1209 | 12301 | 884 | 15295 | 614 | 9107 |
| 4L-2S | | MI | 4001 | 1777 | 5366 | 1578 | 6677 | 1324 | 7436 | 1122 | 8290 | 812 | 10117 | 694 | 5019 |
| 8-#11 | 1.49 | MA | 7525 | 1845 | 9575 | 1688 | 12453 | 1413 | 14233 | 1193 | 16445 | 849 | 20800 | 738 | 11219 |
| 2L-4S | | MI | 3655 | 1845 | 4948 | 1630 | 6074 | 1362 | 6647 | 1154 | 7189 | 814 | 8627 | 488 | 5964 |
| 8-#11 | 1.49 | MA | 6940 | 1845 | 8640 | 1705 | 11270 | 1429 | 12803 | 1207 | 14518 | 869 | 18132 | 637 | 11163 |
| 3E | | MI | 3831 | 1845 | 5284 | 1618 | 6512 | 1353 | 7206 | 1139 | 7953 | 811 | 9548 | 550 | 6010 |
| 8-#11 | 1.49 | MA | 6602 | 1845 | 7999 | 1723 | 10432 | 1445 | 11731 | 1229 | 13052 | 881 | 16347 | 573 | 10959 |
| 4L-2S | | MI | 4120 | 1845 | 5760 | 1607 | 7115 | 1344 | 7934 | 1132 | 8933 | 801 | 10842 | 665 | 6014 |
| 8-#14 | 2.15 | MA | 8229 | 2008 | 11247 | 1784 | 14519 | 1483 | 16708 | 1236 | 19752 | 840 | 25362 | 727 | 15943 |
| 2L-4S | | MI | 3814 | 2008 | 5456 | 1730 | 6669 | 1434 | 7332 | 1200 | 8088 | 804 | 9759 | 369 | 7959 |
| 8-#14 | 2.15 | MA | 7454 | 2008 | 9909 | 1808 | 12828 | 1505 | 14662 | 1257 | 16998 | 867 | 21548 | 578 | 15794 |
| 3E | | MI | 4048 | 2008 | 5935 | 1714 | 7292 | 1422 | 8127 | 1181 | 9174 | 802 | 11047 | 457 | 8346 |
| 8-#14 | 2.15 | MA | 7007 | 2008 | 8992 | 1832 | 11628 | 1527 | 13127 | 1287 | 14899 | 884 | 18980 | 486 | 15058 |
| 4L-2S | | MI | 4433 | 2008 | 6610 | 1698 | 8146 | 1410 | 9160 | 1172 | 10564 | 789 | 12849 | 622 | 8393 |
| 8-#18 | 3.83 | MA | 8674 | 2420 | 13030 | 2071 | 16681 | 1699 | 19272 | 1382 | 23159 | 862 | 30045 | 428 | 27098 |
| 3E | | MI | 4560 | 2420 | 7489 | 1960 | 9175 | 1599 | 10362 | 1289 | 12144 | 778 | 14528 | 192 | 13855 |
| 8-#18 | 3.83 | MA | 8009 | 2420 | 11421 | 2112 | 14577 | 1737 | 16582 | 1434 | 19481 | 889 | 25508 | 261 | 23675 |
| 4L-2S | | MI | 5113 | 2420 | 8647 | 1936 | 10640 | 1582 | 12134 | 1278 | 14531 | 762 | 17508 | 485 | 14118 |
| 10-#10 | 1.52 | MA | 7599 | 1852 | 9597 | 1700 | 12548 | 1423 | 14384 | 1200 | 16680 | 854 | 21150 | 742 | 11510 |
| 2L-5S | | MI | 3667 | 1852 | 4839 | 1656 | 5961 | 1390 | 6555 | 1171 | 7080 | 832 | 8556 | 485 | 5959 |
| 10-#10 | 1.52 | MA | 7120 | 1852 | 8827 | 1715 | 11573 | 1436 | 13205 | 1213 | 15093 | 871 | 18953 | 661 | 11467 |
| 3L-4S | | MI | 3790 | 1852 | 5088 | 1645 | 6313 | 1376 | 6971 | 1164 | 7656 | 823 | 9335 | 540 | 6151 |
| 10-#10 | 1.52 | MA | 6850 | 1852 | 8301 | 1729 | 10885 | 1450 | 12324 | 1231 | 13888 | 881 | 17493 | 610 | 11340 |
| 4L-3S | | MI | 3933 | 1852 | 5366 | 1635 | 6677 | 1367 | 7436 | 1151 | 8290 | 819 | 10117 | 593 | 6183 |
| 10-#10 | 1.52 | MA | 6546 | 1852 | 7827 | 1742 | 10223 | 1469 | 11541 | 1244 | 12802 | 898 | 15939 | 562 | 10882 |
| 5L-2S | | MI | 4173 | 1852 | 5763 | 1625 | 7178 | 1358 | 8042 | 1144 | 9107 | 809 | 11220 | 687 | 6188 |
| 10-#11 | 1.87 | MA | 7952 | 1937 | 10510 | 1746 | 13636 | 1455 | 15664 | 1219 | 18371 | 846 | 23468 | 734 | 13952 |
| 2L-5S | | MI | 3732 | 1937 | 5123 | 1699 | 6250 | 1421 | 6872 | 1188 | 7475 | 821 | 9007 | 407 | 6953 |
| 10-#11 | 1.87 | MA | 7395 | 1937 | 9575 | 1763 | 12453 | 1471 | 14233 | 1234 | 16445 | 865 | 20800 | 632 | 13881 |
| 3L-4S | | MI | 3876 | 1937 | 5424 | 1687 | 6676 | 1405 | 7375 | 1181 | 8170 | 811 | 9921 | 475 | 7330 |
| 10-#11 | 1.87 | MA | 7082 | 1937 | 8935 | 1780 | 11616 | 1487 | 13162 | 1256 | 14979 | 878 | 19014 | 568 | 13668 |
| 4L-3S | | MI | 4042 | 1937 | 5760 | 1676 | 7115 | 1395 | 7934 | 1166 | 8933 | 808 | 10842 | 538 | 7395 |
| 10-#11 | 1.87 | MA | 6725 | 1937 | 8364 | 1797 | 10809 | 1510 | 12208 | 1271 | 13657 | 897 | 17118 | 507 | 12837 |
| 5L-2S | | MI | 4319 | 1937 | 6236 | 1664 | 7717 | 1386 | 8663 | 1159 | 9914 | 798 | 12136 | 653 | 7412 |
| 10-#14 | 2.69 | MA | 8075 | 2140 | 11247 | 1891 | 14519 | 1566 | 16708 | 1295 | 19752 | 862 | 25362 | 571 | 19674 |
| 3L-4S | | MI | 4119 | 2140 | 6131 | 1812 | 7522 | 1495 | 8364 | 1239 | 9478 | 799 | 11561 | 347 | 9809 |
| 10-#14 | 2.69 | MA | 7672 | 2140 | 10329 | 1915 | 13320 | 1588 | 15173 | 1326 | 17653 | 879 | 22794 | 479 | 18905 |
| 4L-3S | | MI | 4343 | 2140 | 6610 | 1797 | 8146 | 1483 | 9160 | 1220 | 10564 | 797 | 12849 | 435 | 10292 |
| 10-#14 | 2.69 | MA | 7175 | 2140 | 9517 | 1939 | 12163 | 1621 | 13806 | 1347 | 15759 | 906 | 20073 | 389 | 17385 |
| 5L-2S | | MI | 4695 | 2140 | 7285 | 1781 | 9000 | 1470 | 10193 | 1211 | 11955 | 784 | 14650 | 600 | 10361 |
| 10-#18 | 4.78 | MA | 9116 | 2655 | 13757 | 2259 | 17532 | 1845 | 20155 | 1503 | 24293 | 881 | 32170 | 249 | 30426 |
| 4L-3S | | MI | 5020 | 2655 | 8647 | 2107 | 10640 | 1707 | 12134 | 1358 | 14531 | 769 | 17508 | 138 | 17017 |
| 10-#18 | 4.78 | MA | 8286 | 2655 | 12329 | 2300 | 15501 | 1900 | 17756 | 1537 | 20968 | 925 | 27382 | 80 | 27091 |
| 5L-2S | | MI | 5529 | 2655 | 9806 | 2083 | 12106 | 1690 | 13906 | 1347 | 16917 | 753 | 20487 | 432 | 17473 |
| 12-#10 | 1.82 | MA | 7954 | 1927 | 10367 | 1747 | 13523 | 1457 | 15563 | 1222 | 18267 | 851 | 23348 | 738 | 13761 |
| 2L-6S | | MI | 3679 | 1927 | 4993 | 1711 | 6143 | 1433 | 6755 | 1206 | 7335 | 833 | 8904 | 410 | 6835 |
| 12-#10 | 1.82 | MA | 7494 | 1927 | 9597 | 1761 | 12548 | 1471 | 14384 | 1235 | 16680 | 868 | 21150 | 657 | 13709 |
| 3L-5S | | MI | 3855 | 1927 | 5235 | 1702 | 6462 | 1424 | 7162 | 1193 | 7897 | 829 | 9659 | 478 | 7063 |
| 12-#10 | 1.82 | MA | 7241 | 1927 | 9071 | 1776 | 11860 | 1484 | 13503 | 1253 | 15475 | 879 | 19691 | 606 | 13575 |
| 4E | | MI | 3974 | 1927 | 5484 | 1692 | 6815 | 1410 | 7578 | 1186 | 8473 | 820 | 10438 | 533 | 7295 |

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis



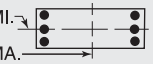

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 12-#10 | 1.82 | MA | 6943 | 1927 | 8598 | 1789 | 11198 | 1503 | 12720 | 1266 | 14389 | 895 | 18137 | 558 | 13102 |
| 5L-3S | | MI | 4110 | 1927 | 5763 | 1682 | 7178 | 1401 | 8042 | 1173 | 9107 | 816 | 11220 | 586 | 7337 |
| 12-#10 | 1.82 | MA | 6600 | 1927 | 8090 | 1797 | 10587 | 1515 | 11976 | 1279 | 13332 | 906 | 16784 | 502 | 12487 |
| 6L-2S | | MI | 4342 | 1927 | 6160 | 1672 | 7680 | 1393 | 8649 | 1166 | 9924 | 807 | 12324 | 679 | 7351 |
| 12-#11 | 2.24 | MA | 7834 | 2029 | 10510 | 1820 | 13636 | 1513 | 15664 | 1261 | 18371 | 862 | 23468 | 627 | 16599 |
| 3L-5S | | MI | 3956 | 2029 | 5599 | 1756 | 6853 | 1463 | 7600 | 1215 | 8456 | 817 | 10301 | 395 | 8280 |
| 12-#11 | 2.24 | MA | 7544 | 2029 | 9870 | 1837 | 12799 | 1529 | 14593 | 1283 | 16906 | 874 | 21682 | 564 | 16380 |
| 4E | | MI | 4091 | 2029 | 5900 | 1745 | 7279 | 1447 | 8103 | 1207 | 9151 | 807 | 11214 | 463 | 8696 |
| 12-#11 | 2.24 | MA | 7193 | 2029 | 9299 | 1854 | 11992 | 1552 | 13639 | 1298 | 15583 | 894 | 19786 | 503 | 15537 |
| 5L-3S | | MI | 4247 | 2029 | 6236 | 1733 | 7717 | 1437 | 8663 | 1193 | 9914 | 804 | 12136 | 525 | 8775 |
| 12-#11 | 2.24 | MA | 6791 | 2029 | 8682 | 1863 | 11257 | 1567 | 12732 | 1313 | 14296 | 906 | 18135 | 431 | 14804 |
| 6L-2S | | MI | 4515 | 2029 | 6712 | 1722 | 8319 | 1428 | 9391 | 1186 | 10895 | 794 | 13429 | 640 | 8804 |
| 12-#14 | 3.23 | MA | 8308 | 2273 | 11666 | 1998 | 15011 | 1649 | 17219 | 1365 | 20408 | 874 | 26609 | 472 | 22760 |
| 4E | | MI | 4427 | 2273 | 6806 | 1895 | 8376 | 1556 | 9397 | 1278 | 10869 | 794 | 13363 | 325 | 11673 |
| 12-#14 | 3.23 | MA | 7821 | 2273 | 10854 | 2022 | 13855 | 1681 | 15851 | 1386 | 18513 | 901 | 23888 | 382 | 21266 |
| 5L-3S | | MI | 4619 | 2273 | 7285 | 1880 | 9000 | 1544 | 10193 | 1259 | 11955 | 792 | 14650 | 412 | 12236 |
| 12-#14 | 3.23 | MA | 7283 | 2273 | 9971 | 2035 | 12811 | 1704 | 14519 | 1416 | 16668 | 918 | 21518 | 276 | 19586 |
| 6L-2S | | MI | 4952 | 2273 | 7960 | 1864 | 9854 | 1531 | 11225 | 1250 | 13345 | 779 | 16452 | 578 | 12324 |
| 12-#18 | 5.74 | MA | 9358 | 2891 | 14664 | 2447 | 18456 | 2009 | 21329 | 1606 | 25780 | 916 | 34044 | 68 | 33810 |
| 5L-3S | | MI | 5468 | 2891 | 9806 | 2254 | 12106 | 1815 | 13906 | 1428 | 16917 | 760 | 20487 | 85 | 20166 |
| 12-#18 | 5.74 | MA | 8531 | 2891 | 13143 | 2471 | 16623 | 2046 | 18990 | 1658 | 22540 | 944 | 29859 | -124 | 29302 |
| 6L-2S | | MI | 5939 | 2891 | 10964 | 2230 | 13571 | 1798 | 15679 | 1417 | 19303 | 744 | 23467 | 378 | 20825 |
| 14-#10 | 2.13 | MA | 7857 | 2001 | 10367 | 1808 | 13523 | 1505 | 15563 | 1257 | 18267 | 865 | 23348 | 653 | 15952 |
| 3L-6S | | MI | 3866 | 2001 | 5389 | 1758 | 6644 | 1467 | 7362 | 1228 | 8152 | 830 | 10007 | 403 | 7956 |
| 14-#10 | 2.13 | MA | 7619 | 2001 | 9842 | 1823 | 12835 | 1518 | 14682 | 1275 | 17062 | 876 | 21888 | 602 | 15812 |
| 4L-5S | | MI | 4036 | 2001 | 5632 | 1749 | 6964 | 1459 | 7769 | 1215 | 8715 | 827 | 10763 | 471 | 8174 |
| 14-#10 | 2.13 | MA | 7326 | 2001 | 9368 | 1836 | 12172 | 1538 | 13899 | 1288 | 15976 | 892 | 20334 | 554 | 15325 |
| 5L-4S | | MI | 4154 | 2001 | 5881 | 1739 | 7317 | 1444 | 8185 | 1208 | 9290 | 817 | 11542 | 526 | 8438 |
| 14-#10 | 2.13 | MA | 6997 | 2001 | 8860 | 1844 | 11562 | 1550 | 13155 | 1301 | 14919 | 903 | 18982 | 498 | 14729 |
| 6L-3S | | MI | 4283 | 2001 | 6160 | 1729 | 7680 | 1436 | 8649 | 1195 | 9924 | 813 | 12324 | 579 | 8490 |
| 14-#10 | 2.13 | MA | 6708 | 2001 | 8375 | 1854 | 10924 | 1558 | 12388 | 1318 | 13892 | 920 | 17589 | 463 | 13993 |
| 7L-2S | | MI | 4507 | 2001 | 6556 | 1718 | 8182 | 1427 | 9256 | 1188 | 10741 | 804 | 13427 | 672 | 8511 |
| 14-#11 | 2.61 | MA | 7991 | 2121 | 10805 | 1895 | 13982 | 1571 | 16024 | 1310 | 18832 | 871 | 24349 | 559 | 19096 |
| 4L-5S | | MI | 4167 | 2121 | 6075 | 1814 | 7455 | 1505 | 8329 | 1242 | 9436 | 814 | 11594 | 382 | 9615 |
| 14-#11 | 2.61 | MA | 7645 | 2121 | 10234 | 1911 | 13175 | 1594 | 15070 | 1325 | 17510 | 890 | 22453 | 498 | 18242 |
| 5L-4S | | MI | 4300 | 2121 | 6376 | 1802 | 7881 | 1489 | 8832 | 1234 | 10131 | 804 | 12508 | 450 | 10019 |
| 14-#11 | 2.61 | MA | 7262 | 2121 | 9617 | 1920 | 12440 | 1610 | 14163 | 1340 | 16222 | 903 | 20803 | 426 | 17523 |
| 6L-3S | | MI | 4454 | 2121 | 6712 | 1791 | 8319 | 1479 | 9391 | 1220 | 10895 | 801 | 13429 | 513 | 10153 |
| 14-#11 | 2.61 | MA | 6924 | 2121 | 9026 | 1932 | 11664 | 1619 | 13242 | 1361 | 14971 | 922 | 19096 | 383 | 16384 |
| 7L-2S | | MI | 4702 | 2121 | 7189 | 1779 | 8921 | 1470 | 10120 | 1213 | 11876 | 791 | 14723 | 627 | 10192 |
| 14-#14 | 3.77 | MA | 8442 | 2405 | 12191 | 2105 | 15546 | 1742 | 17897 | 1425 | 21268 | 896 | 27702 | 375 | 25146 |
| 5L-4S | | MI | 4712 | 2405 | 7481 | 1978 | 9230 | 1617 | 10430 | 1317 | 12259 | 789 | 15164 | 303 | 13550 |
| 14-#14 | 3.77 | MA | 7937 | 2405 | 11308 | 2117 | 14503 | 1765 | 16565 | 1455 | 19422 | 913 | 25332 | 269 | 23451 |
| 6L-3S | | MI | 4888 | 2405 | 7960 | 1962 | 9854 | 1604 | 11225 | 1298 | 13345 | 787 | 16452 | 390 | 14180 |
| 14-#14 | 3.77 | MA | 7490 | 2405 | 10462 | 2134 | 13392 | 1778 | 15278 | 1476 | 17629 | 940 | 22874 | 206 | 21709 |
| 7L-2S | | MI | 5203 | 2405 | 8634 | 1947 | 10708 | 1592 | 12258 | 1289 | 14735 | 774 | 18254 | 556 | 14284 |
| 14-#18 | 6.70 | MA | 9694 | 3126 | 15479 | 2618 | 19577 | 2154 | 22564 | 1727 | 27352 | 935 | 36521 | -136 | 35678 |
| 6L-3S | | MI | 5907 | 3126 | 10964 | 2401 | 13571 | 1924 | 15679 | 1497 | 19303 | 751 | 23467 | 31 | 23341 |
| 16-#10 | 2.43 | MA | 7988 | 2076 | 10612 | 1869 | 13809 | 1553 | 15861 | 1297 | 18650 | 873 | 24086 | 598 | 18051 |
| 4L-6S | | MI | 4048 | 2076 | 5786 | 1805 | 7146 | 1502 | 7969 | 1250 | 8969 | 828 | 11111 | 396 | 9080 |
| 16-#10 | 2.43 | MA | 7698 | 2076 | 10139 | 1883 | 13147 | 1572 | 15078 | 1310 | 17564 | 890 | 22532 | 550 | 17551 |
| 5E | | MI | 4213 | 2076 | 6029 | 1796 | 7466 | 1493 | 8376 | 1237 | 9532 | 824 | 11866 | 464 | 9289 |
| 16-#10 | 2.43 | MA | 7383 | 2076 | 9631 | 1890 | 12537 | 1584 | 14334 | 1323 | 16506 | 900 | 21179 | 494 | 16972 |
| 6L-4S | | MI | 4329 | 2076 | 6278 | 1786 | 7819 | 1479 | 8792 | 1230 | 10108 | 814 | 12646 | 519 | 9581 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis



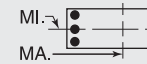

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.43 | MA | 7107 | 2076 | 9145 | 1900 | 11898 | 1592 | 13567 | 1340 | 15479 | 917 | 19786 | 459 | 16228 |
| 7L-3S | | MI | 4452 | 2076 | 6556 | 1775 | 8182 | 1470 | 9256 | 1217 | 10741 | 810 | 13427 | 572 | 9640 |
| 16-#10 | 2.43 | MA | 6853 | 2076 | 8611 | 1917 | 11240 | 1608 | 12794 | 1348 | 14456 | 928 | 18433 | 413 | 15462 |
| 8L-2S | | MI | 4670 | 2076 | 6953 | 1765 | 8684 | 1461 | 9863 | 1210 | 11558 | 801 | 14531 | 665 | 9668 |
| 16-#11 | 2.99 | MA | 8084 | 2213 | 11170 | 1969 | 14358 | 1636 | 16501 | 1352 | 19436 | 887 | 25121 | 493 | 20949 |
| 5E | | MI | 4383 | 2213 | 6551 | 1871 | 8057 | 1547 | 9057 | 1269 | 10417 | 810 | 12888 | 370 | 10954 |
| 16-#11 | 2.99 | MA | 7718 | 2213 | 10552 | 1978 | 13623 | 1652 | 15594 | 1367 | 18149 | 900 | 23470 | 422 | 20242 |
| 6L-4S | | MI | 4515 | 2213 | 6852 | 1860 | 8483 | 1531 | 9560 | 1261 | 11112 | 801 | 13802 | 438 | 11340 |
| 16-#11 | 2.99 | MA | 7398 | 2213 | 9961 | 1990 | 12847 | 1661 | 14673 | 1388 | 16898 | 919 | 21763 | 378 | 19094 |
| 7L-3S | | MI | 4648 | 2213 | 7189 | 1848 | 8921 | 1522 | 10120 | 1247 | 11876 | 798 | 14723 | 500 | 11530 |
| 16-#11 | 2.99 | MA | 7099 | 2213 | 9311 | 2010 | 12046 | 1680 | 13732 | 1398 | 15651 | 931 | 20111 | 319 | 17981 |
| 8L-2S | | MI | 4886 | 2213 | 7665 | 1836 | 9524 | 1512 | 10848 | 1240 | 12856 | 788 | 16016 | 615 | 11578 |
| 16-#14 | 4.31 | MA | 8567 | 2538 | 12645 | 2200 | 16194 | 1826 | 18611 | 1494 | 22177 | 908 | 29146 | 263 | 27317 |
| 6L-4S | | MI | 4990 | 2538 | 8156 | 2061 | 10084 | 1678 | 11462 | 1356 | 13650 | 784 | 16966 | 281 | 15437 |
| 16-#14 | 4.31 | MA | 8151 | 2538 | 11799 | 2217 | 15083 | 1839 | 17324 | 1515 | 20383 | 935 | 26688 | 199 | 25563 |
| 7L-3S | | MI | 5151 | 2538 | 8634 | 2045 | 10708 | 1665 | 12258 | 1337 | 14735 | 782 | 18254 | 368 | 16124 |
| 16-#14 | 4.31 | MA | 7733 | 2538 | 10868 | 2245 | 13936 | 1865 | 15988 | 1529 | 18596 | 953 | 24315 | 112 | 23792 |
| 8L-2S | | MI | 5451 | 2538 | 9309 | 2029 | 11561 | 1653 | 13291 | 1328 | 16126 | 769 | 20055 | 534 | 16242 |
| 18-#10 | 2.73 | MA | 8061 | 2151 | 10909 | 1929 | 14122 | 1606 | 16256 | 1332 | 19151 | 887 | 24730 | 546 | 19779 |
| 5L-6S | | MI | 4227 | 2151 | 6183 | 1852 | 7648 | 1536 | 8576 | 1272 | 9787 | 825 | 12215 | 388 | 10206 |
| 18-#10 | 2.73 | MA | 7758 | 2151 | 10401 | 1937 | 13511 | 1618 | 15512 | 1344 | 18094 | 898 | 23377 | 490 | 19216 |
| 6L-5S | | MI | 4386 | 2151 | 6425 | 1842 | 7968 | 1527 | 8983 | 1259 | 10349 | 821 | 12970 | 457 | 10408 |
| 18-#10 | 2.73 | MA | 7495 | 2151 | 9916 | 1947 | 12873 | 1627 | 14746 | 1362 | 17066 | 914 | 21984 | 455 | 18463 |
| 7L-4S | | MI | 4502 | 2151 | 6675 | 1832 | 8320 | 1513 | 9399 | 1252 | 10925 | 811 | 13749 | 512 | 10724 |
| 18-#10 | 2.73 | MA | 7246 | 2151 | 9381 | 1964 | 12215 | 1642 | 13973 | 1370 | 16043 | 925 | 20631 | 409 | 17699 |
| 8L-3S | | MI | 4625 | 2151 | 6953 | 1822 | 8684 | 1504 | 9863 | 1239 | 11558 | 808 | 14531 | 565 | 10790 |
| 18-#10 | 2.73 | MA | 6930 | 2151 | 8914 | 1975 | 11604 | 1653 | 13194 | 1385 | 15034 | 942 | 19242 | 356 | 16759 |
| 9L-2S | | MI | 4828 | 2151 | 7350 | 1812 | 9186 | 1496 | 10470 | 1232 | 12376 | 798 | 15634 | 658 | 10824 |
| 18-#11 | 3.36 | MA | 8161 | 2304 | 11487 | 2035 | 14806 | 1694 | 17025 | 1394 | 20076 | 896 | 26138 | 417 | 22961 |
| 6L-5S | | MI | 4583 | 2304 | 7027 | 1929 | 8659 | 1590 | 9786 | 1296 | 11398 | 807 | 14182 | 357 | 12299 |
| 18-#11 | 3.36 | MA | 7858 | 2304 | 10897 | 2047 | 14030 | 1704 | 16104 | 1415 | 18824 | 915 | 24431 | 373 | 21805 |
| 7L-4S | | MI | 4714 | 2304 | 7328 | 1917 | 9085 | 1573 | 10289 | 1288 | 12093 | 797 | 15095 | 425 | 12667 |
| 18-#11 | 3.36 | MA | 7565 | 2304 | 10247 | 2067 | 13229 | 1722 | 15163 | 1425 | 17578 | 928 | 22778 | 315 | 20685 |
| 8L-3S | | MI | 4838 | 2304 | 7665 | 1905 | 9524 | 1564 | 10848 | 1274 | 12856 | 794 | 16016 | 488 | 12906 |
| 18-#11 | 3.36 | MA | 7195 | 2304 | 9684 | 2081 | 12486 | 1735 | 14215 | 1443 | 16348 | 947 | 21076 | 249 | 19568 |
| 9L-2S | | MI | 5067 | 2304 | 8141 | 1894 | 10126 | 1554 | 11576 | 1267 | 13837 | 784 | 17310 | 602 | 12961 |
| 18-#14 | 4.84 | MA | 8790 | 2670 | 13137 | 2299 | 16775 | 1900 | 19369 | 1554 | 23138 | 930 | 30502 | 192 | 29417 |
| 7L-4S | | MI | 5262 | 2670 | 8831 | 2143 | 10938 | 1738 | 12495 | 1395 | 15040 | 780 | 18768 | 259 | 17332 |
| 18-#14 | 4.84 | MA | 8379 | 2670 | 12205 | 2328 | 15627 | 1926 | 18034 | 1568 | 21351 | 948 | 28129 | 105 | 27653 |
| 8L-3S | | MI | 5410 | 2670 | 9309 | 2128 | 11561 | 1726 | 13291 | 1376 | 16126 | 777 | 20055 | 346 | 18070 |
| 20-#10 | 3.04 | MA | 8124 | 2226 | 11171 | 1984 | 14486 | 1653 | 16691 | 1366 | 19681 | 895 | 25575 | 486 | 21461 |
| 6E | | MI | 4402 | 2226 | 6579 | 1898 | 8150 | 1570 | 9183 | 1294 | 10604 | 822 | 13318 | 381 | 11336 |
| 20-#10 | 3.04 | MA | 7873 | 2226 | 10686 | 1994 | 13848 | 1661 | 15925 | 1384 | 18654 | 911 | 24182 | 451 | 20697 |
| 7L-5S | | MI | 4556 | 2226 | 6822 | 1889 | 8470 | 1562 | 9590 | 1281 | 11166 | 818 | 14074 | 450 | 11530 |
| 20-#10 | 3.04 | MA | 7627 | 2226 | 10152 | 2011 | 13189 | 1676 | 15151 | 1392 | 17630 | 922 | 22829 | 405 | 19935 |
| 8L-4S | | MI | 4681 | 2226 | 7071 | 1879 | 8822 | 1547 | 10006 | 1274 | 11742 | 809 | 14853 | 504 | 11868 |
| 20-#10 | 3.04 | MA | 7323 | 2226 | 9685 | 2022 | 12579 | 1687 | 14373 | 1407 | 16621 | 939 | 21439 | 352 | 18991 |
| 9L-3S | | MI | 4787 | 2226 | 7350 | 1869 | 9186 | 1539 | 10470 | 1261 | 12376 | 805 | 15634 | 557 | 11939 |
| 20-#10 | 3.04 | MA | 7039 | 2226 | 9201 | 2030 | 11981 | 1699 | 13622 | 1417 | 15580 | 947 | 20083 | 312 | 18066 |
| 10L-2S | | MI | 4983 | 2226 | 7746 | 1858 | 9687 | 1530 | 11077 | 1254 | 13193 | 795 | 16738 | 651 | 11978 |
| 20-#11 | 3.73 | MA | 8306 | 2396 | 11832 | 2104 | 15213 | 1746 | 17535 | 1442 | 20751 | 912 | 27098 | 369 | 24516 |
| 7L-5S | | MI | 4779 | 2396 | 7503 | 1986 | 9262 | 1632 | 10514 | 1323 | 12379 | 804 | 15475 | 345 | 13647 |
| 20-#11 | 3.73 | MA | 8017 | 2396 | 11182 | 2125 | 14412 | 1764 | 16594 | 1452 | 19504 | 925 | 25446 | 310 | 23388 |
| 8L-4S | | MI | 4909 | 2396 | 7804 | 1974 | 9687 | 1615 | 11017 | 1315 | 13074 | 794 | 16389 | 413 | 13999 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

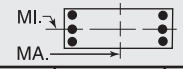
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.73 | MA | 7663 | 2396 | 10619 | 2138 | 13669 | 1777 | 15646 | 1470 | 18274 | 944 | 23744 | 244 | 22265 |
| 9L-3S | | MI | 5025 | 2396 | 8141 | 1963 | 10126 | 1606 | 11576 | 1301 | 13837 | 791 | 17310 | 475 | 14281 |
| 20-#11 | 3.73 | MA | 7332 | 2396 | 10031 | 2149 | 12940 | 1790 | 14732 | 1482 | 17027 | 955 | 22087 | 193 | 21004 |
| 10L-2S | | MI | 5246 | 2396 | 8617 | 1951 | 10728 | 1597 | 12305 | 1294 | 14818 | 781 | 18604 | 590 | 14344 |
| 20-#14 | 5.38 | MA | 9007 | 2802 | 13542 | 2411 | 17319 | 1986 | 20080 | 1607 | 24105 | 943 | 31943 | 98 | 31505 |
| 8L-4S | | MI | 5529 | 2802 | 9506 | 2226 | 11791 | 1799 | 13528 | 1434 | 16430 | 775 | 20569 | 237 | 19234 |
| 22-#10 | 3.34 | MA | 8242 | 2300 | 11456 | 2040 | 14822 | 1695 | 17104 | 1406 | 20241 | 909 | 26379 | 447 | 22932 |
| 7L-6S | | MI | 4586 | 2300 | 6976 | 1945 | 8652 | 1605 | 9790 | 1315 | 11421 | 819 | 14422 | 374 | 12455 |
| 22-#10 | 3.34 | MA | 8000 | 2300 | 10922 | 2057 | 14164 | 1711 | 16330 | 1414 | 19217 | 919 | 25026 | 401 | 22169 |
| 8L-5S | | MI | 4732 | 2300 | 7219 | 1936 | 8971 | 1596 | 10197 | 1303 | 11983 | 815 | 15177 | 442 | 12655 |
| 22-#10 | 3.34 | MA | 7707 | 2300 | 10455 | 2068 | 13554 | 1722 | 15551 | 1429 | 18208 | 936 | 23637 | 348 | 21222 |
| 9L-4S | | MI | 4846 | 2300 | 7468 | 1926 | 9324 | 1582 | 10613 | 1296 | 12559 | 806 | 15956 | 497 | 12989 |
| 22-#10 | 3.34 | MA | 7434 | 2300 | 9972 | 2077 | 12955 | 1733 | 14801 | 1439 | 17168 | 944 | 22281 | 308 | 20293 |
| 10L-3S | | MI | 4946 | 2300 | 7746 | 1915 | 9687 | 1573 | 11077 | 1283 | 13193 | 802 | 16738 | 550 | 13088 |
| 22-#10 | 3.34 | MA | 7176 | 2300 | 9498 | 2087 | 12353 | 1743 | 14062 | 1450 | 16132 | 958 | 20963 | 260 | 19340 |
| 11L-2S | | MI | 5135 | 2300 | 8143 | 1905 | 10189 | 1564 | 11684 | 1276 | 14010 | 793 | 17842 | 643 | 13131 |
| 22-#11 | 4.11 | MA | 8458 | 2488 | 12117 | 2182 | 15595 | 1806 | 18025 | 1479 | 21431 | 921 | 28113 | 305 | 26092 |
| 8L-5S | | MI | 4972 | 2488 | 7979 | 2043 | 9864 | 1674 | 11242 | 1350 | 13359 | 800 | 16769 | 332 | 14998 |
| 22-#11 | 4.11 | MA | 8118 | 2488 | 11554 | 2196 | 14852 | 1819 | 17077 | 1497 | 20201 | 940 | 26411 | 239 | 24963 |
| 9L-4S | | MI | 5101 | 2488 | 8280 | 2032 | 10290 | 1658 | 11745 | 1342 | 14054 | 790 | 17682 | 400 | 15337 |
| 22-#11 | 4.11 | MA | 7803 | 2488 | 10967 | 2206 | 14123 | 1832 | 16163 | 1508 | 18953 | 952 | 24754 | 188 | 23705 |
| 10L-3S | | MI | 5210 | 2488 | 8617 | 2020 | 10728 | 1648 | 12305 | 1328 | 14818 | 787 | 18604 | 463 | 15657 |
| 24-#10 | 3.65 | MA | 8364 | 2375 | 11693 | 2104 | 15139 | 1745 | 17509 | 1436 | 20805 | 917 | 27224 | 398 | 24397 |
| 8L-6S | | MI | 4755 | 2375 | 7373 | 1992 | 9153 | 1639 | 10397 | 1337 | 12238 | 816 | 15525 | 367 | 13567 |
| 24-#10 | 3.65 | MA | 8081 | 2375 | 11226 | 2115 | 14528 | 1756 | 16730 | 1451 | 19795 | 933 | 25835 | 345 | 23453 |
| 9L-5S | | MI | 4895 | 2375 | 7615 | 1983 | 9473 | 1630 | 10804 | 1325 | 12800 | 813 | 16281 | 435 | 13783 |
| 24-#10 | 3.65 | MA | 7820 | 2375 | 10742 | 2124 | 13930 | 1767 | 15980 | 1461 | 18755 | 942 | 24478 | 304 | 22520 |
| 10L-4S | | MI | 5008 | 2375 | 7865 | 1972 | 9826 | 1616 | 11220 | 1318 | 13376 | 803 | 17060 | 490 | 14105 |
| 24-#10 | 3.65 | MA | 7573 | 2375 | 10269 | 2134 | 13328 | 1778 | 15241 | 1472 | 17719 | 956 | 23161 | 256 | 21563 |
| 11L-3S | | MI | 5102 | 2375 | 8143 | 1962 | 10189 | 1607 | 11684 | 1305 | 14010 | 799 | 17842 | 543 | 14236 |
| 24-#11 | 4.48 | MA | 8563 | 2580 | 12489 | 2253 | 16035 | 1861 | 18507 | 1524 | 22128 | 937 | 29079 | 235 | 27660 |
| 9L-5S | | MI | 5162 | 2580 | 8455 | 2101 | 10466 | 1716 | 11971 | 1377 | 14340 | 797 | 18062 | 320 | 16352 |
| 24-#11 | 4.48 | MA | 8262 | 2580 | 11902 | 2263 | 15307 | 1874 | 17594 | 1535 | 20880 | 948 | 27422 | 183 | 26406 |
| 10L-4S | | MI | 5290 | 2580 | 8757 | 2089 | 10892 | 1700 | 12474 | 1369 | 15035 | 787 | 18976 | 388 | 16678 |

## RECTANGULAR TIED COLUMNS 22" x 40"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.02 | MA | 7717 | 1821 | 9304 | 1701 | 12147 | 1431 | 13774 | 1220 | 15533 | 899 | 19325 | 783 | 8609 |
| 2E | | MI | 4044 | 1821 | 5466 | 1605 | 6688 | 1349 | 7359 | 1148 | 8047 | 842 | 9542 | 703 | 4435 |
| 4-#18 | 1.82 | MA | 8675 | 2027 | 11563 | 1818 | 14904 | 1516 | 17056 | 1271 | 19902 | 884 | 25339 | 767 | 14888 |
| 2E | | MI | 4420 | 2027 | 6542 | 1712 | 7961 | 1426 | 8855 | 1193 | 10021 | 822 | 11843 | 629 | 7399 |
| 6-#11 | 1.06 | MA | 7797 | 1831 | 9374 | 1713 | 12287 | 1441 | 13970 | 1227 | 15821 | 902 | 19743 | 786 | 8987 |
| 2L-3S | | MI | 3785 | 1831 | 5011 | 1634 | 6158 | 1373 | 6742 | 1166 | 7236 | 858 | 8553 | 601 | 4639 |
| 6-#11 | 1.06 | MA | 7137 | 1831 | 8381 | 1731 | 11031 | 1458 | 12451 | 1242 | 13776 | 922 | 16912 | 686 | 8951 |
| 3L-2S | | MI | 4089 | 1831 | 5487 | 1622 | 6760 | 1363 | 7470 | 1159 | 8216 | 848 | 9847 | 715 | 4625 |
| 6-#14 | 1.53 | MA | 8391 | 1953 | 10724 | 1784 | 13943 | 1492 | 15947 | 1258 | 18458 | 894 | 23375 | 777 | 12766 |
| 2L-3S | | MI | 3922 | 1953 | 5466 | 1703 | 6688 | 1422 | 7359 | 1196 | 8047 | 849 | 9542 | 516 | 6427 |
| 6-#14 | 1.53 | MA | 7500 | 1953 | 9304 | 1809 | 12147 | 1515 | 13774 | 1280 | 15533 | 922 | 19325 | 630 | 12647 |
| 3L-2S | | MI | 4331 | 1953 | 6141 | 1688 | 7541 | 1410 | 8392 | 1187 | 9437 | 837 | 11344 | 681 | 6437 |
| 6-#18 | 2.73 | MA | 9748 | 2262 | 14046 | 1965 | 18045 | 1624 | 20855 | 1341 | 25017 | 875 | 32421 | 754 | 22133 |
| 2L-3S | | MI | 4250 | 2262 | 6542 | 1883 | 7961 | 1551 | 8855 | 1273 | 10021 | 828 | 11843 | 282 | 10606 |
| 6-#18 | 2.73 | MA | 8367 | 2262 | 11563 | 2007 | 14904 | 1663 | 17056 | 1376 | 19902 | 922 | 25339 | 487 | 21613 |
| 3L-2S | | MI | 4865 | 2262 | 7700 | 1859 | 9426 | 1534 | 10627 | 1262 | 12407 | 813 | 14823 | 576 | 10787 |
| 8-#10 | 1.15 | MA | 7958 | 1855 | 9570 | 1736 | 12606 | 1459 | 14393 | 1240 | 16426 | 906 | 20607 | 789 | 9804 |
| 2L-4S | | MI | 3772 | 1855 | 4890 | 1672 | 6057 | 1404 | 6628 | 1197 | 7103 | 869 | 8531 | 585 | 5031 |
| 8-#10 | 1.15 | MA | 7423 | 1855 | 8752 | 1751 | 11572 | 1473 | 13143 | 1253 | 14743 | 923 | 18276 | 709 | 9773 |
| 3E | | MI | 3924 | 1855 | 5169 | 1662 | 6421 | 1395 | 7092 | 1184 | 7737 | 865 | 9313 | 638 | 5043 |

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.15 | MA | 7112 | 1855 | 8196 | 1766 | 10844 | 1487 | 12210 | 1272 | 13467 | 934 | 16735 | 658 | 9656 |
| 4L-2S | | MI | 4174 | 1855 | 5565 | 1651 | 6922 | 1386 | 7699 | 1177 | 8554 | 856 | 10417 | 732 | 5037 |
| 8-#11 | 1.42 | MA | 8273 | 1923 | 10366 | 1771 | 13542 | 1483 | 15489 | 1254 | 17866 | 898 | 22574 | 781 | 11893 |
| 2L-4S | | MI | 3826 | 1923 | 5151 | 1703 | 6322 | 1424 | 6911 | 1207 | 7453 | 857 | 8926 | 526 | 5998 |
| 8-#11 | 1.42 | MA | 7646 | 1923 | 9374 | 1788 | 12287 | 1500 | 13970 | 1269 | 15821 | 918 | 19743 | 681 | 11837 |
| 3E | | MI | 4003 | 1923 | 5487 | 1691 | 6760 | 1415 | 7470 | 1193 | 8216 | 854 | 9847 | 588 | 6035 |
| 8-#11 | 1.42 | MA | 7283 | 1923 | 8695 | 1806 | 11400 | 1516 | 12834 | 1292 | 14268 | 932 | 17858 | 618 | 11633 |
| 4L-2S | | MI | 4294 | 1923 | 5963 | 1679 | 7362 | 1405 | 8199 | 1186 | 9197 | 844 | 11140 | 703 | 6035 |
| 8-#14 | 2.05 | MA | 9033 | 2086 | 12144 | 1867 | 15739 | 1553 | 18119 | 1297 | 21383 | 889 | 27425 | 770 | 16915 |
| 2L-4S | | MI | 3984 | 2086 | 5662 | 1802 | 6918 | 1496 | 7596 | 1254 | 8351 | 847 | 10056 | 406 | 8059 |
| 8-#14 | 2.05 | MA | 8199 | 2086 | 10724 | 1891 | 13943 | 1576 | 15947 | 1319 | 18458 | 917 | 23375 | 623 | 16766 |
| 3E | | MI | 4221 | 2086 | 6141 | 1786 | 7541 | 1483 | 8392 | 1235 | 9437 | 844 | 11344 | 494 | 8380 |
| 8-#14 | 2.05 | MA | 7719 | 2086 | 9752 | 1916 | 12672 | 1599 | 14320 | 1350 | 16232 | 935 | 20663 | 532 | 16123 |
| 4L-2S | | MI | 4609 | 2086 | 6815 | 1770 | 8395 | 1471 | 9425 | 1226 | 10827 | 832 | 13146 | 659 | 8419 |
| 8-#18 | 3.64 | MA | 9513 | 2498 | 14046 | 2155 | 18045 | 1771 | 20855 | 1445 | 25017 | 913 | 32421 | 475 | 28826 |
| 3E | | MI | 4732 | 2498 | 7700 | 2031 | 9426 | 1660 | 10627 | 1342 | 12407 | 820 | 14823 | 229 | 13913 |
| 8-#18 | 3.64 | MA | 8797 | 2498 | 12339 | 2197 | 15814 | 1810 | 18000 | 1498 | 21114 | 942 | 27628 | 310 | 25309 |
| 4L-2S | | MI | 5294 | 2498 | 8859 | 2007 | 10892 | 1642 | 12400 | 1331 | 14793 | 804 | 17802 | 522 | 14153 |
| 10-#10 | 1.44 | MA | 8351 | 1930 | 10387 | 1783 | 13639 | 1493 | 15644 | 1262 | 18110 | 903 | 22938 | 785 | 12195 |
| 2L-5S | | MI | 3837 | 1930 | 5038 | 1729 | 6206 | 1452 | 6819 | 1226 | 7344 | 875 | 8856 | 524 | 6022 |
| 10-#10 | 1.44 | MA | 7837 | 1930 | 9570 | 1798 | 12606 | 1507 | 14393 | 1275 | 16426 | 920 | 20607 | 705 | 12153 |
| 3L-4S | | MI | 3962 | 1930 | 5287 | 1719 | 6559 | 1438 | 7235 | 1218 | 7920 | 866 | 9635 | 578 | 6179 |
| 10-#10 | 1.44 | MA | 7546 | 1930 | 9013 | 1812 | 11877 | 1521 | 13461 | 1294 | 15150 | 931 | 19066 | 654 | 12026 |
| 4L-3S | | MI | 4106 | 1930 | 5565 | 1708 | 6922 | 1429 | 7699 | 1206 | 8554 | 862 | 10417 | 631 | 6204 |
| 10-#10 | 1.44 | MA | 7220 | 1930 | 8508 | 1826 | 11176 | 1540 | 12632 | 1307 | 14000 | 948 | 17423 | 607 | 11603 |
| 5L-2S | | MI | 4348 | 1930 | 5962 | 1698 | 7424 | 1421 | 8306 | 1199 | 9371 | 853 | 11520 | 725 | 6207 |
| 10-#11 | 1.77 | MA | 8732 | 2015 | 11359 | 1828 | 14798 | 1526 | 17007 | 1281 | 19911 | 895 | 25405 | 776 | 14794 |
| 2L-5S | | MI | 3902 | 2015 | 5326 | 1771 | 6498 | 1483 | 7136 | 1242 | 7739 | 864 | 9305 | 445 | 7025 |
| 10-#11 | 1.77 | MA | 8134 | 2015 | 10366 | 1846 | 13542 | 1542 | 15489 | 1296 | 17866 | 915 | 22574 | 676 | 14723 |
| 3L-4S | | MI | 4048 | 2015 | 5627 | 1760 | 6924 | 1466 | 7639 | 1234 | 8434 | 854 | 10219 | 513 | 7366 |
| 10-#11 | 1.77 | MA | 7798 | 2015 | 9688 | 1863 | 12655 | 1558 | 14353 | 1318 | 16313 | 928 | 20689 | 613 | 14510 |
| 4L-3S | | MI | 4215 | 2015 | 5963 | 1748 | 7362 | 1457 | 8199 | 1220 | 9197 | 851 | 11140 | 576 | 7422 |
| 10-#11 | 1.77 | MA | 7412 | 2015 | 9079 | 1880 | 11801 | 1582 | 13343 | 1334 | 14912 | 948 | 18684 | 554 | 13691 |
| 5L-2S | | MI | 4495 | 2015 | 6439 | 1737 | 7965 | 1448 | 8927 | 1213 | 10178 | 841 | 12434 | 690 | 7435 |
| 10-#14 | 2.56 | MA | 8866 | 2218 | 12144 | 1974 | 15739 | 1637 | 18119 | 1358 | 21383 | 912 | 27425 | 616 | 20889 |
| 3L-4S | | MI | 4289 | 2218 | 6337 | 1884 | 7771 | 1556 | 8629 | 1293 | 9742 | 842 | 11858 | 384 | 9905 |
| 10-#14 | 2.56 | MA | 8432 | 2218 | 11171 | 1999 | 14468 | 1660 | 16492 | 1389 | 19158 | 930 | 24714 | 525 | 20219 |
| 4L-3S | | MI | 4517 | 2218 | 6815 | 1869 | 8395 | 1544 | 9425 | 1274 | 10827 | 839 | 13146 | 472 | 10328 |
| 10-#14 | 2.56 | MA | 7895 | 2218 | 10305 | 2023 | 13243 | 1693 | 15044 | 1410 | 17150 | 958 | 21835 | 437 | 18536 |
| 5L-2S | | MI | 4874 | 2218 | 7490 | 1853 | 9249 | 1532 | 10457 | 1265 | 12218 | 827 | 14947 | 637 | 10389 |
| 10-#18 | 4.55 | MA | 9984 | 2733 | 14822 | 2344 | 18955 | 1918 | 21799 | 1568 | 26229 | 933 | 34710 | 298 | 32486 |
| 4L-3S | | MI | 5194 | 2733 | 8859 | 2178 | 10892 | 1768 | 12400 | 1411 | 14793 | 811 | 17802 | 175 | 17175 |
| 10-#18 | 4.55 | MA | 9085 | 2733 | 13309 | 2386 | 16802 | 1975 | 19255 | 1603 | 22704 | 980 | 29641 | 133 | 29063 |
| 5L-2S | | MI | 5711 | 2733 | 10017 | 2154 | 12357 | 1750 | 14172 | 1400 | 17180 | 795 | 20781 | 469 | 17510 |
| 12-#10 | 1.73 | MA | 8732 | 2004 | 11204 | 1830 | 14673 | 1528 | 16894 | 1284 | 19793 | 900 | 25268 | 781 | 14584 |
| 2L-6S | | MI | 3849 | 2004 | 5192 | 1785 | 6388 | 1495 | 7019 | 1260 | 7599 | 877 | 9204 | 448 | 6896 |
| 12-#10 | 1.73 | MA | 8238 | 2004 | 10387 | 1844 | 13639 | 1541 | 15644 | 1297 | 18110 | 917 | 22938 | 701 | 14532 |
| 3L-5S | | MI | 4027 | 2004 | 5434 | 1776 | 6708 | 1487 | 7426 | 1247 | 8162 | 873 | 9959 | 516 | 7125 |
| 12-#10 | 1.73 | MA | 7965 | 2004 | 9830 | 1859 | 12911 | 1555 | 14711 | 1315 | 16834 | 928 | 21397 | 650 | 14398 |
| 4E | | MI | 4146 | 2004 | 5683 | 1765 | 7061 | 1472 | 7842 | 1240 | 8737 | 863 | 10739 | 571 | 7324 |
| 12-#10 | 1.73 | MA | 7644 | 2004 | 9326 | 1872 | 12210 | 1575 | 13882 | 1328 | 15684 | 945 | 19754 | 603 | 13960 |
| 5L-3S | | MI | 4283 | 2004 | 5962 | 1755 | 7424 | 1464 | 8306 | 1228 | 9371 | 859 | 11520 | 624 | 7360 |
| 12-#10 | 1.73 | MA | 7277 | 2004 | 8787 | 1880 | 11559 | 1587 | 13095 | 1342 | 14565 | 957 | 18324 | 548 | 13290 |
| 6L-2S | | MI | 4517 | 2004 | 6359 | 1745 | 7926 | 1455 | 8913 | 1221 | 10188 | 850 | 12624 | 717 | 7372 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 40"

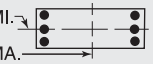
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.13 | MA | 8606 | 2107 | 11359 | 1903 | 14798 | 1584 | 17007 | 1323 | 19911 | 912 | 25405 | 671 | 17610 |
| 3L-5S | | MI | 4127 | 2107 | 5802 | 1829 | 7100 | 1525 | 7865 | 1269 | 8719 | 860 | 10599 | 433 | 8351 |
| 12-#11 | 2.13 | MA | 8293 | 2107 | 10681 | 1921 | 13911 | 1601 | 15872 | 1345 | 18358 | 925 | 23520 | 608 | 17391 |
| 4E | | MI | 4263 | 2107 | 6103 | 1817 | 7526 | 1509 | 8368 | 1261 | 9414 | 850 | 11513 | 500 | 8734 |
| 12-#11 | 2.13 | MA | 7914 | 2107 | 10072 | 1937 | 13056 | 1624 | 14862 | 1361 | 16957 | 945 | 21515 | 549 | 16562 |
| 5L-3S | | MI | 4421 | 2107 | 6439 | 1806 | 7965 | 1499 | 8927 | 1247 | 10178 | 847 | 12434 | 563 | 8804 |
| 12-#11 | 2.13 | MA | 7483 | 2107 | 9417 | 1947 | 12272 | 1639 | 13902 | 1376 | 15594 | 958 | 19770 | 479 | 15762 |
| 6L-2S | | MI | 4691 | 2107 | 6915 | 1794 | 8567 | 1490 | 9655 | 1240 | 11159 | 837 | 13727 | 678 | 8828 |
| 12-#14 | 3.07 | MA | 9115 | 2351 | 12591 | 2082 | 16264 | 1721 | 18665 | 1428 | 22083 | 925 | 28764 | 518 | 24320 |
| 4E | | MI | 4598 | 2351 | 7012 | 1967 | 8625 | 1617 | 9662 | 1332 | 11132 | 837 | 13659 | 362 | 11766 |
| 12-#14 | 3.07 | MA | 8588 | 2351 | 11725 | 2106 | 15039 | 1754 | 17217 | 1449 | 20075 | 953 | 25885 | 430 | 22658 |
| 5L-3S | | MI | 4794 | 2351 | 7490 | 1951 | 9249 | 1605 | 10457 | 1313 | 12218 | 834 | 14947 | 450 | 12273 |
| 12-#14 | 3.07 | MA | 8011 | 2351 | 10788 | 2119 | 13924 | 1776 | 15840 | 1471 | 18120 | 971 | 23379 | 327 | 20954 |
| 6L-2S | | MI | 5132 | 2351 | 8165 | 1936 | 10103 | 1593 | 11490 | 1304 | 13608 | 822 | 16749 | 615 | 12354 |
| 12-#18 | 5.45 | MA | 10234 | 2969 | 15792 | 2533 | 19943 | 2083 | 23054 | 1672 | 27819 | 971 | 36723 | 121 | 36206 |
| 5L-3S | | MI | 5642 | 2969 | 10017 | 2325 | 12357 | 1876 | 14172 | 1480 | 17180 | 802 | 20781 | 122 | 20317 |
| 12-#18 | 5.45 | MA | 9346 | 2969 | 14163 | 2556 | 18001 | 2122 | 20575 | 1726 | 24385 | 1000 | 32305 | -70 | 31973 |
| 6L-2S | | MI | 6123 | 2969 | 11175 | 2301 | 13822 | 1858 | 15944 | 1469 | 19566 | 786 | 23761 | 415 | 20862 |
| 14-#10 | 2.02 | MA | 8628 | 2079 | 11204 | 1891 | 14673 | 1576 | 16894 | 1319 | 19793 | 914 | 25268 | 697 | 16912 |
| 3L-6S | | MI | 4037 | 2079 | 5588 | 1831 | 6890 | 1530 | 7626 | 1282 | 8417 | 874 | 10307 | 441 | 8016 |
| 14-#10 | 2.02 | MA | 8372 | 2079 | 10647 | 1906 | 13945 | 1590 | 15961 | 1337 | 18517 | 926 | 23728 | 646 | 16772 |
| 4L-5S | | MI | 4208 | 2079 | 5831 | 1822 | 7210 | 1521 | 8032 | 1269 | 8979 | 870 | 11063 | 509 | 8234 |
| 14-#10 | 2.02 | MA | 8055 | 2079 | 10143 | 1919 | 13244 | 1609 | 15132 | 1350 | 17367 | 943 | 22085 | 600 | 16321 |
| 5L-4S | | MI | 4326 | 2079 | 6080 | 1812 | 7563 | 1507 | 8449 | 1262 | 9555 | 860 | 11842 | 564 | 8468 |
| 14-#10 | 2.02 | MA | 7703 | 2079 | 9604 | 1927 | 12593 | 1621 | 14345 | 1363 | 16248 | 954 | 20655 | 544 | 15670 |
| 6L-3S | | MI | 4457 | 2079 | 6359 | 1802 | 7926 | 1498 | 8913 | 1250 | 10188 | 857 | 12624 | 617 | 8514 |
| 14-#10 | 2.02 | MA | 7393 | 2079 | 9090 | 1937 | 11917 | 1630 | 13527 | 1380 | 15161 | 971 | 19187 | 510 | 14935 |
| 7L-2S | | MI | 4684 | 2079 | 6755 | 1792 | 8428 | 1489 | 9520 | 1243 | 11005 | 847 | 13727 | 710 | 8532 |
| 14-#11 | 2.48 | MA | 8773 | 2199 | 11673 | 1978 | 15167 | 1643 | 17390 | 1372 | 20402 | 921 | 26352 | 604 | 20275 |
| 4L-5S | | MI | 4339 | 2199 | 6278 | 1886 | 7703 | 1567 | 8593 | 1296 | 9700 | 857 | 11893 | 420 | 9683 |
| 14-#11 | 2.48 | MA | 8400 | 2199 | 11065 | 1995 | 14312 | 1666 | 16381 | 1388 | 19002 | 941 | 24346 | 544 | 19435 |
| 5L-4S | | MI | 4473 | 2199 | 6579 | 1875 | 8128 | 1551 | 9096 | 1288 | 10395 | 847 | 12806 | 488 | 10096 |
| 14-#11 | 2.48 | MA | 7988 | 2199 | 10410 | 2004 | 13528 | 1681 | 15421 | 1403 | 17639 | 954 | 22601 | 474 | 18649 |
| 6L-3S | | MI | 4630 | 2199 | 6915 | 1863 | 8567 | 1541 | 9655 | 1274 | 11159 | 844 | 13727 | 551 | 10183 |
| 14-#11 | 2.48 | MA | 7626 | 2199 | 9784 | 2016 | 12705 | 1691 | 14436 | 1424 | 16314 | 974 | 20801 | 431 | 17492 |
| 7L-2S | | MI | 4881 | 2199 | 7391 | 1852 | 9169 | 1532 | 10384 | 1267 | 12139 | 834 | 15021 | 665 | 10217 |
| 14-#14 | 3.58 | MA | 9255 | 2483 | 13145 | 2188 | 16835 | 1815 | 19389 | 1488 | 23000 | 948 | 29935 | 423 | 26779 |
| 5L-4S | | MI | 4885 | 2483 | 7687 | 2050 | 9479 | 1678 | 10694 | 1371 | 12522 | 832 | 15461 | 340 | 13640 |
| 14-#14 | 3.58 | MA | 8711 | 2483 | 12207 | 2201 | 15721 | 1837 | 18013 | 1510 | 21045 | 966 | 27429 | 320 | 25059 |
| 6L-3S | | MI | 5065 | 2483 | 8165 | 2034 | 10103 | 1666 | 11490 | 1352 | 13608 | 829 | 16749 | 428 | 14218 |
| 14-#14 | 3.58 | MA | 8232 | 2483 | 11311 | 2218 | 14542 | 1851 | 16614 | 1541 | 19146 | 994 | 24837 | 257 | 23285 |
| 7L-2S | | MI | 5385 | 2483 | 8840 | 2019 | 10957 | 1653 | 12523 | 1342 | 14999 | 817 | 18551 | 593 | 14314 |
| 14-#18 | 6.36 | MA | 10592 | 3204 | 16645 | 2703 | 21141 | 2230 | 24374 | 1795 | 29499 | 991 | 39387 | -82 | 38853 |
| 6L-3S | | MI | 6082 | 3204 | 11175 | 2472 | 13822 | 1984 | 15944 | 1549 | 19566 | 793 | 23761 | 68 | 23486 |
| 16-#10 | 2.31 | MA | 8767 | 2154 | 11464 | 1952 | 14979 | 1624 | 17211 | 1359 | 20201 | 923 | 26059 | 642 | 19148 |
| 4L-6S | | MI | 4220 | 2154 | 5985 | 1878 | 7392 | 1564 | 8232 | 1304 | 9234 | 871 | 11411 | 434 | 9138 |
| 16-#10 | 2.31 | MA | 8454 | 2154 | 10960 | 1966 | 14277 | 1643 | 16383 | 1372 | 19051 | 940 | 24416 | 596 | 18685 |
| 5E | | MI | 4386 | 2154 | 6228 | 1869 | 7712 | 1555 | 8639 | 1291 | 9796 | 867 | 12166 | 502 | 9348 |
| 16-#10 | 2.31 | MA | 8116 | 2154 | 10422 | 1974 | 13626 | 1655 | 15595 | 1385 | 17932 | 951 | 22986 | 540 | 18051 |
| 6L-4S | | MI | 4503 | 2154 | 6477 | 1859 | 8064 | 1541 | 9056 | 1284 | 10372 | 858 | 12946 | 557 | 9612 |
| 16-#10 | 2.31 | MA | 7821 | 2154 | 9907 | 1984 | 12950 | 1664 | 14777 | 1402 | 16845 | 968 | 21518 | 506 | 17306 |
| 7L-3S | | MI | 4627 | 2154 | 6755 | 1848 | 8428 | 1532 | 9520 | 1272 | 11005 | 854 | 13727 | 610 | 9665 |
| 16-#10 | 2.31 | MA | 7547 | 2154 | 9342 | 2001 | 12253 | 1680 | 13958 | 1411 | 15762 | 979 | 20088 | 461 | 16482 |
| 8L-2S | | MI | 4847 | 2154 | 7152 | 1838 | 8930 | 1524 | 10127 | 1265 | 11823 | 844 | 14831 | 703 | 9690 |
| 16-#11 | 2.84 | MA | 8870 | 2290 | 12057 | 2052 | 15568 | 1708 | 17899 | 1415 | 21047 | 938 | 27178 | 539 | 22313 |
| 5E | | MI | 4546 | 2290 | 6754 | 1944 | 8305 | 1609 | 9322 | 1323 | 10681 | 853 | 13186 | 408 | 11022 |
| 16-#11 | 2.84 | MA | 8477 | 2290 | 11402 | 2061 | 14784 | 1723 | 16939 | 1430 | 19683 | 951 | 25432 | 469 | 21535 |
| 6L-4S | | MI | 4689 | 2290 | 7055 | 1932 | 8731 | 1593 | 9824 | 1315 | 11376 | 843 | 14100 | 475 | 11415 |

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

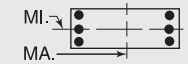
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.84 | MA | 8134 | 2290 | 10777 | 2073 | 13961 | 1733 | 15955 | 1451 | 18359 | 971 | 23632 | 426 | 20370 |
| 7L-3S | | MI | 4825 | 2290 | 7391 | 1921 | 9169 | 1584 | 10384 | 1301 | 12139 | 840 | 15021 | 538 | 11560 |
| 16-#11 | 2.84 | MA | 7811 | 2290 | 10088 | 2094 | 13112 | 1752 | 14958 | 1462 | 17039 | 984 | 21886 | 369 | 19245 |
| 8L-2S | | MI | 5066 | 2290 | 7868 | 1909 | 9771 | 1574 | 11112 | 1294 | 13120 | 830 | 16315 | 653 | 11604 |
| 16-#14 | 4.09 | MA | 9387 | 2615 | 13627 | 2284 | 17517 | 1898 | 20185 | 1549 | 23971 | 961 | 31479 | 313 | 29164 |
| 6L-4S | | MI | 5163 | 2615 | 8362 | 2133 | 10333 | 1739 | 11727 | 1410 | 13913 | 827 | 17263 | 318 | 15524 |
| 16-#14 | 4.09 | MA | 8940 | 2615 | 12731 | 2301 | 16338 | 1912 | 18787 | 1580 | 22071 | 989 | 28888 | 250 | 27378 |
| 7L-3S | | MI | 5329 | 2615 | 8840 | 2117 | 10957 | 1727 | 12523 | 1390 | 14999 | 824 | 18551 | 406 | 16163 |
| 16-#14 | 4.09 | MA | 8488 | 2615 | 11743 | 2330 | 15122 | 1938 | 17358 | 1594 | 20178 | 1007 | 26379 | 166 | 25455 |
| 8L-2S | | MI | 5634 | 2615 | 9515 | 2101 | 11810 | 1714 | 13555 | 1381 | 16389 | 812 | 20352 | 571 | 16273 |
| 18-#10 | 2.60 | MA | 8843 | 2229 | 11777 | 2012 | 15311 | 1678 | 17633 | 1394 | 20734 | 937 | 26747 | 592 | 21051 |
| 5L-6S | | MI | 4399 | 2229 | 6382 | 1925 | 7894 | 1598 | 8839 | 1326 | 10051 | 868 | 12515 | 426 | 10264 |
| 18-#10 | 2.60 | MA | 8518 | 2229 | 11239 | 2020 | 14660 | 1690 | 16846 | 1407 | 19615 | 948 | 25317 | 536 | 20430 |
| 6L-5S | | MI | 4560 | 2229 | 6624 | 1916 | 8214 | 1590 | 9246 | 1313 | 10613 | 864 | 13270 | 495 | 10466 |
| 18-#10 | 2.60 | MA | 8236 | 2229 | 10725 | 2031 | 13984 | 1698 | 16028 | 1424 | 18528 | 965 | 23849 | 502 | 19676 |
| 7L-4S | | MI | 4676 | 2229 | 6873 | 1905 | 8566 | 1575 | 9663 | 1306 | 11189 | 855 | 14049 | 550 | 10756 |
| 18-#10 | 2.60 | MA | 7967 | 2229 | 10159 | 2048 | 13287 | 1714 | 15209 | 1433 | 17446 | 977 | 22419 | 457 | 18854 |
| 8L-3S | | MI | 4794 | 2229 | 7152 | 1895 | 8930 | 1567 | 10127 | 1294 | 11823 | 851 | 14831 | 603 | 10816 |
| 18-#10 | 2.60 | MA | 7629 | 2229 | 9661 | 2059 | 12641 | 1725 | 14384 | 1449 | 16377 | 994 | 20955 | 405 | 17901 |
| 9L-2S | | MI | 5008 | 2229 | 7549 | 1885 | 9431 | 1558 | 10734 | 1287 | 12640 | 841 | 15935 | 696 | 10846 |
| 18-#11 | 3.19 | MA | 8952 | 2382 | 12395 | 2119 | 16039 | 1765 | 18458 | 1457 | 21728 | 947 | 28263 | 464 | 24422 |
| 6L-5S | | MI | 4757 | 2382 | 7230 | 2001 | 8907 | 1651 | 10050 | 1350 | 11662 | 850 | 14480 | 395 | 12365 |
| 18-#11 | 3.19 | MA | 8627 | 2382 | 11769 | 2131 | 15216 | 1776 | 17474 | 1478 | 20403 | 967 | 26464 | 422 | 23247 |
| 7L-4S | | MI | 4889 | 2382 | 7531 | 1989 | 9333 | 1635 | 10553 | 1342 | 12357 | 840 | 15394 | 463 | 12741 |
| 18-#11 | 3.19 | MA | 8310 | 2382 | 11080 | 2151 | 14368 | 1794 | 16477 | 1488 | 19084 | 981 | 24717 | 364 | 22115 |
| 8L-3S | | MI | 5016 | 2382 | 7868 | 1978 | 9771 | 1626 | 11112 | 1328 | 13120 | 837 | 16315 | 525 | 12937 |
| 18-#11 | 3.19 | MA | 7914 | 2382 | 10480 | 2165 | 13581 | 1807 | 15472 | 1507 | 17782 | 1001 | 22922 | 299 | 20955 |
| 9L-2S | | MI | 5248 | 2382 | 8344 | 1966 | 10373 | 1616 | 11841 | 1321 | 14101 | 827 | 17608 | 640 | 12988 |
| 18-#14 | 4.60 | MA | 9624 | 2748 | 14151 | 2384 | 18134 | 1972 | 20959 | 1619 | 24996 | 984 | 32938 | 243 | 31470 |
| 7L-4S | | MI | 5436 | 2748 | 9037 | 2215 | 11187 | 1800 | 12760 | 1448 | 15303 | 822 | 19065 | 296 | 17416 |
| 18-#14 | 4.60 | MA | 9180 | 2748 | 13163 | 2413 | 16918 | 1999 | 19530 | 1633 | 23103 | 1002 | 30429 | 159 | 29555 |
| 8L-3S | | MI | 5589 | 2748 | 9515 | 2200 | 11810 | 1787 | 13555 | 1429 | 16389 | 820 | 20352 | 384 | 18108 |
| 18-#14 | 4.60 | MA | 8654 | 2748 | 12309 | 2433 | 15790 | 2017 | 18091 | 1658 | 21236 | 1030 | 27845 | 64 | 27459 |
| 9L-2S | | MI | 5879 | 2748 | 10190 | 2184 | 12664 | 1775 | 14588 | 1420 | 17779 | 807 | 22154 | 549 | 18230 |
| 20-#10 | 2.89 | MA | 8910 | 2303 | 12056 | 2067 | 15694 | 1724 | 18096 | 1429 | 21299 | 946 | 27648 | 533 | 22808 |
| 6E | | MI | 4575 | 2303 | 6778 | 1972 | 8396 | 1633 | 9446 | 1348 | 10868 | 865 | 13618 | 419 | 11392 |
| 20-#10 | 2.89 | MA | 8641 | 2303 | 11542 | 2077 | 15018 | 1733 | 17278 | 1446 | 20212 | 963 | 26180 | 498 | 22047 |
| 7L-5S | | MI | 4731 | 2303 | 7021 | 1962 | 8715 | 1624 | 9853 | 1335 | 11430 | 861 | 14374 | 488 | 11587 |
| 20-#10 | 2.89 | MA | 8376 | 2303 | 10976 | 2094 | 14321 | 1748 | 16459 | 1455 | 19129 | 974 | 24750 | 453 | 21227 |
| 8L-4S | | MI | 4857 | 2303 | 7270 | 1952 | 9068 | 1610 | 10270 | 1328 | 12006 | 852 | 15153 | 542 | 11900 |
| 20-#10 | 2.89 | MA | 8050 | 2303 | 10478 | 2105 | 13675 | 1759 | 15634 | 1470 | 18061 | 991 | 23286 | 401 | 20268 |
| 9L-3S | | MI | 4965 | 2303 | 7549 | 1942 | 9431 | 1601 | 10734 | 1316 | 12640 | 848 | 15935 | 595 | 11965 |
| 20-#10 | 2.89 | MA | 7746 | 2303 | 9966 | 2114 | 13042 | 1771 | 14840 | 1481 | 16949 | 999 | 21853 | 362 | 19332 |
| 10L-2S | | MI | 5164 | 2303 | 7945 | 1932 | 9933 | 1593 | 11341 | 1309 | 13457 | 839 | 17038 | 689 | 12001 |
| 20-#11 | 3.55 | MA | 9107 | 2474 | 12762 | 2188 | 16472 | 1818 | 18993 | 1505 | 22448 | 964 | 29295 | 417 | 26125 |
| 7L-5S | | MI | 4955 | 2474 | 7706 | 2058 | 9509 | 1694 | 10778 | 1377 | 12642 | 846 | 15773 | 382 | 13711 |
| 20-#11 | 3.55 | MA | 8794 | 2474 | 12073 | 2209 | 15623 | 1836 | 17995 | 1515 | 21128 | 977 | 27548 | 360 | 24984 |
| 8L-4S | | MI | 5085 | 2474 | 8007 | 2047 | 9935 | 1677 | 11281 | 1369 | 13337 | 837 | 16687 | 450 | 14072 |
| 20-#11 | 3.55 | MA | 8415 | 2474 | 11473 | 2222 | 14836 | 1849 | 16991 | 1534 | 19827 | 997 | 25754 | 294 | 23828 |
| 9L-3S | | MI | 5204 | 2474 | 8344 | 2035 | 10373 | 1668 | 11841 | 1355 | 14101 | 834 | 17608 | 513 | 14313 |
| 20-#11 | 3.55 | MA | 8060 | 2474 | 10850 | 2233 | 14065 | 1863 | 16023 | 1546 | 18491 | 1008 | 24002 | 244 | 22477 |
| 10L-2S | | MI | 5428 | 2474 | 8820 | 2024 | 10976 | 1658 | 12569 | 1348 | 15082 | 824 | 18902 | 627 | 14372 |
| 20-#14 | 5.11 | MA | 9852 | 2880 | 14583 | 2496 | 18714 | 2060 | 21703 | 1671 | 26028 | 997 | 34479 | 152 | 33656 |
| 8L-4S | | MI | 5704 | 2880 | 9711 | 2298 | 12040 | 1861 | 13792 | 1487 | 16694 | 817 | 20866 | 274 | 19316 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 5.11 | MA | 9353 | 2880 | 13729 | 2516 | 17586 | 2078 | 20263 | 1697 | 24161 | 1025 | 31895 | 57 | 31551 |
| 9L-3S | | MI | 5845 | 2880 | 10190 | 2283 | 12664 | 1848 | 14588 | 1468 | 17779 | 815 | 22154 | 362 | 20054 |
| 22-#10 | 3.17 | MA | 9036 | 2378 | 12359 | 2124 | 16052 | 1767 | 18528 | 1468 | 21895 | 960 | 28511 | 494 | 24417 |
| 7L-6S | | MI | 4760 | 2378 | 7175 | 2018 | 8897 | 1667 | 10053 | 1370 | 11685 | 863 | 14722 | 412 | 12522 |
| 22-#10 | 3.17 | MA | 8775 | 2378 | 11793 | 2141 | 15355 | 1783 | 17709 | 1477 | 20813 | 971 | 27081 | 450 | 23599 |
| 8L-5S | | MI | 4908 | 2378 | 7418 | 2009 | 9217 | 1658 | 10460 | 1357 | 12248 | 859 | 15477 | 480 | 12711 |
| 22-#10 | 3.17 | MA | 8460 | 2378 | 11295 | 2152 | 14708 | 1794 | 16885 | 1492 | 19744 | 988 | 25617 | 397 | 22635 |
| 9L-4S | | MI | 5022 | 2378 | 7667 | 1999 | 9570 | 1644 | 10877 | 1350 | 12823 | 849 | 16256 | 535 | 13044 |
| 22-#10 | 3.17 | MA | 8169 | 2378 | 10784 | 2161 | 14075 | 1805 | 16090 | 1503 | 18632 | 996 | 24184 | 358 | 21694 |
| 10L-3S | | MI | 5124 | 2378 | 7945 | 1989 | 9933 | 1636 | 11341 | 1338 | 13457 | 845 | 17038 | 588 | 13114 |
| 22-#10 | 3.17 | MA | 7891 | 2378 | 10282 | 2171 | 13433 | 1816 | 15308 | 1514 | 17536 | 1011 | 22792 | 311 | 20716 |
| 11L-2S | | MI | 5318 | 2378 | 8342 | 1978 | 10435 | 1627 | 11948 | 1331 | 14274 | 836 | 18142 | 681 | 13155 |
| 22-#11 | 3.90 | MA | 9267 | 2566 | 13066 | 2266 | 16879 | 1879 | 19514 | 1542 | 23173 | 974 | 30380 | 355 | 27854 |
| 8L-5S | | MI | 5148 | 2566 | 8182 | 2116 | 10111 | 1736 | 11507 | 1404 | 13623 | 843 | 17067 | 370 | 15061 |
| 22-#11 | 3.90 | MA | 8902 | 2566 | 12465 | 2280 | 16092 | 1892 | 18510 | 1561 | 21871 | 994 | 28585 | 290 | 26701 |
| 9L-4S | | MI | 5277 | 2566 | 8483 | 2104 | 10537 | 1719 | 12010 | 1396 | 14318 | 833 | 17981 | 438 | 15407 |
| 22-#11 | 3.90 | MA | 8564 | 2566 | 11842 | 2290 | 15321 | 1905 | 17542 | 1573 | 20536 | 1004 | 26834 | 240 | 25345 |
| 10L-3S | | MI | 5389 | 2566 | 8820 | 2093 | 10976 | 1710 | 12569 | 1382 | 15082 | 830 | 18902 | 500 | 15689 |
| 22-#14 | 5.63 | MA | 10031 | 3013 | 15149 | 2598 | 19382 | 2139 | 22436 | 1736 | 27086 | 1020 | 35945 | 50 | 35643 |
| 9L-4S | | MI | 5968 | 3013 | 10386 | 2381 | 12894 | 1921 | 14825 | 1526 | 18084 | 812 | 22668 | 252 | 21221 |
| 24-#10 | 3.46 | MA | 9165 | 2453 | 12611 | 2188 | 16388 | 1817 | 18960 | 1499 | 22496 | 968 | 29412 | 446 | 25971 |
| 8L-6S | | MI | 4929 | 2453 | 7572 | 2065 | 9399 | 1701 | 10660 | 1392 | 12502 | 860 | 15825 | 405 | 13654 |
| 24-#10 | 3.46 | MA | 8861 | 2453 | 12113 | 2199 | 15742 | 1828 | 18135 | 1514 | 21428 | 985 | 27947 | 393 | 25002 |
| 9L-5S | | MI | 5072 | 2453 | 7814 | 2056 | 9719 | 1693 | 11067 | 1379 | 13065 | 856 | 16581 | 473 | 13837 |
| 24-#10 | 3.46 | MA | 8581 | 2453 | 11601 | 2208 | 15109 | 1840 | 17341 | 1525 | 20316 | 993 | 26515 | 354 | 24056 |
| 10L-4S | | MI | 5186 | 2453 | 8063 | 2046 | 10072 | 1678 | 11484 | 1372 | 13641 | 846 | 17360 | 528 | 14167 |
| 24-#10 | 3.46 | MA | 8316 | 2453 | 11099 | 2218 | 14466 | 1850 | 16558 | 1536 | 19220 | 1008 | 25123 | 307 | 23080 |
| 11L-3S | | MI | 5282 | 2453 | 8342 | 2035 | 10435 | 1670 | 11948 | 1360 | 14274 | 843 | 18142 | 581 | 14263 |
| 24-#11 | 4.25 | MA | 9378 | 2658 | 13458 | 2337 | 17348 | 1934 | 20029 | 1588 | 23916 | 990 | 31416 | 285 | 29574 |
| 9L-5S | | MI | 5339 | 2658 | 8658 | 2173 | 10714 | 1778 | 12235 | 1431 | 14604 | 840 | 18361 | 357 | 16414 |
| 24-#11 | 4.25 | MA | 9055 | 2658 | 12835 | 2348 | 16576 | 1948 | 19061 | 1600 | 22581 | 1001 | 29665 | 235 | 28212 |
| 10L-4S | | MI | 5467 | 2658 | 8959 | 2162 | 11140 | 1762 | 12738 | 1423 | 15299 | 830 | 19274 | 425 | 16747 |

## RECTANGULAR TIED COLUMNS 22" x 42"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.73 | MA | 9490 | 2105 | 12456 | 1901 | 16121 | 1587 | 18459 | 1333 | 21506 | 933 | 27352 | 810 | 15752 |
| 2E | | MI | 4595 | 2105 | 6753 | 1783 | 8213 | 1486 | 9120 | 1245 | 10283 | 864 | 12138 | 666 | 7427 |
| 6-#11 | 1.01 | MA | 8544 | 1909 | 10132 | 1796 | 13342 | 1512 | 15182 | 1288 | 17173 | 951 | 21412 | 829 | 9492 |
| 2L-3S | | MI | 3957 | 1909 | 5214 | 1706 | 6405 | 1434 | 7006 | 1220 | 7499 | 901 | 8851 | 638 | 4660 |
| 6-#11 | 1.01 | MA | 7839 | 1909 | 9082 | 1814 | 12014 | 1528 | 13576 | 1304 | 15010 | 971 | 18417 | 730 | 9457 |
| 3L-2S | | MI | 4262 | 1909 | 5690 | 1694 | 7008 | 1425 | 7734 | 1213 | 8480 | 891 | 10145 | 753 | 4643 |
| 6-#14 | 1.46 | MA | 9182 | 2031 | 11563 | 1866 | 15097 | 1563 | 17277 | 1320 | 19966 | 943 | 25260 | 820 | 13495 |
| 2L-3S | | MI | 4093 | 2031 | 5671 | 1775 | 6937 | 1484 | 7624 | 1249 | 8310 | 892 | 9839 | 553 | 6456 |
| 6-#14 | 1.46 | MA | 8229 | 2031 | 10060 | 1892 | 13196 | 1586 | 14978 | 1342 | 16871 | 972 | 20973 | 675 | 13376 |
| 3L-2S | | MI | 4505 | 2031 | 6346 | 1759 | 7790 | 1471 | 8657 | 1240 | 9700 | 879 | 11641 | 719 | 6460 |
| 6-#18 | 2.60 | MA | 10641 | 2340 | 15086 | 2048 | 19448 | 1695 | 22483 | 1402 | 26924 | 924 | 34854 | 797 | 23429 |
| 2L-3S | | MI | 4421 | 2340 | 6753 | 1954 | 8213 | 1612 | 9120 | 1326 | 10283 | 870 | 12138 | 319 | 10659 |
| 6-#18 | 2.60 | MA | 9160 | 2340 | 12456 | 2091 | 16121 | 1735 | 18459 | 1439 | 21506 | 973 | 27352 | 534 | 22909 |
| 3L-2S | | MI | 5043 | 2340 | 7911 | 1930 | 9678 | 1594 | 10893 | 1315 | 12669 | 855 | 15117 | 613 | 10820 |
| 8-#10 | 1.10 | MA | 8714 | 1933 | 10337 | 1819 | 13677 | 1529 | 15627 | 1301 | 17808 | 955 | 22319 | 832 | 10353 |
| 2L-4S | | MI | 3943 | 1933 | 5089 | 1745 | 6303 | 1466 | 6892 | 1251 | 7367 | 912 | 8832 | 623 | 5055 |
| 8-#10 | 1.10 | MA | 8142 | 1933 | 9473 | 1834 | 12584 | 1543 | 14305 | 1315 | 16029 | 972 | 19855 | 753 | 10322 |
| 3E | | MI | 4096 | 1933 | 5368 | 1735 | 6666 | 1458 | 7356 | 1238 | 8001 | 908 | 9613 | 676 | 5062 |
| 8-#10 | 1.10 | MA | 7812 | 1933 | 8886 | 1849 | 11815 | 1558 | 13320 | 1334 | 14681 | 984 | 18233 | 702 | 10205 |
| 4L-2S | | MI | 4348 | 1933 | 5764 | 1725 | 7168 | 1449 | 7963 | 1231 | 8818 | 899 | 10717 | 770 | 5054 |
| 8-#11 | 1.35 | MA | 9053 | 2001 | 11182 | 1854 | 14670 | 1554 | 16789 | 1315 | 19336 | 947 | 24407 | 824 | 12567 |
| 2L-4S | | MI | 3997 | 2001 | 5354 | 1775 | 6569 | 1486 | 7175 | 1261 | 7717 | 900 | 9224 | 563 | 6030 |

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

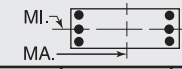
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.35 | MA | 8383 | 2001 | 10132 | 1871 | 13342 | 1571 | 15182 | 1331 | 17173 | 968 | 21412 | 725 | 12511 |
| 3E | | MI | 4175 | 2001 | 5690 | 1763 | 7008 | 1477 | 7734 | 1247 | 8480 | 897 | 10145 | 626 | 6059 |
| 8-#11 | 1.35 | MA | 7995 | 2001 | 9416 | 1889 | 12405 | 1587 | 13983 | 1354 | 15532 | 982 | 19427 | 662 | 12307 |
| 4L-2S | | MI | 4468 | 2001 | 6166 | 1752 | 7610 | 1467 | 8463 | 1240 | 9461 | 887 | 11439 | 740 | 6055 |
| 8-#14 | 1.95 | MA | 9870 | 2163 | 13065 | 1949 | 16998 | 1624 | 19576 | 1359 | 23062 | 938 | 29546 | 813 | 17887 |
| 2L-4S | | MI | 4154 | 2163 | 5868 | 1873 | 7167 | 1557 | 7861 | 1307 | 8615 | 890 | 10353 | 444 | 8157 |
| 8-#14 | 1.95 | MA | 8976 | 2163 | 11563 | 1974 | 15097 | 1647 | 17277 | 1381 | 19966 | 967 | 25260 | 668 | 17738 |
| 3E | | MI | 4393 | 2163 | 6346 | 1858 | 7790 | 1545 | 8657 | 1288 | 9700 | 887 | 11641 | 531 | 8413 |
| 8-#14 | 1.95 | MA | 8463 | 2163 | 10536 | 2000 | 13754 | 1671 | 15558 | 1413 | 17615 | 985 | 22405 | 577 | 17192 |
| 4L-2S | | MI | 4784 | 2163 | 7021 | 1842 | 8644 | 1532 | 9689 | 1279 | 11091 | 874 | 13443 | 697 | 8445 |
| 8-#18 | 3.46 | MA | 10385 | 2575 | 15086 | 2238 | 19448 | 1843 | 22483 | 1508 | 26924 | 964 | 34854 | 521 | 30554 |
| 3E | | MI | 4904 | 2575 | 7911 | 2101 | 9678 | 1720 | 10893 | 1395 | 12669 | 862 | 15117 | 265 | 13968 |
| 8-#18 | 3.46 | MA | 9618 | 2575 | 13282 | 2281 | 17089 | 1883 | 19465 | 1563 | 22796 | 994 | 29807 | 358 | 26959 |
| 4L-2S | | MI | 5474 | 2575 | 9070 | 2078 | 11143 | 1703 | 12665 | 1384 | 15056 | 846 | 18096 | 559 | 14189 |
| 10-#10 | 1.37 | MA | 9134 | 2007 | 11201 | 1866 | 14770 | 1564 | 16949 | 1323 | 19588 | 952 | 24783 | 828 | 12881 |
| 2L-5S | | MI | 4008 | 2007 | 5237 | 1802 | 6452 | 1515 | 7082 | 1280 | 7609 | 919 | 9156 | 562 | 6084 |
| 10-#10 | 1.37 | MA | 8585 | 2007 | 10337 | 1881 | 13677 | 1578 | 15627 | 1337 | 17808 | 969 | 22319 | 749 | 12839 |
| 3L-4S | | MI | 4133 | 2007 | 5486 | 1792 | 6805 | 1501 | 7499 | 1273 | 8184 | 909 | 9935 | 616 | 6205 |
| 10-#10 | 1.37 | MA | 8275 | 2007 | 9750 | 1895 | 12908 | 1592 | 14642 | 1356 | 16461 | 981 | 20698 | 698 | 12711 |
| 4L-3S | | MI | 4278 | 2007 | 5764 | 1782 | 7168 | 1492 | 7963 | 1260 | 8818 | 906 | 10717 | 669 | 6225 |
| 10-#10 | 1.37 | MA | 7924 | 2007 | 9215 | 1909 | 12168 | 1612 | 13767 | 1369 | 15248 | 998 | 18966 | 653 | 12329 |
| 5L-2S | | MI | 4522 | 2007 | 6161 | 1771 | 7670 | 1483 | 8570 | 1253 | 9635 | 896 | 11820 | 763 | 6225 |
| 10-#11 | 1.69 | MA | 9545 | 2093 | 12232 | 1911 | 15999 | 1596 | 18396 | 1342 | 21499 | 944 | 27402 | 819 | 15637 |
| 2L-5S | | MI | 4072 | 2093 | 5529 | 1844 | 6746 | 1545 | 7401 | 1296 | 8002 | 907 | 9604 | 483 | 7096 |
| 10-#11 | 1.69 | MA | 8905 | 2093 | 11182 | 1929 | 14670 | 1613 | 16789 | 1358 | 19336 | 964 | 24407 | 720 | 15566 |
| 3L-4S | | MI | 4219 | 2093 | 5830 | 1832 | 7172 | 1528 | 7903 | 1288 | 8697 | 897 | 10517 | 551 | 7401 |
| 10-#11 | 1.69 | MA | 8545 | 2093 | 10466 | 1947 | 13734 | 1630 | 15590 | 1381 | 17695 | 978 | 22422 | 658 | 15352 |
| 4L-3S | | MI | 4388 | 2093 | 6166 | 1821 | 7610 | 1519 | 8463 | 1274 | 9461 | 894 | 11439 | 613 | 7448 |
| 10-#11 | 1.69 | MA | 8131 | 2093 | 9820 | 1963 | 12832 | 1653 | 14523 | 1397 | 16216 | 999 | 20308 | 600 | 14553 |
| 5L-2S | | MI | 4670 | 2093 | 6642 | 1809 | 8212 | 1509 | 9191 | 1267 | 10442 | 884 | 12732 | 728 | 7458 |
| 10-#14 | 2.44 | MA | 9690 | 2296 | 13065 | 2057 | 16998 | 1708 | 19576 | 1420 | 23062 | 962 | 29546 | 661 | 22104 |
| 3L-4S | | MI | 4460 | 2296 | 6543 | 1956 | 8020 | 1618 | 8894 | 1346 | 10005 | 885 | 12155 | 422 | 9999 |
| 10-#14 | 2.44 | MA | 9225 | 2296 | 12039 | 2083 | 15655 | 1732 | 17857 | 1452 | 20710 | 981 | 26691 | 570 | 21546 |
| 4L-3S | | MI | 4682 | 2296 | 7021 | 1941 | 8644 | 1605 | 9689 | 1327 | 11091 | 882 | 13443 | 509 | 10363 |
| 10-#14 | 2.44 | MA | 8647 | 2296 | 11117 | 2106 | 14362 | 1765 | 16328 | 1474 | 18590 | 1009 | 23655 | 484 | 19696 |
| 5L-2S | | MI | 5052 | 2296 | 7696 | 1925 | 9498 | 1593 | 10722 | 1318 | 12481 | 869 | 15244 | 674 | 10417 |
| 10-#18 | 4.33 | MA | 10886 | 2811 | 15912 | 2429 | 20416 | 1991 | 23488 | 1632 | 28214 | 985 | 37308 | 345 | 34562 |
| 4L-3S | | MI | 5367 | 2811 | 9070 | 2249 | 11143 | 1828 | 12665 | 1464 | 15056 | 853 | 18096 | 212 | 17281 |
| 10-#18 | 4.33 | MA | 9917 | 2811 | 14315 | 2472 | 18142 | 2049 | 20800 | 1669 | 24488 | 1034 | 31959 | 185 | 31063 |
| 5L-2S | | MI | 5893 | 2811 | 10228 | 2225 | 12609 | 1811 | 14437 | 1453 | 17442 | 837 | 21076 | 506 | 17547 |
| 12-#10 | 1.65 | MA | 9542 | 2082 | 12065 | 1912 | 15863 | 1598 | 18270 | 1345 | 21368 | 949 | 27247 | 824 | 15407 |
| 2L-6S | | MI | 4020 | 2082 | 5391 | 1858 | 6634 | 1558 | 7282 | 1315 | 7864 | 920 | 9504 | 486 | 6955 |
| 12-#10 | 1.65 | MA | 9014 | 2082 | 11201 | 1927 | 14770 | 1612 | 16949 | 1359 | 19588 | 966 | 24783 | 745 | 15355 |
| 3L-5S | | MI | 4198 | 2082 | 5633 | 1849 | 6954 | 1549 | 7689 | 1302 | 8426 | 916 | 10259 | 554 | 7185 |
| 12-#10 | 1.65 | MA | 8722 | 2082 | 10614 | 1942 | 14001 | 1626 | 15964 | 1378 | 18241 | 978 | 23162 | 694 | 15221 |
| 4E | | MI | 4318 | 2082 | 5882 | 1839 | 7306 | 1535 | 8106 | 1295 | 9002 | 907 | 11039 | 609 | 7352 |
| 12-#10 | 1.65 | MA | 8377 | 2082 | 10078 | 1955 | 13261 | 1646 | 15089 | 1391 | 17027 | 996 | 21430 | 649 | 14825 |
| 5L-3S | | MI | 4457 | 2082 | 6161 | 1828 | 7670 | 1526 | 8570 | 1282 | 9635 | 903 | 11820 | 662 | 7383 |
| 12-#10 | 1.65 | MA | 7987 | 2082 | 9510 | 1963 | 12569 | 1658 | 14259 | 1404 | 15847 | 1007 | 19924 | 594 | 14097 |
| 6L-2S | | MI | 4693 | 2082 | 6558 | 1818 | 8172 | 1518 | 9177 | 1275 | 10452 | 893 | 12924 | 755 | 7391 |
| 12-#11 | 2.03 | MA | 9410 | 2185 | 12232 | 1986 | 15999 | 1655 | 18396 | 1385 | 21499 | 961 | 27402 | 715 | 18621 |
| 3L-5S | | MI | 4297 | 2185 | 6005 | 1901 | 7348 | 1587 | 8129 | 1323 | 8983 | 903 | 10897 | 470 | 8420 |
| 12-#11 | 2.03 | MA | 9075 | 2185 | 11516 | 2004 | 15062 | 1672 | 17196 | 1408 | 19858 | 975 | 25417 | 653 | 18402 |
| 4E | | MI | 4435 | 2185 | 6306 | 1890 | 7774 | 1570 | 8632 | 1315 | 9678 | 893 | 11811 | 538 | 8770 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.



## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

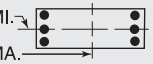



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.03 | MA | 8667 | 2185 | 10870 | 2020 | 14160 | 1696 | 16130 | 1424 | 18380 | 995 | 23303 | 595 | 17593 |
| 5L-3S | | MI | 4595 | 2185 | 6642 | 1878 | 8212 | 1561 | 9191 | 1301 | 10442 | 890 | 12732 | 601 | 8831 |
| 12-#11 | 2.03 | MA | 8208 | 2185 | 10178 | 2030 | 13326 | 1710 | 15117 | 1439 | 16940 | 1009 | 21463 | 526 | 16725 |
| 6L-2S | | MI | 4867 | 2185 | 7118 | 1867 | 8814 | 1552 | 9920 | 1294 | 11422 | 880 | 14026 | 715 | 8852 |
| 12-#14 | 2.92 | MA | 9954 | 2428 | 13541 | 2165 | 17556 | 1793 | 20156 | 1491 | 23806 | 976 | 30978 | 563 | 25895 |
| 4E | | MI | 4770 | 2428 | 7218 | 2039 | 8874 | 1679 | 9926 | 1385 | 11395 | 880 | 13956 | 400 | 11858 |
| 12-#14 | 2.92 | MA | 9387 | 2428 | 12620 | 2189 | 16263 | 1826 | 18627 | 1513 | 21686 | 1004 | 27941 | 477 | 24059 |
| 5L-3S | | MI | 4970 | 2428 | 7696 | 2023 | 9498 | 1666 | 10722 | 1366 | 12481 | 877 | 15244 | 487 | 12309 |
| 12-#14 | 2.92 | MA | 8771 | 2428 | 11629 | 2203 | 15076 | 1848 | 17174 | 1535 | 19622 | 1023 | 25299 | 376 | 22337 |
| 6L-2S | | MI | 5312 | 2428 | 8371 | 2008 | 10352 | 1654 | 11755 | 1357 | 13872 | 865 | 17046 | 652 | 12382 |
| 12-#18 | 5.19 | MA | 11144 | 3046 | 16945 | 2619 | 21469 | 2157 | 24824 | 1738 | 29906 | 1025 | 39460 | 173 | 38631 |
| 5L-3S | | MI | 5817 | 3046 | 10228 | 2396 | 12609 | 1936 | 14437 | 1533 | 17442 | 844 | 21076 | 158 | 20466 |
| 12-#18 | 5.19 | MA | 10194 | 3046 | 15207 | 2641 | 19416 | 2197 | 22205 | 1792 | 26278 | 1055 | 34801 | -14 | 34730 |
| 6L-2S | | MI | 6306 | 3046 | 11387 | 2372 | 14074 | 1919 | 16210 | 1522 | 19828 | 828 | 24055 | 452 | 20900 |
| 14-#10 | 1.92 | MA | 9430 | 2157 | 12065 | 1974 | 15863 | 1647 | 18270 | 1381 | 21368 | 964 | 27247 | 741 | 17872 |
| 3L-6S | | MI | 4208 | 2157 | 5787 | 1905 | 7136 | 1592 | 7889 | 1337 | 8681 | 917 | 10608 | 479 | 8073 |
| 14-#10 | 1.92 | MA | 9156 | 2157 | 11478 | 1989 | 15094 | 1661 | 17286 | 1400 | 20020 | 975 | 25626 | 690 | 17732 |
| 4L-5S | | MI | 4381 | 2157 | 6030 | 1895 | 7456 | 1583 | 8296 | 1324 | 9243 | 913 | 11363 | 547 | 8293 |
| 14-#10 | 1.92 | MA | 8816 | 2157 | 10942 | 2002 | 14354 | 1680 | 16411 | 1413 | 18807 | 993 | 23894 | 645 | 17324 |
| 5L-4S | | MI | 4499 | 2157 | 6279 | 1885 | 7808 | 1569 | 8712 | 1317 | 9819 | 904 | 12142 | 602 | 8498 |
| 14-#10 | 1.92 | MA | 8441 | 2157 | 10373 | 2010 | 13662 | 1692 | 15581 | 1426 | 17626 | 1005 | 22388 | 590 | 16612 |
| 6L-3S | | MI | 4631 | 2157 | 6558 | 1875 | 8172 | 1561 | 9177 | 1304 | 10452 | 900 | 12924 | 655 | 8537 |
| 14-#10 | 1.92 | MA | 8111 | 2157 | 9831 | 2021 | 12948 | 1701 | 14711 | 1443 | 16480 | 1022 | 20844 | 556 | 15886 |
| 7L-2S | | MI | 4860 | 2157 | 6954 | 1865 | 8674 | 1552 | 9783 | 1297 | 11270 | 890 | 14028 | 748 | 8553 |
| 14-#11 | 2.36 | MA | 9587 | 2276 | 12566 | 2061 | 16390 | 1714 | 18803 | 1435 | 22021 | 971 | 28412 | 648 | 21454 |
| 4L-5S | | MI | 4511 | 2276 | 6481 | 1959 | 7950 | 1629 | 8857 | 1350 | 9964 | 900 | 12191 | 458 | 9751 |
| 14-#11 | 2.36 | MA | 9186 | 2276 | 11920 | 2078 | 15488 | 1738 | 17736 | 1451 | 20543 | 992 | 26298 | 590 | 20637 |
| 5L-4S | | MI | 4645 | 2276 | 6782 | 1947 | 8376 | 1613 | 9360 | 1342 | 10659 | 890 | 13105 | 526 | 10139 |
| 14-#11 | 2.36 | MA | 8747 | 2276 | 11228 | 2087 | 14654 | 1753 | 16724 | 1466 | 19103 | 1005 | 24458 | 521 | 19780 |
| 6L-3S | | MI | 4797 | 2276 | 7118 | 1936 | 8814 | 1603 | 9920 | 1328 | 11422 | 887 | 14026 | 588 | 10212 |
| 14-#11 | 2.36 | MA | 8360 | 2276 | 10566 | 2100 | 13785 | 1763 | 15676 | 1487 | 17705 | 1026 | 22565 | 479 | 18611 |
| 7L-2S | | MI | 5060 | 2276 | 7594 | 1924 | 9417 | 1594 | 10648 | 1321 | 12403 | 877 | 15319 | 703 | 10242 |
| 14-#14 | 3.41 | MA | 10100 | 2561 | 14123 | 2272 | 18164 | 1887 | 20926 | 1552 | 24781 | 999 | 32228 | 470 | 28421 |
| 5L-4S | | MI | 5057 | 2561 | 7892 | 2122 | 9728 | 1739 | 10959 | 1424 | 12786 | 875 | 15758 | 378 | 13729 |
| 14-#14 | 3.41 | MA | 9519 | 2561 | 13131 | 2285 | 16977 | 1909 | 19473 | 1574 | 22717 | 1018 | 29585 | 369 | 26682 |
| 6L-3S | | MI | 5241 | 2561 | 8371 | 2106 | 10352 | 1727 | 11755 | 1405 | 13872 | 872 | 17046 | 465 | 14255 |
| 14-#14 | 3.41 | MA | 9006 | 2561 | 12184 | 2303 | 15731 | 1923 | 17983 | 1605 | 20711 | 1047 | 26859 | 307 | 24884 |
| 7L-2S | | MI | 5566 | 2561 | 9046 | 2091 | 11206 | 1715 | 12787 | 1396 | 15262 | 860 | 18848 | 630 | 14344 |
| 14-#18 | 6.06 | MA | 11444 | 3282 | 17837 | 2788 | 22743 | 2305 | 26229 | 1862 | 31696 | 1047 | 42303 | -26 | 42121 |
| 6L-3S | | MI | 6257 | 3282 | 11387 | 2543 | 14074 | 2044 | 16210 | 1602 | 19828 | 835 | 24055 | 105 | 23630 |
| 14-#18 | 6.06 | MA | 10667 | 3282 | 16173 | 2818 | 20557 | 2329 | 23697 | 1898 | 28168 | 1095 | 37473 | -139 | 36821 |
| 7L-2S | | MI | 6715 | 3282 | 12545 | 2519 | 15539 | 2027 | 17982 | 1591 | 22215 | 819 | 27034 | 399 | 24251 |
| 16-#10 | 2.20 | MA | 9578 | 2232 | 12342 | 2036 | 16187 | 1695 | 18607 | 1422 | 21800 | 973 | 28090 | 687 | 20246 |
| 4L-6S | | MI | 4391 | 2232 | 6184 | 1951 | 7638 | 1626 | 8496 | 1358 | 9498 | 914 | 11711 | 472 | 9195 |
| 16-#10 | 2.20 | MA | 9242 | 2232 | 11806 | 2049 | 15447 | 1715 | 17733 | 1435 | 20587 | 990 | 26358 | 641 | 19825 |
| 5E | | MI | 4559 | 2232 | 6427 | 1942 | 7957 | 1618 | 8903 | 1346 | 10060 | 910 | 12467 | 540 | 9406 |
| 16-#10 | 2.20 | MA | 8881 | 2232 | 11237 | 2057 | 14755 | 1727 | 16902 | 1448 | 19406 | 1002 | 24852 | 586 | 19127 |
| 6L-4S | | MI | 4676 | 2232 | 6676 | 1932 | 8310 | 1604 | 9319 | 1339 | 10636 | 901 | 13246 | 595 | 9642 |
| 16-#10 | 2.20 | MA | 8566 | 2232 | 10695 | 2067 | 14041 | 1735 | 16033 | 1465 | 18259 | 1019 | 23308 | 553 | 18393 |
| 7L-3S | | MI | 4802 | 2232 | 6954 | 1922 | 8674 | 1595 | 9783 | 1326 | 11270 | 897 | 14028 | 648 | 9690 |
| 16-#10 | 2.20 | MA | 8273 | 2232 | 10098 | 2085 | 13305 | 1751 | 15168 | 1474 | 17117 | 1031 | 21802 | 509 | 17509 |
| 8L-2S | | MI | 5025 | 2232 | 7351 | 1911 | 9175 | 1586 | 10390 | 1319 | 12087 | 888 | 15131 | 741 | 9711 |
| 16-#11 | 2.70 | MA | 9689 | 2368 | 12970 | 2135 | 16817 | 1780 | 19343 | 1478 | 22706 | 988 | 29293 | 585 | 23684 |
| 5E | | MI | 4719 | 2368 | 6957 | 2016 | 8552 | 1671 | 9586 | 1377 | 10945 | 896 | 13485 | 445 | 11087 |
| 16-#11 | 2.70 | MA | 9269 | 2368 | 12278 | 2145 | 15982 | 1795 | 18330 | 1493 | 21267 | 1002 | 27453 | 516 | 22833 |
| 6L-4S | | MI | 4863 | 2368 | 7258 | 2005 | 8978 | 1655 | 10089 | 1369 | 11640 | 886 | 14398 | 513 | 11489 |
| 16-#11 | 2.70 | MA | 8902 | 2368 | 11616 | 2157 | 15113 | 1805 | 17282 | 1514 | 19868 | 1023 | 25560 | 474 | 21656 |
| 7L-3S | | MI | 5001 | 2368 | 7594 | 1993 | 9417 | 1645 | 10648 | 1355 | 12403 | 883 | 15319 | 576 | 11590 |

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis



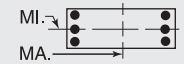

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.70 | MA | 8555 | 2368 | 10889 | 2178 | 14217 | 1824 | 16229 | 1525 | 18475 | 1036 | 23720 | 418 | 20525 |
| 8L-2S | | MI | 5246 | 2368 | 8070 | 1981 | 10019 | 1636 | 11377 | 1348 | 13384 | 873 | 16613 | 690 | 11630 |
| 16-#14 | 3.90 | MA | 10240 | 2693 | 14634 | 2368 | 18878 | 1970 | 21772 | 1613 | 25813 | 1013 | 33871 | 362 | 31027 |
| 6L-4S | | MI | 5337 | 2693 | 8567 | 2205 | 10582 | 1800 | 11992 | 1463 | 14176 | 870 | 17560 | 356 | 15610 |
| 16-#14 | 3.90 | MA | 9761 | 2693 | 13687 | 2385 | 17632 | 1984 | 20282 | 1643 | 23807 | 1042 | 31146 | 301 | 29216 |
| 7L-3S | | MI | 5506 | 2693 | 9046 | 2189 | 11206 | 1788 | 12787 | 1444 | 15262 | 867 | 18848 | 443 | 16201 |
| 16-#14 | 3.90 | MA | 9275 | 2693 | 12644 | 2415 | 16347 | 2011 | 18773 | 1658 | 21809 | 1061 | 28501 | 218 | 27136 |
| 8L-2S | | MI | 5816 | 2693 | 9721 | 2173 | 12059 | 1776 | 13820 | 1435 | 16652 | 855 | 20649 | 608 | 16303 |
| 16-#18 | 6.93 | MA | 12033 | 3517 | 18803 | 2965 | 23884 | 2437 | 27721 | 1968 | 33586 | 1086 | 44975 | -151 | 43959 |
| 7L-3S | | MI | 6691 | 3517 | 12545 | 2690 | 15539 | 2153 | 17982 | 1671 | 22215 | 826 | 27034 | 51 | 26817 |
| 18-#10 | 2.47 | MA | 9658 | 2306 | 12670 | 2095 | 16540 | 1749 | 19055 | 1457 | 22366 | 987 | 28823 | 637 | 22329 |
| 5L-6S | | MI | 4571 | 2306 | 6581 | 1998 | 8140 | 1661 | 9103 | 1380 | 10315 | 911 | 12815 | 464 | 10320 |
| 18-#10 | 2.47 | MA | 9310 | 2306 | 12101 | 2104 | 15848 | 1761 | 18224 | 1470 | 21186 | 999 | 27316 | 583 | 21642 |
| 6L-5S | | MI | 4734 | 2306 | 6823 | 1989 | 8459 | 1652 | 9510 | 1368 | 10877 | 908 | 13570 | 533 | 10522 |
| 18-#10 | 2.47 | MA | 9009 | 2306 | 11558 | 2114 | 15134 | 1770 | 17355 | 1487 | 20039 | 1016 | 25773 | 549 | 20899 |
| 7L-4S | | MI | 4849 | 2306 | 7072 | 1979 | 8812 | 1638 | 9926 | 1361 | 11453 | 898 | 14349 | 588 | 10787 |
| 18-#10 | 2.47 | MA | 8721 | 2306 | 10961 | 2131 | 14398 | 1786 | 16490 | 1496 | 18897 | 1028 | 24267 | 505 | 20018 |
| 8L-3S | | MI | 4970 | 2306 | 7351 | 1968 | 9175 | 1629 | 10390 | 1348 | 12087 | 894 | 15131 | 641 | 10841 |
| 18-#10 | 2.47 | MA | 8360 | 2306 | 10433 | 2142 | 13716 | 1797 | 15620 | 1512 | 17760 | 1045 | 22726 | 452 | 19055 |
| 9L-2S | | MI | 5188 | 2306 | 7748 | 1958 | 9677 | 1621 | 10997 | 1341 | 12904 | 885 | 16235 | 734 | 10868 |
| 18-#11 | 3.04 | MA | 9776 | 2460 | 13328 | 2202 | 17311 | 1837 | 19937 | 1520 | 23430 | 999 | 30448 | 512 | 25887 |
| 6L-5S | | MI | 4932 | 2460 | 7433 | 2074 | 9155 | 1713 | 10314 | 1404 | 11925 | 893 | 14778 | 433 | 12429 |
| 18-#11 | 3.04 | MA | 9428 | 2460 | 12666 | 2215 | 16441 | 1847 | 18889 | 1541 | 22031 | 1019 | 28555 | 469 | 24700 |
| 7L-4S | | MI | 5063 | 2460 | 7734 | 2062 | 9581 | 1697 | 10817 | 1396 | 12620 | 883 | 15692 | 501 | 12813 |
| 18-#11 | 3.04 | MA | 9087 | 2460 | 11939 | 2235 | 15545 | 1866 | 17836 | 1552 | 20638 | 1033 | 26715 | 414 | 23561 |
| 8L-3S | | MI | 5193 | 2460 | 8070 | 2050 | 10019 | 1688 | 11377 | 1382 | 13384 | 880 | 16613 | 563 | 12968 |
| 18-#11 | 3.04 | MA | 8664 | 2460 | 11301 | 2249 | 14714 | 1880 | 16775 | 1571 | 19264 | 1053 | 24827 | 349 | 22310 |
| 9L-2S | | MI | 5429 | 2460 | 8547 | 2039 | 10621 | 1678 | 12105 | 1375 | 14365 | 870 | 17907 | 678 | 13015 |
| 18-#14 | 4.38 | MA | 10491 | 2826 | 15189 | 2468 | 19533 | 2045 | 22582 | 1682 | 26903 | 1037 | 35432 | 294 | 33548 |
| 7L-4S | | MI | 5611 | 2826 | 9242 | 2287 | 11436 | 1861 | 13024 | 1502 | 15567 | 865 | 19361 | 333 | 17500 |
| 18-#14 | 4.38 | MA | 10014 | 2826 | 14146 | 2498 | 18248 | 2072 | 21072 | 1697 | 24904 | 1056 | 32788 | 211 | 31476 |
| 8L-3S | | MI | 5767 | 2826 | 9721 | 2272 | 12059 | 1849 | 13820 | 1483 | 16652 | 862 | 20649 | 421 | 18146 |
| 18-#14 | 4.38 | MA | 9452 | 2826 | 13238 | 2517 | 17056 | 2091 | 19551 | 1723 | 22933 | 1085 | 30070 | 117 | 29355 |
| 9L-2S | | MI | 6063 | 2826 | 10396 | 2256 | 12913 | 1836 | 14853 | 1474 | 18043 | 850 | 22451 | 586 | 18261 |
| 20-#10 | 2.75 | MA | 9729 | 2381 | 12965 | 2150 | 16941 | 1795 | 19546 | 1492 | 22966 | 996 | 29781 | 579 | 24157 |
| 6E | | MI | 4747 | 2381 | 6977 | 2045 | 8641 | 1695 | 9710 | 1402 | 11132 | 909 | 13918 | 457 | 11447 |
| 20-#10 | 2.75 | MA | 9441 | 2381 | 12422 | 2161 | 16227 | 1804 | 18676 | 1509 | 21819 | 1013 | 28237 | 545 | 23405 |
| 7L-5S | | MI | 4905 | 2381 | 7220 | 2036 | 8961 | 1687 | 10117 | 1390 | 11695 | 905 | 14674 | 526 | 11642 |
| 20-#10 | 2.75 | MA | 9156 | 2381 | 11825 | 2178 | 15491 | 1820 | 17812 | 1518 | 20676 | 1025 | 26731 | 501 | 22526 |
| 8L-4S | | MI | 5020 | 2381 | 7469 | 2025 | 9314 | 1672 | 10533 | 1383 | 12270 | 895 | 15453 | 580 | 11931 |
| 20-#10 | 2.75 | MA | 8809 | 2381 | 11297 | 2189 | 14809 | 1831 | 16942 | 1534 | 19540 | 1042 | 25190 | 449 | 21558 |
| 9L-3S | | MI | 5142 | 2381 | 7748 | 2015 | 9677 | 1664 | 10997 | 1370 | 12904 | 891 | 16235 | 633 | 11991 |
| 20-#10 | 2.75 | MA | 8484 | 2381 | 10756 | 2198 | 14141 | 1843 | 16103 | 1545 | 18366 | 1051 | 23681 | 411 | 20615 |
| 10L-2S | | MI | 5345 | 2381 | 8144 | 2005 | 10179 | 1655 | 11604 | 1363 | 13721 | 882 | 17338 | 727 | 12024 |
| 20-#11 | 3.38 | MA | 9940 | 2552 | 13716 | 2272 | 17770 | 1889 | 20496 | 1568 | 24194 | 1016 | 31550 | 465 | 27744 |
| 7L-5S | | MI | 5130 | 2552 | 7909 | 2131 | 9757 | 1755 | 11043 | 1430 | 12906 | 889 | 16072 | 420 | 13774 |
| 20-#11 | 3.38 | MA | 9604 | 2552 | 12989 | 2293 | 16873 | 1909 | 19442 | 1579 | 22801 | 1029 | 29710 | 409 | 26597 |
| 8L-4S | | MI | 5260 | 2552 | 8210 | 2119 | 10183 | 1739 | 11545 | 1423 | 13601 | 879 | 16985 | 488 | 14143 |
| 20-#11 | 3.38 | MA | 9199 | 2552 | 12351 | 2306 | 16042 | 1922 | 18382 | 1597 | 21428 | 1050 | 27822 | 344 | 25349 |
| 9L-3S | | MI | 5382 | 2552 | 8547 | 2108 | 10621 | 1730 | 12105 | 1409 | 14365 | 876 | 17907 | 551 | 14345 |
| 20-#11 | 3.38 | MA | 8820 | 2552 | 11693 | 2317 | 15228 | 1936 | 17360 | 1610 | 20004 | 1060 | 25977 | 295 | 23989 |
| 10L-2S | | MI | 5610 | 2552 | 9023 | 2096 | 11223 | 1720 | 12833 | 1402 | 15345 | 866 | 19200 | 665 | 14399 |
| 20-#14 | 4.87 | MA | 10730 | 2958 | 15649 | 2581 | 20149 | 2133 | 23371 | 1736 | 28000 | 1051 | 37074 | 204 | 35816 |
| 8L-4S | | MI | 5879 | 2958 | 9917 | 2370 | 12289 | 1922 | 14057 | 1541 | 16957 | 860 | 21163 | 311 | 19397 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

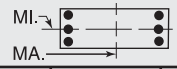
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 4.87 | MA | 10196 | 2958 | 14740 | 2600 | 18957 | 2151 | 21851 | 1762 | 26029 | 1080 | 34356 | 110 | 33686 |
| 9L-3S | | MI | 6024 | 2958 | 10396 | 2355 | 12913 | 1910 | 14853 | 1522 | 18043 | 857 | 22451 | 399 | 20092 |
| 22-#10 | 3.02 | MA | 9863 | 2456 | 13286 | 2208 | 17320 | 1838 | 19998 | 1531 | 23599 | 1011 | 30701 | 541 | 25912 |
| 7L-6S | | MI | 4921 | 2456 | 7374 | 2092 | 9143 | 1729 | 10317 | 1424 | 11950 | 906 | 15022 | 450 | 12577 |
| 22-#10 | 3.02 | MA | 9582 | 2456 | 12689 | 2225 | 16584 | 1854 | 19134 | 1540 | 22456 | 1022 | 29195 | 497 | 25034 |
| 8L-5S | | MI | 5084 | 2456 | 7617 | 2082 | 9463 | 1721 | 10724 | 1412 | 12512 | 902 | 15777 | 518 | 12765 |
| 22-#10 | 3.02 | MA | 9246 | 2456 | 12160 | 2236 | 15902 | 1866 | 18263 | 1556 | 21319 | 1039 | 27655 | 445 | 24060 |
| 9L-4S | | MI | 5199 | 2456 | 7866 | 2072 | 9816 | 1707 | 11140 | 1405 | 13088 | 893 | 16557 | 573 | 13076 |
| 22-#10 | 3.02 | MA | 8935 | 2456 | 11620 | 2245 | 15234 | 1878 | 17425 | 1566 | 20146 | 1048 | 26146 | 407 | 23112 |
| 10L-3S | | MI | 5303 | 2456 | 8144 | 2062 | 10179 | 1698 | 11604 | 1392 | 13721 | 889 | 17338 | 626 | 13141 |
| 22-#10 | 3.02 | MA | 8639 | 2456 | 11091 | 2255 | 14551 | 1888 | 16600 | 1578 | 18989 | 1063 | 24680 | 361 | 22058 |
| 11L-2S | | MI | 5499 | 2456 | 8541 | 2052 | 10681 | 1689 | 12211 | 1385 | 14538 | 879 | 18442 | 719 | 13178 |
| 22-#11 | 3.71 | MA | 10108 | 2644 | 14039 | 2350 | 18202 | 1951 | 21049 | 1606 | 24964 | 1026 | 32705 | 404 | 29633 |
| 8L-5S | | MI | 5324 | 2644 | 8385 | 2188 | 10359 | 1798 | 11771 | 1457 | 13887 | 886 | 17365 | 408 | 15123 |
| 22-#11 | 3.71 | MA | 9719 | 2644 | 13401 | 2364 | 17371 | 1964 | 19988 | 1624 | 23591 | 1046 | 30817 | 339 | 28389 |
| 9L-4S | | MI | 5453 | 2644 | 8686 | 2177 | 10785 | 1781 | 12274 | 1450 | 14582 | 876 | 18279 | 475 | 15477 |
| 22-#11 | 3.71 | MA | 9357 | 2644 | 12743 | 2375 | 16556 | 1978 | 18967 | 1637 | 22167 | 1057 | 28972 | 291 | 27023 |
| 10L-3S | | MI | 5568 | 2644 | 9023 | 2165 | 11223 | 1772 | 12833 | 1436 | 15345 | 873 | 19200 | 538 | 15721 |
| 22-#11 | 3.71 | MA | 9012 | 2644 | 12098 | 2387 | 15733 | 1991 | 17960 | 1650 | 20757 | 1074 | 27181 | 232 | 25629 |
| 11L-2S | | MI | 5788 | 2644 | 9499 | 2154 | 11826 | 1762 | 13562 | 1429 | 16326 | 863 | 20494 | 653 | 15781 |
| 22-#14 | 5.36 | MA | 10919 | 3091 | 16243 | 2683 | 20858 | 2212 | 24150 | 1801 | 29125 | 1075 | 38642 | 103 | 38017 |
| 9L-4S | | MI | 6144 | 3091 | 10592 | 2453 | 13143 | 1983 | 15090 | 1580 | 18347 | 855 | 22965 | 289 | 21300 |
| 24-#10 | 3.30 | MA | 9998 | 2531 | 13553 | 2272 | 17677 | 1889 | 20456 | 1562 | 24236 | 1020 | 31659 | 493 | 27542 |
| 8L-6S | | MI | 5104 | 2531 | 7771 | 2138 | 9645 | 1764 | 10924 | 1446 | 12767 | 903 | 16125 | 443 | 13708 |
| 24-#10 | 3.30 | MA | 9674 | 2531 | 13024 | 2282 | 16995 | 1900 | 19585 | 1578 | 23099 | 1036 | 30119 | 441 | 26563 |
| 9L-5S | | MI | 5249 | 2531 | 8013 | 2129 | 9965 | 1755 | 11331 | 1434 | 13329 | 899 | 16881 | 511 | 13891 |
| 24-#10 | 3.30 | MA | 9374 | 2531 | 12484 | 2292 | 16327 | 1912 | 18747 | 1588 | 21926 | 1045 | 28610 | 403 | 25610 |
| 10L-4S | | MI | 5363 | 2531 | 8262 | 2119 | 10317 | 1741 | 11747 | 1427 | 13905 | 890 | 17660 | 566 | 14220 |
| 24-#10 | 3.30 | MA | 9091 | 2531 | 11955 | 2302 | 15644 | 1922 | 17922 | 1600 | 20769 | 1060 | 27144 | 357 | 24558 |
| 11L-3S | | MI | 5462 | 2531 | 8541 | 2109 | 10681 | 1732 | 12211 | 1414 | 14538 | 886 | 18442 | 619 | 14290 |
| 24-#10 | 3.30 | MA | 8759 | 2531 | 11435 | 2313 | 14912 | 1937 | 17078 | 1617 | 19615 | 1069 | 25659 | 318 | 23450 |
| 12L-2S | | MI | 5652 | 2531 | 8938 | 2098 | 11183 | 1724 | 12818 | 1407 | 15356 | 876 | 19545 | 712 | 14332 |
| 24-#11 | 4.05 | MA | 10226 | 2736 | 14451 | 2421 | 18699 | 2006 | 21595 | 1651 | 25754 | 1043 | 33812 | 334 | 31429 |
| 9L-5S | | MI | 5516 | 2736 | 8861 | 2246 | 10961 | 1840 | 12499 | 1484 | 14868 | 882 | 18659 | 395 | 16475 |
| 24-#11 | 4.05 | MA | 9880 | 2736 | 13793 | 2432 | 17885 | 2020 | 20573 | 1664 | 24330 | 1053 | 31967 | 286 | 30056 |
| 10L-4S | | MI | 5644 | 2736 | 9162 | 2234 | 11387 | 1823 | 13002 | 1477 | 15563 | 873 | 19573 | 463 | 16815 |
| 24-#11 | 4.05 | MA | 9552 | 2736 | 13148 | 2444 | 17061 | 2033 | 19567 | 1677 | 22920 | 1071 | 30176 | 227 | 28657 |
| 11L-3S | | MI | 5752 | 2736 | 9499 | 2223 | 11826 | 1814 | 13562 | 1463 | 16326 | 870 | 20494 | 526 | 17097 |

## RECTANGULAR TIED COLUMNS 22" x 44"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.65 | MA | 10337 | 2182 | 13374 | 1983 | 17376 | 1657 | 19907 | 1394 | 23158 | 982 | 29425 | 853 | 16616 |
| 2E | | MI | 4770 | 2182 | 6964 | 1854 | 8464 | 1547 | 9386 | 1298 | 10545 | 905 | 12432 | 703 | 7455 |
| 6-#14 | 1.39 | MA | 10004 | 2109 | 12426 | 1949 | 16290 | 1633 | 18652 | 1381 | 21524 | 992 | 27203 | 862 | 14224 |
| 2L-3S | | MI | 4265 | 2109 | 5877 | 1847 | 7186 | 1545 | 7889 | 1303 | 8573 | 935 | 10136 | 591 | 6484 |
| 6-#14 | 1.39 | MA | 8989 | 2109 | 10841 | 1975 | 14285 | 1657 | 16227 | 1404 | 18258 | 1021 | 22681 | 719 | 14105 |
| 3L-2S | | MI | 4679 | 2109 | 6552 | 1831 | 8039 | 1533 | 8922 | 1294 | 9964 | 922 | 11938 | 756 | 6483 |
| 6-#18 | 2.48 | MA | 11568 | 2418 | 16151 | 2131 | 20889 | 1765 | 24156 | 1463 | 28879 | 973 | 37346 | 840 | 24725 |
| 2L-3S | | MI | 4592 | 2418 | 6964 | 2025 | 8464 | 1672 | 9386 | 1378 | 10545 | 912 | 12432 | 356 | 10710 |
| 6-#18 | 2.48 | MA | 9985 | 2418 | 13374 | 2175 | 17376 | 1806 | 19907 | 1502 | 23158 | 1023 | 29425 | 580 | 24205 |
| 3L-2S | | MI | 5221 | 2418 | 8123 | 2001 | 9929 | 1655 | 11158 | 1367 | 12932 | 897 | 15411 | 649 | 10853 |
| 8-#10 | 1.05 | MA | 9502 | 2010 | 11130 | 1902 | 14787 | 1600 | 16906 | 1363 | 19239 | 1004 | 24090 | 875 | 10901 |
| 2L-4S | | MI | 4114 | 2010 | 5288 | 1818 | 6549 | 1529 | 7155 | 1305 | 7632 | 956 | 9132 | 661 | 5077 |
| 8-#10 | 1.05 | MA | 8894 | 2010 | 10219 | 1917 | 13635 | 1614 | 15512 | 1376 | 17363 | 1021 | 21492 | 796 | 10871 |
| 3E | | MI | 4268 | 2010 | 5567 | 1808 | 6912 | 1520 | 7619 | 1293 | 8265 | 952 | 9913 | 714 | 5080 |
| 8-#10 | 1.05 | MA | 8543 | 2010 | 9601 | 1932 | 12825 | 1629 | 14475 | 1396 | 15944 | 1033 | 19790 | 746 | 10753 |
| 4L-2S | | MI | 4521 | 2010 | 5963 | 1798 | 7414 | 1511 | 8226 | 1286 | 9082 | 942 | 11017 | 808 | 5070 |

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.29 | MA | 9866 | 2079 | 12023 | 1936 | 15837 | 1624 | 18135 | 1377 | 20855 | 996 | 26298 | 867 | 13241 |
| 2L-4S | | MI | 4167 | 2079 | 5557 | 1848 | 6817 | 1548 | 7439 | 1315 | 7980 | 943 | 9522 | 601 | 6060 |
| 8-#11 | 1.29 | MA | 9152 | 2079 | 10916 | 1954 | 14436 | 1642 | 16440 | 1393 | 18573 | 1017 | 23139 | 769 | 13185 |
| 3E | | MI | 4347 | 2079 | 5893 | 1836 | 7255 | 1538 | 7999 | 1301 | 8744 | 940 | 10443 | 663 | 6082 |
| 8-#11 | 1.29 | MA | 8740 | 2079 | 10162 | 1972 | 13450 | 1659 | 15177 | 1416 | 16845 | 1031 | 21055 | 707 | 12981 |
| 4L-2S | | MI | 4642 | 2079 | 6369 | 1824 | 7858 | 1529 | 8727 | 1294 | 9725 | 930 | 11737 | 778 | 6076 |
| 8-#14 | 1.86 | MA | 10739 | 2241 | 14012 | 2032 | 18296 | 1694 | 21078 | 1420 | 24790 | 987 | 31726 | 856 | 18859 |
| 2L-4S | | MI | 4324 | 2241 | 6073 | 1945 | 7416 | 1618 | 8126 | 1361 | 8878 | 932 | 10650 | 481 | 8254 |
| 8-#14 | 1.86 | MA | 9786 | 2241 | 12426 | 2058 | 16290 | 1718 | 18652 | 1443 | 21524 | 1016 | 27203 | 712 | 18710 |
| 3E | | MI | 4565 | 2241 | 6552 | 1930 | 8039 | 1606 | 8922 | 1342 | 9964 | 930 | 11938 | 569 | 8444 |
| 8-#14 | 1.86 | MA | 9239 | 2241 | 11345 | 2083 | 14876 | 1742 | 16841 | 1476 | 19046 | 1036 | 24205 | 622 | 18164 |
| 4L-2S | | MI | 4960 | 2241 | 7227 | 1914 | 8893 | 1594 | 9954 | 1333 | 11354 | 917 | 13740 | 734 | 8470 |
| 8-#18 | 3.31 | MA | 11290 | 2653 | 16151 | 2322 | 20889 | 1914 | 24156 | 1571 | 28879 | 1014 | 37346 | 568 | 32282 |
| 3E | | MI | 5076 | 2653 | 8123 | 2172 | 9929 | 1780 | 11158 | 1447 | 12932 | 903 | 15411 | 302 | 14021 |
| 8-#18 | 3.31 | MA | 10471 | 2653 | 14250 | 2366 | 18403 | 1955 | 20974 | 1626 | 24527 | 1046 | 32044 | 405 | 28625 |
| 4L-2S | | MI | 5653 | 2653 | 9281 | 2148 | 11395 | 1763 | 12931 | 1436 | 15318 | 888 | 18390 | 596 | 14224 |
| 10-#10 | 1.31 | MA | 9949 | 2085 | 12041 | 1948 | 15939 | 1634 | 18299 | 1385 | 21115 | 1001 | 26687 | 871 | 13567 |
| 2L-5S | | MI | 4178 | 2085 | 5435 | 1875 | 6698 | 1577 | 7346 | 1334 | 7873 | 962 | 9456 | 600 | 6144 |
| 10-#10 | 1.31 | MA | 9365 | 2085 | 11130 | 1963 | 14787 | 1649 | 16906 | 1398 | 19239 | 1019 | 24090 | 792 | 13524 |
| 3L-4S | | MI | 4304 | 2085 | 5685 | 1865 | 7050 | 1563 | 7762 | 1327 | 8449 | 953 | 10235 | 654 | 6230 |
| 10-#10 | 1.31 | MA | 9035 | 2085 | 10512 | 1979 | 13977 | 1663 | 15869 | 1418 | 17820 | 1031 | 22388 | 742 | 13397 |
| 4L-3S | | MI | 4451 | 2085 | 5963 | 1855 | 7414 | 1554 | 8226 | 1315 | 9082 | 949 | 11017 | 707 | 6246 |
| 10-#10 | 1.31 | MA | 8660 | 2085 | 9945 | 1992 | 13199 | 1683 | 14949 | 1431 | 16543 | 1048 | 20567 | 697 | 13062 |
| 5L-2S | | MI | 4696 | 2085 | 6360 | 1845 | 7916 | 1546 | 8833 | 1308 | 9900 | 939 | 12121 | 801 | 6243 |
| 10-#11 | 1.61 | MA | 10391 | 2171 | 13131 | 1994 | 17238 | 1667 | 19829 | 1404 | 23136 | 993 | 29456 | 862 | 16479 |
| 2L-5S | | MI | 4242 | 2171 | 5732 | 1916 | 6993 | 1606 | 7665 | 1350 | 8266 | 950 | 9902 | 520 | 7164 |
| 10-#11 | 1.61 | MA | 9708 | 2171 | 12023 | 2012 | 15837 | 1684 | 18135 | 1420 | 20855 | 1014 | 26298 | 764 | 16408 |
| 3L-4S | | MI | 4390 | 2171 | 6033 | 1905 | 7419 | 1590 | 8168 | 1342 | 8961 | 940 | 10816 | 588 | 7434 |
| 10-#11 | 1.61 | MA | 9325 | 2171 | 11269 | 2030 | 14851 | 1701 | 16871 | 1443 | 19126 | 1028 | 24214 | 702 | 16195 |
| 4L-3S | | MI | 4560 | 2171 | 6369 | 1893 | 7858 | 1581 | 8727 | 1328 | 9725 | 937 | 11737 | 651 | 7473 |
| 10-#11 | 1.61 | MA | 8881 | 2171 | 10585 | 2046 | 13902 | 1725 | 15749 | 1459 | 17569 | 1049 | 21990 | 645 | 15421 |
| 5L-2S | | MI | 4845 | 2171 | 6845 | 1882 | 8460 | 1571 | 9456 | 1321 | 10705 | 927 | 13030 | 765 | 7480 |
| 10-#14 | 2.32 | MA | 10546 | 2374 | 14012 | 2140 | 18296 | 1779 | 21078 | 1482 | 24790 | 1011 | 31726 | 706 | 23319 |
| 3L-4S | | MI | 4631 | 2374 | 6748 | 2028 | 8269 | 1679 | 9158 | 1400 | 10268 | 927 | 12452 | 459 | 10092 |
| 10-#14 | 2.32 | MA | 10049 | 2374 | 12931 | 2166 | 16881 | 1803 | 19267 | 1514 | 22312 | 1031 | 28728 | 615 | 22786 |
| 4L-3S | | MI | 4856 | 2374 | 7227 | 2013 | 8893 | 1667 | 9954 | 1381 | 11354 | 925 | 13740 | 547 | 10396 |
| 10-#14 | 2.32 | MA | 9431 | 2374 | 11955 | 2190 | 15519 | 1837 | 17657 | 1537 | 20079 | 1061 | 25534 | 531 | 20864 |
| 5L-2S | | MI | 5230 | 2374 | 7902 | 1997 | 9747 | 1655 | 10987 | 1372 | 12744 | 912 | 15541 | 712 | 10444 |
| 10-#18 | 4.13 | MA | 11820 | 2889 | 17027 | 2513 | 21916 | 2064 | 25223 | 1696 | 30248 | 1037 | 39965 | 393 | 36654 |
| 4L-3S | | MI | 5541 | 2889 | 9281 | 2319 | 11395 | 1889 | 12931 | 1517 | 15318 | 895 | 18390 | 249 | 17336 |
| 10-#18 | 4.13 | MA | 10781 | 2889 | 15333 | 2556 | 19520 | 2122 | 22391 | 1734 | 26321 | 1087 | 34335 | 236 | 33092 |
| 5L-2S | | MI | 6075 | 2889 | 10439 | 2296 | 12860 | 1871 | 14703 | 1506 | 17704 | 879 | 21370 | 542 | 17584 |
| 12-#10 | 1.57 | MA | 10385 | 2160 | 12951 | 1995 | 17091 | 1669 | 19692 | 1407 | 22991 | 998 | 29285 | 867 | 16230 |
| 2L-6S | | MI | 4191 | 2160 | 5589 | 1931 | 6880 | 1620 | 7546 | 1369 | 8128 | 963 | 9804 | 524 | 7012 |
| 12-#10 | 1.57 | MA | 9821 | 2160 | 12041 | 2010 | 15939 | 1683 | 18299 | 1420 | 21115 | 1016 | 26687 | 789 | 16178 |
| 3L-5S | | MI | 4370 | 2160 | 5832 | 1922 | 7200 | 1612 | 7953 | 1356 | 8690 | 959 | 10560 | 592 | 7244 |
| 12-#10 | 1.57 | MA | 9511 | 2160 | 11422 | 2025 | 15129 | 1697 | 17262 | 1440 | 19696 | 1028 | 24985 | 738 | 16044 |
| 4E | | MI | 4490 | 2160 | 6081 | 1912 | 7552 | 1597 | 8369 | 1349 | 9266 | 950 | 11339 | 647 | 7379 |
| 12-#10 | 1.57 | MA | 9142 | 2160 | 10856 | 2038 | 14351 | 1717 | 16342 | 1453 | 18419 | 1046 | 23165 | 694 | 15696 |
| 5L-3S | | MI | 4630 | 2160 | 6360 | 1901 | 7916 | 1589 | 8833 | 1337 | 9900 | 946 | 12121 | 700 | 7405 |
| 12-#10 | 1.57 | MA | 8727 | 2160 | 10257 | 2047 | 13618 | 1729 | 15468 | 1467 | 17177 | 1058 | 21581 | 640 | 14905 |
| 6L-2S | | MI | 4868 | 2160 | 6757 | 1891 | 8417 | 1580 | 9440 | 1330 | 10717 | 937 | 13224 | 793 | 7411 |
| 12-#11 | 1.93 | MA | 10246 | 2262 | 13131 | 2069 | 17238 | 1726 | 19829 | 1447 | 23136 | 1010 | 29456 | 759 | 19632 |
| 3L-5S | | MI | 4467 | 2262 | 6208 | 1974 | 7596 | 1649 | 8393 | 1377 | 9247 | 946 | 11196 | 508 | 8487 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 44"

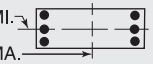
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.93 | MA | 9888 | 2262 | 12377 | 2087 | 16252 | 1743 | 18566 | 1470 | 21408 | 1025 | 27373 | 697 | 19413 |
| 4E | | MI | 4606 | 2262 | 6509 | 1962 | 8022 | 1632 | 8896 | 1369 | 9942 | 936 | 12109 | 576 | 8805 |
| 12-#11 | 1.93 | MA | 9452 | 2262 | 11692 | 2103 | 15302 | 1767 | 17443 | 1486 | 19851 | 1046 | 25149 | 640 | 18632 |
| 5L-3S | | MI | 4768 | 2262 | 6845 | 1951 | 8460 | 1623 | 9456 | 1355 | 10705 | 933 | 13030 | 638 | 8859 |
| 12-#11 | 1.93 | MA | 8964 | 2262 | 10963 | 2113 | 14418 | 1782 | 16377 | 1502 | 18336 | 1060 | 23215 | 573 | 17693 |
| 6L-2S | | MI | 5043 | 2262 | 7321 | 1939 | 9062 | 1613 | 10184 | 1348 | 11686 | 923 | 14324 | 753 | 8876 |
| 12-#14 | 2.79 | MA | 10826 | 2506 | 14516 | 2249 | 18887 | 1864 | 21693 | 1553 | 25578 | 1026 | 33250 | 608 | 27413 |
| 4E | | MI | 4942 | 2506 | 7423 | 2111 | 9123 | 1740 | 10191 | 1439 | 11659 | 922 | 14253 | 437 | 11947 |
| 12-#14 | 2.79 | MA | 10219 | 2506 | 13540 | 2272 | 17525 | 1898 | 20083 | 1576 | 23345 | 1056 | 30056 | 524 | 25467 |
| 5L-3S | | MI | 5145 | 2506 | 7902 | 2095 | 9747 | 1728 | 10987 | 1420 | 12744 | 920 | 15541 | 525 | 12345 |
| 12-#14 | 2.79 | MA | 9563 | 2506 | 12495 | 2286 | 16266 | 1920 | 18553 | 1599 | 21171 | 1075 | 27277 | 425 | 23737 |
| 6L-2S | | MI | 5491 | 2506 | 8577 | 2080 | 10601 | 1715 | 12020 | 1411 | 14135 | 907 | 17343 | 690 | 12411 |
| 12-#18 | 4.96 | MA | 12086 | 3124 | 18110 | 2703 | 23033 | 2231 | 26640 | 1803 | 32042 | 1078 | 42257 | 224 | 41084 |
| 5L-3S | | MI | 5991 | 3124 | 10439 | 2467 | 12860 | 1997 | 14703 | 1586 | 17704 | 886 | 21370 | 195 | 20614 |
| 12-#18 | 4.96 | MA | 11073 | 3124 | 16276 | 2726 | 20853 | 2270 | 23948 | 1841 | 28219 | 1110 | 37355 | 41 | 37102 |
| 6L-2S | | MI | 6489 | 3124 | 11598 | 2443 | 14325 | 1979 | 16475 | 1575 | 20091 | 870 | 24349 | 489 | 20938 |
| 14-#10 | 1.84 | MA | 10265 | 2235 | 12951 | 2057 | 17091 | 1717 | 19692 | 1442 | 22991 | 1013 | 29285 | 785 | 18832 |
| 3L-6S | | MI | 4379 | 2235 | 5986 | 1978 | 7382 | 1655 | 8153 | 1391 | 8945 | 960 | 10908 | 517 | 8129 |
| 14-#10 | 1.84 | MA | 9972 | 2235 | 12333 | 2072 | 16281 | 1732 | 18655 | 1462 | 21572 | 1025 | 27583 | 734 | 18692 |
| 4L-5S | | MI | 4553 | 2235 | 6229 | 1969 | 7701 | 1646 | 8560 | 1378 | 9507 | 957 | 11663 | 585 | 8350 |
| 14-#10 | 1.84 | MA | 9609 | 2235 | 11767 | 2085 | 15503 | 1752 | 17735 | 1475 | 20295 | 1043 | 25762 | 690 | 18333 |
| 5L-4S | | MI | 4671 | 2235 | 6478 | 1958 | 8054 | 1632 | 8976 | 1371 | 10083 | 947 | 12442 | 640 | 8526 |
| 14-#10 | 1.84 | MA | 9210 | 2235 | 11167 | 2093 | 14770 | 1763 | 16861 | 1489 | 19053 | 1055 | 24179 | 636 | 17556 |
| 6L-3S | | MI | 4805 | 2235 | 6757 | 1948 | 8417 | 1623 | 9440 | 1359 | 10717 | 943 | 13224 | 693 | 8560 |
| 14-#10 | 1.84 | MA | 8859 | 2235 | 10596 | 2104 | 14019 | 1772 | 15940 | 1505 | 17847 | 1073 | 22560 | 603 | 16847 |
| 7L-2S | | MI | 5036 | 2235 | 7153 | 1938 | 8919 | 1614 | 10047 | 1352 | 11534 | 934 | 14328 | 786 | 8573 |
| 14-#11 | 2.26 | MA | 10434 | 2354 | 13484 | 2145 | 17653 | 1785 | 20260 | 1497 | 23689 | 1021 | 30532 | 692 | 22634 |
| 4L-5S | | MI | 4684 | 2354 | 6684 | 2031 | 8198 | 1691 | 9122 | 1403 | 10228 | 943 | 12489 | 495 | 9816 |
| 14-#11 | 2.26 | MA | 10004 | 2354 | 12800 | 2161 | 16703 | 1809 | 19138 | 1513 | 22132 | 1042 | 28308 | 636 | 21846 |
| 5L-4S | | MI | 4817 | 2354 | 6985 | 2020 | 8624 | 1674 | 9625 | 1396 | 10923 | 933 | 13403 | 563 | 10175 |
| 14-#11 | 2.26 | MA | 9537 | 2354 | 12070 | 2171 | 15819 | 1824 | 18072 | 1529 | 20617 | 1056 | 26373 | 568 | 20915 |
| 6L-3S | | MI | 4971 | 2354 | 7321 | 2008 | 9062 | 1665 | 10184 | 1382 | 11686 | 930 | 14324 | 626 | 10240 |
| 14-#11 | 2.26 | MA | 9126 | 2354 | 11374 | 2183 | 14903 | 1835 | 16961 | 1550 | 19145 | 1077 | 24388 | 526 | 19759 |
| 7L-2S | | MI | 5238 | 2354 | 7797 | 1997 | 9664 | 1656 | 10912 | 1375 | 12667 | 920 | 15618 | 740 | 10267 |
| 14-#14 | 3.25 | MA | 10977 | 2639 | 15125 | 2355 | 19530 | 1959 | 22508 | 1615 | 26611 | 1051 | 34579 | 518 | 30070 |
| 5L-4S | | MI | 5230 | 2639 | 8098 | 2194 | 9977 | 1801 | 11224 | 1478 | 13049 | 917 | 16055 | 415 | 13816 |
| 14-#14 | 3.25 | MA | 10358 | 2639 | 14080 | 2369 | 18271 | 1980 | 20979 | 1638 | 24438 | 1070 | 31800 | 418 | 28322 |
| 6L-3S | | MI | 5417 | 2639 | 8577 | 2178 | 10601 | 1789 | 12020 | 1459 | 14135 | 915 | 17343 | 503 | 14291 |
| 14-#14 | 3.25 | MA | 9812 | 2639 | 13082 | 2387 | 16959 | 1995 | 19398 | 1668 | 22326 | 1100 | 28940 | 357 | 26446 |
| 7L-2S | | MI | 5747 | 2639 | 9252 | 2163 | 11455 | 1776 | 13052 | 1450 | 15525 | 902 | 19145 | 668 | 14374 |
| 14-#18 | 5.79 | MA | 12403 | 3360 | 19053 | 2873 | 24366 | 2378 | 28197 | 1910 | 33940 | 1102 | 45277 | 28 | 45118 |
| 6L-3S | | MI | 6433 | 3360 | 11598 | 2614 | 14325 | 2105 | 16475 | 1655 | 20091 | 877 | 24349 | 142 | 23772 |
| 14-#18 | 5.79 | MA | 11573 | 3360 | 17299 | 2903 | 22060 | 2403 | 25461 | 1966 | 30225 | 1151 | 40209 | -83 | 39797 |
| 7L-2S | | MI | 6898 | 3360 | 12756 | 2590 | 15791 | 2088 | 18248 | 1644 | 22477 | 861 | 27329 | 435 | 24289 |
| 16-#10 | 2.10 | MA | 10421 | 2309 | 13244 | 2119 | 17433 | 1766 | 20049 | 1484 | 23448 | 1022 | 30180 | 731 | 21343 |
| 4L-6S | | MI | 4563 | 2309 | 6383 | 2025 | 7883 | 1689 | 8760 | 1413 | 9762 | 958 | 12011 | 510 | 9250 |
| 16-#10 | 2.10 | MA | 10063 | 2309 | 12677 | 2132 | 16655 | 1786 | 19128 | 1497 | 22171 | 1040 | 28360 | 686 | 20973 |
| 5E | | MI | 4732 | 2309 | 6625 | 2015 | 8203 | 1680 | 9167 | 1400 | 10324 | 954 | 12767 | 578 | 9462 |
| 16-#10 | 2.10 | MA | 9679 | 2309 | 12078 | 2140 | 15922 | 1798 | 18255 | 1511 | 20929 | 1052 | 26776 | 632 | 20207 |
| 6L-4S | | MI | 4849 | 2309 | 6875 | 2005 | 8556 | 1666 | 9583 | 1393 | 10900 | 944 | 13546 | 633 | 9671 |
| 16-#10 | 2.10 | MA | 9344 | 2309 | 11507 | 2151 | 15171 | 1807 | 17334 | 1527 | 19723 | 1070 | 25157 | 599 | 19489 |
| 7L-3S | | MI | 4977 | 2309 | 7153 | 1995 | 8919 | 1657 | 10047 | 1381 | 11534 | 940 | 14328 | 686 | 9714 |
| 16-#10 | 2.10 | MA | 9030 | 2309 | 10878 | 2168 | 14396 | 1823 | 16423 | 1537 | 18521 | 1082 | 23575 | 556 | 18544 |
| 8L-2S | | MI | 5201 | 2309 | 7550 | 1985 | 9421 | 1649 | 10654 | 1374 | 12351 | 931 | 15431 | 779 | 9733 |
| 16-#11 | 2.58 | MA | 10540 | 2446 | 13907 | 2218 | 18104 | 1851 | 20832 | 1540 | 24413 | 1039 | 31466 | 631 | 25062 |
| 5E | | MI | 4892 | 2446 | 7160 | 2089 | 8800 | 1733 | 9850 | 1430 | 11208 | 939 | 13783 | 483 | 11152 |
| 16-#11 | 2.58 | MA | 10092 | 2446 | 13177 | 2228 | 17220 | 1866 | 19766 | 1556 | 22898 | 1053 | 29532 | 563 | 24136 |
| 6L-4S | | MI | 5024 | 2446 | 7461 | 2077 | 9226 | 1717 | 10353 | 1423 | 11903 | 929 | 14697 | 551 | 11544 |

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

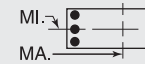



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.58 | MA | 9702 | 2446 | 12481 | 2241 | 16304 | 1877 | 18655 | 1577 | 21427 | 1074 | 27547 | 521 | 22970 |
| 7L-3S | | MI | 5177 | 2446 | 7797 | 2066 | 9664 | 1707 | 10912 | 1409 | 12667 | 926 | 15618 | 613 | 11620 |
| 16-#11 | 2.58 | MA | 9331 | 2446 | 11715 | 2262 | 15360 | 1896 | 17546 | 1588 | 19961 | 1088 | 25613 | 467 | 21821 |
| 8L-2S | | MI | 5425 | 2446 | 8273 | 2054 | 10267 | 1698 | 11641 | 1402 | 13648 | 916 | 16911 | 728 | 11655 |
| 16-#14 | 3.72 | MA | 11125 | 2771 | 15666 | 2452 | 20277 | 2041 | 23405 | 1677 | 27704 | 1065 | 36322 | 411 | 32906 |
| 6L-4S | | MI | 5510 | 2771 | 8773 | 2277 | 10831 | 1862 | 12256 | 1517 | 14439 | 912 | 17857 | 393 | 15694 |
| 16-#14 | 3.72 | MA | 10615 | 2771 | 14667 | 2470 | 18964 | 2056 | 21823 | 1707 | 25592 | 1095 | 33463 | 350 | 31037 |
| 7L-3S | | MI | 5683 | 2771 | 9252 | 2261 | 11455 | 1849 | 13052 | 1497 | 15525 | 910 | 19145 | 481 | 16238 |
| 16-#14 | 3.72 | MA | 10094 | 2771 | 13569 | 2500 | 17611 | 2084 | 20233 | 1722 | 23488 | 1114 | 30683 | 270 | 28836 |
| 8L-2S | | MI | 5998 | 2771 | 9927 | 2245 | 12308 | 1837 | 14085 | 1488 | 16916 | 897 | 20946 | 646 | 16333 |
| 16-#18 | 6.61 | MA | 12926 | 3595 | 20077 | 3050 | 25574 | 2511 | 29710 | 2035 | 35946 | 1143 | 48130 | -95 | 47456 |
| 7L-3S | | MI | 6867 | 3595 | 12756 | 2761 | 15791 | 2213 | 18248 | 1724 | 22477 | 868 | 27329 | 88 | 26953 |
| 18-#10 | 2.36 | MA | 10505 | 2384 | 13588 | 2178 | 17807 | 1820 | 20522 | 1519 | 24047 | 1037 | 30957 | 682 | 23615 |
| 5L-6S | | MI | 4743 | 2384 | 6780 | 2071 | 8385 | 1723 | 9367 | 1435 | 10579 | 955 | 13115 | 502 | 10374 |
| 18-#10 | 2.36 | MA | 10135 | 2384 | 12989 | 2187 | 17074 | 1832 | 19648 | 1533 | 22805 | 1049 | 29374 | 628 | 22859 |
| 6L-5S | | MI | 4907 | 2384 | 7022 | 2062 | 8705 | 1715 | 9773 | 1422 | 11142 | 951 | 13870 | 571 | 10578 |
| 18-#10 | 2.36 | MA | 9814 | 2384 | 12417 | 2197 | 16323 | 1841 | 18727 | 1549 | 21599 | 1067 | 27755 | 595 | 22131 |
| 7L-4S | | MI | 5023 | 2384 | 7271 | 2052 | 9058 | 1700 | 10190 | 1415 | 11717 | 941 | 14650 | 626 | 10816 |
| 18-#10 | 2.36 | MA | 9506 | 2384 | 11789 | 2215 | 15548 | 1857 | 17817 | 1559 | 20397 | 1079 | 26172 | 552 | 21188 |
| 8L-3S | | MI | 5146 | 2384 | 7550 | 2042 | 9421 | 1692 | 10654 | 1403 | 12351 | 938 | 15431 | 679 | 10866 |
| 18-#10 | 2.36 | MA | 9122 | 2384 | 11229 | 2226 | 14831 | 1869 | 16901 | 1575 | 19191 | 1096 | 24557 | 500 | 20221 |
| 9L-2S | | MI | 5364 | 2384 | 7947 | 2031 | 9923 | 1683 | 11261 | 1395 | 13168 | 928 | 16535 | 772 | 10890 |
| 18-#11 | 2.90 | MA | 10632 | 2538 | 14285 | 2286 | 18621 | 1908 | 21460 | 1583 | 25180 | 1049 | 32691 | 559 | 27358 |
| 6L-5S | | MI | 5106 | 2538 | 7636 | 2146 | 9402 | 1775 | 10578 | 1457 | 12189 | 936 | 15076 | 470 | 12492 |
| 18-#11 | 2.90 | MA | 10262 | 2538 | 13588 | 2298 | 17705 | 1919 | 20349 | 1604 | 23708 | 1071 | 30706 | 517 | 26181 |
| 7L-4S | | MI | 5238 | 2538 | 7937 | 2134 | 9828 | 1759 | 11081 | 1450 | 12884 | 926 | 15990 | 538 | 12885 |
| 18-#11 | 2.90 | MA | 9896 | 2538 | 12822 | 2319 | 16761 | 1938 | 19240 | 1615 | 22242 | 1085 | 28771 | 462 | 25023 |
| 8L-3S | | MI | 5370 | 2538 | 8273 | 2123 | 10267 | 1749 | 11641 | 1436 | 13648 | 923 | 16911 | 601 | 12998 |
| 18-#11 | 2.90 | MA | 9447 | 2538 | 12146 | 2333 | 15886 | 1952 | 18124 | 1634 | 20790 | 1105 | 26791 | 398 | 23678 |
| 9L-2S | | MI | 5610 | 2538 | 8749 | 2111 | 10869 | 1740 | 12369 | 1429 | 14628 | 913 | 18205 | 715 | 13041 |
| 18-#14 | 4.18 | MA | 11390 | 2903 | 16253 | 2552 | 20970 | 2117 | 24249 | 1746 | 28858 | 1090 | 37985 | 343 | 35628 |
| 7L-4S | | MI | 5785 | 2903 | 9448 | 2359 | 11685 | 1923 | 13289 | 1555 | 15830 | 907 | 19658 | 371 | 17582 |
| 18-#14 | 4.18 | MA | 10880 | 2903 | 15154 | 2582 | 19617 | 2145 | 22659 | 1761 | 26754 | 1110 | 35205 | 263 | 33416 |
| 8L-3S | | MI | 5945 | 2903 | 9927 | 2344 | 12308 | 1910 | 14085 | 1536 | 16916 | 905 | 20946 | 458 | 18184 |
| 18-#14 | 4.18 | MA | 10281 | 2903 | 14191 | 2602 | 18361 | 2164 | 21057 | 1788 | 24679 | 1139 | 32353 | 169 | 31242 |
| 9L-2S | | MI | 6246 | 2903 | 10602 | 2328 | 13162 | 1898 | 15117 | 1527 | 18306 | 892 | 22748 | 624 | 18292 |
| 20-#10 | 2.62 | MA | 10580 | 2459 | 13899 | 2234 | 18226 | 1866 | 21041 | 1555 | 24681 | 1047 | 31971 | 625 | 25510 |
| 6E | | MI | 4920 | 2459 | 7176 | 2118 | 8887 | 1758 | 9973 | 1457 | 11397 | 952 | 14218 | 495 | 11501 |
| 20-#10 | 2.62 | MA | 10273 | 2459 | 13328 | 2244 | 17475 | 1875 | 20120 | 1571 | 23474 | 1064 | 30352 | 591 | 24773 |
| 7L-5S | | MI | 5079 | 2459 | 7419 | 2109 | 9207 | 1749 | 10380 | 1444 | 11959 | 948 | 14974 | 564 | 11697 |
| 20-#10 | 2.62 | MA | 9969 | 2459 | 12699 | 2262 | 16700 | 1892 | 19210 | 1581 | 22273 | 1076 | 28770 | 548 | 23833 |
| 8L-4S | | MI | 5195 | 2459 | 7668 | 2099 | 9559 | 1735 | 10797 | 1437 | 12535 | 939 | 15753 | 618 | 11961 |
| 20-#10 | 2.62 | MA | 9599 | 2459 | 12140 | 2272 | 15983 | 1903 | 18294 | 1597 | 21067 | 1093 | 27154 | 496 | 22859 |
| 9L-3S | | MI | 5320 | 2459 | 7947 | 2088 | 9923 | 1726 | 11261 | 1424 | 13168 | 935 | 16535 | 671 | 12016 |
| 20-#10 | 2.62 | MA | 9254 | 2459 | 11571 | 2282 | 15280 | 1915 | 17412 | 1608 | 19832 | 1102 | 25569 | 459 | 21914 |
| 10L-2S | | MI | 5525 | 2459 | 8343 | 2078 | 10425 | 1717 | 11868 | 1417 | 13985 | 925 | 17638 | 765 | 12046 |
| 20-#11 | 3.22 | MA | 10806 | 2630 | 14696 | 2356 | 19106 | 1961 | 22044 | 1631 | 25989 | 1067 | 33864 | 512 | 29392 |
| 7L-5S | | MI | 5305 | 2630 | 8112 | 2203 | 10005 | 1817 | 11307 | 1484 | 13170 | 932 | 16370 | 458 | 13837 |
| 20-#11 | 3.22 | MA | 10446 | 2630 | 13930 | 2377 | 18162 | 1981 | 20935 | 1642 | 24523 | 1081 | 31930 | 457 | 28225 |
| 8L-4S | | MI | 5435 | 2630 | 8413 | 2192 | 10430 | 1801 | 11810 | 1477 | 13865 | 922 | 17284 | 526 | 14213 |
| 20-#11 | 3.22 | MA | 10014 | 2630 | 13254 | 2390 | 17287 | 1994 | 19818 | 1661 | 23071 | 1102 | 29950 | 393 | 26884 |
| 9L-3S | | MI | 5560 | 2630 | 8749 | 2180 | 10869 | 1792 | 12369 | 1463 | 14628 | 919 | 18205 | 588 | 14375 |
| 20-#11 | 3.22 | MA | 9611 | 2630 | 12561 | 2401 | 16430 | 2009 | 18742 | 1674 | 21566 | 1112 | 28011 | 346 | 25499 |
| 10L-2S | | MI | 5791 | 2630 | 9226 | 2169 | 11471 | 1782 | 13098 | 1456 | 15609 | 909 | 19498 | 703 | 14425 |
| 20-#14 | 4.65 | MA | 11641 | 3036 | 16740 | 2665 | 21622 | 2205 | 25085 | 1800 | 30021 | 1105 | 39728 | 256 | 37996 |
| 8L-4S | | MI | 6054 | 3036 | 10123 | 2442 | 12538 | 1983 | 14322 | 1594 | 17220 | 902 | 21460 | 349 | 19477 |
| 20-#14 | 4.65 | MA | 11072 | 3036 | 15776 | 2685 | 20367 | 2225 | 23483 | 1827 | 27946 | 1134 | 36876 | 162 | 35812 |
| 9L-3S | | MI | 6203 | 3036 | 10602 | 2426 | 13162 | 1971 | 15117 | 1575 | 18306 | 900 | 22748 | 436 | 20130 |

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 2.89 | MA | 10721 | 2534 | 14238 | 2291 | 18627 | 1910 | 21513 | 1593 | 25350 | 1061 | 32950 | 587 | 27416 |
| 7L-6S | | MI | 5094 | 2534 | 7573 | 2165 | 9389 | 1792 | 10580 | 1479 | 12214 | 949 | 15322 | 488 | 12629 |
| 22-#10 | 2.89 | MA | 10421 | 2534 | 13610 | 2308 | 17852 | 1926 | 20603 | 1603 | 24149 | 1074 | 31367 | 544 | 26477 |
| 8L-5S | | MI | 5249 | 2534 | 7816 | 2156 | 9709 | 1783 | 10987 | 1466 | 12776 | 945 | 16077 | 557 | 12819 |
| 22-#10 | 2.89 | MA | 10064 | 2534 | 13050 | 2319 | 17135 | 1938 | 19687 | 1619 | 22943 | 1090 | 29752 | 492 | 25497 |
| 9L-4S | | MI | 5375 | 2534 | 8065 | 2145 | 10061 | 1769 | 11404 | 1459 | 13352 | 936 | 16857 | 611 | 13106 |
| 22-#10 | 2.89 | MA | 9732 | 2534 | 12481 | 2329 | 16432 | 1950 | 18805 | 1630 | 21708 | 1099 | 28166 | 455 | 24547 |
| 10L-3S | | MI | 5481 | 2534 | 8343 | 2135 | 10425 | 1760 | 11868 | 1446 | 13985 | 932 | 17638 | 664 | 13167 |
| 22-#10 | 2.89 | MA | 9418 | 2534 | 11924 | 2339 | 15708 | 1960 | 17937 | 1641 | 20490 | 1114 | 26627 | 410 | 23414 |
| 11L-2S | | MI | 5680 | 2534 | 8740 | 2125 | 10927 | 1752 | 12475 | 1439 | 14803 | 923 | 18742 | 758 | 13201 |
| 22-#11 | 3.55 | MA | 10982 | 2722 | 15037 | 2434 | 19563 | 2023 | 22629 | 1669 | 26804 | 1078 | 35089 | 453 | 31427 |
| 8L-5S | | MI | 5500 | 2722 | 8588 | 2261 | 10607 | 1859 | 12035 | 1511 | 14151 | 929 | 17664 | 445 | 15184 |
| 22-#11 | 3.55 | MA | 10567 | 2722 | 14361 | 2447 | 18688 | 2036 | 21512 | 1688 | 25353 | 1098 | 33108 | 388 | 30091 |
| 9L-4S | | MI | 5629 | 2722 | 8889 | 2249 | 11033 | 1843 | 12538 | 1504 | 14845 | 919 | 18577 | 513 | 15545 |
| 22-#11 | 3.55 | MA | 10182 | 2722 | 13668 | 2459 | 17831 | 2051 | 20437 | 1701 | 23847 | 1109 | 31170 | 341 | 28699 |
| 10L-3S | | MI | 5747 | 2722 | 9226 | 2238 | 11471 | 1834 | 13098 | 1490 | 15609 | 916 | 19498 | 576 | 15752 |
| 22-#11 | 3.55 | MA | 9815 | 2722 | 12989 | 2471 | 16958 | 2063 | 19377 | 1715 | 22363 | 1127 | 29287 | 283 | 27279 |
| 11L-2S | | MI | 5971 | 2722 | 9702 | 2226 | 12073 | 1824 | 13826 | 1483 | 16590 | 906 | 20792 | 690 | 15809 |
| 22-#14 | 5.11 | MA | 11840 | 3168 | 17362 | 2767 | 22373 | 2286 | 25909 | 1866 | 31212 | 1129 | 41398 | 155 | 40382 |
| 9L-4S | | MI | 6320 | 3168 | 10798 | 2525 | 13392 | 2044 | 15354 | 1633 | 18611 | 897 | 23262 | 327 | 21378 |
| 24-#10 | 3.15 | MA | 10864 | 2609 | 14521 | 2355 | 19004 | 1960 | 21997 | 1625 | 26025 | 1071 | 33965 | 540 | 29121 |
| 8L-6S | | MI | 5279 | 2609 | 7970 | 2211 | 9891 | 1826 | 11187 | 1501 | 13031 | 946 | 16426 | 481 | 13760 |
| 24-#10 | 3.15 | MA | 10518 | 2609 | 13961 | 2366 | 18286 | 1972 | 21081 | 1641 | 24819 | 1087 | 32349 | 488 | 28136 |
| 9L-5S | | MI | 5425 | 2609 | 8212 | 2202 | 10210 | 1818 | 11594 | 1488 | 13593 | 943 | 17181 | 549 | 13944 |
| 24-#10 | 3.15 | MA | 10199 | 2609 | 13392 | 2375 | 17584 | 1984 | 20198 | 1652 | 23584 | 1096 | 30764 | 451 | 27180 |
| 10L-4S | | MI | 5539 | 2609 | 8461 | 2192 | 10563 | 1803 | 12011 | 1481 | 14169 | 933 | 17960 | 604 | 14251 |
| 24-#10 | 3.15 | MA | 9898 | 2609 | 12835 | 2386 | 16860 | 1994 | 19330 | 1663 | 22366 | 1111 | 29224 | 406 | 26050 |
| 11L-3S | | MI | 5641 | 2609 | 8740 | 2182 | 10927 | 1795 | 12475 | 1468 | 14803 | 929 | 18742 | 657 | 14316 |
| 24-#10 | 3.15 | MA | 9543 | 2609 | 12288 | 2397 | 16090 | 2010 | 18442 | 1681 | 21152 | 1121 | 27598 | 360 | 24923 |
| 12L-2S | | MI | 5834 | 2609 | 9137 | 2172 | 11428 | 1786 | 13082 | 1461 | 15620 | 920 | 19846 | 750 | 14355 |
| 24-#11 | 3.87 | MA | 11107 | 2813 | 15469 | 2505 | 20089 | 2079 | 23207 | 1715 | 27634 | 1095 | 36267 | 383 | 33297 |
| 9L-5S | | MI | 5692 | 2813 | 9064 | 2318 | 11209 | 1902 | 12764 | 1538 | 15131 | 925 | 18957 | 433 | 16535 |
| 24-#11 | 3.87 | MA | 10738 | 2813 | 14775 | 2516 | 19232 | 2093 | 22131 | 1728 | 26128 | 1105 | 34328 | 336 | 31899 |
| 10L-4S | | MI | 5821 | 2813 | 9365 | 2307 | 11635 | 1885 | 13267 | 1531 | 15826 | 915 | 19871 | 501 | 16883 |
| 24-#11 | 3.87 | MA | 10388 | 2813 | 14096 | 2529 | 18359 | 2106 | 21072 | 1742 | 24644 | 1123 | 32446 | 279 | 30473 |
| 11L-3S | | MI | 5932 | 2813 | 9702 | 2295 | 12073 | 1876 | 13826 | 1517 | 16590 | 912 | 20792 | 563 | 17129 |

## RECTANGULAR TIED COLUMNS 24" x 24"

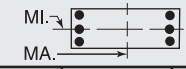
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#9 | 1.04 | MA | 2962 | 1195 | 3813 | 1082 | 4804 | 910 | 5363 | 775 | 5957 | 569 | 7332 | 496 | 3313 |
| 2L-3S | | MI | 2734 | 1195 | 3461 | 1091 | 4359 | 918 | 4825 | 781 | 5233 | 578 | 6329 | 423 | 3315 |
| 6-#10 | 1.32 | MA | 3082 | 1243 | 4108 | 1109 | 5162 | 929 | 5788 | 786 | 6522 | 565 | 8105 | 491 | 4136 |
| 2L-3S | | MI | 2803 | 1243 | 3664 | 1120 | 4601 | 939 | 5109 | 795 | 5608 | 576 | 6841 | 398 | 4126 |
| 6-#11 | 1.63 | MA | 3186 | 1294 | 4432 | 1132 | 5530 | 945 | 6211 | 795 | 7072 | 558 | 8758 | 474 | 4967 |
| 2L-3S | | MI | 2863 | 1294 | 3899 | 1145 | 4855 | 956 | 5395 | 804 | 5973 | 570 | 7269 | 359 | 4941 |
| 6-#14 | 2.34 | MA | 3454 | 1416 | 5143 | 1202 | 6399 | 996 | 7247 | 826 | 8453 | 550 | 10522 | 449 | 6963 |
| 2L-3S | | MI | 3024 | 1416 | 4386 | 1219 | 5441 | 1010 | 6088 | 837 | 6892 | 565 | 8439 | 284 | 6863 |
| 6-#18 | 4.17 | MA | 4042 | 1725 | 6861 | 1382 | 8513 | 1127 | 9774 | 907 | 11828 | 530 | 14664 | 368 | 11802 |
| 2L-3S | | MI | 3421 | 1725 | 5556 | 1410 | 6862 | 1149 | 7776 | 923 | 9138 | 552 | 11189 | 74 | 10977 |
| 8-#8 | 1.10 | MA | 2995 | 1204 | 3858 | 1091 | 4876 | 917 | 5457 | 780 | 6091 | 570 | 7522 | 497 | 3490 |
| 2L-4S | | MI | 2708 | 1204 | 3384 | 1106 | 4268 | 930 | 4704 | 794 | 5071 | 581 | 6166 | 406 | 3478 |
| 8-#9 | 1.39 | MA | 3121 | 1254 | 4164 | 1119 | 5249 | 937 | 5901 | 792 | 6682 | 566 | 8336 | 492 | 4349 |
| 2L-4S | | MI | 2772 | 1254 | 3567 | 1137 | 4484 | 953 | 4954 | 810 | 5399 | 580 | 6628 | 377 | 4300 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

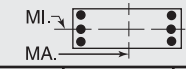
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.76 | MA | 3275 | 1317 | 4551 | 1156 | 5723 | 964 | 6466 | 808 | 7435 | 562 | 9369 | 487 | 5436 |
| 2L-4S | | MI | 2854 | 1317 | 3798 | 1178 | 4758 | 983 | 5271 | 830 | 5817 | 578 | 7214 | 339 | 5316 |
| 8-#11 | 2.17 | MA | 3410 | 1386 | 4966 | 1190 | 6205 | 988 | 7027 | 822 | 8171 | 554 | 10248 | 466 | 6527 |
| 2L-4S | | MI | 2923 | 1386 | 4058 | 1215 | 5041 | 1009 | 5587 | 846 | 6220 | 571 | 7704 | 286 | 6173 |
| 8-#14 | 3.13 | MA | 3750 | 1548 | 5901 | 1285 | 7358 | 1057 | 8406 | 865 | 10014 | 545 | 12605 | 433 | 9169 |
| 2L-4S | | MI | 3118 | 1548 | 4610 | 1320 | 5703 | 1086 | 6359 | 898 | 7240 | 566 | 9043 | 176 | 8147 |
| 8-#18 | 5.56 | MA | 4512 | 1960 | 8167 | 1530 | 10165 | 1235 | 11771 | 976 | 14517 | 522 | 18140 | 328 | 15586 |
| 2L-4S | | MI | 3624 | 1960 | 5935 | 1585 | 7306 | 1278 | 8234 | 1026 | 9726 | 547 | 12179 | -121 | 11968 |
| 10-#10 | 2.20 | MA | 3463 | 1392 | 4994 | 1202 | 6284 | 998 | 7145 | 830 | 8349 | 559 | 10632 | 483 | 6731 |
| 2L-5S | | MI | 2923 | 1392 | 3965 | 1236 | 4927 | 1033 | 5487 | 860 | 6090 | 587 | 7586 | 280 | 6127 |
| 10-#10 | 2.20 | MA | 3211 | 1392 | 4551 | 1214 | 5723 | 1008 | 6466 | 838 | 7435 | 570 | 9369 | 390 | 6696 |
| 3L-4S | | MI | 3066 | 1392 | 4241 | 1225 | 5319 | 1017 | 5950 | 852 | 6730 | 576 | 8478 | 335 | 6567 |
| 10-#11 | 2.71 | MA | 3627 | 1478 | 5499 | 1247 | 6879 | 1030 | 7843 | 849 | 9270 | 551 | 11737 | 457 | 8082 |
| 2L-5S | | MI | 3008 | 1478 | 4257 | 1285 | 5243 | 1069 | 5844 | 882 | 6546 | 580 | 8142 | 210 | 7177 |
| 10-#11 | 2.71 | MA | 3339 | 1478 | 4966 | 1260 | 6205 | 1041 | 7027 | 858 | 8171 | 563 | 10248 | 343 | 8021 |
| 3L-4S | | MI | 3171 | 1478 | 4591 | 1272 | 5716 | 1051 | 6404 | 873 | 7319 | 568 | 9194 | 277 | 7653 |
| 10-#14 | 3.91 | MA | 4036 | 1681 | 6659 | 1368 | 8316 | 1118 | 9566 | 904 | 11575 | 540 | 14688 | 418 | 11370 |
| 2L-5S | | MI | 3249 | 1681 | 4890 | 1420 | 5986 | 1171 | 6720 | 948 | 7698 | 576 | 9655 | 63 | 9429 |
| 10-#14 | 3.91 | MA | 3682 | 1681 | 5901 | 1385 | 7358 | 1132 | 8406 | 915 | 10014 | 555 | 12605 | 253 | 11218 |
| 3L-4S | | MI | 3477 | 1681 | 5367 | 1402 | 6662 | 1147 | 7518 | 937 | 8801 | 561 | 11126 | 161 | 10271 |
| 10-#18 | 6.94 | MA | 4481 | 2196 | 8167 | 1704 | 10165 | 1365 | 11771 | 1061 | 14517 | 534 | 18140 | -6 | 18118 |
| 3L-4S | | MI | 4199 | 2196 | 7241 | 1732 | 8958 | 1387 | 10231 | 1095 | 12416 | 539 | 15654 | -161 | 15231 |

## RECTANGULAR TIED COLUMNS 24" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.00 | MA | 3446 | 1287 | 4437 | 1165 | 5576 | 980 | 6211 | 835 | 6873 | 615 | 8435 | 536 | 3732 |
| 2E | | MI | 3159 | 1287 | 4135 | 1155 | 5147 | 971 | 5708 | 827 | 6287 | 609 | 7626 | 524 | 3414 |
| 4-#14 | 1.44 | MA | 3660 | 1368 | 4979 | 1209 | 6228 | 1012 | 6983 | 854 | 7896 | 608 | 9778 | 522 | 5232 |
| 2E | | MI | 3347 | 1368 | 4625 | 1199 | 5734 | 1003 | 6402 | 846 | 7206 | 602 | 8795 | 506 | 4770 |
| 4-#18 | 2.56 | MA | 4143 | 1574 | 6287 | 1325 | 7817 | 1096 | 8871 | 905 | 10408 | 593 | 12959 | 477 | 8874 |
| 2E | | MI | 3768 | 1574 | 5801 | 1314 | 7158 | 1086 | 8091 | 896 | 9451 | 586 | 11542 | 449 | 8044 |
| 6-#10 | 1.22 | MA | 3590 | 1328 | 4665 | 1199 | 5911 | 1006 | 6641 | 853 | 7474 | 618 | 9284 | 538 | 4547 |
| 2L-3S | | MI | 3008 | 1328 | 3896 | 1201 | 4891 | 1008 | 5422 | 855 | 5923 | 624 | 7201 | 440 | 4150 |
| 6-#10 | 1.22 | MA | 3278 | 1328 | 4175 | 1211 | 5291 | 1017 | 5891 | 863 | 6464 | 630 | 7886 | 447 | 4538 |
| 3L-2S | | MI | 3289 | 1328 | 4339 | 1190 | 5452 | 998 | 6100 | 846 | 6837 | 613 | 8464 | 533 | 4154 |
| 6-#11 | 1.50 | MA | 3711 | 1379 | 5028 | 1222 | 6323 | 1022 | 7115 | 862 | 8090 | 611 | 10121 | 531 | 5472 |
| 2L-3S | | MI | 3067 | 1379 | 4135 | 1225 | 5147 | 1024 | 5708 | 863 | 6287 | 617 | 7626 | 401 | 4971 |
| 6-#11 | 1.50 | MA | 3347 | 1379 | 4437 | 1236 | 5576 | 1034 | 6211 | 872 | 6873 | 625 | 8435 | 417 | 5446 |
| 3L-2S | | MI | 3394 | 1379 | 4668 | 1212 | 5822 | 1014 | 6525 | 854 | 7386 | 605 | 9116 | 515 | 4989 |
| 6-#14 | 2.16 | MA | 4017 | 1501 | 5820 | 1292 | 7291 | 1073 | 8269 | 893 | 9628 | 603 | 12144 | 512 | 7692 |
| 2L-3S | | MI | 3228 | 1501 | 4625 | 1299 | 5734 | 1078 | 6402 | 896 | 7206 | 612 | 8795 | 325 | 6908 |
| 6-#14 | 2.16 | MA | 3532 | 1501 | 4979 | 1311 | 6228 | 1089 | 6983 | 906 | 7896 | 621 | 9778 | 347 | 7592 |
| 3L-2S | | MI | 3664 | 1501 | 5383 | 1281 | 6693 | 1064 | 7561 | 885 | 8767 | 597 | 10878 | 490 | 6990 |
| 6-#18 | 3.85 | MA | 4697 | 1810 | 7740 | 1473 | 9655 | 1204 | 11094 | 974 | 13401 | 584 | 16935 | 448 | 13098 |
| 2L-3S | | MI | 3624 | 1810 | 5801 | 1488 | 7158 | 1216 | 8091 | 981 | 9451 | 599 | 11542 | 115 | 11207 |
| 6-#18 | 3.85 | MA | 3990 | 1810 | 6287 | 1503 | 7817 | 1229 | 8871 | 994 | 10408 | 611 | 12959 | 154 | 12480 |
| 3L-2S | | MI | 4259 | 1810 | 7107 | 1461 | 8810 | 1194 | 10089 | 965 | 12141 | 577 | 15018 | 409 | 11839 |
| 8-#8 | 1.01 | MA | 3490 | 1289 | 4387 | 1181 | 5593 | 994 | 6273 | 847 | 6994 | 623 | 8631 | 543 | 3831 |
| 2L-4S | | MI | 2911 | 1289 | 3612 | 1187 | 4556 | 999 | 5016 | 855 | 5386 | 629 | 6527 | 448 | 3501 |
| 8-#8 | 1.01 | MA | 3289 | 1289 | 4078 | 1189 | 5202 | 1001 | 5800 | 853 | 6357 | 631 | 7750 | 488 | 3833 |
| 3E | | MI | 3020 | 1289 | 3806 | 1180 | 4810 | 993 | 5341 | 846 | 5830 | 625 | 7085 | 482 | 3509 |
| 8-#8 | 1.01 | MA | 3169 | 1289 | 3865 | 1197 | 4922 | 1008 | 5443 | 862 | 5869 | 636 | 7141 | 455 | 3819 |
| 4L-2S | | MI | 3201 | 1289 | 4086 | 1172 | 5164 | 986 | 5769 | 840 | 6406 | 618 | 7883 | 539 | 3505 |
| 8-#9 | 1.28 | MA | 3633 | 1339 | 4727 | 1209 | 6006 | 1014 | 6765 | 859 | 7649 | 620 | 9532 | 539 | 4781 |
| 2L-4S | | MI | 2976 | 1339 | 3797 | 1218 | 4773 | 1022 | 5267 | 870 | 5714 | 628 | 6988 | 419 | 4331 |
| 8-#9 | 1.28 | MA | 3388 | 1339 | 4338 | 1219 | 5515 | 1023 | 6170 | 866 | 6848 | 630 | 8424 | 469 | 4773 |
| 3E | | MI | 3108 | 1339 | 4042 | 1209 | 5093 | 1014 | 5676 | 859 | 6273 | 623 | 7692 | 462 | 4363 |

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



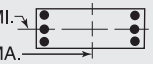

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.28 | MA | 3243 | 1339 | 4068 | 1228 | 5163 | 1031 | 5720 | 878 | 6233 | 635 | 7656 | 426 | 4732 |
| 4L-2S | | MI | 3328 | 1339 | 4394 | 1200 | 5538 | 1006 | 6214 | 852 | 6997 | 614 | 8696 | 535 | 4366 |
| 8-#10 | 1.63 | MA | 3809 | 1402 | 5155 | 1246 | 6531 | 1041 | 7391 | 875 | 8484 | 616 | 10682 | 534 | 5985 |
| 2L-4S | | MI | 3057 | 1402 | 4029 | 1259 | 5048 | 1052 | 5584 | 890 | 6132 | 626 | 7574 | 381 | 5359 |
| 8-#10 | 1.63 | MA | 3512 | 1402 | 4665 | 1258 | 5911 | 1051 | 6641 | 884 | 7474 | 628 | 9284 | 444 | 5961 |
| 3E | | MI | 3217 | 1402 | 4339 | 1248 | 5452 | 1042 | 6100 | 877 | 6837 | 621 | 8464 | 436 | 5438 |
| 8-#10 | 1.63 | MA | 3336 | 1402 | 4325 | 1270 | 5466 | 1062 | 6073 | 899 | 6697 | 634 | 8311 | 389 | 5864 |
| 4L-2S | | MI | 3484 | 1402 | 4783 | 1236 | 6013 | 1033 | 6779 | 868 | 7750 | 610 | 9728 | 529 | 5456 |
| 8-#11 | 2.00 | MA | 3965 | 1471 | 5619 | 1280 | 7071 | 1065 | 8019 | 889 | 9307 | 608 | 11806 | 526 | 7201 |
| 2L-4S | | MI | 3125 | 1471 | 4294 | 1295 | 5334 | 1077 | 5901 | 906 | 6535 | 619 | 8062 | 327 | 6288 |
| 8-#11 | 2.00 | MA | 3621 | 1471 | 5028 | 1293 | 6323 | 1076 | 7115 | 899 | 8090 | 621 | 10121 | 412 | 7155 |
| 3E | | MI | 3311 | 1471 | 4668 | 1282 | 5822 | 1067 | 6525 | 890 | 7386 | 614 | 9116 | 393 | 6514 |
| 8-#11 | 2.00 | MA | 3417 | 1471 | 4615 | 1307 | 5785 | 1088 | 6427 | 916 | 7151 | 628 | 8933 | 344 | 6906 |
| 4L-2S | | MI | 3620 | 1471 | 5202 | 1270 | 6497 | 1056 | 7341 | 881 | 8485 | 602 | 10605 | 507 | 6551 |
| 8-#14 | 2.88 | MA | 4358 | 1633 | 6660 | 1375 | 8355 | 1134 | 9555 | 932 | 11359 | 598 | 14510 | 502 | 10141 |
| 2L-4S | | MI | 3318 | 1633 | 4849 | 1399 | 5997 | 1153 | 6673 | 957 | 7554 | 613 | 9399 | 217 | 8281 |
| 8-#14 | 2.88 | MA | 3908 | 1633 | 5820 | 1394 | 7291 | 1150 | 8269 | 945 | 9628 | 616 | 12144 | 337 | 10011 |
| 3E | | MI | 3573 | 1633 | 5383 | 1382 | 6693 | 1139 | 7561 | 935 | 8767 | 607 | 10878 | 309 | 9085 |
| 8-#14 | 2.88 | MA | 3640 | 1633 | 5231 | 1413 | 6523 | 1166 | 7288 | 969 | 8288 | 624 | 10472 | 241 | 9123 |
| 4L-2S | | MI | 3965 | 1633 | 6140 | 1364 | 7651 | 1125 | 8720 | 924 | 10328 | 592 | 12961 | 475 | 9198 |
| 8-#18 | 5.13 | MA | 5230 | 2045 | 9192 | 1620 | 11492 | 1312 | 13316 | 1043 | 16393 | 575 | 20910 | 418 | 17314 |
| 2L-4S | | MI | 3819 | 2045 | 6180 | 1663 | 7603 | 1345 | 8549 | 1084 | 10040 | 594 | 12532 | -80 | 12398 |
| 8-#18 | 5.13 | MA | 4603 | 2045 | 7740 | 1650 | 9655 | 1337 | 11094 | 1063 | 13401 | 602 | 16935 | 125 | 16493 |
| 3E | | MI | 4167 | 2045 | 7107 | 1635 | 8810 | 1324 | 10089 | 1050 | 12141 | 590 | 15018 | 75 | 14770 |
| 8-#18 | 5.13 | MA | 4222 | 2045 | 6715 | 1681 | 8319 | 1362 | 9389 | 1101 | 11074 | 611 | 14109 | -38 | 14028 |
| 4L-2S | | MI | 4733 | 2045 | 8412 | 1608 | 10461 | 1302 | 12086 | 1035 | 14830 | 568 | 18493 | 368 | 15624 |
| 10-#10 | 2.04 | MA | 4022 | 1477 | 5645 | 1293 | 7151 | 1075 | 8141 | 897 | 9493 | 613 | 12080 | 530 | 7417 |
| 2L-5S | | MI | 3127 | 1477 | 4197 | 1316 | 5217 | 1102 | 5800 | 920 | 6405 | 634 | 7946 | 322 | 6215 |
| 10-#10 | 2.04 | MA | 3738 | 1477 | 5155 | 1304 | 6531 | 1085 | 7391 | 906 | 8484 | 625 | 10682 | 440 | 7381 |
| 3L-4S | | MI | 3270 | 1477 | 4473 | 1305 | 5608 | 1086 | 6263 | 912 | 7045 | 623 | 8838 | 377 | 6632 |
| 10-#10 | 2.04 | MA | 3575 | 1477 | 4815 | 1316 | 6086 | 1096 | 6823 | 921 | 7707 | 631 | 9709 | 385 | 7274 |
| 4L-3S | | MI | 3418 | 1477 | 4783 | 1294 | 6013 | 1077 | 6779 | 898 | 7750 | 618 | 9728 | 432 | 6723 |
| 10-#10 | 2.04 | MA | 3410 | 1477 | 4512 | 1328 | 5656 | 1112 | 6314 | 930 | 7003 | 644 | 8730 | 334 | 6806 |
| 5L-2S | | MI | 3674 | 1477 | 5226 | 1283 | 6573 | 1067 | 7457 | 890 | 8664 | 607 | 10992 | 525 | 6753 |
| 10-#11 | 2.50 | MA | 4211 | 1562 | 6210 | 1337 | 7818 | 1107 | 8923 | 916 | 10524 | 604 | 13491 | 521 | 8924 |
| 2L-5S | | MI | 3211 | 1562 | 4493 | 1365 | 5535 | 1137 | 6158 | 942 | 6860 | 627 | 8499 | 252 | 7277 |
| 10-#11 | 2.50 | MA | 3885 | 1562 | 5619 | 1351 | 7071 | 1119 | 8019 | 926 | 9307 | 618 | 11806 | 407 | 8863 |
| 3L-4S | | MI | 3375 | 1562 | 4827 | 1352 | 6008 | 1120 | 6717 | 933 | 7634 | 615 | 9551 | 319 | 7763 |
| 10-#11 | 2.50 | MA | 3698 | 1562 | 5206 | 1365 | 6532 | 1131 | 7331 | 943 | 8368 | 624 | 10619 | 339 | 8552 |
| 4L-3S | | MI | 3546 | 1562 | 5202 | 1340 | 6497 | 1109 | 7341 | 917 | 8485 | 610 | 10605 | 384 | 8055 |
| 10-#11 | 2.50 | MA | 3507 | 1562 | 4838 | 1378 | 6011 | 1149 | 6715 | 953 | 7515 | 638 | 9430 | 273 | 7985 |
| 5L-2S | | MI | 3840 | 1562 | 5735 | 1327 | 7172 | 1098 | 8157 | 908 | 9584 | 598 | 12095 | 499 | 8108 |
| 10-#14 | 3.61 | MA | 4683 | 1765 | 7501 | 1458 | 9418 | 1195 | 10841 | 971 | 13091 | 593 | 16876 | 492 | 12585 |
| 2L-5S | | MI | 3439 | 1765 | 5129 | 1499 | 6280 | 1239 | 7034 | 1007 | 8012 | 623 | 10011 | 105 | 9631 |
| 10-#14 | 3.61 | MA | 4280 | 1765 | 6660 | 1477 | 8355 | 1211 | 9555 | 984 | 11359 | 611 | 14510 | 327 | 12433 |
| 3L-4S | | MI | 3680 | 1765 | 5607 | 1482 | 6955 | 1214 | 7832 | 996 | 9115 | 608 | 11482 | 202 | 10398 |
| 10-#14 | 3.61 | MA | 4029 | 1765 | 6072 | 1495 | 7587 | 1227 | 8574 | 1008 | 10020 | 619 | 12839 | 231 | 11489 |
| 4L-3S | | MI | 3891 | 1765 | 6140 | 1464 | 7651 | 1200 | 8720 | 974 | 10328 | 602 | 12961 | 294 | 11265 |
| 10-#14 | 3.61 | MA | 3767 | 1765 | 5546 | 1514 | 6842 | 1253 | 7694 | 1021 | 8803 | 637 | 11168 | 135 | 10638 |
| 5L-2S | | MI | 4254 | 1765 | 6898 | 1447 | 8610 | 1185 | 9880 | 963 | 11889 | 587 | 15044 | 459 | 11401 |
| 10-#18 | 6.41 | MA | 5188 | 2281 | 9192 | 1797 | 11492 | 1445 | 13316 | 1132 | 16393 | 593 | 20910 | 95 | 20537 |
| 3L-4S | | MI | 4394 | 2281 | 7486 | 1810 | 9254 | 1453 | 10546 | 1153 | 12729 | 585 | 16007 | -121 | 15702 |
| 10-#18 | 6.41 | MA | 4871 | 2281 | 8168 | 1828 | 10157 | 1470 | 11612 | 1170 | 14066 | 602 | 18084 | -67 | 17868 |
| 4L-3S | | MI | 4687 | 2281 | 8412 | 1783 | 10461 | 1432 | 12086 | 1120 | 14830 | 581 | 18493 | 34 | 18367 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



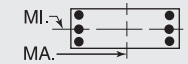

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 2.44 | MA | 4228 | 1552 | 6136 | 1339 | 7771 | 1109 | 8891 | 919 | 10503 | 610 | 13478 | 527 | 8846 |
| 2L-6S | | MI | 3146 | 1552 | 4363 | 1372 | 5423 | 1145 | 6027 | 956 | 6694 | 637 | 8348 | 248 | 7115 |
| 12-#10 | 2.44 | MA | 3957 | 1552 | 5645 | 1351 | 7151 | 1120 | 8141 | 928 | 9493 | 622 | 12080 | 436 | 8802 |
| 3L-5S | | MI | 3335 | 1552 | 4640 | 1363 | 5778 | 1136 | 6479 | 942 | 7319 | 631 | 9209 | 318 | 7468 |
| 12-#10 | 2.44 | MA | 3805 | 1552 | 5305 | 1363 | 6707 | 1130 | 7573 | 943 | 8717 | 629 | 11107 | 381 | 8685 |
| 4E | | MI | 3475 | 1552 | 4916 | 1352 | 6169 | 1121 | 6941 | 934 | 7959 | 621 | 10101 | 373 | 7900 |
| 12-#10 | 2.44 | MA | 3643 | 1552 | 5002 | 1375 | 6276 | 1146 | 7064 | 952 | 8013 | 641 | 10128 | 330 | 8198 |
| 5L-3S | | MI | 3614 | 1552 | 5226 | 1341 | 6573 | 1111 | 7457 | 920 | 8664 | 615 | 10992 | 428 | 8007 |
| 12-#10 | 2.44 | MA | 3435 | 1552 | 4691 | 1383 | 5887 | 1157 | 6568 | 967 | 7327 | 647 | 9188 | 260 | 7805 |
| 6L-2S | | MI | 3859 | 1552 | 5669 | 1330 | 7134 | 1101 | 8136 | 912 | 9577 | 604 | 12256 | 521 | 8046 |
| 12-#11 | 3.00 | MA | 4451 | 1654 | 6800 | 1395 | 8565 | 1149 | 9827 | 943 | 11742 | 601 | 15177 | 517 | 10645 |
| 2L-6S | | MI | 3235 | 1654 | 4699 | 1434 | 5780 | 1190 | 6427 | 984 | 7204 | 629 | 8970 | 159 | 8211 |
| 12-#11 | 3.00 | MA | 4141 | 1654 | 6210 | 1408 | 7818 | 1161 | 8923 | 953 | 10524 | 614 | 13491 | 402 | 10571 |
| 3L-5S | | MI | 3455 | 1654 | 5026 | 1423 | 6209 | 1179 | 6974 | 969 | 7959 | 624 | 9989 | 243 | 8787 |
| 12-#11 | 3.00 | MA | 3968 | 1654 | 5797 | 1422 | 7280 | 1173 | 8235 | 970 | 9585 | 621 | 12304 | 334 | 10208 |
| 4E | | MI | 3615 | 1654 | 5361 | 1410 | 6683 | 1162 | 7533 | 960 | 8733 | 612 | 11040 | 311 | 9249 |
| 12-#11 | 3.00 | MA | 3781 | 1654 | 5429 | 1436 | 6758 | 1192 | 7619 | 980 | 8733 | 635 | 11115 | 268 | 9667 |
| 5L-3S | | MI | 3782 | 1654 | 5735 | 1397 | 7172 | 1151 | 8157 | 944 | 9584 | 607 | 12095 | 376 | 9596 |
| 12-#11 | 3.00 | MA | 3539 | 1654 | 5060 | 1446 | 6286 | 1203 | 7018 | 997 | 7901 | 641 | 9967 | 181 | 9027 |
| 6L-2S | | MI | 4051 | 1654 | 6269 | 1384 | 7846 | 1140 | 8973 | 935 | 10683 | 595 | 13584 | 491 | 9661 |
| 12-#14 | 4.33 | MA | 4625 | 1898 | 7501 | 1559 | 9418 | 1272 | 10841 | 1023 | 13091 | 606 | 16876 | 317 | 14859 |
| 3L-5S | | MI | 3788 | 1898 | 5887 | 1582 | 7238 | 1300 | 8193 | 1046 | 9573 | 618 | 12094 | 89 | 11751 |
| 12-#14 | 4.33 | MA | 4421 | 1898 | 6912 | 1578 | 8650 | 1288 | 9860 | 1047 | 11751 | 614 | 15205 | 221 | 13866 |
| 4E | | MI | 4011 | 1898 | 6364 | 1565 | 7914 | 1275 | 8991 | 1035 | 10676 | 603 | 13565 | 187 | 12528 |
| 12-#14 | 4.33 | MA | 4161 | 1898 | 6386 | 1597 | 7905 | 1314 | 8980 | 1060 | 10534 | 632 | 13534 | 125 | 13015 |
| 5L-3S | | MI | 4198 | 1898 | 6898 | 1547 | 8610 | 1261 | 9880 | 1013 | 11889 | 597 | 15044 | 279 | 13448 |
| 12-#18 | 7.69 | MA | 5491 | 2516 | 9621 | 1975 | 11995 | 1579 | 13834 | 1239 | 17059 | 593 | 22060 | -96 | 21660 |
| 4E | | MI | 4945 | 2516 | 8791 | 1957 | 10906 | 1562 | 12544 | 1222 | 15419 | 576 | 19483 | -161 | 18956 |
| 14-#10 | 2.85 | MA | 4170 | 1627 | 6136 | 1398 | 7771 | 1154 | 8891 | 950 | 10503 | 619 | 13478 | 432 | 10222 |
| 3L-6S | | MI | 3356 | 1627 | 4807 | 1419 | 5984 | 1180 | 6705 | 978 | 7608 | 634 | 9612 | 244 | 8364 |
| 14-#10 | 2.85 | MA | 4029 | 1627 | 5795 | 1410 | 7327 | 1165 | 8322 | 965 | 9726 | 626 | 12505 | 378 | 10078 |
| 4L-5S | | MI | 3536 | 1627 | 5084 | 1410 | 6339 | 1170 | 7157 | 964 | 8232 | 629 | 10473 | 314 | 8725 |
| 14-#10 | 2.85 | MA | 3869 | 1627 | 5492 | 1422 | 6896 | 1181 | 7814 | 974 | 9023 | 638 | 11526 | 326 | 9594 |
| 5L-4S | | MI | 3675 | 1627 | 5360 | 1399 | 6730 | 1155 | 7619 | 956 | 8872 | 618 | 11365 | 369 | 9139 |
| 14-#10 | 2.85 | MA | 3670 | 1627 | 5181 | 1430 | 6507 | 1191 | 7318 | 989 | 8336 | 644 | 10586 | 256 | 9197 |
| 6L-3S | | MI | 3804 | 1627 | 5669 | 1388 | 7134 | 1145 | 8136 | 942 | 9577 | 612 | 12256 | 424 | 9291 |
| 14-#10 | 2.85 | MA | 3494 | 1627 | 4829 | 1443 | 6118 | 1200 | 6838 | 998 | 7669 | 657 | 9658 | 213 | 8675 |
| 7L-2S | | MI | 4040 | 1627 | 6113 | 1377 | 7695 | 1136 | 8814 | 934 | 10491 | 602 | 13519 | 517 | 9338 |
| 14-#11 | 3.50 | MA | 4398 | 1746 | 6800 | 1466 | 8565 | 1203 | 9827 | 980 | 11742 | 611 | 15177 | 397 | 12280 |
| 3L-6S | | MI | 3482 | 1746 | 5232 | 1491 | 6455 | 1232 | 7243 | 1011 | 8303 | 625 | 10459 | 151 | 9715 |
| 14-#11 | 3.50 | MA | 4230 | 1746 | 6388 | 1479 | 8027 | 1215 | 9139 | 997 | 10802 | 618 | 13990 | 330 | 11871 |
| 4L-5S | | MI | 3690 | 1746 | 5560 | 1480 | 6884 | 1222 | 7790 | 996 | 9058 | 620 | 11478 | 235 | 10302 |
| 14-#11 | 3.50 | MA | 4046 | 1746 | 6020 | 1493 | 7506 | 1234 | 8523 | 1007 | 9950 | 631 | 12800 | 263 | 11353 |
| 5L-4S | | MI | 3862 | 1746 | 5894 | 1467 | 7358 | 1204 | 8350 | 987 | 9832 | 608 | 12530 | 302 | 10742 |
| 14-#11 | 3.50 | MA | 3816 | 1746 | 5651 | 1504 | 7033 | 1246 | 7922 | 1024 | 9118 | 638 | 11653 | 176 | 10706 |
| 6L-3S | | MI | 4001 | 1746 | 6269 | 1455 | 7846 | 1193 | 8973 | 971 | 10683 | 603 | 13584 | 368 | 11137 |
| 14-#14 | 5.05 | MA | 4780 | 2030 | 7753 | 1661 | 9713 | 1349 | 11146 | 1085 | 13482 | 609 | 17571 | 211 | 16253 |
| 4L-5S | | MI | 4112 | 2030 | 6644 | 1665 | 8197 | 1360 | 9353 | 1085 | 11134 | 613 | 14177 | 74 | 13878 |
| 14-#14 | 5.05 | MA | 4524 | 2030 | 7227 | 1680 | 8968 | 1375 | 10266 | 1099 | 12266 | 627 | 15900 | 115 | 15398 |
| 5L-4S | | MI | 4331 | 2030 | 7122 | 1647 | 8872 | 1336 | 10151 | 1073 | 12237 | 598 | 15648 | 171 | 14668 |
| 16-#10 | 3.26 | MA | 4246 | 1701 | 6285 | 1456 | 7947 | 1199 | 9072 | 987 | 10736 | 623 | 13903 | 374 | 11461 |
| 4L-6S | | MI | 3560 | 1701 | 5250 | 1465 | 6545 | 1214 | 7384 | 1000 | 8521 | 631 | 10876 | 240 | 9616 |
| 16-#10 | 3.26 | MA | 4088 | 1701 | 5982 | 1468 | 7516 | 1215 | 8564 | 996 | 10032 | 635 | 12924 | 322 | 10994 |
| 5E | | MI | 3732 | 1701 | 5527 | 1457 | 6900 | 1205 | 7835 | 986 | 9146 | 626 | 11737 | 310 | 9986 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

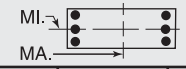
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 3.26 | MA | 3898 | 1701 | 5671 | 1476 | 7127 | 1226 | 8068 | 1011 | 9346 | 642 | 11984 | 252 | 10591 |
| 6L-4S | | MI | 3869 | 1701 | 5803 | 1446 | 7291 | 1189 | 8298 | 978 | 9785 | 615 | 12629 | 365 | 10384 |
| 16-#10 | 3.26 | MA | 3732 | 1701 | 5319 | 1490 | 6738 | 1235 | 7588 | 1020 | 8678 | 654 | 11056 | 209 | 10084 |
| 7L-3S | | MI | 3998 | 1701 | 6113 | 1434 | 7695 | 1180 | 8814 | 964 | 10491 | 610 | 13519 | 420 | 10575 |
| 16-#11 | 4.00 | MA | 4500 | 1838 | 6979 | 1537 | 8775 | 1257 | 10044 | 1024 | 12019 | 614 | 15675 | 325 | 13541 |
| 4L-6S | | MI | 3735 | 1838 | 5766 | 1549 | 7130 | 1275 | 8060 | 1038 | 9402 | 622 | 11949 | 142 | 11224 |
| 16-#11 | 4.00 | MA | 4303 | 1838 | 6611 | 1550 | 8253 | 1276 | 9428 | 1034 | 11167 | 628 | 14486 | 258 | 13044 |
| 5E | | MI | 3930 | 1838 | 6093 | 1537 | 7559 | 1264 | 8606 | 1023 | 10157 | 617 | 12968 | 227 | 11822 |
| 16-#11 | 4.00 | MA | 4084 | 1838 | 6242 | 1561 | 7781 | 1288 | 8826 | 1051 | 10335 | 634 | 13338 | 172 | 12390 |
| 6L-4S | | MI | 4088 | 1838 | 6428 | 1525 | 8033 | 1246 | 9166 | 1014 | 10931 | 605 | 14019 | 294 | 12243 |
| 16-#14 | 5.77 | MA | 4877 | 2163 | 8067 | 1763 | 10032 | 1436 | 11552 | 1138 | 13997 | 622 | 18267 | 105 | 17787 |
| 5E | | MI | 4426 | 2163 | 7402 | 1748 | 9155 | 1421 | 10512 | 1124 | 12695 | 608 | 16260 | 58 | 16013 |
| 18-#10 | 3.66 | MA | 4303 | 1776 | 6472 | 1515 | 8136 | 1249 | 9314 | 1018 | 11042 | 632 | 14322 | 319 | 12397 |
| 5L-6S | | MI | 3758 | 1776 | 5694 | 1512 | 7106 | 1249 | 8062 | 1022 | 9435 | 628 | 12139 | 236 | 10871 |
| 18-#10 | 3.66 | MA | 4121 | 1776 | 6161 | 1523 | 7747 | 1260 | 8818 | 1033 | 10356 | 639 | 13382 | 249 | 11988 |
| 6L-5S | | MI | 3924 | 1776 | 5970 | 1503 | 7461 | 1239 | 8514 | 1008 | 10059 | 623 | 13000 | 306 | 11250 |
| 18-#10 | 3.66 | MA | 3962 | 1776 | 5809 | 1536 | 7358 | 1269 | 8338 | 1042 | 9688 | 651 | 12454 | 205 | 11495 |
| 7L-4S | | MI | 4071 | 1776 | 6247 | 1492 | 7852 | 1224 | 8976 | 1000 | 10699 | 612 | 13892 | 361 | 11633 |
| 18-#11 | 4.50 | MA | 4566 | 1930 | 7202 | 1608 | 9001 | 1318 | 10332 | 1061 | 12384 | 624 | 16171 | 254 | 14738 |
| 5L-6S | | MI | 3968 | 1930 | 6299 | 1606 | 7805 | 1317 | 8876 | 1065 | 10501 | 618 | 13438 | 134 | 12736 |
| 18-#11 | 4.50 | MA | 4363 | 1930 | 6833 | 1618 | 8528 | 1330 | 9730 | 1078 | 11553 | 631 | 15023 | 167 | 14076 |
| 6L-5S | | MI | 4153 | 1930 | 6627 | 1595 | 8234 | 1306 | 9423 | 1050 | 11256 | 613 | 14457 | 219 | 13345 |
| 20-#10 | 4.07 | MA | 4338 | 1851 | 6651 | 1570 | 8367 | 1294 | 9568 | 1055 | 11365 | 636 | 14780 | 245 | 13388 |
| 6E | | MI | 3967 | 1851 | 6137 | 1559 | 7667 | 1283 | 8741 | 1044 | 10348 | 626 | 13403 | 232 | 12129 |
| 20-#10 | 4.07 | MA | 4187 | 1851 | 6299 | 1583 | 7978 | 1303 | 9088 | 1064 | 10698 | 648 | 13852 | 201 | 12908 |
| 7L-5S | | MI | 4121 | 1851 | 6414 | 1550 | 8021 | 1273 | 9192 | 1030 | 10973 | 620 | 14264 | 302 | 12517 |
| 20-#11 | 5.00 | MA | 4618 | 2022 | 7424 | 1676 | 9276 | 1372 | 10634 | 1105 | 12770 | 627 | 16709 | 162 | 15766 |
| 6E | | MI | 4196 | 2022 | 6833 | 1663 | 8479 | 1359 | 9692 | 1092 | 11600 | 615 | 14928 | 126 | 14252 |

## RECTANGULAR TIED COLUMNS 24" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.34 | MA | 4217 | 1453 | 5600 | 1300 | 7058 | 1089 | 7928 | 921 | 8954 | 661 | 11150 | 575 | 5718 |
| 2E | | MI | 3555 | 1453 | 4864 | 1278 | 6028 | 1071 | 6716 | 905 | 7520 | 649 | 9151 | 547 | 4793 |
| 4-#18 | 2.38 | MA | 4766 | 1659 | 7045 | 1416 | 8814 | 1173 | 10015 | 972 | 11731 | 646 | 14799 | 542 | 9738 |
| 2E | | MI | 3980 | 1659 | 6047 | 1392 | 7455 | 1153 | 8406 | 955 | 9765 | 632 | 11895 | 490 | 8077 |
| 6-#10 | 1.13 | MA | 4134 | 1412 | 5250 | 1289 | 6703 | 1083 | 7544 | 920 | 8479 | 672 | 10524 | 585 | 4959 |
| 2L-3S | | MI | 3212 | 1412 | 4127 | 1282 | 5181 | 1077 | 5735 | 915 | 6238 | 671 | 7560 | 482 | 4172 |
| 6-#10 | 1.13 | MA | 3786 | 1412 | 4713 | 1302 | 6024 | 1094 | 6723 | 930 | 7373 | 685 | 8992 | 497 | 4949 |
| 3L-2S | | MI | 3496 | 1412 | 4571 | 1271 | 5742 | 1067 | 6413 | 906 | 7152 | 661 | 8824 | 575 | 4172 |
| 6-#11 | 1.39 | MA | 4272 | 1464 | 5651 | 1313 | 7159 | 1099 | 8069 | 929 | 9161 | 665 | 11450 | 578 | 5977 |
| 2L-3S | | MI | 3271 | 1464 | 4371 | 1305 | 5439 | 1093 | 6022 | 923 | 6602 | 664 | 7984 | 442 | 5000 |
| 6-#11 | 1.39 | MA | 3866 | 1464 | 5002 | 1327 | 6339 | 1112 | 7077 | 940 | 7826 | 679 | 9601 | 466 | 5952 |
| 3L-2S | | MI | 3602 | 1464 | 4904 | 1292 | 6114 | 1082 | 6838 | 914 | 7701 | 653 | 9473 | 557 | 5010 |
| 6-#14 | 2.01 | MA | 4618 | 1585 | 6523 | 1382 | 8226 | 1150 | 9340 | 960 | 10856 | 656 | 13784 | 568 | 8421 |
| 2L-3S | | MI | 3432 | 1585 | 4864 | 1378 | 6028 | 1146 | 6716 | 956 | 7520 | 659 | 9151 | 366 | 6949 |
| 6-#14 | 2.01 | MA | 4075 | 1585 | 5600 | 1402 | 7058 | 1167 | 7928 | 975 | 8954 | 676 | 11150 | 404 | 8321 |
| 3L-2S | | MI | 3874 | 1585 | 5622 | 1361 | 6986 | 1132 | 7875 | 944 | 9081 | 644 | 11234 | 531 | 7017 |
| 6-#18 | 3.57 | MA | 5393 | 1894 | 8645 | 1563 | 10838 | 1281 | 12463 | 1041 | 15027 | 637 | 19277 | 522 | 14394 |
| 2L-3S | | MI | 3827 | 1894 | 6047 | 1567 | 7455 | 1282 | 8406 | 1040 | 9765 | 645 | 11895 | 156 | 11432 |
| 6-#18 | 3.57 | MA | 4596 | 1894 | 7045 | 1596 | 8814 | 1309 | 10015 | 1064 | 11731 | 668 | 14799 | 228 | 13935 |
| 3L-2S | | MI | 4475 | 1894 | 7352 | 1539 | 9106 | 1261 | 10404 | 1024 | 12454 | 623 | 15371 | 449 | 11875 |
| 8-#9 | 1.19 | MA | 4181 | 1424 | 5316 | 1300 | 6805 | 1091 | 7678 | 926 | 8668 | 673 | 10792 | 586 | 5213 |
| 2L-4S | | MI | 3179 | 1424 | 4027 | 1299 | 5062 | 1091 | 5579 | 930 | 6029 | 676 | 7349 | 461 | 4360 |
| 8-#9 | 1.19 | MA | 3909 | 1424 | 4891 | 1309 | 6267 | 1100 | 7027 | 934 | 7792 | 684 | 9579 | 517 | 5205 |
| 3E | | MI | 3313 | 1424 | 4272 | 1290 | 5382 | 1083 | 5988 | 919 | 6588 | 671 | 8053 | 504 | 4383 |
| 8-#9 | 1.19 | MA | 3748 | 1424 | 4597 | 1319 | 5883 | 1109 | 6536 | 947 | 7121 | 690 | 8747 | 475 | 5164 |
| 4L-2S | | MI | 3536 | 1424 | 4624 | 1281 | 5827 | 1075 | 6526 | 912 | 7313 | 662 | 9056 | 577 | 4384 |

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



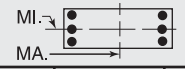

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 8-#10 | 1.51 | MA | 4379 | 1487 | 5787 | 1336 | 7382 | 1118 | 8365 | 942 | 9585 | 669 | 12055 | 581 | 6533 |
| 2L-4S | | MI | 3260 | 1487 | 4261 | 1339 | 5337 | 1121 | 5897 | 950 | 6447 | 674 | 7933 | 423 | 5399 |
| 8-#10 | 1.51 | MA | 4048 | 1487 | 5250 | 1348 | 6703 | 1129 | 7544 | 952 | 8479 | 682 | 10524 | 493 | 6509 |
| 3E | | MI | 3422 | 1487 | 4571 | 1328 | 5742 | 1111 | 6413 | 937 | 7152 | 669 | 8824 | 478 | 5463 |
| 8-#10 | 1.51 | MA | 3853 | 1487 | 4878 | 1361 | 6218 | 1140 | 6923 | 968 | 7631 | 690 | 9469 | 439 | 6413 |
| 4L-2S | | MI | 3693 | 1487 | 5014 | 1317 | 6302 | 1101 | 7092 | 928 | 8065 | 658 | 10088 | 571 | 5476 |
| 8-#11 | 1.86 | MA | 4557 | 1555 | 6299 | 1370 | 7979 | 1141 | 9061 | 956 | 10497 | 661 | 13299 | 573 | 7875 |
| 2L-4S | | MI | 3328 | 1555 | 4530 | 1375 | 5626 | 1146 | 6214 | 965 | 6849 | 666 | 8419 | 369 | 6399 |
| 8-#11 | 1.86 | MA | 4173 | 1555 | 5651 | 1384 | 7159 | 1154 | 8069 | 967 | 9161 | 676 | 11450 | 462 | 7829 |
| 3E | | MI | 3516 | 1555 | 4904 | 1362 | 6114 | 1135 | 6838 | 950 | 7701 | 661 | 9473 | 434 | 6546 |
| 8-#11 | 1.86 | MA | 3946 | 1555 | 5200 | 1399 | 6571 | 1167 | 7317 | 985 | 8134 | 684 | 10163 | 395 | 7654 |
| 4L-2S | | MI | 3830 | 1555 | 5438 | 1350 | 6789 | 1124 | 7654 | 941 | 8800 | 649 | 10963 | 549 | 6575 |
| 8-#14 | 2.68 | MA | 5002 | 1718 | 7446 | 1465 | 9394 | 1211 | 10753 | 999 | 12758 | 651 | 16417 | 561 | 11113 |
| 2L-4S | | MI | 3520 | 1718 | 5088 | 1479 | 6291 | 1221 | 6987 | 1016 | 7868 | 660 | 9755 | 259 | 8411 |
| 8-#14 | 2.68 | MA | 4497 | 1718 | 6523 | 1485 | 8226 | 1228 | 9340 | 1014 | 10856 | 671 | 13784 | 398 | 10983 |
| 3E | | MI | 3768 | 1718 | 5622 | 1461 | 6986 | 1207 | 7875 | 994 | 9081 | 654 | 11234 | 351 | 9129 |
| 8-#14 | 2.68 | MA | 4199 | 1718 | 5880 | 1505 | 7386 | 1246 | 8267 | 1039 | 9389 | 682 | 11935 | 300 | 10117 |
| 4L-2S | | MI | 4180 | 1718 | 6380 | 1444 | 7945 | 1192 | 9035 | 983 | 10642 | 639 | 13317 | 516 | 9227 |
| 8-#18 | 4.76 | MA | 5990 | 2130 | 10245 | 1710 | 12862 | 1389 | 14911 | 1110 | 18322 | 628 | 23755 | 502 | 19042 |
| 2L-4S | | MI | 4015 | 2130 | 6426 | 1741 | 7899 | 1412 | 8864 | 1142 | 10353 | 640 | 12885 | -40 | 12822 |
| 8-#18 | 4.76 | MA | 5282 | 2130 | 8645 | 1743 | 10838 | 1417 | 12463 | 1134 | 15027 | 659 | 19277 | 208 | 18480 |
| 3E | | MI | 4372 | 2130 | 7352 | 1714 | 9106 | 1391 | 10404 | 1109 | 12454 | 636 | 15371 | 115 | 14982 |
| 8-#18 | 4.76 | MA | 4857 | 2130 | 7523 | 1776 | 9375 | 1445 | 10594 | 1174 | 12474 | 673 | 16109 | 40 | 15886 |
| 4L-2S | | MI | 4952 | 2130 | 8658 | 1686 | 10758 | 1369 | 12401 | 1093 | 15144 | 614 | 18846 | 409 | 15661 |
| 10-#10 | 1.89 | MA | 4616 | 1562 | 6323 | 1383 | 8061 | 1152 | 9187 | 964 | 10691 | 666 | 13586 | 577 | 8103 |
| 2L-5S | | MI | 3331 | 1562 | 4428 | 1397 | 5507 | 1170 | 6113 | 981 | 6720 | 682 | 8305 | 364 | 6300 |
| 10-#10 | 1.89 | MA | 4301 | 1562 | 5787 | 1395 | 7382 | 1163 | 8365 | 974 | 9585 | 679 | 12055 | 489 | 8067 |
| 3L-4S | | MI | 3474 | 1562 | 4704 | 1386 | 5898 | 1155 | 6575 | 972 | 7360 | 671 | 9197 | 419 | 6673 |
| 10-#10 | 1.89 | MA | 4119 | 1562 | 5415 | 1408 | 6897 | 1174 | 7745 | 990 | 8737 | 687 | 11000 | 435 | 7960 |
| 4L-3S | | MI | 3625 | 1562 | 5014 | 1375 | 6302 | 1145 | 7092 | 958 | 8065 | 666 | 10088 | 474 | 6750 |
| 10-#10 | 1.89 | MA | 3932 | 1562 | 5085 | 1420 | 6428 | 1191 | 7191 | 1000 | 7969 | 700 | 9936 | 386 | 7493 |
| 5L-2S | | MI | 3884 | 1562 | 5457 | 1364 | 6863 | 1136 | 7770 | 950 | 8979 | 655 | 11351 | 567 | 6774 |
| 10-#11 | 2.32 | MA | 4833 | 1647 | 6947 | 1427 | 8799 | 1184 | 10052 | 983 | 11832 | 658 | 15148 | 568 | 9766 |
| 2L-5S | | MI | 3415 | 1647 | 4729 | 1445 | 5827 | 1206 | 6471 | 1001 | 7175 | 674 | 8857 | 293 | 7374 |
| 10-#11 | 2.32 | MA | 4468 | 1647 | 6299 | 1442 | 7979 | 1196 | 9061 | 994 | 10497 | 673 | 13299 | 457 | 9705 |
| 3L-4S | | MI | 3578 | 1647 | 5063 | 1432 | 6300 | 1188 | 7031 | 992 | 7948 | 663 | 9909 | 360 | 7870 |
| 10-#11 | 2.32 | MA | 4260 | 1647 | 5848 | 1456 | 7391 | 1209 | 8309 | 1012 | 9469 | 681 | 12012 | 390 | 9467 |
| 4L-3S | | MI | 3753 | 1647 | 5438 | 1420 | 6789 | 1177 | 7654 | 977 | 8800 | 658 | 10963 | 426 | 8089 |
| 10-#11 | 2.32 | MA | 4042 | 1647 | 5447 | 1471 | 6821 | 1229 | 7636 | 1023 | 8539 | 695 | 10717 | 327 | 8803 |
| 5L-2S | | MI | 4051 | 1647 | 5971 | 1407 | 7464 | 1166 | 8471 | 968 | 9899 | 646 | 12452 | 540 | 8133 |
| 10-#14 | 3.35 | MA | 5369 | 1850 | 8370 | 1548 | 10562 | 1271 | 12165 | 1038 | 14660 | 646 | 19051 | 554 | 13800 |
| 2L-5S | | MI | 3642 | 1850 | 5368 | 1579 | 6573 | 1306 | 7348 | 1066 | 8326 | 670 | 10367 | 146 | 9829 |
| 10-#14 | 3.35 | MA | 4900 | 1850 | 7446 | 1568 | 9394 | 1289 | 10753 | 1053 | 12758 | 666 | 16417 | 391 | 13648 |
| 3L-4S | | MI | 3882 | 1850 | 5846 | 1561 | 7249 | 1282 | 8146 | 1055 | 9429 | 655 | 11838 | 243 | 10522 |
| 10-#14 | 3.35 | MA | 4632 | 1850 | 6803 | 1588 | 8554 | 1307 | 9679 | 1078 | 11291 | 677 | 14569 | 293 | 12725 |
| 4L-3S | | MI | 4100 | 1850 | 6380 | 1544 | 7945 | 1268 | 9035 | 1033 | 10642 | 649 | 13317 | 335 | 11310 |
| 10-#14 | 3.35 | MA | 4332 | 1850 | 6229 | 1608 | 7740 | 1334 | 8718 | 1093 | 9962 | 697 | 12715 | 199 | 11879 |
| 5L-2S | | MI | 4472 | 1850 | 7137 | 1527 | 8904 | 1253 | 10194 | 1022 | 12203 | 634 | 15400 | 501 | 11431 |
| 10-#18 | 5.95 | MA | 5936 | 2365 | 10245 | 1890 | 12862 | 1525 | 14911 | 1203 | 18322 | 650 | 23755 | 188 | 22962 |
| 3L-4S | | MI | 4591 | 2365 | 7731 | 1889 | 9551 | 1520 | 10861 | 1211 | 13042 | 631 | 16360 | -80 | 16165 |
| 10-#18 | 5.95 | MA | 5581 | 2365 | 9123 | 1923 | 11398 | 1553 | 13041 | 1243 | 15770 | 664 | 20587 | 19 | 20471 |
| 4L-3S | | MI | 4893 | 2365 | 8658 | 1861 | 10758 | 1499 | 12401 | 1178 | 15144 | 627 | 18846 | 75 | 18568 |
| 12-#10 | 2.27 | MA | 4847 | 1637 | 6860 | 1430 | 8740 | 1186 | 10008 | 986 | 11797 | 663 | 15118 | 573 | 9669 |
| 2L-6S | | MI | 3349 | 1637 | 4595 | 1453 | 5713 | 1214 | 6340 | 1016 | 7010 | 685 | 8708 | 290 | 7248 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

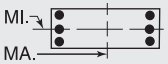



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 12-#10 | 2.27 | MA | 4545 | 1637 | 6323 | 1442 | 8061 | 1197 | 9187 | 996 | 10691 | 676 | 13586 | 485 | 9625 |
| 3L-5S | | MI | 3540 | 1637 | 4872 | 1444 | 6068 | 1205 | 6791 | 1002 | 7634 | 679 | 9569 | 360 | 7549 |
| 12-#10 | 2.27 | MA | 4376 | 1637 | 5952 | 1454 | 7576 | 1209 | 8566 | 1012 | 9843 | 684 | 12532 | 431 | 9508 |
| 4E | | MI | 3680 | 1637 | 5148 | 1433 | 6459 | 1189 | 7254 | 994 | 8274 | 668 | 10461 | 415 | 7948 |
| 12-#10 | 2.27 | MA | 4192 | 1637 | 5622 | 1467 | 7107 | 1225 | 8012 | 1022 | 9075 | 697 | 11467 | 383 | 9021 |
| 5L-3S | | MI | 3822 | 1637 | 5457 | 1422 | 6863 | 1180 | 7770 | 980 | 8979 | 663 | 11351 | 470 | 8035 |
| 12-#10 | 2.27 | MA | 3961 | 1637 | 5277 | 1475 | 6683 | 1237 | 7471 | 1037 | 8327 | 705 | 10449 | 313 | 8649 |
| 6L-2S | | MI | 4071 | 1637 | 5901 | 1411 | 7424 | 1170 | 8448 | 972 | 9892 | 652 | 12615 | 563 | 8068 |
| 12-#11 | 2.79 | MA | 5101 | 1739 | 7595 | 1485 | 9619 | 1226 | 11044 | 1010 | 13167 | 654 | 16997 | 563 | 11656 |
| 2L-6S | | MI | 3437 | 1739 | 4935 | 1514 | 6072 | 1259 | 6741 | 1044 | 7518 | 676 | 9328 | 200 | 8357 |
| 12-#11 | 2.79 | MA | 4754 | 1739 | 6947 | 1499 | 8799 | 1239 | 10052 | 1021 | 11832 | 669 | 15148 | 452 | 11582 |
| 3L-5S | | MI | 3659 | 1739 | 5262 | 1503 | 6502 | 1248 | 7287 | 1028 | 8274 | 671 | 10346 | 285 | 8880 |
| 12-#11 | 2.79 | MA | 4561 | 1739 | 6497 | 1514 | 8211 | 1252 | 9300 | 1039 | 10805 | 677 | 13861 | 385 | 11289 |
| 4E | | MI | 3820 | 1739 | 5597 | 1490 | 6975 | 1230 | 7847 | 1019 | 9047 | 659 | 11398 | 352 | 9352 |
| 12-#11 | 2.79 | MA | 4348 | 1739 | 6096 | 1528 | 7641 | 1271 | 8628 | 1050 | 9874 | 692 | 12566 | 322 | 10652 |
| 5L-3S | | MI | 3982 | 1739 | 5971 | 1477 | 7464 | 1219 | 8471 | 1004 | 9899 | 654 | 12452 | 418 | 9630 |
| 12-#11 | 2.79 | MA | 4079 | 1739 | 5685 | 1538 | 7127 | 1284 | 7972 | 1069 | 8966 | 700 | 11322 | 236 | 10011 |
| 6L-2S | | MI | 4266 | 1739 | 6505 | 1464 | 8139 | 1208 | 9287 | 995 | 10998 | 642 | 13942 | 532 | 9687 |
| 12-#14 | 4.02 | MA | 5301 | 1983 | 8370 | 1651 | 10562 | 1350 | 12165 | 1092 | 14660 | 661 | 19051 | 384 | 16317 |
| 3L-5S | | MI | 3992 | 1983 | 6126 | 1661 | 7532 | 1367 | 8507 | 1105 | 9887 | 665 | 12450 | 130 | 11941 |
| 12-#14 | 4.02 | MA | 5049 | 1983 | 7726 | 1671 | 9722 | 1368 | 11092 | 1117 | 13193 | 672 | 17202 | 287 | 15345 |
| 4E | | MI | 4215 | 1983 | 6604 | 1644 | 8208 | 1343 | 9305 | 1094 | 10990 | 650 | 13921 | 228 | 12646 |
| 12-#14 | 4.02 | MA | 4754 | 1983 | 7152 | 1691 | 8908 | 1395 | 10131 | 1132 | 11864 | 692 | 15349 | 192 | 14506 |
| 5L-3S | | MI | 4409 | 1983 | 7137 | 1627 | 8904 | 1328 | 10194 | 1072 | 12203 | 644 | 15400 | 320 | 13492 |
| 12-#14 | 4.02 | MA | 4396 | 1983 | 6573 | 1706 | 8172 | 1413 | 9193 | 1157 | 10566 | 702 | 13562 | 67 | 13216 |
| 6L-2S | | MI | 4756 | 1983 | 7895 | 1609 | 9862 | 1314 | 11353 | 1061 | 13764 | 629 | 17483 | 485 | 13632 |
| 12-#18 | 7.14 | MA | 6272 | 2601 | 10723 | 2070 | 13422 | 1661 | 15489 | 1313 | 19066 | 655 | 25065 | -1 | 25062 |
| 4E | | MI | 5142 | 2601 | 9037 | 2036 | 11202 | 1629 | 12859 | 1280 | 15732 | 622 | 19836 | -120 | 19455 |
| 14-#10 | 2.65 | MA | 4783 | 1711 | 6860 | 1489 | 8740 | 1232 | 10008 | 1018 | 11797 | 674 | 15118 | 481 | 11182 |
| 3L-6S | | MI | 3559 | 1711 | 5038 | 1499 | 6274 | 1249 | 7018 | 1038 | 7923 | 682 | 9972 | 286 | 8492 |
| 14-#10 | 2.65 | MA | 4625 | 1711 | 6489 | 1501 | 8255 | 1243 | 9388 | 1034 | 10949 | 681 | 14063 | 427 | 11059 |
| 4L-5S | | MI | 3742 | 1711 | 5315 | 1491 | 6629 | 1239 | 7470 | 1024 | 8547 | 676 | 10833 | 356 | 8804 |
| 14-#10 | 2.65 | MA | 4443 | 1711 | 6159 | 1513 | 7786 | 1260 | 8833 | 1044 | 10181 | 694 | 12999 | 379 | 10554 |
| 5L-4S | | MI | 3881 | 1711 | 5591 | 1480 | 7020 | 1224 | 7932 | 1016 | 9187 | 666 | 11724 | 411 | 9224 |
| 14-#10 | 2.65 | MA | 4223 | 1711 | 5814 | 1521 | 7362 | 1271 | 8293 | 1059 | 9433 | 702 | 11980 | 309 | 10179 |
| 6L-3S | | MI | 4014 | 1711 | 5901 | 1468 | 7424 | 1214 | 8448 | 1002 | 9892 | 660 | 12615 | 466 | 9319 |
| 14-#10 | 2.65 | MA | 4028 | 1711 | 5472 | 1529 | 6929 | 1279 | 7770 | 1069 | 8705 | 715 | 10973 | 269 | 9576 |
| 7L-2S | | MI | 4253 | 1711 | 6344 | 1457 | 7985 | 1204 | 9127 | 994 | 10806 | 649 | 13879 | 559 | 9361 |
| 14-#11 | 3.25 | MA | 5032 | 1831 | 7595 | 1557 | 9619 | 1281 | 11044 | 1048 | 13167 | 666 | 16997 | 447 | 13459 |
| 3L-6S | | MI | 3684 | 1831 | 5468 | 1571 | 6747 | 1301 | 7557 | 1071 | 8617 | 673 | 10817 | 192 | 9856 |
| 14-#11 | 3.25 | MA | 4854 | 1831 | 7145 | 1571 | 9031 | 1294 | 10292 | 1066 | 12140 | 674 | 15710 | 380 | 13118 |
| 4L-5S | | MI | 3896 | 1831 | 5796 | 1560 | 7176 | 1290 | 8104 | 1055 | 9373 | 668 | 11836 | 277 | 10392 |
| 14-#11 | 3.25 | MA | 4643 | 1831 | 6744 | 1586 | 8462 | 1313 | 9620 | 1077 | 11209 | 689 | 14415 | 317 | 12506 |
| 5L-4S | | MI | 4068 | 1831 | 6130 | 1547 | 7650 | 1272 | 8663 | 1046 | 10146 | 656 | 12887 | 344 | 10841 |
| 14-#11 | 3.25 | MA | 4387 | 1831 | 6333 | 1596 | 7947 | 1326 | 8964 | 1096 | 10302 | 697 | 13171 | 231 | 11861 |
| 6L-3S | | MI | 4212 | 1831 | 6505 | 1535 | 8139 | 1261 | 9287 | 1031 | 10998 | 651 | 13942 | 409 | 11172 |
| 14-#11 | 3.25 | MA | 4161 | 1831 | 5867 | 1612 | 7432 | 1337 | 8329 | 1107 | 9418 | 711 | 11944 | 178 | 11163 |
| 7L-2S | | MI | 4473 | 1831 | 7038 | 1522 | 8813 | 1251 | 10103 | 1022 | 12097 | 639 | 15431 | 524 | 11239 |
| 14-#14 | 4.69 | MA | 5473 | 2115 | 8649 | 1754 | 10890 | 1428 | 12505 | 1156 | 15095 | 667 | 19836 | 280 | 17974 |
| 4L-5S | | MI | 4317 | 2115 | 6884 | 1744 | 8490 | 1428 | 9667 | 1144 | 11448 | 660 | 14533 | 115 | 14062 |
| 14-#14 | 4.69 | MA | 5180 | 2115 | 8076 | 1774 | 10076 | 1456 | 11544 | 1171 | 13766 | 687 | 17982 | 185 | 17139 |
| 5L-4S | | MI | 4536 | 2115 | 7361 | 1727 | 9166 | 1404 | 10465 | 1133 | 12551 | 645 | 16004 | 212 | 14781 |
| 14-#14 | 4.69 | MA | 4825 | 2115 | 7496 | 1789 | 9340 | 1474 | 10605 | 1196 | 12468 | 697 | 16196 | 60 | 15882 |
| 6L-3S | | MI | 4710 | 2115 | 7895 | 1709 | 9862 | 1389 | 11353 | 1111 | 13764 | 639 | 17483 | 304 | 15677 |
| 16-#10 | 3.02 | MA | 4867 | 1786 | 7026 | 1548 | 8934 | 1277 | 10209 | 1056 | 12055 | 678 | 15594 | 424 | 12612 |
| 4L-6S | | MI | 3764 | 1786 | 5482 | 1546 | 6835 | 1283 | 7697 | 1060 | 8836 | 679 | 11235 | 282 | 9740 |
| 16-#10 | 3.02 | MA | 4688 | 1786 | 6695 | 1560 | 8465 | 1294 | 9655 | 1066 | 11287 | 692 | 14530 | 375 | 12090 |
| 5E | | MI | 3940 | 1786 | 5758 | 1537 | 7190 | 1273 | 8148 | 1046 | 9461 | 674 | 12096 | 352 | 10062 |

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis



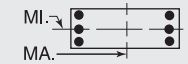

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 3.02 | MA | 4477 | 1786 | 6350 | 1568 | 8041 | 1305 | 9114 | 1081 | 10539 | 699 | 13511 | 305 | 11712 |
| 6L-4S | | MI | 4077 | 1786 | 6035 | 1526 | 7581 | 1258 | 8611 | 1038 | 10101 | 663 | 12988 | 407 | 10471 |
| 16-#10 | 3.02 | MA | 4292 | 1786 | 6009 | 1576 | 7608 | 1314 | 8591 | 1091 | 9811 | 712 | 12504 | 265 | 11124 |
| 7L-3S | | MI | 4202 | 1786 | 6344 | 1515 | 7985 | 1248 | 9127 | 1024 | 10806 | 657 | 13879 | 462 | 10604 |
| 16-#10 | 3.02 | MA | 4121 | 1786 | 5632 | 1591 | 7144 | 1327 | 8073 | 1101 | 9086 | 720 | 11534 | 210 | 10501 |
| 8L-2S | | MI | 4431 | 1786 | 6788 | 1504 | 8546 | 1239 | 9805 | 1016 | 11719 | 647 | 15142 | 555 | 10652 |
| 16-#11 | 3.71 | MA | 5157 | 1923 | 7793 | 1629 | 9851 | 1336 | 11284 | 1093 | 13476 | 670 | 17559 | 376 | 14955 |
| 4L-6S | | MI | 3925 | 1923 | 6002 | 1629 | 7422 | 1343 | 8373 | 1098 | 9716 | 669 | 12306 | 184 | 11360 |
| 16-#11 | 3.71 | MA | 4930 | 1923 | 7392 | 1643 | 9282 | 1356 | 10612 | 1104 | 12545 | 685 | 16264 | 313 | 14365 |
| 5E | | MI | 4138 | 1923 | 6329 | 1617 | 7851 | 1332 | 8920 | 1082 | 10472 | 664 | 13325 | 268 | 11908 |
| 16-#11 | 3.71 | MA | 4686 | 1923 | 6981 | 1653 | 8767 | 1369 | 9956 | 1123 | 11637 | 693 | 15020 | 227 | 13715 |
| 6L-4S | | MI | 4296 | 1923 | 6664 | 1605 | 8325 | 1314 | 9479 | 1073 | 11245 | 652 | 14377 | 336 | 12338 |
| 16-#11 | 3.71 | MA | 4473 | 1923 | 6515 | 1669 | 8252 | 1380 | 9320 | 1134 | 10754 | 708 | 13793 | 173 | 13025 |
| 7L-3S | | MI | 4428 | 1923 | 7038 | 1592 | 8813 | 1304 | 10103 | 1058 | 12097 | 647 | 15431 | 401 | 12714 |
| 16-#14 | 5.36 | MA | 5573 | 2248 | 8999 | 1857 | 11244 | 1517 | 12956 | 1210 | 15668 | 682 | 20616 | 178 | 19777 |
| 5E | | MI | 4633 | 2248 | 7641 | 1827 | 9449 | 1489 | 10826 | 1183 | 13009 | 655 | 16616 | 100 | 16190 |
| 16-#14 | 5.36 | MA | 5265 | 2248 | 8419 | 1872 | 10508 | 1534 | 12018 | 1235 | 14370 | 692 | 18830 | 54 | 18551 |
| 6L-4S | | MI | 4848 | 2248 | 8119 | 1810 | 10125 | 1465 | 11624 | 1171 | 14112 | 640 | 18087 | 197 | 16924 |
| 18-#10 | 3.40 | MA | 4927 | 1861 | 7232 | 1607 | 9144 | 1328 | 10476 | 1088 | 12393 | 689 | 16061 | 371 | 13629 |
| 5L-6S | | MI | 3964 | 1861 | 5925 | 1593 | 7396 | 1317 | 8375 | 1082 | 9750 | 676 | 12499 | 278 | 10992 |
| 18-#10 | 3.40 | MA | 4724 | 1861 | 6887 | 1615 | 8720 | 1340 | 9936 | 1103 | 11645 | 696 | 15043 | 302 | 13248 |
| 6L-5S | | MI | 4133 | 1861 | 6202 | 1584 | 7750 | 1308 | 8827 | 1068 | 10374 | 671 | 13360 | 348 | 11324 |
| 18-#10 | 3.40 | MA | 4548 | 1861 | 6545 | 1623 | 8288 | 1348 | 9412 | 1113 | 10917 | 709 | 14036 | 261 | 12674 |
| 7L-4S | | MI | 4281 | 1861 | 6478 | 1573 | 8142 | 1292 | 9289 | 1060 | 11014 | 660 | 14252 | 403 | 11718 |
| 18-#10 | 3.40 | MA | 4387 | 1861 | 6169 | 1638 | 7824 | 1361 | 8894 | 1123 | 10192 | 717 | 13066 | 207 | 12054 |
| 8L-3S | | MI | 4392 | 1861 | 6788 | 1562 | 8546 | 1283 | 9805 | 1046 | 11719 | 655 | 15142 | 458 | 11888 |
| 18-#11 | 4.18 | MA | 5226 | 2015 | 8040 | 1700 | 10102 | 1398 | 11604 | 1131 | 13880 | 682 | 18113 | 308 | 16227 |
| 5L-6S | | MI | 4173 | 2015 | 6535 | 1686 | 8097 | 1385 | 9189 | 1125 | 10815 | 666 | 13796 | 176 | 12868 |
| 18-#11 | 4.18 | MA | 4999 | 2015 | 7629 | 1711 | 9587 | 1411 | 10947 | 1150 | 12973 | 690 | 16869 | 222 | 15572 |
| 6L-5S | | MI | 4362 | 2015 | 6862 | 1675 | 8526 | 1374 | 9736 | 1109 | 11571 | 661 | 14815 | 260 | 13428 |
| 18-#11 | 4.18 | MA | 4776 | 2015 | 7163 | 1727 | 9072 | 1422 | 10312 | 1161 | 12089 | 705 | 15642 | 169 | 14889 |
| 7L-4S | | MI | 4518 | 2015 | 7197 | 1662 | 9000 | 1357 | 10296 | 1100 | 12344 | 649 | 15866 | 327 | 13841 |
| 18-#14 | 6.03 | MA | 5668 | 2380 | 9343 | 1954 | 11676 | 1595 | 13431 | 1274 | 16272 | 687 | 21463 | 47 | 21223 |
| 6L-5S | | MI | 4940 | 2380 | 8399 | 1910 | 10407 | 1550 | 11985 | 1222 | 14570 | 650 | 18699 | 84 | 18326 |
| 20-#10 | 3.78 | MA | 4966 | 1936 | 7424 | 1662 | 9399 | 1374 | 10757 | 1125 | 12751 | 693 | 16574 | 298 | 14786 |
| 6E | | MI | 4159 | 1936 | 6369 | 1640 | 7957 | 1352 | 9053 | 1104 | 10663 | 673 | 13763 | 274 | 12247 |
| 20-#10 | 3.78 | MA | 4799 | 1936 | 7082 | 1670 | 8967 | 1382 | 10234 | 1135 | 12023 | 707 | 15567 | 257 | 14225 |
| 7L-5S | | MI | 4332 | 1936 | 6645 | 1631 | 8311 | 1342 | 9505 | 1090 | 11288 | 668 | 14624 | 344 | 12589 |
| 20-#10 | 3.78 | MA | 4645 | 1936 | 6705 | 1685 | 8503 | 1396 | 9715 | 1144 | 11298 | 714 | 14597 | 203 | 13607 |
| 8L-4S | | MI | 4467 | 1936 | 6921 | 1620 | 8703 | 1327 | 9967 | 1082 | 11927 | 657 | 15516 | 399 | 12969 |
| 20-#11 | 4.64 | MA | 5283 | 2106 | 8278 | 1768 | 10407 | 1453 | 11939 | 1176 | 14308 | 686 | 18718 | 217 | 17432 |
| 6E | | MI | 4402 | 2106 | 7069 | 1743 | 8771 | 1427 | 10006 | 1152 | 11914 | 662 | 15285 | 167 | 14380 |
| 20-#11 | 4.64 | MA | 5096 | 2106 | 7811 | 1784 | 9892 | 1464 | 11304 | 1188 | 13425 | 701 | 17491 | 164 | 16755 |
| 7L-5S | | MI | 4581 | 2106 | 7396 | 1732 | 9201 | 1416 | 10552 | 1136 | 12670 | 657 | 16304 | 252 | 14952 |
| 22-#10 | 4.16 | MA | 5043 | 2010 | 7619 | 1716 | 9646 | 1417 | 11055 | 1157 | 13129 | 704 | 17098 | 253 | 15778 |
| 7L-6S | | MI | 4365 | 2010 | 6812 | 1686 | 8518 | 1386 | 9732 | 1126 | 11577 | 671 | 15026 | 270 | 13504 |
| 22-#10 | 4.16 | MA | 4894 | 2010 | 7242 | 1731 | 9182 | 1430 | 10537 | 1166 | 12404 | 711 | 16128 | 199 | 15159 |
| 8L-5S | | MI | 4516 | 2010 | 7089 | 1678 | 8872 | 1376 | 10183 | 1112 | 12201 | 665 | 15887 | 340 | 13856 |
| 22-#11 | 5.11 | MA | 5386 | 2198 | 8460 | 1841 | 10712 | 1506 | 12296 | 1215 | 14760 | 698 | 19340 | 159 | 18623 |
| 7L-6S | | MI | 4626 | 2198 | 7602 | 1801 | 9446 | 1469 | 10822 | 1179 | 13013 | 659 | 16775 | 159 | 15895 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

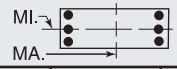



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.25 | MA | 4809 | 1538 | 6247 | 1390 | 7930 | 1166 | 8922 | 988 | 10064 | 715 | 12523 | 622 | 6204 |
| 2E | | MI | 3762 | 1538 | 5103 | 1358 | 6322 | 1138 | 7030 | 964 | 7834 | 696 | 9507 | 588 | 4815 |
| 4-#18 | 2.22 | MA | 5424 | 1744 | 7831 | 1506 | 9854 | 1250 | 11209 | 1039 | 13107 | 699 | 16707 | 604 | 10602 |
| 2E | | MI | 4191 | 1744 | 6292 | 1471 | 7751 | 1220 | 8722 | 1013 | 10078 | 678 | 12248 | 530 | 8110 |
| 6-#10 | 1.06 | MA | 4712 | 1497 | 5861 | 1380 | 7537 | 1160 | 8496 | 987 | 9537 | 725 | 11827 | 632 | 5370 |
| 2L-3S | | MI | 3416 | 1497 | 4359 | 1362 | 5471 | 1146 | 6047 | 975 | 6554 | 719 | 7920 | 524 | 4193 |
| 6-#10 | 1.06 | MA | 4329 | 1497 | 5278 | 1392 | 6799 | 1172 | 7603 | 998 | 8335 | 739 | 10163 | 545 | 5361 |
| 3L-2S | | MI | 3703 | 1497 | 4802 | 1351 | 6031 | 1136 | 6726 | 966 | 7467 | 708 | 9183 | 617 | 4189 |
| 6-#11 | 1.30 | MA | 4868 | 1548 | 6300 | 1403 | 8037 | 1176 | 9071 | 996 | 10285 | 718 | 12843 | 625 | 6483 |
| 2L-3S | | MI | 3475 | 1548 | 4607 | 1385 | 5731 | 1161 | 6335 | 982 | 6917 | 712 | 8341 | 484 | 5027 |
| 6-#11 | 1.30 | MA | 4420 | 1548 | 5595 | 1418 | 7144 | 1190 | 7992 | 1008 | 8832 | 734 | 10830 | 516 | 6457 |
| 3L-2S | | MI | 3809 | 1548 | 5140 | 1372 | 6406 | 1150 | 7152 | 973 | 8016 | 700 | 9831 | 598 | 5031 |
| 6-#14 | 1.88 | MA | 5255 | 1670 | 7254 | 1473 | 9203 | 1227 | 10461 | 1027 | 12137 | 710 | 15393 | 615 | 9150 |
| 2L-3S | | MI | 3636 | 1670 | 5103 | 1458 | 6322 | 1214 | 7030 | 1015 | 7834 | 706 | 9507 | 407 | 6988 |
| 6-#14 | 1.88 | MA | 4654 | 1670 | 6247 | 1494 | 7930 | 1246 | 8922 | 1044 | 10064 | 732 | 12523 | 455 | 9050 |
| 3L-2S | | MI | 4084 | 1670 | 5861 | 1440 | 7280 | 1199 | 8189 | 1003 | 9395 | 691 | 11590 | 573 | 7043 |
| 6-#18 | 3.33 | MA | 6127 | 1979 | 9578 | 1653 | 12064 | 1358 | 13882 | 1108 | 16706 | 690 | 21690 | 592 | 15690 |
| 2L-3S | | MI | 4030 | 1979 | 6292 | 1645 | 7751 | 1349 | 8722 | 1098 | 10078 | 691 | 12248 | 196 | 11589 |
| 6-#18 | 3.33 | MA | 5213 | 1979 | 7831 | 1688 | 9854 | 1388 | 11209 | 1134 | 13107 | 725 | 16707 | 298 | 15231 |
| 3L-2S | | MI | 4690 | 1979 | 7598 | 1618 | 9403 | 1328 | 10719 | 1082 | 12767 | 670 | 15724 | 490 | 11911 |
| 8-#9 | 1.11 | MA | 4764 | 1508 | 5932 | 1390 | 7647 | 1168 | 8640 | 993 | 9741 | 727 | 12116 | 633 | 5645 |
| 2L-4S | | MI | 3383 | 1508 | 4257 | 1380 | 5351 | 1160 | 5891 | 991 | 6345 | 724 | 7709 | 503 | 4386 |
| 8-#9 | 1.11 | MA | 4464 | 1508 | 5470 | 1400 | 7063 | 1177 | 7933 | 1002 | 8789 | 738 | 10798 | 565 | 5637 |
| 3E | | MI | 3517 | 1508 | 4502 | 1371 | 5671 | 1152 | 6300 | 979 | 6903 | 719 | 8413 | 546 | 4403 |
| 8-#9 | 1.11 | MA | 4287 | 1508 | 5152 | 1410 | 6647 | 1187 | 7401 | 1015 | 8061 | 745 | 9902 | 524 | 5596 |
| 4L-2S | | MI | 3742 | 1508 | 4854 | 1362 | 6116 | 1145 | 6839 | 973 | 7628 | 710 | 9416 | 619 | 4400 |
| 8-#10 | 1.41 | MA | 4984 | 1572 | 6445 | 1426 | 8275 | 1194 | 9389 | 1009 | 10739 | 722 | 13492 | 628 | 7082 |
| 2L-4S | | MI | 3463 | 1572 | 4492 | 1420 | 5627 | 1190 | 6210 | 1010 | 6762 | 722 | 8293 | 464 | 5435 |
| 8-#10 | 1.41 | MA | 4619 | 1572 | 5861 | 1439 | 7537 | 1206 | 8496 | 1020 | 9537 | 736 | 11827 | 541 | 7058 |
| 3E | | MI | 3627 | 1572 | 4802 | 1409 | 6031 | 1180 | 6726 | 997 | 7467 | 716 | 9183 | 520 | 5487 |
| 8-#10 | 1.41 | MA | 4405 | 1572 | 5459 | 1452 | 7011 | 1218 | 7823 | 1036 | 8618 | 745 | 10691 | 488 | 6962 |
| 4L-2S | | MI | 3901 | 1572 | 5245 | 1398 | 6592 | 1170 | 7404 | 988 | 8380 | 706 | 10447 | 613 | 5496 |
| 8-#11 | 1.73 | MA | 5184 | 1640 | 7006 | 1460 | 8929 | 1218 | 10151 | 1023 | 11739 | 715 | 14856 | 620 | 8548 |
| 2L-4S | | MI | 3531 | 1640 | 4766 | 1455 | 5918 | 1214 | 6528 | 1025 | 7164 | 713 | 8777 | 410 | 6475 |
| 8-#11 | 1.73 | MA | 4760 | 1640 | 6300 | 1475 | 8037 | 1232 | 9071 | 1035 | 10285 | 731 | 12843 | 511 | 8503 |
| 3E | | MI | 3722 | 1640 | 5140 | 1442 | 6406 | 1203 | 7152 | 1009 | 8016 | 708 | 9831 | 476 | 6576 |
| 8-#11 | 1.73 | MA | 4510 | 1640 | 5812 | 1491 | 7399 | 1246 | 8256 | 1054 | 9170 | 740 | 11456 | 445 | 8332 |
| 4L-2S | | MI | 4039 | 1640 | 5674 | 1430 | 7081 | 1192 | 7968 | 1000 | 9115 | 696 | 11320 | 590 | 6599 |
| 8-#14 | 2.50 | MA | 5681 | 1803 | 8260 | 1555 | 10475 | 1288 | 12000 | 1066 | 14209 | 705 | 18262 | 608 | 12085 |
| 2L-4S | | MI | 3721 | 1803 | 5327 | 1558 | 6584 | 1289 | 7301 | 1075 | 8182 | 707 | 10111 | 300 | 8538 |
| 8-#14 | 2.50 | MA | 5121 | 1803 | 7254 | 1576 | 9203 | 1306 | 10461 | 1082 | 12137 | 727 | 15393 | 448 | 11955 |
| 3E | | MI | 3974 | 1803 | 5861 | 1541 | 7280 | 1275 | 8189 | 1054 | 9395 | 701 | 11590 | 392 | 9170 |
| 8-#14 | 2.50 | MA | 4793 | 1803 | 6555 | 1598 | 8291 | 1325 | 9295 | 1109 | 10544 | 739 | 13400 | 352 | 11128 |
| 4L-2S | | MI | 4393 | 1803 | 6619 | 1523 | 8239 | 1260 | 9349 | 1042 | 10956 | 686 | 13673 | 557 | 9255 |
| 8-#18 | 4.44 | MA | 6791 | 2215 | 11325 | 1800 | 14274 | 1466 | 16555 | 1177 | 20305 | 682 | 26673 | 580 | 20770 |
| 2L-4S | | MI | 4211 | 2215 | 6671 | 1820 | 8196 | 1479 | 9179 | 1200 | 10666 | 687 | 13238 | 1 | 13234 |
| 8-#18 | 4.44 | MA | 6000 | 2215 | 9578 | 1835 | 12064 | 1496 | 13882 | 1203 | 16706 | 716 | 21690 | 286 | 20276 |
| 3E | | MI | 4577 | 2215 | 7598 | 1792 | 9403 | 1457 | 10719 | 1167 | 12767 | 683 | 15724 | 156 | 15191 |
| 8-#18 | 4.44 | MA | 5491 | 2215 | 8358 | 1870 | 10472 | 1527 | 11848 | 1247 | 13928 | 733 | 18179 | 112 | 17491 |
| 4L-2S | | MI | 5171 | 2215 | 8903 | 1765 | 11055 | 1436 | 12717 | 1151 | 15457 | 661 | 19200 | 450 | 15699 |
| 10-#10 | 1.76 | MA | 5247 | 1647 | 7029 | 1473 | 9014 | 1229 | 10282 | 1031 | 11942 | 719 | 15156 | 624 | 8788 |
| 2L-5S | | MI | 3534 | 1647 | 4660 | 1478 | 5797 | 1239 | 6426 | 1041 | 7036 | 730 | 8665 | 406 | 6381 |
| 10-#10 | 1.76 | MA | 4898 | 1647 | 6445 | 1486 | 8275 | 1241 | 9389 | 1042 | 10739 | 733 | 13492 | 537 | 8753 |
| 3L-4S | | MI | 3678 | 1647 | 4936 | 1467 | 6188 | 1224 | 6888 | 1032 | 7675 | 719 | 9556 | 460 | 6710 |
| 10-#10 | 1.76 | MA | 4699 | 1647 | 6043 | 1499 | 7749 | 1252 | 8716 | 1058 | 9820 | 742 | 12356 | 485 | 8645 |
| 4L-3S | | MI | 3831 | 1647 | 5245 | 1456 | 6592 | 1214 | 7404 | 1019 | 8380 | 714 | 10447 | 516 | 6775 |
| 10-#10 | 1.76 | MA | 4488 | 1647 | 5685 | 1512 | 7242 | 1270 | 8116 | 1069 | 8989 | 756 | 11158 | 430 | 8188 |
| 5L-2S | | MI | 4094 | 1647 | 5689 | 1445 | 7153 | 1205 | 8083 | 1010 | 9294 | 703 | 11711 | 609 | 6795 |

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 10-#11 | 2.17 | MA | 5490 | 1732 | 7712 | 1518 | 9822 | 1261 | 11231 | 1050 | 13193 | 711 | 16869 | 615 | 10609 |
| 2L-5S | | MI | 3618 | 1732 | 4965 | 1525 | 6119 | 1274 | 6785 | 1061 | 7489 | 722 | 9214 | 335 | 7467 |
| 10-#11 | 2.17 | MA | 5087 | 1732 | 7006 | 1533 | 8929 | 1274 | 10151 | 1062 | 11739 | 727 | 14856 | 506 | 10548 |
| 3L-4S | | MI | 3782 | 1732 | 5299 | 1512 | 6593 | 1256 | 7344 | 1052 | 8263 | 710 | 10266 | 402 | 7974 |
| 10-#11 | 2.17 | MA | 4857 | 1732 | 6518 | 1548 | 8291 | 1288 | 9335 | 1081 | 10624 | 736 | 13468 | 440 | 10365 |
| 4L-3S | | MI | 3960 | 1732 | 5674 | 1500 | 7081 | 1245 | 7968 | 1036 | 9115 | 705 | 11320 | 467 | 8121 |
| 10-#11 | 2.17 | MA | 4612 | 1732 | 6083 | 1563 | 7675 | 1308 | 8606 | 1093 | 9615 | 752 | 12069 | 380 | 9629 |
| 5L-2S | | MI | 4262 | 1732 | 6207 | 1487 | 7756 | 1235 | 8784 | 1027 | 10214 | 693 | 12810 | 582 | 8158 |
| 10-#14 | 3.13 | MA | 6094 | 1935 | 9266 | 1638 | 11748 | 1348 | 13539 | 1105 | 16282 | 700 | 21132 | 601 | 15015 |
| 2L-5S | | MI | 3844 | 1935 | 5607 | 1658 | 6867 | 1374 | 7662 | 1125 | 8640 | 717 | 10723 | 187 | 10008 |
| 10-#14 | 3.13 | MA | 5568 | 1935 | 8260 | 1659 | 10475 | 1367 | 12000 | 1121 | 14209 | 722 | 18262 | 441 | 14863 |
| 3L-4S | | MI | 4068 | 1935 | 6085 | 1641 | 7543 | 1350 | 8460 | 1114 | 9743 | 702 | 12194 | 285 | 10643 |
| 10-#14 | 3.13 | MA | 5272 | 1935 | 7561 | 1680 | 9563 | 1386 | 10834 | 1148 | 12616 | 734 | 16270 | 345 | 13980 |
| 4L-3S | | MI | 4308 | 1935 | 6619 | 1623 | 8239 | 1335 | 9349 | 1092 | 10956 | 696 | 13673 | 377 | 11352 |
| 10-#14 | 3.13 | MA | 4933 | 1935 | 6940 | 1702 | 8681 | 1415 | 9792 | 1164 | 11173 | 755 | 14264 | 256 | 13011 |
| 5L-2S | | MI | 4688 | 1935 | 7376 | 1606 | 9197 | 1321 | 10508 | 1081 | 12517 | 681 | 15756 | 542 | 11461 |
| 10-#18 | 5.56 | MA | 6723 | 2450 | 11325 | 1982 | 14274 | 1605 | 16555 | 1273 | 20305 | 707 | 26673 | 274 | 25334 |
| 3L-4S | | MI | 4788 | 2450 | 7977 | 1967 | 9847 | 1587 | 11177 | 1270 | 13356 | 678 | 16714 | -39 | 16621 |
| 10-#18 | 5.56 | MA | 6329 | 2450 | 10105 | 2017 | 12682 | 1635 | 14521 | 1316 | 17527 | 724 | 23162 | 100 | 22515 |
| 4L-3S | | MI | 5100 | 2450 | 8903 | 1939 | 11055 | 1566 | 12717 | 1236 | 15457 | 674 | 19200 | 116 | 18766 |
| 10-#18 | 5.56 | MA | 5759 | 2450 | 9017 | 2052 | 11140 | 1683 | 12699 | 1342 | 15006 | 759 | 19645 | -71 | 19395 |
| 5L-2S | | MI | 5640 | 2450 | 10209 | 1912 | 12706 | 1544 | 14714 | 1220 | 18146 | 652 | 22675 | 410 | 19482 |
| 12-#10 | 2.12 | MA | 5503 | 1722 | 7612 | 1520 | 9752 | 1263 | 11175 | 1053 | 13144 | 717 | 16821 | 620 | 10492 |
| 2L-6S | | MI | 3552 | 1722 | 4826 | 1533 | 6003 | 1283 | 6652 | 1076 | 7325 | 732 | 9067 | 332 | 7354 |
| 12-#10 | 2.12 | MA | 5169 | 1722 | 7029 | 1533 | 9014 | 1275 | 10282 | 1064 | 11942 | 731 | 15156 | 534 | 10447 |
| 3L-5S | | MI | 3744 | 1722 | 5103 | 1525 | 6358 | 1274 | 7104 | 1063 | 7949 | 727 | 9928 | 402 | 7628 |
| 12-#10 | 2.12 | MA | 4982 | 1722 | 6626 | 1546 | 8488 | 1287 | 9609 | 1080 | 11022 | 739 | 14020 | 481 | 10331 |
| 4E | | MI | 3885 | 1722 | 5379 | 1514 | 6749 | 1258 | 7566 | 1054 | 8589 | 716 | 10820 | 456 | 7986 |
| 12-#10 | 2.12 | MA | 4775 | 1722 | 6269 | 1558 | 7980 | 1304 | 9009 | 1091 | 10191 | 753 | 12822 | 426 | 9853 |
| 5L-3S | | MI | 4030 | 1722 | 5689 | 1503 | 7153 | 1249 | 8083 | 1040 | 9294 | 711 | 11711 | 512 | 8062 |
| 12-#10 | 2.12 | MA | 4522 | 1722 | 5890 | 1566 | 7521 | 1316 | 8424 | 1107 | 9381 | 761 | 11774 | 365 | 9440 |
| 6L-2S | | MI | 4282 | 1722 | 6132 | 1491 | 7714 | 1239 | 8761 | 1032 | 10207 | 700 | 12974 | 605 | 8090 |
| 12-#11 | 2.60 | MA | 5788 | 1824 | 8417 | 1575 | 10715 | 1303 | 12310 | 1077 | 14646 | 708 | 18881 | 610 | 12666 |
| 2L-6S | | MI | 3639 | 1824 | 5171 | 1594 | 6364 | 1327 | 7054 | 1103 | 7833 | 723 | 9685 | 242 | 8498 |
| 12-#11 | 2.60 | MA | 5403 | 1824 | 7712 | 1590 | 9822 | 1316 | 11231 | 1089 | 13193 | 724 | 16869 | 501 | 12593 |
| 3L-5S | | MI | 3864 | 1824 | 5498 | 1583 | 6794 | 1316 | 7601 | 1088 | 8588 | 718 | 10704 | 326 | 8969 |
| 12-#11 | 2.60 | MA | 5190 | 1824 | 7223 | 1605 | 9184 | 1330 | 10415 | 1108 | 12078 | 733 | 15481 | 435 | 12385 |
| 4E | | MI | 4025 | 1824 | 5833 | 1570 | 7267 | 1298 | 8160 | 1079 | 9362 | 706 | 11755 | 394 | 9452 |
| 12-#11 | 2.60 | MA | 4950 | 1824 | 6789 | 1620 | 8567 | 1351 | 9686 | 1120 | 11068 | 749 | 14082 | 375 | 11647 |
| 5L-3S | | MI | 4190 | 1824 | 6207 | 1557 | 7756 | 1287 | 8784 | 1063 | 10214 | 701 | 12810 | 459 | 9664 |
| 12-#11 | 2.60 | MA | 4654 | 1824 | 6336 | 1630 | 8010 | 1364 | 8975 | 1139 | 10085 | 758 | 12742 | 290 | 11013 |
| 6L-2S | | MI | 4480 | 1824 | 6741 | 1544 | 8431 | 1277 | 9600 | 1054 | 11312 | 690 | 14299 | 574 | 9714 |
| 12-#14 | 3.75 | MA | 6016 | 2068 | 9266 | 1742 | 11748 | 1428 | 13539 | 1160 | 16282 | 717 | 21132 | 435 | 17775 |
| 3L-5S | | MI | 4196 | 2068 | 6365 | 1741 | 7825 | 1435 | 8822 | 1164 | 10201 | 712 | 12806 | 172 | 12128 |
| 12-#14 | 3.75 | MA | 5732 | 2068 | 8567 | 1763 | 10836 | 1447 | 12373 | 1187 | 14689 | 729 | 19139 | 339 | 16843 |
| 4E | | MI | 4419 | 2068 | 6843 | 1724 | 8501 | 1411 | 9620 | 1153 | 11304 | 697 | 14277 | 269 | 12762 |
| 12-#14 | 3.75 | MA | 5399 | 2068 | 7946 | 1784 | 9954 | 1476 | 11331 | 1203 | 13246 | 751 | 17134 | 249 | 15915 |
| 5L-3S | | MI | 4619 | 2068 | 7376 | 1706 | 9197 | 1396 | 10508 | 1131 | 12517 | 691 | 15756 | 361 | 13535 |
| 12-#14 | 3.75 | MA | 5005 | 2068 | 7306 | 1799 | 9156 | 1495 | 10314 | 1230 | 11839 | 762 | 15209 | 125 | 14535 |
| 6L-2S | | MI | 4975 | 2068 | 8134 | 1689 | 10156 | 1382 | 11667 | 1120 | 14078 | 676 | 17839 | 526 | 13663 |
| 12-#18 | 6.67 | MA | 7092 | 2686 | 11852 | 2164 | 14892 | 1743 | 17194 | 1385 | 21126 | 715 | 28144 | 88 | 27551 |
| 4E | | MI | 5340 | 2686 | 9282 | 2114 | 11499 | 1695 | 13174 | 1339 | 16045 | 669 | 20189 | -80 | 19945 |
| 12-#18 | 6.67 | MA | 6535 | 2686 | 10764 | 2200 | 13350 | 1791 | 15372 | 1411 | 18605 | 750 | 24628 | -83 | 24188 |
| 5L-3S | | MI | 5608 | 2686 | 10209 | 2087 | 12706 | 1674 | 14714 | 1305 | 18146 | 665 | 22675 | 76 | 22370 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 30"

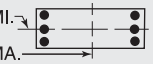
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 14-#10 | 2.47 | MA | 5431 | 1796 | 7612 | 1579 | 9752 | 1309 | 11175 | 1086 | 13144 | 728 | 16821 | 530 | 12142 |
| 3L-6S | | MI | 3763 | 1796 | 5270 | 1580 | 6564 | 1318 | 7331 | 1098 | 8238 | 730 | 10331 | 328 | 8617 |
| 14-#10 | 2.47 | MA | 5257 | 1796 | 7210 | 1592 | 9226 | 1321 | 10502 | 1102 | 12224 | 736 | 15685 | 477 | 12019 |
| 4L-5S | | MI | 3948 | 1796 | 5546 | 1571 | 6919 | 1308 | 7782 | 1084 | 8862 | 724 | 11192 | 398 | 8880 |
| 14-#10 | 2.47 | MA | 5053 | 1796 | 6852 | 1605 | 8718 | 1338 | 9902 | 1113 | 11393 | 750 | 14487 | 423 | 11522 |
| 5L-4S | | MI | 4087 | 1796 | 5823 | 1560 | 7310 | 1293 | 8245 | 1076 | 9502 | 713 | 12084 | 452 | 9263 |
| 14-#10 | 2.47 | MA | 4811 | 1796 | 6473 | 1613 | 8260 | 1350 | 9317 | 1129 | 10583 | 759 | 13439 | 362 | 11124 |
| 6L-3S | | MI | 4223 | 1796 | 6132 | 1549 | 7714 | 1283 | 8761 | 1062 | 10207 | 708 | 12974 | 508 | 9347 |
| 14-#10 | 2.47 | MA | 4597 | 1796 | 6103 | 1621 | 7783 | 1358 | 8751 | 1140 | 9795 | 773 | 12353 | 323 | 10495 |
| 7L-2S | | MI | 4466 | 1796 | 6576 | 1538 | 8275 | 1273 | 9440 | 1054 | 11121 | 697 | 14238 | 601 | 9383 |
| 14-#11 | 3.03 | MA | 5711 | 1916 | 8417 | 1648 | 10715 | 1359 | 12310 | 1116 | 14646 | 720 | 18881 | 497 | 14639 |
| 3L-6S | | MI | 3887 | 1916 | 5704 | 1651 | 7039 | 1369 | 7870 | 1130 | 8932 | 720 | 11174 | 234 | 9993 |
| 14-#11 | 3.03 | MA | 5513 | 1916 | 7929 | 1663 | 10077 | 1372 | 11495 | 1135 | 13531 | 729 | 17494 | 431 | 14382 |
| 4L-5S | | MI | 4102 | 1916 | 6032 | 1640 | 7469 | 1358 | 8417 | 1115 | 9687 | 715 | 12193 | 318 | 10478 |
| 14-#11 | 3.03 | MA | 5276 | 1916 | 7495 | 1678 | 9460 | 1393 | 10766 | 1147 | 12522 | 745 | 16094 | 371 | 13669 |
| 5L-4S | | MI | 4261 | 1916 | 6366 | 1627 | 7942 | 1340 | 8977 | 1106 | 10461 | 703 | 13245 | 385 | 10938 |
| 14-#11 | 3.03 | MA | 4995 | 1916 | 7042 | 1688 | 8902 | 1406 | 10055 | 1166 | 11538 | 755 | 14754 | 285 | 13035 |
| 6L-3S | | MI | 4423 | 1916 | 6741 | 1615 | 8431 | 1330 | 9600 | 1090 | 11312 | 698 | 14299 | 451 | 11206 |
| 14-#11 | 3.03 | MA | 4745 | 1916 | 6592 | 1697 | 8334 | 1417 | 9367 | 1179 | 10581 | 771 | 13430 | 235 | 12269 |
| 7L-2S | | MI | 4690 | 1916 | 7274 | 1602 | 9105 | 1319 | 10416 | 1081 | 12411 | 686 | 15789 | 565 | 11266 |
| 14-#14 | 4.38 | MA | 6204 | 2200 | 9573 | 1846 | 12109 | 1508 | 13913 | 1226 | 16761 | 724 | 22009 | 332 | 19714 |
| 4L-5S | | MI | 4523 | 2200 | 7123 | 1824 | 8784 | 1496 | 9981 | 1203 | 11762 | 707 | 14889 | 156 | 14242 |
| 14-#14 | 4.38 | MA | 5849 | 2200 | 8952 | 1867 | 11226 | 1537 | 12870 | 1242 | 15318 | 746 | 20004 | 242 | 18825 |
| 5L-4S | | MI | 4742 | 2200 | 7600 | 1806 | 9460 | 1472 | 10779 | 1192 | 12865 | 692 | 16360 | 254 | 14892 |
| 14-#14 | 4.38 | MA | 5478 | 2200 | 8312 | 1882 | 10428 | 1555 | 11853 | 1269 | 13911 | 758 | 18079 | 118 | 17442 |
| 6L-3S | | MI | 4921 | 2200 | 8134 | 1789 | 10156 | 1457 | 11667 | 1170 | 14078 | 686 | 17839 | 346 | 15720 |
| 14-#18 | 7.78 | MA | 7278 | 2921 | 12511 | 2347 | 15560 | 1900 | 18045 | 1480 | 22204 | 741 | 29610 | -95 | 28939 |
| 5L-4S | | MI | 5875 | 2921 | 10588 | 2261 | 13151 | 1804 | 15172 | 1408 | 18735 | 660 | 23665 | -120 | 23221 |
| 16-#10 | 2.82 | MA | 5525 | 1871 | 7793 | 1639 | 9964 | 1355 | 11395 | 1124 | 13427 | 733 | 17350 | 473 | 13709 |
| 4L-6S | | MI | 3969 | 1871 | 5713 | 1627 | 7125 | 1352 | 8009 | 1120 | 9152 | 727 | 11595 | 324 | 9862 |
| 16-#10 | 2.82 | MA | 5323 | 1871 | 7436 | 1652 | 9456 | 1373 | 10795 | 1135 | 12595 | 747 | 16152 | 419 | 13195 |
| 5E | | MI | 4146 | 1871 | 5990 | 1618 | 7479 | 1342 | 8461 | 1106 | 9776 | 721 | 12456 | 394 | 10136 |
| 16-#10 | 2.82 | MA | 5091 | 1871 | 7057 | 1659 | 8998 | 1385 | 10210 | 1151 | 11785 | 756 | 15103 | 358 | 12811 |
| 6L-4S | | MI | 4284 | 1871 | 6266 | 1607 | 7871 | 1327 | 8923 | 1098 | 10416 | 711 | 13348 | 448 | 10541 |
| 16-#10 | 2.82 | MA | 4888 | 1871 | 6686 | 1668 | 8521 | 1393 | 9644 | 1162 | 10997 | 770 | 14017 | 319 | 12182 |
| 7L-3S | | MI | 4412 | 1871 | 6576 | 1596 | 8275 | 1317 | 9440 | 1084 | 11121 | 705 | 14238 | 504 | 10632 |
| 16-#10 | 2.82 | MA | 4699 | 1871 | 6278 | 1683 | 8018 | 1406 | 9072 | 1171 | 10212 | 778 | 12970 | 267 | 11533 |
| 8L-2S | | MI | 4648 | 1871 | 7019 | 1585 | 8836 | 1308 | 10118 | 1076 | 12034 | 694 | 15502 | 597 | 10675 |
| 16-#11 | 3.47 | MA | 5828 | 2008 | 8634 | 1720 | 10969 | 1414 | 12574 | 1162 | 14985 | 726 | 19507 | 426 | 16385 |
| 4L-6S | | MI | 4128 | 2008 | 6238 | 1709 | 7714 | 1411 | 8687 | 1157 | 10031 | 716 | 12664 | 226 | 11492 |
| 16-#11 | 3.47 | MA | 5594 | 2008 | 8200 | 1735 | 10352 | 1435 | 11845 | 1174 | 13976 | 742 | 18107 | 366 | 15696 |
| 5E | | MI | 4346 | 2008 | 6565 | 1697 | 8143 | 1400 | 9233 | 1142 | 10786 | 711 | 13683 | 310 | 11992 |
| 16-#11 | 3.47 | MA | 5325 | 2008 | 7747 | 1745 | 9795 | 1449 | 11135 | 1193 | 12992 | 751 | 16767 | 281 | 15060 |
| 6L-4S | | MI | 4504 | 2008 | 6900 | 1685 | 8617 | 1383 | 9793 | 1133 | 11560 | 700 | 14734 | 377 | 12432 |
| 16-#11 | 3.47 | MA | 5090 | 2008 | 7298 | 1755 | 9227 | 1459 | 10447 | 1205 | 12035 | 767 | 15443 | 230 | 14314 |
| 7L-3S | | MI | 4641 | 2008 | 7274 | 1672 | 9105 | 1372 | 10416 | 1117 | 12411 | 695 | 15789 | 443 | 12748 |
| 16-#14 | 5.00 | MA | 6307 | 2333 | 9958 | 1950 | 12499 | 1597 | 14410 | 1281 | 17391 | 741 | 22873 | 235 | 21738 |
| 5E | | MI | 4840 | 2333 | 7880 | 1907 | 9743 | 1557 | 11140 | 1242 | 13323 | 702 | 16972 | 141 | 16365 |
| 16-#14 | 5.00 | MA | 5965 | 2333 | 9318 | 1964 | 11701 | 1616 | 13393 | 1308 | 15984 | 753 | 20948 | 111 | 20350 |
| 6L-4S | | MI | 5055 | 2333 | 8358 | 1889 | 10418 | 1532 | 11938 | 1231 | 14426 | 687 | 18443 | 238 | 17030 |
| 18-#10 | 3.17 | MA | 5587 | 1946 | 8020 | 1699 | 10195 | 1407 | 11688 | 1157 | 13797 | 745 | 17816 | 415 | 14870 |
| 5L-6S | | MI | 4169 | 1946 | 6157 | 1674 | 7686 | 1386 | 8688 | 1142 | 10065 | 724 | 12858 | 320 | 11110 |
| 18-#10 | 3.17 | MA | 5364 | 1946 | 7640 | 1706 | 9736 | 1419 | 11103 | 1173 | 12987 | 753 | 16768 | 354 | 14499 |
| 6L-5S | | MI | 4341 | 1946 | 6433 | 1665 | 8040 | 1377 | 9139 | 1128 | 10689 | 719 | 13719 | 390 | 11396 |
| 18-#10 | 3.17 | MA | 5170 | 1946 | 7270 | 1715 | 9260 | 1427 | 10537 | 1184 | 12200 | 767 | 15682 | 315 | 13869 |
| 7L-4S | | MI | 4477 | 1946 | 6709 | 1654 | 8432 | 1361 | 9602 | 1120 | 11329 | 708 | 14611 | 444 | 11801 |
| 18-#10 | 3.17 | MA | 4992 | 1946 | 6861 | 1730 | 8757 | 1441 | 9965 | 1193 | 11415 | 775 | 14635 | 263 | 13220 |
| 8L-3S | | MI | 4605 | 1946 | 7019 | 1643 | 8836 | 1352 | 10118 | 1106 | 12034 | 702 | 15502 | 500 | 11916 |

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 3.90 | MA | 5903 | 2099 | 8906 | 1793 | 11245 | 1477 | 12925 | 1201 | 15429 | 739 | 20120 | 361 | 17726 |
| 5L-6S | | MI | 4378 | 2099 | 6771 | 1766 | 8389 | 1453 | 9503 | 1184 | 11130 | 713 | 14153 | 217 | 12996 |
| 18-#11 | 3.90 | MA | 5646 | 2099 | 8453 | 1802 | 10688 | 1491 | 12214 | 1220 | 14446 | 748 | 18780 | 276 | 17088 |
| 6L-5S | | MI | 4571 | 2099 | 7098 | 1755 | 8818 | 1443 | 10050 | 1169 | 11885 | 708 | 15172 | 302 | 13509 |
| 18-#11 | 3.90 | MA | 5424 | 2099 | 8003 | 1812 | 10120 | 1501 | 11526 | 1232 | 13489 | 764 | 17455 | 226 | 16361 |
| 7L-4S | | MI | 4727 | 2099 | 7433 | 1742 | 9292 | 1425 | 10609 | 1160 | 12659 | 696 | 16224 | 369 | 13932 |
| 18-#14 | 5.63 | MA | 6410 | 2465 | 10324 | 2047 | 12974 | 1677 | 14932 | 1347 | 18056 | 748 | 23818 | 104 | 23257 |
| 6L-5S | | MI | 5148 | 2465 | 8638 | 1989 | 10701 | 1618 | 12299 | 1281 | 14884 | 697 | 19055 | 125 | 18494 |
| 20-#10 | 3.53 | MA | 5630 | 2021 | 8224 | 1753 | 10474 | 1453 | 11996 | 1195 | 14190 | 750 | 18433 | 350 | 16189 |
| 6E | | MI | 4366 | 2021 | 6600 | 1720 | 8247 | 1421 | 9366 | 1164 | 10978 | 721 | 14122 | 316 | 12362 |
| 20-#10 | 3.53 | MA | 5446 | 2021 | 7853 | 1762 | 9998 | 1461 | 11430 | 1206 | 13402 | 764 | 17346 | 311 | 15559 |
| 7L-5S | | MI | 4531 | 2021 | 6877 | 1712 | 8601 | 1411 | 9818 | 1150 | 11603 | 716 | 14983 | 386 | 12659 |
| 20-#10 | 3.53 | MA | 5276 | 2021 | 7445 | 1777 | 9495 | 1475 | 10858 | 1214 | 12617 | 773 | 16299 | 259 | 14908 |
| 8L-4S | | MI | 4678 | 2021 | 7153 | 1700 | 8993 | 1396 | 10280 | 1142 | 12243 | 705 | 15875 | 440 | 13050 |
| 20-#11 | 4.33 | MA | 5961 | 2191 | 9159 | 1860 | 11580 | 1533 | 13294 | 1247 | 15899 | 744 | 20793 | 271 | 19119 |
| 6E | | MI | 4608 | 2191 | 7305 | 1823 | 9064 | 1495 | 10319 | 1211 | 12229 | 710 | 15643 | 209 | 14505 |
| 20-#11 | 4.33 | MA | 5749 | 2191 | 8709 | 1870 | 11012 | 1544 | 12606 | 1259 | 14942 | 760 | 19468 | 221 | 18407 |
| 7L-5S | | MI | 4791 | 2191 | 7632 | 1812 | 9493 | 1485 | 10866 | 1196 | 12984 | 705 | 16662 | 294 | 15031 |
| 22-#10 | 3.88 | MA | 5715 | 2095 | 8437 | 1808 | 10736 | 1496 | 12323 | 1228 | 14604 | 761 | 19011 | 308 | 17247 |
| 7L-6S | | MI | 4573 | 2095 | 7043 | 1767 | 8808 | 1455 | 10045 | 1186 | 11892 | 718 | 15386 | 312 | 13616 |
| 22-#10 | 3.88 | MA | 5547 | 2095 | 8029 | 1824 | 10233 | 1509 | 11751 | 1236 | 13819 | 770 | 17964 | 255 | 16596 |
| 8L-5S | | MI | 4728 | 2095 | 7320 | 1758 | 9162 | 1445 | 10496 | 1172 | 12516 | 713 | 16247 | 382 | 13924 |
| 22-#11 | 4.77 | MA | 6098 | 2283 | 9415 | 1927 | 11905 | 1586 | 13686 | 1286 | 16396 | 757 | 21481 | 216 | 20452 |
| 7L-6S | | MI | 4833 | 2283 | 7838 | 1881 | 9738 | 1538 | 11135 | 1238 | 13328 | 706 | 17132 | 201 | 16016 |
| 24-#10 | 4.23 | MA | 5813 | 2170 | 8612 | 1870 | 10971 | 1544 | 12644 | 1258 | 15021 | 767 | 19629 | 251 | 18283 |
| 8L-6S | | MI | 4761 | 2170 | 7487 | 1814 | 9369 | 1489 | 10723 | 1208 | 12805 | 716 | 16650 | 308 | 14873 |

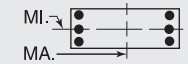
## RECTANGULAR TIED COLUMNS 24" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.17 | MA | 5436 | 1623 | 6922 | 1480 | 8844 | 1243 | 9965 | 1055 | 11228 | 768 | 13960 | 669 | 6690 |
| 2E | | MI | 3968 | 1623 | 5343 | 1437 | 6615 | 1206 | 7344 | 1023 | 8148 | 743 | 9863 | 629 | 4837 |
| 4-#18 | 2.08 | MA | 6119 | 1829 | 8643 | 1596 | 10936 | 1327 | 12451 | 1106 | 14536 | 753 | 18510 | 651 | 11466 |
| 2E | | MI | 4402 | 1829 | 6538 | 1549 | 8048 | 1286 | 9037 | 1071 | 10391 | 725 | 12602 | 571 | 8142 |
| 6-#11 | 1.22 | MA | 5499 | 1633 | 6977 | 1493 | 8957 | 1253 | 10124 | 1063 | 11463 | 771 | 14300 | 671 | 6988 |
| 2L-3S | | MI | 3680 | 1633 | 4843 | 1465 | 6023 | 1229 | 6649 | 1042 | 7231 | 759 | 8699 | 525 | 5053 |
| 6-#11 | 1.22 | MA | 5008 | 1633 | 6214 | 1509 | 7992 | 1267 | 8956 | 1076 | 9891 | 788 | 12123 | 565 | 6962 |
| 3L-2S | | MI | 4016 | 1633 | 5376 | 1452 | 6698 | 1218 | 7465 | 1033 | 8330 | 747 | 10188 | 640 | 5052 |
| 6-#14 | 1.76 | MA | 5927 | 1755 | 8011 | 1563 | 10222 | 1304 | 11631 | 1094 | 13471 | 763 | 17066 | 662 | 9879 |
| 2L-3S | | MI | 3840 | 1755 | 5343 | 1537 | 6615 | 1282 | 7344 | 1074 | 8148 | 753 | 9863 | 449 | 7025 |
| 6-#14 | 1.76 | MA | 5268 | 1755 | 6922 | 1585 | 8844 | 1324 | 9965 | 1112 | 11228 | 786 | 13960 | 505 | 9779 |
| 3L-2S | | MI | 4293 | 1755 | 6100 | 1520 | 7574 | 1267 | 8503 | 1062 | 9709 | 738 | 11946 | 614 | 7069 |
| 6-#18 | 3.13 | MA | 6901 | 2064 | 10537 | 1743 | 13333 | 1435 | 15350 | 1175 | 18438 | 744 | 23913 | 639 | 16986 |
| 2L-3S | | MI | 4233 | 2064 | 6538 | 1724 | 8048 | 1416 | 9037 | 1156 | 10391 | 738 | 12602 | 237 | 11659 |
| 6-#18 | 3.13 | MA | 5887 | 2064 | 8643 | 1780 | 10936 | 1467 | 12451 | 1204 | 14536 | 781 | 18510 | 352 | 16527 |
| 3L-2S | | MI | 4905 | 2064 | 7843 | 1696 | 9700 | 1395 | 11034 | 1140 | 13081 | 716 | 16077 | 531 | 11946 |
| 8-#9 | 1.04 | MA | 5382 | 1593 | 6576 | 1480 | 8531 | 1245 | 9651 | 1060 | 10866 | 780 | 13504 | 680 | 6077 |
| 2L-4S | | MI | 3586 | 1593 | 4486 | 1461 | 5640 | 1229 | 6204 | 1051 | 6660 | 772 | 8069 | 545 | 4411 |
| 8-#9 | 1.04 | MA | 5054 | 1593 | 6077 | 1491 | 7900 | 1255 | 8888 | 1069 | 9839 | 792 | 12081 | 613 | 6069 |
| 3E | | MI | 3722 | 1593 | 4732 | 1452 | 5960 | 1221 | 6613 | 1040 | 7219 | 767 | 8773 | 588 | 4422 |
| 8-#9 | 1.04 | MA | 4861 | 1593 | 5734 | 1501 | 7452 | 1265 | 8315 | 1083 | 9055 | 799 | 11121 | 572 | 6028 |
| 4L-2S | | MI | 3949 | 1593 | 5083 | 1443 | 6405 | 1214 | 7151 | 1033 | 7943 | 758 | 9776 | 661 | 4417 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.32 | MA | 5625 | 1657 | 7130 | 1516 | 9211 | 1271 | 10462 | 1076 | 11947 | 776 | 14992 | 675 | 7630 |
| 2L-4S | | MI | 3667 | 1657 | 4724 | 1501 | 5917 | 1258 | 6522 | 1070 | 7077 | 770 | 8652 | 506 | 5468 |
| 8-#10 | 1.32 | MA | 5225 | 1657 | 6500 | 1530 | 8413 | 1284 | 9498 | 1088 | 10649 | 790 | 13194 | 590 | 7606 |
| 3E | | MI | 3833 | 1657 | 5034 | 1490 | 6321 | 1249 | 7039 | 1057 | 7782 | 764 | 9543 | 561 | 5509 |
| 8-#10 | 1.32 | MA | 4991 | 1657 | 6067 | 1543 | 7847 | 1296 | 8773 | 1105 | 9658 | 800 | 11977 | 537 | 7510 |
| 4L-2S | | MI | 4109 | 1657 | 5477 | 1479 | 6882 | 1239 | 7717 | 1048 | 8696 | 753 | 10807 | 655 | 5514 |
| 8-#11 | 1.63 | MA | 5848 | 1725 | 7740 | 1550 | 9922 | 1295 | 11291 | 1090 | 13034 | 768 | 16476 | 667 | 9222 |
| 2L-4S | | MI | 3734 | 1725 | 5002 | 1535 | 6210 | 1282 | 6842 | 1084 | 7479 | 761 | 9134 | 452 | 6520 |
| 8-#11 | 1.63 | MA | 5382 | 1725 | 6977 | 1566 | 8957 | 1310 | 10124 | 1103 | 11463 | 785 | 14300 | 560 | 9177 |
| 3E | | MI | 3927 | 1725 | 5376 | 1522 | 6698 | 1271 | 7465 | 1069 | 8330 | 756 | 10188 | 517 | 6605 |
| 8-#11 | 1.63 | MA | 5109 | 1725 | 6451 | 1582 | 8269 | 1324 | 9244 | 1123 | 10260 | 795 | 12813 | 495 | 9006 |
| 4L-2S | | MI | 4248 | 1725 | 5910 | 1510 | 7373 | 1261 | 8281 | 1060 | 9429 | 744 | 11678 | 632 | 6622 |
| 8-#14 | 2.34 | MA | 6397 | 1888 | 9100 | 1645 | 11599 | 1364 | 13297 | 1133 | 15714 | 758 | 20171 | 655 | 13057 |
| 2L-4S | | MI | 3923 | 1888 | 5567 | 1637 | 6878 | 1357 | 7615 | 1134 | 8497 | 754 | 10467 | 341 | 8661 |
| 8-#14 | 2.34 | MA | 5781 | 1888 | 8011 | 1668 | 10222 | 1384 | 11631 | 1151 | 13471 | 781 | 17066 | 498 | 12927 |
| 3E | | MI | 4179 | 1888 | 6100 | 1620 | 7574 | 1342 | 8503 | 1113 | 9709 | 748 | 11946 | 433 | 9210 |
| 8-#14 | 2.34 | MA | 5421 | 1888 | 7258 | 1690 | 9238 | 1404 | 10373 | 1179 | 11751 | 795 | 14929 | 404 | 12155 |
| 4L-2S | | MI | 4606 | 1888 | 6858 | 1603 | 8532 | 1328 | 9663 | 1101 | 11270 | 733 | 14029 | 599 | 9283 |
| 8-#18 | 4.17 | MA | 7633 | 2300 | 12431 | 1890 | 15729 | 1543 | 18248 | 1245 | 22340 | 735 | 29316 | 627 | 22498 |
| 2L-4S | | MI | 4409 | 2300 | 6917 | 1898 | 8493 | 1546 | 9494 | 1259 | 10979 | 733 | 13591 | 42 | 13389 |
| 8-#18 | 4.17 | MA | 6755 | 2300 | 10537 | 1927 | 13333 | 1575 | 15350 | 1273 | 18438 | 773 | 23913 | 340 | 22004 |
| 3E | | MI | 4782 | 2300 | 7843 | 1871 | 9700 | 1524 | 11034 | 1225 | 13081 | 729 | 16077 | 197 | 15395 |
| 8-#18 | 4.17 | MA | 6193 | 2300 | 9220 | 1964 | 11613 | 1608 | 13151 | 1319 | 15435 | 793 | 20144 | 168 | 19118 |
| 4L-2S | | MI | 5389 | 2300 | 9149 | 1843 | 11351 | 1503 | 13032 | 1210 | 15770 | 707 | 19553 | 491 | 15736 |
| 10-#10 | 1.65 | MA | 5914 | 1732 | 7761 | 1563 | 10008 | 1306 | 11426 | 1098 | 13245 | 773 | 16790 | 671 | 9474 |
| 2L-5S | | MI | 3738 | 1732 | 4891 | 1559 | 6087 | 1308 | 6738 | 1101 | 7351 | 778 | 9024 | 448 | 6459 |
| 10-#10 | 1.65 | MA | 5531 | 1732 | 7130 | 1577 | 9211 | 1318 | 10462 | 1110 | 11947 | 788 | 14992 | 586 | 9439 |
| 3L-4S | | MI | 3882 | 1732 | 5167 | 1548 | 6478 | 1293 | 7201 | 1092 | 7990 | 767 | 9916 | 502 | 6745 |
| 10-#10 | 1.65 | MA | 5313 | 1732 | 6697 | 1590 | 8644 | 1330 | 9737 | 1127 | 10956 | 797 | 13775 | 534 | 9331 |
| 4L-3S | | MI | 4038 | 1732 | 5477 | 1537 | 6882 | 1283 | 7717 | 1079 | 8696 | 761 | 10807 | 557 | 6800 |
| 10-#10 | 1.65 | MA | 5079 | 1732 | 6313 | 1603 | 8098 | 1348 | 9091 | 1138 | 10061 | 812 | 12488 | 481 | 8891 |
| 5L-2S | | MI | 4303 | 1732 | 5920 | 1525 | 7443 | 1274 | 8395 | 1070 | 9609 | 751 | 12070 | 651 | 6815 |
| 10-#11 | 2.03 | MA | 6185 | 1817 | 8503 | 1608 | 10888 | 1337 | 12459 | 1117 | 14606 | 764 | 18653 | 662 | 11451 |
| 2L-5S | | MI | 3822 | 1817 | 5201 | 1605 | 6411 | 1342 | 7098 | 1120 | 7804 | 769 | 9572 | 376 | 7556 |
| 10-#11 | 2.03 | MA | 5741 | 1817 | 7740 | 1623 | 9922 | 1352 | 11291 | 1130 | 13034 | 781 | 16476 | 555 | 11390 |
| 3L-4S | | MI | 3986 | 1817 | 5535 | 1592 | 6885 | 1324 | 7658 | 1111 | 8578 | 757 | 10624 | 443 | 8050 |
| 10-#11 | 2.03 | MA | 5489 | 1817 | 7214 | 1639 | 9234 | 1366 | 10411 | 1150 | 11832 | 792 | 14989 | 490 | 11207 |
| 4L-3S | | MI | 4166 | 1817 | 5910 | 1580 | 7373 | 1314 | 8281 | 1096 | 9429 | 752 | 11678 | 509 | 8151 |
| 10-#11 | 2.03 | MA | 5216 | 1817 | 6746 | 1655 | 8570 | 1387 | 9626 | 1163 | 10744 | 809 | 13485 | 433 | 10465 |
| 5L-2S | | MI | 4473 | 1817 | 6443 | 1567 | 8048 | 1303 | 9098 | 1087 | 10528 | 740 | 13167 | 623 | 8183 |
| 10-#14 | 2.93 | MA | 6851 | 2020 | 10189 | 1728 | 12976 | 1425 | 14963 | 1172 | 17957 | 753 | 23277 | 648 | 16230 |
| 2L-5S | | MI | 4047 | 2020 | 5847 | 1738 | 7161 | 1442 | 7976 | 1184 | 8954 | 764 | 11079 | 228 | 10119 |
| 10-#14 | 2.93 | MA | 6272 | 2020 | 9100 | 1750 | 11599 | 1445 | 13297 | 1190 | 15714 | 776 | 20171 | 492 | 16078 |
| 3L-4S | | MI | 4271 | 2020 | 6324 | 1720 | 7836 | 1418 | 8774 | 1173 | 10057 | 749 | 12550 | 326 | 10761 |
| 10-#14 | 2.93 | MA | 5947 | 2020 | 8347 | 1772 | 10615 | 1465 | 12038 | 1217 | 13994 | 790 | 18034 | 397 | 15252 |
| 4L-3S | | MI | 4516 | 2020 | 6858 | 1703 | 8532 | 1403 | 9663 | 1152 | 11270 | 743 | 14029 | 418 | 11393 |
| 10-#14 | 2.93 | MA | 5569 | 2020 | 7677 | 1795 | 9664 | 1495 | 10915 | 1235 | 12438 | 813 | 15878 | 311 | 14152 |
| 5L-2S | | MI | 4903 | 2020 | 7616 | 1685 | 9491 | 1389 | 10822 | 1140 | 12831 | 728 | 16112 | 583 | 11490 |
| 10-#18 | 5.21 | MA | 7550 | 2535 | 12431 | 2074 | 15729 | 1684 | 18248 | 1342 | 22340 | 764 | 29316 | 328 | 27494 |
| 3L-4S | | MI | 4987 | 2535 | 8222 | 2045 | 10144 | 1654 | 11492 | 1328 | 13669 | 724 | 17067 | 1 | 17059 |
| 10-#18 | 5.21 | MA | 7115 | 2535 | 11114 | 2111 | 14009 | 1716 | 16049 | 1388 | 19337 | 784 | 25547 | 156 | 24582 |
| 4L-3S | | MI | 5307 | 2535 | 9149 | 2018 | 11351 | 1633 | 13032 | 1294 | 15770 | 720 | 19553 | 157 | 18960 |
| 10-#18 | 5.21 | MA | 6442 | 2535 | 9941 | 2148 | 12344 | 1767 | 14083 | 1417 | 16615 | 821 | 21760 | -7 | 21733 |
| 5L-2S | | MI | 5861 | 2535 | 10454 | 1990 | 13003 | 1611 | 15029 | 1279 | 18460 | 698 | 23028 | 450 | 19520 |
| 12-#10 | 1.98 | MA | 6195 | 1806 | 8391 | 1610 | 10805 | 1340 | 12391 | 1120 | 14544 | 770 | 18588 | 667 | 11315 |
| 2L-6S | | MI | 3755 | 1806 | 5058 | 1614 | 6293 | 1352 | 6965 | 1136 | 7640 | 780 | 9427 | 373 | 7431 |
| 12-#10 | 1.98 | MA | 5828 | 1806 | 7761 | 1623 | 10008 | 1352 | 11426 | 1132 | 13245 | 785 | 16790 | 582 | 11270 |
| 3L-5S | | MI | 3949 | 1806 | 5334 | 1605 | 6648 | 1342 | 7417 | 1123 | 8264 | 775 | 10288 | 444 | 7704 |

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 12-#10 | 1.98 | MA | 5623 | 1806 | 7327 | 1637 | 9442 | 1365 | 10702 | 1149 | 12255 | 794 | 15573 | 530 | 11154 |
| 4E | | MI | 4090 | 1806 | 5611 | 1594 | 7039 | 1327 | 7879 | 1114 | 8904 | 764 | 11180 | 498 | 8022 |
| 12-#10 | 1.98 | MA | 5394 | 1806 | 6943 | 1650 | 8895 | 1383 | 10056 | 1160 | 11359 | 809 | 14286 | 477 | 10693 |
| 5L-3S | | MI | 4237 | 1806 | 5920 | 1583 | 7443 | 1318 | 8395 | 1101 | 9609 | 759 | 12070 | 553 | 8088 |
| 12-#10 | 1.98 | MA | 5117 | 1806 | 6530 | 1657 | 8402 | 1395 | 9426 | 1177 | 10488 | 818 | 13164 | 417 | 10231 |
| 6L-2S | | MI | 4493 | 1806 | 6364 | 1572 | 8004 | 1308 | 9074 | 1092 | 10522 | 748 | 13334 | 647 | 8112 |
| 12-#11 | 2.44 | MA | 6512 | 1909 | 9266 | 1665 | 11853 | 1380 | 13626 | 1144 | 16178 | 761 | 20829 | 657 | 13677 |
| 2L-6S | | MI | 3841 | 1909 | 5407 | 1674 | 6656 | 1395 | 7368 | 1163 | 8148 | 771 | 10043 | 284 | 8636 |
| 12-#11 | 2.44 | MA | 6089 | 1909 | 8503 | 1681 | 10888 | 1394 | 12459 | 1157 | 14606 | 778 | 18653 | 550 | 13604 |
| 3L-5S | | MI | 4068 | 1909 | 5734 | 1663 | 7086 | 1384 | 7914 | 1147 | 8903 | 766 | 11061 | 368 | 9056 |
| 12-#11 | 2.44 | MA | 5855 | 1909 | 7977 | 1697 | 10200 | 1408 | 11579 | 1177 | 13404 | 788 | 17166 | 485 | 13413 |
| 4E | | MI | 4229 | 1909 | 6069 | 1650 | 7560 | 1367 | 8474 | 1138 | 9677 | 754 | 12113 | 435 | 9550 |
| 12-#11 | 2.44 | MA | 5587 | 1909 | 7509 | 1712 | 9535 | 1430 | 10794 | 1190 | 12316 | 805 | 15661 | 428 | 12650 |
| 5L-3S | | MI | 4398 | 1909 | 6443 | 1637 | 8048 | 1356 | 9098 | 1123 | 10528 | 749 | 13167 | 501 | 9696 |
| 12-#11 | 2.44 | MA | 5263 | 1909 | 7014 | 1722 | 8935 | 1444 | 10028 | 1210 | 11256 | 815 | 14226 | 343 | 12033 |
| 6L-2S | | MI | 4692 | 1909 | 6977 | 1624 | 8723 | 1345 | 9914 | 1114 | 11627 | 737 | 14657 | 615 | 9740 |
| 12-#14 | 3.52 | MA | 6746 | 2152 | 10189 | 1833 | 12976 | 1506 | 14963 | 1229 | 17957 | 772 | 23277 | 485 | 19233 |
| 3L-5S | | MI | 4401 | 2152 | 6604 | 1820 | 8119 | 1503 | 9136 | 1223 | 10515 | 759 | 13162 | 213 | 12268 |
| 12-#14 | 3.52 | MA | 6451 | 2152 | 9435 | 1855 | 11992 | 1526 | 13704 | 1256 | 16238 | 785 | 21140 | 390 | 18358 |
| 4E | | MI | 4624 | 2152 | 7082 | 1803 | 8795 | 1479 | 9934 | 1212 | 11618 | 744 | 14633 | 310 | 12875 |
| 12-#14 | 3.52 | MA | 6081 | 2152 | 8766 | 1877 | 11041 | 1556 | 12581 | 1274 | 14681 | 809 | 18984 | 304 | 17302 |
| 5L-3S | | MI | 4829 | 2152 | 7616 | 1786 | 9491 | 1464 | 10822 | 1190 | 12831 | 738 | 16112 | 402 | 13577 |
| 12-#14 | 3.52 | MA | 5649 | 2152 | 8066 | 1891 | 10182 | 1576 | 11485 | 1302 | 13165 | 822 | 16920 | 181 | 15884 |
| 6L-2S | | MI | 5192 | 2152 | 8373 | 1768 | 10449 | 1450 | 11981 | 1179 | 14392 | 723 | 18195 | 568 | 13693 |
| 12-#18 | 6.25 | MA | 7950 | 2771 | 13008 | 2258 | 16405 | 1824 | 18948 | 1457 | 23239 | 775 | 30950 | 144 | 30056 |
| 4E | | MI | 5540 | 2771 | 9528 | 2192 | 11796 | 1762 | 13489 | 1397 | 16358 | 715 | 20542 | -39 | 20427 |
| 12-#18 | 6.25 | MA | 7327 | 2771 | 11835 | 2295 | 14741 | 1875 | 16981 | 1486 | 20517 | 813 | 27163 | -19 | 27053 |
| 5L-3S | | MI | 5817 | 2771 | 10454 | 2165 | 13003 | 1741 | 15029 | 1364 | 18460 | 711 | 23028 | 116 | 22555 |
| 14-#10 | 2.32 | MA | 6116 | 1881 | 8391 | 1670 | 10805 | 1387 | 12391 | 1154 | 14544 | 782 | 18588 | 578 | 13102 |
| 3L-6S | | MI | 3967 | 1881 | 5501 | 1661 | 6854 | 1386 | 7644 | 1158 | 8553 | 777 | 10690 | 369 | 8692 |
| 14-#10 | 2.32 | MA | 5925 | 1881 | 7958 | 1683 | 10239 | 1399 | 11666 | 1170 | 13553 | 791 | 17371 | 526 | 12979 |
| 4L-5S | | MI | 4154 | 1881 | 5778 | 1652 | 7208 | 1377 | 8095 | 1144 | 9178 | 772 | 11551 | 440 | 8953 |
| 14-#10 | 2.32 | MA | 5698 | 1881 | 7574 | 1697 | 9693 | 1417 | 11020 | 1182 | 12658 | 806 | 16084 | 473 | 12498 |
| 5L-4S | | MI | 4293 | 1881 | 6054 | 1641 | 7600 | 1362 | 8558 | 1136 | 9817 | 761 | 12443 | 494 | 9299 |
| 14-#10 | 2.32 | MA | 5434 | 1881 | 7160 | 1704 | 9199 | 1429 | 10391 | 1199 | 11786 | 815 | 14962 | 413 | 12053 |
| 6L-3S | | MI | 4432 | 1881 | 6364 | 1630 | 8004 | 1352 | 9074 | 1122 | 10522 | 756 | 13334 | 549 | 9374 |
| 14-#10 | 2.32 | MA | 5200 | 1881 | 6761 | 1713 | 8679 | 1437 | 9782 | 1210 | 10938 | 830 | 13796 | 376 | 11421 |
| 7L-2S | | MI | 4679 | 1881 | 6807 | 1619 | 8565 | 1342 | 9752 | 1114 | 11436 | 745 | 14598 | 643 | 9406 |
| 14-#11 | 2.84 | MA | 6427 | 2001 | 9266 | 1738 | 11853 | 1436 | 13626 | 1184 | 16178 | 775 | 20829 | 546 | 15818 |
| 3L-6S | | MI | 4090 | 2001 | 5940 | 1731 | 7331 | 1437 | 8184 | 1190 | 9246 | 767 | 11532 | 275 | 10126 |
| 14-#11 | 2.84 | MA | 6209 | 2001 | 8740 | 1754 | 11165 | 1451 | 12746 | 1204 | 14975 | 785 | 19342 | 480 | 15621 |
| 4L-5S | | MI | 4308 | 2001 | 6268 | 1720 | 7761 | 1426 | 8731 | 1174 | 10002 | 762 | 12551 | 360 | 10562 |
| 14-#11 | 2.84 | MA | 5945 | 2001 | 8273 | 1770 | 10500 | 1472 | 11961 | 1217 | 13888 | 802 | 17838 | 423 | 14841 |
| 5L-4S | | MI | 4466 | 2001 | 6602 | 1707 | 8234 | 1409 | 9290 | 1165 | 10776 | 750 | 13602 | 427 | 11033 |
| 14-#11 | 2.84 | MA | 5637 | 2001 | 7778 | 1779 | 9900 | 1486 | 11196 | 1237 | 12828 | 812 | 16402 | 338 | 14227 |
| 6L-3S | | MI | 4625 | 2001 | 6977 | 1695 | 8723 | 1398 | 9914 | 1150 | 11627 | 745 | 14657 | 492 | 11239 |
| 14-#11 | 2.84 | MA | 5365 | 2001 | 7293 | 1790 | 9279 | 1496 | 10455 | 1250 | 11798 | 829 | 14980 | 291 | 13355 |
| 7L-2S | | MI | 4905 | 2001 | 7510 | 1682 | 9398 | 1387 | 10730 | 1141 | 12726 | 733 | 16146 | 607 | 11293 |
| 14-#14 | 4.10 | MA | 6939 | 2285 | 10524 | 1938 | 13370 | 1587 | 15370 | 1295 | 18481 | 780 | 24246 | 383 | 21473 |
| 4L-5S | | MI | 4729 | 2285 | 7362 | 1903 | 9078 | 1564 | 10295 | 1262 | 12076 | 754 | 15245 | 197 | 14419 |
| 14-#14 | 4.10 | MA | 6573 | 2285 | 9855 | 1960 | 12419 | 1617 | 14247 | 1313 | 16925 | 804 | 22089 | 297 | 20456 |
| 5L-4S | | MI | 4948 | 2285 | 7840 | 1886 | 9753 | 1539 | 11093 | 1251 | 13179 | 739 | 16716 | 295 | 15000 |
| 14-#14 | 4.10 | MA | 6167 | 2285 | 9154 | 1974 | 11560 | 1637 | 13151 | 1341 | 15408 | 817 | 20026 | 175 | 19006 |
| 6L-3S | | MI | 5133 | 2285 | 8373 | 1868 | 10449 | 1525 | 11981 | 1229 | 14392 | 733 | 18195 | 387 | 15762 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 14-#14 | 4.10 | MA | 5808 | 2285 | 8461 | 1988 | 10681 | 1652 | 12091 | 1359 | 13932 | 841 | 17985 | 103 | 17509 |
| 7L-2S | | MI | 5476 | 2285 | 9131 | 1851 | 11408 | 1510 | 13141 | 1218 | 15953 | 718 | 20279 | 552 | 15893 |
| 14-#18 | 7.29 | MA | 8141 | 3006 | 13729 | 2442 | 17137 | 1983 | 19879 | 1555 | 24419 | 804 | 32566 | -31 | 32325 |
| 5L-4S | | MI | 6075 | 3006 | 10833 | 2340 | 13447 | 1870 | 15487 | 1466 | 19048 | 706 | 24018 | -79 | 23733 |
| 16-#10 | 2.65 | MA | 6218 | 1956 | 8588 | 1730 | 11036 | 1433 | 12630 | 1192 | 14851 | 788 | 19169 | 522 | 14806 |
| 4L-6S | | MI | 4173 | 1956 | 5945 | 1708 | 7415 | 1421 | 8322 | 1180 | 9467 | 775 | 11954 | 365 | 9956 |
| 16-#10 | 2.65 | MA | 5994 | 1956 | 8204 | 1743 | 10490 | 1451 | 11984 | 1204 | 13956 | 803 | 17882 | 470 | 14308 |
| 5E | | MI | 4353 | 1956 | 6221 | 1699 | 7769 | 1411 | 8774 | 1166 | 10091 | 769 | 12815 | 436 | 10208 |
| 16-#10 | 2.65 | MA | 5740 | 1956 | 7790 | 1751 | 9997 | 1464 | 11355 | 1221 | 13085 | 812 | 16760 | 409 | 13877 |
| 6L-4S | | MI | 4491 | 1956 | 6497 | 1688 | 8161 | 1396 | 9236 | 1158 | 10731 | 758 | 13707 | 490 | 10578 |
| 16-#10 | 2.65 | MA | 5518 | 1956 | 7391 | 1760 | 9477 | 1471 | 10746 | 1232 | 12237 | 827 | 15594 | 373 | 13247 |
| 7L-3S | | MI | 4622 | 1956 | 6807 | 1677 | 8565 | 1386 | 9752 | 1144 | 11436 | 753 | 14598 | 545 | 10659 |
| 16-#10 | 2.65 | MA | 5312 | 1956 | 6951 | 1776 | 8935 | 1486 | 10122 | 1240 | 11392 | 836 | 14471 | 322 | 12581 |
| 8L-2S | | MI | 4861 | 1956 | 7251 | 1666 | 9126 | 1377 | 10431 | 1136 | 12349 | 742 | 15861 | 639 | 10698 |
| 16-#11 | 3.25 | MA | 6554 | 2092 | 9503 | 1811 | 12130 | 1493 | 13914 | 1231 | 16547 | 781 | 21519 | 476 | 17831 |
| 4L-6S | | MI | 4332 | 2092 | 6474 | 1789 | 8006 | 1479 | 9000 | 1217 | 10345 | 764 | 13021 | 267 | 11622 |
| 16-#11 | 3.25 | MA | 6293 | 2092 | 9036 | 1827 | 11466 | 1514 | 13129 | 1244 | 15460 | 798 | 20014 | 418 | 17036 |
| 5E | | MI | 4541 | 2092 | 6801 | 1777 | 8435 | 1469 | 9547 | 1201 | 11101 | 759 | 14040 | 352 | 12073 |
| 16-#11 | 3.25 | MA | 5999 | 2092 | 8541 | 1837 | 10866 | 1528 | 12363 | 1264 | 14400 | 809 | 18578 | 334 | 16424 |
| 6L-4S | | MI | 4711 | 2092 | 7136 | 1765 | 8909 | 1451 | 10106 | 1192 | 11874 | 747 | 15092 | 419 | 12524 |
| 16-#11 | 3.25 | MA | 5742 | 2092 | 8056 | 1847 | 10244 | 1538 | 11623 | 1277 | 13369 | 826 | 17156 | 286 | 15566 |
| 7L-3S | | MI | 4852 | 2092 | 7510 | 1752 | 9398 | 1440 | 10730 | 1176 | 12726 | 742 | 16146 | 484 | 12782 |
| 16-#11 | 3.25 | MA | 5502 | 2092 | 7521 | 1866 | 9586 | 1555 | 10877 | 1287 | 12342 | 836 | 15786 | 222 | 14585 |
| 8L-2S | | MI | 5112 | 2092 | 8043 | 1739 | 10072 | 1429 | 11546 | 1168 | 13825 | 730 | 17635 | 599 | 12845 |
| 16-#14 | 4.69 | MA | 7078 | 2417 | 10944 | 2043 | 13796 | 1678 | 15913 | 1352 | 19168 | 799 | 25195 | 290 | 23614 |
| 5E | | MI | 5047 | 2417 | 8120 | 1986 | 10036 | 1625 | 11454 | 1301 | 13637 | 749 | 17328 | 182 | 16536 |
| 16-#14 | 4.69 | MA | 6668 | 2417 | 10243 | 2057 | 12937 | 1698 | 14817 | 1380 | 17651 | 812 | 23132 | 168 | 22153 |
| 6L-4S | | MI | 5263 | 2417 | 8597 | 1969 | 10712 | 1600 | 12252 | 1290 | 14740 | 734 | 18799 | 280 | 17135 |
| 16-#14 | 4.69 | MA | 6333 | 2417 | 9550 | 2071 | 12058 | 1713 | 13757 | 1397 | 16175 | 836 | 21091 | 96 | 20647 |
| 7L-3S | | MI | 5431 | 2417 | 9131 | 1951 | 11408 | 1586 | 13141 | 1268 | 15953 | 728 | 20279 | 372 | 17948 |
| 18-#10 | 2.98 | MA | 6283 | 2031 | 8834 | 1790 | 11287 | 1486 | 12949 | 1226 | 15255 | 800 | 19679 | 466 | 16120 |
| 5L-6S | | MI | 4375 | 2031 | 6388 | 1754 | 7976 | 1455 | 9000 | 1202 | 10380 | 772 | 13218 | 361 | 11223 |
| 18-#10 | 2.98 | MA | 6039 | 2031 | 8421 | 1797 | 10794 | 1498 | 12319 | 1243 | 14383 | 809 | 18557 | 405 | 15703 |
| 6L-5S | | MI | 4548 | 2031 | 6665 | 1746 | 8330 | 1445 | 9452 | 1188 | 11004 | 766 | 14079 | 432 | 11466 |
| 18-#10 | 2.98 | MA | 5827 | 2031 | 8021 | 1806 | 10274 | 1506 | 11711 | 1254 | 13535 | 824 | 17392 | 369 | 15074 |
| 7L-4S | | MI | 4685 | 2031 | 6941 | 1735 | 8722 | 1430 | 9914 | 1180 | 11644 | 756 | 14971 | 486 | 11857 |
| 18-#10 | 2.98 | MA | 5632 | 2031 | 7581 | 1822 | 9732 | 1520 | 11086 | 1262 | 12691 | 833 | 16269 | 318 | 14404 |
| 8L-3S | | MI | 4809 | 2031 | 7251 | 1723 | 9126 | 1421 | 10431 | 1166 | 12349 | 750 | 15861 | 542 | 11944 |
| 18-#10 | 2.98 | MA | 5381 | 2031 | 7203 | 1833 | 9229 | 1530 | 10444 | 1276 | 11857 | 848 | 15106 | 264 | 13657 |
| 9L-2S | | MI | 5039 | 2031 | 7694 | 1712 | 9687 | 1411 | 11109 | 1158 | 13263 | 739 | 17125 | 635 | 11989 |
| 18-#11 | 3.66 | MA | 6633 | 2184 | 9799 | 1885 | 12431 | 1556 | 14296 | 1271 | 17032 | 795 | 22191 | 413 | 19234 |
| 5L-6S | | MI | 4584 | 2184 | 7007 | 1846 | 8681 | 1522 | 9816 | 1244 | 11444 | 760 | 14511 | 259 | 13122 |
| 18-#11 | 3.66 | MA | 6351 | 2184 | 9304 | 1894 | 11831 | 1571 | 13531 | 1291 | 15972 | 805 | 20755 | 329 | 18623 |
| 6L-5S | | MI | 4780 | 2184 | 7334 | 1835 | 9110 | 1511 | 10363 | 1228 | 12200 | 755 | 15530 | 343 | 13588 |
| 18-#11 | 3.66 | MA | 6107 | 2184 | 8819 | 1904 | 11209 | 1581 | 12790 | 1304 | 14941 | 822 | 19333 | 281 | 17778 |
| 7L-4S | | MI | 4936 | 2184 | 7669 | 1822 | 9584 | 1493 | 10923 | 1219 | 12973 | 743 | 16581 | 410 | 14021 |
| 18-#11 | 3.66 | MA | 5882 | 2184 | 8285 | 1923 | 10551 | 1597 | 12044 | 1314 | 13914 | 832 | 17963 | 217 | 16791 |
| 8L-3S | | MI | 5067 | 2184 | 8043 | 1809 | 10072 | 1482 | 11546 | 1203 | 13825 | 738 | 17635 | 476 | 14324 |
| 18-#14 | 5.27 | MA | 7190 | 2550 | 11332 | 2140 | 14314 | 1758 | 16483 | 1419 | 19894 | 807 | 26237 | 161 | 25300 |
| 6L-5S | | MI | 5357 | 2550 | 8877 | 2069 | 10995 | 1685 | 12614 | 1340 | 15198 | 744 | 19411 | 167 | 18660 |
| 18-#14 | 5.27 | MA | 6882 | 2550 | 10639 | 2154 | 13435 | 1773 | 15422 | 1436 | 18419 | 831 | 24196 | 89 | 23785 |
| 7L-4S | | MI | 5570 | 2550 | 9355 | 2051 | 11670 | 1661 | 13412 | 1329 | 16301 | 729 | 20882 | 264 | 19277 |
| 20-#10 | 3.31 | MA | 6330 | 2105 | 9051 | 1844 | 11591 | 1532 | 13284 | 1264 | 15681 | 807 | 20355 | 401 | 17531 |
| 6E | | MI | 4572 | 2105 | 6831 | 1801 | 8537 | 1489 | 9679 | 1224 | 11294 | 769 | 14482 | 358 | 12474 |
| 20-#10 | 3.31 | MA | 6128 | 2105 | 8652 | 1853 | 11071 | 1540 | 12675 | 1276 | 14834 | 821 | 19190 | 365 | 16902 |
| 7L-5S | | MI | 4740 | 2105 | 7108 | 1792 | 8891 | 1480 | 10130 | 1210 | 11918 | 764 | 15343 | 428 | 12727 |
| 20-#10 | 3.31 | MA | 5940 | 2105 | 8212 | 1869 | 10529 | 1554 | 12050 | 1284 | 13989 | 831 | 18066 | 315 | 16227 |
| 8L-4S | | MI | 4875 | 2105 | 7384 | 1781 | 9283 | 1465 | 10593 | 1202 | 12558 | 753 | 16235 | 482 | 13129 |

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 3.31 | MA | 5695 | 2105 | 7833 | 1880 | 10026 | 1564 | 11409 | 1298 | 13156 | 845 | 16904 | 260 | 15483 |
| 9L-3S | | MI | 4999 | 2105 | 7694 | 1770 | 9687 | 1455 | 11109 | 1188 | 13263 | 747 | 17125 | 538 | 13229 |
| 20-#11 | 4.06 | MA | 6695 | 2276 | 10067 | 1951 | 12796 | 1613 | 14698 | 1318 | 17544 | 802 | 22931 | 324 | 20825 |
| 6E | | MI | 4814 | 2276 | 7541 | 1903 | 9356 | 1564 | 10633 | 1271 | 12543 | 757 | 16000 | 251 | 14627 |
| 20-#11 | 4.06 | MA | 6464 | 2276 | 9582 | 1962 | 12175 | 1623 | 13958 | 1330 | 16513 | 819 | 21509 | 277 | 19989 |
| 7L-5S | | MI | 5001 | 2276 | 7868 | 1892 | 9785 | 1553 | 11179 | 1255 | 13299 | 752 | 17019 | 335 | 15107 |
| 20-#11 | 4.06 | MA | 6243 | 2276 | 9048 | 1981 | 11517 | 1640 | 13212 | 1341 | 15486 | 829 | 20139 | 212 | 18997 |
| 8L-4S | | MI | 5156 | 2276 | 8203 | 1879 | 10259 | 1535 | 11739 | 1246 | 14072 | 740 | 18071 | 402 | 15523 |
| 20-#14 | 5.86 | MA | 7379 | 2682 | 11728 | 2237 | 14813 | 1834 | 17088 | 1475 | 20662 | 826 | 27302 | 82 | 26923 |
| 7L-5S | | MI | 5661 | 2682 | 9635 | 2152 | 11953 | 1746 | 13773 | 1379 | 16759 | 739 | 21494 | 151 | 20790 |
| 22-#10 | 3.64 | MA | 6423 | 2180 | 9282 | 1900 | 11869 | 1574 | 13639 | 1298 | 16132 | 819 | 20988 | 361 | 18731 |
| 7L-6S | | MI | 4766 | 2180 | 7275 | 1848 | 9098 | 1524 | 10357 | 1246 | 12207 | 766 | 15745 | 354 | 13725 |
| 22-#10 | 3.64 | MA | 6237 | 2180 | 8842 | 1916 | 11327 | 1589 | 13015 | 1306 | 15288 | 828 | 19864 | 311 | 18050 |
| 8L-5S | | MI | 4939 | 2180 | 7551 | 1839 | 9452 | 1514 | 10809 | 1232 | 12831 | 761 | 16606 | 424 | 13990 |
| 22-#10 | 3.64 | MA | 6001 | 2180 | 8464 | 1927 | 10824 | 1598 | 12373 | 1320 | 14454 | 843 | 18702 | 256 | 17308 |
| 9L-4S | | MI | 5073 | 2180 | 7828 | 1828 | 9844 | 1499 | 11271 | 1224 | 13471 | 750 | 17498 | 478 | 14379 |
| 22-#11 | 4.47 | MA | 6812 | 2368 | 10345 | 2019 | 13140 | 1665 | 15125 | 1357 | 18085 | 815 | 23686 | 272 | 22201 |
| 7L-6S | | MI | 5040 | 2368 | 8074 | 1961 | 10030 | 1606 | 11449 | 1298 | 13642 | 753 | 17490 | 242 | 16135 |
| 22-#11 | 4.47 | MA | 6594 | 2368 | 9811 | 2038 | 12482 | 1682 | 14379 | 1368 | 17058 | 825 | 22316 | 207 | 21202 |
| 8L-5S | | MI | 5219 | 2368 | 8401 | 1950 | 10460 | 1595 | 11996 | 1282 | 14398 | 748 | 18509 | 327 | 16630 |
| 24-#10 | 3.97 | MA | 6528 | 2255 | 9472 | 1962 | 12124 | 1623 | 13979 | 1328 | 16586 | 825 | 21662 | 307 | 19873 |
| 8L-6S | | MI | 4970 | 2255 | 7718 | 1894 | 9659 | 1558 | 11036 | 1268 | 13120 | 763 | 17009 | 350 | 14980 |
| 24-#10 | 3.97 | MA | 6300 | 2255 | 9094 | 1973 | 11621 | 1633 | 13338 | 1342 | 15753 | 840 | 20500 | 252 | 19133 |
| 9L-5S | | MI | 5122 | 2255 | 7995 | 1886 | 10013 | 1548 | 11487 | 1254 | 13745 | 758 | 17870 | 420 | 15257 |
| 24-#11 | 4.88 | MA | 6938 | 2460 | 10574 | 2095 | 13447 | 1724 | 15547 | 1395 | 18630 | 822 | 24492 | 202 | 23408 |
| 8L-6S | | MI | 5262 | 2460 | 8608 | 2018 | 10705 | 1648 | 12265 | 1325 | 14741 | 750 | 18979 | 234 | 17647 |

## RECTANGULAR TIED COLUMNS 24" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.10 | MA | 6097 | 1708 | 7624 | 1570 | 9801 | 1320 | 11057 | 1122 | 12445 | 821 | 15460 | 716 | 7176 |
| 2E | | MI | 4175 | 1708 | 5582 | 1517 | 6909 | 1274 | 7658 | 1082 | 8463 | 790 | 10219 | 671 | 4859 |
| 4-#18 | 1.96 | MA | 6851 | 1914 | 9482 | 1686 | 12061 | 1403 | 13744 | 1173 | 16018 | 806 | 20375 | 698 | 12330 |
| 2E | | MI | 4611 | 1914 | 6783 | 1627 | 8345 | 1353 | 9352 | 1130 | 10704 | 771 | 12955 | 612 | 8173 |
| 6-#11 | 1.15 | MA | 6165 | 1718 | 7681 | 1583 | 9920 | 1330 | 11225 | 1130 | 12693 | 825 | 15821 | 718 | 7494 |
| 2L-3S | | MI | 3884 | 1718 | 5079 | 1545 | 6315 | 1297 | 6962 | 1101 | 7546 | 807 | 9056 | 567 | 5077 |
| 6-#11 | 1.15 | MA | 5631 | 1718 | 6861 | 1599 | 8882 | 1345 | 9970 | 1144 | 11003 | 843 | 13480 | 613 | 7468 |
| 3L-2S | | MI | 4223 | 1718 | 5612 | 1532 | 6990 | 1287 | 7779 | 1092 | 8645 | 795 | 10546 | 681 | 5072 |
| 6-#14 | 1.65 | MA | 6636 | 1840 | 8795 | 1653 | 11283 | 1380 | 12850 | 1161 | 14858 | 816 | 18802 | 709 | 10608 |
| 2L-3S | | MI | 4045 | 1840 | 5582 | 1617 | 6909 | 1349 | 7658 | 1133 | 8463 | 800 | 10219 | 490 | 7060 |
| 6-#14 | 1.65 | MA | 5916 | 1840 | 7624 | 1676 | 9801 | 1401 | 11057 | 1180 | 12445 | 841 | 15460 | 555 | 10508 |
| 3L-2S | | MI | 4501 | 1840 | 6339 | 1599 | 7867 | 1335 | 8817 | 1121 | 10024 | 785 | 12302 | 655 | 7094 |
| 6-#18 | 2.94 | MA | 7707 | 2149 | 11524 | 1833 | 14643 | 1512 | 16867 | 1242 | 20223 | 797 | 26198 | 686 | 18282 |
| 2L-3S | | MI | 4437 | 2149 | 6783 | 1802 | 8345 | 1483 | 9352 | 1214 | 10704 | 784 | 12955 | 278 | 11725 |
| 6-#18 | 2.94 | MA | 6596 | 2149 | 9482 | 1872 | 12061 | 1546 | 13744 | 1273 | 16018 | 838 | 20375 | 405 | 17823 |
| 3L-2S | | MI | 5119 | 2149 | 8088 | 1775 | 9996 | 1461 | 11349 | 1199 | 13394 | 762 | 16430 | 571 | 11981 |
| 8-#10 | 1.25 | MA | 6300 | 1742 | 7843 | 1607 | 10189 | 1348 | 11584 | 1144 | 13208 | 829 | 16557 | 722 | 8179 |
| 2L-4S | | MI | 3870 | 1742 | 4955 | 1582 | 6207 | 1327 | 6835 | 1130 | 7392 | 817 | 9012 | 548 | 5499 |
| 8-#10 | 1.25 | MA | 5865 | 1742 | 7166 | 1620 | 9332 | 1361 | 10548 | 1155 | 11813 | 844 | 14625 | 638 | 8155 |
| 3E | | MI | 4038 | 1742 | 5265 | 1571 | 6611 | 1318 | 7351 | 1117 | 8097 | 812 | 9902 | 603 | 5531 |
| 8-#10 | 1.25 | MA | 5612 | 1742 | 6702 | 1634 | 8725 | 1374 | 9772 | 1173 | 10751 | 854 | 13327 | 586 | 8059 |
| 4L-2S | | MI | 4316 | 1742 | 5708 | 1559 | 7172 | 1308 | 8030 | 1108 | 9011 | 801 | 11166 | 697 | 5533 |
| 8-#11 | 1.53 | MA | 6547 | 1810 | 8502 | 1640 | 10957 | 1372 | 12480 | 1157 | 14383 | 821 | 18161 | 713 | 9896 |
| 2L-4S | | MI | 3937 | 1810 | 5238 | 1615 | 6502 | 1350 | 7155 | 1144 | 7793 | 808 | 9492 | 493 | 6562 |
| 8-#11 | 1.53 | MA | 6039 | 1810 | 7681 | 1657 | 9920 | 1387 | 11225 | 1171 | 12693 | 839 | 15821 | 609 | 9851 |
| 3E | | MI | 4132 | 1810 | 5612 | 1602 | 6990 | 1340 | 7779 | 1128 | 8645 | 803 | 10546 | 559 | 6632 |
| 8-#11 | 1.53 | MA | 5742 | 1810 | 7117 | 1673 | 9182 | 1402 | 10281 | 1191 | 11402 | 850 | 14234 | 544 | 9680 |
| 4L-2S | | MI | 4456 | 1810 | 6146 | 1590 | 7665 | 1329 | 8595 | 1119 | 9744 | 791 | 12035 | 673 | 6644 |

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

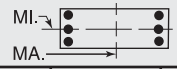
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.21 | MA | 7150 | 1972 | 9967 | 1736 | 12765 | 1441 | 14643 | 1200 | 17272 | 811 | 22144 | 702 | 14029 |
| 2L-4S | | MI | 4126 | 1972 | 5806 | 1717 | 7172 | 1425 | 7929 | 1193 | 8811 | 801 | 10823 | 383 | 8782 |
| 8-#14 | 2.21 | MA | 6476 | 1972 | 8795 | 1759 | 11283 | 1462 | 12850 | 1219 | 14858 | 836 | 18802 | 548 | 13899 |
| 3E | | MI | 4385 | 1972 | 6339 | 1700 | 7867 | 1410 | 8817 | 1172 | 10024 | 795 | 12302 | 475 | 9247 |
| 8-#14 | 2.21 | MA | 6085 | 1972 | 7987 | 1781 | 10227 | 1483 | 11500 | 1248 | 13012 | 851 | 16522 | 454 | 13198 |
| 4L-2S | | MI | 4816 | 1972 | 7097 | 1682 | 8826 | 1396 | 9977 | 1160 | 11584 | 780 | 14385 | 640 | 9311 |
| 8-#18 | 3.92 | MA | 8514 | 2385 | 13565 | 1980 | 17225 | 1620 | 19990 | 1312 | 24428 | 788 | 32021 | 674 | 24226 |
| 2L-4S | | MI | 4607 | 2385 | 7162 | 1977 | 8789 | 1613 | 9809 | 1317 | 11293 | 779 | 13944 | 82 | 13541 |
| 8-#18 | 3.92 | MA | 7514 | 2385 | 11524 | 2019 | 14643 | 1654 | 16867 | 1342 | 20223 | 829 | 26198 | 393 | 23732 |
| 3E | | MI | 4988 | 2385 | 8088 | 1949 | 9996 | 1591 | 11349 | 1284 | 13394 | 775 | 16430 | 237 | 15461 |
| 8-#18 | 3.92 | MA | 6931 | 2385 | 10109 | 2057 | 12795 | 1689 | 14504 | 1390 | 16995 | 851 | 22173 | 223 | 20766 |
| 4L-2S | | MI | 5606 | 2385 | 9394 | 1922 | 11648 | 1570 | 13347 | 1268 | 16083 | 754 | 19906 | 531 | 15773 |
| 10-#10 | 1.56 | MA | 6616 | 1816 | 8520 | 1653 | 11045 | 1383 | 12620 | 1165 | 14602 | 826 | 18488 | 718 | 10160 |
| 2L-5S | | MI | 3942 | 1816 | 5123 | 1639 | 6377 | 1377 | 7051 | 1161 | 7666 | 825 | 9384 | 490 | 6536 |
| 10-#10 | 1.56 | MA | 6199 | 1816 | 7843 | 1667 | 10189 | 1395 | 11584 | 1177 | 13208 | 842 | 16557 | 634 | 10125 |
| 3L-4S | | MI | 4086 | 1816 | 5399 | 1628 | 6768 | 1362 | 7513 | 1152 | 8306 | 815 | 10275 | 544 | 6777 |
| 10-#10 | 1.56 | MA | 5962 | 1816 | 7379 | 1681 | 9582 | 1408 | 10807 | 1195 | 12145 | 851 | 15259 | 582 | 10017 |
| 4L-3S | | MI | 4244 | 1816 | 5708 | 1617 | 7172 | 1352 | 8030 | 1139 | 9011 | 809 | 11166 | 599 | 6823 |
| 10-#10 | 1.56 | MA | 5705 | 1816 | 6967 | 1695 | 8996 | 1427 | 10116 | 1206 | 11187 | 867 | 13882 | 532 | 9602 |
| 5L-2S | | MI | 4512 | 1816 | 6152 | 1606 | 7733 | 1342 | 8708 | 1130 | 9924 | 798 | 12430 | 693 | 6835 |
| 10-#11 | 1.91 | MA | 6915 | 1902 | 9322 | 1698 | 11995 | 1414 | 13736 | 1184 | 16073 | 818 | 20501 | 709 | 12294 |
| 2L-5S | | MI | 4025 | 1902 | 5437 | 1685 | 6703 | 1410 | 7412 | 1180 | 8118 | 816 | 9930 | 418 | 7643 |
| 10-#11 | 1.91 | MA | 6431 | 1902 | 8502 | 1714 | 10957 | 1429 | 12480 | 1198 | 14383 | 836 | 18161 | 604 | 12233 |
| 3L-4S | | MI | 4190 | 1902 | 5771 | 1673 | 7177 | 1393 | 7971 | 1171 | 8892 | 805 | 10981 | 485 | 8093 |
| 10-#11 | 1.91 | MA | 6156 | 1902 | 7937 | 1730 | 10220 | 1444 | 11537 | 1218 | 13093 | 847 | 16574 | 539 | 12050 |
| 4L-3S | | MI | 4372 | 1902 | 6146 | 1660 | 7665 | 1382 | 8595 | 1155 | 9744 | 800 | 12035 | 550 | 8181 |
| 10-#11 | 1.91 | MA | 5855 | 1902 | 7437 | 1747 | 9508 | 1466 | 10695 | 1232 | 11927 | 865 | 14897 | 475 | 11308 |
| 5L-2S | | MI | 4683 | 1902 | 6679 | 1647 | 8340 | 1371 | 9411 | 1146 | 10843 | 788 | 13525 | 665 | 8207 |
| 10-#14 | 2.76 | MA | 7646 | 2105 | 11139 | 1818 | 14247 | 1502 | 16435 | 1239 | 19685 | 806 | 25486 | 695 | 17445 |
| 2L-5S | | MI | 4250 | 2105 | 6086 | 1817 | 7454 | 1510 | 8290 | 1244 | 9269 | 811 | 11435 | 270 | 10227 |
| 10-#14 | 2.76 | MA | 7012 | 2105 | 9967 | 1841 | 12765 | 1523 | 14643 | 1258 | 17272 | 831 | 22144 | 541 | 17293 |
| 3L-4S | | MI | 4474 | 2105 | 6563 | 1800 | 8130 | 1485 | 9088 | 1232 | 10372 | 796 | 12906 | 367 | 10876 |
| 10-#14 | 2.76 | MA | 6658 | 2105 | 9159 | 1864 | 11709 | 1544 | 13292 | 1287 | 15426 | 846 | 19863 | 448 | 16540 |
| 4L-3S | | MI | 4724 | 2105 | 7097 | 1782 | 8826 | 1471 | 9977 | 1211 | 11584 | 790 | 14385 | 459 | 11432 |
| 10-#14 | 2.76 | MA | 6240 | 2105 | 8442 | 1887 | 10690 | 1575 | 12087 | 1305 | 13757 | 871 | 17458 | 351 | 15304 |
| 5L-2S | | MI | 5118 | 2105 | 7855 | 1765 | 9784 | 1457 | 11136 | 1199 | 13145 | 775 | 16468 | 624 | 11519 |
| 10-#18 | 4.90 | MA | 8415 | 2620 | 13565 | 2166 | 17225 | 1762 | 19990 | 1411 | 24428 | 820 | 32021 | 380 | 29654 |
| 3L-4S | | MI | 5186 | 2620 | 8468 | 2124 | 10441 | 1721 | 11807 | 1386 | 13982 | 771 | 17420 | 42 | 17203 |
| 10-#18 | 4.90 | MA | 7937 | 2620 | 12150 | 2204 | 15378 | 1797 | 17628 | 1459 | 21200 | 842 | 27995 | 211 | 26671 |
| 4L-3S | | MI | 5515 | 2620 | 9394 | 2096 | 11648 | 1699 | 13347 | 1353 | 16083 | 766 | 19906 | 197 | 19152 |
| 10-#18 | 4.90 | MA | 7190 | 2620 | 10892 | 2243 | 13591 | 1849 | 15517 | 1490 | 18277 | 883 | 23939 | 55 | 23715 |
| 5L-2S | | MI | 6080 | 2620 | 10700 | 2069 | 13299 | 1678 | 15344 | 1337 | 18773 | 745 | 23381 | 491 | 19558 |
| 12-#10 | 1.87 | MA | 6923 | 1891 | 9197 | 1700 | 11901 | 1417 | 13656 | 1187 | 15997 | 823 | 20419 | 714 | 12138 |
| 2L-6S | | MI | 3958 | 1891 | 5289 | 1695 | 6583 | 1421 | 7278 | 1196 | 7955 | 828 | 9786 | 415 | 7505 |
| 12-#10 | 1.87 | MA | 6522 | 1891 | 8520 | 1714 | 11045 | 1430 | 12620 | 1199 | 14602 | 839 | 18488 | 630 | 12093 |
| 3L-5S | | MI | 4154 | 1891 | 5566 | 1686 | 6937 | 1411 | 7729 | 1183 | 8579 | 823 | 10647 | 486 | 7777 |
| 12-#10 | 1.87 | MA | 6300 | 1891 | 8056 | 1728 | 10438 | 1443 | 11843 | 1217 | 13540 | 849 | 17190 | 578 | 11977 |
| 4E | | MI | 4295 | 1891 | 5842 | 1675 | 7329 | 1396 | 8192 | 1174 | 9219 | 812 | 11539 | 540 | 8056 |
| 12-#10 | 1.87 | MA | 6047 | 1891 | 7644 | 1741 | 9853 | 1461 | 11152 | 1228 | 12581 | 864 | 15813 | 528 | 11540 |
| 5L-3S | | MI | 4444 | 1891 | 6152 | 1664 | 7733 | 1386 | 8708 | 1161 | 9924 | 806 | 12430 | 595 | 8113 |
| 12-#10 | 1.87 | MA | 5747 | 1891 | 7197 | 1748 | 9324 | 1473 | 10494 | 1240 | 11648 | 874 | 14615 | 469 | 11028 |
| 6L-2S | | MI | 4703 | 1891 | 6595 | 1653 | 8294 | 1377 | 9387 | 1152 | 10838 | 795 | 13693 | 689 | 8133 |
| 12-#11 | 2.29 | MA | 7273 | 1994 | 10142 | 1755 | 13033 | 1457 | 14991 | 1211 | 17763 | 814 | 22841 | 704 | 14688 |
| 2L-6S | | MI | 4044 | 1994 | 5643 | 1754 | 6948 | 1463 | 7681 | 1222 | 8462 | 818 | 10400 | 325 | 8771 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.29 | MA | 6810 | 1994 | 9322 | 1772 | 11995 | 1472 | 13736 | 1225 | 16073 | 832 | 20501 | 599 | 14615 |
| 3L-5S | | MI | 4273 | 1994 | 5970 | 1743 | 7378 | 1452 | 8228 | 1207 | 9217 | 813 | 11419 | 410 | 9140 |
| 12-#11 | 2.29 | MA | 6555 | 1994 | 8758 | 1788 | 11258 | 1486 | 12792 | 1245 | 14783 | 843 | 18914 | 535 | 14423 |
| 4E | | MI | 4434 | 1994 | 6305 | 1730 | 7852 | 1435 | 8787 | 1198 | 9991 | 801 | 12470 | 477 | 9625 |
| 12-#11 | 2.29 | MA | 6260 | 1994 | 8257 | 1804 | 10546 | 1508 | 11951 | 1259 | 13617 | 861 | 17237 | 470 | 13663 |
| 5L-3S | | MI | 4606 | 1994 | 6679 | 1717 | 8340 | 1424 | 9411 | 1182 | 10843 | 796 | 13525 | 542 | 9727 |
| 12-#11 | 2.29 | MA | 5908 | 1994 | 7720 | 1813 | 9903 | 1523 | 11130 | 1279 | 12481 | 872 | 15774 | 395 | 13063 |
| 6L-2S | | MI | 4904 | 1994 | 7213 | 1704 | 9015 | 1413 | 10227 | 1173 | 11942 | 784 | 15014 | 657 | 9765 |
| 12-#14 | 3.31 | MA | 7529 | 2237 | 11139 | 1924 | 14247 | 1584 | 16435 | 1297 | 19685 | 826 | 25486 | 534 | 20691 |
| 3L-5S | | MI | 4591 | 2237 | 6843 | 1900 | 8413 | 1571 | 9450 | 1282 | 10830 | 806 | 13518 | 254 | 12370 |
| 12-#14 | 3.31 | MA | 7207 | 2237 | 10331 | 1947 | 13191 | 1605 | 15085 | 1326 | 17839 | 841 | 23205 | 441 | 19891 |
| 4E | | MI | 4828 | 2237 | 7321 | 1883 | 9089 | 1546 | 10248 | 1271 | 11933 | 791 | 14989 | 352 | 12986 |
| 12-#14 | 3.31 | MA | 6798 | 2237 | 9614 | 1970 | 12172 | 1636 | 13880 | 1344 | 16170 | 866 | 20800 | 345 | 18699 |
| 5L-3S | | MI | 5039 | 2237 | 7855 | 1865 | 9784 | 1532 | 11136 | 1250 | 13145 | 785 | 16468 | 444 | 13617 |
| 12-#14 | 3.31 | MA | 6328 | 2237 | 8852 | 1983 | 11251 | 1657 | 12705 | 1373 | 14544 | 881 | 18696 | 236 | 17228 |
| 6L-2S | | MI | 5409 | 2237 | 8613 | 1848 | 10743 | 1517 | 12295 | 1238 | 14706 | 770 | 18552 | 609 | 13723 |
| 12-#18 | 5.88 | MA | 8847 | 2855 | 14192 | 2352 | 17960 | 1905 | 20751 | 1529 | 25405 | 834 | 33818 | 198 | 32585 |
| 4E | | MI | 5740 | 2855 | 9773 | 2271 | 12092 | 1829 | 13804 | 1455 | 16672 | 762 | 20896 | 2 | 20885 |
| 12-#18 | 5.88 | MA | 8156 | 2855 | 12934 | 2390 | 16173 | 1957 | 18640 | 1559 | 22482 | 874 | 29762 | 42 | 29588 |
| 5L-3S | | MI | 6026 | 2855 | 10700 | 2243 | 13299 | 1808 | 15344 | 1422 | 18773 | 758 | 23381 | 157 | 22738 |
| 14-#10 | 2.18 | MA | 6837 | 1966 | 9197 | 1761 | 11901 | 1464 | 13656 | 1221 | 15997 | 836 | 20419 | 626 | 14062 |
| 3L-6S | | MI | 4170 | 1966 | 5733 | 1742 | 7144 | 1455 | 7956 | 1218 | 8868 | 825 | 11050 | 411 | 8764 |
| 14-#10 | 2.18 | MA | 6628 | 1966 | 8733 | 1774 | 11295 | 1477 | 12879 | 1239 | 14935 | 846 | 19121 | 574 | 13940 |
| 4L-5S | | MI | 4359 | 1966 | 6009 | 1733 | 7498 | 1446 | 8408 | 1205 | 9493 | 820 | 11911 | 482 | 9025 |
| 14-#10 | 2.18 | MA | 6379 | 1966 | 8321 | 1788 | 10709 | 1495 | 12188 | 1250 | 13976 | 861 | 17745 | 524 | 13483 |
| 5L-4S | | MI | 4499 | 1966 | 6286 | 1722 | 7890 | 1430 | 8870 | 1196 | 10132 | 809 | 12803 | 536 | 9334 |
| 14-#10 | 2.18 | MA | 6091 | 1966 | 7874 | 1795 | 10180 | 1508 | 11530 | 1262 | 13042 | 871 | 16546 | 465 | 12987 |
| 6L-3S | | MI | 4640 | 1966 | 6595 | 1711 | 8294 | 1421 | 9387 | 1183 | 10838 | 804 | 13693 | 591 | 9400 |
| 14-#10 | 2.18 | MA | 5838 | 1966 | 7446 | 1804 | 9618 | 1515 | 10862 | 1280 | 12135 | 886 | 15304 | 429 | 12358 |
| 7L-2S | | MI | 4890 | 1966 | 7039 | 1700 | 8855 | 1411 | 10065 | 1174 | 11751 | 793 | 14957 | 685 | 9428 |
| 14-#11 | 2.68 | MA | 7179 | 2085 | 10142 | 1829 | 13033 | 1514 | 14991 | 1252 | 17763 | 829 | 22841 | 594 | 16997 |
| 3L-6S | | MI | 4293 | 2085 | 6176 | 1811 | 7623 | 1505 | 8498 | 1249 | 9561 | 815 | 11889 | 317 | 10257 |
| 14-#11 | 2.68 | MA | 6941 | 2085 | 9578 | 1845 | 12295 | 1529 | 14047 | 1272 | 16473 | 840 | 21254 | 530 | 16800 |
| 4L-5S | | MI | 4513 | 2085 | 6504 | 1800 | 8053 | 1495 | 9044 | 1234 | 10316 | 810 | 12908 | 401 | 10643 |
| 14-#11 | 2.68 | MA | 6650 | 2085 | 9078 | 1862 | 11583 | 1551 | 13206 | 1286 | 15307 | 858 | 19577 | 465 | 16022 |
| 5L-4S | | MI | 4672 | 2085 | 6838 | 1787 | 8526 | 1477 | 9604 | 1225 | 11090 | 798 | 13960 | 468 | 11125 |
| 14-#11 | 2.68 | MA | 6315 | 2085 | 8540 | 1871 | 10941 | 1566 | 12386 | 1306 | 14171 | 869 | 18114 | 391 | 15436 |
| 6L-3S | | MI | 4834 | 2085 | 7213 | 1775 | 9015 | 1466 | 10227 | 1209 | 11942 | 793 | 15014 | 534 | 11271 |
| 14-#11 | 2.68 | MA | 6019 | 2085 | 8020 | 1882 | 10266 | 1575 | 11593 | 1320 | 13067 | 887 | 16595 | 345 | 14449 |
| 7L-2S | | MI | 5120 | 2085 | 7746 | 1762 | 9690 | 1455 | 11044 | 1200 | 13041 | 781 | 16504 | 649 | 11320 |
| 14-#14 | 3.86 | MA | 7738 | 2370 | 11502 | 2030 | 14673 | 1666 | 16877 | 1364 | 20253 | 836 | 26547 | 434 | 23250 |
| 4L-5S | | MI | 4935 | 2370 | 7601 | 1983 | 9371 | 1632 | 10609 | 1321 | 12390 | 801 | 15601 | 239 | 14522 |
| 14-#14 | 3.86 | MA | 7334 | 2370 | 10785 | 2053 | 13654 | 1696 | 15672 | 1383 | 18584 | 861 | 24142 | 338 | 22098 |
| 5L-4S | | MI | 5154 | 2370 | 8079 | 1965 | 10047 | 1607 | 11407 | 1310 | 13493 | 786 | 17072 | 336 | 15107 |
| 14-#14 | 3.86 | MA | 6892 | 2370 | 10024 | 2066 | 12733 | 1717 | 14498 | 1412 | 16957 | 876 | 22038 | 230 | 20615 |
| 6L-3S | | MI | 5345 | 2370 | 8613 | 1948 | 10743 | 1593 | 12295 | 1288 | 14706 | 780 | 18552 | 428 | 15803 |
| 14-#14 | 3.86 | MA | 6501 | 2370 | 9280 | 2081 | 11777 | 1732 | 13362 | 1431 | 15376 | 901 | 19856 | 161 | 19049 |
| 7L-2S | | MI | 5695 | 2370 | 9370 | 1930 | 11701 | 1578 | 13455 | 1277 | 16267 | 765 | 20635 | 594 | 15924 |
| 14-#18 | 6.86 | MA | 9043 | 3091 | 14975 | 2537 | 18756 | 2065 | 21764 | 1628 | 26688 | 865 | 35584 | 30 | 35461 |
| 5L-4S | | MI | 6276 | 3091 | 11079 | 2418 | 13744 | 1937 | 15802 | 1525 | 19361 | 753 | 24371 | -38 | 24236 |
| 16-#10 | 2.49 | MA | 6947 | 2041 | 9410 | 1821 | 12151 | 1511 | 13915 | 1261 | 16329 | 843 | 21052 | 571 | 15903 |
| 4L-6S | | MI | 4378 | 2041 | 6176 | 1788 | 7705 | 1490 | 8635 | 1240 | 9782 | 822 | 12314 | 407 | 10026 |
| 16-#10 | 2.49 | MA | 6701 | 2041 | 8998 | 1835 | 11566 | 1530 | 13223 | 1272 | 15371 | 858 | 19676 | 520 | 15429 |
| 5E | | MI | 4560 | 2041 | 6453 | 1780 | 8059 | 1480 | 9086 | 1226 | 10406 | 817 | 13175 | 478 | 10277 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 34"

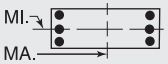
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.49 | MA | 6425 | 2041 | 8551 | 1842 | 11037 | 1542 | 12566 | 1284 | 14437 | 868 | 18477 | 461 | 14949 |
| 6L-4S | | MI | 4698 | 2041 | 6729 | 1769 | 8451 | 1465 | 9549 | 1218 | 11046 | 806 | 14067 | 532 | 10613 |
| 16-#10 | 2.49 | MA | 6183 | 2041 | 8123 | 1851 | 10474 | 1550 | 11898 | 1301 | 13529 | 884 | 17235 | 425 | 14323 |
| 7L-3S | | MI | 4832 | 2041 | 7039 | 1757 | 8855 | 1455 | 10065 | 1204 | 11751 | 801 | 14957 | 587 | 10686 |
| 16-#10 | 2.49 | MA | 5960 | 2041 | 7651 | 1867 | 9893 | 1564 | 11220 | 1309 | 12625 | 893 | 16035 | 376 | 13647 |
| 8L-2S | | MI | 5074 | 2041 | 7482 | 1746 | 9416 | 1445 | 10743 | 1196 | 12664 | 790 | 16221 | 681 | 10721 |
| 16-#11 | 3.06 | MA | 7317 | 2177 | 10398 | 1903 | 13333 | 1571 | 15302 | 1299 | 18163 | 836 | 23594 | 525 | 19179 |
| 4L-6S | | MI | 4536 | 2177 | 6710 | 1869 | 8298 | 1548 | 9314 | 1276 | 10660 | 811 | 13379 | 309 | 11749 |
| 16-#11 | 3.06 | MA | 7029 | 2177 | 9898 | 1919 | 12621 | 1593 | 14461 | 1313 | 16997 | 854 | 21917 | 460 | 18385 |
| 5E | | MI | 4747 | 2177 | 7037 | 1857 | 8728 | 1537 | 9860 | 1261 | 11415 | 806 | 14398 | 393 | 12152 |
| 16-#11 | 3.06 | MA | 6709 | 2177 | 9361 | 1928 | 11979 | 1608 | 13641 | 1333 | 15861 | 865 | 20454 | 386 | 17805 |
| 6L-4S | | MI | 4905 | 2177 | 7372 | 1845 | 9201 | 1519 | 10420 | 1252 | 12189 | 794 | 15449 | 460 | 12613 |
| 16-#11 | 3.06 | MA | 6429 | 2177 | 8841 | 1939 | 11303 | 1617 | 12848 | 1347 | 14757 | 883 | 18935 | 341 | 16827 |
| 7L-3S | | MI | 5064 | 2177 | 7746 | 1832 | 9690 | 1508 | 11044 | 1236 | 13041 | 789 | 16504 | 526 | 12814 |
| 16-#11 | 3.06 | MA | 6169 | 2177 | 8268 | 1958 | 10598 | 1635 | 12037 | 1357 | 13657 | 894 | 17470 | 278 | 15825 |
| 8L-2S | | MI | 5329 | 2177 | 8279 | 1819 | 10364 | 1498 | 11860 | 1227 | 14140 | 777 | 17993 | 640 | 12872 |
| 16-#14 | 4.41 | MA | 7855 | 2502 | 11957 | 2135 | 15136 | 1757 | 17465 | 1422 | 20997 | 856 | 27484 | 331 | 25501 |
| 5E | | MI | 5254 | 2502 | 8359 | 2065 | 10330 | 1692 | 11768 | 1360 | 13951 | 796 | 17684 | 223 | 16680 |
| 16-#14 | 4.41 | MA | 7437 | 2502 | 11196 | 2149 | 14215 | 1778 | 16290 | 1451 | 19371 | 871 | 25379 | 223 | 24002 |
| 6L-4S | | MI | 5470 | 2502 | 8837 | 2048 | 11006 | 1668 | 12566 | 1349 | 15054 | 781 | 19155 | 321 | 17237 |
| 16-#14 | 4.41 | MA | 7072 | 2502 | 10451 | 2164 | 13259 | 1793 | 15154 | 1470 | 17789 | 896 | 23198 | 155 | 22425 |
| 7L-3S | | MI | 5644 | 2502 | 9370 | 2031 | 11701 | 1654 | 13455 | 1327 | 16267 | 775 | 20635 | 413 | 17989 |
| 18-#10 | 2.80 | MA | 7015 | 2116 | 9675 | 1881 | 12422 | 1564 | 14259 | 1294 | 16765 | 856 | 21607 | 516 | 17378 |
| 5L-6S | | MI | 4580 | 2116 | 6619 | 1835 | 8266 | 1524 | 9313 | 1262 | 10695 | 820 | 13577 | 403 | 11291 |
| 18-#10 | 2.80 | MA | 6750 | 2116 | 9228 | 1889 | 11893 | 1577 | 13602 | 1306 | 15832 | 865 | 20408 | 457 | 16912 |
| 6L-5S | | MI | 4756 | 2116 | 6896 | 1826 | 8620 | 1514 | 9765 | 1248 | 11320 | 814 | 14438 | 474 | 11533 |
| 18-#10 | 2.80 | MA | 6519 | 2116 | 8800 | 1898 | 11331 | 1584 | 12934 | 1323 | 14924 | 881 | 19167 | 421 | 16287 |
| 7L-4S | | MI | 4893 | 2116 | 7172 | 1815 | 9012 | 1499 | 10227 | 1240 | 11959 | 803 | 15330 | 528 | 11892 |
| 18-#10 | 2.80 | MA | 6308 | 2116 | 8328 | 1914 | 10750 | 1599 | 12256 | 1331 | 14020 | 891 | 17966 | 373 | 15605 |
| 8L-3S | | MI | 5020 | 2116 | 7482 | 1804 | 9416 | 1489 | 10743 | 1226 | 12664 | 798 | 16221 | 583 | 11972 |
| 18-#10 | 2.80 | MA | 6032 | 2116 | 7923 | 1925 | 10211 | 1609 | 11569 | 1346 | 13128 | 906 | 16728 | 319 | 14782 |
| 9L-2S | | MI | 5255 | 2116 | 7925 | 1793 | 9977 | 1480 | 11422 | 1218 | 13578 | 787 | 17485 | 677 | 12012 |
| 18-#11 | 3.44 | MA | 7399 | 2269 | 10718 | 1976 | 13659 | 1635 | 15716 | 1340 | 18687 | 851 | 24257 | 456 | 20752 |
| 5L-6S | | MI | 4773 | 2269 | 7243 | 1926 | 8973 | 1590 | 10130 | 1303 | 11759 | 808 | 14868 | 300 | 13245 |
| 18-#11 | 3.44 | MA | 7092 | 2269 | 10181 | 1985 | 13017 | 1650 | 14896 | 1360 | 17551 | 862 | 22794 | 381 | 20177 |
| 6L-5S | | MI | 4988 | 2269 | 7570 | 1915 | 9402 | 1579 | 10677 | 1288 | 12514 | 803 | 15887 | 385 | 13665 |
| 18-#11 | 3.44 | MA | 6827 | 2269 | 9661 | 1996 | 12341 | 1660 | 14103 | 1374 | 16447 | 880 | 21275 | 336 | 19205 |
| 7L-4S | | MI | 5145 | 2269 | 7905 | 1902 | 9876 | 1561 | 11236 | 1279 | 13288 | 791 | 16939 | 452 | 14108 |
| 18-#11 | 3.44 | MA | 6579 | 2269 | 9088 | 2016 | 11636 | 1677 | 13292 | 1384 | 15347 | 891 | 19811 | 273 | 18197 |
| 8L-3S | | MI | 5280 | 2269 | 8279 | 1889 | 10364 | 1551 | 11860 | 1263 | 14140 | 786 | 17993 | 517 | 14358 |
| 18-#14 | 4.96 | MA | 7966 | 2635 | 12367 | 2232 | 15697 | 1839 | 18083 | 1490 | 21785 | 866 | 28721 | 216 | 27361 |
| 6L-5S | | MI | 5565 | 2635 | 9117 | 2148 | 11288 | 1753 | 12928 | 1399 | 15512 | 791 | 19767 | 208 | 18823 |
| 18-#14 | 4.96 | MA | 7624 | 2635 | 11623 | 2247 | 14741 | 1853 | 16947 | 1509 | 20203 | 891 | 26540 | 148 | 25802 |
| 7L-4S | | MI | 5779 | 2635 | 9594 | 2131 | 11964 | 1729 | 13726 | 1388 | 16615 | 776 | 21238 | 305 | 19376 |
| 20-#10 | 3.11 | MA | 7067 | 2190 | 9905 | 1935 | 12750 | 1611 | 14637 | 1328 | 17226 | 863 | 22339 | 453 | 18877 |
| 6E | | MI | 4778 | 2190 | 7063 | 1882 | 8827 | 1558 | 9992 | 1284 | 11609 | 817 | 14841 | 399 | 12559 |
| 20-#10 | 3.11 | MA | 6847 | 2190 | 9477 | 1945 | 12187 | 1618 | 13970 | 1345 | 16319 | 878 | 21098 | 417 | 18251 |
| 7L-5S | | MI | 4949 | 2190 | 7340 | 1873 | 9181 | 1549 | 10443 | 1270 | 12233 | 811 | 15702 | 470 | 12793 |
| 20-#10 | 3.11 | MA | 6639 | 2190 | 9005 | 1961 | 11606 | 1633 | 13292 | 1353 | 15415 | 888 | 19898 | 369 | 17563 |
| 8L-4S | | MI | 5084 | 2190 | 7616 | 1862 | 9573 | 1533 | 10905 | 1262 | 12873 | 800 | 16594 | 524 | 13172 |
| 20-#10 | 3.11 | MA | 6373 | 2190 | 8600 | 1972 | 11067 | 1643 | 12605 | 1368 | 14523 | 903 | 18660 | 315 | 16742 |
| 9L-3S | | MI | 5212 | 2190 | 7925 | 1851 | 9977 | 1524 | 11422 | 1248 | 13578 | 795 | 17485 | 579 | 13257 |
| 20-#10 | 3.11 | MA | 6124 | 2190 | 8174 | 1980 | 10539 | 1654 | 11942 | 1377 | 13625 | 913 | 17456 | 272 | 15908 |
| 10L-2S | | MI | 5430 | 2190 | 8369 | 1840 | 10538 | 1514 | 12100 | 1240 | 14491 | 784 | 18748 | 673 | 13303 |
| 20-#11 | 3.82 | MA | 7466 | 2361 | 11002 | 2043 | 14055 | 1692 | 16152 | 1387 | 19242 | 859 | 25134 | 376 | 22550 |
| 6E | | MI | 5021 | 2361 | 7777 | 1983 | 9648 | 1632 | 10946 | 1330 | 12858 | 804 | 16358 | 292 | 14747 |
| 20-#11 | 3.82 | MA | 7214 | 2361 | 10482 | 2054 | 13379 | 1702 | 15359 | 1401 | 18137 | 876 | 23615 | 331 | 21583 |
| 7L-5S | | MI | 5211 | 2361 | 8104 | 1972 | 10077 | 1621 | 11493 | 1315 | 13613 | 799 | 17377 | 377 | 15182 |

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

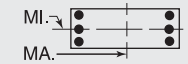
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.82 | MA | 6971 | 2361 | 9909 | 2073 | 12673 | 1719 | 14548 | 1411 | 17037 | 888 | 22151 | 269 | 20569 |
| 8L-4S | | MI | 5366 | 2361 | 8439 | 1959 | 10551 | 1603 | 12052 | 1306 | 14387 | 787 | 18428 | 444 | 15608 |
| 20-#14 | 5.51 | MA | 8210 | 2767 | 12795 | 2330 | 16223 | 1914 | 18739 | 1548 | 22617 | 886 | 29882 | 141 | 29179 |
| 7L-5S | | MI | 5870 | 2767 | 9874 | 2231 | 12247 | 1814 | 14087 | 1438 | 17073 | 787 | 21850 | 192 | 20948 |
| 22-#10 | 3.42 | MA | 7167 | 2265 | 10154 | 1991 | 13043 | 1653 | 15006 | 1367 | 17714 | 875 | 23029 | 413 | 20215 |
| 7L-6S | | MI | 4973 | 2265 | 7506 | 1928 | 9388 | 1593 | 10670 | 1306 | 12522 | 814 | 16105 | 395 | 13829 |
| 22-#10 | 3.42 | MA | 6962 | 2265 | 9682 | 2008 | 12463 | 1667 | 14328 | 1375 | 16809 | 885 | 21829 | 365 | 19522 |
| 8L-5S | | MI | 5138 | 2265 | 7783 | 1920 | 9742 | 1583 | 11121 | 1292 | 13146 | 809 | 16966 | 466 | 14055 |
| 22-#10 | 3.42 | MA | 6705 | 2265 | 9277 | 2019 | 11924 | 1678 | 13640 | 1390 | 15917 | 900 | 20591 | 311 | 18703 |
| 9L-4S | | MI | 5285 | 2265 | 8059 | 1909 | 10134 | 1568 | 11584 | 1284 | 13786 | 798 | 17858 | 520 | 14452 |
| 22-#10 | 3.42 | MA | 6467 | 2265 | 8851 | 2027 | 11395 | 1688 | 12978 | 1399 | 15020 | 910 | 19387 | 268 | 17865 |
| 10L-3S | | MI | 5392 | 2265 | 8369 | 1898 | 10538 | 1558 | 12100 | 1270 | 14491 | 792 | 18748 | 575 | 14542 |
| 22-#11 | 4.21 | MA | 7593 | 2453 | 11302 | 2111 | 14417 | 1744 | 16614 | 1428 | 19828 | 873 | 25955 | 326 | 23961 |
| 7L-6S | | MI | 5247 | 2453 | 8310 | 2041 | 10323 | 1674 | 11762 | 1357 | 13957 | 801 | 17847 | 284 | 16252 |
| 22-#11 | 4.21 | MA | 7352 | 2453 | 10729 | 2130 | 13711 | 1761 | 15803 | 1438 | 18727 | 884 | 24491 | 264 | 22941 |
| 8L-5S | | MI | 5430 | 2453 | 8637 | 2030 | 10752 | 1663 | 12309 | 1342 | 14712 | 796 | 18866 | 368 | 16703 |
| 24-#10 | 3.74 | MA | 7278 | 2340 | 10359 | 2054 | 13319 | 1702 | 15364 | 1397 | 18204 | 882 | 23760 | 361 | 21480 |
| 8L-6S | | MI | 5179 | 2340 | 7950 | 1975 | 9948 | 1627 | 11348 | 1328 | 13436 | 811 | 17369 | 391 | 15084 |
| 24-#10 | 3.74 | MA | 7030 | 2340 | 9954 | 2066 | 12780 | 1712 | 14676 | 1412 | 17312 | 898 | 22522 | 307 | 20664 |
| 9L-5S | | MI | 5334 | 2340 | 8226 | 1967 | 10303 | 1617 | 11800 | 1314 | 14060 | 806 | 18230 | 462 | 15320 |
| 24-#10 | 3.74 | MA | 6801 | 2340 | 9528 | 2074 | 12252 | 1722 | 14014 | 1421 | 16414 | 907 | 21318 | 264 | 19822 |
| 10L-4S | | MI | 5468 | 2340 | 8503 | 1955 | 10694 | 1602 | 12262 | 1306 | 14700 | 795 | 19121 | 516 | 15707 |
| 24-#11 | 4.59 | MA | 7726 | 2545 | 11550 | 2188 | 14749 | 1803 | 17058 | 1465 | 20417 | 881 | 26831 | 259 | 25312 |
| 8L-6S | | MI | 5470 | 2545 | 8844 | 2098 | 10997 | 1716 | 12579 | 1384 | 15056 | 797 | 19337 | 276 | 17760 |

## RECTANGULAR TIED COLUMNS 24" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.04 | MA | 6794 | 1792 | 8353 | 1660 | 10800 | 1397 | 12199 | 1189 | 13714 | 875 | 17025 | 762 | 7662 |
| 2E | | MI | 4381 | 1792 | 5821 | 1596 | 7203 | 1342 | 7972 | 1142 | 8777 | 837 | 10575 | 712 | 4880 |
| 4-#18 | 1.85 | MA | 7618 | 1998 | 10349 | 1776 | 13227 | 1480 | 15085 | 1240 | 17553 | 859 | 22304 | 745 | 13194 |
| 2E | | MI | 4819 | 1998 | 7028 | 1706 | 8641 | 1420 | 9667 | 1188 | 11018 | 818 | 13308 | 652 | 8204 |
| 6-#11 | 1.08 | MA | 6867 | 1803 | 8412 | 1673 | 10924 | 1407 | 12376 | 1197 | 13976 | 878 | 17405 | 765 | 7999 |
| 2L-3S | | MI | 4088 | 1803 | 5315 | 1625 | 6608 | 1366 | 7276 | 1161 | 7860 | 854 | 9414 | 608 | 5101 |
| 6-#11 | 1.08 | MA | 6288 | 1803 | 7534 | 1690 | 9814 | 1422 | 11033 | 1211 | 12168 | 897 | 14901 | 662 | 7973 |
| 3L-2S | | MI | 4430 | 1803 | 5848 | 1612 | 7282 | 1355 | 8092 | 1152 | 8959 | 842 | 10903 | 723 | 5092 |
| 6-#14 | 1.56 | MA | 7380 | 1925 | 9607 | 1743 | 12387 | 1457 | 14119 | 1228 | 16298 | 870 | 20603 | 755 | 11337 |
| 2L-3S | | MI | 4249 | 1925 | 5821 | 1696 | 7203 | 1417 | 7972 | 1192 | 8777 | 847 | 10575 | 531 | 7093 |
| 6-#14 | 1.56 | MA | 6599 | 1925 | 8353 | 1767 | 10800 | 1479 | 12199 | 1248 | 13714 | 896 | 17025 | 605 | 11237 |
| 3L-2S | | MI | 4709 | 1925 | 6579 | 1679 | 8161 | 1403 | 9132 | 1180 | 10338 | 832 | 12658 | 696 | 7119 |
| 6-#18 | 2.78 | MA | 8550 | 2234 | 12537 | 1923 | 15996 | 1589 | 18433 | 1309 | 22061 | 851 | 28547 | 733 | 19578 |
| 2L-3S | | MI | 4640 | 2234 | 7028 | 1880 | 8641 | 1550 | 9667 | 1273 | 11018 | 831 | 13308 | 318 | 11787 |
| 6-#18 | 2.78 | MA | 7342 | 2234 | 10349 | 1963 | 13227 | 1625 | 15085 | 1342 | 17553 | 893 | 22304 | 457 | 19119 |
| 3L-2S | | MI | 5333 | 2234 | 8334 | 1853 | 10293 | 1528 | 11664 | 1257 | 13707 | 809 | 16783 | 612 | 12016 |
| 8-#10 | 1.18 | MA | 7011 | 1827 | 8582 | 1697 | 11209 | 1425 | 12756 | 1211 | 14521 | 882 | 18185 | 768 | 8728 |
| 2L-4S | | MI | 4074 | 1827 | 5187 | 1662 | 6497 | 1396 | 7148 | 1190 | 7707 | 865 | 9371 | 590 | 5527 |
| 8-#10 | 1.18 | MA | 6540 | 1827 | 7859 | 1711 | 10293 | 1438 | 11648 | 1223 | 13030 | 898 | 16120 | 686 | 8704 |
| 3E | | MI | 4242 | 1827 | 5496 | 1651 | 6901 | 1387 | 7664 | 1177 | 8412 | 860 | 10262 | 645 | 5552 |
| 8-#10 | 1.18 | MA | 6266 | 1827 | 7363 | 1725 | 9646 | 1452 | 10820 | 1241 | 11897 | 909 | 14741 | 635 | 8608 |
| 4L-2S | | MI | 4524 | 1827 | 5940 | 1640 | 7462 | 1377 | 8342 | 1168 | 9326 | 849 | 11525 | 739 | 5550 |
| 8-#11 | 1.44 | MA | 7281 | 1895 | 9290 | 1731 | 12035 | 1449 | 13719 | 1224 | 15784 | 875 | 19909 | 760 | 10570 |
| 2L-4S | | MI | 4140 | 1895 | 5474 | 1695 | 6794 | 1419 | 7469 | 1203 | 8108 | 855 | 9849 | 535 | 6601 |
| 8-#11 | 1.44 | MA | 6731 | 1895 | 8412 | 1747 | 10924 | 1465 | 12376 | 1238 | 13976 | 893 | 17405 | 657 | 10525 |
| 3E | | MI | 4337 | 1895 | 5848 | 1682 | 7282 | 1408 | 8092 | 1188 | 8959 | 850 | 10903 | 600 | 6659 |
| 8-#11 | 1.44 | MA | 6410 | 1895 | 7810 | 1764 | 10137 | 1480 | 11368 | 1260 | 12598 | 905 | 15719 | 593 | 10354 |
| 4L-2S | | MI | 4664 | 1895 | 6382 | 1670 | 7957 | 1397 | 8908 | 1179 | 10058 | 839 | 12393 | 715 | 6666 |
| 8-#14 | 2.08 | MA | 7939 | 2057 | 10861 | 1826 | 13973 | 1518 | 16038 | 1267 | 18883 | 865 | 24181 | 749 | 15001 |
| 2L-4S | | MI | 4328 | 2057 | 6045 | 1796 | 7465 | 1492 | 8243 | 1252 | 9125 | 848 | 11179 | 424 | 8900 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

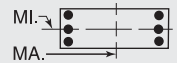
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.08 | MA | 7207 | 2057 | 9607 | 1849 | 12387 | 1540 | 14119 | 1287 | 16298 | 891 | 20603 | 598 | 14871 |
| 3E | | MI | 4591 | 2057 | 6579 | 1779 | 8161 | 1478 | 9132 | 1231 | 10338 | 842 | 12658 | 516 | 9284 |
| 8-#14 | 2.08 | MA | 6784 | 2057 | 8744 | 1873 | 11259 | 1562 | 12676 | 1317 | 14326 | 907 | 18178 | 505 | 14256 |
| 4L-2S | | MI | 5026 | 2057 | 7336 | 1762 | 9120 | 1464 | 10291 | 1219 | 11899 | 827 | 14741 | 681 | 9338 |
| 8-#18 | 3.70 | MA | 9434 | 2469 | 14726 | 2071 | 18764 | 1697 | 21782 | 1379 | 26569 | 842 | 34789 | 721 | 25954 |
| 2L-4S | | MI | 4806 | 2469 | 7407 | 2055 | 9086 | 1680 | 10124 | 1375 | 11606 | 826 | 14297 | 123 | 13691 |
| 8-#18 | 3.70 | MA | 8337 | 2469 | 12537 | 2110 | 15996 | 1733 | 18433 | 1411 | 22061 | 884 | 28547 | 444 | 25460 |
| 3E | | MI | 5194 | 2469 | 8334 | 2028 | 10293 | 1658 | 11664 | 1342 | 13707 | 822 | 16783 | 278 | 15523 |
| 8-#18 | 3.70 | MA | 7704 | 2469 | 11025 | 2150 | 14020 | 1769 | 15907 | 1461 | 18608 | 909 | 24266 | 277 | 22423 |
| 4L-2S | | MI | 5823 | 2469 | 9639 | 2000 | 11944 | 1637 | 13662 | 1326 | 16397 | 800 | 20259 | 572 | 15809 |
| 10-#10 | 1.47 | MA | 7353 | 1901 | 9306 | 1743 | 12124 | 1460 | 13863 | 1233 | 16012 | 880 | 20249 | 765 | 10846 |
| 2L-5S | | MI | 4146 | 1901 | 5354 | 1720 | 6666 | 1446 | 7364 | 1221 | 7981 | 873 | 9743 | 532 | 6609 |
| 10-#10 | 1.47 | MA | 6902 | 1901 | 8582 | 1758 | 11209 | 1473 | 12756 | 1245 | 14521 | 896 | 18185 | 682 | 10810 |
| 3L-4S | | MI | 4290 | 1901 | 5630 | 1709 | 7058 | 1431 | 7826 | 1212 | 8621 | 862 | 10635 | 586 | 6808 |
| 10-#10 | 1.47 | MA | 6645 | 1901 | 8087 | 1772 | 10561 | 1486 | 11927 | 1263 | 13388 | 906 | 16806 | 631 | 10703 |
| 4L-3S | | MI | 4450 | 1901 | 5940 | 1698 | 7462 | 1421 | 8342 | 1199 | 9326 | 857 | 11525 | 641 | 6846 |
| 10-#10 | 1.47 | MA | 6365 | 1901 | 7645 | 1785 | 9937 | 1505 | 11190 | 1275 | 12365 | 922 | 15340 | 582 | 10319 |
| 5L-2S | | MI | 4721 | 1901 | 6383 | 1687 | 8023 | 1411 | 9021 | 1190 | 10239 | 846 | 12789 | 735 | 6855 |
| 10-#11 | 1.81 | MA | 7681 | 1987 | 10168 | 1788 | 13145 | 1491 | 15062 | 1251 | 17593 | 871 | 22413 | 756 | 13136 |
| 2L-5S | | MI | 4229 | 1987 | 5673 | 1765 | 6995 | 1479 | 7725 | 1239 | 8433 | 864 | 10287 | 459 | 7727 |
| 10-#11 | 1.81 | MA | 7156 | 1987 | 9290 | 1805 | 12035 | 1507 | 13719 | 1265 | 15784 | 890 | 19909 | 652 | 13075 |
| 3L-4S | | MI | 4393 | 1987 | 6007 | 1753 | 7469 | 1461 | 8285 | 1230 | 9207 | 852 | 11339 | 527 | 8134 |
| 10-#11 | 1.81 | MA | 6859 | 1987 | 8687 | 1822 | 11247 | 1522 | 12711 | 1287 | 14406 | 902 | 18223 | 588 | 12892 |
| 4L-3S | | MI | 4579 | 1987 | 6382 | 1740 | 7957 | 1450 | 8908 | 1215 | 10058 | 847 | 12393 | 592 | 8209 |
| 10-#11 | 1.81 | MA | 6529 | 1987 | 8154 | 1838 | 10488 | 1545 | 11814 | 1301 | 13162 | 920 | 16436 | 526 | 12160 |
| 5L-2S | | MI | 4892 | 1987 | 6915 | 1727 | 8632 | 1439 | 9725 | 1206 | 11157 | 835 | 13882 | 707 | 8231 |
| 10-#14 | 2.60 | MA | 8478 | 2190 | 12116 | 1909 | 15560 | 1579 | 17957 | 1306 | 21467 | 860 | 27759 | 742 | 18660 |
| 2L-5S | | MI | 4453 | 2190 | 6325 | 1897 | 7748 | 1578 | 8605 | 1303 | 9583 | 858 | 11791 | 311 | 10331 |
| 10-#14 | 2.60 | MA | 7788 | 2190 | 10861 | 1932 | 13973 | 1601 | 16038 | 1326 | 18883 | 886 | 24181 | 591 | 18508 |
| 3L-4S | | MI | 4678 | 2190 | 6803 | 1879 | 8424 | 1553 | 9402 | 1291 | 10686 | 843 | 13262 | 408 | 10989 |
| 10-#14 | 2.60 | MA | 7404 | 2190 | 9999 | 1956 | 12846 | 1622 | 14595 | 1356 | 16910 | 902 | 21756 | 498 | 17844 |
| 4L-3S | | MI | 4920 | 2190 | 7336 | 1862 | 9120 | 1539 | 10291 | 1270 | 11899 | 837 | 14741 | 500 | 11470 |
| 10-#14 | 2.60 | MA | 6947 | 2190 | 9234 | 1979 | 11758 | 1654 | 13309 | 1375 | 15128 | 928 | 19193 | 405 | 16465 |
| 5L-2S | | MI | 5332 | 2190 | 8094 | 1844 | 10078 | 1524 | 11450 | 1258 | 13460 | 822 | 16825 | 666 | 11548 |
| 10-#18 | 4.63 | MA | 9318 | 2705 | 14726 | 2258 | 18764 | 1841 | 21782 | 1480 | 26569 | 876 | 34789 | 432 | 31814 |
| 3L-4S | | MI | 5386 | 2705 | 8713 | 2202 | 10737 | 1788 | 12122 | 1445 | 14295 | 817 | 17773 | 83 | 17344 |
| 10-#18 | 4.63 | MA | 8737 | 2705 | 13214 | 2297 | 16789 | 1877 | 19255 | 1530 | 23116 | 901 | 30508 | 264 | 28750 |
| 4L-3S | | MI | 5722 | 2705 | 9639 | 2175 | 11944 | 1766 | 13662 | 1411 | 16397 | 813 | 20259 | 238 | 19268 |
| 10-#18 | 4.63 | MA | 7975 | 2705 | 11871 | 2337 | 14880 | 1931 | 17000 | 1563 | 19993 | 943 | 26183 | 114 | 25676 |
| 5L-2S | | MI | 6300 | 2705 | 10945 | 2147 | 13596 | 1745 | 15659 | 1395 | 19086 | 791 | 23735 | 532 | 19596 |
| 12-#10 | 1.76 | MA | 7686 | 1976 | 10030 | 1790 | 13040 | 1494 | 14971 | 1254 | 17503 | 877 | 22313 | 761 | 12961 |
| 2L-6S | | MI | 4161 | 1976 | 5521 | 1776 | 6873 | 1490 | 7591 | 1256 | 8270 | 876 | 10146 | 457 | 7576 |
| 12-#10 | 1.76 | MA | 7252 | 1976 | 9306 | 1804 | 12124 | 1507 | 13863 | 1267 | 16012 | 893 | 20249 | 678 | 12916 |
| 3L-5S | | MI | 4358 | 1976 | 5797 | 1767 | 7227 | 1480 | 8042 | 1243 | 8894 | 870 | 11007 | 528 | 7849 |
| 12-#10 | 1.76 | MA | 7011 | 1976 | 8811 | 1818 | 11477 | 1520 | 13034 | 1285 | 14879 | 903 | 18870 | 627 | 12800 |
| 4E | | MI | 4500 | 1976 | 6074 | 1756 | 7619 | 1465 | 8504 | 1234 | 9534 | 859 | 11899 | 582 | 8088 |
| 12-#10 | 1.76 | MA | 6735 | 1976 | 8368 | 1832 | 10853 | 1539 | 12297 | 1297 | 13856 | 919 | 17405 | 578 | 12395 |
| 5L-3S | | MI | 4651 | 1976 | 6383 | 1745 | 8023 | 1455 | 9021 | 1221 | 10239 | 854 | 12789 | 637 | 8137 |
| 12-#10 | 1.76 | MA | 6412 | 1976 | 7891 | 1839 | 10283 | 1551 | 11596 | 1309 | 12861 | 930 | 16129 | 520 | 11830 |
| 6L-2S | | MI | 4913 | 1976 | 6827 | 1734 | 8584 | 1446 | 9699 | 1212 | 11153 | 843 | 14053 | 731 | 8154 |
| 12-#11 | 2.17 | MA | 8069 | 2079 | 11045 | 1845 | 14256 | 1533 | 16405 | 1278 | 19401 | 868 | 24917 | 751 | 15699 |
| 2L-6S | | MI | 4246 | 2079 | 5879 | 1834 | 7241 | 1531 | 7995 | 1282 | 8777 | 865 | 10758 | 367 | 8902 |
| 12-#11 | 2.17 | MA | 7567 | 2079 | 10168 | 1862 | 13145 | 1549 | 15062 | 1292 | 17593 | 886 | 22413 | 648 | 15626 |
| 3L-5S | | MI | 4477 | 2079 | 6206 | 1823 | 7670 | 1521 | 8542 | 1266 | 9532 | 860 | 11776 | 451 | 9222 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



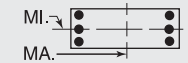

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.17 | MA | 7291 | 2079 | 9565 | 1879 | 12358 | 1564 | 14054 | 1313 | 16215 | 898 | 20726 | 584 | 15434 |
| 4E | | MI | 4639 | 2079 | 6541 | 1810 | 8144 | 1503 | 9101 | 1257 | 10306 | 849 | 12828 | 518 | 9667 |
| 12-#11 | 2.17 | MA | 6967 | 2079 | 9032 | 1896 | 11598 | 1587 | 13157 | 1328 | 14971 | 917 | 18940 | 521 | 14683 |
| 5L-3S | | MI | 4813 | 2079 | 6915 | 1797 | 8632 | 1492 | 9725 | 1242 | 11157 | 844 | 13882 | 584 | 9757 |
| 12-#11 | 2.17 | MA | 6587 | 2079 | 8453 | 1904 | 10913 | 1602 | 12282 | 1349 | 13759 | 929 | 17384 | 448 | 14026 |
| 6L-2S | | MI | 5115 | 2079 | 7449 | 1784 | 9307 | 1481 | 10541 | 1233 | 12256 | 832 | 15372 | 698 | 9790 |
| 12-#14 | 3.13 | MA | 8349 | 2322 | 12116 | 2015 | 15560 | 1662 | 17957 | 1365 | 21467 | 881 | 27759 | 584 | 22149 |
| 3L-5S | | MI | 4795 | 2322 | 7083 | 1979 | 8706 | 1638 | 9764 | 1342 | 11144 | 853 | 13874 | 295 | 12470 |
| 12-#14 | 3.13 | MA | 7999 | 2322 | 11253 | 2039 | 14433 | 1683 | 16514 | 1394 | 19494 | 897 | 25334 | 491 | 21440 |
| 4E | | MI | 5033 | 2322 | 7560 | 1962 | 9382 | 1614 | 10562 | 1330 | 12247 | 838 | 15345 | 393 | 13094 |
| 12-#14 | 3.13 | MA | 7550 | 2322 | 10488 | 2062 | 13344 | 1715 | 15228 | 1414 | 17712 | 923 | 22771 | 398 | 20106 |
| 5L-3S | | MI | 5248 | 2322 | 8094 | 1945 | 10078 | 1600 | 11450 | 1309 | 13460 | 832 | 16825 | 485 | 13656 |
| 12-#14 | 3.13 | MA | 7042 | 2322 | 9666 | 2075 | 12363 | 1737 | 13975 | 1444 | 15976 | 939 | 20536 | 291 | 18590 |
| 6L-2S | | MI | 5625 | 2322 | 8852 | 1927 | 11037 | 1585 | 12610 | 1297 | 15020 | 817 | 18908 | 650 | 13753 |
| 12-#18 | 5.56 | MA | 9781 | 2940 | 15402 | 2445 | 19557 | 1985 | 22604 | 1599 | 27625 | 892 | 36750 | 252 | 35076 |
| 4E | | MI | 5941 | 2940 | 10019 | 2349 | 12389 | 1896 | 14119 | 1514 | 16985 | 808 | 21249 | 43 | 21019 |
| 12-#18 | 5.56 | MA | 9023 | 2940 | 14059 | 2484 | 17649 | 2039 | 20349 | 1632 | 24501 | 934 | 32425 | 102 | 31973 |
| 5L-3S | | MI | 6235 | 2940 | 10945 | 2322 | 13596 | 1874 | 15659 | 1480 | 19086 | 804 | 23735 | 198 | 22918 |
| 12-#18 | 5.56 | MA | 8193 | 2940 | 12646 | 2509 | 15925 | 2075 | 18149 | 1682 | 21457 | 959 | 28291 | -115 | 27810 |
| 6L-2S | | MI | 6768 | 2940 | 12250 | 2294 | 15247 | 1853 | 17657 | 1465 | 21776 | 782 | 27210 | 491 | 23379 |
| 14-#10 | 2.06 | MA | 7593 | 2051 | 10030 | 1851 | 13040 | 1541 | 14971 | 1289 | 17503 | 890 | 22313 | 674 | 15022 |
| 3L-6S | | MI | 4374 | 2051 | 5964 | 1822 | 7434 | 1524 | 8269 | 1278 | 9183 | 873 | 11409 | 453 | 8833 |
| 14-#10 | 2.06 | MA | 7366 | 2051 | 9535 | 1865 | 12392 | 1555 | 14142 | 1307 | 16369 | 900 | 20935 | 623 | 14900 |
| 4L-5S | | MI | 4565 | 2051 | 6241 | 1814 | 7788 | 1515 | 8720 | 1265 | 9808 | 868 | 12270 | 524 | 9095 |
| 14-#10 | 2.06 | MA | 7094 | 2051 | 9092 | 1879 | 11768 | 1573 | 13404 | 1319 | 15347 | 916 | 19469 | 574 | 14475 |
| 5L-4S | | MI | 4704 | 2051 | 6517 | 1803 | 8180 | 1499 | 9183 | 1256 | 10448 | 857 | 13162 | 578 | 9367 |
| 14-#10 | 2.06 | MA | 6784 | 2051 | 8615 | 1886 | 11199 | 1586 | 12703 | 1331 | 14352 | 927 | 18194 | 516 | 13927 |
| 6L-3S | | MI | 4848 | 2051 | 6827 | 1791 | 8584 | 1490 | 9699 | 1243 | 11153 | 851 | 14053 | 633 | 9425 |
| 14-#10 | 2.06 | MA | 6510 | 2051 | 8158 | 1896 | 10598 | 1594 | 11989 | 1349 | 13384 | 943 | 16876 | 481 | 13299 |
| 7L-2S | | MI | 5101 | 2051 | 7270 | 1780 | 9145 | 1480 | 10378 | 1234 | 12066 | 840 | 15317 | 727 | 9450 |
| 14-#11 | 2.53 | MA | 7967 | 2170 | 11045 | 1920 | 14256 | 1591 | 16405 | 1319 | 19401 | 883 | 24917 | 643 | 18177 |
| 3L-6S | | MI | 4496 | 2170 | 6412 | 1891 | 7915 | 1574 | 8811 | 1309 | 9876 | 862 | 12247 | 358 | 10385 |
| 14-#11 | 2.53 | MA | 7709 | 2170 | 10443 | 1936 | 13468 | 1607 | 15397 | 1340 | 18023 | 895 | 23230 | 579 | 17979 |
| 4L-5S | | MI | 4719 | 2170 | 6740 | 1880 | 8345 | 1563 | 9358 | 1293 | 10631 | 857 | 13266 | 443 | 10723 |
| 14-#11 | 2.53 | MA | 7390 | 2170 | 9910 | 1953 | 12709 | 1629 | 14500 | 1355 | 16779 | 914 | 21444 | 516 | 17211 |
| 5L-4S | | MI | 4878 | 2170 | 7074 | 1867 | 8819 | 1545 | 9917 | 1284 | 11405 | 845 | 14317 | 510 | 11201 |
| 14-#11 | 2.53 | MA | 7027 | 2170 | 9330 | 1962 | 12024 | 1645 | 13625 | 1376 | 15567 | 925 | 19887 | 443 | 16577 |
| 6L-3S | | MI | 5042 | 2170 | 7449 | 1855 | 9307 | 1534 | 10541 | 1269 | 12256 | 840 | 15372 | 575 | 11302 |
| 14-#11 | 2.53 | MA | 6708 | 2170 | 8775 | 1973 | 11295 | 1654 | 12780 | 1390 | 14390 | 944 | 18273 | 399 | 15555 |
| 7L-2S | | MI | 5333 | 2170 | 7982 | 1842 | 9982 | 1524 | 11357 | 1260 | 13355 | 828 | 16861 | 690 | 11346 |
| 14-#14 | 3.65 | MA | 8574 | 2455 | 12507 | 2121 | 16019 | 1744 | 18434 | 1433 | 22078 | 892 | 28912 | 484 | 25045 |
| 4L-5S | | MI | 5140 | 2455 | 7840 | 2062 | 9665 | 1699 | 10923 | 1380 | 12705 | 848 | 15957 | 280 | 14618 |
| 14-#14 | 3.65 | MA | 8132 | 2455 | 11743 | 2145 | 14931 | 1776 | 17148 | 1453 | 20296 | 918 | 26349 | 391 | 23751 |
| 5L-4S | | MI | 5360 | 2455 | 8318 | 2045 | 10341 | 1675 | 11721 | 1369 | 13808 | 833 | 17428 | 377 | 15211 |
| 14-#14 | 3.65 | MA | 7652 | 2455 | 10921 | 2158 | 13949 | 1798 | 15894 | 1483 | 18560 | 934 | 24114 | 284 | 22217 |
| 6L-3S | | MI | 5556 | 2455 | 8852 | 2027 | 11037 | 1660 | 12610 | 1348 | 15020 | 827 | 18908 | 470 | 15842 |
| 14-#14 | 3.65 | MA | 7229 | 2455 | 10126 | 2174 | 12916 | 1811 | 14682 | 1503 | 16873 | 960 | 21792 | 219 | 20615 |
| 7L-2S | | MI | 5913 | 2455 | 9609 | 2010 | 11995 | 1646 | 13769 | 1336 | 16581 | 812 | 20991 | 635 | 15955 |
| 14-#18 | 6.48 | MA | 9982 | 3176 | 16248 | 2632 | 20417 | 2147 | 23697 | 1701 | 29009 | 926 | 38668 | 90 | 38270 |
| 5L-4S | | MI | 6478 | 3176 | 11324 | 2496 | 14040 | 2004 | 16117 | 1583 | 19674 | 799 | 24724 | 2 | 24711 |
| 14-#18 | 6.48 | MA | 9276 | 3176 | 14834 | 2656 | 18693 | 2183 | 21498 | 1751 | 25965 | 951 | 34534 | -128 | 33795 |
| 6L-3S | | MI | 6736 | 3176 | 12250 | 2469 | 15247 | 1983 | 17657 | 1549 | 21776 | 795 | 27210 | 157 | 26522 |
| 16-#10 | 2.35 | MA | 7711 | 2126 | 10258 | 1912 | 13308 | 1589 | 15249 | 1328 | 17860 | 898 | 22999 | 619 | 17001 |
| 4L-6S | | MI | 4582 | 2126 | 6408 | 1869 | 7995 | 1558 | 8947 | 1300 | 10097 | 870 | 12673 | 449 | 10094 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

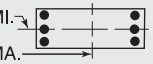



$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.35 | MA | 7443 | 2126 | 9816 | 1925 | 12684 | 1608 | 14512 | 1341 | 16838 | 914 | 21534 | 570 | 16558 |
| 5E | | MI | 4766 | 2126 | 6684 | 1860 | 8349 | 1549 | 9399 | 1287 | 10721 | 865 | 13534 | 520 | 10345 |
| 16-#10 | 2.35 | MA | 7144 | 2126 | 9338 | 1933 | 12114 | 1620 | 13811 | 1353 | 15843 | 924 | 20258 | 512 | 16026 |
| 6L-4S | | MI | 4904 | 2126 | 6960 | 1849 | 8741 | 1534 | 9861 | 1278 | 11361 | 854 | 14426 | 574 | 10646 |
| 16-#10 | 2.35 | MA | 6884 | 2126 | 8881 | 1942 | 11514 | 1628 | 13096 | 1371 | 14875 | 940 | 18941 | 477 | 15398 |
| 7L-3S | | MI | 5041 | 2126 | 7270 | 1838 | 9145 | 1524 | 10378 | 1265 | 12066 | 849 | 15317 | 629 | 10712 |
| 16-#10 | 2.35 | MA | 6643 | 2126 | 8379 | 1959 | 10894 | 1643 | 12368 | 1378 | 13911 | 950 | 17664 | 430 | 14678 |
| 8L-2S | | MI | 5286 | 2126 | 7713 | 1827 | 9706 | 1514 | 11056 | 1256 | 12980 | 838 | 16580 | 723 | 10743 |
| 16-#11 | 2.89 | MA | 8116 | 2262 | 11321 | 1994 | 14579 | 1649 | 16741 | 1367 | 19832 | 891 | 25734 | 574 | 20527 |
| 4L-6S | | MI | 4740 | 2262 | 6946 | 1949 | 8590 | 1616 | 9627 | 1336 | 10975 | 858 | 13736 | 350 | 11873 |
| 16-#11 | 2.89 | MA | 7801 | 2262 | 10787 | 2011 | 13819 | 1671 | 15843 | 1382 | 18587 | 910 | 23948 | 511 | 19743 |
| 5E | | MI | 4954 | 2262 | 7273 | 1937 | 9020 | 1605 | 10174 | 1320 | 11730 | 854 | 14755 | 435 | 12229 |
| 16-#11 | 2.89 | MA | 7454 | 2262 | 10208 | 2019 | 13134 | 1687 | 14968 | 1403 | 17376 | 922 | 22391 | 438 | 19130 |
| 6L-4S | | MI | 5111 | 2262 | 7608 | 1925 | 9493 | 1587 | 10733 | 1311 | 12504 | 842 | 15807 | 502 | 12701 |
| 16-#11 | 2.89 | MA | 7151 | 2262 | 9653 | 2031 | 12405 | 1696 | 14123 | 1417 | 16198 | 941 | 20777 | 394 | 18100 |
| 7L-3S | | MI | 5275 | 2262 | 7982 | 1912 | 9982 | 1577 | 11357 | 1295 | 13355 | 837 | 16861 | 567 | 12846 |
| 16-#11 | 2.89 | MA | 6870 | 2262 | 9041 | 2050 | 11652 | 1714 | 13247 | 1427 | 15024 | 952 | 19219 | 334 | 17083 |
| 8L-2S | | MI | 5545 | 2262 | 8515 | 1899 | 10657 | 1566 | 12173 | 1287 | 14454 | 825 | 18351 | 682 | 12899 |
| 16-#14 | 4.17 | MA | 8695 | 2587 | 12997 | 2228 | 16518 | 1837 | 19067 | 1492 | 22880 | 913 | 29927 | 384 | 27398 |
| 5E | | MI | 5461 | 2587 | 8598 | 2145 | 10623 | 1760 | 12082 | 1419 | 14266 | 844 | 18040 | 265 | 16773 |
| 16-#14 | 4.17 | MA | 8242 | 2587 | 12175 | 2241 | 15536 | 1858 | 17814 | 1522 | 21144 | 929 | 27692 | 277 | 25843 |
| 6L-4S | | MI | 5677 | 2587 | 9076 | 2128 | 11299 | 1736 | 12880 | 1408 | 15369 | 828 | 19511 | 362 | 17338 |
| 16-#14 | 4.17 | MA | 7846 | 2587 | 11380 | 2257 | 14502 | 1872 | 16602 | 1542 | 19457 | 955 | 25370 | 212 | 24231 |
| 7L-3S | | MI | 5857 | 2587 | 9609 | 2110 | 11995 | 1721 | 13769 | 1386 | 16581 | 822 | 20991 | 454 | 18029 |
| 16-#14 | 4.17 | MA | 7462 | 2587 | 10504 | 2285 | 13424 | 1897 | 15360 | 1557 | 17775 | 971 | 23133 | 122 | 22555 |
| 8L-2S | | MI | 6195 | 2587 | 10367 | 2093 | 12954 | 1707 | 14928 | 1375 | 18142 | 807 | 23074 | 619 | 18155 |
| 16-#18 | 7.41 | MA | 10264 | 3411 | 17023 | 2803 | 21462 | 2291 | 24846 | 1820 | 30473 | 942 | 40776 | -140 | 39743 |
| 6L-4S | | MI | 7002 | 3411 | 12630 | 2644 | 15692 | 2112 | 18114 | 1652 | 22364 | 790 | 28200 | -38 | 28050 |
| 18-#10 | 2.65 | MA | 7783 | 2200 | 10540 | 1972 | 13600 | 1642 | 15619 | 1363 | 18329 | 911 | 23598 | 566 | 18644 |
| 5L-6S | | MI | 4785 | 2200 | 6851 | 1916 | 8556 | 1593 | 9626 | 1322 | 11010 | 867 | 13937 | 445 | 11357 |
| 18-#10 | 2.65 | MA | 7496 | 2200 | 10062 | 1980 | 13030 | 1654 | 14918 | 1375 | 17334 | 921 | 22323 | 508 | 18127 |
| 6L-5S | | MI | 4964 | 2200 | 7128 | 1907 | 8910 | 1583 | 10077 | 1308 | 11635 | 862 | 14798 | 516 | 11600 |
| 18-#10 | 2.65 | MA | 7247 | 2200 | 9605 | 1989 | 12429 | 1662 | 14203 | 1392 | 16366 | 937 | 21005 | 473 | 17498 |
| 7L-4S | | MI | 5100 | 2200 | 7404 | 1896 | 9302 | 1568 | 10540 | 1300 | 12274 | 851 | 15690 | 570 | 11926 |
| 18-#10 | 2.65 | MA | 7016 | 2200 | 9102 | 2006 | 11810 | 1677 | 13476 | 1400 | 15402 | 947 | 19729 | 426 | 16779 |
| 8L-3S | | MI | 5230 | 2200 | 7713 | 1885 | 9706 | 1558 | 11056 | 1286 | 12980 | 846 | 16580 | 625 | 11998 |
| 18-#10 | 2.65 | MA | 6717 | 2200 | 8666 | 2017 | 11235 | 1688 | 12742 | 1415 | 14452 | 963 | 18415 | 372 | 15920 |
| 9L-2S | | MI | 5468 | 2200 | 8157 | 1874 | 10267 | 1549 | 11734 | 1278 | 13893 | 835 | 17844 | 719 | 12035 |
| 18-#11 | 3.25 | MA | 8201 | 2354 | 11665 | 2068 | 14930 | 1713 | 17186 | 1409 | 20396 | 907 | 26451 | 507 | 22278 |
| 5L-6S | | MI | 4978 | 2354 | 7479 | 2006 | 9265 | 1658 | 10444 | 1363 | 12074 | 855 | 15226 | 342 | 13366 |
| 18-#11 | 3.25 | MA | 7869 | 2354 | 11086 | 2077 | 14245 | 1729 | 16312 | 1430 | 19184 | 918 | 24895 | 433 | 21685 |
| 6L-5S | | MI | 5184 | 2354 | 7806 | 1995 | 9695 | 1647 | 10990 | 1347 | 12829 | 850 | 16245 | 426 | 13740 |
| 18-#11 | 3.25 | MA | 7581 | 2354 | 10531 | 2088 | 13515 | 1738 | 15466 | 1444 | 18006 | 937 | 23281 | 389 | 20645 |
| 7L-4S | | MI | 5354 | 2354 | 8141 | 1982 | 10168 | 1630 | 11550 | 1338 | 13603 | 838 | 17296 | 494 | 14194 |
| 18-#11 | 3.25 | MA | 7311 | 2354 | 9919 | 2108 | 12762 | 1756 | 14590 | 1454 | 16833 | 949 | 21723 | 329 | 19621 |
| 8L-3S | | MI | 5492 | 2354 | 8515 | 1969 | 10657 | 1619 | 12173 | 1322 | 14454 | 833 | 18351 | 559 | 14390 |
| 18-#11 | 3.25 | MA | 6961 | 2354 | 9393 | 2122 | 12063 | 1768 | 13698 | 1471 | 15675 | 968 | 20114 | 263 | 18595 |
| 9L-2S | | MI | 5751 | 2354 | 9049 | 1957 | 11331 | 1608 | 12990 | 1314 | 15553 | 821 | 19840 | 674 | 14451 |
| 18-#14 | 4.69 | MA | 8814 | 2720 | 13429 | 2323 | 17123 | 1919 | 19733 | 1561 | 23729 | 924 | 31270 | 270 | 29470 |
| 6L-5S | | MI | 5774 | 2720 | 9356 | 2228 | 11582 | 1821 | 13242 | 1458 | 15826 | 839 | 20123 | 249 | 18933 |
| 18-#14 | 4.69 | MA | 8443 | 2720 | 12634 | 2339 | 16089 | 1933 | 18521 | 1581 | 22041 | 950 | 28948 | 205 | 27846 |
| 7L-4S | | MI | 5987 | 2720 | 9833 | 2210 | 12258 | 1797 | 14040 | 1447 | 16929 | 823 | 21594 | 347 | 19473 |
| 18-#14 | 4.69 | MA | 8066 | 2720 | 11759 | 2367 | 15011 | 1958 | 17280 | 1595 | 20359 | 966 | 26711 | 115 | 26178 |
| 8L-3S | | MI | 6152 | 2720 | 10367 | 2193 | 12954 | 1782 | 14928 | 1425 | 18142 | 817 | 23074 | 439 | 20217 |
| 20-#10 | 2.94 | MA | 7839 | 2275 | 10786 | 2026 | 13945 | 1689 | 16026 | 1397 | 18825 | 918 | 24387 | 504 | 20230 |
| 6E | | MI | 4984 | 2275 | 7294 | 1962 | 9117 | 1627 | 10304 | 1344 | 11924 | 864 | 15201 | 441 | 12623 |
| 20-#10 | 2.94 | MA | 7600 | 2275 | 10329 | 2036 | 13345 | 1697 | 15311 | 1414 | 17857 | 934 | 23070 | 469 | 19598 |
| 7L-5S | | MI | 5157 | 2275 | 7571 | 1954 | 9471 | 1618 | 10756 | 1330 | 12548 | 859 | 16062 | 512 | 12858 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

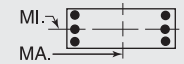
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 2.94 | MA | 7374 | 2275 | 9826 | 2052 | 12726 | 1712 | 14583 | 1422 | 16893 | 945 | 21793 | 422 | 18880 |
| 8L-4S | | MI | 5293 | 2275 | 7847 | 1943 | 9863 | 1602 | 11218 | 1322 | 13188 | 848 | 16953 | 566 | 13206 |
| 20-#10 | 2.94 | MA | 7086 | 2275 | 9390 | 2064 | 12151 | 1722 | 13850 | 1437 | 15943 | 961 | 20479 | 369 | 18016 |
| 9L-3S | | MI | 5417 | 2275 | 8157 | 1932 | 10267 | 1593 | 11734 | 1308 | 13893 | 843 | 17844 | 621 | 13284 |
| 20-#10 | 2.94 | MA | 6817 | 2275 | 8935 | 2072 | 11588 | 1733 | 13143 | 1447 | 14974 | 970 | 19199 | 327 | 17169 |
| 10L-2S | | MI | 5647 | 2275 | 8600 | 1921 | 10828 | 1583 | 12413 | 1300 | 14806 | 832 | 19108 | 715 | 13326 |
| 20-#11 | 3.61 | MA | 8273 | 2446 | 11964 | 2134 | 15355 | 1771 | 17655 | 1457 | 20993 | 915 | 27399 | 429 | 24241 |
| 6E | | MI | 5227 | 2446 | 8013 | 2063 | 9940 | 1700 | 11260 | 1390 | 13173 | 852 | 16715 | 334 | 14864 |
| 20-#11 | 3.61 | MA | 8000 | 2446 | 11408 | 2145 | 14626 | 1780 | 16809 | 1471 | 19815 | 934 | 25785 | 385 | 23190 |
| 7L-5S | | MI | 5421 | 2446 | 8340 | 2052 | 10369 | 1689 | 11806 | 1374 | 13928 | 847 | 17734 | 418 | 15256 |
| 20-#11 | 3.61 | MA | 7734 | 2446 | 10797 | 2165 | 13873 | 1798 | 15933 | 1481 | 18641 | 946 | 24227 | 324 | 22159 |
| 8L-4S | | MI | 5576 | 2446 | 8675 | 2039 | 10843 | 1672 | 12366 | 1365 | 14702 | 835 | 18786 | 485 | 15691 |
| 20-#11 | 3.61 | MA | 7399 | 2446 | 10271 | 2179 | 13173 | 1810 | 15041 | 1498 | 17483 | 964 | 22618 | 258 | 21128 |
| 9L-3S | | MI | 5706 | 2446 | 9049 | 2027 | 11331 | 1661 | 12990 | 1349 | 15553 | 830 | 19840 | 551 | 15934 |
| 20-#14 | 5.21 | MA | 9024 | 2852 | 13889 | 2422 | 17676 | 1994 | 20440 | 1619 | 24625 | 945 | 32526 | 198 | 31462 |
| 7L-5S | | MI | 6080 | 2852 | 10113 | 2310 | 12540 | 1882 | 14401 | 1497 | 17387 | 834 | 22206 | 234 | 21098 |
| 20-#14 | 5.21 | MA | 8653 | 2852 | 13013 | 2450 | 16597 | 2019 | 19199 | 1634 | 22943 | 961 | 30289 | 108 | 29800 |
| 8L-4S | | MI | 6292 | 2852 | 10591 | 2293 | 13216 | 1857 | 15199 | 1486 | 18490 | 818 | 23677 | 331 | 21616 |
| 22-#10 | 3.23 | MA | 7946 | 2350 | 11053 | 2083 | 14261 | 1731 | 16418 | 1436 | 19348 | 931 | 25134 | 465 | 21697 |
| 7L-6S | | MI | 5180 | 2350 | 7738 | 2009 | 9677 | 1662 | 10983 | 1366 | 12837 | 862 | 16464 | 437 | 13891 |
| 22-#10 | 3.23 | MA | 7722 | 2350 | 10550 | 2099 | 13641 | 1746 | 15690 | 1444 | 18384 | 942 | 23857 | 418 | 20981 |
| 8L-5S | | MI | 5347 | 2350 | 8014 | 2001 | 10032 | 1652 | 11434 | 1352 | 13462 | 856 | 17325 | 508 | 14118 |
| 22-#10 | 3.23 | MA | 7445 | 2350 | 10113 | 2110 | 13066 | 1757 | 14957 | 1459 | 17434 | 958 | 22544 | 365 | 20113 |
| 9L-4S | | MI | 5482 | 2350 | 8291 | 1989 | 10423 | 1637 | 11897 | 1344 | 14101 | 845 | 18217 | 562 | 14487 |
| 22-#10 | 3.23 | MA | 7187 | 2350 | 9659 | 2119 | 12503 | 1768 | 14251 | 1469 | 16465 | 967 | 21264 | 323 | 19261 |
| 10L-3S | | MI | 5606 | 2350 | 8600 | 1978 | 10828 | 1627 | 12413 | 1330 | 14806 | 840 | 19108 | 617 | 14569 |
| 22-#11 | 3.97 | MA | 8409 | 2538 | 12286 | 2203 | 15736 | 1823 | 18152 | 1498 | 21623 | 930 | 28289 | 380 | 25734 |
| 7L-6S | | MI | 5455 | 2538 | 8546 | 2121 | 10615 | 1742 | 12076 | 1417 | 14272 | 848 | 18205 | 325 | 16366 |
| 22-#11 | 3.97 | MA | 8146 | 2538 | 11675 | 2223 | 14983 | 1840 | 17276 | 1508 | 20450 | 942 | 26730 | 319 | 24697 |
| 8L-5S | | MI | 5641 | 2538 | 8873 | 2110 | 11044 | 1732 | 12623 | 1401 | 15027 | 843 | 19224 | 410 | 16774 |
| 22-#11 | 3.97 | MA | 7824 | 2538 | 11149 | 2236 | 14284 | 1853 | 16384 | 1525 | 19292 | 961 | 25122 | 253 | 23660 |
| 9L-4S | | MI | 5795 | 2538 | 9208 | 2097 | 11518 | 1714 | 13182 | 1392 | 15801 | 831 | 20275 | 477 | 17194 |
| 22-#14 | 5.73 | MA | 9273 | 2984 | 14267 | 2533 | 18184 | 2080 | 21118 | 1673 | 25527 | 956 | 33867 | 102 | 33423 |
| 8L-5S | | MI | 6381 | 2984 | 10871 | 2393 | 13499 | 1943 | 15560 | 1536 | 18948 | 829 | 24289 | 218 | 23231 |
| 24-#10 | 3.53 | MA | 8064 | 2425 | 11274 | 2146 | 14557 | 1780 | 16798 | 1466 | 19875 | 939 | 25922 | 414 | 23082 |
| 8L-6S | | MI | 5372 | 2425 | 8181 | 2056 | 10238 | 1696 | 11661 | 1388 | 13751 | 859 | 17728 | 433 | 15162 |
| 24-#10 | 3.53 | MA | 7796 | 2425 | 10837 | 2157 | 13982 | 1791 | 16064 | 1481 | 18925 | 955 | 24608 | 361 | 22209 |
| 9L-5S | | MI | 5546 | 2425 | 8458 | 2047 | 10593 | 1686 | 12113 | 1374 | 14375 | 854 | 18589 | 504 | 15382 |
| 24-#10 | 3.53 | MA | 7548 | 2425 | 10383 | 2166 | 13419 | 1802 | 15358 | 1491 | 17956 | 964 | 23328 | 319 | 21353 |
| 10L-4S | | MI | 5680 | 2425 | 8734 | 2036 | 10984 | 1671 | 12575 | 1366 | 15015 | 843 | 19481 | 558 | 15768 |
| 24-#11 | 4.33 | MA | 8550 | 2629 | 12552 | 2280 | 16094 | 1883 | 18619 | 1535 | 22258 | 939 | 29234 | 315 | 27235 |
| 8L-6S | | MI | 5678 | 2629 | 9080 | 2178 | 11290 | 1785 | 12892 | 1444 | 15370 | 845 | 19694 | 317 | 17872 |
| 24-#11 | 4.33 | MA | 8241 | 2629 | 12027 | 2294 | 15394 | 1895 | 17727 | 1552 | 21100 | 957 | 27625 | 248 | 26193 |
| 9L-5S | | MI | 5857 | 2629 | 9407 | 2167 | 11719 | 1774 | 13439 | 1428 | 16126 | 840 | 20713 | 402 | 18296 |

## RECTANGULAR TIED COLUMNS 24" x 38"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.75 | MA | 8422 | 2083 | 11242 | 1866 | 14436 | 1557 | 16476 | 1307 | 19141 | 913 | 24298 | 792 | 14058 |
| 2E | | MI | 5028 | 2083 | 7274 | 1784 | 8938 | 1487 | 9982 | 1246 | 11331 | 864 | 13661 | 693 | 8234 |
| 6-#11 | 1.03 | MA | 7602 | 1888 | 9170 | 1763 | 11972 | 1484 | 13576 | 1264 | 15312 | 931 | 19053 | 812 | 8505 |
| 2L-3S | | MI | 4292 | 1888 | 5551 | 1705 | 6900 | 1434 | 7590 | 1220 | 8175 | 901 | 9771 | 650 | 5123 |
| 6-#11 | 1.03 | MA | 6980 | 1888 | 8235 | 1781 | 10789 | 1500 | 12145 | 1279 | 13386 | 951 | 16386 | 710 | 8479 |
| 3L-2S | | MI | 4636 | 1888 | 6084 | 1692 | 7575 | 1423 | 8406 | 1211 | 9274 | 889 | 11261 | 765 | 5111 |
| 6-#14 | 1.48 | MA | 8159 | 2010 | 10446 | 1833 | 13533 | 1534 | 15437 | 1295 | 17792 | 923 | 22467 | 802 | 12066 |
| 2L-3S | | MI | 4453 | 2010 | 6060 | 1776 | 7496 | 1485 | 8286 | 1251 | 9091 | 894 | 10931 | 573 | 7125 |
| 6-#14 | 1.48 | MA | 7317 | 2010 | 9108 | 1857 | 11841 | 1557 | 13391 | 1316 | 15037 | 950 | 18653 | 654 | 11966 |
| 3L-2S | | MI | 4917 | 2010 | 6818 | 1758 | 8455 | 1470 | 9446 | 1240 | 10652 | 879 | 13014 | 738 | 7142 |

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

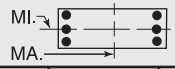
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 2.63 | MA | 9431 | 2319 | 13578 | 2014 | 17391 | 1665 | 20049 | 1377 | 23952 | 904 | 30960 | 780 | 20874 |
| 2L-3S | | MI | 4829 | 2319 | 7274 | 1959 | 8938 | 1617 | 9982 | 1331 | 11331 | 877 | 13661 | 359 | 11846 |
| 6-#18 | 2.63 | MA | 8123 | 2319 | 11242 | 2055 | 14436 | 1703 | 16476 | 1411 | 19141 | 949 | 24298 | 508 | 20415 |
| 3L-2S | | MI | 5545 | 2319 | 8579 | 1931 | 10589 | 1595 | 11979 | 1315 | 14020 | 855 | 17137 | 653 | 12050 |
| 8-#10 | 1.11 | MA | 7756 | 1911 | 9349 | 1787 | 12271 | 1502 | 13977 | 1278 | 15888 | 936 | 19877 | 815 | 9276 |
| 2L-4S | | MI | 4277 | 1911 | 5418 | 1743 | 6787 | 1465 | 7460 | 1251 | 8022 | 913 | 9731 | 632 | 5554 |
| 8-#10 | 1.11 | MA | 7250 | 1911 | 8578 | 1801 | 11296 | 1516 | 12798 | 1290 | 14301 | 952 | 17679 | 734 | 9252 |
| 3E | | MI | 4447 | 1911 | 5728 | 1732 | 7191 | 1455 | 7977 | 1237 | 8728 | 908 | 10621 | 687 | 5572 |
| 8-#10 | 1.11 | MA | 6956 | 1911 | 8052 | 1816 | 10609 | 1529 | 11917 | 1309 | 13096 | 963 | 16219 | 683 | 9156 |
| 4L-2S | | MI | 4730 | 1911 | 6171 | 1721 | 7752 | 1446 | 8655 | 1229 | 9641 | 897 | 11885 | 781 | 5568 |
| 8-#11 | 1.37 | MA | 8050 | 1980 | 10105 | 1821 | 13155 | 1526 | 15007 | 1291 | 17239 | 928 | 21721 | 807 | 11244 |
| 2L-4S | | MI | 4343 | 1980 | 5710 | 1775 | 7086 | 1487 | 7782 | 1263 | 8422 | 903 | 10207 | 576 | 6637 |
| 8-#11 | 1.37 | MA | 7457 | 1980 | 9170 | 1838 | 11972 | 1542 | 13576 | 1306 | 15312 | 947 | 19053 | 706 | 11199 |
| 3E | | MI | 4542 | 1980 | 6084 | 1762 | 7575 | 1476 | 8406 | 1247 | 9274 | 898 | 11261 | 642 | 6684 |
| 8-#11 | 1.37 | MA | 7112 | 1980 | 8530 | 1855 | 11134 | 1558 | 12505 | 1328 | 13847 | 960 | 17268 | 642 | 11028 |
| 4L-2S | | MI | 4872 | 1980 | 6618 | 1750 | 8249 | 1465 | 9222 | 1238 | 10373 | 886 | 12750 | 756 | 6688 |
| 8-#14 | 1.97 | MA | 8764 | 2142 | 11783 | 1916 | 15224 | 1595 | 17482 | 1334 | 20546 | 918 | 26281 | 795 | 15973 |
| 2L-4S | | MI | 4530 | 2142 | 6284 | 1876 | 7759 | 1560 | 8557 | 1311 | 9439 | 895 | 11535 | 465 | 9015 |
| 8-#14 | 1.97 | MA | 7973 | 2142 | 10446 | 1940 | 13533 | 1618 | 15437 | 1355 | 17792 | 945 | 22467 | 647 | 15843 |
| 3E | | MI | 4796 | 2142 | 6818 | 1859 | 8455 | 1546 | 9446 | 1290 | 10652 | 889 | 13014 | 557 | 9318 |
| 8-#14 | 1.97 | MA | 7517 | 2142 | 9528 | 1964 | 12333 | 1640 | 13902 | 1385 | 15693 | 962 | 19899 | 555 | 15329 |
| 4L-2S | | MI | 5236 | 2142 | 7576 | 1841 | 9413 | 1531 | 10605 | 1278 | 12213 | 874 | 15098 | 722 | 9365 |
| 8-#18 | 3.51 | MA | 10393 | 2554 | 15914 | 2161 | 20346 | 1774 | 23623 | 1446 | 28764 | 895 | 37622 | 767 | 27682 |
| 2L-4S | | MI | 5005 | 2554 | 7653 | 2133 | 9382 | 1747 | 10439 | 1434 | 11919 | 872 | 14651 | 164 | 13837 |
| 8-#18 | 3.51 | MA | 9197 | 2554 | 13578 | 2202 | 17391 | 1811 | 20049 | 1480 | 23952 | 940 | 30960 | 496 | 27188 |
| 3E | | MI | 5399 | 2554 | 8579 | 2106 | 10589 | 1725 | 11979 | 1400 | 14020 | 868 | 17137 | 319 | 15583 |
| 8-#18 | 3.51 | MA | 8513 | 2554 | 11968 | 2243 | 15288 | 1849 | 17359 | 1531 | 20274 | 967 | 26423 | 330 | 24070 |
| 4L-2S | | MI | 6039 | 2554 | 9885 | 2079 | 12241 | 1703 | 13977 | 1384 | 16710 | 846 | 20612 | 613 | 15846 |
| 10-#10 | 1.39 | MA | 8126 | 1986 | 10119 | 1834 | 13246 | 1536 | 15156 | 1300 | 17475 | 933 | 22074 | 811 | 11532 |
| 2L-5S | | MI | 4350 | 1986 | 5585 | 1801 | 6956 | 1515 | 7676 | 1281 | 8296 | 921 | 10102 | 574 | 6681 |
| 10-#10 | 1.39 | MA | 7639 | 1986 | 9349 | 1848 | 12271 | 1550 | 13977 | 1312 | 15888 | 949 | 19877 | 730 | 11496 |
| 3L-4S | | MI | 4494 | 1986 | 5862 | 1790 | 7348 | 1499 | 8139 | 1272 | 8936 | 910 | 10994 | 628 | 6837 |
| 10-#10 | 1.39 | MA | 7363 | 1986 | 8823 | 1862 | 11583 | 1563 | 13096 | 1330 | 14683 | 960 | 18417 | 679 | 11389 |
| 4L-3S | | MI | 4655 | 1986 | 6171 | 1779 | 7752 | 1490 | 8655 | 1259 | 9641 | 905 | 11885 | 683 | 6869 |
| 10-#10 | 1.39 | MA | 7059 | 1986 | 8349 | 1876 | 10921 | 1583 | 12313 | 1343 | 13597 | 977 | 16863 | 631 | 11044 |
| 5L-2S | | MI | 4929 | 1986 | 6615 | 1768 | 8313 | 1480 | 9333 | 1250 | 10554 | 894 | 13149 | 777 | 6874 |
| 10-#11 | 1.71 | MA | 8482 | 2072 | 11040 | 1878 | 14338 | 1568 | 16438 | 1318 | 19166 | 925 | 24389 | 802 | 13978 |
| 2L-5S | | MI | 4433 | 2072 | 5909 | 1845 | 7287 | 1547 | 8039 | 1299 | 8748 | 911 | 10645 | 501 | 7809 |
| 10-#11 | 1.71 | MA | 7916 | 2072 | 10105 | 1895 | 13155 | 1584 | 15007 | 1333 | 17239 | 944 | 21721 | 701 | 13917 |
| 3L-4S | | MI | 4597 | 2072 | 6243 | 1833 | 7761 | 1529 | 8598 | 1290 | 9521 | 899 | 11696 | 568 | 8172 |
| 10-#11 | 1.71 | MA | 7595 | 2072 | 9465 | 1913 | 12317 | 1600 | 13935 | 1355 | 15773 | 956 | 19935 | 637 | 13735 |
| 4L-3S | | MI | 4785 | 2072 | 6618 | 1820 | 8249 | 1518 | 9222 | 1274 | 10373 | 894 | 12750 | 634 | 8237 |
| 10-#11 | 1.71 | MA | 7237 | 2072 | 8894 | 1929 | 11510 | 1623 | 12982 | 1370 | 14451 | 976 | 18039 | 576 | 13019 |
| 5L-2S | | MI | 5101 | 2072 | 7151 | 1807 | 8924 | 1507 | 10038 | 1265 | 11472 | 882 | 14240 | 748 | 8255 |
| 10-#14 | 2.47 | MA | 9346 | 2275 | 13120 | 1999 | 16916 | 1656 | 19528 | 1373 | 23301 | 913 | 30095 | 788 | 19875 |
| 2L-5S | | MI | 4657 | 2275 | 6564 | 1976 | 8042 | 1645 | 8919 | 1362 | 9897 | 905 | 12147 | 352 | 10432 |
| 10-#14 | 2.47 | MA | 8600 | 2275 | 11783 | 2023 | 15224 | 1678 | 17482 | 1394 | 20546 | 940 | 26281 | 640 | 19723 |
| 3L-4S | | MI | 4881 | 2275 | 7042 | 1959 | 8717 | 1621 | 9717 | 1350 | 11000 | 890 | 13618 | 450 | 11100 |
| 10-#14 | 2.47 | MA | 8186 | 2275 | 10865 | 2047 | 14025 | 1701 | 15948 | 1424 | 18447 | 957 | 23713 | 548 | 19163 |
| 4L-3S | | MI | 5127 | 2275 | 7576 | 1941 | 9413 | 1607 | 10605 | 1329 | 12213 | 884 | 15098 | 542 | 11507 |
| 10-#14 | 2.47 | MA | 7688 | 2275 | 10053 | 2071 | 12868 | 1733 | 14581 | 1445 | 16553 | 984 | 20992 | 457 | 17636 |
| 5L-2S | | MI | 5545 | 2275 | 8333 | 1924 | 10372 | 1592 | 11764 | 1317 | 13774 | 869 | 17181 | 707 | 11576 |
| 10-#18 | 4.39 | MA | 10220 | 2790 | 15914 | 2349 | 20346 | 1919 | 23623 | 1549 | 28764 | 931 | 37622 | 484 | 33974 |
| 3L-4S | | MI | 5586 | 2790 | 8958 | 2281 | 11034 | 1855 | 12437 | 1503 | 14609 | 863 | 18126 | 124 | 17483 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 4.39 | MA | 9626 | 2790 | 14304 | 2390 | 18243 | 1957 | 20933 | 1601 | 25086 | 958 | 33085 | 317 | 30823 |
| 4L-3S | | MI | 5930 | 2790 | 9885 | 2253 | 12241 | 1833 | 13977 | 1469 | 16710 | 859 | 20612 | 279 | 19328 |
| 10-#18 | 4.39 | MA | 8795 | 2790 | 12876 | 2431 | 16212 | 2012 | 18533 | 1635 | 21761 | 1003 | 28297 | 148 | 27668 |
| 5L-2S | | MI | 6518 | 2790 | 11190 | 2226 | 13892 | 1812 | 15974 | 1454 | 19399 | 838 | 24088 | 572 | 19633 |
| 12-#10 | 1.67 | MA | 8485 | 2061 | 10890 | 1880 | 14220 | 1571 | 16334 | 1322 | 19062 | 930 | 24272 | 807 | 13784 |
| 2L-6S | | MI | 4364 | 2061 | 5752 | 1856 | 7163 | 1559 | 7903 | 1316 | 8585 | 924 | 10505 | 499 | 7644 |
| 12-#10 | 1.67 | MA | 8017 | 2061 | 10119 | 1895 | 13246 | 1584 | 15156 | 1334 | 17475 | 947 | 22074 | 726 | 13739 |
| 3L-5S | | MI | 4563 | 2061 | 6029 | 1848 | 7517 | 1549 | 8355 | 1303 | 9209 | 918 | 11366 | 570 | 7919 |
| 12-#10 | 1.67 | MA | 7757 | 2061 | 9593 | 1909 | 12558 | 1598 | 14275 | 1352 | 16270 | 958 | 20614 | 675 | 13623 |
| 4E | | MI | 4705 | 2061 | 6305 | 1837 | 7909 | 1534 | 8817 | 1294 | 9849 | 907 | 12258 | 624 | 8118 |
| 12-#10 | 1.67 | MA | 7458 | 2061 | 9120 | 1923 | 11895 | 1617 | 13492 | 1365 | 15184 | 974 | 19060 | 627 | 13257 |
| 5L-3S | | MI | 4858 | 2061 | 6615 | 1825 | 8313 | 1524 | 9333 | 1281 | 10554 | 902 | 13149 | 679 | 8160 |
| 12-#10 | 1.67 | MA | 7111 | 2061 | 8612 | 1930 | 11285 | 1629 | 12748 | 1378 | 14127 | 985 | 17708 | 571 | 12636 |
| 6L-2S | | MI | 5122 | 2061 | 7058 | 1814 | 8874 | 1514 | 10012 | 1272 | 11468 | 891 | 14412 | 773 | 8174 |
| 12-#11 | 2.05 | MA | 8902 | 2163 | 11976 | 1936 | 15521 | 1610 | 17869 | 1345 | 21092 | 921 | 27056 | 798 | 16710 |
| 2L-6S | | MI | 4449 | 2163 | 6115 | 1914 | 7533 | 1600 | 8308 | 1341 | 9091 | 913 | 11115 | 408 | 8990 |
| 12-#11 | 2.05 | MA | 8359 | 2163 | 11040 | 1953 | 14338 | 1626 | 16438 | 1360 | 19166 | 940 | 24389 | 696 | 16636 |
| 3L-5S | | MI | 4682 | 2163 | 6442 | 1903 | 7962 | 1589 | 8855 | 1326 | 9847 | 908 | 12134 | 493 | 9301 |
| 12-#11 | 2.05 | MA | 8061 | 2163 | 10400 | 1970 | 13500 | 1642 | 15366 | 1382 | 17700 | 953 | 22603 | 633 | 16445 |
| 4E | | MI | 4844 | 2163 | 6777 | 1890 | 8436 | 1571 | 9415 | 1317 | 10620 | 896 | 13186 | 560 | 9707 |
| 12-#11 | 2.05 | MA | 7709 | 2163 | 9830 | 1987 | 12693 | 1665 | 14413 | 1396 | 16378 | 972 | 20707 | 571 | 15712 |
| 5L-3S | | MI | 5020 | 2163 | 7151 | 1877 | 8924 | 1560 | 10038 | 1301 | 11472 | 891 | 14240 | 625 | 9786 |
| 12-#11 | 2.05 | MA | 7301 | 2163 | 9212 | 1996 | 11959 | 1681 | 13506 | 1411 | 15090 | 985 | 19056 | 500 | 14994 |
| 6L-2S | | MI | 5325 | 2163 | 7685 | 1864 | 9599 | 1550 | 10854 | 1292 | 12571 | 879 | 15729 | 740 | 9815 |
| 12-#14 | 2.96 | MA | 9205 | 2407 | 13120 | 2106 | 16916 | 1739 | 19528 | 1433 | 23301 | 935 | 30095 | 633 | 23607 |
| 3L-5S | | MI | 4999 | 2407 | 7322 | 2059 | 9000 | 1706 | 10078 | 1401 | 11458 | 900 | 14230 | 337 | 12567 |
| 12-#14 | 2.96 | MA | 8827 | 2407 | 12202 | 2130 | 15716 | 1762 | 17993 | 1463 | 21202 | 952 | 27527 | 541 | 23006 |
| 4E | | MI | 5220 | 2407 | 7800 | 2041 | 9676 | 1682 | 10876 | 1389 | 12561 | 885 | 15701 | 434 | 13200 |
| 12-#14 | 2.96 | MA | 8338 | 2407 | 11390 | 2154 | 14559 | 1794 | 16626 | 1484 | 19307 | 979 | 24806 | 450 | 21522 |
| 5L-3S | | MI | 5457 | 2407 | 8333 | 2024 | 10372 | 1667 | 11764 | 1368 | 13774 | 879 | 17181 | 526 | 13694 |
| 12-#14 | 2.96 | MA | 7791 | 2407 | 10507 | 2167 | 13516 | 1817 | 15294 | 1514 | 17462 | 996 | 22436 | 345 | 19970 |
| 6L-2S | | MI | 5841 | 2407 | 9091 | 2007 | 11330 | 1653 | 12924 | 1356 | 15335 | 864 | 19264 | 691 | 13782 |
| 12-#18 | 5.26 | MA | 10753 | 3025 | 16640 | 2537 | 21197 | 2065 | 24506 | 1670 | 29897 | 949 | 39747 | 305 | 37576 |
| 4E | | MI | 6142 | 3025 | 10264 | 2428 | 12685 | 1963 | 14434 | 1572 | 17298 | 855 | 21602 | 83 | 21150 |
| 12-#18 | 5.26 | MA | 9872 | 3025 | 15212 | 2578 | 19167 | 2120 | 22107 | 1704 | 26573 | 994 | 34959 | 136 | 34389 |
| 5L-3S | | MI | 6444 | 3025 | 11190 | 2400 | 13892 | 1941 | 15974 | 1539 | 19399 | 850 | 24088 | 238 | 23079 |
| 12-#18 | 5.26 | MA | 9028 | 3025 | 13691 | 2602 | 17333 | 2158 | 19767 | 1756 | 23334 | 1021 | 30774 | -56 | 30523 |
| 6L-2S | | MI | 6989 | 3025 | 12496 | 2373 | 15544 | 1920 | 17972 | 1523 | 22089 | 829 | 27563 | 532 | 23417 |
| 14-#10 | 1.95 | MA | 8384 | 2136 | 10890 | 1941 | 14220 | 1619 | 16334 | 1356 | 19062 | 944 | 24272 | 722 | 15982 |
| 3L-6S | | MI | 4578 | 2136 | 6196 | 1903 | 7724 | 1593 | 8582 | 1338 | 9499 | 921 | 11769 | 495 | 8900 |
| 14-#10 | 1.95 | MA | 8139 | 2136 | 10364 | 1956 | 13532 | 1632 | 15454 | 1374 | 17857 | 955 | 22812 | 671 | 15860 |
| 4L-5S | | MI | 4770 | 2136 | 6472 | 1894 | 8078 | 1583 | 9033 | 1325 | 10123 | 915 | 12630 | 566 | 9163 |
| 14-#10 | 1.95 | MA | 7844 | 2136 | 9890 | 1969 | 12870 | 1651 | 14671 | 1387 | 16771 | 971 | 21258 | 623 | 15474 |
| 5L-4S | | MI | 4910 | 2136 | 6748 | 1883 | 8470 | 1568 | 9496 | 1316 | 10763 | 904 | 13522 | 620 | 9398 |
| 14-#10 | 1.95 | MA | 7511 | 2136 | 9382 | 1977 | 12260 | 1663 | 13926 | 1400 | 15714 | 982 | 19906 | 567 | 14871 |
| 6L-3S | | MI | 5056 | 2136 | 7058 | 1872 | 8874 | 1558 | 10012 | 1303 | 11468 | 899 | 14412 | 675 | 9450 |
| 14-#10 | 1.95 | MA | 7217 | 2136 | 8897 | 1987 | 11621 | 1672 | 13160 | 1417 | 14687 | 999 | 18513 | 532 | 14249 |
| 7L-2S | | MI | 5312 | 2136 | 7501 | 1861 | 9435 | 1549 | 10690 | 1294 | 12381 | 888 | 15676 | 769 | 9471 |
| 14-#11 | 2.39 | MA | 8791 | 2255 | 11976 | 2010 | 15521 | 1669 | 17869 | 1387 | 21092 | 937 | 27056 | 691 | 19356 |
| 3L-6S | | MI | 4700 | 2255 | 6648 | 1971 | 8207 | 1642 | 9125 | 1368 | 10190 | 909 | 12605 | 400 | 10502 |
| 14-#11 | 2.39 | MA | 8512 | 2255 | 11335 | 2027 | 14684 | 1685 | 16797 | 1409 | 19627 | 950 | 25270 | 628 | 19159 |
| 4L-5S | | MI | 4924 | 2255 | 6975 | 1960 | 8637 | 1631 | 9671 | 1353 | 10946 | 904 | 13623 | 484 | 10800 |
| 14-#11 | 2.39 | MA | 8165 | 2255 | 10765 | 2044 | 13877 | 1707 | 15843 | 1423 | 18304 | 969 | 23374 | 567 | 18408 |
| 5L-4S | | MI | 5084 | 2255 | 7310 | 1947 | 9111 | 1613 | 10231 | 1344 | 11719 | 892 | 14675 | 552 | 11242 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 38"

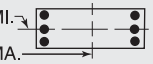
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.39 | MA | 7775 | 2255 | 10147 | 2053 | 13142 | 1723 | 14937 | 1438 | 17017 | 981 | 21723 | 495 | 17715 |
| 6L-3S | | MI | 5251 | 2255 | 7685 | 1935 | 9599 | 1603 | 10854 | 1328 | 12571 | 887 | 15729 | 617 | 11332 |
| 14-#11 | 2.39 | MA | 7431 | 2255 | 9557 | 2065 | 12366 | 1732 | 14016 | 1460 | 15765 | 1001 | 20016 | 452 | 16688 |
| 7L-2S | | MI | 5545 | 2255 | 8218 | 1922 | 10274 | 1592 | 11671 | 1319 | 13670 | 876 | 17219 | 732 | 11371 |
| 14-#14 | 3.45 | MA | 9446 | 2540 | 13540 | 2213 | 17408 | 1823 | 20039 | 1502 | 23957 | 947 | 31341 | 534 | 26855 |
| 4L-5S | | MI | 5346 | 2540 | 8080 | 2142 | 9959 | 1767 | 11237 | 1440 | 13019 | 896 | 16313 | 321 | 14712 |
| 14-#14 | 3.45 | MA | 8965 | 2540 | 12727 | 2237 | 16251 | 1855 | 18672 | 1523 | 22062 | 974 | 28620 | 443 | 25404 |
| 5L-4S | | MI | 5566 | 2540 | 8557 | 2124 | 10634 | 1743 | 12035 | 1428 | 14122 | 880 | 17784 | 419 | 15314 |
| 14-#14 | 3.45 | MA | 8448 | 2540 | 11844 | 2250 | 15208 | 1877 | 17340 | 1553 | 20216 | 991 | 26251 | 338 | 23837 |
| 6L-3S | | MI | 5767 | 2540 | 9091 | 2107 | 11330 | 1728 | 12924 | 1407 | 15335 | 874 | 19264 | 511 | 15881 |
| 14-#14 | 3.45 | MA | 7992 | 2540 | 10998 | 2266 | 14096 | 1891 | 16053 | 1574 | 18423 | 1019 | 23793 | 275 | 22208 |
| 7L-2S | | MI | 6130 | 2540 | 9849 | 2089 | 12289 | 1714 | 14083 | 1395 | 16896 | 859 | 21347 | 676 | 15985 |
| 14-#18 | 6.14 | MA | 10960 | 3261 | 17548 | 2725 | 22121 | 2228 | 25680 | 1773 | 31384 | 985 | 41621 | 124 | 41110 |
| 5L-4S | | MI | 6680 | 3261 | 11569 | 2575 | 14337 | 2071 | 16432 | 1641 | 19988 | 846 | 25077 | 43 | 24836 |
| 14-#18 | 6.14 | MA | 10195 | 3261 | 16026 | 2749 | 20288 | 2266 | 23341 | 1825 | 28145 | 1012 | 37436 | -68 | 37015 |
| 6L-3S | | MI | 6946 | 3261 | 12496 | 2547 | 15544 | 2050 | 17972 | 1608 | 22089 | 842 | 27563 | 198 | 26692 |
| 16-#10 | 2.23 | MA | 8511 | 2210 | 11134 | 2003 | 14507 | 1667 | 16633 | 1396 | 19445 | 952 | 25010 | 667 | 18098 |
| 4L-6S | | MI | 4787 | 2210 | 6639 | 1950 | 8285 | 1627 | 9260 | 1360 | 10412 | 918 | 13033 | 491 | 10159 |
| 16-#10 | 2.23 | MA | 8220 | 2210 | 10661 | 2016 | 13845 | 1686 | 15849 | 1409 | 18358 | 968 | 23456 | 620 | 17694 |
| 5E | | MI | 4973 | 2210 | 6916 | 1941 | 8639 | 1618 | 9712 | 1347 | 11036 | 913 | 13894 | 562 | 10411 |
| 16-#10 | 2.23 | MA | 7899 | 2210 | 10153 | 2024 | 13234 | 1698 | 15105 | 1422 | 17301 | 979 | 22103 | 563 | 17108 |
| 6L-4S | | MI | 5111 | 2210 | 7192 | 1930 | 9031 | 1602 | 10174 | 1338 | 11676 | 902 | 14786 | 616 | 10679 |
| 16-#10 | 2.23 | MA | 7618 | 2210 | 9667 | 2034 | 12596 | 1706 | 14339 | 1439 | 16274 | 996 | 20710 | 528 | 16484 |
| 7L-3S | | MI | 5250 | 2210 | 7501 | 1919 | 9435 | 1593 | 10690 | 1325 | 12381 | 896 | 15676 | 671 | 10738 |
| 16-#10 | 2.23 | MA | 7359 | 2210 | 9133 | 2050 | 11938 | 1722 | 13566 | 1447 | 15251 | 1007 | 19357 | 482 | 15704 |
| 8L-2S | | MI | 5498 | 2210 | 7945 | 1908 | 9996 | 1583 | 11369 | 1316 | 13295 | 885 | 16940 | 765 | 10765 |
| 16-#11 | 2.74 | MA | 8950 | 2347 | 12271 | 2085 | 15867 | 1727 | 18228 | 1436 | 21553 | 946 | 27938 | 623 | 21875 |
| 4L-6S | | MI | 4944 | 2347 | 7182 | 2029 | 8882 | 1684 | 9941 | 1395 | 11289 | 906 | 14094 | 392 | 11994 |
| 16-#11 | 2.74 | MA | 8608 | 2347 | 11700 | 2101 | 15060 | 1750 | 17274 | 1450 | 20231 | 965 | 26042 | 562 | 21109 |
| 5E | | MI | 5160 | 2347 | 7509 | 2017 | 9312 | 1673 | 10487 | 1380 | 12045 | 901 | 15113 | 476 | 12304 |
| 16-#11 | 2.74 | MA | 8234 | 2347 | 11082 | 2110 | 14325 | 1765 | 16368 | 1465 | 18943 | 978 | 24391 | 490 | 20437 |
| 6L-4S | | MI | 5318 | 2347 | 7844 | 2005 | 9786 | 1656 | 11047 | 1371 | 12818 | 889 | 16164 | 543 | 12777 |
| 16-#11 | 2.74 | MA | 7908 | 2347 | 10492 | 2122 | 13549 | 1775 | 15447 | 1487 | 17692 | 997 | 22684 | 447 | 19400 |
| 7L-3S | | MI | 5476 | 2347 | 8218 | 1992 | 10274 | 1645 | 11671 | 1355 | 13670 | 884 | 17219 | 609 | 12878 |
| 16-#11 | 2.74 | MA | 7606 | 2347 | 9842 | 2142 | 12748 | 1793 | 14506 | 1497 | 16445 | 1010 | 21032 | 388 | 18359 |
| 8L-2S | | MI | 5760 | 2347 | 8751 | 1979 | 10949 | 1634 | 12487 | 1346 | 14769 | 872 | 18708 | 723 | 12925 |
| 16-#14 | 3.95 | MA | 9572 | 2672 | 14064 | 2320 | 17943 | 1916 | 20718 | 1562 | 24816 | 969 | 32434 | 437 | 29286 |
| 5E | | MI | 5668 | 2672 | 8837 | 2224 | 10917 | 1828 | 12397 | 1478 | 14580 | 891 | 18396 | 306 | 16863 |
| 16-#14 | 3.95 | MA | 9083 | 2672 | 13181 | 2332 | 16899 | 1938 | 19386 | 1592 | 22971 | 987 | 30065 | 331 | 27703 |
| 6L-4S | | MI | 5885 | 2672 | 9315 | 2207 | 11593 | 1804 | 13195 | 1467 | 15683 | 875 | 19867 | 403 | 17437 |
| 16-#14 | 3.95 | MA | 8656 | 2672 | 12336 | 2349 | 15788 | 1952 | 18098 | 1613 | 21177 | 1014 | 27607 | 268 | 26062 |
| 7L-3S | | MI | 6069 | 2672 | 9849 | 2190 | 12289 | 1789 | 14083 | 1446 | 16896 | 869 | 21347 | 495 | 18068 |
| 16-#14 | 3.95 | MA | 8238 | 2672 | 11404 | 2377 | 14641 | 1977 | 16763 | 1627 | 19390 | 1031 | 25234 | 181 | 24232 |
| 8L-2S | | MI | 6415 | 2672 | 10606 | 2172 | 13247 | 1775 | 15242 | 1434 | 18456 | 854 | 23430 | 661 | 18186 |
| 16-#18 | 7.02 | MA | 11258 | 3496 | 18362 | 2896 | 23243 | 2374 | 26915 | 1894 | 32957 | 1003 | 44098 | -80 | 43467 |
| 6L-4S | | MI | 7205 | 3496 | 12875 | 2722 | 15988 | 2179 | 18429 | 1710 | 22677 | 837 | 28553 | 3 | 28536 |
| 18-#10 | 2.51 | MA | 8586 | 2285 | 11431 | 2063 | 14819 | 1720 | 17028 | 1431 | 19946 | 966 | 25653 | 616 | 19918 |
| 5L-6S | | MI | 4991 | 2285 | 7082 | 1996 | 8846 | 1662 | 9938 | 1382 | 11325 | 915 | 14296 | 487 | 11421 |
| 18-#10 | 2.51 | MA | 8277 | 2285 | 10923 | 2070 | 14209 | 1732 | 16284 | 1444 | 18889 | 977 | 24301 | 559 | 19347 |
| 6L-5S | | MI | 5171 | 2285 | 7359 | 1988 | 9200 | 1652 | 10390 | 1369 | 11950 | 910 | 15157 | 558 | 11664 |
| 18-#10 | 2.51 | MA | 8009 | 2285 | 10438 | 2080 | 13571 | 1740 | 15518 | 1461 | 17861 | 993 | 22908 | 524 | 18719 |
| 7L-4S | | MI | 5308 | 2285 | 7635 | 1977 | 9592 | 1637 | 10852 | 1360 | 12590 | 899 | 16049 | 612 | 11959 |
| 18-#10 | 2.51 | MA | 7759 | 2285 | 9904 | 2097 | 12912 | 1756 | 14744 | 1469 | 16838 | 1004 | 21555 | 478 | 17941 |
| 8L-3S | | MI | 5440 | 2285 | 7945 | 1966 | 9996 | 1627 | 11369 | 1347 | 13295 | 894 | 16940 | 667 | 12024 |
| 18-#10 | 2.51 | MA | 7438 | 2285 | 9436 | 2108 | 12302 | 1767 | 13965 | 1484 | 15829 | 1020 | 20166 | 425 | 17071 |
| 9L-2S | | MI | 5682 | 2285 | 8388 | 1955 | 10557 | 1617 | 12047 | 1338 | 14208 | 883 | 18204 | 761 | 12058 |
| 18-#11 | 3.08 | MA | 9039 | 2439 | 12635 | 2159 | 16243 | 1792 | 18705 | 1477 | 22157 | 962 | 28709 | 557 | 23813 |
| 5L-6S | | MI | 5183 | 2439 | 7715 | 2086 | 9557 | 1726 | 10757 | 1422 | 12388 | 902 | 15583 | 383 | 13484 |

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



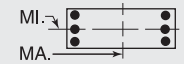

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 18-#11 | 3.08 | MA | 8681 | 2439 | 12018 | 2168 | 15508 | 1807 | 17799 | 1492 | 20870 | 975 | 27059 | 486 | 23162 |
| 6L-5S | | MI | 5392 | 2439 | 8042 | 2075 | 9987 | 1715 | 11304 | 1407 | 13144 | 897 | 16602 | 468 | 13814 |
| 18-#11 | 3.08 | MA | 8371 | 2439 | 11427 | 2180 | 14732 | 1817 | 16878 | 1514 | 19619 | 994 | 25352 | 442 | 22111 |
| 7L-4S | | MI | 5562 | 2439 | 8377 | 2062 | 10460 | 1698 | 11863 | 1398 | 13917 | 886 | 17654 | 535 | 14277 |
| 18-#11 | 3.08 | MA | 8077 | 2439 | 10777 | 2200 | 13931 | 1835 | 15936 | 1524 | 18372 | 1006 | 23699 | 384 | 21064 |
| 8L-3S | | MI | 5704 | 2439 | 8751 | 2049 | 10949 | 1687 | 12487 | 1382 | 14769 | 881 | 18708 | 601 | 14422 |
| 18-#11 | 3.08 | MA | 7701 | 2439 | 10214 | 2213 | 13188 | 1848 | 14988 | 1541 | 17142 | 1026 | 21997 | 318 | 19961 |
| 9L-2S | | MI | 5968 | 2439 | 9285 | 2037 | 11624 | 1676 | 13303 | 1373 | 15868 | 869 | 20197 | 715 | 14478 |
| 18-#14 | 4.44 | MA | 9698 | 2804 | 14519 | 2415 | 18591 | 1999 | 21432 | 1631 | 25726 | 982 | 33879 | 324 | 31569 |
| 6L-5S | | MI | 5982 | 2804 | 9595 | 2307 | 11876 | 1889 | 13556 | 1517 | 16141 | 886 | 20479 | 290 | 19020 |
| 18-#14 | 4.44 | MA | 9298 | 2804 | 13673 | 2432 | 17479 | 2012 | 20144 | 1652 | 23932 | 1009 | 31421 | 261 | 29917 |
| 7L-4S | | MI | 6196 | 2804 | 10073 | 2290 | 12551 | 1864 | 14354 | 1506 | 17244 | 870 | 21950 | 388 | 19569 |
| 18-#14 | 4.44 | MA | 8888 | 2804 | 12741 | 2460 | 16332 | 2038 | 18809 | 1666 | 22145 | 1026 | 29048 | 174 | 28094 |
| 8L-3S | | MI | 6366 | 2804 | 10606 | 2272 | 13247 | 1850 | 15242 | 1484 | 18456 | 864 | 23430 | 480 | 20257 |
| 20-#10 | 2.79 | MA | 8646 | 2360 | 11694 | 2117 | 15184 | 1766 | 17463 | 1466 | 20476 | 974 | 26499 | 555 | 21587 |
| 6E | | MI | 5190 | 2360 | 7526 | 2043 | 9406 | 1696 | 10617 | 1404 | 12239 | 912 | 15560 | 483 | 12686 |
| 20-#10 | 2.79 | MA | 8389 | 2360 | 11208 | 2127 | 14545 | 1775 | 16697 | 1483 | 19449 | 990 | 25106 | 521 | 20955 |
| 7L-5S | | MI | 5365 | 2360 | 7802 | 2035 | 9761 | 1686 | 11068 | 1390 | 12863 | 907 | 16421 | 554 | 12921 |
| 20-#10 | 2.79 | MA | 8143 | 2360 | 10674 | 2144 | 13887 | 1790 | 15923 | 1491 | 18425 | 1001 | 23753 | 475 | 20179 |
| 8L-4S | | MI | 5501 | 2360 | 8079 | 2023 | 10152 | 1671 | 11531 | 1382 | 13503 | 896 | 17313 | 608 | 13239 |
| 20-#10 | 2.79 | MA | 7834 | 2360 | 10207 | 2155 | 13277 | 1801 | 15144 | 1506 | 17416 | 1018 | 22363 | 422 | 19303 |
| 9L-3S | | MI | 5628 | 2360 | 8388 | 2012 | 10557 | 1661 | 12047 | 1368 | 14208 | 891 | 18204 | 663 | 13311 |
| 20-#10 | 2.79 | MA | 7545 | 2360 | 9724 | 2164 | 12679 | 1812 | 14394 | 1516 | 16375 | 1026 | 21007 | 381 | 18447 |
| 10L-2S | | MI | 5862 | 2360 | 8832 | 2001 | 11117 | 1652 | 12726 | 1360 | 15122 | 880 | 19467 | 757 | 13350 |
| 20-#11 | 3.42 | MA | 9117 | 2531 | 12953 | 2225 | 16691 | 1849 | 19230 | 1519 | 22797 | 971 | 29726 | 481 | 25882 |
| 6E | | MI | 5417 | 2531 | 8249 | 2143 | 10232 | 1768 | 11573 | 1449 | 13487 | 899 | 17073 | 375 | 14979 |
| 20-#11 | 3.42 | MA | 8822 | 2531 | 12362 | 2237 | 15915 | 1859 | 18308 | 1541 | 21545 | 990 | 28019 | 437 | 24807 |
| 7L-5S | | MI | 5630 | 2531 | 8576 | 2132 | 10661 | 1758 | 12120 | 1434 | 14242 | 894 | 18092 | 460 | 15327 |
| 20-#11 | 3.42 | MA | 8532 | 2531 | 11712 | 2257 | 15114 | 1877 | 17367 | 1550 | 20299 | 1003 | 26367 | 379 | 23768 |
| 8L-4S | | MI | 5786 | 2531 | 8910 | 2119 | 11135 | 1740 | 12679 | 1425 | 15016 | 882 | 19143 | 527 | 15773 |
| 20-#11 | 3.42 | MA | 8171 | 2531 | 11149 | 2271 | 14371 | 1890 | 16419 | 1568 | 19069 | 1022 | 24665 | 313 | 22669 |
| 9L-3S | | MI | 5919 | 2531 | 9285 | 2107 | 11624 | 1729 | 13303 | 1409 | 15868 | 877 | 20197 | 592 | 15966 |
| 20-#11 | 3.42 | MA | 7835 | 2531 | 10562 | 2281 | 13642 | 1903 | 15505 | 1580 | 17821 | 1034 | 23007 | 261 | 21439 |
| 10L-2S | | MI | 6173 | 2531 | 9818 | 2094 | 12298 | 1718 | 14119 | 1400 | 16967 | 865 | 21687 | 707 | 16029 |
| 20-#14 | 4.93 | MA | 9923 | 2937 | 15010 | 2514 | 19171 | 2073 | 22190 | 1691 | 26686 | 1004 | 35235 | 254 | 33771 |
| 7L-5S | | MI | 6290 | 2937 | 10353 | 2390 | 12834 | 1950 | 14715 | 1556 | 17702 | 881 | 22562 | 275 | 21182 |
| 20-#14 | 4.93 | MA | 9519 | 2937 | 14078 | 2543 | 18024 | 2099 | 20855 | 1705 | 24899 | 1021 | 32862 | 167 | 31956 |
| 8L-4S | | MI | 6502 | 2937 | 10830 | 2373 | 13510 | 1925 | 15513 | 1545 | 18805 | 865 | 24034 | 372 | 21709 |
| 22-#10 | 3.06 | MA | 8761 | 2435 | 11979 | 2174 | 15520 | 1809 | 17875 | 1505 | 21036 | 987 | 27303 | 517 | 23190 |
| 7L-6S | | MI | 5387 | 2435 | 7969 | 2090 | 9967 | 1730 | 11295 | 1426 | 13152 | 909 | 16824 | 479 | 13953 |
| 22-#10 | 3.06 | MA | 8518 | 2435 | 11445 | 2191 | 14862 | 1825 | 17102 | 1513 | 20012 | 998 | 25950 | 471 | 22416 |
| 8L-5S | | MI | 5557 | 2435 | 8246 | 2081 | 10322 | 1721 | 11747 | 1412 | 13777 | 904 | 17685 | 550 | 14180 |
| 22-#10 | 3.06 | MA | 8219 | 2435 | 10977 | 2202 | 14251 | 1835 | 16323 | 1528 | 19003 | 1015 | 24561 | 418 | 21535 |
| 9L-4S | | MI | 5692 | 2435 | 8522 | 2070 | 10713 | 1705 | 12209 | 1404 | 14416 | 893 | 18577 | 604 | 14520 |
| 22-#10 | 3.06 | MA | 7942 | 2435 | 10494 | 2210 | 13653 | 1847 | 15573 | 1538 | 17963 | 1023 | 23204 | 378 | 20675 |
| 10L-3S | | MI | 5820 | 2435 | 8832 | 2059 | 11117 | 1696 | 12726 | 1390 | 15122 | 888 | 19467 | 659 | 14597 |
| 22-#10 | 3.06 | MA | 7678 | 2435 | 10021 | 2220 | 13051 | 1857 | 14834 | 1549 | 16927 | 1037 | 21887 | 329 | 19744 |
| 11L-2S | | MI | 6038 | 2435 | 9275 | 2048 | 11678 | 1686 | 13404 | 1382 | 16035 | 877 | 20731 | 753 | 14640 |
| 22-#11 | 3.76 | MA | 9262 | 2623 | 13297 | 2294 | 17098 | 1901 | 19739 | 1568 | 23472 | 987 | 30687 | 433 | 27519 |
| 7L-6S | | MI | 5662 | 2623 | 8782 | 2201 | 10907 | 1811 | 12389 | 1476 | 14586 | 896 | 18562 | 367 | 16479 |
| 22-#11 | 3.76 | MA | 8976 | 2623 | 12647 | 2315 | 16297 | 1919 | 18798 | 1577 | 22225 | 1000 | 29034 | 374 | 26472 |
| 8L-5S | | MI | 5851 | 2623 | 9109 | 2190 | 11336 | 1800 | 12936 | 1461 | 15341 | 891 | 19581 | 451 | 16844 |
| 22-#11 | 3.76 | MA | 8629 | 2623 | 12085 | 2328 | 15554 | 1932 | 17850 | 1595 | 20995 | 1019 | 27332 | 308 | 25376 |
| 9L-4S | | MI | 6005 | 2623 | 9444 | 2177 | 11810 | 1782 | 13496 | 1452 | 16115 | 879 | 20633 | 519 | 17274 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

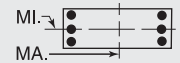
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 22-#11 | 3.76 | MA | 8307 | 2623 | 11497 | 2339 | 14825 | 1945 | 16936 | 1607 | 19748 | 1030 | 25675 | 257 | 24141 |
| 10L-3S | | MI | 6131 | 2623 | 9818 | 2164 | 12298 | 1771 | 14119 | 1436 | 16967 | 874 | 21687 | 584 | 17510 |
| 22-#14 | 5.43 | MA | 10133 | 3069 | 15416 | 2626 | 19715 | 2160 | 22901 | 1744 | 27654 | 1016 | 36676 | 160 | 35818 |
| 8L-5S | | MI | 6592 | 3069 | 11110 | 2473 | 13793 | 2010 | 15874 | 1595 | 19262 | 876 | 24646 | 260 | 23349 |
| 24-#10 | 3.34 | MA | 8886 | 2510 | 12215 | 2237 | 15836 | 1859 | 18281 | 1535 | 21600 | 996 | 28148 | 467 | 24653 |
| 8L-6S | | MI | 5580 | 2510 | 8413 | 2137 | 10528 | 1765 | 11974 | 1448 | 14066 | 907 | 18087 | 475 | 15222 |
| 24-#10 | 3.34 | MA | 8597 | 2510 | 11748 | 2248 | 15226 | 1870 | 17502 | 1550 | 20590 | 1012 | 26759 | 414 | 23768 |
| 9L-5S | | MI | 5745 | 2510 | 8689 | 2128 | 10883 | 1755 | 12425 | 1434 | 14690 | 901 | 18948 | 546 | 15443 |
| 24-#10 | 3.34 | MA | 8330 | 2510 | 11265 | 2257 | 14628 | 1881 | 16752 | 1560 | 19550 | 1021 | 25402 | 374 | 22902 |
| 10L-4S | | MI | 5892 | 2510 | 8965 | 2117 | 11274 | 1740 | 12888 | 1426 | 15330 | 890 | 19840 | 600 | 15802 |
| 24-#10 | 3.34 | MA | 8077 | 2510 | 10791 | 2267 | 14025 | 1891 | 16012 | 1571 | 18514 | 1035 | 24085 | 325 | 21974 |
| 11L-3S | | MI | 5999 | 2510 | 9275 | 2106 | 11678 | 1730 | 13404 | 1412 | 16035 | 885 | 20731 | 655 | 15882 |
| 24-#11 | 4.11 | MA | 9411 | 2714 | 13583 | 2372 | 17480 | 1962 | 20229 | 1604 | 24152 | 996 | 31702 | 369 | 29176 |
| 8L-6S | | MI | 5887 | 2714 | 9316 | 2258 | 11582 | 1853 | 13206 | 1503 | 15685 | 892 | 20052 | 359 | 17982 |
| 24-#11 | 4.11 | MA | 9077 | 2714 | 13020 | 2386 | 16737 | 1974 | 19281 | 1622 | 22922 | 1016 | 30000 | 303 | 28084 |
| 9L-5S | | MI | 6069 | 2714 | 9643 | 2247 | 12011 | 1842 | 13752 | 1487 | 16440 | 887 | 21070 | 443 | 18364 |
| 24-#11 | 4.11 | MA | 8768 | 2714 | 12432 | 2396 | 16008 | 1988 | 18367 | 1634 | 21674 | 1027 | 28343 | 252 | 26843 |
| 10L-4S | | MI | 6222 | 2714 | 9977 | 2234 | 12485 | 1824 | 14312 | 1479 | 17214 | 875 | 22122 | 510 | 18780 |

## RECTANGULAR TIED COLUMNS 24" x 40"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.67 | MA | 9261 | 2168 | 12163 | 1957 | 15688 | 1634 | 17916 | 1374 | 20782 | 966 | 26354 | 839 | 14922 |
| 2E | | MI | 5236 | 2168 | 7519 | 1863 | 9234 | 1554 | 10297 | 1304 | 11644 | 910 | 14014 | 734 | 8263 |
| 6-#14 | 1.41 | MA | 8974 | 2095 | 11311 | 1923 | 14721 | 1611 | 16804 | 1362 | 19338 | 976 | 24395 | 849 | 12795 |
| 2L-3S | | MI | 4657 | 2095 | 6299 | 1855 | 7790 | 1553 | 8600 | 1310 | 9405 | 941 | 11287 | 614 | 7156 |
| 6-#14 | 1.41 | MA | 8070 | 2095 | 9891 | 1948 | 12925 | 1634 | 14631 | 1384 | 16413 | 1004 | 20345 | 703 | 12695 |
| 3L-2S | | MI | 5125 | 2095 | 7057 | 1838 | 8748 | 1538 | 9760 | 1299 | 10966 | 926 | 13371 | 779 | 7166 |
| 6-#18 | 2.50 | MA | 10348 | 2404 | 14646 | 2104 | 18829 | 1742 | 21715 | 1444 | 25896 | 957 | 33436 | 826 | 22170 |
| 2L-3S | | MI | 5033 | 2404 | 7519 | 2037 | 9234 | 1684 | 10297 | 1389 | 11644 | 923 | 14014 | 400 | 11902 |
| 6-#18 | 2.50 | MA | 8939 | 2404 | 12163 | 2146 | 15688 | 1781 | 17916 | 1479 | 20782 | 1004 | 26354 | 559 | 21711 |
| 3L-2S | | MI | 5758 | 2404 | 8825 | 2010 | 10886 | 1662 | 12295 | 1374 | 14334 | 902 | 17490 | 694 | 12083 |
| 8-#10 | 1.06 | MA | 8536 | 1996 | 10142 | 1877 | 13376 | 1579 | 15247 | 1345 | 17307 | 989 | 21632 | 862 | 9825 |
| 2L-4S | | MI | 4481 | 1996 | 5650 | 1824 | 7077 | 1534 | 7773 | 1311 | 8337 | 961 | 10090 | 674 | 5579 |
| 8-#10 | 1.06 | MA | 7993 | 1996 | 9325 | 1892 | 12342 | 1593 | 13997 | 1358 | 15624 | 1006 | 19301 | 782 | 9801 |
| 3E | | MI | 4652 | 1996 | 5959 | 1813 | 7481 | 1524 | 8289 | 1297 | 9043 | 955 | 10981 | 729 | 5592 |
| 8-#10 | 1.06 | MA | 7679 | 1996 | 8768 | 1906 | 11614 | 1607 | 13064 | 1376 | 14348 | 1017 | 17761 | 731 | 9705 |
| 4L-2S | | MI | 4937 | 1996 | 6403 | 1802 | 8042 | 1515 | 8968 | 1289 | 9956 | 944 | 12244 | 822 | 5585 |
| 8-#11 | 1.30 | MA | 8854 | 2065 | 10948 | 1911 | 14317 | 1603 | 16344 | 1358 | 18747 | 981 | 23597 | 854 | 11918 |
| 2L-4S | | MI | 4547 | 2065 | 5946 | 1855 | 7378 | 1555 | 8096 | 1322 | 8737 | 950 | 10564 | 618 | 6672 |
| 8-#11 | 1.30 | MA | 8218 | 2065 | 9955 | 1929 | 13061 | 1619 | 14826 | 1373 | 16702 | 1001 | 20765 | 754 | 11873 |
| 3E | | MI | 4747 | 2065 | 6320 | 1842 | 7867 | 1544 | 8719 | 1307 | 9588 | 945 | 11618 | 683 | 6709 |
| 8-#11 | 1.30 | MA | 7849 | 2065 | 9277 | 1946 | 12174 | 1636 | 13690 | 1396 | 15149 | 1014 | 18880 | 691 | 11702 |
| 4L-2S | | MI | 5079 | 2065 | 6854 | 1830 | 8541 | 1534 | 9536 | 1298 | 10687 | 933 | 13108 | 798 | 6709 |
| 8-#14 | 1.88 | MA | 9624 | 2227 | 12731 | 2006 | 16517 | 1672 | 18976 | 1401 | 22263 | 971 | 28445 | 842 | 16945 |
| 2L-4S | | MI | 4733 | 2227 | 6523 | 1955 | 8052 | 1628 | 8871 | 1370 | 9753 | 942 | 11891 | 506 | 9127 |
| 8-#14 | 1.88 | MA | 8774 | 2227 | 11311 | 2031 | 14721 | 1695 | 16804 | 1423 | 19338 | 999 | 24395 | 696 | 16815 |
| 3E | | MI | 5001 | 2227 | 7057 | 1938 | 8748 | 1614 | 9760 | 1349 | 10966 | 936 | 13371 | 598 | 9352 |
| 8-#14 | 1.88 | MA | 8285 | 2227 | 10339 | 2056 | 13450 | 1718 | 15177 | 1454 | 17113 | 1017 | 21684 | 604 | 16344 |
| 4L-2S | | MI | 5445 | 2227 | 7815 | 1921 | 9707 | 1599 | 10919 | 1338 | 12527 | 921 | 15454 | 764 | 9391 |
| 8-#18 | 3.33 | MA | 11383 | 2639 | 17128 | 2251 | 21969 | 1850 | 25514 | 1513 | 31011 | 948 | 40518 | 814 | 29410 |
| 2L-4S | | MI | 5205 | 2639 | 7898 | 2212 | 9679 | 1814 | 10755 | 1492 | 12233 | 919 | 15004 | 205 | 13981 |
| 8-#18 | 3.33 | MA | 10093 | 2639 | 14646 | 2293 | 18829 | 1889 | 21715 | 1548 | 25896 | 995 | 33436 | 547 | 28916 |
| 3E | | MI | 5605 | 2639 | 8825 | 2184 | 10886 | 1792 | 12295 | 1459 | 14334 | 915 | 17490 | 360 | 15641 |
| 8-#18 | 3.33 | MA | 9357 | 2639 | 12939 | 2335 | 16598 | 1928 | 18860 | 1601 | 21994 | 1024 | 28644 | 382 | 25734 |
| 4L-2S | | MI | 6254 | 2639 | 10130 | 2157 | 12537 | 1770 | 14292 | 1443 | 17023 | 893 | 20965 | 653 | 15881 |
| 10-#10 | 1.32 | MA | 8933 | 2071 | 10960 | 1924 | 14410 | 1613 | 16497 | 1367 | 18991 | 986 | 23963 | 858 | 12217 |
| 2L-5S | | MI | 4554 | 2071 | 5817 | 1882 | 7246 | 1584 | 7989 | 1341 | 8611 | 969 | 10462 | 616 | 6751 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

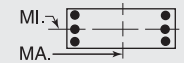



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.32 | MA | 8411 | 2071 | 10142 | 1938 | 13376 | 1627 | 15247 | 1380 | 17307 | 1003 | 21632 | 778 | 12182 |
| 3L-4S | | MI | 4698 | 2071 | 6093 | 1871 | 7638 | 1568 | 8451 | 1333 | 9251 | 958 | 11354 | 670 | 6864 |
| 10-#10 | 1.32 | MA | 8115 | 2071 | 9586 | 1953 | 12647 | 1641 | 14314 | 1398 | 16031 | 1015 | 20092 | 727 | 12074 |
| 4L-3S | | MI | 4861 | 2071 | 6403 | 1859 | 8042 | 1559 | 8968 | 1319 | 9956 | 953 | 12244 | 725 | 6890 |
| 10-#10 | 1.32 | MA | 7788 | 2071 | 9081 | 1966 | 11946 | 1660 | 13485 | 1411 | 14882 | 1032 | 18449 | 681 | 11775 |
| 5L-2S | | MI | 5136 | 2071 | 6846 | 1848 | 8603 | 1549 | 9646 | 1311 | 10870 | 942 | 13508 | 818 | 6893 |
| 10-#11 | 1.63 | MA | 9319 | 2156 | 11940 | 1968 | 15572 | 1645 | 17863 | 1385 | 20791 | 978 | 26428 | 849 | 14821 |
| 2L-5S | | MI | 4637 | 2156 | 6145 | 1925 | 7579 | 1615 | 8352 | 1358 | 9062 | 959 | 11002 | 542 | 7889 |
| 10-#11 | 1.63 | MA | 8711 | 2156 | 10948 | 1986 | 14317 | 1661 | 16344 | 1400 | 18747 | 998 | 23597 | 749 | 14760 |
| 3L-4S | | MI | 4801 | 2156 | 6479 | 1913 | 8053 | 1597 | 8912 | 1349 | 9836 | 947 | 12054 | 610 | 8209 |
| 10-#11 | 1.63 | MA | 8367 | 2156 | 10269 | 2003 | 13430 | 1678 | 15209 | 1423 | 17193 | 1011 | 21712 | 686 | 14577 |
| 4L-3S | | MI | 4991 | 2156 | 6854 | 1900 | 8541 | 1587 | 9536 | 1334 | 10687 | 942 | 13108 | 675 | 8264 |
| 10-#11 | 1.63 | MA | 7980 | 2156 | 9661 | 2020 | 12575 | 1701 | 14199 | 1438 | 15793 | 1031 | 19706 | 626 | 13886 |
| 5L-2S | | MI | 5310 | 2156 | 7387 | 1887 | 9216 | 1576 | 10352 | 1325 | 11786 | 930 | 14597 | 790 | 8278 |
| 10-#14 | 2.34 | MA | 10251 | 2359 | 14151 | 2089 | 18313 | 1733 | 21149 | 1440 | 25188 | 966 | 32496 | 835 | 21090 |
| 2L-5S | | MI | 4860 | 2359 | 6803 | 2056 | 8335 | 1713 | 9233 | 1421 | 10211 | 952 | 12503 | 393 | 10530 |
| 10-#14 | 2.34 | MA | 9448 | 2360 | 12731 | 2114 | 16517 | 1756 | 18976 | 1461 | 22263 | 994 | 28445 | 689 | 20938 |
| 3L-4S | | MI | 5084 | 2360 | 7281 | 2038 | 9011 | 1689 | 10031 | 1409 | 11314 | 937 | 13974 | 491 | 11208 |
| 10-#14 | 2.34 | MA | 9002 | 2359 | 11759 | 2138 | 15246 | 1779 | 17349 | 1493 | 20038 | 1013 | 25734 | 597 | 20471 |
| 4L-3S | | MI | 5333 | 2360 | 7815 | 2021 | 9707 | 1674 | 10919 | 1388 | 12527 | 931 | 15454 | 583 | 11543 |
| 10-#14 | 2.34 | MA | 8464 | 2359 | 10893 | 2162 | 14021 | 1812 | 15901 | 1514 | 18030 | 1041 | 22855 | 509 | 18807 |
| 5L-2S | | MI | 5757 | 2360 | 8572 | 2003 | 10665 | 1660 | 12078 | 1376 | 14088 | 916 | 17537 | 748 | 11604 |
| 10-#18 | 4.17 | MA | 11191 | 2875 | 17128 | 2440 | 21969 | 1998 | 25514 | 1617 | 31011 | 986 | 40518 | 534 | 36134 |
| 3L-4S | | MI | 5787 | 2875 | 9204 | 2359 | 11330 | 1922 | 12752 | 1561 | 14922 | 910 | 18479 | 164 | 17619 |
| 10-#18 | 4.17 | MA | 10551 | 2875 | 15422 | 2482 | 19739 | 2036 | 22659 | 1671 | 27108 | 1015 | 35726 | 370 | 32914 |
| 4L-3S | | MI | 6138 | 2875 | 10130 | 2332 | 12537 | 1900 | 14292 | 1528 | 17023 | 906 | 20965 | 319 | 19385 |
| 10-#18 | 4.17 | MA | 9650 | 2875 | 13909 | 2525 | 17586 | 2093 | 20115 | 1706 | 23583 | 1062 | 30657 | 205 | 29691 |
| 5L-2S | | MI | 6736 | 2875 | 11436 | 2304 | 14189 | 1878 | 16290 | 1512 | 19713 | 884 | 24441 | 613 | 19670 |
| 12-#10 | 1.59 | MA | 9319 | 2146 | 11777 | 1971 | 15443 | 1648 | 17748 | 1389 | 20674 | 983 | 26294 | 854 | 14607 |
| 2L-6S | | MI | 4567 | 2146 | 5984 | 1937 | 7453 | 1628 | 8216 | 1376 | 8900 | 971 | 10865 | 541 | 7710 |
| 12-#10 | 1.59 | MA | 8816 | 2146 | 10960 | 1985 | 14410 | 1662 | 16497 | 1402 | 18991 | 1000 | 23963 | 774 | 14562 |
| 3L-5S | | MI | 4768 | 2146 | 6260 | 1928 | 7807 | 1618 | 8667 | 1363 | 9525 | 966 | 11726 | 612 | 7987 |
| 12-#10 | 1.59 | MA | 8538 | 2146 | 10403 | 2000 | 13681 | 1675 | 15565 | 1420 | 17715 | 1012 | 22423 | 723 | 14446 |
| 4E | | MI | 4909 | 2146 | 6536 | 1917 | 8199 | 1603 | 9130 | 1354 | 10164 | 955 | 12618 | 666 | 8147 |
| 12-#10 | 1.59 | MA | 8215 | 2146 | 9898 | 2013 | 12980 | 1695 | 14736 | 1433 | 16565 | 1029 | 20780 | 677 | 14126 |
| 5L-3S | | MI | 5064 | 2146 | 6846 | 1906 | 8603 | 1593 | 9646 | 1341 | 10870 | 950 | 13508 | 721 | 8183 |
| 12-#10 | 1.59 | MA | 7844 | 2146 | 9360 | 2021 | 12329 | 1707 | 13948 | 1446 | 15446 | 1040 | 19350 | 621 | 13447 |
| 6L-2S | | MI | 5331 | 2146 | 7290 | 1895 | 9164 | 1583 | 10325 | 1332 | 11783 | 939 | 14772 | 814 | 8195 |
| 12-#11 | 1.95 | MA | 9771 | 2248 | 12933 | 2026 | 16828 | 1687 | 19382 | 1412 | 22836 | 974 | 29259 | 844 | 17721 |
| 2L-6S | | MI | 4652 | 2248 | 6351 | 1994 | 7825 | 1668 | 8622 | 1401 | 9406 | 960 | 11473 | 450 | 9069 |
| 12-#11 | 1.95 | MA | 9187 | 2248 | 11940 | 2043 | 15572 | 1704 | 17863 | 1427 | 20791 | 994 | 26428 | 744 | 17647 |
| 3L-5S | | MI | 4887 | 2248 | 6678 | 1983 | 8254 | 1657 | 9169 | 1385 | 10161 | 955 | 12491 | 534 | 9378 |
| 12-#11 | 1.95 | MA | 8866 | 2248 | 11262 | 2061 | 14685 | 1720 | 16728 | 1450 | 19238 | 1008 | 24543 | 681 | 17456 |
| 4E | | MI | 5048 | 2248 | 7013 | 1970 | 8728 | 1639 | 9728 | 1376 | 10935 | 943 | 13543 | 601 | 9745 |
| 12-#11 | 1.95 | MA | 8486 | 2248 | 10653 | 2077 | 13831 | 1743 | 15718 | 1465 | 17838 | 1028 | 22538 | 622 | 16748 |
| 5L-3S | | MI | 5227 | 2248 | 7387 | 1957 | 9216 | 1629 | 10352 | 1361 | 11786 | 938 | 14597 | 667 | 9814 |
| 12-#11 | 1.95 | MA | 8049 | 2248 | 9999 | 2087 | 13047 | 1758 | 14758 | 1480 | 16474 | 1041 | 20792 | 552 | 15968 |
| 6L-2S | | MI | 5536 | 2248 | 7920 | 1944 | 9891 | 1618 | 11168 | 1352 | 12885 | 926 | 16087 | 781 | 9839 |
| 12-#14 | 2.81 | MA | 10098 | 2492 | 14151 | 2196 | 18313 | 1817 | 21149 | 1500 | 25188 | 989 | 32496 | 682 | 25065 |
| 3L-5S | | MI | 5204 | 2492 | 7561 | 2138 | 9294 | 1774 | 10392 | 1460 | 11772 | 948 | 14586 | 378 | 12662 |
| 12-#14 | 2.81 | MA | 9690 | 2492 | 13179 | 2221 | 17042 | 1840 | 19522 | 1532 | 22963 | 1008 | 29784 | 590 | 24586 |
| 4E | | MI | 5424 | 2492 | 8039 | 2121 | 9969 | 1750 | 11190 | 1448 | 12875 | 932 | 16057 | 475 | 13305 |
| 12-#14 | 2.81 | MA | 9162 | 2492 | 12313 | 2245 | 15817 | 1873 | 18074 | 1553 | 20955 | 1036 | 26906 | 502 | 22930 |
| 5L-3S | | MI | 5667 | 2492 | 8572 | 2104 | 10665 | 1735 | 12078 | 1427 | 14088 | 926 | 17537 | 567 | 13731 |
| 12-#14 | 2.81 | MA | 8575 | 2492 | 11375 | 2258 | 14702 | 1895 | 16697 | 1575 | 19001 | 1054 | 24399 | 399 | 21368 |
| 6L-2S | | MI | 6055 | 2492 | 9330 | 2086 | 11624 | 1721 | 13238 | 1415 | 15649 | 911 | 19620 | 733 | 13812 |
| 12-#18 | 5.00 | MA | 11762 | 3110 | 17905 | 2630 | 22879 | 2145 | 26458 | 1740 | 32223 | 1006 | 42808 | 357 | 40093 |
| 4E | | MI | 6344 | 3110 | 10509 | 2506 | 12982 | 2030 | 14750 | 1630 | 17611 | 901 | 21955 | 124 | 21280 |
| 12-#18 | 5.00 | MA | 10806 | 3110 | 16392 | 2672 | 20727 | 2201 | 23914 | 1775 | 28698 | 1053 | 37739 | 193 | 36836 |
| 5L-3S | | MI | 6653 | 3110 | 11436 | 2479 | 14189 | 2008 | 16290 | 1597 | 19713 | 897 | 24441 | 279 | 23137 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis



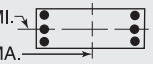

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 5.00 | MA | 9899 | 3110 | 14762 | 2695 | 18785 | 2240 | 21435 | 1829 | 25264 | 1082 | 33321 | 2 | 33305 |
| 6L-2S | | MI | 7209 | 3110 | 12741 | 2451 | 15840 | 1987 | 18287 | 1581 | 22402 | 875 | 27916 | 573 | 23454 |
| 14-#10 | 1.85 | MA | 9210 | 2221 | 11777 | 2032 | 15443 | 1696 | 17748 | 1424 | 20674 | 998 | 26294 | 770 | 16942 |
| 3L-6S | | MI | 4782 | 2221 | 6427 | 1984 | 8014 | 1662 | 8894 | 1398 | 9814 | 968 | 12128 | 537 | 8964 |
| 14-#10 | 1.85 | MA | 8947 | 2221 | 11220 | 2047 | 14715 | 1710 | 16815 | 1442 | 19398 | 1009 | 24754 | 719 | 16820 |
| 4L-5S | | MI | 4976 | 2221 | 6704 | 1975 | 8368 | 1652 | 9346 | 1385 | 10438 | 963 | 12989 | 608 | 9229 |
| 14-#10 | 1.85 | MA | 8629 | 2221 | 10716 | 2060 | 14014 | 1729 | 15986 | 1455 | 18248 | 1026 | 23111 | 673 | 16481 |
| 5L-4S | | MI | 5116 | 2221 | 6980 | 1964 | 8760 | 1637 | 9808 | 1376 | 11078 | 952 | 13881 | 662 | 9429 |
| 14-#10 | 1.85 | MA | 8272 | 2221 | 10177 | 2068 | 13363 | 1741 | 15199 | 1468 | 17130 | 1037 | 21681 | 617 | 15820 |
| 6L-3S | | MI | 5263 | 2221 | 7290 | 1953 | 9164 | 1627 | 10325 | 1363 | 11783 | 947 | 14772 | 717 | 9474 |
| 14-#10 | 1.85 | MA | 7958 | 2221 | 9663 | 2078 | 12687 | 1750 | 14381 | 1485 | 16043 | 1054 | 20213 | 583 | 15209 |
| 7L-2S | | MI | 5522 | 2221 | 7733 | 1942 | 9725 | 1618 | 11003 | 1354 | 12696 | 936 | 16036 | 810 | 9492 |
| 14-#11 | 2.27 | MA | 9650 | 2340 | 12933 | 2101 | 16828 | 1746 | 19382 | 1454 | 22836 | 991 | 29259 | 739 | 20535 |
| 3L-6S | | MI | 4903 | 2340 | 6884 | 2051 | 8500 | 1710 | 9438 | 1428 | 10505 | 957 | 12962 | 441 | 10579 |
| 14-#11 | 2.27 | MA | 9350 | 2340 | 12255 | 2118 | 15941 | 1762 | 18246 | 1477 | 21283 | 1004 | 27374 | 676 | 20338 |
| 4L-5S | | MI | 5129 | 2340 | 7211 | 2040 | 8929 | 1699 | 9985 | 1412 | 11260 | 952 | 13981 | 526 | 10875 |
| 14-#11 | 2.27 | MA | 8975 | 2340 | 11646 | 2135 | 15087 | 1786 | 17236 | 1492 | 19883 | 1024 | 25369 | 617 | 19614 |
| 5L-4S | | MI | 5289 | 2340 | 7546 | 2027 | 9403 | 1682 | 10544 | 1403 | 12034 | 940 | 15032 | 593 | 11281 |
| 14-#11 | 2.27 | MA | 8557 | 2340 | 10991 | 2144 | 14302 | 1801 | 16277 | 1507 | 18519 | 1037 | 23623 | 547 | 18858 |
| 6L-3S | | MI | 5459 | 2340 | 7920 | 2015 | 9891 | 1671 | 11168 | 1387 | 12885 | 935 | 16087 | 659 | 11362 |
| 14-#11 | 2.27 | MA | 8189 | 2340 | 10365 | 2156 | 13480 | 1811 | 15292 | 1529 | 17194 | 1057 | 21824 | 504 | 17817 |
| 7L-2S | | MI | 5757 | 2340 | 8454 | 2002 | 10566 | 1660 | 11984 | 1379 | 13984 | 923 | 17576 | 773 | 11397 |
| 14-#14 | 3.28 | MA | 10354 | 2624 | 14599 | 2304 | 18838 | 1901 | 21694 | 1571 | 25888 | 1003 | 33834 | 583 | 28682 |
| 4L-5S | | MI | 5552 | 2624 | 8319 | 2221 | 10252 | 1835 | 11551 | 1499 | 13333 | 943 | 16669 | 363 | 14803 |
| 14-#14 | 3.28 | MA | 9834 | 2624 | 13733 | 2328 | 17613 | 1934 | 20246 | 1592 | 23880 | 1031 | 30956 | 495 | 27053 |
| 5L-4S | | MI | 5772 | 2624 | 8796 | 2204 | 10928 | 1810 | 12349 | 1487 | 14436 | 927 | 18140 | 460 | 15414 |
| 14-#14 | 3.28 | MA | 9279 | 2624 | 12795 | 2341 | 16498 | 1956 | 18870 | 1613 | 21926 | 1049 | 28449 | 392 | 25474 |
| 6L-3S | | MI | 5977 | 2624 | 9330 | 2186 | 11624 | 1796 | 13238 | 1466 | 15649 | 921 | 19620 | 552 | 15919 |
| 14-#14 | 3.28 | MA | 8790 | 2624 | 11898 | 2358 | 15319 | 1970 | 17471 | 1645 | 20026 | 1077 | 25858 | 330 | 23807 |
| 7L-2S | | MI | 6347 | 2624 | 10088 | 2169 | 12582 | 1782 | 14397 | 1454 | 17210 | 906 | 21703 | 717 | 16015 |
| 14-#18 | 5.83 | MA | 11974 | 3345 | 18875 | 2819 | 23868 | 2309 | 27713 | 1845 | 33813 | 1044 | 44821 | 181 | 43981 |
| 5L-4S | | MI | 6883 | 3345 | 11815 | 2653 | 14633 | 2138 | 16747 | 1699 | 20301 | 892 | 25431 | 84 | 24960 |
| 14-#18 | 5.83 | MA | 11076 | 3345 | 17245 | 2842 | 21925 | 2348 | 25234 | 1898 | 30379 | 1073 | 40403 | -10 | 40338 |
| 6L-3S | | MI | 7157 | 3345 | 12741 | 2626 | 15840 | 2116 | 18287 | 1666 | 22402 | 888 | 27916 | 239 | 26860 |
| 16-#10 | 2.12 | MA | 9346 | 2295 | 12037 | 2093 | 15749 | 1744 | 18065 | 1464 | 21082 | 1006 | 27085 | 716 | 19195 |
| 4L-6S | | MI | 4991 | 2295 | 6870 | 2030 | 8575 | 1696 | 9573 | 1420 | 10727 | 966 | 13392 | 533 | 10222 |
| 16-#10 | 2.12 | MA | 9032 | 2295 | 11533 | 2107 | 15047 | 1764 | 17236 | 1477 | 19932 | 1023 | 25442 | 669 | 18838 |
| 5E | | MI | 5179 | 2295 | 7147 | 2022 | 8929 | 1687 | 10024 | 1407 | 11351 | 960 | 14253 | 604 | 10476 |
| 16-#10 | 2.12 | MA | 8688 | 2295 | 10994 | 2115 | 14396 | 1775 | 16449 | 1490 | 18813 | 1035 | 24012 | 613 | 18195 |
| 6L-4S | | MI | 5317 | 2295 | 7423 | 2011 | 9321 | 1671 | 10487 | 1398 | 11991 | 949 | 15145 | 658 | 10710 |
| 16-#10 | 2.12 | MA | 8388 | 2295 | 10480 | 2125 | 13720 | 1784 | 15631 | 1507 | 17726 | 1051 | 22544 | 579 | 17580 |
| 7L-3S | | MI | 5458 | 2295 | 7733 | 2000 | 9725 | 1662 | 11003 | 1385 | 12696 | 944 | 16036 | 713 | 10763 |
| 16-#10 | 2.12 | MA | 8111 | 2295 | 9915 | 2142 | 13023 | 1800 | 14812 | 1516 | 16643 | 1063 | 21114 | 534 | 16739 |
| 8L-2S | | MI | 5710 | 2295 | 8176 | 1989 | 10286 | 1652 | 11681 | 1376 | 13610 | 933 | 17299 | 806 | 10787 |
| 16-#11 | 2.60 | MA | 9820 | 2432 | 13247 | 2176 | 17197 | 1804 | 19765 | 1504 | 23328 | 1001 | 30206 | 672 | 23223 |
| 4L-6S | | MI | 5148 | 2432 | 7418 | 2109 | 9174 | 1752 | 10254 | 1455 | 11604 | 953 | 14451 | 433 | 12093 |
| 16-#11 | 2.60 | MA | 9450 | 2432 | 12639 | 2192 | 16342 | 1828 | 18755 | 1519 | 21927 | 1021 | 28200 | 612 | 22484 |
| 5E | | MI | 5367 | 2432 | 7745 | 2097 | 9604 | 1742 | 10801 | 1439 | 12359 | 948 | 15470 | 518 | 12378 |
| 16-#11 | 2.60 | MA | 9050 | 2432 | 11984 | 2201 | 15558 | 1843 | 17795 | 1534 | 20564 | 1034 | 26455 | 542 | 21746 |
| 6L-4S | | MI | 5525 | 2432 | 8080 | 2085 | 10078 | 1724 | 11361 | 1430 | 13133 | 936 | 16522 | 585 | 12817 |
| 16-#11 | 2.60 | MA | 8700 | 2432 | 11358 | 2214 | 14735 | 1853 | 16811 | 1556 | 19239 | 1054 | 24655 | 499 | 20696 |
| 7L-3S | | MI | 5686 | 2432 | 8454 | 2072 | 10566 | 1713 | 11984 | 1414 | 13984 | 931 | 17576 | 650 | 12908 |
| 16-#11 | 2.60 | MA | 8376 | 2432 | 10669 | 2234 | 13887 | 1872 | 15814 | 1566 | 17919 | 1067 | 22908 | 442 | 19653 |
| 8L-2S | | MI | 5974 | 2432 | 8987 | 2059 | 11241 | 1702 | 12800 | 1406 | 15083 | 919 | 19066 | 765 | 12952 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

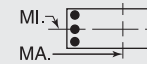
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.75 | MA | 10484 | 2757 | 15152 | 2411 | 19409 | 1995 | 22419 | 1631 | 26806 | 1026 | 35006 | 489 | 31176 |
| 5E | | MI | 5876 | 2757 | 9076 | 2304 | 11211 | 1896 | 12711 | 1538 | 14894 | 938 | 18752 | 347 | 16952 |
| 16-#14 | 3.75 | MA | 9959 | 2757 | 14215 | 2424 | 18294 | 2017 | 21042 | 1652 | 24851 | 1044 | 32500 | 385 | 29580 |
| 6L-4S | | MI | 6092 | 2757 | 9554 | 2286 | 11886 | 1871 | 13509 | 1526 | 15997 | 922 | 20223 | 445 | 17535 |
| 16-#14 | 3.75 | MA | 9501 | 2757 | 13318 | 2441 | 17116 | 2031 | 19644 | 1684 | 22951 | 1072 | 29908 | 323 | 27919 |
| 7L-3S | | MI | 6281 | 2757 | 10088 | 2269 | 12582 | 1857 | 14397 | 1505 | 17210 | 916 | 21703 | 537 | 18107 |
| 16-#14 | 3.75 | MA | 9049 | 2757 | 12331 | 2470 | 15900 | 2057 | 18215 | 1697 | 21058 | 1090 | 27399 | 238 | 25930 |
| 8L-2S | | MI | 6633 | 2757 | 10846 | 2252 | 13541 | 1842 | 15556 | 1493 | 18771 | 901 | 23786 | 702 | 18217 |
| 16-#18 | 6.67 | MA | 12289 | 3581 | 19728 | 2989 | 25066 | 2456 | 29032 | 1967 | 35493 | 1064 | 47485 | -22 | 47302 |
| 6L-4S | | MI | 7409 | 3581 | 13120 | 2800 | 16285 | 2246 | 18745 | 1769 | 22990 | 883 | 28906 | 44 | 28654 |
| 18-#10 | 2.38 | MA | 9425 | 2370 | 12350 | 2153 | 16081 | 1798 | 18487 | 1499 | 21615 | 1020 | 27773 | 665 | 21199 |
| 5L-6S | | MI | 5196 | 2370 | 7314 | 2077 | 9135 | 1731 | 10251 | 1442 | 11641 | 963 | 14656 | 529 | 11483 |
| 18-#10 | 2.38 | MA | 9093 | 2370 | 11812 | 2161 | 15430 | 1810 | 17699 | 1512 | 20497 | 1032 | 26343 | 610 | 20571 |
| 6L-5S | | MI | 5378 | 2370 | 7591 | 2069 | 9490 | 1721 | 10703 | 1429 | 12265 | 958 | 15517 | 600 | 11728 |
| 18-#10 | 2.38 | MA | 8806 | 2370 | 11297 | 2171 | 14754 | 1818 | 16882 | 1529 | 19410 | 1049 | 24875 | 575 | 19951 |
| 7L-4S | | MI | 5515 | 2370 | 7867 | 2057 | 9881 | 1706 | 11165 | 1420 | 12905 | 947 | 16409 | 654 | 11991 |
| 18-#10 | 2.38 | MA | 8536 | 2370 | 10732 | 2189 | 14057 | 1834 | 16063 | 1538 | 18327 | 1060 | 23445 | 530 | 19112 |
| 8L-3S | | MI | 5650 | 2370 | 8176 | 2046 | 10286 | 1696 | 11681 | 1407 | 13610 | 941 | 17299 | 709 | 12050 |
| 18-#10 | 2.38 | MA | 8192 | 2370 | 10234 | 2199 | 13411 | 1845 | 15238 | 1553 | 17258 | 1077 | 21980 | 478 | 18236 |
| 9L-2S | | MI | 5894 | 2370 | 8620 | 2035 | 10846 | 1686 | 12360 | 1398 | 14523 | 930 | 18563 | 802 | 12080 |
| 18-#11 | 2.92 | MA | 9913 | 2524 | 13631 | 2249 | 17598 | 1870 | 20274 | 1546 | 23972 | 1017 | 31031 | 607 | 25357 |
| 5L-6S | | MI | 5388 | 2524 | 7951 | 2166 | 9849 | 1795 | 11071 | 1482 | 12703 | 950 | 15941 | 425 | 13601 |
| 18-#11 | 2.92 | MA | 9529 | 2524 | 12976 | 2259 | 16814 | 1885 | 19314 | 1561 | 22609 | 1030 | 29286 | 537 | 24633 |
| 6L-5S | | MI | 5599 | 2524 | 8278 | 2155 | 10279 | 1784 | 11617 | 1466 | 13458 | 945 | 16960 | 509 | 13886 |
| 18-#11 | 2.92 | MA | 9196 | 2524 | 12351 | 2271 | 15991 | 1895 | 18330 | 1583 | 21284 | 1050 | 27486 | 494 | 23574 |
| 7L-4S | | MI | 5755 | 2524 | 8613 | 2142 | 10752 | 1766 | 12177 | 1457 | 14232 | 933 | 18011 | 577 | 14354 |
| 18-#11 | 2.92 | MA | 8878 | 2524 | 11662 | 2291 | 15142 | 1914 | 17333 | 1593 | 19964 | 1063 | 25740 | 437 | 22524 |
| 8L-3S | | MI | 5916 | 2524 | 8987 | 2129 | 11241 | 1755 | 12800 | 1441 | 15083 | 928 | 19066 | 642 | 14453 |
| 18-#11 | 2.92 | MA | 8475 | 2524 | 11061 | 2305 | 14355 | 1927 | 16328 | 1611 | 18662 | 1084 | 23945 | 372 | 21328 |
| 9L-2S | | MI | 6184 | 2524 | 9521 | 2117 | 11916 | 1744 | 13617 | 1433 | 16182 | 916 | 20555 | 757 | 14505 |
| 18-#14 | 4.22 | MA | 10619 | 2889 | 15635 | 2507 | 20091 | 2078 | 23215 | 1691 | 27776 | 1039 | 36550 | 378 | 33686 |
| 6L-5S | | MI | 6191 | 2889 | 9834 | 2387 | 12169 | 1957 | 13870 | 1576 | 16455 | 933 | 20835 | 332 | 19106 |
| 18-#14 | 4.22 | MA | 10189 | 2889 | 14738 | 2524 | 18912 | 2091 | 21816 | 1722 | 25876 | 1067 | 33958 | 316 | 32013 |
| 7L-4S | | MI | 6405 | 2889 | 10312 | 2369 | 12845 | 1932 | 14668 | 1565 | 17558 | 917 | 22307 | 429 | 19664 |
| 18-#14 | 4.22 | MA | 9745 | 2889 | 13751 | 2553 | 17696 | 2118 | 20388 | 1736 | 23983 | 1085 | 31449 | 231 | 30031 |
| 8L-3S | | MI | 6579 | 2889 | 10846 | 2352 | 13541 | 1918 | 15556 | 1544 | 18771 | 911 | 23786 | 521 | 20295 |
| 18-#14 | 4.22 | MA | 9209 | 2889 | 12897 | 2572 | 16567 | 2136 | 18948 | 1762 | 22116 | 1113 | 28865 | 136 | 28060 |
| 9L-2S | | MI | 6915 | 2889 | 11603 | 2334 | 14499 | 1903 | 16716 | 1532 | 20332 | 896 | 25869 | 686 | 20417 |
| 20-#10 | 2.65 | MA | 9489 | 2445 | 12629 | 2208 | 16464 | 1844 | 18950 | 1534 | 22180 | 1029 | 28674 | 606 | 22949 |
| 6E | | MI | 5397 | 2445 | 7757 | 2124 | 9696 | 1765 | 10930 | 1464 | 12554 | 960 | 15920 | 525 | 12746 |
| 20-#10 | 2.65 | MA | 9213 | 2445 | 12115 | 2218 | 15788 | 1853 | 18132 | 1551 | 21093 | 1046 | 27206 | 571 | 22322 |
| 7L-5S | | MI | 5573 | 2445 | 8034 | 2115 | 10051 | 1755 | 11381 | 1451 | 13178 | 955 | 16781 | 596 | 12983 |
| 20-#10 | 2.65 | MA | 8948 | 2445 | 11549 | 2235 | 15091 | 1868 | 17313 | 1560 | 20010 | 1057 | 25776 | 527 | 21485 |
| 8L-4S | | MI | 5709 | 2445 | 8310 | 2104 | 10442 | 1740 | 11844 | 1442 | 13818 | 944 | 17672 | 650 | 13272 |
| 20-#10 | 2.65 | MA | 8616 | 2445 | 11051 | 2246 | 14445 | 1880 | 16488 | 1575 | 18942 | 1074 | 24311 | 474 | 20604 |
| 9L-3S | | MI | 5838 | 2445 | 8620 | 2093 | 10846 | 1730 | 12360 | 1429 | 14523 | 939 | 18563 | 705 | 13337 |
| 20-#10 | 2.65 | MA | 8307 | 2445 | 10539 | 2255 | 13812 | 1891 | 15694 | 1586 | 17830 | 1082 | 22878 | 435 | 19744 |
| 10L-2S | | MI | 6076 | 2445 | 9063 | 2082 | 11407 | 1721 | 13038 | 1420 | 15437 | 928 | 19827 | 798 | 13373 |
| 20-#11 | 3.25 | MA | 9996 | 2616 | 13969 | 2316 | 18069 | 1927 | 20833 | 1588 | 24654 | 1027 | 32117 | 532 | 27521 |
| 6E | | MI | 5623 | 2616 | 8485 | 2223 | 10524 | 1837 | 11887 | 1509 | 13802 | 946 | 17430 | 417 | 15093 |
| 20-#11 | 3.25 | MA | 9679 | 2616 | 13343 | 2328 | 17247 | 1937 | 19848 | 1610 | 23329 | 1047 | 30318 | 490 | 26453 |
| 7L-5S | | MI | 5839 | 2616 | 8812 | 2212 | 10954 | 1826 | 12433 | 1493 | 14557 | 941 | 18449 | 501 | 15398 |
| 20-#11 | 3.25 | MA | 9366 | 2616 | 12654 | 2349 | 16398 | 1956 | 18851 | 1620 | 22009 | 1060 | 28571 | 432 | 25394 |
| 8L-4S | | MI | 5995 | 2616 | 9146 | 2199 | 11427 | 1808 | 12993 | 1484 | 15331 | 929 | 19501 | 568 | 15854 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

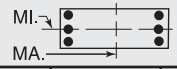
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.25 | MA | 8979 | 2616 | 12054 | 2362 | 15611 | 1969 | 17847 | 1638 | 20707 | 1080 | 26776 | 367 | 24202 |
| 9L-3S | | MI | 6132 | 2616 | 9521 | 2187 | 11916 | 1797 | 13617 | 1468 | 16182 | 924 | 20555 | 634 | 15998 |
| 20-#11 | 3.25 | MA | 8618 | 2616 | 11431 | 2373 | 14839 | 1983 | 16879 | 1650 | 19372 | 1091 | 25025 | 317 | 22946 |
| 10L-2S | | MI | 6390 | 2616 | 10054 | 2174 | 12590 | 1787 | 14433 | 1460 | 17281 | 913 | 22044 | 748 | 16056 |
| 20-#14 | 4.69 | MA | 10858 | 3022 | 16158 | 2606 | 20708 | 2152 | 23989 | 1761 | 28801 | 1062 | 38008 | 309 | 36107 |
| 7L-5S | | MI | 6499 | 3022 | 10592 | 2469 | 13128 | 2017 | 15029 | 1615 | 18016 | 928 | 22919 | 316 | 21266 |
| 20-#14 | 4.69 | MA | 10421 | 3022 | 15171 | 2635 | 19492 | 2179 | 22560 | 1775 | 26908 | 1080 | 35499 | 224 | 34133 |
| 8L-4S | | MI | 6711 | 3022 | 11070 | 2452 | 13803 | 1993 | 15827 | 1604 | 19119 | 912 | 24390 | 414 | 21801 |
| 20-#14 | 4.69 | MA | 9911 | 3022 | 14317 | 2655 | 18364 | 2197 | 21121 | 1801 | 25041 | 1108 | 32915 | 129 | 32153 |
| 9L-3S | | MI | 6872 | 3022 | 11603 | 2435 | 14499 | 1979 | 16716 | 1582 | 20332 | 907 | 25869 | 506 | 22484 |
| 22-#10 | 2.91 | MA | 9612 | 2520 | 12932 | 2265 | 16822 | 1887 | 19382 | 1573 | 22776 | 1043 | 29537 | 567 | 24694 |
| 7L-6S | | MI | 5594 | 2520 | 8201 | 2171 | 10257 | 1799 | 11608 | 1486 | 13467 | 957 | 17183 | 521 | 14012 |
| 22-#10 | 2.91 | MA | 9350 | 2520 | 12366 | 2282 | 16125 | 1903 | 18563 | 1582 | 21694 | 1054 | 28107 | 523 | 23859 |
| 8L-5S | | MI | 5766 | 2520 | 8477 | 2162 | 10612 | 1790 | 12060 | 1472 | 14092 | 952 | 18044 | 592 | 14241 |
| 22-#10 | 2.91 | MA | 9029 | 2520 | 11868 | 2293 | 15478 | 1914 | 17739 | 1597 | 20625 | 1071 | 26642 | 470 | 22972 |
| 9L-4S | | MI | 5901 | 2520 | 8754 | 2151 | 11003 | 1774 | 12522 | 1464 | 14732 | 941 | 18936 | 646 | 14553 |
| 22-#10 | 2.91 | MA | 8732 | 2520 | 11356 | 2302 | 14846 | 1926 | 16944 | 1608 | 19514 | 1080 | 25209 | 431 | 22107 |
| 10L-3S | | MI | 6024 | 2520 | 9063 | 2140 | 11407 | 1765 | 13038 | 1450 | 15437 | 936 | 19827 | 701 | 14623 |
| 22-#10 | 2.91 | MA | 8450 | 2520 | 10855 | 2312 | 14203 | 1936 | 16162 | 1619 | 18417 | 1094 | 23818 | 384 | 21099 |
| 11L-2S | | MI | 6255 | 2520 | 9507 | 2129 | 11968 | 1755 | 13717 | 1442 | 16350 | 925 | 21090 | 794 | 14664 |
| 22-#11 | 3.57 | MA | 10151 | 2707 | 14336 | 2386 | 18502 | 1979 | 21367 | 1637 | 25374 | 1043 | 33149 | 485 | 29331 |
| 7L-6S | | MI | 5870 | 2707 | 9018 | 2281 | 11199 | 1879 | 12703 | 1536 | 14901 | 943 | 18920 | 408 | 16589 |
| 22-#11 | 3.57 | MA | 9842 | 2707 | 13647 | 2406 | 17654 | 1998 | 20370 | 1647 | 24054 | 1057 | 31402 | 428 | 28265 |
| 8L-5S | | MI | 6062 | 2707 | 9345 | 2270 | 11628 | 1868 | 13250 | 1520 | 15656 | 938 | 19939 | 493 | 16913 |
| 22-#11 | 3.57 | MA | 9469 | 2707 | 13047 | 2420 | 16866 | 2011 | 19366 | 1665 | 22752 | 1077 | 29607 | 362 | 27076 |
| 9L-4S | | MI | 6216 | 2707 | 9680 | 2257 | 12102 | 1850 | 13809 | 1511 | 16430 | 926 | 20990 | 560 | 17353 |
| 22-#11 | 3.57 | MA | 9124 | 2707 | 12424 | 2431 | 16095 | 2025 | 18398 | 1677 | 21416 | 1087 | 27856 | 312 | 25815 |
| 10L-3S | | MI | 6345 | 2707 | 10054 | 2244 | 12590 | 1840 | 14433 | 1495 | 17281 | 921 | 22044 | 626 | 17543 |
| 22-#14 | 5.16 | MA | 11079 | 3154 | 16591 | 2718 | 21288 | 2240 | 24733 | 1814 | 29834 | 1075 | 39550 | 218 | 38235 |
| 8L-5S | | MI | 6803 | 3154 | 11350 | 2552 | 14086 | 2078 | 16189 | 1654 | 19577 | 923 | 25002 | 301 | 23430 |
| 22-#14 | 5.16 | MA | 10592 | 3154 | 15736 | 2738 | 20160 | 2258 | 23293 | 1840 | 27966 | 1103 | 36966 | 123 | 36246 |
| 9L-4S | | MI | 7013 | 3154 | 11827 | 2535 | 14762 | 2054 | 16987 | 1643 | 20680 | 907 | 26473 | 398 | 23944 |
| 24-#10 | 3.17 | MA | 9743 | 2594 | 13183 | 2329 | 17158 | 1937 | 19814 | 1604 | 23377 | 1052 | 30438 | 519 | 26232 |
| 8L-6S | | MI | 5788 | 2594 | 8644 | 2217 | 10818 | 1834 | 12286 | 1508 | 14381 | 954 | 18447 | 517 | 15280 |
| 24-#10 | 3.17 | MA | 9433 | 2594 | 12685 | 2340 | 16512 | 1948 | 18989 | 1619 | 22309 | 1069 | 28973 | 466 | 25339 |
| 9L-5S | | MI | 5955 | 2594 | 8921 | 2209 | 11173 | 1824 | 12738 | 1494 | 15005 | 949 | 19308 | 588 | 15502 |
| 24-#10 | 3.17 | MA | 9147 | 2594 | 12174 | 2349 | 15879 | 1960 | 18194 | 1630 | 21197 | 1077 | 27540 | 427 | 24469 |
| 10L-4S | | MI | 6089 | 2594 | 9197 | 2198 | 11564 | 1809 | 13200 | 1486 | 15645 | 938 | 20200 | 642 | 15834 |
| 24-#10 | 3.17 | MA | 8876 | 2594 | 11672 | 2359 | 15237 | 1970 | 17412 | 1641 | 20101 | 1091 | 26149 | 380 | 23464 |
| 11L-3S | | MI | 6214 | 2594 | 9507 | 2187 | 11968 | 1799 | 13717 | 1472 | 16350 | 933 | 21090 | 697 | 15909 |
| 24-#11 | 3.90 | MA | 10307 | 2799 | 14640 | 2464 | 18909 | 2040 | 21889 | 1674 | 26099 | 1053 | 34234 | 423 | 31135 |
| 8L-6S | | MI | 6095 | 2799 | 9551 | 2338 | 11874 | 1921 | 13519 | 1563 | 16000 | 939 | 20409 | 400 | 18090 |
| 24-#11 | 3.90 | MA | 9949 | 2799 | 14039 | 2477 | 18122 | 2053 | 20884 | 1692 | 24797 | 1073 | 32439 | 358 | 29950 |
| 9L-5S | | MI | 6280 | 2799 | 9879 | 2327 | 12303 | 1910 | 14066 | 1547 | 16755 | 934 | 21428 | 485 | 18432 |
| 24-#11 | 3.90 | MA | 9617 | 2799 | 13416 | 2488 | 17351 | 2067 | 19917 | 1704 | 23461 | 1084 | 30688 | 308 | 28683 |
| 10L-4S | | MI | 6433 | 2799 | 10213 | 2314 | 12777 | 1893 | 14625 | 1538 | 17529 | 923 | 22480 | 552 | 18856 |
| 24-#14 | 5.63 | MA | 11258 | 3287 | 17156 | 2821 | 21956 | 2319 | 25466 | 1879 | 30892 | 1098 | 41016 | 116 | 40339 |
| 9L-5S | | MI | 7101 | 3287 | 12107 | 2635 | 15045 | 2139 | 17348 | 1693 | 21138 | 918 | 27085 | 285 | 25598 |

## RECTANGULAR TIED COLUMNS 24" x 42"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.59 | MA | 10135 | 2253 | 13110 | 2047 | 16981 | 1711 | 19405 | 1441 | 22476 | 1020 | 28475 | 885 | 15786 |
| 2E | | MI | 5443 | 2253 | 7765 | 1941 | 9531 | 1621 | 10612 | 1363 | 11958 | 957 | 14367 | 775 | 8291 |
| 6-#14 | 1.34 | MA | 9823 | 2179 | 12204 | 2014 | 15951 | 1688 | 18221 | 1429 | 20937 | 1030 | 26387 | 896 | 13524 |
| 2L-3S | | MI | 4861 | 2179 | 6539 | 1935 | 8083 | 1620 | 8915 | 1369 | 9719 | 988 | 11643 | 655 | 7185 |
| 6-#14 | 1.34 | MA | 8857 | 2179 | 10701 | 2039 | 14050 | 1712 | 15921 | 1451 | 17842 | 1059 | 22101 | 751 | 13424 |
| 3L-2S | | MI | 5332 | 2179 | 7296 | 1917 | 9042 | 1606 | 10074 | 1358 | 11280 | 973 | 13727 | 820 | 7189 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



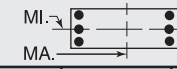

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#18 | 2.38 | MA | 11301 | 2489 | 15740 | 2194 | 20308 | 1819 | 23429 | 1511 | 27894 | 1011 | 35977 | 873 | 23466 |
| 2L-3S | | MI | 5237 | 2489 | 7765 | 2116 | 9531 | 1751 | 10612 | 1448 | 11958 | 970 | 14367 | 441 | 11955 |
| 6-#18 | 2.38 | MA | 9790 | 2489 | 13110 | 2237 | 16981 | 1859 | 19405 | 1547 | 22476 | 1059 | 28475 | 609 | 23007 |
| 3L-2S | | MI | 5970 | 2489 | 9070 | 2088 | 11182 | 1729 | 12610 | 1432 | 14647 | 948 | 17843 | 734 | 12116 |
| 8-#10 | 1.01 | MA | 9350 | 2081 | 10963 | 1967 | 14523 | 1656 | 16567 | 1412 | 18780 | 1042 | 23452 | 909 | 10374 |
| 2L-4S | | MI | 4684 | 2081 | 5881 | 1905 | 7367 | 1603 | 8086 | 1371 | 8653 | 1008 | 10450 | 716 | 5603 |
| 8-#10 | 1.01 | MA | 8771 | 2081 | 10099 | 1982 | 13430 | 1670 | 15245 | 1425 | 17000 | 1060 | 20988 | 830 | 10350 |
| 3E | | MI | 4857 | 2081 | 6191 | 1893 | 7771 | 1593 | 8602 | 1357 | 9358 | 1003 | 11340 | 771 | 5611 |
| 8-#10 | 1.01 | MA | 8436 | 2081 | 9512 | 1997 | 12661 | 1684 | 14260 | 1444 | 15653 | 1072 | 19366 | 779 | 10254 |
| 4L-2S | | MI | 5143 | 2081 | 6634 | 1882 | 8332 | 1584 | 9280 | 1349 | 10271 | 992 | 12604 | 864 | 5602 |
| 8-#11 | 1.24 | MA | 9693 | 2149 | 11817 | 2001 | 15521 | 1680 | 17731 | 1425 | 20307 | 1035 | 25536 | 901 | 12592 |
| 2L-4S | | MI | 4750 | 2149 | 6182 | 1935 | 7670 | 1623 | 8409 | 1382 | 9051 | 997 | 10922 | 659 | 6704 |
| 8-#11 | 1.24 | MA | 9013 | 2149 | 10767 | 2019 | 14193 | 1697 | 16125 | 1441 | 18144 | 1055 | 22541 | 802 | 12546 |
| 3E | | MI | 4952 | 2149 | 6556 | 1922 | 8159 | 1613 | 9033 | 1366 | 9903 | 992 | 11976 | 725 | 6733 |
| 8-#11 | 1.24 | MA | 8620 | 2149 | 10051 | 2037 | 13256 | 1713 | 14925 | 1464 | 16503 | 1069 | 20557 | 739 | 12376 |
| 4L-2S | | MI | 5286 | 2149 | 7090 | 1910 | 8834 | 1602 | 9849 | 1357 | 11002 | 981 | 13465 | 839 | 6729 |
| 8-#14 | 1.79 | MA | 10520 | 2312 | 13707 | 2096 | 17852 | 1749 | 20520 | 1468 | 24033 | 1025 | 30673 | 889 | 17917 |
| 2L-4S | | MI | 4936 | 2312 | 6763 | 2035 | 8346 | 1696 | 9185 | 1430 | 10067 | 989 | 12247 | 548 | 9238 |
| 8-#14 | 1.79 | MA | 9611 | 2312 | 12204 | 2122 | 15951 | 1773 | 18221 | 1490 | 20937 | 1054 | 26387 | 744 | 17787 |
| 3E | | MI | 5206 | 2312 | 7296 | 2017 | 9042 | 1681 | 10074 | 1408 | 11280 | 983 | 13727 | 640 | 9385 |
| 8-#14 | 1.79 | MA | 9087 | 2312 | 11177 | 2147 | 14608 | 1796 | 16501 | 1522 | 18586 | 1073 | 23533 | 653 | 17316 |
| 4L-2S | | MI | 5654 | 2312 | 8054 | 2000 | 10000 | 1667 | 11233 | 1397 | 12841 | 968 | 15810 | 805 | 9417 |
| 8-#18 | 3.17 | MA | 12411 | 2724 | 18370 | 2341 | 23635 | 1927 | 27453 | 1580 | 33312 | 1002 | 43479 | 861 | 31138 |
| 2L-4S | | MI | 5405 | 2724 | 8144 | 2290 | 9975 | 1880 | 11070 | 1550 | 12546 | 965 | 15357 | 245 | 14122 |
| 8-#18 | 3.17 | MA | 11025 | 2724 | 15740 | 2384 | 20308 | 1967 | 23429 | 1617 | 27894 | 1050 | 35977 | 597 | 30644 |
| 3E | | MI | 5811 | 2724 | 9070 | 2263 | 11182 | 1859 | 12610 | 1517 | 14647 | 961 | 17843 | 400 | 15696 |
| 8-#18 | 3.17 | MA | 10237 | 2724 | 13936 | 2427 | 17950 | 2007 | 20411 | 1671 | 23766 | 1081 | 30929 | 433 | 27416 |
| 4L-2S | | MI | 6469 | 2724 | 10376 | 2235 | 12834 | 1837 | 14607 | 1501 | 17337 | 939 | 21318 | 694 | 15917 |
| 10-#10 | 1.26 | MA | 9775 | 2156 | 11827 | 2014 | 15616 | 1690 | 17889 | 1434 | 20560 | 1040 | 25916 | 905 | 12903 |
| 2L-5S | | MI | 4758 | 2156 | 6048 | 1962 | 7536 | 1652 | 8302 | 1401 | 8926 | 1017 | 10821 | 658 | 6819 |
| 10-#10 | 1.26 | MA | 9218 | 2156 | 10963 | 2029 | 14523 | 1704 | 16567 | 1447 | 18780 | 1057 | 23452 | 826 | 12868 |
| 3L-4S | | MI | 4902 | 2156 | 6325 | 1951 | 7928 | 1637 | 8764 | 1393 | 9566 | 1006 | 11713 | 712 | 6891 |
| 10-#10 | 1.26 | MA | 8902 | 2156 | 10375 | 2044 | 13754 | 1719 | 15582 | 1466 | 17433 | 1069 | 21831 | 775 | 12760 |
| 4L-3S | | MI | 5066 | 2156 | 6634 | 1940 | 8332 | 1628 | 9280 | 1379 | 10271 | 1000 | 12604 | 767 | 6911 |
| 10-#10 | 1.26 | MA | 8551 | 2156 | 9840 | 2057 | 13014 | 1738 | 14707 | 1479 | 16219 | 1086 | 20099 | 730 | 12501 |
| 5L-2S | | MI | 5344 | 2156 | 7078 | 1929 | 8893 | 1618 | 9959 | 1371 | 11185 | 989 | 13868 | 860 | 6911 |
| 10-#11 | 1.55 | MA | 10192 | 2241 | 12867 | 2059 | 16849 | 1722 | 19338 | 1452 | 22470 | 1031 | 28531 | 896 | 15663 |
| 2L-5S | | MI | 4840 | 2241 | 6381 | 2005 | 7871 | 1683 | 8666 | 1418 | 9377 | 1006 | 11360 | 584 | 7966 |
| 10-#11 | 1.55 | MA | 9540 | 2241 | 11817 | 2076 | 15521 | 1739 | 17731 | 1468 | 20307 | 1052 | 25536 | 797 | 15602 |
| 3L-4S | | MI | 5005 | 2241 | 6715 | 1993 | 8345 | 1666 | 9225 | 1409 | 10150 | 994 | 12411 | 651 | 8243 |
| 10-#11 | 1.55 | MA | 9173 | 2241 | 11101 | 2094 | 14584 | 1756 | 16532 | 1491 | 18666 | 1065 | 23552 | 734 | 15419 |
| 4L-3S | | MI | 5196 | 2241 | 7090 | 1980 | 8834 | 1655 | 9849 | 1393 | 11002 | 989 | 13465 | 717 | 8290 |
| 10-#11 | 1.55 | MA | 8757 | 2241 | 10454 | 2111 | 13682 | 1779 | 15466 | 1506 | 17188 | 1086 | 21437 | 676 | 14760 |
| 5L-2S | | MI | 5518 | 2241 | 7623 | 1967 | 9508 | 1644 | 10665 | 1384 | 12101 | 977 | 14955 | 831 | 8300 |
| 10-#14 | 2.23 | MA | 11192 | 2444 | 15209 | 2179 | 19753 | 1810 | 22819 | 1507 | 27129 | 1020 | 34960 | 882 | 22305 |
| 2L-5S | | MI | 5063 | 2444 | 7043 | 2135 | 8629 | 1781 | 9547 | 1480 | 10525 | 1000 | 12859 | 435 | 10625 |
| 10-#14 | 2.23 | MA | 10331 | 2444 | 13707 | 2204 | 17852 | 1833 | 20520 | 1529 | 24033 | 1049 | 30673 | 737 | 22153 |
| 3L-4S | | MI | 5288 | 2444 | 7520 | 2118 | 9305 | 1757 | 10345 | 1468 | 11628 | 984 | 14330 | 532 | 11314 |
| 10-#14 | 2.23 | MA | 9853 | 2444 | 12680 | 2230 | 16509 | 1857 | 18800 | 1561 | 21681 | 1068 | 27819 | 646 | 21686 |
| 4L-3S | | MI | 5540 | 2444 | 8054 | 2100 | 10000 | 1742 | 11233 | 1447 | 12841 | 978 | 15810 | 624 | 11578 |
| 10-#14 | 2.23 | MA | 9274 | 2444 | 11759 | 2253 | 15216 | 1891 | 17271 | 1583 | 19561 | 1096 | 24782 | 561 | 19984 |
| 5L-2S | | MI | 5967 | 2444 | 8812 | 2083 | 10959 | 1728 | 12392 | 1436 | 14402 | 963 | 17893 | 789 | 11632 |
| 10-#18 | 3.97 | MA | 12200 | 2959 | 18370 | 2531 | 23635 | 2076 | 27453 | 1686 | 33312 | 1041 | 43479 | 585 | 38294 |
| 3L-4S | | MI | 5988 | 2959 | 9449 | 2437 | 11627 | 1989 | 13067 | 1619 | 15235 | 956 | 18833 | 205 | 17753 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

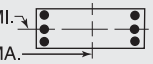



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 10-#18 | 3.97 | MA | 11511 | 2959 | 16566 | 2575 | 21277 | 2116 | 24435 | 1740 | 29184 | 1072 | 38431 | 421 | 35021 |
| 4L-3S | | MI | 6345 | 2959 | 10376 | 2410 | 12834 | 1967 | 14607 | 1586 | 17337 | 952 | 21318 | 360 | 19441 |
| 10-#18 | 3.97 | MA | 10541 | 2959 | 14969 | 2618 | 19002 | 2173 | 21747 | 1777 | 25458 | 1120 | 33081 | 261 | 31744 |
| 5L-2S | | MI | 6953 | 2959 | 11681 | 2382 | 14485 | 1945 | 16605 | 1570 | 20026 | 930 | 24794 | 654 | 19707 |
| 12-#10 | 1.51 | MA | 10189 | 2231 | 12691 | 2061 | 16709 | 1725 | 19210 | 1456 | 22340 | 1037 | 28380 | 901 | 15430 |
| 2L-6S | | MI | 4771 | 2231 | 6215 | 2018 | 7743 | 1696 | 8529 | 1437 | 9215 | 1019 | 11224 | 583 | 7773 |
| 12-#10 | 1.51 | MA | 9651 | 2231 | 11827 | 2076 | 15616 | 1739 | 17889 | 1469 | 20560 | 1054 | 25916 | 822 | 15385 |
| 3L-5S | | MI | 4972 | 2231 | 6492 | 2009 | 8097 | 1687 | 8980 | 1423 | 9840 | 1014 | 12085 | 654 | 8053 |
| 12-#10 | 1.51 | MA | 9353 | 2231 | 11239 | 2091 | 14847 | 1753 | 16904 | 1488 | 19212 | 1066 | 24295 | 771 | 15269 |
| 4E | | MI | 5114 | 2231 | 6768 | 1998 | 8489 | 1671 | 9443 | 1415 | 10479 | 1003 | 12977 | 708 | 8175 |
| 12-#10 | 1.51 | MA | 9007 | 2231 | 10704 | 2104 | 14107 | 1773 | 16029 | 1501 | 17999 | 1083 | 22563 | 726 | 15002 |
| 5L-3S | | MI | 5271 | 2231 | 7078 | 1987 | 8893 | 1662 | 9959 | 1401 | 11185 | 998 | 13868 | 763 | 8206 |
| 12-#10 | 1.51 | MA | 8611 | 2231 | 10135 | 2112 | 13415 | 1784 | 15199 | 1515 | 16819 | 1095 | 21056 | 671 | 14263 |
| 6L-2S | | MI | 5540 | 2231 | 7521 | 1976 | 9454 | 1652 | 10637 | 1393 | 12098 | 987 | 15131 | 856 | 8214 |
| 12-#11 | 1.86 | MA | 10675 | 2333 | 13917 | 2116 | 18178 | 1764 | 20944 | 1479 | 24633 | 1028 | 31526 | 891 | 18732 |
| 2L-6S | | MI | 4855 | 2333 | 6587 | 2074 | 8117 | 1736 | 8935 | 1460 | 9720 | 1007 | 11830 | 491 | 9144 |
| 12-#11 | 1.86 | MA | 10050 | 2333 | 12867 | 2134 | 16849 | 1781 | 19338 | 1495 | 22470 | 1048 | 28531 | 792 | 18658 |
| 3L-5S | | MI | 5091 | 2333 | 6914 | 2063 | 8546 | 1725 | 9482 | 1445 | 10476 | 1002 | 12849 | 576 | 9454 |
| 12-#11 | 1.86 | MA | 9707 | 2333 | 12151 | 2152 | 15913 | 1798 | 18138 | 1518 | 20830 | 1062 | 26547 | 730 | 18467 |
| 4E | | MI | 5253 | 2333 | 7249 | 2050 | 9020 | 1708 | 10042 | 1436 | 11249 | 991 | 13901 | 643 | 9781 |
| 12-#11 | 1.86 | MA | 9298 | 2333 | 11504 | 2168 | 15011 | 1821 | 17072 | 1533 | 19351 | 1083 | 24432 | 671 | 17792 |
| 5L-3S | | MI | 5434 | 2333 | 7623 | 2037 | 9508 | 1697 | 10665 | 1420 | 12101 | 986 | 14955 | 708 | 9842 |
| 12-#11 | 1.86 | MA | 8832 | 2333 | 10812 | 2178 | 14177 | 1836 | 16059 | 1549 | 17912 | 1096 | 22592 | 603 | 16943 |
| 6L-2S | | MI | 5745 | 2333 | 8156 | 2024 | 10183 | 1686 | 11481 | 1411 | 13200 | 974 | 16444 | 823 | 9863 |
| 12-#14 | 2.68 | MA | 11026 | 2577 | 15209 | 2287 | 19753 | 1894 | 22819 | 1568 | 27129 | 1044 | 34960 | 731 | 26523 |
| 3L-5S | | MI | 5408 | 2577 | 7800 | 2218 | 9587 | 1842 | 10706 | 1519 | 12086 | 995 | 14942 | 419 | 12755 |
| 12-#14 | 2.68 | MA | 10588 | 2577 | 14183 | 2312 | 18410 | 1918 | 21100 | 1600 | 24777 | 1063 | 32105 | 640 | 26061 |
| 4E | | MI | 5629 | 2577 | 8278 | 2200 | 10263 | 1817 | 11504 | 1507 | 13189 | 979 | 16413 | 517 | 13407 |
| 12-#14 | 2.68 | MA | 10020 | 2577 | 13261 | 2336 | 17117 | 1952 | 19570 | 1622 | 22657 | 1091 | 29069 | 554 | 24348 |
| 5L-3S | | MI | 5875 | 2577 | 8812 | 2183 | 10959 | 1803 | 12392 | 1486 | 14402 | 973 | 17893 | 609 | 13767 |
| 12-#14 | 2.68 | MA | 9394 | 2577 | 12270 | 2350 | 15930 | 1973 | 18117 | 1644 | 20592 | 1110 | 26426 | 453 | 22783 |
| 6L-2S | | MI | 6270 | 2577 | 9569 | 2166 | 11918 | 1789 | 13552 | 1474 | 15963 | 958 | 19976 | 774 | 13840 |
| 12-#18 | 4.76 | MA | 12727 | 3195 | 19196 | 2722 | 24604 | 2224 | 28459 | 1810 | 34602 | 1063 | 45933 | 409 | 42627 |
| 4E | | MI | 6546 | 3195 | 10755 | 2585 | 13278 | 2097 | 15065 | 1689 | 17925 | 947 | 22308 | 165 | 21408 |
| 12-#18 | 4.76 | MA | 11775 | 3195 | 17599 | 2765 | 22329 | 2281 | 25771 | 1846 | 30876 | 1111 | 40583 | 249 | 39313 |
| 5L-3S | | MI | 6863 | 3195 | 11681 | 2557 | 14485 | 2075 | 16605 | 1655 | 20026 | 943 | 24794 | 320 | 23192 |
| 12-#18 | 4.76 | MA | 10805 | 3195 | 15861 | 2787 | 20276 | 2321 | 23152 | 1901 | 27248 | 1142 | 35924 | 62 | 35499 |
| 6L-2S | | MI | 7428 | 3195 | 12987 | 2530 | 16137 | 2053 | 18602 | 1639 | 22715 | 922 | 28270 | 614 | 23492 |
| 14-#10 | 1.76 | MA | 10072 | 2305 | 12691 | 2122 | 16709 | 1773 | 19210 | 1491 | 22340 | 1051 | 28380 | 818 | 17903 |
| 3L-6S | | MI | 4986 | 2305 | 6659 | 2065 | 8304 | 1731 | 9207 | 1458 | 10129 | 1016 | 12488 | 579 | 9026 |
| 14-#10 | 1.76 | MA | 9790 | 2305 | 12103 | 2137 | 15940 | 1787 | 18226 | 1510 | 20992 | 1063 | 26759 | 767 | 17780 |
| 4L-5S | | MI | 5181 | 2305 | 6935 | 2056 | 8658 | 1721 | 9659 | 1445 | 10753 | 1011 | 13349 | 650 | 9293 |
| 14-#10 | 1.76 | MA | 9449 | 2305 | 11568 | 2150 | 15200 | 1807 | 17351 | 1523 | 19779 | 1081 | 25027 | 722 | 17494 |
| 5L-4S | | MI | 5321 | 2305 | 7211 | 2045 | 9050 | 1706 | 10121 | 1436 | 11393 | 1000 | 14241 | 704 | 9458 |
| 14-#10 | 1.76 | MA | 9068 | 2305 | 10999 | 2159 | 14508 | 1819 | 16521 | 1537 | 18598 | 1092 | 23521 | 667 | 16774 |
| 6L-3S | | MI | 5471 | 2305 | 7521 | 2034 | 9454 | 1696 | 10637 | 1423 | 12098 | 995 | 15131 | 759 | 9497 |
| 14-#10 | 1.76 | MA | 8733 | 2305 | 10456 | 2169 | 13794 | 1828 | 15651 | 1553 | 17451 | 1110 | 21977 | 633 | 16179 |
| 7L-2S | | MI | 5732 | 2305 | 7964 | 2023 | 10015 | 1687 | 11316 | 1414 | 13012 | 984 | 16395 | 852 | 9513 |
| 14-#11 | 2.17 | MA | 10545 | 2425 | 13917 | 2191 | 18178 | 1823 | 20944 | 1522 | 24633 | 1045 | 31526 | 787 | 21715 |
| 3L-6S | | MI | 5107 | 2425 | 7120 | 2131 | 8792 | 1778 | 9752 | 1487 | 10819 | 1004 | 13320 | 483 | 10653 |
| 14-#11 | 2.17 | MA | 10223 | 2425 | 13201 | 2209 | 17241 | 1840 | 19745 | 1545 | 22993 | 1059 | 29542 | 725 | 21517 |
| 4L-5S | | MI | 5335 | 2425 | 7447 | 2120 | 9221 | 1768 | 10298 | 1472 | 11575 | 999 | 14338 | 567 | 10949 |
| 14-#11 | 2.17 | MA | 9821 | 2425 | 12554 | 2225 | 16339 | 1864 | 18679 | 1560 | 21514 | 1079 | 27427 | 667 | 20827 |
| 5L-4S | | MI | 5495 | 2425 | 7782 | 2107 | 9695 | 1750 | 10858 | 1463 | 12348 | 987 | 15390 | 635 | 11318 |
| 14-#11 | 2.17 | MA | 9374 | 2425 | 11862 | 2235 | 15505 | 1878 | 17666 | 1576 | 20075 | 1093 | 25587 | 598 | 19999 |
| 6L-3S | | MI | 5667 | 2425 | 8156 | 2095 | 10183 | 1739 | 11481 | 1447 | 13200 | 982 | 16444 | 700 | 11391 |
| 14-#11 | 2.17 | MA | 8981 | 2425 | 11201 | 2247 | 14636 | 1889 | 16618 | 1597 | 18676 | 1113 | 23695 | 556 | 18957 |
| 7L-2S | | MI | 5967 | 2425 | 8690 | 2082 | 10858 | 1728 | 12298 | 1438 | 14299 | 970 | 17934 | 815 | 11422 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



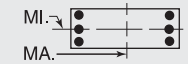

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 3.13 | MA | 11298 | 2709 | 15685 | 2395 | 20311 | 1979 | 23399 | 1639 | 27873 | 1058 | 36391 | 633 | 30440 |
| 4L-5S | | MI | 5742 | 2709 | 8558 | 2301 | 10546 | 1903 | 11865 | 1558 | 13647 | 990 | 17025 | 404 | 14893 |
| 14-#14 | 3.13 | MA | 10738 | 2709 | 14764 | 2419 | 19018 | 2012 | 21870 | 1661 | 25752 | 1086 | 33355 | 547 | 28711 |
| 5L-4S | | MI | 5978 | 2709 | 9036 | 2283 | 11222 | 1878 | 12663 | 1546 | 14750 | 974 | 18496 | 501 | 15513 |
| 14-#14 | 3.13 | MA | 10145 | 2709 | 13773 | 2432 | 17831 | 2034 | 20417 | 1683 | 23688 | 1105 | 30712 | 446 | 27129 |
| 6L-3S | | MI | 6188 | 2709 | 9569 | 2266 | 11918 | 1864 | 13552 | 1525 | 15963 | 968 | 19976 | 593 | 15956 |
| 14-#14 | 3.13 | MA | 9623 | 2709 | 12825 | 2450 | 16585 | 2049 | 18927 | 1714 | 21682 | 1134 | 27987 | 384 | 25335 |
| 7L-2S | | MI | 6563 | 2709 | 10327 | 2248 | 12876 | 1849 | 14711 | 1513 | 17524 | 953 | 22059 | 759 | 16045 |
| 14-#18 | 5.56 | MA | 13027 | 3430 | 20229 | 2912 | 25656 | 2390 | 29795 | 1916 | 36294 | 1102 | 48085 | 236 | 46883 |
| 5L-4S | | MI | 7086 | 3430 | 12060 | 2732 | 14930 | 2205 | 17062 | 1758 | 20614 | 939 | 25784 | 125 | 25082 |
| 14-#18 | 5.56 | MA | 12062 | 3430 | 18491 | 2934 | 23603 | 2429 | 27176 | 1970 | 32666 | 1133 | 43426 | 49 | 43090 |
| 6L-3S | | MI | 7368 | 3430 | 12987 | 2704 | 16137 | 2183 | 18602 | 1724 | 22715 | 934 | 28270 | 280 | 26948 |
| 14-#18 | 5.56 | MA | 11265 | 3430 | 16828 | 2964 | 21417 | 2453 | 24644 | 2007 | 29138 | 1181 | 38596 | -63 | 38307 |
| 7L-2S | | MI | 7896 | 3430 | 14292 | 2677 | 17788 | 2162 | 20600 | 1709 | 25405 | 913 | 31745 | 573 | 27275 |
| 16-#10 | 2.02 | MA | 10216 | 2380 | 12967 | 2184 | 17032 | 1822 | 19547 | 1532 | 22772 | 1060 | 29223 | 764 | 20293 |
| 4L-6S | | MI | 5196 | 2380 | 7102 | 2111 | 8864 | 1765 | 9885 | 1480 | 11042 | 1013 | 13752 | 575 | 10283 |
| 16-#10 | 2.02 | MA | 9879 | 2380 | 12432 | 2197 | 16293 | 1841 | 18673 | 1545 | 21558 | 1078 | 27491 | 718 | 19990 |
| 5E | | MI | 5385 | 2380 | 7379 | 2103 | 9219 | 1755 | 10337 | 1467 | 11667 | 1008 | 14613 | 646 | 10539 |
| 16-#10 | 2.02 | MA | 9512 | 2380 | 11863 | 2205 | 15601 | 1853 | 17842 | 1559 | 20378 | 1090 | 25985 | 663 | 19287 |
| 6L-4S | | MI | 5524 | 2380 | 7655 | 2091 | 9610 | 1740 | 10799 | 1458 | 12306 | 997 | 15504 | 700 | 10740 |
| 16-#10 | 2.02 | MA | 9192 | 2380 | 11320 | 2216 | 14887 | 1862 | 16973 | 1575 | 19231 | 1107 | 24441 | 630 | 18686 |
| 7L-3S | | MI | 5667 | 2380 | 7964 | 2080 | 10015 | 1731 | 11316 | 1445 | 13012 | 992 | 16395 | 755 | 10787 |
| 16-#10 | 2.02 | MA | 8896 | 2380 | 10723 | 2233 | 14151 | 1878 | 16108 | 1584 | 18089 | 1119 | 22935 | 586 | 17782 |
| 8L-2S | | MI | 5920 | 2380 | 8408 | 2069 | 10575 | 1721 | 11994 | 1436 | 13925 | 981 | 17659 | 848 | 10809 |
| 16-#11 | 2.48 | MA | 10726 | 2517 | 14251 | 2266 | 18569 | 1882 | 21351 | 1572 | 25156 | 1055 | 32537 | 720 | 24571 |
| 4L-6S | | MI | 5353 | 2517 | 7654 | 2189 | 9467 | 1821 | 10568 | 1514 | 11918 | 1001 | 14809 | 475 | 12165 |
| 16-#11 | 2.48 | MA | 10328 | 2517 | 13604 | 2283 | 17667 | 1906 | 20285 | 1587 | 23677 | 1076 | 30422 | 662 | 23866 |
| 5E | | MI | 5573 | 2517 | 7981 | 2177 | 9896 | 1810 | 11115 | 1499 | 12674 | 996 | 15828 | 559 | 12450 |
| 16-#11 | 2.48 | MA | 9900 | 2517 | 12912 | 2292 | 16833 | 1921 | 19272 | 1603 | 22238 | 1089 | 28582 | 593 | 23054 |
| 6L-4S | | MI | 5731 | 2517 | 8316 | 2165 | 10370 | 1792 | 11674 | 1490 | 13447 | 984 | 16879 | 626 | 12855 |
| 16-#11 | 2.48 | MA | 9527 | 2517 | 12251 | 2305 | 15964 | 1931 | 18225 | 1624 | 20840 | 1110 | 26690 | 551 | 22003 |
| 7L-3S | | MI | 5894 | 2517 | 8690 | 2152 | 10858 | 1781 | 12298 | 1474 | 14299 | 979 | 17934 | 692 | 12938 |
| 16-#11 | 2.48 | MA | 9178 | 2517 | 11524 | 2326 | 15068 | 1950 | 17171 | 1635 | 19447 | 1124 | 24850 | 495 | 20961 |
| 8L-2S | | MI | 6186 | 2517 | 9223 | 2139 | 11533 | 1770 | 13114 | 1465 | 15398 | 967 | 19423 | 806 | 12977 |
| 16-#14 | 3.57 | MA | 11434 | 2842 | 16267 | 2502 | 20918 | 2073 | 24169 | 1700 | 28848 | 1081 | 37641 | 540 | 33075 |
| 5E | | MI | 6083 | 2842 | 9316 | 2383 | 11504 | 1964 | 13025 | 1597 | 15208 | 985 | 19108 | 388 | 17038 |
| 16-#14 | 3.57 | MA | 10871 | 2842 | 15276 | 2515 | 19732 | 2095 | 22716 | 1722 | 26784 | 1100 | 34999 | 439 | 31475 |
| 6L-4S | | MI | 6299 | 2842 | 9793 | 2366 | 12180 | 1939 | 13823 | 1585 | 16311 | 969 | 20580 | 486 | 17631 |
| 16-#14 | 3.57 | MA | 10381 | 2842 | 14328 | 2533 | 18486 | 2109 | 21226 | 1753 | 24778 | 1129 | 32273 | 377 | 29687 |
| 7L-3S | | MI | 6493 | 2842 | 10327 | 2349 | 12876 | 1925 | 14711 | 1564 | 17524 | 963 | 22059 | 578 | 18145 |
| 16-#14 | 3.57 | MA | 9895 | 2842 | 13285 | 2562 | 17201 | 2136 | 19716 | 1767 | 22780 | 1148 | 29629 | 294 | 27647 |
| 8L-2S | | MI | 6851 | 2842 | 11085 | 2331 | 13835 | 1910 | 15870 | 1552 | 19085 | 948 | 24142 | 743 | 18247 |
| 16-#18 | 6.35 | MA | 13358 | 3666 | 21121 | 3082 | 26930 | 2538 | 31200 | 2039 | 38083 | 1124 | 50928 | 37 | 50682 |
| 6L-4S | | MI | 7613 | 3666 | 13366 | 2879 | 16581 | 2313 | 19060 | 1827 | 23304 | 930 | 29259 | 84 | 28771 |
| 16-#18 | 6.35 | MA | 12543 | 3666 | 19458 | 3111 | 24744 | 2561 | 28668 | 2076 | 34556 | 1173 | 46098 | -75 | 45603 |
| 7L-3S | | MI | 7864 | 3666 | 14292 | 2851 | 17788 | 2291 | 20600 | 1794 | 25405 | 926 | 31745 | 239 | 30632 |
| 18-#10 | 2.27 | MA | 10299 | 2455 | 13296 | 2244 | 17386 | 1876 | 19995 | 1567 | 23338 | 1075 | 29956 | 714 | 22488 |
| 5L-6S | | MI | 5401 | 2455 | 7545 | 2158 | 9425 | 1799 | 10564 | 1502 | 11956 | 1011 | 15015 | 571 | 11543 |
| 18-#10 | 2.27 | MA | 9945 | 2455 | 12727 | 2252 | 16694 | 1887 | 19164 | 1580 | 22158 | 1087 | 28449 | 660 | 21801 |
| 6L-5S | | MI | 5585 | 2455 | 7822 | 2149 | 9780 | 1790 | 11015 | 1489 | 12580 | 1005 | 15876 | 642 | 11790 |
| 18-#10 | 2.27 | MA | 9637 | 2455 | 12184 | 2262 | 15980 | 1896 | 18295 | 1597 | 21011 | 1104 | 26905 | 626 | 21193 |
| 7L-4S | | MI | 5722 | 2455 | 8098 | 2138 | 10171 | 1775 | 11478 | 1480 | 13220 | 994 | 16768 | 696 | 12021 |
| 18-#10 | 2.27 | MA | 9348 | 2455 | 11587 | 2280 | 15244 | 1912 | 17430 | 1606 | 19869 | 1116 | 25400 | 582 | 20291 |
| 8L-3S | | MI | 5859 | 2455 | 8408 | 2127 | 10575 | 1765 | 11994 | 1467 | 13925 | 989 | 17659 | 751 | 12075 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

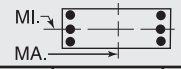



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.27 | MA | 8982 | 2455 | 11058 | 2290 | 14562 | 1924 | 16560 | 1622 | 18732 | 1133 | 23859 | 530 | 19414 |
| 9L-2S | | MI | 6106 | 2455 | 8851 | 2116 | 11136 | 1755 | 12673 | 1458 | 14838 | 978 | 18922 | 844 | 12103 |
| 18-#11 | 2.79 | MA | 10823 | 2609 | 14654 | 2340 | 18995 | 1948 | 21892 | 1614 | 25840 | 1072 | 33417 | 657 | 26909 |
| 5L-6S | | MI | 5593 | 2609 | 8187 | 2246 | 10141 | 1863 | 11384 | 1541 | 13017 | 997 | 16298 | 467 | 13682 |
| 18-#11 | 2.79 | MA | 10412 | 2609 | 13962 | 2350 | 18161 | 1963 | 20879 | 1630 | 24401 | 1086 | 31577 | 588 | 26109 |
| 6L-5S | | MI | 5806 | 2609 | 8514 | 2235 | 10571 | 1852 | 11931 | 1526 | 13773 | 992 | 17317 | 551 | 13956 |
| 18-#11 | 2.79 | MA | 10056 | 2609 | 13301 | 2362 | 17292 | 1973 | 19831 | 1651 | 23003 | 1106 | 29685 | 546 | 25048 |
| 7L-4S | | MI | 5963 | 2609 | 8849 | 2222 | 11045 | 1834 | 12490 | 1517 | 14546 | 980 | 18369 | 618 | 14392 |
| 18-#11 | 2.79 | MA | 9714 | 2609 | 12574 | 2383 | 16396 | 1992 | 18778 | 1662 | 21610 | 1120 | 27845 | 490 | 24001 |
| 8L-3S | | MI | 6118 | 2609 | 9223 | 2209 | 11533 | 1823 | 13114 | 1501 | 15398 | 975 | 19423 | 684 | 14484 |
| 18-#11 | 2.79 | MA | 9284 | 2609 | 11936 | 2396 | 15565 | 2006 | 17717 | 1680 | 20236 | 1141 | 25957 | 425 | 22710 |
| 9L-2S | | MI | 6399 | 2609 | 9757 | 2197 | 12208 | 1813 | 13930 | 1492 | 16497 | 963 | 20912 | 798 | 14531 |
| 18-#14 | 4.02 | MA | 11576 | 2974 | 16778 | 2598 | 21633 | 2156 | 25015 | 1761 | 29879 | 1095 | 39285 | 432 | 35820 |
| 6L-5S | | MI | 6399 | 2974 | 10073 | 2466 | 12463 | 2024 | 14184 | 1636 | 16769 | 980 | 21191 | 373 | 19190 |
| 18-#14 | 4.02 | MA | 11115 | 2974 | 15831 | 2615 | 20387 | 2170 | 23525 | 1792 | 27874 | 1124 | 36559 | 370 | 34039 |
| 7L-4S | | MI | 6613 | 2974 | 10551 | 2449 | 13139 | 2000 | 14982 | 1624 | 17872 | 964 | 22663 | 470 | 19757 |
| 18-#14 | 4.02 | MA | 10638 | 2974 | 14788 | 2645 | 19102 | 2197 | 22016 | 1806 | 25875 | 1143 | 33915 | 288 | 31989 |
| 8L-3S | | MI | 6792 | 2974 | 11085 | 2431 | 13835 | 1986 | 15870 | 1603 | 19085 | 959 | 24142 | 562 | 20333 |
| 18-#14 | 4.02 | MA | 10065 | 2974 | 13879 | 2665 | 17910 | 2216 | 20495 | 1833 | 23904 | 1172 | 31197 | 193 | 29968 |
| 9L-2S | | MI | 7134 | 2974 | 11842 | 2414 | 14793 | 1971 | 17030 | 1591 | 20646 | 943 | 26225 | 728 | 20448 |
| 18-#18 | 7.14 | MA | 13880 | 3901 | 22088 | 3258 | 28071 | 2670 | 32692 | 2145 | 39974 | 1164 | 53599 | -88 | 52850 |
| 7L-4S | | MI | 8129 | 3901 | 14671 | 3026 | 18233 | 2421 | 21057 | 1896 | 25993 | 921 | 32735 | 44 | 32474 |
| 20-#10 | 2.52 | MA | 10367 | 2530 | 13591 | 2299 | 17787 | 1922 | 20486 | 1602 | 23937 | 1084 | 30913 | 656 | 24316 |
| 6E | | MI | 5603 | 2530 | 7989 | 2205 | 9986 | 1834 | 11242 | 1524 | 12869 | 1008 | 16279 | 567 | 12805 |
| 20-#10 | 2.52 | MA | 10072 | 2530 | 13048 | 2309 | 17073 | 1931 | 19616 | 1619 | 22791 | 1101 | 29370 | 622 | 23700 |
| 7L-5S | | MI | 5781 | 2530 | 8265 | 2196 | 10341 | 1824 | 11694 | 1511 | 13493 | 1003 | 17140 | 638 | 13043 |
| 20-#10 | 2.52 | MA | 9787 | 2530 | 12451 | 2326 | 16337 | 1947 | 18752 | 1628 | 21648 | 1113 | 27864 | 578 | 22800 |
| 8L-4S | | MI | 5917 | 2530 | 8542 | 2185 | 10732 | 1809 | 12156 | 1502 | 14133 | 992 | 18032 | 692 | 13303 |
| 20-#10 | 2.52 | MA | 9433 | 2530 | 11922 | 2337 | 15655 | 1958 | 17881 | 1644 | 20511 | 1130 | 26323 | 526 | 21917 |
| 9L-3S | | MI | 6049 | 2530 | 8851 | 2174 | 11136 | 1799 | 12673 | 1489 | 14838 | 986 | 18922 | 747 | 13363 |
| 20-#10 | 2.52 | MA | 9104 | 2530 | 11382 | 2346 | 14987 | 1970 | 17043 | 1655 | 19338 | 1138 | 24814 | 488 | 21015 |
| 10L-2S | | MI | 6289 | 2530 | 9295 | 2163 | 11697 | 1790 | 13351 | 1480 | 15752 | 975 | 20186 | 840 | 13395 |
| 20-#11 | 3.10 | MA | 10911 | 2700 | 15012 | 2407 | 19490 | 2005 | 22485 | 1657 | 26564 | 1082 | 34572 | 584 | 29164 |
| 6E | | MI | 5829 | 2700 | 8721 | 2303 | 10816 | 1905 | 12200 | 1568 | 14116 | 994 | 17788 | 458 | 15202 |
| 20-#11 | 3.10 | MA | 10571 | 2700 | 14351 | 2420 | 18620 | 2015 | 21438 | 1678 | 25166 | 1103 | 32680 | 541 | 28093 |
| 7L-5S | | MI | 6035 | 2700 | 9048 | 2292 | 11246 | 1894 | 12747 | 1553 | 14872 | 989 | 18807 | 543 | 15466 |
| 20-#11 | 3.10 | MA | 10234 | 2700 | 13624 | 2440 | 17724 | 2035 | 20385 | 1689 | 23773 | 1117 | 30840 | 485 | 27037 |
| 8L-4S | | MI | 6205 | 2700 | 9382 | 2279 | 11719 | 1876 | 13306 | 1544 | 15645 | 977 | 19858 | 610 | 15930 |
| 20-#11 | 3.10 | MA | 9821 | 2700 | 12986 | 2454 | 16893 | 2048 | 19324 | 1707 | 22399 | 1137 | 28952 | 421 | 25750 |
| 9L-3S | | MI | 6345 | 2700 | 9757 | 2267 | 12208 | 1866 | 13930 | 1528 | 16497 | 972 | 20912 | 675 | 16029 |
| 20-#11 | 3.10 | MA | 9436 | 2700 | 12327 | 2465 | 16079 | 2062 | 18302 | 1720 | 20975 | 1148 | 27107 | 372 | 24473 |
| 10L-2S | | MI | 6607 | 2700 | 10290 | 2254 | 12883 | 1855 | 14746 | 1519 | 17596 | 960 | 22402 | 790 | 16083 |
| 20-#14 | 4.46 | MA | 11829 | 3107 | 17333 | 2698 | 22288 | 2231 | 25824 | 1831 | 30969 | 1119 | 40846 | 363 | 38391 |
| 7L-5S | | MI | 6709 | 3107 | 10831 | 2549 | 13421 | 2085 | 15343 | 1674 | 18330 | 975 | 23275 | 358 | 21347 |
| 20-#14 | 4.46 | MA | 11358 | 3107 | 16290 | 2728 | 21003 | 2258 | 24315 | 1845 | 28971 | 1138 | 38201 | 281 | 36330 |
| 8L-4S | | MI | 6921 | 3107 | 11309 | 2532 | 14097 | 2061 | 16141 | 1663 | 19433 | 959 | 24746 | 455 | 21891 |
| 20-#14 | 4.46 | MA | 10813 | 3107 | 15382 | 2747 | 19811 | 2277 | 22794 | 1872 | 27000 | 1167 | 35483 | 186 | 34300 |
| 9L-3S | | MI | 7087 | 3107 | 11842 | 2514 | 14793 | 2046 | 17030 | 1642 | 20646 | 954 | 26225 | 547 | 22522 |
| 22-#10 | 2.77 | MA | 10498 | 2604 | 13912 | 2356 | 18166 | 1965 | 20938 | 1641 | 24570 | 1098 | 31834 | 618 | 26207 |
| 7L-6S | | MI | 5800 | 2604 | 8432 | 2251 | 10547 | 1868 | 11921 | 1546 | 13783 | 1005 | 17543 | 563 | 14070 |
| 22-#10 | 2.77 | MA | 10216 | 2604 | 13315 | 2373 | 17430 | 1981 | 20074 | 1650 | 23428 | 1110 | 30328 | 574 | 25310 |
| 8L-5S | | MI | 5974 | 2604 | 8709 | 2243 | 10902 | 1858 | 12372 | 1533 | 14407 | 1000 | 18404 | 634 | 14301 |
| 22-#10 | 2.77 | MA | 9874 | 2604 | 12786 | 2384 | 16748 | 1992 | 19203 | 1666 | 22291 | 1127 | 28788 | 522 | 24421 |
| 9L-4S | | MI | 6110 | 2604 | 8985 | 2232 | 11293 | 1843 | 12835 | 1524 | 15047 | 989 | 19296 | 688 | 14584 |
| 22-#10 | 2.77 | MA | 9556 | 2604 | 12246 | 2393 | 16080 | 2004 | 18365 | 1677 | 21118 | 1136 | 27279 | 484 | 23520 |
| 10L-3S | | MI | 6235 | 2604 | 9295 | 2221 | 11697 | 1834 | 13351 | 1510 | 15752 | 984 | 20186 | 743 | 14649 |
| 22-#10 | 2.77 | MA | 9255 | 2604 | 11716 | 2404 | 15397 | 2014 | 17540 | 1688 | 19961 | 1150 | 25813 | 438 | 22482 |
| 11L-2S | | MI | 6470 | 2604 | 9738 | 2209 | 12258 | 1824 | 14029 | 1502 | 16665 | 973 | 21450 | 836 | 14687 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.40 | MA | 11075 | 2792 | 15401 | 2477 | 19949 | 2058 | 23044 | 1705 | 27329 | 1100 | 35675 | 536 | 31138 |
| 7L-6S | | MI | 6077 | 2792 | 9254 | 2361 | 11491 | 1947 | 13017 | 1595 | 15215 | 990 | 19277 | 450 | 16698 |
| 22-#11 | 3.40 | MA | 10742 | 2792 | 14674 | 2498 | 19052 | 2077 | 21991 | 1716 | 25936 | 1113 | 33835 | 481 | 30074 |
| 8L-5S | | MI | 6272 | 2792 | 9581 | 2350 | 11920 | 1936 | 13563 | 1579 | 15971 | 985 | 20296 | 535 | 16980 |
| 22-#11 | 3.40 | MA | 10345 | 2792 | 14036 | 2511 | 18221 | 2090 | 20930 | 1734 | 24562 | 1134 | 31947 | 416 | 28791 |
| 9L-4S | | MI | 6426 | 2792 | 9916 | 2337 | 12394 | 1919 | 14123 | 1571 | 16744 | 973 | 21348 | 602 | 17430 |
| 22-#11 | 3.40 | MA | 9976 | 2792 | 13377 | 2522 | 17407 | 2104 | 19909 | 1747 | 23138 | 1144 | 30102 | 367 | 27508 |
| 10L-3S | | MI | 6558 | 2792 | 10290 | 2324 | 12883 | 1908 | 14746 | 1555 | 17596 | 968 | 22402 | 667 | 17574 |
| 22-#11 | 3.40 | MA | 9624 | 2792 | 12733 | 2535 | 16584 | 2117 | 18903 | 1760 | 21728 | 1162 | 28311 | 309 | 26194 |
| 11L-2S | | MI | 6812 | 2792 | 10824 | 2311 | 13557 | 1897 | 15563 | 1546 | 18695 | 956 | 23891 | 782 | 17635 |
| 22-#14 | 4.91 | MA | 12060 | 3239 | 17793 | 2811 | 22904 | 2319 | 26614 | 1884 | 32067 | 1133 | 42488 | 274 | 40671 |
| 8L-5S | | MI | 7013 | 3239 | 11589 | 2632 | 14380 | 2146 | 16503 | 1713 | 19891 | 970 | 25358 | 342 | 23509 |
| 22-#14 | 4.91 | MA | 11540 | 3239 | 16884 | 2830 | 21712 | 2338 | 25093 | 1910 | 30095 | 1162 | 39770 | 180 | 38632 |
| 9L-4S | | MI | 7224 | 3239 | 12066 | 2614 | 15056 | 2122 | 17301 | 1702 | 20994 | 954 | 26829 | 440 | 24032 |
| 24-#10 | 3.02 | MA | 10636 | 2679 | 14179 | 2420 | 18523 | 2015 | 21396 | 1672 | 25208 | 1107 | 32792 | 570 | 27819 |
| 8L-6S | | MI | 5995 | 2679 | 8876 | 2298 | 11108 | 1902 | 12599 | 1568 | 14696 | 1002 | 18806 | 559 | 15337 |
| 24-#10 | 3.02 | MA | 10304 | 2679 | 13650 | 2431 | 17841 | 2027 | 20525 | 1688 | 24071 | 1124 | 31252 | 518 | 26924 |
| 9L-5S | | MI | 6165 | 2679 | 9152 | 2289 | 11463 | 1893 | 13051 | 1554 | 15320 | 997 | 19667 | 630 | 15561 |
| 24-#10 | 3.02 | MA | 9999 | 2679 | 13110 | 2440 | 17173 | 2039 | 19687 | 1699 | 22897 | 1133 | 29743 | 480 | 26025 |
| 10L-4S | | MI | 6299 | 2679 | 9428 | 2278 | 11854 | 1878 | 13513 | 1546 | 15960 | 986 | 20559 | 684 | 15866 |
| 24-#10 | 3.02 | MA | 9709 | 2679 | 12580 | 2450 | 16490 | 2049 | 18862 | 1710 | 21740 | 1148 | 28277 | 434 | 24983 |
| 11L-3S | | MI | 6428 | 2679 | 9738 | 2267 | 12258 | 1868 | 14029 | 1532 | 16665 | 981 | 21450 | 739 | 15936 |
| 24-#10 | 3.02 | MA | 9377 | 2679 | 12061 | 2462 | 15758 | 2064 | 18018 | 1727 | 20587 | 1157 | 26792 | 395 | 23930 |
| 12L-2S | | MI | 6647 | 2679 | 10181 | 2256 | 12819 | 1858 | 14708 | 1524 | 17579 | 970 | 22714 | 832 | 15978 |
| 24-#11 | 3.71 | MA | 11239 | 2884 | 15724 | 2555 | 20381 | 2119 | 23598 | 1743 | 28099 | 1110 | 36830 | 476 | 33111 |
| 8L-6S | | MI | 6303 | 2884 | 9787 | 2418 | 12166 | 1989 | 13833 | 1622 | 16314 | 987 | 20767 | 442 | 18196 |
| 24-#11 | 3.71 | MA | 10856 | 2884 | 15086 | 2569 | 19549 | 2132 | 22537 | 1761 | 26725 | 1130 | 34942 | 411 | 31831 |
| 9L-5S | | MI | 6491 | 2884 | 10115 | 2407 | 12595 | 1978 | 14379 | 1606 | 17070 | 982 | 21785 | 526 | 18498 |
| 24-#11 | 3.71 | MA | 10502 | 2884 | 14427 | 2580 | 18735 | 2146 | 21515 | 1774 | 25301 | 1141 | 33097 | 362 | 30542 |
| 10L-4S | | MI | 6645 | 2884 | 10449 | 2394 | 13069 | 1961 | 14939 | 1598 | 17843 | 970 | 22837 | 593 | 18932 |
| 24-#11 | 3.71 | MA | 10166 | 2884 | 13783 | 2592 | 17912 | 2159 | 20509 | 1787 | 23891 | 1158 | 31306 | 304 | 29223 |
| 11L-3S | | MI | 6769 | 2884 | 10824 | 2382 | 13557 | 1950 | 15563 | 1582 | 18695 | 965 | 23891 | 659 | 19119 |
| 24-#14 | 5.36 | MA | 12249 | 3371 | 18387 | 2913 | 23613 | 2399 | 27392 | 1949 | 33191 | 1157 | 44056 | 173 | 42964 |
| 9L-5S | | MI | 7313 | 3371 | 12346 | 2714 | 15338 | 2207 | 17662 | 1752 | 21452 | 965 | 27441 | 327 | 25675 |

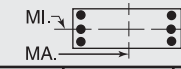
## RECTANGULAR TIED COLUMNS 24" x 44"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.52 | MA | 11045 | 2338 | 14085 | 2137 | 18317 | 1788 | 20944 | 1508 | 24223 | 1073 | 30660 | 932 | 16650 |
| 2E | | MI | 5651 | 2338 | 8010 | 2019 | 9827 | 1688 | 10927 | 1421 | 12271 | 1003 | 14720 | 815 | 8319 |
| 6-#14 | 1.28 | MA | 10708 | 2264 | 13124 | 2104 | 17224 | 1765 | 19687 | 1496 | 22590 | 1083 | 28443 | 943 | 14253 |
| 2L-3S | | MI | 5065 | 2264 | 6778 | 2014 | 8377 | 1688 | 9229 | 1428 | 10033 | 1035 | 12000 | 696 | 7213 |
| 6-#14 | 1.28 | MA | 9678 | 2264 | 11538 | 2129 | 15218 | 1789 | 17261 | 1519 | 19323 | 1113 | 23920 | 800 | 14153 |
| 3L-2S | | MI | 5539 | 2264 | 7535 | 1997 | 9336 | 1674 | 10388 | 1417 | 11594 | 1020 | 14083 | 862 | 7212 |
| 6-#18 | 2.27 | MA | 12291 | 2573 | 16862 | 2284 | 21830 | 1896 | 25193 | 1578 | 29944 | 1064 | 38581 | 920 | 24762 |
| 2L-3S | | MI | 5440 | 2573 | 8010 | 2194 | 9827 | 1818 | 10927 | 1506 | 12271 | 1016 | 14720 | 481 | 12006 |
| 6-#18 | 2.27 | MA | 10677 | 2573 | 14085 | 2328 | 18317 | 1937 | 20944 | 1616 | 24223 | 1114 | 30660 | 660 | 24303 |
| 3L-2S | | MI | 6181 | 2573 | 9316 | 2167 | 11479 | 1796 | 12925 | 1490 | 14960 | 994 | 18196 | 775 | 12149 |
| 8-#11 | 1.18 | MA | 10567 | 2234 | 12714 | 2091 | 16768 | 1757 | 19167 | 1492 | 21921 | 1088 | 27540 | 948 | 13266 |
| 2L-4S | | MI | 4953 | 2234 | 6418 | 2015 | 7962 | 1692 | 8723 | 1441 | 9366 | 1045 | 11279 | 701 | 6734 |
| 8-#11 | 1.18 | MA | 9844 | 2234 | 11606 | 2109 | 15367 | 1774 | 17473 | 1508 | 19640 | 1109 | 24381 | 850 | 13220 |
| 3E | | MI | 5157 | 2234 | 6792 | 2002 | 8451 | 1681 | 9346 | 1426 | 10218 | 1040 | 12333 | 766 | 6756 |
| 8-#11 | 1.18 | MA | 9425 | 2234 | 10852 | 2128 | 14380 | 1791 | 16209 | 1531 | 17911 | 1123 | 22297 | 787 | 13050 |
| 4L-2S | | MI | 5493 | 2234 | 7326 | 1990 | 9126 | 1670 | 10163 | 1417 | 11317 | 1028 | 13823 | 881 | 6750 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

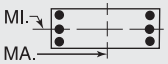



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.70 | MA | 11452 | 2397 | 14709 | 2186 | 19230 | 1826 | 22112 | 1535 | 25856 | 1078 | 32965 | 936 | 18889 |
| 2L-4S | | MI | 5139 | 2397 | 7002 | 2114 | 8640 | 1764 | 9500 | 1489 | 10382 | 1036 | 12603 | 589 | 9290 |
| 8-#14 | 1.70 | MA | 10482 | 2397 | 13124 | 2212 | 17224 | 1850 | 19687 | 1558 | 22590 | 1108 | 28443 | 793 | 18759 |
| 3E | | MI | 5412 | 2397 | 7535 | 2097 | 9336 | 1749 | 10388 | 1467 | 11594 | 1030 | 14083 | 681 | 9416 |
| 8-#14 | 1.70 | MA | 9924 | 2397 | 12042 | 2238 | 15809 | 1874 | 17875 | 1591 | 20112 | 1127 | 25445 | 702 | 18288 |
| 4L-2S | | MI | 5863 | 2397 | 8293 | 2080 | 10294 | 1735 | 11547 | 1456 | 13155 | 1015 | 16166 | 846 | 9442 |
| 8-#18 | 3.03 | MA | 13476 | 2809 | 19639 | 2431 | 25343 | 2004 | 29443 | 1647 | 35665 | 1055 | 46503 | 908 | 32866 |
| 2L-4S | | MI | 5583 | 2809 | 8389 | 2369 | 10272 | 1947 | 11385 | 1609 | 12859 | 1011 | 15710 | 286 | 14261 |
| 8-#18 | 3.03 | MA | 11993 | 2809 | 16862 | 2475 | 21830 | 2045 | 25193 | 1685 | 29944 | 1105 | 38581 | 647 | 32372 |
| 3E | | MI | 6017 | 2809 | 9316 | 2341 | 11479 | 1926 | 12925 | 1575 | 14960 | 1007 | 18196 | 441 | 15749 |
| 8-#18 | 3.03 | MA | 11151 | 2809 | 14961 | 2519 | 19344 | 2086 | 22011 | 1741 | 25592 | 1137 | 33279 | 485 | 29113 |
| 4L-2S | | MI | 6683 | 2809 | 10621 | 2314 | 13130 | 1904 | 14922 | 1559 | 17650 | 986 | 21672 | 735 | 15952 |
| 10-#10 | 1.20 | MA | 10652 | 2241 | 12721 | 2104 | 16864 | 1767 | 19329 | 1501 | 22182 | 1093 | 27933 | 952 | 13589 |
| 2L-5S | | MI | 4962 | 2241 | 6280 | 2043 | 7826 | 1721 | 8614 | 1461 | 9241 | 1064 | 11181 | 700 | 6860 |
| 10-#10 | 1.20 | MA | 10059 | 2241 | 11811 | 2119 | 15712 | 1782 | 17936 | 1514 | 20306 | 1111 | 25335 | 873 | 13554 |
| 3L-4S | | MI | 5106 | 2241 | 6556 | 2032 | 8218 | 1706 | 9077 | 1453 | 9881 | 1053 | 12073 | 754 | 6916 |
| 10-#10 | 1.20 | MA | 9723 | 2241 | 11192 | 2134 | 14903 | 1796 | 16899 | 1534 | 18887 | 1123 | 23633 | 823 | 13446 |
| 4L-3S | | MI | 5272 | 2241 | 6866 | 2021 | 8622 | 1696 | 9593 | 1439 | 10586 | 1048 | 12963 | 809 | 6932 |
| 10-#10 | 1.20 | MA | 9348 | 2241 | 10626 | 2147 | 14124 | 1816 | 15979 | 1547 | 17610 | 1141 | 21812 | 778 | 13187 |
| 5L-2S | | MI | 5551 | 2241 | 7309 | 2010 | 9183 | 1687 | 10272 | 1431 | 11500 | 1037 | 14227 | 902 | 6929 |
| 10-#11 | 1.48 | MA | 11099 | 2326 | 13821 | 2149 | 18169 | 1799 | 20861 | 1519 | 24202 | 1085 | 30698 | 943 | 16506 |
| 2L-5S | | MI | 5043 | 2326 | 6617 | 2085 | 8164 | 1751 | 8979 | 1477 | 9691 | 1053 | 11717 | 626 | 8042 |
| 10-#11 | 1.48 | MA | 10405 | 2326 | 12714 | 2167 | 16768 | 1816 | 19167 | 1535 | 21921 | 1106 | 27540 | 845 | 16445 |
| 3L-4S | | MI | 5209 | 2326 | 6951 | 2073 | 8637 | 1734 | 9539 | 1468 | 10465 | 1041 | 12769 | 693 | 8276 |
| 10-#11 | 1.48 | MA | 10014 | 2326 | 11960 | 2185 | 15781 | 1833 | 17904 | 1558 | 20193 | 1120 | 25456 | 783 | 16262 |
| 4L-3S | | MI | 5402 | 2326 | 7326 | 2060 | 9126 | 1723 | 10163 | 1453 | 11317 | 1036 | 13823 | 758 | 8316 |
| 10-#11 | 1.48 | MA | 9569 | 2326 | 11275 | 2201 | 14832 | 1857 | 16782 | 1575 | 18636 | 1141 | 23232 | 726 | 15642 |
| 5L-2S | | MI | 5726 | 2326 | 7859 | 2047 | 9801 | 1712 | 10979 | 1444 | 12416 | 1024 | 15312 | 873 | 8322 |
| 10-#14 | 2.13 | MA | 12169 | 2529 | 16295 | 2269 | 21235 | 1887 | 24538 | 1574 | 29122 | 1073 | 37488 | 929 | 23520 |
| 2L-5S | | MI | 5267 | 2529 | 7282 | 2214 | 8922 | 1849 | 9861 | 1539 | 10839 | 1047 | 13215 | 476 | 10719 |
| 10-#14 | 2.13 | MA | 11250 | 2529 | 14709 | 2295 | 19230 | 1911 | 22112 | 1597 | 25856 | 1103 | 32965 | 786 | 23368 |
| 3L-4S | | MI | 5491 | 2529 | 7759 | 2197 | 9598 | 1824 | 10659 | 1528 | 11942 | 1031 | 14686 | 573 | 11418 |
| 10-#14 | 2.13 | MA | 10740 | 2529 | 13628 | 2321 | 17815 | 1935 | 20301 | 1629 | 23378 | 1122 | 29967 | 696 | 22901 |
| 4L-3S | | MI | 5746 | 2529 | 8293 | 2180 | 10294 | 1810 | 11547 | 1506 | 13155 | 1025 | 16166 | 665 | 11611 |
| 10-#14 | 2.13 | MA | 10119 | 2529 | 12652 | 2344 | 16453 | 1969 | 18691 | 1652 | 21145 | 1152 | 26774 | 612 | 21168 |
| 5L-2S | | MI | 6177 | 2529 | 9051 | 2162 | 11253 | 1796 | 12707 | 1495 | 14716 | 1010 | 18249 | 831 | 11659 |
| 10-#18 | 3.79 | MA | 13245 | 3044 | 19639 | 2622 | 25343 | 2154 | 29443 | 1754 | 35665 | 1096 | 46503 | 635 | 40454 |
| 3L-4S | | MI | 6189 | 3044 | 9695 | 2516 | 11923 | 2055 | 13382 | 1678 | 15549 | 1003 | 19186 | 246 | 17885 |
| 10-#18 | 3.79 | MA | 12508 | 3044 | 17738 | 2667 | 22857 | 2195 | 26260 | 1810 | 31313 | 1128 | 41200 | 472 | 37145 |
| 4L-3S | | MI | 6553 | 3044 | 10621 | 2488 | 13130 | 2034 | 14922 | 1644 | 17650 | 999 | 21672 | 401 | 19496 |
| 10-#18 | 3.79 | MA | 11467 | 3044 | 16043 | 2709 | 20461 | 2253 | 23428 | 1848 | 27386 | 1178 | 35570 | 316 | 33826 |
| 5L-2S | | MI | 7170 | 3044 | 11927 | 2461 | 14782 | 2012 | 16920 | 1629 | 20339 | 977 | 25147 | 695 | 19744 |
| 12-#10 | 1.44 | MA | 11093 | 2316 | 13632 | 2151 | 18016 | 1802 | 20722 | 1523 | 24058 | 1090 | 30530 | 948 | 16253 |
| 2L-6S | | MI | 4974 | 2316 | 6447 | 2099 | 8033 | 1765 | 8841 | 1497 | 9530 | 1067 | 11584 | 625 | 7835 |
| 12-#10 | 1.44 | MA | 10520 | 2316 | 12721 | 2166 | 16864 | 1816 | 19329 | 1536 | 22182 | 1108 | 27933 | 869 | 16208 |
| 3L-5S | | MI | 5177 | 2316 | 6723 | 2090 | 8387 | 1756 | 9293 | 1483 | 10155 | 1062 | 12445 | 696 | 8117 |
| 12-#10 | 1.44 | MA | 10203 | 2316 | 12103 | 2181 | 16055 | 1830 | 18292 | 1556 | 20763 | 1120 | 26231 | 819 | 16092 |
| 4E | | MI | 5319 | 2316 | 6999 | 2079 | 8779 | 1740 | 9755 | 1475 | 10795 | 1051 | 13337 | 750 | 8202 |
| 12-#10 | 1.44 | MA | 9833 | 2316 | 11537 | 2194 | 15276 | 1850 | 17372 | 1569 | 19486 | 1138 | 24410 | 775 | 15835 |
| 5L-3S | | MI | 5477 | 2316 | 7309 | 2068 | 9183 | 1731 | 10272 | 1461 | 11500 | 1045 | 14227 | 805 | 8228 |
| 12-#10 | 1.44 | MA | 9413 | 2316 | 10937 | 2203 | 14544 | 1862 | 16498 | 1583 | 18244 | 1150 | 22827 | 721 | 15084 |
| 6L-2S | | MI | 5748 | 2316 | 7752 | 2057 | 9744 | 1721 | 10950 | 1453 | 12413 | 1034 | 15491 | 898 | 8234 |
| 12-#11 | 1.77 | MA | 11615 | 2418 | 14928 | 2206 | 19569 | 1841 | 22556 | 1546 | 26484 | 1081 | 33857 | 938 | 19743 |
| 2L-6S | | MI | 5058 | 2418 | 6823 | 2154 | 8409 | 1804 | 9249 | 1520 | 10035 | 1055 | 12188 | 533 | 9217 |
| 12-#11 | 1.77 | MA | 10948 | 2418 | 13821 | 2224 | 18169 | 1858 | 20861 | 1562 | 24202 | 1102 | 30698 | 840 | 19669 |
| 3L-5S | | MI | 5295 | 2418 | 7150 | 2143 | 8838 | 1794 | 9796 | 1504 | 10790 | 1050 | 13206 | 617 | 9527 |
| 12-#11 | 1.77 | MA | 10582 | 2418 | 13067 | 2242 | 17182 | 1875 | 19598 | 1585 | 22474 | 1116 | 28615 | 778 | 19478 |
| 4E | | MI | 5458 | 2418 | 7485 | 2130 | 9312 | 1776 | 10355 | 1495 | 11564 | 1038 | 14258 | 684 | 9816 |

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis



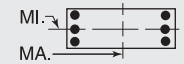

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.77 | MA | 10144 | 2418 | 12382 | 2259 | 16233 | 1899 | 18476 | 1602 | 20917 | 1137 | 26391 | 721 | 18843 |
| 5L-3S | | MI | 5641 | 2418 | 7859 | 2117 | 9801 | 1765 | 10979 | 1479 | 12416 | 1033 | 15312 | 750 | 9869 |
| 12-#11 | 1.77 | MA | 9649 | 2418 | 11653 | 2268 | 15349 | 1914 | 17410 | 1618 | 19402 | 1152 | 24457 | 653 | 17922 |
| 6L-2S | | MI | 5954 | 2418 | 8392 | 2104 | 10475 | 1754 | 11795 | 1471 | 13515 | 1021 | 16802 | 864 | 9887 |
| 12-#14 | 2.56 | MA | 11990 | 2662 | 16295 | 2378 | 21235 | 1972 | 24538 | 1636 | 29122 | 1098 | 37488 | 779 | 27981 |
| 3L-5S | | MI | 5612 | 2662 | 8039 | 2297 | 9881 | 1910 | 11020 | 1578 | 12400 | 1042 | 15298 | 461 | 12845 |
| 12-#14 | 2.56 | MA | 11522 | 2662 | 15213 | 2403 | 19821 | 1996 | 22727 | 1668 | 26644 | 1117 | 34490 | 689 | 27519 |
| 4E | | MI | 5833 | 2662 | 8517 | 2280 | 10557 | 1885 | 11818 | 1566 | 13503 | 1026 | 16769 | 558 | 13508 |
| 12-#14 | 2.56 | MA | 10913 | 2662 | 14237 | 2427 | 18459 | 2030 | 21117 | 1691 | 24411 | 1147 | 31296 | 605 | 25773 |
| 5L-3S | | MI | 6072 | 2662 | 9051 | 2262 | 11253 | 1871 | 12707 | 1545 | 14716 | 1020 | 18249 | 650 | 13803 |
| 12-#14 | 2.56 | MA | 10247 | 2662 | 13192 | 2441 | 17200 | 2051 | 19587 | 1714 | 22237 | 1167 | 28517 | 505 | 24215 |
| 6L-2S | | MI | 6483 | 2662 | 9809 | 2245 | 12211 | 1856 | 13866 | 1534 | 16277 | 1005 | 20332 | 815 | 13869 |
| 12-#18 | 4.55 | MA | 13801 | 3280 | 20515 | 2814 | 26371 | 2303 | 30509 | 1879 | 37034 | 1119 | 49122 | 460 | 45177 |
| 4E | | MI | 6748 | 3280 | 11000 | 2663 | 13575 | 2164 | 15380 | 1747 | 18238 | 994 | 22661 | 205 | 21534 |
| 12-#18 | 4.55 | MA | 12781 | 3280 | 18821 | 2856 | 23974 | 2361 | 27677 | 1917 | 33107 | 1169 | 43492 | 304 | 41820 |
| 5L-3S | | MI | 7072 | 3280 | 11927 | 2636 | 14782 | 2142 | 16920 | 1713 | 20339 | 990 | 25147 | 361 | 23247 |
| 12-#18 | 4.55 | MA | 11747 | 3280 | 16987 | 2880 | 21794 | 2401 | 24985 | 1955 | 29284 | 1201 | 38590 | 120 | 37714 |
| 6L-2S | | MI | 7647 | 3280 | 13232 | 2608 | 16434 | 2120 | 18917 | 1698 | 23029 | 968 | 28623 | 654 | 23530 |
| 14-#10 | 1.68 | MA | 10969 | 2390 | 13632 | 2213 | 18016 | 1850 | 20722 | 1558 | 24058 | 1105 | 30530 | 866 | 18863 |
| 3L-6S | | MI | 5190 | 2390 | 6890 | 2145 | 8593 | 1800 | 9520 | 1519 | 10444 | 1064 | 12847 | 621 | 9087 |
| 14-#10 | 1.68 | MA | 10668 | 2390 | 13014 | 2228 | 17207 | 1865 | 19686 | 1578 | 22639 | 1117 | 28828 | 815 | 18740 |
| 4L-5S | | MI | 5386 | 2390 | 7167 | 2137 | 8948 | 1790 | 9971 | 1505 | 11068 | 1059 | 13708 | 692 | 9356 |
| 14-#10 | 1.68 | MA | 10303 | 2390 | 12447 | 2241 | 16428 | 1885 | 18765 | 1591 | 21362 | 1135 | 27007 | 771 | 18485 |
| 5L-4S | | MI | 5526 | 2390 | 7443 | 2125 | 9339 | 1775 | 10434 | 1497 | 11708 | 1048 | 14600 | 746 | 9486 |
| 14-#10 | 1.68 | MA | 9899 | 2390 | 11848 | 2249 | 15696 | 1896 | 17892 | 1605 | 20120 | 1147 | 25424 | 717 | 17733 |
| 6L-3S | | MI | 5678 | 2390 | 7752 | 2114 | 9744 | 1765 | 10950 | 1483 | 12413 | 1043 | 15491 | 801 | 9521 |
| 14-#10 | 1.68 | MA | 9543 | 2390 | 11277 | 2260 | 14944 | 1905 | 16970 | 1621 | 18913 | 1165 | 23805 | 683 | 17113 |
| 7L-2S | | MI | 5941 | 2390 | 8196 | 2103 | 10304 | 1755 | 11628 | 1474 | 13327 | 1032 | 16755 | 894 | 9533 |
| 14-#11 | 2.07 | MA | 11476 | 2510 | 14928 | 2282 | 19569 | 1900 | 22556 | 1589 | 26484 | 1099 | 33857 | 835 | 22894 |
| 3L-6S | | MI | 5310 | 2510 | 7356 | 2211 | 9084 | 1847 | 10065 | 1547 | 11134 | 1051 | 13677 | 525 | 10724 |
| 14-#11 | 2.07 | MA | 11132 | 2510 | 14174 | 2300 | 18583 | 1918 | 21292 | 1612 | 24755 | 1113 | 31774 | 773 | 22697 |
| 4L-5S | | MI | 5540 | 2510 | 7683 | 2200 | 9513 | 1836 | 10612 | 1531 | 11889 | 1046 | 14696 | 609 | 11021 |
| 14-#11 | 2.07 | MA | 10701 | 2510 | 13490 | 2316 | 17634 | 1942 | 20170 | 1629 | 23198 | 1134 | 29550 | 716 | 22048 |
| 5L-4S | | MI | 5700 | 2510 | 8018 | 2187 | 9987 | 1818 | 11171 | 1522 | 12663 | 1034 | 15747 | 676 | 11354 |
| 14-#11 | 2.07 | MA | 10226 | 2510 | 12760 | 2326 | 16749 | 1956 | 19104 | 1645 | 21683 | 1148 | 27615 | 649 | 21144 |
| 6L-3S | | MI | 5874 | 2510 | 8392 | 2175 | 10475 | 1807 | 11795 | 1506 | 13515 | 1029 | 16802 | 742 | 11420 |
| 14-#11 | 2.07 | MA | 9808 | 2510 | 12064 | 2339 | 15834 | 1967 | 17993 | 1666 | 20212 | 1169 | 25630 | 607 | 20109 |
| 7L-2S | | MI | 6178 | 2510 | 8926 | 2162 | 11150 | 1797 | 12611 | 1498 | 14613 | 1018 | 18291 | 856 | 11446 |
| 14-#14 | 2.98 | MA | 12278 | 2794 | 16799 | 2486 | 21826 | 2057 | 25153 | 1707 | 29910 | 1112 | 39012 | 682 | 32141 |
| 4L-5S | | MI | 5948 | 2794 | 8797 | 2380 | 10839 | 1970 | 12180 | 1617 | 13961 | 1037 | 17381 | 445 | 14980 |
| 14-#14 | 2.98 | MA | 11678 | 2794 | 15823 | 2510 | 20464 | 2091 | 23542 | 1730 | 27677 | 1142 | 35818 | 598 | 30378 |
| 5L-4S | | MI | 6184 | 2794 | 9275 | 2363 | 11515 | 1946 | 12977 | 1605 | 15064 | 1021 | 18852 | 543 | 15611 |
| 14-#14 | 2.98 | MA | 11047 | 2794 | 14778 | 2524 | 19205 | 2112 | 22013 | 1753 | 25504 | 1162 | 33039 | 498 | 28800 |
| 6L-3S | | MI | 6398 | 2794 | 9809 | 2345 | 12211 | 1932 | 13866 | 1584 | 16277 | 1016 | 20332 | 635 | 15992 |
| 14-#14 | 2.98 | MA | 10490 | 2794 | 13779 | 2541 | 17893 | 2127 | 20432 | 1783 | 23392 | 1191 | 30180 | 437 | 26875 |
| 7L-2S | | MI | 6778 | 2794 | 10566 | 2328 | 13170 | 1917 | 15025 | 1572 | 17838 | 1000 | 22415 | 800 | 16075 |
| 14-#18 | 5.30 | MA | 14041 | 3515 | 21598 | 3004 | 27487 | 2470 | 31926 | 1986 | 38829 | 1160 | 51413 | 291 | 49813 |
| 5L-4S | | MI | 7289 | 3515 | 12306 | 2810 | 15226 | 2272 | 17377 | 1816 | 20928 | 985 | 26137 | 165 | 25202 |
| 14-#18 | 5.30 | MA | 13082 | 3515 | 19764 | 3027 | 25307 | 2509 | 29234 | 2024 | 35006 | 1192 | 46511 | 108 | 45732 |
| 6L-3S | | MI | 7578 | 3515 | 13232 | 2783 | 16434 | 2250 | 18917 | 1783 | 23029 | 981 | 28623 | 320 | 27002 |
| 14-#18 | 5.30 | MA | 12233 | 3515 | 18010 | 3057 | 23001 | 2534 | 26499 | 2080 | 31290 | 1242 | 41443 | -3 | 41428 |
| 7L-2S | | MI | 8117 | 3515 | 14538 | 2755 | 18085 | 2229 | 20915 | 1767 | 25718 | 959 | 32098 | 614 | 27313 |
| 16-#10 | 1.92 | MA | 11122 | 2465 | 13924 | 2275 | 18359 | 1899 | 21079 | 1599 | 24515 | 1114 | 31426 | 811 | 21390 |
| 4L-6S | | MI | 5400 | 2465 | 7333 | 2192 | 9154 | 1834 | 10198 | 1540 | 11357 | 1061 | 14111 | 617 | 10342 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

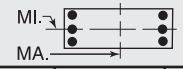



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 1.92 | MA | 10761 | 2465 | 13358 | 2288 | 17580 | 1919 | 20159 | 1613 | 23238 | 1132 | 29605 | 767 | 21138 |
| 5E | | MI | 5591 | 2465 | 7610 | 2183 | 9509 | 1824 | 10650 | 1527 | 11982 | 1056 | 14972 | 688 | 10601 |
| 16-#10 | 1.92 | MA | 10371 | 2465 | 12759 | 2296 | 16848 | 1931 | 19285 | 1627 | 21996 | 1144 | 28022 | 713 | 20383 |
| 6L-4S | | MI | 5730 | 2465 | 7886 | 2172 | 9900 | 1809 | 11112 | 1518 | 12621 | 1045 | 15864 | 742 | 10769 |
| 16-#10 | 1.92 | MA | 10030 | 2465 | 12187 | 2307 | 16096 | 1940 | 18364 | 1643 | 20789 | 1162 | 26403 | 680 | 19765 |
| 7L-3S | | MI | 5875 | 2465 | 8196 | 2161 | 10304 | 1799 | 11628 | 1505 | 13327 | 1040 | 16755 | 797 | 10811 |
| 16-#10 | 1.92 | MA | 9715 | 2465 | 11559 | 2324 | 15322 | 1956 | 17454 | 1653 | 19588 | 1174 | 24820 | 637 | 18832 |
| 8L-2S | | MI | 6131 | 2465 | 8639 | 2150 | 10865 | 1790 | 12307 | 1496 | 14240 | 1029 | 18018 | 890 | 10830 |
| 16-#11 | 2.36 | MA | 11667 | 2602 | 15282 | 2357 | 19984 | 1960 | 22987 | 1639 | 27036 | 1109 | 34932 | 768 | 25918 |
| 4L-6S | | MI | 5557 | 2602 | 7890 | 2269 | 9759 | 1889 | 10881 | 1574 | 12233 | 1048 | 15166 | 516 | 12236 |
| 16-#11 | 2.36 | MA | 11242 | 2602 | 14597 | 2373 | 19034 | 1984 | 21865 | 1656 | 25480 | 1131 | 32709 | 711 | 25257 |
| 5E | | MI | 5779 | 2602 | 8217 | 2257 | 10188 | 1878 | 11428 | 1558 | 12988 | 1043 | 16185 | 601 | 12520 |
| 16-#11 | 2.36 | MA | 10786 | 2602 | 13868 | 2383 | 18150 | 1998 | 20799 | 1672 | 23965 | 1145 | 30774 | 644 | 24367 |
| 6L-4S | | MI | 5937 | 2602 | 8552 | 2245 | 10662 | 1860 | 11988 | 1549 | 13762 | 1031 | 17237 | 668 | 12892 |
| 16-#11 | 2.36 | MA | 10388 | 2602 | 13171 | 2396 | 17235 | 2009 | 19688 | 1692 | 22493 | 1166 | 28789 | 602 | 23321 |
| 7L-3S | | MI | 6103 | 2602 | 8926 | 2232 | 11150 | 1850 | 12611 | 1533 | 14613 | 1026 | 18291 | 733 | 12968 |
| 16-#11 | 2.36 | MA | 10015 | 2602 | 12405 | 2417 | 16291 | 2029 | 18578 | 1703 | 21027 | 1180 | 26855 | 547 | 22208 |
| 8L-2S | | MI | 6398 | 2602 | 9459 | 2219 | 11825 | 1839 | 13427 | 1525 | 15712 | 1014 | 19781 | 848 | 13003 |
| 16-#14 | 3.41 | MA | 12419 | 2927 | 17408 | 2593 | 22470 | 2152 | 25968 | 1769 | 30943 | 1137 | 40341 | 591 | 34982 |
| 5E | | MI | 6290 | 2927 | 9555 | 2463 | 11798 | 2031 | 13339 | 1656 | 15522 | 1032 | 19464 | 430 | 17123 |
| 16-#14 | 3.41 | MA | 11819 | 2927 | 16363 | 2606 | 21211 | 2173 | 24439 | 1792 | 28770 | 1157 | 37562 | 492 | 33386 |
| 6L-4S | | MI | 6507 | 2927 | 10033 | 2445 | 12474 | 2007 | 14137 | 1644 | 16625 | 1016 | 20936 | 527 | 17725 |
| 16-#14 | 3.41 | MA | 11297 | 2927 | 15365 | 2624 | 19898 | 2188 | 22857 | 1822 | 26658 | 1186 | 34703 | 430 | 31467 |
| 7L-3S | | MI | 6705 | 2927 | 10566 | 2428 | 13170 | 1992 | 15025 | 1623 | 17838 | 1011 | 22415 | 619 | 18182 |
| 16-#14 | 3.41 | MA | 10775 | 2927 | 14266 | 2654 | 18545 | 2216 | 21267 | 1837 | 24554 | 1206 | 31923 | 350 | 29385 |
| 8L-2S | | MI | 7068 | 2927 | 11324 | 2411 | 14128 | 1978 | 16185 | 1611 | 19399 | 995 | 24498 | 784 | 18277 |
| 16-#18 | 6.06 | MA | 14463 | 3751 | 22541 | 3174 | 28820 | 2617 | 33483 | 2093 | 40727 | 1184 | 54433 | 96 | 53749 |
| 6L-4S | | MI | 7817 | 3751 | 13611 | 2957 | 16878 | 2380 | 19375 | 1885 | 23617 | 976 | 29612 | 125 | 28887 |
| 16-#18 | 6.06 | MA | 13591 | 3751 | 20787 | 3204 | 26515 | 2642 | 30748 | 2149 | 37011 | 1233 | 49365 | -15 | 49258 |
| 7L-3S | | MI | 8075 | 3751 | 14538 | 2930 | 18085 | 2358 | 20915 | 1852 | 25718 | 972 | 32098 | 280 | 30762 |
| 18-#10 | 2.16 | MA | 11208 | 2540 | 14269 | 2334 | 18732 | 1953 | 21552 | 1635 | 25114 | 1129 | 32202 | 763 | 23783 |
| 5L-6S | | MI | 5606 | 2540 | 7777 | 2239 | 9715 | 1868 | 10877 | 1562 | 12271 | 1058 | 15375 | 613 | 11601 |
| 18-#10 | 2.16 | MA | 10831 | 2540 | 13669 | 2343 | 18000 | 1965 | 20678 | 1649 | 23872 | 1142 | 30619 | 709 | 23035 |
| 6L-5S | | MI | 5792 | 2540 | 8053 | 2230 | 10070 | 1859 | 11328 | 1549 | 12895 | 1053 | 16236 | 684 | 11850 |
| 18-#10 | 2.16 | MA | 10504 | 2540 | 13098 | 2353 | 17248 | 1974 | 19757 | 1665 | 22665 | 1159 | 29000 | 676 | 22416 |
| 7L-4S | | MI | 5929 | 2540 | 8330 | 2219 | 10461 | 1843 | 11791 | 1540 | 13535 | 1042 | 17128 | 738 | 12051 |
| 18-#10 | 2.16 | MA | 10194 | 2540 | 12469 | 2371 | 16474 | 1990 | 18847 | 1675 | 21463 | 1171 | 27418 | 633 | 21478 |
| 8L-3S | | MI | 6068 | 2540 | 8639 | 2208 | 10865 | 1834 | 12307 | 1527 | 14240 | 1037 | 18018 | 793 | 12100 |
| 18-#10 | 2.16 | MA | 9805 | 2540 | 11910 | 2381 | 15756 | 2002 | 17931 | 1691 | 20258 | 1188 | 25802 | 581 | 20604 |
| 9L-2S | | MI | 6318 | 2540 | 9083 | 2197 | 11426 | 1824 | 12985 | 1518 | 15154 | 1026 | 19282 | 886 | 12125 |
| 18-#11 | 2.66 | MA | 11768 | 2693 | 15705 | 2431 | 20435 | 2026 | 23559 | 1682 | 27761 | 1127 | 35867 | 707 | 28468 |
| 5L-6S | | MI | 5798 | 2693 | 8423 | 2326 | 10433 | 1931 | 11698 | 1601 | 13332 | 1044 | 16656 | 508 | 13751 |
| 18-#11 | 2.66 | MA | 11330 | 2693 | 14975 | 2441 | 19551 | 2041 | 22493 | 1699 | 26246 | 1141 | 33933 | 639 | 27590 |
| 6L-5S | | MI | 6013 | 2693 | 8750 | 2315 | 10863 | 1920 | 12244 | 1585 | 14087 | 1039 | 17675 | 593 | 14025 |
| 18-#11 | 2.66 | MA | 10951 | 2693 | 14279 | 2453 | 18636 | 2051 | 21382 | 1719 | 24774 | 1162 | 31948 | 597 | 26533 |
| 7L-4S | | MI | 6170 | 2693 | 9085 | 2302 | 11337 | 1903 | 12804 | 1576 | 14861 | 1028 | 18726 | 660 | 14430 |
| 18-#11 | 2.66 | MA | 10585 | 2693 | 13513 | 2474 | 17692 | 2071 | 20273 | 1730 | 23308 | 1177 | 30013 | 543 | 25423 |
| 8L-3S | | MI | 6328 | 2693 | 9459 | 2289 | 11825 | 1892 | 13427 | 1560 | 15712 | 1023 | 19781 | 725 | 14514 |
| 18-#11 | 2.66 | MA | 10128 | 2693 | 12837 | 2488 | 16817 | 2084 | 19156 | 1749 | 21856 | 1197 | 28033 | 478 | 24105 |
| 9L-2S | | MI | 6614 | 2693 | 9993 | 2277 | 12500 | 1881 | 14244 | 1552 | 16811 | 1011 | 21270 | 840 | 14557 |
| 18-#14 | 3.84 | MA | 12568 | 3059 | 17949 | 2689 | 23217 | 2234 | 26864 | 1830 | 32036 | 1152 | 42084 | 485 | 37971 |
| 6L-5S | | MI | 6608 | 3059 | 10313 | 2546 | 12757 | 2092 | 14498 | 1695 | 17083 | 1027 | 21548 | 414 | 19273 |
| 18-#14 | 3.84 | MA | 12077 | 3059 | 16950 | 2707 | 21904 | 2249 | 25283 | 1861 | 29924 | 1181 | 39225 | 424 | 36060 |
| 7L-4S | | MI | 6822 | 3059 | 10790 | 2528 | 13432 | 2068 | 15296 | 1683 | 18186 | 1011 | 23019 | 512 | 19849 |
| 18-#14 | 3.84 | MA | 11566 | 3059 | 15852 | 2737 | 20551 | 2276 | 23693 | 1876 | 27820 | 1201 | 36445 | 343 | 33966 |
| 8L-3S | | MI | 7005 | 3059 | 11324 | 2511 | 14128 | 2053 | 16185 | 1662 | 19399 | 1006 | 24498 | 604 | 20371 |
| 18-#14 | 3.84 | MA | 10956 | 3059 | 14888 | 2756 | 19295 | 2296 | 22091 | 1903 | 25745 | 1231 | 33593 | 249 | 31902 |
| 9L-2S | | MI | 7353 | 3059 | 12082 | 2493 | 15087 | 2039 | 17344 | 1650 | 20960 | 990 | 26581 | 769 | 20479 |
| 18-#18 | 6.82 | MA | 15013 | 3986 | 23565 | 3351 | 30028 | 2750 | 34997 | 2218 | 42732 | 1225 | 57286 | -28 | 57037 |
| 7L-4S | | MI | 8334 | 3986 | 14917 | 3104 | 18529 | 2488 | 21372 | 1954 | 26306 | 967 | 33088 | 85 | 32585 |

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 20-#10 | 2.41 | MA | 11280 | 2615 | 14580 | 2389 | 19152 | 1999 | 22072 | 1671 | 25748 | 1139 | 33217 | 705 | 25689 |
| 6E | | MI | 5808 | 2615 | 8220 | 2285 | 10276 | 1903 | 11555 | 1584 | 13184 | 1056 | 16638 | 609 | 12862 |
| 20-#10 | 2.41 | MA | 10966 | 2615 | 14008 | 2400 | 18400 | 2008 | 21150 | 1687 | 24541 | 1157 | 31598 | 672 | 25068 |
| 7L-5S | | MI | 5989 | 2615 | 8497 | 2277 | 10631 | 1893 | 12007 | 1571 | 13809 | 1050 | 17499 | 680 | 13103 |
| 20-#10 | 2.41 | MA | 10661 | 2615 | 13380 | 2418 | 17626 | 2025 | 20240 | 1697 | 23339 | 1169 | 30015 | 629 | 24123 |
| 8L-4S | | MI | 6125 | 2615 | 8773 | 2266 | 11022 | 1878 | 12469 | 1562 | 14448 | 1039 | 18391 | 734 | 13333 |
| 20-#10 | 2.41 | MA | 10285 | 2615 | 12820 | 2428 | 16908 | 2036 | 19324 | 1713 | 22134 | 1185 | 28400 | 577 | 23243 |
| 9L-3S | | MI | 6258 | 2615 | 9083 | 2255 | 11426 | 1868 | 12985 | 1549 | 15154 | 1034 | 19282 | 789 | 13388 |
| 20-#10 | 2.41 | MA | 9935 | 2615 | 12251 | 2438 | 16205 | 2048 | 18442 | 1724 | 20899 | 1194 | 26814 | 540 | 22276 |
| 10L-2S | | MI | 6502 | 2615 | 9526 | 2243 | 11987 | 1858 | 13664 | 1540 | 16067 | 1023 | 20546 | 882 | 13418 |
| 20-#11 | 2.95 | MA | 11861 | 2785 | 16083 | 2498 | 20952 | 2083 | 24187 | 1726 | 28527 | 1138 | 37092 | 634 | 30813 |
| 6E | | MI | 6034 | 2785 | 8957 | 2383 | 11108 | 1973 | 12514 | 1628 | 14431 | 1041 | 18145 | 500 | 15269 |
| 20-#11 | 2.95 | MA | 11499 | 2785 | 15386 | 2511 | 20036 | 2093 | 23076 | 1746 | 27056 | 1159 | 35106 | 592 | 29745 |
| 7L-5S | | MI | 6243 | 2785 | 9284 | 2372 | 11538 | 1962 | 13061 | 1612 | 15186 | 1036 | 19164 | 584 | 15534 |
| 20-#11 | 2.95 | MA | 11138 | 2785 | 14620 | 2532 | 19093 | 2113 | 21967 | 1757 | 25589 | 1173 | 33172 | 538 | 28637 |
| 8L-4S | | MI | 6399 | 2785 | 9618 | 2359 | 12012 | 1945 | 13620 | 1603 | 15960 | 1024 | 20216 | 651 | 15968 |
| 20-#11 | 2.95 | MA | 10699 | 2785 | 13944 | 2545 | 18218 | 2127 | 20850 | 1776 | 24138 | 1194 | 31192 | 473 | 27312 |
| 9L-3S | | MI | 6557 | 2785 | 9993 | 2347 | 12500 | 1934 | 14244 | 1587 | 16811 | 1019 | 21270 | 717 | 16060 |
| 20-#11 | 2.95 | MA | 10289 | 2785 | 13251 | 2556 | 17361 | 2141 | 19775 | 1789 | 22632 | 1204 | 29253 | 426 | 26019 |
| 10L-2S | | MI | 6823 | 2785 | 10526 | 2334 | 13175 | 1923 | 15060 | 1579 | 17910 | 1007 | 22759 | 831 | 16110 |
| 20-#14 | 4.26 | MA | 12835 | 3191 | 18536 | 2790 | 23910 | 2310 | 27709 | 1900 | 33190 | 1176 | 43747 | 417 | 40652 |
| 7L-5S | | MI | 6919 | 3191 | 11070 | 2628 | 13715 | 2153 | 15657 | 1734 | 18644 | 1022 | 23631 | 399 | 21428 |
| 20-#14 | 4.26 | MA | 12332 | 3191 | 17437 | 2820 | 22556 | 2337 | 26119 | 1915 | 31087 | 1196 | 40967 | 336 | 38547 |
| 8L-4S | | MI | 7131 | 3191 | 11548 | 2611 | 14391 | 2129 | 16455 | 1722 | 19747 | 1006 | 25102 | 496 | 21980 |
| 20-#14 | 4.26 | MA | 11751 | 3191 | 16474 | 2839 | 21301 | 2357 | 24517 | 1942 | 29012 | 1226 | 38115 | 242 | 36473 |
| 9L-3S | | MI | 7301 | 3191 | 12082 | 2594 | 15087 | 2114 | 17344 | 1701 | 20960 | 1001 | 26581 | 588 | 22560 |
| 22-#10 | 2.65 | MA | 11418 | 2689 | 14919 | 2447 | 19552 | 2043 | 22544 | 1709 | 26417 | 1154 | 34195 | 668 | 27720 |
| 7L-6S | | MI | 6007 | 2689 | 8664 | 2332 | 10837 | 1937 | 12233 | 1606 | 14098 | 1053 | 17902 | 605 | 14126 |
| 22-#10 | 2.65 | MA | 11117 | 2689 | 14291 | 2464 | 18777 | 2059 | 21634 | 1719 | 25215 | 1166 | 32613 | 625 | 26768 |
| 8L-5S | | MI | 6183 | 2689 | 8940 | 2323 | 11192 | 1927 | 12685 | 1593 | 14722 | 1048 | 18763 | 676 | 14359 |
| 22-#10 | 2.65 | MA | 10753 | 2689 | 13731 | 2475 | 18060 | 2071 | 20717 | 1735 | 24010 | 1182 | 30997 | 573 | 25882 |
| 9L-4S | | MI | 6318 | 2689 | 9216 | 2312 | 11583 | 1912 | 13147 | 1584 | 15362 | 1037 | 19655 | 730 | 14615 |
| 22-#10 | 2.65 | MA | 10416 | 2689 | 13162 | 2484 | 17357 | 2083 | 19835 | 1746 | 22775 | 1191 | 29412 | 536 | 24917 |
| 10L-3S | | MI | 6446 | 2689 | 9526 | 2301 | 11987 | 1902 | 13664 | 1571 | 16067 | 1031 | 20546 | 785 | 14675 |
| 22-#10 | 2.65 | MA | 10095 | 2689 | 12605 | 2495 | 16634 | 2093 | 18967 | 1757 | 21557 | 1206 | 27872 | 491 | 23867 |
| 11L-2S | | MI | 6684 | 2689 | 9969 | 2290 | 12548 | 1893 | 14342 | 1562 | 16980 | 1020 | 21809 | 878 | 14710 |
| 22-#11 | 3.25 | MA | 12035 | 2877 | 16494 | 2568 | 21437 | 2136 | 24771 | 1773 | 29337 | 1155 | 38265 | 588 | 32957 |
| 7L-6S | | MI | 6267 | 2877 | 9490 | 2441 | 11783 | 2015 | 13330 | 1655 | 15530 | 1038 | 19635 | 492 | 16791 |
| 22-#11 | 3.25 | MA | 11679 | 2877 | 15728 | 2589 | 20493 | 2155 | 23661 | 1784 | 27871 | 1170 | 36331 | 533 | 31851 |
| 8L-5S | | MI | 6482 | 2877 | 9817 | 2430 | 12213 | 2005 | 13877 | 1639 | 16285 | 1033 | 20654 | 576 | 17047 |
| 22-#11 | 3.25 | MA | 11255 | 2877 | 15052 | 2602 | 19618 | 2169 | 22545 | 1803 | 26419 | 1190 | 34350 | 469 | 30519 |
| 9L-4S | | MI | 6636 | 2877 | 10152 | 2417 | 12686 | 1987 | 14436 | 1630 | 17059 | 1021 | 21705 | 643 | 17507 |
| 22-#11 | 3.25 | MA | 10862 | 2877 | 14358 | 2614 | 18761 | 2183 | 21469 | 1816 | 24913 | 1201 | 32412 | 421 | 29220 |
| 10L-3S | | MI | 6772 | 2877 | 10526 | 2404 | 13175 | 1976 | 15060 | 1614 | 17910 | 1016 | 22759 | 709 | 17606 |
| 22-#11 | 3.25 | MA | 10488 | 2877 | 13679 | 2626 | 17888 | 2196 | 20410 | 1830 | 23429 | 1219 | 30529 | 364 | 27887 |
| 11L-2S | | MI | 7029 | 2877 | 11060 | 2391 | 13850 | 1965 | 15876 | 1606 | 19009 | 1004 | 24249 | 823 | 17662 |
| 22-#14 | 4.69 | MA | 13078 | 3324 | 19023 | 2903 | 24562 | 2398 | 28545 | 1954 | 34353 | 1191 | 45490 | 329 | 43128 |
| 8L-5S | | MI | 7224 | 3324 | 11828 | 2711 | 14674 | 2214 | 16817 | 1772 | 20205 | 1017 | 25714 | 383 | 23587 |
| 22-#14 | 4.69 | MA | 12523 | 3324 | 18059 | 2922 | 23307 | 2417 | 26943 | 1981 | 32278 | 1221 | 42638 | 235 | 41044 |
| 9L-4S | | MI | 7434 | 3324 | 12306 | 2694 | 15349 | 2189 | 17615 | 1761 | 21308 | 1001 | 27185 | 481 | 24119 |
| 24-#10 | 2.89 | MA | 11563 | 2764 | 15201 | 2511 | 19929 | 2093 | 23027 | 1741 | 27091 | 1163 | 35210 | 621 | 29413 |
| 8L-6S | | MI | 6203 | 2764 | 9107 | 2379 | 11398 | 1971 | 12912 | 1628 | 15011 | 1050 | 19166 | 601 | 15392 |
| 24-#10 | 2.89 | MA | 11211 | 2764 | 14642 | 2522 | 19212 | 2105 | 22111 | 1757 | 25886 | 1179 | 33595 | 569 | 28521 |
| 9L-5S | | MI | 6374 | 2764 | 9384 | 2370 | 11753 | 1962 | 13363 | 1615 | 15635 | 1045 | 20027 | 672 | 15618 |
| 24-#10 | 2.89 | MA | 10885 | 2764 | 14073 | 2531 | 18509 | 2117 | 21229 | 1768 | 24651 | 1188 | 32009 | 532 | 27558 |
| 10L-4S | | MI | 6509 | 2764 | 9660 | 2359 | 12144 | 1946 | 13826 | 1606 | 16275 | 1034 | 20919 | 726 | 15897 |
| 24-#10 | 2.89 | MA | 10578 | 2764 | 13515 | 2542 | 17786 | 2127 | 20360 | 1779 | 23433 | 1204 | 30470 | 487 | 26504 |
| 11L-3S | | MI | 6632 | 2764 | 9969 | 2348 | 12548 | 1937 | 14342 | 1592 | 16980 | 1028 | 21809 | 781 | 15962 |

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 24-#10 | 2.89 | MA | 10223 | 2764 | 12969 | 2553 | 17015 | 2143 | 19472 | 1797 | 22219 | 1214 | 28844 | 441 | 25439 |
| 12L-2S | | MI | 6863 | 2764 | 10413 | 2337 | 13109 | 1927 | 15021 | 1584 | 17894 | 1018 | 23073 | 874 | 16001 |
| 24-#11 | 3.55 | MA | 12207 | 2969 | 16835 | 2647 | 21894 | 2197 | 25356 | 1811 | 30152 | 1166 | 39490 | 528 | 35065 |
| 8L-6S | | MI | 6511 | 2969 | 10023 | 2498 | 12458 | 2058 | 14146 | 1682 | 16629 | 1034 | 21124 | 483 | 18301 |
| 24-#11 | 3.55 | MA | 11798 | 2969 | 16159 | 2660 | 21019 | 2211 | 24239 | 1830 | 28700 | 1187 | 37509 | 464 | 33726 |
| 9L-5S | | MI | 6702 | 2969 | 10351 | 2487 | 12887 | 2047 | 14693 | 1666 | 17384 | 1029 | 22143 | 568 | 18563 |
| 24-#11 | 3.55 | MA | 11421 | 2969 | 15466 | 2671 | 20162 | 2225 | 23163 | 1843 | 27195 | 1197 | 35570 | 417 | 32421 |
| 10L-4S | | MI | 6856 | 2969 | 10685 | 2474 | 13361 | 2029 | 15252 | 1657 | 18158 | 1017 | 23195 | 635 | 19007 |
| 24-#11 | 3.55 | MA | 11064 | 2969 | 14787 | 2684 | 19289 | 2238 | 22104 | 1857 | 25710 | 1215 | 33688 | 359 | 31083 |
| 11L-3S | | MI | 6984 | 2969 | 11060 | 2462 | 13850 | 2018 | 15876 | 1641 | 19009 | 1012 | 24249 | 700 | 19151 |
| 24-#14 | 5.11 | MA | 13276 | 3456 | 19645 | 3005 | 25312 | 2478 | 29369 | 2020 | 35544 | 1216 | 47160 | 229 | 45615 |
| 9L-5S | | MI | 7524 | 3456 | 12586 | 2794 | 15632 | 2275 | 17976 | 1811 | 21766 | 1012 | 27797 | 368 | 25751 |

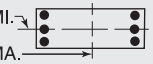
## RECTANGULAR TIED COLUMNS 24" x 46"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#18 | 1.45 | MA | 11990 | 2423 | 15087 | 2227 | 19695 | 1865 | 22532 | 1576 | 26023 | 1126 | 32908 | 979 | 17514 |
| 2E | | MI | 5858 | 2423 | 8255 | 2098 | 10124 | 1755 | 11242 | 1479 | 12584 | 1050 | 15074 | 856 | 8347 |
| 6-#14 | 1.22 | MA | 11627 | 2349 | 14070 | 2194 | 18539 | 1842 | 21202 | 1563 | 24295 | 1137 | 30562 | 990 | 14982 |
| 2L-3S | | MI | 5269 | 2349 | 7017 | 2094 | 8671 | 1756 | 9543 | 1487 | 10348 | 1082 | 12356 | 738 | 7241 |
| 6-#14 | 1.22 | MA | 10534 | 2349 | 12402 | 2220 | 16429 | 1867 | 18649 | 1587 | 20858 | 1167 | 25804 | 848 | 14882 |
| 3L-2S | | MI | 5746 | 2349 | 7775 | 2076 | 9629 | 1742 | 10702 | 1476 | 11908 | 1067 | 14439 | 903 | 7234 |
| 6-#18 | 2.17 | MA | 13317 | 2658 | 18011 | 2374 | 23395 | 1973 | 27007 | 1645 | 32047 | 1117 | 41249 | 967 | 26058 |
| 2L-3S | | MI | 5644 | 2658 | 8255 | 2272 | 10124 | 1884 | 11242 | 1564 | 12584 | 1063 | 15074 | 522 | 12055 |
| 6-#18 | 2.17 | MA | 11598 | 2658 | 15087 | 2419 | 19695 | 2015 | 22532 | 1684 | 26023 | 1169 | 32908 | 709 | 25599 |
| 3L-2S | | MI | 6392 | 2658 | 9561 | 2245 | 11776 | 1863 | 13240 | 1549 | 15274 | 1041 | 18549 | 816 | 12181 |
| 8-#11 | 1.13 | MA | 11476 | 2319 | 13637 | 2181 | 18057 | 1834 | 20652 | 1559 | 23588 | 1141 | 29607 | 994 | 13940 |
| 2L-4S | | MI | 5157 | 2319 | 6654 | 2095 | 8255 | 1760 | 9036 | 1501 | 9681 | 1092 | 11637 | 742 | 6763 |
| 8-#11 | 1.13 | MA | 10708 | 2319 | 12472 | 2200 | 16583 | 1851 | 18870 | 1576 | 21188 | 1163 | 26284 | 897 | 13894 |
| 3E | | MI | 5362 | 2319 | 7028 | 2082 | 8743 | 1749 | 9660 | 1485 | 10532 | 1087 | 12691 | 808 | 6779 |
| 8-#11 | 1.13 | MA | 10264 | 2319 | 11681 | 2218 | 15547 | 1869 | 17543 | 1599 | 19372 | 1178 | 24102 | 835 | 13723 |
| 4L-2S | | MI | 5700 | 2319 | 7562 | 2070 | 9418 | 1738 | 10476 | 1476 | 11631 | 1075 | 14180 | 922 | 6770 |
| 8-#14 | 1.63 | MA | 12419 | 2482 | 15739 | 2277 | 20650 | 1903 | 23754 | 1602 | 27732 | 1132 | 35321 | 983 | 19861 |
| 2L-4S | | MI | 5341 | 2482 | 7241 | 2194 | 8933 | 1831 | 9814 | 1548 | 10696 | 1083 | 12959 | 630 | 9336 |
| 8-#14 | 1.63 | MA | 11387 | 2482 | 14070 | 2303 | 18539 | 1927 | 21202 | 1626 | 24295 | 1162 | 30562 | 841 | 19731 |
| 3E | | MI | 5617 | 2482 | 7775 | 2176 | 9629 | 1817 | 10702 | 1526 | 11908 | 1077 | 14439 | 722 | 9447 |
| 8-#14 | 1.63 | MA | 10795 | 2482 | 12934 | 2329 | 17053 | 1952 | 19298 | 1659 | 21691 | 1182 | 27421 | 751 | 19260 |
| 4L-2S | | MI | 6071 | 2482 | 8532 | 2159 | 10588 | 1802 | 11861 | 1515 | 13469 | 1062 | 16522 | 887 | 9467 |
| 8-#18 | 2.90 | MA | 14579 | 2894 | 20935 | 2521 | 27094 | 2081 | 31481 | 1714 | 38072 | 1109 | 49590 | 955 | 34594 |
| 2L-4S | | MI | 5784 | 2894 | 8634 | 2447 | 10568 | 2014 | 11700 | 1667 | 13172 | 1058 | 16063 | 327 | 14397 |
| 8-#18 | 2.90 | MA | 12997 | 2894 | 18011 | 2566 | 23395 | 2123 | 27007 | 1753 | 32047 | 1160 | 41249 | 697 | 34100 |
| 3E | | MI | 6223 | 2894 | 9561 | 2420 | 11776 | 1993 | 13240 | 1633 | 15274 | 1054 | 18549 | 482 | 15801 |
| 8-#18 | 2.90 | MA | 12100 | 2894 | 16013 | 2611 | 20781 | 2165 | 23661 | 1810 | 27471 | 1193 | 35692 | 535 | 30827 |
| 4L-2S | | MI | 6897 | 2894 | 10866 | 2392 | 13427 | 1971 | 15237 | 1618 | 17963 | 1032 | 22025 | 776 | 15987 |
| 10-#10 | 1.15 | MA | 11564 | 2326 | 13643 | 2194 | 18155 | 1844 | 20819 | 1568 | 23857 | 1146 | 30013 | 999 | 14275 |
| 2L-5S | | MI | 5166 | 2326 | 6511 | 2124 | 8116 | 1790 | 8927 | 1521 | 9556 | 1112 | 11540 | 742 | 6893 |
| 10-#10 | 1.15 | MA | 10935 | 2326 | 12685 | 2210 | 16944 | 1859 | 19354 | 1582 | 21885 | 1164 | 27282 | 921 | 14239 |
| 3L-4S | | MI | 5310 | 2326 | 6787 | 2113 | 8508 | 1775 | 9390 | 1513 | 10196 | 1101 | 12432 | 796 | 6940 |
| 10-#10 | 1.15 | MA | 10579 | 2326 | 12036 | 2225 | 16094 | 1873 | 18265 | 1601 | 20395 | 1177 | 25500 | 871 | 14132 |
| 4L-3S | | MI | 5477 | 2326 | 7097 | 2102 | 8912 | 1765 | 9906 | 1499 | 10901 | 1096 | 13323 | 851 | 6951 |
| 10-#10 | 1.15 | MA | 10179 | 2326 | 11439 | 2238 | 15277 | 1894 | 17299 | 1615 | 19054 | 1195 | 23590 | 827 | 13872 |
| 5L-2S | | MI | 5758 | 2326 | 7540 | 2091 | 9473 | 1756 | 10584 | 1491 | 11815 | 1085 | 14587 | 944 | 6947 |
| 10-#11 | 1.41 | MA | 12041 | 2411 | 14802 | 2239 | 19530 | 1876 | 22435 | 1586 | 25987 | 1138 | 32929 | 990 | 17348 |
| 2L-5S | | MI | 5246 | 2411 | 6853 | 2165 | 8456 | 1820 | 9293 | 1537 | 10006 | 1101 | 12075 | 667 | 8116 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

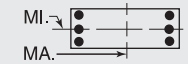
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.41 | MA | 11304 | 2411 | 13637 | 2257 | 18057 | 1893 | 20652 | 1603 | 23588 | 1159 | 29607 | 893 | 17287 |
| 3L-4S | | MI | 5413 | 2411 | 7187 | 2153 | 8929 | 1802 | 9852 | 1528 | 10780 | 1089 | 13126 | 734 | 8308 |
| 10-#11 | 1.41 | MA | 10889 | 2411 | 12845 | 2276 | 17020 | 1911 | 19325 | 1626 | 21772 | 1174 | 27424 | 831 | 17104 |
| 4L-3S | | MI | 5608 | 2411 | 7562 | 2140 | 9418 | 1791 | 10476 | 1512 | 11631 | 1084 | 14180 | 800 | 8341 |
| 10-#11 | 1.41 | MA | 10414 | 2411 | 12123 | 2292 | 16024 | 1935 | 18147 | 1643 | 20137 | 1196 | 25091 | 775 | 16531 |
| 5L-2S | | MI | 5934 | 2411 | 8095 | 2127 | 10093 | 1780 | 11292 | 1503 | 12730 | 1072 | 15670 | 914 | 8344 |
| 10-#14 | 2.04 | MA | 13182 | 2614 | 17407 | 2359 | 22760 | 1964 | 26307 | 1641 | 31168 | 1127 | 40079 | 976 | 24735 |
| 2L-5S | | MI | 5470 | 2614 | 7521 | 2294 | 9216 | 1917 | 10175 | 1598 | 11154 | 1094 | 13571 | 517 | 10810 |
| 10-#14 | 2.04 | MA | 12204 | 2614 | 15739 | 2386 | 20650 | 1988 | 23754 | 1664 | 27732 | 1157 | 35321 | 834 | 24583 |
| 3L-4S | | MI | 5695 | 2614 | 7999 | 2277 | 9892 | 1892 | 10973 | 1587 | 12257 | 1078 | 15042 | 615 | 11507 |
| 10-#14 | 2.04 | MA | 11661 | 2614 | 14603 | 2412 | 19163 | 2013 | 21851 | 1698 | 25128 | 1177 | 32180 | 744 | 24116 |
| 4L-3S | | MI | 5953 | 2614 | 8532 | 2259 | 10588 | 1878 | 11861 | 1565 | 13469 | 1072 | 16522 | 707 | 11644 |
| 10-#14 | 2.04 | MA | 10999 | 2614 | 13572 | 2435 | 17733 | 2048 | 20160 | 1721 | 22782 | 1207 | 28829 | 662 | 22361 |
| 5L-2S | | MI | 6387 | 2614 | 9290 | 2242 | 11546 | 1863 | 13021 | 1554 | 15030 | 1057 | 18605 | 872 | 11686 |
| 10-#18 | 3.62 | MA | 14326 | 3129 | 20935 | 2713 | 27094 | 2231 | 31481 | 1822 | 38072 | 1151 | 49590 | 685 | 42614 |
| 3L-4S | | MI | 6391 | 3129 | 9940 | 2594 | 12220 | 2122 | 13697 | 1736 | 15862 | 1049 | 19539 | 286 | 18015 |
| 10-#18 | 3.62 | MA | 13540 | 3129 | 18937 | 2758 | 24480 | 2273 | 28135 | 1879 | 33495 | 1184 | 44033 | 523 | 39286 |
| 4L-3S | | MI | 6761 | 3129 | 10866 | 2567 | 13427 | 2101 | 15237 | 1703 | 17963 | 1045 | 22025 | 442 | 19548 |
| 10-#18 | 3.62 | MA | 12429 | 3129 | 17145 | 2801 | 21962 | 2333 | 25159 | 1918 | 29368 | 1235 | 38123 | 370 | 35938 |
| 5L-2S | | MI | 7386 | 3129 | 12172 | 2539 | 15079 | 2079 | 17235 | 1687 | 20653 | 1023 | 25500 | 735 | 19780 |
| 12-#10 | 1.38 | MA | 12032 | 2400 | 14600 | 2241 | 19366 | 1878 | 22284 | 1590 | 25829 | 1144 | 32744 | 995 | 17076 |
| 2L-6S | | MI | 5177 | 2400 | 6678 | 2179 | 8322 | 1834 | 9154 | 1557 | 9846 | 1115 | 11943 | 667 | 7895 |
| 12-#10 | 1.38 | MA | 11424 | 2400 | 13643 | 2256 | 18155 | 1893 | 20819 | 1604 | 23857 | 1162 | 30013 | 917 | 17031 |
| 3L-5S | | MI | 5381 | 2400 | 6955 | 2171 | 8677 | 1824 | 9606 | 1543 | 10470 | 1109 | 12804 | 738 | 8169 |
| 12-#10 | 1.38 | MA | 11087 | 2400 | 12994 | 2272 | 17305 | 1908 | 19730 | 1623 | 22367 | 1174 | 28230 | 867 | 16915 |
| 4E | | MI | 5523 | 2400 | 7231 | 2159 | 9068 | 1809 | 10068 | 1535 | 11110 | 1098 | 13696 | 792 | 8227 |
| 12-#10 | 1.38 | MA | 10693 | 2400 | 12396 | 2285 | 16488 | 1928 | 18764 | 1637 | 21026 | 1192 | 26321 | 823 | 16658 |
| 5L-3S | | MI | 5683 | 2400 | 7540 | 2148 | 9473 | 1800 | 10584 | 1521 | 11815 | 1093 | 14587 | 847 | 8249 |
| 12-#10 | 1.38 | MA | 10249 | 2400 | 11767 | 2293 | 15715 | 1939 | 17847 | 1651 | 19722 | 1205 | 24661 | 770 | 15909 |
| 6L-2S | | MI | 5956 | 2400 | 7984 | 2137 | 10033 | 1790 | 11263 | 1513 | 12728 | 1082 | 15850 | 940 | 8253 |
| 12-#11 | 1.70 | MA | 12590 | 2503 | 15967 | 2296 | 21004 | 1918 | 24217 | 1613 | 28387 | 1135 | 36252 | 985 | 20753 |
| 2L-6S | | MI | 5261 | 2503 | 7059 | 2234 | 8701 | 1873 | 9563 | 1579 | 10350 | 1102 | 12545 | 574 | 9288 |
| 12-#11 | 1.70 | MA | 11881 | 2503 | 14802 | 2315 | 19530 | 1935 | 22435 | 1630 | 25987 | 1156 | 32929 | 888 | 20680 |
| 3L-5S | | MI | 5500 | 2503 | 7386 | 2223 | 9131 | 1862 | 10109 | 1564 | 11105 | 1097 | 13564 | 659 | 9600 |
| 12-#11 | 1.70 | MA | 11491 | 2503 | 14010 | 2333 | 18494 | 1953 | 21107 | 1653 | 24171 | 1171 | 30747 | 826 | 20489 |
| 4E | | MI | 5662 | 2503 | 7721 | 2210 | 9604 | 1844 | 10669 | 1555 | 11879 | 1085 | 14616 | 726 | 9849 |
| 12-#11 | 1.70 | MA | 11025 | 2503 | 13288 | 2349 | 17497 | 1977 | 19929 | 1670 | 22536 | 1192 | 28414 | 770 | 19902 |
| 5L-3S | | MI | 5847 | 2503 | 8095 | 2197 | 10093 | 1833 | 11292 | 1539 | 12730 | 1080 | 15670 | 791 | 9896 |
| 12-#11 | 1.70 | MA | 10500 | 2503 | 12521 | 2359 | 16563 | 1992 | 18810 | 1686 | 20946 | 1207 | 26385 | 704 | 18905 |
| 6L-2S | | MI | 6163 | 2503 | 8628 | 2184 | 10767 | 1823 | 12109 | 1530 | 13829 | 1068 | 17159 | 906 | 9910 |
| 12-#14 | 2.45 | MA | 12990 | 2747 | 17407 | 2468 | 22760 | 2049 | 26307 | 1703 | 31168 | 1152 | 40079 | 827 | 29439 |
| 3L-5S | | MI | 5817 | 2747 | 8279 | 2377 | 10175 | 1977 | 11334 | 1637 | 12715 | 1089 | 15654 | 502 | 12933 |
| 12-#14 | 2.45 | MA | 12491 | 2747 | 16271 | 2494 | 21274 | 2074 | 24403 | 1736 | 28564 | 1172 | 36939 | 737 | 28977 |
| 4E | | MI | 6038 | 2747 | 8756 | 2359 | 10850 | 1953 | 12132 | 1626 | 13818 | 1073 | 17125 | 599 | 13607 |
| 12-#14 | 2.45 | MA | 11842 | 2747 | 15240 | 2518 | 19843 | 2108 | 22712 | 1760 | 26218 | 1202 | 33587 | 655 | 27206 |
| 5L-3S | | MI | 6279 | 2747 | 9290 | 2342 | 11546 | 1939 | 13021 | 1604 | 15030 | 1068 | 18605 | 691 | 13837 |
| 12-#14 | 2.45 | MA | 11134 | 2747 | 14141 | 2532 | 18512 | 2130 | 21106 | 1783 | 23936 | 1223 | 30672 | 558 | 25662 |
| 6L-2S | | MI | 6696 | 2747 | 10048 | 2325 | 12505 | 1924 | 14180 | 1593 | 16591 | 1052 | 20688 | 857 | 13897 |
| 12-#18 | 4.35 | MA | 14912 | 3365 | 21861 | 2905 | 28180 | 2382 | 32609 | 1948 | 39519 | 1175 | 52374 | 511 | 47744 |
| 4E | | MI | 6951 | 3365 | 11246 | 2741 | 13871 | 2230 | 15695 | 1805 | 18551 | 1040 | 23014 | 246 | 21658 |
| 12-#18 | 4.35 | MA | 13823 | 3365 | 20069 | 2948 | 25662 | 2441 | 29633 | 1987 | 35392 | 1227 | 46464 | 358 | 44356 |
| 5L-3S | | MI | 7281 | 3365 | 12172 | 2714 | 15079 | 2209 | 17235 | 1772 | 20653 | 1036 | 25500 | 401 | 23300 |
| 12-#18 | 4.35 | MA | 12723 | 3365 | 18140 | 2972 | 23353 | 2480 | 26805 | 2027 | 31375 | 1260 | 41320 | 178 | 39951 |
| 6L-2S | | MI | 7865 | 3365 | 13478 | 2686 | 16730 | 2187 | 19232 | 1756 | 23342 | 1014 | 28976 | 695 | 23567 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

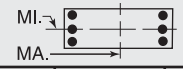



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 1.61 | MA | 11900 | 2475 | 14600 | 2303 | 19366 | 1927 | 22284 | 1626 | 25829 | 1159 | 32744 | 913 | 19823 |
| 3L-6S | | MI | 5394 | 2475 | 7121 | 2226 | 8883 | 1868 | 9832 | 1579 | 10759 | 1112 | 13207 | 663 | 9145 |
| 14-#10 | 1.61 | MA | 11581 | 2475 | 13951 | 2318 | 18516 | 1942 | 21195 | 1645 | 24339 | 1171 | 30961 | 863 | 19700 |
| 4L-5S | | MI | 5591 | 2475 | 7398 | 2217 | 9238 | 1859 | 10284 | 1565 | 11383 | 1107 | 14068 | 734 | 9418 |
| 14-#10 | 1.61 | MA | 11192 | 2475 | 13354 | 2331 | 17699 | 1962 | 20229 | 1659 | 22999 | 1189 | 29052 | 819 | 19445 |
| 5L-4S | | MI | 5732 | 2475 | 7674 | 2206 | 9629 | 1844 | 10746 | 1557 | 12023 | 1096 | 14960 | 788 | 9513 |
| 14-#10 | 1.61 | MA | 10764 | 2475 | 12724 | 2340 | 16926 | 1974 | 19312 | 1673 | 21695 | 1202 | 27392 | 767 | 18696 |
| 6L-3S | | MI | 5885 | 2475 | 7984 | 2195 | 10033 | 1834 | 11263 | 1543 | 12728 | 1090 | 15850 | 843 | 9543 |
| 14-#10 | 1.61 | MA | 10387 | 2475 | 12124 | 2351 | 16136 | 1983 | 18339 | 1689 | 20428 | 1220 | 25697 | 733 | 18037 |
| 7L-2S | | MI | 6150 | 2475 | 8427 | 2184 | 10594 | 1824 | 11941 | 1535 | 13642 | 1079 | 17114 | 936 | 9554 |
| 14-#11 | 1.98 | MA | 12442 | 2595 | 15967 | 2372 | 21004 | 1978 | 24217 | 1657 | 28387 | 1153 | 36252 | 883 | 24074 |
| 3L-6S | | MI | 5514 | 2595 | 7592 | 2291 | 9376 | 1915 | 10379 | 1606 | 11449 | 1099 | 14035 | 566 | 10794 |
| 14-#11 | 1.98 | MA | 12076 | 2595 | 15175 | 2390 | 19967 | 1995 | 22890 | 1680 | 26571 | 1167 | 34069 | 821 | 23876 |
| 4L-5S | | MI | 5745 | 2595 | 7919 | 2280 | 9805 | 1904 | 10925 | 1591 | 12204 | 1094 | 15053 | 651 | 11091 |
| 14-#11 | 1.98 | MA | 11616 | 2595 | 14452 | 2407 | 18971 | 2019 | 21711 | 1697 | 24936 | 1189 | 31736 | 765 | 23277 |
| 5L-4S | | MI | 5905 | 2595 | 8254 | 2267 | 10279 | 1886 | 11485 | 1582 | 12978 | 1082 | 16105 | 718 | 11389 |
| 14-#11 | 1.98 | MA | 11112 | 2595 | 13686 | 2417 | 18036 | 2034 | 20592 | 1713 | 23345 | 1203 | 29707 | 699 | 22295 |
| 6L-3S | | MI | 6082 | 2595 | 8628 | 2255 | 10767 | 1876 | 12109 | 1566 | 13829 | 1077 | 17159 | 783 | 11447 |
| 14-#11 | 1.98 | MA | 10669 | 2595 | 12954 | 2430 | 17074 | 2045 | 19418 | 1734 | 21800 | 1225 | 27629 | 657 | 21270 |
| 7L-2S | | MI | 6388 | 2595 | 9162 | 2242 | 11442 | 1865 | 12925 | 1557 | 14928 | 1065 | 18649 | 898 | 11471 |
| 14-#14 | 2.85 | MA | 13293 | 2879 | 17939 | 2577 | 23384 | 2135 | 26956 | 1775 | 32001 | 1167 | 41697 | 731 | 33842 |
| 4L-5S | | MI | 6153 | 2879 | 9036 | 2460 | 11133 | 2038 | 12494 | 1676 | 14275 | 1084 | 17737 | 486 | 15066 |
| 14-#14 | 2.85 | MA | 12654 | 2879 | 16908 | 2601 | 21953 | 2169 | 25265 | 1799 | 29655 | 1198 | 38346 | 648 | 32052 |
| 5L-4S | | MI | 6371 | 2879 | 9514 | 2442 | 11809 | 2014 | 13292 | 1664 | 15378 | 1068 | 19209 | 584 | 15707 |
| 14-#14 | 2.85 | MA | 11983 | 2879 | 15809 | 2615 | 20622 | 2190 | 23658 | 1822 | 27372 | 1218 | 35430 | 551 | 30488 |
| 6L-3S | | MI | 6608 | 2879 | 10048 | 2425 | 12505 | 1999 | 14180 | 1643 | 16591 | 1063 | 20688 | 676 | 16028 |
| 14-#14 | 2.85 | MA | 11392 | 2879 | 14760 | 2633 | 19243 | 2206 | 21986 | 1852 | 25155 | 1248 | 32437 | 490 | 28428 |
| 7L-2S | | MI | 6993 | 2879 | 10805 | 2407 | 13463 | 1985 | 15339 | 1632 | 18152 | 1047 | 22771 | 841 | 16104 |
| 14-#18 | 5.07 | MA | 15160 | 3600 | 22994 | 3095 | 29361 | 2549 | 34107 | 2057 | 41416 | 1218 | 54806 | 346 | 52773 |
| 5L-4S | | MI | 7493 | 3600 | 12551 | 2889 | 15523 | 2339 | 17692 | 1874 | 21241 | 1031 | 26490 | 206 | 25321 |
| 14-#18 | 5.07 | MA | 14139 | 3600 | 21064 | 3119 | 27052 | 2588 | 31279 | 2096 | 37399 | 1251 | 49661 | 166 | 48394 |
| 6L-3S | | MI | 7789 | 3600 | 13478 | 2861 | 16730 | 2317 | 19232 | 1841 | 23342 | 1027 | 28976 | 361 | 27055 |
| 14-#18 | 5.07 | MA | 13236 | 3600 | 19220 | 3150 | 24628 | 2614 | 28381 | 2151 | 33495 | 1302 | 44355 | 56 | 43999 |
| 7L-2S | | MI | 8337 | 3600 | 14783 | 2834 | 18382 | 2295 | 21230 | 1825 | 26031 | 1006 | 32451 | 655 | 27351 |
| 16-#10 | 1.84 | MA | 12062 | 2550 | 14908 | 2365 | 19727 | 1976 | 22660 | 1667 | 26311 | 1169 | 33692 | 859 | 22487 |
| 4L-6S | | MI | 5605 | 2550 | 7565 | 2273 | 9444 | 1903 | 10511 | 1601 | 11672 | 1109 | 14471 | 659 | 10400 |
| 16-#10 | 1.84 | MA | 11678 | 2550 | 14311 | 2378 | 18910 | 1997 | 21694 | 1681 | 24971 | 1187 | 31782 | 815 | 22235 |
| 5E | | MI | 5797 | 2550 | 7841 | 2264 | 9799 | 1893 | 10962 | 1587 | 12297 | 1104 | 15332 | 730 | 10662 |
| 16-#10 | 1.84 | MA | 11264 | 2550 | 13681 | 2387 | 18137 | 2008 | 20777 | 1695 | 23667 | 1199 | 30122 | 763 | 21484 |
| 6L-4S | | MI | 5936 | 2550 | 8118 | 2253 | 10190 | 1878 | 11425 | 1579 | 12937 | 1093 | 16223 | 784 | 10797 |
| 16-#10 | 1.84 | MA | 10903 | 2550 | 13081 | 2397 | 17347 | 2017 | 19804 | 1711 | 22401 | 1217 | 28428 | 729 | 20825 |
| 7L-3S | | MI | 6082 | 2550 | 8427 | 2242 | 10594 | 1868 | 11941 | 1565 | 13642 | 1087 | 17114 | 839 | 10835 |
| 16-#10 | 1.84 | MA | 10567 | 2550 | 12421 | 2415 | 16534 | 2034 | 18848 | 1721 | 21139 | 1230 | 26769 | 687 | 19890 |
| 8L-2S | | MI | 6341 | 2550 | 8871 | 2231 | 11155 | 1859 | 12620 | 1556 | 14555 | 1077 | 18378 | 932 | 10851 |
| 16-#11 | 2.26 | MA | 12644 | 2686 | 16340 | 2448 | 21441 | 2037 | 24672 | 1707 | 28970 | 1164 | 37391 | 816 | 27266 |
| 4L-6S | | MI | 5761 | 2686 | 8126 | 2349 | 10051 | 1957 | 11195 | 1633 | 12547 | 1095 | 15524 | 558 | 12304 |
| 16-#11 | 2.26 | MA | 12190 | 2686 | 15617 | 2464 | 20444 | 2062 | 23493 | 1724 | 27335 | 1185 | 35059 | 761 | 26655 |
| 5E | | MI | 5985 | 2686 | 8453 | 2337 | 10480 | 1946 | 11742 | 1618 | 13303 | 1090 | 16543 | 642 | 12589 |
| 16-#11 | 2.26 | MA | 11706 | 2686 | 14850 | 2474 | 19510 | 2076 | 22374 | 1740 | 25745 | 1200 | 33030 | 694 | 25685 |
| 6L-4S | | MI | 6143 | 2686 | 8788 | 2325 | 10954 | 1929 | 12301 | 1609 | 14077 | 1078 | 17594 | 709 | 12928 |
| 16-#11 | 2.26 | MA | 11284 | 2686 | 14119 | 2487 | 18548 | 2087 | 21200 | 1761 | 24200 | 1221 | 30952 | 653 | 24649 |
| 7L-3S | | MI | 6312 | 2686 | 9162 | 2312 | 11442 | 1918 | 12925 | 1593 | 14928 | 1073 | 18649 | 775 | 12997 |
| 16-#11 | 2.26 | MA | 10886 | 2686 | 13314 | 2508 | 17556 | 2107 | 20035 | 1772 | 22660 | 1236 | 28924 | 599 | 23464 |
| 8L-2S | | MI | 6609 | 2686 | 9695 | 2299 | 12117 | 1907 | 13741 | 1584 | 16027 | 1061 | 20138 | 890 | 13028 |
| 16-#14 | 3.26 | MA | 13440 | 3011 | 18577 | 2683 | 24064 | 2230 | 27817 | 1838 | 33092 | 1193 | 43104 | 642 | 36898 |
| 5E | | MI | 6497 | 3011 | 9794 | 2542 | 12092 | 2099 | 13653 | 1715 | 15836 | 1079 | 19821 | 471 | 17206 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 16-#14 | 3.26 | MA | 12802 | 3011 | 17478 | 2698 | 22733 | 2251 | 26211 | 1861 | 30809 | 1213 | 40189 | 544 | 35313 |
| 6L-4S | | MI | 6714 | 3011 | 10272 | 2525 | 12767 | 2075 | 14451 | 1703 | 16939 | 1063 | 21292 | 568 | 17818 |
| 16-#14 | 3.26 | MA | 12247 | 3011 | 16428 | 2716 | 21353 | 2267 | 24538 | 1891 | 28591 | 1243 | 37196 | 483 | 33261 |
| 7L-3S | | MI | 6916 | 3011 | 10805 | 2508 | 13463 | 2060 | 15339 | 1682 | 18152 | 1058 | 22771 | 660 | 18218 |
| 16-#14 | 3.26 | MA | 11691 | 3011 | 15274 | 2746 | 19931 | 2295 | 22867 | 1906 | 26382 | 1263 | 34281 | 404 | 31142 |
| 8L-2S | | MI | 7284 | 3011 | 11563 | 2490 | 14422 | 2046 | 16499 | 1670 | 19713 | 1042 | 24854 | 826 | 18307 |
| 16-#18 | 5.80 | MA | 15502 | 3836 | 23989 | 3266 | 30751 | 2696 | 35753 | 2165 | 43423 | 1242 | 58003 | 153 | 56838 |
| 6L-4S | | MI | 8022 | 3836 | 13857 | 3036 | 17175 | 2447 | 19690 | 1944 | 23930 | 1022 | 29966 | 166 | 29001 |
| 16-#18 | 5.80 | MA | 14674 | 3836 | 22144 | 3297 | 28327 | 2722 | 32855 | 2220 | 39519 | 1294 | 52696 | 43 | 52419 |
| 7L-3S | | MI | 8287 | 3836 | 14783 | 3008 | 18382 | 2425 | 21230 | 1910 | 26031 | 1018 | 32451 | 321 | 30815 |
| 16-#18 | 5.80 | MA | 13732 | 3836 | 20115 | 3349 | 25827 | 2770 | 29917 | 2245 | 35629 | 1327 | 47549 | -104 | 47051 |
| 8L-2S | | MI | 8803 | 3836 | 16089 | 2981 | 20033 | 2404 | 23227 | 1894 | 28721 | 997 | 35927 | 615 | 31134 |
| 18-#10 | 2.07 | MA | 12152 | 2625 | 15268 | 2425 | 20121 | 2031 | 23159 | 1703 | 26943 | 1184 | 34513 | 812 | 25026 |
| 5L-6S | | MI | 5811 | 2625 | 8008 | 2319 | 10005 | 1937 | 11189 | 1622 | 12586 | 1106 | 15734 | 655 | 11658 |
| 18-#10 | 2.07 | MA | 11752 | 2625 | 14639 | 2433 | 19348 | 2042 | 22242 | 1717 | 25639 | 1196 | 32853 | 759 | 24274 |
| 6L-5S | | MI | 5998 | 2625 | 8285 | 2311 | 10360 | 1928 | 11641 | 1609 | 13210 | 1101 | 16595 | 726 | 11909 |
| 18-#10 | 2.07 | MA | 11405 | 2625 | 14039 | 2444 | 18558 | 2052 | 21269 | 1733 | 24373 | 1214 | 31159 | 725 | 23614 |
| 7L-4S | | MI | 6136 | 2625 | 8561 | 2300 | 10751 | 1912 | 12103 | 1600 | 13850 | 1090 | 17487 | 780 | 12080 |
| 18-#10 | 2.07 | MA | 11075 | 2625 | 13379 | 2462 | 17745 | 2068 | 20313 | 1743 | 23112 | 1227 | 29500 | 683 | 22672 |
| 8L-3S | | MI | 6277 | 2625 | 8871 | 2289 | 11155 | 1903 | 12620 | 1587 | 14555 | 1085 | 18378 | 835 | 12124 |
| 18-#10 | 2.07 | MA | 10663 | 2625 | 12788 | 2472 | 16992 | 2080 | 19351 | 1759 | 21837 | 1243 | 27809 | 632 | 21807 |
| 9L-2S | | MI | 6529 | 2625 | 9314 | 2277 | 11716 | 1893 | 13298 | 1578 | 15469 | 1074 | 19641 | 928 | 12146 |
| 18-#11 | 2.54 | MA | 12749 | 2778 | 16782 | 2521 | 21918 | 2104 | 25275 | 1751 | 29735 | 1182 | 38381 | 756 | 30036 |
| 5L-6S | | MI | 6003 | 2778 | 8659 | 2406 | 10726 | 1999 | 12011 | 1660 | 13646 | 1092 | 17013 | 550 | 13818 |
| 18-#11 | 2.54 | MA | 12283 | 2778 | 16015 | 2531 | 20983 | 2118 | 24157 | 1767 | 28144 | 1196 | 36352 | 689 | 29075 |
| 6L-5S | | MI | 6220 | 2778 | 8986 | 2395 | 11155 | 1988 | 12558 | 1645 | 14402 | 1087 | 18032 | 634 | 14092 |
| 18-#11 | 2.54 | MA | 11881 | 2778 | 15284 | 2544 | 20021 | 2129 | 22982 | 1788 | 26599 | 1218 | 34274 | 648 | 28028 |
| 7L-4S | | MI | 6377 | 2778 | 9321 | 2382 | 11629 | 1971 | 13117 | 1636 | 15175 | 1075 | 19084 | 701 | 14466 |
| 18-#11 | 2.54 | MA | 11490 | 2778 | 14479 | 2566 | 19030 | 2149 | 21817 | 1799 | 25060 | 1233 | 32246 | 595 | 26846 |
| 8L-3S | | MI | 6538 | 2778 | 9695 | 2369 | 12117 | 1960 | 13741 | 1620 | 16027 | 1070 | 20138 | 767 | 14544 |
| 18-#11 | 2.54 | MA | 11006 | 2778 | 13765 | 2579 | 18111 | 2163 | 20644 | 1818 | 23524 | 1253 | 30173 | 530 | 25514 |
| 9L-2S | | MI | 6827 | 2778 | 10229 | 2357 | 12792 | 1949 | 14557 | 1611 | 17126 | 1058 | 21627 | 881 | 14584 |
| 18-#14 | 3.67 | MA | 13597 | 3144 | 19146 | 2780 | 24843 | 2312 | 28763 | 1900 | 34246 | 1208 | 44947 | 537 | 40139 |
| 6L-5S | | MI | 6816 | 3144 | 10552 | 2625 | 13050 | 2160 | 14812 | 1754 | 17397 | 1074 | 21904 | 455 | 19354 |
| 18-#14 | 3.67 | MA | 13074 | 3144 | 18097 | 2799 | 23463 | 2327 | 27091 | 1930 | 32028 | 1238 | 41955 | 476 | 38094 |
| 7L-4S | | MI | 7030 | 3144 | 11029 | 2608 | 13726 | 2136 | 15610 | 1742 | 18500 | 1058 | 23375 | 553 | 19939 |
| 18-#14 | 3.67 | MA | 12528 | 3144 | 16943 | 2829 | 22041 | 2355 | 25420 | 1945 | 29819 | 1259 | 39039 | 397 | 35963 |
| 8L-3S | | MI | 7218 | 3144 | 11563 | 2590 | 14422 | 2121 | 16499 | 1721 | 19713 | 1053 | 24854 | 645 | 20408 |
| 18-#14 | 3.67 | MA | 11881 | 3144 | 15925 | 2848 | 20723 | 2375 | 23737 | 1973 | 27634 | 1288 | 36053 | 304 | 33861 |
| 9L-2S | | MI | 7571 | 3144 | 12321 | 2573 | 15380 | 2107 | 17658 | 1709 | 21274 | 1037 | 26937 | 810 | 20509 |
| 18-#18 | 6.52 | MA | 16061 | 4071 | 25069 | 3444 | 32026 | 2830 | 37330 | 2289 | 45543 | 1285 | 61038 | 31 | 60838 |
| 7L-4S | | MI | 8540 | 4071 | 15162 | 3183 | 18826 | 2555 | 21687 | 2013 | 26620 | 1014 | 33441 | 126 | 32694 |
| 18-#18 | 6.52 | MA | 15137 | 4071 | 23039 | 3497 | 29526 | 2878 | 34392 | 2315 | 41654 | 1318 | 55890 | -116 | 55136 |
| 8L-3S | | MI | 8778 | 4071 | 16089 | 3155 | 20033 | 2533 | 23227 | 1979 | 28721 | 1010 | 35927 | 281 | 34561 |
| 20-#10 | 2.30 | MA | 12228 | 2699 | 15596 | 2480 | 20559 | 2077 | 23707 | 1739 | 27611 | 1193 | 35584 | 755 | 27065 |
| 6E | | MI | 6014 | 2699 | 8452 | 2366 | 10566 | 1971 | 11868 | 1644 | 13499 | 1103 | 16998 | 651 | 12918 |
| 20-#10 | 2.30 | MA | 11895 | 2699 | 14996 | 2491 | 19770 | 2086 | 22734 | 1755 | 26345 | 1212 | 33889 | 722 | 26402 |
| 7L-5S | | MI | 6196 | 2699 | 8728 | 2357 | 10921 | 1962 | 12319 | 1631 | 14124 | 1098 | 17859 | 722 | 13161 |
| 20-#10 | 2.30 | MA | 11570 | 2699 | 14336 | 2509 | 18956 | 2103 | 21778 | 1765 | 25084 | 1224 | 32231 | 680 | 25453 |
| 8L-4S | | MI | 6333 | 2699 | 9004 | 2346 | 11312 | 1947 | 12782 | 1622 | 14763 | 1087 | 18751 | 776 | 13362 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 46"

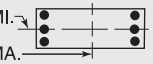
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 20-#10 | 2.30 | MA | 11171 | 2699 | 13746 | 2519 | 18203 | 2114 | 20816 | 1781 | 23810 | 1240 | 30540 | 628 | 24581 |
| 9L-3S | | MI | 6468 | 2699 | 9314 | 2335 | 11716 | 1937 | 13298 | 1609 | 15469 | 1082 | 19641 | 831 | 13413 |
| 20-#10 | 2.30 | MA | 10800 | 2699 | 13148 | 2529 | 17465 | 2127 | 19890 | 1792 | 22513 | 1249 | 28878 | 592 | 23548 |
| 10L-2S | | MI | 6714 | 2699 | 9758 | 2324 | 12277 | 1927 | 13976 | 1600 | 16382 | 1071 | 20905 | 924 | 13440 |
| 20-#11 | 2.83 | MA | 12847 | 2870 | 17180 | 2589 | 22457 | 2160 | 25939 | 1794 | 30544 | 1193 | 39674 | 685 | 32466 |
| 6E | | MI | 6240 | 2870 | 9193 | 2463 | 11400 | 2041 | 12827 | 1687 | 14745 | 1088 | 18503 | 541 | 15335 |
| 20-#11 | 2.83 | MA | 12462 | 2870 | 16448 | 2602 | 21495 | 2171 | 24764 | 1815 | 28999 | 1215 | 37597 | 643 | 31407 |
| 7L-5S | | MI | 6451 | 2870 | 9520 | 2452 | 11830 | 2031 | 13374 | 1671 | 15501 | 1083 | 19522 | 626 | 15600 |
| 20-#11 | 2.83 | MA | 12077 | 2870 | 15644 | 2623 | 20503 | 2191 | 23599 | 1826 | 27459 | 1229 | 35569 | 590 | 30227 |
| 8L-4S | | MI | 6606 | 2870 | 9854 | 2439 | 12304 | 2013 | 13934 | 1663 | 16274 | 1071 | 20573 | 693 | 16005 |
| 20-#11 | 2.83 | MA | 11611 | 2870 | 14930 | 2636 | 19584 | 2205 | 22426 | 1845 | 25923 | 1249 | 33496 | 526 | 28888 |
| 9L-3S | | MI | 6768 | 2870 | 10229 | 2427 | 12792 | 2002 | 14557 | 1647 | 17126 | 1066 | 21627 | 758 | 16091 |
| 20-#11 | 2.83 | MA | 11176 | 2870 | 14201 | 2648 | 18685 | 2220 | 21297 | 1859 | 24342 | 1260 | 31463 | 479 | 27584 |
| 10L-2S | | MI | 7038 | 2870 | 10762 | 2414 | 13467 | 1991 | 15373 | 1638 | 18225 | 1055 | 23117 | 873 | 16137 |
| 20-#14 | 4.08 | MA | 13878 | 3276 | 19765 | 2881 | 25574 | 2388 | 29643 | 1969 | 35465 | 1233 | 46713 | 469 | 42927 |
| 7L-5S | | MI | 7128 | 3276 | 11309 | 2708 | 14009 | 2221 | 15972 | 1793 | 18958 | 1069 | 23987 | 440 | 21507 |
| 20-#14 | 4.08 | MA | 13341 | 3276 | 18611 | 2912 | 24152 | 2416 | 27972 | 1984 | 33255 | 1254 | 43798 | 391 | 40784 |
| 8L-4S | | MI | 7340 | 3276 | 11787 | 2690 | 14684 | 2196 | 16769 | 1781 | 20061 | 1053 | 25458 | 538 | 22068 |
| 20-#14 | 4.08 | MA | 12723 | 3276 | 17593 | 2931 | 22833 | 2436 | 26289 | 2012 | 31070 | 1283 | 40812 | 297 | 38671 |
| 9L-3S | | MI | 7515 | 3276 | 12321 | 2673 | 15380 | 2182 | 17658 | 1760 | 21274 | 1048 | 26937 | 630 | 22597 |
| 20-#14 | 4.08 | MA | 12146 | 3276 | 16548 | 2947 | 21542 | 2457 | 24669 | 2030 | 28802 | 1298 | 37890 | 229 | 36472 |
| 10L-2S | | MI | 7854 | 3276 | 13079 | 2656 | 16339 | 2167 | 18817 | 1748 | 22835 | 1032 | 29020 | 795 | 22709 |
| 20-#18 | 7.25 | MA | 16604 | 4306 | 25963 | 3644 | 33225 | 2986 | 38866 | 2384 | 47678 | 1309 | 64231 | -128 | 63181 |
| 8L-4S | | MI | 9050 | 4306 | 16468 | 3330 | 20478 | 2663 | 23685 | 2082 | 29309 | 1005 | 36917 | 85 | 36399 |
| 22-#10 | 2.53 | MA | 12374 | 2774 | 15953 | 2538 | 20981 | 2120 | 24198 | 1777 | 28317 | 1209 | 36620 | 718 | 29190 |
| 7L-6S | | MI | 6214 | 2774 | 8895 | 2413 | 11127 | 2006 | 12546 | 1666 | 14413 | 1101 | 18262 | 647 | 14181 |
| 22-#10 | 2.53 | MA | 12053 | 2774 | 15293 | 2555 | 20167 | 2137 | 23243 | 1787 | 27056 | 1221 | 34962 | 676 | 28235 |
| 8L-5S | | MI | 6391 | 2774 | 9172 | 2404 | 11482 | 1996 | 12998 | 1653 | 15037 | 1095 | 19123 | 718 | 14416 |
| 22-#10 | 2.53 | MA | 11667 | 2774 | 14703 | 2566 | 19414 | 2149 | 22281 | 1803 | 25782 | 1237 | 33271 | 624 | 27356 |
| 9L-4S | | MI | 6527 | 2774 | 9448 | 2393 | 11873 | 1981 | 13460 | 1644 | 15677 | 1084 | 20015 | 772 | 14645 |
| 22-#10 | 2.53 | MA | 11309 | 2774 | 14105 | 2576 | 18677 | 2161 | 21355 | 1814 | 24485 | 1247 | 31609 | 588 | 26325 |
| 10L-3S | | MI | 6657 | 2774 | 9758 | 2382 | 12277 | 1971 | 13976 | 1631 | 16382 | 1079 | 20905 | 827 | 14701 |
| 22-#10 | 2.53 | MA | 10970 | 2774 | 13520 | 2586 | 17913 | 2171 | 20443 | 1826 | 23207 | 1262 | 29995 | 543 | 25267 |
| 11L-2S | | MI | 6897 | 2774 | 10201 | 2371 | 12838 | 1962 | 14655 | 1622 | 17296 | 1068 | 22169 | 920 | 14733 |
| 22-#11 | 3.11 | MA | 13030 | 2962 | 17613 | 2659 | 22968 | 2214 | 26546 | 1842 | 31398 | 1211 | 40919 | 638 | 34786 |
| 7L-6S | | MI | 6473 | 2962 | 9726 | 2521 | 12075 | 2084 | 13644 | 1714 | 15844 | 1085 | 19992 | 533 | 16855 |
| 22-#11 | 3.11 | MA | 12650 | 2962 | 16808 | 2681 | 21977 | 2233 | 25381 | 1853 | 29859 | 1226 | 38891 | 585 | 33609 |
| 8L-5S | | MI | 6678 | 2962 | 10053 | 2510 | 12505 | 2073 | 14190 | 1698 | 16600 | 1080 | 21011 | 618 | 17112 |
| 22-#11 | 3.11 | MA | 12200 | 2962 | 16095 | 2694 | 21058 | 2247 | 24208 | 1872 | 28323 | 1246 | 36818 | 521 | 32261 |
| 9L-4S | | MI | 6846 | 2962 | 10388 | 2497 | 12978 | 2055 | 14750 | 1690 | 17373 | 1068 | 22063 | 685 | 17544 |
| 22-#11 | 3.11 | MA | 11783 | 2962 | 15366 | 2705 | 20158 | 2262 | 23079 | 1886 | 26742 | 1257 | 34786 | 475 | 30951 |
| 10L-3S | | MI | 6985 | 2962 | 10762 | 2484 | 13467 | 2044 | 15373 | 1674 | 18225 | 1063 | 23117 | 750 | 17636 |
| 22-#11 | 3.11 | MA | 11387 | 2962 | 14653 | 2718 | 19235 | 2274 | 21967 | 1900 | 25183 | 1275 | 32812 | 418 | 29541 |
| 11L-2S | | MI | 7246 | 2962 | 11296 | 2471 | 14142 | 2034 | 16190 | 1665 | 19324 | 1051 | 24606 | 865 | 17689 |
| 22-#14 | 4.48 | MA | 14132 | 3409 | 20279 | 2995 | 26262 | 2477 | 30525 | 2023 | 36692 | 1249 | 48556 | 384 | 45604 |
| 8L-5S | | MI | 7434 | 3409 | 12067 | 2791 | 14967 | 2282 | 17131 | 1832 | 20519 | 1064 | 26070 | 425 | 23664 |
| 22-#14 | 4.48 | MA | 13541 | 3409 | 19261 | 3014 | 24944 | 2497 | 28842 | 2051 | 34507 | 1278 | 45571 | 291 | 43482 |
| 9L-4S | | MI | 7645 | 3409 | 12545 | 2773 | 15643 | 2257 | 17929 | 1820 | 21622 | 1048 | 27541 | 522 | 24205 |
| 22-#14 | 4.48 | MA | 12993 | 3409 | 18217 | 3030 | 23652 | 2518 | 27221 | 2069 | 32239 | 1293 | 42649 | 222 | 41281 |
| 10L-3S | | MI | 7808 | 3409 | 13079 | 2756 | 16339 | 2243 | 18817 | 1799 | 22835 | 1043 | 29020 | 614 | 24787 |
| 24-#10 | 2.76 | MA | 12526 | 2849 | 16251 | 2602 | 21378 | 2171 | 24708 | 1809 | 29028 | 1218 | 37692 | 672 | 31016 |
| 8L-6S | | MI | 6410 | 2849 | 9338 | 2460 | 11688 | 2040 | 13225 | 1688 | 15326 | 1098 | 19525 | 643 | 15447 |
| 24-#10 | 2.76 | MA | 12152 | 2849 | 15660 | 2613 | 20625 | 2183 | 23746 | 1825 | 27754 | 1235 | 36001 | 620 | 30131 |
| 9L-5S | | MI | 6583 | 2849 | 9615 | 2451 | 12042 | 2031 | 13676 | 1675 | 15951 | 1092 | 20386 | 714 | 15674 |
| 24-#10 | 2.76 | MA | 11807 | 2849 | 15063 | 2622 | 19888 | 2195 | 22820 | 1836 | 26457 | 1244 | 34340 | 584 | 29102 |
| 10L-4S | | MI | 6718 | 2849 | 9891 | 2440 | 12434 | 2015 | 14139 | 1666 | 16590 | 1082 | 21278 | 768 | 15927 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#10 | 2.76 | MA | 11480 | 2849 | 14478 | 2633 | 19124 | 2205 | 21908 | 1848 | 25179 | 1259 | 32726 | 540 | 28039 |
| 11L-3S | | MI | 6843 | 2849 | 10201 | 2429 | 12838 | 2006 | 14655 | 1653 | 17296 | 1076 | 22169 | 823 | 15988 |
| 24-#10 | 2.76 | MA | 11103 | 2849 | 13904 | 2645 | 18315 | 2221 | 20972 | 1866 | 23905 | 1270 | 31024 | 494 | 26966 |
| 12L-2S | | MI | 7078 | 2849 | 10644 | 2418 | 13399 | 1996 | 15333 | 1644 | 18209 | 1065 | 23433 | 916 | 16024 |
| 24-#11 | 3.39 | MA | 13211 | 3054 | 17973 | 2738 | 23450 | 2276 | 27163 | 1880 | 32258 | 1222 | 42214 | 580 | 36990 |
| 8L-6S | | MI | 6720 | 3054 | 10259 | 2578 | 12750 | 2126 | 14460 | 1741 | 16943 | 1081 | 21482 | 525 | 18378 |
| 24-#11 | 3.39 | MA | 12776 | 3054 | 17259 | 2751 | 22531 | 2290 | 25990 | 1899 | 30722 | 1243 | 40140 | 516 | 35635 |
| 9L-5S | | MI | 6913 | 3054 | 10587 | 2567 | 13180 | 2115 | 15006 | 1725 | 17699 | 1076 | 22500 | 609 | 18627 |
| 24-#11 | 3.39 | MA | 12375 | 3054 | 16531 | 2763 | 21632 | 2304 | 24861 | 1913 | 29141 | 1253 | 38108 | 470 | 34318 |
| 10L-4S | | MI | 7067 | 3054 | 10921 | 2554 | 13653 | 2097 | 15566 | 1717 | 18472 | 1065 | 23552 | 677 | 19081 |
| 24-#11 | 3.39 | MA | 11996 | 3054 | 15818 | 2775 | 20709 | 2317 | 23749 | 1927 | 27582 | 1272 | 36135 | 414 | 32911 |
| 11L-3S | | MI | 7198 | 3054 | 11296 | 2542 | 14142 | 2086 | 16190 | 1701 | 19324 | 1060 | 24606 | 742 | 19182 |
| 24-#11 | 3.39 | MA | 11547 | 3054 | 15118 | 2789 | 19723 | 2336 | 22612 | 1948 | 26027 | 1284 | 34048 | 357 | 31392 |
| 12L-2S | | MI | 7451 | 3054 | 11829 | 2529 | 14816 | 2076 | 17006 | 1692 | 20423 | 1048 | 26096 | 857 | 19240 |
| 24-#14 | 4.89 | MA | 14339 | 3541 | 20929 | 3096 | 27054 | 2558 | 31394 | 2089 | 37944 | 1273 | 50329 | 284 | 48292 |
| 9L-5S | | MI | 7736 | 3541 | 12825 | 2873 | 15926 | 2342 | 18290 | 1870 | 22080 | 1059 | 28153 | 409 | 25826 |
| 24-#14 | 4.89 | MA | 13818 | 3541 | 19885 | 3113 | 25762 | 2578 | 29774 | 2108 | 35675 | 1288 | 47407 | 215 | 46083 |
| 10L-4S | | MI | 7945 | 3541 | 13303 | 2856 | 16601 | 2318 | 19088 | 1859 | 23183 | 1043 | 29624 | 507 | 26347 |

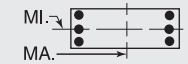
## RECTANGULAR TIED COLUMNS 24" x 48"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.39 | MA | 12970 | 2508 | 16115 | 2317 | 21116 | 1942 | 24170 | 1643 | 27876 | 1180 | 35220 | 1026 | 18378 |
| 2E | | MI | 6065 | 2508 | 8501 | 2176 | 10421 | 1822 | 11557 | 1538 | 12897 | 1096 | 15427 | 897 | 8374 |
| 6-#14 | 1.17 | MA | 12581 | 2434 | 15044 | 2284 | 19897 | 1919 | 22766 | 1630 | 26053 | 1190 | 32745 | 1036 | 15711 |
| 2L-3S | | MI | 5474 | 2434 | 7256 | 2173 | 8964 | 1824 | 9857 | 1546 | 10662 | 1129 | 12712 | 779 | 7267 |
| 6-#14 | 1.17 | MA | 11425 | 2434 | 13293 | 2311 | 17682 | 1944 | 20087 | 1654 | 22446 | 1221 | 27751 | 896 | 15611 |
| 3L-2S | | MI | 5952 | 2434 | 8014 | 2156 | 9923 | 1809 | 11016 | 1535 | 12223 | 1114 | 14795 | 944 | 7256 |
| 6-#18 | 2.08 | MA | 14379 | 2743 | 19187 | 2464 | 25001 | 2050 | 28869 | 1712 | 34204 | 1171 | 43981 | 1014 | 27354 |
| 2L-3S | | MI | 5848 | 2743 | 8501 | 2351 | 10421 | 1951 | 11557 | 1623 | 12897 | 1109 | 15427 | 563 | 12102 |
| 6-#18 | 2.08 | MA | 12554 | 2743 | 16115 | 2510 | 21116 | 2093 | 24170 | 1752 | 27876 | 1223 | 35220 | 759 | 26895 |
| 3L-2S | | MI | 6603 | 2743 | 9806 | 2323 | 12072 | 1930 | 13555 | 1607 | 15587 | 1087 | 18902 | 856 | 12213 |
| 8-#11 | 1.08 | MA | 12419 | 2404 | 14588 | 2272 | 19388 | 1911 | 22187 | 1626 | 25307 | 1195 | 31738 | 1041 | 14614 |
| 2L-4S | | MI | 5360 | 2404 | 6890 | 2175 | 8547 | 1828 | 9350 | 1560 | 9995 | 1139 | 11994 | 784 | 6791 |
| 8-#11 | 1.08 | MA | 11607 | 2404 | 13366 | 2290 | 17842 | 1928 | 20317 | 1643 | 22790 | 1217 | 28252 | 945 | 14568 |
| 3E | | MI | 5566 | 2404 | 7264 | 2162 | 9035 | 1817 | 9973 | 1545 | 10847 | 1135 | 13048 | 849 | 6800 |
| 8-#11 | 1.08 | MA | 11138 | 2404 | 12536 | 2309 | 16756 | 1946 | 18926 | 1667 | 20886 | 1232 | 25970 | 883 | 14397 |
| 4L-2S | | MI | 5906 | 2404 | 7798 | 2150 | 9710 | 1806 | 10790 | 1536 | 11946 | 1123 | 14538 | 964 | 6789 |
| 8-#14 | 1.56 | MA | 13421 | 2567 | 16795 | 2367 | 22112 | 1980 | 25446 | 1669 | 29661 | 1185 | 37740 | 1029 | 20833 |
| 2L-4S | | MI | 5544 | 2567 | 7480 | 2273 | 9227 | 1899 | 10128 | 1607 | 11010 | 1130 | 13315 | 671 | 9380 |
| 8-#14 | 1.56 | MA | 12328 | 2567 | 15044 | 2393 | 19897 | 2005 | 22766 | 1693 | 26053 | 1216 | 32745 | 889 | 20703 |
| 3E | | MI | 5822 | 2567 | 8014 | 2256 | 9923 | 1885 | 11016 | 1585 | 12223 | 1124 | 14795 | 763 | 9477 |
| 8-#14 | 1.56 | MA | 11701 | 2567 | 13854 | 2420 | 18339 | 2030 | 20771 | 1727 | 23323 | 1237 | 29462 | 800 | 20232 |
| 4L-2S | | MI | 6279 | 2567 | 8772 | 2238 | 10881 | 1870 | 12175 | 1574 | 13784 | 1109 | 16878 | 929 | 9491 |
| 8-#18 | 2.78 | MA | 15718 | 2979 | 22258 | 2612 | 28887 | 2158 | 33569 | 1781 | 40531 | 1162 | 52742 | 1001 | 36322 |
| 2L-4S | | MI | 5985 | 2979 | 8880 | 2525 | 10865 | 2081 | 12015 | 1725 | 13486 | 1104 | 16416 | 367 | 14532 |
| 8-#18 | 2.78 | MA | 14036 | 2979 | 19187 | 2657 | 25001 | 2201 | 28869 | 1821 | 34204 | 1214 | 43981 | 747 | 35828 |
| 3E | | MI | 6428 | 2979 | 9806 | 2498 | 12072 | 2059 | 13555 | 1692 | 15587 | 1100 | 18902 | 522 | 15851 |
| 8-#18 | 2.78 | MA | 13085 | 2979 | 17091 | 2703 | 22260 | 2244 | 25360 | 1879 | 29402 | 1249 | 38169 | 586 | 32557 |
| 4L-2S | | MI | 7110 | 2979 | 11112 | 2471 | 13724 | 2038 | 15552 | 1676 | 18276 | 1078 | 22378 | 816 | 16021 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

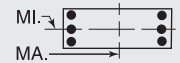



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.10 | MA | 12510 | 2411 | 14591 | 2284 | 19488 | 1921 | 22358 | 1635 | 25585 | 1200 | 32157 | 1045 | 14961 |
| 2L-5S | | MI | 5370 | 2411 | 6743 | 2205 | 8406 | 1859 | 9240 | 1581 | 9872 | 1160 | 11900 | 784 | 6924 |
| 10-#10 | 1.10 | MA | 11845 | 2411 | 13587 | 2300 | 18218 | 1936 | 20822 | 1649 | 23516 | 1218 | 29293 | 968 | 14925 |
| 3L-4S | | MI | 5514 | 2411 | 7019 | 2194 | 8797 | 1844 | 9702 | 1573 | 10511 | 1149 | 12792 | 838 | 6963 |
| 10-#10 | 1.10 | MA | 11468 | 2411 | 12907 | 2316 | 17327 | 1951 | 19681 | 1669 | 21955 | 1231 | 27430 | 919 | 14818 |
| 4L-3S | | MI | 5682 | 2411 | 7329 | 2182 | 9202 | 1834 | 10219 | 1559 | 11217 | 1144 | 13682 | 893 | 6971 |
| 10-#10 | 1.10 | MA | 11044 | 2411 | 12279 | 2328 | 16472 | 1971 | 18669 | 1683 | 20551 | 1249 | 25432 | 876 | 14558 |
| 5L-2S | | MI | 5965 | 2411 | 7772 | 2171 | 9762 | 1824 | 10897 | 1551 | 12130 | 1133 | 14946 | 986 | 6964 |
| 10-#11 | 1.35 | MA | 13019 | 2496 | 15810 | 2329 | 20934 | 1953 | 24057 | 1653 | 27825 | 1191 | 35224 | 1036 | 18190 |
| 2L-5S | | MI | 5448 | 2496 | 7088 | 2245 | 8748 | 1888 | 9606 | 1596 | 10321 | 1148 | 12432 | 709 | 8188 |
| 10-#11 | 1.35 | MA | 12238 | 2496 | 14588 | 2348 | 19388 | 1970 | 22187 | 1670 | 25307 | 1213 | 31738 | 940 | 18130 |
| 3L-4S | | MI | 5617 | 2496 | 7423 | 2233 | 9222 | 1870 | 10166 | 1587 | 11094 | 1136 | 13484 | 776 | 8338 |
| 10-#11 | 1.35 | MA | 11798 | 2496 | 13758 | 2366 | 18302 | 1988 | 20796 | 1694 | 23404 | 1228 | 29456 | 879 | 17947 |
| 4L-3S | | MI | 5813 | 2496 | 7798 | 2220 | 9710 | 1859 | 10790 | 1572 | 11946 | 1131 | 14538 | 841 | 8365 |
| 10-#11 | 1.35 | MA | 11295 | 2496 | 12997 | 2382 | 17258 | 2013 | 19562 | 1711 | 21691 | 1250 | 27014 | 824 | 17426 |
| 5L-2S | | MI | 6142 | 2496 | 8331 | 2207 | 10385 | 1849 | 11606 | 1563 | 13045 | 1119 | 16027 | 956 | 8365 |
| 10-#14 | 1.95 | MA | 14231 | 2699 | 18546 | 2450 | 24327 | 2041 | 28125 | 1708 | 33268 | 1180 | 42735 | 1023 | 25950 |
| 2L-5S | | MI | 5673 | 2699 | 7760 | 2373 | 9510 | 1984 | 10489 | 1657 | 11468 | 1141 | 13927 | 558 | 10899 |
| 10-#14 | 1.95 | MA | 13192 | 2699 | 16795 | 2476 | 22112 | 2066 | 25446 | 1732 | 29661 | 1211 | 37740 | 882 | 25798 |
| 3L-4S | | MI | 5899 | 2699 | 8238 | 2356 | 10186 | 1960 | 11287 | 1646 | 12571 | 1125 | 15398 | 656 | 11553 |
| 10-#14 | 1.95 | MA | 12616 | 2699 | 15605 | 2503 | 20554 | 2091 | 23450 | 1766 | 26930 | 1232 | 34456 | 793 | 25331 |
| 4L-3S | | MI | 6159 | 2699 | 8772 | 2339 | 10881 | 1946 | 12175 | 1624 | 13784 | 1120 | 16878 | 748 | 11676 |
| 10-#14 | 1.95 | MA | 11913 | 2699 | 14519 | 2526 | 19055 | 2126 | 21678 | 1789 | 24472 | 1263 | 30948 | 712 | 23561 |
| 5L-2S | | MI | 6597 | 2699 | 9529 | 2321 | 11840 | 1931 | 13335 | 1613 | 15344 | 1104 | 18961 | 913 | 11712 |
| 10-#18 | 3.47 | MA | 15445 | 3214 | 22258 | 2804 | 28887 | 2309 | 33569 | 1890 | 40531 | 1205 | 52742 | 734 | 44774 |
| 3L-4S | | MI | 6593 | 3214 | 10185 | 2673 | 12517 | 2189 | 14012 | 1794 | 16175 | 1095 | 19892 | 327 | 18143 |
| 10-#18 | 3.47 | MA | 14608 | 3214 | 20163 | 2850 | 26146 | 2352 | 30059 | 1948 | 35730 | 1240 | 46930 | 574 | 41442 |
| 4L-3S | | MI | 6968 | 3214 | 11112 | 2645 | 13724 | 2168 | 15552 | 1761 | 18276 | 1091 | 22378 | 482 | 19600 |
| 10-#18 | 3.47 | MA | 13426 | 3214 | 18273 | 2892 | 23506 | 2413 | 26939 | 1988 | 31402 | 1293 | 40740 | 424 | 37952 |
| 5L-2S | | MI | 7602 | 3214 | 12417 | 2618 | 15375 | 2146 | 17550 | 1745 | 20966 | 1070 | 25853 | 776 | 19816 |
| 12-#10 | 1.32 | MA | 13006 | 2485 | 15595 | 2331 | 20758 | 1955 | 23894 | 1657 | 27653 | 1197 | 35021 | 1042 | 17899 |
| 2L-6S | | MI | 5381 | 2485 | 6909 | 2260 | 8612 | 1903 | 9467 | 1617 | 10161 | 1162 | 12303 | 709 | 7953 |
| 12-#10 | 1.32 | MA | 12362 | 2485 | 14591 | 2347 | 19488 | 1970 | 22358 | 1671 | 25585 | 1215 | 32157 | 965 | 17854 |
| 3L-5S | | MI | 5585 | 2485 | 7186 | 2251 | 8967 | 1893 | 9918 | 1603 | 10785 | 1157 | 13164 | 780 | 8202 |
| 12-#10 | 1.32 | MA | 12005 | 2485 | 13911 | 2362 | 18597 | 1985 | 21217 | 1691 | 24024 | 1228 | 30294 | 915 | 17738 |
| 4E | | MI | 5728 | 2485 | 7462 | 2240 | 9358 | 1878 | 10381 | 1595 | 11425 | 1146 | 14056 | 834 | 8252 |
| 12-#10 | 1.32 | MA | 11588 | 2485 | 13283 | 2375 | 17742 | 2005 | 20206 | 1705 | 22620 | 1247 | 28296 | 872 | 17481 |
| 5L-3S | | MI | 5889 | 2485 | 7772 | 2229 | 9762 | 1868 | 10897 | 1581 | 12130 | 1141 | 14946 | 889 | 8270 |
| 12-#10 | 1.32 | MA | 11119 | 2485 | 12623 | 2384 | 16928 | 2017 | 19246 | 1719 | 21254 | 1259 | 26559 | 820 | 16738 |
| 6L-2S | | MI | 6164 | 2485 | 8215 | 2218 | 10323 | 1859 | 11575 | 1573 | 13043 | 1130 | 16210 | 982 | 8271 |
| 12-#11 | 1.63 | MA | 13600 | 2588 | 17032 | 2386 | 22480 | 1995 | 25927 | 1680 | 30343 | 1188 | 38710 | 1032 | 21764 |
| 2L-6S | | MI | 5464 | 2588 | 7295 | 2314 | 8993 | 1941 | 9876 | 1639 | 10664 | 1149 | 12903 | 616 | 9357 |
| 12-#11 | 1.63 | MA | 12849 | 2588 | 15810 | 2405 | 20934 | 2013 | 24057 | 1697 | 27825 | 1210 | 35224 | 936 | 21691 |
| 3L-5S | | MI | 5704 | 2588 | 7622 | 2303 | 9423 | 1930 | 10423 | 1623 | 11419 | 1144 | 13921 | 700 | 9670 |
| 12-#11 | 1.63 | MA | 12436 | 2588 | 14980 | 2424 | 19848 | 2030 | 22666 | 1721 | 25922 | 1225 | 32942 | 874 | 21500 |
| 4E | | MI | 5867 | 2588 | 7957 | 2290 | 9896 | 1912 | 10982 | 1614 | 12193 | 1133 | 14973 | 768 | 9881 |
| 12-#11 | 1.63 | MA | 11940 | 2588 | 14220 | 2440 | 18804 | 2055 | 21432 | 1738 | 24209 | 1247 | 30500 | 819 | 20968 |
| 5L-3S | | MI | 6054 | 2588 | 8331 | 2277 | 10385 | 1902 | 11606 | 1598 | 13045 | 1128 | 16027 | 833 | 9922 |
| 12-#11 | 1.63 | MA | 11386 | 2588 | 13416 | 2450 | 17820 | 2069 | 20260 | 1755 | 22542 | 1262 | 28377 | 754 | 19892 |
| 6L-2S | | MI | 6372 | 2588 | 8864 | 2264 | 11060 | 1891 | 12422 | 1590 | 14144 | 1116 | 17517 | 948 | 9933 |
| 12-#14 | 2.34 | MA | 14026 | 2831 | 18546 | 2559 | 24327 | 2126 | 28125 | 1771 | 33268 | 1206 | 42735 | 876 | 30897 |
| 3L-5S | | MI | 6021 | 2831 | 8518 | 2456 | 10468 | 2045 | 11648 | 1696 | 13029 | 1136 | 16010 | 543 | 13019 |
| 12-#14 | 2.34 | MA | 13495 | 2831 | 17356 | 2585 | 22769 | 2152 | 26129 | 1805 | 30538 | 1227 | 39451 | 786 | 30435 |
| 4E | | MI | 6242 | 2831 | 8996 | 2439 | 11144 | 2021 | 12446 | 1685 | 14132 | 1120 | 17482 | 641 | 13704 |
| 12-#14 | 2.34 | MA | 12805 | 2831 | 16270 | 2609 | 21270 | 2187 | 24357 | 1828 | 28079 | 1258 | 35942 | 706 | 28648 |
| 5L-3S | | MI | 6486 | 2831 | 9529 | 2421 | 11840 | 2006 | 13335 | 1663 | 15344 | 1115 | 18961 | 733 | 13871 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

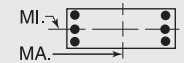



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 12-#14 | 2.34 | MA | 12057 | 2831 | 15117 | 2623 | 19867 | 2208 | 22674 | 1852 | 25687 | 1279 | 32891 | 609 | 27127 |
| 6L-2S | | MI | 6909 | 2831 | 10287 | 2404 | 12798 | 1992 | 14494 | 1652 | 16905 | 1099 | 21044 | 898 | 13925 |
| 12-#18 | 4.17 | MA | 16059 | 3449 | 23234 | 2997 | 30031 | 2460 | 34758 | 2017 | 42057 | 1231 | 55691 | 561 | 50327 |
| 4E | | MI | 7154 | 3449 | 11491 | 2820 | 14168 | 2297 | 16010 | 1864 | 18865 | 1087 | 23368 | 287 | 21781 |
| 12-#18 | 4.17 | MA | 14900 | 3449 | 21345 | 3039 | 27391 | 2521 | 31638 | 2057 | 37730 | 1284 | 49501 | 412 | 46852 |
| 5L-3S | | MI | 7490 | 3449 | 12417 | 2792 | 15375 | 2276 | 17550 | 1830 | 20966 | 1083 | 25853 | 442 | 23352 |
| 12-#18 | 4.17 | MA | 13735 | 3449 | 19320 | 3064 | 24955 | 2559 | 28674 | 2098 | 33518 | 1318 | 44114 | 235 | 42209 |
| 6L-2S | | MI | 8083 | 3449 | 13723 | 2765 | 17027 | 2254 | 19547 | 1814 | 23655 | 1061 | 29329 | 736 | 23604 |
| 14-#10 | 1.54 | MA | 12867 | 2560 | 15595 | 2393 | 20758 | 2004 | 23894 | 1693 | 27653 | 1213 | 35021 | 961 | 20783 |
| 3L-6S | | MI | 5597 | 2560 | 7353 | 2307 | 9173 | 1937 | 10145 | 1639 | 11074 | 1160 | 13566 | 705 | 9203 |
| 14-#10 | 1.54 | MA | 12528 | 2560 | 14915 | 2409 | 19868 | 2019 | 22754 | 1713 | 26092 | 1225 | 33158 | 911 | 20660 |
| 4L-5S | | MI | 5796 | 2560 | 7630 | 2298 | 9528 | 1928 | 10597 | 1625 | 11698 | 1154 | 14427 | 776 | 9479 |
| 14-#10 | 1.54 | MA | 12116 | 2560 | 14287 | 2422 | 19012 | 2040 | 21742 | 1727 | 24688 | 1244 | 31160 | 868 | 20405 |
| 5L-4S | | MI | 5937 | 2560 | 7906 | 2287 | 9919 | 1912 | 11059 | 1617 | 12338 | 1143 | 15319 | 830 | 9539 |
| 14-#10 | 1.54 | MA | 11663 | 2560 | 13627 | 2431 | 18198 | 2051 | 20782 | 1741 | 23323 | 1257 | 29423 | 816 | 19663 |
| 6L-3S | | MI | 6091 | 2560 | 8215 | 2276 | 10323 | 1903 | 11575 | 1603 | 13043 | 1138 | 16210 | 885 | 9565 |
| 14-#10 | 1.54 | MA | 11265 | 2560 | 12998 | 2441 | 17371 | 2061 | 19757 | 1757 | 21996 | 1275 | 27653 | 783 | 18964 |
| 7L-2S | | MI | 6359 | 2560 | 8659 | 2265 | 10884 | 1893 | 12254 | 1595 | 13957 | 1127 | 17473 | 978 | 9574 |
| 14-#11 | 1.90 | MA | 13443 | 2680 | 17032 | 2462 | 22480 | 2055 | 25927 | 1724 | 30343 | 1206 | 38710 | 931 | 25253 |
| 3L-6S | | MI | 5718 | 2680 | 7828 | 2371 | 9668 | 1983 | 10692 | 1666 | 11763 | 1146 | 14392 | 608 | 10861 |
| 14-#11 | 1.90 | MA | 13054 | 2680 | 16203 | 2481 | 21394 | 2073 | 24536 | 1748 | 28440 | 1221 | 36428 | 869 | 25056 |
| 4L-5S | | MI | 5950 | 2680 | 8155 | 2360 | 10097 | 1972 | 11239 | 1650 | 12518 | 1141 | 15411 | 692 | 11160 |
| 14-#11 | 1.90 | MA | 12566 | 2680 | 15442 | 2497 | 20350 | 2097 | 23302 | 1765 | 26726 | 1243 | 33986 | 815 | 24512 |
| 5L-4S | | MI | 6111 | 2680 | 8490 | 2347 | 10571 | 1955 | 11798 | 1641 | 13292 | 1129 | 16462 | 759 | 11422 |
| 14-#11 | 1.90 | MA | 12033 | 2680 | 14638 | 2507 | 19366 | 2111 | 22130 | 1782 | 25060 | 1258 | 31863 | 749 | 23450 |
| 6L-3S | | MI | 6289 | 2680 | 8864 | 2335 | 11060 | 1944 | 12422 | 1625 | 14144 | 1124 | 17517 | 825 | 11475 |
| 14-#11 | 1.90 | MA | 11565 | 2680 | 13871 | 2521 | 18357 | 2123 | 20892 | 1802 | 23441 | 1280 | 29693 | 708 | 22442 |
| 7L-2S | | MI | 6598 | 2680 | 9398 | 2322 | 11734 | 1933 | 13238 | 1617 | 15243 | 1112 | 19006 | 939 | 11495 |
| 14-#14 | 2.73 | MA | 14344 | 2964 | 19107 | 2668 | 24984 | 2212 | 28808 | 1843 | 34145 | 1222 | 44446 | 779 | 35543 |
| 4L-5S | | MI | 6358 | 2964 | 9276 | 2539 | 11427 | 2106 | 12808 | 1735 | 14590 | 1131 | 18094 | 528 | 15150 |
| 14-#14 | 2.73 | MA | 13664 | 2964 | 18021 | 2691 | 23485 | 2247 | 27036 | 1867 | 31686 | 1253 | 40937 | 699 | 33734 |
| 5L-4S | | MI | 6577 | 2964 | 9753 | 2522 | 12103 | 2082 | 13606 | 1724 | 15693 | 1115 | 19565 | 625 | 15801 |
| 14-#14 | 2.73 | MA | 12954 | 2964 | 16868 | 2706 | 22082 | 2268 | 25353 | 1891 | 29294 | 1274 | 37885 | 602 | 32192 |
| 6L-3S | | MI | 6817 | 2964 | 10287 | 2504 | 12798 | 2067 | 14494 | 1702 | 16905 | 1110 | 21044 | 717 | 16063 |
| 14-#14 | 2.73 | MA | 12329 | 2964 | 15768 | 2724 | 20635 | 2284 | 23589 | 1921 | 26970 | 1305 | 34759 | 542 | 29993 |
| 7L-2S | | MI | 7208 | 2964 | 11045 | 2487 | 13757 | 2053 | 15653 | 1691 | 18466 | 1094 | 23127 | 882 | 16133 |
| 14-#18 | 4.86 | MA | 16314 | 3685 | 24416 | 3186 | 31277 | 2629 | 36338 | 2127 | 44057 | 1275 | 58262 | 399 | 55752 |
| 5L-4S | | MI | 7697 | 3685 | 12796 | 2967 | 15820 | 2406 | 18007 | 1933 | 21554 | 1078 | 26843 | 247 | 25439 |
| 14-#18 | 4.86 | MA | 15232 | 3685 | 22391 | 3211 | 28840 | 2667 | 33373 | 2167 | 39845 | 1310 | 52875 | 222 | 51078 |
| 6L-3S | | MI | 8000 | 3685 | 13723 | 2940 | 17027 | 2384 | 19547 | 1899 | 23655 | 1074 | 29329 | 402 | 27107 |
| 14-#18 | 4.86 | MA | 14274 | 3685 | 20457 | 3242 | 26297 | 2693 | 30313 | 2221 | 35753 | 1362 | 47331 | 113 | 46565 |
| 7L-2S | | MI | 8556 | 3685 | 15028 | 2912 | 18678 | 2362 | 21545 | 1884 | 26345 | 1052 | 32805 | 696 | 27389 |
| 16-#10 | 1.76 | MA | 13037 | 2635 | 15919 | 2456 | 21138 | 2054 | 24290 | 1735 | 28161 | 1223 | 36022 | 907 | 23584 |
| 4L-6S | | MI | 5809 | 2635 | 7796 | 2353 | 9734 | 1972 | 10824 | 1661 | 11988 | 1157 | 14830 | 701 | 10456 |
| 16-#10 | 1.76 | MA | 12630 | 2635 | 15291 | 2468 | 20282 | 2074 | 23278 | 1749 | 26757 | 1241 | 34024 | 864 | 23332 |
| 5E | | MI | 6002 | 2635 | 8073 | 2345 | 10089 | 1962 | 11275 | 1647 | 12612 | 1152 | 15691 | 772 | 10721 |
| 16-#10 | 1.76 | MA | 12192 | 2635 | 14631 | 2477 | 19468 | 2085 | 22318 | 1763 | 25391 | 1254 | 32287 | 812 | 22590 |
| 6L-4S | | MI | 6142 | 2635 | 8349 | 2334 | 10480 | 1947 | 11738 | 1639 | 13252 | 1141 | 16583 | 826 | 10824 |
| 16-#10 | 1.76 | MA | 11810 | 2635 | 14002 | 2488 | 18641 | 2095 | 21294 | 1779 | 24065 | 1272 | 30517 | 779 | 21889 |
| 7L-3S | | MI | 6290 | 2635 | 8659 | 2323 | 10884 | 1937 | 12254 | 1625 | 13957 | 1135 | 17473 | 881 | 10858 |
| 16-#10 | 1.76 | MA | 11454 | 2635 | 13311 | 2506 | 17789 | 2112 | 20292 | 1789 | 22744 | 1285 | 28782 | 738 | 20968 |
| 8L-2S | | MI | 6551 | 2635 | 9102 | 2311 | 11445 | 1927 | 12932 | 1617 | 14870 | 1124 | 18737 | 974 | 10872 |
| 16-#11 | 2.17 | MA | 13655 | 2771 | 17425 | 2539 | 22940 | 2115 | 26406 | 1775 | 30957 | 1218 | 39914 | 864 | 28614 |
| 4L-6S | | MI | 5965 | 2771 | 8362 | 2429 | 10343 | 2025 | 11508 | 1693 | 12862 | 1143 | 15881 | 599 | 12370 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



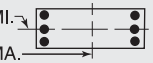

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 16-#11 | 2.17 | MA | 13173 | 2771 | 16664 | 2554 | 21896 | 2139 | 25171 | 1792 | 29244 | 1240 | 37472 | 810 | 28060 |
| 5E | | MI | 6191 | 2771 | 8689 | 2417 | 10772 | 2014 | 12055 | 1677 | 13617 | 1138 | 16900 | 684 | 12657 |
| 16-#11 | 2.17 | MA | 12661 | 2771 | 15860 | 2565 | 20912 | 2154 | 23999 | 1809 | 27578 | 1255 | 35349 | 744 | 27008 |
| 6L-4S | | MI | 6350 | 2771 | 9024 | 2405 | 11246 | 1997 | 12615 | 1668 | 14391 | 1126 | 17952 | 751 | 12962 |
| 16-#11 | 2.17 | MA | 12214 | 2771 | 15093 | 2578 | 19903 | 2165 | 22762 | 1829 | 25959 | 1277 | 33179 | 703 | 25988 |
| 7L-3S | | MI | 6520 | 2771 | 9398 | 2392 | 11734 | 1986 | 13238 | 1652 | 15243 | 1121 | 19006 | 816 | 13025 |
| 16-#11 | 2.17 | MA | 11792 | 2771 | 14250 | 2600 | 18864 | 2185 | 21540 | 1840 | 24347 | 1292 | 31057 | 651 | 24729 |
| 8L-2S | | MI | 6820 | 2771 | 9931 | 2379 | 12409 | 1975 | 14055 | 1644 | 16342 | 1109 | 20496 | 931 | 13053 |
| 16-#14 | 3.13 | MA | 14496 | 3096 | 19772 | 2774 | 25700 | 2308 | 29715 | 1906 | 35293 | 1248 | 45932 | 692 | 38821 |
| 5E | | MI | 6704 | 3096 | 10033 | 2622 | 12385 | 2167 | 13967 | 1774 | 16151 | 1126 | 20177 | 512 | 17288 |
| 16-#14 | 3.13 | MA | 13820 | 3096 | 18619 | 2789 | 24297 | 2329 | 28033 | 1930 | 32901 | 1269 | 42880 | 596 | 37257 |
| 6L-4S | | MI | 6921 | 3096 | 10511 | 2604 | 13061 | 2142 | 14765 | 1762 | 17254 | 1110 | 21648 | 610 | 17910 |
| 16-#14 | 3.13 | MA | 13232 | 3096 | 17519 | 2807 | 22850 | 2345 | 26269 | 1960 | 30578 | 1300 | 39754 | 536 | 35067 |
| 7L-3S | | MI | 7127 | 3096 | 11045 | 2587 | 13757 | 2128 | 15653 | 1741 | 18466 | 1105 | 23127 | 702 | 18254 |
| 16-#14 | 3.13 | MA | 12641 | 3096 | 16309 | 2838 | 21359 | 2373 | 24517 | 1976 | 28263 | 1321 | 36703 | 458 | 32919 |
| 8L-2S | | MI | 7500 | 3096 | 11802 | 2570 | 14715 | 2114 | 16813 | 1730 | 20027 | 1089 | 25210 | 867 | 18337 |
| 16-#18 | 5.56 | MA | 16672 | 3920 | 25463 | 3358 | 32725 | 2775 | 38073 | 2236 | 46173 | 1301 | 61636 | 210 | 59947 |
| 6L-4S | | MI | 8227 | 3920 | 14102 | 3114 | 17471 | 2514 | 20005 | 2002 | 24244 | 1069 | 30319 | 206 | 29114 |
| 16-#18 | 5.56 | MA | 15793 | 3920 | 23528 | 3389 | 30182 | 2802 | 35012 | 2290 | 42080 | 1353 | 56092 | 101 | 55409 |
| 7L-3S | | MI | 8499 | 3920 | 15028 | 3087 | 18678 | 2492 | 21545 | 1968 | 26345 | 1065 | 32805 | 362 | 30866 |
| 16-#18 | 5.56 | MA | 14792 | 3920 | 21400 | 3443 | 27559 | 2850 | 31931 | 2317 | 38003 | 1388 | 50704 | -43 | 50487 |
| 8L-2S | | MI | 9024 | 3920 | 16334 | 3059 | 20330 | 2470 | 23542 | 1953 | 29034 | 1043 | 36280 | 655 | 31172 |
| 18-#10 | 1.98 | MA | 13131 | 2710 | 16295 | 2515 | 21552 | 2108 | 24815 | 1771 | 28825 | 1238 | 36888 | 860 | 26260 |
| 5L-6S | | MI | 6016 | 2710 | 8240 | 2400 | 10295 | 2006 | 11502 | 1683 | 12901 | 1154 | 16094 | 697 | 11713 |
| 18-#10 | 1.98 | MA | 12708 | 2710 | 15635 | 2524 | 20738 | 2120 | 23855 | 1785 | 27460 | 1251 | 35151 | 808 | 25517 |
| 6L-5S | | MI | 6205 | 2710 | 8516 | 2392 | 10650 | 1996 | 11954 | 1669 | 13525 | 1149 | 16955 | 768 | 11968 |
| 18-#10 | 1.98 | MA | 12341 | 2710 | 15006 | 2535 | 19911 | 2129 | 22830 | 1801 | 26133 | 1269 | 33381 | 775 | 24814 |
| 7L-4S | | MI | 6343 | 2710 | 8793 | 2380 | 11041 | 1981 | 12416 | 1661 | 14165 | 1138 | 17847 | 822 | 12108 |
| 18-#10 | 1.98 | MA | 11990 | 2710 | 14315 | 2553 | 19059 | 2146 | 21829 | 1811 | 24813 | 1282 | 31646 | 734 | 23886 |
| 8L-3S | | MI | 6485 | 2710 | 9102 | 2369 | 11445 | 1971 | 12932 | 1647 | 14870 | 1132 | 18737 | 877 | 12148 |
| 18-#10 | 1.98 | MA | 11555 | 2710 | 13694 | 2563 | 18270 | 2158 | 20821 | 1827 | 23470 | 1298 | 29880 | 682 | 23015 |
| 9L-2S | | MI | 6739 | 2710 | 9546 | 2358 | 12006 | 1962 | 13611 | 1638 | 15784 | 1122 | 20001 | 970 | 12168 |
| 18-#11 | 2.44 | MA | 13765 | 2863 | 17886 | 2612 | 23442 | 2182 | 27041 | 1819 | 31762 | 1236 | 40959 | 805 | 31611 |
| 5L-6S | | MI | 6208 | 2863 | 8895 | 2486 | 11018 | 2067 | 12325 | 1720 | 13961 | 1139 | 17371 | 591 | 13883 |
| 18-#11 | 2.44 | MA | 13272 | 2863 | 17082 | 2622 | 22458 | 2196 | 25869 | 1835 | 30095 | 1251 | 38835 | 740 | 30566 |
| 6L-5S | | MI | 6427 | 2863 | 9222 | 2475 | 11447 | 2057 | 12871 | 1704 | 14716 | 1134 | 18390 | 676 | 14159 |
| 18-#11 | 2.44 | MA | 12845 | 2863 | 16315 | 2635 | 21449 | 2207 | 24632 | 1856 | 28477 | 1273 | 36665 | 698 | 29534 |
| 7L-4S | | MI | 6584 | 2863 | 9557 | 2462 | 11921 | 2039 | 13431 | 1695 | 15490 | 1122 | 19441 | 743 | 14502 |
| 18-#11 | 2.44 | MA | 12430 | 2863 | 15472 | 2657 | 20410 | 2227 | 23410 | 1867 | 26865 | 1288 | 34543 | 646 | 28277 |
| 8L-3S | | MI | 6747 | 2863 | 9931 | 2449 | 12409 | 2028 | 14055 | 1679 | 16342 | 1117 | 20496 | 808 | 14573 |
| 18-#11 | 2.44 | MA | 11918 | 2863 | 14720 | 2670 | 19447 | 2241 | 22181 | 1887 | 25244 | 1308 | 32377 | 582 | 26936 |
| 9L-2S | | MI | 7039 | 2863 | 10465 | 2437 | 13084 | 2017 | 14871 | 1671 | 17441 | 1105 | 21985 | 923 | 14609 |
| 18-#14 | 3.52 | MA | 14661 | 3229 | 20370 | 2871 | 26512 | 2390 | 30712 | 1969 | 36509 | 1264 | 47875 | 589 | 42322 |
| 6L-5S | | MI | 7024 | 3229 | 10791 | 2705 | 13344 | 2228 | 15126 | 1813 | 17711 | 1121 | 22260 | 497 | 19433 |
| 18-#14 | 3.52 | MA | 14106 | 3229 | 19270 | 2890 | 25065 | 2406 | 28948 | 1998 | 34185 | 1295 | 44748 | 529 | 40140 |
| 7L-4S | | MI | 7238 | 3229 | 11269 | 2687 | 14020 | 2203 | 15924 | 1801 | 18814 | 1105 | 23731 | 594 | 20029 |
| 18-#14 | 3.52 | MA | 13526 | 3229 | 18060 | 2921 | 23574 | 2434 | 27196 | 2015 | 31870 | 1316 | 41698 | 451 | 37979 |
| 8L-3S | | MI | 7430 | 3229 | 11802 | 2670 | 14715 | 2189 | 16813 | 1780 | 20027 | 1100 | 25210 | 686 | 20444 |
| 18-#14 | 3.52 | MA | 12841 | 3229 | 16988 | 2940 | 22193 | 2454 | 25432 | 2042 | 29564 | 1345 | 38578 | 359 | 35846 |
| 9L-2S | | MI | 7789 | 3229 | 12560 | 2652 | 15674 | 2174 | 17972 | 1768 | 21588 | 1084 | 27293 | 852 | 20539 |
| 18-#18 | 6.25 | MA | 17258 | 4156 | 26600 | 3537 | 34067 | 2910 | 39712 | 2359 | 48408 | 1344 | 64853 | 89 | 64254 |
| 7L-4S | | MI | 8746 | 4156 | 15408 | 3261 | 19123 | 2622 | 22003 | 2071 | 26933 | 1060 | 33794 | 166 | 32803 |
| 18-#18 | 6.25 | MA | 16276 | 4156 | 24471 | 3590 | 31445 | 2959 | 36630 | 2386 | 44331 | 1379 | 59465 | -55 | 59089 |
| 8L-3S | | MI | 8991 | 4156 | 16334 | 3234 | 20330 | 2600 | 23542 | 2038 | 29034 | 1056 | 36280 | 321 | 34629 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

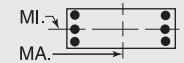



$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 2.20 | MA | 13212 | 2784 | 16639 | 2571 | 22009 | 2154 | 25391 | 1807 | 29528 | 1248 | 38015 | 804 | 28442 |
| 6E | | MI | 6220 | 2784 | 8683 | 2447 | 10856 | 2040 | 12180 | 1704 | 13814 | 1151 | 17357 | 693 | 12973 |
| 20-#10 | 2.20 | MA | 12858 | 2784 | 16011 | 2582 | 21181 | 2164 | 24366 | 1823 | 28202 | 1266 | 36245 | 771 | 27739 |
| 7L-5S | | MI | 6403 | 2784 | 8960 | 2438 | 11211 | 2031 | 12632 | 1691 | 14439 | 1146 | 18218 | 764 | 13219 |
| 20-#10 | 2.20 | MA | 12513 | 2784 | 15319 | 2600 | 20329 | 2180 | 23365 | 1833 | 26881 | 1279 | 34510 | 730 | 26803 |
| 8L-4S | | MI | 6540 | 2784 | 9236 | 2427 | 11602 | 2015 | 13094 | 1682 | 15079 | 1135 | 19110 | 818 | 13391 |
| 20-#10 | 2.20 | MA | 12092 | 2784 | 14698 | 2610 | 19540 | 2192 | 22357 | 1849 | 25538 | 1295 | 32744 | 678 | 25932 |
| 9L-3S | | MI | 6677 | 2784 | 9546 | 2416 | 12006 | 2006 | 13611 | 1669 | 15784 | 1130 | 20001 | 873 | 13437 |
| 20-#10 | 2.20 | MA | 11700 | 2784 | 14072 | 2620 | 18768 | 2205 | 21388 | 1861 | 24180 | 1305 | 31006 | 643 | 24830 |
| 10L-2S | | MI | 6926 | 2784 | 9989 | 2405 | 12567 | 1996 | 14289 | 1660 | 16697 | 1119 | 21265 | 966 | 13462 |
| 20-#11 | 2.71 | MA | 13868 | 2955 | 18304 | 2680 | 24004 | 2238 | 27739 | 1862 | 32613 | 1248 | 42321 | 735 | 34123 |
| 6E | | MI | 6446 | 2955 | 9429 | 2543 | 11692 | 2110 | 13141 | 1747 | 15060 | 1136 | 18860 | 583 | 15399 |
| 20-#11 | 2.71 | MA | 13460 | 2955 | 17537 | 2693 | 22995 | 2249 | 26501 | 1883 | 30995 | 1270 | 40151 | 694 | 33079 |
| 7L-5S | | MI | 6658 | 2955 | 9756 | 2532 | 12122 | 2099 | 13688 | 1731 | 15815 | 1131 | 19879 | 667 | 15665 |
| 20-#11 | 2.71 | MA | 13051 | 2955 | 16694 | 2714 | 21956 | 2269 | 25280 | 1894 | 29382 | 1285 | 38029 | 641 | 31826 |
| 8L-4S | | MI | 6814 | 2955 | 10090 | 2520 | 12596 | 2081 | 14247 | 1722 | 16589 | 1119 | 20931 | 735 | 16041 |
| 20-#11 | 2.71 | MA | 12557 | 2955 | 15942 | 2727 | 20994 | 2284 | 24051 | 1914 | 27762 | 1305 | 35863 | 577 | 30476 |
| 9L-3S | | MI | 6970 | 2955 | 10465 | 2507 | 13084 | 2070 | 14871 | 1706 | 17441 | 1114 | 21985 | 800 | 16120 |
| 20-#11 | 2.71 | MA | 12098 | 2955 | 15179 | 2739 | 20051 | 2299 | 22868 | 1928 | 26105 | 1316 | 33738 | 532 | 29167 |
| 10L-2S | | MI | 7253 | 2955 | 10998 | 2494 | 13759 | 2060 | 15687 | 1698 | 18540 | 1102 | 23474 | 915 | 16163 |
| 20-#14 | 3.91 | MA | 14956 | 3361 | 21021 | 2973 | 27280 | 2467 | 31627 | 2037 | 37792 | 1290 | 49743 | 522 | 45213 |
| 7L-5S | | MI | 7337 | 3361 | 11549 | 2787 | 14302 | 2289 | 16286 | 1852 | 19272 | 1116 | 24343 | 481 | 21584 |
| 20-#14 | 3.91 | MA | 14385 | 3361 | 19812 | 3004 | 25789 | 2495 | 29875 | 2053 | 35477 | 1311 | 46692 | 444 | 43039 |
| 8L-4S | | MI | 7550 | 3361 | 12026 | 2770 | 14978 | 2264 | 17084 | 1840 | 20375 | 1100 | 25814 | 579 | 22155 |
| 20-#14 | 3.91 | MA | 13731 | 3361 | 18739 | 3022 | 24408 | 2515 | 28111 | 2081 | 33171 | 1340 | 43573 | 352 | 40895 |
| 9L-3S | | MI | 7728 | 3361 | 12560 | 2753 | 15674 | 2250 | 17972 | 1819 | 21588 | 1095 | 27293 | 671 | 22634 |
| 20-#14 | 3.91 | MA | 13120 | 3361 | 17644 | 3039 | 23055 | 2536 | 26413 | 2101 | 30793 | 1355 | 40516 | 285 | 38546 |
| 10L-2S | | MI | 8073 | 3361 | 13318 | 2735 | 16632 | 2235 | 19131 | 1807 | 23149 | 1079 | 29376 | 836 | 22740 |
| 20-#18 | 6.94 | MA | 17711 | 4391 | 27542 | 3737 | 35330 | 3067 | 41330 | 2455 | 50658 | 1370 | 68226 | -67 | 67647 |
| 8L-4S | | MI | 9256 | 4391 | 16713 | 3408 | 20774 | 2730 | 24000 | 2140 | 29622 | 1051 | 37270 | 126 | 36504 |
| 22-#10 | 2.43 | MA | 13365 | 2859 | 17015 | 2628 | 22451 | 2198 | 25903 | 1845 | 30270 | 1264 | 39109 | 767 | 30664 |
| 7L-6S | | MI | 6420 | 2859 | 9126 | 2494 | 11417 | 2075 | 12859 | 1726 | 14728 | 1148 | 18621 | 689 | 14235 |
| 22-#10 | 2.43 | MA | 13024 | 2859 | 16323 | 2646 | 21599 | 2215 | 24901 | 1855 | 28950 | 1276 | 37375 | 726 | 29721 |
| 8L-5S | | MI | 6599 | 2859 | 9403 | 2485 | 11771 | 2065 | 13310 | 1713 | 15352 | 1143 | 19482 | 760 | 14473 |
| 22-#10 | 2.43 | MA | 12616 | 2859 | 15702 | 2657 | 20810 | 2227 | 23894 | 1871 | 27607 | 1292 | 35608 | 674 | 28842 |
| 9L-4S | | MI | 6735 | 2859 | 9679 | 2474 | 12163 | 2050 | 13773 | 1704 | 15992 | 1132 | 20374 | 814 | 14674 |
| 22-#10 | 2.43 | MA | 12237 | 2859 | 15076 | 2667 | 20038 | 2239 | 22924 | 1883 | 26248 | 1302 | 33870 | 639 | 27743 |
| 10L-3S | | MI | 6867 | 2859 | 9989 | 2463 | 12567 | 2040 | 14289 | 1691 | 16697 | 1127 | 21265 | 869 | 14726 |
| 22-#10 | 2.43 | MA | 11879 | 2859 | 14463 | 2678 | 19234 | 2249 | 21969 | 1895 | 24910 | 1318 | 32183 | 596 | 26681 |
| 11L-2S | | MI | 7109 | 2859 | 10432 | 2452 | 13128 | 2031 | 14968 | 1682 | 17611 | 1116 | 22528 | 962 | 14755 |
| 22-#11 | 2.98 | MA | 14060 | 3047 | 18760 | 2750 | 24541 | 2291 | 28371 | 1910 | 33512 | 1266 | 43637 | 689 | 36625 |
| 7L-6S | | MI | 6679 | 3047 | 9962 | 2601 | 12367 | 2152 | 13957 | 1774 | 16159 | 1132 | 20350 | 575 | 16919 |
| 22-#11 | 2.98 | MA | 13657 | 3047 | 17916 | 2772 | 23502 | 2311 | 27150 | 1921 | 31900 | 1282 | 41515 | 636 | 35374 |
| 8L-5S | | MI | 6886 | 3047 | 10289 | 2590 | 12797 | 2141 | 14504 | 1758 | 16914 | 1127 | 21369 | 659 | 17176 |
| 22-#11 | 2.98 | MA | 13180 | 3047 | 17165 | 2785 | 22540 | 2326 | 25921 | 1941 | 30280 | 1302 | 39350 | 573 | 34017 |
| 9L-4S | | MI | 7056 | 3047 | 10624 | 2577 | 13271 | 2123 | 15063 | 1749 | 17688 | 1115 | 22420 | 726 | 17581 |
| 22-#11 | 2.98 | MA | 12739 | 3047 | 16401 | 2796 | 21597 | 2341 | 24738 | 1955 | 28623 | 1313 | 37224 | 527 | 32700 |
| 10L-3S | | MI | 7197 | 3047 | 10998 | 2564 | 13759 | 2113 | 15687 | 1733 | 18540 | 1110 | 23474 | 792 | 17667 |
| 22-#11 | 2.98 | MA | 12319 | 3047 | 15654 | 2810 | 20625 | 2353 | 23573 | 1969 | 26989 | 1331 | 35159 | 472 | 31195 |
| 11L-2S | | MI | 7462 | 3047 | 11532 | 2551 | 14434 | 2102 | 16503 | 1724 | 19639 | 1098 | 24964 | 906 | 17716 |
| 22-#14 | 4.30 | MA | 15221 | 3494 | 21563 | 3086 | 28005 | 2556 | 32554 | 2092 | 39085 | 1306 | 51687 | 438 | 48099 |
| 8L-5S | | MI | 7645 | 3494 | 12306 | 2870 | 15261 | 2349 | 17445 | 1891 | 20833 | 1111 | 26426 | 466 | 23740 |
| 22-#14 | 4.30 | MA | 14595 | 3494 | 20490 | 3105 | 26623 | 2576 | 30790 | 2120 | 36778 | 1335 | 48567 | 345 | 45944 |
| 9L-4S | | MI | 7855 | 3494 | 12784 | 2853 | 15937 | 2325 | 18243 | 1879 | 21936 | 1095 | 27897 | 563 | 24289 |
| 22-#14 | 4.30 | MA | 14015 | 3494 | 19395 | 3122 | 25270 | 2597 | 29092 | 2140 | 34400 | 1350 | 45511 | 278 | 43602 |
| 10L-3S | | MI | 8022 | 3494 | 13318 | 2835 | 16632 | 2311 | 19131 | 1858 | 23149 | 1090 | 29376 | 655 | 24824 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#10 | 2.65 | MA | 13524 | 2934 | 17327 | 2693 | 22870 | 2249 | 26438 | 1877 | 31018 | 1274 | 40239 | 722 | 32626 |
| 8L-6S | | MI | 6617 | 2934 | 9570 | 2540 | 11978 | 2109 | 13537 | 1748 | 15641 | 1146 | 19885 | 685 | 15500 |
| 24-#10 | 2.65 | MA | 13128 | 2934 | 16706 | 2703 | 22081 | 2261 | 25430 | 1893 | 29675 | 1290 | 38472 | 671 | 31752 |
| 9L-5S | | MI | 6792 | 2934 | 9847 | 2532 | 12332 | 2099 | 13989 | 1735 | 16266 | 1140 | 20746 | 756 | 15730 |
| 24-#10 | 2.65 | MA | 12763 | 2934 | 16080 | 2713 | 21308 | 2274 | 24460 | 1905 | 28317 | 1299 | 36734 | 635 | 30656 |
| 10L-4S | | MI | 6927 | 2934 | 10123 | 2521 | 12724 | 2084 | 14451 | 1726 | 16905 | 1129 | 21638 | 810 | 15957 |
| 24-#10 | 2.65 | MA | 12417 | 2934 | 15467 | 2724 | 20504 | 2283 | 23506 | 1917 | 26978 | 1315 | 35047 | 592 | 29588 |
| 11L-3S | | MI | 7054 | 2934 | 10432 | 2509 | 13128 | 2074 | 14968 | 1713 | 17611 | 1124 | 22528 | 865 | 16013 |
| 24-#10 | 2.65 | MA | 12007 | 2934 | 14866 | 2736 | 19657 | 2299 | 22520 | 1934 | 25643 | 1326 | 33269 | 546 | 28485 |
| 12L-2S | | MI | 7291 | 2934 | 10876 | 2498 | 13689 | 2065 | 15646 | 1704 | 18524 | 1113 | 23792 | 958 | 16047 |
| 24-#11 | 3.25 | MA | 14249 | 3139 | 19139 | 2829 | 25048 | 2354 | 29020 | 1948 | 34418 | 1278 | 45002 | 632 | 38923 |
| 8L-6S | | MI | 6910 | 3139 | 10495 | 2658 | 13042 | 2194 | 14773 | 1801 | 17258 | 1129 | 21839 | 566 | 18440 |
| 24-#11 | 3.25 | MA | 13789 | 3139 | 18387 | 2842 | 24086 | 2368 | 27791 | 1968 | 32798 | 1298 | 42836 | 568 | 37557 |
| 9L-5S | | MI | 7123 | 3139 | 10823 | 2647 | 13472 | 2183 | 15320 | 1785 | 18013 | 1124 | 22858 | 651 | 18690 |
| 24-#11 | 3.25 | MA | 13365 | 3139 | 17623 | 2854 | 23143 | 2383 | 26608 | 1982 | 31141 | 1309 | 40710 | 523 | 36233 |
| 10L-4S | | MI | 7277 | 3139 | 11157 | 2634 | 13945 | 2166 | 15879 | 1776 | 18787 | 1112 | 23910 | 718 | 19121 |
| 24-#11 | 3.25 | MA | 12963 | 3139 | 16876 | 2867 | 22171 | 2395 | 25443 | 1996 | 29507 | 1328 | 38645 | 467 | 34732 |
| 11L-3S | | MI | 7411 | 3139 | 11532 | 2622 | 14434 | 2155 | 16503 | 1760 | 19639 | 1107 | 24964 | 784 | 19213 |
| 24-#11 | 3.25 | MA | 12486 | 3139 | 16143 | 2881 | 21137 | 2414 | 24252 | 2018 | 27878 | 1340 | 36466 | 411 | 33187 |
| 12L-2S | | MI | 7668 | 3139 | 12065 | 2609 | 15109 | 2144 | 17319 | 1751 | 20738 | 1095 | 26453 | 898 | 19268 |
| 24-#14 | 4.69 | MA | 15438 | 3626 | 22241 | 3188 | 28838 | 2637 | 33469 | 2159 | 40385 | 1330 | 53562 | 338 | 50994 |
| 9L-5S | | MI | 7947 | 3626 | 13064 | 2953 | 16219 | 2410 | 18604 | 1930 | 22394 | 1106 | 28509 | 450 | 25900 |
| 24-#14 | 4.69 | MA | 14885 | 3626 | 21146 | 3205 | 27485 | 2658 | 31771 | 2178 | 38008 | 1346 | 50505 | 271 | 48658 |
| 10L-4S | | MI | 8157 | 3626 | 13542 | 2935 | 16895 | 2386 | 19402 | 1918 | 23497 | 1090 | 29980 | 548 | 26429 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

# CHAPTER 4 – ROUND-TIED COLUMNS

**General.** Reinforced concrete round columns are most frequently used for structures with large, open areas and few partitions. The round column is usually formed with standard prefabricated forms available in diameter multiples of 1 or 2 inches, which leave a smooth finish suitable for exposed use. Paint or decorative finish treatment, if used, is ordinarily applied directly to the structural concrete. Reusable round column steel forms or one-use waterproofed fiber forms are both commercially available.

The ACI Building Code permits round columns provided with either tied or spiral lateral reinforcement. Other variations possible include conical column capitals to increase available perimeter for shear resistance. Round, spirally reinforced columns with capitals and flat slabs with drop panels are the original heavy duty concrete floor system developed as the preferred construction to replace earlier systems of timber and masonry.

In this Chapter, the design axial load and moment strengths (capacities) of "short", round-tied columns are tabulated for 12-inch to 36-inch diameters in 2-inch increments with $f'_c$ = 4,000, 5,000, 6,000, and 8,000 psi, and Grade 60 reinforcing bars; and for 24-inch to 48-inch diameters in 2-inch increments with $f'_c$ = 6,000, 8,000, and 10,000 psi, and Grade 75 reinforcing bars. The tabulated capacities cover the allowable range of vertical bar areas (0.01 to 0.08 times $A_g$).

**Spirals Versus Ties.** Spiral reinforcement conforming to minimum code requirements (ACI 10.9.3, Eq. 10-5) ensures maximum ductile behavior for concrete columns, even at loading to failure. This property is essential for earthquake resistance (ductile frames), for blast resistance, and desirable in ordinary structures. For absolute minimum size round columns (maximum capacity for a given size), spiral reinforcement must be used. The Code permits use of

$$\phi P_{n\,(\max)} = 0.85\phi[0.85 f'_c\,(A_g - A_{st}) + f_y A_{st}],$$

for spiral columns (ACI 10.3.6.1) compared to

$$\phi P_{n(\max)} = 0.80\phi[0.85 f'_c\,(A_g - A_{st}) + f_y A_{st}],$$

for tied columns (ACI 10.3.6.2).

The reduction in design strength for spiral columns is also less than for tied columns, i.e., the strength-reduction factor, $\phi$ = 0.75, for spirally reinforced columns versus $\phi$ = 0.65 for tied columns (ACI 9.3.2.2). For columns with heavy axial loads, subject to relatively small factored moments, and using the maximum allowed vertical bar area, these two code provisions encourage the use of spiral reinforcement to achieve the minimum size of a round column.

Spiral reinforcement is more costly, by weight, than vertical reinforcing bars. The spiral weight for the minimum column area to qualify for the two special code provisions cited above is considerable. For this reason, it will ordinarily be more economical to achieve the required load capacity for a designated size round-tied column by increasing the vertical bar area or concrete strength, where possible.

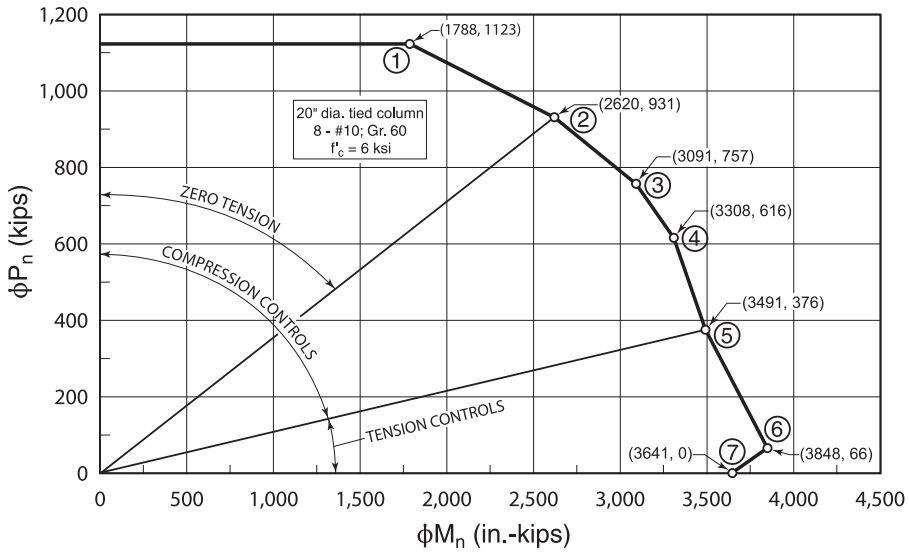



**Figure 4-1 Control Points for Load-Moment Interaction Curves**

Tabulated designs for "short" spirally reinforced columns are provided on the enclosed CD-ROM. The tables cover 12-inch to 36-inch diameters in 2-inch increments with $f'_c$ = 4,000, 5,000, 6,000, and 8,000 psi and Grade 60 reinforcing bars; and for 24-inch to 48-inch diameters in 2-inch increments with $f'_c$ = 6,000, 8,000, and 10,000 psi and Grade 75 reinforcing bars. In all of the tables, the minimum yield strength of the spiral reinforcement is 60,000 psi.

**Load-Moment Interaction Curves.** Fig. 4-1 was constructed from the tabulated values for column capacity on Page 4-28. "Control points" for column load-moment interaction curves refer to values of $\phi P_n$ and $\phi M_n$ necessary to construct the interaction diagram from maximum design axial load and corresponding moment strength to pure design moment strength, and limiting values convenient for compliance with various Code requirements.

The control points on the load-moment interaction diagram in Fig. 4-1 identify:

1. The coordinates of Point 1 are the maximum design axial load strength, $\phi P_{n(max)}=0.80\phi\,[0.85f'_c\,(A_g - A_{st}) + f_y A_{st}]$, for round-tied columns (ACI 10.3.6.2); and the corresponding design moment strength, $\phi M_n$.

2. Point 2 is the zero tension point. Location of this point is convenient where end-bearing splices are used (ACI 12.17.4). At Point 2, the stress in the bars nearest the tension face is zero. For a larger factored moment, the stress becomes tensile. The coordinates of Point 2 are designated $\phi P_{ot}$ and $\phi M_{ot}$.

3. At Point 3, the tensile stress in the bars nearest the tension face of the column is 25 percent of the specified yield strength. For Grade 60 reinforcing bars, the tensile stress is 0.25 (60,000) = 15,000 psi. Point 3 is not a "control point", per se. The coordinates of the point, $\phi P_{15}$, $\phi M_{15}$, are tabulated for convenience in constructing the load-moment ($\phi P_n - \phi M_n$) interaction curve.

4. At Point 4, the tensile stress in the bars nearest the tension face of the column is 50 percent of $f_y$, that is, 30,000 psi for Grade 60 reinforcing bars. The coordinates of Point 4 are designated $\phi P_{30}$ and $\phi M_{30}$.

5. At Point 5, $\phi P_b$ and $\phi M_b$ are the design axial load and moment strengths at balanced strain conditions. At this point, the tensile steel reaches the strain corresponding to its specified yield strength, $f_y$, i.e., "100% $f_y$", and concrete compressive strain reaches its assumed ultimate value of 0.003.

ACI 10.3.3 defines the column section as being compression-controlled, with $\phi$ = 0.65 (tied) or 0.75 (spiral), when the extreme steel strain is less than or equal to $f_y/E_s$.

6. Point 6 is the condition where the strain in the extreme tension steel is equal to 0.005. ACI 10.3.4 defines the column section as being tension-controlled, with $\phi$ = 0.90, when the extreme steel strain is equal to or greater than 0.005.

When the extreme steel strain is between $f_y/E_s$ (compression-controlled) and 0.005 (tension-controlled), the column section is in a transition region where the $\phi$-factor is assumed to vary linearly with the extreme steel strain.

7. Point 7, the last control point, is the pure design moment strength when the design axial load strength is zero.

**Concrete Cover.** All column design axial load and moment strengths (capacities) tabulated in this *Handbook* were calculated using the specified concrete cover prescribed for cast-in-place columns, 1½ inches to ties or spirals (ACI 7.7.1). For all column vertical bars, #10 and smaller; 3/8 inch was allowed for #3 ties, and for #11, #14, and #18 vertical bars, ½ inch for #4 ties, as the minimum sizes of ties permitted (ACI 7.10.5.1).

The radial distances, $d_r$, from the nearest point on the face of the column to the center of vertical bars, used in calculations are shown in Table 4-1:

**Table 4-1 Depth from Nearest Face to Center of Vertical Bars***

| Bar Size | #5 | #6 | #7 | #8 | #9 | #10 | #11 | #14 | #18 |
|---|---|---|---|---|---|---|---|---|---|
| $d_r$ (in.) | 2.19 | 2.25 | 2.31 | 2.38 | 2.44 | 2.51 | 2.71 | 2.85 | 3.12 |

* Based on 1-1/2 in. concrete cover to the tie or spiral.

**Steel Areas and Bar Orientation.** In some design handbooks, calculations for tabulated design axial load and moment strengths of round columns are based on the assumption that the behavior of the vertical bars is the same as that of a vertical steel tube of equivalent cross-sectional area and average diameter equal to ($h - 2d_r$). The equivalent area tube method increases in accuracy with increasing numbers of vertical bars and gives a single average design moment strength for bending in any direction. Since the ACI Building Code permits the use of round-tied columns with a minimum of four vertical bars (minimum of six vertical bars with spirals), the design axial load and moment strengths in this Chapter have been computed using actual bar areas, oriented so that one bar is located on the x-axis for bending about the x-axis. See Fig. 4-2. The bar-by-bar method is, of course, more accurate than the equivalent tube method.

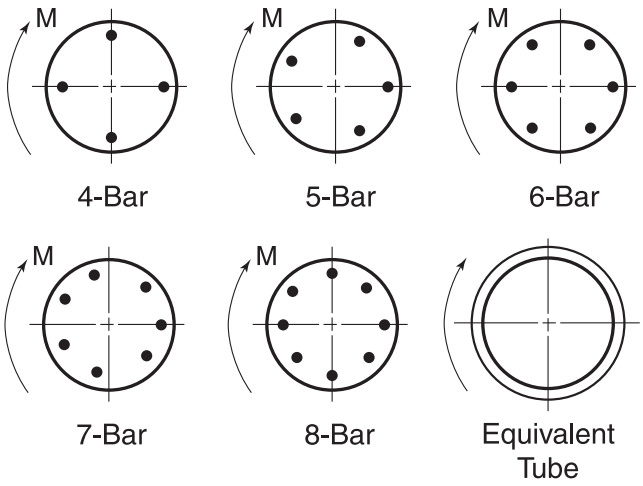



**Figure 4-2 Orientation of Bar Patterns Used for Calculation of Load Capacity Tables**

It is not practicable to prescribe orientation of vertical bars in round columns when more than four bars are used, and not advisable without rigorous field inspection when using only four bars. For this reason, it is prudent to base calculations on the bar arrangement giving minimum design moment strength and to use this value for the design moment strength in any direction.

**Tie Patterns.** As a general rule, in selecting column reinforcement for maximum economy, the required steel area should be furnished in the largest size bars practicable. Fewer bars simplify and speed up field assembly. For this reason, 4-bar arrangements should be considered when feasible. Note that for the 4-bar round column an economical square tie may be used. See Fig. 4-3 and Table 4-2 for suggested tie arrangements.

TABLE 4-2 Minimum Tie Sizes and Maximum Spacings*

| Column Diameter *h* (in.) | Vertical Bar Size | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | #3 Ties | | | | | | #4 Ties | | | #5 Ties |
| | #5 | #6 | #7 | #8 | #9 | #10 | #11 | #14 | #18 | #18 |
| 12 | 10 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| 14 | 10 | 12 | 14 | 14 | 14 | 14 | 14 | 14 | 14 | 14 |
| 16 | 10 | 12 | 14 | 16 | 16 | 16 | 16 | 16 | 16 | 16 |
| 18 | 10 | 12 | 14 | 16 | 18 | 18 | 18 | 18 | 18 | 18 |
| 20 | 10 | 12 | 14 | 16 | 18 | 18 | 20 | 20 | 20 | 20 |
| 22 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 22 | 22 | 22 |
| 24 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 24 |
| 26 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 26 |
| 28 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 28 |
| 30 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 30 |
| 32 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 30 |
| 34 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 30 |
| 36 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 30 |
| 38 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 30 |
| 40 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 30 |
| 42 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 30 |
| 44 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 30 |
| 46 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 30 |
| 48 | 10 | 12 | 14 | 16 | 18 | 18 | 22 | 24 | 24 | 30 |

* Based on ACI 7.10.5.1 and ACI 7.10.5.2.

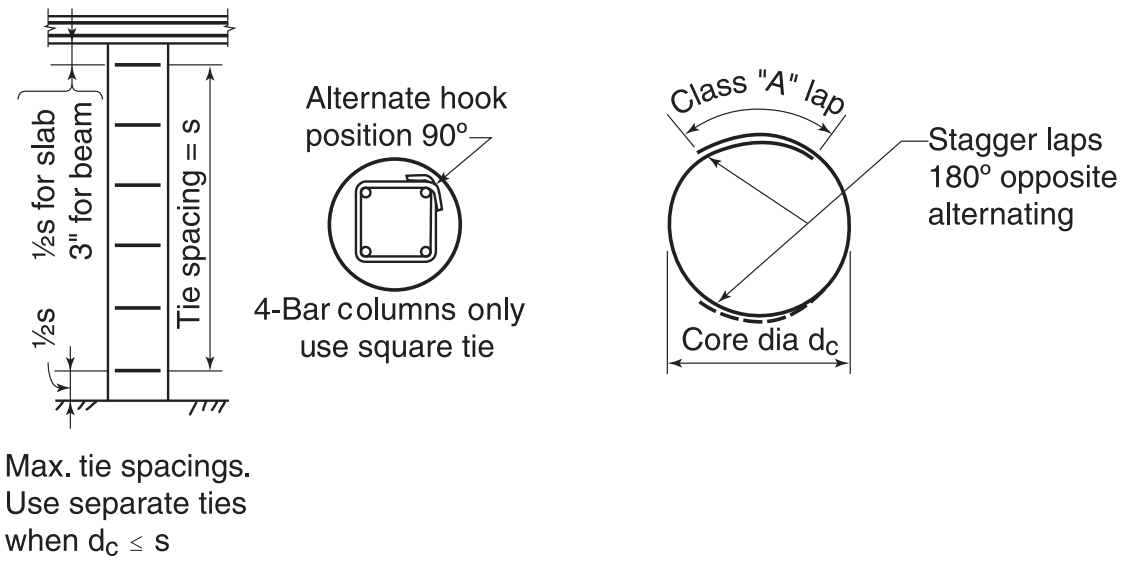



**Figure 4-3 Suggested Ties**

## USE OF TABLES FOR ROUND-TIED COLUMNS

**Example 1**

Select a round-tied column for an intermediate floor in a flat slab parking garage. Story height is 9′-0″. Concrete compressive strength, $f'_c$, in the columns above is 4,000 psi. Grade 60 reinforcing bars are used throughout. Column height (clear) between floor and drop panel is 8′-0″. The entire structure at this level is braced against sidesway. The service dead load is 200 kips; the service live load, using loads per square foot specified in the applicable building code after all reductions permitted in live load by the local building code, is 160 kips. Unbalanced factored live load on the floor above requires that the column resist a factored moment of 147 ft-kips.

$P_u = 1.2(200) + 1.6(160) = 240 + 256 = 496$ kips
$M_u = 147$ ft-kips = 1,764 in.-kips

For this example, assume the column above has an 18-in. diameter, and that it is desired to maintain the same size through this floor and two floors below. Previous investigation of the column above indicates that slenderness effects need not be considered since $k\ell_u/r = [(1.0)(96)/(0.25)(18)] = 21.4 < 22$ (ACI 10.10.1(b) with $M_1 = M_2$).

Enter the table on Page 4-13 with $P_u = 496$ kips and $M_u = 1{,}765$ in.-kips. Interpolating as necessary, read:

| Vertical Bars | $\phi P_n$ (kips) | $\phi M_n$ (in.-kips) | *Rho*,% |
|---|---|---|---|
| 5 – #14 | 496 | 1,901 | 4.42 |
| 6 – #14 | 496 | 2,184 | 5.31 |
| 7 – #11 | 496 | 1,907 | 4.29 |

Use an 18-in. diameter column with 7 – #11 vertical bars and #4 ties spaced at 18 in.; $f'_c = 4{,}000$ psi.

**Example 2**

Select a column design for the columns that are two floors below those of Example 1. From structural analysis, $P_u = 1{,}104$ kips and the factored moment $M_u$ due to unbalanced gravity load is 127 ft-kips = 1,524 in.-kips.

Refer to the table on Page 4-13; none of the tabulated designs provide the required combination of

$$\phi P_n \geq 1{,}104 \text{ kips and } \phi M_n \geq 1{,}524 \text{ in.-kips}$$

Tied columns with an 18-in. diameter and with $f'_c = 4{,}000$ psi will not suffice. At this point, there are three options:

1. Use a larger diameter column
2. Use a higher $f'_c$
3. Use a spiral in combination with options (1) or (2) if minimum diameter is essential.

Consider Option 1; try a 22-in. diameter column with $f'_c = 4{,}000$ psi; enter the table on Page 4-14 and read for 11 – #11 vertical bars:

$\phi P_n = 1{,}177$ kips and $\phi M_n = 1{,}879$ in.-kips, okay

Consider Option 2; try an 18-in. diameter column with $f'_c = 8{,}000$ psi; enter the table on Page 4-35 and read for 10 – #10 vertical bars:

$\phi P_n = 1{,}251$ kips and $\phi M_n = 1{,}787$ in.-kips, okay

**Example 3**

Part of the structure in Examples 1 and 2 includes a ground floor with a ceiling height of 15 feet. For these exterior columns, $P_u = 828$ kips and factored moments due to unbalanced gravity load are $M_u = +62$ ft.-kips at the top and –35 ft.-kips at the bottom. For evaluating slenderness effects, this floor is also braced by elements other than columns against sidesway. Again, it is desired to use an 18-in. round column.

Slenderness effects have to be considered since
$k\ell_u/r = 1.0(15)(12)/(0.25)(18) = 40 > 22$

$$e = \frac{M_u}{P_u} = \frac{(62)(12)}{828} = 0.9 \text{ in.}$$

Min. $e = 0.6 + 0.03h = 0.6 + 0.03(18) = 1.14$ in.
Use min. $e = 1.14$ in.

Refer to the table on Page 4-28 for $f' = 6{,}000$ psi. Allow about 100 percent reserve in $\phi M_n$ for slenderness effects; required $\phi M_n = 828(1.14)(2) = 1{,}890$ in.-kips.

Try an 18-in. diameter column with 6-#11 vertical bars:

$E_c = 57{,}000\sqrt{f'_c}$ (ACI 8.5.1)

$E_c = 57{,}000\sqrt{6{,}000} = 4.4 \times 10^6$ psi

$$I_g = \frac{\pi h^4}{64} = \frac{\pi(18)^4}{64} = 5{,}150 \text{ in.}^4$$

For a tube equivalent in area to 6 – #11 vertical bars, $A_s = (6)(1.56) = 9.36$ in.$^2$; $d = 18 - 2(1.50) - 2(0.5) - 1.41 = 12.59$ in.; $\Delta = 6(1.56)/\pi(12.59) = 0.24$ in.; the inner diameter $d_1 = 12.59 - 0.24 = 12.35$ in.; and the outer diameter $d_2 = 12.59 + 0.24 = 12.83$ in.

The moment of inertia for the reinforcing steel:

$$I_{se} = \frac{\pi(d_2^4 - d_1^4)}{64} = \frac{\pi(27{,}096 - 23{,}263)}{64} = 188 \text{ in.}^4$$

The total factored axial load, $P_u = 828$ kips is given in this example. To calculate $\beta_{dns}$, the factored dead load and factored live load are required. Assume the dead load and live load are in same proportions as in Example 1. Then

$$\beta_{dns} = \frac{1.2(200)}{1.2(200) + 1.6(160)} = 0.48$$

$$EI = \frac{0.2E_c I_g + E_s I_{se}}{1 + \beta_{dns}} \text{ . . . . . (ACI 10.10.6.1, Eq. 10-14)}$$

$$EI = \frac{0.2(4.4 \times 10^6)(5{,}150) + (29 \times 10^6)(188)}{1 + 0.48} = 6.75 \times 10^9$$

Critical load, $P_c$, for $k$ = 1.0 (braced frame):

$$P_c = \frac{\pi^2 EI}{(k\ell_u)^2} = \frac{\pi^2 (6.75 \times 10^9)}{(1 \times 15 \times 12)^2} = 2{,}056 \text{ kips}$$

Moment magnification factor, $\delta_{ns}$,

$$\delta_{ns} = \frac{C_m}{1 - \dfrac{P_u}{0.75 P_c}} \geq 1.0 \quad \text{(ACI 10.10.6, Eq. 10-12)}$$

$$C_m = 0.6 + 0.4 \frac{M_1}{M_2} \quad \text{(ACI 10.10.6.4, Eq. 10-16)}$$

$$C_m = 0.6 + 0.4(35/62) = 0.826$$

$$\delta_{ns} = \frac{0.826}{1 - \dfrac{828}{(0.75)(2{,}056)}} = 1.78$$

Magnified moment, $M_c = \delta_{ns} M_2 = (1.78)(828)(1.14)$

$$M_c = 1{,}680 \text{ in.-kips}$$

The column must be able to resist

$P_u$ = 828 kips and $M_u = M_c$ = 1,680 in.-kips

From Page 4-28, for an 18-in. diameter column with 6 – #11 vertical bars, and interpolating as necessary:

$\phi P_n$ = 828 kips and $\phi M_n$ = 1,676 in.-kips, okay.

**Example 4**

The interior columns in the 15-ft high portion of the structure of Example 3 must support a factored load, $P_u$ = 1,104 kips and resist factored moments 994 in.-kips at the top and –427 in.-kips at the footing

$$e = \frac{994}{1104} = 0.9 \text{ in.} < \text{min. } e = 0.6 + 0.03h = 1.14 \text{ in.}$$

$$C_m = 0.6 + 0.4\left(\frac{-427}{944}\right) = 0.43$$

For architectural reasons, 18-in. diameter round columns are desired. Use $f'_c$ = 6,000 psi to match the exterior columns in Example 3. See table on Page 4-28. Try 11-#11 vertical bars.

From Example 3:

$E_c = 4.4 \times 10^6$ psi

$I_g$ = 5,150 in.$^4$

$\beta_{dns} = 0.48$

$A_s = (11)(1.56) = 17.16$ in.$^2$ The equivalent tube has $\Delta = 11(1.56)/\pi\,(12.59) = 0.43$ in.; an inner diameter $d_1 = 12.59 - 0.43 = 12.16$ in.; and an outer diameter $d_2 = 12.59 + 0.43 = 13.02$ in.

The moment of inertia for the reinforcing steel:

$I_{se} = (0.0491)\,(d_2^4 - d_1^4) = (0.0491)\,(28{,}737 - 21{,}864)$

$I_{se}$ = 337 in.$^4$

$$EI = \frac{0.2E_c I_g + E_s I_{se}}{1 + \beta_{dns}}$$

$$EI = \frac{(0.2)(4.4 \times 10^6)(5.15 \times 10^3) + (29 \times 10^6)(337)}{1 + 0.48}$$

$$EI = 9.67 \times 10^9$$

Critical load, $P_c = \dfrac{\pi^2 EI}{(k\ell_u)^2}$

$$P_c = \frac{(\pi)^2 (9.67 \times 10^9)}{(180)^2} = 2{,}946 \text{ kips}$$

Moment magnification factor,

$$\delta_{ns} = \frac{C_m}{1 - \dfrac{P_u}{0.75 P_c}} \geq 1.0$$

$$\delta_{ns} = \frac{0.43}{1 - \dfrac{1104}{(0.75)(2{,}946)}} = 0.86 < 1.0,\ \delta_{ns} = 1.0$$

Magnified moment, $M_c = \delta_{ns} M_2 = (1.00)(1{,}104)(1.14)$

$$M_c = 1{,}259 \text{ in.-kips}$$

The column must be able to resist $P_u$ = 1,104 kips and $M_u = M_c$ = 1,259 in.-kips.

From Page 4-28, for an 18-in. diameter column with 11-#11 vertical bars, and interpolating as necessary: $\phi P_n$ = 1,104 kips and $\phi M_n$ = 1,738 in.-kips, okay.

**Manual Example**

Review a round-tied column 20 inches in diameter with $f'_c$ = 6,000 psi and 6–#9 vertical (longitudinal) reinforcing bars. Compute values of $\phi P_n$ and $\phi M_n$ at control points. Compare computed values versus the tabulated values in this Chapter. The printed-out values are displayed in Table 4-3.

The dimensions in Fig. 4-4 are based on 1½ inches of concrete cover to the #3 ties. For $f'_c$ = 6,000 psi, $\beta_1$ = 0.75 (ACI 10.2.7.3), $E_s = 29 \times 10^6$ psi (ACI 8.5.2). Strength–reduction factors: $\phi$ = 0.65 for compression and $\phi$ = 0.90 for flexure (ACI 9.3.2).

Table 4-3 Interaction Table for Chapter 4 Manual Example

| ROUND TIED COLUMNS 20" DIAMETER | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Short Columns – no sidesway | | | | | | | | | | | | $f_c' = 6{,}000$ psi<br>$\phi M_n$ in inch-kips | | $f_y = 60{,}000$ psi<br>$\phi P_n$ in.-kips |
| BARS | RHO | Max. Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t = 0.005$ | | $\phi P_n = 0$ |
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#9 | 1.91 | 1645 | 1004 | 2487 | 789 | 2794 | 638 | 2913 | 523 | 2927 | 333 | 2949 | 111 | 2353 |

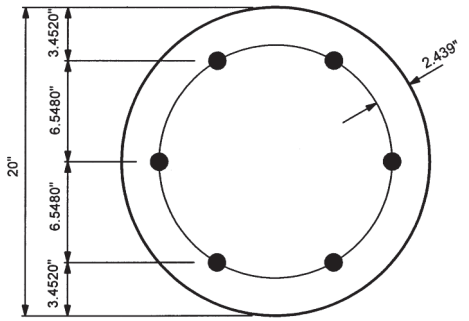



**Figure 4-4 Dimensions – Manual Example**

In the general case, (Fig. 4-5), the distance from the extreme compression fiber to the neutral axis, $c$, has to be determined by iteration. The distance, $c$, can be expressed in terms of the tensile strain, $\varepsilon_s = f_s / E_s$, in the outermost bars:

$$c = \frac{d_{sn}}{1 + f_s/(E_s \varepsilon_c)}$$

Where:

$d_{sn}$ = Maximum distance to bars from extreme compression surface

$f_s$ = Tensile stress in outermost bars.

$\varepsilon_c$ = Maximum compressive strain in concrete
= 0.003 (ACI 10.2.3)

$E_s$ = Modulus of elasticity of bars
$= 29 \times 10^6$ psi

For those bars which are located in the concrete compression zone ($d_{si} < \beta_1 c$), their compressive stress must be reduced by $0.85 f_c'$ to account for the area of the concrete occupied by the reinforcing bar or their compressive force must be reduced by $0.85 f_c' A_b$. In this example, the reduction for a #9 bar is:

0.85(6) = 5.1 ksi, or
5.1(1) = 5.1 kips

**1. $\phi P_{n(max)}$ and $\phi M_n$**

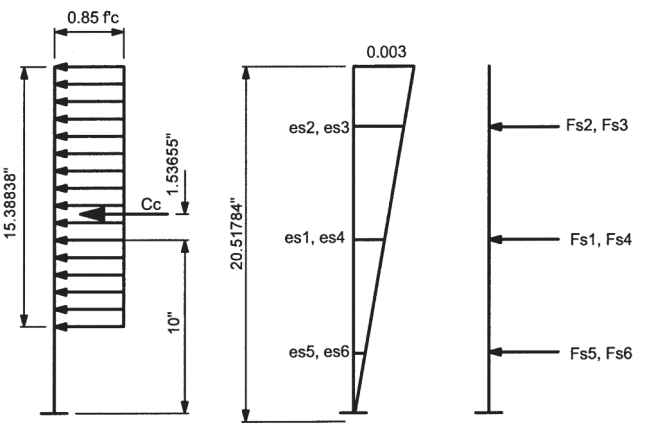



**Figure 4-6 $\phi P_{n(max)}$ and $\phi M_n$**

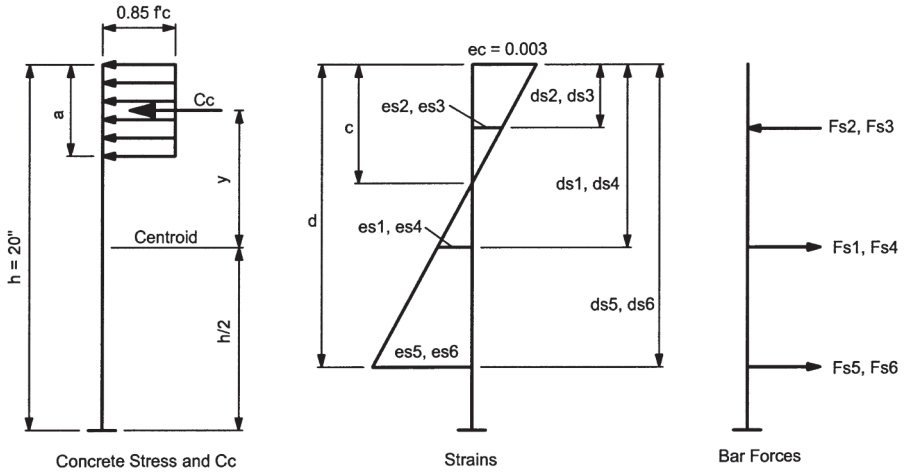



**Figure 4-5 General Case**

The value of $\phi P_{n(max)}$ can be solved directly by ACI Eq. 10-2:

$$\phi P_{n(max)} = 0.80\phi[0.85 f'_c (A_g - A_{st}) + f_y A_{st}]$$
$$= 0.80(0.65)[0.85(6)(314.16 - 6) + 60(6)]$$
$$= 1{,}004 \text{ kips (tabulated = 1,004)}$$

For this condition, the exact value of strain in the outermost bars (bars 5 and 6) is not evident (Fig. 4-6). The entire cross-section will be in compression, so $c > h$.

Through iteration, $c = 20.51791$ in.

From Fig. 4-5, the bar strains, stresses, forces, and moments of the forces about the column centroid can be expressed:

$$\varepsilon_{si} = \varepsilon_c (1 - d_{si}/c)$$
$$f_{si} = E_s \varepsilon_{si} (\leq 60 \text{ ksi})$$
$$F_{si} = f_{si} A_b (A_b = 1 \text{ in.}^2)$$
$$M_{si} = F_{si}(h/2 - d_{si})$$

Bars forces and moments about column centroid are tabulated below:

| Bar | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 10.0000 | 0.0015379 | 44.598 | 39.498* | 0 |
| 2 | 3.4520 | 0.0024953 | 60.000 | 54.900* | 359.486 |
| 3 | 3.4520 | 0.0024953 | 60.000 | 54.900* | 359.486 |
| 4 | 10.0000 | 0.0015379 | 44.598 | 39.498* | 0 |
| 5 | 16.5480 | 0.0005804 | 16.833 | 16.833 | -110.222 |
| 6 | 16.5480 | 0.0005804 | 16.833 | 16.833 | -110.222 |
| | | | | 222.462 | 498.525 |

*$F_{si}$ reduced by 5.1 kips

Compute the concrete compression resultant based on the rectangular stress block, $C_c$, and moment, $M_c$, about the column centroid. For a circular segment with a height of $a$:

$\alpha$ = One-half the subtended angle (radians)
$= \cos^{-1}[(h - 2a)/h]$

$A_c$ = Area of concrete compression zone
$= h^2 [2\alpha - \sin(2\alpha)]/8$

$y$ = Distance of concrete compression zone centroid from the column centroid
$= 2h^3 \sin \alpha^3/(24 A_c)$

The depth of the equivalent stress block:

$a = \beta_1 c = 0.75(20.51791) = 15.38843$ in.

Properties of the concrete compression zone:

$\alpha = \cos^{-1}[(20 - 2(15.38843))/20]$
$= 2.13985$ rad

$A_c = 20^2 [2(2.13985) - \sin(2 \times 2.13985)]/8$
$= 259.37708$ in.$^2$

$y = 2(20)^3 \sin(2.13985)^3/(24 \times 259.37708)$
$= 1.53656$ in.

Concrete compression resultant, $C_c$, and moment, $M_c$, about the column centroid:

$C_c = 0.85 f'_c A_c$
$= 0.85(6)259.37708 = 1{,}322.823$ kips

$M_c = C_c(y)$
$= 1{,}322.823(1.53656) = 2{,}032.597$ in.-kips

$\Sigma$ Forces = 0
$-P_n + 222.462 + 1{,}322.823 = 0$
$P_n = 1{,}545.285$ kips
$\phi P_n = (0.65)(1{,}545.285) = 1{,}004$ kips
(tabulated = 1,004)

$\Sigma$ Moments = 0
$-M_n + 498.528 + 2{,}032.597 = 0$
$M_n = 2{,}531.125$ in.-kips
$\phi M_n = (0.65)(2{,}531.125) = 1{,}645$ in.-kips
(tabulated = 1,645)

**2. $\phi P_{ot}$ and $\phi M_{ot}$ (Point of zero tension)**

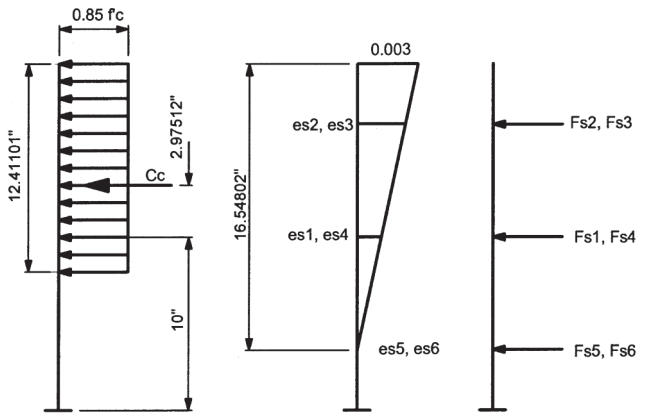



**Figure 4-7 $\phi P_{ot}$ and $\phi M_{ot}$ (Point of Zero Tension)**

For this condition, the $c$ distance is easily determined by inspection from Fig. 4-7 because $\varepsilon_{s5}$, $\varepsilon_{s6} = f_{s5}/E_s = f_{s6}/E_s = 0$; hence, $c = 20 - 3.4520 = 16.5480$ in., or by the equation:

$$c = \frac{d_{sn}}{1 + f_s/(E_s \varepsilon_c)}$$

$$= \frac{16.5480}{1 + 0/(29{,}000 \times 0.003)} = 16.5480 \text{ in.}$$

Note that the point of "zero tension" is defined in this Chapter as the load-moment combination resulting in zero strain at the center of the column longitudinal bar on the tension face. The diameter of the bar is neglected because the stress in the bar on either side of its center reverses sign and totals zero. Where two layers of bars are used, as with bundled bars, the same definition (to centroid of bundle) is satisfactory for practical use in designing splices.

Bars forces and moments about column centroid are tabulated below:

| Bar | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 10.0000 | 0.0011871 | 34.426 | 29.326* | 0 |
| 2 | 3.4520 | 0.0023742 | 60.000 | 54.900* | 359.486 |
| 3 | 3.4520 | 0.0023742 | 60.000 | 54.900* | 359.486 |
| 4 | 10.0000 | 0.0011871 | 34.426 | 29.326* | 0 |
| 5 | 16.5480 | 0 | 0 | 0 | 0 |
| 6 | 16.5480 | 0 | 0 | 0 | 0 |
| | | | | 168.451 | 718.972 |

*$F_{si}$ reduced by 5.1 kips

The depth of the equivalent stress block:

$a = 0.75(16.5480) = 12.4110$ in.

Properties of the concrete compression zone:

$$\alpha = \cos^{-1}[(20 - 2(12.4110))/20] = 1.81430 \text{ rad}$$

$$A_c = 20^2[2(1.81430) - \sin(2 \times 1.81430)]/8 = 204.82916 \text{ in.}^2$$

$$y = 2(20)^3 \sin(1.81430)^3/(24 \times 204.82916) = 2.97511 \text{ in.}$$

Concrete compression resultant, $C_c$, and moment, $M_c$, about the column centroid:

$C_c = 0.85(6)204.82916 = 1{,}044.629$ kips

$M_c = 1{,}044.629(2.97511) = 3{,}107.886$ in.-kips

$\Sigma$ Forces = 0

$-P_n + 168.451 + 1{,}044.629 = 0$

$P_n = 1{,}213.080$ kips

$\phi P_n = (0.65)(1{,}213.080) = 789$ kips (tabulated = 789)

$\Sigma$ Moments = 0

$-M_n + 718.972 + 3{,}107.886 = 0$

$M_n = 3{,}826.858$ in.-kips

$\phi M_n = (0.65)(3{,}826.858) = 2{,}487$ in.-kips (tabulated = 2,487)

**3. 25% Tension**

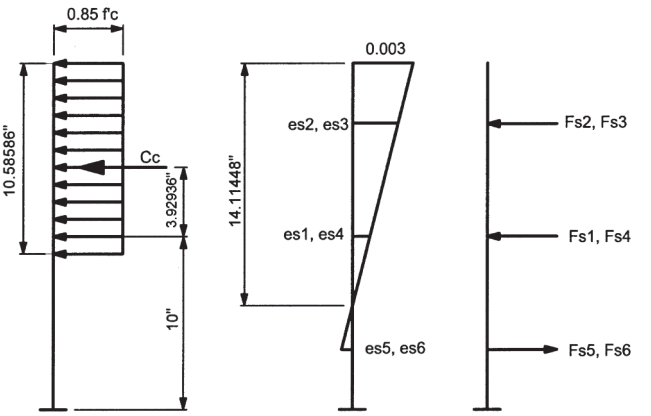



**Figure 4-8 25% Tension**

The tensile stress in bars 5 and 6 = 0.25(60) = 15 ksi.

$$c = \frac{16.5480}{1 + 15/(29{,}000 \times 0.003)} = 14.11448 \text{ in.}$$

Bars forces and moments about column centroid are tabulated below:

| Bar | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 10.0000 | 0.0008745 | 25.361 | 20.261* | 0 |
| 2 | 3.4520 | 0.0022663 | 60.000 | 54.900* | 359.486 |
| 3 | 3.4520 | 0.0022663 | 60.000 | 54.900* | 359.486 |
| 4 | 10.0000 | 0.0008745 | 25.361 | 20.261* | 0 |
| 5 | 16.5480 | -0.0005172 | -15.000 | -15.000 | 98.220 |
| 6 | 16.5480 | -0.0005172 | -15.000 | -15.000 | 98.220 |
| | | | | 120.322 | 915.413 |

*$F_{si}$ reduced by 5.1 kips

The depth of the equivalent stress block:

$a = 0.75(14.11448) = 10.58586$ in.

Properties of the concrete compression zone:

$$\alpha = \cos^{-1}[(20 - 2(10.58586))/20] = 1.62942 \text{ rad}$$

$$A_c = 20^2[2(1.62942) - \sin(2 \times 1.62942)]/8 = 168.79013 \text{ in.}^2$$

$$y = 2(20)^3 \sin(1.62942)^3/(24 \times 168.79013) = 3.92936 \text{ in.}$$

Concrete compression resultant, $C_c$, and moment, $M_c$, about the column centroid:

$C_c = 0.85(6)168.79013 = 860.830$ kips

$M_c = 860.830(3.92936) = 3{,}382.511$ in.-kips

Σ Forces = 0

$-P_n + 120.322 + 860.830 = 0$

$P_n = 981.152$ kips

$\phi P_n = (0.65)(981.152) = 638$ kips

(tabulated = 638)

Σ Moments = 0

$-M_n + 915.913 + 3{,}382.511 = 0$

$M_n = 4{,}297.924$ in.-kips

$\phi M_n = (0.65)(4{,}297.924) = 2{,}794$ in.-kips

(tabulated = 2,794)

**4. 50% Tension**

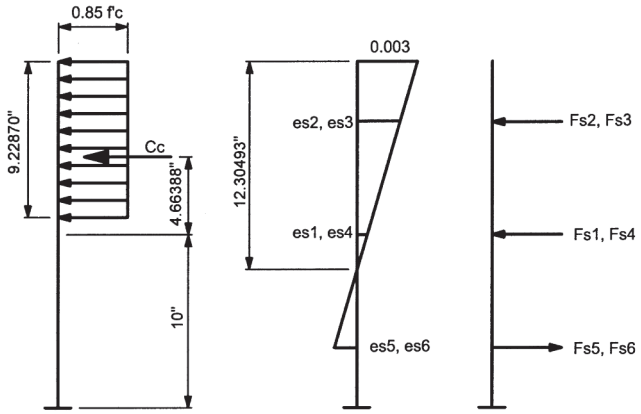



**Figure 4-9 50% Tension**

The tensile stress in bars 5 and 6 = 0.50(60) = 30 ksi.

$$c = \frac{16.5480}{1 + 30/(29{,}000 \times 0.003)} = 12.30493 \text{ in.}$$

Bars forces and moments about column centroid are tabulated below:

| Bar | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 10.0000 | 0.0005620 | 16.297 | 16.297 | 0 |
| 2 | 3.4520 | 0.0021584 | 60.000 | 54.900* | 359.486 |
| 3 | 3.4520 | 0.0021584 | 60.000 | 54.900* | 359.486 |
| 4 | 10.0000 | 0.0005620 | 16.297 | 16.297 | 0 |
| 5 | 16.5480 | -0.0010345 | -30.000 | -30.000 | 196.441 |
| 6 | 16.5480 | -0.0010345 | -30.000 | -30.000 | 196.441 |
| | | | | 82.393 | 1,111.854 |

*$F_{si}$ reduced by 5.1 kips

The depth of the equivalent stress block:

$a = 0.75(12.30493) = 9.22870$ in.

Properties of the concrete compression zone:

$\alpha = \cos^{-1}[(20 - 2(9.22870))/20]$

$= 1.49359$ rad

$A_c = 20^2[2(1.49359) - \sin(2 \times 1.49359)]/8$

$= 141.66901$ in.$^2$

$y = 2(20)^3 \sin(1.49359)^3/(24 \times 141.66901)$

$= 4.66388$ in.

Concrete compression resultant, $C_c$, and moment, $M_c$, about the column centroid:

$C_c = 0.85(6)141.66901 = 722.512$ kips

$M_c = 722.512(4.66388) = 3{,}369.709$ in.-kips

Σ Forces = 0

$-P_n + 82.393 + 722.512 = 0$

$P_n = 804.905$ kips

$\phi P_n = (0.65)(804.905) = 523$ kips

(tabulated = 523)

Σ Moments = 0

$-M_n + 1{,}111.854 + 3{,}369.709 = 0$

$M_n = 4{,}481.563$ in.-kips

$\phi M_n = (0.65)(4{,}481.563) = 2{,}913$ in.-kips

(tabulated = 2,913)

**5. 100% $f_y$ ($\phi P_b$ and $\phi M_b$, Balance)**

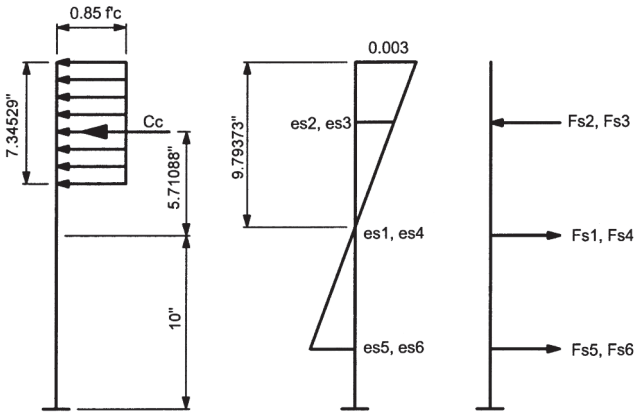



**Figure 4-10 100% $f_y$ ($\phi P_b$ and $\phi M_b$, Balance)**

The tensile stress in bars 5 and 6 = $f_y$ = 60 ksi.

$$c = \frac{16.5480}{1 + 60/(29{,}000 \times 0.003)} = 9.79373 \text{ in.}$$

Bars forces and moments about column centroid are tabulated below:

| Bar | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 10.0000 | -0.0000632 | -1.832 | -1.832 | 0 |
| 2 | 3.4520 | 0.0019426 | 56.335 | 51.235* | 335.489 |
| 3 | 3.4520 | 0.0019426 | 56.335 | 51.235* | 335.489 |
| 4 | 10.0000 | -0.0000632 | -1.832 | -1.832 | 0 |
| 5 | 16.5480 | -0.0020690 | -60.000 | -60.000 | 392.881 |
| 6 | 16.5480 | -0.0020690 | -60.000 | -60.000 | 392.881 |
| | | | | -21.194 | 1,456.740 |

*$F_{si}$ reduced by 5.1 kips

The depth of the equivalent stress block:

$a = 0.75(9.79373) = 7.34529$ in.

Properties of the concrete compression zone:

$$\alpha = \cos^{-1}[(20 - 2(7.34529))/20] = 1.30210 \text{ rad}$$

$$A_c = 20^2[2(1.30210) - \sin(2 \times 1.30210)]/8 = 104.61592 \text{ in.}^2$$

$$y = 2(20)^3 \sin(1.30210)^3/(24 \times 104.61592) = 5.71088 \text{ in.}$$

Concrete compression resultant, $C_c$, and moment, $M_c$, about the column centroid:

$$C_c = 0.85(6)104.61592 = 533.541 \text{ kips}$$

$$M_c = 533.541(5.71088) = 3{,}046.988 \text{ in.-kips}$$

$\Sigma$ Forces = 0

$-P_n - 21.194 + 533.541 = 0$

$P_n = 512.347$ kips

$\phi P_n = (0.65)(512.347) = 333$ kips (tabulated = 333)

$\Sigma$ Moments = 0

$-M_n + 1{,}456.740 + 3{,}046.988 = 0$

$M_n = 4{,}503.728$ in.-kips

$\phi M_n = (0.65)(4{,}503.728) = 2{,}927$ in.-kips (tabulated = 2,927)

**6. $\varepsilon_t = 0.005$**

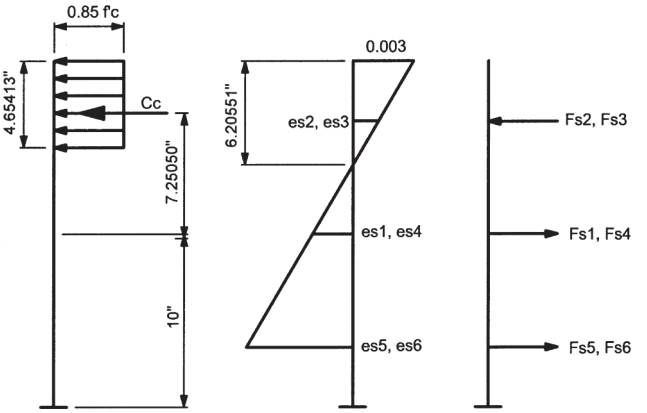



**Figure 4-11 $\varepsilon_t = 0.005$**

$c = 16.5480(0.003)/(0.003 + 0.005) = 6.20551$ in.

Bars forces and moments about column centroid are tabulated below:

| Bar | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 10.0000 | -0.0018344 | -53.198 | -53.198 | 0 |
| 2 | 3.4520 | 0.0013312 | 38.604 | 33.504* | 219.384 |
| 3 | 3.4520 | 0.0013312 | 38.604 | 33.504* | 219.384 |
| 4 | 10.0000 | -0.0018344 | -53.198 | -53.198 | 0 |
| 5 | 16.5480 | -0.0050000 | -60.000 | -60.000 | 392.881 |
| 6 | 16.5480 | -0.0050000 | -60.000 | -60.000 | 392.881 |
| | | | | -159.388 | 1,224.530 |

*$F_{si}$ reduced by 5.1 kips

The depth of the equivalent stress block:

$a = 0.75(6.20551) = 4.65413$ in.

Properties of the concrete compression zone:

$$\alpha = \cos^{-1}[(20 - 2(4.65413))/20] = 1.00678 \text{ rad}$$

$$A_c = 20^2[2(1.00678) - \sin(2 \times 1.00678)]/8 = 55.49907 \text{ in.}^2$$

$$y = 2(20)^3 \sin(1.00678)^3/(24 \times 55.49907) = 7.25050 \text{ in.}$$

Concrete compression resultant, $C_c$, and moment, $M_c$, about the column centroid:

$$C_c = 0.85(6)55.49907 = 283.045 \text{ kips}$$

$$M_c = 283.045(7.25050) = 2{,}052.220 \text{ in.-kips}$$

Σ Forces = 0
$-P_n - 159.388 + 283.045 = 0$
$P_n = 123.657$ kips
$\phi P_n = (0.90)(123.657) = 111$ kips
(tabulated = 111)

Σ Moments = 0
$-M_n + 1{,}224.530 + 2{,}052.220 = 0$
$M_n = 3{,}276.750$ in.-kips
$\phi M_n = (0.90)(3{,}276.750) = 2{,}949$ in.-kips
(tabulated = 2,949)

**7. $\phi M_n$ ($\phi P_n = 0$)**

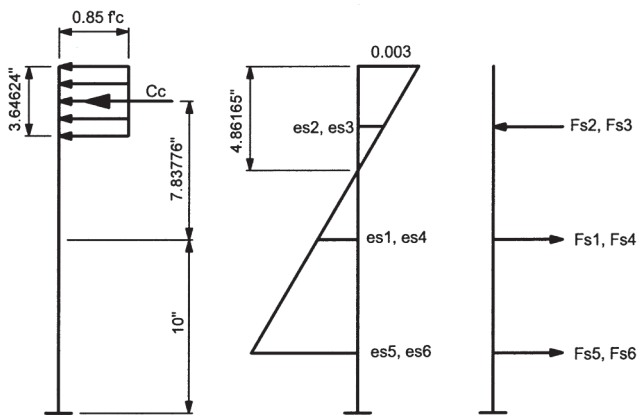



**Figure 4-12 $\phi M_n$ ($\phi P_n = 0$)**

Through iteration, $c = 4.86165$ in.

Bars forces and moments about column centroid are tabulated below:

| Bar | $d_{si}$ (in.) | $\varepsilon_{si}$ | $f_{si}$ (ksi) | $F_{si}$ (kips) | $M_{si}$ (in.-kips) |
|---|---|---|---|---|---|
| 1 | 10.0000 | -0.0031707 | -60.000 | -60.000 | 0 |
| 2 | 3.4520 | 0.0008699 | 25.226 | 20.126* | 131.787 |
| 3 | 3.4520 | 0.0008699 | 25.226 | 20.126* | 131.787 |
| 4 | 10.0000 | -0.0031707 | -60.000 | -60.000 | 0 |
| 5 | 16.5480 | -0.0072114 | -60.000 | -60.000 | 392.881 |
| 6 | 16.5480 | -0.0072114 | -60.000 | -60.000 | 392.881 |
| | | | | -199.747 | 1,049.337 |

*$F_{si}$ reduced by 5.1 kips

The depth of the equivalent stress block:
$a = 0.75(4.86165) = 3.64624$ in.

Properties of the concrete compression zone:

$\alpha = \cos^{-1}[(20 - 2(3.64624))/20]$
$= 0.88230$ rad

$A_c = 20^2[2(0.88230) - \sin(2 \times 0.88230)]/8$
$= 39.16617$ in.$^2$

$y = 2(20)^3 \sin(0.88230)^3/(24 \times 39.16617)$
$= 7.83776$ in.

Concrete compression resultant, $C_c$, and moment, $M_c$, about the column centroid:

$C_c = 0.85(6)39.16617 = 199.747$ kips
$M_c = 199.747(7.83776) = 1{,}565.569$ in.-kips

Σ Forces = 0
$-P_n - 199.747 + 199.747 = 0$
$P_n = 0$ kips
$\phi P_n = (0.90)(0) = 0$ kips

Σ Moments = 0
$-M_n + 1{,}049.337 + 1{,}565.569 = 0$
$M_n = 2{,}614.906$ in.-kips
$\phi M_n = (0.90)(2{,}614.906) = 2{,}353$ in.-kips
(tabulated = 2,353)

## ROUND TIED COLUMNS 12" DIA.

Short columns – no sidesway. $f'_c$ = 4,000 psi. $f_y$ = 60,000 psi. $\phi M_n$ in inch-kips. $\phi P_n$ in kips.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#5 | 1.10 | 219 | 236 | 292 | 209 | 357 | 171 | 384 | 141 | 388 | 94 | 396 | 33 | 293 |
| 4-#6 | 1.56 | 222 | 252 | 312 | 218 | 380 | 177 | 411 | 144 | 420 | 91 | 430 | 15 | 393 |
| 4-#7 | 2.12 | 226 | 271 | 336 | 228 | 407 | 184 | 441 | 147 | 458 | 88 | 470 | -8 | 471 |
| 4-#8 | 2.79 | 231 | 293 | 363 | 241 | 439 | 193 | 476 | 151 | 500 | 83 | 515 | -36 | 518 |
| 4-#9 | 3.54 | 236 | 318 | 391 | 255 | 473 | 202 | 512 | 155 | 545 | 78 | 561 | -68 | 565 |
| 4-#10 | 4.49 | 243 | 349 | 426 | 273 | 514 | 214 | 556 | 165 | 600 | 70 | 617 | -111 | 619 |
| 4-#11 | 5.52 | 245 | 384 | 461 | 288 | 541 | 220 | 584 | 165 | 632 | 55 | 635 | -164 | 644 |
| 4-#14 | 7.96 | 261 | 465 | 538 | 332 | 621 | 245 | 674 | 175 | 744 | 29 | 735 | -276 | 750 |
| 5-#5 | 1.37 | 228 | 246 | 315 | 211 | 378 | 172 | 403 | 139 | 408 | 88 | 415 | 27 | 336 |
| 5-#6 | 1.95 | 234 | 265 | 341 | 222 | 407 | 179 | 436 | 143 | 449 | 84 | 458 | 6 | 442 |
| 5-#7 | 2.65 | 242 | 288 | 371 | 236 | 442 | 189 | 474 | 147 | 496 | 79 | 508 | -19 | 517 |
| 5-#8 | 3.49 | 251 | 316 | 405 | 252 | 481 | 199 | 517 | 153 | 551 | 72 | 564 | -51 | 582 |
| 5-#9 | 4.42 | 261 | 347 | 441 | 270 | 521 | 210 | 563 | 158 | 607 | 64 | 621 | -86 | 647 |
| 5-#10 | 5.61 | 274 | 387 | 485 | 293 | 571 | 225 | 619 | 165 | 677 | 53 | 689 | -133 | 714 |
| 5-#11 | 6.90 | 279 | 430 | 523 | 312 | 603 | 232 | 653 | 163 | 718 | 33 | 708 | -195 | 738 |
| 6-#5 | 1.64 | 230 | 255 | 347 | 209 | 403 | 168 | 424 | 134 | 430 | 79 | 423 | 9 | 396 |
| 6-#6 | 2.33 | 237 | 278 | 379 | 221 | 438 | 175 | 464 | 138 | 480 | 73 | 473 | -18 | 480 |
| 6-#7 | 3.18 | 246 | 306 | 417 | 237 | 480 | 185 | 512 | 142 | 539 | 65 | 531 | -50 | 545 |
| 6-#8 | 4.19 | 256 | 339 | 459 | 256 | 528 | 196 | 566 | 147 | 607 | 55 | 595 | -90 | 615 |
| 6-#9 | 5.31 | 267 | 377 | 503 | 276 | 578 | 208 | 622 | 152 | 678 | 44 | 679 | -129 | 686 |
| 6-#10 | 6.74 | 282 | 424 | 556 | 302 | 638 | 223 | 691 | 157 | 765 | 28 | 761 | -187 | 770 |
| 7-#5 | 1.92 | 234 | 264 | 335 | 226 | 403 | 183 | 436 | 147 | 451 | 88 | 467 | 12 | 438 |
| 7-#6 | 2.72 | 244 | 291 | 370 | 242 | 443 | 194 | 481 | 152 | 507 | 83 | 528 | -16 | 535 |
| 7-#7 | 3.71 | 255 | 324 | 411 | 261 | 491 | 208 | 534 | 159 | 574 | 77 | 604 | -49 | 616 |
| 7-#8 | 4.89 | 268 | 363 | 458 | 284 | 545 | 224 | 594 | 167 | 649 | 68 | 685 | -92 | 699 |
| 7-#9 | 6.19 | 283 | 406 | 507 | 310 | 602 | 241 | 657 | 177 | 729 | 58 | 767 | -141 | 778 |
| 8-#5 | 2.19 | 240 | 273 | 340 | 235 | 414 | 190 | 450 | 152 | 473 | 90 | 500 | 5 | 490 |
| 8-#6 | 3.11 | 252 | 304 | 379 | 254 | 459 | 203 | 502 | 159 | 536 | 85 | 571 | -27 | 572 |
| 8-#7 | 4.24 | 265 | 341 | 424 | 277 | 512 | 219 | 562 | 167 | 612 | 79 | 655 | -67 | 660 |
| 8-#8 | 5.59 | 281 | 386 | 476 | 305 | 573 | 237 | 631 | 176 | 698 | 70 | 749 | -115 | 756 |

## ROUND TIED COLUMNS 14" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.14 | 353 | 324 | 451 | 294 | 567 | 242 | 620 | 199 | 644 | 135 | 672 | 52 | 493 |
| 4-#7 | 1.56 | 359 | 343 | 482 | 305 | 603 | 249 | 661 | 203 | 695 | 133 | 730 | 32 | 642 |
| 4-#8 | 2.05 | 366 | 365 | 517 | 318 | 644 | 258 | 709 | 208 | 755 | 130 | 797 | 8 | 784 |
| 4-#9 | 2.60 | 374 | 390 | 555 | 332 | 688 | 268 | 761 | 213 | 818 | 126 | 867 | -20 | 866 |
| 4-#10 | 3.30 | 385 | 422 | 601 | 351 | 744 | 281 | 825 | 221 | 896 | 121 | 952 | -57 | 949 |
| 4-#11 | 4.05 | 390 | 456 | 651 | 366 | 795 | 290 | 878 | 223 | 951 | 109 | 998 | -108 | 995 |
| 4-#14 | 5.85 | 413 | 537 | 757 | 413 | 922 | 322 | 1014 | 236 | 1120 | 92 | 1171 | -215 | 1159 |
| 5-#5 | 1.01 | 361 | 318 | 462 | 286 | 568 | 235 | 614 | 194 | 627 | 131 | 650 | 62 | 425 |
| 5-#6 | 1.43 | 370 | 337 | 494 | 298 | 607 | 243 | 659 | 198 | 682 | 128 | 713 | 44 | 563 |
| 5-#7 | 1.95 | 382 | 360 | 534 | 312 | 653 | 253 | 712 | 203 | 747 | 124 | 787 | 21 | 723 |
| 5-#8 | 2.57 | 396 | 388 | 579 | 328 | 706 | 264 | 773 | 210 | 822 | 119 | 871 | -6 | 873 |
| 5-#9 | 3.25 | 412 | 419 | 627 | 347 | 763 | 277 | 838 | 217 | 902 | 114 | 958 | -37 | 970 |
| 5-#10 | 4.13 | 431 | 459 | 687 | 371 | 833 | 293 | 918 | 225 | 1001 | 106 | 1066 | -79 | 1084 |
| 5-#11 | 5.07 | 441 | 502 | 745 | 392 | 896 | 306 | 976 | 226 | 1072 | 90 | 1121 | -136 | 1145 |
| 5-#14 | 7.31 | 485 | 603 | 879 | 451 | 1048 | 344 | 1147 | 247 | 1286 | 63 | 1334 | -254 | 1345 |
| 6-#5 | 1.21 | 363 | 327 | 507 | 280 | 607 | 229 | 646 | 186 | 655 | 120 | 659 | 42 | 497 |
| 6-#6 | 1.71 | 373 | 350 | 549 | 293 | 657 | 238 | 701 | 190 | 723 | 115 | 732 | 18 | 667 |
| 6-#7 | 2.34 | 386 | 378 | 598 | 309 | 716 | 249 | 767 | 197 | 805 | 109 | 817 | -13 | 820 |
| 6-#8 | 3.08 | 401 | 412 | 655 | 329 | 782 | 261 | 842 | 204 | 899 | 102 | 914 | -49 | 923 |
| 6-#9 | 3.90 | 416 | 449 | 716 | 350 | 852 | 275 | 921 | 211 | 998 | 93 | 1015 | -90 | 1027 |
| 6-#10 | 4.95 | 436 | 496 | 792 | 378 | 939 | 293 | 1020 | 219 | 1122 | 81 | 1138 | -144 | 1151 |
| 6-#11 | 6.08 | 450 | 548 | 865 | 404 | 1004 | 304 | 1091 | 221 | 1210 | 59 | 1202 | -213 | 1229 |

## ROUND TIED COLUMNS 14" DIA.

Short columns – no sidesway. $f'_c$ = 4,000 psi. $f_y$ = 60,000 psi. $\phi M_n$ in inch-kips. $\phi P_n$ in kips.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 7-#5 | 1.41 | 369 | 336 | 482 | 302 | 601 | 248 | 656 | 203 | 684 | 132 | 723 | 49 | 560 |
| 7-#6 | 2.00 | 383 | 363 | 528 | 318 | 654 | 260 | 716 | 209 | 760 | 129 | 812 | 25 | 739 |
| 7-#7 | 2.73 | 399 | 396 | 583 | 338 | 717 | 274 | 789 | 218 | 851 | 125 | 916 | -6 | 919 |
| 7-#8 | 3.59 | 418 | 435 | 645 | 363 | 789 | 292 | 873 | 228 | 956 | 119 | 1035 | -43 | 1047 |
| 7-#9 | 4.55 | 439 | 478 | 713 | 390 | 867 | 310 | 964 | 238 | 1067 | 112 | 1159 | -86 | 1175 |
| 7-#10 | 5.78 | 466 | 534 | 796 | 424 | 963 | 335 | 1076 | 252 | 1205 | 103 | 1310 | -142 | 1320 |
| 7-#11 | 7.09 | 483 | 594 | 872 | 455 | 1045 | 354 | 1158 | 256 | 1304 | 82 | 1407 | -216 | 1401 |
| 8-#5 | 1.61 | 376 | 345 | 488 | 312 | 613 | 256 | 674 | 208 | 712 | 135 | 762 | 42 | 627 |
| 8-#6 | 2.29 | 392 | 376 | 540 | 332 | 673 | 270 | 742 | 217 | 799 | 132 | 863 | 14 | 833 |
| 8-#7 | 3.12 | 411 | 413 | 600 | 357 | 744 | 287 | 824 | 227 | 902 | 128 | 983 | -21 | 987 |
| 8-#8 | 4.11 | 434 | 458 | 670 | 385 | 826 | 307 | 919 | 239 | 1021 | 123 | 1134 | -60 | 1125 |
| 8-#9 | 5.20 | 458 | 508 | 744 | 417 | 913 | 329 | 1020 | 251 | 1147 | 117 | 1280 | -108 | 1266 |
| 8-#10 | 6.60 | 489 | 571 | 836 | 457 | 1021 | 357 | 1146 | 267 | 1304 | 107 | 1458 | -172 | 1436 |

## ROUND TIED COLUMNS 16" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.19 | 535 | 426 | 659 | 394 | 849 | 324 | 939 | 267 | 991 | 182 | 1059 | 75 | 778 |
| 4-#8 | 1.57 | 544 | 448 | 703 | 407 | 900 | 334 | 998 | 273 | 1068 | 181 | 1147 | 53 | 986 |
| 4-#9 | 1.99 | 555 | 473 | 750 | 421 | 955 | 344 | 1062 | 279 | 1151 | 179 | 1241 | 28 | 1188 |
| 4-#10 | 2.53 | 568 | 505 | 809 | 440 | 1024 | 357 | 1142 | 286 | 1255 | 176 | 1358 | -5 | 1358 |
| 4-#11 | 3.10 | 575 | 539 | 874 | 456 | 1092 | 367 | 1216 | 290 | 1335 | 167 | 1435 | -50 | 1429 |
| 4-#14 | 4.48 | 610 | 620 | 1009 | 504 | 1253 | 400 | 1405 | 309 | 1563 | 154 | 1685 | -144 | 1660 |
| 4-#18 | 7.96 | 693 | 826 | 1324 | 624 | 1630 | 482 | 1833 | 349 | 2080 | 114 | 2225 | -405 | 2151 |
| 5-#6 | 1.09 | 549 | 420 | 685 | 384 | 858 | 317 | 939 | 261 | 977 | 177 | 1034 | 84 | 687 |
| 5-#7 | 1.49 | 565 | 444 | 736 | 398 | 915 | 327 | 1005 | 267 | 1061 | 174 | 1132 | 64 | 886 |
| 5-#8 | 1.96 | 584 | 472 | 794 | 415 | 982 | 339 | 1081 | 274 | 1158 | 171 | 1246 | 39 | 1110 |
| 5-#9 | 2.49 | 604 | 503 | 856 | 433 | 1053 | 352 | 1164 | 281 | 1261 | 167 | 1365 | 12 | 1334 |
| 5-#10 | 3.16 | 629 | 542 | 934 | 457 | 1143 | 369 | 1268 | 291 | 1390 | 161 | 1513 | -25 | 1519 |
| 5-#11 | 3.88 | 648 | 585 | 1002 | 481 | 1226 | 383 | 1361 | 297 | 1491 | 148 | 1609 | -76 | 1625 |
| 5-#14 | 5.60 | 705 | 687 | 1176 | 542 | 1433 | 425 | 1595 | 318 | 1781 | 129 | 1923 | -181 | 1927 |
| 6-#6 | 1.31 | 551 | 433 | 759 | 376 | 923 | 307 | 1000 | 251 | 1028 | 162 | 1055 | 58 | 809 |
| 6-#7 | 1.79 | 568 | 461 | 820 | 393 | 996 | 319 | 1083 | 257 | 1132 | 158 | 1169 | 30 | 1054 |
| 6-#8 | 2.36 | 588 | 495 | 890 | 412 | 1081 | 333 | 1180 | 264 | 1253 | 152 | 1300 | -3 | 1300 |
| 6-#9 | 2.98 | 609 | 532 | 966 | 434 | 1173 | 348 | 1283 | 271 | 1383 | 145 | 1438 | -41 | 1442 |
| 6-#10 | 3.79 | 635 | 580 | 1061 | 462 | 1289 | 367 | 1412 | 281 | 1544 | 135 | 1609 | -92 | 1611 |
| 6-#11 | 4.66 | 653 | 631 | 1156 | 488 | 1392 | 383 | 1516 | 291 | 1670 | 118 | 1719 | -158 | 1727 |
| 6-#14 | 6.71 | 716 | 753 | 1377 | 559 | 1645 | 428 | 1804 | 312 | 2032 | 87 | 2079 | -295 | 2079 |
| 7-#5 | 1.08 | 546 | 419 | 662 | 390 | 848 | 323 | 934 | 267 | 977 | 181 | 1047 | 89 | 687 |
| 7-#6 | 1.53 | 564 | 446 | 718 | 406 | 914 | 335 | 1010 | 274 | 1074 | 179 | 1164 | 68 | 910 |
| 7-#7 | 2.09 | 586 | 479 | 786 | 427 | 994 | 350 | 1101 | 283 | 1192 | 177 | 1303 | 40 | 1169 |
| 7-#8 | 2.75 | 610 | 518 | 864 | 452 | 1085 | 369 | 1207 | 294 | 1327 | 173 | 1463 | 7 | 1443 |
| 7-#9 | 3.48 | 637 | 562 | 947 | 479 | 1184 | 388 | 1321 | 306 | 1471 | 169 | 1632 | -31 | 1637 |
| 7-#10 | 4.42 | 673 | 617 | 1052 | 514 | 1307 | 414 | 1463 | 321 | 1650 | 162 | 1841 | -81 | 1847 |
| 7-#11 | 5.43 | 697 | 677 | 1158 | 547 | 1418 | 435 | 1588 | 331 | 1792 | 147 | 1978 | -150 | 1987 |
| 7-#14 | 7.83 | 781 | 819 | 1402 | 636 | 1699 | 497 | 1917 | 365 | 2196 | 123 | 2421 | -294 | 2387 |
| 8-#5 | 1.23 | 555 | 428 | 663 | 401 | 863 | 332 | 956 | 274 | 1011 | 185 | 1097 | 84 | 762 |
| 8-#6 | 1.75 | 575 | 459 | 727 | 421 | 937 | 347 | 1041 | 283 | 1120 | 184 | 1230 | 59 | 1023 |
| 8-#7 | 2.39 | 600 | 497 | 803 | 446 | 1026 | 365 | 1144 | 294 | 1251 | 181 | 1389 | 28 | 1318 |
| 8-#8 | 3.14 | 628 | 541 | 891 | 476 | 1129 | 386 | 1263 | 307 | 1405 | 179 | 1572 | -11 | 1573 |
| 8-#9 | 3.98 | 658 | 591 | 986 | 509 | 1240 | 409 | 1391 | 321 | 1570 | 175 | 1765 | -55 | 1765 |
| 8-#10 | 5.05 | 699 | 655 | 1105 | 551 | 1378 | 439 | 1552 | 339 | 1776 | 170 | 2004 | -113 | 1995 |
| 8-#11 | 6.21 | 729 | 723 | 1220 | 590 | 1502 | 464 | 1691 | 351 | 1937 | 154 | 2199 | -183 | 2154 |
| 9-#10 | 5.68 | 728 | 692 | 1179 | 569 | 1469 | 455 | 1664 | 349 | 1911 | 161 | 2178 | -136 | 2146 |
| 9-#11 | 6.98 | 763 | 769 | 1307 | 613 | 1614 | 485 | 1821 | 363 | 2094 | 143 | 2360 | -222 | 2314 |
| 10-#10 | 6.32 | 764 | 729 | 1291 | 580 | 1575 | 461 | 1785 | 348 | 2058 | 147 | 2313 | -180 | 2268 |

## ROUND TIED COLUMNS 18" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.24 | 770 | 543 | 924 | 508 | 1212 | 420 | 1353 | 346 | 1445 | 237 | 1575 | 101 | 1165 |
| 4-#9 | 1.57 | 784 | 568 | 980 | 523 | 1278 | 430 | 1430 | 352 | 1544 | 235 | 1694 | 78 | 1429 |
| 4-#10 | 2.00 | 801 | 599 | 1051 | 542 | 1360 | 444 | 1526 | 360 | 1670 | 233 | 1843 | 48 | 1740 |
| 4-#11 | 2.45 | 812 | 634 | 1133 | 558 | 1445 | 454 | 1618 | 365 | 1785 | 227 | 1951 | 7 | 1937 |
| 4-#14 | 3.54 | 851 | 715 | 1298 | 607 | 1641 | 488 | 1847 | 384 | 2080 | 220 | 2281 | -78 | 2259 |
| 4-#18 | 6.29 | 960 | 921 | 1686 | 730 | 2105 | 573 | 2393 | 433 | 2749 | 192 | 3020 | -311 | 2915 |
| 5-#7 | 1.18 | 795 | 538 | 973 | 497 | 1237 | 411 | 1365 | 339 | 1441 | 229 | 1554 | 109 | 1053 |
| 5-#8 | 1.55 | 818 | 566 | 1043 | 514 | 1317 | 423 | 1458 | 346 | 1561 | 227 | 1697 | 87 | 1323 |
| 5-#9 | 1.96 | 843 | 597 | 1119 | 533 | 1403 | 437 | 1557 | 354 | 1690 | 224 | 1850 | 62 | 1609 |
| 5-#10 | 2.50 | 874 | 637 | 1213 | 557 | 1511 | 454 | 1683 | 365 | 1851 | 221 | 2040 | 28 | 1952 |
| 5-#11 | 3.07 | 897 | 679 | 1313 | 578 | 1616 | 468 | 1799 | 371 | 1984 | 210 | 2177 | -18 | 2180 |
| 5-#14 | 4.42 | 970 | 781 | 1532 | 640 | 1870 | 512 | 2096 | 396 | 2351 | 196 | 2595 | -112 | 2580 |
| 5-#18 | 7.86 | 1143 | 1039 | 2014 | 802 | 2467 | 622 | 2791 | 456 | 3198 | 149 | 3522 | -374 | 3440 |
| 6-#6 | 1.04 | 776 | 528 | 1014 | 471 | 1252 | 387 | 1361 | 319 | 1403 | 215 | 1451 | 101 | 951 |
| 6-#7 | 1.41 | 798 | 556 | 1086 | 488 | 1339 | 399 | 1463 | 325 | 1531 | 211 | 1595 | 75 | 1245 |
| 6-#8 | 1.86 | 822 | 589 | 1170 | 507 | 1440 | 412 | 1582 | 334 | 1679 | 206 | 1760 | 44 | 1579 |
| 6-#9 | 2.36 | 848 | 626 | 1261 | 529 | 1550 | 428 | 1712 | 342 | 1838 | 201 | 1936 | 10 | 1911 |
| 6-#10 | 2.99 | 883 | 674 | 1374 | 557 | 1688 | 448 | 1876 | 354 | 2038 | 193 | 2156 | -36 | 2156 |
| 6-#11 | 3.68 | 907 | 725 | 1493 | 583 | 1823 | 465 | 2012 | 359 | 2204 | 178 | 2315 | -98 | 2314 |
| 6-#14 | 5.31 | 984 | 847 | 1762 | 655 | 2152 | 515 | 2378 | 382 | 2662 | 154 | 2797 | -227 | 2775 |
| 7-#6 | 1.21 | 793 | 541 | 945 | 507 | 1230 | 420 | 1371 | 347 | 1455 | 235 | 1593 | 114 | 1086 |
| 7-#7 | 1.65 | 821 | 574 | 1026 | 527 | 1325 | 436 | 1481 | 357 | 1596 | 233 | 1767 | 89 | 1398 |
| 7-#8 | 2.17 | 852 | 613 | 1119 | 552 | 1435 | 454 | 1608 | 369 | 1760 | 231 | 1969 | 58 | 1752 |
| 7-#9 | 2.75 | 886 | 656 | 1219 | 580 | 1554 | 475 | 1746 | 381 | 1937 | 228 | 2184 | 24 | 2107 |
| 7-#10 | 3.49 | 928 | 712 | 1345 | 616 | 1705 | 502 | 1919 | 398 | 2161 | 224 | 2452 | -22 | 2453 |
| 7-#11 | 4.29 | 963 | 771 | 1478 | 649 | 1850 | 525 | 2077 | 409 | 2354 | 213 | 2649 | -84 | 2652 |
| 7-#14 | 6.19 | 1066 | 913 | 1774 | 739 | 2198 | 590 | 2483 | 447 | 2865 | 196 | 3239 | -213 | 3207 |
| 8-#6 | 1.38 | 807 | 554 | 949 | 523 | 1258 | 434 | 1407 | 357 | 1510 | 241 | 1676 | 107 | 1212 |
| 8-#7 | 1.89 | 837 | 591 | 1039 | 548 | 1365 | 452 | 1531 | 369 | 1668 | 239 | 1875 | 78 | 1579 |
| 8-#8 | 2.48 | 872 | 636 | 1144 | 578 | 1490 | 474 | 1675 | 383 | 1853 | 238 | 2105 | 43 | 1980 |
| 8-#9 | 3.14 | 910 | 685 | 1257 | 611 | 1624 | 498 | 1830 | 398 | 2052 | 236 | 2351 | 4 | 2341 |
| 8-#10 | 3.99 | 957 | 749 | 1399 | 653 | 1792 | 529 | 2025 | 418 | 2304 | 233 | 2656 | -49 | 2649 |
| 8-#11 | 4.90 | 999 | 817 | 1550 | 694 | 1951 | 556 | 2202 | 431 | 2526 | 222 | 2883 | -121 | 2865 |
| 8-#14 | 7.07 | 1115 | 980 | 1887 | 803 | 2343 | 632 | 2659 | 477 | 3112 | 208 | 3558 | -271 | 3496 |
| 9-#10 | 4.49 | 992 | 786 | 1498 | 673 | 1895 | 544 | 2157 | 427 | 2474 | 226 | 2859 | -75 | 2850 |
| 9-#11 | 5.52 | 1040 | 863 | 1658 | 717 | 2077 | 575 | 2363 | 444 | 2725 | 213 | 3134 | -149 | 3087 |
| 10-#10 | 4.99 | 1038 | 824 | 1639 | 683 | 2027 | 549 | 2299 | 424 | 2665 | 214 | 3043 | -112 | 2990 |
| 10-#11 | 6.13 | 1091 | 909 | 1818 | 731 | 2227 | 582 | 2529 | 442 | 2936 | 197 | 3329 | -201 | 3257 |
| 11-#10 | 5.49 | 1067 | 861 | 1658 | 724 | 2103 | 583 | 2394 | 455 | 2790 | 227 | 3277 | -126 | 3220 |
| 11-#11 | 6.74 | 1125 | 955 | 1852 | 780 | 2320 | 622 | 2642 | 477 | 3094 | 212 | 3595 | -220 | 3504 |
| 12-#10 | 5.99 | 1115 | 898 | 1726 | 753 | 2182 | 608 | 2513 | 472 | 2940 | 232 | 3489 | -149 | 3412 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 20" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.01 | 1049 | 648 | 1182 | 622 | 1586 | 516 | 1784 | 429 | 1902 | 299 | 2091 | 152 | 1342 |
| 4-#9 | 1.27 | 1067 | 673 | 1249 | 637 | 1663 | 527 | 1872 | 435 | 2016 | 298 | 2235 | 131 | 1654 |
| 4-#10 | 1.62 | 1088 | 705 | 1332 | 656 | 1760 | 540 | 1984 | 443 | 2162 | 296 | 2416 | 104 | 2038 |
| 4-#11 | 1.99 | 1103 | 739 | 1432 | 672 | 1863 | 550 | 2095 | 448 | 2299 | 290 | 2555 | 65 | 2400 |
| 4-#14 | 2.86 | 1151 | 820 | 1627 | 721 | 2093 | 585 | 2364 | 468 | 2652 | 286 | 2967 | -12 | 2963 |
| 4-#18 | 5.09 | 1284 | 1026 | 2088 | 847 | 2644 | 673 | 3011 | 520 | 3502 | 270 | 3911 | -225 | 3801 |
| 5-#8 | 1.26 | 1105 | 672 | 1335 | 626 | 1717 | 518 | 1910 | 427 | 2037 | 288 | 2234 | 138 | 1540 |
| 5-#9 | 1.59 | 1136 | 703 | 1424 | 645 | 1818 | 531 | 2027 | 435 | 2188 | 286 | 2420 | 115 | 1876 |
| 5-#10 | 2.02 | 1173 | 742 | 1535 | 669 | 1946 | 549 | 2174 | 446 | 2379 | 283 | 2652 | 84 | 2293 |
| 5-#11 | 2.48 | 1203 | 785 | 1657 | 691 | 2073 | 564 | 2314 | 453 | 2554 | 276 | 2832 | 42 | 2689 |
| 5-#14 | 3.58 | 1288 | 887 | 1918 | 753 | 2375 | 609 | 2666 | 480 | 3003 | 266 | 3358 | -45 | 3359 |
| 5-#18 | 6.37 | 1499 | 1144 | 2533 | 910 | 3091 | 722 | 3505 | 545 | 4046 | 231 | 4551 | -283 | 4462 |
| 6-#7 | 1.15 | 1081 | 661 | 1402 | 594 | 1751 | 488 | 1917 | 402 | 2008 | 270 | 2103 | 123 | 1437 |
| 6-#8 | 1.51 | 1111 | 695 | 1500 | 614 | 1868 | 502 | 2055 | 410 | 2184 | 266 | 2304 | 95 | 1829 |
| 6-#9 | 1.91 | 1143 | 732 | 1605 | 636 | 1996 | 517 | 2206 | 419 | 2373 | 262 | 2519 | 62 | 2245 |
| 6-#10 | 2.43 | 1182 | 780 | 1738 | 664 | 2157 | 537 | 2397 | 430 | 2612 | 256 | 2788 | 20 | 2731 |
| 6-#11 | 2.98 | 1217 | 831 | 1880 | 690 | 2317 | 555 | 2581 | 439 | 2818 | 243 | 2996 | -37 | 2994 |
| 6-#14 | 4.30 | 1310 | 953 | 2197 | 763 | 2704 | 606 | 3033 | 467 | 3374 | 223 | 3603 | -156 | 3574 |
| 6-#18 | 7.64 | 1543 | 1262 | 2954 | 946 | 3635 | 735 | 4069 | 528 | 4677 | 162 | 4977 | -482 | 4844 |
| 7-#7 | 1.34 | 1109 | 679 | 1305 | 640 | 1720 | 531 | 1935 | 439 | 2080 | 296 | 2318 | 140 | 1635 |
| 7-#8 | 1.76 | 1147 | 718 | 1414 | 665 | 1848 | 550 | 2085 | 452 | 2271 | 295 | 2563 | 112 | 2051 |
| 7-#9 | 2.23 | 1189 | 761 | 1532 | 693 | 1987 | 571 | 2247 | 465 | 2480 | 293 | 2824 | 80 | 2493 |
| 7-#10 | 2.83 | 1240 | 817 | 1679 | 729 | 2163 | 598 | 2451 | 482 | 2743 | 290 | 3152 | 38 | 3014 |
| 7-#11 | 3.48 | 1280 | 877 | 1839 | 763 | 2339 | 622 | 2643 | 494 | 2982 | 281 | 3409 | -19 | 3410 |
| 7-#14 | 5.01 | 1408 | 1019 | 2189 | 854 | 2759 | 690 | 3127 | 535 | 3609 | 271 | 4150 | -137 | 4127 |
| 8-#7 | 1.53 | 1129 | 697 | 1313 | 662 | 1764 | 549 | 1993 | 453 | 2165 | 304 | 2448 | 132 | 1832 |
| 8-#8 | 2.01 | 1172 | 741 | 1435 | 692 | 1911 | 572 | 2161 | 468 | 2381 | 303 | 2727 | 100 | 2322 |
| 8-#9 | 2.55 | 1217 | 791 | 1566 | 725 | 2071 | 597 | 2344 | 484 | 2615 | 302 | 3025 | 63 | 2823 |
| 8-#10 | 3.23 | 1274 | 854 | 1732 | 768 | 2271 | 629 | 2574 | 504 | 2911 | 300 | 3399 | 15 | 3354 |
| 8-#11 | 3.97 | 1320 | 923 | 1911 | 808 | 2464 | 657 | 2789 | 519 | 3180 | 292 | 3694 | -51 | 3683 |
| 8-#14 | 5.73 | 1462 | 1085 | 2307 | 918 | 2933 | 736 | 3334 | 568 | 3884 | 283 | 4540 | -188 | 4474 |
| 9-#10 | 3.64 | 1316 | 892 | 1852 | 787 | 2393 | 639 | 2721 | 512 | 3113 | 294 | 3643 | -11 | 3642 |
| 9-#11 | 4.47 | 1370 | 969 | 2050 | 833 | 2604 | 674 | 2970 | 531 | 3418 | 284 | 3978 | -83 | 3963 |
| 9-#14 | 6.45 | 1536 | 1151 | 2490 | 954 | 3132 | 763 | 3594 | 587 | 4217 | 272 | 4934 | -234 | 4829 |
| 10-#10 | 4.04 | 1363 | 929 | 2030 | 797 | 2545 | 646 | 2889 | 509 | 3327 | 281 | 3862 | -45 | 3814 |
| 10-#11 | 4.97 | 1433 | 1015 | 2247 | 846 | 2787 | 681 | 3166 | 528 | 3683 | 270 | 4236 | -126 | 4159 |
| 10-#14 | 7.16 | 1615 | 1218 | 2749 | 975 | 3380 | 775 | 3866 | 585 | 4585 | 252 | 5298 | -298 | 5119 |
| 11-#10 | 4.45 | 1399 | 967 | 2038 | 840 | 2622 | 682 | 2999 | 542 | 3484 | 298 | 4147 | -57 | 4112 |
| 11-#11 | 5.46 | 1473 | 1060 | 2271 | 896 | 2889 | 723 | 3298 | 566 | 3856 | 286 | 4563 | -143 | 4481 |
| 12-#10 | 4.85 | 1457 | 1004 | 2115 | 870 | 2713 | 708 | 3129 | 559 | 3662 | 305 | 4402 | -77 | 4368 |
| 12-#11 | 5.96 | 1541 | 1106 | 2365 | 932 | 2999 | 753 | 3460 | 587 | 4065 | 293 | 4859 | -171 | 4748 |
| 13-#10 | 5.26 | 1479 | 1041 | 2217 | 895 | 2850 | 724 | 3277 | 571 | 3848 | 299 | 4632 | -108 | 4572 |
| 14-#10 | 5.66 | 1527 | 1079 | 2347 | 911 | 2993 | 738 | 3448 | 575 | 4049 | 290 | 4848 | -139 | 4777 |

## ROUND TIED COLUMNS 22" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi

$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.05 | 1408 | 790 | 1559 | 763 | 2119 | 634 | 2398 | 527 | 2577 | 367 | 2872 | 188 | 1879 |
| 4-#10 | 1.34 | 1435 | 822 | 1655 | 782 | 2230 | 647 | 2526 | 535 | 2744 | 366 | 3085 | 162 | 2324 |
| 4-#11 | 1.64 | 1454 | 856 | 1773 | 798 | 2350 | 657 | 2655 | 539 | 2901 | 360 | 3257 | 126 | 2759 |
| 4-#14 | 2.37 | 1513 | 937 | 1999 | 848 | 2616 | 693 | 2964 | 561 | 3306 | 356 | 3752 | 54 | 3621 |
| 4-#18 | 4.21 | 1655 | 1143 | 2535 | 974 | 3254 | 783 | 3712 | 614 | 4292 | 345 | 4903 | -143 | 4813 |
| 5-#8 | 1.04 | 1452 | 788 | 1672 | 749 | 2190 | 622 | 2446 | 516 | 2602 | 356 | 2855 | 190 | 1762 |
| 5-#9 | 1.32 | 1488 | 819 | 1775 | 768 | 2306 | 636 | 2580 | 525 | 2774 | 354 | 3070 | 168 | 2149 |
| 5-#10 | 1.67 | 1533 | 859 | 1904 | 793 | 2453 | 655 | 2749 | 536 | 2993 | 352 | 3342 | 138 | 2630 |
| 5-#11 | 2.05 | 1569 | 902 | 2049 | 814 | 2603 | 669 | 2914 | 543 | 3198 | 345 | 3584 | 102 | 3103 |
| 5-#14 | 2.96 | 1671 | 1003 | 2352 | 878 | 2953 | 715 | 3321 | 571 | 3727 | 338 | 4218 | 22 | 4138 |
| 5-#18 | 5.26 | 1919 | 1261 | 3072 | 1037 | 3789 | 832 | 4299 | 640 | 4987 | 314 | 5684 | -198 | 5579 |
| 6-#8 | 1.25 | 1459 | 812 | 1884 | 732 | 2373 | 602 | 2614 | 494 | 2776 | 332 | 2939 | 148 | 2079 |
| 6-#9 | 1.58 | 1497 | 849 | 2005 | 754 | 2518 | 617 | 2786 | 503 | 2996 | 328 | 3193 | 117 | 2559 |
| 6-#10 | 2.00 | 1544 | 896 | 2157 | 782 | 2702 | 637 | 3004 | 515 | 3274 | 323 | 3512 | 78 | 3155 |
| 6-#11 | 2.46 | 1582 | 948 | 2323 | 808 | 2889 | 654 | 3217 | 524 | 3521 | 312 | 3771 | 25 | 3693 |
| 6-#14 | 3.55 | 1698 | 1069 | 2688 | 881 | 3334 | 706 | 3745 | 554 | 4176 | 295 | 4504 | -87 | 4483 |
| 6-#18 | 6.31 | 1968 | 1378 | 3565 | 1066 | 4410 | 836 | 5013 | 628 | 5728 | 245 | 6195 | -389 | 6036 |
| 7-#7 | 1.10 | 1457 | 796 | 1629 | 765 | 2186 | 637 | 2470 | 530 | 2652 | 365 | 2965 | 196 | 1877 |
| 7-#8 | 1.45 | 1503 | 835 | 1753 | 791 | 2332 | 656 | 2641 | 542 | 2872 | 364 | 3252 | 169 | 2356 |
| 7-#9 | 1.84 | 1552 | 878 | 1888 | 818 | 2491 | 677 | 2828 | 556 | 3110 | 363 | 3561 | 140 | 2867 |
| 7-#10 | 2.34 | 1614 | 934 | 2057 | 855 | 2692 | 704 | 3064 | 574 | 3413 | 361 | 3950 | 101 | 3501 |
| 7-#11 | 2.87 | 1663 | 993 | 2245 | 888 | 2898 | 728 | 3293 | 588 | 3694 | 353 | 4268 | 48 | 4080 |
| 7-#14 | 4.14 | 1806 | 1136 | 2649 | 980 | 3382 | 798 | 3855 | 631 | 4421 | 346 | 5162 | -62 | 5148 |
| 7-#18 | 7.37 | 2176 | 1496 | 3617 | 1214 | 4549 | 973 | 5203 | 737 | 6168 | 321 | 7227 | -362 | 7021 |
| 8-#7 | 1.26 | 1479 | 813 | 1628 | 788 | 2229 | 657 | 2538 | 546 | 2750 | 374 | 3118 | 189 | 2089 |
| 8-#8 | 1.66 | 1530 | 858 | 1766 | 818 | 2397 | 679 | 2731 | 561 | 2998 | 374 | 3445 | 159 | 2652 |
| 8-#9 | 2.10 | 1584 | 908 | 1917 | 851 | 2579 | 705 | 2941 | 577 | 3266 | 374 | 3797 | 125 | 3255 |
| 8-#10 | 2.67 | 1651 | 971 | 2106 | 894 | 2810 | 738 | 3207 | 599 | 3607 | 374 | 4240 | 80 | 3960 |
| 8-#11 | 3.28 | 1707 | 1039 | 2316 | 935 | 3047 | 767 | 3460 | 615 | 3924 | 366 | 4605 | 19 | 4541 |
| 8-#14 | 4.74 | 1865 | 1202 | 2770 | 1045 | 3594 | 849 | 4094 | 667 | 4741 | 362 | 5624 | -107 | 5575 |
| 9-#10 | 3.01 | 1699 | 1008 | 2249 | 913 | 2955 | 748 | 3368 | 605 | 3840 | 368 | 4527 | 55 | 4302 |
| 9-#11 | 3.69 | 1766 | 1085 | 2480 | 959 | 3212 | 780 | 3659 | 625 | 4199 | 359 | 4942 | -12 | 4939 |
| 9-#14 | 5.33 | 1959 | 1268 | 2991 | 1082 | 3827 | 869 | 4379 | 683 | 5129 | 352 | 6095 | -152 | 6026 |
| 10-#10 | 3.34 | 1755 | 1046 | 2469 | 923 | 3136 | 753 | 3565 | 601 | 4073 | 352 | 4741 | 14 | 4700 |
| 10-#11 | 4.10 | 1830 | 1131 | 2723 | 972 | 3420 | 788 | 3889 | 621 | 4489 | 342 | 5242 | -53 | 5174 |
| 10-#14 | 5.92 | 2048 | 1334 | 3306 | 1103 | 4106 | 885 | 4698 | 681 | 5552 | 331 | 6524 | -212 | 6342 |
| 11-#10 | 3.68 | 1794 | 1083 | 2460 | 967 | 3211 | 791 | 3688 | 637 | 4256 | 371 | 5117 | 12 | 5070 |
| 11-#11 | 4.51 | 1879 | 1177 | 2733 | 1024 | 3523 | 832 | 4038 | 662 | 4703 | 363 | 5632 | -68 | 5580 |
| 11-#14 | 6.51 | 2120 | 1401 | 3351 | 1173 | 4272 | 945 | 4913 | 735 | 5842 | 356 | 7054 | -237 | 6845 |
| 12-#10 | 4.01 | 1863 | 1121 | 2546 | 998 | 3314 | 818 | 3828 | 654 | 4474 | 381 | 5415 | -5 | 5412 |
| 12-#11 | 4.92 | 1957 | 1223 | 2839 | 1061 | 3648 | 864 | 4213 | 682 | 4949 | 372 | 5980 | -92 | 5931 |
| 13-#10 | 4.34 | 1885 | 1158 | 2660 | 1023 | 3473 | 834 | 4000 | 666 | 4675 | 375 | 5686 | -36 | 5666 |
| 13-#11 | 5.33 | 1990 | 1269 | 2976 | 1092 | 3834 | 884 | 4416 | 698 | 5200 | 366 | 6296 | -130 | 6210 |
| 14-#10 | 4.68 | 1934 | 1195 | 2815 | 1038 | 3634 | 846 | 4202 | 671 | 4906 | 366 | 5938 | -65 | 5898 |
| 14-#11 | 5.75 | 2057 | 1315 | 3153 | 1112 | 4028 | 900 | 4652 | 703 | 5475 | 355 | 6593 | -167 | 6489 |
| 15-#10 | 5.01 | 1973 | 1233 | 2882 | 1076 | 3733 | 877 | 4318 | 696 | 5100 | 378 | 6254 | -84 | 6189 |
| 16-#10 | 5.35 | 2023 | 1270 | 2957 | 1106 | 3858 | 903 | 4469 | 713 | 5299 | 384 | 6547 | -101 | 6470 |

## ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi

$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.12 | 1846 | 949 | 2023 | 921 | 2775 | 765 | 3158 | 636 | 3422 | 442 | 3861 | 225 | 2609 |
| 4-#11 | 1.38 | 1871 | 983 | 2159 | 936 | 2914 | 775 | 3306 | 640 | 3601 | 437 | 4066 | 191 | 3110 |
| 4-#14 | 1.99 | 1941 | 1065 | 2417 | 986 | 3215 | 811 | 3656 | 662 | 4058 | 434 | 4644 | 123 | 4272 |
| 4-#18 | 3.54 | 2108 | 1271 | 3030 | 1114 | 3942 | 902 | 4506 | 717 | 5176 | 425 | 6005 | -61 | 5959 |
| 5-#9 | 1.11 | 1905 | 947 | 2174 | 904 | 2873 | 751 | 3226 | 623 | 3458 | 429 | 3839 | 228 | 2426 |
| 5-#10 | 1.40 | 1958 | 987 | 2321 | 929 | 3039 | 770 | 3417 | 635 | 3705 | 427 | 4153 | 200 | 2972 |
| 5-#11 | 1.72 | 2002 | 1029 | 2491 | 950 | 3213 | 784 | 3607 | 642 | 3939 | 420 | 4415 | 162 | 3515 |
| 5-#14 | 2.49 | 2120 | 1131 | 2838 | 1014 | 3611 | 831 | 4069 | 671 | 4539 | 414 | 5185 | 91 | 4792 |
| 5-#18 | 4.42 | 2398 | 1388 | 3664 | 1176 | 4569 | 950 | 5187 | 743 | 5997 | 397 | 6927 | -114 | 6824 |
| 6-#8 | 1.05 | 1872 | 939 | 2327 | 862 | 2962 | 711 | 3268 | 587 | 3461 | 403 | 3675 | 205 | 2330 |
| 6-#9 | 1.33 | 1917 | 976 | 2463 | 884 | 3125 | 726 | 3460 | 597 | 3716 | 400 | 3968 | 176 | 2874 |
| 6-#10 | 1.68 | 1972 | 1024 | 2635 | 912 | 3332 | 746 | 3705 | 608 | 4033 | 396 | 4338 | 138 | 3552 |
| 6-#11 | 2.07 | 2018 | 1075 | 2826 | 938 | 3546 | 763 | 3948 | 617 | 4321 | 386 | 4648 | 88 | 4223 |
| 6-#14 | 2.98 | 2144 | 1197 | 3240 | 1011 | 4049 | 815 | 4545 | 648 | 5076 | 372 | 5509 | -17 | 5504 |
| 6-#18 | 5.31 | 2463 | 1506 | 4237 | 1197 | 5271 | 947 | 6001 | 725 | 6879 | 331 | 7521 | -300 | 7362 |
| 7-#8 | 1.22 | 1923 | 963 | 2140 | 928 | 2893 | 773 | 3289 | 642 | 3569 | 440 | 4048 | 231 | 2671 |
| 7-#9 | 1.55 | 1980 | 1006 | 2292 | 956 | 3072 | 794 | 3498 | 656 | 3839 | 440 | 4404 | 202 | 3250 |
| 7-#10 | 1.97 | 2051 | 1061 | 2483 | 992 | 3299 | 821 | 3764 | 674 | 4181 | 439 | 4853 | 166 | 3972 |
| 7-#11 | 2.41 | 2112 | 1121 | 2699 | 1026 | 3535 | 845 | 4030 | 688 | 4504 | 432 | 5234 | 116 | 4682 |
| 7-#14 | 3.48 | 2278 | 1263 | 3158 | 1119 | 4083 | 915 | 4677 | 734 | 5332 | 427 | 6283 | 13 | 6229 |
| 7-#18 | 6.19 | 2702 | 1624 | 4262 | 1354 | 5411 | 1093 | 6223 | 845 | 7333 | 409 | 8736 | -267 | 8576 |
| 8-#8 | 1.40 | 1955 | 986 | 2142 | 957 | 2957 | 797 | 3391 | 663 | 3712 | 452 | 4261 | 221 | 2986 |
| 8-#9 | 1.77 | 2018 | 1035 | 2312 | 990 | 3162 | 823 | 3629 | 680 | 4016 | 452 | 4670 | 190 | 3668 |
| 8-#10 | 2.25 | 2096 | 1099 | 2525 | 1033 | 3422 | 856 | 3930 | 702 | 4401 | 453 | 5188 | 148 | 4519 |
| 8-#11 | 2.76 | 2162 | 1167 | 2765 | 1074 | 3694 | 886 | 4223 | 718 | 4765 | 447 | 5625 | 91 | 5281 |
| 8-#14 | 3.98 | 2343 | 1330 | 3280 | 1184 | 4326 | 970 | 4947 | 772 | 5697 | 445 | 6819 | -27 | 6804 |
| 8-#18 | 7.07 | 2805 | 1742 | 4523 | 1465 | 5831 | 1179 | 6689 | 905 | 7947 | 433 | 9615 | -350 | 9345 |
| 9-#10 | 2.53 | 2150 | 1136 | 2710 | 1049 | 3594 | 866 | 4107 | 707 | 4658 | 446 | 5517 | 123 | 4926 |
| 9-#11 | 3.10 | 2227 | 1213 | 2978 | 1094 | 3889 | 898 | 4439 | 727 | 5079 | 440 | 6013 | 60 | 5745 |
| 9-#14 | 4.48 | 2443 | 1396 | 3536 | 1221 | 4588 | 989 | 5257 | 787 | 6140 | 436 | 7366 | -71 | 7328 |
| 9-#18 | 7.96 | 2992 | 1859 | 4934 | 1532 | 6249 | 1226 | 7239 | 937 | 8698 | 417 | 10530 | -428 | 10118 |
| 10-#10 | 2.81 | 2213 | 1174 | 2953 | 1059 | 3806 | 870 | 4333 | 701 | 4917 | 429 | 5760 | 83 | 5434 |
| 10-#11 | 3.45 | 2301 | 1259 | 3251 | 1110 | 4132 | 905 | 4704 | 722 | 5392 | 420 | 6304 | 11 | 6262 |
| 10-#14 | 4.97 | 2552 | 1462 | 3914 | 1242 | 4913 | 1004 | 5623 | 784 | 6597 | 412 | 7859 | -128 | 7697 |
| 11-#10 | 3.09 | 2259 | 1211 | 2929 | 1107 | 3876 | 910 | 4465 | 740 | 5124 | 451 | 6195 | 83 | 5818 |
| 11-#11 | 3.79 | 2354 | 1305 | 3242 | 1164 | 4233 | 952 | 4870 | 766 | 5637 | 444 | 6810 | 8 | 6777 |
| 11-#14 | 5.47 | 2624 | 1528 | 3942 | 1314 | 5081 | 1065 | 5865 | 841 | 6937 | 441 | 8477 | -150 | 8315 |
| 12-#10 | 3.37 | 2332 | 1248 | 3022 | 1139 | 3990 | 937 | 4617 | 757 | 5368 | 462 | 6537 | 68 | 6260 |
| 12-#11 | 4.14 | 2447 | 1351 | 3358 | 1202 | 4373 | 984 | 5057 | 786 | 5933 | 457 | 7212 | -13 | 7204 |
| 12-#14 | 5.97 | 2743 | 1594 | 4116 | 1367 | 5283 | 1110 | 6139 | 870 | 7340 | 456 | 9036 | -183 | 8808 |
| 13-#10 | 3.65 | 2363 | 1286 | 3150 | 1162 | 4172 | 954 | 4813 | 770 | 5600 | 456 | 6848 | 37 | 6679 |
| 13-#11 | 4.48 | 2479 | 1397 | 3511 | 1232 | 4586 | 1005 | 5289 | 802 | 6202 | 449 | 7578 | -51 | 7544 |
| 13-#14 | 6.47 | 2822 | 1661 | 4329 | 1412 | 5580 | 1141 | 6464 | 893 | 7733 | 446 | 9548 | -238 | 9271 |
| 14-#10 | 3.93 | 2419 | 1323 | 3331 | 1177 | 4353 | 964 | 5037 | 773 | 5862 | 447 | 7135 | 10 | 7093 |
| 14-#11 | 4.83 | 2546 | 1443 | 3718 | 1251 | 4802 | 1019 | 5560 | 807 | 6514 | 438 | 7918 | -85 | 7857 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 15-#10 | 4.21 | 2462 | 1361 | 3395 | 1216 | 4460 | 997 | 5174 | 801 | 6074 | 460 | 7501 | -8 | 7494 |
| 15-#11 | 5.17 | 2598 | 1489 | 3809 | 1297 | 4936 | 1057 | 5719 | 839 | 6774 | 453 | 8345 | -110 | 8245 |
| 16-#10 | 4.49 | 2510 | 1398 | 3478 | 1247 | 4595 | 1024 | 5343 | 818 | 6295 | 466 | 7837 | -23 | 7813 |
| 16-#11 | 5.52 | 2665 | 1534 | 3910 | 1335 | 5103 | 1090 | 5921 | 859 | 7041 | 460 | 8740 | -130 | 8622 |
| 17-#10 | 4.77 | 2567 | 1435 | 3623 | 1271 | 4767 | 1038 | 5525 | 830 | 6544 | 464 | 8173 | -50 | 8092 |
| 18-#10 | 5.05 | 2614 | 1473 | 3805 | 1287 | 4955 | 1050 | 5726 | 835 | 6813 | 459 | 8452 | -77 | 8378 |

## ROUND TIED COLUMNS 26" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.18 | 2358 | 1122 | 2595 | 1087 | 3560 | 903 | 4056 | 750 | 4407 | 520 | 4990 | 259 | 3461 |
| 4-#14 | 1.70 | 2440 | 1204 | 2884 | 1137 | 3897 | 939 | 4446 | 772 | 4916 | 517 | 5652 | 194 | 4781 |
| 4-#18 | 3.01 | 2634 | 1410 | 3574 | 1266 | 4713 | 1031 | 5399 | 828 | 6166 | 510 | 7225 | 21 | 7171 |
| 5-#10 | 1.20 | 2453 | 1126 | 2791 | 1076 | 3711 | 895 | 4186 | 742 | 4522 | 508 | 5078 | 265 | 3321 |
| 5-#11 | 1.47 | 2505 | 1168 | 2986 | 1098 | 3909 | 910 | 4400 | 749 | 4785 | 501 | 5383 | 229 | 3934 |
| 5-#14 | 2.12 | 2642 | 1270 | 3379 | 1162 | 4356 | 957 | 4918 | 779 | 5456 | 497 | 6225 | 155 | 5373 |
| 5-#18 | 3.77 | 2961 | 1527 | 4313 | 1326 | 5436 | 1078 | 6176 | 853 | 7095 | 482 | 8287 | -31 | 8200 |
| 6-#9 | 1.13 | 2407 | 1115 | 2986 | 1026 | 3824 | 846 | 4238 | 698 | 4524 | 477 | 4853 | 238 | 3189 |
| 6-#10 | 1.44 | 2471 | 1163 | 3178 | 1054 | 4054 | 866 | 4509 | 710 | 4884 | 474 | 5274 | 202 | 3949 |
| 6-#11 | 1.76 | 2525 | 1214 | 3394 | 1079 | 4295 | 882 | 4782 | 718 | 5227 | 466 | 5636 | 154 | 4708 |
| 6-#14 | 2.54 | 2670 | 1336 | 3857 | 1153 | 4856 | 935 | 5447 | 749 | 6082 | 454 | 6625 | 55 | 6422 |
| 6-#18 | 4.52 | 3035 | 1645 | 4976 | 1340 | 6224 | 1067 | 7076 | 828 | 8138 | 419 | 8962 | -213 | 8827 |
| 7-#9 | 1.32 | 2480 | 1145 | 2747 | 1106 | 3737 | 921 | 4268 | 765 | 4673 | 523 | 5362 | 269 | 3642 |
| 7-#10 | 1.67 | 2562 | 1200 | 2961 | 1142 | 3989 | 949 | 4564 | 783 | 5055 | 522 | 5873 | 234 | 4452 |
| 7-#11 | 2.06 | 2632 | 1260 | 3206 | 1175 | 4256 | 972 | 4863 | 797 | 5420 | 516 | 6317 | 187 | 5256 |
| 7-#14 | 2.97 | 2824 | 1402 | 3720 | 1269 | 4869 | 1043 | 5586 | 844 | 6349 | 513 | 7521 | 90 | 7102 |
| 7-#18 | 5.27 | 3287 | 1763 | 4960 | 1506 | 6358 | 1222 | 7345 | 961 | 8606 | 500 | 10366 | -174 | 10243 |
| 8-#9 | 1.51 | 2522 | 1174 | 2755 | 1141 | 3827 | 951 | 4416 | 791 | 4871 | 537 | 5644 | 256 | 4087 |
| 8-#10 | 1.91 | 2612 | 1238 | 2992 | 1184 | 4115 | 984 | 4753 | 813 | 5302 | 538 | 6227 | 217 | 5042 |
| 8-#11 | 2.35 | 2690 | 1306 | 3264 | 1225 | 4422 | 1014 | 5085 | 831 | 5713 | 533 | 6761 | 165 | 5988 |
| 8-#14 | 3.39 | 2896 | 1468 | 3838 | 1336 | 5126 | 1099 | 5899 | 886 | 6759 | 533 | 8132 | 54 | 7921 |
| 8-#18 | 6.03 | 3399 | 1881 | 5229 | 1617 | 6844 | 1315 | 7868 | 1024 | 9299 | 528 | 11373 | -249 | 11144 |
| 9-#10 | 2.15 | 2674 | 1275 | 3205 | 1200 | 4316 | 995 | 4945 | 817 | 5579 | 530 | 6619 | 194 | 5529 |
| 9-#11 | 2.64 | 2763 | 1352 | 3508 | 1245 | 4650 | 1027 | 5320 | 837 | 6056 | 525 | 7201 | 135 | 6520 |
| 9-#14 | 3.81 | 3009 | 1535 | 4164 | 1367 | 5432 | 1119 | 6234 | 899 | 7256 | 525 | 8755 | 11 | 8706 |
| 9-#18 | 6.78 | 3624 | 1998 | 5699 | 1685 | 7331 | 1351 | 8461 | 1053 | 10149 | 514 | 12425 | -325 | 12073 |
| 10-#10 | 2.39 | 2745 | 1312 | 3489 | 1207 | 4562 | 997 | 5202 | 810 | 5867 | 512 | 6894 | 155 | 6102 |
| 10-#11 | 2.94 | 2846 | 1398 | 3828 | 1258 | 4932 | 1033 | 5621 | 831 | 6401 | 504 | 7527 | 86 | 7168 |
| 10-#14 | 4.24 | 3115 | 1601 | 4579 | 1393 | 5807 | 1133 | 6650 | 895 | 7749 | 498 | 9229 | -58 | 9189 |
| 10-#18 | 7.53 | 3802 | 2116 | 6374 | 1731 | 7930 | 1385 | 9154 | 1053 | 11039 | 477 | 13388 | -424 | 12800 |
| 11-#10 | 2.63 | 2796 | 1350 | 3447 | 1258 | 4624 | 1039 | 5338 | 850 | 6100 | 537 | 7356 | 151 | 6569 |
| 11-#11 | 3.23 | 2907 | 1444 | 3801 | 1316 | 5027 | 1081 | 5797 | 877 | 6677 | 531 | 8106 | 85 | 7688 |
| 11-#14 | 4.66 | 3211 | 1667 | 4585 | 1467 | 5974 | 1196 | 6917 | 956 | 8133 | 531 | 10021 | -64 | 9924 |
| 12-#10 | 2.87 | 2879 | 1387 | 3546 | 1291 | 4749 | 1068 | 5506 | 869 | 6362 | 547 | 7750 | 141 | 7123 |
| 12-#11 | 3.53 | 3004 | 1490 | 3926 | 1355 | 5180 | 1115 | 6001 | 899 | 7001 | 544 | 8561 | 67 | 8267 |
| 12-#14 | 5.09 | 3344 | 1733 | 4775 | 1521 | 6198 | 1242 | 7208 | 984 | 8600 | 549 | 10655 | -93 | 10563 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 13-#10 | 3.11 | 2912 | 1425 | 3689 | 1314 | 4950 | 1084 | 5726 | 882 | 6631 | 543 | 8112 | 112 | 7559 |
| 13-#11 | 3.82 | 3047 | 1536 | 4096 | 1384 | 5422 | 1136 | 6262 | 914 | 7311 | 537 | 8977 | 30 | 8833 |
| 13-#14 | 5.51 | 3422 | 1800 | 5010 | 1565 | 6534 | 1273 | 7575 | 1008 | 9027 | 538 | 11240 | -147 | 11070 |
| 14-#10 | 3.35 | 2978 | 1462 | 3898 | 1328 | 5156 | 1093 | 5972 | 883 | 6923 | 533 | 8450 | 87 | 8050 |
| 14-#11 | 4.11 | 3123 | 1581 | 4335 | 1403 | 5661 | 1148 | 6559 | 918 | 7660 | 526 | 9362 | -3 | 9359 |
| 14-#14 | 5.93 | 3527 | 1866 | 5325 | 1595 | 6866 | 1295 | 7997 | 1017 | 9523 | 524 | 11788 | -194 | 11578 |
| 15-#10 | 3.59 | 3022 | 1499 | 3958 | 1368 | 5270 | 1127 | 6122 | 913 | 7150 | 547 | 8847 | 68 | 8518 |
| 15-#11 | 4.41 | 3180 | 1627 | 4423 | 1450 | 5805 | 1188 | 6742 | 953 | 7942 | 542 | 9848 | -26 | 9824 |
| 16-#10 | 3.83 | 3078 | 1537 | 4047 | 1400 | 5436 | 1148 | 6317 | 932 | 7398 | 554 | 9219 | 55 | 8976 |
| 16-#11 | 4.70 | 3244 | 1673 | 4534 | 1488 | 5985 | 1221 | 6969 | 974 | 8237 | 549 | 10296 | -44 | 10239 |
| 17-#10 | 4.07 | 3139 | 1574 | 4210 | 1424 | 5607 | 1168 | 6513 | 943 | 7676 | 552 | 9604 | 28 | 9469 |
| 17-#11 | 5.00 | 3320 | 1719 | 4726 | 1518 | 6214 | 1238 | 7210 | 989 | 8569 | 547 | 10745 | -78 | 10608 |
| 18-#10 | 4.31 | 3195 | 1611 | 4416 | 1439 | 5824 | 1181 | 6740 | 948 | 7967 | 547 | 9929 | 4 | 9913 |
| 18-#11 | 5.29 | 3383 | 1765 | 4968 | 1537 | 6464 | 1254 | 7478 | 995 | 8927 | 542 | 11118 | -110 | 10987 |
| 19-#10 | 4.54 | 3260 | 1649 | 4480 | 1477 | 5931 | 1211 | 6915 | 971 | 8204 | 557 | 10335 | -14 | 10314 |
| 20-#10 | 4.78 | 3308 | 1686 | 4605 | 1506 | 6087 | 1234 | 7092 | 990 | 8465 | 564 | 10690 | -32 | 10643 |

## ROUND TIED COLUMNS 28" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.01 | 2922 | 1272 | 3082 | 1251 | 4295 | 1042 | 4913 | 868 | 5328 | 610 | 6007 | 328 | 3809 |
| 4-#14 | 1.46 | 3017 | 1354 | 3404 | 1301 | 4668 | 1078 | 5344 | 890 | 5889 | 607 | 6770 | 268 | 5287 |
| 4-#18 | 2.60 | 3239 | 1560 | 4173 | 1430 | 5574 | 1171 | 6399 | 948 | 7270 | 602 | 8573 | 105 | 8266 |
| 5-#10 | 1.03 | 3026 | 1276 | 3318 | 1236 | 4476 | 1031 | 5064 | 858 | 5454 | 596 | 6128 | 335 | 3674 |
| 5-#11 | 1.27 | 3086 | 1318 | 3538 | 1257 | 4698 | 1045 | 5303 | 865 | 5747 | 589 | 6476 | 300 | 4359 |
| 5-#14 | 1.83 | 3242 | 1420 | 3973 | 1322 | 5194 | 1093 | 5877 | 895 | 6489 | 585 | 7428 | 230 | 5962 |
| 5-#18 | 3.25 | 3604 | 1677 | 5021 | 1487 | 6397 | 1215 | 7276 | 971 | 8308 | 573 | 9696 | 42 | 9527 |
| 6-#10 | 1.24 | 3047 | 1313 | 3789 | 1207 | 4874 | 995 | 5426 | 820 | 5841 | 556 | 6329 | 269 | 4347 |
| 6-#11 | 1.52 | 3109 | 1364 | 4032 | 1232 | 5142 | 1011 | 5728 | 828 | 6228 | 549 | 6743 | 224 | 5195 |
| 6-#14 | 2.19 | 3275 | 1486 | 4544 | 1306 | 5762 | 1064 | 6461 | 859 | 7202 | 541 | 7862 | 129 | 7183 |
| 6-#18 | 3.90 | 3688 | 1795 | 5785 | 1493 | 7277 | 1197 | 8263 | 939 | 9512 | 512 | 10526 | -126 | 10434 |
| 7-#9 | 1.14 | 3056 | 1295 | 3256 | 1268 | 4492 | 1058 | 5146 | 882 | 5623 | 612 | 6426 | 338 | 4043 |
| 7-#10 | 1.44 | 3150 | 1350 | 3493 | 1304 | 4770 | 1086 | 5471 | 901 | 6044 | 612 | 7002 | 305 | 4942 |
| 7-#11 | 1.77 | 3230 | 1410 | 3767 | 1337 | 5069 | 1110 | 5804 | 915 | 6451 | 606 | 7524 | 261 | 5841 |
| 7-#14 | 2.56 | 3449 | 1552 | 4337 | 1431 | 5746 | 1181 | 6602 | 962 | 7481 | 605 | 8885 | 169 | 7963 |
| 7-#18 | 4.55 | 3969 | 1913 | 5716 | 1669 | 7398 | 1362 | 8557 | 1082 | 9994 | 597 | 12126 | -80 | 12061 |
| 8-#9 | 1.30 | 3103 | 1324 | 3249 | 1305 | 4580 | 1091 | 5306 | 911 | 5842 | 629 | 6745 | 328 | 4509 |
| 8-#10 | 1.65 | 3206 | 1388 | 3510 | 1348 | 4897 | 1124 | 5682 | 934 | 6317 | 630 | 7391 | 289 | 5567 |
| 8-#11 | 2.03 | 3295 | 1456 | 3814 | 1388 | 5238 | 1153 | 6055 | 952 | 6777 | 626 | 7990 | 239 | 6628 |
| 8-#14 | 2.92 | 3529 | 1618 | 4449 | 1499 | 6015 | 1238 | 6959 | 1009 | 7937 | 628 | 9556 | 135 | 8977 |
| 8-#18 | 5.20 | 4091 | 2030 | 5990 | 1782 | 7914 | 1455 | 9155 | 1150 | 10767 | 628 | 13262 | -149 | 13104 |
| 9-#10 | 1.86 | 3275 | 1425 | 3753 | 1362 | 5125 | 1133 | 5890 | 937 | 6615 | 621 | 7826 | 266 | 6145 |
| 9-#11 | 2.28 | 3377 | 1502 | 4092 | 1407 | 5502 | 1166 | 6308 | 957 | 7144 | 616 | 8510 | 211 | 7256 |
| 9-#14 | 3.29 | 3649 | 1685 | 4818 | 1530 | 6368 | 1259 | 7320 | 1020 | 8470 | 617 | 10272 | 94 | 9787 |
| 9-#18 | 5.85 | 4321 | 2148 | 6581 | 1841 | 8477 | 1494 | 9791 | 1177 | 11716 | 615 | 14452 | -224 | 14202 |
| 10-#10 | 2.06 | 3354 | 1462 | 4082 | 1368 | 5411 | 1133 | 6179 | 927 | 6931 | 601 | 8152 | 229 | 6754 |
| 10-#11 | 2.53 | 3470 | 1548 | 4461 | 1418 | 5824 | 1170 | 6646 | 948 | 7525 | 594 | 8876 | 164 | 8020 |
| 10-#14 | 3.65 | 3772 | 1751 | 5289 | 1553 | 6794 | 1271 | 7786 | 1014 | 9016 | 590 | 10800 | 27 | 10677 |
| 10-#18 | 6.50 | 4536 | 2266 | 7302 | 1896 | 9155 | 1526 | 10568 | 1176 | 12669 | 575 | 15377 | -342 | 14983 |

## ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway $f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 11-#10 | 2.27 | 3413 | 1500 | 4016 | 1422 | 5462 | 1178 | 6318 | 970 | 7190 | 628 | 8649 | 226 | 7305 |
| 11-#11 | 2.79 | 3539 | 1594 | 4414 | 1479 | 5911 | 1221 | 6828 | 997 | 7832 | 624 | 9484 | 159 | 8622 |
| 11-#14 | 4.02 | 3872 | 1817 | 5281 | 1632 | 6958 | 1336 | 8065 | 1077 | 9443 | 626 | 11651 | 17 | 11573 |
| 11-#18 | 7.15 | 4729 | 2384 | 7389 | 2017 | 9516 | 1629 | 11089 | 1275 | 13385 | 625 | 16842 | -360 | 16173 |
| 12-#10 | 2.48 | 3503 | 1537 | 4121 | 1456 | 5596 | 1208 | 6502 | 989 | 7472 | 639 | 9089 | 217 | 7912 |
| 12-#11 | 3.04 | 3646 | 1640 | 4546 | 1520 | 6077 | 1256 | 7052 | 1020 | 8179 | 637 | 10005 | 146 | 9313 |
| 12-#14 | 4.38 | 4028 | 1883 | 5486 | 1687 | 7202 | 1384 | 8386 | 1107 | 9944 | 643 | 12387 | -4 | 12382 |
| 13-#10 | 2.68 | 3542 | 1575 | 4279 | 1478 | 5816 | 1224 | 6746 | 1002 | 7772 | 635 | 9493 | 188 | 8437 |
| 13-#11 | 3.29 | 3696 | 1686 | 4734 | 1548 | 6341 | 1276 | 7342 | 1035 | 8535 | 631 | 10484 | 110 | 9901 |
| 13-#14 | 4.75 | 4103 | 1950 | 5744 | 1730 | 7576 | 1415 | 8794 | 1130 | 10437 | 635 | 13062 | -55 | 12977 |
| 14-#10 | 2.89 | 3616 | 1612 | 4521 | 1491 | 6049 | 1232 | 7015 | 1002 | 8100 | 626 | 9860 | 164 | 9046 |
| 14-#11 | 3.55 | 3780 | 1731 | 5008 | 1566 | 6611 | 1287 | 7666 | 1038 | 8922 | 620 | 10932 | 81 | 10538 |
| 14-#14 | 5.12 | 4228 | 2016 | 6103 | 1759 | 7942 | 1435 | 9253 | 1138 | 10987 | 621 | 13674 | -101 | 13553 |
| 15-#10 | 3.09 | 3665 | 1649 | 4572 | 1532 | 6168 | 1268 | 7177 | 1034 | 8343 | 641 | 10313 | 146 | 9533 |
| 15-#11 | 3.80 | 3838 | 1777 | 5091 | 1614 | 6764 | 1329 | 7866 | 1074 | 9222 | 637 | 11455 | 57 | 11162 |
| 15-#14 | 5.48 | 4311 | 2082 | 6256 | 1824 | 8177 | 1490 | 9543 | 1185 | 11420 | 643 | 14428 | -135 | 14187 |
| 16-#10 | 3.30 | 3727 | 1687 | 4668 | 1565 | 6346 | 1289 | 7397 | 1054 | 8616 | 648 | 10728 | 135 | 10063 |
| 16-#11 | 4.05 | 3913 | 1823 | 5210 | 1653 | 6986 | 1355 | 8124 | 1097 | 9549 | 645 | 11947 | 40 | 11755 |
| 16-#14 | 5.85 | 4436 | 2148 | 6435 | 1879 | 8459 | 1537 | 9903 | 1216 | 11882 | 653 | 15116 | -161 | 14835 |
| 17-#10 | 3.51 | 3795 | 1724 | 4850 | 1589 | 6536 | 1309 | 7609 | 1065 | 8924 | 647 | 11131 | 104 | 10580 |
| 17-#11 | 4.31 | 3993 | 1869 | 5425 | 1683 | 7211 | 1379 | 8383 | 1111 | 9917 | 643 | 12456 | 8 | 12416 |
| 18-#10 | 3.71 | 3849 | 1761 | 5079 | 1603 | 6780 | 1321 | 7861 | 1069 | 9236 | 640 | 11492 | 83 | 11095 |
| 18-#11 | 4.56 | 4067 | 1915 | 5694 | 1701 | 7497 | 1395 | 8682 | 1117 | 10302 | 636 | 12887 | -22 | 12847 |
| 19-#10 | 3.92 | 3929 | 1799 | 5144 | 1642 | 6893 | 1353 | 8047 | 1093 | 9498 | 652 | 11958 | 68 | 11625 |
| 19-#11 | 4.81 | 4153 | 1961 | 5782 | 1747 | 7639 | 1432 | 8915 | 1146 | 10615 | 649 | 13423 | -44 | 13350 |
| 20-#10 | 4.13 | 3981 | 1836 | 5276 | 1671 | 7064 | 1376 | 8242 | 1112 | 9795 | 660 | 12368 | 51 | 12115 |
| 20-#11 | 5.07 | 4217 | 2007 | 5947 | 1783 | 7846 | 1460 | 9149 | 1168 | 10960 | 657 | 13892 | -67 | 13783 |
| 21-#10 | 4.33 | 4057 | 1874 | 5422 | 1698 | 7248 | 1396 | 8479 | 1124 | 10075 | 657 | 12767 | 27 | 12650 |
| 22-#10 | 4.54 | 4111 | 1911 | 5624 | 1719 | 7464 | 1409 | 8720 | 1134 | 10384 | 653 | 13130 | 0 | 13129 |

## ROUND TIED COLUMNS 30" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.27 | 3677 | 1515 | 3980 | 1476 | 5535 | 1227 | 6358 | 1018 | 6986 | 704 | 7992 | 343 | 5792 |
| 4-#18 | 2.26 | 3929 | 1721 | 4828 | 1606 | 6532 | 1321 | 7516 | 1077 | 8499 | 700 | 10058 | 191 | 9427 |
| 5-#11 | 1.10 | 3749 | 1479 | 4152 | 1429 | 5587 | 1191 | 6323 | 990 | 6832 | 684 | 7702 | 375 | 4790 |
| 5-#14 | 1.59 | 3925 | 1581 | 4630 | 1493 | 6133 | 1239 | 6953 | 1020 | 7645 | 680 | 8763 | 308 | 6558 |
| 5-#18 | 2.83 | 4333 | 1838 | 5786 | 1659 | 7459 | 1362 | 8493 | 1097 | 9645 | 670 | 11310 | 128 | 10685 |
| 6-#10 | 1.08 | 3705 | 1474 | 4474 | 1372 | 5800 | 1134 | 6462 | 938 | 6921 | 645 | 7513 | 340 | 4745 |
| 6-#11 | 1.32 | 3777 | 1525 | 4743 | 1397 | 6096 | 1150 | 6794 | 946 | 7345 | 638 | 7978 | 296 | 5683 |
| 6-#14 | 1.91 | 3963 | 1647 | 5305 | 1470 | 6775 | 1202 | 7596 | 977 | 8408 | 630 | 9228 | 205 | 7878 |
| 6-#18 | 3.40 | 4403 | 1956 | 6670 | 1658 | 8438 | 1336 | 9571 | 1058 | 11011 | 609 | 12220 | -39 | 12190 |
| 7-#10 | 1.26 | 3820 | 1511 | 4083 | 1479 | 5648 | 1234 | 6495 | 1027 | 7157 | 709 | 8257 | 380 | 5441 |
| 7-#11 | 1.54 | 3912 | 1571 | 4388 | 1511 | 5978 | 1258 | 6861 | 1041 | 7606 | 703 | 8848 | 338 | 6438 |
| 7-#14 | 2.23 | 4154 | 1713 | 5015 | 1605 | 6721 | 1329 | 7735 | 1089 | 8737 | 703 | 10384 | 251 | 8780 |
| 7-#18 | 3.96 | 4739 | 2074 | 6531 | 1845 | 8536 | 1511 | 9880 | 1210 | 11507 | 699 | 14022 | 14 | 13953 |
| 8-#10 | 1.44 | 3881 | 1549 | 4083 | 1524 | 5773 | 1274 | 6715 | 1062 | 7457 | 729 | 8692 | 366 | 6098 |
| 8-#11 | 1.77 | 3984 | 1617 | 4420 | 1564 | 6150 | 1303 | 7139 | 1081 | 7964 | 725 | 9356 | 318 | 7271 |

## ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway $f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.55 | 4247 | 1780 | 5116 | 1675 | 6999 | 1388 | 8134 | 1139 | 9239 | 728 | 11085 | 217 | 10029 |
| 8-#18 | 4.53 | 4870 | 2192 | 6807 | 1958 | 9081 | 1605 | 10558 | 1284 | 12359 | 734 | 15290 | -50 | 15203 |
| 9-#10 | 1.62 | 3960 | 1586 | 4358 | 1538 | 6029 | 1282 | 6951 | 1065 | 7774 | 718 | 9169 | 343 | 6774 |
| 9-#11 | 1.99 | 4076 | 1663 | 4734 | 1583 | 6447 | 1315 | 7412 | 1085 | 8356 | 714 | 9929 | 290 | 8005 |
| 9-#14 | 2.86 | 4379 | 1846 | 5530 | 1705 | 7400 | 1409 | 8521 | 1149 | 9808 | 716 | 11903 | 178 | 10907 |
| 9-#18 | 5.09 | 5123 | 2309 | 7466 | 2017 | 9722 | 1646 | 11239 | 1309 | 13381 | 719 | 16618 | -124 | 16467 |
| 10-#10 | 1.80 | 4047 | 1624 | 4737 | 1540 | 6359 | 1281 | 7274 | 1053 | 8119 | 697 | 9543 | 308 | 7415 |
| 10-#11 | 2.21 | 4178 | 1709 | 5156 | 1590 | 6815 | 1317 | 7789 | 1074 | 8773 | 690 | 10359 | 245 | 8816 |
| 10-#14 | 3.18 | 4515 | 1912 | 6062 | 1725 | 7881 | 1419 | 9039 | 1141 | 10407 | 688 | 12505 | 114 | 11940 |
| 10-#18 | 5.66 | 5360 | 2427 | 8277 | 2070 | 10481 | 1677 | 12101 | 1307 | 14422 | 677 | 17645 | -238 | 17340 |
| 11-#10 | 1.98 | 4110 | 1661 | 4640 | 1598 | 6395 | 1328 | 7413 | 1098 | 8404 | 727 | 10078 | 304 | 8057 |
| 11-#11 | 2.43 | 4255 | 1755 | 5081 | 1655 | 6890 | 1370 | 7974 | 1126 | 9111 | 723 | 11009 | 240 | 9517 |
| 11-#14 | 3.50 | 4626 | 1978 | 6035 | 1808 | 8038 | 1487 | 9328 | 1206 | 10878 | 727 | 13420 | 103 | 12868 |
| 11-#18 | 6.22 | 5547 | 2545 | 8353 | 2196 | 10847 | 1782 | 12654 | 1409 | 15214 | 732 | 19282 | -252 | 18691 |
| 12-#10 | 2.16 | 4212 | 1698 | 4751 | 1633 | 6538 | 1359 | 7612 | 1119 | 8705 | 738 | 10516 | 290 | 8697 |
| 12-#11 | 2.65 | 4373 | 1801 | 5222 | 1697 | 7068 | 1407 | 8217 | 1149 | 9482 | 736 | 11585 | 229 | 10325 |
| 12-#14 | 3.82 | 4787 | 2044 | 6254 | 1865 | 8302 | 1536 | 9678 | 1238 | 11413 | 744 | 14225 | 85 | 13820 |
| 12-#18 | 6.79 | 5807 | 2662 | 8765 | 2291 | 11323 | 1863 | 13266 | 1459 | 16167 | 761 | 20609 | -301 | 19793 |
| 13-#10 | 2.34 | 4256 | 1736 | 4949 | 1652 | 6777 | 1374 | 7881 | 1131 | 9034 | 734 | 11009 | 268 | 9308 |
| 13-#11 | 2.87 | 4425 | 1847 | 5428 | 1725 | 7356 | 1426 | 8538 | 1165 | 9877 | 731 | 12115 | 193 | 10995 |
| 13-#14 | 4.14 | 4881 | 2111 | 6535 | 1907 | 8707 | 1566 | 10128 | 1261 | 11971 | 738 | 14977 | 34 | 14796 |
| 13-#18 | 7.36 | 6013 | 2780 | 9237 | 2370 | 12020 | 1921 | 14031 | 1502 | 17087 | 746 | 21851 | -395 | 20895 |
| 14-#10 | 2.52 | 4332 | 1773 | 5201 | 1667 | 7039 | 1381 | 8173 | 1130 | 9401 | 725 | 11388 | 242 | 9951 |
| 14-#11 | 3.09 | 4523 | 1893 | 5739 | 1741 | 7659 | 1437 | 8889 | 1166 | 10307 | 720 | 12602 | 164 | 11742 |
| 14-#14 | 4.46 | 5017 | 2177 | 6940 | 1936 | 9116 | 1586 | 10625 | 1267 | 12575 | 724 | 15698 | -6 | 15689 |
| 15-#10 | 2.70 | 4392 | 1810 | 5242 | 1709 | 7162 | 1419 | 8348 | 1163 | 9659 | 740 | 11906 | 228 | 10532 |
| 15-#11 | 3.31 | 4586 | 1938 | 5814 | 1791 | 7819 | 1480 | 9105 | 1204 | 10626 | 737 | 13191 | 142 | 12386 |
| 15-#14 | 4.77 | 5108 | 2243 | 7090 | 2002 | 9366 | 1643 | 10941 | 1317 | 13035 | 746 | 16490 | -43 | 16411 |
| 16-#10 | 2.87 | 4461 | 1848 | 5343 | 1742 | 7350 | 1440 | 8582 | 1184 | 9958 | 748 | 12373 | 218 | 11171 |
| 16-#11 | 3.53 | 4669 | 1984 | 5942 | 1830 | 8054 | 1506 | 9394 | 1228 | 10985 | 746 | 13735 | 127 | 13071 |
| 16-#14 | 5.09 | 5223 | 2309 | 7283 | 2057 | 9712 | 1679 | 11346 | 1350 | 13543 | 757 | 17253 | -66 | 17131 |
| 17-#10 | 3.05 | 4533 | 1885 | 5543 | 1766 | 7559 | 1460 | 8826 | 1192 | 10295 | 747 | 12794 | 187 | 11725 |
| 17-#11 | 3.75 | 4756 | 2030 | 6179 | 1860 | 8302 | 1530 | 9672 | 1242 | 11389 | 744 | 14268 | 90 | 13763 |
| 17-#14 | 5.41 | 5348 | 2375 | 7611 | 2101 | 10059 | 1715 | 11745 | 1371 | 14116 | 755 | 18006 | -120 | 17758 |
| 18-#10 | 3.23 | 4595 | 1923 | 5800 | 1779 | 7827 | 1471 | 9098 | 1199 | 10628 | 739 | 13191 | 165 | 12317 |
| 18-#11 | 3.97 | 4828 | 2076 | 6477 | 1878 | 8622 | 1546 | 10002 | 1248 | 11800 | 737 | 14743 | 64 | 14419 |
| 19-#10 | 3.41 | 4680 | 1960 | 5863 | 1819 | 7950 | 1505 | 9293 | 1224 | 10916 | 752 | 13707 | 152 | 12872 |
| 19-#11 | 4.19 | 4932 | 2122 | 6566 | 1925 | 8772 | 1584 | 10248 | 1277 | 12145 | 751 | 15354 | 45 | 15131 |
| 20-#10 | 3.59 | 4741 | 1997 | 6003 | 1848 | 8135 | 1528 | 9506 | 1243 | 11236 | 761 | 14165 | 136 | 13437 |
| 20-#11 | 4.41 | 5002 | 2168 | 6741 | 1961 | 8997 | 1613 | 10504 | 1300 | 12534 | 761 | 15888 | 24 | 15761 |
| 21-#10 | 3.77 | 4819 | 2035 | 6164 | 1875 | 8334 | 1548 | 9766 | 1255 | 11548 | 758 | 14599 | 112 | 14006 |
| 21-#11 | 4.63 | 5102 | 2214 | 6932 | 1994 | 9238 | 1637 | 10815 | 1315 | 12902 | 757 | 16415 | -6 | 16403 |
| 22-#10 | 3.95 | 4883 | 2072 | 6387 | 1896 | 8573 | 1561 | 10026 | 1264 | 11887 | 754 | 14999 | 86 | 14545 |
| 23-#10 | 4.13 | 4959 | 2109 | 6491 | 1929 | 8725 | 1592 | 10235 | 1286 | 12176 | 764 | 15495 | 73 | 15141 |
| 24-#10 | 4.31 | 5029 | 2147 | 6617 | 1961 | 8906 | 1614 | 10465 | 1306 | 12477 | 770 | 15933 | 52 | 15674 |

## ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.12 | 4425 | 1687 | 4614 | 1665 | 6504 | 1387 | 7494 | 1155 | 8215 | 808 | 9359 | 423 | 6295 |
| 4-#18 | 1.99 | 4708 | 1893 | 5543 | 1794 | 7592 | 1481 | 8755 | 1214 | 9860 | 804 | 11602 | 274 | 10477 |
| 5-#14 | 1.40 | 4697 | 1753 | 5353 | 1677 | 7177 | 1396 | 8155 | 1154 | 8934 | 781 | 10242 | 390 | 7162 |
| 5-#18 | 2.49 | 5152 | 2011 | 6615 | 1842 | 8628 | 1519 | 9837 | 1232 | 11115 | 773 | 13069 | 217 | 11753 |
| 6-#11 | 1.16 | 4532 | 1697 | 5534 | 1574 | 7164 | 1299 | 7989 | 1072 | 8593 | 733 | 9352 | 373 | 6171 |
| 6-#14 | 1.68 | 4741 | 1819 | 6146 | 1647 | 7902 | 1351 | 8859 | 1104 | 9746 | 726 | 10731 | 285 | 8574 |
| 6-#18 | 2.98 | 5230 | 2128 | 7635 | 1835 | 9712 | 1485 | 11007 | 1185 | 12600 | 708 | 14054 | 50 | 13834 |
| 7-#10 | 1.11 | 4578 | 1684 | 4735 | 1665 | 6630 | 1393 | 7642 | 1163 | 8403 | 812 | 9657 | 459 | 5954 |
| 7-#11 | 1.36 | 4682 | 1743 | 5072 | 1698 | 6992 | 1416 | 8042 | 1177 | 8894 | 807 | 10305 | 418 | 7045 |
| 7-#14 | 1.96 | 4952 | 1885 | 5755 | 1792 | 7800 | 1488 | 8992 | 1225 | 10126 | 807 | 11992 | 334 | 9611 |
| 7-#18 | 3.48 | 5601 | 2246 | 7411 | 2032 | 9779 | 1671 | 11328 | 1347 | 13153 | 807 | 16065 | 109 | 15452 |
| 8-#10 | 1.26 | 4645 | 1721 | 4714 | 1713 | 6750 | 1434 | 7871 | 1199 | 8729 | 834 | 10137 | 448 | 6634 |
| 8-#11 | 1.55 | 4762 | 1789 | 5085 | 1753 | 7163 | 1463 | 8334 | 1218 | 9284 | 830 | 10868 | 401 | 7919 |
| 8-#14 | 2.24 | 5055 | 1952 | 5841 | 1864 | 8085 | 1548 | 9429 | 1278 | 10674 | 835 | 12760 | 303 | 10942 |
| 8-#18 | 3.98 | 5744 | 2364 | 7684 | 2147 | 10350 | 1766 | 12085 | 1427 | 14086 | 844 | 17380 | 45 | 17187 |
| 9-#10 | 1.42 | 4733 | 1758 | 5024 | 1725 | 7035 | 1442 | 8136 | 1201 | 9066 | 822 | 10657 | 424 | 7417 |
| 9-#11 | 1.75 | 4864 | 1835 | 5437 | 1770 | 7493 | 1475 | 8640 | 1222 | 9700 | 818 | 11493 | 372 | 8769 |
| 9-#14 | 2.52 | 5200 | 2018 | 6303 | 1893 | 8531 | 1569 | 9847 | 1286 | 11279 | 821 | 13657 | 264 | 11957 |
| 9-#18 | 4.48 | 6020 | 2481 | 8414 | 2206 | 11071 | 1809 | 12811 | 1449 | 15172 | 827 | 18927 | -22 | 18884 |
| 10-#10 | 1.58 | 4829 | 1796 | 5458 | 1725 | 7412 | 1438 | 8493 | 1187 | 9440 | 799 | 11037 | 387 | 8084 |
| 10-#11 | 1.94 | 4976 | 1881 | 5917 | 1774 | 7913 | 1474 | 9057 | 1209 | 10153 | 792 | 11985 | 330 | 9621 |
| 10-#14 | 2.80 | 5350 | 2084 | 6902 | 1910 | 9075 | 1577 | 10418 | 1276 | 11930 | 791 | 14355 | 204 | 13254 |
| 10-#18 | 4.97 | 6241 | 2599 | 9314 | 2255 | 11915 | 1838 | 13759 | 1445 | 16309 | 785 | 20060 | -134 | 19874 |
| 11-#10 | 1.74 | 4899 | 1833 | 5323 | 1786 | 7430 | 1489 | 8631 | 1236 | 9751 | 832 | 11653 | 387 | 8826 |
| 11-#11 | 2.13 | 5059 | 1927 | 5808 | 1843 | 7972 | 1531 | 9244 | 1263 | 10524 | 828 | 12679 | 324 | 10430 |
| 11-#14 | 3.08 | 5472 | 2150 | 6846 | 1997 | 9220 | 1648 | 10715 | 1344 | 12446 | 834 | 15325 | 192 | 14203 |
| 11-#18 | 5.47 | 6481 | 2717 | 9379 | 2386 | 12282 | 1945 | 14337 | 1549 | 17177 | 843 | 21754 | -159 | 21401 |
| 12-#10 | 1.89 | 5011 | 1870 | 5438 | 1823 | 7580 | 1521 | 8845 | 1257 | 10072 | 843 | 12134 | 374 | 9493 |
| 12-#11 | 2.33 | 5191 | 1973 | 5956 | 1886 | 8161 | 1568 | 9506 | 1288 | 10918 | 841 | 13312 | 316 | 11281 |
| 12-#14 | 3.36 | 5647 | 2217 | 7080 | 2055 | 9504 | 1698 | 11094 | 1377 | 13014 | 851 | 16210 | 176 | 15286 |
| 12-#18 | 5.97 | 6765 | 2835 | 9821 | 2483 | 12797 | 2028 | 15002 | 1601 | 18189 | 872 | 23248 | -196 | 22606 |
| 13-#10 | 2.05 | 5060 | 1908 | 5656 | 1841 | 7841 | 1535 | 9139 | 1270 | 10429 | 839 | 12668 | 352 | 10200 |
| 13-#11 | 2.52 | 5249 | 2019 | 6213 | 1910 | 8473 | 1587 | 9857 | 1303 | 11347 | 837 | 13893 | 280 | 12052 |
| 13-#14 | 3.64 | 5750 | 2283 | 7387 | 2096 | 9941 | 1728 | 11587 | 1401 | 13625 | 845 | 17036 | 125 | 16301 |
| 13-#18 | 6.47 | 6963 | 2952 | 10331 | 2561 | 13550 | 2084 | 15841 | 1646 | 19225 | 861 | 24660 | -286 | 23854 |
| 14-#10 | 2.21 | 5144 | 1945 | 5943 | 1854 | 8133 | 1540 | 9455 | 1266 | 10834 | 830 | 13061 | 325 | 10871 |
| 14-#11 | 2.72 | 5350 | 2065 | 6534 | 1929 | 8810 | 1596 | 10237 | 1302 | 11825 | 826 | 14394 | 249 | 12905 |
| 14-#14 | 3.92 | 5900 | 2349 | 7840 | 2124 | 10393 | 1746 | 12121 | 1404 | 14297 | 832 | 17793 | 84 | 17364 |
| 14-#18 | 6.96 | 7298 | 3070 | 11035 | 2618 | 14286 | 2125 | 16768 | 1661 | 20365 | 840 | 25994 | -358 | 24871 |
| 15-#10 | 2.37 | 5210 | 1983 | 5971 | 1898 | 8257 | 1580 | 9641 | 1302 | 11107 | 846 | 13633 | 312 | 11537 |
| 15-#11 | 2.91 | 5426 | 2111 | 6597 | 1980 | 8976 | 1641 | 10467 | 1342 | 12163 | 844 | 15067 | 230 | 13636 |
| 15-#14 | 4.20 | 5990 | 2415 | 7984 | 2191 | 10658 | 1805 | 12461 | 1457 | 14783 | 854 | 18700 | 51 | 18400 |
| 16-#10 | 2.53 | 5285 | 2020 | 6076 | 1932 | 8455 | 1602 | 9890 | 1322 | 11433 | 855 | 14164 | 305 | 12208 |
| 16-#11 | 3.10 | 5516 | 2157 | 6731 | 2020 | 9224 | 1668 | 10775 | 1367 | 12554 | 854 | 15671 | 218 | 14430 |
| 16-#14 | 4.48 | 6123 | 2481 | 8189 | 2248 | 11024 | 1842 | 12909 | 1491 | 15337 | 867 | 19538 | 30 | 19375 |
| 17-#10 | 2.68 | 5364 | 2057 | 6294 | 1955 | 8684 | 1622 | 10160 | 1331 | 11792 | 853 | 14603 | 273 | 12849 |
| 17-#11 | 3.30 | 5612 | 2202 | 6992 | 2050 | 9496 | 1692 | 11092 | 1378 | 12994 | 852 | 16225 | 179 | 15148 |
| 17-#14 | 4.76 | 6251 | 2548 | 8550 | 2292 | 11404 | 1878 | 13338 | 1512 | 15962 | 865 | 20357 | -23 | 20300 |

## ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.84 | 5432 | 2095 | 6580 | 1967 | 8977 | 1632 | 10458 | 1338 | 12154 | 845 | 15035 | 251 | 13534 |
| 18-#11 | 3.49 | 5690 | 2248 | 7321 | 2066 | 9844 | 1707 | 11446 | 1387 | 13432 | 843 | 16745 | 153 | 15895 |
| 18-#14 | 5.04 | 6384 | 2614 | 8993 | 2319 | 11887 | 1902 | 13844 | 1522 | 16596 | 855 | 21099 | -60 | 20954 |
| 19-#10 | 3.00 | 5526 | 2132 | 6640 | 2009 | 9106 | 1666 | 10663 | 1363 | 12467 | 859 | 15601 | 239 | 14146 |
| 19-#11 | 3.69 | 5800 | 2294 | 7410 | 2115 | 10006 | 1747 | 11704 | 1416 | 13807 | 858 | 17416 | 136 | 16638 |
| 19-#14 | 5.32 | 6521 | 2680 | 9148 | 2385 | 12130 | 1956 | 14226 | 1562 | 17126 | 874 | 22036 | -88 | 21810 |
| 20-#10 | 3.16 | 5586 | 2169 | 6787 | 2038 | 9308 | 1691 | 10893 | 1383 | 12808 | 868 | 16084 | 223 | 14800 |
| 20-#11 | 3.88 | 5881 | 2340 | 7594 | 2151 | 10250 | 1776 | 11982 | 1440 | 14226 | 869 | 18017 | 117 | 17358 |
| 21-#10 | 3.32 | 5677 | 2207 | 6964 | 2065 | 9521 | 1710 | 11176 | 1395 | 13154 | 866 | 16578 | 201 | 15394 |
| 21-#11 | 4.07 | 5983 | 2386 | 7803 | 2184 | 10509 | 1800 | 12321 | 1455 | 14632 | 866 | 18580 | 87 | 18112 |
| 22-#10 | 3.47 | 5748 | 2244 | 7209 | 2085 | 9785 | 1722 | 11456 | 1403 | 13522 | 862 | 17015 | 175 | 16014 |
| 22-#11 | 4.27 | 6066 | 2432 | 8092 | 2209 | 10820 | 1816 | 12661 | 1466 | 15075 | 861 | 19103 | 55 | 18798 |
| 23-#10 | 3.63 | 5830 | 2282 | 7316 | 2119 | 9942 | 1754 | 11680 | 1426 | 13829 | 871 | 17542 | 162 | 16624 |
| 23-#11 | 4.46 | 6166 | 2478 | 8232 | 2250 | 11021 | 1854 | 12934 | 1493 | 15453 | 873 | 19749 | 38 | 19553 |
| 24-#10 | 3.79 | 5907 | 2319 | 7453 | 2151 | 10138 | 1777 | 11926 | 1446 | 14156 | 878 | 18018 | 141 | 17230 |
| 25-#10 | 3.95 | 5983 | 2356 | 7641 | 2175 | 10376 | 1796 | 12194 | 1458 | 14512 | 878 | 18537 | 126 | 17853 |
| 26-#10 | 4.11 | 6075 | 2394 | 7893 | 2193 | 10615 | 1812 | 12477 | 1469 | 14874 | 875 | 19038 | 105 | 18438 |

## ROUND TIED COLUMNS 34" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.76 | 5582 | 2076 | 6322 | 1994 | 8760 | 1652 | 10126 | 1360 | 11363 | 916 | 13301 | 361 | 11379 |
| 5-#14 | 1.24 | 5563 | 1936 | 6147 | 1873 | 8335 | 1562 | 9490 | 1296 | 10364 | 889 | 11872 | 476 | 7773 |
| 5-#18 | 2.20 | 6067 | 2194 | 7516 | 2038 | 9911 | 1687 | 11314 | 1376 | 12726 | 883 | 14980 | 309 | 12775 |
| 6-#11 | 1.03 | 5382 | 1881 | 6408 | 1762 | 8353 | 1457 | 9320 | 1207 | 9981 | 834 | 10872 | 454 | 6660 |
| 6-#14 | 1.49 | 5613 | 2003 | 7071 | 1835 | 9149 | 1509 | 10260 | 1239 | 11224 | 827 | 12382 | 368 | 9272 |
| 6-#18 | 2.64 | 6153 | 2312 | 8685 | 2023 | 11108 | 1644 | 12581 | 1320 | 14306 | 810 | 16036 | 142 | 15359 |
| 7-#11 | 1.20 | 5547 | 1927 | 5821 | 1897 | 8116 | 1585 | 9355 | 1321 | 10323 | 917 | 11916 | 503 | 7662 |
| 7-#14 | 1.73 | 5845 | 2069 | 6561 | 1991 | 8990 | 1657 | 10381 | 1369 | 11657 | 918 | 13747 | 421 | 10456 |
| 7-#18 | 3.08 | 6561 | 2429 | 8359 | 2231 | 11133 | 1840 | 12908 | 1493 | 14940 | 920 | 18236 | 205 | 16999 |
| 8-#10 | 1.12 | 5503 | 1904 | 5503 | 1904 | 7835 | 1605 | 9158 | 1346 | 10143 | 946 | 11739 | 534 | 7174 |
| 8-#11 | 1.37 | 5632 | 1973 | 5810 | 1954 | 8283 | 1634 | 9660 | 1365 | 10746 | 942 | 12534 | 488 | 8573 |
| 8-#14 | 1.98 | 5958 | 2135 | 6629 | 2065 | 9279 | 1719 | 10840 | 1425 | 12251 | 948 | 14590 | 393 | 11862 |
| 8-#18 | 3.52 | 6717 | 2547 | 8625 | 2348 | 11728 | 1938 | 13745 | 1577 | 15954 | 961 | 19625 | 142 | 18955 |
| 9-#10 | 1.26 | 5601 | 1942 | 5753 | 1925 | 8150 | 1612 | 9451 | 1347 | 10499 | 933 | 12299 | 510 | 8063 |
| 9-#11 | 1.55 | 5746 | 2018 | 6204 | 1970 | 8648 | 1644 | 9999 | 1368 | 11187 | 928 | 13212 | 459 | 9548 |
| 9-#14 | 2.23 | 6117 | 2201 | 7141 | 2093 | 9769 | 1739 | 11304 | 1433 | 12892 | 933 | 15566 | 354 | 13020 |
| 9-#18 | 3.97 | 7002 | 2665 | 9427 | 2406 | 12528 | 1981 | 14515 | 1597 | 17104 | 942 | 21318 | 76 | 20883 |
| 10-#10 | 1.40 | 5705 | 1979 | 6248 | 1921 | 8578 | 1605 | 9846 | 1331 | 10901 | 907 | 12683 | 470 | 8761 |
| 10-#11 | 1.72 | 5869 | 2064 | 6748 | 1971 | 9124 | 1642 | 10459 | 1352 | 11674 | 901 | 13719 | 415 | 10436 |
| 10-#14 | 2.48 | 6281 | 2267 | 7813 | 2106 | 10382 | 1745 | 11931 | 1420 | 13595 | 901 | 16356 | 297 | 14386 |
| 10-#18 | 4.41 | 7256 | 2782 | 10422 | 2451 | 13463 | 2008 | 15552 | 1592 | 18337 | 898 | 22631 | -28 | 22589 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway $f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 11-#10 | 1.54 | 5782 | 2016 | 6069 | 1986 | 8574 | 1660 | 9980 | 1382 | 11240 | 943 | 13382 | 474 | 9610 |
| 11-#11 | 1.89 | 5960 | 2110 | 6597 | 2043 | 9163 | 1702 | 10645 | 1409 | 12077 | 940 | 14504 | 413 | 11362 |
| 11-#14 | 2.73 | 6414 | 2334 | 7720 | 2197 | 10512 | 1819 | 12233 | 1491 | 14156 | 947 | 17386 | 284 | 15498 |
| 11-#18 | 4.85 | 7498 | 2900 | 10467 | 2589 | 13827 | 2118 | 16151 | 1698 | 19282 | 961 | 24412 | -57 | 24282 |
| 12-#10 | 1.68 | 5904 | 2054 | 6186 | 2025 | 8730 | 1693 | 10208 | 1405 | 11579 | 955 | 13907 | 463 | 10301 |
| 12-#11 | 2.06 | 6104 | 2156 | 6752 | 2088 | 9362 | 1740 | 10925 | 1435 | 12495 | 953 | 15126 | 397 | 12249 |
| 12-#14 | 2.97 | 6605 | 2400 | 7969 | 2258 | 10814 | 1871 | 12640 | 1525 | 14758 | 964 | 18253 | 257 | 16801 |
| 12-#18 | 5.29 | 7825 | 3018 | 10940 | 2687 | 14380 | 2203 | 16869 | 1752 | 20353 | 989 | 26044 | -89 | 25612 |
| 13-#10 | 1.82 | 5959 | 2091 | 6426 | 2042 | 9012 | 1706 | 10528 | 1417 | 11965 | 951 | 14467 | 440 | 11108 |
| 13-#11 | 2.23 | 6169 | 2202 | 7032 | 2111 | 9699 | 1758 | 11307 | 1451 | 12959 | 949 | 15826 | 370 | 13130 |
| 13-#14 | 3.22 | 6711 | 2466 | 8348 | 2293 | 11284 | 1899 | 13176 | 1549 | 15419 | 959 | 19251 | 220 | 17848 |
| 13-#18 | 5.73 | 8017 | 3136 | 11489 | 2764 | 15187 | 2258 | 17782 | 1797 | 21497 | 981 | 27590 | -178 | 27127 |
| 14-#10 | 1.96 | 6050 | 2129 | 6750 | 2054 | 9336 | 1710 | 10870 | 1412 | 12405 | 941 | 14887 | 413 | 11804 |
| 14-#11 | 2.41 | 6278 | 2248 | 7394 | 2128 | 10072 | 1766 | 11716 | 1448 | 13485 | 938 | 16341 | 338 | 14023 |
| 14-#14 | 3.47 | 6880 | 2532 | 8806 | 2324 | 11782 | 1916 | 13750 | 1551 | 16160 | 946 | 20032 | 177 | 19046 |
| 14-#18 | 6.17 | 8353 | 3253 | 12267 | 2820 | 15993 | 2298 | 18774 | 1810 | 22744 | 960 | 29069 | -245 | 28322 |
| 15-#10 | 2.10 | 6121 | 2166 | 6761 | 2099 | 9460 | 1752 | 11065 | 1449 | 12698 | 959 | 15515 | 400 | 12562 |
| 15-#11 | 2.58 | 6362 | 2294 | 7442 | 2181 | 10241 | 1813 | 11960 | 1490 | 13842 | 957 | 17079 | 320 | 14853 |
| 15-#14 | 3.72 | 6978 | 2599 | 8941 | 2393 | 12058 | 1978 | 14114 | 1605 | 16673 | 969 | 21050 | 148 | 20123 |
| 15-#18 | 6.61 | 8542 | 3371 | 12619 | 2932 | 16531 | 2394 | 19428 | 1895 | 23658 | 995 | 30683 | -312 | 29765 |
| 16-#10 | 2.24 | 6206 | 2203 | 6870 | 2134 | 9667 | 1774 | 11328 | 1470 | 13050 | 968 | 16101 | 395 | 13262 |
| 16-#11 | 2.75 | 6461 | 2340 | 7583 | 2222 | 10501 | 1840 | 12286 | 1515 | 14265 | 968 | 17762 | 311 | 15742 |
| 16-#14 | 3.97 | 7122 | 2665 | 9158 | 2450 | 12445 | 2015 | 14588 | 1640 | 17272 | 983 | 21980 | 130 | 21225 |
| 17-#10 | 2.38 | 6292 | 2241 | 7107 | 2157 | 9917 | 1794 | 11625 | 1479 | 13430 | 966 | 16567 | 363 | 13990 |
| 17-#11 | 2.92 | 6562 | 2386 | 7865 | 2251 | 10798 | 1864 | 12636 | 1526 | 14733 | 965 | 18338 | 272 | 16547 |
| 17-#14 | 4.21 | 7261 | 2731 | 9549 | 2494 | 12858 | 2051 | 15075 | 1657 | 17949 | 981 | 22830 | 75 | 22393 |
| 18-#10 | 2.52 | 6365 | 2278 | 7424 | 2168 | 10236 | 1803 | 11949 | 1485 | 13821 | 957 | 17035 | 341 | 14707 |
| 18-#11 | 3.09 | 6650 | 2432 | 8230 | 2267 | 11175 | 1878 | 13021 | 1534 | 15205 | 956 | 18902 | 245 | 17415 |
| 18-#14 | 4.46 | 7405 | 2797 | 10034 | 2520 | 13379 | 2074 | 15613 | 1671 | 18622 | 970 | 23640 | 38 | 23423 |
| 19-#10 | 2.66 | 6468 | 2315 | 7479 | 2211 | 10369 | 1839 | 12163 | 1511 | 14160 | 972 | 17651 | 331 | 15404 |
| 19-#11 | 3.26 | 6770 | 2478 | 8315 | 2317 | 11348 | 1919 | 13291 | 1565 | 15611 | 973 | 19634 | 230 | 18184 |
| 19-#14 | 4.71 | 7554 | 2863 | 10193 | 2588 | 13643 | 2129 | 16014 | 1712 | 19197 | 990 | 24661 | 13 | 24597 |
| 20-#10 | 2.80 | 6533 | 2353 | 7632 | 2240 | 10588 | 1864 | 12410 | 1531 | 14521 | 981 | 18160 | 313 | 16126 |
| 20-#11 | 3.44 | 6849 | 2523 | 8508 | 2353 | 11610 | 1949 | 13591 | 1589 | 16056 | 983 | 20265 | 210 | 19001 |
| 20-#14 | 4.96 | 7677 | 2930 | 10483 | 2639 | 14021 | 2171 | 16443 | 1745 | 19838 | 1005 | 25578 | -15 | 25531 |
| 21-#10 | 2.94 | 6630 | 2390 | 7825 | 2267 | 10816 | 1883 | 12714 | 1543 | 14897 | 979 | 18695 | 293 | 16788 |
| 21-#11 | 3.61 | 6968 | 2569 | 8737 | 2386 | 11887 | 1973 | 13958 | 1604 | 16504 | 981 | 20901 | 183 | 19783 |
| 22-#10 | 3.08 | 6710 | 2428 | 8094 | 2286 | 11104 | 1895 | 13016 | 1551 | 15299 | 976 | 19186 | 267 | 17511 |
| 22-#11 | 3.78 | 7058 | 2615 | 9052 | 2410 | 12227 | 1988 | 14322 | 1614 | 16982 | 976 | 21470 | 151 | 20572 |
| 23-#10 | 3.22 | 6795 | 2465 | 8203 | 2321 | 11283 | 1924 | 13256 | 1575 | 15624 | 986 | 19741 | 254 | 18147 |
| 23-#11 | 3.95 | 7166 | 2661 | 9196 | 2452 | 12436 | 2027 | 14615 | 1642 | 17383 | 988 | 22159 | 135 | 21384 |
| 24-#10 | 3.36 | 6883 | 2502 | 8350 | 2354 | 11477 | 1950 | 13516 | 1595 | 15977 | 992 | 20259 | 234 | 18829 |
| 24-#11 | 4.12 | 7265 | 2707 | 9375 | 2492 | 12692 | 2054 | 14936 | 1667 | 17808 | 995 | 22775 | 109 | 22144 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway $f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 25-#10 | 3.50 | 6965 | 2540 | 8552 | 2377 | 11735 | 1969 | 13806 | 1607 | 16361 | 993 | 20794 | 216 | 19476 |
| 25-#11 | 4.30 | 7369 | 2753 | 9619 | 2521 | 13001 | 2077 | 15284 | 1682 | 18271 | 995 | 23450 | 90 | 22952 |
| 26-#10 | 3.64 | 7059 | 2577 | 8829 | 2395 | 11992 | 1985 | 14118 | 1618 | 16746 | 989 | 21346 | 197 | 20136 |
| 27-#10 | 3.78 | 7138 | 2614 | 8929 | 2431 | 12183 | 2013 | 14352 | 1638 | 17089 | 999 | 21877 | 182 | 20793 |
| 28-#10 | 3.92 | 7230 | 2652 | 9098 | 2459 | 12392 | 2039 | 14610 | 1658 | 17460 | 1006 | 22429 | 163 | 21427 |

## ROUND TIED COLUMNS 36" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.57 | 6558 | 2271 | 7167 | 2208 | 10044 | 1833 | 11636 | 1515 | 13016 | 1033 | 15163 | 453 | 12277 |
| 5-#14 | 1.11 | 6530 | 2131 | 7015 | 2081 | 9613 | 1739 | 10966 | 1447 | 11944 | 1004 | 13629 | 563 | 8392 |
| 5-#18 | 1.96 | 7085 | 2388 | 8492 | 2246 | 11315 | 1864 | 12933 | 1528 | 14487 | 998 | 17055 | 405 | 13807 |
| 6-#14 | 1.33 | 6586 | 2197 | 8085 | 2035 | 10526 | 1678 | 11806 | 1382 | 12851 | 935 | 14190 | 455 | 9970 |
| 6-#18 | 2.36 | 7179 | 2506 | 9825 | 2222 | 12633 | 1812 | 14301 | 1464 | 16161 | 918 | 18176 | 236 | 16695 |
| 7-#11 | 1.07 | 6512 | 2121 | 6640 | 2108 | 9357 | 1764 | 10809 | 1474 | 11903 | 1033 | 13691 | 593 | 8295 |
| 7-#14 | 1.55 | 6839 | 2263 | 7438 | 2202 | 10297 | 1836 | 11910 | 1523 | 13338 | 1035 | 15666 | 512 | 11313 |
| 7-#18 | 2.75 | 7624 | 2624 | 9377 | 2443 | 12605 | 2020 | 14629 | 1647 | 16879 | 1040 | 20523 | 302 | 18508 |
| 8-#11 | 1.23 | 6603 | 2167 | 6603 | 2167 | 9518 | 1816 | 11124 | 1520 | 12359 | 1061 | 14366 | 580 | 9232 |
| 8-#14 | 1.77 | 6963 | 2329 | 7483 | 2278 | 10587 | 1901 | 12390 | 1580 | 13979 | 1068 | 16586 | 487 | 12784 |
| 8-#18 | 3.14 | 7793 | 2741 | 9632 | 2562 | 13220 | 2120 | 15524 | 1734 | 17973 | 1083 | 22037 | 243 | 20786 |
| 9-#10 | 1.12 | 6568 | 2136 | 6568 | 2136 | 9380 | 1793 | 10906 | 1502 | 12083 | 1050 | 14106 | 601 | 8676 |
| 9-#11 | 1.38 | 6729 | 2213 | 7038 | 2182 | 9918 | 1825 | 11498 | 1523 | 12823 | 1046 | 15095 | 551 | 10340 |
| 9-#14 | 1.99 | 7136 | 2396 | 8047 | 2305 | 11124 | 1920 | 12901 | 1588 | 14655 | 1051 | 17639 | 448 | 14099 |
| 9-#18 | 3.54 | 8101 | 2859 | 10510 | 2619 | 14091 | 2162 | 16359 | 1754 | 19188 | 1062 | 23874 | 177 | 22772 |
| 10-#10 | 1.25 | 6682 | 2173 | 7110 | 2130 | 9863 | 1783 | 11340 | 1483 | 12513 | 1022 | 14491 | 558 | 9445 |
| 10-#11 | 1.53 | 6863 | 2259 | 7652 | 2180 | 10455 | 1819 | 12002 | 1504 | 13346 | 1016 | 15609 | 504 | 11259 |
| 10-#14 | 2.21 | 7314 | 2462 | 8797 | 2315 | 11809 | 1923 | 13585 | 1573 | 15410 | 1017 | 18448 | 388 | 15529 |
| 10-#18 | 3.93 | 8377 | 2977 | 11604 | 2660 | 15131 | 2188 | 17487 | 1747 | 20515 | 1017 | 25365 | 80 | 24911 |
| 11-#10 | 1.37 | 6765 | 2211 | 6881 | 2199 | 9832 | 1841 | 11468 | 1538 | 12879 | 1061 | 15277 | 566 | 10360 |
| 11-#11 | 1.69 | 6962 | 2305 | 7453 | 2256 | 10469 | 1883 | 12186 | 1565 | 13781 | 1058 | 16494 | 506 | 12311 |
| 11-#14 | 2.43 | 7459 | 2528 | 8661 | 2410 | 11920 | 2001 | 13891 | 1647 | 16016 | 1066 | 19611 | 380 | 16786 |
| 11-#18 | 4.32 | 8638 | 3095 | 11618 | 2802 | 15488 | 2301 | 18106 | 1856 | 21537 | 1084 | 27236 | 49 | 26931 |
| 12-#10 | 1.50 | 6898 | 2248 | 6995 | 2239 | 9993 | 1876 | 11710 | 1562 | 13237 | 1074 | 15846 | 556 | 11120 |
| 12-#11 | 1.84 | 7118 | 2351 | 7613 | 2303 | 10677 | 1923 | 12483 | 1592 | 14222 | 1072 | 17169 | 491 | 13231 |
| 12-#14 | 2.65 | 7666 | 2594 | 8923 | 2472 | 12238 | 2054 | 14326 | 1683 | 16651 | 1084 | 20553 | 355 | 18184 |
| 12-#18 | 4.72 | 8993 | 3212 | 12126 | 2903 | 16078 | 2388 | 18876 | 1912 | 22668 | 1112 | 29006 | 20 | 28894 |
| 13-#10 | 1.62 | 6958 | 2286 | 7261 | 2256 | 10297 | 1888 | 12056 | 1573 | 13651 | 1069 | 16430 | 531 | 12005 |
| 13-#11 | 1.99 | 7189 | 2396 | 7918 | 2324 | 11039 | 1940 | 12896 | 1607 | 14722 | 1067 | 17901 | 464 | 14232 |
| 13-#14 | 2.87 | 7780 | 2660 | 9333 | 2506 | 12742 | 2081 | 14905 | 1706 | 17363 | 1079 | 21629 | 319 | 19391 |
| 13-#18 | 5.11 | 9197 | 3330 | 12715 | 2978 | 16940 | 2441 | 19864 | 1956 | 23902 | 1104 | 30687 | -68 | 30506 |
| 14-#10 | 1.75 | 7058 | 2323 | 7627 | 2266 | 10656 | 1891 | 12424 | 1566 | 14118 | 1058 | 16878 | 504 | 12752 |
| 14-#11 | 2.15 | 7308 | 2442 | 8323 | 2340 | 11450 | 1946 | 13336 | 1602 | 15296 | 1056 | 18451 | 431 | 15156 |
| 14-#14 | 3.09 | 7964 | 2727 | 9843 | 2536 | 13288 | 2097 | 15520 | 1706 | 18174 | 1066 | 22435 | 274 | 20778 |
| 14-#18 | 5.50 | 9554 | 3448 | 13569 | 3033 | 17819 | 2480 | 20922 | 1968 | 25273 | 1086 | 32215 | -138 | 31778 |
| 15-#10 | 1.87 | 7134 | 2360 | 7616 | 2313 | 10777 | 1934 | 12627 | 1605 | 14439 | 1078 | 17563 | 493 | 13609 |
| 15-#11 | 2.30 | 7397 | 2488 | 8354 | 2394 | 11621 | 1996 | 13593 | 1646 | 15671 | 1077 | 19256 | 415 | 16094 |
| 15-#14 | 3.32 | 8070 | 2793 | 9965 | 2607 | 13574 | 2161 | 15905 | 1762 | 18713 | 1091 | 23544 | 246 | 21890 |
| 15-#18 | 5.89 | 9731 | 3566 | 13921 | 3147 | 18387 | 2580 | 21621 | 2055 | 26234 | 1121 | 34047 | -198 | 33388 |

## ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.00 | 7227 | 2398 | 7727 | 2348 | 10993 | 1957 | 12904 | 1626 | 14817 | 1088 | 18179 | 488 | 14333 |
| 16-#11 | 2.45 | 7507 | 2534 | 8499 | 2436 | 11893 | 2023 | 13936 | 1672 | 16126 | 1088 | 20018 | 409 | 17021 |
| 16-#14 | 3.54 | 8225 | 2859 | 10193 | 2665 | 13979 | 2198 | 16406 | 1797 | 19359 | 1105 | 24588 | 233 | 23127 |
| 16-#18 | 6.29 | 10054 | 3683 | 14353 | 3246 | 19130 | 2643 | 22521 | 2115 | 27347 | 1142 | 35731 | -235 | 35054 |
| 17-#10 | 2.12 | 7320 | 2435 | 7984 | 2371 | 11264 | 1976 | 13224 | 1636 | 15219 | 1085 | 18697 | 458 | 15155 |
| 17-#11 | 2.61 | 7617 | 2580 | 8804 | 2465 | 12214 | 2047 | 14318 | 1683 | 16622 | 1085 | 20616 | 369 | 17928 |
| 17-#14 | 3.76 | 8376 | 2925 | 10613 | 2708 | 14427 | 2234 | 16939 | 1815 | 20075 | 1103 | 25470 | 177 | 24335 |
| 18-#10 | 2.25 | 7401 | 2472 | 8335 | 2381 | 11609 | 1984 | 13580 | 1641 | 15638 | 1076 | 19199 | 435 | 15904 |
| 18-#11 | 2.76 | 7712 | 2626 | 9206 | 2480 | 12622 | 2059 | 14736 | 1691 | 17128 | 1076 | 21224 | 342 | 18871 |
| 18-#14 | 3.98 | 8511 | 2992 | 11145 | 2733 | 14988 | 2256 | 17522 | 1829 | 20799 | 1091 | 26345 | 140 | 25489 |
| 19-#10 | 2.37 | 7512 | 2510 | 8382 | 2425 | 11745 | 2021 | 13802 | 1668 | 16003 | 1092 | 19830 | 422 | 16684 |
| 19-#11 | 2.91 | 7843 | 2672 | 9286 | 2531 | 12801 | 2102 | 15017 | 1722 | 17566 | 1093 | 22017 | 328 | 19737 |
| 19-#14 | 4.20 | 8692 | 3058 | 11304 | 2803 | 15268 | 2313 | 17941 | 1870 | 21418 | 1113 | 27452 | 116 | 26748 |
| 20-#10 | 2.50 | 7583 | 2547 | 8541 | 2455 | 11981 | 2048 | 14066 | 1689 | 16385 | 1101 | 20401 | 408 | 17433 |
| 20-#11 | 3.07 | 7928 | 2718 | 9488 | 2567 | 13085 | 2133 | 15338 | 1747 | 18036 | 1104 | 22680 | 307 | 20690 |
| 20-#14 | 4.42 | 8824 | 3124 | 11608 | 2854 | 15676 | 2355 | 18402 | 1904 | 22096 | 1127 | 28413 | 87 | 27897 |
| 21-#10 | 2.62 | 7687 | 2585 | 8751 | 2482 | 12224 | 2066 | 14389 | 1700 | 16788 | 1099 | 20977 | 388 | 18179 |
| 21-#11 | 3.22 | 8057 | 2764 | 9736 | 2600 | 13380 | 2156 | 15732 | 1762 | 18522 | 1102 | 23373 | 282 | 21501 |
| 21-#14 | 4.64 | 9001 | 3190 | 11950 | 2902 | 16095 | 2390 | 18962 | 1927 | 22783 | 1125 | 29392 | 49 | 29120 |
| 22-#10 | 2.74 | 7775 | 2622 | 9045 | 2500 | 12539 | 2077 | 14716 | 1707 | 17226 | 1096 | 21523 | 364 | 18933 |
| 22-#11 | 3.37 | 8155 | 2810 | 10079 | 2624 | 13750 | 2171 | 16122 | 1771 | 19040 | 1097 | 24003 | 250 | 22378 |
| 22-#14 | 4.86 | 9129 | 3256 | 12414 | 2939 | 16604 | 2414 | 19513 | 1943 | 23517 | 1119 | 30271 | 3 | 30253 |
| 23-#10 | 2.87 | 7866 | 2659 | 9154 | 2536 | 12722 | 2108 | 14971 | 1732 | 17569 | 1106 | 22106 | 351 | 19663 |
| 23-#11 | 3.52 | 8266 | 2856 | 10226 | 2666 | 13986 | 2207 | 16434 | 1800 | 19463 | 1109 | 24725 | 234 | 23220 |
| 24-#10 | 2.99 | 7962 | 2697 | 9307 | 2569 | 12929 | 2134 | 15246 | 1753 | 17948 | 1113 | 22667 | 331 | 20431 |
| 24-#11 | 3.68 | 8378 | 2902 | 10419 | 2707 | 14238 | 2238 | 16773 | 1825 | 19920 | 1117 | 25394 | 209 | 24070 |
| 25-#10 | 3.12 | 8051 | 2734 | 9528 | 2592 | 13207 | 2152 | 15557 | 1764 | 18357 | 1113 | 23242 | 314 | 21136 |
| 25-#11 | 3.83 | 8485 | 2947 | 10680 | 2736 | 14572 | 2261 | 17148 | 1840 | 20418 | 1117 | 26121 | 191 | 24929 |
| 26-#10 | 3.24 | 8152 | 2771 | 9830 | 2610 | 13484 | 2168 | 15898 | 1776 | 18768 | 1110 | 23819 | 293 | 21879 |
| 26-#11 | 3.98 | 8614 | 2993 | 11033 | 2758 | 14903 | 2282 | 17549 | 1853 | 20919 | 1114 | 26807 | 164 | 25763 |
| 27-#10 | 3.37 | 8234 | 2809 | 9930 | 2646 | 13686 | 2196 | 16143 | 1796 | 19136 | 1120 | 24398 | 279 | 22563 |
| 27-#11 | 4.14 | 8708 | 3039 | 11168 | 2801 | 15154 | 2315 | 17854 | 1878 | 21362 | 1125 | 27485 | 144 | 26623 |
| 28-#10 | 3.49 | 8336 | 2846 | 10110 | 2675 | 13906 | 2222 | 16419 | 1816 | 19529 | 1127 | 25008 | 262 | 23267 |
| 29-#10 | 3.62 | 8410 | 2884 | 10305 | 2702 | 14170 | 2241 | 16728 | 1828 | 19925 | 1127 | 25523 | 241 | 23980 |
| 30-#10 | 3.74 | 8501 | 2921 | 10557 | 2723 | 14454 | 2259 | 17045 | 1839 | 20342 | 1126 | 26077 | 216 | 24670 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 12" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#5 | 1.10 | 274 | 286 | 385 | 240 | 444 | 196 | 463 | 162 | 452 | 109 | 448 | 44 | 303 |
| 4-#6 | 1.56 | 278 | 301 | 405 | 248 | 467 | 201 | 489 | 166 | 483 | 106 | 481 | 25 | 407 |
| 4-#7 | 2.12 | 283 | 320 | 428 | 258 | 493 | 208 | 519 | 169 | 520 | 102 | 520 | 2 | 517 |
| 4-#8 | 2.79 | 288 | 342 | 455 | 270 | 524 | 216 | 553 | 174 | 562 | 97 | 565 | -26 | 569 |
| 4-#9 | 3.54 | 296 | 366 | 483 | 283 | 557 | 224 | 588 | 178 | 606 | 91 | 610 | -59 | 617 |
| 4-#10 | 4.49 | 304 | 397 | 517 | 300 | 598 | 236 | 631 | 184 | 660 | 84 | 664 | -102 | 673 |
| 4-#11 | 5.52 | 307 | 431 | 550 | 314 | 623 | 240 | 657 | 183 | 690 | 68 | 680 | -155 | 699 |
| 4-#14 | 7.96 | 325 | 511 | 626 | 356 | 701 | 264 | 745 | 192 | 800 | 41 | 805 | -260 | 806 |
| 5-#5 | 1.37 | 283 | 295 | 408 | 241 | 464 | 196 | 481 | 160 | 471 | 102 | 466 | 37 | 350 |
| 5-#6 | 1.95 | 290 | 314 | 433 | 252 | 492 | 203 | 512 | 163 | 510 | 98 | 508 | 16 | 461 |
| 5-#7 | 2.65 | 299 | 337 | 462 | 265 | 526 | 211 | 550 | 167 | 557 | 92 | 558 | -10 | 563 |
| 5-#8 | 3.49 | 311 | 364 | 495 | 280 | 564 | 222 | 592 | 172 | 610 | 85 | 613 | -41 | 631 |
| 5-#9 | 4.42 | 322 | 395 | 530 | 298 | 604 | 232 | 637 | 177 | 666 | 77 | 669 | -77 | 699 |
| 5-#10 | 5.61 | 336 | 434 | 574 | 320 | 652 | 246 | 691 | 182 | 734 | 66 | 735 | -124 | 778 |
| 5-#11 | 6.90 | 342 | 476 | 610 | 338 | 682 | 252 | 723 | 180 | 773 | 44 | 771 | -181 | 807 |
| 6-#5 | 1.64 | 285 | 304 | 438 | 237 | 487 | 190 | 499 | 153 | 490 | 93 | 471 | 18 | 410 |
| 6-#6 | 2.33 | 293 | 326 | 469 | 249 | 521 | 197 | 538 | 156 | 539 | 86 | 520 | -8 | 525 |
| 6-#7 | 3.18 | 303 | 354 | 507 | 264 | 562 | 206 | 585 | 160 | 597 | 78 | 591 | -37 | 592 |
| 6-#8 | 4.19 | 315 | 387 | 549 | 283 | 609 | 217 | 638 | 165 | 664 | 68 | 658 | -76 | 665 |
| 6-#9 | 5.31 | 327 | 424 | 591 | 302 | 658 | 228 | 693 | 169 | 734 | 56 | 727 | -120 | 737 |
| 6-#10 | 6.74 | 343 | 471 | 643 | 327 | 717 | 242 | 761 | 174 | 820 | 39 | 808 | -177 | 823 |
| 7-#5 | 1.92 | 290 | 313 | 428 | 255 | 489 | 207 | 513 | 167 | 514 | 102 | 521 | 23 | 457 |
| 7-#6 | 2.72 | 300 | 339 | 462 | 271 | 528 | 217 | 557 | 173 | 569 | 97 | 583 | -5 | 585 |
| 7-#7 | 3.71 | 314 | 372 | 502 | 290 | 575 | 231 | 609 | 179 | 634 | 90 | 654 | -40 | 666 |
| 7-#8 | 4.89 | 328 | 410 | 548 | 312 | 628 | 246 | 669 | 187 | 709 | 81 | 734 | -82 | 756 |
| 7-#9 | 6.19 | 344 | 453 | 596 | 337 | 683 | 262 | 730 | 194 | 787 | 70 | 815 | -131 | 836 |
| 8-#5 | 2.19 | 295 | 322 | 433 | 265 | 500 | 214 | 528 | 173 | 535 | 104 | 551 | 15 | 514 |
| 8-#6 | 3.11 | 308 | 352 | 470 | 283 | 544 | 226 | 579 | 180 | 598 | 99 | 623 | -16 | 629 |
| 8-#7 | 4.24 | 323 | 389 | 515 | 306 | 596 | 241 | 638 | 189 | 672 | 92 | 706 | -57 | 712 |
| 8-#8 | 5.59 | 341 | 433 | 565 | 333 | 656 | 259 | 706 | 198 | 757 | 83 | 798 | -106 | 810 |

## ROUND TIED COLUMNS 14" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.14 | 440 | 391 | 599 | 337 | 708 | 276 | 748 | 229 | 748 | 156 | 757 | 67 | 507 |
| 4-#7 | 1.56 | 447 | 410 | 630 | 347 | 743 | 283 | 788 | 234 | 798 | 153 | 814 | 47 | 662 |
| 4-#8 | 2.05 | 456 | 432 | 665 | 360 | 783 | 291 | 835 | 240 | 857 | 150 | 880 | 22 | 835 |
| 4-#9 | 2.60 | 464 | 456 | 702 | 373 | 826 | 301 | 886 | 246 | 918 | 146 | 948 | -6 | 949 |
| 4-#10 | 3.30 | 476 | 487 | 748 | 391 | 880 | 313 | 949 | 253 | 995 | 141 | 1032 | -43 | 1034 |
| 4-#11 | 4.05 | 485 | 521 | 796 | 405 | 930 | 321 | 999 | 256 | 1048 | 128 | 1076 | -96 | 1081 |
| 4-#14 | 5.85 | 511 | 601 | 900 | 450 | 1054 | 351 | 1133 | 272 | 1215 | 110 | 1245 | -203 | 1248 |
| 5-#5 | 1.01 | 447 | 385 | 609 | 329 | 707 | 269 | 741 | 222 | 729 | 151 | 734 | 76 | 442 |
| 5-#6 | 1.43 | 458 | 404 | 642 | 340 | 745 | 276 | 784 | 227 | 783 | 148 | 796 | 58 | 584 |
| 5-#7 | 1.95 | 471 | 427 | 680 | 353 | 790 | 286 | 836 | 232 | 847 | 143 | 868 | 35 | 750 |
| 5-#8 | 2.57 | 487 | 455 | 725 | 369 | 842 | 297 | 896 | 239 | 921 | 138 | 952 | 8 | 932 |
| 5-#9 | 3.25 | 503 | 485 | 772 | 387 | 897 | 309 | 960 | 245 | 1000 | 132 | 1038 | -24 | 1048 |
| 5-#10 | 4.13 | 525 | 524 | 831 | 410 | 967 | 324 | 1038 | 253 | 1097 | 124 | 1144 | -66 | 1167 |
| 5-#11 | 5.07 | 538 | 566 | 887 | 429 | 1027 | 336 | 1094 | 255 | 1165 | 107 | 1197 | -124 | 1240 |
| 5-#14 | 7.31 | 584 | 666 | 1018 | 487 | 1175 | 372 | 1261 | 271 | 1376 | 80 | 1407 | -242 | 1441 |
| 6-#5 | 1.21 | 448 | 394 | 654 | 320 | 743 | 261 | 769 | 214 | 753 | 139 | 739 | 55 | 512 |
| 6-#6 | 1.71 | 460 | 417 | 695 | 333 | 792 | 269 | 823 | 218 | 820 | 134 | 810 | 31 | 689 |
| 6-#7 | 2.34 | 474 | 445 | 743 | 348 | 850 | 280 | 887 | 223 | 901 | 128 | 893 | 0 | 893 |
| 6-#8 | 3.08 | 491 | 478 | 799 | 367 | 915 | 292 | 961 | 230 | 993 | 120 | 989 | -37 | 1000 |
| 6-#9 | 3.90 | 509 | 514 | 859 | 388 | 983 | 305 | 1039 | 236 | 1092 | 110 | 1088 | -78 | 1107 |
| 6-#10 | 4.95 | 531 | 561 | 934 | 414 | 1069 | 321 | 1136 | 244 | 1214 | 98 | 1209 | -132 | 1234 |
| 6-#11 | 6.08 | 546 | 612 | 1005 | 439 | 1132 | 332 | 1205 | 244 | 1299 | 76 | 1315 | -190 | 1313 |

## ROUND TIED COLUMNS 14" DIA.

Short columns – no sidesway $f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 7-#5 | 1.41 | 456 | 403 | 630 | 344 | 740 | 282 | 782 | 231 | 787 | 152 | 808 | 63 | 582 |
| 7-#6 | 2.00 | 471 | 429 | 676 | 360 | 792 | 293 | 842 | 238 | 862 | 149 | 895 | 39 | 768 |
| 7-#7 | 2.73 | 489 | 462 | 729 | 380 | 854 | 307 | 913 | 246 | 951 | 144 | 998 | 8 | 977 |
| 7-#8 | 3.59 | 509 | 501 | 791 | 403 | 925 | 324 | 996 | 256 | 1055 | 138 | 1115 | -30 | 1127 |
| 7-#9 | 4.55 | 531 | 543 | 857 | 429 | 1001 | 342 | 1085 | 267 | 1164 | 131 | 1250 | -69 | 1260 |
| 7-#10 | 5.78 | 562 | 598 | 940 | 463 | 1096 | 365 | 1195 | 280 | 1300 | 120 | 1403 | -125 | 1414 |
| 7-#11 | 7.09 | 581 | 657 | 1014 | 491 | 1175 | 383 | 1274 | 284 | 1396 | 99 | 1484 | -203 | 1496 |
| 8-#5 | 1.61 | 463 | 412 | 636 | 356 | 753 | 290 | 801 | 237 | 816 | 156 | 854 | 59 | 649 |
| 8-#6 | 2.29 | 480 | 442 | 687 | 375 | 812 | 304 | 869 | 247 | 901 | 152 | 957 | 32 | 867 |
| 8-#7 | 3.12 | 500 | 479 | 746 | 399 | 881 | 320 | 949 | 257 | 1003 | 148 | 1079 | -3 | 1080 |
| 8-#8 | 4.11 | 524 | 523 | 815 | 426 | 961 | 340 | 1042 | 269 | 1120 | 142 | 1217 | -45 | 1209 |
| 8-#9 | 5.20 | 549 | 572 | 887 | 457 | 1047 | 361 | 1141 | 282 | 1244 | 135 | 1362 | -94 | 1353 |
| 8-#10 | 6.60 | 584 | 635 | 977 | 496 | 1154 | 388 | 1266 | 298 | 1399 | 125 | 1538 | -158 | 1526 |

## ROUND TIED COLUMNS 16" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.19 | 664 | 514 | 881 | 452 | 1060 | 371 | 1133 | 305 | 1149 | 210 | 1188 | 95 | 798 |
| 4-#8 | 1.57 | 675 | 536 | 924 | 464 | 1110 | 379 | 1190 | 310 | 1225 | 208 | 1276 | 72 | 1015 |
| 4-#9 | 1.99 | 687 | 560 | 971 | 478 | 1164 | 389 | 1253 | 315 | 1307 | 206 | 1368 | 47 | 1241 |
| 4-#10 | 2.53 | 702 | 592 | 1029 | 496 | 1232 | 401 | 1332 | 322 | 1409 | 203 | 1483 | 14 | 1456 |
| 4-#11 | 3.10 | 712 | 625 | 1093 | 510 | 1298 | 410 | 1403 | 333 | 1485 | 193 | 1556 | -32 | 1556 |
| 4-#14 | 4.48 | 746 | 705 | 1226 | 556 | 1455 | 441 | 1589 | 354 | 1711 | 180 | 1802 | -127 | 1793 |
| 4-#18 | 7.96 | 841 | 908 | 1535 | 672 | 1826 | 519 | 2008 | 400 | 2219 | 138 | 2333 | -390 | 2289 |
| 5-#6 | 1.09 | 676 | 508 | 903 | 442 | 1068 | 362 | 1130 | 298 | 1133 | 204 | 1162 | 103 | 711 |
| 5-#7 | 1.49 | 694 | 531 | 952 | 455 | 1124 | 372 | 1194 | 305 | 1215 | 201 | 1259 | 83 | 917 |
| 5-#8 | 1.96 | 713 | 559 | 1008 | 472 | 1189 | 383 | 1270 | 312 | 1310 | 197 | 1371 | 58 | 1148 |
| 5-#9 | 2.49 | 734 | 589 | 1068 | 490 | 1259 | 396 | 1351 | 320 | 1411 | 192 | 1489 | 30 | 1393 |
| 5-#10 | 3.16 | 761 | 628 | 1142 | 514 | 1346 | 412 | 1453 | 330 | 1539 | 186 | 1635 | -7 | 1638 |
| 5-#11 | 3.88 | 781 | 670 | 1218 | 534 | 1427 | 424 | 1542 | 335 | 1636 | 173 | 1727 | -58 | 1748 |
| 5-#14 | 5.60 | 844 | 770 | 1388 | 593 | 1629 | 465 | 1772 | 357 | 1922 | 152 | 2037 | -165 | 2078 |
| 6-#6 | 1.31 | 679 | 521 | 979 | 430 | 1128 | 350 | 1185 | 289 | 1177 | 188 | 1175 | 76 | 832 |
| 6-#7 | 1.79 | 697 | 549 | 1039 | 446 | 1200 | 361 | 1267 | 295 | 1280 | 183 | 1288 | 48 | 1086 |
| 6-#8 | 2.36 | 718 | 582 | 1108 | 465 | 1283 | 374 | 1362 | 302 | 1399 | 176 | 1417 | 14 | 1373 |
| 6-#9 | 2.98 | 741 | 618 | 1182 | 485 | 1374 | 388 | 1464 | 310 | 1527 | 169 | 1552 | -25 | 1558 |
| 6-#10 | 3.79 | 772 | 665 | 1275 | 512 | 1487 | 407 | 1591 | 320 | 1686 | 159 | 1721 | -76 | 1733 |
| 6-#11 | 4.66 | 793 | 716 | 1368 | 537 | 1587 | 421 | 1690 | 323 | 1809 | 141 | 1827 | -143 | 1850 |
| 6-#14 | 6.71 | 860 | 836 | 1586 | 606 | 1836 | 464 | 1974 | 344 | 2166 | 109 | 2182 | -281 | 2208 |
| 7-#5 | 1.08 | 674 | 507 | 884 | 448 | 1059 | 369 | 1128 | 305 | 1135 | 209 | 1177 | 109 | 712 |
| 7-#6 | 1.53 | 694 | 534 | 940 | 463 | 1124 | 381 | 1202 | 312 | 1230 | 206 | 1292 | 87 | 943 |
| 7-#7 | 2.09 | 717 | 566 | 1006 | 483 | 1202 | 395 | 1291 | 320 | 1346 | 203 | 1429 | 59 | 1212 |
| 7-#8 | 2.75 | 744 | 605 | 1083 | 507 | 1292 | 413 | 1395 | 330 | 1479 | 199 | 1587 | 25 | 1510 |
| 7-#9 | 3.48 | 773 | 647 | 1166 | 534 | 1388 | 432 | 1507 | 344 | 1621 | 194 | 1754 | -13 | 1758 |
| 7-#10 | 4.42 | 810 | 702 | 1269 | 568 | 1509 | 457 | 1647 | 359 | 1798 | 187 | 1960 | -64 | 1975 |
| 7-#11 | 5.43 | 840 | 761 | 1373 | 598 | 1617 | 476 | 1768 | 368 | 1936 | 171 | 2093 | -133 | 2123 |
| 7-#14 | 7.83 | 927 | 901 | 1613 | 684 | 1893 | 536 | 2091 | 402 | 2334 | 145 | 2564 | -270 | 2533 |
| 8-#5 | 1.23 | 682 | 516 | 885 | 460 | 1075 | 379 | 1151 | 312 | 1170 | 213 | 1228 | 104 | 786 |
| 8-#6 | 1.75 | 704 | 546 | 948 | 479 | 1148 | 393 | 1234 | 321 | 1277 | 211 | 1359 | 78 | 1055 |
| 8-#7 | 2.39 | 731 | 583 | 1023 | 503 | 1235 | 410 | 1335 | 331 | 1407 | 209 | 1516 | 46 | 1371 |
| 8-#8 | 3.14 | 761 | 628 | 1109 | 532 | 1336 | 431 | 1452 | 343 | 1558 | 205 | 1696 | 7 | 1685 |
| 8-#9 | 3.98 | 794 | 676 | 1202 | 564 | 1445 | 453 | 1578 | 356 | 1721 | 201 | 1886 | -37 | 1891 |
| 8-#10 | 5.05 | 835 | 739 | 1320 | 605 | 1581 | 482 | 1736 | 373 | 1924 | 195 | 2159 | -86 | 2126 |
| 8-#11 | 6.21 | 871 | 806 | 1433 | 642 | 1701 | 505 | 1871 | 392 | 2082 | 178 | 2321 | -165 | 2288 |
| 9-#10 | 5.68 | 865 | 776 | 1393 | 622 | 1670 | 497 | 1846 | 387 | 2056 | 186 | 2297 | -119 | 2287 |
| 9-#11 | 6.98 | 906 | 851 | 1519 | 663 | 1811 | 525 | 1998 | 400 | 2235 | 166 | 2475 | -206 | 2455 |
| 10-#10 | 6.32 | 905 | 813 | 1484 | 638 | 1772 | 501 | 1963 | 388 | 2201 | 171 | 2429 | -163 | 2402 |

## ROUND TIED COLUMNS 18" DIA.

Short columns – no sidesway $f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.24 | 954 | 654 | 1239 | 583 | 1515 | 479 | 1632 | 395 | 1673 | 272 | 1763 | 126 | 1193 |
| 4-#9 | 1.57 | 969 | 678 | 1296 | 597 | 1580 | 489 | 1707 | 401 | 1771 | 271 | 1880 | 103 | 1467 |
| 4-#10 | 2.00 | 989 | 710 | 1366 | 615 | 1661 | 502 | 1801 | 408 | 1894 | 268 | 2026 | 73 | 1804 |
| 4-#11 | 2.45 | 1003 | 743 | 1447 | 629 | 1743 | 510 | 1890 | 411 | 2005 | 261 | 2130 | 31 | 2062 |
| 4-#14 | 3.54 | 1047 | 823 | 1609 | 676 | 1935 | 542 | 2114 | 429 | 2297 | 253 | 2455 | -55 | 2447 |
| 4-#18 | 6.29 | 1167 | 1026 | 1990 | 794 | 2390 | 624 | 2651 | 495 | 2955 | 223 | 3183 | -290 | 3113 |
| 5-#7 | 1.18 | 974 | 649 | 1283 | 572 | 1537 | 469 | 1640 | 387 | 1665 | 264 | 1739 | 134 | 1087 |
| 5-#8 | 1.55 | 999 | 677 | 1351 | 589 | 1616 | 481 | 1730 | 393 | 1782 | 261 | 1880 | 112 | 1366 |
| 5-#9 | 1.96 | 1026 | 707 | 1423 | 607 | 1700 | 494 | 1828 | 401 | 1910 | 258 | 2031 | 86 | 1660 |
| 5-#10 | 2.50 | 1059 | 746 | 1514 | 631 | 1806 | 511 | 1951 | 411 | 2069 | 254 | 2219 | 52 | 2025 |
| 5-#11 | 3.07 | 1085 | 788 | 1610 | 651 | 1908 | 523 | 2064 | 420 | 2197 | 242 | 2352 | 6 | 2334 |
| 5-#14 | 4.42 | 1160 | 889 | 1820 | 712 | 2157 | 565 | 2355 | 445 | 2559 | 227 | 2765 | -90 | 2786 |
| 5-#18 | 7.86 | 1345 | 1142 | 2310 | 865 | 2742 | 670 | 3038 | 506 | 3394 | 178 | 3681 | -354 | 3655 |
| 6-#6 | 1.04 | 957 | 639 | 1329 | 541 | 1548 | 443 | 1629 | 367 | 1620 | 248 | 1628 | 124 | 975 |
| 6-#7 | 1.41 | 980 | 667 | 1400 | 557 | 1633 | 454 | 1729 | 374 | 1746 | 244 | 1769 | 98 | 1279 |
| 6-#8 | 1.86 | 1006 | 700 | 1482 | 576 | 1732 | 467 | 1846 | 382 | 1892 | 239 | 1932 | 67 | 1624 |
| 6-#9 | 2.36 | 1035 | 736 | 1571 | 597 | 1839 | 481 | 1974 | 392 | 2049 | 233 | 2105 | 32 | 1989 |
| 6-#10 | 2.99 | 1070 | 783 | 1683 | 624 | 1975 | 500 | 2136 | 404 | 2246 | 225 | 2322 | -15 | 2324 |
| 6-#11 | 3.68 | 1102 | 834 | 1799 | 648 | 2106 | 516 | 2267 | 409 | 2408 | 209 | 2476 | -77 | 2487 |
| 6-#14 | 5.31 | 1185 | 954 | 2064 | 718 | 2430 | 564 | 2627 | 434 | 2861 | 183 | 2951 | -208 | 2956 |
| 7-#6 | 1.21 | 975 | 652 | 1261 | 581 | 1533 | 480 | 1649 | 396 | 1682 | 271 | 1780 | 139 | 1124 |
| 7-#7 | 1.65 | 1005 | 684 | 1341 | 601 | 1625 | 494 | 1756 | 405 | 1820 | 268 | 1952 | 113 | 1446 |
| 7-#8 | 2.17 | 1039 | 723 | 1433 | 625 | 1734 | 512 | 1881 | 416 | 1982 | 265 | 2152 | 83 | 1811 |
| 7-#9 | 2.75 | 1076 | 765 | 1532 | 652 | 1851 | 532 | 2016 | 428 | 2157 | 262 | 2364 | 48 | 2197 |
| 7-#10 | 3.49 | 1121 | 820 | 1656 | 686 | 1998 | 558 | 2187 | 444 | 2378 | 258 | 2628 | 2 | 2623 |
| 7-#11 | 4.29 | 1156 | 879 | 1787 | 717 | 2139 | 579 | 2340 | 453 | 2566 | 245 | 2820 | -61 | 2833 |
| 7-#14 | 6.19 | 1270 | 1019 | 2079 | 805 | 2481 | 642 | 2739 | 496 | 3070 | 227 | 3403 | -192 | 3416 |
| 8-#6 | 1.38 | 988 | 664 | 1264 | 599 | 1561 | 494 | 1687 | 407 | 1739 | 277 | 1864 | 132 | 1247 |
| 8-#7 | 1.89 | 1021 | 702 | 1353 | 623 | 1667 | 512 | 1808 | 418 | 1895 | 275 | 2060 | 103 | 1625 |
| 8-#8 | 2.48 | 1059 | 746 | 1456 | 652 | 1789 | 533 | 1949 | 431 | 2077 | 273 | 2287 | 68 | 2055 |
| 8-#9 | 3.14 | 1099 | 794 | 1567 | 684 | 1921 | 556 | 2102 | 445 | 2274 | 270 | 2529 | 27 | 2449 |
| 8-#10 | 3.99 | 1150 | 857 | 1707 | 725 | 2087 | 586 | 2294 | 464 | 2522 | 266 | 2831 | -26 | 2831 |
| 8-#11 | 4.90 | 1191 | 924 | 1855 | 764 | 2241 | 611 | 2466 | 476 | 2739 | 255 | 3052 | -99 | 3053 |
| 8-#14 | 7.07 | 1310 | 1084 | 2187 | 869 | 2626 | 684 | 2915 | 519 | 3317 | 239 | 3792 | -234 | 3692 |
| 9-#10 | 4.49 | 1188 | 894 | 1805 | 743 | 2187 | 600 | 2423 | 473 | 2689 | 259 | 3052 | -48 | 3036 |
| 9-#11 | 5.52 | 1235 | 969 | 1964 | 785 | 2363 | 629 | 2623 | 488 | 2934 | 245 | 3306 | -126 | 3287 |
| 10-#10 | 4.99 | 1227 | 931 | 1922 | 758 | 2315 | 603 | 2560 | 468 | 2876 | 246 | 3216 | -89 | 3212 |
| 10-#11 | 6.13 | 1290 | 1015 | 2094 | 805 | 2510 | 634 | 2785 | 493 | 3141 | 227 | 3497 | -179 | 3448 |
| 11-#10 | 5.49 | 1258 | 967 | 1953 | 797 | 2386 | 642 | 2657 | 500 | 3002 | 259 | 3449 | -103 | 3437 |
| 11-#11 | 6.74 | 1322 | 1060 | 2142 | 851 | 2597 | 679 | 2899 | 520 | 3308 | 247 | 3761 | -198 | 3727 |
| 12-#10 | 5.99 | 1310 | 1004 | 2033 | 822 | 2470 | 663 | 2775 | 517 | 3152 | 265 | 3661 | -126 | 3640 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 20" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.01 | 1299 | 786 | 1616 | 717 | 2006 | 592 | 2171 | 491 | 2220 | 344 | 2354 | 185 | 1370 |
| 4-#9 | 1.27 | 1318 | 810 | 1682 | 731 | 2082 | 601 | 2258 | 496 | 2333 | 343 | 2496 | 163 | 1692 |
| 4-#10 | 1.62 | 1342 | 842 | 1764 | 749 | 2177 | 614 | 2367 | 504 | 2476 | 341 | 2674 | 135 | 2091 |
| 4-#11 | 1.99 | 1361 | 875 | 1863 | 763 | 2276 | 622 | 2474 | 507 | 2608 | 334 | 2808 | 96 | 2477 |
| 4-#14 | 2.86 | 1415 | 955 | 2056 | 810 | 2502 | 655 | 2738 | 525 | 2956 | 328 | 3214 | 17 | 3175 |
| 4-#18 | 5.09 | 1547 | 1158 | 2510 | 930 | 3043 | 739 | 3374 | 573 | 3794 | 311 | 4144 | -198 | 4073 |
| 5-#8 | 1.26 | 1352 | 809 | 1759 | 719 | 2131 | 591 | 2289 | 487 | 2347 | 332 | 2491 | 169 | 1587 |
| 5-#9 | 1.59 | 1384 | 839 | 1845 | 738 | 2230 | 604 | 2404 | 495 | 2495 | 329 | 2674 | 145 | 1933 |
| 5-#10 | 2.02 | 1424 | 878 | 1952 | 762 | 2355 | 621 | 2548 | 505 | 2684 | 326 | 2904 | 114 | 2362 |
| 5-#11 | 2.48 | 1456 | 920 | 2070 | 782 | 2479 | 634 | 2684 | 510 | 2854 | 317 | 3079 | 71 | 2781 |
| 5-#14 | 3.58 | 1547 | 1020 | 2320 | 844 | 2774 | 677 | 3029 | 541 | 3296 | 306 | 3599 | -16 | 3603 |
| 5-#18 | 6.37 | 1772 | 1274 | 2910 | 1000 | 3477 | 786 | 3854 | 607 | 4325 | 268 | 4779 | -257 | 4723 |
| 6-#7 | 1.15 | 1328 | 799 | 1834 | 682 | 2158 | 558 | 2287 | 462 | 2308 | 312 | 2347 | 153 | 1472 |
| 6-#8 | 1.51 | 1361 | 832 | 1930 | 700 | 2273 | 571 | 2423 | 471 | 2481 | 308 | 2545 | 124 | 1876 |
| 6-#9 | 1.91 | 1395 | 868 | 2034 | 721 | 2398 | 586 | 2571 | 480 | 2668 | 303 | 2757 | 91 | 2305 |
| 6-#10 | 2.43 | 1438 | 915 | 2165 | 749 | 2556 | 605 | 2759 | 492 | 2904 | 296 | 3022 | 48 | 2837 |
| 6-#11 | 2.98 | 1473 | 966 | 2304 | 773 | 2713 | 620 | 2938 | 501 | 3105 | 282 | 3225 | -10 | 3226 |
| 6-#14 | 4.30 | 1580 | 1086 | 2616 | 843 | 3093 | 669 | 3383 | 531 | 3654 | 261 | 3823 | -131 | 3820 |
| 6-#18 | 7.64 | 1824 | 1390 | 3360 | 1021 | 4009 | 792 | 4404 | 597 | 4941 | 197 | 5177 | -460 | 5105 |
| 7-#7 | 1.34 | 1359 | 816 | 1738 | 734 | 2136 | 606 | 2318 | 501 | 2393 | 340 | 2578 | 172 | 1688 |
| 7-#8 | 1.76 | 1400 | 855 | 1846 | 758 | 2262 | 624 | 2465 | 512 | 2582 | 338 | 2819 | 143 | 2118 |
| 7-#9 | 2.23 | 1444 | 897 | 1962 | 785 | 2399 | 644 | 2624 | 525 | 2787 | 336 | 3077 | 111 | 2572 |
| 7-#10 | 2.83 | 1501 | 952 | 2107 | 819 | 2571 | 670 | 2825 | 541 | 3047 | 332 | 3402 | 68 | 3135 |
| 7-#11 | 3.48 | 1545 | 1011 | 2265 | 850 | 2743 | 692 | 3011 | 551 | 3281 | 322 | 3653 | 11 | 3614 |
| 7-#14 | 5.01 | 1674 | 1151 | 2610 | 939 | 3155 | 758 | 3487 | 590 | 3899 | 310 | 4385 | -109 | 4387 |
| 8-#7 | 1.53 | 1378 | 833 | 1744 | 757 | 2182 | 625 | 2378 | 515 | 2481 | 349 | 2709 | 164 | 1882 |
| 8-#8 | 2.01 | 1423 | 878 | 1863 | 785 | 2327 | 647 | 2544 | 529 | 2694 | 347 | 2983 | 131 | 2386 |
| 8-#9 | 2.55 | 1472 | 926 | 1993 | 818 | 2484 | 671 | 2723 | 544 | 2925 | 346 | 3278 | 93 | 2922 |
| 8-#10 | 3.23 | 1533 | 989 | 2156 | 859 | 2680 | 702 | 2950 | 563 | 3218 | 344 | 3647 | 44 | 3502 |
| 8-#11 | 3.97 | 1584 | 1056 | 2334 | 898 | 2868 | 727 | 3159 | 576 | 3481 | 334 | 3935 | -22 | 3935 |
| 8-#14 | 5.73 | 1726 | 1216 | 2723 | 1004 | 3329 | 804 | 3696 | 623 | 4176 | 324 | 4770 | -161 | 4740 |
| 9-#10 | 3.64 | 1576 | 1026 | 2277 | 877 | 2791 | 714 | 3093 | 571 | 3415 | 336 | 3889 | 19 | 3823 |
| 9-#11 | 4.47 | 1638 | 1101 | 2472 | 921 | 3004 | 744 | 3335 | 587 | 3713 | 325 | 4245 | -49 | 4219 |
| 9-#14 | 6.45 | 1805 | 1281 | 2905 | 1038 | 3524 | 830 | 3950 | 641 | 4503 | 311 | 5200 | -199 | 5112 |
| 10-#10 | 4.04 | 1624 | 1062 | 2427 | 891 | 2946 | 716 | 3256 | 565 | 3623 | 322 | 4107 | -16 | 4106 |
| 10-#11 | 4.97 | 1691 | 1147 | 2635 | 939 | 3183 | 748 | 3526 | 582 | 3973 | 309 | 4475 | -98 | 4465 |
| 10-#14 | 7.16 | 1891 | 1347 | 3117 | 1068 | 3766 | 840 | 4216 | 649 | 4864 | 290 | 5528 | -270 | 5390 |
| 11-#10 | 4.45 | 1661 | 1099 | 2447 | 932 | 3018 | 756 | 3368 | 600 | 3784 | 339 | 4392 | -28 | 4389 |
| 11-#11 | 5.46 | 1735 | 1192 | 2675 | 987 | 3279 | 796 | 3660 | 622 | 4148 | 326 | 4801 | -115 | 4781 |
| 12-#10 | 4.85 | 1716 | 1136 | 2538 | 958 | 3116 | 779 | 3497 | 617 | 3961 | 346 | 4648 | -47 | 4637 |
| 12-#11 | 5.96 | 1806 | 1237 | 2786 | 1018 | 3396 | 822 | 3821 | 642 | 4357 | 333 | 5097 | -142 | 5062 |
| 13-#10 | 5.26 | 1746 | 1173 | 2636 | 983 | 3251 | 794 | 3643 | 629 | 4145 | 340 | 4872 | -80 | 4848 |
| 14-#10 | 5.66 | 1792 | 1210 | 2766 | 998 | 3390 | 807 | 3811 | 632 | 4342 | 330 | 5084 | -111 | 5050 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 22" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.05 | 1740 | 956 | 2135 | 879 | 2679 | 726 | 2916 | 602 | 3004 | 423 | 3226 | 228 | 1916 |
| 4-#10 | 1.34 | 1770 | 987 | 2230 | 897 | 2788 | 739 | 3042 | 610 | 3168 | 421 | 3436 | 201 | 2376 |
| 4-#11 | 1.64 | 1793 | 1021 | 2347 | 911 | 2905 | 747 | 3166 | 613 | 3320 | 414 | 3602 | 165 | 2830 |
| 4-#14 | 2.37 | 1859 | 1101 | 2571 | 958 | 3166 | 780 | 3469 | 632 | 3719 | 410 | 4089 | 91 | 3843 |
| 4-#18 | 4.21 | 2016 | 1304 | 3100 | 1080 | 3793 | 866 | 4205 | 681 | 4692 | 396 | 5224 | -108 | 5174 |
| 5-#8 | 1.04 | 1777 | 955 | 2239 | 864 | 2745 | 713 | 2957 | 590 | 3020 | 410 | 3214 | 231 | 1814 |
| 5-#9 | 1.32 | 1815 | 985 | 2339 | 883 | 2859 | 726 | 3088 | 598 | 3190 | 407 | 3431 | 209 | 2212 |
| 5-#10 | 1.67 | 1863 | 1024 | 2463 | 908 | 3003 | 743 | 3254 | 609 | 3405 | 405 | 3703 | 180 | 2706 |
| 5-#11 | 2.05 | 1903 | 1066 | 2603 | 927 | 3149 | 756 | 3413 | 614 | 3604 | 396 | 3920 | 140 | 3195 |
| 5-#14 | 2.96 | 2011 | 1166 | 2895 | 990 | 3492 | 800 | 3812 | 640 | 4125 | 388 | 4547 | 58 | 4320 |
| 5-#18 | 5.26 | 2265 | 1420 | 3586 | 1148 | 4313 | 912 | 4774 | 716 | 5368 | 361 | 5998 | -164 | 5989 |
| 6-#8 | 1.25 | 1789 | 978 | 2459 | 839 | 2916 | 687 | 3109 | 568 | 3178 | 383 | 3266 | 184 | 2128 |
| 6-#9 | 1.58 | 1829 | 1014 | 2578 | 860 | 3059 | 701 | 3278 | 578 | 3395 | 379 | 3516 | 153 | 2622 |
| 6-#10 | 2.00 | 1880 | 1061 | 2728 | 887 | 3240 | 720 | 3492 | 590 | 3669 | 373 | 3831 | 112 | 3235 |
| 6-#11 | 2.46 | 1923 | 1111 | 2891 | 911 | 3422 | 736 | 3699 | 599 | 3910 | 361 | 4084 | 58 | 3840 |
| 6-#14 | 3.55 | 2040 | 1231 | 3250 | 981 | 3859 | 785 | 4220 | 631 | 4558 | 343 | 4807 | -54 | 4804 |
| 6-#18 | 6.31 | 2338 | 1536 | 4113 | 1161 | 4919 | 910 | 5469 | 709 | 6091 | 290 | 6475 | -360 | 6382 |
| 7-#7 | 1.10 | 1787 | 962 | 2205 | 881 | 2744 | 729 | 2985 | 606 | 3076 | 420 | 3317 | 235 | 1937 |
| 7-#8 | 1.45 | 1836 | 1000 | 2328 | 905 | 2887 | 747 | 3153 | 617 | 3292 | 418 | 3600 | 208 | 2431 |
| 7-#9 | 1.84 | 1888 | 1043 | 2461 | 932 | 3044 | 768 | 3336 | 630 | 3527 | 417 | 3905 | 178 | 2957 |
| 7-#10 | 2.34 | 1953 | 1098 | 2629 | 967 | 3241 | 794 | 3569 | 647 | 3826 | 414 | 4289 | 138 | 3606 |
| 7-#11 | 2.87 | 2010 | 1157 | 2814 | 998 | 3442 | 816 | 3791 | 659 | 4100 | 405 | 4601 | 84 | 4244 |
| 7-#14 | 4.14 | 2162 | 1297 | 3213 | 1087 | 3917 | 883 | 4344 | 700 | 4817 | 396 | 5485 | -27 | 5485 |
| 7-#18 | 7.37 | 2532 | 1652 | 4169 | 1313 | 5064 | 1052 | 5670 | 801 | 6543 | 367 | 7525 | -331 | 7420 |
| 8-#7 | 1.26 | 1807 | 979 | 2201 | 905 | 2789 | 750 | 3056 | 622 | 3178 | 430 | 3472 | 229 | 2143 |
| 8-#8 | 1.66 | 1862 | 1023 | 2338 | 934 | 2954 | 772 | 3246 | 637 | 3421 | 429 | 3795 | 198 | 2721 |
| 8-#9 | 2.10 | 1920 | 1072 | 2486 | 966 | 3133 | 796 | 3453 | 652 | 3687 | 428 | 4142 | 163 | 3339 |
| 8-#10 | 2.67 | 1991 | 1135 | 2673 | 1008 | 3361 | 828 | 3714 | 672 | 4023 | 427 | 4579 | 117 | 4109 |
| 8-#11 | 3.28 | 2053 | 1202 | 2880 | 1046 | 3592 | 855 | 3961 | 686 | 4333 | 419 | 4936 | 55 | 4739 |
| 8-#14 | 4.74 | 2220 | 1362 | 3328 | 1153 | 4130 | 934 | 4585 | 736 | 5140 | 412 | 5942 | -73 | 5924 |
| 9-#10 | 3.01 | 2042 | 1171 | 2816 | 1025 | 3493 | 840 | 3870 | 678 | 4250 | 420 | 4862 | 92 | 4464 |
| 9-#11 | 3.69 | 2113 | 1247 | 3044 | 1069 | 3743 | 870 | 4154 | 696 | 4602 | 410 | 5269 | 24 | 5177 |
| 9-#14 | 5.33 | 2312 | 1427 | 3548 | 1187 | 4343 | 958 | 4863 | 752 | 5520 | 401 | 6454 | -110 | 6384 |
| 10-#10 | 3.34 | 2096 | 1208 | 3004 | 1038 | 3677 | 840 | 4060 | 671 | 4476 | 403 | 5114 | 59 | 4888 |
| 10-#11 | 4.10 | 2176 | 1292 | 3250 | 1086 | 3954 | 873 | 4377 | 689 | 4884 | 392 | 5569 | -17 | 5567 |
| 10-#14 | 5.92 | 2394 | 1492 | 3809 | 1217 | 4630 | 967 | 5174 | 746 | 5935 | 379 | 6840 | -177 | 6696 |
| 11-#10 | 3.68 | 2140 | 1245 | 3010 | 1081 | 3747 | 883 | 4187 | 709 | 4663 | 423 | 5452 | 49 | 5243 |
| 11-#11 | 4.51 | 2228 | 1338 | 3277 | 1136 | 4051 | 922 | 4530 | 732 | 5103 | 414 | 5959 | -33 | 5953 |
| 11-#14 | 6.51 | 2476 | 1558 | 3879 | 1283 | 4784 | 1033 | 5391 | 802 | 6228 | 404 | 7366 | -203 | 7222 |
| 12-#10 | 4.01 | 2203 | 1282 | 3111 | 1109 | 3856 | 906 | 4327 | 726 | 4881 | 434 | 5752 | 32 | 5629 |
| 12-#11 | 4.92 | 2303 | 1383 | 3401 | 1169 | 4183 | 950 | 4704 | 752 | 5349 | 423 | 6308 | -56 | 6291 |
| 13-#10 | 4.34 | 2240 | 1319 | 3221 | 1133 | 4013 | 922 | 4496 | 738 | 5079 | 426 | 6015 | 0 | 6015 |
| 13-#11 | 5.33 | 2346 | 1428 | 3533 | 1199 | 4368 | 969 | 4903 | 767 | 5596 | 415 | 6616 | -96 | 6579 |
| 14-#10 | 4.68 | 2293 | 1356 | 3376 | 1147 | 4170 | 933 | 4693 | 741 | 5306 | 416 | 6263 | -29 | 6252 |
| 14-#11 | 5.75 | 2408 | 1473 | 3710 | 1217 | 4556 | 984 | 5135 | 771 | 5865 | 404 | 6908 | -133 | 6856 |
| 15-#10 | 5.01 | 2327 | 1392 | 3424 | 1188 | 4270 | 964 | 4811 | 768 | 5507 | 433 | 6602 | -45 | 6555 |
| 16-#10 | 5.35 | 2374 | 1429 | 3513 | 1216 | 4393 | 991 | 4960 | 783 | 5699 | 435 | 6871 | -66 | 6838 |

## ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway $f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.12 | 2278 | 1147 | 2769 | 1060 | 3504 | 876 | 3834 | 727 | 3979 | 509 | 4324 | 272 | 2660 |
| 4-#11 | 1.38 | 2306 | 1181 | 2905 | 1074 | 3639 | 884 | 3976 | 729 | 4152 | 502 | 4522 | 237 | 3180 |
| 4-#14 | 1.99 | 2384 | 1261 | 3160 | 1121 | 3935 | 918 | 4319 | 749 | 4602 | 498 | 5091 | 168 | 4389 |
| 4-#18 | 3.54 | 2569 | 1464 | 3766 | 1243 | 4649 | 1004 | 5155 | 800 | 5705 | 487 | 6433 | -18 | 6423 |
| 5-#9 | 1.11 | 2328 | 1145 | 2909 | 1042 | 3596 | 860 | 3891 | 712 | 4004 | 493 | 4311 | 277 | 2495 |
| 5-#10 | 1.40 | 2383 | 1184 | 3050 | 1067 | 3758 | 877 | 4079 | 723 | 4247 | 491 | 4626 | 249 | 3055 |
| 5-#11 | 1.72 | 2431 | 1226 | 3216 | 1087 | 3927 | 890 | 4262 | 728 | 4474 | 483 | 4885 | 211 | 3616 |
| 5-#14 | 2.49 | 2556 | 1326 | 3550 | 1150 | 4318 | 935 | 4716 | 755 | 5065 | 476 | 5621 | 135 | 4928 |
| 5-#18 | 4.42 | 2851 | 1580 | 4344 | 1310 | 5258 | 1049 | 5815 | 823 | 6504 | 455 | 7345 | -72 | 7338 |
| 6-#8 | 1.05 | 2298 | 1137 | 3075 | 991 | 3672 | 814 | 3916 | 672 | 3989 | 465 | 4106 | 248 | 2380 |
| 6-#9 | 1.33 | 2345 | 1174 | 3210 | 1012 | 3833 | 828 | 4105 | 680 | 4240 | 461 | 4395 | 219 | 2939 |
| 6-#10 | 1.68 | 2404 | 1221 | 3379 | 1039 | 4036 | 847 | 4346 | 691 | 4553 | 457 | 4760 | 180 | 3635 |
| 6-#11 | 2.07 | 2455 | 1271 | 3567 | 1063 | 4244 | 863 | 4582 | 707 | 4834 | 445 | 5063 | 129 | 4329 |
| 6-#14 | 2.98 | 2591 | 1391 | 3974 | 1133 | 4739 | 912 | 5170 | 739 | 5580 | 430 | 5912 | 23 | 5830 |
| 6-#18 | 5.31 | 2938 | 1696 | 4956 | 1314 | 5941 | 1038 | 6605 | 821 | 7362 | 386 | 7898 | -264 | 7807 |
| 7-#8 | 1.22 | 2352 | 1160 | 2886 | 1066 | 3619 | 883 | 3959 | 733 | 4122 | 506 | 4507 | 277 | 2752 |
| 7-#9 | 1.55 | 2413 | 1203 | 3037 | 1093 | 3795 | 903 | 4165 | 746 | 4387 | 505 | 4859 | 249 | 3349 |
| 7-#10 | 1.97 | 2489 | 1258 | 3226 | 1128 | 4017 | 930 | 4427 | 763 | 4725 | 503 | 5303 | 211 | 4088 |
| 7-#11 | 2.41 | 2554 | 1316 | 3440 | 1159 | 4248 | 952 | 4685 | 776 | 5040 | 495 | 5676 | 160 | 4820 |
| 7-#14 | 3.48 | 2734 | 1456 | 3894 | 1249 | 4786 | 1019 | 5321 | 819 | 5856 | 488 | 6712 | 56 | 6463 |
| 7-#18 | 6.19 | 3162 | 1811 | 4983 | 1477 | 6091 | 1191 | 6843 | 925 | 7833 | 466 | 9138 | -227 | 9055 |
| 8-#8 | 1.40 | 2381 | 1183 | 2884 | 1097 | 3685 | 909 | 4067 | 755 | 4269 | 519 | 4722 | 268 | 3060 |
| 8-#9 | 1.77 | 2448 | 1232 | 3051 | 1129 | 3887 | 934 | 4300 | 771 | 4569 | 518 | 5126 | 236 | 3759 |
| 8-#10 | 2.25 | 2532 | 1294 | 3262 | 1171 | 4142 | 965 | 4596 | 791 | 4949 | 518 | 5638 | 193 | 4631 |
| 8-#11 | 2.76 | 2604 | 1362 | 3500 | 1209 | 4409 | 993 | 4882 | 806 | 5305 | 511 | 6065 | 135 | 5497 |
| 8-#14 | 3.98 | 2797 | 1522 | 4007 | 1316 | 5030 | 1075 | 5594 | 857 | 6225 | 507 | 7244 | 15 | 7188 |
| 8-#18 | 7.07 | 3263 | 1927 | 5231 | 1590 | 6511 | 1277 | 7310 | 983 | 8449 | 491 | 10006 | -313 | 9826 |
| 9-#10 | 2.53 | 2591 | 1331 | 3430 | 1188 | 4300 | 977 | 4767 | 796 | 5200 | 510 | 5962 | 168 | 5069 |
| 9-#11 | 3.10 | 2673 | 1407 | 3692 | 1231 | 4587 | 1008 | 5091 | 814 | 5612 | 502 | 6448 | 104 | 5965 |
| 9-#14 | 4.48 | 2897 | 1587 | 4263 | 1350 | 5269 | 1097 | 5896 | 871 | 6659 | 496 | 7786 | -29 | 7779 |
| 9-#18 | 7.96 | 3454 | 2043 | 5641 | 1654 | 6918 | 1323 | 7848 | 1014 | 9188 | 472 | 11001 | -376 | 10628 |
| 10-#10 | 2.81 | 2651 | 1368 | 3657 | 1198 | 4515 | 975 | 4984 | 787 | 5449 | 491 | 6245 | 136 | 5599 |
| 10-#11 | 3.45 | 2745 | 1452 | 3945 | 1247 | 4834 | 1009 | 5347 | 806 | 5915 | 481 | 6790 | 64 | 6523 |
| 10-#14 | 4.97 | 2994 | 1652 | 4582 | 1379 | 5602 | 1104 | 6253 | 865 | 7107 | 471 | 8280 | -85 | 8149 |
| 11-#10 | 3.09 | 2702 | 1405 | 3647 | 1245 | 4581 | 1021 | 5122 | 828 | 5663 | 514 | 6640 | 128 | 6015 |
| 11-#11 | 3.79 | 2805 | 1497 | 3954 | 1300 | 4929 | 1061 | 5518 | 852 | 6166 | 506 | 7245 | 51 | 7005 |
| 11-#14 | 5.47 | 3081 | 1717 | 4637 | 1448 | 5759 | 1173 | 6498 | 924 | 7451 | 501 | 8896 | -109 | 8845 |
| 12-#10 | 3.37 | 2772 | 1442 | 3756 | 1274 | 4702 | 1046 | 5275 | 845 | 5907 | 525 | 6984 | 113 | 6490 |
| 12-#11 | 4.14 | 2888 | 1542 | 4090 | 1334 | 5076 | 1090 | 5705 | 872 | 6462 | 519 | 7648 | 31 | 7518 |
| 12-#14 | 5.97 | 3206 | 1783 | 4840 | 1494 | 5972 | 1212 | 6771 | 953 | 7853 | 516 | 9456 | -141 | 9370 |
| 13-#10 | 3.65 | 2813 | 1478 | 3881 | 1297 | 4881 | 1061 | 5467 | 858 | 6135 | 519 | 7287 | 82 | 6896 |
| 13-#11 | 4.48 | 2941 | 1588 | 4238 | 1363 | 5288 | 1109 | 5933 | 887 | 6727 | 510 | 8005 | -8 | 8002 |
| 13-#14 | 6.47 | 3274 | 1848 | 5045 | 1539 | 6267 | 1241 | 7090 | 975 | 8240 | 504 | 9955 | -197 | 9805 |
| 14-#10 | 3.93 | 2878 | 1515 | 4062 | 1310 | 5057 | 1070 | 5685 | 859 | 6390 | 509 | 7569 | 54 | 7332 |
| 14-#11 | 4.83 | 3012 | 1633 | 4445 | 1380 | 5497 | 1122 | 6198 | 891 | 7032 | 498 | 8340 | -43 | 8321 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway $f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 15-#10 | 4.21 | 2915 | 1552 | 4105 | 1353 | 5165 | 1103 | 5824 | 888 | 6605 | 522 | 7934 | 35 | 7771 |
| 15-#11 | 5.17 | 3057 | 1678 | 4511 | 1431 | 5632 | 1161 | 6357 | 924 | 7302 | 518 | 8797 | -62 | 8724 |
| 16-#10 | 4.49 | 2969 | 1589 | 4203 | 1381 | 5298 | 1130 | 5992 | 905 | 6826 | 528 | 8270 | 21 | 8179 |
| 16-#11 | 5.52 | 3122 | 1723 | 4630 | 1465 | 5797 | 1194 | 6559 | 943 | 7559 | 520 | 9160 | -88 | 9106 |
| 17-#10 | 4.77 | 3023 | 1626 | 4347 | 1404 | 5458 | 1146 | 6170 | 917 | 7077 | 529 | 8604 | -7 | 8600 |
| 18-#10 | 5.05 | 3070 | 1662 | 4492 | 1424 | 5633 | 1161 | 6368 | 921 | 7336 | 521 | 8875 | -35 | 8852 |

## ROUND TIED COLUMNS 26" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.18 | 2907 | 1354 | 3543 | 1251 | 4487 | 1033 | 4915 | 856 | 5116 | 598 | 5578 | 314 | 3529 |
| 4-#14 | 1.70 | 2998 | 1434 | 3830 | 1298 | 4819 | 1067 | 5298 | 876 | 5617 | 594 | 6231 | 249 | 4896 |
| 4-#18 | 3.01 | 3212 | 1637 | 4512 | 1421 | 5621 | 1154 | 6234 | 928 | 6849 | 585 | 7783 | 73 | 7572 |
| 5-#10 | 1.20 | 2991 | 1357 | 3722 | 1240 | 4631 | 1023 | 5034 | 847 | 5219 | 584 | 5654 | 319 | 3411 |
| 5-#11 | 1.47 | 3047 | 1399 | 3912 | 1260 | 4823 | 1036 | 5241 | 853 | 5474 | 576 | 5986 | 287 | 4043 |
| 5-#14 | 2.12 | 3191 | 1499 | 4291 | 1323 | 5262 | 1081 | 5750 | 880 | 6136 | 570 | 6831 | 215 | 5520 |
| 5-#18 | 3.77 | 3530 | 1753 | 5189 | 1485 | 6322 | 1197 | 6986 | 950 | 7752 | 553 | 8831 | 20 | 8743 |
| 6-#9 | 1.13 | 2949 | 1347 | 3937 | 1178 | 4728 | 967 | 5065 | 798 | 5197 | 549 | 5404 | 289 | 3257 |
| 6-#10 | 1.44 | 3016 | 1394 | 4126 | 1205 | 4954 | 986 | 5332 | 809 | 5552 | 546 | 5819 | 253 | 4035 |
| 6-#11 | 1.76 | 3075 | 1445 | 4339 | 1228 | 5189 | 1001 | 5597 | 815 | 5887 | 536 | 6172 | 204 | 4819 |
| 6-#14 | 2.54 | 3232 | 1565 | 4795 | 1299 | 5741 | 1051 | 6252 | 856 | 6732 | 524 | 7149 | 103 | 6652 |
| 6-#18 | 4.52 | 3604 | 1869 | 5897 | 1480 | 7087 | 1178 | 7857 | 940 | 8765 | 486 | 9456 | -169 | 9386 |
| 7-#9 | 1.32 | 3026 | 1376 | 3694 | 1269 | 4661 | 1052 | 5123 | 872 | 5378 | 600 | 5948 | 324 | 3751 |
| 7-#10 | 1.67 | 3113 | 1431 | 3905 | 1304 | 4908 | 1078 | 5414 | 889 | 5755 | 599 | 6454 | 289 | 4583 |
| 7-#11 | 2.06 | 3189 | 1490 | 4149 | 1335 | 5169 | 1100 | 5705 | 902 | 6111 | 591 | 6888 | 240 | 5408 |
| 7-#14 | 2.97 | 3391 | 1630 | 4657 | 1425 | 5771 | 1168 | 6416 | 946 | 7027 | 586 | 8078 | 142 | 7358 |
| 7-#18 | 5.27 | 3884 | 1985 | 5883 | 1654 | 7235 | 1341 | 8147 | 1057 | 9256 | 570 | 10893 | -125 | 10839 |
| 8-#9 | 1.51 | 3064 | 1405 | 3695 | 1308 | 4753 | 1084 | 5277 | 899 | 5583 | 616 | 6234 | 312 | 4184 |
| 8-#10 | 1.91 | 3160 | 1468 | 3929 | 1349 | 5037 | 1115 | 5608 | 921 | 6007 | 616 | 6810 | 271 | 5160 |
| 8-#11 | 2.35 | 3245 | 1535 | 4200 | 1387 | 5337 | 1143 | 5932 | 936 | 6409 | 610 | 7332 | 218 | 6137 |
| 8-#14 | 3.39 | 3466 | 1695 | 4766 | 1494 | 6029 | 1224 | 6733 | 989 | 7442 | 608 | 8686 | 105 | 8245 |
| 8-#18 | 6.03 | 3993 | 2101 | 6137 | 1768 | 7720 | 1433 | 8672 | 1119 | 9951 | 599 | 11888 | -203 | 11749 |
| 9-#10 | 2.15 | 3228 | 1505 | 4124 | 1365 | 5222 | 1127 | 5793 | 924 | 6277 | 607 | 7195 | 248 | 5688 |
| 9-#11 | 2.64 | 3324 | 1580 | 4421 | 1408 | 5547 | 1158 | 6159 | 942 | 6743 | 600 | 7767 | 187 | 6708 |
| 9-#14 | 3.81 | 3579 | 1760 | 5059 | 1527 | 6311 | 1248 | 7058 | 1001 | 7929 | 597 | 9303 | 61 | 9000 |
| 9-#18 | 6.78 | 4209 | 2217 | 6605 | 1832 | 8165 | 1477 | 9252 | 1148 | 10788 | 582 | 12933 | -280 | 12721 |
| 10-#10 | 2.39 | 3295 | 1542 | 4391 | 1372 | 5471 | 1123 | 6039 | 913 | 6552 | 587 | 7453 | 206 | 6254 |
| 10-#11 | 2.94 | 3404 | 1626 | 4720 | 1421 | 5832 | 1156 | 6448 | 932 | 7076 | 577 | 8147 | 148 | 7418 |
| 10-#14 | 4.24 | 3687 | 1826 | 5441 | 1555 | 6693 | 1253 | 7462 | 992 | 8409 | 569 | 9859 | 7 | 9828 |
| 10-#18 | 7.53 | 4371 | 2333 | 7166 | 1892 | 8782 | 1497 | 9930 | 1143 | 11663 | 543 | 13903 | -376 | 13414 |
| 11-#10 | 2.63 | 3352 | 1578 | 4384 | 1420 | 5539 | 1168 | 6182 | 956 | 6794 | 613 | 7955 | 209 | 6754 |
| 11-#11 | 3.23 | 3473 | 1671 | 4711 | 1478 | 5921 | 1211 | 6631 | 981 | 7361 | 605 | 8671 | 138 | 7952 |
| 11-#14 | 4.66 | 3786 | 1891 | 5476 | 1627 | 6849 | 1324 | 7734 | 1056 | 8799 | 603 | 10567 | -13 | 10561 |
| 12-#10 | 2.87 | 3431 | 1615 | 4481 | 1453 | 5661 | 1197 | 6351 | 975 | 7058 | 624 | 8330 | 196 | 7319 |
| 12-#11 | 3.53 | 3565 | 1716 | 4859 | 1513 | 6084 | 1242 | 6836 | 1002 | 7685 | 619 | 9128 | 120 | 8566 |
| 12-#14 | 5.09 | 3913 | 1956 | 5699 | 1675 | 7085 | 1365 | 8026 | 1084 | 9266 | 621 | 11204 | -42 | 11175 |
| 13-#10 | 3.11 | 3480 | 1652 | 4619 | 1475 | 5860 | 1212 | 6567 | 987 | 7322 | 618 | 8682 | 165 | 7795 |
| 13-#11 | 3.82 | 3622 | 1761 | 5023 | 1542 | 6322 | 1261 | 7091 | 1017 | 7990 | 611 | 9534 | 82 | 9113 |
| 13-#14 | 5.51 | 4001 | 2021 | 5925 | 1718 | 7418 | 1394 | 8385 | 1107 | 9686 | 609 | 11775 | -98 | 11700 |

## ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 3.35 | 3546 | 1689 | 4830 | 1487 | 6059 | 1220 | 6806 | 986 | 7606 | 608 | 9013 | 140 | 8330 |
| 14-#11 | 4.11 | 3708 | 1806 | 5263 | 1558 | 6555 | 1272 | 7381 | 1019 | 8331 | 599 | 9911 | 48 | 9686 |
| 14-#14 | 5.93 | 4126 | 2087 | 6241 | 1745 | 7741 | 1415 | 8799 | 1114 | 10173 | 594 | 12315 | -146 | 12199 |
| 15-#10 | 3.59 | 3594 | 1726 | 4866 | 1531 | 6175 | 1255 | 6959 | 1018 | 7837 | 622 | 9410 | 120 | 8787 |
| 15-#11 | 4.41 | 3757 | 1852 | 5323 | 1610 | 6701 | 1313 | 7567 | 1055 | 8615 | 615 | 10396 | 25 | 10277 |
| 16-#10 | 3.83 | 3655 | 1762 | 4971 | 1560 | 6316 | 1282 | 7153 | 1036 | 8084 | 629 | 9783 | 107 | 9273 |
| 16-#11 | 4.70 | 3830 | 1897 | 5454 | 1645 | 6877 | 1346 | 7792 | 1075 | 8910 | 623 | 10844 | 7 | 10812 |
| 17-#10 | 4.07 | 3712 | 1799 | 5134 | 1583 | 6497 | 1298 | 7345 | 1048 | 8358 | 627 | 10165 | 81 | 9753 |
| 17-#11 | 5.00 | 3900 | 1942 | 5645 | 1673 | 7091 | 1365 | 8029 | 1090 | 9246 | 623 | 11291 | -27 | 11269 |
| 18-#10 | 4.31 | 3767 | 1836 | 5298 | 1603 | 6700 | 1313 | 7567 | 1051 | 8644 | 620 | 10480 | 55 | 10219 |
| 18-#11 | 5.29 | 3963 | 1987 | 5837 | 1698 | 7324 | 1384 | 8292 | 1095 | 9590 | 613 | 11653 | -61 | 11605 |
| 19-#10 | 4.54 | 3835 | 1873 | 5380 | 1638 | 6817 | 1341 | 7738 | 1078 | 8888 | 634 | 10889 | 37 | 10711 |
| 20-#10 | 4.78 | 3885 | 1910 | 5483 | 1671 | 6962 | 1366 | 7919 | 1093 | 9142 | 638 | 11239 | 18 | 11152 |

## ROUND TIED COLUMNS 28" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.01 | 3604 | 1542 | 4265 | 1443 | 5458 | 1195 | 5993 | 994 | 6222 | 702 | 6751 | 394 | 3877 |
| 4-#14 | 1.46 | 3708 | 1622 | 4585 | 1490 | 5826 | 1229 | 6416 | 1014 | 6774 | 698 | 7504 | 333 | 5400 |
| 4-#18 | 2.60 | 3953 | 1825 | 5346 | 1613 | 6716 | 1316 | 7453 | 1067 | 8135 | 690 | 9282 | 167 | 8737 |
| 5-#10 | 1.03 | 3695 | 1545 | 4484 | 1428 | 5630 | 1182 | 6130 | 982 | 6332 | 685 | 6855 | 398 | 3772 |
| 5-#11 | 1.27 | 3759 | 1587 | 4698 | 1447 | 5846 | 1194 | 6362 | 987 | 6616 | 678 | 7193 | 362 | 4477 |
| 5-#14 | 1.83 | 3923 | 1687 | 5118 | 1511 | 6333 | 1239 | 6925 | 1015 | 7348 | 672 | 8187 | 299 | 6120 |
| 5-#18 | 3.25 | 4306 | 1941 | 6128 | 1674 | 7514 | 1356 | 8300 | 1086 | 9142 | 657 | 10466 | 114 | 9907 |
| 6-#10 | 1.24 | 3724 | 1582 | 4975 | 1385 | 6005 | 1136 | 6460 | 936 | 6684 | 641 | 7019 | 329 | 4436 |
| 6-#11 | 1.52 | 3792 | 1632 | 5215 | 1408 | 6266 | 1151 | 6754 | 942 | 7062 | 632 | 7422 | 282 | 5309 |
| 6-#14 | 2.19 | 3969 | 1752 | 5719 | 1478 | 6876 | 1200 | 7476 | 971 | 8024 | 623 | 8527 | 186 | 7352 |
| 6-#18 | 3.90 | 4389 | 2057 | 6942 | 1659 | 8367 | 1328 | 9251 | 1068 | 10308 | 591 | 11158 | -73 | 11124 |
| 7-#9 | 1.14 | 3735 | 1564 | 4438 | 1460 | 5651 | 1212 | 6221 | 1008 | 6512 | 703 | 7168 | 403 | 4161 |
| 7-#10 | 1.44 | 3833 | 1619 | 4673 | 1495 | 5924 | 1238 | 6541 | 1026 | 6927 | 703 | 7737 | 370 | 5085 |
| 7-#11 | 1.77 | 3920 | 1677 | 4947 | 1525 | 6216 | 1260 | 6864 | 1038 | 7324 | 695 | 8248 | 325 | 6008 |
| 7-#14 | 2.56 | 4149 | 1817 | 5510 | 1615 | 6881 | 1328 | 7649 | 1083 | 8339 | 692 | 9594 | 231 | 8181 |
| 7-#18 | 4.55 | 4706 | 2173 | 6872 | 1846 | 8505 | 1503 | 9574 | 1196 | 10821 | 680 | 12800 | -23 | 12789 |
| 8-#9 | 1.30 | 3776 | 1593 | 4423 | 1500 | 5742 | 1246 | 6388 | 1038 | 6739 | 721 | 7491 | 393 | 4613 |
| 8-#10 | 1.65 | 3884 | 1655 | 4681 | 1542 | 6054 | 1278 | 6758 | 1060 | 7208 | 722 | 8130 | 354 | 5695 |
| 8-#11 | 2.03 | 3983 | 1723 | 4984 | 1579 | 6388 | 1305 | 7121 | 1076 | 7656 | 716 | 8716 | 303 | 6784 |
| 8-#14 | 2.92 | 4232 | 1883 | 5610 | 1687 | 7152 | 1387 | 8011 | 1130 | 8802 | 716 | 10263 | 196 | 9350 |
| 8-#18 | 5.20 | 4824 | 2288 | 7129 | 1961 | 9022 | 1596 | 10174 | 1265 | 11598 | 712 | 13924 | -93 | 13852 |
| 9-#10 | 1.86 | 3961 | 1692 | 4905 | 1556 | 6265 | 1289 | 6958 | 1062 | 7496 | 711 | 8557 | 330 | 6320 |
| 9-#11 | 2.28 | 4071 | 1768 | 5238 | 1599 | 6631 | 1320 | 7366 | 1080 | 8014 | 705 | 9228 | 274 | 7461 |
| 9-#14 | 3.29 | 4359 | 1948 | 5944 | 1719 | 7477 | 1411 | 8361 | 1140 | 9324 | 704 | 10971 | 154 | 10140 |
| 9-#18 | 5.85 | 5066 | 2404 | 7658 | 2025 | 9539 | 1642 | 10796 | 1290 | 12531 | 696 | 15106 | -169 | 14972 |
| 10-#10 | 2.06 | 4036 | 1729 | 5216 | 1560 | 6553 | 1282 | 7234 | 1049 | 7797 | 689 | 8862 | 291 | 6918 |
| 10-#11 | 2.53 | 4160 | 1813 | 5583 | 1609 | 6957 | 1315 | 7690 | 1068 | 8379 | 681 | 9572 | 224 | 8218 |
| 10-#14 | 3.65 | 4478 | 2013 | 6380 | 1743 | 7911 | 1413 | 8812 | 1130 | 9854 | 674 | 11587 | 102 | 11098 |
| 10-#18 | 6.50 | 5242 | 2520 | 8315 | 2085 | 10235 | 1661 | 11555 | 1285 | 13465 | 654 | 16193 | -261 | 15741 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 11-#10 | 2.27 | 4099 | 1766 | 5187 | 1612 | 6611 | 1330 | 7382 | 1095 | 8068 | 718 | 9405 | 293 | 7511 |
| 11-#11 | 2.79 | 4235 | 1858 | 5582 | 1666 | 7037 | 1374 | 7881 | 1120 | 8698 | 712 | 10231 | 226 | 8862 |
| 11-#14 | 4.02 | 4589 | 2078 | 6440 | 1814 | 8063 | 1487 | 9099 | 1196 | 10290 | 711 | 12390 | 84 | 11934 |
| 11-#18 | 7.15 | 5441 | 2636 | 8459 | 2200 | 10569 | 1775 | 12079 | 1387 | 14186 | 704 | 17492 | -304 | 17010 |
| 12-#10 | 2.48 | 4187 | 1803 | 5289 | 1647 | 6743 | 1361 | 7567 | 1114 | 8352 | 730 | 9824 | 282 | 8109 |
| 12-#11 | 3.04 | 4339 | 1904 | 5713 | 1707 | 7214 | 1405 | 8105 | 1142 | 9047 | 725 | 10726 | 209 | 9617 |
| 12-#14 | 4.38 | 4728 | 2144 | 6643 | 1869 | 8322 | 1530 | 9420 | 1225 | 10791 | 729 | 13088 | 57 | 12820 |
| 13-#10 | 2.68 | 4243 | 1839 | 5444 | 1668 | 6960 | 1375 | 7806 | 1126 | 8646 | 725 | 10217 | 251 | 8673 |
| 13-#11 | 3.29 | 4404 | 1949 | 5895 | 1735 | 7476 | 1424 | 8390 | 1157 | 9395 | 719 | 11193 | 172 | 10223 |
| 13-#14 | 4.75 | 4822 | 2209 | 6892 | 1912 | 8692 | 1559 | 9820 | 1248 | 11276 | 719 | 13746 | 4 | 13727 |
| 14-#10 | 2.89 | 4317 | 1876 | 5686 | 1678 | 7185 | 1381 | 8066 | 1124 | 8965 | 714 | 10575 | 226 | 9272 |
| 14-#11 | 3.55 | 4493 | 1994 | 6170 | 1749 | 7737 | 1434 | 8705 | 1157 | 9773 | 706 | 11633 | 141 | 10896 |
| 14-#14 | 5.12 | 4969 | 2274 | 7252 | 1938 | 9047 | 1578 | 10269 | 1253 | 11815 | 704 | 14349 | -43 | 14312 |
| 15-#10 | 3.09 | 4368 | 1913 | 5711 | 1725 | 7307 | 1418 | 8233 | 1157 | 9212 | 729 | 11029 | 209 | 9807 |
| 15-#11 | 3.80 | 4555 | 2039 | 6221 | 1803 | 7892 | 1476 | 8908 | 1195 | 10077 | 723 | 12155 | 117 | 11511 |
| 15-#14 | 5.48 | 5041 | 2339 | 7362 | 2010 | 9283 | 1633 | 10561 | 1302 | 12250 | 726 | 15099 | -78 | 14990 |
| 16-#10 | 3.30 | 4439 | 1950 | 5824 | 1754 | 7458 | 1446 | 8452 | 1177 | 9485 | 737 | 11445 | 197 | 10406 |
| 16-#11 | 4.05 | 4636 | 2084 | 6362 | 1839 | 8080 | 1510 | 9165 | 1218 | 10403 | 732 | 12648 | 101 | 12135 |
| 16-#14 | 5.85 | 5159 | 2404 | 7571 | 2059 | 9560 | 1680 | 10919 | 1332 | 12711 | 736 | 15787 | -104 | 15643 |
| 17-#10 | 3.51 | 4501 | 1987 | 6006 | 1777 | 7658 | 1462 | 8660 | 1188 | 9788 | 735 | 11870 | 171 | 10906 |
| 17-#11 | 4.31 | 4710 | 2130 | 6576 | 1867 | 8318 | 1529 | 9419 | 1232 | 10766 | 728 | 13154 | 68 | 12781 |
| 18-#10 | 3.71 | 4563 | 2024 | 6190 | 1795 | 7886 | 1476 | 8906 | 1191 | 10094 | 727 | 12195 | 144 | 11454 |
| 18-#11 | 4.56 | 4784 | 2175 | 6791 | 1891 | 8586 | 1548 | 9712 | 1236 | 11144 | 721 | 13571 | 37 | 13387 |
| 19-#10 | 3.92 | 4638 | 2060 | 6274 | 1832 | 8011 | 1505 | 9087 | 1219 | 10365 | 742 | 12665 | 129 | 11965 |
| 19-#11 | 4.81 | 4873 | 2220 | 6902 | 1934 | 8742 | 1582 | 9938 | 1269 | 11466 | 738 | 14111 | 15 | 14042 |
| 20-#10 | 4.13 | 4693 | 2097 | 6383 | 1865 | 8170 | 1531 | 9287 | 1234 | 10654 | 748 | 13069 | 112 | 12496 |
| 20-#11 | 5.07 | 4948 | 2265 | 7039 | 1974 | 8934 | 1613 | 10178 | 1287 | 11802 | 742 | 14573 | -8 | 14563 |
| 21-#10 | 4.33 | 4775 | 2134 | 6548 | 1888 | 8362 | 1548 | 9515 | 1249 | 10936 | 747 | 13466 | 87 | 13026 |
| 22-#10 | 4.54 | 4832 | 2171 | 6774 | 1904 | 8587 | 1556 | 9756 | 1254 | 11234 | 739 | 13879 | 69 | 13525 |

## ROUND TIED COLUMNS 30" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.27 | 4521 | 1823 | 5431 | 1697 | 6965 | 1403 | 7685 | 1162 | 8084 | 810 | 8906 | 418 | 5903 |
| 4-#18 | 2.26 | 4797 | 2026 | 6272 | 1820 | 7944 | 1491 | 8822 | 1216 | 9575 | 803 | 10944 | 264 | 9831 |
| 5-#11 | 1.10 | 4573 | 1788 | 5583 | 1649 | 7005 | 1364 | 7633 | 1131 | 7911 | 786 | 8594 | 447 | 4917 |
| 5-#14 | 1.59 | 4757 | 1888 | 6045 | 1712 | 7541 | 1409 | 8252 | 1160 | 8712 | 781 | 9641 | 379 | 6728 |
| 5-#18 | 2.83 | 5187 | 2142 | 7160 | 1876 | 8843 | 1527 | 9766 | 1232 | 10684 | 768 | 12259 | 210 | 11016 |
| 6-#10 | 1.08 | 4534 | 1783 | 5935 | 1579 | 7198 | 1298 | 7742 | 1073 | 7966 | 743 | 8371 | 410 | 4838 |
| 6-#11 | 1.32 | 4611 | 1834 | 6201 | 1601 | 7486 | 1312 | 8065 | 1079 | 8380 | 735 | 8824 | 365 | 5800 |
| 6-#14 | 1.91 | 4810 | 1954 | 6755 | 1671 | 8153 | 1362 | 8854 | 1108 | 9430 | 726 | 10058 | 272 | 8052 |
| 6-#18 | 3.40 | 5280 | 2258 | 8100 | 1852 | 9789 | 1490 | 10800 | 1183 | 12004 | 701 | 13014 | 24 | 12910 |
| 7-#10 | 1.26 | 4655 | 1820 | 5534 | 1700 | 7074 | 1411 | 7819 | 1173 | 8252 | 814 | 9171 | 455 | 5597 |
| 7-#11 | 1.54 | 4754 | 1879 | 5839 | 1730 | 7396 | 1432 | 8175 | 1184 | 8690 | 807 | 9750 | 412 | 6624 |
| 7-#14 | 2.23 | 5011 | 2019 | 6459 | 1820 | 8126 | 1501 | 9034 | 1230 | 9805 | 804 | 11269 | 323 | 9018 |
| 7-#18 | 3.96 | 5635 | 2374 | 7959 | 2051 | 9910 | 1676 | 11145 | 1345 | 12540 | 796 | 14869 | 82 | 14422 |

## ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.44 | 4711 | 1857 | 5523 | 1750 | 7203 | 1453 | 8047 | 1209 | 8562 | 835 | 9611 | 442 | 6234 |
| 8-#11 | 1.77 | 4821 | 1924 | 5859 | 1786 | 7571 | 1479 | 8461 | 1226 | 9057 | 830 | 10261 | 392 | 7437 |
| 8-#14 | 2.55 | 5103 | 2084 | 6546 | 1894 | 8407 | 1561 | 9440 | 1281 | 10316 | 832 | 11969 | 289 | 10270 |
| 8-#18 | 4.53 | 5763 | 2490 | 8214 | 2169 | 10456 | 1771 | 11828 | 1419 | 13398 | 832 | 16125 | 17 | 16048 |
| 9-#10 | 1.62 | 4798 | 1894 | 5778 | 1763 | 7439 | 1462 | 8274 | 1210 | 8868 | 823 | 10079 | 417 | 6967 |
| 9-#11 | 1.99 | 4922 | 1969 | 6148 | 1805 | 7846 | 1493 | 8723 | 1228 | 9437 | 817 | 10825 | 363 | 8231 |
| 9-#14 | 2.86 | 5243 | 2149 | 6922 | 1925 | 8778 | 1586 | 9814 | 1289 | 10871 | 817 | 12778 | 249 | 11208 |
| 9-#18 | 5.09 | 6013 | 2606 | 8806 | 2232 | 11046 | 1819 | 12491 | 1442 | 14401 | 814 | 17443 | -58 | 17394 |
| 10-#10 | 1.80 | 4880 | 1930 | 6139 | 1763 | 7770 | 1453 | 8580 | 1194 | 9194 | 799 | 10429 | 379 | 7592 |
| 10-#11 | 2.21 | 5019 | 2014 | 6546 | 1811 | 8217 | 1487 | 9083 | 1213 | 9835 | 791 | 11229 | 315 | 9029 |
| 10-#14 | 3.18 | 5374 | 2214 | 7418 | 1945 | 9266 | 1585 | 10315 | 1277 | 11450 | 786 | 13351 | 182 | 12420 |
| 10-#18 | 5.66 | 6222 | 2722 | 9549 | 2289 | 11825 | 1835 | 13332 | 1435 | 15421 | 770 | 18645 | -146 | 18260 |
| 11-#10 | 1.98 | 4950 | 1967 | 6080 | 1819 | 7816 | 1505 | 8731 | 1244 | 9495 | 831 | 11016 | 383 | 8285 |
| 11-#11 | 2.43 | 5103 | 2060 | 6520 | 1873 | 8301 | 1544 | 9280 | 1268 | 10188 | 825 | 11937 | 318 | 9782 |
| 11-#14 | 3.50 | 5498 | 2280 | 7464 | 2022 | 9431 | 1657 | 10614 | 1346 | 11934 | 827 | 14339 | 181 | 13279 |
| 11-#18 | 6.22 | 6442 | 2838 | 9684 | 2409 | 12162 | 1953 | 13892 | 1540 | 16220 | 825 | 20103 | -186 | 19712 |
| 12-#10 | 2.16 | 5047 | 2004 | 6188 | 1856 | 7956 | 1537 | 8932 | 1265 | 9799 | 843 | 11480 | 373 | 8911 |
| 12-#11 | 2.65 | 5217 | 2105 | 6658 | 1915 | 8476 | 1581 | 9525 | 1292 | 10561 | 839 | 12485 | 303 | 10579 |
| 12-#14 | 3.82 | 5650 | 2345 | 7679 | 2079 | 9690 | 1707 | 10964 | 1377 | 12470 | 845 | 15102 | 156 | 14300 |
| 12-#18 | 6.79 | 6717 | 2954 | 10164 | 2492 | 12663 | 2025 | 14501 | 1589 | 17171 | 855 | 21433 | -235 | 21022 |
| 13-#10 | 2.34 | 5109 | 2041 | 6359 | 1876 | 8193 | 1550 | 9196 | 1276 | 10120 | 838 | 11913 | 342 | 9568 |
| 13-#11 | 2.87 | 5290 | 2150 | 6858 | 1942 | 8761 | 1599 | 9838 | 1307 | 10948 | 833 | 13002 | 266 | 11298 |
| 13-#14 | 4.14 | 5755 | 2410 | 7952 | 2119 | 10091 | 1735 | 11406 | 1400 | 13019 | 837 | 15836 | 103 | 15246 |
| 13-#18 | 7.36 | 6890 | 3070 | 10619 | 2570 | 13355 | 2079 | 15253 | 1632 | 18077 | 838 | 22646 | -332 | 22034 |
| 14-#10 | 2.52 | 5192 | 2078 | 6637 | 1884 | 8445 | 1555 | 9478 | 1272 | 10476 | 828 | 12281 | 315 | 10198 |
| 14-#11 | 3.09 | 5390 | 2195 | 7171 | 1955 | 9053 | 1607 | 10180 | 1305 | 11367 | 821 | 13478 | 235 | 12095 |
| 14-#14 | 4.46 | 5919 | 2475 | 8357 | 2144 | 10487 | 1752 | 11891 | 1402 | 13610 | 821 | 16546 | 62 | 16211 |
| 15-#10 | 2.70 | 5248 | 2114 | 6648 | 1932 | 8572 | 1594 | 9657 | 1307 | 10740 | 844 | 12802 | 301 | 10821 |
| 15-#11 | 3.31 | 5458 | 2241 | 7211 | 2011 | 9217 | 1652 | 10399 | 1345 | 11692 | 838 | 14068 | 213 | 12778 |
| 15-#14 | 4.77 | 5996 | 2541 | 8460 | 2218 | 10740 | 1810 | 12209 | 1454 | 14074 | 843 | 17335 | 25 | 17194 |
| 16-#10 | 2.87 | 5327 | 2151 | 6767 | 1963 | 8730 | 1622 | 9891 | 1328 | 11040 | 852 | 13270 | 291 | 11455 |
| 16-#11 | 3.53 | 5548 | 2286 | 7361 | 2047 | 9416 | 1686 | 10688 | 1370 | 12050 | 848 | 14613 | 199 | 13505 |
| 16-#14 | 5.09 | 6127 | 2606 | 8685 | 2268 | 11034 | 1857 | 12612 | 1486 | 14580 | 855 | 18099 | 2 | 18090 |
| 17-#10 | 3.05 | 5395 | 2188 | 6968 | 1986 | 8951 | 1638 | 10124 | 1339 | 11371 | 850 | 13713 | 264 | 12049 |
| 17-#11 | 3.75 | 5629 | 2331 | 7599 | 2076 | 9678 | 1705 | 10960 | 1383 | 12448 | 845 | 15173 | 166 | 14177 |
| 17-#14 | 5.41 | 6241 | 2671 | 9013 | 2310 | 11401 | 1887 | 13004 | 1507 | 15146 | 851 | 18891 | -45 | 18817 |
| 18-#10 | 3.23 | 5463 | 2225 | 7175 | 2002 | 9201 | 1651 | 10395 | 1341 | 11697 | 842 | 14071 | 237 | 12700 |
| 18-#11 | 3.97 | 5710 | 2376 | 7837 | 2098 | 9976 | 1723 | 11283 | 1387 | 12851 | 837 | 15602 | 133 | 14878 |
| 19-#10 | 3.41 | 5546 | 2262 | 7259 | 2041 | 9337 | 1682 | 10587 | 1370 | 11988 | 854 | 14592 | 224 | 13261 |
| 19-#11 | 4.19 | 5809 | 2421 | 7952 | 2143 | 10142 | 1759 | 11522 | 1420 | 13206 | 855 | 16218 | 115 | 15564 |
| 20-#10 | 3.59 | 5607 | 2299 | 7372 | 2074 | 9509 | 1709 | 10804 | 1386 | 12307 | 863 | 15044 | 208 | 13870 |
| 20-#11 | 4.41 | 5882 | 2467 | 8096 | 2183 | 10351 | 1791 | 11784 | 1439 | 13586 | 861 | 16745 | 93 | 16245 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 21-#10 | 3.77 | 5694 | 2335 | 7555 | 2096 | 9729 | 1721 | 11055 | 1401 | 12621 | 863 | 15476 | 183 | 14421 |
| 21-#11 | 4.63 | 5990 | 2512 | 8312 | 2211 | 10603 | 1811 | 12084 | 1457 | 13957 | 860 | 17269 | 63 | 16950 |
| 22-#10 | 3.95 | 5761 | 2372 | 7804 | 2111 | 9966 | 1732 | 11315 | 1405 | 12947 | 855 | 15930 | 165 | 14995 |
| 23-#10 | 4.13 | 5837 | 2409 | 7878 | 2149 | 10115 | 1764 | 11518 | 1431 | 13242 | 868 | 16395 | 148 | 15566 |
| 24-#10 | 4.31 | 5909 | 2446 | 8025 | 2178 | 10295 | 1786 | 11752 | 1448 | 13536 | 871 | 16856 | 131 | 16133 |

## ROUND TIED COLUMNS 32" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.12 | 5444 | 2038 | 6375 | 1919 | 8245 | 1589 | 9114 | 1321 | 9558 | 930 | 10479 | 510 | 6405 |
| 4-#18 | 1.99 | 5753 | 2241 | 7296 | 2042 | 9314 | 1677 | 10352 | 1375 | 11178 | 923 | 12692 | 358 | 10731 |
| 5-#14 | 1.40 | 5702 | 2104 | 7076 | 1928 | 8894 | 1592 | 9741 | 1314 | 10240 | 898 | 11320 | 472 | 7344 |
| 5-#18 | 2.49 | 6181 | 2357 | 8294 | 2091 | 10319 | 1710 | 11394 | 1388 | 12390 | 886 | 14108 | 295 | 12046 |
| 6-#11 | 1.16 | 5540 | 2049 | 7306 | 1808 | 8858 | 1485 | 9540 | 1225 | 9859 | 844 | 10389 | 452 | 6293 |
| 6-#14 | 1.68 | 5761 | 2169 | 7910 | 1878 | 9583 | 1535 | 10397 | 1254 | 10998 | 835 | 11752 | 362 | 8753 |
| 6-#18 | 2.98 | 6283 | 2473 | 9377 | 2059 | 11365 | 1663 | 12513 | 1330 | 13819 | 814 | 15034 | 124 | 14449 |
| 7-#10 | 1.11 | 5588 | 2035 | 6495 | 1920 | 8366 | 1596 | 9257 | 1330 | 9741 | 933 | 10777 | 546 | 6115 |
| 7-#11 | 1.36 | 5699 | 2094 | 6832 | 1949 | 8720 | 1617 | 9646 | 1342 | 10220 | 926 | 11412 | 503 | 7246 |
| 7-#14 | 1.96 | 5984 | 2234 | 7508 | 2039 | 9514 | 1685 | 10580 | 1387 | 11435 | 924 | 13079 | 417 | 9869 |
| 7-#18 | 3.48 | 6664 | 2589 | 9147 | 2271 | 11459 | 1862 | 12879 | 1503 | 14423 | 919 | 17111 | 189 | 15984 |
| 8-#10 | 1.26 | 5648 | 2072 | 6460 | 1972 | 8492 | 1640 | 9497 | 1369 | 10080 | 957 | 11265 | 535 | 6778 |
| 8-#11 | 1.55 | 5770 | 2139 | 6831 | 2008 | 8895 | 1666 | 9948 | 1385 | 10622 | 951 | 11979 | 486 | 8095 |
| 8-#14 | 2.24 | 6085 | 2299 | 7579 | 2115 | 9803 | 1748 | 11026 | 1442 | 11994 | 954 | 13848 | 386 | 11190 |
| 8-#18 | 3.98 | 6816 | 2705 | 9397 | 2391 | 12032 | 1959 | 13642 | 1583 | 15364 | 959 | 18414 | 123 | 17842 |
| 9-#10 | 1.42 | 5745 | 2109 | 6750 | 1984 | 8755 | 1648 | 9750 | 1369 | 10404 | 943 | 11773 | 510 | 7618 |
| 9-#11 | 1.75 | 5884 | 2184 | 7156 | 2025 | 9200 | 1679 | 10241 | 1387 | 11024 | 937 | 12594 | 457 | 9016 |
| 9-#14 | 2.52 | 6239 | 2364 | 8000 | 2146 | 10215 | 1772 | 11429 | 1448 | 12583 | 938 | 14734 | 346 | 12277 |
| 9-#18 | 4.48 | 7089 | 2821 | 10054 | 2453 | 12697 | 2008 | 14348 | 1604 | 16429 | 938 | 19950 | 55 | 19625 |
| 10-#10 | 1.58 | 5835 | 2146 | 7166 | 1980 | 9133 | 1636 | 10088 | 1350 | 10755 | 917 | 12124 | 469 | 8273 |
| 10-#11 | 1.94 | 5990 | 2230 | 7612 | 2028 | 9624 | 1670 | 10639 | 1369 | 11454 | 909 | 13055 | 411 | 9849 |
| 10-#14 | 2.80 | 6383 | 2430 | 8562 | 2162 | 10766 | 1769 | 11979 | 1433 | 13211 | 905 | 15398 | 282 | 13562 |
| 10-#18 | 4.97 | 7317 | 2937 | 10882 | 2505 | 13562 | 2021 | 15273 | 1594 | 17540 | 893 | 21039 | -62 | 20975 |
| 11-#10 | 1.74 | 5912 | 2182 | 7071 | 2041 | 9161 | 1692 | 10241 | 1403 | 11086 | 952 | 12763 | 472 | 9075 |
| 11-#11 | 2.13 | 6082 | 2275 | 7554 | 2094 | 9693 | 1731 | 10841 | 1428 | 11843 | 946 | 13814 | 414 | 10721 |
| 11-#14 | 3.08 | 6515 | 2495 | 8582 | 2243 | 10922 | 1844 | 12289 | 1506 | 13743 | 949 | 16451 | 281 | 14603 |
| 11-#18 | 5.47 | 7558 | 3053 | 11086 | 2622 | 13899 | 2142 | 15858 | 1703 | 18419 | 953 | 22858 | -70 | 22733 |
| 12-#10 | 1.89 | 6018 | 2219 | 7182 | 2079 | 9309 | 1725 | 10458 | 1425 | 11410 | 964 | 13310 | 469 | 9724 |
| 12-#11 | 2.33 | 6207 | 2320 | 7699 | 2138 | 9879 | 1770 | 11104 | 1453 | 12240 | 961 | 14418 | 401 | 11555 |
| 12-#14 | 3.36 | 6685 | 2560 | 8812 | 2302 | 11200 | 1896 | 12669 | 1538 | 14313 | 968 | 17291 | 259 | 15831 |
| 12-#18 | 5.97 | 7830 | 3169 | 11525 | 2718 | 14442 | 2216 | 16521 | 1753 | 19430 | 982 | 24270 | -118 | 24052 |
| 13-#10 | 2.05 | 6087 | 2256 | 7371 | 2098 | 9566 | 1737 | 10745 | 1436 | 11759 | 959 | 13777 | 438 | 10484 |
| 13-#11 | 2.52 | 6288 | 2365 | 7919 | 2164 | 10187 | 1786 | 11447 | 1468 | 12661 | 954 | 14984 | 364 | 12384 |
| 13-#14 | 3.64 | 6800 | 2625 | 9109 | 2342 | 11633 | 1923 | 13152 | 1561 | 14913 | 960 | 18097 | 206 | 16809 |
| 13-#18 | 6.47 | 8047 | 3285 | 12017 | 2794 | 15188 | 2269 | 17346 | 1797 | 20451 | 969 | 25651 | -211 | 25213 |
| 14-#10 | 2.21 | 6178 | 2293 | 7686 | 2105 | 9848 | 1741 | 11050 | 1430 | 12152 | 948 | 14158 | 410 | 11138 |
| 14-#11 | 2.72 | 6398 | 2411 | 8273 | 2176 | 10513 | 1793 | 11815 | 1464 | 13126 | 942 | 15473 | 331 | 13221 |
| 14-#14 | 3.92 | 6967 | 2691 | 9565 | 2365 | 12072 | 1939 | 13674 | 1562 | 15570 | 945 | 18841 | 164 | 17920 |
| 14-#18 | 6.96 | 8354 | 3401 | 12721 | 2846 | 15904 | 2307 | 18256 | 1809 | 21573 | 946 | 26970 | -285 | 26370 |

## ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 15-#10 | 2.37 | 6240 | 2330 | 7680 | 2155 | 9977 | 1782 | 11241 | 1468 | 12433 | 966 | 14734 | 396 | 11856 |
| 15-#11 | 2.91 | 6470 | 2456 | 8298 | 2233 | 10682 | 1840 | 12051 | 1506 | 13471 | 961 | 16148 | 312 | 14008 |
| 15-#14 | 4.20 | 7065 | 2756 | 9656 | 2441 | 12339 | 1999 | 14017 | 1616 | 16061 | 968 | 19746 | 131 | 18947 |
| 16-#10 | 2.53 | 6323 | 2366 | 7805 | 2186 | 10143 | 1811 | 11491 | 1488 | 12759 | 975 | 15268 | 390 | 12518 |
| 16-#11 | 3.10 | 6573 | 2501 | 8456 | 2270 | 10891 | 1874 | 12359 | 1530 | 13862 | 971 | 16753 | 300 | 14847 |
| 16-#14 | 4.48 | 7208 | 2821 | 9896 | 2492 | 12649 | 2047 | 14463 | 1650 | 16614 | 981 | 20585 | 110 | 19958 |
| 17-#10 | 2.68 | 6400 | 2403 | 8024 | 2208 | 10384 | 1826 | 11748 | 1500 | 13112 | 972 | 15730 | 361 | 13205 |
| 17-#11 | 3.30 | 6660 | 2546 | 8717 | 2298 | 11179 | 1894 | 12661 | 1544 | 14295 | 969 | 17337 | 267 | 15597 |
| 17-#14 | 4.76 | 7327 | 2886 | 10257 | 2534 | 13051 | 2076 | 14884 | 1670 | 17230 | 978 | 21447 | 63 | 21064 |
| 18-#10 | 2.84 | 6476 | 2440 | 8258 | 2224 | 10657 | 1838 | 12045 | 1501 | 13465 | 963 | 16119 | 334 | 13887 |
| 18-#11 | 3.49 | 6750 | 2591 | 8983 | 2320 | 11503 | 1910 | 13015 | 1547 | 14723 | 959 | 17806 | 234 | 16414 |
| 18-#14 | 5.04 | 7457 | 2951 | 10607 | 2569 | 13502 | 2104 | 15380 | 1678 | 17854 | 967 | 22120 | 17 | 22026 |
| 19-#10 | 3.00 | 6564 | 2477 | 8339 | 2264 | 10802 | 1870 | 12246 | 1531 | 13782 | 977 | 16691 | 323 | 14527 |
| 19-#11 | 3.69 | 6857 | 2637 | 9098 | 2366 | 11684 | 1948 | 13267 | 1582 | 15101 | 974 | 18483 | 217 | 17137 |
| 19-#14 | 5.32 | 7601 | 3017 | 10802 | 2631 | 13769 | 2152 | 15751 | 1724 | 18398 | 991 | 23063 | -10 | 23041 |
| 20-#10 | 3.16 | 6633 | 2514 | 8458 | 2297 | 10989 | 1898 | 12482 | 1548 | 14122 | 986 | 17169 | 306 | 15206 |
| 20-#11 | 3.88 | 6937 | 2682 | 9249 | 2406 | 11909 | 1980 | 13551 | 1602 | 15519 | 985 | 19076 | 197 | 17904 |
| 21-#10 | 3.32 | 6728 | 2551 | 8658 | 2320 | 11225 | 1910 | 12755 | 1562 | 14470 | 987 | 17659 | 284 | 15833 |
| 21-#11 | 4.07 | 7051 | 2727 | 9486 | 2434 | 12197 | 1996 | 13878 | 1620 | 15928 | 985 | 19636 | 167 | 18637 |
| 22-#10 | 3.47 | 6796 | 2587 | 8932 | 2334 | 11485 | 1921 | 13033 | 1566 | 14824 | 979 | 18084 | 256 | 16511 |
| 22-#11 | 4.27 | 7137 | 2772 | 9808 | 2453 | 12504 | 2010 | 14218 | 1626 | 16355 | 975 | 20231 | 145 | 19366 |
| 23-#10 | 3.63 | 6885 | 2624 | 9006 | 2372 | 11640 | 1954 | 13253 | 1593 | 15139 | 992 | 18648 | 248 | 17103 |
| 23-#11 | 4.46 | 7237 | 2818 | 9909 | 2499 | 12701 | 2049 | 14484 | 1657 | 16742 | 991 | 20835 | 123 | 20127 |
| 24-#10 | 3.79 | 6963 | 2661 | 9165 | 2402 | 11835 | 1975 | 13502 | 1610 | 15458 | 995 | 19150 | 231 | 17749 |
| 25-#10 | 3.95 | 7043 | 2698 | 9325 | 2428 | 12054 | 1997 | 13761 | 1624 | 15815 | 998 | 19606 | 208 | 18356 |
| 26-#10 | 4.11 | 7128 | 2735 | 9550 | 2447 | 12304 | 2009 | 14044 | 1631 | 16166 | 991 | 20102 | 186 | 18963 |

## ROUND TIED COLUMNS 34" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.76 | 6827 | 2470 | 8424 | 2278 | 10835 | 1876 | 12053 | 1544 | 12957 | 1051 | 14624 | 457 | 11629 |
| 5-#14 | 1.24 | 6764 | 2333 | 8219 | 2158 | 10403 | 1786 | 11403 | 1480 | 11942 | 1022 | 13178 | 569 | 7968 |
| 5-#18 | 2.20 | 7292 | 2586 | 9541 | 2321 | 11950 | 1904 | 13196 | 1554 | 14270 | 1012 | 16244 | 399 | 13087 |
| 6-#11 | 1.03 | 6587 | 2278 | 8536 | 2028 | 10392 | 1670 | 11190 | 1382 | 11510 | 961 | 12128 | 543 | 6786 |
| 6-#14 | 1.49 | 6830 | 2398 | 9190 | 2098 | 11175 | 1719 | 12115 | 1411 | 12737 | 952 | 13619 | 457 | 9456 |
| 6-#18 | 2.64 | 7405 | 2702 | 10781 | 2279 | 13103 | 1847 | 14402 | 1486 | 15783 | 932 | 17229 | 226 | 15821 |
| 7-#11 | 1.20 | 6760 | 2323 | 7931 | 2183 | 10196 | 1814 | 11289 | 1509 | 11925 | 1052 | 13255 | 600 | 7879 |
| 7-#14 | 1.73 | 7074 | 2463 | 8665 | 2273 | 11055 | 1882 | 12297 | 1554 | 13240 | 1052 | 15066 | 516 | 10734 |
| 7-#18 | 3.08 | 7823 | 2818 | 10444 | 2505 | 13162 | 2059 | 14784 | 1672 | 16481 | 1049 | 19508 | 297 | 17523 |
| 8-#10 | 1.12 | 6702 | 2301 | 7499 | 2209 | 9930 | 1840 | 11117 | 1539 | 11774 | 1086 | 13103 | 633 | 7326 |
| 8-#11 | 1.37 | 6838 | 2368 | 7904 | 2245 | 10369 | 1866 | 11606 | 1555 | 12363 | 1080 | 13881 | 586 | 8759 |
| 8-#14 | 1.98 | 7179 | 2528 | 8714 | 2352 | 11349 | 1947 | 12767 | 1612 | 13848 | 1084 | 15912 | 488 | 12119 |
| 8-#18 | 3.52 | 7989 | 2934 | 10684 | 2627 | 13759 | 2158 | 15629 | 1757 | 17505 | 1092 | 20888 | 232 | 19698 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 9-#10 | 1.26 | 6809 | 2338 | 7825 | 2219 | 10222 | 1847 | 11397 | 1538 | 12115 | 1070 | 13651 | 608 | 8234 |
| 9-#11 | 1.55 | 6963 | 2414 | 8270 | 2261 | 10706 | 1877 | 11931 | 1556 | 12787 | 1064 | 14546 | 556 | 9816 |
| 9-#14 | 2.23 | 7354 | 2594 | 9183 | 2381 | 11802 | 1970 | 13215 | 1618 | 14470 | 1066 | 16874 | 448 | 13366 |
| 9-#18 | 3.97 | 8287 | 3050 | 11409 | 2689 | 14498 | 2208 | 16377 | 1775 | 18632 | 1069 | 22566 | 165 | 21547 |
| 10-#10 | 1.40 | 6907 | 2375 | 8303 | 2211 | 10650 | 1832 | 11769 | 1516 | 12491 | 1042 | 14000 | 565 | 8964 |
| 10-#11 | 1.72 | 7079 | 2459 | 8790 | 2259 | 11184 | 1865 | 12367 | 1535 | 13248 | 1034 | 15018 | 508 | 10679 |
| 10-#14 | 2.48 | 7510 | 2659 | 9816 | 2393 | 12422 | 1965 | 13817 | 1600 | 15146 | 1032 | 17625 | 387 | 14714 |
| 10-#18 | 4.41 | 8535 | 3166 | 12327 | 2736 | 15455 | 2219 | 17386 | 1763 | 19833 | 1023 | 23829 | 56 | 23592 |
| 11-#10 | 1.54 | 6991 | 2411 | 8164 | 2277 | 10658 | 1891 | 11922 | 1573 | 12853 | 1081 | 14728 | 572 | 9832 |
| 11-#11 | 1.89 | 7179 | 2504 | 8691 | 2330 | 11236 | 1930 | 12572 | 1597 | 13673 | 1075 | 15830 | 509 | 11679 |
| 11-#14 | 2.73 | 7654 | 2724 | 9803 | 2479 | 12564 | 2043 | 14136 | 1676 | 15727 | 1079 | 18747 | 385 | 15904 |
| 11-#18 | 4.85 | 8797 | 3282 | 12522 | 2859 | 15830 | 2332 | 17997 | 1875 | 20793 | 1087 | 25749 | 45 | 25472 |
| 12-#10 | 1.68 | 7106 | 2448 | 8276 | 2317 | 10812 | 1926 | 12153 | 1596 | 13197 | 1093 | 15324 | 570 | 10550 |
| 12-#11 | 2.06 | 7315 | 2549 | 8842 | 2376 | 11431 | 1970 | 12855 | 1624 | 14095 | 1090 | 16536 | 504 | 12545 |
| 12-#14 | 2.97 | 7839 | 2789 | 10048 | 2540 | 12860 | 2097 | 14544 | 1710 | 16331 | 1098 | 19665 | 366 | 17237 |
| 12-#18 | 5.29 | 9090 | 3398 | 12990 | 2957 | 16371 | 2419 | 18713 | 1927 | 21864 | 1116 | 27293 | 1 | 27288 |
| 13-#10 | 1.82 | 7182 | 2485 | 8485 | 2335 | 11089 | 1937 | 12466 | 1607 | 13573 | 1088 | 15811 | 537 | 11387 |
| 13-#11 | 2.23 | 7405 | 2594 | 9083 | 2401 | 11764 | 1986 | 13227 | 1638 | 14550 | 1084 | 17150 | 466 | 13493 |
| 13-#14 | 3.22 | 7966 | 2854 | 10371 | 2579 | 13325 | 2123 | 15069 | 1733 | 16981 | 1091 | 20543 | 313 | 18374 |
| 13-#18 | 5.73 | 9327 | 3514 | 13520 | 3032 | 17171 | 2471 | 19610 | 1971 | 22991 | 1105 | 28806 | -92 | 28615 |
| 14-#10 | 1.96 | 7283 | 2522 | 8842 | 2340 | 11403 | 1939 | 12794 | 1599 | 13999 | 1076 | 16217 | 509 | 12094 |
| 14-#11 | 2.41 | 7525 | 2640 | 9482 | 2410 | 12125 | 1991 | 13623 | 1632 | 15060 | 1071 | 17650 | 432 | 14365 |
| 14-#14 | 3.47 | 8147 | 2920 | 10879 | 2600 | 13808 | 2137 | 15628 | 1731 | 17705 | 1076 | 21308 | 269 | 19683 |
| 14-#18 | 6.17 | 9661 | 3630 | 14298 | 3083 | 17955 | 2508 | 20583 | 1980 | 24217 | 1083 | 30267 | -160 | 29851 |
| 15-#10 | 2.10 | 7349 | 2559 | 8815 | 2392 | 11532 | 1983 | 12996 | 1639 | 14301 | 1095 | 16851 | 497 | 12912 |
| 15-#11 | 2.58 | 7604 | 2685 | 9488 | 2470 | 12298 | 2041 | 13874 | 1677 | 15425 | 1091 | 18392 | 415 | 15262 |
| 15-#14 | 3.72 | 8255 | 2985 | 10956 | 2678 | 14088 | 2200 | 15996 | 1788 | 18224 | 1100 | 22326 | 239 | 20735 |
| 15-#18 | 6.61 | 9832 | 3746 | 14554 | 3207 | 18494 | 2605 | 21237 | 2067 | 25134 | 1117 | 31868 | -229 | 31316 |
| 16-#10 | 2.24 | 7440 | 2596 | 8944 | 2424 | 11704 | 2012 | 13260 | 1660 | 14654 | 1105 | 17439 | 493 | 13606 |
| 16-#11 | 2.75 | 7716 | 2730 | 9654 | 2508 | 12517 | 2075 | 14200 | 1702 | 15849 | 1102 | 19077 | 406 | 16138 |
| 16-#14 | 3.97 | 8411 | 3050 | 11210 | 2730 | 14414 | 2248 | 16470 | 1822 | 18823 | 1114 | 23257 | 222 | 21882 |
| 17-#10 | 2.38 | 7525 | 2632 | 9183 | 2446 | 11968 | 2027 | 13543 | 1671 | 15028 | 1102 | 17894 | 459 | 14381 |
| 17-#11 | 2.92 | 7811 | 2775 | 9936 | 2535 | 12830 | 2094 | 14533 | 1716 | 16310 | 1099 | 19685 | 372 | 16992 |
| 17-#14 | 4.21 | 8539 | 3115 | 11602 | 2772 | 14852 | 2277 | 16934 | 1843 | 19491 | 1111 | 24154 | 174 | 23030 |
| 18-#10 | 2.52 | 7607 | 2669 | 9445 | 2460 | 12265 | 2037 | 13866 | 1672 | 15408 | 1092 | 18352 | 436 | 15089 |
| 18-#11 | 3.09 | 7909 | 2821 | 10234 | 2556 | 13182 | 2109 | 14918 | 1718 | 16770 | 1089 | 20193 | 338 | 17900 |
| 18-#14 | 4.46 | 8680 | 3181 | 11988 | 2805 | 15338 | 2304 | 17474 | 1850 | 20151 | 1099 | 24887 | 127 | 24117 |
| 19-#10 | 2.66 | 7703 | 2706 | 9522 | 2502 | 12414 | 2071 | 14076 | 1702 | 15752 | 1108 | 18976 | 427 | 15819 |
| 19-#11 | 3.26 | 8023 | 2866 | 10347 | 2604 | 13373 | 2149 | 15182 | 1754 | 17181 | 1105 | 20933 | 324 | 18705 |
| 19-#14 | 4.71 | 8837 | 3246 | 12189 | 2869 | 15628 | 2355 | 17864 | 1897 | 20727 | 1119 | 25916 | 103 | 25301 |
| 20-#10 | 2.80 | 7778 | 2743 | 9644 | 2535 | 12649 | 2093 | 14330 | 1720 | 16113 | 1117 | 19478 | 409 | 16526 |
| 20-#11 | 3.44 | 8112 | 2911 | 10504 | 2644 | 13617 | 2182 | 15488 | 1774 | 17624 | 1116 | 21556 | 303 | 19605 |
| 20-#14 | 4.96 | 8965 | 3311 | 12427 | 2926 | 15978 | 2401 | 18302 | 1925 | 21366 | 1134 | 26820 | 73 | 26385 |
| 21-#10 | 2.94 | 7882 | 2780 | 9862 | 2558 | 12871 | 2111 | 14622 | 1734 | 16482 | 1114 | 20010 | 388 | 17239 |
| 21-#11 | 3.61 | 8237 | 2956 | 10762 | 2672 | 13925 | 2197 | 15843 | 1792 | 18075 | 1117 | 22188 | 276 | 20368 |
| 22-#10 | 3.08 | 7955 | 2816 | 10162 | 2571 | 13155 | 2121 | 14923 | 1737 | 16876 | 1110 | 20487 | 361 | 17949 |
| 22-#11 | 3.78 | 8323 | 3001 | 11114 | 2690 | 14260 | 2210 | 16206 | 1797 | 18536 | 1107 | 22742 | 241 | 21194 |

## ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway $f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 23-#10 | 3.22 | 8050 | 2853 | 10235 | 2610 | 13315 | 2155 | 15159 | 1765 | 17210 | 1123 | 21083 | 353 | 18644 |
| 23-#11 | 3.95 | 8439 | 3047 | 11216 | 2737 | 14465 | 2250 | 16492 | 1830 | 18946 | 1123 | 23478 | 232 | 21984 |
| 24-#10 | 3.36 | 8138 | 2890 | 10406 | 2641 | 13524 | 2177 | 15423 | 1782 | 17555 | 1127 | 21629 | 337 | 19370 |
| 24-#11 | 4.12 | 8540 | 3092 | 11424 | 2772 | 14720 | 2277 | 16818 | 1850 | 19361 | 1127 | 24128 | 211 | 22793 |
| 25-#10 | 3.50 | 8224 | 2927 | 10579 | 2666 | 13762 | 2199 | 15703 | 1796 | 17941 | 1129 | 22123 | 314 | 20031 |
| 25-#11 | 4.30 | 8643 | 3137 | 11631 | 2804 | 15004 | 2304 | 17154 | 1868 | 19825 | 1130 | 24722 | 182 | 23597 |
| 26-#10 | 3.64 | 8317 | 2964 | 10826 | 2685 | 14030 | 2210 | 16014 | 1803 | 18313 | 1122 | 22643 | 291 | 20726 |
| 27-#10 | 3.78 | 8401 | 3001 | 10951 | 2718 | 14205 | 2242 | 16248 | 1824 | 18662 | 1135 | 23170 | 275 | 21378 |
| 28-#10 | 3.92 | 8499 | 3037 | 11089 | 2750 | 14426 | 2265 | 16503 | 1843 | 19025 | 1139 | 23721 | 256 | 22041 |

## ROUND TIED COLUMNS 36" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.57 | 8026 | 2713 | 9662 | 2528 | 12515 | 2088 | 13936 | 1724 | 14922 | 1187 | 16750 | 562 | 12524 |
| 5-#14 | 1.11 | 7951 | 2576 | 9480 | 2403 | 12075 | 1992 | 13249 | 1655 | 13829 | 1154 | 15193 | 669 | 8599 |
| 5-#18 | 1.96 | 8530 | 2829 | 10906 | 2565 | 13747 | 2111 | 15181 | 1730 | 16335 | 1145 | 18573 | 507 | 14139 |
| 6-#14 | 1.33 | 8024 | 2641 | 10603 | 2333 | 12940 | 1915 | 14019 | 1577 | 14658 | 1076 | 15671 | 555 | 10160 |
| 6-#18 | 2.36 | 8654 | 2945 | 12319 | 2513 | 15013 | 2043 | 16477 | 1652 | 17930 | 1057 | 19609 | 332 | 17052 |
| 7-#11 | 1.07 | 7947 | 2566 | 9143 | 2432 | 11833 | 2023 | 13115 | 1687 | 13815 | 1187 | 15293 | 703 | 8501 |
| 7-#14 | 1.55 | 8290 | 2706 | 9935 | 2522 | 12757 | 2092 | 14198 | 1732 | 15231 | 1187 | 17247 | 620 | 11613 |
| 7-#18 | 2.75 | 9109 | 3061 | 11856 | 2754 | 15027 | 2269 | 16873 | 1850 | 18726 | 1186 | 22053 | 406 | 18967 |
| 8-#11 | 1.23 | 8030 | 2611 | 9085 | 2496 | 12001 | 2078 | 13444 | 1735 | 14290 | 1217 | 15980 | 691 | 9428 |
| 8-#14 | 1.77 | 8402 | 2771 | 9957 | 2603 | 13053 | 2159 | 14691 | 1792 | 15888 | 1222 | 18172 | 595 | 13055 |
| 8-#18 | 3.14 | 9290 | 3177 | 12080 | 2878 | 15645 | 2370 | 17778 | 1939 | 19833 | 1233 | 23559 | 345 | 21622 |
| 9-#10 | 1.12 | 7997 | 2581 | 9010 | 2470 | 11848 | 2058 | 13226 | 1718 | 14013 | 1206 | 15723 | 712 | 8855 |
| 9-#11 | 1.38 | 8167 | 2657 | 9494 | 2510 | 12372 | 2088 | 13803 | 1736 | 14736 | 1200 | 16693 | 660 | 10599 |
| 9-#14 | 1.99 | 8594 | 2837 | 10478 | 2630 | 13550 | 2180 | 15183 | 1798 | 16543 | 1202 | 19209 | 555 | 14473 |
| 9-#18 | 3.54 | 9612 | 3293 | 12877 | 2938 | 16450 | 2418 | 18588 | 1957 | 21021 | 1208 | 25378 | 278 | 23520 |
| 10-#10 | 1.25 | 8103 | 2618 | 9557 | 2457 | 12330 | 2039 | 13633 | 1693 | 14411 | 1174 | 16068 | 666 | 9662 |
| 10-#11 | 1.53 | 8292 | 2702 | 10085 | 2504 | 12909 | 2072 | 14279 | 1712 | 15226 | 1167 | 17165 | 609 | 11519 |
| 10-#14 | 2.21 | 8764 | 2902 | 11189 | 2638 | 14241 | 2172 | 15838 | 1777 | 17266 | 1165 | 19972 | 490 | 15879 |
| 10-#18 | 3.93 | 9881 | 3409 | 13891 | 2982 | 17512 | 2428 | 19684 | 1942 | 22312 | 1159 | 26813 | 176 | 25823 |
| 11-#10 | 1.37 | 8195 | 2654 | 9367 | 2528 | 12313 | 2103 | 13785 | 1753 | 14806 | 1217 | 16888 | 677 | 10588 |
| 11-#11 | 1.69 | 8401 | 2747 | 9939 | 2581 | 12938 | 2142 | 14485 | 1778 | 15690 | 1212 | 18084 | 615 | 12645 |
| 11-#14 | 2.43 | 8919 | 2967 | 11135 | 2729 | 14367 | 2255 | 16165 | 1856 | 17897 | 1217 | 21168 | 486 | 17229 |
| 11-#18 | 4.32 | 10165 | 3525 | 14062 | 3110 | 17883 | 2545 | 20317 | 2057 | 23354 | 1228 | 28836 | 163 | 27748 |
| 12-#10 | 1.50 | 8319 | 2691 | 9474 | 2569 | 12472 | 2139 | 14030 | 1778 | 15170 | 1230 | 17535 | 676 | 11387 |
| 12-#11 | 1.84 | 8549 | 2792 | 10093 | 2628 | 13143 | 2183 | 14786 | 1805 | 16136 | 1227 | 18850 | 611 | 13548 |
| 12-#14 | 2.65 | 9120 | 3032 | 11392 | 2793 | 14679 | 2310 | 16601 | 1892 | 18536 | 1236 | 22235 | 477 | 18620 |
| 12-#18 | 4.72 | 10481 | 3641 | 14564 | 3211 | 18459 | 2634 | 21086 | 2112 | 24485 | 1257 | 30514 | 123 | 29785 |
| 13-#10 | 1.62 | 8401 | 2728 | 9708 | 2587 | 12772 | 2150 | 14367 | 1788 | 15574 | 1224 | 18041 | 642 | 12276 |
| 13-#11 | 1.99 | 8647 | 2837 | 10357 | 2652 | 13500 | 2198 | 15189 | 1819 | 16624 | 1220 | 19490 | 572 | 14624 |
| 13-#14 | 2.87 | 9258 | 3097 | 11742 | 2830 | 15177 | 2335 | 17169 | 1915 | 19235 | 1228 | 23182 | 424 | 19914 |
| 13-#18 | 5.11 | 10723 | 3757 | 15133 | 3285 | 19314 | 2684 | 22057 | 2155 | 25700 | 1246 | 32158 | 31 | 31951 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway $f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 1.75 | 8512 | 2765 | 10110 | 2590 | 13118 | 2149 | 14720 | 1778 | 16022 | 1211 | 18471 | 613 | 13065 |
| 14-#11 | 2.15 | 8778 | 2883 | 10803 | 2660 | 13898 | 2201 | 15613 | 1811 | 17179 | 1207 | 20021 | 538 | 15525 |
| 14-#14 | 3.09 | 9455 | 3163 | 12307 | 2850 | 15707 | 2348 | 17766 | 1910 | 20026 | 1214 | 23970 | 378 | 21329 |
| 14-#18 | 5.50 | 11100 | 3873 | 15990 | 3333 | 20169 | 2720 | 23093 | 2162 | 27048 | 1226 | 33665 | -41 | 33557 |
| 15-#10 | 1.87 | 8584 | 2802 | 10058 | 2644 | 13245 | 2196 | 14933 | 1820 | 16356 | 1232 | 19164 | 603 | 13930 |
| 15-#11 | 2.30 | 8863 | 2928 | 10786 | 2722 | 14073 | 2253 | 15878 | 1858 | 17566 | 1229 | 20833 | 522 | 16540 |
| 15-#14 | 3.32 | 9567 | 3228 | 12365 | 2930 | 15997 | 2414 | 18157 | 1970 | 20574 | 1239 | 25080 | 350 | 22528 |
| 15-#18 | 5.89 | 11281 | 3989 | 16238 | 3460 | 20740 | 2820 | 23794 | 2252 | 28012 | 1261 | 35485 | -102 | 35204 |
| 16-#10 | 2.00 | 8682 | 2839 | 10190 | 2677 | 13424 | 2225 | 15210 | 1841 | 16735 | 1243 | 19784 | 599 | 14704 |
| 16-#11 | 2.45 | 8980 | 2973 | 10959 | 2760 | 14301 | 2288 | 16222 | 1883 | 18022 | 1241 | 21597 | 517 | 17448 |
| 16-#14 | 3.54 | 9741 | 3293 | 12632 | 2983 | 16338 | 2461 | 18657 | 2004 | 21219 | 1254 | 26126 | 337 | 23863 |
| 16-#18 | 6.29 | 11583 | 4105 | 16740 | 3549 | 21368 | 2902 | 24689 | 2310 | 29122 | 1282 | 37169 | -138 | 36836 |
| 17-#10 | 2.12 | 8775 | 2875 | 10449 | 2698 | 13709 | 2240 | 15515 | 1853 | 17130 | 1239 | 20289 | 567 | 15547 |
| 17-#11 | 2.61 | 9088 | 3018 | 11264 | 2787 | 14640 | 2307 | 16587 | 1898 | 18509 | 1237 | 22180 | 475 | 18422 |
| 17-#14 | 3.76 | 9879 | 3358 | 13054 | 3024 | 16811 | 2491 | 19167 | 2026 | 21925 | 1250 | 27057 | 288 | 25046 |
| 18-#10 | 2.25 | 8864 | 2912 | 10742 | 2711 | 14032 | 2249 | 15869 | 1853 | 17537 | 1229 | 20779 | 543 | 16312 |
| 18-#11 | 2.76 | 9195 | 3064 | 11595 | 2806 | 15021 | 2321 | 17003 | 1900 | 19003 | 1226 | 22776 | 448 | 19358 |
| 18-#14 | 3.98 | 10032 | 3424 | 13480 | 3056 | 17335 | 2515 | 19750 | 2032 | 22634 | 1238 | 27850 | 242 | 26266 |
| 19-#10 | 2.37 | 8967 | 2949 | 10812 | 2754 | 14185 | 2284 | 16087 | 1884 | 17908 | 1246 | 21448 | 535 | 17135 |
| 19-#11 | 2.91 | 9318 | 3109 | 11704 | 2856 | 15220 | 2362 | 17278 | 1936 | 19446 | 1244 | 23579 | 435 | 20268 |
| 19-#14 | 4.20 | 10202 | 3489 | 13684 | 3122 | 17643 | 2569 | 20158 | 2080 | 23256 | 1259 | 28966 | 219 | 27493 |
| 20-#10 | 2.50 | 9049 | 2986 | 10937 | 2788 | 14438 | 2307 | 16359 | 1902 | 18290 | 1255 | 21984 | 517 | 17868 |
| 20-#11 | 3.07 | 9415 | 3154 | 11866 | 2896 | 15484 | 2396 | 17607 | 1957 | 19915 | 1255 | 24233 | 413 | 21205 |
| 20-#14 | 4.42 | 10339 | 3554 | 13932 | 3179 | 18021 | 2616 | 20629 | 2109 | 23932 | 1274 | 29913 | 188 | 28712 |
| 21-#10 | 2.62 | 9162 | 3023 | 11205 | 2807 | 14675 | 2325 | 16669 | 1916 | 18687 | 1252 | 22556 | 496 | 18674 |
| 21-#11 | 3.22 | 9549 | 3199 | 12147 | 2925 | 15812 | 2411 | 17986 | 1975 | 20395 | 1252 | 24922 | 387 | 22088 |
| 21-#14 | 4.64 | 10526 | 3619 | 14320 | 3221 | 18487 | 2638 | 21170 | 2136 | 24624 | 1276 | 30887 | 150 | 29950 |
| 22-#10 | 2.74 | 9240 | 3059 | 11502 | 2822 | 14985 | 2334 | 16994 | 1919 | 19115 | 1248 | 23087 | 471 | 19410 |
| 22-#11 | 3.37 | 9643 | 3244 | 12530 | 2941 | 16176 | 2423 | 18375 | 1979 | 20903 | 1246 | 25534 | 354 | 23029 |
| 22-#14 | 4.86 | 10666 | 3685 | 14839 | 3249 | 18991 | 2660 | 21721 | 2145 | 25333 | 1264 | 31744 | 102 | 31104 |
| 23-#10 | 2.87 | 9343 | 3096 | 11571 | 2863 | 15148 | 2369 | 17245 | 1948 | 19468 | 1262 | 23675 | 458 | 20192 |
| 23-#11 | 3.52 | 9769 | 3290 | 12631 | 2989 | 16388 | 2464 | 18682 | 2013 | 21337 | 1263 | 26309 | 344 | 23886 |
| 24-#10 | 2.99 | 9439 | 3133 | 11751 | 2893 | 15371 | 2392 | 17524 | 1965 | 19839 | 1266 | 24305 | 447 | 20948 |
| 24-#11 | 3.68 | 9878 | 3335 | 12854 | 3026 | 16660 | 2491 | 19025 | 2033 | 21783 | 1267 | 27013 | 324 | 24794 |
| 25-#10 | 3.12 | 9532 | 3170 | 11940 | 2919 | 15628 | 2413 | 17825 | 1979 | 20249 | 1268 | 24837 | 425 | 21692 |
| 25-#11 | 3.83 | 9989 | 3380 | 13077 | 3057 | 16967 | 2518 | 19388 | 2051 | 22282 | 1270 | 27653 | 296 | 25635 |
| 26-#10 | 3.24 | 9633 | 3207 | 12211 | 2937 | 15916 | 2424 | 18165 | 1986 | 20646 | 1261 | 25379 | 400 | 22448 |
| 26-#11 | 3.98 | 10108 | 3425 | 13392 | 3081 | 17313 | 2533 | 19788 | 2060 | 22767 | 1262 | 28333 | 268 | 26494 |
| 27-#10 | 3.37 | 9721 | 3244 | 12337 | 2971 | 16100 | 2456 | 18411 | 2007 | 21021 | 1274 | 25953 | 386 | 23178 |
| 27-#11 | 4.14 | 10217 | 3471 | 13560 | 3121 | 17542 | 2571 | 20094 | 2084 | 23218 | 1276 | 29005 | 247 | 27358 |
| 28-#10 | 3.49 | 9829 | 3280 | 12483 | 3003 | 16334 | 2479 | 18684 | 2027 | 21406 | 1278 | 26563 | 369 | 23939 |
| 29-#10 | 3.62 | 9910 | 3317 | 12706 | 3027 | 16578 | 2500 | 18989 | 2038 | 21803 | 1281 | 27068 | 346 | 24652 |
| 30-#10 | 3.74 | 10007 | 3354 | 12928 | 3050 | 16872 | 2514 | 19298 | 2049 | 22207 | 1275 | 27617 | 321 | 25399 |

## ROUND TIED COLUMNS 12" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#5 | 1.10 | 328 | 335 | 483 | 264 | 530 | 214 | 537 | 178 | 508 | 120 | 490 | 51 | 310 |
| 4-#6 | 1.56 | 333 | 350 | 502 | 271 | 551 | 219 | 562 | 181 | 539 | 116 | 523 | 33 | 418 |
| 4-#7 | 2.12 | 339 | 368 | 525 | 281 | 577 | 225 | 591 | 184 | 575 | 112 | 561 | 9 | 542 |
| 4-#8 | 2.79 | 346 | 390 | 550 | 292 | 607 | 233 | 624 | 189 | 616 | 108 | 604 | -19 | 609 |
| 4-#9 | 3.54 | 353 | 414 | 577 | 305 | 639 | 241 | 658 | 193 | 659 | 102 | 648 | -52 | 659 |
| 4-#10 | 4.49 | 362 | 445 | 611 | 321 | 679 | 252 | 701 | 198 | 712 | 94 | 702 | -96 | 716 |
| 4-#11 | 5.52 | 370 | 478 | 642 | 334 | 702 | 266 | 724 | 196 | 740 | 77 | 740 | -142 | 742 |
| 4-#14 | 7.96 | 391 | 557 | 715 | 375 | 778 | 292 | 810 | 205 | 848 | 50 | 844 | -253 | 851 |
| 5-#5 | 1.37 | 338 | 344 | 504 | 264 | 547 | 214 | 552 | 174 | 525 | 113 | 507 | 44 | 361 |
| 5-#6 | 1.95 | 347 | 363 | 528 | 275 | 575 | 220 | 583 | 178 | 564 | 108 | 549 | 23 | 476 |
| 5-#7 | 2.65 | 357 | 386 | 556 | 287 | 608 | 229 | 620 | 181 | 609 | 102 | 597 | -3 | 599 |
| 5-#8 | 3.49 | 369 | 413 | 589 | 302 | 645 | 238 | 661 | 186 | 662 | 95 | 651 | -35 | 670 |
| 5-#9 | 4.42 | 383 | 443 | 623 | 319 | 683 | 249 | 704 | 190 | 717 | 86 | 707 | -70 | 740 |
| 5-#10 | 5.61 | 399 | 481 | 665 | 340 | 730 | 266 | 758 | 195 | 784 | 75 | 792 | -112 | 821 |
| 5-#11 | 6.90 | 407 | 523 | 699 | 357 | 758 | 272 | 787 | 193 | 831 | 58 | 810 | -174 | 857 |
| 6-#5 | 1.64 | 340 | 353 | 532 | 259 | 567 | 209 | 568 | 167 | 542 | 103 | 519 | 28 | 422 |
| 6-#6 | 2.33 | 349 | 375 | 562 | 270 | 601 | 217 | 606 | 170 | 590 | 96 | 570 | 2 | 563 |
| 6-#7 | 3.18 | 361 | 403 | 598 | 285 | 641 | 227 | 652 | 174 | 648 | 88 | 630 | -30 | 630 |
| 6-#8 | 4.19 | 374 | 435 | 639 | 303 | 686 | 238 | 704 | 178 | 713 | 77 | 697 | -69 | 704 |
| 6-#9 | 5.31 | 388 | 471 | 681 | 322 | 734 | 250 | 758 | 182 | 782 | 65 | 765 | -113 | 779 |
| 6-#10 | 6.74 | 405 | 517 | 731 | 345 | 792 | 265 | 825 | 186 | 866 | 48 | 847 | -170 | 866 |
| 7-#5 | 1.92 | 346 | 362 | 523 | 280 | 573 | 225 | 586 | 182 | 570 | 114 | 563 | 30 | 472 |
| 7-#6 | 2.72 | 357 | 388 | 556 | 295 | 611 | 235 | 628 | 187 | 625 | 109 | 623 | 2 | 618 |
| 7-#7 | 3.71 | 371 | 420 | 594 | 314 | 656 | 248 | 679 | 194 | 690 | 102 | 694 | -33 | 711 |
| 7-#8 | 4.89 | 387 | 458 | 638 | 336 | 708 | 263 | 737 | 201 | 764 | 93 | 773 | -75 | 798 |
| 7-#9 | 6.19 | 406 | 500 | 684 | 360 | 762 | 278 | 798 | 208 | 842 | 83 | 853 | -125 | 883 |
| 8-#5 | 2.19 | 351 | 371 | 530 | 289 | 585 | 232 | 601 | 188 | 591 | 115 | 594 | 23 | 529 |
| 8-#6 | 3.11 | 364 | 400 | 566 | 307 | 628 | 244 | 651 | 195 | 652 | 110 | 664 | -9 | 668 |
| 8-#7 | 4.24 | 380 | 437 | 610 | 328 | 678 | 259 | 709 | 203 | 725 | 102 | 746 | -49 | 764 |
| 8-#8 | 5.59 | 399 | 480 | 659 | 354 | 737 | 276 | 775 | 212 | 809 | 93 | 838 | -99 | 868 |

## ROUND TIED COLUMNS 14" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.14 | 526 | 458 | 758 | 371 | 847 | 303 | 869 | 251 | 840 | 171 | 826 | 78 | 518 |
| 4-#7 | 1.56 | 535 | 477 | 787 | 381 | 881 | 309 | 908 | 256 | 889 | 168 | 882 | 57 | 678 |
| 4-#8 | 2.05 | 545 | 498 | 821 | 393 | 920 | 317 | 953 | 261 | 947 | 165 | 947 | 32 | 858 |
| 4-#9 | 2.60 | 555 | 522 | 857 | 406 | 962 | 326 | 1003 | 267 | 1007 | 161 | 1014 | 4 | 1007 |
| 4-#10 | 3.30 | 568 | 553 | 902 | 423 | 1014 | 337 | 1065 | 274 | 1083 | 155 | 1096 | -34 | 1101 |
| 4-#11 | 4.05 | 576 | 586 | 947 | 435 | 1061 | 344 | 1112 | 276 | 1133 | 142 | 1138 | -86 | 1149 |
| 4-#14 | 5.85 | 611 | 665 | 1049 | 478 | 1182 | 372 | 1242 | 291 | 1297 | 123 | 1304 | -195 | 1319 |
| 5-#5 | 1.01 | 532 | 452 | 765 | 362 | 844 | 295 | 859 | 244 | 820 | 166 | 802 | 87 | 454 |
| 5-#6 | 1.43 | 543 | 471 | 797 | 373 | 881 | 302 | 901 | 248 | 872 | 162 | 863 | 68 | 602 |
| 5-#7 | 1.95 | 558 | 494 | 835 | 386 | 924 | 311 | 952 | 253 | 935 | 158 | 935 | 46 | 772 |
| 5-#8 | 2.57 | 574 | 521 | 878 | 401 | 975 | 321 | 1011 | 259 | 1008 | 153 | 1017 | 18 | 963 |
| 5-#9 | 3.25 | 591 | 551 | 924 | 418 | 1029 | 333 | 1073 | 265 | 1085 | 146 | 1102 | -14 | 1110 |
| 5-#10 | 4.13 | 613 | 590 | 981 | 441 | 1096 | 348 | 1149 | 273 | 1181 | 138 | 1206 | -56 | 1232 |
| 5-#11 | 5.07 | 630 | 631 | 1034 | 459 | 1153 | 358 | 1202 | 273 | 1246 | 120 | 1258 | -115 | 1308 |
| 5-#14 | 7.31 | 682 | 729 | 1162 | 514 | 1298 | 392 | 1366 | 288 | 1453 | 92 | 1464 | -234 | 1544 |
| 6-#5 | 1.21 | 534 | 461 | 807 | 352 | 875 | 285 | 882 | 234 | 839 | 153 | 803 | 65 | 524 |
| 6-#6 | 1.71 | 547 | 484 | 846 | 364 | 922 | 293 | 935 | 238 | 905 | 148 | 872 | 40 | 707 |
| 6-#7 | 2.34 | 562 | 511 | 893 | 379 | 979 | 303 | 998 | 243 | 984 | 141 | 955 | 9 | 919 |
| 6-#8 | 3.08 | 580 | 544 | 948 | 397 | 1042 | 315 | 1070 | 249 | 1076 | 133 | 1049 | -28 | 1060 |
| 6-#9 | 3.90 | 601 | 580 | 1006 | 417 | 1110 | 327 | 1147 | 255 | 1173 | 124 | 1146 | -70 | 1170 |
| 6-#10 | 4.95 | 625 | 626 | 1079 | 443 | 1193 | 351 | 1242 | 262 | 1293 | 111 | 1311 | -113 | 1300 |
| 6-#11 | 6.08 | 643 | 675 | 1147 | 465 | 1253 | 362 | 1308 | 262 | 1376 | 88 | 1377 | -180 | 1380 |

## ROUND TIED COLUMNS 14" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 7-#5 | 1.41 | 543 | 470 | 786 | 379 | 878 | 308 | 902 | 253 | 878 | 168 | 876 | 74 | 600 |
| 7-#6 | 2.00 | 559 | 496 | 829 | 394 | 928 | 319 | 960 | 259 | 951 | 164 | 969 | 51 | 791 |
| 7-#7 | 2.73 | 578 | 528 | 880 | 414 | 988 | 333 | 1030 | 267 | 1039 | 158 | 1073 | 21 | 1013 |
| 7-#8 | 3.59 | 601 | 566 | 940 | 437 | 1058 | 349 | 1111 | 276 | 1141 | 152 | 1192 | -17 | 1189 |
| 7-#9 | 4.55 | 625 | 608 | 1003 | 463 | 1132 | 366 | 1197 | 286 | 1249 | 144 | 1315 | -59 | 1326 |
| 7-#10 | 5.78 | 655 | 662 | 1082 | 496 | 1224 | 388 | 1306 | 299 | 1391 | 138 | 1466 | -115 | 1488 |
| 7-#11 | 7.09 | 680 | 720 | 1152 | 525 | 1300 | 405 | 1381 | 302 | 1485 | 116 | 1545 | -194 | 1572 |
| 8-#5 | 1.61 | 548 | 479 | 794 | 390 | 892 | 317 | 922 | 260 | 908 | 171 | 924 | 70 | 666 |
| 8-#6 | 2.29 | 567 | 509 | 843 | 409 | 949 | 330 | 987 | 268 | 992 | 168 | 1026 | 42 | 890 |
| 8-#7 | 3.12 | 589 | 545 | 902 | 431 | 1017 | 345 | 1066 | 278 | 1092 | 163 | 1147 | 7 | 1129 |
| 8-#8 | 4.11 | 614 | 589 | 968 | 458 | 1095 | 364 | 1157 | 290 | 1207 | 157 | 1284 | -35 | 1295 |
| 8-#9 | 5.20 | 641 | 637 | 1039 | 488 | 1179 | 385 | 1255 | 302 | 1330 | 149 | 1427 | -84 | 1447 |
| 8-#10 | 6.60 | 676 | 698 | 1127 | 526 | 1283 | 411 | 1377 | 318 | 1482 | 139 | 1603 | -149 | 1597 |

## ROUND TIED COLUMNS 16" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.19 | 792 | 602 | 1120 | 497 | 1271 | 406 | 1316 | 338 | 1290 | 231 | 1294 | 109 | 814 |
| 4-#8 | 1.57 | 805 | 623 | 1162 | 509 | 1320 | 414 | 1372 | 344 | 1364 | 229 | 1380 | 87 | 1037 |
| 4-#9 | 1.99 | 819 | 647 | 1207 | 522 | 1372 | 423 | 1433 | 350 | 1444 | 226 | 1471 | 61 | 1272 |
| 4-#10 | 2.53 | 837 | 678 | 1264 | 540 | 1438 | 435 | 1510 | 358 | 1545 | 223 | 1584 | 27 | 1526 |
| 4-#11 | 3.10 | 849 | 711 | 1325 | 552 | 1500 | 442 | 1578 | 361 | 1618 | 212 | 1654 | -19 | 1656 |
| 4-#14 | 4.48 | 888 | 790 | 1454 | 596 | 1654 | 472 | 1760 | 381 | 1840 | 198 | 1896 | -115 | 1898 |
| 4-#18 | 7.96 | 995 | 990 | 1755 | 708 | 2015 | 546 | 2171 | 425 | 2340 | 155 | 2418 | -379 | 2400 |
| 5-#6 | 1.09 | 802 | 596 | 1140 | 487 | 1275 | 397 | 1310 | 328 | 1270 | 224 | 1266 | 118 | 731 |
| 5-#7 | 1.49 | 820 | 619 | 1187 | 500 | 1330 | 406 | 1373 | 333 | 1350 | 220 | 1362 | 97 | 941 |
| 5-#8 | 1.96 | 841 | 646 | 1241 | 516 | 1393 | 417 | 1446 | 340 | 1444 | 216 | 1472 | 72 | 1179 |
| 5-#9 | 2.49 | 863 | 676 | 1299 | 533 | 1461 | 429 | 1526 | 347 | 1544 | 212 | 1589 | 44 | 1430 |
| 5-#10 | 3.16 | 891 | 714 | 1372 | 556 | 1546 | 445 | 1626 | 357 | 1669 | 205 | 1734 | 6 | 1716 |
| 5-#11 | 3.88 | 914 | 756 | 1444 | 574 | 1623 | 456 | 1711 | 361 | 1763 | 191 | 1823 | -46 | 1845 |
| 5-#14 | 5.60 | 978 | 854 | 1610 | 632 | 1820 | 494 | 1936 | 381 | 2045 | 169 | 2129 | -153 | 2183 |
| 6-#6 | 1.31 | 806 | 609 | 1209 | 472 | 1328 | 383 | 1357 | 316 | 1308 | 207 | 1273 | 89 | 850 |
| 6-#7 | 1.79 | 826 | 636 | 1267 | 487 | 1398 | 393 | 1438 | 321 | 1409 | 202 | 1383 | 61 | 1112 |
| 6-#8 | 2.36 | 849 | 669 | 1334 | 505 | 1480 | 406 | 1531 | 329 | 1527 | 195 | 1510 | 26 | 1408 |
| 6-#9 | 2.98 | 873 | 705 | 1407 | 525 | 1568 | 419 | 1631 | 336 | 1653 | 187 | 1644 | -13 | 1649 |
| 6-#10 | 3.79 | 904 | 751 | 1498 | 552 | 1680 | 437 | 1755 | 345 | 1810 | 177 | 1810 | -64 | 1827 |
| 6-#11 | 4.66 | 933 | 800 | 1588 | 574 | 1775 | 450 | 1852 | 348 | 1929 | 158 | 1913 | -132 | 1948 |
| 6-#14 | 6.71 | 1005 | 919 | 1800 | 641 | 2019 | 506 | 2130 | 367 | 2282 | 125 | 2354 | -251 | 2311 |
| 7-#5 | 1.08 | 801 | 595 | 1120 | 494 | 1270 | 405 | 1311 | 335 | 1275 | 230 | 1283 | 123 | 728 |
| 7-#6 | 1.53 | 822 | 621 | 1174 | 510 | 1333 | 416 | 1383 | 342 | 1368 | 227 | 1396 | 101 | 969 |
| 7-#7 | 2.09 | 848 | 653 | 1238 | 530 | 1409 | 430 | 1470 | 350 | 1482 | 223 | 1532 | 73 | 1245 |
| 7-#8 | 2.75 | 878 | 691 | 1311 | 553 | 1497 | 447 | 1572 | 361 | 1613 | 219 | 1687 | 39 | 1556 |
| 7-#9 | 3.48 | 909 | 733 | 1390 | 579 | 1591 | 465 | 1681 | 372 | 1753 | 213 | 1852 | 0 | 1852 |
| 7-#10 | 4.42 | 948 | 787 | 1489 | 613 | 1708 | 489 | 1819 | 386 | 1928 | 206 | 2055 | -51 | 2074 |
| 7-#11 | 5.43 | 978 | 845 | 1588 | 643 | 1812 | 507 | 1935 | 394 | 2062 | 188 | 2215 | -114 | 2228 |
| 7-#14 | 7.83 | 1069 | 983 | 1818 | 729 | 2082 | 565 | 2252 | 426 | 2454 | 161 | 2657 | -258 | 2650 |
| 8-#5 | 1.23 | 808 | 604 | 1125 | 507 | 1287 | 415 | 1336 | 344 | 1311 | 234 | 1346 | 121 | 805 |
| 8-#6 | 1.75 | 832 | 634 | 1186 | 525 | 1358 | 428 | 1417 | 352 | 1417 | 232 | 1480 | 96 | 1081 |
| 8-#7 | 2.39 | 860 | 670 | 1259 | 549 | 1443 | 445 | 1516 | 363 | 1545 | 229 | 1640 | 65 | 1405 |
| 8-#8 | 3.14 | 893 | 714 | 1343 | 576 | 1542 | 465 | 1631 | 376 | 1694 | 225 | 1824 | 28 | 1747 |
| 8-#9 | 3.98 | 927 | 762 | 1435 | 607 | 1648 | 486 | 1754 | 390 | 1854 | 220 | 2019 | -16 | 2023 |
| 8-#10 | 5.05 | 971 | 823 | 1549 | 647 | 1781 | 514 | 1909 | 407 | 2055 | 214 | 2260 | -73 | 2229 |
| 8-#11 | 6.21 | 1007 | 889 | 1658 | 683 | 1898 | 536 | 2040 | 418 | 2208 | 196 | 2419 | -152 | 2394 |
| 9-#10 | 5.68 | 1005 | 860 | 1622 | 663 | 1868 | 529 | 2016 | 413 | 2192 | 208 | 2393 | -106 | 2417 |
| 9-#11 | 6.98 | 1046 | 934 | 1743 | 703 | 2004 | 556 | 2164 | 424 | 2368 | 188 | 2567 | -194 | 2568 |
| 10-#10 | 6.32 | 1037 | 896 | 1708 | 678 | 1967 | 532 | 2130 | 413 | 2325 | 189 | 2523 | -150 | 2541 |

## ROUND TIED COLUMNS 18" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.24 | 1137 | 765 | 1582 | 642 | 1819 | 525 | 1897 | 438 | 1877 | 299 | 1917 | 145 | 1215 |
| 4-#9 | 1.57 | 1154 | 789 | 1637 | 656 | 1882 | 534 | 1970 | 444 | 1972 | 297 | 2032 | 122 | 1497 |
| 4-#10 | 2.00 | 1176 | 820 | 1705 | 673 | 1961 | 546 | 2062 | 452 | 2094 | 295 | 2176 | 91 | 1845 |
| 4-#11 | 2.45 | 1193 | 853 | 1783 | 685 | 2039 | 553 | 2146 | 456 | 2201 | 287 | 2276 | 48 | 2160 |
| 4-#14 | 3.54 | 1243 | 932 | 1941 | 730 | 2226 | 584 | 2366 | 477 | 2488 | 278 | 2596 | -38 | 2595 |
| 4-#18 | 6.29 | 1361 | 1132 | 2313 | 844 | 2670 | 661 | 2892 | 529 | 3137 | 247 | 3312 | -275 | 3271 |
| 5-#7 | 1.18 | 1153 | 760 | 1622 | 630 | 1836 | 514 | 1900 | 425 | 1864 | 290 | 1890 | 153 | 1114 |
| 5-#8 | 1.55 | 1179 | 788 | 1688 | 646 | 1912 | 526 | 1988 | 432 | 1979 | 287 | 2030 | 130 | 1399 |
| 5-#9 | 1.96 | 1207 | 818 | 1758 | 664 | 1995 | 538 | 2084 | 440 | 2104 | 284 | 2178 | 104 | 1702 |
| 5-#10 | 2.50 | 1241 | 856 | 1847 | 687 | 2098 | 554 | 2204 | 450 | 2261 | 279 | 2364 | 70 | 2076 |
| 5-#11 | 3.07 | 1270 | 898 | 1939 | 705 | 2195 | 565 | 2312 | 455 | 2385 | 266 | 2493 | 23 | 2418 |
| 5-#14 | 4.42 | 1350 | 996 | 2144 | 764 | 2438 | 606 | 2597 | 479 | 2741 | 250 | 2902 | -74 | 2929 |
| 5-#18 | 7.86 | 1549 | 1246 | 2621 | 913 | 3010 | 706 | 3267 | 536 | 3563 | 198 | 3807 | -339 | 3871 |
| 6-#6 | 1.04 | 1136 | 750 | 1661 | 596 | 1837 | 486 | 1880 | 402 | 1811 | 273 | 1771 | 141 | 994 |
| 6-#7 | 1.41 | 1161 | 778 | 1730 | 611 | 1920 | 496 | 1978 | 409 | 1935 | 269 | 1910 | 115 | 1305 |
| 6-#8 | 1.86 | 1189 | 810 | 1810 | 629 | 2018 | 508 | 2093 | 417 | 2079 | 263 | 2070 | 84 | 1660 |
| 6-#9 | 2.36 | 1219 | 846 | 1897 | 649 | 2123 | 522 | 2219 | 426 | 2233 | 257 | 2241 | 48 | 2036 |
| 6-#10 | 2.99 | 1257 | 892 | 2007 | 676 | 2256 | 540 | 2377 | 437 | 2428 | 248 | 2455 | 1 | 2452 |
| 6-#11 | 3.68 | 1289 | 942 | 2118 | 698 | 2382 | 555 | 2504 | 441 | 2586 | 232 | 2605 | -62 | 2621 |
| 6-#14 | 5.31 | 1377 | 1060 | 2377 | 766 | 2700 | 601 | 2858 | 465 | 3033 | 205 | 3072 | -194 | 3100 |
| 7-#6 | 1.21 | 1157 | 763 | 1599 | 642 | 1835 | 526 | 1912 | 435 | 1884 | 297 | 1933 | 157 | 1153 |
| 7-#7 | 1.65 | 1188 | 795 | 1676 | 661 | 1926 | 540 | 2018 | 444 | 2020 | 294 | 2103 | 132 | 1484 |
| 7-#8 | 2.17 | 1224 | 833 | 1764 | 685 | 2031 | 557 | 2140 | 455 | 2179 | 291 | 2300 | 100 | 1859 |
| 7-#9 | 2.75 | 1263 | 875 | 1859 | 712 | 2146 | 576 | 2273 | 467 | 2352 | 287 | 2510 | 65 | 2256 |
| 7-#10 | 3.49 | 1314 | 929 | 1978 | 746 | 2290 | 601 | 2440 | 482 | 2569 | 282 | 2771 | 18 | 2707 |
| 7-#11 | 4.29 | 1353 | 987 | 2102 | 776 | 2426 | 621 | 2587 | 492 | 2753 | 269 | 2958 | -45 | 2975 |
| 7-#14 | 6.19 | 1466 | 1124 | 2383 | 863 | 2760 | 682 | 2979 | 528 | 3249 | 249 | 3533 | -177 | 3570 |
| 8-#6 | 1.38 | 1167 | 775 | 1607 | 659 | 1867 | 541 | 1953 | 448 | 1943 | 304 | 2018 | 151 | 1275 |
| 8-#7 | 1.89 | 1202 | 812 | 1694 | 682 | 1970 | 558 | 2072 | 459 | 2097 | 302 | 2211 | 121 | 1662 |
| 8-#8 | 2.48 | 1243 | 855 | 1795 | 710 | 2089 | 578 | 2210 | 473 | 2276 | 299 | 2435 | 85 | 2102 |
| 8-#9 | 3.14 | 1285 | 903 | 1903 | 741 | 2218 | 601 | 2360 | 488 | 2470 | 296 | 2674 | 44 | 2550 |
| 8-#10 | 3.99 | 1339 | 965 | 2040 | 781 | 2380 | 629 | 2549 | 507 | 2715 | 291 | 3025 | 2 | 3020 |
| 8-#11 | 4.90 | 1384 | 1031 | 2184 | 818 | 2529 | 652 | 2715 | 519 | 2927 | 279 | 3251 | -70 | 3199 |
| 8-#14 | 7.07 | 1510 | 1189 | 2508 | 921 | 2906 | 723 | 3156 | 564 | 3497 | 262 | 3932 | -217 | 3848 |
| 9-#10 | 4.49 | 1379 | 1001 | 2137 | 798 | 2477 | 643 | 2674 | 511 | 2879 | 283 | 3194 | -31 | 3202 |
| 9-#11 | 5.52 | 1430 | 1076 | 2290 | 838 | 2647 | 670 | 2868 | 526 | 3130 | 273 | 3444 | -110 | 3466 |
| 10-#10 | 4.99 | 1417 | 1037 | 2248 | 811 | 2599 | 644 | 2806 | 510 | 3061 | 270 | 3355 | -72 | 3363 |
| 10-#11 | 6.13 | 1476 | 1120 | 2414 | 856 | 2789 | 674 | 3025 | 526 | 3320 | 250 | 3632 | -163 | 3646 |
| 11-#10 | 5.49 | 1452 | 1074 | 2281 | 851 | 2674 | 684 | 2905 | 538 | 3197 | 287 | 3587 | -87 | 3595 |
| 11-#11 | 6.74 | 1517 | 1165 | 2465 | 903 | 2879 | 719 | 3141 | 557 | 3491 | 270 | 3894 | -183 | 3889 |
| 12-#10 | 5.99 | 1497 | 1110 | 2337 | 883 | 2758 | 705 | 3024 | 559 | 3339 | 288 | 3800 | -110 | 3797 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 20" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.01 | 1547 | 923 | 2091 | 792 | 2430 | 650 | 2541 | 543 | 2505 | 379 | 2570 | 208 | 1392 |
| 4-#9 | 1.27 | 1569 | 947 | 2155 | 805 | 2503 | 659 | 2626 | 550 | 2615 | 377 | 2710 | 187 | 1722 |
| 4-#10 | 1.62 | 1596 | 978 | 2235 | 822 | 2596 | 671 | 2733 | 558 | 2757 | 374 | 2885 | 158 | 2131 |
| 4-#11 | 1.99 | 1617 | 1011 | 2330 | 835 | 2690 | 678 | 2834 | 562 | 2883 | 367 | 3015 | 119 | 2533 |
| 4-#14 | 2.86 | 1678 | 1090 | 2518 | 880 | 2910 | 709 | 3092 | 583 | 3226 | 360 | 3415 | 39 | 3317 |
| 4-#18 | 5.09 | 1823 | 1290 | 2962 | 995 | 3438 | 788 | 3715 | 638 | 4052 | 341 | 4331 | -178 | 4288 |
| 5-#8 | 1.26 | 1596 | 946 | 2227 | 792 | 2545 | 647 | 2650 | 535 | 2623 | 364 | 2701 | 192 | 1624 |
| 5-#9 | 1.59 | 1630 | 976 | 2310 | 810 | 2641 | 660 | 2761 | 543 | 2768 | 361 | 2882 | 168 | 1979 |
| 5-#10 | 2.02 | 1671 | 1014 | 2415 | 833 | 2763 | 676 | 2903 | 553 | 2954 | 358 | 3110 | 137 | 2418 |
| 5-#11 | 2.48 | 1707 | 1056 | 2528 | 851 | 2881 | 688 | 3033 | 559 | 3119 | 348 | 3280 | 93 | 2850 |
| 5-#14 | 3.58 | 1803 | 1154 | 2772 | 911 | 3169 | 729 | 3370 | 584 | 3554 | 336 | 3794 | 5 | 3778 |
| 5-#18 | 6.37 | 2030 | 1404 | 3347 | 1063 | 3856 | 834 | 4179 | 647 | 4568 | 295 | 4962 | -238 | 4996 |
| 6-#7 | 1.15 | 1575 | 936 | 2292 | 750 | 2559 | 611 | 2634 | 506 | 2572 | 343 | 2545 | 174 | 1499 |
| 6-#8 | 1.51 | 1609 | 968 | 2386 | 768 | 2671 | 624 | 2768 | 514 | 2743 | 338 | 2740 | 145 | 1912 |
| 6-#9 | 1.91 | 1645 | 1004 | 2487 | 789 | 2794 | 638 | 2913 | 523 | 2927 | 333 | 2949 | 111 | 2353 |
| 6-#10 | 2.43 | 1691 | 1051 | 2615 | 815 | 2949 | 656 | 3098 | 535 | 3160 | 326 | 3211 | 68 | 2899 |
| 6-#11 | 2.98 | 1730 | 1100 | 2749 | 837 | 3099 | 670 | 3271 | 543 | 3356 | 311 | 3409 | 9 | 3379 |
| 6-#14 | 4.30 | 1836 | 1219 | 3054 | 905 | 3472 | 717 | 3709 | 571 | 3899 | 289 | 3998 | -113 | 4012 |
| 6-#18 | 7.64 | 2110 | 1518 | 3782 | 1078 | 4372 | 835 | 4713 | 634 | 5170 | 223 | 5333 | -445 | 5312 |
| 7-#7 | 1.34 | 1608 | 953 | 2203 | 810 | 2555 | 664 | 2683 | 549 | 2674 | 374 | 2790 | 195 | 1730 |
| 7-#8 | 1.76 | 1651 | 991 | 2307 | 833 | 2678 | 681 | 2828 | 561 | 2860 | 371 | 3028 | 166 | 2170 |
| 7-#9 | 2.23 | 1698 | 1033 | 2418 | 860 | 2811 | 700 | 2983 | 573 | 3061 | 368 | 3284 | 133 | 2636 |
| 7-#10 | 2.83 | 1757 | 1087 | 2558 | 894 | 2979 | 725 | 3180 | 590 | 3317 | 364 | 3604 | 90 | 3212 |
| 7-#11 | 3.48 | 1806 | 1145 | 2708 | 924 | 3145 | 746 | 3359 | 600 | 3545 | 353 | 3849 | 31 | 3727 |
| 7-#14 | 5.01 | 1946 | 1283 | 3040 | 1012 | 3549 | 810 | 3827 | 639 | 4155 | 339 | 4573 | -90 | 4591 |
| 8-#7 | 1.53 | 1624 | 970 | 2216 | 832 | 2604 | 683 | 2747 | 566 | 2765 | 382 | 2922 | 187 | 1922 |
| 8-#8 | 2.01 | 1672 | 1014 | 2334 | 860 | 2746 | 704 | 2910 | 580 | 2974 | 381 | 3193 | 153 | 2437 |
| 8-#9 | 2.55 | 1724 | 1062 | 2460 | 891 | 2899 | 728 | 3086 | 596 | 3202 | 379 | 3483 | 115 | 2986 |
| 8-#10 | 3.23 | 1788 | 1123 | 2620 | 931 | 3091 | 757 | 3308 | 616 | 3491 | 376 | 3848 | 66 | 3641 |
| 8-#11 | 3.97 | 1843 | 1189 | 2792 | 968 | 3273 | 781 | 3511 | 630 | 3747 | 365 | 4129 | -2 | 4130 |
| 8-#14 | 5.73 | 1994 | 1347 | 3173 | 1071 | 3725 | 855 | 4037 | 678 | 4433 | 353 | 5057 | -122 | 4948 |
| 9-#10 | 3.64 | 1835 | 1159 | 2738 | 948 | 3198 | 769 | 3446 | 619 | 3683 | 367 | 4115 | 45 | 3934 |
| 9-#11 | 4.47 | 1899 | 1234 | 2928 | 989 | 3404 | 797 | 3681 | 635 | 3975 | 355 | 4442 | -27 | 4448 |
| 9-#14 | 6.45 | 2073 | 1411 | 3353 | 1103 | 3913 | 881 | 4285 | 689 | 4754 | 339 | 5389 | -179 | 5335 |
| 10-#10 | 4.04 | 1879 | 1196 | 2881 | 960 | 3346 | 769 | 3602 | 616 | 3886 | 352 | 4306 | 6 | 4285 |
| 10-#11 | 4.97 | 1951 | 1279 | 3083 | 1005 | 3575 | 799 | 3865 | 633 | 4229 | 339 | 4667 | -77 | 4672 |
| 10-#14 | 7.16 | 2146 | 1475 | 3555 | 1131 | 4148 | 888 | 4544 | 689 | 5109 | 317 | 5711 | -251 | 5684 |
| 11-#10 | 4.45 | 1922 | 1232 | 2905 | 1002 | 3423 | 811 | 3719 | 648 | 4059 | 374 | 4590 | -7 | 4591 |
| 11-#11 | 5.46 | 2001 | 1323 | 3127 | 1054 | 3675 | 848 | 4003 | 669 | 4417 | 360 | 4991 | -95 | 4997 |
| 12-#10 | 4.85 | 1973 | 1268 | 2969 | 1036 | 3520 | 833 | 3849 | 668 | 4227 | 377 | 4846 | -26 | 4845 |
| 12-#11 | 5.96 | 2062 | 1368 | 3204 | 1094 | 3792 | 874 | 4164 | 694 | 4615 | 363 | 5289 | -122 | 5279 |
| 13-#10 | 5.26 | 2009 | 1304 | 3079 | 1056 | 3646 | 852 | 3991 | 676 | 4415 | 374 | 5093 | -54 | 5062 |
| 14-#10 | 5.66 | 2064 | 1341 | 3193 | 1073 | 3787 | 859 | 4154 | 682 | 4601 | 360 | 5274 | -91 | 5262 |

## ROUND TIED COLUMNS 22" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.05 | 2071 | 1122 | 2770 | 971 | 3247 | 798 | 3414 | 667 | 3387 | 465 | 3517 | 257 | 1946 |
| 4-#10 | 1.34 | 2103 | 1153 | 2862 | 989 | 3353 | 810 | 3536 | 676 | 3548 | 463 | 3724 | 230 | 2416 |
| 4-#11 | 1.64 | 2129 | 1186 | 2975 | 1000 | 3464 | 816 | 3654 | 679 | 3694 | 455 | 3884 | 193 | 2884 |
| 4-#14 | 2.37 | 2203 | 1265 | 3193 | 1045 | 3718 | 848 | 3950 | 701 | 4087 | 450 | 4364 | 119 | 3972 |
| 4-#18 | 4.21 | 2376 | 1465 | 3710 | 1162 | 4330 | 929 | 4671 | 758 | 5046 | 434 | 5483 | -82 | 5457 |
| 5-#8 | 1.04 | 2102 | 1121 | 2867 | 954 | 3303 | 783 | 3444 | 650 | 3394 | 450 | 3500 | 260 | 1854 |
| 5-#9 | 1.32 | 2141 | 1151 | 2964 | 972 | 3414 | 795 | 3572 | 658 | 3560 | 447 | 3713 | 237 | 2261 |
| 5-#10 | 1.67 | 2190 | 1189 | 3085 | 996 | 3554 | 812 | 3734 | 668 | 3772 | 444 | 3983 | 208 | 2766 |
| 5-#11 | 2.05 | 2232 | 1231 | 3220 | 1014 | 3693 | 823 | 3886 | 674 | 3965 | 435 | 4194 | 167 | 3270 |
| 5-#14 | 2.96 | 2346 | 1329 | 3504 | 1074 | 4028 | 865 | 4277 | 700 | 4478 | 425 | 4815 | 84 | 4447 |
| 5-#18 | 5.26 | 2614 | 1579 | 4179 | 1228 | 4830 | 973 | 5220 | 767 | 5703 | 396 | 6250 | -139 | 6267 |
| 6-#8 | 1.25 | 2117 | 1143 | 3071 | 923 | 3454 | 752 | 3575 | 622 | 3533 | 421 | 3532 | 210 | 2165 |
| 6-#9 | 1.58 | 2159 | 1179 | 3187 | 943 | 3593 | 766 | 3740 | 631 | 3747 | 416 | 3779 | 179 | 2672 |
| 6-#10 | 2.00 | 2213 | 1226 | 3334 | 969 | 3770 | 784 | 3951 | 643 | 4017 | 410 | 4090 | 137 | 3300 |
| 6-#11 | 2.46 | 2259 | 1275 | 3491 | 991 | 3945 | 798 | 4152 | 651 | 4252 | 397 | 4336 | 83 | 3924 |
| 6-#14 | 3.55 | 2385 | 1394 | 3842 | 1059 | 4374 | 845 | 4664 | 681 | 4892 | 378 | 5049 | -31 | 5053 |
| 6-#18 | 6.31 | 2709 | 1693 | 4686 | 1233 | 5414 | 965 | 5893 | 756 | 6407 | 322 | 6695 | -340 | 6653 |
| 7-#7 | 1.10 | 2115 | 1128 | 2830 | 974 | 3308 | 801 | 3479 | 666 | 3455 | 461 | 3605 | 264 | 1973 |
| 7-#8 | 1.45 | 2167 | 1166 | 2949 | 998 | 3448 | 818 | 3643 | 677 | 3668 | 459 | 3885 | 236 | 2489 |
| 7-#9 | 1.84 | 2222 | 1208 | 3077 | 1024 | 3600 | 838 | 3823 | 690 | 3899 | 457 | 4187 | 206 | 3026 |
| 7-#10 | 2.34 | 2291 | 1262 | 3237 | 1059 | 3793 | 863 | 4050 | 707 | 4194 | 454 | 4566 | 165 | 3694 |
| 7-#11 | 2.87 | 2350 | 1320 | 3414 | 1089 | 3987 | 883 | 4265 | 718 | 4461 | 443 | 4871 | 110 | 4346 |
| 7-#14 | 4.14 | 2517 | 1458 | 3798 | 1177 | 4452 | 948 | 4808 | 760 | 5168 | 433 | 5745 | -2 | 5745 |
| 7-#18 | 7.37 | 2906 | 1807 | 4716 | 1403 | 5575 | 1111 | 6110 | 861 | 6871 | 400 | 7762 | -309 | 7729 |
| 8-#7 | 1.26 | 2133 | 1145 | 2835 | 998 | 3358 | 822 | 3555 | 685 | 3561 | 472 | 3763 | 257 | 2185 |
| 8-#8 | 1.66 | 2189 | 1189 | 2969 | 1026 | 3519 | 843 | 3741 | 700 | 3802 | 471 | 4081 | 226 | 2776 |
| 8-#9 | 2.10 | 2250 | 1236 | 3114 | 1057 | 3695 | 867 | 3943 | 716 | 4063 | 469 | 4424 | 191 | 3407 |
| 8-#10 | 2.67 | 2327 | 1298 | 3296 | 1097 | 3917 | 897 | 4200 | 737 | 4395 | 467 | 4855 | 144 | 4192 |
| 8-#11 | 3.28 | 2392 | 1364 | 3498 | 1134 | 4141 | 923 | 4439 | 751 | 4697 | 458 | 5204 | 81 | 4926 |
| 8-#14 | 4.74 | 2569 | 1522 | 3936 | 1238 | 4668 | 999 | 5052 | 802 | 5493 | 450 | 6197 | -50 | 6194 |
| 9-#10 | 3.01 | 2381 | 1334 | 3437 | 1113 | 4043 | 908 | 4350 | 738 | 4617 | 459 | 5167 | 124 | 4568 |
| 9-#11 | 3.69 | 2457 | 1409 | 3659 | 1154 | 4285 | 937 | 4625 | 754 | 4960 | 448 | 5572 | 56 | 5324 |
| 9-#14 | 5.33 | 2662 | 1586 | 4153 | 1270 | 4873 | 1022 | 5322 | 810 | 5867 | 436 | 6714 | -85 | 6660 |
| 10-#10 | 3.34 | 2431 | 1371 | 3617 | 1124 | 4219 | 906 | 4531 | 733 | 4834 | 441 | 5385 | 86 | 5038 |
| 10-#11 | 4.10 | 2516 | 1453 | 3856 | 1170 | 4487 | 937 | 4839 | 751 | 5234 | 429 | 5834 | 9 | 5801 |
| 10-#14 | 5.92 | 2743 | 1650 | 4403 | 1297 | 5150 | 1028 | 5623 | 810 | 6272 | 414 | 7094 | -153 | 7069 |
| 11-#10 | 3.68 | 2479 | 1407 | 3627 | 1169 | 4295 | 951 | 4665 | 768 | 5026 | 462 | 5725 | 75 | 5384 |
| 11-#11 | 4.51 | 2575 | 1498 | 3887 | 1221 | 4590 | 989 | 4998 | 790 | 5469 | 456 | 6222 | -7 | 6223 |
| 11-#14 | 6.51 | 2827 | 1715 | 4477 | 1365 | 5309 | 1096 | 5845 | 860 | 6586 | 446 | 7616 | -180 | 7565 |
| 12-#10 | 4.01 | 2538 | 1443 | 3697 | 1204 | 4405 | 974 | 4805 | 789 | 5245 | 472 | 6025 | 59 | 5786 |
| 12-#11 | 4.92 | 2644 | 1543 | 3974 | 1263 | 4723 | 1016 | 5172 | 815 | 5703 | 460 | 6573 | -30 | 6570 |
| 13-#10 | 4.34 | 2581 | 1479 | 3822 | 1224 | 4551 | 993 | 4970 | 797 | 5448 | 468 | 6282 | 25 | 6174 |
| 13-#11 | 5.33 | 2694 | 1587 | 4123 | 1288 | 4894 | 1039 | 5367 | 825 | 5956 | 457 | 6912 | -64 | 6865 |
| 14-#10 | 4.68 | 2641 | 1516 | 3958 | 1240 | 4709 | 999 | 5162 | 802 | 5661 | 454 | 6525 | -4 | 6525 |
| 14-#11 | 5.75 | 2771 | 1632 | 4279 | 1309 | 5085 | 1048 | 5593 | 832 | 6210 | 439 | 7161 | -109 | 7140 |
| 15-#10 | 5.01 | 2678 | 1552 | 4037 | 1274 | 4805 | 1034 | 5282 | 825 | 5864 | 470 | 6868 | -19 | 6864 |
| 16-#10 | 5.35 | 2729 | 1588 | 4126 | 1301 | 4933 | 1057 | 5431 | 845 | 6055 | 472 | 7132 | -41 | 7120 |

## ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.12 | 2707 | 1345 | 3595 | 1171 | 4246 | 962 | 4484 | 805 | 4481 | 559 | 4705 | 307 | 2699 |
| 4-#11 | 1.38 | 2739 | 1378 | 3726 | 1182 | 4373 | 969 | 4618 | 808 | 4647 | 552 | 4896 | 271 | 3234 |
| 4-#14 | 1.99 | 2825 | 1457 | 3975 | 1227 | 4662 | 1000 | 4954 | 830 | 5089 | 547 | 5457 | 202 | 4479 |
| 4-#18 | 3.54 | 3028 | 1657 | 4567 | 1344 | 5359 | 1082 | 5772 | 889 | 6175 | 534 | 6781 | 13 | 6744 |
| 5-#9 | 1.11 | 2749 | 1342 | 3726 | 1150 | 4324 | 944 | 4528 | 784 | 4492 | 542 | 4684 | 311 | 2549 |
| 5-#10 | 1.40 | 2805 | 1381 | 3864 | 1174 | 4482 | 961 | 4711 | 794 | 4731 | 539 | 4995 | 283 | 3121 |
| 5-#11 | 1.72 | 2855 | 1422 | 4023 | 1192 | 4643 | 972 | 4886 | 800 | 4951 | 530 | 5248 | 244 | 3696 |
| 5-#14 | 2.49 | 2986 | 1521 | 4349 | 1252 | 5024 | 1015 | 5330 | 827 | 5533 | 521 | 5977 | 167 | 5039 |
| 5-#18 | 4.42 | 3297 | 1771 | 5124 | 1408 | 5943 | 1124 | 6407 | 896 | 6951 | 498 | 7683 | -42 | 7688 |
| 6-#8 | 1.05 | 2721 | 1335 | 3876 | 1093 | 4377 | 893 | 4528 | 741 | 4456 | 511 | 4458 | 280 | 2419 |
| 6-#9 | 1.33 | 2770 | 1371 | 4007 | 1113 | 4534 | 907 | 4714 | 750 | 4704 | 507 | 4743 | 250 | 2990 |
| 6-#10 | 1.68 | 2832 | 1417 | 4173 | 1139 | 4733 | 925 | 4950 | 762 | 5013 | 502 | 5103 | 211 | 3702 |
| 6-#11 | 2.07 | 2887 | 1467 | 4354 | 1161 | 4933 | 939 | 5178 | 770 | 5287 | 490 | 5398 | 159 | 4415 |
| 6-#14 | 2.98 | 3032 | 1585 | 4752 | 1229 | 5417 | 986 | 5756 | 801 | 6023 | 473 | 6237 | 52 | 6040 |
| 6-#18 | 5.31 | 3378 | 1885 | 5713 | 1403 | 6598 | 1107 | 7169 | 880 | 7784 | 426 | 8197 | -238 | 8154 |
| 7-#8 | 1.22 | 2779 | 1358 | 3698 | 1179 | 4354 | 969 | 4604 | 805 | 4617 | 555 | 4884 | 312 | 2816 |
| 7-#9 | 1.55 | 2842 | 1400 | 3843 | 1205 | 4526 | 989 | 4805 | 818 | 4879 | 554 | 5232 | 283 | 3426 |
| 7-#10 | 1.97 | 2922 | 1454 | 4025 | 1240 | 4743 | 1014 | 5061 | 835 | 5211 | 551 | 5671 | 245 | 4184 |
| 7-#11 | 2.41 | 2992 | 1511 | 4230 | 1269 | 4965 | 1034 | 5311 | 847 | 5518 | 542 | 6036 | 193 | 4936 |
| 7-#14 | 3.48 | 3180 | 1649 | 4666 | 1358 | 5492 | 1099 | 5935 | 891 | 6323 | 533 | 7061 | 87 | 6652 |
| 7-#18 | 6.19 | 3638 | 1999 | 5714 | 1585 | 6770 | 1265 | 7430 | 997 | 8274 | 507 | 9460 | -200 | 9428 |
| 8-#8 | 1.40 | 2803 | 1380 | 3709 | 1209 | 4427 | 996 | 4717 | 825 | 4771 | 569 | 5102 | 303 | 3118 |
| 8-#9 | 1.77 | 2873 | 1428 | 3873 | 1240 | 4624 | 1020 | 4947 | 840 | 5066 | 568 | 5500 | 270 | 3831 |
| 8-#10 | 2.25 | 2960 | 1490 | 4078 | 1280 | 4874 | 1050 | 5237 | 868 | 5441 | 567 | 6006 | 226 | 4722 |
| 8-#11 | 2.76 | 3040 | 1556 | 4310 | 1316 | 5131 | 1076 | 5513 | 883 | 5788 | 558 | 6423 | 167 | 5609 |
| 8-#14 | 3.98 | 3243 | 1714 | 4806 | 1420 | 5740 | 1155 | 6213 | 936 | 6696 | 553 | 7588 | 45 | 7409 |
| 8-#18 | 7.07 | 3732 | 2113 | 6004 | 1686 | 7192 | 1350 | 7900 | 1067 | 8891 | 533 | 10315 | -287 | 10200 |
| 9-#10 | 2.53 | 3025 | 1526 | 4243 | 1295 | 5025 | 1061 | 5400 | 868 | 5685 | 558 | 6326 | 201 | 5184 |
| 9-#11 | 3.10 | 3114 | 1601 | 4499 | 1336 | 5302 | 1090 | 5715 | 885 | 6087 | 549 | 6845 | 143 | 6107 |
| 9-#14 | 4.48 | 3350 | 1778 | 5058 | 1452 | 5970 | 1177 | 6505 | 942 | 7121 | 540 | 8186 | 11 | 8136 |
| 9-#18 | 7.96 | 3919 | 2227 | 6410 | 1747 | 7587 | 1395 | 8425 | 1084 | 9619 | 512 | 11323 | -348 | 11027 |
| 10-#10 | 2.81 | 3081 | 1562 | 4460 | 1303 | 5229 | 1057 | 5606 | 861 | 5923 | 538 | 6606 | 169 | 5713 |
| 10-#11 | 3.45 | 3180 | 1645 | 4740 | 1349 | 5538 | 1088 | 5958 | 879 | 6379 | 527 | 7142 | 96 | 6720 |
| 10-#14 | 4.97 | 3441 | 1842 | 5364 | 1478 | 6291 | 1180 | 6849 | 940 | 7557 | 514 | 8621 | -55 | 8610 |
| 11-#10 | 3.09 | 3136 | 1599 | 4456 | 1352 | 5302 | 1104 | 5752 | 899 | 6145 | 562 | 7003 | 160 | 6151 |
| 11-#11 | 3.79 | 3246 | 1690 | 4755 | 1404 | 5640 | 1142 | 6138 | 922 | 6638 | 552 | 7598 | 83 | 7190 |
| 11-#14 | 5.47 | 3537 | 1906 | 5425 | 1549 | 6454 | 1251 | 7101 | 994 | 7926 | 551 | 9234 | -79 | 9215 |
| 12-#10 | 3.37 | 3202 | 1635 | 4531 | 1389 | 5425 | 1129 | 5907 | 921 | 6390 | 573 | 7349 | 146 | 6675 |
| 12-#11 | 4.14 | 3324 | 1734 | 4849 | 1448 | 5789 | 1171 | 6326 | 947 | 6934 | 565 | 8003 | 63 | 7724 |
| 12-#14 | 5.97 | 3644 | 1971 | 5567 | 1608 | 6668 | 1290 | 7375 | 1029 | 8309 | 559 | 9794 | -111 | 9751 |
| 13-#10 | 3.65 | 3251 | 1671 | 4671 | 1407 | 5592 | 1148 | 6094 | 928 | 6623 | 570 | 7644 | 113 | 7078 |
| 13-#11 | 4.48 | 3383 | 1779 | 5016 | 1471 | 5985 | 1194 | 6548 | 957 | 7206 | 560 | 8350 | 22 | 8241 |
| 13-#14 | 6.47 | 3727 | 2035 | 5800 | 1644 | 6942 | 1324 | 7687 | 1044 | 8706 | 554 | 10282 | -169 | 10193 |
| 14-#10 | 3.93 | 3322 | 1707 | 4832 | 1422 | 5768 | 1151 | 6305 | 932 | 6862 | 555 | 7920 | 85 | 7526 |
| 14-#11 | 4.83 | 3466 | 1823 | 5200 | 1492 | 6197 | 1201 | 6806 | 964 | 7493 | 543 | 8681 | -13 | 8678 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway $f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 15-#10 | 4.21 | 3361 | 1744 | 4910 | 1458 | 5873 | 1189 | 6447 | 958 | 7088 | 573 | 8316 | 72 | 7957 |
| 15-#11 | 5.17 | 3514 | 1868 | 5306 | 1534 | 6326 | 1245 | 6968 | 993 | 7767 | 563 | 9141 | -32 | 9132 |
| 16-#10 | 4.49 | 3422 | 1780 | 5007 | 1486 | 6012 | 1212 | 6616 | 979 | 7300 | 575 | 8621 | 52 | 8381 |
| 16-#11 | 5.52 | 3584 | 1912 | 5425 | 1567 | 6499 | 1273 | 7169 | 1017 | 8022 | 565 | 9498 | -58 | 9476 |
| 17-#10 | 4.77 | 3469 | 1816 | 5129 | 1512 | 6163 | 1232 | 6790 | 986 | 7549 | 575 | 8953 | 24 | 8834 |
| 18-#10 | 5.05 | 3523 | 1852 | 5289 | 1528 | 6339 | 1241 | 6982 | 993 | 7802 | 566 | 9215 | -5 | 9213 |

## ROUND TIED COLUMNS 26" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#11 | 1.18 | 3454 | 1586 | 4593 | 1381 | 5430 | 1134 | 5742 | 949 | 5753 | 657 | 6062 | 355 | 3582 |
| 4-#14 | 1.70 | 3553 | 1665 | 4873 | 1426 | 5753 | 1166 | 6116 | 971 | 6246 | 653 | 6706 | 289 | 4984 |
| 4-#18 | 3.01 | 3787 | 1865 | 5540 | 1543 | 6535 | 1248 | 7032 | 1030 | 7459 | 641 | 8236 | 111 | 7886 |
| 5-#10 | 1.20 | 3526 | 1589 | 4762 | 1368 | 5560 | 1123 | 5847 | 932 | 5843 | 642 | 6161 | 364 | 3482 |
| 5-#11 | 1.47 | 3584 | 1631 | 4946 | 1385 | 5743 | 1134 | 6045 | 937 | 6090 | 633 | 6455 | 327 | 4129 |
| 5-#14 | 2.12 | 3733 | 1729 | 5316 | 1447 | 6171 | 1177 | 6542 | 965 | 6741 | 625 | 7292 | 254 | 5639 |
| 5-#18 | 3.77 | 4088 | 1979 | 6193 | 1603 | 7207 | 1288 | 7754 | 1036 | 8334 | 605 | 9272 | 57 | 9008 |
| 6-#9 | 1.13 | 3487 | 1579 | 4958 | 1299 | 5628 | 1061 | 5847 | 880 | 5795 | 604 | 5853 | 327 | 3308 |
| 6-#10 | 1.44 | 3557 | 1626 | 5142 | 1325 | 5849 | 1079 | 6109 | 892 | 6145 | 600 | 6263 | 290 | 4104 |
| 6-#11 | 1.76 | 3620 | 1675 | 5348 | 1346 | 6075 | 1092 | 6364 | 899 | 6472 | 589 | 6607 | 240 | 4907 |
| 6-#14 | 2.54 | 3785 | 1793 | 5793 | 1413 | 6615 | 1139 | 7008 | 930 | 7306 | 576 | 7572 | 138 | 6785 |
| 6-#18 | 4.52 | 4180 | 2093 | 6872 | 1588 | 7936 | 1261 | 8588 | 1010 | 9314 | 535 | 9850 | -137 | 9820 |
| 7-#9 | 1.32 | 3568 | 1608 | 4727 | 1402 | 5600 | 1153 | 5946 | 957 | 6012 | 659 | 6430 | 365 | 3835 |
| 7-#10 | 1.67 | 3659 | 1662 | 4931 | 1437 | 5841 | 1179 | 6231 | 975 | 6383 | 657 | 6930 | 329 | 4684 |
| 7-#11 | 2.06 | 3740 | 1720 | 5164 | 1466 | 6092 | 1198 | 6511 | 986 | 6729 | 648 | 7355 | 279 | 5534 |
| 7-#14 | 2.97 | 3954 | 1858 | 5653 | 1555 | 6681 | 1264 | 7209 | 1031 | 7632 | 641 | 8532 | 179 | 7522 |
| 7-#18 | 5.27 | 4478 | 2207 | 6831 | 1783 | 8115 | 1431 | 8909 | 1142 | 9832 | 620 | 11317 | -91 | 11300 |
| 8-#9 | 1.51 | 3601 | 1636 | 4745 | 1440 | 5700 | 1186 | 6108 | 983 | 6224 | 675 | 6718 | 353 | 4261 |
| 8-#10 | 1.91 | 3700 | 1698 | 4975 | 1480 | 5977 | 1217 | 6433 | 1003 | 6642 | 675 | 7287 | 311 | 5257 |
| 8-#11 | 2.35 | 3790 | 1764 | 5237 | 1515 | 6267 | 1242 | 6746 | 1026 | 7034 | 667 | 7798 | 257 | 6257 |
| 8-#14 | 3.39 | 4025 | 1922 | 5791 | 1619 | 6945 | 1321 | 7532 | 1081 | 8053 | 664 | 9136 | 142 | 8503 |
| 8-#18 | 6.03 | 4579 | 2322 | 7134 | 1886 | 8604 | 1523 | 9439 | 1217 | 10531 | 651 | 12299 | -171 | 12218 |
| 9-#10 | 2.15 | 3775 | 1734 | 5166 | 1493 | 6154 | 1228 | 6609 | 1005 | 6903 | 664 | 7667 | 287 | 5815 |
| 9-#11 | 2.64 | 3877 | 1809 | 5455 | 1534 | 6468 | 1256 | 6963 | 1026 | 7359 | 656 | 8228 | 225 | 6858 |
| 9-#14 | 3.81 | 4145 | 1986 | 6081 | 1650 | 7216 | 1344 | 7847 | 1085 | 8530 | 651 | 9815 | 108 | 9253 |
| 9-#18 | 6.78 | 4791 | 2436 | 7596 | 1947 | 9035 | 1566 | 10004 | 1231 | 11353 | 631 | 13454 | -230 | 13222 |
| 10-#10 | 2.39 | 3837 | 1771 | 5420 | 1497 | 6388 | 1220 | 6840 | 1000 | 7165 | 643 | 7980 | 256 | 6377 |
| 10-#11 | 2.94 | 3951 | 1853 | 5740 | 1544 | 6738 | 1251 | 7237 | 1018 | 7678 | 632 | 8605 | 187 | 7568 |
| 10-#14 | 4.24 | 4246 | 2050 | 6447 | 1675 | 7583 | 1345 | 8235 | 1081 | 8995 | 622 | 10303 | 44 | 10101 |
| 10-#18 | 7.53 | 4956 | 2550 | 8136 | 2004 | 9634 | 1581 | 10665 | 1236 | 12211 | 591 | 14316 | -342 | 13889 |
| 11-#10 | 2.63 | 3899 | 1807 | 5401 | 1552 | 6457 | 1271 | 6995 | 1037 | 7418 | 669 | 8426 | 249 | 6904 |
| 11-#11 | 3.23 | 4025 | 1898 | 5740 | 1604 | 6838 | 1309 | 7432 | 1065 | 7972 | 661 | 9131 | 176 | 8139 |
| 11-#14 | 4.66 | 4356 | 2115 | 6490 | 1749 | 7748 | 1419 | 8517 | 1139 | 9393 | 655 | 11010 | 23 | 10891 |
| 12-#10 | 2.87 | 3973 | 1843 | 5479 | 1590 | 6592 | 1297 | 7167 | 1055 | 7684 | 681 | 8803 | 235 | 7466 |
| 12-#11 | 3.53 | 4113 | 1942 | 5841 | 1648 | 7002 | 1339 | 7638 | 1091 | 8298 | 674 | 9591 | 159 | 8805 |
| 12-#14 | 5.09 | 4473 | 2179 | 6644 | 1810 | 7985 | 1459 | 8809 | 1174 | 9860 | 674 | 11648 | -5 | 11646 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway $f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 13-#10 | 3.11 | 4029 | 1879 | 5635 | 1607 | 6776 | 1315 | 7377 | 1067 | 7952 | 679 | 9147 | 204 | 7967 |
| 13-#11 | 3.82 | 4179 | 1987 | 6026 | 1671 | 7224 | 1363 | 7888 | 1100 | 8610 | 670 | 9986 | 119 | 9351 |
| 13-#14 | 5.51 | 4568 | 2243 | 6902 | 1845 | 8295 | 1494 | 9161 | 1189 | 10292 | 668 | 12205 | -63 | 12176 |
| 14-#10 | 3.35 | 4110 | 1916 | 5824 | 1620 | 6976 | 1317 | 7606 | 1073 | 8218 | 664 | 9472 | 178 | 8531 |
| 14-#11 | 4.11 | 4274 | 2032 | 6239 | 1690 | 7458 | 1367 | 8168 | 1106 | 8930 | 653 | 10357 | 85 | 9937 |
| 14-#14 | 5.93 | 4711 | 2307 | 7181 | 1877 | 8623 | 1506 | 9564 | 1201 | 10751 | 645 | 12738 | -112 | 12677 |
| 15-#10 | 3.59 | 4152 | 1952 | 5897 | 1658 | 7088 | 1357 | 7764 | 1097 | 8462 | 682 | 9904 | 164 | 9001 |
| 15-#11 | 4.41 | 4328 | 2076 | 6344 | 1733 | 7599 | 1413 | 8358 | 1137 | 9229 | 674 | 10883 | 68 | 10519 |
| 16-#10 | 3.83 | 4222 | 1988 | 6003 | 1687 | 7238 | 1381 | 7959 | 1115 | 8700 | 685 | 10241 | 145 | 9508 |
| 16-#11 | 4.70 | 4407 | 2121 | 6475 | 1768 | 7784 | 1442 | 8583 | 1162 | 9512 | 677 | 11288 | 43 | 11074 |
| 17-#10 | 4.07 | 4273 | 2024 | 6141 | 1713 | 7415 | 1396 | 8147 | 1126 | 8978 | 686 | 10622 | 118 | 9980 |
| 17-#11 | 5.00 | 4469 | 2165 | 6637 | 1800 | 7985 | 1465 | 8815 | 1172 | 9844 | 677 | 11733 | 9 | 11683 |
| 18-#10 | 4.31 | 4334 | 2061 | 6321 | 1727 | 7611 | 1410 | 8362 | 1128 | 9249 | 675 | 10926 | 91 | 10482 |
| 18-#11 | 5.29 | 4542 | 2210 | 6848 | 1819 | 8220 | 1478 | 9071 | 1180 | 10180 | 666 | 12083 | -26 | 12070 |
| 19-#10 | 4.54 | 4399 | 2097 | 6384 | 1767 | 7731 | 1438 | 8535 | 1156 | 9496 | 689 | 11338 | 74 | 10960 |
| 20-#10 | 4.78 | 4453 | 2133 | 6504 | 1796 | 7873 | 1464 | 8715 | 1171 | 9748 | 692 | 11754 | 66 | 11425 |

## ROUND TIED COLUMNS 28" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#11 | 1.01 | 4283 | 1811 | 5583 | 1596 | 6645 | 1314 | 7036 | 1091 | 7027 | 771 | 7364 | 442 | 3930 |
| 4-#14 | 1.46 | 4395 | 1890 | 5895 | 1641 | 7003 | 1346 | 7449 | 1109 | 7569 | 767 | 8107 | 380 | 5487 |
| 4-#18 | 2.60 | 4661 | 2090 | 6639 | 1758 | 7871 | 1428 | 8463 | 1183 | 8910 | 757 | 9861 | 212 | 9104 |
| 5-#10 | 1.03 | 4361 | 1814 | 5790 | 1578 | 6800 | 1299 | 7155 | 1081 | 7121 | 753 | 7492 | 450 | 3849 |
| 5-#11 | 1.27 | 4427 | 1856 | 5997 | 1595 | 7005 | 1309 | 7375 | 1085 | 7395 | 744 | 7828 | 415 | 4569 |
| 5-#14 | 1.83 | 4595 | 1954 | 6407 | 1656 | 7481 | 1352 | 7927 | 1114 | 8115 | 737 | 8773 | 345 | 6247 |
| 5-#18 | 3.25 | 4995 | 2204 | 7394 | 1814 | 8634 | 1464 | 9274 | 1186 | 9883 | 719 | 11029 | 157 | 10208 |
| 6-#10 | 1.24 | 4396 | 1851 | 6252 | 1525 | 7132 | 1246 | 7440 | 1033 | 7433 | 704 | 7581 | 373 | 4506 |
| 6-#11 | 1.52 | 4468 | 1900 | 6483 | 1546 | 7383 | 1258 | 7723 | 1039 | 7802 | 695 | 7975 | 325 | 5401 |
| 6-#14 | 2.19 | 4654 | 2018 | 6976 | 1614 | 7979 | 1306 | 8433 | 1071 | 8752 | 684 | 9066 | 227 | 7488 |
| 6-#18 | 3.90 | 5098 | 2318 | 8173 | 1788 | 9442 | 1428 | 10180 | 1151 | 11009 | 649 | 11664 | -35 | 11656 |
| 7-#9 | 1.14 | 4409 | 1833 | 5738 | 1616 | 6833 | 1331 | 7259 | 1105 | 7312 | 772 | 7778 | 451 | 4236 |
| 7-#10 | 1.44 | 4511 | 1887 | 5963 | 1650 | 7100 | 1357 | 7572 | 1121 | 7721 | 771 | 8341 | 417 | 5196 |
| 7-#11 | 1.77 | 4603 | 1945 | 6225 | 1679 | 7380 | 1376 | 7883 | 1137 | 8106 | 762 | 8842 | 371 | 6144 |
| 7-#14 | 2.56 | 4844 | 2083 | 6767 | 1768 | 8031 | 1442 | 8653 | 1182 | 9108 | 757 | 10172 | 275 | 8359 |
| 7-#18 | 4.55 | 5423 | 2432 | 8078 | 1997 | 9621 | 1611 | 10543 | 1296 | 11556 | 741 | 13345 | 19 | 13246 |
| 8-#9 | 1.30 | 4444 | 1861 | 5740 | 1656 | 6934 | 1367 | 7437 | 1136 | 7549 | 791 | 8105 | 441 | 4695 |
| 8-#10 | 1.65 | 4555 | 1923 | 5993 | 1696 | 7239 | 1397 | 7799 | 1157 | 8011 | 791 | 8736 | 401 | 5796 |
| 8-#11 | 2.03 | 4657 | 1989 | 6288 | 1731 | 7561 | 1422 | 8150 | 1170 | 8448 | 784 | 9310 | 348 | 6911 |
| 8-#14 | 2.92 | 4923 | 2147 | 6901 | 1835 | 8310 | 1501 | 9024 | 1222 | 9578 | 782 | 10838 | 240 | 9531 |
| 8-#18 | 5.20 | 5545 | 2547 | 8389 | 2102 | 10144 | 1704 | 11150 | 1377 | 12338 | 775 | 14456 | -54 | 14428 |
| 9-#10 | 1.86 | 4640 | 1959 | 6213 | 1708 | 7440 | 1407 | 7989 | 1157 | 8289 | 779 | 9157 | 377 | 6460 |
| 9-#11 | 2.28 | 4756 | 2034 | 6537 | 1748 | 7793 | 1436 | 8383 | 1173 | 8794 | 771 | 9815 | 319 | 7627 |
| 9-#14 | 3.29 | 5057 | 2211 | 7230 | 1864 | 8622 | 1524 | 9361 | 1238 | 10087 | 768 | 11539 | 198 | 10374 |
| 9-#18 | 5.85 | 5781 | 2661 | 8911 | 2162 | 10643 | 1749 | 11755 | 1388 | 13255 | 756 | 15758 | -112 | 15563 |
| 10-#10 | 2.06 | 4708 | 1996 | 6510 | 1708 | 7710 | 1397 | 8246 | 1150 | 8573 | 755 | 9521 | 347 | 7051 |
| 10-#11 | 2.53 | 4837 | 2078 | 6868 | 1754 | 8101 | 1428 | 8689 | 1169 | 9143 | 745 | 10234 | 281 | 8379 |
| 10-#14 | 3.65 | 5168 | 2275 | 7648 | 1885 | 9037 | 1523 | 9793 | 1232 | 10599 | 737 | 12154 | 146 | 11413 |
| 10-#18 | 6.50 | 5963 | 2775 | 9544 | 2218 | 11319 | 1762 | 12492 | 1391 | 14169 | 712 | 16725 | -220 | 16573 |

## ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 11-#10 | 2.27 | 4777 | 2032 | 6468 | 1767 | 7771 | 1452 | 8410 | 1190 | 8858 | 786 | 10004 | 340 | 7682 |
| 11-#11 | 2.79 | 4920 | 2123 | 6850 | 1819 | 8195 | 1490 | 8895 | 1213 | 9475 | 777 | 10818 | 272 | 9057 |
| 11-#14 | 4.02 | 5287 | 2340 | 7680 | 1965 | 9201 | 1600 | 10092 | 1293 | 11047 | 774 | 12957 | 128 | 12228 |
| 11-#18 | 7.15 | 6178 | 2889 | 9696 | 2335 | 11660 | 1880 | 13025 | 1483 | 14897 | 761 | 18013 | -265 | 17775 |
| 12-#10 | 2.48 | 4858 | 2068 | 6550 | 1807 | 7917 | 1479 | 8598 | 1210 | 9144 | 797 | 10427 | 329 | 8268 |
| 12-#11 | 3.04 | 5017 | 2167 | 6955 | 1865 | 8374 | 1521 | 9121 | 1235 | 9825 | 791 | 11316 | 255 | 9809 |
| 12-#14 | 4.38 | 5420 | 2404 | 7846 | 2028 | 9461 | 1642 | 10414 | 1315 | 11549 | 793 | 13657 | 101 | 13148 |
| 13-#10 | 2.68 | 4922 | 2104 | 6723 | 1823 | 8118 | 1496 | 8830 | 1221 | 9432 | 791 | 10809 | 297 | 8860 |
| 13-#11 | 3.29 | 5091 | 2212 | 7160 | 1887 | 8617 | 1543 | 9399 | 1250 | 10181 | 789 | 11771 | 217 | 10454 |
| 13-#14 | 4.75 | 5526 | 2468 | 8129 | 2061 | 9806 | 1677 | 10806 | 1345 | 12045 | 789 | 14300 | 45 | 14042 |
| 14-#10 | 2.89 | 5011 | 2141 | 6941 | 1835 | 8343 | 1497 | 9080 | 1217 | 9741 | 780 | 11160 | 271 | 9456 |
| 14-#11 | 3.55 | 5198 | 2256 | 7406 | 1904 | 8880 | 1547 | 9703 | 1258 | 10534 | 770 | 12202 | 185 | 11183 |
| 14-#14 | 5.12 | 5675 | 2532 | 8448 | 2092 | 10166 | 1687 | 11243 | 1355 | 12553 | 766 | 14894 | -1 | 14894 |
| 15-#10 | 3.09 | 5060 | 2177 | 7008 | 1875 | 8462 | 1539 | 9253 | 1252 | 10004 | 800 | 11653 | 260 | 10016 |
| 15-#11 | 3.80 | 5255 | 2301 | 7507 | 1950 | 9030 | 1595 | 9911 | 1287 | 10855 | 793 | 12772 | 168 | 11786 |
| 15-#14 | 5.48 | 5765 | 2596 | 8627 | 2151 | 10392 | 1750 | 11539 | 1398 | 13009 | 794 | 15707 | -27 | 15679 |
| 16-#10 | 3.30 | 5134 | 2213 | 7121 | 1904 | 8621 | 1563 | 9473 | 1271 | 10268 | 803 | 12031 | 243 | 10621 |
| 16-#11 | 4.05 | 5348 | 2346 | 7648 | 1985 | 9228 | 1624 | 10169 | 1309 | 11170 | 796 | 13217 | 145 | 12441 |
| 16-#14 | 5.85 | 5892 | 2661 | 8836 | 2200 | 10681 | 1790 | 11896 | 1419 | 13451 | 797 | 16327 | -63 | 16258 |
| 17-#10 | 3.51 | 5194 | 2249 | 7277 | 1930 | 8818 | 1578 | 9675 | 1282 | 10574 | 804 | 12453 | 216 | 11157 |
| 17-#11 | 4.31 | 5415 | 2390 | 7830 | 2017 | 9462 | 1642 | 10417 | 1323 | 11538 | 797 | 13721 | 112 | 13077 |
| 18-#10 | 3.71 | 5262 | 2286 | 7478 | 1943 | 9038 | 1591 | 9914 | 1283 | 10864 | 792 | 12766 | 187 | 11753 |
| 18-#11 | 4.56 | 5496 | 2435 | 8065 | 2035 | 9720 | 1660 | 10702 | 1325 | 11897 | 784 | 14125 | 79 | 13726 |
| 19-#10 | 3.92 | 5331 | 2322 | 7541 | 1985 | 9167 | 1620 | 10098 | 1312 | 11139 | 808 | 13241 | 173 | 12247 |
| 19-#11 | 4.81 | 5580 | 2479 | 8152 | 2084 | 9880 | 1694 | 10931 | 1359 | 12223 | 801 | 14668 | 57 | 14364 |
| 20-#10 | 4.13 | 5394 | 2358 | 7669 | 2013 | 9323 | 1647 | 10297 | 1327 | 11426 | 813 | 13718 | 167 | 12792 |
| 20-#11 | 5.07 | 5653 | 2524 | 8311 | 2119 | 10069 | 1725 | 11169 | 1377 | 12555 | 805 | 15218 | 47 | 14966 |
| 21-#10 | 4.33 | 5472 | 2394 | 7832 | 2035 | 9512 | 1662 | 10521 | 1341 | 11705 | 812 | 14071 | 136 | 13314 |
| 22-#10 | 4.54 | 5530 | 2431 | 8008 | 2057 | 9708 | 1677 | 10756 | 1345 | 11996 | 803 | 14449 | 113 | 13836 |

## ROUND TIED COLUMNS 30" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.27 | 5361 | 2132 | 7050 | 1873 | 8424 | 1539 | 8967 | 1273 | 9073 | 890 | 9657 | 474 | 5989 |
| 4-#18 | 2.26 | 5659 | 2331 | 7872 | 1990 | 9379 | 1622 | 10079 | 1348 | 10541 | 881 | 11669 | 317 | 10027 |
| 5-#11 | 1.10 | 5393 | 2097 | 7188 | 1821 | 8442 | 1498 | 8892 | 1245 | 8879 | 864 | 9378 | 508 | 5016 |
| 5-#14 | 1.59 | 5580 | 2196 | 7639 | 1882 | 8964 | 1541 | 9496 | 1274 | 9667 | 857 | 10432 | 441 | 6864 |
| 5-#18 | 2.83 | 6027 | 2446 | 8729 | 2039 | 10237 | 1654 | 10980 | 1347 | 11610 | 841 | 12964 | 262 | 11240 |
| 6-#10 | 1.08 | 5358 | 2092 | 7513 | 1742 | 8593 | 1425 | 8957 | 1184 | 8896 | 817 | 9071 | 461 | 4910 |
| 6-#11 | 1.32 | 5439 | 2142 | 7770 | 1761 | 8870 | 1437 | 9268 | 1191 | 9299 | 807 | 9514 | 415 | 5894 |
| 6-#14 | 1.91 | 5646 | 2260 | 8312 | 1829 | 9523 | 1485 | 10043 | 1222 | 10337 | 797 | 10732 | 320 | 8192 |
| 6-#18 | 3.40 | 6142 | 2560 | 9627 | 2004 | 11127 | 1607 | 11957 | 1303 | 12879 | 770 | 13652 | 69 | 13334 |
| 7-#10 | 1.26 | 5485 | 2128 | 7130 | 1880 | 8530 | 1549 | 9098 | 1284 | 9239 | 893 | 9924 | 510 | 5717 |
| 7-#11 | 1.54 | 5590 | 2186 | 7422 | 1908 | 8839 | 1568 | 9440 | 1294 | 9664 | 885 | 10490 | 466 | 6766 |
| 7-#14 | 2.23 | 5858 | 2324 | 8019 | 1998 | 9553 | 1634 | 10283 | 1344 | 10763 | 881 | 11993 | 376 | 9210 |
| 7-#18 | 3.96 | 6503 | 2674 | 9462 | 2227 | 11300 | 1803 | 12356 | 1460 | 13461 | 868 | 15555 | 131 | 14801 |
| 8-#10 | 1.44 | 5533 | 2165 | 7144 | 1929 | 8671 | 1592 | 9340 | 1322 | 9560 | 916 | 10367 | 497 | 6341 |
| 8-#11 | 1.77 | 5647 | 2231 | 7471 | 1963 | 9026 | 1616 | 9739 | 1336 | 10043 | 909 | 11004 | 446 | 7570 |

## ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.55 | 5938 | 2388 | 8143 | 2067 | 9845 | 1695 | 10700 | 1389 | 11284 | 909 | 12691 | 341 | 10456 |
| 8-#18 | 4.53 | 6638 | 2788 | 9777 | 2334 | 11854 | 1898 | 13048 | 1547 | 14327 | 906 | 16799 | 64 | 16490 |
| 9-#10 | 1.62 | 5628 | 2201 | 7394 | 1939 | 8895 | 1600 | 9553 | 1321 | 9854 | 902 | 10827 | 472 | 7119 |
| 9-#11 | 1.99 | 5759 | 2275 | 7754 | 1979 | 9288 | 1629 | 9988 | 1338 | 10410 | 894 | 11559 | 416 | 8411 |
| 9-#14 | 2.86 | 6093 | 2453 | 8514 | 2095 | 10200 | 1718 | 11060 | 1396 | 11825 | 892 | 13491 | 300 | 11444 |
| 9-#18 | 5.09 | 6899 | 2902 | 10362 | 2393 | 12425 | 1945 | 13691 | 1555 | 15311 | 885 | 18107 | -11 | 18101 |
| 10-#10 | 1.80 | 5702 | 2237 | 7739 | 1935 | 9205 | 1587 | 9837 | 1311 | 10160 | 876 | 11239 | 443 | 7733 |
| 10-#11 | 2.21 | 5847 | 2320 | 8135 | 1981 | 9638 | 1618 | 10325 | 1330 | 10787 | 867 | 12042 | 380 | 9201 |
| 10-#14 | 3.18 | 6215 | 2517 | 8990 | 2111 | 10666 | 1714 | 11536 | 1394 | 12382 | 860 | 14184 | 251 | 12658 |
| 10-#18 | 5.66 | 7097 | 3017 | 11077 | 2446 | 13178 | 1956 | 14506 | 1557 | 16306 | 839 | 19316 | -98 | 19243 |
| 11-#10 | 1.98 | 5779 | 2273 | 7667 | 1999 | 9256 | 1646 | 10008 | 1355 | 10479 | 910 | 11764 | 437 | 8471 |
| 11-#11 | 2.43 | 5938 | 2364 | 8092 | 2051 | 9724 | 1684 | 10541 | 1377 | 11157 | 902 | 12671 | 371 | 9995 |
| 11-#14 | 3.50 | 6346 | 2581 | 9005 | 2197 | 10826 | 1795 | 11852 | 1451 | 12881 | 901 | 15051 | 232 | 13601 |
| 11-#18 | 6.22 | 7335 | 3131 | 11223 | 2569 | 13527 | 2077 | 15078 | 1652 | 17116 | 894 | 20764 | -140 | 20624 |
| 12-#10 | 2.16 | 5868 | 2310 | 7753 | 2041 | 9412 | 1675 | 10213 | 1376 | 10786 | 922 | 12233 | 428 | 9082 |
| 12-#11 | 2.65 | 6045 | 2409 | 8202 | 2099 | 9917 | 1717 | 10789 | 1401 | 11533 | 916 | 13223 | 357 | 10786 |
| 12-#14 | 3.82 | 6492 | 2645 | 9181 | 2262 | 11108 | 1838 | 12205 | 1482 | 13418 | 920 | 15818 | 208 | 14681 |
| 12-#18 | 6.79 | 7568 | 3245 | 11561 | 2675 | 14027 | 2147 | 15686 | 1712 | 18065 | 924 | 22095 | -188 | 21821 |
| 13-#10 | 2.34 | 5939 | 2346 | 7944 | 2056 | 9631 | 1691 | 10468 | 1387 | 11100 | 916 | 12653 | 396 | 9774 |
| 13-#11 | 2.87 | 6128 | 2454 | 8428 | 2119 | 10181 | 1738 | 11094 | 1416 | 11912 | 909 | 13726 | 318 | 11539 |
| 13-#14 | 4.14 | 6610 | 2710 | 9490 | 2294 | 11481 | 1872 | 12636 | 1505 | 13979 | 918 | 16534 | 153 | 15605 |
| 13-#18 | 7.36 | 7775 | 3359 | 12080 | 2739 | 14672 | 2212 | 16424 | 1741 | 18996 | 917 | 23281 | -289 | 22839 |
| 14-#10 | 2.52 | 6035 | 2382 | 8195 | 2065 | 9882 | 1690 | 10738 | 1381 | 11444 | 905 | 13012 | 369 | 10397 |
| 14-#11 | 3.09 | 6244 | 2498 | 8708 | 2135 | 10473 | 1740 | 11422 | 1411 | 12318 | 896 | 14193 | 287 | 12333 |
| 14-#14 | 4.46 | 6772 | 2774 | 9852 | 2323 | 11882 | 1880 | 13107 | 1519 | 14536 | 894 | 17233 | 111 | 16602 |
| 15-#10 | 2.70 | 6091 | 2418 | 8251 | 2108 | 10007 | 1735 | 10925 | 1418 | 11726 | 925 | 13534 | 354 | 11050 |
| 15-#11 | 3.31 | 6309 | 2543 | 8803 | 2182 | 10633 | 1791 | 11650 | 1453 | 12662 | 919 | 14834 | 271 | 13046 |
| 15-#14 | 4.77 | 6870 | 2838 | 10030 | 2384 | 12124 | 1946 | 13431 | 1558 | 15022 | 923 | 18093 | 83 | 17593 |
| 16-#10 | 2.87 | 6173 | 2455 | 8371 | 2138 | 10175 | 1759 | 11161 | 1438 | 12016 | 930 | 14004 | 345 | 11691 |
| 16-#11 | 3.53 | 6407 | 2587 | 8953 | 2218 | 10843 | 1820 | 11939 | 1477 | 13008 | 924 | 15329 | 250 | 13849 |
| 16-#14 | 5.09 | 7016 | 2902 | 10255 | 2434 | 12432 | 1987 | 13834 | 1589 | 15509 | 928 | 18782 | 50 | 18506 |
| 17-#10 | 3.05 | 6239 | 2491 | 8543 | 2164 | 10392 | 1773 | 11387 | 1448 | 12351 | 931 | 14444 | 317 | 12309 |
| 17-#11 | 3.75 | 6485 | 2632 | 9156 | 2251 | 11101 | 1838 | 12204 | 1490 | 13412 | 925 | 15886 | 217 | 14511 |
| 17-#14 | 5.41 | 7116 | 2967 | 10533 | 2482 | 12795 | 2014 | 14217 | 1610 | 16083 | 930 | 19572 | 3 | 19554 |
| 18-#10 | 3.23 | 6315 | 2527 | 8769 | 2175 | 10632 | 1785 | 11650 | 1449 | 12659 | 918 | 14789 | 288 | 12950 |
| 18-#11 | 3.97 | 6575 | 2676 | 9417 | 2267 | 11388 | 1855 | 12518 | 1492 | 13794 | 911 | 16300 | 183 | 15265 |
| 19-#10 | 3.41 | 6389 | 2563 | 8830 | 2218 | 10773 | 1817 | 11845 | 1478 | 12961 | 935 | 15314 | 276 | 13537 |
| 19-#11 | 4.19 | 6665 | 2721 | 9504 | 2317 | 11559 | 1890 | 12760 | 1526 | 14153 | 929 | 16920 | 165 | 15924 |
| 20-#10 | 3.59 | 6459 | 2600 | 8964 | 2247 | 10943 | 1844 | 12062 | 1494 | 13271 | 940 | 15761 | 259 | 14181 |
| 20-#11 | 4.41 | 6748 | 2765 | 9673 | 2352 | 11765 | 1923 | 13021 | 1545 | 14530 | 935 | 17543 | 157 | 16621 |
| 21-#10 | 3.77 | 6545 | 2636 | 9145 | 2269 | 11147 | 1859 | 12308 | 1509 | 13582 | 939 | 16231 | 240 | 14746 |
| 21-#11 | 4.63 | 6849 | 2810 | 9887 | 2379 | 12013 | 1942 | 13316 | 1563 | 14897 | 934 | 18010 | 119 | 17321 |
| 22-#10 | 3.95 | 6609 | 2672 | 9340 | 2290 | 11364 | 1873 | 12561 | 1512 | 13900 | 930 | 16647 | 217 | 15347 |
| 23-#10 | 4.13 | 6695 | 2708 | 9440 | 2324 | 11528 | 1902 | 12766 | 1538 | 14198 | 944 | 17107 | 199 | 15918 |
| 24-#10 | 4.31 | 6766 | 2745 | 9560 | 2357 | 11695 | 1927 | 12999 | 1555 | 14489 | 946 | 17568 | 182 | 16496 |

## ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.12 | 6458 | 2390 | 8346 | 2121 | 10027 | 1747 | 10682 | 1449 | 10771 | 1022 | 11403 | 574 | 6489 |
| 4-#18 | 1.99 | 6790 | 2590 | 9248 | 2238 | 11070 | 1830 | 11893 | 1497 | 12365 | 1013 | 13587 | 419 | 10924 |
| 5-#14 | 1.40 | 6698 | 2454 | 9020 | 2123 | 10635 | 1744 | 11265 | 1445 | 11411 | 986 | 12283 | 542 | 7488 |
| 5-#18 | 2.49 | 7192 | 2704 | 10210 | 2281 | 12026 | 1857 | 12884 | 1520 | 13529 | 971 | 15092 | 370 | 12284 |
| 6-#11 | 1.16 | 6542 | 2400 | 9219 | 1993 | 10549 | 1629 | 11012 | 1352 | 10985 | 928 | 11236 | 509 | 6388 |
| 6-#14 | 1.68 | 6771 | 2518 | 9809 | 2060 | 11259 | 1676 | 11853 | 1384 | 12109 | 918 | 12581 | 418 | 8898 |
| 6-#18 | 2.98 | 7318 | 2818 | 11245 | 2235 | 13005 | 1799 | 13934 | 1465 | 14897 | 894 | 15824 | 177 | 14868 |
| 7-#10 | 1.11 | 6592 | 2387 | 8466 | 2122 | 10144 | 1755 | 10821 | 1458 | 10950 | 1024 | 11700 | 609 | 6211 |
| 7-#11 | 1.36 | 6708 | 2445 | 8765 | 2154 | 10484 | 1773 | 11195 | 1468 | 11414 | 1015 | 12321 | 566 | 7400 |
| 7-#14 | 1.96 | 7005 | 2582 | 9416 | 2243 | 11260 | 1839 | 12110 | 1511 | 12612 | 1012 | 13971 | 478 | 10084 |
| 7-#18 | 3.48 | 7718 | 2932 | 10994 | 2473 | 13165 | 2009 | 14367 | 1635 | 15559 | 1003 | 17961 | 246 | 16410 |
| 8-#10 | 1.26 | 6642 | 2423 | 8434 | 2178 | 10284 | 1801 | 11077 | 1498 | 11304 | 1049 | 12194 | 598 | 6891 |
| 8-#11 | 1.55 | 6769 | 2489 | 8795 | 2212 | 10673 | 1824 | 11513 | 1513 | 11831 | 1042 | 12893 | 548 | 8235 |
| 8-#14 | 2.24 | 7090 | 2647 | 9527 | 2315 | 11562 | 1903 | 12571 | 1567 | 13184 | 1044 | 14740 | 446 | 11388 |
| 8-#18 | 3.98 | 7865 | 3046 | 11309 | 2583 | 13748 | 2106 | 15143 | 1701 | 16510 | 1044 | 19253 | 178 | 18359 |
| 9-#10 | 1.42 | 6747 | 2459 | 8718 | 2187 | 10534 | 1807 | 11315 | 1497 | 11613 | 1034 | 12692 | 573 | 7748 |
| 9-#11 | 1.75 | 6893 | 2534 | 9115 | 2226 | 10964 | 1836 | 11790 | 1513 | 12218 | 1026 | 13498 | 518 | 9211 |
| 9-#14 | 2.52 | 7263 | 2711 | 9942 | 2342 | 11957 | 1925 | 12956 | 1572 | 13756 | 1025 | 15615 | 406 | 12533 |
| 9-#18 | 4.48 | 8151 | 3161 | 11958 | 2641 | 14391 | 2154 | 15825 | 1734 | 17553 | 1021 | 20776 | 110 | 20128 |
| 10-#10 | 1.58 | 6829 | 2495 | 9116 | 2178 | 10886 | 1791 | 11626 | 1475 | 11939 | 1006 | 13015 | 530 | 8424 |
| 10-#11 | 1.94 | 6990 | 2578 | 9551 | 2223 | 11361 | 1822 | 12160 | 1502 | 12622 | 996 | 14042 | 484 | 10032 |
| 10-#14 | 2.80 | 7395 | 2775 | 10481 | 2354 | 12481 | 1918 | 13478 | 1568 | 14357 | 990 | 16406 | 360 | 13813 |
| 10-#18 | 4.97 | 8366 | 3275 | 12754 | 2688 | 15226 | 2162 | 16719 | 1733 | 18635 | 973 | 22102 | 25 | 21963 |
| 11-#10 | 1.74 | 6913 | 2532 | 9008 | 2248 | 10924 | 1854 | 11804 | 1531 | 12293 | 1043 | 13719 | 540 | 9244 |
| 11-#11 | 2.13 | 7090 | 2623 | 9474 | 2299 | 11436 | 1891 | 12386 | 1554 | 13033 | 1035 | 14718 | 476 | 10961 |
| 11-#14 | 3.08 | 7538 | 2839 | 10470 | 2445 | 12634 | 2003 | 13810 | 1628 | 14908 | 1036 | 17331 | 341 | 14904 |
| 11-#18 | 5.47 | 8629 | 3389 | 12895 | 2819 | 15577 | 2287 | 17321 | 1818 | 19528 | 1033 | 23682 | -15 | 23660 |
| 12-#10 | 1.89 | 7010 | 2568 | 9095 | 2291 | 11089 | 1884 | 12026 | 1554 | 12621 | 1056 | 14235 | 532 | 9909 |
| 12-#11 | 2.33 | 7205 | 2667 | 9590 | 2349 | 11642 | 1926 | 12654 | 1579 | 13434 | 1050 | 15327 | 463 | 11777 |
| 12-#14 | 3.36 | 7698 | 2904 | 10657 | 2512 | 12938 | 2048 | 14192 | 1661 | 15481 | 1055 | 18175 | 319 | 16178 |
| 12-#18 | 5.97 | 8880 | 3503 | 13257 | 2927 | 16120 | 2359 | 17984 | 1867 | 20539 | 1063 | 25096 | -63 | 25001 |
| 13-#10 | 2.05 | 7086 | 2604 | 9306 | 2305 | 11326 | 1899 | 12304 | 1564 | 12961 | 1049 | 14689 | 500 | 10701 |
| 13-#11 | 2.52 | 7298 | 2712 | 9837 | 2368 | 11927 | 1946 | 12987 | 1593 | 13845 | 1043 | 15878 | 424 | 12648 |
| 13-#14 | 3.64 | 7828 | 2968 | 10993 | 2543 | 13340 | 2081 | 14664 | 1683 | 16070 | 1045 | 18962 | 264 | 17226 |
| 13-#18 | 6.47 | 9107 | 3617 | 13818 | 2990 | 16817 | 2423 | 18792 | 1910 | 21585 | 1060 | 26446 | -159 | 26175 |
| 14-#10 | 2.21 | 7192 | 2640 | 9641 | 2304 | 11605 | 1896 | 12593 | 1556 | 13339 | 1037 | 15057 | 471 | 11354 |
| 14-#11 | 2.72 | 7424 | 2756 | 10156 | 2381 | 12252 | 1946 | 13339 | 1587 | 14295 | 1029 | 16355 | 391 | 13479 |
| 14-#14 | 3.92 | 8004 | 3032 | 11401 | 2570 | 13782 | 2087 | 15168 | 1680 | 16711 | 1029 | 19693 | 222 | 18361 |
| 14-#18 | 6.96 | 9421 | 3732 | 14444 | 3050 | 17547 | 2446 | 19683 | 1944 | 22647 | 1023 | 27751 | -233 | 27356 |
| 15-#10 | 2.37 | 7255 | 2677 | 9636 | 2357 | 11745 | 1940 | 12795 | 1595 | 13642 | 1059 | 15638 | 458 | 12116 |
| 15-#11 | 2.91 | 7497 | 2801 | 10240 | 2431 | 12418 | 2000 | 13585 | 1631 | 14663 | 1054 | 17031 | 372 | 14302 |
| 15-#14 | 4.20 | 8112 | 3096 | 11574 | 2634 | 14039 | 2156 | 15520 | 1736 | 17229 | 1060 | 20675 | 198 | 19379 |
| 16-#10 | 2.53 | 7344 | 2713 | 9761 | 2389 | 11910 | 1968 | 13046 | 1615 | 13958 | 1065 | 16173 | 452 | 12773 |
| 16-#11 | 3.10 | 7604 | 2845 | 10399 | 2469 | 12640 | 2029 | 13894 | 1655 | 15040 | 1059 | 17637 | 360 | 15142 |
| 16-#14 | 4.48 | 8274 | 3161 | 11815 | 2684 | 14366 | 2197 | 15966 | 1770 | 17761 | 1066 | 21434 | 167 | 20428 |
| 17-#10 | 2.68 | 7416 | 2749 | 9948 | 2413 | 12148 | 1983 | 13297 | 1627 | 14314 | 1065 | 16631 | 423 | 13486 |
| 17-#11 | 3.30 | 7690 | 2890 | 10622 | 2500 | 12922 | 2047 | 14189 | 1668 | 15479 | 1060 | 18218 | 326 | 15931 |
| 17-#14 | 4.76 | 8382 | 3225 | 12122 | 2732 | 14762 | 2224 | 16377 | 1790 | 18387 | 1068 | 22293 | 120 | 21520 |

## ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.84 | 7500 | 2785 | 10203 | 2423 | 12409 | 1993 | 13583 | 1626 | 14647 | 1051 | 17006 | 394 | 14154 |
| 18-#11 | 3.49 | 7788 | 2934 | 10912 | 2515 | 13234 | 2062 | 14531 | 1669 | 15884 | 1045 | 18670 | 292 | 16787 |
| 18-#14 | 5.04 | 8523 | 3289 | 12508 | 2758 | 15198 | 2251 | 16861 | 1795 | 18980 | 1049 | 22945 | 72 | 22524 |
| 19-#10 | 3.00 | 7581 | 2822 | 10260 | 2469 | 12559 | 2026 | 13790 | 1657 | 14978 | 1070 | 17584 | 384 | 14830 |
| 19-#11 | 3.69 | 7885 | 2979 | 10998 | 2567 | 13420 | 2100 | 14787 | 1705 | 16277 | 1065 | 19353 | 276 | 17524 |
| 19-#14 | 5.32 | 8661 | 3353 | 12660 | 2828 | 15470 | 2300 | 17234 | 1842 | 19529 | 1074 | 23892 | 45 | 23648 |
| 20-#10 | 3.16 | 7658 | 2858 | 10400 | 2498 | 12745 | 2055 | 14025 | 1673 | 15308 | 1075 | 18055 | 365 | 15502 |
| 20-#11 | 3.88 | 7976 | 3024 | 11175 | 2603 | 13643 | 2133 | 15071 | 1724 | 16683 | 1071 | 19938 | 255 | 18328 |
| 21-#10 | 3.32 | 7751 | 2894 | 10599 | 2519 | 12963 | 2069 | 14292 | 1688 | 15652 | 1075 | 18586 | 349 | 16166 |
| 21-#11 | 4.07 | 8087 | 3068 | 11410 | 2630 | 13909 | 2152 | 15392 | 1742 | 17087 | 1071 | 20548 | 232 | 19053 |
| 22-#10 | 3.47 | 7821 | 2930 | 10813 | 2539 | 13202 | 2082 | 14563 | 1690 | 15997 | 1066 | 19040 | 326 | 16838 |
| 22-#11 | 4.27 | 8172 | 3113 | 11661 | 2656 | 14191 | 2169 | 15723 | 1747 | 17504 | 1060 | 21093 | 204 | 19811 |
| 23-#10 | 3.63 | 7915 | 2967 | 10915 | 2575 | 13373 | 2112 | 14785 | 1717 | 16315 | 1080 | 19529 | 308 | 17475 |
| 23-#11 | 4.46 | 8284 | 3157 | 11795 | 2697 | 14408 | 2204 | 15991 | 1778 | 17894 | 1076 | 21691 | 181 | 20574 |
| 24-#10 | 3.79 | 7989 | 3003 | 11047 | 2608 | 13554 | 2137 | 15033 | 1734 | 16632 | 1082 | 20031 | 291 | 18159 |
| 25-#10 | 3.95 | 8077 | 3039 | 11230 | 2630 | 13783 | 2154 | 15287 | 1748 | 16986 | 1085 | 20478 | 267 | 18754 |
| 26-#10 | 4.11 | 8158 | 3076 | 11426 | 2651 | 14014 | 2170 | 15564 | 1754 | 17329 | 1077 | 20969 | 244 | 19385 |

## ROUND TIED COLUMNS 34" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.76 | 8062 | 2865 | 10775 | 2502 | 12956 | 2051 | 13917 | 1685 | 14395 | 1154 | 15711 | 528 | 11819 |
| 5-#14 | 1.24 | 7956 | 2729 | 10560 | 2381 | 12503 | 1959 | 13245 | 1628 | 13360 | 1122 | 14336 | 648 | 8121 |
| 5-#18 | 2.20 | 8498 | 2979 | 11852 | 2538 | 14015 | 2073 | 15000 | 1703 | 15652 | 1109 | 17424 | 483 | 13339 |
| 6-#11 | 1.03 | 7785 | 2675 | 10839 | 2239 | 12432 | 1834 | 12968 | 1525 | 12871 | 1056 | 13155 | 609 | 6883 |
| 6-#14 | 1.49 | 8036 | 2793 | 11479 | 2306 | 13198 | 1881 | 13875 | 1556 | 14082 | 1046 | 14627 | 521 | 9604 |
| 6-#18 | 2.64 | 8637 | 3093 | 13036 | 2481 | 15087 | 2003 | 16123 | 1638 | 17092 | 1023 | 18193 | 287 | 16104 |
| 7-#11 | 1.20 | 7967 | 2720 | 10293 | 2411 | 12324 | 1992 | 13161 | 1653 | 13370 | 1155 | 14358 | 672 | 8039 |
| 7-#14 | 1.73 | 8292 | 2857 | 10968 | 2505 | 13164 | 2058 | 14149 | 1696 | 14666 | 1153 | 16149 | 586 | 10964 |
| 7-#18 | 3.08 | 9072 | 3207 | 12681 | 2735 | 15226 | 2228 | 16590 | 1807 | 17863 | 1145 | 20546 | 363 | 17872 |
| 8-#10 | 1.12 | 7893 | 2698 | 9873 | 2444 | 12091 | 2023 | 13025 | 1687 | 13253 | 1191 | 14230 | 706 | 7447 |
| 8-#11 | 1.37 | 8032 | 2764 | 10268 | 2477 | 12514 | 2046 | 13496 | 1701 | 13825 | 1184 | 14991 | 657 | 8906 |
| 8-#14 | 1.98 | 8383 | 2922 | 11061 | 2581 | 13474 | 2125 | 14637 | 1755 | 15290 | 1187 | 16997 | 557 | 12327 |
| 8-#18 | 3.52 | 9235 | 3321 | 12991 | 2848 | 15836 | 2328 | 17449 | 1893 | 18899 | 1190 | 21915 | 296 | 20284 |
| 9-#10 | 1.26 | 8006 | 2734 | 10193 | 2451 | 12367 | 2028 | 13287 | 1685 | 13578 | 1174 | 14765 | 680 | 8369 |
| 9-#11 | 1.55 | 8167 | 2809 | 10627 | 2489 | 12834 | 2056 | 13803 | 1700 | 14232 | 1167 | 15643 | 626 | 10017 |
| 9-#14 | 2.23 | 8573 | 2986 | 11523 | 2606 | 13908 | 2145 | 15064 | 1759 | 15893 | 1166 | 17946 | 516 | 13643 |
| 9-#18 | 3.97 | 9546 | 3436 | 13708 | 2904 | 16551 | 2376 | 18171 | 1910 | 20002 | 1164 | 23580 | 228 | 22105 |
| 10-#10 | 1.40 | 8096 | 2770 | 10651 | 2438 | 12765 | 2008 | 13627 | 1659 | 13923 | 1143 | 15082 | 634 | 9125 |
| 10-#11 | 1.72 | 8273 | 2853 | 11125 | 2482 | 13282 | 2038 | 14206 | 1676 | 14662 | 1134 | 16081 | 575 | 10874 |
| 10-#14 | 2.48 | 8717 | 3050 | 12130 | 2612 | 14495 | 2135 | 15631 | 1752 | 16536 | 1129 | 18831 | 473 | 14981 |
| 10-#18 | 4.41 | 9780 | 3550 | 14591 | 2947 | 17472 | 2381 | 19143 | 1919 | 21169 | 1115 | 25094 | 151 | 24192 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 11-#10 | 1.54 | 8187 | 2807 | 10499 | 2513 | 12786 | 2076 | 13810 | 1719 | 14313 | 1184 | 15882 | 649 | 10001 |
| 11-#11 | 1.89 | 8382 | 2898 | 11008 | 2563 | 13343 | 2113 | 14441 | 1741 | 15115 | 1177 | 16974 | 585 | 11938 |
| 11-#14 | 2.73 | 8873 | 3114 | 12085 | 2709 | 14638 | 2225 | 15978 | 1817 | 17142 | 1179 | 19818 | 454 | 16231 |
| 11-#18 | 4.85 | 10054 | 3664 | 14718 | 3084 | 17824 | 2510 | 19776 | 2008 | 22147 | 1180 | 26759 | 109 | 26050 |
| 12-#10 | 1.68 | 8292 | 2843 | 10586 | 2558 | 12960 | 2108 | 14048 | 1743 | 14662 | 1198 | 16446 | 643 | 10748 |
| 12-#11 | 2.06 | 8507 | 2942 | 11128 | 2615 | 13561 | 2149 | 14729 | 1768 | 15541 | 1192 | 17640 | 575 | 12782 |
| 12-#14 | 2.97 | 9045 | 3179 | 12284 | 2779 | 14962 | 2272 | 16391 | 1850 | 17750 | 1198 | 20742 | 435 | 17565 |
| 12-#18 | 5.29 | 10337 | 3778 | 15104 | 3195 | 18408 | 2584 | 20493 | 2059 | 23218 | 1210 | 28307 | 65 | 27928 |
| 13-#10 | 1.82 | 8376 | 2879 | 10818 | 2571 | 13216 | 2122 | 14350 | 1753 | 15029 | 1191 | 16918 | 609 | 11591 |
| 13-#11 | 2.23 | 8607 | 2987 | 11398 | 2633 | 13868 | 2168 | 15091 | 1782 | 15985 | 1185 | 18237 | 536 | 13780 |
| 13-#14 | 3.22 | 9188 | 3243 | 12648 | 2809 | 15393 | 2303 | 16902 | 1873 | 18387 | 1189 | 21598 | 381 | 18763 |
| 13-#18 | 5.73 | 10585 | 3892 | 15708 | 3256 | 19154 | 2646 | 21372 | 2102 | 24371 | 1209 | 29785 | -31 | 29734 |
| 14-#10 | 1.96 | 8490 | 2915 | 11196 | 2568 | 13524 | 2117 | 14659 | 1743 | 15437 | 1178 | 17310 | 579 | 12327 |
| 14-#11 | 2.41 | 8744 | 3031 | 11822 | 2634 | 14226 | 2166 | 15467 | 1773 | 16478 | 1171 | 18723 | 501 | 14641 |
| 14-#14 | 3.47 | 9378 | 3307 | 13105 | 2833 | 15879 | 2308 | 17441 | 1868 | 19092 | 1173 | 22349 | 335 | 20100 |
| 14-#18 | 6.17 | 10904 | 4006 | 16401 | 3314 | 19952 | 2668 | 22321 | 2107 | 25532 | 1172 | 31230 | -100 | 31008 |
| 15-#10 | 2.10 | 8560 | 2952 | 11170 | 2623 | 13667 | 2162 | 14876 | 1784 | 15764 | 1202 | 17949 | 568 | 13150 |
| 15-#11 | 2.58 | 8826 | 3076 | 11828 | 2697 | 14398 | 2222 | 15731 | 1820 | 16870 | 1197 | 19468 | 484 | 15583 |
| 15-#14 | 3.72 | 9498 | 3371 | 13270 | 2900 | 16150 | 2380 | 17820 | 1926 | 19642 | 1204 | 23364 | 305 | 21216 |
| 15-#18 | 6.61 | 11130 | 4121 | 16806 | 3416 | 20464 | 2779 | 22981 | 2196 | 26490 | 1219 | 32968 | -152 | 32478 |
| 16-#10 | 2.24 | 8657 | 2988 | 11299 | 2655 | 13839 | 2192 | 15141 | 1805 | 16106 | 1208 | 18539 | 563 | 13873 |
| 16-#11 | 2.75 | 8942 | 3120 | 11995 | 2735 | 14631 | 2252 | 16058 | 1844 | 17279 | 1203 | 20155 | 475 | 16466 |
| 16-#14 | 3.97 | 9675 | 3436 | 13525 | 2951 | 16493 | 2420 | 18293 | 1960 | 20219 | 1211 | 24296 | 288 | 22409 |
| 17-#10 | 2.38 | 8734 | 3024 | 11504 | 2680 | 14097 | 2206 | 15417 | 1816 | 16484 | 1208 | 19027 | 535 | 14673 |
| 17-#11 | 2.92 | 9036 | 3165 | 12236 | 2766 | 14938 | 2270 | 16384 | 1858 | 17746 | 1204 | 20758 | 440 | 17356 |
| 17-#14 | 4.21 | 9791 | 3500 | 13858 | 2998 | 16924 | 2448 | 18747 | 1981 | 20896 | 1214 | 25189 | 239 | 23538 |
| 18-#10 | 2.52 | 8827 | 3060 | 11788 | 2688 | 14381 | 2215 | 15728 | 1815 | 16841 | 1193 | 19431 | 505 | 15379 |
| 18-#11 | 3.09 | 9144 | 3209 | 12560 | 2779 | 15275 | 2284 | 16755 | 1858 | 18180 | 1187 | 21248 | 405 | 18249 |
| 18-#14 | 4.46 | 9945 | 3564 | 14284 | 3023 | 17394 | 2473 | 19273 | 1985 | 21523 | 1194 | 25899 | 191 | 24675 |
| 19-#10 | 2.66 | 8914 | 3097 | 11838 | 2735 | 14538 | 2250 | 15944 | 1847 | 17201 | 1213 | 20062 | 496 | 16151 |
| 19-#11 | 3.26 | 9248 | 3254 | 12642 | 2834 | 15474 | 2324 | 17025 | 1895 | 18608 | 1209 | 21994 | 392 | 19090 |
| 19-#14 | 4.71 | 10089 | 3628 | 14438 | 3095 | 17690 | 2524 | 19666 | 2033 | 22120 | 1221 | 26934 | 167 | 25862 |
| 20-#10 | 2.80 | 8998 | 3133 | 11984 | 2765 | 14740 | 2279 | 16198 | 1864 | 17552 | 1218 | 20558 | 478 | 16847 |
| 20-#11 | 3.44 | 9347 | 3299 | 12827 | 2869 | 15715 | 2358 | 17331 | 1915 | 19039 | 1215 | 22610 | 369 | 19983 |
| 20-#14 | 4.96 | 10231 | 3692 | 14716 | 3145 | 18035 | 2571 | 20103 | 2060 | 22740 | 1228 | 27825 | 136 | 26990 |
| 21-#10 | 2.94 | 9097 | 3169 | 12201 | 2786 | 14974 | 2293 | 16484 | 1878 | 17925 | 1219 | 21087 | 457 | 17604 |
| 21-#11 | 3.61 | 9468 | 3343 | 13084 | 2896 | 15999 | 2376 | 17679 | 1933 | 19484 | 1216 | 23296 | 349 | 20806 |
| 22-#10 | 3.08 | 9175 | 3205 | 12437 | 2805 | 15234 | 2305 | 16776 | 1879 | 18301 | 1210 | 21641 | 440 | 18302 |
| 22-#11 | 3.78 | 9559 | 3388 | 13358 | 2921 | 16307 | 2392 | 18032 | 1936 | 19934 | 1205 | 23887 | 321 | 21690 |
| 23-#10 | 3.22 | 9278 | 3242 | 12540 | 2842 | 15413 | 2336 | 17015 | 1908 | 18639 | 1224 | 22157 | 422 | 19026 |
| 23-#11 | 3.95 | 9682 | 3432 | 13496 | 2964 | 16534 | 2428 | 18321 | 1969 | 20348 | 1221 | 24525 | 299 | 22479 |
| 24-#10 | 3.36 | 9356 | 3278 | 12682 | 2876 | 15607 | 2362 | 17278 | 1925 | 18981 | 1227 | 22703 | 406 | 19748 |
| 24-#11 | 4.12 | 9776 | 3477 | 13669 | 3005 | 16770 | 2459 | 18645 | 1989 | 20759 | 1224 | 25175 | 278 | 23312 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.



## ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 25-#10 | 3.50 | 9452 | 3314 | 12879 | 2897 | 15854 | 2379 | 17552 | 1939 | 19363 | 1229 | 23188 | 382 | 20436 |
| 25-#11 | 4.30 | 9892 | 3521 | 13906 | 3031 | 17066 | 2480 | 18975 | 2007 | 21220 | 1227 | 25756 | 247 | 24108 |
| 26-#10 | 3.64 | 9542 | 3350 | 13096 | 2918 | 16103 | 2393 | 17856 | 1945 | 19726 | 1221 | 23701 | 358 | 21158 |
| 27-#10 | 3.78 | 9630 | 3387 | 13245 | 2948 | 16292 | 2421 | 18086 | 1969 | 20078 | 1234 | 24270 | 348 | 21842 |
| 28-#10 | 3.92 | 9724 | 3423 | 13410 | 2975 | 16499 | 2448 | 18345 | 1984 | 20438 | 1238 | 24775 | 323 | 22555 |

## ROUND TIED COLUMNS 36" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.57 | 9483 | 3156 | 12462 | 2784 | 15048 | 2286 | 16165 | 1884 | 16644 | 1303 | 18055 | 642 | 12712 |
| 5-#14 | 1.11 | 9363 | 3021 | 12268 | 2656 | 14582 | 2189 | 15449 | 1814 | 15525 | 1267 | 16478 | 747 | 8763 |
| 5-#18 | 1.96 | 9955 | 3270 | 13662 | 2812 | 16214 | 2302 | 17341 | 1897 | 17993 | 1255 | 19974 | 600 | 14406 |
| 6-#14 | 1.33 | 9450 | 3085 | 13331 | 2568 | 15355 | 2098 | 16123 | 1740 | 16268 | 1183 | 16881 | 629 | 10312 |
| 6-#18 | 2.36 | 10106 | 3385 | 15010 | 2742 | 17387 | 2220 | 18538 | 1821 | 19500 | 1160 | 20771 | 402 | 17341 |
| 7-#11 | 1.07 | 9375 | 3011 | 11955 | 2690 | 14372 | 2225 | 15350 | 1850 | 15544 | 1303 | 16614 | 783 | 8631 |
| 7-#14 | 1.55 | 9729 | 3149 | 12732 | 2776 | 15276 | 2290 | 16411 | 1893 | 16938 | 1301 | 18546 | 700 | 11858 |
| 7-#18 | 2.75 | 10575 | 3499 | 14533 | 3013 | 17497 | 2461 | 19036 | 2005 | 20384 | 1296 | 23303 | 481 | 19340 |
| 8-#11 | 1.23 | 9444 | 3056 | 11899 | 2759 | 14561 | 2282 | 15703 | 1900 | 16039 | 1335 | 17310 | 772 | 9583 |
| 8-#14 | 1.77 | 9826 | 3213 | 12754 | 2862 | 15591 | 2361 | 16926 | 1954 | 17615 | 1338 | 19475 | 674 | 13273 |
| 8-#18 | 3.14 | 10742 | 3613 | 14834 | 3129 | 18131 | 2564 | 19960 | 2094 | 21508 | 1344 | 24800 | 419 | 22114 |
| 9-#10 | 1.12 | 9415 | 3026 | 11828 | 2732 | 14407 | 2263 | 15483 | 1884 | 15761 | 1323 | 17058 | 793 | 8995 |
| 9-#11 | 1.38 | 9591 | 3100 | 12301 | 2769 | 14912 | 2290 | 16040 | 1899 | 16465 | 1316 | 18009 | 740 | 10776 |
| 9-#14 | 1.99 | 10034 | 3278 | 13266 | 2886 | 16066 | 2380 | 17395 | 1958 | 18248 | 1316 | 20498 | 633 | 14771 |
| 9-#18 | 3.54 | 11093 | 3727 | 15621 | 3184 | 18908 | 2610 | 20741 | 2110 | 22668 | 1316 | 26604 | 351 | 24077 |
| 10-#10 | 1.25 | 9512 | 3062 | 12352 | 2713 | 14853 | 2238 | 15852 | 1854 | 16124 | 1289 | 17365 | 744 | 9834 |
| 10-#11 | 1.53 | 9706 | 3145 | 12866 | 2757 | 15414 | 2269 | 16477 | 1871 | 16920 | 1280 | 18442 | 686 | 11726 |
| 10-#14 | 2.21 | 10189 | 3342 | 13948 | 2887 | 16720 | 2365 | 18010 | 1932 | 18933 | 1276 | 21217 | 565 | 16161 |
| 10-#18 | 3.93 | 11345 | 3841 | 16597 | 3221 | 19930 | 2612 | 21793 | 2116 | 23919 | 1265 | 28305 | 281 | 26495 |
| 11-#10 | 1.37 | 9611 | 3098 | 12150 | 2794 | 14854 | 2312 | 16040 | 1919 | 16552 | 1334 | 18266 | 763 | 10766 |
| 11-#11 | 1.69 | 9824 | 3189 | 12703 | 2844 | 15457 | 2348 | 16719 | 1941 | 17416 | 1327 | 19450 | 701 | 12865 |
| 11-#14 | 2.43 | 10357 | 3406 | 13861 | 2990 | 16849 | 2460 | 18370 | 2016 | 19594 | 1330 | 22527 | 573 | 17582 |
| 11-#18 | 4.32 | 11641 | 3956 | 16696 | 3365 | 20278 | 2746 | 22454 | 2209 | 24985 | 1334 | 30058 | 236 | 28389 |
| 12-#10 | 1.50 | 9724 | 3134 | 12231 | 2841 | 15036 | 2345 | 16294 | 1944 | 16923 | 1349 | 18879 | 759 | 11599 |
| 12-#11 | 1.84 | 9959 | 3234 | 12824 | 2898 | 15686 | 2386 | 17028 | 1969 | 17868 | 1343 | 20175 | 693 | 13801 |
| 12-#14 | 2.65 | 10544 | 3470 | 14069 | 3062 | 17192 | 2509 | 18812 | 2052 | 20238 | 1350 | 23531 | 556 | 18969 |
| 12-#18 | 4.72 | 11947 | 4070 | 17111 | 3479 | 20903 | 2823 | 23225 | 2263 | 26117 | 1364 | 31741 | 197 | 30502 |
| 13-#10 | 1.62 | 9814 | 3171 | 12489 | 2853 | 15311 | 2358 | 16619 | 1954 | 17316 | 1341 | 19369 | 723 | 12492 |
| 13-#11 | 1.99 | 10067 | 3278 | 13118 | 2915 | 16015 | 2404 | 17418 | 1982 | 18344 | 1335 | 20796 | 652 | 14900 |
| 13-#14 | 2.87 | 10699 | 3534 | 14464 | 3090 | 17654 | 2539 | 19364 | 2074 | 20923 | 1340 | 24454 | 501 | 20325 |
| 13-#18 | 5.11 | 12216 | 4184 | 17759 | 3538 | 21698 | 2883 | 24175 | 2306 | 27313 | 1351 | 33347 | 102 | 32634 |
| 14-#10 | 1.75 | 9938 | 3207 | 12912 | 2847 | 15651 | 2350 | 16950 | 1941 | 17744 | 1326 | 19782 | 694 | 13327 |
| 14-#11 | 2.15 | 10215 | 3323 | 13592 | 2913 | 16408 | 2399 | 17819 | 1971 | 18879 | 1321 | 21311 | 617 | 15821 |
| 14-#14 | 3.09 | 10903 | 3599 | 15070 | 3098 | 18184 | 2541 | 19938 | 2066 | 21692 | 1325 | 25224 | 454 | 21722 |
| 14-#18 | 5.50 | 12558 | 4298 | 18524 | 3595 | 22566 | 2903 | 25184 | 2308 | 28635 | 1329 | 34835 | 29 | 34658 |
| 15-#10 | 1.87 | 10015 | 3243 | 12862 | 2906 | 15795 | 2399 | 17179 | 1985 | 18093 | 1349 | 20483 | 683 | 14183 |
| 15-#11 | 2.30 | 10305 | 3367 | 13576 | 2979 | 16601 | 2454 | 18101 | 2020 | 19296 | 1348 | 22127 | 601 | 16898 |
| 15-#14 | 3.32 | 11035 | 3663 | 15126 | 3182 | 18490 | 2609 | 20343 | 2128 | 22275 | 1357 | 26334 | 426 | 22984 |
| 15-#18 | 5.89 | 12805 | 4412 | 18932 | 3699 | 23110 | 3018 | 25894 | 2400 | 29646 | 1376 | 36804 | -16 | 36576 |

## ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.00 | 10120 | 3280 | 12995 | 2939 | 15974 | 2429 | 17460 | 2006 | 18475 | 1360 | 21105 | 679 | 14990 |
| 16-#11 | 2.45 | 10431 | 3412 | 13749 | 3018 | 16827 | 2489 | 18447 | 2045 | 19738 | 1355 | 22894 | 596 | 17800 |
| 16-#14 | 3.54 | 11215 | 3727 | 15394 | 3235 | 18827 | 2658 | 20844 | 2162 | 22897 | 1365 | 27381 | 413 | 24384 |
| 16-#18 | 6.29 | 13139 | 4526 | 19434 | 3786 | 23769 | 3087 | 26785 | 2457 | 30711 | 1385 | 38326 | -71 | 38185 |
| 17-#10 | 2.12 | 10203 | 3316 | 13217 | 2962 | 16253 | 2443 | 17756 | 2017 | 18873 | 1359 | 21645 | 652 | 15835 |
| 17-#11 | 2.61 | 10530 | 3456 | 14010 | 3048 | 17159 | 2507 | 18802 | 2059 | 20230 | 1355 | 23521 | 560 | 18809 |
| 17-#14 | 3.76 | 11352 | 3791 | 15753 | 3281 | 19293 | 2685 | 21341 | 2183 | 23612 | 1367 | 28307 | 363 | 25607 |
| 18-#10 | 2.25 | 10304 | 3352 | 13533 | 2970 | 16560 | 2450 | 18096 | 2015 | 19255 | 1344 | 22077 | 622 | 16625 |
| 18-#11 | 2.76 | 10650 | 3501 | 14368 | 3060 | 17524 | 2519 | 19203 | 2059 | 20695 | 1338 | 24047 | 524 | 19734 |
| 18-#14 | 3.98 | 11519 | 3856 | 16221 | 3304 | 19797 | 2708 | 21909 | 2187 | 24285 | 1346 | 29074 | 315 | 26943 |
| 19-#10 | 2.37 | 10398 | 3388 | 13575 | 3019 | 16722 | 2487 | 18322 | 2048 | 19643 | 1365 | 22755 | 614 | 17460 |
| 19-#11 | 2.91 | 10761 | 3546 | 14444 | 3117 | 17731 | 2560 | 19486 | 2097 | 21158 | 1362 | 24858 | 512 | 20687 |
| 19-#14 | 4.20 | 11673 | 3920 | 16375 | 3378 | 20113 | 2762 | 22322 | 2236 | 24931 | 1375 | 30198 | 293 | 28112 |
| 20-#10 | 2.50 | 10488 | 3425 | 13726 | 3048 | 16940 | 2517 | 18594 | 2066 | 20015 | 1370 | 23284 | 595 | 18216 |
| 20-#11 | 3.07 | 10869 | 3590 | 14637 | 3152 | 17993 | 2596 | 19815 | 2117 | 21614 | 1367 | 25504 | 489 | 21614 |
| 20-#14 | 4.42 | 11827 | 3984 | 16667 | 3428 | 20486 | 2810 | 22791 | 2264 | 25586 | 1383 | 31131 | 260 | 29382 |
| 21-#10 | 2.62 | 10595 | 3461 | 13961 | 3070 | 17190 | 2530 | 18897 | 2080 | 20415 | 1371 | 23852 | 575 | 19055 |
| 21-#11 | 3.22 | 10997 | 3635 | 14915 | 3179 | 18296 | 2613 | 20186 | 2135 | 22097 | 1369 | 26250 | 471 | 22554 |
| 21-#14 | 4.64 | 12005 | 4048 | 17052 | 3468 | 20918 | 2837 | 23322 | 2291 | 26271 | 1384 | 32189 | 232 | 30577 |
| 22-#10 | 2.74 | 10679 | 3497 | 14221 | 3087 | 17473 | 2542 | 19212 | 2080 | 20823 | 1362 | 24465 | 559 | 19791 |
| 22-#11 | 3.37 | 11098 | 3679 | 15216 | 3203 | 18630 | 2629 | 20564 | 2137 | 22583 | 1358 | 26902 | 443 | 23476 |
| 22-#14 | 4.86 | 12148 | 4113 | 17454 | 3507 | 21381 | 2864 | 23860 | 2297 | 26964 | 1370 | 33105 | 192 | 31770 |
| 23-#10 | 2.87 | 10790 | 3533 | 14323 | 3125 | 17658 | 2573 | 19467 | 2110 | 21182 | 1376 | 25008 | 541 | 20610 |
| 23-#11 | 3.52 | 11231 | 3724 | 15356 | 3247 | 18866 | 2666 | 20873 | 2172 | 23021 | 1374 | 27572 | 421 | 24378 |
| 24-#10 | 2.99 | 10875 | 3570 | 14470 | 3160 | 17865 | 2600 | 19746 | 2127 | 21550 | 1380 | 25599 | 526 | 21356 |
| 24-#11 | 3.68 | 11332 | 3768 | 15541 | 3289 | 19118 | 2698 | 21216 | 2192 | 23464 | 1378 | 28277 | 400 | 25333 |
| 25-#10 | 3.12 | 10978 | 3606 | 14686 | 3181 | 18131 | 2617 | 20041 | 2141 | 21957 | 1382 | 26120 | 502 | 22142 |
| 25-#11 | 3.83 | 11458 | 3813 | 15795 | 3315 | 19437 | 2719 | 21571 | 2209 | 23959 | 1381 | 28904 | 371 | 26189 |
| 26-#10 | 3.24 | 11076 | 3642 | 14924 | 3201 | 18398 | 2631 | 20372 | 2147 | 22343 | 1373 | 26655 | 477 | 22893 |
| 26-#11 | 3.98 | 11570 | 3857 | 16071 | 3341 | 19758 | 2737 | 21962 | 2217 | 24433 | 1371 | 29577 | 342 | 27082 |
| 27-#10 | 3.37 | 11171 | 3678 | 15076 | 3231 | 18598 | 2660 | 20613 | 2172 | 22721 | 1387 | 27275 | 468 | 23652 |
| 27-#11 | 4.14 | 11685 | 3902 | 16270 | 3377 | 20005 | 2771 | 22262 | 2246 | 24886 | 1387 | 30303 | 328 | 27940 |
| 28-#10 | 3.49 | 11272 | 3715 | 15252 | 3260 | 18817 | 2686 | 20891 | 2187 | 23103 | 1391 | 27835 | 445 | 24410 |
| 29-#10 | 3.62 | 11364 | 3751 | 15440 | 3287 | 19084 | 2698 | 21185 | 2202 | 23496 | 1393 | 28376 | 428 | 25145 |
| 30-#10 | 3.74 | 11471 | 3787 | 15687 | 3304 | 19372 | 2712 | 21493 | 2208 | 23892 | 1387 | 28873 | 396 | 25925 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 12" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#5 | 1.10 | 437 | 434 | 674 | 292 | 681 | 238 | 659 | 195 | 592 | 131 | 544 | 59 | 319 |
| 4-#6 | 1.56 | 444 | 449 | 691 | 298 | 700 | 243 | 682 | 197 | 621 | 128 | 575 | 40 | 433 |
| 4-#7 | 2.12 | 452 | 466 | 711 | 307 | 724 | 250 | 709 | 201 | 656 | 123 | 612 | 16 | 565 |
| 4-#8 | 2.79 | 461 | 487 | 734 | 318 | 752 | 258 | 740 | 204 | 695 | 118 | 671 | -8 | 659 |
| 4-#9 | 3.54 | 471 | 511 | 758 | 329 | 781 | 268 | 773 | 208 | 737 | 112 | 718 | -40 | 711 |
| 4-#10 | 4.49 | 483 | 540 | 789 | 344 | 819 | 280 | 813 | 213 | 788 | 103 | 774 | -82 | 771 |
| 4-#11 | 5.52 | 492 | 573 | 814 | 355 | 836 | 284 | 832 | 210 | 813 | 86 | 790 | -135 | 799 |
| 4-#14 | 7.96 | 519 | 649 | 882 | 413 | 907 | 309 | 912 | 218 | 916 | 58 | 893 | -246 | 911 |
| 5-#5 | 1.37 | 445 | 443 | 689 | 291 | 693 | 235 | 670 | 191 | 609 | 125 | 566 | 53 | 377 |
| 5-#6 | 1.95 | 455 | 461 | 710 | 301 | 719 | 242 | 699 | 193 | 647 | 121 | 609 | 33 | 497 |
| 5-#7 | 2.65 | 467 | 483 | 736 | 312 | 749 | 250 | 733 | 196 | 692 | 115 | 659 | 7 | 636 |
| 5-#8 | 3.49 | 481 | 509 | 766 | 327 | 784 | 260 | 772 | 200 | 744 | 108 | 716 | -24 | 732 |
| 5-#9 | 4.42 | 496 | 538 | 797 | 342 | 819 | 270 | 813 | 204 | 799 | 100 | 774 | -58 | 792 |
| 5-#10 | 5.61 | 514 | 576 | 836 | 362 | 863 | 283 | 864 | 208 | 866 | 88 | 843 | -104 | 878 |
| 5-#11 | 6.90 | 528 | 616 | 864 | 384 | 886 | 288 | 889 | 204 | 901 | 67 | 860 | -167 | 921 |
| 6-#5 | 1.64 | 449 | 451 | 707 | 284 | 705 | 228 | 679 | 182 | 617 | 113 | 570 | 35 | 438 |
| 6-#6 | 2.33 | 460 | 473 | 735 | 295 | 737 | 236 | 715 | 185 | 664 | 106 | 621 | 9 | 587 |
| 6-#7 | 3.18 | 473 | 500 | 769 | 314 | 775 | 245 | 759 | 188 | 720 | 97 | 680 | -23 | 695 |
| 6-#8 | 4.19 | 489 | 531 | 807 | 332 | 818 | 255 | 808 | 191 | 784 | 86 | 746 | -62 | 777 |
| 6-#9 | 5.31 | 506 | 566 | 846 | 351 | 862 | 267 | 860 | 195 | 850 | 73 | 814 | -106 | 859 |
| 6-#10 | 6.74 | 529 | 611 | 893 | 376 | 917 | 281 | 924 | 198 | 932 | 55 | 895 | -164 | 921 |
| 7-#5 | 1.92 | 457 | 460 | 709 | 307 | 720 | 247 | 704 | 198 | 652 | 125 | 616 | 37 | 494 |
| 7-#6 | 2.72 | 471 | 485 | 739 | 321 | 756 | 257 | 745 | 203 | 705 | 119 | 675 | 9 | 649 |
| 7-#7 | 3.71 | 488 | 516 | 775 | 339 | 798 | 269 | 793 | 208 | 768 | 112 | 757 | -22 | 762 |
| 7-#8 | 4.89 | 507 | 553 | 815 | 360 | 847 | 283 | 848 | 214 | 840 | 103 | 839 | -64 | 862 |
| 7-#9 | 6.19 | 528 | 594 | 858 | 383 | 898 | 299 | 905 | 221 | 915 | 92 | 921 | -113 | 957 |
| 8-#5 | 2.19 | 460 | 469 | 718 | 316 | 734 | 255 | 721 | 204 | 673 | 126 | 647 | 30 | 552 |
| 8-#6 | 3.11 | 476 | 497 | 752 | 333 | 774 | 267 | 768 | 211 | 732 | 120 | 716 | -2 | 718 |
| 8-#7 | 4.24 | 494 | 533 | 792 | 353 | 822 | 282 | 824 | 218 | 803 | 112 | 797 | -43 | 818 |
| 8-#8 | 5.59 | 516 | 575 | 838 | 378 | 877 | 300 | 886 | 226 | 883 | 102 | 905 | -87 | 926 |

## ROUND TIED COLUMNS 14" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.14 | 699 | 593 | 1070 | 411 | 1096 | 336 | 1070 | 275 | 979 | 187 | 915 | 88 | 533 |
| 4-#7 | 1.56 | 710 | 611 | 1097 | 420 | 1127 | 343 | 1107 | 279 | 1026 | 184 | 969 | 68 | 701 |
| 4-#8 | 2.05 | 722 | 632 | 1127 | 430 | 1163 | 352 | 1150 | 284 | 1081 | 181 | 1031 | 42 | 891 |
| 4-#9 | 2.60 | 735 | 655 | 1160 | 442 | 1202 | 361 | 1196 | 289 | 1140 | 176 | 1096 | 13 | 1069 |
| 4-#10 | 3.30 | 752 | 685 | 1201 | 458 | 1251 | 374 | 1255 | 296 | 1213 | 170 | 1176 | -25 | 1183 |
| 4-#11 | 4.05 | 765 | 717 | 1239 | 469 | 1291 | 382 | 1296 | 298 | 1258 | 156 | 1213 | -78 | 1235 |
| 4-#14 | 5.85 | 802 | 793 | 1332 | 508 | 1404 | 413 | 1420 | 311 | 1416 | 136 | 1431 | -174 | 1411 |
| 5-#5 | 1.01 | 700 | 587 | 1072 | 401 | 1088 | 326 | 1056 | 267 | 955 | 182 | 890 | 97 | 471 |
| 5-#6 | 1.43 | 713 | 605 | 1100 | 411 | 1121 | 333 | 1095 | 270 | 1005 | 178 | 949 | 79 | 625 |
| 5-#7 | 1.95 | 728 | 627 | 1135 | 423 | 1162 | 341 | 1143 | 275 | 1066 | 173 | 1019 | 55 | 804 |
| 5-#8 | 2.57 | 746 | 654 | 1174 | 438 | 1209 | 352 | 1199 | 280 | 1136 | 167 | 1099 | 27 | 1005 |
| 5-#9 | 3.25 | 766 | 683 | 1216 | 454 | 1259 | 363 | 1258 | 286 | 1210 | 160 | 1182 | -5 | 1186 |
| 5-#10 | 4.13 | 790 | 720 | 1269 | 475 | 1323 | 378 | 1330 | 293 | 1318 | 156 | 1284 | -48 | 1314 |
| 5-#11 | 5.07 | 810 | 760 | 1314 | 491 | 1372 | 388 | 1376 | 292 | 1380 | 139 | 1370 | -97 | 1395 |
| 5-#14 | 7.31 | 866 | 856 | 1432 | 543 | 1508 | 422 | 1532 | 305 | 1588 | 111 | 1587 | -213 | 1645 |
| 6-#5 | 1.21 | 704 | 596 | 1098 | 388 | 1105 | 315 | 1068 | 256 | 966 | 168 | 899 | 78 | 541 |
| 6-#6 | 1.71 | 719 | 617 | 1134 | 399 | 1150 | 323 | 1118 | 259 | 1030 | 162 | 973 | 55 | 731 |
| 6-#7 | 2.34 | 736 | 644 | 1178 | 413 | 1203 | 334 | 1178 | 264 | 1107 | 155 | 1060 | 25 | 953 |
| 6-#8 | 3.08 | 757 | 675 | 1229 | 430 | 1263 | 346 | 1247 | 269 | 1196 | 147 | 1160 | -11 | 1166 |
| 6-#9 | 3.90 | 779 | 710 | 1283 | 449 | 1327 | 359 | 1320 | 274 | 1290 | 136 | 1264 | -50 | 1287 |
| 6-#10 | 4.95 | 806 | 755 | 1352 | 473 | 1406 | 376 | 1412 | 281 | 1407 | 123 | 1392 | -103 | 1382 |
| 6-#11 | 6.08 | 829 | 803 | 1412 | 507 | 1459 | 385 | 1471 | 280 | 1484 | 99 | 1456 | -171 | 1466 |

## ROUND TIED COLUMNS 14" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 7-#5 | 1.41 | 714 | 604 | 1095 | 418 | 1124 | 339 | 1100 | 276 | 1017 | 185 | 970 | 86 | 624 |
| 7-#6 | 2.00 | 733 | 630 | 1135 | 433 | 1171 | 350 | 1155 | 282 | 1089 | 181 | 1056 | 61 | 825 |
| 7-#7 | 2.73 | 755 | 661 | 1182 | 451 | 1227 | 363 | 1222 | 289 | 1176 | 175 | 1159 | 31 | 1055 |
| 7-#8 | 3.59 | 781 | 697 | 1237 | 474 | 1293 | 379 | 1299 | 297 | 1276 | 169 | 1275 | -7 | 1280 |
| 7-#9 | 4.55 | 810 | 738 | 1296 | 498 | 1363 | 396 | 1382 | 307 | 1382 | 161 | 1397 | -50 | 1426 |
| 7-#10 | 5.78 | 846 | 790 | 1370 | 530 | 1450 | 418 | 1485 | 318 | 1514 | 151 | 1545 | -107 | 1598 |
| 7-#11 | 7.09 | 873 | 846 | 1431 | 555 | 1517 | 433 | 1553 | 320 | 1603 | 128 | 1660 | -176 | 1697 |
| 8-#5 | 1.61 | 719 | 613 | 1107 | 430 | 1142 | 349 | 1123 | 284 | 1046 | 187 | 1015 | 81 | 691 |
| 8-#6 | 2.29 | 739 | 642 | 1153 | 447 | 1195 | 362 | 1186 | 291 | 1127 | 183 | 1115 | 53 | 924 |
| 8-#7 | 3.12 | 764 | 677 | 1207 | 469 | 1259 | 378 | 1261 | 300 | 1224 | 177 | 1234 | 18 | 1187 |
| 8-#8 | 4.11 | 793 | 719 | 1269 | 495 | 1333 | 397 | 1348 | 311 | 1336 | 171 | 1369 | -25 | 1381 |
| 8-#9 | 5.20 | 823 | 766 | 1335 | 523 | 1412 | 418 | 1441 | 323 | 1455 | 162 | 1510 | -75 | 1539 |
| 8-#10 | 6.60 | 862 | 825 | 1417 | 559 | 1511 | 445 | 1558 | 337 | 1603 | 151 | 1682 | -140 | 1727 |

## ROUND TIED COLUMNS 16" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.19 | 1049 | 777 | 1598 | 551 | 1654 | 452 | 1626 | 371 | 1503 | 253 | 1431 | 123 | 836 |
| 4-#8 | 1.57 | 1065 | 798 | 1637 | 562 | 1699 | 460 | 1679 | 376 | 1575 | 250 | 1514 | 100 | 1069 |
| 4-#9 | 1.99 | 1082 | 822 | 1678 | 574 | 1747 | 470 | 1736 | 381 | 1652 | 248 | 1602 | 74 | 1316 |
| 4-#10 | 2.53 | 1103 | 851 | 1729 | 590 | 1808 | 483 | 1809 | 389 | 1750 | 244 | 1711 | 40 | 1616 |
| 4-#11 | 3.10 | 1121 | 884 | 1780 | 600 | 1861 | 491 | 1869 | 391 | 1816 | 232 | 1776 | -7 | 1778 |
| 4-#14 | 4.48 | 1169 | 960 | 1899 | 641 | 2005 | 523 | 2041 | 409 | 2031 | 217 | 2011 | -104 | 2030 |
| 4-#18 | 7.96 | 1283 | 1154 | 2178 | 744 | 2346 | 605 | 2434 | 450 | 2516 | 171 | 2516 | -372 | 2542 |
| 5-#6 | 1.09 | 1052 | 772 | 1607 | 539 | 1648 | 438 | 1611 | 359 | 1477 | 245 | 1400 | 132 | 756 |
| 5-#7 | 1.49 | 1072 | 794 | 1651 | 551 | 1699 | 447 | 1671 | 364 | 1555 | 241 | 1494 | 111 | 976 |
| 5-#8 | 1.96 | 1094 | 820 | 1700 | 566 | 1758 | 458 | 1740 | 370 | 1645 | 236 | 1602 | 85 | 1225 |
| 5-#9 | 2.49 | 1118 | 849 | 1754 | 583 | 1821 | 470 | 1815 | 377 | 1742 | 231 | 1716 | 56 | 1485 |
| 5-#10 | 3.16 | 1149 | 887 | 1821 | 604 | 1901 | 486 | 1911 | 385 | 1863 | 224 | 1857 | 18 | 1798 |
| 5-#11 | 3.88 | 1175 | 927 | 1882 | 620 | 1968 | 496 | 1987 | 388 | 1950 | 208 | 1942 | -34 | 1965 |
| 5-#14 | 5.60 | 1246 | 1022 | 2036 | 675 | 2154 | 535 | 2202 | 406 | 2252 | 195 | 2241 | -143 | 2317 |
| 6-#6 | 1.31 | 1060 | 784 | 1653 | 521 | 1680 | 423 | 1641 | 345 | 1502 | 227 | 1396 | 101 | 876 |
| 6-#7 | 1.79 | 1082 | 811 | 1707 | 535 | 1746 | 434 | 1718 | 350 | 1601 | 221 | 1503 | 72 | 1147 |
| 6-#8 | 2.36 | 1107 | 842 | 1770 | 552 | 1824 | 447 | 1807 | 357 | 1715 | 214 | 1626 | 38 | 1457 |
| 6-#9 | 2.98 | 1135 | 877 | 1838 | 571 | 1907 | 461 | 1903 | 363 | 1837 | 205 | 1815 | 10 | 1786 |
| 6-#10 | 3.79 | 1170 | 922 | 1923 | 595 | 2014 | 480 | 2022 | 372 | 1990 | 194 | 1991 | -39 | 1943 |
| 6-#11 | 4.66 | 1199 | 970 | 2002 | 616 | 2100 | 493 | 2110 | 373 | 2103 | 174 | 2102 | -104 | 2069 |
| 6-#14 | 6.71 | 1280 | 1084 | 2203 | 678 | 2332 | 536 | 2378 | 391 | 2446 | 139 | 2475 | -238 | 2440 |
| 7-#5 | 1.08 | 1054 | 771 | 1597 | 549 | 1651 | 447 | 1619 | 367 | 1491 | 252 | 1428 | 139 | 749 |
| 7-#6 | 1.53 | 1077 | 796 | 1646 | 563 | 1709 | 458 | 1687 | 373 | 1583 | 250 | 1541 | 117 | 1007 |
| 7-#7 | 2.09 | 1105 | 827 | 1705 | 582 | 1781 | 471 | 1770 | 381 | 1694 | 246 | 1678 | 90 | 1292 |
| 7-#8 | 2.75 | 1137 | 864 | 1773 | 604 | 1864 | 488 | 1867 | 390 | 1823 | 242 | 1835 | 56 | 1616 |
| 7-#9 | 3.48 | 1172 | 905 | 1847 | 629 | 1952 | 506 | 1972 | 400 | 1961 | 236 | 2001 | 18 | 1942 |
| 7-#10 | 4.42 | 1216 | 957 | 1939 | 661 | 2064 | 529 | 2104 | 413 | 2133 | 229 | 2206 | -33 | 2225 |
| 7-#11 | 5.43 | 1256 | 1013 | 2026 | 688 | 2156 | 546 | 2210 | 420 | 2261 | 211 | 2335 | -103 | 2390 |
| 7-#14 | 7.83 | 1360 | 1147 | 2242 | 770 | 2413 | 603 | 2514 | 449 | 2648 | 184 | 2770 | -247 | 2797 |
| 8-#5 | 1.23 | 1060 | 780 | 1608 | 562 | 1674 | 459 | 1649 | 376 | 1527 | 256 | 1487 | 136 | 831 |
| 8-#6 | 1.75 | 1085 | 808 | 1664 | 579 | 1740 | 472 | 1726 | 384 | 1629 | 253 | 1619 | 111 | 1118 |
| 8-#7 | 2.39 | 1116 | 844 | 1732 | 601 | 1821 | 489 | 1820 | 394 | 1753 | 249 | 1776 | 80 | 1454 |
| 8-#8 | 3.14 | 1152 | 886 | 1811 | 627 | 1914 | 509 | 1930 | 406 | 1898 | 245 | 1958 | 41 | 1832 |
| 8-#9 | 3.98 | 1191 | 932 | 1896 | 657 | 2015 | 531 | 2048 | 419 | 2053 | 239 | 2150 | -2 | 2151 |
| 8-#10 | 5.05 | 1239 | 992 | 2003 | 695 | 2141 | 559 | 2197 | 435 | 2248 | 232 | 2387 | -60 | 2408 |
| 8-#11 | 6.21 | 1281 | 1056 | 2100 | 727 | 2245 | 581 | 2317 | 444 | 2393 | 212 | 2541 | -140 | 2585 |
| 9-#10 | 5.68 | 1276 | 1027 | 2061 | 714 | 2220 | 568 | 2298 | 439 | 2383 | 225 | 2510 | -95 | 2552 |
| 9-#11 | 6.98 | 1323 | 1099 | 2168 | 751 | 2345 | 593 | 2434 | 449 | 2550 | 204 | 2721 | -175 | 2737 |
| 10-#10 | 6.32 | 1303 | 1062 | 2145 | 722 | 2310 | 574 | 2403 | 439 | 2507 | 204 | 2636 | -140 | 2679 |

## ROUND TIED COLUMNS 18" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.24 | 1501 | 987 | 2276 | 712 | 2376 | 584 | 2348 | 480 | 2188 | 328 | 2116 | 163 | 1246 |
| 4-#9 | 1.57 | 1522 | 1010 | 2326 | 724 | 2433 | 594 | 2417 | 485 | 2280 | 325 | 2227 | 139 | 1541 |
| 4-#10 | 2.00 | 1548 | 1040 | 2388 | 740 | 2507 | 607 | 2503 | 493 | 2397 | 322 | 2367 | 108 | 1906 |
| 4-#11 | 2.45 | 1570 | 1072 | 2453 | 750 | 2573 | 614 | 2577 | 496 | 2496 | 314 | 2460 | 65 | 2263 |
| 4-#14 | 3.54 | 1631 | 1149 | 2598 | 791 | 2748 | 648 | 2786 | 515 | 2774 | 304 | 2771 | -23 | 2775 |
| 4-#18 | 6.29 | 1774 | 1342 | 2943 | 897 | 3167 | 733 | 3289 | 564 | 3403 | 269 | 3467 | -264 | 3469 |
| 5-#7 | 1.18 | 1509 | 983 | 2300 | 698 | 2378 | 568 | 2338 | 466 | 2165 | 317 | 2085 | 171 | 1152 |
| 5-#8 | 1.55 | 1536 | 1009 | 2360 | 713 | 2448 | 579 | 2421 | 472 | 2276 | 314 | 2222 | 147 | 1449 |
| 5-#9 | 1.96 | 1565 | 1038 | 2425 | 730 | 2525 | 591 | 2512 | 479 | 2397 | 309 | 2367 | 121 | 1761 |
| 5-#10 | 2.50 | 1602 | 1075 | 2506 | 751 | 2622 | 607 | 2626 | 488 | 2549 | 304 | 2549 | 86 | 2150 |
| 5-#11 | 3.07 | 1635 | 1116 | 2585 | 767 | 2707 | 618 | 2723 | 491 | 2664 | 290 | 2672 | 39 | 2530 |
| 5-#14 | 4.42 | 1722 | 1211 | 2775 | 823 | 2935 | 658 | 2995 | 513 | 3009 | 272 | 3072 | -59 | 3108 |
| 5-#18 | 7.86 | 1928 | 1453 | 3220 | 963 | 3477 | 759 | 3636 | 565 | 3807 | 216 | 3957 | -328 | 4079 |
| 6-#6 | 1.04 | 1494 | 973 | 2309 | 660 | 2353 | 537 | 2295 | 441 | 2097 | 299 | 1953 | 158 | 1021 |
| 6-#7 | 1.41 | 1521 | 999 | 2373 | 674 | 2431 | 548 | 2389 | 447 | 2217 | 294 | 2088 | 131 | 1342 |
| 6-#8 | 1.86 | 1552 | 1031 | 2448 | 691 | 2523 | 561 | 2500 | 454 | 2357 | 288 | 2244 | 99 | 1710 |
| 6-#9 | 2.36 | 1585 | 1066 | 2529 | 710 | 2623 | 576 | 2620 | 462 | 2507 | 281 | 2410 | 62 | 2103 |
| 6-#10 | 2.99 | 1627 | 1111 | 2632 | 734 | 2749 | 594 | 2773 | 473 | 2697 | 272 | 2618 | 15 | 2572 |
| 6-#11 | 3.68 | 1664 | 1159 | 2730 | 754 | 2863 | 609 | 2889 | 476 | 2846 | 254 | 2864 | -31 | 2784 |
| 6-#14 | 5.31 | 1763 | 1273 | 2973 | 818 | 3167 | 657 | 3230 | 498 | 3281 | 225 | 3361 | -157 | 3276 |
| 7-#6 | 1.21 | 1514 | 985 | 2289 | 712 | 2388 | 580 | 2360 | 477 | 2198 | 327 | 2130 | 175 | 1188 |
| 7-#7 | 1.65 | 1548 | 1016 | 2359 | 730 | 2473 | 594 | 2460 | 485 | 2332 | 324 | 2296 | 149 | 1536 |
| 7-#8 | 2.17 | 1587 | 1053 | 2441 | 753 | 2572 | 611 | 2576 | 495 | 2488 | 321 | 2514 | 122 | 1925 |
| 7-#9 | 2.75 | 1629 | 1093 | 2529 | 778 | 2680 | 630 | 2703 | 506 | 2658 | 317 | 2725 | 87 | 2337 |
| 7-#10 | 3.49 | 1682 | 1146 | 2641 | 810 | 2816 | 654 | 2863 | 520 | 2873 | 312 | 2988 | 41 | 2832 |
| 7-#11 | 4.29 | 1730 | 1202 | 2750 | 838 | 2938 | 673 | 2998 | 527 | 3049 | 298 | 3174 | -22 | 3188 |
| 7-#14 | 6.19 | 1855 | 1336 | 3013 | 920 | 3256 | 733 | 3374 | 561 | 3539 | 279 | 3755 | -152 | 3761 |
| 8-#6 | 1.38 | 1524 | 997 | 2306 | 730 | 2427 | 597 | 2408 | 490 | 2257 | 332 | 2242 | 174 | 1314 |
| 8-#7 | 1.89 | 1561 | 1033 | 2386 | 752 | 2524 | 615 | 2521 | 500 | 2405 | 329 | 2439 | 145 | 1715 |
| 8-#8 | 2.48 | 1604 | 1075 | 2480 | 778 | 2637 | 635 | 2653 | 513 | 2579 | 326 | 2668 | 111 | 2172 |
| 8-#9 | 3.14 | 1652 | 1121 | 2582 | 807 | 2759 | 658 | 2796 | 527 | 2768 | 322 | 2912 | 71 | 2659 |
| 8-#10 | 3.99 | 1711 | 1181 | 2710 | 846 | 2913 | 687 | 2977 | 545 | 3006 | 316 | 3216 | 19 | 3154 |
| 8-#11 | 4.90 | 1763 | 1245 | 2838 | 879 | 3047 | 710 | 3131 | 555 | 3207 | 302 | 3435 | -53 | 3453 |
| 8-#14 | 7.07 | 1902 | 1398 | 3144 | 977 | 3407 | 783 | 3555 | 598 | 3762 | 282 | 4107 | -202 | 4143 |
| 9-#10 | 4.49 | 1756 | 1216 | 2788 | 866 | 3000 | 694 | 3094 | 547 | 3175 | 311 | 3373 | -16 | 3381 |
| 9-#11 | 5.52 | 1816 | 1288 | 2923 | 904 | 3156 | 720 | 3275 | 560 | 3406 | 296 | 3613 | -96 | 3657 |
| 10-#10 | 4.99 | 1787 | 1251 | 2893 | 872 | 3110 | 699 | 3214 | 545 | 3335 | 292 | 3528 | -57 | 3547 |
| 10-#11 | 6.13 | 1853 | 1331 | 3044 | 913 | 3284 | 728 | 3419 | 559 | 3583 | 270 | 3796 | -149 | 3841 |
| 11-#10 | 5.49 | 1828 | 1286 | 2930 | 918 | 3193 | 735 | 3321 | 573 | 3478 | 310 | 3794 | -66 | 3817 |
| 11-#11 | 6.74 | 1902 | 1375 | 3095 | 967 | 3382 | 768 | 3542 | 590 | 3760 | 291 | 4097 | -162 | 4089 |
| 12-#10 | 5.99 | 1865 | 1321 | 2995 | 945 | 3279 | 760 | 3441 | 594 | 3618 | 310 | 3969 | -97 | 3990 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 20" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.01 | 2043 | 1198 | 3062 | 882 | 3211 | 724 | 3176 | 597 | 2944 | 415 | 2851 | 232 | 1423 |
| 4-#9 | 1.27 | 2068 | 1222 | 3120 | 893 | 3279 | 733 | 3255 | 603 | 3050 | 412 | 2987 | 210 | 1765 |
| 4-#10 | 1.62 | 2099 | 1251 | 3193 | 909 | 3364 | 746 | 3356 | 610 | 3186 | 410 | 3157 | 181 | 2191 |
| 4-#11 | 1.99 | 2126 | 1283 | 3272 | 918 | 3444 | 753 | 3444 | 613 | 3303 | 401 | 3279 | 140 | 2614 |
| 4-#14 | 2.86 | 2199 | 1360 | 3445 | 960 | 3650 | 787 | 3689 | 633 | 3635 | 393 | 3668 | 59 | 3501 |
| 4-#18 | 5.09 | 2371 | 1553 | 3856 | 1067 | 4147 | 875 | 4284 | 684 | 4437 | 372 | 4559 | -161 | 4552 |
| 5-#8 | 1.26 | 2083 | 1220 | 3168 | 878 | 3299 | 715 | 3260 | 586 | 3043 | 398 | 2973 | 215 | 1679 |
| 5-#9 | 1.59 | 2118 | 1249 | 3245 | 895 | 3388 | 727 | 3365 | 593 | 3184 | 395 | 3150 | 190 | 2047 |
| 5-#10 | 2.02 | 2161 | 1287 | 3341 | 916 | 3502 | 743 | 3500 | 602 | 3363 | 390 | 3373 | 158 | 2498 |
| 5-#11 | 2.48 | 2201 | 1327 | 3438 | 932 | 3605 | 754 | 3616 | 606 | 3517 | 380 | 3535 | 114 | 2950 |
| 5-#14 | 3.58 | 2304 | 1422 | 3664 | 988 | 3877 | 795 | 3938 | 629 | 3939 | 365 | 4039 | 24 | 3945 |
| 5-#18 | 6.37 | 2551 | 1664 | 4201 | 1132 | 4527 | 900 | 4713 | 687 | 4923 | 320 | 5183 | -221 | 5266 |
| 6-#7 | 1.15 | 2065 | 1210 | 3193 | 831 | 3275 | 677 | 3212 | 554 | 2970 | 376 | 2798 | 195 | 1538 |
| 6-#8 | 1.51 | 2102 | 1242 | 3280 | 847 | 3381 | 690 | 3340 | 562 | 3136 | 370 | 2987 | 165 | 1964 |
| 6-#9 | 1.91 | 2141 | 1277 | 3374 | 866 | 3497 | 704 | 3480 | 570 | 3315 | 364 | 3191 | 131 | 2422 |
| 6-#10 | 2.43 | 2190 | 1322 | 3494 | 891 | 3644 | 723 | 3657 | 581 | 3542 | 356 | 3446 | 86 | 2992 |
| 6-#11 | 2.98 | 2235 | 1370 | 3612 | 910 | 3780 | 737 | 3817 | 587 | 3727 | 340 | 3634 | 26 | 3542 |
| 6-#14 | 4.30 | 2353 | 1484 | 3898 | 974 | 4137 | 786 | 4239 | 613 | 4256 | 316 | 4208 | -98 | 4243 |
| 6-#18 | 7.64 | 2634 | 1775 | 4587 | 1137 | 4998 | 911 | 5209 | 671 | 5496 | 246 | 5798 | -388 | 5566 |
| 7-#7 | 1.34 | 2096 | 1227 | 3161 | 898 | 3323 | 732 | 3306 | 601 | 3103 | 408 | 3065 | 217 | 1788 |
| 7-#8 | 1.76 | 2142 | 1264 | 3257 | 920 | 3439 | 749 | 3444 | 612 | 3283 | 405 | 3297 | 188 | 2242 |
| 7-#9 | 2.23 | 2191 | 1305 | 3360 | 945 | 3564 | 768 | 3592 | 623 | 3493 | 405 | 3547 | 154 | 2725 |
| 7-#10 | 2.83 | 2253 | 1357 | 3490 | 978 | 3723 | 792 | 3780 | 638 | 3745 | 401 | 3860 | 110 | 3324 |
| 7-#11 | 3.48 | 2311 | 1413 | 3622 | 1005 | 3872 | 811 | 3944 | 646 | 3964 | 390 | 4150 | 60 | 3897 |
| 7-#14 | 5.01 | 2459 | 1547 | 3933 | 1088 | 4255 | 874 | 4392 | 683 | 4566 | 377 | 4879 | -60 | 4906 |
| 8-#7 | 1.53 | 2112 | 1244 | 3186 | 921 | 3384 | 755 | 3380 | 619 | 3201 | 418 | 3237 | 216 | 1978 |
| 8-#8 | 2.01 | 2163 | 1286 | 3295 | 948 | 3517 | 776 | 3535 | 632 | 3404 | 415 | 3513 | 184 | 2511 |
| 8-#9 | 2.55 | 2217 | 1332 | 3414 | 977 | 3663 | 800 | 3703 | 647 | 3625 | 412 | 3810 | 147 | 3080 |
| 8-#10 | 3.23 | 2286 | 1392 | 3563 | 1015 | 3845 | 830 | 3916 | 666 | 3905 | 408 | 4182 | 100 | 3788 |
| 8-#11 | 3.97 | 2352 | 1456 | 3716 | 1048 | 4009 | 853 | 4103 | 677 | 4149 | 396 | 4467 | 34 | 4346 |
| 8-#14 | 5.73 | 2517 | 1609 | 4075 | 1146 | 4439 | 929 | 4609 | 723 | 4817 | 381 | 5310 | -102 | 5327 |
| 9-#10 | 3.64 | 2343 | 1427 | 3658 | 1035 | 3940 | 835 | 4043 | 667 | 4103 | 404 | 4372 | 65 | 4086 |
| 9-#11 | 4.47 | 2415 | 1499 | 3826 | 1073 | 4128 | 862 | 4262 | 680 | 4384 | 390 | 4688 | -9 | 4693 |
| 9-#14 | 6.45 | 2605 | 1671 | 4221 | 1185 | 4613 | 944 | 4843 | 730 | 5150 | 374 | 5618 | -163 | 5662 |
| 10-#10 | 4.04 | 2377 | 1462 | 3792 | 1039 | 4069 | 837 | 4183 | 662 | 4278 | 382 | 4555 | 25 | 4456 |
| 10-#11 | 4.97 | 2457 | 1542 | 3974 | 1081 | 4280 | 867 | 4429 | 677 | 4608 | 366 | 4906 | -59 | 4926 |
| 10-#14 | 7.16 | 2664 | 1733 | 4420 | 1201 | 4827 | 956 | 5084 | 730 | 5466 | 342 | 5933 | -235 | 5962 |
| 11-#10 | 4.45 | 2426 | 1497 | 3823 | 1088 | 4160 | 876 | 4311 | 694 | 4462 | 405 | 4880 | 19 | 4797 |
| 11-#11 | 5.46 | 2514 | 1586 | 4022 | 1137 | 4393 | 911 | 4577 | 712 | 4806 | 389 | 5277 | -69 | 5300 |
| 12-#10 | 4.85 | 2468 | 1532 | 3898 | 1117 | 4260 | 903 | 4443 | 715 | 4628 | 407 | 5093 | -8 | 5095 |
| 12-#11 | 5.96 | 2565 | 1629 | 4112 | 1171 | 4512 | 943 | 4740 | 738 | 5000 | 390 | 5523 | -105 | 5543 |
| 13-#10 | 5.26 | 2514 | 1568 | 3993 | 1141 | 4378 | 915 | 4579 | 721 | 4813 | 403 | 5339 | -36 | 5348 |
| 14-#10 | 5.66 | 2562 | 1603 | 4103 | 1151 | 4508 | 926 | 4731 | 726 | 5024 | 399 | 5505 | -75 | 5517 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 22" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.05 | 2731 | 1455 | 4076 | 1081 | 4300 | 888 | 4269 | 733 | 3980 | 509 | 3896 | 285 | 1988 |
| 4-#10 | 1.34 | 2767 | 1485 | 4160 | 1097 | 4398 | 901 | 4384 | 741 | 4134 | 506 | 4097 | 258 | 2474 |
| 4-#11 | 1.64 | 2799 | 1517 | 4254 | 1106 | 4491 | 908 | 4486 | 743 | 4269 | 498 | 4248 | 220 | 2964 |
| 4-#14 | 2.37 | 2884 | 1593 | 4455 | 1147 | 4728 | 942 | 4767 | 763 | 4648 | 491 | 4715 | 144 | 4105 |
| 4-#18 | 4.21 | 3088 | 1787 | 4933 | 1255 | 5304 | 1030 | 5454 | 816 | 5579 | 473 | 5805 | -60 | 5801 |
| 5-#8 | 1.04 | 2747 | 1453 | 4141 | 1061 | 4326 | 866 | 4273 | 713 | 3966 | 493 | 3870 | 288 | 1913 |
| 5-#9 | 1.32 | 2787 | 1482 | 4230 | 1078 | 4429 | 878 | 4394 | 720 | 4127 | 489 | 4079 | 265 | 2335 |
| 5-#10 | 1.67 | 2837 | 1520 | 4341 | 1100 | 4560 | 894 | 4548 | 730 | 4332 | 485 | 4343 | 235 | 2852 |
| 5-#11 | 2.05 | 2884 | 1560 | 4457 | 1115 | 4681 | 905 | 4684 | 733 | 4511 | 475 | 4546 | 193 | 3376 |
| 5-#14 | 2.96 | 3004 | 1655 | 4721 | 1171 | 4996 | 947 | 5056 | 757 | 5009 | 463 | 5154 | 109 | 4598 |
| 5-#18 | 5.26 | 3291 | 1897 | 5349 | 1317 | 5754 | 1054 | 5959 | 819 | 6199 | 429 | 6562 | -118 | 6609 |
| 6-#8 | 1.25 | 2769 | 1475 | 4281 | 1021 | 4417 | 832 | 4353 | 681 | 4068 | 461 | 3871 | 235 | 2219 |
| 6-#9 | 1.58 | 2814 | 1510 | 4389 | 1040 | 4549 | 847 | 4511 | 690 | 4276 | 455 | 4111 | 203 | 2741 |
| 6-#10 | 2.00 | 2871 | 1555 | 4526 | 1064 | 4717 | 866 | 4714 | 700 | 4539 | 449 | 4414 | 161 | 3394 |
| 6-#11 | 2.46 | 2924 | 1603 | 4664 | 1083 | 4875 | 880 | 4899 | 706 | 4762 | 434 | 4649 | 105 | 4049 |
| 6-#14 | 3.55 | 3060 | 1718 | 4994 | 1147 | 5283 | 929 | 5392 | 735 | 5385 | 413 | 5345 | -12 | 5349 |
| 6-#18 | 6.31 | 3389 | 2008 | 5791 | 1311 | 6279 | 1055 | 6581 | 805 | 6863 | 353 | 6948 | -327 | 6983 |
| 7-#7 | 1.10 | 2762 | 1460 | 4126 | 1084 | 4351 | 885 | 4325 | 730 | 4040 | 504 | 3981 | 292 | 2024 |
| 7-#8 | 1.45 | 2814 | 1497 | 4235 | 1106 | 4482 | 902 | 4481 | 741 | 4246 | 501 | 4254 | 264 | 2568 |
| 7-#9 | 1.84 | 2871 | 1538 | 4354 | 1131 | 4625 | 921 | 4652 | 752 | 4470 | 498 | 4549 | 232 | 3124 |
| 7-#10 | 2.34 | 2943 | 1590 | 4504 | 1164 | 4807 | 946 | 4870 | 768 | 4755 | 494 | 4921 | 191 | 3813 |
| 7-#11 | 2.87 | 3009 | 1646 | 4659 | 1190 | 4981 | 965 | 5066 | 777 | 5033 | 489 | 5213 | 135 | 4496 |
| 7-#14 | 4.14 | 3181 | 1780 | 5018 | 1274 | 5422 | 1028 | 5587 | 815 | 5731 | 479 | 6155 | 33 | 6004 |
| 7-#18 | 7.37 | 3595 | 2119 | 5881 | 1489 | 6492 | 1190 | 6839 | 909 | 7413 | 447 | 8191 | -269 | 8092 |
| 8-#7 | 1.26 | 2780 | 1477 | 4147 | 1110 | 4416 | 910 | 4415 | 751 | 4156 | 516 | 4185 | 292 | 2245 |
| 8-#8 | 1.66 | 2838 | 1519 | 4272 | 1136 | 4568 | 931 | 4592 | 764 | 4389 | 514 | 4509 | 262 | 2854 |
| 8-#9 | 2.10 | 2901 | 1565 | 4407 | 1165 | 4734 | 955 | 4786 | 779 | 4642 | 512 | 4858 | 228 | 3505 |
| 8-#10 | 2.67 | 2980 | 1625 | 4578 | 1203 | 4945 | 986 | 5031 | 799 | 4965 | 509 | 5298 | 184 | 4319 |
| 8-#11 | 3.28 | 3054 | 1689 | 4757 | 1236 | 5148 | 1011 | 5252 | 811 | 5251 | 497 | 5652 | 122 | 5126 |
| 8-#14 | 4.74 | 3250 | 1842 | 5169 | 1334 | 5649 | 1088 | 5841 | 859 | 6026 | 486 | 6667 | -3 | 6668 |
| 9-#10 | 3.01 | 3047 | 1660 | 4690 | 1222 | 5056 | 990 | 5168 | 798 | 5191 | 504 | 5522 | 150 | 4718 |
| 9-#11 | 3.69 | 3132 | 1733 | 4887 | 1260 | 5276 | 1017 | 5423 | 812 | 5522 | 492 | 5914 | 81 | 5527 |
| 9-#14 | 5.33 | 3353 | 1904 | 5346 | 1373 | 5836 | 1101 | 6094 | 864 | 6412 | 480 | 7037 | -63 | 7056 |
| 10-#10 | 3.34 | 3085 | 1695 | 4856 | 1223 | 5206 | 990 | 5326 | 791 | 5375 | 479 | 5730 | 111 | 5216 |
| 10-#11 | 4.10 | 3178 | 1776 | 5071 | 1265 | 5453 | 1020 | 5614 | 807 | 5758 | 465 | 6167 | 32 | 6029 |
| 10-#14 | 5.92 | 3419 | 1967 | 5588 | 1387 | 6087 | 1112 | 6371 | 862 | 6772 | 446 | 7406 | -131 | 7422 |
| 11-#10 | 3.68 | 3142 | 1731 | 4879 | 1277 | 5303 | 1032 | 5478 | 827 | 5593 | 505 | 6068 | 99 | 5591 |
| 11-#11 | 4.51 | 3245 | 1819 | 5112 | 1326 | 5575 | 1068 | 5789 | 846 | 6008 | 493 | 6611 | 25 | 6494 |
| 11-#14 | 6.51 | 3513 | 2029 | 5664 | 1465 | 6262 | 1172 | 6606 | 911 | 7098 | 480 | 8003 | -147 | 7928 |
| 12-#10 | 4.01 | 3189 | 1766 | 4962 | 1307 | 5418 | 1060 | 5621 | 848 | 5799 | 511 | 6370 | 83 | 6001 |
| 12-#11 | 4.92 | 3302 | 1862 | 5214 | 1361 | 5711 | 1101 | 5966 | 872 | 6239 | 496 | 6902 | -8 | 6904 |
| 13-#10 | 4.34 | 3243 | 1801 | 5069 | 1330 | 5554 | 1073 | 5777 | 854 | 5997 | 506 | 6657 | 55 | 6387 |
| 13-#11 | 5.33 | 3366 | 1905 | 5342 | 1391 | 5872 | 1117 | 6152 | 879 | 6487 | 492 | 7239 | -42 | 7249 |
| 14-#10 | 4.68 | 3295 | 1836 | 5199 | 1339 | 5697 | 1082 | 5955 | 859 | 6196 | 490 | 6850 | 18 | 6771 |
| 14-#11 | 5.75 | 3429 | 1948 | 5492 | 1404 | 6048 | 1130 | 6363 | 886 | 6776 | 487 | 7468 | -89 | 7479 |
| 15-#10 | 5.01 | 3344 | 1871 | 5265 | 1384 | 5801 | 1113 | 6082 | 882 | 6426 | 513 | 7198 | 3 | 7181 |
| 16-#10 | 5.35 | 3403 | 1906 | 5348 | 1410 | 5930 | 1140 | 6231 | 901 | 6630 | 519 | 7545 | -5 | 7545 |

## ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.12 | 3563 | 1740 | 5304 | 1304 | 5626 | 1072 | 5606 | 884 | 5258 | 613 | 5202 | 341 | 2757 |
| 4-#11 | 1.38 | 3601 | 1772 | 5414 | 1312 | 5733 | 1078 | 5722 | 886 | 5409 | 604 | 5381 | 305 | 3312 |
| 4-#14 | 1.99 | 3699 | 1849 | 5643 | 1353 | 6001 | 1112 | 6039 | 906 | 5837 | 598 | 5928 | 234 | 4609 |
| 4-#18 | 3.54 | 3934 | 2042 | 6189 | 1461 | 6655 | 1201 | 6818 | 961 | 6890 | 582 | 7218 | 42 | 7087 |
| 5-#9 | 1.11 | 3585 | 1738 | 5394 | 1279 | 5664 | 1044 | 5615 | 860 | 5243 | 593 | 5170 | 345 | 2628 |
| 5-#10 | 1.40 | 3642 | 1775 | 5521 | 1301 | 5812 | 1061 | 5788 | 869 | 5473 | 589 | 5475 | 316 | 3213 |
| 5-#11 | 1.72 | 3696 | 1815 | 5658 | 1316 | 5951 | 1070 | 5944 | 873 | 5678 | 579 | 5717 | 277 | 3810 |
| 5-#14 | 2.49 | 3833 | 1911 | 5959 | 1373 | 6309 | 1113 | 6367 | 898 | 6242 | 568 | 6431 | 198 | 5199 |
| 5-#18 | 4.42 | 4163 | 2153 | 6681 | 1519 | 7178 | 1222 | 7397 | 961 | 7619 | 540 | 8106 | -14 | 8113 |
| 6-#8 | 1.05 | 3564 | 1731 | 5469 | 1213 | 5648 | 990 | 5556 | 813 | 5164 | 559 | 4908 | 311 | 2475 |
| 6-#9 | 1.33 | 3616 | 1766 | 5591 | 1231 | 5796 | 1004 | 5733 | 821 | 5405 | 555 | 5186 | 280 | 3062 |
| 6-#10 | 1.68 | 3681 | 1810 | 5745 | 1256 | 5984 | 1023 | 5960 | 832 | 5706 | 549 | 5537 | 240 | 3797 |
| 6-#11 | 2.07 | 3741 | 1859 | 5904 | 1274 | 6164 | 1036 | 6170 | 838 | 5965 | 535 | 5819 | 187 | 4542 |
| 6-#14 | 2.98 | 3897 | 1973 | 6277 | 1338 | 6625 | 1085 | 6726 | 866 | 6683 | 517 | 6637 | 77 | 6281 |
| 6-#18 | 5.31 | 4274 | 2264 | 7184 | 1502 | 7754 | 1212 | 8091 | 940 | 8401 | 465 | 8548 | -219 | 8570 |
| 7-#8 | 1.22 | 3615 | 1753 | 5393 | 1311 | 5719 | 1071 | 5712 | 882 | 5383 | 607 | 5375 | 346 | 2891 |
| 7-#9 | 1.55 | 3679 | 1793 | 5527 | 1336 | 5880 | 1089 | 5904 | 894 | 5636 | 604 | 5715 | 316 | 3531 |
| 7-#10 | 1.97 | 3761 | 1846 | 5696 | 1368 | 6085 | 1114 | 6148 | 910 | 5958 | 601 | 6145 | 276 | 4313 |
| 7-#11 | 2.41 | 3837 | 1902 | 5876 | 1394 | 6283 | 1133 | 6377 | 920 | 6248 | 589 | 6495 | 223 | 5094 |
| 7-#14 | 3.48 | 4033 | 2035 | 6283 | 1478 | 6783 | 1197 | 6975 | 960 | 7030 | 578 | 7498 | 115 | 6928 |
| 7-#18 | 6.19 | 4506 | 2374 | 7267 | 1695 | 7999 | 1360 | 8411 | 1059 | 8997 | 563 | 10017 | -153 | 9878 |
| 8-#8 | 1.40 | 3642 | 1774 | 5425 | 1343 | 5813 | 1102 | 5844 | 909 | 5549 | 622 | 5594 | 336 | 3201 |
| 8-#9 | 1.77 | 3713 | 1821 | 5577 | 1372 | 5999 | 1126 | 6062 | 924 | 5835 | 620 | 5983 | 302 | 3936 |
| 8-#10 | 2.25 | 3803 | 1881 | 5769 | 1410 | 6235 | 1157 | 6340 | 944 | 6199 | 618 | 6581 | 273 | 4855 |
| 8-#11 | 2.76 | 3888 | 1945 | 5975 | 1442 | 6468 | 1182 | 6594 | 957 | 6528 | 607 | 7003 | 215 | 5777 |
| 8-#14 | 3.98 | 4106 | 2098 | 6441 | 1541 | 7047 | 1262 | 7266 | 1007 | 7411 | 599 | 8192 | 97 | 7765 |
| 8-#18 | 7.07 | 4640 | 2485 | 7571 | 1794 | 8433 | 1461 | 8891 | 1131 | 9551 | 572 | 10982 | -222 | 10942 |
| 9-#10 | 2.53 | 3880 | 1916 | 5901 | 1427 | 6367 | 1161 | 6486 | 942 | 6447 | 612 | 6837 | 239 | 5348 |
| 9-#11 | 3.10 | 3979 | 1988 | 6127 | 1465 | 6619 | 1188 | 6778 | 956 | 6834 | 602 | 7306 | 173 | 6305 |
| 9-#14 | 4.48 | 4231 | 2160 | 6646 | 1578 | 7255 | 1273 | 7538 | 1009 | 7850 | 593 | 8624 | 39 | 8427 |
| 9-#18 | 7.96 | 4841 | 2596 | 7906 | 1866 | 8799 | 1487 | 9389 | 1143 | 10307 | 563 | 11708 | -326 | 11647 |
| 10-#10 | 2.81 | 3923 | 1951 | 6097 | 1426 | 6538 | 1158 | 6663 | 933 | 6645 | 585 | 7068 | 200 | 5881 |
| 10-#11 | 3.45 | 4030 | 2031 | 6349 | 1468 | 6821 | 1188 | 6992 | 949 | 7082 | 572 | 7590 | 126 | 6976 |
| 10-#14 | 4.97 | 4304 | 2222 | 6939 | 1591 | 7541 | 1281 | 7851 | 1006 | 8231 | 556 | 9046 | -27 | 9049 |
| 11-#10 | 3.09 | 3987 | 1986 | 6112 | 1484 | 6641 | 1203 | 6834 | 972 | 6898 | 615 | 7466 | 191 | 6349 |
| 11-#11 | 3.79 | 4106 | 2074 | 6381 | 1533 | 6951 | 1239 | 7194 | 992 | 7373 | 604 | 8043 | 111 | 7463 |
| 11-#14 | 5.47 | 4412 | 2284 | 7007 | 1673 | 7728 | 1345 | 8123 | 1060 | 8618 | 595 | 9649 | -54 | 9657 |
| 12-#10 | 3.37 | 4039 | 2021 | 6204 | 1516 | 6769 | 1233 | 6993 | 994 | 7131 | 621 | 7814 | 177 | 6879 |
| 12-#11 | 4.14 | 4169 | 2118 | 6494 | 1570 | 7104 | 1273 | 7386 | 1018 | 7653 | 610 | 8450 | 92 | 8007 |
| 12-#14 | 5.97 | 4501 | 2347 | 7172 | 1723 | 7945 | 1392 | 8398 | 1095 | 8994 | 600 | 10210 | -86 | 10206 |
| 13-#10 | 3.65 | 4100 | 2056 | 6323 | 1537 | 6924 | 1245 | 7169 | 1000 | 7358 | 617 | 8143 | 150 | 7316 |
| 13-#11 | 4.48 | 4242 | 2161 | 6636 | 1598 | 7288 | 1289 | 7597 | 1026 | 7918 | 605 | 8839 | 58 | 8531 |
| 13-#14 | 6.47 | 4604 | 2409 | 7373 | 1766 | 8204 | 1416 | 8697 | 1107 | 9384 | 594 | 10757 | -134 | 10738 |
| 14-#10 | 3.93 | 4159 | 2092 | 6474 | 1545 | 7081 | 1252 | 7363 | 1003 | 7580 | 600 | 8362 | 113 | 7790 |
| 14-#11 | 4.83 | 4312 | 2204 | 6810 | 1609 | 7481 | 1300 | 7836 | 1032 | 8188 | 585 | 9101 | 13 | 9040 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.



## ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 15-#10 | 4.21 | 4214 | 2127 | 6540 | 1591 | 7198 | 1286 | 7515 | 1029 | 7814 | 619 | 8764 | 100 | 8232 |
| 15-#11 | 5.17 | 4378 | 2247 | 6899 | 1664 | 7621 | 1338 | 8008 | 1059 | 8496 | 613 | 9568 | -5 | 9569 |
| 16-#10 | 4.49 | 4280 | 2162 | 6632 | 1618 | 7339 | 1313 | 7684 | 1050 | 8064 | 631 | 9162 | 94 | 8689 |
| 16-#11 | 5.52 | 4458 | 2290 | 7012 | 1696 | 7793 | 1372 | 8208 | 1084 | 8769 | 620 | 10037 | -15 | 10036 |
| 17-#10 | 4.77 | 4331 | 2197 | 6764 | 1639 | 7481 | 1326 | 7850 | 1056 | 8287 | 625 | 9437 | 58 | 9123 |
| 18-#10 | 5.05 | 4401 | 2232 | 6895 | 1657 | 7643 | 1340 | 8030 | 1061 | 8544 | 620 | 9727 | 35 | 9553 |

## ROUND TIED COLUMNS 26" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.18 | 4543 | 2050 | 6767 | 1536 | 7185 | 1263 | 7169 | 1041 | 6741 | 720 | 6693 | 396 | 3660 |
| 4-#14 | 1.70 | 4654 | 2126 | 7024 | 1577 | 7485 | 1297 | 7522 | 1062 | 7216 | 714 | 7320 | 328 | 5112 |
| 4-#18 | 3.01 | 4921 | 2320 | 7640 | 1685 | 8218 | 1387 | 8393 | 1118 | 8392 | 699 | 8812 | 146 | 8287 |
| 5-#10 | 1.20 | 4588 | 2053 | 6895 | 1520 | 7276 | 1242 | 7239 | 1021 | 6804 | 702 | 6783 | 404 | 3580 |
| 5-#11 | 1.47 | 4648 | 2093 | 7053 | 1535 | 7434 | 1251 | 7414 | 1024 | 7033 | 691 | 7065 | 366 | 4250 |
| 5-#14 | 2.12 | 4803 | 2189 | 7395 | 1592 | 7836 | 1294 | 7888 | 1050 | 7664 | 682 | 7885 | 291 | 5809 |
| 5-#18 | 3.77 | 5175 | 2431 | 8212 | 1739 | 8814 | 1404 | 9046 | 1115 | 9210 | 656 | 9829 | 91 | 9367 |
| 6-#9 | 1.13 | 4558 | 2043 | 6995 | 1440 | 7255 | 1175 | 7163 | 965 | 6701 | 661 | 6428 | 363 | 3383 |
| 6-#10 | 1.44 | 4630 | 2088 | 7167 | 1464 | 7464 | 1194 | 7413 | 976 | 7042 | 656 | 6828 | 325 | 4201 |
| 6-#11 | 1.76 | 4699 | 2136 | 7347 | 1482 | 7666 | 1207 | 7648 | 981 | 7352 | 644 | 7157 | 274 | 5035 |
| 6-#14 | 2.54 | 4875 | 2251 | 7764 | 1546 | 8180 | 1256 | 8267 | 1010 | 8165 | 628 | 8098 | 169 | 6988 |
| 6-#18 | 4.52 | 5301 | 2541 | 8781 | 1710 | 9442 | 1384 | 9792 | 1084 | 10125 | 583 | 10322 | -112 | 10334 |
| 7-#9 | 1.32 | 4628 | 2071 | 6894 | 1559 | 7347 | 1273 | 7366 | 1049 | 6992 | 720 | 7058 | 405 | 3949 |
| 7-#10 | 1.67 | 4719 | 2123 | 7083 | 1591 | 7575 | 1298 | 7637 | 1065 | 7351 | 717 | 7547 | 367 | 4824 |
| 7-#11 | 2.06 | 4806 | 2179 | 7288 | 1616 | 7798 | 1316 | 7893 | 1074 | 7678 | 706 | 7956 | 317 | 5705 |
| 7-#14 | 2.97 | 5026 | 2313 | 7744 | 1701 | 8355 | 1381 | 8561 | 1115 | 8555 | 696 | 9109 | 214 | 7766 |
| 7-#18 | 5.27 | 5559 | 2652 | 8850 | 1918 | 9719 | 1546 | 10195 | 1219 | 10771 | 686 | 11836 | -62 | 11848 |
| 8-#9 | 1.51 | 4666 | 2099 | 6939 | 1598 | 7474 | 1304 | 7550 | 1082 | 7220 | 738 | 7348 | 391 | 4371 |
| 8-#10 | 1.91 | 4767 | 2158 | 7153 | 1636 | 7736 | 1332 | 7861 | 1103 | 7626 | 736 | 7903 | 349 | 5396 |
| 8-#11 | 2.35 | 4863 | 2223 | 7387 | 1667 | 7997 | 1368 | 8148 | 1116 | 7997 | 726 | 8534 | 312 | 6433 |
| 8-#14 | 3.39 | 5107 | 2375 | 7906 | 1766 | 8642 | 1447 | 8903 | 1167 | 8988 | 720 | 9899 | 201 | 8869 |
| 8-#18 | 6.03 | 5714 | 2763 | 9172 | 2019 | 10226 | 1653 | 10738 | 1295 | 11402 | 700 | 13131 | -99 | 13110 |
| 9-#10 | 2.15 | 4853 | 2194 | 7305 | 1652 | 7889 | 1347 | 8016 | 1098 | 7890 | 729 | 8326 | 332 | 5993 |
| 9-#11 | 2.64 | 4966 | 2266 | 7561 | 1689 | 8174 | 1373 | 8343 | 1113 | 8328 | 720 | 8878 | 270 | 7074 |
| 9-#14 | 3.81 | 5251 | 2438 | 8141 | 1802 | 8885 | 1459 | 9193 | 1167 | 9478 | 714 | 10392 | 143 | 9582 |
| 9-#18 | 6.78 | 5941 | 2873 | 9554 | 2091 | 10621 | 1676 | 11271 | 1304 | 12255 | 692 | 13971 | -201 | 13949 |
| 10-#10 | 2.39 | 4901 | 2229 | 7531 | 1646 | 8081 | 1340 | 8209 | 1087 | 8103 | 700 | 8583 | 294 | 6556 |
| 10-#11 | 2.94 | 5022 | 2309 | 7820 | 1688 | 8402 | 1371 | 8580 | 1103 | 8595 | 687 | 9191 | 223 | 7790 |
| 10-#14 | 4.24 | 5330 | 2500 | 8487 | 1812 | 9208 | 1465 | 9541 | 1161 | 9879 | 674 | 10863 | 78 | 10472 |
| 10-#18 | 7.53 | 6077 | 2984 | 10088 | 2126 | 11174 | 1702 | 11889 | 1307 | 13020 | 634 | 14815 | -315 | 14725 |
| 11-#10 | 2.63 | 4972 | 2264 | 7540 | 1709 | 8189 | 1389 | 8398 | 1129 | 8395 | 733 | 9032 | 286 | 7121 |
| 11-#11 | 3.23 | 5108 | 2352 | 7844 | 1758 | 8538 | 1425 | 8806 | 1150 | 8929 | 723 | 9717 | 211 | 8400 |
| 11-#14 | 4.66 | 5452 | 2562 | 8545 | 1899 | 9406 | 1532 | 9851 | 1220 | 10323 | 716 | 11562 | 55 | 11254 |
| 12-#10 | 2.87 | 5030 | 2299 | 7638 | 1743 | 8331 | 1410 | 8576 | 1153 | 8648 | 739 | 9413 | 273 | 7682 |
| 12-#11 | 3.53 | 5177 | 2395 | 7967 | 1797 | 8709 | 1461 | 9017 | 1177 | 9238 | 730 | 10179 | 194 | 9110 |
| 12-#14 | 5.09 | 5550 | 2624 | 8726 | 1951 | 9648 | 1581 | 10146 | 1255 | 10762 | 726 | 12202 | 27 | 12067 |
| 13-#10 | 3.11 | 5098 | 2334 | 7770 | 1764 | 8502 | 1432 | 8772 | 1158 | 8909 | 737 | 9793 | 247 | 8209 |
| 13-#11 | 3.82 | 5259 | 2438 | 8124 | 1824 | 8916 | 1477 | 9253 | 1184 | 9542 | 726 | 10620 | 161 | 9668 |
| 13-#14 | 5.51 | 5667 | 2687 | 8947 | 1993 | 9940 | 1605 | 10482 | 1267 | 11185 | 719 | 12824 | -21 | 12823 |

## ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 3.35 | 5163 | 2369 | 7944 | 1769 | 8677 | 1437 | 8981 | 1159 | 9155 | 719 | 10053 | 213 | 8790 |
| 14-#11 | 4.11 | 5336 | 2482 | 8324 | 1833 | 9125 | 1485 | 9511 | 1188 | 9840 | 706 | 10915 | 117 | 10281 |
| 14-#14 | 5.93 | 5776 | 2749 | 9217 | 2012 | 10242 | 1623 | 10861 | 1278 | 11619 | 692 | 13253 | -84 | 13240 |
| 15-#10 | 3.59 | 5226 | 2404 | 8020 | 1812 | 8806 | 1473 | 9152 | 1187 | 9411 | 739 | 10494 | 199 | 9282 |
| 15-#11 | 4.41 | 5411 | 2525 | 8413 | 1890 | 9281 | 1526 | 9713 | 1219 | 10150 | 728 | 11449 | 101 | 10878 |
| 16-#10 | 3.83 | 5298 | 2439 | 8109 | 1846 | 8958 | 1490 | 9348 | 1210 | 9646 | 741 | 10819 | 179 | 9856 |
| 16-#11 | 4.70 | 5498 | 2568 | 8537 | 1923 | 9468 | 1560 | 9939 | 1245 | 10483 | 743 | 11978 | 93 | 11475 |
| 17-#10 | 4.07 | 5356 | 2475 | 8258 | 1866 | 9117 | 1515 | 9527 | 1215 | 9939 | 747 | 11252 | 159 | 10306 |
| 17-#11 | 5.00 | 5567 | 2611 | 8713 | 1948 | 9658 | 1576 | 10160 | 1252 | 10780 | 736 | 12347 | 49 | 12060 |
| 18-#10 | 4.31 | 5433 | 2510 | 8404 | 1883 | 9304 | 1528 | 9727 | 1220 | 10215 | 740 | 11587 | 138 | 10820 |
| 18-#11 | 5.29 | 5659 | 2654 | 8886 | 1971 | 9875 | 1593 | 10401 | 1260 | 11123 | 729 | 12736 | 21 | 12624 |
| 19-#10 | 4.54 | 5483 | 2545 | 8494 | 1919 | 9425 | 1550 | 9906 | 1243 | 10446 | 749 | 11948 | 113 | 11312 |
| 20-#10 | 4.78 | 5551 | 2580 | 8598 | 1952 | 9575 | 1570 | 10086 | 1262 | 10711 | 756 | 12327 | 99 | 11783 |

## ROUND TIED COLUMNS 28" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.01 | 5637 | 2350 | 8329 | 1780 | 8867 | 1451 | 8845 | 1210 | 8281 | 845 | 8168 | 490 | 4006 |
| 4-#14 | 1.46 | 5761 | 2426 | 8614 | 1821 | 9198 | 1498 | 9234 | 1231 | 8803 | 840 | 8891 | 426 | 5614 |
| 4-#18 | 2.60 | 6060 | 2620 | 9301 | 1929 | 10011 | 1588 | 10196 | 1287 | 10101 | 826 | 10603 | 255 | 9416 |
| 5-#10 | 1.03 | 5685 | 2353 | 8482 | 1758 | 8969 | 1438 | 8917 | 1186 | 8340 | 824 | 8281 | 498 | 3953 |
| 5-#11 | 1.27 | 5753 | 2393 | 8659 | 1772 | 9146 | 1447 | 9112 | 1189 | 8593 | 814 | 8603 | 461 | 4698 |
| 5-#14 | 1.83 | 5925 | 2489 | 9039 | 1828 | 9592 | 1490 | 9636 | 1215 | 9290 | 805 | 9530 | 389 | 6428 |
| 5-#18 | 3.25 | 6341 | 2731 | 9958 | 1977 | 10680 | 1601 | 10923 | 1282 | 11005 | 781 | 11744 | 199 | 10522 |
| 6-#10 | 1.24 | 5732 | 2388 | 8808 | 1691 | 9174 | 1380 | 9092 | 1131 | 8570 | 771 | 8301 | 415 | 4606 |
| 6-#11 | 1.52 | 5810 | 2436 | 9010 | 1708 | 9397 | 1392 | 9351 | 1136 | 8920 | 760 | 8678 | 366 | 5530 |
| 6-#14 | 2.19 | 6005 | 2551 | 9471 | 1771 | 9964 | 1441 | 10033 | 1165 | 9846 | 747 | 9743 | 265 | 7696 |
| 6-#18 | 3.90 | 6481 | 2841 | 10598 | 1935 | 11360 | 1569 | 11718 | 1240 | 12048 | 707 | 12280 | -3 | 12280 |
| 7-#9 | 1.14 | 5729 | 2371 | 8472 | 1801 | 9043 | 1468 | 9056 | 1216 | 8555 | 845 | 8576 | 498 | 4335 |
| 7-#10 | 1.44 | 5830 | 2423 | 8681 | 1833 | 9294 | 1497 | 9354 | 1232 | 8951 | 842 | 9127 | 463 | 5346 |
| 7-#11 | 1.77 | 5927 | 2479 | 8910 | 1857 | 9542 | 1515 | 9637 | 1241 | 9314 | 831 | 9609 | 415 | 6328 |
| 7-#14 | 2.56 | 6171 | 2613 | 9416 | 1942 | 10157 | 1579 | 10374 | 1282 | 10286 | 823 | 10913 | 317 | 8619 |
| 7-#18 | 4.55 | 6765 | 2952 | 10645 | 2159 | 11668 | 1745 | 12189 | 1389 | 12668 | 800 | 14021 | 55 | 13709 |
| 8-#9 | 1.30 | 5771 | 2399 | 8509 | 1844 | 9178 | 1506 | 9263 | 1253 | 8813 | 865 | 8908 | 488 | 4811 |
| 8-#10 | 1.65 | 5883 | 2458 | 8745 | 1881 | 9466 | 1534 | 9610 | 1274 | 9261 | 864 | 9523 | 446 | 5943 |
| 8-#11 | 2.03 | 5990 | 2523 | 9006 | 1911 | 9755 | 1555 | 9931 | 1287 | 9674 | 854 | 10075 | 392 | 7095 |
| 8-#14 | 2.92 | 6261 | 2675 | 9581 | 2010 | 10466 | 1649 | 10769 | 1339 | 10773 | 850 | 11568 | 280 | 9798 |
| 8-#18 | 5.20 | 6921 | 3063 | 10982 | 2263 | 12215 | 1854 | 12816 | 1472 | 13461 | 835 | 15480 | 25 | 15359 |
| 9-#10 | 1.86 | 5979 | 2494 | 8919 | 1895 | 9638 | 1542 | 9773 | 1267 | 9540 | 855 | 9990 | 429 | 6663 |
| 9-#11 | 2.28 | 6105 | 2566 | 9205 | 1931 | 9957 | 1574 | 10137 | 1282 | 10025 | 846 | 10638 | 371 | 7859 |
| 9-#14 | 3.29 | 6424 | 2737 | 9847 | 2044 | 10745 | 1660 | 11076 | 1337 | 11295 | 842 | 12356 | 251 | 10689 |
| 9-#18 | 5.85 | 7195 | 3173 | 11413 | 2334 | 12673 | 1880 | 13381 | 1477 | 14410 | 828 | 16434 | -76 | 16426 |
| 10-#10 | 2.06 | 6032 | 2529 | 9178 | 1884 | 9855 | 1538 | 9983 | 1253 | 9767 | 824 | 10289 | 392 | 7240 |
| 10-#11 | 2.53 | 6167 | 2609 | 9500 | 1925 | 10212 | 1568 | 10396 | 1269 | 10312 | 811 | 10984 | 325 | 8615 |
| 10-#14 | 3.65 | 6510 | 2800 | 10237 | 2050 | 11106 | 1663 | 11459 | 1328 | 11732 | 799 | 12874 | 187 | 11834 |
| 10-#18 | 6.50 | 7342 | 3284 | 12034 | 2368 | 13290 | 1903 | 14067 | 1478 | 15217 | 765 | 17377 | -185 | 17319 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 11-#10 | 2.27 | 6111 | 2564 | 9174 | 1953 | 9966 | 1586 | 10190 | 1299 | 10100 | 860 | 10780 | 385 | 7911 |
| 11-#11 | 2.79 | 6262 | 2652 | 9516 | 2002 | 10354 | 1626 | 10642 | 1320 | 10693 | 851 | 11571 | 315 | 9340 |
| 11-#14 | 4.02 | 6645 | 2862 | 10292 | 2143 | 11313 | 1734 | 11796 | 1390 | 12234 | 846 | 13672 | 167 | 12666 |
| 11-#18 | 7.15 | 7576 | 3395 | 12183 | 2504 | 13666 | 2008 | 14627 | 1568 | 16014 | 830 | 18638 | -235 | 18536 |
| 12-#10 | 2.48 | 6174 | 2599 | 9281 | 1989 | 10122 | 1613 | 10387 | 1324 | 10373 | 867 | 11207 | 374 | 8498 |
| 12-#11 | 3.04 | 6338 | 2695 | 9648 | 2043 | 10542 | 1651 | 10877 | 1348 | 11026 | 858 | 12073 | 298 | 10091 |
| 12-#14 | 4.38 | 6753 | 2924 | 10490 | 2198 | 11580 | 1785 | 12123 | 1428 | 12707 | 856 | 14375 | 141 | 13596 |
| 13-#10 | 2.68 | 6249 | 2634 | 9425 | 2008 | 10307 | 1629 | 10604 | 1329 | 10664 | 865 | 11629 | 348 | 9124 |
| 13-#11 | 3.29 | 6428 | 2738 | 9820 | 2068 | 10768 | 1679 | 11137 | 1355 | 11372 | 855 | 12576 | 267 | 10769 |
| 13-#14 | 4.75 | 6881 | 2986 | 10731 | 2238 | 11904 | 1809 | 12495 | 1440 | 13193 | 851 | 15089 | 95 | 14504 |
| 14-#10 | 2.89 | 6320 | 2669 | 9624 | 2011 | 10501 | 1637 | 10827 | 1328 | 10936 | 847 | 11907 | 314 | 9734 |
| 14-#11 | 3.55 | 6513 | 2781 | 10049 | 2076 | 10999 | 1685 | 11414 | 1357 | 11699 | 834 | 12923 | 225 | 11532 |
| 14-#14 | 5.12 | 7001 | 3049 | 11036 | 2255 | 12232 | 1824 | 12903 | 1448 | 13671 | 824 | 15567 | 34 | 15377 |
| 15-#10 | 3.09 | 6390 | 2704 | 9698 | 2057 | 10643 | 1671 | 11019 | 1358 | 11215 | 868 | 12412 | 302 | 10318 |
| 15-#11 | 3.80 | 6597 | 2825 | 10152 | 2128 | 11171 | 1729 | 11640 | 1391 | 12035 | 858 | 13503 | 208 | 12179 |
| 15-#14 | 5.48 | 7119 | 3111 | 11183 | 2333 | 12475 | 1880 | 13213 | 1490 | 14140 | 854 | 16390 | 9 | 16339 |
| 16-#10 | 3.30 | 6468 | 2739 | 9794 | 2092 | 10806 | 1694 | 11241 | 1383 | 11476 | 870 | 12777 | 284 | 10925 |
| 16-#11 | 4.05 | 6692 | 2868 | 10271 | 2169 | 11371 | 1750 | 11899 | 1418 | 12345 | 860 | 13932 | 183 | 12892 |
| 16-#14 | 5.85 | 7254 | 3173 | 11379 | 2380 | 12765 | 1928 | 13569 | 1527 | 14658 | 875 | 16986 | -31 | 16967 |
| 17-#10 | 3.51 | 6533 | 2775 | 9959 | 2112 | 10982 | 1712 | 11432 | 1387 | 11799 | 877 | 13255 | 264 | 11482 |
| 17-#11 | 4.31 | 6768 | 2911 | 10466 | 2194 | 11581 | 1780 | 12135 | 1425 | 12734 | 867 | 14505 | 159 | 13498 |
| 18-#10 | 3.71 | 6618 | 2810 | 10122 | 2127 | 11190 | 1719 | 11652 | 1392 | 12092 | 868 | 13602 | 242 | 12096 |
| 18-#11 | 4.56 | 6871 | 2954 | 10658 | 2215 | 11829 | 1796 | 12401 | 1432 | 13100 | 859 | 14950 | 133 | 14162 |
| 19-#10 | 3.92 | 6675 | 2845 | 10216 | 2165 | 11322 | 1754 | 11846 | 1416 | 12351 | 879 | 14021 | 220 | 12638 |
| 19-#11 | 4.81 | 6937 | 2997 | 10779 | 2259 | 11989 | 1823 | 12637 | 1460 | 13404 | 870 | 15426 | 103 | 14803 |
| 20-#10 | 4.13 | 6750 | 2880 | 10327 | 2198 | 11487 | 1775 | 12044 | 1435 | 12653 | 888 | 14458 | 208 | 13196 |
| 20-#11 | 5.07 | 7026 | 3040 | 10917 | 2299 | 12187 | 1848 | 12874 | 1483 | 13754 | 879 | 15927 | 85 | 15428 |
| 21-#10 | 4.33 | 6811 | 2915 | 10478 | 2218 | 11659 | 1794 | 12259 | 1444 | 12905 | 881 | 14794 | 175 | 13727 |
| 22-#10 | 4.54 | 6882 | 2950 | 10644 | 2239 | 11847 | 1802 | 12480 | 1452 | 13200 | 876 | 15166 | 152 | 14262 |

## ROUND TIED COLUMNS 30" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.27 | 7032 | 2748 | 10429 | 2083 | 11157 | 1695 | 11191 | 1413 | 10614 | 975 | 10640 | 528 | 6114 |
| 4-#18 | 2.26 | 7364 | 2942 | 11186 | 2191 | 12049 | 1804 | 12246 | 1469 | 12033 | 962 | 12604 | 367 | 10312 |
| 5-#11 | 1.10 | 7022 | 2715 | 10495 | 2027 | 11106 | 1658 | 11055 | 1366 | 10374 | 945 | 10347 | 562 | 5152 |
| 5-#14 | 1.59 | 7211 | 2811 | 10911 | 2083 | 11595 | 1700 | 11629 | 1392 | 11136 | 936 | 11380 | 493 | 7054 |
| 5-#18 | 2.83 | 7672 | 3053 | 11925 | 2231 | 12794 | 1812 | 13044 | 1460 | 13020 | 915 | 13867 | 311 | 11571 |
| 6-#10 | 1.08 | 6998 | 2710 | 10686 | 1935 | 11132 | 1580 | 11012 | 1299 | 10313 | 894 | 9972 | 510 | 5012 |
| 6-#11 | 1.32 | 7084 | 2758 | 10909 | 1951 | 11377 | 1592 | 11296 | 1303 | 10694 | 883 | 10396 | 463 | 6026 |
| 6-#14 | 1.91 | 7300 | 2873 | 11415 | 2013 | 11997 | 1641 | 12040 | 1332 | 11705 | 871 | 11584 | 366 | 8402 |
| 6-#18 | 3.40 | 7825 | 3163 | 12653 | 2177 | 13527 | 1768 | 13885 | 1408 | 14187 | 839 | 14436 | 109 | 13886 |
| 7-#10 | 1.26 | 7104 | 2745 | 10504 | 2093 | 11259 | 1706 | 11317 | 1412 | 10774 | 976 | 10907 | 564 | 5864 |
| 7-#11 | 1.54 | 7212 | 2802 | 10760 | 2117 | 11532 | 1729 | 11628 | 1421 | 11173 | 966 | 11453 | 518 | 6963 |
| 7-#14 | 2.23 | 7481 | 2935 | 11316 | 2201 | 12206 | 1793 | 12433 | 1463 | 12240 | 959 | 12926 | 426 | 9488 |
| 7-#18 | 3.96 | 8136 | 3274 | 12669 | 2419 | 13864 | 1960 | 14423 | 1570 | 14863 | 939 | 16416 | 174 | 15319 |
| 8-#10 | 1.44 | 7162 | 2781 | 10560 | 2145 | 11441 | 1752 | 11595 | 1457 | 11121 | 1001 | 11355 | 550 | 6495 |
| 8-#11 | 1.77 | 7281 | 2845 | 10850 | 2174 | 11759 | 1772 | 11961 | 1471 | 11576 | 992 | 11967 | 497 | 7763 |

## ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.55 | 7580 | 2997 | 11479 | 2272 | 12535 | 1846 | 12882 | 1524 | 12782 | 989 | 13615 | 388 | 10734 |
| 8-#18 | 4.53 | 8308 | 3385 | 13017 | 2526 | 14450 | 2072 | 15140 | 1659 | 15745 | 978 | 18042 | 151 | 17236 |
| 9-#10 | 1.62 | 7267 | 2816 | 10757 | 2157 | 11631 | 1758 | 11777 | 1449 | 11413 | 990 | 11863 | 532 | 7313 |
| 9-#11 | 1.99 | 7408 | 2888 | 11075 | 2193 | 11985 | 1783 | 12177 | 1464 | 11945 | 982 | 12584 | 476 | 8661 |
| 9-#14 | 2.86 | 7758 | 3060 | 11779 | 2305 | 12852 | 1877 | 13205 | 1520 | 13335 | 979 | 14508 | 361 | 11783 |
| 9-#18 | 5.09 | 8614 | 3495 | 13498 | 2596 | 14972 | 2098 | 15738 | 1662 | 16762 | 969 | 19109 | 51 | 18790 |
| 10-#10 | 1.80 | 7326 | 2851 | 11053 | 2141 | 11875 | 1750 | 12003 | 1431 | 11652 | 956 | 12200 | 496 | 7934 |
| 10-#11 | 2.21 | 7476 | 2931 | 11409 | 2181 | 12269 | 1780 | 12456 | 1447 | 12250 | 945 | 12983 | 432 | 9449 |
| 10-#14 | 3.18 | 7854 | 3122 | 12215 | 2305 | 13250 | 1875 | 13622 | 1508 | 13805 | 934 | 15092 | 300 | 13009 |
| 10-#18 | 5.66 | 8773 | 3606 | 14193 | 2625 | 15655 | 2119 | 16490 | 1660 | 17636 | 904 | 20149 | -56 | 20131 |
| 11-#10 | 1.98 | 7413 | 2886 | 11031 | 2216 | 11989 | 1803 | 12229 | 1482 | 12028 | 997 | 12738 | 490 | 8715 |
| 11-#11 | 2.43 | 7580 | 2974 | 11411 | 2264 | 12417 | 1836 | 12725 | 1502 | 12680 | 988 | 13619 | 422 | 10300 |
| 11-#14 | 3.50 | 8002 | 3184 | 12265 | 2406 | 13467 | 1951 | 13986 | 1574 | 14369 | 985 | 15957 | 279 | 14016 |
| 11-#18 | 6.22 | 9031 | 3717 | 14345 | 2768 | 16049 | 2227 | 17099 | 1755 | 18526 | 974 | 21571 | -102 | 21533 |
| 12-#10 | 2.16 | 7482 | 2921 | 11146 | 2254 | 12159 | 1832 | 12445 | 1508 | 12323 | 1004 | 13212 | 481 | 9328 |
| 12-#11 | 2.65 | 7663 | 3017 | 11553 | 2307 | 12622 | 1869 | 12983 | 1532 | 13038 | 996 | 14177 | 408 | 11086 |
| 12-#14 | 3.82 | 8120 | 3246 | 12477 | 2462 | 13759 | 1984 | 14347 | 1613 | 14876 | 995 | 16729 | 256 | 15185 |
| 12-#18 | 6.79 | 9231 | 3827 | 14732 | 2858 | 16554 | 2312 | 17709 | 1816 | 19414 | 988 | 22904 | -149 | 22755 |
| 13-#10 | 2.34 | 7564 | 2956 | 11304 | 2272 | 12358 | 1847 | 12682 | 1513 | 12639 | 1002 | 13675 | 455 | 10073 |
| 13-#11 | 2.87 | 7762 | 3060 | 11742 | 2331 | 12865 | 1889 | 13268 | 1539 | 13421 | 993 | 14732 | 376 | 11881 |
| 13-#14 | 4.14 | 8260 | 3309 | 12739 | 2501 | 14108 | 2017 | 14755 | 1625 | 15424 | 992 | 17521 | 210 | 16118 |
| 13-#18 | 7.36 | 9478 | 3938 | 15180 | 2934 | 17167 | 2358 | 18416 | 1840 | 20329 | 981 | 24228 | -232 | 23984 |
| 14-#10 | 2.52 | 7641 | 2991 | 11530 | 2273 | 12573 | 1842 | 12919 | 1509 | 12940 | 984 | 13953 | 419 | 10694 |
| 14-#11 | 3.09 | 7855 | 3104 | 12000 | 2336 | 13120 | 1901 | 13563 | 1538 | 13781 | 972 | 15104 | 335 | 12697 |
| 14-#14 | 4.46 | 8391 | 3371 | 13082 | 2516 | 14469 | 2040 | 15191 | 1630 | 15946 | 964 | 18092 | 154 | 17138 |
| 15-#10 | 2.70 | 7719 | 3026 | 11599 | 2321 | 12726 | 1889 | 13131 | 1542 | 13243 | 1005 | 14533 | 410 | 11379 |
| 15-#11 | 3.31 | 7947 | 3147 | 12100 | 2391 | 13306 | 1941 | 13813 | 1575 | 14144 | 996 | 15760 | 320 | 13439 |
| 15-#14 | 4.77 | 8522 | 3433 | 13254 | 2587 | 14734 | 2089 | 15534 | 1676 | 16450 | 995 | 18965 | 127 | 18132 |
| 16-#10 | 2.87 | 7803 | 3062 | 11701 | 2357 | 12899 | 1913 | 13370 | 1567 | 13530 | 1009 | 14946 | 394 | 12011 |
| 16-#11 | 3.53 | 8050 | 3190 | 12228 | 2434 | 13520 | 1969 | 14105 | 1604 | 14486 | 1000 | 16238 | 297 | 14249 |
| 16-#14 | 5.09 | 8668 | 3495 | 13442 | 2645 | 15044 | 2127 | 15937 | 1715 | 16928 | 997 | 19629 | 91 | 19152 |
| 17-#10 | 3.05 | 7874 | 3097 | 11883 | 2376 | 13092 | 1931 | 13584 | 1572 | 13857 | 1010 | 15382 | 366 | 12663 |
| 17-#11 | 3.75 | 8135 | 3233 | 12445 | 2458 | 13752 | 1991 | 14356 | 1610 | 14911 | 1007 | 16869 | 273 | 14957 |
| 17-#14 | 5.41 | 8788 | 3558 | 13744 | 2682 | 15371 | 2162 | 16303 | 1725 | 17536 | 1009 | 20525 | 57 | 20153 |
| 18-#10 | 3.23 | 7966 | 3132 | 12064 | 2390 | 13317 | 1936 | 13824 | 1576 | 14192 | 1006 | 15827 | 350 | 13304 |
| 18-#11 | 3.97 | 8246 | 3276 | 12656 | 2477 | 14025 | 2000 | 14647 | 1616 | 15299 | 998 | 17327 | 245 | 15753 |
| 19-#10 | 3.41 | 8031 | 3167 | 12162 | 2430 | 13465 | 1973 | 14032 | 1601 | 14480 | 1018 | 16294 | 331 | 13935 |
| 19-#11 | 4.19 | 8321 | 3319 | 12783 | 2523 | 14198 | 2042 | 14900 | 1645 | 15637 | 1010 | 17875 | 218 | 16432 |
| 20-#10 | 3.59 | 8114 | 3202 | 12280 | 2463 | 13645 | 1995 | 14249 | 1621 | 14807 | 1027 | 16783 | 320 | 14573 |
| 20-#11 | 4.41 | 8420 | 3363 | 12929 | 2564 | 14415 | 2068 | 15161 | 1669 | 16033 | 1021 | 18444 | 203 | 17138 |
| 21-#10 | 3.77 | 8180 | 3237 | 12446 | 2483 | 13829 | 2014 | 14484 | 1630 | 15087 | 1021 | 17148 | 288 | 15177 |
| 21-#11 | 4.63 | 8500 | 3406 | 13127 | 2589 | 14642 | 2092 | 15443 | 1680 | 16365 | 1013 | 18888 | 163 | 17851 |
| 22-#10 | 3.95 | 8258 | 3272 | 12628 | 2503 | 14036 | 2021 | 14721 | 1636 | 15408 | 1016 | 17556 | 264 | 15824 |
| 23-#10 | 4.13 | 8332 | 3308 | 12733 | 2537 | 14201 | 2055 | 14941 | 1663 | 15691 | 1024 | 18067 | 252 | 16408 |
| 24-#10 | 4.31 | 8406 | 3343 | 12859 | 2570 | 14374 | 2075 | 15163 | 1679 | 15995 | 1031 | 18466 | 227 | 17024 |

## ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.12 | 8478 | 3093 | 12483 | 2365 | 13380 | 1927 | 13413 | 1609 | 12665 | 1119 | 12615 | 637 | 6613 |
| 4-#18 | 1.99 | 8844 | 3286 | 13313 | 2471 | 14352 | 2001 | 14559 | 1664 | 14205 | 1107 | 14745 | 479 | 11206 |
| 5-#14 | 1.40 | 8673 | 3155 | 13029 | 2357 | 13863 | 1926 | 13885 | 1582 | 13219 | 1077 | 13451 | 603 | 7690 |
| 5-#18 | 2.49 | 9178 | 3397 | 14135 | 2504 | 15173 | 2038 | 15429 | 1650 | 15272 | 1057 | 16210 | 427 | 12631 |
| 6-#11 | 1.16 | 8533 | 3103 | 13062 | 2211 | 13623 | 1806 | 13500 | 1483 | 12699 | 1016 | 12324 | 565 | 6523 |
| 6-#14 | 1.68 | 8769 | 3217 | 13613 | 2274 | 14295 | 1854 | 14307 | 1511 | 13794 | 1003 | 13637 | 472 | 9109 |
| 6-#18 | 2.98 | 9346 | 3508 | 14962 | 2437 | 15959 | 1982 | 16311 | 1587 | 16515 | 974 | 16805 | 224 | 15293 |
| 7-#10 | 1.11 | 8554 | 3090 | 12569 | 2372 | 13488 | 1936 | 13543 | 1606 | 12835 | 1120 | 12911 | 672 | 6349 |
| 7-#11 | 1.36 | 8672 | 3146 | 12851 | 2395 | 13787 | 1951 | 13881 | 1614 | 13270 | 1110 | 13509 | 627 | 7609 |
| 7-#14 | 1.96 | 8966 | 3280 | 13458 | 2479 | 14520 | 2023 | 14755 | 1655 | 14432 | 1103 | 15125 | 537 | 10371 |
| 7-#18 | 3.48 | 9683 | 3618 | 14935 | 2697 | 16325 | 2190 | 16919 | 1764 | 17297 | 1086 | 19037 | 298 | 16907 |
| 8-#10 | 1.26 | 8617 | 3125 | 12613 | 2428 | 13679 | 1985 | 13844 | 1653 | 13221 | 1147 | 13412 | 660 | 7052 |
| 8-#11 | 1.55 | 8747 | 3189 | 12932 | 2457 | 14027 | 2005 | 14242 | 1667 | 13717 | 1138 | 14084 | 608 | 8436 |
| 8-#14 | 2.24 | 9074 | 3342 | 13617 | 2554 | 14868 | 2078 | 15256 | 1722 | 15032 | 1137 | 15888 | 502 | 11678 |
| 8-#18 | 3.98 | 9871 | 3729 | 15293 | 2807 | 16949 | 2269 | 17729 | 1860 | 18269 | 1130 | 20300 | 225 | 19190 |
| 9-#10 | 1.42 | 8731 | 3160 | 12836 | 2438 | 13887 | 1989 | 14044 | 1645 | 13526 | 1135 | 13961 | 642 | 7936 |
| 9-#11 | 1.75 | 8885 | 3232 | 13185 | 2472 | 14274 | 2014 | 14481 | 1658 | 14105 | 1126 | 14753 | 587 | 9494 |
| 9-#14 | 2.52 | 9269 | 3404 | 13951 | 2585 | 15217 | 2098 | 15599 | 1715 | 15614 | 1124 | 16862 | 475 | 12896 |
| 9-#18 | 4.48 | 10205 | 3840 | 15826 | 2875 | 17536 | 2332 | 18359 | 1859 | 19346 | 1118 | 22006 | 180 | 20775 |
| 10-#10 | 1.58 | 8796 | 3195 | 13173 | 2416 | 14160 | 1977 | 14285 | 1622 | 13773 | 1098 | 14292 | 603 | 8637 |
| 10-#11 | 1.94 | 8961 | 3275 | 13563 | 2456 | 14592 | 2007 | 14780 | 1638 | 14424 | 1087 | 15203 | 544 | 10295 |
| 10-#14 | 2.80 | 9375 | 3466 | 14439 | 2580 | 15660 | 2103 | 16048 | 1700 | 16115 | 1077 | 17531 | 417 | 14183 |
| 10-#18 | 4.97 | 10381 | 3950 | 16592 | 2898 | 18285 | 2348 | 19176 | 1855 | 20290 | 1051 | 23145 | 76 | 22688 |
| 11-#10 | 1.74 | 8890 | 3230 | 13129 | 2498 | 14276 | 2036 | 14531 | 1678 | 14196 | 1143 | 14921 | 602 | 9475 |
| 11-#11 | 2.13 | 9074 | 3319 | 13545 | 2545 | 14743 | 2069 | 15071 | 1698 | 14906 | 1134 | 15892 | 535 | 11281 |
| 11-#14 | 3.08 | 9536 | 3529 | 14475 | 2687 | 15884 | 2174 | 16441 | 1770 | 16744 | 1133 | 18458 | 397 | 15349 |
| 11-#18 | 5.47 | 10663 | 4061 | 16748 | 3050 | 18697 | 2461 | 19828 | 1953 | 21278 | 1126 | 24701 | 32 | 24494 |
| 12-#10 | 1.89 | 8965 | 3265 | 13250 | 2538 | 14459 | 2066 | 14768 | 1705 | 14513 | 1151 | 15445 | 594 | 10170 |
| 12-#11 | 2.33 | 9164 | 3362 | 13698 | 2590 | 14965 | 2103 | 15353 | 1729 | 15290 | 1143 | 16508 | 523 | 12096 |
| 12-#14 | 3.36 | 9663 | 3591 | 14705 | 2746 | 16201 | 2219 | 16834 | 1811 | 17286 | 1143 | 19309 | 375 | 16623 |
| 12-#18 | 5.97 | 10879 | 4172 | 17166 | 3143 | 19246 | 2513 | 20495 | 2017 | 22223 | 1140 | 26118 | -16 | 26102 |
| 13-#10 | 2.05 | 9054 | 3301 | 13423 | 2555 | 14673 | 2080 | 15025 | 1710 | 14854 | 1148 | 15874 | 560 | 10982 |
| 13-#11 | 2.52 | 9272 | 3405 | 13903 | 2613 | 15225 | 2122 | 15663 | 1736 | 15705 | 1140 | 17114 | 491 | 13017 |
| 13-#14 | 3.64 | 9816 | 3653 | 14988 | 2783 | 16575 | 2250 | 17279 | 1822 | 17883 | 1140 | 20178 | 331 | 17717 |
| 13-#18 | 6.47 | 11151 | 4282 | 17648 | 3217 | 19906 | 2593 | 21268 | 2041 | 23251 | 1136 | 27617 | -94 | 27511 |
| 14-#10 | 2.21 | 9137 | 3336 | 13678 | 2553 | 14908 | 2073 | 15274 | 1703 | 15183 | 1129 | 16223 | 530 | 11670 |
| 14-#11 | 2.72 | 9372 | 3448 | 14193 | 2616 | 15505 | 2118 | 15975 | 1732 | 16101 | 1118 | 17487 | 448 | 13864 |
| 14-#14 | 3.92 | 9958 | 3715 | 15371 | 2796 | 16970 | 2271 | 17741 | 1825 | 18459 | 1113 | 20768 | 273 | 18959 |
| 14-#18 | 6.96 | 11389 | 4393 | 18260 | 3256 | 20583 | 2627 | 22110 | 2060 | 24260 | 1093 | 28689 | -193 | 28480 |
| 15-#10 | 2.37 | 9223 | 3371 | 13739 | 2604 | 15072 | 2123 | 15507 | 1739 | 15511 | 1153 | 16867 | 523 | 12447 |
| 15-#11 | 2.91 | 9474 | 3491 | 14289 | 2673 | 15706 | 2174 | 16250 | 1772 | 16493 | 1144 | 18236 | 436 | 14725 |
| 15-#14 | 4.20 | 10101 | 3777 | 15543 | 2869 | 17257 | 2323 | 18118 | 1873 | 19000 | 1145 | 21766 | 250 | 19976 |
| 16-#10 | 2.53 | 9313 | 3406 | 13847 | 2641 | 15256 | 2147 | 15764 | 1764 | 15826 | 1157 | 17342 | 510 | 13115 |
| 16-#11 | 3.10 | 9584 | 3534 | 14424 | 2717 | 15933 | 2203 | 16563 | 1802 | 16867 | 1148 | 18770 | 415 | 15569 |
| 16-#14 | 4.48 | 10258 | 3840 | 15744 | 2928 | 17586 | 2362 | 18565 | 1915 | 19523 | 1148 | 22499 | 216 | 21144 |
| 17-#10 | 2.68 | 9391 | 3441 | 14045 | 2659 | 15466 | 2165 | 16000 | 1770 | 16173 | 1157 | 17795 | 481 | 13870 |
| 17-#11 | 3.30 | 9677 | 3577 | 14661 | 2741 | 16185 | 2225 | 16841 | 1808 | 17296 | 1149 | 19344 | 381 | 16389 |
| 17-#14 | 4.76 | 10390 | 3902 | 16075 | 2965 | 17944 | 2396 | 18957 | 1924 | 20184 | 1161 | 23472 | 183 | 22182 |

## ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.84 | 9490 | 3476 | 14247 | 2671 | 15709 | 2168 | 16259 | 1772 | 16533 | 1152 | 18277 | 465 | 14535 |
| 18-#11 | 3.49 | 9797 | 3621 | 14894 | 2758 | 16479 | 2232 | 17156 | 1813 | 17737 | 1145 | 19928 | 363 | 17245 |
| 18-#14 | 5.04 | 10561 | 3964 | 16391 | 2996 | 18365 | 2411 | 19411 | 1936 | 20790 | 1148 | 24195 | 144 | 23263 |
| 19-#10 | 3.00 | 9562 | 3511 | 14348 | 2713 | 15869 | 2208 | 16482 | 1798 | 16849 | 1166 | 18794 | 447 | 15262 |
| 19-#11 | 3.69 | 9881 | 3664 | 15026 | 2806 | 16671 | 2277 | 17427 | 1843 | 18110 | 1159 | 20534 | 338 | 18037 |
| 19-#14 | 5.32 | 10680 | 4026 | 16598 | 3059 | 18634 | 2469 | 19795 | 1974 | 21302 | 1165 | 25028 | 104 | 24349 |
| 20-#10 | 3.16 | 9654 | 3546 | 14470 | 2748 | 16066 | 2231 | 16718 | 1820 | 17199 | 1175 | 19310 | 435 | 15924 |
| 20-#11 | 3.88 | 9990 | 3707 | 15181 | 2847 | 16907 | 2304 | 17711 | 1868 | 18537 | 1170 | 21174 | 324 | 18885 |
| 21-#10 | 3.32 | 9724 | 3582 | 14652 | 2767 | 16263 | 2249 | 16974 | 1828 | 17510 | 1170 | 19728 | 405 | 16621 |
| 21-#11 | 4.07 | 10076 | 3750 | 15397 | 2872 | 17149 | 2327 | 18018 | 1878 | 18903 | 1163 | 21647 | 285 | 19637 |
| 22-#10 | 3.47 | 9809 | 3617 | 14852 | 2786 | 16488 | 2255 | 17224 | 1834 | 17856 | 1165 | 20172 | 382 | 17321 |
| 22-#11 | 4.27 | 10177 | 3793 | 15633 | 2897 | 17418 | 2336 | 18329 | 1887 | 19324 | 1157 | 22182 | 256 | 20417 |
| 23-#10 | 3.63 | 9890 | 3652 | 14961 | 2821 | 16663 | 2290 | 17455 | 1856 | 18159 | 1173 | 20718 | 370 | 17977 |
| 23-#11 | 4.46 | 10276 | 3836 | 15773 | 2938 | 17634 | 2378 | 18616 | 1920 | 19693 | 1167 | 22847 | 240 | 21177 |
| 24-#10 | 3.79 | 9970 | 3687 | 15099 | 2855 | 16851 | 2311 | 17702 | 1877 | 18490 | 1180 | 21153 | 345 | 18671 |
| 25-#10 | 3.95 | 10056 | 3722 | 15267 | 2875 | 17061 | 2332 | 17955 | 1891 | 18817 | 1177 | 21643 | 326 | 19301 |
| 26-#10 | 4.11 | 10135 | 3757 | 15452 | 2895 | 17282 | 2341 | 18207 | 1895 | 19162 | 1173 | 22065 | 296 | 19990 |

## ROUND TIED COLUMNS 34" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.76 | 10511 | 3653 | 15695 | 2771 | 16936 | 2248 | 17154 | 1873 | 16632 | 1262 | 17126 | 596 | 12097 |
| 5-#14 | 1.24 | 10322 | 3522 | 15408 | 2649 | 16414 | 2168 | 16422 | 1785 | 15555 | 1228 | 15757 | 718 | 8334 |
| 5-#18 | 2.20 | 10872 | 3764 | 16607 | 2795 | 17835 | 2280 | 18093 | 1853 | 17775 | 1209 | 18789 | 548 | 13703 |
| 6-#11 | 1.03 | 10169 | 3469 | 15484 | 2489 | 16151 | 2034 | 15981 | 1674 | 14949 | 1157 | 14477 | 673 | 7022 |
| 6-#14 | 1.49 | 10426 | 3584 | 16080 | 2551 | 16876 | 2082 | 16850 | 1702 | 16128 | 1145 | 15915 | 583 | 9818 |
| 6-#18 | 2.64 | 11054 | 3874 | 17542 | 2714 | 18674 | 2209 | 19014 | 1778 | 19064 | 1116 | 19399 | 343 | 16537 |
| 7-#11 | 1.20 | 10319 | 3512 | 15200 | 2692 | 16323 | 2196 | 16416 | 1819 | 15622 | 1263 | 15803 | 742 | 8222 |
| 7-#14 | 1.73 | 10638 | 3646 | 15858 | 2776 | 17114 | 2258 | 17358 | 1861 | 16878 | 1257 | 17557 | 654 | 11269 |
| 7-#18 | 3.08 | 11419 | 3985 | 17461 | 2993 | 19068 | 2435 | 19697 | 1970 | 19985 | 1243 | 21869 | 424 | 18404 |
| 8-#10 | 1.12 | 10259 | 3491 | 14920 | 2730 | 16198 | 2234 | 16375 | 1862 | 15578 | 1303 | 15712 | 777 | 7615 |
| 8-#11 | 1.37 | 10401 | 3556 | 15269 | 2758 | 16575 | 2253 | 16805 | 1875 | 16116 | 1294 | 16442 | 726 | 9116 |
| 8-#14 | 1.98 | 10755 | 3708 | 16010 | 2855 | 17482 | 2326 | 17896 | 1930 | 17538 | 1294 | 18402 | 623 | 12629 |
| 8-#18 | 3.52 | 11622 | 4096 | 17824 | 3107 | 19730 | 2517 | 20599 | 2072 | 21050 | 1290 | 23210 | 353 | 21057 |
| 9-#10 | 1.26 | 10381 | 3527 | 15170 | 2737 | 16425 | 2237 | 16593 | 1853 | 15895 | 1289 | 16299 | 758 | 8563 |
| 9-#11 | 1.55 | 10549 | 3599 | 15552 | 2771 | 16844 | 2260 | 17066 | 1866 | 16520 | 1281 | 17162 | 704 | 10265 |
| 9-#14 | 2.23 | 10965 | 3771 | 16381 | 2884 | 17862 | 2344 | 18273 | 1923 | 18148 | 1279 | 19455 | 595 | 14030 |
| 9-#18 | 3.97 | 11984 | 4206 | 18412 | 3174 | 20379 | 2579 | 21261 | 2069 | 22185 | 1276 | 25069 | 308 | 22819 |
| 10-#10 | 1.40 | 10453 | 3562 | 15552 | 2709 | 16726 | 2209 | 16848 | 1826 | 16148 | 1250 | 16620 | 716 | 9349 |
| 10-#11 | 1.72 | 10633 | 3642 | 15977 | 2749 | 17196 | 2249 | 17384 | 1842 | 16852 | 1238 | 17614 | 658 | 11150 |
| 10-#14 | 2.48 | 11082 | 3833 | 16924 | 2872 | 18352 | 2345 | 18755 | 1904 | 18678 | 1229 | 20205 | 539 | 15369 |
| 10-#18 | 4.41 | 12178 | 4317 | 19252 | 3191 | 21198 | 2592 | 22142 | 2061 | 23197 | 1206 | 26378 | 211 | 25002 |
| 11-#10 | 1.54 | 10555 | 3597 | 15481 | 2798 | 16844 | 2284 | 17115 | 1886 | 16621 | 1298 | 17345 | 719 | 10242 |
| 11-#11 | 1.89 | 10756 | 3685 | 15935 | 2845 | 17350 | 2316 | 17699 | 1906 | 17389 | 1290 | 18406 | 654 | 12244 |
| 11-#14 | 2.73 | 11257 | 3895 | 16940 | 2986 | 18582 | 2422 | 19176 | 1978 | 19374 | 1290 | 21200 | 519 | 16707 |
| 11-#18 | 4.85 | 12483 | 4428 | 19407 | 3350 | 21626 | 2692 | 22838 | 2163 | 24285 | 1287 | 28022 | 164 | 26847 |

## ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.68 | 10635 | 3632 | 15607 | 2840 | 17040 | 2316 | 17372 | 1916 | 16960 | 1307 | 17919 | 714 | 11025 |
| 12-#11 | 2.06 | 10852 | 3728 | 16097 | 2892 | 17589 | 2353 | 18005 | 1939 | 17799 | 1299 | 19081 | 644 | 13120 |
| 12-#14 | 2.97 | 11394 | 3957 | 17187 | 3048 | 18924 | 2468 | 19604 | 2021 | 19951 | 1300 | 22131 | 501 | 18036 |
| 12-#18 | 5.29 | 12716 | 4538 | 19856 | 3446 | 22220 | 2764 | 23562 | 2229 | 25288 | 1300 | 29575 | 122 | 28799 |
| 13-#10 | 1.82 | 10731 | 3667 | 15797 | 2856 | 17268 | 2329 | 17648 | 1919 | 17325 | 1304 | 18364 | 678 | 11886 |
| 13-#11 | 2.23 | 10969 | 3771 | 16320 | 2914 | 17867 | 2370 | 18340 | 1945 | 18245 | 1296 | 19646 | 602 | 14183 |
| 13-#14 | 3.22 | 11560 | 4020 | 17493 | 3084 | 19323 | 2498 | 20085 | 2032 | 20596 | 1297 | 23075 | 456 | 19290 |
| 13-#18 | 5.73 | 13006 | 4649 | 20373 | 3518 | 22924 | 2825 | 24401 | 2254 | 26420 | 1299 | 31212 | 44 | 30902 |
| 14-#10 | 1.96 | 10821 | 3702 | 16083 | 2851 | 17524 | 2319 | 17911 | 1910 | 17677 | 1284 | 18731 | 647 | 12662 |
| 14-#11 | 2.41 | 11077 | 3815 | 16644 | 2913 | 18171 | 2363 | 18668 | 1939 | 18677 | 1274 | 20108 | 567 | 15050 |
| 14-#14 | 3.47 | 11713 | 4082 | 17918 | 3094 | 19752 | 2497 | 20573 | 2033 | 21228 | 1270 | 23671 | 396 | 20642 |
| 14-#18 | 6.17 | 13267 | 4760 | 21047 | 3555 | 23660 | 2874 | 25294 | 2270 | 27520 | 1256 | 32404 | -51 | 32321 |
| 15-#10 | 2.10 | 10914 | 3737 | 16134 | 2906 | 17699 | 2373 | 18166 | 1949 | 18036 | 1309 | 19442 | 642 | 13485 |
| 15-#11 | 2.58 | 11187 | 3858 | 16732 | 2975 | 18386 | 2423 | 18969 | 1981 | 19098 | 1301 | 20935 | 557 | 16038 |
| 15-#14 | 3.72 | 11869 | 4144 | 18087 | 3170 | 20061 | 2573 | 20984 | 2084 | 21806 | 1303 | 24793 | 377 | 21834 |
| 15-#18 | 6.61 | 13536 | 4870 | 21419 | 3670 | 24199 | 2953 | 25975 | 2344 | 28501 | 1305 | 34160 | -102 | 34015 |
| 16-#10 | 2.24 | 11011 | 3773 | 16247 | 2944 | 17893 | 2397 | 18439 | 1975 | 18378 | 1315 | 19969 | 631 | 14239 |
| 16-#11 | 2.75 | 11305 | 3901 | 16875 | 3019 | 18626 | 2452 | 19302 | 2012 | 19505 | 1306 | 21544 | 540 | 16911 |
| 16-#14 | 3.97 | 12037 | 4206 | 18302 | 3231 | 20410 | 2612 | 21461 | 2126 | 22375 | 1308 | 25611 | 346 | 23189 |
| 17-#10 | 2.38 | 11096 | 3808 | 16461 | 2961 | 18121 | 2415 | 18697 | 1980 | 18744 | 1314 | 20450 | 602 | 15061 |
| 17-#11 | 2.92 | 11407 | 3944 | 17130 | 3042 | 18900 | 2475 | 19608 | 2018 | 19960 | 1307 | 22140 | 505 | 17852 |
| 17-#14 | 4.21 | 12181 | 4269 | 18659 | 3267 | 20797 | 2646 | 21892 | 2136 | 23038 | 1311 | 26496 | 298 | 24264 |
| 18-#10 | 2.52 | 11202 | 3843 | 16686 | 2971 | 18381 | 2416 | 18976 | 1982 | 19129 | 1308 | 20967 | 585 | 15787 |
| 18-#11 | 3.09 | 11536 | 3987 | 17390 | 3058 | 19215 | 2480 | 19947 | 2022 | 20432 | 1301 | 22770 | 486 | 18739 |
| 18-#14 | 4.46 | 12364 | 4331 | 19006 | 3296 | 21248 | 2659 | 22383 | 2146 | 23727 | 1307 | 27411 | 273 | 25490 |
| 19-#10 | 2.66 | 11281 | 3878 | 16787 | 3016 | 18552 | 2457 | 19213 | 2009 | 19476 | 1324 | 21535 | 569 | 16596 |
| 19-#11 | 3.26 | 11630 | 4030 | 17525 | 3108 | 19424 | 2527 | 20236 | 2054 | 20839 | 1317 | 23435 | 463 | 19643 |
| 19-#14 | 4.71 | 12496 | 4393 | 19222 | 3361 | 21545 | 2720 | 22791 | 2186 | 24286 | 1325 | 28325 | 235 | 26614 |
| 20-#10 | 2.80 | 11381 | 3913 | 16915 | 3050 | 18767 | 2482 | 19469 | 2031 | 19847 | 1333 | 22080 | 556 | 17300 |
| 20-#11 | 3.44 | 11747 | 4074 | 17687 | 3150 | 19679 | 2554 | 20543 | 2079 | 21294 | 1329 | 24110 | 448 | 20526 |
| 20-#14 | 4.96 | 12664 | 4455 | 19463 | 3419 | 21906 | 2758 | 23225 | 2221 | 24937 | 1340 | 29299 | 215 | 27777 |
| 21-#10 | 2.94 | 11456 | 3948 | 17113 | 3070 | 18977 | 2499 | 19741 | 2039 | 20185 | 1328 | 22534 | 528 | 18096 |
| 21-#11 | 3.61 | 11839 | 4117 | 17922 | 3174 | 19936 | 2577 | 20875 | 2090 | 21698 | 1322 | 24648 | 411 | 21397 |
| 22-#10 | 3.08 | 11549 | 3983 | 17331 | 3087 | 19221 | 2505 | 20010 | 2044 | 20561 | 1322 | 23030 | 505 | 18819 |
| 22-#11 | 3.78 | 11950 | 4160 | 18179 | 3198 | 20229 | 2586 | 21204 | 2097 | 22150 | 1316 | 25228 | 382 | 22295 |
| 23-#10 | 3.22 | 11635 | 4018 | 17444 | 3124 | 19405 | 2541 | 20260 | 2068 | 20884 | 1332 | 23607 | 493 | 19569 |
| 23-#11 | 3.95 | 12054 | 4203 | 18325 | 3241 | 20457 | 2628 | 21503 | 2125 | 22544 | 1326 | 25938 | 368 | 23144 |
| 24-#10 | 3.36 | 11722 | 4054 | 17592 | 3159 | 19608 | 2562 | 20523 | 2089 | 21243 | 1339 | 24082 | 469 | 20289 |
| 24-#11 | 4.12 | 12159 | 4246 | 18504 | 3282 | 20702 | 2653 | 21825 | 2150 | 22973 | 1334 | 26502 | 337 | 24058 |
| 25-#10 | 3.50 | 11815 | 4089 | 17774 | 3178 | 19836 | 2583 | 20786 | 2097 | 21594 | 1336 | 24612 | 451 | 21008 |
| 25-#11 | 4.30 | 12270 | 4289 | 18723 | 3306 | 20975 | 2679 | 22154 | 2167 | 23398 | 1330 | 27139 | 314 | 24821 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 26-#10 | 3.64 | 11900 | 4124 | 17977 | 3198 | 20072 | 2591 | 21071 | 2106 | 21959 | 1331 | 25051 | 419 | 21734 |
| 27-#10 | 3.78 | 11996 | 4159 | 18122 | 3226 | 20261 | 2624 | 21316 | 2132 | 22295 | 1339 | 25696 | 417 | 22451 |
| 28-#10 | 3.92 | 12081 | 4194 | 18283 | 3252 | 20475 | 2645 | 21564 | 2146 | 22668 | 1347 | 26252 | 398 | 23174 |

## ROUND TIED COLUMNS 36" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#18 | 1.57 | 12376 | 4042 | 18348 | 3090 | 19818 | 2511 | 20048 | 2094 | 19332 | 1426 | 19761 | 720 | 12986 |
| 5-#14 | 1.11 | 12169 | 3910 | 18064 | 2959 | 19264 | 2424 | 19256 | 2000 | 18159 | 1387 | 18276 | 837 | 8986 |
| 5-#18 | 1.96 | 12765 | 4152 | 19356 | 3104 | 20797 | 2536 | 21055 | 2069 | 20547 | 1369 | 21619 | 675 | 14787 |
| 6-#14 | 1.33 | 12281 | 3973 | 18833 | 2846 | 19759 | 2325 | 19688 | 1906 | 18723 | 1295 | 18432 | 699 | 10529 |
| 6-#18 | 2.36 | 12961 | 4263 | 20408 | 3008 | 21691 | 2451 | 22010 | 1981 | 21873 | 1266 | 22234 | 466 | 17782 |
| 7-#11 | 1.07 | 12164 | 3901 | 17823 | 3008 | 19158 | 2457 | 19249 | 2038 | 18245 | 1425 | 18351 | 863 | 8817 |
| 7-#14 | 1.55 | 12509 | 4035 | 18531 | 3091 | 20008 | 2518 | 20260 | 2080 | 19596 | 1420 | 20243 | 777 | 12182 |
| 7-#18 | 2.75 | 13353 | 4374 | 20261 | 3308 | 22111 | 2677 | 22773 | 2189 | 22944 | 1408 | 24907 | 552 | 19901 |
| 8-#11 | 1.23 | 12253 | 3944 | 17876 | 3078 | 19421 | 2517 | 19666 | 2097 | 18787 | 1460 | 19058 | 851 | 9802 |
| 8-#14 | 1.77 | 12635 | 4097 | 18674 | 3175 | 20394 | 2590 | 20836 | 2152 | 20316 | 1460 | 21172 | 749 | 13587 |
| 8-#18 | 3.14 | 13573 | 4484 | 20627 | 3426 | 22808 | 2780 | 23750 | 2295 | 24103 | 1459 | 26377 | 485 | 22690 |
| 9-#10 | 1.12 | 12230 | 3915 | 17776 | 3056 | 19261 | 2499 | 19441 | 2074 | 18505 | 1448 | 18815 | 873 | 9195 |
| 9-#11 | 1.38 | 12412 | 3988 | 18191 | 3089 | 19713 | 2522 | 19950 | 2087 | 19206 | 1444 | 19827 | 828 | 11031 |
| 9-#14 | 1.99 | 12861 | 4159 | 19083 | 3201 | 20805 | 2606 | 21247 | 2144 | 20953 | 1444 | 22304 | 721 | 15184 |
| 9-#18 | 3.54 | 13962 | 4595 | 21270 | 3491 | 23510 | 2823 | 24462 | 2291 | 25295 | 1442 | 28387 | 441 | 24743 |
| 10-#10 | 1.25 | 12308 | 3951 | 18207 | 3022 | 19593 | 2467 | 19708 | 2043 | 18792 | 1410 | 19198 | 836 | 10070 |
| 10-#11 | 1.53 | 12504 | 4031 | 18668 | 3060 | 20100 | 2493 | 20286 | 2058 | 19548 | 1398 | 20269 | 779 | 12016 |
| 10-#14 | 2.21 | 12989 | 4222 | 19685 | 3183 | 21343 | 2603 | 21759 | 2120 | 21509 | 1391 | 23057 | 661 | 16568 |
| 10-#18 | 3.93 | 14174 | 4706 | 22189 | 3501 | 24411 | 2850 | 25407 | 2279 | 26373 | 1370 | 29863 | 350 | 27391 |
| 11-#10 | 1.37 | 12418 | 3986 | 18104 | 3118 | 19710 | 2548 | 19998 | 2108 | 19317 | 1463 | 20025 | 844 | 11017 |
| 11-#11 | 1.69 | 12636 | 4074 | 18597 | 3163 | 20256 | 2580 | 20626 | 2128 | 20144 | 1455 | 21175 | 780 | 13179 |
| 11-#14 | 2.43 | 13178 | 4284 | 19677 | 3304 | 21580 | 2685 | 22211 | 2200 | 22277 | 1456 | 24197 | 648 | 18090 |
| 11-#18 | 4.32 | 14504 | 4816 | 22332 | 3668 | 24854 | 2956 | 26147 | 2386 | 27563 | 1456 | 31600 | 302 | 29264 |
| 12-#10 | 1.50 | 12504 | 4021 | 18230 | 3162 | 19918 | 2582 | 20275 | 2139 | 19680 | 1473 | 20650 | 840 | 11914 |
| 12-#11 | 1.84 | 12739 | 4117 | 18765 | 3213 | 20511 | 2618 | 20956 | 2162 | 20581 | 1465 | 21911 | 772 | 14158 |
| 12-#14 | 2.65 | 13324 | 4346 | 19939 | 3369 | 21946 | 2734 | 22672 | 2245 | 22889 | 1466 | 25211 | 632 | 19466 |
| 12-#18 | 4.72 | 14753 | 4927 | 22817 | 3768 | 25493 | 3030 | 26929 | 2454 | 28625 | 1470 | 33289 | 263 | 31468 |
| 13-#10 | 1.62 | 12608 | 4056 | 18441 | 3176 | 20162 | 2593 | 20571 | 2142 | 20069 | 1469 | 21109 | 802 | 12801 |
| 13-#11 | 1.99 | 12864 | 4160 | 19007 | 3233 | 20807 | 2634 | 21316 | 2167 | 21057 | 1461 | 22496 | 728 | 15284 |
| 13-#14 | 2.87 | 13503 | 4408 | 20269 | 3403 | 22370 | 2762 | 23190 | 2255 | 23580 | 1464 | 26088 | 573 | 20892 |
| 13-#18 | 5.11 | 15066 | 5038 | 23370 | 3838 | 26240 | 3089 | 27834 | 2479 | 29844 | 1468 | 35065 | 186 | 33639 |
| 14-#10 | 1.75 | 12704 | 4091 | 18760 | 3168 | 20439 | 2581 | 20846 | 2130 | 20434 | 1447 | 21494 | 771 | 13669 |
| 14-#11 | 2.15 | 12981 | 4203 | 19368 | 3230 | 21137 | 2625 | 21660 | 2159 | 21522 | 1438 | 22983 | 692 | 16254 |
| 14-#14 | 3.09 | 13667 | 4471 | 20738 | 3410 | 22834 | 2759 | 23704 | 2253 | 24267 | 1436 | 26829 | 525 | 22296 |
| 14-#18 | 5.50 | 15346 | 5148 | 24108 | 3872 | 27036 | 3102 | 28777 | 2492 | 31050 | 1428 | 36279 | 87 | 35689 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 15-#10 | 1.87 | 12804 | 4126 | 18799 | 3227 | 20624 | 2638 | 21123 | 2172 | 20834 | 1475 | 22274 | 768 | 14536 |
| 15-#11 | 2.30 | 13100 | 4247 | 19446 | 3294 | 21365 | 2688 | 21987 | 2204 | 21976 | 1467 | 23890 | 684 | 17331 |
| 15-#14 | 3.32 | 13836 | 4533 | 20902 | 3490 | 23164 | 2838 | 24149 | 2307 | 24884 | 1471 | 28056 | 507 | 23647 |
| 15-#18 | 5.89 | 15637 | 5259 | 24487 | 3990 | 27615 | 3220 | 29515 | 2569 | 32090 | 1477 | 38270 | 44 | 37936 |
| 16-#10 | 2.00 | 12907 | 4161 | 18916 | 3266 | 20828 | 2663 | 21413 | 2198 | 21203 | 1482 | 22830 | 756 | 15382 |
| 16-#11 | 2.45 | 13226 | 4290 | 19596 | 3340 | 21618 | 2718 | 22341 | 2235 | 22416 | 1474 | 24574 | 670 | 18274 |
| 16-#14 | 3.54 | 14015 | 4595 | 21129 | 3552 | 23532 | 2877 | 24655 | 2349 | 25499 | 1477 | 28982 | 481 | 25056 |
| 16-#18 | 6.29 | 15948 | 5370 | 24904 | 4092 | 28274 | 3286 | 30404 | 2640 | 33134 | 1482 | 39735 | -17 | 39712 |
| 17-#10 | 2.12 | 12999 | 4196 | 19147 | 3282 | 21074 | 2680 | 21690 | 2203 | 21589 | 1480 | 23362 | 729 | 16244 |
| 17-#11 | 2.61 | 13336 | 4333 | 19871 | 3362 | 21912 | 2739 | 22675 | 2242 | 22895 | 1473 | 25192 | 634 | 19340 |
| 17-#14 | 3.76 | 14171 | 4657 | 21513 | 3587 | 23949 | 2911 | 25127 | 2360 | 26199 | 1479 | 29898 | 432 | 26325 |
| 18-#10 | 2.25 | 13112 | 4232 | 19397 | 3290 | 21352 | 2679 | 21992 | 2204 | 21937 | 1463 | 23759 | 697 | 17061 |
| 18-#11 | 2.76 | 13473 | 4376 | 20157 | 3376 | 22249 | 2742 | 23038 | 2245 | 23397 | 1467 | 25867 | 614 | 20257 |
| 18-#14 | 3.98 | 14367 | 4720 | 21893 | 3614 | 24430 | 2923 | 25653 | 2370 | 26935 | 1474 | 30884 | 406 | 27757 |
| 19-#10 | 2.37 | 13198 | 4267 | 19496 | 3337 | 21533 | 2723 | 22244 | 2233 | 22375 | 1491 | 24525 | 697 | 17909 |
| 19-#11 | 2.91 | 13576 | 4419 | 20293 | 3429 | 22472 | 2792 | 23344 | 2277 | 23841 | 1485 | 26594 | 593 | 21282 |
| 19-#14 | 4.20 | 14511 | 4782 | 22117 | 3682 | 24750 | 2986 | 26086 | 2411 | 27543 | 1494 | 31879 | 371 | 28934 |
| 20-#10 | 2.50 | 13307 | 4302 | 19629 | 3372 | 21767 | 2748 | 22519 | 2255 | 22769 | 1500 | 25107 | 684 | 18700 |
| 20-#11 | 3.07 | 13704 | 4462 | 20462 | 3471 | 22750 | 2821 | 23675 | 2304 | 24324 | 1496 | 27303 | 578 | 22194 |
| 20-#14 | 4.42 | 14693 | 4844 | 22370 | 3740 | 25142 | 3025 | 26554 | 2447 | 28233 | 1509 | 32902 | 349 | 30248 |
| 21-#10 | 2.62 | 13387 | 4337 | 19843 | 3391 | 21990 | 2765 | 22807 | 2263 | 23131 | 1495 | 25595 | 656 | 19557 |
| 21-#11 | 3.22 | 13802 | 4505 | 20717 | 3495 | 23023 | 2843 | 24029 | 2314 | 24762 | 1490 | 27891 | 542 | 23180 |
| 21-#14 | 4.64 | 14832 | 4906 | 22726 | 3777 | 25535 | 3058 | 27064 | 2463 | 28856 | 1501 | 33735 | 297 | 31476 |
| 22-#10 | 2.74 | 13487 | 4372 | 20081 | 3407 | 22253 | 2769 | 23095 | 2267 | 23537 | 1489 | 26144 | 634 | 20344 |
| 22-#11 | 3.37 | 13922 | 4549 | 20996 | 3517 | 23338 | 2850 | 24379 | 2320 | 25249 | 1483 | 28530 | 514 | 24140 |
| 22-#14 | 4.86 | 15002 | 4969 | 23107 | 3814 | 25981 | 3074 | 27571 | 2476 | 29558 | 1494 | 34637 | 257 | 32685 |
| 23-#10 | 2.87 | 13579 | 4407 | 20196 | 3446 | 22446 | 2807 | 23364 | 2292 | 23882 | 1499 | 26753 | 622 | 21170 |
| 23-#11 | 3.52 | 14033 | 4592 | 21147 | 3562 | 23578 | 2894 | 24701 | 2349 | 25667 | 1494 | 29278 | 499 | 25070 |
| 24-#10 | 2.99 | 13673 | 4442 | 20352 | 3481 | 22663 | 2828 | 23643 | 2313 | 24268 | 1507 | 27269 | 599 | 21936 |
| 24-#11 | 3.68 | 14146 | 4635 | 21340 | 3604 | 23841 | 2919 | 25043 | 2375 | 26130 | 1503 | 29890 | 470 | 26031 |
| 25-#10 | 3.12 | 13772 | 4478 | 20550 | 3500 | 22908 | 2849 | 23925 | 2322 | 24642 | 1504 | 27839 | 581 | 22751 |
| 25-#11 | 3.83 | 14265 | 4678 | 21574 | 3628 | 24135 | 2945 | 25396 | 2392 | 26586 | 1499 | 30577 | 447 | 26919 |
| 26-#10 | 3.24 | 13864 | 4513 | 20771 | 3519 | 23159 | 2856 | 24234 | 2331 | 25028 | 1499 | 28293 | 548 | 23500 |
| 26-#11 | 3.98 | 14376 | 4721 | 21833 | 3653 | 24442 | 2955 | 25752 | 2397 | 27062 | 1494 | 31153 | 409 | 27883 |
| 27-#10 | 3.37 | 13967 | 4548 | 20921 | 3548 | 23362 | 2890 | 24494 | 2357 | 25392 | 1507 | 28919 | 539 | 24310 |
| 27-#11 | 4.14 | 14500 | 4764 | 22026 | 3686 | 24688 | 2995 | 26070 | 2427 | 27495 | 1503 | 31978 | 405 | 28750 |
| 28-#10 | 3.49 | 14058 | 4583 | 21092 | 3575 | 23588 | 2911 | 24761 | 2371 | 25787 | 1515 | 29611 | 530 | 25058 |
| 29-#10 | 3.62 | 14163 | 4618 | 21274 | 3602 | 23822 | 2932 | 25053 | 2386 | 26179 | 1517 | 30070 | 505 | 25838 |
| 30-#10 | 3.74 | 14251 | 4653 | 21499 | 3617 | 24084 | 2943 | 25333 | 2389 | 26548 | 1509 | 30611 | 479 | 26604 |

## ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway. $f'_c$ = 6,000 psi $f_y$ = 75,000 psi. $\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.38 | 2669 | 1427 | 3868 | 1197 | 4589 | 936 | 4767 | 746 | 4647 | 459 | 5091 | 250 | 3946 |
| 4-#14 | 1.99 | 2715 | 1527 | 4176 | 1249 | 4932 | 969 | 5160 | 766 | 5156 | 441 | 5735 | 171 | 5152 |
| 4-#18 | 3.54 | 2809 | 1781 | 4889 | 1381 | 5744 | 1052 | 6098 | 813 | 6376 | 391 | 7260 | -41 | 7206 |
| 5-#11 | 1.72 | 2745 | 1483 | 4147 | 1206 | 4827 | 935 | 5007 | 731 | 4942 | 425 | 5550 | 202 | 4457 |
| 5-#14 | 2.49 | 2817 | 1609 | 4516 | 1272 | 5255 | 977 | 5504 | 752 | 5590 | 398 | 6404 | 106 | 5907 |
| 5-#18 | 4.42 | 2968 | 1927 | 5384 | 1438 | 6270 | 1082 | 6688 | 802 | 7142 | 323 | 8421 | -150 | 8221 |
| 6-#11 | 2.07 | 2809 | 1540 | 4515 | 1181 | 5116 | 903 | 5279 | 697 | 5263 | 372 | 5737 | 117 | 5246 |
| 6-#14 | 2.98 | 2901 | 1690 | 4966 | 1256 | 5648 | 948 | 5901 | 717 | 6079 | 332 | 6718 | -9 | 6709 |
| 6-#18 | 5.31 | 3120 | 2072 | 6029 | 1444 | 6913 | 1060 | 7386 | 763 | 8027 | 222 | 9027 | -346 | 8554 |
| 7-#11 | 2.41 | 2828 | 1597 | 4421 | 1292 | 5214 | 998 | 5489 | 772 | 5591 | 421 | 6464 | 130 | 5816 |
| 7-#14 | 3.48 | 2926 | 1772 | 4923 | 1389 | 5804 | 1062 | 6179 | 805 | 6494 | 387 | 7670 | -4 | 7664 |
| 7-#18 | 6.19 | 3165 | 2217 | 6105 | 1633 | 7207 | 1221 | 7824 | 883 | 8653 | 292 | 10509 | -362 | 9802 |
| 8-#11 | 2.76 | 2862 | 1653 | 4516 | 1341 | 5392 | 1037 | 5724 | 804 | 5912 | 431 | 6896 | 104 | 6480 |
| 8-#14 | 3.98 | 2972 | 1854 | 5087 | 1455 | 6060 | 1112 | 6506 | 846 | 6936 | 397 | 8259 | -46 | 8191 |
| 8-#18 | 7.07 | 3250 | 2363 | 6428 | 1739 | 7651 | 1298 | 8373 | 946 | 9386 | 301 | 11471 | -449 | 10651 |
| 9-#11 | 3.10 | 2914 | 1710 | 4739 | 1364 | 5609 | 1054 | 5970 | 806 | 6247 | 417 | 7400 | 58 | 7113 |
| 9-#14 | 4.48 | 3052 | 1936 | 5383 | 1491 | 6363 | 1140 | 6854 | 851 | 7413 | 378 | 8974 | -111 | 8691 |
| 9-#18 | 7.96 | 3389 | 2508 | 6898 | 1806 | 8156 | 1351 | 8963 | 957 | 10202 | 267 | 12681 | -564 | 11281 |
| 10-#11 | 3.45 | 2952 | 1767 | 4988 | 1377 | 5864 | 1052 | 6242 | 799 | 6571 | 383 | 7745 | 12 | 7693 |
| 10-#14 | 4.97 | 3099 | 2018 | 5699 | 1517 | 6714 | 1143 | 7240 | 846 | 7882 | 333 | 9477 | -176 | 9172 |
| 11-#11 | 3.79 | 3002 | 1823 | 5049 | 1439 | 6009 | 1107 | 6450 | 838 | 6881 | 405 | 8272 | -19 | 8237 |
| 11-#14 | 5.47 | 3176 | 2099 | 5826 | 1597 | 6926 | 1214 | 7529 | 894 | 8303 | 359 | 10193 | -228 | 9728 |
| 12-#11 | 4.14 | 3061 | 1880 | 5168 | 1485 | 6198 | 1138 | 6685 | 862 | 7182 | 403 | 8734 | -42 | 8661 |
| 12-#14 | 5.97 | 3252 | 2181 | 6005 | 1660 | 7196 | 1255 | 7858 | 927 | 8723 | 354 | 10832 | -263 | 10257 |
| 13-#11 | 4.48 | 3086 | 1937 | 5366 | 1513 | 6410 | 1160 | 6930 | 868 | 7515 | 393 | 9136 | -95 | 8956 |
| 13-#14 | 6.47 | 3313 | 2263 | 6276 | 1701 | 7492 | 1288 | 8205 | 937 | 9195 | 339 | 11401 | -340 | 10631 |
| 14-#11 | 4.83 | 3125 | 1994 | 5583 | 1537 | 6648 | 1167 | 7197 | 870 | 7844 | 368 | 9538 | -139 | 9266 |
| 15-#11 | 5.17 | 3179 | 2050 | 5705 | 1580 | 6812 | 1211 | 7411 | 898 | 8149 | 380 | 10046 | -165 | 9641 |
| 16-#11 | 5.52 | 3228 | 2107 | 5859 | 1618 | 7006 | 1238 | 7647 | 920 | 8452 | 375 | 10482 | -206 | 10012 |

## ROUND TIED COLUMNS 26" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.18 | 3382 | 1635 | 4750 | 1396 | 5697 | 1096 | 5924 | 878 | 5744 | 553 | 6280 | 334 | 4384 |
| 4-#14 | 1.70 | 3440 | 1735 | 5096 | 1448 | 6086 | 1130 | 6369 | 898 | 6319 | 537 | 7014 | 259 | 6008 |
| 4-#18 | 3.01 | 3560 | 1990 | 5925 | 1582 | 7014 | 1216 | 7439 | 948 | 7709 | 492 | 8769 | 57 | 8589 |
| 5-#11 | 1.47 | 3474 | 1692 | 5095 | 1401 | 5972 | 1091 | 6193 | 860 | 6068 | 518 | 6789 | 285 | 4979 |
| 5-#14 | 2.12 | 3564 | 1817 | 5516 | 1467 | 6457 | 1134 | 6756 | 882 | 6802 | 493 | 7766 | 193 | 6753 |
| 5-#18 | 3.77 | 3753 | 2135 | 6509 | 1637 | 7617 | 1243 | 8107 | 936 | 8570 | 424 | 10093 | -51 | 10018 |
| 6-#11 | 1.76 | 3560 | 1748 | 5543 | 1367 | 6307 | 1052 | 6496 | 819 | 6416 | 461 | 6983 | 198 | 5991 |
| 6-#14 | 2.54 | 3678 | 1899 | 6056 | 1443 | 6910 | 1099 | 7201 | 841 | 7339 | 423 | 8106 | 77 | 7775 |
| 6-#18 | 4.52 | 3960 | 2280 | 7273 | 1635 | 8355 | 1214 | 8895 | 892 | 9561 | 321 | 10773 | -245 | 10397 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway. $f'_c$ = 6,000 psi $f_y$ = 75,000 psi. $\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 7-#11 | 2.06 | 3574 | 1805 | 5384 | 1489 | 6402 | 1158 | 6735 | 904 | 6800 | 517 | 7830 | 216 | 6621 |
| 7-#14 | 2.97 | 3700 | 1981 | 5960 | 1588 | 7072 | 1223 | 7516 | 939 | 7821 | 486 | 9208 | 88 | 8748 |
| 7-#18 | 5.27 | 3970 | 2426 | 7316 | 1837 | 8674 | 1387 | 9392 | 1023 | 10282 | 399 | 12484 | -253 | 11946 |
| 8-#11 | 2.35 | 3621 | 1862 | 5477 | 1542 | 6597 | 1199 | 6997 | 938 | 7164 | 529 | 8322 | 194 | 7417 |
| 8-#14 | 3.39 | 3757 | 2062 | 6122 | 1656 | 7356 | 1277 | 7883 | 983 | 8322 | 499 | 9881 | 50 | 9656 |
| 8-#18 | 6.03 | 4094 | 2571 | 7668 | 1946 | 9172 | 1469 | 10012 | 1091 | 11113 | 413 | 13586 | -333 | 12902 |
| 9-#11 | 2.64 | 3682 | 1918 | 5735 | 1564 | 6845 | 1216 | 7274 | 940 | 7537 | 515 | 8842 | 141 | 8072 |
| 9-#14 | 3.81 | 3843 | 2144 | 6467 | 1692 | 7699 | 1304 | 8275 | 988 | 8857 | 480 | 10689 | -14 | 10578 |
| 9-#18 | 6.78 | 4255 | 2717 | 8208 | 2014 | 9746 | 1522 | 10680 | 1102 | 12034 | 380 | 14965 | -446 | 13718 |
| 10-#11 | 2.94 | 3722 | 1975 | 6039 | 1575 | 7136 | 1211 | 7579 | 931 | 7896 | 480 | 9272 | 103 | 8768 |
| 10-#14 | 4.24 | 3897 | 2226 | 6847 | 1716 | 8100 | 1305 | 8710 | 981 | 9380 | 434 | 11253 | -77 | 11107 |
| 10-#18 | 7.53 | 4355 | 2862 | 8769 | 2071 | 10408 | 1536 | 11428 | 1100 | 12952 | 305 | 15957 | -558 | 14270 |
| 11-#11 | 3.23 | 3781 | 2032 | 6080 | 1640 | 7292 | 1271 | 7813 | 973 | 8249 | 506 | 9873 | 75 | 9500 |
| 11-#14 | 4.66 | 3980 | 2308 | 6960 | 1800 | 8332 | 1381 | 9035 | 1034 | 9859 | 464 | 12069 | -124 | 11789 |
| 12-#11 | 3.53 | 3846 | 2088 | 6210 | 1687 | 7503 | 1303 | 8076 | 999 | 8588 | 505 | 10401 | 54 | 10137 |
| 12-#14 | 5.09 | 4089 | 2389 | 7155 | 1865 | 8633 | 1423 | 9405 | 1068 | 10332 | 461 | 12799 | -157 | 12446 |
| 13-#11 | 3.82 | 3883 | 2145 | 6435 | 1715 | 7742 | 1324 | 8352 | 1005 | 8961 | 495 | 10853 | 3 | 10841 |
| 13-#14 | 5.51 | 4135 | 2471 | 7463 | 1906 | 8968 | 1456 | 9795 | 1078 | 10862 | 447 | 13441 | -231 | 12872 |
| 14-#11 | 4.11 | 3929 | 2202 | 6680 | 1737 | 8012 | 1331 | 8651 | 1007 | 9328 | 470 | 11307 | -42 | 11222 |
| 14-#14 | 5.93 | 4190 | 2553 | 7796 | 1943 | 9343 | 1470 | 10219 | 1083 | 11389 | 413 | 14089 | -294 | 13325 |
| 15-#11 | 4.41 | 3993 | 2259 | 6815 | 1784 | 8193 | 1377 | 8891 | 1037 | 9672 | 484 | 11882 | -64 | 11737 |
| 16-#11 | 4.70 | 4028 | 2315 | 6984 | 1823 | 8410 | 1406 | 9156 | 1060 | 10014 | 481 | 12379 | -104 | 12126 |
| 17-#11 | 5.00 | 4092 | 2372 | 7170 | 1857 | 8645 | 1430 | 9431 | 1068 | 10384 | 473 | 12867 | -140 | 12516 |
| 18-#11 | 5.29 | 4159 | 2429 | 7408 | 1879 | 8904 | 1442 | 9725 | 1075 | 10790 | 463 | 13313 | -195 | 12805 |

## ROUND TIED COLUMNS 28" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.01 | 4211 | 1860 | 5755 | 1611 | 6960 | 1269 | 7254 | 1020 | 7001 | 655 | 7637 | 424 | 4820 |
| 4-#14 | 1.46 | 4281 | 1960 | 6140 | 1663 | 7403 | 1304 | 7751 | 1041 | 7643 | 640 | 8462 | 351 | 6690 |
| 4-#18 | 2.60 | 4428 | 2215 | 7063 | 1797 | 8449 | 1391 | 8953 | 1094 | 9202 | 599 | 10448 | 158 | 9882 |
| 5-#11 | 1.27 | 4318 | 1916 | 6168 | 1611 | 7282 | 1260 | 7552 | 998 | 7352 | 617 | 8194 | 373 | 5507 |
| 5-#14 | 1.83 | 4426 | 2042 | 6647 | 1679 | 7826 | 1304 | 8181 | 1022 | 8172 | 594 | 9294 | 284 | 7545 |
| 5-#18 | 3.25 | 4657 | 2360 | 7768 | 1850 | 9132 | 1415 | 9700 | 1079 | 10157 | 530 | 11932 | 49 | 11676 |
| 6-#11 | 1.52 | 4426 | 1973 | 6713 | 1569 | 7668 | 1213 | 7886 | 951 | 7723 | 556 | 8387 | 283 | 6606 |
| 6-#14 | 2.19 | 4571 | 2124 | 7288 | 1646 | 8343 | 1261 | 8674 | 974 | 8754 | 520 | 9653 | 166 | 8853 |
| 6-#18 | 3.90 | 4922 | 2505 | 8661 | 1840 | 9969 | 1380 | 10578 | 1030 | 11250 | 424 | 12681 | -143 | 12441 |
| 7-#11 | 1.77 | 4437 | 2030 | 6473 | 1703 | 7756 | 1330 | 8153 | 1045 | 8168 | 619 | 9363 | 308 | 7358 |
| 7-#14 | 2.56 | 4586 | 2205 | 7115 | 1803 | 8505 | 1397 | 9026 | 1082 | 9309 | 591 | 10915 | 184 | 9848 |
| 7-#18 | 4.55 | 4917 | 2651 | 8657 | 2056 | 10308 | 1565 | 11135 | 1172 | 12071 | 512 | 14631 | -143 | 14323 |
| 8-#11 | 2.03 | 4495 | 2087 | 6562 | 1759 | 7959 | 1374 | 8444 | 1083 | 8576 | 634 | 9919 | 288 | 8398 |
| 8-#14 | 2.92 | 4661 | 2287 | 7281 | 1874 | 8815 | 1453 | 9434 | 1130 | 9869 | 607 | 11673 | 151 | 10924 |
| 8-#18 | 5.20 | 5030 | 2796 | 9009 | 2166 | 10859 | 1651 | 11826 | 1243 | 13001 | 529 | 15874 | -216 | 15385 |
| 9-#11 | 2.28 | 4567 | 2143 | 6856 | 1779 | 8245 | 1390 | 8751 | 1083 | 8987 | 620 | 10496 | 236 | 9066 |
| 9-#14 | 3.29 | 4761 | 2369 | 7672 | 1908 | 9201 | 1480 | 9870 | 1134 | 10460 | 588 | 12500 | 76 | 12078 |
| 9-#18 | 5.85 | 5217 | 2942 | 9636 | 2235 | 11503 | 1703 | 12573 | 1255 | 14027 | 498 | 17423 | -328 | 16357 |

## ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.53 | 4607 | 2200 | 7209 | 1787 | 8575 | 1382 | 9090 | 1072 | 9380 | 583 | 10966 | 197 | 9889 |
| 10-#14 | 3.65 | 4815 | 2451 | 8127 | 1931 | 9653 | 1478 | 10354 | 1125 | 11038 | 541 | 13196 | 24 | 13073 |
| 10-#18 | 6.50 | 5344 | 3087 | 10292 | 2291 | 12248 | 1716 | 13408 | 1252 | 15048 | 423 | 18531 | -436 | 17077 |
| 11-#11 | 2.79 | 4678 | 2257 | 7237 | 1857 | 8738 | 1446 | 9349 | 1119 | 9778 | 612 | 11645 | 173 | 10651 |
| 11-#14 | 4.02 | 4911 | 2533 | 8219 | 2018 | 9904 | 1559 | 10715 | 1182 | 11575 | 575 | 14115 | -18 | 14071 |
| 11-#18 | 7.15 | 5510 | 3232 | 10581 | 2424 | 12706 | 1838 | 14012 | 1334 | 15924 | 468 | 20031 | -528 | 18301 |
| 12-#11 | 3.04 | 4760 | 2313 | 7375 | 1906 | 8964 | 1479 | 9641 | 1146 | 10156 | 613 | 12238 | 153 | 11402 |
| 12-#14 | 4.38 | 5044 | 2614 | 8430 | 2085 | 10236 | 1603 | 11126 | 1218 | 12103 | 573 | 14938 | -49 | 14820 |
| 13-#11 | 3.29 | 4792 | 2370 | 7627 | 1933 | 9235 | 1501 | 9947 | 1152 | 10568 | 603 | 12740 | 104 | 12226 |
| 13-#14 | 4.75 | 5078 | 2696 | 8776 | 2126 | 10610 | 1636 | 11560 | 1228 | 12690 | 560 | 15653 | -121 | 15335 |
| 14-#11 | 3.55 | 4853 | 2427 | 7902 | 1953 | 9542 | 1507 | 10279 | 1153 | 10972 | 578 | 13245 | 59 | 12923 |
| 14-#14 | 5.12 | 5156 | 2778 | 9143 | 2161 | 11030 | 1648 | 12031 | 1233 | 13274 | 526 | 16379 | -184 | 15883 |
| 15-#11 | 3.80 | 4914 | 2484 | 8041 | 2002 | 9734 | 1555 | 10546 | 1185 | 11357 | 594 | 13889 | 39 | 13700 |
| 15-#14 | 5.48 | 5250 | 2860 | 9371 | 2225 | 11317 | 1712 | 12405 | 1274 | 13806 | 545 | 17269 | -217 | 16544 |
| 16-#11 | 4.05 | 4961 | 2540 | 8234 | 2043 | 9970 | 1584 | 10839 | 1209 | 11737 | 592 | 14447 | 0 | 14445 |
| 16-#14 | 5.85 | 5334 | 2942 | 9644 | 2280 | 11658 | 1753 | 12819 | 1307 | 14339 | 540 | 18047 | -274 | 17200 |
| 17-#11 | 4.31 | 5028 | 2597 | 8434 | 2076 | 10234 | 1609 | 11144 | 1218 | 12147 | 584 | 14990 | -34 | 14900 |
| 18-#11 | 4.56 | 5107 | 2654 | 8704 | 2098 | 10529 | 1620 | 11470 | 1224 | 12595 | 574 | 15487 | -89 | 15239 |
| 19-#11 | 4.81 | 5151 | 2710 | 8830 | 2151 | 10736 | 1662 | 11743 | 1250 | 12956 | 580 | 16093 | -109 | 15782 |
| 20-#11 | 5.07 | 5210 | 2767 | 9023 | 2188 | 10976 | 1689 | 12037 | 1272 | 13355 | 581 | 16739 | -135 | 16201 |

## ROUND TIED COLUMNS 30" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.27 | 5245 | 2202 | 7317 | 1895 | 8882 | 1489 | 9320 | 1194 | 9140 | 751 | 10093 | 449 | 7322 |
| 4-#18 | 2.26 | 5421 | 2456 | 8335 | 2029 | 10062 | 1580 | 10655 | 1249 | 10869 | 713 | 12310 | 263 | 11251 |
| 5-#11 | 1.10 | 5285 | 2158 | 7378 | 1838 | 8772 | 1442 | 9098 | 1147 | 8807 | 724 | 9777 | 466 | 6042 |
| 5-#14 | 1.59 | 5412 | 2284 | 7906 | 1905 | 9374 | 1486 | 9793 | 1171 | 9712 | 702 | 11000 | 380 | 8289 |
| 5-#18 | 2.83 | 5687 | 2602 | 9169 | 2079 | 10827 | 1600 | 11481 | 1231 | 11915 | 642 | 13951 | 154 | 13072 |
| 6-#11 | 1.32 | 5417 | 2215 | 8034 | 1786 | 9211 | 1386 | 9460 | 1093 | 9196 | 657 | 9962 | 372 | 7221 |
| 6-#14 | 1.91 | 5590 | 2365 | 8673 | 1863 | 9959 | 1434 | 10332 | 1117 | 10335 | 623 | 11371 | 260 | 9984 |
| 6-#18 | 3.40 | 5968 | 2747 | 10203 | 2060 | 11767 | 1557 | 12448 | 1176 | 13107 | 532 | 14762 | -39 | 14692 |
| 7-#11 | 1.54 | 5425 | 2272 | 7698 | 1933 | 9284 | 1515 | 9758 | 1197 | 9708 | 729 | 11076 | 404 | 8101 |
| 7-#14 | 2.23 | 5600 | 2447 | 8406 | 2033 | 10116 | 1583 | 10723 | 1236 | 10968 | 703 | 12802 | 285 | 10988 |
| 7-#18 | 3.96 | 5993 | 2892 | 10114 | 2288 | 12121 | 1754 | 13065 | 1330 | 14033 | 630 | 16960 | -31 | 16889 |
| 8-#11 | 1.77 | 5494 | 2328 | 7780 | 1992 | 9494 | 1561 | 10078 | 1238 | 10161 | 746 | 11698 | 388 | 9207 |
| 8-#14 | 2.55 | 5690 | 2529 | 8573 | 2108 | 10436 | 1641 | 11172 | 1286 | 11589 | 721 | 13648 | 255 | 12246 |
| 8-#18 | 4.53 | 6125 | 3038 | 10485 | 2402 | 12723 | 1844 | 13828 | 1405 | 15065 | 651 | 18347 | -98 | 18107 |
| 9-#11 | 1.99 | 5574 | 2385 | 8113 | 2011 | 9813 | 1576 | 10415 | 1237 | 10588 | 726 | 12332 | 335 | 10045 |
| 9-#14 | 2.86 | 5802 | 2611 | 9013 | 2141 | 10878 | 1668 | 11652 | 1289 | 12206 | 695 | 14560 | 181 | 13440 |
| 9-#18 | 5.09 | 6333 | 3183 | 11187 | 2470 | 13438 | 1896 | 14653 | 1417 | 16195 | 620 | 19925 | -227 | 19255 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.21 | 5618 | 2442 | 8515 | 2014 | 10192 | 1566 | 10787 | 1223 | 11035 | 693 | 12839 | 296 | 11056 |
| 10-#14 | 3.18 | 5860 | 2692 | 9523 | 2159 | 11385 | 1664 | 12185 | 1278 | 12867 | 654 | 15320 | 129 | 14598 |
| 10-#18 | 5.66 | 6413 | 3329 | 11958 | 2525 | 14270 | 1907 | 15576 | 1412 | 17318 | 545 | 21289 | -314 | 20072 |
| 11-#11 | 2.43 | 5696 | 2498 | 8528 | 2090 | 10353 | 1634 | 11072 | 1274 | 11479 | 725 | 13599 | 276 | 11839 |
| 11-#14 | 3.50 | 5971 | 2774 | 9612 | 2252 | 11646 | 1748 | 12581 | 1340 | 13465 | 691 | 16345 | 91 | 15854 |
| 11-#18 | 6.22 | 6622 | 3474 | 12229 | 2662 | 14766 | 2034 | 16243 | 1500 | 18290 | 594 | 22958 | -399 | 21518 |
| 12-#11 | 2.65 | 5787 | 2555 | 8673 | 2141 | 10598 | 1668 | 11392 | 1303 | 11896 | 727 | 14259 | 257 | 12714 |
| 12-#14 | 3.82 | 6093 | 2856 | 9838 | 2321 | 12000 | 1794 | 13034 | 1378 | 14048 | 692 | 17262 | 62 | 16917 |
| 12-#18 | 6.79 | 6835 | 3619 | 12651 | 2775 | 15400 | 2108 | 17016 | 1560 | 19275 | 588 | 24488 | -458 | 22916 |
| 13-#11 | 2.87 | 5832 | 2612 | 8947 | 2166 | 10898 | 1690 | 11729 | 1309 | 12347 | 718 | 14810 | 209 | 13582 |
| 13-#14 | 4.14 | 6163 | 2938 | 10219 | 2361 | 12419 | 1827 | 13512 | 1388 | 14692 | 679 | 18049 | -8 | 18025 |
| 13-#18 | 7.36 | 6996 | 3765 | 13287 | 2851 | 16098 | 2169 | 17835 | 1580 | 20389 | 566 | 25844 | -586 | 23811 |
| 14-#11 | 3.09 | 5904 | 2668 | 9261 | 2185 | 11245 | 1694 | 12094 | 1308 | 12789 | 692 | 15364 | 164 | 14382 |
| 14-#14 | 4.46 | 6252 | 3020 | 10627 | 2394 | 12896 | 1839 | 14031 | 1392 | 15332 | 644 | 18851 | -71 | 18652 |
| 15-#11 | 3.31 | 5968 | 2725 | 9400 | 2237 | 11446 | 1745 | 12387 | 1343 | 13215 | 710 | 16080 | 146 | 15295 |
| 15-#14 | 4.77 | 6351 | 3101 | 10865 | 2461 | 13196 | 1905 | 14442 | 1436 | 15920 | 666 | 19838 | -101 | 19428 |
| 16-#11 | 3.53 | 6022 | 2782 | 9607 | 2278 | 11703 | 1775 | 12708 | 1368 | 13634 | 709 | 16700 | 108 | 16053 |
| 16-#14 | 5.09 | 6418 | 3183 | 11174 | 2519 | 13565 | 1946 | 14897 | 1469 | 16508 | 662 | 20704 | -157 | 20187 |
| 17-#11 | 3.75 | 6099 | 2839 | 9831 | 2312 | 11995 | 1799 | 13044 | 1376 | 14083 | 702 | 17296 | 75 | 16890 |
| 17-#14 | 5.41 | 6538 | 3265 | 11477 | 2568 | 13975 | 1982 | 15373 | 1483 | 17148 | 652 | 21552 | -206 | 20867 |
| 18-#11 | 3.97 | 6168 | 2895 | 10135 | 2332 | 12314 | 1810 | 13403 | 1382 | 14530 | 681 | 17845 | 21 | 17722 |
| 19-#11 | 4.19 | 6239 | 2952 | 10266 | 2387 | 12545 | 1853 | 13702 | 1410 | 14972 | 698 | 18513 | 3 | 18499 |
| 20-#11 | 4.41 | 6306 | 3009 | 10468 | 2425 | 12809 | 1882 | 14025 | 1433 | 15411 | 701 | 19224 | -21 | 19008 |
| 21-#11 | 4.63 | 6362 | 3065 | 10725 | 2455 | 13093 | 1907 | 14360 | 1443 | 15838 | 690 | 19768 | -58 | 19582 |

## ROUND TIED COLUMNS 32" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.12 | 6341 | 2460 | 8635 | 2143 | 10549 | 1688 | 11088 | 1358 | 10822 | 868 | 11918 | 552 | 7951 |
| 4-#18 | 1.99 | 6548 | 2714 | 9750 | 2277 | 11845 | 1779 | 12557 | 1415 | 12721 | 833 | 14368 | 372 | 12696 |
| 5-#14 | 1.40 | 6531 | 2542 | 9315 | 2148 | 11114 | 1681 | 11604 | 1331 | 11435 | 817 | 12898 | 481 | 9041 |
| 5-#18 | 2.49 | 6852 | 2860 | 10708 | 2322 | 12714 | 1796 | 13461 | 1394 | 13856 | 761 | 16162 | 262 | 14521 |
| 6-#11 | 1.16 | 6530 | 2473 | 9518 | 2019 | 10949 | 1571 | 11234 | 1244 | 10847 | 765 | 11721 | 467 | 7837 |
| 6-#14 | 1.68 | 6737 | 2624 | 10221 | 2096 | 11770 | 1620 | 12189 | 1269 | 12095 | 733 | 13273 | 358 | 10885 |
| 6-#18 | 2.98 | 7187 | 3005 | 11909 | 2294 | 13761 | 1744 | 14517 | 1331 | 15142 | 646 | 17028 | 69 | 16681 |
| 7-#11 | 1.36 | 6545 | 2530 | 9069 | 2180 | 10995 | 1712 | 11562 | 1360 | 11432 | 846 | 12983 | 506 | 8851 |
| 7-#14 | 1.96 | 6748 | 2705 | 9844 | 2279 | 11912 | 1781 | 12620 | 1399 | 12812 | 821 | 14884 | 390 | 12090 |
| 7-#18 | 3.48 | 7207 | 3151 | 11716 | 2535 | 14125 | 1956 | 15196 | 1497 | 16180 | 753 | 19484 | 84 | 18958 |
| 8-#11 | 1.55 | 6619 | 2586 | 9138 | 2242 | 11216 | 1762 | 11904 | 1403 | 11931 | 865 | 13673 | 493 | 10021 |
| 8-#14 | 2.24 | 6854 | 2787 | 10006 | 2358 | 12246 | 1843 | 13110 | 1453 | 13495 | 842 | 15820 | 364 | 13689 |
| 8-#18 | 3.98 | 7359 | 3296 | 12105 | 2654 | 14759 | 2048 | 16030 | 1576 | 17314 | 778 | 21017 | 23 | 20898 |
| 9-#11 | 1.75 | 6710 | 2643 | 9513 | 2259 | 11569 | 1775 | 12279 | 1402 | 12393 | 844 | 14362 | 439 | 10989 |
| 9-#14 | 2.52 | 6971 | 2869 | 10499 | 2390 | 12732 | 1868 | 13634 | 1455 | 14165 | 816 | 16816 | 289 | 14844 |
| 9-#18 | 4.48 | 7578 | 3441 | 12884 | 2721 | 15565 | 2101 | 16934 | 1587 | 18548 | 748 | 22752 | -106 | 22422 |

## ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.94 | 6762 | 2700 | 9969 | 2258 | 12001 | 1762 | 12684 | 1385 | 12873 | 810 | 14904 | 400 | 12137 |
| 10-#14 | 2.80 | 7040 | 2951 | 11069 | 2403 | 13309 | 1861 | 14216 | 1442 | 14879 | 773 | 17636 | 238 | 16178 |
| 10-#18 | 4.97 | 7669 | 3587 | 13749 | 2772 | 16484 | 2109 | 17946 | 1581 | 19771 | 672 | 24241 | -191 | 23299 |
| 11-#11 | 2.13 | 6850 | 2757 | 9958 | 2339 | 12156 | 1834 | 12995 | 1440 | 13366 | 845 | 15748 | 383 | 13052 |
| 11-#14 | 3.08 | 7166 | 3032 | 11148 | 2502 | 13569 | 1950 | 14648 | 1507 | 15540 | 814 | 18770 | 204 | 17481 |
| 11-#18 | 5.47 | 7905 | 3732 | 14021 | 2915 | 17017 | 2241 | 18675 | 1673 | 20843 | 726 | 26084 | -270 | 25159 |
| 12-#11 | 2.33 | 6948 | 2813 | 10112 | 2392 | 12420 | 1870 | 13337 | 1469 | 13823 | 849 | 16476 | 366 | 14072 |
| 12-#14 | 3.36 | 7295 | 3114 | 11387 | 2573 | 13952 | 1997 | 15142 | 1547 | 16178 | 816 | 19782 | 176 | 18703 |
| 12-#18 | 5.97 | 8129 | 3878 | 14476 | 3031 | 17690 | 2317 | 19520 | 1736 | 21923 | 722 | 27776 | -326 | 26625 |
| 13-#11 | 2.52 | 7007 | 2870 | 10410 | 2416 | 12749 | 1891 | 13710 | 1476 | 14313 | 839 | 17076 | 318 | 14967 |
| 13-#14 | 3.64 | 7375 | 3196 | 11798 | 2611 | 14412 | 2030 | 15664 | 1557 | 16880 | 804 | 20641 | 108 | 20068 |
| 13-#18 | 6.47 | 8283 | 4023 | 15177 | 3107 | 18470 | 2379 | 20418 | 1757 | 23141 | 701 | 29264 | -450 | 27583 |
| 14-#11 | 2.72 | 7078 | 2927 | 10765 | 2432 | 13123 | 1893 | 14109 | 1474 | 14791 | 812 | 17678 | 273 | 15890 |
| 14-#14 | 3.92 | 7486 | 3278 | 12257 | 2642 | 14939 | 2041 | 16231 | 1560 | 17574 | 769 | 21518 | 45 | 21241 |
| 14-#18 | 6.96 | 8503 | 4168 | 15888 | 3174 | 19336 | 2407 | 21397 | 1770 | 24362 | 644 | 30796 | -557 | 28620 |
| 15-#11 | 2.91 | 7156 | 2983 | 10902 | 2487 | 13346 | 1947 | 14425 | 1510 | 15259 | 833 | 18410 | 250 | 16840 |
| 15-#14 | 4.20 | 7579 | 3360 | 12501 | 2713 | 15260 | 2109 | 16679 | 1606 | 18220 | 792 | 22604 | 18 | 22507 |
| 16-#11 | 3.10 | 7219 | 3040 | 11116 | 2529 | 13625 | 1978 | 14771 | 1536 | 15716 | 832 | 19149 | 221 | 17710 |
| 16-#14 | 4.48 | 7665 | 3441 | 12827 | 2771 | 15661 | 2152 | 17176 | 1641 | 18863 | 790 | 23559 | -37 | 23436 |
| 17-#11 | 3.30 | 7299 | 3097 | 11371 | 2563 | 13939 | 2002 | 15141 | 1545 | 16205 | 826 | 19799 | 188 | 18681 |
| 17-#14 | 4.76 | 7786 | 3523 | 13169 | 2821 | 16110 | 2188 | 17696 | 1655 | 19561 | 781 | 24485 | -84 | 24190 |
| 18-#11 | 3.49 | 7378 | 3154 | 11710 | 2582 | 14286 | 2011 | 15535 | 1550 | 16690 | 805 | 20398 | 134 | 19529 |
| 18-#14 | 5.04 | 7910 | 3605 | 13622 | 2853 | 16596 | 2205 | 18252 | 1665 | 20258 | 752 | 25346 | -161 | 24755 |
| 19-#11 | 3.69 | 7455 | 3210 | 11837 | 2638 | 14534 | 2057 | 15857 | 1579 | 17152 | 818 | 21129 | 119 | 20446 |
| 19-#14 | 5.32 | 8003 | 3687 | 13840 | 2928 | 16958 | 2266 | 18712 | 1703 | 20934 | 776 | 26367 | -187 | 25672 |
| 20-#11 | 3.88 | 7540 | 3267 | 12054 | 2677 | 14830 | 2086 | 16206 | 1603 | 17652 | 826 | 21794 | 82 | 21365 |
| 21-#11 | 4.07 | 7597 | 3324 | 12336 | 2708 | 15142 | 2106 | 16574 | 1613 | 18118 | 816 | 22503 | 60 | 22200 |
| 22-#11 | 4.27 | 7666 | 3380 | 12628 | 2737 | 15469 | 2125 | 16964 | 1622 | 18623 | 804 | 23151 | 19 | 23062 |
| 23-#11 | 4.46 | 7751 | 3437 | 12808 | 2782 | 15739 | 2161 | 17290 | 1647 | 19063 | 808 | 23826 | -8 | 23797 |

## ROUND TIED COLUMNS 34" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.76 | 7816 | 2989 | 11316 | 2541 | 13819 | 1991 | 14671 | 1591 | 14771 | 960 | 16634 | 486 | 14215 |
| 5-#14 | 1.24 | 7791 | 2817 | 10882 | 2407 | 13057 | 1889 | 13628 | 1501 | 13354 | 939 | 14999 | 588 | 9800 |
| 5-#18 | 2.20 | 8159 | 3135 | 12398 | 2581 | 14806 | 2005 | 15654 | 1566 | 15993 | 886 | 18577 | 375 | 16020 |
| 6-#11 | 1.03 | 7779 | 2748 | 11174 | 2266 | 12896 | 1768 | 13220 | 1405 | 12688 | 880 | 13676 | 567 | 8454 |
| 6-#14 | 1.49 | 8010 | 2899 | 11941 | 2344 | 13789 | 1818 | 14259 | 1431 | 14045 | 849 | 15372 | 460 | 11766 |
| 6-#18 | 2.64 | 8533 | 3280 | 13788 | 2543 | 15964 | 1944 | 16799 | 1496 | 17368 | 766 | 19491 | 179 | 18496 |
| 7-#11 | 1.20 | 7806 | 2805 | 10625 | 2437 | 12908 | 1923 | 13580 | 1533 | 13353 | 970 | 15097 | 614 | 9612 |
| 7-#14 | 1.73 | 8037 | 2980 | 11436 | 2542 | 13902 | 1992 | 14730 | 1573 | 14852 | 946 | 17172 | 501 | 13138 |
| 7-#18 | 3.08 | 8565 | 3426 | 13475 | 2799 | 16332 | 2170 | 17540 | 1674 | 18524 | 883 | 22215 | 203 | 20833 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.37 | 7889 | 2861 | 10646 | 2508 | 13139 | 1975 | 13938 | 1578 | 13900 | 991 | 15857 | 604 | 10839 |
| 8-#14 | 1.98 | 8159 | 3062 | 11590 | 2624 | 14255 | 2057 | 15248 | 1629 | 15599 | 970 | 18201 | 478 | 14997 |
| 8-#18 | 3.52 | 8739 | 3571 | 13876 | 2922 | 16987 | 2264 | 18446 | 1756 | 19762 | 911 | 23898 | 147 | 23049 |
| 9-#11 | 1.55 | 7987 | 2918 | 11066 | 2524 | 13526 | 1988 | 14351 | 1576 | 14396 | 970 | 16599 | 549 | 11949 |
| 9-#14 | 2.23 | 8283 | 3144 | 12138 | 2654 | 14788 | 2081 | 15829 | 1631 | 16322 | 943 | 19280 | 403 | 16290 |
| 9-#18 | 3.97 | 8948 | 3716 | 14736 | 2987 | 17877 | 2317 | 19429 | 1767 | 21035 | 868 | 25789 | 18 | 25665 |
| 10-#11 | 1.72 | 8048 | 2975 | 11582 | 2517 | 14007 | 1971 | 14794 | 1556 | 14907 | 933 | 17053 | 494 | 13155 |
| 10-#14 | 2.48 | 8362 | 3226 | 12775 | 2662 | 15437 | 2071 | 16460 | 1615 | 17087 | 899 | 20156 | 351 | 17813 |
| 10-#18 | 4.41 | 9073 | 3862 | 15684 | 3033 | 18904 | 2323 | 20529 | 1759 | 22421 | 804 | 27399 | -65 | 27196 |
| 11-#11 | 1.89 | 8146 | 3032 | 11536 | 2604 | 14160 | 2048 | 15121 | 1615 | 15450 | 972 | 18105 | 496 | 14201 |
| 11-#14 | 2.73 | 8499 | 3307 | 12829 | 2768 | 15693 | 2164 | 16928 | 1685 | 17812 | 944 | 21404 | 322 | 19152 |
| 11-#18 | 4.85 | 9308 | 4007 | 15967 | 3184 | 19444 | 2459 | 21321 | 1856 | 23594 | 862 | 29420 | -138 | 28916 |
| 12-#11 | 2.06 | 8250 | 3088 | 11701 | 2659 | 14442 | 2085 | 15490 | 1646 | 15947 | 977 | 18903 | 479 | 15403 |
| 12-#14 | 2.97 | 8640 | 3389 | 13088 | 2841 | 16105 | 2213 | 17450 | 1725 | 18507 | 947 | 22512 | 295 | 20545 |
| 12-#18 | 5.29 | 9574 | 4153 | 16453 | 3302 | 20172 | 2537 | 22239 | 1922 | 24770 | 861 | 31276 | -192 | 30566 |
| 13-#11 | 2.23 | 8324 | 3145 | 12023 | 2682 | 14801 | 2106 | 15894 | 1652 | 16476 | 968 | 19550 | 433 | 16390 |
| 13-#14 | 3.22 | 8740 | 3471 | 13529 | 2878 | 16607 | 2246 | 18025 | 1736 | 19266 | 935 | 23443 | 228 | 22000 |
| 13-#18 | 5.73 | 9723 | 4298 | 17202 | 3376 | 21022 | 2599 | 23215 | 1943 | 26091 | 841 | 32896 | -313 | 31669 |
| 14-#11 | 2.41 | 8403 | 3202 | 12487 | 2686 | 15204 | 2105 | 16336 | 1649 | 16989 | 940 | 20199 | 386 | 17444 |
| 14-#14 | 3.47 | 8866 | 3553 | 14042 | 2907 | 17171 | 2254 | 18644 | 1738 | 20014 | 899 | 24393 | 165 | 23294 |
| 14-#18 | 6.17 | 9918 | 4443 | 17989 | 3442 | 21996 | 2628 | 24279 | 1955 | 27415 | 784 | 34568 | -420 | 32827 |
| 15-#11 | 2.58 | 8483 | 3258 | 12554 | 2754 | 15440 | 2162 | 16668 | 1688 | 17501 | 962 | 21002 | 367 | 18424 |
| 15-#14 | 3.72 | 8962 | 3635 | 14290 | 2980 | 17525 | 2326 | 19124 | 1786 | 20719 | 925 | 25495 | 130 | 24747 |
| 15-#18 | 6.61 | 10135 | 4589 | 18522 | 3553 | 22607 | 2738 | 25110 | 2028 | 28591 | 819 | 36547 | -476 | 34305 |
| 16-#11 | 2.75 | 8559 | 3315 | 12775 | 2797 | 15747 | 2194 | 17043 | 1714 | 17997 | 963 | 21808 | 338 | 19416 |
| 16-#14 | 3.97 | 9060 | 3716 | 14628 | 3039 | 17957 | 2370 | 19655 | 1822 | 21417 | 924 | 26624 | 87 | 26048 |
| 17-#11 | 2.92 | 8648 | 3372 | 13057 | 2830 | 16081 | 2218 | 17443 | 1723 | 18526 | 956 | 22512 | 306 | 20445 |
| 17-#14 | 4.21 | 9194 | 3798 | 15012 | 3089 | 18437 | 2405 | 20224 | 1836 | 22173 | 915 | 27629 | 41 | 27383 |
| 18-#11 | 3.09 | 8732 | 3428 | 13437 | 2849 | 16460 | 2226 | 17872 | 1728 | 19047 | 935 | 23160 | 251 | 21417 |
| 18-#14 | 4.46 | 9300 | 3880 | 15512 | 3121 | 18964 | 2421 | 20835 | 1846 | 22926 | 887 | 28565 | -36 | 28430 |
| 19-#11 | 3.26 | 8818 | 3485 | 13558 | 2906 | 16724 | 2273 | 18218 | 1758 | 19550 | 950 | 23955 | 239 | 22438 |
| 19-#14 | 4.71 | 9430 | 3962 | 15729 | 3197 | 19352 | 2484 | 21325 | 1885 | 23626 | 904 | 29673 | -58 | 29444 |
| 20-#11 | 3.44 | 8904 | 3542 | 13790 | 2945 | 17038 | 2303 | 18596 | 1782 | 20047 | 948 | 24677 | 204 | 23374 |
| 20-#14 | 4.96 | 9563 | 4043 | 16070 | 3252 | 19810 | 2526 | 21861 | 1919 | 24393 | 916 | 30690 | -112 | 30235 |
| 21-#11 | 3.61 | 8979 | 3599 | 14098 | 2976 | 17382 | 2323 | 18994 | 1793 | 20596 | 948 | 25449 | 181 | 24336 |
| 22-#11 | 3.78 | 9055 | 3655 | 14414 | 3004 | 17738 | 2341 | 19410 | 1801 | 21141 | 936 | 26149 | 142 | 25329 |
| 23-#11 | 3.95 | 9143 | 3712 | 14608 | 3051 | 18028 | 2378 | 19770 | 1827 | 21619 | 942 | 26887 | 115 | 26237 |
| 24-#11 | 4.12 | 9215 | 3769 | 14822 | 3095 | 18324 | 2411 | 20150 | 1851 | 22136 | 944 | 27642 | 89 | 27173 |
| 25-#11 | 4.30 | 9303 | 3825 | 15113 | 3126 | 18670 | 2433 | 20543 | 1862 | 22642 | 935 | 28331 | 48 | 28057 |

## ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.57 | 9234 | 3281 | 13042 | 2823 | 16007 | 2217 | 17006 | 1777 | 17031 | 1095 | 19122 | 606 | 15474 |
| 5-#14 | 1.11 | 9200 | 3108 | 12618 | 2681 | 15210 | 2109 | 15879 | 1682 | 15480 | 1068 | 17225 | 689 | 10568 |
| 5-#18 | 1.96 | 9618 | 3426 | 14258 | 2856 | 17115 | 2227 | 18074 | 1748 | 18337 | 1017 | 21210 | 492 | 17425 |
| 6-#14 | 1.33 | 9433 | 3190 | 13844 | 2607 | 16030 | 2028 | 16553 | 1603 | 16197 | 972 | 17678 | 568 | 12649 |
| 6-#18 | 2.36 | 10014 | 3572 | 15852 | 2807 | 18389 | 2155 | 19306 | 1669 | 19796 | 892 | 22162 | 294 | 20383 |
| 7-#11 | 1.07 | 9216 | 3096 | 12315 | 2716 | 15035 | 2146 | 15818 | 1716 | 15483 | 1101 | 17429 | 728 | 10384 |
| 7-#14 | 1.55 | 9477 | 3272 | 13241 | 2814 | 16106 | 2216 | 17066 | 1757 | 17101 | 1079 | 19679 | 617 | 14199 |
| 7-#18 | 2.75 | 10060 | 3717 | 15399 | 3078 | 18732 | 2394 | 20111 | 1860 | 21077 | 1019 | 25167 | 326 | 22763 |
| 8-#11 | 1.23 | 9309 | 3153 | 12312 | 2791 | 15274 | 2202 | 16198 | 1764 | 16078 | 1125 | 18263 | 720 | 11664 |
| 8-#14 | 1.77 | 9605 | 3354 | 13333 | 2907 | 16478 | 2284 | 17608 | 1815 | 17913 | 1105 | 20804 | 597 | 16158 |
| 8-#18 | 3.14 | 10272 | 3863 | 15807 | 3205 | 19428 | 2493 | 21083 | 1946 | 22420 | 1050 | 27002 | 275 | 25273 |
| 9-#11 | 1.38 | 9414 | 3210 | 12779 | 2805 | 15697 | 2213 | 16643 | 1761 | 16608 | 1103 | 19058 | 665 | 12924 |
| 9-#14 | 1.99 | 9745 | 3435 | 13938 | 2936 | 17058 | 2306 | 18242 | 1817 | 18688 | 1078 | 21964 | 522 | 17651 |
| 9-#18 | 3.54 | 10490 | 4008 | 16751 | 3270 | 20395 | 2544 | 22151 | 1957 | 23792 | 1008 | 29047 | 147 | 27979 |
| 10-#11 | 1.53 | 9483 | 3266 | 13362 | 2793 | 16218 | 2192 | 17129 | 1738 | 17148 | 1064 | 19531 | 609 | 14182 |
| 10-#14 | 2.21 | 9836 | 3517 | 14648 | 2938 | 17769 | 2293 | 18930 | 1798 | 19502 | 1031 | 22711 | 449 | 19502 |
| 10-#18 | 3.93 | 10632 | 4153 | 17788 | 3309 | 21541 | 2548 | 23338 | 1946 | 25279 | 942 | 30777 | 65 | 30361 |
| 11-#11 | 1.69 | 9592 | 3323 | 13275 | 2886 | 16377 | 2274 | 17472 | 1801 | 17744 | 1106 | 20684 | 614 | 15378 |
| 11-#14 | 2.43 | 9988 | 3599 | 14669 | 3050 | 18031 | 2392 | 19420 | 1872 | 20295 | 1080 | 24260 | 444 | 20868 |
| 11-#18 | 4.32 | 10893 | 4299 | 18072 | 3468 | 22086 | 2689 | 24193 | 2049 | 26555 | 1005 | 32979 | -3 | 32966 |
| 12-#11 | 1.84 | 9703 | 3380 | 13448 | 2943 | 16677 | 2313 | 17868 | 1833 | 18282 | 1112 | 21552 | 599 | 16626 |
| 12-#14 | 2.65 | 10138 | 3681 | 14947 | 3125 | 18471 | 2442 | 19981 | 1914 | 21046 | 1085 | 25466 | 419 | 22443 |
| 12-#18 | 4.72 | 11132 | 4444 | 18591 | 3588 | 22868 | 2769 | 25179 | 2116 | 27828 | 1006 | 35001 | -55 | 34787 |
| 13-#11 | 1.99 | 9791 | 3437 | 13796 | 2965 | 17063 | 2333 | 18304 | 1839 | 18849 | 1103 | 22246 | 552 | 17748 |
| 13-#14 | 2.87 | 10258 | 3763 | 15421 | 3161 | 19015 | 2474 | 20601 | 1924 | 21862 | 1073 | 26468 | 353 | 23943 |
| 13-#18 | 5.11 | 11351 | 4590 | 19388 | 3661 | 23789 | 2831 | 26239 | 2137 | 29253 | 987 | 36751 | -174 | 36034 |
| 14-#11 | 2.15 | 9879 | 3493 | 14313 | 2966 | 17498 | 2330 | 18780 | 1834 | 19396 | 1074 | 22941 | 505 | 19007 |
| 14-#14 | 3.09 | 10380 | 3844 | 16088 | 3173 | 19617 | 2479 | 21283 | 1925 | 22664 | 1036 | 27489 | 289 | 25405 |
| 14-#18 | 5.50 | 11566 | 4735 | 20256 | 3725 | 24826 | 2857 | 27389 | 2149 | 30678 | 930 | 38563 | -281 | 37366 |
| 15-#11 | 2.30 | 9965 | 3550 | 14365 | 3037 | 17746 | 2390 | 19137 | 1875 | 19953 | 1098 | 23816 | 488 | 20048 |
| 15-#14 | 3.32 | 10499 | 3926 | 16238 | 3264 | 19992 | 2555 | 21785 | 1976 | 23428 | 1064 | 28687 | 257 | 27010 |
| 15-#18 | 5.89 | 11756 | 4880 | 20811 | 3840 | 25500 | 2971 | 28286 | 2225 | 31952 | 967 | 40710 | -332 | 38978 |
| 16-#11 | 2.45 | 10050 | 3607 | 14591 | 3080 | 18081 | 2424 | 19540 | 1903 | 20488 | 1100 | 24690 | 460 | 21171 |
| 16-#14 | 3.54 | 10608 | 4008 | 16588 | 3324 | 20467 | 2600 | 22357 | 2013 | 24182 | 1064 | 29913 | 215 | 28373 |
| 16-#18 | 6.29 | 11989 | 5026 | 21479 | 3941 | 26312 | 3045 | 29279 | 2285 | 33240 | 962 | 42627 | -431 | 40585 |
| 17-#11 | 2.61 | 10150 | 3663 | 14899 | 3114 | 18434 | 2446 | 19971 | 1912 | 21056 | 1093 | 25447 | 429 | 22245 |
| 17-#14 | 3.76 | 10758 | 4090 | 17009 | 3374 | 20973 | 2635 | 22970 | 2027 | 24995 | 1056 | 30996 | 170 | 29890 |
| 18-#11 | 2.76 | 10239 | 3720 | 15326 | 3131 | 18847 | 2453 | 20424 | 1914 | 21615 | 1071 | 26144 | 374 | 23326 |
| 18-#14 | 3.98 | 10868 | 4172 | 17565 | 3404 | 21545 | 2650 | 23628 | 2036 | 25803 | 1027 | 32006 | 93 | 31339 |
| 19-#11 | 2.91 | 10334 | 3777 | 15438 | 3190 | 19127 | 2502 | 20804 | 1947 | 22159 | 1088 | 27004 | 364 | 24409 |
| 19-#14 | 4.20 | 11000 | 4253 | 17778 | 3482 | 21959 | 2715 | 24157 | 2077 | 26561 | 1046 | 33203 | 74 | 32752 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.07 | 10434 | 3833 | 15684 | 3230 | 19456 | 2532 | 21212 | 1972 | 22695 | 1087 | 27784 | 330 | 25436 |
| 20-#14 | 4.42 | 11165 | 4335 | 18141 | 3538 | 22441 | 2757 | 24734 | 2111 | 27318 | 1044 | 34303 | 22 | 34195 |
| 21-#11 | 3.22 | 10507 | 3890 | 16019 | 3261 | 19834 | 2553 | 21634 | 1982 | 23285 | 1087 | 28617 | 308 | 26530 |
| 21-#14 | 4.64 | 11249 | 4417 | 18606 | 3583 | 22965 | 2787 | 25343 | 2127 | 28162 | 1044 | 35488 | -9 | 35448 |
| 22-#11 | 3.37 | 10599 | 3947 | 16360 | 3287 | 20221 | 2570 | 22079 | 1990 | 23869 | 1075 | 29368 | 268 | 27544 |
| 22-#14 | 4.86 | 11369 | 4499 | 19070 | 3627 | 23505 | 2815 | 25980 | 2141 | 29002 | 1028 | 36571 | -65 | 36282 |
| 23-#11 | 3.52 | 10695 | 4004 | 16561 | 3336 | 20522 | 2608 | 22466 | 2017 | 24386 | 1081 | 30171 | 243 | 28581 |
| 24-#11 | 3.68 | 10772 | 4060 | 16795 | 3381 | 20839 | 2641 | 22885 | 2042 | 24943 | 1085 | 30986 | 218 | 29647 |
| 25-#11 | 3.83 | 10868 | 4117 | 17104 | 3411 | 21213 | 2663 | 23298 | 2053 | 25487 | 1076 | 31731 | 177 | 30651 |
| 26-#11 | 3.98 | 10965 | 4174 | 17427 | 3441 | 21602 | 2684 | 23741 | 2063 | 26070 | 1065 | 32478 | 143 | 31645 |
| 27-#11 | 4.14 | 11053 | 4230 | 17688 | 3481 | 21906 | 2718 | 24132 | 2088 | 26589 | 1070 | 33355 | 117 | 32621 |

## ROUND TIED COLUMNS 38" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.41 | 10811 | 3589 | 14937 | 3120 | 18420 | 2455 | 19557 | 1973 | 19514 | 1236 | 21845 | 731 | 16597 |
| 5-#18 | 1.76 | 11235 | 3735 | 16296 | 3146 | 19652 | 2461 | 20733 | 1940 | 20901 | 1156 | 24073 | 614 | 18729 |
| 6-#14 | 1.19 | 11014 | 3498 | 15940 | 2886 | 18504 | 2249 | 19086 | 1784 | 18563 | 1101 | 20205 | 681 | 13532 |
| 6-#18 | 2.12 | 11655 | 3880 | 18110 | 3087 | 21048 | 2378 | 22052 | 1852 | 22438 | 1024 | 25055 | 413 | 22342 |
| 7-#14 | 1.39 | 11075 | 3580 | 15172 | 3109 | 18537 | 2452 | 19633 | 1951 | 19572 | 1218 | 22420 | 738 | 15284 |
| 7-#18 | 2.47 | 11728 | 4025 | 17496 | 3374 | 21358 | 2632 | 22921 | 2057 | 23852 | 1162 | 28352 | 455 | 24746 |
| 8-#11 | 1.10 | 10888 | 3461 | 14145 | 3091 | 17634 | 2443 | 18697 | 1961 | 18480 | 1266 | 20904 | 842 | 12493 |
| 8-#14 | 1.59 | 11216 | 3662 | 15243 | 3207 | 18925 | 2524 | 20207 | 2013 | 20450 | 1248 | 23643 | 722 | 17324 |
| 8-#18 | 2.82 | 11968 | 4171 | 17907 | 3506 | 22094 | 2734 | 23936 | 2145 | 25301 | 1197 | 30342 | 408 | 27570 |
| 9-#11 | 1.24 | 10999 | 3518 | 14663 | 3102 | 18093 | 2451 | 19174 | 1956 | 19043 | 1243 | 21750 | 787 | 13915 |
| 9-#14 | 1.79 | 11366 | 3744 | 15909 | 3233 | 19554 | 2545 | 20888 | 2013 | 21276 | 1219 | 24883 | 646 | 19006 |
| 9-#18 | 3.17 | 12195 | 4316 | 18937 | 3568 | 23140 | 2785 | 25112 | 2157 | 26770 | 1154 | 32541 | 279 | 30393 |
| 10-#11 | 1.38 | 11077 | 3575 | 15319 | 3085 | 18658 | 2425 | 19704 | 1930 | 19609 | 1201 | 22239 | 729 | 15219 |
| 10-#14 | 1.98 | 11469 | 3826 | 16698 | 3230 | 20319 | 2527 | 21639 | 1991 | 22138 | 1170 | 25667 | 572 | 21007 |
| 10-#18 | 3.53 | 12355 | 4462 | 20071 | 3602 | 24407 | 2786 | 26388 | 2142 | 28357 | 1087 | 34385 | 198 | 33016 |
| 11-#11 | 1.51 | 11197 | 3631 | 15182 | 3184 | 18820 | 2514 | 20062 | 1997 | 20260 | 1248 | 23497 | 737 | 16566 |
| 11-#14 | 2.18 | 11636 | 3907 | 16679 | 3348 | 20595 | 2632 | 22150 | 2069 | 23000 | 1223 | 27351 | 572 | 22600 |
| 11-#18 | 3.88 | 12643 | 4607 | 20335 | 3767 | 24954 | 2931 | 27298 | 2250 | 29739 | 1154 | 36773 | 135 | 35953 |
| 12-#11 | 1.65 | 11315 | 3688 | 15362 | 3243 | 19136 | 2554 | 20486 | 2031 | 20840 | 1255 | 24437 | 723 | 17861 |
| 12-#14 | 2.38 | 11796 | 3989 | 16974 | 3426 | 21062 | 2684 | 22752 | 2113 | 23809 | 1230 | 28655 | 548 | 24397 |
| 12-#18 | 4.23 | 12893 | 4752 | 20898 | 3891 | 25789 | 3013 | 28336 | 2318 | 31109 | 1157 | 38963 | 85 | 38372 |
| 13-#11 | 1.79 | 11418 | 3745 | 15737 | 3264 | 19546 | 2573 | 20953 | 2036 | 21445 | 1245 | 25178 | 677 | 19124 |
| 13-#14 | 2.58 | 11936 | 4071 | 17481 | 3461 | 21643 | 2715 | 23417 | 2123 | 24681 | 1217 | 29727 | 482 | 25955 |
| 13-#18 | 4.59 | 13143 | 4898 | 21744 | 3962 | 26783 | 3075 | 29487 | 2341 | 32638 | 1138 | 40843 | -32 | 40706 |
| 14-#11 | 1.93 | 11515 | 3802 | 16310 | 3263 | 20020 | 2568 | 21454 | 2029 | 22025 | 1215 | 25915 | 629 | 20436 |
| 14-#14 | 2.78 | 12071 | 4153 | 18216 | 3470 | 22290 | 2718 | 24146 | 2122 | 25535 | 1180 | 30819 | 418 | 27573 |
| 14-#18 | 4.94 | 13382 | 5043 | 22696 | 4023 | 27881 | 3098 | 30739 | 2352 | 34163 | 1081 | 42793 | -138 | 42185 |
| 15-#11 | 2.06 | 11605 | 3858 | 16345 | 3337 | 20276 | 2630 | 21845 | 2074 | 22628 | 1242 | 26865 | 614 | 21627 |
| 15-#14 | 2.98 | 12198 | 4234 | 18355 | 3565 | 22684 | 2797 | 24686 | 2176 | 26360 | 1210 | 32116 | 389 | 29229 |
| 15-#18 | 5.29 | 13580 | 5189 | 23270 | 4143 | 28614 | 3217 | 31681 | 2430 | 35537 | 1121 | 44940 | -204 | 43989 |

## ROUND TIED COLUMNS 38" DIA.

Short columns – no sidesway $f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.20 | 11702 | 3915 | 16575 | 3381 | 20635 | 2666 | 22276 | 2102 | 23203 | 1244 | 27808 | 587 | 22955 |
| 16-#14 | 3.17 | 12319 | 4316 | 18715 | 3624 | 23202 | 2844 | 25299 | 2213 | 27170 | 1211 | 33438 | 347 | 30756 |
| 16-#18 | 5.64 | 13760 | 5334 | 23964 | 4244 | 29489 | 3292 | 32740 | 2491 | 36922 | 1117 | 47184 | -283 | 45771 |
| 17-#11 | 2.34 | 11811 | 3972 | 16910 | 3414 | 21013 | 2687 | 22734 | 2110 | 23809 | 1237 | 28617 | 557 | 24072 |
| 17-#14 | 3.37 | 12472 | 4398 | 19171 | 3674 | 23735 | 2877 | 25956 | 2227 | 28040 | 1203 | 34598 | 304 | 32468 |
| 17-#18 | 6.00 | 14072 | 5479 | 24719 | 4336 | 30434 | 3357 | 33878 | 2518 | 38438 | 1103 | 49204 | -363 | 47391 |
| 18-#11 | 2.48 | 11905 | 4028 | 17384 | 3430 | 21460 | 2693 | 23214 | 2112 | 24404 | 1215 | 29362 | 501 | 25285 |
| 18-#14 | 3.57 | 12598 | 4480 | 19788 | 3704 | 24353 | 2891 | 26648 | 2235 | 28903 | 1174 | 35682 | 227 | 33939 |
| 19-#11 | 2.61 | 12007 | 4085 | 17486 | 3490 | 21769 | 2739 | 23621 | 2146 | 24991 | 1233 | 30288 | 494 | 26398 |
| 19-#14 | 3.77 | 12744 | 4562 | 19995 | 3784 | 24791 | 2958 | 27225 | 2278 | 29720 | 1195 | 36970 | 210 | 35531 |
| 20-#11 | 2.75 | 12124 | 4142 | 17745 | 3531 | 22098 | 2774 | 24067 | 2173 | 25566 | 1233 | 31127 | 460 | 27550 |
| 20-#14 | 3.97 | 12908 | 4643 | 20380 | 3840 | 25295 | 3000 | 27847 | 2314 | 30532 | 1193 | 38152 | 160 | 37155 |
| 21-#11 | 2.89 | 12202 | 4198 | 18107 | 3562 | 22504 | 2795 | 24510 | 2182 | 26172 | 1228 | 31956 | 431 | 28712 |
| 21-#14 | 4.17 | 13018 | 4725 | 20881 | 3885 | 25868 | 3031 | 28489 | 2329 | 31435 | 1194 | 39427 | 129 | 38634 |
| 22-#11 | 3.03 | 12293 | 4255 | 18476 | 3587 | 22929 | 2812 | 24987 | 2189 | 26820 | 1220 | 32823 | 399 | 29812 |
| 22-#14 | 4.36 | 13149 | 4807 | 21379 | 3927 | 26452 | 3059 | 29169 | 2342 | 32333 | 1178 | 40586 | 74 | 40180 |
| 23-#11 | 3.16 | 12405 | 4312 | 18682 | 3637 | 23241 | 2850 | 25401 | 2218 | 27376 | 1228 | 33692 | 375 | 31000 |
| 23-#14 | 4.56 | 13299 | 4889 | 21709 | 3994 | 26917 | 3110 | 29756 | 2380 | 33112 | 1186 | 41795 | 35 | 41579 |
| 24-#11 | 3.30 | 12490 | 4369 | 18935 | 3683 | 23580 | 2885 | 25843 | 2242 | 27973 | 1232 | 34567 | 351 | 32069 |
| 25-#11 | 3.44 | 12596 | 4425 | 19263 | 3713 | 23981 | 2906 | 26293 | 2253 | 28556 | 1223 | 35368 | 311 | 33198 |
| 26-#11 | 3.58 | 12699 | 4482 | 19614 | 3742 | 24392 | 2926 | 26767 | 2263 | 29178 | 1213 | 36167 | 277 | 34321 |
| 27-#11 | 3.71 | 12791 | 4539 | 19887 | 3783 | 24723 | 2962 | 27185 | 2289 | 29736 | 1218 | 37110 | 253 | 35400 |
| 28-#11 | 3.85 | 12897 | 4595 | 20169 | 3821 | 25071 | 2995 | 27618 | 2312 | 30331 | 1221 | 37906 | 223 | 36481 |

## ROUND TIED COLUMNS 40" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.27 | 12555 | 3914 | 17008 | 3435 | 21070 | 2707 | 22361 | 2179 | 22231 | 1385 | 24815 | 861 | 17718 |
| 5-#18 | 1.59 | 13020 | 4060 | 18522 | 3453 | 22415 | 2707 | 23645 | 2142 | 23697 | 1301 | 26996 | 724 | 20043 |
| 6-#14 | 1.07 | 12762 | 3823 | 18240 | 3180 | 21225 | 2484 | 21871 | 1975 | 21156 | 1237 | 22965 | 799 | 14416 |
| 6-#18 | 1.91 | 13464 | 4205 | 20573 | 3381 | 23954 | 2613 | 25050 | 2045 | 25307 | 1162 | 28180 | 536 | 24234 |
| 7-#14 | 1.25 | 12840 | 3905 | 17285 | 3421 | 21207 | 2702 | 22446 | 2156 | 22276 | 1365 | 25406 | 866 | 16372 |
| 7-#18 | 2.23 | 13566 | 4350 | 19874 | 3672 | 24223 | 2882 | 25984 | 2264 | 26860 | 1312 | 31783 | 588 | 26783 |
| 8-#14 | 1.43 | 12996 | 3987 | 17330 | 3523 | 21609 | 2778 | 23059 | 2221 | 23222 | 1398 | 26730 | 853 | 18498 |
| 8-#18 | 2.55 | 13833 | 4496 | 20185 | 3822 | 24998 | 2989 | 27042 | 2355 | 28418 | 1350 | 33931 | 545 | 29939 |
| 9-#11 | 1.12 | 12749 | 3843 | 16722 | 3416 | 20727 | 2703 | 21957 | 2162 | 21711 | 1391 | 24689 | 914 | 14921 |
| 9-#14 | 1.61 | 13155 | 4069 | 18059 | 3547 | 22288 | 2797 | 23785 | 2219 | 24098 | 1368 | 28048 | 776 | 20379 |
| 9-#18 | 2.86 | 14070 | 4641 | 21305 | 3883 | 26124 | 3038 | 28305 | 2366 | 29983 | 1307 | 36282 | 416 | 32822 |
| 10-#11 | 1.24 | 12838 | 3900 | 17461 | 3393 | 21339 | 2671 | 22531 | 2133 | 22303 | 1346 | 25191 | 854 | 16265 |
| 10-#14 | 1.79 | 13271 | 4150 | 18935 | 3539 | 23109 | 2773 | 24601 | 2194 | 25006 | 1317 | 28867 | 700 | 22465 |
| 10-#18 | 3.18 | 14249 | 4787 | 22541 | 3911 | 27482 | 3034 | 29691 | 2349 | 31668 | 1237 | 37874 | 298 | 35744 |
| 11-#11 | 1.37 | 12969 | 3956 | 17268 | 3499 | 21500 | 2766 | 22904 | 2204 | 23012 | 1397 | 26558 | 867 | 17772 |
| 11-#14 | 1.97 | 13453 | 4232 | 18867 | 3663 | 23397 | 2885 | 25133 | 2277 | 25940 | 1374 | 30689 | 704 | 24246 |
| 11-#18 | 3.50 | 14565 | 4932 | 22776 | 4083 | 28061 | 3186 | 30637 | 2461 | 33159 | 1309 | 40816 | 277 | 38773 |

## ROUND TIED COLUMNS 40" DIA.

Short columns – no sidesway $f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.49 | 13094 | 4013 | 17442 | 3560 | 21832 | 2809 | 23356 | 2240 | 23629 | 1405 | 27570 | 854 | 19111 |
| 12-#14 | 2.15 | 13622 | 4314 | 19176 | 3743 | 23890 | 2939 | 25774 | 2323 | 26807 | 1381 | 32093 | 682 | 26323 |
| 12-#18 | 3.82 | 14826 | 5077 | 23382 | 4210 | 28949 | 3270 | 31746 | 2531 | 34627 | 1314 | 43174 | 229 | 41462 |
| 13-#11 | 1.61 | 13210 | 4070 | 17855 | 3579 | 22266 | 2826 | 23854 | 2244 | 24276 | 1395 | 28357 | 808 | 20523 |
| 13-#14 | 2.33 | 13780 | 4396 | 19719 | 3777 | 24503 | 2969 | 26485 | 2332 | 27734 | 1369 | 33235 | 617 | 27991 |
| 13-#18 | 4.14 | 15082 | 5223 | 24280 | 4279 | 30015 | 3332 | 32977 | 2553 | 36258 | 1296 | 45184 | 114 | 44451 |
| 14-#11 | 1.74 | 13319 | 4126 | 18489 | 3575 | 22780 | 2819 | 24380 | 2235 | 24888 | 1363 | 29136 | 759 | 21881 |
| 14-#14 | 2.51 | 13931 | 4478 | 20525 | 3783 | 25202 | 2969 | 27251 | 2329 | 28640 | 1330 | 34395 | 552 | 29798 |
| 14-#18 | 4.46 | 15373 | 5368 | 25513 | 4312 | 31176 | 3352 | 34342 | 2564 | 37883 | 1237 | 47270 | 7 | 47215 |
| 15-#11 | 1.86 | 13414 | 4183 | 18497 | 3653 | 23044 | 2884 | 24803 | 2282 | 25537 | 1392 | 30163 | 746 | 23212 |
| 15-#14 | 2.69 | 14058 | 4559 | 20649 | 3881 | 25614 | 3051 | 27839 | 2386 | 29528 | 1363 | 35793 | 525 | 31496 |
| 15-#18 | 4.77 | 15551 | 5513 | 25908 | 4461 | 31951 | 3474 | 35322 | 2644 | 39358 | 1281 | 49580 | -55 | 49316 |
| 16-#11 | 1.99 | 13512 | 4240 | 18734 | 3698 | 23417 | 2920 | 25265 | 2312 | 26148 | 1395 | 31175 | 720 | 24599 |
| 16-#14 | 2.86 | 14200 | 4641 | 21018 | 3942 | 26165 | 3100 | 28493 | 2425 | 30394 | 1365 | 37212 | 485 | 33199 |
| 16-#18 | 5.09 | 15774 | 5659 | 26627 | 4562 | 32904 | 3552 | 36454 | 2707 | 40840 | 1279 | 51993 | -132 | 51315 |
| 17-#11 | 2.11 | 13640 | 4297 | 19096 | 3730 | 23829 | 2942 | 25745 | 2319 | 26798 | 1389 | 32037 | 690 | 25858 |
| 17-#14 | 3.04 | 14366 | 4723 | 21511 | 3991 | 26734 | 3133 | 29189 | 2438 | 31320 | 1357 | 38450 | 442 | 34980 |
| 17-#18 | 5.41 | 16078 | 5804 | 27439 | 4655 | 33896 | 3616 | 37671 | 2734 | 42460 | 1265 | 54153 | -210 | 53055 |
| 18-#11 | 2.23 | 13740 | 4353 | 19616 | 3745 | 24310 | 2946 | 26257 | 2320 | 27428 | 1366 | 32828 | 634 | 27247 |
| 18-#14 | 3.22 | 14500 | 4805 | 22191 | 4020 | 27399 | 3146 | 29920 | 2444 | 32238 | 1328 | 39606 | 365 | 36601 |
| 18-#18 | 5.73 | 16330 | 5950 | 28489 | 4717 | 35013 | 3650 | 38973 | 2756 | 44084 | 1219 | 56194 | -342 | 54346 |
| 19-#11 | 2.36 | 13851 | 4410 | 19709 | 3807 | 24631 | 2994 | 26690 | 2356 | 28058 | 1385 | 33821 | 629 | 28432 |
| 19-#14 | 3.40 | 14660 | 4886 | 22389 | 4101 | 27882 | 3207 | 30535 | 2490 | 33113 | 1350 | 40985 | 351 | 38411 |
| 20-#11 | 2.48 | 13984 | 4467 | 19981 | 3849 | 24977 | 3030 | 27170 | 2383 | 28668 | 1385 | 34719 | 596 | 29714 |
| 20-#14 | 3.58 | 14842 | 4968 | 22795 | 4159 | 28387 | 3257 | 31212 | 2527 | 33982 | 1349 | 42251 | 302 | 40034 |
| 21-#11 | 2.61 | 14066 | 4523 | 20366 | 3879 | 25411 | 3050 | 27638 | 2392 | 29318 | 1381 | 35605 | 568 | 30908 |
| 21-#14 | 3.76 | 14960 | 5050 | 23333 | 4204 | 28999 | 3287 | 31885 | 2541 | 34906 | 1343 | 43516 | 261 | 41690 |
| 22-#11 | 2.73 | 14165 | 4580 | 20769 | 3903 | 25876 | 3066 | 28147 | 2398 | 30006 | 1373 | 36526 | 536 | 32132 |
| 22-#14 | 3.94 | 15103 | 5132 | 23867 | 4244 | 29637 | 3315 | 32611 | 2554 | 35900 | 1334 | 44850 | 217 | 43409 |
| 23-#11 | 2.86 | 14285 | 4637 | 20978 | 3955 | 26196 | 3106 | 28588 | 2429 | 30601 | 1382 | 37461 | 512 | 33382 |
| 23-#14 | 4.12 | 15249 | 5214 | 24208 | 4312 | 30118 | 3367 | 33237 | 2593 | 36734 | 1343 | 46151 | 180 | 44973 |
| 24-#11 | 2.98 | 14379 | 4693 | 21242 | 4000 | 26557 | 3141 | 29051 | 2453 | 31235 | 1386 | 38397 | 489 | 34545 |
| 24-#14 | 4.30 | 15378 | 5295 | 24602 | 4377 | 30636 | 3416 | 33908 | 2627 | 37637 | 1348 | 47474 | 145 | 46591 |
| 25-#11 | 3.10 | 14488 | 4750 | 21597 | 4031 | 26985 | 3162 | 29537 | 2465 | 31858 | 1377 | 39254 | 449 | 35807 |
| 25-#14 | 4.48 | 15540 | 5377 | 25092 | 4421 | 31242 | 3448 | 34591 | 2644 | 38524 | 1336 | 48695 | 87 | 48120 |
| 26-#11 | 3.23 | 14603 | 4807 | 21979 | 4059 | 27420 | 3181 | 30045 | 2474 | 32521 | 1367 | 40104 | 416 | 36952 |
| 27-#11 | 3.35 | 14707 | 4864 | 22258 | 4101 | 27772 | 3218 | 30482 | 2500 | 33116 | 1373 | 41114 | 393 | 38157 |
| 28-#11 | 3.48 | 14808 | 4920 | 22555 | 4140 | 28147 | 3252 | 30943 | 2524 | 33749 | 1376 | 41968 | 364 | 39353 |
| 29-#11 | 3.60 | 14913 | 4977 | 22874 | 4177 | 28557 | 3274 | 31429 | 2536 | 34374 | 1368 | 42891 | 331 | 40526 |
| 30-#11 | 3.72 | 15012 | 5034 | 23286 | 4204 | 28983 | 3295 | 31943 | 2549 | 35037 | 1360 | 43702 | 291 | 41729 |

## ROUND TIED COLUMNS 42" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#18 | 1.15 | 14474 | 4256 | 19266 | 3766 | 23969 | 2972 | 25430 | 2396 | 25196 | 1542 | 28047 | 998 | 18835 |
| 5-#18 | 1.44 | 14982 | 4401 | 20944 | 3776 | 25427 | 2965 | 26822 | 2355 | 26737 | 1454 | 30347 | 857 | 21369 |
| 6-#18 | 1.73 | 15450 | 4547 | 23250 | 3691 | 27121 | 2860 | 28313 | 2247 | 28414 | 1307 | 31551 | 665 | 25789 |
| 7-#14 | 1.14 | 14781 | 4247 | 19589 | 3749 | 24129 | 2965 | 25526 | 2371 | 25226 | 1519 | 28650 | 999 | 17475 |
| 7-#18 | 2.02 | 15580 | 4692 | 22351 | 4001 | 27341 | 3145 | 29295 | 2480 | 30115 | 1468 | 35473 | 726 | 28660 |
| 8-#14 | 1.30 | 14951 | 4328 | 19600 | 3856 | 24542 | 3045 | 26176 | 2440 | 26236 | 1554 | 30079 | 990 | 19677 |
| 8-#18 | 2.31 | 15877 | 4837 | 22648 | 4155 | 28152 | 3256 | 30414 | 2575 | 31783 | 1510 | 37782 | 688 | 32379 |
| 9-#11 | 1.01 | 14676 | 4185 | 18967 | 3746 | 23612 | 2968 | 25005 | 2379 | 24627 | 1546 | 27889 | 1047 | 15940 |
| 9-#14 | 1.46 | 15120 | 4410 | 20393 | 3877 | 25272 | 3062 | 26949 | 2437 | 27167 | 1524 | 31474 | 912 | 21772 |
| 9-#18 | 2.60 | 16123 | 4983 | 23862 | 4214 | 29360 | 3304 | 31759 | 2584 | 33444 | 1466 | 40283 | 559 | 35309 |
| 10-#11 | 1.13 | 14774 | 4241 | 19799 | 3718 | 24272 | 2931 | 25613 | 2345 | 25241 | 1498 | 28399 | 985 | 17320 |
| 10-#14 | 1.62 | 15248 | 4492 | 21368 | 3863 | 26153 | 3033 | 27829 | 2408 | 28118 | 1470 | 32323 | 834 | 23934 |
| 10-#18 | 2.89 | 16322 | 5128 | 25208 | 4235 | 30803 | 3294 | 33260 | 2565 | 35224 | 1394 | 41961 | 440 | 38545 |
| 11-#11 | 1.24 | 14917 | 4298 | 19539 | 3830 | 24426 | 3032 | 26011 | 2422 | 26009 | 1553 | 29879 | 1002 | 18997 |
| 11-#14 | 1.79 | 15446 | 4574 | 21241 | 3994 | 26448 | 3151 | 28381 | 2496 | 29127 | 1531 | 34288 | 843 | 25915 |
| 11-#18 | 3.18 | 16667 | 5274 | 25407 | 4414 | 31419 | 3454 | 34242 | 2681 | 36825 | 1471 | 45121 | 424 | 41654 |
| 12-#11 | 1.35 | 15049 | 4355 | 19705 | 3892 | 24777 | 3076 | 26491 | 2460 | 26659 | 1562 | 30966 | 991 | 20373 |
| 12-#14 | 1.95 | 15625 | 4656 | 21551 | 4076 | 26967 | 3207 | 29062 | 2543 | 30046 | 1540 | 35793 | 821 | 28072 |
| 12-#18 | 3.46 | 16940 | 5419 | 26053 | 4545 | 32358 | 3541 | 35421 | 2753 | 38392 | 1478 | 47649 | 378 | 44628 |
| 13-#11 | 1.46 | 15174 | 4411 | 20159 | 3912 | 25236 | 3092 | 27020 | 2463 | 27349 | 1552 | 31798 | 945 | 21943 |
| 13-#14 | 2.11 | 15798 | 4737 | 22143 | 4109 | 27613 | 3236 | 29818 | 2552 | 31036 | 1528 | 37004 | 757 | 29952 |
| 13-#18 | 3.75 | 17219 | 5564 | 27003 | 4612 | 33485 | 3601 | 36733 | 2776 | 40126 | 1460 | 49788 | 264 | 47964 |
| 14-#11 | 1.58 | 15299 | 4468 | 20857 | 3905 | 25791 | 3083 | 27572 | 2451 | 27997 | 1519 | 32616 | 894 | 23343 |
| 14-#14 | 2.27 | 15968 | 4819 | 23025 | 4112 | 28365 | 3234 | 30620 | 2546 | 31991 | 1488 | 38230 | 691 | 32079 |
| 14-#18 | 4.04 | 17548 | 5710 | 28339 | 4642 | 34723 | 3618 | 38175 | 2785 | 41850 | 1401 | 52007 | 157 | 50750 |
| 15-#11 | 1.69 | 15399 | 4525 | 20833 | 3986 | 26061 | 3151 | 28021 | 2501 | 28687 | 1550 | 33722 | 884 | 24834 |
| 15-#14 | 2.44 | 16103 | 4901 | 23123 | 4214 | 28793 | 3319 | 31255 | 2606 | 32943 | 1523 | 39732 | 667 | 33811 |
| 15-#18 | 4.33 | 17730 | 5855 | 28734 | 4795 | 35538 | 3744 | 39230 | 2868 | 43427 | 1447 | 54483 | 98 | 53789 |
| 16-#11 | 1.80 | 15506 | 4581 | 21076 | 4031 | 26448 | 3188 | 28519 | 2532 | 29335 | 1553 | 34805 | 858 | 26252 |
| 16-#14 | 2.60 | 16259 | 4983 | 23506 | 4275 | 29367 | 3368 | 31952 | 2646 | 33859 | 1526 | 41250 | 627 | 35700 |
| 16-#18 | 4.62 | 17973 | 6000 | 29477 | 4897 | 36570 | 3825 | 40434 | 2932 | 45007 | 1446 | 57065 | 22 | 56885 |
| 17-#11 | 1.91 | 15647 | 4638 | 21468 | 4063 | 26894 | 3209 | 29021 | 2539 | 30025 | 1547 | 35718 | 829 | 27652 |
| 17-#14 | 2.76 | 16440 | 5065 | 24036 | 4324 | 29983 | 3401 | 32680 | 2659 | 34849 | 1518 | 42564 | 585 | 37528 |
| 17-#18 | 4.91 | 18301 | 6146 | 30347 | 4990 | 37608 | 3887 | 41730 | 2960 | 46729 | 1433 | 59366 | -53 | 59080 |
| 18-#11 | 2.03 | 15753 | 4695 | 22030 | 4076 | 27412 | 3212 | 29565 | 2538 | 30700 | 1524 | 36554 | 772 | 29088 |
| 18-#14 | 2.92 | 16581 | 5146 | 24774 | 4351 | 30696 | 3413 | 33458 | 2664 | 35820 | 1488 | 43790 | 507 | 39377 |
| 18-#18 | 5.20 | 18507 | 6291 | 31495 | 5051 | 38802 | 3920 | 43093 | 2979 | 48455 | 1387 | 61542 | -186 | 60492 |
| 19-#11 | 2.14 | 15873 | 4752 | 22118 | 4141 | 27739 | 3261 | 30025 | 2576 | 31363 | 1544 | 37617 | 769 | 30427 |
| 19-#14 | 3.09 | 16755 | 5228 | 24968 | 4435 | 31199 | 3476 | 34111 | 2711 | 36755 | 1512 | 45263 | 497 | 41240 |
| 19-#18 | 5.49 | 18824 | 6437 | 31973 | 5183 | 39727 | 4017 | 44222 | 3050 | 50033 | 1419 | 64030 | -219 | 62781 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 42" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 20-#11 | 2.25 | 16019 | 4808 | 22402 | 4183 | 28105 | 3298 | 30527 | 2604 | 32012 | 1545 | 38574 | 738 | 31879 |
| 20-#14 | 3.25 | 16947 | 5310 | 25395 | 4493 | 31728 | 3526 | 34837 | 2749 | 37673 | 1512 | 46613 | 449 | 42975 |
| 21-#11 | 2.36 | 16107 | 4865 | 22810 | 4212 | 28568 | 3318 | 31032 | 2613 | 32700 | 1540 | 39517 | 709 | 33166 |
| 21-#14 | 3.41 | 17070 | 5392 | 25965 | 4538 | 32380 | 3556 | 35546 | 2764 | 38661 | 1506 | 47961 | 408 | 44819 |
| 22-#11 | 2.48 | 16215 | 4922 | 23248 | 4235 | 29064 | 3334 | 31573 | 2618 | 33439 | 1532 | 40491 | 677 | 34505 |
| 22-#14 | 3.57 | 17237 | 5473 | 26541 | 4577 | 33072 | 3584 | 36318 | 2775 | 39714 | 1496 | 49375 | 364 | 46569 |
| 23-#11 | 2.59 | 16338 | 4978 | 23459 | 4288 | 29401 | 3375 | 32040 | 2650 | 34063 | 1542 | 41493 | 655 | 35787 |
| 23-#14 | 3.74 | 17390 | 5555 | 26893 | 4647 | 33570 | 3637 | 36984 | 2816 | 40603 | 1507 | 50769 | 329 | 48320 |
| 24-#11 | 2.70 | 16446 | 5035 | 23731 | 4335 | 29783 | 3410 | 32525 | 2675 | 34738 | 1546 | 42490 | 633 | 37075 |
| 24-#14 | 3.90 | 17531 | 5637 | 27303 | 4712 | 34119 | 3686 | 37684 | 2850 | 41558 | 1512 | 52179 | 295 | 50157 |
| 25-#11 | 2.81 | 16564 | 5092 | 24116 | 4365 | 30239 | 3432 | 33041 | 2686 | 35399 | 1538 | 43403 | 592 | 38394 |
| 25-#14 | 4.06 | 17707 | 5719 | 27832 | 4756 | 34764 | 3718 | 38420 | 2868 | 42505 | 1500 | 53482 | 237 | 51794 |
| 26-#11 | 2.93 | 16685 | 5148 | 24530 | 4393 | 30698 | 3450 | 33589 | 2696 | 36103 | 1527 | 44303 | 560 | 39639 |
| 26-#14 | 4.22 | 17861 | 5801 | 28386 | 4801 | 35415 | 3748 | 39190 | 2884 | 43517 | 1487 | 54782 | 191 | 53509 |
| 27-#11 | 3.04 | 16801 | 5205 | 24813 | 4436 | 31068 | 3488 | 34045 | 2722 | 36735 | 1534 | 45309 | 530 | 40978 |
| 28-#11 | 3.15 | 16912 | 5262 | 25126 | 4474 | 31472 | 3523 | 34535 | 2746 | 37408 | 1538 | 46293 | 509 | 42227 |
| 29-#11 | 3.27 | 17017 | 5319 | 25467 | 4512 | 31902 | 3544 | 35051 | 2759 | 38072 | 1530 | 47274 | 477 | 43496 |
| 30-#11 | 3.38 | 17131 | 5375 | 25905 | 4538 | 32356 | 3565 | 35589 | 2770 | 38770 | 1521 | 48136 | 437 | 44770 |
| 31-#11 | 3.49 | 17249 | 5432 | 26126 | 4588 | 32739 | 3600 | 36058 | 2795 | 39409 | 1526 | 49174 | 416 | 45995 |
| 32-#11 | 3.60 | 17353 | 5489 | 26449 | 4626 | 33133 | 3633 | 36552 | 2818 | 40080 | 1529 | 50118 | 382 | 47292 |

## ROUND TIED COLUMNS 44" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.05 | 16578 | 4614 | 21717 | 4113 | 27130 | 3251 | 28777 | 2624 | 28421 | 1706 | 31554 | 1140 | 19950 |
| 5-#18 | 1.32 | 17128 | 4759 | 23573 | 4116 | 28706 | 3236 | 30279 | 2578 | 30034 | 1613 | 33966 | 996 | 22704 |
| 6-#18 | 1.58 | 17620 | 4905 | 26151 | 4016 | 30560 | 3120 | 31854 | 2459 | 31771 | 1459 | 35180 | 798 | 27344 |
| 7-#14 | 1.04 | 16907 | 4605 | 22091 | 4094 | 27314 | 3241 | 28884 | 2597 | 28435 | 1681 | 32167 | 1138 | 18591 |
| 7-#18 | 1.84 | 17781 | 5050 | 25029 | 4345 | 30722 | 3421 | 32878 | 2707 | 33628 | 1632 | 39435 | 870 | 30503 |
| 8-#14 | 1.18 | 17091 | 4687 | 22064 | 4205 | 27736 | 3325 | 29571 | 2669 | 29500 | 1718 | 33703 | 1132 | 20863 |
| 8-#18 | 2.10 | 18083 | 5196 | 25306 | 4505 | 31568 | 3537 | 34065 | 2805 | 35408 | 1677 | 41908 | 836 | 34889 |
| 9-#14 | 1.33 | 17270 | 4768 | 22921 | 4224 | 28519 | 3340 | 30391 | 2665 | 30495 | 1688 | 35173 | 1053 | 23183 |
| 9-#18 | 2.37 | 18364 | 5341 | 26617 | 4561 | 32858 | 3583 | 35492 | 2813 | 37163 | 1633 | 44558 | 706 | 37851 |
| 10-#11 | 1.03 | 16895 | 4599 | 22342 | 4058 | 27472 | 3203 | 28968 | 2568 | 28435 | 1657 | 31875 | 1123 | 18385 |
| 10-#14 | 1.48 | 17411 | 4850 | 24005 | 4203 | 29462 | 3305 | 31320 | 2631 | 31487 | 1630 | 36049 | 974 | 25415 |
| 10-#18 | 2.63 | 18583 | 5486 | 28081 | 4576 | 34389 | 3567 | 37108 | 2792 | 39036 | 1558 | 46319 | 586 | 41419 |
| 11-#11 | 1.13 | 17050 | 4656 | 22005 | 4178 | 27612 | 3311 | 29397 | 2651 | 29257 | 1716 | 33475 | 1144 | 20180 |
| 11-#14 | 1.63 | 17625 | 4932 | 23812 | 4342 | 29758 | 3431 | 31908 | 2725 | 32574 | 1696 | 38161 | 986 | 27607 |
| 11-#18 | 2.89 | 18940 | 5632 | 28234 | 4762 | 35040 | 3735 | 38125 | 2913 | 40752 | 1640 | 49700 | 576 | 44594 |
| 12-#11 | 1.23 | 17188 | 4713 | 22161 | 4242 | 27983 | 3357 | 29904 | 2690 | 29949 | 1726 | 34637 | 1133 | 21648 |
| 12-#14 | 1.78 | 17813 | 5014 | 24118 | 4425 | 30305 | 3489 | 32629 | 2774 | 33536 | 1706 | 39769 | 967 | 29836 |
| 12-#18 | 3.16 | 19242 | 5777 | 28918 | 4896 | 36030 | 3824 | 39376 | 2987 | 42418 | 1649 | 52399 | 531 | 47869 |

## ROUND TIED COLUMNS 44" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 13-#11 | 1.33 | 17323 | 4770 | 22657 | 4260 | 28467 | 3372 | 30465 | 2692 | 30676 | 1716 | 35513 | 1087 | 23383 |
| 13-#14 | 1.92 | 18002 | 5096 | 24762 | 4457 | 30985 | 3516 | 33430 | 2782 | 34591 | 1694 | 41048 | 902 | 31912 |
| 13-#18 | 3.42 | 19546 | 5923 | 29923 | 4962 | 37211 | 3882 | 40768 | 3008 | 44254 | 1630 | 54666 | 419 | 51310 |
| 14-#11 | 1.44 | 17464 | 4826 | 23424 | 4250 | 29065 | 3360 | 31042 | 2678 | 31365 | 1682 | 36368 | 1035 | 24821 |
| 14-#14 | 2.07 | 18192 | 5177 | 25724 | 4458 | 31792 | 3511 | 34269 | 2773 | 35601 | 1652 | 42338 | 835 | 34150 |
| 14-#18 | 3.68 | 19912 | 6068 | 31366 | 4989 | 38535 | 3897 | 42275 | 3014 | 46075 | 1570 | 57018 | 311 | 54363 |
| 15-#11 | 1.54 | 17569 | 4883 | 23363 | 4334 | 29339 | 3432 | 31517 | 2731 | 32094 | 1714 | 37556 | 1028 | 26468 |
| 15-#14 | 2.22 | 18333 | 5259 | 25791 | 4563 | 32234 | 3600 | 34941 | 2837 | 36608 | 1690 | 43946 | 814 | 36112 |
| 15-#18 | 3.95 | 20101 | 6213 | 31755 | 5146 | 39387 | 4027 | 43416 | 3102 | 47756 | 1619 | 59662 | 256 | 57796 |
| 16-#11 | 1.64 | 17685 | 4940 | 23612 | 4381 | 29740 | 3469 | 32051 | 2763 | 32782 | 1719 | 38710 | 1003 | 27925 |
| 16-#14 | 2.37 | 18493 | 5341 | 26187 | 4626 | 32829 | 3649 | 35690 | 2879 | 37575 | 1693 | 45562 | 775 | 38259 |
| 16-#18 | 4.21 | 20364 | 6359 | 32520 | 5249 | 40480 | 4109 | 44693 | 3168 | 49434 | 1620 | 62413 | 181 | 60872 |
| 17-#11 | 1.74 | 17835 | 4996 | 24033 | 4413 | 30221 | 3490 | 32576 | 2769 | 33510 | 1712 | 39674 | 973 | 29473 |
| 17-#14 | 2.52 | 18700 | 5423 | 26756 | 4674 | 33494 | 3683 | 36451 | 2890 | 38625 | 1685 | 46954 | 734 | 40125 |
| 17-#18 | 4.47 | 20717 | 6504 | 33451 | 5340 | 41582 | 4171 | 46056 | 3195 | 51259 | 1607 | 64854 | 107 | 64034 |
| 18-#11 | 1.85 | 17950 | 5053 | 24642 | 4423 | 30775 | 3492 | 33152 | 2767 | 34224 | 1688 | 40550 | 916 | 30951 |
| 18-#14 | 2.66 | 18848 | 5505 | 27547 | 4699 | 34255 | 3693 | 37275 | 2894 | 39662 | 1655 | 48249 | 656 | 42159 |
| 18-#18 | 4.74 | 20930 | 6650 | 34699 | 5401 | 42856 | 4203 | 47491 | 3213 | 53085 | 1561 | 67165 | -26 | 67016 |
| 19-#11 | 1.95 | 18080 | 5110 | 24720 | 4490 | 31109 | 3543 | 33639 | 2807 | 34927 | 1710 | 41687 | 915 | 32431 |
| 19-#14 | 2.81 | 19029 | 5586 | 27741 | 4785 | 34772 | 3757 | 37966 | 2943 | 40642 | 1680 | 49817 | 647 | 44069 |
| 19-#18 | 5.00 | 21272 | 6795 | 35174 | 5535 | 43830 | 4302 | 48689 | 3286 | 54763 | 1595 | 69809 | -55 | 69484 |
| 20-#11 | 2.05 | 18235 | 5167 | 25015 | 4534 | 31494 | 3580 | 34162 | 2835 | 35615 | 1711 | 42705 | 884 | 33929 |
| 20-#14 | 2.96 | 19239 | 5668 | 28188 | 4844 | 35330 | 3809 | 38723 | 2982 | 41615 | 1681 | 51251 | 601 | 45979 |
| 20-#18 | 5.26 | 21615 | 6940 | 35995 | 5634 | 44825 | 4388 | 50012 | 3349 | 56453 | 1591 | 72269 | -143 | 71398 |
| 21-#11 | 2.15 | 18335 | 5223 | 25447 | 4562 | 31985 | 3600 | 34705 | 2845 | 36343 | 1707 | 43704 | 856 | 35360 |
| 21-#14 | 3.11 | 19378 | 5750 | 28790 | 4888 | 36023 | 3839 | 39486 | 2996 | 42660 | 1675 | 52682 | 560 | 47967 |
| 22-#11 | 2.26 | 18451 | 5280 | 25922 | 4584 | 32510 | 3614 | 35278 | 2849 | 37111 | 1698 | 44730 | 824 | 36866 |
| 22-#14 | 3.26 | 19541 | 5832 | 29411 | 4926 | 36760 | 3865 | 40304 | 3007 | 43788 | 1666 | 54176 | 517 | 49793 |
| 23-#11 | 2.36 | 18581 | 5337 | 26133 | 4639 | 32868 | 3657 | 35764 | 2881 | 37786 | 1709 | 45801 | 803 | 38238 |
| 23-#14 | 3.40 | 19721 | 5913 | 29771 | 4998 | 37283 | 3920 | 41008 | 3049 | 44717 | 1677 | 55664 | 482 | 51730 |
| 24-#11 | 2.46 | 18691 | 5393 | 26413 | 4685 | 33270 | 3693 | 36277 | 2907 | 38501 | 1714 | 46859 | 782 | 39658 |
| 24-#14 | 3.55 | 19874 | 5995 | 30196 | 5063 | 37863 | 3970 | 41740 | 3084 | 45730 | 1683 | 57161 | 450 | 53602 |
| 25-#11 | 2.56 | 18827 | 5450 | 26828 | 4716 | 33748 | 3714 | 36824 | 2918 | 39200 | 1706 | 47827 | 741 | 41010 |
| 25-#14 | 3.70 | 20063 | 6077 | 30765 | 5108 | 38548 | 4002 | 42519 | 3101 | 46733 | 1671 | 58544 | 392 | 55477 |
| 26-#11 | 2.67 | 18955 | 5507 | 27274 | 4743 | 34237 | 3731 | 37411 | 2927 | 39933 | 1694 | 48777 | 709 | 42381 |
| 26-#14 | 3.85 | 20225 | 6159 | 31361 | 5151 | 39231 | 4031 | 43346 | 3117 | 47806 | 1658 | 59920 | 346 | 57402 |
| 27-#11 | 2.77 | 19076 | 5563 | 27561 | 4787 | 34626 | 3770 | 37886 | 2955 | 40611 | 1702 | 49847 | 681 | 43782 |
| 27-#14 | 4.00 | 20399 | 6241 | 31819 | 5210 | 39801 | 4082 | 44034 | 3153 | 48749 | 1665 | 61420 | 302 | 59152 |
| 28-#11 | 2.87 | 19203 | 5620 | 27889 | 4826 | 35051 | 3805 | 38405 | 2979 | 41328 | 1707 | 50895 | 660 | 45127 |
| 28-#14 | 4.14 | 20601 | 6322 | 32300 | 5265 | 40412 | 4132 | 44774 | 3187 | 49761 | 1670 | 62900 | 271 | 60938 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 44" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 29-#11 | 2.98 | 19314 | 5677 | 28252 | 4863 | 35508 | 3827 | 38951 | 2991 | 42023 | 1699 | 51932 | 628 | 46524 |
| 30-#11 | 3.08 | 19426 | 5734 | 28718 | 4888 | 35992 | 3847 | 39514 | 3002 | 42757 | 1690 | 52845 | 588 | 47826 |
| 31-#11 | 3.18 | 19565 | 5790 | 28948 | 4939 | 36394 | 3883 | 40014 | 3028 | 43435 | 1695 | 53949 | 568 | 49180 |
| 32-#11 | 3.28 | 19676 | 5847 | 29290 | 4978 | 36804 | 3917 | 40540 | 3052 | 44157 | 1699 | 54952 | 535 | 50519 |
| 33-#11 | 3.39 | 19797 | 5904 | 29685 | 5010 | 37273 | 3939 | 41074 | 3064 | 44849 | 1691 | 55971 | 507 | 51830 |
| 34-#11 | 3.49 | 19932 | 5960 | 30080 | 5042 | 37762 | 3962 | 41631 | 3077 | 45583 | 1684 | 57069 | 478 | 53206 |

## ROUND TIED COLUMNS 46" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 5-#18 | 1.20 | 19468 | 5134 | 26417 | 4471 | 32263 | 3521 | 34028 | 2812 | 33599 | 1780 | 37866 | 1140 | 24051 |
| 6-#18 | 1.44 | 19984 | 5280 | 29288 | 4356 | 34284 | 3391 | 35687 | 2681 | 35390 | 1617 | 39079 | 936 | 28901 |
| 7-#18 | 1.68 | 20175 | 5425 | 27917 | 4706 | 34381 | 3711 | 36754 | 2944 | 37411 | 1803 | 43682 | 1019 | 32364 |
| 8-#14 | 1.08 | 19423 | 5062 | 24730 | 4571 | 31204 | 3619 | 33258 | 2910 | 33036 | 1890 | 37616 | 1281 | 22056 |
| 8-#18 | 1.93 | 20502 | 5571 | 28166 | 4870 | 35258 | 3831 | 38007 | 3047 | 39296 | 1851 | 46323 | 989 | 36946 |
| 9-#14 | 1.22 | 19610 | 5143 | 25655 | 4587 | 32042 | 3631 | 34125 | 2903 | 34093 | 1859 | 39156 | 1201 | 24612 |
| 9-#18 | 2.17 | 20799 | 5716 | 29571 | 4924 | 36633 | 3874 | 39517 | 3053 | 41154 | 1806 | 49119 | 859 | 40301 |
| 10-#14 | 1.35 | 19767 | 5225 | 26857 | 4560 | 33050 | 3591 | 35096 | 2865 | 35125 | 1798 | 40056 | 1119 | 26907 |
| 10-#18 | 2.41 | 21039 | 5861 | 31170 | 4932 | 38254 | 3853 | 41249 | 3028 | 43118 | 1729 | 50958 | 737 | 44365 |
| 11-#11 | 1.03 | 19375 | 5031 | 24676 | 4543 | 31072 | 3603 | 33075 | 2891 | 32746 | 1881 | 37280 | 1284 | 21343 |
| 11-#14 | 1.49 | 19997 | 5307 | 26586 | 4706 | 33338 | 3723 | 35727 | 2965 | 36278 | 1868 | 42322 | 1136 | 29338 |
| 11-#18 | 2.65 | 21423 | 6007 | 31266 | 5127 | 38936 | 4029 | 42301 | 3154 | 44950 | 1815 | 54566 | 733 | 47594 |
| 12-#11 | 1.13 | 19521 | 5088 | 24818 | 4608 | 31462 | 3652 | 33609 | 2931 | 33512 | 1899 | 38597 | 1282 | 22937 |
| 12-#14 | 1.62 | 20196 | 5389 | 26885 | 4791 | 33917 | 3783 | 36488 | 3016 | 37298 | 1879 | 44034 | 1118 | 31617 |
| 12-#18 | 2.89 | 21741 | 6152 | 31964 | 5262 | 39976 | 4119 | 43623 | 3230 | 46708 | 1826 | 57438 | 690 | 51184 |
| 13-#11 | 1.22 | 19666 | 5145 | 25358 | 4625 | 31973 | 3665 | 34194 | 2932 | 34276 | 1887 | 39516 | 1236 | 24753 |
| 13-#14 | 1.76 | 20400 | 5471 | 27585 | 4823 | 34632 | 3809 | 37334 | 3023 | 38409 | 1866 | 45379 | 1054 | 33900 |
| 13-#18 | 3.13 | 22070 | 6297 | 33047 | 5327 | 41212 | 4176 | 45095 | 3251 | 48654 | 1808 | 59833 | 579 | 54711 |
| 14-#11 | 1.31 | 19822 | 5201 | 26199 | 4612 | 32616 | 3650 | 34805 | 2915 | 35003 | 1852 | 40406 | 1183 | 26316 |
| 14-#14 | 1.90 | 20610 | 5552 | 28631 | 4820 | 35495 | 3801 | 38210 | 3011 | 39482 | 1824 | 46731 | 985 | 36209 |
| 14-#18 | 3.37 | 22427 | 6443 | 34602 | 5352 | 42623 | 4189 | 46667 | 3254 | 50572 | 1747 | 62314 | 470 | 58053 |
| 15-#11 | 1.41 | 19933 | 5258 | 26096 | 4700 | 32892 | 3725 | 35305 | 2972 | 35772 | 1887 | 41678 | 1177 | 28090 |
| 15-#14 | 2.03 | 20758 | 5634 | 28661 | 4929 | 35949 | 3894 | 38919 | 3078 | 40539 | 1863 | 48448 | 967 | 38365 |
| 15-#18 | 3.61 | 22671 | 6588 | 34971 | 5513 | 43512 | 4322 | 47892 | 3347 | 52358 | 1798 | 65129 | 418 | 61822 |
| 16-#11 | 1.50 | 20058 | 5315 | 26348 | 4748 | 33305 | 3763 | 35875 | 3005 | 36501 | 1892 | 42904 | 1153 | 29618 |
| 16-#14 | 2.17 | 20931 | 5716 | 29070 | 4992 | 36565 | 3944 | 39721 | 3121 | 41563 | 1868 | 50164 | 929 | 40704 |
| 16-#18 | 3.85 | 22954 | 6734 | 35767 | 5616 | 44647 | 4405 | 49244 | 3414 | 54125 | 1800 | 68051 | 345 | 64939 |
| 17-#11 | 1.60 | 20219 | 5371 | 26801 | 4779 | 33818 | 3784 | 36422 | 3010 | 37268 | 1885 | 43919 | 1124 | 31321 |
| 17-#14 | 2.30 | 21155 | 5798 | 29678 | 5040 | 37279 | 3978 | 40513 | 3132 | 42670 | 1860 | 51631 | 888 | 42766 |
| 17-#18 | 4.09 | 23310 | 6879 | 36759 | 5708 | 45832 | 4468 | 50664 | 3439 | 56062 | 1788 | 70632 | 272 | 68418 |
| 18-#11 | 1.69 | 20341 | 5428 | 27458 | 4787 | 34414 | 3784 | 37031 | 3007 | 38007 | 1860 | 44833 | 1067 | 32837 |
| 18-#14 | 2.44 | 21312 | 5879 | 30527 | 5063 | 38090 | 3986 | 41383 | 3135 | 43771 | 1829 | 52991 | 810 | 45001 |
| 18-#18 | 4.33 | 23554 | 7024 | 38095 | 5767 | 47185 | 4498 | 52182 | 3457 | 57988 | 1741 | 73076 | 139 | 71827 |

## ROUND TIED COLUMNS 46" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 19-#11 | 1.78 | 20481 | 5485 | 27524 | 4857 | 34752 | 3837 | 37544 | 3049 | 38764 | 1883 | 46046 | 1066 | 34465 |
| 19-#14 | 2.57 | 21506 | 5961 | 30717 | 5152 | 38619 | 4052 | 42113 | 3186 | 44801 | 1856 | 54659 | 803 | 46952 |
| 19-#18 | 4.57 | 23893 | 7170 | 38579 | 5903 | 48201 | 4599 | 53448 | 3532 | 59767 | 1777 | 75877 | 113 | 75073 |
| 20-#11 | 1.88 | 20645 | 5541 | 27829 | 4901 | 35156 | 3875 | 38089 | 3077 | 39492 | 1885 | 47124 | 1037 | 36004 |
| 20-#14 | 2.71 | 21727 | 6043 | 31183 | 5212 | 39206 | 4104 | 42902 | 3225 | 45830 | 1857 | 56178 | 758 | 49043 |
| 20-#18 | 4.81 | 24284 | 7315 | 39441 | 6003 | 49240 | 4686 | 54859 | 3597 | 61546 | 1774 | 78484 | 27 | 78321 |
| 21-#11 | 1.97 | 20753 | 5598 | 28286 | 4929 | 35677 | 3894 | 38666 | 3086 | 40259 | 1881 | 48179 | 1008 | 37575 |
| 21-#14 | 2.84 | 21883 | 6125 | 31816 | 5255 | 39940 | 4134 | 43718 | 3240 | 46932 | 1851 | 57692 | 718 | 51082 |
| 21-#18 | 5.05 | 24533 | 7461 | 40526 | 6085 | 50501 | 4742 | 56239 | 3624 | 63473 | 1766 | 81121 | -44 | 80841 |
| 22-#11 | 2.07 | 20882 | 5655 | 28801 | 4950 | 36230 | 3907 | 39274 | 3090 | 40996 | 1860 | 49100 | 962 | 39126 |
| 22-#14 | 2.98 | 22058 | 6207 | 32486 | 5292 | 40715 | 4159 | 44583 | 3250 | 48106 | 1841 | 59264 | 674 | 53081 |
| 22-#18 | 5.30 | 24842 | 7606 | 41579 | 6162 | 51823 | 4798 | 57744 | 3651 | 65547 | 1753 | 83913 | -118 | 82515 |
| 23-#11 | 2.16 | 21019 | 5712 | 29009 | 5006 | 36607 | 3952 | 39780 | 3124 | 41776 | 1883 | 50398 | 956 | 40635 |
| 23-#14 | 3.11 | 22249 | 6288 | 32852 | 5365 | 41269 | 4216 | 45315 | 3293 | 49104 | 1854 | 60847 | 641 | 55191 |
| 24-#11 | 2.25 | 21138 | 5768 | 29296 | 5052 | 37031 | 3988 | 40321 | 3149 | 42537 | 1889 | 51517 | 936 | 42209 |
| 24-#14 | 3.25 | 22414 | 6370 | 33290 | 5431 | 41880 | 4267 | 46087 | 3328 | 50175 | 1860 | 62432 | 609 | 57112 |
| 25-#11 | 2.35 | 21285 | 5825 | 29738 | 5083 | 37531 | 4009 | 40898 | 3161 | 43264 | 1880 | 52541 | 895 | 43664 |
| 25-#14 | 3.38 | 22606 | 6452 | 33901 | 5476 | 42597 | 4298 | 46910 | 3345 | 51233 | 1849 | 63896 | 552 | 59172 |
| 26-#11 | 2.44 | 21421 | 5882 | 30223 | 5109 | 38051 | 4025 | 41511 | 3169 | 44035 | 1869 | 53540 | 863 | 45218 |
| 26-#14 | 3.52 | 22787 | 6534 | 34540 | 5519 | 43322 | 4326 | 47795 | 3362 | 52349 | 1835 | 65346 | 506 | 61135 |
| 27-#11 | 2.53 | 21550 | 5938 | 30510 | 5154 | 38457 | 4066 | 42020 | 3198 | 44753 | 1877 | 54675 | 836 | 46610 |
| 27-#14 | 3.66 | 22974 | 6616 | 35007 | 5578 | 43919 | 4379 | 48510 | 3398 | 53358 | 1844 | 66936 | 464 | 63104 |
| 28-#11 | 2.63 | 21690 | 5995 | 30853 | 5194 | 38899 | 4101 | 42567 | 3223 | 45521 | 1883 | 55785 | 816 | 48083 |
| 28-#14 | 3.79 | 23170 | 6697 | 35512 | 5633 | 44565 | 4429 | 49291 | 3432 | 54432 | 1849 | 68506 | 433 | 65148 |
| 29-#11 | 2.72 | 21807 | 6052 | 31240 | 5231 | 39388 | 4122 | 43142 | 3235 | 46243 | 1874 | 56879 | 785 | 49516 |
| 29-#14 | 3.93 | 23333 | 6779 | 36050 | 5688 | 45249 | 4460 | 50114 | 3451 | 55483 | 1838 | 70073 | 388 | 66983 |
| 30-#11 | 2.82 | 21928 | 6108 | 31734 | 5255 | 39901 | 4142 | 43731 | 3245 | 47017 | 1865 | 57843 | 744 | 50941 |
| 31-#11 | 2.91 | 22077 | 6165 | 31969 | 5307 | 40317 | 4179 | 44258 | 3272 | 47734 | 1871 | 59012 | 725 | 52409 |
| 32-#11 | 3.00 | 22195 | 6222 | 32332 | 5346 | 40749 | 4213 | 44820 | 3296 | 48489 | 1875 | 60076 | 692 | 53792 |
| 33-#11 | 3.10 | 22324 | 6279 | 32746 | 5378 | 41244 | 4236 | 45377 | 3308 | 49226 | 1868 | 61152 | 665 | 55251 |
| 34-#11 | 3.19 | 22467 | 6335 | 33169 | 5409 | 41762 | 4258 | 45965 | 3320 | 50000 | 1861 | 62310 | 636 | 56636 |
| 35-#11 | 3.29 | 22588 | 6392 | 33479 | 5454 | 42194 | 4287 | 46498 | 3345 | 50746 | 1870 | 63365 | 612 | 58048 |
| 36-#11 | 3.38 | 22711 | 6449 | 33790 | 5497 | 42652 | 4315 | 47051 | 3369 | 51464 | 1868 | 64494 | 586 | 59473 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 48" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 5-#18 | 1.11 | 22009 | 5526 | 29485 | 4843 | 36111 | 3818 | 38071 | 3055 | 37446 | 1954 | 42062 | 1291 | 25408 |
| 6-#18 | 1.33 | 22550 | 5671 | 32669 | 4712 | 38306 | 3674 | 39824 | 2912 | 39283 | 1783 | 43261 | 1080 | 30458 |
| 7-#18 | 1.55 | 22773 | 5817 | 31023 | 5083 | 38327 | 4013 | 40935 | 3192 | 41478 | 1982 | 48227 | 1174 | 34245 |
| 8-#18 | 1.77 | 23123 | 5962 | 31239 | 5253 | 39234 | 4138 | 42254 | 3299 | 43449 | 2032 | 51039 | 1148 | 38997 |
| 9-#14 | 1.12 | 22153 | 5535 | 28604 | 4966 | 35851 | 3936 | 38164 | 3153 | 37962 | 2037 | 43438 | 1355 | 26060 |
| 9-#18 | 1.99 | 23437 | 6107 | 32736 | 5303 | 40695 | 4179 | 43848 | 3303 | 45429 | 1987 | 53980 | 1017 | 42669 |
| 10-#14 | 1.24 | 22325 | 5617 | 29932 | 4933 | 36928 | 3889 | 39176 | 3109 | 39045 | 1973 | 44358 | 1270 | 28411 |
| 10-#18 | 2.21 | 23699 | 6253 | 34483 | 5305 | 42411 | 4152 | 45673 | 3273 | 47481 | 1906 | 55893 | 894 | 47296 |
| 11-#14 | 1.37 | 22571 | 5699 | 29574 | 5087 | 37204 | 4028 | 39851 | 3216 | 40221 | 2039 | 46665 | 1282 | 31075 |
| 11-#18 | 2.43 | 24110 | 6398 | 34514 | 5508 | 43113 | 4335 | 46782 | 3406 | 49433 | 1998 | 59733 | 894 | 50653 |
| 12-#11 | 1.03 | 22055 | 5479 | 27684 | 4991 | 35227 | 3960 | 37619 | 3183 | 37360 | 2078 | 42859 | 1437 | 24238 |
| 12-#14 | 1.49 | 22780 | 5780 | 29864 | 5174 | 37815 | 4091 | 40651 | 3268 | 41346 | 2059 | 48600 | 1275 | 33414 |
| 12-#18 | 2.65 | 24445 | 6544 | 35218 | 5645 | 44208 | 4428 | 48175 | 3484 | 51263 | 2009 | 62779 | 853 | 54574 |
| 13-#11 | 1.12 | 22211 | 5536 | 28271 | 5007 | 35764 | 3971 | 38229 | 3183 | 38160 | 2066 | 43820 | 1390 | 26133 |
| 13-#14 | 1.62 | 22996 | 5862 | 30621 | 5204 | 38565 | 4115 | 41534 | 3274 | 42511 | 2046 | 50012 | 1211 | 35914 |
| 13-#18 | 2.87 | 24800 | 6689 | 36385 | 5710 | 45500 | 4484 | 49728 | 3505 | 53333 | 1992 | 65300 | 743 | 58174 |
| 14-#11 | 1.21 | 22382 | 5593 | 29190 | 4990 | 36454 | 3953 | 38872 | 3164 | 38914 | 2029 | 44742 | 1336 | 27845 |
| 14-#14 | 1.74 | 23230 | 5944 | 31755 | 5199 | 39487 | 4105 | 42455 | 3260 | 43647 | 2003 | 51422 | 1141 | 38288 |
| 14-#18 | 3.09 | 25190 | 6834 | 38057 | 5731 | 47000 | 4493 | 51365 | 3505 | 55352 | 1930 | 67910 | 633 | 61820 |
| 15-#11 | 1.29 | 22498 | 5649 | 29040 | 5082 | 36730 | 4032 | 39398 | 3223 | 39736 | 2066 | 46102 | 1333 | 29673 |
| 15-#14 | 1.87 | 23386 | 6026 | 31744 | 5311 | 39950 | 4201 | 43201 | 3330 | 44756 | 2044 | 53251 | 1126 | 40648 |
| 15-#18 | 3.32 | 25447 | 6980 | 38398 | 5895 | 47923 | 4631 | 52656 | 3601 | 57230 | 1984 | 70898 | 585 | 65686 |
| 16-#11 | 1.38 | 22632 | 5706 | 29295 | 5131 | 37156 | 4071 | 40000 | 3258 | 40506 | 2073 | 47400 | 1309 | 31330 |
| 16-#14 | 1.99 | 23572 | 6107 | 32163 | 5376 | 40587 | 4252 | 44056 | 3375 | 45837 | 2050 | 55068 | 1088 | 43077 |
| 16-#18 | 3.54 | 25753 | 7125 | 39225 | 6000 | 49099 | 4714 | 54101 | 3670 | 59082 | 1986 | 73991 | 513 | 69086 |
| 17-#11 | 1.47 | 22806 | 5763 | 29780 | 5161 | 37699 | 4091 | 40574 | 3262 | 41311 | 2065 | 48465 | 1280 | 33135 |
| 17-#14 | 2.11 | 23813 | 6189 | 32812 | 5423 | 41346 | 4285 | 44880 | 3385 | 47000 | 2041 | 56611 | 1048 | 45311 |
| 17-#18 | 3.76 | 26126 | 7271 | 40279 | 6091 | 50368 | 4778 | 55578 | 3694 | 61131 | 1975 | 76711 | 441 | 72897 |
| 18-#11 | 1.55 | 22935 | 5820 | 30488 | 5167 | 38340 | 4090 | 41215 | 3257 | 42073 | 2039 | 49415 | 1223 | 34746 |
| 18-#14 | 2.24 | 23978 | 6271 | 33720 | 5443 | 42212 | 4292 | 45797 | 3386 | 48139 | 2009 | 58030 | 969 | 47742 |
| 18-#18 | 3.98 | 26387 | 7416 | 41697 | 6148 | 51803 | 4806 | 57178 | 3711 | 63176 | 1928 | 79288 | 308 | 76354 |
| 19-#11 | 1.64 | 23084 | 5876 | 30537 | 5240 | 38681 | 4144 | 41754 | 3301 | 42885 | 2064 | 50707 | 1224 | 36543 |
| 19-#14 | 2.36 | 24186 | 6353 | 33905 | 5535 | 42752 | 4360 | 46565 | 3439 | 49244 | 2038 | 59803 | 965 | 49884 |
| 19-#18 | 4.20 | 26750 | 7561 | 42197 | 6288 | 52848 | 4909 | 58512 | 3788 | 65034 | 1965 | 82248 | 286 | 79906 |
| 20-#11 | 1.72 | 23257 | 5933 | 30853 | 5285 | 39103 | 4183 | 42321 | 3330 | 43654 | 2067 | 51846 | 1196 | 38104 |
| 20-#14 | 2.49 | 24420 | 6435 | 34388 | 5596 | 43367 | 4413 | 47385 | 3478 | 50330 | 2040 | 61407 | 921 | 52169 |
| 20-#18 | 4.42 | 27115 | 7707 | 43099 | 6389 | 53941 | 4997 | 59980 | 3853 | 66905 | 1963 | 85002 | 202 | 83616 |
| 21-#11 | 1.81 | 23377 | 5990 | 31335 | 5312 | 39653 | 4202 | 42928 | 3339 | 44451 | 2062 | 52957 | 1167 | 39822 |
| 21-#14 | 2.61 | 24592 | 6516 | 35055 | 5638 | 44142 | 4443 | 48253 | 3494 | 51489 | 2034 | 63004 | 880 | 54251 |
| 21-#18 | 4.64 | 27434 | 7852 | 44235 | 6470 | 55273 | 5053 | 61455 | 3882 | 68938 | 1955 | 87789 | 131 | 86835 |
| 22-#11 | 1.90 | 23516 | 6046 | 31891 | 5331 | 40236 | 4214 | 43576 | 3342 | 45222 | 2041 | 53920 | 1120 | 41413 |
| 22-#14 | 2.74 | 24779 | 6598 | 35774 | 5674 | 44956 | 4466 | 49166 | 3503 | 52619 | 2008 | 64418 | 816 | 56432 |
| 22-#18 | 4.86 | 27763 | 7998 | 45359 | 6546 | 56676 | 5108 | 63042 | 3908 | 71146 | 1943 | 90728 | 57 | 90345 |

## ROUND TIED COLUMNS 48" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 23-#11 | 1.98 | 23660 | 6103 | 32095 | 5389 | 40631 | 4260 | 44101 | 3377 | 46047 | 2065 | 55296 | 1115 | 43063 |
| 23-#14 | 2.86 | 24973 | 6680 | 36144 | 5749 | 45542 | 4525 | 49926 | 3547 | 53771 | 2038 | 66333 | 804 | 58616 |
| 23-#18 | 5.08 | 28075 | 8143 | 46141 | 6664 | 57713 | 5197 | 64402 | 3975 | 72918 | 1958 | 93557 | -9 | 93495 |
| 24-#11 | 2.07 | 23787 | 6160 | 32389 | 5436 | 41076 | 4297 | 44670 | 3403 | 46859 | 2072 | 56477 | 1096 | 44681 |
| 24-#14 | 2.98 | 25159 | 6762 | 36595 | 5815 | 46184 | 4576 | 50739 | 3583 | 54905 | 2045 | 68005 | 774 | 60687 |
| 25-#11 | 2.16 | 23942 | 6217 | 32858 | 5466 | 41599 | 4317 | 45278 | 3414 | 47613 | 2062 | 57556 | 1055 | 46283 |
| 25-#14 | 3.11 | 25364 | 6844 | 37244 | 5860 | 46931 | 4607 | 51606 | 3600 | 56005 | 2033 | 69550 | 717 | 62929 |
| 26-#11 | 2.24 | 24089 | 6273 | 33382 | 5492 | 42150 | 4333 | 45917 | 3422 | 48422 | 2050 | 58604 | 1023 | 47925 |
| 26-#14 | 3.23 | 25555 | 6925 | 37931 | 5902 | 47699 | 4635 | 52530 | 3615 | 57176 | 2019 | 71074 | 672 | 64934 |
| 27-#11 | 2.33 | 24227 | 6330 | 33670 | 5538 | 42574 | 4374 | 46458 | 3452 | 49181 | 2060 | 59804 | 997 | 49457 |
| 27-#14 | 3.36 | 25756 | 7007 | 38406 | 5962 | 48324 | 4689 | 53291 | 3653 | 58242 | 2028 | 72755 | 631 | 67088 |
| 28-#11 | 2.41 | 24381 | 6387 | 34027 | 5578 | 43033 | 4410 | 47034 | 3477 | 49981 | 2065 | 60978 | 977 | 51094 |
| 28-#14 | 3.48 | 25967 | 7089 | 38934 | 6018 | 48994 | 4739 | 54113 | 3688 | 59388 | 2035 | 74414 | 600 | 69170 |
| 29-#11 | 2.50 | 24504 | 6443 | 34437 | 5615 | 43553 | 4432 | 47633 | 3489 | 50749 | 2057 | 62129 | 946 | 52558 |
| 29-#14 | 3.61 | 26130 | 7171 | 39503 | 6072 | 49723 | 4771 | 54980 | 3707 | 60480 | 2024 | 76065 | 556 | 71238 |
| 30-#11 | 2.59 | 24633 | 6500 | 34961 | 5638 | 44096 | 4451 | 48252 | 3498 | 51561 | 2048 | 63143 | 906 | 54112 |
| 30-#14 | 3.73 | 26328 | 7252 | 40218 | 6110 | 50484 | 4802 | 55864 | 3723 | 61651 | 2012 | 77529 | 499 | 73440 |
| 31-#11 | 2.67 | 24787 | 6557 | 35201 | 5691 | 44526 | 4488 | 48807 | 3526 | 52319 | 2055 | 64378 | 888 | 55632 |
| 31-#14 | 3.85 | 26522 | 7334 | 40602 | 6183 | 51121 | 4852 | 56656 | 3759 | 62720 | 2019 | 79267 | 470 | 75358 |
| 32-#11 | 2.76 | 24918 | 6613 | 35584 | 5731 | 44979 | 4522 | 49401 | 3551 | 53105 | 2059 | 65502 | 855 | 57123 |
| 33-#11 | 2.84 | 25057 | 6670 | 36018 | 5762 | 45501 | 4545 | 49985 | 3563 | 53885 | 2052 | 66634 | 828 | 58673 |
| 34-#11 | 2.93 | 25207 | 6727 | 36469 | 5793 | 46044 | 4567 | 50604 | 3575 | 54702 | 2044 | 67853 | 799 | 60126 |
| 35-#11 | 3.02 | 25340 | 6784 | 36788 | 5839 | 46500 | 4597 | 51164 | 3600 | 55480 | 2054 | 68966 | 776 | 61670 |
| 36-#11 | 3.10 | 25471 | 6840 | 37110 | 5882 | 46981 | 4625 | 51740 | 3623 | 56235 | 2052 | 70156 | 751 | 63122 |
| 37-#11 | 3.19 | 25605 | 6897 | 37552 | 5915 | 47475 | 4653 | 52340 | 3637 | 57046 | 2051 | 71207 | 718 | 64619 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.38 | 3540 | 1821 | 5556 | 1327 | 5878 | 1039 | 5768 | 816 | 5296 | 503 | 5577 | 284 | 4060 |
| 4-#14 | 1.99 | 3606 | 1919 | 5843 | 1375 | 6201 | 1075 | 6143 | 834 | 5790 | 484 | 6206 | 203 | 5421 |
| 4-#18 | 3.54 | 3754 | 2167 | 6511 | 1497 | 6971 | 1166 | 7043 | 877 | 6979 | 431 | 7697 | -12 | 7684 |
| 5-#11 | 1.72 | 3630 | 1876 | 5781 | 1330 | 6066 | 1028 | 5965 | 797 | 5559 | 466 | 6018 | 235 | 4599 |
| 5-#14 | 2.49 | 3728 | 1999 | 6127 | 1392 | 6471 | 1070 | 6441 | 815 | 6190 | 437 | 6859 | 137 | 6153 |
| 5-#18 | 4.42 | 3950 | 2309 | 6941 | 1550 | 7437 | 1175 | 7580 | 859 | 7703 | 357 | 8843 | -122 | 8724 |
| 6-#11 | 2.07 | 3722 | 1932 | 6065 | 1294 | 6281 | 995 | 6175 | 758 | 5837 | 411 | 6158 | 145 | 5485 |
| 6-#14 | 2.98 | 3852 | 2078 | 6491 | 1365 | 6790 | 1042 | 6777 | 776 | 6635 | 368 | 7118 | 16 | 7049 |
| 6-#18 | 5.31 | 4138 | 2451 | 7500 | 1543 | 8004 | 1160 | 8215 | 817 | 8543 | 254 | 9378 | -327 | 9025 |
| 7-#11 | 2.41 | 3738 | 1987 | 6067 | 1417 | 6462 | 1091 | 6453 | 837 | 6236 | 468 | 6924 | 160 | 6064 |
| 7-#14 | 3.48 | 3877 | 2158 | 6540 | 1509 | 7025 | 1154 | 7117 | 867 | 7129 | 434 | 8107 | 24 | 7985 |
| 7-#18 | 6.19 | 4200 | 2593 | 7659 | 1743 | 8368 | 1310 | 8707 | 938 | 9267 | 340 | 11066 | -315 | 10342 |
| 8-#11 | 2.76 | 3795 | 2042 | 6181 | 1467 | 6657 | 1136 | 6701 | 870 | 6538 | 472 | 7475 | 152 | 6752 |
| 8-#14 | 3.98 | 3953 | 2238 | 6723 | 1575 | 7297 | 1213 | 7457 | 909 | 7539 | 435 | 8863 | 6 | 8835 |
| 8-#18 | 7.07 | 4312 | 2734 | 7995 | 1846 | 8823 | 1403 | 9263 | 1002 | 9934 | 332 | 12138 | -384 | 11178 |
| 9-#11 | 3.10 | 3854 | 2098 | 6367 | 1494 | 6856 | 1146 | 6930 | 870 | 6864 | 457 | 7861 | 89 | 7380 |
| 9-#14 | 4.48 | 4038 | 2318 | 6971 | 1617 | 7578 | 1229 | 7784 | 911 | 8007 | 415 | 9412 | -83 | 9292 |
| 9-#18 | 7.96 | 4477 | 2876 | 8395 | 1926 | 9299 | 1436 | 9826 | 1007 | 10741 | 297 | 13066 | -542 | 11833 |
| 10-#11 | 3.45 | 3893 | 2153 | 6597 | 1496 | 7079 | 1146 | 7175 | 861 | 7163 | 421 | 8193 | 42 | 7991 |
| 10-#14 | 4.97 | 4091 | 2398 | 7274 | 1629 | 7895 | 1238 | 8143 | 904 | 8447 | 367 | 9901 | -149 | 9697 |
| 11-#11 | 3.79 | 3957 | 2208 | 6674 | 1567 | 7249 | 1198 | 7403 | 900 | 7489 | 444 | 8717 | 9 | 8680 |
| 11-#14 | 5.47 | 4180 | 2477 | 7409 | 1721 | 8131 | 1302 | 8448 | 952 | 8883 | 394 | 10608 | -203 | 10261 |
| 12-#11 | 4.14 | 4022 | 2264 | 6812 | 1607 | 7443 | 1234 | 7641 | 925 | 7786 | 441 | 9181 | -14 | 9163 |
| 12-#14 | 5.97 | 4274 | 2557 | 7610 | 1775 | 8403 | 1351 | 8779 | 985 | 9387 | 407 | 11248 | -238 | 10825 |
| 13-#11 | 4.48 | 4064 | 2319 | 6985 | 1639 | 7642 | 1248 | 7891 | 936 | 8143 | 437 | 9624 | -59 | 9533 |
| 13-#14 | 6.47 | 4339 | 2637 | 7850 | 1823 | 8684 | 1373 | 9133 | 1002 | 9802 | 382 | 11876 | -304 | 11177 |
| 14-#11 | 4.83 | 4125 | 2374 | 7193 | 1655 | 7861 | 1260 | 8125 | 930 | 8482 | 417 | 9959 | -114 | 9789 |
| 15-#11 | 5.17 | 4175 | 2430 | 7299 | 1711 | 8036 | 1298 | 8361 | 964 | 8764 | 423 | 10473 | -139 | 10230 |
| 16-#11 | 5.52 | 4223 | 2485 | 7445 | 1747 | 8230 | 1331 | 8583 | 979 | 9085 | 423 | 11021 | -163 | 10546 |

## ROUND TIED COLUMNS 26" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#11 | 1.18 | 4480 | 2099 | 6924 | 1552 | 7362 | 1218 | 7218 | 961 | 6585 | 607 | 6911 | 375 | 4496 |
| 4-#14 | 1.70 | 4558 | 2197 | 7247 | 1599 | 7728 | 1254 | 7643 | 980 | 7144 | 589 | 7629 | 298 | 6249 |
| 4-#18 | 3.01 | 4735 | 2445 | 8025 | 1724 | 8608 | 1347 | 8670 | 1026 | 8498 | 541 | 9345 | 92 | 9012 |
| 5-#11 | 1.47 | 4586 | 2154 | 7202 | 1550 | 7573 | 1202 | 7434 | 938 | 6869 | 567 | 7398 | 324 | 5128 |
| 5-#14 | 2.12 | 4703 | 2276 | 7595 | 1613 | 8033 | 1244 | 7973 | 958 | 7583 | 540 | 8360 | 230 | 7028 |
| 5-#18 | 3.77 | 4967 | 2587 | 8529 | 1773 | 9136 | 1353 | 9273 | 1006 | 9307 | 466 | 10649 | -17 | 10631 |
| 6-#11 | 1.76 | 4688 | 2209 | 7542 | 1504 | 7813 | 1160 | 7657 | 893 | 7161 | 507 | 7533 | 232 | 6173 |
| 6-#14 | 2.54 | 4849 | 2356 | 8027 | 1575 | 8390 | 1209 | 8338 | 912 | 8064 | 467 | 8633 | 109 | 8116 |
| 6-#18 | 4.52 | 5210 | 2729 | 9182 | 1757 | 9777 | 1331 | 9979 | 958 | 10240 | 360 | 11245 | -220 | 10981 |
| 7-#11 | 2.06 | 4714 | 2265 | 7508 | 1640 | 8018 | 1268 | 7985 | 982 | 7634 | 573 | 8431 | 253 | 6848 |
| 7-#14 | 2.97 | 4878 | 2436 | 8051 | 1734 | 8657 | 1333 | 8738 | 1014 | 8644 | 542 | 9784 | 123 | 9080 |
| 7-#18 | 5.27 | 5266 | 2870 | 9335 | 1972 | 10190 | 1494 | 10550 | 1091 | 11080 | 456 | 13003 | -224 | 12623 |

## ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 2.35 | 4776 | 2320 | 7626 | 1694 | 8237 | 1317 | 8267 | 1018 | 7979 | 579 | 9058 | 248 | 7726 |
| 8-#14 | 3.39 | 4971 | 2516 | 8237 | 1803 | 8963 | 1396 | 9122 | 1060 | 9111 | 546 | 10643 | 110 | 10100 |
| 8-#18 | 6.03 | 5400 | 3012 | 9706 | 2079 | 10704 | 1591 | 11181 | 1160 | 11840 | 453 | 14418 | -261 | 13555 |
| 9-#11 | 2.64 | 4844 | 2375 | 7840 | 1719 | 8460 | 1326 | 8522 | 1017 | 8341 | 564 | 9493 | 186 | 8370 |
| 9-#14 | 3.81 | 5059 | 2596 | 8527 | 1844 | 9279 | 1411 | 9489 | 1061 | 9634 | 526 | 11267 | 21 | 11146 |
| 9-#18 | 6.78 | 5561 | 3154 | 10165 | 2159 | 11244 | 1625 | 11818 | 1166 | 12749 | 420 | 15483 | -417 | 14589 |
| 10-#11 | 2.94 | 4891 | 2431 | 8118 | 1719 | 8711 | 1323 | 8792 | 1006 | 8669 | 526 | 9858 | 139 | 9106 |
| 10-#14 | 4.24 | 5123 | 2675 | 8887 | 1854 | 9637 | 1417 | 9889 | 1052 | 10123 | 477 | 11813 | -43 | 11749 |
| 10-#18 | 7.53 | 5667 | 3296 | 10721 | 2194 | 11860 | 1650 | 12526 | 1162 | 13622 | 339 | 16456 | -531 | 15328 |
| 11-#11 | 3.23 | 4961 | 2486 | 8184 | 1794 | 8902 | 1379 | 9054 | 1049 | 9044 | 553 | 10459 | 110 | 9856 |
| 11-#14 | 4.66 | 5228 | 2755 | 9015 | 1950 | 9901 | 1486 | 10237 | 1105 | 10622 | 508 | 12621 | -92 | 12448 |
| 12-#11 | 3.53 | 5035 | 2541 | 8336 | 1836 | 9119 | 1417 | 9322 | 1076 | 9380 | 551 | 10990 | 89 | 10507 |
| 12-#14 | 5.09 | 5326 | 2835 | 9237 | 2006 | 10207 | 1537 | 10610 | 1140 | 11088 | 503 | 13353 | -125 | 13126 |
| 13-#11 | 3.82 | 5092 | 2597 | 8532 | 1868 | 9343 | 1431 | 9584 | 1080 | 9779 | 548 | 11487 | 45 | 11271 |
| 13-#14 | 5.51 | 5403 | 2915 | 9509 | 2054 | 10524 | 1560 | 11008 | 1157 | 11656 | 499 | 14060 | -189 | 13673 |
| 14-#11 | 4.11 | 5151 | 2652 | 8765 | 1881 | 9590 | 1442 | 9862 | 1080 | 10155 | 527 | 11865 | -9 | 11850 |
| 14-#14 | 5.93 | 5502 | 2994 | 9832 | 2079 | 10873 | 1579 | 11385 | 1151 | 12200 | 471 | 14604 | -266 | 14021 |
| 15-#11 | 4.41 | 5216 | 2707 | 8884 | 1940 | 9785 | 1483 | 10129 | 1117 | 10476 | 536 | 12448 | -31 | 12391 |
| 16-#11 | 4.70 | 5272 | 2763 | 9046 | 1978 | 10003 | 1517 | 10379 | 1133 | 10837 | 538 | 13069 | -54 | 12793 |
| 17-#11 | 5.00 | 5337 | 2818 | 9245 | 2005 | 10227 | 1534 | 10656 | 1146 | 11173 | 523 | 13481 | -100 | 13272 |
| 18-#11 | 5.29 | 5401 | 2873 | 9445 | 2031 | 10469 | 1550 | 10923 | 1145 | 11550 | 507 | 13966 | -148 | 13633 |

## ROUND TIED COLUMNS 28" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.01 | 5573 | 2399 | 8501 | 1796 | 9068 | 1410 | 8894 | 1118 | 8068 | 718 | 8441 | 472 | 4931 |
| 4-#14 | 1.46 | 5663 | 2496 | 8859 | 1843 | 9485 | 1448 | 9369 | 1138 | 8692 | 702 | 9247 | 397 | 6880 |
| 4-#18 | 2.60 | 5869 | 2745 | 9725 | 1968 | 10476 | 1542 | 10522 | 1187 | 10211 | 658 | 11190 | 201 | 10369 |
| 5-#11 | 1.27 | 5694 | 2454 | 8830 | 1788 | 9312 | 1390 | 9126 | 1091 | 8370 | 676 | 8969 | 419 | 5664 |
| 5-#14 | 1.83 | 5830 | 2576 | 9278 | 1851 | 9826 | 1433 | 9728 | 1112 | 9168 | 651 | 10051 | 329 | 7774 |
| 5-#18 | 3.25 | 6139 | 2887 | 10332 | 2013 | 11068 | 1544 | 11189 | 1164 | 11103 | 582 | 12648 | 91 | 12132 |
| 6-#11 | 1.52 | 5803 | 2509 | 9239 | 1731 | 9575 | 1339 | 9358 | 1038 | 8671 | 611 | 9090 | 324 | 6789 |
| 6-#14 | 2.19 | 5986 | 2656 | 9783 | 1803 | 10221 | 1389 | 10120 | 1059 | 9679 | 573 | 10330 | 205 | 9238 |
| 6-#18 | 3.90 | 6415 | 3028 | 11086 | 1987 | 11781 | 1514 | 11964 | 1109 | 12124 | 472 | 13297 | -111 | 13153 |
| 7-#11 | 1.77 | 5842 | 2565 | 9159 | 1882 | 9805 | 1460 | 9742 | 1138 | 9226 | 685 | 10131 | 352 | 7588 |
| 7-#14 | 2.56 | 6034 | 2736 | 9764 | 1976 | 10520 | 1526 | 10582 | 1172 | 10353 | 656 | 11655 | 226 | 10250 |
| 7-#18 | 4.55 | 6474 | 3170 | 11225 | 2218 | 12244 | 1691 | 12619 | 1254 | 13087 | 578 | 15307 | -107 | 15129 |
| 8-#11 | 2.03 | 5914 | 2620 | 9280 | 1939 | 10039 | 1512 | 10058 | 1178 | 9615 | 694 | 10684 | 331 | 8644 |
| 8-#14 | 2.92 | 6143 | 2816 | 9961 | 2049 | 10858 | 1592 | 11013 | 1221 | 10879 | 663 | 12403 | 190 | 11422 |
| 8-#18 | 5.20 | 6646 | 3312 | 11603 | 2328 | 12818 | 1793 | 13327 | 1327 | 13942 | 579 | 16897 | -137 | 16181 |
| 9-#11 | 2.28 | 5987 | 2675 | 9524 | 1963 | 10295 | 1519 | 10339 | 1176 | 10013 | 678 | 11320 | 288 | 9397 |
| 9-#14 | 3.29 | 6234 | 2895 | 10290 | 2088 | 11211 | 1607 | 11420 | 1222 | 11456 | 644 | 13317 | 129 | 12507 |
| 9-#18 | 5.85 | 6812 | 3454 | 12138 | 2407 | 13421 | 1826 | 14036 | 1334 | 14953 | 547 | 18098 | -292 | 17410 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.53 | 6042 | 2731 | 9842 | 1958 | 10574 | 1514 | 10633 | 1162 | 10368 | 639 | 11716 | 241 | 10268 |
| 10-#14 | 3.65 | 6310 | 2975 | 10715 | 2096 | 11610 | 1609 | 11859 | 1211 | 11991 | 593 | 13917 | 65 | 13552 |
| 10-#18 | 6.50 | 6935 | 3596 | 12782 | 2440 | 14110 | 1849 | 14823 | 1328 | 15921 | 466 | 19184 | -401 | 18307 |
| 11-#11 | 2.79 | 6123 | 2786 | 9903 | 2040 | 10783 | 1575 | 10930 | 1209 | 10794 | 669 | 12398 | 216 | 11043 |
| 11-#14 | 4.02 | 6423 | 3055 | 10830 | 2196 | 11903 | 1684 | 12252 | 1268 | 12555 | 628 | 14830 | 21 | 14730 |
| 11-#18 | 7.15 | 7136 | 3738 | 13068 | 2593 | 14600 | 1957 | 15451 | 1409 | 16820 | 512 | 20656 | -498 | 19359 |
| 12-#11 | 3.04 | 6201 | 2841 | 10068 | 2083 | 11018 | 1613 | 11228 | 1237 | 11170 | 669 | 12995 | 196 | 11816 |
| 12-#14 | 4.38 | 6534 | 3135 | 11073 | 2255 | 12242 | 1737 | 12668 | 1305 | 13076 | 625 | 15656 | -10 | 15638 |
| 13-#11 | 3.29 | 6274 | 2897 | 10288 | 2114 | 11272 | 1628 | 11519 | 1241 | 11573 | 659 | 13546 | 154 | 12653 |
| 13-#14 | 4.75 | 6632 | 3215 | 11378 | 2302 | 12595 | 1759 | 13083 | 1312 | 13705 | 621 | 16442 | -72 | 16285 |
| 14-#11 | 3.55 | 6341 | 2952 | 10545 | 2124 | 11549 | 1637 | 11825 | 1241 | 12022 | 645 | 13965 | 99 | 13373 |
| 14-#14 | 5.12 | 6727 | 3294 | 11731 | 2324 | 12984 | 1777 | 13527 | 1315 | 14306 | 594 | 17052 | -148 | 16732 |
| 15-#11 | 3.80 | 6406 | 3007 | 10686 | 2180 | 11761 | 1680 | 12123 | 1280 | 12383 | 655 | 14621 | 80 | 14192 |
| 15-#14 | 5.48 | 6823 | 3374 | 11926 | 2406 | 13288 | 1833 | 13936 | 1366 | 14797 | 604 | 17952 | -181 | 17508 |
| 16-#11 | 4.05 | 6476 | 3062 | 10857 | 2227 | 11999 | 1715 | 12401 | 1297 | 12785 | 658 | 15163 | 39 | 14932 |
| 16-#14 | 5.85 | 6914 | 3454 | 12188 | 2460 | 13628 | 1882 | 14325 | 1389 | 15361 | 606 | 18706 | -242 | 18064 |
| 17-#11 | 4.31 | 6550 | 3118 | 11070 | 2253 | 12250 | 1732 | 12709 | 1310 | 13157 | 644 | 15774 | 13 | 15701 |
| 18-#11 | 4.56 | 6618 | 3173 | 11296 | 2278 | 12525 | 1748 | 13002 | 1309 | 13573 | 628 | 16313 | -34 | 16238 |
| 19-#11 | 4.81 | 6693 | 3228 | 11457 | 2325 | 12740 | 1784 | 13294 | 1341 | 13932 | 632 | 16851 | -63 | 16697 |
| 20-#11 | 5.07 | 6771 | 3284 | 11629 | 2369 | 12980 | 1817 | 13574 | 1357 | 14331 | 634 | 17448 | -97 | 17198 |

## ROUND TIED COLUMNS 30" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.27 | 6932 | 2819 | 10695 | 2105 | 11475 | 1654 | 11337 | 1307 | 10451 | 822 | 11076 | 503 | 7508 |
| 4-#18 | 2.26 | 7168 | 3067 | 11649 | 2230 | 12593 | 1752 | 12617 | 1358 | 12135 | 781 | 13245 | 313 | 11805 |
| 5-#11 | 1.10 | 6966 | 2776 | 10685 | 2044 | 11298 | 1592 | 11059 | 1256 | 10078 | 793 | 10745 | 520 | 6206 |
| 5-#14 | 1.59 | 7121 | 2898 | 11178 | 2107 | 11867 | 1636 | 11724 | 1277 | 10958 | 769 | 11948 | 432 | 8528 |
| 5-#18 | 2.83 | 7477 | 3209 | 12366 | 2271 | 13248 | 1749 | 13346 | 1332 | 13106 | 704 | 14853 | 203 | 13580 |
| 6-#11 | 1.32 | 7082 | 2831 | 11173 | 1975 | 11585 | 1531 | 11296 | 1194 | 10380 | 722 | 10844 | 421 | 7405 |
| 6-#14 | 1.91 | 7287 | 2978 | 11777 | 2048 | 12300 | 1582 | 12137 | 1216 | 11494 | 686 | 12224 | 305 | 10299 |
| 6-#18 | 3.40 | 7770 | 3351 | 13229 | 2233 | 14035 | 1709 | 14186 | 1270 | 14208 | 589 | 15547 | 1 | 15542 |
| 7-#11 | 1.54 | 7135 | 2887 | 11036 | 2142 | 11838 | 1666 | 11740 | 1306 | 11026 | 804 | 12039 | 457 | 8339 |
| 7-#14 | 2.23 | 7354 | 3058 | 11703 | 2236 | 12631 | 1733 | 12669 | 1341 | 12271 | 778 | 13735 | 335 | 11407 |
| 7-#18 | 3.96 | 7860 | 3492 | 13320 | 2479 | 14548 | 1901 | 14930 | 1428 | 15304 | 706 | 17821 | 12 | 17742 |
| 8-#11 | 1.77 | 7216 | 2942 | 11158 | 2204 | 12086 | 1721 | 12091 | 1349 | 11462 | 816 | 12661 | 439 | 9460 |
| 8-#14 | 2.55 | 7467 | 3138 | 11909 | 2313 | 12987 | 1802 | 13147 | 1394 | 12857 | 788 | 14572 | 302 | 12800 |
| 8-#18 | 4.53 | 8060 | 3634 | 13725 | 2594 | 15180 | 2007 | 15716 | 1505 | 16256 | 710 | 19589 | -11 | 19062 |
| 9-#11 | 1.99 | 7294 | 2997 | 11433 | 2225 | 12370 | 1727 | 12398 | 1345 | 11894 | 800 | 13356 | 395 | 10351 |
| 9-#14 | 2.86 | 7575 | 3218 | 12278 | 2351 | 13390 | 1816 | 13593 | 1393 | 13488 | 768 | 15577 | 241 | 13912 |
| 9-#18 | 5.09 | 8231 | 3776 | 14324 | 2673 | 15848 | 2040 | 16498 | 1511 | 17367 | 679 | 20927 | -165 | 20511 |
| 10-#11 | 2.21 | 7358 | 3053 | 11789 | 2215 | 12685 | 1718 | 12716 | 1328 | 12274 | 759 | 13780 | 348 | 11454 |
| 10-#14 | 3.18 | 7663 | 3297 | 12749 | 2353 | 13832 | 1816 | 14070 | 1379 | 14067 | 716 | 16228 | 178 | 15132 |
| 10-#18 | 5.66 | 8373 | 3918 | 15074 | 2704 | 16610 | 2060 | 17361 | 1504 | 18428 | 598 | 22122 | -272 | 21485 |

## ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway $f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 11-#11 | 2.43 | 7449 | 3108 | 11848 | 2303 | 12905 | 1783 | 13048 | 1381 | 12754 | 793 | 14547 | 327 | 12269 |
| 11-#14 | 3.50 | 7790 | 3377 | 12871 | 2461 | 14147 | 1895 | 14510 | 1442 | 14699 | 755 | 17251 | 138 | 16389 |
| 11-#18 | 6.22 | 8601 | 4060 | 15350 | 2861 | 17150 | 2174 | 18061 | 1590 | 19431 | 649 | 23765 | -361 | 22771 |
| 12-#11 | 2.65 | 7532 | 3163 | 12024 | 2349 | 13162 | 1824 | 13378 | 1410 | 13170 | 794 | 15213 | 308 | 13173 |
| 12-#14 | 3.82 | 7907 | 3457 | 13134 | 2521 | 14510 | 1949 | 14969 | 1481 | 15276 | 753 | 18172 | 109 | 17499 |
| 12-#18 | 6.79 | 8792 | 4202 | 15821 | 2958 | 17788 | 2263 | 18835 | 1651 | 20397 | 639 | 25297 | -419 | 24060 |
| 13-#11 | 2.87 | 7616 | 3219 | 12261 | 2378 | 13441 | 1838 | 13696 | 1414 | 13610 | 784 | 15816 | 267 | 14040 |
| 13-#14 | 4.14 | 8023 | 3537 | 13468 | 2568 | 14906 | 1972 | 15425 | 1488 | 15909 | 740 | 19036 | 49 | 18772 |
| 13-#18 | 7.36 | 9005 | 4344 | 16387 | 3046 | 18454 | 2305 | 19624 | 1667 | 21594 | 635 | 26791 | -529 | 24904 |
| 14-#11 | 3.09 | 7697 | 3274 | 12552 | 2386 | 13752 | 1846 | 14029 | 1412 | 14097 | 769 | 16276 | 211 | 14881 |
| 14-#14 | 4.46 | 8135 | 3617 | 13858 | 2587 | 15344 | 1989 | 15910 | 1490 | 16620 | 722 | 19710 | -28 | 19647 |
| 15-#11 | 3.31 | 7765 | 3329 | 12698 | 2446 | 13979 | 1891 | 14360 | 1454 | 14500 | 781 | 17005 | 195 | 15800 |
| 15-#14 | 4.77 | 8238 | 3696 | 14089 | 2663 | 15667 | 2047 | 16364 | 1543 | 17167 | 735 | 20710 | -57 | 20566 |
| 16-#11 | 3.53 | 7846 | 3385 | 12882 | 2493 | 14240 | 1927 | 14667 | 1472 | 14944 | 786 | 17608 | 155 | 16632 |
| 16-#14 | 5.09 | 8341 | 3776 | 14361 | 2729 | 16036 | 2096 | 16794 | 1567 | 17789 | 739 | 21550 | -117 | 21235 |
| 17-#11 | 3.75 | 7930 | 3440 | 13120 | 2519 | 14517 | 1944 | 15004 | 1485 | 15352 | 771 | 18279 | 131 | 17495 |
| 17-#14 | 5.41 | 8459 | 3856 | 14688 | 2768 | 16428 | 2122 | 17274 | 1588 | 18371 | 719 | 22505 | -152 | 21923 |
| 18-#11 | 3.97 | 8001 | 3495 | 13373 | 2543 | 14811 | 1959 | 15325 | 1483 | 15805 | 755 | 18872 | 83 | 18328 |
| 19-#11 | 4.19 | 8082 | 3551 | 13545 | 2592 | 15055 | 1997 | 15648 | 1517 | 16203 | 761 | 19468 | 57 | 19132 |
| 20-#11 | 4.41 | 8176 | 3606 | 13725 | 2636 | 15319 | 2031 | 15956 | 1534 | 16642 | 764 | 20125 | 25 | 20006 |
| 21-#11 | 4.63 | 8241 | 3661 | 13965 | 2665 | 15590 | 2049 | 16292 | 1549 | 17093 | 758 | 20646 | -14 | 20608 |

## ROUND TIED COLUMNS 32" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.12 | 8377 | 3163 | 12771 | 2387 | 13730 | 1876 | 13566 | 1489 | 12434 | 951 | 13130 | 615 | 8135 |
| 4-#18 | 1.99 | 8643 | 3411 | 13815 | 2510 | 14957 | 1974 | 14973 | 1541 | 14283 | 913 | 15526 | 431 | 13320 |
| 5-#14 | 1.40 | 8588 | 3243 | 13324 | 2381 | 14174 | 1853 | 13979 | 1454 | 12971 | 894 | 14066 | 542 | 9290 |
| 5-#18 | 2.49 | 8992 | 3553 | 14633 | 2546 | 15695 | 1967 | 15762 | 1510 | 15330 | 833 | 17280 | 319 | 15081 |
| 6-#11 | 1.16 | 8537 | 3176 | 13361 | 2237 | 13860 | 1737 | 13487 | 1361 | 12303 | 840 | 12809 | 523 | 8022 |
| 6-#14 | 1.68 | 8764 | 3323 | 14025 | 2310 | 14645 | 1788 | 14409 | 1384 | 13523 | 805 | 14329 | 411 | 11184 |
| 6-#18 | 2.98 | 9302 | 3695 | 15626 | 2496 | 16554 | 1917 | 16662 | 1440 | 16506 | 713 | 18009 | 116 | 17358 |
| 7-#11 | 1.36 | 8604 | 3231 | 13155 | 2421 | 14129 | 1886 | 13997 | 1486 | 13049 | 932 | 14171 | 567 | 9101 |
| 7-#14 | 1.96 | 8851 | 3402 | 13886 | 2515 | 15001 | 1954 | 15015 | 1522 | 14411 | 907 | 16038 | 449 | 12458 |
| 7-#18 | 3.48 | 9425 | 3837 | 15658 | 2759 | 17118 | 2125 | 17501 | 1611 | 17744 | 840 | 20560 | 136 | 19624 |
| 8-#11 | 1.55 | 8694 | 3286 | 13276 | 2487 | 14398 | 1944 | 14379 | 1531 | 13534 | 946 | 14864 | 553 | 10282 |
| 8-#14 | 2.24 | 8977 | 3482 | 14097 | 2597 | 15381 | 2026 | 15542 | 1578 | 15061 | 920 | 16968 | 420 | 14234 |
| 8-#18 | 3.98 | 9653 | 3979 | 16089 | 2878 | 17791 | 2234 | 18366 | 1693 | 18795 | 849 | 22064 | 70 | 21813 |
| 9-#11 | 1.75 | 8777 | 3342 | 13584 | 2506 | 14708 | 1949 | 14717 | 1527 | 13999 | 930 | 15617 | 508 | 11314 |
| 9-#14 | 2.52 | 9093 | 3562 | 14508 | 2633 | 15822 | 2039 | 16025 | 1576 | 15744 | 900 | 18063 | 359 | 15362 |
| 9-#18 | 4.48 | 9829 | 4121 | 16753 | 2956 | 18541 | 2268 | 19220 | 1699 | 20006 | 818 | 23982 | -35 | 23897 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway $f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.94 | 8850 | 3397 | 13981 | 2491 | 15063 | 1937 | 15056 | 1506 | 14401 | 886 | 16065 | 460 | 12476 |
| 10-#14 | 2.80 | 9193 | 3642 | 15028 | 2629 | 16320 | 2035 | 16540 | 1559 | 16364 | 846 | 18761 | 295 | 16770 |
| 10-#18 | 4.97 | 9992 | 4262 | 17586 | 2982 | 19377 | 2284 | 20159 | 1689 | 21157 | 736 | 25284 | -140 | 24938 |
| 11-#11 | 2.13 | 8951 | 3452 | 14029 | 2585 | 15291 | 2007 | 15427 | 1564 | 14938 | 924 | 16921 | 443 | 13453 |
| 11-#14 | 3.08 | 9334 | 3722 | 15154 | 2744 | 16648 | 2119 | 17028 | 1626 | 17068 | 889 | 19898 | 260 | 18066 |
| 11-#18 | 5.47 | 10247 | 4404 | 17874 | 3146 | 19967 | 2404 | 20933 | 1781 | 22268 | 792 | 27103 | -223 | 26446 |
| 12-#11 | 2.33 | 9040 | 3508 | 14219 | 2633 | 15571 | 2049 | 15781 | 1594 | 15395 | 926 | 17657 | 426 | 14579 |
| 12-#14 | 3.36 | 9458 | 3801 | 15434 | 2806 | 17044 | 2176 | 17531 | 1667 | 17701 | 889 | 20916 | 232 | 19347 |
| 12-#18 | 5.97 | 10445 | 4546 | 18385 | 3246 | 20646 | 2494 | 21781 | 1845 | 23329 | 784 | 28798 | -279 | 27975 |
| 13-#11 | 2.52 | 9135 | 3563 | 14475 | 2661 | 15876 | 2062 | 16133 | 1598 | 15873 | 917 | 18312 | 385 | 15466 |
| 13-#14 | 3.64 | 9589 | 3881 | 15793 | 2851 | 17477 | 2198 | 18027 | 1674 | 18389 | 876 | 21858 | 174 | 20776 |
| 13-#18 | 6.47 | 10662 | 4688 | 19008 | 3334 | 21390 | 2538 | 22644 | 1860 | 24530 | 763 | 30435 | -385 | 28899 |
| 14-#11 | 2.72 | 9230 | 3618 | 14801 | 2667 | 16207 | 2067 | 16493 | 1594 | 16397 | 900 | 18810 | 329 | 16439 |
| 14-#14 | 3.92 | 9721 | 3961 | 16227 | 2868 | 17958 | 2213 | 18554 | 1675 | 19159 | 857 | 22593 | 97 | 21941 |
| 14-#18 | 6.96 | 10924 | 4830 | 19705 | 3380 | 22204 | 2577 | 23578 | 1872 | 25899 | 736 | 31734 | -517 | 29956 |
| 15-#11 | 2.91 | 9302 | 3674 | 14950 | 2729 | 16462 | 2117 | 16836 | 1632 | 16843 | 915 | 19616 | 315 | 17409 |
| 15-#14 | 4.20 | 9822 | 4041 | 16470 | 2948 | 18307 | 2275 | 19052 | 1731 | 19763 | 873 | 23696 | 70 | 23271 |
| 16-#11 | 3.10 | 9384 | 3729 | 15141 | 2778 | 16747 | 2154 | 17186 | 1658 | 17329 | 920 | 20281 | 276 | 18345 |
| 16-#14 | 4.48 | 9947 | 4121 | 16757 | 3015 | 18711 | 2325 | 19523 | 1757 | 20444 | 878 | 24623 | 12 | 24540 |
| 17-#11 | 3.30 | 9486 | 3784 | 15410 | 2804 | 17044 | 2170 | 17556 | 1671 | 17772 | 906 | 20925 | 243 | 19313 |
| 17-#14 | 4.76 | 10078 | 4200 | 17123 | 3054 | 19139 | 2351 | 20047 | 1777 | 21078 | 858 | 25665 | -21 | 25442 |
| 18-#11 | 3.49 | 9562 | 3840 | 15692 | 2826 | 17361 | 2183 | 17908 | 1668 | 18261 | 890 | 21656 | 205 | 20194 |
| 18-#14 | 5.04 | 10183 | 4280 | 17505 | 3091 | 19593 | 2374 | 20551 | 1776 | 21788 | 837 | 26596 | -88 | 26316 |
| 19-#11 | 3.69 | 9651 | 3895 | 15865 | 2877 | 17626 | 2223 | 18258 | 1704 | 18701 | 897 | 22311 | 181 | 21129 |
| 19-#14 | 5.32 | 10317 | 4360 | 17778 | 3159 | 19968 | 2426 | 21041 | 1823 | 22393 | 844 | 27503 | -128 | 27091 |
| 20-#11 | 3.88 | 9752 | 3950 | 16060 | 2922 | 17923 | 2259 | 18592 | 1721 | 19180 | 901 | 23030 | 152 | 22041 |
| 21-#11 | 4.07 | 9830 | 4006 | 16323 | 2950 | 18210 | 2276 | 18959 | 1736 | 19670 | 895 | 23602 | 112 | 22944 |
| 22-#11 | 4.27 | 9913 | 4061 | 16600 | 2978 | 18525 | 2294 | 19317 | 1738 | 20122 | 875 | 24241 | 71 | 23865 |
| 23-#11 | 4.46 | 10000 | 4116 | 16785 | 3023 | 18795 | 2329 | 19661 | 1768 | 20596 | 886 | 24982 | 51 | 24685 |

## ROUND TIED COLUMNS 34" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.76 | 10306 | 3778 | 16236 | 2810 | 17595 | 2211 | 17606 | 1735 | 16672 | 1052 | 18049 | 555 | 14780 |
| 5-#14 | 1.24 | 10243 | 3609 | 15730 | 2674 | 16765 | 2084 | 16508 | 1642 | 15219 | 1028 | 16419 | 657 | 10060 |
| 5-#18 | 2.20 | 10694 | 3920 | 17154 | 2838 | 18425 | 2200 | 18453 | 1700 | 17790 | 969 | 19942 | 440 | 16608 |
| 6-#11 | 1.03 | 10178 | 3542 | 15818 | 2516 | 16419 | 1956 | 15948 | 1539 | 14454 | 965 | 14998 | 631 | 8639 |
| 6-#14 | 1.49 | 10429 | 3689 | 16542 | 2589 | 17272 | 2007 | 16951 | 1562 | 15780 | 932 | 16659 | 522 | 12070 |
| 6-#18 | 2.64 | 11022 | 4062 | 18294 | 2776 | 19357 | 2139 | 19409 | 1621 | 19033 | 844 | 20697 | 235 | 19250 |
| 7-#11 | 1.20 | 10260 | 3598 | 15533 | 2718 | 16703 | 2121 | 16532 | 1677 | 15268 | 1061 | 16542 | 684 | 9876 |
| 7-#14 | 1.73 | 10535 | 3769 | 16326 | 2813 | 17648 | 2189 | 17638 | 1714 | 16791 | 1044 | 18580 | 568 | 13523 |
| 7-#18 | 3.08 | 11178 | 4203 | 18255 | 3057 | 19972 | 2363 | 20349 | 1806 | 20422 | 982 | 23538 | 264 | 21562 |
| 8-#11 | 1.37 | 10359 | 3653 | 15647 | 2789 | 16993 | 2183 | 16939 | 1725 | 15846 | 1084 | 17309 | 673 | 11109 |
| 8-#14 | 1.98 | 10675 | 3849 | 16540 | 2899 | 18058 | 2265 | 18202 | 1773 | 17506 | 1060 | 19606 | 543 | 15404 |
| 8-#18 | 3.52 | 11437 | 4345 | 18709 | 3181 | 20675 | 2475 | 21294 | 1892 | 21575 | 994 | 25193 | 203 | 24056 |

## ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 9-#11 | 1.55 | 10446 | 3708 | 15990 | 2806 | 17330 | 2186 | 17308 | 1720 | 16344 | 1067 | 18119 | 627 | 12293 |
| 9-#14 | 2.23 | 10798 | 3929 | 16995 | 2932 | 18537 | 2276 | 18735 | 1771 | 18239 | 1039 | 20789 | 481 | 16797 |
| 9-#18 | 3.97 | 11618 | 4487 | 19440 | 3257 | 21502 | 2508 | 22219 | 1897 | 22886 | 963 | 27278 | 98 | 26550 |
| 10-#11 | 1.72 | 10530 | 3764 | 16434 | 2784 | 17718 | 2169 | 17672 | 1696 | 16764 | 1021 | 18586 | 578 | 13507 |
| 10-#14 | 2.48 | 10910 | 4008 | 17568 | 2922 | 19091 | 2269 | 19285 | 1750 | 18898 | 983 | 21530 | 418 | 18464 |
| 10-#18 | 4.41 | 11801 | 4629 | 20345 | 3276 | 22429 | 2521 | 23233 | 1884 | 24124 | 879 | 28683 | -5 | 28671 |
| 11-#11 | 1.89 | 10642 | 3819 | 16463 | 2886 | 17961 | 2245 | 18074 | 1757 | 17362 | 1063 | 19537 | 564 | 14626 |
| 11-#14 | 2.73 | 11067 | 4088 | 17684 | 3045 | 19433 | 2358 | 19823 | 1822 | 19676 | 1030 | 22786 | 387 | 19825 |
| 11-#18 | 4.85 | 12067 | 4771 | 20656 | 3450 | 23042 | 2646 | 24082 | 1982 | 25345 | 940 | 30683 | -82 | 30427 |
| 12-#11 | 2.06 | 10735 | 3874 | 16669 | 2936 | 18263 | 2289 | 18458 | 1790 | 17862 | 1067 | 20344 | 549 | 15835 |
| 12-#14 | 2.97 | 11198 | 4168 | 17990 | 3110 | 19861 | 2416 | 20358 | 1864 | 20367 | 1032 | 23902 | 361 | 21253 |
| 12-#18 | 5.29 | 12290 | 4913 | 21205 | 3552 | 23780 | 2738 | 25006 | 2048 | 26503 | 935 | 32544 | -136 | 32125 |
| 13-#11 | 2.23 | 10838 | 3930 | 16945 | 2963 | 18594 | 2301 | 18837 | 1793 | 18376 | 1057 | 20959 | 499 | 16880 |
| 13-#14 | 3.22 | 11344 | 4248 | 18374 | 3153 | 20331 | 2438 | 20904 | 1872 | 21110 | 1019 | 24921 | 303 | 22729 |
| 13-#18 | 5.73 | 12532 | 5055 | 21867 | 3638 | 24588 | 2782 | 25943 | 2064 | 27805 | 915 | 34323 | -239 | 33216 |
| 14-#11 | 2.41 | 10951 | 3985 | 17308 | 2965 | 18944 | 2304 | 19234 | 1788 | 18850 | 1026 | 21585 | 452 | 18046 |
| 14-#14 | 3.47 | 11497 | 4328 | 18855 | 3168 | 20840 | 2450 | 21475 | 1871 | 21937 | 1000 | 25716 | 225 | 24062 |
| 14-#18 | 6.17 | 12790 | 5196 | 22635 | 3682 | 25501 | 2822 | 26954 | 2075 | 29285 | 888 | 35742 | -371 | 34419 |
| 15-#11 | 2.58 | 11026 | 4040 | 17458 | 3032 | 19222 | 2356 | 19599 | 1827 | 19427 | 1056 | 22469 | 440 | 19041 |
| 15-#14 | 3.72 | 11603 | 4407 | 19106 | 3251 | 21231 | 2516 | 21984 | 1919 | 22600 | 1017 | 26924 | 202 | 25593 |
| 15-#18 | 6.61 | 12982 | 5338 | 23135 | 3807 | 26138 | 2917 | 27854 | 2163 | 30366 | 906 | 37739 | -426 | 36141 |
| 16-#11 | 2.75 | 11117 | 4096 | 17655 | 3081 | 19536 | 2395 | 19979 | 1855 | 19955 | 1063 | 23197 | 402 | 20109 |
| 16-#14 | 3.97 | 11730 | 4487 | 19405 | 3318 | 21668 | 2568 | 22517 | 1956 | 23339 | 1024 | 27939 | 145 | 26878 |
| 17-#11 | 2.92 | 11229 | 4151 | 17951 | 3106 | 19850 | 2410 | 20379 | 1868 | 20433 | 1049 | 23893 | 370 | 21107 |
| 17-#14 | 4.21 | 11884 | 4567 | 19814 | 3358 | 22123 | 2593 | 23090 | 1977 | 24025 | 1005 | 28936 | 99 | 28317 |
| 18-#11 | 3.09 | 11311 | 4206 | 18267 | 3127 | 20194 | 2422 | 20760 | 1864 | 20958 | 1032 | 24682 | 332 | 22112 |
| 18-#14 | 4.46 | 11998 | 4647 | 20234 | 3394 | 22613 | 2615 | 23641 | 1976 | 24791 | 983 | 30078 | 46 | 29743 |
| 19-#11 | 3.26 | 11410 | 4262 | 18441 | 3180 | 20480 | 2464 | 21139 | 1901 | 21439 | 1041 | 25396 | 311 | 23162 |
| 19-#14 | 4.71 | 12138 | 4726 | 20513 | 3463 | 23018 | 2669 | 24167 | 2024 | 25452 | 992 | 31065 | 10 | 31008 |
| 20-#11 | 3.44 | 11517 | 4317 | 18649 | 3226 | 20796 | 2500 | 21501 | 1919 | 21959 | 1045 | 26177 | 282 | 24114 |
| 20-#14 | 4.96 | 12288 | 4806 | 20816 | 3526 | 23476 | 2719 | 24678 | 2047 | 26184 | 996 | 32165 | -33 | 32048 |
| 21-#11 | 3.61 | 11609 | 4372 | 18937 | 3254 | 21112 | 2518 | 21899 | 1935 | 22445 | 1032 | 26801 | 243 | 25150 |
| 22-#11 | 3.78 | 11699 | 4428 | 19234 | 3280 | 21454 | 2535 | 22277 | 1935 | 22974 | 1019 | 27490 | 203 | 26114 |
| 23-#11 | 3.95 | 11792 | 4483 | 19436 | 3328 | 21745 | 2571 | 22658 | 1968 | 23491 | 1031 | 28300 | 184 | 27089 |
| 24-#11 | 4.12 | 11889 | 4538 | 19657 | 3372 | 22050 | 2605 | 23023 | 1984 | 23968 | 1027 | 28968 | 149 | 28092 |
| 25-#11 | 4.30 | 11987 | 4594 | 19930 | 3401 | 22373 | 2624 | 23416 | 2000 | 24495 | 1022 | 29714 | 114 | 28986 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.57 | 12168 | 4167 | 18928 | 3129 | 20533 | 2462 | 20528 | 1941 | 19316 | 1199 | 20828 | 684 | 15900 |
| 5-#14 | 1.11 | 12096 | 3998 | 18413 | 2985 | 19651 | 2330 | 19330 | 1842 | 17719 | 1169 | 19023 | 779 | 10839 |
| 5-#18 | 1.96 | 12596 | 4308 | 19952 | 3148 | 21457 | 2446 | 21437 | 1901 | 20502 | 1113 | 22855 | 567 | 17918 |
| 6-#14 | 1.33 | 12292 | 4078 | 19346 | 2886 | 20201 | 2241 | 19780 | 1751 | 18281 | 1066 | 19229 | 638 | 12956 |
| 6-#18 | 2.36 | 12942 | 4450 | 21250 | 3074 | 22462 | 2373 | 22444 | 1812 | 21803 | 981 | 23624 | 358 | 21216 |
| 7-#11 | 1.07 | 12114 | 3986 | 18183 | 3034 | 19577 | 2370 | 19355 | 1880 | 17780 | 1204 | 19166 | 807 | 10662 |
| 7-#14 | 1.55 | 12419 | 4158 | 19040 | 3129 | 20595 | 2438 | 20554 | 1917 | 19358 | 1179 | 21376 | 694 | 14603 |
| 7-#18 | 2.75 | 13132 | 4592 | 21127 | 3373 | 23104 | 2613 | 23491 | 2012 | 23354 | 1130 | 26770 | 397 | 23557 |
| 8-#11 | 1.23 | 12224 | 4042 | 18289 | 3110 | 19888 | 2436 | 19795 | 1931 | 18415 | 1231 | 20010 | 799 | 11942 |
| 8-#14 | 1.77 | 12572 | 4238 | 19253 | 3220 | 21035 | 2518 | 21153 | 1979 | 20206 | 1208 | 22501 | 673 | 16576 |
| 8-#18 | 3.14 | 13392 | 4734 | 21600 | 3503 | 23861 | 2729 | 24512 | 2102 | 24612 | 1146 | 28579 | 341 | 26374 |
| 9-#11 | 1.38 | 12315 | 4097 | 18669 | 3124 | 20252 | 2437 | 20188 | 1924 | 18943 | 1213 | 20875 | 753 | 13287 |
| 9-#14 | 1.99 | 12703 | 4317 | 19755 | 3251 | 21553 | 2528 | 21732 | 1976 | 20989 | 1187 | 23770 | 610 | 18159 |
| 9-#18 | 3.54 | 13608 | 4876 | 22401 | 3576 | 24755 | 2761 | 25513 | 2106 | 26019 | 1115 | 30831 | 236 | 28939 |
| 10-#11 | 1.53 | 12409 | 4152 | 19163 | 3096 | 20663 | 2415 | 20581 | 1897 | 19380 | 1164 | 21358 | 701 | 14548 |
| 10-#14 | 2.21 | 12828 | 4397 | 20385 | 3234 | 22152 | 2516 | 22323 | 1952 | 21683 | 1127 | 24551 | 545 | 20099 |
| 10-#18 | 3.93 | 13812 | 5018 | 23381 | 3589 | 25782 | 2772 | 26600 | 2090 | 27342 | 1029 | 32335 | 134 | 31387 |
| 11-#11 | 1.69 | 12531 | 4208 | 19169 | 3205 | 20931 | 2497 | 21014 | 1963 | 20042 | 1210 | 22408 | 692 | 15819 |
| 11-#14 | 2.43 | 12999 | 4477 | 20485 | 3364 | 22518 | 2612 | 22898 | 2029 | 22540 | 1179 | 25930 | 519 | 21596 |
| 11-#18 | 4.32 | 14103 | 5160 | 23708 | 3771 | 26418 | 2902 | 27527 | 2194 | 28678 | 1095 | 34520 | 62 | 34153 |
| 12-#11 | 1.84 | 12630 | 4263 | 19390 | 3258 | 21256 | 2543 | 21430 | 1997 | 20584 | 1215 | 23288 | 678 | 17077 |
| 12-#14 | 2.65 | 13138 | 4557 | 20817 | 3432 | 22979 | 2672 | 23477 | 2073 | 23289 | 1183 | 27146 | 494 | 23217 |
| 12-#18 | 4.72 | 14338 | 5301 | 24297 | 3877 | 27214 | 2997 | 28521 | 2262 | 29933 | 1093 | 36549 | 11 | 36473 |
| 13-#11 | 1.99 | 12742 | 4318 | 19685 | 3283 | 21610 | 2555 | 21836 | 2000 | 21134 | 1205 | 23947 | 628 | 18263 |
| 13-#14 | 2.87 | 13299 | 4637 | 21226 | 3474 | 23486 | 2692 | 24063 | 2079 | 24086 | 1170 | 28102 | 424 | 24732 |
| 13-#18 | 5.11 | 14605 | 5443 | 24999 | 3961 | 28088 | 3040 | 29537 | 2278 | 31336 | 1073 | 38469 | -90 | 37826 |
| 14-#11 | 2.15 | 12871 | 4374 | 20089 | 3283 | 21983 | 2554 | 22259 | 1993 | 21636 | 1172 | 24613 | 580 | 19556 |
| 14-#14 | 3.09 | 13473 | 4716 | 21756 | 3485 | 24023 | 2702 | 24689 | 2078 | 24838 | 1129 | 29094 | 359 | 26243 |
| 14-#18 | 5.50 | 14899 | 5585 | 25840 | 4002 | 29054 | 3076 | 30625 | 2288 | 32925 | 1045 | 40007 | -222 | 39218 |
| 15-#11 | 2.30 | 12950 | 4429 | 20236 | 3353 | 22281 | 2610 | 22657 | 2035 | 22266 | 1205 | 25579 | 571 | 20664 |
| 15-#14 | 3.32 | 13584 | 4796 | 22014 | 3572 | 24445 | 2771 | 25228 | 2129 | 25692 | 1169 | 30409 | 339 | 27853 |
| 15-#18 | 5.89 | 15102 | 5727 | 26366 | 4131 | 29762 | 3176 | 31602 | 2379 | 34101 | 1067 | 42177 | -273 | 41112 |
| 16-#11 | 2.45 | 13049 | 4484 | 20439 | 3403 | 22626 | 2651 | 23067 | 2063 | 22837 | 1212 | 26370 | 534 | 21923 |
| 16-#14 | 3.54 | 13724 | 4876 | 22323 | 3641 | 24926 | 2825 | 25804 | 2166 | 26491 | 1177 | 31513 | 283 | 29354 |
| 16-#18 | 6.29 | 15340 | 5869 | 26949 | 4247 | 30573 | 3264 | 32536 | 2422 | 35461 | 1075 | 44036 | -377 | 42460 |
| 17-#11 | 2.61 | 13166 | 4540 | 20760 | 3428 | 22956 | 2665 | 23497 | 2076 | 23349 | 1199 | 27118 | 503 | 22945 |
| 17-#14 | 3.76 | 13888 | 4956 | 22769 | 3680 | 25405 | 2849 | 26420 | 2187 | 27229 | 1158 | 32587 | 238 | 30913 |
| 18-#11 | 2.76 | 13261 | 4595 | 21114 | 3447 | 23328 | 2675 | 23895 | 2071 | 23910 | 1181 | 27964 | 464 | 24082 |
| 18-#14 | 3.98 | 14015 | 5036 | 23237 | 3715 | 25934 | 2869 | 27011 | 2185 | 28049 | 1136 | 33816 | 185 | 32362 |
| 19-#11 | 2.91 | 13369 | 4650 | 21287 | 3502 | 23635 | 2720 | 24313 | 2110 | 24433 | 1192 | 28739 | 445 | 25186 |
| 19-#14 | 4.20 | 14167 | 5115 | 23520 | 3786 | 26370 | 2926 | 27581 | 2235 | 28767 | 1146 | 34885 | 152 | 33816 |
| 20-#11 | 3.07 | 13483 | 4706 | 21509 | 3549 | 23967 | 2756 | 24706 | 2129 | 24994 | 1196 | 29583 | 418 | 26240 |
| 20-#14 | 4.42 | 14326 | 5195 | 23844 | 3850 | 26852 | 2976 | 28132 | 2260 | 29557 | 1151 | 36074 | 111 | 35371 |

## ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway $f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 21-#11 | 3.22 | 13584 | 4761 | 21820 | 3577 | 24315 | 2774 | 25126 | 2144 | 25516 | 1184 | 30258 | 379 | 27386 |
| 21-#14 | 4.64 | 14472 | 5275 | 24280 | 3892 | 27337 | 3003 | 28743 | 2283 | 30305 | 1134 | 37034 | 55 | 36692 |
| 22-#11 | 3.37 | 13687 | 4816 | 22140 | 3601 | 24684 | 2790 | 25529 | 2143 | 26083 | 1171 | 30996 | 339 | 28396 |
| 22-#14 | 4.86 | 14613 | 5355 | 24723 | 3933 | 27861 | 3030 | 29328 | 2285 | 31126 | 1118 | 38103 | -1 | 38098 |
| 23-#11 | 3.52 | 13785 | 4872 | 22352 | 3651 | 24988 | 2827 | 25941 | 2177 | 26642 | 1184 | 31877 | 322 | 29505 |
| 24-#11 | 3.68 | 13881 | 4927 | 22594 | 3696 | 25317 | 2861 | 26345 | 2195 | 27156 | 1180 | 32600 | 287 | 30548 |
| 25-#11 | 3.83 | 13999 | 4982 | 22883 | 3724 | 25665 | 2881 | 26757 | 2211 | 27723 | 1176 | 33404 | 253 | 31625 |
| 26-#11 | 3.98 | 14097 | 5038 | 23189 | 3753 | 26039 | 2901 | 27165 | 2213 | 28252 | 1159 | 34055 | 210 | 32731 |
| 27-#11 | 4.14 | 14200 | 5093 | 23443 | 3791 | 26343 | 2935 | 27573 | 2244 | 28805 | 1168 | 35031 | 194 | 33683 |

## ROUND TIED COLUMNS 38" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.41 | 14241 | 4578 | 21907 | 3466 | 23789 | 2729 | 23740 | 2157 | 22231 | 1354 | 23879 | 819 | 17016 |
| 5-#18 | 1.76 | 14710 | 4720 | 23044 | 3477 | 24808 | 2707 | 24731 | 2113 | 23479 | 1265 | 26033 | 700 | 19240 |
| 6-#14 | 1.19 | 14366 | 4489 | 22453 | 3200 | 23448 | 2487 | 22915 | 1951 | 21038 | 1207 | 22052 | 761 | 13840 |
| 6-#18 | 2.12 | 15073 | 4861 | 24509 | 3388 | 25885 | 2621 | 25783 | 2014 | 24830 | 1125 | 26806 | 486 | 23257 |
| 7-#14 | 1.39 | 14513 | 4569 | 22044 | 3463 | 23861 | 2702 | 23774 | 2132 | 22255 | 1332 | 24440 | 826 | 15697 |
| 7-#18 | 2.47 | 15298 | 5003 | 24289 | 3708 | 26554 | 2878 | 26945 | 2230 | 26555 | 1286 | 30272 | 535 | 25607 |
| 8-#11 | 1.10 | 14298 | 4453 | 21216 | 3450 | 23101 | 2705 | 22963 | 2149 | 21255 | 1386 | 22985 | 932 | 12780 |
| 8-#14 | 1.59 | 14680 | 4649 | 22252 | 3559 | 24331 | 2787 | 24417 | 2197 | 23177 | 1364 | 25668 | 808 | 17754 |
| 8-#18 | 2.82 | 15581 | 5145 | 24778 | 3843 | 27364 | 2999 | 28020 | 2321 | 27919 | 1305 | 32238 | 484 | 28768 |
| 9-#11 | 1.24 | 14394 | 4508 | 21636 | 3462 | 23492 | 2703 | 23380 | 2140 | 21812 | 1366 | 23802 | 875 | 14298 |
| 9-#14 | 1.79 | 14815 | 4728 | 22803 | 3588 | 24887 | 2794 | 25033 | 2193 | 24009 | 1342 | 27022 | 745 | 19541 |
| 9-#18 | 3.17 | 15810 | 5287 | 25651 | 3914 | 28327 | 3029 | 29120 | 2327 | 29423 | 1275 | 34655 | 379 | 31387 |
| 10-#11 | 1.38 | 14498 | 4563 | 22185 | 3427 | 23927 | 2675 | 23799 | 2109 | 22261 | 1314 | 24396 | 831 | 15599 |
| 10-#14 | 1.98 | 14957 | 4808 | 23495 | 3565 | 25520 | 2777 | 25672 | 2166 | 24735 | 1280 | 27837 | 678 | 21565 |
| 10-#18 | 3.53 | 16036 | 5429 | 26711 | 3920 | 29455 | 3037 | 30278 | 2307 | 30827 | 1187 | 36253 | 277 | 34137 |
| 11-#11 | 1.51 | 14631 | 4619 | 22161 | 3543 | 24219 | 2765 | 24266 | 2180 | 22992 | 1364 | 25551 | 826 | 17031 |
| 11-#14 | 2.18 | 15143 | 4888 | 23573 | 3702 | 25921 | 2880 | 26285 | 2247 | 25674 | 1336 | 29346 | 657 | 23265 |
| 11-#18 | 3.88 | 16353 | 5571 | 27034 | 4110 | 30113 | 3172 | 31276 | 2416 | 32281 | 1257 | 38630 | 211 | 37076 |
| 12-#11 | 1.65 | 14735 | 4674 | 22395 | 3599 | 24566 | 2813 | 24714 | 2216 | 23578 | 1371 | 26505 | 813 | 18332 |
| 12-#14 | 2.38 | 15289 | 4968 | 23930 | 3773 | 26415 | 2942 | 26908 | 2293 | 26483 | 1341 | 30663 | 633 | 25239 |
| 12-#18 | 4.23 | 16600 | 5713 | 27677 | 4219 | 30967 | 3269 | 32327 | 2485 | 33635 | 1257 | 40828 | 161 | 39589 |
| 13-#11 | 1.79 | 14857 | 4729 | 22712 | 3622 | 24939 | 2823 | 25147 | 2218 | 24163 | 1360 | 27207 | 764 | 19669 |
| 13-#14 | 2.58 | 15461 | 5048 | 24365 | 3813 | 26954 | 2961 | 27535 | 2299 | 27334 | 1328 | 31685 | 564 | 26783 |
| 13-#18 | 4.59 | 16893 | 5854 | 28419 | 4301 | 31907 | 3312 | 33429 | 2502 | 35137 | 1237 | 42889 | 63 | 42473 |
| 14-#11 | 1.93 | 15003 | 4785 | 23158 | 3619 | 25339 | 2819 | 25587 | 2208 | 24691 | 1327 | 27911 | 715 | 21008 |
| 14-#14 | 2.78 | 15662 | 5127 | 24947 | 3822 | 27525 | 2968 | 28200 | 2296 | 28130 | 1286 | 32742 | 498 | 28484 |
| 14-#18 | 4.94 | 17223 | 5996 | 29335 | 4340 | 32924 | 3345 | 34609 | 2511 | 36835 | 1209 | 44542 | -70 | 44287 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 38" DIA.

Short columns – no sidesway $f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 15-#11 | 2.06 | 15086 | 4840 | 23301 | 3693 | 25657 | 2879 | 26027 | 2254 | 25376 | 1362 | 28961 | 708 | 22258 |
| 15-#14 | 2.98 | 15777 | 5207 | 25208 | 3913 | 27976 | 3040 | 28784 | 2349 | 29056 | 1329 | 34167 | 481 | 30137 |
| 15-#18 | 5.29 | 17419 | 6138 | 29886 | 4474 | 33700 | 3450 | 35584 | 2587 | 38108 | 1234 | 46888 | -116 | 46425 |
| 16-#11 | 2.20 | 15193 | 4895 | 23507 | 3743 | 26029 | 2921 | 26468 | 2283 | 25990 | 1370 | 29817 | 672 | 23595 |
| 16-#14 | 3.17 | 15929 | 5287 | 25527 | 3982 | 28503 | 3096 | 29403 | 2388 | 29915 | 1338 | 35361 | 426 | 31818 |
| 16-#18 | 5.64 | 17698 | 6280 | 30491 | 4589 | 34576 | 3539 | 36640 | 2649 | 39571 | 1244 | 48901 | -219 | 47957 |
| 17-#11 | 2.34 | 15316 | 4951 | 23855 | 3768 | 26381 | 2935 | 26923 | 2296 | 26537 | 1356 | 30616 | 641 | 24784 |
| 17-#14 | 3.37 | 16105 | 5367 | 26008 | 4020 | 29006 | 3119 | 30062 | 2409 | 30704 | 1319 | 36511 | 382 | 33497 |
| 17-#18 | 6.00 | 17968 | 6422 | 31302 | 4663 | 35480 | 3586 | 37791 | 2689 | 40952 | 1211 | 50908 | -299 | 49599 |
| 18-#11 | 2.48 | 15422 | 5006 | 24249 | 3786 | 26779 | 2943 | 27341 | 2289 | 27132 | 1338 | 31317 | 582 | 26103 |
| 18-#14 | 3.57 | 16244 | 5447 | 26527 | 4054 | 29573 | 3138 | 30680 | 2405 | 31577 | 1296 | 37825 | 328 | 35046 |
| 19-#11 | 2.61 | 15539 | 5061 | 24419 | 3843 | 27108 | 2990 | 27793 | 2330 | 27698 | 1350 | 32355 | 585 | 27234 |
| 19-#14 | 3.77 | 16410 | 5526 | 26813 | 4127 | 30039 | 3197 | 31304 | 2458 | 32353 | 1308 | 38979 | 299 | 36690 |
| 20-#11 | 2.75 | 15660 | 5117 | 24654 | 3890 | 27456 | 3026 | 28223 | 2350 | 28301 | 1356 | 33262 | 559 | 28420 |
| 20-#14 | 3.97 | 16577 | 5606 | 27158 | 4192 | 30545 | 3248 | 31900 | 2483 | 33202 | 1314 | 40257 | 259 | 38274 |
| 21-#11 | 2.89 | 15771 | 5172 | 24990 | 3918 | 27829 | 3044 | 28664 | 2365 | 28859 | 1344 | 33987 | 521 | 29598 |
| 21-#14 | 4.17 | 16739 | 5686 | 27627 | 4234 | 31075 | 3275 | 32543 | 2506 | 34003 | 1298 | 41291 | 204 | 39822 |
| 22-#11 | 3.03 | 15886 | 5227 | 25333 | 3941 | 28232 | 3059 | 29093 | 2363 | 29462 | 1330 | 34774 | 481 | 30734 |
| 22-#14 | 4.36 | 16896 | 5766 | 28100 | 4274 | 31639 | 3301 | 33165 | 2508 | 34879 | 1281 | 42434 | 148 | 41499 |
| 23-#11 | 3.16 | 15990 | 5283 | 25553 | 3992 | 28550 | 3098 | 29537 | 2399 | 30065 | 1344 | 35727 | 464 | 31950 |
| 23-#14 | 4.56 | 17040 | 5845 | 28437 | 4341 | 32101 | 3352 | 33784 | 2554 | 35718 | 1297 | 43758 | 121 | 42937 |
| 24-#11 | 3.30 | 16095 | 5338 | 25816 | 4038 | 28901 | 3133 | 29963 | 2417 | 30617 | 1341 | 36505 | 431 | 33093 |
| 25-#11 | 3.44 | 16219 | 5393 | 26122 | 4066 | 29274 | 3152 | 30410 | 2433 | 31223 | 1337 | 37369 | 397 | 34254 |
| 26-#11 | 3.58 | 16328 | 5449 | 26454 | 4094 | 29669 | 3171 | 30846 | 2435 | 31787 | 1319 | 38063 | 354 | 35384 |
| 27-#11 | 3.71 | 16439 | 5504 | 26721 | 4133 | 30001 | 3206 | 31284 | 2467 | 32382 | 1330 | 39013 | 330 | 36496 |
| 28-#11 | 3.85 | 16564 | 5559 | 26997 | 4170 | 30356 | 3240 | 31701 | 2483 | 32937 | 1326 | 39980 | 318 | 37672 |

## ROUND TIED COLUMNS 40" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.27 | 16536 | 5011 | 25188 | 3823 | 27380 | 3010 | 27281 | 2386 | 25431 | 1517 | 27216 | 961 | 18131 |
| 5-#18 | 1.59 | 17046 | 5153 | 26445 | 3825 | 28479 | 2981 | 28351 | 2337 | 26737 | 1424 | 29492 | 838 | 20572 |
| 6-#14 | 1.07 | 16662 | 4922 | 25879 | 3531 | 27031 | 2748 | 26370 | 2162 | 24068 | 1356 | 25143 | 889 | 14725 |
| 6-#18 | 1.91 | 17427 | 5295 | 28088 | 3720 | 29644 | 2882 | 29443 | 2226 | 28130 | 1276 | 30256 | 620 | 24886 |
| 7-#14 | 1.25 | 16830 | 5002 | 25353 | 3817 | 27462 | 2981 | 27317 | 2358 | 25436 | 1493 | 27789 | 964 | 16805 |
| 7-#18 | 2.23 | 17687 | 5436 | 27758 | 4061 | 30340 | 3157 | 30727 | 2458 | 29910 | 1432 | 34058 | 679 | 27601 |
| 8-#14 | 1.43 | 17011 | 5082 | 25553 | 3918 | 27962 | 3070 | 28010 | 2427 | 26435 | 1528 | 29123 | 950 | 18939 |
| 8-#18 | 2.55 | 17994 | 5578 | 28259 | 4201 | 31204 | 3283 | 31857 | 2553 | 31513 | 1473 | 36186 | 633 | 31235 |
| 9-#11 | 1.12 | 16695 | 4941 | 24902 | 3817 | 27068 | 2984 | 26901 | 2368 | 24966 | 1528 | 27109 | 1013 | 15342 |
| 9-#14 | 1.61 | 17152 | 5162 | 26154 | 3944 | 28557 | 3075 | 28664 | 2421 | 27313 | 1505 | 30407 | 872 | 20941 |
| 9-#18 | 2.86 | 18236 | 5720 | 29205 | 4270 | 32234 | 3311 | 33034 | 2557 | 33112 | 1441 | 38765 | 527 | 33895 |
| 10-#11 | 1.24 | 16810 | 4997 | 25514 | 3776 | 27527 | 2950 | 27345 | 2333 | 25424 | 1473 | 27714 | 968 | 16660 |
| 10-#14 | 1.79 | 17308 | 5241 | 26913 | 3914 | 29224 | 3052 | 29347 | 2390 | 28068 | 1440 | 31405 | 817 | 23042 |
| 10-#18 | 3.18 | 18484 | 5862 | 30350 | 4269 | 33432 | 3313 | 34283 | 2535 | 34594 | 1351 | 40453 | 425 | 36964 |

## ROUND TIED COLUMNS 40" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 11-#11 | 1.37 | 16953 | 5052 | 25456 | 3900 | 27843 | 3047 | 27847 | 2410 | 26227 | 1527 | 28980 | 967 | 18263 |
| 11-#14 | 1.97 | 17510 | 5321 | 26964 | 4059 | 29661 | 3162 | 30002 | 2477 | 29094 | 1500 | 33048 | 800 | 24944 |
| 11-#18 | 3.50 | 18827 | 6004 | 30664 | 4467 | 34144 | 3456 | 35336 | 2648 | 36170 | 1427 | 43027 | 364 | 39982 |
| 12-#11 | 1.49 | 17063 | 5107 | 25693 | 3958 | 28212 | 3097 | 28328 | 2447 | 26854 | 1535 | 30009 | 955 | 19602 |
| 12-#14 | 2.15 | 17663 | 5401 | 27343 | 4133 | 30186 | 3226 | 30669 | 2524 | 29963 | 1507 | 34468 | 778 | 27030 |
| 12-#18 | 3.82 | 19087 | 6146 | 31358 | 4580 | 35056 | 3556 | 36462 | 2720 | 37623 | 1428 | 45396 | 317 | 42785 |
| 13-#11 | 1.61 | 17195 | 5163 | 26069 | 3973 | 28603 | 3106 | 28788 | 2448 | 27478 | 1524 | 30754 | 906 | 21098 |
| 13-#14 | 2.33 | 17849 | 5481 | 27807 | 4171 | 30752 | 3244 | 31337 | 2530 | 30867 | 1494 | 35555 | 710 | 28812 |
| 13-#18 | 4.14 | 19406 | 6288 | 32142 | 4660 | 36062 | 3598 | 37639 | 2737 | 39225 | 1409 | 47322 | 195 | 46023 |
| 14-#11 | 1.74 | 17352 | 5218 | 26532 | 3973 | 29032 | 3099 | 29242 | 2436 | 28031 | 1489 | 31494 | 855 | 22478 |
| 14-#14 | 2.51 | 18071 | 5561 | 28443 | 4176 | 31363 | 3248 | 32027 | 2524 | 31706 | 1451 | 36674 | 643 | 30783 |
| 14-#18 | 4.46 | 19773 | 6429 | 33136 | 4695 | 37129 | 3627 | 38921 | 2745 | 40770 | 1345 | 49364 | 87 | 48648 |
| 15-#11 | 1.86 | 17444 | 5273 | 26663 | 4051 | 29369 | 3162 | 29725 | 2485 | 28724 | 1520 | 32630 | 851 | 23878 |
| 15-#14 | 2.69 | 18194 | 5640 | 28705 | 4272 | 31843 | 3324 | 32670 | 2581 | 32705 | 1496 | 38212 | 629 | 32511 |
| 15-#18 | 4.77 | 19977 | 6571 | 33709 | 4834 | 37958 | 3736 | 39943 | 2823 | 42401 | 1408 | 51889 | 44 | 51565 |
| 16-#11 | 1.99 | 17560 | 5329 | 26877 | 4103 | 29758 | 3205 | 30199 | 2515 | 29426 | 1536 | 33551 | 816 | 25259 |
| 16-#14 | 2.86 | 18358 | 5720 | 29032 | 4341 | 32407 | 3382 | 33333 | 2621 | 33625 | 1506 | 39497 | 575 | 34343 |
| 16-#18 | 5.09 | 20283 | 6713 | 34336 | 4950 | 38915 | 3828 | 41074 | 2887 | 43968 | 1419 | 54057 | -57 | 53814 |
| 17-#11 | 2.11 | 17690 | 5384 | 27252 | 4127 | 30141 | 3219 | 30653 | 2520 | 30011 | 1522 | 34402 | 785 | 26590 |
| 17-#14 | 3.04 | 18540 | 5800 | 29550 | 4380 | 32942 | 3404 | 34029 | 2642 | 34465 | 1487 | 40723 | 532 | 36066 |
| 17-#18 | 5.41 | 20565 | 6855 | 35206 | 5024 | 39861 | 3874 | 42303 | 2927 | 45443 | 1388 | 56203 | -135 | 55593 |
| 18-#11 | 2.23 | 17801 | 5439 | 27680 | 4143 | 30567 | 3226 | 31116 | 2519 | 30639 | 1503 | 35144 | 726 | 27988 |
| 18-#14 | 3.22 | 18697 | 5880 | 30122 | 4412 | 33548 | 3422 | 34678 | 2636 | 35391 | 1464 | 41818 | 450 | 37792 |
| 18-#18 | 5.73 | 20818 | 6997 | 36101 | 5095 | 40911 | 3918 | 43491 | 2929 | 47103 | 1353 | 58685 | -226 | 56847 |
| 19-#11 | 2.36 | 17932 | 5495 | 27852 | 4202 | 30913 | 3274 | 31602 | 2562 | 31250 | 1516 | 36259 | 731 | 29273 |
| 19-#14 | 3.40 | 18876 | 5960 | 30408 | 4487 | 34045 | 3483 | 35348 | 2691 | 36225 | 1478 | 43360 | 451 | 39605 |
| 20-#11 | 2.48 | 18060 | 5550 | 28100 | 4250 | 31280 | 3311 | 32066 | 2583 | 31890 | 1522 | 37230 | 706 | 30652 |
| 20-#14 | 3.58 | 19053 | 6039 | 30773 | 4553 | 34573 | 3534 | 35997 | 2718 | 37134 | 1485 | 44729 | 413 | 41242 |
| 21-#11 | 2.61 | 18180 | 5605 | 28456 | 4278 | 31678 | 3329 | 32531 | 2597 | 32488 | 1511 | 38005 | 668 | 31857 |
| 21-#14 | 3.76 | 19229 | 6119 | 31276 | 4595 | 35140 | 3561 | 36670 | 2740 | 37987 | 1468 | 45837 | 358 | 43024 |
| 22-#11 | 2.73 | 18309 | 5661 | 28828 | 4299 | 32115 | 3344 | 32987 | 2595 | 33126 | 1497 | 38839 | 628 | 33126 |
| 22-#14 | 3.94 | 19403 | 6199 | 31780 | 4633 | 35752 | 3587 | 37332 | 2741 | 38917 | 1451 | 47052 | 302 | 44689 |
| 23-#11 | 2.86 | 18419 | 5716 | 29056 | 4352 | 32447 | 3383 | 33462 | 2632 | 33773 | 1512 | 39866 | 613 | 34399 |
| 23-#14 | 4.12 | 19555 | 6279 | 32133 | 4701 | 36235 | 3639 | 37995 | 2789 | 39817 | 1468 | 48478 | 276 | 46370 |
| 24-#11 | 2.98 | 18531 | 5771 | 29331 | 4399 | 32821 | 3419 | 33909 | 2650 | 34360 | 1509 | 40698 | 580 | 35645 |
| 24-#14 | 4.30 | 19715 | 6359 | 32538 | 4767 | 36768 | 3688 | 38638 | 2814 | 40650 | 1464 | 49651 | 228 | 48093 |
| 25-#11 | 3.10 | 18667 | 5827 | 29662 | 4426 | 33220 | 3438 | 34392 | 2666 | 35008 | 1505 | 41622 | 547 | 36898 |
| 25-#14 | 4.48 | 19908 | 6438 | 32997 | 4808 | 37335 | 3717 | 39321 | 2838 | 41575 | 1458 | 50969 | 180 | 49640 |
| 26-#11 | 3.23 | 18782 | 5882 | 30078 | 4439 | 33634 | 3456 | 34857 | 2668 | 35608 | 1488 | 42360 | 504 | 38095 |
| 27-#11 | 3.35 | 18902 | 5937 | 30296 | 4494 | 33989 | 3492 | 35318 | 2700 | 36243 | 1499 | 43378 | 481 | 39341 |
| 28-#11 | 3.48 | 19034 | 5993 | 30588 | 4531 | 34373 | 3527 | 35763 | 2717 | 36834 | 1496 | 44414 | 469 | 40540 |
| 29-#11 | 3.60 | 19146 | 6048 | 30898 | 4568 | 34757 | 3546 | 36246 | 2734 | 37480 | 1493 | 45225 | 427 | 41765 |
| 30-#11 | 3.72 | 19266 | 6103 | 31280 | 4591 | 35166 | 3567 | 36723 | 2739 | 38088 | 1477 | 46095 | 393 | 42980 |

## ROUND TIED COLUMNS 42" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.15 | 19065 | 5466 | 28786 | 4198 | 31325 | 3306 | 31169 | 2626 | 28933 | 1689 | 30856 | 1109 | 19243 |
| 5-#18 | 1.44 | 19616 | 5608 | 30172 | 4190 | 32500 | 3269 | 32316 | 2572 | 30292 | 1591 | 33246 | 983 | 21915 |
| 6-#18 | 1.73 | 20014 | 5750 | 32005 | 4069 | 33757 | 3157 | 33442 | 2449 | 31715 | 1435 | 33988 | 759 | 26448 |
| 7-#14 | 1.14 | 19380 | 5457 | 28982 | 4189 | 31418 | 3274 | 31205 | 2596 | 28916 | 1662 | 31437 | 1109 | 17927 |
| 7-#18 | 2.02 | 20311 | 5892 | 31548 | 4432 | 34479 | 3451 | 34836 | 2697 | 33686 | 1604 | 38144 | 829 | 29479 |
| 8-#14 | 1.30 | 19575 | 5537 | 29169 | 4296 | 31945 | 3368 | 31951 | 2670 | 29989 | 1700 | 32881 | 1098 | 20131 |
| 8-#18 | 2.31 | 20642 | 6034 | 32056 | 4579 | 35397 | 3581 | 36042 | 2796 | 35408 | 1648 | 40436 | 787 | 33744 |
| 9-#11 | 1.01 | 19230 | 5397 | 28485 | 4192 | 30998 | 3280 | 30768 | 2608 | 28420 | 1698 | 30716 | 1158 | 16303 |
| 9-#14 | 1.46 | 19722 | 5617 | 29820 | 4318 | 32581 | 3371 | 32641 | 2661 | 30918 | 1676 | 34237 | 1019 | 22362 |
| 9-#18 | 2.60 | 20897 | 6176 | 33079 | 4645 | 36496 | 3607 | 37290 | 2799 | 37100 | 1616 | 43176 | 681 | 36460 |
| 10-#11 | 1.13 | 19355 | 5452 | 29168 | 4143 | 31480 | 3239 | 31225 | 2568 | 28884 | 1639 | 31329 | 1110 | 17730 |
| 10-#14 | 1.62 | 19893 | 5697 | 30655 | 4281 | 33282 | 3341 | 33367 | 2627 | 31698 | 1607 | 35268 | 963 | 24531 |
| 10-#18 | 2.89 | 21167 | 6317 | 34314 | 4636 | 37753 | 3603 | 38632 | 2773 | 38657 | 1522 | 44949 | 577 | 39866 |
| 11-#11 | 1.24 | 19509 | 5507 | 29068 | 4276 | 31817 | 3344 | 31775 | 2651 | 29763 | 1699 | 32711 | 1114 | 19476 |
| 11-#14 | 1.79 | 20111 | 5777 | 30673 | 4435 | 33753 | 3459 | 34065 | 2719 | 32814 | 1673 | 37053 | 950 | 26647 |
| 11-#18 | 3.18 | 21538 | 6459 | 34613 | 4843 | 38529 | 3755 | 39743 | 2892 | 40360 | 1603 | 47726 | 522 | 42952 |
| 12-#11 | 1.35 | 19624 | 5563 | 29304 | 4336 | 32211 | 3382 | 32290 | 2690 | 30425 | 1707 | 33818 | 1103 | 20884 |
| 12-#14 | 1.95 | 20272 | 5856 | 31061 | 4511 | 34311 | 3526 | 34778 | 2768 | 33739 | 1681 | 38576 | 930 | 28806 |
| 12-#18 | 3.46 | 21809 | 6601 | 35357 | 4960 | 39498 | 3857 | 40945 | 2966 | 41913 | 1607 | 50268 | 477 | 46060 |
| 13-#11 | 1.46 | 19766 | 5618 | 29716 | 4350 | 32621 | 3403 | 32776 | 2690 | 31089 | 1696 | 34603 | 1054 | 22569 |
| 13-#14 | 2.11 | 20472 | 5936 | 31609 | 4538 | 34904 | 3542 | 35485 | 2773 | 34701 | 1668 | 39728 | 861 | 30788 |
| 13-#18 | 3.75 | 22155 | 6743 | 36184 | 5038 | 40559 | 3897 | 42196 | 2982 | 43614 | 1588 | 52316 | 357 | 49471 |
| 14-#11 | 1.58 | 19932 | 5673 | 30226 | 4346 | 33078 | 3394 | 33244 | 2675 | 31669 | 1660 | 35376 | 1002 | 23965 |
| 14-#14 | 2.27 | 20705 | 6016 | 32260 | 4550 | 35555 | 3543 | 36201 | 2764 | 35582 | 1623 | 40907 | 793 | 32977 |
| 14-#18 | 4.04 | 22547 | 6885 | 37260 | 5070 | 41689 | 3923 | 43543 | 2988 | 45248 | 1522 | 54486 | 248 | 52299 |
| 15-#11 | 1.69 | 20036 | 5729 | 30340 | 4428 | 33435 | 3461 | 33764 | 2727 | 32412 | 1693 | 36603 | 1001 | 25524 |
| 15-#14 | 2.44 | 20846 | 6096 | 32513 | 4649 | 36063 | 3623 | 36901 | 2825 | 36583 | 1661 | 42561 | 782 | 34863 |
| 15-#18 | 4.33 | 22772 | 7027 | 37850 | 5213 | 42570 | 4037 | 44650 | 3071 | 46996 | 1589 | 57193 | 209 | 55552 |
| 16-#11 | 1.80 | 20161 | 5784 | 30562 | 4481 | 33841 | 3490 | 34277 | 2759 | 33157 | 1709 | 37590 | 966 | 26943 |
| 16-#14 | 2.60 | 21022 | 6176 | 32853 | 4720 | 36652 | 3681 | 37609 | 2867 | 37632 | 1681 | 43937 | 729 | 36928 |
| 16-#18 | 4.62 | 23106 | 7169 | 38497 | 5330 | 43607 | 4132 | 45855 | 3136 | 48668 | 1602 | 59517 | 109 | 58556 |
| 17-#11 | 1.91 | 20297 | 5839 | 30965 | 4505 | 34254 | 3517 | 34750 | 2763 | 33778 | 1695 | 38491 | 936 | 28424 |
| 17-#14 | 2.76 | 21213 | 6255 | 33408 | 4758 | 37231 | 3704 | 38303 | 2876 | 38528 | 1663 | 45238 | 687 | 38688 |
| 17-#18 | 4.91 | 23400 | 7310 | 39428 | 5403 | 44596 | 4176 | 47162 | 3176 | 50235 | 1570 | 61802 | 33 | 61537 |
| 18-#11 | 2.03 | 20417 | 5895 | 31427 | 4518 | 34708 | 3523 | 35239 | 2760 | 34446 | 1676 | 39272 | 876 | 29865 |
| 18-#14 | 2.92 | 21386 | 6335 | 34026 | 4788 | 37877 | 3720 | 39022 | 2879 | 39505 | 1639 | 46398 | 604 | 40601 |
| 18-#18 | 5.20 | 23674 | 7452 | 40407 | 5473 | 45715 | 4219 | 48400 | 3176 | 51995 | 1536 | 64443 | -58 | 63357 |
| 19-#11 | 2.14 | 20560 | 5950 | 31602 | 4581 | 35068 | 3573 | 35758 | 2806 | 35093 | 1690 | 40466 | 883 | 31293 |
| 19-#14 | 3.09 | 21578 | 6415 | 34320 | 4866 | 38400 | 3783 | 39738 | 2936 | 40400 | 1655 | 48046 | 608 | 42461 |
| 19-#18 | 5.49 | 24007 | 7594 | 41015 | 5592 | 46630 | 4314 | 49602 | 3262 | 53478 | 1552 | 66655 | -114 | 66080 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 42" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.25 | 20694 | 6005 | 31861 | 4630 | 35457 | 3597 | 36245 | 2827 | 35774 | 1697 | 41502 | 859 | 32741 |
| 20-#14 | 3.25 | 21764 | 6495 | 34704 | 4933 | 38955 | 3835 | 40436 | 2965 | 41361 | 1662 | 49505 | 571 | 44275 |
| 21-#11 | 2.36 | 20824 | 6061 | 32238 | 4656 | 35880 | 3628 | 36746 | 2841 | 36408 | 1685 | 42327 | 821 | 34104 |
| 21-#14 | 3.41 | 21948 | 6575 | 35236 | 4974 | 39558 | 3862 | 41144 | 2986 | 42273 | 1646 | 50687 | 517 | 46245 |
| 22-#11 | 2.48 | 20967 | 6116 | 32641 | 4676 | 36345 | 3642 | 37228 | 2838 | 37091 | 1671 | 43207 | 781 | 35571 |
| 22-#14 | 3.57 | 22147 | 6654 | 35777 | 5010 | 40220 | 3887 | 41845 | 2986 | 43257 | 1628 | 51974 | 462 | 47945 |
| 23-#11 | 2.59 | 21082 | 6171 | 32874 | 4731 | 36698 | 3683 | 37734 | 2876 | 37773 | 1687 | 44198 | 757 | 36873 |
| 23-#14 | 3.74 | 22306 | 6734 | 36145 | 5081 | 40722 | 3940 | 42553 | 3035 | 44217 | 1647 | 53501 | 437 | 49815 |
| 24-#11 | 2.70 | 21203 | 6227 | 33160 | 4778 | 37095 | 3706 | 38202 | 2895 | 38398 | 1685 | 45196 | 736 | 38253 |
| 24-#14 | 3.90 | 22478 | 6814 | 36568 | 5147 | 41288 | 3990 | 43226 | 3060 | 45100 | 1643 | 54753 | 390 | 51610 |
| 25-#11 | 2.81 | 21346 | 6282 | 33518 | 4806 | 37518 | 3738 | 38715 | 2911 | 39085 | 1681 | 46179 | 702 | 39537 |
| 25-#14 | 4.06 | 22683 | 6894 | 37063 | 5188 | 41891 | 4019 | 43960 | 3085 | 46085 | 1638 | 56158 | 342 | 53385 |
| 26-#11 | 2.93 | 21463 | 6337 | 33965 | 4818 | 37953 | 3755 | 39215 | 2913 | 39721 | 1663 | 46960 | 659 | 40863 |
| 26-#14 | 4.22 | 22848 | 6974 | 37677 | 5210 | 42520 | 4047 | 44671 | 3090 | 47006 | 1614 | 57292 | 281 | 55319 |
| 27-#11 | 3.04 | 21601 | 6393 | 34187 | 4873 | 38329 | 3793 | 39699 | 2946 | 40398 | 1676 | 48047 | 638 | 42190 |
| 28-#11 | 3.15 | 21740 | 6448 | 34494 | 4911 | 38743 | 3815 | 40172 | 2963 | 41026 | 1673 | 49152 | 626 | 43468 |
| 29-#11 | 3.27 | 21863 | 6503 | 34826 | 4947 | 39145 | 3847 | 40684 | 2980 | 41711 | 1670 | 50013 | 585 | 44829 |
| 30-#11 | 3.38 | 21993 | 6559 | 35230 | 4970 | 39580 | 3867 | 41183 | 2984 | 42351 | 1654 | 50938 | 551 | 46066 |
| 31-#11 | 3.49 | 22117 | 6614 | 35470 | 5022 | 39964 | 3895 | 41672 | 3015 | 43075 | 1671 | 51876 | 521 | 47374 |
| 32-#11 | 3.60 | 22237 | 6669 | 35786 | 5059 | 40364 | 3922 | 42149 | 3031 | 43753 | 1674 | 52890 | 495 | 48659 |

## ROUND TIED COLUMNS 44" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.05 | 21839 | 5944 | 32717 | 4593 | 35640 | 3617 | 35422 | 2879 | 32752 | 1868 | 34814 | 1263 | 20353 |
| 5-#18 | 1.32 | 22431 | 6086 | 34239 | 4574 | 36892 | 3572 | 36643 | 2819 | 34157 | 1765 | 37310 | 1133 | 23270 |
| 6-#18 | 1.58 | 22848 | 6228 | 36274 | 4435 | 38242 | 3445 | 37797 | 2683 | 35601 | 1601 | 38016 | 903 | 28010 |
| 7-#14 | 1.04 | 22171 | 5935 | 32947 | 4579 | 35744 | 3582 | 35456 | 2846 | 32709 | 1839 | 35400 | 1260 | 19064 |
| 7-#18 | 1.84 | 23181 | 6370 | 35674 | 4823 | 38990 | 3759 | 39303 | 2948 | 37775 | 1783 | 42543 | 985 | 31353 |
| 8-#14 | 1.18 | 22385 | 6015 | 33118 | 4692 | 36300 | 3662 | 36256 | 2924 | 33849 | 1880 | 36958 | 1253 | 21329 |
| 8-#18 | 2.10 | 23536 | 6511 | 36187 | 4975 | 39960 | 3895 | 40591 | 3051 | 39620 | 1831 | 45005 | 947 | 35797 |
| 9-#14 | 1.33 | 22538 | 6095 | 33817 | 4711 | 36975 | 3682 | 36981 | 2914 | 34837 | 1855 | 38383 | 1173 | 23801 |
| 9-#18 | 2.37 | 23805 | 6653 | 37289 | 5038 | 41129 | 3918 | 41910 | 3052 | 41404 | 1798 | 47606 | 816 | 39011 |
| 10-#11 | 1.03 | 22146 | 5930 | 33161 | 4529 | 35805 | 3543 | 35461 | 2814 | 32655 | 1814 | 35255 | 1259 | 18811 |
| 10-#14 | 1.48 | 22725 | 6175 | 34738 | 4666 | 37711 | 3645 | 37734 | 2874 | 35639 | 1783 | 39442 | 1114 | 26032 |
| 10-#18 | 2.63 | 24098 | 6795 | 38619 | 5021 | 42447 | 3907 | 43344 | 3023 | 43031 | 1701 | 49756 | 736 | 42844 |
| 11-#11 | 1.13 | 22311 | 5985 | 33013 | 4671 | 36158 | 3655 | 36067 | 2904 | 33604 | 1877 | 36760 | 1267 | 20645 |
| 11-#14 | 1.63 | 22957 | 6254 | 34715 | 4830 | 38212 | 3771 | 38492 | 2973 | 36850 | 1854 | 41374 | 1106 | 28374 |
| 11-#18 | 2.89 | 24495 | 6937 | 38897 | 5238 | 43285 | 4068 | 44514 | 3148 | 44865 | 1788 | 52743 | 686 | 45983 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 44" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.23 | 22431 | 6040 | 33248 | 4733 | 36580 | 3696 | 36616 | 2945 | 34313 | 1888 | 37945 | 1258 | 22181 |
| 12-#14 | 1.78 | 23126 | 6334 | 35108 | 4908 | 38806 | 3820 | 39251 | 3024 | 37822 | 1862 | 43003 | 1087 | 30599 |
| 12-#18 | 3.16 | 24779 | 7079 | 39689 | 5358 | 44312 | 4172 | 45792 | 3224 | 46521 | 1793 | 55459 | 642 | 49412 |
| 13-#11 | 1.33 | 22583 | 6096 | 33696 | 4746 | 37009 | 3709 | 37128 | 2944 | 35011 | 1876 | 38771 | 1209 | 23957 |
| 13-#14 | 1.92 | 23340 | 6414 | 35704 | 4934 | 39426 | 3855 | 39998 | 3028 | 38845 | 1849 | 44218 | 1019 | 32791 |
| 13-#18 | 3.42 | 25152 | 7221 | 40560 | 5434 | 45419 | 4211 | 47117 | 3239 | 48319 | 1774 | 57629 | 523 | 52909 |
| 14-#11 | 1.44 | 22758 | 6151 | 34256 | 4738 | 37495 | 3703 | 37609 | 2926 | 35622 | 1838 | 39574 | 1155 | 25468 |
| 14-#14 | 2.07 | 23586 | 6494 | 36413 | 4941 | 40117 | 3852 | 40738 | 3015 | 39771 | 1803 | 45454 | 950 | 35052 |
| 14-#18 | 3.68 | 25563 | 7363 | 41720 | 5462 | 46620 | 4234 | 48517 | 3242 | 50040 | 1707 | 59923 | 414 | 56031 |
| 15-#11 | 1.54 | 22873 | 6206 | 34350 | 4824 | 37870 | 3767 | 38168 | 2982 | 36412 | 1873 | 40893 | 1156 | 27181 |
| 15-#14 | 2.22 | 23743 | 6574 | 36652 | 5045 | 40654 | 3937 | 41488 | 3080 | 40836 | 1843 | 47228 | 941 | 37134 |
| 15-#18 | 3.95 | 25816 | 7504 | 42325 | 5610 | 47553 | 4352 | 49721 | 3329 | 51908 | 1777 | 62816 | 379 | 59638 |
| 16-#11 | 1.64 | 23007 | 6262 | 34579 | 4879 | 38294 | 3804 | 38720 | 3015 | 37205 | 1890 | 41948 | 1122 | 28647 |
| 16-#14 | 2.37 | 23933 | 6653 | 37007 | 5118 | 41268 | 3976 | 42251 | 3123 | 41945 | 1864 | 48696 | 889 | 39418 |
| 16-#18 | 4.21 | 26141 | 7646 | 42992 | 5728 | 48654 | 4449 | 51001 | 3396 | 53684 | 1791 | 65296 | 280 | 62670 |
| 17-#11 | 1.74 | 23151 | 6317 | 35010 | 4901 | 38738 | 3824 | 39211 | 3018 | 37859 | 1876 | 42898 | 1093 | 30309 |
| 17-#14 | 2.52 | 24133 | 6733 | 37599 | 5154 | 41891 | 4018 | 42973 | 3132 | 42894 | 1846 | 50072 | 847 | 41362 |
| 17-#18 | 4.47 | 26484 | 7788 | 43984 | 5801 | 49701 | 4492 | 52375 | 3435 | 55344 | 1760 | 67720 | 206 | 65973 |
| 18-#11 | 1.85 | 23279 | 6372 | 35507 | 4912 | 39219 | 3834 | 39725 | 3014 | 38563 | 1856 | 43714 | 1032 | 31765 |
| 18-#14 | 2.66 | 24321 | 6813 | 38259 | 5182 | 42576 | 4032 | 43730 | 3133 | 43934 | 1822 | 51295 | 764 | 43471 |
| 18-#18 | 4.74 | 26780 | 7930 | 45049 | 5870 | 50890 | 4534 | 53673 | 3434 | 57204 | 1726 | 69926 | 66 | 69448 |
| 19-#11 | 1.95 | 23434 | 6428 | 35683 | 4978 | 39593 | 3880 | 40279 | 3061 | 39252 | 1872 | 44992 | 1041 | 33343 |
| 19-#14 | 2.81 | 24526 | 6893 | 38564 | 5263 | 43120 | 4098 | 44494 | 3192 | 44877 | 1839 | 53050 | 771 | 45372 |
| 19-#18 | 5.00 | 27135 | 8072 | 45666 | 5991 | 51859 | 4632 | 54952 | 3522 | 58784 | 1744 | 72874 | 62 | 72440 |
| 20-#11 | 2.05 | 23575 | 6483 | 35954 | 5028 | 40005 | 3912 | 40788 | 3083 | 39976 | 1879 | 46093 | 1019 | 34831 |
| 20-#14 | 2.96 | 24723 | 6972 | 38967 | 5331 | 43708 | 4130 | 45223 | 3222 | 45896 | 1847 | 54600 | 736 | 47371 |
| 20-#18 | 5.26 | 27463 | 8214 | 46397 | 6105 | 52892 | 4719 | 56213 | 3569 | 60546 | 1754 | 75530 | -7 | 75490 |
| 21-#11 | 2.15 | 23713 | 6538 | 36352 | 5053 | 40453 | 3936 | 41325 | 3097 | 40644 | 1868 | 46967 | 980 | 36338 |
| 21-#14 | 3.11 | 24919 | 7052 | 39527 | 5371 | 44346 | 4177 | 45983 | 3243 | 46860 | 1831 | 55856 | 681 | 49392 |
| 22-#11 | 2.26 | 23871 | 6594 | 36786 | 5072 | 40940 | 3955 | 41832 | 3093 | 41352 | 1852 | 47893 | 941 | 37884 |
| 22-#14 | 3.26 | 25138 | 7132 | 40109 | 5406 | 45049 | 4201 | 46723 | 3243 | 47913 | 1814 | 57214 | 626 | 51268 |
| 23-#11 | 2.36 | 23991 | 6649 | 37025 | 5128 | 41318 | 3991 | 42364 | 3133 | 42037 | 1863 | 48953 | 917 | 39315 |
| 23-#14 | 3.40 | 25305 | 7212 | 40489 | 5479 | 45580 | 4256 | 47475 | 3294 | 48920 | 1833 | 58678 | 589 | 53338 |
| 24-#11 | 2.46 | 24121 | 6704 | 37320 | 5176 | 41738 | 4021 | 42861 | 3152 | 42754 | 1868 | 50013 | 897 | 40858 |
| 24-#14 | 3.55 | 25489 | 7292 | 40928 | 5545 | 46179 | 4286 | 48178 | 3319 | 49857 | 1829 | 60175 | 557 | 55159 |
| 25-#11 | 2.56 | 24272 | 6760 | 37739 | 5197 | 42181 | 4046 | 43402 | 3168 | 43479 | 1865 | 51055 | 863 | 42226 |
| 25-#14 | 3.70 | 25698 | 7371 | 41462 | 5587 | 46818 | 4335 | 48955 | 3343 | 50899 | 1825 | 61665 | 509 | 57169 |
| 26-#11 | 2.67 | 24397 | 6815 | 38185 | 5215 | 42642 | 4055 | 43937 | 3169 | 44139 | 1846 | 51878 | 820 | 43688 |
| 26-#14 | 3.85 | 25884 | 7451 | 42118 | 5608 | 47476 | 4362 | 49718 | 3348 | 51876 | 1801 | 62865 | 449 | 59112 |
| 27-#11 | 2.77 | 24546 | 6870 | 38409 | 5271 | 43040 | 4101 | 44444 | 3203 | 44865 | 1860 | 53035 | 800 | 45073 |
| 27-#14 | 4.00 | 26080 | 7531 | 42472 | 5684 | 48044 | 4413 | 50439 | 3393 | 52879 | 1817 | 64484 | 416 | 60951 |
| 28-#11 | 2.87 | 24693 | 6926 | 38732 | 5310 | 43477 | 4130 | 44946 | 3220 | 45536 | 1857 | 53980 | 770 | 46453 |
| 28-#14 | 4.14 | 26283 | 7611 | 42943 | 5737 | 48667 | 4443 | 51151 | 3417 | 53823 | 1812 | 66145 | 399 | 62923 |

## ROUND TIED COLUMNS 44" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 29-#11 | 2.98 | 24826 | 6981 | 39085 | 5346 | 43903 | 4156 | 45488 | 3238 | 46253 | 1854 | 55121 | 748 | 47874 |
| 30-#11 | 3.08 | 24966 | 7036 | 39514 | 5367 | 44365 | 4168 | 46007 | 3241 | 46924 | 1838 | 56100 | 714 | 49213 |
| 31-#11 | 3.18 | 25097 | 7092 | 39764 | 5421 | 44770 | 4211 | 46529 | 3273 | 47642 | 1849 | 57099 | 685 | 50658 |
| 32-#11 | 3.28 | 25225 | 7147 | 40100 | 5458 | 45188 | 4238 | 47039 | 3290 | 48423 | 1860 | 58176 | 659 | 51966 |
| 33-#11 | 3.39 | 25375 | 7202 | 40438 | 5495 | 45628 | 4266 | 47568 | 3307 | 49081 | 1851 | 59197 | 631 | 53388 |
| 34-#11 | 3.49 | 25502 | 7258 | 40847 | 5518 | 46099 | 4281 | 48087 | 3312 | 49807 | 1843 | 60093 | 585 | 54760 |

## ROUND TIED COLUMNS 46" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 5-#18 | 1.20 | 25504 | 6586 | 38663 | 4977 | 41673 | 3889 | 41349 | 3077 | 38348 | 1948 | 41699 | 1290 | 24635 |
| 6-#18 | 1.44 | 25939 | 6728 | 40913 | 4819 | 43116 | 3747 | 42524 | 2928 | 39803 | 1774 | 42356 | 1053 | 29574 |
| 7-#18 | 1.68 | 26304 | 6869 | 40154 | 5232 | 43890 | 4082 | 44150 | 3210 | 42194 | 1970 | 47272 | 1146 | 33246 |
| 8-#14 | 1.08 | 25452 | 6515 | 37413 | 5108 | 41042 | 3990 | 40944 | 3190 | 38041 | 2068 | 41369 | 1414 | 22534 |
| 8-#18 | 1.93 | 26688 | 7011 | 40665 | 5391 | 44912 | 4223 | 45522 | 3318 | 44155 | 2021 | 49908 | 1113 | 37858 |
| 9-#14 | 1.22 | 25612 | 6595 | 38165 | 5123 | 41758 | 4007 | 41703 | 3178 | 39085 | 2042 | 42858 | 1333 | 25259 |
| 9-#18 | 2.17 | 26963 | 7153 | 41842 | 5450 | 46150 | 4244 | 46911 | 3317 | 46037 | 1988 | 52649 | 981 | 41399 |
| 10-#14 | 1.35 | 25813 | 6674 | 39176 | 5070 | 42529 | 3963 | 42472 | 3132 | 39906 | 1967 | 43942 | 1272 | 27545 |
| 10-#18 | 2.41 | 27287 | 7295 | 43280 | 5425 | 47529 | 4225 | 48435 | 3284 | 47731 | 1888 | 54889 | 899 | 45896 |
| 11-#11 | 1.03 | 25369 | 6485 | 37307 | 5085 | 40888 | 3975 | 40741 | 3169 | 37777 | 2065 | 41141 | 1427 | 21821 |
| 11-#14 | 1.49 | 26061 | 6754 | 39106 | 5243 | 43055 | 4098 | 43301 | 3238 | 41203 | 2042 | 46028 | 1269 | 30125 |
| 11-#18 | 2.65 | 27711 | 7437 | 43530 | 5651 | 48430 | 4395 | 49667 | 3415 | 49701 | 1980 | 58092 | 855 | 49075 |
| 12-#11 | 1.13 | 25495 | 6540 | 37537 | 5149 | 41337 | 4025 | 41325 | 3212 | 38534 | 2076 | 42407 | 1419 | 23490 |
| 12-#14 | 1.62 | 26237 | 6834 | 39502 | 5323 | 43689 | 4149 | 44107 | 3291 | 42237 | 2052 | 47765 | 1251 | 32408 |
| 12-#18 | 2.89 | 28008 | 7579 | 44347 | 5773 | 49514 | 4502 | 51022 | 3493 | 51451 | 1987 | 60984 | 814 | 52842 |
| 13-#11 | 1.22 | 25657 | 6596 | 38024 | 5160 | 41786 | 4036 | 41855 | 3210 | 39264 | 2064 | 43271 | 1370 | 25344 |
| 13-#14 | 1.76 | 26466 | 6914 | 40147 | 5348 | 44336 | 4182 | 44893 | 3294 | 43311 | 2038 | 49041 | 1183 | 34822 |
| 13-#18 | 3.13 | 28409 | 7721 | 45369 | 5831 | 50669 | 4539 | 52420 | 3508 | 53356 | 1968 | 63274 | 696 | 56412 |
| 14-#11 | 1.31 | 25840 | 6651 | 38637 | 5149 | 42301 | 4027 | 42355 | 3189 | 39904 | 2025 | 44101 | 1315 | 26989 |
| 14-#14 | 1.90 | 26724 | 6994 | 40918 | 5352 | 45069 | 4177 | 45655 | 3279 | 44291 | 1991 | 50332 | 1112 | 37179 |
| 14-#18 | 3.37 | 28837 | 7862 | 46533 | 5873 | 51940 | 4560 | 53871 | 3507 | 55162 | 1900 | 65691 | 585 | 59844 |
| 15-#11 | 1.41 | 25968 | 6706 | 38708 | 5239 | 42694 | 4095 | 42953 | 3248 | 40745 | 2062 | 45517 | 1319 | 28774 |
| 15-#14 | 2.03 | 26899 | 7073 | 41140 | 5460 | 45633 | 4255 | 46456 | 3347 | 45415 | 2033 | 52228 | 1107 | 39437 |
| 15-#18 | 3.61 | 29119 | 8004 | 47139 | 6026 | 52924 | 4682 | 55171 | 3599 | 57008 | 1955 | 68773 | 554 | 63625 |
| 16-#11 | 1.50 | 26111 | 6762 | 38942 | 5295 | 43135 | 4133 | 43545 | 3283 | 41585 | 2080 | 46640 | 1286 | 30372 |
| 16-#14 | 2.17 | 27101 | 7153 | 41507 | 5534 | 46272 | 4305 | 47275 | 3392 | 46590 | 2056 | 53790 | 1056 | 41788 |
| 16-#18 | 3.85 | 29466 | 8146 | 47835 | 6145 | 54071 | 4779 | 56530 | 3668 | 59024 | 1988 | 71411 | 456 | 66868 |
| 17-#11 | 1.60 | 26261 | 6817 | 39403 | 5317 | 43606 | 4153 | 44055 | 3285 | 42273 | 2066 | 47639 | 1256 | 32148 |
| 17-#14 | 2.30 | 27311 | 7233 | 42138 | 5570 | 46939 | 4337 | 48025 | 3399 | 47590 | 2037 | 55240 | 1014 | 43938 |
| 17-#18 | 4.09 | 29828 | 8288 | 48888 | 6217 | 55196 | 4823 | 57894 | 3688 | 60786 | 1958 | 73972 | 383 | 70616 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 46" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.69 | 26398 | 6872 | 39937 | 5325 | 44120 | 4161 | 44592 | 3279 | 42997 | 2044 | 48487 | 1195 | 33688 |
| 18-#14 | 2.44 | 27504 | 7313 | 42843 | 5595 | 47664 | 4359 | 48820 | 3399 | 48690 | 2013 | 56520 | 931 | 46317 |
| 18-#18 | 4.33 | 30146 | 8430 | 50027 | 6284 | 56454 | 4863 | 59327 | 3703 | 62743 | 1922 | 76303 | 243 | 74034 |
| 19-#11 | 1.78 | 26563 | 6928 | 40112 | 5394 | 44507 | 4209 | 45182 | 3329 | 43743 | 2062 | 49733 | 1196 | 35424 |
| 19-#14 | 2.57 | 27733 | 7393 | 43156 | 5680 | 48228 | 4417 | 49631 | 3461 | 49684 | 2031 | 58388 | 940 | 48381 |
| 19-#18 | 4.57 | 30525 | 8572 | 50666 | 6408 | 57471 | 4964 | 60684 | 3794 | 64424 | 1942 | 79428 | 243 | 77351 |
| 20-#11 | 1.88 | 26713 | 6983 | 40393 | 5445 | 44940 | 4241 | 45714 | 3351 | 44510 | 2070 | 51018 | 1184 | 36948 |
| 20-#14 | 2.71 | 27939 | 7472 | 43577 | 5749 | 48848 | 4460 | 50392 | 3490 | 50763 | 2040 | 60030 | 906 | 50532 |
| 20-#18 | 4.81 | 30869 | 8714 | 51435 | 6523 | 58552 | 5051 | 62032 | 3842 | 66279 | 1953 | 82242 | 176 | 81005 |
| 21-#11 | 1.97 | 26861 | 7038 | 40813 | 5469 | 45414 | 4265 | 46283 | 3365 | 45214 | 2058 | 51942 | 1146 | 38605 |
| 21-#14 | 2.84 | 28148 | 7552 | 44166 | 5788 | 49523 | 4497 | 51204 | 3512 | 51779 | 2024 | 61359 | 851 | 52596 |
| 21-#18 | 5.05 | 31237 | 8855 | 52454 | 6600 | 59724 | 5102 | 63417 | 3882 | 68064 | 1927 | 84561 | 80 | 83949 |
| 22-#11 | 2.07 | 27032 | 7094 | 41281 | 5487 | 45924 | 4268 | 46819 | 3360 | 45945 | 2042 | 52911 | 1106 | 40190 |
| 22-#14 | 2.98 | 28387 | 7632 | 44789 | 5821 | 50258 | 4529 | 51983 | 3511 | 52872 | 2005 | 62786 | 797 | 54657 |
| 22-#18 | 5.30 | 31635 | 8997 | 53463 | 6673 | 61011 | 5155 | 64804 | 3889 | 70017 | 1900 | 87115 | -14 | 87036 |
| 23-#11 | 2.16 | 27156 | 7149 | 41522 | 5545 | 46327 | 4321 | 47376 | 3401 | 46678 | 2054 | 54043 | 1084 | 41765 |
| 23-#14 | 3.11 | 28563 | 7712 | 45181 | 5896 | 50826 | 4576 | 52769 | 3563 | 53874 | 2016 | 64346 | 760 | 56791 |
| 24-#11 | 2.25 | 27297 | 7204 | 41826 | 5593 | 46770 | 4351 | 47901 | 3420 | 47442 | 2060 | 55165 | 1064 | 43350 |
| 24-#14 | 3.25 | 28758 | 7792 | 45636 | 5962 | 51459 | 4617 | 53512 | 3589 | 54946 | 2023 | 65931 | 729 | 58775 |
| 25-#11 | 2.35 | 27455 | 7260 | 42272 | 5614 | 47232 | 4376 | 48472 | 3436 | 48196 | 2056 | 56265 | 1030 | 44871 |
| 25-#14 | 3.38 | 28978 | 7871 | 46257 | 5994 | 52126 | 4655 | 54332 | 3613 | 56045 | 2019 | 67508 | 682 | 60985 |
| 26-#11 | 2.44 | 27589 | 7315 | 42753 | 5631 | 47719 | 4384 | 49027 | 3436 | 48888 | 2037 | 57129 | 988 | 46477 |
| 26-#14 | 3.52 | 29179 | 7951 | 46907 | 6024 | 52820 | 4692 | 55147 | 3618 | 57057 | 1994 | 68771 | 622 | 62956 |
| 27-#11 | 2.53 | 27745 | 7370 | 42978 | 5688 | 48139 | 4431 | 49572 | 3472 | 49659 | 2051 | 58358 | 969 | 47968 |
| 27-#14 | 3.66 | 29388 | 8031 | 47268 | 6101 | 53420 | 4734 | 55900 | 3663 | 58132 | 2011 | 70488 | 591 | 64982 |
| 28-#11 | 2.63 | 27903 | 7426 | 43317 | 5727 | 48594 | 4461 | 50102 | 3490 | 50379 | 2050 | 59361 | 939 | 49497 |
| 28-#14 | 3.79 | 29601 | 8111 | 47763 | 6155 | 54079 | 4775 | 56652 | 3688 | 59135 | 2007 | 71902 | 546 | 67037 |
| 29-#11 | 2.72 | 28045 | 7481 | 43691 | 5763 | 49050 | 4487 | 50672 | 3507 | 51124 | 2047 | 60564 | 917 | 50948 |
| 29-#14 | 3.93 | 29803 | 8191 | 48287 | 6209 | 54720 | 4813 | 57471 | 3714 | 60221 | 2004 | 73627 | 515 | 68986 |
| 30-#11 | 2.82 | 28199 | 7536 | 44144 | 5784 | 49537 | 4498 | 51212 | 3509 | 51830 | 2030 | 61596 | 883 | 52419 |
| 31-#11 | 2.91 | 28332 | 7592 | 44404 | 5838 | 49959 | 4542 | 51766 | 3542 | 52590 | 2042 | 62656 | 855 | 53905 |
| 32-#11 | 3.00 | 28472 | 7647 | 44760 | 5876 | 50399 | 4569 | 52311 | 3560 | 53408 | 2053 | 63798 | 830 | 55393 |
| 33-#11 | 3.10 | 28632 | 7702 | 45115 | 5913 | 50865 | 4596 | 52862 | 3577 | 54109 | 2044 | 64754 | 793 | 56872 |
| 34-#11 | 3.19 | 28765 | 7757 | 45550 | 5936 | 51362 | 4611 | 53409 | 3582 | 54872 | 2036 | 65821 | 756 | 58289 |
| 35-#11 | 3.29 | 28916 | 7813 | 45832 | 5987 | 51775 | 4651 | 53961 | 3612 | 55574 | 2039 | 66968 | 739 | 59745 |
| 36-#11 | 3.38 | 29076 | 7868 | 46180 | 6024 | 52221 | 4678 | 54497 | 3629 | 56325 | 2043 | 67981 | 704 | 61179 |

## ROUND TIED COLUMNS 48" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 5-#18 | 1.11 | 28845 | 7108 | 43459 | 5398 | 46860 | 4220 | 46440 | 3346 | 42880 | 2139 | 46428 | 1453 | 26012 |
| 6-#18 | 1.33 | 29298 | 7250 | 45937 | 5220 | 48397 | 4062 | 47641 | 3183 | 44334 | 1954 | 47020 | 1209 | 31139 |
| 7-#18 | 1.55 | 29690 | 7392 | 45001 | 5659 | 49196 | 4419 | 49395 | 3484 | 46956 | 2165 | 52346 | 1315 | 35159 |
| 8-#18 | 1.77 | 30110 | 7533 | 45507 | 5825 | 50270 | 4566 | 50853 | 3597 | 49017 | 2219 | 55160 | 1286 | 39929 |
| 9-#14 | 1.12 | 28953 | 7117 | 42877 | 5554 | 46947 | 4347 | 46824 | 3454 | 43667 | 2237 | 47679 | 1500 | 26736 |
| 9-#18 | 1.99 | 30395 | 7675 | 46757 | 5880 | 51578 | 4584 | 52311 | 3594 | 51016 | 2185 | 58039 | 1152 | 43813 |
| 10-#14 | 1.24 | 29170 | 7197 | 43986 | 5493 | 47754 | 4296 | 47607 | 3402 | 44515 | 2158 | 48783 | 1436 | 29070 |
| 10-#18 | 2.21 | 30745 | 7817 | 48315 | 5847 | 53018 | 4558 | 53900 | 3556 | 52773 | 2082 | 60363 | 1069 | 48502 |
| 11-#14 | 1.37 | 29434 | 7276 | 43862 | 5675 | 48304 | 4429 | 48509 | 3516 | 45902 | 2238 | 51029 | 1438 | 31899 |
| 11-#18 | 2.43 | 31196 | 7959 | 48529 | 6083 | 53975 | 4737 | 55218 | 3693 | 54884 | 2180 | 63788 | 1031 | 52190 |
| 12-#11 | 1.03 | 28827 | 7062 | 42189 | 5584 | 46500 | 4369 | 46433 | 3492 | 43102 | 2273 | 47218 | 1588 | 24814 |
| 12-#14 | 1.49 | 29618 | 7356 | 44259 | 5758 | 48978 | 4493 | 49362 | 3571 | 46999 | 2250 | 52876 | 1422 | 34234 |
| 12-#18 | 2.65 | 31507 | 8101 | 49365 | 6207 | 55122 | 4847 | 56651 | 3774 | 56709 | 2187 | 66859 | 991 | 56348 |
| 13-#11 | 1.12 | 29000 | 7118 | 42715 | 5594 | 46968 | 4378 | 46981 | 3488 | 43864 | 2261 | 48120 | 1538 | 26742 |
| 13-#14 | 1.62 | 29861 | 7436 | 44953 | 5782 | 49652 | 4514 | 50177 | 3573 | 48124 | 2235 | 54213 | 1354 | 36880 |
| 13-#18 | 2.87 | 31923 | 8243 | 50464 | 6264 | 56324 | 4882 | 58123 | 3788 | 58733 | 2169 | 69269 | 873 | 59980 |
| 14-#11 | 1.21 | 29192 | 7173 | 43385 | 5578 | 47512 | 4365 | 47499 | 3464 | 44520 | 2219 | 48974 | 1481 | 28526 |
| 14-#14 | 1.74 | 30132 | 7516 | 45789 | 5781 | 50426 | 4515 | 50971 | 3554 | 49154 | 2187 | 55555 | 1281 | 39294 |
| 14-#18 | 3.09 | 32382 | 8385 | 51714 | 6303 | 57666 | 4899 | 59623 | 3784 | 60628 | 2100 | 71805 | 761 | 63736 |
| 15-#11 | 1.29 | 29332 | 7228 | 43428 | 5673 | 47924 | 4438 | 48138 | 3527 | 45424 | 2259 | 50490 | 1488 | 30381 |
| 15-#14 | 1.87 | 30324 | 7596 | 45991 | 5894 | 51018 | 4598 | 51823 | 3626 | 50342 | 2231 | 57577 | 1279 | 41771 |
| 15-#18 | 3.32 | 32694 | 8526 | 52315 | 6459 | 58702 | 5026 | 61003 | 3880 | 62577 | 2157 | 75079 | 734 | 67602 |
| 16-#11 | 1.38 | 29484 | 7284 | 43667 | 5731 | 48381 | 4477 | 48766 | 3563 | 46313 | 2278 | 51682 | 1455 | 32116 |
| 16-#14 | 1.99 | 30538 | 7675 | 46370 | 5969 | 51682 | 4649 | 52698 | 3673 | 51583 | 2255 | 59233 | 1229 | 44183 |
| 16-#18 | 3.54 | 33063 | 8668 | 53041 | 6581 | 59894 | 5124 | 62459 | 3951 | 64691 | 2191 | 77876 | 638 | 71148 |
| 17-#11 | 1.47 | 29641 | 7339 | 44158 | 5751 | 48878 | 4496 | 49298 | 3564 | 47033 | 2263 | 52729 | 1426 | 33959 |
| 17-#14 | 2.11 | 30759 | 7755 | 47040 | 6004 | 52390 | 4680 | 53476 | 3679 | 52633 | 2236 | 60756 | 1188 | 46540 |
| 17-#18 | 3.76 | 33444 | 8810 | 54157 | 6652 | 61097 | 5168 | 63874 | 3970 | 66555 | 2161 | 80574 | 566 | 75254 |
| 18-#11 | 1.55 | 29786 | 7394 | 44732 | 5757 | 49426 | 4488 | 49858 | 3557 | 47776 | 2240 | 53607 | 1365 | 35633 |
| 18-#14 | 2.24 | 30963 | 7835 | 47791 | 6026 | 53159 | 4701 | 54308 | 3677 | 53767 | 2210 | 62090 | 1104 | 48985 |
| 18-#18 | 3.98 | 33785 | 8952 | 55360 | 6716 | 62425 | 5206 | 65380 | 3983 | 68628 | 2126 | 83028 | 425 | 78705 |
| 19-#11 | 1.64 | 29962 | 7450 | 44902 | 5829 | 49826 | 4553 | 50461 | 3602 | 48582 | 2260 | 54936 | 1367 | 37457 |
| 19-#14 | 2.36 | 31210 | 7915 | 48111 | 6115 | 53742 | 4761 | 55168 | 3741 | 54838 | 2230 | 64076 | 1115 | 51266 |
| 19-#18 | 4.20 | 34186 | 9094 | 56031 | 6844 | 63479 | 5309 | 66816 | 4077 | 70387 | 2147 | 86332 | 429 | 82349 |
| 20-#11 | 1.72 | 30120 | 7505 | 45195 | 5881 | 50282 | 4586 | 51039 | 3631 | 49392 | 2269 | 56294 | 1356 | 39091 |
| 20-#14 | 2.49 | 31425 | 7994 | 48550 | 6185 | 54395 | 4805 | 55960 | 3771 | 55978 | 2240 | 65810 | 1082 | 53715 |
| 20-#18 | 4.42 | 34547 | 9236 | 56836 | 6961 | 64617 | 5398 | 68219 | 4125 | 72340 | 2159 | 89305 | 363 | 86063 |
| 21-#11 | 1.81 | 30277 | 7560 | 45636 | 5905 | 50781 | 4609 | 51637 | 3645 | 50122 | 2257 | 57266 | 1317 | 40916 |
| 21-#14 | 2.61 | 31647 | 8074 | 49167 | 6223 | 55106 | 4841 | 56822 | 3793 | 57045 | 2224 | 67212 | 1027 | 55856 |
| 21-#18 | 4.64 | 34940 | 9378 | 57902 | 7036 | 65854 | 5449 | 69698 | 4166 | 74223 | 2133 | 91757 | 268 | 89500 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 48" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.90 | 30463 | 7616 | 46139 | 5920 | 51313 | 4611 | 52204 | 3639 | 50884 | 2240 | 58278 | 1277 | 42525 |
| 22-#14 | 2.74 | 31907 | 8154 | 49834 | 6255 | 55873 | 4852 | 57642 | 3791 | 58175 | 2204 | 68707 | 973 | 58110 |
| 22-#18 | 4.86 | 35369 | 9519 | 58976 | 7108 | 67217 | 5501 | 71157 | 4173 | 76301 | 2107 | 94444 | 175 | 93122 |
| 23-#11 | 1.98 | 30591 | 7671 | 46382 | 5981 | 51740 | 4665 | 52787 | 3681 | 51663 | 2253 | 59482 | 1256 | 44251 |
| 23-#14 | 2.86 | 32090 | 8234 | 50236 | 6331 | 56478 | 4921 | 58462 | 3844 | 59247 | 2218 | 70365 | 937 | 60290 |
| 23-#18 | 5.08 | 35674 | 9661 | 59768 | 7226 | 68242 | 5589 | 72585 | 4255 | 78208 | 2136 | 97214 | 104 | 96470 |
| 24-#11 | 2.07 | 30742 | 7726 | 46695 | 6029 | 52208 | 4696 | 53341 | 3701 | 52478 | 2260 | 60667 | 1237 | 45873 |
| 24-#14 | 2.98 | 32298 | 8314 | 50705 | 6398 | 57144 | 4963 | 59247 | 3870 | 60383 | 2226 | 72038 | 907 | 62554 |
| 25-#11 | 2.16 | 30908 | 7782 | 47166 | 6049 | 52688 | 4721 | 53942 | 3717 | 53260 | 2255 | 61826 | 1204 | 47539 |
| 25-#14 | 3.11 | 32529 | 8393 | 51365 | 6430 | 57838 | 5001 | 60109 | 3895 | 61525 | 2221 | 73700 | 860 | 64737 |
| 26-#11 | 2.24 | 31050 | 7837 | 47684 | 6065 | 53203 | 4728 | 54517 | 3716 | 53984 | 2236 | 62730 | 1161 | 49185 |
| 26-#14 | 3.23 | 32730 | 8473 | 52060 | 6459 | 58570 | 5016 | 60957 | 3899 | 62585 | 2195 | 75026 | 801 | 66870 |
| 27-#11 | 2.33 | 31217 | 7892 | 47909 | 6124 | 53643 | 4776 | 55099 | 3753 | 54801 | 2251 | 64030 | 1143 | 50816 |
| 27-#14 | 3.36 | 32966 | 8553 | 52426 | 6537 | 59201 | 5080 | 61760 | 3946 | 63722 | 2214 | 76842 | 771 | 69092 |
| 28-#11 | 2.41 | 31383 | 7948 | 48264 | 6164 | 54117 | 4806 | 55658 | 3771 | 55552 | 2250 | 65092 | 1114 | 52465 |
| 28-#14 | 3.48 | 33190 | 8633 | 52945 | 6592 | 59887 | 5121 | 62553 | 3971 | 64794 | 2211 | 78339 | 727 | 71178 |
| 29-#11 | 2.50 | 31534 | 8003 | 48659 | 6200 | 54602 | 4832 | 56251 | 3788 | 56343 | 2247 | 66357 | 1092 | 54042 |
| 29-#14 | 3.61 | 33405 | 8713 | 53499 | 6645 | 60570 | 5159 | 63415 | 3996 | 65922 | 2207 | 80155 | 696 | 73314 |
| 30-#11 | 2.59 | 31701 | 8058 | 49138 | 6219 | 55116 | 4843 | 56818 | 3790 | 57082 | 2230 | 67441 | 1058 | 55684 |
| 30-#14 | 3.73 | 33639 | 8792 | 54162 | 6679 | 61301 | 5179 | 64236 | 4002 | 66998 | 2184 | 81724 | 649 | 75478 |
| 31-#11 | 2.67 | 31840 | 8114 | 49405 | 6274 | 55553 | 4887 | 57402 | 3823 | 57886 | 2243 | 68563 | 1031 | 57229 |
| 31-#14 | 3.85 | 33837 | 8872 | 54572 | 6753 | 61937 | 5239 | 65057 | 4047 | 68124 | 2199 | 83294 | 606 | 77581 |
| 32-#11 | 2.76 | 31989 | 8169 | 49783 | 6313 | 56017 | 4915 | 57979 | 3842 | 58738 | 2254 | 69769 | 1006 | 58822 |
| 33-#11 | 2.84 | 32157 | 8224 | 50154 | 6349 | 56507 | 4942 | 58556 | 3859 | 59481 | 2245 | 70776 | 969 | 60335 |
| 34-#11 | 2.93 | 32298 | 8280 | 50616 | 6371 | 57025 | 4956 | 59130 | 3863 | 60285 | 2237 | 71898 | 933 | 61881 |
| 35-#11 | 3.02 | 32459 | 8335 | 50908 | 6424 | 57465 | 4997 | 59713 | 3894 | 61018 | 2240 | 73108 | 917 | 63429 |
| 36-#11 | 3.10 | 32628 | 8390 | 51269 | 6461 | 57934 | 5024 | 60271 | 3911 | 61809 | 2244 | 74177 | 883 | 64933 |
| 37-#11 | 3.19 | 32776 | 8446 | 51691 | 6492 | 58419 | 5052 | 60864 | 3929 | 62557 | 2236 | 75307 | 857 | 66514 |

## ROUND TIED COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.38 | 4367 | 2215 | 6768 | 1620 | 7130 | 1271 | 6953 | 1003 | 6286 | 633 | 6539 | 392 | 4135 |
| 4-#14 | 1.99 | 4427 | 2311 | 7053 | 1663 | 7445 | 1304 | 7318 | 1018 | 6769 | 612 | 7151 | 309 | 5741 |
| 4-#18 | 3.54 | 4561 | 2553 | 7713 | 1775 | 8196 | 1389 | 8194 | 1056 | 7930 | 555 | 8605 | 89 | 8301 |
| 5-#11 | 1.72 | 4455 | 2269 | 6998 | 1615 | 7304 | 1251 | 7129 | 977 | 6523 | 591 | 6958 | 339 | 4733 |
| 5-#14 | 2.49 | 4548 | 2389 | 7336 | 1673 | 7697 | 1290 | 7590 | 992 | 7138 | 559 | 7783 | 240 | 6467 |
| 5-#18 | 4.42 | 4753 | 2691 | 8132 | 1820 | 8634 | 1387 | 8696 | 1029 | 8615 | 473 | 9732 | -25 | 9716 |
| 6-#11 | 2.07 | 4543 | 2323 | 7296 | 1564 | 7504 | 1208 | 7311 | 929 | 6766 | 528 | 7040 | 241 | 5680 |
| 6-#14 | 2.98 | 4663 | 2466 | 7713 | 1630 | 7999 | 1252 | 7897 | 943 | 7546 | 484 | 7978 | 110 | 7487 |
| 6-#18 | 5.31 | 4925 | 2829 | 8697 | 1796 | 9180 | 1362 | 9298 | 977 | 9416 | 363 | 10186 | -241 | 9986 |
| 7-#11 | 2.41 | 4557 | 2377 | 7267 | 1704 | 7693 | 1316 | 7613 | 1017 | 7205 | 594 | 7857 | 264 | 6309 |
| 7-#14 | 3.48 | 4686 | 2544 | 7730 | 1791 | 8240 | 1375 | 8259 | 1044 | 8081 | 558 | 9017 | 124 | 8385 |
| 7-#18 | 6.19 | 4986 | 2968 | 8819 | 2013 | 9542 | 1521 | 9804 | 1105 | 10179 | 457 | 11964 | -216 | 11448 |
| 8-#11 | 2.76 | 4608 | 2431 | 7371 | 1757 | 7887 | 1365 | 7864 | 1054 | 7506 | 599 | 8437 | 259 | 7137 |
| 8-#14 | 3.98 | 4760 | 2622 | 7900 | 1859 | 8509 | 1437 | 8599 | 1089 | 8485 | 558 | 9808 | 112 | 9291 |
| 8-#18 | 7.07 | 5088 | 3106 | 9141 | 2116 | 9992 | 1617 | 10358 | 1172 | 10830 | 447 | 13047 | -283 | 12239 |
| 9-#11 | 3.10 | 4668 | 2485 | 7554 | 1781 | 8077 | 1371 | 8082 | 1050 | 7825 | 583 | 8797 | 193 | 7711 |
| 9-#14 | 4.48 | 4838 | 2700 | 8143 | 1898 | 8779 | 1449 | 8914 | 1086 | 8945 | 537 | 10324 | 19 | 10227 |
| 9-#18 | 7.96 | 5218 | 3244 | 9528 | 2193 | 10450 | 1644 | 10901 | 1172 | 11627 | 411 | 13922 | -448 | 13183 |
| 10-#11 | 3.45 | 4704 | 2539 | 7789 | 1777 | 8292 | 1367 | 8314 | 1037 | 8102 | 542 | 9111 | 144 | 8386 |
| 10-#14 | 4.97 | 4889 | 2778 | 8448 | 1903 | 9087 | 1453 | 9257 | 1076 | 9360 | 484 | 10796 | -50 | 10743 |
| 11-#11 | 3.79 | 4761 | 2593 | 7850 | 1854 | 8461 | 1422 | 8547 | 1079 | 8441 | 568 | 9637 | 111 | 9062 |
| 11-#14 | 5.47 | 4974 | 2855 | 8565 | 2001 | 9317 | 1520 | 9565 | 1125 | 9808 | 514 | 11497 | -105 | 11348 |
| 12-#11 | 4.14 | 4828 | 2647 | 7981 | 1894 | 8651 | 1459 | 8783 | 1105 | 8733 | 564 | 10104 | 89 | 9653 |
| 12-#14 | 5.97 | 5063 | 2933 | 8758 | 2054 | 9584 | 1570 | 9892 | 1160 | 10326 | 530 | 12139 | -139 | 11953 |
| 13-#11 | 4.48 | 4865 | 2701 | 8150 | 1925 | 8844 | 1471 | 9029 | 1115 | 9093 | 561 | 10544 | 43 | 10350 |
| 13-#14 | 6.47 | 5110 | 3011 | 8990 | 2101 | 9856 | 1589 | 10241 | 1176 | 10723 | 502 | 12763 | -206 | 12440 |
| 14-#11 | 4.83 | 4912 | 2755 | 8358 | 1936 | 9057 | 1480 | 9250 | 1106 | 9423 | 539 | 10853 | -15 | 10837 |
| 15-#11 | 5.17 | 4972 | 2809 | 8452 | 1995 | 9227 | 1519 | 9488 | 1142 | 9702 | 545 | 11375 | -39 | 11323 |
| 16-#11 | 5.52 | 5016 | 2863 | 8593 | 2031 | 9418 | 1553 | 9704 | 1156 | 10024 | 546 | 11941 | -60 | 11857 |

## ROUND TIED COLUMNS 26" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.18 | 5534 | 2562 | 8459 | 1901 | 8958 | 1494 | 8736 | 1184 | 7857 | 762 | 8151 | 503 | 4571 |
| 4-#14 | 1.70 | 5606 | 2658 | 8780 | 1944 | 9316 | 1527 | 9149 | 1200 | 8403 | 742 | 8850 | 424 | 6372 |
| 4-#18 | 3.01 | 5767 | 2900 | 9550 | 2058 | 10175 | 1614 | 10148 | 1241 | 9725 | 689 | 10524 | 214 | 9686 |
| 5-#11 | 1.47 | 5638 | 2616 | 8746 | 1890 | 9155 | 1468 | 8925 | 1153 | 8109 | 716 | 8610 | 448 | 5274 |
| 5-#14 | 2.12 | 5748 | 2736 | 9132 | 1948 | 9601 | 1507 | 9448 | 1169 | 8805 | 686 | 9553 | 353 | 7221 |
| 5-#18 | 3.77 | 5996 | 3038 | 10045 | 2097 | 10673 | 1608 | 10710 | 1210 | 10488 | 606 | 11803 | 100 | 11265 |
| 6-#11 | 1.76 | 5736 | 2670 | 9107 | 1826 | 9377 | 1413 | 9113 | 1096 | 8356 | 648 | 8673 | 347 | 6299 |
| 6-#14 | 2.54 | 5890 | 2814 | 9582 | 1892 | 9939 | 1459 | 9777 | 1112 | 9240 | 605 | 9747 | 221 | 8632 |
| 6-#18 | 4.52 | 6221 | 3177 | 10710 | 2061 | 11288 | 1573 | 11376 | 1151 | 11372 | 492 | 12301 | -114 | 12197 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 26" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 7-#11 | 2.06 | 5759 | 2724 | 9032 | 1983 | 9591 | 1537 | 9473 | 1198 | 8882 | 723 | 9637 | 378 | 7056 |
| 7-#14 | 2.97 | 5913 | 2891 | 9564 | 2071 | 10212 | 1597 | 10205 | 1226 | 9872 | 690 | 10964 | 244 | 9543 |
| 7-#18 | 5.27 | 6278 | 3315 | 10816 | 2296 | 11701 | 1748 | 11967 | 1293 | 12263 | 598 | 14122 | -111 | 13991 |
| 8-#11 | 2.35 | 5818 | 2778 | 9137 | 2040 | 9808 | 1590 | 9759 | 1237 | 9226 | 731 | 10298 | 377 | 8017 |
| 8-#14 | 3.39 | 6004 | 2969 | 9734 | 2142 | 10515 | 1664 | 10592 | 1275 | 10334 | 694 | 11864 | 237 | 10636 |
| 8-#18 | 6.03 | 6402 | 3453 | 11169 | 2404 | 12209 | 1849 | 12597 | 1365 | 13006 | 592 | 15597 | -139 | 14898 |
| 9-#11 | 2.64 | 5884 | 2832 | 9349 | 2062 | 10023 | 1594 | 10002 | 1232 | 9580 | 714 | 10703 | 311 | 8734 |
| 9-#14 | 3.81 | 6087 | 3047 | 10020 | 2180 | 10819 | 1675 | 10943 | 1271 | 10848 | 673 | 12449 | 143 | 11607 |
| 9-#18 | 6.78 | 6553 | 3592 | 11615 | 2481 | 12728 | 1876 | 13211 | 1365 | 13904 | 558 | 16602 | -303 | 16047 |
| 10-#11 | 2.94 | 5928 | 2886 | 9635 | 2054 | 10265 | 1586 | 10256 | 1217 | 9882 | 671 | 11046 | 261 | 9568 |
| 10-#14 | 4.24 | 6146 | 3125 | 10385 | 2182 | 11166 | 1675 | 11325 | 1258 | 11306 | 618 | 12973 | 76 | 12575 |
| 10-#18 | 7.53 | 6647 | 3730 | 12171 | 2505 | 13329 | 1896 | 13897 | 1357 | 14735 | 470 | 17552 | -419 | 16851 |
| 11-#11 | 3.23 | 5994 | 2940 | 9679 | 2137 | 10453 | 1647 | 10524 | 1263 | 10273 | 702 | 11652 | 233 | 10267 |
| 11-#14 | 4.66 | 6239 | 3203 | 10490 | 2285 | 11425 | 1748 | 11677 | 1313 | 11820 | 653 | 13778 | 27 | 13659 |
| 12-#11 | 3.53 | 6065 | 2994 | 9822 | 2179 | 10667 | 1686 | 10791 | 1291 | 10604 | 700 | 12187 | 213 | 10983 |
| 12-#14 | 5.09 | 6340 | 3280 | 10701 | 2341 | 11726 | 1801 | 12047 | 1350 | 12278 | 646 | 14514 | -5 | 14506 |
| 13-#11 | 3.82 | 6117 | 3048 | 10015 | 2209 | 10884 | 1698 | 11044 | 1293 | 11005 | 697 | 12679 | 169 | 11741 |
| 13-#14 | 5.51 | 6408 | 3358 | 10966 | 2387 | 12032 | 1819 | 12439 | 1366 | 12850 | 644 | 15216 | -70 | 15097 |
| 14-#11 | 4.11 | 6172 | 3102 | 10250 | 2217 | 11124 | 1705 | 11312 | 1291 | 11371 | 675 | 13027 | 110 | 12407 |
| 14-#14 | 5.93 | 6506 | 3436 | 11289 | 2406 | 12372 | 1836 | 12797 | 1355 | 13384 | 614 | 15722 | -152 | 15476 |
| 15-#11 | 4.41 | 6232 | 3156 | 10354 | 2280 | 11315 | 1748 | 11581 | 1330 | 11690 | 683 | 13622 | 90 | 13166 |
| 16-#11 | 4.70 | 6290 | 3210 | 10510 | 2317 | 11528 | 1782 | 11825 | 1345 | 12052 | 686 | 14263 | 70 | 13873 |
| 17-#11 | 5.00 | 6350 | 3264 | 10707 | 2342 | 11745 | 1797 | 12098 | 1358 | 12376 | 669 | 14653 | 21 | 14545 |
| 18-#11 | 5.29 | 6412 | 3318 | 10903 | 2366 | 11981 | 1811 | 12352 | 1353 | 12745 | 652 | 15130 | -27 | 15085 |

## ROUND TIED COLUMNS 28" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.01 | 6891 | 2937 | 10411 | 2206 | 11066 | 1734 | 10800 | 1379 | 9671 | 900 | 10007 | 623 | 5005 |
| 4-#14 | 1.46 | 6975 | 3033 | 10768 | 2248 | 11474 | 1768 | 11261 | 1396 | 10280 | 882 | 10792 | 547 | 7001 |
| 4-#18 | 2.60 | 7164 | 3275 | 11626 | 2361 | 12442 | 1856 | 12383 | 1439 | 11763 | 833 | 12688 | 345 | 11160 |
| 5-#11 | 1.27 | 7011 | 2991 | 10755 | 2187 | 11294 | 1703 | 11000 | 1343 | 9934 | 851 | 10499 | 565 | 5823 |
| 5-#14 | 1.83 | 7139 | 3111 | 11195 | 2246 | 11794 | 1742 | 11585 | 1361 | 10711 | 823 | 11561 | 473 | 7983 |
| 5-#18 | 3.25 | 7431 | 3413 | 12228 | 2396 | 13000 | 1845 | 13004 | 1405 | 12601 | 747 | 14113 | 230 | 12741 |
| 6-#11 | 1.52 | 7115 | 3045 | 11194 | 2109 | 11537 | 1636 | 11190 | 1277 | 10177 | 776 | 10533 | 460 | 6919 |
| 6-#14 | 2.19 | 7290 | 3188 | 11727 | 2176 | 12166 | 1682 | 11931 | 1294 | 11165 | 736 | 11744 | 338 | 9615 |
| 6-#18 | 3.90 | 7699 | 3552 | 13001 | 2347 | 13686 | 1799 | 13730 | 1337 | 13560 | 628 | 14645 | 15 | 14573 |
| 7-#11 | 1.77 | 7151 | 3099 | 11059 | 2285 | 11778 | 1776 | 11614 | 1392 | 10799 | 862 | 11657 | 499 | 7817 |
| 7-#14 | 2.56 | 7332 | 3266 | 11652 | 2373 | 12473 | 1837 | 12431 | 1422 | 11905 | 831 | 13152 | 370 | 10667 |
| 7-#18 | 4.55 | 7743 | 3690 | 13080 | 2602 | 14149 | 1992 | 14412 | 1494 | 14588 | 746 | 16736 | 28 | 16568 |
| 8-#11 | 2.03 | 7219 | 3153 | 11163 | 2346 | 12010 | 1832 | 11935 | 1436 | 11191 | 872 | 12213 | 478 | 8841 |
| 8-#14 | 2.92 | 7427 | 3344 | 11830 | 2449 | 12808 | 1908 | 12866 | 1475 | 12427 | 838 | 13894 | 332 | 12044 |
| 8-#18 | 5.20 | 7911 | 3828 | 13436 | 2713 | 14715 | 2098 | 15120 | 1571 | 15427 | 745 | 18395 | 7 | 18358 |
| 9-#11 | 2.28 | 7290 | 3207 | 11407 | 2366 | 12257 | 1835 | 12202 | 1429 | 11578 | 855 | 12851 | 435 | 9693 |
| 9-#14 | 3.29 | 7525 | 3422 | 12155 | 2485 | 13148 | 1918 | 13255 | 1470 | 12993 | 817 | 14818 | 273 | 13037 |
| 9-#18 | 5.85 | 8066 | 3967 | 13958 | 2789 | 15297 | 2124 | 15803 | 1571 | 16424 | 712 | 19528 | -155 | 19227 |

## ROUND TIED COLUMNS 28" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.53 | 7343 | 3261 | 11736 | 2352 | 12526 | 1823 | 12478 | 1410 | 11901 | 810 | 13220 | 385 | 10701 |
| 10-#14 | 3.65 | 7596 | 3500 | 12590 | 2482 | 13535 | 1914 | 13673 | 1454 | 13492 | 760 | 15390 | 207 | 14185 |
| 10-#18 | 6.50 | 8178 | 4105 | 14604 | 2810 | 15968 | 2141 | 16564 | 1561 | 17344 | 623 | 20585 | -268 | 20100 |
| 11-#11 | 2.79 | 7418 | 3315 | 11771 | 2442 | 12733 | 1890 | 12783 | 1462 | 12348 | 845 | 13912 | 362 | 11505 |
| 11-#14 | 4.02 | 7701 | 3577 | 12676 | 2592 | 13822 | 1993 | 14071 | 1515 | 14076 | 800 | 16304 | 163 | 15322 |
| 11-#18 | 7.15 | 8369 | 4243 | 14855 | 2971 | 16445 | 2251 | 17189 | 1642 | 18261 | 673 | 22036 | -367 | 21232 |
| 12-#11 | 3.04 | 7494 | 3369 | 11925 | 2486 | 12963 | 1930 | 13080 | 1492 | 12719 | 844 | 14515 | 343 | 12366 |
| 12-#14 | 4.38 | 7809 | 3655 | 12906 | 2650 | 14155 | 2048 | 14484 | 1554 | 14588 | 795 | 17135 | 133 | 16361 |
| 13-#11 | 3.29 | 7562 | 3423 | 12141 | 2516 | 13209 | 1942 | 13360 | 1493 | 13115 | 834 | 15059 | 300 | 13151 |
| 13-#14 | 4.75 | 7899 | 3733 | 13205 | 2696 | 14497 | 2066 | 14885 | 1557 | 15221 | 793 | 17915 | 70 | 17555 |
| 14-#11 | 3.55 | 7624 | 3477 | 12403 | 2520 | 13479 | 1947 | 13654 | 1489 | 13561 | 819 | 15444 | 241 | 13942 |
| 14-#14 | 5.12 | 7987 | 3811 | 13559 | 2711 | 14876 | 2081 | 15315 | 1558 | 15808 | 763 | 18481 | -12 | 18461 |
| 15-#11 | 3.80 | 7688 | 3531 | 12530 | 2579 | 13686 | 1993 | 13957 | 1531 | 13921 | 830 | 16114 | 223 | 14798 |
| 15-#14 | 5.48 | 8083 | 3889 | 13734 | 2798 | 15172 | 2138 | 15727 | 1611 | 16294 | 773 | 19395 | -43 | 19311 |
| 16-#11 | 4.05 | 7756 | 3585 | 12689 | 2627 | 13919 | 2029 | 14228 | 1548 | 14325 | 833 | 16641 | 181 | 15562 |
| 16-#14 | 5.85 | 8168 | 3967 | 13985 | 2850 | 15505 | 2188 | 16106 | 1632 | 16858 | 776 | 20126 | -106 | 19909 |
| 17-#11 | 4.31 | 7825 | 3639 | 12901 | 2650 | 14163 | 2043 | 14530 | 1561 | 14683 | 817 | 17265 | 157 | 16370 |
| 18-#11 | 4.56 | 7891 | 3693 | 13124 | 2673 | 14431 | 2057 | 14811 | 1556 | 15089 | 800 | 17795 | 109 | 17124 |
| 19-#11 | 4.81 | 7958 | 3747 | 13275 | 2721 | 14641 | 2093 | 15103 | 1590 | 15445 | 804 | 18321 | 78 | 17875 |
| 20-#11 | 5.07 | 8032 | 3801 | 13436 | 2766 | 14875 | 2127 | 15376 | 1604 | 15842 | 805 | 18919 | 45 | 18684 |

## ROUND TIED COLUMNS 30" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.27 | 8548 | 3436 | 13036 | 2576 | 13927 | 2027 | 13677 | 1607 | 12419 | 1032 | 12997 | 677 | 7628 |
| 4-#18 | 2.26 | 8767 | 3678 | 13983 | 2688 | 15020 | 2117 | 14923 | 1652 | 14064 | 986 | 15114 | 482 | 12721 |
| 5-#11 | 1.10 | 8588 | 3394 | 13048 | 2507 | 13743 | 1955 | 13377 | 1548 | 12017 | 996 | 12645 | 690 | 6380 |
| 5-#14 | 1.59 | 8735 | 3513 | 13534 | 2565 | 14296 | 1995 | 14023 | 1566 | 12875 | 969 | 13826 | 601 | 8755 |
| 5-#18 | 2.83 | 9072 | 3816 | 14699 | 2717 | 15639 | 2099 | 15598 | 1613 | 14971 | 898 | 16680 | 366 | 14277 |
| 6-#11 | 1.32 | 8699 | 3448 | 13577 | 2414 | 14007 | 1876 | 13561 | 1471 | 12249 | 914 | 12638 | 579 | 7540 |
| 6-#14 | 1.91 | 8895 | 3591 | 14169 | 2481 | 14704 | 1922 | 14382 | 1490 | 13340 | 875 | 13987 | 461 | 10506 |
| 6-#18 | 3.40 | 9356 | 3954 | 15590 | 2653 | 16394 | 2042 | 16380 | 1536 | 15999 | 772 | 17237 | 149 | 16434 |
| 7-#11 | 1.54 | 8748 | 3502 | 13369 | 2609 | 14272 | 2033 | 14056 | 1601 | 12977 | 1011 | 13938 | 628 | 8591 |
| 7-#14 | 2.23 | 8956 | 3669 | 14024 | 2698 | 15044 | 2095 | 14960 | 1632 | 14198 | 981 | 15601 | 502 | 11731 |
| 7-#18 | 3.96 | 9431 | 4093 | 15606 | 2927 | 16909 | 2253 | 17161 | 1708 | 17175 | 902 | 19611 | 172 | 18486 |
| 8-#11 | 1.77 | 8826 | 3556 | 13470 | 2676 | 14518 | 2093 | 14415 | 1648 | 13417 | 1024 | 14565 | 610 | 9670 |
| 8-#14 | 2.55 | 9064 | 3747 | 14207 | 2779 | 15396 | 2169 | 15444 | 1689 | 14783 | 992 | 16435 | 469 | 13369 |
| 8-#18 | 4.53 | 9629 | 4231 | 15985 | 3044 | 17533 | 2364 | 17947 | 1790 | 18111 | 906 | 21458 | 158 | 20572 |
| 9-#11 | 1.99 | 8902 | 3610 | 13746 | 2694 | 14792 | 2094 | 14705 | 1641 | 13837 | 1006 | 15262 | 567 | 10670 |
| 9-#14 | 2.86 | 9169 | 3825 | 14573 | 2813 | 15785 | 2178 | 15869 | 1683 | 15400 | 971 | 17449 | 410 | 14515 |
| 9-#18 | 5.09 | 9787 | 4369 | 16570 | 3119 | 18176 | 2389 | 18699 | 1789 | 19207 | 873 | 22720 | -4 | 22712 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.21 | 8963 | 3664 | 14119 | 2673 | 15098 | 2078 | 15001 | 1617 | 14179 | 959 | 15651 | 516 | 11733 |
| 10-#14 | 3.18 | 9251 | 3902 | 15058 | 2803 | 16214 | 2170 | 16322 | 1663 | 15936 | 911 | 18066 | 343 | 15859 |
| 10-#18 | 5.66 | 9918 | 4508 | 17327 | 3137 | 18920 | 2402 | 19533 | 1776 | 20212 | 783 | 23880 | -115 | 23660 |
| 11-#11 | 2.43 | 9048 | 3718 | 14144 | 2771 | 15314 | 2150 | 15345 | 1675 | 14685 | 998 | 16434 | 497 | 12675 |
| 11-#14 | 3.50 | 9371 | 3980 | 15144 | 2921 | 16523 | 2255 | 16769 | 1730 | 16594 | 956 | 19094 | 304 | 17066 |
| 11-#18 | 6.22 | 10136 | 4646 | 17560 | 3303 | 19446 | 2519 | 20232 | 1864 | 21238 | 839 | 25504 | -206 | 25018 |
| 12-#11 | 2.65 | 9129 | 3772 | 14307 | 2818 | 15567 | 2193 | 15674 | 1707 | 15097 | 998 | 17107 | 479 | 13733 |
| 12-#14 | 3.82 | 9485 | 4058 | 15392 | 2982 | 16880 | 2311 | 17226 | 1771 | 17161 | 953 | 20022 | 276 | 18246 |
| 12-#18 | 6.79 | 10317 | 4784 | 18012 | 3399 | 20071 | 2610 | 20997 | 1928 | 22183 | 826 | 27040 | -263 | 26428 |
| 13-#11 | 2.87 | 9210 | 3826 | 14542 | 2845 | 15837 | 2203 | 15980 | 1707 | 15530 | 988 | 17703 | 437 | 14605 |
| 13-#14 | 4.14 | 9596 | 4136 | 15720 | 3026 | 17263 | 2330 | 17666 | 1774 | 17785 | 939 | 20878 | 215 | 19550 |
| 13-#18 | 7.36 | 10492 | 4922 | 18561 | 3486 | 20716 | 2647 | 21762 | 1937 | 23391 | 825 | 28526 | -374 | 27233 |
| 14-#11 | 3.09 | 9283 | 3880 | 14839 | 2847 | 16140 | 2207 | 16299 | 1702 | 16011 | 972 | 18123 | 377 | 15532 |
| 14-#14 | 4.46 | 9696 | 4214 | 16112 | 3039 | 17691 | 2343 | 18135 | 1773 | 18494 | 921 | 21502 | 133 | 20650 |
| 15-#11 | 3.31 | 9350 | 3933 | 14968 | 2910 | 16361 | 2255 | 16636 | 1747 | 16415 | 985 | 18870 | 363 | 16417 |
| 15-#14 | 4.77 | 9790 | 4291 | 16326 | 3117 | 18005 | 2403 | 18593 | 1830 | 19036 | 933 | 22520 | 105 | 21912 |
| 16-#11 | 3.53 | 9419 | 3987 | 15138 | 2959 | 16617 | 2293 | 16935 | 1765 | 16861 | 990 | 19458 | 321 | 17309 |
| 16-#14 | 5.09 | 9897 | 4369 | 16580 | 3185 | 18367 | 2454 | 19011 | 1853 | 19659 | 938 | 23336 | 43 | 23059 |
| 17-#11 | 3.75 | 9507 | 4041 | 15375 | 2982 | 16886 | 2307 | 17266 | 1777 | 17253 | 974 | 20142 | 299 | 18187 |
| 17-#14 | 5.41 | 10006 | 4447 | 16904 | 3220 | 18747 | 2476 | 19484 | 1872 | 20220 | 915 | 24312 | 11 | 24249 |
| 18-#11 | 3.97 | 9577 | 4095 | 15626 | 3002 | 17173 | 2319 | 17573 | 1771 | 17695 | 956 | 20723 | 250 | 19024 |
| 19-#11 | 4.19 | 9652 | 4149 | 15785 | 3053 | 17410 | 2358 | 17897 | 1807 | 18090 | 962 | 21308 | 223 | 19912 |
| 20-#11 | 4.41 | 9742 | 4203 | 15953 | 3098 | 17668 | 2392 | 18197 | 1823 | 18528 | 965 | 21967 | 192 | 20738 |
| 21-#11 | 4.63 | 9803 | 4257 | 16192 | 3124 | 17932 | 2408 | 18527 | 1837 | 18975 | 959 | 22464 | 150 | 21596 |

## ROUND TIED COLUMNS 32" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.12 | 10341 | 3866 | 15604 | 2927 | 16712 | 2304 | 16417 | 1833 | 14839 | 1192 | 15485 | 815 | 8253 |
| 4-#18 | 1.99 | 10589 | 4108 | 16641 | 3039 | 17912 | 2394 | 17787 | 1879 | 16645 | 1148 | 17823 | 626 | 13927 |
| 5-#14 | 1.40 | 10551 | 3944 | 16178 | 2907 | 17131 | 2266 | 16783 | 1786 | 15315 | 1125 | 16366 | 735 | 9536 |
| 5-#18 | 2.49 | 10933 | 4246 | 17465 | 3060 | 18610 | 2371 | 18516 | 1834 | 17618 | 1057 | 19524 | 507 | 15692 |
| 6-#11 | 1.16 | 10502 | 3878 | 16276 | 2741 | 16809 | 2132 | 16250 | 1679 | 14587 | 1061 | 15007 | 706 | 8161 |
| 6-#14 | 1.68 | 10720 | 4022 | 16928 | 2808 | 17573 | 2179 | 17149 | 1698 | 15781 | 1023 | 16493 | 590 | 11393 |
| 6-#18 | 2.98 | 11233 | 4385 | 18497 | 2981 | 19434 | 2301 | 19346 | 1747 | 18705 | 925 | 20093 | 287 | 18379 |
| 7-#11 | 1.36 | 10565 | 3932 | 15983 | 2958 | 17091 | 2307 | 16823 | 1825 | 15434 | 1169 | 16498 | 764 | 9378 |
| 7-#14 | 1.96 | 10800 | 4099 | 16700 | 3046 | 17941 | 2370 | 17813 | 1856 | 16770 | 1142 | 18329 | 642 | 12812 |
| 7-#18 | 3.48 | 11342 | 4523 | 18436 | 3276 | 20001 | 2531 | 20233 | 1936 | 20041 | 1068 | 22767 | 321 | 20468 |
| 8-#11 | 1.55 | 10652 | 3986 | 16075 | 3029 | 17358 | 2372 | 17213 | 1876 | 15926 | 1186 | 17200 | 750 | 10506 |
| 8-#14 | 2.24 | 10921 | 4177 | 16883 | 3132 | 18316 | 2448 | 18347 | 1918 | 17420 | 1156 | 19259 | 613 | 14545 |
| 8-#18 | 3.98 | 11545 | 4661 | 18835 | 3398 | 20665 | 2646 | 21100 | 2022 | 21077 | 1075 | 24249 | 252 | 22871 |
| 9-#11 | 1.75 | 10731 | 4040 | 16387 | 3044 | 17657 | 2371 | 17533 | 1866 | 16376 | 1167 | 17953 | 706 | 11681 |
| 9-#14 | 2.52 | 11033 | 4255 | 17293 | 3164 | 18742 | 2455 | 18808 | 1911 | 18087 | 1133 | 20361 | 553 | 15900 |
| 9-#18 | 4.48 | 11731 | 4800 | 19487 | 3471 | 21390 | 2671 | 21921 | 2021 | 22270 | 1042 | 26194 | 151 | 25124 |

## ROUND TIED COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.94 | 10802 | 4094 | 16808 | 3017 | 18002 | 2350 | 17846 | 1839 | 16734 | 1116 | 18359 | 653 | 12777 |
| 10-#14 | 2.80 | 11128 | 4333 | 17832 | 3147 | 19226 | 2443 | 19294 | 1886 | 18658 | 1071 | 21018 | 485 | 17596 |
| 10-#18 | 4.97 | 11882 | 4938 | 20331 | 3483 | 22205 | 2679 | 22825 | 2004 | 23358 | 951 | 27453 | 43 | 27186 |
| 11-#11 | 2.13 | 10897 | 4148 | 16814 | 3123 | 18226 | 2428 | 18231 | 1902 | 17303 | 1160 | 19237 | 639 | 13867 |
| 11-#14 | 3.08 | 11261 | 4411 | 17914 | 3274 | 19548 | 2534 | 19792 | 1959 | 19392 | 1121 | 22166 | 452 | 18828 |
| 11-#18 | 5.47 | 12108 | 5076 | 20568 | 3658 | 22780 | 2804 | 23600 | 2099 | 24496 | 1012 | 29257 | -42 | 29151 |
| 12-#11 | 2.33 | 10983 | 4202 | 16989 | 3172 | 18501 | 2473 | 18586 | 1935 | 17757 | 1162 | 19983 | 623 | 14977 |
| 12-#14 | 3.36 | 11382 | 4488 | 18177 | 3337 | 19937 | 2593 | 20293 | 2002 | 20017 | 1120 | 23192 | 425 | 20196 |
| 12-#18 | 5.97 | 12315 | 5215 | 21056 | 3757 | 23446 | 2897 | 24440 | 2166 | 25536 | 1002 | 30958 | -97 | 30722 |
| 13-#11 | 2.52 | 11072 | 4256 | 17243 | 3198 | 18797 | 2483 | 18924 | 1936 | 18225 | 1151 | 20629 | 581 | 15991 |
| 13-#14 | 3.64 | 11508 | 4566 | 18530 | 3380 | 20356 | 2611 | 20772 | 2005 | 20694 | 1106 | 24124 | 366 | 21542 |
| 13-#18 | 6.47 | 12520 | 5353 | 21662 | 3843 | 24166 | 2934 | 25277 | 2175 | 26722 | 980 | 32585 | -204 | 32024 |
| 14-#11 | 2.72 | 11162 | 4310 | 17578 | 3197 | 19119 | 2483 | 19268 | 1928 | 18742 | 1134 | 21082 | 521 | 17134 |
| 14-#14 | 3.92 | 11628 | 4644 | 18970 | 3389 | 20826 | 2622 | 21280 | 2002 | 21460 | 1087 | 24804 | 283 | 22817 |
| 14-#18 | 6.96 | 12718 | 5491 | 22359 | 3879 | 24962 | 2969 | 26185 | 2183 | 28096 | 954 | 33804 | -345 | 32830 |
| 15-#11 | 2.91 | 11232 | 4364 | 17706 | 3263 | 19368 | 2536 | 19614 | 1968 | 19191 | 1150 | 21909 | 509 | 18077 |
| 15-#14 | 4.20 | 11726 | 4722 | 19191 | 3472 | 21166 | 2686 | 21784 | 2062 | 22061 | 1102 | 25928 | 259 | 24243 |
| 16-#11 | 3.10 | 11309 | 4418 | 17881 | 3313 | 19647 | 2574 | 19961 | 1995 | 19679 | 1156 | 22559 | 469 | 19113 |
| 16-#14 | 4.48 | 11835 | 4800 | 19457 | 3540 | 21561 | 2737 | 22242 | 2086 | 22742 | 1109 | 26830 | 199 | 25522 |
| 17-#11 | 3.30 | 11406 | 4472 | 18149 | 3336 | 19935 | 2588 | 20325 | 2008 | 20104 | 1140 | 23195 | 435 | 20016 |
| 17-#14 | 4.76 | 11970 | 4877 | 19821 | 3576 | 21976 | 2760 | 22758 | 2106 | 23353 | 1086 | 27894 | 168 | 26825 |
| 18-#11 | 3.49 | 11483 | 4526 | 18430 | 3355 | 20245 | 2598 | 20659 | 2001 | 20581 | 1122 | 23933 | 398 | 20983 |
| 18-#14 | 5.04 | 12073 | 4955 | 20197 | 3610 | 22420 | 2780 | 23240 | 2100 | 24050 | 1063 | 28811 | 99 | 28121 |
| 19-#11 | 3.69 | 11567 | 4580 | 18589 | 3408 | 20503 | 2640 | 21011 | 2039 | 21018 | 1129 | 24578 | 374 | 21963 |
| 19-#14 | 5.32 | 12192 | 5033 | 20454 | 3679 | 22784 | 2833 | 23731 | 2149 | 24647 | 1069 | 29697 | 58 | 29335 |
| 20-#11 | 3.88 | 11666 | 4634 | 18770 | 3454 | 20793 | 2676 | 21337 | 2055 | 21497 | 1133 | 25298 | 344 | 22853 |
| 21-#11 | 4.07 | 11738 | 4688 | 19032 | 3480 | 21072 | 2691 | 21698 | 2070 | 21982 | 1127 | 25845 | 302 | 23850 |
| 22-#11 | 4.27 | 11814 | 4742 | 19305 | 3506 | 21380 | 2707 | 22042 | 2068 | 22414 | 1105 | 26473 | 260 | 24720 |
| 23-#11 | 4.46 | 11900 | 4796 | 19478 | 3552 | 21642 | 2742 | 22386 | 2100 | 22892 | 1116 | 27221 | 242 | 25657 |

## ROUND TIED COLUMNS 34" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.76 | 12646 | 4566 | 19619 | 3413 | 21148 | 2690 | 20998 | 2121 | 19527 | 1321 | 20832 | 777 | 15047 |
| 5-#14 | 1.24 | 12600 | 4402 | 19149 | 3273 | 20321 | 2554 | 19887 | 2020 | 18050 | 1291 | 19200 | 878 | 10325 |
| 5-#18 | 2.20 | 13030 | 4705 | 20550 | 3425 | 21937 | 2660 | 21777 | 2070 | 20560 | 1225 | 22661 | 656 | 17018 |
| 6-#11 | 1.03 | 12539 | 4337 | 19312 | 3090 | 19964 | 2406 | 19277 | 1901 | 17211 | 1217 | 17657 | 840 | 8785 |
| 6-#14 | 1.49 | 12778 | 4480 | 20024 | 3156 | 20796 | 2453 | 20254 | 1920 | 18509 | 1180 | 19280 | 727 | 12281 |
| 6-#18 | 2.64 | 13345 | 4843 | 21742 | 3330 | 22829 | 2576 | 22651 | 1971 | 21696 | 1085 | 23230 | 432 | 20408 |
| 7-#11 | 1.20 | 12616 | 4391 | 18918 | 3329 | 20264 | 2600 | 19935 | 2063 | 18135 | 1329 | 19356 | 909 | 10178 |
| 7-#14 | 1.73 | 12878 | 4558 | 19698 | 3417 | 21185 | 2663 | 21011 | 2095 | 19640 | 1312 | 21355 | 789 | 13909 |
| 7-#18 | 3.08 | 13487 | 4981 | 21589 | 3647 | 23448 | 2826 | 23651 | 2178 | 23205 | 1242 | 26222 | 477 | 22605 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.37 | 12711 | 4445 | 18999 | 3407 | 20551 | 2669 | 20354 | 2117 | 18735 | 1358 | 20137 | 899 | 11348 |
| 8-#14 | 1.98 | 13012 | 4635 | 19877 | 3509 | 21590 | 2746 | 21584 | 2160 | 20358 | 1329 | 22385 | 765 | 15728 |
| 8-#18 | 3.52 | 13713 | 5120 | 22005 | 3775 | 24142 | 2945 | 24600 | 2269 | 24344 | 1253 | 27856 | 413 | 25255 |
| 9-#11 | 1.55 | 12795 | 4499 | 19349 | 3418 | 20877 | 2666 | 20703 | 2107 | 19214 | 1338 | 20944 | 853 | 12694 |
| 9-#14 | 2.23 | 13132 | 4713 | 20335 | 3538 | 22053 | 2751 | 22093 | 2152 | 21073 | 1306 | 23573 | 704 | 17284 |
| 9-#18 | 3.97 | 13912 | 5258 | 22725 | 3846 | 24940 | 2969 | 25489 | 2266 | 25633 | 1221 | 29968 | 312 | 27565 |
| 10-#11 | 1.72 | 12876 | 4552 | 19822 | 3383 | 21253 | 2640 | 21036 | 2075 | 19584 | 1284 | 21361 | 798 | 13831 |
| 10-#14 | 2.48 | 13239 | 4791 | 20933 | 3514 | 22593 | 2734 | 22610 | 2124 | 21675 | 1241 | 24265 | 635 | 19074 |
| 10-#18 | 4.41 | 14083 | 5396 | 23647 | 3850 | 25846 | 2973 | 26463 | 2246 | 26799 | 1126 | 31322 | 204 | 29925 |
| 11-#11 | 1.89 | 12981 | 4606 | 19801 | 3499 | 21492 | 2725 | 21456 | 2144 | 20221 | 1332 | 22342 | 789 | 15081 |
| 11-#14 | 2.73 | 13386 | 4869 | 20996 | 3649 | 22926 | 2832 | 23162 | 2203 | 22491 | 1295 | 25538 | 606 | 20552 |
| 11-#18 | 4.85 | 14333 | 5535 | 23897 | 4036 | 26442 | 3104 | 27316 | 2348 | 28055 | 1194 | 33312 | 126 | 32524 |
| 12-#11 | 2.06 | 13072 | 4660 | 19989 | 3550 | 21789 | 2772 | 21841 | 2179 | 20718 | 1336 | 23161 | 774 | 16236 |
| 12-#14 | 2.97 | 13514 | 4947 | 21282 | 3716 | 23347 | 2893 | 23694 | 2247 | 23174 | 1296 | 26665 | 582 | 22211 |
| 12-#18 | 5.29 | 14551 | 5673 | 24421 | 4138 | 27166 | 3200 | 28231 | 2417 | 29191 | 1186 | 35181 | 74 | 34671 |
| 13-#11 | 2.23 | 13170 | 4714 | 20263 | 3575 | 22110 | 2781 | 22205 | 2178 | 21221 | 1325 | 23743 | 721 | 17399 |
| 13-#14 | 3.22 | 13655 | 5024 | 21660 | 3756 | 23802 | 2910 | 24221 | 2250 | 23904 | 1282 | 27673 | 523 | 23589 |
| 13-#18 | 5.73 | 14781 | 5811 | 25066 | 4221 | 27950 | 3237 | 29139 | 2426 | 30476 | 1164 | 36948 | -30 | 36861 |
| 14-#11 | 2.41 | 13276 | 4768 | 20640 | 3569 | 22452 | 2778 | 22583 | 2169 | 21663 | 1289 | 24339 | 671 | 18589 |
| 14-#14 | 3.47 | 13795 | 5102 | 22150 | 3762 | 24300 | 2917 | 24771 | 2245 | 24724 | 1262 | 28406 | 439 | 25050 |
| 14-#18 | 6.17 | 15013 | 5949 | 25835 | 4255 | 28843 | 3271 | 30122 | 2433 | 31959 | 1139 | 38277 | -171 | 37794 |
| 15-#11 | 2.58 | 13350 | 4822 | 20763 | 3641 | 22722 | 2834 | 22953 | 2211 | 22267 | 1325 | 25250 | 663 | 19673 |
| 15-#14 | 3.72 | 13899 | 5180 | 22375 | 3850 | 24681 | 2986 | 25280 | 2296 | 25386 | 1280 | 29639 | 419 | 26523 |
| 15-#18 | 6.61 | 15207 | 6088 | 26305 | 4382 | 29460 | 3367 | 31025 | 2525 | 33022 | 1156 | 40297 | -223 | 39597 |
| 16-#11 | 2.75 | 13435 | 4876 | 20943 | 3691 | 23030 | 2875 | 23330 | 2240 | 22798 | 1332 | 25962 | 623 | 20858 |
| 16-#14 | 3.97 | 14018 | 5258 | 22650 | 3919 | 25108 | 3039 | 25808 | 2333 | 26127 | 1288 | 30627 | 360 | 27979 |
| 17-#11 | 2.92 | 13542 | 4930 | 21239 | 3714 | 23334 | 2887 | 23722 | 2252 | 23257 | 1316 | 26650 | 591 | 21887 |
| 17-#14 | 4.21 | 14171 | 5336 | 23058 | 3954 | 25550 | 3060 | 26371 | 2353 | 26788 | 1266 | 31615 | 313 | 29465 |
| 18-#11 | 3.09 | 13625 | 4984 | 21555 | 3731 | 23671 | 2896 | 24084 | 2244 | 23768 | 1297 | 27445 | 553 | 22999 |
| 18-#14 | 4.46 | 14280 | 5413 | 23474 | 3987 | 26029 | 3079 | 26899 | 2347 | 27537 | 1242 | 32772 | 262 | 30797 |
| 19-#11 | 3.26 | 13718 | 5038 | 21712 | 3787 | 23949 | 2939 | 24466 | 2284 | 24247 | 1306 | 28150 | 531 | 24007 |
| 19-#14 | 4.71 | 14410 | 5491 | 23733 | 4058 | 26423 | 3135 | 27426 | 2398 | 28191 | 1250 | 33739 | 224 | 32198 |
| 20-#11 | 3.44 | 13823 | 5092 | 21905 | 3833 | 24258 | 2976 | 24820 | 2301 | 24767 | 1311 | 28933 | 503 | 25027 |
| 20-#14 | 4.96 | 14557 | 5569 | 24017 | 4122 | 26871 | 3186 | 27923 | 2420 | 28922 | 1255 | 34841 | 182 | 33614 |
| 21-#11 | 3.61 | 13904 | 5146 | 22191 | 3859 | 24565 | 2992 | 25211 | 2316 | 25237 | 1296 | 29529 | 461 | 26077 |
| 22-#11 | 3.78 | 13992 | 5200 | 22486 | 3883 | 24900 | 3006 | 25574 | 2313 | 25754 | 1282 | 30205 | 420 | 27052 |
| 23-#11 | 3.95 | 14084 | 5254 | 22674 | 3931 | 25182 | 3043 | 25954 | 2347 | 26277 | 1295 | 31025 | 402 | 28128 |
| 24-#11 | 4.12 | 14166 | 5308 | 22882 | 3976 | 25481 | 3077 | 26311 | 2363 | 26742 | 1290 | 31671 | 365 | 29125 |
| 25-#11 | 4.30 | 14269 | 5362 | 23151 | 4003 | 25795 | 3095 | 26696 | 2378 | 27264 | 1285 | 32412 | 330 | 30118 |

## ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.57 | 14951 | 5052 | 22935 | 3811 | 24760 | 3003 | 24572 | 2378 | 22728 | 1503 | 24162 | 936 | 16163 |
| 5-#14 | 1.11 | 14898 | 4888 | 22466 | 3661 | 23880 | 2861 | 23357 | 2269 | 21099 | 1467 | 22347 | 1029 | 11123 |
| 5-#18 | 1.96 | 15375 | 5191 | 23982 | 3812 | 25639 | 2968 | 25404 | 2320 | 23816 | 1404 | 26112 | 811 | 18356 |
| 6-#14 | 1.33 | 15085 | 4966 | 23478 | 3527 | 24395 | 2744 | 23718 | 2156 | 21540 | 1347 | 22367 | 871 | 13171 |
| 6-#18 | 2.36 | 15707 | 5329 | 25347 | 3701 | 26600 | 2868 | 26316 | 2209 | 24991 | 1255 | 26667 | 582 | 22187 |
| 7-#11 | 1.07 | 14915 | 4877 | 22195 | 3724 | 23813 | 2911 | 23409 | 2316 | 21204 | 1508 | 22532 | 1061 | 10990 |
| 7-#14 | 1.55 | 15205 | 5044 | 23039 | 3812 | 24805 | 2974 | 24577 | 2349 | 22745 | 1479 | 24698 | 944 | 15021 |
| 7-#18 | 2.75 | 15883 | 5467 | 25087 | 4041 | 27249 | 3138 | 27437 | 2433 | 26685 | 1425 | 29994 | 639 | 24599 |
| 8-#11 | 1.23 | 15020 | 4931 | 22260 | 3807 | 24120 | 2986 | 23864 | 2374 | 21864 | 1540 | 23395 | 1055 | 12195 |
| 8-#14 | 1.77 | 15352 | 5121 | 23210 | 3910 | 25239 | 3063 | 25187 | 2417 | 23616 | 1513 | 25831 | 924 | 16918 |
| 8-#18 | 3.14 | 16131 | 5606 | 25514 | 4176 | 27995 | 3262 | 28463 | 2529 | 27931 | 1441 | 31785 | 581 | 27722 |
| 9-#11 | 1.38 | 15107 | 4985 | 22651 | 3816 | 24472 | 2980 | 24234 | 2361 | 22371 | 1519 | 24254 | 1008 | 13725 |
| 9-#14 | 1.99 | 15476 | 5199 | 23717 | 3935 | 25739 | 3065 | 25738 | 2408 | 24377 | 1488 | 27104 | 862 | 18690 |
| 9-#18 | 3.54 | 16343 | 5744 | 26306 | 4244 | 28859 | 3284 | 29425 | 2525 | 29314 | 1408 | 34063 | 480 | 30074 |
| 10-#11 | 1.53 | 15199 | 5038 | 23182 | 3773 | 24871 | 2946 | 24592 | 2325 | 22748 | 1461 | 24677 | 951 | 14896 |
| 10-#14 | 2.21 | 15600 | 5277 | 24380 | 3903 | 26323 | 3042 | 26292 | 2375 | 25006 | 1420 | 27826 | 791 | 20557 |
| 10-#18 | 3.93 | 16535 | 5882 | 27309 | 4239 | 29863 | 3285 | 30466 | 2501 | 30555 | 1311 | 35505 | 372 | 32750 |
| 11-#11 | 1.69 | 15314 | 5092 | 23127 | 3897 | 25134 | 3040 | 25047 | 2400 | 23458 | 1515 | 25766 | 946 | 16317 |
| 11-#14 | 2.43 | 15761 | 5355 | 24416 | 4048 | 26681 | 3148 | 26884 | 2460 | 25908 | 1480 | 29231 | 768 | 22236 |
| 11-#18 | 4.32 | 16809 | 6021 | 27565 | 4436 | 30481 | 3422 | 31400 | 2610 | 31933 | 1384 | 37687 | 300 | 35431 |
| 12-#11 | 1.84 | 15410 | 5146 | 23326 | 3952 | 25453 | 3089 | 25464 | 2437 | 23999 | 1520 | 26660 | 934 | 17510 |
| 12-#14 | 2.65 | 15896 | 5433 | 24725 | 4118 | 27133 | 3211 | 27461 | 2506 | 26650 | 1482 | 30460 | 745 | 24091 |
| 12-#18 | 4.72 | 17038 | 6159 | 28125 | 4541 | 31261 | 3520 | 32386 | 2681 | 33165 | 1379 | 39726 | 251 | 37864 |
| 13-#11 | 1.99 | 15517 | 5200 | 23622 | 3975 | 25796 | 3097 | 25855 | 2436 | 24536 | 1509 | 27283 | 881 | 18851 |
| 13-#14 | 2.87 | 16047 | 5510 | 25129 | 4156 | 27625 | 3227 | 28028 | 2508 | 27433 | 1468 | 31368 | 670 | 25657 |
| 13-#18 | 5.11 | 17294 | 6297 | 28810 | 4622 | 32109 | 3557 | 33371 | 2691 | 34549 | 1358 | 41632 | 149 | 40669 |
| 14-#11 | 2.15 | 15639 | 5254 | 24043 | 3965 | 26160 | 3090 | 26256 | 2424 | 25002 | 1471 | 27915 | 829 | 20064 |
| 14-#14 | 3.09 | 16212 | 5588 | 25672 | 4159 | 28150 | 3230 | 28629 | 2502 | 28142 | 1422 | 32325 | 603 | 27350 |
| 14-#18 | 5.50 | 17561 | 6435 | 29655 | 4652 | 33055 | 3587 | 34427 | 2695 | 36140 | 1331 | 43070 | 7 | 43015 |
| 15-#11 | 2.30 | 15716 | 5308 | 24159 | 4041 | 26450 | 3151 | 26660 | 2470 | 25663 | 1510 | 28912 | 824 | 21297 |
| 15-#14 | 3.32 | 16321 | 5666 | 25898 | 4251 | 28560 | 3303 | 29170 | 2556 | 29031 | 1468 | 33671 | 586 | 28900 |
| 15-#18 | 5.89 | 17745 | 6574 | 30147 | 4785 | 33741 | 3689 | 35408 | 2792 | 37300 | 1352 | 45269 | -40 | 45139 |
| 16-#11 | 2.45 | 15809 | 5362 | 24341 | 4093 | 26789 | 3193 | 27067 | 2499 | 26238 | 1518 | 29687 | 785 | 22527 |
| 16-#14 | 3.54 | 16452 | 5744 | 26182 | 4321 | 29032 | 3359 | 29740 | 2595 | 29832 | 1477 | 34747 | 527 | 30505 |
| 16-#18 | 6.29 | 17992 | 6712 | 30691 | 4903 | 34535 | 3778 | 36316 | 2832 | 38659 | 1361 | 47073 | -149 | 46565 |
| 17-#11 | 2.61 | 15923 | 5416 | 24664 | 4115 | 27109 | 3205 | 27489 | 2512 | 26729 | 1502 | 30426 | 753 | 23697 |
| 17-#14 | 3.76 | 16617 | 5822 | 26626 | 4356 | 29497 | 3379 | 30345 | 2614 | 30542 | 1454 | 35811 | 482 | 32036 |
| 18-#11 | 2.76 | 16017 | 5470 | 25021 | 4130 | 27472 | 3211 | 27866 | 2501 | 27272 | 1482 | 31275 | 715 | 24944 |
| 18-#14 | 3.98 | 16737 | 5900 | 27091 | 4387 | 30013 | 3396 | 30911 | 2607 | 31343 | 1430 | 37054 | 430 | 33543 |
| 19-#11 | 2.91 | 16118 | 5524 | 25172 | 4188 | 27771 | 3258 | 28288 | 2544 | 27795 | 1493 | 32043 | 696 | 26074 |
| 19-#14 | 4.20 | 16879 | 5977 | 27352 | 4460 | 30437 | 3454 | 31483 | 2660 | 32055 | 1441 | 38104 | 396 | 35145 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.07 | 16229 | 5578 | 25378 | 4236 | 28096 | 3295 | 28672 | 2562 | 28357 | 1498 | 32891 | 669 | 27260 |
| 20-#14 | 4.42 | 17035 | 6055 | 27654 | 4526 | 30908 | 3506 | 32020 | 2683 | 32844 | 1446 | 39295 | 355 | 36582 |
| 21-#11 | 3.22 | 16322 | 5632 | 25687 | 4261 | 28434 | 3310 | 29085 | 2576 | 28862 | 1484 | 33534 | 627 | 28338 |
| 21-#14 | 4.64 | 17171 | 6133 | 28086 | 4564 | 31380 | 3529 | 32621 | 2706 | 33569 | 1426 | 40213 | 296 | 38134 |
| 22-#11 | 3.37 | 16420 | 5686 | 26006 | 4283 | 28795 | 3324 | 29471 | 2572 | 29414 | 1469 | 34257 | 586 | 29446 |
| 22-#14 | 4.86 | 17301 | 6211 | 28523 | 4602 | 31892 | 3554 | 33183 | 2704 | 34374 | 1408 | 41265 | 238 | 39619 |
| 23-#11 | 3.52 | 16517 | 5740 | 26201 | 4333 | 29091 | 3362 | 29883 | 2608 | 29981 | 1483 | 35150 | 570 | 30587 |
| 24-#11 | 3.68 | 16607 | 5794 | 26429 | 4380 | 29412 | 3397 | 30277 | 2625 | 30483 | 1479 | 35850 | 534 | 31679 |
| 25-#11 | 3.83 | 16717 | 5848 | 26715 | 4405 | 29750 | 3414 | 30682 | 2640 | 31044 | 1474 | 36650 | 499 | 32793 |
| 26-#11 | 3.98 | 16819 | 5902 | 27017 | 4432 | 30117 | 3433 | 31075 | 2639 | 31552 | 1454 | 37265 | 452 | 33840 |
| 27-#11 | 4.14 | 16915 | 5956 | 27263 | 4469 | 30412 | 3466 | 31481 | 2671 | 32108 | 1465 | 38272 | 440 | 34923 |

## ROUND TIED COLUMNS 38" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.41 | 17519 | 5566 | 26610 | 4233 | 28769 | 3336 | 28514 | 2648 | 26267 | 1696 | 27831 | 1103 | 17276 |
| 5-#18 | 1.76 | 17984 | 5704 | 27781 | 4223 | 29741 | 3293 | 29418 | 2584 | 27404 | 1591 | 29894 | 974 | 19707 |
| 6-#14 | 1.19 | 17655 | 5480 | 27311 | 3919 | 28393 | 3052 | 27563 | 2406 | 24892 | 1523 | 25770 | 1022 | 14062 |
| 6-#18 | 2.12 | 18332 | 5843 | 29331 | 4093 | 30769 | 3176 | 30361 | 2460 | 28608 | 1433 | 30421 | 739 | 23758 |
| 7-#14 | 1.39 | 17795 | 5557 | 26741 | 4230 | 28822 | 3304 | 28523 | 2617 | 26262 | 1669 | 28378 | 1107 | 16149 |
| 7-#18 | 2.47 | 18543 | 5981 | 28947 | 4459 | 31446 | 3468 | 31611 | 2703 | 30501 | 1618 | 34102 | 808 | 26462 |
| 8-#11 | 1.10 | 17591 | 5444 | 25878 | 4232 | 28086 | 3321 | 27764 | 2646 | 25333 | 1733 | 26993 | 1219 | 13049 |
| 8-#14 | 1.59 | 17955 | 5635 | 26900 | 4334 | 29286 | 3398 | 29181 | 2689 | 27213 | 1707 | 29619 | 1091 | 18116 |
| 8-#18 | 2.82 | 18813 | 6119 | 29382 | 4600 | 32245 | 3597 | 32695 | 2803 | 31856 | 1638 | 36054 | 756 | 30265 |
| 9-#11 | 1.24 | 17682 | 5498 | 26312 | 4237 | 28464 | 3312 | 28155 | 2631 | 25864 | 1710 | 27777 | 1160 | 14688 |
| 9-#14 | 1.79 | 18085 | 5713 | 27459 | 4356 | 29824 | 3397 | 29766 | 2678 | 28018 | 1681 | 30973 | 1028 | 20116 |
| 9-#18 | 3.17 | 19038 | 6258 | 30248 | 4665 | 33176 | 3617 | 33751 | 2799 | 33332 | 1604 | 38495 | 654 | 32647 |
| 10-#11 | 1.38 | 17785 | 5552 | 26907 | 4186 | 28887 | 3272 | 28535 | 2590 | 26246 | 1649 | 28325 | 1112 | 15972 |
| 10-#14 | 1.98 | 18223 | 5791 | 28192 | 4316 | 30441 | 3367 | 30361 | 2641 | 28670 | 1609 | 31718 | 955 | 22054 |
| 10-#18 | 3.53 | 19252 | 6396 | 31339 | 4652 | 34280 | 3613 | 34858 | 2769 | 34644 | 1504 | 40022 | 545 | 35660 |
| 11-#11 | 1.51 | 17910 | 5606 | 26811 | 4320 | 29174 | 3374 | 29028 | 2671 | 27032 | 1707 | 29529 | 1112 | 17535 |
| 11-#14 | 2.18 | 18399 | 5869 | 28195 | 4470 | 30833 | 3482 | 30997 | 2731 | 29663 | 1674 | 33263 | 937 | 23947 |
| 11-#18 | 3.88 | 19551 | 6534 | 31579 | 4859 | 34918 | 3758 | 35867 | 2885 | 36148 | 1584 | 42402 | 480 | 38409 |
| 12-#11 | 1.65 | 18010 | 5660 | 27020 | 4378 | 29514 | 3425 | 29478 | 2710 | 27619 | 1714 | 30501 | 1101 | 18799 |
| 12-#14 | 2.38 | 18541 | 5946 | 28524 | 4543 | 31317 | 3547 | 31619 | 2780 | 30466 | 1678 | 34596 | 916 | 25875 |
| 12-#18 | 4.23 | 19792 | 6673 | 32188 | 4968 | 35755 | 3859 | 36909 | 2958 | 37479 | 1581 | 44613 | 433 | 41145 |
| 13-#11 | 1.79 | 18127 | 5714 | 27339 | 4398 | 29875 | 3431 | 29894 | 2708 | 28189 | 1702 | 31162 | 1048 | 20310 |
| 13-#14 | 2.58 | 18705 | 6024 | 28957 | 4580 | 31840 | 3562 | 32224 | 2782 | 31300 | 1664 | 35565 | 842 | 27641 |
| 13-#18 | 4.59 | 20074 | 6811 | 32914 | 5047 | 36668 | 3894 | 37978 | 2968 | 38961 | 1560 | 46657 | 333 | 44201 |
| 14-#11 | 1.93 | 18265 | 5768 | 27807 | 4385 | 30267 | 3421 | 30309 | 2693 | 28676 | 1663 | 31826 | 995 | 21557 |
| 14-#14 | 2.78 | 18894 | 6102 | 29556 | 4578 | 32399 | 3562 | 32861 | 2773 | 32049 | 1616 | 36581 | 773 | 29600 |
| 14-#18 | 4.94 | 20375 | 6949 | 33839 | 5073 | 37662 | 3921 | 39122 | 2972 | 40657 | 1532 | 48202 | 191 | 46673 |
| 15-#11 | 2.06 | 18346 | 5822 | 27912 | 4466 | 30576 | 3486 | 30758 | 2743 | 29398 | 1704 | 32914 | 992 | 22949 |
| 15-#14 | 2.98 | 19007 | 6180 | 29779 | 4675 | 32837 | 3639 | 33449 | 2830 | 33014 | 1665 | 38043 | 759 | 31277 |
| 15-#18 | 5.29 | 20567 | 7088 | 34348 | 5211 | 38416 | 4029 | 40089 | 3049 | 41916 | 1557 | 50582 | 148 | 49525 |

## ROUND TIED COLUMNS 38" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.20 | 18447 | 5876 | 28096 | 4519 | 30940 | 3530 | 31196 | 2774 | 30016 | 1714 | 33753 | 955 | 24218 |
| 16-#14 | 3.17 | 19150 | 6258 | 30070 | 4746 | 33353 | 3697 | 34062 | 2870 | 33877 | 1675 | 39208 | 702 | 33098 |
| 16-#18 | 5.64 | 20842 | 7226 | 34912 | 5329 | 39273 | 4120 | 41132 | 3113 | 43379 | 1568 | 52538 | 40 | 52216 |
| 17-#11 | 2.34 | 18568 | 5930 | 28446 | 4540 | 31282 | 3540 | 31642 | 2785 | 30540 | 1697 | 34542 | 923 | 25561 |
| 17-#14 | 3.37 | 19319 | 6335 | 30551 | 4781 | 33841 | 3716 | 34710 | 2890 | 34635 | 1653 | 40347 | 657 | 34666 |
| 17-#18 | 6.00 | 21099 | 7364 | 35716 | 5397 | 40151 | 4161 | 42265 | 3151 | 44712 | 1530 | 54530 | -40 | 54383 |
| 18-#11 | 2.48 | 18666 | 5984 | 28845 | 4553 | 31671 | 3545 | 32036 | 2773 | 31115 | 1676 | 35195 | 860 | 26828 |
| 18-#14 | 3.57 | 19459 | 6413 | 31069 | 4810 | 34396 | 3731 | 35299 | 2880 | 35487 | 1628 | 41674 | 605 | 36360 |
| 19-#11 | 2.61 | 18782 | 6038 | 28990 | 4613 | 31990 | 3594 | 32494 | 2818 | 31683 | 1689 | 36277 | 867 | 28101 |
| 19-#14 | 3.77 | 19614 | 6491 | 31328 | 4886 | 34849 | 3792 | 35926 | 2936 | 36258 | 1640 | 42809 | 574 | 38021 |
| 20-#11 | 2.75 | 18900 | 6092 | 29207 | 4662 | 32331 | 3632 | 32915 | 2837 | 32286 | 1696 | 37189 | 842 | 29395 |
| 20-#14 | 3.97 | 19779 | 6569 | 31649 | 4952 | 35343 | 3844 | 36507 | 2961 | 37106 | 1647 | 44090 | 535 | 39623 |
| 21-#11 | 2.89 | 19005 | 6146 | 29541 | 4687 | 32694 | 3647 | 33347 | 2851 | 32825 | 1681 | 37881 | 801 | 30608 |
| 21-#14 | 4.17 | 19926 | 6647 | 32114 | 4990 | 35859 | 3867 | 37139 | 2982 | 37881 | 1627 | 45080 | 476 | 41376 |
| 22-#11 | 3.03 | 19113 | 6200 | 29885 | 4707 | 33088 | 3660 | 33758 | 2845 | 33412 | 1666 | 38649 | 760 | 31956 |
| 22-#14 | 4.36 | 20075 | 6724 | 32582 | 5027 | 36410 | 3891 | 37737 | 2979 | 38740 | 1608 | 46203 | 419 | 42883 |
| 23-#11 | 3.16 | 19215 | 6254 | 30086 | 4759 | 33397 | 3700 | 34202 | 2883 | 34024 | 1681 | 39617 | 744 | 33069 |
| 23-#14 | 4.56 | 20217 | 6802 | 32898 | 5094 | 36859 | 3942 | 38355 | 3028 | 39586 | 1626 | 47541 | 393 | 44532 |
| 24-#11 | 3.30 | 19313 | 6307 | 30333 | 4807 | 33740 | 3735 | 34618 | 2900 | 34564 | 1677 | 40371 | 709 | 34295 |
| 25-#11 | 3.44 | 19433 | 6361 | 30636 | 4832 | 34104 | 3752 | 35058 | 2916 | 35163 | 1673 | 41229 | 675 | 35440 |
| 26-#11 | 3.58 | 19534 | 6415 | 30965 | 4857 | 34490 | 3769 | 35477 | 2914 | 35704 | 1653 | 41885 | 628 | 36616 |
| 27-#11 | 3.71 | 19646 | 6469 | 31223 | 4896 | 34812 | 3805 | 35914 | 2948 | 36303 | 1664 | 42844 | 606 | 37801 |
| 28-#11 | 3.85 | 19769 | 6523 | 31490 | 4932 | 35159 | 3839 | 36321 | 2963 | 36846 | 1659 | 43837 | 596 | 38932 |

## ROUND TIED COLUMNS 40" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.27 | 20365 | 6108 | 30662 | 4678 | 33197 | 3687 | 32868 | 2933 | 30163 | 1899 | 31859 | 1278 | 18388 |
| 5-#18 | 1.59 | 20871 | 6246 | 31966 | 4656 | 34246 | 3634 | 33841 | 2863 | 31343 | 1789 | 34026 | 1145 | 21069 |
| 6-#14 | 1.07 | 20502 | 6021 | 31544 | 4332 | 32810 | 3377 | 31810 | 2669 | 28585 | 1709 | 29508 | 1180 | 14955 |
| 6-#18 | 1.91 | 21235 | 6384 | 33715 | 4506 | 35359 | 3502 | 34807 | 2724 | 32564 | 1621 | 34509 | 903 | 25329 |
| 7-#14 | 1.25 | 20663 | 6099 | 30825 | 4671 | 33259 | 3651 | 32875 | 2899 | 30134 | 1869 | 32412 | 1279 | 17293 |
| 7-#18 | 2.23 | 21481 | 6523 | 33189 | 4900 | 36064 | 3816 | 36196 | 2988 | 34510 | 1799 | 38565 | 985 | 28347 |
| 8-#14 | 1.43 | 20836 | 6177 | 30966 | 4782 | 33752 | 3751 | 33586 | 2977 | 31168 | 1911 | 33766 | 1266 | 19321 |
| 8-#18 | 2.55 | 21775 | 6661 | 33628 | 5048 | 36915 | 3951 | 37338 | 3091 | 36139 | 1846 | 40683 | 937 | 32328 |
| 9-#11 | 1.12 | 20535 | 6040 | 30348 | 4682 | 32876 | 3663 | 32488 | 2916 | 29714 | 1911 | 31774 | 1331 | 15649 |
| 9-#14 | 1.61 | 20972 | 6255 | 31580 | 4801 | 34328 | 3748 | 34205 | 2963 | 32015 | 1883 | 35009 | 1185 | 21564 |
| 9-#18 | 2.86 | 22013 | 6799 | 34571 | 5109 | 37912 | 3969 | 38467 | 3085 | 37706 | 1810 | 43285 | 835 | 35220 |
| 10-#11 | 1.24 | 20648 | 6094 | 31017 | 4622 | 33323 | 3615 | 32887 | 2869 | 30095 | 1846 | 32324 | 1281 | 17059 |
| 10-#14 | 1.79 | 21125 | 6332 | 32390 | 4751 | 34979 | 3710 | 34840 | 2921 | 32686 | 1808 | 35962 | 1127 | 23563 |
| 10-#18 | 3.18 | 22248 | 6938 | 35755 | 5087 | 39084 | 3957 | 39658 | 3052 | 39085 | 1707 | 44889 | 725 | 38654 |
| 11-#11 | 1.37 | 20783 | 6148 | 30873 | 4766 | 33632 | 3726 | 33420 | 2957 | 30964 | 1910 | 33651 | 1286 | 18709 |
| 11-#14 | 1.97 | 21315 | 6410 | 32352 | 4916 | 35405 | 3834 | 35522 | 3018 | 33775 | 1878 | 37653 | 1114 | 25684 |
| 11-#18 | 3.50 | 22572 | 7076 | 35973 | 5304 | 39775 | 4112 | 40727 | 3174 | 40721 | 1792 | 47476 | 667 | 41455 |

## ROUND TIED COLUMNS 40" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.49 | 20889 | 6202 | 31081 | 4826 | 33994 | 3780 | 33905 | 2998 | 31593 | 1919 | 34701 | 1276 | 20103 |
| 12-#14 | 2.15 | 21464 | 6488 | 32701 | 4992 | 35920 | 3902 | 36189 | 3069 | 34639 | 1885 | 39091 | 1095 | 27678 |
| 12-#18 | 3.82 | 22825 | 7214 | 36629 | 5418 | 40669 | 4215 | 41845 | 3249 | 42151 | 1792 | 49861 | 621 | 44514 |
| 13-#11 | 1.61 | 21015 | 6256 | 31468 | 4836 | 34373 | 3784 | 34345 | 2995 | 32199 | 1906 | 35400 | 1223 | 21700 |
| 13-#14 | 2.33 | 21642 | 6566 | 33162 | 5027 | 36469 | 3915 | 36832 | 3069 | 35524 | 1870 | 40121 | 1021 | 29656 |
| 13-#18 | 4.14 | 23133 | 7352 | 37397 | 5494 | 41646 | 4250 | 42985 | 3259 | 43730 | 1771 | 51699 | 492 | 47655 |
| 14-#11 | 1.74 | 21168 | 6310 | 31952 | 4828 | 34793 | 3770 | 34772 | 2976 | 32705 | 1865 | 36094 | 1169 | 23069 |
| 14-#14 | 2.51 | 21854 | 6644 | 33822 | 5021 | 37067 | 3911 | 37492 | 3057 | 36311 | 1820 | 41193 | 950 | 31718 |
| 14-#18 | 4.46 | 23471 | 7491 | 38405 | 5517 | 42690 | 4272 | 44228 | 3262 | 45206 | 1698 | 53689 | 380 | 50422 |
| 15-#11 | 1.86 | 21254 | 6364 | 32038 | 4913 | 35121 | 3840 | 35265 | 3031 | 33429 | 1901 | 37275 | 1169 | 24607 |
| 15-#14 | 2.69 | 21972 | 6721 | 34038 | 5123 | 37533 | 3993 | 38141 | 3119 | 37354 | 1872 | 42775 | 940 | 33560 |
| 15-#18 | 4.77 | 23671 | 7629 | 38929 | 5660 | 43494 | 4385 | 45243 | 3342 | 46890 | 1770 | 56256 | 342 | 53627 |
| 16-#11 | 1.99 | 21364 | 6417 | 32227 | 4968 | 35502 | 3884 | 35737 | 3063 | 34149 | 1919 | 38180 | 1132 | 25932 |
| 16-#14 | 2.86 | 22127 | 6799 | 34334 | 5196 | 38085 | 4053 | 38797 | 3161 | 38279 | 1883 | 44030 | 884 | 35609 |
| 16-#18 | 5.09 | 23937 | 7767 | 39510 | 5779 | 44431 | 4479 | 46360 | 3407 | 48457 | 1783 | 58363 | 236 | 56348 |
| 17-#11 | 2.11 | 21491 | 6471 | 32605 | 4988 | 35873 | 3895 | 36175 | 3065 | 34709 | 1903 | 39017 | 1101 | 27435 |
| 17-#14 | 3.04 | 22305 | 6877 | 34853 | 5229 | 38604 | 4071 | 39481 | 3179 | 39086 | 1861 | 45242 | 840 | 37354 |
| 17-#18 | 5.41 | 24242 | 7906 | 40374 | 5846 | 45350 | 4518 | 47570 | 3446 | 49880 | 1746 | 60493 | 157 | 59274 |
| 18-#11 | 2.23 | 21596 | 6525 | 33042 | 4998 | 36290 | 3897 | 36619 | 3059 | 35313 | 1881 | 39706 | 1037 | 28738 |
| 18-#14 | 3.22 | 22460 | 6955 | 35426 | 5256 | 39198 | 4084 | 40098 | 3168 | 39987 | 1835 | 46272 | 753 | 39246 |
| 18-#18 | 5.73 | 24480 | 8044 | 41255 | 5912 | 46378 | 4559 | 48713 | 3440 | 51511 | 1709 | 63014 | 70 | 62417 |
| 19-#11 | 2.36 | 21724 | 6579 | 33184 | 5062 | 36626 | 3949 | 37111 | 3107 | 35928 | 1896 | 40871 | 1047 | 30163 |
| 19-#14 | 3.40 | 22627 | 7033 | 35681 | 5335 | 39680 | 4148 | 40773 | 3227 | 40818 | 1850 | 47874 | 760 | 40991 |
| 20-#11 | 2.48 | 21849 | 6633 | 33411 | 5112 | 36985 | 3987 | 37565 | 3127 | 36570 | 1902 | 41848 | 1023 | 31497 |
| 20-#14 | 3.58 | 22801 | 7110 | 36020 | 5402 | 40197 | 4200 | 41407 | 3253 | 41726 | 1857 | 49247 | 722 | 42735 |
| 21-#11 | 2.61 | 21962 | 6687 | 33768 | 5136 | 37372 | 4002 | 38021 | 3140 | 37147 | 1888 | 42587 | 981 | 32854 |
| 21-#14 | 3.76 | 22962 | 7188 | 36520 | 5440 | 40748 | 4224 | 42068 | 3273 | 42552 | 1838 | 50307 | 663 | 44551 |
| 22-#11 | 2.73 | 22084 | 6741 | 34142 | 5154 | 37801 | 4014 | 38456 | 3134 | 37768 | 1872 | 43400 | 940 | 34245 |
| 22-#14 | 3.94 | 23129 | 7266 | 37020 | 5474 | 41348 | 4246 | 42703 | 3270 | 43462 | 1818 | 51500 | 606 | 46222 |
| 23-#11 | 2.86 | 22191 | 6795 | 34347 | 5209 | 38123 | 4055 | 38933 | 3173 | 38425 | 1889 | 44444 | 926 | 35530 |
| 23-#14 | 4.12 | 23279 | 7344 | 37348 | 5544 | 41816 | 4299 | 43365 | 3320 | 44371 | 1838 | 52941 | 582 | 48070 |
| 24-#11 | 2.98 | 22297 | 6849 | 34605 | 5257 | 38488 | 4092 | 39370 | 3190 | 38999 | 1886 | 45252 | 892 | 36916 |
| 24-#14 | 4.30 | 23428 | 7422 | 37731 | 5611 | 42337 | 4349 | 43993 | 3343 | 45184 | 1831 | 54077 | 530 | 49703 |
| 25-#11 | 3.10 | 22428 | 6903 | 34933 | 5282 | 38876 | 4108 | 39844 | 3206 | 39639 | 1882 | 46168 | 858 | 38144 |
| 25-#14 | 4.48 | 23610 | 7499 | 38184 | 5649 | 42889 | 4375 | 44664 | 3367 | 46099 | 1826 | 55387 | 482 | 51504 |
| 26-#11 | 3.23 | 22533 | 6957 | 35362 | 5289 | 39282 | 4124 | 40291 | 3204 | 40214 | 1861 | 46865 | 812 | 39455 |
| 27-#11 | 3.35 | 22656 | 7011 | 35554 | 5346 | 39627 | 4161 | 40751 | 3239 | 40855 | 1874 | 47893 | 790 | 40700 |
| 28-#11 | 3.48 | 22787 | 7065 | 35837 | 5382 | 40002 | 4196 | 41186 | 3254 | 41432 | 1869 | 48958 | 781 | 41933 |
| 29-#11 | 3.60 | 22888 | 7119 | 36136 | 5418 | 40376 | 4213 | 41660 | 3271 | 42071 | 1866 | 49735 | 736 | 43209 |
| 30-#11 | 3.72 | 23002 | 7173 | 36520 | 5438 | 40776 | 4232 | 42122 | 3273 | 42657 | 1847 | 50593 | 702 | 44405 |

## ROUND TIED COLUMNS 42" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.15 | 23503 | 6677 | 35111 | 5147 | 38067 | 4057 | 37655 | 3233 | 34436 | 2112 | 36265 | 1461 | 19497 |
| 5-#18 | 1.44 | 24050 | 6815 | 36558 | 5113 | 39190 | 3994 | 38695 | 3156 | 35652 | 1996 | 38527 | 1323 | 22444 |
| 6-#18 | 1.73 | 24430 | 6954 | 38520 | 4942 | 40391 | 3844 | 39677 | 3002 | 36878 | 1818 | 38950 | 1074 | 26901 |
| 7-#14 | 1.14 | 23823 | 6668 | 35309 | 5136 | 38139 | 4018 | 37658 | 3196 | 34379 | 2080 | 36820 | 1458 | 18452 |
| 7-#18 | 2.02 | 24712 | 7092 | 37833 | 5364 | 41124 | 4182 | 41195 | 3286 | 39044 | 2011 | 43402 | 1169 | 30253 |
| 8-#14 | 1.30 | 24010 | 6746 | 35428 | 5254 | 38659 | 4123 | 38426 | 3279 | 35493 | 2125 | 38291 | 1450 | 20533 |
| 8-#18 | 2.31 | 25029 | 7230 | 38270 | 5519 | 42027 | 4324 | 42416 | 3394 | 40799 | 2063 | 45690 | 1127 | 34401 |
| 9-#11 | 1.01 | 23680 | 6609 | 34781 | 5150 | 37730 | 4032 | 37253 | 3215 | 33939 | 2123 | 36148 | 1511 | 16615 |
| 9-#14 | 1.46 | 24151 | 6824 | 36096 | 5268 | 39274 | 4117 | 39078 | 3263 | 36388 | 2096 | 39600 | 1367 | 23034 |
| 9-#18 | 2.60 | 25281 | 7369 | 39293 | 5577 | 43091 | 4338 | 43612 | 3386 | 42454 | 2026 | 48451 | 1023 | 37624 |
| 10-#11 | 1.13 | 23803 | 6663 | 35532 | 5081 | 38201 | 3976 | 37658 | 3162 | 34315 | 2053 | 36693 | 1457 | 18156 |
| 10-#14 | 1.62 | 24319 | 6902 | 36994 | 5210 | 39958 | 4071 | 39749 | 3215 | 37072 | 2016 | 40575 | 1306 | 25086 |
| 10-#18 | 2.89 | 25538 | 7507 | 40578 | 5545 | 44322 | 4319 | 44889 | 3348 | 43895 | 1919 | 50127 | 912 | 41701 |
| 11-#11 | 1.24 | 23948 | 6717 | 35332 | 5235 | 38529 | 4097 | 38246 | 3258 | 35270 | 2123 | 38149 | 1468 | 19893 |
| 11-#14 | 1.79 | 24524 | 6980 | 36908 | 5385 | 40418 | 4205 | 40479 | 3319 | 38263 | 2092 | 42419 | 1299 | 27447 |
| 11-#18 | 3.18 | 25887 | 7645 | 40765 | 5773 | 45075 | 4484 | 46020 | 3477 | 45668 | 2011 | 52926 | 860 | 44570 |
| 12-#11 | 1.35 | 24059 | 6771 | 35536 | 5298 | 38915 | 4136 | 38765 | 3301 | 35937 | 2133 | 39280 | 1460 | 21456 |
| 12-#14 | 1.95 | 24680 | 7057 | 37260 | 5464 | 40965 | 4276 | 41193 | 3372 | 39184 | 2100 | 43966 | 1281 | 29499 |
| 12-#18 | 3.46 | 26152 | 7783 | 41467 | 5891 | 46025 | 4590 | 47214 | 3555 | 47200 | 2013 | 55487 | 817 | 47969 |
| 13-#11 | 1.46 | 24195 | 6825 | 35961 | 5307 | 39313 | 4155 | 39230 | 3297 | 36581 | 2120 | 40016 | 1406 | 23095 |
| 13-#14 | 2.11 | 24871 | 7135 | 37819 | 5485 | 41540 | 4286 | 41874 | 3372 | 40124 | 2085 | 45055 | 1208 | 31701 |
| 13-#18 | 3.75 | 26488 | 7922 | 42279 | 5965 | 47054 | 4623 | 48426 | 3564 | 48875 | 1992 | 57442 | 689 | 51182 |
| 14-#11 | 1.58 | 24357 | 6879 | 36497 | 5294 | 39761 | 4138 | 39668 | 3275 | 37109 | 2077 | 40736 | 1350 | 24600 |
| 14-#14 | 2.27 | 25100 | 7213 | 38488 | 5487 | 42177 | 4279 | 42555 | 3356 | 40946 | 2033 | 46179 | 1136 | 33825 |
| 14-#18 | 4.04 | 26862 | 8060 | 43372 | 5983 | 48160 | 4641 | 49729 | 3563 | 50433 | 1917 | 59552 | 576 | 54260 |
| 15-#11 | 1.69 | 24454 | 6933 | 36559 | 5384 | 40107 | 4212 | 40201 | 3333 | 37886 | 2115 | 42014 | 1354 | 26210 |
| 15-#14 | 2.44 | 25230 | 7291 | 38689 | 5594 | 42670 | 4366 | 43264 | 3423 | 41980 | 2076 | 47884 | 1129 | 35879 |
| 15-#18 | 4.33 | 27070 | 8198 | 43907 | 6132 | 49015 | 4759 | 50831 | 3649 | 52240 | 1993 | 62308 | 542 | 57667 |
| 16-#11 | 1.80 | 24572 | 6987 | 36753 | 5440 | 40505 | 4241 | 40712 | 3367 | 38652 | 2135 | 42986 | 1318 | 27668 |
| 16-#14 | 2.60 | 25397 | 7369 | 38995 | 5668 | 43247 | 4426 | 43966 | 3466 | 43053 | 2101 | 49231 | 1074 | 37994 |
| 16-#18 | 4.62 | 27355 | 8337 | 44504 | 6252 | 50032 | 4857 | 52022 | 3716 | 53913 | 2008 | 64569 | 437 | 60573 |
| 17-#11 | 1.91 | 24706 | 7041 | 37160 | 5460 | 40906 | 4268 | 41167 | 3368 | 39245 | 2118 | 43872 | 1287 | 29272 |
| 17-#14 | 2.76 | 25584 | 7446 | 39551 | 5701 | 43809 | 4444 | 44638 | 3471 | 43913 | 2079 | 50517 | 1030 | 39947 |
| 17-#18 | 4.91 | 27680 | 8475 | 45430 | 6319 | 50990 | 4894 | 53310 | 3754 | 55425 | 1971 | 66835 | 360 | 63953 |
| 18-#11 | 2.03 | 24819 | 7095 | 37634 | 5467 | 41351 | 4268 | 41634 | 3361 | 39887 | 2095 | 44595 | 1222 | 30674 |
| 18-#14 | 2.92 | 25745 | 7524 | 40174 | 5725 | 44442 | 4455 | 45331 | 3470 | 44862 | 2052 | 51605 | 942 | 42088 |
| 18-#18 | 5.20 | 27939 | 8613 | 46397 | 6383 | 52086 | 4932 | 54497 | 3746 | 57153 | 1933 | 69516 | 273 | 67031 |
| 19-#11 | 2.14 | 24959 | 7149 | 37774 | 5534 | 41700 | 4322 | 42162 | 3411 | 40540 | 2112 | 45844 | 1234 | 32258 |
| 19-#14 | 3.09 | 25934 | 7602 | 40431 | 5807 | 44949 | 4522 | 46053 | 3531 | 45756 | 2069 | 53319 | 952 | 43979 |
| 19-#18 | 5.49 | 28250 | 8752 | 46963 | 6504 | 52974 | 5029 | 55698 | 3836 | 58615 | 1948 | 71676 | 213 | 69989 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 42" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.25 | 25090 | 7203 | 38011 | 5585 | 42080 | 4344 | 42638 | 3431 | 41224 | 2119 | 46886 | 1211 | 33628 |
| 20-#14 | 3.25 | 26117 | 7680 | 40787 | 5876 | 45492 | 4575 | 46735 | 3559 | 46718 | 2077 | 54783 | 916 | 45919 |
| 21-#11 | 2.36 | 25212 | 7256 | 38388 | 5608 | 42492 | 4376 | 43130 | 3444 | 41835 | 2105 | 47673 | 1170 | 35161 |
| 21-#14 | 3.41 | 26291 | 7758 | 41316 | 5913 | 46079 | 4598 | 47430 | 3579 | 47599 | 2058 | 55913 | 857 | 47777 |
| 22-#11 | 2.48 | 25347 | 7310 | 38795 | 5625 | 42948 | 4386 | 43589 | 3437 | 42498 | 2089 | 48529 | 1129 | 36566 |
| 22-#14 | 3.57 | 26477 | 7835 | 41855 | 5945 | 46728 | 4620 | 48103 | 3574 | 48562 | 2038 | 57175 | 801 | 49634 |
| 23-#11 | 2.59 | 25458 | 7364 | 39003 | 5682 | 43289 | 4429 | 44098 | 3478 | 43193 | 2107 | 49512 | 1104 | 37997 |
| 23-#14 | 3.74 | 26634 | 7913 | 42195 | 6018 | 47214 | 4674 | 48810 | 3626 | 49532 | 2059 | 58721 | 778 | 51557 |
| 24-#11 | 2.70 | 25574 | 7418 | 39269 | 5730 | 43677 | 4449 | 44556 | 3496 | 43804 | 2104 | 50512 | 1083 | 39424 |
| 24-#14 | 3.90 | 26795 | 7991 | 42593 | 6085 | 47768 | 4725 | 49466 | 3650 | 50394 | 2053 | 59934 | 728 | 53443 |
| 25-#11 | 2.81 | 25715 | 7472 | 39625 | 5755 | 44089 | 4483 | 45059 | 3511 | 44483 | 2099 | 51487 | 1049 | 40804 |
| 25-#14 | 4.06 | 26991 | 8069 | 43083 | 6123 | 48355 | 4750 | 50188 | 3674 | 51370 | 2047 | 61329 | 679 | 55345 |
| 26-#11 | 2.93 | 25826 | 7526 | 40087 | 5761 | 44515 | 4497 | 45540 | 3509 | 45091 | 2078 | 52223 | 1002 | 42250 |
| 26-#14 | 4.22 | 27159 | 8147 | 43712 | 6137 | 48970 | 4777 | 50874 | 3674 | 52255 | 2020 | 62406 | 614 | 57119 |
| 27-#11 | 3.04 | 25956 | 7580 | 40280 | 5819 | 44881 | 4536 | 46023 | 3544 | 45775 | 2092 | 53323 | 982 | 43605 |
| 28-#11 | 3.15 | 26097 | 7634 | 40578 | 5856 | 45285 | 4555 | 46485 | 3560 | 46390 | 2088 | 54458 | 973 | 44998 |
| 29-#11 | 3.27 | 26210 | 7688 | 40898 | 5892 | 45676 | 4589 | 46988 | 3577 | 47067 | 2085 | 55284 | 929 | 46305 |
| 30-#11 | 3.38 | 26334 | 7742 | 41306 | 5911 | 46102 | 4607 | 47469 | 3578 | 47682 | 2066 | 56194 | 894 | 47633 |
| 31-#11 | 3.49 | 26453 | 7796 | 41521 | 5965 | 46475 | 4633 | 47956 | 3610 | 48422 | 2086 | 57114 | 863 | 49002 |
| 32-#11 | 3.60 | 26568 | 7850 | 41827 | 6001 | 46866 | 4659 | 48422 | 3625 | 49099 | 2090 | 58128 | 837 | 50324 |

## ROUND TIED COLUMNS 44" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.05 | 26948 | 7274 | 39976 | 5640 | 43400 | 4446 | 42897 | 3548 | 39104 | 2336 | 41068 | 1653 | 20605 |
| 5-#18 | 1.32 | 27536 | 7412 | 41575 | 5593 | 44597 | 4372 | 44000 | 3464 | 40349 | 2214 | 43415 | 1510 | 23831 |
| 6-#18 | 1.58 | 27932 | 7551 | 43767 | 5399 | 45887 | 4204 | 44991 | 3293 | 41567 | 2024 | 43762 | 1252 | 28475 |
| 7-#14 | 1.04 | 27286 | 7265 | 40213 | 5624 | 43482 | 4403 | 42896 | 3508 | 39017 | 2301 | 41621 | 1646 | 19606 |
| 7-#18 | 1.84 | 28250 | 7689 | 42899 | 5851 | 46648 | 4566 | 46643 | 3598 | 43970 | 2234 | 48631 | 1361 | 32181 |
| 8-#14 | 1.18 | 27490 | 7343 | 40305 | 5749 | 44029 | 4490 | 43721 | 3596 | 40205 | 2349 | 43215 | 1642 | 21753 |
| 8-#18 | 2.10 | 28591 | 7827 | 43328 | 6014 | 47602 | 4715 | 47948 | 3712 | 45855 | 2290 | 51095 | 1324 | 36484 |
| 9-#14 | 1.33 | 27637 | 7421 | 41026 | 5759 | 44683 | 4505 | 44405 | 3577 | 41154 | 2319 | 44586 | 1557 | 24512 |
| 9-#18 | 2.37 | 28846 | 7966 | 44435 | 6068 | 48734 | 4726 | 49211 | 3702 | 47596 | 2252 | 53640 | 1189 | 40057 |
| 10-#11 | 1.03 | 27263 | 7260 | 40472 | 5563 | 43543 | 4356 | 42877 | 3470 | 38924 | 2271 | 41450 | 1643 | 19264 |
| 10-#14 | 1.48 | 27820 | 7499 | 42022 | 5692 | 45403 | 4451 | 45095 | 3523 | 41847 | 2235 | 45577 | 1493 | 26621 |
| 10-#18 | 2.63 | 29136 | 8104 | 45827 | 6027 | 50024 | 4698 | 50573 | 3659 | 49095 | 2141 | 55752 | 1106 | 44289 |
| 11-#11 | 1.13 | 27421 | 7314 | 40208 | 5728 | 43887 | 4486 | 43527 | 3574 | 39962 | 2346 | 43044 | 1658 | 21085 |
| 11-#14 | 1.63 | 28040 | 7577 | 41880 | 5878 | 45890 | 4594 | 45892 | 3636 | 43145 | 2317 | 47582 | 1492 | 29236 |
| 11-#18 | 2.89 | 29510 | 8242 | 45976 | 6266 | 50838 | 4874 | 51768 | 3795 | 51011 | 2239 | 58773 | 1060 | 47713 |
| 12-#11 | 1.23 | 27536 | 7368 | 40405 | 5794 | 44300 | 4528 | 44082 | 3619 | 40677 | 2358 | 44259 | 1652 | 22790 |
| 12-#14 | 1.78 | 28203 | 7654 | 42232 | 5959 | 46472 | 4643 | 46653 | 3691 | 44115 | 2326 | 49239 | 1476 | 31338 |
| 12-#18 | 3.16 | 29788 | 8381 | 46720 | 6387 | 51844 | 4983 | 53040 | 3875 | 52645 | 2243 | 61513 | 1019 | 51509 |

## ROUND TIED COLUMNS 44" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 13-#11 | 1.33 | 27681 | 7422 | 40869 | 5801 | 44716 | 4537 | 44571 | 3614 | 41353 | 2344 | 45029 | 1598 | 24503 |
| 13-#14 | 1.92 | 28408 | 7732 | 42841 | 5979 | 47073 | 4677 | 47371 | 3690 | 45114 | 2311 | 50385 | 1402 | 33777 |
| 13-#18 | 3.42 | 30138 | 8519 | 47578 | 6459 | 52919 | 5014 | 54322 | 3884 | 54415 | 2222 | 63581 | 892 | 54781 |
| 14-#11 | 1.44 | 27851 | 7476 | 41462 | 5783 | 45193 | 4524 | 45018 | 3588 | 41905 | 2299 | 45771 | 1540 | 26150 |
| 14-#14 | 2.07 | 28648 | 7810 | 43574 | 5976 | 47751 | 4665 | 48073 | 3670 | 45975 | 2257 | 51559 | 1329 | 35956 |
| 14-#18 | 3.68 | 30546 | 8657 | 48761 | 6473 | 54094 | 5029 | 55673 | 3879 | 56052 | 2145 | 65808 | 778 | 58188 |
| 15-#11 | 1.54 | 27961 | 7530 | 41496 | 5879 | 45556 | 4594 | 45592 | 3650 | 42736 | 2340 | 47151 | 1547 | 27828 |
| 15-#14 | 2.22 | 28796 | 7888 | 43753 | 6089 | 48271 | 4757 | 48833 | 3741 | 47077 | 2303 | 53392 | 1325 | 38232 |
| 15-#18 | 3.95 | 30778 | 8796 | 49303 | 6628 | 54999 | 5151 | 56875 | 3970 | 57986 | 2225 | 68758 | 748 | 61677 |
| 16-#11 | 1.64 | 28087 | 7584 | 41693 | 5937 | 45970 | 4633 | 46143 | 3686 | 43551 | 2361 | 48190 | 1512 | 29427 |
| 16-#14 | 2.37 | 28974 | 7966 | 44069 | 6164 | 48873 | 4794 | 49591 | 3786 | 48213 | 2328 | 54831 | 1271 | 40407 |
| 16-#18 | 4.21 | 31084 | 8934 | 49915 | 6749 | 56078 | 5251 | 58141 | 4039 | 59765 | 2241 | 71173 | 645 | 65106 |
| 17-#11 | 1.74 | 28228 | 7638 | 42130 | 5955 | 46402 | 4651 | 46616 | 3686 | 44176 | 2343 | 49124 | 1481 | 31095 |
| 17-#14 | 2.52 | 29171 | 8043 | 44665 | 6196 | 49478 | 4836 | 50289 | 3790 | 49124 | 2306 | 56189 | 1228 | 42570 |
| 17-#18 | 4.47 | 31428 | 9072 | 50903 | 6814 | 57095 | 5288 | 59493 | 4076 | 61366 | 2205 | 73576 | 569 | 68610 |
| 18-#11 | 1.85 | 28349 | 7692 | 42643 | 5959 | 46875 | 4657 | 47105 | 3677 | 44850 | 2320 | 49875 | 1415 | 32635 |
| 18-#14 | 2.66 | 29343 | 8121 | 45333 | 6217 | 50150 | 4845 | 51018 | 3787 | 50132 | 2279 | 57334 | 1139 | 44776 |
| 18-#18 | 4.74 | 31709 | 9211 | 51958 | 6877 | 58259 | 5324 | 60737 | 4066 | 63189 | 2167 | 75671 | 420 | 71740 |
| 19-#11 | 1.95 | 28498 | 7746 | 42779 | 6030 | 47236 | 4705 | 47669 | 3729 | 45547 | 2338 | 51215 | 1430 | 34286 |
| 19-#14 | 2.81 | 29549 | 8199 | 45596 | 6303 | 50677 | 4914 | 51789 | 3851 | 51075 | 2297 | 59161 | 1152 | 46869 |
| 19-#18 | 5.00 | 32042 | 9349 | 52528 | 7001 | 59199 | 5424 | 62016 | 4159 | 64750 | 2184 | 78718 | 426 | 75028 |
| 20-#11 | 2.05 | 28639 | 7800 | 43025 | 6082 | 47639 | 4737 | 48168 | 3751 | 46275 | 2346 | 52324 | 1408 | 35788 |
| 20-#14 | 2.96 | 29742 | 8277 | 45968 | 6373 | 51251 | 4943 | 52502 | 3879 | 52095 | 2306 | 60718 | 1118 | 49077 |
| 20-#18 | 5.26 | 32365 | 9487 | 53213 | 7117 | 60209 | 5513 | 63245 | 4203 | 66507 | 2195 | 81377 | 357 | 78380 |
| 21-#11 | 2.15 | 28769 | 7854 | 43424 | 6105 | 48075 | 4760 | 48694 | 3764 | 46919 | 2332 | 53157 | 1366 | 37441 |
| 21-#14 | 3.11 | 29927 | 8355 | 46526 | 6409 | 51873 | 4991 | 53248 | 3899 | 53027 | 2287 | 61918 | 1059 | 51065 |
| 22-#11 | 2.26 | 28919 | 7908 | 43865 | 6119 | 48553 | 4776 | 49177 | 3755 | 47604 | 2314 | 54055 | 1325 | 38919 |
| 22-#14 | 3.26 | 30133 | 8432 | 47108 | 6440 | 52561 | 5011 | 53957 | 3893 | 54056 | 2267 | 63247 | 1002 | 53119 |
| 23-#11 | 2.36 | 29033 | 7961 | 44074 | 6178 | 48919 | 4814 | 49712 | 3797 | 48290 | 2325 | 55109 | 1301 | 40504 |
| 23-#14 | 3.40 | 30298 | 8510 | 47456 | 6514 | 53076 | 5068 | 54709 | 3948 | 55075 | 2289 | 64691 | 963 | 55134 |
| 24-#11 | 2.46 | 29159 | 8015 | 44348 | 6227 | 49330 | 4843 | 50198 | 3816 | 49007 | 2332 | 56172 | 1281 | 41966 |
| 24-#14 | 3.55 | 30470 | 8588 | 47869 | 6582 | 53662 | 5094 | 55396 | 3971 | 55990 | 2283 | 66190 | 932 | 57160 |
| 25-#11 | 2.56 | 29307 | 8069 | 44774 | 6243 | 49760 | 4867 | 50729 | 3831 | 49722 | 2327 | 57205 | 1247 | 43521 |
| 25-#14 | 3.70 | 30677 | 8666 | 48397 | 6620 | 54284 | 5145 | 56159 | 3995 | 57022 | 2278 | 67670 | 884 | 59122 |
| 26-#11 | 2.67 | 29426 | 8123 | 45229 | 6256 | 50212 | 4872 | 51243 | 3828 | 50351 | 2305 | 57979 | 1201 | 44979 |
| 26-#14 | 3.85 | 30845 | 8744 | 49071 | 6633 | 54927 | 5169 | 56896 | 3995 | 57960 | 2250 | 68807 | 819 | 61066 |
| 27-#11 | 2.77 | 29566 | 8177 | 45421 | 6316 | 50598 | 4920 | 51750 | 3864 | 51086 | 2321 | 59151 | 1182 | 46476 |
| 27-#14 | 4.00 | 31043 | 8821 | 49387 | 6712 | 55479 | 5220 | 57613 | 4042 | 58970 | 2268 | 70439 | 787 | 63084 |
| 28-#11 | 2.87 | 29716 | 8231 | 45733 | 6354 | 51026 | 4949 | 52241 | 3881 | 51744 | 2317 | 60071 | 1150 | 47963 |
| 28-#14 | 4.14 | 31244 | 8899 | 49844 | 6764 | 56089 | 5246 | 58308 | 4064 | 59892 | 2261 | 72144 | 774 | 64965 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 44" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 29-#11 | 2.98 | 29840 | 8285 | 46074 | 6389 | 51441 | 4974 | 52772 | 3898 | 52452 | 2314 | 61232 | 1130 | 49408 |
| 30-#11 | 3.08 | 29973 | 8339 | 46508 | 6407 | 51892 | 4982 | 53272 | 3897 | 53097 | 2294 | 62194 | 1095 | 50960 |
| 31-#11 | 3.18 | 30097 | 8393 | 46731 | 6462 | 52286 | 5027 | 53793 | 3931 | 53819 | 2307 | 63174 | 1064 | 52325 |
| 32-#11 | 3.28 | 30222 | 8447 | 47056 | 6499 | 52694 | 5053 | 54291 | 3947 | 54611 | 2320 | 64252 | 1039 | 53783 |
| 33-#11 | 3.39 | 30367 | 8501 | 47383 | 6535 | 53123 | 5080 | 54810 | 3964 | 55248 | 2308 | 65266 | 1011 | 55142 |
| 34-#11 | 3.49 | 30489 | 8555 | 47793 | 6555 | 53585 | 5092 | 55312 | 3966 | 55962 | 2300 | 66120 | 962 | 56555 |

## ROUND TIED COLUMNS 46" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 5-#18 | 1.20 | 31343 | 8037 | 47039 | 6096 | 50492 | 4768 | 49779 | 3786 | 45454 | 2441 | 48710 | 1704 | 25230 |
| 6-#18 | 1.44 | 31756 | 8176 | 49475 | 5878 | 51870 | 4580 | 50771 | 3598 | 46651 | 2239 | 48961 | 1437 | 30045 |
| 7-#18 | 1.68 | 32110 | 8314 | 48405 | 6362 | 52658 | 4969 | 52565 | 3925 | 49307 | 2467 | 54272 | 1561 | 34130 |
| 8-#14 | 1.08 | 31291 | 7968 | 45615 | 6268 | 49884 | 4899 | 49494 | 3929 | 45331 | 2583 | 48556 | 1842 | 22981 |
| 8-#18 | 1.93 | 32474 | 8452 | 48821 | 6532 | 53663 | 5124 | 53959 | 4045 | 51316 | 2526 | 56918 | 1529 | 38576 |
| 9-#14 | 1.22 | 31444 | 8046 | 46394 | 6274 | 50579 | 4911 | 50208 | 3907 | 46331 | 2552 | 49984 | 1757 | 25887 |
| 9-#18 | 2.17 | 32740 | 8590 | 50008 | 6582 | 54863 | 5132 | 55286 | 4032 | 53151 | 2488 | 59595 | 1392 | 42520 |
| 10-#14 | 1.35 | 31643 | 8124 | 47496 | 6196 | 51333 | 4848 | 50908 | 3845 | 47030 | 2463 | 50986 | 1689 | 28170 |
| 10-#18 | 2.41 | 33056 | 8729 | 51521 | 6531 | 56213 | 5096 | 56730 | 3984 | 54702 | 2372 | 61785 | 1307 | 46895 |
| 11-#11 | 1.03 | 31214 | 7939 | 45519 | 6245 | 49729 | 4885 | 49286 | 3905 | 45068 | 2580 | 48355 | 1857 | 22285 |
| 11-#14 | 1.49 | 31877 | 8201 | 47288 | 6394 | 51844 | 5002 | 51782 | 3967 | 48427 | 2551 | 53161 | 1694 | 30939 |
| 11-#18 | 2.65 | 33456 | 8867 | 51624 | 6782 | 57087 | 5282 | 57993 | 4128 | 56767 | 2477 | 65036 | 1268 | 50665 |
| 12-#11 | 1.13 | 31334 | 7993 | 45706 | 6314 | 50169 | 4939 | 49876 | 3953 | 45833 | 2593 | 49654 | 1852 | 24139 |
| 12-#14 | 1.62 | 32047 | 8279 | 47638 | 6479 | 52465 | 5054 | 52591 | 4025 | 49461 | 2562 | 54930 | 1679 | 33196 |
| 12-#18 | 2.89 | 33746 | 9005 | 52387 | 6906 | 58149 | 5395 | 59343 | 4211 | 58496 | 2483 | 67956 | 1229 | 54991 |
| 13-#11 | 1.22 | 31489 | 8047 | 46212 | 6319 | 50604 | 4946 | 50381 | 3946 | 46538 | 2578 | 50459 | 1799 | 25923 |
| 13-#14 | 1.76 | 32266 | 8357 | 48299 | 6496 | 53093 | 5085 | 53346 | 4022 | 50509 | 2546 | 56132 | 1605 | 35885 |
| 13-#18 | 3.13 | 34120 | 9144 | 53419 | 6954 | 59270 | 5423 | 60696 | 4218 | 60370 | 2462 | 70137 | 1103 | 58452 |
| 14-#11 | 1.31 | 31668 | 8101 | 46865 | 6296 | 51110 | 4929 | 50844 | 3916 | 47113 | 2531 | 51219 | 1738 | 27718 |
| 14-#14 | 1.90 | 32518 | 8435 | 49100 | 6489 | 53811 | 5070 | 54066 | 3998 | 51414 | 2491 | 57351 | 1530 | 38109 |
| 14-#18 | 3.37 | 34549 | 9282 | 54591 | 6985 | 60515 | 5434 | 62093 | 4209 | 62083 | 2383 | 72477 | 987 | 62203 |
| 15-#11 | 1.41 | 31789 | 8155 | 46867 | 6398 | 51491 | 5004 | 51460 | 3983 | 48000 | 2575 | 52705 | 1748 | 29462 |
| 15-#14 | 2.03 | 32683 | 8513 | 49252 | 6607 | 54358 | 5154 | 54880 | 4073 | 52584 | 2539 | 59316 | 1530 | 40620 |
| 15-#18 | 3.61 | 34809 | 9420 | 55125 | 7146 | 61469 | 5562 | 63393 | 4306 | 63967 | 2445 | 75625 | 962 | 65763 |
| 16-#11 | 1.50 | 31924 | 8209 | 47066 | 6457 | 51921 | 5043 | 52051 | 4020 | 48866 | 2597 | 53813 | 1714 | 31207 |
| 16-#14 | 2.17 | 32873 | 8590 | 49578 | 6684 | 54983 | 5204 | 55694 | 4121 | 53788 | 2566 | 60848 | 1477 | 42846 |
| 16-#18 | 3.85 | 35136 | 9559 | 55761 | 7269 | 62592 | 5662 | 64737 | 4376 | 66023 | 2484 | 78196 | 860 | 69520 |
| 17-#11 | 1.60 | 32071 | 8263 | 47534 | 6474 | 52380 | 5061 | 52541 | 4019 | 49521 | 2579 | 54793 | 1683 | 32938 |
| 17-#14 | 2.30 | 33079 | 8668 | 50214 | 6715 | 55632 | 5234 | 56418 | 4124 | 54746 | 2544 | 62278 | 1434 | 45231 |
| 17-#18 | 4.09 | 35485 | 9697 | 56812 | 7334 | 63685 | 5700 | 66062 | 4390 | 67722 | 2448 | 80734 | 786 | 73109 |
| 18-#11 | 1.69 | 32201 | 8317 | 48088 | 6475 | 52884 | 5065 | 53052 | 4008 | 50211 | 2554 | 55570 | 1617 | 34622 |
| 18-#14 | 2.44 | 33263 | 8746 | 50930 | 6733 | 56343 | 5253 | 57182 | 4119 | 55810 | 2516 | 63473 | 1344 | 47495 |
| 18-#18 | 4.33 | 35803 | 9835 | 57943 | 7394 | 64917 | 5734 | 67453 | 4400 | 69638 | 2409 | 82945 | 636 | 76544 |

## ROUND TIED COLUMNS 46" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 19-#11 | 1.78 | 32360 | 8371 | 48218 | 6550 | 53258 | 5116 | 53654 | 4063 | 50970 | 2574 | 56854 | 1621 | 36333 |
| 19-#14 | 2.57 | 33486 | 8824 | 51196 | 6823 | 56889 | 5312 | 58003 | 4186 | 56808 | 2535 | 65421 | 1360 | 49798 |
| 19-#18 | 4.57 | 36158 | 9974 | 58529 | 7521 | 65904 | 5836 | 68812 | 4497 | 71301 | 2429 | 86178 | 646 | 80179 |
| 20-#11 | 1.88 | 32509 | 8425 | 48472 | 6603 | 53682 | 5148 | 54175 | 4085 | 51741 | 2583 | 58179 | 1612 | 38021 |
| 20-#14 | 2.71 | 33688 | 8902 | 51584 | 6894 | 57495 | 5355 | 58746 | 4214 | 57888 | 2545 | 67071 | 1326 | 52069 |
| 20-#18 | 4.81 | 36497 | 10112 | 59248 | 7639 | 66960 | 5926 | 70126 | 4542 | 73152 | 2441 | 88996 | 579 | 83574 |
| 21-#11 | 1.97 | 32648 | 8478 | 48893 | 6624 | 54144 | 5170 | 54732 | 4098 | 52418 | 2569 | 59058 | 1571 | 39688 |
| 21-#14 | 2.84 | 33886 | 8980 | 52171 | 6929 | 58152 | 5390 | 59544 | 4235 | 58870 | 2526 | 68340 | 1268 | 54266 |
| 21-#18 | 5.05 | 36851 | 10250 | 60257 | 7708 | 68101 | 5971 | 71488 | 4581 | 74883 | 2409 | 91218 | 476 | 86996 |
| 22-#11 | 2.07 | 32812 | 8532 | 49371 | 6637 | 54644 | 5168 | 55241 | 4088 | 53123 | 2550 | 59996 | 1529 | 41303 |
| 22-#14 | 2.98 | 34111 | 9057 | 52797 | 6957 | 58872 | 5421 | 60289 | 4227 | 59935 | 2505 | 69735 | 1211 | 56581 |
| 22-#18 | 5.30 | 37212 | 10389 | 61252 | 7777 | 69363 | 6020 | 72825 | 4580 | 76802 | 2379 | 93736 | 381 | 90600 |
| 23-#11 | 2.16 | 32930 | 8586 | 49579 | 6698 | 55034 | 5225 | 55803 | 4132 | 53860 | 2563 | 61124 | 1507 | 42974 |
| 23-#14 | 3.11 | 34284 | 9135 | 53152 | 7035 | 59423 | 5467 | 61077 | 4283 | 60933 | 2516 | 71277 | 1174 | 58716 |
| 24-#11 | 2.25 | 33065 | 8640 | 49860 | 6748 | 55467 | 5255 | 56317 | 4151 | 54624 | 2570 | 62250 | 1487 | 44543 |
| 24-#14 | 3.25 | 34468 | 9213 | 53578 | 7103 | 60041 | 5507 | 61803 | 4307 | 62002 | 2524 | 72864 | 1143 | 60953 |
| 25-#11 | 2.35 | 33221 | 8694 | 50313 | 6764 | 55916 | 5279 | 56878 | 4166 | 55368 | 2565 | 63341 | 1453 | 46237 |
| 25-#14 | 3.38 | 34685 | 9291 | 54207 | 7128 | 60690 | 5544 | 62608 | 4331 | 63089 | 2519 | 74429 | 1095 | 62955 |
| 26-#11 | 2.44 | 33347 | 8748 | 50805 | 6776 | 56394 | 5282 | 57410 | 4162 | 56026 | 2542 | 64152 | 1407 | 47745 |
| 26-#14 | 3.52 | 34864 | 9369 | 54865 | 7152 | 61370 | 5580 | 63394 | 4331 | 64060 | 2490 | 75625 | 1030 | 65089 |
| 27-#11 | 2.53 | 33498 | 8802 | 50995 | 6837 | 56801 | 5332 | 57955 | 4199 | 56808 | 2559 | 65397 | 1389 | 49391 |
| 27-#14 | 3.66 | 35078 | 9446 | 55184 | 7233 | 61952 | 5621 | 64144 | 4379 | 65143 | 2509 | 77357 | 1001 | 67164 |
| 28-#11 | 2.63 | 33651 | 8856 | 51322 | 6875 | 57246 | 5361 | 58474 | 4217 | 57513 | 2557 | 66374 | 1357 | 50915 |
| 28-#14 | 3.79 | 35289 | 9524 | 55663 | 7285 | 62597 | 5660 | 64879 | 4402 | 66123 | 2503 | 78732 | 953 | 69218 |
| 29-#11 | 2.72 | 33790 | 8910 | 51684 | 6910 | 57690 | 5386 | 59033 | 4233 | 58249 | 2552 | 67598 | 1338 | 52504 |
| 29-#14 | 3.93 | 35479 | 9602 | 56169 | 7338 | 63220 | 5697 | 65683 | 4427 | 67198 | 2499 | 80488 | 925 | 71397 |
| 30-#11 | 2.82 | 33935 | 8964 | 52144 | 6927 | 58167 | 5394 | 59553 | 4232 | 58926 | 2533 | 68611 | 1303 | 54096 |
| 31-#11 | 2.91 | 34064 | 9018 | 52373 | 6984 | 58576 | 5439 | 60104 | 4267 | 59692 | 2546 | 69653 | 1274 | 55615 |
| 32-#11 | 3.00 | 34198 | 9072 | 52718 | 7021 | 59007 | 5465 | 60638 | 4284 | 60523 | 2559 | 70795 | 1249 | 57198 |
| 33-#11 | 3.10 | 34353 | 9126 | 53061 | 7056 | 59460 | 5492 | 61178 | 4300 | 61201 | 2548 | 71715 | 1209 | 58677 |
| 34-#11 | 3.19 | 34480 | 9180 | 53499 | 7076 | 59947 | 5504 | 61706 | 4301 | 61951 | 2539 | 72766 | 1171 | 60246 |
| 35-#11 | 3.29 | 34626 | 9234 | 53755 | 7130 | 60348 | 5546 | 62255 | 4333 | 62642 | 2542 | 73922 | 1155 | 61703 |
| 36-#11 | 3.38 | 34779 | 9288 | 54092 | 7165 | 60783 | 5571 | 62779 | 4349 | 63391 | 2545 | 74906 | 1118 | 63176 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND TIED COLUMNS 48" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 5-#18 | 1.11 | 35486 | 8690 | 52968 | 6622 | 56894 | 5182 | 56043 | 4122 | 50985 | 2679 | 54430 | 1907 | 26642 |
| 6-#18 | 1.33 | 35915 | 8828 | 55665 | 6379 | 58361 | 4973 | 57038 | 3917 | 52147 | 2464 | 54567 | 1630 | 31615 |
| 7-#18 | 1.55 | 36296 | 8966 | 54371 | 6896 | 59176 | 5390 | 58985 | 4267 | 55075 | 2710 | 60344 | 1769 | 36100 |
| 8-#18 | 1.77 | 36694 | 9105 | 54769 | 7074 | 60231 | 5552 | 60468 | 4392 | 57191 | 2773 | 63176 | 1742 | 40679 |
| 9-#14 | 1.12 | 35587 | 8698 | 52219 | 6812 | 56981 | 5336 | 56510 | 4252 | 51927 | 2795 | 55815 | 1964 | 27267 |
| 9-#18 | 1.99 | 36970 | 9243 | 56033 | 7119 | 61499 | 5557 | 61860 | 4377 | 59138 | 2733 | 65983 | 1604 | 45011 |
| 10-#14 | 1.24 | 35801 | 8776 | 53433 | 6724 | 57772 | 5264 | 57215 | 4182 | 52640 | 2702 | 56821 | 1892 | 29732 |
| 10-#18 | 2.21 | 37313 | 9381 | 57681 | 7058 | 62910 | 5511 | 63361 | 4322 | 60736 | 2613 | 68244 | 1516 | 49518 |
| 11-#14 | 1.37 | 36050 | 8854 | 53151 | 6934 | 58304 | 5415 | 58170 | 4313 | 54141 | 2796 | 59174 | 1903 | 32627 |
| 11-#18 | 2.43 | 37739 | 9520 | 57729 | 7321 | 63837 | 5709 | 64717 | 4475 | 62955 | 2725 | 71732 | 1484 | 53652 |
| 12-#11 | 1.03 | 35468 | 8646 | 51460 | 6857 | 56545 | 5368 | 56170 | 4302 | 51423 | 2839 | 55487 | 2062 | 25502 |
| 12-#14 | 1.49 | 36227 | 8932 | 53497 | 7021 | 58965 | 5483 | 59028 | 4374 | 55241 | 2809 | 61058 | 1890 | 35071 |
| 12-#18 | 2.65 | 38041 | 9658 | 58505 | 7448 | 64961 | 5825 | 66146 | 4561 | 64762 | 2732 | 74835 | 1447 | 58118 |
| 13-#11 | 1.12 | 35633 | 8700 | 52010 | 6861 | 57000 | 5373 | 56691 | 4292 | 52158 | 2823 | 56324 | 2007 | 27355 |
| 13-#14 | 1.62 | 36460 | 9010 | 54211 | 7038 | 59619 | 5500 | 59810 | 4369 | 56336 | 2792 | 62314 | 1816 | 37874 |
| 13-#18 | 2.87 | 38439 | 9796 | 59616 | 7495 | 66128 | 5851 | 67568 | 4567 | 66751 | 2711 | 77128 | 1321 | 61987 |
| 14-#11 | 1.21 | 35820 | 8753 | 52728 | 6832 | 57535 | 5352 | 57167 | 4259 | 52740 | 2773 | 57099 | 1945 | 29305 |
| 14-#14 | 1.74 | 36724 | 9088 | 55086 | 7025 | 60379 | 5493 | 60557 | 4342 | 57285 | 2735 | 63575 | 1739 | 40285 |
| 14-#18 | 3.09 | 38889 | 9935 | 60882 | 7521 | 67444 | 5857 | 69011 | 4553 | 68545 | 2631 | 79578 | 1204 | 66306 |
| 15-#11 | 1.29 | 35952 | 8807 | 52691 | 6940 | 57932 | 5432 | 57827 | 4330 | 53699 | 2821 | 58695 | 1958 | 31112 |
| 15-#14 | 1.87 | 36906 | 9165 | 55206 | 7149 | 60951 | 5582 | 61425 | 4421 | 58524 | 2786 | 65676 | 1742 | 42976 |
| 15-#18 | 3.32 | 39178 | 10073 | 61399 | 7688 | 68447 | 5991 | 70393 | 4655 | 70538 | 2695 | 82928 | 1183 | 69924 |
| 16-#11 | 1.38 | 36097 | 8861 | 52891 | 7001 | 58379 | 5473 | 58455 | 4369 | 54615 | 2844 | 59873 | 1925 | 33009 |
| 16-#14 | 1.99 | 37108 | 9243 | 55540 | 7228 | 61601 | 5634 | 62296 | 4471 | 59797 | 2814 | 67303 | 1690 | 45313 |
| 16-#18 | 3.54 | 39526 | 10211 | 62061 | 7813 | 69614 | 6093 | 71833 | 4729 | 72695 | 2736 | 85656 | 1082 | 74024 |
| 17-#11 | 1.47 | 36250 | 8915 | 53392 | 7017 | 58863 | 5489 | 58966 | 4367 | 55300 | 2826 | 60899 | 1894 | 34800 |
| 17-#14 | 2.11 | 37324 | 9321 | 56217 | 7258 | 62290 | 5663 | 63047 | 4472 | 60802 | 2791 | 68804 | 1648 | 47973 |
| 17-#18 | 3.76 | 39891 | 10350 | 63176 | 7876 | 70783 | 6130 | 73207 | 4741 | 74492 | 2700 | 88329 | 1009 | 77687 |
| 18-#11 | 1.55 | 36388 | 8969 | 53990 | 7015 | 59401 | 5474 | 59497 | 4354 | 56005 | 2798 | 61698 | 1827 | 36634 |
| 18-#14 | 2.24 | 37519 | 9399 | 56984 | 7272 | 63044 | 5679 | 63845 | 4465 | 61896 | 2761 | 70044 | 1558 | 50245 |
| 18-#18 | 3.98 | 40236 | 10488 | 64375 | 7933 | 72084 | 6162 | 74667 | 4749 | 76519 | 2661 | 90653 | 858 | 81441 |
| 19-#11 | 1.64 | 36559 | 9023 | 54108 | 7093 | 59787 | 5545 | 60107 | 4403 | 56826 | 2821 | 63072 | 1833 | 38402 |
| 19-#14 | 2.36 | 37759 | 9477 | 57249 | 7366 | 63608 | 5741 | 64715 | 4535 | 62974 | 2783 | 72118 | 1575 | 52769 |
| 19-#18 | 4.20 | 40613 | 10626 | 64986 | 8065 | 73106 | 6267 | 76107 | 4849 | 78262 | 2682 | 94074 | 872 | 85307 |
| 20-#11 | 1.72 | 36715 | 9077 | 54372 | 7148 | 60232 | 5579 | 60681 | 4434 | 57641 | 2831 | 64472 | 1825 | 40237 |
| 20-#14 | 2.49 | 37971 | 9554 | 57652 | 7438 | 64246 | 5785 | 65491 | 4564 | 64116 | 2794 | 73861 | 1543 | 55096 |
| 20-#18 | 4.42 | 40967 | 10765 | 65738 | 8184 | 74219 | 6358 | 77475 | 4894 | 80212 | 2695 | 97052 | 808 | 88865 |
| 21-#11 | 1.81 | 36863 | 9131 | 54816 | 7168 | 60719 | 5600 | 61267 | 4447 | 58343 | 2816 | 65396 | 1783 | 41959 |
| 21-#14 | 2.61 | 38181 | 9632 | 58269 | 7472 | 64939 | 5820 | 66336 | 4585 | 65147 | 2775 | 75199 | 1484 | 57502 |
| 21-#18 | 4.64 | 41330 | 10903 | 66794 | 8252 | 75422 | 6403 | 78929 | 4934 | 82037 | 2663 | 99402 | 705 | 92752 |
| 22-#11 | 1.90 | 37041 | 9185 | 55331 | 7178 | 61241 | 5596 | 61805 | 4435 | 59076 | 2796 | 66373 | 1741 | 43718 |
| 22-#14 | 2.74 | 38427 | 9710 | 58941 | 7499 | 65691 | 5824 | 67120 | 4576 | 66246 | 2752 | 76658 | 1428 | 59936 |
| 22-#18 | 4.86 | 41738 | 11041 | 67855 | 8319 | 76758 | 6450 | 80335 | 4932 | 84078 | 2635 | 102049 | 610 | 96285 |

## ROUND TIED COLUMNS 48" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 23-#11 | 1.98 | 37164 | 9239 | 55537 | 7242 | 61654 | 5655 | 62394 | 4481 | 59861 | 2810 | 67576 | 1720 | 45444 |
| 23-#14 | 2.86 | 38603 | 9788 | 59302 | 7579 | 66277 | 5898 | 67943 | 4633 | 67315 | 2766 | 78299 | 1392 | 62214 |
| 23-#18 | 5.08 | 42039 | 11180 | 68599 | 8439 | 77751 | 6538 | 81757 | 5019 | 85998 | 2666 | 104764 | 535 | 99947 |
| 24-#11 | 2.07 | 37308 | 9293 | 55825 | 7292 | 62111 | 5685 | 62937 | 4501 | 60677 | 2819 | 68766 | 1702 | 47153 |
| 24-#14 | 2.98 | 38803 | 9866 | 59740 | 7647 | 66927 | 5938 | 68709 | 4658 | 68448 | 2775 | 79975 | 1362 | 64636 |
| 25-#11 | 2.16 | 37471 | 9347 | 56305 | 7308 | 62579 | 5709 | 63525 | 4515 | 61448 | 2813 | 69913 | 1668 | 48902 |
| 25-#14 | 3.11 | 39031 | 9943 | 60408 | 7672 | 67604 | 5975 | 69556 | 4682 | 69578 | 2769 | 81626 | 1314 | 66836 |
| 26-#11 | 2.24 | 37605 | 9401 | 56836 | 7318 | 63083 | 5711 | 64076 | 4510 | 62135 | 2790 | 70760 | 1621 | 50548 |
| 26-#14 | 3.23 | 39221 | 10021 | 61114 | 7695 | 68321 | 5985 | 70373 | 4680 | 70593 | 2739 | 82879 | 1250 | 69188 |
| 27-#11 | 2.33 | 37767 | 9455 | 57022 | 7381 | 63510 | 5763 | 64659 | 4550 | 62964 | 2807 | 72081 | 1605 | 52297 |
| 27-#14 | 3.36 | 39445 | 10099 | 61434 | 7778 | 68933 | 6052 | 71174 | 4730 | 71740 | 2760 | 84713 | 1221 | 71359 |
| 28-#11 | 2.41 | 37926 | 9509 | 57363 | 7420 | 63973 | 5791 | 65206 | 4568 | 63700 | 2805 | 73115 | 1573 | 53907 |
| 28-#14 | 3.48 | 39673 | 10177 | 61936 | 7831 | 69603 | 6091 | 71949 | 4754 | 72789 | 2755 | 86168 | 1175 | 73550 |
| 29-#11 | 2.50 | 38075 | 9563 | 57747 | 7455 | 64446 | 5817 | 65788 | 4583 | 64481 | 2802 | 74401 | 1554 | 55675 |
| 29-#14 | 3.61 | 39874 | 10255 | 62471 | 7883 | 70268 | 6129 | 72795 | 4779 | 73904 | 2750 | 88016 | 1147 | 75778 |
| 30-#11 | 2.59 | 38233 | 9617 | 58234 | 7470 | 64949 | 5823 | 66333 | 4581 | 65189 | 2781 | 75464 | 1519 | 57274 |
| 30-#14 | 3.73 | 40093 | 10332 | 63138 | 7911 | 70985 | 6144 | 73588 | 4780 | 74941 | 2724 | 89564 | 1098 | 77904 |
| 31-#11 | 2.67 | 38367 | 9671 | 58468 | 7528 | 65374 | 5870 | 66915 | 4617 | 66000 | 2796 | 76569 | 1491 | 58939 |
| 31-#14 | 3.85 | 40283 | 10410 | 63509 | 7988 | 71601 | 6206 | 74404 | 4826 | 76071 | 2741 | 91101 | 1054 | 80181 |
| 32-#11 | 2.76 | 38510 | 9724 | 58833 | 7566 | 65826 | 5897 | 67480 | 4635 | 66866 | 2809 | 77776 | 1466 | 60559 |
| 33-#11 | 2.84 | 38676 | 9778 | 59192 | 7601 | 66304 | 5923 | 68046 | 4651 | 67585 | 2798 | 78744 | 1426 | 62180 |
| 34-#11 | 2.93 | 38808 | 9832 | 59658 | 7620 | 66812 | 5934 | 68600 | 4652 | 68375 | 2789 | 79848 | 1389 | 63820 |
| 35-#11 | 3.02 | 38964 | 9886 | 59921 | 7675 | 67238 | 5977 | 69179 | 4685 | 69097 | 2792 | 81069 | 1374 | 65425 |
| 36-#11 | 3.10 | 39124 | 9940 | 60271 | 7711 | 67697 | 6003 | 69725 | 4700 | 69885 | 2796 | 82107 | 1338 | 67059 |
| 37-#11 | 3.19 | 39270 | 9994 | 60690 | 7739 | 68169 | 6030 | 70308 | 4718 | 70611 | 2785 | 83229 | 1311 | 68616 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

# CHAPTER 5 – STRENGTH DESIGN OF FLEXURAL MEMBERS AND DEVELOPMENT AND LAP SPLICE DESIGN DATA FOR REINFORCING BARS

## INTRODUCTION

Strength design of flexural members utilizes the design assumptions given in Chapter 2 for columns. These assumptions recognize that, as the nominal strength of reinforced concrete is approached, the plastic range of the materials is reached, and stress and strain are no longer proportional. At nominal strength, the actual concrete stress distribution in the member is not triangular but curvilinear. It is also assumed that the reinforcing steel behaves elastically. The tabulated designs in this *Handbook* are based on an assumed rectangular concrete stress distribution at nominal strength (ACI 10.2.7).

Strength design consists of two steps: first, a member is proportioned to ensure its strength using appropriate safety factors; and second, the member must be checked to ensure that deflection and cracking at service load conditions will be within acceptable limits. Strength design is described in this Chapter; serviceability, in Chapter 6.

## STRENGTH DESIGN–GENERAL PRINCIPLES

**General.** Strength design of flexural members is based on the concept that after the yield strength of the reinforcement is reached, the reinforcement continues to elongate until the maximum compressive fiber strain of the concrete section is reached. The design limitations of the ACI Building Code ensure that sections will be underreinforced for flexure, so that yielding of the reinforcement occurs before the concrete crushes. The nominal flexural strength of a section is computed as the resistance when the reinforcement reaches the yield strength.

**Load Factors.** Load factors provide for safety against overloads. The ACI Building Code requires that the actual or specified dead, live, wind, earthquake and other service load effects each be increased by an appropriate load factor to determine the factored loads. The design strength at each section of a member must be equal to, or greater than, the effect of the factored loads. The greatest factored load combination controls the design. The combinations to be reviewed (ACI 9.2.1) are:

$U = 1.4(D + F)$

$U = 1.2(D + F + T) + 1.6(L + H) + 0.5(L_r \text{ or } S \text{ or } R)$

$U = 1.2D + 1.6(L_r \text{ or } S \text{ or } R) + (1.0L \text{ or } 0.8W)$

$U = 1.2D + 1.6W + 1.0L + 0.5(L_r \text{ or } S \text{ or } R)$

$U = 1.2D + 1.0E + 1.0L + 0.2S$

$U = 0.9D + 1.6W + 1.6H$

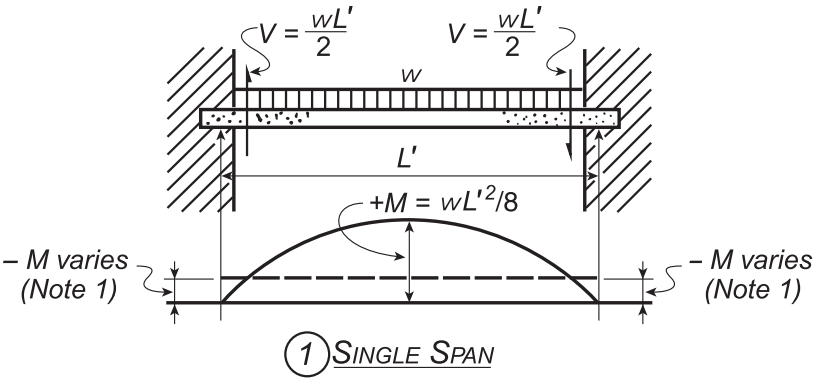
$U = 0.9D + 1.0E + 1.6H$

where:

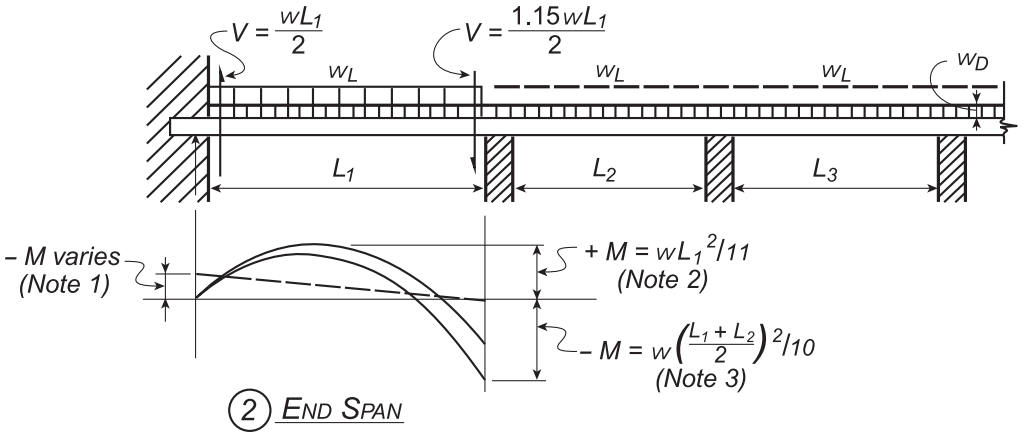
$D$ = **Dead Load**
$E$ = **Earthquake Load**
$F$ = **Fluid Load**
$H$ = **Soil Load**
$L$ = **Live Load**
$L_r$ = **Roof Live Load**
$R$ = **Rain Load**
$S$ = **Snow Load**
$T$ = **Temperature, Creep and Shrinkage Load**
$W$ = **Wind Load**

**Strength-Reduction Factors.** The second portion of the safety factor, called strength-reduction factor or $\phi$-factor, is prescribed to recognize possible sources of understrength, such as variations in quality (strength) of materials, permissible tolerances in dimensions and in location of reinforcement, and approximations in structural analysis. The Code permits the following $\phi$-factors for flexural members: 0.90 for flexure, and 0.75 for shear and torsion. In this *Handbook*, the term **usable** indicates that all relevant $\phi$-factors have been applied in the computation of the tabulated usable factored load capacities. No further consideration of the proper $\phi$-factors is required in these tables.

**Maximum Usable Superimposed Factored Load.** Factored load capacity in the tabulated designs is the least value as determined by shear, development of reinforcement, and flexure. As tabulated in Chapters 7 through 11 of this *Handbook*, factored load capacity is the combination of live loads and any dead load other than the weight of the floor system itself, multiplied by their appropriate load factors, that are *superimposed* on the structural member being designed. Except in Chapter 12 (Beams), 1.2 (the dead load factor) times the weight of the floor has been deducted from the total factored load capacity to obtain the tabulated values of the net *superimposed* factored load capacity. When the required load capacity is computed, only superimposed dead loads, such as ceilings, floor finishes, partitions, and the like times the load

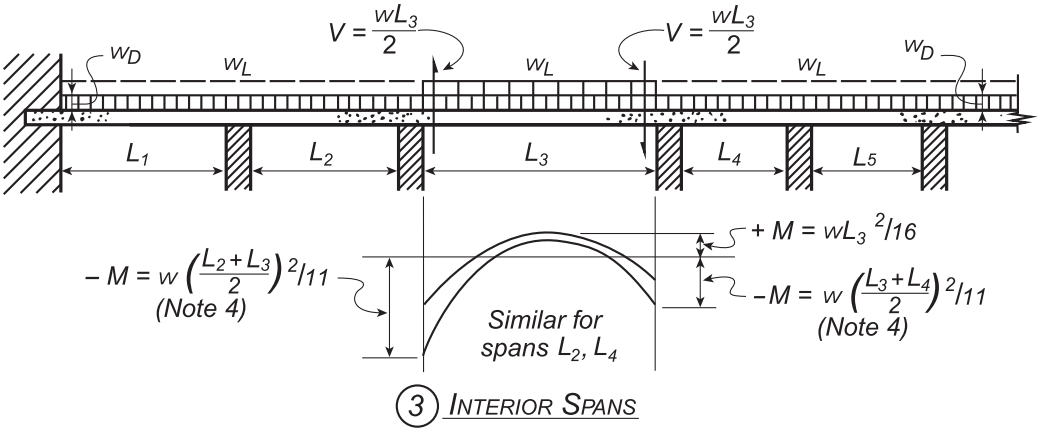



**Note 1.** For a single span, $+M = wL'^2/8$ and no theoretical negative moment is developed. When members are built into masonry walls or made monolithic with concrete walls, beams, or columns, restraint occurs causing some negative moment. In the tabulated designs in this *Handbook*, to prevent top cracking adjacent to the supports, separate hooked top bars are shown in the tops of members at supports. The hooks on these bars can be placed in an inclined position when the depth of the member is insufficient to accommodate them in a vertical position.




**Note 2.** For all end spans, a coefficient for positive moment, $+M = wL_1^2/11$, was used for the condition of no restraint at the discontinuous end. If the discontinuous end is monolithic with the support, the ACI Building Code permits use of the coefficient $+M = wL'^2/14$ and the total tabulated capacities (when positive moment governs) may increase up to 27 percent.

**Note 3.** When only two spans are continuous, the ACI Building Code requires an increase in negative moment to $-M = wL^2/9$ and capacities should be reduced or reinforcement may be increased to maintain tabulated capacity.




**Note 4.** For continuous slabs with spans ≦10'-0", the ACI Building Code permits a negative moment of $-M = wL^2/12$. The tabulated designs are based upon $-M = wL^2/11$ throughout, except in those short span slabs.

**Figure 5-1 Moment and Shear Coefficients for One-Way Members**

factor for dead load, need be included along with other loads times their prescribed load factors. An example problem reviews the use of the tabulated designs.

**Frame Analysis.** The ACI Building Code prescribes an elastic analysis for all indeterminate concrete structures. For buildings of the usual type of construction, spans, and story heights, the Code permits the use of approximate methods of analysis for the determination of elastic moments and shears within certain ranges of variation in span lengths and loads. The tabulated designs for all continuous floor systems in this *Handbook* are based on the approximate methods of analysis (ACI 8.3.3 and 13.6). The limitations on the use of one-way moment coefficients are that two or more spans be continuous, that the longer of adjacent spans not exceed the shorter by more than 20 percent, that loads are uniformly distributed, and that the (unfactored) unit live load does not exceed three times the (unfactored) unit dead load (ACI 8.3.3). For two-way slabs, according to ACI 13.6, the number of continuous spans must be three or more, the length-to-width ratio of panels cannot exceed 2.0, successive span lengths must not differ by more than one-third of the longer span, live load cannot exceed two times the dead load, and the direct design method is applicable to uniformly distributed gravity loads only.

Conservatively, no consideration for redistribution of stress due to inelastic behavior of frames loaded beyond first yielding has been made. The two-way slab factored moments in the tabulated designs in Chapters 9, 10 and 11 can be adjusted up to 10 percent (ACI 13.6.7).

Moments and shears for beams and one-way slab systems have been computed as shown in Fig. 5-1.

**Flexural Computations.** For flexural members, which are reinforced with tension steel only, the design moment strength, from equilibrium of internal moment and forces (Fig. 5-2), is:

$$\phi M_n = \phi A_s f_y (d - a/2) \qquad (1)$$

where:

$$a = \frac{A_s f_y}{0.85 f_c' b} \qquad (2)$$

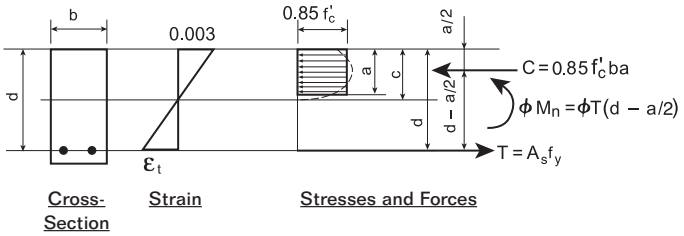



**Figure 5-2 Reinforced Concrete Section with Tension Steel Only**

It is conservative to use these equations if there is no compression reinforcement. Substituting Equation (2) into Equation (1), replacing $\varphi M_n$ with $M_u$, and then solving for the required $A_s$:

$$A_s = \frac{0.85 f_c' b d}{f_y} - \sqrt{\left(\frac{0.85 f_c' b d}{f_y}\right)^2 - \frac{1.7 f_c' M_u b}{\phi f_y^2}} \qquad (3)$$

Equation (3) can be simplified for different concrete compressive strengths. If $b$ = 12 inches (1 ft. width), $f_y$ = 60,000 psi, assuming $\varphi$ = 0.90, and $M_u$ is in units of in.-kips/ft:

| $f_c'$, psi | Equation (3) per ft. width |
|---|---|
| 3,000 psi | $A_s = 0.510\,d - \sqrt{0.260\,d^2 - 0.0189\,M_u}$ |
| 4,000 psi | $A_s = 0.680\,d - \sqrt{0.462\,d^2 - 0.0252\,M_u}$ |
| 5,000 psi | $A_s = 0.850\,d - \sqrt{0.723\,d^2 - 0.0315\,M_u}$ |
| 6,000 psi | $A_s = 1.020\,d - \sqrt{1.040\,d^2 - 0.0378\,M_u}$ |

By introducing the variable $R_n$:

$$R_n = \frac{M_u}{\phi b d^2}$$

it is possible to develop a somewhat simpler expression for the required $A_s$:

$$A_s = \frac{0.85 f_c' b d}{f_y}\left[1 - \sqrt{1 - \frac{2 R_n}{0.85 f_c'}}\right] \qquad (4)$$

Likewise, Equation (4) can be simplified for different concrete compressive strengths. If $b$ = 12 inches (1 ft. width), $f_y$ = 60,000 psi, assuming $\varphi$ = 0.90, and $M_u$ is in units of in.-kips/ft:

| $f_c'$, psi | Equation (4) per ft. width |
|---|---|
| 3,000 | $A_s = (0.510\,d)\left[1 - \sqrt{1 - 0.0726\,M_u/d^2}\right]$ |
| 4,000 | $A_s = (0.680\,d)\left[1 - \sqrt{1 - 0.0545\,M_u/d^2}\right]$ |
| 5,000 | $A_s = (0.850\,d)\left[1 - \sqrt{1 - 0.0436\,M_u/d^2}\right]$ |
| 6,000 | $A_s = (1.020\,d)\left[1 - \sqrt{1 - 0.0363\,M_u/d^2}\right]$ |

The strength-reduction factor, $\varphi$, is equal to 0.90 when the net tensile strain, $\varepsilon_t$, in the extreme tension steel is ≥ 0.005 (ACI 10.3.4). Referring to Fig. 5-2, $\varepsilon_t$ can be expressed as:

$$\varepsilon_t = 0.003\,(d/c - 1) \geq 0.005$$

Solving for $c$ with $\varepsilon_t \geq 0.005$:

$$c \leq 0.003\,d / 0.008$$

From Equation (2) with $c = a/\beta_1$:

$$c = \frac{A_s\ f_y}{0.85\ f_c^{'}\ \beta_1\ b}$$

where:

| $f_c'$, psi | $\beta_1$ |
|---|---|
| ≤ 4,000 | 0.85 |
| 5,000 | 0.80 |
| 6,000 | 0.75 |
| 7,000 | 0.70 |
| ≥ 8,000 | 0.65 |

Equating and solving for $\rho$ where $\rho = A_s/bd$:

$$\rho \leq \left(\frac{0.85\ f_c^{'}\ \beta_1}{f_y}\right)\left(\frac{3}{8}\right) \qquad (5)$$

Note that Equation (5) is an expression for the maximum value of $\rho$ for which $\varepsilon_t$ is not less than 0.005 and, therefore, $\varphi$ = 0.90, i.e., a "tension-controlled" section.

The variable $\rho$ in Equation (5) can be solved for different concrete strengths. If $f_y$ = 60,000 psi:

| $f_c'$, psi | Equation (5) |
|---|---|
| 3,000 | $\rho \leq 0.0135$ |
| 4,000 | $\rho \leq 0.0181$ |
| 5,000 | $\rho \leq 0.0213$ |
| 6,000 | $\rho \leq 0.0239$ |

In summary, for flexural members which are reinforced with tension steel only, the required $A_s$ can be determined by two methods:

Method 1:

$$A_s = \frac{0.85\ f_c^{'}\ b\ d}{f_y} - \sqrt{\left(\frac{0.85\ f_c^{'}\ b\ d}{f_y}\right)^2 - \frac{1.7 f_c^{'}\ M_u\ b}{\phi\ f_y^{\ 2}}}$$

Method 2:

$$A_s = \left(\frac{0.85\ f_c^{'}\ b\ d}{f_y}\right)\left[1 - \sqrt{1 - \frac{2\ R_n}{0.85\ f_c^{'}}}\right]$$

where:

$$R_n = \frac{M_u}{\phi\ b\ d^2}$$

Use Equation (5) as a check for $\varepsilon_t \geq 0.005$ (to confirm $\varphi$ = 0.90).

**Example:** $f_c'$ = 4,000 psi; $f_y$ = 60,000 psi; $b$ = 24 in.; $d$ = 12.5 in.; $M_u$ = 250 ft-k; $\varphi$ = 0.90 (assumed)

Method 1:

$$\frac{0.85\ f_c^{'}\ b\ d}{f_y} = \frac{0.85\ (4{,}000)\ 24\ (12.5)}{60{,}000} = 17.00\ \text{in}^2.$$

$$\frac{1.7 f_c^{'}\ M_u\ b}{\phi\ f_y^2} = \frac{1.7\ (4{,}000)\ 250\ (12{,}000)\ 24}{0.9\ (60{,}000)^2} = 151.1\ \text{in}^4.$$

$$\text{Required } A_s = 17.00 - \sqrt{(17.00)^2 - 151.1} = 5.26\ \text{in}^2.$$

Method 2:

$$R_n = \frac{M_u}{\phi\ b\ d^2} = \frac{250\ (12{,}000)}{0.9\ (24)\ 12.5^2} = 889\ \text{psi}$$

$$\frac{2\ R_n}{0.85\ f_c^{'}} = \frac{2\ (889)}{0.85\ (4{,}000)} = 0.523$$

$$\frac{0.85\ f_c^{'}\ b\ d}{f_y} = \frac{0.85\ (4{,}000)\ 24\ (12.5)}{60{,}000} = 17.00\ \text{in.}^2$$

$$\text{Required } A_s = 17.00\,[\,1 - \sqrt{1 - 0.523}\,] = 5.26\ \text{in.}^2$$

From Equation (5):

$$\rho \leq \frac{0.85\ f_c^{'}\ \beta_1}{f_y}\left(\frac{3}{8}\right) = \frac{0.85\ (4{,}000)\ 0.85}{60{,}000}\left(\frac{3}{8}\right) = 0.0181$$

$$\rho_{act} = A_s\ /(b\ d) = 5.26/(24\ x\ 12.5) = 0.0175$$

0.0175 < 0.0181

OK ($\rho_{act} \leq \rho_{max}$, $\varepsilon_t \geq 0.005$ and $\varphi$ = 0.90)

**Comparison to Earlier Codes**

Alternatively, the maximum $\rho$, based on a minimum value of $\varepsilon_t$ of 0.005, can be compared to the previous Code limit of 0.75 $\rho_b$. The expression for $\rho_b$ is:

$$\rho_b = \frac{0.85\ \beta_1\ f_c^{'}}{f_y}\,\frac{87{,}000}{87{,}000 + f_y} \qquad (6)$$

Calculating the ratio of maximum $\rho$ from Equation (5) divided by Equation (6):

$$\frac{\rho_{max}}{\rho_b} = \left(\frac{3}{8}\right)\left(\frac{87{,}000 + f_y}{87{,}000}\right)$$

For $f_y$ of 60,000 psi, this ratio equals 0.634. Therefore, with the $\varepsilon_t$ limit of 0.005, the maximum $\rho$ in the current Code when $f_y$ = 60,000 psi is 63 percent of $\rho_b$, compared to the previous limit of 75 percent of $\rho_b$.

**Other Simplifications**

From Equation (1), if $M_u$ is substituted for $\varphi M_n$ and re-arranging the terms, the required area of steel is:

$$A_s = \frac{M_u}{(\phi\, f_y\, j)\, d} \qquad (7)$$

where:

$$j = 1 - a/2\,d \qquad (8)$$

Substituting Equation (2) into Equation (8):

$$j = 1 - \frac{f_y\, \rho}{0.85\,(2)\, f_c'} \qquad (9)$$

If the reinforcement ratio is assumed to be the maximum value from Equation (5), then substituting into Equation (9):

$$j \geq 1 - \frac{3\,\beta_1}{16}$$

The variable $j$ can be tabulated for different values of concrete compressive strength:

| $f_c'$, psi | $j$ |
|---|---|
| 3,000 | 0.841 |
| 4,000 | 0.841 |
| 5,000 | 0.850 |
| 6,000 | 0.859 |

This minimum value for $j$ can be used to approximate the required $A_s$. For the example:

$$j \geq 1 - \frac{3\,\beta_1}{16} = 1 - \frac{3\,(0.85)}{16} = 0.841$$

The required area of steel is:

$$A_s \approx \frac{M_u}{\phi\, f_y\, j\, d} = \frac{M_u}{0.90\,(60{,}000)\,0.841\,(d)} = \frac{M_u}{45{,}400\,d}$$

$$A_s \approx \frac{250\,(12{,}000)}{45{,}400\,(12.5)} = 5.28 \text{ in.}^2$$ which is equivalent to the required $A_s$ of 5.26 in$^2$.

This approximate Equation (7) for determining the required $A_s$ can be derived for other concrete compressive strengths:

| $f_c'$, psi | Equation (7) |
|---|---|
| 3,000 | $A_s \approx \frac{M_u}{45{,}400\,d}$ |
| 4,000 | $A_s \approx \frac{M_u}{45{,}400\,d}$ |
| 5,000 | $A_s \approx \frac{M_u}{45{,}900\,d}$ |
| 6,000 | $A_s \approx \frac{M_u}{46{,}400\,d}$ |

For manually determining the required $A_s$, Equation (7) can be simplified further by assuming $\varphi$ = 0.90, $j \approx 0.90$, $f_y$ = 60 ksi, and with $M_u$ in units of ft-kips, the required area of steel is:

$$A_s \approx \frac{M_u}{\phi\, f_y\, j\, d} \approx \frac{M_u\,(12)}{0.90\,(60)\;0.9(d)} \approx \frac{M_u}{4d}$$

After calculating the approximate required $A_s$ and selecting the reinforcement, the actual design moment strength, $\phi M_n$, should be calculated for the selected reinforcement and compared to $M_u$; and the steel reinforcement ratio, $\rho$, for the required selected reinforcement should be compared with 0.63 $\rho_b$ (when $f_y$ = 60,000 psi) to confirm that $\varphi$ = 0.90 (a tension-controlled section).

For the example:

$$A_s \approx \frac{M_u}{4d} \approx \frac{250(12)}{4(12.5)} \approx 5.00 \text{ in.}^2$$

Instead of selecting the reinforcement in this example, calculate $\phi M_n$ for $A_s$ = 5.00 in.$^2$:

$$a = \frac{A_s\, f_y}{0.85\, f_c'\, b} = \frac{5.00(60)}{0.85(4)(24)} = 3.68 \text{ in.}$$

$$\phi M_n = \phi A_s f_y (d - a/2)$$
$$= 0.90(5.00)(60)(12.5 - \frac{3.68}{2})/12$$

$\phi M_n$ = 239.9 ft-kips < $M_u$; need larger amount of $A_s$

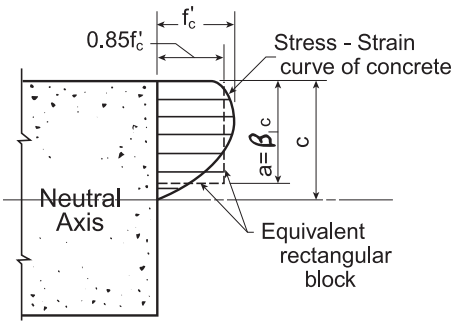
Need 4 to 5 percent additional design moment strength because of simplifying assumption of $j = 0.9$; hence try approximately 4 to 5 percent more $A_s$. If the required $A_s$ is 1.05(5.00) = 5.25 in.$^2$, then:

$$a = \frac{5.25(60)}{0.85(4)(24)} = 3.86 \text{ in.}$$

$$\phi M_n = 0.90(5.25)(60)(12.5 - \frac{3.68}{2})/12$$
$$= 249.7 \text{ ft-kips} \approx M_u$$

confirm that $\varphi = 0.90$:

$$\rho = \frac{A_s}{b\,d} = \frac{5.25}{(24)(12.5)} = 0.0175 < 0.63\rho_b;\ \varphi = 0.90$$




For doubly-reinforced sections, additional tensile reinforcement balanced by force in compression reinforcement need not be reduced by the 0.75 factor (ACI 10.3.3).

**Figure 5-3 Rectangular Stress Block for Strength Design**

**Rectangular Beam with Compression Reinforcement.** When effects of the compression reinforcement are neglected in flexural computations, the same formulas and limit on tension reinforcement percentage apply. For designs tabulated in this *Handbook*, compression reinforcement has been neglected, but should be considered when it is necessary to compute creep deflection.

**T-Beams.** When the flange thickness $h$ equals or exceeds the depth of the equivalent rectangular stress block $a$, the section may be designed as rectangular beam with an effective flange width (ACI 8.12).

When the flange thickness is less than $a$:

$$\phi M_n = \phi[(A_s - A_{sf})f_y(d - a/2) + A_{sf}f_y(d - 0.5h)]$$

where $A_{sf}$ = the steel area necessary to develop the compressive strength of the overhanging flanges, i.e.:

$$A_{sf} = 0.85(b - b')hf'_c/f_y$$

and $a = (A_s - A_{sf})f_y/0.85f'_c\,b'$

# DEVELOPMENT AND LAP SPLICE DESIGN DATA FOR REINFORCING BARS

## COMPRESSION DEVELOPMENT LENGTHS AND COMPRESSION LAP SPLICES

**TABLE 5-1 – Compression Dowel Embedment and Compression Lap Splices for Grade 60 Bars and All Concrete with $f'_c \geq 3{,}000$ psi**

| Bar Size | Dowel Embedment $22d_b$ | Minimum Lap Length | |
|---|---|---|---|
| | | Standard Lap $30d_b$ | With Column* Spirals $22.5d_b$ |
| #3 | 9″ | 12″ | 12″ |
| #4 | 11″ | 15″ | 12″ |
| #5 | 14″ | 19″ | 14″ |
| #6 | 17″ | 23″ | 17″ |
| #7 | 19″ | 27″ | 20″ |
| #8 | 22″ | 30″ | 23″ |
| #9 | 25″ | 34″ | 25″ |
| #10 | 28″ | 38″ | 29″ |
| #11 | 31″ | 43″ | 32″ |
| #14 | 38″ | – | – |
| #18 | 50″ | – | – |

*For use in spirally-reinforced columns with spirals conforming to ACI 7.10.4 and 10.9.3. Regarding anchorage and lap splicing of spirals, the ACI Building Code requirements are:

7.10.4.4 – Anchorage of spiral reinforcement shall be provided by 1-1/2 extra turns of spiral bar or wire at each end of a spiral unit.

7.10.4.5 – Spiral reinforcement shall be spliced, if needed, by any one of the following methods:

(a) Lap splices not less than the larger of 12 in. and the length indicated in one of (1) through (5) below:

(1) deformed uncoated bar or wire . . . . . .48 $d_b$

(2) plain uncoated bar or wire . . . . . .72 $d_b$

(3) epoxy-coated deformed bar or wire . . . . . .72 $d_b$

(4) plain uncoated bar or wire with a standard stirrup or tie hook in accordance with ACI 7.1.3 at ends of lapped spiral reinforcement.The hooks shall be embedded within the core confined by the spiral reinforcement . . . . . .48 $d_b$

(5) epoxy-coated deformed bar or wire with a standard stirrup or tie hook in accordance with ACI 7.1.3 at ends of lapped spiral reinforcement. The hooks shall be embedded within the core confined by the spiral reinforcement . . . . . .48 $d_b$

(b) Full mechanical or welded splices in accordance with 12.14.3.

## DOWEL EMBEDMENT

Minimum compression dowel embedment required by ACI 12.3.2 for Grade 60 ($f_y$ = 60,000 psi) reinforcing bars and all concrete with $f'_c \geq$ 3,000 psi = 22 bar diameters ($22d_b$). See Table 5-1.

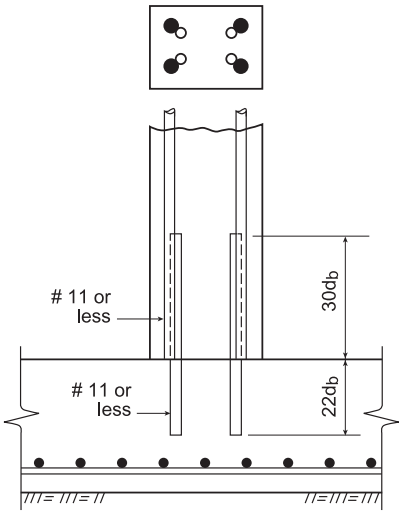



**Figure 5-4 Footing Dowels to Column Vertical Bars—Lap Splices for Compression Only (#11 Bars or Smaller)**

## COMPRESSION LAP SPLICES

Based on the provisions in ACI 12.16.1, for Grade 60 bars, bar sizes #3 through #11, and all concrete with $f'_c \geq$ 3,000 psi, lap lengths = 30 bar diameters ($30d_b$). See Table 5-1. Lap splices are not permitted for #14 and #18 bars, except if spliced to #11 and smaller bars (ACI 12.16.2 and 15.8.2.3). Use the $30d_b$ dimension with the smaller bar.

## TENSION DEVELOPMENT LENGTHS AND TENSION LAP SPLICE LENGTHS

ACI 12.2.2 and 12.2.3 present the provisions for determining tension development length $\ell_d$. ACI 12.2.1 requires that $\ell_d$ be not less than 12 inches.

### Section 12.2.2 Provisions for Tension $\ell_d$

For the following conditions:

- bars with clear spacing not less than $d_b$, with concrete cover not less than $d_b$, and for bars in beams or columns with stirrups or ties throughout $\ell_d$ not less than the minimum required by the Code;
- bars with clear spacing not less than 2 $d_b$ and with concrete cover not less than $d_b$,

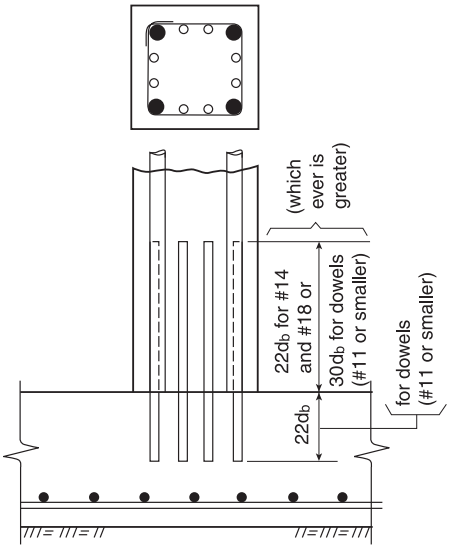



**Figure 5-5 Footing Dowels (#11 Bars or Smaller) to Column Vertical Bars (#14 or #18)—Lap Splices for Compression Only**

the tension development lengths are:

Bar sizes #3 through #6 $\ell_d = (0.04 f_y \ \psi_t \ \psi_e / \lambda\sqrt{f'_c}) \ d_b$

Bar sizes #7 through #18 $\ell_d = (0.05 f_y \ \psi_t \ \psi_e / \lambda\sqrt{f'_c}) \ d_b$

For other cases:

Bar sizes #3 through #6 $\ell_d = (0.06 f_y \ \psi_t \ \psi_e / \lambda\sqrt{f'_c}) \ d_b$

Bar sizes #7 through #18 $\ell_d = (0.075 f_y \ \psi_t \ \psi_e / \lambda\sqrt{f'_c}) \ d_b$

Where:

$\psi_t$ = 1.3 for "top" bars

$\psi_t$ = 1.0 for "other" bars

$\psi_e$ = 1.0 for uncoated bars and zinc-coated (galvanized) bars

$\psi_e$ = 1.5 for epoxy-coated bars with concrete cover < $3d_b$, or clear spacing < $6d_b$

$\psi_e$ = 1.2 for other concrete cover and clear spacing conditions of epoxy-coated bars

The product of $\psi_t \ \psi_e$ need not be taken greater than 1.7.

$\lambda$ = 0.75 for lightweight aggregate concrete

$\lambda$ = 1.0 for normal-weight concrete

Tables 5-2(a) through 5-2(h) and Tables 5-4(a) through 5-4(b) present values of tension $\ell_d$ based on ACI 12.2.2. All tabulated data are for Grade 60 ($f_y$ = 60,000 psi) reinforcing bars, uncoated and epoxy-coated, in normal-weight concrete having a compressive strength, $f'_c$ , ranging from 3,000 to 10,000 psi. Tables 5-4(a) and (b) list $\ell_d$ in terms of multiples of $d_b$.

## Tension Lap Splices

Tension lap splices (minimum of 12 inches) are specified as Class A or Class B (ACI 12.15.1). The classes are multiples of tension development lengths: Class A = $1.0\ell_d$ and Class B = $1.3\ell_d$ without the 12 inch minimum of ACI 12.2.1. Tables 5-2(a) through 5-2(h) and Tables 5-4(a) through 5-4(b) present values of Class A and Class B tension lap splice lengths based on ACI 12.2.2 and 12.15.1. All tabulated data are for Grade 60 ($f_y$ = 60,000 psi) reinforcing bars, uncoated and epoxy-coated, in normal-weight concrete having a compressive strength, $f'_c$, ranging from 3,000 to 10,000 psi.

The lap Class depends on the ratio of area of reinforcing steel provided to that required and the percentage of reinforcement spliced at any one location, as shown in the following table:

| $\frac{A_{s\ provided}}{A_{s\ required}}$ | Maximum Percent of $A_s$ Spliced within Required Lap Length | |
|---|---|---|
| | 50% | 100% |
| ≥ 2 | Class A | Class B |
| ≤ 2 | Class B | Class B |

## Section 12.2.3 Provisions for Tension $\ell_d$

The provisions in Section 12.2.3 are applicable to all conditions of clear spacing, concrete cover and transverse reinforcement. Tension development length is calculated by ACI Code Eq. 12-1:

$$\ell_d = \left( \frac{3}{40} \frac{f_y}{\lambda \sqrt{f'_c}} \frac{\psi_t \psi_e \psi_s}{\left( \frac{c_b + K_{tr}}{d_b} \right)} \right) d_b$$

where:

$c_b$ = spacing or concrete cover dimension; use the smaller of either the distance from the center of the bar to the nearest concrete surface or one-half the center-to-center spacing of the bars being developed

$\psi_s$ = 0.8 for bar sizes #3 through #6

$\psi_s$ = 1.0 for bar sizes #7 through #18

The quantity $(c_b + K_{tr})/d_b$ is limited to a maximum value of 2.5. The $K_{tr}$ term accounts for the beneficial effect of transverse reinforcement.

$K_{tr} = 40A_{tr}/sn$

$A_{tr}$ = total area of all transverse reinforcement within the spacing $s$, which crosses the potential plane of splitting through the bars being developed

$s$ = maximum $c$.-$c$. spacing of transverse reinforcement within $\ell_d$

$n$ = number of bars being developed along the plane of splitting

The notation $\psi_t$, $\psi_e$ and $\lambda$ are defined in the preceding discussion of Section 12.2.2.

For simplification, $K_{tr}$ can be taken as zero even if transverse reinforcement is present.

The provisions in ACI 12.2.3 normally do not lend themselves to extensive tabulation of tension development lengths and tension lap splices. Only limited cases and conditions can be tabulated. Tables 5-3(a) through 5-3(h) are examples of such limited tabulation. The tables give values of tension $\ell_d$ and tension lap splice lengths, based on Code Section 12.2.3, for walls and slabs. The values for "Lap Class A" are also the values of $\ell_d$, because the required lap length for a Class A tension lap splice is 1.0 $\ell_d$.

An important restriction on the use of Tables 5-3(a) through 5-3(h) is described in Note 3, i.e., it is assumed that the notation $c_b$ in the quantity, $(c_b + K_{tr})/d_b$, in ACI Code Eq. 12-1 is governed by concrete cover rather than by one-half the center-to-center spacing of the bars.

## Standard End Hooks

Tables 5-5(a) and 5-5(b) give the minimum tension development (embedment) lengths $\ell_{dh}$ for standard end hooks on Grade 60 ($f_y$ = 60,000 psi) uncoated and epoxy-coated reinforcing bars in normal-weight concrete.

For 180º hooks at right angles to exposed concrete surfaces, CRSI recommends that a minimum 2 inches of concrete cover be provided to the tail of the hook (ACI 7.7). The minimum tension embedment lengths which will provide the recommended 2 inches of concrete cover to the tail of the hook are given in Table 5-7.

## Headed Reinforcing Bars

ACI 318-08 contains new provisions for the development of headed and mechanically anchored deformed bars in tension. Tables 5-6(a) and 5-6(b) give the minimum development (embedment) lengths $\ell_{dt}$ for headed reinforcing bars of Grade 60 ($f_y$ = 60,000 psi) uncoated and epoxy-coated bars in normal-weight concrete (ACI 12.6). Use of headed reinforcing bars is limited to the following conditions:

- $f_y \leq$ 60,000 psi
- Bar Size ≤ #11
- Normal-weight concrete
- Net bearing area, $A_{brg}$, ≥ 4 $A_b$ where $A_b$ is the area of the headed bar. Net bearing area is equal to the total area of the head, minus the area of the bar, $A_b$.
- Clear concrete cover for bars ≥ 2 $d_b$, and
- Clear spacing between bars ≥ 4 $d_b$

## Code Provisions Used in Tabulated Designs

The provisions in ACI 12.2.2 and 12.2.3 are used in the computer programs for producing the tabulated designs in the *Handbook*. Whenever the required tension development length is checked versus the available embedment length and other criteria of Code Chapter 12, the programs select the shorter $\ell_d$ calculated from ACI 12.2.2 or 12.2.3.

Table 5-2(a) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
$f'_c$ = 3,000 psi

| BAR SIZE | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP BARS | | OTHER BARS | | TOP BARS | | OTHER BARS | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 | A | 22 | 32 | 17 | 25 | 28 | 42 | 25 | 37 |
| | B | 28 | 42 | 22 | 32 | 37 | 55 | 32 | 48 |
| #4 | A | 29 | 43 | 22 | 33 | 38 | 56 | 33 | 50 |
| | B | 37 | 56 | 29 | 43 | 49 | 73 | 43 | 64 |
| #5 | A | 36 | 54 | 28 | 41 | 47 | 70 | 41 | 62 |
| | B | 47 | 70 | 36 | 54 | 61 | 91 | 54 | 80 |
| #6 | A | 43 | 64 | 33 | 50 | 56 | 84 | 50 | 74 |
| | B | 56 | 84 | 43 | 64 | 73 | 109 | 64 | 96 |
| #7 | A | 63 | 94 | 48 | 72 | 82 | 123 | 72 | 108 |
| | B | 81 | 122 | 63 | 94 | 106 | 159 | 94 | 140 |
| #8 | A | 72 | 107 | 55 | 82 | 93 | 140 | 82 | 124 |
| | B | 93 | 139 | 72 | 107 | 121 | 182 | 107 | 161 |
| #9 | A | 81 | 121 | 62 | 93 | 105 | 158 | 93 | 139 |
| | B | 105 | 157 | 81 | 121 | 137 | 205 | 121 | 181 |
| #10 | A | 91 | 136 | 70 | 105 | 119 | 178 | 105 | 157 |
| | B | 118 | 177 | 91 | 136 | 154 | 231 | 136 | 204 |
| #11 | A | 101 | 151 | 78 | 116 | 132 | 197 | 116 | 174 |
| | B | 131 | 196 | 101 | 151 | 171 | 256 | 151 | 226 |
| #14 | N/A | 121 | 181 | 93 | 139 | 158 | 237 | 139 | 209 |
| #18 | N/A | 161 | 241 | 124 | 186 | 210 | 316 | 186 | 278 |

**Notes:**

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths and tension lap splice lengths are calculated per ACI 318-08, Sections 12.2.2 and 12.15, respectively.
3. Tabulated values for beams or columns are based on transverse reinforcement and concrete cover meeting minimum Code requirements.
4. Cases 1 and 2, which depend on the type of structural member, concrete cover, and center-to-center spacing of the bars, are defined as:

| | | |
|---|---|---|
| **Beams, Columns** | Case 1 | Concrete cover at least 1.0 $d_b$ **and** c.-c. spacing at least 2.0 $d_b$ |
| | Case 2 | Concrete cover less than 1.0 $d_b$ **or** c.-c. spacing less than 2.0 $d_b$ |
| **All Others** | Case 1 | Concrete cover at least 1.0 $d_b$ **and** c.-c. spacing at least 3.0 $d_b$ |
| | Case 2 | Concrete cover less than 1.0 $d_b$ **or** c.-c. spacing less than 3.0 $d_b$ |

5. Lap splice lengths (minimum of 12 inches) are multiples of tension development lengths; Class A = 1.0 $\ell_d$ and Class B = 1.3 $\ell_d$ (ACI 12.15.1). When determining the lap splice length, $\ell_d$ is calculated without the 12-inch minimum of ACI 12.2.1.
6. ACI 318 does not allow tension lap splices of #14 or #18 [#43 or #57] bars. The tabulated values for those bar sizes are the tension development lengths.
7. Top bars are horizontal bars with more than 12 inches of concrete cast below the bars.
8. For epoxy-coated bars, if the c.-c. spacing is at least 7.0 $d_b$ and the concrete cover is at least 3.0 $d_b$, then Case 1 lengths may be multiplied by 0.918 (for top bars) or 0.8 (for other bars).
9. For Grade 75 (minimum yield strength of 75,000 psi) reinforcing bars, lengths must be multiplied by 1.25.
10. For lightweight aggregate concrete, multiply the tabulated values by 1.33.

Table 5-2(b) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
$f'_c$ = 4,000 psi

| BAR SIZE | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP BARS | | OTHER BARS | | TOP BARS | | OTHER BARS | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 | A | 19 | 28 | 15 | 22 | 24 | 37 | 22 | 32 |
| | B | 24 | 36 | 19 | 28 | 32 | 47 | 28 | 42 |
| #4 | A | 25 | 37 | 19 | 29 | 33 | 49 | 29 | 43 |
| | B | 32 | 48 | 25 | 37 | 42 | 63 | 37 | 56 |
| #5 | A | 31 | 47 | 24 | 36 | 41 | 61 | 36 | 54 |
| | B | 40 | 60 | 31 | 47 | 53 | 79 | 47 | 70 |
| #6 | A | 37 | 56 | 29 | 43 | 49 | 73 | 43 | 64 |
| | B | 48 | 72 | 37 | 56 | 63 | 95 | 56 | 84 |
| #7 | A | 54 | 81 | 42 | 63 | 71 | 106 | 63 | 94 |
| | B | 70 | 106 | 54 | 81 | 92 | 138 | 81 | 122 |
| #8 | A | 62 | 93 | 48 | 71 | 81 | 121 | 71 | 107 |
| | B | 80 | 121 | 62 | 93 | 105 | 158 | 93 | 139 |
| #9 | A | 70 | 105 | 54 | 81 | 91 | 137 | 81 | 121 |
| | B | 91 | 136 | 70 | 105 | 119 | 178 | 105 | 157 |
| #10 | A | 79 | 118 | 61 | 91 | 103 | 154 | 91 | 136 |
| | B | 102 | 153 | 79 | 118 | 133 | 200 | 118 | 177 |
| #11 | A | 87 | 131 | 67 | 101 | 114 | 171 | 101 | 151 |
| | B | 113 | 170 | 87 | 131 | 148 | 222 | 131 | 196 |
| #14 | N/A | 105 | 157 | 81 | 121 | 137 | 205 | 121 | 181 |
| #18 | N/A | 139 | 209 | 107 | 161 | 182 | 273 | 161 | 241 |

***Reference Table 5-2(a) Notes.***

Table 5-2(c) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
$f'_c$ = 5,000 psi

| BAR SIZE | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP BARS | | OTHER BARS | | TOP BARS | | OTHER BARS | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 | A | 17 | 25 | 13 | 19 | 22 | 33 | 19 | 29 |
| | B | 22 | 33 | 17 | 25 | 28 | 42 | 25 | 38 |
| #4 | A | 22 | 33 | 17 | 26 | 29 | 44 | 26 | 38 |
| | B | 29 | 43 | 22 | 33 | 38 | 57 | 33 | 50 |
| #5 | A | 28 | 42 | 22 | 32 | 36 | 54 | 32 | 48 |
| | B | 36 | 54 | 28 | 42 | 47 | 71 | 42 | 62 |
| #6 | A | 33 | 50 | 26 | 38 | 44 | 65 | 38 | 58 |
| | B | 43 | 65 | 33 | 50 | 57 | 85 | 50 | 75 |
| #7 | A | 49 | 73 | 37 | 56 | 63 | 95 | 56 | 84 |
| | B | 63 | 94 | 49 | 73 | 82 | 123 | 73 | 109 |
| #8 | A | 55 | 83 | 43 | 64 | 72 | 108 | 64 | 96 |
| | B | 72 | 108 | 55 | 83 | 94 | 141 | 83 | 124 |
| #9 | A | 63 | 94 | 48 | 72 | 82 | 122 | 72 | 108 |
| | B | 81 | 122 | 63 | 94 | 106 | 159 | 94 | 140 |
| #10 | A | 70 | 105 | 54 | 81 | 92 | 138 | 81 | 122 |
| | B | 91 | 137 | 70 | 105 | 119 | 179 | 105 | 158 |
| #11 | A | 78 | 117 | 60 | 90 | 102 | 153 | 90 | 135 |
| | B | 101 | 152 | 78 | 117 | 133 | 199 | 117 | 175 |
| #14 | N/A | 94 | 140 | 72 | 108 | 122 | 183 | 108 | 162 |
| #18 | N/A | 125 | 187 | 96 | 144 | 163 | 244 | 144 | 216 |

***Reference Table 5-2(a) Notes.***

Table 5-2(d) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
$f'_c$ = 6,000 psi

| BAR SIZE | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP BARS | | OTHER BARS | | TOP BARS | | OTHER BARS | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 | A | 15 | 23 | 12 | 18 | 20 | 30 | 18 | 26 |
| | B | 20 | 30 | 15 | 23 | 26 | 39 | 23 | 34 |
| #4 | A | 20 | 31 | 16 | 24 | 27 | 40 | 24 | 35 |
| | B | 26 | 40 | 20 | 31 | 35 | 52 | 31 | 46 |
| #5 | A | 25 | 38 | 20 | 29 | 33 | 50 | 29 | 44 |
| | B | 33 | 49 | 25 | 38 | 43 | 64 | 38 | 57 |
| #6 | A | 31 | 46 | 24 | 35 | 40 | 60 | 35 | 53 |
| | B | 40 | 59 | 31 | 46 | 52 | 77 | 46 | 68 |
| #7 | A | 44 | 66 | 34 | 51 | 58 | 87 | 51 | 77 |
| | B | 58 | 86 | 44 | 66 | 75 | 113 | 66 | 99 |
| #8 | A | 51 | 76 | 39 | 58 | 66 | 99 | 58 | 87 |
| | B | 66 | 98 | 51 | 76 | 86 | 129 | 76 | 114 |
| #9 | A | 57 | 85 | 44 | 66 | 75 | 112 | 66 | 99 |
| | B | 74 | 111 | 57 | 85 | 97 | 145 | 85 | 128 |
| #10 | A | 64 | 96 | 49 | 74 | 84 | 126 | 74 | 111 |
| | B | 83 | 125 | 64 | 96 | 109 | 163 | 96 | 144 |
| #11 | A | 71 | 107 | 55 | 82 | 93 | 140 | 82 | 123 |
| | B | 93 | 139 | 71 | 107 | 121 | 181 | 107 | 160 |
| #14 | N/A | 86 | 128 | 66 | 99 | 112 | 168 | 99 | 148 |
| #18 | N/A | 114 | 171 | 88 | 131 | 149 | 223 | 131 | 197 |

***Reference Table 5-2(a) Notes.***

Table 5-2(e) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
$f'_c$ = 7,000 psi

| BAR SIZE | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP BARS | | OTHER BARS | | TOP BARS | | OTHER BARS | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 | A | 14 | 21 | 12 | 16 | 19 | 28 | 16 | 25 |
| | B | 18 | 28 | 14 | 21 | 24 | 36 | 21 | 32 |
| #4 | A | 19 | 28 | 15 | 22 | 25 | 37 | 22 | 33 |
| | B | 25 | 37 | 19 | 28 | 32 | 48 | 28 | 42 |
| #5 | A | 24 | 35 | 18 | 27 | 31 | 46 | 27 | 41 |
| | B | 31 | 46 | 24 | 35 | 40 | 60 | 35 | 53 |
| #6 | A | 28 | 42 | 22 | 33 | 37 | 55 | 33 | 49 |
| | B | 37 | 55 | 28 | 42 | 48 | 72 | 42 | 63 |
| #7 | A | 41 | 61 | 32 | 47 | 54 | 80 | 47 | 71 |
| | B | 53 | 80 | 41 | 61 | 70 | 104 | 61 | 92 |
| #8 | A | 47 | 70 | 36 | 54 | 61 | 92 | 54 | 81 |
| | B | 61 | 91 | 47 | 70 | 80 | 119 | 70 | 105 |
| #9 | A | 53 | 79 | 41 | 61 | 69 | 103 | 61 | 91 |
| | B | 69 | 103 | 53 | 79 | 90 | 134 | 79 | 119 |
| #10 | A | 59 | 89 | 46 | 69 | 78 | 116 | 69 | 103 |
| | B | 77 | 116 | 59 | 89 | 101 | 151 | 89 | 133 |
| #11 | A | 66 | 99 | 51 | 76 | 86 | 129 | 76 | 114 |
| | B | 86 | 128 | 66 | 99 | 112 | 168 | 99 | 148 |
| #14 | N/A | 79 | 119 | 61 | 91 | 103 | 155 | 91 | 137 |
| #18 | N/A | 106 | 158 | 81 | 122 | 138 | 207 | 122 | 182 |

***Reference Table 5-2(a) Notes.***

Table 5-2(f) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
$f'_c$ = 8,000 psi

| BAR SIZE | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP BARS | | OTHER BARS | | TOP BARS | | OTHER BARS | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 | A | 13 | 20 | 12 | 15 | 17 | 26 | 15 | 23 |
| | B | 17 | 26 | 13 | 20 | 23 | 34 | 20 | 30 |
| #4 | A | 18 | 26 | 14 | 20 | 23 | 35 | 20 | 30 |
| | B | 23 | 34 | 18 | 26 | 30 | 45 | 26 | 40 |
| #5 | A | 22 | 33 | 17 | 25 | 29 | 43 | 25 | 38 |
| | B | 29 | 43 | 22 | 33 | 37 | 56 | 33 | 49 |
| #6 | A | 26 | 40 | 20 | 30 | 35 | 52 | 30 | 46 |
| | B | 34 | 51 | 26 | 40 | 45 | 67 | 40 | 59 |
| #7 | A | 38 | 58 | 30 | 44 | 50 | 75 | 44 | 66 |
| | B | 50 | 75 | 38 | 58 | 65 | 98 | 58 | 86 |
| #8 | A | 44 | 66 | 34 | 51 | 57 | 86 | 51 | 76 |
| | B | 57 | 85 | 44 | 66 | 74 | 111 | 66 | 98 |
| #9 | A | 49 | 74 | 38 | 57 | 65 | 97 | 57 | 85 |
| | B | 64 | 96 | 49 | 74 | 84 | 126 | 74 | 111 |
| #10 | A | 56 | 83 | 43 | 64 | 73 | 109 | 64 | 96 |
| | B | 72 | 108 | 56 | 83 | 94 | 142 | 83 | 125 |
| #11 | A | 62 | 93 | 48 | 71 | 81 | 121 | 71 | 107 |
| | B | 80 | 120 | 62 | 93 | 105 | 157 | 93 | 139 |
| #14 | N/A | 74 | 111 | 57 | 85 | 97 | 145 | 85 | 128 |
| #18 | N/A | 99 | 148 | 76 | 114 | 129 | 193 | 114 | 171 |

***Reference Table 5-2(a) Notes.***

Table 5-2(g) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
$f'_c$ = 9,000 psi

| BAR SIZE | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP BARS | | OTHER BARS | | TOP BARS | | OTHER BARS | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 | A | 13 | 19 | 12 | 15 | 16 | 24 | 15 | 22 |
| | B | 16 | 24 | 13 | 19 | 21 | 32 | 19 | 28 |
| #4 | A | 17 | 25 | 13 | 19 | 22 | 33 | 19 | 29 |
| | B | 22 | 32 | 17 | 25 | 28 | 42 | 25 | 37 |
| #5 | A | 21 | 31 | 16 | 24 | 27 | 41 | 24 | 36 |
| | B | 27 | 40 | 21 | 31 | 35 | 53 | 31 | 47 |
| #6 | A | 25 | 37 | 19 | 29 | 33 | 49 | 29 | 43 |
| | B | 32 | 48 | 25 | 37 | 42 | 63 | 37 | 56 |
| #7 | A | 36 | 54 | 28 | 42 | 47 | 71 | 42 | 63 |
| | B | 47 | 70 | 36 | 54 | 61 | 92 | 54 | 81 |
| #8 | A | 41 | 62 | 32 | 48 | 54 | 81 | 48 | 71 |
| | B | 54 | 80 | 41 | 62 | 70 | 105 | 62 | 93 |
| #9 | A | 47 | 70 | 36 | 54 | 61 | 91 | 54 | 81 |
| | B | 61 | 91 | 47 | 70 | 79 | 119 | 70 | 105 |
| #10 | A | 53 | 79 | 40 | 61 | 69 | 103 | 61 | 91 |
| | B | 68 | 102 | 53 | 79 | 89 | 133 | 79 | 118 |
| #11 | A | 58 | 87 | 45 | 67 | 76 | 114 | 67 | 101 |
| | B | 76 | 113 | 58 | 87 | 99 | 148 | 87 | 131 |
| #14 | N/A | 70 | 105 | 54 | 81 | 91 | 137 | 81 | 121 |
| #18 | N/A | 93 | 139 | 72 | 107 | 122 | 182 | 107 | 161 |

***Reference Table 5-2(a) Notes.***

Table 5-2(h) – Tension Development and Lap Splice Lengths for Bars (ACI 12.2.2)
$f'_c \geq$ 10,000 psi

| BAR SIZE | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP BARS | | OTHER BARS | | TOP BARS | | OTHER BARS | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 | A | 12 | 18 | 12 | 14 | 16 | 23 | 14 | 21 |
| | B | 16 | 23 | 12 | 18 | 20 | 30 | 18 | 27 |
| #4 | A | 16 | 24 | 12 | 18 | 21 | 31 | 18 | 27 |
| | B | 21 | 31 | 16 | 24 | 27 | 40 | 24 | 35 |
| #5 | A | 20 | 30 | 15 | 23 | 26 | 39 | 23 | 34 |
| | B | 26 | 38 | 20 | 30 | 33 | 50 | 30 | 44 |
| #6 | A | 24 | 35 | 18 | 27 | 31 | 46 | 27 | 41 |
| | B | 31 | 46 | 24 | 35 | 40 | 60 | 35 | 53 |
| #7 | A | 34 | 51 | 27 | 40 | 45 | 67 | 40 | 59 |
| | B | 45 | 67 | 34 | 51 | 58 | 87 | 51 | 77 |
| #8 | A | 39 | 59 | 30 | 45 | 51 | 77 | 45 | 68 |
| | B | 51 | 76 | 39 | 59 | 67 | 100 | 59 | 88 |
| #9 | A | 44 | 66 | 34 | 51 | 58 | 87 | 51 | 76 |
| | B | 57 | 86 | 44 | 66 | 75 | 112 | 66 | 99 |
| #10 | A | 50 | 75 | 38 | 57 | 65 | 97 | 57 | 86 |
| | B | 65 | 97 | 50 | 75 | 85 | 127 | 75 | 112 |
| #11 | A | 55 | 83 | 43 | 64 | 72 | 108 | 64 | 95 |
| | B | 72 | 108 | 55 | 83 | 94 | 141 | 83 | 124 |
| #14 | N/A | 66 | 99 | 51 | 76 | 87 | 130 | 76 | 115 |
| #18 | N/A | 88 | 132 | 68 | 102 | 115 | 173 | 102 | 153 |

**Notes:**

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths and tension lap splice lengths are calculated per ACI 318-08, Sections 12.2.2 and 12.15, respectively.
3. Tabulated values for beams or columns are based on transverse reinforcement and concrete cover meeting minimum Code requirements.
4. Cases 1 and 2, which depend on the type of structural member, concrete cover, and center-to-center spacing of the bars, are defined as:

| | | |
|---|---|---|
| **Beams, Columns** | Case 1 | Concrete cover at least 1.0 $d_b$ **and** c.-c. spacing at least 2.0 $d_b$ |
| | Case 2 | Concrete cover less than 1.0 $d_b$ **or** c.-c. spacing less than 2.0 $d_b$ |
| **All Others** | Case 1 | Concrete cover at least 1.0 $d_b$ **and** c.-c. spacing at least 3.0 $d_b$ |
| | Case 2 | Concrete cover less than 1.0 $d_b$ **or** c.-c. spacing less than 3.0 $d_b$ |

5. Lap splice lengths (minimum of 12 inches) are multiples of tension development lengths; Class A = 1.0 $\ell_d$ and Class B = 1.3 $\ell_d$ (ACI 12.15.1). When determining the lap splice length, $\ell_d$ is calculated without the 12-inch minimum of ACI 12.2.1.
6. ACI 318 does not allow tension lap splices of #14 or #18 [#43 or #57] bars. The tabulated values for those bar sizes are the tension development lengths.
7. Top bars are horizontal bars with more than 12 inches of concrete cast below the bars.
8. For epoxy-coated bars, if the c.-c. spacing is at least 7.0 $d_b$ and the concrete cover is at least 3.0 $d_b$, then Case 1 lengths may be multiplied by 0.918 (for top bars) or 0.8 (for other bars).
9. For Grade 75 (minimum yield strength of 75,000 psi) reinforcing bars, lengths must be multiplied by 1.25.
10. For lightweight aggregate concrete, multiply the tabulated values by 1.33.

## Table 5-3(a) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
## $f'_c$ = 3,000 psi

| BAR SIZE | LAP CLASS | CONCRETE COVER = 0.75 in. | | | | CONCRETE COVER = 1.00 in. | | | | CONCRETE COVER = 1.5 in. | | | | CONCRETE COVER = 2.00 in. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | |
| | | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other |
| #3 | A | 13 | 12 | 17 | 15 | 13 | 12 | 17 | 15 | 13 | 12 | 17 | 15 | 13 | 12 | 17 | 15 |
| | B | 17 | 13 | 22 | 20 | 17 | 13 | 22 | 20 | 17 | 13 | 22 | 20 | 17 | 13 | 22 | 20 |
| #4 | A | 22 | 17 | 28 | 25 | 17 | 13 | 23 | 20 | 17 | 13 | 23 | 20 | 17 | 13 | 23 | 20 |
| | B | 28 | 22 | 37 | 32 | 23 | 17 | 29 | 26 | 23 | 17 | 29 | 26 | 23 | 17 | 29 | 26 |
| #5 | A | 32 | 24 | 41 | 37 | 26 | 20 | 34 | 30 | 22 | 17 | 28 | 25 | 22 | 17 | 28 | 25 |
| | B | 41 | 32 | 54 | 47 | 33 | 26 | 44 | 38 | 28 | 22 | 37 | 32 | 28 | 22 | 37 | 32 |
| #6 | A | 43 | 33 | 56 | 50 | 35 | 27 | 46 | 41 | 26 | 20 | 34 | 30 | 26 | 20 | 34 | 30 |
| | B | 56 | 43 | 73 | 64 | 46 | 35 | 60 | 53 | 34 | 26 | 44 | 39 | 34 | 26 | 44 | 39 |
| #7 | A | 69 | 53 | 90 | 80 | 57 | 44 | 75 | 66 | 43 | 33 | 55 | 49 | 38 | 29 | 49 | 43 |
| | B | 90 | 69 | 117 | 104 | 74 | 57 | 97 | 86 | 55 | 43 | 72 | 64 | 49 | 38 | 64 | 56 |
| #8 | A | 86 | 66 | 112 | 99 | 72 | 55 | 93 | 82 | 54 | 41 | 70 | 62 | 43 | 33 | 56 | 50 |
| | B | 111 | 86 | 146 | 128 | 93 | 72 | 121 | 107 | 70 | 54 | 91 | 80 | 56 | 43 | 73 | 64 |
| #9 | A | 104 | 80 | 136 | 120 | 87 | 67 | 114 | 101 | 66 | 51 | 86 | 76 | 53 | 41 | 70 | 61 |
| | B | 135 | 104 | 176 | 155 | 113 | 87 | 148 | 131 | 86 | 66 | 112 | 99 | 69 | 53 | 90 | 80 |
| #10 | A | 125 | 96 | 163 | 144 | 106 | 81 | 138 | 122 | 81 | 62 | 106 | 93 | 66 | 51 | 86 | 76 |
| | B | 162 | 125 | 212 | 187 | 137 | 106 | 179 | 158 | 105 | 81 | 137 | 121 | 85 | 66 | 111 | 98 |
| #11 | A | 146 | 113 | 191 | 169 | 125 | 96 | 163 | 144 | 97 | 74 | 126 | 111 | 79 | 61 | 103 | 91 |
| | B | 190 | 146 | 248 | 219 | 162 | 125 | 212 | 187 | 125 | 97 | 164 | 145 | 102 | 79 | 134 | 118 |

**Notes:**

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths and tension lap splice lengths are calculated per ACI 318-08, Sections 12.2.3 and 12.15, respectively, with bar sizes limited to #3 through #11.
3. When the variable "$c_b$" from ACI 12.2.3 was calculated, it was assumed that concrete cover controlled. That is, c.-c. spacing was assumed to be greater than 1.0 $d_b$ plus twice the concrete cover.
4. Lap splice lengths (minimum of 12 inches) are multiples of tension development lengths; Class A = 1.0 $\ell_d$ and Class B = 1.3 $\ell_d$ (ACI 318 12.15.1). When determining the lap splice length, $\ell_d$ is calculated without the 12-inch minimum of ACI 12.2.1.
5. Top bars are horizontal bars with more than 12 inches of concrete cast below the bars.
6. For epoxy-coated bars, if the c.-c. spacing is at least 7.0 $d_b$ and the concrete cover is at least 3.0 $d_b$, then lengths may be multiplied by 0.918 (for top bars) or 0.8 (for other bars).
7. For Grade 75 (minimum yield strength of 75,000 psi) reinforcing bars, lengths must be multiplied by 1.25.
8. For lightweight aggregate concrete, multiply the tabulated values by 1.33.

Table 5-3(b) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
$f'_c$ = 4,000 psi

| BAR SIZE | LAP CLASS | CONCRETE COVER = 0.75 in. | | | | CONCRETE COVER = 1.00 in. | | | | CONCRETE COVER = 1.5 in. | | | | CONCRETE COVER = 2.00 in. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | |
| | | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other |
| #3 | A | 12 | 12 | 15 | 13 | 12 | 12 | 15 | 13 | 12 | 12 | 15 | 13 | 12 | 12 | 15 | 13 |
| | B | 15 | 12 | 19 | 17 | 15 | 12 | 19 | 17 | 15 | 12 | 19 | 17 | 15 | 12 | 19 | 17 |
| #4 | A | 19 | 15 | 24 | 22 | 15 | 12 | 20 | 17 | 15 | 12 | 20 | 17 | 15 | 12 | 20 | 17 |
| | B | 24 | 19 | 32 | 28 | 20 | 15 | 25 | 22 | 20 | 15 | 25 | 22 | 20 | 15 | 25 | 22 |
| #5 | A | 28 | 21 | 36 | 32 | 22 | 17 | 29 | 26 | 19 | 15 | 24 | 22 | 19 | 15 | 24 | 22 |
| | B | 36 | 28 | 47 | 41 | 29 | 22 | 38 | 33 | 24 | 19 | 32 | 28 | 24 | 19 | 32 | 28 |
| #6 | A | 37 | 29 | 49 | 43 | 31 | 24 | 40 | 35 | 22 | 17 | 29 | 26 | 22 | 17 | 29 | 26 |
| | B | 48 | 37 | 63 | 56 | 40 | 31 | 52 | 46 | 29 | 22 | 38 | 34 | 29 | 22 | 38 | 34 |
| #7 | A | 60 | 46 | 78 | 69 | 50 | 38 | 65 | 57 | 37 | 28 | 48 | 42 | 33 | 25 | 43 | 38 |
| | B | 78 | 60 | 102 | 90 | 64 | 50 | 84 | 74 | 48 | 37 | 62 | 55 | 42 | 33 | 55 | 49 |
| #8 | A | 74 | 57 | 97 | 86 | 62 | 48 | 81 | 71 | 47 | 36 | 61 | 54 | 37 | 29 | 49 | 43 |
| | B | 96 | 74 | 126 | 111 | 80 | 62 | 105 | 93 | 60 | 47 | 79 | 70 | 48 | 37 | 63 | 56 |
| #9 | A | 90 | 69 | 117 | 104 | 76 | 58 | 99 | 87 | 57 | 44 | 75 | 66 | 46 | 36 | 60 | 53 |
| | B | 117 | 90 | 153 | 135 | 98 | 76 | 128 | 113 | 74 | 57 | 97 | 86 | 60 | 46 | 78 | 69 |
| #10 | A | 108 | 83 | 141 | 125 | 92 | 70 | 120 | 106 | 70 | 54 | 92 | 81 | 57 | 44 | 74 | 66 |
| | B | 140 | 108 | 183 | 162 | 119 | 92 | 155 | 137 | 91 | 70 | 119 | 105 | 74 | 57 | 97 | 85 |
| #11 | A | 127 | 98 | 166 | 146 | 108 | 83 | 141 | 125 | 84 | 64 | 109 | 97 | 68 | 53 | 89 | 79 |
| | B | 165 | 127 | 215 | 190 | 141 | 108 | 184 | 162 | 109 | 84 | 142 | 125 | 89 | 68 | 116 | 102 |

***Reference Table 5-3(a) Notes.***

Table 5-3(c) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
$f'_c$ = 5,000 psi

| BAR SIZE | LAP CLASS | CONCRETE COVER = 0.75 in. | | | | CONCRETE COVER = 1.00 in. | | | | CONCRETE COVER = 1.5 in. | | | | CONCRETE COVER = 2.00 in. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | |
| | | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other |
| #3 | A | 12 | 12 | 13 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 13 | 12 |
| | B | 13 | 12 | 17 | 15 | 13 | 12 | 17 | 15 | 13 | 12 | 17 | 15 | 13 | 12 | 17 | 15 |
| #4 | A | 17 | 13 | 22 | 19 | 14 | 12 | 18 | 16 | 14 | 12 | 18 | 16 | 14 | 12 | 18 | 16 |
| | B | 22 | 17 | 28 | 25 | 18 | 14 | 23 | 20 | 18 | 14 | 23 | 20 | 18 | 14 | 23 | 20 |
| #5 | A | 25 | 19 | 32 | 28 | 20 | 15 | 26 | 23 | 17 | 13 | 22 | 19 | 17 | 13 | 22 | 19 |
| | B | 32 | 25 | 42 | 37 | 26 | 20 | 34 | 30 | 22 | 17 | 28 | 25 | 22 | 17 | 28 | 25 |
| #6 | A | 33 | 26 | 44 | 38 | 27 | 21 | 36 | 32 | 20 | 16 | 26 | 23 | 20 | 16 | 26 | 23 |
| | B | 43 | 33 | 57 | 50 | 35 | 27 | 46 | 41 | 26 | 20 | 34 | 30 | 26 | 20 | 34 | 30 |
| #7 | A | 54 | 41 | 70 | 62 | 44 | 34 | 58 | 51 | 33 | 25 | 43 | 38 | 29 | 23 | 38 | 34 |
| | B | 70 | 54 | 91 | 80 | 58 | 44 | 75 | 66 | 43 | 33 | 56 | 49 | 38 | 29 | 50 | 44 |
| #8 | A | 66 | 51 | 87 | 77 | 55 | 43 | 72 | 64 | 42 | 32 | 54 | 48 | 33 | 26 | 44 | 38 |
| | B | 86 | 66 | 113 | 100 | 72 | 55 | 94 | 83 | 54 | 42 | 71 | 62 | 43 | 33 | 57 | 50 |
| #9 | A | 80 | 62 | 105 | 93 | 68 | 52 | 88 | 78 | 51 | 40 | 67 | 59 | 41 | 32 | 54 | 48 |
| | B | 104 | 80 | 136 | 120 | 88 | 68 | 115 | 101 | 67 | 51 | 87 | 77 | 54 | 41 | 70 | 62 |
| #10 | A | 97 | 74 | 126 | 111 | 82 | 63 | 107 | 94 | 63 | 48 | 82 | 72 | 51 | 39 | 67 | 59 |
| | B | 126 | 97 | 164 | 145 | 106 | 82 | 139 | 123 | 82 | 63 | 107 | 94 | 66 | 51 | 86 | 76 |
| #11 | A | 113 | 87 | 148 | 131 | 97 | 75 | 126 | 112 | 75 | 58 | 98 | 86 | 61 | 47 | 80 | 70 |
| | B | 147 | 113 | 192 | 170 | 126 | 97 | 164 | 145 | 97 | 75 | 127 | 112 | 79 | 61 | 104 | 92 |

***Reference Table 5-3(a) Notes.***

Table 5-3(d) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
$f'_c$ = 6,000 psi

| BAR SIZE | LAP CLASS | CONCRETE COVER = 0.75 in. | | | | CONCRETE COVER = 1.00 in. | | | | CONCRETE COVER = 1.5 in. | | | | CONCRETE COVER = 2.00 in. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | |
| | | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other |
| #3 | A | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | B | 12 | 12 | 16 | 14 | 12 | 12 | 16 | 14 | 12 | 12 | 16 | 14 | 12 | 12 | 16 | 14 |
| #4 | A | 15 | 12 | 20 | 18 | 12 | 12 | 16 | 14 | 12 | 12 | 16 | 14 | 12 | 12 | 16 | 14 |
| | B | 20 | 15 | 26 | 23 | 16 | 12 | 21 | 18 | 16 | 12 | 21 | 18 | 16 | 12 | 21 | 18 |
| #5 | A | 23 | 17 | 29 | 26 | 18 | 14 | 24 | 21 | 15 | 12 | 20 | 18 | 15 | 12 | 20 | 18 |
| | B | 29 | 23 | 38 | 34 | 24 | 18 | 31 | 27 | 20 | 15 | 26 | 23 | 20 | 15 | 26 | 23 |
| #6 | A | 31 | 24 | 40 | 35 | 25 | 19 | 33 | 29 | 18 | 14 | 24 | 21 | 18 | 14 | 24 | 21 |
| | B | 40 | 31 | 52 | 46 | 32 | 25 | 42 | 37 | 24 | 18 | 31 | 27 | 24 | 18 | 31 | 27 |
| #7 | A | 49 | 38 | 64 | 56 | 41 | 31 | 53 | 47 | 30 | 23 | 39 | 35 | 27 | 21 | 35 | 31 |
| | B | 64 | 49 | 83 | 73 | 53 | 41 | 69 | 61 | 39 | 30 | 51 | 45 | 35 | 27 | 45 | 40 |
| #8 | A | 61 | 47 | 79 | 70 | 51 | 39 | 66 | 58 | 38 | 29 | 50 | 44 | 31 | 24 | 40 | 35 |
| | B | 79 | 61 | 103 | 91 | 66 | 51 | 86 | 76 | 49 | 38 | 64 | 57 | 40 | 31 | 52 | 46 |
| #9 | A | 73 | 57 | 96 | 85 | 62 | 48 | 81 | 71 | 47 | 36 | 61 | 54 | 38 | 29 | 49 | 44 |
| | B | 95 | 73 | 125 | 110 | 80 | 62 | 105 | 92 | 61 | 47 | 79 | 70 | 49 | 38 | 64 | 57 |
| #10 | A | 88 | 68 | 115 | 102 | 75 | 58 | 98 | 86 | 57 | 44 | 75 | 66 | 47 | 36 | 61 | 54 |
| | B | 115 | 88 | 150 | 132 | 97 | 75 | 127 | 112 | 74 | 57 | 97 | 86 | 60 | 47 | 79 | 70 |
| #11 | A | 103 | 80 | 135 | 119 | 88 | 68 | 115 | 102 | 68 | 53 | 89 | 79 | 56 | 43 | 73 | 64 |
| | B | 134 | 103 | 176 | 155 | 115 | 88 | 150 | 132 | 89 | 68 | 116 | 102 | 72 | 56 | 95 | 84 |

***Reference Table 5-3(a) Notes.***

Table 5-3(e) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
$f'_c$ = 7,000 psi

| BAR SIZE | LAP CLASS | CONCRETE COVER = 0.75 in. | | | | CONCRETE COVER = 1.00 in. | | | | CONCRETE COVER = 1.5 in. | | | | CONCRETE COVER = 2.00 in. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | |
| | | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other |
| #3 | A | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | B | 12 | 12 | 15 | 13 | 12 | 12 | 15 | 13 | 12 | 12 | 15 | 13 | 12 | 12 | 15 | 13 |
| #4 | A | 14 | 12 | 19 | 16 | 12 | 12 | 15 | 13 | 12 | 12 | 15 | 13 | 12 | 12 | 15 | 13 |
| | B | 18 | 14 | 24 | 21 | 15 | 12 | 19 | 17 | 15 | 12 | 19 | 17 | 15 | 12 | 19 | 17 |
| #5 | A | 21 | 16 | 27 | 24 | 17 | 13 | 22 | 20 | 14 | 12 | 19 | 16 | 14 | 12 | 19 | 16 |
| | B | 27 | 21 | 35 | 31 | 22 | 17 | 29 | 25 | 18 | 14 | 24 | 21 | 18 | 14 | 24 | 21 |
| #6 | A | 28 | 22 | 37 | 33 | 23 | 18 | 30 | 27 | 17 | 13 | 22 | 20 | 17 | 13 | 22 | 20 |
| | B | 37 | 28 | 48 | 42 | 30 | 23 | 39 | 35 | 22 | 17 | 29 | 25 | 22 | 17 | 29 | 25 |
| #7 | A | 45 | 35 | 59 | 52 | 38 | 29 | 49 | 43 | 28 | 22 | 36 | 32 | 25 | 19 | 32 | 29 |
| | B | 59 | 45 | 77 | 68 | 49 | 38 | 64 | 56 | 36 | 28 | 47 | 42 | 32 | 25 | 42 | 37 |
| #8 | A | 56 | 43 | 73 | 65 | 47 | 36 | 61 | 54 | 35 | 27 | 46 | 41 | 28 | 22 | 37 | 33 |
| | B | 73 | 56 | 95 | 84 | 61 | 47 | 80 | 70 | 46 | 35 | 60 | 53 | 37 | 28 | 48 | 42 |
| #9 | A | 68 | 52 | 89 | 78 | 57 | 44 | 75 | 66 | 43 | 33 | 57 | 50 | 35 | 27 | 46 | 40 |
| | B | 88 | 68 | 115 | 102 | 74 | 57 | 97 | 86 | 56 | 43 | 74 | 65 | 45 | 35 | 59 | 52 |
| #10 | A | 82 | 63 | 107 | 94 | 69 | 53 | 90 | 80 | 53 | 41 | 69 | 61 | 43 | 33 | 56 | 50 |
| | B | 106 | 82 | 139 | 122 | 90 | 69 | 118 | 104 | 69 | 53 | 90 | 80 | 56 | 43 | 73 | 64 |
| #11 | A | 96 | 74 | 125 | 111 | 82 | 63 | 107 | 94 | 63 | 49 | 83 | 73 | 52 | 40 | 68 | 60 |
| | B | 125 | 96 | 163 | 144 | 106 | 82 | 139 | 123 | 82 | 63 | 107 | 95 | 67 | 52 | 88 | 77 |

***Reference Table 5-3(a) Notes.***

Table 5-3(f) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
$f'_c$ = 8,000 psi

| BAR SIZE | LAP CLASS | CONCRETE COVER = 0.75 in. | | | | CONCRETE COVER = 1.00 in. | | | | CONCRETE COVER = 1.5 in. | | | | CONCRETE COVER = 2.00 in. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | |
| | | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other |
| #3 | A | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | B | 12 | 12 | 14 | 12 | 12 | 12 | 14 | 12 | 12 | 12 | 14 | 12 | 12 | 12 | 14 | 12 |
| #4 | A | 13 | 12 | 17 | 15 | 12 | 12 | 14 | 12 | 12 | 12 | 14 | 12 | 12 | 12 | 14 | 12 |
| | B | 17 | 13 | 23 | 20 | 14 | 12 | 18 | 16 | 14 | 12 | 18 | 16 | 14 | 12 | 18 | 16 |
| #5 | A | 20 | 15 | 25 | 22 | 16 | 12 | 21 | 18 | 13 | 12 | 17 | 15 | 13 | 12 | 17 | 15 |
| | B | 25 | 20 | 33 | 29 | 21 | 16 | 27 | 24 | 17 | 13 | 23 | 20 | 17 | 13 | 23 | 20 |
| #6 | A | 26 | 20 | 35 | 30 | 22 | 17 | 28 | 25 | 16 | 12 | 21 | 18 | 16 | 12 | 21 | 18 |
| | B | 34 | 26 | 45 | 40 | 28 | 22 | 37 | 32 | 21 | 16 | 27 | 24 | 21 | 16 | 27 | 24 |
| #7 | A | 42 | 33 | 55 | 49 | 35 | 27 | 46 | 40 | 26 | 20 | 34 | 30 | 23 | 18 | 30 | 27 |
| | B | 55 | 42 | 72 | 64 | 46 | 35 | 60 | 53 | 34 | 26 | 44 | 39 | 30 | 23 | 39 | 35 |
| #8 | A | 53 | 41 | 69 | 61 | 44 | 34 | 57 | 51 | 33 | 25 | 43 | 38 | 26 | 20 | 35 | 30 |
| | B | 68 | 53 | 89 | 79 | 57 | 44 | 74 | 66 | 43 | 33 | 56 | 49 | 34 | 26 | 45 | 40 |
| #9 | A | 64 | 49 | 83 | 73 | 54 | 41 | 70 | 62 | 41 | 31 | 53 | 47 | 33 | 25 | 43 | 38 |
| | B | 83 | 64 | 108 | 95 | 69 | 54 | 91 | 80 | 53 | 41 | 69 | 61 | 42 | 33 | 55 | 49 |
| #10 | A | 76 | 59 | 100 | 88 | 65 | 50 | 85 | 75 | 50 | 38 | 65 | 57 | 40 | 31 | 53 | 46 |
| | B | 99 | 76 | 130 | 115 | 84 | 65 | 110 | 97 | 65 | 50 | 84 | 74 | 52 | 40 | 68 | 60 |
| #11 | A | 90 | 69 | 117 | 103 | 77 | 59 | 100 | 88 | 59 | 46 | 77 | 68 | 48 | 37 | 63 | 56 |
| | B | 116 | 90 | 152 | 134 | 99 | 77 | 130 | 115 | 77 | 59 | 101 | 89 | 63 | 48 | 82 | 72 |

***Reference Table 5-3(a) Notes.***

Table 5-3(g) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
$f'_c$ = 9,000 psi

| BAR SIZE | LAP CLASS | CONCRETE COVER = 0.75 in. | | | | CONCRETE COVER = 1.00 in. | | | | CONCRETE COVER = 1.5 in. | | | | CONCRETE COVER = 2.00 in. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | |
| | | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other |
| #3 | A | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | B | 12 | 12 | 13 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 13 | 12 |
| #4 | A | 13 | 12 | 16 | 15 | 12 | 12 | 13 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 13 | 12 |
| | B | 16 | 13 | 21 | 19 | 13 | 12 | 17 | 15 | 13 | 12 | 17 | 15 | 13 | 12 | 17 | 15 |
| #5 | A | 18 | 14 | 24 | 21 | 15 | 12 | 19 | 17 | 13 | 12 | 16 | 15 | 13 | 12 | 16 | 15 |
| | B | 24 | 18 | 31 | 28 | 19 | 15 | 25 | 22 | 16 | 13 | 21 | 19 | 16 | 13 | 21 | 19 |
| #6 | A | 25 | 19 | 33 | 29 | 20 | 16 | 27 | 24 | 15 | 12 | 20 | 17 | 15 | 12 | 20 | 17 |
| | B | 32 | 25 | 42 | 37 | 27 | 20 | 35 | 31 | 20 | 15 | 25 | 22 | 20 | 15 | 25 | 22 |
| #7 | A | 40 | 31 | 52 | 46 | 33 | 26 | 43 | 38 | 25 | 19 | 32 | 28 | 22 | 17 | 29 | 25 |
| | B | 52 | 40 | 68 | 60 | 43 | 33 | 56 | 50 | 32 | 25 | 42 | 37 | 28 | 22 | 37 | 33 |
| #8 | A | 50 | 38 | 65 | 57 | 41 | 32 | 54 | 48 | 31 | 24 | 41 | 36 | 25 | 19 | 33 | 29 |
| | B | 64 | 50 | 84 | 74 | 54 | 41 | 70 | 62 | 40 | 31 | 53 | 47 | 32 | 25 | 42 | 37 |
| #9 | A | 60 | 46 | 78 | 69 | 50 | 39 | 66 | 58 | 38 | 30 | 50 | 44 | 31 | 24 | 40 | 36 |
| | B | 78 | 60 | 102 | 90 | 66 | 50 | 86 | 76 | 50 | 38 | 65 | 57 | 40 | 31 | 52 | 46 |
| #10 | A | 72 | 56 | 94 | 83 | 61 | 47 | 80 | 70 | 47 | 36 | 61 | 54 | 38 | 29 | 50 | 44 |
| | B | 94 | 72 | 122 | 108 | 79 | 61 | 104 | 92 | 61 | 47 | 79 | 70 | 49 | 38 | 64 | 57 |
| #11 | A | 85 | 65 | 110 | 98 | 72 | 56 | 94 | 83 | 56 | 43 | 73 | 64 | 46 | 35 | 60 | 53 |
| | B | 110 | 85 | 144 | 127 | 94 | 72 | 123 | 108 | 73 | 56 | 95 | 84 | 59 | 46 | 77 | 68 |

***Reference Table 5-3(a) Notes.***

## Table 5-3(h) – Tension Development and Lap Splice Lengths for Bars in Walls and Slabs (ACI 12.2.3)
## $f'_c \geq$ 10,000 psi

| BAR SIZE | LAP CLASS | CONCRETE COVER = 0.75 in. | | | | CONCRETE COVER = 1.00 in. | | | | CONCRETE COVER = 1.5 in. | | | | CONCRETE COVER = 2.00 in. | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | | UNCOATED | | EPOXY-COATED | |
| | | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other | Top | Other |
| #3 | A | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| | B | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| #4 | A | 12 | 12 | 16 | 14 | 12 | 12 | 13 | 12 | 12 | 12 | 13 | 12 | 12 | 12 | 13 | 12 |
| | B | 16 | 12 | 20 | 18 | 12 | 12 | 16 | 14 | 12 | 12 | 16 | 14 | 12 | 12 | 16 | 14 |
| #5 | A | 18 | 14 | 23 | 20 | 14 | 12 | 19 | 16 | 12 | 12 | 16 | 14 | 12 | 12 | 16 | 14 |
| | B | 23 | 18 | 30 | 26 | 18 | 14 | 24 | 21 | 16 | 12 | 20 | 18 | 16 | 12 | 20 | 18 |
| #6 | A | 24 | 18 | 31 | 27 | 19 | 15 | 25 | 22 | 14 | 12 | 19 | 17 | 14 | 12 | 19 | 17 |
| | B | 31 | 24 | 40 | 35 | 25 | 19 | 33 | 29 | 19 | 14 | 24 | 21 | 19 | 14 | 24 | 21 |
| #7 | A | 38 | 29 | 50 | 44 | 31 | 24 | 41 | 36 | 23 | 18 | 31 | 27 | 21 | 16 | 27 | 24 |
| | B | 49 | 38 | 64 | 57 | 41 | 31 | 53 | 47 | 30 | 23 | 40 | 35 | 27 | 21 | 35 | 31 |
| #8 | A | 47 | 36 | 61 | 54 | 39 | 30 | 51 | 45 | 30 | 23 | 39 | 34 | 24 | 18 | 31 | 27 |
| | B | 61 | 47 | 80 | 71 | 51 | 39 | 67 | 59 | 38 | 30 | 50 | 44 | 31 | 24 | 40 | 35 |
| #9 | A | 57 | 44 | 74 | 66 | 48 | 37 | 63 | 55 | 36 | 28 | 47 | 42 | 29 | 23 | 38 | 34 |
| | B | 74 | 57 | 97 | 85 | 62 | 48 | 81 | 72 | 47 | 36 | 62 | 54 | 38 | 29 | 50 | 44 |
| #10 | A | 68 | 53 | 89 | 79 | 58 | 45 | 76 | 67 | 44 | 34 | 58 | 51 | 36 | 28 | 47 | 42 |
| | B | 89 | 68 | 116 | 102 | 75 | 58 | 98 | 87 | 58 | 44 | 75 | 67 | 47 | 36 | 61 | 54 |
| #11 | A | 80 | 62 | 105 | 93 | 69 | 53 | 90 | 79 | 53 | 41 | 69 | 61 | 43 | 33 | 57 | 50 |
| | B | 104 | 80 | 136 | 120 | 89 | 69 | 116 | 103 | 69 | 53 | 90 | 79 | 56 | 43 | 73 | 65 |

**Notes:**

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths and tension lap splice lengths are calculated per ACI 318-08, Sections 12.2.3 and 12.15, respectively, with bar sizes limited to #3 through #11.
3. When the variable "$c_b$" from ACI 12.2.3 was calculated, it was assumed that concrete cover controlled. That is, c.-c. spacing was assumed to be greater than 1.0 $d_b$ plus twice the concrete cover.
4. Lap splice lengths (minimum of 12 inches) are multiples of tension development lengths; Class A = 1.0 $\ell_d$ and Class B = 1.3 $\ell_d$ (ACI 318 12.15.1). When determining the lap splice length, $\ell_d$ is calculated without the 12-inch minimum of ACI 12.2.1.
5. Top bars are horizontal bars with more than 12 inches of concrete cast below the bars.
6. For epoxy-coated bars, if the c.-c. spacing is at least 7.0 $d_b$ and the concrete cover is at least 3.0 $d_b$, then lengths may be multiplied by 0.918 (for top bars) or 0.8 (for other bars).
7. For Grade 75 (minimum yield strength of 75,000 psi) reinforcing bars, lengths must be multiplied by 1.25.
8. For lightweight aggregate concrete, multiply the tabulated values by 1.33.

## Table 5-4(a) – Tension Development and Lap Splice Lengths for Bars, Multiples of Bar Diameter

$f'_c$ = 3,000 psi

| BAR SIZES | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP | | OTHER | | TOP | | OTHER | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 to #6 | A | $57d_b$ | $86d_b$ | $44d_b$ | $66d_b$ | $75d_b$ | $112d_b$ | $66d_b$ | $99d_b$ |
| | B | $74d_b$ | $111d_b$ | $57d_b$ | $86d_b$ | $97d_b$ | $146d_b$ | $86d_b$ | $128d_b$ |
| #7 to #18 | A | $72d_b$ | $107d_b$ | $55d_b$ | $82d_b$ | $93d_b$ | $140d_b$ | $82d_b$ | $124d_b$ |
| | B | $93d_b$ | $139d_b$ | $72d_b$ | $107d_b$ | $121d_b$ | $182d_b$ | $107d_b$ | $161d_b$ |

$f'_c$ = 4,000 psi

| BAR SIZES | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP | | OTHER | | TOP | | OTHER | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 to #6 | A | $50d_b$ | $74d_b$ | $38d_b$ | $57d_b$ | $65d_b$ | $97d_b$ | $57d_b$ | $86d_b$ |
| | B | $64d_b$ | $96d_b$ | $50d_b$ | $74d_b$ | $84d_b$ | $126d_b$ | $74d_b$ | $111d_b$ |
| #7 to #18 | A | $62d_b$ | $93d_b$ | $48d_b$ | $71d_b$ | $81d_b$ | $121d_b$ | $71d_b$ | $107d_b$ |
| | B | $80d_b$ | $121d_b$ | $62d_b$ | $93d_b$ | $105d_b$ | $158d_b$ | $93d_b$ | $139d_b$ |

$f'_c$ = 5,000 psi

| BAR SIZES | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP | | OTHER | | TOP | | OTHER | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 to #6 | A | $44d_b$ | $66d_b$ | $34d_b$ | $51d_b$ | $58d_b$ | $87d_b$ | $51d_b$ | $77d_b$ |
| | B | $58d_b$ | $86d_b$ | $44d_b$ | $66d_b$ | $75d_b$ | $113d_b$ | $66d_b$ | $100d_b$ |
| #7 to #18 | A | $55d_b$ | $83d_b$ | $43d_b$ | $64d_b$ | $72d_b$ | $108d_b$ | $64d_b$ | $96d_b$ |
| | B | $72d_b$ | $108d_b$ | $55d_b$ | $83d_b$ | $94d_b$ | $141d_b$ | $83d_b$ | $124d_b$ |

**Notes:**

1. ACI 318-08 facilitates expressing tension development lengths and tension lap splice lengths as multiples of bar diameters. These tables present these values, for various concrete strengths, for both uncoated and epoxy-coated bars.
2. Tabulated values are based on a minimum yield strength of 60,000 psi.
3. Tension development lengths and tension lap splice lengths are calculated per ACI 318, Sections 12.2.2 and 12.15, respectively.
4. Tabulated values for beams or columns are based on transverse reinforcement and concrete cover meeting minimum Code requirements.
5. Cases 1 and 2, which depend on the type of structural member, concrete cover, and center-to-center spacing of the bars, are defined as:

| | | |
|---|---|---|
| **Beams, Columns** | Case 1 | Concrete cover at least 1.0 *db* **and** c.-c. spacing at least 2.0 $d_b$ |
| | Case 2 | Concrete cover less than 1.0 $d_b$ **or** c.-c. spacing less than 2.0 $d_b$ |
| **All Others** | Case 1 | Concrete cover at least 1.0 $d_b$ **and** c.-c. spacing at least 3.0 $d_b$ |
| | Case 2 | Concrete cover less than 1.0 $d_b$ **or** c.-c. spacing less than 3.0 $d_b$ |

6. Lap splice lengths (minimum of 12 inches) are multiples of tension development lengths; Class A = 1.0 $\ell_d$ and Class B = 1.3 $\ell_d$ (ACI 12.15.1). When determining lap splice length, $\ell_d$ is calculated without the 12-inch minimum of ACI 12.2.1.
7. ACI 318 does not allow tension lap splices of #14 or #18 bars. The tabulated values for those bar sizes are the tension development lengths.
8. Top bars are horizontal bars with more than 12 inches of concrete cast below the bars.
9. For epoxy-coated bars, if the c.-c. spacing is at least 7.0 $d_b$ and the concrete cover is at least 3.0 $d_b$, then Case 1 lengths may be multiplied by 0.918 (for top bars) or 0.8 (for other bars).
10. For Grade 75 (minimum yield strength of 75,000 psi) reinforcing bars, lengths must be multiplied by 1.25.
11. For lightweight aggregate concrete, multiply the tabulated values by 1.33.

Table 5-4(b) – Tension Development and Lap Splice Lengths for Bars, Multiples of Bar Diameter

$f'_c$ = 6,000 psi

| BAR SIZES | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP | | OTHER | | TOP | | OTHER | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 to #6 [#10 to #19] | A | $41d_b$ | $61d_b$ | $31d_b$ | $47d_b$ | $53d_b$ | $79d_b$ | $47d_b$ | $70d_b$ |
| | B | $53d_b$ | $79d_b$ | $41d_b$ | $61d_b$ | $69d_b$ | $103d_b$ | $61d_b$ | $91d_b$ |
| #7 to #18 [#22 to #57] | A | $51d_b$ | $76d_b$ | $39d_b$ | $58d_b$ | $66d_b$ | $99d_b$ | $58d_b$ | $87d_b$ |
| | B | $66d_b$ | $98d_b$ | $51d_b$ | $76d_b$ | $86d_b$ | $129d_b$ | $76d_b$ | $114d_b$ |

$f'_c$ = 7,000 psi

| BAR SIZES | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP | | OTHER | | TOP | | OTHER | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 to #6 [#10 to #19] | A | $38d_b$ | $56d_b$ | $29d_b$ | $43d_b$ | $49d_b$ | $73d_b$ | $43d_b$ | $65d_b$ |
| | B | $49d_b$ | $73d_b$ | $38d_b$ | $56d_b$ | $64d_b$ | $95d_b$ | $56d_b$ | $84d_b$ |
| #7 to #18 [#22 to #57] | A | $47d_b$ | $70d_b$ | $36d_b$ | $54d_b$ | $61d_b$ | $92d_b$ | $54d_b$ | $81d_b$ |
| | B | $61d_b$ | $91d_b$ | $47d_b$ | $70d_b$ | $80d_b$ | $119d_b$ | $70d_b$ | $105d_b$ |

$f'_c$ = 8,000 psi

| BAR SIZES | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP | | OTHER | | TOP | | OTHER | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 to #6 [#10 to #19] | A | $35d_b$ | $53d_b$ | $27d_b$ | $41d_b$ | $46d_b$ | $69d_b$ | $41d_b$ | $61d_b$ |
| | B | $46d_b$ | $68d_b$ | $35d_b$ | $53d_b$ | $60d_b$ | $89d_b$ | $53d_b$ | $79d_b$ |
| #7 to #18 [#22 to #57] | A | $44d_b$ | $66d_b$ | $34d_b$ | $51d_b$ | $57d_b$ | $86d_b$ | $51d_b$ | $76d_b$ |
| | B | $57d_b$ | $85d_b$ | $44d_b$ | $66d_b$ | $74d_b$ | $111d_b$ | $66d_b$ | $98d_b$ |

$f'_c$ = 9,000 psi

| BAR SIZES | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP | | OTHER | | TOP | | OTHER | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 to #6 [#10 to #19] | A | $33d_b$ | $50d_b$ | $26d_b$ | $38d_b$ | $43d_b$ | $65d_b$ | $38d_b$ | $57d_b$ |
| | B | $43d_b$ | $64d_b$ | $33d_b$ | $50d_b$ | $56d_b$ | $84d_b$ | $50d_b$ | $74d_b$ |
| #7 to #18 [#22 to #57] | A | $41d_b$ | $62d_b$ | $32d_b$ | $48d_b$ | $54d_b$ | $81d_b$ | $48d_b$ | $71d_b$ |
| | B | $54d_b$ | $80d_b$ | $41d_b$ | $62d_b$ | $70d_b$ | $105d_b$ | $62d_b$ | $93d_b$ |

$f'_c \geq$ 10,000 psi

| BAR SIZES | LAP CLASS | UNCOATED BARS | | | | EPOXY-COATED BARS | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | TOP | | OTHER | | TOP | | OTHER | |
| | | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 | Case 1 | Case 2 |
| #3 to #6 [#10 to #19] | A | $32d_b$ | $47d_b$ | $24d_b$ | $36d_b$ | $41d_b$ | $61d_b$ | $36d_b$ | $54d_b$ |
| | B | $41d_b$ | $61d_b$ | $32d_b$ | $47d_b$ | $53d_b$ | $80d_b$ | $47d_b$ | $71d_b$ |
| #7 to #18 [#22 to #57] | A | $39d_b$ | $59d_b$ | $30d_b$ | $45d_b$ | $51d_b$ | $77d_b$ | $45d_b$ | $68d_b$ |
| | B | $51d_b$ | $76d_b$ | $39d_b$ | $59d_b$ | $67d_b$ | $100d_b$ | $59d_b$ | $88d_b$ |

***Reference Table 5-4(a) Notes.***

## Table 5-5(a) – Tension Development Lengths for Standard Hooks

| BAR SIZE | $f'_c$ = 3,000 psi | | $f'_c$ = 4,000 psi | | $f'_c$ = 5,000 psi | | $f'_c$ = 6,000 psi | |
|---|---|---|---|---|---|---|---|---|
| | Uncoated | Epoxy-Coated | Uncoated | Epoxy-Coated | Uncoated | Epoxy-Coated | Uncoated | Epoxy-Coated |
| #3 | 9 | 10 | 7 | 9 | 7 | 8 | 6 | 7 |
| #4 | 11 | 13 | 10 | 12 | 9 | 10 | 8 | 10 |
| #5 | 14 | 17 | 12 | 15 | 11 | 13 | 10 | 12 |
| #6 | 17 | 20 | 15 | 17 | 13 | 16 | 12 | 14 |
| #7 | 19 | 23 | 17 | 20 | 15 | 18 | 14 | 17 |
| #8 | 22 | 27 | 19 | 23 | 17 | 21 | 16 | 19 |
| #9 | 25 | 30 | 22 | 26 | 19 | 23 | 18 | 21 |
| #10 | 28 | 34 | 24 | 29 | 22 | 26 | 20 | 24 |
| #11 | 31 | 37 | 27 | 32 | 24 | 29 | 22 | 27 |
| #14 | 37 | 45 | 32 | 39 | 29 | 35 | 27 | 32 |
| #18 | 50 | 60 | 43 | 52 | 39 | 46 | 35 | 42 |

**Notes:**

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths of standard hooks are calculated per ACI 318-08, Section 12.5.
3. For bar sizes #3 through #11 only:
   a. If concrete cover conforms to ACI 12.5.3(a), then a modification factor of 0.7 may be applied but the length must not be less than 8.0 $d_b$ nor 6 inches.
   b. If hook is enclosed in ties or stirrups per ACI 12.5.3(b) or 12.5.3(c), then a modification factor of 0.8 may be applied but the length must not be less than 8.0 $d_b$ nor 6 inches.
   b. When applying modification factors noted above, see Table 5-7 for minimum hook embedment needed to provide 2 inches of concrete cover to tail of 180° hooks.
4. For Grade 75 (minimum yield strength of 75,000 psi) reinforcing bars, lengths must be multiplied by 1.25.
5. For lightweight aggregate concrete, multiply the tabulated values by 1.33.

## Table 5-5(b) – Tension Development Lengths for Standard Hooks

| BAR SIZE | $f'_c$ = 7,000 psi | | $f'_c$ = 8,000 psi | | $f'_c$ = 9,000 psi | | $f'_c \geq$ 10,000 psi | |
|---|---|---|---|---|---|---|---|---|
| | Uncoated | Epoxy-Coated | Uncoated | Epoxy-Coated | Uncoated | Epoxy-Coated | Uncoated | Epoxy-Coated |
| #3 [#10] | 6 | 7 | 6 | 6 | 6 | 6 | 6 | 6 |
| #4 [#13] | 7 | 9 | 7 | 8 | 7 | 8 | 6 | 7 |
| #5 [#16] | 9 | 11 | 9 | 10 | 8 | 10 | 8 | 9 |
| #6 [#19] | 11 | 13 | 10 | 12 | 10 | 12 | 9 | 11 |
| #7 [#22] | 13 | 15 | 12 | 14 | 11 | 14 | 11 | 13 |
| #8 [#25] | 15 | 18 | 14 | 16 | 13 | 15 | 12 | 15 |
| #9 [#29] | 16 | 20 | 15 | 18 | 15 | 17 | 14 | 17 |
| #10 [#32] | 19 | 22 | 17 | 21 | 16 | 20 | 16 | 19 |
| #11 [#36] | 21 | 25 | 19 | 23 | 18 | 22 | 17 | 21 |
| #14 [#43] | 25 | 29 | 23 | 28 | 22 | 26 | 21 | 25 |
| #18 [#57] | 33 | 39 | 31 | 37 | 29 | 35 | 27 | 33 |

***Reference Table 5-5(a) Notes.***

Table 5-6(a) – Tension Development Lengths for Headed Reinforcing Bars

| BAR SIZE | $f'_c$ = 3,000 psi | | $f'_c$ = 4,000 psi | | $f'_c$ = 5,000 psi | | $f'_c$ = 6,000 psi | |
|---|---|---|---|---|---|---|---|---|
| | Uncoated | Epoxy-Coated | Uncoated | Epoxy-Coated | Uncoated | Epoxy-Coated | Uncoated | Epoxy-Coated |
| #3 | 7 | 8 | 6 | 7 | 6 | 6 | 6 | 6 |
| #4 | 9 | 11 | 8 | 9 | 7 | 8 | 6 | 8 |
| #5 | 11 | 13 | 10 | 12 | 9 | 10 | 8 | 10 |
| #6 | 13 | 16 | 12 | 14 | 10 | 13 | 10 | 11 |
| #7 | 16 | 19 | 14 | 16 | 12 | 15 | 11 | 13 |
| #8 | 18 | 21 | 15 | 19 | 14 | 17 | 13 | 15 |
| #9 | 20 | 24 | 17 | 21 | 16 | 19 | 14 | 17 |
| #10 | 23 | 27 | 20 | 23 | 18 | 21 | 16 | 19 |
| #11 | 25 | 30 | 22 | 26 | 19 | 23 | 18 | 21 |

**Notes:**

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths of headed bars are calculated per ACI 318-08, Section 12.6.

Table 5-6(b) – Tension Development Lengths for Headed Reinforcing Bars

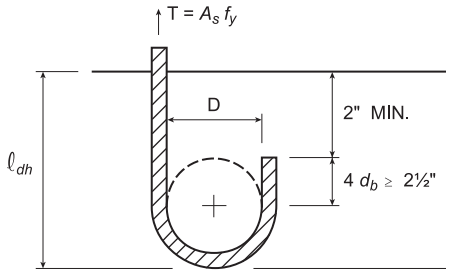
| BAR SIZE | $f'_c$ = 7,000 psi | | $f'_c$ = 8,000 psi | | $f'_c$ = 9,000 psi | | $f'_c$ = 10,000 psi | |
|---|---|---|---|---|---|---|---|---|
| | Uncoated | Epoxy-Coated | Uncoated | Epoxy-Coated | Uncoated | Epoxy-Coated | Uncoated | Epoxy-Coated |
| #3 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| #4 | 6 | 7 | 6 | 7 | 6 | 6 | 6 | 6 |
| #5 | 7 | 9 | 7 | 8 | 7 | 8 | 6 | 8 |
| #6 | 9 | 11 | 8 | 10 | 8 | 9 | 8 | 9 |
| #7 | 10 | 12 | 10 | 12 | 9 | 11 | 9 | 10 |
| #8 | 12 | 14 | 11 | 13 | 10 | 12 | 10 | 12 |
| #9 | 13 | 16 | 12 | 15 | 12 | 14 | 11 | 13 |
| #10 | 15 | 18 | 14 | 17 | 13 | 16 | 12 | 15 |
| #11 | 16 | 20 | 15 | 18 | 15 | 17 | 14 | 17 |

**Notes:**

1. Tabulated values are based on a minimum yield strength of 60,000 psi. Lengths are in inches.
2. Tension development lengths of headed bars are calculated per ACI 318-08, Section 12.6.

TABLE 5-7 Minimum Embedment Lengths to Provide 2 inches of Concrete Cover to Tail of Standard 180° End Hooks

| #3 | #4 | #5 | #6 | #7 | #8 | #9 | #10 | #11 | #14 | #18 |
|---|---|---|---|---|---|---|---|---|---|---|
| 6″ | 7″ | 7″ | 8″ | 9″ | 10″ | 12″ | 14″ | 15″ | 20″ | 25″ |




Standard 180° End Hooks (ACI 7.1)

# STANDARD HOOKS

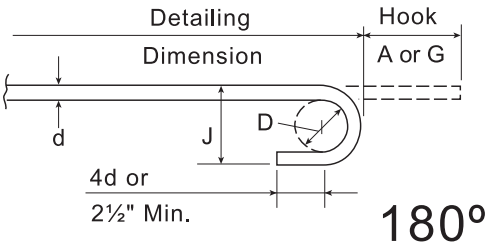
All specific sizes recommended by CRSI below meet minimum requirements of ACI 318.

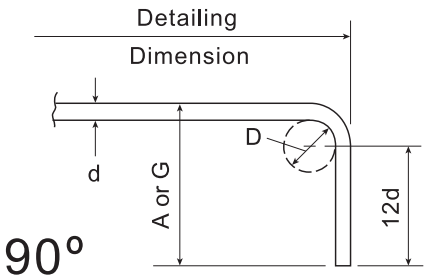
## RECOMMENDED END HOOKS

All grades of steel (minimum yield strengths)

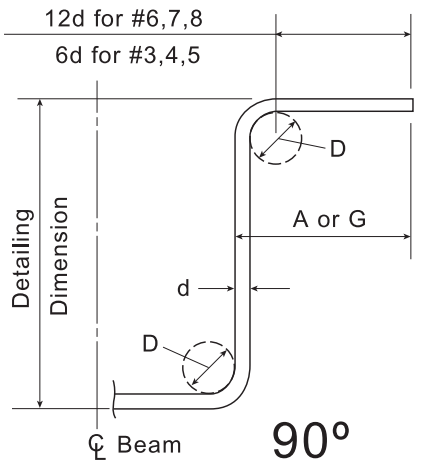
D = Finished inside bend diameter
*d* = Bar diameter

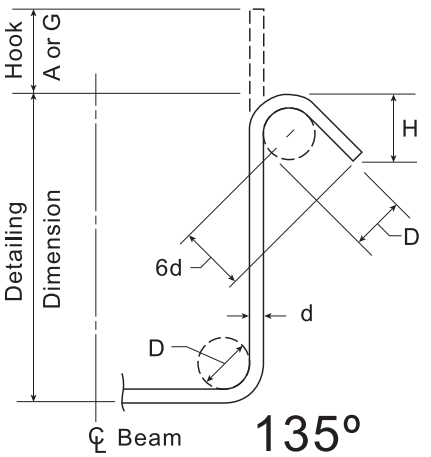
| Bar Size | D | 180° HOOKS | | 90° HOOKS |
|---|---|---|---|---|
| | | A or G | J | A or G |
| #3 | 2¼″ | 5″ | 3″ | 6″ |
| #4 | 3″ | 6″ | 4″ | 8″ |
| #5 | 3¾″ | 7″ | 5″ | 10″ |
| #6 | 4½″ | 8″ | 6″ | 1′-0″ |
| #7 | 5¼″ | 10″ | 7″ | 1′-2″ |
| #8 | 6″ | 11″ | 8″ | 1′-4″ |
| #9 | 9½″ | 1′-3″ | 11¾″ | 1′-7″ |
| #10 | 10¾″ | 1′-5″ | 1′-1¼″ | 1′-10″ |
| #11 | 12″ | 1′-7″ | 1′-2¾″ | 2′-0″ |
| #14 | 18¼″ | 2′-3″ | 1′-9¾″ | 2′-7″ |
| #18 | 24″ | 3′-0″ | 2′-4½″ | 3′-5″ |



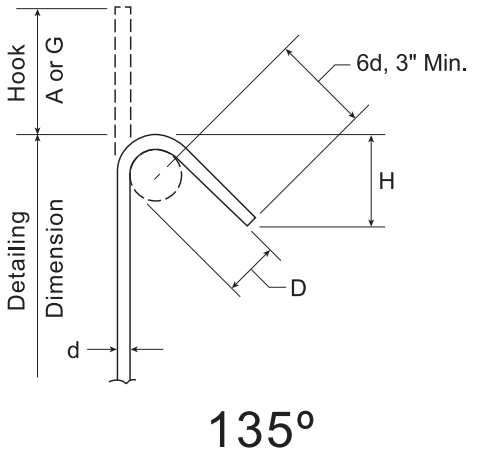




## STIRRUP/TIE HOOKS




## SEISMIC STIRRUP/TIE HOOKS




## STIRRUP/TIE HOOK DIMENSIONS

| Bar Size | D | 90° Hook | 135° Hook | |
|---|---|---|---|---|
| | | Hook A or G | Hook A or G | H (Approx.) |
| #3 | 1½″ | 4″ | 4″ | 2½″ |
| #4 | 2″ | 4½″ | 4½″ | 3″ |
| #5 | 2½″ | 6″ | 5½″ | 3¾″ |
| #6 | 4½″ | 1′-0″ | 8″ | 4½″ |
| #7 | 5¼″ | 1′-2″ | 9″ | 5¼″ |
| #8 | 6″ | 1′-4″ | 10½″ | 6″ |

## SEISMIC STIRRUP/TIE HOOK DIMENSIONS

| Bar Size | D | 135° Hook | |
|---|---|---|---|
| | | Hook A or G | H (Approx.) |
| #3 | 1½″ | 4¼″ | 3″ |
| #4 | 2″ | 4½″ | 3″ |
| #5 | 2½″ | 5½″ | 3¾″ |
| #6 | 4½″ | 8″ | 4½″ |
| #7 | 5¼″ | 9″ | 5¼″ |
| #8 | 6″ | 10½″ | 6″ |

# CHAPTER 6 – SERVICEABILITY REQUIREMENTS

**General.** Strength design permits the utilization of larger percentages of tension reinforcement without compression reinforcement, and allows advantageous use of higher strength reinforcement. Shallower construction can result. Once the safety of the member or floor system is determined by strength design, it is necessary to confirm that both deflection and cracking are within tolerable limits at service load levels. If the required reinforcement is provided as small bars spaced close together, crack control requirements are easier to satisfy.

**Deflection Control.** Deflections must be computed and compared to allowable limits for particular loading combinations when the thickness used is less than the minimums tabulated below (ACI 9.5.2.1).

*For one-way construction:*

| Member | Minimum Thickness, $h$ † | | | |
|---|---|---|---|---|
| | Simply Supported | One End Continuous | Both Ends Continuous | Cantilever |
| Solid slabs | $\ell/20$ | $\ell/24$ | $\ell/28$ | $\ell/10$ |
| Beams or joists | $\ell/16$ | $\ell/18.5$ | $\ell/21$ | $\ell/8$ |

† Members not supporting or attached to partitions or other construction likely to be damaged by large deflections.

Values of $h$ for normal-weight concrete and Grade 60 reinforcing bars.

$\ell$ = c.-c. spans.

*For two-way flat plate construction without beams:* Exterior and interior panels: $h \geq \ell_n/33$ (5 in. min.). For the effects of edge beams, drop panels, rectangular panels, edge panels, and corner panels, see Table 10-1.

Computed deflections are limited to values that are acceptable for various conditions of loading and design requirements. These acceptable limits are given as fractions of the span lengths and vary with the use of a structure. For example, a floor supporting partitions or supporting a ceiling below can tolerate much less deflection, because of cracking of the supported elements, than the same floor without a ceiling or partitions. If the problem is that of establishing clearance under a flexural member and over, say, a plate glass store front, many factors, such as age, moisture content, actual $E_c$, settlement of supports, realistic end restraints, and the like, have an influence on the actual deflection.

When the computed long-term deflection exceeds the allowable, one of the most satisfactory means of decreasing these creep-caused deflections is the addition of compressive reinforcement.

**Deflection Computations.**†† The calculation of deflections requires the computation of $E_c$, the modulus of elasticity of the concrete, and $I_e$, the effective moment of inertia of the cross-section.

The modulus of elasticity for concrete $E_c = w^{1.5}\, 33\, \sqrt{f'_c}$. Use the specified concrete compressive strength $f'_c$ for preliminary calculations. For normal-weight concrete, $E_c$ may be taken as $57{,}000\, \sqrt{f'_c}$ (ACI 8.5.1). Taking $f'_c$ as 3000 psi, $E_c$ = 3,122,000 psi; and for $f'_c$ = 4,000 psi, $E_c$ = 3,605,000 psi.

The effective moment of inertia, $I_e$, is a function of the gross moment of inertia, $I_g$, the cracked moment of inertia, $I_{cr}$, and the ratio of the cracking moment, $M_{cr}$, to the actual (service load) moment, $M_a$.

For values of $I_g$ and $I_{cr}$ for solid sections, see Table 12-1; for standard joist or waffle slab sections, see Table 8-1, Gross Section Properties, for $I_g$, and the load capacity tables footnote for $I_{cr}$ with each individual combination of bars and for $M_{cr}$. Determining the cracking moment:

$$M_{cr} = f_r I_g / y_t$$

where $f_r = 7.5\sqrt{f'_c}$ for normal-weight concrete and $y_t$ is the distance from the neutral axis of the solid section to the tension fiber.

Code Equation (9-8) for calculating the effective moment of inertia $I_e$ is

$$I_e = (M_{cr}/M_a)^3 I_g + [1 - (M_{cr}/M_a)^3] I_{cr}$$

*One-way slabs, joists and beams*. For the uniform load conditions upon which all of the tabulated designs in this *Handbook* are based, deflections can be estimated from the relationship $\Delta = KwL'^4\, 1728/E_c I_e$ where $K$ is a constant related to the degree of restraint at either

†† It should be emphasized that the calculations illustrated result in a *computed* deflection only. The results are useful to determine compliance with minimum code limits. These results may be used as a starting point to estimate *actual* deflections, but must be modified to reflect other parameters such as the need for camber, effects of restraint, shrinkage, probable curing and construction sequences — all of which influence the actual deflection. The *computed* deflections tabulated in this *Handbook* should be evaluated to determine adjustments necessary for use in preparing estimates of *actual probable deflection*.

end; $w$ is the uniform load, plf; $L'$ is the appropriate span in feet; $E_c$ is the modulus of elasticity of the concrete, psi; and $I_e$ is the effective moment of inertia of the cross-section, in.$^4$, and $\Delta$ is in inches.

Three conditions of restraint have been tabulated for one-way flexural members:

(1) Simple, single span, $+M = wL'^2/8$;

The value of $K$ for a single span when $+M = wL'^2/8$ is given in textbooks as $K = 5/384$. Settlement of the supports has little effect on this coefficient.

(2) End span of continuous member, $+M = wL'^2/11$.

For end spans with $+M = wL'^2/11$, the value of $K$ is not so readily found in textbooks. A value of $K$ for gravity loads is obtained by the conjugate beam concept as $K = 3.25/384$, assuming no settlement of supports.

(3) For interior spans with $+M = wL'^2/16$ the same limitations apply and the same method can be used, resulting in $K = 2/384$.

These coefficients are summarized in the table below:

| Values of $K$ in $\Delta = KwL'^4\ 1728/E_cI_e$ | | |
|---|---|---|
| Type of Restraint | Maximum Positive Moment | Value of $K$ |
| Simple Span | $+wL'^2/8$ | 5/384 |
| End Span | $+wL'^2/11$ | 3.25/384 |
| Interior Span | $+wL'^2/16$ | 2/384 |

**Applications**

*One-Way Systems*. All factored load capacity tables in this *Handbook* can be used without the need to compute deflection for all floor and roof systems where they do not support non-structural elements liable to be damaged by service load deflections greater than $\ell/360$. For one-way systems where capacity is controlled by deflection, such values are so noted.

When the one-way floor or roof system supports elements liable to be damaged by deflections greater than $\ell/360$, the designs can be selected above the horizontal line in each table, which identifies minimum depth/span ratio above which the Code does not require deflection computations. Alternatively, design aids can be used to determine values of $E_c$ and $I_e$ for calculation of deflection, or deflection can be conservatively estimated from known loading conditions (tabulated) and the deflection equation for the tabulated loading pattern. See examples in Chapters 7 and 8.

*Retaining Walls*. Deflection at the top of all retaining wall designs has been computed assuming the base of the wall is fixed. Thickness/height proportions were selected for the tabulated designs so that deflection is less than $h_w/240$. The exposed face should be cambered if a vertical face design is desired. If a battered face is on the exposed side, no further precaution is needed.

*Two-Way Slab Systems*. Slab thickness, $h$, for flat plates and flat slabs; or rib-plus-slab, $h$, for waffle flat slabs may be compared to the limits in Table 10-1, to ensure that deflection computations are not required.

If it becomes necessary to compute deflections of two-way slab systems, due to use of less depth than that of the minumum depth/span ratios or to estimate camber required for level floors, some simplifications may be made. Since the cracking moment/actual moment ratio ($M_{cr}/M_a$) → 1.0 for joist and waffle slabs, use of an average gross moment of inertia gives reasonable results. For solid slabs, use of an average ($M_{cr}/M_a$) ratio for computation of $I_e$ and center-to-center spans should be conservative.

The simplest way to estimate maximum elastic deflection at service (elastic) loading for a two-way flat slab or a waffle slab is to use an elastic plate on point supports.* Simplifying assumptions, justifiable for such estimates, include, in addition to the usual assumptions of elasticity and homogeneity: (1) basically uncracked behavior, i.e., use of gross moment of inertia, (2) average moment of inertia based on ratio of twice the solid head or drop area to total area, (3) spans c.-c. of columns neglecting size of column, and capital, if any, and (4) load on panel is uniformly applied.

The basic plate formula* for deflection, $\Delta$, at the center of interior panels is:

$$\Delta = k\,\frac{wL^4}{E_c t_e^{\,3}}\,(144) \text{ in inches, where}$$

$w$ = service load, psf
$L$ = longer span of panel, feet
$L'$ = shorter span of panel, feet
$t_e$ = equivalent average thickness, inches (Measure of moment of inertia)
$k$ = coefficient depending on ratio of spans

Notes: All terms must be expressed in consistent units. This equation is similar in form to that for one-way slab deflection given previously.

*S. Timoshenko and S. Woinowsky-Krieger, *Theory of Plates and Shells*, Second Edition, McGraw-Hill Co., 1959.

For uniformly loaded rectangular panels, values for $k$ are:

| Ratio spans $L/L'$ = | 1 | 1.1 | 1.2 | 1.3 | 1.4 | 1.5 | 2.0* |
|---|---|---|---|---|---|---|---|
| $k$ = | 0.0634 | 0.0532 | 0.0467 | 0.0423 | 0.0391 | 0.0368 | 0.0319 |

* Limiting ratio for Direct Design – ACI 13.6.1.2.
For "checkerboard loading," square panels: $k = 0.0539$.
For alternate bays loaded, which produces largest deflections, basic formula is modified for square panels to: $\Delta = 0.1028 \frac{wL^4}{E_c t_e^3}$ and is applicable when five or more bays are continuous transversely to direction of loaded bays. These formulas conservatively assume point support at all columns.

**Example**

This example illustrates the deflection computation of a waffle slab. Deflection of a flat slab would be computed in a similar manner.

A typical load test following requirements of the ACI Building Code on a standard waffle flat slab will serve to illustrate the simplified procedure suggested for computing deflection.

*Design Data:*

Roof with square panels of 36-foot spans, 6-inch wide ribs on a 3′-0″ module with 30 × 30 × 12 standard forms; top slab thickness 4 inches. Total depth = 12 + 4 = 16 inches. Solid head of 18′-0″.

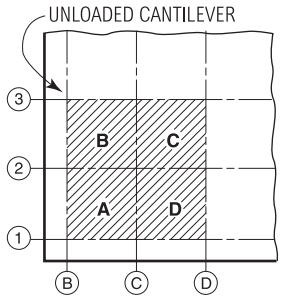
*Load Test Data:*

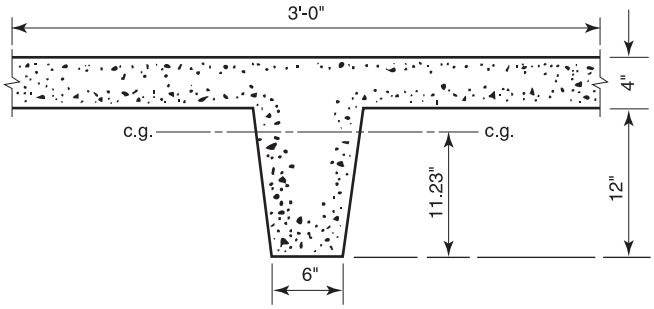
Test Load = Average 15-inch depth of water
= 78 psf

Four panels loaded between column centerlines 1 and 3 and centerlines B and D including one corner panel, two edge panels, and one interior panel. Immediate and 24-hour readings were taken at centers of each panel as follows:

| Location | Mark | Immediate† | 24-hour† |
|---|---|---|---|
| Corner panel | A | –0.240 in. | –0.288 in. |
| Edge panel | B | –0.180 in. | –0.192 in. |
| Interior panel | C | –0.096 in. | –0.108 in. |
| Edge panel | D | –0.204 in. | –0.264 in. |

† Probable accuracy of measurement ± 0.024 in.




*Solution:* (Note: See Chapters 10 and 11 for explanation of procedure for computing equivalent average thickness, $t_e$, for solid flat slab and waffle flat slab respectively.)

Solid Head Area, $I_h = \frac{12 \times 16^3}{12} = 4{,}096$ in.$^4$ per 12 in. width

Waffle Area:

Use rib width 6 in.

$X_{c.g.}$ = 11.23 in. from bottom

For 36 in. width:

$$I_w = \frac{36 \times 4^3}{12} + (144)(2.77)^2 + \frac{6 \times 12^3}{12} + (72)(5.23)^2$$
$$= 4{,}130 \text{ in.}^4$$

For 12 in. width, $I_w = 4{,}130/3 = 1{,}377$ in.$^4$

$$\frac{\text{Area of Solid Head}}{\text{Area of Total Panel}} = \frac{(18)(18)}{(36)(36)} = \tfrac{1}{4}$$

Multiply ratio of solid area by two because stiffness in the area of maximum moment has most effect on deflection.

$$\text{Average } I_{gross} = \frac{4{,}096 \times 2 + 1{,}377 \times 3}{5} = 2{,}464 \text{ in.}^4/12 \text{ in.}$$

Compute equivalent average thickness, $t_e$:

$$\frac{12 \times t_e^3}{12} = 2{,}464 \text{ in.}^4 \qquad t_e^3 = 2{,}464 \text{ in.}^3 \text{ and } t_e = 13.5 \text{ in.}$$

Load $w = \frac{78}{144}$ psi

$L = 36 \times 12$ in.

Take $E_c = 3{,}500{,}000$ psi

Estimated deflection $\Delta = k \frac{wL^4}{E_c t_e^3}$

The selection of the proper coefficient $k$ usually requires some study of the loading pattern when attempting to predict results of a load test since the exact $k$ values were derived for a uniform load pattern extending far beyond the usual practicable limits of test loading. For this example, approximate $k$ as the coefficient for an interior panel with all the surrounding panels loaded at least two bays distant is usual. For a square interior panel, this computed deflection would be:

$$\Delta = 0.0634 \times \frac{78}{144} \times \frac{(36 \times 12)^4}{3.5 \times 10^6 \times 2{,}464} = 0.141 \text{ in.}$$

To correlate computed deflection with the conditions of this test in which half the surrounding panels were loaded, a lower coefficient than for all panels loaded is proper. The "checkerboard" loading coefficient of 0.0539 is probably more appropriate, although it does not model the load test either. Try a value of 0.055.

$$\Delta = \frac{0.055}{0.0634} \times 0.141 = 0.122 \text{ in.} = 0.01 \text{ ft}$$

Measured $\Delta = 0.009$ ft. This correlation is probably closer than could be usually expected.

**Crack Control.** To control crack widths, flexural reinforcement must be well-distributed in the zones of maximum concrete tension. Bar spacing in two-way slabs should not be greater than 2*h* (ACI 13.3.2).

The final crack width after a period of time depends on the magnitude of (1) flexural cracking, (2) shrinkage, (3) creep, and (4) temperature movements. The effects of the last three items may be partially counteracted in many ways.

*T-Beams.* Where the top flanges of major T-beams are in tension, part of the negative moment reinforcement must be distributed over an effective flange width (ACI 10.6.6). The effective flange width is the smaller of: the width defined for flexural design (ACI 8.12), or a width equal to 1/10 of the span. If the effective flange width exceeds 1/10 the span, some longitudinal reinforcement must be placed in the outer portions of the flange.

*Skin Reinforcement.* If the depth of the web of a beam exceeds 36 inches, longitudinal skin reinforcement must be provided in the vertical faces of the web to control the crack width in the web (ACI 10.6.7). Without web reinforcement, the crack width in the web could be wider than at the tension reinforcement level. The skin reinforcement must be uniformly distributed along both side faces of the web for a distance *h*/2 from the tension face. Spacing of the skin reinforcement should not exceed the same limits as flexural reinforcement for one-way slabs and beams (see next Section). The Code permits inclusion of the skin reinforcement in computation of design moment strength, provided a compatibility analysis is made to determine the stresses in the individual bars.

**Maximum Spacings for Reinforcing Bars.** It is generally agreed that the size and spacing of flexural cracks are a function of steel stress, the amount of concrete cover over bars, and the area of concrete surrounding and tributary to the area of an individual bar.

*One-Way Slabs and Beams.* According to the ACI Building Code, reinforcing bars must not be spaced farther apart than the spacing calculated from Code Eq. (10-4):

$$s = 15\left(\frac{40{,}000}{f_s}\right) - 2.5c_c \le 12\left(\frac{40{,}000}{f_s}\right)$$

where $f_s$ can be taken as 40 ksi for Grade 60 bars and $c_c$ = concrete cover.

For one-way slabs with ¾ inches of concrete cover to the flexural reinforcement, the maximum bar spacing is 12 inches. For beams with #4 stirrups and 1½ inches of concrete cover to the stirrups, the maximum bar spacing is 10 inches.

# CHAPTER 7 – ONE-WAY SLABS

## ONE-WAY SOLID SLABS

This Chapter presents tabulated designs for uniform depth solid concrete slabs reinforced for flexure in one direction and only for temperature and shrinkage in the other direction. The tabulated factored usable superimposed loads were obtained as the least value determined by shear, or positive or negative flexure.

## GENERAL CODE CONSIDERATIONS

Factored moments are computed from the empirical coefficients of ACI 8.3.3,* as an elastic beam free to rotate on unyielding supports. ACI 8.3.3 limits the use of empirical moment coefficients to ratios of live load to dead load—unfactored gravity loads—of not more than three. Since part of the superimposed gravity load may be dead load, the ratio of live to dead load may vary in each instance. Therefore, superimposed gravity loads are tabulated well above three times the dead weight of the slab itself.

The recommended reinforcement details in Fig. 7-1 show where straight reinforcing bars are cut off, anchored, and extended in accordance with current standard practices and the *ACI Detailing Manual.* These practices have worked satisfactorily for many years for normal load and span ratios. Necessary modifications must be made when the conditions of an individual design require them. A practical, economical design should use no more than two or three bar sizes for slabs across an entire floor. The bar sizes tabulated in the load tables must be adjusted to fit tabulated areas for simple, fast placing in the entire floor or roof slab, which may include variable spans and loads. Such adjustments can be made with smaller bar sizes at closer spacings without checking anchorages. Larger bars may be substituted at larger spacings if tension development length and crack control requirements are satisfied. For example, some top bars should be extended to be continuous throughout the span if the ratio of live to dead load exceeds three.

## SCOPE OF TABULATED DESIGNS

These tabulated designs for one-way solid slabs give the *factored usable superimposed load,* in pounds per square foot. In other words, the tabulated loads are net factored superimposed loads. Total factored load was calculated and reduced by the prescribed strength-reduction factors ($\phi$-factors), from which 1.2 times the slab weight was deducted using a unit weight of 150 pounds per cubic foot (pcf). One set of material strengths is used: normal-weight concrete with $f_c' =$ 4,000 psi and reinforcing bars with $f_y =$ 60,000 psi.

Three cases of end restraint are considered: (1) single spans simply supported; (2) end spans free on one end and continuous on the other; and (3) interior spans continuous on both ends.

Factored usable superimposed loads are tabulated for slabs with various ratios of flexural reinforcement: single spans for the minimum, $\rho \geqq 0.0018bh$, $\rho \approx 0.0025bd$, $\rho \approx 0.0050bd$, $\rho \approx 0.0075bd$, and $\rho \approx 0.0100bd$; end and interior spans for minimum recommended top reinforcing steel, $\rho \approx 0.0018bh$, $\rho \approx 0.0025$, 0.0050, 0.0075, and $0.0100bd$.

For $f_c' = 4{,}000$ psi and $f_y = 60{,}000$ psi, the maximum $\rho = 0.0181$ for tension-controlled sections. All of the ratios of flexural reinforcement are less than 0.0181 so that the strength-reduction factor, $\phi$, is 0.90 for flexure.

The recommended minimum reinforcement * is a variable percentage since for adequate rigidity of top bars under ordinary construction traffic in monolithic construction, minimum size #4 bars at a maximum spacing of 12 inches are recommended. For thin slabs, this practical minimum is well within Code limits, i.e., $A_s = 0.0018bh$ spaced at 18 inches or $3h$ maximum. An exception is made for thin single span slabs where cross traffic is not expected. The recommended maximum reinforcement ratio, $\rho \leq 0.010bd$, is the maximum for economy is most routine applications. Bar spacing is also limited by the Code's requirements for crack control (ACI 10.6.4). For ¾ inches of concrete cover, which is used in the tabulated designs, the maximum bar spacing is 12 inches. The limit on top reinforcement for a balanced design at continuous supports controls the bottom reinforcement where end spans and interior spans are equal.

Temperature-shrinkage reinforcement in structural floor and roof slabs is tabulated for reinforcing bars with $f_y =$ 60,000 psi.

## BASIS FOR DESIGN

Flexural design is based on factored moments computed by the coefficients per ACI 8.3.3. See Chapter 5.

* In all cases, equal or greater than the minimum prescribed in ACI 10.5.4.

Design shear strength, $\phi V_n$, was calculated in accordance with ACI 11.2. Both "short" and "long" formulas were compared and the larger value of $\phi V_n$ was used. Tension development of reinforcing bars has been checked in accordance with ACI Chapter 12, applied to bars anchored in accordance with the recommended reinforcement details in Fig. 7-1. Elastic deflections for all full tabulated superimposed loads divided by 1.6 are less than $\ell/360$. Thus, the tabulated designs need not be investigated for any live load deflection. Creep deflections will vary according to proportion of the superimposed service loads of long-term duration. Where long-term deflection limits of the Code apply, e.g., slabs supporting or attached to brittle partitions, long-term deflection must be computed. See example, Chapter 6.

## ASSUMPTIONS IN DESIGN

It was assumed that end restraint at free ends of the slab has a negligible effect on the positive moment. Top bars tabulated in Single Span tables provide at least one-third of the area tabulated for bottom reinforcing steel but not less than #4 in size, except for short single span slabs, nor at spacings more than 12 inches. The top reinforcing steel is sufficient for free ends supported by monolithic beams or girders, where the Code moment coefficient = 1/24 $w_u \ell_n^2$ applies, as well as the ordinary incidental restraint when end bearing is provided by masonry walls.

For interior spans, tabulated top reinforcing steel at continuous supports is based upon an adjoining span equal to the span being considered. This condition will fit the typical case where the adjacent span slab thickness is equal, the span lengths are equal, and the spans are loaded with the same uniformly distributed load. This condition should always be adequate where the adjoining spans are shorter or more lightly loaded. In order to fit unequal spans, provide the top steel area tabulated for the longer span and have that reinforcement extend one-third the longer span length on both sides of the support.

For end spans, top reinforcing steel at the continuous interior supports is calculated for an interior span of the *same slab thickness.* This condition will fit the typical practical situation. Where slabs of varying thickness are used for special load-span conditions, the tabulated top steel area for the shallower span must be provided using added straight top bars for any deficiency.

## USE OF LOAD TABLES — SINGLE SPAN

**Single Span Example 1** – Design a single span solid slab floor to span 12′-8″ clear between masonry bearing walls for the following superimposed service loads. Space permits a 6-in. depth.

| | |
|---|---|
| Live load | 150 psf |
| Floor finish | 13 psf |
| Ceiling | 8 psf |

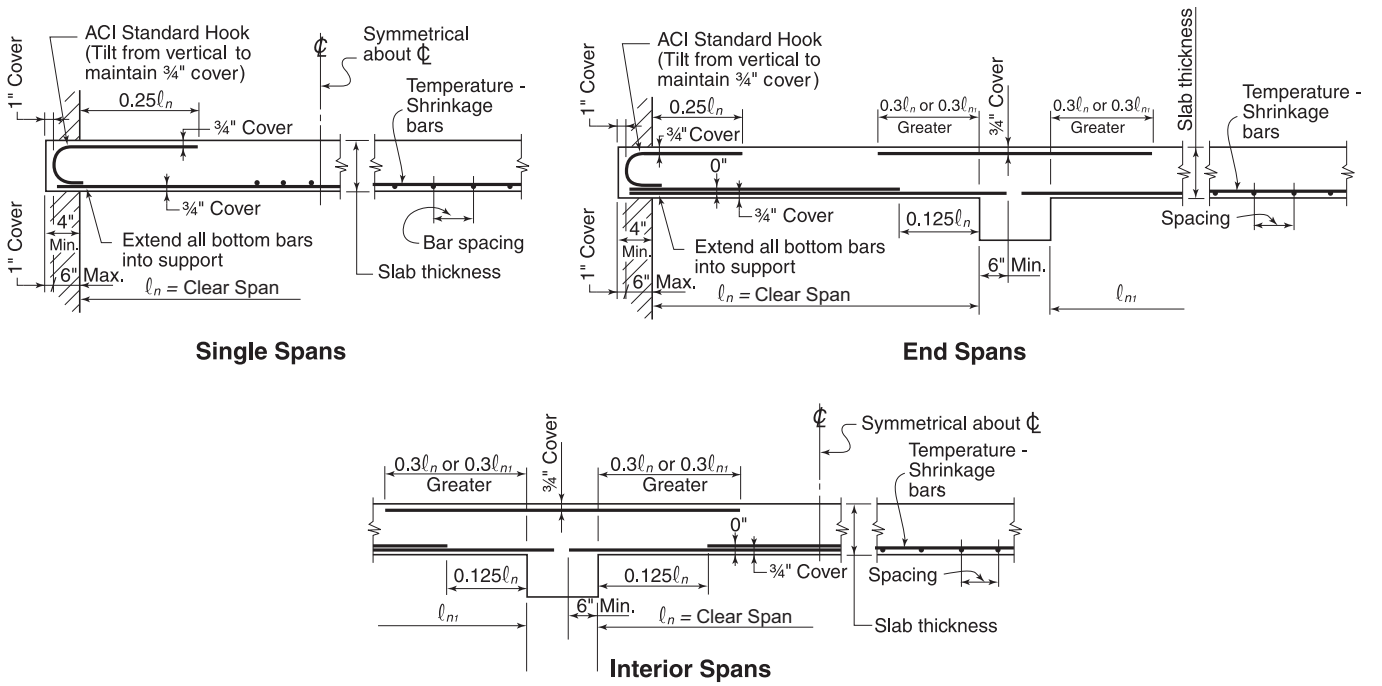



**Figure 7-1 Recommended Bar Details – Solid Slabs**

*Solution:*

*Strength Design*

The total factored superimposed load requirement is:

Live load $150 \times 1.6 = 240$ psf
Dead load $(13 + 8) \times 1.2 = \underline{25}$
$w_u = 265$ psf

Since the clear span is 12′-8″ and a minimum bearing width of 4 inches is recommended, the span center-to-center of bearings for design is 12′-8″ + 2″+ 2″ = 13′-0″.

Try each load table beginning with minimum reinforcement to determine if the 6-in. depth is feasible.

See Page 7-5, $\rho \approx 0.0018$: $w_u =$ 49 psf capacity < 265
See Page 7-6, $\rho \approx 0.0025$: $w_u =$ 83 psf capacity < 265
See Page 7-7, $\rho \approx 0.0050$: $w_u = 220$ psf capacity < 265
See Page 7-8, $\rho \approx 0.0075$: $w_u = 296$* psf capacity > 265
Use design from Page 7-8; $\rho \approx 0.0075$; $h = 6$ in.

| | |
|---|---|
| Bottom bars | #6 spaced at 12 in. |
| Top bars | #4 spaced at 12 in. |
| Temp.-shrinkage bars | #3 spaced at 10 in. |

Recommended bar details are shown in Fig. 7-1.

*Serviceability Check*

1. Deflection – Note asterisk on Page 7-8 load (296*) indicates an elastic deflection of $\ell/360$ at a service load of 296/1.6.

$$\text{Live load deflection} = \left(\frac{240}{296}\right)\left(\frac{13 \times 12}{360}\right) = 0.35 \text{ in.}$$

2. Crack control – The maximum spacing permitted by ACI 10.6.4: $s = 12(40{,}000/f_s) = 12(40{,}000/40{,}000) = 12$ in. The spacing of the #6 bottom bars is 12 in. = 12 in., Okay.

**Single Span Example 2** – Design a minimum depth roof slab for a single clear span of 16 ft between supporting monolithic beams for the following superimposed service loads:

Live load, $L = 30$ psf
Roofing material, $D = 15$ psf

*Solution:*

*Strength Design*

Augment and accumulate loads for factored superimposed capacity required:**

$30 \times 1.6 + 15 \times 1.2 = 66$ psf. See table on Page 7-8, $\rho \approx 0.0075$. Select a 5-in. slab, $w_u = 89$* psf capacity.

** Note: Total factored load superimposed on the supporting beams is the sum of 1.2 times the slab weight, $1.2 \times 63 + 66$ psf = 142 psf times half span 8 feet = 1,136 plf.

Reinforcing bars required are:

| | |
|---|---|
| Bottom bars | #5 spaced at 10 in. |
| Top bars | #3 spaced at 12 in. |
| Temp.-shrinkage bars | #3 spaced at 11 in. |

*Serviceability Check*

1. Deflection – Note asterisk next to $w_u$. Live load deflections are approximately

$$\left(\frac{1.6 \times 30}{89}\right)\left(\frac{16 \times 12}{360}\right) = 0.29 \text{ in.}$$

2. Crack Control – Spacing of #5 bars is 10 in.< 12 in., Okay.

**Single Span Example 3** – Repeat requirements of Example 1, $\ell_n = 13'\text{-}0''$; $D = 21$ psf, $L = 150$ psf and $w_u = 265$ psf, with the additional serviceability requirement that rigid partitions are to be attached to the slab so that the design must meet the deflection limit of $\ell_n/480$ for the sum of elastic live load deflection plus creep deflection. Assume that the partition weight is equivalent to 20 psf additional uniform dead load.

The computed long-term deflection occurring after installation of partitions plus the computed elastic deflection due to service live loads is limited by the Code to $\leq \ell_n/480$. Assume that partition installation will be scheduled last. An estimated 50 percent of the long-term deflection due to dead weight of slab, floor finish, and ceiling will have occurred. Determine minimum thickness required for these design conditions.

*Strength Design*

*A*ccumulate total superimposed factored load

$w_u = (1.2)(20 + 21) + (1.6)(150) = 289$ psf

From:
Page 7-7, 7-in. slab with $\rho \approx 0.0050$, $w_u = 343$ psf
Page 7-8, 6½-in. slab with $\rho \approx 0.0075$, $w_u = 389$* psf.

*Serviceability Check*

The deflection limit will control this design. Accumulate an equivalent factored load which would result in an immediate deflection equal to (360/480) times $\ell/360$. Try a 7½-in. slab. $D = 94$ psf.

Effect of partitions on long-term deflection; if duration $\geq 5$ years, $\xi = 2.0$ (ACI 9.5.2.5); if no compression reinforcement, the multiplier $\lambda = 2.0$.

$$\begin{aligned}\text{Equiv. } w_u &= (D + L)(1.6)(480/360) = (D + L)(2.13)\\ &= [(2)(20) + 21 + 94 + 150](2.13)\\ &= (305)(2.13) = 650 \text{ psf}\end{aligned}$$

From Page 7-8, $\rho \approx 0.0075$, for 7½-in. slab: $w_u = 582$* psf

7

Try an 8-in. slab, $D$ = 100 psf.

Equiv. $w_u$ = (305 + 6)(2.13) = 662 psf

From Page 7-8, $\rho \approx 0.0075$, for 8-in. slab: $w_u$ = 714* psf

Use the 8-in. slab (note asterisk).

Live load deflection = $\left(\frac{1.6 \times 150}{714}\right)\left(\frac{13 \times 12}{360}\right) = 0.15$ in.

$\frac{\ell_n}{480} = \frac{13 \times 12}{360} = 0.33$ in.

Select reinforcement from table on Page 7-8, $\rho = 0.0075$;

| | |
|---|---|
| Bottom bars | #7 spaced at 11 in. |
| Top bars | #4 spaced at 12 in. |
| Temp.-shrinkage bars | #3 spaced at 7 in. |

## MANUAL CALCULATION—LOAD TABLES FOR SINGLE SPAN

**Example 4. Single Span**—Derive the factored usable superimposed load value tabulated for an 8-in. solid slab with recommended minimum reinforcement on a single span of 14 ft. From Page 7-5 with $\rho \geq 0.0018\,bh$ (recommended minimum reinforcement), $h$ = 8 in. and #3 bottom bars spaced at 7 in., the factored usable superimposed load is 119 psf. Derive the load value of 119 psf.

*Flexure*

Compute the design moment strength,

$\phi M_n = \phi A_s f_y\ (d - a/2)$

Where $A_s$ = 0.189 in.$^2$/ft for #3 bottom bars spaced at 7 in.

$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.189(60)}{0.85(4)(12)} = 0.28$ in.

$d = h$ – cover – $0.5d_b$

$d$ = 8 – 0.75 – 0.375/2 = 7.06 in.

$\phi M_n = 0.90(0.189)(60)(7.06 - 0.28/2)/12 = 5.89$ ft-kips/ft

Equate $M_u = \phi M_n$ where $M_u = w_u \ell^2/8$

$w_u\,(14)^2/8 = 5.89$

$w_u$ = 0.240 klf or 240 psf

$w_D$ = 8/12(150) = 100 psf (8-in. slab)

Factored usable superimposed load =
240 – 1.2(100) = 120 psf (tabulated = 119, Okay)

*Shear*

Design shear strength is the larger of (ACI 11.2):

$\phi V_c = 2\phi\sqrt{f'_c}\,b_w d$, or . . . . . (ACI Eq. 11-3)

$\phi V_c = \phi\left(1.9\sqrt{f'_c} + 2500\,\rho_w \frac{V_u d}{M_u}\right) b_w d$ (ACI Eq. 11-5)

$\phi V_c = 2(0.75)\sqrt{4{,}000}(12)(7.06)/1000 = 8.04$ kips/ft

At the critical section, a distance $d$ from the face of the support, for uniformly distributed load,

$\frac{V_u d}{M_u} = \frac{w_u(\ell_n/2 - d)d}{w_u d(\ell_n/2 - d/2)} = \frac{\ell_n/2 - d}{\ell_n/2 - d/2}$

$\frac{V_u d}{M_u} = \frac{(14)(12)/2 - 7.06}{(14)(12)/2 - 7.06/2} = 0.96$

$\phi V_c = 0.75(1.9\sqrt{4{,}000}$
$+ 2500\left(\frac{0.189}{7.06 \times 12}\right)(0.96))(12)(7.06)1000)$
= 7.98 kips/ft

Take $\phi V_c$ = 8.04 kips/ft

At a distance $d$ from the face of the support,

$V_u = w_u(\ell_n/2 - d)$

Equate $V_u = \phi V_n$

$w_u\,(14/2 - 7.06/12) = 8.04$

$w_u$ = 1.25 klf or 1,250 psf

Design moment strength governs; hence, $w_u$ = 120 psf

*Tension Development of #3 bottom bars*

Check tension development of #3 bottom bars spaced at 7 in.

Concrete cover = 0.75 in. = 0.75/0.375 = $2d_b$

Spacing = 7 in. = 7/0.375 = $19d_b$

From Table 5-2(b) under "Uncoated Bars" and "Other Bars"; for "Case 1" and "Lap Class A":

$\ell_d$ = 15 in.

Check available embedment length vs. 15 in.

Maximum $+M_u$ occurs at midspan; the distance from midspan to the end of the #3 bars = 7 ft = 84 in. plus the embedment beyond the face of the support; total embedment provided, 84 + embedment > $\ell_d$ of 15 in., Okay.

Check $\ell_d \leq M_n/V_u + \ell_a$ . . . . . (ACI 12.11.3, Eq. 12-5)

Where $M_n = \phi M_n/\phi$ = 5.89/0.90 = 6.54 ft-kips/ft

$V_u$ at support = $w_u(\ell_n/2)$

= 0.240(14/2) = 1.68 kips/ft

$\ell_a$ = embedment beyond center of support; assume $\ell_a$ is at least 1 in.

$M_n/V_u$ = 6.54(12)/1.68 = 46.7

46.7 + 1 = 47.7 in. > $\ell_d$, Okay

## SOLID ONE-WAY SLABS—SINGLE SPAN

Recommended Minimum Reinforcement

$f'_c$ = 4,000 psi — Grade 60 Bars — $\rho \geq 0.0018bh$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #4 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 12 | 11 | 11 |
| Top Bars | #3 | #3 | #3 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| T-S Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 11 | 11 |
| Areas of Steel ($in.^2/ft$) Bottom | 0.110 | 0.110 | 0.110 | 0.120 | 0.132 | 0.147 | 0.165 | 0.165 | 0.189 | 0.189 | 0.200 | 0.218 | 0.218 |
| Slab Wt. (psf) | 50 | 56 | 63 | 69 | 75 | 81 | 88 | 94 | 100 | 106 | 113 | 119 | 125 |
| Steel Wt. (psf) | 0.94 | 0.94 | 0.94 | 1.14 | 1.24 | 1.32 | 1.46 | 1.46 | 1.62 | 1.62 | 1.75 | 1.76 | 1.76 |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
| 6'-0" | 267 | 315 | 361 | 453 | 564 | 702 | 874 | 949 | | | | | |
| 6'-6" | 219 | 258 | 297 | 374 | 468 | 584 | 729 | 792 | 991 | | | | |
| 7'-0" | 180 | 213 | 245 | 311 | 391 | 490 | 614 | 667 | 838 | 900 | | | |
| 7'-6" | 149 | 177 | 204 | 260 | 329 | 414 | 521 | 566 | 715 | 768 | 869 | | |
| 8'-0" | 124 | 148 | 170 | 218 | 278 | 352 | 445 | 484 | 614 | 659 | 747 | 880 | 934 |
| 8'-6" | 103 | 123 | 142 | 184 | 236 | 301 | 382 | 416 | 530 | 569 | 646 | 763 | 810 |
| 9'-0" | 85 | 102 | 118 | 155 | 201 | 258 | 329 | 359 | 459 | 494 | 562 | 665 | 706 |
| 9'-6" | 70 | 85 | 98 | 131 | 171 | 221 | 285 | 310 | 400 | 430 | 490 | 582 | 618 |
| 10'-0" | 57 | 70 | 81 | 110 | 145 | 190 | 247 | 269 | 349 | 376 | 429 | 511 | 543 |
| 10'-6" | 46 | 57 | 67 | 92 | 123 | 163 | 214 | 234 | 306 | 329 | 376 | 451 | 479 |
| 11'-0" | | 46 | 54 | 76 | 104 | 140 | 185 | 203 | 268 | 289 | 331 | 398 | 423 |
| 11'-6" | | | 43 | 63 | 88 | 120 | 161 | 176 | 235 | 253 | 291 | 352 | 374 |
| 12'-0" | | | | 51 | 73 | 102 | 139 | 152 | 206 | 222 | 256 | 311 | 331 |
| 12'-6" | | | | 40 | 60 | 86 | 120 | 131 | 180 | 195 | 226 | 276 | 294 |
| 13'-0" | | | | | 49 | 73 | 103 | 113 | 157 | 170 | 198 | 244 | 260 |
| 13'-6" | | | | | | 60 | 87 | 97 | 137 | 149 | 174 | 216 | 230 |
| 14'-0" | | | | | | 49 | 74 | 82 | 119 | 129 | 152 | 191 | 204 |
| 14'-6" | | | | | | | 62 | 69 | 103 | 112 | 133 | 168 | 180 |
| 15'-0" | | | | | | | 51 | 57 | 88 | 96 | 115 | 148 | 158 |
| 15'-6" | | | | | | | 41 | 46 | 75 | 82 | 99 | 129 | 138 |
| 16'-0" | | | | | | | | | 63 | 69 | 85 | 112 | 121 |
| 16'-6" | | | | | | | | | 52 | 57 | 71 | 97 | 104 |
| 17'-0" | | | | | | | | | 42 | 47 | 59 | 83 | 90 |
| 17'-6" | | | | | | | | | | | 48 | 70 | 76 |
| 18'-0" | | | | | | | | | | | | 59 | 64 |
| 18'-6" | | | | | | | | | | | | 48 | 52 |
| 19'-0" | | | | | | | | | | | | | 42 |
| 19'-6" | | | | | | | | | | | | | |
| 20'-0" | | | | | | | | | | | | | |

**Note: CRSI recommendations for minimum reinforcement are based on practical considerations of rigidity against displacement under normal construction traffic. In all cases, these minimums satisfy minimum prescribed in ACI 10.5. See Fig. 7-1 for reinforcing bar details.**

## SOLID ONE-WAY SLABS—SINGLE SPAN

Bottom Steel for + $M_u$

$f'_c$ = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0025$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #4 | #4 | #4 | #4 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 10 | 9 | 8 | 7 | 7 | 12 | 11 | 10 | 10 | 9 | 8 |
| Top Bars | #3 | #3 | #3 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| T-S Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 11 | 11 |
| Areas of Steel (in.$^2$/ft) Bottom | 0.110 | 0.110 | 0.132 | 0.147 | 0.165 | 0.189 | 0.189 | 0.200 | 0.218 | 0.240 | 0.240 | 0.267 | 0.300 |
| Slab Wt. (psf) | 50 | 56 | 63 | 69 | 75 | 81 | 88 | 94 | 100 | 106 | 113 | 119 | 125 |
| Steel Wt. (psf) | 0.94 | 0.94 | 1.02 | 1.23 | 1.35 | 1.47 | 1.54 | 1.57 | 1.70 | 1.77 | 1.89 | 1.93 | 2.04 |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
| 6'-0" | 267 | 315 | 447 | 570 | 724 | 925 | | | | | | | |
| 6'-6" | 219 | 258 | 370 | 473 | 604 | 773 | 845 | 969 | | | | | |
| 7'-0" | 180 | 213 | 308 | 396 | 508 | 653 | 714 | 820 | 975 | | | | |
| 7'-6" | 149 | 177 | 259 | 335 | 431 | 557 | 608 | 699 | 834 | 997 | | | |
| 8'-0" | 124 | 148 | 218 | 284 | 368 | 477 | 522 | 601 | 719 | 861 | 920 | | |
| 8'-6" | 103 | 123 | 185 | 242 | 315 | 412 | 450 | 519 | 623 | 748 | 799 | 960 | |
| 9'-0" | 85 | 102 | 156 | 207 | 272 | 357 | 390 | 451 | 542 | 653 | 698 | 840 | |
| 9'-6" | 70 | 85 | 133 | 177 | 235 | 310 | 339 | 393 | 474 | 573 | 613 | 740 | 900 |
| 10'-0" | 57 | 70 | 112 | 152 | 203 | 270 | 296 | 344 | 416 | 505 | 540 | 654 | 797 |
| 10'-6" | 46 | 57 | 95 | 130 | 176 | 236 | 258 | 301 | 367 | 446 | 477 | 579 | 709 |
| 11'-0" | | 46 | 80 | 111 | 152 | 206 | 226 | 265 | 323 | 395 | 422 | 515 | 633 |
| 11'-6" | | | 66 | 94 | 131 | 181 | 198 | 232 | 286 | 351 | 375 | 459 | 566 |
| 12'-0" | | | 55 | 80 | 113 | 158 | 173 | 204 | 252 | 312 | 333 | 410 | 508 |
| 12'-6" | | | 44 | 67 | 97 | 138 | 151 | 179 | 223 | 277 | 296 | 367 | 456 |
| 13'-0" | | | | 56 | 83 | 120 | 132 | 157 | 197 | 247 | 264 | 328 | 410 |
| 13'-6" | | | | 46 | 70 | 104 | 114 | 138 | 174 | 219 | 235 | 294 | 370 |
| 14'-0" | | | | | 59 | 90 | 99 | 120 | 153 | 195 | 209 | 263 | 333 |
| 14'-6" | | | | | 49 | 77 | 85 | 104 | 135 | 173 | 185 | 236 | 300 |
| 15'-0" | | | | | 40 | 66 | 73 | 90 | 118 | 153 | 164 | 211 | 271 |
| 15'-6" | | | | | | 55 | 61 | 77 | 103 | 136 | 145 | 188 | 244 |
| 16'-0" | | | | | | 46 | 51 | 65 | 89 | 119 | 128 | 168 | 220 |
| 16'-6" | | | | | | | 42 | 55 | 77 | 105 | 112 | 149 | 198 |
| 17'-0" | | | | | | | | 45 | 65 | 91 | 98 | 132 | 177 |
| 17'-6" | | | | | | | | | 55 | 79 | 85 | 117 | 159 |
| 18'-0" | | | | | | | | | 45 | 68 | 72 | 103 | 142 |
| 18'-6" | | | | | | | | | | 57 | 61 | 90 | 126 |
| 19'-0" | | | | | | | | | | 48 | 51 | 77 | 112 |
| 19'-6" | | | | | | | | | | | 42 | 66 | 99 |
| 20'-0" | | | | | | | | | | | | 56 | 86 |

**Note: See Fig. 7-1 for reinforcing bar details.**

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

**"H" – Use hooked or headed bars.**

## SOLID ONE-WAY SLABS—SINGLE SPAN

Bottom Steel for + $M_u$

$f'_c$ = 4,000 psi  Grade 60 Bars  $\rho \approx 0.0050$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Bars | #4 | #4 | #4 | #4 | #5 | #5 | #5 | #5 | #6 | #6 | #6 | #6 | #6 |
| Spacing (in.) | 12 | 11 | 10 | 8 | 12 | 11 | 10 | 9 | 12 | 11 | 11 | 10 | 9 |
| Top Bars | #3 | #3 | #3 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| T-S Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #4 | #4 |
| Spacing (in.) | 11 | 11 | 11 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 11 | 11 |
| Areas of Steel (in.$^2$/ft) Bottom | 0.200 | 0.218 | 0.240 | 0.300 | 0.310 | 0.338 | 0.372 | 0.413 | 0.440 | 0.480 | 0.480 | 0.528 | 0.587 |
| Slab Wt. (psf) | 50 | 56 | 63 | 69 | 75 | 81 | 88 | 94 | 100 | 106 | 113 | 119 | 125 |
| Steel Wt. (psf) | 1.25 | 1.31 | 1.38 | 1.73 | 1.83 | 1.96 | 2.15 | 2.29 | 2.48 | 2.61 | 2.72 | 2.84 | 3.04 |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
| 6'-0" | 510 | 661 | 841 | | | | | | | | | | |
| 6'-6" | 425 | 553 | 705 | | | | | | | | | | |
| 7'-0" | 359 | 467 | 598 | 860 | 982 | | | | | | | | |
| 7'-6" | 305 | 398 | 511 | 738 | 844 | | | | | | | | |
| 8'-0" | 260 | 342 | 440 | 639 | 730 | 889 | | | | | | | |
| 8'-6" | 224 | 295 | 381 | 556 | 637 | 776 | 943 | | | | | | |
| 9'-0" | 193 | 256 | 332 | 487 | 558 | 682 | 830 | | | | | | |
| 9'-6" | 167 | 223 | 290 | 429 | 492 | 602 | 734 | 898 | | | | | |
| 10'-0" | 145 | 194 | 254 | 379 | 435 | 534 | 652 | 799 | 917 | | | | |
| 10'-6" | 126 | 170 | 223 | 336 | 386 | 475 | 582 | 714 | 821 | 973 | | | |
| 11'-0" | 109 | 149 | 197 | 299 | 344 | 424 | 521 | 641 | 737 | 875 | 938 | | |
| 11'-6" | 95 | 131 | 174 | 266 | 307 | 380 | 467 | 577 | 664 | 790 | 847 | | |
| 12'-0" | 82 | 114 | 153 | 238 | 274 | 341 | 421 | 520 | 600 | 715 | 766 | 911 | |
| 12'-6" | 71 | 100 | 135 | 212 | 246 | 306 | 379 | 471 | 544 | 649 | 696 | 828 | 991 |
| 13'-0" | 61 | 87 | 119 | 190 | 220 | 276 | 343 | 427 | 493 | 590 | 633 | 755 | 905 |
| 13'-6" | 52 | 76 | 105 | 170 | 198 | 249 | 310 | 387 | 449 | 538 | 577 | 690 | 828 |
| 14'-0" | 44 | 66 | 92 | 152 | 178 | 225 | 281 | 352 | 409 | 491 | 527 | 631 | 759 |
| 14'-6" | | 57 | 81 | 136 | 159 | 203 | 255 | 321 | 373 | 449 | 482 | 579 | 698 |
| 15'-0" | | 49 | 71 | 122 | 143 | 183 | 231 | 292 | 341 | 411 | 441 | 531 | 642 |
| 15'-6" | | 41 | 61 | 109 | 128 | 165 | 210 | 266 | 311 | 377 | 405 | 488 | 592 |
| 16'-0" | | | 53 | 97 | 115 | 149 | 190 | 243 | 285 | 346 | 372 | 450 | 546 |
| 16'-6" | | | 45 | 86 | 102 | 134 | 172 | 222 | 261 | 318 | 341 | 414 | 504 |
| 17'-0" | | | | 77 | 91 | 121 | 156 | 202 | 239 | 292 | 314 | 382 | 466 |
| 17'-6" | | | | 68 | 81 | 109 | 142 | 185 | 218 | 268 | 288 | 352 | 432 |
| 18'-0" | | | | 59 | 72 | 97 | 128 | 168 | 200 | 247 | 265 | 325 | 400 |
| 18'-6" | | | | 52 | 63 | 87 | 115 | 153 | 183 | 227 | 244 | 300 | 370 |
| 19'-0" | | | | 45 | 55 | 77 | 104 | 139 | 167 | 208 | 224 | 277 | 343 |
| 19'-6" | | | | | 48 | 68 | 93 | 127 | 152 | 191 | 206 | 256 | 318 |
| 20'-0" | | | | | 41 | 60 | 83 | 115 | 139 | 176 | 189 | 236 | 295 |

**Note: See Fig. 7-1 for reinforcing bar details.**

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

**"H" – Use hooked or headed bars.**

## SOLID ONE-WAY SLABS—SINGLE SPAN

Bottom Steel for + $M_u$

$f'_c$ = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0075$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Bars | #4 | #5 | #5 | #5 | #6 | #6 | #6 | #7 | #7 | #7 | #7 | #8 | #8 |
| Spacing (in.) | 8 | 12 | 10 | 9 | 12 | 10 | 9 | 12 | 11 | 10 | 10 | 12 | 12 |
| Top Bars | #3 | #3 | #3 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| T-S Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 |
| Spacing (in.) | 11 | 11 | 11 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 6 |
| Areas of Steel (in.$^2$/ft) Bottom | 0.300 | 0.310 | 0.372 | 0.413 | 0.440 | 0.528 | 0.587 | 0.600 | 0.655 | 0.720 | 0.720 | 0.790 | 0.790 |
| Slab Wt. (psf) | 50 | 56 | 63 | 69 | 75 | 81 | 88 | 94 | 100 | 106 | 113 | 119 | 125 |
| Steel Wt. (psf) | 1.58 | 1.63 | 1.83 | 2.12 | 2.29 | 2.63 | 2.90 | 2.94 | 3.20 | 3.43 | 3.54 | 3.76 | 3.76 |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
| 6'-0" | 773 | 927 | | | | | | | | | | | |
| 6'-6" | 650 | 780 | | | | | | | | | | | |
| 7'-0" | 530* | 663 | 925 | | | | | | | | | | |
| 7'-6" | 441* | 569 | 796 | | | | | | | | | | |
| 8'-0" | 370* | 492 | 690 | 878 | | | | | | | | | |
| 8'-6" | 317* | 428 | 586* | 768 | 907 | | | | | | | | |
| 9'-0" | 267* | 367* | 497* | 656* | 799 | | | | | | | | |
| 9'-6" | 230* | 313* | 429* | 565* | 708 | 934* | | | | | | | |
| 10'-0" | 198* | 273* | 372* | 494* | 619* | 814* | | | | | | | |
| 10'-6" | 172* | 235* | 324* | 428* | 544* | 707* | 895* | | | | | | |
| 11'-0" | 149* | 205* | 284* | 375* | 475* | 624* | 786* | 935 | | | | | |
| 11'-6" | 130* | 180* | 251* | 331* | 422* | 551* | 691* | 822* | | | | | |
| 12'-0" | 115* | 160* | 221* | 293* | 374* | 488* | 612* | 733* | 893* | | | | |
| 12'-6" | 101* | 139* | 195* | 260* | 332* | 435* | 545* | 653* | 795* | 970* | | | |
| 13'-0" | 88* | 123* | 174* | 231* | 296* | 389* | 487* | 582* | 714* | 867* | 981 | | |
| 13'-6" | 77* | 110* | 154* | 208* | 265* | 348* | 437* | 522* | 642* | 781* | 900 | | |
| 14'-0" | 69* | 97* | 138* | 186* | 238* | 313* | 393* | 470* | 579* | 704* | 815* | 969 | |
| 14'-6" | 60* | 86* | 123* | 166* | 212* | 282* | 355* | 425* | 521* | 637* | 734* | 874* | 954 |
| 15'-0" | 54* | 77* | 110* | 149* | 192* | 255* | 321* | 385* | 472* | 577* | 666* | 790* | 882 |
| 15'-6" | 47* | 69* | 99* | 135* | 173* | 230* | 291* | 349* | 429* | 525* | 607* | 719* | 816 |
| 16'-0" | 42* | 61* | 89* | 122* | 157* | 209* | 265* | 318* | 391* | 479* | 554* | 655* | 750* |
| 16'-6" | | 54* | 79* | 110* | 142* | 190* | 241* | 290* | 357* | 437* | 507* | 601* | 684* |
| 17'-0" | | 49* | 72* | 99* | 129* | 172* | 220* | 265* | 326* | 400* | 464* | 551* | 627* |
| 17'-6" | | 44* | 65* | 90* | 117* | 157* | 201* | 242* | 299* | 367* | 426* | 506* | 576* |
| 18'-0" | | | 59* | 82* | 107* | 144* | 184* | 222* | 275* | 338* | 392* | 466* | 530* |
| 18'-6" | | | 53* | 74* | 97* | 132* | 169* | 204* | 253* | 311* | 361* | 429* | 489* |
| 19'-0" | | | 48* | 68* | 89* | 121* | 156* | 188* | 233* | 286* | 333* | 396* | 453* |
| 19'-6" | | | 44* | 62* | 81* | 111* | 143* | 173* | 215* | 265* | 308* | 367* | 419* |
| 20'-0" | | | 40* | 56* | 74* | 102* | 132* | 160* | 199* | 245* | 285* | 340* | 389* |

**Note: See Fig. 7-1 for reinforcing bar details.**

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

**"H" – Use hooked or headed bars.**

## SOLID ONE-WAY SLABS—SINGLE SPAN

Bottom Steel for + $M_u$

$f'_c$ = 4,000 psi  Grade 60 Bars  $\rho \approx 0.0100$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bottom Bars | #5 | #5 | #6 | #6 | #7 | #7 | #7 | #8 | #8 | #8 | #8 | #9 | #9 |
| Spacing (in.) | 10 | 9 | 11 | 10 | 12 | 11 | 10 | 12 | 11 | 10 | 10 | 12 | 11 |
| Top Bars | #3 | #3 | #3 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| T-S Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 |
| Spacing (in.) | 11 | 11 | 11 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 6 |
| Areas of Steel (in.$^2$/ft) Bottom | 0.372 | 0.413 | 0.480 | 0.528 | 0.600 | 0.655 | 0.720 | 0.790 | 0.862 | 0.948 | 0.948 | 1.000 | 1.091 |
| Slab Wt. (psf) | 50 | 56 | 63 | 69 | 75 | 81 | 88 | 94 | 100 | 106 | 113 | 119 | 125 |
| Steel Wt. (psf) | 1.83 | 1.97 | 2.22 | 2.53 | 2.83 | 3.05 | 3.35 | 3.57 | 3.89 | 4.18 | 4.29 | 4.49 | 4.80 |

| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6'-0" | 835* | | | | | | | | | | | | |
| 6'-6" | 675* | | | | | | | | | | | | |
| 7'-0" | 549* | 771* | | | | | | | | | | | |
| 7'-6" | 460* | 644* | | | | | | | | | | | |
| 8'-0" | 386* | 540* | 730* | | | | | | | | | | |
| 8'-6" | 327* | 458* | 622* | 826* | | | | | | | | | |
| 9'-0" | 276* | 388* | 528* | 706* | | | | | | | | | |
| 9'-6" | 237* | 334* | 455* | 605* | 786H* | | | | | | | | |
| 10'-0" | 204* | 289* | 394* | 524* | 684H* | | | | | | | | |
| 10'-6" | 177* | 253* | 343* | 456* | 596* | 761* | | | | | | | |
| 11'-0" | 154* | 221* | 300* | 400* | 523* | 667* | | | | | | | |
| 11'-6" | 135* | 193* | 264* | 352* | 461* | 587* | 747* | | | | | | |
| 12'-0" | 118* | 171* | 233* | 311* | 408* | 520* | 660* | | | | | | |
| 12'-6" | 104* | 149* | 208* | 277* | 363* | 463* | 587* | 726* | | | | | |
| 13'-0" | 91* | 133* | 184* | 246* | 324* | 413* | 524* | 649* | | | | | |
| 13'-6" | 81* | 118* | 164* | 220* | 290* | 370* | 470* | 582* | 718* | | | | |
| 14'-0" | 71* | 105* | 146* | 197* | 260* | 333* | 423* | 524* | 647* | | | | |
| 14'-6" | 63* | 93* | 131* | 178* | 234* | 300* | 381* | 473* | 584* | 718* | | | |
| 15'-0" | 56* | 84* | 118* | 160* | 211* | 271* | 345* | 428* | 529* | 651* | 755* | | |
| 15'-6" | 50* | 75* | 106* | 144* | 191* | 246* | 313* | 389* | 481* | 592* | 686* | 801* | |
| 16'-0" | 44* | 67* | 95* | 130* | 172* | 223* | 285* | 354* | 438* | 539* | 626* | 730* | |
| 16'-6" | 40* | 60* | 86* | 118* | 157* | 203* | 260* | 323* | 400* | 492* | 572* | 668* | 799* |
| 17'-0" | | 54* | 77* | 107* | 143* | 186* | 237* | 295* | 366* | 451* | 524* | 612* | 732* |
| 17'-6" | | 49* | 70* | 97* | 130* | 170* | 218* | 270* | 336* | 414* | 481* | 562* | 673* |
| 18'-0" | | 44* | 64* | 89* | 119* | 155* | 199* | 248* | 308* | 380* | 442* | 518* | 619* |
| 18'-6" | | 40* | 58* | 81* | 109* | 143* | 183* | 228* | 284* | 350* | 408* | 477* | 571* |
| 19'-0" | | | 53* | 74* | 100* | 131* | 168* | 210* | 262* | 323* | 376* | 441* | 528* |
| 19'-6" | | | 48* | 68* | 92* | 120* | 155* | 194* | 242* | 299* | 348* | 408* | 488* |
| 20'-0" | | | 44* | 62* | 84* | 111* | 143* | 179* | 224* | 277* | 322* | 378* | 453* |

**Note: See Fig. 7-1 for reinforcing bar details.**

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

**"H" – Use hooked or headed bars.**

## USE OF LOAD TABLES FOR END SPAN AND INTERIOR SPAN

**Example 5. End Span and Interior Span**—Select a solid slab design for a floor supported by monolithic beams at (clear) spacings of 15 ft. Superimposed service loads are: live load = 120 psf; celing construction = 10 psf; floor finish = 10 psf. No masonry partitions will be supported nor attached to the slab.

Augment and accumulate the superimposed factored loads:

Live load $120 \times 1.6 = 192$ psf
Dead load $20 \times 1.2 = \underline{24}$
Superimposed $w_u = 216$ psf

For equal loads and spans, the end span is most critical for thickness (factored shear is 1.15 times that in interior spans). Select end span design first, if it is desired to use the same depth of slab throughout.

See table for **End Span** mininum thickness tabulated, Page 7-18. Select thickness, $h$ = 5½ in.; factored usable superimposed load $w_u$ = 250* psf with $\rho \approx 0.0075$.

Bottom bars: #5 spaced at 10 in.
Top bars: #5 spaced at 9 in.
Temperature-shrinkage bars: #3 spaced at 11 in.
Top bars at free end: #4 spaced at 12 in. Provide end hooks; see Fig. 7-1 for recommended bar details.

*Interior Spans*

Since exterior span top steel is used for interior span top steel, see table on Page 7-23 for minimum thickness. For $h$ = 5½ in. (determined from end span), factored usable superimposed load $w_u = 292$ psf > 216.

Read reinforcement for $\rho \approx 0.0075$:
Bottom bars: #5 spaced at 12 in.
Top bars: #5 spaced at 9 in. (same as exterior span)
Temperature-shrinkage bars: #3 spaced at 11 in.

*Serviceability Check*

1. Deflection—Maximum deflection occurs in the end span. (See Chapter 6). At a service load, (1/1.6)(216) = 135 psf, the live load deflection limit is $\ell/360$. (Note asterisk in load capacity table.) Service live load, $L$ = 120.

$$\text{Live load deflection} = \left(\frac{120}{135}\right)\left(\frac{15 \times 12}{360}\right) = 0.44\,\text{in.} < \ell/360$$

2. Crack Control—For ¾ in. of concrete cover, bar spacing is limited to 12 in. (ACI 10.6.4). Note that the maximum bar spacing used, #5 spaced at 12 in., is satisfactory.

**Example 6. End Span and Interior Span**—Some areas of interior spans in the same floor system described in Example 5 have to support partitions (service load = 10 psf) which would be damaged by large deflections. The partitions will be installed last, after an estimated 50 percent of other long-term load deflection occurs. Service live load (offices) in this area of the floor is 60 psf. Check long-term deflection.

Account for long-term sustained service load effects = (2) long-term load of partitions + (1)($D + L$) = (2)(10) + (69 + 10 + 10 + 60) = 169 psf equivalent superimposed load. Enter table for $\rho \approx 0.010$ on Page 7-24 with $h$ = 5½ in. clear span = 15′-0″, and read factored usable superimposed load, $w_u$ = 380 psf, which causes less deflection than $\ell/360$.

(380)(360/480) = 285 psf which causes less deflection than $\ell/480$.

Equivalent service live load, $L$ = 285/1.6 = 178 psf > 169. Thus, long-term deflection should be satisfactory.

For a complete manual calculation, see Pages 7-11 through 7-14.

## MANUAL CALCULATION

**Example 7. End Span**— Derive the factored usable superimposed load tabulated for an 7-in. solid slab with a percentage of reinforcement, $\rho \approx 0.0075$, on an 18-ft span. $f'_c$ = 4,000 psi.

From the table on Page 7-18 with $\rho \approx 0.0075$, $h$ = 7 in., and with #6 top bars at the first interior support which are spaced at 9 in. and #6 bottom bars spaced at 11 in., the factored usable superimposed load is 299 psf. Derive the load value of 299 psf.

*Flexure*

Compute the design positive moment strength based on the #6 bottom bars spaced at 11 in.:

$$\phi M_n = \phi A_s f_y (d - a/2)$$

Where $A_s$ = 12/11(0.44) = 0.480 in.$^2$/ft for #6 bottom bars spaced at 11 in.

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.480(60)}{0.85(4)(12)} = 0.71 \text{ in.}$$

$$d = h - \text{cover} - 0.5 d_b$$

$$d = 7.0 - 0.75 - 0.375 = 5.87 \text{ in.}$$

$$\phi M_n = 0.90(0.480)(60)(5.87 - 0.71/2)/12$$
$$= 11.91 \text{ ft-kips/ft}$$

Equate + $M_u = \phi M_n$ where + $M_u = w_u \ell_n^2/11$

$$w_u(18)^2/11 = 11.91$$

$$w_u = 0.404 \text{ klf or } 404 \text{ psf}$$

Compute the design moment strength based on the #6 top bars at the first interior support which are spaced at 9 in.:

$$\phi M_n = \phi A_s f_y \ (d - a/2)$$

Where $A_s$ = (12/9)(0.44) = 0.587 in.$^2$/ft for #6 top bars spaced at 9 in.

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.587(60)}{0.85(4)(12)} = 0.86 \text{ in.}$$

$$d = h - \text{cover} - 0.5 d_b$$

$$d = 7.0 - 0.75 - 0.375 = 5.87 \text{ in.}$$

$$\phi M_n = 0.90(0.587)(60)(5.87 - 0.86/2)/12$$
$$= 14.37 \text{ ft-kips/ft}$$

Equate – $M_u = \phi M_n$ where – $M_u = w_u \ell_n^2/10$

$$w_u(18)^2/10 = 14.37$$

$$w_u = 0.444 \text{ klf or } 444 \text{ psf}$$

Positive $\phi M_n$ governs flexural capacity; hence, $w_u$ = 404 psf

Factored usable superimposed load = 404 – 1.2(150 × 7/12) = 299 psf (tabulated = 299, okay)

Recalculating – $M_u$:

$$- M_u = w_u(\ell_n)^2/10$$
$$= .404\ (18)^2/10$$
$$= 13.09 \text{ ft-kips/ft}$$

*Shear*

Compute design shear strength based on ACI Eq. 11-3,

$$\phi V_c = 2\phi\sqrt{f'_c}\, b_w d$$
$$= 2(0.75)\sqrt{4{,}000}(12)(5.87)/1{,}000 = 6.68 \text{ kips/ft}$$

A factored superimposed load based on ACI Eq. 11-5 cannot be derived directly because the quantity $V_u d/M_u$ is dependent on the load.

Equate $V_u = \phi V_c$

Compute $V_u$ at a distance $d$ from the face of the support; at the support, maximum $V_u = 1.15\ w_u \ell_n/2$ (ACI 8.3.3):

$$V_u = 1.15\ w_u(\ell_n/2 - d) \le \phi V_c$$

$$1.15\ w_u(18/2 - 5.87/12) = 6.68$$

$$w_u = 0.714 \text{ klf or } 714 \text{ psf}$$

Flexural capacity governs; hence, the factored usable superimposed load = 299 psf

*Tension Development*

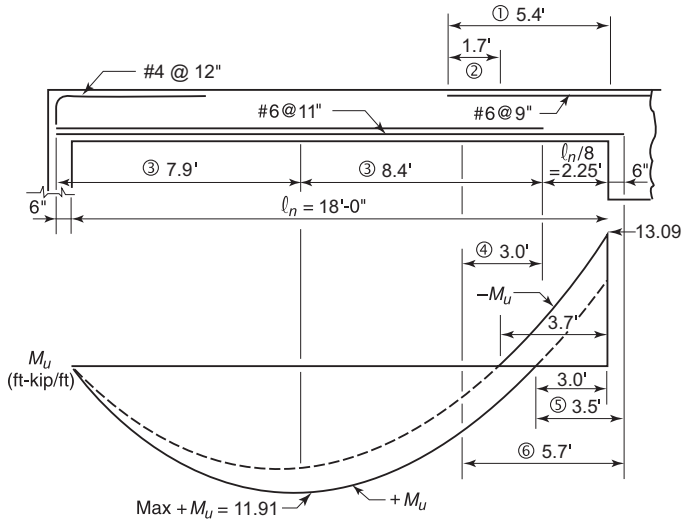
#6 top bars at the first interior support which are spaced at 9 in.

Concrete cover = 0.75 in. = 0.75/0.75 = $1.0 d_b$

Spacing = 9 in. = 9/0.75 = $12.0 d_b$

From Table 5-2(b) under "Uncoated Bars" and "Other Bars"; for "Case 1" and "Lap Class A" (for $h$ = 7 in., this is less than 12 in. of concrete below the #6 bars):

$\ell_d$ = 29 in. = 2.42 ft




Top Bars:

Check $\ell_d$ = 29 in. vs. embedment length provided and check embedment lengths provided beyond the point where the bars are no longer required to resist flexure; i.e., check the Dimension labeled ① vs. ACI 12.1.1 and Dimension ② vs. ACI 12.10.3.

Dimension ① = 5.4 ft > $\ell_d$ = 2.42 ft, okay

Dimension ② = 1.7 ft > $12d_b$ = 12(0.75) = 9.0 in. = 0.75 ft, okay

Dimension ② = 1.7 ft > $d$ = 5.87 in. = 0.49 ft, okay

Bottom Bars:

#6 bottom bars spaced at 11 in.

Concrete cover = 0.75 in. = 0.75/0.75 = $1.0d_b$
Spacing = 11 in. = 11/0.75 = $15d_b$

From Table 5-2(b) under "Uncoated Bars" and "Other Bars"; for "Case 1" and "Lap Class A":

$\ell_d$ = 29 in. = 2.42 ft

At the inflection point, ACI 12.11.3 requires checking,

$$\ell_d \le \frac{M_n}{V_u} + \ell_a \quad \text{. . . . . (ACI Eq. 12-5)}$$

Where $M_n = \frac{\phi M_n}{\phi} = \frac{11.91}{0.90}$ = 13.23 ft-kips/ft

$V_u = w_u\,(\ell_n/2 - 2.4) = 0.404(18/2 - 2.4)$ = 2.67 kips/ft

$\ell_a$ is the larger of $12d_b$ or $d$

$12d_b$ = 12(0.75) = 9 in.

$d$ = 5.87 in.

Use $\ell_a = 12d_b$ = 9 in.

$$\frac{M_n}{V_u} + \ell_a = \frac{13.23(12)}{2.67} + 9 = 59.5 + 9 = 68.5 \text{ in.}$$

68.5 in. > $\ell_d$ = 29 in., okay

Check $\ell_d$ = 29 in. vs. embedment length provided, and check embedment lengths provided beyond the point where the bars are no longer required to resist flexure, i.e., check the Dimension labeled ③ vs. ACI 12.1.1, check the Dimensions labeled ④ and ⑤ vs. ACI 12.10.3, and check the Dimension labeled ⑥ vs. ACI 12.1.1.

Dimension ③ = 7.90 ft or 8.4 ft > $\ell_d$ = 2.42 ft, okay

Dimension ④ = 3.0 ft > $12d_b$ = 12(0.75) = 9 in. = 0.75 ft, okay

Dimension ④ = 3.0 ft > $d$ = 5.87 in. = 0.49 ft, okay

Dimension ⑤ = 3.5 ft > $12d_b$ = 9 in. = 0.75 ft, okay

Dimension ⑤ = 3.5 ft > $d$ = 5.87 in. = 0.49 ft, okay

Dimension ⑥ is the distance from the end of the bottom bars (#6 spaced at 22 in.) to the point on the factored moment diagram where $\phi M_n$ of the #6 bars spaced at 22 in. = 6.15 ft-kips/ft = $M_u$.

## MANUAL CALCULATION

**Example 8. Interior Span**— Derive the factored usable superimposed load tabulated for an 8-in. solid slab with minimum reinforcement on a 15-ft span.

From the table on Page 7-20 with minimum reinforcement, $h$ = 8 in., and with #4 top bars spaced at 12 in. and #3 bottom bars spaced at 7 in., the factored usable superimposed load is 181 psf. Derive the load value of 181 psf.

*Flexure*

Compute the design positive moment strength based on the #3 bottom bars spaced at 7 in.:

$$\phi M_n = \phi A_s f_y\ (d - a/2)$$

Where $A_s$ = 12/7(0.11) = 0.189 in.$^2$/ft for #3 bottom bars spaced at 7 in.

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.189(60)}{0.85(4)(12)} = 0.28 \text{ in.}$$

$$d = h - \text{cover} - 0.5 d_b$$

$$d = 8.0 - 0.75 - 0.19 = 7.06 \text{ in.}$$

$$\phi M_n = 0.90(0.189)(60)(7.06 - 0.28/2)/12 = 5.88 \text{ ft-kips/ft}$$

Equate $+M_u = \phi M_n$ where $+M_u = w_u \ell_n^2/16$

$w_u(15)^2/16 = 5.88$

$w_u$ = 0.418 klf or 418 psf

Compute the design moment strength based on the #4 top bars spaced at 12 in.:

$$\phi M_n = \phi A_s f_y\ (d - a/2)$$

Where $A_s$ = 12/12(0.20) = 0.20 in.$^2$/ft for #4 top bars spaced at 12 in.

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{0.20(60)}{0.85(4)(12)} = 0.29 \text{ in.}$$

$$d = h - \text{cover} - 0.5 d_b$$

$$d = 8.0 - 0.75 - 0.25 = 7.0 \text{ in.}$$

$$\phi M_n = 0.90(0.20)(60)(7.0 - 0.29/2)/12 = 6.17 \text{ ft-kips/ft}$$

Equate $-M_u = \phi M_n$ where $-M_u = w_u \ell_n^2/11$

$w_u(15)^2/11 = 6.17$

$w_u$ = 0.301 klf or 301 psf

Negative $\phi M_n$ governs flexural capacity; hence, $w_u$ = 301 psf

Factored usable superimposed load = 301 – 1.2(100) = 181 psf (tabulated = 181, okay)

Recalculating $+M_u$:

$+M_u = w_u \ell_n^2/16$

$= 0.301\ (15)^2/16$

$= 4.23$ ft-kips/ft

*Shear*

Compute the design shear strength based on ACI Eq. 11-3,

$$\phi V_c = 2\phi \sqrt{f'_c}\, b_w d$$

$$= 2(0.75)\sqrt{4{,}000}(12)(7)/1{,}000 = 7.97 \text{ kips/ft}$$

A factored usable superimposed load based on ACI Eq. 11-5 cannot be derived directly because the quantity $V_u d/M_u$ is dependent on the load.

Equate $V_u = \phi V_c$

Compute $V_u$ at a distance $d$ from the face of the support; at the support, maximum $V_u = w_u \ell_n/2$ (ACI 8.3.3):

$V_u = w_u(\ell_n/2 - d)$

$w_u(15/2 - 7/12) = 7.97$ k/ft

$w_u$ = 1.15 klf or 1,150 psf

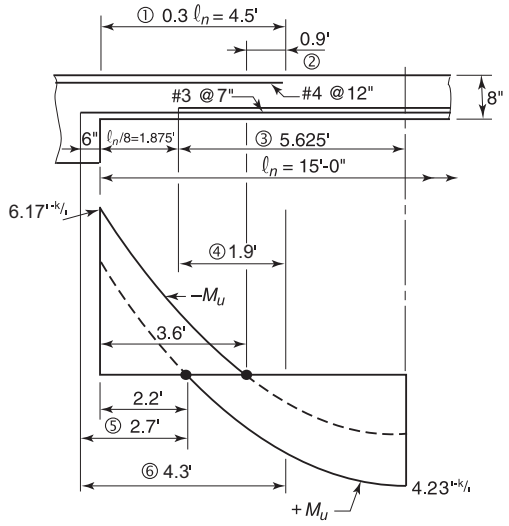
Flexural capacity governs; hence, the factored usable superimposed load = 181 psf

*Tension Development*

#4 top bars are spaced at 12 in.

Concrete cover = 0.75 in. = 0.75/0.5 = 1.5 $d_b$

Spacing = 12 in. = 12/0.5 = 24 $d_b$



From Table 5-2(b) under "Uncoated Bars" and "Other Bars"; for "Case 1" and "Lap Class A" (for $h$ = 8 in., less than 12 in. of concrete will be cast below the #4 bars):

$\ell_d$ = 19 in. = 1.58 ft

Check $\ell_d$ = 19 in. vs. embedment length provided and check embedment lengths provided beyond the point where the bars are no longer required to resist flexure; i.e., check the Dimension labeled ① vs. ACI 12.1.1 and Dimension ② vs. ACI 12.10.3.

Dimension ① = 4.5 ft > $\ell_d$ = 1.58 ft, okay

Dimension ② = 0.9 ft > 12$d_b$ = 12(0.5) = 6.0 in. = 0.5 ft, okay

Dimension ② = 0.9 ft > $d$ = 7 in. = 0.58 ft, okay

#3 bottom bars spaced at 7 in.

From Table 5-2(b) under "Uncoated Bars" and "Other Bars"; for "Case 1" and "Lap Class A":

$\ell_d$ = 15 in. = 1.25 ft

At the inflection point, ACI 12.11.3 requires checking,

$$\ell_d \le \frac{M_n}{V_u} + \ell_a \quad \text{. . . . . (ACI Eq. 12-5)}$$

Where $M_n = \dfrac{\phi M_n}{\phi} = \dfrac{5.88}{0.90}$ = 6.53 ft-kips/ft

$V_u = w_u(\ell_n/2 - 2.2) = 0.301(15/2 - 2.2) = 1.59$ kips/ft

$\ell_a$ is the larger of 12 $d_b$ or $d$

12$d_b$ = 12(0.375) = 4.5 in.

$d$ = 7 in.

Use $\ell_a$ = 7 in.

$$\frac{M_n}{V_u} + \ell_a = \frac{6.53(12)}{1.59} + 7 = 49.3 + 7 = 56.3 \text{ in.}$$

56.3 in. > $\ell_d$ = 15 in., okay

Check $\ell_d$ = 15 in. vs. embedment length provided, and check embedment lengths provided beyond the point where the bars are no longer required to resist flexure, i.e., check the Dimension labeled ③ vs. ACI 12.1.1, check the Dimensions labeled ④ and ⑤ vs. ACI 12.10.3, and check the Dimension labeled ⑥ vs. ACI 12.1.1.

Dimension ③ = 5.625 ft > $\ell_d$ = 1.25 ft, okay

Dimension ④ = 1.9 ft > 12 $d_b$ = 12(0.375) = 4.5 in. = 0.4 ft, okay

Dimension ④ = 1.9 ft > $d$ = 7 in. = 0.58 ft, okay

Dimension ⑤ = 2.7 ft > 12 $d_b$ = 4.5 in. = 0.4 ft, okay

Dimension ⑤ = 2.7 ft > $d$ = 7 in. = 0.58 ft, okay

Dimension ⑥ is the distance from the end of the bottom bars (#3 spaced at 14 in.) to the point on the factored moment diagram where $\phi M_n$ of the #3 bars spaced at 14 in. = 2.96 ft-kips/ft = $M_u$.

Dimension ⑥ = 4.3 ft > $\ell_d$ = 1.25 ft, okay

## SOLID ONE-WAY SLABS—END SPAN

Recommended Minimum Reinforcement

$f'_c$ = 4,000 psi — Grade 60 Bars — $\rho \geq 0.0018bh$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top Bars<br>Spacing (in.) | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>11 | #4<br>11 |
| Bottom Bars<br>Spacing (in.) | #3<br>12 | #3<br>12 | #3<br>12 | #3<br>11 | #3<br>10 | #3<br>9 | #3<br>8 | #3<br>8 | #3<br>7 | #3<br>7 | #4<br>12 | #4<br>11 | #4<br>11 |
| Top Bars Free End<br>Spacing (in.) | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 |
| T-S Bars<br>Spacing (in.) | #3<br>12 | #3<br>12 | #3<br>12 | #3<br>11 | #3<br>10 | #3<br>9 | #3<br>8 | #3<br>8 | #3<br>7 | #3<br>7 | #3<br>6 | #4<br>11 | #4<br>11 |
| Areas of Steel ($in.^2/ft$)<br>Top Interior<br>Bottom | <br>0.200<br>0.110 | <br>0.200<br>0.110 | <br>0.200<br>0.110 | <br>0.200<br>0.120 | <br>0.200<br>0.132 | <br>0.200<br>0.147 | <br>0.200<br>0.165 | <br>0.200<br>0.165 | <br>0.200<br>0.189 | <br>0.200<br>0.189 | <br>0.200<br>0.200 | <br>0.218<br>0.218 | <br>0.218<br>0.218 |
| Slab Wt. (psf)<br>Steel Wt. (psf) | 50<br>1.10 | 56<br>1.10 | 63<br>1.10 | 69<br>1.15 | 75<br>1.24 | 81<br>1.33 | 88<br>1.46 | 94<br>1.46 | 100<br>1.61 | 106<br>1.61 | 113<br>1.75 | 119<br>1.77 | 125<br>1.77 |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
| 6'-0"<br>6'-6" | 390<br>323 | 458<br>381 | 526<br>437 | 654<br>545 | 810<br>677 | <br>839 | | | | | | | |
| 7'-0"<br>7'-6"<br>8'-0"<br>8'-6"<br>9'-0"<br>9'-6" | 271<br>228<br>193<br>164<br>140<br>119 | 319<br>269<br>228<br>194<br>166<br>142 | 366<br>309<br>262<br>224<br>191<br>164 | 459<br>389<br>332<br>284<br>245<br>211 | 571<br>486<br>416<br>358<br>310<br>269 | 710<br>606<br>521<br>450<br>391<br>341 | 884<br>756<br>652<br>565<br>493<br>431 | 960<br>821<br>708<br>614<br>536<br>469 | <br><br>889<br>774<br>677<br>595 | <br><br>954<br>831<br>727<br>640 | <br><br><br>939<br>823<br>725 | <br><br><br><br>968<br>854 | <br><br><br><br><br>907 |
| 10'-0"<br>10'-6"<br>11'-0"<br>11'-6"<br>12'-0"<br>12'-6" | 102<br>87<br>74<br>62<br>52<br>43 | 122<br>104<br>89<br>76<br>64<br>54 | 141<br>120<br>103<br>88<br>74<br>63 | 182<br>158<br>136<br>117<br>101<br>87 | 234<br>204<br>177<br>155<br>135<br>117 | 298<br>261<br>229<br>202<br>177<br>156 | 379<br>334<br>295<br>261<br>231<br>204 | 412<br>364<br>321<br>284<br>252<br>223 | 525<br>439<br>389<br>346<br>308<br>274 | 565<br>472<br>419<br>372<br>332<br>296 | 641<br>505<br>448<br>398<br>354<br>316 | 757<br>599<br>533<br>476<br>425<br>380 | 804<br>636<br>566<br>505<br>452<br>405 |
| 13'-0"<br>13'-6"<br>14'-0"<br>14'-6"<br>15'-0"<br>15'-6" | | 44 | 52<br>43 | 74<br>62<br>52<br>43 | 101<br>87<br>75<br>64<br>54<br>44 | 136<br>119<br>104<br>91<br>78<br>67 | 181<br>160<br>141<br>125<br>109<br>96 | 198<br>175<br>155<br>137<br>120<br>106 | 244<br>218<br>194<br>173<br>153<br>136 | 264<br>235<br>210<br>187<br>166<br>148 | 282<br>252<br>224<br>200<br>178<br>158 | 341<br>306<br>274<br>246<br>220<br>197 | 363<br>325<br>292<br>262<br>235<br>211 |
| 16'-0"<br>16'-6"<br>17'-0"<br>17'-6"<br>18'-0"<br>18'-6" | | | | | | 57<br>48 | 83<br>72<br>62<br>52<br>44 | 92<br>80<br>69<br>58<br>49<br>40 | 120<br>106<br>93<br>81<br>70<br>60 | 131<br>115<br>101<br>88<br>76<br>66 | 140<br>123<br>108<br>95<br>82<br>70 | 176<br>157<br>140<br>124<br>109<br>96 | 188<br>168<br>150<br>133<br>117<br>103 |
| 19'-0"<br>19'-6"<br>20'-0" | | | | | | | | | 50<br>42 | 56<br>46 | 60<br>50<br>41 | 83<br>72<br>61 | 90<br>78<br>66 |

**Note: CRSI recommendations for minimum reinforcement are based on practical considerations of rigidity against displacement under normal construction traffic. In all cases, these minimums satisfy minimum prescribed in ACI 10.5. See Fig. 7-1 for reinforcing bar details.**

## SOLID ONE-WAY SLABS—END SPAN

Top Steel for $-M_u$

$f'_c$ = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0025$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top Bars Spacing (in.) | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 | #4 11 | #4 10 | #4 10 | #4 9 | #4 8 |
| Bottom Bars Spacing (in.) | #3 12 | #3 12 | #3 12 | #3 10 | #3 9 | #3 8 | #3 8 | #3 7 | #4 12 | #4 11 | #4 11 | #4 10 | #4 9 |
| Top Bars Free End Spacing (in.) | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 | #4 12 |
| T-S Bars Spacing (in.) | #3 12 | #3 12 | #3 12 | #3 11 | #3 10 | #3 9 | #3 8 | #3 8 | #3 7 | #3 7 | #3 6 | #4 11 | #4 11 |
| Areas of Steel ($in.^2/ft$) Top Interior Bottom | 0.200 0.110 | 0.200 0.110 | 0.200 0.110 | 0.200 0.132 | 0.200 0.147 | 0.200 0.165 | 0.200 0.165 | 0.200 0.189 | 0.218 0.200 | 0.240 0.218 | 0.240 0.218 | 0.267 0.240 | 0.300 0.267 |
| Slab Wt. (psf) Steel Wt. (psf) | 50 1.10 | 56 1.10 | 63 1.10 | 69 1.19 | 75 1.29 | 81 1.38 | 88 1.46 | 94 1.54 | 100 1.65 | 106 1.73 | 113 1.84 | 119 1.89 | 125 2.00 |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
| 6'-0" | 390 | 458 | 526 | 727 | 908 | | | | | | | | |
| 6'-6" | 323 | 381 | 437 | 607 | 760 | 954 | | | | | | | |
| 7'-0" | 271 | 319 | 366 | 512 | 643 | 809 | 884 | | | | | | |
| 7'-6" | 228 | 269 | 309 | 435 | 549 | 692 | 756 | 952 | | | | | |
| 8'-0" | 193 | 228 | 262 | 372 | 471 | 596 | 652 | 823 | 939 | | | | |
| 8'-6" | 164 | 194 | 224 | 320 | 407 | 517 | 565 | 716 | 818 | 969 | | | |
| 9'-0" | 140 | 166 | 191 | 277 | 353 | 451 | 493 | 627 | 717 | 850 | 909 | | |
| 9'-6" | 119 | 142 | 164 | 240 | 308 | 394 | 431 | 551 | 631 | 750 | 802 | 952 | |
| 10'-0" | 102 | 122 | 141 | 208 | 269 | 346 | 379 | 486 | 558 | 665 | 710 | 845 | |
| 10'-6" | 87 | 104 | 120 | 181 | 236 | 305 | 334 | 405 | 488 | 589 | 630 | 753 | 903 |
| 11'-0" | 74 | 89 | 103 | 158 | 207 | 269 | 295 | 359 | 434 | 526 | 562 | 674 | 810 |
| 11'-6" | 62 | 76 | 88 | 137 | 181 | 238 | 261 | 319 | 387 | 470 | 503 | 604 | 728 |
| 12'-0" | 52 | 64 | 74 | 119 | 159 | 211 | 231 | 284 | 346 | 421 | 450 | 543 | 656 |
| 12'-6" | 43 | 54 | 63 | 103 | 140 | 187 | 204 | 252 | 309 | 378 | 404 | 489 | 593 |
| 13'-0" | | 44 | 52 | 89 | 122 | 165 | 181 | 225 | 277 | 340 | 364 | 442 | 537 |
| 13'-6" | | | 43 | 77 | 107 | 146 | 160 | 200 | 248 | 306 | 327 | 399 | 487 |
| 14'-0" | | | | 65 | 93 | 129 | 141 | 178 | 222 | 276 | 295 | 361 | 442 |
| 14'-6" | | | | 55 | 80 | 114 | 125 | 159 | 199 | 248 | 266 | 327 | 402 |
| 15'-0" | | | | 46 | 69 | 100 | 109 | 141 | 178 | 224 | 239 | 296 | 366 |
| 15'-6" | | | | | 59 | 87 | 96 | 125 | 159 | 201 | 215 | 268 | 333 |
| 16'-0" | | | | | 50 | 76 | 83 | 110 | 142 | 181 | 194 | 243 | 303 |
| 16'-6" | | | | | 42 | 65 | 72 | 97 | 126 | 163 | 174 | 220 | 276 |
| 17'-0" | | | | | | 56 | 62 | 84 | 112 | 146 | 156 | 199 | 251 |
| 17'-6" | | | | | | 47 | 52 | 73 | 99 | 130 | 140 | 179 | 229 |
| 18'-0" | | | | | | | 44 | 63 | 87 | 116 | 125 | 162 | 208 |
| 18'-6" | | | | | | | | 54 | 76 | 103 | 111 | 146 | 189 |
| 19'-0" | | | | | | | | 45 | 65 | 91 | 98 | 131 | 171 |
| 19'-6" | | | | | | | | | 56 | 80 | 86 | 117 | 155 |
| 20'-0" | | | | | | | | | 47 | 70 | 75 | 104 | 140 |

**Note: See Fig. 7-1 for reinforcing bar details.**

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

**"H" – Use hooked or headed bars.**

## SOLID ONE-WAY SLABS—END SPAN

Top Steel for $-M_u$

$f'_c$ = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0050$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top Bars | #4 | #4 | #4 | #4 | #5 | #5 | #5 | #5 | #6 | #6 | #6 | #6 | #6 |
| Spacing (in.) | 12 | 11 | 10 | 8 | 12 | 11 | 10 | 9 | 12 | 11 | 11 | 10 | 9 |
| Bottom Bars | #3 | #4 | #4 | #4 | #4 | #5 | #5 | #5 | #5 | #5 | #6 | #6 | #6 |
| Spacing (in.) | 7 | 12 | 11 | 9 | 8 | 12 | 11 | 10 | 9 | 9 | 12 | 11 | 11 |
| Top Bars Free End | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 |
| T-S Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #4 | #4 |
| Spacing (in.) | 12 | 11 | 11 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 11 | 11 |
| Areas of Steel ($in.^2/ft$) | | | | | | | | | | | | | |
| Top Interior | 0.200 | 0.218 | 0.240 | 0.300 | 0.310 | 0.338 | 0.372 | 0.413 | 0.440 | 0.480 | 0.480 | 0.528 | 0.587 |
| Bottom | 0.189 | 0.200 | 0.218 | 0.267 | 0.300 | 0.310 | 0.338 | 0.372 | 0.413 | 0.413 | 0.440 | 0.480 | 0.480 |
| Slab Wt. (psf) | 50 | 56 | 63 | 69 | 75 | 81 | 88 | 94 | 100 | 106 | 113 | 119 | 125 |
| Steel Wt. (psf) | 1.35 | 1.41 | 1.49 | 1.70 | 1.87 | 1.97 | 2.17 | 2.32 | 2.56 | 2.60 | 2.82 | 2.95 | 3.01 |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
| 6'-0" | 697 | 854 | | | | | | | | | | | |
| 6'-6" | 585 | 718 | 905 | | | | | | | | | | |
| 7'-0" | 496 | 609 | 770 | | | | | | | | | | |
| 7'-6" | 424 | 522 | 661 | 926 | | | | | | | | | |
| 8'-0" | 366 | 451 | 572 | 804 | | | | | | | | | |
| 8'-6" | 317 | 392 | 498 | 703 | 892 | | | | | | | | |
| 9'-0" | 276 | 342 | 436 | 618 | 785 | 889 | | | | | | | |
| 9'-6" | 242 | 300 | 383 | 546 | 696 | 788 | 949 | | | | | | |
| 10'-0" | 212 | 264 | 338 | 485 | 619 | 701 | 846 | | | | | | |
| 10'-6" | 172 | 230 | 298 | 432 | 505 | 618 | 754 | 916 | | | | | |
| 11'-0" | 152 | 203 | 265 | 386 | 452 | 555 | 677 | 824 | 951 | | | | |
| 11'-6" | 134 | 180 | 236 | 346 | 406 | 499 | 611 | 745 | 860 | 976 | | | |
| 12'-0" | 118 | 160 | 211 | 311 | 366 | 451 | 552 | 675 | 780 | 886 | 992 | | |
| 12'-6" | 104 | 142 | 188 | 280 | 330 | 408 | 501 | 613 | 710 | 806 | 904 | | |
| 13'-0" | 91 | 126 | 168 | 253 | 298 | 369 | 455 | 558 | 647 | 736 | 825 | 979 | |
| 13'-6" | 80 | 112 | 150 | 228 | 270 | 335 | 414 | 509 | 591 | 673 | 755 | 898 | 960 |
| 14'-0" | 70 | 100 | 134 | 206 | 245 | 305 | 378 | 466 | 541 | 617 | 693 | 825 | 882 |
| 14'-6" | 62 | 88 | 120 | 187 | 222 | 278 | 345 | 426 | 496 | 566 | 637 | 759 | 812 |
| 15'-0" | 54 | 78 | 107 | 169 | 201 | 253 | 315 | 391 | 456 | 521 | 586 | 700 | 749 |
| 15'-6" | 46 | 69 | 96 | 153 | 183 | 231 | 288 | 359 | 419 | 480 | 540 | 646 | 692 |
| 16'-0" | 40 | 60 | 85 | 139 | 166 | 211 | 264 | 330 | 386 | 442 | 498 | 598 | 640 |
| 16'-6" | | 53 | 76 | 125 | 151 | 192 | 242 | 303 | 356 | 408 | 461 | 554 | 593 |
| 17'-0" | | 46 | 67 | 113 | 137 | 175 | 222 | 279 | 328 | 377 | 426 | 513 | 550 |
| 17'-6" | | | 59 | 102 | 124 | 160 | 203 | 257 | 303 | 349 | 394 | 476 | 511 |
| 18'-0" | | | 51 | 92 | 112 | 146 | 186 | 237 | 280 | 323 | 365 | 442 | 474 |
| 18'-6" | | | 45 | 83 | 101 | 133 | 171 | 218 | 258 | 299 | 339 | 411 | 441 |
| 19'-0" | | | | 74 | 91 | 121 | 156 | 201 | 239 | 277 | 314 | 382 | 410 |
| 19'-6" | | | | 66 | 82 | 110 | 143 | 185 | 221 | 256 | 291 | 356 | 382 |
| 20'-0" | | | | 59 | 74 | 100 | 131 | 170 | 204 | 237 | 270 | 331 | 356 |

**Note: See Fig. 7-1 for reinforcing bar details.**

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

**"H" – Use hooked or headed bars.**

## SOLID ONE-WAY SLABS—END SPAN

$f'_c$ = 4,000 psi — Grade 60 Bars — Top Steel for $-M_u$ $\rho \approx 0.0075$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top Bars Spacing (in.) | #4<br>8 | #5<br>12 | #5<br>10 | #5<br>9 | #6<br>12 | #6<br>10 | #6<br>9 | #7<br>12 | #7<br>11 | #7<br>10 | #7<br>10 | #8<br>12 | #8<br>12 |
| Bottom Bars Spacing (in.) | #4<br>9 | #4<br>8 | #5<br>11 | #5<br>10 | #5<br>9 | #6<br>12 | #6<br>11 | #6<br>10 | #6<br>9 | #7<br>12 | #7<br>11 | #7<br>10 | #7<br>10 |
| Top Bars Free End Spacing (in.) | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>12 | #4<br>11 | #4<br>10 | #4<br>10 |
| T-S Bars Spacing (in.) | #3<br>11 | #3<br>11 | #3<br>11 | #3<br>11 | #3<br>10 | #3<br>9 | #3<br>8 | #3<br>8 | #3<br>7 | #3<br>7 | #3<br>6 | #3<br>6 | #3<br>6 |
| Areas of Steel ($in.^2/ft$)<br>Top Interior<br>Bottom | <br>0.300<br>0.267 | <br>0.310<br>0.300 | <br>0.372<br>0.338 | <br>0.413<br>0.372 | <br>0.440<br>0.413 | <br>0.528<br>0.440 | <br>0.587<br>0.480 | <br>0.600<br>0.528 | <br>0.655<br>0.587 | <br>0.720<br>0.600 | <br>0.720<br>0.655 | <br>0.790<br>0.720 | <br>0.790<br>0.720 |
| Slab Wt. (psf)<br>Steel Wt. (psf) | 50<br>1.70 | 56<br>1.81 | 63<br>2.00 | 69<br>2.15 | 75<br>2.37 | 81<br>2.60 | 88<br>2.87 | 94<br>3.03 | 100<br>3.35 | 106<br>3.46 | 113<br>3.76 | 119<br>4.05 | 125<br>4.05 |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
| 6'-0"<br>6'-6" | 967<br>815 | | | | | | | | | | | | |
| 7'-0"<br>7'-6"<br>8'-0"<br>8'-6"<br>9'-0"<br>9'-6" | 695<br>597<br>518<br>452<br>396<br>349 | 926<br>798<br>693<br>606<br>533<br>472 | <br><br>888<br>778<br>686<br>608 | <br><br><br>978<br>863<br>766 | <br><br><br><br><br>960 | | | | | | | | |
| 10'-0"<br>10'-6"<br>11'-0"<br>11'-6"<br>12'-0"<br>12'-6" | 309<br>275<br>245<br>219<br>196<br>172* | 419<br>338<br>302<br>271<br>243<br>219 | 541<br>480<br>431<br>388<br>350<br>316 | 683<br>612<br>550<br>496<br>449<br>407 | 857<br>727<br>654<br>591<br>535<br>486 | <br>900<br>811<br>734<br>666<br>606 | <br><br>978<br>886<br>805<br>733 | <br><br><br><br>973H<br>888H | | | | | |
| 13'-0"<br>13'-6"<br>14'-0"<br>14'-6"<br>15'-0"<br>15'-6" | 154*<br>137*<br>123*<br>109*<br>99*<br>88* | 197<br>178<br>161<br>145<br>131<br>119 | 287<br>260<br>233*<br>210*<br>191*<br>173* | 370<br>337<br>308<br>279*<br>250*<br>227* | 443<br>404<br>369<br>338<br>310<br>285 | 553<br>506<br>464<br>425<br>391<br>360 | 670<br>614<br>563<br>518<br>477<br>440 | 812H<br>745H<br>685H<br>631H<br>582H<br>538H | 983H<br>903H<br>831H<br>766H<br>708H<br>656H | <br>992H<br>913H<br>843H<br>779H<br>722H | <br><br><br>986H<br>913H<br>846H | <br><br><br><br><br>991H | |
| 16'-0"<br>16'-6"<br>17'-0"<br>17'-6"<br>18'-0"<br>18'-6" | 79*<br>71*<br>64*<br>57*<br>52*<br>47* | 107<br>97<br>87<br>78<br>70<br>63 | 155*<br>142*<br>129*<br>116*<br>107*<br>97* | 208*<br>189*<br>173*<br>157*<br>143*<br>132* | 261<br>240<br>221<br>204<br>188<br>172* | 332<br>306<br>283<br>261<br>238*<br>220* | 406<br>376<br>348<br>322<br>299<br>277 | 498H<br>461H<br>428H<br>398<br>363*<br>336* | 608H<br>564H<br>525H<br>484*<br>445*<br>411* | 669H<br>622H<br>578H<br>539<br>502<br>468 | 786H<br>731H<br>680H<br>634<br>592<br>553 | 922H<br>858H<br>800H<br>747H<br>698H<br>653H | 984H<br>916H<br>854H<br>798H<br>746H<br>698H |
| 19'-0"<br>19'-6"<br>20'-0" | 42 | 56<br>50<br>44 | 88*<br>81*<br>74* | 121*<br>110*<br>101* | 158*<br>145*<br>133* | 203*<br>187*<br>172* | 255*<br>234*<br>216* | 311*<br>288*<br>265* | 381*<br>351*<br>325* | 438<br>409<br>382 | 517<br>484<br>454 | 612H<br>574H<br>538 | 654H<br>613H<br>575 |

**Note: See Fig. 7-1 for reinforcing bar details.**

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

**"H" – Use hooked or headed bars.**

## SOLID ONE-WAY SLABS—END SPAN

Top Steel for $-M_u$

$f'_c$ = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0100$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top Bars | #5 | #5 | #6 | #6 | #7 | #7 | #7 | #8 | #8 | #8 | #8 | #9 | #9 |
| Spacing (in.) | 10 | 9 | 11 | 10 | 12 | 11 | 10 | 12 | 11 | 10 | 10 | 12 | 11 |
| Bottom Bars | #5 | #5 | #6 | #6 | #6 | #7 | #7 | #7 | #7 | #8 | #8 | #8 | #9 |
| Spacing (in.) | 11 | 10 | 12 | 11 | 10 | 12 | 11 | 10 | 9 | 12 | 11 | 10 | 12 |
| Top Bars Free End | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 10 | 10 |
| T-S Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 |
| Spacing (in.) | 11 | 11 | 11 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 6 |
| Areas of Steel ($in.^2/ft$) | | | | | | | | | | | | | |
| Top Interior | 0.372 | 0.413 | 0.480 | 0.528 | 0.600 | 0.655 | 0.720 | 0.790 | 0.862 | 0.948 | 0.948 | 1.000 | 1.091 |
| Bottom | 0.338 | 0.372 | 0.440 | 0.480 | 0.528 | 0.600 | 0.655 | 0.720 | 0.800 | 0.790 | 0.862 | 0.948 | 1.000 |
| Slab Wt. (psf) | 50 | 56 | 63 | 69 | 75 | 81 | 88 | 94 | 100 | 106 | 113 | 119 | 125 |
| Steel Wt. (psf) | 2.00 | 2.15 | 2.46 | 2.64 | 2.92 | 3.24 | 3.56 | 3.83 | 4.24 | 4.27 | 4.63 | 4.98 | 5.25 |

| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6'-0" | 995H | | | | | | | | | | | | |
| 6'-6" | 907 | | | | | | | | | | | | |
| 7'-0" | 833 | 991 | | | | | | | | | | | |
| 7'-6" | 718* | 915 | | | | | | | | | | | |
| 8'-0" | 578* | 842 | 967 | | | | | | | | | | |
| 8'-6" | 481* | 721* | 901 | | | | | | | | | | |
| 9'-0" | 403* | 614* | 834* | 964 | | | | | | | | | |
| 9'-6" | 341* | 536* | 721* | 904 | | | | | | | | | |
| 10'-0" | 292* | 463* | 623* | 824* | 945H | | | | | | | | |
| 10'-6" | 253* | 409* | 550* | 722* | 892H | 996H | | | | | | | |
| 11'-0" | 219* | 356* | 480* | 631* | 814H* | 942H | | | | | | | |
| 11'-6" | 228* | 315* | 429* | 563* | 720H* | 893H | 987H | | | | | | |
| 12'-0" | 202* | 279* | 381* | 497* | 644H* | 817H* | 937H | | | | | | |
| 12'-6" | 179* | 251* | 339* | 444* | 575H* | 729H* | 892H | 967H | | | | | |
| 13'-0" | 158* | 224* | 301* | 397* | 516H* | 654H* | 817H* | 921H | | | | | |
| 13'-6" | 142* | 199* | 270* | 357* | 461H* | 585H* | 732H* | 880H | 959H | | | | |
| 14'-0" | 126* | 180* | 245* | 322* | 416H* | 528H* | 664H* | 815H* | 917H | 994H | | | |
| 14'-6" | 112* | 162* | 219* | 291* | 377H* | 478H* | 601H* | 742H* | 879H | 952H | | | |
| 15'-0" | 102* | 146* | 200* | 265* | 342H* | 434H* | 546H* | 671H* | 829H* | 913H | 983H | | |
| 15'-6" | 91* | 131* | 179* | 241* | 311H* | 395H* | 498H* | 611H* | 754H* | 877H | 944H | | |
| 16'-0" | 81* | 118* | 164* | 217* | 285H* | 361H* | 454H* | 558H* | 690H* | 814H* | 907H | 964H | |
| 16'-6" | 73* | 107* | 149* | 198* | 260H* | 330H* | 416H* | 511H* | 630H* | 748H* | 873H | 927H | 992H |
| 17'-0" | 66* | 97* | 135* | 182* | 237H* | 302H* | 381H* | 469H* | 578H* | 687H* | 808H* | 893H | 955H |
| 17'-6" | 59* | 88* | 123* | 166* | 217* | 277* | 350* | 431H* | 531H* | 632H* | 746H* | 861H | 921H |
| 18'-0" | 54* | 80* | 112* | 152* | 198* | 255* | 322* | 397H* | 490H* | 583H* | 688H* | 814H* | 888H |
| 18'-6" | 49* | 73* | 102* | 139* | 182* | 235* | 297* | 366H* | 452H* | 538H* | 636H* | 750H* | 858H |
| 19'-0" | 44* | 66* | 93* | 127* | 168* | 217* | 274* | 338H* | 418H* | 498H* | 589H* | 696H* | 817H* |
| 19'-6" | 40* | 60* | 86* | 117* | 155* | 200* | 253* | 313H* | 387H* | 462H* | 546H* | 645H* | 756H* |
| 20'-0" | | 55* | 79* | 108* | 143* | 185* | 234* | 290* | 359* | 429* | 507* | 600H* | 702H* |

**Note: See Fig. 7-1 for reinforcing bar details.**

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

**"H" – Use hooked or headed bars.**

## SOLID ONE-WAY SLABS—INTERIOR SPAN

$f'_c$ = 4,000 psi — Grade 60 Bars — Recommended Minimum Steel Top and Bottom

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top Bars | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 11 |
| Bottom Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #4 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 12 | 11 | 11 |
| T-S Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 11 | 11 |
| Areas of Steel (in.$^2$/ft) | | | | | | | | | | | | | |
| Top Interior | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 | 0.218 | 0.218 |
| Bottom | 0.110 | 0.110 | 0.110 | 0.120 | 0.132 | 0.147 | 0.165 | 0.165 | 0.189 | 0.189 | 0.200 | 0.218 | 0.218 |
| Slab Wt. (psf) | 50 | 56 | 63 | 69 | 75 | 81 | 88 | 94 | 100 | 106 | 113 | 119 | 125 |
| Steel Wt. (psf) | 1.11 | 1.11 | 1.11 | 1.15 | 1.25 | 1.33 | 1.46 | 1.46 | 1.60 | 1.60 | 1.74 | 1.78 | 1.78 |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
| 6'-0" | 595 | 698 | 799 | 990 | | | | | | | | | |
| 6'-6" | 498 | 584 | 670 | 831 | | | | | | | | | |
| 7'-0" | 421 | 495 | 567 | 705 | 872 | | | | | | | | |
| 7'-6" | 359 | 422 | 484 | 603 | 748 | 926 | | | | | | | |
| 8'-0" | 308 | 363 | 416 | 520 | 646 | 802 | 881 | 958 | | | | | |
| 8'-6" | 266 | 314 | 360 | 451 | 562 | 699 | 768 | 836 | 903 | 971 | | | |
| 9'-0" | 231 | 272 | 313 | 394 | 492 | 613 | 674 | 733 | 793 | 852 | 910 | | |
| 9'-6" | 201 | 238 | 273 | 345 | 432 | 540 | 594 | 647 | 699 | 752 | 803 | 945 | |
| 10'-0" | 175 | 208 | 239 | 303 | 381 | 478 | 526 | 572 | 619 | 666 | 712 | 839 | 890 |
| 10'-6" | 153 | 182 | 210 | 267 | 337 | 383 | 419 | 457 | 495 | 532 | 569 | 673 | 715 |
| 11'-0" | 134 | 160 | 184 | 236 | 299 | 340 | 373 | 406 | 440 | 474 | 506 | 601 | 638 |
| 11'-6" | 118 | 141 | 162 | 209 | 266 | 303 | 332 | 362 | 392 | 422 | 451 | 537 | 571 |
| 12'-0" | 103 | 124 | 143 | 185 | 237 | 270 | 296 | 323 | 350 | 378 | 404 | 482 | 512 |
| 12'-6" | 90 | 109 | 126 | 164 | 211 | 241 | 265 | 289 | 313 | 338 | 361 | 433 | 460 |
| 13'-0" | 79 | 95 | 110 | 145 | 189 | 216 | 237 | 259 | 281 | 303 | 324 | 389 | 414 |
| 13'-6" | 69 | 83 | 97 | 129 | 168 | 193 | 212 | 232 | 252 | 272 | 290 | 351 | 373 |
| 14'-0" | 60 | 73 | 85 | 114 | 150 | 173 | 189 | 207 | 225 | 244 | 260 | 316 | 336 |
| 14'-6" | 52 | 63 | 74 | 100 | 134 | 154 | 169 | 186 | 202 | 218 | 233 | 285 | 303 |
| 15'-0" | 44 | 55 | 64 | 88 | 119 | 138 | 151 | 166 | 181 | 196 | 209 | 257 | 274 |
| 15'-6" | | 47 | 55 | 77 | 106 | 123 | 135 | 148 | 162 | 175 | 187 | 231 | 247 |
| 16'-0" | | 40 | 47 | 68 | 94 | 109 | 120 | 132 | 144 | 157 | 167 | 208 | 222 |
| 16'-6" | | | 40 | 59 | 83 | 97 | 107 | 118 | 129 | 140 | 149 | 187 | 200 |
| 17'-0" | | | | 50 | 73 | 86 | 94 | 104 | 114 | 124 | 133 | 168 | 180 |
| 17'-6" | | | | 43 | 63 | 75 | 83 | 92 | 101 | 110 | 118 | 151 | 161 |
| 18'-0" | | | | | 55 | 66 | 73 | 81 | 89 | 97 | 104 | 135 | 144 |
| 18'-6" | | | | | 47 | 57 | 63 | 70 | 78 | 85 | 91 | 120 | 128 |
| 19'-0" | | | | | 40 | 49 | 54 | 61 | 67 | 74 | 79 | 106 | 114 |
| 19'-6" | | | | | | 42 | 46 | 52 | 58 | 64 | 68 | 93 | 100 |
| 20'-0" | | | | | | | | 44 | 49 | 54 | 58 | 82 | 88 |

**Note: CRSI recommendations for minimum reinforcement are based on practical considerations of rigidity against displacement under normal construction traffic. In all cases, these minimums satisfy minimum prescribed in ACI 10.5. See Fig. 7-1 for reinforcing bar details.**

## SOLID ONE-WAY SLABS—INTERIOR SPAN

Top Steel for $-M_u$

$f'_c$ = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0025$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top Bars | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 12 | 11 | 10 | 10 | 9 | 8 |
| Bottom Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 12 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 11 | 10 |
| T-S Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 11 | 11 |
| Areas of Steel (in.$^2$/ft) | | | | | | | | | | | | | |
| Top Interior | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 | 0.200 | 0.218 | 0.240 | 0.240 | 0.267 | 0.300 |
| Bottom | 0.110 | 0.110 | 0.110 | 0.110 | 0.120 | 0.132 | 0.147 | 0.165 | 0.165 | 0.189 | 0.189 | 0.218 | 0.240 |
| Slab Wt. (psf) | 50 | 56 | 63 | 69 | 75 | 81 | 88 | 94 | 100 | 106 | 113 | 119 | 125 |
| Steel Wt. (psf) | 1.11 | 1.11 | 1.11 | 1.12 | 1.21 | 1.28 | 1.40 | 1.46 | 1.57 | 1.68 | 1.80 | 1.87 | 2.00 |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
| 6'-0" | 595 | 698 | 799 | 902 | | | | | | | | | |
| 6'-6" | 498 | 584 | 670 | 756 | 926 | | | | | | | | |
| 7'-0" | 421 | 495 | 567 | 640 | 786 | 962 | | | | | | | |
| 7'-6" | 359 | 422 | 484 | 547 | 673 | 825 | | | | | | | |
| 8'-0" | 308 | 363 | 416 | 471 | 580 | 713 | 876 | 958 | | | | | |
| 8'-6" | 266 | 314 | 360 | 408 | 504 | 621 | 764 | 836 | 994 | | | | |
| 9'-0" | 231 | 272 | 313 | 355 | 440 | 543 | 670 | 733 | 874 | | | | |
| 9'-6" | 201 | 238 | 273 | 310 | 385 | 477 | 590 | 647 | 772 | 924 | 987 | | |
| 10'-0" | 175 | 208 | 239 | 271 | 339 | 421 | 522 | 572 | 685 | 821 | 877 | | |
| 10'-6" | 153 | 182 | 210 | 238 | 299 | 373 | 419 | 457 | 549 | 661 | 707 | 851 | |
| 11'-0" | 134 | 160 | 184 | 210 | 264 | 331 | 373 | 406 | 490 | 591 | 632 | 762 | 927 |
| 11'-6" | 118 | 141 | 162 | 185 | 234 | 295 | 332 | 362 | 438 | 530 | 566 | 685 | 835 |
| 12'-0" | 103 | 124 | 143 | 163 | 208 | 263 | 296 | 323 | 392 | 476 | 509 | 618 | 755 |
| 12'-6" | 90 | 109 | 126 | 144 | 184 | 234 | 265 | 289 | 352 | 429 | 458 | 558 | 684 |
| 13'-0" | 79 | 95 | 110 | 127 | 164 | 209 | 237 | 259 | 316 | 387 | 414 | 505 | 621 |
| 13'-6" | 69 | 83 | 97 | 111 | 145 | 187 | 212 | 232 | 285 | 349 | 374 | 458 | 565 |
| 14'-0" | 60 | 73 | 85 | 98 | 129 | 167 | 189 | 207 | 256 | 316 | 338 | 416 | 514 |
| 14'-6" | 52 | 63 | 74 | 85 | 114 | 149 | 169 | 186 | 231 | 286 | 306 | 378 | 469 |
| 15'-0" | 44 | 55 | 64 | 74 | 100 | 133 | 151 | 166 | 208 | 259 | 277 | 344 | 429 |
| 15'-6" | | 47 | 55 | 64 | 88 | 118 | 135 | 148 | 187 | 234 | 251 | 313 | 392 |
| 16'-0" | | 40 | 47 | 55 | 77 | 105 | 120 | 132 | 168 | 212 | 227 | 285 | 359 |
| 16'-6" | | | 40 | 47 | 67 | 93 | 107 | 118 | 151 | 192 | 205 | 259 | 328 |
| 17'-0" | | | | | 58 | 82 | 94 | 104 | 135 | 173 | 185 | 236 | 300 |
| 17'-6" | | | | | 50 | 72 | 83 | 92 | 121 | 156 | 167 | 214 | 275 |
| 18'-0" | | | | | 42 | 62 | 73 | 81 | 107 | 141 | 151 | 195 | 252 |
| 18'-6" | | | | | | 54 | 63 | 70 | 95 | 126 | 135 | 177 | 230 |
| 19'-0" | | | | | | 46 | 54 | 61 | 84 | 113 | 121 | 160 | 211 |
| 19'-6" | | | | | | | 46 | 52 | 74 | 101 | 108 | 145 | 192 |
| 20'-0" | | | | | | | | 44 | 64 | 90 | 96 | 131 | 175 |

**Note: See Fig. 7-1 for reinforcing bar details.**

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

**"H" – Use hooked or headed bars.**

## SOLID ONE-WAY SLABS—INTERIOR SPAN

Top Steel for $-M_u$

$f'_c$ = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0050$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top Bars | #4 | #4 | #4 | #4 | #5 | #5 | #5 | #5 | #6 | #6 | #6 | #6 | #6 |
| Spacing (in.) | 12 | 11 | 10 | 8 | 12 | 11 | 10 | 9 | 12 | 11 | 11 | 10 | 9 |
| Bottom Bars | #3 | #3 | #3 | #4 | #4 | #4 | #4 | #5 | #5 | #5 | #5 | #5 | #5 |
| Spacing (in.) | 9 | 8 | 7 | 11 | 10 | 9 | 8 | 12 | 11 | 11 | 10 | 9 | 9 |
| T-S Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #4 | #4 |
| Spacing (in.) | 12 | 12 | 12 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 11 | 11 |
| Areas of Steel (in.$^2$/ft) | | | | | | | | | | | | | |
| Top Interior | 0.200 | 0.218 | 0.240 | 0.300 | 0.310 | 0.338 | 0.372 | 0.413 | 0.440 | 0.480 | 0.480 | 0.528 | 0.587 |
| Bottom | 0.147 | 0.165 | 0.189 | 0.218 | 0.240 | 0.267 | 0.300 | 0.310 | 0.338 | 0.338 | 0.372 | 0.413 | 0.413 |
| Slab Wt. (psf) | 50 | 56 | 63 | 69 | 75 | 81 | 88 | 94 | 100 | 106 | 113 | 119 | 125 |
| Steel Wt. (psf) | 1.22 | 1.31 | 1.42 | 1.63 | 1.78 | 1.95 | 2.19 | 2.31 | 2.54 | 2.62 | 2.83 | 3.00 | 3.12 |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
| 6'-0" | 795 | | | | | | | | | | | | |
| 6'-6" | 668 | 863 | | | | | | | | | | | |
| 7'-0" | 568 | 735 | 935 | | | | | | | | | | |
| 7'-6" | 487 | 631 | 804 | | | | | | | | | | |
| 8'-0" | 421 | 547 | 698 | 981 | | | | | | | | | |
| 8'-6" | 366 | 477 | 609 | 860 | 1000 | | | | | | | | |
| 9'-0" | 320 | 418 | 535 | 758 | 883 | | | | | | | | |
| 9'-6" | 281 | 368 | 473 | 672 | 783 | 952 | | | | | | | |
| 10'-0" | 247 | 326 | 419 | 598 | 698 | 850 | | | | | | | |
| 10'-6" | 196 | 259 | 336 | 493 | 565 | 690 | 840 | | | | | | |
| 11'-0" | 173 | 230 | 299 | 442 | 507 | 620 | 756 | 924 | | | | | |
| 11'-6" | 153 | 205 | 267 | 397 | 456 | 559 | 682 | 835 | 958 | | | | |
| 12'-0" | 136 | 183 | 239 | 358 | 411 | 505 | 618 | 758 | 870 | | | | |
| 12'-6" | 120 | 163 | 214 | 323 | 372 | 458 | 561 | 690 | 793 | 940 | | | |
| 13'-0" | 107 | 146 | 193 | 293 | 337 | 416 | 511 | 629 | 724 | 859 | 921 | | |
| 13'-6" | 94 | 130 | 173 | 265 | 306 | 379 | 466 | 575 | 662 | 788 | 844 | | |
| 14'-0" | 84 | 116 | 156 | 241 | 278 | 345 | 426 | 527 | 607 | 723 | 776 | 922 | |
| 14'-6" | 74 | 104 | 140 | 219 | 253 | 315 | 390 | 483 | 558 | 666 | 714 | 849 | |
| 15'-0" | 65 | 93 | 126 | 199 | 231 | 288 | 357 | 444 | 514 | 614 | 658 | 784 | 939 |
| 15'-6" | 57 | 82 | 113 | 181 | 210 | 264 | 328 | 409 | 473 | 567 | 608 | 725 | 870 |
| 16'-0" | 50 | 73 | 101 | 165 | 192 | 242 | 301 | 377 | 437 | 524 | 562 | 672 | 807 |
| 16'-6" | 43 | 65 | 91 | 150 | 175 | 221 | 277 | 348 | 404 | 485 | 520 | 623 | 750 |
| 17'-0" | | 57 | 81 | 137 | 159 | 203 | 255 | 321 | 373 | 449 | 482 | 579 | 698 |
| 17'-6" | | 50 | 72 | 124 | 145 | 186 | 234 | 296 | 345 | 417 | 447 | 538 | 650 |
| 18'-0" | | 44 | 64 | 113 | 132 | 170 | 216 | 274 | 320 | 387 | 415 | 501 | 606 |
| 18'-6" | | | 57 | 102 | 121 | 156 | 199 | 253 | 296 | 360 | 386 | 466 | 566 |
| 19'-0" | | | 50 | 93 | 110 | 143 | 183 | 234 | 275 | 334 | 359 | 435 | 529 |
| 19'-6" | | | 43 | 84 | 99 | 131 | 168 | 217 | 255 | 311 | 334 | 406 | 494 |
| 20'-0" | | | | 76 | 90 | 119 | 155 | 200 | 236 | 289 | 311 | 378 | 462 |

**Note: See Fig. 7-1 for reinforcing bar details.**

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

**"H" – Use hooked or headed bars.**

## SOLID ONE-WAY SLABS—INTERIOR SPAN

Top Steel for $-M_u$

$f'_c$ = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0075$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top Bars | #4 | #5 | #5 | #5 | #6 | #6 | #6 | #7 | #7 | #7 | #7 | #8 | #8 |
| Spacing (in.) | 8 | 12 | 10 | 9 | 12 | 10 | 9 | 12 | 11 | 10 | 10 | 12 | 12 |
| Bottom Bars | #4 | #4 | #4 | #5 | #5 | #5 | #5 | #6 | #6 | #6 | #6 | #7 | #7 |
| Spacing (in.) | 11 | 10 | 8 | 12 | 11 | 10 | 9 | 12 | 11 | 10 | 9 | 12 | 12 |
| T-S Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 |
| Spacing (in.) | 11 | 11 | 11 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 6 |
| Areas of Steel ($in.^2/ft$) | | | | | | | | | | | | | |
| Top Interior | 0.300 | 0.310 | 0.372 | 0.413 | 0.440 | 0.528 | 0.587 | 0.600 | 0.655 | 0.720 | 0.720 | 0.790 | 0.790 |
| Bottom | 0.218 | 0.240 | 0.300 | 0.310 | 0.338 | 0.372 | 0.413 | 0.440 | 0.480 | 0.528 | 0.587 | 0.600 | 0.600 |
| Slab Wt. (psf) | 50 | 56 | 63 | 69 | 75 | 81 | 88 | 94 | 100 | 106 | 113 | 119 | 125 |
| Steel Wt. (psf) | 1.63 | 1.72 | 2.02 | 2.14 | 2.35 | 2.67 | 2.98 | 3.10 | 3.41 | 3.69 | 3.98 | 4.14 | 4.14 |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
| 6'-0" | | | | | | | | | | | | | |
| 6'-6" | 995 | | | | | | | | | | | | |
| 7'-0" | 849 | | | | | | | | | | | | |
| 7'-6" | 732 | 887 | | | | | | | | | | | |
| 8'-0" | 636 | 772 | | | | | | | | | | | |
| 8'-6" | 557 | 676 | 942 | | | | | | | | | | |
| 9'-0" | 490 | 595 | 832 | | | | | | | | | | |
| 9'-6" | 434 | 527 | 739 | 939 | | | | | | | | | |
| 10'-0" | 385 | 469 | 660 | 839 | 991 | | | | | | | | |
| 10'-6" | 314 | 379 | 536 | 684 | 808 | | | | | | | | |
| 11'-0" | 281 | 339 | 481 | 615 | 729 | 979 | | | | | | | |
| 11'-6" | 251 | 305 | 434 | 556 | 659 | 888 | | | | | | | |
| 12'-0" | 226 | 274 | 392 | 504 | 598 | 807 | 992 | | | | | | |
| 12'-6" | 204 | 247 | 356 | 458 | 544 | 736 | 905 | | | | | | |
| 13'-0" | 184 | 224 | 323 | 417 | 496 | 673 | 829 | 918H | | | | | |
| 13'-6" | 166 | 202 | 294 | 381 | 453 | 617 | 761 | 843H | | | | | |
| 14'-0" | 150 | 184 | 268 | 348 | 415 | 567 | 700 | 776H | 926H | | | | |
| 14'-6" | 136 | 166 | 245 | 319 | 381 | 522 | 646 | 716H | 855H | | | | |
| 15'-0" | 123 | 151 | 224 | 292 | 350 | 481 | 596 | 662H | 791H | 947H | | | |
| 15'-6" | 111 | 137 | 205 | 269 | 322 | 445 | 552 | 612H | 733H | 878H | 944H | | |
| 16'-0" | 101 | 125 | 187 | 247 | 297 | 411 | 511 | 568H | 681H | 817H | 878H | | |
| 16'-6" | 91 | 113 | 172 | 227 | 274 | 381 | 474 | 527H | 633H | 760H | 817H | 958H | |
| 17'-0" | 82 | 103 | 157 | 209 | 252 | 353 | 441 | 490H | 589H | 709H | 762H | 894H | 955H |
| 17'-6" | 74 | 93 | 144 | 193 | 233 | 328 | 410 | 456 | 549 | 662 | 711 | 836H | 892H |
| 18'-0" | 67 | 84 | 132 | 178 | 215 | 304 | 382 | 425 | 513 | 618 | 665 | 782H | 835H |
| 18'-6" | 60 | 76 | 121 | 164 | 199 | 283 | 356 | 396 | 479 | 579 | 622 | 733H | 783H |
| 19'-0" | 54 | 69 | 111 | 151 | 184 | 263 | 332 | 370 | 448 | 542 | 583 | 687H | 734H |
| 19'-6" | 48 | 62 | 101 | 139 | 170 | 245 | 310 | 345 | 419 | 508 | 546 | 645H | 690H |
| 20'-0" | 43 | 55 | 93 | 128 | 157 | 228 | 289 | 323 | 392 | 477 | 513 | 606 | 648 |

**Note: See Fig. 7-1 for reinforcing bar details.**

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

**"H" – Use hooked or headed bars.**

## SOLID ONE-WAY SLABS—INTERIOR SPAN

Top Steel for $-M_u$

$f'_c$ = 4,000 psi — Grade 60 Bars — $\rho \approx 0.0100$

| Thickness (in.) | 4 | 4½ | 5 | 5½ | 6 | 6½ | 7 | 7½ | 8 | 8½ | 9 | 9½ | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Top Bars | #5 | #5 | #6 | #6 | #7 | #7 | #7 | #8 | #8 | #8 | #8 | #9 | #9 |
| Spacing (in.) | 10 | 9 | 11 | 10 | 12 | 11 | 10 | 12 | 11 | 10 | 10 | 12 | 11 |
| Bottom Bars | #4 | #5 | #5 | #5 | #6 | #6 | #6 | #7 | #7 | #7 | #7 | #8 | #8 |
| Spacing (in.) | 8 | 12 | 10 | 9 | 12 | 11 | 10 | 12 | 11 | 10 | 10 | 12 | 12 |
| T-S Bars | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 | #3 |
| Spacing (in.) | 11 | 11 | 11 | 11 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | 6 | 6 |
| Areas of Steel ($in.^2/ft$) | | | | | | | | | | | | | |
| Top Interior | 0.372 | 0.413 | 0.480 | 0.528 | 0.600 | 0.655 | 0.720 | 0.790 | 0.862 | 0.948 | 0.948 | 1.000 | 1.091 |
| Bottom | 0.300 | 0.310 | 0.372 | 0.413 | 0.440 | 0.480 | 0.528 | 0.600 | 0.655 | 0.720 | 0.720 | 0.790 | 0.790 |
| Slab Wt. (psf) | 50 | 56 | 63 | 69 | 75 | 81 | 88 | 94 | 100 | 106 | 113 | 119 | 125 |
| Steel Wt. (psf) | 2.02 | 2.14 | 2.47 | 2.69 | 2.99 | 3.26 | 3.61 | 3.95 | 4.34 | 4.71 | 4.82 | 5.13 | 5.31 |

| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (psf) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6'-0" | | | | | | | | | | | | | |
| 6'-6" | | | | | | | | | | | | | |
| 7'-0" | 967 | | | | | | | | | | | | |
| 7'-6" | 891 | | | | | | | | | | | | |
| 8'-0" | 775 | 986 | | | | | | | | | | | |
| 8'-6" | 680 | 900 | | | | | | | | | | | |
| 9'-0" | 600 | 796 | 980 | | | | | | | | | | |
| 9'-6" | 532 | 707 | 920 | | | | | | | | | | |
| 10'-0" | 475 | 632 | 837 | 991 | | | | | | | | | |
| 10'-6" | 384 | 514 | 683 | 862 | | | | | | | | | |
| 11'-0" | 345 | 462 | 615 | 778 | 982H | | | | | | | | |
| 11'-6" | 310 | 417 | 557 | 704 | 891H | | | | | | | | |
| 12'-0" | 280 | 377 | 505 | 640 | 811H | 989H | | | | | | | |
| 12'-6" | 253 | 343 | 459 | 583 | 740H | 904H | | | | | | | |
| 13'-0" | 230 | 312 | 419 | 533 | 678H | 828H | 994H | | | | | | |
| 13'-6" | 209 | 284 | 383 | 488 | 622H | 761H | 927H | | | | | | |
| 14'-0" | 190 | 259 | 351 | 448 | 572H | 701H | 854H | 985H | | | | | |
| 14'-6" | 173 | 237 | 322 | 412 | 527H | 647H | 789H | 941H | | | | | |
| 15'-0" | 157 | 217 | 296 | 380 | 486H | 598H | 731H | 872H | 987H | | | | |
| 15'-6" | 144 | 199 | 272 | 350 | 450H | 554H | 678H | 809H | 949H | | | | |
| 16'-0" | 131 | 183 | 251 | 324 | 417H | 514H | 629H | 753H | 899H | 988H | | | |
| 16'-6" | 119* | 168 | 231 | 299 | 386H | 477H | 585H | 701H | 838H | 952H | | | |
| 17'-0" | 107* | 152* | 210* | 277 | 359H | 444H | 545H | 654H | 782H | 918H | 987H | | |
| 17'-6" | 98* | 139* | 192* | 257 | 331* | 413 | 509 | 611H | 731H | 876H | 944H | | |
| 18'-0" | 89* | 127* | 176* | 236* | 304* | 385 | 475 | 571H | 685H | 821H | 885H | 977H | |
| 18'-6" | 81* | 116* | 162* | 216* | 281* | 358* | 444 | 534H | 642H | 771H | 831H | 934H | |
| 19'-0" | 75 | 107* | 149* | 201* | 258* | 329* | 415 | 501H | 602H | 724H | 781H | 878H | 976H |
| 19'-6" | 68 | 98* | 137* | 186* | 239* | 306* | 385* | 470H | 566H | 681H | 734H | 827H | 945H |
| 20'-0" | 62 | 90* | 126* | 172* | 221* | 284* | 356* | 441 | 532 | 641 | 691 | 779H | 914H |

**Note: See Fig. 7-1 for reinforcing bar details.**

***Service loads corresponding to 1/1.6 of the tabulated superimposed load results in calculated immediate deflection of 1/360 span.**

**"H" – Use hooked or headed bars.**

# CHAPTER 8 – ONE-WAY CONCRETE JOIST CONSTRUCTION

## GENERAL CONSIDERATIONS

**Description**. Concrete joist construction is a method of construction consisting of a monolithic combination of regularly spaced joists (ribs) and a thin slab of concrete cast in place to form an integral unit with the supporting beams, columns, or walls. In *one-way concrete joist* construction, the joists are arranged in one direction between parallel supports. In the first part of this Chapter, the term "concrete joist construction" refers only to joists formed by removable standard size forms,* and limited to dimensions and proportions conforming to ACI 8.13. The limits in ACI 8.13 are: (1) maximum 30 in. clear spacing between ribs; (2) minimum width of rib = 1.0/3.5 times the depth of rib but not less than 4 in.; and (3) minimum slab thickness $^1/_{12}$ of clear distance between ribs but not less than 1½ in. Practical considerations for ease of placing reinforcing bars and vibrating concrete and tolerances in concrete cover usually make it desirable to use a minimum rib width of 5 in.

*Types and sizes listed in Chapter 10, "Recommended Industry Practice for Concrete Joist Construction", CRSI *Manual of Standard Practice*.

Wide-module joist construction is covered on Pages 8-90 through 8-168.

**Standard Dimensions of Forms.** Joist (rib) widths tabulated for design in this Chapter vary from 5 in. to 7 in. Standard forms for the pan spaces between ribs are 20-in. or 30-in. wide and 8, 10, 12, 14, 16, or 20 in. deep. Standard end forms consist of square end forms. Tapered end forms for the 20-in. width taper to 16-in. in a distance of three feet. The 30-in. wide tapered end form tapers to 25 in. in three feet. See Fig. 8-1. Note that the structural integrity requirements of ACI 7.13 are not included in the reinforcement details shown in Fig. 8-1.

**Basic Features of Joist Construction.** In general, joist construction was developed to save dead weight and reinforcement. As desired spans increase, the utility of solid slab construction is rapidly offset by the increase in dead load of the slab itself. Joist construction enables the designer to provide the depth required for adequate stiffness and efficient utilization of the reinforcement without excessively high dead load-live load ratios. Standard size re-usable forms make it pos-



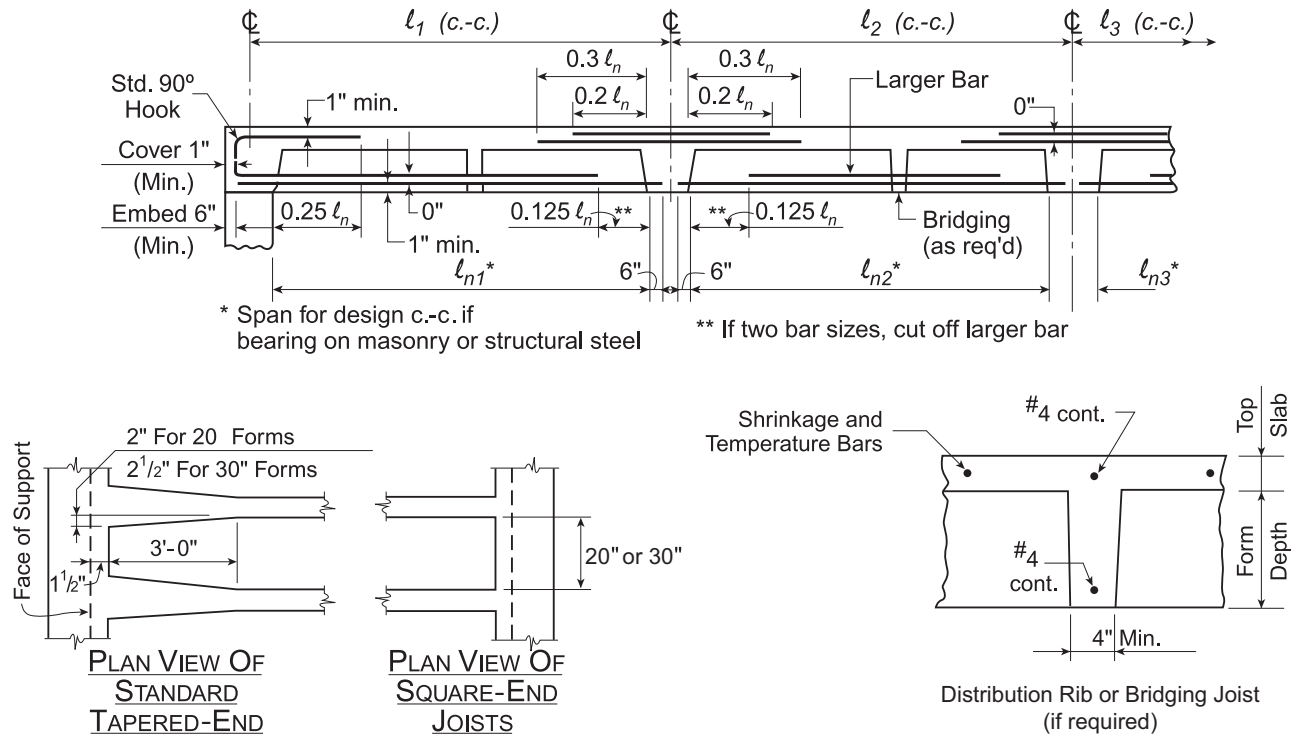



**Figure 8-1 Recommended Bar Details – Multiple Spans**

sible to reasonably optimize and eliminate unnecessary dead weight for overall economy. Longer spans or relatively heavy loads can be accommodated by using special tapered-end forms which permit widening of the ribs in areas of high shear. Special architectural ceiling effects may be achieved by leaving the rib patterns exposed or by integrating acoustic material and lighting fixtures with the rib patterns. Additional stiffness on column lines or under partitions in the direction of the joists is easily provided by an increased spacing of the standard forms leaving wider ribs at these points. Where openings are required under such partitions for piping or conduits, the use of two joist ribs with a special half-width filler form will provide the additional stiffness for the partition and a thin slab in the area of required openings.

**Joist-Band System.** Many span combinations can be designed for uniform depth construction by supporting the joists on wide "band-beams." Instead of selecting joist depth and supporting beam sizes separately to achieve minor reductions in material, the modern design for maximum overall economy is to make both joist system and framing beams the same depth. The usual procedure is to select a standard joist depth suitable for the beams as well, even if the joist is deeper than required for the joist design. Often, deflection limits for the beam can be satisfied by orienting the system so that beams span in the shorter direction. Alternatively, for live loads less than 100 psf, the live load reductions permitted in many adopted building codes for beams can often be applied for maximum economy in reinforcement to beams oriented in the long direction, when such reductions are not applicable to design of the joists.

Preliminary dimensions and flexural reinforcement required for wide band-beams, where factored shear is resisted by concrete, can be selected quickly from the joist load tables. See "Design From Load Tables" sections.

Separate beam forms are eliminated in one-way joist construction. The same deck forms the joist and beam soffit; ends of removable forms are used to form beam sides; and width of the beam can be adjusted for the occasional irregular spans. Overall building heights are reduced while maintaining the same clear ceiling height at a uniform depth. The simplified formwork, faster construction, level ceiling with no obstructing beams to complicate piping, conduit or ductwork, and reduced height of walls, columns and vertical services — all make for net overall economy in the complete building.

## DESIGN CONSIDERATIONS FOR JOIST CONSTRUCTION

**Economy.** Maximum overall economy in joist construction, as in any reinforced concrete design, is achieved only by considering the relatively high costs of formwork and construction time versus material costs. Almost invariably overall economy is achieved by maximum re-use of the same forms throughout a project, not only throughout each floor, but also the same layout and size of forms for all floors and the roof. The use of special filler forms to match rib spacing module to column spacing can often be avoided by use of one wider joist at the edge or on column lines. Use of square-end joists (non-tapered) simplifies forming. Tapered-end load strength increases have been shown in load tables. Load strengths controlled by design shear strength are indicated by an asterisk. When the asterisk appears after the load strength for square-end joists (first line) and not on the load strength for tapered-end joists (second line), the tapered-end is required to develop the full design strength of the reinforcement.

For a continuous floor system with many identical spans, it will usually be advantageous to select a uniform design depth adequate for all interior spans with square ends and to utilize tapered ends to increase shear capacity in end spans only. For a continuous three-bay floor system with two end spans and only one interior span, select a uniform depth adequate with square-end joists in end spans is recommended.

**Shrinkage and Temperature Reinforcement.** Shrinkage and temperature reinforcement in the concrete top slab over forms and in a direction normal to the span of the joists should be of reinforcing bars or welded wire reinforcement at least equal in area to the values in the following table and increased where necessary for flexure in the slab, giving due consideration to concentrated loads:

| Top Slab Thickness | Bars | Welded Wire Reinforcement** |
|---|---|---|
| 3" | #3@15* | 12 x 12 – W6.5 x W6.5 |
| 3½" | #3@17 | 12 x 12 – W7.6 x W7.6 |
| 4" | #3@15 | 12 x 12 – W8.6 x W8.6 |
| 4½" | #3@12 | 12 x 12 – W9.7 x W9.7 |
| 5" | #3@12 | 12 x 12 – W10.8 x W10.8 |

Reinforcement based on $f_y$ = 60,000 psi.
* Maximum spacing permitted by ACI 7.12.2.2 (5 times slab thickness ≤ 18 in.).
** Commonly available styles.

**Distribution Ribs or Bridging Joists.** Load distribution ribs are ribs normal to direction of span. As the name implies, load distribution ribs are provided to equalize joist deflection and thus ensure that the effect of concentrated or unequal loads is resisted by a number of joists.* Load distribution ribs are often omitted for roofs designed for uniform load only. For floor construction, use distribution ribs at least 4 in. wide, reinforced with at least one #4 bar continuous in both top and bottom, and spaced as follows:

- None in spans less than 20 feet,
- One near the center of spans from 20 to 30 feet, and
- Two near the third points of spans over 30 feet

**Openings.** One of the inherent advantages of joist construction is that single openings can be located through the thin slab between ribs without significant loss of structural strength to the system. Larger openings which interrupt one or more joists must be provided with header joists normal to the interrupted joists to distribute the load to adjacent full-length joists. Joists adjacent to such openings will require additional reinforcement, or increased width, or both. Very large openings should be framed by supporting beams.

**Control of Deflections.** The ACI Building Code requires that computed deflection be limited (ACI 9.5.1). A method of computing deflections and limits for various loading conditions are prescribed (ACI 9.5.2). See "Manual Example" sections for a general explanation.

Under the prescribed method of computation for deflection, computed deflection is a function of continuity, concrete modulus of elasticity, and effective moment of inertia, in addition to load and span. Deflection coefficients are taken as 5/384, 3.25/384, and 2/384, respectively, for single, end, and interior spans for one-way joists designed with the approximate moment coefficients (ACI 8.3.3). The load strengths tabulated in this Chapter are for joists of normal-weight concrete ($w$ = 150 pcf) and $f'_c$ = 4,000 psi, for which $E_c = 3.6 \times 10^6$ psi (ACI 8.5.1). The effective moment of inertia, $I_e$, is a function of the ratio of the cracking moment, $M_{cr}$, to the actual maximum moment, $M_a$, as well as the ratio of the cracked to gross section moment of inertia.

Since $M_a$ is a function of the service load causing the deflection, a direct solution is not feasible for the load limited by deflection as under previous ACI Codes. Tabulations of loads limited by a given deflection limit or elastic deflections resulting from the loads limited by strength design are not very useful, since deflection increments are not proportional to load increments but to the total previous load, plus the load increment.

To comply with the Code requirements for deflection conservatively without tedious iterative trial and error calculations, all joist load capacities tabulated in this Chapter have been investigated for deflection. Load strengths designated by a plus sign will cause a computed elastic live load(1) deflection equal to $\ell/480$ for multiple span joists and $\ell/360$ for single span joists. All other load strengths are controlled by strength in shear (marked *) or flexure (unmarked). The haunch effect for tapered ends has conservatively been neglected for deflection computations. Also, the value $M_a$ has been taken conservatively as the maximum applied moment for an upper bound deflection solution in the computer program, since the maximum cracking in some cases will have occurred before the load pattern for maximum deflection occurs.

**Long-Term Deflections.** For loading conditions where much of the superimposed service load is added "dead load" or relatively long-term live load, it may be necessary to compute long-term deflection or to estimate deflection due to partial loads to establish required camber or clearance to other connected elements. For these purposes, the following design aids will provide all of the required data, except $M_a$ for which the actual service load must be known:

a. Table 8-1 "Gross Section Properties."
b. Load strength table with "Properties for Design" table at bottom.
c. Code Equation (9-8) relating $M_{cr}/M_a$ and $I_{cr}/I_g$ to solution for $I_e$:
$$I_e = (M_{cr}/M_a)^3 I_g + [1 - (M_{cr}/M_a)^3] I_{cr}$$
d. Deflection coefficients for each span and continuity conditions in the load tables.

To determine the elastic deflection for a given service (actual) load, $w_a$, the five-step procedure is:

*Step 1.* Calculate $M_a$. (= $\frac{1}{8} w_a \ell^2$ for single spans; = $\frac{1}{11} w_a \ell^2$ for end spans; = $\frac{1}{16} w_a \ell^2$ for interior spans). Use actual service load for $w_a$.

*Step 2.* Read $M_{cr}$ in Table 8-1. (Positive value only for single span; both positive and negative for continuous spans). Compute $M_{cr}/M_a$ value or values.

* "Effective Width of One-Way Monolithic Joist Construction as a Two-Way System", Structural Bulletin No. 8, Concrete Reinforcing Steel Institute, 1983.

(1) "Live load" is actual service load (which is equal to the superimposed factored load divided by the load factor for live load, i.e., 1.6).

*Step 3.* Read $I_{cr}/I_g$ under load strength table. (Positive for single spans; positive and negative for continuous spans.)

*Step 4.* Use Code Eq. 9-8 with values of $M_{cr}/M_a$, and $I_{cr}/I_g$ and calculate values of $I_e/I_g$. (Positive only for single spans; positive and negative for continuous spans.) Compute average $I_e$ (continuous spans only).

*Step 5.* Read "Deflection Coefficient" from load table. Compute deflection, Δ:

$$\Delta = (\text{Defl. Coeff.}) \frac{w_a}{I_e}$$

It will always be conservative to use this value for elastic deflection with the multiplier factors for long-term deflection given in ACI 9.5.2.5.

**Crack Control.** ACI 10.6 limits the spacing of flexural reinforcement in tension zones to control cracking. The maximum spacing of reinforcing bars, $s$, is limited to the smaller value calculated by:

$$s = 15\left(\frac{40}{f_s}\right) - 2.5c_c \text{ or } s = 12\ (40/f_s)$$

Where:

$f_s$ = calculated flexural tensile stress in reinforcement at service loads, ksi. The value of $f_s$ can be taken as $(2/3)\,f_y$.

$c_c$ = clear concrete cover, in. (distance or dimension from nearest concrete surface in tension to the surface of the flexural tension reinforcement).

In this Chapter, two locations for maximum spacing are investigated: the approximation of the longer bottom bar tensile stress at the point in which the shorter bar starts (at 0.2 $\ell_n$ from the face of the support), and for the top bars at the center of the interior support.

**Unequal Continuous Spans.** Bending moments are computed from the clear span for factored positive moment in continuous spans and from the average of the two adjacent clear spans for factored negative moment. The limitations are that the larger of two adjacent spans does not exceed the shorter by more than 20 percent and that the unit live load (unfactored) does not exceed three times the unit dead load (unfactored). See ACI 8.3.3.

The values tabulated under End Spans apply accurately only when there are two additional approximately equal spans continuous with the one under consideration. If there is only one adjacent span, the factored negative moment should be $w_u\ell_n^2/9$ instead of $w_u\ell_n^2/10$, and load values should be reduced accordingly. Load values obtained from factored positive moment would not change.

The load strengths tabulated under Interior Spans apply accurately only when there are two additional approximately equal spans continuous with each end of the span under consideration. If either end is continuous with an end span, the factored negative moment should be $w_u\ell_n^2/10$ instead of $w_u\ell_n^2/11$ and the top reinforcement tabulated for End Spans should be used. Load values obtained from factored positive moment would not change.

## TABULATED DESIGNS

**Scope.** Since the tables for standard joist construction cover many pages, a general outline of the table arrangement will be helpful. The tables are divided into two main sets: (1) multiple spans, and (2) single spans. Recommended requirements and an illustrative example for each set are shown. Each set is subdivided into two parts, the first for 20-in. wide forms and the second for 30-in. wide forms. Within each such set, the tables are divided by depth of form and thickness of top slab.

**Load Strengths Tabulated.** These tables are based upon the strength design method. These tables give the usable superimposed factored load strength in pounds per square foot of floor (psf). If the floor system is a part of the primary lateral force resisting structure, alternate combinations of factored loads including lateral force moments must also be considered. Capacities have been reduced by the applicable strength-reduction, $\phi$-factors, and 1.2 times the dead weight of the joist construction itself has been deducted. Material strengths are $f'_c$ = 4,000 and $f_y$ = 60,000 psi. The practicable range of widths, depths, spacings, spans and joists, and combinations of reinforcing bars are shown. Strengths are computed as the least of those determined by design moment strength (positive or negative bending), design shear strength, development of reinforcement, or deflection.

The effects of superimposed dead loads (other than the weight of the joist construction itself) and of live loads augmented by the proper loads factors are combined: $w_u = 1.2D + 1.6L$. The total superimposed factored load is then compared with the tabulated capacities.

The appropriate empirical bending moment coefficients (ACI 8.3.3) are used; in the case of end spans, the factored positive moment is taken as $w_u\ell_n^2/11$, i.e., without restraint at the outer end.

**Live Load Limitations.** ACI 8.3.3 establishes moment and shear coefficients for cases where the unit live load (unfactored) does not exceed three times the unit dead load (unfactored). The tabulated designs are based upon these coefficients.

Since the dead load in such analyses includes not only the weight of the concrete slab but also any ceilings, floor finishes, partitions and similar immovable features, it is impossible to predetermine when the ratio of live load to dead load will exceed three. The user is cautioned to check the ratio of live to dead loads in the higher strengths. If the ratio is greater, the effect of unbalanced panel loads may require more accurate analysis and appropriate adjustments made in bar areas and cut-off points.

The tabulated designs in this Chapter apply for the particular conditions described. For final designs, the numerous variables in loads, stiffness, continuity and in the quality of materials have to be considered.

**Details of Reinforcement.** The arrangement of reinforcing bars, bar supports, the bar spacing, and the embedment of bars conform generally to the *ACI Detailing Manual*. Typical details recommended are shown in Figs. 8-1 and 8-2.

**Basis of Load Tables.** These tabulated designs were developed by a computer program. The program is based on the following procedures, assumptions, and Code provisions.

Factored moment coefficients from ACI 8.3.3:

End span factored positive moment = $w_u\ell_n^2/11$

End span factored negative moment = $w_u\ell_n^2/10$ at continuous end

End span "free end" factored negative moment = $w_u\ell_n^2/33$ (allow $^1/_3$ factored positive moment)

Interior span factored positive moment = $w_u\ell_n^2/16$

Interior span factored negative moment = $w_u\ell_n^2/11$

Single span factored positive moment = $w_u\ell'_n{}^2/8$ where $\ell'$ = clear span plus 4 in.

Single span "free end" factored negative moment = $w_u\ell'_n{}^2/24$ (allow $^1/_3$ factored positive moment)

Design moment strength was determined in accordance with the strength design method. See Chapter 5. The effect of compression reinforcement has been neglected. Compression reinforcement should be considered, however, if undertaking a computation of long-term deflection for camber or fitting to other attached elements. Critical sections investigated for minimum strength are (1) positive moment at midspan, (2) negative moment at face of support including average width of tapered end if used, (3) shear and moment at and development lengths from bar cut-off points and inflection points, (4) shear at a distance $d$ from the face of the support with average width of square or tapered end, and (5) shear at root of taper where used.

**Top Reinforcement.** Combinations of two bottom reinforcing bars tabulated begin at the smaller of $\rho = \frac{3\sqrt{f'_c}}{f_y}$; $\rho = \frac{200}{f_y}$; or $\frac{4}{3}$ times the required tension reinforcement (ACI 10.5.1) where $\rho$, the tension reinforcement ratio, is based on a rectangular concrete area,

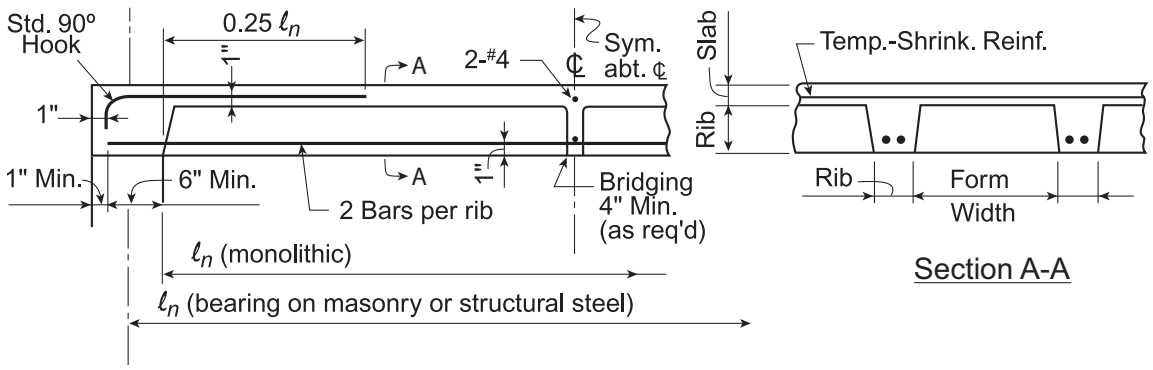



**Figure 8-2 Recommended Bar Details – Single Span**

*bd*, plus the two triangular areas inside the sloping form sides. The maximum size for bottom bars in the tabulated designs was determined as the least allowed for (1) maximum reinforcement such that $\varepsilon_t \geq 0.005$ so that the cross section is tension-controlled and therefore $\phi = 0.90$, (2) minimum bar spacing and concrete cover prescribed (ACI 7.6 and 7.7.1, respectively), or (3) load strength for flexure less than for shear with tapered end.

The areas of the two bottom bars control the joist capacity when load strength is controlled by flexure, since the strength established by the bottom bars is used to select top bars. The area of top steel tabulated is as near the theoretical area required as possible, for minimum number of bars, limited by the available choice of bar sizes and spacings in 0.5-in. increments. The computer program selects the largest size bar, with maximum spacings, not to exceed 107 percent of the theoretical area required.

Where tabulated areas of top steel for adjoining spans are unequal, the larger area of top steel as tabulated will be satisfactory, since the Code provides for calculating the factored moment on the basis of the average of adjacent spans (ACI 8.3.3). No redistribution of factored negative moment is permitted for adjustment of tabulated top bar areas (ACI 8.4).

**Shear.** Factored shear is calculated assuming full uniform load (no partial span loads) as $w_u\ell_n/2$ at all supports except the first interior support for continuous end span joists which is taken as 1.15 $w_u\ell_n/2$ (ACI 8.3.3).

Critical sections at which design shear strength is investigated are (1) distance, *d*, from face of support for interior supports (2) distance, *d*, from center of bearing for free ends (3) at the root of the taper, if used, (4) at bar cut-off points where tension steel ratio, $\rho$, is minimum. Design shear strength is computed by both prescribed formulas (ACI 11.2.1 and 11.2.2) and the maximum value was used. For standard joists, $V_c$ is permitted to be 10 percent more than that specified in Chapter 11 of the ACI 318 Building Code (ACI 8.13.8). For tapered ends, factored shear was computed at sections three inches apart, beginning at *d* from the center of bearing to midspan. It was determined that critical sections for a full uniform load condition are at the root of the taper in spite of the variable design shear strength as reinforcement ratio changes with variable width.

**Development of Reinforcement.** Development of reinforcement is investigated, including end anchorage for tabulated bars cut off as shown in recommended bar details, Figs. 8-1 and 8-2. Substitution of equivalent areas of smaller top bars is conservative and requires no further computation of development. Bar sizes are selected so that development would satisfy Code requirements (ACI 12.10, 12.11, and 12.12) and, therefore, not limit the load strength as determined by flexure, shear, or deflection. See Fig. 8-10.

To understand how to extend the scope of the tabulated designs or to adapt same to non-typical conditions, a manual example is included preceding each of the sets of load tables.

## DESIGN FROM LOAD TABLES (MULTIPLE SPAN JOIST CONSTRUCTION)

**Example 1.** Using 30-in. wide forms, select a joist floor design and review calculations to support a service live load equal to 65 psf and an allowance for superimposed service dead loads of 20 psf for partitions, 3 psf for bridging, and 12 psf for ceiling and mechanical loads on clear spans of 27 feet. A 3-in. thick top slab will satisfy the adopted building code for fire and use requirements. See Fig. 8-3 for layout.

Try: 12 + 3 with 6-in. ribs at 36 in. (Page 8-29) using standard square-end joists.

Superimposed factored load = (1.2)(20+3+12)+(1.6)(65)
= 42 + 104
= 146 psf

Read from table:

*End span:* Tabulated capacity = 147 psf
Top bars #4 at 8" at first interior support

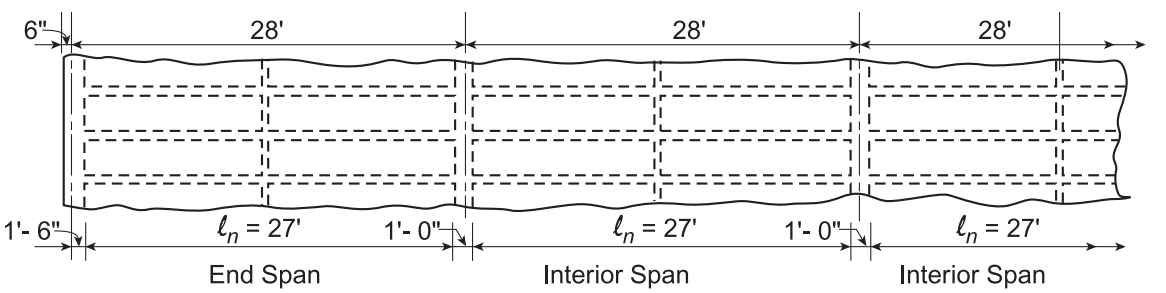



**Figure 8-3 Multiple Span Layout – Example 1**

Bottom bars 1-#5 and 1-#6 (per rib)
Weight of bars = 1.04 psf for above bars only.

See "Recommended Details," Fig. 8-1. Top bars at exterior edge, $A_s \approx {}^1/_3(0.31 + 0.44)$ in 36 in. $= \frac{0.75}{9} = 0.083$ in.$^2$/ft. Use # 4 at 12" with standard 90° end hooks.

*Interior spans:* Tabulated capacity = 147 psf
Top bars #4 at 9"
Bottom bars 1-#4 and 1-#5 (per rib)
Weight of bars = 0.93 psf. Add for shrinkage and temperature reinforcement, if required.

Concrete quantity (from Table 8-1, normal-weight concrete) = 67 psf

Including bridging (3 psf) $= \left(\frac{67+3}{150}\right)(144) = 0.67$ c.f./s.f.

Load capacities limited by deflection of $\ell_n/480$ are marked with double asterisks in the tabulated designs. The load strength for the design selected is not limited by deflection, and so the upper limit on the immediate live load deflection will be

$$\left(\frac{65}{146/1.6}\right)\left(\frac{\ell_n}{480}\right) = \ell_n/674 \text{ or less.}$$

This calculation is sufficient to satisfy the Code requirement (ACI 9.5.2.1) that deflection be computed for $\ell_n/h$ ratios above 18.5 for end spans and 21 for interior spans (values below horizontal lines in table exceed these limits). The estimated deflection above would be considered satisfactory without further calculations for all floors and roofs "not supporting or attached to non-structural elements likely to be damaged by large deflections." (ACI 9.5, Table 9.5(a)).

**Example 2.** *Unequal spans within limitations of table.* For the same loads as in Example 1, select a joist floor design for alternate clear spans: 22.5 ft., 27 ft., 22.5 ft., etc. Note that this variation in span is the maximum permitted without analysis to adjust the coefficients (ACI 8.3.3); the longer span exceeds shorter span 20 percent. See Fig. 8-4.

Try: 12 + 3 with 6-in. ribs at 36 in., using standard square-end joists as in Example 1, Superimposed factored load = 146 psf. See Page 8-29.

*End span.* Interpolate in second column between strengths 135 and 155 psf for spans of 22 and 25 feet, respectively.

Strength $= \frac{1}{2}(135 + 155) = 145$ psf, O.K.

*Read* Top bars: #4 at 11" at exterior span first interior support
Bottom bars: 1- #4 and 1- #5 (per rib)
Weight (of these bars) = 0.71 psf

For top bars at exterior edge, $A_s \approx 1/3\ (0.20 + 0.31)$ in 36 in. = 0.06 in.$^2$/ft. Use #3 at 12" with standard 90° end hooks. (CRSI recommends a minimum of #4 at 12" where cross traffic on top bars is expected, but at the exterior edge such traffic can be avoided.)



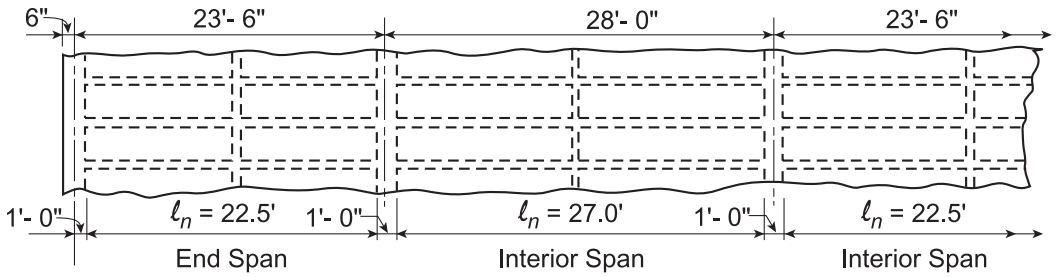



**Figure 8-4 Multiple Span Layout – Example 2**

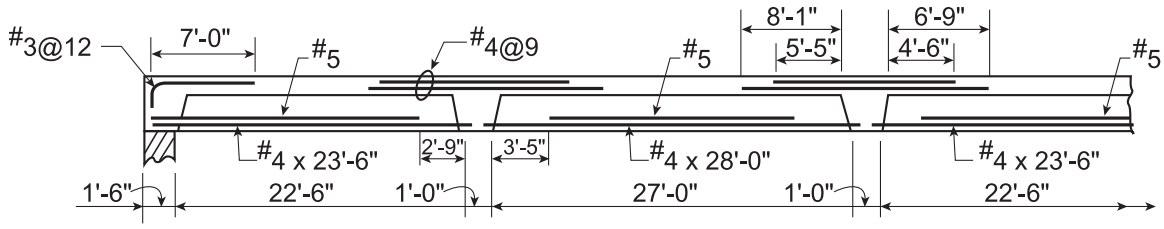



**Figure 8-5 Bar Length Details – Example 2**

*Interior span.* For tabulated capacity = 147 psf

(Check whether top bar design for interior or exterior span controls.)

Top bars #4 at 9" > #4 at 12". Use at *all* interior supports.

Bottom bars: 1- #4 and 1- #5 (per rib)

Weight (of these bars) = 0.93 psf

Concrete quantity (Table 8-1) = 67 psf for normal-weight concrete, including bridging:

$$\frac{(67+3)}{150}(144) = 0.67 \text{ c.f./s.f.}$$

Immediate deflection is less than $\ell_n/480$ for full superimposed load. Approximate live load deflection: $\Delta_{LL} \approx \ell_n/674$ as in Example 1.

*Bar lengths.* See Fig. 8-5 for details.

**Example 3.** Unequal loads within the limitation of $L \leq 3D$. For the layout in Fig. 8-3, Example 1, provide for a service live load = 100 psf in the first interior span and service live load in other spans = 50 psf. Dead load in all spans will be as in Example 1. Use the same joist sizes.

*End span (same as Example 1):*

Top bars, exterior edge #4 at 12

Bottom bars per rib 1- #5 plus 1- #6

Top bars, first interior support #4 at 8"; but check requirements of first interior span and use the larger.

*1st Interior Span*.

Superimposed factored load

$$= (1.2)(20+3+12)+(1.6)(100)$$
$$= 42 + 160$$
$$= 202 \text{ psf}$$

Read from table.

Superimposed load capacity = 199 * Square end

= 251 Tapered end

Bottom bars per rib 1- #5 plus 1- #6

For top bars, linearly interpolate for $w_u$ = 202, between 251 for #5 at 9″ and 195 for #4 at 7″.

Top bars: Use #5 at 10½″ (spacing to nearest ½ in.)

*Other Interior Spans* – Same as Example 1

*Bar length details.* See Fig. 8-6.

**Example 4.** *Wide flat beams*. Assume the interior beams supporting the joist floor of Example 1 (see Fig. 8-3) have clear spans of 20 ft. Select a preliminary design for these beams to maintain a uniform depth for simple formwork.

From Example 1:

Service live load, $L$ = 65 psf

Superimposed service dead load = 35 psf

Joist dead load = 67 psi

Total service dead load, $D$ = 102 psf

Total superimposed factored load on interior beams,

$$w_u = 1.2D + 1.6L$$

$$(28)[(1.2)(102) + (1.6)(65)]/1000 = 6.34 \text{ klf}$$

To estimate how wide the beams supporting the joist floor has to be, use the joist tabulated design for square ends. In the load table, Page 8-29, read the maximum superimposed load (controlled by shear on a square end) for an interior span of 20 ft = 322* psf. Load per linear foot = (3)(0.322) = 0.97 klf.

Ratio of effective beam depth to joist depth with 1 in. concrete cover for joists and 2 in. cover for beams = $\frac{12.5}{13.5}$

Ratio of allowable joist shear to beam shear = 1.10.

Required width of beam without stirrups,

$$b = \left(\frac{6.34}{1.10}\right)(6)\left(\frac{13.5}{12.5}\right)(1.10) = 41 \text{ in.}$$

Read in tabulated design, maximum superimposed load controlled by flexure for interior span joist with span = 20 ft, $w_u$ = 247 psf.

Total load per linear ft = (3)[247 +(67)(1.2)] = 3(247 + 80)

Total load = (0.327)(3) = 0.98 klf

Required area of steel in joist system at $d$ = 13.5 in.:

Top bars #4 at 11", $A_s = \left(\frac{36}{11}\right)(0.20) = 0.65 \text{ in.}^2$

Bottom bars 2- #4, $A_s$ = 0.40 in.$^2$

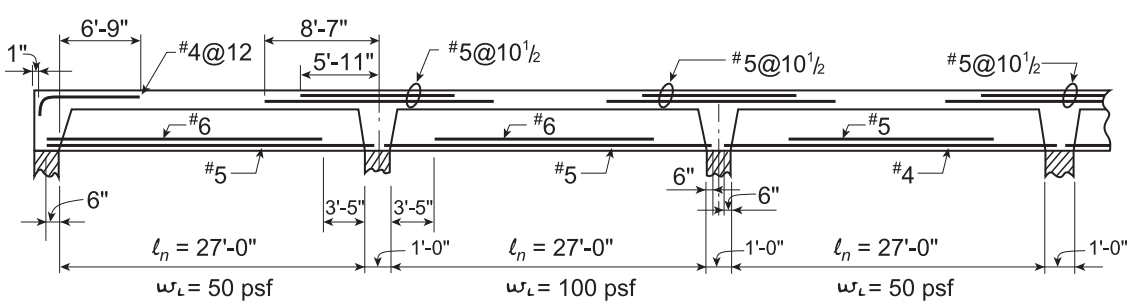



**Figure 8-6 Bar Length Details – Example 3**

Required beam reinforcement for $d$ = 12.5 in.:

Beam, $A_s$ = (Joist, $A_s$)$\left(\frac{6.34}{0.98}\right)\left(\frac{13.5}{12.5}\right)$ = 6.99 (Joist, $A_s$)

Top steel: $A_s$ = (6.99) (0.65) = 4.54 in.$^2$
Use 6-#8 bars ($A_s$ = 4.74 in.$^2$)

Bottom steel: $A_s$ = (6.99)(0.40) = 2.80 in.$^2$
Use 5-#7 bars ($A_s$ = 3.00 in.$^2$)

Note: To complete this preliminary design for interior spans, dead load of the solid beam area, reduced clear span for the joist design, possible live load reductions for the beam usually permitted for live loads equal to or less than 100 psf, and provision of nominal stirrups which will also support top beam bars (say #3 at 12") are possible refinements. See Chapter 12 for such examples.

## MANUAL EXAMPLE

To extend designs beyond the scope of the tabulated designs and to know how the tabulated designs are computed, detailed computations are presented as a review for the design of the interior span used in Example 1.

**Review**

See Fig. 8-7

| | | | |
|---|---|---|---|
| Joist $\left(\frac{192}{144}\right)(150)\left(\frac{12}{36}\right)$ | = | 67 | psf |
| Bridging | = | 3 | psf |
| Partitions | = | 20 | psf |
| Ceiling and mechanical | = | 12 | psf |
| | $D$ = | 102 | psf |
| | $L$ = | 65 | psf |

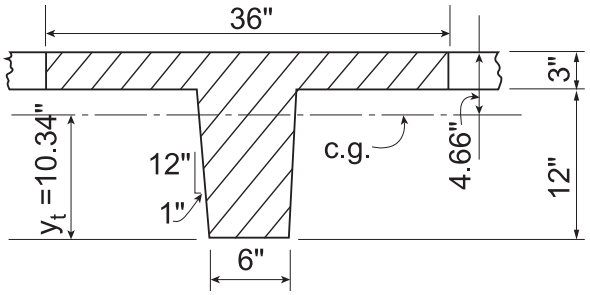



**Figure 8-7 Gross Section – Example 1**

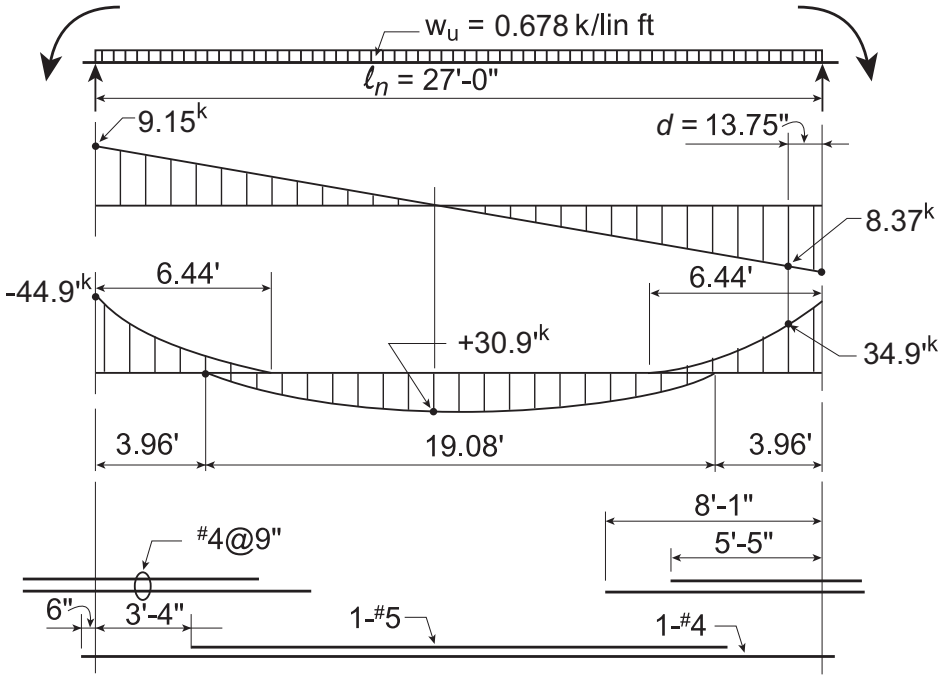



**Figure 8-8 Strength Design – Example 1**

*Interior Span* – See Fig. 8-8

$w_D + w_L = w_u = 1.2D + 1.6L = [(1.2)(0.102) + 1.6(0.065)]\frac{36}{12}$
$= (0.122 + 0.104)(3)$

$w_u = 0.678$ k/ft

Factored shear = 1/2 $w_u \ell_n = \frac{1}{2}(0.678)(27) = 9.15$ kips

*Flexure*

$-M_u = \frac{w_u \ell_n^2}{11} = (0.678)(27)^2/11 = -44.9$ ft-kips

$+M_u = \frac{w_u \ell_n^2}{16} = (0.678)(27)^2/16 = +30.9$ ft-kips

*Required* $A_s = \frac{M_u}{f_y(d - a/2)}$

$a = \frac{A_s f_y}{0.85 f_c' b} = \frac{60}{3.4}\frac{A_s}{b} = 17.65\frac{A_s}{b}$

Try 1-#4 and 1-#5: $A_s = 0.51$ in$^2$.

$+\phi M_n$: $a = (17.65)\frac{(0.51)}{36} = 0.25$ in.

$c = a/\beta_1 = 0.25/0.85 = 0.29$ in.

$d = 15 - 1 - 0.625/2 = 13.69$ in.

$\varepsilon_t = 0.003\,(d/c - 1)$
$= 0.003\,(13.69/0.29 - 1) = 0.139$

$\varepsilon_t > 0.005$, so $\phi = 0.90$

Try #4@ 9″

$-\phi M_n$: $a = (17.65)\frac{(0.20)(12/9)(3)}{(6.19)} = 2.28$ in.

$c = 2.28/0.85 = 2.68$ in.

$d = 15 - 1 - 0.500/2 = 13.75$ in.

$\varepsilon_t = 0.003\,(13.75/2.68 - 1) = 0.012$

$\varepsilon_t > 0.005$, so $\phi = 0.90$

Design moment strength, $\phi M_n$, provided:

$\phi M_n = \phi A_s f_y (d - a/2)$

$+\phi M_n = (0.90)(0.51)(60)\left(13.69 - \frac{0.25}{2}\right)\frac{1}{12}$
$= +31.1$ ft-kips $> +M_u = 30.9$ ft-kips

$-\phi M_n = (0.90)(0.80)(60)\left(13.75 - \frac{2.28}{2}\right)\frac{1}{12}$
$= -45.4$ ft-kips $> -M_u = -44.9$ ft-kips

Note that the flexural strength is controlled by the two bottom bars per rib. Top bars are spaced to the nearest 0.5 in. to match the flexural strength predetermined by the bottom bar selection.

*Shear.* Factored shear, $V_u$, at distance $d$ from support. See Fig. 8-8.

$V_u = 9.15 - (0.678)\left(\frac{13.75}{12}\right) = 8.37$ kips

Design shear strength ("short" formula)

$b_w = \left[\frac{8.29 + 6.0}{2}\right] = 7.14$ in.

$\phi V_c = (1.10)\,\phi\, 2\sqrt{f_c'}\, b_w d$
$= (1.10)(0.75)(2)\sqrt{4{,}000}\,(7.14)(13.75)/1{,}000$
$= 10.25$ kips $> 8.37$ kips, Okay.

Design shear strength was also computed by the "long" formula, compared to that by the short formula, and the larger value used as a basis for superimposed load capacities marked by one asterisk. In this case, the short formula gave the larger value. Long formula:

$\phi V_c = (1.10)\phi\left[1.9\sqrt{f_c'} + 2{,}500\,\rho_w\,\frac{V_u d}{M_u}\right] b_w d$

$A_s = 0.20\,(12/9)(3) = 0.80$ in$^2$.

$\rho_w = \frac{0.80}{(7.14)(13.75)} = 0.00815$

$\frac{V_u d}{M_u} = \frac{(8.37)(13.75)}{(34.9)(12)} = 0.275$

$\phi V_c = (1.10)(0.75)[1.9\sqrt{4{,}000} + (2{,}500)(0.00815)(0.275)]$
$(7.14)(13.75)/1{,}000$
$= 10.19$ kips $< 10.25$ kips by short formula

*Development of reinforcement*. See Fig. 8-10.

Bottom bars

#4; concrete cover = 1″ or $2d_b$
c.-c. spacing to #5 = 3.65″ or $7.3d_b$

#5; concrete cover = 1″ or $1.6d_b$
c.-c. spacing to #4 = 3.65″ or $5.8d_b$

Top bars #4 @ 9″
concrete cover = 1″ or $2d_b$
c.-c. spacing = 9″ or $18d_b$

Chapter 5; Table 5-3(b):

| Bar Location | $\ell_d$ |
|---|---|
| #4 Bottom | 12″ = 1′ |
| #5 Bottom | 17″ = 1.42′ |
| #4 Top | 15″ = 1.25′ |

Embedment from point of maximum tension to cut-off (ACI 12.1; 12.12.2):

Dimension ① = 5.40′ > $\ell_d$ = 1.25′ for shorter top bars

Dimension ② = 5.53′ > $\ell_d$ = 1.25′ for longer top bars

Dimension ③ = 10.12′ > $\ell_d$ = 1.42′ for shorter (#5) bottom bars

Extension of cut-off the greater of $12d_b$ or $d$ beyond zero theoretical stress (ACI 12.10.3) or $\ell_n/16$ (ACI 12.12.3):

$d$ for top bars $= \frac{13.75}{12} = 1.14$ ft

#4 bar: $12d_b = 6$ in.

$\ell_n/16 = 27/16 = 1.69$ ft

$d$ for bottom bars $= \frac{13.69}{12} = 1.14$ ft

#5 bar: $12d_b = 7½$ in.

Dimension ④ $= 1.66' \approx 1.69'$ for longer top bar (#4)
Dimension ⑤ $= 2.83' > 1.14'$ for shorter top bar (#4)
Dimension ⑥ $= 2.71' > 1.14'$ for shorter bottom bar (# 5)
Dimension ⑦ $= 4.46' > 1.14'$ for longer bottom bar (#4)
Embedment of continuing bars, $\ell_d$, beyond the point of zero theoretical stress in cut-off bars not less than $\ell_d$ (ACI 12.10.4):
Dimension ⑧ $= 6.59' > \ell_d = 1.0'$ for # 4 bottom bar

The shorter top bars are cut off in a tension zone, which is permissible if at the cut-off

$V_u < (2/3)\ \phi V_c$ (ACI 12.10.5.1):

$V_u = 5.49$ kips $< (0.667)\ \phi V_c = (0.667)(10.25) = 6.84$ kips

Bottom bars at inflection point (ACI 12.11.3):

The quantity $\left(\frac{M_n}{V_u} + \ell_a\right)$ must be larger than $\ell_d$.

$M_n = \frac{30.9}{0.90} = 34.3$ ft-kips $\quad V_u = 6.47$ kips

$\ell_a$ = the greater value, $d$ or $12d_b = 1.14$ ft

$\frac{M_n}{V_u} + \ell_a = \frac{34.3}{6.47} + 1.14 = 6.44$ ft $> 1.42$ ft: Okay

To conform to the requirements for structural integrity, the #4 bottom bar has to be lap spliced over the support to a bottom bar in the adjacent spans (ACI 7.13.2.1). A Class B tension lap splice is required. Detailing the #4 bar for structural integrity would affect the check of Dimension 8.

**Interior Span-Serviceability Requirements**

Cracked Section Properties – See Fig. 8-11

$n \quad = E_s/E_c = 29 \times 10^6/3.644 \times 10^6 = 7.96 = 8$

$+I_{cr} \quad = 643$ in.$^4$

$+I_{cr}/I_g = 643/3{,}541 = 0.181$ (Tabulated 0.181)

$-I_{cr} \quad = 734$, $-I_c/I_g = 0.207$ (Tabulated 0.207)

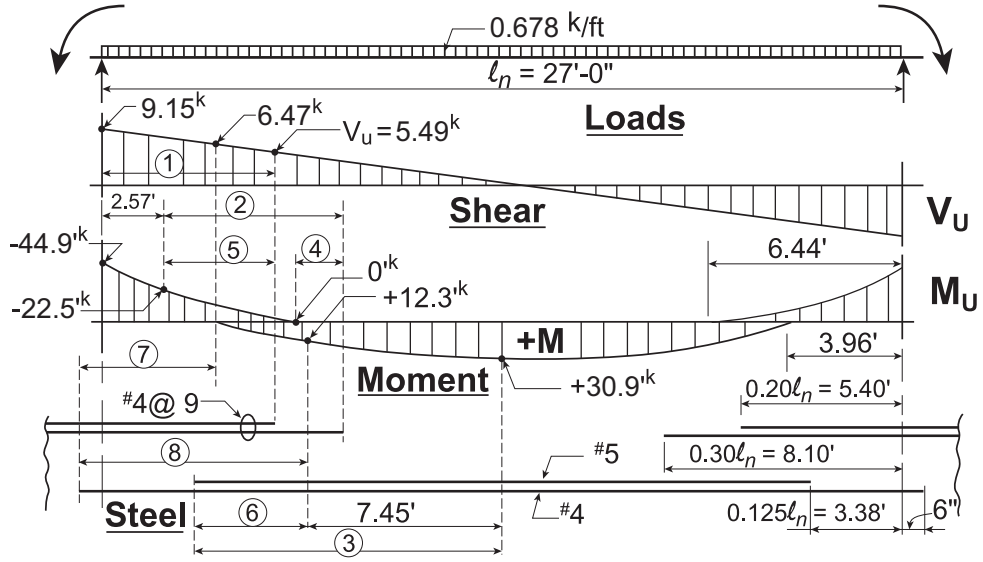



**Figure 8-10 Embedment Lengths Available vs. Required Development Lengths**

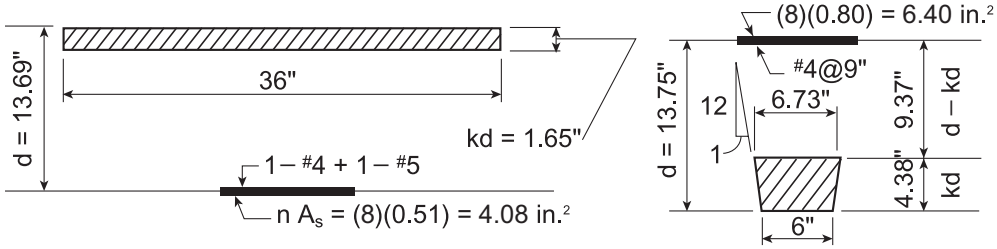



**Figure 8-11 Cracked Section – Example 1**

$+M_{cr}$ = 13.5 ft-kips, $-M_{cr}$ = 30.1 ft-kips
(From Table 8-1)

Total service load, $w_s$

$w_s = (102 + 65)\ 36/12 = 501$ plf

Maximum moment, $M_a$

$$\pm M_a \approx \frac{w_s \ell_n^2}{16} = (0.501)(27)^2/16 = 22.8 \text{ ft-kips}$$

$$I_e = \left(\frac{M_{cr}}{M_a}\right)^3 I_g + \left[1 - \left(\frac{M_{cr}}{M_a}\right)^3\right] I_{cr}$$

$\leq I_g$ (ACI 9.5.2.3, Eq. 9-8)

$$+I_e = \left(\frac{13.5}{22.8}\right)^3 (3{,}541) + \left[1 - \left(\frac{13.5}{22.8}\right)^3\right](643)$$

$= 735 + 510 = 1{,}245$ in.$^4$

$$-I_e = \left(\frac{30.1}{22.8}\right)^3 (3{,}541) + \left[1 - \left(\frac{30.1}{22.8}\right)^3\right] 734 > I_g$$

Use $-I_e = 3{,}541$ in.$^4$

Average effective moment of inertia,

$I_e$ = Average of ($+I_e$ and $-I_e$) (ACI 9.5.2.4)
= (0.5)(1,245 + 3,541)
= 2,393 in.$^4$

Live load deflection $\Delta_L = \left(\frac{2}{384}\right) \frac{w \ell_n^4}{E_c I_e}$

where $w$ is load per inch

Tabulated deflection coefficient, $DC = 3.938$ (Page 8-29)

$$\left(\frac{2}{384}\right) \frac{(27)^4(12)^3}{E_c} (3) = 3.9377$$

$$\Delta_L = \frac{(3.938)(65)}{(2{,}393)} = 0.11 \text{ in.}$$

$$< \frac{\ell_n}{480} = \frac{(27)(12)}{480} = 0.675 \text{ in.}$$

Note: The service load negative moment at the support is less than the service load positive moment at mid-span. The use of two bottom bars per rib is necessarily within all spacing limitations imposed for crack control. All spacings tabulated for top bars are within the crack control limits. For these reasons, no serviceability condition investigation for crack control is required for joist tabulated designs in this Chapter.

## TABLE 8-1(a) GROSS SECTION PROPERTIES — STANDARD JOIST CONSTRUCTION [1]

| [2] Joist | 3-Inch Top Slab | | | | | | 4-Inch Top Slab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gross Area[3] ($in.^2$) | Wt[4] (psf) | $Y_{cg}$[3] (in.) | $I_g$[3] ($in.^4$) | $+M_{cr}$ (ft-k) | $-M_{cr}$[3] (ft-k) | Gross Area[3] ($in.^2$) | Wt[4] (psf) | $Y_{cg}$[3] (in.) | $I_g$[3] ($in.^4$) | $+M_{cr}$ (ft-k) | $-M_{cr}$[3] (ft-k) |
| 8 + 5 + 20 | 120.3 | 60 | 7.49 | 1,104 | 5.8 | 12.4 | 145.3 | 73 | 8.18 | 1,439 | 7.0 | 14.9 |
| | 152.3 | | 6.75 | 1,582 | | 14.7 | 177.3 | | 7.42 | 2,067 | | 17.9 |
| 8 + 6 + 20 | 131.3 | 63 | 7.32 | 1,254 | 6.8 | 13.5 | 157.3 | 76 | 8.01 | 1,636 | 8.1 | 16.2 |
| | 163.3 | | 6.67 | 1,709 | | 15.6 | 189.3 | | 7.33 | 2,234 | | 18.9 |
| 10 + 5 + 20 | 133.3 | 67 | 8.76 | 1,826 | 8.2 | 17.0 | 158.3 | 79 | 9.51 | 2,301 | 9.6 | 20.2 |
| | 173.3 | | 7.89 | 2,594 | | 20.1 | 198.3 | | 8.60 | 3,283 | | 24.0 |
| 10 + 6 + 20 | 146.3 | 70 | 8.56 | 2,069 | 9.6 | 18.4 | 172.3 | 83 | 9.30 | 2,610 | 11.1 | 22.0 |
| | 186.3 | | 7.80 | 2,801 | | 21.3 | 212.3 | | 8.49 | 3,545 | | 25.5 |
| 12 + 5 + 20 | 147.0 | 74 | 9.99 | 2,799 | 11.1 | 22.1 | 172.0 | 86 | 10.79 | 3,450 | 12.6 | 26.2 |
| | 195.0 | | 9.01 | 3,951 | | 26.1 | 220.0 | | 9.75 | 4,887 | | 30.9 |
| 12 + 6 + 20 | 162.0 | 78 | 9.76 | 3,165 | 12.8 | 23.9 | 188.0 | 90 | 10.55 | 3,905 | 14.6 | 28.3 |
| | 210.0 | | 8.90 | 4,264 | | 27.6 | 236.0 | | 9.63 | 5,274 | | 32.7 |
| 8 + 5 + 30 | 150.3 | 54 | 7.89 | 1,223 | 6.1 | 15.5 | 185.3 | 66 | 8.57 | 1,597 | 7.4 | 18.4 |
| | 190.3 | | 7.07 | 1,914 | | 19.3 | 225.3 | | 7.76 | 2,497 | | 23.3 |
| 8 + 6 + 30 | 161.3 | 56 | 7.73 | 1,393 | 7.1 | 16.8 | 197.3 | 69 | 8.41 | 1,815 | 8.5 | 20.0 |
| | 201.3 | | 6.99 | 2,051 | | 20.2 | 237.3 | | 7.67 | 2,676 | | 24.4 |
| 10 + 5 + 30 | 163.3 | 58 | 9.26 | 2,032 | 8.7 | 21.5 | 198.3 | 71 | 10.01 | 2,552 | 10.1 | 25.3 |
| | 213.3 | | 8.26 | 3,145 | | 26.2 | 248.3 | | 9.00 | 3,972 | | 31.4 |
| 10 + 6 + 30 | 176.3 | 61 | 9.06 | 2,307 | 10.1 | 23.1 | 212.3 | 74 | 9.81 | 2,899 | 11.7 | 27.4 |
| | 226.3 | | 8.16 | 3,366 | | 27.5 | 262.3 | | 8.90 | 4,253 | | 32.9 |
| 12 + 5 + 30 | 177.0 | 63 | 10.58 | 3,128 | 11.7 | 28.0 | 212.0 | 76 | 11.40 | 3,837 | 13.3 | 32.9 |
| | 237.0 | | 9.42 | 4,790 | | 34.0 | 272.0 | | 10.21 | 5,919 | | 40.4 |
| 12 + 6 + 30 | 192.0 | 67 | 10.34 | 3,541 | 13.5 | 30.1 | 228.0 | 79 | 11.16 | 4,350 | 15.4 | 35.5 |
| | 252.0 | | 9.31 | 5,124 | | 35.6 | 288.0 | | 10.08 | 6,334 | | 42.3 |
| 14 + 5 + 30 | 191.3 | 68 | 11.86 | 4,549 | 15.2 | 35.0 | 226.3 | 81 | 12.74 | 5,492 | 17.0 | 41.2 |
| | 261.3 | | 10.56 | 6,905 | | 42.4 | 296.3 | | 11.38 | 8,394 | | 50.1 |
| 14 + 6 + 30 | 208.3 | 72 | 11.59 | 5,135 | 17.5 | 37.5 | 244.3 | 85 | 12.46 | 6,210 | 19.7 | 44.3 |
| | 278.3 | | 10.44 | 7,382 | | 44.4 | 314.3 | | 11.24 | 8,976 | | 52.5 |
| 16 + 6 + 30 | 225.3 | 78 | 12.81 | 7,127 | 22.0 | 45.5 | 261.3 | 91 | 13.73 | 8,521 | 24.5 | 53.7 |
| | 305.3 | | 11.55 | 10,197 | | 54.1 | 341.3 | | 12.39 | 12,237 | | 63.5 |
| 16 + 7 + 30 | 244.3 | 83 | 12.55 | 7,890 | 24.9 | 48.3 | 281.3 | 95 | 13.46 | 9,446 | 27.7 | 57.1 |
| | 324.3 | | 11.43 | 10,844 | | 56.6 | 361.3 | | 12.25 | 13,011 | | 66.4 |
| 20 + 6 + 30 | 261.3 | 91 | 15.18 | 12,469 | 32.5 | 63.0 | 297.3 | 103 | 16.19 | 14,664 | 35.8 | 74.2 |
| | 361.3 | | 13.74 | 17,741 | | 75.8 | 397.3 | | 14.63 | 20,860 | | 88.0 |
| 20 + 7 + 30 | 284.3 | 96 | 14.88 | 13,769 | 36.6 | 67.0 | 321.3 | 109 | 15.87 | 16,205 | 40.4 | 78.8 |
| | 384.3 | | 13.61 | 18,864 | | 79.4 | 421.3 | | 14.48 | 22,168 | | 92.0 |

(1) $f'_c$ = 4,000 psi, rib side slope = 1 to 12.
(2) First value is the pan depth, second value is the rib width, and the third value is the pan width (in.)
(3) First value is for a standard section; second value is at a tapered end.
(4) For normal-weight concrete, $w$ = 150 pcf (added weight of tapers is neglected.)

## TABLE 8-1(b) GROSS SECTION PROPERTIES — STANDARD JOIST CONSTRUCTION (1)

| (2) Joist | 4.5-Inch Top Slab | | | | | | 5-Inch Top Slab | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Gross Area(3) ($in.^2$) | Wt(4) (psf) | $Y_{cg}$(3) (in.) | $I_g$(3) ($in.^4$) | $+M_{cr}$ (ft-k) | $-M_{cr}$(3) (ft-k) | Gross Area(3) ($in.^2$) | Wt(4) (psf) | $Y_{cg}$(3) (in.) | $I_g$(3) ($in.^4$) | $+M_{cr}$ (ft-k) | $-M_{cr}$(3) (ft-k) |
| 8 + 5 + 20 | 157.8 | 79 | 8.50 | 1,630 | 7.6 | 16.1 | 170.3 | 85 | 8.81 | 1,840 | 8.3 | 17.4 |
| | 189.8 | | 7.74 | 2,340 | | 19.4 | 202.3 | | 8.05 | 2,634 | | 21.0 |
| 8 + 6 + 20 | 170.3 | 82 | 8.33 | 1,852 | 8.8 | 17.6 | 183.3 | 88 | 8.65 | 2,087 | 9.5 | 19.0 |
| | 202.3 | | 7.65 | 2,528 | | 20.6 | 215.3 | | 7.96 | 2,846 | | 22.3 |
| 10 + 5 + 20 | 170.8 | 85 | 9.86 | 2,561 | 10.3 | 21.8 | 183.3 | 92 | 10.19 | 2,841 | 11.0 | 23.3 |
| | 210.8 | | 8.93 | 3,659 | | 26.0 | 223.3 | | 9.26 | 4,058 | | 27.9 |
| 10 + 6 + 20 | 185.3 | 89 | 9.65 | 2,906 | 11.9 | 23.7 | 198.3 | 95 | 9.99 | 3,222 | 12.8 | 25.4 |
| | 225.3 | | 8.83 | 3,951 | | 27.5 | 238.3 | | 9.15 | 4,383 | | 29.6 |
| 12 + 5 + 20 | 184.5 | 92 | 11.16 | 3,797 | 13.4 | 28.1 | 197.0 | 99 | 11.52 | 4,163 | 14.3 | 30.0 |
| | 232.5 | | 10.10 | 5,388 | | 33.3 | 245.0 | | 10.43 | 5,913 | | 35.6 |
| 12 + 6 + 20 | 201.0 | 97 | 10.92 | 4,300 | 15.6 | 30.5 | 214.0 | 103 | 11.28 | 4,715 | 16.5 | 32.6 |
| | 249.0 | | 9.97 | 5,815 | | 35.2 | 262.0 | | 10.31 | 6,382 | | 37.7 |
| 8 + 5 + 30 | 202.8 | 72 | 8.89 | 1,813 | 8.1 | 19.8 | 220.3 | 79 | 9.19 | 2,054 | 8.8 | 21.3 |
| | 242.8 | | 8.08 | 2,825 | | 25.3 | 260.3 | | 8.40 | 3,181 | | 27.3 |
| 8 + 6 + 30 | 215.3 | 75 | 8.74 | 2,058 | 9.3 | 21.6 | 233.3 | 81 | 9.04 | 2,326 | 10.2 | 23.2 |
| | 255.3 | | 7.99 | 3,028 | | 26.6 | 273.3 | | 8.31 | 3,409 | | 28.7 |
| 10 + 5 + 30 | 215.8 | 77 | 10.35 | 2,841 | 10.8 | 27.1 | 233.3 | 83 | 10.68 | 3,155 | 11.7 | 28.9 |
| | 265.8 | | 9.35 | 4,422 | | 33.9 | 283.3 | | 9.68 | 4,902 | | 36.4 |
| 10 + 6 + 30 | 230.3 | 80 | 10.16 | 3,227 | 12.6 | 29.4 | 248.3 | 86 | 10.49 | 3,579 | 13.5 | 31.4 |
| | 280.3 | | 9.24 | 4,737 | | 35.6 | 298.3 | | 9.57 | 5,251 | | 38.2 |
| 12 + 5 + 30 | 229.5 | 82 | 11.77 | 4,219 | 14.2 | 35.2 | 247.0 | 88 | 12.12 | 4,623 | 15.1 | 37.4 |
| | 289.5 | | 10.57 | 6,520 | | 43.5 | 307.0 | | 10.92 | 7,151 | | 46.5 |
| 12 + 6 + 30 | 246.0 | 85 | 11.53 | 4,783 | 16.4 | 38.0 | 264.0 | 92 | 11.89 | 5,241 | 17.4 | 40.5 |
| | 306.0 | | 10.45 | 6,979 | | 45.6 | 324.0 | | 10.80 | 7,655 | | 48.8 |
| 14 + 5 + 30 | 243.8 | 87 | 13.13 | 5,986 | 18.0 | 44.1 | 261.3 | 93 | 13.51 | 6,502 | 19.0 | 46.8 |
| | 313.8 | | 11.76 | 9,174 | | 53.8 | 331.3 | | 12.13 | 9,983 | | 57.5 |
| 14 + 6 + 30 | 262.3 | 91 | 12.86 | 6,773 | 20.8 | 47.4 | 280.3 | 97 | 13.24 | 7,358 | 22.0 | 50.5 |
| | 332.3 | | 11.62 | 9,812 | | 56.4 | 350.3 | | 11.99 | 10,679 | | 60.2 |
| 16 + 6 + 30 | 279.3 | 97 | 14.15 | 9,238 | 25.8 | 57.5 | 297.3 | 103 | 14.55 | 9,975 | 27.1 | 61.1 |
| | 359.3 | | 12.78 | 13,295 | | 68.1 | 377.3 | | 13.16 | 14,385 | | 72.5 |
| 16 + 7 + 30 | 299.8 | 101 | 13.88 | 10,246 | 29.2 | 61.2 | 318.3 | 108 | 14.28 | 11,068 | 30.6 | 65.1 |
| | 379.8 | | 12.64 | 14,137 | | 71.1 | 398.3 | | 13.02 | 15,297 | | 75.8 |
| 20 + 6 + 30 | 315.3 | 109 | 16.65 | 15,768 | 37.4 | 79.4 | 333.3 | 116 | 17.08 | 16,887 | 39.1 | 84.3 |
| | 415.3 | | 15.05 | 22,454 | | 93.9 | 433.3 | | 15.45 | 24,079 | | 99.7 |
| 20 + 7 + 30 | 339.8 | 115 | 16.33 | 17,433 | 42.2 | 84.3 | 358.3 | 121 | 16.76 | 18,677 | 44.0 | 89.6 |
| | 439.8 | | 14.89 | 23,861 | | 98.1 | 458.3 | | 15.29 | 25,587 | | 104.1 |

(1) $f'_c$ = 4,000 psi, rib side slope = 1 to 12.
(2) First value is the pan depth, second value is the rib width, and the third value is the pan width (in.)
(3) First value is for a standard section; second value is at a tapered end.
(4) For normal-weight concrete, $w$ = 150 pcf (added weight of tapers is neglected.)

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 3.0″ Top Slab = 11.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 10.5 | # 4 8 | # 5 10 | # 6 7 | End Span Defl. Coeff. (3) | # 4 11 | # 4 10 | # 5 11 | # 5 9 | # 6 6 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 3 | # 4 | # 4 | # 5 | # 5 | | # 3 | # 3 | # 4 | # 4 | # 5 | |
| | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| Steel (psf) | | 0.64 | 0.79 | 1.01 | 1.25 | 1.78 | | 0.68 | 0.82 | 1.13 | 1.39 | 2.38 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 11'-0" | | 498* | 502* | 529* | 552* | | 0.122 | | | | | | |
| | | 514 | 682 | 774* | 796* | | | | | | | | |
| 12'-0" | | 421 | 440* | 462* | 478* | 587* | 0.173 | | | | | | |
| | | 0 | 562 | 684* | 700* | 746* | | | | | | | |
| 13'-0" | | 348 | 388* | 405* | 418* | 504* | 0.239 | | | | | | |
| | | 0 | 468 | 608* | 620* | 658* | | | | | | | |
| 14'-0" | | 290 | 345* | 359* | 370* | 440* | 0.321 | 305 | 396* | 405* | 415* | 472* | 0.198 |
| | | 0 | 393 | 515 | 556* | 595* | | 0 | 454 | 605 | 633* | 689* | |
| 15'-0" | | 243 | 310* | 322* | 330* | 389* | 0.423 | 256 | 358* | 366* | 374* | 423* | 0.260 |
| | | 0 | 333 | 440 | 503* | 550* | | 0 | 387 | 518 | 576* | 623* | |
| 16'-0" | | 205 | 281* | 291* | 298* | 347* | 0.548 | 217 | 326* | 333* | 340* | 381* | 0.337 |
| | | 0 | 284 | 378 | 458* | 493* | | 0 | 331 | 446 | 527* | 568* | |
| 17'-0" | | 173 | 243 | 264* | 270* | 312* | 0.698 | 184 | 285 | 304* | 310* | 346* | 0.430 |
| | | 0 | 0 | 326 | 410 | 445* | | 0 | 0 | 387 | 486* | 521* | |
| 18'-0" | | 147 | 209 | 241* | 246* | 282* | 0.878 | 156 | 246 | 279* | 285* | 316* | 0.540 |
| | | 0 | 0 | 283 | 358 | 404* | | 0 | 0 | 337 | 445 | 480* | |
| 19'-0" | | 124 | 180 | 221* | 225* | 257* | 1.090 | 133 | 214 | 258* | 262* | 290* | 0.671 |
| | | 0 | 0 | 247 | 314 | 370* | | 0 | 0 | 295 | 392 | 444* | |
| 20'-0" | | 105 | 156 | 204* | 207* | 235* | 1.338 | 113 | 186 | 238* | 243* | 267* | 0.823 |
| | | 0 | 0 | 216 | 276 | 340* | | 0 | 0 | 260 | 346 | 413* | |
| 21'-0" | | 89 | 135 | 188* | 191* | 216* | 1.626 | 95 | 162 | 221* | 225* | 247* | 1.001 |
| | | 0 | 0 | 189 | 244 | 306 | | 0 | 0 | 229 | 307 | 381* | |
| 22'-0" | | 74 | 116 | 166 | 177* | 199* | 1.959 | 80 | 141 | 202 | 210* | 229* | 1.205 |
| | | 0 | 0 | 0 | 216 | 272 | | 0 | 0 | 0 | 274 | 347 | |
| 23'-0" | | 62 | 100 | 145 | 164* | 184* | 2.340 | 67 | 123 | 179 | 195* | 213* | 1.440 |
| | | 0 | 0 | 0 | 191 | 243 | | 0 | 0 | 0 | 244 | 311 | |
| 24'-0" | | 51 | 86 | 128 | 153* | 170* | 2.774 | 56 | 107 | 158 | 183* | 199* | 1.707 |
| | | 0 | 0 | 0 | 170 | 214+ | | 0 | 0 | 0 | 218 | 280 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.40 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.45 | 0.48 | 0.62 | 0.77 | 1.57 | | 0.45 | 0.50 | 0.70 | 0.86 | 1.83 | |
| STEEL % (UNIFORM) | 0.80 | 0.84 | 1.10 | 1.38 | 2.81 | | 0.80 | 0.88 | 1.25 | 1.53 | 3.28 | |
| (TAPERED) | 0.48 | 0.50 | 0.65 | 0.82 | 1.67 | | 0.48 | 0.52 | 0.74 | 0.91 | 1.94 | |
| EFF. DEPTH, IN. | 9.75 | 9.75 | 9.75 | 9.69 | 9.62 | | 9.75 | 9.75 | 9.69 | 9.69 | 9.62 | |
| $-I_{cr}/I_{gr}$ | 0.191 | 0.198 | 0.243 | 0.279 | 0.437 | | 0.191 | 0.205 | 0.261 | 0.300 | 0.479 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.13 | 0.16 | 0.21 | 0.26 | 0.31 | | 0.09 | 0.13 | 0.16 | 0.21 | 0.26 | |
| EFF. DEPTH, IN. | 9.75 | 9.75 | 9.69 | 9.69 | 9.62 | | 9.81 | 9.75 | 9.75 | 9.69 | 9.69 | |
| $+I_{cr}/I_{gr}$ | 0.176 | 0.222 | 0.271 | 0.322 | 0.374 | | 0.130 | 0.176 | 0.222 | 0.271 | 0.322 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 3.0″ Top Slab = 11.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 8.5 | # 5 10 | # 5 8.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 10 | # 4 8 | # 5 9.5 | # 5 7.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 3 | # 4 | # 4 | # 5 | # 5 | | # 3 | # 3 | # 4 | # 4 | # 5 | |
| | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| Steel (psf) | | 0.63 | 0.76 | 0.97 | 1.22 | 1.46 | | 0.67 | 0.81 | 1.04 | 1.33 | 1.68 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 14'-0" | | 272 | 372 | 400* | 413* | 426* | 0.334 | 287 | 431 | 455* | 463* | 477* | 0.206 |
| | | 0 | 0 | 490 | 592* | 605* | | 0 | 0 | 576 | 673* | 687* | |
| 15'-0" | | 227 | 314 | 359* | 370* | 381* | 0.440 | 240 | 365 | 413* | 419* | 431* | 0.271 |
| | | 0 | 0 | 417 | 521 | 547* | | 0 | 0 | 492 | 613* | 624* | |
| 16'-0" | | 191 | 267 | 325* | 335* | 344* | 0.570 | 202 | 312 | 376* | 381* | 392* | 0.351 |
| | | 0 | 0 | 357 | 448 | 498* | | 0 | 0 | 423 | 554 | 572* | |
| 17'-0" | | 160 | 228 | 297* | 304* | 312* | 0.726 | 170 | 268 | 345* | 349* | 358* | 0.447 |
| | | 0 | 0 | 307 | 388 | 457* | | 0 | 0 | 366 | 482 | 526* | |
| 18'-0" | | 135 | 195 | 266 | 278* | 285* | 0.913 | 144 | 231 | 317* | 321* | 329* | 0.562 |
| | | 0 | 0 | 0 | 338 | 419 | | 0 | 0 | 318 | 422 | 487* | |
| 19'-0" | | 113 | 167 | 231 | 255* | 261* | 1.133 | 121 | 199 | 278 | 297* | 303* | 0.697 |
| | | 0 | 0 | 0 | 296 | 369 | | 0 | 0 | 0 | 371 | 453* | |
| 20'-0" | | 95 | 144 | 201 | 236* | 241* | 1.391 | 102 | 172 | 243 | 275* | 281* | 0.856 |
| | | 0 | 0 | 0 | 259 | 325 | | 0 | 0 | 0 | 327 | 412 | |
| 21'-0" | | 79 | 123 | 175 | 218* | 222* | 1.691 | 85 | 149 | 214 | 256* | 261* | 1.041 |
| | | 0 | 0 | 0 | 228 | 288 | | 0 | 0 | 0 | 290 | 367 | |
| 22'-0" | | 65 | 105 | 153 | 201 | 206* | 2.037 | 71 | 129 | 188 | 238* | 243* | 1.254 |
| | | 0 | 0 | 0 | 0 | 256 | | 0 | 0 | 0 | 257 | 327 | |
| 23'-0" | | 53 | 90 | 133 | 178 | 192* | 2.433 | 58 | 112 | 165 | 223* | 227* | 1.497 |
| | | 0 | 0 | 0 | 0 | 227 | | 0 | 0 | 0 | 229 | 293 | |
| 24'-0" | | 42 | 76 | 116 | 157 | 179* | 2.885 | 47 | 96 | 146 | 204 | 213* | 1.775 |
| | | 0 | 0 | 0 | 0 | 203 | | 0 | 0 | 0 | 0 | 263 | |
| 25'-0" | | | 64 | 101 | 139 | 159+ | 3.397 | | 83 | 128 | 182 | 200* | 2.090 |
| | | | 0 | 0 | 0 | 181 | | | 0 | 0 | 0 | 236 | |
| 26'-0" | | | 54 | 88 | 122 | 138+ | 3.974 | | 71 | 113 | 162 | 187* | 2.445 |
| | | | 0 | 0 | 0 | 161 | | | 0 | 0 | 0 | 213 | |
| 27'-0" | | | 44 | 76 | 108 | 121+ | 4.621 | | 60 | 99 | 145 | 176* | 2.844 |
| | | | 0 | 0 | 0 | 144 | | | 0 | 0 | 0 | 192 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.42 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.47 | 0.47 | 0.61 | 0.81 | 0.95 | | 0.47 | 0.52 | 0.65 | 0.85 | 1.07 | |
| STEEL % (UNIFORM) | 0.71 | 0.71 | 0.92 | 1.22 | 1.44 | | 0.71 | 0.78 | 0.98 | 1.29 | 1.63 | |
| (TAPERED) | 0.45 | 0.45 | 0.58 | 0.77 | 0.91 | | 0.45 | 0.49 | 0.62 | 0.81 | 1.03 | |
| EFF. DEPTH, IN. | 9.75 | 9.75 | 9.75 | 9.69 | 9.69 | | 9.75 | 9.75 | 9.75 | 9.69 | 9.69 | |
| $-I_{cr}/I_{gr}$ | 0.180 | 0.180 | 0.220 | 0.266 | 0.298 | | 0.180 | 0.194 | 0.230 | 0.276 | 0.325 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.12 | 0.16 | 0.20 | 0.25 | 0.30 | | 0.09 | 0.12 | 0.16 | 0.20 | 0.25 | |
| EFF. DEPTH, IN. | 9.75 | 9.75 | 9.69 | 9.69 | 9.62 | | 9.81 | 9.75 | 9.75 | 9.69 | 9.69 | |
| $+I_{cr}/I_{gr}$ | 0.156 | 0.196 | 0.240 | 0.285 | 0.331 | | 0.115 | 0.156 | 0.196 | 0.240 | 0.285 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 20" Forms + 5" Rib @ 25" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 3.0″ Top Slab = 13.0″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8 | # 5 10 | # 5 8 | # 6 6 | End Span Defl. Coeff. (3) | # 4 10 | # 4 7.5 | # 5 9 | # 5 7 | # 7 7 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.80 | 1.01 | 1.25 | 1.52 | 2.10 | | 0.82 | 1.10 | 1.39 | 1.77 | 2.79 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 18'-0" | | 260 | 317* | 324* | 337* | 390* | 0.878 | 304 | 367* | 372* | 384* | 424* | 0.540 |
| | | 0 | 349 | 441 | 487* | 504* | | 0 | 414 | 545 | 571* | 609* | |
| 19'-0" | | 225 | 291* | 297* | 308* | 354* | 1.090 | 265 | 338* | 343* | 353* | 388* | 0.671 |
| | | 0 | 305 | 387 | 445* | 462* | | 0 | 364 | 481 | 528* | 563* | |
| 20'-0" | | 195 | 268 | 274* | 283* | 324* | 1.338 | 231 | 314* | 318* | 327* | 357* | 0.823 |
| | | 0 | 0 | 341 | 410* | 425* | | 0 | 320 | 426 | 485* | 523* | |
| 21'-0" | | 169 | 235 | 253* | 261* | 297* | 1.626 | 202 | 283 | 295* | 303* | 330* | 1.001 |
| | | 0 | 0 | 302 | 378 | 408* | | 0 | 0 | 379 | 444* | 486* | |
| 22'-0" | | 147 | 207 | 234* | 242* | 273* | 1.959 | 177 | 251 | 275* | 282* | 306* | 1.205 |
| | | 0 | 0 | 268 | 337 | 377* | | 0 | 0 | 338 | 403* | 450* | |
| 23'-0" | | 128 | 183 | 218* | 225* | 253* | 2.340 | 155 | 222 | 257* | 263* | 285* | 1.440 |
| | | 0 | 0 | 238 | 302 | 351* | | 0 | 0 | 303 | 369* | 415* | |
| 24'-0" | | 111 | 161 | 203* | 209* | 234* | 2.774 | 136 | 198 | 241* | 246* | 266* | 1.707 |
| | | 0 | 0 | 212 | 271 | 327* | | 0 | 0 | 271 | 339* | 382* | |
| 25'-0" | | 96 | 142 | 189 | 195* | 218* | 3.266 | 119 | 176 | 226* | 231* | 249* | 2.010 |
| | | 0 | 0 | 0 | 243 | 298 | | 0 | 0 | 244 | 312 | 350* | |
| 26'-0" | | 82 | 125 | 169 | 182* | 203* | 3.821 | 104 | 156 | 212* | 217* | 233* | 2.351 |
| | | 0 | 0 | 0 | 219 | 269 | | 0 | 0 | 219 | 283 | 323* | |
| 27'-0" | | 70 | 110 | 151 | 171* | 190* | 4.443 | 90 | 139 | 197 | 204* | 219* | 2.734 |
| | | 0 | 0 | 0 | 197 | 244 | | 0 | 0 | 0 | 256 | 299* | |
| 28'-0" | | 60 | 97 | 135 | 160* | 178* | 5.139 | 78 | 124 | 178 | 193* | 206* | 3.163 |
| | | 0 | 0 | 0 | 177 | 221 | | 0 | 0 | 0 | 233 | 278* | |
| 29'-0" | | 50 | 85 | 120 | 150* | 166* | 5.914 | 67 | 110 | 160 | 182* | 194* | 3.639 |
| | | 0 | 0 | 0 | 160 | 198+ | | 0 | 0 | 0 | 211 | 259* | |
| 30'-0" | | 42 | 74 | 107 | 139+ | 153+ | 6.772 | 58 | 97 | 144 | 172* | 183* | 4.168 |
| | | 0 | 0 | 0 | 144 | 178+ | | 0 | 0 | 0 | 192 | 242* | |
| 31'-0" | | | 64 | 95 | 124+ | 137+ | 7.722 | 49 | 86 | 130 | 163* | 173* | 4.752 |
| | | | 0 | 0 | 130 | 161+ | | 0 | 0 | 0 | 175 | 226 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.44 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.50 | 0.62 | 0.77 | 0.97 | 1.83 | | 0.50 | 0.67 | 0.86 | 1.11 | 2.14 | |
| STEEL % (UNIFORM) | 0.71 | 0.89 | 1.11 | 1.39 | 2.64 | | 0.71 | 0.95 | 1.23 | 1.59 | 3.11 | |
| (TAPERED) | 0.43 | 0.53 | 0.66 | 0.83 | 1.58 | | 0.43 | 0.57 | 0.74 | 0.95 | 1.86 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | | 11.75 | 11.75 | 11.69 | 11.69 | 11.56 | |
| $-I_{cr}/I_{gr}$ | 0.189 | 0.224 | 0.259 | 0.304 | 0.458 | | 0.189 | 0.235 | 0.280 | 0.334 | 0.496 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.14 | 0.17 | 0.21 | 0.26 | 0.30 | | 0.11 | 0.14 | 0.17 | 0.21 | 0.26 | |
| EFF. DEPTH, IN. | 11.75 | 11.69 | 11.69 | 11.62 | 11.62 | | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | |
| $+I_{cr}/I_{gr}$ | 0.198 | 0.244 | 0.290 | 0.339 | 0.389 | | 0.157 | 0.198 | 0.244 | 0.290 | 0.339 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 20" Forms + 6" Rib @ 26" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 3.0″ Top Slab = 13.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 8.5 | # 4 7 | # 5 8.5 | # 5 7 | End Span Defl. Coeff. (3) | # 4 10 | # 4 8 | # 5 9.5 | # 5 7.5 | # 5 6 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.76 | 0.97 | 1.19 | 1.46 | 1.75 | | 0.81 | 1.04 | 1.33 | 1.68 | 2.04 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 18'-0" | | 243 | 330 | 363* | 373* | 386* | 0.913 | 286 | 392 | 417* | 427* | 439* | 0.562 |
| | | 0 | 0 | 417 | 517 | 540* | | 0 | 0 | 518 | 607* | 619* | |
| 19'-0" | | 210 | 287 | 334* | 342* | 353* | 1.133 | 248 | 343 | 386* | 394* | 405* | 0.697 |
| | | 0 | 0 | 366 | 455 | 499* | | 0 | 0 | 456 | 564* | 574* | |
| 20'-0" | | 181 | 251 | 308* | 315* | 325* | 1.391 | 215 | 301 | 358* | 365* | 375* | 0.856 |
| | | 0 | 0 | 322 | 403 | 462* | | 0 | 0 | 403 | 507 | 535* | |
| 21'-0" | | 156 | 220 | 284 | 292* | 300* | 1.691 | 188 | 266 | 333* | 340* | 348* | 1.041 |
| | | 0 | 0 | 0 | 357 | 431* | | 0 | 0 | 358 | 452 | 497* | |
| 22'-0" | | 135 | 193 | 251 | 271* | 279* | 2.037 | 163 | 234 | 311* | 317* | 324* | 1.254 |
| | | 0 | 0 | 0 | 318 | 386 | | 0 | 0 | 319 | 404 | 460* | |
| 23'-0" | | 116 | 169 | 223 | 252* | 259* | 2.433 | 142 | 207 | 284 | 296* | 303* | 1.497 |
| | | 0 | 0 | 0 | 284 | 346 | | 0 | 0 | 0 | 363 | 423* | |
| 24'-0" | | 100 | 148 | 198 | 235* | 242* | 2.885 | 124 | 184 | 254 | 278* | 284* | 1.775 |
| | | 0 | 0 | 0 | 254 | 311 | | 0 | 0 | 0 | 326 | 390* | |
| 25'-0" | | 85 | 130 | 176 | 220* | 226* | 3.397 | 107 | 163 | 228 | 261* | 267* | 2.090 |
| | | 0 | 0 | 0 | 227 | 280 | | 0 | 0 | 0 | 294 | 360* | |
| 26'-0" | | 73 | 114 | 156 | 204 | 212* | 3.974 | 93 | 144 | 204 | 246* | 251* | 2.445 |
| | | 0 | 0 | 0 | 0 | 252 | | 0 | 0 | 0 | 265 | 335* | |
| 27'-0" | | 61 | 100 | 139 | 183 | 198* | 4.621 | 80 | 127 | 183 | 232* | 236* | 2.844 |
| | | 0 | 0 | 0 | 0 | 228 | | 0 | 0 | 0 | 240 | 304 | |
| 28'-0" | | 51 | 87 | 123 | 164 | 187* | 5.345 | 69 | 112 | 164 | 217 | 223* | 3.289 |
| | | 0 | 0 | 0 | 0 | 206 | | 0 | 0 | 0 | 0 | 277 | |
| 29'-0" | | 42 | 75 | 109 | 147 | 167+ | 6.150 | 58 | 99 | 148 | 197 | 211* | 3.785 |
| | | 0 | 0 | 0 | 0 | 186 | | 0 | 0 | 0 | 0 | 252 | |
| 30'-0" | | | 65 | 96 | 132 | 148+ | 7.043 | 49 | 87 | 132 | 178 | 200* | 4.334 |
| | | | 0 | 0 | 0 | 169 | | 0 | 0 | 0 | 0 | 230 | |
| 31'-0" | | | 55 | 85 | 118 | 133+ | 8.030 | 40 | 76 | 119 | 162 | 189* | 4.942 |
| | | | 0 | 0 | 0 | 152 | | 0 | 0 | 0 | 0 | 210 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.47 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.47 | 0.61 | 0.74 | 0.95 | 1.15 | | 0.52 | 0.65 | 0.85 | 1.07 | 1.34 | |
| STEEL % (UNIFORM) | 0.58 | 0.75 | 0.91 | 1.16 | 1.41 | | 0.63 | 0.79 | 1.04 | 1.32 | 1.65 | |
| (TAPERED) | 0.37 | 0.47 | 0.58 | 0.74 | 0.90 | | 0.40 | 0.50 | 0.66 | 0.84 | 1.05 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.75 | 11.69 | 11.69 | | 11.75 | 11.75 | 11.69 | 11.69 | 11.69 | |
| $-I_{cr}/I_{gr}$ | 0.165 | 0.203 | 0.235 | 0.278 | 0.320 | | 0.178 | 0.212 | 0.256 | 0.304 | 0.356 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.13 | 0.17 | 0.20 | 0.25 | 0.29 | | 0.10 | 0.13 | 0.17 | 0.20 | 0.25 | |
| EFF. DEPTH, IN. | 11.75 | 11.69 | 11.69 | 11.62 | 11.62 | | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | |
| $+I_{cr}/I_{gr}$ | 0.176 | 0.216 | 0.257 | 0.301 | 0.345 | | 0.139 | 0.176 | 0.216 | 0.257 | 0.301 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 20" Forms + 5" Rib @ 25" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 3.0″ Top Slab = 15.0″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8 | # 5 10 | # 5 8.5 | # 5 7 | End Span Defl. Coeff. (3) | # 4 10 | # 4 8 | # 5 9.5 | # 5 7.5 | # 6 6 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.80 | 1.01 | 1.25 | 1.50 | 1.80 | | 0.82 | 1.06 | 1.35 | 1.71 | 2.54 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 20'-0" | | 234 | 320 | 347* | 356* | 368* | 1.338 | 276 | 381 | 398* | 408* | 440* | 0.823 |
| | | 0 | 0 | 407 | 484* | 499* | | 0 | 0 | 506 | 582* | 622* | |
| 21'-0" | | 204 | 282 | 320* | 328* | 339* | 1.626 | 242 | 337 | 370* | 379* | 407* | 1.001 |
| | | 0 | 0 | 361 | 451 | 472* | | 0 | 0 | 451 | 533* | 578* | |
| 22'-0" | | 178 | 249 | 297* | 304* | 314* | 1.959 | 213 | 299 | 345* | 353* | 378* | 1.205 |
| | | 0 | 0 | 321 | 403 | 439* | | 0 | 0 | 403 | 486* | 535* | |
| 23'-0" | | 155 | 220 | 276* | 282* | 291* | 2.340 | 187 | 266 | 323* | 330* | 352* | 1.440 |
| | | 0 | 0 | 286 | 361 | 409* | | 0 | 0 | 361 | 446* | 492* | |
| 24'-0" | | 135 | 195 | 255 | 263* | 271* | 2.774 | 164 | 237 | 302* | 309* | 329* | 1.707 |
| | | 0 | 0 | 0 | 324 | 383* | | 0 | 0 | 324 | 411* | 451* | |
| 25'-0" | | 118 | 173 | 228 | 246* | 253* | 3.266 | 145 | 212 | 284* | 290* | 308* | 2.010 |
| | | 0 | 0 | 0 | 292 | 356 | | 0 | 0 | 292 | 372 | 416* | |
| 26'-0" | | 102 | 153 | 204 | 230* | 237* | 3.821 | 127 | 189 | 263 | 273* | 290* | 2.351 |
| | | 0 | 0 | 0 | 263 | 323 | | 0 | 0 | 0 | 338 | 385* | |
| 27'-0" | | 88 | 135 | 183 | 216* | 222* | 4.443 | 111 | 169 | 237 | 257* | 272* | 2.734 |
| | | 0 | 0 | 0 | 237 | 293 | | 0 | 0 | 0 | 307 | 358* | |
| 28'-0" | | 76 | 119 | 164 | 203* | 208* | 5.139 | 97 | 151 | 214 | 243* | 257* | 3.163 |
| | | 0 | 0 | 0 | 214 | 266 | | 0 | 0 | 0 | 279 | 333* | |
| 29'-0" | | 64 | 105 | 147 | 191* | 196* | 5.914 | 84 | 134 | 194 | 229* | 242* | 3.639 |
| | | 0 | 0 | 0 | 194 | 242 | | 0 | 0 | 0 | 254 | 312* | |
| 30'-0" | | 54 | 93 | 131 | 175 | 185* | 6.772 | 73 | 120 | 175 | 217* | 229* | 4.168 |
| | | 0 | 0 | 0 | 0 | 220 | | 0 | 0 | 0 | 231 | 292* | |
| 31'-0" | | 45 | 81 | 117 | 158 | 174* | 7.722 | 63 | 106 | 158 | 206* | 217* | 4.752 |
| | | 0 | 0 | 0 | 0 | 200 | | 0 | 0 | 0 | 211 | 271 | |
| 32'-0" | | | 71 | 104 | 143 | 165* | 8.767 | 53 | 94 | 143 | 193 | 206* | 5.395 |
| | | | 0 | 0 | 0 | 183 | | 0 | 0 | 0 | 0 | 249 | |
| 33'-0" | | | 61 | 93 | 129 | 156* | 9.915 | 45 | 83 | 129 | 176 | 195* | 6.102 |
| | | | 0 | 0 | 0 | 166 | | 0 | 0 | 0 | 0 | 229 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.49 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.50 | 0.62 | 0.77 | 0.91 | 1.11 | | 0.50 | 0.62 | 0.82 | 1.03 | 1.83 | |
| STEEL % (UNIFORM) | 0.59 | 0.74 | 0.92 | 1.08 | 1.32 | | 0.59 | 0.74 | 0.97 | 1.23 | 2.19 | |
| (TAPERED) | 0.36 | 0.45 | 0.56 | 0.66 | 0.80 | | 0.36 | 0.45 | 0.59 | 0.74 | 1.33 | |
| EFF. DEPTH, IN. | 13.75 | 13.75 | 13.69 | 13.69 | 13.69 | | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | |
| $-I_{cr}/I_{gr}$ | 0.174 | 0.208 | 0.242 | 0.273 | 0.314 | | 0.174 | 0.208 | 0.252 | 0.299 | 0.436 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.12 | 0.15 | 0.18 | 0.22 | 0.26 | | 0.09 | 0.12 | 0.15 | 0.18 | 0.22 | |
| EFF. DEPTH, IN. | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | |
| $+I_{cr}/I_{gr}$ | 0.180 | 0.222 | 0.264 | 0.310 | 0.356 | | 0.142 | 0.180 | 0.222 | 0.264 | 0.310 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 20" Forms + 6" Rib @ 26" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 3.0″ Top Slab = 15.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 8.5 | # 4 7 | # 5 9 | # 5 7.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 8 | # 5 10 | # 5 8 | # 6 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.76 | 0.97 | 1.19 | 1.44 | 1.72 | | 0.77 | 1.04 | 1.30 | 1.62 | 2.00 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 20'-0" | | 217 | 300 | 383 | 393* | 404* | 1.391 | 257 | 358 | 445* | 453* | 461* | 0.856 |
| | | 0 | 0 | 0 | 479 | 545* | | 0 | 0 | 478 | 600 | 636* | |
| 21'-0" | | 188 | 263 | 339 | 364* | 373* | 1.691 | 225 | 316 | 414* | 422* | 429* | 1.041 |
| | | 0 | 0 | 0 | 425 | 511* | | 0 | 0 | 425 | 536 | 592* | |
| 22'-0" | | 163 | 231 | 300 | 338* | 346* | 2.037 | 196 | 280 | 379 | 394* | 400* | 1.254 |
| | | 0 | 0 | 0 | 379 | 459 | | 0 | 0 | 0 | 480 | 548* | |
| 23'-0" | | 141 | 204 | 267 | 314* | 322* | 2.433 | 172 | 248 | 339 | 368* | 374* | 1.497 |
| | | 0 | 0 | 0 | 339 | 412 | | 0 | 0 | 0 | 431 | 505* | |
| 24'-0" | | 122 | 179 | 237 | 294* | 301* | 2.885 | 150 | 220 | 304 | 346* | 350* | 1.775 |
| | | 0 | 0 | 0 | 304 | 371 | | 0 | 0 | 0 | 388 | 466* | |
| 25'-0" | | 105 | 158 | 211 | 272 | 281* | 3.397 | 131 | 195 | 272 | 325* | 329* | 2.090 |
| | | 0 | 0 | 0 | 0 | 335 | | 0 | 0 | 0 | 350 | 432* | |
| 26'-0" | | 90 | 139 | 188 | 245 | 264* | 3.974 | 114 | 174 | 245 | 306* | 310* | 2.445 |
| | | 0 | 0 | 0 | 0 | 302 | | 0 | 0 | 0 | 317 | 399 | |
| 27'-0" | | 77 | 122 | 168 | 220 | 248* | 4.621 | 99 | 154 | 220 | 287 | 292* | 2.844 |
| | | 0 | 0 | 0 | 0 | 273 | | 0 | 0 | 0 | 0 | 363 | |
| 28'-0" | | 65 | 107 | 149 | 198 | 233* | 5.345 | 85 | 137 | 198 | 260 | 276* | 3.289 |
| | | 0 | 0 | 0 | 0 | 248 | | 0 | 0 | 0 | 0 | 331 | |
| 29'-0" | | 54 | 93 | 133 | 178 | 220* | 6.150 | 73 | 121 | 178 | 236 | 261* | 3.785 |
| | | 0 | 0 | 0 | 0 | 224 | | 0 | 0 | 0 | 0 | 302 | |
| 30'-0" | | 44 | 81 | 118 | 160 | 204 | 7.043 | 62 | 107 | 160 | 214 | 248* | 4.334 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 276 | |
| 31'-0" | | | 70 | 105 | 144 | 185 | 8.030 | 52 | 94 | 144 | 195 | 235* | 4.942 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 253 | |
| 32'-0" | | | 60 | 92 | 130 | 168 | 9.118 | 43 | 83 | 130 | 177 | 223* | 5.611 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 231 | |
| 33'-0" | | | 50 | 81 | 116 | 152 | 10.312 | | 72 | 116 | 161 | 212 | 6.346 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.47 | 0.61 | 0.74 | 0.90 | 1.07 | | 0.47 | 0.65 | 0.81 | 1.01 | 1.27 | |
| STEEL % (UNIFORM) | 0.48 | 0.62 | 0.76 | 0.92 | 1.10 | | 0.48 | 0.66 | 0.82 | 1.03 | 1.31 | |
| (TAPERED) | 0.31 | 0.40 | 0.48 | 0.59 | 0.70 | | 0.31 | 0.42 | 0.53 | 0.66 | 0.84 | |
| EFF. DEPTH, IN. | 13.75 | 13.75 | 13.75 | 13.69 | 13.69 | | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | |
| $-I_{cr}/I_{gr}$ | 0.153 | 0.188 | 0.219 | 0.249 | 0.286 | | 0.153 | 0.197 | 0.230 | 0.272 | 0.319 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.11 | 0.14 | 0.17 | 0.21 | 0.25 | | 0.09 | 0.11 | 0.14 | 0.17 | 0.21 | |
| EFF. DEPTH, IN. | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | |
| $+I_{cr}/I_{gr}$ | 0.159 | 0.197 | 0.235 | 0.275 | 0.317 | | 0.126 | 0.159 | 0.197 | 0.235 | 0.275 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 4.0″ Top Slab = 12.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 10 | # 4 8 | # 5 10 | # 5 8 | End Span Defl. Coeff. (3) | # 4 11 | # 4 10 | # 4 7.5 | # 5 9 | # 6 6.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | |
| Steel (psf) | | 0.64 | 0.80 | 1.01 | 1.25 | 1.52 | | 0.68 | 0.82 | 1.10 | 1.39 | 2.26 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 12'-0" | | 456 | 497* | 517* | 538* | 570* | 0.173 | | | | | | |
| | | 0 | 612 | 756* | 776* | 808* | | | | | | | |
| 13'-0" | | 376 | 440* | 457* | 473* | 500* | 0.239 | | | | | | |
| | | 0 | 509 | 665 | 691* | 717* | | | | | | | |
| 14'-0" | | 312 | 390* | 404* | 417* | 438* | 0.321 | | | | | | |
| | | 0 | 426 | 562 | 616* | 638* | | | | | | | |
| 15'-0" | | 260 | 349* | 360* | 370* | 388* | 0.423 | | 400* | | 419* | | 0.260 |
| | | 0 | 360 | 478 | 555* | 573* | | | 419 | | 635* | | |
| 16'-0" | | 218 | 306 | 324* | 332* | 347* | 0.548 | 231 | 357 | 372* | 379* | 420* | 0.337 |
| | | 0 | 0 | 409 | 505* | 519* | | 0 | 0 | 485 | 580* | 620* | |
| 17'-0" | | 183 | 261 | 293* | 300* | 313* | 0.698 | 194 | 306 | 340* | 345* | 380* | 0.430 |
| | | 0 | 0 | 352 | 446 | 474* | | 0 | 0 | 419 | 533* | 567* | |
| 18'-0" | | 154 | 223 | 267* | 273* | 284* | 0.878 | 164 | 264 | 311* | 316* | 346* | 0.540 |
| | | 0 | 0 | 305 | 388 | 434* | | 0 | 0 | 365 | 484 | 522* | |
| 19'-0" | | 129 | 191 | 244* | 249* | 259* | 1.090 | 138 | 228 | 286* | 291* | 317* | 0.671 |
| | | 0 | 0 | 265 | 339 | 396* | | 0 | 0 | 318 | 425 | 483* | |
| 20'-0" | | 108 | 164 | 224* | 228* | 237* | 1.338 | 116 | 197 | 264* | 268* | 292* | 0.823 |
| | | 0 | 0 | 230 | 297 | 363* | | 0 | 0 | 279 | 375 | 447* | |
| 21'-0" | | 90 | 141 | 201 | 210* | 217* | 1.626 | 97 | 170 | 244 | 248* | 269* | 1.001 |
| | | 0 | 0 | 0 | 262 | 331 | | 0 | 0 | 0 | 332 | 412* | |
| 22'-0" | | 74 | 120 | 175 | 194* | 200* | 1.959 | 81 | 147 | 215 | 230* | 249* | 1.205 |
| | | 0 | 0 | 0 | 231 | 293 | | 0 | 0 | 0 | 295 | 375 | |
| 23'-0" | | 60 | 102 | 153 | 179* | 185* | 2.340 | 66 | 127 | 189 | 214* | 231* | 1.440 |
| | | 0 | 0 | 0 | 203 | 261 | | 0 | 0 | 0 | 262 | 336 | |
| 24'-0" | | 48 | 87 | 133 | 166* | 171* | 2.774 | 54 | 110 | 167 | 200* | 215* | 1.707 |
| | | 0 | 0 | 0 | 180 | 232 | | 0 | 0 | 0 | 233 | 301 | |
| 25'-0" | | | 73 | 116 | 154* | 159* | 3.266 | 42 | 94 | 147 | 186* | 200* | 2.010 |
| | | | 0 | 0 | 159 | 207 | | 0 | 0 | 0 | 208 | 271 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.48 CF/SF) (4)

| NEGATIVE MOMENT | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STEEL AREA (SQ. IN.) | 0.45 | 0.50 | 0.62 | 0.77 | 0.98 | | 0.45 | 0.50 | 0.67 | 0.86 | 1.69 | |
| STEEL % (UNIFORM) | 0.72 | 0.79 | 0.99 | 1.23 | 1.54 | | 0.72 | 0.79 | 1.05 | 1.37 | 2.71 | |
| (TAPERED) | 0.43 | 0.47 | 0.59 | 0.73 | 0.92 | | 0.43 | 0.47 | 0.63 | 0.81 | 1.61 | |
| EFF. DEPTH, IN. | 10.75 | 10.75 | 10.75 | 10.69 | 10.69 | | 10.75 | 10.75 | 10.75 | 10.69 | 10.62 | |
| $-I_{cr}/I_{gr}$ | 0.182 | 0.196 | 0.232 | 0.268 | 0.314 | | 0.182 | 0.196 | 0.244 | 0.289 | 0.445 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.12 | 0.15 | 0.19 | 0.23 | 0.28 | | 0.08 | 0.12 | 0.15 | 0.19 | 0.23 | |
| EFF. DEPTH, IN. | 10.75 | 10.75 | 10.69 | 10.69 | 10.62 | | 10.81 | 10.75 | 10.75 | 10.69 | 10.69 | |
| $+I_{cr}/I_{gr}$ | 0.166 | 0.209 | 0.256 | 0.304 | 0.314 | | 0.122 | 0.166 | 0.209 | 0.256 | 0.304 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 4.0″ Top Slab = 12.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 8.5 | # 4 7 | # 5 8.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 10 | # 4 8 | # 5 9.5 | # 5 7.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | |
| Steel (psf) | | 0.63 | 0.76 | 0.97 | 1.19 | 1.46 | | 0.67 | 0.81 | 1.04 | 1.33 | 1.68 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 14'-0" | | 293 | 403 | 449* | 463* | 480* | 0.334 | | | | | | |
| | | 0 | 0 | 533 | 656* | 672* | | | | | | | |
| 15'-0" | | 243 | 339 | 402* | 413* | 428* | 0.440 | | 396 | | 469* | | 0.271 |
| | | 0 | 0 | 453 | 568 | 606* | | | 0 | | 677* | | |
| 16'-0" | | 203 | 287 | 363* | 373* | 384* | 0.570 | 215 | 337 | 419* | 426* | 437* | 0.351 |
| | | 0 | 0 | 387 | 488 | 550* | | 0 | 0 | 459 | 604 | 631* | |
| 17'-0" | | 169 | 244 | 329* | 338* | 348* | 0.726 | 180 | 288 | 383* | 389* | 399* | 0.447 |
| | | 0 | 0 | 332 | 422 | 503* | | 0 | 0 | 396 | 525 | 580* | |
| 18'-0" | | 141 | 208 | 286 | 308* | 316* | 0.913 | 151 | 247 | 344 | 357* | 366* | 0.562 |
| | | 0 | 0 | 0 | 366 | 457 | | 0 | 0 | 0 | 458 | 535* | |
| 19'-0" | | 117 | 177 | 248 | 282* | 289* | 1.133 | 126 | 212 | 299 | 329* | 336* | 0.697 |
| | | 0 | 0 | 0 | 319 | 401 | | 0 | 0 | 0 | 402 | 496* | |
| 20'-0" | | 97 | 151 | 215 | 260* | 266* | 1.391 | 105 | 182 | 261 | 304* | 311* | 0.856 |
| | | 0 | 0 | 0 | 279 | 353 | | 0 | 0 | 0 | 354 | 448 | |
| 21'-0" | | 79 | 128 | 186 | 240* | 245* | 1.691 | 86 | 157 | 228 | 282* | 288* | 1.041 |
| | | 0 | 0 | 0 | 245 | 311 | | 0 | 0 | 0 | 312 | 398 | |
| 22'-0" | | 64 | 109 | 161 | 215 | 226* | 2.037 | 70 | 135 | 200 | 262* | 268* | 1.254 |
| | | 0 | 0 | 0 | 0 | 275 | | 0 | 0 | 0 | 276 | 354 | |
| 23'-0" | | 51 | 92 | 140 | 189 | 210* | 2.433 | 57 | 116 | 175 | 245* | 250* | 1.497 |
| | | 0 | 0 | 0 | 0 | 244 | | 0 | 0 | 0 | 0 | 316 | |
| 24'-0" | | | 77 | 121 | 166 | 195* | 2.885 | 45 | 99 | 153 | 218 | 233* | 1.775 |
| | | | 0 | 0 | 0 | 217 | | 0 | 0 | 0 | 0 | 283 | |
| 25'-0" | | | 63 | 104 | 146 | 182* | 3.397 | | 84 | 134 | 193 | 218* | 2.090 |
| | | | 0 | 0 | 0 | 193 | | | 0 | 0 | 0 | 254 | |
| 26'-0" | | | 52 | 90 | 128 | 169* | 3.974 | | 71 | 117 | 172 | 205* | 2.445 |
| | | | 0 | 0 | 0 | 171 | | | 0 | 0 | 0 | 228 | |
| 27'-0" | | | 41 | 76 | 112 | 152 | 4.621 | | 59 | 102 | 153 | 192* | 2.844 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 204 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.50 CF/SF) (4)

| NEGATIVE MOMENT | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STEEL AREA (SQ. IN.) | 0.47 | 0.47 | 0.61 | 0.74 | 0.95 | | 0.47 | 0.52 | 0.65 | 0.85 | 1.07 | |
| STEEL % (UNIFORM) | 0.64 | 0.64 | 0.83 | 1.00 | 1.29 | | 0.64 | 0.70 | 0.88 | 1.15 | 1.46 | |
| (TAPERED) | 0.40 | 0.40 | 0.52 | 0.63 | 0.81 | | 0.40 | 0.44 | 0.55 | 0.73 | 0.92 | |
| EFF. DEPTH, IN. | 10.75 | 10.75 | 10.75 | 10.75 | 10.69 | | 10.75 | 10.75 | 10.75 | 10.69 | 10.69 | |
| $-I_{cr}/I_{gr}$ | 0.172 | 0.172 | 0.210 | 0.243 | 0.287 | | 0.172 | 0.185 | 0.220 | 0.265 | 0.313 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.11 | 0.14 | 0.18 | 0.22 | 0.27 | | 0.08 | 0.11 | 0.14 | 0.18 | 0.22 | |
| EFF. DEPTH, IN. | 10.75 | 10.75 | 10.69 | 10.69 | 10.62 | | 10.81 | 10.75 | 10.75 | 10.69 | 10.69 | |
| $+I_{cr}/I_{gr}$ | 0.146 | 0.184 | 0.226 | 0.269 | 0.314 | | 0.108 | 0.146 | 0.184 | 0.226 | 0.269 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 20" Forms + 5" Rib @ 25" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 4.0″ Top Slab = 14.0″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8 | # 5 10 | # 5 8 | # 5 7 | End Span Defl. Coeff. (3) | # 4 10 | # 4 7.5 | # 5 9 | # 5 7.5 | # 7 7 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.80 | 1.01 | 1.25 | 1.52 | 1.80 | | 0.82 | 1.10 | 1.39 | 1.71 | 2.79 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 18'-0" | | 275 | 348* | 357* | 371* | 382* | 0.878 | 323 | | 409* | 418* | | 0.540 |
| | | 0 | 372 | 472 | 519* | 537* | | 0 | | 585 | 615* | | |
| 19'-0" | | 237 | 319* | 326* | 338* | 347* | 1.090 | 280 | 371* | 376* | 384* | | 0.671 |
| | | 0 | 325 | 414 | 475* | 491* | | 0 | 388 | 515 | 568* | | |
| 20'-0" | | 204 | 284 | 299* | 310* | 318* | 1.338 | 243 | 340 | 348* | 355* | | 0.823 |
| | | 0 | 0 | 364 | 436* | 451* | | 0 | 0 | 456 | 521* | | |
| 21'-0" | | 176 | 248 | 276* | 285* | 292* | 1.626 | 212 | 300 | 322* | 329* | | 1.001 |
| | | 0 | 0 | 321 | 404 | 428* | | 0 | 0 | 405 | 475* | | |
| 22'-0" | | 152 | 218 | 255* | 263* | 270* | 1.959 | 185 | 265 | 300* | 305* | | 1.205 |
| | | 0 | 0 | 284 | 360 | 397* | | 0 | 0 | 360 | 432* | | |
| 23'-0" | | 131 | 191 | 236* | 244* | 249* | 2.340 | 161 | 234 | 280* | 285* | 311* | 1.440 |
| | | 0 | 0 | 252 | 321 | 370* | | 0 | 0 | 321 | 395* | 449* | |
| 24'-0" | | 113 | 168 | 220* | 226* | 231* | 2.774 | 140 | 207 | 261* | 266* | 290* | 1.707 |
| | | 0 | 0 | 224 | 287 | 345* | | 0 | 0 | 287 | 363* | 413* | |
| 25'-0" | | 96 | 147 | 199 | 211* | 215* | 3.266 | 121 | 184 | 245* | 249* | 270* | 2.010 |
| | | 0 | 0 | 0 | 257 | 317 | | 0 | 0 | 257 | 332 | 378* | |
| 26'-0" | | 82 | 129 | 176 | 197* | 201* | 3.821 | 105 | 163 | 230* | 233* | 253* | 2.351 |
| | | 0 | 0 | 0 | 231 | 286 | | 0 | 0 | 231 | 300 | 349* | |
| 27'-0" | | 69 | 113 | 157 | 184* | 187* | 4.443 | 90 | 144 | 207 | 219* | 237* | 2.734 |
| | | 0 | 0 | 0 | 207 | 258 | | 0 | 0 | 0 | 271 | 322* | |
| 28'-0" | | 58 | 98 | 139 | 172* | 175* | 5.139 | 77 | 127 | 186 | 206* | 223* | 3.163 |
| | | 0 | 0 | 0 | 186 | 233 | | 0 | 0 | 0 | 245 | 299* | |
| 29'-0" | | 47 | 85 | 123 | 161* | 164* | 5.914 | 66 | 112 | 167 | 194* | 209* | 3.639 |
| | | 0 | 0 | 0 | 167 | 211 | | 0 | 0 | 0 | 222 | 278* | |
| 30'-0" | | | 73 | 109 | 149 | 154* | 6.772 | 55 | 98 | 150 | 183* | 197* | 4.168 |
| | | | 0 | 0 | 0 | 191 | | 0 | 0 | 0 | 202 | 260* | |
| 31'-0" | | | 62 | 96 | 134 | 144* | 7.722 | 46 | 86 | 134 | 173* | 186* | 4.752 |
| | | | 0 | 0 | 0 | 173 | | 0 | 0 | 0 | 183 | 238 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.50 | 0.62 | 0.77 | 0.97 | 1.11 | | 0.50 | 0.67 | 0.86 | 1.03 | 2.14 | |
| STEEL % (UNIFORM) | 0.65 | 0.81 | 1.01 | 1.26 | 1.44 | | 0.65 | 0.86 | 1.12 | 1.34 | 2.82 | |
| (TAPERED) | 0.39 | 0.49 | 0.61 | 0.76 | 0.87 | | 0.39 | 0.52 | 0.67 | 0.81 | 1.70 | |
| EFF. DEPTH, IN. | 12.75 | 12.75 | 12.69 | 12.69 | 12.69 | | 12.75 | 12.75 | 12.69 | 12.69 | 12.56 | |
| $-I_{cr}/I_{gr}$ | 0.179 | 0.213 | 0.248 | 0.292 | 0.321 | | 0.179 | 0.224 | 0.268 | 0.305 | 0.481 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.13 | 0.16 | 0.20 | 0.24 | 0.28 | | 0.10 | 0.13 | 0.16 | 0.20 | 0.24 | |
| EFF. DEPTH, IN. | 12.75 | 12.69 | 12.69 | 12.62 | 12.62 | | 12.75 | 12.75 | 12.69 | 12.69 | 12.62 | |
| $+I_{cr}/I_{gr}$ | 0.187 | 0.230 | 0.274 | 0.320 | 0.368 | | 0.148 | 0.187 | 0.230 | 0.274 | 0.320 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 20" Forms + 6" Rib @ 26" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 4.0″ Top Slab = 14.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 8.5 | # 4 7 | # 5 9 | # 5 7.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 8 | # 5 10 | # 5 8 | # 6 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.76 | 0.97 | 1.19 | 1.44 | 1.72 | | 0.77 | 1.04 | 1.30 | 1.62 | 2.00 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 18'-0" | | 256 | 350 | 398* | 406* | 419* | 0.913 | 302 | | 455* | 465* | 474* | 0.562 |
| | | 0 | 0 | 445 | 554 | 580* | | 0 | | 555 | 655* | 663* | |
| 19'-0" | | 219 | 304 | 365* | 371* | 382* | 1.133 | 261 | 364 | 420* | 429* | 437* | 0.697 |
| | | 0 | 0 | 389 | 487 | 535* | | 0 | 0 | 487 | 607* | 614* | |
| 20'-0" | | 188 | 264 | 336* | 341* | 351* | 1.391 | 226 | 319 | 389* | 397* | 403* | 0.856 |
| | | 0 | 0 | 342 | 430 | 493* | | 0 | 0 | 430 | 543 | 571* | |
| 21'-0" | | 161 | 231 | 301 | 315* | 324* | 1.691 | 195 | 280 | 361* | 368* | 374* | 1.041 |
| | | 0 | 0 | 0 | 381 | 460* | | 0 | 0 | 381 | 483 | 530* | |
| 22'-0" | | 138 | 201 | 265 | 292* | 299* | 2.037 | 169 | 246 | 337* | 343* | 348* | 1.254 |
| | | 0 | 0 | 0 | 338 | 412 | | 0 | 0 | 338 | 431 | 489* | |
| 23'-0" | | 118 | 176 | 234 | 271* | 278* | 2.433 | 146 | 217 | 301 | 320* | 325* | 1.497 |
| | | 0 | 0 | 0 | 301 | 368 | | 0 | 0 | 0 | 386 | 450* | |
| 24'-0" | | 100 | 153 | 207 | 252* | 258* | 2.885 | 126 | 191 | 268 | 300* | 304* | 1.775 |
| | | 0 | 0 | 0 | 268 | 330 | | 0 | 0 | 0 | 346 | 414* | |
| 25'-0" | | 84 | 133 | 183 | 235* | 241* | 3.397 | 108 | 168 | 239 | 281* | 285* | 2.090 |
| | | 0 | 0 | 0 | 239 | 296 | | 0 | 0 | 0 | 311 | 382* | |
| 26'-0" | | 70 | 116 | 161 | 213 | 225* | 3.974 | 93 | 148 | 214 | 264* | 267* | 2.445 |
| | | 0 | 0 | 0 | 0 | 266 | | 0 | 0 | 0 | 280 | 355* | |
| 27'-0" | | 58 | 100 | 142 | 191 | 211* | 4.621 | 79 | 130 | 191 | 248* | 251* | 2.844 |
| | | 0 | 0 | 0 | 0 | 240 | | 0 | 0 | 0 | 253 | 323 | |
| 28'-0" | | 47 | 86 | 125 | 170 | 198* | 5.345 | 66 | 114 | 170 | 228 | 237* | 3.289 |
| | | 0 | 0 | 0 | 0 | 216 | | 0 | 0 | 0 | 0 | 293 | |
| 29'-0" | | | 73 | 110 | 152 | 186* | 6.150 | 55 | 99 | 152 | 206 | 223* | 3.785 |
| | | | 0 | 0 | 0 | 195 | | 0 | 0 | 0 | 0 | 266 | |
| 30'-0" | | | 62 | 96 | 135 | 175* | 7.043 | 45 | 86 | 136 | 186 | 211* | 4.334 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 242 | |
| 31'-0" | | | 52 | 84 | 120 | 158 | 8.030 | | 74 | 121 | 167 | 200* | 4.942 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 221 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.47 | 0.61 | 0.74 | 0.90 | 1.07 | | 0.47 | 0.65 | 0.81 | 1.01 | 1.27 | |
| STEEL % (UNIFORM) | 0.52 | 0.68 | 0.82 | 1.00 | 1.20 | | 0.52 | 0.72 | 0.90 | 1.13 | 1.43 | |
| (TAPERED) | 0.34 | 0.43 | 0.53 | 0.64 | 0.77 | | 0.34 | 0.46 | 0.57 | 0.72 | 0.91 | |
| EFF. DEPTH, IN. | 12.75 | 12.75 | 12.75 | 12.69 | 12.69 | | 12.75 | 12.75 | 12.69 | 12.69 | 12.62 | |
| $-I_{cr}/I_{gr}$ | 0.157 | 0.193 | 0.224 | 0.255 | 0.291 | | 0.157 | 0.202 | 0.235 | 0.278 | 0.324 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.12 | 0.15 | 0.19 | 0.23 | 0.27 | | 0.09 | 0.12 | 0.15 | 0.19 | 0.23 | |
| EFF. DEPTH, IN. | 12.75 | 12.69 | 12.69 | 12.62 | 12.62 | | 12.75 | 12.75 | 12.69 | 12.69 | 12.62 | |
| $+I_{cr}/I_{gr}$ | 0.165 | 0.204 | 0.242 | 0.284 | 0.326 | | 0.131 | 0.165 | 0.204 | 0.242 | 0.284 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 4.0″ Top Slab = 16.0″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8 | # 5 10 | # 5 8.5 | # 5 7 | End Span Defl. Coeff. (3) | # 4 10 | # 4 8 | # 5 9.5 | # 5 7.5 | # 5 6 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | |
| Steel (psf) | | 0.80 | 1.01 | 1.25 | 1.50 | 1.80 | | 0.82 | 1.06 | 1.35 | 1.71 | 2.08 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 20'-0" | | 243 | 336 | 376* | 386* | 400* | 1.338 | | | | | | |
| | | 0 | 0 | 429 | 512* | 527* | | | | | | | |
| 21'-0" | | 211 | 295 | 346* | 355* | 368* | 1.626 | 252 | 354 | 401* | 410* | 421* | 1.001 |
| | | 0 | 0 | 380 | 475* | 496* | | 0 | 0 | 476 | 572* | 591* | |
| 22'-0" | | 183 | 260 | 321* | 328* | 339* | 1.959 | 220 | 314 | 373* | 381* | 391* | 1.205 |
| | | 0 | 0 | 337 | 425 | 461* | | 0 | 0 | 425 | 521* | 541* | |
| 23'-0" | | 159 | 229 | 298* | 304* | 314* | 2.340 | 193 | 278 | 348* | 356* | 365* | 1.440 |
| | | 0 | 0 | 299 | 380 | 429* | | 0 | 0 | 380 | 477* | 495* | |
| 24'-0" | | 137 | 202 | 266 | 283* | 292* | 2.774 | 169 | 247 | 326* | 333* | 341* | 1.707 |
| | | 0 | 0 | 0 | 341 | 401* | | 0 | 0 | 340 | 435 | 455* | |
| 25'-0" | | 118 | 178 | 237 | 264* | 272* | 3.266 | 147 | 219 | 305 | 312* | 319* | 2.010 |
| | | 0 | 0 | 0 | 306 | 375* | | 0 | 0 | 0 | 392 | 420* | |
| 26'-0" | | 102 | 156 | 212 | 247* | 254* | 3.821 | 128 | 195 | 275 | 293* | 300* | 2.351 |
| | | 0 | 0 | 0 | 275 | 339 | | 0 | 0 | 0 | 355 | 389* | |
| 27'-0" | | 87 | 137 | 189 | 231* | 237* | 4.443 | 111 | 173 | 247 | 275* | 282* | 2.734 |
| | | 0 | 0 | 0 | 247 | 307 | | 0 | 0 | 0 | 322 | 362* | |
| 28'-0" | | 73 | 121 | 168 | 216* | 222* | 5.139 | 96 | 154 | 222 | 260* | 265* | 3.163 |
| | | 0 | 0 | 0 | 223 | 278 | | 0 | 0 | 0 | 292 | 338* | |
| 29'-0" | | 61 | 105 | 150 | 201 | 209* | 5.914 | 83 | 136 | 200 | 245* | 250* | 3.639 |
| | | 0 | 0 | 0 | 0 | 252 | | 0 | 0 | 0 | 265 | 316* | |
| 30'-0" | | 51 | 92 | 133 | 181 | 196* | 6.772 | 71 | 121 | 180 | 232* | 236* | 4.168 |
| | | 0 | 0 | 0 | 0 | 229 | | 0 | 0 | 0 | 241 | 297* | |
| 31'-0" | | 41 | 79 | 118 | 163 | 185* | 7.722 | 60 | 106 | 162 | 219 | 224* | 4.752 |
| | | 0 | 0 | 0 | 0 | 208 | | 0 | 0 | 0 | 0 | 279* | |
| 32'-0" | | | 68 | 104 | 146 | 174* | 8.767 | 49 | 94 | 146 | 199 | 212* | 5.395 |
| | | | 0 | 0 | 0 | 189 | | 0 | 0 | 0 | 0 | 260 | |
| 33'-0" | | | 58 | 92 | 131 | 164* | 9.915 | 40 | 82 | 131 | 181 | 201* | 6.102 |
| | | | 0 | 0 | 0 | 171 | | 0 | 0 | 0 | 0 | 238 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) (4)

| NEGATIVE MOMENT | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STEEL AREA (SQ. IN.) | 0.50 | 0.62 | 0.77 | 0.91 | 1.11 | | 0.50 | 0.62 | 0.82 | 1.03 | 1.29 | |
| STEEL % (UNIFORM) | 0.54 | 0.68 | 0.85 | 1.00 | 1.21 | | 0.54 | 0.68 | 0.89 | 1.13 | 1.41 | |
| (TAPERED) | 0.33 | 0.41 | 0.52 | 0.61 | 0.74 | | 0.33 | 0.41 | 0.54 | 0.69 | 0.86 | |
| EFF. DEPTH, IN. | 14.75 | 14.75 | 14.69 | 14.69 | 14.69 | | 14.75 | 14.75 | 14.69 | 14.69 | 14.69 | |
| $-I_{cr}/I_{gr}$ | 0.165 | 0.197 | 0.230 | 0.260 | 0.300 | | 0.165 | 0.197 | 0.239 | 0.285 | 0.334 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.11 | 0.14 | 0.17 | 0.21 | 0.24 | | 0.08 | 0.11 | 0.14 | 0.17 | 0.21 | |
| EFF. DEPTH, IN. | 14.75 | 14.69 | 14.69 | 14.62 | 14.62 | | 14.75 | 14.75 | 14.69 | 14.69 | 14.62 | |
| $+I_{cr}/I_{gr}$ | 0.169 | 0.209 | 0.249 | 0.292 | 0.336 | | 0.134 | 0.169 | 0.209 | 0.249 | 0.292 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 4.0″ Top Slab = 16.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 8.5 | # 4 7 | # 5 9 | # 5 7.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 8 | # 5 10 | # 5 8 | # 6 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | |
| Steel (psf) | | 0.76 | 0.97 | 1.19 | 1.44 | 1.72 | | 0.77 | 1.04 | 1.30 | 1.62 | 2.00 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 20'-0" | | 225 | 314 | 404 | 427* | 439* | 1.391 | | | | | | |
| | | 0 | 0 | 0 | 507 | 576* | | | | | | | |
| 21'-0" | | 194 | 275 | 356 | 394* | 405* | 1.691 | 234 | 332 | 448* | 457* | 465* | 1.041 |
| | | 0 | 0 | 0 | 450 | 539* | | 0 | 0 | 449 | 568 | 635* | |
| 22'-0" | | 167 | 241 | 315 | 365* | 374* | 2.037 | 203 | 293 | 400 | 426* | 432* | 1.254 |
| | | 0 | 0 | 0 | 400 | 487 | | 0 | 0 | 0 | 508 | 587* | |
| 23'-0" | | 144 | 211 | 279 | 339* | 348* | 2.433 | 177 | 259 | 357 | 398* | 404* | 1.497 |
| | | 0 | 0 | 0 | 357 | 436 | | 0 | 0 | 0 | 455 | 541* | |
| 24'-0" | | 123 | 185 | 248 | 316* | 324* | 2.885 | 153 | 229 | 319 | 373* | 378* | 1.775 |
| | | 0 | 0 | 0 | 319 | 392 | | 0 | 0 | 0 | 409 | 499* | |
| 25'-0" | | 105 | 162 | 220 | 285 | 302* | 3.397 | 133 | 202 | 285 | 350* | 355* | 2.090 |
| | | 0 | 0 | 0 | 0 | 352 | | 0 | 0 | 0 | 369 | 462* | |
| 26'-0" | | 89 | 142 | 195 | 256 | 283* | 3.974 | 115 | 179 | 255 | 329* | 333* | 2.445 |
| | | 0 | 0 | 0 | 0 | 318 | | 0 | 0 | 0 | 333 | 421 | |
| 27'-0" | | 75 | 123 | 173 | 229 | 265* | 4.621 | 98 | 158 | 229 | 301 | 314* | 2.844 |
| | | 0 | 0 | 0 | 0 | 287 | | 0 | 0 | 0 | 0 | 383 | |
| 28'-0" | | 62 | 107 | 153 | 206 | 249* | 5.345 | 84 | 139 | 205 | 272 | 296* | 3.289 |
| | | 0 | 0 | 0 | 0 | 259 | | 0 | 0 | 0 | 0 | 348 | |
| 29'-0" | | 50 | 93 | 135 | 184 | 234 | 6.150 | 71 | 122 | 184 | 246 | 280* | 3.785 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 317 | |
| 30'-0" | | 40 | 79 | 119 | 165 | 212 | 7.043 | 59 | 107 | 165 | 223 | 265* | 4.334 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 289 | |
| 31'-0" | | | 67 | 105 | 148 | 191 | 8.030 | 48 | 94 | 147 | 202 | 251* | 4.942 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 264 | |
| 32'-0" | | | 57 | 92 | 132 | 173 | 9.118 | | 81 | 132 | 183 | 238* | 5.611 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 241 | |
| 33'-0" | | | 47 | 80 | 118 | 156 | 10.312 | | 70 | 117 | 165 | 220 | 6.346 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) (4)

| NEGATIVE MOMENT | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STEEL AREA (SQ. IN.) | 0.47 | 0.61 | 0.74 | 0.90 | 1.07 | | 0.47 | 0.65 | 0.81 | 1.01 | 1.27 | |
| STEEL % (UNIFORM) | 0.44 | 0.57 | 0.70 | 0.84 | 1.01 | | 0.44 | 0.61 | 0.76 | 0.95 | 1.20 | |
| (TAPERED) | 0.29 | 0.37 | 0.45 | 0.54 | 0.65 | | 0.29 | 0.39 | 0.49 | 0.61 | 0.77 | |
| EFF. DEPTH, IN. | 14.75 | 14.75 | 14.75 | 14.69 | 14.69 | | 14.75 | 14.75 | 14.69 | 14.69 | 14.62 | |
| $-I_{cr}/I_{gr}$ | 0.144 | 0.178 | 0.207 | 0.237 | 0.272 | | 0.144 | 0.186 | 0.219 | 0.259 | 0.304 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.10 | 0.13 | 0.16 | 0.20 | 0.23 | | 0.08 | 0.10 | 0.13 | 0.16 | 0.20 | |
| EFF. DEPTH, IN. | 14.75 | 14.69 | 14.69 | 14.62 | 14.62 | | 14.75 | 14.75 | 14.69 | 14.69 | 14.62 | |
| $+I_{cr}/I_{gr}$ | 0.150 | 0.185 | 0.221 | 0.259 | 0.298 | | 0.118 | 0.150 | 0.185 | 0.221 | 0.259 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 20" Forms + 5" Rib @ 25" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 4.5″ Top Slab = 12.5″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8 | # 5 10 | # 5 8 | # 6 6 | End Span Defl. Coeff. (3) | # 4 10 | # 4 7.5 | # 5 9 | # 6 6.5 | # 6 5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.80 | 1.01 | 1.25 | 1.52 | 2.10 | | 0.82 | 1.10 | 1.39 | 2.26 | 2.84 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 17'-0" | | 270 | 309* | 317* | 331* | 388* | 0.698 | 318 | 358* | 364* | 402* | 426* | 0.430 |
| | | 0 | 366 | 464 | 495* | 514* | | 0 | 436 | 558* | 595* | 620* | |
| 18'-0" | | 231 | 281* | 287* | 299* | 349* | 0.878 | 273 | 328* | 333* | 365* | 387* | 0.540 |
| | | 0 | 316 | 403 | 449* | 467* | | 0 | 379 | 504 | 547* | 568* | |
| 19'-0" | | 197 | 257* | 262* | 272* | 315* | 1.090 | 235 | 301* | 306* | 334* | 353* | 0.671 |
| | | 0 | 274 | 352 | 410* | 426* | | 0 | 330 | 442 | 505* | 524* | |
| 20'-0" | | 169 | 235* | 240* | 249* | 287* | 1.338 | 203 | 278* | 282* | 307* | 324* | 0.823 |
| | | 0 | 238 | 309 | 375* | 391* | | 0 | 289 | 390 | 467* | 485* | |
| 21'-0" | | 144 | 207 | 220* | 228* | 262* | 1.626 | 175 | 253 | 261* | 283* | 298* | 1.001 |
| | | 0 | 0 | 271 | 344 | 369* | | 0 | 0 | 345 | 431* | 450* | |
| 22'-0" | | 123 | 180 | 203* | 210* | 240* | 1.959 | 151 | 222 | 242* | 262* | 275* | 1.205 |
| | | 0 | 0 | 239 | 305 | 340* | | 0 | 0 | 306 | 390 | 416* | |
| 23'-0" | | 104 | 157 | 187* | 194* | 220* | 2.340 | 130 | 195 | 225* | 242* | 255* | 1.440 |
| | | 0 | 0 | 210 | 271 | 315* | | 0 | 0 | 271 | 349 | 382* | |
| 24'-0" | | 88 | 136 | 173* | 179* | 203* | 2.774 | 112 | 171 | 209* | 225* | 237* | 1.707 |
| | | 0 | 0 | 185 | 241 | 292* | | 0 | 0 | 242 | 313 | 350* | |
| 25'-0" | | 74 | 118 | 161* | 166* | 188* | 3.266 | 96 | 150 | 195* | 210* | 220* | 2.010 |
| | | 0 | 0 | 163 | 214 | 266 | | 0 | 0 | 215 | 281 | 320* | |
| 26'-0" | | 61 | 102 | 144 | 154* | 174* | 3.821 | 81 | 132 | 182* | 196* | 205* | 2.351 |
| | | 0 | 0 | 0 | 191 | 239 | | 0 | 0 | 192 | 252 | 293* | |
| 27'-0" | | 50 | 88 | 126 | 143* | 161* | 4.443 | 68 | 115 | 171* | 183* | 192* | 2.734 |
| | | 0 | 0 | 0 | 170 | 215 | | 0 | 0 | 0 | 227 | 270* | |
| 28'-0" | | | 75 | 111 | 133* | 149* | 5.139 | 57 | 101 | 152 | 171* | 179* | 3.163 |
| | | | 0 | 0 | 152 | 193 | | 0 | 0 | 0 | 204 | 250* | |
| 29'-0" | | | 63 | 97 | 124* | 139* | 5.914 | 47 | 87 | 135 | 160* | 168* | 3.639 |
| | | | 0 | 0 | 135 | 174 | | 0 | 0 | 0 | 184 | 231* | |
| 30'-0" | | | 53 | 84 | 115* | 129* | 6.772 | | 75 | 120 | 150* | 157* | 4.168 |
| | | | 0 | 0 | 120 | 156 | | | 0 | 0 | 166 | 215* | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.50 | 0.62 | 0.77 | 0.97 | 1.83 | | 0.50 | 0.67 | 0.86 | 1.69 | 2.20 | |
| STEEL % (UNIFORM) | 0.75 | 0.94 | 1.17 | 1.46 | 2.78 | | 0.75 | 1.00 | 1.30 | 2.57 | 3.34 | |
| (TAPERED) | 0.45 | 0.56 | 0.70 | 0.87 | 1.66 | | 0.45 | 0.60 | 0.77 | 1.53 | 1.99 | |
| EFF. DEPTH, IN. | 11.25 | 11.25 | 11.19 | 11.19 | 11.12 | | 11.25 | 11.25 | 11.19 | 11.12 | 11.12 | |
| $-I_{cr}/I_{gr}$ | 0.192 | 0.227 | 0.263 | 0.308 | 0.461 | | 0.192 | 0.238 | 0.284 | 0.439 | 0.514 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.14 | 0.18 | 0.22 | 0.27 | 0.32 | | 0.11 | 0.14 | 0.18 | 0.22 | 0.27 | |
| EFF. DEPTH, IN. | 11.25 | 11.19 | 11.19 | 11.12 | 11.12 | | 11.25 | 11.25 | 11.19 | 11.19 | 11.12 | |
| $+I_{cr}/I_{gr}$ | 0.203 | 0.249 | 0.296 | 0.346 | 0.397 | | 0.161 | 0.203 | 0.249 | 0.296 | 0.346 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 20" Forms + 6" Rib @ 26" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 4.5″ Top Slab = 12.5″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 8.5 | # 4 7 | # 5 8.5 | # 5 7 | End Span Defl. Coeff. (3) | # 4 10 | # 4 8 | # 5 9.5 | # 5 7.5 | # 5 4 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.76 | 0.97 | 1.19 | 1.46 | 1.75 | | 0.81 | 1.04 | 1.33 | 1.68 | 2.57 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 17'-0" | | 253 | 345 | 356* | 367* | 381* | 0.726 | 298 | 404* | 410* | 421* | 465* | 0.447 |
| | | 0 | 0 | 439 | 527* | 541* | | 0 | 412 | 547 | 607* | 652* | |
| 18'-0" | | 215 | 297 | 325* | 334* | 346* | 0.913 | 255 | 357 | 376* | 385* | 424* | 0.562 |
| | | 0 | 0 | 381 | 476 | 495* | | 0 | 0 | 477 | 560* | 599* | |
| 19'-0" | | 182 | 257 | 297* | 305* | 315* | 1.133 | 219 | 310 | 346* | 354* | 389* | 0.697 |
| | | 0 | 0 | 332 | 417 | 456* | | 0 | 0 | 418 | 519* | 553* | |
| 20'-0" | | 155 | 222 | 273* | 280* | 289* | 1.391 | 188 | 270 | 320* | 327* | 358* | 0.856 |
| | | 0 | 0 | 290 | 367 | 422* | | 0 | 0 | 368 | 467 | 513* | |
| 21'-0" | | 131 | 192 | 252* | 257* | 265* | 1.691 | 161 | 236 | 296* | 303* | 330* | 1.041 |
| | | 0 | 0 | 254 | 323 | 392* | | 0 | 0 | 324 | 414 | 478* | |
| 22'-0" | | 111 | 166 | 222 | 238* | 245* | 2.037 | 138 | 206 | 276* | 281* | 306* | 1.254 |
| | | 0 | 0 | 0 | 286 | 351 | | 0 | 0 | 287 | 368 | 445* | |
| 23'-0" | | 93 | 144 | 195 | 220* | 227* | 2.433 | 118 | 180 | 254 | 262* | 284* | 1.497 |
| | | 0 | 0 | 0 | 253 | 313 | | 0 | 0 | 0 | 329 | 412* | |
| 24'-0" | | 77 | 124 | 171 | 204* | 210* | 2.885 | 100 | 158 | 225 | 245* | 265* | 1.775 |
| | | 0 | 0 | 0 | 224 | 279 | | 0 | 0 | 0 | 294 | 371 | |
| 25'-0" | | 64 | 106 | 150 | 190* | 195* | 3.397 | 85 | 137 | 200 | 229* | 247* | 2.090 |
| | | 0 | 0 | 0 | 199 | 249 | | 0 | 0 | 0 | 263 | 335 | |
| 26'-0" | | 51 | 91 | 131 | 177 | 182* | 3.974 | 71 | 120 | 177 | 214* | 231* | 2.445 |
| | | 0 | 0 | 0 | 0 | 223 | | 0 | 0 | 0 | 236 | 302 | |
| 27'-0" | | 40 | 77 | 114 | 157 | 169* | 4.621 | 59 | 104 | 157 | 201* | 216* | 2.844 |
| | | 0 | 0 | 0 | 0 | 200 | | 0 | 0 | 0 | 211 | 273 | |
| 28'-0" | | | 65 | 99 | 139 | 158* | 5.345 | 48 | 90 | 139 | 189* | 203* | 3.289 |
| | | | 0 | 0 | 0 | 179 | | 0 | 0 | 0 | 190 | 247 | |
| 29'-0" | | | 54 | 86 | 123 | 148* | 6.150 | | 77 | 123 | 170 | 191* | 3.785 |
| | | | 0 | 0 | 0 | 160 | | | 0 | 0 | 0 | 223 | |
| 30'-0" | | | 44 | 74 | 108 | 132+ | 7.043 | | 65 | 109 | 152 | 180* | 4.334 |
| | | | 0 | 0 | 0 | 143 | | | 0 | 0 | 0 | 202 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.47 | 0.61 | 0.74 | 0.95 | 1.15 | | 0.52 | 0.65 | 0.85 | 1.07 | 2.02 | |
| STEEL % (UNIFORM) | 0.61 | 0.78 | 0.95 | 1.22 | 1.48 | | 0.67 | 0.83 | 1.09 | 1.39 | 2.60 | |
| (TAPERED) | 0.38 | 0.50 | 0.60 | 0.78 | 0.94 | | 0.42 | 0.53 | 0.69 | 0.88 | 1.65 | |
| EFF. DEPTH, IN. | 11.25 | 11.25 | 11.25 | 11.19 | 11.19 | | 11.25 | 11.25 | 11.19 | 11.19 | 11.19 | |
| $-I_{cr}/I_{gr}$ | 0.168 | 0.205 | 0.238 | 0.281 | 0.323 | | 0.181 | 0.215 | 0.259 | 0.307 | 0.466 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.14 | 0.18 | 0.21 | 0.26 | 0.30 | | 0.11 | 0.14 | 0.18 | 0.21 | 0.26 | |
| EFF. DEPTH, IN. | 11.25 | 11.19 | 11.19 | 11.12 | 11.12 | | 11.25 | 11.25 | 11.19 | 11.19 | 11.12 | |
| $+I_{cr}/I_{gr}$ | 0.179 | 0.220 | 0.262 | 0.306 | 0.351 | | 0.142 | 0.179 | 0.220 | 0.262 | 0.306 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 4.5″ Top Slab = 14.5″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8 | # 5 10 | # 5 8 | # 5 7 | End Span Defl. Coeff. (3) | # 4 10 | # 4 7.5 | # 5 9 | # 5 7.5 | # 7 7.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.80 | 1.01 | 1.25 | 1.52 | 1.80 | | 0.82 | 1.10 | 1.39 | 1.71 | 2.68 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 19'-0" | | 243 | 333* | 341* | 354* | 364* | 1.090 | 287 | 388* | 394* | 402* | | 0.671 |
| | | 0 | 334 | 427 | 489* | 506* | | 0 | 399 | 533 | 590* | | |
| 20'-0" | | 209 | 292 | 312* | 324* | 333* | 1.338 | 249 | 351 | 364* | 371* | | 0.823 |
| | | 0 | 0 | 375 | 449* | 465* | | 0 | 0 | 471 | 541* | | |
| 21'-0" | | 180 | 255 | 288* | 298* | 305* | 1.626 | 217 | 308 | 337* | 343* | | 1.001 |
| | | 0 | 0 | 331 | 417 | 440* | | 0 | 0 | 417 | 494* | | |
| 22'-0" | | 155 | 223 | 265* | 275* | 281* | 1.959 | 188 | 272 | 313* | 319* | | 1.205 |
| | | 0 | 0 | 292 | 371 | 408* | | 0 | 0 | 371 | 448* | | |
| 23'-0" | | 133 | 195 | 246* | 254* | 260* | 2.340 | 164 | 240 | 291* | 297* | 321* | 1.440 |
| | | 0 | 0 | 259 | 331 | 379* | | 0 | 0 | 331 | 410* | 460* | |
| 24'-0" | | 114 | 171 | 228* | 236* | 241* | 2.774 | 142 | 212 | 272* | 277* | 298* | 1.707 |
| | | 0 | 0 | 229 | 295 | 353* | | 0 | 0 | 296 | 377* | 421* | |
| 25'-0" | | 97 | 150 | 203 | 219* | 224* | 3.266 | 123 | 187 | 255* | 259* | 278* | 2.010 |
| | | 0 | 0 | 0 | 264 | 326 | | 0 | 0 | 264 | 342 | 386* | |
| 26'-0" | | 82 | 131 | 180 | 204* | 208* | 3.821 | 106 | 166 | 237 | 243* | 260* | 2.351 |
| | | 0 | 0 | 0 | 237 | 294 | | 0 | 0 | 0 | 309 | 356* | |
| 27'-0" | | 68 | 114 | 160 | 190* | 194* | 4.443 | 91 | 146 | 212 | 228* | 244* | 2.734 |
| | | 0 | 0 | 0 | 212 | 265 | | 0 | 0 | 0 | 279 | 329* | |
| 28'-0" | | 56 | 99 | 141 | 178* | 182* | 5.139 | 77 | 129 | 190 | 214* | 229* | 3.163 |
| | | 0 | 0 | 0 | 190 | 239 | | 0 | 0 | 0 | 252 | 305* | |
| 29'-0" | | 46 | 85 | 125 | 166* | 170* | 5.914 | 65 | 113 | 170 | 201* | 215* | 3.639 |
| | | 0 | 0 | 0 | 170 | 216 | | 0 | 0 | 0 | 228 | 284* | |
| 30'-0" | | | 73 | 110 | 152 | 159* | 6.772 | 54 | 99 | 152 | 190* | 202* | 4.168 |
| | | | 0 | 0 | 0 | 195 | | 0 | 0 | 0 | 206 | 265* | |
| 31'-0" | | | 62 | 96 | 136 | 149* | 7.722 | 44 | 86 | 136 | 179* | 190* | 4.752 |
| | | | 0 | 0 | 0 | 176 | | 0 | 0 | 0 | 187 | 244 | |
| 32'-0" | | | 51 | 84 | 121 | 140* | 8.767 | | 74 | 121 | 169 | 180* | 5.395 |
| | | | 0 | 0 | 0 | 159 | | | 0 | 0 | 0 | 223 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.50 | 0.62 | 0.77 | 0.97 | 1.11 | | 0.50 | 0.67 | 0.86 | 1.03 | 2.00 | |
| STEEL % (UNIFORM) | 0.62 | 0.77 | 0.96 | 1.20 | 1.38 | | 0.62 | 0.82 | 1.07 | 1.28 | 2.51 | |
| (TAPERED) | 0.37 | 0.47 | 0.58 | 0.73 | 0.83 | | 0.37 | 0.50 | 0.65 | 0.78 | 1.52 | |
| EFF. DEPTH, IN. | 13.25 | 13.25 | 13.19 | 13.19 | 13.19 | | 13.25 | 13.25 | 13.19 | 13.19 | 13.06 | |
| $-I_{cr}/I_{gr}$ | 0.176 | 0.209 | 0.243 | 0.286 | 0.315 | | 0.176 | 0.220 | 0.263 | 0.300 | 0.455 | |
| POSITIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.12 | 0.15 | 0.19 | 0.23 | 0.27 | | 0.09 | 0.12 | 0.15 | 0.19 | 0.23 | |
| EFF. DEPTH, IN. | 13.25 | 13.19 | 13.19 | 13.12 | 13.12 | | 13.25 | 13.25 | 13.19 | 13.19 | 13.12 | |
| $+I_{cr}/I_{gr}$ | 0.182 | 0.224 | 0.267 | 0.313 | 0.359 | | 0.144 | 0.182 | 0.224 | 0.267 | 0.313 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 4.5″ Top Slab = 14.5″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 8.5 | # 4 7 | # 5 9 | # 5 7.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 8 | # 5 10 | # 5 8 | # 6 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.76 | 0.97 | 1.19 | 1.44 | 1.72 | | 0.77 | 1.04 | 1.30 | 1.62 | 2.00 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 19'-0" | | 225 | 313 | 381* | 388* | 400* | 1.133 | 268 | 376 | 439* | 448* | 457* | 0.697 |
| | | 0 | 0 | 402 | 504 | 553* | | 0 | 0 | 504 | 630* | 639* | |
| 20'-0" | | 192 | 272 | 351* | 357* | 367* | 1.391 | 231 | 328 | 406* | 415* | 422* | 0.856 |
| | | 0 | 0 | 352 | 444 | 509* | | 0 | 0 | 444 | 561 | 593* | |
| 21'-0" | | 164 | 237 | 310 | 329* | 338* | 1.691 | 200 | 288 | 377* | 384* | 391* | 1.041 |
| | | 0 | 0 | 0 | 393 | 477* | | 0 | 0 | 393 | 499 | 551* | |
| 22'-0" | | 140 | 206 | 272 | 304* | 312* | 2.037 | 172 | 253 | 348 | 358* | 363* | 1.254 |
| | | 0 | 0 | 0 | 348 | 425 | | 0 | 0 | 0 | 445 | 508* | |
| 23'-0" | | 119 | 179 | 240 | 282* | 290* | 2.433 | 149 | 222 | 310 | 334* | 339* | 1.497 |
| | | 0 | 0 | 0 | 310 | 380 | | 0 | 0 | 0 | 398 | 467* | |
| 24'-0" | | 101 | 156 | 212 | 263* | 269* | 2.885 | 128 | 195 | 276 | 312* | 317* | 1.775 |
| | | 0 | 0 | 0 | 276 | 340 | | 0 | 0 | 0 | 357 | 429* | |
| 25'-0" | | 84 | 135 | 187 | 245* | 251* | 3.397 | 109 | 172 | 246 | 293* | 296* | 2.090 |
| | | 0 | 0 | 0 | 246 | 305 | | 0 | 0 | 0 | 320 | 397* | |
| 26'-0" | | 70 | 117 | 165 | 219 | 234* | 3.974 | 93 | 151 | 219 | 275* | 278* | 2.445 |
| | | 0 | 0 | 0 | 0 | 274 | | 0 | 0 | 0 | 288 | 367 | |
| 27'-0" | | 57 | 101 | 145 | 195 | 219* | 4.621 | 78 | 132 | 195 | 258* | 261* | 2.844 |
| | | 0 | 0 | 0 | 0 | 246 | | 0 | 0 | 0 | 259 | 333 | |
| 28'-0" | | 46 | 86 | 127 | 174 | 205* | 5.345 | 65 | 115 | 174 | 234 | 246* | 3.289 |
| | | 0 | 0 | 0 | 0 | 222 | | 0 | 0 | 0 | 0 | 302 | |
| 29'-0" | | | 73 | 111 | 155 | 192* | 6.150 | 54 | 100 | 155 | 211 | 232* | 3.785 |
| | | | 0 | 0 | 0 | 199 | | 0 | 0 | 0 | 0 | 274 | |
| 30'-0" | | | 61 | 97 | 138 | 179 | 7.043 | 43 | 86 | 138 | 190 | 219* | 4.334 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 249 | |
| 31'-0" | | | 50 | 84 | 122 | 161 | 8.030 | | 74 | 122 | 171 | 207* | 4.942 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 226 | |
| 32'-0" | | | 41 | 72 | 108 | 145 | 9.118 | | 63 | 108 | 154 | 196* | 5.611 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 206 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF) (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.47 | 0.61 | 0.74 | 0.90 | 1.07 | | 0.47 | 0.65 | 0.81 | 1.01 | 1.27 | |
| STEEL % (UNIFORM) | 0.50 | 0.65 | 0.79 | 0.96 | 1.15 | | 0.50 | 0.69 | 0.86 | 1.08 | 1.37 | |
| (TAPERED) | 0.32 | 0.42 | 0.50 | 0.61 | 0.73 | | 0.32 | 0.44 | 0.55 | 0.69 | 0.87 | |
| EFF. DEPTH, IN. | 13.25 | 13.25 | 13.25 | 13.19 | 13.19 | | 13.25 | 13.25 | 13.19 | 13.19 | 13.12 | |
| $-I_{cr}/I_{gr}$ | 0.153 | 0.188 | 0.219 | 0.250 | 0.286 | | 0.153 | 0.198 | 0.231 | 0.273 | 0.319 | |
| POSITIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.12 | 0.15 | 0.18 | 0.22 | 0.26 | | 0.09 | 0.12 | 0.15 | 0.18 | 0.22 | |
| EFF. DEPTH, IN. | 13.25 | 13.19 | 13.19 | 13.12 | 13.12 | | 13.25 | 13.25 | 13.19 | 13.19 | 13.12 | |
| $+I_{cr}/I_{gr}$ | 0.161 | 0.198 | 0.236 | 0.277 | 0.318 | | 0.127 | 0.161 | 0.198 | 0.236 | 0.277 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth

| TOP BARS | Size @ | # 4 8 | # 5 10 | # 5 8.5 | # 5 7 | # 6 8 | End Span Defl. Coeff. (3) | # 4 8 | # 5 9.5 | # 5 7.5 | # 5 6 | # 7 6 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| Steel (psf) | | 1.01 | 1.25 | 1.50 | 1.80 | 2.14 | | 1.06 | 1.35 | 1.71 | 2.08 | 3.31 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 22'-0" | | 265 | 333* | 341* | 353* | 366* | 1.959 | 321 | 387* | 396* | 407* | | 1.205 |
| | | 0 | 345 | 436 | 472* | 497* | | 0 | 436 | 539* | 560* | | |
| 23'-0" | | 233 | 306 | 316* | 326* | 338* | 2.340 | 284 | 361* | 369* | 379* | 417* | 1.440 |
| | | 0 | 0 | 390 | 439* | 463* | | 0 | 389 | 493* | 511* | 576* | |
| 24'-0" | | 205 | 272 | 293* | 303* | 313* | 2.774 | 252 | 338* | 345* | 354* | 388* | 1.707 |
| | | 0 | 0 | 349 | 410* | 432* | | 0 | 348 | 446 | 470* | 533* | |
| 25'-0" | | 180 | 242 | 273* | 282* | 291* | 3.266 | 223 | 312 | 323* | 331* | 362* | 2.010 |
| | | 0 | 0 | 313 | 384* | 405* | | 0 | 0 | 402 | 434* | 491* | |
| 26'-0" | | 158 | 215 | 255* | 263* | 271* | 3.821 | 198 | 280 | 303* | 310* | 338* | 2.351 |
| | | 0 | 0 | 281 | 347 | 380* | | 0 | 0 | 364 | 402* | 453* | |
| 27'-0" | | 139 | 192 | 239* | 245* | 253* | 4.443 | 176 | 252 | 285* | 292* | 317* | 2.734 |
| | | 0 | 0 | 252 | 314 | 358* | | 0 | 0 | 329 | 374* | 419* | |
| 28'-0" | | 121 | 170 | 223* | 230* | 236* | 5.139 | 156 | 226 | 269* | 274* | 298* | 3.163 |
| | | 0 | 0 | 227 | 284 | 335* | | 0 | 0 | 298 | 349* | 389* | |
| 29'-0" | | 105 | 151 | 204 | 215* | 221* | 5.914 | 137 | 204 | 253* | 259* | 280* | 3.639 |
| | | 0 | 0 | 0 | 257 | 311* | | 0 | 0 | 270 | 326* | 362* | |
| 30'-0" | | 91 | 134 | 183 | 202* | 208* | 6.772 | 121 | 183 | 239* | 244* | 264* | 4.168 |
| | | 0 | 0 | 0 | 233 | 290* | | 0 | 0 | 245 | 306* | 338* | |
| 31'-0" | | 78 | 119 | 165 | 190* | 195* | 7.722 | 106 | 164 | 223 | 231* | 249* | 4.752 |
| | | 0 | 0 | 0 | 211 | 267 | | 0 | 0 | 0 | 287* | 316* | |
| 32'-0" | | 67 | 104 | 148 | 179* | 184* | 8.767 | 93 | 147 | 202 | 218* | 235* | 5.395 |
| | | 0 | 0 | 0 | 192 | 244 | | 0 | 0 | 0 | 265 | 297* | |
| 33'-0" | | 56 | 92 | 132 | 169* | 173* | 9.915 | 81 | 132 | 184 | 207* | 222* | 6.102 |
| | | 0 | 0 | 0 | 174 | 223 | | 0 | 0 | 0 | 243 | 279* | |
| 34'-0" | | 46 | 80 | 118 | 157 | 163* | 11.173 | 70 | 118 | 167 | 196* | 211* | 6.876 |
| | | 0 | 0 | 0 | 0 | 203 | | 0 | 0 | 0 | 222 | 262* | |
| 35'-0" | | | 69 | 105 | 142 | 153* | 12.547 | 60 | 105 | 151 | 186* | 200* | 7.721 |
| | | | 0 | 0 | 0 | 186 | | 0 | 0 | 0 | 204 | 247* | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 0.77 | 0.91 | 1.11 | 1.38 | | 0.62 | 0.82 | 1.03 | 1.29 | 2.50 | |
| STEEL % (UNIFORM) | 0.65 | 0.81 | 0.96 | 1.16 | 1.45 | | 0.65 | 0.86 | 1.09 | 1.36 | 2.65 | |
| (TAPERED) | 0.40 | 0.50 | 0.58 | 0.71 | 0.89 | | 0.40 | 0.52 | 0.66 | 0.83 | 1.62 | |
| EFF. DEPTH, IN. | 15.25 | 15.19 | 15.19 | 15.19 | 15.12 | | 15.25 | 15.19 | 15.19 | 15.19 | 15.06 | |
| $-I_{cr}/I_{gr}$ | 0.193 | 0.226 | 0.255 | 0.294 | 0.339 | | 0.193 | 0.235 | 0.280 | 0.328 | 0.496 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | |
| STEEL % | 0.13 | 0.16 | 0.20 | 0.23 | 0.28 | | 0.10 | 0.13 | 0.16 | 0.20 | 0.23 | |
| EFF. DEPTH, IN. | 15.19 | 15.19 | 15.12 | 15.12 | 15.06 | | 15.25 | 15.19 | 15.19 | 15.12 | 15.12 | |
| $+I_{cr}/I_{gr}$ | 0.203 | 0.242 | 0.285 | 0.328 | 0.376 | | 0.164 | 0.203 | 0.242 | 0.285 | 0.328 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth

| TOP BARS | Size @ | # 4 8 | # 4 7 | # 5 9 | # 5 7.5 | # 6 9 | End Span Defl. Coeff. (3) | # 4 8 | # 5 10 | # 5 8 | # 6 9 | # 7 10 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| Steel (psf) | | 0.98 | 1.19 | 1.44 | 1.72 | 2.02 | | 1.04 | 1.30 | 1.62 | 2.00 | 2.44 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 22'-0" | | 245 | 321 | 378* | 388* | 396* | 2.037 | 298 | 409 | 441* | 448* | | 1.254 |
| | | 0 | 0 | 410 | 499 | 529* | | 0 | 0 | 521 | 606* | | |
| 23'-0" | | 214 | 284 | 351* | 360* | 367* | 2.433 | 263 | 364 | 412* | 418* | 425* | 1.497 |
| | | 0 | 0 | 365 | 447 | 493* | | 0 | 0 | 466 | 559* | 573* | |
| 24'-0" | | 187 | 251 | 325 | 335* | 341* | 2.885 | 232 | 325 | 385* | 391* | 397* | 1.775 |
| | | 0 | 0 | 0 | 401 | 460* | | 0 | 0 | 419 | 514* | 528* | |
| 25'-0" | | 163 | 223 | 291 | 312* | 318* | 3.397 | 205 | 290 | 362* | 367* | 372* | 2.090 |
| | | 0 | 0 | 0 | 360 | 431* | | 0 | 0 | 377 | 476* | 488* | |
| 26'-0" | | 142 | 197 | 260 | 292* | 297* | 3.974 | 180 | 260 | 340 | 344* | 349* | 2.445 |
| | | 0 | 0 | 0 | 324 | 400 | | 0 | 0 | 0 | 431 | 452* | |
| 27'-0" | | 123 | 174 | 233 | 273* | 278* | 4.621 | 159 | 232 | 306 | 324* | 329* | 2.844 |
| | | 0 | 0 | 0 | 292 | 363 | | 0 | 0 | 0 | 391 | 421* | |
| 28'-0" | | 106 | 154 | 208 | 256* | 261* | 5.345 | 139 | 208 | 277 | 306* | 310* | 3.289 |
| | | 0 | 0 | 0 | 263 | 329 | | 0 | 0 | 0 | 356 | 393* | |
| 29'-0" | | 91 | 135 | 186 | 238 | 245* | 6.150 | 122 | 186 | 250 | 288* | 292* | 3.785 |
| | | 0 | 0 | 0 | 0 | 299 | | 0 | 0 | 0 | 324 | 368* | |
| 30'-0" | | 77 | 119 | 166 | 214 | 230* | 7.043 | 106 | 166 | 226 | 273* | 276* | 4.334 |
| | | 0 | 0 | 0 | 0 | 271 | | 0 | 0 | 0 | 295 | 345* | |
| 31'-0" | | 65 | 104 | 148 | 193 | 217* | 8.030 | 92 | 148 | 204 | 258* | 261* | 4.942 |
| | | 0 | 0 | 0 | 0 | 247 | | 0 | 0 | 0 | 269 | 324* | |
| 32'-0" | | 54 | 90 | 132 | 174 | 204* | 9.118 | 79 | 132 | 184 | 245* | 247* | 5.611 |
| | | 0 | 0 | 0 | 0 | 224 | | 0 | 0 | 0 | 0 | 305* | |
| 33'-0" | | 44 | 78 | 117 | 157 | 193* | 10.312 | 68 | 117 | 166 | 223 | 235* | 6.346 |
| | | 0 | 0 | 0 | 0 | 204 | | 0 | 0 | 0 | 0 | 281 | |
| 34'-0" | | | 67 | 104 | 141 | 182* | 11.620 | 57 | 103 | 150 | 204 | 223* | 7.151 |
| | | | 0 | 0 | 0 | 185 | | 0 | 0 | 0 | 0 | 258 | |
| 35'-0" | | | 56 | 91 | 126 | 168 | 13.049 | 47 | 91 | 135 | 186 | 212* | 8.030 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 237 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.74 | 0.90 | 1.07 | 1.27 | | 0.65 | 0.81 | 1.01 | 1.27 | 1.56 | |
| STEEL % (UNIFORM) | 0.59 | 0.67 | 0.81 | 0.97 | 1.16 | | 0.59 | 0.73 | 0.91 | 1.16 | 1.43 | |
| (TAPERED) | 0.38 | 0.43 | 0.52 | 0.63 | 0.75 | | 0.38 | 0.47 | 0.59 | 0.75 | 0.92 | |
| EFF. DEPTH, IN. | 15.25 | 15.25 | 15.19 | 15.19 | 15.12 | | 15.25 | 15.19 | 15.19 | 15.12 | 15.06 | |
| $-I_{cr}/I_{gr}$ | 0.182 | 0.203 | 0.232 | 0.266 | 0.298 | | 0.182 | 0.214 | 0.254 | 0.298 | 0.342 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | |
| STEEL % | 0.13 | 0.16 | 0.19 | 0.22 | 0.27 | | 0.10 | 0.13 | 0.16 | 0.19 | 0.22 | |
| EFF. DEPTH, IN. | 15.19 | 15.19 | 15.12 | 15.12 | 15.06 | | 15.25 | 15.19 | 15.19 | 15.12 | 15.12 | |
| $+I_{cr}/I_{gr}$ | 0.180 | 0.215 | 0.253 | 0.291 | 0.334 | | 0.146 | 0.180 | 0.215 | 0.253 | 0.291 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 5.0″ Top Slab = 13.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 10 | # 4 8 | # 5 10 | # 5 8 | End Span Defl. Coeff. (3) | # 4 11 | # 4 10 | # 4 7.5 | # 5 9 | # 5 7 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | |
| Steel (psf) | | 0.64 | 0.80 | 1.01 | 1.25 | 1.52 | | 0.68 | 0.82 | 1.10 | 1.39 | 1.77 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 17'-0" | | 194 | 279 | 326* | 334* | 349* | 0.698 | 206 | 329 | 377* | 384* | 397* | 0.430 |
| | | 0 | 0 | 380 | 482 | 513* | | 0 | 0 | 453 | 584* | 596* | |
| 18'-0" | | 162 | 238 | 296* | 303* | 315* | 0.878 | 173 | 282 | 345* | 351* | 362* | 0.540 |
| | | 0 | 0 | 328 | 419 | 465* | | 0 | 0 | 393 | 524 | 549* | |
| 19'-0" | | 135 | 203 | 270* | 276* | 287* | 1.090 | 145 | 243 | 317* | 322* | 332* | 0.671 |
| | | 0 | 0 | 284 | 365 | 424* | | 0 | 0 | 342 | 459 | 506* | |
| 20'-0" | | 112 | 173 | 246 | 252* | 262* | 1.338 | 121 | 209 | 292* | 296* | 305* | 0.823 |
| | | 0 | 0 | 0 | 320 | 388* | | 0 | 0 | 299 | 405 | 464* | |
| 21'-0" | | 92 | 148 | 214 | 231* | 240* | 1.626 | 100 | 180 | 261 | 274* | 281* | 1.001 |
| | | 0 | 0 | 0 | 281 | 357 | | 0 | 0 | 0 | 357 | 422* | |
| 22'-0" | | 75 | 125 | 186 | 213* | 220* | 1.959 | 82 | 155 | 229 | 253* | 261* | 1.205 |
| | | 0 | 0 | 0 | 247 | 316 | | 0 | 0 | 0 | 317 | 382* | |
| 23'-0" | | 60 | 106 | 161 | 196* | 203* | 2.340 | 66 | 133 | 201 | 235* | 242* | 1.440 |
| | | 0 | 0 | 0 | 217 | 280 | | 0 | 0 | 0 | 281 | 347* | |
| 24'-0" | | 46 | 89 | 140 | 181* | 187* | 2.774 | 52 | 114 | 176 | 219* | 225* | 1.707 |
| | | 0 | 0 | 0 | 191 | 249 | | 0 | 0 | 0 | 250 | 318* | |
| 25'-0" | | | 74 | 121 | 168 | 173* | 3.266 | 40 | 97 | 154 | 204* | 209* | 2.010 |
| | | | 0 | 0 | 0 | 221 | | 0 | 0 | 0 | 222 | 291 | |
| 26'-0" | | | 61 | 104 | 147 | 161* | 3.821 | | 82 | 135 | 191* | 195* | 2.351 |
| | | | 0 | 0 | 0 | 197 | | | 0 | 0 | 198 | 261 | |
| 27'-0" | | | 49 | 89 | 129 | 149* | 4.443 | | 69 | 118 | 176 | 183* | 2.734 |
| | | | 0 | 0 | 0 | 175 | | | 0 | 0 | 0 | 235 | |
| 28'-0" | | | | 75 | 113 | 139* | 5.139 | | 57 | 102 | 156 | 171* | 3.163 |
| | | | | 0 | 0 | 156 | | | 0 | 0 | 0 | 211 | |
| 29'-0" | | | | 63 | 98 | 129* | 5.914 | | 46 | 88 | 139 | 160* | 3.639 |
| | | | | 0 | 0 | 138 | | | 0 | 0 | 0 | 190 | |
| 30'-0" | | | | 52 | 85 | 120* | 6.772 | | | 76 | 123 | 150* | 4.168 |
| | | | | 0 | 0 | 122 | | | | 0 | 0 | 171 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.45 | 0.50 | 0.62 | 0.77 | 0.97 | | 0.45 | 0.50 | 0.67 | 0.86 | 1.11 | |
| STEEL % (UNIFORM) | 0.65 | 0.71 | 0.89 | 1.11 | 1.39 | | 0.65 | 0.71 | 0.95 | 1.23 | 1.59 | |
| (TAPERED) | 0.39 | 0.43 | 0.53 | 0.66 | 0.83 | | 0.39 | 0.43 | 0.57 | 0.74 | 0.95 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.75 | 11.69 | 11.69 | | 11.75 | 11.75 | 11.75 | 11.69 | 11.69 | |
| $-I_{cr}/I_{gr}$ | 0.174 | 0.187 | 0.222 | 0.257 | 0.302 | | 0.174 | 0.187 | 0.233 | 0.278 | 0.331 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.11 | 0.14 | 0.17 | 0.21 | 0.26 | | 0.07 | 0.11 | 0.14 | 0.17 | 0.21 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | | 11.81 | 11.75 | 11.75 | 11.69 | 11.69 | |
| $+I_{cr}/I_{gr}$ | 0.156 | 0.197 | 0.242 | 0.288 | 0.336 | | 0.115 | 0.156 | 0.197 | 0.242 | 0.288 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 5.0″ Top Slab = 13.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 8.5 | # 4 7 | # 5 8.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 10 | # 4 8 | # 5 9.5 | # 5 7.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | |
| Steel (psf) | | 0.63 | 0.76 | 0.97 | 1.19 | 1.46 | | 0.67 | 0.81 | 1.04 | 1.33 | 1.68 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 17'-0" | | 179 | 261 | 358 | 376* | 387* | 0.726 | 191 | 309 | 426* | 432* | 443* | 0.447 |
| | | 0 | 0 | 0 | 456 | 551* | | 0 | 0 | 428 | 569 | 635* | |
| 18'-0" | | 148 | 221 | 308 | 342* | 351* | 0.913 | 159 | 264 | 370 | 396* | 406* | 0.562 |
| | | 0 | 0 | 0 | 396 | 495 | | 0 | 0 | 0 | 496 | 586* | |
| 19'-0" | | 122 | 188 | 266 | 312* | 321* | 1.133 | 132 | 226 | 322 | 364* | 373* | 0.697 |
| | | 0 | 0 | 0 | 344 | 434 | | 0 | 0 | 0 | 434 | 542* | |
| 20'-0" | | 100 | 159 | 229 | 287* | 294* | 1.391 | 108 | 194 | 280 | 336* | 344* | 0.856 |
| | | 0 | 0 | 0 | 300 | 381 | | 0 | 0 | 0 | 382 | 485 | |
| 21'-0" | | 81 | 135 | 198 | 263 | 270* | 1.691 | 88 | 166 | 244 | 311* | 318* | 1.041 |
| | | 0 | 0 | 0 | 0 | 336 | | 0 | 0 | 0 | 336 | 430 | |
| 22'-0" | | 64 | 113 | 171 | 230 | 249* | 2.037 | 71 | 142 | 213 | 289* | 295* | 1.254 |
| | | 0 | 0 | 0 | 0 | 296 | | 0 | 0 | 0 | 297 | 382 | |
| 23'-0" | | 50 | 95 | 148 | 201 | 231* | 2.433 | 56 | 121 | 186 | 263 | 275* | 1.497 |
| | | 0 | 0 | 0 | 0 | 262 | | 0 | 0 | 0 | 0 | 341 | |
| 24'-0" | | | 78 | 127 | 176 | 214* | 2.885 | 43 | 102 | 162 | 233 | 256* | 1.775 |
| | | | 0 | 0 | 0 | 232 | | 0 | 0 | 0 | 0 | 304 | |
| 25'-0" | | | 64 | 109 | 154 | 199* | 3.397 | | 86 | 141 | 206 | 240* | 2.090 |
| | | | 0 | 0 | 0 | 206 | | | 0 | 0 | 0 | 272 | |
| 26'-0" | | | 51 | 92 | 134 | 182 | 3.974 | | 71 | 122 | 183 | 224* | 2.445 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 244 | |
| 27'-0" | | | | 78 | 117 | 161 | 4.621 | | 58 | 106 | 162 | 210* | 2.844 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 218 | |
| 28'-0" | | | | 65 | 101 | 142 | 5.345 | | 47 | 91 | 143 | 196 | 3.289 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 53 | 87 | 126 | 6.150 | | | 77 | 126 | 175 | 3.785 |
| | | | | 0 | 0 | 0 | | | | 0 | 0 | 0 | |
| 30'-0" | | | | 43 | 75 | 110 | 7.043 | | | 65 | 111 | 157 | 4.334 |
| | | | | 0 | 0 | 0 | | | | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.47 | 0.47 | 0.61 | 0.74 | 0.95 | | 0.47 | 0.52 | 0.65 | 0.85 | 1.07 | |
| STEEL % (UNIFORM) | 0.58 | 0.58 | 0.75 | 0.91 | 1.16 | | 0.58 | 0.63 | 0.79 | 1.04 | 1.32 | |
| (TAPERED) | 0.37 | 0.37 | 0.47 | 0.58 | 0.74 | | 0.37 | 0.40 | 0.50 | 0.66 | 0.84 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.75 | 11.75 | 11.69 | | 11.75 | 11.75 | 11.75 | 11.69 | 11.69 | |
| $-I_{cr}/I_{gr}$ | 0.164 | 0.164 | 0.201 | 0.233 | 0.276 | | 0.164 | 0.177 | 0.210 | 0.254 | 0.302 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.10 | 0.13 | 0.17 | 0.20 | 0.25 | | 0.07 | 0.10 | 0.13 | 0.17 | 0.20 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | | 11.81 | 11.75 | 11.75 | 11.69 | 11.69 | |
| $+I_{cr}/I_{gr}$ | 0.138 | 0.174 | 0.214 | 0.255 | 0.298 | | 0.102 | 0.138 | 0.174 | 0.214 | 0.255 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 5.0″ Top Slab = 15.0″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8 | # 5 10 | # 5 8.5 | # 5 7 | End Span Defl. Coeff. (3) | # 4 10 | # 4 8 | # 5 9.5 | # 5 7.5 | # 6 6 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.80 | 1.01 | 1.25 | 1.50 | 1.80 | | 0.82 | 1.06 | 1.35 | 1.71 | 2.54 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 19'-0" | | 247 | 343 | 355* | 365* | 380* | 1.090 | | | | | 456* | 0.671 |
| | | 0 | 0 | 439 | 503* | 520* | | | | | | 648* | |
| 20'-0" | | 212 | 298 | 325* | 334* | 346* | 1.338 | 254 | 359 | 377* | 386* | 418* | 0.823 |
| | | 0 | 0 | 385 | 462* | 477* | | 0 | 0 | 484 | 561* | 600* | |
| 21'-0" | | 182 | 260 | 299* | 306* | 318* | 1.626 | 220 | 316 | 348* | 357* | 385* | 1.001 |
| | | 0 | 0 | 339 | 429 | 451* | | 0 | 0 | 429 | 512* | 556* | |
| 22'-0" | | 156 | 227 | 275* | 282* | 292* | 1.959 | 191 | 278 | 323* | 331* | 356* | 1.205 |
| | | 0 | 0 | 299 | 381 | 417* | | 0 | 0 | 381 | 464* | 513* | |
| 23'-0" | | 134 | 199 | 255* | 261* | 270* | 2.340 | 165 | 245 | 301* | 308* | 331* | 1.440 |
| | | 0 | 0 | 264 | 339 | 387* | | 0 | 0 | 339 | 424* | 471* | |
| 24'-0" | | 114 | 173 | 234 | 242* | 250* | 2.774 | 143 | 216 | 281* | 287* | 308* | 1.707 |
| | | 0 | 0 | 0 | 302 | 361* | | 0 | 0 | 302 | 389* | 430* | |
| 25'-0" | | 96 | 151 | 207 | 224* | 231* | 3.266 | 123 | 190 | 263* | 268* | 287* | 2.010 |
| | | 0 | 0 | 0 | 270 | 335 | | 0 | 0 | 270 | 351 | 394* | |
| 26'-0" | | 80 | 131 | 183 | 209* | 215* | 3.821 | 105 | 167 | 241 | 251* | 268* | 2.351 |
| | | 0 | 0 | 0 | 241 | 301 | | 0 | 0 | 0 | 316 | 363* | |
| 27'-0" | | 67 | 114 | 161 | 195* | 200* | 4.443 | 90 | 147 | 216 | 235* | 251* | 2.734 |
| | | 0 | 0 | 0 | 216 | 271 | | 0 | 0 | 0 | 285 | 336* | |
| 28'-0" | | 54 | 98 | 142 | 182* | 187* | 5.139 | 76 | 129 | 193 | 221* | 235* | 3.163 |
| | | 0 | 0 | 0 | 193 | 244 | | 0 | 0 | 0 | 257 | 312* | |
| 29'-0" | | 43 | 84 | 125 | 170* | 175* | 5.914 | 63 | 113 | 172 | 208* | 221* | 3.639 |
| | | 0 | 0 | 0 | 172 | 220 | | 0 | 0 | 0 | 232 | 290* | |
| 30'-0" | | | 71 | 110 | 154 | 163* | 6.772 | 51 | 98 | 154 | 196* | 208* | 4.168 |
| | | | 0 | 0 | 0 | 198 | | 0 | 0 | 0 | 210 | 270* | |
| 31'-0" | | | 59 | 96 | 137 | 153* | 7.722 | 41 | 85 | 137 | 184* | 195* | 4.752 |
| | | | 0 | 0 | 0 | 179 | | 0 | 0 | 0 | 189 | 249 | |
| 32'-0" | | | 49 | 83 | 122 | 143* | 8.767 | | 73 | 122 | 171 | 184* | 5.395 |
| | | | 0 | 0 | 0 | 161 | | | 0 | 0 | 0 | 227 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.50 | 0.62 | 0.77 | 0.91 | 1.11 | | 0.50 | 0.62 | 0.82 | 1.03 | 1.83 | |
| STEEL % (UNIFORM) | 0.59 | 0.74 | 0.92 | 1.08 | 1.32 | | 0.59 | 0.74 | 0.97 | 1.23 | 2.19 | |
| (TAPERED) | 0.36 | 0.45 | 0.56 | 0.66 | 0.80 | | 0.36 | 0.45 | 0.59 | 0.74 | 1.33 | |
| EFF. DEPTH, IN. | 13.75 | 13.75 | 13.69 | 13.69 | 13.69 | | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | |
| $-I_{cr}/I_{gr}$ | 0.172 | 0.205 | 0.239 | 0.269 | 0.309 | | 0.172 | 0.205 | 0.248 | 0.295 | 0.430 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.12 | 0.15 | 0.18 | 0.22 | 0.26 | | 0.09 | 0.12 | 0.15 | 0.18 | 0.22 | |
| EFF. DEPTH, IN. | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | |
| $+I_{cr}/I_{gr}$ | 0.177 | 0.219 | 0.260 | 0.305 | 0.351 | | 0.140 | 0.177 | 0.219 | 0.260 | 0.305 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 5.0″ Top Slab = 15.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 8.5 | # 4 7 | # 5 9 | # 5 7.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 8 | # 5 10 | # 5 8 | # 6 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.76 | 0.97 | 1.19 | 1.44 | 1.72 | | 0.77 | 1.04 | 1.30 | 1.62 | 2.00 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 19'-0" | | 230 | 322 | 398* | 406* | 419* | 1.133 | | | | | 478* | 0.697 |
| | | 0 | 0 | 414 | 520 | 571* | | | | | | 663* | |
| 20'-0" | | 197 | 279 | 363 | 373* | 384* | 1.391 | 237 | 338 | 424* | 433* | 441* | 0.856 |
| | | 0 | 0 | 0 | 458 | 524* | | 0 | 0 | 458 | 580 | 616* | |
| 21'-0" | | 168 | 243 | 318 | 343* | 353* | 1.691 | 204 | 296 | 394* | 401* | 408* | 1.041 |
| | | 0 | 0 | 0 | 405 | 491* | | 0 | 0 | 405 | 515 | 572* | |
| 22'-0" | | 143 | 211 | 280 | 317* | 326* | 2.037 | 176 | 259 | 359 | 373* | 379* | 1.254 |
| | | 0 | 0 | 0 | 359 | 439 | | 0 | 0 | 0 | 459 | 528* | |
| 23'-0" | | 121 | 183 | 246 | 294* | 302* | 2.433 | 151 | 228 | 318 | 348* | 353* | 1.497 |
| | | 0 | 0 | 0 | 319 | 392 | | 0 | 0 | 0 | 410 | 485* | |
| 24'-0" | | 101 | 159 | 217 | 273* | 280* | 2.885 | 130 | 200 | 283 | 325* | 330* | 1.775 |
| | | 0 | 0 | 0 | 283 | 351 | | 0 | 0 | 0 | 368 | 446* | |
| 25'-0" | | 85 | 137 | 191 | 252 | 261* | 3.397 | 110 | 175 | 252 | 305* | 309* | 2.090 |
| | | 0 | 0 | 0 | 0 | 314 | | 0 | 0 | 0 | 330 | 411* | |
| 26'-0" | | 70 | 118 | 168 | 224 | 243* | 3.974 | 93 | 153 | 224 | 286* | 289* | 2.445 |
| | | 0 | 0 | 0 | 0 | 282 | | 0 | 0 | 0 | 296 | 378 | |
| 27'-0" | | 56 | 101 | 147 | 200 | 227* | 4.621 | 78 | 134 | 200 | 266 | 272* | 2.844 |
| | | 0 | 0 | 0 | 0 | 253 | | 0 | 0 | 0 | 0 | 343 | |
| 28'-0" | | 44 | 86 | 129 | 178 | 213* | 5.345 | 65 | 116 | 178 | 240 | 256* | 3.289 |
| | | 0 | 0 | 0 | 0 | 227 | | 0 | 0 | 0 | 0 | 311 | |
| 29'-0" | | | 73 | 112 | 158 | 199* | 6.150 | 53 | 101 | 158 | 216 | 241* | 3.785 |
| | | | 0 | 0 | 0 | 204 | | 0 | 0 | 0 | 0 | 282 | |
| 30'-0" | | | 60 | 98 | 140 | 183 | 7.043 | 42 | 87 | 140 | 194 | 227* | 4.334 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 256 | |
| 31'-0" | | | 49 | 84 | 124 | 164 | 8.030 | | 74 | 124 | 174 | 215* | 4.942 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 232 | |
| 32'-0" | | | | 72 | 109 | 147 | 9.118 | | 62 | 109 | 157 | 203* | 5.611 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 211 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.47 | 0.61 | 0.74 | 0.90 | 1.07 | | 0.47 | 0.65 | 0.81 | 1.01 | 1.27 | |
| STEEL % (UNIFORM) | 0.48 | 0.62 | 0.76 | 0.92 | 1.10 | | 0.48 | 0.66 | 0.82 | 1.03 | 1.31 | |
| (TAPERED) | 0.31 | 0.40 | 0.48 | 0.59 | 0.70 | | 0.31 | 0.42 | 0.53 | 0.66 | 0.84 | |
| EFF. DEPTH, IN. | 13.75 | 13.75 | 13.75 | 13.69 | 13.69 | | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | |
| $-I_{cr}/I_{gr}$ | 0.150 | 0.184 | 0.215 | 0.245 | 0.280 | | 0.150 | 0.193 | 0.226 | 0.267 | 0.313 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.11 | 0.14 | 0.17 | 0.21 | 0.25 | | 0.09 | 0.11 | 0.14 | 0.17 | 0.21 | |
| EFF. DEPTH, IN. | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | |
| $+I_{cr}/I_{gr}$ | 0.157 | 0.193 | 0.231 | 0.270 | 0.311 | | 0.124 | 0.157 | 0.193 | 0.231 | 0.270 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 5" Rib @ 25" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 5.0″ Top Slab = 17.0″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8 | # 5 10 | # 5 8.5 | # 5 7 | End Span Defl. Coeff. (3) | # 4 10 | # 4 8 | # 5 9.5 | # 5 7.5 | # 5 6 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.80 | 1.01 | 1.25 | 1.50 | 1.80 | | 0.82 | 1.06 | 1.35 | 1.71 | 2.08 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 22'-0" | | 187 | 269 | 344* | 353* | 365* | 1.959 | 227 | | 401* | | 421* | 1.205 |
| | | 0 | 0 | 352 | 446 | 482* | | 0 | | 445 | | 577* | |
| 23'-0" | | 161 | 236 | 311 | 327* | 337* | 2.340 | 197 | 289 | 374* | 382* | 392* | 1.440 |
| | | 0 | 0 | 0 | 398 | 448* | | 0 | 0 | 397 | 507 | 527* | |
| 24'-0" | | 138 | 207 | 276 | 303* | 313* | 2.774 | 172 | 255 | 349* | 357* | 366* | 1.707 |
| | | 0 | 0 | 0 | 356 | 418* | | 0 | 0 | 355 | 456 | 484* | |
| 25'-0" | | 118 | 181 | 245 | 282* | 291* | 3.266 | 149 | 226 | 318 | 334* | 342* | 2.010 |
| | | 0 | 0 | 0 | 319 | 391* | | 0 | 0 | 0 | 411 | 447* | |
| 26'-0" | | 100 | 159 | 218 | 263* | 271* | 3.821 | 129 | 200 | 285 | 313* | 320* | 2.351 |
| | | 0 | 0 | 0 | 286 | 354 | | 0 | 0 | 0 | 371 | 414* | |
| 27'-0" | | 84 | 138 | 193 | 245* | 253* | 4.443 | 111 | 177 | 256 | 294* | 301* | 2.734 |
| | | 0 | 0 | 0 | 256 | 320 | | 0 | 0 | 0 | 335 | 384* | |
| 28'-0" | | 70 | 120 | 171 | 230* | 236* | 5.139 | 94 | 156 | 229 | 277* | 283* | 3.163 |
| | | 0 | 0 | 0 | 0 | 289 | | 0 | 0 | 0 | 303 | 358* | |
| 29'-0" | | 57 | 104 | 152 | 206 | 221* | 5.914 | 80 | 137 | 206 | 261* | 266* | 3.639 |
| | | 0 | 0 | 0 | 0 | 261 | | 0 | 0 | 0 | 275 | 335* | |
| 30'-0" | | 46 | 89 | 134 | 185 | 207* | 6.772 | 67 | 120 | 184 | 246* | 251* | 4.168 |
| | | 0 | 0 | 0 | 0 | 236 | | 0 | 0 | 0 | 249 | 314* | |
| 31'-0" | | | 76 | 118 | 166 | 195* | 7.722 | 55 | 105 | 165 | 226 | 237* | 4.752 |
| | | | 0 | 0 | 0 | 214 | | 0 | 0 | 0 | 0 | 294* | |
| 32'-0" | | | 64 | 103 | 148 | 183* | 8.767 | 44 | 91 | 148 | 204 | 224* | 5.395 |
| | | | 0 | 0 | 0 | 193 | | 0 | 0 | 0 | 0 | 270 | |
| 33'-0" | | | 53 | 90 | 132 | 172* | 9.915 | | 79 | 132 | 185 | 212* | 6.102 |
| | | | 0 | 0 | 0 | 175 | | | 0 | 0 | 0 | 246 | |
| 34'-0" | | | 43 | 78 | 117 | 158 | 11.173 | | 67 | 117 | 167 | 201* | 6.876 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 225 | |
| 35'-0" | | | | 67 | 104 | 142 | 12.547 | | 57 | 104 | 151 | 190* | 7.721 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 206 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF) (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.50 | 0.62 | 0.77 | 0.91 | 1.11 | | 0.50 | 0.62 | 0.82 | 1.03 | 1.29 | |
| STEEL % (UNIFORM) | 0.50 | 0.63 | 0.78 | 0.92 | 1.12 | | 0.50 | 0.63 | 0.82 | 1.04 | 1.31 | |
| (TAPERED) | 0.31 | 0.38 | 0.48 | 0.56 | 0.68 | | 0.31 | 0.38 | 0.50 | 0.64 | 0.80 | |
| EFF. DEPTH, IN. | 15.75 | 15.75 | 15.69 | 15.69 | 15.69 | | 15.75 | 15.75 | 15.69 | 15.69 | 15.69 | |
| $-I_{cr}/I_{gr}$ | 0.158 | 0.189 | 0.221 | 0.250 | 0.289 | | 0.158 | 0.189 | 0.230 | 0.275 | 0.322 | |
| POSITIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.10 | 0.13 | 0.16 | 0.19 | 0.23 | | 0.08 | 0.10 | 0.13 | 0.16 | 0.19 | |
| EFF. DEPTH, IN. | 15.75 | 15.69 | 15.69 | 15.62 | 15.62 | | 15.75 | 15.75 | 15.69 | 15.69 | 15.62 | |
| $+I_{cr}/I_{gr}$ | 0.160 | 0.199 | 0.237 | 0.278 | 0.320 | | 0.127 | 0.160 | 0.199 | 0.237 | 0.278 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 20" Forms + 6" Rib @ 26" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 5.0″ Top Slab = 17.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 8.5 | # 4 7 | # 5 9 | # 5 7.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 8.5 | # 5 10 | # 5 8 | # 6 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.76 | 0.97 | 1.19 | 1.44 | 1.72 | | 0.77 | 1.01 | 1.30 | 1.62 | 2.00 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 22'-0" | | 171 | 249 | 329 | 392* | 403* | 2.037 | 209 | | 419 | | 466* | 1.254 |
| | | 0 | 0 | 0 | 420 | 513 | | 0 | | 0 | | 626* | |
| 23'-0" | | 146 | 218 | 290 | 364* | 374* | 2.433 | 181 | 268 | 373 | 427* | 434* | 1.497 |
| | | 0 | 0 | 0 | 374 | 458 | | 0 | 0 | 0 | 479 | 577* | |
| 24'-0" | | 124 | 190 | 257 | 333 | 347* | 2.885 | 156 | 236 | 332 | 400* | 406* | 1.775 |
| | | 0 | 0 | 0 | 0 | 411 | | 0 | 0 | 0 | 430 | 531* | |
| 25'-0" | | 104 | 165 | 227 | 297 | 323* | 3.397 | 134 | 208 | 297 | 375* | 380* | 2.090 |
| | | 0 | 0 | 0 | 0 | 369 | | 0 | 0 | 0 | 386 | 489 | |
| 26'-0" | | 87 | 143 | 200 | 265 | 302* | 3.974 | 114 | 183 | 265 | 348 | 357* | 2.445 |
| | | 0 | 0 | 0 | 0 | 332 | | 0 | 0 | 0 | 0 | 443 | |
| 27'-0" | | 72 | 124 | 177 | 237 | 283* | 4.621 | 97 | 161 | 237 | 313 | 336* | 2.844 |
| | | 0 | 0 | 0 | 0 | 299 | | 0 | 0 | 0 | 0 | 401 | |
| 28'-0" | | 58 | 106 | 156 | 212 | 265* | 5.345 | 81 | 141 | 211 | 283 | 316* | 3.289 |
| | | 0 | 0 | 0 | 0 | 269 | | 0 | 0 | 0 | 0 | 365 | |
| 29'-0" | | 46 | 91 | 137 | 189 | 242 | 6.150 | 68 | 123 | 189 | 255 | 298* | 3.785 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 331 | |
| 30'-0" | | | 77 | 119 | 169 | 218 | 7.043 | 55 | 107 | 168 | 230 | 282* | 4.334 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 302 | |
| 31'-0" | | | 64 | 104 | 150 | 197 | 8.030 | 44 | 92 | 150 | 208 | 267* | 4.942 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 275 | |
| 32'-0" | | | 52 | 90 | 133 | 177 | 9.118 | | 79 | 133 | 187 | 250 | 5.611 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 33'-0" | | | 42 | 77 | 118 | 159 | 10.312 | | 66 | 117 | 169 | 228 | 6.346 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 34'-0" | | | | 66 | 104 | 142 | 11.620 | | 55 | 103 | 152 | 207 | 7.151 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 35'-0" | | | | 55 | 91 | 127 | 13.049 | | 45 | 91 | 136 | 189 | 8.030 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF) (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.47 | 0.61 | 0.74 | 0.90 | 1.07 | | 0.47 | 0.61 | 0.81 | 1.01 | 1.27 | |
| STEEL % (UNIFORM) | 0.41 | 0.53 | 0.64 | 0.78 | 0.94 | | 0.41 | 0.53 | 0.70 | 0.88 | 1.11 | |
| (TAPERED) | 0.27 | 0.34 | 0.42 | 0.50 | 0.61 | | 0.27 | 0.34 | 0.45 | 0.57 | 0.72 | |
| EFF. DEPTH, IN. | 15.75 | 15.75 | 15.75 | 15.69 | 15.69 | | 15.75 | 15.75 | 15.69 | 15.69 | 15.62 | |
| $-I_{cr}/I_{gr}$ | 0.138 | 0.170 | 0.198 | 0.227 | 0.261 | | 0.138 | 0.170 | 0.210 | 0.249 | 0.293 | |
| POSITIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.10 | 0.13 | 0.15 | 0.18 | 0.22 | | 0.08 | 0.10 | 0.13 | 0.15 | 0.18 | |
| EFF. DEPTH, IN. | 15.75 | 15.69 | 15.69 | 15.62 | 15.62 | | 15.75 | 15.75 | 15.69 | 15.69 | 15.62 | |
| $+I_{cr}/I_{gr}$ | 0.142 | 0.176 | 0.210 | 0.247 | 0.284 | | 0.112 | 0.142 | 0.176 | 0.210 | 0.247 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 3.0″ Top Slab = 11.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 11 | # 4 9 | # 5 7 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 10.5 | # 4 8 | # 4 4 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 3 | # 4 | # 4 | # 5 | # 5 | | # 3 | # 3 | # 4 | # 4 | # 5 | |
| | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| Steel (psf) | | 0.51 | 0.61 | 0.72 | 0.89 | 1.26 | | 0.59 | 0.67 | 0.78 | 1.00 | 1.63 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 14'-0" | | 194 | 244* | 244* | 253* | 302* | 0.450 | 205 | 275* | 277* | 286* | 327* | 0.277 |
| | | 0 | 269 | 357 | 399* | 411* | | 0 | 312 | 421 | 482* | 522* | |
| 15'-0" | | 161 | 217* | 217* | 225* | 266* | 0.593 | 170 | 248* | 249* | 257* | 291* | 0.365 |
| | | 0 | 226 | 302 | 365* | 380* | | 0 | 264 | 358 | 438* | 472* | |
| 16'-0" | | 133 | 191 | 195* | 201* | 236* | 0.767 | 142 | 224 | 225* | 232* | 261* | 0.472 |
| | | 0 | 0 | 258 | 325* | 338* | | 0 | 0 | 307 | 399* | 430* | |
| 17'-0" | | 111 | 161 | 176* | 181* | 211* | 0.978 | 118 | 191 | 205* | 211* | 236* | 0.602 |
| | | 0 | 0 | 221 | 282 | 304* | | 0 | 0 | 264 | 351 | 393* | |
| 18'-0" | | 92 | 137 | 159* | 164* | 189* | 1.229 | 98 | 163 | 187* | 192* | 215* | 0.756 |
| | | 0 | 0 | 190 | 244 | 275* | | 0 | 0 | 229 | 306 | 361* | |
| 19'-0" | | 76 | 116 | 145* | 149* | 171* | 1.525 | 81 | 140 | 171* | 176* | 196* | 0.939 |
| | | 0 | 0 | 164 | 213 | 251* | | 0 | 0 | 199 | 268 | 329* | |
| 20'-0" | | 62 | 98 | 132* | 136* | 156* | 1.873 | 67 | 120 | 158* | 162* | 180* | 1.153 |
| | | 0 | 0 | 142 | 185 | 229* | | 0 | 0 | 173 | 236 | 298* | |
| 21'-0" | | 50 | 83 | 121* | 125* | 142* | 2.276 | 55 | 103 | 146* | 149* | 165* | 1.401 |
| | | 0 | 0 | 122 | 162 | 207 | | 0 | 0 | 151 | 208 | 265 | |
| 22'-0" | | 40 | 70 | 106 | 114* | 130* | 2.742 | 44 | 88 | 132 | 138* | 152* | 1.687 |
| | | 0 | 0 | 0 | 142 | 183 | | 0 | 0 | 0 | 183 | 236 | |
| 23'-0" | | | 59 | 91 | 105* | 119* | 3.276 | | 75 | 115 | 128* | 141* | 2.016 |
| | | | 0 | 0 | 124 | 162 | | | 0 | 0 | 162 | 210 | |
| 24'-0" | | | 48 | 78 | 97* | 109* | 3.884 | | 63 | 100 | 119* | 130* | 2.390 |
| | | | 0 | 0 | 109 | 143 | | | 0 | 0 | 144 | 188 | |
| 25'-0" | | | 40 | 67 | 89* | 100* | 4.572 | | 53 | 87 | 110* | 121* | 2.814 |
| | | | 0 | 0 | 95 | 127 | | | 0 | 0 | 127 | 168 | |
| 26'-0" | | | | 57 | 82* | 93* | 5.349 | | 44 | 76 | 103* | 112* | 3.292 |
| | | | | 0 | 83 | 112 | | | 0 | 0 | 113 | 150 | |
| 27'-0" | | | | 48 | 72 | 85* | 6.221 | | | 65 | 96* | 105* | 3.828 |
| | | | | 0 | 0 | 99 | | | | 0 | 100 | 135 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.36 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.64 | 0.78 | 1.55 | | 0.64 | 0.64 | 0.67 | 0.88 | 1.75 | |
| STEEL % (UNIFORM) | 1.12 | 1.12 | 1.12 | 1.37 | 2.76 | | 1.12 | 1.12 | 1.18 | 1.54 | 3.09 | |
| (TAPERED) | 0.60 | 0.60 | 0.60 | 0.74 | 1.48 | | 0.60 | 0.60 | 0.63 | 0.83 | 1.66 | |
| EFF. DEPTH, IN. | 9.75 | 9.75 | 9.75 | 9.75 | 9.69 | | 9.75 | 9.75 | 9.75 | 9.75 | 9.75 | |
| $-I_{cr}/I_{gr}$ | 0.222 | 0.222 | 0.222 | 0.256 | 0.398 | | 0.222 | 0.222 | 0.230 | 0.278 | 0.434 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.09 | 0.12 | 0.15 | 0.18 | 0.22 | | 0.06 | 0.09 | 0.12 | 0.15 | 0.18 | |
| EFF. DEPTH, IN. | 9.75 | 9.75 | 9.69 | 9.69 | 9.62 | | 9.81 | 9.75 | 9.75 | 9.69 | 9.69 | |
| $+I_{cr}/I_{gr}$ | 0.164 | 0.207 | 0.254 | 0.303 | 0.353 | | 0.121 | 0.164 | 0.207 | 0.254 | 0.303 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 3.0″ Top Slab = 11.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 11 | # 4 9.5 | # 5 11 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 11 | # 4 8.5 | # 5 10.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 3 | # 4 | # 4 | # 5 | # 5 | | # 3 | # 3 | # 4 | # 4 | # 5 | |
| | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| Steel (psf) | | 0.50 | 0.60 | 0.71 | 0.86 | 1.07 | | 0.58 | 0.66 | 0.75 | 0.95 | 1.20 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 14'-0" | | 185 | 257 | 279* | 285* | 299* | 0.463 | 195 | 300 | 316* | 325* | 331* | 0.285 |
| | | 0 | 0 | 343 | 430 | 459* | | 0 | 0 | 405 | 515* | 520* | |
| 15'-0" | | 152 | 215 | 249* | 255* | 266* | 0.610 | 161 | 252 | 285* | 293* | 298* | 0.375 |
| | | 0 | 0 | 290 | 366 | 416* | | 0 | 0 | 344 | 452 | 473* | |
| 16'-0" | | 126 | 181 | 224* | 229* | 238* | 0.789 | 134 | 213 | 259* | 265* | 270* | 0.486 |
| | | 0 | 0 | 247 | 313 | 376* | | 0 | 0 | 294 | 390 | 432* | |
| 17'-0" | | 104 | 153 | 203* | 207* | 215* | 1.006 | 111 | 181 | 236* | 242* | 245* | 0.619 |
| | | 0 | 0 | 211 | 270 | 337 | | 0 | 0 | 253 | 337 | 397* | |
| 18'-0" | | 85 | 129 | 181 | 189* | 195* | 1.264 | 91 | 154 | 217* | 221* | 224* | 0.778 |
| | | 0 | 0 | 0 | 233 | 293 | | 0 | 0 | 218 | 294 | 364* | |
| 19'-0" | | 69 | 109 | 155 | 172* | 178* | 1.569 | 75 | 132 | 189 | 204* | 206* | 0.966 |
| | | 0 | 0 | 0 | 203 | 256 | | 0 | 0 | 0 | 257 | 325 | |
| 20'-0" | | 56 | 92 | 133 | 158* | 163* | 1.926 | 61 | 112 | 164 | 188* | 190* | 1.185 |
| | | 0 | 0 | 0 | 176 | 224 | | 0 | 0 | 0 | 225 | 287 | |
| 21'-0" | | 45 | 77 | 115 | 145* | 150* | 2.342 | 49 | 96 | 142 | 174* | 176* | 1.441 |
| | | 0 | 0 | 0 | 153 | 197 | | 0 | 0 | 0 | 198 | 254 | |
| 22'-0" | | | 64 | 99 | 134* | 138* | 2.820 | | 81 | 124 | 161* | 163* | 1.736 |
| | | | 0 | 0 | 0 | 174 | | | 0 | 0 | 174 | 225 | |
| 23'-0" | | | 53 | 84 | 117 | 127* | 3.369 | | 68 | 107 | 150* | 151* | 2.073 |
| | | | 0 | 0 | 0 | 153 | | | 0 | 0 | 154 | 201 | |
| 24'-0" | | | 43 | 72 | 102 | 117* | 3.995 | | 57 | 93 | 136 | 141* | 2.458 |
| | | | 0 | 0 | 0 | 135 | | | 0 | 0 | 0 | 179 | |
| 25'-0" | | | | 61 | 88 | 109* | 4.703 | | 47 | 81 | 120 | 131* | 2.894 |
| | | | | 0 | 0 | 119 | | | 0 | 0 | 0 | 159 | |
| 26'-0" | | | | 51 | 77 | 101* | 5.502 | | | 69 | 105 | 123* | 3.386 |
| | | | | 0 | 0 | 105 | | | | 0 | 0 | 142 | |
| 27'-0" | | | | 43 | 66 | 93 | 6.398 | | | 59 | 93 | 115* | 3.938 |
| | | | | 0 | 0 | 0 | | | | 0 | 0 | 127 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.37 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.65 | 0.76 | 1.01 | | 0.65 | 0.65 | 0.65 | 0.85 | 1.06 | |
| STEEL % (UNIFORM) | 0.99 | 0.99 | 0.99 | 1.14 | 1.54 | | 0.99 | 0.99 | 0.99 | 1.28 | 1.61 | |
| (TAPERED) | 0.57 | 0.57 | 0.57 | 0.66 | 0.89 | | 0.57 | 0.57 | 0.57 | 0.74 | 0.93 | |
| EFF. DEPTH, IN. | 9.75 | 9.75 | 9.75 | 9.75 | 9.69 | | 9.75 | 9.75 | 9.75 | 9.75 | 9.69 | |
| $-I_{cr}/I_{gr}$ | 0.208 | 0.208 | 0.208 | 0.232 | 0.282 | | 0.208 | 0.208 | 0.208 | 0.252 | 0.291 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.09 | 0.11 | 0.15 | 0.18 | 0.22 | | 0.06 | 0.09 | 0.11 | 0.15 | 0.18 | |
| EFF. DEPTH, IN. | 9.75 | 9.75 | 9.69 | 9.69 | 9.62 | | 9.81 | 9.75 | 9.75 | 9.69 | 9.69 | |
| $+I_{cr}/I_{gr}$ | 0.144 | 0.182 | 0.224 | 0.267 | 0.311 | | 0.106 | 0.144 | 0.182 | 0.224 | 0.267 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 3.0″ Top Slab = 13.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 11 | # 4 9 | # 4 7.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 11 | # 4 8 | # 5 10 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | |
| Steel (psf) | | 0.51 | 0.61 | 0.72 | 0.89 | 1.08 | | 0.59 | 0.67 | 0.77 | 1.00 | 1.25 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 17'-0" | | 142 | 204 | 236* | 244* | 253* | 0.978 | 151 | 239 | 271* | 280* | 286* | 0.602 |
| | | 0 | 0 | 276 | 350 | 370* | | 0 | 0 | 328 | 433 | 462* | |
| 18'-0" | | 119 | 174 | 215* | 222* | 229* | 1.229 | 127 | 206 | 248* | 256* | 261* | 0.756 |
| | | 0 | 0 | 239 | 304 | 335* | | 0 | 0 | 285 | 379 | 419* | |
| 19'-0" | | 100 | 149 | 196* | 202* | 208* | 1.525 | 107 | 177 | 229* | 235* | 239* | 0.939 |
| | | 0 | 0 | 207 | 266 | 306* | | 0 | 0 | 249 | 333 | 378* | |
| 20'-0" | | 83 | 128 | 180* | 185* | 191* | 1.873 | 90 | 153 | 211* | 217* | 220* | 1.153 |
| | | 0 | 0 | 0 | 233 | 280* | | 0 | 0 | 217 | 294 | 338* | |
| 21'-0" | | 69 | 109 | 157 | 170* | 175* | 2.276 | 75 | 132 | 191 | 201* | 204* | 1.401 |
| | | 0 | 0 | 0 | 205 | 260 | | 0 | 0 | 0 | 260 | 303* | |
| 22'-0" | | 57 | 93 | 137 | 157* | 161* | 2.742 | 62 | 114 | 168 | 186* | 189* | 1.687 |
| | | 0 | 0 | 0 | 181 | 231 | | 0 | 0 | 0 | 231 | 275* | |
| 23'-0" | | 46 | 79 | 119 | 145* | 149* | 3.276 | 51 | 99 | 147 | 173* | 175* | 2.016 |
| | | 0 | 0 | 0 | 159 | 205 | | 0 | 0 | 0 | 205 | 250* | |
| 24'-0" | | | 67 | 104 | 134* | 138* | 3.884 | 41 | 85 | 130 | 161* | 163* | 2.390 |
| | | | 0 | 0 | 141 | 183 | | 0 | 0 | 0 | 183 | 229* | |
| 25'-0" | | | 56 | 90 | 124 | 128* | 4.572 | | 73 | 114 | 151* | 152* | 2.814 |
| | | | 0 | 0 | 0 | 163 | | | 0 | 0 | 163 | 211* | |
| 26'-0" | | | 47 | 78 | 109 | 119* | 5.349 | | 62 | 100 | 141* | 142* | 3.292 |
| | | | 0 | 0 | 0 | 145 | | | 0 | 0 | 145 | 191 | |
| 27'-0" | | | | 67 | 96 | 110* | 6.221 | | 52 | 88 | 130 | 133* | 3.828 |
| | | | | 0 | 0 | 130 | | | 0 | 0 | 0 | 172 | |
| 28'-0" | | | | 58 | 85 | 103* | 7.195 | | 44 | 77 | 116 | 125* | 4.428 |
| | | | | 0 | 0 | 116 | | | 0 | 0 | 0 | 155 | |
| 29'-0" | | | | 49 | 74 | 96* | 8.279 | | | 67 | 103 | 117* | 5.095 |
| | | | | 0 | 0 | 103 | | | | 0 | 0 | 140 | |
| 30'-0" | | | | 41 | 65 | 89* | 9.481 | | | 58 | 92 | 110* | 5.835 |
| | | | | 0 | 0 | 92 | | | | 0 | 0 | 126 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.39 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.64 | 0.78 | 0.93 | | 0.64 | 0.64 | 0.64 | 0.88 | 1.09 | |
| STEEL % (UNIFORM) | 0.91 | 0.91 | 0.91 | 1.11 | 1.33 | | 0.91 | 0.91 | 0.91 | 1.25 | 1.55 | |
| (TAPERED) | 0.49 | 0.49 | 0.49 | 0.60 | 0.72 | | 0.49 | 0.49 | 0.49 | 0.68 | 0.85 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.75 | 11.75 | 11.75 | | 11.75 | 11.75 | 11.75 | 11.75 | 11.69 | |
| $-I_{cr}/I_{gr}$ | 0.204 | 0.204 | 0.204 | 0.237 | 0.270 | | 0.204 | 0.204 | 0.204 | 0.258 | 0.296 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.08 | 0.10 | 0.12 | 0.15 | 0.18 | | 0.05 | 0.08 | 0.10 | 0.12 | 0.15 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | | 11.81 | 11.75 | 11.75 | 11.69 | 11.69 | |
| $+I_{cr}/I_{gr}$ | 0.145 | 0.184 | 0.227 | 0.270 | 0.317 | | 0.106 | 0.145 | 0.184 | 0.227 | 0.270 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 3.0″ Top Slab = 13.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 7.5 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 8.5 | # 4 7 | # 5 8.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | |
| Steel (psf) | | 0.60 | 0.71 | 0.86 | 1.05 | 1.25 | | 0.66 | 0.75 | 0.95 | 1.18 | 1.46 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 17'-0" | | 192 | 263 | 275* | 286* | 292* | 1.006 | 227 | 311* | 318* | 324* | 332* | 0.619 |
| | | 0 | 0 | 335 | 411* | 424* | | 0 | 313 | 416 | 498* | 505* | |
| 18'-0" | | 164 | 227 | 250* | 260* | 264* | 1.264 | 194 | 272 | 291* | 297* | 303* | 0.778 |
| | | 0 | 0 | 291 | 363 | 385* | | 0 | 0 | 363 | 456 | 466* | |
| 19'-0" | | 139 | 196 | 229* | 237* | 241* | 1.569 | 167 | 236 | 268* | 273* | 279* | 0.966 |
| | | 0 | 0 | 253 | 319 | 352* | | 0 | 0 | 318 | 402 | 427* | |
| 20'-0" | | 119 | 170 | 210* | 218* | 221* | 1.926 | 143 | 206 | 248* | 252* | 257* | 1.185 |
| | | 0 | 0 | 221 | 280 | 323* | | 0 | 0 | 280 | 355 | 389* | |
| 21'-0" | | 101 | 147 | 194 | 200* | 203* | 2.342 | 123 | 180 | 230* | 234* | 238* | 1.441 |
| | | 0 | 0 | 0 | 247 | 302 | | 0 | 0 | 247 | 316 | 353* | |
| 22'-0" | | 85 | 127 | 170 | 185* | 188* | 2.820 | 106 | 157 | 214* | 217* | 221* | 1.736 |
| | | 0 | 0 | 0 | 219 | 269 | | 0 | 0 | 219 | 281 | 320* | |
| 23'-0" | | 72 | 110 | 149 | 171* | 174* | 3.369 | 90 | 138 | 194 | 202* | 206* | 2.073 |
| | | 0 | 0 | 0 | 194 | 239 | | 0 | 0 | 0 | 251 | 292* | |
| 24'-0" | | 60 | 95 | 131 | 159* | 161* | 3.995 | 77 | 120 | 172 | 189* | 192* | 2.458 |
| | | 0 | 0 | 0 | 172 | 214 | | 0 | 0 | 0 | 224 | 268* | |
| 25'-0" | | 49 | 82 | 115 | 148* | 150* | 4.703 | 65 | 105 | 153 | 177* | 179* | 2.894 |
| | | 0 | 0 | 0 | 153 | 191 | | 0 | 0 | 0 | 201 | 247* | |
| 26'-0" | | 40 | 70 | 101 | 136 | 139* | 5.502 | 55 | 92 | 136 | 166* | 168* | 3.386 |
| | | 0 | 0 | 0 | 0 | 171 | | 0 | 0 | 0 | 180 | 228* | |
| 27'-0" | | | 60 | 88 | 121 | 130* | 6.398 | 45 | 80 | 120 | 156* | 158* | 3.938 |
| | | | 0 | 0 | 0 | 154 | | 0 | 0 | 0 | 162 | 209 | |
| 28'-0" | | | 50 | 77 | 107 | 122* | 7.400 | | 69 | 107 | 145 | 148* | 4.554 |
| | | | 0 | 0 | 0 | 138 | | | 0 | 0 | 0 | 189 | |
| 29'-0" | | | 42 | 67 | 95 | 114* | 8.516 | | 59 | 95 | 130 | 139* | 5.240 |
| | | | 0 | 0 | 0 | 123 | | | 0 | 0 | 0 | 171 | |
| 30'-0" | | | | 57 | 84 | 106* | 9.752 | | 51 | 84 | 117 | 131* | 6.001 |
| | | | | 0 | 0 | 110 | | | 0 | 0 | 0 | 155 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.41 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.76 | 0.96 | 1.12 | | 0.65 | 0.65 | 0.85 | 1.03 | 1.31 | |
| STEEL % (UNIFORM) | 0.80 | 0.80 | 0.92 | 1.17 | 1.37 | | 0.80 | 0.80 | 1.03 | 1.25 | 1.61 | |
| (TAPERED) | 0.47 | 0.47 | 0.54 | 0.68 | 0.80 | | 0.47 | 0.47 | 0.60 | 0.73 | 0.94 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.75 | 11.75 | 11.69 | | 11.75 | 11.75 | 11.75 | 11.75 | 11.69 | |
| $-I_{cr}/I_{gr}$ | 0.191 | 0.191 | 0.214 | 0.255 | 0.280 | | 0.191 | 0.191 | 0.232 | 0.268 | 0.314 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.09 | 0.12 | 0.15 | 0.18 | 0.21 | | 0.07 | 0.09 | 0.12 | 0.15 | 0.18 | |
| EFF. DEPTH, IN. | 11.75 | 11.69 | 11.69 | 11.62 | 11.62 | | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | |
| $+I_{cr}/I_{gr}$ | 0.162 | 0.200 | 0.239 | 0.280 | 0.323 | | 0.128 | 0.162 | 0.200 | 0.239 | 0.280 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 3.0″ Top Slab = 15.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9 | # 4 7.5 | # 5 9.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 8.5 | # 5 10 | # 5 6 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.61 | 0.72 | 0.89 | 1.08 | 1.29 | | 0.67 | 0.77 | 0.97 | 1.25 | 1.79 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 19'-0" | | 181 | 249 | 259* | 267* | 276* | 1.525 | | | | | | |
| | | 0 | 0 | 318 | 363* | 374* | | | | | | | |
| 20'-0" | | 156 | 217 | 237* | 245* | 252* | 1.873 | 185 | 261 | 274* | 281* | 303* | 1.153 |
| | | 0 | 0 | 280 | 333* | 344* | | 0 | 0 | 351 | 413* | 457* | |
| 21'-0" | | 134 | 190 | 218* | 225* | 231* | 2.276 | 161 | 230 | 254* | 260* | 280* | 1.401 |
| | | 0 | 0 | 247 | 312 | 328* | | 0 | 0 | 311 | 372* | 415* | |
| 22'-0" | | 115 | 166 | 202* | 207* | 213* | 2.742 | 140 | 202 | 236* | 241* | 259* | 1.687 |
| | | 0 | 0 | 218 | 277 | 304* | | 0 | 0 | 277 | 337* | 375* | |
| 23'-0" | | 99 | 146 | 187* | 192* | 197* | 3.276 | 122 | 179 | 220* | 224* | 241* | 2.016 |
| | | 0 | 0 | 193 | 247 | 282* | | 0 | 0 | 247 | 308* | 341* | |
| 24'-0" | | 85 | 128 | 171 | 178* | 182* | 3.884 | 106 | 158 | 206* | 209* | 224* | 2.390 |
| | | 0 | 0 | 0 | 221 | 263* | | 0 | 0 | 220 | 283* | 311* | |
| 25'-0" | | 72 | 112 | 152 | 165* | 169* | 4.572 | 91 | 140 | 192* | 196* | 209* | 2.814 |
| | | 0 | 0 | 0 | 198 | 244 | | 0 | 0 | 197 | 255 | 286* | |
| 26'-0" | | 61 | 98 | 135 | 154* | 158* | 5.349 | 79 | 123 | 176 | 183* | 196* | 3.292 |
| | | 0 | 0 | 0 | 177 | 220 | | 0 | 0 | 0 | 230 | 264* | |
| 27'-0" | | 51 | 85 | 119 | 144* | 147* | 6.221 | 67 | 109 | 158 | 172* | 183* | 3.828 |
| | | 0 | 0 | 0 | 158 | 198 | | 0 | 0 | 0 | 208 | 244* | |
| 28'-0" | | 42 | 74 | 106 | 134* | 137* | 7.195 | 57 | 96 | 142 | 162* | 172* | 4.428 |
| | | 0 | 0 | 0 | 142 | 179 | | 0 | 0 | 0 | 188 | 227* | |
| 29'-0" | | | 63 | 93 | 126* | 128* | 8.279 | 48 | 84 | 127 | 152* | 162* | 5.095 |
| | | | 0 | 0 | 127 | 162 | | 0 | 0 | 0 | 170 | 211* | |
| 30'-0" | | | 54 | 82 | 114 | 120* | 9.481 | 40 | 74 | 114 | 143* | 152* | 5.835 |
| | | | 0 | 0 | 0 | 146 | | 0 | 0 | 0 | 154 | 197* | |
| 31'-0" | | | 46 | 72 | 102 | 113* | 10.810 | | 64 | 102 | 135* | 144* | 6.652 |
| | | | 0 | 0 | 0 | 132 | | | 0 | 0 | 139 | 183 | |
| 32'-0" | | | | 63 | 91 | 106* | 12.274 | | 56 | 91 | 126 | 135* | 7.553 |
| | | | | 0 | 0 | 119 | | | 0 | 0 | 0 | 167 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.42 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.78 | 0.93 | 1.14 | | 0.64 | 0.64 | 0.82 | 1.09 | 1.81 | |
| STEEL % (UNIFORM) | 0.75 | 0.75 | 0.92 | 1.10 | 1.36 | | 0.75 | 0.75 | 0.97 | 1.29 | 2.15 | |
| (TAPERED) | 0.42 | 0.42 | 0.51 | 0.61 | 0.75 | | 0.42 | 0.42 | 0.54 | 0.71 | 1.19 | |
| EFF. DEPTH, IN. | 13.75 | 13.75 | 13.75 | 13.75 | 13.69 | | 13.75 | 13.75 | 13.75 | 13.69 | 13.69 | |
| $-I_{cr}/I_{gr}$ | 0.188 | 0.188 | 0.220 | 0.251 | 0.287 | | 0.188 | 0.188 | 0.229 | 0.277 | 0.391 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.08 | 0.11 | 0.13 | 0.16 | 0.18 | | 0.06 | 0.08 | 0.11 | 0.13 | 0.16 | |
| EFF. DEPTH, IN. | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | |
| $+I_{cr}/I_{gr}$ | 0.165 | 0.205 | 0.245 | 0.288 | 0.332 | | 0.130 | 0.165 | 0.205 | 0.245 | 0.288 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 3.0″ Top Slab = 15.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 8 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 9 | # 4 7 | # 5 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.60 | 0.71 | 0.86 | 1.04 | 1.25 | | 0.66 | 0.75 | 0.93 | 1.18 | 1.42 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 19'-0" | | 169 | 235 | 290* | 298* | 307* | 1.569 | | | | | | |
| | | 0 | 0 | 303 | 380 | 414* | | | | | | | |
| 20'-0" | | 144 | 204 | 265 | 273* | 281* | 1.926 | 173 | 247 | 310* | 318* | 322* | 1.185 |
| | | 0 | 0 | 0 | 335 | 380* | | 0 | 0 | 334 | 423 | 467* | |
| 21'-0" | | 123 | 178 | 233 | 252* | 258* | 2.342 | 150 | 216 | 288* | 294* | 298* | 1.441 |
| | | 0 | 0 | 0 | 296 | 360* | | 0 | 0 | 296 | 376 | 424* | |
| 22'-0" | | 105 | 155 | 205 | 233* | 239* | 2.820 | 129 | 190 | 262 | 274* | 277* | 1.736 |
| | | 0 | 0 | 0 | 263 | 321 | | 0 | 0 | 0 | 335 | 386* | |
| 23'-0" | | 89 | 135 | 181 | 216* | 221* | 3.369 | 111 | 167 | 233 | 255* | 258* | 2.073 |
| | | 0 | 0 | 0 | 234 | 287 | | 0 | 0 | 0 | 300 | 353* | |
| 24'-0" | | 76 | 117 | 159 | 201* | 205* | 3.995 | 96 | 147 | 207 | 239* | 241* | 2.458 |
| | | 0 | 0 | 0 | 208 | 257 | | 0 | 0 | 0 | 269 | 325* | |
| 25'-0" | | 63 | 102 | 141 | 185 | 191* | 4.703 | 82 | 129 | 185 | 224* | 226* | 2.894 |
| | | 0 | 0 | 0 | 0 | 231 | | 0 | 0 | 0 | 241 | 300* | |
| 26'-0" | | 52 | 88 | 124 | 165 | 179* | 5.502 | 70 | 113 | 165 | 210* | 212* | 3.386 |
| | | 0 | 0 | 0 | 0 | 207 | | 0 | 0 | 0 | 217 | 277 | |
| 27'-0" | | 43 | 76 | 109 | 147 | 167* | 6.398 | 59 | 99 | 147 | 195 | 199* | 3.938 |
| | | 0 | 0 | 0 | 0 | 186 | | 0 | 0 | 0 | 0 | 251 | |
| 28'-0" | | | 65 | 96 | 131 | 156* | 7.400 | 49 | 86 | 131 | 176 | 188* | 4.554 |
| | | | 0 | 0 | 0 | 167 | | 0 | 0 | 0 | 0 | 228 | |
| 29'-0" | | | 55 | 84 | 117 | 147* | 8.516 | 40 | 75 | 116 | 159 | 177* | 5.240 |
| | | | 0 | 0 | 0 | 151 | | 0 | 0 | 0 | 0 | 207 | |
| 30'-0" | | | 46 | 73 | 104 | 135 | 9.752 | | 65 | 104 | 143 | 167* | 6.001 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 188 | |
| 31'-0" | | | | 63 | 92 | 122 | 11.119 | | 55 | 92 | 129 | 158* | 6.842 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 171 | |
| 32'-0" | | | | 54 | 82 | 109 | 12.625 | | 47 | 81 | 116 | 149* | 7.769 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 155 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.44 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.76 | 0.90 | 1.12 | | 0.65 | 0.65 | 0.80 | 1.03 | 1.24 | |
| STEEL % (UNIFORM) | 0.67 | 0.67 | 0.77 | 0.92 | 1.14 | | 0.67 | 0.67 | 0.81 | 1.05 | 1.27 | |
| (TAPERED) | 0.39 | 0.39 | 0.45 | 0.54 | 0.67 | | 0.39 | 0.39 | 0.48 | 0.62 | 0.75 | |
| EFF. DEPTH, IN. | 13.75 | 13.75 | 13.75 | 13.75 | 13.69 | | 13.75 | 13.75 | 13.75 | 13.75 | 13.69 | |
| $-I_{cr}/I_{gr}$ | 0.177 | 0.177 | 0.198 | 0.226 | 0.262 | | 0.177 | 0.177 | 0.207 | 0.250 | 0.283 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.08 | 0.10 | 0.13 | 0.15 | 0.18 | | 0.06 | 0.08 | 0.10 | 0.13 | 0.15 | |
| EFF. DEPTH, IN. | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | |
| $+I_{cr}/I_{gr}$ | 0.146 | 0.181 | 0.217 | 0.255 | 0.294 | | 0.115 | 0.146 | 0.181 | 0.217 | 0.255 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

14″ Deep Rib + 3.0″ Top Slab = 17.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 7.5 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 8.5 | # 4 7 | # 5 8.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.61 | 0.72 | 0.88 | 1.08 | 1.28 | | 0.67 | 0.77 | 0.97 | 1.20 | 1.48 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 22'-0" | | 137 | 196 | 249* | 258* | 263* | 2.742 | 166 | | 292* | | 304* | 1.687 |
| | | 0 | 0 | 256 | 324 | 346* | | 0 | | 323 | | 414* | |
| 23'-0" | | 119 | 172 | 227 | 239* | 243* | 3.276 | 145 | 210 | 272* | 277* | 283* | 2.016 |
| | | 0 | 0 | 0 | 289 | 322* | | 0 | 0 | 288 | 367* | 379* | |
| 24'-0" | | 102 | 152 | 202 | 222* | 226* | 3.884 | 126 | 186 | 254* | 259* | 264* | 2.390 |
| | | 0 | 0 | 0 | 259 | 300* | | 0 | 0 | 258 | 331 | 348* | |
| 25'-0" | | 88 | 133 | 179 | 207* | 210* | 4.572 | 110 | 165 | 231 | 242* | 247* | 2.814 |
| | | 0 | 0 | 0 | 232 | 281* | | 0 | 0 | 0 | 298 | 321* | |
| 26'-0" | | 75 | 117 | 160 | 193* | 196* | 5.349 | 95 | 146 | 208 | 228* | 232* | 3.292 |
| | | 0 | 0 | 0 | 209 | 258 | | 0 | 0 | 0 | 270 | 298* | |
| 27'-0" | | 64 | 103 | 142 | 180* | 183* | 6.221 | 82 | 130 | 187 | 214* | 218* | 3.828 |
| | | 0 | 0 | 0 | 187 | 233 | | 0 | 0 | 0 | 244 | 277* | |
| 28'-0" | | 53 | 90 | 126 | 169 | 171* | 7.195 | 71 | 115 | 168 | 202* | 205* | 4.428 |
| | | 0 | 0 | 0 | 0 | 211 | | 0 | 0 | 0 | 221 | 259* | |
| 29'-0" | | 44 | 78 | 112 | 152 | 161* | 8.279 | 61 | 102 | 151 | 190* | 193* | 5.095 |
| | | 0 | 0 | 0 | 0 | 191 | | 0 | 0 | 0 | 201 | 242* | |
| 30'-0" | | | 68 | 99 | 136 | 151* | 9.481 | 51 | 90 | 136 | 180* | 182* | 5.835 |
| | | | 0 | 0 | 0 | 174 | | 0 | 0 | 0 | 182 | 227* | |
| 31'-0" | | | 58 | 88 | 122 | 142* | 10.810 | 43 | 79 | 122 | 165 | 172* | 6.652 |
| | | | 0 | 0 | 0 | 157 | | 0 | 0 | 0 | 0 | 213* | |
| 32'-0" | | | 49 | 77 | 110 | 133* | 12.274 | | 69 | 109 | 150 | 163* | 7.553 |
| | | | 0 | 0 | 0 | 143 | | | 0 | 0 | 0 | 197 | |
| 33'-0" | | | 42 | 68 | 98 | 126* | 13.882 | | 60 | 98 | 136 | 154* | 8.543 |
| | | | 0 | 0 | 0 | 129 | | | 0 | 0 | 0 | 180 | |
| 34'-0" | | | | 59 | 88 | 117 | 15.642 | | 52 | 87 | 124 | 146* | 9.626 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 165 | |
| 35'-0" | | | | 51 | 78 | 106 | 17.565 | | 44 | 78 | 112 | 139* | 10.809 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 151 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.46 CF/SF) [4]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.74 | 0.93 | 1.09 | | 0.64 | 0.64 | 0.82 | 1.00 | 1.28 | |
| STEEL % (UNIFORM) | 0.64 | 0.64 | 0.74 | 0.94 | 1.10 | | 0.64 | 0.64 | 0.83 | 1.01 | 1.29 | |
| (TAPERED) | 0.36 | 0.36 | 0.41 | 0.52 | 0.61 | | 0.36 | 0.36 | 0.46 | 0.56 | 0.72 | |
| EFF. DEPTH, IN. | 15.75 | 15.75 | 15.75 | 15.75 | 15.69 | | 15.75 | 15.75 | 15.75 | 15.75 | 15.69 | |
| $-I_{cr}/I_{gr}$ | 0.175 | 0.175 | 0.197 | 0.235 | 0.260 | | 0.175 | 0.175 | 0.214 | 0.248 | 0.293 | |
| POSITIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.07 | 0.09 | 0.11 | 0.14 | 0.16 | | 0.06 | 0.07 | 0.09 | 0.11 | 0.14 | |
| EFF. DEPTH, IN. | 15.75 | 15.69 | 15.69 | 15.62 | 15.62 | | 15.75 | 15.75 | 15.69 | 15.69 | 15.62 | |
| $+I_{cr}/I_{gr}$ | 0.151 | 0.187 | 0.224 | 0.264 | 0.305 | | 0.119 | 0.151 | 0.187 | 0.224 | 0.264 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

14″ Deep Rib + 3.0″ Top Slab = 17.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 8 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 9 | # 4 7 | # 5 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.60 | 0.71 | 0.86 | 1.04 | 1.25 | | 0.66 | 0.75 | 0.93 | 1.18 | 1.42 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 22'-0" | | 127 | 184 | 241 | 288* | 296* | 2.820 | 154 | | 307 | | 340* | 1.736 |
| | | 0 | 0 | 0 | 308 | 375 | | 0 | | 0 | | 459* | |
| 23'-0" | | 108 | 161 | 214 | 268* | 274* | 3.369 | 134 | 197 | 273 | 314* | 318* | 2.073 |
| | | 0 | 0 | 0 | 274 | 336 | | 0 | 0 | 0 | 350 | 420* | |
| 24'-0" | | 92 | 140 | 189 | 245 | 255* | 3.995 | 116 | 174 | 244 | 294* | 297* | 2.458 |
| | | 0 | 0 | 0 | 0 | 302 | | 0 | 0 | 0 | 314 | 387* | |
| 25'-0" | | 78 | 123 | 167 | 219 | 238* | 4.703 | 100 | 154 | 218 | 276* | 279* | 2.894 |
| | | 0 | 0 | 0 | 0 | 271 | | 0 | 0 | 0 | 283 | 358 | |
| 26'-0" | | 66 | 107 | 148 | 196 | 222* | 5.502 | 86 | 135 | 195 | 255 | 262* | 3.386 |
| | | 0 | 0 | 0 | 0 | 244 | | 0 | 0 | 0 | 0 | 324 | |
| 27'-0" | | 55 | 93 | 131 | 175 | 208* | 6.398 | 73 | 119 | 174 | 230 | 246* | 3.938 |
| | | 0 | 0 | 0 | 0 | 220 | | 0 | 0 | 0 | 0 | 294 | |
| 28'-0" | | 45 | 80 | 116 | 157 | 195* | 7.400 | 62 | 105 | 156 | 208 | 232* | 4.554 |
| | | 0 | 0 | 0 | 0 | 198 | | 0 | 0 | 0 | 0 | 268 | |
| 29'-0" | | | 69 | 102 | 140 | 179 | 8.516 | 52 | 92 | 140 | 188 | 219* | 5.240 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 244 | |
| 30'-0" | | | 59 | 90 | 125 | 162 | 9.752 | 43 | 80 | 125 | 170 | 207* | 6.001 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 222 | |
| 31'-0" | | | 49 | 78 | 112 | 146 | 11.119 | | 69 | 111 | 154 | 196* | 6.842 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 202 | |
| 32'-0" | | | 41 | 68 | 100 | 132 | 12.625 | | 60 | 99 | 139 | 185 | 7.769 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 33'-0" | | | | 59 | 89 | 119 | 14.278 | | 51 | 88 | 125 | 168 | 8.787 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 34'-0" | | | | 51 | 78 | 107 | 16.089 | | 43 | 78 | 113 | 154 | 9.901 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 35'-0" | | | | 43 | 69 | 96 | 18.067 | | | 69 | 102 | 140 | 11.118 |
| | | | | 0 | 0 | 0 | | | | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.48 CF/SF) [4]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.76 | 0.90 | 1.12 | | 0.65 | 0.65 | 0.80 | 1.03 | 1.24 | |
| STEEL % (UNIFORM) | 0.57 | 0.57 | 0.66 | 0.78 | 0.97 | | 0.57 | 0.57 | 0.69 | 0.89 | 1.08 | |
| (TAPERED) | 0.34 | 0.34 | 0.39 | 0.46 | 0.58 | | 0.34 | 0.34 | 0.41 | 0.53 | 0.64 | |
| EFF. DEPTH, IN. | 15.75 | 15.75 | 15.75 | 15.75 | 15.69 | | 15.75 | 15.75 | 15.75 | 15.75 | 15.69 | |
| $-I_{cr}/I_{gr}$ | 0.165 | 0.165 | 0.185 | 0.212 | 0.247 | | 0.165 | 0.165 | 0.193 | 0.234 | 0.267 | |
| POSITIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.07 | 0.09 | 0.11 | 0.13 | 0.16 | | 0.05 | 0.07 | 0.09 | 0.11 | 0.13 | |
| EFF. DEPTH, IN. | 15.75 | 15.69 | 15.69 | 15.62 | 15.62 | | 15.75 | 15.75 | 15.69 | 15.69 | 15.62 | |
| $+I_{cr}/I_{gr}$ | 0.134 | 0.166 | 0.199 | 0.234 | 0.271 | | 0.105 | 0.134 | 0.166 | 0.199 | 0.234 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

16″ Deep Rib + 3.0″ Top Slab = 19.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 10 | # 4 8 | # 5 10 | # 5 8.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 9 | # 4 7 | # 5 9 | # 5 7.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| Steel (psf) | | 0.71 | 0.85 | 1.04 | 1.25 | 1.46 | | 0.75 | 0.93 | 1.18 | 1.42 | 1.71 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 25'-0" | | 142 | 193 | 251 | 287* | 294* | 4.703 | | 250 | | 334* | 340* | 2.894 |
| | | 0 | 0 | 0 | 310 | 369* | | | 0 | | 408 | 429* | |
| 26'-0" | | 125 | 171 | 225 | 268* | 275* | 5.502 | 157 | 224 | 292 | 314* | 320* | 3.386 |
| | | 0 | 0 | 0 | 280 | 345 | | 0 | 0 | 0 | 370 | 399* | |
| 27'-0" | | 109 | 152 | 202 | 251* | 257* | 6.398 | 138 | 201 | 264 | 296* | 301* | 3.938 |
| | | 0 | 0 | 0 | 253 | 313 | | 0 | 0 | 0 | 337 | 372* | |
| 28'-0" | | 94 | 135 | 181 | 228 | 241* | 7.400 | 122 | 180 | 239 | 279* | 284* | 4.554 |
| | | 0 | 0 | 0 | 0 | 285 | | 0 | 0 | 0 | 306 | 348* | |
| 29'-0" | | 82 | 119 | 163 | 206 | 227* | 8.516 | 107 | 162 | 216 | 264* | 268* | 5.240 |
| | | 0 | 0 | 0 | 0 | 259 | | 0 | 0 | 0 | 279 | 326* | |
| 30'-0" | | 70 | 105 | 146 | 187 | 214* | 9.752 | 94 | 145 | 196 | 250* | 254* | 6.001 |
| | | 0 | 0 | 0 | 0 | 236 | | 0 | 0 | 0 | 255 | 306* | |
| 31'-0" | | 60 | 93 | 130 | 169 | 201* | 11.119 | 82 | 130 | 177 | 233 | 240* | 6.842 |
| | | 0 | 0 | 0 | 0 | 215 | | 0 | 0 | 0 | 0 | 289 | |
| 32'-0" | | 50 | 81 | 117 | 153 | 190* | 12.625 | 71 | 116 | 161 | 212 | 228* | 7.769 |
| | | 0 | 0 | 0 | 0 | 196 | | 0 | 0 | 0 | 0 | 265 | |
| 33'-0" | | 42 | 71 | 104 | 138 | 179 | 14.278 | 62 | 103 | 146 | 194 | 217* | 8.787 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 244 | |
| 34'-0" | | | 61 | 93 | 125 | 163 | 16.089 | 52 | 92 | 132 | 177 | 206* | 9.901 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 224 | |
| 35'-0" | | | 52 | 82 | 112 | 148 | 18.067 | 44 | 81 | 119 | 162 | 196* | 11.118 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 206 | |
| 36'-0" | | | 44 | 72 | 101 | 135 | 20.222 | | 72 | 107 | 148 | 187* | 12.445 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 190 | |
| 37'-0" | | | | 64 | 91 | 123 | 22.565 | | 63 | 96 | 135 | 174 | 13.886 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 38'-0" | | | | 55 | 81 | 112 | 25.105 | | 55 | 87 | 123 | 161 | 15.449 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.72 | 0.90 | 1.12 | 1.31 | | 0.65 | 0.80 | 1.03 | 1.24 | 1.49 | |
| STEEL % (UNIFORM) | 0.49 | 0.54 | 0.68 | 0.84 | 0.99 | | 0.49 | 0.60 | 0.77 | 0.94 | 1.13 | |
| (TAPERED) | 0.30 | 0.33 | 0.41 | 0.51 | 0.60 | | 0.30 | 0.36 | 0.46 | 0.56 | 0.67 | |
| EFF. DEPTH, IN. | 17.75 | 17.75 | 17.75 | 17.69 | 17.69 | | 17.75 | 17.75 | 17.75 | 17.69 | 17.69 | |
| $-I_{cr}/I_{gr}$ | 0.155 | 0.167 | 0.199 | 0.233 | 0.263 | | 0.155 | 0.181 | 0.221 | 0.252 | 0.288 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | |
| STEEL % | 0.08 | 0.10 | 0.12 | 0.14 | 0.16 | | 0.06 | 0.08 | 0.10 | 0.12 | 0.14 | |
| EFF. DEPTH, IN. | 17.69 | 17.69 | 17.62 | 17.62 | 17.56 | | 17.75 | 17.69 | 17.69 | 17.62 | 17.62 | |
| $+I_{cr}/I_{gr}$ | 0.153 | 0.184 | 0.217 | 0.251 | 0.290 | | 0.123 | 0.153 | 0.184 | 0.217 | 0.251 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 7" Rib @ 37" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

16″ Deep Rib + 3.0″ Top Slab = 19.0″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8.5 | # 4 7 | # 5 9 | # 5 8 | End Span Defl. Coeff. (3) | # 4 9 | # 4 7.5 | # 5 9.5 | # 5 8 | # 6 9.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| | # | # 5 | # 6 | # 6 | # 7 | # 7 | | # 5 | # 5 | # 6 | # 6 | # 7 | |
| Steel (psf) | | 0.83 | 1.00 | 1.20 | 1.41 | 1.63 | | 0.92 | 1.13 | 1.36 | 1.63 | 1.93 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 25'-0" | | 179 | 236 | 294 | 320* | 326* | 4.834 | 235 | | 367* | 373* | 378* | 2.975 |
| | | 0 | 0 | 0 | 362 | 408* | | 0 | | 389 | 467* | 476* | |
| 26'-0" | | 158 | 211 | 264 | 300* | 305* | 5.655 | 209 | 276 | 345* | 351* | 355* | 3.480 |
| | | 0 | 0 | 0 | 328 | 383* | | 0 | 0 | 352 | 429 | 442* | |
| 27'-0" | | 139 | 188 | 237 | 281* | 286* | 6.576 | 187 | 248 | 319 | 330* | 334* | 4.047 |
| | | 0 | 0 | 0 | 296 | 356 | | 0 | 0 | 0 | 391 | 413* | |
| 28'-0" | | 123 | 168 | 214 | 264* | 268* | 7.606 | 167 | 224 | 290 | 312* | 315* | 4.681 |
| | | 0 | 0 | 0 | 269 | 324 | | 0 | 0 | 0 | 356 | 386* | |
| 29'-0" | | 107 | 150 | 192 | 244 | 253* | 8.752 | 149 | 202 | 263 | 295* | 298* | 5.386 |
| | | 0 | 0 | 0 | 0 | 296 | | 0 | 0 | 0 | 325 | 362* | |
| 30'-0" | | 94 | 133 | 173 | 221 | 238* | 10.023 | 132 | 182 | 239 | 279* | 282* | 6.168 |
| | | 0 | 0 | 0 | 0 | 270 | | 0 | 0 | 0 | 298 | 341* | |
| 31'-0" | | 82 | 118 | 156 | 201 | 225* | 11.428 | 118 | 164 | 218 | 265* | 268* | 7.033 |
| | | 0 | 0 | 0 | 0 | 246 | | 0 | 0 | 0 | 272 | 321* | |
| 32'-0" | | 70 | 105 | 140 | 182 | 212* | 12.975 | 104 | 148 | 198 | 249 | 254* | 7.985 |
| | | 0 | 0 | 0 | 0 | 225 | | 0 | 0 | 0 | 0 | 303* | |
| 33'-0" | | 60 | 93 | 126 | 165 | 201* | 14.675 | 92 | 133 | 180 | 229 | 241* | 9.031 |
| | | 0 | 0 | 0 | 0 | 206 | | 0 | 0 | 0 | 0 | 286 | |
| 34'-0" | | 51 | 82 | 113 | 150 | 188 | 16.536 | 81 | 120 | 164 | 209 | 230* | 10.176 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 264 | |
| 35'-0" | | 42 | 71 | 101 | 136 | 172 | 18.569 | 71 | 107 | 149 | 192 | 219* | 11.427 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 243 | |
| 36'-0" | | | 62 | 90 | 123 | 157 | 20.784 | 61 | 96 | 136 | 176 | 208* | 12.790 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 224 | |
| 37'-0" | | | 53 | 80 | 111 | 143 | 23.191 | 53 | 85 | 123 | 161 | 199* | 14.272 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 207 | |
| 38'-0" | | | 45 | 70 | 100 | 130 | 25.802 | 45 | 76 | 111 | 148 | 190* | 15.878 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 191 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.74 | 0.87 | 1.06 | 1.27 | 1.43 | | 0.82 | 0.99 | 1.21 | 1.43 | 1.71 | |
| STEEL % (UNIFORM) | 0.49 | 0.58 | 0.70 | 0.85 | 0.96 | | 0.55 | 0.66 | 0.81 | 0.96 | 1.15 | |
| (TAPERED) | 0.31 | 0.36 | 0.44 | 0.53 | 0.60 | | 0.34 | 0.41 | 0.51 | 0.60 | 0.72 | |
| EFF. DEPTH, IN. | 17.75 | 17.75 | 17.75 | 17.69 | 17.69 | | 17.75 | 17.75 | 17.69 | 17.69 | 17.62 | |
| $-I_{cr}/I_{gr}$ | 0.159 | 0.181 | 0.211 | 0.241 | 0.264 | | 0.173 | 0.200 | 0.232 | 0.264 | 0.298 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | |
| STEEL % | 0.09 | 0.12 | 0.13 | 0.16 | 0.18 | | 0.08 | 0.09 | 0.12 | 0.13 | 0.16 | |
| EFF. DEPTH, IN. | 17.69 | 17.62 | 17.62 | 17.56 | 17.56 | | 17.69 | 17.69 | 17.62 | 17.62 | 17.56 | |
| $+I_{cr}/I_{gr}$ | 0.166 | 0.197 | 0.227 | 0.262 | 0.298 | | 0.139 | 0.166 | 0.197 | 0.227 | 0.262 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

20″ Deep Rib + 3.0″ Top Slab = 23.0″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8 | # 4 7 | # 5 9 | # 5 7.5 | End Span Defl. Coeff. (3) | # 4 9 | # 4 7.5 | # 5 9.5 | # 5 8 | # 6 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| | # | # 5 | # 6 | # 6 | # 7 | # 7 | | # 5 | # 5 | # 6 | # 6 | # 7 | |
| Steel (psf) | | 0.85 | 1.04 | 1.23 | 1.44 | 1.69 | | 0.93 | 1.14 | 1.38 | 1.66 | 2.01 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'-0" | | 135 | 185 | 236 | 293* | 301* | 9.752 | | | | | | |
| | | 0 | 0 | 0 | 297 | 355* | | | | | | | |
| 31'-0" | | 120 | 166 | 214 | 271 | 284* | 11.119 | 165 | 224 | 292 | 327* | 333* | 6.842 |
| | | 0 | 0 | 0 | 0 | 329 | | 0 | 0 | 0 | 361 | 384* | |
| 32'-0" | | 105 | 149 | 194 | 247 | 268* | 12.625 | 148 | 203 | 267 | 311* | 316* | 7.769 |
| | | 0 | 0 | 0 | 0 | 302 | | 0 | 0 | 0 | 332 | 363* | |
| 33'-0" | | 93 | 134 | 176 | 226 | 254* | 14.278 | 133 | 185 | 245 | 296* | 300* | 8.787 |
| | | 0 | 0 | 0 | 0 | 277 | | 0 | 0 | 0 | 306 | 344* | |
| 34'-0" | | 81 | 120 | 159 | 207 | 241* | 16.089 | 119 | 168 | 224 | 281* | 286* | 9.901 |
| | | 0 | 0 | 0 | 0 | 255 | | 0 | 0 | 0 | 0 | 326* | |
| 35'-0" | | 70 | 107 | 144 | 189 | 228* | 18.067 | 106 | 152 | 205 | 259 | 272* | 11.118 |
| | | 0 | 0 | 0 | 0 | 234 | | 0 | 0 | 0 | 0 | 309* | |
| 36'-0" | | 60 | 95 | 130 | 172 | 215 | 20.222 | 94 | 138 | 188 | 239 | 260* | 12.445 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 294* | |
| 37'-0" | | 51 | 84 | 117 | 157 | 198 | 22.565 | 83 | 124 | 172 | 221 | 248* | 13.886 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 279 | |
| 38'-0" | | 43 | 74 | 106 | 144 | 182 | 25.105 | 73 | 112 | 158 | 203 | 237* | 15.449 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 259 | |
| 39'-0" | | | 65 | 95 | 131 | 167 | 27.853 | 64 | 101 | 144 | 188 | 226* | 17.141 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 240 | |
| 40'-0" | | | 56 | 85 | 119 | 153 | 30.822 | 55 | 91 | 132 | 173 | 216* | 18.967 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 223 | |
| 41'-0" | | | 48 | 75 | 108 | 141 | 34.022 | 47 | 81 | 120 | 159 | 207 | 20.936 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| 42'-0" | | | 41 | 67 | 98 | 129 | 37.464 | 40 | 72 | 109 | 147 | 192 | 23.055 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| 43'-0" | | | | 58 | 88 | 118 | 41.162 | | 64 | 99 | 135 | 178 | 25.330 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) [4] | | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | | 0.72 | 0.90 | 1.03 | 1.24 | 1.49 | | 0.80 | 0.96 | 1.17 | 1.39 | 1.76 | |
| STEEL % (UNIFORM) | | 0.42 | 0.53 | 0.61 | 0.73 | 0.88 | | 0.47 | 0.56 | 0.69 | 0.82 | 1.04 | |
| (TAPERED) | | 0.26 | 0.32 | 0.37 | 0.45 | 0.54 | | 0.29 | 0.34 | 0.42 | 0.50 | 0.64 | |
| EFF. DEPTH, IN. | | 21.75 | 21.75 | 21.75 | 21.69 | 21.69 | | 21.75 | 21.75 | 21.69 | 21.69 | 21.62 | |
| $-I_{cr}/I_{gr}$ | | 0.149 | 0.179 | 0.199 | 0.228 | 0.262 | | 0.162 | 0.188 | 0.219 | 0.250 | 0.295 | |
| POSITIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | |
| STEEL % | | 0.08 | 0.10 | 0.11 | 0.13 | 0.15 | | 0.07 | 0.08 | 0.10 | 0.11 | 0.13 | |
| EFF. DEPTH, IN. | | 21.69 | 21.62 | 21.62 | 21.56 | 21.56 | | 21.69 | 21.69 | 21.62 | 21.62 | 21.56 | |
| $+I_{cr}/I_{gr}$ | | 0.160 | 0.190 | 0.220 | 0.255 | 0.290 | | 0.134 | 0.160 | 0.190 | 0.220 | 0.255 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 7" Rib @ 37" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

20″ Deep Rib + 3.0″ Top Slab = 23.0″ Total Depth

| TOP BARS | Size @ | # 4 8 | # 4 7 | # 5 9.5 | # 5 8 | # 6 9.5 | End Span Defl. Coeff. (3) | # 5 11 | # 5 9.5 | # 5 8 | # 5 7 | # 6 8 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 5 | # 6 | # 6 | # 7 | # 7 | | # 5 | # 5 | # 6 | # 6 | # 7 | |
| | # | # 6 | # 6 | # 7 | # 7 | # 8 | | # 5 | # 6 | # 6 | # 7 | # 7 | |
| Steel (psf) | | 1.02 | 1.20 | 1.40 | 1.63 | 1.89 | | 1.16 | 1.36 | 1.63 | 1.88 | 2.29 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'-0" | | 171 | 220 | 280 | 328* | 335* | 10.023 | | | | | | |
| | | 0 | 0 | 0 | 340 | 394* | | | | | | | |
| 31'-0" | | 153 | 199 | 255 | 309* | 316* | 11.428 | 209 | 275 | 342 | 365* | 371* | 7.033 |
| | | 0 | 0 | 0 | 311 | 374* | | 0 | 0 | 0 | 419* | 428* | |
| 32'-0" | | 136 | 180 | 232 | 285 | 299* | 12.975 | 189 | 251 | 314 | 347* | 353* | 7.985 |
| | | 0 | 0 | 0 | 0 | 346 | | 0 | 0 | 0 | 390 | 405* | |
| 33'-0" | | 121 | 162 | 211 | 261 | 283* | 14.675 | 171 | 229 | 288 | 330* | 335* | 9.031 |
| | | 0 | 0 | 0 | 0 | 318 | | 0 | 0 | 0 | 360 | 383* | |
| 34'-0" | | 108 | 146 | 192 | 239 | 268* | 16.536 | 154 | 209 | 265 | 315* | 319* | 10.176 |
| | | 0 | 0 | 0 | 0 | 293 | | 0 | 0 | 0 | 332 | 363* | |
| 35'-0" | | 95 | 131 | 175 | 219 | 254* | 18.569 | 139 | 191 | 244 | 300* | 304* | 11.427 |
| | | 0 | 0 | 0 | 0 | 270 | | 0 | 0 | 0 | 307 | 345* | |
| 36'-0" | | 84 | 118 | 159 | 201 | 242* | 20.784 | 125 | 174 | 224 | 284 | 290* | 12.790 |
| | | 0 | 0 | 0 | 0 | 249 | | 0 | 0 | 0 | 0 | 328* | |
| 37'-0" | | 73 | 105 | 144 | 184 | 229 | 23.191 | 112 | 159 | 206 | 262 | 277* | 14.272 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 313* | |
| 38'-0" | | 63 | 94 | 131 | 168 | 211 | 25.802 | 100 | 144 | 189 | 243 | 265* | 15.878 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 297 | |
| 39'-0" | | 54 | 83 | 118 | 154 | 195 | 28.627 | 89 | 131 | 174 | 225 | 254* | 17.617 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 276 | |
| 40'-0" | | 46 | 73 | 107 | 140 | 180 | 31.678 | 79 | 119 | 159 | 208 | 243* | 19.494 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 257 | |
| 41'-0" | | | 64 | 96 | 128 | 165 | 34.967 | 70 | 108 | 146 | 192 | 232* | 21.518 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 239 | |
| 42'-0" | | | 56 | 86 | 117 | 152 | 38.505 | 61 | 97 | 134 | 178 | 222 | 23.695 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| 43'-0" | | | 48 | 77 | 106 | 140 | 42.305 | 53 | 87 | 122 | 164 | 207 | 26.034 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF) [4] | | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | | 0.93 | 1.06 | 1.21 | 1.43 | 1.71 | | 1.04 | 1.21 | 1.43 | 1.64 | 2.04 | |
| STEEL % (UNIFORM) | | 0.48 | 0.55 | 0.63 | 0.75 | 0.90 | | 0.55 | 0.63 | 0.75 | 0.86 | 1.07 | |
| (TAPERED) | | 0.31 | 0.35 | 0.40 | 0.48 | 0.57 | | 0.35 | 0.40 | 0.48 | 0.55 | 0.68 | |
| EFF. DEPTH, IN. | | 21.75 | 21.75 | 21.69 | 21.69 | 21.62 | | 21.69 | 21.69 | 21.69 | 21.69 | 21.62 | |
| $-I_{cr}/I_{gr}$ | | 0.170 | 0.189 | 0.209 | 0.239 | 0.272 | | 0.186 | 0.209 | 0.239 | 0.265 | 0.309 | |
| POSITIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | |
| STEEL % | | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | | 0.08 | 0.09 | 0.11 | 0.13 | 0.15 | |
| EFF. DEPTH, IN. | | 21.62 | 21.62 | 21.56 | 21.56 | 21.50 | | 21.69 | 21.62 | 21.62 | 21.56 | 21.56 | |
| $+I_{cr}/I_{gr}$ | | 0.173 | 0.200 | 0.231 | 0.263 | 0.298 | | 0.146 | 0.173 | 0.200 | 0.231 | 0.263 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 4.0″ Top Slab = 12.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 11 | # 4 9 | # 5 11 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 10.5 | # 4 8 | # 4 4 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 3 | # 4 | # 4 | # 5 | # 5 | | # 3 | # 3 | # 4 | # 4 | # 5 | |
| | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| Steel (psf) | | 0.51 | 0.61 | 0.72 | 0.89 | 1.09 | | 0.59 | 0.67 | 0.78 | 1.00 | 1.63 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 14'-0" | | 207 | 273* | 273* | 284* | 298* | 0.450 | | | | | | |
| | | 0 | 289 | 387 | 439* | 452* | | | | | | | |
| 15'-0" | | 170 | 241* | 241* | 251* | 262* | 0.593 | | 275* | | 286* | | 0.365 |
| | | 0 | 242 | 326 | 393* | 407* | | | 283 | | 480* | | |
| 16'-0" | | 140 | 203 | 215* | 223* | 232* | 0.767 | 149 | 239 | 249* | 257* | 291* | 0.472 |
| | | 0 | 0 | 277 | 349* | 362* | | 0 | 0 | 331 | 437* | 471* | |
| 17'-0" | | 115 | 170 | 193* | 200* | 208* | 0.978 | 122 | 203 | 226* | 233* | 262* | 0.602 |
| | | 0 | 0 | 237 | 304 | 325* | | 0 | 0 | 284 | 380 | 430* | |
| 18'-0" | | 94 | 143 | 174* | 180* | 187* | 1.229 | 101 | 172 | 206* | 212* | 237* | 0.756 |
| | | 0 | 0 | 202 | 262 | 293* | | 0 | 0 | 245 | 331 | 394* | |
| 19'-0" | | 76 | 121 | 158* | 163* | 169* | 1.525 | 82 | 147 | 188* | 193* | 216* | 0.939 |
| | | 0 | 0 | 173 | 227 | 266* | | 0 | 0 | 212 | 289 | 359* | |
| 20'-0" | | 61 | 101 | 144* | 148* | 153* | 1.873 | 66 | 124 | 172* | 177* | 197* | 1.153 |
| | | 0 | 0 | 149 | 197 | 242* | | 0 | 0 | 183 | 253 | 323 | |
| 21'-0" | | 48 | 84 | 128 | 135* | 139* | 2.276 | 53 | 105 | 158* | 162* | 180* | 1.401 |
| | | 0 | 0 | 0 | 172 | 222 | | 0 | 0 | 159 | 222 | 286 | |
| 22'-0" | | | 70 | 109 | 123* | 127* | 2.742 | 41 | 89 | 138 | 150* | 166* | 1.687 |
| | | | 0 | 0 | 149 | 195 | | 0 | 0 | 0 | 195 | 253 | |
| 23'-0" | | | 57 | 93 | 112* | 116* | 3.276 | | 75 | 119 | 138* | 152* | 2.016 |
| | | | 0 | 0 | 130 | 171 | | | 0 | 0 | 172 | 225 | |
| 24'-0" | | | 46 | 79 | 103* | 106* | 3.884 | | 62 | 103 | 128* | 141* | 2.390 |
| | | | 0 | 0 | 113 | 151 | | | 0 | 0 | 151 | 200 | |
| 25'-0" | | | | 67 | 94* | 97* | 4.572 | | 51 | 89 | 118* | 130* | 2.814 |
| | | | | 0 | 98 | 133 | | | 0 | 0 | 133 | 178 | |
| 26'-0" | | | | 55 | 84 | 89* | 5.349 | | 41 | 76 | 109* | 120* | 3.292 |
| | | | | 0 | 0 | 117 | | | 0 | 0 | 117 | 159 | |
| 27'-0" | | | | 46 | 72 | 82* | 6.221 | | | 65 | 101* | 112* | 3.828 |
| | | | | 0 | 0 | 103 | | | | 0 | 103 | 141 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.44 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.64 | 0.78 | 0.99 | | 0.64 | 0.64 | 0.67 | 0.88 | 1.75 | |
| STEEL % (UNIFORM) | 1.00 | 1.00 | 1.00 | 1.23 | 1.57 | | 1.00 | 1.00 | 1.05 | 1.38 | 2.76 | |
| (TAPERED) | 0.54 | 0.54 | 0.54 | 0.66 | 0.85 | | 0.54 | 0.54 | 0.57 | 0.75 | 1.49 | |
| EFF. DEPTH, IN. | 10.75 | 10.75 | 10.75 | 10.75 | 10.69 | | 10.75 | 10.75 | 10.75 | 10.75 | 10.75 | |
| $-I_{cr}/I_{gr}$ | 0.212 | 0.212 | 0.212 | 0.246 | 0.286 | | 0.212 | 0.212 | 0.220 | 0.267 | 0.421 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.08 | 0.11 | 0.14 | 0.17 | 0.20 | | 0.06 | 0.08 | 0.11 | 0.14 | 0.17 | |
| EFF. DEPTH, IN. | 10.75 | 10.75 | 10.69 | 10.69 | 10.62 | | 10.81 | 10.75 | 10.75 | 10.69 | 10.69 | |
| $+I_{cr}/I_{gr}$ | 0.153 | 0.194 | 0.239 | 0.285 | 0.334 | | 0.113 | 0.153 | 0.194 | 0.239 | 0.285 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 4.0″ Top Slab = 12.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 11 | # 4 9.5 | # 5 11 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 11 | # 4 8.5 | # 4 7 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 3 | # 4 | # 4 | # 5 | # 5 | | # 3 | # 3 | # 4 | # 4 | # 5 | |
| | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| Steel (psf) | | 0.50 | 0.60 | 0.71 | 0.86 | 1.07 | | 0.58 | 0.66 | 0.75 | 0.95 | 1.18 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 14'-0" | | 195 | 275 | 310* | 318* | 335* | 0.463 | | | | | | |
| | | 0 | 0 | 370 | 467 | 504* | | | | | | | |
| 15'-0" | | 159 | 229 | 276* | 283* | 296* | 0.610 | | 270 | | 325* | | 0.375 |
| | | 0 | 0 | 312 | 396 | 452* | | | 0 | | 491 | | |
| 16'-0" | | 130 | 191 | 247* | 253* | 264* | 0.789 | 139 | 227 | 286* | 293* | 300* | 0.486 |
| | | 0 | 0 | 264 | 338 | 403* | | 0 | 0 | 316 | 422 | 475* | |
| 17'-0" | | 106 | 160 | 223* | 228* | 237* | 1.006 | 113 | 191 | 260* | 266* | 272* | 0.619 |
| | | 0 | 0 | 224 | 290 | 362* | | 0 | 0 | 271 | 364 | 436* | |
| 18'-0" | | 85 | 134 | 191 | 206* | 214* | 1.264 | 92 | 162 | 232 | 243* | 248* | 0.778 |
| | | 0 | 0 | 0 | 249 | 315 | | 0 | 0 | 0 | 316 | 398* | |
| 19'-0" | | 68 | 111 | 163 | 187* | 194* | 1.569 | 74 | 137 | 200 | 223* | 227* | 0.966 |
| | | 0 | 0 | 0 | 215 | 275 | | 0 | 0 | 0 | 275 | 351 | |
| 20'-0" | | 53 | 92 | 139 | 171* | 177* | 1.926 | 59 | 115 | 172 | 205* | 209* | 1.185 |
| | | 0 | 0 | 0 | 186 | 240 | | 0 | 0 | 0 | 240 | 309 | |
| 21'-0" | | 41 | 76 | 118 | 156* | 162* | 2.342 | 46 | 97 | 149 | 189* | 192* | 1.441 |
| | | 0 | 0 | 0 | 161 | 210 | | 0 | 0 | 0 | 210 | 272 | |
| 22'-0" | | | 62 | 100 | 139 | 148* | 2.820 | | 81 | 128 | 174* | 177* | 1.736 |
| | | | 0 | 0 | 0 | 184 | | | 0 | 0 | 184 | 241 | |
| 23'-0" | | | 50 | 85 | 120 | 136* | 3.369 | | 67 | 110 | 161 | 164* | 2.073 |
| | | | 0 | 0 | 0 | 161 | | | 0 | 0 | 0 | 213 | |
| 24'-0" | | | | 71 | 104 | 125* | 3.995 | | 55 | 94 | 141 | 152* | 2.458 |
| | | | | 0 | 0 | 141 | | | 0 | 0 | 0 | 189 | |
| 25'-0" | | | | 59 | 89 | 115* | 4.703 | | 44 | 80 | 124 | 142* | 2.894 |
| | | | | 0 | 0 | 123 | | | 0 | 0 | 0 | 168 | |
| 26'-0" | | | | 48 | 76 | 106* | 5.502 | | | 68 | 108 | 132* | 3.386 |
| | | | | 0 | 0 | 108 | | | | 0 | 0 | 149 | |
| 27'-0" | | | | | 65 | 94 | 6.398 | | | 57 | 94 | 123* | 3.938 |
| | | | | | 0 | 0 | | | | 0 | 0 | 132 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.46 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.65 | 0.76 | 1.01 | | 0.65 | 0.65 | 0.65 | 0.85 | 1.03 | |
| STEEL % (UNIFORM) | 0.88 | 0.88 | 0.88 | 1.02 | 1.38 | | 0.88 | 0.88 | 0.88 | 1.14 | 1.39 | |
| (TAPERED) | 0.51 | 0.51 | 0.51 | 0.59 | 0.80 | | 0.51 | 0.51 | 0.51 | 0.66 | 0.80 | |
| EFF. DEPTH, IN. | 10.75 | 10.75 | 10.75 | 10.75 | 10.69 | | 10.75 | 10.75 | 10.75 | 10.75 | 10.75 | |
| $-I_{cr}/I_{gr}$ | 0.199 | 0.199 | 0.199 | 0.222 | 0.271 | | 0.199 | 0.199 | 0.199 | 0.241 | 0.277 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.08 | 0.10 | 0.13 | 0.16 | 0.20 | | 0.06 | 0.08 | 0.10 | 0.13 | 0.16 | |
| EFF. DEPTH, IN. | 10.75 | 10.75 | 10.69 | 10.69 | 10.62 | | 10.81 | 10.75 | 10.75 | 10.69 | 10.69 | |
| $+I_{cr}/I_{gr}$ | 0.135 | 0.171 | 0.211 | 0.252 | 0.294 | | 0.099 | 0.135 | 0.171 | 0.211 | 0.252 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 4.0″ Top Slab = 14.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 11 | # 4 9 | # 4 7.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 11 | # 4 8.5 | # 5 10 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | |
| Steel (psf) | | 0.51 | 0.61 | 0.72 | 0.89 | 1.08 | | 0.59 | 0.67 | 0.77 | 0.97 | 1.25 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 17'-0" | | 145 | 211 | 256* | 265* | 275* | 0.978 | | | | | | |
| | | 0 | 0 | 290 | 371 | 390* | | | | | | | |
| 18'-0" | | 120 | 179 | 232* | 239* | 248* | 1.229 | | 214 | | 276* | 283* | 0.756 |
| | | 0 | 0 | 250 | 321 | 353* | | | 0 | | 402 | 450* | |
| 19'-0" | | 99 | 152 | 211* | 217* | 224* | 1.525 | 106 | 183 | 246* | 252* | 258* | 0.939 |
| | | 0 | 0 | 215 | 280 | 321* | | 0 | 0 | 260 | 352 | 405* | |
| 20'-0" | | 81 | 129 | 186 | 198* | 204* | 1.873 | 88 | 157 | 226* | 232* | 237* | 1.153 |
| | | 0 | 0 | 0 | 244 | 294* | | 0 | 0 | 227 | 310 | 362* | |
| 21'-0" | | 65 | 109 | 161 | 181* | 187* | 2.276 | 71 | 134 | 198 | 214* | 218* | 1.401 |
| | | 0 | 0 | 0 | 213 | 273 | | 0 | 0 | 0 | 273 | 325* | |
| 22'-0" | | 52 | 92 | 139 | 166* | 171* | 2.742 | 57 | 115 | 172 | 198* | 202* | 1.687 |
| | | 0 | 0 | 0 | 187 | 241 | | 0 | 0 | 0 | 241 | 293* | |
| 23'-0" | | 40 | 77 | 120 | 153* | 157* | 3.276 | 45 | 98 | 150 | 183* | 187* | 2.016 |
| | | 0 | 0 | 0 | 164 | 214 | | 0 | 0 | 0 | 213 | 266* | |
| 24'-0" | | | 63 | 103 | 141* | 145* | 3.884 | | 83 | 131 | 170* | 173* | 2.390 |
| | | | 0 | 0 | 143 | 189 | | | 0 | 0 | 189 | 243* | |
| 25'-0" | | | 52 | 88 | 125 | 133* | 4.572 | | 69 | 114 | 158* | 161* | 2.814 |
| | | | 0 | 0 | 0 | 168 | | | 0 | 0 | 167 | 221 | |
| 26'-0" | | | 41 | 75 | 109 | 123* | 5.349 | | 58 | 99 | 147* | 150* | 3.292 |
| | | | 0 | 0 | 0 | 148 | | | 0 | 0 | 148 | 198 | |
| 27'-0" | | | | 63 | 95 | 114* | 6.221 | | 47 | 86 | 131 | 140* | 3.828 |
| | | | | 0 | 0 | 131 | | | 0 | 0 | 0 | 177 | |
| 28'-0" | | | | 53 | 82 | 106* | 7.195 | | | 74 | 116 | 130* | 4.428 |
| | | | | 0 | 0 | 116 | | | | 0 | 0 | 159 | |
| 29'-0" | | | | 44 | 71 | 98* | 8.279 | | | 63 | 102 | 122* | 5.095 |
| | | | | 0 | 0 | 103 | | | | 0 | 0 | 142 | |
| 30'-0" | | | | | 61 | 90 | 9.481 | | | 53 | 90 | 114* | 5.835 |
| | | | | | 0 | 0 | | | | 0 | 0 | 127 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.47 CF/SF) (4)

| NEGATIVE MOMENT | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.64 | 0.78 | 0.93 | | 0.64 | 0.64 | 0.64 | 0.82 | 1.09 | |
| STEEL % (UNIFORM) | 0.82 | 0.82 | 0.82 | 1.01 | 1.21 | | 0.82 | 0.82 | 0.82 | 1.07 | 1.41 | |
| (TAPERED) | 0.45 | 0.45 | 0.45 | 0.55 | 0.66 | | 0.45 | 0.45 | 0.45 | 0.58 | 0.77 | |
| EFF. DEPTH, IN. | 12.75 | 12.75 | 12.75 | 12.75 | 12.75 | | 12.75 | 12.75 | 12.75 | 12.75 | 12.69 | |
| $-I_{cr}/I_{gr}$ | 0.195 | 0.195 | 0.195 | 0.227 | 0.259 | | 0.195 | 0.195 | 0.195 | 0.237 | 0.285 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.07 | 0.09 | 0.11 | 0.14 | 0.17 | | 0.05 | 0.07 | 0.09 | 0.11 | 0.14 | |
| EFF. DEPTH, IN. | 12.75 | 12.75 | 12.69 | 12.69 | 12.62 | | 12.81 | 12.75 | 12.75 | 12.69 | 12.69 | |
| $+I_{cr}/I_{gr}$ | 0.137 | 0.173 | 0.214 | 0.256 | 0.300 | | 0.100 | 0.137 | 0.173 | 0.214 | 0.256 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 4.0″ Top Slab = 14.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 8 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 8.5 | # 5 7 | # 5 8.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | |
| Steel (psf) | | 0.60 | 0.71 | 0.86 | 1.04 | 1.25 | | 0.66 | 0.75 | 0.95 | 1.18 | 1.46 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 17'-0" | | 200 | 276 | 299* | 308* | 318* | 1.006 | | | | | | |
| | | 0 | 0 | 354 | 435* | 448* | | | | | | | |
| 18'-0" | | 168 | 237 | 271* | 279* | 287* | 1.264 | 202 | | 316* | 322* | 330* | 0.778 |
| | | 0 | 0 | 306 | 386 | 406* | | 0 | | 385 | 486 | 501* | |
| 19'-0" | | 142 | 204 | 247* | 253* | 261* | 1.569 | 172 | 247 | 290* | 296* | 302* | 0.966 |
| | | 0 | 0 | 266 | 337 | 370* | | 0 | 0 | 337 | 427 | 459* | |
| 20'-0" | | 119 | 175 | 226* | 232* | 238* | 1.926 | 146 | 214 | 267* | 272* | 278* | 1.185 |
| | | 0 | 0 | 231 | 296 | 339* | | 0 | 0 | 295 | 377 | 418* | |
| 21'-0" | | 100 | 150 | 201 | 213* | 218* | 2.342 | 125 | 186 | 247* | 251* | 256* | 1.441 |
| | | 0 | 0 | 0 | 260 | 319 | | 0 | 0 | 259 | 334 | 378* | |
| 22'-0" | | 83 | 129 | 176 | 196* | 200* | 2.820 | 106 | 162 | 228 | 233* | 237* | 1.736 |
| | | 0 | 0 | 0 | 229 | 283 | | 0 | 0 | 0 | 296 | 342* | |
| 23'-0" | | 69 | 111 | 153 | 180* | 185* | 3.369 | 89 | 140 | 201 | 216* | 220* | 2.073 |
| | | 0 | 0 | 0 | 202 | 251 | | 0 | 0 | 0 | 263 | 312* | |
| 24'-0" | | 56 | 94 | 133 | 167* | 171* | 3.995 | 74 | 122 | 178 | 201* | 205* | 2.458 |
| | | 0 | 0 | 0 | 178 | 224 | | 0 | 0 | 0 | 235 | 285* | |
| 25'-0" | | 44 | 80 | 116 | 155* | 158* | 4.703 | 62 | 105 | 157 | 188* | 191* | 2.894 |
| | | 0 | 0 | 0 | 157 | 199 | | 0 | 0 | 0 | 209 | 262* | |
| 26'-0" | | | 67 | 100 | 138 | 147* | 5.502 | 50 | 90 | 138 | 176* | 178* | 3.386 |
| | | | 0 | 0 | 0 | 177 | | 0 | 0 | 0 | 187 | 242 | |
| 27'-0" | | | 56 | 87 | 122 | 136* | 6.398 | 40 | 77 | 122 | 164* | 167* | 3.938 |
| | | | 0 | 0 | 0 | 158 | | 0 | 0 | 0 | 167 | 218 | |
| 28'-0" | | | 46 | 74 | 107 | 127* | 7.400 | | 66 | 107 | 149 | 156* | 4.554 |
| | | | 0 | 0 | 0 | 141 | | | 0 | 0 | 0 | 196 | |
| 29'-0" | | | | 63 | 94 | 118* | 8.516 | | 55 | 94 | 132 | 146* | 5.240 |
| | | | | 0 | 0 | 125 | | | 0 | 0 | 0 | 177 | |
| 30'-0" | | | | 53 | 82 | 110* | 9.752 | | 46 | 82 | 118 | 137* | 6.001 |
| | | | | 0 | 0 | 111 | | | 0 | 0 | 0 | 160 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.49 CF/SF) (4)

| NEGATIVE MOMENT | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.76 | 0.90 | 1.12 | | 0.65 | 0.65 | 0.85 | 1.03 | 1.31 | |
| STEEL % (UNIFORM) | 0.73 | 0.73 | 0.84 | 1.00 | 1.25 | | 0.73 | 0.73 | 0.94 | 1.14 | 1.47 | |
| (TAPERED) | 0.43 | 0.43 | 0.49 | 0.59 | 0.73 | | 0.43 | 0.43 | 0.55 | 0.67 | 0.86 | |
| EFF. DEPTH, IN. | 12.75 | 12.75 | 12.75 | 12.75 | 12.69 | | 12.75 | 12.75 | 12.75 | 12.75 | 12.69 | |
| $-I_{cr}/I_{gr}$ | 0.183 | 0.183 | 0.205 | 0.233 | 0.269 | | 0.183 | 0.183 | 0.223 | 0.257 | 0.302 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.09 | 0.11 | 0.14 | 0.17 | 0.19 | | 0.07 | 0.09 | 0.11 | 0.14 | 0.17 | |
| EFF. DEPTH, IN. | 12.75 | 12.69 | 12.69 | 12.62 | 12.62 | | 12.75 | 12.75 | 12.69 | 12.69 | 12.62 | |
| $+I_{cr}/I_{gr}$ | 0.153 | 0.189 | 0.226 | 0.265 | 0.306 | | 0.121 | 0.153 | 0.189 | 0.226 | 0.265 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 4.0″ Top Slab = 16.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 7.5 | # 5 9.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 8.5 | # 5 10 | # 5 8.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.61 | 0.72 | 0.88 | 1.08 | 1.29 | | 0.67 | 0.77 | 0.97 | 1.25 | 1.48 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 19'-0" | | 184 | 257 | 275* | 287* | 297* | 1.525 | | | | | | |
| | | 0 | 0 | 332 | 380* | 391* | | | | | | | |
| 20'-0" | | 157 | 223 | 251* | 261* | 270* | 1.873 | | | | | | |
| | | 0 | 0 | 291 | 348* | 359* | | | | | | | |
| 21'-0" | | 134 | 194 | 230* | 239* | 247* | 2.276 | 163 | 236 | 271* | 277* | 283* | 1.401 |
| | | 0 | 0 | 255 | 325 | 340* | | 0 | 0 | 324 | 394* | 407* | |
| 22'-0" | | 114 | 169 | 212* | 219* | 226* | 2.742 | 140 | 207 | 251* | 256* | 261* | 1.687 |
| | | 0 | 0 | 224 | 288 | 314* | | 0 | 0 | 287 | 357* | 368* | |
| 23'-0" | | 96 | 147 | 195* | 202* | 208* | 3.276 | 121 | 182 | 233* | 238* | 242* | 2.016 |
| | | 0 | 0 | 197 | 256 | 291* | | 0 | 0 | 255 | 326* | 335* | |
| 24'-0" | | 81 | 127 | 174 | 187* | 192* | 3.884 | 103 | 159 | 217* | 221* | 225* | 2.390 |
| | | 0 | 0 | 0 | 227 | 271* | | 0 | 0 | 227 | 294 | 306* | |
| 25'-0" | | 67 | 110 | 153 | 173* | 177* | 4.572 | 88 | 140 | 202 | 206* | 210* | 2.814 |
| | | 0 | 0 | 0 | 202 | 252* | | 0 | 0 | 0 | 264 | 282* | |
| 26'-0" | | 55 | 95 | 134 | 160* | 164* | 5.349 | 74 | 122 | 179 | 192* | 196* | 3.292 |
| | | 0 | 0 | 0 | 180 | 227 | | 0 | 0 | 0 | 237 | 260* | |
| 27'-0" | | 45 | 81 | 118 | 149* | 153* | 6.221 | 62 | 107 | 160 | 180* | 183* | 3.828 |
| | | 0 | 0 | 0 | 160 | 203 | | 0 | 0 | 0 | 213 | 241* | |
| 28'-0" | | | 69 | 103 | 139* | 142* | 7.195 | 52 | 93 | 142 | 169* | 172* | 4.428 |
| | | | 0 | 0 | 143 | 183 | | 0 | 0 | 0 | 192 | 223* | |
| 29'-0" | | | 58 | 90 | 127 | 132* | 8.279 | 42 | 80 | 126 | 158* | 161* | 5.095 |
| | | | 0 | 0 | 0 | 164 | | 0 | 0 | 0 | 173 | 208* | |
| 30'-0" | | | 48 | 78 | 112 | 123* | 9.481 | | 69 | 112 | 148* | 151* | 5.835 |
| | | | 0 | 0 | 0 | 147 | | | 0 | 0 | 155 | 194* | |
| 31'-0" | | | | 67 | 100 | 115* | 10.810 | | 59 | 99 | 140* | 142* | 6.652 |
| | | | | 0 | 0 | 132 | | | 0 | 0 | 0 | 181* | |
| 32'-0" | | | | 58 | 88 | 107* | 12.274 | | 50 | 87 | 125 | 133* | 7.553 |
| | | | | 0 | 0 | 118 | | | 0 | 0 | 0 | 169 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.50 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.74 | 0.93 | 1.14 | | 0.64 | 0.64 | 0.82 | 1.09 | 1.28 | |
| STEEL % (UNIFORM) | 0.69 | 0.69 | 0.80 | 1.02 | 1.25 | | 0.69 | 0.69 | 0.90 | 1.19 | 1.40 | |
| (TAPERED) | 0.38 | 0.38 | 0.44 | 0.56 | 0.69 | | 0.38 | 0.38 | 0.50 | 0.66 | 0.77 | |
| EFF. DEPTH, IN. | 14.75 | 14.75 | 14.75 | 14.75 | 14.69 | | 14.75 | 14.75 | 14.75 | 14.69 | 14.69 | |
| $-I_{cr}/I_{gr}$ | 0.180 | 0.180 | 0.201 | 0.240 | 0.275 | | 0.180 | 0.180 | 0.219 | 0.266 | 0.298 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.08 | 0.10 | 0.12 | 0.15 | 0.17 | | 0.06 | 0.08 | 0.10 | 0.12 | 0.15 | |
| EFF. DEPTH, IN. | 14.75 | 14.69 | 14.69 | 14.62 | 14.62 | | 14.75 | 14.75 | 14.69 | 14.69 | 14.62 | |
| $+I_{cr}/I_{gr}$ | 0.156 | 0.193 | 0.231 | 0.272 | 0.314 | | 0.123 | 0.156 | 0.193 | 0.231 | 0.272 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 4.0″ Top Slab = 16.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 8 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 9 | # 4 7 | # 5 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.60 | 0.71 | 0.86 | 1.04 | 1.25 | | 0.66 | 0.75 | 0.93 | 1.18 | 1.42 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 19'-0" | | 173 | 244 | 313* | 321* | 331* | 1.569 | | | | | | |
| | | 0 | 0 | 317 | 400 | 435* | | | | | | | |
| 20'-0" | | 146 | 211 | 276 | 294* | 302* | 1.926 | | | | | | |
| | | 0 | 0 | 0 | 351 | 399* | | | | | | | |
| 21'-0" | | 124 | 183 | 242 | 270* | 277* | 2.342 | 152 | 224 | 309 | 316* | 320* | 1.441 |
| | | 0 | 0 | 0 | 310 | 376* | | 0 | 0 | 0 | 395 | 452* | |
| 22'-0" | | 104 | 158 | 212 | 249* | 255* | 2.820 | 130 | 195 | 273 | 293* | 297* | 1.736 |
| | | 0 | 0 | 0 | 274 | 337 | | 0 | 0 | 0 | 352 | 410* | |
| 23'-0" | | 88 | 136 | 186 | 230* | 236* | 3.369 | 111 | 171 | 242 | 273* | 276* | 2.073 |
| | | 0 | 0 | 0 | 243 | 300 | | 0 | 0 | 0 | 314 | 375* | |
| 24'-0" | | 73 | 117 | 163 | 213* | 218* | 3.995 | 94 | 149 | 214 | 255* | 257* | 2.458 |
| | | 0 | 0 | 0 | 215 | 268 | | 0 | 0 | 0 | 280 | 344* | |
| 25'-0" | | 59 | 101 | 143 | 191 | 203* | 4.703 | 79 | 130 | 190 | 238* | 240* | 2.894 |
| | | 0 | 0 | 0 | 0 | 239 | | 0 | 0 | 0 | 251 | 318* | |
| 26'-0" | | 48 | 86 | 125 | 169 | 188* | 5.502 | 66 | 113 | 168 | 223* | 225* | 3.386 |
| | | 0 | 0 | 0 | 0 | 214 | | 0 | 0 | 0 | 225 | 289 | |
| 27'-0" | | | 73 | 109 | 150 | 176* | 6.398 | 54 | 98 | 149 | 201 | 211* | 3.938 |
| | | | 0 | 0 | 0 | 192 | | 0 | 0 | 0 | 0 | 261 | |
| 28'-0" | | | 61 | 94 | 133 | 164* | 7.400 | 44 | 84 | 132 | 181 | 198* | 4.554 |
| | | | 0 | 0 | 0 | 172 | | 0 | 0 | 0 | 0 | 236 | |
| 29'-0" | | | 50 | 82 | 117 | 153* | 8.516 | | 72 | 117 | 162 | 186* | 5.240 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 214 | |
| 30'-0" | | | 41 | 70 | 103 | 137 | 9.752 | | 61 | 103 | 145 | 175* | 6.001 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 194 | |
| 31'-0" | | | | 59 | 91 | 122 | 11.119 | | 51 | 90 | 130 | 165* | 6.842 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 175 | |
| 32'-0" | | | | 50 | 79 | 109 | 12.625 | | 42 | 79 | 116 | 156* | 7.769 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 159 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.76 | 0.90 | 1.12 | | 0.65 | 0.65 | 0.80 | 1.03 | 1.24 | |
| STEEL % (UNIFORM) | 0.61 | 0.61 | 0.71 | 0.84 | 1.05 | | 0.61 | 0.61 | 0.75 | 0.96 | 1.17 | |
| (TAPERED) | 0.36 | 0.36 | 0.42 | 0.50 | 0.62 | | 0.36 | 0.36 | 0.44 | 0.57 | 0.69 | |
| EFF. DEPTH, IN. | 14.75 | 14.75 | 14.75 | 14.75 | 14.69 | | 14.75 | 14.75 | 14.75 | 14.75 | 14.69 | |
| $-I_{cr}/I_{gr}$ | 0.168 | 0.168 | 0.189 | 0.216 | 0.251 | | 0.168 | 0.168 | 0.197 | 0.238 | 0.271 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.08 | 0.10 | 0.12 | 0.14 | 0.17 | | 0.06 | 0.08 | 0.10 | 0.12 | 0.14 | |
| EFF. DEPTH, IN. | 14.75 | 14.69 | 14.69 | 14.62 | 14.62 | | 14.75 | 14.75 | 14.69 | 14.69 | 14.62 | |
| $+I_{cr}/I_{gr}$ | 0.138 | 0.171 | 0.204 | 0.241 | 0.278 | | 0.109 | 0.138 | 0.171 | 0.204 | 0.241 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

14″ Deep Rib + 4.0″ Top Slab = 18.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 7.5 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 8.5 | # 4 7 | # 5 8.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.61 | 0.72 | 0.88 | 1.08 | 1.28 | | 0.67 | 0.77 | 0.97 | 1.20 | 1.48 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 22'-0" | | 136 | 198 | 262 | 273* | 278* | 2.742 | | | | | | |
| | | 0 | 0 | 0 | 335 | 357* | | | | | | | |
| 23'-0" | | 116 | 173 | 231 | 252* | 257* | 3.276 | | | | | | |
| | | 0 | 0 | 0 | 298 | 332* | | | | | | | |
| 24'-0" | | 99 | 151 | 204 | 233* | 237* | 3.884 | 124 | 188 | 264 | 273* | 278* | 2.390 |
| | | 0 | 0 | 0 | 266 | 309* | | 0 | 0 | 0 | 342 | 365* | |
| 25'-0" | | 83 | 132 | 181 | 216* | 220* | 4.572 | 106 | 165 | 236 | 255* | 260* | 2.814 |
| | | 0 | 0 | 0 | 237 | 288* | | 0 | 0 | 0 | 307 | 337* | |
| 26'-0" | | 69 | 114 | 160 | 201* | 204* | 5.349 | 91 | 145 | 211 | 238* | 243* | 3.292 |
| | | 0 | 0 | 0 | 212 | 265 | | 0 | 0 | 0 | 277 | 311* | |
| 27'-0" | | 57 | 99 | 141 | 187* | 190* | 6.221 | 77 | 128 | 188 | 224* | 228* | 3.828 |
| | | 0 | 0 | 0 | 189 | 238 | | 0 | 0 | 0 | 249 | 289* | |
| 28'-0" | | 46 | 85 | 124 | 169 | 177* | 7.195 | 65 | 112 | 168 | 210* | 214* | 4.428 |
| | | 0 | 0 | 0 | 0 | 215 | | 0 | 0 | 0 | 225 | 269* | |
| 29'-0" | | | 73 | 109 | 151 | 166* | 8.279 | 54 | 98 | 150 | 197* | 201* | 5.095 |
| | | | 0 | 0 | 0 | 194 | | 0 | 0 | 0 | 203 | 251* | |
| 30'-0" | | | 62 | 96 | 135 | 155* | 9.481 | 44 | 85 | 134 | 183 | 189* | 5.835 |
| | | | 0 | 0 | 0 | 174 | | 0 | 0 | 0 | 0 | 235* | |
| 31'-0" | | | 51 | 83 | 120 | 145* | 10.810 | | 73 | 119 | 166 | 178* | 6.652 |
| | | | 0 | 0 | 0 | 157 | | | 0 | 0 | 0 | 219 | |
| 32'-0" | | | 42 | 72 | 107 | 136* | 12.274 | | 63 | 106 | 149 | 168* | 7.553 |
| | | | 0 | 0 | 0 | 142 | | | 0 | 0 | 0 | 199 | |
| 33'-0" | | | | 62 | 94 | 127 | 13.882 | | 53 | 94 | 135 | 159* | 8.543 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 182 | |
| 34'-0" | | | | 53 | 83 | 114 | 15.642 | | 45 | 83 | 121 | 150* | 9.626 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 166 | |
| 35'-0" | | | | 44 | 73 | 102 | 17.565 | | | 72 | 109 | 142* | 10.809 |
| | | | | 0 | 0 | 0 | | | | 0 | 0 | 151 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.54 CF/SF) [4]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.74 | 0.93 | 1.09 | | 0.64 | 0.64 | 0.82 | 1.00 | 1.28 | |
| STEEL % (UNIFORM) | 0.59 | 0.59 | 0.69 | 0.87 | 1.02 | | 0.59 | 0.59 | 0.77 | 0.93 | 1.20 | |
| (TAPERED) | 0.33 | 0.33 | 0.39 | 0.49 | 0.57 | | 0.33 | 0.33 | 0.43 | 0.52 | 0.67 | |
| EFF. DEPTH, IN. | 16.75 | 16.75 | 16.75 | 16.75 | 16.69 | | 16.75 | 16.75 | 16.75 | 16.75 | 16.69 | |
| $-I_{cr}/I_{gr}$ | 0.167 | 0.167 | 0.187 | 0.224 | 0.248 | | 0.167 | 0.167 | 0.204 | 0.236 | 0.279 | |
| POSITIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.07 | 0.09 | 0.11 | 0.13 | 0.15 | | 0.05 | 0.07 | 0.09 | 0.11 | 0.13 | |
| EFF. DEPTH, IN. | 16.75 | 16.69 | 16.69 | 16.62 | 16.62 | | 16.75 | 16.75 | 16.69 | 16.69 | 16.62 | |
| $+I_{cr}/I_{gr}$ | 0.142 | 0.176 | 0.211 | 0.249 | 0.287 | | 0.112 | 0.142 | 0.176 | 0.211 | 0.249 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

14″ Deep Rib + 4.0″ Top Slab = 18.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 10 | # 4 8 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 9 | # 4 7 | # 5 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.60 | 0.71 | 0.85 | 1.04 | 1.25 | | 0.66 | 0.75 | 0.93 | 1.18 | 1.42 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 22'-0" | | 125 | 185 | 247 | 305* | 314* | 2.820 | | | | | | |
| | | 0 | 0 | 0 | 318 | 390 | | | | | | | |
| 23'-0" | | 105 | 161 | 217 | 282 | 290* | 3.369 | | | | | | |
| | | 0 | 0 | 0 | 0 | 348 | | | | | | | |
| 24'-0" | | 88 | 139 | 191 | 251 | 269* | 3.995 | 113 | 175 | 249 | 311* | 314* | 2.458 |
| | | 0 | 0 | 0 | 0 | 311 | | 0 | 0 | 0 | 325 | 407* | |
| 25'-0" | | 73 | 120 | 168 | 223 | 250* | 4.703 | 96 | 153 | 222 | 291* | 294* | 2.894 |
| | | 0 | 0 | 0 | 0 | 279 | | 0 | 0 | 0 | 0 | 371 | |
| 26'-0" | | 60 | 104 | 148 | 198 | 233* | 5.502 | 81 | 134 | 197 | 261 | 275* | 3.386 |
| | | 0 | 0 | 0 | 0 | 250 | | 0 | 0 | 0 | 0 | 335 | |
| 27'-0" | | 48 | 89 | 130 | 177 | 217* | 6.398 | 68 | 117 | 176 | 235 | 259* | 3.938 |
| | | 0 | 0 | 0 | 0 | 224 | | 0 | 0 | 0 | 0 | 303 | |
| 28'-0" | | | 75 | 113 | 157 | 201 | 7.400 | 56 | 101 | 156 | 211 | 243* | 4.554 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 275 | |
| 29'-0" | | | 63 | 99 | 139 | 181 | 8.516 | 45 | 88 | 139 | 190 | 229* | 5.240 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 249 | |
| 30'-0" | | | 52 | 85 | 124 | 162 | 9.752 | | 75 | 123 | 171 | 216* | 6.001 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 226 | |
| 31'-0" | | | 43 | 74 | 109 | 145 | 11.119 | | 64 | 108 | 154 | 204* | 6.842 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 205 | |
| 32'-0" | | | | 63 | 96 | 130 | 12.625 | | 54 | 95 | 138 | 187 | 7.769 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 33'-0" | | | | 53 | 84 | 116 | 14.278 | | 44 | 84 | 123 | 169 | 8.787 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 34'-0" | | | | 44 | 74 | 104 | 16.089 | | | 73 | 110 | 154 | 9.901 |
| | | | | 0 | 0 | 0 | | | | 0 | 0 | 0 | |
| 35'-0" | | | | | 64 | 92 | 18.067 | | | 63 | 98 | 139 | 11.118 |
| | | | | | 0 | 0 | | | | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) [4]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.72 | 0.90 | 1.12 | | 0.65 | 0.65 | 0.80 | 1.03 | 1.24 | |
| STEEL % (UNIFORM) | 0.53 | 0.53 | 0.58 | 0.73 | 0.90 | | 0.53 | 0.53 | 0.65 | 0.83 | 1.01 | |
| (TAPERED) | 0.32 | 0.32 | 0.35 | 0.43 | 0.54 | | 0.32 | 0.32 | 0.39 | 0.50 | 0.60 | |
| EFF. DEPTH, IN. | 16.75 | 16.75 | 16.75 | 16.75 | 16.69 | | 16.75 | 16.75 | 16.75 | 16.75 | 16.69 | |
| $-I_{cr}/I_{gr}$ | 0.156 | 0.156 | 0.169 | 0.201 | 0.235 | | 0.156 | 0.156 | 0.183 | 0.222 | 0.254 | |
| POSITIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.07 | 0.08 | 0.10 | 0.13 | 0.15 | | 0.05 | 0.07 | 0.08 | 0.10 | 0.13 | |
| EFF. DEPTH, IN. | 16.75 | 16.69 | 16.69 | 16.62 | 16.62 | | 16.75 | 16.75 | 16.69 | 16.69 | 16.62 | |
| $+I_{cr}/I_{gr}$ | 0.126 | 0.156 | 0.187 | 0.221 | 0.255 | | 0.099 | 0.126 | 0.156 | 0.187 | 0.221 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

16″ Deep Rib + 4.0″ Top Slab = 20.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 10 | # 4 8 | # 5 10 | # 5 9 | End Span Defl. Coeff. (3) | # 4 11 | # 4 9 | # 4 7 | # 5 9 | # 5 7.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| Steel (psf) | | 0.71 | 0.85 | 1.04 | 1.25 | 1.44 | | 0.75 | 0.93 | 1.18 | 1.42 | 1.71 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 25'-0" | | 140 | 194 | 255 | 301* | 306* | 4.703 | | | | | | |
| | | 0 | 0 | 0 | 318 | 376* | | | | | | | |
| 26'-0" | | 121 | 171 | 228 | 281* | 285* | 5.502 | | | | 329* | | 3.386 |
| | | 0 | 0 | 0 | 286 | 352* | | | | | 381 | | |
| 27'-0" | | 105 | 150 | 203 | 257 | 266* | 6.398 | 136 | 202 | 269 | 310* | 315* | 3.938 |
| | | 0 | 0 | 0 | 0 | 321 | | 0 | 0 | 0 | 346 | 387* | |
| 28'-0" | | 90 | 132 | 181 | 231 | 249* | 7.400 | 119 | 180 | 242 | 292* | 297* | 4.554 |
| | | 0 | 0 | 0 | 0 | 291 | | 0 | 0 | 0 | 314 | 362* | |
| 29'-0" | | 76 | 116 | 162 | 208 | 234* | 8.516 | 103 | 160 | 218 | 275* | 280* | 5.240 |
| | | 0 | 0 | 0 | 0 | 264 | | 0 | 0 | 0 | 285 | 339* | |
| 30'-0" | | 64 | 101 | 144 | 187 | 219* | 9.752 | 89 | 143 | 197 | 259 | 264* | 6.001 |
| | | 0 | 0 | 0 | 0 | 239 | | 0 | 0 | 0 | 0 | 318* | |
| 31'-0" | | 53 | 88 | 128 | 168 | 206* | 11.119 | 77 | 127 | 177 | 236 | 250* | 6.842 |
| | | 0 | 0 | 0 | 0 | 217 | | 0 | 0 | 0 | 0 | 295 | |
| 32'-0" | | 43 | 75 | 113 | 151 | 194* | 12.625 | 65 | 112 | 160 | 214 | 236* | 7.769 |
| | | 0 | 0 | 0 | 0 | 197 | | 0 | 0 | 0 | 0 | 270 | |
| 33'-0" | | | 64 | 100 | 136 | 179 | 14.278 | 55 | 99 | 144 | 195 | 224* | 8.787 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 247 | |
| 34'-0" | | | 54 | 88 | 122 | 162 | 16.089 | 45 | 87 | 129 | 177 | 212* | 9.901 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 227 | |
| 35'-0" | | | 45 | 77 | 109 | 147 | 18.067 | | 76 | 115 | 161 | 202* | 11.118 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 208 | |
| 36'-0" | | | | 66 | 97 | 133 | 20.222 | | 66 | 103 | 146 | 190 | 12.445 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 37'-0" | | | | 57 | 86 | 120 | 22.565 | | 56 | 92 | 133 | 174 | 13.886 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 38'-0" | | | | 48 | 75 | 108 | 25.105 | | 48 | 81 | 120 | 160 | 15.449 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.72 | 0.90 | 1.12 | 1.24 | | 0.65 | 0.80 | 1.03 | 1.24 | 1.49 | |
| STEEL % (UNIFORM) | 0.46 | 0.51 | 0.63 | 0.79 | 0.88 | | 0.46 | 0.56 | 0.73 | 0.88 | 1.05 | |
| (TAPERED) | 0.28 | 0.31 | 0.38 | 0.48 | 0.53 | | 0.28 | 0.34 | 0.44 | 0.53 | 0.63 | |
| EFF. DEPTH, IN. | 18.75 | 18.75 | 18.75 | 18.69 | 18.69 | | 18.75 | 18.75 | 18.75 | 18.69 | 18.69 | |
| $-I_{cr}/I_{gr}$ | 0.146 | 0.157 | 0.188 | 0.221 | 0.239 | | 0.146 | 0.171 | 0.209 | 0.239 | 0.274 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | |
| STEEL % | 0.08 | 0.09 | 0.11 | 0.13 | 0.16 | | 0.06 | 0.08 | 0.09 | 0.11 | 0.13 | |
| EFF. DEPTH, IN. | 18.69 | 18.69 | 18.62 | 18.62 | 18.56 | | 18.75 | 18.69 | 18.69 | 18.62 | 18.62 | |
| $+I_{cr}/I_{gr}$ | 0.144 | 0.172 | 0.204 | 0.236 | 0.272 | | 0.116 | 0.144 | 0.172 | 0.204 | 0.236 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 7" Rib @ 37" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

16″ Deep Rib + 4.0″ Top Slab = 20.0″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8.5 | # 4 7 | # 5 9 | # 5 8 | End Span Defl. Coeff. (3) | # 4 9 | # 4 7.5 | # 5 9.5 | # 5 8 | # 6 9.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| | # | # 5 | # 6 | # 6 | # 7 | # 7 | | # 5 | # 5 | # 6 | # 6 | # 7 | |
| Steel (psf) | | 0.83 | 1.00 | 1.20 | 1.41 | 1.63 | | 0.92 | 1.13 | 1.36 | 1.63 | 1.93 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 25'-0" | | 181 | 241 | 302 | 338* | 345* | 4.834 | | | | | | |
| | | 0 | 0 | 0 | 375 | 422* | | | | | | | |
| 26'-0" | | 158 | 214 | 270 | 316* | 322* | 5.655 | | | 363 | | 375* | 3.480 |
| | | 0 | 0 | 0 | 338 | 396* | | | | 0 | | 464* | |
| 27'-0" | | 139 | 190 | 242 | 295* | 301* | 6.576 | 189 | 254 | 329 | 348* | 352* | 4.047 |
| | | 0 | 0 | 0 | 305 | 368 | | 0 | 0 | 0 | 405 | 432* | |
| 28'-0" | | 121 | 169 | 217 | 276 | 282* | 7.606 | 168 | 228 | 298 | 328* | 332* | 4.681 |
| | | 0 | 0 | 0 | 0 | 335 | | 0 | 0 | 0 | 368 | 404* | |
| 29'-0" | | 105 | 150 | 195 | 249 | 265* | 8.752 | 148 | 205 | 270 | 310* | 313* | 5.386 |
| | | 0 | 0 | 0 | 0 | 304 | | 0 | 0 | 0 | 335 | 378* | |
| 30'-0" | | 91 | 132 | 175 | 225 | 249* | 10.023 | 131 | 184 | 244 | 293* | 296* | 6.168 |
| | | 0 | 0 | 0 | 0 | 277 | | 0 | 0 | 0 | 306 | 355* | |
| 31'-0" | | 78 | 117 | 156 | 204 | 234* | 11.428 | 116 | 165 | 222 | 277* | 280* | 7.033 |
| | | 0 | 0 | 0 | 0 | 252 | | 0 | 0 | 0 | 279 | 334* | |
| 32'-0" | | 66 | 102 | 140 | 184 | 221* | 12.975 | 101 | 148 | 201 | 255 | 266* | 7.985 |
| | | 0 | 0 | 0 | 0 | 229 | | 0 | 0 | 0 | 0 | 315* | |
| 33'-0" | | 55 | 89 | 124 | 166 | 209* | 14.675 | 89 | 132 | 182 | 233 | 252* | 9.031 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 294 | |
| 34'-0" | | 45 | 78 | 111 | 150 | 190 | 16.536 | 77 | 118 | 165 | 213 | 239* | 10.176 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 270 | |
| 35'-0" | | | 67 | 98 | 135 | 173 | 18.569 | 66 | 105 | 149 | 194 | 227* | 11.427 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 249 | |
| 36'-0" | | | 57 | 86 | 121 | 157 | 20.784 | 56 | 93 | 135 | 177 | 216* | 12.790 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 229 | |
| 37'-0" | | | 48 | 76 | 109 | 143 | 23.191 | 47 | 82 | 121 | 162 | 206* | 14.272 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 210 | |
| 38'-0" | | | | 66 | 97 | 129 | 25.802 | | 71 | 109 | 148 | 194 | 15.878 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.74 | 0.87 | 1.06 | 1.27 | 1.43 | | 0.82 | 0.99 | 1.21 | 1.43 | 1.71 | |
| STEEL % (UNIFORM) | 0.46 | 0.54 | 0.66 | 0.80 | 0.90 | | 0.51 | 0.61 | 0.76 | 0.90 | 1.08 | |
| (TAPERED) | 0.29 | 0.34 | 0.42 | 0.50 | 0.57 | | 0.32 | 0.39 | 0.48 | 0.57 | 0.68 | |
| EFF. DEPTH, IN. | 18.75 | 18.75 | 18.75 | 18.69 | 18.69 | | 18.75 | 18.75 | 18.69 | 18.69 | 18.62 | |
| $-I_{cr}/I_{gr}$ | 0.149 | 0.170 | 0.199 | 0.228 | 0.249 | | 0.163 | 0.188 | 0.219 | 0.249 | 0.283 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | |
| STEEL % | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | | 0.07 | 0.09 | 0.11 | 0.13 | 0.15 | |
| EFF. DEPTH, IN. | 18.69 | 18.62 | 18.62 | 18.56 | 18.56 | | 18.69 | 18.69 | 18.62 | 18.62 | 18.56 | |
| $+I_{cr}/I_{gr}$ | 0.156 | 0.184 | 0.213 | 0.246 | 0.280 | | 0.130 | 0.156 | 0.184 | 0.213 | 0.246 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

20″ Deep Rib + 4.0″ Top Slab = 24.0″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8 | # 4 7 | # 5 9 | # 5 7.5 | End Span Defl. Coeff. (3) | # 4 9 | # 4 7.5 | # 5 9.5 | # 5 8 | # 6 9.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | |
| Steel (psf) | | 0.85 | 1.04 | 1.23 | 1.44 | 1.69 | | 0.93 | 1.14 | 1.38 | 1.66 | 1.96 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'-0" | | 132 | 184 | 237 | 301 | 314* | 9.752 | | | | | | |
| | | 0 | 0 | 0 | 0 | 363* | | | | | | | |
| 31'-0" | | 116 | 165 | 214 | 274 | 295* | 11.119 | | | | | | |
| | | 0 | 0 | 0 | 0 | 335 | | | | | | | |
| 32'-0" | | 101 | 147 | 194 | 250 | 278* | 12.625 | 146 | | 270 | | 327* | 7.769 |
| | | 0 | 0 | 0 | 0 | 306 | | 0 | | 0 | | 373* | |
| 33'-0" | | 88 | 131 | 175 | 227 | 263* | 14.278 | 129 | 184 | 247 | 307* | 310* | 8.787 |
| | | 0 | 0 | 0 | 0 | 281 | | 0 | 0 | 0 | 311 | 353* | |
| 34'-0" | | 75 | 116 | 157 | 207 | 248* | 16.089 | 115 | 166 | 225 | 285 | 295* | 9.901 |
| | | 0 | 0 | 0 | 0 | 257 | | 0 | 0 | 0 | 0 | 334* | |
| 35'-0" | | 64 | 103 | 142 | 188 | 235* | 18.067 | 101 | 150 | 206 | 262 | 280* | 11.118 |
| | | 0 | 0 | 0 | 0 | 236 | | 0 | 0 | 0 | 0 | 317* | |
| 36'-0" | | 54 | 90 | 127 | 171 | 216 | 20.222 | 89 | 135 | 188 | 241 | 267* | 12.445 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 301* | |
| 37'-0" | | 44 | 79 | 114 | 156 | 198 | 22.565 | 78 | 121 | 171 | 222 | 254* | 13.886 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 283 | |
| 38'-0" | | | 68 | 101 | 141 | 181 | 25.105 | 67 | 108 | 156 | 204 | 243* | 15.449 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 261 | |
| 39'-0" | | | 58 | 90 | 128 | 166 | 27.853 | 57 | 96 | 141 | 187 | 232* | 17.141 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 242 | |
| 40'-0" | | | 49 | 79 | 115 | 151 | 30.822 | 49 | 85 | 128 | 172 | 221* | 18.967 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 224 | |
| 41'-0" | | | 41 | 69 | 104 | 138 | 34.022 | 40 | 75 | 116 | 157 | 207 | 20.936 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| 42'-0" | | | | 60 | 93 | 126 | 37.464 | | 66 | 105 | 144 | 192 | 23.055 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 43'-0" | | | | 52 | 83 | 114 | 41.162 | | 57 | 94 | 132 | 177 | 25.330 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.72 | 0.90 | 1.03 | 1.24 | 1.49 | | 0.80 | 0.96 | 1.17 | 1.39 | 1.67 | |
| STEEL % (UNIFORM) | 0.40 | 0.50 | 0.57 | 0.69 | 0.83 | | 0.45 | 0.53 | 0.66 | 0.78 | 0.93 | |
| (TAPERED) | 0.25 | 0.31 | 0.35 | 0.42 | 0.51 | | 0.27 | 0.33 | 0.40 | 0.48 | 0.57 | |
| EFF. DEPTH, IN. | 22.75 | 22.75 | 22.75 | 22.69 | 22.69 | | 22.75 | 22.75 | 22.69 | 22.69 | 22.62 | |
| $-I_{cr}/I_{gr}$ | 0.140 | 0.168 | 0.187 | 0.215 | 0.247 | | 0.152 | 0.177 | 0.206 | 0.235 | 0.267 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | |
| STEEL % | 0.08 | 0.09 | 0.11 | 0.13 | 0.15 | | 0.06 | 0.08 | 0.09 | 0.11 | 0.13 | |
| EFF. DEPTH, IN. | 22.69 | 22.62 | 22.62 | 22.56 | 22.56 | | 22.69 | 22.69 | 22.62 | 22.62 | 22.56 | |
| $+I_{cr}/I_{gr}$ | 0.150 | 0.178 | 0.206 | 0.238 | 0.271 | | 0.125 | 0.150 | 0.178 | 0.206 | 0.238 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 7" Rib @ 37" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

20″ Deep Rib + 4.0″ Top Slab = 24.0″ Total Depth

| TOP BARS | Size @ | # 4 8 | # 4 7 | # 5 9.5 | # 5 8 | # 6 9.5 | End Span Defl. Coeff. (3) | # 5 11 | # 5 9.5 | # 5 8 | # 5 7 | # 5 6 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | |
| Steel (psf) | | 1.02 | 1.20 | 1.40 | 1.63 | 1.89 | | 1.16 | 1.36 | 1.63 | 1.88 | 2.20 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'-0" | | 169 | 221 | 283 | 340* | 348* | 10.023 | | | | | | |
| | | 0 | 0 | 0 | 346 | 403* | | | | | | | |
| 31'-0" | | 150 | 198 | 256 | 315 | 328* | 11.428 | | | | | | |
| | | 0 | 0 | 0 | 0 | 382* | | | | | | | |
| 32'-0" | | 133 | 178 | 233 | 288 | 309* | 12.975 | | 253 | | 360* | 366* | 7.985 |
| | | 0 | 0 | 0 | 0 | 352 | | | 0 | | 398 | 416* | |
| 33'-0" | | 117 | 159 | 211 | 263 | 292* | 14.675 | 168 | 230 | 292 | 342* | 347* | 9.031 |
| | | 0 | 0 | 0 | 0 | 323 | | 0 | 0 | 0 | 366 | 394* | |
| 34'-0" | | 102 | 143 | 191 | 240 | 276* | 16.536 | 151 | 209 | 267 | 326* | 330* | 10.176 |
| | | 0 | 0 | 0 | 0 | 297 | | 0 | 0 | 0 | 337 | 373* | |
| 35'-0" | | 89 | 127 | 173 | 219 | 262* | 18.569 | 135 | 190 | 245 | 310* | 314* | 11.427 |
| | | 0 | 0 | 0 | 0 | 273 | | 0 | 0 | 0 | 311 | 354* | |
| 36'-0" | | 77 | 113 | 156 | 200 | 248* | 20.784 | 120 | 172 | 224 | 287 | 300* | 12.790 |
| | | 0 | 0 | 0 | 0 | 250 | | 0 | 0 | 0 | 0 | 336* | |
| 37'-0" | | 66 | 100 | 141 | 182 | 230 | 23.191 | 107 | 156 | 205 | 265 | 286* | 14.272 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 320* | |
| 38'-0" | | 56 | 88 | 127 | 166 | 211 | 25.802 | 95 | 141 | 188 | 244 | 273* | 15.878 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 301 | |
| 39'-0" | | 46 | 77 | 114 | 151 | 194 | 28.627 | 83 | 127 | 172 | 225 | 260* | 17.617 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 279 | |
| 40'-0" | | | 67 | 102 | 137 | 178 | 31.678 | 73 | 114 | 157 | 207 | 249* | 19.494 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 259 | |
| 41'-0" | | | 57 | 90 | 124 | 163 | 34.967 | 63 | 103 | 143 | 191 | 238* | 21.518 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 240 | |
| 42'-0" | | | 48 | 80 | 112 | 149 | 38.505 | 54 | 92 | 130 | 176 | 223 | 23.695 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| 43'-0" | | | 40 | 70 | 101 | 136 | 42.305 | 45 | 81 | 118 | 162 | 206 | 26.034 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.06 | 1.21 | 1.43 | 1.71 | | 1.04 | 1.21 | 1.43 | 1.64 | 1.91 | |
| STEEL % (UNIFORM) | 0.46 | 0.52 | 0.60 | 0.71 | 0.85 | | 0.52 | 0.60 | 0.71 | 0.81 | 0.95 | |
| (TAPERED) | 0.29 | 0.33 | 0.38 | 0.45 | 0.55 | | 0.33 | 0.38 | 0.45 | 0.52 | 0.61 | |
| EFF. DEPTH, IN. | 22.75 | 22.75 | 22.69 | 22.69 | 22.62 | | 22.69 | 22.69 | 22.69 | 22.69 | 22.69 | |
| $-I_{cr}/I_{gr}$ | 0.160 | 0.178 | 0.196 | 0.225 | 0.256 | | 0.175 | 0.196 | 0.225 | 0.249 | 0.280 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | |
| STEEL % | 0.09 | 0.11 | 0.12 | 0.14 | 0.17 | | 0.07 | 0.09 | 0.11 | 0.12 | 0.14 | |
| EFF. DEPTH, IN. | 22.62 | 22.62 | 22.56 | 22.56 | 22.50 | | 22.69 | 22.62 | 22.62 | 22.56 | 22.56 | |
| $+I_{cr}/I_{gr}$ | 0.161 | 0.187 | 0.216 | 0.246 | 0.279 | | 0.136 | 0.161 | 0.187 | 0.216 | 0.246 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 4.5″ Top Slab = 12.5″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9 | # 5 11 | # 5 6 | End Span Defl. Coeff. (3) | # 4 11 | # 4 10.5 | # 4 8 | # 4 4 | # 6 7 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.61 | 0.72 | 0.89 | 1.09 | 1.49 | | 0.67 | 0.78 | 1.00 | 1.63 | 2.03 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 16'-0" | | 209 | 226* | 235* | 245* | 294* | 0.767 | 247 | 262* | 270* | 306* | 319* | 0.472 |
| | | 0 | 287 | 361* | 374* | 389* | | 0 | 343 | 456* | 492* | 503* | |
| 17'-0" | | 175 | 203* | 210* | 218* | 260* | 0.978 | 209 | 237* | 244* | 275* | 286* | 0.602 |
| | | 0 | 244 | 315 | 335* | 349* | | 0 | 294 | 395 | 449* | 458* | |
| 18'-0" | | 147 | 182* | 189* | 196* | 232* | 1.229 | 177 | 215* | 222* | 249* | 258* | 0.756 |
| | | 0 | 209 | 271 | 302* | 314* | | 0 | 253 | 343 | 411* | 420* | |
| 19'-0" | | 123 | 165* | 170* | 176* | 208* | 1.525 | 150 | 196* | 202* | 226* | 234* | 0.939 |
| | | 0 | 178 | 235 | 274* | 285* | | 0 | 218 | 299 | 374* | 385* | |
| 20'-0" | | 102 | 150* | 154* | 160* | 187* | 1.873 | 127 | 180* | 185* | 206* | 213* | 1.153 |
| | | 0 | 152 | 203 | 249* | 260* | | 0 | 188 | 261 | 335 | 351* | |
| 21'-0" | | 85 | 130 | 140* | 145* | 169* | 2.276 | 107 | 163 | 169* | 188* | 194* | 1.401 |
| | | 0 | 0 | 176 | 229 | 245* | | 0 | 0 | 229 | 296 | 318* | |
| 22'-0" | | 69 | 111 | 128* | 132* | 153* | 2.742 | 90 | 141 | 156* | 173* | 178* | 1.687 |
| | | 0 | 0 | 153 | 201 | 224* | | 0 | 0 | 201 | 262 | 286* | |
| 23'-0" | | 56 | 94 | 116* | 120* | 140* | 3.276 | 75 | 121 | 143* | 159* | 163* | 2.016 |
| | | 0 | 0 | 133 | 176 | 206* | | 0 | 0 | 176 | 232 | 257* | |
| 24'-0" | | 45 | 79 | 106* | 110* | 127* | 3.884 | 62 | 104 | 132* | 146* | 150* | 2.390 |
| | | 0 | 0 | 115 | 155 | 190* | | 0 | 0 | 155 | 206 | 231* | |
| 25'-0" | | | 66 | 97* | 100* | 116* | 4.572 | 50 | 89 | 122* | 135* | 138* | 2.814 |
| | | | 0 | 99 | 136 | 174 | | 0 | 0 | 136 | 183 | 210* | |
| 26'-0" | | | 55 | 85 | 92* | 106* | 5.349 | 40 | 76 | 113* | 125* | 128* | 3.292 |
| | | | 0 | 0 | 119 | 154 | | 0 | 0 | 119 | 163 | 191* | |
| 27'-0" | | | 44 | 72 | 84* | 97* | 6.221 | | 64 | 104 | 115* | 118* | 3.828 |
| | | | 0 | 0 | 104 | 136 | | | 0 | 0 | 145 | 174* | |
| 28'-0" | | | | 61 | 77* | 89* | 7.195 | | 54 | 91 | 107* | 109* | 4.428 |
| | | | | 0 | 91 | 121 | | | 0 | 0 | 128 | 160* | |
| 29'-0" | | | | 51 | 70* | 81* | 8.279 | | 44 | 79 | 99* | 101* | 5.095 |
| | | | | 0 | 79 | 107 | | | 0 | 0 | 114 | 146* | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.48 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.78 | 0.99 | 1.81 | | 0.64 | 0.67 | 0.88 | 1.75 | 2.20 | |
| STEEL % (UNIFORM) | 0.95 | 0.95 | 1.16 | 1.49 | 2.72 | | 0.95 | 1.00 | 1.31 | 2.62 | 3.34 | |
| (TAPERED) | 0.52 | 0.52 | 0.63 | 0.81 | 1.48 | | 0.52 | 0.54 | 0.71 | 1.42 | 1.81 | |
| EFF. DEPTH, IN. | 11.25 | 11.25 | 11.25 | 11.19 | 11.19 | | 11.25 | 11.25 | 11.25 | 11.25 | 11.12 | |
| $-I_{cr}/I_{gr}$ | 0.207 | 0.207 | 0.240 | 0.281 | 0.417 | | 0.207 | 0.214 | 0.261 | 0.414 | 0.462 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.10 | 0.13 | 0.16 | 0.19 | 0.23 | | 0.08 | 0.10 | 0.13 | 0.16 | 0.19 | |
| EFF. DEPTH, IN. | 11.25 | 11.19 | 11.19 | 11.12 | 11.12 | | 11.25 | 11.25 | 11.19 | 11.19 | 11.12 | |
| $+I_{cr}/I_{gr}$ | 0.188 | 0.232 | 0.276 | 0.324 | 0.373 | | 0.149 | 0.188 | 0.232 | 0.276 | 0.324 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 4.5″ Top Slab = 12.5″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 7.5 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 8.5 | # 4 7 | # 6 8 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.60 | 0.71 | 0.86 | 1.05 | 1.25 | | 0.66 | 0.75 | 0.95 | 1.18 | 1.85 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 16'-0" | | 197 | 260* | 266* | 278* | 284* | 0.789 | 234 | 301* | 308* | 316* | 347* | 0.486 |
| | | 0 | 273 | 350 | 417* | 431* | | 0 | 328 | 438 | 497* | 527* | |
| 17'-0" | | 164 | 232 | 239* | 249* | 254* | 1.006 | 197 | 273* | 280* | 286* | 313* | 0.619 |
| | | 0 | 0 | 300 | 374* | 387* | | 0 | 280 | 378 | 455* | 481* | |
| 18'-0" | | 137 | 197 | 216* | 225* | 229* | 1.264 | 166 | 240 | 255* | 260* | 284* | 0.778 |
| | | 0 | 0 | 258 | 327 | 350* | | 0 | 0 | 327 | 416* | 441* | |
| 19'-0" | | 113 | 167 | 196* | 204* | 207* | 1.569 | 140 | 206 | 233* | 238* | 258* | 0.966 |
| | | 0 | 0 | 222 | 285 | 318* | | 0 | 0 | 285 | 364 | 406* | |
| 20'-0" | | 94 | 142 | 179* | 185* | 188* | 1.926 | 117 | 177 | 214* | 218* | 236* | 1.185 |
| | | 0 | 0 | 192 | 248 | 290* | | 0 | 0 | 248 | 320 | 373* | |
| 21'-0" | | 76 | 121 | 163* | 169* | 172* | 2.342 | 98 | 152 | 197* | 201* | 217* | 1.441 |
| | | 0 | 0 | 165 | 217 | 269 | | 0 | 0 | 217 | 282 | 341* | |
| 22'-0" | | 62 | 102 | 143 | 155* | 157* | 2.820 | 81 | 131 | 182* | 185* | 199* | 1.736 |
| | | 0 | 0 | 0 | 189 | 237 | | 0 | 0 | 189 | 249 | 309* | |
| 23'-0" | | 49 | 85 | 123 | 142* | 144* | 3.369 | 67 | 112 | 165 | 171* | 184* | 2.073 |
| | | 0 | 0 | 0 | 165 | 209 | | 0 | 0 | 0 | 220 | 279* | |
| 24'-0" | | | 71 | 105 | 130* | 132* | 3.995 | 54 | 95 | 145 | 159* | 170* | 2.458 |
| | | | 0 | 0 | 145 | 185 | | 0 | 0 | 0 | 195 | 251 | |
| 25'-0" | | | 58 | 90 | 120* | 121* | 4.703 | 43 | 81 | 126 | 147* | 157* | 2.894 |
| | | | 0 | 0 | 126 | 163 | | 0 | 0 | 0 | 172 | 225 | |
| 26'-0" | | | 47 | 77 | 110 | 112* | 5.502 | | 68 | 110 | 137* | 146* | 3.386 |
| | | | 0 | 0 | 0 | 144 | | | 0 | 0 | 152 | 201 | |
| 27'-0" | | | | 64 | 95 | 103* | 6.398 | | 56 | 95 | 127* | 135* | 3.938 |
| | | | | 0 | 0 | 127 | | | 0 | 0 | 135 | 180 | |
| 28'-0" | | | | 53 | 82 | 95* | 7.400 | | 46 | 82 | 118* | 126* | 4.554 |
| | | | | 0 | 0 | 112 | | | 0 | 0 | 119 | 161 | |
| 29'-0" | | | | 44 | 70 | 87* | 8.516 | | | 71 | 105 | 117* | 5.240 |
| | | | | 0 | 0 | 98 | | | | 0 | 0 | 144 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.50 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.76 | 0.96 | 1.12 | | 0.65 | 0.65 | 0.85 | 1.03 | 1.98 | |
| STEEL % (UNIFORM) | 0.84 | 0.84 | 0.97 | 1.23 | 1.44 | | 0.84 | 0.84 | 1.09 | 1.32 | 2.57 | |
| (TAPERED) | 0.49 | 0.49 | 0.56 | 0.71 | 0.84 | | 0.49 | 0.49 | 0.63 | 0.77 | 1.49 | |
| EFF. DEPTH, IN. | 11.25 | 11.25 | 11.25 | 11.25 | 11.19 | | 11.25 | 11.25 | 11.25 | 11.25 | 11.12 | |
| $-I_{cr}/I_{gr}$ | 0.195 | 0.195 | 0.217 | 0.259 | 0.284 | | 0.195 | 0.195 | 0.236 | 0.272 | 0.410 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.10 | 0.13 | 0.15 | 0.19 | 0.22 | | 0.08 | 0.10 | 0.13 | 0.15 | 0.19 | |
| EFF. DEPTH, IN. | 11.25 | 11.19 | 11.19 | 11.12 | 11.12 | | 11.25 | 11.25 | 11.19 | 11.19 | 11.12 | |
| $+I_{cr}/I_{gr}$ | 0.166 | 0.205 | 0.244 | 0.286 | 0.330 | | 0.131 | 0.166 | 0.205 | 0.244 | 0.286 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 4.5″ Top Slab = 14.5″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9 | # 4 7.5 | # 5 9.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 8.5 | # 5 10 | # 6 7.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.61 | 0.72 | 0.89 | 1.08 | 1.29 | | 0.67 | 0.77 | 0.97 | 1.25 | 1.95 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 19'-0" | | 154 | 219* | 226* | 234* | 242* | 1.525 | 186 | 256* | 263* | 269* | 299* | 0.939 |
| | | 0 | 220 | 287 | 330* | 342* | | 0 | 267 | 363 | 420* | 467* | |
| 20'-0" | | 130 | 190 | 205* | 212* | 219* | 1.873 | 159 | 232 | 241* | 247* | 273* | 1.153 |
| | | 0 | 0 | 250 | 301* | 312* | | 0 | 0 | 318 | 375* | 426* | |
| 21'-0" | | 110 | 163 | 188* | 193* | 200* | 2.276 | 136 | 202 | 222* | 227* | 250* | 1.401 |
| | | 0 | 0 | 218 | 280 | 297* | | 0 | 0 | 280 | 336* | 387* | |
| 22'-0" | | 92 | 141 | 172* | 177* | 182* | 2.742 | 115 | 175 | 205* | 209* | 230* | 1.687 |
| | | 0 | 0 | 190 | 247 | 274* | | 0 | 0 | 247 | 303* | 349* | |
| 23'-0" | | 76 | 121 | 158* | 162* | 167* | 3.276 | 98 | 153 | 189* | 193* | 212* | 2.016 |
| | | 0 | 0 | 166 | 218 | 253* | | 0 | 0 | 218 | 275* | 315* | |
| 24'-0" | | 62 | 103 | 145* | 149* | 153* | 3.884 | 82 | 133 | 176* | 179* | 196* | 2.390 |
| | | 0 | 0 | 0 | 193 | 235* | | 0 | 0 | 193 | 251* | 285* | |
| 25'-0" | | 50 | 88 | 126 | 137* | 141* | 4.572 | 68 | 115 | 163* | 166* | 182* | 2.814 |
| | | 0 | 0 | 0 | 171 | 215 | | 0 | 0 | 170 | 226 | 260* | |
| 26'-0" | | | 74 | 110 | 127* | 130* | 5.349 | 56 | 99 | 150 | 154* | 169* | 3.292 |
| | | | 0 | 0 | 151 | 192 | | 0 | 0 | 0 | 202 | 238* | |
| 27'-0" | | | 62 | 95 | 117* | 120* | 6.221 | 45 | 85 | 133 | 144* | 157* | 3.828 |
| | | | 0 | 0 | 133 | 171 | | 0 | 0 | 0 | 181 | 218* | |
| 28'-0" | | | 51 | 82 | 108* | 111* | 7.195 | | 73 | 117 | 134* | 146* | 4.428 |
| | | | 0 | 0 | 117 | 153 | | | 0 | 0 | 161 | 201* | |
| 29'-0" | | | 42 | 70 | 100* | 102* | 8.279 | | 61 | 103 | 125* | 136* | 5.095 |
| | | | 0 | 0 | 103 | 136 | | | 0 | 0 | 144 | 186* | |
| 30'-0" | | | | 59 | 90 | 94* | 9.481 | | 51 | 90 | 117* | 127* | 5.835 |
| | | | | 0 | 0 | 121 | | | 0 | 0 | 129 | 172* | |
| 31'-0" | | | | 50 | 78 | 87* | 10.810 | | 42 | 78 | 109* | 118* | 6.652 |
| | | | | 0 | 0 | 108 | | | 0 | 0 | 115 | 156 | |
| 32'-0" | | | | 41 | 68 | 81* | 12.274 | | | 68 | 102* | 110* | 7.553 |
| | | | | 0 | 0 | 95 | | | | 0 | 0 | 141 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.51 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.78 | 0.93 | 1.14 | | 0.64 | 0.64 | 0.82 | 1.09 | 2.05 | |
| STEEL % (UNIFORM) | 0.79 | 0.79 | 0.96 | 1.15 | 1.42 | | 0.79 | 0.79 | 1.02 | 1.35 | 2.57 | |
| (TAPERED) | 0.43 | 0.43 | 0.53 | 0.63 | 0.78 | | 0.43 | 0.43 | 0.56 | 0.74 | 1.41 | |
| EFF. DEPTH, IN. | 13.25 | 13.25 | 13.25 | 13.25 | 13.19 | | 13.25 | 13.25 | 13.25 | 13.19 | 13.12 | |
| $-I_{cr}/I_{gr}$ | 0.191 | 0.191 | 0.222 | 0.254 | 0.290 | | 0.191 | 0.191 | 0.232 | 0.280 | 0.422 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.09 | 0.11 | 0.13 | 0.16 | 0.19 | | 0.07 | 0.09 | 0.11 | 0.13 | 0.16 | |
| EFF. DEPTH, IN. | 13.25 | 13.19 | 13.19 | 13.12 | 13.12 | | 13.25 | 13.25 | 13.19 | 13.19 | 13.12 | |
| $+I_{cr}/I_{gr}$ | 0.169 | 0.209 | 0.249 | 0.293 | 0.338 | | 0.133 | 0.169 | 0.209 | 0.249 | 0.293 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 4.5″ Top Slab = 14.5″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 9.5 | # 4 8 | # 5 10 | # 5 8.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 8.5 | # 4 7 | # 5 9 | # 6 6.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| Steel (psf) | | 0.71 | 0.86 | 1.04 | 1.25 | 1.46 | | 0.75 | 0.95 | 1.18 | 1.42 | 2.26 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 19'-0" | | 208 | 257* | 264* | 272* | 282* | 1.569 | 253 | 302* | 308* | 313* | 349* | 0.966 |
| | | 0 | 273 | 347 | 381* | 393* | | 0 | 346 | 441 | 472* | 513* | |
| 20'-0" | | 178 | 235* | 241* | 248* | 256* | 1.926 | 219 | 278* | 283* | 287* | 319* | 1.185 |
| | | 0 | 237 | 304 | 348* | 360* | | 0 | 303 | 388 | 429* | 474* | |
| 21'-0" | | 153 | 206 | 221* | 227* | 234* | 2.342 | 190 | 257* | 261* | 265* | 293* | 1.441 |
| | | 0 | 0 | 267 | 329 | 344* | | 0 | 266 | 343 | 388* | 437* | |
| 22'-0" | | 131 | 179 | 203* | 208* | 214* | 2.820 | 164 | 234 | 242* | 245* | 270* | 1.736 |
| | | 0 | 0 | 234 | 291 | 318* | | 0 | 0 | 304 | 351* | 401* | |
| 23'-0" | | 111 | 156 | 187* | 191* | 197* | 3.369 | 142 | 206 | 224* | 227* | 250* | 2.073 |
| | | 0 | 0 | 206 | 258 | 294* | | 0 | 0 | 270 | 319* | 367* | |
| 24'-0" | | 94 | 135 | 172* | 177* | 182* | 3.995 | 123 | 181 | 209* | 211* | 232* | 2.458 |
| | | 0 | 0 | 182 | 229 | 274* | | 0 | 0 | 240 | 292* | 333* | |
| 25'-0" | | 79 | 117 | 160* | 163* | 168* | 4.703 | 106 | 159 | 194* | 196* | 215* | 2.894 |
| | | 0 | 0 | 0 | 203 | 255* | | 0 | 0 | 214 | 268* | 304* | |
| 26'-0" | | 66 | 101 | 140 | 151* | 155* | 5.502 | 90 | 140 | 181* | 183* | 200* | 3.386 |
| | | 0 | 0 | 0 | 181 | 229 | | 0 | 0 | 190 | 248* | 279* | |
| 27'-0" | | 54 | 86 | 123 | 140* | 144* | 6.398 | 77 | 123 | 169* | 171* | 187* | 3.938 |
| | | 0 | 0 | 0 | 161 | 205 | | 0 | 0 | 170 | 223 | 257* | |
| 28'-0" | | 44 | 74 | 108 | 130* | 134* | 7.400 | 65 | 107 | 151 | 160* | 174* | 4.554 |
| | | 0 | 0 | 0 | 143 | 184 | | 0 | 0 | 0 | 201 | 237* | |
| 29'-0" | | | 62 | 94 | 121* | 124* | 8.516 | 54 | 94 | 134 | 150* | 163* | 5.240 |
| | | | 0 | 0 | 126 | 165 | | 0 | 0 | 0 | 180 | 220* | |
| 30'-0" | | | 52 | 81 | 112 | 115* | 9.752 | 44 | 81 | 119 | 140* | 153* | 6.001 |
| | | | 0 | 0 | 0 | 148 | | 0 | 0 | 0 | 162 | 204* | |
| 31'-0" | | | 42 | 70 | 99 | 107* | 11.119 | | 70 | 105 | 132* | 143* | 6.842 |
| | | | 0 | 0 | 0 | 132 | | | 0 | 0 | 146 | 187 | |
| 32'-0" | | | | 60 | 87 | 100* | 12.625 | | 60 | 93 | 123* | 134* | 7.769 |
| | | | | 0 | 0 | 118 | | | 0 | 0 | 131 | 170 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.76 | 0.90 | 1.12 | 1.31 | | 0.65 | 0.85 | 1.03 | 1.24 | 2.44 | |
| STEEL % (UNIFORM) | 0.70 | 0.81 | 0.96 | 1.19 | 1.40 | | 0.70 | 0.90 | 1.09 | 1.32 | 2.62 | |
| (TAPERED) | 0.41 | 0.47 | 0.56 | 0.70 | 0.82 | | 0.41 | 0.53 | 0.64 | 0.78 | 1.54 | |
| EFF. DEPTH, IN. | 13.25 | 13.25 | 13.25 | 13.19 | 13.19 | | 13.25 | 13.25 | 13.25 | 13.19 | 13.12 | |
| $-I_{cr}/I_{gr}$ | 0.179 | 0.200 | 0.228 | 0.264 | 0.297 | | 0.179 | 0.218 | 0.252 | 0.285 | 0.441 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | |
| STEEL % | 0.11 | 0.13 | 0.16 | 0.19 | 0.22 | | 0.08 | 0.11 | 0.13 | 0.16 | 0.19 | |
| EFF. DEPTH, IN. | 13.19 | 13.19 | 13.12 | 13.12 | 13.06 | | 13.25 | 13.19 | 13.19 | 13.12 | 13.12 | |
| $+I_{cr}/I_{gr}$ | 0.184 | 0.220 | 0.259 | 0.298 | 0.342 | | 0.149 | 0.184 | 0.220 | 0.259 | 0.298 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 9.5 | # 4 7.5 | # 5 10 | # 5 8 | End Span Defl. Coeff. (3) | # 4 11 | # 4 8.5 | # 5 10 | # 5 8.5 | # 6 6.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| Steel (psf) | | 0.72 | 0.88 | 1.08 | 1.28 | 1.52 | | 0.77 | 0.97 | 1.25 | 1.48 | 2.29 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 21'-0" | | 197 | 238* | 247* | 253* | 266* | 2.276 | | | | | | |
| | | 0 | 260 | 332* | 342* | 363* | | | | | | | |
| 22'-0" | | 170 | 218* | 227* | 231* | 243* | 2.742 | 210 | 259* | 265* | 270* | 300* | 1.687 |
| | | 0 | 228 | 294 | 316* | 336* | | 0 | 293 | 368* | 379* | 438* | |
| 23'-0" | | 147 | 200 | 208* | 212* | 223* | 3.276 | 184 | 240* | 245* | 250* | 277* | 2.016 |
| | | 0 | 0 | 260 | 292* | 311* | | 0 | 259 | 335* | 345* | 396* | |
| 24'-0" | | 127 | 176 | 192* | 196* | 205* | 3.884 | 161 | 224* | 228* | 232* | 256* | 2.390 |
| | | 0 | 0 | 231 | 272* | 289* | | 0 | 230 | 301 | 315* | 360* | |
| 25'-0" | | 110 | 154 | 178* | 181* | 189* | 4.572 | 140 | 204 | 212* | 216* | 238* | 2.814 |
| | | 0 | 0 | 205 | 253* | 270* | | 0 | 0 | 269 | 290* | 329* | |
| 26'-0" | | 94 | 135 | 165* | 167* | 175* | 5.349 | 122 | 182 | 198* | 202* | 221* | 3.292 |
| | | 0 | 0 | 182 | 230 | 252* | | 0 | 0 | 241 | 267* | 301* | |
| 27'-0" | | 80 | 118 | 153* | 155* | 162* | 6.221 | 106 | 161 | 185* | 188* | 206* | 3.828 |
| | | 0 | 0 | 162 | 206 | 236* | | 0 | 0 | 217 | 247* | 277* | |
| 28'-0" | | 67 | 103 | 142* | 144* | 150* | 7.195 | 92 | 143 | 173* | 176* | 193* | 4.428 |
| | | 0 | 0 | 144 | 185 | 221* | | 0 | 0 | 195 | 229* | 256* | |
| 29'-0" | | 56 | 89 | 127 | 134* | 139* | 8.279 | 79 | 127 | 162* | 165* | 180* | 5.095 |
| | | 0 | 0 | 0 | 166 | 207* | | 0 | 0 | 175 | 213* | 237* | |
| 30'-0" | | 46 | 77 | 112 | 124* | 130* | 9.481 | 67 | 112 | 152* | 155* | 168* | 5.835 |
| | | 0 | 0 | 0 | 148 | 188* | | 0 | 0 | 157 | 198* | 220* | |
| 31'-0" | | | 66 | 99 | 116* | 121* | 10.810 | 57 | 98 | 140 | 145* | 158* | 6.652 |
| | | | 0 | 0 | 133 | 172* | | 0 | 0 | 0 | 185* | 205* | |
| 32'-0" | | | 56 | 87 | 108* | 112* | 12.274 | 47 | 86 | 126 | 136* | 148* | 7.553 |
| | | | 0 | 0 | 118 | 156 | | 0 | 0 | 0 | 171 | 191* | |
| 33'-0" | | | 46 | 76 | 100* | 105* | 13.882 | | 75 | 112 | 128* | 139* | 8.543 |
| | | | 0 | 0 | 105 | 141 | | | 0 | 0 | 155 | 179* | |
| 34'-0" | | | | 66 | 93* | 97* | 15.642 | | 65 | 100 | 120* | 131* | 9.626 |
| | | | | 0 | 94 | 127 | | | 0 | 0 | 140 | 167* | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.74 | 0.93 | 1.09 | 1.36 | | 0.64 | 0.82 | 1.09 | 1.28 | 2.37 | |
| STEEL % (UNIFORM) | 0.67 | 0.77 | 0.98 | 1.14 | 1.43 | | 0.67 | 0.86 | 1.14 | 1.34 | 2.50 | |
| (TAPERED) | 0.37 | 0.43 | 0.54 | 0.63 | 0.79 | | 0.37 | 0.48 | 0.63 | 0.75 | 1.39 | |
| EFF. DEPTH, IN. | 15.25 | 15.25 | 15.25 | 15.19 | 15.19 | | 15.25 | 15.25 | 15.19 | 15.19 | 15.12 | |
| $-I_{cr}/I_{gr}$ | 0.176 | 0.197 | 0.236 | 0.261 | 0.305 | | 0.176 | 0.215 | 0.261 | 0.293 | 0.437 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | |
| STEEL % | 0.10 | 0.12 | 0.14 | 0.17 | 0.20 | | 0.07 | 0.10 | 0.12 | 0.14 | 0.17 | |
| EFF. DEPTH, IN. | 15.19 | 15.19 | 15.12 | 15.12 | 15.06 | | 15.25 | 15.19 | 15.19 | 15.12 | 15.12 | |
| $+I_{cr}/I_{gr}$ | 0.189 | 0.225 | 0.266 | 0.307 | 0.353 | | 0.152 | 0.189 | 0.225 | 0.266 | 0.307 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 9.5 | # 4 8 | # 5 10 | # 5 8.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 9 | # 4 7 | # 5 9 | # 5 7.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| Steel (psf) | | 0.71 | 0.86 | 1.04 | 1.25 | 1.46 | | 0.75 | 0.93 | 1.18 | 1.42 | 1.71 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 21'-0" | | 185 | 246 | 279* | 287* | 296* | 2.342 | | | | | | |
| | | 0 | 0 | 317 | 384* | 399* | | | | | | | |
| 22'-0" | | 159 | 215 | 257* | 264* | 272* | 2.820 | 198 | 278 | 303* | 307* | 314* | 1.736 |
| | | 0 | 0 | 280 | 345 | 369* | | 0 | 0 | 360 | 423* | 437* | |
| 23'-0" | | 137 | 188 | 237* | 243* | 251* | 3.369 | 172 | 246 | 282* | 285* | 292* | 2.073 |
| | | 0 | 0 | 247 | 307 | 342* | | 0 | 0 | 320 | 386* | 398* | |
| 24'-0" | | 118 | 165 | 219 | 225* | 231* | 3.995 | 150 | 218 | 263* | 266* | 271* | 2.458 |
| | | 0 | 0 | 0 | 273 | 319* | | 0 | 0 | 286 | 354* | 365* | |
| 25'-0" | | 100 | 144 | 193 | 209* | 214* | 4.703 | 130 | 192 | 245* | 248* | 253* | 2.894 |
| | | 0 | 0 | 0 | 244 | 297* | | 0 | 0 | 255 | 327* | 336* | |
| 26'-0" | | 85 | 125 | 171 | 194* | 199* | 5.502 | 113 | 170 | 228 | 232* | 237* | 3.386 |
| | | 0 | 0 | 0 | 218 | 273 | | 0 | 0 | 0 | 295 | 310* | |
| 27'-0" | | 71 | 108 | 151 | 180* | 185* | 6.398 | 97 | 150 | 204 | 217* | 221* | 3.938 |
| | | 0 | 0 | 0 | 194 | 246 | | 0 | 0 | 0 | 266 | 288* | |
| 28'-0" | | 59 | 94 | 133 | 168* | 172* | 7.400 | 83 | 133 | 183 | 204* | 208* | 4.554 |
| | | 0 | 0 | 0 | 174 | 222 | | 0 | 0 | 0 | 241 | 267* | |
| 29'-0" | | 48 | 80 | 117 | 155 | 161* | 8.516 | 70 | 117 | 164 | 191* | 195* | 5.240 |
| | | 0 | 0 | 0 | 0 | 200 | | 0 | 0 | 0 | 217 | 249* | |
| 30'-0" | | | 68 | 103 | 138 | 150* | 9.752 | 59 | 102 | 146 | 180* | 183* | 6.001 |
| | | | 0 | 0 | 0 | 180 | | 0 | 0 | 0 | 196 | 233* | |
| 31'-0" | | | 58 | 90 | 123 | 140* | 11.119 | 49 | 89 | 130 | 169* | 173* | 6.842 |
| | | | 0 | 0 | 0 | 162 | | 0 | 0 | 0 | 177 | 218* | |
| 32'-0" | | | 48 | 78 | 109 | 131* | 12.625 | 40 | 78 | 116 | 160* | 163* | 7.769 |
| | | | 0 | 0 | 0 | 146 | | 0 | 0 | 0 | 0 | 204* | |
| 33'-0" | | | | 67 | 96 | 123* | 14.278 | | 67 | 103 | 144 | 153* | 8.787 |
| | | | | 0 | 0 | 131 | | | 0 | 0 | 0 | 187 | |
| 34'-0" | | | | 57 | 85 | 115* | 16.089 | | 57 | 91 | 130 | 145* | 9.901 |
| | | | | 0 | 0 | 117 | | | 0 | 0 | 0 | 170 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.76 | 0.90 | 1.12 | 1.31 | | 0.65 | 0.80 | 1.03 | 1.24 | 1.49 | |
| STEEL % (UNIFORM) | 0.59 | 0.68 | 0.81 | 1.01 | 1.19 | | 0.59 | 0.72 | 0.93 | 1.12 | 1.35 | |
| (TAPERED) | 0.35 | 0.41 | 0.48 | 0.60 | 0.70 | | 0.35 | 0.43 | 0.55 | 0.67 | 0.80 | |
| EFF. DEPTH, IN. | 15.25 | 15.25 | 15.25 | 15.19 | 15.19 | | 15.25 | 15.25 | 15.25 | 15.19 | 15.19 | |
| $-I_{cr}/I_{gr}$ | 0.165 | 0.185 | 0.211 | 0.246 | 0.277 | | 0.165 | 0.193 | 0.234 | 0.266 | 0.303 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | |
| STEEL % | 0.09 | 0.11 | 0.14 | 0.16 | 0.19 | | 0.07 | 0.09 | 0.11 | 0.14 | 0.16 | |
| EFF. DEPTH, IN. | 15.19 | 15.19 | 15.12 | 15.12 | 15.06 | | 15.25 | 15.19 | 15.19 | 15.12 | 15.12 | |
| $+I_{cr}/I_{gr}$ | 0.167 | 0.199 | 0.235 | 0.271 | 0.312 | | 0.134 | 0.167 | 0.199 | 0.235 | 0.271 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 9.5 | # 4 7.5 | # 5 10 | # 5 8 | End Span Defl. Coeff. (3) | # 4 11 | # 4 8.5 | # 4 7 | # 5 8.5 | # 5 7 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| Steel (psf) | | 0.72 | 0.88 | 1.08 | 1.28 | 1.52 | | 0.77 | 0.97 | 1.20 | 1.48 | 1.80 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 25'-0" | | 131 | 182 | 222* | 226* | 236* | 4.572 | 166 | 239 | 262* | 267* | 274* | 2.814 |
| | | 0 | 0 | 240 | 293* | 310* | | 0 | 0 | 312 | 345* | 357* | |
| 26'-0" | | 114 | 160 | 206* | 209* | 218* | 5.349 | 146 | 213 | 245* | 249* | 256* | 3.292 |
| | | 0 | 0 | 214 | 269 | 290* | | 0 | 0 | 281 | 319* | 329* | |
| 27'-0" | | 98 | 141 | 191 | 195* | 203* | 6.221 | 127 | 190 | 229* | 233* | 239* | 3.828 |
| | | 0 | 0 | 0 | 241 | 272* | | 0 | 0 | 253 | 296* | 305* | |
| 28'-0" | | 83 | 124 | 170 | 181* | 189* | 7.195 | 111 | 169 | 215* | 219* | 224* | 4.428 |
| | | 0 | 0 | 0 | 217 | 255* | | 0 | 0 | 228 | 275* | 283* | |
| 29'-0" | | 71 | 108 | 151 | 169* | 176* | 8.279 | 96 | 150 | 202* | 205* | 210* | 5.095 |
| | | 0 | 0 | 0 | 195 | 240* | | 0 | 0 | 205 | 256* | 264* | |
| 30'-0" | | 59 | 94 | 135 | 158* | 164* | 9.481 | 83 | 134 | 185 | 193* | 198* | 5.835 |
| | | 0 | 0 | 0 | 176 | 225 | | 0 | 0 | 0 | 240* | 246* | |
| 31'-0" | | 49 | 82 | 119 | 147* | 153* | 10.810 | 71 | 119 | 166 | 182* | 186* | 6.652 |
| | | 0 | 0 | 0 | 158 | 204 | | 0 | 0 | 0 | 221 | 230* | |
| 32'-0" | | | 70 | 106 | 138* | 143* | 12.274 | 60 | 105 | 150 | 171* | 175* | 7.553 |
| | | | 0 | 0 | 142 | 185 | | 0 | 0 | 0 | 201 | 216* | |
| 33'-0" | | | 60 | 93 | 127 | 134* | 13.882 | 51 | 92 | 134 | 161* | 165* | 8.543 |
| | | | 0 | 0 | 0 | 167 | | 0 | 0 | 0 | 183 | 203* | |
| 34'-0" | | | 50 | 82 | 113 | 126* | 15.642 | 42 | 81 | 121 | 152* | 156* | 9.626 |
| | | | 0 | 0 | 0 | 152 | | 0 | 0 | 0 | 166 | 190* | |
| 35'-0" | | | 41 | 71 | 101 | 118* | 17.565 | | 70 | 108 | 144* | 147* | 10.809 |
| | | | 0 | 0 | 0 | 137 | | | 0 | 0 | 151 | 179* | |
| 36'-0" | | | | 61 | 90 | 110* | 19.661 | | 61 | 96 | 136* | 139* | 12.099 |
| | | | | 0 | 0 | 124 | | | 0 | 0 | 137 | 169* | |
| 37'-0" | | | | 53 | 80 | 103* | 21.938 | | 52 | 86 | 124 | 131* | 13.500 |
| | | | | 0 | 0 | 112 | | | 0 | 0 | 0 | 159* | |
| 38'-0" | | | | 44 | 70 | 97* | 24.407 | | 44 | 76 | 112 | 124* | 15.020 |
| | | | | 0 | 0 | 100 | | | 0 | 0 | 0 | 149 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.74 | 0.93 | 1.09 | 1.36 | | 0.64 | 0.82 | 1.00 | 1.28 | 1.55 | |
| STEEL % (UNIFORM) | 0.57 | 0.66 | 0.84 | 0.98 | 1.23 | | 0.57 | 0.74 | 0.90 | 1.15 | 1.40 | |
| (TAPERED) | 0.32 | 0.37 | 0.47 | 0.55 | 0.69 | | 0.32 | 0.42 | 0.51 | 0.65 | 0.79 | |
| EFF. DEPTH, IN. | 17.25 | 17.25 | 17.25 | 17.19 | 17.19 | | 17.25 | 17.25 | 17.25 | 17.19 | 17.19 | |
| $-I_{cr}/I_{gr}$ | 0.163 | 0.183 | 0.220 | 0.244 | 0.287 | | 0.163 | 0.200 | 0.231 | 0.274 | 0.315 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | |
| STEEL % | 0.08 | 0.10 | 0.13 | 0.15 | 0.17 | | 0.07 | 0.08 | 0.10 | 0.13 | 0.15 | |
| EFF. DEPTH, IN. | 17.19 | 17.19 | 17.12 | 17.12 | 17.06 | | 17.25 | 17.19 | 17.19 | 17.12 | 17.12 | |
| $+I_{cr}/I_{gr}$ | 0.172 | 0.206 | 0.243 | 0.281 | 0.323 | | 0.138 | 0.172 | 0.206 | 0.243 | 0.281 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 10 | # 4 8 | # 5 10 | # 5 8.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 9 | # 4 7 | # 5 9 | # 5 7.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| Steel (psf) | | 0.71 | 0.85 | 1.04 | 1.25 | 1.46 | | 0.75 | 0.93 | 1.18 | 1.42 | 1.71 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 25'-0" | | 120 | 169 | 226 | 257* | 264* | 4.703 | 154 | 224 | 296 | 302* | 308* | 2.894 |
| | | 0 | 0 | 0 | 283 | 341* | | 0 | 0 | 0 | 378 | 396* | |
| 26'-0" | | 103 | 148 | 200 | 239* | 245* | 5.502 | 134 | 199 | 265 | 283* | 289* | 3.386 |
| | | 0 | 0 | 0 | 254 | 317 | | 0 | 0 | 0 | 341 | 367* | |
| 27'-0" | | 87 | 129 | 178 | 223* | 228* | 6.398 | 116 | 177 | 238 | 266* | 271* | 3.938 |
| | | 0 | 0 | 0 | 227 | 286 | | 0 | 0 | 0 | 309 | 341* | |
| 28'-0" | | 73 | 113 | 158 | 203 | 213* | 7.400 | 100 | 157 | 214 | 250* | 254* | 4.554 |
| | | 0 | 0 | 0 | 0 | 258 | | 0 | 0 | 0 | 279 | 317* | |
| 29'-0" | | 61 | 98 | 140 | 182 | 199* | 8.516 | 86 | 139 | 192 | 235* | 239* | 5.240 |
| | | 0 | 0 | 0 | 0 | 233 | | 0 | 0 | 0 | 253 | 296* | |
| 30'-0" | | 50 | 84 | 123 | 163 | 187* | 9.752 | 73 | 122 | 172 | 221* | 225* | 6.001 |
| | | 0 | 0 | 0 | 0 | 211 | | 0 | 0 | 0 | 229 | 278* | |
| 31'-0" | | 40 | 72 | 108 | 146 | 175* | 11.119 | 62 | 108 | 154 | 208 | 213* | 6.842 |
| | | 0 | 0 | 0 | 0 | 190 | | 0 | 0 | 0 | 0 | 260* | |
| 32'-0" | | | 60 | 95 | 130 | 164* | 12.625 | 51 | 94 | 138 | 188 | 201* | 7.769 |
| | | | 0 | 0 | 0 | 172 | | 0 | 0 | 0 | 0 | 239 | |
| 33'-0" | | | 50 | 83 | 116 | 154* | 14.278 | 42 | 82 | 123 | 170 | 190* | 8.787 |
| | | | 0 | 0 | 0 | 155 | | 0 | 0 | 0 | 0 | 218 | |
| 34'-0" | | | 41 | 72 | 103 | 140 | 16.089 | | 71 | 110 | 154 | 179* | 9.901 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 199 | |
| 35'-0" | | | | 61 | 91 | 126 | 18.067 | | 61 | 97 | 139 | 170* | 11.118 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 182 | |
| 36'-0" | | | | 52 | 80 | 113 | 20.222 | | 51 | 86 | 126 | 161* | 12.445 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 166 | |
| 37'-0" | | | | 43 | 70 | 101 | 22.565 | | 43 | 75 | 113 | 151 | 13.886 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 38'-0" | | | | | 60 | 90 | 25.105 | | | 66 | 101 | 138 | 15.449 |
| | | | | | 0 | 0 | | | | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.72 | 0.90 | 1.12 | 1.31 | | 0.65 | 0.80 | 1.03 | 1.24 | 1.49 | |
| STEEL % (UNIFORM) | 0.51 | 0.56 | 0.70 | 0.87 | 1.03 | | 0.51 | 0.62 | 0.80 | 0.97 | 1.16 | |
| (TAPERED) | 0.31 | 0.34 | 0.42 | 0.52 | 0.61 | | 0.31 | 0.37 | 0.48 | 0.58 | 0.70 | |
| EFF. DEPTH, IN. | 17.25 | 17.25 | 17.25 | 17.19 | 17.19 | | 17.25 | 17.25 | 17.25 | 17.19 | 17.19 | |
| $-I_{cr}/I_{gr}$ | 0.153 | 0.165 | 0.197 | 0.230 | 0.259 | | 0.153 | 0.179 | 0.218 | 0.249 | 0.284 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | |
| STEEL % | 0.08 | 0.10 | 0.12 | 0.14 | 0.17 | | 0.06 | 0.08 | 0.10 | 0.12 | 0.14 | |
| EFF. DEPTH, IN. | 17.19 | 17.19 | 17.12 | 17.12 | 17.06 | | 17.25 | 17.19 | 17.19 | 17.12 | 17.12 | |
| $+I_{cr}/I_{gr}$ | 0.152 | 0.182 | 0.215 | 0.249 | 0.287 | | 0.122 | 0.152 | 0.182 | 0.215 | 0.249 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8 | # 5 10 | # 5 9 | # 5 7.5 | End Span Defl. Coeff. (3) | # 4 9 | # 4 7 | # 5 9 | # 5 7.5 | # 6 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| | # | # 5 | # 6 | # 6 | # 7 | # 7 | | # 5 | # 5 | # 6 | # 6 | # 7 | |
| Steel (psf) | | 0.85 | 1.04 | 1.25 | 1.44 | 1.69 | | 0.93 | 1.18 | 1.42 | 1.71 | 2.01 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 27'-0" | | 150 | 205 | 260 | 273* | 282* | 6.398 | 203 | | 318* | | 328* | 3.938 |
| | | 0 | 0 | 0 | 326 | 349* | | 0 | | 351 | | 404* | |
| 28'-0" | | 131 | 182 | 233 | 255* | 263* | 7.400 | 181 | 244 | 299* | 304* | 308* | 4.554 |
| | | 0 | 0 | 0 | 295 | 329* | | 0 | 0 | 318 | 370* | 376* | |
| 29'-0" | | 115 | 162 | 210 | 239* | 246* | 8.516 | 161 | 220 | 282* | 287* | 290* | 5.240 |
| | | 0 | 0 | 0 | 267 | 310* | | 0 | 0 | 288 | 346* | 352* | |
| 30'-0" | | 99 | 144 | 188 | 224* | 231* | 9.752 | 142 | 198 | 262 | 270* | 274* | 6.001 |
| | | 0 | 0 | 0 | 242 | 293* | | 0 | 0 | 0 | 324* | 330* | |
| 31'-0" | | 86 | 127 | 169 | 210* | 217* | 11.119 | 126 | 178 | 238 | 255* | 258* | 6.842 |
| | | 0 | 0 | 0 | 219 | 270 | | 0 | 0 | 0 | 299 | 310* | |
| 32'-0" | | 73 | 112 | 151 | 198* | 203* | 12.625 | 111 | 160 | 216 | 241* | 244* | 7.769 |
| | | 0 | 0 | 0 | 0 | 246 | | 0 | 0 | 0 | 273 | 291* | |
| 33'-0" | | 62 | 98 | 135 | 179 | 191* | 14.278 | 97 | 143 | 196 | 229* | 231* | 8.787 |
| | | 0 | 0 | 0 | 0 | 224 | | 0 | 0 | 0 | 250 | 274* | |
| 34'-0" | | 52 | 86 | 121 | 162 | 180* | 16.089 | 85 | 128 | 178 | 217* | 219* | 9.901 |
| | | 0 | 0 | 0 | 0 | 205 | | 0 | 0 | 0 | 229 | 259* | |
| 35'-0" | | 42 | 74 | 107 | 147 | 170* | 18.067 | 74 | 114 | 161 | 205* | 208* | 11.118 |
| | | 0 | 0 | 0 | 0 | 186 | | 0 | 0 | 0 | 209 | 245* | |
| 36'-0" | | | 64 | 95 | 132 | 160* | 20.222 | 63 | 102 | 146 | 191 | 197* | 12.445 |
| | | | 0 | 0 | 0 | 170 | | 0 | 0 | 0 | 0 | 231* | |
| 37'-0" | | | 54 | 84 | 119 | 151* | 22.565 | 54 | 90 | 132 | 175 | 187* | 13.886 |
| | | | 0 | 0 | 0 | 155 | | 0 | 0 | 0 | 0 | 219* | |
| 38'-0" | | | 45 | 73 | 107 | 140 | 25.105 | 45 | 79 | 119 | 160 | 178* | 15.449 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 208* | |
| 39'-0" | | | | 64 | 95 | 127 | 27.853 | | 69 | 107 | 146 | 169* | 17.141 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 192 | |
| 40'-0" | | | | 55 | 85 | 115 | 30.822 | | 60 | 96 | 133 | 161* | 18.967 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 176 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.72 | 0.90 | 1.12 | 1.24 | 1.49 | | 0.80 | 1.03 | 1.24 | 1.49 | 1.76 | |
| STEEL % (UNIFORM) | 0.49 | 0.61 | 0.77 | 0.85 | 1.02 | | 0.55 | 0.70 | 0.85 | 1.02 | 1.21 | |
| (TAPERED) | 0.30 | 0.37 | 0.46 | 0.51 | 0.62 | | 0.33 | 0.42 | 0.51 | 0.62 | 0.73 | |
| EFF. DEPTH, IN. | 19.25 | 19.25 | 19.19 | 19.19 | 19.19 | | 19.25 | 19.25 | 19.19 | 19.19 | 19.12 | |
| $-I_{cr}/I_{gr}$ | 0.154 | 0.184 | 0.216 | 0.234 | 0.268 | | 0.168 | 0.204 | 0.234 | 0.268 | 0.300 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | |
| STEEL % | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | | 0.07 | 0.09 | 0.11 | 0.13 | 0.15 | |
| EFF. DEPTH, IN. | 19.19 | 19.12 | 19.12 | 19.06 | 19.06 | | 19.19 | 19.19 | 19.12 | 19.12 | 19.06 | |
| $+I_{cr}/I_{gr}$ | 0.168 | 0.199 | 0.230 | 0.265 | 0.302 | | 0.140 | 0.168 | 0.199 | 0.230 | 0.265 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 7" Rib @ 37" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8.5 | # 4 7 | # 5 9 | # 5 8 | End Span Defl. Coeff. (3) | # 4 9 | # 4 7.5 | # 5 9.5 | # 5 8 | # 6 9.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| | # | # 5 | # 6 | # 6 | # 7 | # 7 | | # 5 | # 5 | # 6 | # 6 | # 7 | |
| Steel (psf) | | 0.83 | 1.00 | 1.20 | 1.41 | 1.63 | | 0.92 | 1.13 | 1.36 | 1.63 | 1.93 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 27'-0" | | 138 | 191 | 245 | 303* | 308* | 6.576 | 190 | | 333 | | 362* | 4.047 |
| | | 0 | 0 | 0 | 309 | 374 | | 0 | | 0 | | 442* | |
| 28'-0" | | 120 | 169 | 219 | 279 | 289* | 7.606 | 168 | 230 | 302 | 337* | 341* | 4.681 |
| | | 0 | 0 | 0 | 0 | 340 | | 0 | 0 | 0 | 374 | 413* | |
| 29'-0" | | 104 | 150 | 196 | 252 | 271* | 8.752 | 148 | 206 | 273 | 318* | 321* | 5.386 |
| | | 0 | 0 | 0 | 0 | 308 | | 0 | 0 | 0 | 340 | 387* | |
| 30'-0" | | 89 | 132 | 175 | 227 | 254* | 10.023 | 131 | 185 | 247 | 300* | 303* | 6.168 |
| | | 0 | 0 | 0 | 0 | 280 | | 0 | 0 | 0 | 310 | 363* | |
| 31'-0" | | 76 | 116 | 156 | 205 | 239* | 11.428 | 115 | 165 | 224 | 283 | 287* | 7.033 |
| | | 0 | 0 | 0 | 0 | 255 | | 0 | 0 | 0 | 0 | 341* | |
| 32'-0" | | 63 | 101 | 139 | 185 | 226* | 12.975 | 100 | 147 | 202 | 258 | 272* | 7.985 |
| | | 0 | 0 | 0 | 0 | 232 | | 0 | 0 | 0 | 0 | 322* | |
| 33'-0" | | 52 | 88 | 124 | 167 | 210 | 14.675 | 87 | 131 | 183 | 235 | 258* | 9.031 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 298 | |
| 34'-0" | | 42 | 76 | 109 | 150 | 191 | 16.536 | 75 | 117 | 165 | 215 | 244* | 10.176 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 274 | |
| 35'-0" | | | 65 | 96 | 135 | 174 | 18.569 | 64 | 103 | 149 | 196 | 232* | 11.427 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 251 | |
| 36'-0" | | | 54 | 84 | 121 | 157 | 20.784 | 53 | 91 | 134 | 178 | 221* | 12.790 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 231 | |
| 37'-0" | | | 45 | 73 | 108 | 143 | 23.191 | 44 | 80 | 121 | 162 | 210* | 14.272 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 212 | |
| 38'-0" | | | | 63 | 96 | 129 | 25.802 | | 69 | 108 | 147 | 195 | 15.878 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 39'-0" | | | | 54 | 85 | 116 | 28.627 | | 60 | 96 | 134 | 179 | 17.617 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 40'-0" | | | | 45 | 75 | 104 | 31.678 | | 51 | 86 | 121 | 164 | 19.494 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.74 | 0.87 | 1.06 | 1.27 | 1.43 | | 0.82 | 0.99 | 1.21 | 1.43 | 1.71 | |
| STEEL % (UNIFORM) | 0.45 | 0.53 | 0.64 | 0.77 | 0.87 | | 0.50 | 0.60 | 0.73 | 0.87 | 1.04 | |
| (TAPERED) | 0.28 | 0.33 | 0.40 | 0.49 | 0.55 | | 0.31 | 0.38 | 0.46 | 0.55 | 0.66 | |
| EFF. DEPTH, IN. | 19.25 | 19.25 | 19.25 | 19.19 | 19.19 | | 19.25 | 19.25 | 19.19 | 19.19 | 19.12 | |
| $-I_{cr}/I_{gr}$ | 0.146 | 0.166 | 0.194 | 0.223 | 0.244 | | 0.159 | 0.184 | 0.214 | 0.244 | 0.277 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | |
| STEEL % | 0.09 | 0.11 | 0.12 | 0.15 | 0.17 | | 0.07 | 0.09 | 0.11 | 0.12 | 0.15 | |
| EFF. DEPTH, IN. | 19.19 | 19.12 | 19.12 | 19.06 | 19.06 | | 19.19 | 19.19 | 19.12 | 19.12 | 19.06 | |
| $+I_{cr}/I_{gr}$ | 0.152 | 0.180 | 0.208 | 0.240 | 0.273 | | 0.127 | 0.152 | 0.180 | 0.208 | 0.240 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth

| TOP BARS | Size @ | # 4 8 | # 4 7 | # 5 9 | # 5 7.5 | # 6 9 | End Span Defl. Coeff. (3) | # 5 11 | # 5 9.5 | # 5 8 | # 6 9.5 | # 6 8 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | |
| Steel (psf) | | 1.04 | 1.23 | 1.44 | 1.69 | 1.96 | | 1.18 | 1.38 | 1.66 | 1.96 | 2.32 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'-0" | | 146 | 194 | 251 | 284* | 290* | 12.625 | | | | | | |
| | | 0 | 0 | 0 | 309 | 341* | | | | | | | |
| 33'-0" | | 129 | 174 | 228 | 268* | 274* | 14.278 | 183 | 248 | 313* | 316* | 322* | 8.787 |
| | | 0 | 0 | 0 | 283 | 324* | | 0 | 0 | 0 | 358* | 366* | |
| 34'-0" | | 114 | 156 | 207 | 253* | 258* | 16.089 | 165 | 226 | 287 | 300* | 306* | 9.901 |
| | | 0 | 0 | 0 | 259 | 306* | | 0 | 0 | 0 | 339* | 346* | |
| 35'-0" | | 100 | 140 | 188 | 237 | 244* | 18.067 | 149 | 206 | 264 | 285* | 291* | 11.118 |
| | | 0 | 0 | 0 | 0 | 287* | | 0 | 0 | 0 | 321* | 328* | |
| 36'-0" | | 88 | 125 | 171 | 217 | 231* | 20.222 | 133 | 187 | 242 | 272* | 276* | 12.445 |
| | | 0 | 0 | 0 | 0 | 270 | | 0 | 0 | 0 | 305* | 311* | |
| 37'-0" | | 76 | 112 | 155 | 198 | 218* | 22.565 | 119 | 170 | 222 | 259* | 263* | 13.886 |
| | | 0 | 0 | 0 | 0 | 248 | | 0 | 0 | 0 | 285 | 295* | |
| 38'-0" | | 65 | 99 | 140 | 181 | 207* | 25.105 | 106 | 155 | 204 | 246* | 251* | 15.449 |
| | | 0 | 0 | 0 | 0 | 229 | | 0 | 0 | 0 | 263 | 281* | |
| 39'-0" | | 55 | 87 | 126 | 165 | 196* | 27.853 | 94 | 140 | 187 | 235* | 239* | 17.141 |
| | | 0 | 0 | 0 | 0 | 210 | | 0 | 0 | 0 | 243 | 267* | |
| 40'-0" | | 46 | 77 | 113 | 150 | 186* | 30.822 | 83 | 127 | 171 | 224* | 228* | 18.967 |
| | | 0 | 0 | 0 | 0 | 194 | | 0 | 0 | 0 | 0 | 254* | |
| 41'-0" | | | 67 | 102 | 137 | 177* | 34.022 | 73 | 114 | 157 | 207 | 218* | 20.936 |
| | | | 0 | 0 | 0 | 178 | | 0 | 0 | 0 | 0 | 242* | |
| 42'-0" | | | 57 | 91 | 124 | 163 | 37.464 | 63 | 103 | 143 | 191 | 208* | 23.055 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 231* | |
| 43'-0" | | | 49 | 80 | 113 | 150 | 41.162 | 54 | 92 | 130 | 177 | 199* | 25.330 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 220* | |
| 44'-0" | | | 41 | 71 | 102 | 137 | 45.127 | 46 | 82 | 119 | 163 | 190* | 27.770 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 207 | |
| 45'-0" | | | | 62 | 91 | 125 | 49.371 | | 73 | 108 | 150 | 182* | 30.382 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 193 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.73 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.90 | 1.03 | 1.24 | 1.49 | 1.76 | | 1.01 | 1.17 | 1.39 | 1.67 | 1.98 | |
| STEEL % (UNIFORM) | 0.49 | 0.56 | 0.67 | 0.81 | 0.96 | | 0.55 | 0.64 | 0.76 | 0.91 | 1.08 | |
| (TAPERED) | 0.30 | 0.34 | 0.41 | 0.50 | 0.59 | | 0.34 | 0.39 | 0.47 | 0.56 | 0.66 | |
| EFF. DEPTH, IN. | 23.25 | 23.25 | 23.19 | 23.19 | 23.12 | | 23.19 | 23.19 | 23.19 | 23.12 | 23.12 | |
| $-I_{cr}/I_{gr}$ | 0.164 | 0.182 | 0.210 | 0.241 | 0.272 | | 0.179 | 0.201 | 0.230 | 0.261 | 0.296 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | |
| STEEL % | 0.09 | 0.11 | 0.13 | 0.14 | 0.17 | | 0.07 | 0.09 | 0.11 | 0.13 | 0.14 | |
| EFF. DEPTH, IN. | 23.12 | 23.12 | 23.06 | 23.06 | 23.00 | | 23.19 | 23.12 | 23.12 | 23.06 | 23.06 | |
| $+I_{cr}/I_{gr}$ | 0.173 | 0.200 | 0.232 | 0.264 | 0.299 | | 0.146 | 0.173 | 0.200 | 0.232 | 0.264 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 7" Rib @ 37" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth

| TOP BARS | Size @ | # 4 8 | # 4 7 | # 5 9.5 | # 5 8 | # 5 7 | End Span Defl. Coeff. (3) | # 5 11 | # 5 9.5 | # 5 8 | # 5 7 | # 5 6 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | |
| Steel (psf) | | 1.02 | 1.20 | 1.40 | 1.63 | 1.87 | | 1.16 | 1.36 | 1.63 | 1.88 | 2.20 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'-0" | | 131 | 178 | 233 | 290 | 315* | 12.975 | | | | | | |
| | | 0 | 0 | 0 | 0 | 355 | | | | | | | |
| 33'-0" | | 115 | 159 | 211 | 264 | 297* | 14.675 | 168 | 231 | 294 | 349* | 354* | 9.031 |
| | | 0 | 0 | 0 | 0 | 326 | | 0 | 0 | 0 | 370 | 401* | |
| 34'-0" | | 100 | 142 | 191 | 241 | 281* | 16.536 | 150 | 209 | 269 | 332* | 337* | 10.176 |
| | | 0 | 0 | 0 | 0 | 299 | | 0 | 0 | 0 | 341 | 379* | |
| 35'-0" | | 87 | 126 | 172 | 220 | 266* | 18.569 | 134 | 190 | 246 | 314 | 320* | 11.427 |
| | | 0 | 0 | 0 | 0 | 274 | | 0 | 0 | 0 | 0 | 360* | |
| 36'-0" | | 75 | 111 | 155 | 200 | 252 | 20.784 | 119 | 172 | 225 | 289 | 305* | 12.790 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 342* | |
| 37'-0" | | 63 | 98 | 140 | 182 | 231 | 23.191 | 105 | 155 | 205 | 266 | 291* | 14.272 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 325* | |
| 38'-0" | | 53 | 86 | 125 | 165 | 212 | 25.802 | 93 | 140 | 188 | 245 | 277* | 15.878 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 303 | |
| 39'-0" | | 43 | 74 | 112 | 150 | 194 | 28.627 | 81 | 126 | 171 | 226 | 265* | 17.617 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 281 | |
| 40'-0" | | | 64 | 100 | 136 | 178 | 31.678 | 70 | 113 | 156 | 208 | 253* | 19.494 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 260 | |
| 41'-0" | | | 54 | 88 | 123 | 162 | 34.967 | 60 | 101 | 142 | 191 | 241 | 21.518 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| 42'-0" | | | 45 | 77 | 110 | 148 | 38.505 | 51 | 89 | 128 | 176 | 223 | 23.695 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| 43'-0" | | | | 68 | 99 | 135 | 42.305 | 42 | 79 | 116 | 161 | 207 | 26.034 |
| | | | | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| 44'-0" | | | | 58 | 88 | 123 | 46.380 | | 69 | 105 | 148 | 191 | 28.542 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 45'-0" | | | | 50 | 78 | 111 | 50.742 | | 60 | 94 | 135 | 177 | 31.226 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.06 | 1.21 | 1.43 | 1.64 | | 1.04 | 1.21 | 1.43 | 1.64 | 1.91 | |
| STEEL % (UNIFORM) | 0.45 | 0.51 | 0.58 | 0.69 | 0.79 | | 0.50 | 0.58 | 0.69 | 0.79 | 0.92 | |
| (TAPERED) | 0.29 | 0.33 | 0.37 | 0.44 | 0.51 | | 0.32 | 0.37 | 0.44 | 0.51 | 0.59 | |
| EFF. DEPTH, IN. | 23.25 | 23.25 | 23.19 | 23.19 | 23.19 | | 23.19 | 23.19 | 23.19 | 23.19 | 23.19 | |
| $-I_{cr}/I_{gr}$ | 0.156 | 0.173 | 0.192 | 0.219 | 0.243 | | 0.170 | 0.192 | 0.219 | 0.243 | 0.273 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | |
| STEEL % | 0.09 | 0.10 | 0.12 | 0.14 | 0.16 | | 0.07 | 0.09 | 0.10 | 0.12 | 0.14 | |
| EFF. DEPTH, IN. | 23.12 | 23.12 | 23.06 | 23.06 | 23.00 | | 23.19 | 23.12 | 23.12 | 23.06 | 23.06 | |
| $+I_{cr}/I_{gr}$ | 0.157 | 0.181 | 0.210 | 0.239 | 0.272 | | 0.132 | 0.157 | 0.181 | 0.210 | 0.239 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 5.0″ Top Slab = 13.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 11 | # 4 9 | # 4 7.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 11 | # 4 8 | # 5 10 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 3 | # 4 | # 4 | # 5 | # 5 | | # 3 | # 3 | # 4 | # 4 | # 5 | |
| | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| Steel (psf) | | 0.51 | 0.61 | 0.72 | 0.89 | 1.08 | | 0.59 | 0.67 | 0.77 | 1.00 | 1.25 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 14'-0" | | 218 | 303* | 303* | 316* | 331* | 0.450 | | | | | | |
| | | 0 | 308 | 415 | 478* | 493* | | | | | | | |
| 15'-0" | | 178 | 256 | 266* | 277* | 290* | 0.593 | | | | | | |
| | | 0 | 0 | 349 | 420* | 434* | | | | | | | |
| 16'-0" | | 145 | 214 | 236* | 246* | 256* | 0.767 | | | | | | |
| | | 0 | 0 | 296 | 372* | 385* | | | | | | | |
| 17'-0" | | 117 | 178 | 211* | 219* | 228* | 0.978 | 126 | 214 | 246* | 255* | 260* | 0.602 |
| | | 0 | 0 | 251 | 325 | 344* | | 0 | 0 | 303 | 408 | 437* | |
| 18'-0" | | 94 | 149 | 190* | 196* | 204* | 1.229 | 102 | 180 | 223* | 231* | 236* | 0.756 |
| | | 0 | 0 | 213 | 279 | 310* | | 0 | 0 | 260 | 354 | 394* | |
| 19'-0" | | 75 | 124 | 171* | 177* | 183* | 1.525 | 82 | 152 | 203* | 210* | 214* | 0.939 |
| | | 0 | 0 | 182 | 241 | 281* | | 0 | 0 | 223 | 308 | 352* | |
| 20'-0" | | 58 | 102 | 155* | 160* | 165* | 1.873 | 64 | 128 | 186* | 192* | 195* | 1.153 |
| | | 0 | 0 | 0 | 208 | 255* | | 0 | 0 | 192 | 269 | 313* | |
| 21'-0" | | 44 | 84 | 132 | 145* | 150* | 2.276 | 49 | 107 | 166 | 176* | 178* | 1.401 |
| | | 0 | 0 | 0 | 180 | 235 | | 0 | 0 | 0 | 235 | 278* | |
| 22'-0" | | | 68 | 111 | 131* | 136* | 2.742 | | 89 | 142 | 161* | 164* | 1.687 |
| | | | 0 | 0 | 155 | 205 | | | 0 | 0 | 205 | 250* | |
| 23'-0" | | | 54 | 94 | 119* | 123* | 3.276 | | 74 | 122 | 148* | 150* | 2.016 |
| | | | 0 | 0 | 134 | 180 | | | 0 | 0 | 180 | 225* | |
| 24'-0" | | | 42 | 78 | 109* | 112* | 3.884 | | 60 | 104 | 136* | 138* | 2.390 |
| | | | 0 | 0 | 115 | 157 | | | 0 | 0 | 157 | 204* | |
| 25'-0" | | | | 65 | 99 | 102* | 4.572 | | 48 | 89 | 125* | 127* | 2.814 |
| | | | | 0 | 0 | 138 | | | 0 | 0 | 138 | 186* | |
| 26'-0" | | | | 53 | 84 | 93* | 5.349 | | | 75 | 116* | 117* | 3.292 |
| | | | | 0 | 0 | 120 | | | | 0 | 120 | 166 | |
| 27'-0" | | | | 42 | 71 | 85* | 6.221 | | | 62 | 104 | 108* | 3.828 |
| | | | | 0 | 0 | 104 | | | | 0 | 0 | 147 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.64 | 0.78 | 0.93 | | 0.64 | 0.64 | 0.64 | 0.88 | 1.09 | |
| STEEL % (UNIFORM) | 0.91 | 0.91 | 0.91 | 1.11 | 1.33 | | 0.91 | 0.91 | 0.91 | 1.25 | 1.55 | |
| (TAPERED) | 0.49 | 0.49 | 0.49 | 0.60 | 0.72 | | 0.49 | 0.49 | 0.49 | 0.68 | 0.85 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.75 | 11.75 | 11.75 | | 11.75 | 11.75 | 11.75 | 11.75 | 11.69 | |
| $-I_{cr}/I_{gr}$ | 0.202 | 0.202 | 0.202 | 0.234 | 0.267 | | 0.202 | 0.202 | 0.202 | 0.255 | 0.293 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.08 | 0.10 | 0.12 | 0.15 | 0.18 | | 0.05 | 0.08 | 0.10 | 0.12 | 0.15 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | | 11.81 | 11.75 | 11.75 | 11.69 | 11.69 | |
| $+I_{cr}/I_{gr}$ | 0.143 | 0.182 | 0.224 | 0.268 | 0.314 | | 0.105 | 0.143 | 0.182 | 0.224 | 0.268 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

8″ Deep Rib + 5.0″ Top Slab = 13.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 11 | # 4 9.5 | # 4 7.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 11 | # 4 8.5 | # 4 7 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 3 | # 4 | # 4 | # 5 | # 5 | | # 3 | # 3 | # 4 | # 4 | # 5 | |
| | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| Steel (psf) | | 0.50 | 0.60 | 0.71 | 0.86 | 1.05 | | 0.58 | 0.66 | 0.75 | 0.95 | 1.18 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 14'-0" | | 207 | 295 | 346* | 355* | 374* | 0.463 | | | | | | |
| | | 0 | 0 | 399 | 504 | 551* | | | | | | | |
| 15'-0" | | 168 | 244 | 306* | 314* | 329* | 0.610 | | | | | | |
| | | 0 | 0 | 335 | 427 | 486* | | | | | | | |
| 16'-0" | | 136 | 203 | 273* | 280* | 293* | 0.789 | | | | | | |
| | | 0 | 0 | 282 | 363 | 431* | | | | | | | |
| 17'-0" | | 109 | 168 | 239 | 251* | 262* | 1.006 | 117 | 203 | 287* | 294* | 300* | 0.619 |
| | | 0 | 0 | 0 | 311 | 387* | | 0 | 0 | 289 | 392 | 474* | |
| 18'-0" | | 87 | 140 | 203 | 226* | 236* | 1.264 | 94 | 170 | 248 | 267* | 273* | 0.778 |
| | | 0 | 0 | 0 | 267 | 339 | | 0 | 0 | 0 | 339 | 432 | |
| 19'-0" | | 68 | 115 | 172 | 205* | 213* | 1.569 | 74 | 143 | 212 | 244* | 249* | 0.966 |
| | | 0 | 0 | 0 | 229 | 295 | | 0 | 0 | 0 | 294 | 378 | |
| 20'-0" | | 52 | 95 | 146 | 186* | 194* | 1.926 | 58 | 119 | 182 | 224* | 228* | 1.185 |
| | | 0 | 0 | 0 | 197 | 256 | | 0 | 0 | 0 | 256 | 331 | |
| 21'-0" | | | 77 | 123 | 170 | 176* | 2.342 | 43 | 99 | 156 | 206* | 210* | 1.441 |
| | | | 0 | 0 | 0 | 223 | | 0 | 0 | 0 | 223 | 292 | |
| 22'-0" | | | 61 | 103 | 146 | 161* | 2.820 | | 82 | 133 | 190* | 193* | 1.736 |
| | | | 0 | 0 | 0 | 195 | | | 0 | 0 | 195 | 257 | |
| 23'-0" | | | 48 | 86 | 125 | 147* | 3.369 | | 66 | 114 | 170 | 178* | 2.073 |
| | | | 0 | 0 | 0 | 170 | | | 0 | 0 | 0 | 227 | |
| 24'-0" | | | | 71 | 107 | 135* | 3.995 | | 53 | 96 | 148 | 165* | 2.458 |
| | | | | 0 | 0 | 148 | | | 0 | 0 | 0 | 200 | |
| 25'-0" | | | | 58 | 91 | 124* | 4.703 | | 41 | 81 | 129 | 153* | 2.894 |
| | | | | 0 | 0 | 129 | | | 0 | 0 | 0 | 177 | |
| 26'-0" | | | | 46 | 77 | 112 | 5.502 | | | 68 | 112 | 142* | 3.386 |
| | | | | 0 | 0 | 0 | | | | 0 | 0 | 156 | |
| 27'-0" | | | | | 64 | 97 | 6.398 | | | 56 | 96 | 132* | 3.938 |
| | | | | | 0 | 0 | | | | 0 | 0 | 138 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.54 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.65 | 0.76 | 0.96 | | 0.65 | 0.65 | 0.65 | 0.85 | 1.03 | |
| STEEL % (UNIFORM) | 0.80 | 0.80 | 0.80 | 0.92 | 1.17 | | 0.80 | 0.80 | 0.80 | 1.03 | 1.25 | |
| (TAPERED) | 0.47 | 0.47 | 0.47 | 0.54 | 0.68 | | 0.47 | 0.47 | 0.47 | 0.60 | 0.73 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.75 | 11.75 | 11.75 | | 11.75 | 11.75 | 11.75 | 11.75 | 11.75 | |
| $-I_{cr}/I_{gr}$ | 0.190 | 0.190 | 0.190 | 0.212 | 0.253 | | 0.190 | 0.190 | 0.190 | 0.231 | 0.266 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.07 | 0.09 | 0.12 | 0.15 | 0.18 | | 0.05 | 0.07 | 0.09 | 0.12 | 0.15 | |
| EFF. DEPTH, IN. | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | | 11.81 | 11.75 | 11.75 | 11.69 | 11.69 | |
| $+I_{cr}/I_{gr}$ | 0.127 | 0.161 | 0.198 | 0.237 | 0.278 | | 0.093 | 0.127 | 0.161 | 0.198 | 0.237 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 5.0″ Top Slab = 15.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 11 | # 4 9 | # 4 7.5 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 11 | # 4 8.5 | # 5 10 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | |
| Steel (psf) | | 0.51 | 0.61 | 0.72 | 0.89 | 1.08 | | 0.59 | 0.67 | 0.77 | 0.97 | 1.25 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 17'-0" | | 149 | 221 | 279* | 289* | 301* | 0.978 | | | | | | |
| | | 0 | 0 | 306 | 393 | 413* | | | | | | | |
| 18'-0" | | 122 | 186 | 251* | 260* | 270* | 1.229 | | | | | | |
| | | 0 | 0 | 262 | 339 | 373* | | | | | | | |
| 19'-0" | | 99 | 157 | 225 | 235* | 243* | 1.525 | | | | | | |
| | | 0 | 0 | 0 | 294 | 339* | | | | | | | |
| 20'-0" | | 80 | 132 | 193 | 213* | 221* | 1.873 | 87 | 161 | 237 | 250* | 257* | 1.153 |
| | | 0 | 0 | 0 | 256 | 309* | | 0 | 0 | 0 | 327 | 389* | |
| 21'-0" | | 63 | 110 | 166 | 194* | 201* | 2.276 | 69 | 137 | 206 | 230* | 236* | 1.401 |
| | | 0 | 0 | 0 | 223 | 288 | | 0 | 0 | 0 | 287 | 348* | |
| 22'-0" | | 49 | 91 | 142 | 178* | 183* | 2.742 | 54 | 116 | 178 | 212* | 217* | 1.687 |
| | | 0 | 0 | 0 | 194 | 253 | | 0 | 0 | 0 | 253 | 313* | |
| 23'-0" | | | 75 | 122 | 163* | 168* | 3.276 | 41 | 98 | 155 | 196* | 200* | 2.016 |
| | | | 0 | 0 | 169 | 223 | | 0 | 0 | 0 | 223 | 284* | |
| 24'-0" | | | 61 | 104 | 147 | 154* | 3.884 | | 82 | 134 | 182* | 185* | 2.390 |
| | | | 0 | 0 | 0 | 197 | | | 0 | 0 | 196 | 259* | |
| 25'-0" | | | 48 | 88 | 128 | 141* | 4.572 | | 67 | 116 | 168* | 172* | 2.814 |
| | | | 0 | 0 | 0 | 174 | | | 0 | 0 | 173 | 231 | |
| 26'-0" | | | | 74 | 111 | 130* | 5.349 | | 55 | 99 | 152 | 159* | 3.292 |
| | | | | 0 | 0 | 153 | | | 0 | 0 | 0 | 206 | |
| 27'-0" | | | | 61 | 95 | 120* | 6.221 | | 43 | 85 | 134 | 148* | 3.828 |
| | | | | 0 | 0 | 134 | | | 0 | 0 | 0 | 184 | |
| 28'-0" | | | | 50 | 82 | 110* | 7.195 | | | 72 | 118 | 138* | 4.428 |
| | | | | 0 | 0 | 118 | | | | 0 | 0 | 164 | |
| 29'-0" | | | | | 69 | 102* | 8.279 | | | 60 | 103 | 128* | 5.095 |
| | | | | | 0 | 103 | | | | 0 | 0 | 146 | |
| 30'-0" | | | | | 58 | 90 | 9.481 | | | 50 | 90 | 119* | 5.835 |
| | | | | | 0 | 0 | | | | 0 | 0 | 130 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.64 | 0.78 | 0.93 | | 0.64 | 0.64 | 0.64 | 0.82 | 1.09 | |
| STEEL % (UNIFORM) | 0.75 | 0.75 | 0.75 | 0.92 | 1.10 | | 0.75 | 0.75 | 0.75 | 0.97 | 1.29 | |
| (TAPERED) | 0.42 | 0.42 | 0.42 | 0.51 | 0.61 | | 0.42 | 0.42 | 0.42 | 0.54 | 0.71 | |
| EFF. DEPTH, IN. | 13.75 | 13.75 | 13.75 | 13.75 | 13.75 | | 13.75 | 13.75 | 13.75 | 13.75 | 13.69 | |
| $-I_{cr}/I_{gr}$ | 0.187 | 0.187 | 0.187 | 0.218 | 0.249 | | 0.187 | 0.187 | 0.187 | 0.227 | 0.275 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | |
| STEEL % | 0.06 | 0.08 | 0.11 | 0.13 | 0.16 | | 0.05 | 0.06 | 0.08 | 0.11 | 0.13 | |
| EFF. DEPTH, IN. | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | | 13.81 | 13.75 | 13.75 | 13.69 | 13.69 | |
| $+I_{cr}/I_{gr}$ | 0.129 | 0.164 | 0.203 | 0.243 | 0.285 | | 0.095 | 0.129 | 0.164 | 0.203 | 0.243 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

10″ Deep Rib + 5.0″ Top Slab = 15.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 8 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 9 | # 4 7 | # 5 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | |
| Steel (psf) | | 0.60 | 0.71 | 0.86 | 1.04 | 1.25 | | 0.66 | 0.75 | 0.93 | 1.18 | 1.42 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 17'-0" | | 208 | 291 | 326* | 336* | 349* | 1.006 | | | | | | |
| | | 0 | 0 | 375 | 462* | 475* | | | | | | | |
| 18'-0" | | 174 | 249 | 295* | 303* | 314* | 1.264 | | | | | | |
| | | 0 | 0 | 324 | 410 | 430* | | | | | | | |
| 19'-0" | | 146 | 212 | 268* | 275* | 284* | 1.569 | | | | | | |
| | | 0 | 0 | 280 | 357 | 391* | | | | | | | |
| 20'-0" | | 122 | 182 | 242 | 250* | 258* | 1.926 | 151 | 224 | 288* | 295* | 299* | 1.185 |
| | | 0 | 0 | 0 | 312 | 358* | | 0 | 0 | 311 | 400 | 444* | |
| 21'-0" | | 101 | 155 | 210 | 229* | 236* | 2.342 | 127 | 193 | 265* | 272* | 275* | 1.441 |
| | | 0 | 0 | 0 | 273 | 337* | | 0 | 0 | 273 | 353 | 401* | |
| 22'-0" | | 82 | 132 | 182 | 210* | 216* | 2.820 | 106 | 167 | 239 | 251* | 254* | 1.736 |
| | | 0 | 0 | 0 | 240 | 299 | | 0 | 0 | 0 | 312 | 363* | |
| 23'-0" | | 67 | 112 | 158 | 193* | 198* | 3.369 | 89 | 144 | 210 | 233* | 235* | 2.073 |
| | | 0 | 0 | 0 | 211 | 264 | | 0 | 0 | 0 | 277 | 330* | |
| 24'-0" | | 53 | 94 | 137 | 178* | 183* | 3.995 | 73 | 124 | 185 | 216* | 218* | 2.458 |
| | | 0 | 0 | 0 | 185 | 234 | | 0 | 0 | 0 | 246 | 302* | |
| 25'-0" | | 40 | 79 | 118 | 162 | 168* | 4.703 | 59 | 106 | 162 | 201* | 203* | 2.894 |
| | | 0 | 0 | 0 | 0 | 208 | | 0 | 0 | 0 | 219 | 277* | |
| 26'-0" | | | 65 | 101 | 142 | 156* | 5.502 | 47 | 90 | 142 | 187* | 189* | 3.386 |
| | | | 0 | 0 | 0 | 184 | | 0 | 0 | 0 | 194 | 254 | |
| 27'-0" | | | 53 | 86 | 124 | 144* | 6.398 | | 76 | 124 | 173 | 176* | 3.938 |
| | | | 0 | 0 | 0 | 163 | | | 0 | 0 | 0 | 228 | |
| 28'-0" | | | 42 | 73 | 108 | 134* | 7.400 | | 63 | 108 | 153 | 165* | 4.554 |
| | | | 0 | 0 | 0 | 145 | | | 0 | 0 | 0 | 205 | |
| 29'-0" | | | | 61 | 94 | 124* | 8.516 | | 52 | 94 | 136 | 154* | 5.240 |
| | | | | 0 | 0 | 128 | | | 0 | 0 | 0 | 184 | |
| 30'-0" | | | | 50 | 81 | 113 | 9.752 | | 42 | 81 | 120 | 144* | 6.001 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 165 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.76 | 0.90 | 1.12 | | 0.65 | 0.65 | 0.80 | 1.03 | 1.24 | |
| STEEL % (UNIFORM) | 0.67 | 0.67 | 0.77 | 0.92 | 1.14 | | 0.67 | 0.67 | 0.81 | 1.05 | 1.27 | |
| (TAPERED) | 0.39 | 0.39 | 0.45 | 0.54 | 0.67 | | 0.39 | 0.39 | 0.48 | 0.62 | 0.75 | |
| EFF. DEPTH, IN. | 13.75 | 13.75 | 13.75 | 13.75 | 13.69 | | 13.75 | 13.75 | 13.75 | 13.75 | 13.69 | |
| $-I_{cr}/I_{gr}$ | 0.175 | 0.175 | 0.196 | 0.224 | 0.260 | | 0.175 | 0.175 | 0.205 | 0.247 | 0.280 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.08 | 0.10 | 0.13 | 0.15 | 0.18 | | 0.06 | 0.08 | 0.10 | 0.13 | 0.15 | |
| EFF. DEPTH, IN. | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | |
| $+I_{cr}/I_{gr}$ | 0.145 | 0.179 | 0.214 | 0.252 | 0.291 | | 0.114 | 0.145 | 0.179 | 0.214 | 0.252 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 5.0″ Top Slab = 17.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 7.5 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 8.5 | # 4 7 | # 5 8.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.61 | 0.72 | 0.88 | 1.08 | 1.28 | | 0.67 | 0.77 | 0.97 | 1.20 | 1.48 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 19'-0" | | 188 | 267 | 296* | 309* | 317* | 1.525 | | | | | | |
| | | 0 | 0 | 347 | 399* | 410* | | | | | | | |
| 20'-0" | | 159 | 231 | 269* | 281* | 287* | 1.873 | | | | | | |
| | | 0 | 0 | 302 | 364* | 375* | | | | | | | |
| 21'-0" | | 135 | 199 | 246* | 256* | 262* | 2.276 | | | | | | |
| | | 0 | 0 | 264 | 339* | 349* | | | | | | | |
| 22'-0" | | 113 | 172 | 225* | 234* | 239* | 2.742 | 142 | | 268* | | 280* | 1.687 |
| | | 0 | 0 | 232 | 300 | 322* | | 0 | | 299 | | 390* | |
| 23'-0" | | 95 | 148 | 203 | 215* | 219* | 3.276 | 121 | 186 | 248* | 253* | 259* | 2.016 |
| | | 0 | 0 | 0 | 265 | 298* | | 0 | 0 | 264 | 343* | 355* | |
| 24'-0" | | 78 | 128 | 178 | 198* | 202* | 3.884 | 102 | 162 | 230* | 235* | 240* | 2.390 |
| | | 0 | 0 | 0 | 235 | 276* | | 0 | 0 | 234 | 307 | 324* | |
| 25'-0" | | 64 | 109 | 155 | 183* | 186* | 4.572 | 86 | 141 | 207 | 218* | 223* | 2.814 |
| | | 0 | 0 | 0 | 208 | 257* | | 0 | 0 | 0 | 274 | 297* | |
| 26'-0" | | 51 | 93 | 136 | 169* | 172* | 5.349 | 71 | 122 | 184 | 204* | 208* | 3.292 |
| | | 0 | 0 | 0 | 185 | 234 | | 0 | 0 | 0 | 246 | 274* | |
| 27'-0" | | 40 | 79 | 118 | 156* | 159* | 6.221 | 58 | 106 | 163 | 190* | 194* | 3.828 |
| | | 0 | 0 | 0 | 163 | 209 | | 0 | 0 | 0 | 220 | 253* | |
| 28'-0" | | | 66 | 102 | 145 | 147* | 7.195 | 47 | 91 | 144 | 178* | 181* | 4.428 |
| | | | 0 | 0 | 0 | 187 | | 0 | 0 | 0 | 197 | 235* | |
| 29'-0" | | | 54 | 88 | 128 | 137* | 8.279 | | 78 | 127 | 166* | 169* | 5.095 |
| | | | 0 | 0 | 0 | 167 | | | 0 | 0 | 177 | 218* | |
| 30'-0" | | | 44 | 75 | 112 | 127* | 9.481 | | 66 | 112 | 156* | 158* | 5.835 |
| | | | 0 | 0 | 0 | 150 | | | 0 | 0 | 158 | 203* | |
| 31'-0" | | | | 64 | 98 | 118* | 10.810 | | 55 | 98 | 141 | 148* | 6.652 |
| | | | | 0 | 0 | 133 | | | 0 | 0 | 0 | 189* | |
| 32'-0" | | | | 53 | 86 | 109* | 12.274 | | 45 | 85 | 126 | 139* | 7.553 |
| | | | | 0 | 0 | 119 | | | 0 | 0 | 0 | 173 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.74 | 0.93 | 1.09 | | 0.64 | 0.64 | 0.82 | 1.00 | 1.28 | |
| STEEL % (UNIFORM) | 0.64 | 0.64 | 0.74 | 0.94 | 1.10 | | 0.64 | 0.64 | 0.83 | 1.01 | 1.29 | |
| (TAPERED) | 0.36 | 0.36 | 0.41 | 0.52 | 0.61 | | 0.36 | 0.36 | 0.46 | 0.56 | 0.72 | |
| EFF. DEPTH, IN. | 15.75 | 15.75 | 15.75 | 15.75 | 15.69 | | 15.75 | 15.75 | 15.75 | 15.75 | 15.69 | |
| $-I_{cr}/I_{gr}$ | 0.173 | 0.173 | 0.193 | 0.231 | 0.256 | | 0.173 | 0.173 | 0.211 | 0.244 | 0.288 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.07 | 0.09 | 0.11 | 0.14 | 0.16 | | 0.06 | 0.07 | 0.09 | 0.11 | 0.14 | |
| EFF. DEPTH, IN. | 15.75 | 15.69 | 15.69 | 15.62 | 15.62 | | 15.75 | 15.75 | 15.69 | 15.69 | 15.62 | |
| $+I_{cr}/I_{gr}$ | 0.148 | 0.184 | 0.220 | 0.260 | 0.300 | | 0.117 | 0.148 | 0.184 | 0.220 | 0.260 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

12″ Deep Rib + 5.0″ Top Slab = 17.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 8 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 9 | # 4 7 | # 5 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.60 | 0.71 | 0.86 | 1.04 | 1.25 | | 0.66 | 0.75 | 0.93 | 1.18 | 1.42 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 19'-0" | | 175 | 252 | 329 | 345* | 356* | 1.569 | | | | | | |
| | | 0 | 0 | 0 | 418 | 456* | | | | | | | |
| 20'-0" | | 147 | 216 | 286 | 314* | 324* | 1.926 | | | | | | |
| | | 0 | 0 | 0 | 367 | 418* | | | | | | | |
| 21'-0" | | 123 | 186 | 249 | 288* | 296* | 2.342 | | | | | | |
| | | 0 | 0 | 0 | 322 | 391* | | | | | | | |
| 22'-0" | | 103 | 160 | 217 | 264* | 272* | 2.820 | 130 | | 283 | | 316* | 1.736 |
| | | 0 | 0 | 0 | 284 | 351 | | 0 | | 0 | | 435* | |
| 23'-0" | | 84 | 137 | 190 | 244* | 250* | 3.369 | 110 | 173 | 249 | 290* | 294* | 2.073 |
| | | 0 | 0 | 0 | 250 | 312 | | 0 | 0 | 0 | 326 | 396* | |
| 24'-0" | | 68 | 116 | 165 | 221 | 231* | 3.995 | 92 | 150 | 220 | 270* | 273* | 2.458 |
| | | 0 | 0 | 0 | 0 | 278 | | 0 | 0 | 0 | 290 | 363* | |
| 25'-0" | | 54 | 99 | 143 | 195 | 214* | 4.703 | 76 | 130 | 194 | 252* | 255* | 2.894 |
| | | 0 | 0 | 0 | 0 | 247 | | 0 | 0 | 0 | 259 | 334 | |
| 26'-0" | | 42 | 83 | 124 | 172 | 198* | 5.502 | 62 | 111 | 171 | 231 | 238* | 3.386 |
| | | 0 | 0 | 0 | 0 | 220 | | 0 | 0 | 0 | 0 | 300 | |
| 27'-0" | | | 69 | 107 | 151 | 184* | 6.398 | 49 | 95 | 150 | 206 | 222* | 3.938 |
| | | | 0 | 0 | 0 | 196 | | 0 | 0 | 0 | 0 | 270 | |
| 28'-0" | | | 56 | 92 | 133 | 171* | 7.400 | | 81 | 132 | 184 | 208* | 4.554 |
| | | | 0 | 0 | 0 | 174 | | | 0 | 0 | 0 | 244 | |
| 29'-0" | | | 45 | 78 | 116 | 155 | 8.516 | | 68 | 116 | 164 | 195* | 5.240 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 220 | |
| 30'-0" | | | | 66 | 101 | 138 | 9.752 | | 56 | 101 | 146 | 183* | 6.001 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 198 | |
| 31'-0" | | | | 54 | 88 | 122 | 11.119 | | 45 | 87 | 130 | 172* | 6.842 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 178 | |
| 32'-0" | | | | 44 | 76 | 108 | 12.625 | | | 75 | 115 | 161 | 7.769 |
| | | | | 0 | 0 | 0 | | | | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.76 | 0.90 | 1.12 | | 0.65 | 0.65 | 0.80 | 1.03 | 1.24 | |
| STEEL % (UNIFORM) | 0.57 | 0.57 | 0.66 | 0.78 | 0.97 | | 0.57 | 0.57 | 0.69 | 0.89 | 1.08 | |
| (TAPERED) | 0.34 | 0.34 | 0.39 | 0.46 | 0.58 | | 0.34 | 0.34 | 0.41 | 0.53 | 0.64 | |
| EFF. DEPTH, IN. | 15.75 | 15.75 | 15.75 | 15.75 | 15.69 | | 15.75 | 15.75 | 15.75 | 15.75 | 15.69 | |
| $-I_{cr}/I_{gr}$ | 0.162 | 0.162 | 0.181 | 0.207 | 0.242 | | 0.162 | 0.162 | 0.189 | 0.229 | 0.261 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.07 | 0.09 | 0.11 | 0.13 | 0.16 | | 0.05 | 0.07 | 0.09 | 0.11 | 0.13 | |
| EFF. DEPTH, IN. | 15.75 | 15.69 | 15.69 | 15.62 | 15.62 | | 15.75 | 15.75 | 15.69 | 15.69 | 15.62 | |
| $+I_{cr}/I_{gr}$ | 0.131 | 0.163 | 0.195 | 0.230 | 0.265 | | 0.103 | 0.131 | 0.163 | 0.195 | 0.230 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 5" Rib @ 35" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

14″ Deep Rib + 5.0″ Top Slab = 19.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 9.5 | # 4 7.5 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 8.5 | # 4 7 | # 5 8.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.61 | 0.72 | 0.88 | 1.08 | 1.28 | | 0.67 | 0.77 | 0.97 | 1.20 | 1.48 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 22'-0" | | 135 | 202 | 269 | 290* | 297* | 2.742 | | | | | | |
| | | 0 | 0 | 0 | 346 | 371* | | | | | | | |
| 23'-0" | | 114 | 175 | 237 | 267* | 272* | 3.276 | | | | | | |
| | | 0 | 0 | 0 | 307 | 344* | | | | | | | |
| 24'-0" | | 96 | 152 | 208 | 246* | 251* | 3.884 | | | | | | |
| | | 0 | 0 | 0 | 273 | 319* | | | | | | | |
| 25'-0" | | 80 | 131 | 183 | 228* | 232* | 4.572 | 104 | | 242 | | 275* | 2.814 |
| | | 0 | 0 | 0 | 243 | 298* | | 0 | | 0 | | 353* | |
| 26'-0" | | 65 | 113 | 161 | 211* | 215* | 5.349 | 88 | 146 | 215 | 251* | 256* | 3.292 |
| | | 0 | 0 | 0 | 216 | 272 | | 0 | 0 | 0 | 285 | 326* | |
| 27'-0" | | 52 | 96 | 141 | 192 | 199* | 6.221 | 73 | 127 | 191 | 235* | 240* | 3.828 |
| | | 0 | 0 | 0 | 0 | 244 | | 0 | 0 | 0 | 256 | 303* | |
| 28'-0" | | 41 | 82 | 123 | 171 | 185* | 7.195 | 60 | 110 | 170 | 220* | 224* | 4.428 |
| | | 0 | 0 | 0 | 0 | 219 | | 0 | 0 | 0 | 230 | 281* | |
| 29'-0" | | | 69 | 107 | 152 | 173* | 8.279 | 49 | 95 | 151 | 207* | 210* | 5.095 |
| | | | 0 | 0 | 0 | 197 | | 0 | 0 | 0 | 0 | 262* | |
| 30'-0" | | | 57 | 93 | 134 | 161* | 9.481 | | 82 | 134 | 186 | 198* | 5.835 |
| | | | 0 | 0 | 0 | 177 | | | 0 | 0 | 0 | 244* | |
| 31'-0" | | | 46 | 80 | 119 | 150* | 10.810 | | 69 | 118 | 167 | 186* | 6.652 |
| | | | 0 | 0 | 0 | 158 | | | 0 | 0 | 0 | 224 | |
| 32'-0" | | | | 68 | 105 | 140* | 12.274 | | 58 | 104 | 150 | 175* | 7.553 |
| | | | | 0 | 0 | 142 | | | 0 | 0 | 0 | 203 | |
| 33'-0" | | | | 57 | 92 | 127 | 13.882 | | 48 | 91 | 134 | 164* | 8.543 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 184 | |
| 34'-0" | | | | 47 | 80 | 113 | 15.642 | | | 79 | 120 | 155* | 9.626 |
| | | | | 0 | 0 | 0 | | | | 0 | 0 | 167 | |
| 35'-0" | | | | | 69 | 100 | 17.565 | | | 68 | 107 | 146* | 10.809 |
| | | | | | 0 | 0 | | | | 0 | 0 | 151 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF) [4]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.64 | 0.64 | 0.74 | 0.93 | 1.09 | | 0.64 | 0.64 | 0.82 | 1.00 | 1.28 | |
| STEEL % (UNIFORM) | 0.55 | 0.55 | 0.64 | 0.81 | 0.95 | | 0.55 | 0.55 | 0.72 | 0.87 | 1.11 | |
| (TAPERED) | 0.31 | 0.31 | 0.36 | 0.46 | 0.53 | | 0.31 | 0.31 | 0.40 | 0.49 | 0.63 | |
| EFF. DEPTH, IN. | 17.75 | 17.75 | 17.75 | 17.75 | 17.69 | | 17.75 | 17.75 | 17.75 | 17.75 | 17.69 | |
| $-I_{cr}/I_{gr}$ | 0.160 | 0.160 | 0.180 | 0.216 | 0.239 | | 0.160 | 0.160 | 0.196 | 0.227 | 0.270 | |
| POSITIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.06 | 0.08 | 0.10 | 0.12 | 0.14 | | 0.05 | 0.06 | 0.08 | 0.10 | 0.12 | |
| EFF. DEPTH, IN. | 17.75 | 17.69 | 17.69 | 17.62 | 17.62 | | 17.75 | 17.75 | 17.69 | 17.69 | 17.62 | |
| $+I_{cr}/I_{gr}$ | 0.135 | 0.168 | 0.201 | 0.237 | 0.274 | | 0.106 | 0.135 | 0.168 | 0.201 | 0.237 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

14″ Deep Rib + 5.0″ Top Slab = 19.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 11 | # 4 10 | # 4 8 | # 5 10 | End Span Defl. Coeff. (3) | # 4 11 | # 4 11 | # 4 9 | # 4 7 | # 5 9 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 4 | # 5 | # 5 | # 6 | | # 3 | # 4 | # 4 | # 5 | # 5 | |
| | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| Steel (psf) | | 0.60 | 0.71 | 0.85 | 1.04 | 1.25 | | 0.66 | 0.75 | 0.93 | 1.18 | 1.42 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 22'-0" | | 124 | 188 | 254 | 325* | 334* | 2.820 | | | | | | |
| | | 0 | 0 | 0 | 329 | 405 | | | | | | | |
| 23'-0" | | 103 | 162 | 222 | 291 | 308* | 3.369 | | | | | | |
| | | 0 | 0 | 0 | 0 | 361 | | | | | | | |
| 24'-0" | | 85 | 140 | 195 | 258 | 285* | 3.995 | | | | | | |
| | | 0 | 0 | 0 | 0 | 322 | | | | | | | |
| 25'-0" | | 70 | 120 | 170 | 228 | 264* | 4.703 | 93 | | 227 | | 311* | 2.894 |
| | | 0 | 0 | 0 | 0 | 288 | | 0 | | 0 | | 385 | |
| 26'-0" | | 55 | 102 | 148 | 202 | 245* | 5.502 | 78 | 134 | 201 | 269 | 291* | 3.386 |
| | | 0 | 0 | 0 | 0 | 257 | | 0 | 0 | 0 | 0 | 348 | |
| 27'-0" | | 43 | 86 | 129 | 179 | 228* | 6.398 | 63 | 116 | 178 | 241 | 273* | 3.938 |
| | | 0 | 0 | 0 | 0 | 230 | | 0 | 0 | 0 | 0 | 314 | |
| 28'-0" | | | 72 | 112 | 158 | 206 | 7.400 | 51 | 99 | 157 | 216 | 256* | 4.554 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 284 | |
| 29'-0" | | | 59 | 96 | 140 | 184 | 8.516 | | 85 | 139 | 193 | 241* | 5.240 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 256 | |
| 30'-0" | | | 47 | 82 | 123 | 164 | 9.752 | | 71 | 122 | 173 | 227* | 6.001 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 232 | |
| 31'-0" | | | | 70 | 108 | 146 | 11.119 | | 59 | 107 | 155 | 210 | 6.842 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 32'-0" | | | | 58 | 94 | 130 | 12.625 | | 49 | 93 | 138 | 190 | 7.769 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 33'-0" | | | | 48 | 81 | 115 | 14.278 | | | 80 | 123 | 171 | 8.787 |
| | | | | 0 | 0 | 0 | | | | 0 | 0 | 0 | |
| 34'-0" | | | | | 70 | 102 | 16.089 | | | 69 | 109 | 155 | 9.901 |
| | | | | | 0 | 0 | | | | 0 | 0 | 0 | |
| 35'-0" | | | | | 59 | 89 | 18.067 | | | 59 | 96 | 139 | 11.118 |
| | | | | | 0 | 0 | | | | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF) [4]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.65 | 0.72 | 0.90 | 1.12 | | 0.65 | 0.65 | 0.80 | 1.03 | 1.24 | |
| STEEL % (UNIFORM) | 0.49 | 0.49 | 0.54 | 0.68 | 0.84 | | 0.49 | 0.49 | 0.60 | 0.77 | 0.94 | |
| (TAPERED) | 0.30 | 0.30 | 0.33 | 0.41 | 0.51 | | 0.30 | 0.30 | 0.36 | 0.46 | 0.56 | |
| EFF. DEPTH, IN. | 17.75 | 17.75 | 17.75 | 17.75 | 17.69 | | 17.75 | 17.75 | 17.75 | 17.75 | 17.69 | |
| $-I_{cr}/I_{gr}$ | 0.150 | 0.150 | 0.162 | 0.193 | 0.226 | | 0.150 | 0.150 | 0.176 | 0.214 | 0.244 | |
| POSITIVE MOMENT | | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | |
| STEEL % | 0.06 | 0.08 | 0.10 | 0.12 | 0.14 | | 0.05 | 0.06 | 0.08 | 0.10 | 0.12 | |
| EFF. DEPTH, IN. | 17.75 | 17.69 | 17.69 | 17.62 | 17.62 | | 17.75 | 17.75 | 17.69 | 17.69 | 17.62 | |
| $+I_{cr}/I_{gr}$ | 0.119 | 0.149 | 0.178 | 0.210 | 0.243 | | 0.094 | 0.119 | 0.149 | 0.178 | 0.210 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

16″ Deep Rib + 5.0″ Top Slab = 21.0″ Total Depth

| TOP BARS | Size @ | # 4 11 | # 4 10 | # 4 8 | # 4 7 | # 5 9 | End Span Defl. Coeff. (3) | # 4 11 | # 4 9 | # 4 7.5 | # 5 9 | # 5 7.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 4 | # 5 | # 5 | # 6 | # 6 | | # 4 | # 4 | # 5 | # 5 | # 6 | |
| | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| Steel (psf) | | 0.71 | 0.85 | 1.04 | 1.23 | 1.44 | | 0.75 | 0.93 | 1.14 | 1.42 | 1.71 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 25'-0" | | 139 | 196 | 261 | 315* | 323* | 4.703 | | | | | | |
| | | 0 | 0 | 0 | 327 | 388* | | | | | | | |
| 26'-0" | | 119 | 172 | 232 | 293 | 300* | 5.502 | | | | | | |
| | | 0 | 0 | 0 | 0 | 363* | | | | | | | |
| 27'-0" | | 102 | 150 | 206 | 262 | 280* | 6.398 | | | | | | |
| | | 0 | 0 | 0 | 0 | 330 | | | | | | | |
| 28'-0" | | 86 | 131 | 183 | 235 | 261* | 7.400 | | 181 | 247 | 306* | 312* | 4.554 |
| | | 0 | 0 | 0 | 0 | 298 | | | 0 | 0 | 322 | 377* | |
| 29'-0" | | 72 | 114 | 162 | 211 | 244* | 8.516 | 100 | 161 | 222 | 288* | 294* | 5.240 |
| | | 0 | 0 | 0 | 0 | 270 | | 0 | 0 | 0 | 292 | 353* | |
| 30'-0" | | 59 | 98 | 143 | 189 | 229* | 9.752 | 86 | 142 | 199 | 265 | 277* | 6.001 |
| | | 0 | 0 | 0 | 0 | 244 | | 0 | 0 | 0 | 0 | 331* | |
| 31'-0" | | 47 | 84 | 126 | 169 | 215* | 11.119 | 72 | 125 | 178 | 240 | 261* | 6.842 |
| | | 0 | 0 | 0 | 0 | 221 | | 0 | 0 | 0 | 0 | 302 | |
| 32'-0" | | | 71 | 111 | 151 | 199 | 12.625 | 60 | 110 | 160 | 218 | 247* | 7.769 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 276 | |
| 33'-0" | | | 59 | 97 | 135 | 180 | 14.278 | 49 | 96 | 143 | 197 | 233* | 8.787 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 252 | |
| 34'-0" | | | 49 | 84 | 120 | 163 | 16.089 | | 83 | 127 | 179 | 221* | 9.901 |
| | | | 0 | 0 | 0 | 0 | | | 0 | 0 | 0 | 231 | |
| 35'-0" | | | | 72 | 106 | 146 | 18.067 | | 71 | 113 | 162 | 209* | 11.118 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 211 | |
| 36'-0" | | | | 62 | 93 | 132 | 20.222 | | 61 | 100 | 146 | 192 | 12.445 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 37'-0" | | | | 52 | 82 | 118 | 22.565 | | 51 | 88 | 132 | 175 | 13.886 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 38'-0" | | | | 43 | 71 | 105 | 25.105 | | 42 | 77 | 118 | 160 | 15.449 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.65 | 0.72 | 0.90 | 1.03 | 1.24 | | 0.65 | 0.80 | 0.96 | 1.24 | 1.49 | |
| STEEL % (UNIFORM) | 0.43 | 0.48 | 0.60 | 0.68 | 0.82 | | 0.43 | 0.53 | 0.64 | 0.82 | 0.99 | |
| (TAPERED) | 0.26 | 0.29 | 0.36 | 0.41 | 0.50 | | 0.26 | 0.32 | 0.38 | 0.50 | 0.60 | |
| EFF. DEPTH, IN. | 19.75 | 19.75 | 19.75 | 19.75 | 19.69 | | 19.75 | 19.75 | 19.75 | 19.69 | 19.69 | |
| $-I_{cr}/I_{gr}$ | 0.140 | 0.151 | 0.180 | 0.200 | 0.230 | | 0.140 | 0.164 | 0.190 | 0.230 | 0.263 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | |
| STEEL % | 0.07 | 0.09 | 0.11 | 0.12 | 0.15 | | 0.06 | 0.07 | 0.09 | 0.11 | 0.12 | |
| EFF. DEPTH, IN. | 19.69 | 19.69 | 19.62 | 19.62 | 19.56 | | 19.75 | 19.69 | 19.69 | 19.62 | 19.62 | |
| $+I_{cr}/I_{gr}$ | 0.137 | 0.164 | 0.194 | 0.225 | 0.260 | | 0.110 | 0.137 | 0.164 | 0.194 | 0.225 | |

| STANDARD ONE-WAY JOISTS [1] MULTIPLE SPANS | 30" Forms + 7" Rib @ 37" c.-c. [2] FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

16″ Deep Rib + 5.0″ Top Slab = 21.0″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8.5 | # 4 7 | # 5 9 | # 5 8 | End Span Defl. Coeff. (3) | # 4 9 | # 4 7.5 | # 5 9.5 | # 5 8 | # 6 9.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # | # 5 | # 5 | # 6 | # 6 | # 7 | | # 4 | # 5 | # 5 | # 6 | # 6 | |
| | # | # 5 | # 6 | # 6 | # 7 | # 7 | | # 5 | # 5 | # 6 | # 6 | # 7 | |
| Steel (psf) | | 0.83 | 1.00 | 1.20 | 1.41 | 1.63 | | 0.92 | 1.13 | 1.36 | 1.63 | 1.93 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 25'-0" | | 181 | 245 | 309 | 356* | 363* | 4.834 | | | | | | |
| | | 0 | 0 | 0 | 386 | 435* | | | | | | | |
| 26'-0" | | 158 | 216 | 276 | 332* | 338* | 5.655 | | | | | | |
| | | 0 | 0 | 0 | 347 | 408* | | | | | | | |
| 27'-0" | | 137 | 191 | 246 | 310* | 315* | 6.576 | | | | | | |
| | | 0 | 0 | 0 | 312 | 379 | | | | | | | |
| 28'-0" | | 118 | 169 | 220 | 281 | 295* | 7.606 | 167 | 231 | 304 | 344* | 348* | 4.681 |
| | | 0 | 0 | 0 | 0 | 344 | | 0 | 0 | 0 | 379 | 421* | |
| 29'-0" | | 101 | 148 | 196 | 253 | 276* | 8.752 | 147 | 206 | 275 | 324* | 328* | 5.386 |
| | | 0 | 0 | 0 | 0 | 311 | | 0 | 0 | 0 | 344 | 394* | |
| 30'-0" | | 86 | 130 | 175 | 228 | 259* | 10.023 | 129 | 184 | 248 | 306* | 310* | 6.168 |
| | | 0 | 0 | 0 | 0 | 283 | | 0 | 0 | 0 | 313 | 369* | |
| 31'-0" | | 72 | 114 | 155 | 205 | 243* | 11.428 | 112 | 164 | 224 | 285 | 293* | 7.033 |
| | | 0 | 0 | 0 | 0 | 256 | | 0 | 0 | 0 | 0 | 347* | |
| 32'-0" | | 60 | 99 | 138 | 185 | 229* | 12.975 | 97 | 146 | 202 | 260 | 277* | 7.985 |
| | | 0 | 0 | 0 | 0 | 233 | | 0 | 0 | 0 | 0 | 327* | |
| 33'-0" | | 48 | 85 | 122 | 166 | 211 | 14.675 | 84 | 130 | 183 | 236 | 262* | 9.031 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 301 | |
| 34'-0" | | | 72 | 107 | 149 | 191 | 16.536 | 71 | 115 | 165 | 215 | 248* | 10.176 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 276 | |
| 35'-0" | | | 61 | 94 | 133 | 173 | 18.569 | 60 | 101 | 148 | 196 | 236* | 11.427 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 253 | |
| 36'-0" | | | 51 | 82 | 119 | 156 | 20.784 | 50 | 88 | 133 | 178 | 224* | 12.790 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 232 | |
| 37'-0" | | | 41 | 70 | 105 | 141 | 23.191 | 40 | 77 | 119 | 161 | 213 | 14.272 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| 38'-0" | | | | 60 | 93 | 127 | 25.802 | | 66 | 106 | 146 | 195 | 15.878 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF) [4]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.74 | 0.87 | 1.06 | 1.27 | 1.43 | | 0.82 | 0.99 | 1.21 | 1.43 | 1.71 | |
| STEEL % (UNIFORM) | 0.43 | 0.51 | 0.62 | 0.75 | 0.84 | | 0.48 | 0.58 | 0.71 | 0.84 | 1.01 | |
| (TAPERED) | 0.27 | 0.32 | 0.39 | 0.47 | 0.53 | | 0.31 | 0.37 | 0.45 | 0.53 | 0.64 | |
| EFF. DEPTH, IN. | 19.75 | 19.75 | 19.75 | 19.69 | 19.69 | | 19.75 | 19.75 | 19.69 | 19.69 | 19.62 | |
| $-I_{cr}/I_{gr}$ | 0.143 | 0.163 | 0.190 | 0.219 | 0.239 | | 0.156 | 0.180 | 0.210 | 0.239 | 0.272 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | |
| STEEL % | 0.09 | 0.10 | 0.12 | 0.14 | 0.17 | | 0.07 | 0.09 | 0.10 | 0.12 | 0.14 | |
| EFF. DEPTH, IN. | 19.69 | 19.62 | 19.62 | 19.56 | 19.56 | | 19.69 | 19.69 | 19.62 | 19.62 | 19.56 | |
| $+I_{cr}/I_{gr}$ | 0.148 | 0.175 | 0.203 | 0.235 | 0.267 | | 0.124 | 0.148 | 0.175 | 0.203 | 0.235 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 6" Rib @ 36" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

20″ Deep Rib + 5.0″ Top Slab = 25.0″ Total Depth

| TOP BARS | Size @ | # 4 10 | # 4 8 | # 4 7 | # 5 9 | # 5 7.5 | End Span Defl. Coeff. (3) | # 4 9 | # 4 7.5 | # 5 9.5 | # 5 8 | # 6 9.5 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | |
| Steel (psf) | | 0.85 | 1.04 | 1.23 | 1.44 | 1.69 | | 0.93 | 1.14 | 1.38 | 1.66 | 1.96 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'-0" | | 128 | 183 | 238 | 305 | 326* | 9.752 | | | | | | |
| | | 0 | 0 | 0 | 0 | 370* | | | | | | | |
| 31'-0" | | 111 | 162 | 214 | 276 | 306* | 11.119 | | | | | | |
| | | 0 | 0 | 0 | 0 | 340 | | | | | | | |
| 32'-0" | | 95 | 144 | 192 | 251 | 288* | 12.625 | | | | | | |
| | | 0 | 0 | 0 | 0 | 310 | | | | | | | |
| 33'-0" | | 81 | 127 | 172 | 228 | 271* | 14.278 | 125 | | 248 | | 321* | 8.787 |
| | | 0 | 0 | 0 | 0 | 283 | | 0 | | 0 | | 363* | |
| 34'-0" | | 69 | 111 | 154 | 206 | 256* | 16.089 | 110 | 163 | 225 | 288 | 305* | 9.901 |
| | | 0 | 0 | 0 | 0 | 259 | | 0 | 0 | 0 | 0 | 343* | |
| 35'-0" | | 57 | 97 | 138 | 187 | 236 | 18.067 | 96 | 146 | 205 | 264 | 289* | 11.118 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 325* | |
| 36'-0" | | 46 | 84 | 123 | 169 | 216 | 20.222 | 83 | 131 | 186 | 242 | 275* | 12.445 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 308* | |
| 37'-0" | | | 72 | 109 | 152 | 197 | 22.565 | 71 | 116 | 169 | 221 | 262* | 13.886 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 285 | |
| 38'-0" | | | 61 | 96 | 137 | 179 | 25.105 | 60 | 103 | 153 | 203 | 249* | 15.449 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 263 | |
| 39'-0" | | | 51 | 84 | 123 | 163 | 27.853 | 50 | 91 | 138 | 185 | 237* | 17.141 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 243 | |
| 40'-0" | | | 42 | 73 | 110 | 148 | 30.822 | 41 | 79 | 124 | 169 | 224 | 18.967 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| 41'-0" | | | | 63 | 98 | 134 | 34.022 | | 69 | 111 | 154 | 206 | 20.936 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 42'-0" | | | | 53 | 87 | 121 | 37.464 | | 59 | 99 | 141 | 190 | 23.055 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |
| 43'-0" | | | | 44 | 77 | 109 | 41.162 | | 50 | 88 | 128 | 175 | 25.330 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.72 | 0.90 | 1.03 | 1.24 | 1.49 | | 0.80 | 0.96 | 1.17 | 1.39 | 1.67 | |
| STEEL % (UNIFORM) | 0.38 | 0.47 | 0.54 | 0.66 | 0.79 | | 0.42 | 0.51 | 0.62 | 0.74 | 0.89 | |
| (TAPERED) | 0.23 | 0.29 | 0.33 | 0.40 | 0.48 | | 0.26 | 0.31 | 0.38 | 0.45 | 0.54 | |
| EFF. DEPTH, IN. | 23.75 | 23.75 | 23.75 | 23.69 | 23.69 | | 23.75 | 23.75 | 23.69 | 23.69 | 23.62 | |
| $-I_{cr}/I_{gr}$ | 0.133 | 0.160 | 0.178 | 0.205 | 0.236 | | 0.145 | 0.169 | 0.197 | 0.225 | 0.256 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | |
| STEEL % | 0.07 | 0.09 | 0.10 | 0.12 | 0.14 | | 0.06 | 0.07 | 0.09 | 0.10 | 0.12 | |
| EFF. DEPTH, IN. | 23.69 | 23.62 | 23.62 | 23.56 | 23.56 | | 23.69 | 23.69 | 23.62 | 23.62 | 23.56 | |
| $+I_{cr}/I_{gr}$ | 0.142 | 0.169 | 0.195 | 0.226 | 0.258 | | 0.119 | 0.142 | 0.169 | 0.195 | 0.226 | |

| STANDARD ONE-WAY JOISTS (1) MULTIPLE SPANS | 30" Forms + 7" Rib @ 37" c.-c. (2) FACTORED USABLE SUPERIMPOSED LOAD (PSF) | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|

20″ Deep Rib + 5.0″ Top Slab = 25.0″ Total Depth

| TOP BARS | Size @ | # 4 8 | # 4 7 | # 5 9.5 | # 5 8 | # 5 7 | End Span Defl. Coeff. (3) | # 5 11 | # 5 9.5 | # 5 8 | # 5 7 | # 5 6 | Int. Span Defl. Coeff. (3) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BOTTOM BARS | # # | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | |
| Steel (psf) | | 1.02 | 1.20 | 1.40 | 1.63 | 1.87 | | 1.16 | 1.36 | 1.63 | 1.88 | 2.20 | |
| CLEAR SPAN | | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'-0" | | 168 | 222 | 287 | 353 | 363* | 10.023 | | | | | | |
| | | 0 | 0 | 0 | 0 | 411* | | | | | | | |
| 31'-0" | | 148 | 199 | 259 | 321 | 341* | 11.428 | | | | | | |
| | | 0 | 0 | 0 | 0 | 389* | | | | | | | |
| 32'-0" | | 130 | 177 | 234 | 292 | 321* | 12.975 | | | | | | |
| | | 0 | 0 | 0 | 0 | 359 | | | | | | | |
| 33'-0" | | 114 | 158 | 212 | 266 | 303* | 14.675 | | 231 | | 356* | | 9.031 |
| | | 0 | 0 | 0 | 0 | 329 | | | 0 | | 374 | | |
| 34'-0" | | 99 | 140 | 191 | 242 | 286* | 16.536 | 149 | 210 | 271 | 339* | 344* | 10.176 |
| | | 0 | 0 | 0 | 0 | 302 | | 0 | 0 | 0 | 344 | 386* | |
| 35'-0" | | 85 | 124 | 172 | 220 | 271* | 18.569 | 133 | 190 | 247 | 317 | 327* | 11.427 |
| | | 0 | 0 | 0 | 0 | 276 | | 0 | 0 | 0 | 0 | 365* | |
| 36'-0" | | 72 | 110 | 155 | 200 | 253 | 20.784 | 117 | 171 | 226 | 291 | 311* | 12.790 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 347* | |
| 37'-0" | | 61 | 96 | 139 | 182 | 232 | 23.191 | 103 | 154 | 206 | 268 | 296* | 14.272 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 330* | |
| 38'-0" | | 50 | 83 | 124 | 165 | 212 | 25.802 | 90 | 139 | 188 | 246 | 282* | 15.878 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 306 | |
| 39'-0" | | 40 | 72 | 110 | 149 | 194 | 28.627 | 78 | 124 | 171 | 227 | 269* | 17.617 |
| | | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 283 | |
| 40'-0" | | | 61 | 98 | 135 | 177 | 31.678 | 67 | 111 | 155 | 208 | 257* | 19.494 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 262 | |
| 41'-0" | | | 51 | 86 | 121 | 162 | 34.967 | 57 | 99 | 141 | 191 | 242 | 21.518 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| 42'-0" | | | 42 | 75 | 109 | 147 | 38.505 | 47 | 87 | 127 | 175 | 224 | 23.695 |
| | | | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | |
| 43'-0" | | | | 65 | 97 | 134 | 42.305 | | 76 | 115 | 161 | 207 | 26.034 |
| | | | | 0 | 0 | 0 | | | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(4) Exclusive of bridging joists and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

PROPERTIES FOR DESIGN (CONCRETE 0.81 CF/SF) (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.06 | 1.21 | 1.43 | 1.64 | | 1.04 | 1.21 | 1.43 | 1.64 | 1.91 | |
| STEEL % (UNIFORM) | 0.43 | 0.50 | 0.57 | 0.67 | 0.77 | | 0.49 | 0.57 | 0.67 | 0.77 | 0.90 | |
| (TAPERED) | 0.28 | 0.32 | 0.36 | 0.43 | 0.50 | | 0.32 | 0.36 | 0.43 | 0.50 | 0.58 | |
| EFF. DEPTH, IN. | 23.75 | 23.75 | 23.69 | 23.69 | 23.69 | | 23.69 | 23.69 | 23.69 | 23.69 | 23.69 | |
| $-I_{cr}/I_{gr}$ | 0.152 | 0.170 | 0.188 | 0.215 | 0.238 | | 0.167 | 0.188 | 0.215 | 0.238 | 0.267 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | |
| STEEL % | 0.09 | 0.10 | 0.12 | 0.14 | 0.16 | | 0.07 | 0.09 | 0.10 | 0.12 | 0.14 | |
| EFF. DEPTH, IN. | 23.62 | 23.62 | 23.56 | 23.56 | 23.50 | | 23.69 | 23.62 | 23.62 | 23.56 | 23.56 | |
| $+I_{cr}/I_{gr}$ | 0.153 | 0.177 | 0.205 | 0.234 | 0.265 | | 0.129 | 0.153 | 0.177 | 0.205 | 0.234 | |

## DESIGN FROM LOAD TABLES (SINGLE SPAN JOIST CONSTRUCTION)

**Example 5:** Using 30-in. wide forms, select a design and review calculations for a service live load of 180 psf and an allowance of 26 psf for superimposed service dead loads (bridging joist, 3 psf, and floor finish, 23 psf) on a floor system. The clear span is 15.5 ft, bearing 6 in. at each end on masonry walls. Provide a 3-in. top slab. The bearing at each end is assumed to be 4 in.

For design, span $\ell_n$ = 15.5
+ 2 × dist. center to face of bearing
= 15.5 + 2 × 0.25
= 16′-0″

If available depth permits, select design with a total depth such that $\ell_n/h$ is about 20. Try 8″ + 3″; see table, Page 8-66.

Superimposed factored load
= 1.2 × 26 + 1.6 × 180 = 319 psf

Try 8 + 3 with 5 in. joists at 35 in. and $\ell_n$ = 16 ft.

Maximum tabulated capacity, square-end = 370 * psf
tapered-end = 374 * psf

Use the tapered-end design with two #6 straight bottom bars (max. tabulated capacity = 291* psf (square), = 330 psf (tapered)). Note that tabulated designs for square-end joist is controlled by shear (marked with one asterisk). The span, $\ell_n$, is greater than 16 $h$ (below solid line in table). For simple spans greater than 16 $h$, the Code requires that computed immediate deflection due to live load be less than $R_n/360$ for floors not supporting nor attached to non-structural elements likely to be damaged by large deflections (ACI 9.5.2.6). No deflection computations are required in using these tabulated designs unless they are intended to support such elements.

If the deflection was computed for this design, it would be less than $\ell_n/360$ for a live load = $\frac{330}{1.6}$ = 206 psf, > the live load = 180 psf.

(Note that a plus sign in these columns indicates factored load capacities (1.6L) for which deflection equals $\ell_n/360$.)

See recommended bar details, Fig. 8-2. Both bottom bars extend 5 in. into the support for minimum end cover of 1 in. Although not required for a perfectly free end, hooked top bars extending 0.25 $\ell_n$ into the span are recommended as a practical precaution against top cracking due to inadvertent end restraint at the supports. The total area of such top bars should be approximately equal to the area of the smaller bottom bar. Use 3-#4 bars with 90º end hooks to fit into the 11-in. depth with proper concrete cover. End hooks of 90º for # 4 bars are 0.8 × 10 = 8 in. deep. See Table 5-5(a), Chapter 5. Note that #4 bars will be fully developed 0.7 × 10 = 7 in. from end hook.

Provide per rib: 2 – #6 × 16′-4″ Bottom
3 – #4 × 4′-5″ Top

For a detailed review of this design, see the Manual Example on Page 8-52.

**Example 6:** *Single Span – Design Strength Controlled by Deflection*. As noted, all designs for single span joists have been investigated for deflection. The superimposed load causing an immediate deflection equal to $\ell_n/360$ was computed, multiplied by the live load factor, 1.6, and compared to the superimposed factored loads determined by flexure strength and shear strength. Superimposed factored load strengths limited by deflection equal to $\ell_n/360$ are designated by a plus sign. These superimposed loads were determined as follows for the joist slab design of Example 5, used on a span of $\ell_n$ = 23 ft.

| | | |
|---|---|---|
| Dead load (joist) | = | 54 psf |
| Live load | = | 85 psf |
| Total service load | = | 139 psf |
| $w_D$ = 1.2 × 54 | = | 65 psf |
| $w_L$ = 1.6 × 85 | = | 136 psf |
| Factored load $w_u$ | = | 201 psf |

From Table 8-1(a), $I_g$ = 1,223 in.$^4$; $M_{cr}$, = 6.1 ft -kips
Read from load table, Page 8-66, $I_{cr}/I_g$ = 0.406

Maximum actual moment, $M_a = \frac{(0.139)(35/12)(23)^2}{8}$
= 26.8 ft-kips
$M_{cr}/M_a$ = 6.1/26.8 = 0.228

Using Code Equation (9-8):
$I_e/I_g = (M_{cr}/M_a)^3 + [1 - (M_{cr}/M_a)^3]I_{cr}/I_g$
$= 0.228^3 + [1 - (0.228)^3]0.406$
= 0.413
From load table, Page 8-66, deflection coefficient = 5.039. Immediate live load deflection,

$$\Delta_L = \frac{(DC)(w)}{I_c} = \frac{(5.039)(85)}{(0.413)(1{,}223)} = 0.85 \text{ in.}$$

$$\frac{\Delta}{\ell_n} = \frac{0.85}{(12)(23)} = \frac{\ell_n}{325} > \frac{\ell_n}{360}$$

Superimposed factored load = 1.6 × 85 = 136 psf
Therefore > 123 + tabulated

Note: It is very difficult to manually solve for the superimposed load causing a given deflection since the quantity, $M_a$, includes this load. The necessary trial and error iteration is, however, convenient by computer.

## MANUAL EXAMPLE

To extend designs beyond the scope of the tabulated designs or to know how the tabulated strengths were computed, detailed computations are presented for the design in Example 5.

**Review:** Example 5
*Loads:* See Table 8-1 Gross Section Properties

Joist: (150.3)(150/144)(12/35) = 54 psf
Bridging: (Allow) = 3 psf
Wearing surface (floor finish) = 23 psf
Dead load = 80 psf

Factored load, $w_u$

$w_u = 1.2D + 1.6L = (1.2 \times 80) + (1.6 \times 180) = 384$ psf

Superimposed factored load = 384 – (1.2 × 54) = 319 psf

2 – #6 = 0.88 in.$^2$

$$\rho = \frac{0.88}{(35)(9.5)} = 0.00265$$

$$a = \frac{A_s f_y}{0.85 f'_c b} = \frac{(0.88)(60)}{0.85(4)(35)} = 0.44 \text{ in.}$$

From Flexural Computations section in Chapter 5:
$\rho_{max} = 0.0181$
$\rho = 0.00265 < 0.0181$, so $\phi = 0.90$

Design moment strength, $\phi M_n$

$\phi M_n = (0.90)(0.88)(60)(9.5 - 0.44/2)/12$
= 36.7 ft-kip

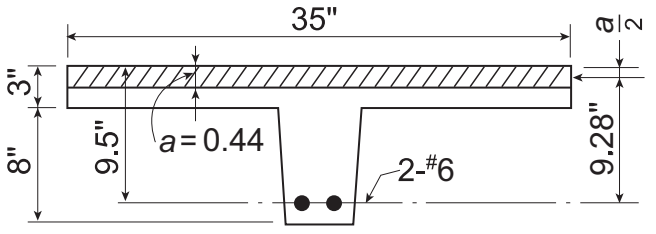



**Figure 8-12 Section Dimensions**

Maximum design strength for positive moment, $w_u$, in psf.

$$w_u = \frac{(8)(36.7)(1{,}000)}{(35/12)(16)^2} = 393 \text{ psf}$$

Maximum superimposed design strength for positive moment
= 393 – (1.2 × 54)
= 393 – 65 = 328 > 319 psf. Bending moment not critical.

*Shear*
For square-end, average width
$b$ = ½(6.83 + 5.25) = 6.04 in.
$d$ = 9.50 in.; $A_s$ = 0.88 in.$^2$

$$\rho_w = \frac{0.88}{9.5 \text{ x } 6.04} = 0.0153$$

Short formula for shear strength, $\phi V_c$:

$\phi V_c = (1.10)\ \phi\ (2)\ \sqrt{f'_c}\ b_w d$
= (1.10)(0.75)(2) $\sqrt{4{,}000}$ (6.04)(9.5)/1,000
= 5.99 kips

Long formula for shear strength, $\phi V_c$, at a distance, $d$, from the support:

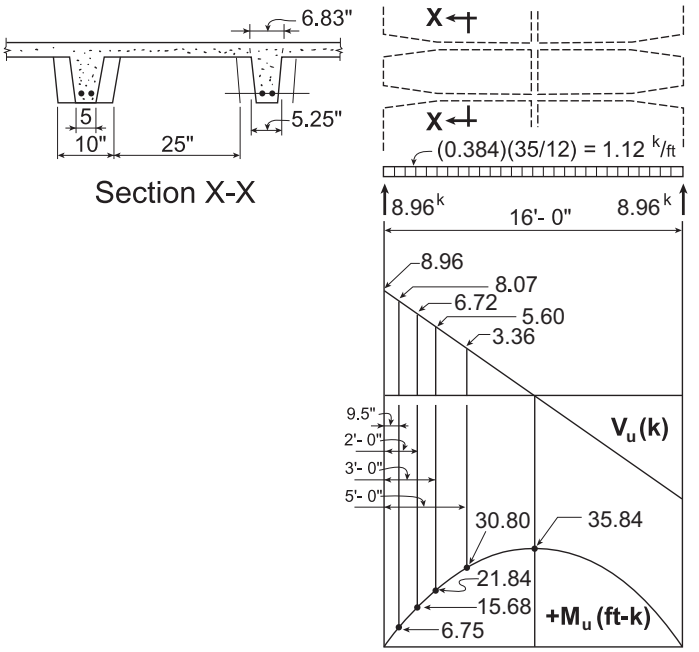



**Figure 8-13 Simple Span Analysis**

*On Square End*

$\phi V_c = (1.10)\ \phi\ (1.9\sqrt{f'_c} + 2{,}500\ \rho_w V_u d/M_u) b_w d$
= (1.10)(0.75)[1.9$\sqrt{4{,}000}$ + 2,500 (0.0153)
(8.07 × 9.5)/(6.75 × 12)](6.04)(9.5)/1,000
$\phi V_c$ = 7.40 kips < 8.07, tapered end joist is required.

Maximum factored superimposed load with square end joists:

$$w_u = \frac{7{,}400}{(35/12)(8.00 - 9.5/12)} - 1.2 \text{ x } 54$$

= 287 psf (291 * Tabulated)

*On Tapered End.* Shear investigation of a tapered-end joist using the long formula is too complex for manual solution when straight bars are cut off within the taper. The simplest method is to have the allowable and actual shear checked every 2 in. from midspan to a distance, *d*, from the face of the support. Even with the simplification offered by full length bars, the solution is complex. Results of the manual solution are listed in Table 8-2. Note that the critical section with both long and short formulas for shear occurred at the root of the taper for a 16 foot span. Since the tapered length is a constant 36 in., the location of the critical section for all spans cannot be predicted.

TABLE 8-2 SUMMARY SHEAR CALCULATIONS – EXAMPLE 5

| Quantity | Distance from Support | | | |
|---|---|---|---|---|
| | *d* | 2'-0" | 3'-0" | 5'-0" |
| $V_u$, kips | 8.07 | 6.72 | 5.60 | 3.36 |
| $M_u$, ft-kips | 6.75 | 15.68 | 21.84 | 30.80 |
| d, in. | 9.5 | 9.5 | 9.5 | 9.5 |
| $V_u d/M_u$ | 0.946 | 0.339 | 0.203 | 0.086 |
| Average $b_w$, in. | 9.72 | 7.71 | 6.04 | 6.04 |
| $b_w d$, in.$^2$ | 92.34 | 73.25 | 57.38 | 57.38 |
| $A_s$, in.$^2$ | 0.88 | 0.88 | 0.88 | 0.88 |
| $\rho_w$ | 0.00953 | 0.01201 | 0.01534 | 0.01534 |
| $\phi V_c$ (short formula), kips | 9.64 | 7.64 | 5.99 | 5.99 |
| $\phi V_c$ (long formula), kips | 10.87 | 7.88 | 6.06 | 5.85 |

Maximum $\phi V_c$ at start of taper = 6,060 lb

$$\left.\begin{array}{l}\text{Maximum factored}\\ \text{superimposed load}\\ \text{for shear}\end{array}\right\} = \frac{6060}{\left(\frac{35}{12}\right)(5)} - (54)(1.2)$$

$$= 416 - 65 = 351 \text{ psf}$$

(330 Tabulated)

## COMPUTED DEFLECTIONS

The computation procedure prescribed by the Code is too long for routine use as a manual calculation. For this reason, the necessary properties of the joist design sections, gross and cracked, have been tabulated in this Chapter. See Table 8-1 Gross Section Properties and "Design Properties" (cracked) under each load table. A deflection coefficient is also tabulated opposite each span for each joist section in the load tables.

This coefficient, DC = $\frac{k\ell_u^4(\text{spacing}/12)(1/12)}{384E_c}$, where $k$ = 5 for single spans. The effect of the tapered haunch is conservatively neglected. Using these design aids, deflection is computed for the example as follows:

1. In load table, read $DC$ = 1.18 for $\ell_n$ = 16′-0″. Under "Design Properties," read $I_{cr}/I_g$ = 0.406.
2. In Table 8-1(a), read $I_g$ = 1,223 in.$^4$ and + $M_{cr}$ = 6.1 ft-kips
3. Compute maximum moment at service load.
   $D + L$ = 80 + 180 = 260 psf.
   $$M_a = \frac{(0.260)(35/12)(16)^2}{8} = 24.3 \text{ ft-kips}$$
4. Using Code Equation (9-8):
   $M_{cr}/M_a$ = 6.1/24.3 = 0.251
   $I_{cr}$ = 0.406 (1,223) = 497 in.$^4$
   $I_e = (M_{cr}/M_a)^3 I_g + [1 - (M_{cr}/M_a)^3] I_{cr}$
   $= (0.251)^3(1{,}223) + [1 - (0.251)^3]497$
   = 508 in.$^4$
5. Immediate live load deflection, $\Delta_{LL}$
   $$\Delta_{LL} = \frac{(DC)w = (1.18)(180)}{I_e \qquad 508} = 0.42 \text{ in.}$$
   $$= \frac{0.42\,\ell_n}{16 \times 12} = \ell_n/457$$

**Development.** Bar sizes in a single span must be small enough so that at the supports the quantity,

$$\left(\frac{M_n}{V_u} + \ell_a\right) \geq \ell_d$$

$M_n = \frac{36.7}{0.90} = 40.8$ ft-kips
$V_u$ = 8.96 kips
$\ell_a$ = 2 in. (embedment beyond center of support)

Chapter 5; Table 5-2(b)

| Bar Size | Cover | c.-c. spacing | $\ell_d$ |
|---|---|---|---|
| #6 | 1″ or $1.33d_b$ | 2.50″ or $3.33d_b$ | 43″= 3.58′ |

$$\frac{M_n}{V_u} + \ell_a = \frac{40.8}{8.96} + \frac{2}{12} = 4.72 \text{ ft} > 3.58 \text{ ft, OK}$$

The embedment length provided, from midspan (max. $M_u$) to the end of the bars, must be ≥ $\ell_d$: 8.5′ > 3.58′, Okay.

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 3.0" Top Slab = 11.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.36 | 0.50 | 0.64 | 0.82 | 1.00 | 1.22 | 1.44 | 1.70 | 1.96 | 2.26 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 12'-0" | 185 | 286 | 389 | 509 | 572* | 592* | 615* | 639* | 668* | 697* | 0.267 |
| | 0 | 0 | 0 | 0 | 632 | 770 | 873* | 896* | 913* | 919* | |
| 13'-0" | 146 | 233 | 320 | 423 | 516* | 534* | 555* | 578* | 604* | 631* | 0.367 |
| | 0 | 0 | 0 | 0 | 528 | 645 | 758 | 767* | 775* | 780* | |
| 14'-0" | 116 | 191 | 266 | 355 | 445 | 486* | 505* | 526* | 550* | 576* | 0.494 |
| | 0 | 0 | 0 | 0 | 0 | 546 | 643 | 662 | 672* | 676* | |
| 15'-0" | 92 | 157 | 223 | 300 | 378 | 445* | 463* | 482* | 505* | 528* | 0.651 |
| | 0 | 0 | 0 | 0 | 0 | 467 | 551 | 568 | 591* | 595* | |
| 16'-0" | 72 | 129 | 187 | 255 | 324 | 401 | 426* | 444* | 465* | 487* | 0.843 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 476 | 490 | 510 | 530* | |
| 17'-0" | 56 | 106 | 157 | 217 | 279 | 347 | 394* | 411* | 431* | 452* | 1.074 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 407+ | 426 | 444 | 468 | |
| 18'-0" | 42 | 87 | 132 | 186 | 241 | 302 | 343+ | 372 | 388 | 410 | 1.350 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 19'-0" | | 71 | 111 | 160 | 209 | 258+ | 291+ | 326 | 341 | 360 | 1.676 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 20'-0" | | 57 | 94 | 137 | 181 | 221+ | 249+ | 282+ | 301 | 318 | 2.058 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 21'-0" | | 45 | 78 | 117 | 158 | 191+ | 215+ | 243+ | 266 | 282 | 2.502 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22'-0" | | | 65 | 101 | 137 | 166+ | 187+ | 211+ | 236 | 250 | 3.013 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | | 53 | 86 | 119 | 145+ | 164+ | 185+ | 207+ | 223 | 3.600 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | 43 | 73 | 104 | 127+ | 144+ | 163+ | 183+ | 199 | 4.268 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | | 62 | 90 | 112+ | 127+ | 144+ | 161+ | 178 | 5.025 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.40 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | |
| STEEL PERCENT | 0.09 | 0.13 | 0.16 | 0.21 | 0.26 | 0.31 | 0.37 | 0.44 | 0.50 | 0.59 | |
| DEPTH, D IN. | 9.81 | 9.75 | 9.75 | 9.69 | 9.69 | 9.62 | 9.62 | 9.56 | 9.56 | 9.50 | |
| $+I_{cr}/I_{gr}$ | 0.130 | 0.176 | 0.222 | 0.271 | 0.322 | 0.374 | 0.429 | 0.487 | 0.548 | 0.609 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 3.0" Top Slab = 11.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.35 | 0.48 | 0.62 | 0.79 | 0.96 | 1.17 | 1.39 | 1.64 | 1.89 | 2.18 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 12'-0" | 171 | 269 | 368 | 484 | 602 | 647* | 669* | 692* | 720* | 748* | 0.277 |
| | 0 | 0 | 0 | 0 | 0 | 735 | 871 | 939* | 967* | 993* | |
| 13'-0" | 135 | 218 | 302 | 401 | 502 | 584* | 605* | 626* | 651* | 677* | 0.382 |
| | 0 | 0 | 0 | 0 | 0 | 615 | 731 | 851* | 864* | 868* | |
| 14'-0" | 106 | 177 | 250 | 335 | 422 | 520 | 550* | 570* | 593* | 617* | 0.514 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 620 | 734 | 749* | 753* | |
| 15'-0" | 82 | 145 | 208 | 282 | 358 | 443 | 504* | 523* | 544* | 566* | 0.677 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 530 | 629 | 651 | 662* | |
| 16'-0" | 63 | 118 | 174 | 239 | 305 | 380 | 457 | 482* | 502* | 523* | 0.877 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 536+ | 563 | 578 | |
| 17'-0" | 47 | 96 | 145 | 203 | 262 | 328 | 396 | 446* | 465* | 484* | 1.117 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 490 | 504 | |
| 18'-0" | | 77 | 121 | 173 | 225 | 284 | 336+ | 376+ | 421+ | 441 | 1.404 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 19'-0" | | 62 | 101 | 147 | 194 | 247 | 286+ | 319+ | 358+ | 388 | 1.743 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 20'-0" | | 48 | 84 | 125 | 168 | 216 | 245+ | 274+ | 307+ | 343 | 2.140 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 21'-0" | | | 69 | 107 | 145 | 189 | 211+ | 236+ | 265+ | 294+ | 2.602 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22'-0" | | | 56 | 90 | 126 | 165 | 184+ | 205+ | 230+ | 255+ | 3.134 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | | 45 | 76 | 108 | 145 | 160+ | 180+ | 202+ | 223+ | 3.744 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | | 64 | 93 | 127 | 141+ | 158+ | 177+ | 197+ | 4.438 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | | 53 | 80 | 111 | 125+ | 140+ | 157+ | 174+ | 5.226 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.42 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | |
| STEEL PERCENT | 0.09 | 0.12 | 0.16 | 0.20 | 0.25 | 0.30 | 0.35 | 0.42 | 0.48 | 0.56 | |
| DEPTH, D IN. | 9.81 | 9.75 | 9.75 | 9.69 | 9.69 | 9.62 | 9.62 | 9.56 | 9.56 | 9.50 | |
| $+I_{cr}/I_{gr}$ | 0.115 | 0.156 | 0.196 | 0.240 | 0.285 | 0.331 | 0.380 | 0.431 | 0.486 | 0.540 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 3.0" Top Slab = 13.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.50 | 0.64 | 0.82 | 1.00 | 1.22 | 1.44 | 1.70 | 1.96 | 2.26 | 2.56 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 16'-0" | 163 | 233 | 315 | 399 | 494 | 523* | 541* | 562* | 585* | 610* | 0.843 |
| | 0 | 0 | 0 | 0 | 0 | 591 | 653* | 660* | 666* | 675* | |
| 17'-0" | 135 | 197 | 270 | 344 | 429 | 483* | 500* | 520* | 541* | 565* | 1.074 |
| | 0 | 0 | 0 | 0 | 0 | 514 | 587* | 594* | 600* | 608* | |
| 18'-0" | 112 | 167 | 232 | 298 | 374 | 448* | 465* | 483* | 503* | 525* | 1.350 |
| | 0 | 0 | 0 | 0 | 0 | 450 | 532* | 539* | 544* | 552* | |
| 19'-0" | 92 | 141 | 200 | 259 | 327 | 396 | 433* | 451* | 469* | 490* | 1.676 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 476 | 492* | 497* | 504* | |
| 20'-0" | 75 | 120 | 173 | 226 | 287 | 349 | 405* | 422* | 439* | 459* | 2.058 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 422 | 440 | 453 | 463* | |
| 21'-0" | 60 | 101 | 149 | 198 | 253 | 309 | 368+ | 391 | 404 | 421 | 2.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22'-0" | 48 | 85 | 129 | 173 | 223 | 275 | 320+ | 349 | 361 | 376 | 3.013 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | 71 | 111 | 151 | 197 | 244 | 280+ | 313 | 323 | 337 | 3.600 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | 58 | 95 | 132 | 175 | 218 | 246+ | 277+ | 290 | 303 | 4.268 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | 47 | 81 | 116 | 155 | 194 | 218+ | 245+ | 261 | 273 | 5.025 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 69 | 101 | 137 | 174 | 193+ | 217+ | 235 | 246 | 5.878 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 58 | 88 | 121 | 153+ | 173+ | 194+ | 212 | 222 | 6.836 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 48 | 76 | 107 | 139 | 155+ | 174+ | 192 | 201 | 7.906 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 40 | 65 | 94 | 124 | 139+ | 156+ | 173 | 182 | 9.098 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.44 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | |
| STEEL PERCENT | 0.11 | 0.14 | 0.17 | 0.21 | 0.26 | 0.30 | 0.36 | 0.42 | 0.48 | 0.55 | |
| DEPTH, D IN. | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | 11.62 | 11.56 | 11.56 | 11.50 | 11.50 | |
| $+I_{cr}/I_{gr}$ | 0.157 | 0.198 | 0.244 | 0.290 | 0.339 | 0.389 | 0.443 | 0.500 | 0.559 | 0.621 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 3.0" Top Slab = 13.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.48 | 0.62 | 0.79 | 0.96 | 1.17 | 1.39 | 1.64 | 1.89 | 2.18 | 2.46 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 16'-0" | 150 | 217 | 297 | 377 | 469 | 562 | 589* | 609* | 630* | 654* | 0.877 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 672 | 734* | 739* | 748* | |
| 17'-0" | 123 | 183 | 253 | 325 | 406 | 489 | 545* | 564* | 583* | 606* | 1.117 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 586 | 661* | 666* | 674* | |
| 18'-0" | 101 | 154 | 217 | 280 | 353 | 427 | 506* | 524* | 542* | 564* | 1.404 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 513 | 600* | 604* | 612* | |
| 19'-0" | 82 | 129 | 186 | 243 | 308 | 374 | 452 | 489* | 506* | 526* | 1.743 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 532 | 552* | 559* | |
| 20'-0" | 65 | 108 | 159 | 211 | 270 | 330 | 400 | 457* | 474* | 493* | 2.140 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 466+ | 502 | 514* | |
| 21'-0" | 52 | 91 | 137 | 184 | 237 | 291 | 355 | 402+ | 445* | 463* | 2.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 448 | 464 | |
| 22'-0" | | 75 | 117 | 160 | 208 | 258 | 316 | 350+ | 389+ | 415 | 3.134 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | 61 | 100 | 139 | 183 | 229 | 275+ | 306+ | 340+ | 372 | 3.744 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | 50 | 85 | 121 | 161 | 203 | 241+ | 269+ | 299+ | 331+ | 4.438 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 72 | 105 | 142 | 180 | 213+ | 238+ | 265+ | 293+ | 5.226 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 60 | 90 | 125 | 160 | 190+ | 211+ | 235+ | 261+ | 6.113 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 49 | 78 | 110 | 143 | 169+ | 189+ | 210+ | 233+ | 7.109 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 40 | 66 | 96 | 127 | 152+ | 169+ | 188+ | 208+ | 8.223 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 56 | 84 | 112 | 136+ | 152+ | 169+ | 188+ | 9.462 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.47 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | |
| STEEL PERCENT | 0.10 | 0.13 | 0.17 | 0.20 | 0.25 | 0.29 | 0.35 | 0.40 | 0.46 | 0.53 | |
| DEPTH, D IN. | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | 11.62 | 11.56 | 11.56 | 11.50 | 11.50 | |
| $+I_{cr}/I_{gr}$ | 0.139 | 0.176 | 0.216 | 0.257 | 0.301 | 0.345 | 0.394 | 0.444 | 0.496 | 0.552 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 3.0" Top Slab = 15.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.50 | 0.64 | 0.82 | 1.00 | 1.22 | 1.44 | 1.70 | 1.96 | 2.26 | 2.56 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 136 | 201 | 278 | 356 | 445 | 536 | 555* | 574* | 594* | 616* | 1.350 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 643 | 656* | 662* | 671* | |
| 19'-0" | 113 | 171 | 240 | 310 | 390 | 472 | 517* | 535* | 554* | 575* | 1.676 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 568 | 599* | 605* | 614* | |
| 20'-0" | 93 | 146 | 208 | 271 | 344 | 417 | 483* | 500* | 518* | 538* | 2.058 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 504 | 551* | 556* | 565* | |
| 21'-0" | 76 | 124 | 181 | 238 | 303 | 370 | 448 | 469* | 486* | 505* | 2.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 509* | 514* | 522* | |
| 22'-0" | 62 | 105 | 157 | 209 | 268 | 329 | 401 | 441* | 457* | 475* | 3.013 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 472* | 477* | 484* | |
| 23'-0" | 49 | 89 | 136 | 183 | 238 | 293 | 359 | 416* | 431* | 448* | 3.600 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 426 | 444* | 451* | |
| 24'-0" | | 74 | 117 | 161 | 211 | 262 | 322 | 384 | 403 | 418 | 4.268 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | 61 | 101 | 142 | 188 | 235 | 290 | 347 | 364 | 378 | 5.025 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | 50 | 87 | 124 | 167 | 210 | 261 | 308+ | 330 | 343 | 5.878 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | 40 | 74 | 109 | 148 | 188 | 236 | 275+ | 299 | 312 | 6.836 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 63 | 95 | 132 | 169 | 213 | 246+ | 272 | 283 | 7.906 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 52 | 82 | 117 | 151 | 193 | 222+ | 248 | 258 | 9.098 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 43 | 71 | 103 | 136 | 174 | 200+ | 226 | 235 | 10.419 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | | 61 | 91 | 121 | 157 | 181+ | 202+ | 215 | 11.879 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.49 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | |
| STEEL PERCENT | 0.09 | 0.12 | 0.15 | 0.18 | 0.22 | 0.26 | 0.31 | 0.35 | 0.41 | 0.47 | |
| DEPTH, D IN. | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | 13.56 | 13.56 | 13.50 | 13.50 | |
| $+I_{cr}/I_{gr}$ | 0.142 | 0.180 | 0.222 | 0.264 | 0.310 | 0.356 | 0.407 | 0.460 | 0.516 | 0.574 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 3.0" Top Slab = 15.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.62 | 0.79 | 0.96 | 1.17 | 1.39 | 1.64 | 1.89 | 2.18 | 2.46 | 2.80 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 185 | 259 | 334 | 420 | 507 | 604* | 622* | 641* | 663* | 684* | 1.404 |
| | 0 | 0 | 0 | 0 | 0 | 610 | 715 | 731* | 740* | 747* | |
| 19'-0" | 157 | 223 | 290 | 367 | 446 | 538 | 580* | 598* | 618* | 638* | 1.743 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 632 | 669* | 677* | 683* | |
| 20'-0" | 132 | 192 | 253 | 322 | 393 | 477 | 543* | 559* | 579* | 597* | 2.140 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 562 | 615* | 623* | 629* | |
| 21'-0" | 111 | 166 | 221 | 284 | 348 | 423 | 501 | 525* | 543* | 561* | 2.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 568* | 576* | 582* | |
| 22'-0" | 93 | 143 | 193 | 250 | 308 | 378 | 448 | 494* | 511* | 528* | 3.134 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 528* | 535* | 540* | |
| 23'-0" | 77 | 122 | 168 | 221 | 274 | 337 | 402 | 466* | 483* | 499* | 3.744 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 475 | 498* | 503* | |
| 24'-0" | 63 | 105 | 147 | 195 | 244 | 302 | 361 | 428 | 456* | 472* | 4.438 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 464 | 0 | |
| 25'-0" | 51 | 89 | 128 | 172 | 218 | 271 | 326 | 376+ | 420 | 430 | 5.226 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | 40 | 75 | 111 | 152 | 194 | 244 | 294 | 334+ | 370+ | 390 | 6.113 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | 63 | 96 | 134 | 173 | 219 | 266 | 298+ | 331+ | 355 | 7.109 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | 52 | 83 | 118 | 154 | 197 | 240 | 267+ | 296+ | 324 | 8.223 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | 42 | 71 | 104 | 138 | 177 | 218 | 241+ | 267+ | 292+ | 9.462 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 60 | 91 | 122 | 160 | 197 | 217+ | 241+ | 264+ | 10.836 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 50 | 79 | 109 | 143 | 179 | 197+ | 218+ | 239+ | 12.355 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.11 | 0.14 | 0.17 | 0.21 | 0.25 | 0.29 | 0.34 | 0.40 | 0.45 | 0.51 | |
| DEPTH, D IN. | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | 13.56 | 13.56 | 13.50 | 13.50 | 13.44 | |
| $+I_{cr}/I_{gr}$ | 0.159 | 0.197 | 0.235 | 0.275 | 0.317 | 0.362 | 0.410 | 0.459 | 0.511 | 0.561 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 4.0" Top Slab = 12.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.36 | 0.50 | 0.64 | 0.82 | 1.00 | 1.22 | 1.44 | 1.70 | 1.96 | 2.26 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 12'-0" | 195 | 308 | 421 | 555 | 631* | 650* | 673* | 698* | 726* | 756* | 0.267 |
| | 0 | 0 | 0 | 0 | 691 | 844 | 952* | 975* | 1004* | 1021* | |
| 13'-0" | 153 | 249 | 346 | 460 | 567* | 585* | 606* | 629* | 655* | 683* | 0.367 |
| | 0 | 0 | 0 | 0 | 576 | 706 | 840 | 851* | 860* | 867* | |
| 14'-0" | 120 | 203 | 286 | 384 | 484 | 531* | 550* | 571* | 596* | 621* | 0.494 |
| | 0 | 0 | 0 | 0 | 0 | 597 | 712 | 736* | 744* | 750* | |
| 15'-0" | 93 | 165 | 238 | 323 | 410 | 484* | 503* | 522* | 545* | 569* | 0.651 |
| | 0 | 0 | 0 | 0 | 0 | 509 | 609 | 646* | 654* | 659* | |
| 16'-0" | 71 | 135 | 198 | 274 | 350 | 436 | 462* | 480* | 501* | 523* | 0.843 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 525 | 574* | 581* | 586* | |
| 17'-0" | 53 | 109 | 166 | 232 | 300 | 377 | 426* | 443* | 463* | 484* | 1.074 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 455 | 506 | 521* | 526* | |
| 18'-0" | | 88 | 138 | 198 | 258 | 326 | 395* | 411* | 430* | 449* | 1.350 |
| | | 0 | 0 | 0 | 0 | 0 | 396 | 442 | 460 | 475 | |
| 19'-0" | | 70 | 115 | 168 | 223 | 284 | 346 | 382* | 400* | 417 | 1.676 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 388 | 404 | 0 | |
| 20'-0" | | 54 | 95 | 143 | 192 | 248 | 304 | 341 | 356 | 368 | 2.058 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 21'-0" | | 41 | 78 | 122 | 166 | 216 | 268 | 301 | 315 | 326 | 2.502 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22'-0" | | | 63 | 103 | 144 | 189 | 233+ | 263+ | 279 | 289 | 3.013 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | | 51 | 87 | 124 | 166 | 204+ | 230+ | 248 | 257 | 3.600 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | | 73 | 107 | 145 | 179+ | 202+ | 220 | 229 | 4.268 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | | 60 | 91 | 127 | 158+ | 179+ | 196 | 204 | 5.025 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.48 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | |
| STEEL PERCENT | 0.08 | 0.12 | 0.15 | 0.19 | 0.23 | 0.28 | 0.33 | 0.39 | 0.45 | 0.53 | |
| DEPTH, D IN. | 10.81 | 10.75 | 10.75 | 10.69 | 10.69 | 10.62 | 10.62 | 10.56 | 10.56 | 10.50 | |
| $+I_{cr}/I_{gr}$ | 0.122 | 0.166 | 0.209 | 0.256 | 0.304 | 0.355 | 0.407 | 0.463 | 0.522 | 0.581 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 4.0" Top Slab = 12.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.35 | 0.48 | 0.62 | 0.79 | 0.96 | 1.17 | 1.39 | 1.64 | 1.89 | 2.18 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 12'-0" | 181 | 289 | 398 | 527 | 658 | 713* | 735* | 758* | 786* | 814* | 0.277 |
| | 0 | 0 | 0 | 0 | 0 | 806 | 957 | 1025* | 1053* | 1080* | |
| 13'-0" | 141 | 233 | 326 | 436 | 547 | 642* | 663* | 684* | 709* | 735* | 0.382 |
| | 0 | 0 | 0 | 0 | 0 | 673 | 802 | 927* | 952* | 964* | |
| 14'-0" | 109 | 188 | 268 | 363 | 459 | 568 | 602* | 621* | 645* | 669* | 0.514 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 679 | 808 | 829* | 834* | |
| 15'-0" | 83 | 152 | 222 | 304 | 388 | 483 | 550* | 568* | 590* | 612* | 0.677 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 579 | 692 | 729* | 733* | |
| 16'-0" | 62 | 122 | 184 | 256 | 330 | 413 | 498 | 523* | 543* | 564* | 0.877 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 597 | 648* | 652* | |
| 17'-0" | 44 | 98 | 152 | 217 | 282 | 355 | 431 | 483* | 502* | 521* | 1.117 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 519 | 582* | 586* | |
| 18'-0" | | 78 | 126 | 183 | 241 | 307 | 374 | 448* | 466* | 484* | 1.404 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 453 | 511 | 525 | |
| 19'-0" | | 60 | 104 | 155 | 207 | 266 | 327 | 397 | 434* | 451* | 1.743 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 450 | 462 | |
| 20'-0" | | 45 | 85 | 131 | 178 | 231 | 286 | 341+ | 382+ | 408 | 2.140 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 21'-0" | | | 68 | 110 | 153 | 201 | 251 | 295+ | 329+ | 361 | 2.602 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22'-0" | | | 54 | 92 | 131 | 175 | 220 | 256+ | 286+ | 321 | 3.134 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | | 42 | 77 | 112 | 153 | 194 | 224+ | 250+ | 278+ | 3.744 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | | 63 | 96 | 133 | 170 | 197+ | 220+ | 245+ | 4.438 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | | 51 | 81 | 115 | 150 | 174+ | 195+ | 217+ | 5.226 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.50 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | |
| STEEL PERCENT | 0.08 | 0.11 | 0.14 | 0.18 | 0.22 | 0.27 | 0.32 | 0.38 | 0.44 | 0.51 | |
| DEPTH, D IN. | 10.81 | 10.75 | 10.75 | 10.69 | 10.69 | 10.62 | 10.62 | 10.56 | 10.56 | 10.50 | |
| $+I_{cr}/I_{gr}$ | 0.108 | 0.146 | 0.184 | 0.226 | 0.269 | 0.314 | 0.360 | 0.410 | 0.462 | 0.515 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 4.0" Top Slab = 14.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.50 | 0.64 | 0.82 | 1.00 | 1.22 | 1.44 | 1.70 | 1.96 | 2.26 | 2.56 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 16'-0" | 169 | 245 | 335 | 427 | 530 | 564* | 583* | 604* | 627* | 652* | 0.843 |
| | 0 | 0 | 0 | 0 | 0 | 636 | 712* | 720* | 727* | 737* | |
| 17'-0" | 139 | 206 | 286 | 367 | 459 | 521* | 538* | 558* | 579* | 603* | 1.074 |
| | 0 | 0 | 0 | 0 | 0 | 553 | 639* | 647* | 653* | 663* | |
| 18'-0" | 114 | 174 | 245 | 317 | 399 | 482* | 499* | 517* | 537* | 559* | 1.350 |
| | 0 | 0 | 0 | 0 | 0 | 483 | 579* | 586* | 592* | 601* | |
| 19'-0" | 92 | 146 | 210 | 275 | 348 | 423 | 464* | 482* | 500* | 521* | 1.676 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 512 | 535* | 540* | 548* | |
| 20'-0" | 74 | 123 | 180 | 239 | 305 | 373 | 433* | 450* | 468* | 487* | 2.058 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 453 | 490* | 496* | 503* | |
| 21'-0" | 58 | 102 | 155 | 208 | 268 | 329 | 402 | 421* | 438* | 457* | 2.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 452* | 457* | 464* | |
| 22'-0" | 45 | 85 | 132 | 181 | 236 | 292 | 358 | 396* | 412* | 430* | 3.013 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 403 | 416 | 0 | |
| 23'-0" | | 69 | 113 | 157 | 208 | 259 | 319 | 361 | 372 | 388 | 3.600 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | 56 | 96 | 137 | 183 | 230 | 285 | 324 | 334 | 348 | 4.268 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | 44 | 81 | 118 | 161 | 204 | 255 | 291 | 301 | 313 | 5.025 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 68 | 102 | 142 | 182 | 229 | 262 | 271 | 283 | 5.878 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 56 | 88 | 124 | 162 | 205 | 232+ | 244 | 255 | 6.836 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 45 | 75 | 109 | 144 | 184 | 208+ | 220 | 231 | 7.906 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 64 | 95 | 127 | 165 | 187+ | 199 | 208 | 9.098 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | |
| STEEL PERCENT | 0.10 | 0.13 | 0.16 | 0.20 | 0.24 | 0.28 | 0.33 | 0.38 | 0.44 | 0.51 | |
| DEPTH, D IN. | 12.75 | 12.75 | 12.69 | 12.69 | 12.62 | 12.62 | 12.56 | 12.56 | 12.50 | 12.50 | |
| $+I_{cr}/I_{gr}$ | 0.148 | 0.187 | 0.230 | 0.274 | 0.320 | 0.368 | 0.421 | 0.475 | 0.531 | 0.591 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 4.0" Top Slab = 14.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.48 | 0.62 | 0.79 | 0.96 | 1.17 | 1.39 | 1.64 | 1.89 | 2.18 | 2.46 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 16'-0" | 154 | 227 | 314 | 402 | 502 | 604 | 635* | 655* | 676* | 700* | 0.877 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 724 | 799* | 805* | 814* | |
| 17'-0" | 125 | 190 | 267 | 345 | 433 | 524 | 586* | 605* | 625* | 648* | 1.117 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 630 | 718* | 724* | 733* | |
| 18'-0" | 101 | 159 | 227 | 297 | 376 | 456 | 543* | 561* | 580* | 601* | 1.404 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 551 | 648 | 656* | 665* | |
| 19'-0" | 80 | 132 | 194 | 256 | 327 | 399 | 484 | 523* | 540* | 560* | 1.743 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 571 | 599* | 607* | |
| 20'-0" | 63 | 109 | 165 | 221 | 285 | 350 | 427 | 488* | 505* | 524* | 2.140 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 506 | 550* | 557* | |
| 21'-0" | 48 | 90 | 140 | 191 | 249 | 309 | 378 | 449 | 473* | 492* | 2.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 507* | 514* | |
| 22'-0" | | 73 | 119 | 165 | 218 | 272 | 336 | 401 | 445* | 462* | 3.134 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 463 | 476* | |
| 23'-0" | | 58 | 100 | 143 | 191 | 241 | 299 | 358 | 408+ | 429 | 3.744 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | 45 | 84 | 123 | 168 | 213 | 266 | 321 | 359+ | 386 | 4.438 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 70 | 106 | 147 | 188 | 237 | 288 | 317+ | 348 | 5.226 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 57 | 90 | 128 | 167 | 212 | 254+ | 282+ | 314 | 6.113 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 45 | 76 | 111 | 147 | 189 | 227+ | 252+ | 279+ | 7.109 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | 64 | 97 | 130 | 169 | 203+ | 226+ | 250+ | 8.223 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 53 | 83 | 114 | 151 | 183+ | 203+ | 225+ | 9.462 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | |
| STEEL PERCENT | 0.09 | 0.12 | 0.15 | 0.19 | 0.23 | 0.27 | 0.32 | 0.37 | 0.43 | 0.49 | |
| DEPTH, D IN. | 12.75 | 12.75 | 12.69 | 12.69 | 12.62 | 12.62 | 12.56 | 12.56 | 12.50 | 12.50 | |
| $+I_{cr}/I_{gr}$ | 0.131 | 0.165 | 0.204 | 0.242 | 0.284 | 0.326 | 0.373 | 0.421 | 0.472 | 0.524 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 4.0" Top Slab = 16.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.50 | 0.64 | 0.82 | 1.00 | 1.22 | 1.44 | 1.70 | 1.96 | 2.26 | 2.56 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 138 | 208 | 291 | 375 | 471 | 568 | 593* | 612* | 632* | 655* | 1.350 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 684 | 706* | 713* | 723* | |
| 19'-0" | 114 | 176 | 250 | 326 | 412 | 499 | 552* | 570* | 588* | 610* | 1.676 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 603 | 644* | 651* | 661* | |
| 20'-0" | 92 | 149 | 216 | 284 | 362 | 440 | 515* | 532* | 550* | 570* | 2.058 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 534 | 592* | 598* | 607* | |
| 21'-0" | 74 | 125 | 186 | 248 | 318 | 390 | 475 | 498* | 515* | 534* | 2.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 546* | 552* | 560* | |
| 22'-0" | 58 | 105 | 160 | 217 | 281 | 346 | 423 | 468* | 484* | 502* | 3.013 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 502 | 512* | 520* | |
| 23'-0" | 45 | 87 | 138 | 189 | 248 | 308 | 379 | 440* | 456* | 473* | 3.600 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 451 | 476* | 484* | |
| 24'-0" | | 72 | 118 | 165 | 219 | 274 | 339 | 405 | 430* | 446* | 4.268 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 444* | 451* | |
| 25'-0" | | 58 | 101 | 144 | 194 | 245 | 304 | 365 | 407* | 422* | 5.025 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 411 | 423* | |
| 26'-0" | | 46 | 85 | 126 | 172 | 218 | 274 | 330 | 372 | 386 | 5.878 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 72 | 109 | 152 | 195 | 246 | 298 | 338 | 351 | 6.836 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 59 | 94 | 134 | 174 | 222 | 270 | 307 | 319 | 7.906 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 48 | 81 | 118 | 155 | 200 | 245 | 279 | 290 | 9.098 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | | 69 | 103 | 138 | 180 | 222 | 254 | 264 | 10.419 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | | 58 | 90 | 123 | 162 | 201 | 231 | 241 | 11.879 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | |
| STEEL PERCENT | 0.08 | 0.11 | 0.14 | 0.17 | 0.21 | 0.24 | 0.29 | 0.33 | 0.38 | 0.44 | |
| DEPTH, D IN. | 14.75 | 14.75 | 14.69 | 14.69 | 14.62 | 14.62 | 14.56 | 14.56 | 14.50 | 14.50 | |
| $+I_{cr}/I_{gr}$ | 0.134 | 0.169 | 0.209 | 0.249 | 0.292 | 0.336 | 0.385 | 0.435 | 0.489 | 0.544 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 4.0" Top Slab = 16.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.62 | 0.79 | 0.96 | 1.17 | 1.39 | 1.64 | 1.89 | 2.18 | 2.46 | 2.80 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 191 | 271 | 352 | 444 | 538 | 647* | 665* | 684* | 706* | 727* | 1.404 |
| | 0 | 0 | 0 | 0 | 0 | 649 | 763 | 787* | 797* | 804* | |
| 19'-0" | 161 | 232 | 305 | 388 | 472 | 572 | 619* | 637* | 657* | 677* | 1.743 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 673 | 719* | 728* | 735* | |
| 20'-0" | 134 | 199 | 264 | 339 | 415 | 505 | 578* | 595* | 614* | 633* | 2.140 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 597 | 661* | 670* | 676* | |
| 21'-0" | 112 | 170 | 230 | 298 | 366 | 448 | 531 | 558* | 576* | 594* | 2.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 610* | 619* | 625* | |
| 22'-0" | 92 | 146 | 200 | 261 | 324 | 399 | 475 | 524* | 542* | 559* | 3.134 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 561 | 574* | 580* | |
| 23'-0" | 75 | 124 | 173 | 230 | 287 | 356 | 425 | 494* | 510* | 527* | 3.744 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 504 | 534* | 540* | |
| 24'-0" | 60 | 105 | 150 | 202 | 255 | 318 | 381 | 454 | 482* | 498* | 4.438 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 499* | 504* | |
| 25'-0" | 47 | 88 | 130 | 178 | 227 | 284 | 343 | 410 | 456* | 471* | 5.226 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 467* | 473* | |
| 26'-0" | | 73 | 112 | 156 | 201 | 255 | 309 | 371 | 432 | 442 | 6.113 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | 60 | 96 | 137 | 179 | 228 | 279 | 336 | 386+ | 402 | 7.109 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | 48 | 82 | 120 | 159 | 205 | 251 | 305 | 346+ | 366 | 8.223 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 69 | 104 | 141 | 183 | 227 | 277 | 312+ | 334 | 9.462 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 57 | 90 | 124 | 164 | 205 | 251 | 281+ | 305 | 10.836 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 47 | 78 | 109 | 147 | 185 | 229 | 255+ | 279 | 12.355 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.10 | 0.13 | 0.16 | 0.20 | 0.23 | 0.27 | 0.32 | 0.37 | 0.42 | 0.48 | |
| DEPTH, D IN. | 14.75 | 14.69 | 14.69 | 14.62 | 14.62 | 14.56 | 14.56 | 14.50 | 14.50 | 14.44 | |
| $+I_{cr}/I_{gr}$ | 0.150 | 0.185 | 0.221 | 0.259 | 0.298 | 0.342 | 0.387 | 0.434 | 0.484 | 0.531 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 4.5" Top Slab = 12.5" Total Depth | | | | | | | | | |
| BOTTOM BARS | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.50 | 0.64 | 0.82 | 1.00 | 1.22 | 1.44 | 1.70 | 1.96 | 2.26 | 2.56 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 15'-0" | 170 | 246 | 336 | 427 | 506* | 524* | 544* | 567* | 590* | 617* | 0.651 |
| | 0 | 0 | 0 | 0 | 530 | 636 | 678* | 686* | 692* | 702* | |
| 16'-0" | 138 | 205 | 284 | 364 | 455 | 481* | 500* | 521* | 543* | 568* | 0.843 |
| | 0 | 0 | 0 | 0 | 0 | 547 | 602* | 610* | 615* | 624* | |
| 17'-0" | 111 | 170 | 240 | 311 | 392 | 443* | 461* | 480* | 501* | 525* | 1.074 |
| | 0 | 0 | 0 | 0 | 0 | 474 | 540* | 547* | 552* | 560* | |
| 18'-0" | 89 | 142 | 204 | 267 | 339 | 410* | 427* | 445* | 465* | 487* | 1.350 |
| | 0 | 0 | 0 | 0 | 0 | 412 | 480 | 494* | 499* | 506* | |
| 19'-0" | 70 | 117 | 173 | 230 | 295 | 360 | 397* | 414* | 433* | 454* | 1.676 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 421 | 438 | 453 | 461* | |
| 20'-0" | 54 | 97 | 147 | 198 | 257 | 316 | 370* | 386 | 399 | 419 | 2.058 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 371 | 0 | 0 | 0 | |
| 21'-0" | 40 | 79 | 125 | 171 | 224 | 278 | 328 | 341 | 353 | 372 | 2.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22'-0" | | 63 | 105 | 147 | 196 | 244 | 290 | 303 | 313 | 330 | 3.013 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | 50 | 88 | 127 | 171 | 216 | 254+ | 269 | 279 | 294 | 3.600 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | 73 | 109 | 149 | 190 | 223+ | 239 | 248 | 262 | 4.268 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 60 | 93 | 130 | 168 | 198+ | 213 | 221 | 234 | 5.025 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 48 | 79 | 113 | 148 | 176+ | 190 | 197 | 209 | 5.878 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | | 66 | 98 | 130 | 157+ | 169 | 176 | 187 | 6.836 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | 55 | 84 | 114 | 140+ | 150 | 157 | 167 | 7.906 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | |
| STEEL PERCENT | 0.11 | 0.14 | 0.18 | 0.22 | 0.27 | 0.32 | 0.38 | 0.43 | 0.51 | 0.57 | |
| DEPTH, D IN. | 11.25 | 11.25 | 11.19 | 11.19 | 11.12 | 11.12 | 11.06 | 11.06 | 11.00 | 11.00 | |
| $+I_{cr}/I_{gr}$ | 0.161 | 0.203 | 0.249 | 0.296 | 0.346 | 0.397 | 0.452 | 0.509 | 0.568 | 0.631 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 4.5" Top Slab = 12.5" Total Depth | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.62 | 0.79 | 0.96 | 1.17 | 1.39 | 1.64 | 1.89 | 2.18 | 2.46 | 2.80 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 16'-0" | 190 | 266 | 343 | 430 | 519 | 545* | 565* | 586* | 610* | 633* | 0.877 |
| | 0 | 0 | 0 | 0 | 0 | 624 | 680* | 685* | 693* | 698* | |
| 17'-0" | 157 | 224 | 292 | 370 | 449 | 503* | 522* | 541* | 564* | 586* | 1.117 |
| | 0 | 0 | 0 | 0 | 0 | 541 | 610* | 615* | 623* | 628* | |
| 18'-0" | 129 | 189 | 250 | 319 | 390 | 466* | 484* | 502* | 523* | 544* | 1.404 |
| | 0 | 0 | 0 | 0 | 0 | 472 | 552* | 556* | 564* | 568* | |
| 19'-0" | 106 | 160 | 214 | 276 | 340 | 414 | 450* | 468* | 488* | 507* | 1.743 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 489 | 502 | 513* | 518* | |
| 20'-0" | 86 | 134 | 184 | 240 | 297 | 364 | 420* | 437* | 456* | 472 | 2.140 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 422+ | 443 | 460 | 0 | |
| 21'-0" | 69 | 113 | 158 | 208 | 260 | 321 | 364+ | 393 | 408 | 419 | 2.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22'-0" | 54 | 94 | 135 | 181 | 228 | 283 | 317+ | 349 | 363 | 373 | 3.134 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | 41 | 78 | 115 | 157 | 200 | 248+ | 277+ | 311 | 324 | 333 | 3.744 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | 63 | 97 | 136 | 176 | 218+ | 244+ | 271+ | 289 | 298 | 4.438 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | 50 | 82 | 118 | 154 | 193+ | 216+ | 240+ | 259 | 267 | 5.226 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 68 | 101 | 135 | 171+ | 192+ | 213+ | 232 | 239 | 6.113 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 56 | 87 | 118 | 153+ | 171+ | 190+ | 208 | 215 | 7.109 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 45 | 74 | 103 | 137 | 153+ | 170+ | 186 | 193 | 8.223 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 62 | 89 | 121 | 138+ | 153+ | 167 | 173 | 9.462 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.14 | 0.18 | 0.21 | 0.26 | 0.30 | 0.36 | 0.42 | 0.49 | 0.55 | 0.63 | |
| DEPTH, D IN. | 11.25 | 11.19 | 11.19 | 11.12 | 11.12 | 11.06 | 11.06 | 11.00 | 11.00 | 10.94 | |
| $+I_{cr}/I_{gr}$ | 0.179 | 0.220 | 0.262 | 0.306 | 0.351 | 0.400 | 0.451 | 0.504 | 0.559 | 0.611 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 4.5" Top Slab = 14.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.64 | 0.82 | 1.00 | 1.22 | 1.44 | 1.70 | 1.96 | 2.26 | 2.56 | 2.91 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 177 | 251 | 326 | 412 | 499 | 516* | 535* | 555* | 577* | 599* | 1.350 |
| | 0 | 0 | 0 | 0 | 0 | 602 | 611* | 617* | 626* | 633* | |
| 19'-0" | 148 | 215 | 282 | 359 | 437 | 480* | 498* | 517* | 538* | 559* | 1.676 |
| | 0 | 0 | 0 | 0 | 0 | 530 | 557* | 562* | 571* | 577* | |
| 20'-0" | 124 | 184 | 245 | 314 | 385 | 448* | 465* | 482* | 502* | 522* | 2.058 |
| | 0 | 0 | 0 | 0 | 0 | 468 | 510* | 516* | 524* | 530* | |
| 21'-0" | 103 | 157 | 213 | 275 | 339 | 415 | 435* | 452* | 471* | 490* | 2.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 470* | 475* | 483* | 0 | |
| 22'-0" | 85 | 134 | 185 | 242 | 300 | 369 | 408* | 424* | 442* | 460* | 3.013 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 432 | 440* | 447* | 0 | |
| 23'-0" | 69 | 114 | 160 | 213 | 266 | 329 | 384* | 399 | 415 | 427 | 3.600 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 387 | 0 | 0 | 0 | |
| 24'-0" | 55 | 97 | 139 | 187 | 236 | 294 | 347 | 358 | 372 | 384 | 4.268 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | 42 | 81 | 120 | 164 | 209 | 263 | 311 | 322 | 335 | 346 | 5.025 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | 67 | 103 | 144 | 186 | 235 | 280 | 290 | 302 | 312 | 5.878 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | 55 | 88 | 126 | 165 | 210 | 252 | 261 | 273 | 282 | 6.836 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | 44 | 75 | 110 | 146 | 189 | 228 | 236 | 246 | 255 | 7.906 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 63 | 96 | 129 | 169 | 205 | 213 | 223 | 231 | 9.098 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 52 | 83 | 114 | 151 | 185 | 192 | 201 | 209 | 10.419 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 42 | 71 | 100 | 135 | 167 | 173 | 182 | 189 | 11.879 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.12 | 0.15 | 0.19 | 0.23 | 0.27 | 0.32 | 0.37 | 0.43 | 0.49 | 0.55 | |
| DEPTH, D IN. | 13.25 | 13.19 | 13.19 | 13.12 | 13.12 | 13.06 | 13.06 | 13.00 | 13.00 | 12.94 | |
| $+I_{cr}/I_{gr}$ | 0.182 | 0.224 | 0.267 | 0.313 | 0.359 | 0.411 | 0.464 | 0.520 | 0.578 | 0.633 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 4.5" Top Slab = 14.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.62 | 0.79 | 0.96 | 1.17 | 1.39 | 1.64 | 1.89 | 2.18 | 2.46 | 2.80 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 162 | 233 | 305 | 388 | 472 | 563* | 581* | 600* | 622* | 642* | 1.404 |
| | 0 | 0 | 0 | 0 | 0 | 571 | 671 | 683* | 692* | 698* | |
| 19'-0" | 134 | 198 | 263 | 337 | 412 | 501 | 541* | 559* | 579* | 599* | 1.743 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 592 | 624* | 632* | 638* | |
| 20'-0" | 111 | 168 | 227 | 294 | 362 | 442 | 505* | 522* | 541* | 560* | 2.140 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 524 | 572* | 580* | 585* | |
| 21'-0" | 90 | 143 | 196 | 256 | 318 | 391 | 465 | 489* | 507* | 525* | 2.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 527* | 535* | 540* | |
| 22'-0" | 73 | 121 | 169 | 224 | 280 | 346 | 414 | 459* | 476* | 493* | 3.134 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 488* | 495* | 500* | |
| 23'-0" | 57 | 101 | 145 | 196 | 247 | 308 | 370 | 432* | 449* | 465* | 3.744 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 440 | 460* | 0 | |
| 24'-0" | 44 | 84 | 125 | 171 | 218 | 274 | 331 | 395 | 414 | 425 | 4.438 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | 69 | 107 | 149 | 193 | 244 | 296 | 346+ | 373 | 383 | 5.226 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | 56 | 90 | 130 | 170 | 218 | 266 | 307+ | 337 | 346 | 6.113 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | 44 | 76 | 113 | 150 | 194 | 239 | 274+ | 305 | 313 | 7.109 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 63 | 97 | 132 | 173 | 215 | 246+ | 273+ | 284 | 8.223 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 52 | 83 | 116 | 154 | 193 | 221+ | 245+ | 257 | 9.462 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 41 | 71 | 101 | 137 | 173 | 200+ | 222+ | 233 | 10.836 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | | 60 | 88 | 121 | 155 | 181+ | 201+ | 212 | 12.355 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.12 | 0.15 | 0.18 | 0.22 | 0.26 | 0.31 | 0.35 | 0.41 | 0.47 | 0.53 | |
| DEPTH, D IN. | 13.25 | 13.19 | 13.19 | 13.12 | 13.12 | 13.06 | 13.06 | 13.00 | 13.00 | 12.94 | |
| $+I_{cr}/I_{gr}$ | 0.161 | 0.198 | 0.236 | 0.277 | 0.318 | 0.364 | 0.411 | 0.461 | 0.513 | 0.562 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 4.5" Top Slab = 16.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.64 | 0.82 | 1.00 | 1.22 | 1.44 | 1.70 | 1.96 | 2.26 | 2.56 | 2.91 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 20'-0" | 150 | 220 | 290 | 371 | 452 | 531* | 548* | 566* | 586* | 606* | 2.058 |
| | 0 | 0 | 0 | 0 | 0 | 549 | 613* | 619* | 629* | 636* | |
| 21'-0" | 126 | 189 | 253 | 326 | 400 | 488 | 513* | 530* | 549* | 568* | 2.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 565* | 571* | 580* | 587* | |
| 22'-0" | 105 | 162 | 220 | 287 | 355 | 435 | 481* | 498* | 516* | 534* | 3.013 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 516 | 529* | 538* | 544* | |
| 23'-0" | 87 | 139 | 192 | 253 | 315 | 388 | 453* | 468* | 486* | 503* | 3.600 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 463 | 492* | 500* | 507* | |
| 24'-0" | 70 | 119 | 168 | 223 | 280 | 348 | 416 | 442* | 458* | 475* | 4.268 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 459* | 467* | 0 | |
| 25'-0" | 56 | 101 | 146 | 197 | 250 | 312 | 375 | 417* | 433* | 449* | 5.025 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 430* | 437* | 0 | |
| 26'-0" | 44 | 85 | 126 | 174 | 222 | 280 | 338 | 395 | 409 | 421 | 5.878 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | 71 | 109 | 153 | 198 | 251 | 305 | 358 | 372 | 383 | 6.836 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | 58 | 94 | 135 | 176 | 226 | 276 | 325 | 338 | 348 | 7.906 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | 46 | 80 | 118 | 157 | 203 | 250 | 296 | 307 | 317 | 9.098 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 67 | 103 | 139 | 183 | 226 | 269 | 280 | 289 | 10.419 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 56 | 90 | 124 | 164 | 205 | 245 | 255 | 263 | 11.879 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | 46 | 77 | 109 | 147 | 186 | 223 | 233 | 240 | 13.488 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | | | 66 | 96 | 132 | 168 | 203 | 212 | 219 | 15.255 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.10 | 0.13 | 0.16 | 0.20 | 0.23 | 0.28 | 0.32 | 0.37 | 0.42 | 0.48 | |
| DEPTH, D IN. | 15.25 | 15.19 | 15.19 | 15.12 | 15.12 | 15.06 | 15.06 | 15.00 | 15.00 | 14.94 | |
| $+I_{cr}/I_{gr}$ | 0.164 | 0.203 | 0.242 | 0.285 | 0.328 | 0.376 | 0.425 | 0.478 | 0.532 | 0.584 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 4.5" Top Slab = 16.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.62 | 0.79 | 0.96 | 1.17 | 1.39 | 1.64 | 1.89 | 2.18 | 2.46 | 2.80 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 20'-0" | 134 | 201 | 269 | 346 | 425 | 519 | 596* | 613* | 632* | 651* | 2.140 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 614 | 683* | 692* | 699* | |
| 21'-0" | 111 | 172 | 233 | 303 | 375 | 459 | 546 | 574* | 592* | 610* | 2.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 631* | 639* | 646* | |
| 22'-0" | 91 | 146 | 202 | 266 | 331 | 408 | 487 | 539* | 556* | 573* | 3.134 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 576 | 593* | 599* | |
| 23'-0" | 73 | 124 | 175 | 233 | 293 | 364 | 435 | 507* | 524* | 540* | 3.744 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 517 | 551* | 557* | |
| 24'-0" | 57 | 104 | 151 | 205 | 259 | 324 | 390 | 466 | 494* | 510* | 4.438 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 515* | 520* | |
| 25'-0" | 44 | 87 | 130 | 180 | 230 | 290 | 351 | 420 | 467* | 482* | 5.226 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 482* | 487* | |
| 26'-0" | | 71 | 111 | 157 | 204 | 259 | 315 | 379 | 443* | 457* | 6.113 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 445 | 0 | |
| 27'-0" | | 58 | 95 | 137 | 180 | 232 | 284 | 343 | 404 | 425 | 7.109 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | 45 | 80 | 119 | 160 | 207 | 256 | 311 | 367 | 387 | 8.223 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 67 | 103 | 141 | 185 | 231 | 282 | 335 | 353 | 9.462 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 55 | 89 | 124 | 166 | 208 | 256 | 305 | 322 | 10.836 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 44 | 76 | 109 | 148 | 187 | 232 | 275+ | 294 | 12.355 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | | 64 | 95 | 131 | 168 | 211 | 250+ | 269 | 14.027 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | | | 53 | 82 | 117 | 151 | 191 | 228+ | 246 | 15.865 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.10 | 0.13 | 0.16 | 0.19 | 0.22 | 0.27 | 0.31 | 0.36 | 0.41 | 0.46 | |
| DEPTH, D IN. | 15.25 | 15.19 | 15.19 | 15.12 | 15.12 | 15.06 | 15.06 | 15.00 | 15.00 | 14.94 | |
| $+I_{cr}/I_{gr}$ | 0.146 | 0.180 | 0.215 | 0.253 | 0.291 | 0.334 | 0.378 | 0.424 | 0.473 | 0.520 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 5.0" Top Slab = 13.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.36 | 0.50 | 0.64 | 0.82 | 1.00 | 1.22 | 1.44 | 1.70 | 1.96 | 2.26 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 12'-0" | 207 | 331 | 455 | 602 | 694* | 714* | 737* | 762* | 790* | 821* | 0.267 |
| | 0 | 0 | 0 | 0 | 751 | 920 | 1035* | 1058* | 1087* | 1116* | |
| 13'-0" | 161 | 266 | 372 | 498 | 623* | 641* | 662* | 685* | 711* | 739* | 0.367 |
| | 0 | 0 | 0 | 0 | 625 | 769 | 916 | 939* | 949* | 956* | |
| 14'-0" | 125 | 216 | 307 | 415 | 524 | 580* | 600* | 621* | 645* | 671* | 0.494 |
| | 0 | 0 | 0 | 0 | 0 | 649 | 775 | 811* | 820* | 827* | |
| 15'-0" | 96 | 175 | 254 | 348 | 444 | 528* | 547* | 566* | 589* | 613* | 0.651 |
| | 0 | 0 | 0 | 0 | 0 | 552 | 662 | 711* | 720* | 726* | |
| 16'-0" | 72 | 141 | 211 | 294 | 377 | 473 | 501* | 519* | 541* | 563* | 0.843 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 570 | 631* | 639* | 645* | |
| 17'-0" | 52 | 113 | 175 | 248 | 323 | 407 | 461* | 479* | 499* | 520* | 1.074 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 493 | 565* | 573* | 578* | |
| 18'-0" | | 90 | 145 | 211 | 277 | 352 | 427* | 443* | 462* | 481* | 1.350 |
| | | 0 | 0 | 0 | 0 | 0 | 429 | 510* | 517* | 522* | |
| 19'-0" | | 70 | 120 | 178 | 238 | 305 | 374 | 411* | 429* | 448* | 1.676 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 455 | 470* | 475* | |
| 20'-0" | | 53 | 98 | 151 | 205 | 266 | 328 | 383* | 400* | 418* | 2.058 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 400 | 418 | 432 | |
| 21'-0" | | | 79 | 127 | 176 | 231 | 288 | 354 | 370 | 382 | 2.502 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22'-0" | | | 63 | 107 | 151 | 202 | 253 | 313 | 328 | 339 | 3.013 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | | 49 | 89 | 130 | 176 | 223 | 278 | 291 | 302 | 3.600 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | | 74 | 111 | 153 | 196 | 247 | 259 | 269 | 4.268 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | | 60 | 94 | 133 | 173 | 219 | 231 | 240 | 5.025 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | |
| STEEL PERCENT | 0.07 | 0.11 | 0.14 | 0.17 | 0.21 | 0.26 | 0.30 | 0.36 | 0.42 | 0.48 | |
| DEPTH, D IN. | 11.81 | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | 11.62 | 11.56 | 11.56 | 11.50 | |
| $+I_{cr}/I_{gr}$ | 0.115 | 0.156 | 0.197 | 0.242 | 0.288 | 0.336 | 0.386 | 0.440 | 0.496 | 0.554 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 5.0" Top Slab = 13.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 3 | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.35 | 0.48 | 0.62 | 0.79 | 0.96 | 1.17 | 1.39 | 1.64 | 1.89 | 2.18 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 12'-0" | 192 | 310 | 430 | 571 | 715 | 784* | 807* | 830* | 858* | 886* | 0.277 |
| | 0 | 0 | 0 | 0 | 0 | 878 | 1044 | 1115* | 1143* | 1170* | |
| 13'-0" | 148 | 249 | 351 | 471 | 593 | 705* | 725* | 747* | 772* | 798* | 0.382 |
| | 0 | 0 | 0 | 0 | 0 | 732 | 874 | 1006* | 1031* | 1057* | |
| 14'-0" | 113 | 200 | 288 | 392 | 497 | 617 | 657* | 677* | 700* | 725* | 0.514 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 739 | 882 | 913* | 919* | |
| 15'-0" | 85 | 160 | 237 | 328 | 419 | 524 | 600* | 618* | 640* | 662* | 0.677 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 630 | 755 | 802* | 807* | |
| 16'-0" | 62 | 128 | 195 | 275 | 356 | 447 | 541 | 567* | 587* | 608* | 0.877 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 651 | 713* | 718* | |
| 17'-0" | 42 | 101 | 161 | 232 | 303 | 384 | 467 | 523* | 542* | 562* | 1.117 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 564 | 639* | 644* | |
| 18'-0" | | 79 | 132 | 195 | 259 | 331 | 405 | 484* | 502* | 521* | 1.404 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 492 | 578* | 582* | |
| 19'-0" | | 60 | 108 | 164 | 221 | 286 | 353 | 430 | 467* | 485* | 1.743 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 510 | 530* | |
| 20'-0" | | 44 | 87 | 138 | 189 | 248 | 308 | 378 | 436* | 452* | 2.140 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 450 | 481 | |
| 21'-0" | | | 69 | 115 | 162 | 215 | 269 | 333 | 398 | 423* | 2.602 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 426 | |
| 22'-0" | | | 53 | 95 | 138 | 187 | 236 | 294 | 349+ | 379 | 3.134 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | | 40 | 78 | 117 | 162 | 207 | 260 | 306+ | 338 | 3.744 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | | 63 | 99 | 140 | 181 | 230 | 269+ | 301 | 4.438 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | | 50 | 83 | 121 | 159 | 204 | 238+ | 264+ | 5.226 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.22 | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | |
| STEEL PERCENT | 0.07 | 0.10 | 0.13 | 0.17 | 0.20 | 0.25 | 0.29 | 0.35 | 0.40 | 0.46 | |
| DEPTH, D IN. | 11.81 | 11.75 | 11.75 | 11.69 | 11.69 | 11.62 | 11.62 | 11.56 | 11.56 | 11.50 | |
| $+I_{cr}/I_{gr}$ | 0.102 | 0.138 | 0.174 | 0.214 | 0.255 | 0.298 | 0.342 | 0.390 | 0.441 | 0.492 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 5.0" Top Slab = 15.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.50 | 0.64 | 0.82 | 1.00 | 1.22 | 1.44 | 1.70 | 1.96 | 2.26 | 2.56 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 16'-0" | 175 | 257 | 354 | 453 | 565 | 607* | 626* | 647* | 670* | 695* | 0.843 |
| | 0 | 0 | 0 | 0 | 0 | 680 | 771* | 780* | 788* | 798* | |
| 17'-0" | 142 | 215 | 301 | 388 | 488 | 559* | 577* | 597* | 618* | 641* | 1.074 |
| | 0 | 0 | 0 | 0 | 0 | 590 | 692* | 700* | 707* | 718* | |
| 18'-0" | 115 | 179 | 257 | 334 | 424 | 514 | 534* | 552* | 572* | 595* | 1.350 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 621 | 634* | 640* | 650* | |
| 19'-0" | 92 | 150 | 219 | 289 | 369 | 450 | 496* | 513* | 532* | 553* | 1.676 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 546 | 578* | 584* | 592* | |
| 20'-0" | 72 | 124 | 187 | 250 | 322 | 395 | 462* | 478* | 496* | 516* | 2.058 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 482 | 529* | 535* | 543* | |
| 21'-0" | 55 | 102 | 159 | 216 | 282 | 348 | 427 | 447* | 464* | 483* | 2.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 487* | 492* | 500* | |
| 22'-0" | 40 | 83 | 135 | 187 | 247 | 307 | 379 | 419* | 436* | 454* | 3.013 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 450* | 455* | 463* | |
| 23'-0" | | 67 | 114 | 162 | 216 | 272 | 337 | 394* | 410* | 427* | 3.600 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 404 | 423* | 430* | |
| 24'-0" | | 52 | 96 | 140 | 190 | 241 | 301 | 362 | 381 | 396 | 4.268 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | 40 | 80 | 120 | 166 | 213 | 269 | 325 | 342 | 357 | 5.025 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 65 | 103 | 145 | 189 | 240 | 292 | 308 | 321 | 5.878 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 52 | 87 | 127 | 167 | 214 | 263 | 278 | 290 | 6.836 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 41 | 73 | 110 | 147 | 192 | 237 | 251 | 262 | 7.906 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 61 | 95 | 130 | 171 | 213 | 226 | 237 | 9.098 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | |
| STEEL PERCENT | 0.09 | 0.12 | 0.15 | 0.18 | 0.22 | 0.26 | 0.31 | 0.35 | 0.41 | 0.47 | |
| DEPTH, D IN. | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | 13.56 | 13.56 | 13.50 | 13.50 | |
| $+I_{cr}/I_{gr}$ | 0.140 | 0.177 | 0.219 | 0.260 | 0.305 | 0.351 | 0.401 | 0.454 | 0.508 | 0.566 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 5.0" Top Slab = 15.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.48 | 0.62 | 0.79 | 0.96 | 1.17 | 1.39 | 1.64 | 1.89 | 2.18 | 2.46 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 16'-0" | 160 | 239 | 333 | 428 | 536 | 647 | 684* | 705* | 726* | 750* | 0.877 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 777 | 866* | 873* | 883* | |
| 17'-0" | 129 | 199 | 282 | 366 | 462 | 560 | 631* | 650* | 670* | 693* | 1.117 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 675 | 779* | 785* | 794* | |
| 18'-0" | 102 | 165 | 239 | 314 | 400 | 487 | 584* | 602* | 621* | 642* | 1.404 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 590 | 695 | 711* | 720* | |
| 19'-0" | 80 | 136 | 203 | 270 | 347 | 425 | 518 | 560* | 577* | 598* | 1.743 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 612 | 648* | 657* | |
| 20'-0" | 61 | 112 | 172 | 233 | 302 | 373 | 456 | 522* | 539* | 558* | 2.140 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 541 | 595* | 603* | |
| 21'-0" | 45 | 91 | 145 | 200 | 263 | 327 | 403 | 480 | 505* | 523* | 2.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 548* | 556* | |
| 22'-0" | | 72 | 122 | 172 | 230 | 288 | 357 | 427 | 474* | 491* | 3.134 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 507* | 514* | |
| 23'-0" | | 57 | 102 | 148 | 200 | 254 | 317 | 381 | 446* | 462* | 3.744 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 454 | 478* | |
| 24'-0" | | 43 | 84 | 127 | 175 | 224 | 282 | 341 | 408 | 436* | 4.438 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 443 | |
| 25'-0" | | | 69 | 108 | 152 | 197 | 251 | 305 | 367 | 399 | 5.226 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 55 | 91 | 132 | 174 | 223 | 274 | 331 | 361 | 6.113 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 43 | 76 | 114 | 153 | 199 | 245 | 298 | 326 | 7.109 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | 63 | 98 | 134 | 177 | 220 | 269 | 295 | 8.223 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 51 | 84 | 117 | 157 | 197 | 240+ | 267 | 9.462 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | |
| STEEL PERCENT | 0.09 | 0.11 | 0.14 | 0.17 | 0.21 | 0.25 | 0.29 | 0.34 | 0.40 | 0.45 | |
| DEPTH, D IN. | 13.75 | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | 13.56 | 13.56 | 13.50 | 13.50 | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.157 | 0.193 | 0.231 | 0.270 | 0.311 | 0.356 | 0.402 | 0.451 | 0.502 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 5″ Rib @ 25″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 5.0" Top Slab = 17.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 3 # 4 | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | Deflection Coeff. (3) |
| Steel (psf) | 0.50 | 0.64 | 0.82 | 1.00 | 1.22 | 1.44 | 1.70 | 1.96 | 2.26 | 2.56 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 139 | 214 | 303 | 392 | 495 | 599 | 632* | 651* | 671* | 694* | 1.350 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 724 | 756* | 764* | 775* | |
| 19'-0" | 113 | 180 | 259 | 340 | 432 | 526 | 587* | 605* | 624* | 645* | 1.676 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 637 | 690* | 697* | 707* | |
| 20'-0" | 90 | 150 | 222 | 295 | 378 | 463 | 547* | 564* | 582* | 602* | 2.058 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 563 | 633* | 640* | 649* | |
| 21'-0" | 71 | 125 | 191 | 256 | 332 | 409 | 500 | 527* | 544* | 563* | 2.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 583* | 590* | 599* | |
| 22'-0" | 54 | 104 | 163 | 223 | 292 | 362 | 445 | 494* | 511* | 529* | 3.013 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 529 | 546* | 555* | |
| 23'-0" | | 85 | 139 | 194 | 257 | 321 | 397 | 465* | 480* | 497* | 3.600 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 474 | 508* | 516* | |
| 24'-0" | | 68 | 118 | 168 | 226 | 285 | 355 | 426 | 452* | 469* | 4.268 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 473* | 481* | |
| 25'-0" | | 53 | 99 | 146 | 199 | 253 | 318 | 383 | 427* | 443* | 5.025 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 442* | 450* | |
| 26'-0" | | 40 | 83 | 126 | 175 | 225 | 285 | 345 | 404* | 419* | 5.878 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 414 | 422* | |
| 27'-0" | | | 68 | 108 | 154 | 200 | 255 | 311 | 375 | 392 | 6.836 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 55 | 92 | 135 | 178 | 229 | 281 | 341 | 356 | 7.906 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 43 | 78 | 117 | 158 | 205 | 254 | 309 | 324 | 9.098 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | | 65 | 102 | 139 | 184 | 230 | 281 | 295 | 10.419 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | | 53 | 88 | 123 | 165 | 207 | 256 | 269 | 11.879 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.31 | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | |
| STEEL PERCENT | 0.08 | 0.10 | 0.13 | 0.16 | 0.19 | 0.23 | 0.27 | 0.31 | 0.36 | 0.41 | |
| DEPTH, D IN. | 15.75 | 15.75 | 15.69 | 15.69 | 15.62 | 15.62 | 15.56 | 15.56 | 15.50 | 15.50 | |
| $+I_{cr}/I_{gr}$ | 0.127 | 0.160 | 0.199 | 0.237 | 0.278 | 0.320 | 0.368 | 0.416 | 0.467 | 0.521 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 20″ Forms = 6″ Rib @ 26″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 5.0" Top Slab = 17.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.62 | 0.79 | 0.96 | 1.17 | 1.39 | 1.64 | 1.89 | 2.18 | 2.46 | 2.80 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 196 | 282 | 368 | 467 | 568 | 687 | 709* | 728* | 750* | 771* | 1.404 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 809 | 843* | 854* | 862* | |
| 19'-0" | 163 | 240 | 318 | 406 | 497 | 604 | 659* | 677* | 697* | 717* | 1.743 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 713 | 770* | 780* | 787* | |
| 20'-0" | 135 | 205 | 274 | 355 | 436 | 533 | 615* | 632* | 651* | 670* | 2.140 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 631 | 707* | 716* | 723* | |
| 21'-0" | 111 | 174 | 237 | 310 | 384 | 472 | 561 | 591* | 609* | 627* | 2.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 652* | 661* | 668* | |
| 22'-0" | 90 | 148 | 205 | 272 | 339 | 419 | 500 | 555* | 572* | 589* | 3.134 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 593 | 613* | 619* | |
| 23'-0" | 72 | 124 | 177 | 238 | 300 | 373 | 447 | 522* | 538* | 555* | 3.744 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 532 | 570* | 576* | |
| 24'-0" | 56 | 104 | 153 | 208 | 265 | 332 | 401 | 478 | 508* | 523* | 4.438 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 532* | 538* | |
| 25'-0" | 42 | 86 | 131 | 182 | 234 | 296 | 359 | 431 | 480* | 495* | 5.226 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 498* | 503* | |
| 26'-0" | | 70 | 112 | 159 | 207 | 265 | 323 | 389 | 454* | 469* | 6.113 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 457 | 472* | |
| 27'-0" | | 56 | 95 | 139 | 183 | 236 | 290 | 352 | 415 | 445* | 7.109 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | 44 | 79 | 120 | 162 | 211 | 261 | 319 | 377 | 411 | 8.223 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 65 | 104 | 142 | 188 | 235 | 289 | 343 | 374 | 9.462 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 53 | 89 | 125 | 168 | 212 | 262 | 312 | 342 | 10.836 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 42 | 75 | 109 | 149 | 190 | 237 | 285 | 312 | 12.355 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.10 | 0.13 | 0.15 | 0.18 | 0.22 | 0.26 | 0.30 | 0.34 | 0.39 | 0.45 | |
| DEPTH, D IN. | 15.75 | 15.69 | 15.69 | 15.62 | 15.62 | 15.56 | 15.56 | 15.50 | 15.50 | 15.44 | |
| $+I_{cr}/I_{gr}$ | 0.142 | 0.176 | 0.210 | 0.247 | 0.284 | 0.326 | 0.369 | 0.415 | 0.463 | 0.509 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 3.0" Top Slab = 11.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4<br># 4 | # 4<br># 5 | # 5<br># 5 | # 5<br># 6 | # 6<br># 6 | # 6<br># 7 | # 7<br># 7 | # 7<br># 8 | # 8<br># 8 | # 8<br># 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 14'-0" | 178<br>0 | 242<br>0 | 307<br>0 | 333*<br>380 | 347*<br>451 | 362*<br>461* | 380*<br>466* | 398*<br>470* | 418*<br>476* | 438*<br>480* | 0.692 |
| 15'-0" | 146<br>0 | 202<br>0 | 259<br>0 | 304*<br>323 | 317*<br>384 | 331*<br>397 | 347*<br>408* | 364*<br>411* | 383*<br>417* | 402*<br>421* | 0.912 |
| 16'-0" | 121<br>0 | 170<br>0 | 220<br>0 | 276<br>0 | 291*<br>330 | 304*<br>341 | 319*<br>357 | 335*<br>365* | 352*<br>370* | 370*<br>374* | 1.180 |
| 17'-0" | 100<br>0 | 143<br>0 | 187<br>0 | 237<br>0 | 268*<br>285 | 280*<br>295 | 294*<br>308 | 309*<br>326* | 326*<br>332* | 342*<br>0 | 1.504 |
| 18'-0" | 82<br>0 | 120<br>0 | 160<br>0 | 204<br>0 | 247<br>0 | 256<br>0 | 268<br>0 | 285<br>0 | 302*<br>0 | 318*<br>0 | 1.890 |
| 19'-0" | 67<br>0 | 101<br>0 | 137<br>0 | 177<br>0 | 215<br>0 | 223<br>0 | 234<br>0 | 249<br>0 | 281*<br>0 | 296*<br>0 | 2.347 |
| 20'-0" | 54<br>0 | 85<br>0 | 117<br>0 | 153<br>0 | 188<br>0 | 195<br>0 | 205<br>0 | 218<br>0 | 255<br>0 | 277*<br>0 | 2.881 |
| 21'-0" | 43<br>0 | 71<br>0 | 100<br>0 | 133<br>0 | 162+<br>0 | 171<br>0 | 180<br>0 | 192<br>0 | 225<br>0 | 260*<br>0 | 3.502 |
| 22'-0" | | 59<br>0 | 85<br>0 | 115<br>0 | 141+<br>0 | 150<br>0 | 158<br>0 | 169<br>0 | 200<br>0 | 231<br>0 | 4.219 |
| 23'-0" | | 48<br>0 | 73<br>0 | 100<br>0 | 123+<br>0 | 131<br>0 | 139<br>0 | 149<br>0 | 177<br>0 | 206<br>0 | 5.039 |
| 24'-0" | | | 61<br>0 | 86<br>0 | 108+<br>0 | 115<br>0 | 122<br>0 | 132<br>0 | 157<br>0 | 184<br>0 | 5.975 |
| 25'-0" | | | 51<br>0 | 74<br>0 | 95+<br>0 | 101<br>0 | 108<br>0 | 116<br>0 | 140<br>0 | 164<br>0 | 7.035 |
| 26'-0" | | | 43<br>0 | 64<br>0 | 84<br>0 | 89<br>0 | 94<br>0 | 102<br>0 | 124<br>0 | 147<br>0 | 8.229 |
| 27'-0" | | | | 55<br>0 | 74<br>0 | 77<br>0 | 83<br>0 | 90<br>0 | 111<br>0 | 131<br>0 | 9.570 |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.36 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.12 | 0.15 | 0.18 | 0.22 | 0.26 | 0.31 | 0.36 | 0.42 | 0.48 | 0.54 | |
| DEPTH, D IN. | 9.75 | 9.69 | 9.69 | 9.62 | 9.62 | 9.56 | 9.56 | 9.50 | 9.50 | 9.44 | |
| $+I_{cr}/I_{gr}$ | 0.207 | 0.254 | 0.303 | 0.353 | 0.406 | 0.463 | 0.523 | 0.583 | 0.649 | 0.708 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 3.0" Top Slab = 11.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4<br># 4 | # 4<br># 5 | # 5<br># 5 | # 5<br># 6 | # 6<br># 6 | # 6<br># 7 | # 7<br># 7 | # 7<br># 8 | # 8<br># 8 | # 8<br># 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.45 | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 14'-0" | 169<br>0 | 231<br>0 | 294<br>0 | 366<br>0 | 385*<br>439 | 399*<br>523* | 416*<br>528* | 433*<br>531* | 453*<br>537* | 472*<br>540* | 0.712 |
| 15'-0" | 138<br>0 | 192<br>0 | 248<br>0 | 310<br>0 | 351*<br>374 | 365*<br>447 | 380*<br>463* | 396*<br>466* | 415*<br>471* | 433*<br>474* | 0.938 |
| 16'-0" | 113<br>0 | 161<br>0 | 209<br>0 | 264<br>0 | 320<br>0 | 335*<br>385 | 350*<br>400 | 365*<br>412 | 382*<br>419* | 399*<br>421* | 1.214 |
| 17'-0" | 93<br>0 | 135<br>0 | 178<br>0 | 226<br>0 | 276<br>0 | 309*<br>333 | 323*<br>346 | 337*<br>357 | 353*<br>372 | 369*<br>378* | 1.547 |
| 18'-0" | 75<br>0 | 113<br>0 | 151<br>0 | 195<br>0 | 239<br>0 | 286*<br>0 | 299*<br>302 | 311<br>0 | 325<br>0 | 343*<br>0 | 1.944 |
| 19'-0" | 61<br>0 | 94<br>0 | 129<br>0 | 168<br>0 | 208<br>0 | 243+<br>0 | 264<br>0 | 272<br>0 | 284<br>0 | 319<br>0 | 2.414 |
| 20'-0" | 48<br>0 | 79<br>0 | 110<br>0 | 145<br>0 | 181<br>0 | 208+<br>0 | 231<br>0 | 239<br>0 | 250<br>0 | 281<br>0 | 2.964 |
| 21'-0" | | 65<br>0 | 93<br>0 | 125<br>0 | 158<br>0 | 180+<br>0 | 204<br>0 | 211<br>0 | 221<br>0 | 249<br>0 | 3.602 |
| 22'-0" | | 53<br>0 | 79<br>0 | 108<br>0 | 138<br>0 | 156+<br>0 | 176+<br>0 | 186<br>0 | 195<br>0 | 221<br>0 | 4.339 |
| 23'-0" | | 43<br>0 | 66<br>0 | 93<br>0 | 120<br>0 | 137+<br>0 | 154+<br>0 | 164<br>0 | 173<br>0 | 196<br>0 | 5.183 |
| 24'-0" | | | 55<br>0 | 80<br>0 | 105<br>0 | 120+<br>0 | 135+<br>0 | 145<br>0 | 153<br>0 | 175<br>0 | 6.145 |
| 25'-0" | | | 46<br>0 | 68<br>0 | 91<br>0 | 106+<br>0 | 119+<br>0 | 129<br>0 | 136<br>0 | 156<br>0 | 7.235 |
| 26'-0" | | | | 58<br>0 | 79<br>0 | 94+<br>0 | 106+<br>0 | 114<br>0 | 120<br>0 | 139<br>0 | 8.464 |
| 27'-0" | | | | 49<br>0 | 69<br>0 | 84+<br>0 | 95+<br>0 | 101<br>0 | 107<br>0 | 124<br>0 | 9.844 |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.37 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.11 | 0.15 | 0.18 | 0.22 | 0.25 | 0.30 | 0.35 | 0.41 | 0.46 | 0.53 | |
| DEPTH, D IN. | 9.75 | 9.69 | 9.69 | 9.62 | 9.62 | 9.56 | 9.56 | 9.50 | 9.50 | 9.44 | |
| $+I_{cr}/I_{gr}$ | 0.182 | 0.224 | 0.267 | 0.311 | 0.358 | 0.408 | 0.461 | 0.515 | 0.573 | 0.625 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 3.0" Top Slab = 13.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 15'-0" | 186 | 253 | 322 | 380* | 394* | 408* | 424* | 441* | 460* | 479* | 0.912 |
| | 0 | 0 | 0 | 400 | 480 | 511* | 517* | 522* | 529* | 534* | |
| 16'-0" | 155 | 214 | 275 | 343 | 361* | 374* | 389* | 405* | 423* | 441* | 1.180 |
| | 0 | 0 | 0 | 0 | 414 | 454* | 459* | 464* | 470* | 475* | |
| 17'-0" | 129 | 182 | 235 | 296 | 333* | 345* | 359* | 374* | 391* | 408* | 1.504 |
| | 0 | 0 | 0 | 0 | 358 | 407* | 412* | 416* | 422* | 426* | |
| 18'-0" | 107 | 154 | 202 | 257 | 308* | 320* | 333* | 347* | 363* | 379* | 1.890 |
| | 0 | 0 | 0 | 0 | 312 | 368* | 373* | 376* | 382* | 386* | |
| 19'-0" | 89 | 131 | 174 | 223 | 273 | 297* | 310* | 323* | 338* | 353* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 332 | 339* | 342* | 348* | 0 | |
| 20'-0" | 74 | 112 | 151 | 195 | 240 | 277* | 289* | 302* | 316* | 330* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 293 | 306 | 314* | 319* | 0 | |
| 21'-0" | 60 | 95 | 130 | 170 | 211 | 259 | 270* | 281 | 293 | 309* | 3.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 271 | 0 | 0 | 0 | |
| 22'-0" | 49 | 80 | 112 | 149 | 186 | 230 | 241 | 249 | 261 | 291* | 4.219 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | 67 | 97 | 130 | 164 | 204 | 214 | 222 | 233 | 261 | 5.039 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | 56 | 83 | 114 | 145 | 182 | 191 | 198 | 208 | 234 | 5.975 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | 46 | 71 | 99 | 128 | 162 | 170 | 177 | 186 | 210 | 7.035 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 60 | 87 | 113 | 144 | 152 | 159 | 167 | 189 | 8.229 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 51 | 75 | 100 | 129 | 136 | 142 | 150 | 170 | 9.570 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 42 | 65 | 88 | 115 | 122 | 127 | 134 | 153 | 11.069 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.39 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.10 | 0.12 | 0.15 | 0.18 | 0.22 | 0.26 | 0.30 | 0.35 | 0.39 | 0.45 | |
| DEPTH, D IN. | 11.75 | 11.69 | 11.69 | 11.62 | 11.62 | 11.56 | 11.56 | 11.50 | 11.50 | 11.44 | |
| $+I_{cr}/I_{gr}$ | 0.184 | 0.227 | 0.270 | 0.317 | 0.365 | 0.418 | 0.473 | 0.530 | 0.591 | 0.648 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 3.0" Top Slab = 13.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.45 | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 16'-0" | 145 | 203 | 262 | 329 | 397 | 413* | 427* | 442* | 460* | 477* | 1.214 |
| | 0 | 0 | 0 | 0 | 0 | 478 | 518* | 521* | 528* | 532* | |
| 17'-0" | 120 | 171 | 223 | 283 | 343 | 381* | 394* | 409* | 425* | 441* | 1.547 |
| | 0 | 0 | 0 | 0 | 0 | 415 | 465* | 468* | 474* | 478* | |
| 18'-0" | 99 | 145 | 191 | 244 | 298 | 353* | 366* | 379* | 394* | 409* | 1.944 |
| | 0 | 0 | 0 | 0 | 0 | 362 | 420* | 424* | 429* | 433* | |
| 19'-0" | 81 | 122 | 164 | 212 | 260 | 317 | 340* | 353* | 367* | 382* | 2.414 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 376 | 386* | 391* | 395* | |
| 20'-0" | 66 | 103 | 141 | 184 | 228 | 279 | 318* | 330* | 343* | 357* | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 332 | 354* | 358* | 362* | |
| 21'-0" | 53 | 87 | 121 | 160 | 200 | 246 | 294 | 309* | 322* | 335* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 315 | 328 | 0 | |
| 22'-0" | 42 | 73 | 104 | 139 | 175 | 218 | 262 | 281 | 292 | 301 | 4.339 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | 60 | 89 | 121 | 154 | 193 | 233 | 251 | 261 | 269 | 5.183 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | 49 | 75 | 105 | 135 | 171 | 204+ | 224 | 234 | 241 | 6.145 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | 40 | 64 | 91 | 119 | 152 | 181+ | 201 | 209 | 216 | 7.235 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 53 | 79 | 105 | 135 | 161+ | 180 | 188 | 194 | 8.464 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 44 | 68 | 92 | 120 | 143+ | 160+ | 169 | 175 | 9.844 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | 58 | 80 | 106 | 128+ | 143+ | 152 | 157 | 11.385 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 49 | 70 | 94 | 115+ | 129+ | 137 | 142 | 13.101 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.41 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.09 | 0.12 | 0.15 | 0.18 | 0.21 | 0.25 | 0.29 | 0.34 | 0.38 | 0.43 | |
| DEPTH, D IN. | 11.75 | 11.69 | 11.69 | 11.62 | 11.62 | 11.56 | 11.56 | 11.50 | 11.50 | 11.44 | |
| $+I_{cr}/I_{gr}$ | 0.162 | 0.200 | 0.239 | 0.280 | 0.323 | 0.369 | 0.418 | 0.469 | 0.523 | 0.573 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 3.0" Top Slab = 15.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 132 | 187 | 243 | 308 | 372* | 384* | 398* | 412* | 428* | 444* | 1.890 |
| | 0 | 0 | 0 | 0 | 373 | 450* | 456* | 461* | 467* | 473* | |
| 19'-0" | 111 | 160 | 211 | 268 | 327 | 357* | 370* | 383* | 398* | 413* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 397 | 416* | 420* | 426* | 431* | |
| 20'-0" | 92 | 137 | 183 | 235 | 288 | 333* | 345* | 358* | 372* | 386* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 351 | 381* | 385* | 391* | 396* | |
| 21'-0" | 77 | 117 | 159 | 206 | 254 | 311 | 323* | 335* | 348* | 362* | 3.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 351* | 355* | 360* | 365* | |
| 22'-0" | 63 | 100 | 138 | 181 | 225 | 277 | 303* | 314* | 327* | 340* | 4.219 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 325* | 328* | 334* | 0 | |
| 23'-0" | 51 | 85 | 120 | 159 | 199 | 247 | 285* | 296* | 308* | 320* | 5.039 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 295 | 305* | 310* | 0 | |
| 24'-0" | 41 | 72 | 104 | 140 | 177 | 220 | 265 | 279* | 291* | 300 | 5.975 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | 60 | 90 | 123 | 157 | 197 | 238 | 251 | 262 | 271 | 7.035 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | 50 | 77 | 108 | 139 | 176 | 214 | 227 | 236 | 245 | 8.229 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | 41 | 66 | 95 | 124 | 158 | 193 | 205 | 214 | 221 | 9.570 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 56 | 83 | 110 | 142 | 174 | 185 | 193 | 200 | 11.069 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 47 | 72 | 97 | 127 | 157 | 167 | 175 | 182 | 12.737 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | | 62 | 86 | 114 | 142 | 151 | 159 | 165 | 14.587 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | | 53 | 75 | 102 | 128 | 137 | 144 | 150 | 16.631 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.42 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.08 | 0.11 | 0.13 | 0.16 | 0.18 | 0.22 | 0.25 | 0.29 | 0.33 | 0.38 | |
| DEPTH, D IN. | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | 13.56 | 13.56 | 13.50 | 13.50 | 13.44 | |
| $+I_{cr}/I_{gr}$ | 0.165 | 0.205 | 0.245 | 0.288 | 0.332 | 0.381 | 0.432 | 0.486 | 0.542 | 0.596 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 3.0" Top Slab = 15.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.45 | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 121 | 175 | 230 | 292 | 356 | 424* | 437* | 450* | 466* | 481* | 1.944 |
| | 0 | 0 | 0 | 0 | 0 | 432 | 509 | 515* | 522* | 526* | |
| 19'-0" | 101 | 149 | 198 | 254 | 311 | 379 | 406* | 419* | 433* | 448* | 2.414 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 448 | 470* | 476* | 481* | |
| 20'-0" | 83 | 127 | 171 | 222 | 273 | 334 | 379* | 391* | 405* | 418* | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 397 | 431* | 437* | 441* | |
| 21'-0" | 68 | 107 | 147 | 193 | 240 | 296 | 352 | 366* | 379* | 392* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 398* | 403* | 407* | |
| 22'-0" | 54 | 91 | 127 | 169 | 212 | 262 | 314 | 344* | 356* | 369* | 4.339 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 368* | 373* | 377* | |
| 23'-0" | 43 | 76 | 109 | 148 | 187 | 233 | 280 | 324* | 336* | 347* | 5.183 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 334 | 347* | 351* | |
| 24'-0" | | 63 | 94 | 129 | 165 | 207 | 251 | 300 | 317* | 328* | 6.145 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 323* | 0 | |
| 25'-0" | | 52 | 80 | 113 | 146 | 185 | 225 | 270 | 295 | 303 | 7.235 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | 42 | 68 | 98 | 129 | 165 | 202 | 244 | 266 | 274 | 8.464 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 57 | 85 | 113 | 147 | 181 | 220 | 241 | 248 | 9.844 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 48 | 73 | 100 | 131 | 163 | 199 | 218 | 225 | 11.385 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 63 | 87 | 117 | 146 | 180 | 198 | 204 | 13.101 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | | 54 | 76 | 104 | 131 | 163 | 180 | 185 | 15.004 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | | 45 | 66 | 92 | 118 | 148 | 163 | 169 | 17.106 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.44 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.08 | 0.10 | 0.13 | 0.15 | 0.18 | 0.21 | 0.25 | 0.29 | 0.33 | 0.37 | |
| DEPTH, D IN. | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | 13.56 | 13.56 | 13.50 | 13.50 | 13.44 | |
| $+I_{cr}/I_{gr}$ | 0.146 | 0.181 | 0.217 | 0.255 | 0.294 | 0.338 | 0.383 | 0.431 | 0.481 | 0.529 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14" Deep Rib + 3.0" Top Slab = 17.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 19'-0" | 132 | 189 | 247 | 314 | 381 | 422* | 435* | 449* | 464* | 479* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 462 | 496* | 501* | 508* | 514* | |
| 20'-0" | 111 | 163 | 215 | 275 | 336 | 394* | 406* | 419* | 433* | 447* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 409 | 455* | 460* | 467* | 472* | |
| 21'-0" | 93 | 140 | 187 | 242 | 297 | 363 | 380* | 392* | 406* | 419* | 3.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 420* | 424* | 431* | 436* | |
| 22'-0" | 78 | 120 | 163 | 213 | 264 | 324 | 356* | 368* | 381* | 394* | 4.219 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 385 | 393* | 399* | 404* | |
| 23'-0" | 64 | 103 | 143 | 188 | 234 | 289 | 335* | 346* | 358* | 371* | 5.039 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 345 | 366* | 371* | 376* | |
| 24'-0" | 52 | 88 | 124 | 166 | 208 | 259 | 310 | 326* | 338* | 350* | 5.975 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 341* | 347* | 351* | |
| 25'-0" | 42 | 75 | 108 | 147 | 186 | 232 | 280 | 308* | 320* | 331* | 7.035 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 319* | 324* | 0 | |
| 26'-0" | | 63 | 94 | 129 | 165 | 208 | 252 | 292* | 303* | 314* | 8.229 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 299* | 304* | 0 | |
| 27'-0" | | 52 | 81 | 114 | 147 | 187 | 228 | 274 | 287 | 296 | 9.570 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | 43 | 69 | 100 | 131 | 168 | 206 | 249 | 261 | 269 | 11.069 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 59 | 88 | 117 | 151 | 187 | 227 | 238 | 246 | 12.737 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 50 | 77 | 104 | 136 | 169 | 207 | 217 | 224 | 14.587 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 42 | 67 | 92 | 122 | 153 | 188 | 198 | 205 | 16.631 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | | 57 | 81 | 110 | 139 | 172 | 181 | 187 | 18.883 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.46 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.07 | 0.09 | 0.11 | 0.14 | 0.16 | 0.19 | 0.22 | 0.26 | 0.29 | 0.33 | |
| DEPTH, D IN. | 15.75 | 15.69 | 15.69 | 15.62 | 15.62 | 15.56 | 15.56 | 15.50 | 15.50 | 15.44 | |
| $+I_{cr}/I_{gr}$ | 0.151 | 0.187 | 0.224 | 0.264 | 0.305 | 0.351 | 0.398 | 0.448 | 0.501 | 0.553 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14" Deep Rib + 3.0" Top Slab = 17.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 20'-0" | 151 | 202 | 261 | 320 | 391 | 447* | 459* | 473* | 486* | 502* | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 463 | 513* | 520* | 525* | 532* | |
| 21'-0" | 129 | 175 | 228 | 282 | 346 | 412 | 430* | 443* | 456* | 470* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 474* | 480* | 485* | 492* | |
| 22'-0" | 110 | 152 | 200 | 249 | 308 | 367 | 403* | 416* | 428* | 442* | 4.339 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 436 | 445* | 450* | 456* | |
| 23'-0" | 93 | 132 | 176 | 221 | 274 | 329 | 380* | 392* | 403* | 417* | 5.183 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 391 | 414* | 419* | 425* | |
| 24'-0" | 78 | 114 | 154 | 196 | 245 | 295 | 352 | 370* | 381* | 393* | 6.145 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 387* | 391* | 397* | |
| 25'-0" | 65 | 98 | 135 | 173 | 219 | 265 | 318 | 349* | 360* | 372* | 7.235 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 362* | 366* | 0 | |
| 26'-0" | 54 | 84 | 119 | 154 | 196 | 238 | 287 | 331* | 341* | 353* | 8.464 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 337 | 344* | 0 | |
| 27'-0" | 44 | 72 | 104 | 136 | 175 | 215 | 260 | 306 | 324* | 335* | 9.844 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | 61 | 90 | 121 | 157 | 194 | 236 | 279 | 304 | 314 | 11.385 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | 51 | 78 | 107 | 140 | 175 | 214 | 254 | 277 | 287 | 13.101 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | 42 | 68 | 94 | 125 | 157 | 194 | 231 | 253 | 262 | 15.004 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 58 | 82 | 112 | 142 | 176 | 211 | 232 | 240 | 17.106 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | 49 | 72 | 100 | 128 | 160 | 193 | 212 | 220 | 19.423 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | | 41 | 63 | 89 | 115 | 145 | 176 | 194 | 202 | 21.967 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.48 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | |
| STEEL PERCENT | 0.09 | 0.11 | 0.13 | 0.16 | 0.19 | 0.21 | 0.25 | 0.28 | 0.32 | 0.36 | |
| DEPTH, D IN. | 15.69 | 15.69 | 15.62 | 15.62 | 15.56 | 15.56 | 15.50 | 15.50 | 15.44 | 15.44 | |
| $+I_{cr}/I_{gr}$ | 0.166 | 0.199 | 0.234 | 0.271 | 0.311 | 0.354 | 0.399 | 0.446 | 0.492 | 0.540 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16" Deep Rib + 3.0" Top Slab = 19.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 21'-0" | 150 | 202 | 262 | 323 | 396 | 470 | 497* | 510* | 523* | 538* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 552* | 559* | 565* | 572* | |
| 22'-0" | 128 | 175 | 230 | 286 | 352 | 420 | 466* | 479* | 491* | 505* | 4.339 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 497 | 519* | 524* | 532* | |
| 23'-0" | 109 | 153 | 203 | 253 | 314 | 376 | 439* | 451* | 462* | 476* | 5.183 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 447 | 483* | 488* | 495* | |
| 24'-0" | 93 | 132 | 178 | 225 | 281 | 338 | 403 | 425* | 436* | 449* | 6.145 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 451* | 456* | 463* | |
| 25'-0" | 78 | 115 | 157 | 200 | 251 | 304 | 364 | 402* | 413* | 425* | 7.235 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 423* | 428* | 434* | |
| 26'-0" | 65 | 99 | 138 | 178 | 225 | 274 | 329 | 381* | 391* | 403* | 8.464 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 386 | 402* | 408* | |
| 27'-0" | 53 | 85 | 121 | 158 | 202 | 247 | 299 | 351 | 371* | 382* | 9.844 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 379* | 385* | |
| 28'-0" | 43 | 72 | 106 | 140 | 181 | 223 | 271 | 320 | 353* | 364* | 11.385 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 358* | 0 | |
| 29'-0" | | 61 | 93 | 124 | 163 | 202 | 246 | 292 | 336* | 346* | 13.101 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 338* | 0 | |
| 30'-0" | | 51 | 80 | 110 | 146 | 182 | 224 | 266 | 312 | 330* | 15.004 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | 42 | 69 | 97 | 131 | 165 | 204 | 244 | 286 | 311 | 17.106 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | 59 | 85 | 117 | 149 | 185 | 223 | 262 | 286 | 19.423 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | | 50 | 75 | 104 | 134 | 169 | 204 | 241 | 264 | 21.967 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | | | 42 | 65 | 93 | 121 | 153 | 187 | 222 | 243 | 24.753 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | |
| STEEL PERCENT | 0.08 | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.22 | 0.25 | 0.29 | 0.32 | |
| DEPTH, D IN. | 17.69 | 17.69 | 17.62 | 17.62 | 17.56 | 17.56 | 17.50 | 17.50 | 17.44 | 17.44 | |
| $+I_{cr}/I_{gr}$ | 0.153 | 0.184 | 0.217 | 0.251 | 0.290 | 0.329 | 0.372 | 0.416 | 0.460 | 0.506 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16" Deep Rib + 3.0" Top Slab = 19.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.55 | 0.68 | 0.83 | 0.97 | 1.15 | 1.33 | 1.53 | 1.73 | 1.97 | 2.21 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 21'-0" | 137 | 188 | 246 | 306 | 377 | 449 | 532 | 550* | 562* | 577* | 3.702 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 610* | 616* | 623* | |
| 22'-0" | 116 | 162 | 216 | 270 | 334 | 400 | 476 | 516* | 528* | 542* | 4.460 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 553 | 572* | 579* | |
| 23'-0" | 98 | 140 | 189 | 238 | 297 | 357 | 427 | 486* | 497* | 510* | 5.327 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 497 | 533* | 539* | |
| 24'-0" | 81 | 120 | 165 | 211 | 265 | 320 | 384 | 448 | 469* | 482* | 6.316 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 498* | 504* | |
| 25'-0" | 67 | 103 | 144 | 186 | 236 | 287 | 346 | 405 | 444* | 456* | 7.436 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 467* | 473* | |
| 26'-0" | 55 | 88 | 126 | 165 | 211 | 258 | 312 | 367 | 421* | 432* | 8.700 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 426 | 445* | |
| 27'-0" | 43 | 74 | 109 | 145 | 188 | 232 | 282 | 333 | 388 | 410* | 10.117 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 419* | |
| 28'-0" | | 62 | 95 | 128 | 168 | 209 | 255 | 303 | 353 | 390* | 11.701 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 396* | |
| 29'-0" | | 51 | 82 | 113 | 150 | 188 | 231 | 276 | 323 | 371 | 13.465 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | 41 | 70 | 99 | 134 | 169 | 209 | 251 | 295 | 340 | 15.420 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 59 | 86 | 119 | 152 | 190 | 229 | 270 | 312 | 17.581 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | 49 | 75 | 105 | 136 | 172 | 208 | 247 | 287 | 19.962 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | | 40 | 64 | 93 | 122 | 156 | 190 | 226 | 264 | 22.577 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | | | | 55 | 82 | 109 | 141 | 173 | 207 | 242 | 25.440 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | |
| STEEL PERCENT | 0.08 | 0.09 | 0.12 | 0.13 | 0.16 | 0.18 | 0.21 | 0.24 | 0.28 | 0.31 | |
| DEPTH, D IN. | 17.69 | 17.69 | 17.62 | 17.62 | 17.56 | 17.56 | 17.50 | 17.50 | 17.44 | 17.44 | |
| $+I_{cr}/I_{gr}$ | 0.139 | 0.166 | 0.197 | 0.227 | 0.262 | 0.298 | 0.337 | 0.377 | 0.417 | 0.459 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20" Deep Rib + 3.0" Top Slab = 23.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | # 9 #10 | #10 #10 | Deflection Coeff. (3) |
| Steel (psf) | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | 2.57 | 2.87 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 26'-0" | 176 | 225 | 284 | 343 | 412 | 482 | 500* | 512* | 526* | 541* | 8.464 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 524* | 532* | 539* | 549* | |
| 27'-0" | 155 | 200 | 255 | 310 | 374 | 439 | 475* | 486* | 499* | 514* | 9.844 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 494* | 501* | 509* | 518* | |
| 28'-0" | 136 | 179 | 229 | 281 | 340 | 401 | 451* | 462* | 475* | 489* | 11.385 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 466 | 474* | 481* | 490* | |
| 29'-0" | 120 | 159 | 206 | 254 | 310 | 366 | 427 | 440* | 452* | 466* | 13.101 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 449* | 456* | 0 | |
| 30'-0" | 105 | 142 | 186 | 231 | 282 | 335 | 391 | 419* | 431* | 444* | 15.004 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 426* | 433* | 0 | |
| 31'-0" | 91 | 126 | 167 | 209 | 258 | 307 | 360 | 400* | 412* | 424* | 17.106 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 405* | 0 | 0 | |
| 32'-0" | 79 | 111 | 150 | 189 | 235 | 281 | 331 | 381 | 393* | 406* | 19.423 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | 67 | 98 | 134 | 172 | 214 | 258 | 304 | 352 | 377* | 388* | 21.967 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | 57 | 86 | 120 | 155 | 196 | 237 | 280 | 325 | 361* | 372* | 24.753 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 35'-0" | 48 | 75 | 107 | 140 | 178 | 217 | 258 | 301 | 346* | 357* | 27.796 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 36'-0" | | 65 | 95 | 127 | 163 | 199 | 238 | 278 | 328 | 343* | 31.111 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 37'-0" | | 55 | 85 | 114 | 148 | 183 | 220 | 258 | 304 | 321 | 34.715 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 38'-0" | | 47 | 74 | 102 | 135 | 168 | 203 | 238 | 283 | 299 | 38.623 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 39'-0" | | | 65 | 92 | 122 | 153 | 187 | 221 | 263 | 278 | 42.852 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | 2.27 | 2.54 | |
| STEEL PERCENT | 0.10 | 0.11 | 0.13 | 0.15 | 0.18 | 0.20 | 0.23 | 0.26 | 0.30 | 0.33 | |
| DEPTH, D IN. | 21.62 | 21.62 | 21.56 | 21.56 | 21.50 | 21.50 | 21.44 | 21.44 | 21.36 | 21.36 | |
| $+I_{cr}/I_{gr}$ | 0.190 | 0.220 | 0.255 | 0.290 | 0.328 | 0.368 | 0.408 | 0.449 | 0.497 | 0.546 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20" Deep Rib + 3.0" Top Slab = 23.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | # 9 #10 | #10 #10 | Deflection Coeff. (3) |
| Steel (psf) | 0.83 | 0.97 | 1.15 | 1.33 | 1.53 | 1.73 | 1.97 | 2.21 | 2.50 | 2.79 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 26'-0" | 162 | 210 | 267 | 325 | 393 | 461 | 534 | 551* | 564* | 579* | 8.700 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 577* | 585* | 594* | |
| 27'-0" | 142 | 186 | 239 | 293 | 356 | 419 | 487 | 523* | 535* | 550* | 10.117 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 545* | 552* | 561* | |
| 28'-0" | 124 | 165 | 214 | 265 | 322 | 381 | 444 | 497* | 509* | 523* | 11.701 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 509 | 522* | 530* | |
| 29'-0" | 108 | 146 | 192 | 239 | 293 | 348 | 406 | 466 | 485* | 498* | 13.465 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 494* | 503* | |
| 30'-0" | 93 | 129 | 172 | 216 | 266 | 317 | 372 | 428 | 462* | 475* | 15.420 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 469* | 477* | |
| 31'-0" | 80 | 113 | 154 | 194 | 242 | 290 | 341 | 394 | 442* | 454* | 17.581 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 446* | 0 | |
| 32'-0" | 68 | 99 | 137 | 175 | 220 | 265 | 313 | 362 | 422* | 434* | 19.962 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 423 | 0 | |
| 33'-0" | 57 | 86 | 122 | 158 | 200 | 242 | 287 | 334 | 391 | 416* | 22.577 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | 47 | 75 | 108 | 142 | 181 | 221 | 264 | 308 | 362 | 398* | 25.440 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 35'-0" | | 64 | 96 | 128 | 165 | 202 | 243 | 284 | 335 | 382* | 28.568 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 36'-0" | | 54 | 84 | 114 | 149 | 185 | 223 | 262 | 310 | 359 | 31.975 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 37'-0" | | 45 | 73 | 102 | 135 | 169 | 205 | 242 | 287 | 334 | 35.679 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 38'-0" | | | 64 | 91 | 122 | 154 | 188 | 223 | 267 | 311 | 39.696 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 39'-0" | | | 54 | 80 | 110 | 140 | 173 | 206 | 247 | 289 | 44.042 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | 2.27 | 2.54 | |
| STEEL PERCENT | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | 0.20 | 0.23 | 0.25 | 0.29 | 0.32 | |
| DEPTH, D IN. | 21.62 | 21.62 | 21.56 | 21.56 | 21.50 | 21.50 | 21.44 | 21.44 | 21.36 | 21.36 | |
| $+I_{cr}/I_{gr}$ | 0.173 | 0.200 | 0.231 | 0.263 | 0.298 | 0.334 | 0.371 | 0.408 | 0.452 | 0.497 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 4.0" Top Slab = 12.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 14'-0" | 189 | 259 | 331 | 362* | 376* | 391* | 409* | 427* | 447* | 468* | 0.692 |
| | 0 | 0 | 0 | 413 | 497 | 509* | 515* | 519* | 526* | 531* | |
| 15'-0" | 154 | 216 | 278 | 329* | 342* | 356* | 372* | 389* | 408* | 427* | 0.912 |
| | 0 | 0 | 0 | 350 | 423 | 445* | 450* | 454* | 460* | 465* | |
| 16'-0" | 126 | 180 | 235 | 298 | 313* | 326* | 341* | 357* | 375* | 393* | 1.180 |
| | 0 | 0 | 0 | 0 | 362 | 393* | 398* | 402* | 408* | 412* | |
| 17'-0" | 102 | 150 | 199 | 255 | 288* | 300* | 314* | 329* | 346* | 362* | 1.504 |
| | 0 | 0 | 0 | 0 | 311 | 349 | 355* | 359* | 364* | 368* | |
| 18'-0" | 83 | 125 | 169 | 218 | 265* | 277* | 290* | 304* | 320* | 336* | 1.890 |
| | 0 | 0 | 0 | 0 | 269 | 303 | 316 | 323* | 328* | 0 | |
| 19'-0" | 66 | 104 | 144 | 188 | 233 | 256* | 269* | 282* | 297* | 312* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 264 | 276 | 286 | 0 | 0 | |
| 20'-0" | 52 | 86 | 122 | 162 | 203 | 230 | 241 | 251 | 276 | 291* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 21'-0" | 40 | 71 | 103 | 139 | 177 | 201 | 211 | 220 | 243 | 272* | 3.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22'-0" | | 58 | 87 | 120 | 154 | 176 | 185 | 193 | 214 | 249 | 4.219 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | 46 | 73 | 103 | 134 | 155 | 163 | 170 | 189 | 221 | 5.039 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | 60 | 88 | 116 | 135 | 143 | 150 | 167 | 197 | 5.975 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 49 | 75 | 101 | 119 | 126 | 132 | 148 | 175 | 7.035 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 40 | 63 | 87 | 104 | 110 | 116 | 131 | 156 | 8.229 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | | 53 | 75 | 90 | 96 | 102 | 115 | 139 | 9.570 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.44 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.11 | 0.14 | 0.17 | 0.20 | 0.24 | 0.28 | 0.32 | 0.38 | 0.43 | 0.49 | |
| DEPTH, D IN. | 10.75 | 10.69 | 10.69 | 10.62 | 10.62 | 10.56 | 10.56 | 10.50 | 10.50 | 10.44 | |
| $+I_{cr}/I_{gr}$ | 0.194 | 0.239 | 0.285 | 0.334 | 0.384 | 0.438 | 0.496 | 0.555 | 0.618 | 0.676 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 4.0" Top Slab = 12.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.45 | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 14'-0" | 178 | 247 | 317 | 396 | 417* | 432* | 449* | 466* | 486* | 505* | 0.712 |
| | 0 | 0 | 0 | 0 | 478 | 573 | 582* | 585* | 592* | 596* | |
| 15'-0" | 144 | 204 | 265 | 334 | 380* | 393* | 409* | 425* | 444* | 462* | 0.938 |
| | 0 | 0 | 0 | 0 | 405 | 488 | 509* | 513* | 519* | 523* | |
| 16'-0" | 116 | 169 | 223 | 284 | 346 | 360* | 375* | 390* | 407* | 424* | 1.214 |
| | 0 | 0 | 0 | 0 | 0 | 419 | 451* | 454* | 460* | 463* | |
| 17'-0" | 94 | 140 | 188 | 242 | 297 | 332* | 345* | 359* | 376* | 392* | 1.547 |
| | 0 | 0 | 0 | 0 | 0 | 362 | 403* | 406* | 411* | 415* | |
| 18'-0" | 75 | 116 | 159 | 207 | 256 | 306* | 319* | 333* | 348* | 363* | 1.944 |
| | 0 | 0 | 0 | 0 | 0 | 314 | 357 | 366* | 371* | 374* | |
| 19'-0" | 58 | 96 | 134 | 177 | 221 | 273 | 296* | 309* | 323* | 337* | 2.414 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 312 | 322 | 335 | 340* | |
| 20'-0" | 45 | 78 | 113 | 152 | 192 | 238 | 273 | 282 | 294 | 304 | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 21'-0" | | 63 | 94 | 130 | 166 | 208 | 240 | 248 | 259 | 268 | 3.602 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22'-0" | | 50 | 79 | 111 | 144 | 182 | 212 | 219 | 229 | 237 | 4.339 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | | 65 | 94 | 124 | 160 | 186 | 193 | 202 | 210 | 5.183 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | 53 | 80 | 108 | 140 | 164 | 170 | 179 | 186 | 6.145 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 42 | 67 | 93 | 123 | 145 | 151 | 158 | 165 | 7.235 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | | 56 | 79 | 107 | 128 | 133 | 140 | 146 | 8.464 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | | 46 | 67 | 93 | 112 | 117 | 124 | 129 | 9.844 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.46 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.10 | 0.13 | 0.16 | 0.20 | 0.23 | 0.27 | 0.32 | 0.37 | 0.42 | 0.48 | |
| DEPTH, D IN. | 10.75 | 10.69 | 10.69 | 10.62 | 10.62 | 10.56 | 10.56 | 10.50 | 10.50 | 10.44 | |
| $+I_{cr}/I_{gr}$ | 0.171 | 0.211 | 0.252 | 0.294 | 0.339 | 0.387 | 0.438 | 0.490 | 0.546 | 0.598 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 4.0" Top Slab = 14.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 15'-0" | 192 | 266 | 341 | 408* | 422* | 436* | 452* | 469* | 488* | 507* | 0.912 |
| | 0 | 0 | 0 | 426 | 513 | 554* | 560* | 565* | 573* | 579* | |
| 16'-0" | 158 | 223 | 289 | 364 | 386* | 399* | 414* | 430* | 448* | 466* | 1.180 |
| | 0 | 0 | 0 | 0 | 441 | 491* | 497* | 501* | 509* | 514* | |
| 17'-0" | 130 | 188 | 246 | 313 | 354* | 367* | 381* | 396* | 413* | 430* | 1.504 |
| | 0 | 0 | 0 | 0 | 380 | 439* | 445* | 449* | 456* | 461* | |
| 18'-0" | 107 | 158 | 210 | 270 | 327* | 339* | 352* | 366* | 382* | 398* | 1.890 |
| | 0 | 0 | 0 | 0 | 330 | 396* | 401* | 405* | 412* | 416* | |
| 19'-0" | 87 | 133 | 180 | 233 | 287 | 314* | 326* | 340* | 355* | 370* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 352 | 364* | 368* | 374* | 378* | |
| 20'-0" | 70 | 112 | 154 | 202 | 251 | 292* | 304* | 316* | 331* | 345* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 309 | 333* | 336* | 342* | 346* | |
| 21'-0" | 56 | 94 | 132 | 175 | 220 | 272* | 283* | 295* | 309* | 322* | 3.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 305* | 309* | 314* | 0 | |
| 22'-0" | 43 | 78 | 112 | 152 | 193 | 241 | 265* | 277* | 289* | 302* | 4.219 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 274 | 284 | 0 | 0 | |
| 23'-0" | | 64 | 96 | 132 | 169 | 213 | 243 | 252 | 264 | 276 | 5.039 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | 52 | 81 | 114 | 148 | 188 | 217 | 225 | 235 | 246 | 5.975 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | 41 | 68 | 98 | 130 | 167 | 193 | 200 | 210 | 220 | 7.035 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 56 | 85 | 114 | 148 | 172 | 179 | 188 | 197 | 8.229 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 46 | 72 | 99 | 131 | 153 | 160 | 168 | 177 | 9.570 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | 61 | 86 | 116 | 136 | 142 | 150 | 158 | 11.069 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.47 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.09 | 0.11 | 0.14 | 0.17 | 0.20 | 0.24 | 0.27 | 0.32 | 0.36 | 0.41 | |
| DEPTH, D IN. | 12.75 | 12.69 | 12.69 | 12.62 | 12.62 | 12.56 | 12.56 | 12.50 | 12.50 | 12.44 | |
| $+I_{cr}/I_{gr}$ | 0.173 | 0.214 | 0.256 | 0.300 | 0.346 | 0.397 | 0.450 | 0.505 | 0.563 | 0.619 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 4.0" Top Slab = 14.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.45 | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 16'-0" | 148 | 211 | 275 | 348 | 423 | 441* | 456* | 471* | 489* | 506* | 1.214 |
| | 0 | 0 | 0 | 0 | 0 | 511 | 560* | 564* | 571* | 576* | |
| 17'-0" | 121 | 177 | 233 | 298 | 364 | 406* | 420* | 434* | 451* | 467* | 1.547 |
| | 0 | 0 | 0 | 0 | 0 | 442 | 502* | 506* | 512* | 517* | |
| 18'-0" | 98 | 148 | 199 | 256 | 315 | 375* | 388* | 402* | 417* | 432* | 1.944 |
| | 0 | 0 | 0 | 0 | 0 | 385 | 453* | 457* | 463* | 467* | |
| 19'-0" | 79 | 124 | 169 | 221 | 274 | 336 | 360* | 373* | 388* | 402* | 2.414 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 400 | 416* | 421* | 425* | |
| 20'-0" | 63 | 103 | 144 | 191 | 238 | 295 | 336* | 348* | 362* | 375* | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 352 | 380* | 385* | 389* | |
| 21'-0" | 48 | 85 | 122 | 165 | 208 | 259 | 311 | 325* | 338* | 351* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 349* | 354* | 358* | |
| 22'-0" | | 70 | 103 | 142 | 181 | 228 | 276 | 304* | 317* | 329* | 4.339 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 322 | 327* | 330* | |
| 23'-0" | | 56 | 87 | 122 | 158 | 201 | 245 | 286* | 298* | 307 | 5.183 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 287 | 0 | 0 | |
| 24'-0" | | 44 | 73 | 105 | 138 | 177 | 217 | 256 | 266 | 274 | 6.145 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 60 | 90 | 120 | 156 | 193 | 229 | 238 | 246 | 7.235 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 49 | 76 | 105 | 138 | 172 | 205 | 214 | 221 | 8.464 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | | 64 | 90 | 121 | 153 | 184 | 192 | 198 | 9.844 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | 54 | 78 | 107 | 136 | 164 | 172 | 178 | 11.385 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 44 | 67 | 93 | 121 | 147 | 154 | 160 | 13.101 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.49 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.09 | 0.11 | 0.14 | 0.17 | 0.19 | 0.23 | 0.27 | 0.31 | 0.35 | 0.40 | |
| DEPTH, D IN. | 12.75 | 12.69 | 12.69 | 12.62 | 12.62 | 12.56 | 12.56 | 12.50 | 12.50 | 12.44 | |
| $+I_{cr}/I_{gr}$ | 0.153 | 0.189 | 0.226 | 0.265 | 0.306 | 0.351 | 0.397 | 0.446 | 0.498 | 0.547 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 4.0" Top Slab = 16.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 132 | 191 | 252 | 321 | 391 | 406* | 420* | 434* | 450* | 466* | 1.890 |
| | 0 | 0 | 0 | 0 | 0 | 475 | 486* | 492* | 499* | 505* | |
| 19'-0" | 109 | 162 | 216 | 278 | 342 | 376* | 389* | 403* | 418* | 433* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 417 | 443* | 447* | 454* | 460* | |
| 20'-0" | 89 | 137 | 186 | 242 | 299 | 350* | 362* | 375* | 389* | 404* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 367 | 405* | 410* | 416* | 421* | |
| 21'-0" | 72 | 116 | 160 | 211 | 263 | 325 | 338* | 350* | 364* | 377* | 3.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 372* | 377* | 383* | 388* | |
| 22'-0" | 58 | 98 | 138 | 184 | 232 | 288 | 316* | 328* | 341* | 354* | 4.219 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 344* | 348* | 354* | 358* | |
| 23'-0" | 45 | 82 | 119 | 161 | 204 | 255 | 297* | 308* | 320* | 332* | 5.039 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 308 | 322* | 328* | 0 | |
| 24'-0" | | 67 | 101 | 140 | 180 | 227 | 275 | 290* | 301* | 313* | 5.975 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 300* | 305* | 0 | |
| 25'-0" | | 55 | 86 | 122 | 159 | 202 | 246 | 273* | 284* | 295* | 7.035 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 279* | 0 | 0 | |
| 26'-0" | | 44 | 73 | 106 | 140 | 180 | 221 | 252 | 262 | 271 | 8.229 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 61 | 92 | 123 | 160 | 198 | 227 | 237 | 245 | 9.570 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 50 | 79 | 108 | 142 | 178 | 204 | 214 | 221 | 11.069 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 41 | 67 | 94 | 127 | 159 | 184 | 193 | 200 | 12.737 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | | 57 | 82 | 112 | 143 | 166 | 174 | 181 | 14.587 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | | 47 | 71 | 99 | 128 | 150 | 157 | 164 | 16.631 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.50 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.08 | 0.10 | 0.12 | 0.15 | 0.17 | 0.20 | 0.24 | 0.27 | 0.31 | 0.35 | |
| DEPTH, D IN. | 14.75 | 14.69 | 14.69 | 14.62 | 14.62 | 14.56 | 14.56 | 14.50 | 14.50 | 14.44 | |
| $+I_{cr}/I_{gr}$ | 0.156 | 0.193 | 0.231 | 0.272 | 0.314 | 0.361 | 0.410 | 0.461 | 0.515 | 0.568 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 4.0" Top Slab = 16.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.45 | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 122 | 180 | 238 | 306 | 374 | 451* | 464* | 477* | 493* | 508* | 1.944 |
| | 0 | 0 | 0 | 0 | 0 | 456 | 539 | 552* | 559* | 564* | |
| 19'-0" | 100 | 152 | 204 | 265 | 326 | 399 | 430* | 443* | 458* | 472* | 2.414 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 474 | 503* | 509* | 514* | |
| 20'-0" | 81 | 128 | 175 | 230 | 285 | 351 | 401* | 413* | 427* | 440* | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 418 | 461* | 467* | 471* | |
| 21'-0" | 64 | 107 | 150 | 199 | 250 | 310 | 371 | 386* | 399* | 412* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 424* | 430* | 434* | |
| 22'-0" | 50 | 89 | 128 | 173 | 219 | 274 | 329 | 362* | 374* | 386* | 4.339 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 392* | 397* | 402* | |
| 23'-0" | | 73 | 109 | 150 | 192 | 242 | 293 | 340* | 352* | 363* | 5.183 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 351 | 369* | 373* | |
| 24'-0" | | 59 | 92 | 130 | 169 | 215 | 261 | 315 | 331* | 342* | 6.145 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 343* | 347* | |
| 25'-0" | | 47 | 78 | 113 | 148 | 190 | 233 | 283 | 313* | 323* | 7.235 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 321* | 324* | |
| 26'-0" | | | 65 | 97 | 130 | 169 | 209 | 254 | 295* | 306* | 8.464 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 299 | 0 | |
| 27'-0" | | | 53 | 83 | 113 | 150 | 187 | 229 | 270 | 278 | 9.844 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 43 | 70 | 99 | 132 | 167 | 206 | 245 | 252 | 11.385 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 59 | 86 | 117 | 149 | 186 | 222 | 228 | 13.101 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | | 49 | 74 | 103 | 133 | 167 | 201 | 207 | 15.004 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | | 40 | 63 | 91 | 119 | 150 | 182 | 188 | 17.106 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.08 | 0.10 | 0.12 | 0.14 | 0.17 | 0.20 | 0.23 | 0.27 | 0.30 | 0.34 | |
| DEPTH, D IN. | 14.75 | 14.69 | 14.69 | 14.62 | 14.62 | 14.56 | 14.56 | 14.50 | 14.50 | 14.44 | |
| $+I_{cr}/I_{gr}$ | 0.138 | 0.171 | 0.204 | 0.241 | 0.278 | 0.320 | 0.363 | 0.408 | 0.456 | 0.503 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14" Deep Rib + 4.0" Top Slab = 18.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 19'-0" | 130 | 191 | 253 | 324 | 396 | 445* | 458* | 471* | 486* | 501* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 482 | 524* | 530* | 538* | 544* | |
| 20'-0" | 108 | 163 | 219 | 283 | 348 | 414* | 426* | 439* | 453* | 467* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 425 | 481* | 486* | 493* | 499* | |
| 21'-0" | 89 | 139 | 189 | 247 | 306 | 377 | 397* | 410* | 423* | 437* | 3.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 443* | 448* | 455* | 460* | |
| 22'-0" | 72 | 118 | 164 | 217 | 270 | 335 | 372* | 384* | 397* | 410* | 4.219 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 400 | 414* | 421* | 426* | |
| 23'-0" | 58 | 99 | 141 | 190 | 239 | 298 | 349* | 360* | 373* | 385* | 5.039 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 358 | 384* | 391* | 396* | |
| 24'-0" | 45 | 83 | 122 | 166 | 212 | 266 | 320 | 339* | 351* | 363* | 5.975 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 358* | 364* | 369* | |
| 25'-0" | | 69 | 105 | 146 | 187 | 237 | 288 | 319* | 331* | 342* | 7.035 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 334* | 340* | 345* | |
| 26'-0" | | 56 | 89 | 127 | 166 | 212 | 259 | 302* | 313* | 324* | 8.229 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 312 | 318* | 0 | |
| 27'-0" | | 45 | 76 | 111 | 147 | 189 | 233 | 282 | 296* | 306* | 9.570 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 299* | 0 | |
| 28'-0" | | | 64 | 96 | 130 | 169 | 209 | 256 | 281* | 291* | 11.069 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | 53 | 83 | 114 | 151 | 189 | 232 | 260 | 268 | 12.737 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 43 | 71 | 100 | 135 | 170 | 210 | 236 | 244 | 14.587 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | | 61 | 88 | 120 | 153 | 191 | 215 | 222 | 16.631 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | | 51 | 76 | 107 | 137 | 173 | 196 | 203 | 18.883 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.54 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.07 | 0.09 | 0.11 | 0.13 | 0.15 | 0.18 | 0.21 | 0.24 | 0.27 | 0.31 | |
| DEPTH, D IN. | 16.75 | 16.69 | 16.69 | 16.62 | 16.62 | 16.56 | 16.56 | 16.50 | 16.50 | 16.44 | |
| $+I_{cr}/I_{gr}$ | 0.142 | 0.176 | 0.211 | 0.249 | 0.287 | 0.331 | 0.376 | 0.424 | 0.474 | 0.524 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14" Deep Rib + 4.0" Top Slab = 18.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 20'-0" | 151 | 205 | 267 | 331 | 406 | 470* | 482* | 496* | 510* | 525* | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 483 | 543* | 550* | 556* | 563* | |
| 21'-0" | 127 | 176 | 233 | 290 | 359 | 429 | 451* | 464* | 477* | 491* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 501* | 507* | 513* | 520* | |
| 22'-0" | 107 | 152 | 203 | 256 | 318 | 382 | 422* | 435* | 447* | 461* | 4.339 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 454 | 470* | 475* | 482* | |
| 23'-0" | 89 | 130 | 177 | 225 | 282 | 340 | 397* | 409* | 420* | 434* | 5.183 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 407 | 436* | 441* | 448* | |
| 24'-0" | 73 | 111 | 154 | 198 | 251 | 304 | 365 | 385* | 396* | 409* | 6.145 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 407* | 411* | 418* | |
| 25'-0" | 60 | 94 | 134 | 175 | 223 | 272 | 329 | 363* | 374* | 386* | 7.235 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 380* | 385* | 391* | |
| 26'-0" | 47 | 79 | 116 | 154 | 199 | 244 | 296 | 343* | 354* | 365* | 8.464 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 349 | 361* | 367* | |
| 27'-0" | | 66 | 100 | 135 | 177 | 219 | 267 | 317 | 335* | 346* | 9.844 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 339* | 0 | |
| 28'-0" | | 54 | 86 | 119 | 157 | 196 | 241 | 287 | 318* | 329* | 11.385 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 319* | 0 | |
| 29'-0" | | 44 | 73 | 104 | 139 | 176 | 218 | 261 | 302* | 313* | 13.101 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 62 | 90 | 124 | 158 | 197 | 237 | 278 | 287 | 15.004 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 51 | 78 | 109 | 141 | 178 | 215 | 254 | 263 | 17.106 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | 42 | 67 | 96 | 126 | 161 | 196 | 232 | 240 | 19.423 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | | | 57 | 84 | 113 | 145 | 178 | 212 | 220 | 21.967 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | |
| STEEL PERCENT | 0.08 | 0.10 | 0.13 | 0.15 | 0.17 | 0.20 | 0.23 | 0.27 | 0.30 | 0.34 | |
| DEPTH, D IN. | 16.69 | 16.69 | 16.62 | 16.62 | 16.56 | 16.56 | 16.50 | 16.50 | 16.44 | 16.44 | |
| $+I_{cr}/I_{gr}$ | 0.156 | 0.187 | 0.221 | 0.255 | 0.294 | 0.334 | 0.377 | 0.421 | 0.465 | 0.511 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16" Deep Rib + 4.0" Top Slab = 20.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 21'-0" | 148 | 203 | 267 | 331 | 408 | 487 | 520* | 534* | 547* | 562* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 577 | 587* | 594* | 602* | |
| 22'-0" | 125 | 175 | 233 | 292 | 362 | 434 | 487* | 500* | 513* | 527* | 4.339 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 516 | 544* | 550* | 558* | |
| 23'-0" | 105 | 151 | 204 | 258 | 322 | 388 | 458* | 470* | 482* | 495* | 5.183 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 463 | 507* | 512* | 520* | |
| 24'-0" | 88 | 130 | 178 | 228 | 287 | 347 | 416 | 443* | 454* | 467* | 6.145 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 473* | 478* | 485* | |
| 25'-0" | 72 | 111 | 156 | 201 | 256 | 311 | 375 | 418* | 428* | 441* | 7.235 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 440 | 448* | 454* | |
| 26'-0" | 58 | 94 | 136 | 178 | 228 | 279 | 338 | 395* | 405* | 417* | 8.464 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 398 | 420* | 427* | |
| 27'-0" | 46 | 79 | 118 | 157 | 204 | 251 | 306 | 361 | 384* | 395* | 9.844 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 395* | 401* | |
| 28'-0" | | 66 | 102 | 138 | 182 | 226 | 277 | 328 | 364* | 375* | 11.385 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 373* | 378* | |
| 29'-0" | | 54 | 88 | 121 | 162 | 203 | 250 | 299 | 346* | 357* | 13.101 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 350 | 358* | |
| 30'-0" | | 44 | 75 | 106 | 144 | 183 | 227 | 272 | 320 | 340* | 15.004 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 63 | 93 | 128 | 164 | 205 | 248 | 293 | 324* | 17.106 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | 52 | 80 | 113 | 147 | 186 | 226 | 268 | 309* | 19.423 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | | 43 | 69 | 100 | 132 | 168 | 206 | 245 | 286 | 21.967 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | | | | 58 | 88 | 118 | 152 | 187 | 225 | 263 | 24.753 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | |
| STEEL PERCENT | 0.08 | 0.09 | 0.11 | 0.13 | 0.16 | 0.18 | 0.21 | 0.24 | 0.27 | 0.30 | |
| DEPTH, D IN. | 18.69 | 18.69 | 18.62 | 18.62 | 18.56 | 18.56 | 18.50 | 18.50 | 18.44 | 18.44 | |
| $+I_{cr}/I_{gr}$ | 0.144 | 0.172 | 0.204 | 0.236 | 0.272 | 0.309 | 0.350 | 0.392 | 0.433 | 0.477 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16" Deep Rib + 4.0" Top Slab = 20.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.55 | 0.68 | 0.83 | 0.97 | 1.15 | 1.33 | 1.53 | 1.73 | 1.97 | 2.21 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 21'-0" | 136 | 190 | 252 | 315 | 390 | 466 | 554 | 578* | 590* | 605* | 3.702 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 643* | 649* | 657* | |
| 22'-0" | 114 | 163 | 219 | 276 | 345 | 415 | 495 | 542* | 554* | 567* | 4.460 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 576 | 602* | 609* | |
| 23'-0" | 94 | 139 | 191 | 243 | 306 | 370 | 443 | 509* | 520* | 534* | 5.327 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 518 | 560* | 567* | |
| 24'-0" | 77 | 118 | 166 | 214 | 272 | 330 | 397 | 466 | 490* | 503* | 6.316 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 523* | 530* | |
| 25'-0" | 62 | 100 | 144 | 188 | 241 | 295 | 357 | 420 | 463* | 475* | 7.436 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 488 | 497* | |
| 26'-0" | 49 | 84 | 124 | 165 | 214 | 264 | 322 | 380 | 438* | 450* | 8.700 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 442 | 467* | |
| 27'-0" | | 70 | 107 | 145 | 191 | 237 | 290 | 344 | 402 | 426* | 10.117 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 439* | |
| 28'-0" | | 57 | 92 | 127 | 169 | 212 | 262 | 312 | 366 | 405* | 11.701 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 414* | |
| 29'-0" | | 45 | 78 | 110 | 150 | 190 | 236 | 283 | 333 | 384 | 13.465 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 65 | 96 | 133 | 170 | 213 | 257 | 304 | 351 | 15.420 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 54 | 82 | 117 | 152 | 192 | 233 | 277 | 322 | 17.581 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | 43 | 70 | 103 | 136 | 173 | 212 | 253 | 295 | 19.962 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | | | 59 | 90 | 121 | 156 | 193 | 231 | 271 | 22.577 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | | | | 49 | 78 | 107 | 141 | 175 | 211 | 248 | 25.440 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | |
| STEEL PERCENT | 0.07 | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | 0.20 | 0.23 | 0.26 | 0.29 | |
| DEPTH, D IN. | 18.69 | 18.69 | 18.62 | 18.62 | 18.56 | 18.56 | 18.50 | 18.50 | 18.44 | 18.44 | |
| $+I_{cr}/I_{gr}$ | 0.130 | 0.156 | 0.184 | 0.213 | 0.246 | 0.280 | 0.317 | 0.354 | 0.392 | 0.432 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20" Deep Rib + 4.0" Top Slab = 24.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | # 9 #10 | #10 #10 | Deflection Coeff. (3) |
| Steel (psf) | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | 2.57 | 2.87 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 26'-0" | 175 | 226 | 288 | 350 | 423 | 496 | 519* | 531* | 545* | 561* | 8.464 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 545* | 553* | 562* | 572* | |
| 27'-0" | 153 | 201 | 258 | 316 | 383 | 451 | 492* | 504* | 517* | 532* | 9.844 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 514* | 521* | 529* | 539* | |
| 28'-0" | 134 | 178 | 231 | 285 | 347 | 411 | 467* | 478* | 491* | 505* | 11.385 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 479 | 492* | 500* | 509* | |
| 29'-0" | 116 | 157 | 207 | 257 | 315 | 374 | 438 | 455* | 467* | 480* | 13.101 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 466* | 473* | 482* | |
| 30'-0" | 100 | 139 | 185 | 232 | 287 | 342 | 401 | 433* | 445* | 458* | 15.004 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 442* | 449* | 0 | |
| 31'-0" | 86 | 122 | 166 | 210 | 261 | 312 | 368 | 413* | 424* | 437* | 17.106 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 419* | 426* | 0 | |
| 32'-0" | 73 | 107 | 148 | 189 | 237 | 285 | 337 | 390 | 405* | 417* | 19.423 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | 61 | 93 | 132 | 170 | 215 | 261 | 310 | 360 | 387* | 399* | 21.967 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | 51 | 81 | 117 | 153 | 196 | 239 | 285 | 332 | 370* | 382* | 24.753 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 35'-0" | 41 | 69 | 103 | 138 | 178 | 218 | 262 | 306 | 355* | 366* | 27.796 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 36'-0" | | 58 | 91 | 123 | 161 | 199 | 240 | 282 | 334 | 351* | 31.111 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 37'-0" | | 49 | 79 | 110 | 146 | 182 | 221 | 261 | 310 | 337* | 34.715 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 38'-0" | | 40 | 69 | 98 | 132 | 166 | 203 | 241 | 287 | 319 | 38.623 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 39'-0" | | | 59 | 87 | 119 | 152 | 187 | 222 | 266 | 296 | 42.852 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | 2.27 | 2.54 | |
| STEEL PERCENT | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | 0.20 | 0.22 | 0.25 | 0.28 | 0.32 | |
| DEPTH, D IN. | 22.62 | 22.62 | 22.56 | 22.56 | 22.50 | 22.50 | 22.44 | 22.44 | 22.36 | 22.36 | |
| $+I_{cr}/I_{gr}$ | 0.178 | 0.206 | 0.238 | 0.271 | 0.307 | 0.344 | 0.382 | 0.421 | 0.467 | 0.514 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20" Deep Rib + 4.0" Top Slab = 24.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | # 9 #10 | #10 #10 | Deflection Coeff. (3) |
| Steel (psf) | 0.83 | 0.97 | 1.15 | 1.33 | 1.53 | 1.73 | 1.97 | 2.21 | 2.50 | 2.79 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 26'-0" | 159 | 209 | 270 | 330 | 401 | 472 | 549 | 571* | 584* | 599* | 8.700 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 600* | 608* | 617* | |
| 27'-0" | 138 | 185 | 240 | 297 | 362 | 429 | 500 | 541* | 554* | 568* | 10.117 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 565* | 573* | 582* | |
| 28'-0" | 119 | 162 | 214 | 267 | 328 | 389 | 455 | 514* | 526* | 540* | 11.701 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 523 | 541* | 550* | |
| 29'-0" | 102 | 143 | 191 | 240 | 296 | 354 | 416 | 478 | 501* | 514* | 13.465 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 513* | 521* | |
| 30'-0" | 87 | 125 | 170 | 215 | 268 | 322 | 380 | 438 | 477* | 490* | 15.420 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 486* | 494* | |
| 31'-0" | 73 | 108 | 151 | 193 | 243 | 293 | 347 | 402 | 455* | 467* | 17.581 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 462* | 470* | |
| 32'-0" | 61 | 94 | 133 | 173 | 220 | 267 | 318 | 369 | 434 | 446* | 19.962 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 447* | |
| 33'-0" | 49 | 80 | 118 | 155 | 199 | 243 | 291 | 340 | 400 | 427* | 22.577 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | | 68 | 103 | 139 | 180 | 222 | 267 | 312 | 369 | 408* | 25.440 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 35'-0" | | 57 | 90 | 123 | 162 | 202 | 244 | 287 | 341 | 391* | 28.568 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 36'-0" | | 46 | 78 | 110 | 146 | 184 | 224 | 264 | 315 | 367 | 31.975 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 37'-0" | | | 67 | 97 | 132 | 167 | 205 | 243 | 291 | 340 | 35.679 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 38'-0" | | | 56 | 85 | 118 | 151 | 187 | 224 | 269 | 316 | 39.696 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 39'-0" | | | 47 | 74 | 105 | 137 | 171 | 206 | 249 | 293 | 44.042 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | 2.27 | 2.54 | |
| STEEL PERCENT | 0.09 | 0.11 | 0.12 | 0.14 | 0.17 | 0.19 | 0.22 | 0.24 | 0.27 | 0.31 | |
| DEPTH, D IN. | 22.62 | 22.62 | 22.56 | 22.56 | 22.50 | 22.50 | 22.44 | 22.44 | 22.36 | 22.36 | |
| $+I_{cr}/I_{gr}$ | 0.161 | 0.187 | 0.216 | 0.246 | 0.279 | 0.313 | 0.347 | 0.383 | 0.424 | 0.467 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 4.5" Top Slab = 12.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 15'-0" | 158 | 222 | 288 | 343* | 356* | 370* | 386* | 403* | 422* | 441* | 0.912 |
| | 0 | 0 | 0 | 363 | 439 | 466* | 471* | 476* | 482* | 487* | |
| 16'-0" | 128 | 185 | 243 | 309 | 325* | 338* | 353* | 369* | 387* | 405* | 1.180 |
| | 0 | 0 | 0 | 0 | 376 | 411* | 417* | 420* | 427* | 431* | |
| 17'-0" | 104 | 154 | 205 | 263 | 298* | 310* | 324* | 339* | 356* | 373* | 1.504 |
| | 0 | 0 | 0 | 0 | 323 | 367* | 372* | 375* | 381* | 385* | |
| 18'-0" | 83 | 128 | 174 | 226 | 274* | 286* | 299* | 313* | 329* | 345* | 1.890 |
| | 0 | 0 | 0 | 0 | 279 | 328 | 334* | 337* | 343* | 347* | |
| 19'-0" | 66 | 106 | 147 | 194 | 241 | 265* | 277* | 290* | 305* | 320* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 286 | 299 | 305* | 310* | 0 | |
| 20'-0" | 51 | 87 | 124 | 166 | 209 | 245* | 257* | 270* | 284* | 298* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 249 | 261 | 271 | 0 | 0 | |
| 21'-0" | | 71 | 105 | 143 | 182 | 218 | 229 | 238 | 252 | 278* | 3.502 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22'-0" | | 57 | 88 | 122 | 158 | 191 | 201 | 209 | 222 | 259 | 4.219 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | 45 | 73 | 104 | 137 | 167 | 176 | 184 | 195 | 229 | 5.039 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | 60 | 89 | 119 | 147 | 155 | 162 | 172 | 204 | 5.975 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 48 | 75 | 103 | 128 | 136 | 142 | 152 | 181 | 7.035 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | | 63 | 88 | 112 | 119 | 125 | 134 | 161 | 8.229 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | | 52 | 76 | 98 | 104 | 110 | 118 | 143 | 9.570 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | 42 | 64 | 85 | 91 | 96 | 104 | 126 | 11.069 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.48 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.10 | 0.13 | 0.16 | 0.19 | 0.23 | 0.27 | 0.31 | 0.36 | 0.41 | 0.47 | |
| DEPTH, D IN. | 11.25 | 11.19 | 11.19 | 11.12 | 11.12 | 11.06 | 11.06 | 11.00 | 11.00 | 10.94 | |
| $+I_{cr}/I_{gr}$ | 0.188 | 0.232 | 0.276 | 0.324 | 0.373 | 0.426 | 0.482 | 0.540 | 0.602 | 0.659 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 4.5" Top Slab = 12.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.45 | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 15'-0" | 147 | 210 | 274 | 347 | 396* | 409* | 425* | 441* | 459* | 478* | 0.938 |
| | 0 | 0 | 0 | 0 | 422 | 509 | 534* | 537* | 544* | 548* | |
| 16'-0" | 119 | 174 | 230 | 294 | 360 | 374* | 389* | 404* | 421* | 438* | 1.214 |
| | 0 | 0 | 0 | 0 | 0 | 436 | 472* | 475* | 482* | 485* | |
| 17'-0" | 95 | 144 | 194 | 250 | 308 | 344* | 358* | 372* | 388* | 404* | 1.547 |
| | 0 | 0 | 0 | 0 | 0 | 376 | 422* | 425* | 431* | 434* | |
| 18'-0" | 75 | 118 | 163 | 213 | 265 | 317* | 330* | 344* | 359* | 374* | 1.944 |
| | 0 | 0 | 0 | 0 | 0 | 326 | 380* | 383* | 388* | 391* | |
| 19'-0" | 58 | 97 | 137 | 182 | 229 | 283 | 306* | 319* | 333* | 347* | 2.414 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 339 | 347* | 352* | 355* | |
| 20'-0" | 43 | 79 | 115 | 156 | 198 | 247 | 284* | 296* | 310* | 324* | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 297 | 306 | 319 | 0 | |
| 21'-0" | | 63 | 96 | 133 | 171 | 215 | 261 | 269 | 281 | 290 | 3.602 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 22'-0" | | 49 | 79 | 113 | 148 | 188 | 230 | 237 | 248 | 256 | 4.339 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | | 65 | 96 | 127 | 164 | 202 | 209 | 219 | 227 | 5.183 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | 52 | 80 | 110 | 144 | 179 | 185 | 194 | 201 | 6.145 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 41 | 67 | 94 | 125 | 157 | 163 | 172 | 178 | 7.235 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | | 55 | 80 | 109 | 139 | 144 | 152 | 158 | 8.464 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | | 45 | 68 | 95 | 122 | 127 | 134 | 140 | 9.844 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | | 56 | 82 | 107 | 112 | 118 | 123 | 11.385 |
| | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.50 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.10 | 0.13 | 0.15 | 0.19 | 0.22 | 0.26 | 0.30 | 0.35 | 0.40 | 0.45 | |
| DEPTH, D IN. | 11.25 | 11.19 | 11.19 | 11.12 | 11.12 | 11.06 | 11.06 | 11.00 | 11.00 | 10.94 | |
| $+I_{cr}/I_{gr}$ | 0.166 | 0.205 | 0.244 | 0.286 | 0.330 | 0.377 | 0.427 | 0.478 | 0.532 | 0.583 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 4.5" Top Slab = 14.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 16'-0" | 161 | 228 | 297 | 375 | 399* | 412* | 427* | 443* | 462* | 479* | 1.180 |
| | 0 | 0 | 0 | 0 | 455 | 510* | 516* | 521* | 529* | 534* | |
| 17'-0" | 132 | 192 | 252 | 321 | 366* | 379* | 393* | 408* | 425* | 442* | 1.504 |
| | 0 | 0 | 0 | 0 | 392 | 456* | 462* | 467* | 474* | 479* | |
| 18'-0" | 107 | 161 | 215 | 277 | 337* | 349* | 363* | 377* | 393* | 409* | 1.890 |
| | 0 | 0 | 0 | 0 | 340 | 411* | 416* | 421* | 427* | 432* | |
| 19'-0" | 87 | 135 | 183 | 239 | 295 | 323* | 336* | 349* | 364* | 379* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 362 | 378* | 382* | 388* | 393* | |
| 20'-0" | 69 | 113 | 156 | 206 | 257 | 300* | 312* | 325* | 339* | 353* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 318 | 345* | 349* | 354* | 359* | |
| 21'-0" | 54 | 94 | 133 | 179 | 225 | 280* | 291* | 303* | 316* | 330* | 3.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 316* | 320* | 325* | 0 | |
| 22'-0" | 41 | 77 | 113 | 155 | 197 | 247 | 272* | 283* | 296* | 309* | 4.219 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 291* | 294* | 299* | 0 | |
| 23'-0" | | 62 | 96 | 133 | 172 | 218 | 254* | 265* | 278* | 290* | 5.039 |
| | | 0 | 0 | 0 | 0 | 0 | 260 | 269 | 0 | 0 | |
| 24'-0" | | 50 | 80 | 115 | 150 | 192 | 231 | 239 | 251 | 260 | 5.975 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 67 | 99 | 131 | 170 | 206 | 213 | 224 | 232 | 7.035 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 55 | 84 | 114 | 150 | 183 | 190 | 200 | 208 | 8.229 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 44 | 71 | 99 | 132 | 163 | 170 | 179 | 186 | 9.570 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | 60 | 86 | 117 | 145 | 151 | 160 | 166 | 11.069 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 49 | 74 | 102 | 129 | 135 | 142 | 149 | 12.737 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.51 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.09 | 0.11 | 0.13 | 0.16 | 0.19 | 0.23 | 0.26 | 0.31 | 0.35 | 0.40 | |
| DEPTH, D IN. | 13.25 | 13.19 | 13.19 | 13.12 | 13.12 | 13.06 | 13.06 | 13.00 | 13.00 | 12.94 | |
| $+I_{cr}/I_{gr}$ | 0.169 | 0.209 | 0.249 | 0.293 | 0.338 | 0.387 | 0.439 | 0.493 | 0.550 | 0.605 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 4.5" Top Slab = 14.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.45 | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 16'-0" | 150 | 216 | 282 | 358 | 436 | 457* | 472* | 487* | 505* | 522* | 1.214 |
| | 0 | 0 | 0 | 0 | 0 | 528 | 582* | 587* | 594* | 599* | |
| 17'-0" | 122 | 180 | 239 | 307 | 375 | 420* | 434* | 448* | 465* | 481* | 1.547 |
| | 0 | 0 | 0 | 0 | 0 | 457 | 521* | 526* | 532* | 537* | |
| 18'-0" | 98 | 150 | 203 | 263 | 324 | 388* | 401* | 414* | 430* | 445* | 1.944 |
| | 0 | 0 | 0 | 0 | 0 | 397 | 471* | 475* | 481* | 485* | |
| 19'-0" | 78 | 125 | 172 | 226 | 281 | 346 | 372* | 384* | 399* | 413* | 2.414 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 413 | 431* | 437* | 441* | |
| 20'-0" | 61 | 103 | 146 | 195 | 244 | 303 | 346* | 358* | 372* | 385* | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 363 | 394* | 400* | 404* | |
| 21'-0" | 47 | 85 | 123 | 168 | 213 | 266 | 320 | 334* | 347* | 360* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 362* | 367* | 371* | |
| 22'-0" | | 69 | 104 | 144 | 185 | 234 | 283 | 313* | 325* | 337* | 4.339 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 334* | 339* | 342* | |
| 23'-0" | | 55 | 87 | 124 | 161 | 206 | 251 | 293* | 305* | 317* | 5.183 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 303 | 313* | 0 | |
| 24'-0" | | 42 | 72 | 106 | 140 | 181 | 223 | 270 | 285 | 293 | 6.145 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 59 | 90 | 122 | 159 | 198 | 241 | 255 | 262 | 7.235 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 47 | 76 | 105 | 140 | 175 | 216 | 228 | 235 | 8.464 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | | 63 | 90 | 123 | 156 | 193 | 205 | 211 | 9.844 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | 52 | 77 | 107 | 138 | 173 | 183 | 190 | 11.385 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 42 | 66 | 94 | 122 | 155 | 164 | 170 | 13.101 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.08 | 0.11 | 0.13 | 0.16 | 0.19 | 0.22 | 0.26 | 0.30 | 0.34 | 0.38 | |
| DEPTH, D IN. | 13.25 | 13.19 | 13.19 | 13.12 | 13.12 | 13.06 | 13.06 | 13.00 | 13.00 | 12.94 | |
| $+I_{cr}/I_{gr}$ | 0.149 | 0.184 | 0.220 | 0.259 | 0.298 | 0.342 | 0.388 | 0.436 | 0.487 | 0.535 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 4.5" Top Slab = 16.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4<br># 4 | # 4<br># 5 | # 5<br># 5 | # 5<br># 6 | # 6<br># 6 | # 6<br># 7 | # 7<br># 7 | # 7<br># 8 | # 8<br># 8 | # 8<br># 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 132<br>0 | 194<br>0 | 256<br>0 | 328<br>0 | 401<br>0 | 418*<br>487 | 432*<br>503* | 446*<br>508* | 462*<br>516* | 478*<br>522* | 1.890 |
| 19'-0" | 108<br>0 | 164<br>0 | 220<br>0 | 284<br>0 | 350<br>0 | 387*<br>427 | 400*<br>457* | 414*<br>462* | 429*<br>469* | 444*<br>475* | 2.347 |
| 20'-0" | 88<br>0 | 138<br>0 | 189<br>0 | 247<br>0 | 306<br>0 | 360*<br>376 | 372*<br>418* | 385*<br>423* | 399*<br>429* | 413*<br>435* | 2.881 |
| 21'-0" | 71<br>0 | 116<br>0 | 162<br>0 | 215<br>0 | 268<br>0 | 332<br>0 | 347*<br>384* | 359*<br>388* | 373*<br>395* | 386*<br>400* | 3.502 |
| 22'-0" | 56<br>0 | 97<br>0 | 139<br>0 | 187<br>0 | 236<br>0 | 294<br>0 | 324*<br>353 | 336*<br>358* | 349*<br>364* | 362*<br>369* | 4.219 |
| 23'-0" | 42<br>0 | 80<br>0 | 119<br>0 | 162<br>0 | 207<br>0 | 260<br>0 | 304*<br>314 | 315*<br>332* | 327*<br>338* | 340*<br>342* | 5.039 |
| 24'-0" | | 66<br>0 | 101<br>0 | 141<br>0 | 182<br>0 | 231<br>0 | 281<br>0 | 296*<br>308* | 308*<br>314* | 319*<br>0 | 5.975 |
| 25'-0" | | 53<br>0 | 85<br>0 | 122<br>0 | 160<br>0 | 205<br>0 | 251<br>0 | 278*<br>287* | 290*<br>292* | 301*<br>0 | 7.035 |
| 26'-0" | | 41<br>0 | 71<br>0 | 106<br>0 | 141<br>0 | 182<br>0 | 224<br>0 | 263*<br>266 | 273*<br>0 | 284*<br>0 | 8.229 |
| 27'-0" | | | 59<br>0 | 91<br>0 | 123<br>0 | 162<br>0 | 201<br>0 | 239<br>0 | 249<br>0 | 258<br>0 | 9.570 |
| 28'-0" | | | 48<br>0 | 77<br>0 | 108<br>0 | 143<br>0 | 180<br>0 | 216<br>0 | 225<br>0 | 233<br>0 | 11.069 |
| 29'-0" | | | | 66<br>0 | 94<br>0 | 127<br>0 | 161<br>0 | 194<br>0 | 203<br>0 | 211<br>0 | 12.737 |
| 30'-0" | | | | 55<br>0 | 81<br>0 | 112<br>0 | 144<br>0 | 175<br>0 | 183<br>0 | 190<br>0 | 14.587 |
| 31'-0" | | | | 45<br>0 | 70<br>0 | 99<br>0 | 129<br>0 | 158<br>0 | 165<br>0 | 172<br>0 | 16.631 |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.07 | 0.10 | 0.12 | 0.14 | 0.17 | 0.20 | 0.23 | 0.26 | 0.30 | 0.34 | |
| DEPTH, D IN. | 15.25 | 15.19 | 15.19 | 15.12 | 15.12 | 15.06 | 15.06 | 15.00 | 15.00 | 14.94 | |
| $+I_{cr}/I_{gr}$ | 0.152 | 0.189 | 0.225 | 0.266 | 0.307 | 0.353 | 0.400 | 0.451 | 0.504 | 0.555 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 4.5" Top Slab = 16.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4<br># 5 | # 5<br># 5 | # 5<br># 6 | # 6<br># 6 | # 6<br># 7 | # 7<br># 7 | # 7<br># 8 | # 8<br># 8 | # 8<br># 9 | # 9<br># 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 182<br>0 | 243<br>0 | 313<br>0 | 383<br>0 | 465*<br>468 | 478*<br>554 | 491*<br>570* | 507*<br>577* | 522*<br>583* | 539*<br>591* | 1.944 |
| 19'-0" | 153<br>0 | 207<br>0 | 270<br>0 | 334<br>0 | 409<br>0 | 443*<br>487 | 456*<br>519* | 471*<br>526* | 485*<br>531* | 501*<br>539* | 2.414 |
| 20'-0" | 128<br>0 | 177<br>0 | 234<br>0 | 291<br>0 | 359<br>0 | 412*<br>429 | 424*<br>475* | 438*<br>482* | 452*<br>487* | 467*<br>494* | 2.964 |
| 21'-0" | 107<br>0 | 151<br>0 | 202<br>0 | 255<br>0 | 317<br>0 | 380<br>0 | 396*<br>437* | 409*<br>443* | 422*<br>448* | 437*<br>455* | 3.602 |
| 22'-0" | 88<br>0 | 129<br>0 | 175<br>0 | 223<br>0 | 279<br>0 | 337<br>0 | 371*<br>403 | 383*<br>410* | 396*<br>414* | 410*<br>421* | 4.339 |
| 23'-0" | 72<br>0 | 109<br>0 | 152<br>0 | 195<br>0 | 247<br>0 | 300<br>0 | 348*<br>360 | 360*<br>380* | 372*<br>384* | 385*<br>390* | 5.183 |
| 24'-0" | 58<br>0 | 92<br>0 | 131<br>0 | 171<br>0 | 218<br>0 | 267<br>0 | 322<br>0 | 339*<br>354* | 350*<br>358* | 363*<br>0 | 6.145 |
| 25'-0" | 45<br>0 | 76<br>0 | 113<br>0 | 149<br>0 | 193<br>0 | 238<br>0 | 289<br>0 | 319*<br>330* | 330*<br>334* | 342*<br>0 | 7.235 |
| 26'-0" | | 63<br>0 | 96<br>0 | 130<br>0 | 171<br>0 | 212<br>0 | 259<br>0 | 302*<br>307 | 312*<br>0 | 324*<br>0 | 8.464 |
| 27'-0" | | 51<br>0 | 82<br>0 | 113<br>0 | 151<br>0 | 189<br>0 | 233<br>0 | 278<br>0 | 294<br>0 | 304<br>0 | 9.844 |
| 28'-0" | | 40<br>0 | 69<br>0 | 98<br>0 | 133<br>0 | 169<br>0 | 209<br>0 | 251<br>0 | 266<br>0 | 276<br>0 | 11.385 |
| 29'-0" | | | 57<br>0 | 85<br>0 | 117<br>0 | 150<br>0 | 188<br>0 | 227<br>0 | 241<br>0 | 250<br>0 | 13.101 |
| 30'-0" | | | 47<br>0 | 72<br>0 | 103<br>0 | 134<br>0 | 169<br>0 | 205<br>0 | 218<br>0 | 227<br>0 | 15.004 |
| 31'-0" | | | | 61<br>0 | 90<br>0 | 119<br>0 | 152<br>0 | 186<br>0 | 198<br>0 | 206<br>0 | 17.106 |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | |
| STEEL PERCENT | 0.09 | 0.11 | 0.14 | 0.16 | 0.19 | 0.22 | 0.26 | 0.29 | 0.33 | 0.37 | |
| DEPTH, D IN. | 15.19 | 15.19 | 15.12 | 15.12 | 15.06 | 15.06 | 15.00 | 15.00 | 14.94 | 14.94 | |
| $+I_{cr}/I_{gr}$ | 0.167 | 0.199 | 0.235 | 0.271 | 0.312 | 0.354 | 0.399 | 0.446 | 0.492 | 0.541 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14" Deep Rib + 4.5" Top Slab = 18.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | 2.33 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 20'-0" | 164 | 221 | 287 | 354 | 425* | 437* | 450* | 464* | 478* | 494* | 2.881 |
| | 0 | 0 | 0 | 0 | 434 | 494* | 500* | 507* | 514* | 522* | |
| 21'-0" | 139 | 191 | 251 | 311 | 384 | 407* | 420* | 433* | 447* | 462* | 3.502 |
| | 0 | 0 | 0 | 0 | 0 | 455* | 460* | 467* | 473* | 481* | |
| 22'-0" | 117 | 164 | 219 | 274 | 341 | 381* | 393* | 406* | 419* | 433* | 4.219 |
| | 0 | 0 | 0 | 0 | 0 | 408 | 425* | 432* | 438* | 445* | |
| 23'-0" | 98 | 141 | 191 | 242 | 303 | 357* | 368* | 381* | 393* | 407* | 5.039 |
| | 0 | 0 | 0 | 0 | 0 | 364 | 395* | 401* | 407* | 413* | |
| 24'-0" | 82 | 121 | 167 | 214 | 270 | 326 | 346* | 358* | 370* | 383* | 5.975 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 367* | 373* | 379* | 385* | |
| 25'-0" | 67 | 104 | 146 | 189 | 240 | 292 | 326* | 337* | 349* | 361* | 7.035 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 343* | 349* | 354* | 0 | |
| 26'-0" | 54 | 88 | 127 | 167 | 214 | 262 | 308* | 319* | 329* | 342* | 8.229 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 318 | 326* | 331* | 0 | |
| 27'-0" | 42 | 74 | 110 | 147 | 191 | 236 | 287 | 301* | 312* | 323* | 9.570 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 306* | 0 | 0 | |
| 28'-0" | | 61 | 95 | 129 | 170 | 212 | 259 | 285* | 295* | 307* | 11.069 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 288* | 0 | 0 | |
| 29'-0" | | 50 | 82 | 113 | 152 | 190 | 235 | 271* | 280* | 291* | 12.737 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | 40 | 69 | 99 | 135 | 171 | 212 | 247 | 255 | 265 | 14.587 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 58 | 86 | 120 | 153 | 192 | 225 | 232 | 242 | 16.631 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | 48 | 74 | 106 | 138 | 174 | 204 | 212 | 221 | 18.883 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | | | 64 | 93 | 123 | 157 | 186 | 193 | 201 | 21.356 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | |
| STEEL PERCENT | 0.08 | 0.10 | 0.13 | 0.15 | 0.17 | 0.20 | 0.23 | 0.27 | 0.30 | 0.34 | |
| DEPTH, D IN. | 17.19 | 17.19 | 17.12 | 17.12 | 17.06 | 17.06 | 17.00 | 17.00 | 16.94 | 16.94 | |
| $+I_{cr}/I_{gr}$ | 0.172 | 0.206 | 0.243 | 0.281 | 0.323 | 0.367 | 0.415 | 0.464 | 0.513 | 0.564 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14" Deep Rib + 4.5" Top Slab = 18.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 20'-0" | 151 | 207 | 271 | 337 | 415 | 483* | 495* | 509* | 523* | 538* | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 494 | 559* | 566* | 572* | 580* | |
| 21'-0" | 127 | 178 | 236 | 295 | 366 | 438 | 462* | 475* | 488* | 503* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 515* | 522* | 527* | 535* | |
| 22'-0" | 106 | 152 | 205 | 259 | 324 | 389 | 433* | 445* | 458* | 472* | 4.339 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 464 | 483* | 488* | 495* | |
| 23'-0" | 88 | 130 | 179 | 228 | 287 | 347 | 406* | 418* | 430* | 443* | 5.183 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 416 | 448* | 453* | 460* | |
| 24'-0" | 72 | 110 | 155 | 200 | 254 | 310 | 373 | 393* | 405* | 418* | 6.145 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 418* | 423* | 429* | |
| 25'-0" | 57 | 93 | 134 | 176 | 226 | 277 | 335 | 371* | 382* | 394* | 7.235 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 390* | 395* | 401* | |
| 26'-0" | 45 | 78 | 116 | 154 | 201 | 247 | 301 | 350* | 361* | 373* | 8.464 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 356 | 370* | 376* | |
| 27'-0" | | 64 | 99 | 135 | 178 | 222 | 271 | 322 | 342* | 353* | 9.844 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 347* | 0 | |
| 28'-0" | | 52 | 85 | 118 | 158 | 198 | 245 | 292 | 324* | 335* | 11.385 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 327* | 0 | |
| 29'-0" | | 41 | 72 | 103 | 140 | 177 | 221 | 265 | 308* | 318* | 13.101 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 60 | 89 | 123 | 159 | 199 | 240 | 284 | 301 | 15.004 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 49 | 76 | 109 | 142 | 179 | 218 | 259 | 275 | 17.106 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | | 65 | 95 | 126 | 162 | 198 | 236 | 252 | 19.423 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | | | 54 | 83 | 112 | 145 | 180 | 216 | 230 | 21.967 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | |
| STEEL PERCENT | 0.08 | 0.10 | 0.12 | 0.14 | 0.17 | 0.20 | 0.23 | 0.26 | 0.29 | 0.33 | |
| DEPTH, D IN. | 17.19 | 17.19 | 17.12 | 17.12 | 17.06 | 17.06 | 17.00 | 17.00 | 16.94 | 16.94 | |
| $+I_{cr}/I_{gr}$ | 0.152 | 0.182 | 0.215 | 0.249 | 0.287 | 0.326 | 0.368 | 0.411 | 0.455 | 0.500 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16" Deep Rib + 4.5" Top Slab = 20.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | # 9 #10 | Deflec-tion Coeff. (3) |
| Steel (psf) | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | 2.57 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 22'-0" | 176 | 235 | 296 | 368 | 441 | 499* | 512* | 524* | 538* | 555* | 4.339 |
| | 0 | 0 | 0 | 0 | 0 | 526 | 558* | 564* | 572* | 580* | |
| 23'-0" | 151 | 205 | 261 | 327 | 394 | 468* | 481* | 492* | 506* | 521* | 5.183 |
| | 0 | 0 | 0 | 0 | 0 | 471 | 519* | 525* | 532* | 540* | |
| 24'-0" | 129 | 179 | 230 | 291 | 352 | 423 | 452* | 464* | 476* | 491* | 6.145 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 484* | 490* | 497* | 504* | |
| 25'-0" | 110 | 156 | 203 | 259 | 316 | 381 | 426* | 437* | 450* | 464* | 7.235 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 448 | 458* | 465* | 472* | |
| 26'-0" | 93 | 135 | 178 | 230 | 283 | 344 | 403* | 413* | 425* | 439* | 8.464 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 405 | 430* | 437* | 443* | |
| 27'-0" | 77 | 117 | 157 | 205 | 254 | 310 | 367 | 391* | 403* | 416* | 9.844 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 404* | 411* | 417* | |
| 28'-0" | 64 | 101 | 138 | 182 | 228 | 280 | 333 | 371* | 382* | 395* | 11.385 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 381* | 387* | 0 | |
| 29'-0" | 52 | 86 | 121 | 162 | 204 | 253 | 303 | 352* | 363* | 375* | 13.101 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 356 | 365* | 0 | |
| 30'-0" | 40 | 73 | 105 | 144 | 183 | 229 | 275 | 325 | 345* | 357* | 15.004 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | 60 | 91 | 127 | 164 | 207 | 250 | 297 | 329* | 340* | 17.106 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | 50 | 78 | 112 | 147 | 187 | 228 | 271 | 314* | 325* | 19.423 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | 40 | 66 | 99 | 131 | 169 | 207 | 248 | 290 | 307 | 21.967 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | | | 56 | 86 | 117 | 152 | 188 | 227 | 266 | 282 | 24.753 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 35'-0" | | | 46 | 75 | 104 | 137 | 171 | 207 | 244 | 260 | 27.796 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | 2.27 | |
| STEEL PERCENT | 0.09 | 0.11 | 0.13 | 0.15 | 0.17 | 0.20 | 0.23 | 0.26 | 0.29 | 0.33 | |
| DEPTH, D IN. | 19.19 | 19.12 | 19.12 | 19.06 | 19.06 | 19.00 | 19.00 | 18.94 | 18.94 | 18.86 | |
| $+I_{cr}/I_{gr}$ | 0.168 | 0.199 | 0.230 | 0.265 | 0.302 | 0.341 | 0.382 | 0.423 | 0.466 | 0.515 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16" Deep Rib + 4.5" Top Slab = 20.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | # 9 #10 | #10 #10 | Deflec-tion Coeff. (3) |
| Steel (psf) | 0.83 | 0.97 | 1.15 | 1.33 | 1.53 | 1.73 | 1.97 | 2.21 | 2.50 | 2.79 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 24'-0" | 166 | 216 | 275 | 335 | 404 | 475 | 501* | 514* | 528* | 544* | 6.316 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 536* | 543* | 550* | 559* | |
| 25'-0" | 144 | 189 | 244 | 299 | 363 | 428 | 473* | 485* | 499* | 514* | 7.436 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 497 | 509* | 515* | 524* | |
| 26'-0" | 124 | 166 | 216 | 267 | 326 | 387 | 447* | 459* | 472* | 487* | 8.700 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 451 | 478* | 484* | 492* | |
| 27'-0" | 106 | 145 | 192 | 239 | 294 | 350 | 409 | 435* | 447* | 462* | 10.117 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 449* | 456* | 463* | |
| 28'-0" | 90 | 126 | 170 | 214 | 265 | 317 | 372 | 413* | 425* | 439* | 11.701 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 424* | 430* | 0 | |
| 29'-0" | 76 | 109 | 150 | 191 | 239 | 287 | 338 | 391 | 404* | 417* | 13.465 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 406* | 0 | |
| 30'-0" | 63 | 94 | 132 | 171 | 215 | 260 | 308 | 357 | 385* | 397* | 15.420 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | 51 | 81 | 116 | 152 | 194 | 236 | 281 | 327 | 367* | 379* | 17.581 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | 40 | 68 | 101 | 135 | 174 | 214 | 256 | 299 | 350* | 362* | 19.962 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | 57 | 88 | 120 | 157 | 194 | 234 | 274 | 324 | 346* | 22.577 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | | 46 | 76 | 106 | 140 | 175 | 213 | 251 | 298 | 325 | 25.440 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 35'-0" | | | 65 | 93 | 126 | 159 | 194 | 230 | 275 | 300 | 28.568 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 36'-0" | | | 55 | 81 | 112 | 143 | 177 | 211 | 253 | 277 | 31.975 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 37'-0" | | | 45 | 70 | 100 | 129 | 161 | 193 | 233 | 256 | 35.679 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | 2.27 | 2.54 | |
| STEEL PERCENT | 0.11 | 0.12 | 0.15 | 0.17 | 0.20 | 0.22 | 0.26 | 0.29 | 0.33 | 0.36 | |
| DEPTH, D IN. | 19.12 | 19.12 | 19.06 | 19.06 | 19.00 | 19.00 | 18.94 | 18.94 | 18.86 | 18.86 | |
| $+I_{cr}/I_{gr}$ | 0.180 | 0.208 | 0.240 | 0.273 | 0.309 | 0.346 | 0.383 | 0.421 | 0.466 | 0.513 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20" Deep Rib + 4.5" Top Slab = 24.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | # 9 #10 | #10 #10 | #10 #11 | Deflection Coeff. (3) |
| Steel (psf) | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | 2.57 | 2.87 | 3.21 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 29'-0" | 156 | 207 | 259 | 318 | 378 | 443 | 462* | 475* | 488* | 502* | 13.101 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 475* | 482* | 491* | 0 | |
| 30'-0" | 138 | 185 | 233 | 289 | 345 | 406 | 440* | 452* | 465* | 478* | 15.004 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 450* | 457* | 466* | 0 | |
| 31'-0" | 120 | 165 | 210 | 262 | 315 | 372 | 419* | 431* | 443* | 456* | 17.106 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 427* | 434* | 0 | 0 | |
| 32'-0" | 105 | 147 | 189 | 238 | 287 | 341 | 395 | 411* | 423* | 435* | 19.423 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 412* | 0 | 0 | |
| 33'-0" | 91 | 130 | 170 | 216 | 262 | 312 | 363 | 392* | 404* | 416* | 21.967 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | 78 | 115 | 152 | 196 | 240 | 287 | 335 | 375* | 387* | 398* | 24.753 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 35'-0" | 66 | 101 | 136 | 177 | 219 | 263 | 308 | 359* | 370* | 381* | 27.796 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 36'-0" | 55 | 88 | 122 | 160 | 200 | 242 | 284 | 338 | 355* | 366* | 31.111 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 37'-0" | 45 | 77 | 108 | 145 | 182 | 222 | 262 | 313 | 341* | 351* | 34.715 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 38'-0" | | 66 | 96 | 130 | 166 | 203 | 242 | 290 | 327* | 337* | 38.623 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 39'-0" | | 56 | 84 | 117 | 151 | 186 | 223 | 268 | 306 | 315 | 42.852 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 40'-0" | | 47 | 74 | 105 | 137 | 171 | 205 | 249 | 285 | 293 | 47.418 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 41'-0" | | | 64 | 94 | 124 | 156 | 189 | 230 | 265 | 272 | 52.341 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 42'-0" | | | 55 | 83 | 112 | 143 | 174 | 213 | 246 | 253 | 57.637 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.73 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | 2.27 | 2.54 | 2.83 | |
| STEEL PERCENT | 0.11 | 0.13 | 0.14 | 0.17 | 0.19 | 0.22 | 0.24 | 0.28 | 0.31 | 0.34 | |
| DEPTH, D IN. | 23.12 | 23.06 | 23.06 | 23.00 | 23.00 | 22.94 | 22.94 | 22.86 | 22.86 | 22.80 | |
| $+I_{cr}/I_{gr}$ | 0.200 | 0.232 | 0.264 | 0.299 | 0.336 | 0.373 | 0.411 | 0.455 | 0.502 | 0.547 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20" Deep Rib + 4.5" Top Slab = 24.5" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | # 9 #10 | #10 #10 | #10 #11 | Deflection Coeff. (3) |
| Steel (psf) | 0.97 | 1.15 | 1.33 | 1.53 | 1.73 | 1.97 | 2.21 | 2.50 | 2.79 | 3.12 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 28'-0" | 162 | 215 | 269 | 331 | 394 | 462 | 524* | 536* | 550* | 563* | 11.701 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 530 | 552* | 561* | 569* | |
| 29'-0" | 141 | 191 | 241 | 299 | 358 | 421 | 485 | 509* | 523* | 535* | 13.465 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 522* | 531* | 539* | |
| 30'-0" | 123 | 169 | 216 | 270 | 325 | 384 | 444 | 485* | 498* | 510* | 15.420 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 495* | 504* | 511* | |
| 31'-0" | 106 | 150 | 194 | 244 | 296 | 351 | 407 | 462* | 475* | 487* | 17.581 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 470* | 478* | 0 | |
| 32'-0" | 91 | 132 | 173 | 221 | 269 | 321 | 374 | 439 | 453* | 465* | 19.962 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 455* | 0 | |
| 33'-0" | 78 | 116 | 155 | 199 | 245 | 293 | 343 | 405 | 433* | 444* | 22.577 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | 65 | 101 | 138 | 180 | 223 | 268 | 315 | 373 | 414* | 425* | 25.440 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 35'-0" | 54 | 88 | 122 | 162 | 202 | 246 | 290 | 344 | 397* | 407* | 28.568 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 36'-0" | 43 | 75 | 108 | 145 | 184 | 224 | 266 | 318 | 371 | 391* | 31.975 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 37'-0" | | 64 | 95 | 130 | 166 | 205 | 245 | 294 | 344 | 375* | 35.679 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 38'-0" | | 53 | 82 | 116 | 151 | 187 | 225 | 271 | 319 | 360* | 39.696 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 39'-0" | | 44 | 71 | 103 | 136 | 171 | 206 | 250 | 296 | 342 | 44.042 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 40'-0" | | | 61 | 91 | 122 | 156 | 189 | 231 | 274 | 318 | 48.736 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 41'-0" | | | 51 | 80 | 110 | 141 | 173 | 213 | 254 | 296 | 53.795 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | 2.27 | 2.54 | 2.83 | |
| STEEL PERCENT | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.21 | 0.24 | 0.27 | 0.30 | 0.34 | |
| DEPTH, D IN. | 23.12 | 23.06 | 23.06 | 23.00 | 23.00 | 22.94 | 22.94 | 22.86 | 22.86 | 22.80 | |
| $+I_{cr}/I_{gr}$ | 0.181 | 0.210 | 0.239 | 0.272 | 0.304 | 0.338 | 0.373 | 0.413 | 0.456 | 0.496 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 5.0" Top Slab = 13.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4<br># 4 | # 4<br># 5 | # 5<br># 5 | # 5<br># 6 | # 6<br># 6 | # 6<br># 7 | # 7<br># 7 | # 7<br># 8 | # 8<br># 8 | # 8<br># 9 | Deflec-tion Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 14'-0" | 198 | 276 | 355 | 392* | 406* | 421* | 439* | 457* | 478* | 498* | 0.692 |
| | 0 | 0 | 0 | 445 | 537 | 557* | 564* | 568* | 576* | 582* | |
| 15'-0" | 160 | 228 | 297 | 355* | 368* | 382* | 399* | 416* | 435* | 454* | 0.912 |
| | 0 | 0 | 0 | 375 | 455 | 486* | 492* | 496* | 503* | 508* | |
| 16'-0" | 129 | 189 | 249 | 318 | 336* | 349* | 364* | 380* | 398* | 416* | 1.180 |
| | 0 | 0 | 0 | 0 | 389 | 429* | 434* | 438* | 445* | 450* | |
| 17'-0" | 104 | 156 | 210 | 271 | 308* | 320* | 334* | 349* | 366* | 382* | 1.504 |
| | 0 | 0 | 0 | 0 | 333 | 382* | 387* | 391* | 397* | 401* | |
| 18'-0" | 82 | 129 | 177 | 231 | 283* | 294* | 308* | 322* | 338* | 353* | 1.890 |
| | 0 | 0 | 0 | 0 | 287 | 343* | 347* | 351* | 357* | 361* | |
| 19'-0" | 64 | 106 | 149 | 198 | 248 | 272* | 284* | 298* | 313* | 328* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 307 | 314* | 317* | 323* | 0 | |
| 20'-0" | 48 | 87 | 125 | 169 | 214 | 252* | 264* | 276* | 290* | 305* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 267 | 281 | 288* | 293* | 0 | |
| 21'-0" | | 70 | 105 | 145 | 186 | 234 | 245* | 255 | 268 | 284* | 3.502 |
| | | 0 | 0 | 0 | 0 | 0 | 246 | 0 | 0 | 0 | |
| 22'-0" | | 55 | 87 | 123 | 161 | 204 | 215 | 224 | 236 | 265* | 4.219 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | 42 | 72 | 105 | 139 | 179 | 189 | 197 | 208 | 236 | 5.039 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | 58 | 88 | 120 | 157 | 166 | 173 | 183 | 209 | 5.975 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 46 | 74 | 103 | 137 | 145 | 152 | 161 | 185 | 7.035 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | | 61 | 88 | 119 | 127 | 133 | 142 | 164 | 8.229 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | | 50 | 75 | 104 | 111 | 117 | 125 | 145 | 9.570 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.10 | 0.12 | 0.15 | 0.18 | 0.22 | 0.26 | 0.30 | 0.35 | 0.39 | 0.45 | |
| DEPTH, D IN. | 11.75 | 11.69 | 11.69 | 11.62 | 11.62 | 11.56 | 11.56 | 11.50 | 11.50 | 11.44 | |
| $+I_{cr}/I_{gr}$ | 0.182 | 0.224 | 0.268 | 0.314 | 0.361 | 0.413 | 0.468 | 0.524 | 0.585 | 0.641 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 8" Deep Rib + 5.0" Top Slab = 13.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4<br># 4 | # 4<br># 5 | # 5<br># 5 | # 5<br># 6 | # 6<br># 6 | # 6<br># 7 | # 7<br># 7 | # 7<br># 8 | # 8<br># 8 | # 8<br># 9 | Deflec-tion Coeff. (3) |
| Steel (psf) | 0.45 | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 14'-0" | 188 | 263 | 340 | 428 | 454* | 468* | 485* | 502* | 522* | 542* | 0.712 |
| | 0 | 0 | 0 | 0 | 517 | 622 | 639* | 643* | 650* | 655* | |
| 15'-0" | 151 | 217 | 284 | 360 | 412* | 425* | 441* | 457* | 476* | 494* | 0.938 |
| | 0 | 0 | 0 | 0 | 438 | 529 | 558* | 562* | 569* | 573* | |
| 16'-0" | 121 | 179 | 238 | 305 | 373 | 389* | 403* | 418* | 436* | 453* | 1.214 |
| | 0 | 0 | 0 | 0 | 0 | 454 | 494* | 497* | 504* | 508* | |
| 17'-0" | 96 | 147 | 199 | 259 | 319 | 357* | 370* | 385* | 401* | 417* | 1.547 |
| | 0 | 0 | 0 | 0 | 0 | 391 | 441* | 444* | 450* | 454* | |
| 18'-0" | 75 | 121 | 167 | 220 | 274 | 329* | 342* | 355* | 370* | 385* | 1.944 |
| | 0 | 0 | 0 | 0 | 0 | 338 | 396* | 400* | 405* | 409* | |
| 19'-0" | 57 | 98 | 140 | 188 | 236 | 293 | 316* | 329* | 343* | 358* | 2.414 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 352 | 362* | 367* | 371* | |
| 20'-0" | 42 | 79 | 117 | 160 | 204 | 255 | 294* | 306* | 319* | 333* | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 308 | 330* | 334* | 338* | |
| 21'-0" | | 63 | 97 | 136 | 176 | 222 | 270 | 285* | 298* | 311* | 3.602 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 291 | 304 | 0 | |
| 22'-0" | | 49 | 80 | 115 | 151 | 194 | 238 | 257 | 268 | 277 | 4.339 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 23'-0" | | | 65 | 97 | 130 | 169 | 209 | 227 | 237 | 245 | 5.183 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 24'-0" | | | 51 | 81 | 111 | 147 | 184 | 200 | 210 | 217 | 6.145 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 40 | 67 | 95 | 128 | 162 | 177 | 185 | 192 | 7.235 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | | 55 | 81 | 111 | 142 | 156 | 164 | 170 | 8.464 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | | 44 | 68 | 96 | 125 | 138 | 145 | 151 | 9.844 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.54 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.09 | 0.12 | 0.15 | 0.18 | 0.21 | 0.25 | 0.29 | 0.34 | 0.38 | 0.43 | |
| DEPTH, D IN. | 11.75 | 11.69 | 11.69 | 11.62 | 11.62 | 11.56 | 11.56 | 11.50 | 11.50 | 11.44 | |
| $+I_{cr}/I_{gr}$ | 0.161 | 0.198 | 0.237 | 0.278 | 0.320 | 0.366 | 0.415 | 0.465 | 0.518 | 0.569 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 5.0" Top Slab = 15.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 15'-0" | 199 | 279 | 360 | 440* | 453* | 467* | 483* | 500* | 520* | 539* | 0.912 |
| | 0 | 0 | 0 | 453 | 547 | 599* | 606* | 611* | 620* | 626* | |
| 16'-0" | 163 | 233 | 304 | 386 | 413* | 426* | 441* | 458* | 476* | 494* | 1.180 |
| | 0 | 0 | 0 | 0 | 469 | 530* | 536* | 542* | 549* | 555* | |
| 17'-0" | 133 | 195 | 258 | 330 | 379* | 391* | 405* | 420* | 437* | 454* | 1.504 |
| | 0 | 0 | 0 | 0 | 404 | 473* | 479* | 484* | 492* | 497* | |
| 18'-0" | 108 | 163 | 219 | 284 | 348* | 360* | 374* | 388* | 404* | 420* | 1.890 |
| | 0 | 0 | 0 | 0 | 349 | 426* | 432* | 437* | 443* | 449* | |
| 19'-0" | 87 | 136 | 187 | 244 | 303 | 333* | 346* | 359* | 374* | 389* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 373 | 392* | 396* | 402* | 407* | |
| 20'-0" | 68 | 113 | 159 | 211 | 264 | 309* | 321* | 334* | 348* | 362* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 327 | 357* | 361* | 367* | 372* | |
| 21'-0" | 53 | 93 | 135 | 182 | 230 | 287 | 299* | 311* | 324* | 338* | 3.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 327* | 331* | 336* | 341* | |
| 22'-0" | | 76 | 114 | 157 | 201 | 253 | 279* | 290* | 303* | 316* | 4.219 |
| | | 0 | 0 | 0 | 0 | 0 | 301* | 304* | 310* | 0 | |
| 23'-0" | | 61 | 96 | 135 | 175 | 223 | 261* | 272* | 284* | 296* | 5.039 |
| | | 0 | 0 | 0 | 0 | 0 | 271 | 281* | 286* | 0 | |
| 24'-0" | | 48 | 80 | 116 | 153 | 196 | 241 | 255* | 267* | 276 | 5.975 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 25'-0" | | | 66 | 99 | 133 | 173 | 214 | 227 | 238 | 247 | 7.035 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 53 | 84 | 115 | 152 | 190 | 203 | 212 | 221 | 8.229 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | 42 | 71 | 100 | 134 | 169 | 181 | 190 | 197 | 9.570 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | 59 | 86 | 118 | 150 | 161 | 169 | 176 | 11.069 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.08 | 0.11 | 0.13 | 0.16 | 0.18 | 0.22 | 0.25 | 0.29 | 0.33 | 0.38 | |
| DEPTH, D IN. | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | 13.56 | 13.56 | 13.50 | 13.50 | 13.44 | |
| $+I_{cr}/I_{gr}$ | 0.164 | 0.203 | 0.243 | 0.285 | 0.329 | 0.378 | 0.428 | 0.482 | 0.537 | 0.591 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10" Deep Rib + 5.0" Top Slab = 15.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.45 | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 16'-0" | 152 | 221 | 290 | 369 | 449 | 473* | 488* | 503* | 521* | 538* | 1.214 |
| | 0 | 0 | 0 | 0 | 0 | 545 | 605* | 609* | 617* | 622* | |
| 17'-0" | 123 | 184 | 245 | 315 | 386 | 435* | 448* | 463* | 479* | 495* | 1.547 |
| | 0 | 0 | 0 | 0 | 0 | 471 | 541* | 546* | 553* | 558* | |
| 18'-0" | 99 | 152 | 207 | 270 | 333 | 401* | 414* | 427* | 443* | 458* | 1.944 |
| | 0 | 0 | 0 | 0 | 0 | 409 | 486 | 492* | 499* | 504* | |
| 19'-0" | 78 | 126 | 175 | 231 | 289 | 356 | 383* | 396* | 411* | 425* | 2.414 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 426 | 447* | 453* | 458* | |
| 20'-0" | 60 | 104 | 148 | 199 | 250 | 311 | 356* | 368* | 382* | 396* | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 374 | 408* | 414* | 418* | |
| 21'-0" | 45 | 85 | 125 | 171 | 217 | 273 | 330 | 343* | 357* | 369* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 375* | 380* | 384* | |
| 22'-0" | | 68 | 104 | 146 | 189 | 239 | 291 | 321* | 334* | 346* | 4.339 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 345* | 350* | 354* | |
| 23'-0" | | 53 | 87 | 125 | 164 | 210 | 257 | 301* | 313* | 324* | 5.183 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 311 | 324* | 328* | |
| 24'-0" | | 40 | 71 | 106 | 142 | 185 | 228 | 277 | 294* | 305* | 6.145 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 301* | 0 | |
| 25'-0" | | | 57 | 90 | 123 | 162 | 202 | 247 | 272 | 280 | 7.235 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 26'-0" | | | 45 | 75 | 106 | 142 | 179 | 221 | 243 | 251 | 8.464 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 27'-0" | | | | 62 | 91 | 124 | 158 | 197 | 218 | 225 | 9.844 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | 51 | 77 | 108 | 140 | 176 | 196 | 202 | 11.385 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 40 | 65 | 94 | 123 | 157 | 175 | 181 | 13.101 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.08 | 0.10 | 0.13 | 0.15 | 0.18 | 0.21 | 0.25 | 0.29 | 0.33 | 0.37 | |
| DEPTH, D IN. | 13.75 | 13.69 | 13.69 | 13.62 | 13.62 | 13.56 | 13.56 | 13.50 | 13.50 | 13.44 | |
| $+I_{cr}/I_{gr}$ | 0.145 | 0.179 | 0.214 | 0.252 | 0.291 | 0.334 | 0.379 | 0.426 | 0.476 | 0.524 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 5.0" Top Slab = 17.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 132 | 196 | 261 | 335 | 410 | 431* | 444* | 459* | 475* | 491* | 1.890 |
| | 0 | 0 | 0 | 0 | 0 | 500 | 519* | 525* | 532* | 539* | |
| 19'-0" | 108 | 165 | 223 | 290 | 357 | 398* | 411* | 425* | 440* | 455* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 438 | 472* | 477* | 484* | 490* | |
| 20'-0" | 87 | 139 | 191 | 251 | 312 | 370* | 382* | 395* | 409* | 423* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 385 | 431* | 436* | 443* | 448* | |
| 21'-0" | 69 | 116 | 163 | 218 | 273 | 339 | 356* | 368* | 382* | 395* | 3.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 396* | 400* | 407* | 412* | |
| 22'-0" | 54 | 96 | 139 | 189 | 240 | 300 | 332* | 344* | 357* | 370* | 4.219 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 361 | 369* | 375* | 380* | |
| 23'-0" | 40 | 79 | 119 | 164 | 210 | 265 | 311* | 322* | 334* | 347* | 5.039 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 321 | 342* | 347* | 352* | |
| 24'-0" | | 64 | 100 | 142 | 184 | 235 | 286 | 302* | 314* | 326* | 5.975 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 317* | 323* | 327* | |
| 25'-0" | | 51 | 84 | 123 | 162 | 208 | 256 | 284* | 296* | 307* | 7.035 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 295* | 300* | 0 | |
| 26'-0" | | | 70 | 105 | 141 | 184 | 228 | 268* | 279* | 290* | 8.229 |
| | | | 0 | 0 | 0 | 0 | 0 | 275* | 280* | 0 | |
| 27'-0" | | | 57 | 90 | 123 | 163 | 204 | 250 | 263 | 272 | 9.570 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | 45 | 76 | 107 | 144 | 182 | 225 | 237 | 245 | 11.069 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 64 | 93 | 127 | 163 | 203 | 214 | 222 | 12.737 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | | 53 | 80 | 112 | 145 | 183 | 193 | 200 | 14.587 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | | 43 | 68 | 98 | 129 | 164 | 174 | 181 | 16.631 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.07 | 0.09 | 0.11 | 0.14 | 0.16 | 0.19 | 0.22 | 0.26 | 0.29 | 0.33 | |
| DEPTH, D IN. | 15.75 | 15.69 | 15.69 | 15.62 | 15.62 | 15.56 | 15.56 | 15.50 | 15.50 | 15.44 | |
| $+I_{cr}/I_{gr}$ | 0.148 | 0.184 | 0.220 | 0.260 | 0.300 | 0.345 | 0.391 | 0.441 | 0.493 | 0.544 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12" Deep Rib + 5.0" Top Slab = 17.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.45 | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 18'-0" | 121 | 183 | 246 | 318 | 391 | 478* | 491* | 505* | 520* | 535* | 1.944 |
| | 0 | 0 | 0 | 0 | 0 | 479 | 568 | 588* | 595* | 601* | |
| 19'-0" | 97 | 153 | 209 | 274 | 340 | 418 | 455* | 468* | 482* | 497* | 2.414 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 498 | 535* | 542* | 547* | |
| 20'-0" | 77 | 127 | 178 | 237 | 296 | 367 | 423* | 435* | 449* | 462* | 2.964 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 439 | 489* | 496* | 501* | |
| 21'-0" | 59 | 105 | 151 | 204 | 258 | 322 | 388 | 406* | 419* | 432* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 450* | 456* | 461* | |
| 22'-0" | 44 | 86 | 128 | 176 | 225 | 284 | 343 | 379* | 392* | 404* | 4.339 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 412 | 421* | 426* | |
| 23'-0" | | 69 | 108 | 152 | 197 | 250 | 305 | 356* | 368* | 379* | 5.183 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 367 | 390* | 395* | |
| 24'-0" | | 54 | 90 | 130 | 172 | 221 | 271 | 328 | 346* | 357* | 6.145 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 363* | 367* | |
| 25'-0" | | 41 | 74 | 111 | 149 | 195 | 241 | 294 | 325* | 336* | 7.235 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 338* | 342* | |
| 26'-0" | | | 60 | 95 | 130 | 172 | 214 | 263 | 307* | 317* | 8.464 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 313 | 320* | |
| 27'-0" | | | 48 | 80 | 112 | 151 | 191 | 236 | 282 | 300* | 9.844 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 28'-0" | | | | 66 | 97 | 133 | 170 | 212 | 255 | 280 | 11.385 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 29'-0" | | | | 54 | 83 | 116 | 151 | 190 | 230 | 253 | 13.101 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | | 44 | 70 | 101 | 133 | 170 | 207 | 229 | 15.004 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | | | 58 | 88 | 118 | 152 | 187 | 208 | 17.106 |
| | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.07 | 0.09 | 0.11 | 0.13 | 0.16 | 0.19 | 0.21 | 0.25 | 0.28 | 0.32 | |
| DEPTH, D IN. | 15.75 | 15.69 | 15.69 | 15.62 | 15.62 | 15.56 | 15.56 | 15.50 | 15.50 | 15.44 | |
| $+I_{cr}/I_{gr}$ | 0.131 | 0.163 | 0.195 | 0.230 | 0.265 | 0.305 | 0.346 | 0.391 | 0.437 | 0.482 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 5″ Rib @ 35″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14" Deep Rib + 5.0" Top Slab = 19.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 4 | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.46 | 0.59 | 0.72 | 0.87 | 1.03 | 1.22 | 1.40 | 1.62 | 1.83 | 2.08 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 19'-0" | 129 | 194 | 260 | 335 | 412 | 470* | 483* | 496* | 511* | 527* | 2.347 |
| | 0 | 0 | 0 | 0 | 0 | 503 | 555* | 562* | 570* | 577* | |
| 20'-0" | 106 | 164 | 223 | 291 | 360 | 436* | 448* | 461* | 476* | 490* | 2.881 |
| | 0 | 0 | 0 | 0 | 0 | 443 | 508* | 514* | 522* | 528* | |
| 21'-0" | 85 | 139 | 192 | 254 | 317 | 391 | 418* | 430* | 444* | 457* | 3.502 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 467* | 473* | 480* | 487* | |
| 22'-0" | 68 | 116 | 165 | 221 | 278 | 347 | 390* | 402* | 415* | 428* | 4.219 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 416 | 437* | 444* | 450* | |
| 23'-0" | 53 | 97 | 142 | 193 | 245 | 308 | 365* | 377* | 389* | 401* | 5.039 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 371 | 405* | 412* | 417* | |
| 24'-0" | | 80 | 121 | 168 | 216 | 273 | 332 | 354* | 366* | 377* | 5.975 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 377* | 383* | 388* | |
| 25'-0" | | 65 | 103 | 146 | 190 | 243 | 297 | 333* | 344* | 356* | 7.035 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 351* | 357* | 362* | |
| 26'-0" | | 51 | 86 | 127 | 168 | 216 | 266 | 314* | 325* | 336* | 8.229 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 323 | 334* | 339* | |
| 27'-0" | | 40 | 72 | 109 | 147 | 193 | 239 | 292 | 307* | 317* | 9.570 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 313* | 318* | |
| 28'-0" | | | 59 | 94 | 129 | 171 | 214 | 263 | 290* | 300* | 11.069 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 294* | 0 | |
| 29'-0" | | | 47 | 80 | 113 | 152 | 192 | 238 | 275* | 285* | 12.737 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 277* | 0 | |
| 30'-0" | | | | 67 | 98 | 135 | 172 | 215 | 258 | 267 | 14.587 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | | 56 | 85 | 119 | 154 | 194 | 235 | 243 | 16.631 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | | 46 | 72 | 105 | 138 | 175 | 214 | 221 | 18.883 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.40 | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | |
| STEEL PERCENT | 0.06 | 0.08 | 0.10 | 0.12 | 0.14 | 0.17 | 0.20 | 0.23 | 0.26 | 0.29 | |
| DEPTH, D IN. | 17.75 | 17.69 | 17.69 | 17.62 | 17.62 | 17.56 | 17.56 | 17.50 | 17.50 | 17.44 | |
| $+I_{cr}/I_{gr}$ | 0.135 | 0.168 | 0.201 | 0.237 | 0.274 | 0.316 | 0.359 | 0.406 | 0.454 | 0.502 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 14" Deep Rib + 5.0" Top Slab = 19.0" Total Depth | | | | | | | | | | | |
| BOTTOM BARS | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | Deflection Coeff. (3) | |
| Steel (psf) | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | | |
| 20'-0" | 152 | 209 | 276 | 343 | 423 | 496* | 508* | 522* | 536* | 551* | 2.964 | |
| | 0 | 0 | 0 | 0 | 0 | 505 | 575* | 582* | 588* | 596* | | |
| 21'-0" | 127 | 179 | 239 | 300 | 373 | 447 | 474* | 487* | 500* | 515* | 3.602 | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 529* | 536* | 542* | 550* | | |
| 22'-0" | 105 | 153 | 207 | 263 | 329 | 397 | 443* | 456* | 468* | 482* | 4.339 | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 474 | 496* | 501* | 509* | | |
| 23'-0" | 86 | 130 | 180 | 231 | 291 | 353 | 416* | 428* | 440* | 453* | 5.183 | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 424 | 460* | 466* | 473* | | |
| 24'-0" | 70 | 110 | 156 | 202 | 258 | 315 | 380 | 402* | 414* | 426* | 6.145 | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 429* | 434* | 440* | | |
| 25'-0" | 55 | 92 | 134 | 177 | 229 | 281 | 341 | 379* | 390* | 402* | 7.235 | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 400* | 405* | 411* | | |
| 26'-0" | 42 | 76 | 115 | 155 | 203 | 251 | 306 | 358* | 368* | 380* | 8.464 | |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 363 | 379* | 385* | | |
| 27'-0" | | 62 | 98 | 135 | 179 | 224 | 276 | 328 | 348* | 360* | 9.844 | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 356* | 362* | | |
| 28'-0" | | 50 | 83 | 118 | 159 | 200 | 248 | 297 | 330* | 341* | 11.385 | |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 335* | 0 | | |
| 29'-0" | | | 70 | 102 | 140 | 179 | 223 | 269 | 313* | 324* | 13.101 | |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 315* | 0 | | |
| 30'-0" | | | 58 | 87 | 123 | 159 | 201 | 244 | 289 | 308* | 15.004 | |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| 31'-0" | | | 46 | 74 | 108 | 142 | 181 | 221 | 263 | 289 | 17.106 | |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| 32'-0" | | | | 63 | 94 | 126 | 163 | 200 | 240 | 264 | 19.423 | |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |
| 33'-0" | | | | 52 | 81 | 111 | 146 | 181 | 218 | 241 | 21.967 | |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | |
| STEEL PERCENT | 0.08 | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.22 | 0.25 | 0.29 | 0.32 | |
| DEPTH, D IN. | 17.69 | 17.69 | 17.62 | 17.62 | 17.56 | 17.56 | 17.50 | 17.50 | 17.44 | 17.44 | |
| $+I_{cr}/I_{gr}$ | 0.149 | 0.178 | 0.210 | 0.243 | 0.280 | 0.319 | 0.360 | 0.403 | 0.445 | 0.490 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16" Deep Rib + 5.0" Top Slab = 21.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.57 | 0.70 | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 21'-0" | 147 | 205 | 273 | 341 | 422 | 505 | 546* | 560* | 573* | 588* | 3.602 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 601 | 618* | 625* | 633* | |
| 22'-0" | 123 | 176 | 237 | 299 | 374 | 449 | 511* | 524* | 536* | 550* | 4.339 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 536 | 572* | 579* | 587* | |
| 23'-0" | 102 | 151 | 207 | 263 | 331 | 400 | 479* | 491* | 503* | 517* | 5.183 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 480 | 532* | 538* | 546* | |
| 24'-0" | 84 | 128 | 180 | 232 | 294 | 358 | 431 | 462* | 473* | 486* | 6.145 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 496* | 502* | 509* | |
| 25'-0" | 67 | 108 | 156 | 204 | 261 | 320 | 387 | 435* | 446* | 459* | 7.235 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 456 | 469* | 476* | |
| 26'-0" | 53 | 91 | 135 | 179 | 232 | 286 | 349 | 411* | 422* | 433* | 8.464 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 412 | 440* | 447* | |
| 27'-0" | 40 | 75 | 116 | 157 | 206 | 257 | 314 | 373 | 399* | 410* | 9.844 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 413* | 420* | |
| 28'-0" | | 61 | 99 | 137 | 183 | 230 | 284 | 338 | 378* | 389* | 11.385 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 389* | 395* | |
| 29'-0" | | 49 | 84 | 120 | 162 | 206 | 256 | 307 | 359* | 369* | 13.101 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 361 | 373* | |
| 30'-0" | | | 70 | 104 | 144 | 184 | 231 | 279 | 329 | 351* | 15.004 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 353* | |
| 31'-0" | | | 58 | 89 | 127 | 165 | 208 | 253 | 301 | 334* | 17.106 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | 47 | 76 | 111 | 147 | 188 | 230 | 274 | 318* | 19.423 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | | | 64 | 97 | 131 | 169 | 209 | 251 | 293 | 21.967 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | | | | 53 | 84 | 116 | 152 | 189 | 229 | 269 | 24.753 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | |
| STEEL PERCENT | 0.07 | 0.09 | 0.11 | 0.12 | 0.15 | 0.17 | 0.20 | 0.23 | 0.26 | 0.29 | |
| DEPTH, D IN. | 19.69 | 19.69 | 19.62 | 19.62 | 19.56 | 19.56 | 19.50 | 19.50 | 19.44 | 19.44 | |
| $+I_{cr}/I_{gr}$ | 0.137 | 0.164 | 0.194 | 0.225 | 0.260 | 0.295 | 0.334 | 0.374 | 0.414 | 0.456 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 16" Deep Rib + 5.0" Top Slab = 21.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 4 # 5 | # 5 # 5 | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | Deflection Coeff. (3) |
| Steel (psf) | 0.55 | 0.68 | 0.83 | 0.97 | 1.15 | 1.33 | 1.53 | 1.73 | 1.97 | 2.21 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 21'-0" | 134 | 191 | 256 | 322 | 402 | 482 | 575 | 606* | 618* | 633* | 3.702 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 670 | 682* | 690* | |
| 22'-0" | 111 | 162 | 222 | 282 | 354 | 428 | 513 | 567* | 579* | 593* | 4.460 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 599 | 632* | 640* | |
| 23'-0" | 90 | 137 | 192 | 247 | 313 | 380 | 458 | 532* | 544* | 557* | 5.327 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 537 | 587* | 595* | |
| 24'-0" | 72 | 115 | 166 | 216 | 277 | 339 | 410 | 482 | 512* | 524* | 6.316 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 548* | 555* | |
| 25'-0" | 56 | 96 | 142 | 189 | 245 | 302 | 368 | 434 | 482* | 494* | 7.436 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 506 | 520* | |
| 26'-0" | 42 | 79 | 122 | 165 | 217 | 269 | 330 | 392 | 456* | 467* | 8.700 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 458 | 488* | |
| 27'-0" | | 64 | 103 | 144 | 192 | 240 | 297 | 354 | 415 | 442* | 10.117 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 459* | |
| 28'-0" | | 50 | 87 | 124 | 169 | 214 | 267 | 320 | 377 | 420* | 11.701 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 432* | |
| 29'-0" | | | 72 | 107 | 149 | 191 | 240 | 289 | 342 | 396 | 13.465 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 30'-0" | | | 59 | 92 | 130 | 170 | 216 | 262 | 311 | 362 | 15.420 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 31'-0" | | | 47 | 77 | 114 | 151 | 194 | 237 | 283 | 331 | 17.581 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 32'-0" | | | | 65 | 99 | 134 | 174 | 214 | 258 | 302 | 19.962 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 33'-0" | | | | 53 | 85 | 118 | 156 | 194 | 235 | 276 | 22.577 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 34'-0" | | | | 42 | 73 | 104 | 139 | 175 | 214 | 253 | 25.440 |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.51 | 0.62 | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | |
| STEEL PERCENT | 0.07 | 0.09 | 0.10 | 0.12 | 0.14 | 0.17 | 0.19 | 0.22 | 0.25 | 0.28 | |
| DEPTH, D IN. | 19.69 | 19.69 | 19.62 | 19.62 | 19.56 | 19.56 | 19.50 | 19.50 | 19.44 | 19.44 | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.148 | 0.175 | 0.203 | 0.235 | 0.267 | 0.302 | 0.338 | 0.375 | 0.413 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 6″ Rib @ 36″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20" Deep Rib + 5.0" Top Slab = 25.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | # 9 #10 | #10 #10 | Deflection Coeff. (3) |
| Steel (psf) | 0.85 | 1.00 | 1.18 | 1.36 | 1.57 | 1.78 | 2.02 | 2.27 | 2.57 | 2.87 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 26'-0" | 172 | 226 | 291 | 356 | 432 | 509 | 538* | 550* | 564* | 580* | 8.464 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 566* | 574* | 583* | 594* | |
| 27'-0" | 150 | 199 | 259 | 320 | 390 | 461 | 509* | 521* | 534* | 549* | 9.844 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 533* | 541* | 549* | 559* | |
| 28'-0" | 129 | 176 | 231 | 288 | 353 | 419 | 483* | 494* | 507* | 521* | 11.385 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 490 | 510* | 518* | 528* | |
| 29'-0" | 111 | 154 | 206 | 259 | 320 | 381 | 448 | 469* | 481* | 495* | 13.101 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 482* | 490* | 499* | |
| 30'-0" | 95 | 135 | 183 | 233 | 290 | 347 | 409 | 446* | 458* | 471* | 15.004 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 457* | 464* | 473* | |
| 31'-0" | 80 | 118 | 163 | 209 | 262 | 316 | 374 | 425* | 436* | 449* | 17.106 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 433* | 440* | 0 | |
| 32'-0" | 66 | 102 | 144 | 188 | 238 | 288 | 343 | 398 | 416* | 428* | 19.423 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 418* | 0 | |
| 33'-0" | 54 | 87 | 127 | 168 | 215 | 263 | 314 | 366 | 397* | 409* | 21.967 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 398* | 0 | |
| 34'-0" | 43 | 74 | 112 | 150 | 194 | 239 | 288 | 337 | 379* | 391* | 24.753 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 35'-0" | | 62 | 98 | 134 | 176 | 218 | 264 | 310 | 363* | 374* | 27.796 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 36'-0" | | 51 | 85 | 119 | 158 | 198 | 241 | 285 | 340 | 358* | 31.111 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 37'-0" | | 41 | 73 | 105 | 142 | 180 | 221 | 263 | 314 | 343* | 34.715 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 38'-0" | | | 62 | 92 | 128 | 164 | 202 | 242 | 291 | 329* | 38.623 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 39'-0" | | | 52 | 81 | 114 | 148 | 185 | 222 | 269 | 315 | 42.852 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | 2.27 | 2.54 | |
| STEEL PERCENT | 0.09 | 0.10 | 0.12 | 0.14 | 0.16 | 0.19 | 0.21 | 0.24 | 0.27 | 0.30 | |
| DEPTH, D IN. | 23.62 | 23.62 | 23.56 | 23.56 | 23.50 | 23.50 | 23.44 | 23.44 | 23.36 | 23.36 | |
| $+I_{cr}/I_{gr}$ | 0.169 | 0.195 | 0.226 | 0.258 | 0.292 | 0.328 | 0.364 | 0.401 | 0.445 | 0.491 | |

| STANDARD (1) ONE-WAY JOISTS SINGLE SPAN | 30″ Forms = 7″ Rib @ 37″ c.-c. FACTORED USABLE SUPERIMPOSED LOAD (PSF)(2) | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 20" Deep Rib + 5.0" Top Slab = 25.0" Total Depth | | | | | | | | | | |
| BOTTOM BARS | # 5 # 6 | # 6 # 6 | # 6 # 7 | # 7 # 7 | # 7 # 8 | # 8 # 8 | # 8 # 9 | # 9 # 9 | # 9 #10 | #10 #10 | Deflection Coeff. (3) |
| Steel (psf) | 0.83 | 0.97 | 1.15 | 1.33 | 1.53 | 1.73 | 1.97 | 2.21 | 2.50 | 2.79 | |
| CLEAR SPAN | FACTORED USABLE SUPERIMPOSED LOAD (PSF) | | | | | | | | | | |
| 26'-0" | 158 | 210 | 273 | 337 | 411 | 485 | 566 | 594* | 607* | 622* | 8.700 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 624* | 633* | 643* | |
| 27'-0" | 136 | 184 | 243 | 302 | 370 | 439 | 514 | 562* | 575* | 589* | 10.117 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 588* | 596* | 606* | |
| 28'-0" | 116 | 161 | 215 | 270 | 334 | 398 | 468 | 533* | 546* | 559* | 11.701 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 538 | 563* | 572* | |
| 29'-0" | 98 | 140 | 191 | 242 | 301 | 362 | 426 | 492 | 518* | 532* | 13.465 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 532* | 541* | |
| 30'-0" | 82 | 122 | 169 | 217 | 272 | 328 | 389 | 450 | 493* | 506* | 15.420 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 504* | 513* | |
| 31'-0" | 68 | 105 | 149 | 194 | 246 | 298 | 355 | 412 | 470* | 482* | 17.581 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 479* | 487* | |
| 32'-0" | 55 | 89 | 131 | 173 | 221 | 271 | 324 | 378 | 445 | 460* | 19.962 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 463* | |
| 33'-0" | 43 | 75 | 114 | 154 | 200 | 246 | 296 | 347 | 410 | 440* | 22.577 |
| | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 441* | |
| 34'-0" | | 62 | 99 | 136 | 180 | 223 | 270 | 318 | 378 | 420* | 25.440 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 35'-0" | | 51 | 85 | 121 | 161 | 203 | 247 | 292 | 348 | 402* | 28.568 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 36'-0" | | 40 | 73 | 106 | 144 | 183 | 225 | 268 | 321 | 375 | 31.975 |
| | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 37'-0" | | | 61 | 93 | 129 | 166 | 206 | 246 | 296 | 347 | 35.679 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 38'-0" | | | 50 | 80 | 115 | 150 | 187 | 226 | 273 | 322 | 39.696 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| 39'-0" | | | 40 | 69 | 102 | 135 | 170 | 207 | 252 | 298 | 44.042 |
| | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |

(1) For gross section properties, see Tables 8-1(a) and 8-1(b).
(2) First load is for standard square joist ends; second load is for special tapered joist ends.
(3) Computation of deflection is not required above horizonal line (thickness ≥ $\ell_n/16$).
(4) Exclusive of bridging joist and tapered ends.
*Controlled by shear capacity. +Capacity at elastic deflection = $\ell_n/360$.

| PROPERTIES FOR DESIGN (CONCRETE 0.81 CF/SF)(4) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POSITIVE MOMENT STEEL (SQ. IN.) AREA | 0.75 | 0.88 | 1.04 | 1.20 | 1.39 | 1.58 | 1.79 | 2.00 | 2.27 | 2.54 | |
| STEEL PERCENT | 0.09 | 0.10 | 0.12 | 0.14 | 0.16 | 0.18 | 0.21 | 0.23 | 0.26 | 0.29 | |
| DEPTH, D IN. | 23.62 | 23.62 | 23.56 | 23.56 | 23.50 | 23.50 | 23.44 | 23.44 | 23.36 | 23.36 | |
| $+I_{cr}/I_{gr}$ | 0.153 | 0.177 | 0.205 | 0.234 | 0.265 | 0.297 | 0.330 | 0.364 | 0.404 | 0.445 | |

# WIDE-MODULE CONCRETE JOIST CONSTRUCTION

## INTRODUCTION

Wide-module joist systems, which are also referred to as "skip-joist" systems, may be defined as joist systems with clear spacings between ribs of more than 30 in. Since this spacing exceeds the spacing limit for joists, as specified by ACI 8.13, the wide-module joists are subject to the design requirements for T-Beams (ACI 8.12).

Of the two types of joist construction, the standard and wide-module, the wide-module is preferred when a 4.5-inch top slab is used. The 4.5-inch top slab is needed when the floor/ceiling assembly is required to have a 2-hour fire-resistant rating. As a result of this floor slab thickness, the most economical system is the one which structurally takes advantage of this thickness, as the wide-module system does.

## DIMENSIONS OF STANDARD FORMS

Joist widths for tabulated designs in this Chapter vary from 6 in. to 10 in. Standard forms for the pan spaces between ribs are 40-in., 53-in. and 66-in. wide and 12, 14, 16, 20 and 24-in. deep. Standard-end forms consist of square-end forms: tapered-end forms are usually not available.

See Fig. 8-14 for recommended bar details for wide-module joist construction.

When the supporting beam is wider than the column, it is recommended that the clear span of the joists be considered as ($\ell_{c\text{-}c}$ – column width).

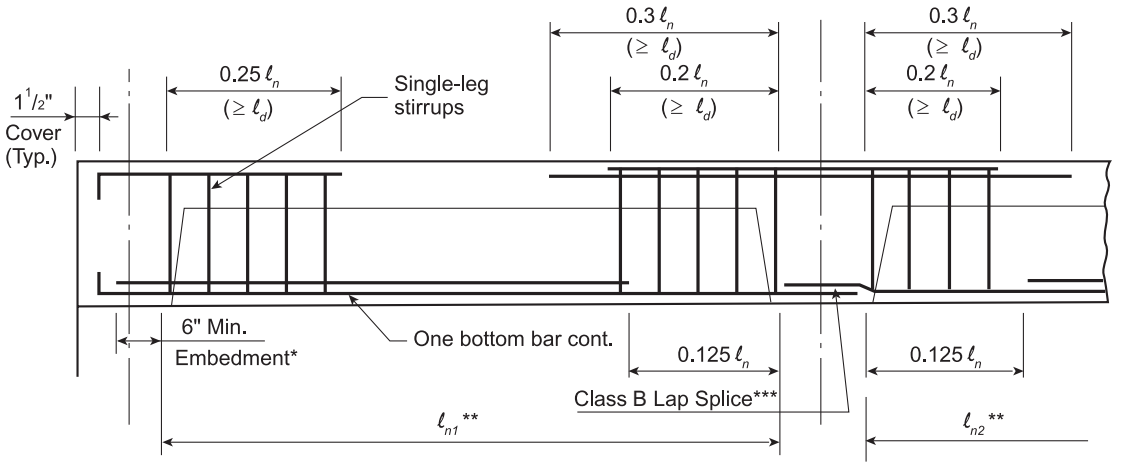
Since the top concrete cover of the joist and girder each have the same minimum value, e.g., 1½ in., it may be necessary to increase the girder top concrete cover by lowering the girder top reinforcement and reduce the effective depth for negative moment calculations, in order to avoid interference with the joist negative moment reinforcement.

The following tables will help in stirrup style selection and bar positioning.

## MAXIMUM BAR SIZE FOR INDIVIDUAL BARS IN THE BOTTOM OF A WIDE-MODULE RIB

| Stirrup Style | No. of Bars | Rib Width at Bottom | | | | |
|---|---|---|---|---|---|---|
| | | 6″ | 7″ | 8″ | 9″ | 10″ |
| "L" | 2 | #6 | #9 | #11 | #14 | #14 |
| | 3 | – | #4 | #6 | #8 | #10 |
| "L" (alt.) or "U" | 2 | #4 | #8 | #10 | #11 | #14 |
| | 3 | – | – | #5 | #8 | #9 |

1. Maximum bar sizes are based on clear spacing requirements of ACI 7.6.1.
2. Side taper of ribs not considered.
3. Based on 1½-in. concrete cover, #4 stirrups.




*If support width ≤ 12", hook two bottom bars.

**If bearing on masonry or structural steel, use c.-c. lengths.

***If lap area extends beyond 0.125 $\ell_n$ cut-off, consider lapping hooks (i.e., ⌐ ). $\ell_{dh}$

**Figure 8-14 Recommended Wide-Module Joist Bar Details**

## MAXIMUM BAR SIZE FOR 2-BAR BUNDLES IN THE BOTTOM OF A WIDE-MODULE RIB

| Stirrup Style | No. of Bars | Rib Width at Bottom | | | | |
|---|---|---|---|---|---|---|
| | | 6″ | 7″ | 8″ | 9″ | 10″ |
| "L" | 1 | #9 | #11 | #11 | #11 | #11 |
| | 2 | #3 | #5 | #6 | #8 | #9 |
| "L" (alt.) or "U" | 1 | #8 | #11 | #11 | #11 | #11 |
| | 2 | – | #4 | #5 | #7 | #8 |

1. Maximum bar sizes are based on clear spacing requirements of ACI 7.6.1 and 7.6.6.5.
2. Side taper of ribs not considered.
3. Based on 1½-in. concrete cover, #4 stirrups.

## GENERAL STRUCTURAL CONSIDERATIONS

Since the wide-module "joists" are technically classified as beams, their design must conform to the requirements of T-Beams (ACI 8.12). Principal requirements are:

1. **Minimum concrete cover.** 1½ in. to stirrups and main flexural bars (top, bottom, and sides) instead of ¾ in. (ACI 7.7.1).
2. **Design shear strength.** $\phi V_c = \phi 2\sqrt{f'_c}\, b_w d$ instead of $\phi V_c = \phi 2.2\sqrt{f'_c}\, b_w d$ (ACI 11.2.1.1).
3. **Minimum area of shear reinforcement.** $A_v = 50(b_w s)/f_y$ when factored shear $V_u > 0.5\phi V_c$ (ACI 11.4.6.3).
4. **Reinforcing steel requirements and recommended details.** Alternative arrangements to provide required shear reinforcement include the common open U-stirrup. With minimum rib widths, the maximum size of the main tensile reinforcement becomes limited by concrete cover requirements. Also with minimum rib widths, fabricating constraints may require wider U-stirrups. In these cases, the U-stirrups may be angled to fit. For minimum rib widths, the use of single leg stirrups simplifies placing the reinforcement. A special note should be included on placing drawings to require alternating the stirrup positions. See Fig. 8-15.

Welded wire reinforcement (plain or deformed) can also be used as shear reinforcement. The vertical wires are developed by two horizontal wires spaced at 2 in. maximum at the top and at the bottom.

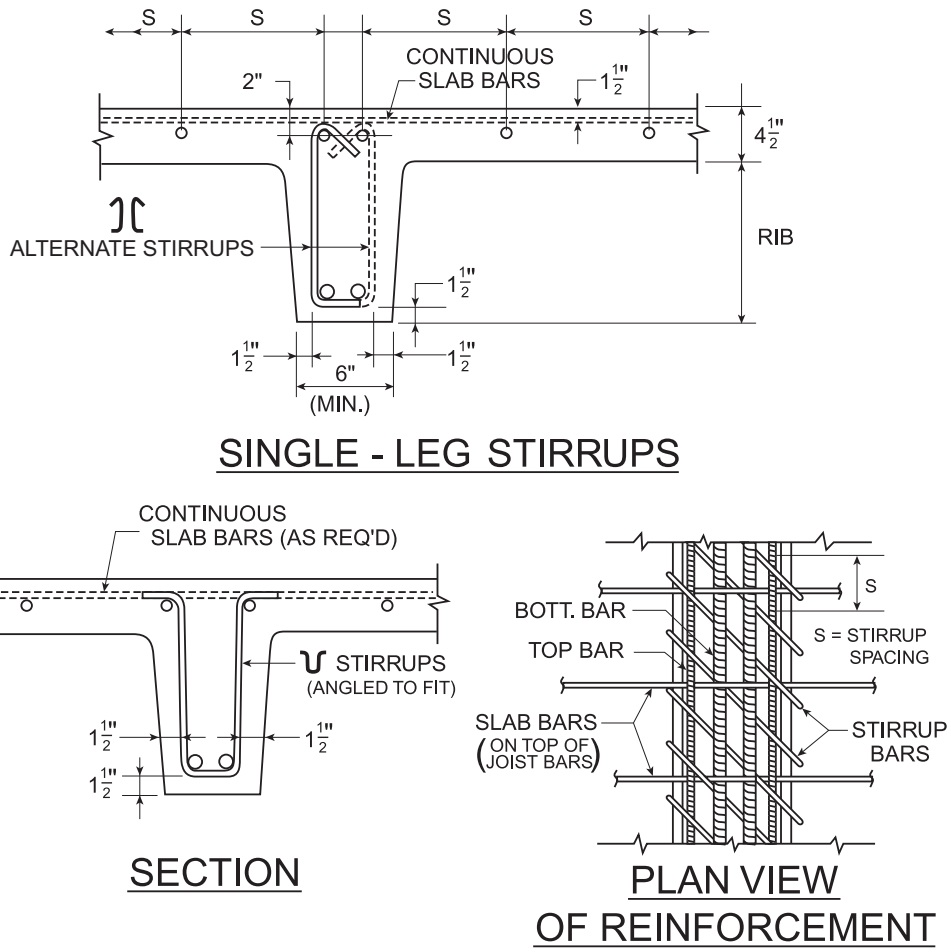



**Figure 8-15 Details for Single Leg and Common U-Stirrup Applications for Shear Reinforcement in Wide-Module Joist Construction**

## TABULATED DESIGNS

Because the wide-module joist tabulated designs, and their use, are very similar to the standard size joists, only their differences will be discussed.

**Scope**. End spans and interior spans, but not single spans, are covered in the tabulated designs. Tapered-end forms are not considered, since stirrups are used to provide for shear capacity.

**Load Strengths Tabulated.** Usable superimposed factored load strength is given in pounds per foot. The first line for a specific clear span gives the superimposed load strength, the second line lists the single-leg stirrup size and minimum distance (in.) from the face of support that the stirrups must extend. Required constant stirrup spacing is noted at the bottom in each load table.

## DESIGN FROM LOAD TABLES (MULTIPLE SPAN WIDE-MODULE JOIST CONSTRUCTION)

**Example 1.** Select a wide-module joist floor design with about a 6 ft. joist spacing and review calculations to support a service live load of 75 psf and an allowance of 30 psf for superimposed dead loads (partitions, ceiling, etc.) on a clear span of 28 ft. See Fig. 8-17 for layout.

Try: 16 + 4½ with 9-in. ribs 66 in. apart (6'-3" c.-c.)

Superimposed factored load $w_u = 1.2D + 1.6L$
$= 1.2(30) + 1.6(75)$
$= 156$ psf $(6.25) = 975$ plf

Read from table on Page 8-117:

End Span: Tabulated strength = 1,198 plf
Top bars #4 at 7.5" at first interior support
Bottom bars 2- #8 (per rib)
Single-leg stirrups: #3 spaced at 8" for 136" from face of support or 18- #3 spaced at 8"

Interior Span: Tabulated strength = 1,393 plf
#4 spaced at 7.5" top bars,
1- #5 and 2- #6 bottom bars
Single-leg stirrups: #3 spaced at 8" for 98" or 14 - #3 spaced at 8"

Concrete quantity (from Table 8-3):

524 plf = 524/6.25 = 84 psf

Load strength was not limited by deflection, so approximate immediate live load deflection will be:

$$\left(\frac{75}{30+75}\right)\left(\frac{\ell_n}{360}\right) = \frac{\ell_n}{504} \text{ (}or\ less\text{)}$$

This calculation is sufficient to satisfy ACI 9.5.2.1 that deflection be computed for $\ell_n/h$ ratios above 18.5 for end spans and 21 for interior spans. The estimated deflection above would be considered satisfactory, without further calculations for all floors and roofs "not supporting or attached to non-structural elements likely to be damaged by large deflections" (ACI Table 9.5(b)).

See Fig. 8-18 details of reinforcing bars for this example.

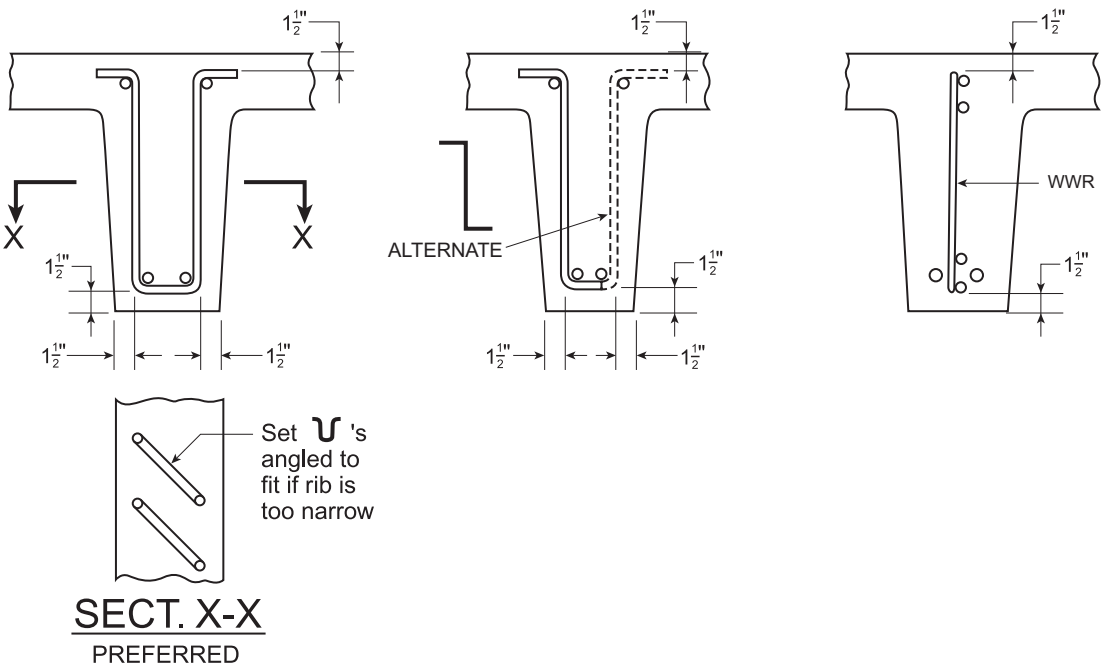



**Figure 8-16 Alternative Stirrup Arrangements**

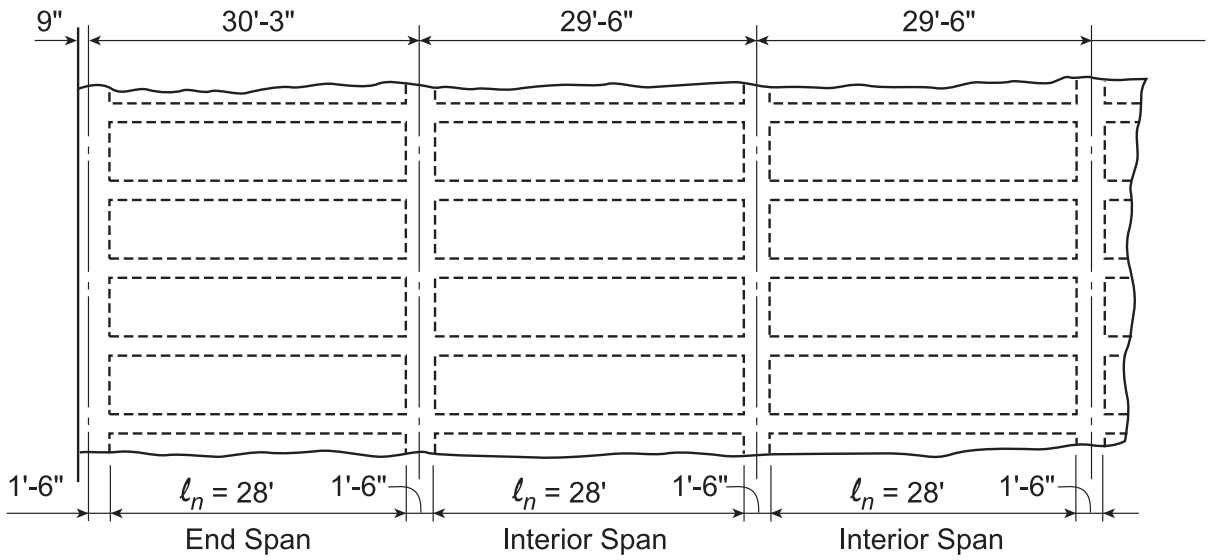



**Figure 8-17 Multiple Span Wide-Module Layout – Example 1**

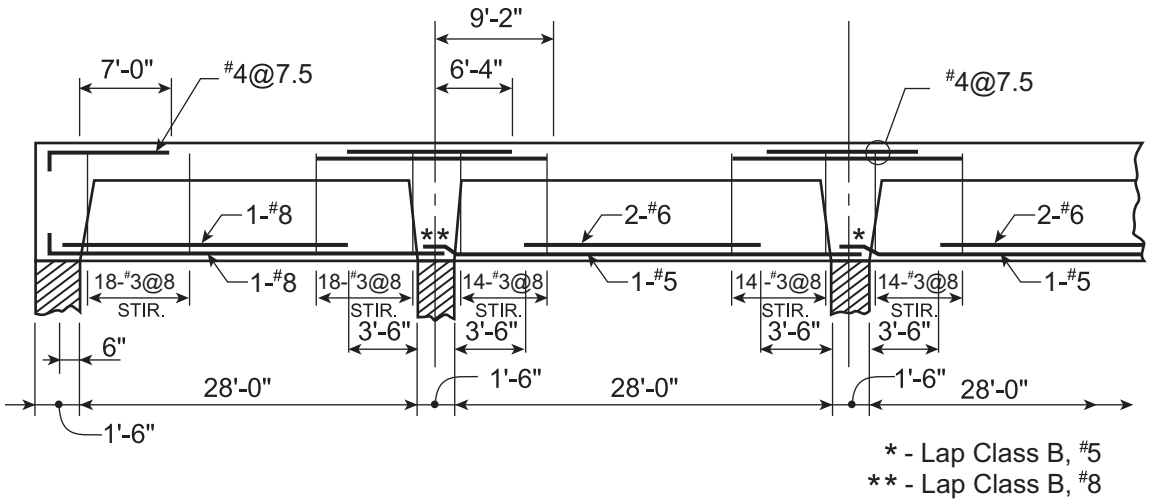



**Figure 8-18 Wide-Module Bar Details – Example 1**

8

## TABLE 8-3(a) GROSS SECTION PROPERTIES — WIDE-MODULE JOIST CONSTRUCTION (1)

| (2) Joist | 4.5-Inch Top Slab | | | | | |
|---|---|---|---|---|---|---|
| | Gross Area(3) (in.²) | Wt.(4) (plf) | $Y_{cg}$(3) (in.) | $I_g$(3) (in.⁴) | $+M_{cr}$ (ft-k) | $-M_{cr}$(3) (ft-k) |
| 12 + 8 + 40 | 324.0 | 338 | 11.57 | 6,295 | 21.5 | 50.5 |
| | 396.0 | | 10.56 | 8,990 | | 59.8 |
| 12 + 9 + 40 | 340.5 | 355 | 11.41 | 6,843 | 23.7 | 53.2 |
| | 412.5 | | 10.47 | 9,448 | | 61.9 |
| 12 + 10 + 40 | 357.0 | 372 | 11.27 | 7,375 | 25.9 | 55.7 |
| | 429.0 | | 10.38 | 9,901 | | 64.0 |
| 14 + 8 + 40 | 344.3 | 359 | 12.91 | 8,902 | 27.3 | 63.0 |
| | 428.3 | | 11.75 | 12,635 | | 74.0 |
| 14 + 9 + 40 | 362.8 | 378 | 12.73 | 9,665 | 30.0 | 66.2 |
| | 446.8 | | 11.65 | 13,274 | | 76.6 |
| 14 + 10 + 40 | 381.3 | 397 | 12.56 | 10,406 | 32.8 | 69.2 |
| | 465.3 | | 11.55 | 13,904 | | 79.1 |
| 16 + 8 + 40 | 365.3 | 381 | 14.22 | 12,128 | 33.7 | 76.3 |
| | 461.3 | | 12.92 | 17,113 | | 89.3 |
| 16 + 9 + 40 | 385.8 | 402 | 14.01 | 13,151 | 37.1 | 80.0 |
| | 481.8 | | 12.81 | 17,972 | | 92.4 |
| 16 + 10 + 40 | 406.3 | 423 | 13.82 | 14,144 | 40.5 | 83.6 |
| | 502.3 | | 12.70 | 18,818 | | 95.4 |
| 18 + 8 + 40 | 387.0 | 403 | 15.49 | 16,027 | 40.9 | 90.4 |
| | 495.0 | | 14.07 | 22,497 | | 105.5 |
| 18 + 9 + 40 | 409.5 | 427 | 15.26 | 17,358 | 45.0 | 94.7 |
| | 517.5 | | 13.95 | 23,618 | | 109.2 |
| 18 + 10 + 40 | 432.0 | 450 | 15.05 | 18,649 | 49.0 | 98.9 |
| | 540.0 | | 13.84 | 24,724 | | 112.8 |
| 20 + 8 + 40 | 409.3 | 426 | 16.74 | 20,652 | 48.8 | 105.1 |
| | 529.3 | | 15.21 | 28,862 | | 122.8 |
| 20 + 9 + 40 | 433.8 | 452 | 16.48 | 22,342 | 53.6 | 110.2 |
| | 553.8 | | 15.08 | 30,292 | | 127.1 |
| 20 + 10 + 40 | 458.3 | 477 | 16.26 | 23,983 | 58.3 | 115.0 |
| | 578.3 | | 14.96 | 31,705 | | 131.3 |
| 22 + 8 + 40 | 432.3 | 450 | 17.96 | 26,057 | 57.3 | 120.6 |
| | 564.3 | | 16.33 | 36,282 | | 141.1 |
| 22 + 9 + 40 | 458.8 | 478 | 17.69 | 28,162 | 62.9 | 126.4 |
| | 590.8 | | 16.20 | 38,074 | | 146.0 |
| 22 + 10 + 40 | 485.3 | 506 | 17.45 | 30,207 | 68.4 | 131.9 |
| | 617.3 | | 16.07 | 39,844 | | 151.0 |
| 24 + 8 + 40 | 456.0 | 475 | 19.17 | 32,297 | 66.6 | 136.8 |
| | 600.0 | | 17.45 | 44,837 | | 160.4 |
| 24 + 9 + 40 | 484.5 | 505 | 18.88 | 34,875 | 73.0 | 143.3 |
| | 628.5 | | 17.30 | 47,044 | | 166.1 |
| 24 + 10 + 40 | 513.0 | 534 | 18.62 | 37,382 | 79.3 | 149.6 |
| | 657.0 | | 17.17 | 49,228 | | 171.8 |

| (2) Joist | 4.5-Inch Top Slab | | | | | |
|---|---|---|---|---|---|---|
| | Gross Area (in.²) | Wt.(4) (plf) | $Y_{cg}$ (in.) | $I_g$ (in.⁴) | $+M_{cr}$ (ft-k) | $-M_{cr}$ (ft-k) |
| 16 + 7 + 53 | 403.3 | 420 | 15.00 | 11,889 | 31.3 | 85.5 |
| 16 + 8 + 53 | 423.8 | 441 | 14.77 | 13,047 | 34.9 | 90.1 |
| 16 + 9 + 53 | 444.3 | 463 | 14.56 | 14,165 | 38.4 | 94.3 |
| 16 + 10 + 53 | 464.8 | 484 | 14.37 | 15,248 | 41.9 | 98.4 |
| 20 + 7 + 53 | 443.3 | 462 | 17.71 | 20,389 | 45.5 | 118.7 |
| 20 + 8 + 53 | 467.8 | 487 | 17.43 | 22,307 | 50.6 | 124.6 |
| 20 + 9 + 53 | 492.3 | 513 | 17.17 | 24,156 | 55.6 | 130.2 |
| 20 + 10 + 53 | 516.8 | 538 | 16.93 | 25,946 | 60.6 | 135.6 |
| 24 + 7 + 53 | 486.0 | 506 | 20.31 | 32,075 | 62.4 | 154.8 |
| 24 + 8 + 53 | 514.5 | 536 | 19.98 | 34,994 | 69.2 | 162.3 |
| 24 + 9 + 53 | 543.0 | 566 | 19.68 | 37,808 | 76.0 | 169.4 |
| 24 + 10 + 53 | 571.5 | 595 | 19.40 | 40,534 | 82.6 | 176.2 |
| 14 + 6 + 66 | 424.3 | 442 | 14.15 | 8,199 | 22.9 | 74.5 |
| 14 + 7 + 66 | 442.8 | 461 | 13.95 | 9,152 | 25.9 | 79.5 |
| 14 + 8 + 66 | 461.3 | 481 | 13.76 | 10,072 | 28.9 | 84.0 |
| 14 + 9 + 66 | 479.8 | 500 | 13.59 | 10,961 | 31.9 | 88.2 |
| 16 + 6 + 66 | 441.3 | 460 | 15.65 | 11,236 | 28.4 | 91.7 |
| 16 + 7 + 66 | 461.8 | 481 | 15.41 | 12,526 | 32.1 | 97.4 |
| 16 + 8 + 66 | 482.3 | 502 | 15.19 | 13,768 | 35.8 | 102.6 |
| 16 + 9 + 66 | 502.8 | 524 | 14.99 | 14,966 | 39.5 | 107.4 |
| 20 + 6 + 66 | 477.3 | 497 | 18.55 | 19,402 | 41.4 | 128.8 |
| 20 + 7 + 66 | 501.8 | 523 | 18.24 | 21,552 | 46.7 | 136.1 |
| 20 + 8 + 66 | 526.3 | 548 | 17.96 | 23,616 | 52.0 | 142.8 |
| 20 + 9 + 66 | 550.8 | 574 | 17.71 | 25,605 | 57.2 | 149.0 |
| 24 + 6 + 66 | 516.0 | 538 | 21.32 | 30,736 | 57.0 | 169.2 |
| 24 + 7 + 66 | 544.5 | 567 | 20.95 | 34,015 | 64.2 | 178.1 |
| 24 + 8 + 66 | 573.0 | 597 | 20.62 | 37,160 | 71.2 | 186.3 |
| 24 + 9 + 66 | 601.5 | 627 | 20.31 | 40,190 | 78.2 | 194.1 |

(1) $f'_c$ = 4,000 psi, rib side slope = 1 to 12.
(2) First value is the pan depth, second value is the rib width, and the third value is the pan width (in.)
(3) First value is for a standard section; second value is at a tapered end.
(4) For normal-weight concrete, w = 150 pcf (added weight of tapers is neglected.)

## TABLE 8-3(b) GROSS SECTION PROPERTIES — WIDE-MODULE JOIST CONSTRUCTION (1)

| (2) Joist | 5-Inch Top Slab | | | | | |
|---|---|---|---|---|---|---|
| | Gross Area(3) ($in.^2$) | Wt.(4) (plf) | $Y_{cg}$(3) (in.) | $I_g$(3) ($in.^4$) | $+M_{cr}$ (ft-k) | $-M_{cr}$(3) (ft-k) |
| 12 + 8 + 40 | 348.0 | 363 | 11.93 | 6,894 | 22.8 | 53.8 |
| | 420.0 | | 10.91 | 9,857 | | 64.0 |
| 12 + 9 + 40 | 365.0 | 380 | 11.77 | 7,495 | 25.2 | 56.7 |
| | 437.0 | | 10.82 | 10,362 | | 66.3 |
| 12 + 10 + 40 | 382.0 | 398 | 11.63 | 8,078 | 27.5 | 59.4 |
| | 454.0 | | 10.73 | 10,859 | | 68.5 |
| 14 + 8 + 40 | 368.3 | 384 | 13.29 | 9,667 | 28.7 | 67.0 |
| | 452.3 | | 12.12 | 13,748 | | 79.0 |
| 14 + 9 + 40 | 387.3 | 403 | 13.11 | 10,499 | 31.7 | 70.4 |
| | 471.3 | | 12.02 | 14,445 | | 81.8 |
| 14 + 10 + 40 | 406.3 | 423 | 12.94 | 11,306 | 34.5 | 73.7 |
| | 490.3 | | 11.92 | 15,133 | | 84.5 |
| 16 + 8 + 40 | 389.3 | 406 | 14.62 | 13,090 | 35.4 | 81.1 |
| | 485.3 | | 13.31 | 18,512 | | 95.1 |
| 16 + 9 + 40 | 410.3 | 427 | 14.41 | 14,200 | 39.0 | 85.1 |
| | 506.3 | | 13.19 | 19,442 | | 98.4 |
| 16 + 10 + 40 | 431.3 | 449 | 14.22 | 15,277 | 42.5 | 89.0 |
| | 527.3 | | 13.09 | 20,360 | | 101.7 |
| 18 + 8 + 40 | 411.0 | 428 | 15.91 | 17,219 | 42.8 | 96.0 |
| | 519.0 | | 14.47 | 24,221 | | 112.3 |
| 18 + 9 + 40 | 434.0 | 452 | 15.68 | 18,657 | 47.0 | 100.7 |
| | 542.0 | | 14.35 | 25,430 | | 116.2 |
| 18 + 10 + 40 | 457.0 | 476 | 15.47 | 20,052 | 51.2 | 105.2 |
| | 565.0 | | 14.23 | 26,623 | | 120.0 |
| 20 + 8 + 40 | 433.3 | 451 | 17.18 | 22,108 | 50.9 | 111.7 |
| | 553.3 | | 15.62 | 30,952 | | 130.5 |
| 20 + 9 + 40 | 458.3 | 477 | 16.92 | 23,928 | 55.9 | 117.1 |
| | 578.3 | | 15.49 | 32,488 | | 135.0 |
| 20 + 10 + 40 | 483.3 | 503 | 16.70 | 25,694 | 60.8 | 122.3 |
| | 603.3 | | 15.36 | 34,004 | | 139.5 |
| 22 + 8 + 40 | 456.3 | 475 | 18.42 | 27,813 | 59.7 | 128.2 |
| | 588.3 | | 16.76 | 38,780 | | 149.7 |
| 22 + 9 + 40 | 483.3 | 503 | 18.15 | 30,072 | 65.5 | 134.3 |
| | 615.3 | | 16.62 | 40,695 | | 154.9 |
| 22 + 10 + 40 | 510.3 | 532 | 17.90 | 32,265 | 71.2 | 140.2 |
| | 642.3 | | 16.48 | 42,586 | | 160.1 |
| 24 + 8 + 40 | 480.0 | 500 | 19.65 | 34,389 | 69.2 | 145.4 |
| | 624.0 | | 17.88 | 47,784 | | 169.9 |
| 24 + 9 + 40 | 509.0 | 530 | 19.36 | 37,147 | 75.9 | 152.3 |
| | 653.0 | | 17.73 | 50,134 | | 175.9 |
| 24 + 10 + 40 | 538.0 | 560 | 19.09 | 39,826 | 82.4 | 158.9 |
| | 682.0 | | 17.60 | 52,456 | | 181.8 |

| (2) Joist | 5-Inch Top Slab | | | | | |
|---|---|---|---|---|---|---|
| | Gross Area ($in.^2$) | Wt.(4) (plf) | $Y_{cg}$ (in.) | $I_g$ ($in.^4$) | $+M_{cr}$ (ft-k) | $-M_{cr}$ (ft-k) |
| 16 + 7 + 53 | 433.3 | 451 | 15.40 | 12,812 | 32.9 | 90.4 |
| 16 + 8 + 53 | 454.3 | 473 | 15.17 | 14,065 | 36.6 | 95.4 |
| 16 + 9 + 53 | 475.3 | 495 | 14.97 | 15,275 | 40.3 | 100.1 |
| 16 + 10 + 53 | 496.3 | 517 | 14.78 | 16,448 | 44.0 | 104.5 |
| 20 + 7 + 53 | 473.3 | 493 | 18.16 | 21,782 | 47.4 | 125.8 |
| 20 + 8 + 53 | 498.3 | 519 | 17.87 | 23,844 | 52.7 | 132.3 |
| 20 + 9 + 53 | 523.3 | 545 | 17.62 | 25,833 | 58.0 | 138.3 |
| 20 + 10 + 53 | 548.3 | 571 | 17.38 | 27,760 | 63.1 | 144.1 |
| 24 + 7 + 53 | 516.0 | 538 | 20.80 | 34,088 | 64.8 | 164.4 |
| 24 + 8 + 53 | 545.0 | 568 | 20.47 | 37,211 | 71.9 | 172.4 |
| 24 + 9 + 53 | 574.0 | 598 | 20.17 | 40,224 | 78.8 | 180.0 |
| 24 + 10 + 53 | 603.0 | 628 | 19.89 | 43,142 | 85.7 | 187.3 |
| 14 + 6 + 66 | 460.3 | 480 | 14.51 | 8,901 | 24.2 | 78.4 |
| 14 + 7 + 66 | 479.3 | 499 | 14.31 | 9,931 | 27.4 | 83.8 |
| 14 + 8 + 66 | 498.3 | 519 | 14.13 | 10,926 | 30.6 | 88.7 |
| 14 + 9 + 66 | 517.3 | 539 | 13.96 | 11,890 | 33.7 | 93.2 |
| 16 + 6 + 66 | 477.3 | 497 | 16.04 | 12,102 | 29.8 | 96.4 |
| 16 + 7 + 66 | 498.3 | 519 | 15.80 | 13,490 | 33.7 | 102.6 |
| 16 + 8 + 66 | 519.3 | 541 | 15.59 | 14,829 | 37.6 | 108.4 |
| 16 + 9 + 66 | 540.3 | 563 | 15.39 | 16,124 | 41.4 | 113.7 |
| 20 + 6 + 66 | 513.3 | 535 | 18.98 | 20,691 | 43.1 | 135.9 |
| 20 + 7 + 66 | 538.3 | 561 | 18.68 | 22,995 | 48.7 | 143.9 |
| 20 + 8 + 66 | 563.3 | 587 | 18.41 | 25,210 | 54.1 | 151.2 |
| 20 + 9 + 66 | 588.3 | 613 | 18.16 | 27,347 | 59.5 | 158.0 |
| 24 + 6 + 66 | 552.0 | 575 | 21.80 | 32,595 | 59.1 | 179.1 |
| 24 + 7 + 66 | 581.0 | 605 | 21.44 | 36,097 | 66.6 | 188.7 |
| 24 + 8 + 66 | 610.0 | 635 | 21.11 | 39,460 | 73.9 | 197.7 |
| 24 + 9 + 66 | 639.0 | 666 | 20.81 | 42,702 | 81.1 | 206.1 |

(1) $f'_c$ = 4,000 psi, rib side slope = 1 to 12.
(2) First value is the pan depth, second value is the rib width, and the third value is the pan width (in.)
(3) First value is for a standard section; second value is at a tapered end.
(4) For normal-weight concrete, w = 150 pcf (added weight of tapers is neglected.)

## TABLE 8-3(c) GROSS SECTION PROPERTIES — WIDE-MODULE JOIST CONSTRUCTION [1]

| [2] Joist | 5.5-Inch Top Slab | | | | | |
|---|---|---|---|---|---|---|
| | Gross Area[3] ($in.^2$) | Wt.[4] (plf) | $Y_{cg}$[3] (in.) | $I_g$[3] ($in.^4$) | $+M_{cr}$ (ft-k) | $-M_{cr}$[3] (ft-k) |
| 12 + 8 + 40 | 372.0 | 388 | 12.27 | 7,530 | 24.3 | 57.0 |
| | 444.0 | | 11.26 | 10,769 | | 68.2 |
| 12 + 9 + 40 | 389.5 | 406 | 12.12 | 8,184 | 26.7 | 60.1 |
| | 461.5 | | 11.16 | 11,321 | | 70.6 |
| 12 + 10 + 40 | 407.0 | 424 | 11.97 | 8,821 | 29.1 | 63.1 |
| | 479.0 | | 11.07 | 11,866 | | 73.0 |
| 14 + 8 + 40 | 392.3 | 409 | 13.66 | 10,467 | 30.3 | 70.8 |
| | 476.3 | | 12.48 | 14,906 | | 84.0 |
| 14 + 9 + 40 | 411.8 | 429 | 13.47 | 11,369 | 33.4 | 74.6 |
| | 495.8 | | 12.38 | 15,664 | | 86.9 |
| 14 + 10 + 40 | 431.3 | 449 | 13.30 | 12,245 | 36.4 | 78.1 |
| | 515.3 | | 12.28 | 16,411 | | 89.8 |
| 16 + 8 + 40 | 413.3 | 431 | 15.00 | 14,085 | 37.1 | 85.7 |
| | 509.3 | | 13.68 | 19,954 | | 100.9 |
| 16 + 9 + 40 | 434.8 | 453 | 14.79 | 15,283 | 40.8 | 90.1 |
| | 530.8 | | 13.56 | 20,960 | | 104.4 |
| 16 + 10 + 40 | 456.3 | 475 | 14.60 | 16,446 | 44.5 | 94.3 |
| | 552.3 | | 13.46 | 21,952 | | 107.9 |
| 18 + 8 + 40 | 435.0 | 453 | 16.32 | 18,440 | 44.7 | 101.5 |
| | 543.0 | | 14.86 | 25,989 | | 118.9 |
| 18 + 9 + 40 | 458.5 | 478 | 16.08 | 19,987 | 49.1 | 106.5 |
| | 566.5 | | 14.73 | 27,288 | | 123.0 |
| 18 + 10 + 40 | 482.0 | 502 | 15.87 | 21,488 | 53.5 | 111.3 |
| | 590.0 | | 14.61 | 28,571 | | 127.1 |
| 20 + 8 + 40 | 457.3 | 476 | 17.60 | 23,590 | 53.0 | 118.1 |
| | 577.3 | | 16.02 | 33,085 | | 138.0 |
| 20 + 9 + 40 | 482.8 | 503 | 17.35 | 25,541 | 58.2 | 123.8 |
| | 602.8 | | 15.88 | 34,728 | | 142.8 |
| 20 + 10 + 40 | 508.3 | 530 | 17.12 | 27,434 | 63.4 | 129.3 |
| | 628.3 | | 15.76 | 36,350 | | 147.5 |
| 22 + 8 + 40 | 480.3 | 500 | 18.87 | 29,590 | 62.0 | 135.5 |
| | 612.3 | | 17.17 | 41,319 | | 158.1 |
| 22 + 9 + 40 | 507.8 | 529 | 18.59 | 32,003 | 68.1 | 142.0 |
| | 639.8 | | 17.02 | 43,360 | | 163.6 |
| 22 + 10 + 40 | 535.3 | 558 | 18.34 | 34,347 | 74.0 | 148.2 |
| | 667.3 | | 16.89 | 45,375 | | 169.0 |
| 24 + 8 + 40 | 504.0 | 525 | 20.11 | 36,496 | 71.7 | 153.6 |
| | 648.0 | | 18.31 | 50,770 | | 179.3 |
| 24 + 9 + 40 | 533.5 | 556 | 19.81 | 39,435 | 78.7 | 160.9 |
| | 677.5 | | 18.15 | 53,266 | | 185.5 |
| 24 + 10 + 40 | 563.0 | 586 | 19.55 | 42,291 | 85.5 | 167.9 |
| | 707.0 | | 18.01 | 55,732 | | 191.7 |

| [2] Joist | 5.5-Inch Top Slab | | | | | |
|---|---|---|---|---|---|---|
| | Gross Area ($in.^2$) | Wt.[4] (plf) | $Y_{cg}$ (in.) | $I_g$ ($in.^4$) | $+M_{cr}$ (ft-k) | $-M_{cr}$ (ft-k) |
| 16 + 7 + 53 | 463.3 | 483 | 15.78 | 13,772 | 34.5 | 95.2 |
| 16 + 8 + 53 | 484.8 | 505 | 15.56 | 15,120 | 38.4 | 100.6 |
| 16 + 9 + 53 | 506.3 | 527 | 15.35 | 16,424 | 42.3 | 105.6 |
| 16 + 10 + 53 | 527.8 | 550 | 15.16 | 17,689 | 46.1 | 110.4 |
| 20 + 7 + 53 | 503.3 | 524 | 18.58 | 23,201 | 49.4 | 132.5 |
| 20 + 8 + 53 | 528.8 | 551 | 18.30 | 25,408 | 54.9 | 139.5 |
| 20 + 9 + 53 | 554.3 | 577 | 18.04 | 27,539 | 60.3 | 146.0 |
| 20 + 10 + 53 | 579.8 | 604 | 17.81 | 29,604 | 65.7 | 152.2 |
| 24 + 7 + 53 | 546.0 | 569 | 21.27 | 36,112 | 67.1 | 173.4 |
| 24 + 8 + 53 | 575.5 | 599 | 20.93 | 39,440 | 74.5 | 182.0 |
| 24 + 9 + 53 | 605.0 | 630 | 20.63 | 42,652 | 81.7 | 190.1 |
| 24 + 10 + 53 | 634.5 | 661 | 20.36 | 45,764 | 88.9 | 197.9 |
| 14 + 6 + 66 | 496.3 | 517 | 14.86 | 9,651 | 25.7 | 82.1 |
| 14 + 7 + 66 | 515.8 | 537 | 14.66 | 10,758 | 29.0 | 87.9 |
| 14 + 8 + 66 | 535.3 | 558 | 14.48 | 11,829 | 32.3 | 93.2 |
| 14 + 9 + 66 | 554.8 | 578 | 14.32 | 12,869 | 35.5 | 98.2 |
| 16 + 6 + 66 | 513.3 | 535 | 16.40 | 13,012 | 31.4 | 100.9 |
| 16 + 7 + 66 | 534.8 | 557 | 16.18 | 14,499 | 35.4 | 107.7 |
| 16 + 8 + 66 | 556.3 | 580 | 15.97 | 15,936 | 39.5 | 113.8 |
| 16 + 9 + 66 | 577.8 | 602 | 15.77 | 17,328 | 43.4 | 119.6 |
| 20 + 6 + 66 | 549.3 | 572 | 19.39 | 22,013 | 44.9 | 142.5 |
| 20 + 7 + 66 | 574.8 | 599 | 19.10 | 24,470 | 50.6 | 151.1 |
| 20 + 8 + 66 | 600.3 | 625 | 18.83 | 26,836 | 56.3 | 159.0 |
| 20 + 9 + 66 | 625.8 | 652 | 18.58 | 29,122 | 62.0 | 166.4 |
| 24 + 6 + 66 | 588.0 | 613 | 22.26 | 34,469 | 61.2 | 188.2 |
| 24 + 7 + 66 | 617.5 | 643 | 21.90 | 38,193 | 68.9 | 198.7 |
| 24 + 8 + 66 | 647.0 | 674 | 21.58 | 41,772 | 76.5 | 208.4 |
| 24 + 9 + 66 | 676.5 | 705 | 21.28 | 45,226 | 84.0 | 217.4 |

(1) $f'_c$ = 4,000 psi, rib side slope = 1 to 12.
(2) First value is the pan depth, second value is the rib width, and the third value is the pan width (in.)
(3) First value is for a standard section; second value is at a tapered end.
(4) For normal-weight concrete, w = 150 pcf (added weight of tapers is neglected.)

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 9 | 7.5 | 10 | | 10 | 7.5 | 10 | 8 | 7 | |
| BOTTOM BARS NO | 1# 4 | 1# 5 | 1# 6 | 1# 6 | 1# 5 | | 1# 4 | 1# 5 | 1# 6 | 1# 6 | 1# 5 | |
| BARS NO | 1# 5 | 1# 6 | 1# 6 | 1# 7 | 2# 6 | | 1# 5 | 1# 6 | 1# 6 | 1# 7 | 2# 6 | |
| STEEL (PSF) | 0.60 | 0.78 | 0.92 | 1.08 | 1.20 | | 0.84 | 1.18 | 1.41 | 1.70 | 1.90 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 235 | 530 | 688 | 881 | 1069 | 1.265 | 526 | 955 | 1185 | 1466 | 1740 | 0.779 |
| STIR | #3- 49 | #3- 86 | #3- 98 | #3-106 | #3-118 | | #3- 64 | #3- 90 | #3- 85 | #3-107 | #3-112 | |
| 25'- 0" | 185 | 457 | 603 | 780 | 954 | 1.490 | 453 | 848 | 1061 | 1319 | 1572 | 0.917 |
| STIR | #3- 46 | #3- 86 | #3- 99 | #3-110 | #3-121 | | #3- 63 | #3- 91 | #3- 92 | #3-110 | #3-115 | |
| 26'- 0" | 140 | 392 | 526 | 691 | 851 | 1.743 | 389 | 754 | 950 | 1189 | 1422 | 1.073 |
| STIR | #3- 43 | #3- 86 | #3-100 | #3-112 | #3-108 | | #3- 62 | #3- 92 | #3-100 | #3-112 | #3-118 | |
| 27'- 0" | 101 | 334 | 459 | 611 | 760 | 2.027 | 331 | 670 | 852 | 1073 | 1290 | 1.247 |
| STIR | #3- 39 | #3- 86 | #3-100 | #3-113 | #3-116 | | #3- 61 | #3- 93 | #3-103 | #3-115 | #3-121 | |
| 28'- 0" | 65 | 282 | 398 | 540 | 678 | 2.344 | 279 | 594 | 763 | 970 | 1171 | 1.443 |
| STIR | #3- 34 | #3- 85 | #3-101 | #3-115 | #3-125 | | #3- 59 | #3- 94 | #3-105 | #3-116 | #3-123 | |
| 29'- 0" | 33 | 235 | 344 | 476 | 605 | 2.698 | 233 | 526 | 684 | 876 | 1064 | 1.660 |
| STIR | #3- 30 | #3- 84 | #3-101 | #3-116 | #3-127 | | #3- 57 | #3- 94 | #3-106 | #3-106 | #3-126 | |
| 30'- 0" | 5 | 193 | 295 | 418 | 538 | 3.090 | 191 | 465 | 613 | 792 | 968 | 1.901 |
| STIR | #3- 25 | #3- 82 | #3-101 | #3-117 | #3-129 | | #3- 55 | #3- 95 | #3-107 | #3-113 | #3-129 | |
| 31'- 0" | | 155 | 250 | 366 | 479 | 3.523 | 153 | 410 | 548 | 716 | 880 | 2.168 |
| STIR | | #3- 81 | #3-100 | #3-117 | #3-130 | | #3- 52 | #3- 95 | #3-108 | #3-120 | #3-131 | |
| 32'- 0" | | 121 | 210 | 318 | 424 | 4.000 | 119 | 360 | 489 | 647 | 801 | 2.461 |
| STIR | | #3- 79 | #3-100 | #3-118 | #3-132 | | #3- 49 | #3- 95 | #3-109 | #3-122 | #3-133 | |
| 33'- 0" | | 89 | 173 | 275 | 375 | 4.523 | 87 | 314 | 436 | 584 | 729 | 2.784 |
| STIR | | #3- 77 | #3- 99 | #3-118 | #3-133 | | #3- 46 | #3- 94 | #3-110 | #3-123 | #3-135 | |
| 34'- 0" | | 61 | 139 | 236 | 329 | 5.097 | 59 | 272 | 387 | 527 | 663 | 3.137 |
| STIR | | #3- 74 | #3- 98 | #3-118 | #3-134 | | #3- 43 | #3- 94 | #3-111 | #3-125 | #3-126 | |
| 35'- 0" | | 34 | 109 | 200 | 288 | 5.724 | 33 | 234 | 343 | 475 | 603 | 3.522 |
| STIR | | #3- 71 | #3- 96 | #3-118 | #3-135 | | #3- 39 | #3- 93 | #3-111 | #3-126 | #3-134 | |
| 36'- 0" | | 10 | 81 | 166 | 250 | 6.407 | 9 | 199 | 302 | 426 | 548 | 3.942 |
| STIR | | #3- 68 | #3- 95 | #3-118 | #3-135 | | #3- 35 | #3- 93 | #3-111 | #3-127 | #3-138 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.96 | 0.96 | 1.07 | 1.28 | 1.49 | | 0.96 | 1.28 | 1.49 | 1.86 | 2.13 | |
| ACTUAL STEEL % | 0.726 | 0.726 | 0.807 | 0.968 | 1.131 | | 0.726 | 0.968 | 1.131 | 1.414 | 1.616 | |
| EFF. DEPTH, IN. | 14.38 | 14.38 | 14.38 | 14.38 | 14.31 | | 14.38 | 14.38 | 14.31 | 14.31 | 14.31 | |
| $-I_{cr}/I_{gr}$ | 0.151 | 0.151 | 0.164 | 0.189 | 0.209 | | 0.151 | 0.189 | 0.209 | 0.246 | 0.270 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.51 | 0.75 | 0.88 | 1.04 | 1.19 | | 0.51 | 0.75 | 0.88 | 1.04 | 1.19 | |
| ACTUAL STEEL % | 0.364 | 0.537 | 0.631 | 0.748 | 0.853 | | 0.364 | 0.537 | 0.631 | 0.748 | 0.853 | |
| EFF. DEPTH, IN. | 14.71 | 14.65 | 14.62 | 14.59 | 14.64 | | 14.71 | 14.65 | 14.62 | 14.59 | 14.64 | |
| $+I_{cr}/I_{gr}$ | 0.116 | 0.164 | 0.189 | 0.218 | 0.248 | | 0.116 | 0.164 | 0.189 | 0.218 | 0.248 | |
| SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 7.5 | 10 | 9 | | 10 | 7 | 8.5 | 7.5 | 9 | |
| BOTTOM BARS NO | 1# 4 | 1# 4 | 2# 4 | 1# 5 | 2# 6 | | 1# 4 | 1# 4 | 2# 4 | 1# 5 | 2# 6 | |
| BARS NO | 1# 5 | 2# 5 | 2# 5 | 2# 6 | 1# 6 | | 1# 5 | 2# 5 | 2# 5 | 2# 6 | 1# 6 | |
| STEEL (PSF) | 0.60 | 0.79 | 1.03 | 1.18 | 1.34 | | 0.84 | 1.23 | 1.59 | 1.81 | 2.12 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 215 | 600 | 847 | 1049 | 1206 | 1.265 | 506 | 1066 | 1426 | 1720 | 1948 | 0.779 |
| STIR | #3- 36 | #3- 85 | #3-101 | #3-102 | #3-118 | | #3- 56 | #3- 89 | #3-102 | #3-108 | #3-112 | |
| 25'- 0" | 164 | 519 | 748 | 934 | 1078 | 1.490 | 433 | 949 | 1281 | 1552 | 1762 | 0.917 |
| STIR | #3- 32 | #3- 85 | #3-102 | #3-110 | #3-120 | | #3- 54 | #3- 90 | #3-104 | #3-111 | #3-116 | |
| 26'- 0" | 120 | 448 | 659 | 831 | 965 | 1.743 | 368 | 845 | 1152 | 1402 | 1597 | 1.073 |
| STIR | #3- 28 | #3- 85 | #3-104 | #3-114 | #3-108 | | #3- 52 | #3- 91 | #3- 95 | #3-113 | #3-118 | |
| 27'- 0" | 80 | 384 | 580 | 740 | 863 | 2.027 | 310 | 753 | 1037 | 1269 | 1450 | 1.247 |
| STIR | #3- 23 | #3- 84 | #3-104 | #3-116 | #3-116 | | #3- 50 | #3- 92 | #3-103 | #3-116 | #3-121 | |
| 28'- 0" | 45 | 327 | 510 | 658 | 773 | 2.344 | 259 | 670 | 935 | 1151 | 1318 | 1.443 |
| STIR | #3- 17 | #3- 84 | #3-105 | #3-118 | #3-125 | | #3- 47 | #3- 93 | #3-108 | #3-118 | #3-124 | |
| 29'- 0" | 13 | 276 | 446 | 584 | 692 | 2.698 | 212 | 596 | 843 | 1044 | 1200 | 1.660 |
| STIR | | #3- 82 | #3-105 | #3-119 | #3-127 | | #3- 44 | #3- 93 | #3-110 | #3-120 | #3-126 | |
| 30'- 0" | | 230 | 389 | 518 | 618 | 3.090 | 170 | 529 | 759 | 947 | 1093 | 1.901 |
| STIR | | #3- 81 | #3-106 | #3-120 | #3-129 | | #3- 41 | #3- 94 | #3-111 | #3-109 | #3-128 | |
| 31'- 0" | | 189 | 337 | 458 | 552 | 3.523 | 133 | 468 | 684 | 860 | 997 | 2.168 |
| STIR | | #3- 79 | #3-106 | #3-121 | #3-130 | | #3- 38 | #3- 94 | #3-112 | #3-117 | #3-131 | |
| 32'- 0" | | 151 | 290 | 404 | 492 | 4.000 | 98 | 413 | 616 | 781 | 909 | 2.461 |
| STIR | | #3- 77 | #3-105 | #3-122 | #3-131 | | #3- 34 | #3- 94 | #3-113 | #3-124 | #3-133 | |
| 33'- 0" | | 116 | 247 | 354 | 437 | 4.523 | 67 | 363 | 554 | 709 | 829 | 2.784 |
| STIR | | #3- 75 | #3-105 | #3-122 | #3-133 | | #3- 30 | #3- 93 | #3-114 | #3-126 | #3-135 | |
| 34'- 0" | | 85 | 208 | 309 | 387 | 5.097 | 38 | 317 | 497 | 643 | 757 | 3.137 |
| STIR | | #3- 72 | #3-104 | #3-123 | #3-134 | | #3- 25 | #3- 93 | #3-115 | #3-127 | #3-126 | |
| 35'- 0" | | 56 | 173 | 268 | 341 | 5.724 | 12 | 275 | 445 | 583 | 690 | 3.522 |
| STIR | | #3- 70 | #3-103 | #3-123 | #3-134 | | #3- 21 | #3- 92 | #3-116 | #3-129 | #3-134 | |
| 36'- 0" | | 30 | 140 | 230 | 299 | 6.407 | | 237 | 397 | 528 | 629 | 3.942 |
| STIR | | #3- 66 | #3-102 | #3-123 | #3-135 | | | #3- 91 | #3-116 | #3-130 | #3-139 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.98 | 0.98 | 1.31 | 1.52 | 1.69 | | 0.98 | 1.40 | 1.79 | 2.03 | 2.40 | |
| ACTUAL STEEL % | 0.669 | 0.669 | 0.891 | 1.041 | 1.157 | | 0.669 | 0.955 | 1.225 | 1.388 | 1.650 | |
| EFF. DEPTH, IN. | 14.38 | 14.38 | 14.38 | 14.31 | 14.31 | | 14.38 | 14.38 | 14.31 | 14.31 | 14.25 | |
| $-I_{cr}/I_{gr}$ | 0.145 | 0.145 | 0.182 | 0.201 | 0.218 | | 0.145 | 0.191 | 0.227 | 0.249 | 0.277 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.51 | 0.82 | 1.02 | 1.19 | 1.32 | | 0.51 | 0.82 | 1.02 | 1.19 | 1.32 | |
| ACTUAL STEEL % | 0.329 | 0.530 | 0.659 | 0.772 | 0.857 | | 0.329 | 0.530 | 0.659 | 0.772 | 0.857 | |
| EFF. DEPTH, IN. | 14.71 | 14.70 | 14.71 | 14.64 | 14.62 | | 14.71 | 14.70 | 14.71 | 14.64 | 14.62 | |
| $+I_{cr}/I_{gr}$ | 0.106 | 0.165 | 0.201 | 0.229 | 0.251 | | 0.106 | 0.165 | 0.201 | 0.229 | 0.251 | |
| SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>12″ Deep Rib + 4.5″ Top Slab = 16.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 7.5 | 10 | 8 | | 10 | 10 | 8.5 | 7 | 6 | |
| BOTTOM BARS NO | 2# 4 | 2# 5 | 2# 5 | 2# 5 | 2# 6 | | 2# 4 | 2# 5 | 2# 5 | 2# 5 | 2# 6 | |
| BARS NO | 1# 4 | 1# 5 | 1# 6 | 2# 5 | 1# 7 | | 1# 4 | 1# 5 | 1# 6 | 2# 5 | 1# 7 | |
| STEEL (PSF) | 0.64 | 0.89 | 1.06 | 1.25 | 1.50 | | 0.88 | 1.38 | 1.62 | 1.95 | 2.28 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 308 | 714 | 872 | 1095 | 1377 | 1.265 | 652 | 1242 | 1471 | 1796 | 2206 | 0.779 |
| STIR | #3- 45 | #3- 88 | #3- 97 | #3-107 | #3-119 | | #3- 62 | #3- 91 | #3- 86 | #3-107 | #4-113 | |
| 25'- 0" | 249 | 623 | 768 | 974 | 1234 | 1.490 | 565 | 1109 | 1321 | 1620 | 1998 | 0.917 |
| STIR | #3- 42 | #3- 88 | #3- 98 | #3-109 | #3-121 | | #3- 61 | #3- 92 | #3- 93 | #3-109 | #3-116 | |
| 26'- 0" | 197 | 542 | 677 | 867 | 1107 | 1.743 | 489 | 992 | 1187 | 1464 | 1813 | 1.073 |
| STIR | #3- 38 | #3- 88 | #3- 99 | #3-111 | #3-124 | | #3- 59 | #3- 94 | #3-101 | #3-111 | #3-118 | |
| 27'- 0" | 150 | 470 | 595 | 771 | 994 | 2.027 | 421 | 887 | 1069 | 1325 | 1649 | 1.247 |
| STIR | #3- 34 | #3- 87 | #3- 99 | #3-112 | #3-114 | | #3- 57 | #3- 95 | #3-103 | #3-113 | #3-122 | |
| 28'- 0" | 108 | 406 | 522 | 686 | 893 | 2.344 | 360 | 794 | 962 | 1201 | 1502 | 1.443 |
| STIR | #3- 29 | #3- 87 | #3-100 | #3-114 | #3-123 | | #3- 55 | #3- 96 | #3-104 | #3-116 | #3-124 | |
| 29'- 0" | 70 | 348 | 456 | 609 | 802 | 2.698 | 305 | 710 | 867 | 1089 | 1370 | 1.660 |
| STIR | #3- 24 | #3- 86 | #3-100 | #3-115 | #3-128 | | #3- 53 | #3- 96 | #3-106 | #3-107 | #3-127 | |
| 30'- 0" | 37 | 296 | 397 | 540 | 720 | 3.090 | 256 | 634 | 781 | 989 | 1251 | 1.901 |
| STIR | #3- 18 | #3- 85 | #3- 99 | #3-116 | #3-130 | | #3- 51 | #3- 97 | #3-107 | #3-115 | #3-129 | |
| 31'- 0" | 6 | 249 | 344 | 477 | 646 | 3.523 | 212 | 565 | 703 | 897 | 1143 | 2.168 |
| STIR | | #3- 83 | #3- 99 | #3-116 | #3-132 | | #3- 48 | #3- 97 | #3-108 | #3-119 | #3-132 | |
| 32'- 0" | | 206 | 295 | 421 | 579 | 4.000 | 171 | 503 | 632 | 815 | 1045 | 2.461 |
| STIR | | #3- 82 | #3- 98 | #3-117 | #3-133 | | #3- 45 | #3- 97 | #3-109 | #3-121 | #3-134 | |
| 33'- 0" | | 167 | 251 | 369 | 518 | 4.523 | 134 | 446 | 568 | 739 | 956 | 2.784 |
| STIR | | #3- 80 | #3- 97 | #3-117 | #3-134 | | #3- 41 | #3- 97 | #3-109 | #3-122 | #3-136 | |
| 34'- 0" | | 132 | 210 | 321 | 462 | 5.097 | 101 | 395 | 509 | 671 | 875 | 3.137 |
| STIR | | #3- 77 | #3- 96 | #3-117 | #3-135 | | #3- 38 | #3- 97 | #3-110 | #3-123 | #3-124 | |
| 35'- 0" | | 99 | 173 | 278 | 411 | 5.724 | 70 | 347 | 455 | 608 | 801 | 3.522 |
| STIR | | #3- 75 | #3- 95 | #3-117 | #3-136 | | #3- 34 | #3- 96 | #3-110 | #3-125 | #3-132 | |
| 36'- 0" | | 69 | 139 | 239 | 364 | 6.407 | 41 | 304 | 406 | 550 | 732 | 3.942 |
| STIR | | #3- 72 | #3- 93 | #3-116 | #3-137 | | #3- 29 | #3- 96 | #3-110 | #3-126 | #3-139 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | | | | | | | | | | | | |
| ACTUAL STEEL % | 1.00 | 1.11 | 1.33 | 1.55 | 1.94 | | 1.00 | 1.55 | 1.82 | 2.21 | 2.58 | |
| EFF. DEPTH, IN. | 0.621 | 0.690 | 0.828 | 0.968 | 1.209 | | 0.621 | 0.968 | 1.138 | 1.382 | 1.613 | |
| $-I_{cr}/I_{gr}$ | 14.38 | 14.38 | 14.38 | 14.31 | 14.31 | | 14.38 | 14.31 | 14.31 | 14.31 | 14.31 | |
| | 0.140 | 0.152 | 0.175 | 0.195 | 0.230 | | 0.140 | 0.195 | 0.220 | 0.253 | 0.282 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | | | | | | | | | | | | |
| ACTUAL STEEL % | 0.60 | 0.93 | 1.06 | 1.24 | 1.48 | | 0.60 | 0.93 | 1.06 | 1.24 | 1.48 | |
| EFF. DEPTH, IN. | 0.353 | 0.549 | 0.627 | 0.732 | 0.879 | | 0.353 | 0.549 | 0.627 | 0.732 | 0.879 | |
| $+I_{cr}/I_{gr}$ | 14.75 | 14.69 | 14.66 | 14.69 | 14.60 | | 14.75 | 14.69 | 14.66 | 14.69 | 14.60 | |
| SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 7.5 | 10 | 8.5 | | 10 | 10 | 8.5 | 7 | 5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 1# 6 | 1# 5 | 1# 7 | | 2# 4 | 1# 6 | 1# 6 | 1# 5 | 1# 7 | |
| BARS NO | 1# 4 | 1# 6 | 1# 7 | 2# 6 | 1# 8 | | 1# 4 | 1# 6 | 1# 7 | 2# 6 | 1# 8 | |
| STEEL (PSF) | 0.66 | 0.92 | 1.08 | 1.20 | 1.45 | | 0.90 | 1.41 | 1.64 | 1.90 | 2.51 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 427 | 814 | 1035 | 1249 | 1513 | 1.265 | 817 | 1380 | 1701 | 2012 | 2396 | 0.779 |
| STIR | #3- 65 | #3- 97 | #3-107 | #3-117 | #3-124 | | #3- 75 | #3- 87 | #3-106 | #3-112 | #4-116 | |
| 25'- 0" | 360 | 717 | 920 | 1117 | 1360 | 1.490 | 719 | 1238 | 1534 | 1820 | 2175 | 0.917 |
| STIR | #3- 63 | #3- 97 | #3-109 | #3-119 | #3-127 | | #3- 75 | #3- 94 | #3-109 | #3-114 | #4-120 | |
| 26'- 0" | 300 | 630 | 818 | 1000 | 1225 | 1.743 | 632 | 1112 | 1385 | 1651 | 1978 | 1.073 |
| STIR | #3- 61 | #3- 98 | #3-111 | #3-110 | #3-130 | | #3- 75 | #3-101 | #3-112 | #3-118 | #4-123 | |
| 27'- 0" | 247 | 553 | 727 | 896 | 1105 | 2.027 | 555 | 1000 | 1253 | 1499 | 1803 | 1.247 |
| STIR | #3- 59 | #3- 99 | #3-112 | #3-118 | #3-132 | | #3- 75 | #3-102 | #3-113 | #3-120 | #3-126 | |
| 28'- 0" | 199 | 484 | 646 | 803 | 997 | 2.344 | 486 | 900 | 1135 | 1364 | 1646 | 1.443 |
| STIR | #3- 56 | #3- 99 | #3-113 | #3-124 | #3-135 | | #3- 74 | #3-104 | #3-100 | #3-123 | #3-129 | |
| 29'- 0" | 157 | 422 | 573 | 719 | 900 | 2.698 | 424 | 809 | 1029 | 1242 | 1505 | 1.660 |
| STIR | #3- 53 | #3- 99 | #3-114 | #3-126 | #3-138 | | #3- 73 | #3-105 | #3-108 | #3-125 | #3-132 | |
| 30'- 0" | 118 | 366 | 507 | 644 | 813 | 3.090 | 368 | 728 | 933 | 1133 | 1378 | 1.901 |
| STIR | #3- 49 | #3- 99 | #3-115 | #3-127 | #3-126 | | #3- 72 | #3-106 | #3-115 | #3-127 | #3-135 | |
| 31'- 0" | 83 | 315 | 447 | 576 | 734 | 3.523 | 317 | 655 | 847 | 1033 | 1264 | 2.168 |
| STIR | #3- 45 | #3- 98 | #3-116 | #3-129 | #3-134 | | #3- 70 | #3-107 | #3-119 | #3-129 | #3-138 | |
| 32'- 0" | 52 | 269 | 393 | 514 | 662 | 4.000 | 271 | 588 | 768 | 943 | 1159 | 2.461 |
| STIR | #3- 41 | #3- 97 | #3-116 | #3-130 | #3-142 | | #3- 69 | #3-108 | #3-121 | #3-132 | #3-141 | |
| 33'- 0" | 23 | 228 | 344 | 457 | 597 | 4.523 | 229 | 527 | 697 | 861 | 1064 | 2.784 |
| STIR | #3- 36 | #3- 96 | #3-116 | #3-131 | #3-144 | | #3- 67 | #3-108 | #3-122 | #3-121 | #3-143 | |
| 34'- 0" | | 189 | 299 | 406 | 538 | 5.097 | 191 | 471 | 631 | 786 | 978 | 3.137 |
| STIR | | #3- 95 | #3-116 | #3-132 | #3-146 | | #3- 65 | #3-109 | #3-123 | #3-129 | #3-145 | |
| 35'- 0" | | 155 | 258 | 359 | 483 | 5.724 | 156 | 421 | 571 | 718 | 898 | 3.522 |
| STIR | | #3- 93 | #3-116 | #3-133 | #3-147 | | #3- 62 | #3-109 | #3-124 | #3-135 | #3-148 | |
| 36'- 0" | | 122 | 220 | 316 | 433 | 6.407 | 124 | 374 | 517 | 655 | 826 | 3.942 |
| STIR | | #3- 92 | #3-115 | #3-133 | #3-149 | | #3- 60 | #3-109 | #3-125 | #3-137 | #3-150 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.96 | 1.07 | 1.28 | 1.49 | 1.75 | | 0.96 | 1.49 | 1.75 | 2.13 | 2.98 | |
| ACTUAL STEEL % | 0.626 | 0.696 | 0.835 | 0.975 | 1.147 | | 0.626 | 0.975 | 1.147 | 1.392 | 1.949 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.31 | 16.31 | | 16.38 | 16.31 | 16.31 | 16.31 | 16.31 | |
| $-I_{cr}/I_{gr}$ | 0.143 | 0.155 | 0.179 | 0.199 | 0.225 | | 0.143 | 0.199 | 0.225 | 0.258 | 0.326 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.60 | 0.88 | 1.04 | 1.19 | 1.39 | | 0.60 | 0.88 | 1.04 | 1.19 | 1.39 | |
| ACTUAL STEEL % | 0.370 | 0.546 | 0.646 | 0.737 | 0.867 | | 0.370 | 0.546 | 0.646 | 0.737 | 0.867 | |
| EFF. DEPTH, IN. | 16.75 | 16.62 | 16.59 | 16.64 | 16.53 | | 16.75 | 16.62 | 16.59 | 16.64 | 16.53 | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.174 | 0.202 | 0.230 | 0.260 | | 0.124 | 0.174 | 0.202 | 0.230 | 0.260 | |
| SINGLE LEG STIRRUP AT IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8 | 10 | 9 | 7.5 | | 10 | 9 | 7.5 | 9.5 | 5 | |
| BOTTOM BARS NO | 2# 4 | 2# 4 | 1# 5 | 2# 6 | 1# 8 | | 2# 4 | 2# 4 | 1# 5 | 2# 6 | 1# 8 | |
| BARS NO | 1# 4 | 2# 5 | 2# 6 | 1# 6 | 1# 8 | | 1# 4 | 2# 5 | 2# 6 | 1# 6 | 1# 8 | |
| STEEL (PSF) | 0.65 | 1.01 | 1.18 | 1.34 | 1.64 | | 0.89 | 1.54 | 1.81 | 2.06 | 3.31 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 277 | 780 | 977 | 1130 | 1422 | 1.743 | 609 | 1342 | 1628 | 1850 | 2275 | 1.073 |
| STIR | #3- 48 | #3-102 | #3-113 | #3-110 | #3-131 | | #3- 66 | #3- 97 | #3-113 | #3-117 | #4-120 | |
| 27'- 0" | 224 | 691 | 873 | 1015 | 1286 | 2.027 | 532 | 1211 | 1477 | 1682 | 2076 | 1.247 |
| STIR | #3- 45 | #3-103 | #3-115 | #3-118 | #3-134 | | #3- 65 | #3-104 | #3-115 | #3-120 | #4-126 | |
| 28'- 0" | 176 | 610 | 780 | 912 | 1164 | 2.344 | 463 | 1094 | 1341 | 1533 | 1899 | 1.443 |
| STIR | #3- 41 | #3-103 | #3-116 | #3-124 | #3-136 | | #3- 64 | #3-107 | #3-118 | #3-123 | #4-130 | |
| 29'- 0" | 134 | 538 | 697 | 819 | 1054 | 2.698 | 401 | 989 | 1220 | 1398 | 1739 | 1.660 |
| STIR | #3- 37 | #3-104 | #3-118 | #3-126 | #3-139 | | #3- 62 | #3-108 | #3-104 | #3-126 | #3-133 | |
| 30'- 0" | 95 | 473 | 621 | 736 | 955 | 3.090 | 345 | 895 | 1110 | 1276 | 1596 | 1.901 |
| STIR | #3- 32 | #3-104 | #3-119 | #3-127 | #3-142 | | #3- 60 | #3-110 | #3-111 | #3-128 | #3-137 | |
| 31'- 0" | 60 | 414 | 553 | 660 | 866 | 3.523 | 294 | 809 | 1011 | 1167 | 1465 | 2.168 |
| STIR | #3- 27 | #3-104 | #3-119 | #3-129 | #3-131 | | #3- 58 | #3-111 | #3-119 | #3-130 | #3-139 | |
| 32'- 0" | 29 | 361 | 491 | 592 | 784 | 4.000 | 248 | 731 | 920 | 1067 | 1347 | 2.461 |
| STIR | #3- 22 | #3-103 | #3-120 | #3-130 | #3-140 | | #3- 55 | #3-112 | #3-123 | #3-132 | #3-142 | |
| 33'- 0" | | 312 | 435 | 529 | 711 | 4.523 | 206 | 661 | 838 | 976 | 1240 | 2.784 |
| STIR | | #3-103 | #3-120 | #3-131 | #3-146 | | #3- 53 | #3-113 | #3-125 | #3-121 | #3-144 | |
| 34'- 0" | | 268 | 383 | 472 | 643 | 5.097 | 168 | 596 | 763 | 893 | 1142 | 3.137 |
| STIR | | #3-102 | #3-121 | #3-132 | #3-148 | | #3- 50 | #3-113 | #3-126 | #3-128 | #3-147 | |
| 35'- 0" | | 227 | 336 | 420 | 581 | 5.724 | 133 | 537 | 695 | 817 | 1052 | 3.522 |
| STIR | | #3-101 | #3-121 | #3-133 | #3-150 | | #3- 46 | #3-114 | #3-127 | #3-136 | #3-150 | |
| 36'- 0" | | 190 | 293 | 372 | 525 | 6.407 | 101 | 483 | 632 | 748 | 969 | 3.942 |
| STIR | | #3- 99 | #3-121 | #3-133 | #3-151 | | #3- 43 | #3-114 | #3-128 | #3-137 | #3-151 | |
| 37'- 0" | | 156 | 253 | 328 | 472 | 7.149 | 71 | 433 | 574 | 684 | 893 | 4.399 |
| STIR | | #3- 98 | #3-120 | #3-133 | #3-153 | | #3- 39 | #3-115 | #3-129 | #3-139 | #3-154 | |
| 38'- 0" | | 124 | 216 | 287 | 424 | 7.953 | 44 | 387 | 521 | 625 | 823 | 4.894 |
| STIR | | #3- 96 | #3-120 | #3-134 | #3-154 | | #3- 35 | #3-115 | #3-130 | #3-140 | #3-156 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.98 | 1.23 | 1.52 | 1.69 | 2.03 | | 0.98 | 1.69 | 2.03 | 2.27 | 4.31 | |
| ACTUAL STEEL % | 0.577 | 0.722 | 0.899 | 0.999 | 1.199 | | 0.577 | 0.999 | 1.199 | 1.349 | 2.563 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.31 | 16.31 | 16.31 | | 16.38 | 16.31 | 16.31 | 16.25 | 16.25 | |
| $-I_{cr}/I_{gr}$ | 0.137 | 0.164 | 0.191 | 0.207 | 0.237 | | 0.137 | 0.207 | 0.237 | 0.255 | 0.393 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.60 | 1.02 | 1.19 | 1.32 | 1.58 | | 0.60 | 1.02 | 1.19 | 1.32 | 1.58 | |
| ACTUAL STEEL % | 0.335 | 0.571 | 0.669 | 0.742 | 0.894 | | 0.335 | 0.571 | 0.669 | 0.742 | 0.894 | |
| EFF. DEPTH, IN. | 16.75 | 16.71 | 16.64 | 16.62 | 16.50 | | 16.75 | 16.71 | 16.64 | 16.62 | 16.50 | |
| $+I_{cr}/I_{gr}$ | 0.115 | 0.186 | 0.212 | 0.232 | 0.269 | | 0.115 | 0.186 | 0.212 | 0.232 | 0.269 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8 | 10 | 8.5 | 7.5 | | 8.5 | 9 | 7.5 | 6 | 7.5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 5 | 2# 6 | 1# 6 | | 2# 4 | 1# 6 | 2# 5 | 2# 6 | 1# 6 | |
| BARS NO | 1# 5 | 1# 7 | 2# 5 | 1# 7 | 2# 7 | | 1# 5 | 1# 7 | 2# 5 | 1# 7 | 2# 7 | |
| STEEL (PSF) | 0.73 | 1.03 | 1.25 | 1.47 | 1.60 | | 1.06 | 1.56 | 1.88 | 2.28 | 2.54 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 386 | 772 | 1018 | 1293 | 1479 | 1.743 | 778 | 1340 | 1698 | 2098 | 2368 | 1.073 |
| STIR | #3- 58 | #3- 96 | #3-110 | #3-108 | #3-129 | | #3- 73 | #3- 99 | #3-111 | #3-118 | #4-122 | |
| 27'- 0" | 323 | 681 | 909 | 1165 | 1337 | 2.027 | 687 | 1208 | 1540 | 1911 | 2161 | 1.247 |
| STIR | #3- 55 | #3- 96 | #3-111 | #3-116 | #3-131 | | #3- 72 | #3-100 | #3-113 | #3-121 | #4-125 | |
| 28'- 0" | 267 | 600 | 812 | 1050 | 1210 | 2.344 | 605 | 1090 | 1398 | 1744 | 1976 | 1.443 |
| STIR | #3- 52 | #3- 96 | #3-112 | #3-125 | #3-134 | | #3- 71 | #3-102 | #3-102 | #3-124 | #4-129 | |
| 29'- 0" | 216 | 527 | 725 | 946 | 1095 | 2.698 | 532 | 984 | 1271 | 1593 | 1810 | 1.660 |
| STIR | #3- 48 | #3- 96 | #3-113 | #3-127 | #3-121 | | #3- 70 | #3-103 | #3-109 | #3-126 | #3-131 | |
| 30'- 0" | 171 | 461 | 646 | 853 | 992 | 3.090 | 466 | 888 | 1157 | 1457 | 1660 | 1.901 |
| STIR | #3- 45 | #3- 95 | #3-114 | #3-129 | #3-129 | | #3- 69 | #3-104 | #3-116 | #3-129 | #3-134 | |
| 31'- 0" | 130 | 402 | 575 | 768 | 899 | 3.523 | 406 | 801 | 1053 | 1335 | 1524 | 2.168 |
| STIR | #3- 40 | #3- 94 | #3-115 | #3-130 | #3-138 | | #3- 67 | #3-105 | #3-118 | #3-131 | #3-137 | |
| 32'- 0" | 92 | 348 | 510 | 692 | 814 | 4.000 | 351 | 722 | 959 | 1223 | 1401 | 2.461 |
| STIR | #3- 36 | #3- 93 | #3-115 | #3-132 | #3-140 | | #3- 65 | #3-105 | #3-120 | #3-133 | #3-139 | |
| 33'- 0" | 58 | 298 | 451 | 622 | 737 | 4.523 | 302 | 651 | 873 | 1122 | 1289 | 2.784 |
| STIR | #3- 31 | #3- 92 | #3-115 | #3-133 | #3-142 | | #3- 63 | #3-106 | #3-121 | #3-119 | #3-141 | |
| 34'- 0" | 27 | 253 | 397 | 558 | 667 | 5.097 | 257 | 585 | 795 | 1029 | 1187 | 3.137 |
| STIR | #3- 26 | #3- 91 | #3-115 | #3-134 | #3-143 | | #3- 61 | #3-106 | #3-122 | #3-126 | #3-144 | |
| 35'- 0" | | 212 | 348 | 500 | 602 | 5.724 | 215 | 526 | 723 | 944 | 1093 | 3.522 |
| STIR | | #3- 89 | #3-115 | #3-135 | #3-145 | | #3- 58 | #3-106 | #3-123 | #3-134 | #3-146 | |
| 36'- 0" | | 174 | 303 | 446 | 543 | 6.407 | 178 | 471 | 657 | 866 | 1007 | 3.942 |
| STIR | | #3- 87 | #3-114 | #3-135 | #3-146 | | #3- 55 | #3-106 | #3-124 | #3-139 | #3-149 | |
| 37'- 0" | | 140 | 261 | 397 | 489 | 7.149 | 143 | 420 | 597 | 795 | 928 | 4.399 |
| STIR | | #3- 85 | #3-114 | #3-136 | #3-147 | | #3- 52 | #3-106 | #3-125 | #3-140 | #3-135 | |
| 38'- 0" | | 108 | 223 | 352 | 439 | 7.953 | 110 | 374 | 541 | 729 | 855 | 4.894 |
| STIR | | #3- 82 | #3-113 | #3-136 | #3-148 | | #3- 49 | #3-105 | #3-125 | #3-142 | #3-142 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.00 | 1.25 | 1.55 | 1.82 | 2.07 | | 1.18 | 1.72 | 2.07 | 2.58 | 2.93 | |
| ACTUAL STEEL % | 0.537 | 0.672 | 0.836 | 0.984 | 1.115 | | 0.632 | 0.929 | 1.115 | 1.394 | 1.590 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.31 | 16.31 | 16.31 | | 16.38 | 16.31 | 16.31 | 16.31 | 16.25 | |
| $-I_{cr}/I_{gr}$ | 0.132 | 0.158 | 0.185 | 0.209 | 0.230 | | 0.150 | 0.201 | 0.230 | 0.270 | 0.293 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.71 | 1.04 | 1.24 | 1.48 | 1.64 | | 0.71 | 1.04 | 1.24 | 1.48 | 1.64 | |
| ACTUAL STEEL % | 0.363 | 0.536 | 0.635 | 0.762 | 0.845 | | 0.363 | 0.536 | 0.635 | 0.762 | 0.845 | |
| EFF. DEPTH, IN. | 16.72 | 16.59 | 16.69 | 16.60 | 16.58 | | 16.72 | 16.59 | 16.69 | 16.60 | 16.58 | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.174 | 0.206 | 0.239 | 0.261 | | 0.124 | 0.174 | 0.206 | 0.239 | 0.261 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 10 | 8.5 | 7.5 | | 9.5 | 8.5 | 7.5 | 9 | 5 | |
| BOTTOM BARS NO | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.70 | 1.08 | 1.20 | 1.45 | 1.67 | | 0.96 | 1.64 | 1.83 | 2.21 | 3.33 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 270 | 751 | 927 | 1146 | 1359 | 2.344 | 600 | 1300 | 1556 | 1875 | 2185 | 1.443 |
| STIR | #3- 57 | #3-112 | #3-123 | #3-135 | #3-142 | | #3- 75 | #3-102 | #3-121 | #3-129 | #4-129 | |
| 29'- 0" | 221 | 669 | 833 | 1038 | 1236 | 2.698 | 529 | 1181 | 1420 | 1717 | 2006 | 1.660 |
| STIR | #3- 54 | #3-113 | #3-124 | #3-120 | #3-145 | | #3- 74 | #3-109 | #3-124 | #3-131 | #4-135 | |
| 30'- 0" | 176 | 595 | 749 | 940 | 1125 | 3.090 | 464 | 1074 | 1297 | 1575 | 1845 | 1.901 |
| STIR | #3- 51 | #3-113 | #3-126 | #3-128 | #3-147 | | #3- 73 | #3-116 | #3-126 | #3-134 | #4-140 | |
| 31'- 0" | 136 | 528 | 672 | 851 | 1025 | 3.523 | 406 | 976 | 1185 | 1446 | 1698 | 2.168 |
| STIR | #3- 47 | #3-114 | #3-127 | #3-137 | #3-150 | | #3- 72 | #3-118 | #3-109 | #3-137 | #4-143 | |
| 32'- 0" | 99 | 468 | 603 | 771 | 934 | 4.000 | 353 | 888 | 1084 | 1329 | 1566 | 2.461 |
| STIR | #3- 43 | #3-114 | #3-128 | #3-141 | #3-153 | | #3- 70 | #3-119 | #3-116 | #3-140 | #3-146 | |
| 33'- 0" | 66 | 413 | 539 | 697 | 851 | 4.523 | 304 | 808 | 992 | 1222 | 1445 | 2.784 |
| STIR | #3- 38 | #3-114 | #3-129 | #3-143 | #3-137 | | #3- 68 | #3-121 | #3-124 | #3-142 | #3-149 | |
| 34'- 0" | 36 | 362 | 482 | 630 | 775 | 5.097 | 260 | 735 | 908 | 1125 | 1335 | 3.137 |
| STIR | #3- 34 | #3-114 | #3-130 | #3-144 | #3-145 | | #3- 66 | #3-122 | #3-131 | #3-145 | #3-152 | |
| 35'- 0" | 8 | 316 | 429 | 569 | 705 | 5.724 | 220 | 667 | 831 | 1036 | 1234 | 3.522 |
| STIR | #3- 28 | #3-114 | #3-130 | #3-146 | #3-154 | | #3- 64 | #3-123 | #3-134 | #3-147 | #3-155 | |
| 36'- 0" | | 274 | 380 | 513 | 642 | 6.407 | 183 | 606 | 761 | 954 | 1141 | 3.942 |
| STIR | | #3-113 | #3-131 | #3-147 | #3-159 | | #3- 61 | #3-124 | #3-136 | #3-149 | #3-157 | |
| 37'- 0" | | 235 | 336 | 461 | 583 | 7.149 | 148 | 549 | 696 | 879 | 1056 | 4.399 |
| STIR | | #3-112 | #3-131 | #3-148 | #3-161 | | #3- 59 | #3-124 | #3-137 | #3-133 | #3-160 | |
| 38'- 0" | | 199 | 294 | 413 | 529 | 7.953 | 117 | 497 | 636 | 809 | 977 | 4.894 |
| STIR | | #3-111 | #3-131 | #3-149 | #3-163 | | #3- 55 | #3-125 | #3-138 | #3-141 | #3-162 | |
| 39'- 0" | | 166 | 256 | 369 | 479 | 8.824 | 88 | 449 | 581 | 745 | 905 | 5.430 |
| STIR | | #3-110 | #3-131 | #3-150 | #3-164 | | #3- 52 | #3-125 | #3-139 | #3-148 | #3-164 | |
| 40'- 0" | | 135 | 221 | 329 | 433 | 9.765 | 61 | 404 | 529 | 686 | 838 | 6.009 |
| STIR | | #3-109 | #3-131 | #3-151 | #3-166 | | #3- 49 | #3-126 | #3-140 | #3-155 | #3-167 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.96 | 1.28 | 1.49 | 1.75 | 1.98 | | 1.01 | 1.75 | 1.98 | 2.35 | 4.22 | |
| ACTUAL STEEL % | 0.548 | 0.731 | 0.853 | 1.004 | 1.137 | | 0.577 | 1.004 | 1.137 | 1.351 | 2.431 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.31 | 18.31 | 18.31 | | 18.38 | 18.31 | 18.31 | 18.25 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.135 | 0.170 | 0.189 | 0.214 | 0.235 | | 0.141 | 0.214 | 0.235 | 0.263 | 0.391 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | |
| EFF. DEPTH, IN. | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.118 | 0.188 | 0.214 | 0.243 | 0.272 | | 0.118 | 0.188 | 0.214 | 0.243 | 0.272 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 9.5 | 7.5 | 9.5 | | 8.5 | 5 | 4.5 | 8 | 6 | |
| BOTTOM BARS NO | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.74 | 1.18 | 1.31 | 1.64 | 1.85 | | 1.07 | 1.77 | 1.99 | 2.50 | 3.73 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 351 | 902 | 1050 | 1334 | 1568 | 2.344 | 730 | 1531 | 1746 | 2160 | 2500 | 1.443 |
| STIR | #3- 62 | #3-115 | #3-123 | #3-136 | #3-143 | | #3- 78 | #3- 99 | #3-121 | #4-130 | #4-128 | |
| 29'- 0" | 294 | 808 | 946 | 1211 | 1429 | 2.698 | 647 | 1395 | 1595 | 1981 | 2297 | 1.660 |
| STIR | #3- 59 | #3-116 | #3-124 | #3-138 | #3-146 | | #3- 78 | #3-106 | #3-124 | #4-132 | #4-133 | |
| 30'- 0" | 243 | 723 | 852 | 1100 | 1303 | 3.090 | 573 | 1271 | 1459 | 1820 | 2115 | 1.901 |
| STIR | #3- 56 | #3-117 | #3-126 | #3-125 | #3-149 | | #3- 77 | #3-113 | #3-127 | #3-136 | #4-140 | |
| 31'- 0" | 197 | 647 | 767 | 1000 | 1190 | 3.523 | 506 | 1160 | 1336 | 1673 | 1950 | 2.168 |
| STIR | #3- 53 | #3-118 | #3-127 | #3-133 | #3-152 | | #3- 76 | #3-120 | #3-109 | #3-139 | #4-144 | |
| 32'- 0" | 155 | 577 | 690 | 908 | 1087 | 4.000 | 445 | 1059 | 1224 | 1541 | 1801 | 2.461 |
| STIR | #3- 49 | #3-118 | #3-128 | #3-142 | #3-155 | | #3- 74 | #3-122 | #3-117 | #3-141 | #4-147 | |
| 33'- 0" | 117 | 514 | 620 | 825 | 993 | 4.523 | 390 | 967 | 1122 | 1420 | 1664 | 2.784 |
| STIR | #3- 45 | #3-119 | #3-129 | #3-145 | #3-157 | | #3- 73 | #3-123 | #3-124 | #3-144 | #4-151 | |
| 34'- 0" | 83 | 456 | 557 | 750 | 908 | 5.097 | 340 | 883 | 1029 | 1310 | 1540 | 3.137 |
| STIR | #3- 41 | #3-119 | #3-130 | #3-147 | #3-142 | | #3- 71 | #3-124 | #3-131 | #3-146 | #4-153 | |
| 35'- 0" | 51 | 403 | 498 | 680 | 829 | 5.724 | 293 | 806 | 944 | 1209 | 1426 | 3.522 |
| STIR | #3- 36 | #3-119 | #3-131 | #3-148 | #3-150 | | #3- 69 | #3-126 | #3-134 | #3-149 | #3-156 | |
| 36'- 0" | 21 | 355 | 444 | 616 | 758 | 6.407 | 251 | 735 | 866 | 1116 | 1321 | 3.942 |
| STIR | #3- 31 | #3-118 | #3-131 | #3-150 | #3-159 | | #3- 67 | #3-127 | #3-135 | #3-150 | #3-159 | |
| 37'- 0" | | 310 | 395 | 558 | 691 | 7.149 | 212 | 670 | 794 | 1031 | 1225 | 4.399 |
| STIR | | #3-118 | #3-131 | #3-151 | #3-163 | | #3- 64 | #3-128 | #3-137 | #3-153 | #3-161 | |
| 38'- 0" | | 269 | 349 | 504 | 630 | 7.953 | 175 | 611 | 727 | 952 | 1136 | 4.894 |
| STIR | | #3-117 | #3-131 | #3-152 | #3-165 | | #3- 62 | #3-128 | #3-138 | #3-137 | #3-163 | |
| 39'- 0" | | 231 | 307 | 454 | 574 | 8.824 | 142 | 555 | 666 | 880 | 1054 | 5.430 |
| STIR | | #3-116 | #3-131 | #3-153 | #3-167 | | #3- 59 | #3-129 | #3-139 | #3-145 | #3-166 | |
| 40'- 0" | | 196 | 268 | 408 | 522 | 9.765 | 111 | 504 | 609 | 812 | 979 | 6.009 |
| STIR | | #3-115 | #3-131 | #3-154 | #3-168 | | #3- 56 | #3-129 | #3-140 | #3-152 | #3-168 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.98 | 1.52 | 1.60 | 2.03 | 2.27 | | 1.15 | 1.96 | 2.18 | 2.69 | 4.90 | |
| ACTUAL STEEL % | 0.506 | 0.788 | 0.830 | 1.051 | 1.182 | | 0.596 | 1.013 | 1.125 | 1.404 | 2.562 | |
| EFF. DEPTH, IN. | 18.38 | 18.31 | 18.31 | 18.31 | 18.25 | | 18.38 | 18.38 | 18.38 | 18.25 | 18.19 | |
| $-I_{cr}/I_{gr}$ | 0.130 | 0.182 | 0.190 | 0.227 | 0.245 | | 0.148 | 0.223 | 0.241 | 0.277 | 0.410 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | |
| EFF. DEPTH, IN. | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.198 | 0.217 | 0.251 | 0.280 | | 0.124 | 0.198 | 0.217 | 0.251 | 0.280 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**40″ Forms + 10″ Ribs @ 50″ c.-c.**
16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 7 | 8.5 | 7.5 | 6 | | 8.5 | 8 | 6 | 8 | 4 | |
| BOTTOM BARS NO | 3# 3 | 1# 5 | 2# 6 | 1# 6 | 2# 7 | | 3# 3 | 1# 5 | 2# 6 | 1# 6 | 2# 7 | |
| BARS NO | 2# 4 | 2# 6 | 1# 7 | 2# 7 | 1# 8 | | 2# 4 | 2# 6 | 1# 7 | 2# 7 | 1# 8 | |
| STEEL (PSF) | 0.75 | 1.13 | 1.47 | 1.60 | 2.00 | | 1.08 | 1.73 | 2.28 | 2.45 | 4.08 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 351 | 876 | 1205 | 1385 | 1777 | 2.344 | 742 | 1506 | 1984 | 2246 | 2815 | 1.443 |
| STIR | #3- 54 | #3-107 | #3-124 | #3-115 | #4-144 | | #3- 73 | #3-108 | #3-123 | #4-128 | #4-128 | |
| 29'- 0" | 293 | 783 | 1089 | 1257 | 1622 | 2.698 | 657 | 1369 | 1815 | 2060 | 2590 | 1.660 |
| STIR | #3- 51 | #3-108 | #3-126 | #3-123 | #3-147 | | #3- 72 | #3-111 | #3-126 | #4-130 | #4-133 | |
| 30'- 0" | 240 | 698 | 984 | 1141 | 1482 | 3.090 | 581 | 1246 | 1663 | 1891 | 2387 | 1.901 |
| STIR | #3- 47 | #3-108 | #3-128 | #3-131 | #3-150 | | #3- 70 | #3-113 | #3-128 | #3-133 | #4-139 | |
| 31'- 0" | 193 | 621 | 890 | 1037 | 1356 | 3.523 | 512 | 1135 | 1525 | 1739 | 2203 | 2.168 |
| STIR | #3- 43 | #3-108 | #3-129 | #3-137 | #3-152 | | #3- 69 | #3-114 | #3-130 | #3-135 | #4-145 | |
| 32'- 0" | 150 | 552 | 804 | 942 | 1241 | 4.000 | 449 | 1034 | 1400 | 1601 | 2036 | 2.461 |
| STIR | #3- 39 | #3-108 | #3-130 | #3-139 | #3-155 | | #3- 67 | #3-115 | #3-114 | #3-139 | #4-148 | |
| 33'- 0" | 110 | 489 | 725 | 855 | 1137 | 4.523 | 392 | 942 | 1286 | 1475 | 1884 | 2.784 |
| STIR | #3- 34 | #3-108 | #3-131 | #3-141 | #3-158 | | #3- 65 | #3-116 | #3-121 | #3-141 | #4-151 | |
| 34'- 0" | 75 | 431 | 654 | 776 | 1041 | 5.097 | 340 | 858 | 1182 | 1360 | 1746 | 3.137 |
| STIR | #3- 29 | #3-107 | #3-132 | #3-142 | #3-160 | | #3- 63 | #3-117 | #3-128 | #3-143 | #4-154 | |
| 35'- 0" | 42 | 378 | 588 | 704 | 954 | 5.724 | 292 | 781 | 1087 | 1255 | 1619 | 3.522 |
| STIR | #3- 23 | #3-106 | #3-133 | #3-143 | #3-148 | | #3- 60 | #3-118 | #3-136 | #3-145 | #4-157 | |
| 36'- 0" | 12 | 329 | 528 | 637 | 874 | 6.407 | 248 | 710 | 999 | 1158 | 1502 | 3.942 |
| STIR | | #3-105 | #3-134 | #3-145 | #3-157 | | #3- 58 | #3-118 | #3-137 | #3-130 | #4-160 | |
| 37'- 0" | | 285 | 473 | 576 | 800 | 7.149 | 208 | 645 | 919 | 1069 | 1395 | 4.399 |
| STIR | | #3-104 | #3-134 | #3-146 | #3-165 | | #3- 55 | #3-119 | #3-139 | #3-137 | #3-163 | |
| 38'- 0" | | 243 | 422 | 520 | 732 | 7.953 | 170 | 585 | 845 | 987 | 1296 | 4.894 |
| STIR | | #3-103 | #3-134 | #3-146 | #3-166 | | #3- 51 | #3-119 | #3-140 | #3-144 | #3-165 | |
| 39'- 0" | | 205 | 375 | 468 | 669 | 8.824 | 136 | 530 | 776 | 911 | 1205 | 5.430 |
| STIR | | #3-101 | #3-134 | #3-147 | #3-168 | | #3- 48 | #3-119 | #3-142 | #3-151 | #3-167 | |
| 40'- 0" | | 170 | 331 | 420 | 611 | 9.765 | 104 | 479 | 713 | 841 | 1120 | 6.009 |
| STIR | | #3- 99 | #3-134 | #3-148 | #3-170 | | #3- 44 | #3-119 | #3-143 | #3-152 | #3-170 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.00 | 1.43 | 1.82 | 2.07 | 2.58 | | 1.18 | 1.94 | 2.58 | 2.75 | 5.50 | |
| ACTUAL STEEL % | 0.472 | 0.674 | 0.864 | 0.979 | 1.224 | | 0.555 | 0.918 | 1.224 | 1.308 | 2.616 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.31 | 18.31 | 18.31 | | 18.38 | 18.31 | 18.31 | 18.25 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.125 | 0.166 | 0.200 | 0.220 | 0.259 | | 0.143 | 0.209 | 0.259 | 0.269 | 0.429 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.73 | 1.19 | 1.48 | 1.64 | 1.99 | | 0.73 | 1.19 | 1.48 | 1.64 | 1.99 | |
| ACTUAL STEEL % | 0.328 | 0.538 | 0.671 | 0.744 | 0.904 | | 0.328 | 0.538 | 0.671 | 0.744 | 0.904 | |
| EFF. DEPTH, IN. | 18.78 | 18.64 | 18.60 | 18.58 | 18.54 | | 18.78 | 18.64 | 18.60 | 18.58 | 18.54 | |
| $+I_{cr}/I_{gr}$ | 0.119 | 0.184 | 0.223 | 0.244 | 0.289 | | 0.119 | 0.184 | 0.223 | 0.244 | 0.289 | |

SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**40″ Forms + 8″ Ribs @ 48″ c.-c.**
18″ Deep Rib + 4.5″ Top Slab = 22.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 6 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 10 | 9 | 7.5 | 9.5 | | 8.5 | 7.5 | 9.5 | 10 | 6 | |
| BOTTOM BARS NO | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.75 | 1.20 | 1.36 | 1.67 | 1.87 | | 1.08 | 1.83 | 2.08 | 2.64 | 3.76 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 223 | 691 | 816 | 1059 | 1258 | 4.000 | 544 | 1225 | 1407 | 1761 | 2050 | 2.461 |
| STIR | #3- 63 | #3-126 | #3-136 | #3-131 | #3-160 | | #3- 84 | #3-118 | #3-136 | #4-146 | #4-149 | |
| 33'- 0" | 180 | 620 | 739 | 967 | 1154 | 4.523 | 482 | 1123 | 1295 | 1627 | 1899 | 2.784 |
| STIR | #3- 60 | #3-127 | #3-137 | #3-139 | #3-163 | | #3- 83 | #3-126 | #3-138 | #3-148 | #4-155 | |
| 34'- 0" | 142 | 556 | 668 | 883 | 1059 | 5.097 | 426 | 1029 | 1191 | 1505 | 1761 | 3.137 |
| STIR | #3- 56 | #3-128 | #3-138 | #3-148 | #3-165 | | #3- 82 | #3-131 | #3-120 | #3-151 | #4-158 | |
| 35'- 0" | 107 | 498 | 603 | 806 | 972 | 5.724 | 375 | 944 | 1097 | 1393 | 1634 | 3.522 |
| STIR | #3- 52 | #3-128 | #3-140 | #3-156 | #3-168 | | #3- 80 | #3-133 | #3-127 | #3-154 | #4-161 | |
| 36'- 0" | 74 | 444 | 543 | 735 | 892 | 6.407 | 328 | 866 | 1010 | 1290 | 1518 | 3.942 |
| STIR | #3- 48 | #3-129 | #3-140 | #3-158 | #3-170 | | #3- 79 | #3-134 | #3-135 | #3-156 | #4-163 | |
| 37'- 0" | 44 | 394 | 489 | 670 | 819 | 7.149 | 285 | 794 | 931 | 1195 | 1411 | 4.399 |
| STIR | #3- 44 | #3-129 | #3-141 | #3-159 | #3-154 | | #3- 77 | #3-135 | #3-142 | #3-159 | #3-166 | |
| 38'- 0" | 17 | 349 | 438 | 610 | 751 | 7.953 | 245 | 728 | 857 | 1108 | 1313 | 4.894 |
| STIR | #3- 39 | #3-129 | #3-142 | #3-161 | #3-163 | | #3- 75 | #3-137 | #3-146 | #3-161 | #3-169 | |
| 39'- 0" | | 307 | 391 | 555 | 689 | 8.824 | 208 | 666 | 789 | 1027 | 1222 | 5.430 |
| STIR | | #3-129 | #3-142 | #3-162 | #3-171 | | #3- 73 | #3-138 | #3-147 | #3-164 | #3-172 | |
| 40'- 0" | | 268 | 348 | 504 | 631 | 9.765 | 174 | 609 | 726 | 953 | 1138 | 6.009 |
| STIR | | #3-128 | #3-142 | #3-164 | #3-177 | | #3- 70 | #3-139 | #3-149 | #3-166 | #3-175 | |
| 41'- 0" | | 231 | 308 | 456 | 577 | 10.778 | 142 | 557 | 668 | 883 | 1059 | 6.633 |
| STIR | | #3-127 | #3-143 | #3-165 | #3-179 | | #3- 68 | #3-139 | #3-150 | #3-147 | #3-177 | |
| 42'- 0" | | 198 | 271 | 412 | 527 | 11.869 | 113 | 508 | 614 | 819 | 987 | 7.304 |
| STIR | | #3-127 | #3-142 | #3-166 | #3-180 | | #3- 65 | #3-140 | #3-151 | #3-154 | #3-179 | |
| 43'- 0" | | 166 | 236 | 371 | 481 | 13.040 | 85 | 462 | 563 | 759 | 919 | 8.025 |
| STIR | | #3-126 | #3-142 | #3-167 | #3-182 | | #3- 62 | #3-141 | #3-153 | #3-161 | #3-182 | |
| 44'- 0" | | 137 | 204 | 332 | 437 | 14.296 | 59 | 420 | 516 | 703 | 856 | 8.798 |
| STIR | | #3-124 | #3-142 | #3-167 | #3-184 | | #3- 58 | #3-141 | #3-153 | #3-169 | #3-185 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.67 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.96 | 1.49 | 1.65 | 1.98 | 2.22 | | 1.13 | 1.98 | 2.22 | 2.88 | 4.80 | |
| ACTUAL STEEL % | 0.486 | 0.756 | 0.840 | 1.008 | 1.133 | | 0.572 | 1.008 | 1.133 | 1.473 | 2.456 | |
| EFF. DEPTH, IN. | 20.38 | 20.31 | 20.31 | 20.31 | 20.25 | | 20.38 | 20.31 | 20.25 | 20.19 | 20.19 | |
| $-I_{cr}/I_{gr}$ | 0.128 | 0.181 | 0.196 | 0.225 | 0.243 | | 0.146 | 0.225 | 0.243 | 0.291 | 0.408 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.342 | 0.575 | 0.638 | 0.768 | 0.871 | | 0.342 | 0.575 | 0.638 | 0.768 | 0.871 | |
| EFF. DEPTH, IN. | 20.72 | 20.64 | 20.62 | 20.50 | 20.46 | | 20.72 | 20.64 | 20.62 | 20.50 | 20.46 | |
| $+I_{cr}/I_{gr}$ | 0.125 | 0.200 | 0.220 | 0.255 | 0.284 | | 0.125 | 0.200 | 0.220 | 0.255 | 0.284 | |

SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>18″ Deep Rib + 4.5″ Top Slab = 22.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 8.5 | 9.5 | 8.5 | | 8 | 5 | 4 | 7 | 4 | |
| BOTTOM BARS NO | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 2# 7 | | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 2# 7 | |
| BARS NO | 1# 6 | 1# 7 | 1# 7 | 1# 9 | 1# 8 | | 1# 6 | 1# 7 | 1# 7 | 1# 9 | 1# 8 | |
| STEEL (PSF) | 0.77 | 1.25 | 1.49 | 1.85 | 2.04 | | 1.13 | 1.84 | 2.25 | 2.82 | 4.11 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 231 | 668 | 942 | 1230 | 1429 | 4.000 | 570 | 1204 | 1604 | 2023 | 2311 | 2.461 |
| STIR | #3- 55 | #3-117 | #3-137 | #3-153 | #3-161 | | #3- 78 | #3-121 | #3-136 | #4-146 | #4-148 | |
| 33'- 0" | 187 | 597 | 855 | 1126 | 1313 | 4.523 | 505 | 1102 | 1477 | 1871 | 2143 | 2.784 |
| STIR | #3- 51 | #3-117 | #3-138 | #3-136 | #3-163 | | #3- 77 | #3-122 | #3-139 | #4-149 | #4-154 | |
| 34'- 0" | 146 | 533 | 776 | 1031 | 1207 | 5.097 | 446 | 1008 | 1362 | 1733 | 1989 | 3.137 |
| STIR | #3- 47 | #3-117 | #3-140 | #3-144 | #3-166 | | #3- 76 | #3-123 | #3-119 | #4-152 | #4-158 | |
| 35'- 0" | 109 | 474 | 704 | 945 | 1110 | 5.724 | 392 | 923 | 1256 | 1607 | 1848 | 3.522 |
| STIR | #3- 43 | #3-117 | #3-141 | #3-152 | #3-169 | | #3- 74 | #3-125 | #3-127 | #3-155 | #4-160 | |
| 36'- 0" | 75 | 420 | 637 | 865 | 1021 | 6.407 | 342 | 844 | 1159 | 1491 | 1719 | 3.942 |
| STIR | #3- 38 | #3-117 | #3-142 | #3-160 | #3-171 | | #3- 72 | #3-126 | #3-134 | #3-157 | #4-164 | |
| 37'- 0" | 44 | 370 | 576 | 791 | 940 | 7.149 | 297 | 772 | 1070 | 1384 | 1600 | 4.399 |
| STIR | #3- 33 | #3-116 | #3-143 | #3-162 | #3-153 | | #3- 70 | #3-126 | #3-141 | #3-160 | #4-166 | |
| 38'- 0" | 15 | 325 | 519 | 724 | 864 | 7.953 | 255 | 705 | 988 | 1285 | 1490 | 4.894 |
| STIR | #3- 28 | #3-116 | #3-143 | #3-164 | #3-161 | | #3- 67 | #3-127 | #3-146 | #3-163 | #4-169 | |
| 39'- 0" | | 282 | 467 | 661 | 795 | 8.824 | 216 | 643 | 912 | 1194 | 1389 | 5.430 |
| STIR | | #3-115 | #3-144 | #3-165 | #3-170 | | #3- 65 | #3-128 | #3-148 | #3-165 | #4-172 | |
| 40'- 0" | | 243 | 419 | 603 | 730 | 9.765 | 180 | 586 | 842 | 1110 | 1295 | 6.009 |
| STIR | | #3-113 | #3-144 | #3-167 | #3-178 | | #3- 62 | #3-128 | #3-149 | #3-167 | #3-175 | |
| 41'- 0" | | 207 | 374 | 549 | 670 | 10.778 | 147 | 533 | 777 | 1032 | 1208 | 6.633 |
| STIR | | #3-112 | #3-144 | #3-168 | #3-180 | | #3- 59 | #3-128 | #3-151 | #3-170 | #3-177 | |
| 42'- 0" | | 173 | 332 | 499 | 614 | 11.869 | 116 | 484 | 716 | 959 | 1127 | 7.304 |
| STIR | | #3-110 | #3-144 | #3-169 | #3-182 | | #3- 56 | #3-129 | #3-152 | #3-151 | #3-179 | |
| 43'- 0" | | 141 | 293 | 453 | 563 | 13.040 | 87 | 438 | 659 | 892 | 1051 | 8.025 |
| STIR | | #3-109 | #3-144 | #3-170 | #3-183 | | #3- 52 | #3-129 | #3-153 | #3-158 | #3-182 | |
| 44'- 0" | | 112 | 257 | 409 | 514 | 14.296 | 60 | 396 | 607 | 828 | 981 | 8.798 |
| STIR | | #3-107 | #3-144 | #3-171 | #3-185 | | #3- 48 | #3-128 | #3-154 | #3-165 | #3-185 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.98 | 1.52 | 1.79 | 2.27 | 2.54 | | 1.23 | 1.96 | 2.45 | 3.08 | 5.39 | |
| ACTUAL STEEL % | 0.450 | 0.699 | 0.823 | 1.049 | 1.172 | | 0.562 | 0.899 | 1.124 | 1.423 | 2.491 | |
| EFF. DEPTH, IN. | 20.38 | 20.31 | 20.31 | 20.25 | 20.25 | | 20.38 | 20.38 | 20.38 | 20.25 | 20.25 | |
| $-I_{cr}/I_{gr}$ | 0.123 | 0.174 | 0.197 | 0.235 | 0.255 | | 0.148 | 0.213 | 0.252 | 0.293 | 0.426 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.75 | 1.20 | 1.48 | 1.79 | 1.99 | | 0.75 | 1.20 | 1.48 | 1.79 | 1.99 | |
| ACTUAL STEEL % | 0.329 | 0.529 | 0.651 | 0.792 | 0.878 | | 0.329 | 0.529 | 0.651 | 0.792 | 0.878 | |
| EFF. DEPTH, IN. | 20.65 | 20.56 | 20.60 | 20.46 | 20.54 | | 20.65 | 20.56 | 20.60 | 20.46 | 20.54 | |
| $+I_{cr}/I_{gr}$ | 0.121 | 0.185 | 0.225 | 0.263 | 0.291 | | 0.121 | 0.185 | 0.225 | 0.263 | 0.291 | |
| SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>18″ Deep Rib + 4.5″ Top Slab = 22.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9.5 | 8 | 9 | 8 | | 7.5 | 7 | 6 | 6.5 | 4 | |
| BOTTOM BARS NO | 1# 4 | 2# 6 | 1# 8 | 2# 7 | 1# 7 | | 1# 4 | 2# 6 | 1# 8 | 2# 7 | 1# 7 | |
| BARS NO | 2# 5 | 1# 6 | 1# 8 | 1# 8 | 2# 8 | | 2# 5 | 1# 6 | 1# 8 | 1# 8 | 2# 8 | |
| STEEL (PSF) | 0.78 | 1.30 | 1.59 | 1.98 | 2.13 | | 1.18 | 1.97 | 2.37 | 3.04 | 4.16 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 274 | 761 | 1004 | 1401 | 1581 | 4.000 | 645 | 1352 | 1706 | 2284 | 2545 | 2.461 |
| STIR | #3- 55 | #3-118 | #3-134 | #3-154 | #4-161 | | #3- 79 | #3-122 | #3-135 | #4-147 | #4-149 | |
| 33'- 0" | 226 | 683 | 912 | 1285 | 1454 | 4.523 | 574 | 1239 | 1572 | 2115 | 2361 | 2.784 |
| STIR | #3- 52 | #3-118 | #3-136 | #3-157 | #3-163 | | #3- 77 | #3-123 | #3-138 | #4-151 | #4-155 | |
| 34'- 0" | 181 | 612 | 828 | 1180 | 1339 | 5.097 | 509 | 1136 | 1449 | 1962 | 2193 | 3.137 |
| STIR | #3- 48 | #3-118 | #3-137 | #3-141 | #3-166 | | #3- 76 | #3-124 | #3-123 | #4-153 | #4-158 | |
| 35'- 0" | 141 | 547 | 751 | 1083 | 1233 | 5.724 | 450 | 1042 | 1337 | 1821 | 2039 | 3.522 |
| STIR | #3- 43 | #3-118 | #3-138 | #3-150 | #3-169 | | #3- 74 | #3-126 | #3-130 | #4-156 | #4-160 | |
| 36'- 0" | 103 | 488 | 680 | 994 | 1136 | 6.407 | 396 | 955 | 1234 | 1691 | 1898 | 3.942 |
| STIR | #3- 39 | #3-118 | #3-139 | #3-158 | #3-171 | | #3- 72 | #3-127 | #3-137 | #4-159 | #4-164 | |
| 37'- 0" | 69 | 433 | 615 | 912 | 1046 | 7.149 | 346 | 875 | 1140 | 1572 | 1768 | 4.399 |
| STIR | #3- 34 | #3-117 | #3-139 | #3-164 | #3-153 | | #3- 70 | #3-128 | #3-143 | #4-161 | #4-166 | |
| 38'- 0" | 37 | 382 | 555 | 837 | 964 | 7.953 | 300 | 802 | 1053 | 1462 | 1648 | 4.894 |
| STIR | #3- 29 | #3-117 | #3-140 | #3-165 | #3-161 | | #3- 68 | #3-128 | #3-144 | #3-163 | #4-169 | |
| 39'- 0" | 8 | 336 | 499 | 767 | 888 | 8.824 | 257 | 734 | 972 | 1361 | 1537 | 5.430 |
| STIR | #3- 23 | #3-116 | #3-140 | #3-167 | #3-170 | | #3- 65 | #3-129 | #3-146 | #3-166 | #4-172 | |
| 40'- 0" | | 292 | 448 | 702 | 817 | 9.765 | 218 | 671 | 897 | 1267 | 1434 | 6.009 |
| STIR | | #3-115 | #3-140 | #3-169 | #3-178 | | #3- 62 | #3-129 | #3-147 | #3-168 | #4-175 | |
| 41'- 0" | | 252 | 400 | 642 | 752 | 10.778 | 182 | 612 | 828 | 1180 | 1339 | 6.633 |
| STIR | | #3-113 | #3-140 | #3-170 | #3-180 | | #3- 59 | #3-130 | #3-148 | #3-171 | #3-177 | |
| 42'- 0" | | 215 | 356 | 587 | 691 | 11.869 | 148 | 558 | 764 | 1099 | 1251 | 7.304 |
| STIR | | #3-112 | #3-140 | #3-171 | #3-181 | | #3- 56 | #3-130 | #3-149 | #3-173 | #3-180 | |
| 43'- 0" | | 180 | 315 | 535 | 634 | 13.040 | 116 | 508 | 704 | 1024 | 1169 | 8.025 |
| STIR | | #3-110 | #3-140 | #3-173 | #3-183 | | #3- 52 | #3-130 | #3-150 | #3-155 | #3-182 | |
| 44'- 0" | | 148 | 276 | 487 | 582 | 14.296 | 86 | 461 | 648 | 953 | 1092 | 8.798 |
| STIR | | #3-108 | #3-139 | #3-174 | #3-185 | | #3- 49 | #3-130 | #3-151 | #3-162 | #3-185 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.00 | 1.63 | 1.94 | 2.44 | 2.75 | | 1.33 | 2.21 | 2.58 | 3.38 | 5.50 | |
| ACTUAL STEEL % | 0.420 | 0.687 | 0.816 | 1.033 | 1.162 | | 0.559 | 0.932 | 1.088 | 1.430 | 2.324 | |
| EFF. DEPTH, IN. | 20.38 | 20.31 | 20.31 | 20.25 | 20.25 | | 20.38 | 20.31 | 20.31 | 20.25 | 20.25 | |
| $-I_{cr}/I_{gr}$ | 0.119 | 0.175 | 0.200 | 0.237 | 0.259 | | 0.150 | 0.222 | 0.249 | 0.300 | 0.417 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.82 | 1.32 | 1.58 | 1.99 | 2.18 | | 0.82 | 1.32 | 1.58 | 1.99 | 2.18 | |
| ACTUAL STEEL % | 0.329 | 0.532 | 0.640 | 0.805 | 0.882 | | 0.329 | 0.532 | 0.640 | 0.805 | 0.882 | |
| EFF. DEPTH, IN. | 20.70 | 20.62 | 20.50 | 20.54 | 20.52 | | 20.70 | 20.62 | 20.50 | 20.54 | 20.52 | |
| $+I_{cr}/I_{gr}$ | 0.123 | 0.190 | 0.220 | 0.272 | 0.294 | | 0.123 | 0.190 | 0.220 | 0.272 | 0.294 | |
| SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 6 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 8 | 9.5 | 8.5 | | 7 | 4 | 6 | 6.5 | 7 | |
| BOTTOM BARS NO | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | |
| BARS NO | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.80 | 1.36 | 1.54 | 1.87 | 2.12 | | 1.25 | 2.14 | 2.33 | 2.97 | 4.23 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 34'- 0" (3) | 280 | 753 | 903 | 1184 | 1378 | 5.097 | 640 | 1328 | 1546 | 1956 | 2237 | 3.137 |
| STIR | #3- 77 | #3-137 | #3-147 | #3-165 | #3-171 | | #3- 96 | #3-123 | #3-146 | #4-156 | #4-157 | |
| 35'- 0" | 235 | 682 | 823 | 1089 | 1271 | 5.724 | 575 | 1224 | 1430 | 1817 | 2082 | 3.522 |
| STIR | #3- 75 | #3-138 | #3-149 | #3-166 | #3-174 | | #3- 96 | #3-130 | #3-148 | #4-160 | #4-161 | |
| 36'- 0" | 194 | 616 | 750 | 1001 | 1174 | 6.407 | 515 | 1129 | 1324 | 1689 | 1940 | 3.942 |
| STIR | #3- 72 | #3-139 | #3-150 | #3-149 | #3-177 | | #3- 95 | #3-138 | #3-151 | #4-162 | #4-167 | |
| 37'- 0" | 156 | 556 | 683 | 920 | 1084 | 7.149 | 460 | 1042 | 1226 | 1572 | 1809 | 4.399 |
| STIR | #3- 69 | #3-139 | #3-152 | #3-157 | #3-180 | | #3- 94 | #3-142 | #3-130 | #4-165 | #4-172 | |
| 38'- 0" | 122 | 501 | 621 | 846 | 1001 | 7.953 | 410 | 961 | 1135 | 1463 | 1689 | 4.894 |
| STIR | #3- 65 | #3-140 | #3-153 | #3-165 | #3-183 | | #3- 93 | #3-144 | #3-137 | #3-168 | #4-175 | |
| 39'- 0" | 90 | 449 | 563 | 777 | 924 | 8.824 | 363 | 886 | 1052 | 1363 | 1577 | 5.430 |
| STIR | #3- 62 | #3-140 | #3-154 | #3-173 | #3-185 | | #3- 92 | #3-145 | #3-144 | #3-170 | #4-178 | |
| 40'- 0" | 60 | 402 | 510 | 714 | 853 | 9.765 | 320 | 817 | 975 | 1271 | 1474 | 6.009 |
| STIR | #3- 58 | #3-140 | #3-155 | #3-175 | #3-165 | | #3- 90 | #3-147 | #3-152 | #3-173 | #4-181 | |
| 41'- 0" | 32 | 358 | 461 | 655 | 788 | 10.778 | 280 | 753 | 903 | 1185 | 1378 | 6.633 |
| STIR | #3- 53 | #3-140 | #3-155 | #3-177 | #3-173 | | #3- 89 | #3-148 | #3-159 | #3-176 | #4-183 | |
| 42'- 0" | 7 | 317 | 415 | 600 | 726 | 11.869 | 243 | 694 | 837 | 1105 | 1289 | 7.304 |
| STIR | #3- 49 | #3-140 | #3-156 | #3-179 | #3-181 | | #3- 87 | #3-149 | #3-160 | #3-178 | #4-186 | |
| 43'- 0" | | 279 | 372 | 549 | 669 | 13.040 | 208 | 638 | 775 | 1031 | 1207 | 8.025 |
| STIR | | #3-140 | #3-156 | #3-180 | #3-190 | | #3- 85 | #3-150 | #3-162 | #3-180 | #3-189 | |
| 44'- 0" | | 243 | 333 | 501 | 616 | 14.296 | 176 | 587 | 717 | 961 | 1129 | 8.798 |
| STIR | | #3-139 | #3-157 | #3-182 | #3-194 | | #3- 82 | #3-151 | #3-163 | #3-183 | #3-191 | |
| 45'- 0" | | 210 | 296 | 456 | 567 | 15.641 | 145 | 538 | 663 | 897 | 1057 | 9.625 |
| STIR | | #3-138 | #3-157 | #3-183 | #3-196 | | #3- 80 | #3-152 | #3-165 | #3-184 | #3-194 | |
| 46'- 0" | | 179 | 261 | 415 | 520 | 17.078 | 117 | 493 | 612 | 836 | 990 | 10.510 |
| STIR | | #3-137 | #3-157 | #3-184 | #3-198 | | #3- 78 | #3-152 | #3-166 | #3-167 | #3-197 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.71 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.96 | 1.65 | 1.86 | 2.22 | 2.48 | | 1.37 | 2.40 | 2.48 | 3.25 | 5.42 | |
| ACTUAL STEEL % | 0.435 | 0.752 | 0.846 | 1.014 | 1.133 | | 0.621 | 1.087 | 1.127 | 1.482 | 2.487 | |
| EFF. DEPTH, IN. | 22.38 | 22.31 | 22.31 | 22.25 | 22.25 | | 22.38 | 22.38 | 22.31 | 22.25 | 22.12 | |
| $-I_{cr}/I_{gr}$ | 0.122 | 0.188 | 0.206 | 0.234 | 0.254 | | 0.163 | 0.250 | 0.255 | 0.307 | 0.426 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | |
| EFF. DEPTH, IN. | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | |
| $+I_{cr}/I_{gr}$ | 0.134 | 0.207 | 0.229 | 0.269 | 0.296 | | 0.134 | 0.207 | 0.229 | 0.269 | 0.296 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 6 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 9.5 | 9 | 7.5 | 6 | 8 | | 7 | 4 | 7.5 | 8.5 | 5 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | |
| BARS NO | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | |
| STEEL (PSF) | 0.90 | 1.41 | 1.62 | 2.03 | 2.16 | | 1.33 | 2.19 | 2.56 | 3.14 | 4.42 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 34'- 0" (3) | 304 | 783 | 1022 | 1347 | 1522 | 5.097 | 689 | 1386 | 1733 | 2206 | 2461 | 3.137 |
| STIR | #3- 72 | #3-132 | #3-148 | #3-165 | #4-171 | | #3- 93 | #3-129 | #3-147 | #4-157 | #4-157 | |
| 35'- 0" | 256 | 708 | 934 | 1241 | 1406 | 5.724 | 619 | 1277 | 1605 | 2051 | 2292 | 3.522 |
| STIR | #3- 69 | #3-132 | #3-149 | #3-167 | #3-174 | | #3- 92 | #3-135 | #3-150 | #4-160 | #4-162 | |
| 36'- 0" | 212 | 640 | 853 | 1143 | 1299 | 6.407 | 556 | 1177 | 1488 | 1909 | 2137 | 3.942 |
| STIR | #3- 66 | #3-133 | #3-151 | #3-147 | #3-177 | | #3- 91 | #3-137 | #3-151 | #4-163 | #4-167 | |
| 37'- 0" | 172 | 577 | 779 | 1053 | 1201 | 7.149 | 497 | 1086 | 1379 | 1779 | 1994 | 4.399 |
| STIR | #3- 63 | #3-133 | #3-152 | #3-156 | #3-180 | | #3- 90 | #3-138 | #3-154 | #4-166 | #4-171 | |
| 38'- 0" | 135 | 519 | 710 | 970 | 1111 | 7.953 | 443 | 1001 | 1279 | 1658 | 1862 | 4.894 |
| STIR | #3- 59 | #3-133 | #3-153 | #3-164 | #3-182 | | #3- 89 | #3-139 | #3-136 | #4-168 | #4-174 | |
| 39'- 0" | 101 | 465 | 647 | 894 | 1027 | 8.824 | 393 | 923 | 1187 | 1547 | 1740 | 5.430 |
| STIR | #3- 55 | #3-133 | #3-154 | #3-173 | #3-185 | | #3- 87 | #3-141 | #3-143 | #4-171 | #4-177 | |
| 40'- 0" | 69 | 415 | 588 | 823 | 949 | 9.765 | 347 | 851 | 1102 | 1443 | 1628 | 6.009 |
| STIR | #3- 51 | #3-133 | #3-155 | #3-176 | #3-166 | | #3- 86 | #3-142 | #3-151 | #4-174 | #4-180 | |
| 41'- 0" | 39 | 369 | 533 | 757 | 877 | 10.778 | 304 | 783 | 1023 | 1348 | 1523 | 6.633 |
| STIR | #3- 46 | #3-133 | #3-156 | #3-178 | #3-174 | | #3- 84 | #3-143 | #3-158 | #3-177 | #4-183 | |
| 42'- 0" | 12 | 326 | 483 | 696 | 811 | 11.869 | 264 | 721 | 949 | 1259 | 1426 | 7.304 |
| STIR | #3- 42 | #3-132 | #3-156 | #3-180 | #3-183 | | #3- 82 | #3-144 | #3-161 | #3-179 | #4-186 | |
| 43'- 0" | | 286 | 436 | 639 | 748 | 13.040 | 227 | 663 | 880 | 1176 | 1335 | 8.025 |
| STIR | | #3-131 | #3-157 | #3-181 | #3-191 | | #3- 79 | #3-144 | #3-162 | #3-182 | #4-189 | |
| 44'- 0" | | 249 | 392 | 586 | 690 | 14.296 | 192 | 609 | 816 | 1099 | 1251 | 8.798 |
| STIR | | #3-131 | #3-157 | #3-182 | #3-193 | | #3- 77 | #3-145 | #3-164 | #3-183 | #4-191 | |
| 45'- 0" | | 214 | 351 | 536 | 636 | 15.641 | 160 | 558 | 757 | 1027 | 1172 | 9.625 |
| STIR | | #3-129 | #3-157 | #3-184 | #3-195 | | #3- 74 | #3-145 | #3-165 | #3-186 | #3-193 | |
| 46'- 0" | | 182 | 312 | 490 | 586 | 17.078 | 130 | 511 | 701 | 959 | 1098 | 10.510 |
| STIR | | #3-128 | #3-157 | #3-185 | #3-197 | | #3- 71 | #3-146 | #3-167 | #3-188 | #3-195 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.03 | 1.69 | 2.03 | 2.53 | 2.69 | | 1.40 | 2.45 | 2.87 | 3.46 | 5.88 | |
| ACTUAL STEEL % | 0.424 | 0.697 | 0.836 | 1.045 | 1.116 | | 0.576 | 1.008 | 1.190 | 1.437 | 2.443 | |
| EFF. DEPTH, IN. | 22.38 | 22.31 | 22.31 | 22.31 | 22.25 | | 22.38 | 22.38 | 22.25 | 22.19 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.122 | 0.181 | 0.208 | 0.246 | 0.256 | | 0.157 | 0.242 | 0.269 | 0.305 | 0.435 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | |
| ACTUAL STEEL % | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | |
| EFF. DEPTH, IN. | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | |
| $+I_{cr}/I_{gr}$ | 0.132 | 0.199 | 0.232 | 0.275 | 0.298 | | 0.132 | 0.199 | 0.232 | 0.275 | 0.298 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**40″ Forms + 10″ Ribs @ 50″ c.-c.**
20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span | # 5 | # 6 | # 7 | # 7 | # 7 | Int. Span |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 9 | 8.5 | 7 | 6 | 7.5 | Defl. Coeff. (2) | 10 | 9 | 10 | 8.5 | 6 | Defl. Coeff. (2) |
| BOTTOM BARS NO | 2# 5 | 2# 6 | 2# 6 | 2# 6 | 2# 8 | | 2# 5 | 2# 6 | 2# 6 | 2# 6 | 2# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 2# 7 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 2# 7 | 1# 8 | |
| STEEL (PSF) | 0.89 | 1.47 | 1.80 | 2.08 | 2.32 | | 1.38 | 2.23 | 2.73 | 3.19 | 4.05 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 34'- 0" (3) | 324 | 842 | 1108 | 1406 | 1668 | 5.097 | 731 | 1486 | 1873 | 2305 | 2686 | 3.137 |
| STIR | | #3- 67 | #3-129 | #3-146 | #3-161 | #4-171 | | #3- 90 | #3-131 | #3-145 | #4-155 | #5-161 | |
| 35'- 0" | 273 | 763 | 1014 | 1294 | 1541 | 5.724 | 658 | 1370 | 1735 | 2143 | 2503 | 3.522 |
| STIR | | #3- 64 | #3-130 | #3-148 | #3-145 | #4-174 | | #3- 89 | #3-134 | #3-148 | #4-158 | #4-164 | |
| 36'- 0" | 227 | 689 | 927 | 1192 | 1425 | 6.407 | 590 | 1263 | 1608 | 1994 | 2334 | 3.942 |
| STIR | | #3- 61 | #3-130 | #3-149 | #3-154 | #3-176 | | #3- 88 | #3-135 | #3-151 | #4-160 | #4-167 | |
| 37'- 0" | 184 | 622 | 847 | 1098 | 1319 | 7.149 | 528 | 1165 | 1492 | 1858 | 2179 | 4.399 |
| STIR | | #3- 57 | #3-130 | #3-150 | #3-162 | #3-179 | | #3- 86 | #3-137 | #3-131 | #4-163 | #4-170 | |
| 38'- 0" | 145 | 560 | 773 | 1011 | 1221 | 7.953 | 471 | 1075 | 1385 | 1731 | 2036 | 4.894 |
| STIR | | #3- 53 | #3-130 | #3-151 | #3-168 | #3-182 | | #3- 85 | #3-138 | #3-138 | #4-166 | #4-174 | |
| 39'- 0" | 108 | 503 | 705 | 931 | 1130 | 8.824 | 418 | 992 | 1286 | 1615 | 1904 | 5.430 |
| STIR | | #3- 49 | #3-130 | #3-152 | #3-170 | #3-184 | | #3- 83 | #3-139 | #3-145 | #4-168 | #4-177 | |
| 40'- 0" | 75 | 449 | 642 | 857 | 1046 | 9.765 | 369 | 914 | 1194 | 1507 | 1782 | 6.009 |
| STIR | | #3- 44 | #3-130 | #3-153 | #3-172 | #3-167 | | #3- 81 | #3-140 | #3-153 | #3-171 | #4-180 | |
| 41'- 0" | 43 | 400 | 583 | 788 | 968 | 10.778 | 324 | 843 | 1109 | 1406 | 1668 | 6.633 |
| STIR | | #3- 39 | #3-129 | #3-154 | #3-173 | #3-175 | | #3- 79 | #3-141 | #3-158 | #3-173 | #4-182 | |
| 42'- 0" | 14 | 354 | 529 | 724 | 895 | 11.869 | 282 | 776 | 1030 | 1313 | 1563 | 7.304 |
| STIR | | #3- 34 | #3-129 | #3-154 | #3-175 | #3-184 | | #3- 77 | #3-142 | #3-160 | #3-176 | #4-185 | |
| 43'- 0" | | 312 | 478 | 664 | 828 | 13.040 | 242 | 714 | 956 | 1226 | 1464 | 8.025 |
| STIR | | | #3-128 | #3-155 | #3-176 | #3-191 | | #3- 74 | #3-142 | #3-161 | #3-178 | #4-187 | |
| 44'- 0" | | 272 | 431 | 608 | 765 | 14.296 | 206 | 656 | 887 | 1146 | 1373 | 8.798 |
| STIR | | | #3-127 | #3-155 | #3-177 | #3-192 | | #3- 72 | #3-143 | #3-163 | #3-157 | #4-191 | |
| 45'- 0" | | 235 | 387 | 556 | 706 | 15.641 | 171 | 602 | 823 | 1070 | 1287 | 9.625 |
| STIR | | | #3-125 | #3-155 | #3-178 | #3-194 | | #3- 69 | #3-143 | #3-164 | #3-164 | #4-193 | |
| 46'- 0" | | 200 | 345 | 508 | 651 | 17.078 | 139 | 552 | 763 | 999 | 1207 | 10.510 |
| STIR | | | #3-124 | #3-155 | #3-179 | #3-196 | | #3- 66 | #3-144 | #3-165 | #3-171 | #3-195 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.76 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.11 | 1.82 | 2.21 | 2.58 | 2.93 | | 1.55 | 2.44 | 3.00 | 3.53 | 5.00 | |
| ACTUAL STEEL % | 0.419 | 0.689 | 0.837 | 0.976 | 1.112 | | 0.586 | 0.927 | 1.141 | 1.342 | 1.902 | |
| EFF. DEPTH, IN. | 22.38 | 22.31 | 22.31 | 22.31 | 22.25 | | 22.31 | 22.25 | 22.19 | 22.19 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.123 | 0.183 | 0.213 | 0.239 | 0.261 | | 0.161 | 0.228 | 0.264 | 0.297 | 0.378 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.48 | 1.76 | 2.08 | 2.37 | | 0.93 | 1.48 | 1.76 | 2.08 | 2.37 | |
| ACTUAL STEEL % | 0.336 | 0.537 | 0.638 | 0.755 | 0.863 | | 0.336 | 0.537 | 0.638 | 0.755 | 0.863 | |
| EFF. DEPTH, IN. | 22.69 | 22.60 | 22.62 | 22.59 | 22.50 | | 22.69 | 22.60 | 22.62 | 22.59 | 22.50 | |
| $+I_{cr}/I_{gr}$ | 0.130 | 0.198 | 0.232 | 0.269 | 0.299 | | 0.130 | 0.198 | 0.232 | 0.269 | 0.299 | |

SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**40″ Forms + 8″ Ribs @ 48″ c.-c.**
22″ Deep Rib + 4.5″ Top Slab = 26.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span | # 4 | # 4 | # 6 | # 7 | # 8 | Int. Span |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 9 | 9 | 7.5 | 6 | 7.5 | Defl. Coeff. (2) | 7 | 4 | 7.5 | 8 | 6 | Defl. Coeff. (2) |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 6 | 1# 9 | 1# 9 | | 1# 6 | 1# 7 | 1# 6 | 1# 9 | 1# 9 | |
| BARS NO | 1# 6 | 1# 8 | 2# 7 | 1# 9 | 1#10 | | 1# 6 | 1# 8 | 2# 7 | 1# 9 | 1#10 | |
| STEEL (PSF) | 0.92 | 1.43 | 1.64 | 2.11 | 2.38 | | 1.34 | 2.21 | 2.58 | 3.33 | 4.86 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 237 | 679 | 899 | 1200 | 1427 | 7.149 | 591 | 1233 | 1553 | 1991 | 2322 | 4.399 |
| STIR | #3- 78 | #3-143 | #3-160 | #3-179 | #4-188 | | #3-100 | #3-141 | #3-159 | #4-170 | #4-169 | |
| 38'- 0" | 197 | 616 | 824 | 1109 | 1325 | 7.953 | 532 | 1141 | 1444 | 1859 | 2173 | 4.894 |
| STIR | #3- 75 | #3-143 | #3-162 | #3-181 | #4-192 | | #3- 99 | #3-146 | #3-162 | #4-174 | #4-174 | |
| 39'- 0" | 160 | 557 | 755 | 1026 | 1231 | 8.824 | 478 | 1056 | 1344 | 1738 | 2036 | 5.430 |
| STIR | #3- 72 | #3-144 | #3-163 | #3-159 | #3-194 | | #3- 99 | #3-148 | #3-163 | #4-176 | #4-179 | |
| 40'- 0" | 125 | 503 | 691 | 948 | 1143 | 9.765 | 428 | 977 | 1251 | 1625 | 1909 | 6.009 |
| STIR | #3- 68 | #3-144 | #3-164 | #3-168 | #3-197 | | #3- 97 | #3-149 | #3-166 | #4-180 | #4-185 | |
| 41'- 0" | 93 | 453 | 632 | 877 | 1062 | 10.778 | 381 | 904 | 1164 | 1521 | 1791 | 6.633 |
| STIR | #3- 65 | #3-144 | #3-166 | #3-176 | #3-199 | | #3- 96 | #3-151 | #3-146 | #4-183 | #4-190 | |
| 42'- 0" | 63 | 406 | 576 | 810 | 987 | 11.869 | 338 | 836 | 1084 | 1424 | 1681 | 7.304 |
| STIR | #3- 61 | #3-144 | #3-167 | #3-185 | #3-202 | | #3- 95 | #3-152 | #3-153 | #4-185 | #4-194 | |
| 43'- 0" | 35 | 362 | 525 | 748 | 916 | 13.040 | 297 | 773 | 1010 | 1334 | 1579 | 8.025 |
| STIR | #3- 56 | #3-144 | #3-168 | #3-190 | #3-205 | | #3- 93 | #3-153 | #3-161 | #3-188 | #4-196 | |
| 44'- 0" | 10 | 322 | 477 | 690 | 851 | 14.296 | 260 | 714 | 940 | 1249 | 1483 | 8.798 |
| STIR | #3- 52 | #3-144 | #3-168 | #3-192 | #3-208 | | #3- 91 | #3-154 | #3-168 | #3-190 | #4-199 | |
| 45'- 0" | | 284 | 432 | 636 | 790 | 15.641 | 225 | 659 | 875 | 1171 | 1394 | 9.625 |
| STIR | | #3-143 | #3-169 | #3-194 | #3-187 | | #3- 89 | #3-155 | #3-173 | #3-192 | #4-202 | |
| 46'- 0" | | 248 | 390 | 585 | 732 | 17.078 | 192 | 607 | 814 | 1097 | 1311 | 10.510 |
| STIR | | #3-143 | #3-170 | #3-195 | #3-195 | | #3- 87 | #3-156 | #3-175 | #3-195 | #4-205 | |
| 47'- 0" | | 215 | 351 | 538 | 679 | 18.613 | 161 | 559 | 757 | 1028 | 1233 | 11.454 |
| STIR | | #3-142 | #3-170 | #3-197 | #3-204 | | #3- 85 | #3-157 | #3-177 | #3-197 | #4-208 | |
| 48'- 0" | | 184 | 314 | 493 | 629 | 20.248 | 132 | 513 | 703 | 963 | 1160 | 12.460 |
| STIR | | #3-141 | #3-170 | #3-198 | #3-213 | | #3- 82 | #3-157 | #3-178 | #3-199 | #4-211 | |
| 49'- 0" | | 155 | 280 | 451 | 581 | 21.989 | 105 | 471 | 653 | 903 | 1091 | 13.532 |
| STIR | | #3-140 | #3-170 | #3-199 | #3-216 | | #3- 80 | #3-158 | #3-179 | #3-202 | #4-213 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.75 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.07 | 1.65 | 1.98 | 2.48 | 2.82 | | 1.37 | 2.40 | 2.82 | 3.60 | 6.32 | |
| ACTUAL STEEL % | 0.436 | 0.678 | 0.814 | 1.017 | 1.159 | | 0.561 | 0.982 | 1.159 | 1.486 | 2.617 | |
| EFF. DEPTH, IN. | 24.38 | 24.31 | 24.31 | 24.31 | 24.25 | | 24.38 | 24.38 | 24.25 | 24.19 | 24.12 | |
| $-I_{cr}/I_{gr}$ | 0.127 | 0.180 | 0.208 | 0.246 | 0.268 | | 0.156 | 0.241 | 0.268 | 0.317 | 0.457 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.64 | 2.00 | 2.27 | | 0.88 | 1.39 | 1.64 | 2.00 | 2.27 | |
| ACTUAL STEEL % | 0.345 | 0.546 | 0.644 | 0.788 | 0.896 | | 0.345 | 0.546 | 0.644 | 0.788 | 0.896 | |
| EFF. DEPTH, IN. | 24.62 | 24.53 | 24.58 | 24.44 | 24.40 | | 24.62 | 24.53 | 24.58 | 24.44 | 24.40 | |
| $+I_{cr}/I_{gr}$ | 0.135 | 0.204 | 0.238 | 0.281 | 0.313 | | 0.135 | 0.204 | 0.238 | 0.281 | 0.313 | |

SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**40″ Forms + 9″ Ribs @ 49″ c.-c.**
22″ Deep Rib + 4.5″ Top Slab = 26.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 8 | # 8 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 9 | 8.5 | 7 | 8 | 10 | | 10 | 9 | 10 | 10 | 6 | |
| BOTTOM BARS NO | 2# 5 | 2# 6 | 1# 8 | 1# 7 | 2# 8 | | 2# 5 | 2# 6 | 1# 8 | 1# 7 | 2# 8 | |
| BARS NO | 1# 5 | 1# 7 | 1# 9 | 2# 8 | 1# 8 | | 1# 5 | 1# 7 | 1# 9 | 2# 8 | 1# 8 | |
| STEEL (PSF) | 0.91 | 1.49 | 1.81 | 2.16 | 2.37 | | 1.39 | 2.25 | 2.75 | 3.40 | 4.84 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 250 | 728 | 988 | 1328 | 1489 | 7.149 | 625 | 1320 | 1699 | 2192 | 2427 | 4.399 |
| STIR | #3- 71 | #3-139 | #3-159 | #3-178 | #4-185 | | #3- 96 | #3-143 | #3-158 | #4-171 | #5-170 | |
| 38'- 0" | 208 | 660 | 907 | 1229 | 1382 | 7.953 | 563 | 1222 | 1581 | 2048 | 2271 | 4.894 |
| STIR | #3- 68 | #3-140 | #3-160 | #3-181 | #4-188 | | #3- 95 | #3-144 | #3-161 | #4-173 | #4-176 | |
| 39'- 0" | 168 | 598 | 832 | 1138 | 1283 | 8.824 | 505 | 1131 | 1472 | 1916 | 2127 | 5.430 |
| STIR | #3- 64 | #3-140 | #3-162 | #3-160 | #3-190 | | #3- 94 | #3-146 | #3-163 | #4-177 | #4-181 | |
| 40'- 0" | 131 | 540 | 763 | 1053 | 1191 | 9.765 | 452 | 1047 | 1371 | 1793 | 1993 | 6.009 |
| STIR | #3- 60 | #3-140 | #3-163 | #3-168 | #3-193 | | #3- 92 | #3-147 | #3-141 | #4-179 | #4-184 | |
| 41'- 0" | 97 | 486 | 698 | 975 | 1106 | 10.778 | 403 | 968 | 1277 | 1679 | 1870 | 6.633 |
| STIR | #3- 56 | #3-140 | #3-164 | #3-177 | #3-195 | | #3- 91 | #3-148 | #3-148 | #4-182 | #4-187 | |
| 42'- 0" | 66 | 437 | 639 | 902 | 1027 | 11.869 | 357 | 896 | 1190 | 1573 | 1755 | 7.304 |
| STIR | #3- 52 | #3-140 | #3-165 | #3-185 | #3-198 | | #3- 89 | #3-150 | #3-155 | #4-185 | #4-190 | |
| 43'- 0" | 36 | 390 | 583 | 834 | 953 | 13.040 | 314 | 828 | 1109 | 1474 | 1648 | 8.025 |
| STIR | #3- 47 | #3-140 | #3-166 | #3-190 | #3-179 | | #3- 87 | #3-151 | #3-162 | #4-187 | #4-193 | |
| 44'- 0" | 9 | 347 | 531 | 771 | 885 | 14.296 | 274 | 765 | 1033 | 1382 | 1548 | 8.798 |
| STIR | #3- 42 | #3-139 | #3-167 | #3-192 | #3-187 | | #3- 85 | #3-152 | #3-170 | #4-189 | #4-195 | |
| 45'- 0" | | 306 | 482 | 712 | 821 | 15.641 | 237 | 706 | 962 | 1296 | 1455 | 9.625 |
| STIR | | #3-138 | #3-167 | #3-193 | #3-196 | | #3- 83 | #3-152 | #3-172 | #3-193 | #4-198 | |
| 46'- 0" | | 268 | 437 | 656 | 761 | 17.078 | 202 | 651 | 896 | 1215 | 1367 | 10.510 |
| STIR | | #3-137 | #3-168 | #3-195 | #3-204 | | #3- 81 | #3-153 | #3-174 | #3-194 | #4-201 | |
| 47'- 0" | | 233 | 394 | 604 | 704 | 18.613 | 169 | 600 | 834 | 1140 | 1286 | 11.454 |
| STIR | | #3-136 | #3-168 | #3-196 | #3-207 | | #3- 78 | #3-154 | #3-175 | #3-197 | #4-203 | |
| 48'- 0" | | 200 | 354 | 556 | 652 | 20.248 | 139 | 551 | 776 | 1069 | 1209 | 12.460 |
| STIR | | #3-135 | #3-168 | #3-198 | #3-209 | | #3- 75 | #3-154 | #3-177 | #3-200 | #4-207 | |
| 49'- 0" | | 168 | 317 | 510 | 602 | 21.989 | 110 | 506 | 722 | 1003 | 1137 | 13.532 |
| STIR | | #3-134 | #3-168 | #3-199 | #3-210 | | #3- 72 | #3-154 | #3-178 | #3-202 | #4-209 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.78 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.09 | 1.79 | 2.17 | 2.69 | 2.94 | | 1.52 | 2.40 | 2.94 | 3.87 | 6.45 | |
| ACTUAL STEEL % | 0.405 | 0.667 | 0.809 | 1.008 | 1.103 | | 0.567 | 0.896 | 1.103 | 1.457 | 2.429 | |
| EFF. DEPTH, IN. | 24.38 | 24.31 | 24.31 | 24.25 | 24.19 | | 24.31 | 24.25 | 24.19 | 24.12 | 24.12 | |
| $-I_{cr}/I_{gr}$ | 0.122 | 0.182 | 0.211 | 0.247 | 0.262 | | 0.160 | 0.226 | 0.262 | 0.318 | 0.447 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.93 | 1.48 | 1.79 | 2.18 | 2.37 | | 0.93 | 1.48 | 1.79 | 2.18 | 2.37 | |
| ACTUAL STEEL % | 0.332 | 0.529 | 0.643 | 0.782 | 0.850 | | 0.332 | 0.529 | 0.643 | 0.782 | 0.850 | |
| EFF. DEPTH, IN. | 24.69 | 24.60 | 24.46 | 24.52 | 24.50 | | 24.69 | 24.60 | 24.46 | 24.52 | 24.50 | |
| $+I_{cr}/I_{gr}$ | 0.132 | 0.201 | 0.236 | 0.283 | 0.305 | | 0.132 | 0.201 | 0.236 | 0.283 | 0.305 | |
| SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**40″ Forms + 10″ Ribs @ 50″ c.-c.**
22″ Deep Rib + 4.5″ Top Slab = 26.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 5 | # 6 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 8 | # 8 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 8 | 8 | 9 | 8 | 9 | | 9.5 | 8 | 9 | 10 | 7.5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 7 | 1# 9 | 2# 8 | | 2# 4 | 1# 6 | 2# 7 | 1# 9 | 2# 8 | |
| BARS NO | 2# 5 | 2# 7 | 1# 8 | 1#10 | 1# 9 | | 2# 5 | 2# 7 | 1# 8 | 1#10 | 1# 9 | |
| STEEL (PSF) | 1.00 | 1.57 | 1.98 | 2.27 | 2.59 | | 1.49 | 2.45 | 3.01 | 3.51 | 4.34 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 298 | 833 | 1133 | 1362 | 1634 | 7.149 | 709 | 1488 | 1924 | 2258 | 2652 | 4.399 |
| STIR | #3- 72 | #3-141 | #3-161 | #3-152 | #4-184 | | #3- 97 | #3-143 | #4-160 | #4-167 | #5-175 | |
| 38'- 0" | 251 | 758 | 1043 | 1260 | 1517 | 7.953 | 640 | 1379 | 1793 | 2109 | 2483 | 4.894 |
| STIR | #3- 69 | #3-141 | #3-163 | #3-160 | #4-187 | | #3- 96 | #3-146 | #4-162 | #4-171 | #5-178 | |
| 39'- 0" | 207 | 689 | 959 | 1166 | 1410 | 8.824 | 577 | 1279 | 1671 | 1971 | 2326 | 5.430 |
| STIR | #3- 65 | #3-142 | #3-164 | #3-168 | #4-190 | | #3- 95 | #3-147 | #3-165 | #4-173 | #5-181 | |
| 40'- 0" | 167 | 625 | 882 | 1078 | 1310 | 9.765 | 519 | 1185 | 1559 | 1844 | 2182 | 6.009 |
| STIR | #3- 62 | #3-142 | #3-166 | #3-177 | #3-192 | | #3- 93 | #3-149 | #3-167 | #4-175 | #4-184 | |
| 41'- 0" | 130 | 566 | 810 | 997 | 1218 | 10.778 | 465 | 1099 | 1454 | 1726 | 2047 | 6.633 |
| STIR | #3- 58 | #3-142 | #3-167 | #3-181 | #3-195 | | #3- 92 | #3-150 | #3-145 | #4-178 | #4-187 | |
| 42'- 0" | 95 | 511 | 743 | 921 | 1132 | 11.869 | 414 | 1019 | 1357 | 1616 | 1922 | 7.304 |
| STIR | #3- 53 | #3-142 | #3-168 | #3-182 | #3-198 | | #3- 90 | #3-151 | #3-152 | #4-181 | #4-190 | |
| 43'- 0" | 63 | 459 | 681 | 851 | 1052 | 13.040 | 367 | 944 | 1267 | 1514 | 1806 | 8.025 |
| STIR | #3- 49 | #3-142 | #3-169 | #3-184 | #3-179 | | #3- 88 | #3-152 | #3-159 | #4-183 | #4-192 | |
| 44'- 0" | 33 | 411 | 623 | 786 | 977 | 14.296 | 323 | 874 | 1183 | 1419 | 1698 | 8.798 |
| STIR | #3- 44 | #3-141 | #3-170 | #3-186 | #3-188 | | #3- 86 | #3-153 | #3-166 | #3-186 | #4-195 | |
| 45'- 0" | 4 | 367 | 569 | 724 | 908 | 15.641 | 283 | 809 | 1104 | 1330 | 1596 | 9.625 |
| STIR | #3- 39 | #3-141 | #3-171 | #3-187 | #3-196 | | #3- 84 | #3-154 | #3-174 | #3-188 | #4-198 | |
| 46'- 0" | | 325 | 519 | 667 | 843 | 17.078 | 244 | 748 | 1031 | 1246 | 1501 | 10.510 |
| STIR | | #3-140 | #3-171 | #3-188 | #3-204 | | #3- 82 | #3-155 | #3-176 | #3-190 | #4-201 | |
| 47'- 0" | | 285 | 471 | 613 | 782 | 18.613 | 208 | 691 | 962 | 1168 | 1413 | 11.454 |
| STIR | | #3-139 | #3-172 | #3-189 | #3-206 | | #3- 79 | #3-155 | #3-178 | #3-167 | #4-203 | |
| 48'- 0" | | 249 | 427 | 563 | 724 | 20.248 | 175 | 638 | 897 | 1095 | 1329 | 12.460 |
| STIR | | #3-138 | #3-172 | #3-191 | #3-208 | | #3- 76 | #3-156 | #3-179 | #3-174 | #4-206 | |
| 49'- 0" | | 214 | 385 | 516 | 670 | 21.989 | 143 | 587 | 836 | 1026 | 1251 | 13.532 |
| STIR | | #3-137 | #3-172 | #3-191 | #3-210 | | #3- 73 | #3-156 | #3-180 | #3-182 | #4-209 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.81 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.25 | 1.94 | 2.44 | 2.75 | 3.33 | | 1.63 | 2.75 | 3.33 | 3.95 | 5.27 | |
| ACTUAL STEEL % | 0.426 | 0.663 | 0.839 | 0.943 | 1.147 | | 0.558 | 0.943 | 1.147 | 1.363 | 1.818 | |
| EFF. DEPTH, IN. | 24.38 | 24.31 | 24.25 | 24.25 | 24.19 | | 24.31 | 24.25 | 24.19 | 24.12 | 24.12 | |
| $-I_{cr}/I_{gr}$ | 0.130 | 0.184 | 0.220 | 0.240 | 0.275 | | 0.161 | 0.240 | 0.275 | 0.310 | 0.378 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 1.02 | 1.64 | 1.99 | 2.27 | 2.58 | | 1.02 | 1.64 | 1.99 | 2.27 | 2.58 | |
| ACTUAL STEEL % | 0.334 | 0.539 | 0.656 | 0.751 | 0.852 | | 0.334 | 0.539 | 0.656 | 0.751 | 0.852 | |
| EFF. DEPTH, IN. | 24.71 | 24.58 | 24.54 | 24.40 | 24.48 | | 24.71 | 24.58 | 24.54 | 24.40 | 24.48 | |
| $+I_{cr}/I_{gr}$ | 0.135 | 0.206 | 0.244 | 0.271 | 0.306 | | 0.135 | 0.206 | 0.244 | 0.271 | 0.306 | |
| SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 6 | # 6 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 8.5 | 5 | 4 | 7.5 | 9 | | 10 | 8 | 7 | 4.5 | 5 | |
| BOTTOM BARS NO | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | |
| BARS NO | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | |
| STEEL (PSF) | 0.93 | 1.65 | 1.91 | 2.38 | 2.70 | | 1.40 | 2.52 | 2.85 | 4.06 | 5.73 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 321 | 927 | 1121 | 1562 | 1808 | 7.149 | 726 | 1607 | 1890 | 2531 | 2889 | 4.399 |
| STIR | #3- 85 | #3-154 | #3-163 | #4-187 | #4-194 | | #3-105 | #3-155 | #4-164 | #5-176 | #5-169 | |
| 38'- 0" | 275 | 849 | 1033 | 1451 | 1684 | 7.953 | 659 | 1494 | 1762 | 2370 | 2709 | 4.894 |
| STIR | #3- 82 | #3-155 | #3-168 | #4-190 | #4-198 | | #3-105 | #3-133 | #4-166 | #4-180 | #5-173 | |
| 39'- 0" | 232 | 777 | 952 | 1349 | 1570 | 8.824 | 597 | 1390 | 1644 | 2221 | 2543 | 5.430 |
| STIR | #3- 80 | #3-157 | #3-170 | #3-193 | #4-201 | | #3-104 | #3-140 | #3-168 | #4-183 | #5-176 | |
| 40'- 0" | 192 | 711 | 877 | 1254 | 1465 | 9.765 | 539 | 1293 | 1535 | 2083 | 2390 | 6.009 |
| STIR | #3- 77 | #3-158 | #3-171 | #3-195 | #4-204 | | #3-104 | #3-147 | #3-170 | #4-186 | #5-178 | |
| 41'- 0" | 156 | 649 | 807 | 1166 | 1367 | 10.778 | 486 | 1203 | 1433 | 1955 | 2247 | 6.633 |
| STIR | #3- 73 | #3-159 | #3-173 | #3-199 | #4-208 | | #3-103 | #3-154 | #3-173 | #4-189 | #5-184 | |
| 42'- 0" | 122 | 592 | 742 | 1084 | 1275 | 11.869 | 436 | 1120 | 1339 | 1837 | 2114 | 7.304 |
| STIR | #3- 70 | #3-159 | #3-174 | #3-201 | #4-211 | | #3-102 | #3-162 | #3-176 | #4-192 | #5-191 | |
| 43'- 0" | 90 | 538 | 682 | 1008 | 1191 | 13.040 | 390 | 1042 | 1251 | 1726 | 1991 | 8.025 |
| STIR | #3- 66 | #3-160 | #3-176 | #3-203 | #4-213 | | #3-100 | #3-165 | #3-150 | #4-195 | #4-197 | |
| 44'- 0" | 60 | 488 | 626 | 937 | 1111 | 14.296 | 347 | 970 | 1169 | 1623 | 1876 | 8.798 |
| STIR | #3- 62 | #3-160 | #3-177 | #3-182 | #3-216 | | #3- 99 | #3-166 | #3-157 | #4-198 | #4-203 | |
| 45'- 0" | 32 | 442 | 573 | 871 | 1037 | 15.641 | 306 | 902 | 1093 | 1526 | 1768 | 9.625 |
| STIR | #3- 58 | #3-160 | #3-178 | #3-190 | #3-219 | | #3- 97 | #3-168 | #3-165 | #4-201 | #4-209 | |
| 46'- 0" | 6 | 398 | 524 | 809 | 968 | 17.078 | 269 | 839 | 1021 | 1436 | 1668 | 10.510 |
| STIR | #3- 53 | #3-161 | #3-179 | #3-198 | #3-221 | | #3- 95 | #3-169 | #3-172 | #4-204 | #4-212 | |
| 47'- 0" | | 357 | 478 | 751 | 904 | 18.613 | 233 | 779 | 954 | 1352 | 1574 | 11.454 |
| STIR | | #3-161 | #3-179 | #3-207 | #3-224 | | #3- 93 | #3-170 | #3-180 | #4-206 | #4-214 | |
| 48'- 0" | | 319 | 435 | 696 | 843 | 20.248 | 200 | 724 | 891 | 1272 | 1485 | 12.460 |
| STIR | | #3-160 | #3-180 | #3-212 | #3-227 | | #3- 91 | #3-172 | #3-185 | #4-209 | #4-218 | |
| 49'- 0" | | 283 | 394 | 645 | 786 | 21.989 | 169 | 671 | 832 | 1198 | 1402 | 13.532 |
| STIR | | #3-160 | #3-181 | #3-214 | #3-229 | | #3- 89 | #3-173 | #3-187 | #4-211 | #4-220 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.79 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.13 | 1.92 | 2.40 | 2.82 | 3.20 | | 1.49 | 2.64 | 3.02 | 4.69 | 7.58 | |
| ACTUAL STEEL % | 0.420 | 0.714 | 0.892 | 1.053 | 1.200 | | 0.555 | 0.987 | 1.128 | 1.755 | 2.852 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.38 | 26.25 | 26.19 | | 26.31 | 26.25 | 26.25 | 26.25 | 26.12 | |
| $-I_{cr}/I_{gr}$ | 0.128 | 0.196 | 0.232 | 0.259 | 0.283 | | 0.159 | 0.247 | 0.273 | 0.372 | 0.500 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | |
| ACTUAL STEEL % | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | |
| EFF. DEPTH, IN. | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | |
| $+I_{cr}/I_{gr}$ | 0.135 | 0.217 | 0.242 | 0.298 | 0.329 | | 0.135 | 0.217 | 0.242 | 0.298 | 0.329 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 8 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 8 | 5 | 4 | 7 | 8 | | 9.5 | 8 | 8.5 | 9.5 | 5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | |
| BARS NO | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | |
| STEEL (PSF) | 1.01 | 1.60 | 2.01 | 2.41 | 2.82 | | 1.50 | 2.47 | 3.14 | 3.66 | 5.75 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 372 | 952 | 1278 | 1628 | 2012 | 7.149 | 817 | 1661 | 2134 | 2644 | 3202 | 4.399 |
| STIR | #3- 85 | #3-149 | #3-161 | #4-184 | #4-195 | | #3-105 | #3-133 | #4-164 | #5-173 | #5-173 | |
| 38'- 0" | 321 | 872 | 1180 | 1512 | 1876 | 7.953 | 743 | 1543 | 1992 | 2475 | 3004 | 4.894 |
| STIR | #3- 82 | #3-150 | #3-169 | #4-186 | #4-198 | | #3-105 | #3-140 | #4-167 | #4-177 | #5-176 | |
| 39'- 0" | 274 | 797 | 1089 | 1405 | 1750 | 8.824 | 675 | 1434 | 1860 | 2319 | 2821 | 5.430 |
| STIR | #3- 79 | #3-150 | #3-171 | #3-189 | #4-202 | | #3-104 | #3-148 | #4-170 | #4-181 | #5-180 | |
| 40'- 0" | 231 | 727 | 1006 | 1306 | 1634 | 9.765 | 612 | 1334 | 1738 | 2175 | 2652 | 6.009 |
| STIR | #3- 76 | #3-151 | #3-173 | #3-191 | #4-205 | | #3-103 | #3-155 | #4-172 | #4-183 | #5-182 | |
| 41'- 0" | 191 | 663 | 928 | 1213 | 1526 | 10.778 | 553 | 1240 | 1625 | 2041 | 2495 | 6.633 |
| STIR | #3- 73 | #3-152 | #3-174 | #3-194 | #4-208 | | #3-103 | #3-157 | #3-175 | #4-186 | #5-186 | |
| 42'- 0" | 153 | 603 | 856 | 1128 | 1426 | 11.869 | 498 | 1153 | 1520 | 1916 | 2349 | 7.304 |
| STIR | #3- 70 | #3-152 | #3-176 | #3-173 | #4-211 | | #3-101 | #3-158 | #3-176 | #4-189 | #5-192 | |
| 43'- 0" | 118 | 548 | 789 | 1048 | 1332 | 13.040 | 448 | 1072 | 1423 | 1800 | 2213 | 8.025 |
| STIR | #3- 66 | #3-152 | #3-177 | #3-182 | #4-214 | | #3-100 | #3-160 | #3-179 | #4-192 | #5-197 | |
| 44'- 0" | 86 | 496 | 726 | 974 | 1245 | 14.296 | 400 | 997 | 1331 | 1692 | 2087 | 8.798 |
| STIR | #3- 62 | #3-152 | #3-179 | #3-190 | #4-217 | | #3- 99 | #3-161 | #3-155 | #4-194 | #5-203 | |
| 45'- 0" | 55 | 448 | 667 | 904 | 1164 | 15.641 | 356 | 927 | 1246 | 1591 | 1968 | 9.625 |
| STIR | #3- 58 | #3-152 | #3-180 | #3-199 | #4-219 | | #3- 97 | #3-162 | #3-162 | #4-197 | #5-208 | |
| 46'- 0" | 27 | 402 | 613 | 839 | 1088 | 17.078 | 315 | 861 | 1167 | 1496 | 1858 | 10.510 |
| STIR | #3- 53 | #3-152 | #3-181 | #3-203 | #3-222 | | #3- 95 | #3-163 | #3-169 | #4-200 | #4-212 | |
| 47'- 0" | | 360 | 561 | 779 | 1016 | 18.613 | 276 | 799 | 1092 | 1408 | 1754 | 11.454 |
| STIR | | #3-151 | #3-181 | #3-205 | #3-225 | | #3- 93 | #3-164 | #3-177 | #4-203 | #4-215 | |
| 48'- 0" | | 320 | 513 | 721 | 949 | 20.248 | 239 | 741 | 1022 | 1325 | 1657 | 12.460 |
| STIR | | #3-151 | #3-182 | #3-206 | #3-227 | | #3- 91 | #3-165 | #3-184 | #4-205 | #4-217 | |
| 49'- 0" | | 283 | 468 | 668 | 887 | 21.989 | 205 | 687 | 956 | 1247 | 1565 | 13.532 |
| STIR | | #3-150 | #3-183 | #3-208 | #3-230 | | #3- 89 | #3-166 | #3-188 | #4-207 | #4-221 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.82 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.23 | 1.96 | 2.45 | 3.08 | 3.68 | | 1.60 | 2.69 | 3.46 | 4.07 | 7.74 | |
| ACTUAL STEEL % | 0.415 | 0.664 | 0.830 | 1.049 | 1.255 | | 0.543 | 0.918 | 1.181 | 1.395 | 2.651 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.38 | 26.25 | 26.19 | | 26.31 | 26.25 | 26.19 | 26.12 | 26.12 | |
| $-I_{cr}/I_{gr}$ | 0.129 | 0.189 | 0.225 | 0.264 | 0.299 | | 0.160 | 0.239 | 0.286 | 0.320 | 0.489 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | |
| ACTUAL STEEL % | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | |
| EFF. DEPTH, IN. | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | |
| $+I_{cr}/I_{gr}$ | 0.137 | 0.209 | 0.249 | 0.290 | 0.334 | | 0.137 | 0.209 | 0.249 | 0.290 | 0.334 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**40″ Forms + 10″ Ribs @ 50″ c.-c.**
24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 5 | # 6 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 8 | # 8 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 7 | 7 | 8 | 7 | 8.5 | | 8 | 7.5 | 8 | 9 | 6 | |
| BOTTOM BARS NO | 1# 5 | 1# 8 | 1# 7 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 7 | 1#10 | 1#10 | |
| BARS NO | 2# 6 | 1# 9 | 2# 8 | 1#10 | 1#11 | | 2# 6 | 1# 9 | 2# 8 | 1#10 | 1#11 | |
| STEEL (PSF) | 1.13 | 1.79 | 2.13 | 2.58 | 2.85 | | 1.73 | 2.69 | 3.29 | 3.94 | 5.19 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 496 | 1051 | 1418 | 1738 | 2001 | 7.149 | 1012 | 1820 | 2354 | 2820 | 3202 | 4.399 |
| STIR | #3- 95 | #3-148 | #3-159 | #4-182 | #4-190 | | #3-113 | #3-133 | #4-164 | #5-173 | #5-178 | |
| 38'- 0" | 436 | 963 | 1311 | 1615 | 1864 | 7.953 | 927 | 1692 | 2199 | 2641 | 3003 | 4.894 |
| STIR | #3- 94 | #3-149 | #3-168 | #4-184 | #4-193 | | #3-113 | #3-141 | #4-167 | #5-176 | #5-181 | |
| 39'- 0" | 382 | 882 | 1212 | 1501 | 1737 | 8.824 | 847 | 1574 | 2055 | 2474 | 2818 | 5.430 |
| STIR | #3- 91 | #3-150 | #3-172 | #3-187 | #4-196 | | #3-112 | #3-148 | #4-169 | #4-179 | #5-185 | |
| 40'- 0" | 331 | 806 | 1121 | 1395 | 1619 | 9.765 | 774 | 1465 | 1922 | 2321 | 2647 | 6.009 |
| STIR | #3- 89 | #3-151 | #3-174 | #3-190 | #4-199 | | #3-112 | #3-155 | #4-173 | #4-182 | #5-187 | |
| 41'- 0" | 284 | 737 | 1036 | 1297 | 1511 | 10.778 | 705 | 1363 | 1798 | 2178 | 2489 | 6.633 |
| STIR | #3- 86 | #3-152 | #3-175 | #3-169 | #4-202 | | #3-112 | #3-156 | #4-175 | #4-185 | #5-191 | |
| 42'- 0" | 241 | 672 | 957 | 1205 | 1409 | 11.869 | 642 | 1269 | 1684 | 2045 | 2342 | 7.304 |
| STIR | #3- 83 | #3-152 | #3-177 | #3-177 | #4-204 | | #3-111 | #3-158 | #4-177 | #4-188 | #5-195 | |
| 43'- 0" | 200 | 611 | 883 | 1121 | 1315 | 13.040 | 583 | 1181 | 1577 | 1922 | 2204 | 8.025 |
| STIR | #3- 80 | #3-152 | #3-178 | #3-186 | #4-207 | | #3-110 | #3-159 | #3-179 | #4-190 | #5-198 | |
| 44'- 0" | 162 | 555 | 815 | 1041 | 1227 | 14.296 | 528 | 1099 | 1477 | 1806 | 2076 | 8.798 |
| STIR | #3- 77 | #3-152 | #3-180 | #3-195 | #3-210 | | #3-109 | #3-160 | #3-154 | #4-193 | #4-200 | |
| 45'- 0" | 127 | 502 | 751 | 967 | 1145 | 15.641 | 477 | 1022 | 1384 | 1699 | 1957 | 9.625 |
| STIR | #3- 74 | #3-152 | #3-181 | #3-198 | #3-212 | | #3-108 | #3-162 | #3-161 | #4-195 | #4-204 | |
| 46'- 0" | 94 | 453 | 691 | 898 | 1068 | 17.078 | 428 | 951 | 1297 | 1598 | 1845 | 10.510 |
| STIR | #3- 70 | #3-152 | #3-182 | #3-200 | #3-191 | | #3-107 | #3-163 | #3-169 | #4-199 | #4-206 | |
| 47'- 0" | 63 | 407 | 635 | 833 | 996 | 18.613 | 383 | 884 | 1215 | 1504 | 1741 | 11.454 |
| STIR | #3- 66 | #3-151 | #3-183 | #3-202 | #3-199 | | #3-105 | #3-164 | #3-176 | #4-201 | #4-209 | |
| 48'- 0" | 34 | 364 | 582 | 773 | 929 | 20.248 | 341 | 821 | 1139 | 1415 | 1642 | 12.460 |
| STIR | #3- 61 | #3-151 | #3-184 | #3-204 | #3-208 | | #3-103 | #3-165 | #3-183 | #4-203 | #4-212 | |
| 49'- 0" | 7 | 323 | 533 | 715 | 865 | 21.989 | 301 | 762 | 1067 | 1332 | 1550 | 13.532 |
| STIR | #3- 57 | #3-150 | #3-184 | #3-205 | #3-217 | | #3-102 | #3-165 | #3-189 | #4-205 | #4-215 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.86 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.43 | 2.21 | 2.75 | 3.14 | 3.53 | | 1.94 | 2.93 | 3.75 | 4.39 | 6.58 | |
| ACTUAL STEEL % | 0.444 | 0.690 | 0.860 | 0.982 | 1.106 | | 0.604 | 0.917 | 1.175 | 1.380 | 2.069 | |
| EFF. DEPTH, IN. | 26.38 | 26.31 | 26.25 | 26.25 | 26.19 | | 26.31 | 26.25 | 26.19 | 26.12 | 26.12 | |
| $-I_{cr}/I_{gr}$ | 0.139 | 0.197 | 0.232 | 0.257 | 0.278 | | 0.177 | 0.244 | 0.291 | 0.324 | 0.427 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 1.19 | 1.79 | 2.18 | 2.54 | 2.83 | | 1.19 | 1.79 | 2.18 | 2.54 | 2.83 | |
| ACTUAL STEEL % | 0.356 | 0.539 | 0.656 | 0.767 | 0.856 | | 0.356 | 0.539 | 0.656 | 0.767 | 0.856 | |
| EFF. DEPTH, IN. | 26.64 | 26.46 | 26.52 | 26.36 | 26.33 | | 26.64 | 26.46 | 26.52 | 26.36 | 26.33 | |
| $+I_{cr}/I_{gr}$ | 0.147 | 0.210 | 0.252 | 0.285 | 0.313 | | 0.147 | 0.210 | 0.252 | 0.285 | 0.313 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**53″ Forms + 7″ Ribs @ 60″ c.-c.**
16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 10 | 8 | 10 | 9 | | 10 | 8 | 9 | 7 | 8 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | | 2# 4 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | |
| BARS NO | 1# 4 | 1# 6 | 1# 7 | 1# 8 | 1# 8 | | 1# 4 | 1# 6 | 1# 7 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.57 | 0.77 | 1.02 | 1.18 | 1.35 | | 0.81 | 1.13 | 1.55 | 2.35 | 2.77 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 202 | 523 | 888 | 1103 | 1318 | 2.344 | 524 | 990 | 1522 | 1834 | 2146 | 1.443 |
| STIR | #3- 68 | #3-107 | #3-116 | #3-141 | #3-147 | | #3- 82 | #3-108 | #3-127 | #4-130 | #4-128 | |
| 29'- 0" | 154 | 453 | 794 | 994 | 1194 | 2.698 | 454 | 889 | 1384 | 1676 | 1966 | 1.660 |
| STIR | #3- 66 | #3-108 | #3-124 | #3-144 | #3-151 | | #3- 82 | #3-111 | #3-130 | #3-136 | #4-131 | |
| 30'- 0" | 111 | 391 | 709 | 896 | 1083 | 3.090 | 391 | 797 | 1260 | 1533 | 1804 | 1.901 |
| STIR | #3- 63 | #3-108 | #3-133 | #3-147 | #3-154 | | #3- 81 | #3-113 | #3-133 | #3-140 | #4-135 | |
| 31'- 0" | 72 | 334 | 632 | 807 | 982 | 3.523 | 334 | 715 | 1148 | 1403 | 1658 | 2.168 |
| STIR | #3- 60 | #3-109 | #3-136 | #3-149 | #3-157 | | #3- 81 | #3-114 | #3-135 | #3-143 | #4-141 | |
| 32'- 0" | 37 | 282 | 562 | 726 | 891 | 4.000 | 283 | 640 | 1047 | 1286 | 1525 | 2.461 |
| STIR | #3- 57 | #3-108 | #3-138 | #3-152 | #3-160 | | #3- 80 | #3-115 | #3-137 | #3-145 | #4-147 | |
| 33'- 0" | 4 | 235 | 498 | 653 | 807 | 4.523 | 236 | 571 | 954 | 1179 | 1404 | 2.784 |
| STIR | #3- 54 | #3-108 | #3-140 | #3-138 | #3-163 | | #3- 79 | #3-116 | #3-140 | #3-148 | #4-153 | |
| 34'- 0" | | 192 | 440 | 586 | 731 | 5.097 | 193 | 509 | 870 | 1082 | 1293 | 3.137 |
| STIR | | #3-108 | #3-141 | #3-147 | #3-166 | | #3- 77 | #3-117 | #3-143 | #3-151 | #3-158 | |
| 35'- 0" | | 153 | 387 | 524 | 662 | 5.724 | 153 | 452 | 792 | 992 | 1192 | 3.522 |
| STIR | | #3-107 | #3-142 | #3-155 | #3-168 | | #3- 76 | #3-118 | #3-145 | #3-154 | #3-161 | |
| 36'- 0" | | 117 | 338 | 468 | 598 | 6.407 | 117 | 400 | 721 | 910 | 1099 | 3.942 |
| STIR | | #3-106 | #3-144 | #3-158 | #3-171 | | #3- 74 | #3-118 | #3-131 | #3-157 | #3-164 | |
| 37'- 0" | | 84 | 293 | 416 | 539 | 7.149 | 84 | 351 | 656 | 835 | 1013 | 4.399 |
| STIR | | #3-105 | #3-145 | #3-160 | #3-173 | | #3- 72 | #3-119 | #3-138 | #3-159 | #3-167 | |
| 38'- 0" | | 53 | 252 | 368 | 485 | 7.953 | 54 | 307 | 595 | 765 | 934 | 4.894 |
| STIR | | #3-103 | #3-145 | #3-161 | #3-162 | | #3- 69 | #3-119 | #3-146 | #3-162 | #3-170 | |
| 39'- 0" | | 25 | 213 | 324 | 435 | 8.824 | 25 | 266 | 540 | 701 | 862 | 5.430 |
| STIR | | #3-102 | #3-146 | #3-163 | #3-170 | | #3- 67 | #3-119 | #3-150 | #3-163 | #3-172 | |
| 40'- 0" | | | 178 | 283 | 388 | 9.765 | | 228 | 488 | 641 | 794 | 6.009 |
| STIR | | | #3-146 | #3-164 | #3-178 | | | #3-119 | #3-152 | #3-166 | #3-175 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.20 | 1.20 | 1.50 | 1.86 | 2.07 | | 1.20 | 1.50 | 2.07 | 3.77 | 4.50 | |
| ACTUAL STEEL % | 0.765 | 0.765 | 0.957 | 1.191 | 1.324 | | 0.765 | 0.957 | 1.324 | 2.425 | 2.906 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.31 | 18.31 | | 18.38 | 18.38 | 18.31 | 18.25 | 18.19 | |
| $-I_{cr}/I_{gr}$ | 0.160 | 0.160 | 0.190 | 0.221 | 0.238 | | 0.160 | 0.190 | 0.238 | 0.355 | 0.392 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.60 | 0.88 | 1.20 | 1.39 | 1.58 | | 0.60 | 0.88 | 1.20 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.361 | 0.533 | 0.729 | 0.846 | 0.962 | | 0.361 | 0.533 | 0.729 | 0.846 | 0.962 | |
| EFF. DEPTH, IN. | 18.75 | 18.62 | 18.56 | 18.53 | 18.50 | | 18.75 | 18.62 | 18.56 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.119 | 0.168 | 0.222 | 0.253 | 0.284 | | 0.119 | 0.168 | 0.222 | 0.253 | 0.284 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 8″ Ribs @ 61″ c.-c.<br>16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9.5 | 8 | 7 | 9.5 | | 10 | 7 | 9.5 | 8 | 6 | |
| BOTTOM BARS NO | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.60 | 0.85 | 0.95 | 1.14 | 1.31 | | 0.84 | 1.28 | 1.44 | 1.73 | 2.72 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 198 | 680 | 857 | 1078 | 1292 | 2.344 | 529 | 1231 | 1488 | 1809 | 2121 | 1.443 |
| STIR | #3- 57 | #3-112 | #3-122 | #3-134 | #3-141 | | #3- 75 | #3-102 | #3-122 | #3-129 | #4-128 | |
| 29'- 0" | 148 | 598 | 763 | 969 | 1169 | 2.698 | 457 | 1111 | 1351 | 1651 | 1941 | 1.660 |
| STIR | #3- 54 | #3-113 | #3-124 | #3-120 | #3-145 | | #3- 74 | #3-110 | #3-124 | #3-131 | #4-134 | |
| 30'- 0" | 104 | 524 | 679 | 871 | 1057 | 3.090 | 392 | 1004 | 1228 | 1508 | 1779 | 1.901 |
| STIR | #3- 51 | #3-114 | #3-126 | #3-128 | #3-148 | | #3- 73 | #3-116 | #3-127 | #3-134 | #4-140 | |
| 31'- 0" | 64 | 457 | 602 | 782 | 957 | 3.523 | 334 | 906 | 1116 | 1378 | 1633 | 2.168 |
| STIR | #3- 47 | #3-114 | #3-127 | #3-137 | #3-150 | | #3- 72 | #3-118 | #3-129 | #3-137 | #4-143 | |
| 32'- 0" | 27 | 397 | 532 | 701 | 865 | 4.000 | 280 | 818 | 1015 | 1261 | 1500 | 2.461 |
| STIR | #3- 43 | #3-114 | #3-128 | #3-141 | #3-152 | | #3- 70 | #3-119 | #3-116 | #3-139 | #3-146 | |
| 33'- 0" | | 341 | 469 | 628 | 782 | 4.523 | 232 | 738 | 923 | 1154 | 1378 | 2.784 |
| STIR | | #3-114 | #3-129 | #3-143 | #3-136 | | #3- 68 | #3-120 | #3-123 | #3-142 | #3-149 | |
| 34'- 0" | | 291 | 411 | 560 | 706 | 5.097 | 188 | 664 | 839 | 1056 | 1268 | 3.137 |
| STIR | | #3-114 | #3-130 | #3-144 | #3-145 | | #3- 66 | #3-122 | #3-131 | #3-144 | #3-152 | |
| 35'- 0" | | 245 | 358 | 499 | 636 | 5.724 | 147 | 597 | 761 | 967 | 1166 | 3.522 |
| STIR | | #3-114 | #3-130 | #3-146 | #3-153 | | #3- 64 | #3-123 | #3-134 | #3-147 | #3-154 | |
| 36'- 0" | | 202 | 309 | 443 | 572 | 6.407 | 110 | 535 | 691 | 885 | 1074 | 3.942 |
| STIR | | #3-113 | #3-131 | #3-147 | #3-159 | | #3- 61 | #3-123 | #3-136 | #3-149 | #3-157 | |
| 37'- 0" | | 163 | 264 | 391 | 514 | 7.149 | 76 | 478 | 626 | 809 | 988 | 4.399 |
| STIR | | #3-113 | #3-131 | #3-148 | #3-161 | | #3- 59 | #3-124 | #3-137 | #3-134 | #3-160 | |
| 38'- 0" | | 127 | 223 | 343 | 459 | 7.953 | 45 | 426 | 566 | 740 | 909 | 4.894 |
| STIR | | #3-112 | #3-131 | #3-149 | #3-163 | | #3- 56 | #3-125 | #3-138 | #3-141 | #3-162 | |
| 39'- 0" | | 94 | 185 | 299 | 409 | 8.824 | 16 | 377 | 510 | 676 | 836 | 5.430 |
| STIR | | #3-110 | #3-131 | #3-150 | #3-164 | | #3- 52 | #3-125 | #3-140 | #3-148 | #3-165 | |
| 40'- 0" | | 63 | 150 | 258 | 363 | 9.765 | | 333 | 459 | 616 | 769 | 6.009 |
| STIR | | #3-109 | #3-130 | #3-151 | #3-166 | | | #3-126 | #3-141 | #3-154 | #3-167 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.22 | 1.28 | 1.52 | 1.74 | 1.99 | | 1.22 | 1.74 | 1.99 | 2.36 | 4.47 | |
| ACTUAL STEEL % | 0.697 | 0.733 | 0.871 | 0.995 | 1.141 | | 0.697 | 0.995 | 1.141 | 1.355 | 2.575 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.38 | 18.31 | | 18.38 | 18.38 | 18.31 | 18.31 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.152 | 0.158 | 0.181 | 0.200 | 0.219 | | 0.152 | 0.200 | 0.219 | 0.248 | 0.377 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | |
| EFF. DEPTH, IN. | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.111 | 0.178 | 0.203 | 0.231 | 0.259 | | 0.111 | 0.178 | 0.203 | 0.231 | 0.259 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 9″ Ribs @ 62″ c.-c.<br>16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8.5 | 7.5 | 9.5 | 8.5 | | 10 | 9.5 | 8.5 | 7 | 4 | |
| BOTTOM BARS NO | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.64 | 0.92 | 1.05 | 1.30 | 1.45 | | 0.88 | 1.43 | 1.61 | 1.98 | 2.89 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 279 | 832 | 981 | 1267 | 1502 | 2.344 | 658 | 1463 | 1679 | 2096 | 2438 | 1.443 |
| STIR | #3- 62 | #3-115 | #3-123 | #3-136 | #3-143 | | #3- 78 | #3- 98 | #3-122 | #4-130 | #4-130 | |
| 29'- 0" | 222 | 738 | 877 | 1144 | 1363 | 2.698 | 576 | 1326 | 1528 | 1916 | 2235 | 1.660 |
| STIR | #3- 60 | #3-116 | #3-124 | #3-139 | #3-146 | | #3- 78 | #3-105 | #3-124 | #4-132 | #4-134 | |
| 30'- 0" | 171 | 653 | 783 | 1032 | 1237 | 3.090 | 502 | 1203 | 1391 | 1754 | 2052 | 1.901 |
| STIR | #3- 57 | #3-117 | #3-126 | #3-125 | #3-149 | | #3- 77 | #3-113 | #3-127 | #3-136 | #4-140 | |
| 31'- 0" | 125 | 576 | 698 | 931 | 1123 | 3.523 | 435 | 1091 | 1267 | 1607 | 1886 | 2.168 |
| STIR | #3- 53 | #3-118 | #3-127 | #3-133 | #3-152 | | #3- 76 | #3-120 | #3-129 | #3-139 | #4-144 | |
| 32'- 0" | 83 | 507 | 621 | 840 | 1020 | 4.000 | 374 | 990 | 1155 | 1474 | 1736 | 2.461 |
| STIR | #3- 50 | #3-118 | #3-128 | #3-142 | #3-155 | | #3- 75 | #3-122 | #3-116 | #3-141 | #4-147 | |
| 33'- 0" | 45 | 443 | 550 | 757 | 926 | 4.523 | 318 | 897 | 1053 | 1353 | 1599 | 2.784 |
| STIR | #3- 46 | #3-119 | #3-129 | #3-145 | #3-157 | | #3- 73 | #3-124 | #3-123 | #3-144 | #4-150 | |
| 34'- 0" | 10 | 385 | 486 | 681 | 840 | 5.097 | 268 | 813 | 960 | 1243 | 1474 | 3.137 |
| STIR | #3- 41 | #3-119 | #3-130 | #3-147 | #3-142 | | #3- 71 | #3-125 | #3-131 | #3-146 | #3-153 | |
| 35'- 0" | | 332 | 427 | 611 | 761 | 5.724 | 221 | 736 | 875 | 1141 | 1360 | 3.522 |
| STIR | | #3-119 | #3-131 | #3-149 | #3-150 | | #3- 69 | #3-126 | #3-134 | #3-149 | #3-155 | |
| 36'- 0" | | 284 | 374 | 547 | 689 | 6.407 | 179 | 665 | 796 | 1048 | 1255 | 3.942 |
| STIR | | #3-118 | #3-131 | #3-150 | #3-159 | | #3- 67 | #3-127 | #3-136 | #3-150 | #3-158 | |
| 37'- 0" | | 239 | 324 | 488 | 623 | 7.149 | 139 | 600 | 724 | 963 | 1158 | 4.399 |
| STIR | | #3-118 | #3-131 | #3-151 | #3-163 | | #3- 65 | #3-128 | #3-137 | #3-152 | #3-161 | |
| 38'- 0" | | 198 | 278 | 434 | 561 | 7.953 | 103 | 540 | 658 | 884 | 1069 | 4.894 |
| STIR | | #3-117 | #3-131 | #3-152 | #3-165 | | #3- 62 | #3-129 | #3-139 | #3-137 | #3-164 | |
| 39'- 0" | | 159 | 236 | 384 | 505 | 8.824 | 70 | 485 | 596 | 811 | 987 | 5.430 |
| STIR | | #3-116 | #3-131 | #3-153 | #3-167 | | #3- 59 | #3-130 | #3-140 | #3-145 | #3-166 | |
| 40'- 0" | | 124 | 197 | 337 | 452 | 9.765 | 39 | 433 | 539 | 743 | 911 | 6.009 |
| STIR | | #3-115 | #3-131 | #3-154 | #3-168 | | #3- 56 | #3-130 | #3-141 | #3-152 | #3-168 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.24 | 1.46 | 1.65 | 2.02 | 2.26 | | 1.24 | 2.02 | 2.26 | 2.75 | 4.80 | |
| ACTUAL STEEL % | 0.641 | 0.754 | 0.854 | 1.050 | 1.173 | | 0.641 | 1.050 | 1.173 | 1.424 | 2.493 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.31 | 18.31 | | 18.38 | 18.31 | 18.31 | 18.31 | 18.31 | |
| $-I_{cr}/I_{gr}$ | 0.145 | 0.165 | 0.182 | 0.210 | 0.228 | | 0.145 | 0.210 | 0.228 | 0.263 | 0.382 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | |
| EFF. DEPTH, IN. | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | |
| $+I_{cr}/I_{gr}$ | 0.117 | 0.187 | 0.206 | 0.239 | 0.266 | | 0.117 | 0.187 | 0.206 | 0.239 | 0.266 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 10″ Ribs @ 63″ c.-c.<br>16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8.5 | 7 | 9.5 | 7.5 | | 10 | 10 | 7.5 | 7 | 7 | |
| BOTTOM BARS NO | 3# 3 | 1# 5 | 2# 6 | 1# 6 | 2# 7 | | 3# 3 | 1# 5 | 2# 6 | 1# 6 | 2# 7 | |
| BARS NO | 2# 4 | 2# 6 | 1# 7 | 2# 7 | 1# 8 | | 2# 4 | 2# 6 | 1# 7 | 2# 7 | 1# 8 | |
| STEEL (PSF) | 0.65 | 0.91 | 1.16 | 1.27 | 1.59 | | 0.89 | 1.38 | 1.82 | 1.94 | 3.19 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 279 | 807 | 1137 | 1318 | 1713 | 2.344 | 671 | 1437 | 1918 | 2182 | 2755 | 1.443 |
| STIR | #3- 54 | #3-107 | #3-124 | #3-114 | #4-144 | | #3- 73 | #3-108 | #3-123 | #4-128 | #4-129 | |
| 29'- 0" | 221 | 712 | 1021 | 1190 | 1557 | 2.698 | 586 | 1301 | 1749 | 1995 | 2529 | 1.660 |
| STIR | #3- 51 | #3-108 | #3-126 | #3-122 | #3-147 | | #3- 72 | #3-111 | #3-125 | #4-130 | #4-133 | |
| 30'- 0" | 168 | 628 | 916 | 1074 | 1417 | 3.090 | 509 | 1177 | 1596 | 1826 | 2325 | 1.901 |
| STIR | #3- 47 | #3-108 | #3-127 | #3-131 | #3-150 | | #3- 70 | #3-113 | #3-128 | #3-133 | #4-138 | |
| 31'- 0" | 121 | 551 | 821 | 969 | 1290 | 3.523 | 440 | 1066 | 1458 | 1673 | 2141 | 2.168 |
| STIR | #3- 43 | #3-108 | #3-129 | #3-137 | #3-153 | | #3- 69 | #3-114 | #3-130 | #3-135 | #4-145 | |
| 32'- 0" | 77 | 481 | 734 | 873 | 1175 | 4.000 | 377 | 964 | 1332 | 1534 | 1973 | 2.461 |
| STIR | #3- 39 | #3-108 | #3-130 | #3-139 | #3-155 | | #3- 67 | #3-115 | #3-113 | #3-139 | #4-149 | |
| 33'- 0" | 38 | 418 | 656 | 786 | 1070 | 4.523 | 320 | 872 | 1218 | 1408 | 1821 | 2.784 |
| STIR | #3- 34 | #3-108 | #3-131 | #3-141 | #3-158 | | #3- 65 | #3-116 | #3-120 | #3-141 | #4-152 | |
| 34'- 0" | 2 | 360 | 584 | 707 | 974 | 5.097 | 268 | 788 | 1114 | 1293 | 1682 | 3.137 |
| STIR | #3- 29 | #3-108 | #3-132 | #3-142 | #3-160 | | #3- 63 | #3-117 | #3-128 | #3-143 | #4-154 | |
| 35'- 0" | | 307 | 518 | 634 | 887 | 5.724 | 220 | 711 | 1018 | 1187 | 1554 | 3.522 |
| STIR | | #3-107 | #3-133 | #3-144 | #3-147 | | #3- 61 | #3-118 | #3-135 | #3-146 | #4-157 | |
| 36'- 0" | | 258 | 458 | 568 | 806 | 6.407 | 176 | 640 | 931 | 1090 | 1437 | 3.942 |
| STIR | | #3-106 | #3-133 | #3-145 | #3-156 | | #3- 58 | #3-119 | #3-138 | #3-130 | #4-160 | |
| 37'- 0" | | 213 | 403 | 507 | 732 | 7.149 | 135 | 575 | 850 | 1001 | 1329 | 4.399 |
| STIR | | #3-105 | #3-134 | #3-146 | #3-165 | | #3- 55 | #3-119 | #3-139 | #3-137 | #3-163 | |
| 38'- 0" | | 172 | 352 | 450 | 664 | 7.953 | 98 | 515 | 776 | 919 | 1230 | 4.894 |
| STIR | | #3-103 | #3-134 | #3-147 | #3-167 | | #3- 52 | #3-119 | #3-141 | #3-144 | #3-165 | |
| 39'- 0" | | 134 | 304 | 398 | 601 | 8.824 | 64 | 459 | 707 | 843 | 1138 | 5.430 |
| STIR | | #3-102 | #3-134 | #3-147 | #3-169 | | #3- 48 | #3-120 | #3-142 | #3-151 | #3-168 | |
| 40'- 0" | | 99 | 261 | 349 | 543 | 9.765 | 32 | 408 | 643 | 773 | 1054 | 6.009 |
| STIR | | #3-100 | #3-134 | #3-148 | #3-170 | | #3- 45 | #3-120 | #3-143 | #3-152 | #3-170 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.26 | 1.48 | 1.80 | 2.06 | 2.60 | | 1.26 | 1.95 | 2.60 | 2.79 | 5.40 | |
| ACTUAL STEEL % | 0.595 | 0.700 | 0.850 | 0.974 | 1.234 | | 0.595 | 0.925 | 1.234 | 1.322 | 2.578 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.31 | 18.31 | | 18.38 | 18.31 | 18.31 | 18.31 | 18.19 | |
| $-I_{cr}/I_{gr}$ | 0.140 | 0.159 | 0.185 | 0.203 | 0.242 | | 0.140 | 0.195 | 0.242 | 0.254 | 0.390 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.73 | 1.19 | 1.48 | 1.64 | 1.99 | | 0.73 | 1.19 | 1.48 | 1.64 | 1.99 | |
| ACTUAL STEEL % | 0.328 | 0.538 | 0.671 | 0.744 | 0.904 | | 0.328 | 0.538 | 0.671 | 0.744 | 0.904 | |
| EFF. DEPTH, IN. | 18.78 | 18.64 | 18.60 | 18.58 | 18.54 | | 18.78 | 18.64 | 18.60 | 18.58 | 18.54 | |
| $+I_{cr}/I_{gr}$ | 0.112 | 0.174 | 0.212 | 0.232 | 0.275 | | 0.112 | 0.174 | 0.212 | 0.232 | 0.275 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 7″ Ribs @ 60″ c.-c.<br>20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8 | 7 | 9.5 | 8 | | 10 | 9 | 8 | 9.5 | 7 | |
| BOTTOM BARS NO | 2# 4 | 1# 7 | 1# 7 | 1# 8 | 1# 8 | | 2# 4 | 1# 7 | 1# 7 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 1# 8 | 1# 8 | 1# 9 | | 1# 5 | 1# 7 | 1# 8 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.65 | 1.02 | 1.15 | 1.33 | 1.51 | | 0.89 | 1.55 | 1.75 | 2.07 | 3.15 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 222 | 744 | 945 | 1146 | 1366 | 4.000 | 574 | 1334 | 1627 | 1919 | 2240 | 2.461 |
| STIR | #3- 77 | #3-135 | #3-136 | #3-157 | #3-166 | | #3- 93 | #3-136 | #3-143 | #4-150 | #4-148 | |
| 33'- 0" | 175 | 666 | 856 | 1045 | 1252 | 4.523 | 507 | 1221 | 1497 | 1771 | 2073 | 2.784 |
| STIR | #3- 74 | #3-136 | #3-144 | #3-161 | #3-168 | | #3- 93 | #3-114 | #3-146 | #4-153 | #4-151 | |
| 34'- 0" | 133 | 596 | 774 | 952 | 1147 | 5.097 | 446 | 1118 | 1378 | 1637 | 1920 | 3.137 |
| STIR | #3- 72 | #3-138 | #3-151 | #3-163 | #3-171 | | #3- 92 | #3-121 | #3-149 | #4-156 | #4-155 | |
| 35'- 0" | 94 | 531 | 699 | 867 | 1051 | 5.724 | 389 | 1024 | 1269 | 1513 | 1781 | 3.522 |
| STIR | #3- 69 | #3-139 | #3-153 | #3-143 | #3-174 | | #3- 92 | #3-128 | #3-151 | #3-159 | #4-161 | |
| 36'- 0" | 59 | 471 | 630 | 789 | 963 | 6.407 | 337 | 938 | 1169 | 1400 | 1653 | 3.942 |
| STIR | #3- 66 | #3-139 | #3-154 | #3-151 | #3-178 | | #3- 91 | #3-136 | #3-154 | #3-162 | #4-167 | |
| 37'- 0" | 26 | 417 | 567 | 717 | 882 | 7.149 | 290 | 858 | 1077 | 1296 | 1535 | 4.399 |
| STIR | #3- 62 | #3-140 | #3-156 | #3-159 | #3-180 | | #3- 89 | #3-143 | #3-156 | #3-164 | #4-172 | |
| 38'- 0" | | 366 | 509 | 651 | 808 | 7.953 | 246 | 785 | 992 | 1200 | 1427 | 4.894 |
| STIR | | #3-141 | #3-157 | #3-168 | #3-183 | | #3- 88 | #3-145 | #3-158 | #3-167 | #4-175 | |
| 39'- 0" | | 320 | 455 | 590 | 739 | 8.824 | 206 | 717 | 914 | 1111 | 1327 | 5.430 |
| STIR | | #3-141 | #3-158 | #3-172 | #3-186 | | #3- 87 | #3-147 | #3-138 | #3-169 | #4-177 | |
| 40'- 0" | | 276 | 405 | 534 | 675 | 9.765 | 168 | 654 | 842 | 1029 | 1234 | 6.009 |
| STIR | | #3-141 | #3-160 | #3-174 | #3-165 | | #3- 85 | #3-148 | #3-145 | #3-173 | #3-181 | |
| 41'- 0" | | 236 | 359 | 481 | 616 | 10.778 | 133 | 596 | 774 | 952 | 1147 | 6.633 |
| STIR | | #3-141 | #3-160 | #3-175 | #3-173 | | #3- 83 | #3-149 | #3-152 | #3-175 | #3-183 | |
| 42'- 0" | | 199 | 316 | 433 | 560 | 11.869 | 101 | 542 | 712 | 881 | 1067 | 7.304 |
| STIR | | #3-141 | #3-161 | #3-177 | #3-181 | | #3- 81 | #3-150 | #3-160 | #3-177 | #3-186 | |
| 43'- 0" | | 164 | 276 | 387 | 509 | 13.040 | 71 | 491 | 654 | 815 | 993 | 8.025 |
| STIR | | #3-141 | #3-162 | #3-178 | #3-190 | | #3- 79 | #3-152 | #3-166 | #3-179 | #3-189 | |
| 44'- 0" | | 132 | 239 | 345 | 461 | 14.296 | 43 | 444 | 599 | 754 | 923 | 8.798 |
| STIR | | #3-140 | #3-162 | #3-180 | #3-194 | | #3- 76 | #3-153 | #3-168 | #3-181 | #3-191 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.20 | 1.50 | 1.71 | 1.96 | 2.33 | | 1.20 | 2.07 | 2.33 | 2.78 | 5.14 | |
| ACTUAL STEEL % | 0.605 | 0.756 | 0.864 | 0.990 | 1.176 | | 0.605 | 1.045 | 1.176 | 1.411 | 2.619 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.38 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.25 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.145 | 0.172 | 0.191 | 0.210 | 0.238 | | 0.145 | 0.218 | 0.238 | 0.269 | 0.401 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.71 | 1.20 | 1.39 | 1.58 | 1.79 | | 0.71 | 1.20 | 1.39 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.340 | 0.578 | 0.670 | 0.763 | 0.865 | | 0.340 | 0.578 | 0.670 | 0.763 | 0.865 | |
| EFF. DEPTH, IN. | 22.72 | 22.56 | 22.53 | 22.50 | 22.46 | | 22.72 | 22.56 | 22.53 | 22.50 | 22.46 | |
| $+I_{cr}/I_{gr}$ | 0.121 | 0.194 | 0.222 | 0.249 | 0.278 | | 0.121 | 0.194 | 0.222 | 0.249 | 0.278 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 8″ Ribs @ 61″ c.-c.<br>20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 10 | 8.5 | 7.5 | | 9.5 | 8.5 | 7.5 | 6 | 5 | |
| BOTTOM BARS NO | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | |
| BARS NO | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.68 | 1.06 | 1.22 | 1.47 | 1.67 | | 0.95 | 1.62 | 1.85 | 2.28 | 3.33 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 310 | 846 | 1016 | 1336 | 1556 | 4.000 | 717 | 1497 | 1744 | 2209 | 2529 | 2.461 |
| STIR | #3- 82 | #3-134 | #3-141 | #3-159 | #4-166 | | #3- 97 | #3-135 | #3-141 | #4-150 | #4-151 | |
| 33'- 0" | 256 | 761 | 921 | 1221 | 1428 | 4.523 | 639 | 1373 | 1605 | 2043 | 2343 | 2.784 |
| STIR | #3- 80 | #3-135 | #3-146 | #3-161 | #4-168 | | #3- 96 | #3-115 | #3-144 | #4-153 | #4-153 | |
| 34'- 0" | 208 | 683 | 833 | 1117 | 1311 | 5.097 | 568 | 1259 | 1478 | 1890 | 2173 | 3.137 |
| STIR | #3- 77 | #3-137 | #3-147 | #3-164 | #3-172 | | #3- 96 | #3-122 | #3-147 | #4-156 | #4-157 | |
| 35'- 0" | 163 | 611 | 753 | 1021 | 1205 | 5.724 | 503 | 1155 | 1362 | 1751 | 2018 | 3.522 |
| STIR | #3- 75 | #3-138 | #3-149 | #3-166 | #3-174 | | #3- 96 | #3-130 | #3-149 | #4-160 | #4-162 | |
| 36'- 0" | 122 | 546 | 680 | 933 | 1106 | 6.407 | 444 | 1060 | 1255 | 1623 | 1875 | 3.942 |
| STIR | #3- 72 | #3-138 | #3-151 | #3-149 | #3-177 | | #3- 95 | #3-137 | #3-151 | #4-162 | #4-168 | |
| 37'- 0" | 84 | 485 | 613 | 852 | 1016 | 7.149 | 389 | 972 | 1157 | 1505 | 1744 | 4.399 |
| STIR | #3- 69 | #3-139 | #3-152 | #3-157 | #3-180 | | #3- 94 | #3-143 | #3-154 | #4-165 | #4-172 | |
| 38'- 0" | 50 | 430 | 550 | 777 | 933 | 7.953 | 338 | 891 | 1067 | 1397 | 1623 | 4.894 |
| STIR | #3- 65 | #3-140 | #3-153 | #3-165 | #3-183 | | #3- 93 | #3-144 | #3-137 | #3-168 | #4-174 | |
| 39'- 0" | 17 | 378 | 493 | 708 | 856 | 8.824 | 291 | 817 | 983 | 1296 | 1511 | 5.430 |
| STIR | #3- 62 | #3-140 | #3-154 | #3-173 | #3-185 | | #3- 92 | #3-146 | #3-144 | #3-170 | #4-177 | |
| 40'- 0" | | 331 | 440 | 644 | 785 | 9.765 | 248 | 747 | 906 | 1203 | 1408 | 6.009 |
| STIR | | #3-140 | #3-155 | #3-175 | #3-164 | | #3- 90 | #3-147 | #3-151 | #3-173 | #4-180 | |
| 41'- 0" | | 287 | 390 | 585 | 719 | 10.778 | 208 | 683 | 834 | 1117 | 1312 | 6.633 |
| STIR | | #3-140 | #3-156 | #3-177 | #3-173 | | #3- 89 | #3-148 | #3-159 | #3-176 | #4-184 | |
| 42'- 0" | | 246 | 344 | 530 | 658 | 11.869 | 171 | 623 | 767 | 1037 | 1223 | 7.304 |
| STIR | | #3-140 | #3-156 | #3-179 | #3-181 | | #3- 87 | #3-149 | #3-160 | #3-178 | #4-186 | |
| 43'- 0" | | 207 | 302 | 479 | 600 | 13.040 | 136 | 568 | 705 | 962 | 1139 | 8.025 |
| STIR | | #3-139 | #3-157 | #3-180 | #3-190 | | #3- 85 | #3-151 | #3-162 | #3-180 | #3-188 | |
| 44'- 0" | | 172 | 262 | 431 | 547 | 14.296 | 103 | 516 | 647 | 893 | 1062 | 8.798 |
| STIR | | #3-139 | #3-157 | #3-182 | #3-194 | | #3- 83 | #3-151 | #3-163 | #3-183 | #3-192 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.22 | 1.63 | 1.89 | 2.22 | 2.52 | | 1.28 | 2.22 | 2.52 | 3.15 | 5.37 | |
| ACTUAL STEEL % | 0.553 | 0.737 | 0.860 | 1.011 | 1.146 | | 0.582 | 1.011 | 1.146 | 1.433 | 2.448 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.31 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.31 | 22.25 | |
| $-I_{cr}/I_{gr}$ | 0.138 | 0.173 | 0.193 | 0.218 | 0.239 | | 0.143 | 0.218 | 0.239 | 0.280 | 0.397 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | |
| EFF. DEPTH, IN. | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | |
| $+I_{cr}/I_{gr}$ | 0.126 | 0.195 | 0.217 | 0.255 | 0.281 | | 0.126 | 0.195 | 0.217 | 0.255 | 0.281 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 9″ Ribs @ 62″ c.-c.<br>20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 9.5 | 7.5 | 7 | | 9 | 8.5 | 7 | 8 | 6 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | |
| BARS NO | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | |
| STEEL (PSF) | 0.75 | 1.10 | 1.28 | 1.61 | 1.71 | | 1.04 | 1.67 | 1.96 | 2.46 | 3.62 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 341 | 884 | 1156 | 1525 | 1724 | 4.000 | 776 | 1566 | 1961 | 2498 | 2788 | 2.461 |
| STIR | #3- 77 | #3-130 | #3-140 | #3-159 | #4-164 | | #3- 94 | #3-114 | #4-142 | #4-151 | #5-148 | |
| 33'- 0" | 284 | 795 | 1050 | 1397 | 1585 | 4.523 | 693 | 1436 | 1807 | 2312 | 2585 | 2.784 |
| STIR | #3- 75 | #3-131 | #3-146 | #3-163 | #4-168 | | #3- 93 | #3-121 | #3-144 | #4-154 | #5-152 | |
| 34'- 0" | 232 | 713 | 953 | 1280 | 1457 | 5.097 | 617 | 1317 | 1667 | 2142 | 2399 | 3.137 |
| STIR | #3- 73 | #3-132 | #3-148 | #3-165 | #4-171 | | #3- 93 | #3-129 | #3-147 | #4-157 | #4-155 | |
| 35'- 0" | 184 | 638 | 865 | 1174 | 1340 | 5.724 | 548 | 1208 | 1538 | 1987 | 2229 | 3.522 |
| STIR | #3- 70 | #3-132 | #3-149 | #3-168 | #3-174 | | #3- 92 | #3-135 | #3-149 | #4-160 | #4-161 | |
| 36'- 0" | 140 | 570 | 784 | 1076 | 1233 | 6.407 | 484 | 1108 | 1420 | 1844 | 2074 | 3.942 |
| STIR | #3- 67 | #3-133 | #3-151 | #3-147 | #3-176 | | #3- 91 | #3-137 | #3-151 | #4-163 | #4-167 | |
| 37'- 0" | 100 | 506 | 709 | 985 | 1135 | 7.149 | 425 | 1016 | 1311 | 1713 | 1930 | 4.399 |
| STIR | #3- 63 | #3-133 | #3-152 | #3-155 | #3-180 | | #3- 90 | #3-139 | #3-153 | #4-166 | #4-171 | |
| 38'- 0" | 63 | 448 | 640 | 902 | 1044 | 7.953 | 371 | 932 | 1211 | 1592 | 1798 | 4.894 |
| STIR | #3- 59 | #3-133 | #3-153 | #3-164 | #3-182 | | #3- 89 | #3-140 | #3-136 | #4-168 | #4-175 | |
| 39'- 0" | 28 | 394 | 577 | 825 | 960 | 8.824 | 321 | 853 | 1119 | 1480 | 1676 | 5.430 |
| STIR | #3- 56 | #3-133 | #3-155 | #3-172 | #3-185 | | #3- 87 | #3-141 | #3-143 | #4-171 | #4-177 | |
| 40'- 0" | | 344 | 518 | 754 | 882 | 9.765 | 275 | 781 | 1033 | 1377 | 1563 | 6.009 |
| STIR | | #3-133 | #3-155 | #3-176 | #3-166 | | #3- 86 | #3-142 | #3-151 | #3-174 | #4-181 | |
| 41'- 0" | | 298 | 463 | 688 | 810 | 10.778 | 232 | 713 | 954 | 1281 | 1458 | 6.633 |
| STIR | | #3-133 | #3-156 | #3-178 | #3-174 | | #3- 84 | #3-143 | #3-158 | #3-177 | #4-183 | |
| 42'- 0" | | 255 | 412 | 627 | 743 | 11.869 | 192 | 651 | 880 | 1192 | 1360 | 7.304 |
| STIR | | #3-132 | #3-157 | #3-180 | #3-183 | | #3- 82 | #3-144 | #3-161 | #3-179 | #4-186 | |
| 43'- 0" | | 215 | 365 | 570 | 680 | 13.040 | 155 | 593 | 811 | 1109 | 1269 | 8.025 |
| STIR | | #3-131 | #3-157 | #3-181 | #3-191 | | #3- 80 | #3-145 | #3-162 | #3-182 | #4-188 | |
| 44'- 0" | | 178 | 321 | 516 | 622 | 14.296 | 120 | 538 | 747 | 1031 | 1184 | 8.798 |
| STIR | | #3-130 | #3-158 | #3-183 | #3-193 | | #3- 77 | #3-146 | #3-164 | #3-183 | #4-191 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.24 | 1.65 | 2.02 | 2.56 | 2.75 | | 1.38 | 2.26 | 2.75 | 3.41 | 6.20 | |
| ACTUAL STEEL % | 0.510 | 0.680 | 0.835 | 1.058 | 1.133 | | 0.567 | 0.933 | 1.133 | 1.412 | 2.576 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.31 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.25 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.132 | 0.166 | 0.193 | 0.230 | 0.242 | | 0.143 | 0.209 | 0.242 | 0.281 | 0.416 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | |
| ACTUAL STEEL % | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | |
| EFF. DEPTH, IN. | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.188 | 0.220 | 0.261 | 0.283 | | 0.124 | 0.188 | 0.220 | 0.261 | 0.283 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**53″ Forms + 10″ Ribs @ 63″ c.-c.**
20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 6 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 7 | 9 | 7.5 | 9 | | 8.5 | 8 | 9.5 | 10 | 7 | |
| BOTTOM BARS NO | 2# 5 | 2# 6 | 2# 6 | 2# 6 | 2# 8 | | 2# 5 | 2# 6 | 2# 6 | 2# 6 | 2# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 2# 7 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 2# 7 | 1# 8 | |
| STEEL (PSF) | 0.74 | 1.16 | 1.42 | 1.66 | 1.87 | | 1.06 | 1.76 | 2.14 | 2.63 | 3.37 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 368 | 955 | 1257 | 1595 | 1893 | 4.000 | 828 | 1684 | 2123 | 2614 | 3048 | 2.461 |
| STIR | #3- 73 | #3-128 | #3-143 | #3-156 | #4-165 | | #3- 91 | #3-117 | #4-141 | #4-149 | #5-154 | |
| 33'- 0" | 307 | 860 | 1144 | 1462 | 1742 | 4.523 | 740 | 1545 | 1958 | 2420 | 2827 | 2.784 |
| STIR | #3- 70 | #3-128 | #3-145 | #3-159 | #4-167 | | #3- 90 | #3-124 | #4-143 | #4-152 | #5-158 | |
| 34'- 0" | 252 | 773 | 1040 | 1339 | 1603 | 5.097 | 660 | 1418 | 1807 | 2242 | 2626 | 3.137 |
| STIR | #3- 67 | #3-129 | #3-146 | #3-162 | #4-170 | | #3- 89 | #3-132 | #3-146 | #4-156 | #5-161 | |
| 35'- 0" | 201 | 693 | 945 | 1228 | 1476 | 5.724 | 586 | 1301 | 1668 | 2079 | 2441 | 3.522 |
| STIR | #3- 64 | #3-130 | #3-148 | #3-145 | #4-174 | | #3- 89 | #3-134 | #3-148 | #4-158 | #4-165 | |
| 36'- 0" | 155 | 619 | 858 | 1125 | 1360 | 6.407 | 519 | 1195 | 1542 | 1930 | 2272 | 3.942 |
| STIR | #3- 61 | #3-130 | #3-149 | #3-153 | #3-177 | | #3- 87 | #3-135 | #3-151 | #4-161 | #4-168 | |
| 37'- 0" | 112 | 552 | 778 | 1030 | 1253 | 7.149 | 457 | 1096 | 1425 | 1793 | 2117 | 4.399 |
| STIR | #3- 57 | #3-130 | #3-151 | #3-162 | #3-179 | | #3- 86 | #3-137 | #3-131 | #4-164 | #4-171 | |
| 38'- 0" | 73 | 490 | 704 | 943 | 1154 | 7.953 | 399 | 1006 | 1317 | 1666 | 1973 | 4.894 |
| STIR | #3- 53 | #3-130 | #3-152 | #3-169 | #3-182 | | #3- 85 | #3-138 | #3-138 | #4-167 | #4-174 | |
| 39'- 0" | 36 | 432 | 635 | 863 | 1063 | 8.824 | 347 | 922 | 1218 | 1549 | 1840 | 5.430 |
| STIR | #3- 49 | #3-130 | #3-153 | #3-170 | #3-184 | | #3- 83 | #3-139 | #3-145 | #4-169 | #4-177 | |
| 40'- 0" | 2 | 379 | 572 | 788 | 979 | 9.765 | 297 | 845 | 1126 | 1441 | 1718 | 6.009 |
| STIR | #3- 44 | #3-130 | #3-153 | #3-172 | #3-166 | | #3- 81 | #3-140 | #3-153 | #3-171 | #4-179 | |
| 41'- 0" | | 329 | 513 | 719 | 901 | 10.778 | 252 | 773 | 1040 | 1340 | 1604 | 6.633 |
| STIR | | #3-129 | #3-154 | #3-174 | #3-175 | | #3- 79 | #3-141 | #3-158 | #3-174 | #4-183 | |
| 42'- 0" | | 283 | 459 | 655 | 828 | 11.869 | 210 | 706 | 961 | 1246 | 1498 | 7.304 |
| STIR | | #3-128 | #3-155 | #3-175 | #3-183 | | #3- 77 | #3-142 | #3-160 | #3-176 | #4-185 | |
| 43'- 0" | | 241 | 408 | 595 | 760 | 13.040 | 170 | 644 | 887 | 1159 | 1399 | 8.025 |
| STIR | | #3-127 | #3-155 | #3-176 | #3-191 | | #3- 74 | #3-142 | #3-161 | #3-178 | #4-188 | |
| 44'- 0" | | 201 | 360 | 539 | 697 | 14.296 | 134 | 586 | 818 | 1078 | 1307 | 8.798 |
| STIR | | #3-126 | #3-155 | #3-178 | #3-193 | | #3- 71 | #3-143 | #3-163 | #3-180 | #4-190 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.26 | 1.80 | 2.17 | 2.60 | 3.08 | | 1.48 | 2.44 | 2.92 | 3.78 | 5.40 | |
| ACTUAL STEEL % | 0.475 | 0.678 | 0.820 | 0.984 | 1.168 | | 0.558 | 0.923 | 1.106 | 1.438 | 2.054 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.31 | 22.31 | 22.25 | | 22.38 | 22.31 | 22.25 | 22.19 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.126 | 0.168 | 0.194 | 0.222 | 0.250 | | 0.144 | 0.212 | 0.241 | 0.288 | 0.367 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.93 | 1.48 | 1.76 | 2.08 | 2.37 | | 0.93 | 1.48 | 1.76 | 2.08 | 2.37 | |
| ACTUAL STEEL % | 0.336 | 0.537 | 0.638 | 0.755 | 0.863 | | 0.336 | 0.537 | 0.638 | 0.755 | 0.863 | |
| EFF. DEPTH, IN. | 22.69 | 22.60 | 22.62 | 22.59 | 22.50 | | 22.69 | 22.60 | 22.62 | 22.59 | 22.50 | |
| $+I_{cr}/I_{gr}$ | 0.122 | 0.187 | 0.219 | 0.254 | 0.284 | | 0.122 | 0.187 | 0.219 | 0.254 | 0.284 | |

SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**53″ Forms + 7″ Ribs @ 60″ c.-c.**
24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 7 | 8.5 | 7.5 | | 8.5 | 8 | 6 | 4 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 8 | 1# 9 | | 1# 6 | 1# 7 | 1# 8 | 1# 9 | |
| BARS NO | 1# 6 | 1# 8 | 1# 9 | 1# 9 | | 1# 6 | 1# 8 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.77 | 1.15 | 1.49 | 1.69 | | 1.09 | 1.75 | 2.30 | 3.07 | |
| CLEAR SPAN | END SPAN | | | | | INTERIOR SPAN | | | | |
| 37'- 0" (3) | 235 | 715 | 1088 | 1282 | 7.149 | 618 | 1316 | 1859 | 2142 | 4.399 |
| STIR | #3- 93 | #3-152 | #3-177 | #3-185 | | #3-111 | #3-129 | #4-169 | #4-175 | |
| 38'- 0" | 191 | 646 | 1000 | 1184 | 7.953 | 555 | 1216 | 1730 | 1999 | 4.894 |
| STIR | #3- 91 | #3-153 | #3-154 | #3-188 | | #3-110 | #3-136 | #4-172 | #4-178 | |
| 39'- 0" | 151 | 583 | 918 | 1094 | 8.824 | 496 | 1124 | 1612 | 1867 | 5.430 |
| STIR | #3- 88 | #3-154 | #3-162 | #3-192 | | #3-110 | #3-143 | #4-175 | #4-181 | |
| 40'- 0" | 113 | 524 | 843 | 1010 | 9.765 | 441 | 1038 | 1502 | 1745 | 6.009 |
| STIR | #3- 86 | #3-155 | #3-171 | #3-194 | | #3-110 | #3-151 | #4-178 | #4-185 | |
| 41'- 0" | 79 | 469 | 773 | 932 | 10.778 | 391 | 959 | 1401 | 1631 | 6.633 |
| STIR | #3- 83 | #3-156 | #3-179 | #3-197 | | #3-109 | #3-158 | #3-181 | #4-188 | |
| 42'- 0" | 46 | 419 | 708 | 859 | 11.869 | 344 | 885 | 1306 | 1526 | 7.304 |
| STIR | #3- 80 | #3-157 | #3-186 | #3-199 | | #3-108 | #3-161 | #3-184 | #4-190 | |
| 43'- 0" | 16 | 372 | 648 | 792 | 13.040 | 300 | 817 | 1218 | 1428 | 8.025 |
| STIR | #3- 77 | #3-157 | #3-188 | #3-177 | | #3-107 | #3-163 | #3-186 | #4-194 | |
| 44'- 0" | | 327 | 591 | 729 | 14.296 | 259 | 753 | 1136 | 1336 | 8.798 |
| STIR | | #3-157 | #3-190 | #3-185 | | #3-106 | #3-164 | #3-188 | #4-197 | |
| 45'- 0" | | 286 | 538 | 670 | 15.641 | 221 | 693 | 1060 | 1251 | 9.625 |
| STIR | | #3-157 | #3-192 | #3-194 | | #3-105 | #3-165 | #3-191 | #4-199 | |
| 46'- 0" | | 248 | 489 | 615 | 17.078 | 185 | 637 | 988 | 1171 | 10.510 |
| STIR | | #3-157 | #3-193 | #3-202 | | #3-103 | #3-167 | #3-193 | #3-201 | |
| 47'- 0" | | 212 | 443 | 564 | 18.613 | 152 | 585 | 921 | 1096 | 11.454 |
| STIR | | #3-157 | #3-194 | #3-208 | | #3-102 | #3-168 | #3-195 | #3-204 | |
| 48'- 0" | | 178 | 400 | 515 | 20.248 | 121 | 535 | 858 | 1026 | 12.460 |
| STIR | | #3-157 | #3-196 | #3-210 | | #3-100 | #3-169 | #3-197 | #3-207 | |
| 49'- 0" | | 146 | 359 | 470 | 21.989 | 91 | 489 | 798 | 960 | 13.532 |
| STIR | | #3-156 | #3-197 | #3-212 | | #3- 98 | #3-170 | #3-176 | #3-209 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF) | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.20 | 1.71 | 2.19 | 2.48 | | 1.41 | 2.33 | 3.10 | 4.65 | |
| ACTUAL STEEL % | 0.495 | 0.707 | 0.905 | 1.025 | | 0.582 | 0.961 | 1.282 | 1.922 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.31 | 26.31 | | 26.38 | 26.31 | 26.31 | 26.31 | |
| $-I_{cr}/I_{gr}$ | 0.132 | 0.176 | 0.210 | 0.231 | | 0.151 | 0.220 | 0.272 | 0.359 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.79 | 2.00 | | 0.88 | 1.39 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.347 | 0.549 | 0.709 | 0.792 | | 0.347 | 0.549 | 0.709 | 0.792 | |
| EFF. DEPTH, IN. | 26.62 | 26.53 | 26.46 | 26.44 | | 26.62 | 26.53 | 26.46 | 26.44 | |
| $+I_{cr}/I_{gr}$ | 0.130 | 0.198 | 0.249 | 0.275 | | 0.130 | 0.198 | 0.249 | 0.275 | |

SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 8″ Ribs @ 61″ c.-c.<br>24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 6 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 8.5 | 9.5 | 8 | | 8 | 7 | 9 | 5 | 5 | |
| BOTTOM BARS NO | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | |
| BARS NO | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | |
| STEEL (PSF) | 0.75 | 1.29 | 1.47 | 1.87 | 2.16 | | 1.11 | 1.99 | 2.23 | 3.47 | 4.42 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 249 | 857 | 1052 | 1496 | 1744 | 7.149 | 655 | 1539 | 1823 | 2469 | 2829 | 4.399 |
| STIR | #3- 85 | #3-155 | #3-162 | #4-187 | #4-195 | | #3-105 | #3-155 | #4-163 | #5-176 | #5-171 | |
| 38'- 0" | 203 | 779 | 964 | 1385 | 1620 | 7.953 | 588 | 1426 | 1695 | 2307 | 2649 | 4.894 |
| STIR | #3- 83 | #3-156 | #3-168 | #4-190 | #4-198 | | #3-105 | #3-133 | #4-166 | #4-179 | #5-174 | |
| 39'- 0" | 160 | 707 | 883 | 1282 | 1505 | 8.824 | 525 | 1321 | 1577 | 2158 | 2482 | 5.430 |
| STIR | #3- 80 | #3-157 | #3-170 | #3-193 | #4-202 | | #3-104 | #3-140 | #3-169 | #4-183 | #5-178 | |
| 40'- 0" | 120 | 641 | 808 | 1187 | 1399 | 9.765 | 468 | 1224 | 1467 | 2019 | 2328 | 6.009 |
| STIR | #3- 77 | #3-158 | #3-172 | #3-196 | #4-204 | | #3-103 | #3-147 | #3-171 | #4-186 | #5-180 | |
| 41'- 0" | 84 | 579 | 738 | 1099 | 1301 | 10.778 | 414 | 1134 | 1366 | 1891 | 2185 | 6.633 |
| STIR | #3- 74 | #3-159 | #3-174 | #3-198 | #4-208 | | #3-102 | #3-155 | #3-173 | #4-189 | #5-185 | |
| 42'- 0" | 49 | 521 | 673 | 1017 | 1209 | 11.869 | 364 | 1051 | 1271 | 1772 | 2052 | 7.304 |
| STIR | #3- 70 | #3-160 | #3-175 | #3-201 | #4-211 | | #3-101 | #3-162 | #3-175 | #4-192 | #5-191 | |
| 43'- 0" | 17 | 468 | 612 | 941 | 1124 | 13.040 | 318 | 973 | 1183 | 1661 | 1928 | 8.025 |
| STIR | #3- 66 | #3-160 | #3-176 | #3-204 | #4-214 | | #3-100 | #3-165 | #3-178 | #4-195 | #4-198 | |
| 44'- 0" | | 418 | 556 | 869 | 1045 | 14.296 | 275 | 900 | 1101 | 1557 | 1812 | 8.798 |
| STIR | | #3-161 | #3-177 | #3-181 | #3-216 | | #3- 98 | #3-166 | #3-157 | #4-198 | #4-204 | |
| 45'- 0" | | 371 | 503 | 803 | 971 | 15.641 | 234 | 832 | 1024 | 1460 | 1704 | 9.625 |
| STIR | | #3-161 | #3-179 | #3-189 | #3-220 | | #3- 97 | #3-168 | #3-164 | #4-200 | #4-209 | |
| 46'- 0" | | 327 | 454 | 741 | 901 | 17.078 | 197 | 769 | 952 | 1370 | 1603 | 10.510 |
| STIR | | #3-161 | #3-179 | #3-198 | #3-222 | | #3- 95 | #3-169 | #3-172 | #4-203 | #4-212 | |
| 47'- 0" | | 287 | 407 | 682 | 836 | 18.613 | 161 | 709 | 885 | 1285 | 1509 | 11.454 |
| STIR | | #3-161 | #3-180 | #3-206 | #3-225 | | #3- 93 | #3-170 | #3-179 | #4-206 | #4-214 | |
| 48'- 0" | | 248 | 364 | 628 | 775 | 20.248 | 128 | 654 | 822 | 1206 | 1420 | 12.460 |
| STIR | | #3-161 | #3-181 | #3-213 | #3-227 | | #3- 91 | #3-171 | #3-185 | #4-209 | #4-218 | |
| 49'- 0" | | 212 | 323 | 576 | 718 | 21.989 | 97 | 601 | 763 | 1131 | 1337 | 13.532 |
| STIR | | #3-161 | #3-181 | #3-214 | #3-229 | | #3- 89 | #3-173 | #3-187 | #4-211 | #4-220 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.22 | 1.89 | 2.22 | 2.83 | 3.36 | | 1.52 | 2.70 | 2.98 | 5.37 | 7.32 | |
| ACTUAL STEEL % | 0.454 | 0.705 | 0.830 | 1.056 | 1.255 | | 0.567 | 1.007 | 1.115 | 2.007 | 2.745 | |
| EFF. DEPTH, IN. | 26.38 | 26.31 | 26.31 | 26.25 | 26.25 | | 26.38 | 26.31 | 26.25 | 26.25 | 26.19 | |
| $-I_{cr}/I_{gr}$ | 0.126 | 0.178 | 0.201 | 0.240 | 0.272 | | 0.151 | 0.233 | 0.249 | 0.375 | 0.454 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | |
| ACTUAL STEEL % | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | |
| EFF. DEPTH, IN. | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | |
| $+I_{cr}/I_{gr}$ | 0.127 | 0.204 | 0.228 | 0.282 | 0.311 | | 0.127 | 0.204 | 0.228 | 0.282 | 0.311 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 9″ Ribs @ 62″ c.-c.<br>24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 6 | # 7 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9.5 | 8 | 9 | 10 | | 7.5 | 7 | 8 | 9 | 6 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | |
| BARS NO | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | |
| STEEL (PSF) | 0.80 | 1.28 | 1.58 | 1.89 | 2.24 | | 1.20 | 1.96 | 2.46 | 2.93 | 4.71 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 301 | 883 | 1210 | 1563 | 1949 | 7.149 | 746 | 1593 | 2069 | 2582 | 3144 | 4.399 |
| STIR | #3- 85 | #3-149 | #3-160 | #4-183 | #4-195 | | #3-105 | #3-133 | #4-164 | #5-174 | #5-171 | |
| 38'- 0" | 250 | 802 | 1112 | 1446 | 1813 | 7.953 | 672 | 1475 | 1926 | 2412 | 2946 | 4.894 |
| STIR | #3- 82 | #3-150 | #3-168 | #4-187 | #4-199 | | #3-105 | #3-140 | #4-167 | #4-177 | #5-174 | |
| 39'- 0" | 203 | 727 | 1021 | 1339 | 1687 | 8.824 | 604 | 1366 | 1794 | 2256 | 2762 | 5.430 |
| STIR | #3- 80 | #3-151 | #3-172 | #3-189 | #4-202 | | #3-104 | #3-148 | #4-170 | #4-181 | #5-177 | |
| 40'- 0" | 159 | 657 | 937 | 1239 | 1570 | 9.765 | 540 | 1265 | 1672 | 2111 | 2592 | 6.009 |
| STIR | #3- 77 | #3-152 | #3-173 | #3-192 | #4-205 | | #3-103 | #3-155 | #4-172 | #4-183 | #5-180 | |
| 41'- 0" | 119 | 593 | 859 | 1147 | 1462 | 10.778 | 481 | 1171 | 1559 | 1977 | 2435 | 6.633 |
| STIR | #3- 73 | #3-152 | #3-175 | #3-195 | #4-208 | | #3-102 | #3-157 | #3-175 | #4-186 | #5-184 | |
| 42'- 0" | 81 | 533 | 787 | 1061 | 1361 | 11.869 | 427 | 1084 | 1453 | 1852 | 2288 | 7.304 |
| STIR | #3- 70 | #3-153 | #3-177 | #3-173 | #4-211 | | #3-101 | #3-158 | #3-176 | #4-189 | #5-190 | |
| 43'- 0" | 46 | 477 | 719 | 981 | 1267 | 13.040 | 376 | 1003 | 1355 | 1735 | 2152 | 8.025 |
| STIR | #3- 66 | #3-153 | #3-178 | #3-181 | #4-214 | | #3-100 | #3-159 | #3-179 | #4-192 | #5-197 | |
| 44'- 0" | 14 | 425 | 657 | 906 | 1180 | 14.296 | 329 | 928 | 1264 | 1627 | 2024 | 8.798 |
| STIR | #3- 62 | #3-153 | #3-179 | #3-190 | #4-217 | | #3- 98 | #3-161 | #3-155 | #4-194 | #5-203 | |
| 45'- 0" | | 377 | 598 | 836 | 1098 | 15.641 | 284 | 857 | 1178 | 1525 | 1906 | 9.625 |
| STIR | | #3-153 | #3-180 | #3-198 | #4-220 | | #3- 97 | #3-162 | #3-162 | #4-197 | #5-209 | |
| 46'- 0" | | 332 | 543 | 771 | 1021 | 17.078 | 243 | 791 | 1099 | 1431 | 1794 | 10.510 |
| STIR | | #3-153 | #3-181 | #3-203 | #4-222 | | #3- 95 | #3-163 | #3-169 | #4-200 | #4-212 | |
| 47'- 0" | | 289 | 492 | 710 | 950 | 18.613 | 204 | 729 | 1024 | 1342 | 1690 | 11.454 |
| STIR | | #3-152 | #3-182 | #3-205 | #3-225 | | #3- 93 | #3-164 | #3-177 | #4-203 | #4-214 | |
| 48'- 0" | | 249 | 443 | 653 | 883 | 20.248 | 168 | 671 | 953 | 1258 | 1593 | 12.460 |
| STIR | | #3-152 | #3-183 | #3-207 | #3-228 | | #3- 91 | #3-165 | #3-184 | #4-205 | #4-218 | |
| 49'- 0" | | 212 | 398 | 599 | 820 | 21.989 | 133 | 616 | 887 | 1180 | 1501 | 13.532 |
| STIR | | #3-151 | #3-184 | #3-208 | #3-230 | | #3- 88 | #3-166 | #3-188 | #4-207 | #4-220 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.73 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.24 | 2.02 | 2.40 | 3.03 | 3.72 | | 1.65 | 2.75 | 3.41 | 4.13 | 8.16 | |
| ACTUAL STEEL % | 0.420 | 0.687 | 0.816 | 1.032 | 1.270 | | 0.560 | 0.932 | 1.161 | 1.411 | 2.796 | |
| EFF. DEPTH, IN. | 26.38 | 26.31 | 26.31 | 26.25 | 26.19 | | 26.38 | 26.31 | 26.25 | 26.19 | 26.12 | |
| $-I_{cr}/I_{gr}$ | 0.120 | 0.178 | 0.203 | 0.241 | 0.278 | | 0.152 | 0.225 | 0.262 | 0.300 | 0.466 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | |
| ACTUAL STEEL % | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | |
| EFF. DEPTH, IN. | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | |
| $+I_{cr}/I_{gr}$ | 0.128 | 0.197 | 0.235 | 0.274 | 0.316 | | 0.128 | 0.197 | 0.235 | 0.274 | 0.316 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**53″ Forms + 10″ Ribs @ 63″ c.-c.**
24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 9 | 9 | 7 | 9 | 10 | | 10 | 9.5 | 10 | 8.5 | 6 | |
| BOTTOM BARS NO | 1# 5 | 1# 8 | 1# 7 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 7 | 1#10 | 1#10 | |
| BARS NO | 2# 6 | 1# 9 | 2# 8 | 1#10 | 1#11 | | 2# 6 | 1# 9 | 2# 8 | 1#10 | 1#11 | |
| STEEL (PSF) | 0.90 | 1.41 | 1.69 | 2.04 | 2.31 | | 1.38 | 2.13 | 2.62 | 3.17 | 4.03 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 424 | 982 | 1351 | 1674 | 1938 | 7.149 | 942 | 1753 | 2290 | 2760 | 3145 | 4.399 |
| STIR | #3- 96 | #3-149 | #3-159 | #4-182 | #4-189 | | #3-113 | #3-133 | #4-165 | #5-173 | #5-178 | |
| 38'- 0" | 365 | 894 | 1244 | 1550 | 1801 | 7.953 | 856 | 1625 | 2134 | 2579 | 2944 | 4.894 |
| STIR | #3- 94 | #3-150 | #3-168 | #4-185 | #4-193 | | #3-113 | #3-140 | #4-167 | #5-176 | #5-182 | |
| 39'- 0" | 310 | 812 | 1145 | 1435 | 1673 | 8.824 | 776 | 1506 | 1990 | 2412 | 2759 | 5.430 |
| STIR | #3- 92 | #3-151 | #3-172 | #4-188 | #4-196 | | #3-113 | #3-148 | #4-170 | #5-179 | #5-185 | |
| 40'- 0" | 260 | 737 | 1053 | 1329 | 1555 | 9.765 | 703 | 1397 | 1857 | 2258 | 2587 | 6.009 |
| STIR | #3- 89 | #3-151 | #3-174 | #3-190 | #4-199 | | #3-112 | #3-155 | #4-172 | #4-182 | #5-188 | |
| 41'- 0" | 213 | 667 | 968 | 1230 | 1446 | 10.778 | 635 | 1295 | 1733 | 2115 | 2428 | 6.633 |
| STIR | #3- 87 | #3-152 | #3-175 | #3-168 | #4-202 | | #3-112 | #3-156 | #4-175 | #4-185 | #5-191 | |
| 42'- 0" | 169 | 602 | 889 | 1139 | 1344 | 11.869 | 571 | 1200 | 1617 | 1982 | 2280 | 7.304 |
| STIR | #3- 84 | #3-152 | #3-177 | #3-177 | #4-205 | | #3-111 | #3-158 | #4-177 | #4-187 | #5-194 | |
| 43'- 0" | 129 | 541 | 815 | 1054 | 1250 | 13.040 | 512 | 1112 | 1510 | 1858 | 2143 | 8.025 |
| STIR | #3- 81 | #3-152 | #3-178 | #3-185 | #4-207 | | #3-110 | #3-159 | #3-179 | #4-190 | #5-198 | |
| 44'- 0" | 91 | 485 | 746 | 974 | 1161 | 14.296 | 457 | 1030 | 1410 | 1742 | 2014 | 8.798 |
| STIR | #3- 77 | #3-153 | #3-180 | #3-194 | #3-210 | | #3-109 | #3-161 | #3-182 | #4-193 | #4-200 | |
| 45'- 0" | 55 | 432 | 682 | 900 | 1079 | 15.641 | 405 | 953 | 1317 | 1634 | 1894 | 9.625 |
| STIR | #3- 74 | #3-152 | #3-181 | #3-199 | #3-212 | | #3-108 | #3-162 | #3-161 | #4-195 | #4-204 | |
| 46'- 0" | 22 | 383 | 622 | 831 | 1002 | 17.078 | 357 | 882 | 1229 | 1533 | 1782 | 10.510 |
| STIR | #3- 70 | #3-152 | #3-182 | #3-201 | #3-190 | | #3-107 | #3-163 | #3-168 | #4-199 | #4-206 | |
| 47'- 0" | | 337 | 566 | 765 | 929 | 18.613 | 312 | 815 | 1148 | 1438 | 1677 | 11.454 |
| STIR | | #3-152 | #3-183 | #3-202 | #3-199 | | #3-105 | #3-164 | #3-175 | #4-201 | #4-209 | |
| 48'- 0" | | 293 | 513 | 704 | 862 | 20.248 | 270 | 751 | 1071 | 1350 | 1578 | 12.460 |
| STIR | | #3-151 | #3-184 | #3-204 | #3-207 | | #3-104 | #3-165 | #3-183 | #4-203 | #4-212 | |
| 49'- 0" | | 252 | 463 | 647 | 798 | 21.989 | 230 | 692 | 999 | 1266 | 1486 | 13.532 |
| STIR | | #3-150 | #3-184 | #3-206 | #3-216 | | #3-102 | #3-166 | #3-189 | #4-205 | #4-215 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.76 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | | | | | | | | | | | | |
| ACTUAL STEEL % | 1.40 | 2.17 | 2.79 | 3.08 | 3.78 | | 1.95 | 2.92 | 3.78 | 4.45 | 6.30 | |
| EFF. DEPTH, IN. | 0.435 | 0.676 | 0.870 | 0.963 | 1.185 | | 0.609 | 0.912 | 1.185 | 1.394 | 1.975 | |
| $-I_{cr}/I_{gr}$ | 26.38 | 26.31 | 26.31 | 26.25 | 26.19 | | 26.31 | 26.25 | 26.19 | 26.19 | 26.19 | |
| | 0.126 | 0.179 | 0.217 | 0.233 | 0.270 | | 0.165 | 0.224 | 0.270 | 0.303 | 0.385 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | | | | | | | | | | | | |
| ACTUAL STEEL % | 1.19 | 1.79 | 2.18 | 2.54 | 2.83 | | 1.19 | 1.79 | 2.18 | 2.54 | 2.83 | |
| EFF. DEPTH, IN. | 0.356 | 0.539 | 0.656 | 0.767 | 0.856 | | 0.356 | 0.539 | 0.656 | 0.767 | 0.856 | |
| $+I_{cr}/I_{gr}$ | 26.64 | 26.46 | 26.52 | 26.36 | 26.33 | | 26.64 | 26.46 | 26.52 | 26.36 | 26.33 | |

SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**66″ Forms + 6″ Ribs @ 72″ c.-c.**
14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 5 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 10 | 10 | 10 | | 10 | 10 | 9.5 | 9.5 | |
| BOTTOM BARS NO | 1# 4 | 1# 5 | 1# 6 | 1# 6 | | 1# 4 | 1# 5 | 1# 6 | 1# 6 | |
| BARS NO | 1# 5 | 1# 6 | 1# 6 | 1# 7 | | 1# 5 | 1# 6 | 1# 6 | 1# 7 | |
| STEEL (PSF) | 0.48 | 0.60 | 0.68 | 0.75 | | 0.72 | 0.84 | 0.94 | 1.30 | |
| CLEAR SPAN | END SPAN | | | | | INTERIOR SPAN | | | | |
| 24'- 0" (3) | 199 | 536 | 718 | 940 | 1.265 | 530 | 1021 | 1286 | 1609 | 0.779 |
| STIR | #3- 73 | #3-102 | #3- 99 | #3-122 | | #3- 80 | #3-103 | #3-110 | #3-115 | |
| 25'- 0" | 142 | 453 | 620 | 825 | 1.490 | 447 | 900 | 1144 | 1441 | 0.917 |
| STIR | #3- 72 | #3-104 | #3-108 | #3-125 | | #3- 81 | #3-105 | #3-112 | #3-118 | |
| 26'- 0" | 91 | 378 | 533 | 723 | 1.743 | 373 | 792 | 1017 | 1293 | 1.073 |
| STIR | #3- 70 | #3-105 | #3-116 | #3-128 | | #3- 81 | #3- 94 | #3-114 | #3-122 | |
| 27'- 0" | 46 | 312 | 456 | 632 | 2.027 | 308 | 696 | 905 | 1160 | 1.247 |
| STIR | #3- 68 | #3-106 | #3-118 | #3-131 | | #3- 81 | #3-101 | #3-118 | #3-124 | |
| 28'- 0" | 5 | 253 | 387 | 550 | 2.344 | 249 | 610 | 804 | 1041 | 1.443 |
| STIR | #3- 66 | #3-107 | #3-119 | #3-133 | | #3- 81 | #3-109 | #3-120 | #3-128 | |
| 29'- 0" | | 200 | 325 | 477 | 2.698 | 196 | 532 | 713 | 935 | 1.660 |
| STIR | | #3-107 | #3-121 | #3-123 | | #3- 81 | #3-110 | #3-122 | #3-130 | |
| 30'- 0" | | 152 | 269 | 411 | 3.090 | 148 | 463 | 632 | 839 | 1.901 |
| STIR | | #3-108 | #3-122 | #3-131 | | #3- 80 | #3-112 | #3-107 | #3-133 | |
| 31'- 0" | | 109 | 218 | 351 | 3.523 | 105 | 400 | 558 | 752 | 2.168 |
| STIR | | #3-108 | #3-123 | #3-137 | | #3- 79 | #3-113 | #3-114 | #3-135 | |
| 32'- 0" | | 69 | 172 | 297 | 4.000 | 66 | 342 | 491 | 673 | 2.461 |
| STIR | | #3-108 | #3-124 | #3-139 | | #3- 78 | #3-114 | #3-121 | #3-139 | |
| 33'- 0" | | 34 | 130 | 247 | 4.523 | 30 | 290 | 430 | 601 | 2.784 |
| STIR | | #3-107 | #3-125 | #3-141 | | #3- 77 | #3-115 | #3-128 | #3-141 | |
| 34'- 0" | | 1 | 91 | 202 | 5.097 | | 243 | 374 | 535 | 3.137 |
| STIR | | #3-107 | #3-125 | #3-142 | | | #3-116 | #3-129 | #3-143 | |
| 35'- 0" | | | 56 | 161 | 5.724 | | 199 | 323 | 475 | 3.522 |
| STIR | | | #3-126 | #3-143 | | | #3-117 | #3-131 | #3-145 | |
| 36'- 0" | | | 24 | 123 | 6.407 | | 159 | 277 | 420 | 3.942 |
| STIR | | | #3-126 | #3-145 | | | #3-118 | #3-132 | #3-148 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.49 CF/SF) | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.44 | 1.44 | 1.44 | 1.44 | | 1.44 | 1.44 | 1.52 | 2.35 | |
| ACTUAL STEEL % | 1.194 | 1.194 | 1.194 | 1.194 | | 1.194 | 1.194 | 1.257 | 1.957 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.38 | | 16.38 | 16.38 | 16.38 | 16.31 | |
| $-I_{cr}/I_{gr}$ | 0.198 | 0.198 | 0.198 | 0.198 | | 0.198 | 0.198 | 0.205 | 0.276 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.51 | 0.75 | 0.88 | 1.04 | | 0.51 | 0.75 | 0.88 | 1.04 | |
| ACTUAL STEEL % | 0.397 | 0.585 | 0.688 | 0.814 | | 0.397 | 0.585 | 0.688 | 0.814 | |
| EFF. DEPTH, IN. | 16.71 | 16.65 | 16.62 | 16.59 | | 16.71 | 16.65 | 16.62 | 16.59 | |
| $+I_{cr}/I_{gr}$ | 0.118 | 0.169 | 0.195 | 0.227 | | 0.118 | 0.169 | 0.195 | 0.227 | |

SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 7″ Ribs @ 73″ c.-c.<br>14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 4 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | 9.5 | 8 | | 10 | 10 | 8 | 7 | 8 | |
| BOTTOM BARS NO | 1# 4 | 1# 6 | 1# 6 | 1# 7 | 1# 7 | | 1# 4 | 1# 6 | 1# 6 | 1# 7 | 1# 7 | |
| BARS NO | 1# 5 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | | 1# 5 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | |
| STEEL (PSF) | 0.48 | 0.67 | 0.74 | 0.84 | 0.97 | | 0.72 | 0.91 | 1.10 | 1.28 | 2.02 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 176 | 695 | 917 | 1139 | 1400 | 1.265 | 507 | 1263 | 1586 | 1909 | 2288 | 0.779 |
| STIR | #3- 60 | #3-104 | #3-116 | #3-122 | #3-128 | | #3- 72 | #3-104 | #3-110 | #3-116 | #4-120 | |
| 25'- 0" | 118 | 597 | 802 | 1006 | 1247 | 1.490 | 424 | 1121 | 1418 | 1716 | 2065 | 0.917 |
| STIR | #3- 58 | #3-106 | #3-104 | #3-125 | #3-132 | | #3- 71 | #3-106 | #3-114 | #3-118 | #4-114 | |
| 26'- 0" | 68 | 510 | 700 | 889 | 1111 | 1.743 | 350 | 994 | 1270 | 1544 | 1868 | 1.073 |
| STIR | #3- 55 | #3-107 | #3-112 | #3-129 | #3-136 | | #3- 71 | #3-109 | #3-116 | #3-121 | #4-117 | |
| 27'- 0" | 23 | 433 | 609 | 784 | 990 | 2.027 | 285 | 882 | 1137 | 1392 | 1692 | 1.247 |
| STIR | #3- 52 | #3-108 | #3-120 | #3-131 | #3-138 | | #3- 70 | #3- 98 | #3-118 | #3-125 | #4-122 | |
| 28'- 0" | | 364 | 527 | 690 | 882 | 2.344 | 226 | 781 | 1018 | 1255 | 1534 | 1.443 |
| STIR | | #3-109 | #3-122 | #3-133 | #3-142 | | #3- 69 | #3-105 | #3-122 | #3-128 | #3-127 | |
| 29'- 0" | | 302 | 454 | 606 | 784 | 2.698 | 173 | 690 | 912 | 1133 | 1393 | 1.660 |
| STIR | | #3-110 | #3-124 | #3-121 | #3-145 | | #3- 68 | #3-112 | #3-124 | #3-131 | #3-133 | |
| 30'- 0" | | 245 | 388 | 530 | 697 | 3.090 | 125 | 609 | 816 | 1022 | 1265 | 1.901 |
| STIR | | #3-111 | #3-125 | #3-130 | #3-148 | | #3- 66 | #3-114 | #3-126 | #3-134 | #3-139 | |
| 31'- 0" | | 195 | 328 | 461 | 617 | 3.523 | 82 | 535 | 729 | 922 | 1150 | 2.168 |
| STIR | | #3-111 | #3-127 | #3-138 | #3-150 | | #3- 65 | #3-115 | #3-129 | #3-137 | #3-144 | |
| 32'- 0" | | 149 | 274 | 398 | 545 | 4.000 | 43 | 468 | 650 | 831 | 1045 | 2.461 |
| STIR | | #3-111 | #3-128 | #3-140 | #3-153 | | #3- 63 | #3-117 | #3-117 | #3-139 | #3-146 | |
| 33'- 0" | | 107 | 224 | 341 | 480 | 4.523 | 7 | 407 | 578 | 749 | 949 | 2.784 |
| STIR | | #3-111 | #3-129 | #3-142 | #3-155 | | #3- 60 | #3-118 | #3-124 | #3-141 | #3-150 | |
| 34'- 0" | | 68 | 179 | 290 | 420 | 5.097 | | 351 | 512 | 673 | 862 | 3.137 |
| STIR | | #3-110 | #3-129 | #3-143 | #3-144 | | | #3-119 | #3-132 | #3-144 | #3-153 | |
| 35'- 0" | | 33 | 138 | 242 | 365 | 5.724 | | 300 | 452 | 604 | 782 | 3.522 |
| STIR | | #3-110 | #3-130 | #3-145 | #3-153 | | | #3-120 | #3-134 | #3-145 | #3-155 | |
| 36'- 0" | | 1 | 100 | 198 | 314 | 6.407 | | 254 | 397 | 540 | 709 | 3.942 |
| STIR | | #3-109 | #3-130 | #3-146 | #3-160 | | | #3-121 | #3-135 | #3-147 | #3-157 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.51 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.46 | 1.46 | 1.46 | 1.54 | 1.83 | | 1.46 | 1.46 | 1.83 | 2.09 | 4.01 | |
| ACTUAL STEEL % | 1.066 | 1.066 | 1.066 | 1.122 | 1.332 | | 1.066 | 1.066 | 1.332 | 1.523 | 2.958 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.38 | 16.38 | | 16.38 | 16.38 | 16.38 | 16.38 | 16.25 | |
| $-I_{cr}/I_{gr}$ | 0.186 | 0.186 | 0.186 | 0.193 | 0.219 | | 0.186 | 0.186 | 0.219 | 0.241 | 0.362 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.88 | 1.04 | 1.20 | 1.39 | | 0.51 | 0.88 | 1.04 | 1.20 | 1.39 | |
| ACTUAL STEEL % | 0.351 | 0.609 | 0.721 | 0.832 | 0.966 | | 0.351 | 0.609 | 0.721 | 0.832 | 0.966 | |
| EFF. DEPTH, IN. | 16.71 | 16.62 | 16.59 | 16.56 | 16.53 | | 16.71 | 16.62 | 16.59 | 16.56 | 16.53 | |
| $+I_{cr}/I_{gr}$ | 0.106 | 0.175 | 0.203 | 0.231 | 0.264 | | 0.106 | 0.175 | 0.203 | 0.231 | 0.264 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 8″ Ribs @ 74″ c.-c.<br>14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 4 | # 4 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | 10 | 8.5 | | 10 | 10 | 8.5 | 7 | 5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 1# 6 | 1# 5 | 1# 7 | | 2# 4 | 1# 6 | 1# 6 | 1# 5 | 1# 7 | |
| BARS NO | 1# 4 | 1# 6 | 1# 7 | 2# 6 | 1# 8 | | 1# 4 | 1# 6 | 1# 7 | 2# 6 | 1# 8 | |
| STEEL (PSF) | 0.51 | 0.67 | 0.73 | 0.77 | 0.94 | | 0.75 | 0.91 | 1.06 | 1.22 | 1.62 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 283 | 672 | 894 | 1110 | 1377 | 1.265 | 674 | 1240 | 1563 | 1877 | 2266 | 0.779 |
| STIR | #3- 65 | #3- 97 | #3-107 | #3-117 | #3-124 | | #3- 75 | #3- 87 | #3-106 | #3-112 | #4-116 | |
| 25'- 0" | 215 | 574 | 779 | 978 | 1224 | 1.490 | 576 | 1098 | 1395 | 1685 | 2043 | 0.917 |
| STIR | #3- 63 | #3- 98 | #3-109 | #3-119 | #3-127 | | #3- 75 | #3- 94 | #3-109 | #3-114 | #4-120 | |
| 26'- 0" | 156 | 487 | 677 | 861 | 1088 | 1.743 | 489 | 971 | 1247 | 1514 | 1845 | 1.073 |
| STIR | #3- 61 | #3- 98 | #3-111 | #3-110 | #3-130 | | #3- 75 | #3-101 | #3-112 | #3-118 | #4-122 | |
| 27'- 0" | 102 | 410 | 586 | 756 | 967 | 2.027 | 411 | 859 | 1114 | 1362 | 1669 | 1.247 |
| STIR | #3- 59 | #3- 99 | #3-112 | #3-118 | #3-133 | | #3- 75 | #3-102 | #3-113 | #3-120 | #3-127 | |
| 28'- 0" | 55 | 341 | 504 | 662 | 859 | 2.344 | 342 | 758 | 995 | 1226 | 1511 | 1.443 |
| STIR | #3- 56 | #3- 99 | #3-114 | #3-124 | #3-136 | | #3- 74 | #3-104 | #3-100 | #3-123 | #3-129 | |
| 29'- 0" | 12 | 278 | 431 | 578 | 761 | 2.698 | 280 | 667 | 889 | 1104 | 1370 | 1.660 |
| STIR | #3- 53 | #3- 99 | #3-115 | #3-126 | #3-138 | | #3- 73 | #3-105 | #3-108 | #3-125 | #3-132 | |
| 30'- 0" | | 222 | 365 | 503 | 674 | 3.090 | 223 | 586 | 793 | 994 | 1242 | 1.901 |
| STIR | | #3- 99 | #3-115 | #3-127 | #3-126 | | #3- 72 | #3-106 | #3-115 | #3-127 | #3-135 | |
| 31'- 0" | | 172 | 305 | 434 | 594 | 3.523 | 173 | 512 | 706 | 894 | 1127 | 2.168 |
| STIR | | #3- 98 | #3-116 | #3-129 | #3-134 | | #3- 71 | #3-107 | #3-119 | #3-130 | #3-138 | |
| 32'- 0" | | 126 | 251 | 372 | 522 | 4.000 | 126 | 445 | 627 | 803 | 1022 | 2.461 |
| STIR | | #3- 98 | #3-116 | #3-130 | #3-142 | | #3- 69 | #3-108 | #3-121 | #3-132 | #3-141 | |
| 33'- 0" | | 84 | 201 | 315 | 457 | 4.523 | 84 | 384 | 555 | 721 | 926 | 2.784 |
| STIR | | #3- 97 | #3-117 | #3-131 | #3-144 | | #3- 67 | #3-108 | #3-122 | #3-121 | #3-143 | |
| 34'- 0" | | 45 | 156 | 264 | 397 | 5.097 | 46 | 328 | 489 | 646 | 839 | 3.137 |
| STIR | | #3- 95 | #3-117 | #3-132 | #3-146 | | #3- 65 | #3-109 | #3-123 | #3-129 | #3-145 | |
| 35'- 0" | | 10 | 115 | 216 | 342 | 5.724 | 11 | 277 | 429 | 577 | 760 | 3.522 |
| STIR | | #3- 94 | #3-116 | #3-133 | #3-148 | | #3- 63 | #3-109 | #3-124 | #3-135 | #3-148 | |
| 36'- 0" | | | 77 | 173 | 291 | 6.407 | | 230 | 374 | 514 | 686 | 3.942 |
| STIR | | | #3-116 | #3-133 | #3-149 | | | #3-109 | #3-125 | #3-137 | #3-150 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.52 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.48 | 1.48 | 1.48 | 1.48 | 1.74 | | 1.48 | 1.48 | 1.74 | 2.11 | 2.96 | |
| ACTUAL STEEL % | 0.965 | 0.965 | 0.965 | 0.965 | 1.135 | | 0.965 | 0.965 | 1.135 | 1.379 | 1.930 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.38 | 16.38 | | 16.38 | 16.38 | 16.38 | 16.38 | 16.38 | |
| $-I_{cr}/I_{gr}$ | 0.177 | 0.177 | 0.177 | 0.177 | 0.199 | | 0.177 | 0.177 | 0.199 | 0.230 | 0.289 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 0.88 | 1.04 | 1.19 | 1.39 | | 0.60 | 0.88 | 1.04 | 1.19 | 1.39 | |
| ACTUAL STEEL % | 0.370 | 0.546 | 0.646 | 0.737 | 0.867 | | 0.370 | 0.546 | 0.646 | 0.737 | 0.867 | |
| EFF. DEPTH, IN. | 16.75 | 16.62 | 16.59 | 16.64 | 16.53 | | 16.75 | 16.62 | 16.59 | 16.64 | 16.53 | |
| $+I_{cr}/I_{gr}$ | 0.113 | 0.159 | 0.185 | 0.211 | 0.240 | | 0.113 | 0.159 | 0.185 | 0.211 | 0.240 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**66″ Forms + 9″ Ribs @ 75″ c.-c.**
**14″ Deep Rib + 4.5″ Top Slab = 18.5″ Total Depth**
**FACTORED USABLE SUPERIMPOSED LOAD (PLF)**

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 10 | 10 | 9 | 7.5 | | 10 | 9 | 7.5 | 10 | 7.5 | |
| BOTTOM BARS NO | 2# 4 | 2# 4 | 1# 5 | 2# 6 | 1# 8 | | 2# 4 | 2# 4 | 1# 5 | 2# 6 | 1# 8 | |
| BARS NO | 1# 4 | 2# 5 | 2# 6 | 1# 6 | 1# 8 | | 1# 4 | 2# 5 | 2# 6 | 1# 6 | 1# 8 | |
| STEEL (PSF) | 0.51 | 0.70 | 0.77 | 0.87 | 1.07 | | 0.75 | 1.00 | 1.17 | 1.35 | 2.19 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 260 | 854 | 1087 | 1268 | 1615 | 1.265 | 651 | 1515 | 1854 | 2117 | 2622 | 0.779 |
| STIR | #3- 54 | #3-100 | #3-103 | #3-117 | #3-125 | | #3- 68 | #3-102 | #3-107 | #3-111 | #4-111 | |
| 25'- 0" | 192 | 740 | 955 | 1122 | 1441 | 1.490 | 553 | 1349 | 1662 | 1904 | 2369 | 0.917 |
| STIR | #3- 52 | #3-101 | #3-111 | #3-119 | #3-129 | | #3- 67 | #3- 90 | #3-110 | #3-115 | #4-115 | |
| 26'- 0" | 133 | 639 | 838 | 992 | 1287 | 1.743 | 466 | 1202 | 1491 | 1715 | 2145 | 1.073 |
| STIR | #3- 49 | #3-102 | #3-113 | #3-110 | #3-132 | | #3- 66 | #3- 97 | #3-113 | #3-117 | #4-119 | |
| 27'- 0" | 79 | 549 | 733 | 876 | 1150 | 2.027 | 388 | 1071 | 1339 | 1547 | 1946 | 1.247 |
| STIR | #3- 45 | #3-103 | #3-115 | #3-118 | #3-134 | | #3- 65 | #3-104 | #3-115 | #3-120 | #4-125 | |
| 28'- 0" | 32 | 468 | 640 | 772 | 1027 | 2.344 | 319 | 954 | 1203 | 1396 | 1767 | 1.443 |
| STIR | #3- 41 | #3-104 | #3-116 | #3-124 | #3-137 | | #3- 64 | #3-107 | #3-118 | #3-123 | #4-130 | |
| 29'- 0" | | 396 | 555 | 679 | 917 | 2.698 | 256 | 849 | 1081 | 1261 | 1606 | 1.660 |
| STIR | | #3-104 | #3-118 | #3-126 | #3-139 | | #3- 62 | #3-108 | #3-104 | #3-125 | #3-134 | |
| 30'- 0" | | 331 | 480 | 595 | 817 | 3.090 | 200 | 754 | 971 | 1139 | 1462 | 1.901 |
| STIR | | #3-104 | #3-119 | #3-127 | #3-142 | | #3- 60 | #3-110 | #3-111 | #3-128 | #3-136 | |
| 31'- 0" | | 271 | 411 | 520 | 727 | 3.523 | 150 | 668 | 871 | 1029 | 1331 | 2.168 |
| STIR | | #3-104 | #3-119 | #3-129 | #3-131 | | #3- 58 | #3-111 | #3-119 | #3-130 | #3-140 | |
| 32'- 0" | | 218 | 349 | 451 | 646 | 4.000 | 103 | 590 | 780 | 928 | 1212 | 2.461 |
| STIR | | #3-104 | #3-120 | #3-130 | #3-140 | | #3- 56 | #3-112 | #3-123 | #3-132 | #3-143 | |
| 33'- 0" | | 169 | 292 | 388 | 571 | 4.523 | 61 | 519 | 698 | 837 | 1104 | 2.784 |
| STIR | | #3-103 | #3-121 | #3-131 | #3-146 | | #3- 53 | #3-113 | #3-125 | #3-121 | #3-145 | |
| 34'- 0" | | 124 | 241 | 331 | 503 | 5.097 | 23 | 454 | 623 | 754 | 1005 | 3.137 |
| STIR | | #3-102 | #3-121 | #3-132 | #3-148 | | #3- 50 | #3-113 | #3-126 | #3-128 | #3-148 | |
| 35'- 0" | | 84 | 193 | 278 | 441 | 5.724 | | 394 | 554 | 677 | 915 | 3.522 |
| STIR | | #3-101 | #3-121 | #3-133 | #3-150 | | | #3-114 | #3-127 | #3-136 | #3-150 | |
| 36'- 0" | | 46 | 150 | 230 | 384 | 6.407 | | 340 | 491 | 607 | 832 | 3.942 |
| STIR | | #3-100 | #3-121 | #3-133 | #3-151 | | | #3-114 | #3-128 | #3-137 | #3-152 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.50 | 1.50 | 1.50 | 1.67 | 2.00 | | 1.50 | 1.67 | 2.00 | 2.33 | 4.40 | |
| ACTUAL STEEL % | 0.884 | 0.884 | 0.884 | 0.982 | 1.178 | | 0.884 | 0.982 | 1.178 | 1.376 | 2.615 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.38 | 16.38 | | 16.38 | 16.38 | 16.38 | 16.31 | 16.25 | |
| $-I_{cr}/I_{gr}$ | 0.169 | 0.169 | 0.169 | 0.183 | 0.209 | | 0.169 | 0.183 | 0.209 | 0.231 | 0.351 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 1.02 | 1.19 | 1.32 | 1.58 | | 0.60 | 1.02 | 1.19 | 1.32 | 1.58 | |
| ACTUAL STEEL % | 0.335 | 0.571 | 0.669 | 0.742 | 0.894 | | 0.335 | 0.571 | 0.669 | 0.742 | 0.894 | |
| EFF. DEPTH, IN. | 16.75 | 16.71 | 16.64 | 16.62 | 16.50 | | 16.75 | 16.71 | 16.64 | 16.62 | 16.50 | |
| $+I_{cr}/I_{gr}$ | 0.104 | 0.170 | 0.194 | 0.213 | 0.247 | | 0.104 | 0.170 | 0.194 | 0.213 | 0.247 | |

SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**66″ Forms + 6″ Ribs @ 72″ c.-c.**
**16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth**
**FACTORED USABLE SUPERIMPOSED LOAD (PLF)**

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 4 | | | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | | | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 10 | 10 | | | | 10 | 9.5 | 8 | | | |
| BOTTOM BARS NO | 1# 4 | 1# 6 | 1# 6 | | | | 1# 4 | 1# 6 | 1# 6 | | | |
| BARS NO | 1# 5 | 1# 6 | 1# 7 | | | | 1# 5 | 1# 6 | 1# 7 | | | |
| STEEL (PSF) | 0.48 | 0.68 | 0.75 | | | | 0.72 | 0.94 | 1.11 | | | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 144 | 641 | 854 | | | 1.743 | 461 | 1183 | 1493 | | | 1.073 |
| STIR | #3- 67 | #3-114 | #3-126 | | | | #3- 79 | #3-113 | #3-121 | | | |
| 27'- 0" | 94 | 554 | 752 | | | 2.027 | 387 | 1057 | 1344 | | | 1.247 |
| STIR | #3- 65 | #3-116 | #3-129 | | | | #3- 79 | #3-117 | #3-123 | | | |
| 28'- 0" | 48 | 477 | 660 | | | 2.344 | 321 | 944 | 1211 | | | 1.443 |
| STIR | #3- 63 | #3-118 | #3-117 | | | | #3- 79 | #3-118 | #3-126 | | | |
| 29'- 0" | 8 | 407 | 578 | | | 2.698 | 262 | 843 | 1092 | | | 1.660 |
| STIR | #3- 61 | #3-119 | #3-126 | | | | #3- 78 | #3-102 | #3-129 | | | |
| 30'- 0" | | 344 | 504 | | | 3.090 | 209 | 751 | 984 | | | 1.901 |
| STIR | | #3-120 | #3-133 | | | | #3- 78 | #3-109 | #3-132 | | | |
| 31'- 0" | | 287 | 437 | | | 3.523 | 160 | 669 | 886 | | | 2.168 |
| STIR | | #3-121 | #3-135 | | | | #3- 77 | #3-116 | #3-134 | | | |
| 32'- 0" | | 236 | 376 | | | 4.000 | 117 | 594 | 798 | | | 2.461 |
| STIR | | #3-122 | #3-137 | | | | #3- 75 | #3-124 | #3-136 | | | |
| 33'- 0" | | 189 | 321 | | | 4.523 | 77 | 525 | 717 | | | 2.784 |
| STIR | | #3-122 | #3-139 | | | | #3- 74 | #3-126 | #3-139 | | | |
| 34'- 0" | | 146 | 270 | | | 5.097 | 40 | 463 | 644 | | | 3.137 |
| STIR | | #3-123 | #3-140 | | | | #3- 72 | #3-127 | #3-141 | | | |
| 35'- 0" | | 106 | 224 | | | 5.724 | 7 | 406 | 576 | | | 3.522 |
| STIR | | #3-123 | #3-141 | | | | #3- 70 | #3-129 | #3-126 | | | |
| 36'- 0" | | 70 | 181 | | | 6.407 | | 353 | 514 | | | 3.942 |
| STIR | | #3-123 | #3-142 | | | | | #3-130 | #3-133 | | | |
| 37'- 0" | | 37 | 142 | | | 7.149 | | 305 | 458 | | | 4.399 |
| STIR | | #3-123 | #3-143 | | | | | #3-131 | #3-141 | | | |
| 38'- 0" | | 6 | 106 | | | 7.953 | | 260 | 405 | | | 4.894 |
| STIR | | #3-122 | #3-144 | | | | | #3-132 | #3-147 | | | |
| PROPERTIES FOR DESIGN (CONCRETE 0.51 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.44 | 1.44 | 1.44 | | | | 1.44 | 1.52 | 1.80 | | | |
| ACTUAL STEEL % | 1.041 | 1.041 | 1.041 | | | | 1.041 | 1.095 | 1.301 | | | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | | | | 18.38 | 18.38 | 18.38 | | | |
| $-I_{cr}/I_{gr}$ | 0.188 | 0.188 | 0.188 | | | | 0.188 | 0.195 | 0.221 | | | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.88 | 1.04 | | | | 0.51 | 0.88 | 1.04 | | | |
| ACTUAL STEEL % | 0.347 | 0.601 | 0.711 | | | | 0.347 | 0.601 | 0.711 | | | |
| EFF. DEPTH, IN. | 18.71 | 18.62 | 18.59 | | | | 18.71 | 18.62 | 18.59 | | | |
| $+I_{cr}/I_{gr}$ | 0.109 | 0.180 | 0.210 | | | | 0.109 | 0.180 | 0.210 | | | |

SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 7″ Ribs @ 73″ c.-c.<br>16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 4 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 9.5 | 8 | 7 | | 10 | 10 | 7 | 4 | 7 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | | 2# 4 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | |
| BARS NO | 1# 4 | 1# 6 | 1# 7 | 1# 8 | 1# 8 | | 1# 4 | 1# 6 | 1# 7 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.52 | 0.67 | 0.84 | 0.97 | 1.11 | | 0.76 | 0.91 | 1.28 | 1.87 | 2.31 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 243 | 616 | 1041 | 1291 | 1540 | 1.743 | 616 | 1158 | 1776 | 2140 | 2503 | 1.073 |
| STIR | | #3- 72 | #3-106 | #3-128 | #3-134 | #3-140 | | #3- 82 | #3- 93 | #3-121 | #4-124 | #4-130 |
| 27'- 0" | 183 | 529 | 923 | 1155 | 1386 | 2.027 | 529 | 1032 | 1605 | 1943 | 2279 | 1.247 |
| STIR | | #3- 70 | #3-107 | #3-130 | #3-138 | #3-144 | | #3- 82 | #3-100 | #3-124 | #4-127 | #4-124 |
| 28'- 0" | 130 | 451 | 818 | 1033 | 1249 | 2.344 | 451 | 919 | 1452 | 1766 | 2079 | 1.443 |
| STIR | | #3- 68 | #3-108 | #3-115 | #3-141 | #3-147 | | #3- 82 | #3-108 | #3-127 | #4-130 | #4-127 |
| 29'- 0" | 82 | 381 | 723 | 924 | 1125 | 2.698 | 382 | 817 | 1314 | 1607 | 1899 | 1.660 |
| STIR | | #3- 66 | #3-108 | #3-124 | #3-143 | #3-151 | | #3- 82 | #3-111 | #3-130 | #3-136 | #4-130 |
| 30'- 0" | 39 | 319 | 638 | 826 | 1013 | 3.090 | 319 | 726 | 1190 | 1464 | 1736 | 1.901 |
| STIR | | #3- 63 | #3-109 | #3-132 | #3-147 | #3-154 | | #3- 82 | #3-113 | #3-132 | #3-139 | #4-134 |
| 31'- 0" | | 262 | 561 | 737 | 912 | 3.523 | 262 | 643 | 1078 | 1334 | 1590 | 2.168 |
| STIR | | | #3-109 | #3-137 | #3-149 | #3-157 | | #3- 81 | #3-114 | #3-135 | #3-142 | #4-141 |
| 32'- 0" | | 210 | 491 | 656 | 821 | 4.000 | 210 | 568 | 976 | 1217 | 1456 | 2.461 |
| STIR | | | #3-109 | #3-138 | #3-151 | #3-160 | | #3- 80 | #3-115 | #3-138 | #3-145 | #4-147 |
| 33'- 0" | | 163 | 427 | 582 | 737 | 4.523 | 163 | 500 | 883 | 1109 | 1335 | 2.784 |
| STIR | | | #3-108 | #3-140 | #3-139 | #3-162 | | #3- 79 | #3-116 | #3-140 | #3-149 | #4-153 |
| 34'- 0" | | 120 | 369 | 515 | 661 | 5.097 | 120 | 437 | 799 | 1012 | 1224 | 3.137 |
| STIR | | | #3-108 | #3-141 | #3-147 | #3-166 | | #3- 77 | #3-117 | #3-142 | #3-150 | #3-158 |
| 35'- 0" | | 81 | 315 | 453 | 591 | 5.724 | 81 | 380 | 721 | 922 | 1122 | 3.522 |
| STIR | | | #3-107 | #3-143 | #3-156 | #3-169 | | #3- 76 | #3-118 | #3-144 | #3-153 | #3-161 |
| 36'- 0" | | 45 | 266 | 397 | 527 | 6.407 | 45 | 328 | 650 | 840 | 1029 | 3.942 |
| STIR | | | #3-106 | #3-144 | #3-158 | #3-170 | | #3- 74 | #3-119 | #3-131 | #3-157 | #3-164 |
| 37'- 0" | | 11 | 221 | 345 | 468 | 7.149 | 12 | 279 | 585 | 764 | 944 | 4.399 |
| STIR | | | #3-105 | #3-145 | #3-160 | #3-154 | | #3- 72 | #3-119 | #3-138 | #3-159 | #3-167 |
| 38'- 0" | | | 180 | 297 | 414 | 7.953 | | 235 | 524 | 695 | 865 | 4.894 |
| STIR | | | | #3-146 | #3-161 | #3-162 | | | #3-119 | #3-146 | #3-160 | #3-170 |
| PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.46 | 1.46 | 1.54 | 1.83 | 2.09 | | 1.46 | 1.46 | 2.09 | 3.65 | 4.59 | |
| ACTUAL STEEL % | 0.931 | 0.931 | 0.980 | 1.164 | 1.330 | | 0.931 | 0.931 | 1.330 | 2.328 | 2.951 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.38 | 18.38 | | 18.38 | 18.38 | 18.38 | 18.38 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.177 | 0.177 | 0.184 | 0.208 | 0.230 | | 0.177 | 0.177 | 0.230 | 0.335 | 0.380 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 0.88 | 1.20 | 1.39 | 1.58 | | 0.60 | 0.88 | 1.20 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.361 | 0.533 | 0.729 | 0.846 | 0.962 | | 0.361 | 0.533 | 0.729 | 0.846 | 0.962 | |
| EFF. DEPTH, IN. | 18.75 | 18.62 | 18.56 | 18.53 | 18.50 | | 18.75 | 18.62 | 18.56 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.114 | 0.162 | 0.214 | 0.244 | 0.274 | | 0.114 | 0.162 | 0.214 | 0.244 | 0.274 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 8″ Ribs @ 74″ c.-c.<br>16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | 8.5 | 7.5 | | 10 | 8.5 | 7.5 | 9.5 | 7.5 | |
| BOTTOM BARS NO | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.54 | 0.73 | 0.77 | 0.94 | 1.08 | | 0.78 | 1.06 | 1.18 | 1.45 | 2.20 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 242 | 803 | 1009 | 1265 | 1515 | 1.743 | 626 | 1442 | 1741 | 2115 | 2478 | 1.073 |
| STIR | #3- 63 | #3-110 | #3-112 | #3-129 | #3-135 | | #3- 76 | #3-110 | #3-116 | #4-122 | #4-122 | |
| 27'- 0" | 180 | 701 | 891 | 1130 | 1361 | 2.027 | 536 | 1293 | 1571 | 1917 | 2254 | 1.247 |
| STIR | #3- 60 | #3-111 | #3-120 | #3-132 | #3-139 | | #3- 76 | #3- 95 | #3-119 | #4-125 | #4-126 | |
| 28'- 0" | 125 | 609 | 787 | 1008 | 1223 | 2.344 | 456 | 1160 | 1418 | 1740 | 2054 | 1.443 |
| STIR | #3- 57 | #3-112 | #3-123 | #3-135 | #3-142 | | #3- 75 | #3-102 | #3-121 | #3-129 | #4-129 | |
| 29'- 0" | 76 | 527 | 692 | 899 | 1099 | 2.698 | 385 | 1041 | 1281 | 1582 | 1874 | 1.660 |
| STIR | #3- 54 | #3-113 | #3-124 | #3-120 | #3-145 | | #3- 74 | #3-110 | #3-124 | #3-131 | #4-134 | |
| 30'- 0" | 31 | 453 | 607 | 800 | 988 | 3.090 | 320 | 933 | 1158 | 1438 | 1711 | 1.901 |
| STIR | #3- 51 | #3-114 | #3-126 | #3-128 | #3-147 | | #3- 73 | #3-116 | #3-126 | #3-134 | #4-140 | |
| 31'- 0" | | 386 | 531 | 711 | 887 | 3.523 | 261 | 835 | 1046 | 1309 | 1564 | 2.168 |
| STIR | | #3-114 | #3-127 | #3-137 | #3-150 | | #3- 72 | #3-118 | #3-109 | #3-137 | #4-144 | |
| 32'- 0" | | 325 | 461 | 630 | 795 | 4.000 | 208 | 747 | 944 | 1191 | 1431 | 2.461 |
| STIR | | #3-114 | #3-128 | #3-141 | #3-153 | | #3- 70 | #3-119 | #3-116 | #3-140 | #3-146 | |
| 33'- 0" | | 269 | 397 | 557 | 712 | 4.523 | 160 | 666 | 852 | 1084 | 1309 | 2.784 |
| STIR | | #3-115 | #3-129 | #3-143 | #3-137 | | #3- 68 | #3-121 | #3-124 | #3-142 | #3-150 | |
| 34'- 0" | | 219 | 339 | 489 | 635 | 5.097 | 115 | 593 | 768 | 986 | 1199 | 3.137 |
| STIR | | #3-114 | #3-130 | #3-144 | #3-145 | | #3- 66 | #3-122 | #3-131 | #3-145 | #3-152 | |
| 35'- 0" | | 173 | 286 | 428 | 566 | 5.724 | 75 | 525 | 690 | 897 | 1097 | 3.522 |
| STIR | | #3-114 | #3-131 | #3-146 | #3-154 | | #3- 64 | #3-123 | #3-134 | #3-146 | #3-155 | |
| 36'- 0" | | 130 | 237 | 371 | 502 | 6.407 | 38 | 463 | 620 | 814 | 1004 | 3.942 |
| STIR | | #3-114 | #3-131 | #3-147 | #3-159 | | #3- 62 | #3-124 | #3-136 | #3-149 | #3-157 | |
| 37'- 0" | | 91 | 193 | 319 | 443 | 7.149 | 4 | 407 | 554 | 739 | 918 | 4.399 |
| STIR | | #3-113 | #3-131 | #3-148 | #3-161 | | #3- 59 | #3-124 | #3-137 | #3-133 | #3-160 | |
| 38'- 0" | | 55 | 151 | 271 | 388 | 7.953 | | 354 | 494 | 669 | 839 | 4.894 |
| STIR | | #3-112 | #3-131 | #3-149 | #3-163 | | | #3-125 | #3-138 | #3-141 | #3-163 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.54 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.48 | 1.48 | 1.48 | 1.74 | 1.97 | | 1.48 | 1.74 | 1.97 | 2.41 | 4.34 | |
| ACTUAL STEEL % | 0.845 | 0.845 | 0.845 | 0.994 | 1.127 | | 0.845 | 0.994 | 1.127 | 1.384 | 2.499 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.38 | 18.38 | | 18.38 | 18.38 | 18.38 | 18.31 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.168 | 0.168 | 0.168 | 0.189 | 0.208 | | 0.168 | 0.189 | 0.208 | 0.239 | 0.351 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | |
| EFF. DEPTH, IN. | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.107 | 0.171 | 0.195 | 0.223 | 0.250 | | 0.107 | 0.171 | 0.195 | 0.223 | 0.250 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 9″ Ribs @ 75″ c.-c.<br>16″ Deep Rib + 4.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 5 | End Span | # 4 | # 4 | # 5 | # 5 | # 6 | Int. Span |
| AT | 10 | 10 | 9 | 7.5 | 10 | Defl. Coeff. (2) | 10 | 7.5 | 10 | 8.5 | 6.5 | Defl. Coeff. (2) |
| BOTTOM BARS NO | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.57 | 0.77 | 0.87 | 1.07 | 1.21 | | 0.81 | 1.17 | 1.35 | 1.63 | 2.50 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 340 | 983 | 1156 | 1490 | 1764 | 1.743 | 780 | 1716 | 1968 | 2453 | 2851 | 1.073 |
| STIR | #3- 67 | #3-112 | #3-111 | #3-130 | #4-136 | | #3- 79 | #3-112 | #3-117 | #4-124 | #4-121 | |
| 27'- 0" | 270 | 866 | 1026 | 1336 | 1590 | 2.027 | 678 | 1545 | 1779 | 2229 | 2598 | 1.247 |
| STIR | #3- 65 | #3-114 | #3-120 | #3-133 | #3-140 | | #3- 79 | #3-115 | #3-120 | #4-127 | #4-125 | |
| 28'- 0" | 207 | 761 | 910 | 1198 | 1434 | 2.344 | 586 | 1393 | 1610 | 2028 | 2372 | 1.443 |
| STIR | #3- 62 | #3-115 | #3-123 | #3-136 | #3-143 | | #3- 78 | #3- 98 | #3-122 | #4-130 | #4-127 | |
| 29'- 0" | 150 | 667 | 806 | 1074 | 1294 | 2.698 | 504 | 1256 | 1458 | 1848 | 2168 | 1.660 |
| STIR | #3- 60 | #3-116 | #3-124 | #3-139 | #3-146 | | #3- 78 | #3-106 | #3-124 | #4-132 | #4-133 | |
| 30'- 0" | 99 | 582 | 712 | 962 | 1168 | 3.090 | 430 | 1132 | 1321 | 1686 | 1985 | 1.901 |
| STIR | #3- 57 | #3-117 | #3-126 | #3-125 | #3-149 | | #3- 77 | #3-113 | #3-127 | #3-136 | #4-139 | |
| 31'- 0" | 53 | 505 | 627 | 861 | 1054 | 3.523 | 362 | 1020 | 1198 | 1539 | 1819 | 2.168 |
| STIR | #3- 53 | #3-118 | #3-127 | #3-133 | #3-152 | | #3- 76 | #3-120 | #3-128 | #3-139 | #4-144 | |
| 32'- 0" | 11 | 435 | 549 | 770 | 950 | 4.000 | 301 | 919 | 1085 | 1406 | 1668 | 2.461 |
| STIR | #3- 50 | #3-118 | #3-128 | #3-142 | #3-154 | | #3- 75 | #3-122 | #3-116 | #3-142 | #4-147 | |
| 33'- 0" | | 372 | 479 | 686 | 856 | 4.523 | 246 | 827 | 983 | 1284 | 1531 | 2.784 |
| STIR | | #3-119 | #3-129 | #3-145 | #3-157 | | #3- 73 | #3-123 | #3-123 | #3-144 | #4-151 | |
| 34'- 0" | | 314 | 415 | 610 | 770 | 5.097 | 195 | 742 | 889 | 1173 | 1406 | 3.137 |
| STIR | | #3-119 | #3-130 | #3-147 | #3-141 | | #3- 71 | #3-125 | #3-130 | #3-146 | #4-153 | |
| 35'- 0" | | 261 | 356 | 540 | 691 | 5.724 | 149 | 665 | 804 | 1072 | 1291 | 3.522 |
| STIR | | #3-119 | #3-131 | #3-148 | #3-150 | | #3- 69 | #3-126 | #3-134 | #3-148 | #3-156 | |
| 36'- 0" | | 212 | 302 | 476 | 619 | 6.407 | 106 | 594 | 725 | 979 | 1186 | 3.942 |
| STIR | | #3-118 | #3-131 | #3-150 | #3-158 | | #3- 67 | #3-127 | #3-136 | #3-151 | #3-159 | |
| 37'- 0" | | 167 | 252 | 417 | 552 | 7.149 | 67 | 529 | 653 | 893 | 1089 | 4.399 |
| STIR | | #3-118 | #3-131 | #3-151 | #3-163 | | #3- 65 | #3-128 | #3-137 | #3-153 | #3-162 | |
| 38'- 0" | | 126 | 207 | 363 | 491 | 7.953 | 31 | 469 | 587 | 814 | 1000 | 4.894 |
| STIR | | #3-117 | #3-131 | #3-152 | #3-165 | | #3- 62 | #3-129 | #3-139 | #3-137 | #3-164 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.50 | 1.50 | 1.67 | 2.00 | 2.33 | | 1.50 | 2.00 | 2.33 | 2.74 | 5.08 | |
| ACTUAL STEEL % | 0.775 | 0.775 | 0.861 | 1.034 | 1.206 | | 0.775 | 1.034 | 1.206 | 1.419 | 2.644 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.38 | 18.31 | | 18.38 | 18.38 | 18.31 | 18.31 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.160 | 0.160 | 0.173 | 0.199 | 0.221 | | 0.160 | 0.199 | 0.221 | 0.248 | 0.371 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | |
| EFF. DEPTH, IN. | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | |
| $+I_{cr}/I_{gr}$ | 0.112 | 0.180 | 0.198 | 0.230 | 0.257 | | 0.112 | 0.180 | 0.198 | 0.230 | 0.257 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 6″ Ribs @ 72″ c.-c.<br>20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | | | | End Span | # 4 | # 4 | | | | Int. Span |
| AT | 10 | 10 | | | | Defl. Coeff. (2) | 10 | 8 | | | | Defl. Coeff. (2) |
| BOTTOM BARS NO | 1# 5 | 1# 6 | | | | | 1# 5 | 1# 6 | | | | |
| BARS NO | 1# 5 | 1# 7 | | | | | 1# 5 | 1# 7 | | | | |
| STEEL (PSF) | 0.54 | 0.75 | | | | | 0.79 | 1.11 | | | | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 288 | 878 | | | | 2.344 | 690 | 1548 | | | | 1.443 |
| STIR | #3- 81 | #3-122 | | | | | #3- 91 | #3-124 | | | | |
| 29'- 0" | 228 | 778 | | | | 2.698 | 603 | 1403 | | | | 1.660 |
| STIR | #3- 80 | #3-128 | | | | | #3- 92 | #3-127 | | | | |
| 30'- 0" | 174 | 688 | | | | 3.090 | 524 | 1272 | | | | 1.901 |
| STIR | #3- 78 | #3-130 | | | | | #3- 92 | #3-130 | | | | |
| 31'- 0" | 125 | 606 | | | | 3.523 | 453 | 1153 | | | | 2.168 |
| STIR | #3- 76 | #3-132 | | | | | #3- 92 | #3-132 | | | | |
| 32'- 0" | 81 | 532 | | | | 4.000 | 389 | 1045 | | | | 2.461 |
| STIR | #3- 74 | #3-133 | | | | | #3- 92 | #3-134 | | | | |
| 33'- 0" | 40 | 465 | | | | 4.523 | 330 | 947 | | | | 2.784 |
| STIR | #3- 72 | #3-135 | | | | | #3- 91 | #3-117 | | | | |
| 34'- 0" | 3 | 403 | | | | 5.097 | 276 | 858 | | | | 3.137 |
| STIR | #3- 69 | #3-136 | | | | | #3- 90 | #3-124 | | | | |
| 35'- 0" | | 347 | | | | 5.724 | 227 | 776 | | | | 3.522 |
| STIR | | #3-137 | | | | | #3- 90 | #3-131 | | | | |
| 36'- 0" | | 295 | | | | 6.407 | 182 | 701 | | | | 3.942 |
| STIR | | #3-137 | | | | | #3- 89 | #3-139 | | | | |
| 37'- 0" | | 247 | | | | 7.149 | 140 | 631 | | | | 4.399 |
| STIR | | #3-138 | | | | | #3- 87 | #3-142 | | | | |
| 38'- 0" | | 204 | | | | 7.953 | 102 | 568 | | | | 4.894 |
| STIR | | #3-138 | | | | | #3- 86 | #3-143 | | | | |
| 39'- 0" | | 163 | | | | 8.824 | 66 | 509 | | | | 5.430 |
| STIR | | #3-139 | | | | | #3- 84 | #3-145 | | | | |
| 40'- 0" | | 126 | | | | 9.765 | 34 | 454 | | | | 6.009 |
| STIR | | #3-139 | | | | | #3- 82 | #3-146 | | | | |
| PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.44 | 1.44 | | | | | 1.44 | 1.80 | | | | |
| ACTUAL STEEL % | 0.818 | 0.818 | | | | | 0.818 | 1.023 | | | | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | | | | | 22.38 | 22.38 | | | | |
| $-I_{cr}/I_{gr}$ | 0.170 | 0.170 | | | | | 0.170 | 0.201 | | | | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.62 | 1.04 | | | | | 0.62 | 1.04 | | | | |
| ACTUAL STEEL % | 0.334 | 0.561 | | | | | 0.334 | 0.561 | | | | |
| EFF. DEPTH, IN. | 22.69 | 22.59 | | | | | 22.69 | 22.59 | | | | |
| $+I_{cr}/I_{gr}$ | 0.113 | 0.182 | | | | | 0.113 | 0.182 | | | | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 7″ Ribs @ 73″ c.-c. 20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 8.5 | 7.5 | 10 | | 10 | 7 | 9.5 | 8 | 6.5 | |
| BOTTOM BARS NO | 2# 4 | 1# 7 | 1# 7 | 1# 8 | 1# 8 | | 2# 4 | 1# 7 | 1# 7 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 1# 8 | 1# 8 | 1# 9 | | 1# 5 | 1# 7 | 1# 8 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.58 | 0.83 | 0.95 | 1.09 | 1.23 | | 0.82 | 1.28 | 1.46 | 1.71 | 2.52 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'- 0" (3) | 256 | 852 | 1082 | 1311 | 1563 | 3.090 | 658 | 1524 | 1859 | 2192 | 2558 | 1.901 |
| STIR | #3- 80 | #3-132 | #3-144 | #3-152 | #4-159 | | #3- 93 | #3-131 | #3-138 | #4-143 | #4-143 | |
| 31'- 0" | 200 | 758 | 973 | 1188 | 1423 | 3.523 | 576 | 1388 | 1701 | 2013 | 2356 | 2.168 |
| STIR | #3- 79 | #3-134 | #3-127 | #3-155 | #4-162 | | #3- 93 | #3-133 | #3-140 | #4-146 | #4-146 | |
| 32'- 0" | 149 | 673 | 875 | 1076 | 1297 | 4.000 | 502 | 1264 | 1557 | 1851 | 2172 | 2.461 |
| STIR | #3- 77 | #3-135 | #3-135 | #3-158 | #3-166 | | #3- 93 | #3-136 | #3-143 | #4-149 | #4-150 | |
| 33'- 0" | 103 | 595 | 785 | 974 | 1182 | 4.523 | 435 | 1151 | 1427 | 1703 | 2005 | 2.784 |
| STIR | #3- 74 | #3-136 | #3-144 | #3-160 | #3-168 | | #3- 93 | #3-115 | #3-146 | #4-152 | #4-152 | |
| 34'- 0" | 60 | 524 | 703 | 882 | 1077 | 5.097 | 373 | 1048 | 1308 | 1568 | 1853 | 3.137 |
| STIR | #3- 72 | #3-138 | #3-151 | #3-163 | #3-172 | | #3- 92 | #3-122 | #3-149 | #4-156 | #4-156 | |
| 35'- 0" | 22 | 459 | 628 | 797 | 981 | 5.724 | 317 | 953 | 1199 | 1444 | 1713 | 3.522 |
| STIR | #3- 69 | #3-139 | #3-153 | #3-143 | #3-175 | | #3- 92 | #3-129 | #3-151 | #3-159 | #4-162 | |
| 36'- 0" | | 400 | 559 | 718 | 893 | 6.407 | 265 | 867 | 1099 | 1330 | 1585 | 3.942 |
| STIR | | #3-140 | #3-154 | #3-151 | #3-177 | | #3- 91 | #3-136 | #3-154 | #3-162 | #4-168 | |
| 37'- 0" | | 345 | 496 | 647 | 812 | 7.149 | 217 | 787 | 1007 | 1226 | 1467 | 4.399 |
| STIR | | #3-140 | #3-156 | #3-159 | #3-180 | | #3- 90 | #3-143 | #3-156 | #3-165 | #4-172 | |
| 38'- 0" | | 294 | 438 | 581 | 737 | 7.953 | 174 | 714 | 922 | 1130 | 1358 | 4.894 |
| STIR | | #3-141 | #3-157 | #3-168 | #3-182 | | #3- 88 | #3-145 | #3-159 | #3-168 | #4-175 | |
| 39'- 0" | | 248 | 384 | 519 | 668 | 8.824 | 133 | 646 | 843 | 1041 | 1257 | 5.430 |
| STIR | | #3-141 | #3-159 | #3-172 | #3-185 | | #3- 87 | #3-146 | #3-138 | #3-170 | #4-177 | |
| 40'- 0" | | 204 | 334 | 463 | 604 | 9.765 | 95 | 583 | 771 | 958 | 1164 | 6.009 |
| STIR | | #3-142 | #3-160 | #3-174 | #3-164 | | #3- 85 | #3-148 | #3-145 | #3-172 | #3-181 | |
| 41'- 0" | | 164 | 287 | 410 | 545 | 10.778 | 61 | 524 | 703 | 882 | 1078 | 6.633 |
| STIR | | #3-142 | #3-161 | #3-175 | #3-173 | | #3- 83 | #3-149 | #3-152 | #3-174 | #3-184 | |
| 42'- 0" | | 127 | 244 | 361 | 490 | 11.869 | 28 | 470 | 641 | 811 | 998 | 7.304 |
| STIR | | #3-141 | #3-161 | #3-177 | #3-181 | | #3- 81 | #3-150 | #3-160 | #3-177 | #3-186 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.46 | 1.46 | 1.72 | 1.95 | 2.26 | | 1.46 | 2.09 | 2.38 | 2.83 | 4.94 | |
| ACTUAL STEEL % | 0.736 | 0.736 | 0.866 | 0.981 | 1.145 | | 0.736 | 1.052 | 1.205 | 1.431 | 2.508 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.38 | 22.38 | 22.31 | | 22.38 | 22.38 | 22.31 | 22.31 | 22.25 | |
| $-I_{cr}/I_{gr}$ | 0.160 | 0.160 | 0.181 | 0.199 | 0.221 | | 0.160 | 0.209 | 0.229 | 0.259 | 0.372 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.71 | 1.20 | 1.39 | 1.58 | 1.79 | | 0.71 | 1.20 | 1.39 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.340 | 0.578 | 0.670 | 0.763 | 0.865 | | 0.340 | 0.578 | 0.670 | 0.763 | 0.865 | |
| EFF. DEPTH, IN. | 22.72 | 22.56 | 22.53 | 22.50 | 22.46 | | 22.72 | 22.56 | 22.53 | 22.50 | 22.46 | |
| $+I_{cr}/I_{gr}$ | 0.116 | 0.187 | 0.213 | 0.239 | 0.268 | | 0.116 | 0.187 | 0.213 | 0.239 | 0.268 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 8″ Ribs @ 74″ c.-c. 20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 8 | 10 | 9 | | 10 | 10 | 9 | 7.5 | 6 | |
| BOTTOM BARS NO | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | |
| BARS NO | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.60 | 0.88 | 1.00 | 1.22 | 1.38 | | 0.84 | 1.36 | 1.53 | 1.85 | 2.77 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'- 0" (3) | 361 | 973 | 1167 | 1532 | 1783 | 3.090 | 824 | 1714 | 1996 | 2528 | 2893 | 1.901 |
| STIR | #3- 85 | #3-131 | #3-124 | #3-153 | #4-159 | | #3- 96 | #3-130 | #3-136 | #4-143 | #5-143 | |
| 31'- 0" | 296 | 869 | 1051 | 1393 | 1628 | 3.523 | 730 | 1564 | 1828 | 2326 | 2668 | 2.168 |
| STIR | #3- 83 | #3-133 | #3-132 | #3-156 | #4-162 | | #3- 97 | #3-133 | #3-139 | #4-147 | #4-147 | |
| 32'- 0" | 238 | 775 | 946 | 1267 | 1488 | 4.000 | 645 | 1427 | 1675 | 2142 | 2463 | 2.461 |
| STIR | #3- 82 | #3-134 | #3-141 | #3-158 | #4-165 | | #3- 97 | #3-135 | #3-141 | #4-150 | #4-151 | |
| 33'- 0" | 184 | 690 | 850 | 1152 | 1360 | 4.523 | 567 | 1302 | 1536 | 1975 | 2277 | 2.784 |
| STIR | #3- 80 | #3-136 | #3-145 | #3-162 | #4-169 | | #3- 97 | #3-115 | #3-144 | #4-153 | #4-153 | |
| 34'- 0" | 135 | 612 | 763 | 1047 | 1243 | 5.097 | 496 | 1189 | 1409 | 1822 | 2107 | 3.137 |
| STIR | #3- 77 | #3-137 | #3-147 | #3-164 | #3-172 | | #3- 96 | #3-122 | #3-146 | #4-156 | #4-157 | |
| 35'- 0" | 91 | 540 | 683 | 951 | 1136 | 5.724 | 431 | 1085 | 1292 | 1683 | 1951 | 3.522 |
| STIR | #3- 75 | #3-138 | #3-149 | #3-167 | #3-175 | | #3- 96 | #3-130 | #3-149 | #4-160 | #4-162 | |
| 36'- 0" | 50 | 474 | 609 | 863 | 1037 | 6.407 | 371 | 989 | 1185 | 1554 | 1808 | 3.942 |
| STIR | #3- 72 | #3-139 | #3-150 | #3-148 | #3-178 | | #3- 95 | #3-137 | #3-151 | #4-162 | #4-168 | |
| 37'- 0" | 12 | 414 | 542 | 782 | 947 | 7.149 | 316 | 901 | 1087 | 1436 | 1676 | 4.399 |
| STIR | #3- 69 | #3-139 | #3-152 | #3-157 | #3-181 | | #3- 94 | #3-143 | #3-153 | #4-165 | #4-172 | |
| 38'- 0" | | 358 | 479 | 707 | 863 | 7.953 | 266 | 820 | 996 | 1328 | 1555 | 4.894 |
| STIR | | #3-140 | #3-153 | #3-165 | #3-183 | | #3- 93 | #3-144 | #3-136 | #3-168 | #4-175 | |
| 39'- 0" | | 307 | 422 | 638 | 786 | 8.824 | 219 | 745 | 913 | 1227 | 1443 | 5.430 |
| STIR | | #3-140 | #3-154 | #3-174 | #3-185 | | #3- 92 | #3-146 | #3-144 | #3-171 | #4-177 | |
| 40'- 0" | | 259 | 368 | 574 | 715 | 9.765 | 176 | 676 | 835 | 1134 | 1339 | 6.009 |
| STIR | | #3-140 | #3-155 | #3-175 | #3-188 | | #3- 91 | #3-147 | #3-151 | #3-173 | #4-181 | |
| 41'- 0" | | 215 | 319 | 514 | 649 | 10.778 | 136 | 612 | 763 | 1048 | 1243 | 6.633 |
| STIR | | #3-140 | #3-155 | #3-177 | #3-172 | | #3- 89 | #3-149 | #3-159 | #3-175 | #4-183 | |
| 42'- 0" | | 174 | 273 | 459 | 587 | 11.869 | 98 | 552 | 696 | 967 | 1154 | 7.304 |
| STIR | | #3-140 | #3-156 | #3-179 | #3-181 | | #3- 87 | #3-150 | #3-161 | #3-178 | #4-186 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.48 | 1.64 | 1.85 | 2.29 | 2.55 | | 1.48 | 2.29 | 2.55 | 3.06 | 5.43 | |
| ACTUAL STEEL % | 0.671 | 0.745 | 0.838 | 1.043 | 1.159 | | 0.671 | 1.043 | 1.159 | 1.390 | 2.475 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.38 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.31 | 22.25 | |
| $-I_{cr}/I_{gr}$ | 0.152 | 0.165 | 0.180 | 0.210 | 0.227 | | 0.152 | 0.210 | 0.227 | 0.259 | 0.378 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | |
| EFF. DEPTH, IN. | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | |
| $+I_{cr}/I_{gr}$ | 0.121 | 0.187 | 0.208 | 0.244 | 0.270 | | 0.121 | 0.187 | 0.208 | 0.244 | 0.270 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 9″ Ribs @ 75″ c.-c.<br>20″ Deep Rib + 4.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 7.5 | 9.5 | 8.5 | | 10 | 10 | 8.5 | 9.5 | 7.5 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | |
| BARS NO | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | |
| STEEL (PSF) | 0.66 | 0.91 | 1.05 | 1.31 | 1.41 | | 0.90 | 1.40 | 1.61 | 2.06 | 2.93 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'- 0" (3) | 401 | 1021 | 1330 | 1752 | 1980 | 3.090 | 896 | 1798 | 2248 | 2862 | 3193 | 1.901 |
| STIR | #3- 81 | #3-127 | #3-124 | #4-153 | #4-158 | | #3- 94 | #3-127 | #4-136 | #4-144 | #5-143 | |
| 31'- 0" | 332 | 912 | 1202 | 1597 | 1811 | 3.523 | 796 | 1640 | 2062 | 2636 | 2947 | 2.168 |
| STIR | #3- 79 | #3-129 | #3-132 | #4-157 | #4-162 | | #3- 94 | #3-107 | #4-139 | #4-148 | #5-146 | |
| 32'- 0" | 269 | 814 | 1086 | 1456 | 1657 | 4.000 | 704 | 1497 | 1892 | 2432 | 2723 | 2.461 |
| STIR | #3- 77 | #3-130 | #3-140 | #3-160 | #4-165 | | #3- 94 | #3-114 | #4-142 | #4-151 | #5-150 | |
| 33'- 0" | 212 | 724 | 980 | 1328 | 1517 | 4.523 | 621 | 1366 | 1738 | 2245 | 2519 | 2.784 |
| STIR | #3- 75 | #3-131 | #3-146 | #3-162 | #4-168 | | #3- 93 | #3-121 | #3-145 | #4-154 | #5-152 | |
| 34'- 0" | 160 | 642 | 883 | 1211 | 1389 | 5.097 | 545 | 1247 | 1598 | 2075 | 2333 | 3.137 |
| STIR | #3- 73 | #3-132 | #3-148 | #3-165 | #4-172 | | #3- 93 | #3-128 | #3-147 | #4-157 | #4-156 | |
| 35'- 0" | 112 | 567 | 794 | 1104 | 1272 | 5.724 | 476 | 1138 | 1469 | 1920 | 2163 | 3.522 |
| STIR | #3- 70 | #3-132 | #3-149 | #3-168 | #3-174 | | #3- 92 | #3-136 | #3-149 | #4-160 | #4-162 | |
| 36'- 0" | 68 | 498 | 713 | 1006 | 1164 | 6.407 | 412 | 1038 | 1351 | 1777 | 2007 | 3.942 |
| STIR | #3- 67 | #3-133 | #3-151 | #3-171 | #3-177 | | #3- 91 | #3-137 | #3-151 | #4-164 | #4-168 | |
| 37'- 0" | 28 | 435 | 638 | 916 | 1066 | 7.149 | 353 | 946 | 1242 | 1645 | 1863 | 4.399 |
| STIR | #3- 63 | #3-133 | #3-152 | #3-155 | #3-180 | | #3- 90 | #3-139 | #3-154 | #4-166 | #4-171 | |
| 38'- 0" | | 377 | 569 | 832 | 975 | 7.953 | 299 | 861 | 1142 | 1524 | 1731 | 4.894 |
| STIR | | #3-133 | #3-153 | #3-163 | #3-182 | | #3- 89 | #3-140 | #3-136 | #4-169 | #4-174 | |
| 39'- 0" | | 323 | 506 | 755 | 890 | 8.824 | 249 | 782 | 1049 | 1412 | 1608 | 5.430 |
| STIR | | #3-133 | #3-154 | #3-172 | #3-185 | | #3- 88 | #3-141 | #3-143 | #4-172 | #4-178 | |
| 40'- 0" | | 273 | 447 | 684 | 812 | 9.765 | 203 | 710 | 963 | 1308 | 1495 | 6.009 |
| STIR | | #3-133 | #3-155 | #3-177 | #3-165 | | #3- 86 | #3-142 | #3-150 | #4-174 | #4-180 | |
| 41'- 0" | | 226 | 392 | 618 | 740 | 10.778 | 160 | 642 | 883 | 1212 | 1390 | 6.633 |
| STIR | | #3-133 | #3-156 | #3-178 | #3-174 | | #3- 84 | #3-143 | #3-158 | #3-176 | #4-183 | |
| 42'- 0" | | 183 | 341 | 556 | 673 | 11.869 | 120 | 580 | 809 | 1123 | 1292 | 7.304 |
| STIR | | #3-132 | #3-157 | #3-180 | #3-182 | | #3- 82 | #3-144 | #3-161 | #3-179 | #4-186 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.50 | 1.67 | 2.00 | 2.45 | 2.74 | | 1.50 | 2.33 | 2.74 | 3.47 | 6.00 | |
| ACTUAL STEEL % | 0.617 | 0.686 | 0.823 | 1.010 | 1.129 | | 0.617 | 0.960 | 1.129 | 1.438 | 2.493 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.38 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.25 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.145 | 0.157 | 0.181 | 0.210 | 0.228 | | 0.145 | 0.202 | 0.228 | 0.269 | 0.384 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | |
| ACTUAL STEEL % | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | |
| EFF. DEPTH, IN. | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | |
| $+I_{cr}/I_{gr}$ | 0.118 | 0.180 | 0.211 | 0.250 | 0.272 | | 0.118 | 0.180 | 0.211 | 0.250 | 0.272 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 7″ Ribs @ 73″ c.-c.<br>24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8.5 | 10 | 9 | | | 10 | 10 | 7.5 | 6 | | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 8 | 1# 9 | | | 1# 6 | 1# 7 | 1# 8 | 1# 9 | | |
| BARS NO | 1# 6 | 1# 8 | 1# 9 | 1# 9 | | | 1# 6 | 1# 8 | 1# 9 | 1# 9 | | |
| STEEL (PSF) | 0.67 | 0.95 | 1.23 | 1.40 | | | 0.91 | 1.42 | 1.86 | 2.78 | | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 35'- 0" (3) | 262 | 799 | 1217 | 1436 | | 5.724 | 690 | 1472 | 2080 | 2398 | | 3.522 |
| STIR | #3- 96 | #3-149 | #3-172 | #4-179 | | | #3-110 | #3-149 | #4-163 | #4-168 | | |
| 36'- 0" | 210 | 718 | 1113 | 1320 | | 6.407 | 615 | 1354 | 1929 | 2229 | | 3.942 |
| STIR | #3- 95 | #3-151 | #3-175 | #3-183 | | | #3-111 | #3-152 | #4-166 | #4-171 | | |
| 37'- 0" | 163 | 644 | 1018 | 1213 | | 7.149 | 546 | 1246 | 1790 | 2074 | | 4.399 |
| STIR | #3- 93 | #3-152 | #3-177 | #3-186 | | | #3-111 | #3-129 | #4-170 | #4-174 | | |
| 38'- 0" | 119 | 575 | 929 | 1115 | | 7.953 | 482 | 1146 | 1662 | 1931 | | 4.894 |
| STIR | #3- 91 | #3-153 | #3-154 | #3-189 | | | #3-111 | #3-136 | #4-172 | #4-178 | | |
| 39'- 0" | 78 | 511 | 848 | 1024 | | 8.824 | 424 | 1053 | 1543 | 1799 | | 5.430 |
| STIR | #3- 89 | #3-154 | #3-162 | #3-191 | | | #3-110 | #3-143 | #4-176 | #4-182 | | |
| 40'- 0" | 41 | 452 | 772 | 940 | | 9.765 | 369 | 968 | 1433 | 1676 | | 6.009 |
| STIR | #3- 86 | #3-155 | #3-170 | #3-194 | | | #3-110 | #3-150 | #4-178 | #4-185 | | |
| 41'- 0" | 6 | 398 | 702 | 862 | | 10.778 | 318 | 888 | 1331 | 1563 | | 6.633 |
| STIR | #3- 83 | #3-156 | #3-179 | #3-197 | | | #3-109 | #3-158 | #3-180 | #4-188 | | |
| 42'- 0" | | 347 | 637 | 789 | | 11.869 | 271 | 814 | 1237 | 1457 | | 7.304 |
| STIR | | #3-157 | #3-187 | #3-199 | | | #3-108 | #3-161 | #3-183 | #4-191 | | |
| 43'- 0" | | 300 | 577 | 721 | | 13.040 | 228 | 746 | 1148 | 1359 | | 8.025 |
| STIR | | #3-157 | #3-188 | #3-177 | | | #3-107 | #3-163 | #3-186 | #4-193 | | |
| 44'- 0" | | 256 | 520 | 658 | | 14.296 | 187 | 681 | 1066 | 1267 | | 8.798 |
| STIR | | #3-157 | #3-190 | #3-185 | | | #3-106 | #3-164 | #3-188 | #4-197 | | |
| 45'- 0" | | 214 | 467 | 599 | | 15.641 | 149 | 622 | 989 | 1182 | | 9.625 |
| STIR | | #3-158 | #3-192 | #3-193 | | | #3-105 | #3-165 | #3-190 | #4-200 | | |
| 46'- 0" | | 176 | 418 | 544 | | 17.078 | 113 | 566 | 918 | 1101 | | 10.510 |
| STIR | | #3-158 | #3-193 | #3-202 | | | #3-103 | #3-167 | #3-193 | #4-202 | | |
| 47'- 0" | | 140 | 372 | 493 | | 18.613 | 79 | 513 | 850 | 1026 | | 11.454 |
| STIR | | #3-157 | #3-195 | #3-208 | | | #3-102 | #3-168 | #3-195 | #3-205 | | |
| PROPERTIES FOR DESIGN (CONCRETE 0.62 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.46 | 1.72 | 2.26 | 2.51 | | | 1.46 | 2.26 | 3.02 | 5.35 | | |
| ACTUAL STEEL % | 0.602 | 0.708 | 0.936 | 1.040 | | | 0.602 | 0.936 | 1.247 | 2.220 | | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.31 | 26.31 | | | 26.38 | 26.31 | 26.31 | 26.25 | | |
| $-I_{cr}/I_{gr}$ | 0.146 | 0.166 | 0.203 | 0.220 | | | 0.146 | 0.203 | 0.251 | 0.369 | | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.79 | 2.00 | | | 0.88 | 1.39 | 1.79 | 2.00 | | |
| ACTUAL STEEL % | 0.347 | 0.549 | 0.709 | 0.792 | | | 0.347 | 0.549 | 0.709 | 0.792 | | |
| EFF. DEPTH, IN. | 26.62 | 26.53 | 26.46 | 26.44 | | | 26.62 | 26.53 | 26.46 | 26.44 | | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.190 | 0.238 | 0.263 | | | 0.124 | 0.190 | 0.238 | 0.263 | | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 8″ Ribs @ 74″ c.-c.<br>24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 10 | 8 | 7 | | 10 | 8.5 | 7.5 | 6 | 6 | |
| BOTTOM BARS NO | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | |
| BARS NO | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | |
| STEEL (PSF) | 0.66 | 1.08 | 1.22 | 1.54 | 1.76 | | 0.90 | 1.64 | 1.85 | 2.88 | 3.67 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 35'- 0"(3) | 282 | 963 | 1182 | 1680 | 1958 | 5.724 | 736 | 1727 | 2045 | 2769 | 3174 | 3.522 |
| STIR | #3- 89 | #3-151 | #3-145 | #4-181 | #4-187 | | #3-106 | #3-151 | #4-158 | #5-169 | #5-174 | |
| 36'- 0" | 227 | 871 | 1078 | 1548 | 1812 | 6.407 | 656 | 1593 | 1894 | 2578 | 2961 | 3.942 |
| STIR | #3- 87 | #3-153 | #3-153 | #4-185 | #4-191 | | #3-106 | #3-153 | #4-161 | #5-173 | #5-168 | |
| 37'- 0" | 177 | 786 | 982 | 1428 | 1677 | 7.149 | 583 | 1470 | 1755 | 2402 | 2765 | 4.399 |
| STIR | #3- 85 | #3-155 | #3-162 | #4-187 | #4-195 | | #3-105 | #3-155 | #4-163 | #5-176 | #5-171 | |
| 38'- 0" | 131 | 708 | 894 | 1316 | 1552 | 7.953 | 516 | 1356 | 1626 | 2240 | 2584 | 4.894 |
| STIR | #3- 83 | #3-156 | #3-169 | #4-190 | #4-198 | | #3-105 | #3-133 | #4-166 | #4-180 | #5-174 | |
| 39'- 0" | 88 | 636 | 812 | 1213 | 1438 | 8.824 | 453 | 1251 | 1508 | 2091 | 2417 | 5.430 |
| STIR | #3- 80 | #3-157 | #3-170 | #3-193 | #4-202 | | #3-104 | #3-140 | #3-169 | #4-183 | #5-178 | |
| 40'- 0" | 48 | 569 | 737 | 1118 | 1331 | 9.765 | 395 | 1154 | 1398 | 1952 | 2262 | 6.009 |
| STIR | #3- 77 | #3-158 | #3-172 | #3-196 | #4-204 | | #3-104 | #3-147 | #3-171 | #4-186 | #5-180 | |
| 41'- 0" | 11 | 507 | 667 | 1030 | 1233 | 10.778 | 342 | 1064 | 1296 | 1823 | 2119 | 6.633 |
| STIR | #3- 74 | #3-159 | #3-174 | #3-198 | #4-208 | | #3-103 | #3-154 | #3-174 | #4-189 | #5-185 | |
| 42'- 0" | | 450 | 602 | 947 | 1141 | 11.869 | 292 | 980 | 1201 | 1704 | 1985 | 7.304 |
| STIR | | #3-160 | #3-175 | #3-201 | #4-211 | | #3-101 | #3-162 | #3-175 | #4-192 | #5-190 | |
| 43'- 0" | | 396 | 541 | 871 | 1055 | 13.040 | 246 | 902 | 1113 | 1593 | 1861 | 8.025 |
| STIR | | #3-160 | #3-176 | #3-204 | #4-214 | | #3-100 | #3-165 | #3-150 | #4-195 | #4-196 | |
| 44'- 0" | | 346 | 485 | 800 | 976 | 14.296 | 202 | 829 | 1031 | 1489 | 1745 | 8.798 |
| STIR | | #3-161 | #3-178 | #3-181 | #3-216 | | #3- 99 | #3-166 | #3-157 | #4-198 | #4-202 | |
| 45'- 0" | | 299 | 432 | 733 | 901 | 15.641 | 162 | 761 | 954 | 1392 | 1637 | 9.625 |
| STIR | | #3-161 | #3-179 | #3-189 | #3-220 | | #3- 97 | #3-168 | #3-164 | #4-201 | #4-208 | |
| 46'- 0" | | 256 | 382 | 671 | 832 | 17.078 | 124 | 698 | 882 | 1301 | 1536 | 10.510 |
| STIR | | #3-161 | #3-180 | #3-198 | #3-222 | | #3- 95 | #3-169 | #3-172 | #4-204 | #4-212 | |
| 47'- 0" | | 215 | 336 | 612 | 767 | 18.613 | 89 | 638 | 815 | 1216 | 1441 | 11.454 |
| STIR | | #3-161 | #3-180 | #3-206 | #3-224 | | #3- 93 | #3-170 | #3-179 | #4-207 | #4-215 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.48 | 1.97 | 2.29 | 2.87 | 3.28 | | 1.48 | 2.70 | 3.06 | 5.43 | 7.40 | |
| ACTUAL STEEL % | 0.550 | 0.734 | 0.855 | 1.069 | 1.222 | | 0.550 | 1.006 | 1.140 | 2.029 | 2.775 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.31 | 26.31 | 26.31 | | 26.38 | 26.31 | 26.31 | 26.25 | 26.19 | |
| $-I_{cr}/I_{gr}$ | 0.139 | 0.174 | 0.194 | 0.229 | 0.253 | | 0.139 | 0.219 | 0.241 | 0.356 | 0.430 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | |
| ACTUAL STEEL % | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | |
| EFF. DEPTH, IN. | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | |
| $+I_{cr}/I_{gr}$ | 0.121 | 0.195 | 0.218 | 0.270 | 0.299 | | 0.121 | 0.195 | 0.218 | 0.270 | 0.299 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 9″ Ribs @ 75″ c.-c.<br>24″ Deep Rib + 4.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 9.5 | 8 | 9 | | 9 | 8.5 | 7 | 8 | 4 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | |
| BARS NO | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | |
| STEEL (PSF) | 0.70 | 1.05 | 1.31 | 1.54 | 1.84 | | 1.00 | 1.61 | 1.99 | 2.42 | 3.95 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 35'- 0" (3) | 344 | 996 | 1363 | 1759 | 2193 | 5.724 | 842 | 1791 | 2324 | 2900 | 3532 | 3.522 |
| STIR | #3- 89 | #3-146 | #3-143 | #4-177 | #5-188 | | #3-106 | #3-147 | #4-158 | #5-167 | #5-174 | |
| 36'- 0" | 284 | 900 | 1247 | 1621 | 2032 | 6.407 | 755 | 1652 | 2156 | 2700 | 3297 | 3.942 |
| STIR | #3- 87 | #3-148 | #3-151 | #4-181 | #4-191 | | #3-106 | #3-126 | #4-161 | #5-171 | #5-167 | |
| 37'- 0" | 228 | 812 | 1140 | 1495 | 1883 | 7.149 | 674 | 1524 | 2001 | 2516 | 3081 | 4.399 |
| STIR | #3- 85 | #3-149 | #3-159 | #4-183 | #4-194 | | #3-105 | #3-133 | #4-164 | #5-173 | #5-170 | |
| 38'- 0" | 177 | 731 | 1042 | 1378 | 1746 | 7.953 | 600 | 1405 | 1858 | 2346 | 2882 | 4.894 |
| STIR | #3- 83 | #3-150 | #3-168 | #4-187 | #4-199 | | #3-105 | #3-140 | #4-167 | #4-177 | #5-173 | |
| 39'- 0" | 130 | 656 | 951 | 1270 | 1620 | 8.824 | 532 | 1296 | 1725 | 2189 | 2698 | 5.430 |
| STIR | #3- 80 | #3-151 | #3-172 | #3-189 | #4-202 | | #3-104 | #3-147 | #4-169 | #4-181 | #5-177 | |
| 40'- 0" | 87 | 586 | 867 | 1170 | 1503 | 9.765 | 468 | 1195 | 1603 | 2044 | 2528 | 6.009 |
| STIR | #3- 77 | #3-152 | #3-174 | #3-192 | #4-205 | | #3-103 | #3-155 | #4-172 | #4-183 | #5-179 | |
| 41'- 0" | 46 | 522 | 789 | 1078 | 1394 | 10.778 | 409 | 1101 | 1490 | 1909 | 2370 | 6.633 |
| STIR | #3- 74 | #3-152 | #3-175 | #3-195 | #4-208 | | #3-102 | #3-157 | #3-175 | #4-186 | #5-185 | |
| 42'- 0" | 9 | 462 | 716 | 991 | 1293 | 11.869 | 355 | 1014 | 1384 | 1784 | 2223 | 7.304 |
| STIR | #3- 70 | #3-152 | #3-177 | #3-173 | #4-211 | | #3-101 | #3-158 | #3-176 | #4-189 | #5-191 | |
| 43'- 0" | | 406 | 649 | 911 | 1199 | 13.040 | 304 | 933 | 1286 | 1668 | 2086 | 8.025 |
| STIR | | #3-153 | #3-178 | #3-181 | #4-214 | | #3-100 | #3-160 | #3-179 | #4-192 | #5-196 | |
| 44'- 0" | | 354 | 586 | 837 | 1111 | 14.296 | 256 | 857 | 1194 | 1559 | 1958 | 8.798 |
| STIR | | #3-153 | #3-179 | #3-190 | #4-217 | | #3- 99 | #3-161 | #3-155 | #4-194 | #5-202 | |
| 45'- 0" | | 305 | 527 | 767 | 1029 | 15.641 | 212 | 786 | 1109 | 1457 | 1839 | 9.625 |
| STIR | | #3-153 | #3-181 | #3-198 | #4-220 | | #3- 97 | #3-162 | #3-162 | #4-197 | #5-208 | |
| 46'- 0" | | 260 | 472 | 701 | 953 | 17.078 | 171 | 720 | 1029 | 1362 | 1728 | 10.510 |
| STIR | | #3-152 | #3-182 | #3-203 | #4-222 | | #3- 95 | #3-163 | #3-169 | #4-200 | #4-212 | |
| 47'- 0" | | 217 | 421 | 640 | 881 | 18.613 | 132 | 658 | 954 | 1273 | 1623 | 11.454 |
| STIR | | #3-152 | #3-183 | #3-205 | #3-225 | | #3- 93 | #3-164 | #3-177 | #4-203 | #4-215 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.67 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.50 | 2.00 | 2.45 | 2.91 | 3.67 | | 1.67 | 2.74 | 3.32 | 4.12 | 8.25 | |
| ACTUAL STEEL % | 0.508 | 0.677 | 0.831 | 0.987 | 1.249 | | 0.564 | 0.929 | 1.128 | 1.405 | 2.809 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.31 | 26.31 | 26.25 | | 26.38 | 26.31 | 26.31 | 26.25 | 26.25 | |
| $-I_{cr}/I_{gr}$ | 0.132 | 0.167 | 0.194 | 0.221 | 0.260 | | 0.144 | 0.211 | 0.243 | 0.283 | 0.446 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | |
| ACTUAL STEEL % | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | |
| EFF. DEPTH, IN. | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | |
| $+I_{cr}/I_{gr}$ | 0.122 | 0.188 | 0.224 | 0.262 | 0.303 | | 0.122 | 0.188 | 0.224 | 0.262 | 0.303 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>11″ Deep Rib + 5.0″ Top Slab = 16.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 9 | 7.5 | 10 | | 10 | 7.5 | 10 | 8 | 7 | |
| BOTTOM BARS NO | 1# 4 | 1# 5 | 1# 6 | 1# 6 | 1# 5 | | 1# 4 | 1# 5 | 1# 6 | 1# 6 | 1# 5 | |
| BARS NO | 1# 5 | 1# 6 | 1# 6 | 1# 7 | 2# 6 | | 1# 5 | 1# 6 | 1# 6 | 1# 7 | 2# 6 | |
| STEEL (PSF) | 0.60 | 0.78 | 0.92 | 1.08 | 1.20 | | 0.84 | 1.18 | 1.41 | 1.70 | 1.90 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 211 | 506 | 665 | 858 | 1046 | 1.265 | 503 | 931 | 1162 | 1442 | 1716 | 0.779 |
| STIR | #3- 49 | #3- 86 | #3- 98 | #3-106 | #3-118 | | #3- 64 | #3- 90 | #3- 85 | #3-107 | #3-112 | |
| 25'- 0" | 161 | 433 | 579 | 757 | 930 | 1.490 | 430 | 825 | 1037 | 1296 | 1548 | 0.917 |
| STIR | #3- 46 | #3- 86 | #3- 99 | #3-110 | #3-121 | | #3- 63 | #3- 91 | #3- 92 | #3-110 | #3-115 | |
| 26'- 0" | 117 | 368 | 503 | 667 | 827 | 1.743 | 365 | 730 | 926 | 1166 | 1399 | 1.073 |
| STIR | #3- 43 | #3- 86 | #3-100 | #3-112 | #3-108 | | #3- 62 | #3- 92 | #3-100 | #3-112 | #3-118 | |
| 27'- 0" | 77 | 310 | 435 | 587 | 736 | 2.027 | 307 | 646 | 828 | 1050 | 1266 | 1.247 |
| STIR | #3- 39 | #3- 86 | #3-100 | #3-113 | #3-116 | | #3- 61 | #3- 93 | #3-103 | #3-115 | #3-121 | |
| 28'- 0" | 41 | 258 | 374 | 516 | 654 | 2.344 | 255 | 570 | 740 | 946 | 1147 | 1.443 |
| STIR | #3- 34 | #3- 85 | #3-101 | #3-115 | #3-125 | | #3- 59 | #3- 94 | #3-105 | #3-116 | #3-123 | |
| 29'- 0" | 10 | 211 | 320 | 452 | 581 | 2.698 | 209 | 503 | 660 | 853 | 1040 | 1.660 |
| STIR | #3- 30 | #3- 84 | #3-101 | #3-116 | #3-127 | | #3- 57 | #3- 94 | #3-106 | #3-106 | #3-126 | |
| 30'- 0" | | 169 | 271 | 394 | 515 | 3.090 | 167 | 442 | 589 | 769 | 944 | 1.901 |
| STIR | | #3- 82 | #3-101 | #3-117 | #3-129 | | #3- 55 | #3- 95 | #3-107 | #3-113 | #3-129 | |
| 31'- 0" | | 131 | 226 | 342 | 455 | 3.523 | 129 | 386 | 524 | 693 | 857 | 2.168 |
| STIR | | #3- 81 | #3-100 | #3-117 | #3-130 | | #3- 52 | #3- 95 | #3-108 | #3-120 | #3-131 | |
| 32'- 0" | | 97 | 186 | 295 | 400 | 4.000 | 95 | 336 | 466 | 624 | 777 | 2.461 |
| STIR | | #3- 79 | #3-100 | #3-118 | #3-132 | | #3- 49 | #3- 95 | #3-109 | #3-122 | #3-133 | |
| 33'- 0" | | 65 | 149 | 251 | 351 | 4.523 | 64 | 290 | 412 | 561 | 705 | 2.784 |
| STIR | | #3- 77 | #3- 99 | #3-118 | #3-133 | | #3- 46 | #3- 94 | #3-110 | #3-123 | #3-135 | |
| 34'- 0" | | 37 | 116 | 212 | 306 | 5.097 | 35 | 249 | 363 | 503 | 640 | 3.137 |
| STIR | | #3- 74 | #3- 98 | #3-118 | #3-134 | | #3- 43 | #3- 94 | #3-111 | #3-125 | #3-126 | |
| 35'- 0" | | 11 | 85 | 176 | 264 | 5.724 | 9 | 210 | 319 | 451 | 579 | 3.522 |
| STIR | | #3- 71 | #3- 96 | #3-118 | #3-135 | | #3- 39 | #3- 93 | #3-111 | #3-126 | #3-134 | |
| 36'- 0" | | | 57 | 143 | 226 | 6.407 | | 175 | 278 | 403 | 524 | 3.942 |
| STIR | | | #3- 95 | #3-118 | #3-135 | | | #3- 93 | #3-111 | #3-127 | #3-138 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.96 | 0.96 | 1.07 | 1.28 | 1.49 | | 0.96 | 1.28 | 1.49 | 1.86 | 2.13 | |
| ACTUAL STEEL % | 0.726 | 0.726 | 0.807 | 0.968 | 1.131 | | 0.726 | 0.968 | 1.131 | 1.414 | 1.616 | |
| EFF. DEPTH, IN. | 14.38 | 14.38 | 14.38 | 14.38 | 14.31 | | 14.38 | 14.38 | 14.31 | 14.31 | 14.31 | |
| $-I_{cr}/I_{gr}$ | 0.151 | 0.151 | 0.164 | 0.189 | 0.209 | | 0.151 | 0.189 | 0.209 | 0.246 | 0.270 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.75 | 0.88 | 1.04 | 1.19 | | 0.51 | 0.75 | 0.88 | 1.04 | 1.19 | |
| ACTUAL STEEL % | 0.364 | 0.537 | 0.631 | 0.748 | 0.853 | | 0.364 | 0.537 | 0.631 | 0.748 | 0.853 | |
| EFF. DEPTH, IN. | 14.71 | 14.65 | 14.62 | 14.59 | 14.64 | | 14.71 | 14.65 | 14.62 | 14.59 | 14.64 | |
| $+I_{cr}/I_{gr}$ | 0.115 | 0.164 | 0.189 | 0.218 | 0.248 | | 0.115 | 0.164 | 0.189 | 0.218 | 0.248 | |
| SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>11″ Deep Rib + 5.0″ Top Slab = 16.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 7.5 | 10 | 9 | | 10 | 7 | 8.5 | 7.5 | 9 | |
| BOTTOM BARS NO | 1# 4 | 1# 4 | 2# 4 | 1# 5 | 2# 6 | | 1# 4 | 1# 4 | 2# 4 | 1# 5 | 2# 6 | |
| BARS NO | 1# 5 | 2# 5 | 2# 5 | 2# 6 | 1# 6 | | 1# 5 | 2# 5 | 2# 5 | 2# 6 | 1# 6 | |
| STEEL (PSF) | 0.60 | 0.79 | 1.03 | 1.18 | 1.34 | | 0.84 | 1.23 | 1.59 | 1.81 | 2.12 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 191 | 576 | 824 | 1025 | 1182 | 1.265 | 482 | 1042 | 1402 | 1696 | 1924 | 0.779 |
| STIR | #3- 36 | #3- 85 | #3-101 | #3-102 | #3-118 | | #3- 56 | #3- 89 | #3-102 | #3-108 | #3-112 | |
| 25'- 0" | 141 | 495 | 724 | 910 | 1054 | 1.490 | 409 | 925 | 1257 | 1528 | 1738 | 0.917 |
| STIR | #3- 32 | #3- 85 | #3-102 | #3-110 | #3-120 | | #3- 54 | #3- 90 | #3-104 | #3-111 | #3-116 | |
| 26'- 0" | 96 | 424 | 635 | 807 | 941 | 1.743 | 344 | 821 | 1128 | 1379 | 1573 | 1.073 |
| STIR | #3- 28 | #3- 85 | #3-104 | #3-114 | #3-108 | | #3- 52 | #3- 91 | #3- 95 | #3-113 | #3-118 | |
| 27'- 0" | 56 | 361 | 556 | 716 | 840 | 2.027 | 287 | 729 | 1014 | 1246 | 1426 | 1.247 |
| STIR | #3- 23 | #3- 84 | #3-104 | #3-116 | #3-116 | | #3- 50 | #3- 92 | #3-103 | #3-116 | #3-121 | |
| 28'- 0" | 21 | 304 | 486 | 634 | 749 | 2.344 | 235 | 646 | 911 | 1127 | 1294 | 1.443 |
| STIR | #3- 17 | #3- 84 | #3-105 | #3-118 | #3-125 | | #3- 47 | #3- 93 | #3-108 | #3-118 | #3-124 | |
| 29'- 0" | | 253 | 422 | 561 | 668 | 2.698 | 188 | 572 | 819 | 1020 | 1176 | 1.660 |
| STIR | | #3- 82 | #3-105 | #3-119 | #3-127 | | #3- 44 | #3- 93 | #3-110 | #3-120 | #3-126 | |
| 30'- 0" | | 207 | 365 | 494 | 595 | 3.090 | 147 | 505 | 736 | 924 | 1069 | 1.901 |
| STIR | | #3- 81 | #3-106 | #3-120 | #3-129 | | #3- 41 | #3- 94 | #3-111 | #3-109 | #3-128 | |
| 31'- 0" | | 165 | 313 | 434 | 528 | 3.523 | 109 | 444 | 660 | 836 | 973 | 2.168 |
| STIR | | #3- 79 | #3-106 | #3-121 | #3-130 | | #3- 38 | #3- 94 | #3-112 | #3-117 | #3-131 | |
| 32'- 0" | | 127 | 266 | 380 | 468 | 4.000 | 74 | 389 | 592 | 757 | 885 | 2.461 |
| STIR | | #3- 77 | #3-105 | #3-122 | #3-131 | | #3- 34 | #3- 94 | #3-113 | #3-124 | #3-133 | |
| 33'- 0" | | 93 | 224 | 330 | 413 | 4.523 | 43 | 339 | 530 | 685 | 806 | 2.784 |
| STIR | | #3- 75 | #3-105 | #3-122 | #3-133 | | #3- 30 | #3- 93 | #3-114 | #3-126 | #3-135 | |
| 34'- 0" | | 61 | 185 | 285 | 363 | 5.097 | 15 | 293 | 473 | 619 | 733 | 3.137 |
| STIR | | #3- 72 | #3-104 | #3-123 | #3-134 | | #3- 25 | #3- 93 | #3-115 | #3-127 | #3-126 | |
| 35'- 0" | | 32 | 149 | 244 | 318 | 5.724 | | 252 | 421 | 559 | 666 | 3.522 |
| STIR | | #3- 70 | #3-103 | #3-123 | #3-134 | | | #3- 92 | #3-116 | #3-129 | #3-134 | |
| 36'- 0" | | 6 | 116 | 206 | 275 | 6.407 | | 213 | 373 | 504 | 605 | 3.942 |
| STIR | | #3- 66 | #3-102 | #3-123 | #3-135 | | | #3- 91 | #3-116 | #3-130 | #3-139 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.98 | 0.98 | 1.31 | 1.52 | 1.69 | | 0.98 | 1.40 | 1.79 | 2.03 | 2.40 | |
| ACTUAL STEEL % | 0.669 | 0.669 | 0.891 | 1.041 | 1.157 | | 0.669 | 0.955 | 1.225 | 1.388 | 1.650 | |
| EFF. DEPTH, IN. | 14.38 | 14.38 | 14.38 | 14.31 | 14.31 | | 14.38 | 14.38 | 14.31 | 14.31 | 14.25 | |
| $-I_{cr}/I_{gr}$ | 0.145 | 0.145 | 0.182 | 0.201 | 0.218 | | 0.145 | 0.191 | 0.227 | 0.248 | 0.277 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.82 | 1.02 | 1.19 | 1.32 | | 0.51 | 0.82 | 1.02 | 1.19 | 1.32 | |
| ACTUAL STEEL % | 0.329 | 0.530 | 0.659 | 0.772 | 0.857 | | 0.329 | 0.530 | 0.659 | 0.772 | 0.857 | |
| EFF. DEPTH, IN. | 14.71 | 14.70 | 14.71 | 14.64 | 14.62 | | 14.71 | 14.70 | 14.71 | 14.64 | 14.62 | |
| $+I_{cr}/I_{gr}$ | 0.106 | 0.165 | 0.201 | 0.229 | 0.251 | | 0.106 | 0.165 | 0.201 | 0.229 | 0.251 | |
| SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>11″ Deep Rib + 5.0″ Top Slab = 16.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 7.5 | 10 | 8 | | 10 | 10 | 8.5 | 7 | 6 | |
| BOTTOM BARS NO | 2# 4 | 2# 5 | 2# 5 | 2# 5 | 2# 6 | | 2# 4 | 2# 5 | 2# 5 | 2# 5 | 2# 6 | |
| BARS NO | 1# 4 | 1# 5 | 1# 6 | 2# 5 | 1# 7 | | 1# 4 | 1# 5 | 1# 6 | 2# 5 | 1# 7 | |
| STEEL (PSF) | 0.64 | 0.89 | 1.06 | 1.25 | 1.50 | | 0.88 | 1.38 | 1.62 | 1.95 | 2.28 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 285 | 690 | 848 | 1071 | 1353 | 1.265 | 628 | 1218 | 1447 | 1772 | 2182 | 0.779 |
| STIR | #3- 45 | #3- 88 | #3- 97 | #3-107 | #3-119 | | #3- 62 | #3- 91 | #3- 86 | #3-107 | #4-113 | |
| 25'- 0" | 225 | 599 | 745 | 950 | 1210 | 1.490 | 542 | 1085 | 1297 | 1596 | 1974 | 0.917 |
| STIR | #3- 42 | #3- 88 | #3- 98 | #3-109 | #3-121 | | #3- 61 | #3- 92 | #3- 93 | #3-109 | #3-116 | |
| 26'- 0" | 173 | 519 | 653 | 843 | 1083 | 1.743 | 465 | 968 | 1164 | 1440 | 1790 | 1.073 |
| STIR | #3- 38 | #3- 88 | #3- 99 | #3-111 | #3-124 | | #3- 59 | #3- 94 | #3-101 | #3-111 | #3-118 | |
| 27'- 0" | 126 | 447 | 571 | 748 | 970 | 2.027 | 397 | 863 | 1045 | 1301 | 1625 | 1.247 |
| STIR | #3- 34 | #3- 87 | #3- 99 | #3-112 | #3-114 | | #3- 57 | #3- 95 | #3-103 | #3-113 | #3-122 | |
| 28'- 0" | 84 | 382 | 498 | 662 | 869 | 2.344 | 336 | 770 | 939 | 1177 | 1478 | 1.443 |
| STIR | #3- 29 | #3- 87 | #3-100 | #3-114 | #3-123 | | #3- 55 | #3- 96 | #3-104 | #3-116 | #3-124 | |
| 29'- 0" | 47 | 324 | 433 | 585 | 779 | 2.698 | 282 | 686 | 843 | 1065 | 1346 | 1.660 |
| STIR | #3- 24 | #3- 86 | #3-100 | #3-115 | #3-128 | | #3- 53 | #3- 96 | #3-106 | #3-107 | #3-127 | |
| 30'- 0" | 13 | 272 | 373 | 516 | 697 | 3.090 | 232 | 610 | 757 | 965 | 1227 | 1.901 |
| STIR | #3- 18 | #3- 85 | #3- 99 | #3-116 | #3-130 | | #3- 51 | #3- 97 | #3-107 | #3-115 | #3-129 | |
| 31'- 0" | | 225 | 320 | 454 | 623 | 3.523 | 188 | 541 | 679 | 874 | 1119 | 2.168 |
| STIR | | #3- 83 | #3- 99 | #3-116 | #3-132 | | #3- 48 | #3- 97 | #3-108 | #3-119 | #3-132 | |
| 32'- 0" | | 182 | 271 | 397 | 555 | 4.000 | 147 | 479 | 608 | 791 | 1022 | 2.461 |
| STIR | | #3- 82 | #3- 98 | #3-117 | #3-133 | | #3- 45 | #3- 97 | #3-109 | #3-121 | #3-134 | |
| 33'- 0" | | 143 | 227 | 345 | 494 | 4.523 | 110 | 422 | 544 | 716 | 933 | 2.784 |
| STIR | | #3- 80 | #3- 97 | #3-117 | #3-134 | | #3- 41 | #3- 97 | #3-109 | #3-122 | #3-136 | |
| 34'- 0" | | 108 | 186 | 298 | 438 | 5.097 | 77 | 371 | 485 | 647 | 851 | 3.137 |
| STIR | | #3- 77 | #3- 96 | #3-117 | #3-135 | | #3- 38 | #3- 97 | #3-110 | #3-123 | #3-124 | |
| 35'- 0" | | 75 | 149 | 254 | 387 | 5.724 | 46 | 323 | 431 | 584 | 777 | 3.522 |
| STIR | | #3- 75 | #3- 95 | #3-117 | #3-136 | | #3- 34 | #3- 96 | #3-110 | #3-125 | #3-132 | |
| 36'- 0" | | 45 | 115 | 215 | 340 | 6.407 | 18 | 280 | 382 | 526 | 708 | 3.942 |
| STIR | | #3- 72 | #3- 93 | #3-116 | #3-137 | | #3- 29 | #3- 96 | #3-110 | #3-126 | #3-139 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.00 | 1.11 | 1.33 | 1.55 | 1.94 | | 1.00 | 1.55 | 1.82 | 2.21 | 2.58 | |
| ACTUAL STEEL % | 0.621 | 0.690 | 0.828 | 0.968 | 1.209 | | 0.621 | 0.968 | 1.138 | 1.382 | 1.613 | |
| EFF. DEPTH, IN. | 14.38 | 14.38 | 14.38 | 14.31 | 14.31 | | 14.38 | 14.31 | 14.31 | 14.31 | 14.31 | |
| $-I_{cr}/I_{gr}$ | 0.140 | 0.152 | 0.175 | 0.195 | 0.230 | | 0.140 | 0.195 | 0.220 | 0.253 | 0.282 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 0.93 | 1.06 | 1.24 | 1.48 | | 0.60 | 0.93 | 1.06 | 1.24 | 1.48 | |
| ACTUAL STEEL % | 0.353 | 0.549 | 0.627 | 0.732 | 0.879 | | 0.353 | 0.549 | 0.627 | 0.732 | 0.879 | |
| EFF. DEPTH, IN. | 14.75 | 14.69 | 14.66 | 14.69 | 14.60 | | 14.75 | 14.69 | 14.66 | 14.69 | 14.60 | |
| $+I_{cr}/I_{gr}$ | 0.116 | 0.171 | 0.192 | 0.222 | 0.257 | | 0.116 | 0.171 | 0.192 | 0.222 | 0.257 | |
| SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 7.5 | 10 | 8.5 | | 10 | 10 | 8.5 | 7 | 5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 1# 6 | 1# 5 | 1# 7 | | 2# 4 | 1# 6 | 1# 6 | 1# 5 | 1# 7 | |
| BARS NO | 1# 4 | 1# 6 | 1# 7 | 2# 6 | 1# 8 | | 1# 4 | 1# 6 | 1# 7 | 2# 6 | 1# 8 | |
| STEEL (PSF) | 0.66 | 0.92 | 1.08 | 1.20 | 1.45 | | 0.90 | 1.41 | 1.64 | 1.90 | 2.51 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 404 | 791 | 1011 | 1225 | 1489 | 1.265 | 793 | 1356 | 1677 | 1988 | 2373 | 0.779 |
| STIR | #3- 65 | #3- 97 | #3-107 | #3-117 | #3-124 | | #3- 75 | #3- 87 | #3-106 | #3-112 | #4-116 | |
| 25'- 0" | 336 | 693 | 896 | 1093 | 1337 | 1.490 | 696 | 1214 | 1510 | 1797 | 2151 | 0.917 |
| STIR | #3- 63 | #3- 97 | #3-109 | #3-119 | #3-127 | | #3- 75 | #3- 94 | #3-109 | #3-114 | #4-120 | |
| 26'- 0" | 277 | 606 | 794 | 977 | 1202 | 1.743 | 609 | 1089 | 1362 | 1627 | 1954 | 1.073 |
| STIR | #3- 61 | #3- 98 | #3-111 | #3-110 | #3-130 | | #3- 75 | #3-101 | #3-112 | #3-118 | #4-123 | |
| 27'- 0" | 223 | 529 | 703 | 872 | 1081 | 2.027 | 532 | 976 | 1230 | 1476 | 1779 | 1.247 |
| STIR | #3- 59 | #3- 99 | #3-112 | #3-118 | #3-132 | | #3- 75 | #3-102 | #3-113 | #3-120 | #3-126 | |
| 28'- 0" | 176 | 460 | 622 | 779 | 974 | 2.344 | 462 | 876 | 1112 | 1340 | 1623 | 1.443 |
| STIR | #3- 56 | #3- 99 | #3-113 | #3-124 | #3-135 | | #3- 74 | #3-104 | #3-100 | #3-123 | #3-129 | |
| 29'- 0" | 133 | 398 | 549 | 696 | 877 | 2.698 | 400 | 786 | 1006 | 1219 | 1482 | 1.660 |
| STIR | #3- 53 | #3- 99 | #3-114 | #3-126 | #3-138 | | #3- 73 | #3-105 | #3-108 | #3-125 | #3-132 | |
| 30'- 0" | 95 | 342 | 483 | 620 | 789 | 3.090 | 344 | 705 | 910 | 1109 | 1355 | 1.901 |
| STIR | #3- 49 | #3- 99 | #3-115 | #3-127 | #3-126 | | #3- 72 | #3-106 | #3-115 | #3-127 | #3-135 | |
| 31'- 0" | 60 | 292 | 424 | 552 | 711 | 3.523 | 294 | 631 | 823 | 1010 | 1240 | 2.168 |
| STIR | #3- 45 | #3- 98 | #3-116 | #3-129 | #3-134 | | #3- 70 | #3-107 | #3-119 | #3-129 | #3-138 | |
| 32'- 0" | 28 | 246 | 370 | 490 | 639 | 4.000 | 248 | 564 | 745 | 920 | 1136 | 2.461 |
| STIR | #3- 41 | #3- 97 | #3-116 | #3-130 | #3-142 | | #3- 69 | #3-108 | #3-121 | #3-132 | #3-141 | |
| 33'- 0" | | 204 | 321 | 434 | 574 | 4.523 | 206 | 503 | 673 | 838 | 1041 | 2.784 |
| STIR | | #3- 96 | #3-116 | #3-131 | #3-144 | | #3- 67 | #3-108 | #3-122 | #3-121 | #3-143 | |
| 34'- 0" | | 166 | 276 | 382 | 514 | 5.097 | 167 | 448 | 608 | 763 | 954 | 3.137 |
| STIR | | #3- 95 | #3-116 | #3-132 | #3-146 | | #3- 65 | #3-109 | #3-123 | #3-129 | #3-145 | |
| 35'- 0" | | 131 | 235 | 335 | 459 | 5.724 | 132 | 397 | 548 | 694 | 875 | 3.522 |
| STIR | | #3- 93 | #3-116 | #3-133 | #3-147 | | #3- 62 | #3-109 | #3-124 | #3-135 | #3-148 | |
| 36'- 0" | | 99 | 197 | 292 | 409 | 6.407 | 100 | 350 | 493 | 631 | 802 | 3.942 |
| STIR | | #3- 92 | #3-115 | #3-133 | #3-149 | | #3- 60 | #3-109 | #3-125 | #3-137 | #3-150 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.96 | 1.07 | 1.28 | 1.49 | 1.75 | | 0.96 | 1.49 | 1.75 | 2.13 | 2.98 | |
| ACTUAL STEEL % | 0.626 | 0.696 | 0.835 | 0.975 | 1.147 | | 0.626 | 0.975 | 1.147 | 1.392 | 1.949 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.31 | 16.31 | | 16.38 | 16.31 | 16.31 | 16.31 | 16.31 | |
| $-I_{cr}/I_{gr}$ | 0.143 | 0.155 | 0.179 | 0.199 | 0.224 | | 0.143 | 0.199 | 0.224 | 0.258 | 0.325 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 0.88 | 1.04 | 1.19 | 1.39 | | 0.60 | 0.88 | 1.04 | 1.19 | 1.39 | |
| ACTUAL STEEL % | 0.370 | 0.546 | 0.646 | 0.737 | 0.867 | | 0.370 | 0.546 | 0.646 | 0.737 | 0.867 | |
| EFF. DEPTH, IN. | 16.75 | 16.62 | 16.59 | 16.64 | 16.53 | | 16.75 | 16.62 | 16.59 | 16.64 | 16.53 | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.174 | 0.202 | 0.229 | 0.260 | | 0.124 | 0.174 | 0.202 | 0.229 | 0.260 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c. 13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8 | 10 | 9 | 7.5 | | 10 | 9 | 7.5 | 9.5 | 5 | |
| BOTTOM BARS NO | 2# 4 | 2# 4 | 1# 5 | 2# 6 | 1# 8 | | 2# 4 | 2# 4 | 1# 5 | 2# 6 | 1# 8 | |
| BARS NO | 1# 4 | 2# 5 | 2# 6 | 1# 6 | 1# 8 | | 1# 4 | 2# 5 | 2# 6 | 1# 6 | 1# 8 | |
| STEEL (PSF) | 0.65 | 1.01 | 1.18 | 1.34 | 1.64 | | 0.89 | 1.54 | 1.81 | 2.06 | 3.31 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 254 | 757 | 954 | 1106 | 1398 | 1.743 | 586 | 1318 | 1604 | 1826 | 2251 | 1.073 |
| STIR | #3- 48 | #3-102 | #3-113 | #3-110 | #3-131 | | #3- 66 | #3- 97 | #3-113 | #3-117 | #4-120 | |
| 27'- 0" | 200 | 667 | 850 | 991 | 1262 | 2.027 | 509 | 1187 | 1453 | 1659 | 2053 | 1.247 |
| STIR | #3- 45 | #3-103 | #3-115 | #3-118 | #3-134 | | #3- 65 | #3-104 | #3-115 | #3-120 | #4-126 | |
| 28'- 0" | 153 | 587 | 757 | 888 | 1140 | 2.344 | 439 | 1071 | 1318 | 1509 | 1875 | 1.443 |
| STIR | #3- 41 | #3-103 | #3-116 | #3-124 | #3-136 | | #3- 64 | #3-107 | #3-118 | #3-123 | #4-130 | |
| 29'- 0" | 110 | 515 | 673 | 796 | 1030 | 2.698 | 377 | 966 | 1196 | 1374 | 1716 | 1.660 |
| STIR | #3- 37 | #3-104 | #3-118 | #3-126 | #3-139 | | #3- 62 | #3-108 | #3-104 | #3-126 | #3-133 | |
| 30'- 0" | 72 | 450 | 598 | 712 | 932 | 3.090 | 321 | 871 | 1086 | 1253 | 1572 | 1.901 |
| STIR | #3- 32 | #3-104 | #3-119 | #3-127 | #3-142 | | #3- 60 | #3-110 | #3-111 | #3-128 | #3-137 | |
| 31'- 0" | 37 | 391 | 529 | 637 | 842 | 3.523 | 270 | 785 | 987 | 1143 | 1442 | 2.168 |
| STIR | #3- 27 | #3-104 | #3-119 | #3-129 | #3-131 | | #3- 58 | #3-111 | #3-119 | #3-130 | #3-139 | |
| 32'- 0" | 5 | 337 | 467 | 568 | 761 | 4.000 | 224 | 708 | 897 | 1043 | 1324 | 2.461 |
| STIR | #3- 22 | #3-103 | #3-120 | #3-130 | #3-140 | | #3- 55 | #3-112 | #3-123 | #3-132 | #3-142 | |
| 33'- 0" | | 289 | 411 | 506 | 687 | 4.523 | 183 | 637 | 815 | 953 | 1216 | 2.784 |
| STIR | | #3-103 | #3-120 | #3-131 | #3-146 | | #3- 53 | #3-113 | #3-125 | #3-121 | #3-144 | |
| 34'- 0" | | 244 | 359 | 449 | 619 | 5.097 | 144 | 572 | 740 | 870 | 1118 | 3.137 |
| STIR | | #3-102 | #3-121 | #3-132 | #3-148 | | #3- 50 | #3-113 | #3-126 | #3-128 | #3-147 | |
| 35'- 0" | | 204 | 312 | 396 | 558 | 5.724 | 109 | 513 | 671 | 794 | 1028 | 3.522 |
| STIR | | #3-101 | #3-121 | #3-133 | #3-150 | | #3- 46 | #3-114 | #3-127 | #3-136 | #3-150 | |
| 36'- 0" | | 166 | 269 | 349 | 501 | 6.407 | 77 | 459 | 608 | 724 | 946 | 3.942 |
| STIR | | #3- 99 | #3-121 | #3-133 | #3-151 | | #3- 43 | #3-114 | #3-128 | #3-137 | #3-151 | |
| 37'- 0" | | 132 | 229 | 305 | 449 | 7.149 | 48 | 409 | 550 | 660 | 870 | 4.399 |
| STIR | | #3- 98 | #3-120 | #3-133 | #3-153 | | #3- 39 | #3-115 | #3-129 | #3-139 | #3-154 | |
| 38'- 0" | | 100 | 192 | 264 | 401 | 7.953 | 20 | 363 | 497 | 601 | 800 | 4.894 |
| STIR | | #3- 96 | #3-120 | #3-134 | #3-154 | | #3- 35 | #3-115 | #3-130 | #3-140 | #3-156 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.98 | 1.23 | 1.52 | 1.69 | 2.03 | | 0.98 | 1.69 | 2.03 | 2.27 | 4.31 | |
| ACTUAL STEEL % | 0.577 | 0.722 | 0.899 | 0.999 | 1.199 | | 0.577 | 0.999 | 1.199 | 1.349 | 2.563 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.31 | 16.31 | 16.31 | | 16.38 | 16.31 | 16.31 | 16.25 | 16.25 | |
| $-I_{cr}/I_{gr}$ | 0.137 | 0.163 | 0.191 | 0.207 | 0.237 | | 0.137 | 0.207 | 0.237 | 0.255 | 0.393 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.60 | 1.02 | 1.19 | 1.32 | 1.58 | | 0.60 | 1.02 | 1.19 | 1.32 | 1.58 | |
| ACTUAL STEEL % | 0.335 | 0.571 | 0.669 | 0.742 | 0.894 | | 0.335 | 0.571 | 0.669 | 0.742 | 0.894 | |
| EFF. DEPTH, IN. | 16.75 | 16.71 | 16.64 | 16.62 | 16.50 | | 16.75 | 16.71 | 16.64 | 16.62 | 16.50 | |
| $+I_{cr}/I_{gr}$ | 0.114 | 0.186 | 0.212 | 0.232 | 0.268 | | 0.114 | 0.186 | 0.212 | 0.232 | 0.268 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c. 13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi $f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8 | 10 | 8.5 | 7.5 | | 8.5 | 9 | 7.5 | 6 | 7.5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 5 | 2# 6 | 1# 6 | | 2# 4 | 1# 6 | 2# 5 | 2# 6 | 1# 6 | |
| BARS NO | 1# 5 | 1# 7 | 2# 5 | 1# 7 | 2# 7 | | 1# 5 | 1# 7 | 2# 5 | 1# 7 | 2# 7 | |
| STEEL (PSF) | 0.73 | 1.03 | 1.25 | 1.47 | 1.60 | | 1.06 | 1.56 | 1.88 | 2.28 | 2.54 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 362 | 749 | 995 | 1270 | 1455 | 1.743 | 754 | 1316 | 1674 | 2075 | 2345 | 1.073 |
| STIR | #3- 58 | #3- 96 | #3-110 | #3-108 | #3-129 | | #3- 73 | #3- 99 | #3-111 | #3-118 | #4-122 | |
| 27'- 0" | 299 | 658 | 886 | 1141 | 1313 | 2.027 | 663 | 1184 | 1516 | 1888 | 2138 | 1.247 |
| STIR | #3- 55 | #3- 96 | #3-111 | #3-116 | #3-131 | | #3- 72 | #3-100 | #3-113 | #3-121 | #4-125 | |
| 28'- 0" | 243 | 576 | 789 | 1026 | 1186 | 2.344 | 581 | 1066 | 1375 | 1720 | 1953 | 1.443 |
| STIR | #3- 52 | #3- 96 | #3-112 | #3-125 | #3-134 | | #3- 71 | #3-102 | #3-102 | #3-124 | #4-129 | |
| 29'- 0" | 193 | 503 | 701 | 923 | 1072 | 2.698 | 508 | 960 | 1248 | 1569 | 1786 | 1.660 |
| STIR | #3- 48 | #3- 96 | #3-113 | #3-127 | #3-121 | | #3- 70 | #3-103 | #3-109 | #3-126 | #3-131 | |
| 30'- 0" | 147 | 438 | 622 | 829 | 969 | 3.090 | 442 | 864 | 1133 | 1434 | 1636 | 1.901 |
| STIR | #3- 45 | #3- 95 | #3-114 | #3-129 | #3-129 | | #3- 69 | #3-104 | #3-116 | #3-129 | #3-134 | |
| 31'- 0" | 106 | 378 | 551 | 745 | 875 | 3.523 | 382 | 778 | 1029 | 1311 | 1501 | 2.168 |
| STIR | #3- 40 | #3- 94 | #3-115 | #3-130 | #3-138 | | #3- 67 | #3-105 | #3-118 | #3-131 | #3-137 | |
| 32'- 0" | 69 | 324 | 486 | 668 | 791 | 4.000 | 328 | 699 | 935 | 1199 | 1378 | 2.461 |
| STIR | #3- 36 | #3- 93 | #3-115 | #3-132 | #3-140 | | #3- 65 | #3-105 | #3-120 | #3-133 | #3-139 | |
| 33'- 0" | 35 | 275 | 428 | 598 | 714 | 4.523 | 278 | 627 | 849 | 1098 | 1266 | 2.784 |
| STIR | #3- 31 | #3- 92 | #3-115 | #3-133 | #3-142 | | #3- 63 | #3-106 | #3-121 | #3-119 | #3-141 | |
| 34'- 0" | 4 | 230 | 374 | 535 | 643 | 5.097 | 233 | 562 | 771 | 1005 | 1163 | 3.137 |
| STIR | #3- 26 | #3- 91 | #3-115 | #3-134 | #3-143 | | #3- 61 | #3-106 | #3-122 | #3-126 | #3-144 | |
| 35'- 0" | | 189 | 324 | 476 | 579 | 5.724 | 192 | 502 | 700 | 921 | 1069 | 3.522 |
| STIR | | #3- 89 | #3-115 | #3-135 | #3-145 | | #3- 58 | #3-106 | #3-123 | #3-134 | #3-146 | |
| 36'- 0" | | 151 | 279 | 423 | 520 | 6.407 | 154 | 447 | 634 | 843 | 983 | 3.942 |
| STIR | | #3- 87 | #3-114 | #3-135 | #3-146 | | #3- 55 | #3-106 | #3-124 | #3-139 | #3-149 | |
| 37'- 0" | | 116 | 238 | 374 | 465 | 7.149 | 119 | 397 | 573 | 771 | 904 | 4.399 |
| STIR | | #3- 85 | #3-114 | #3-136 | #3-147 | | #3- 52 | #3-106 | #3-125 | #3-140 | #3-135 | |
| 38'- 0" | | 84 | 199 | 328 | 415 | 7.953 | 87 | 350 | 517 | 705 | 831 | 4.894 |
| STIR | | #3- 82 | #3-113 | #3-136 | #3-148 | | #3- 49 | #3-105 | #3-125 | #3-142 | #3-142 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.67 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.00 | 1.25 | 1.55 | 1.82 | 2.07 | | 1.18 | 1.72 | 2.07 | 2.58 | 2.93 | |
| ACTUAL STEEL % | 0.537 | 0.672 | 0.836 | 0.984 | 1.115 | | 0.632 | 0.929 | 1.115 | 1.394 | 1.590 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.31 | 16.31 | 16.31 | | 16.38 | 16.31 | 16.31 | 16.31 | 16.25 | |
| $-I_{cr}/I_{gr}$ | 0.132 | 0.157 | 0.185 | 0.209 | 0.229 | | 0.150 | 0.200 | 0.229 | 0.270 | 0.292 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.71 | 1.04 | 1.24 | 1.48 | 1.64 | | 0.71 | 1.04 | 1.24 | 1.48 | 1.64 | |
| ACTUAL STEEL % | 0.363 | 0.536 | 0.635 | 0.762 | 0.845 | | 0.363 | 0.536 | 0.635 | 0.762 | 0.845 | |
| EFF. DEPTH, IN. | 16.72 | 16.59 | 16.69 | 16.60 | 16.58 | | 16.72 | 16.59 | 16.69 | 16.60 | 16.58 | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.173 | 0.206 | 0.238 | 0.260 | | 0.124 | 0.173 | 0.206 | 0.238 | 0.260 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 10 | 8.5 | 7.5 | | 9.5 | 8.5 | 7.5 | 9 | 5 | |
| BOTTOM BARS NO | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.70 | 1.08 | 1.20 | 1.45 | 1.67 | | 0.96 | 1.64 | 1.83 | 2.21 | 3.33 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 247 | 728 | 904 | 1123 | 1336 | 2.344 | 577 | 1277 | 1533 | 1852 | 2162 | 1.443 |
| STIR | #3- 57 | #3-112 | #3-123 | #3-135 | #3-142 | | #3- 75 | #3-102 | #3-121 | #3-129 | #4-129 | |
| 29'- 0" | 197 | 646 | 810 | 1014 | 1213 | 2.698 | 505 | 1158 | 1396 | 1694 | 1983 | 1.660 |
| STIR | #3- 54 | #3-113 | #3-124 | #3-120 | #3-145 | | #3- 74 | #3-109 | #3-124 | #3-131 | #4-135 | |
| 30'- 0" | 153 | 572 | 725 | 916 | 1102 | 3.090 | 441 | 1050 | 1273 | 1551 | 1821 | 1.901 |
| STIR | #3- 51 | #3-113 | #3-126 | #3-128 | #3-147 | | #3- 73 | #3-116 | #3-126 | #3-134 | #4-140 | |
| 31'- 0" | 113 | 505 | 649 | 828 | 1001 | 3.523 | 382 | 953 | 1162 | 1422 | 1675 | 2.168 |
| STIR | #3- 47 | #3-114 | #3-127 | #3-137 | #3-150 | | #3- 72 | #3-118 | #3-109 | #3-137 | #4-143 | |
| 32'- 0" | 76 | 444 | 579 | 747 | 910 | 4.000 | 329 | 865 | 1061 | 1305 | 1542 | 2.461 |
| STIR | #3- 43 | #3-114 | #3-128 | #3-141 | #3-153 | | #3- 70 | #3-119 | #3-116 | #3-140 | #3-146 | |
| 33'- 0" | 43 | 389 | 516 | 674 | 827 | 4.523 | 281 | 785 | 969 | 1199 | 1422 | 2.784 |
| STIR | #3- 38 | #3-114 | #3-129 | #3-143 | #3-137 | | #3- 68 | #3-121 | #3-124 | #3-142 | #3-149 | |
| 34'- 0" | 13 | 339 | 458 | 607 | 751 | 5.097 | 237 | 711 | 885 | 1101 | 1311 | 3.137 |
| STIR | #3- 34 | #3-114 | #3-130 | #3-144 | #3-145 | | #3- 66 | #3-122 | #3-131 | #3-145 | #3-152 | |
| 35'- 0" | | 293 | 405 | 546 | 682 | 5.724 | 196 | 644 | 808 | 1012 | 1211 | 3.522 |
| STIR | | #3-114 | #3-130 | #3-146 | #3-154 | | #3- 64 | #3-123 | #3-134 | #3-147 | #3-155 | |
| 36'- 0" | | 250 | 357 | 490 | 618 | 6.407 | 159 | 582 | 737 | 930 | 1118 | 3.942 |
| STIR | | #3-113 | #3-131 | #3-147 | #3-159 | | #3- 61 | #3-124 | #3-136 | #3-149 | #3-157 | |
| 37'- 0" | | 211 | 312 | 438 | 560 | 7.149 | 125 | 526 | 672 | 855 | 1033 | 4.399 |
| STIR | | #3-112 | #3-131 | #3-148 | #3-161 | | #3- 59 | #3-124 | #3-137 | #3-133 | #3-160 | |
| 38'- 0" | | 175 | 271 | 390 | 506 | 7.953 | 94 | 474 | 613 | 786 | 954 | 4.894 |
| STIR | | #3-111 | #3-131 | #3-149 | #3-163 | | #3- 55 | #3-125 | #3-138 | #3-141 | #3-162 | |
| 39'- 0" | | 142 | 233 | 346 | 456 | 8.824 | 65 | 425 | 557 | 722 | 881 | 5.430 |
| STIR | | #3-110 | #3-131 | #3-150 | #3-164 | | #3- 52 | #3-125 | #3-139 | #3-148 | #3-164 | |
| 40'- 0" | | 111 | 198 | 305 | 410 | 9.765 | 38 | 380 | 506 | 662 | 814 | 6.009 |
| STIR | | #3-109 | #3-131 | #3-151 | #3-166 | | #3- 49 | #3-126 | #3-140 | #3-155 | #3-167 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.67 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.96 | 1.28 | 1.49 | 1.75 | 1.98 | | 1.01 | 1.75 | 1.98 | 2.35 | 4.22 | |
| ACTUAL STEEL % | 0.548 | 0.731 | 0.853 | 1.004 | 1.137 | | 0.577 | 1.004 | 1.137 | 1.351 | 2.431 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.31 | 18.31 | 18.31 | | 18.38 | 18.31 | 18.31 | 18.25 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.135 | 0.169 | 0.189 | 0.214 | 0.234 | | 0.140 | 0.214 | 0.234 | 0.262 | 0.390 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | |
| EFF. DEPTH, IN. | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.118 | 0.187 | 0.213 | 0.242 | 0.271 | | 0.118 | 0.187 | 0.213 | 0.242 | 0.271 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 9.5 | 7.5 | 9.5 | | 8.5 | 5 | 4.5 | 8 | 6 | |
| BOTTOM BARS NO | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.74 | 1.18 | 1.31 | 1.64 | 1.85 | | 1.07 | 1.77 | 1.99 | 2.50 | 3.73 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 327 | 878 | 1026 | 1311 | 1544 | 2.344 | 706 | 1508 | 1723 | 2137 | 2476 | 1.443 |
| STIR | #3- 62 | #3-115 | #3-123 | #3-136 | #3-143 | | #3- 78 | #3- 99 | #3-121 | #4-130 | #4-128 | |
| 29'- 0" | 271 | 785 | 922 | 1188 | 1405 | 2.698 | 624 | 1371 | 1572 | 1958 | 2274 | 1.660 |
| STIR | #3- 59 | #3-116 | #3-124 | #3-138 | #3-146 | | #3- 78 | #3-106 | #3-124 | #4-132 | #4-133 | |
| 30'- 0" | 220 | 700 | 829 | 1077 | 1280 | 3.090 | 550 | 1248 | 1436 | 1796 | 2092 | 1.901 |
| STIR | #3- 56 | #3-117 | #3-126 | #3-125 | #3-149 | | #3- 77 | #3-113 | #3-127 | #3-136 | #4-140 | |
| 31'- 0" | 174 | 623 | 744 | 976 | 1167 | 3.523 | 483 | 1137 | 1312 | 1650 | 1927 | 2.168 |
| STIR | #3- 53 | #3-118 | #3-127 | #3-133 | #3-152 | | #3- 76 | #3-120 | #3-109 | #3-139 | #4-144 | |
| 32'- 0" | 132 | 554 | 667 | 885 | 1064 | 4.000 | 422 | 1036 | 1200 | 1517 | 1777 | 2.461 |
| STIR | #3- 49 | #3-118 | #3-128 | #3-142 | #3-155 | | #3- 74 | #3-122 | #3-117 | #3-141 | #4-147 | |
| 33'- 0" | 94 | 491 | 597 | 802 | 970 | 4.523 | 367 | 944 | 1099 | 1397 | 1641 | 2.784 |
| STIR | #3- 45 | #3-119 | #3-129 | #3-145 | #3-157 | | #3- 73 | #3-123 | #3-124 | #3-144 | #4-151 | |
| 34'- 0" | 59 | 433 | 533 | 726 | 884 | 5.097 | 316 | 860 | 1006 | 1286 | 1516 | 3.137 |
| STIR | #3- 41 | #3-119 | #3-130 | #3-147 | #3-142 | | #3- 71 | #3-124 | #3-131 | #3-146 | #4-153 | |
| 35'- 0" | 27 | 380 | 475 | 657 | 806 | 5.724 | 270 | 783 | 920 | 1185 | 1403 | 3.522 |
| STIR | #3- 36 | #3-119 | #3-131 | #3-148 | #3-150 | | #3- 69 | #3-126 | #3-134 | #3-149 | #3-156 | |
| 36'- 0" | | 331 | 421 | 593 | 734 | 6.407 | 227 | 712 | 842 | 1093 | 1298 | 3.942 |
| STIR | | #3-118 | #3-131 | #3-150 | #3-159 | | #3- 67 | #3-127 | #3-135 | #3-150 | #3-159 | |
| 37'- 0" | | 287 | 371 | 534 | 668 | 7.149 | 188 | 647 | 770 | 1008 | 1202 | 4.399 |
| STIR | | #3-118 | #3-131 | #3-151 | #3-163 | | #3- 64 | #3-128 | #3-137 | #3-153 | #3-161 | |
| 38'- 0" | | 246 | 326 | 480 | 607 | 7.953 | 152 | 587 | 704 | 929 | 1113 | 4.894 |
| STIR | | #3-117 | #3-131 | #3-152 | #3-165 | | #3- 62 | #3-128 | #3-138 | #3-137 | #3-163 | |
| 39'- 0" | | 207 | 284 | 430 | 551 | 8.824 | 119 | 532 | 643 | 856 | 1031 | 5.430 |
| STIR | | #3-116 | #3-131 | #3-153 | #3-167 | | #3- 59 | #3-129 | #3-139 | #3-145 | #3-166 | |
| 40'- 0" | | 172 | 245 | 384 | 499 | 9.765 | 88 | 481 | 586 | 789 | 955 | 6.009 |
| STIR | | #3-115 | #3-131 | #3-154 | #3-168 | | #3- 56 | #3-129 | #3-140 | #3-152 | #3-168 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.98 | 1.52 | 1.60 | 2.03 | 2.27 | | 1.15 | 1.96 | 2.18 | 2.69 | 4.90 | |
| ACTUAL STEEL % | 0.506 | 0.788 | 0.830 | 1.051 | 1.182 | | 0.596 | 1.013 | 1.125 | 1.404 | 2.562 | |
| EFF. DEPTH, IN. | 18.38 | 18.31 | 18.31 | 18.31 | 18.25 | | 18.38 | 18.38 | 18.38 | 18.25 | 18.19 | |
| $-I_{cr}/I_{gr}$ | 0.129 | 0.182 | 0.189 | 0.226 | 0.244 | | 0.147 | 0.222 | 0.240 | 0.276 | 0.408 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | |
| EFF. DEPTH, IN. | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.197 | 0.216 | 0.250 | 0.278 | | 0.124 | 0.197 | 0.216 | 0.250 | 0.278 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7 | 8.5 | 7.5 | 6 | | 8.5 | 8 | 6 | 8 | 4 | |
| BOTTOM BARS NO | 3# 3 | 1# 5 | 2# 6 | 1# 6 | 2# 7 | | 3# 3 | 1# 5 | 2# 6 | 1# 6 | 2# 7 | |
| BARS NO | 2# 4 | 2# 6 | 1# 7 | 2# 7 | 1# 8 | | 2# 4 | 2# 6 | 1# 7 | 2# 7 | 1# 8 | |
| STEEL (PSF) | 0.75 | 1.13 | 1.47 | 1.60 | 2.00 | | 1.08 | 1.73 | 2.28 | 2.45 | 4.08 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 328 | 853 | 1182 | 1362 | 1753 | 2.344 | 718 | 1482 | 1961 | 2223 | 2792 | 1.443 |
| STIR | #3- 54 | #3-107 | #3-124 | #3-115 | #4-144 | | #3- 73 | #3-108 | #3-123 | #4-128 | #4-128 | |
| 29'- 0" | 270 | 759 | 1066 | 1234 | 1598 | 2.698 | 634 | 1346 | 1792 | 2036 | 2567 | 1.660 |
| STIR | #3- 51 | #3-108 | #3-126 | #3-123 | #3-147 | | #3- 72 | #3-111 | #3-126 | #4-130 | #4-133 | |
| 30'- 0" | 217 | 675 | 961 | 1118 | 1459 | 3.090 | 557 | 1223 | 1640 | 1868 | 2364 | 1.901 |
| STIR | #3- 47 | #3-108 | #3-128 | #3-131 | #3-150 | | #3- 70 | #3-113 | #3-128 | #3-133 | #4-139 | |
| 31'- 0" | 169 | 598 | 866 | 1013 | 1332 | 3.523 | 488 | 1112 | 1502 | 1716 | 2180 | 2.168 |
| STIR | #3- 43 | #3-108 | #3-129 | #3-137 | #3-152 | | #3- 69 | #3-114 | #3-130 | #3-135 | #4-145 | |
| 32'- 0" | 126 | 528 | 780 | 918 | 1218 | 4.000 | 425 | 1010 | 1377 | 1577 | 2013 | 2.461 |
| STIR | #3- 39 | #3-108 | #3-130 | #3-139 | #3-155 | | #3- 67 | #3-115 | #3-114 | #3-139 | #4-148 | |
| 33'- 0" | 87 | 465 | 702 | 832 | 1113 | 4.523 | 368 | 918 | 1263 | 1451 | 1861 | 2.784 |
| STIR | #3- 34 | #3-108 | #3-131 | #3-141 | #3-158 | | #3- 65 | #3-116 | #3-121 | #3-141 | #4-151 | |
| 34'- 0" | 51 | 407 | 630 | 753 | 1018 | 5.097 | 316 | 834 | 1159 | 1336 | 1722 | 3.137 |
| STIR | #3- 29 | #3-107 | #3-132 | #3-142 | #3-160 | | #3- 63 | #3-117 | #3-128 | #3-143 | #4-154 | |
| 35'- 0" | 18 | 355 | 565 | 680 | 931 | 5.724 | 268 | 757 | 1063 | 1231 | 1595 | 3.522 |
| STIR | #3- 23 | #3-106 | #3-133 | #3-143 | #3-148 | | #3- 60 | #3-118 | #3-136 | #3-145 | #4-157 | |
| 36'- 0" | | 306 | 505 | 614 | 851 | 6.407 | 225 | 687 | 976 | 1135 | 1479 | 3.942 |
| STIR | | #3-105 | #3-134 | #3-145 | #3-157 | | #3- 58 | #3-118 | #3-137 | #3-130 | #4-160 | |
| 37'- 0" | | 261 | 450 | 553 | 777 | 7.149 | 184 | 622 | 896 | 1046 | 1372 | 4.399 |
| STIR | | #3-104 | #3-134 | #3-146 | #3-165 | | #3- 55 | #3-119 | #3-139 | #3-137 | #3-163 | |
| 38'- 0" | | 220 | 399 | 496 | 709 | 7.953 | 147 | 562 | 822 | 964 | 1273 | 4.894 |
| STIR | | #3-103 | #3-134 | #3-146 | #3-166 | | #3- 51 | #3-119 | #3-140 | #3-144 | #3-165 | |
| 39'- 0" | | 182 | 352 | 444 | 646 | 8.824 | 113 | 506 | 753 | 888 | 1181 | 5.430 |
| STIR | | #3-101 | #3-134 | #3-147 | #3-168 | | #3- 48 | #3-119 | #3-142 | #3-151 | #3-167 | |
| 40'- 0" | | 147 | 308 | 396 | 588 | 9.765 | 81 | 455 | 690 | 818 | 1097 | 6.009 |
| STIR | | #3- 99 | #3-134 | #3-148 | #3-170 | | #3- 44 | #3-119 | #3-143 | #3-152 | #3-170 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.71 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.00 | 1.43 | 1.82 | 2.07 | 2.58 | | 1.18 | 1.94 | 2.58 | 2.75 | 5.50 | |
| ACTUAL STEEL % | 0.472 | 0.674 | 0.864 | 0.979 | 1.224 | | 0.555 | 0.918 | 1.224 | 1.308 | 2.616 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.31 | 18.31 | 18.31 | | 18.38 | 18.31 | 18.31 | 18.25 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.124 | 0.166 | 0.199 | 0.219 | 0.258 | | 0.142 | 0.208 | 0.258 | 0.268 | 0.427 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.73 | 1.19 | 1.48 | 1.64 | 1.99 | | 0.73 | 1.19 | 1.48 | 1.64 | 1.99 | |
| ACTUAL STEEL % | 0.328 | 0.538 | 0.671 | 0.744 | 0.904 | | 0.328 | 0.538 | 0.671 | 0.744 | 0.904 | |
| EFF. DEPTH, IN. | 18.78 | 18.64 | 18.60 | 18.58 | 18.54 | | 18.78 | 18.64 | 18.60 | 18.58 | 18.54 | |
| $+I_{cr}/I_{gr}$ | 0.119 | 0.183 | 0.222 | 0.243 | 0.287 | | 0.119 | 0.183 | 0.222 | 0.243 | 0.287 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>17″ Deep Rib + 5.0″ Top Slab = 22.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 6 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 9 | 7.5 | 9.5 | | 8.5 | 7.5 | 9.5 | 10 | 6 | |
| BOTTOM BARS NO | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.75 | 1.20 | 1.36 | 1.67 | 1.87 | | 1.08 | 1.83 | 2.08 | 2.64 | 3.76 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 199 | 667 | 793 | 1036 | 1235 | 4.000 | 521 | 1201 | 1384 | 1738 | 2027 | 2.461 |
| STIR | #3- 63 | #3-126 | #3-136 | #3-131 | #3-160 | | #3- 84 | #3-118 | #3-136 | #4-146 | #4-149 | |
| 33'- 0" | 157 | 597 | 716 | 944 | 1131 | 4.523 | 459 | 1099 | 1271 | 1604 | 1876 | 2.784 |
| STIR | #3- 60 | #3-127 | #3-137 | #3-139 | #3-163 | | #3- 83 | #3-126 | #3-138 | #3-148 | #4-155 | |
| 34'- 0" | 119 | 533 | 645 | 860 | 1036 | 5.097 | 403 | 1006 | 1168 | 1481 | 1737 | 3.137 |
| STIR | #3- 56 | #3-128 | #3-138 | #3-148 | #3-165 | | #3- 82 | #3-131 | #3-120 | #3-151 | #4-158 | |
| 35'- 0" | 83 | 475 | 580 | 783 | 949 | 5.724 | 352 | 921 | 1074 | 1369 | 1611 | 3.522 |
| STIR | #3- 52 | #3-128 | #3-140 | #3-156 | #3-168 | | #3- 80 | #3-133 | #3-127 | #3-154 | #4-161 | |
| 36'- 0" | 51 | 421 | 520 | 712 | 869 | 6.407 | 305 | 843 | 987 | 1267 | 1495 | 3.942 |
| STIR | #3- 48 | #3-129 | #3-140 | #3-158 | #3-170 | | #3- 79 | #3-134 | #3-135 | #3-156 | #4-163 | |
| 37'- 0" | 21 | 371 | 465 | 647 | 796 | 7.149 | 262 | 771 | 908 | 1172 | 1388 | 4.399 |
| STIR | #3- 44 | #3-129 | #3-141 | #3-159 | #3-154 | | #3- 77 | #3-135 | #3-142 | #3-159 | #3-166 | |
| 38'- 0" | | 326 | 415 | 587 | 728 | 7.953 | 222 | 704 | 834 | 1085 | 1290 | 4.894 |
| STIR | | #3-129 | #3-142 | #3-161 | #3-163 | | #3- 75 | #3-137 | #3-146 | #3-161 | #3-169 | |
| 39'- 0" | | 284 | 368 | 532 | 666 | 8.824 | 185 | 643 | 766 | 1004 | 1199 | 5.430 |
| STIR | | #3-129 | #3-142 | #3-162 | #3-171 | | #3- 73 | #3-138 | #3-147 | #3-164 | #3-172 | |
| 40'- 0" | | 244 | 325 | 480 | 608 | 9.765 | 151 | 586 | 703 | 929 | 1114 | 6.009 |
| STIR | | #3-128 | #3-142 | #3-164 | #3-177 | | #3- 70 | #3-139 | #3-149 | #3-166 | #3-175 | |
| 41'- 0" | | 208 | 285 | 433 | 554 | 10.778 | 119 | 534 | 645 | 860 | 1036 | 6.633 |
| STIR | | #3-127 | #3-143 | #3-165 | #3-179 | | #3- 68 | #3-139 | #3-150 | #3-147 | #3-177 | |
| 42'- 0" | | 175 | 248 | 389 | 504 | 11.869 | 89 | 485 | 591 | 796 | 964 | 7.304 |
| STIR | | #3-127 | #3-142 | #3-166 | #3-180 | | #3- 65 | #3-140 | #3-151 | #3-154 | #3-179 | |
| 43'- 0" | | 143 | 213 | 347 | 457 | 13.040 | 62 | 439 | 540 | 736 | 896 | 8.025 |
| STIR | | #3-126 | #3-142 | #3-167 | #3-182 | | #3- 62 | #3-141 | #3-153 | #3-161 | #3-182 | |
| 44'- 0" | | 114 | 181 | 309 | 414 | 14.296 | 36 | 396 | 493 | 680 | 833 | 8.798 |
| STIR | | #3-124 | #3-142 | #3-167 | #3-184 | | #3- 58 | #3-141 | #3-153 | #3-169 | #3-185 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.96 | 1.49 | 1.65 | 1.98 | 2.22 | | 1.13 | 1.98 | 2.22 | 2.88 | 4.80 | |
| ACTUAL STEEL % | 0.486 | 0.756 | 0.840 | 1.008 | 1.133 | | 0.572 | 1.008 | 1.133 | 1.473 | 2.456 | |
| EFF. DEPTH, IN. | 20.38 | 20.31 | 20.31 | 20.31 | 20.25 | | 20.38 | 20.31 | 20.25 | 20.19 | 20.19 | |
| $-I_{cr}/I_{gr}$ | 0.128 | 0.180 | 0.195 | 0.224 | 0.242 | | 0.146 | 0.224 | 0.242 | 0.289 | 0.406 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.342 | 0.575 | 0.638 | 0.768 | 0.871 | | 0.342 | 0.575 | 0.638 | 0.768 | 0.871 | |
| EFF. DEPTH, IN. | 20.72 | 20.64 | 20.62 | 20.50 | 20.46 | | 20.72 | 20.64 | 20.62 | 20.50 | 20.46 | |
| $+I_{cr}/I_{gr}$ | 0.125 | 0.199 | 0.219 | 0.254 | 0.283 | | 0.125 | 0.199 | 0.219 | 0.254 | 0.283 | |
| SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>17″ Deep Rib + 5.0″ Top Slab = 22.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 8.5 | 9.5 | 8.5 | | 8 | 5 | 4 | 7 | 4 | |
| BOTTOM BARS NO | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 2# 7 | | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 2# 7 | |
| BARS NO | 1# 6 | 1# 7 | 1# 7 | 1# 9 | 1# 8 | | 1# 6 | 1# 7 | 1# 7 | 1# 9 | 1# 8 | |
| STEEL (PSF) | 0.77 | 1.25 | 1.49 | 1.85 | 2.04 | | 1.13 | 1.84 | 2.25 | 2.82 | 4.11 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 208 | 645 | 919 | 1207 | 1406 | 4.000 | 546 | 1181 | 1580 | 2000 | 2288 | 2.461 |
| STIR | #3- 55 | #3-117 | #3-137 | #3-153 | #3-161 | | #3- 78 | #3-121 | #3-136 | #4-146 | #4-148 | |
| 33'- 0" | 164 | 574 | 832 | 1103 | 1290 | 4.523 | 482 | 1079 | 1454 | 1848 | 2119 | 2.784 |
| STIR | #3- 51 | #3-117 | #3-138 | #3-136 | #3-163 | | #3- 77 | #3-122 | #3-139 | #4-149 | #4-154 | |
| 34'- 0" | 123 | 510 | 753 | 1008 | 1184 | 5.097 | 423 | 985 | 1339 | 1710 | 1966 | 3.137 |
| STIR | #3- 47 | #3-117 | #3-140 | #3-144 | #3-166 | | #3- 76 | #3-123 | #3-119 | #4-152 | #4-158 | |
| 35'- 0" | 86 | 451 | 680 | 921 | 1087 | 5.724 | 369 | 900 | 1233 | 1584 | 1825 | 3.522 |
| STIR | #3- 43 | #3-117 | #3-141 | #3-152 | #3-169 | | #3- 74 | #3-125 | #3-127 | #3-155 | #4-160 | |
| 36'- 0" | 52 | 397 | 614 | 842 | 998 | 6.407 | 319 | 821 | 1136 | 1467 | 1695 | 3.942 |
| STIR | #3- 38 | #3-117 | #3-142 | #3-160 | #3-171 | | #3- 72 | #3-126 | #3-134 | #3-157 | #4-164 | |
| 37'- 0" | 21 | 347 | 553 | 768 | 916 | 7.149 | 274 | 749 | 1047 | 1361 | 1576 | 4.399 |
| STIR | #3- 33 | #3-116 | #3-143 | #3-162 | #3-153 | | #3- 70 | #3-126 | #3-141 | #3-160 | #4-166 | |
| 38'- 0" | | 301 | 496 | 700 | 841 | 7.953 | 232 | 682 | 965 | 1262 | 1467 | 4.894 |
| STIR | | #3-116 | #3-143 | #3-164 | #3-161 | | #3- 67 | #3-127 | #3-146 | #3-163 | #4-169 | |
| 39'- 0" | | 259 | 444 | 638 | 771 | 8.824 | 193 | 620 | 889 | 1171 | 1365 | 5.430 |
| STIR | | #3-115 | #3-144 | #3-165 | #3-170 | | #3- 65 | #3-128 | #3-148 | #3-165 | #4-172 | |
| 40'- 0" | | 220 | 395 | 580 | 707 | 9.765 | 157 | 563 | 819 | 1087 | 1272 | 6.009 |
| STIR | | #3-113 | #3-144 | #3-167 | #3-178 | | #3- 62 | #3-128 | #3-149 | #3-167 | #3-175 | |
| 41'- 0" | | 183 | 351 | 526 | 647 | 10.778 | 124 | 510 | 753 | 1009 | 1184 | 6.633 |
| STIR | | #3-112 | #3-144 | #3-168 | #3-180 | | #3- 59 | #3-128 | #3-151 | #3-170 | #3-177 | |
| 42'- 0" | | 150 | 309 | 476 | 591 | 11.869 | 93 | 461 | 693 | 936 | 1104 | 7.304 |
| STIR | | #3-110 | #3-144 | #3-169 | #3-182 | | #3- 56 | #3-129 | #3-152 | #3-151 | #3-179 | |
| 43'- 0" | | 118 | 270 | 430 | 540 | 13.040 | 64 | 415 | 636 | 868 | 1028 | 8.025 |
| STIR | | #3-109 | #3-144 | #3-170 | #3-183 | | #3- 52 | #3-129 | #3-153 | #3-158 | #3-182 | |
| 44'- 0" | | 89 | 234 | 386 | 491 | 14.296 | 37 | 372 | 584 | 805 | 958 | 8.798 |
| STIR | | #3-107 | #3-144 | #3-171 | #3-185 | | #3- 48 | #3-128 | #3-154 | #3-165 | #3-185 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.73 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.98 | 1.52 | 1.79 | 2.27 | 2.54 | | 1.23 | 1.96 | 2.45 | 3.08 | 5.39 | |
| ACTUAL STEEL % | 0.450 | 0.699 | 0.823 | 1.049 | 1.172 | | 0.562 | 0.899 | 1.124 | 1.423 | 2.491 | |
| EFF. DEPTH, IN. | 20.38 | 20.31 | 20.31 | 20.25 | 20.25 | | 20.38 | 20.38 | 20.38 | 20.25 | 20.25 | |
| $-I_{cr}/I_{gr}$ | 0.122 | 0.173 | 0.196 | 0.233 | 0.253 | | 0.147 | 0.212 | 0.250 | 0.291 | 0.423 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.75 | 1.20 | 1.48 | 1.79 | 1.99 | | 0.75 | 1.20 | 1.48 | 1.79 | 1.99 | |
| ACTUAL STEEL % | 0.329 | 0.529 | 0.651 | 0.792 | 0.878 | | 0.329 | 0.529 | 0.651 | 0.792 | 0.878 | |
| EFF. DEPTH, IN. | 20.65 | 20.56 | 20.60 | 20.46 | 20.54 | | 20.65 | 20.56 | 20.60 | 20.46 | 20.54 | |
| $+I_{cr}/I_{gr}$ | 0.120 | 0.184 | 0.224 | 0.262 | 0.290 | | 0.120 | 0.184 | 0.224 | 0.262 | 0.290 | |
| SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>17″ Deep Rib + 5.0″ Top Slab = 22.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9.5 | 8 | 9 | 8 | | 7.5 | 7 | 6 | 6.5 | 4 | |
| BOTTOM BARS NO | 1# 4 | 2# 6 | 1# 8 | 2# 7 | 1# 7 | | 1# 4 | 2# 6 | 1# 8 | 2# 7 | 1# 7 | |
| BARS NO | 2# 5 | 1# 6 | 1# 8 | 1# 8 | 2# 8 | | 2# 5 | 1# 6 | 1# 8 | 1# 8 | 2# 8 | |
| STEEL (PSF) | 0.78 | 1.30 | 1.59 | 1.98 | 2.13 | | 1.18 | 1.97 | 2.37 | 3.04 | 4.16 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 251 | 738 | 981 | 1378 | 1558 | 4.000 | 622 | 1329 | 1683 | 2261 | 2522 | 2.461 |
| STIR | #3- 55 | #3-118 | #3-134 | #3-154 | #4-161 | | #3- 79 | #3-122 | #3-135 | #4-147 | #4-149 | |
| 33'- 0" | 203 | 660 | 889 | 1262 | 1431 | 4.523 | 551 | 1216 | 1549 | 2092 | 2338 | 2.784 |
| STIR | #3- 52 | #3-118 | #3-136 | #3-157 | #3-163 | | #3- 77 | #3-123 | #3-138 | #4-151 | #4-155 | |
| 34'- 0" | 158 | 589 | 804 | 1156 | 1316 | 5.097 | 486 | 1113 | 1426 | 1938 | 2170 | 3.137 |
| STIR | #3- 48 | #3-118 | #3-137 | #3-141 | #3-166 | | #3- 76 | #3-124 | #3-123 | #4-153 | #4-158 | |
| 35'- 0" | 118 | 524 | 727 | 1060 | 1210 | 5.724 | 427 | 1018 | 1314 | 1797 | 2016 | 3.522 |
| STIR | #3- 43 | #3-118 | #3-138 | #3-150 | #3-169 | | #3- 74 | #3-126 | #3-130 | #4-156 | #4-160 | |
| 36'- 0" | 80 | 464 | 657 | 971 | 1113 | 6.407 | 373 | 932 | 1211 | 1668 | 1875 | 3.942 |
| STIR | #3- 39 | #3-118 | #3-139 | #3-158 | #3-171 | | #3- 72 | #3-127 | #3-137 | #4-159 | #4-164 | |
| 37'- 0" | 46 | 410 | 592 | 889 | 1023 | 7.149 | 323 | 852 | 1117 | 1549 | 1745 | 4.399 |
| STIR | #3- 34 | #3-117 | #3-139 | #3-164 | #3-153 | | #3- 70 | #3-128 | #3-143 | #4-161 | #4-166 | |
| 38'- 0" | 14 | 359 | 532 | 813 | 941 | 7.953 | 277 | 778 | 1029 | 1439 | 1625 | 4.894 |
| STIR | #3- 29 | #3-117 | #3-140 | #3-165 | #3-161 | | #3- 68 | #3-128 | #3-144 | #3-163 | #4-169 | |
| 39'- 0" | | 312 | 476 | 744 | 865 | 8.824 | 234 | 711 | 949 | 1338 | 1514 | 5.430 |
| STIR | | #3-116 | #3-140 | #3-167 | #3-170 | | #3- 65 | #3-129 | #3-146 | #3-166 | #4-172 | |
| 40'- 0" | | 269 | 425 | 679 | 794 | 9.765 | 195 | 648 | 874 | 1244 | 1411 | 6.009 |
| STIR | | #3-115 | #3-140 | #3-169 | #3-178 | | #3- 62 | #3-129 | #3-147 | #3-168 | #4-175 | |
| 41'- 0" | | 229 | 377 | 619 | 729 | 10.778 | 158 | 589 | 805 | 1157 | 1316 | 6.633 |
| STIR | | #3-113 | #3-140 | #3-170 | #3-180 | | #3- 59 | #3-130 | #3-148 | #3-171 | #3-177 | |
| 42'- 0" | | 192 | 333 | 564 | 668 | 11.869 | 124 | 535 | 740 | 1076 | 1228 | 7.304 |
| STIR | | #3-112 | #3-140 | #3-171 | #3-181 | | #3- 56 | #3-130 | #3-149 | #3-173 | #3-180 | |
| 43'- 0" | | 157 | 292 | 512 | 611 | 13.040 | 93 | 485 | 680 | 1001 | 1145 | 8.025 |
| STIR | | #3-110 | #3-140 | #3-173 | #3-183 | | #3- 52 | #3-130 | #3-150 | #3-155 | #3-182 | |
| 44'- 0" | | 125 | 253 | 463 | 559 | 14.296 | 63 | 437 | 625 | 930 | 1069 | 8.798 |
| STIR | | #3-108 | #3-139 | #3-174 | #3-185 | | #3- 49 | #3-130 | #3-151 | #3-162 | #3-185 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.75 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.00 | 1.63 | 1.94 | 2.44 | 2.75 | | 1.33 | 2.21 | 2.58 | 3.38 | 5.50 | |
| ACTUAL STEEL % | 0.420 | 0.687 | 0.816 | 1.033 | 1.162 | | 0.559 | 0.932 | 1.088 | 1.430 | 2.324 | |
| EFF. DEPTH, IN. | 20.38 | 20.31 | 20.31 | 20.25 | 20.25 | | 20.38 | 20.31 | 20.31 | 20.25 | 20.25 | |
| $-I_{cr}/I_{gr}$ | 0.118 | 0.174 | 0.199 | 0.235 | 0.257 | | 0.149 | 0.220 | 0.247 | 0.298 | 0.414 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.82 | 1.32 | 1.58 | 1.99 | 2.18 | | 0.82 | 1.32 | 1.58 | 1.99 | 2.18 | |
| ACTUAL STEEL % | 0.329 | 0.532 | 0.640 | 0.805 | 0.882 | | 0.329 | 0.532 | 0.640 | 0.805 | 0.882 | |
| EFF. DEPTH, IN. | 20.70 | 20.62 | 20.50 | 20.54 | 20.52 | | 20.70 | 20.62 | 20.50 | 20.54 | 20.52 | |
| $+I_{cr}/I_{gr}$ | 0.122 | 0.188 | 0.219 | 0.270 | 0.292 | | 0.122 | 0.188 | 0.219 | 0.270 | 0.292 | |
| SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 6 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 8 | 9.5 | 8.5 | | 7 | 4 | 6 | 6.5 | 7 | |
| BOTTOM BARS NO | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | |
| BARS NO | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.80 | 1.36 | 1.54 | 1.87 | 2.12 | | 1.25 | 2.14 | 2.33 | 2.97 | 4.23 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 34'- 0" (3) | 257 | 730 | 880 | 1162 | 1355 | 5.097 | 617 | 1305 | 1523 | 1933 | 2214 | 3.137 |
| STIR | #3- 77 | #3-137 | #3-147 | #3-165 | #3-171 | | #3- 96 | #3-123 | #3-146 | #4-156 | #4-157 | |
| 35'- 0" | 212 | 659 | 800 | 1066 | 1248 | 5.724 | 552 | 1201 | 1407 | 1794 | 2059 | 3.522 |
| STIR | #3- 75 | #3-138 | #3-149 | #3-166 | #3-174 | | #3- 96 | #3-130 | #3-148 | #4-160 | #4-161 | |
| 36'- 0" | 171 | 593 | 727 | 978 | 1151 | 6.407 | 492 | 1106 | 1301 | 1666 | 1917 | 3.942 |
| STIR | #3- 72 | #3-139 | #3-150 | #3-149 | #3-177 | | #3- 95 | #3-138 | #3-151 | #4-162 | #4-167 | |
| 37'- 0" | 134 | 533 | 660 | 898 | 1061 | 7.149 | 437 | 1019 | 1203 | 1549 | 1786 | 4.399 |
| STIR | #3- 69 | #3-139 | #3-152 | #3-157 | #3-180 | | #3- 94 | #3-142 | #3-130 | #4-165 | #4-172 | |
| 38'- 0" | 99 | 478 | 598 | 823 | 978 | 7.953 | 387 | 938 | 1113 | 1441 | 1666 | 4.894 |
| STIR | #3- 65 | #3-140 | #3-153 | #3-165 | #3-183 | | #3- 93 | #3-144 | #3-137 | #3-168 | #4-175 | |
| 39'- 0" | 67 | 426 | 540 | 754 | 901 | 8.824 | 340 | 863 | 1029 | 1340 | 1554 | 5.430 |
| STIR | #3- 62 | #3-140 | #3-154 | #3-173 | #3-185 | | #3- 92 | #3-145 | #3-144 | #3-170 | #4-178 | |
| 40'- 0" | 37 | 379 | 487 | 691 | 830 | 9.765 | 297 | 794 | 952 | 1248 | 1451 | 6.009 |
| STIR | #3- 58 | #3-140 | #3-155 | #3-175 | #3-165 | | #3- 90 | #3-147 | #3-152 | #3-173 | #4-181 | |
| 41'- 0" | 9 | 335 | 438 | 632 | 765 | 10.778 | 257 | 730 | 880 | 1162 | 1355 | 6.633 |
| STIR | #3- 53 | #3-140 | #3-155 | #3-177 | #3-173 | | #3- 89 | #3-148 | #3-159 | #3-176 | #4-183 | |
| 42'- 0" | | 294 | 392 | 577 | 703 | 11.869 | 220 | 671 | 814 | 1082 | 1266 | 7.304 |
| STIR | | #3-140 | #3-156 | #3-179 | #3-181 | | #3- 87 | #3-149 | #3-160 | #3-178 | #4-186 | |
| 43'- 0" | | 256 | 350 | 526 | 646 | 13.040 | 185 | 615 | 752 | 1008 | 1184 | 8.025 |
| STIR | | #3-140 | #3-156 | #3-180 | #3-190 | | #3- 85 | #3-150 | #3-162 | #3-180 | #3-189 | |
| 44'- 0" | | 220 | 310 | 478 | 593 | 14.296 | 153 | 564 | 694 | 938 | 1106 | 8.798 |
| STIR | | #3-139 | #3-157 | #3-182 | #3-194 | | #3- 82 | #3-151 | #3-163 | #3-183 | #3-191 | |
| 45'- 0" | | 187 | 273 | 433 | 544 | 15.641 | 122 | 515 | 640 | 874 | 1034 | 9.625 |
| STIR | | #3-138 | #3-157 | #3-183 | #3-196 | | #3- 80 | #3-152 | #3-165 | #3-184 | #3-194 | |
| 46'- 0" | | 156 | 238 | 392 | 497 | 17.078 | 94 | 470 | 589 | 813 | 967 | 10.510 |
| STIR | | #3-137 | #3-157 | #3-184 | #3-198 | | #3- 78 | #3-152 | #3-166 | #3-167 | #3-197 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.96 | 1.65 | 1.86 | 2.22 | 2.48 | | 1.37 | 2.40 | 2.48 | 3.25 | 5.42 | |
| ACTUAL STEEL % | 0.435 | 0.752 | 0.846 | 1.014 | 1.133 | | 0.621 | 1.087 | 1.127 | 1.482 | 2.487 | |
| EFF. DEPTH, IN. | 22.38 | 22.31 | 22.31 | 22.25 | 22.25 | | 22.38 | 22.38 | 22.31 | 22.25 | 22.12 | |
| $-I_{cr}/I_{gr}$ | 0.121 | 0.186 | 0.204 | 0.232 | 0.252 | | 0.162 | 0.249 | 0.253 | 0.305 | 0.422 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | |
| EFF. DEPTH, IN. | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | |
| $+I_{cr}/I_{gr}$ | 0.133 | 0.205 | 0.227 | 0.267 | 0.294 | | 0.133 | 0.205 | 0.227 | 0.267 | 0.294 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 6 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 9.5 | 9 | 7.5 | 6 | 8 | | 7 | 4 | 7.5 | 8.5 | 5 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | |
| BARS NO | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | |
| STEEL (PSF) | 0.90 | 1.41 | 1.62 | 2.03 | 2.16 | | 1.33 | 2.19 | 2.56 | 3.14 | 4.42 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 34'- 0" (3) | 281 | 760 | 999 | 1324 | 1500 | 5.097 | 666 | 1363 | 1710 | 2183 | 2438 | 3.137 |
| STIR | #3- 72 | #3-132 | #3-148 | #3-165 | #4-171 | | #3- 93 | #3-129 | #3-147 | #4-157 | #4-157 | |
| 35'- 0" | 233 | 685 | 911 | 1218 | 1383 | 5.724 | 596 | 1254 | 1582 | 2028 | 2269 | 3.522 |
| STIR | #3- 69 | #3-132 | #3-149 | #3-167 | #3-174 | | #3- 92 | #3-135 | #3-150 | #4-160 | #4-162 | |
| 36'- 0" | 189 | 617 | 830 | 1120 | 1276 | 6.407 | 533 | 1155 | 1465 | 1886 | 2114 | 3.942 |
| STIR | #3- 66 | #3-133 | #3-151 | #3-147 | #3-177 | | #3- 91 | #3-137 | #3-151 | #4-163 | #4-167 | |
| 37'- 0" | 149 | 554 | 756 | 1030 | 1178 | 7.149 | 474 | 1063 | 1356 | 1756 | 1971 | 4.399 |
| STIR | #3- 63 | #3-133 | #3-152 | #3-156 | #3-180 | | #3- 90 | #3-138 | #3-154 | #4-166 | #4-171 | |
| 38'- 0" | 112 | 496 | 687 | 947 | 1088 | 7.953 | 420 | 978 | 1256 | 1635 | 1839 | 4.894 |
| STIR | #3- 59 | #3-133 | #3-153 | #3-164 | #3-182 | | #3- 89 | #3-139 | #3-136 | #4-168 | #4-174 | |
| 39'- 0" | 78 | 442 | 624 | 871 | 1004 | 8.824 | 370 | 900 | 1164 | 1524 | 1717 | 5.430 |
| STIR | #3- 55 | #3-133 | #3-154 | #3-173 | #3-185 | | #3- 87 | #3-141 | #3-143 | #4-171 | #4-177 | |
| 40'- 0" | 46 | 392 | 565 | 800 | 926 | 9.765 | 324 | 828 | 1079 | 1420 | 1605 | 6.009 |
| STIR | #3- 51 | #3-133 | #3-155 | #3-176 | #3-166 | | #3- 86 | #3-142 | #3-151 | #4-174 | #4-180 | |
| 41'- 0" | 16 | 346 | 510 | 734 | 855 | 10.778 | 281 | 761 | 1000 | 1325 | 1500 | 6.633 |
| STIR | #3- 46 | #3-133 | #3-156 | #3-178 | #3-174 | | #3- 84 | #3-143 | #3-158 | #3-177 | #4-183 | |
| 42'- 0" | | 303 | 460 | 673 | 788 | 11.869 | 241 | 698 | 926 | 1236 | 1403 | 7.304 |
| STIR | | #3-132 | #3-156 | #3-180 | #3-183 | | #3- 82 | #3-144 | #3-161 | #3-179 | #4-186 | |
| 43'- 0" | | 263 | 413 | 616 | 725 | 13.040 | 204 | 640 | 857 | 1153 | 1312 | 8.025 |
| STIR | | #3-131 | #3-157 | #3-181 | #3-191 | | #3- 79 | #3-144 | #3-162 | #3-182 | #4-189 | |
| 44'- 0" | | 226 | 369 | 563 | 667 | 14.296 | 170 | 586 | 793 | 1076 | 1228 | 8.798 |
| STIR | | #3-131 | #3-157 | #3-182 | #3-193 | | #3- 77 | #3-145 | #3-164 | #3-183 | #4-191 | |
| 45'- 0" | | 191 | 328 | 513 | 613 | 15.641 | 137 | 535 | 734 | 1004 | 1149 | 9.625 |
| STIR | | #3-129 | #3-157 | #3-184 | #3-195 | | #3- 74 | #3-145 | #3-165 | #3-186 | #3-193 | |
| 46'- 0" | | 159 | 289 | 467 | 563 | 17.078 | 107 | 488 | 678 | 936 | 1075 | 10.510 |
| STIR | | #3-128 | #3-157 | #3-185 | #3-197 | | #3- 71 | #3-146 | #3-167 | #3-188 | #3-195 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.03 | 1.69 | 2.03 | 2.53 | 2.69 | | 1.40 | 2.45 | 2.87 | 3.46 | 5.88 | |
| ACTUAL STEEL % | 0.424 | 0.697 | 0.836 | 1.045 | 1.116 | | 0.576 | 1.008 | 1.190 | 1.437 | 2.443 | |
| EFF. DEPTH, IN. | 22.38 | 22.31 | 22.31 | 22.31 | 22.25 | | 22.38 | 22.38 | 22.25 | 22.19 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.121 | 0.179 | 0.207 | 0.244 | 0.254 | | 0.156 | 0.240 | 0.267 | 0.302 | 0.431 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | |
| ACTUAL STEEL % | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | |
| EFF. DEPTH, IN. | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | |
| $+I_{cr}/I_{gr}$ | 0.131 | 0.197 | 0.230 | 0.273 | 0.296 | | 0.131 | 0.197 | 0.230 | 0.273 | 0.296 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 9 | 8.5 | 7 | 6 | 7.5 | | 10 | 9 | 10 | 8.5 | 6 | |
| BOTTOM BARS NO | 2# 5 | 2# 6 | 2# 6 | 2# 6 | 2# 8 | | 2# 5 | 2# 6 | 2# 6 | 2# 6 | 2# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 2# 7 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 2# 7 | 1# 8 | |
| STEEL (PSF) | 0.89 | 1.47 | 1.80 | 2.08 | 2.32 | | 1.38 | 2.23 | 2.73 | 3.19 | 4.05 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 34'- 0" (3) | 301 | 819 | 1085 | 1383 | 1645 | 5.097 | 708 | 1463 | 1850 | 2282 | 2663 | 3.137 |
| STIR | #3- 67 | #3-129 | #3-146 | #3-161 | #4-171 | | #3- 90 | #3-131 | #3-145 | #4-155 | #5-161 | |
| 35'- 0" | 250 | 740 | 991 | 1271 | 1518 | 5.724 | 635 | 1347 | 1712 | 2120 | 2480 | 3.522 |
| STIR | #3- 64 | #3-130 | #3-148 | #3-145 | #4-174 | | #3- 89 | #3-134 | #3-148 | #4-158 | #4-164 | |
| 36'- 0" | 204 | 666 | 904 | 1169 | 1403 | 6.407 | 567 | 1240 | 1585 | 1972 | 2311 | 3.942 |
| STIR | #3- 61 | #3-130 | #3-149 | #3-154 | #3-176 | | #3- 88 | #3-135 | #3-151 | #4-160 | #4-167 | |
| 37'- 0" | 161 | 599 | 824 | 1075 | 1296 | 7.149 | 505 | 1142 | 1469 | 1835 | 2156 | 4.399 |
| STIR | #3- 57 | #3-130 | #3-150 | #3-162 | #3-179 | | #3- 86 | #3-137 | #3-131 | #4-163 | #4-170 | |
| 38'- 0" | 122 | 537 | 750 | 988 | 1198 | 7.953 | 448 | 1052 | 1362 | 1708 | 2013 | 4.894 |
| STIR | #3- 53 | #3-130 | #3-151 | #3-168 | #3-182 | | #3- 85 | #3-138 | #3-138 | #4-166 | #4-174 | |
| 39'- 0" | 85 | 480 | 682 | 908 | 1107 | 8.824 | 395 | 969 | 1263 | 1592 | 1881 | 5.430 |
| STIR | #3- 49 | #3-130 | #3-152 | #3-170 | #3-184 | | #3- 83 | #3-139 | #3-145 | #4-168 | #4-177 | |
| 40'- 0" | 52 | 426 | 619 | 834 | 1023 | 9.765 | 346 | 891 | 1171 | 1484 | 1759 | 6.009 |
| STIR | #3- 44 | #3-130 | #3-153 | #3-172 | #3-167 | | #3- 81 | #3-140 | #3-153 | #3-171 | #4-180 | |
| 41'- 0" | 20 | 377 | 560 | 765 | 945 | 10.778 | 301 | 820 | 1086 | 1383 | 1645 | 6.633 |
| STIR | #3- 39 | #3-129 | #3-154 | #3-173 | #3-175 | | #3- 79 | #3-141 | #3-158 | #3-173 | #4-182 | |
| 42'- 0" | | 331 | 506 | 701 | 872 | 11.869 | 259 | 753 | 1007 | 1290 | 1540 | 7.304 |
| STIR | | #3-129 | #3-154 | #3-175 | #3-184 | | #3- 77 | #3-142 | #3-160 | #3-176 | #4-185 | |
| 43'- 0" | | 289 | 455 | 641 | 805 | 13.040 | 219 | 691 | 933 | 1204 | 1442 | 8.025 |
| STIR | | #3-128 | #3-155 | #3-176 | #3-191 | | #3- 74 | #3-142 | #3-161 | #3-178 | #4-187 | |
| 44'- 0" | | 249 | 408 | 585 | 742 | 14.296 | 183 | 633 | 864 | 1123 | 1350 | 8.798 |
| STIR | | #3-127 | #3-155 | #3-177 | #3-192 | | #3- 72 | #3-143 | #3-163 | #3-157 | #4-191 | |
| 45'- 0" | | 212 | 364 | 533 | 683 | 15.641 | 148 | 579 | 800 | 1047 | 1264 | 9.625 |
| STIR | | #3-125 | #3-155 | #3-178 | #3-194 | | #3- 69 | #3-143 | #3-164 | #3-164 | #4-193 | |
| 46'- 0" | | 177 | 322 | 485 | 628 | 17.078 | 116 | 529 | 740 | 976 | 1184 | 10.510 |
| STIR | | #3-124 | #3-155 | #3-179 | #3-196 | | #3- 66 | #3-144 | #3-165 | #3-171 | #3-195 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.79 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.11 | 1.82 | 2.21 | 2.58 | 2.93 | | 1.55 | 2.44 | 3.00 | 3.53 | 5.00 | |
| ACTUAL STEEL % | 0.419 | 0.689 | 0.837 | 0.976 | 1.112 | | 0.586 | 0.927 | 1.141 | 1.342 | 1.902 | |
| EFF. DEPTH, IN. | 22.38 | 22.31 | 22.31 | 22.31 | 22.25 | | 22.31 | 22.25 | 22.19 | 22.19 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.122 | 0.181 | 0.211 | 0.237 | 0.259 | | 0.159 | 0.226 | 0.262 | 0.294 | 0.374 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.48 | 1.76 | 2.08 | 2.37 | | 0.93 | 1.48 | 1.76 | 2.08 | 2.37 | |
| ACTUAL STEEL % | 0.336 | 0.537 | 0.638 | 0.755 | 0.863 | | 0.336 | 0.537 | 0.638 | 0.755 | 0.863 | |
| EFF. DEPTH, IN. | 22.69 | 22.60 | 22.62 | 22.59 | 22.50 | | 22.69 | 22.60 | 22.62 | 22.59 | 22.50 | |
| $+I_{cr}/I_{gr}$ | 0.129 | 0.196 | 0.230 | 0.266 | 0.297 | | 0.129 | 0.196 | 0.230 | 0.266 | 0.297 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n$/18.5 for end spans, $\ell_n$/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>21″ Deep Rib + 5.0″ Top Slab = 26.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 6 | # 7 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 9 | 9 | 7.5 | 6 | 7.5 | | 7 | 4 | 7.5 | 8 | 6 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 6 | 1# 9 | 1# 9 | | 1# 6 | 1# 7 | 1# 6 | 1# 9 | 1# 9 | |
| BARS NO | 1# 6 | 1# 8 | 2# 7 | 1# 9 | 1#10 | | 1# 6 | 1# 8 | 2# 7 | 1# 9 | 1#10 | |
| STEEL (PSF) | 0.92 | 1.43 | 1.64 | 2.11 | 2.38 | | 1.34 | 2.21 | 2.58 | 3.33 | 4.86 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 215 | 656 | 876 | 1177 | 1405 | 7.149 | 569 | 1211 | 1530 | 1968 | 2299 | 4.399 |
| STIR | #3- 78 | #3-143 | #3-160 | #3-179 | #4-188 | | #3-100 | #3-141 | #3-159 | #4-170 | #4-169 | |
| 38'- 0" | 174 | 593 | 801 | 1086 | 1302 | 7.953 | 510 | 1119 | 1422 | 1837 | 2150 | 4.894 |
| STIR | #3- 75 | #3-143 | #3-162 | #3-181 | #4-192 | | #3- 99 | #3-146 | #3-162 | #4-174 | #4-174 | |
| 39'- 0" | 137 | 534 | 732 | 1003 | 1208 | 8.824 | 455 | 1033 | 1321 | 1715 | 2013 | 5.430 |
| STIR | #3- 72 | #3-144 | #3-163 | #3-159 | #3-194 | | #3- 99 | #3-148 | #3-163 | #4-176 | #4-179 | |
| 40'- 0" | 102 | 480 | 668 | 926 | 1120 | 9.765 | 405 | 955 | 1228 | 1603 | 1886 | 6.009 |
| STIR | #3- 68 | #3-144 | #3-164 | #3-168 | #3-197 | | #3- 97 | #3-149 | #3-166 | #4-180 | #4-185 | |
| 41'- 0" | 70 | 430 | 609 | 854 | 1039 | 10.778 | 358 | 881 | 1142 | 1498 | 1768 | 6.633 |
| STIR | #3- 65 | #3-144 | #3-166 | #3-176 | #3-199 | | #3- 96 | #3-151 | #3-146 | #4-183 | #4-190 | |
| 42'- 0" | 40 | 383 | 554 | 787 | 964 | 11.869 | 315 | 813 | 1061 | 1401 | 1658 | 7.304 |
| STIR | #3- 61 | #3-144 | #3-167 | #3-185 | #3-202 | | #3- 95 | #3-152 | #3-153 | #4-185 | #4-194 | |
| 43'- 0" | 13 | 340 | 502 | 725 | 894 | 13.040 | 275 | 750 | 987 | 1311 | 1556 | 8.025 |
| STIR | #3- 56 | #3-144 | #3-168 | #3-190 | #3-205 | | #3- 93 | #3-153 | #3-161 | #3-188 | #4-196 | |
| 44'- 0" | | 299 | 454 | 667 | 828 | 14.296 | 237 | 691 | 917 | 1227 | 1461 | 8.798 |
| STIR | | #3-144 | #3-168 | #3-192 | #3-208 | | #3- 91 | #3-154 | #3-168 | #3-190 | #4-199 | |
| 45'- 0" | | 261 | 410 | 613 | 767 | 15.641 | 202 | 636 | 852 | 1148 | 1372 | 9.625 |
| STIR | | #3-143 | #3-169 | #3-194 | #3-187 | | #3- 89 | #3-155 | #3-173 | #3-192 | #4-202 | |
| 46'- 0" | | 226 | 368 | 562 | 710 | 17.078 | 169 | 584 | 791 | 1074 | 1288 | 10.510 |
| STIR | | #3-143 | #3-170 | #3-195 | #3-195 | | #3- 87 | #3-156 | #3-175 | #3-195 | #4-205 | |
| 47'- 0" | | 192 | 329 | 515 | 656 | 18.613 | 138 | 536 | 734 | 1005 | 1211 | 11.454 |
| STIR | | #3-142 | #3-170 | #3-197 | #3-204 | | #3- 85 | #3-157 | #3-177 | #3-197 | #4-208 | |
| 48'- 0" | | 161 | 292 | 471 | 606 | 20.248 | 109 | 491 | 681 | 941 | 1137 | 12.460 |
| STIR | | #3-141 | #3-170 | #3-198 | #3-213 | | #3- 82 | #3-157 | #3-178 | #3-199 | #4-211 | |
| 49'- 0" | | 132 | 257 | 429 | 559 | 21.989 | 82 | 448 | 630 | 880 | 1069 | 13.532 |
| STIR | | #3-140 | #3-170 | #3-199 | #3-216 | | #3- 80 | #3-158 | #3-179 | #3-202 | #4-213 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.78 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.07 | 1.65 | 1.98 | 2.48 | 2.82 | | 1.37 | 2.40 | 2.82 | 3.60 | 6.32 | |
| ACTUAL STEEL % | 0.436 | 0.678 | 0.814 | 1.017 | 1.159 | | 0.561 | 0.982 | 1.159 | 1.486 | 2.617 | |
| EFF. DEPTH, IN. | 24.38 | 24.31 | 24.31 | 24.31 | 24.25 | | 24.38 | 24.38 | 24.25 | 24.19 | 24.12 | |
| $-I_{cr}/I_{gr}$ | 0.126 | 0.178 | 0.206 | 0.243 | 0.265 | | 0.155 | 0.239 | 0.265 | 0.314 | 0.453 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.64 | 2.00 | 2.27 | | 0.88 | 1.39 | 1.64 | 2.00 | 2.27 | |
| ACTUAL STEEL % | 0.345 | 0.546 | 0.644 | 0.788 | 0.896 | | 0.345 | 0.546 | 0.644 | 0.788 | 0.896 | |
| EFF. DEPTH, IN. | 24.62 | 24.53 | 24.58 | 24.44 | 24.40 | | 24.62 | 24.53 | 24.58 | 24.44 | 24.40 | |
| $+I_{cr}/I_{gr}$ | 0.133 | 0.202 | 0.235 | 0.278 | 0.310 | | 0.133 | 0.202 | 0.235 | 0.278 | 0.310 | |
| SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n$/18.5 for end spans, $\ell_n$/21 for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>21″ Deep Rib + 5.0″ Top Slab = 26.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 8 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 9 | 8.5 | 7 | 8 | 10 | | 10 | 9 | 10 | 10 | 6 | |
| BOTTOM BARS NO | 2# 5 | 2# 6 | 1# 8 | 1# 7 | 2# 8 | | 2# 5 | 2# 6 | 1# 8 | 1# 7 | 2# 8 | |
| BARS NO | 1# 5 | 1# 7 | 1# 9 | 2# 8 | 1# 8 | | 1# 5 | 1# 7 | 1# 9 | 2# 8 | 1# 8 | |
| STEEL (PSF) | 0.91 | 1.49 | 1.81 | 2.16 | 2.37 | | 1.39 | 2.25 | 2.75 | 3.40 | 4.84 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 228 | 705 | 966 | 1305 | 1466 | 7.149 | 603 | 1297 | 1676 | 2169 | 2404 | 4.399 |
| STIR | #3- 71 | #3-139 | #3-159 | #3-178 | #4-185 | | #3- 96 | #3-143 | #3-158 | #4-171 | #5-170 | |
| 38'- 0" | 185 | 638 | 885 | 1206 | 1359 | 7.953 | 540 | 1199 | 1558 | 2026 | 2248 | 4.894 |
| STIR | #3- 68 | #3-140 | #3-160 | #3-181 | #4-188 | | #3- 95 | #3-144 | #3-161 | #4-173 | #4-176 | |
| 39'- 0" | 145 | 575 | 810 | 1115 | 1260 | 8.824 | 483 | 1108 | 1449 | 1893 | 2104 | 5.430 |
| STIR | #3- 64 | #3-140 | #3-162 | #3-160 | #3-190 | | #3- 94 | #3-146 | #3-163 | #4-177 | #4-181 | |
| 40'- 0" | 109 | 517 | 740 | 1030 | 1168 | 9.765 | 429 | 1024 | 1348 | 1770 | 1971 | 6.009 |
| STIR | #3- 60 | #3-140 | #3-163 | #3-168 | #3-193 | | #3- 92 | #3-147 | #3-141 | #4-179 | #4-184 | |
| 41'- 0" | 75 | 464 | 676 | 952 | 1083 | 10.778 | 380 | 946 | 1254 | 1656 | 1847 | 6.633 |
| STIR | #3- 56 | #3-140 | #3-164 | #3-177 | #3-195 | | #3- 91 | #3-148 | #3-148 | #4-182 | #4-187 | |
| 42'- 0" | 43 | 414 | 616 | 879 | 1004 | 11.869 | 334 | 873 | 1167 | 1550 | 1732 | 7.304 |
| STIR | #3- 52 | #3-140 | #3-165 | #3-185 | #3-198 | | #3- 89 | #3-150 | #3-155 | #4-185 | #4-190 | |
| 43'- 0" | 14 | 367 | 560 | 811 | 931 | 13.040 | 291 | 806 | 1086 | 1451 | 1625 | 8.025 |
| STIR | #3- 47 | #3-140 | #3-166 | #3-190 | #3-179 | | #3- 87 | #3-151 | #3-162 | #4-187 | #4-193 | |
| 44'- 0" | | 324 | 508 | 748 | 862 | 14.296 | 251 | 743 | 1010 | 1359 | 1525 | 8.798 |
| STIR | | #3-139 | #3-167 | #3-192 | #3-187 | | #3- 85 | #3-152 | #3-170 | #4-189 | #4-195 | |
| 45'- 0" | | 284 | 460 | 689 | 798 | 15.641 | 214 | 684 | 940 | 1273 | 1432 | 9.625 |
| STIR | | #3-138 | #3-167 | #3-193 | #3-196 | | #3- 83 | #3-152 | #3-172 | #3-193 | #4-198 | |
| 46'- 0" | | 246 | 414 | 634 | 738 | 17.078 | 179 | 629 | 874 | 1193 | 1345 | 10.510 |
| STIR | | #3-137 | #3-168 | #3-195 | #3-204 | | #3- 81 | #3-153 | #3-174 | #3-194 | #4-201 | |
| 47'- 0" | | 210 | 372 | 582 | 682 | 18.613 | 146 | 577 | 812 | 1117 | 1263 | 11.454 |
| STIR | | #3-136 | #3-168 | #3-196 | #3-207 | | #3- 78 | #3-154 | #3-175 | #3-197 | #4-203 | |
| 48'- 0" | | 177 | 332 | 533 | 629 | 20.248 | 116 | 529 | 754 | 1047 | 1186 | 12.460 |
| STIR | | #3-135 | #3-168 | #3-198 | #3-209 | | #3- 75 | #3-154 | #3-177 | #3-200 | #4-207 | |
| 49'- 0" | | 146 | 294 | 487 | 579 | 21.989 | 87 | 483 | 699 | 980 | 1114 | 13.532 |
| STIR | | #3-134 | #3-168 | #3-199 | #3-210 | | #3- 72 | #3-154 | #3-178 | #3-202 | #4-209 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.81 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.09 | 1.79 | 2.17 | 2.69 | 2.94 | | 1.52 | 2.40 | 2.94 | 3.87 | 6.45 | |
| ACTUAL STEEL % | 0.405 | 0.667 | 0.809 | 1.008 | 1.103 | | 0.567 | 0.896 | 1.103 | 1.457 | 2.429 | |
| EFF. DEPTH, IN. | 24.38 | 24.31 | 24.31 | 24.25 | 24.19 | | 24.31 | 24.25 | 24.19 | 24.12 | 24.12 | |
| $-I_{cr}/I_{gr}$ | 0.121 | 0.180 | 0.209 | 0.245 | 0.260 | | 0.158 | 0.224 | 0.260 | 0.314 | 0.442 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.93 | 1.48 | 1.79 | 2.18 | 2.37 | | 0.93 | 1.48 | 1.79 | 2.18 | 2.37 | |
| ACTUAL STEEL % | 0.332 | 0.529 | 0.643 | 0.782 | 0.850 | | 0.332 | 0.529 | 0.643 | 0.782 | 0.850 | |
| EFF. DEPTH, IN. | 24.69 | 24.60 | 24.46 | 24.52 | 24.50 | | 24.69 | 24.60 | 24.46 | 24.52 | 24.50 | |
| $+I_{cr}/I_{gr}$ | 0.131 | 0.199 | 0.234 | 0.280 | 0.301 | | 0.131 | 0.199 | 0.234 | 0.280 | 0.301 | |
| SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>21″ Deep Rib + 5.0″ Top Slab = 26.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 6 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 8 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 8 | 8 | 9 | 8 | 9 | | 9.5 | 8 | 9 | 10 | 7.5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 7 | 1# 9 | 2# 8 | | 2# 4 | 1# 6 | 2# 7 | 1# 9 | 2# 8 | |
| BARS NO | 2# 5 | 2# 7 | 1# 8 | 1#10 | 1# 9 | | 2# 5 | 2# 7 | 1# 8 | 1#10 | 1# 9 | |
| STEEL (PSF) | 1.00 | 1.57 | 1.98 | 2.27 | 2.59 | | 1.49 | 2.45 | 3.01 | 3.51 | 4.34 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 275 | 810 | 1110 | 1340 | 1611 | 7.149 | 686 | 1465 | 1901 | 2235 | 2629 | 4.399 |
| STIR | #3- 72 | #3-141 | #3-161 | #3-152 | #4-184 | | #3- 97 | #3-143 | #4-160 | #4-167 | #5-175 | |
| 38'- 0" | 228 | 736 | 1020 | 1237 | 1494 | 7.953 | 618 | 1356 | 1770 | 2086 | 2460 | 4.894 |
| STIR | #3- 69 | #3-141 | #3-163 | #3-160 | #4-187 | | #3- 96 | #3-146 | #4-162 | #4-171 | #5-178 | |
| 39'- 0" | 184 | 667 | 936 | 1143 | 1387 | 8.824 | 555 | 1256 | 1648 | 1949 | 2304 | 5.430 |
| STIR | #3- 65 | #3-142 | #3-164 | #3-168 | #4-190 | | #3- 95 | #3-147 | #3-165 | #4-173 | #5-181 | |
| 40'- 0" | 144 | 603 | 859 | 1055 | 1287 | 9.765 | 496 | 1163 | 1536 | 1821 | 2159 | 6.009 |
| STIR | #3- 62 | #3-142 | #3-166 | #3-177 | #3-192 | | #3- 93 | #3-149 | #3-167 | #4-175 | #4-184 | |
| 41'- 0" | 107 | 543 | 787 | 974 | 1195 | 10.778 | 442 | 1076 | 1432 | 1703 | 2024 | 6.633 |
| STIR | #3- 58 | #3-142 | #3-167 | #3-181 | #3-195 | | #3- 92 | #3-150 | #3-145 | #4-178 | #4-187 | |
| 42'- 0" | 72 | 488 | 721 | 899 | 1109 | 11.869 | 391 | 996 | 1335 | 1593 | 1900 | 7.304 |
| STIR | #3- 53 | #3-142 | #3-168 | #3-182 | #3-198 | | #3- 90 | #3-151 | #3-152 | #4-181 | #4-190 | |
| 43'- 0" | 40 | 437 | 659 | 828 | 1029 | 13.040 | 344 | 921 | 1244 | 1491 | 1783 | 8.025 |
| STIR | #3- 49 | #3-142 | #3-169 | #3-184 | #3-179 | | #3- 88 | #3-152 | #3-159 | #4-183 | #4-192 | |
| 44'- 0" | 10 | 389 | 601 | 763 | 955 | 14.296 | 301 | 852 | 1160 | 1396 | 1675 | 8.798 |
| STIR | #3- 44 | #3-141 | #3-170 | #3-186 | #3-188 | | #3- 86 | #3-153 | #3-166 | #3-186 | #4-195 | |
| 45'- 0" | | 344 | 547 | 702 | 885 | 15.641 | 260 | 786 | 1081 | 1307 | 1574 | 9.625 |
| STIR | | #3-141 | #3-171 | #3-187 | #3-196 | | #3- 84 | #3-154 | #3-174 | #3-188 | #4-198 | |
| 46'- 0" | | 302 | 496 | 644 | 820 | 17.078 | 222 | 726 | 1008 | 1224 | 1479 | 10.510 |
| STIR | | #3-140 | #3-171 | #3-188 | #3-204 | | #3- 82 | #3-155 | #3-176 | #3-190 | #4-201 | |
| 47'- 0" | | 263 | 449 | 591 | 759 | 18.613 | 186 | 668 | 939 | 1145 | 1390 | 11.454 |
| STIR | | #3-139 | #3-172 | #3-189 | #3-206 | | #3- 79 | #3-155 | #3-178 | #3-167 | #4-203 | |
| 48'- 0" | | 226 | 404 | 540 | 702 | 20.248 | 152 | 615 | 874 | 1072 | 1307 | 12.460 |
| STIR | | #3-138 | #3-172 | #3-191 | #3-208 | | #3- 76 | #3-156 | #3-179 | #3-174 | #4-206 | |
| 49'- 0" | | 191 | 362 | 493 | 648 | 21.989 | 120 | 565 | 813 | 1004 | 1228 | 13.532 |
| STIR | | #3-137 | #3-172 | #3-191 | #3-210 | | #3- 73 | #3-156 | #3-180 | #3-182 | #4-209 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.84 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.25 | 1.94 | 2.44 | 2.75 | 3.33 | | 1.63 | 2.75 | 3.33 | 3.95 | 5.27 | |
| ACTUAL STEEL % | 0.426 | 0.663 | 0.839 | 0.943 | 1.147 | | 0.558 | 0.943 | 1.147 | 1.363 | 1.818 | |
| EFF. DEPTH, IN. | 24.38 | 24.31 | 24.25 | 24.25 | 24.19 | | 24.31 | 24.25 | 24.19 | 24.12 | 24.12 | |
| $-I_{cr}/I_{gr}$ | 0.129 | 0.182 | 0.217 | 0.238 | 0.273 | | 0.159 | 0.238 | 0.273 | 0.306 | 0.374 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 1.02 | 1.64 | 1.99 | 2.27 | 2.58 | | 1.02 | 1.64 | 1.99 | 2.27 | 2.58 | |
| ACTUAL STEEL % | 0.334 | 0.539 | 0.656 | 0.751 | 0.852 | | 0.334 | 0.539 | 0.656 | 0.751 | 0.852 | |
| EFF. DEPTH, IN. | 24.71 | 24.58 | 24.54 | 24.40 | 24.48 | | 24.71 | 24.58 | 24.54 | 24.40 | 24.48 | |
| $+I_{cr}/I_{gr}$ | 0.133 | 0.204 | 0.242 | 0.268 | 0.303 | | 0.133 | 0.204 | 0.242 | 0.268 | 0.303 | |
| SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 6 | # 6 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 8.5 | 5 | 4 | 7.5 | 9 | | 10 | 8 | 7 | 4.5 | 5 | |
| BOTTOM BARS NO | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | |
| BARS NO | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | |
| STEEL (PSF) | 0.93 | 1.65 | 1.91 | 2.38 | 2.70 | | 1.40 | 2.52 | 2.85 | 4.06 | 5.73 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 299 | 904 | 1099 | 1539 | 1785 | 7.149 | 704 | 1585 | 1867 | 2509 | 2867 | 4.399 |
| STIR | #3- 85 | #3-154 | #3-163 | #4-187 | #4-194 | | #3-105 | #3-155 | #4-164 | #5-176 | #5-169 | |
| 38'- 0" | 252 | 827 | 1011 | 1429 | 1662 | 7.953 | 637 | 1472 | 1740 | 2347 | 2687 | 4.894 |
| STIR | #3- 82 | #3-155 | #3-168 | #4-190 | #4-198 | | #3-105 | #3-133 | #4-166 | #4-180 | #5-173 | |
| 39'- 0" | 210 | 755 | 929 | 1326 | 1548 | 8.824 | 574 | 1367 | 1622 | 2199 | 2521 | 5.430 |
| STIR | #3- 80 | #3-157 | #3-170 | #3-193 | #4-201 | | #3-104 | #3-140 | #3-168 | #4-183 | #5-176 | |
| 40'- 0" | 170 | 688 | 854 | 1231 | 1442 | 9.765 | 517 | 1270 | 1512 | 2061 | 2367 | 6.009 |
| STIR | #3- 77 | #3-158 | #3-171 | #3-195 | #4-204 | | #3-104 | #3-147 | #3-170 | #4-186 | #5-178 | |
| 41'- 0" | 133 | 626 | 785 | 1144 | 1344 | 10.778 | 463 | 1181 | 1411 | 1933 | 2224 | 6.633 |
| STIR | #3- 73 | #3-159 | #3-173 | #3-199 | #4-208 | | #3-103 | #3-154 | #3-173 | #4-189 | #5-184 | |
| 42'- 0" | 99 | 569 | 720 | 1062 | 1253 | 11.869 | 414 | 1097 | 1316 | 1814 | 2092 | 7.304 |
| STIR | #3- 70 | #3-159 | #3-174 | #3-201 | #4-211 | | #3-102 | #3-162 | #3-176 | #4-192 | #5-191 | |
| 43'- 0" | 67 | 516 | 659 | 986 | 1168 | 13.040 | 367 | 1020 | 1229 | 1703 | 1968 | 8.025 |
| STIR | #3- 66 | #3-160 | #3-176 | #3-203 | #4-213 | | #3-100 | #3-165 | #3-150 | #4-195 | #4-197 | |
| 44'- 0" | 37 | 466 | 603 | 915 | 1089 | 14.296 | 324 | 947 | 1147 | 1600 | 1853 | 8.798 |
| STIR | #3- 62 | #3-160 | #3-177 | #3-182 | #3-216 | | #3- 99 | #3-166 | #3-157 | #4-198 | #4-203 | |
| 45'- 0" | 10 | 419 | 551 | 849 | 1015 | 15.641 | 284 | 879 | 1070 | 1504 | 1746 | 9.625 |
| STIR | #3- 58 | #3-160 | #3-178 | #3-190 | #3-219 | | #3- 97 | #3-168 | #3-165 | #4-201 | #4-209 | |
| 46'- 0" | | 376 | 501 | 787 | 946 | 17.078 | 246 | 816 | 999 | 1414 | 1645 | 10.510 |
| STIR | | #3-161 | #3-179 | #3-198 | #3-221 | | #3- 95 | #3-169 | #3-172 | #4-204 | #4-212 | |
| 47'- 0" | | 335 | 455 | 728 | 881 | 18.613 | 211 | 757 | 932 | 1329 | 1551 | 11.454 |
| STIR | | #3-161 | #3-179 | #3-207 | #3-224 | | #3- 93 | #3-170 | #3-180 | #4-206 | #4-214 | |
| 48'- 0" | | 297 | 412 | 674 | 820 | 20.248 | 178 | 701 | 869 | 1250 | 1463 | 12.460 |
| STIR | | #3-160 | #3-180 | #3-212 | #3-227 | | #3- 91 | #3-172 | #3-185 | #4-209 | #4-218 | |
| 49'- 0" | | 261 | 371 | 623 | 763 | 21.989 | 146 | 649 | 810 | 1175 | 1380 | 13.532 |
| STIR | | #3-160 | #3-181 | #3-214 | #3-229 | | #3- 89 | #3-173 | #3-187 | #4-211 | #4-220 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.82 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.13 | 1.92 | 2.40 | 2.82 | 3.20 | | 1.49 | 2.64 | 3.02 | 4.69 | 7.58 | |
| ACTUAL STEEL % | 0.420 | 0.714 | 0.892 | 1.053 | 1.200 | | 0.555 | 0.987 | 1.128 | 1.755 | 2.852 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.38 | 26.25 | 26.19 | | 26.31 | 26.25 | 26.25 | 26.25 | 26.12 | |
| $-I_{cr}/I_{gr}$ | 0.126 | 0.194 | 0.230 | 0.256 | 0.280 | | 0.157 | 0.244 | 0.269 | 0.368 | 0.494 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | |
| ACTUAL STEEL % | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | |
| EFF. DEPTH, IN. | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | |
| $+I_{cr}/I_{gr}$ | 0.134 | 0.214 | 0.240 | 0.295 | 0.325 | | 0.134 | 0.214 | 0.240 | 0.295 | 0.325 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 8 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 8 | 5 | 4 | 7 | 8 | | 9.5 | 8 | 8.5 | 9.5 | 5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | |
| BARS NO | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | |
| STEEL (PSF) | 1.01 | 1.60 | 2.01 | 2.41 | 2.82 | | 1.50 | 2.47 | 3.14 | 3.66 | 5.75 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 350 | 930 | 1255 | 1606 | 1989 | 7.149 | 794 | 1638 | 2111 | 2621 | 3179 | 4.399 |
| STIR | #3- 85 | #3-149 | #3-161 | #4-184 | #4-195 | | #3-105 | #3-133 | #4-164 | #5-173 | #5-173 | |
| 38'- 0" | 299 | 849 | 1157 | 1490 | 1853 | 7.953 | 721 | 1521 | 1969 | 2452 | 2982 | 4.894 |
| STIR | #3- 82 | #3-150 | #3-169 | #4-186 | #4-198 | | #3-105 | #3-140 | #4-167 | #4-177 | #5-176 | |
| 39'- 0" | 252 | 774 | 1067 | 1382 | 1728 | 8.824 | 652 | 1412 | 1837 | 2296 | 2799 | 5.430 |
| STIR | #3- 79 | #3-150 | #3-171 | #3-189 | #4-202 | | #3-104 | #3-148 | #4-170 | #4-181 | #5-180 | |
| 40'- 0" | 208 | 705 | 983 | 1283 | 1611 | 9.765 | 589 | 1311 | 1716 | 2152 | 2630 | 6.009 |
| STIR | #3- 76 | #3-151 | #3-173 | #3-191 | #4-205 | | #3-103 | #3-155 | #4-172 | #4-183 | #5-182 | |
| 41'- 0" | 168 | 641 | 905 | 1191 | 1503 | 10.778 | 530 | 1218 | 1603 | 2018 | 2473 | 6.633 |
| STIR | #3- 73 | #3-152 | #3-174 | #3-194 | #4-208 | | #3-103 | #3-157 | #3-175 | #4-186 | #5-186 | |
| 42'- 0" | 131 | 581 | 833 | 1105 | 1403 | 11.869 | 476 | 1131 | 1498 | 1894 | 2327 | 7.304 |
| STIR | #3- 70 | #3-152 | #3-176 | #3-173 | #4-211 | | #3-101 | #3-158 | #3-176 | #4-189 | #5-192 | |
| 43'- 0" | 96 | 525 | 766 | 1026 | 1310 | 13.040 | 425 | 1050 | 1400 | 1778 | 2191 | 8.025 |
| STIR | #3- 66 | #3-152 | #3-177 | #3-182 | #4-214 | | #3-100 | #3-160 | #3-179 | #4-192 | #5-197 | |
| 44'- 0" | 63 | 473 | 703 | 951 | 1223 | 14.296 | 378 | 974 | 1309 | 1669 | 2064 | 8.798 |
| STIR | #3- 62 | #3-152 | #3-179 | #3-190 | #4-217 | | #3- 99 | #3-161 | #3-155 | #4-194 | #5-203 | |
| 45'- 0" | 33 | 425 | 645 | 882 | 1141 | 15.641 | 333 | 904 | 1224 | 1568 | 1946 | 9.625 |
| STIR | #3- 58 | #3-152 | #3-180 | #3-199 | #4-219 | | #3- 97 | #3-162 | #3-162 | #4-197 | #5-208 | |
| 46'- 0" | 4 | 380 | 590 | 817 | 1065 | 17.078 | 292 | 838 | 1144 | 1474 | 1835 | 10.510 |
| STIR | #3- 53 | #3-152 | #3-181 | #3-203 | #3-222 | | #3- 95 | #3-163 | #3-169 | #4-200 | #4-212 | |
| 47'- 0" | | 337 | 539 | 756 | 994 | 18.613 | 253 | 776 | 1069 | 1385 | 1731 | 11.454 |
| STIR | | #3-151 | #3-181 | #3-205 | #3-225 | | #3- 93 | #3-164 | #3-177 | #4-203 | #4-215 | |
| 48'- 0" | | 297 | 491 | 699 | 927 | 20.248 | 217 | 718 | 999 | 1302 | 1634 | 12.460 |
| STIR | | #3-151 | #3-182 | #3-206 | #3-227 | | #3- 91 | #3-165 | #3-184 | #4-205 | #4-217 | |
| 49'- 0" | | 260 | 445 | 645 | 864 | 21.989 | 183 | 664 | 934 | 1224 | 1543 | 13.532 |
| STIR | | #3-150 | #3-183 | #3-208 | #3-230 | | #3- 89 | #3-166 | #3-188 | #4-207 | #4-221 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.85 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.23 | 1.96 | 2.45 | 3.08 | 3.68 | | 1.60 | 2.69 | 3.46 | 4.07 | 7.74 | |
| ACTUAL STEEL % | 0.415 | 0.664 | 0.830 | 1.049 | 1.255 | | 0.543 | 0.918 | 1.181 | 1.395 | 2.651 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.38 | 26.25 | 26.19 | | 26.31 | 26.25 | 26.19 | 26.12 | 26.12 | |
| $-I_{cr}/I_{gr}$ | 0.128 | 0.187 | 0.222 | 0.261 | 0.295 | | 0.158 | 0.236 | 0.283 | 0.316 | 0.483 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | |
| ACTUAL STEEL % | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | |
| EFF. DEPTH, IN. | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | |
| $+I_{cr}/I_{gr}$ | 0.135 | 0.207 | 0.246 | 0.287 | 0.330 | | 0.135 | 0.207 | 0.246 | 0.287 | 0.330 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 6 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 8 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 7 | 7 | 8 | 7 | 8.5 | | 8 | 7.5 | 8 | 9 | 6 | |
| BOTTOM BARS NO | 1# 5 | 1# 8 | 1# 7 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 7 | 1#10 | 1#10 | |
| BARS NO | 2# 6 | 1# 9 | 2# 8 | 1#10 | 1#11 | | 2# 6 | 1# 9 | 2# 8 | 1#10 | 1#11 | |
| STEEL (PSF) | 1.13 | 1.79 | 2.13 | 2.58 | 2.85 | | 1.73 | 2.69 | 3.29 | 3.94 | 5.19 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 473 | 1028 | 1396 | 1716 | 1979 | 7.149 | 990 | 1797 | 2332 | 2798 | 3180 | 4.399 |
| STIR | #3- 95 | #3-148 | #3-159 | #4-182 | #4-190 | | #3-113 | #3-133 | #4-164 | #5-173 | #5-178 | |
| 38'- 0" | 414 | 940 | 1289 | 1592 | 1841 | 7.953 | 904 | 1670 | 2176 | 2618 | 2980 | 4.894 |
| STIR | #3- 94 | #3-149 | #3-168 | #4-184 | #4-193 | | #3-113 | #3-141 | #4-167 | #5-176 | #5-181 | |
| 39'- 0" | 359 | 859 | 1190 | 1478 | 1714 | 8.824 | 825 | 1551 | 2032 | 2452 | 2796 | 5.430 |
| STIR | #3- 91 | #3-150 | #3-172 | #3-187 | #4-196 | | #3-112 | #3-148 | #4-169 | #4-179 | #5-185 | |
| 40'- 0" | 309 | 784 | 1098 | 1372 | 1597 | 9.765 | 751 | 1442 | 1899 | 2298 | 2625 | 6.009 |
| STIR | #3- 89 | #3-151 | #3-174 | #3-190 | #4-199 | | #3-112 | #3-155 | #4-173 | #4-182 | #5-187 | |
| 41'- 0" | 262 | 714 | 1013 | 1274 | 1488 | 10.778 | 683 | 1340 | 1776 | 2155 | 2466 | 6.633 |
| STIR | #3- 86 | #3-152 | #3-175 | #3-169 | #4-202 | | #3-112 | #3-156 | #4-175 | #4-185 | #5-191 | |
| 42'- 0" | 218 | 649 | 934 | 1183 | 1387 | 11.869 | 620 | 1246 | 1661 | 2023 | 2319 | 7.304 |
| STIR | #3- 83 | #3-152 | #3-177 | #3-177 | #4-204 | | #3-111 | #3-158 | #4-177 | #4-188 | #5-195 | |
| 43'- 0" | 178 | 589 | 861 | 1098 | 1292 | 13.040 | 561 | 1158 | 1554 | 1899 | 2182 | 8.025 |
| STIR | #3- 80 | #3-152 | #3-178 | #3-186 | #4-207 | | #3-110 | #3-159 | #3-179 | #4-190 | #5-198 | |
| 44'- 0" | 140 | 532 | 792 | 1019 | 1205 | 14.296 | 505 | 1076 | 1454 | 1784 | 2054 | 8.798 |
| STIR | #3- 77 | #3-152 | #3-180 | #3-195 | #3-210 | | #3-109 | #3-160 | #3-154 | #4-193 | #4-200 | |
| 45'- 0" | 105 | 480 | 728 | 945 | 1122 | 15.641 | 454 | 1000 | 1361 | 1676 | 1934 | 9.625 |
| STIR | #3- 74 | #3-152 | #3-181 | #3-198 | #3-212 | | #3-108 | #3-162 | #3-161 | #4-195 | #4-204 | |
| 46'- 0" | 72 | 431 | 668 | 876 | 1046 | 17.078 | 406 | 928 | 1274 | 1576 | 1823 | 10.510 |
| STIR | #3- 70 | #3-152 | #3-182 | #3-200 | #3-191 | | #3-107 | #3-163 | #3-169 | #4-199 | #4-206 | |
| 47'- 0" | 41 | 385 | 612 | 811 | 974 | 18.613 | 361 | 861 | 1193 | 1481 | 1718 | 11.454 |
| STIR | #3- 66 | #3-151 | #3-183 | #3-202 | #3-199 | | #3-105 | #3-164 | #3-176 | #4-201 | #4-209 | |
| 48'- 0" | 11 | 341 | 560 | 750 | 906 | 20.248 | 319 | 798 | 1116 | 1393 | 1620 | 12.460 |
| STIR | #3- 61 | #3-151 | #3-184 | #3-204 | #3-208 | | #3-103 | #3-165 | #3-183 | #4-203 | #4-212 | |
| 49'- 0" | | 301 | 510 | 693 | 843 | 21.989 | 279 | 739 | 1044 | 1310 | 1528 | 13.532 |
| STIR | | #3-150 | #3-184 | #3-205 | #3-217 | | #3-102 | #3-165 | #3-189 | #4-205 | #4-215 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.89 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.43 | 2.21 | 2.75 | 3.14 | 3.53 | | 1.94 | 2.93 | 3.75 | 4.39 | 6.58 | |
| ACTUAL STEEL % | 0.444 | 0.690 | 0.860 | 0.982 | 1.106 | | 0.604 | 0.917 | 1.175 | 1.380 | 2.069 | |
| EFF. DEPTH, IN. | 26.38 | 26.31 | 26.25 | 26.25 | 26.19 | | 26.31 | 26.25 | 26.19 | 26.12 | 26.12 | |
| $-I_{cr}/I_{gr}$ | 0.138 | 0.195 | 0.229 | 0.254 | 0.275 | | 0.175 | 0.241 | 0.287 | 0.320 | 0.422 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.19 | 1.79 | 2.18 | 2.54 | 2.83 | | 1.19 | 1.79 | 2.18 | 2.54 | 2.83 | |
| ACTUAL STEEL % | 0.356 | 0.539 | 0.656 | 0.767 | 0.856 | | 0.356 | 0.539 | 0.656 | 0.767 | 0.856 | |
| EFF. DEPTH, IN. | 26.64 | 26.46 | 26.52 | 26.36 | 26.33 | | 26.64 | 26.46 | 26.52 | 26.36 | 26.33 | |
| $+I_{cr}/I_{gr}$ | 0.145 | 0.208 | 0.249 | 0.282 | 0.309 | | 0.145 | 0.208 | 0.249 | 0.282 | 0.309 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 7″ Ribs @ 60″ c.-c.<br>15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 8 | 10 | 9 | | 10 | 8 | 9 | 7 | 8 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | | 2# 4 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | |
| BARS NO | 1# 4 | 1# 6 | 1# 7 | 1# 8 | 1# 8 | | 1# 4 | 1# 6 | 1# 7 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.57 | 0.77 | 1.02 | 1.18 | 1.35 | | 0.81 | 1.13 | 1.55 | 2.35 | 2.77 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 171 | 491 | 857 | 1072 | 1286 | 2.344 | 492 | 959 | 1490 | 1803 | 2115 | 1.443 |
| STIR | #3- 68 | #3-107 | #3-116 | #3-141 | #3-147 | | #3- 82 | #3-108 | #3-127 | #4-130 | #4-128 | |
| 29'- 0" | 123 | 422 | 762 | 963 | 1163 | 2.698 | 422 | 857 | 1353 | 1644 | 1935 | 1.660 |
| STIR | #3- 66 | #3-108 | #3-124 | #3-144 | #3-151 | | #3- 82 | #3-111 | #3-130 | #3-136 | #4-131 | |
| 30'- 0" | 80 | 359 | 677 | 865 | 1051 | 3.090 | 360 | 766 | 1229 | 1501 | 1773 | 1.901 |
| STIR | #3- 63 | #3-108 | #3-133 | #3-147 | #3-154 | | #3- 81 | #3-113 | #3-133 | #3-140 | #4-135 | |
| 31'- 0" | 41 | 302 | 600 | 776 | 951 | 3.523 | 303 | 683 | 1117 | 1372 | 1626 | 2.168 |
| STIR | #3- 60 | #3-109 | #3-136 | #3-149 | #3-157 | | #3- 81 | #3-114 | #3-135 | #3-143 | #4-141 | |
| 32'- 0" | 5 | 251 | 530 | 695 | 859 | 4.000 | 251 | 608 | 1015 | 1255 | 1493 | 2.461 |
| STIR | #3- 57 | #3-108 | #3-138 | #3-152 | #3-160 | | #3- 80 | #3-115 | #3-137 | #3-145 | #4-147 | |
| 33'- 0" | | 204 | 467 | 622 | 776 | 4.523 | 204 | 540 | 923 | 1148 | 1372 | 2.784 |
| STIR | | #3-108 | #3-140 | #3-138 | #3-163 | | #3- 79 | #3-116 | #3-140 | #3-148 | #4-153 | |
| 34'- 0" | | 161 | 409 | 554 | 700 | 5.097 | 161 | 478 | 838 | 1050 | 1262 | 3.137 |
| STIR | | #3-108 | #3-141 | #3-147 | #3-166 | | #3- 77 | #3-117 | #3-143 | #3-151 | #3-158 | |
| 35'- 0" | | 122 | 355 | 493 | 630 | 5.724 | 122 | 420 | 761 | 961 | 1160 | 3.522 |
| STIR | | #3-107 | #3-142 | #3-155 | #3-168 | | #3- 76 | #3-118 | #3-145 | #3-154 | #3-161 | |
| 36'- 0" | | 86 | 307 | 437 | 566 | 6.407 | 86 | 368 | 690 | 879 | 1067 | 3.942 |
| STIR | | #3-106 | #3-144 | #3-158 | #3-171 | | #3- 74 | #3-118 | #3-131 | #3-157 | #3-164 | |
| 37'- 0" | | 52 | 262 | 385 | 507 | 7.149 | 53 | 320 | 624 | 803 | 982 | 4.399 |
| STIR | | #3-105 | #3-145 | #3-160 | #3-173 | | #3- 72 | #3-119 | #3-138 | #3-159 | #3-167 | |
| 38'- 0" | | 22 | 220 | 337 | 453 | 7.953 | 22 | 275 | 564 | 734 | 903 | 4.894 |
| STIR | | #3-103 | #3-145 | #3-161 | #3-162 | | #3- 69 | #3-119 | #3-146 | #3-162 | #3-170 | |
| 39'- 0" | | | 182 | 293 | 403 | 8.824 | | 234 | 508 | 669 | 830 | 5.430 |
| STIR | | | #3-146 | #3-163 | #3-170 | | | #3-119 | #3-150 | #3-163 | #3-172 | |
| 40'- 0" | | | 146 | 252 | 357 | 9.765 | | 196 | 457 | 610 | 763 | 6.009 |
| STIR | | | #3-146 | #3-164 | #3-178 | | | #3-119 | #3-152 | #3-166 | #3-175 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.20 | 1.20 | 1.50 | 1.86 | 2.07 | | 1.20 | 1.50 | 2.07 | 3.77 | 4.50 | |
| ACTUAL STEEL % | 0.765 | 0.765 | 0.957 | 1.191 | 1.324 | | 0.765 | 0.957 | 1.324 | 2.425 | 2.906 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.31 | 18.31 | | 18.38 | 18.38 | 18.31 | 18.25 | 18.19 | |
| $-I_{cr}/I_{gr}$ | 0.160 | 0.160 | 0.190 | 0.221 | 0.238 | | 0.160 | 0.190 | 0.238 | 0.354 | 0.392 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 0.88 | 1.20 | 1.39 | 1.58 | | 0.60 | 0.88 | 1.20 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.361 | 0.533 | 0.729 | 0.846 | 0.962 | | 0.361 | 0.533 | 0.729 | 0.846 | 0.962 | |
| EFF. DEPTH, IN. | 18.75 | 18.62 | 18.56 | 18.53 | 18.50 | | 18.75 | 18.62 | 18.56 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.119 | 0.168 | 0.222 | 0.253 | 0.283 | | 0.119 | 0.168 | 0.222 | 0.253 | 0.283 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 8″ Ribs @ 61″ c.-c.<br>15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9.5 | 8 | 7 | 9.5 | | 10 | 7 | 9.5 | 8 | 6 | |
| BOTTOM BARS NO | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.60 | 0.85 | 0.95 | 1.14 | 1.31 | | 0.84 | 1.28 | 1.44 | 1.73 | 2.72 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 166 | 649 | 826 | 1047 | 1261 | 2.344 | 497 | 1199 | 1457 | 1778 | 2089 | 1.443 |
| STIR | #3- 57 | #3-112 | #3-122 | #3-134 | #3-141 | | #3- 75 | #3-102 | #3-122 | #3-129 | #4-128 | |
| 29'- 0" | 117 | 567 | 732 | 938 | 1137 | 2.698 | 425 | 1080 | 1320 | 1619 | 1910 | 1.660 |
| STIR | #3- 54 | #3-113 | #3-124 | #3-120 | #3-145 | | #3- 74 | #3-110 | #3-124 | #3-131 | #4-134 | |
| 30'- 0" | 72 | 493 | 647 | 839 | 1026 | 3.090 | 361 | 972 | 1196 | 1476 | 1748 | 1.901 |
| STIR | #3- 51 | #3-114 | #3-126 | #3-128 | #3-148 | | #3- 73 | #3-116 | #3-127 | #3-134 | #4-140 | |
| 31'- 0" | 32 | 426 | 570 | 750 | 925 | 3.523 | 302 | 875 | 1085 | 1347 | 1601 | 2.168 |
| STIR | #3- 47 | #3-114 | #3-127 | #3-137 | #3-150 | | #3- 72 | #3-118 | #3-129 | #3-137 | #4-143 | |
| 32'- 0" | | 365 | 501 | 670 | 834 | 4.000 | 249 | 787 | 984 | 1229 | 1468 | 2.461 |
| STIR | | #3-114 | #3-128 | #3-141 | #3-152 | | #3- 70 | #3-119 | #3-116 | #3-139 | #3-146 | |
| 33'- 0" | | 310 | 437 | 596 | 750 | 4.523 | 201 | 706 | 891 | 1122 | 1347 | 2.784 |
| STIR | | #3-114 | #3-129 | #3-143 | #3-136 | | #3- 68 | #3-120 | #3-123 | #3-142 | #3-149 | |
| 34'- 0" | | 259 | 379 | 529 | 674 | 5.097 | 156 | 633 | 807 | 1025 | 1236 | 3.137 |
| STIR | | #3-114 | #3-130 | #3-144 | #3-145 | | #3- 66 | #3-122 | #3-131 | #3-144 | #3-152 | |
| 35'- 0" | | 213 | 326 | 468 | 605 | 5.724 | 116 | 565 | 730 | 935 | 1135 | 3.522 |
| STIR | | #3-114 | #3-130 | #3-146 | #3-153 | | #3- 64 | #3-123 | #3-134 | #3-147 | #3-154 | |
| 36'- 0" | | 171 | 278 | 411 | 541 | 6.407 | 79 | 504 | 659 | 853 | 1042 | 3.942 |
| STIR | | #3-113 | #3-131 | #3-147 | #3-159 | | #3- 61 | #3-123 | #3-136 | #3-149 | #3-157 | |
| 37'- 0" | | 132 | 233 | 359 | 482 | 7.149 | 45 | 447 | 594 | 778 | 957 | 4.399 |
| STIR | | #3-113 | #3-131 | #3-148 | #3-161 | | #3- 59 | #3-124 | #3-137 | #3-134 | #3-160 | |
| 38'- 0" | | 96 | 192 | 311 | 428 | 7.953 | 13 | 394 | 534 | 708 | 878 | 4.894 |
| STIR | | #3-112 | #3-131 | #3-149 | #3-163 | | #3- 56 | #3-125 | #3-138 | #3-141 | #3-162 | |
| 39'- 0" | | 62 | 153 | 267 | 378 | 8.824 | | 346 | 479 | 644 | 805 | 5.430 |
| STIR | | #3-110 | #3-131 | #3-150 | #3-164 | | | #3-125 | #3-140 | #3-148 | #3-165 | |
| 40'- 0" | | 31 | 118 | 226 | 331 | 9.765 | | 301 | 427 | 585 | 737 | 6.009 |
| STIR | | #3-109 | #3-130 | #3-151 | #3-166 | | | #3-126 | #3-141 | #3-154 | #3-167 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.22 | 1.28 | 1.52 | 1.74 | 1.99 | | 1.22 | 1.74 | 1.99 | 2.36 | 4.47 | |
| ACTUAL STEEL % | 0.697 | 0.733 | 0.871 | 0.995 | 1.141 | | 0.697 | 0.995 | 1.141 | 1.355 | 2.575 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.38 | 18.31 | | 18.38 | 18.38 | 18.31 | 18.31 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.152 | 0.158 | 0.181 | 0.200 | 0.219 | | 0.152 | 0.200 | 0.219 | 0.248 | 0.377 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | |
| EFF. DEPTH, IN. | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.111 | 0.178 | 0.203 | 0.231 | 0.258 | | 0.111 | 0.178 | 0.203 | 0.231 | 0.258 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 9″ Ribs @ 62″ c.-c.<br>15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8.5 | 7.5 | 9.5 | 8.5 | | 10 | 9.5 | 8.5 | 7 | 4 | |
| BOTTOM BARS NO | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.64 | 0.92 | 1.05 | 1.30 | 1.45 | | 0.88 | 1.43 | 1.61 | 1.98 | 2.89 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 247 | 800 | 949 | 1236 | 1471 | 2.344 | 627 | 1431 | 1648 | 2064 | 2406 | 1.443 |
| STIR | #3- 62 | #3-115 | #3-123 | #3-136 | #3-143 | | #3- 78 | #3- 98 | #3-122 | #4-130 | #4-130 | |
| 29'- 0" | 191 | 706 | 845 | 1112 | 1331 | 2.698 | 545 | 1294 | 1496 | 1885 | 2203 | 1.660 |
| STIR | #3- 60 | #3-116 | #3-124 | #3-139 | #3-146 | | #3- 78 | #3-105 | #3-124 | #4-132 | #4-134 | |
| 30'- 0" | 140 | 622 | 751 | 1001 | 1205 | 3.090 | 470 | 1171 | 1360 | 1723 | 2020 | 1.901 |
| STIR | #3- 57 | #3-117 | #3-126 | #3-125 | #3-149 | | #3- 77 | #3-113 | #3-127 | #3-136 | #4-140 | |
| 31'- 0" | 94 | 545 | 666 | 900 | 1092 | 3.523 | 403 | 1060 | 1236 | 1576 | 1855 | 2.168 |
| STIR | #3- 53 | #3-118 | #3-127 | #3-133 | #3-152 | | #3- 76 | #3-120 | #3-129 | #3-139 | #4-144 | |
| 32'- 0" | 52 | 475 | 589 | 808 | 988 | 4.000 | 342 | 958 | 1124 | 1443 | 1704 | 2.461 |
| STIR | #3- 50 | #3-118 | #3-128 | #3-142 | #3-155 | | #3- 75 | #3-122 | #3-116 | #3-141 | #4-147 | |
| 33'- 0" | 14 | 412 | 519 | 725 | 894 | 4.523 | 287 | 866 | 1022 | 1322 | 1568 | 2.784 |
| STIR | #3- 46 | #3-119 | #3-129 | #3-145 | #3-157 | | #3- 73 | #3-124 | #3-123 | #3-144 | #4-150 | |
| 34'- 0" | | 354 | 455 | 649 | 808 | 5.097 | 236 | 782 | 928 | 1211 | 1443 | 3.137 |
| STIR | | #3-119 | #3-130 | #3-147 | #3-142 | | #3- 71 | #3-125 | #3-131 | #3-146 | #3-153 | |
| 35'- 0" | | 301 | 396 | 579 | 730 | 5.724 | 190 | 705 | 843 | 1110 | 1328 | 3.522 |
| STIR | | #3-119 | #3-131 | #3-149 | #3-150 | | #3- 69 | #3-126 | #3-134 | #3-149 | #3-155 | |
| 36'- 0" | | 252 | 342 | 515 | 658 | 6.407 | 147 | 634 | 765 | 1017 | 1223 | 3.942 |
| STIR | | #3-118 | #3-131 | #3-150 | #3-159 | | #3- 67 | #3-127 | #3-136 | #3-150 | #3-158 | |
| 37'- 0" | | 207 | 293 | 457 | 591 | 7.149 | 108 | 569 | 693 | 931 | 1127 | 4.399 |
| STIR | | #3-118 | #3-131 | #3-151 | #3-163 | | #3- 65 | #3-128 | #3-137 | #3-152 | #3-161 | |
| 38'- 0" | | 166 | 247 | 402 | 530 | 7.953 | 72 | 509 | 626 | 852 | 1038 | 4.894 |
| STIR | | #3-117 | #3-131 | #3-152 | #3-165 | | #3- 62 | #3-129 | #3-139 | #3-137 | #3-164 | |
| 39'- 0" | | 128 | 205 | 352 | 473 | 8.824 | 38 | 453 | 565 | 779 | 956 | 5.430 |
| STIR | | #3-116 | #3-131 | #3-153 | #3-167 | | #3- 59 | #3-130 | #3-140 | #3-145 | #3-166 | |
| 40'- 0" | | 93 | 166 | 306 | 421 | 9.765 | 8 | 402 | 508 | 712 | 879 | 6.009 |
| STIR | | #3-115 | #3-131 | #3-154 | #3-168 | | #3- 56 | #3-130 | #3-141 | #3-152 | #3-168 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.24 | 1.46 | 1.65 | 2.02 | 2.26 | | 1.24 | 2.02 | 2.26 | 2.75 | 4.80 | |
| ACTUAL STEEL % | 0.641 | 0.754 | 0.854 | 1.050 | 1.173 | | 0.641 | 1.050 | 1.173 | 1.424 | 2.493 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.31 | 18.31 | | 18.38 | 18.31 | 18.31 | 18.31 | 18.31 | |
| $-I_{cr}/I_{gr}$ | 0.145 | 0.165 | 0.182 | 0.210 | 0.228 | | 0.145 | 0.210 | 0.228 | 0.262 | 0.381 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | |
| EFF. DEPTH, IN. | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | |
| $+I_{cr}/I_{gr}$ | 0.117 | 0.187 | 0.205 | 0.238 | 0.266 | | 0.117 | 0.187 | 0.205 | 0.238 | 0.266 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 10″ Ribs @ 63″ c.-c.<br>15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8.5 | 7 | 9.5 | 7.5 | | 10 | 10 | 7.5 | 7 | 7 | |
| BOTTOM BARS NO | 3# 3 | 1# 5 | 2# 6 | 1# 6 | 2# 7 | | 3# 3 | 1# 5 | 2# 6 | 1# 6 | 2# 7 | |
| BARS NO | 2# 4 | 2# 6 | 1# 7 | 2# 7 | 1# 8 | | 2# 4 | 2# 6 | 1# 7 | 2# 7 | 1# 8 | |
| STEEL (PSF) | 0.65 | 0.91 | 1.16 | 1.27 | 1.59 | | 0.89 | 1.38 | 1.82 | 1.94 | 3.19 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 248 | 775 | 1106 | 1287 | 1681 | 2.344 | 639 | 1406 | 1887 | 2151 | 2724 | 1.443 |
| STIR | #3- 54 | #3-107 | #3-124 | #3-114 | #4-144 | | #3- 73 | #3-108 | #3-123 | #4-128 | #4-129 | |
| 29'- 0" | 189 | 681 | 989 | 1158 | 1526 | 2.698 | 554 | 1269 | 1717 | 1963 | 2498 | 1.660 |
| STIR | #3- 51 | #3-108 | #3-126 | #3-122 | #3-147 | | #3- 72 | #3-111 | #3-125 | #4-130 | #4-133 | |
| 30'- 0" | 137 | 596 | 884 | 1042 | 1385 | 3.090 | 478 | 1146 | 1565 | 1794 | 2294 | 1.901 |
| STIR | #3- 47 | #3-108 | #3-127 | #3-131 | #3-150 | | #3- 70 | #3-113 | #3-128 | #3-133 | #4-138 | |
| 31'- 0" | 89 | 519 | 789 | 937 | 1259 | 3.523 | 408 | 1034 | 1426 | 1642 | 2109 | 2.168 |
| STIR | #3- 43 | #3-108 | #3-129 | #3-137 | #3-153 | | #3- 69 | #3-114 | #3-130 | #3-135 | #4-145 | |
| 32'- 0" | 46 | 450 | 703 | 842 | 1143 | 4.000 | 346 | 933 | 1301 | 1503 | 1942 | 2.461 |
| STIR | #3- 39 | #3-108 | #3-130 | #3-139 | #3-155 | | #3- 67 | #3-115 | #3-113 | #3-139 | #4-149 | |
| 33'- 0" | 7 | 386 | 624 | 755 | 1039 | 4.523 | 288 | 841 | 1187 | 1377 | 1789 | 2.784 |
| STIR | #3- 34 | #3-108 | #3-131 | #3-141 | #3-158 | | #3- 65 | #3-116 | #3-120 | #3-141 | #4-152 | |
| 34'- 0" | | 328 | 553 | 676 | 943 | 5.097 | 236 | 756 | 1082 | 1261 | 1650 | 3.137 |
| STIR | | #3-108 | #3-132 | #3-142 | #3-160 | | #3- 63 | #3-117 | #3-128 | #3-143 | #4-154 | |
| 35'- 0" | | 275 | 487 | 603 | 855 | 5.724 | 188 | 679 | 987 | 1156 | 1523 | 3.522 |
| STIR | | #3-107 | #3-133 | #3-144 | #3-147 | | #3- 61 | #3-118 | #3-135 | #3-146 | #4-157 | |
| 36'- 0" | | 227 | 427 | 536 | 775 | 6.407 | 144 | 608 | 899 | 1059 | 1406 | 3.942 |
| STIR | | #3-106 | #3-133 | #3-145 | #3-156 | | #3- 58 | #3-119 | #3-138 | #3-130 | #4-160 | |
| 37'- 0" | | 182 | 371 | 475 | 701 | 7.149 | 104 | 543 | 819 | 970 | 1298 | 4.399 |
| STIR | | #3-105 | #3-134 | #3-146 | #3-165 | | #3- 55 | #3-119 | #3-139 | #3-137 | #3-163 | |
| 38'- 0" | | 141 | 320 | 419 | 633 | 7.953 | 67 | 483 | 744 | 887 | 1199 | 4.894 |
| STIR | | #3-103 | #3-134 | #3-147 | #3-167 | | #3- 52 | #3-119 | #3-141 | #3-144 | #3-165 | |
| 39'- 0" | | 102 | 273 | 366 | 569 | 8.824 | 32 | 428 | 676 | 812 | 1107 | 5.430 |
| STIR | | #3-102 | #3-134 | #3-147 | #3-169 | | #3- 48 | #3-120 | #3-142 | #3-151 | #3-168 | |
| 40'- 0" | | 67 | 229 | 318 | 511 | 9.765 | | 376 | 612 | 741 | 1022 | 6.009 |
| STIR | | #3-100 | #3-134 | #3-148 | #3-170 | | | #3-120 | #3-143 | #3-152 | #3-170 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.26 | 1.48 | 1.80 | 2.06 | 2.60 | | 1.26 | 1.95 | 2.60 | 2.79 | 5.40 | |
| ACTUAL STEEL % | 0.595 | 0.700 | 0.850 | 0.974 | 1.234 | | 0.595 | 0.925 | 1.234 | 1.322 | 2.578 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.31 | 18.31 | | 18.38 | 18.31 | 18.31 | 18.31 | 18.19 | |
| $-I_{cr}/I_{gr}$ | 0.139 | 0.158 | 0.184 | 0.202 | 0.241 | | 0.139 | 0.195 | 0.241 | 0.253 | 0.389 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.73 | 1.19 | 1.48 | 1.64 | 1.99 | | 0.73 | 1.19 | 1.48 | 1.64 | 1.99 | |
| ACTUAL STEEL % | 0.328 | 0.538 | 0.671 | 0.744 | 0.904 | | 0.328 | 0.538 | 0.671 | 0.744 | 0.904 | |
| EFF. DEPTH, IN. | 18.78 | 18.64 | 18.60 | 18.58 | 18.54 | | 18.78 | 18.64 | 18.60 | 18.58 | 18.54 | |
| $+I_{cr}/I_{gr}$ | 0.112 | 0.174 | 0.211 | 0.231 | 0.274 | | 0.112 | 0.174 | 0.211 | 0.231 | 0.274 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 7″ Ribs @ 60″ c.-c.<br>19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8 | 7 | 9.5 | 8 | | 10 | 9 | 8 | 9.5 | 7 | |
| BOTTOM BARS NO | 2# 4 | 1# 7 | 1# 7 | 1# 8 | 1# 8 | | 2# 4 | 1# 7 | 1# 7 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 1# 8 | 1# 8 | 1# 9 | | 1# 5 | 1# 7 | 1# 8 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.65 | 1.02 | 1.15 | 1.33 | 1.51 | | 0.89 | 1.55 | 1.75 | 2.07 | 3.15 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 191 | 713 | 914 | 1115 | 1335 | 4.000 | 543 | 1303 | 1596 | 1888 | 2208 | 2.461 |
| STIR | #3- 77 | #3-135 | #3-136 | #3-157 | #3-166 | | #3- 93 | #3-136 | #3-143 | #4-150 | #4-148 | |
| 33'- 0" | 144 | 635 | 825 | 1013 | 1221 | 4.523 | 476 | 1190 | 1466 | 1740 | 2042 | 2.784 |
| STIR | #3- 74 | #3-136 | #3-144 | #3-161 | #3-168 | | #3- 93 | #3-114 | #3-146 | #4-153 | #4-151 | |
| 34'- 0" | 102 | 565 | 743 | 921 | 1116 | 5.097 | 414 | 1087 | 1347 | 1606 | 1889 | 3.137 |
| STIR | #3- 72 | #3-138 | #3-151 | #3-163 | #3-171 | | #3- 92 | #3-121 | #3-149 | #4-156 | #4-155 | |
| 35'- 0" | 63 | 500 | 668 | 836 | 1020 | 5.724 | 358 | 993 | 1238 | 1482 | 1750 | 3.522 |
| STIR | #3- 69 | #3-139 | #3-153 | #3-143 | #3-174 | | #3- 92 | #3-128 | #3-151 | #3-159 | #4-161 | |
| 36'- 0" | 28 | 440 | 599 | 758 | 932 | 6.407 | 306 | 907 | 1138 | 1369 | 1622 | 3.942 |
| STIR | #3- 66 | #3-139 | #3-154 | #3-151 | #3-178 | | #3- 91 | #3-136 | #3-154 | #3-162 | #4-167 | |
| 37'- 0" | | 386 | 536 | 686 | 851 | 7.149 | 259 | 827 | 1046 | 1265 | 1504 | 4.399 |
| STIR | | #3-140 | #3-156 | #3-159 | #3-180 | | #3- 89 | #3-143 | #3-156 | #3-164 | #4-172 | |
| 38'- 0" | | 335 | 478 | 620 | 777 | 7.953 | 215 | 754 | 961 | 1169 | 1396 | 4.894 |
| STIR | | #3-141 | #3-157 | #3-168 | #3-183 | | #3- 88 | #3-145 | #3-158 | #3-167 | #4-175 | |
| 39'- 0" | | 289 | 424 | 559 | 708 | 8.824 | 174 | 686 | 883 | 1080 | 1295 | 5.430 |
| STIR | | #3-141 | #3-158 | #3-172 | #3-186 | | #3- 87 | #3-147 | #3-138 | #3-169 | #4-177 | |
| 40'- 0" | | 245 | 374 | 503 | 644 | 9.765 | 137 | 623 | 811 | 997 | 1203 | 6.009 |
| STIR | | #3-141 | #3-160 | #3-174 | #3-165 | | #3- 85 | #3-148 | #3-145 | #3-173 | #3-181 | |
| 41'- 0" | | 205 | 328 | 450 | 584 | 10.778 | 102 | 565 | 743 | 921 | 1116 | 6.633 |
| STIR | | #3-141 | #3-160 | #3-175 | #3-173 | | #3- 83 | #3-149 | #3-152 | #3-175 | #3-183 | |
| 42'- 0" | | 168 | 285 | 402 | 529 | 11.869 | 70 | 511 | 681 | 850 | 1036 | 7.304 |
| STIR | | #3-141 | #3-161 | #3-177 | #3-181 | | #3- 81 | #3-150 | #3-160 | #3-177 | #3-186 | |
| 43'- 0" | | 133 | 245 | 356 | 478 | 13.040 | 40 | 460 | 623 | 784 | 962 | 8.025 |
| STIR | | #3-141 | #3-162 | #3-178 | #3-190 | | #3- 79 | #3-152 | #3-166 | #3-179 | #3-189 | |
| 44'- 0" | | 101 | 208 | 314 | 430 | 14.296 | 12 | 413 | 568 | 723 | 892 | 8.798 |
| STIR | | #3-140 | #3-162 | #3-180 | #3-194 | | #3- 76 | #3-153 | #3-168 | #3-181 | #3-191 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.20 | 1.50 | 1.71 | 1.96 | 2.33 | | 1.20 | 2.07 | 2.33 | 2.78 | 5.14 | |
| ACTUAL STEEL % | 0.605 | 0.756 | 0.864 | 0.990 | 1.176 | | 0.605 | 1.045 | 1.176 | 1.411 | 2.619 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.38 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.25 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.144 | 0.172 | 0.190 | 0.209 | 0.237 | | 0.144 | 0.217 | 0.237 | 0.267 | 0.399 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.71 | 1.20 | 1.39 | 1.58 | 1.79 | | 0.71 | 1.20 | 1.39 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.340 | 0.578 | 0.670 | 0.763 | 0.865 | | 0.340 | 0.578 | 0.670 | 0.763 | 0.865 | |
| EFF. DEPTH, IN. | 22.72 | 22.56 | 22.53 | 22.50 | 22.46 | | 22.72 | 22.56 | 22.53 | 22.50 | 22.46 | |
| $+I_{cr}/I_{gr}$ | 0.120 | 0.194 | 0.221 | 0.248 | 0.277 | | 0.120 | 0.194 | 0.221 | 0.248 | 0.277 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 8″ Ribs @ 61″ c.-c.<br>19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 10 | 8.5 | 7.5 | | 9.5 | 8.5 | 7.5 | 6 | 5 | |
| BOTTOM BARS NO | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | |
| BARS NO | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.68 | 1.06 | 1.22 | 1.47 | 1.67 | | 0.95 | 1.62 | 1.85 | 2.28 | 3.33 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 279 | 815 | 985 | 1305 | 1525 | 4.000 | 686 | 1466 | 1713 | 2178 | 2498 | 2.461 |
| STIR | #3- 82 | #3-134 | #3-141 | #3-159 | #4-166 | | #3- 97 | #3-135 | #3-141 | #4-150 | #4-151 | |
| 33'- 0" | 225 | 730 | 890 | 1190 | 1397 | 4.523 | 608 | 1342 | 1574 | 2012 | 2312 | 2.784 |
| STIR | #3- 80 | #3-135 | #3-146 | #3-161 | #4-168 | | #3- 96 | #3-115 | #3-144 | #4-153 | #4-153 | |
| 34'- 0" | 177 | 652 | 802 | 1086 | 1280 | 5.097 | 537 | 1228 | 1447 | 1859 | 2142 | 3.137 |
| STIR | #3- 77 | #3-137 | #3-147 | #3-164 | #3-172 | | #3- 96 | #3-122 | #3-147 | #4-156 | #4-157 | |
| 35'- 0" | 132 | 580 | 722 | 990 | 1173 | 5.724 | 472 | 1124 | 1331 | 1720 | 1987 | 3.522 |
| STIR | #3- 75 | #3-138 | #3-149 | #3-166 | #3-174 | | #3- 96 | #3-130 | #3-149 | #4-160 | #4-162 | |
| 36'- 0" | 91 | 515 | 649 | 902 | 1075 | 6.407 | 412 | 1029 | 1224 | 1592 | 1844 | 3.942 |
| STIR | #3- 72 | #3-138 | #3-151 | #3-149 | #3-177 | | #3- 95 | #3-137 | #3-151 | #4-162 | #4-168 | |
| 37'- 0" | 53 | 454 | 582 | 821 | 985 | 7.149 | 358 | 941 | 1126 | 1474 | 1713 | 4.399 |
| STIR | #3- 69 | #3-139 | #3-152 | #3-157 | #3-180 | | #3- 94 | #3-143 | #3-154 | #4-165 | #4-172 | |
| 38'- 0" | 18 | 399 | 519 | 746 | 902 | 7.953 | 307 | 860 | 1036 | 1366 | 1592 | 4.894 |
| STIR | #3- 65 | #3-140 | #3-153 | #3-165 | #3-183 | | #3- 93 | #3-144 | #3-137 | #3-168 | #4-174 | |
| 39'- 0" | | 347 | 462 | 677 | 825 | 8.824 | 260 | 785 | 952 | 1265 | 1480 | 5.430 |
| STIR | | #3-140 | #3-154 | #3-173 | #3-185 | | #3- 92 | #3-146 | #3-144 | #3-170 | #4-177 | |
| 40'- 0" | | 300 | 409 | 613 | 754 | 9.765 | 217 | 716 | 875 | 1172 | 1377 | 6.009 |
| STIR | | #3-140 | #3-155 | #3-175 | #3-164 | | #3- 90 | #3-147 | #3-151 | #3-173 | #4-180 | |
| 41'- 0" | | 256 | 359 | 554 | 688 | 10.778 | 177 | 652 | 803 | 1086 | 1281 | 6.633 |
| STIR | | #3-140 | #3-156 | #3-177 | #3-173 | | #3- 89 | #3-148 | #3-159 | #3-176 | #4-184 | |
| 42'- 0" | | 215 | 313 | 499 | 627 | 11.869 | 140 | 592 | 736 | 1006 | 1192 | 7.304 |
| STIR | | #3-140 | #3-156 | #3-179 | #3-181 | | #3- 87 | #3-149 | #3-160 | #3-178 | #4-186 | |
| 43'- 0" | | 176 | 271 | 448 | 569 | 13.040 | 105 | 537 | 674 | 931 | 1108 | 8.025 |
| STIR | | #3-139 | #3-157 | #3-180 | #3-190 | | #3- 85 | #3-151 | #3-162 | #3-180 | #3-188 | |
| 44'- 0" | | 141 | 231 | 400 | 516 | 14.296 | 72 | 485 | 616 | 862 | 1031 | 8.798 |
| STIR | | #3-139 | #3-157 | #3-182 | #3-194 | | #3- 83 | #3-151 | #3-163 | #3-183 | #3-192 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.67 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.22 | 1.63 | 1.89 | 2.22 | 2.52 | | 1.28 | 2.22 | 2.52 | 3.15 | 5.37 | |
| ACTUAL STEEL % | 0.553 | 0.737 | 0.860 | 1.011 | 1.146 | | 0.582 | 1.011 | 1.146 | 1.433 | 2.448 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.31 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.31 | 22.25 | |
| $-I_{cr}/I_{gr}$ | 0.137 | 0.172 | 0.192 | 0.217 | 0.238 | | 0.143 | 0.217 | 0.238 | 0.279 | 0.395 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | |
| EFF. DEPTH, IN. | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | |
| $+I_{cr}/I_{gr}$ | 0.126 | 0.194 | 0.215 | 0.253 | 0.279 | | 0.126 | 0.194 | 0.215 | 0.253 | 0.279 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 9″ Ribs @ 62″ c.-c.<br>19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 9.5 | 7.5 | 7 | | 9 | 8.5 | 7 | 8 | 6 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | |
| BARS NO | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | |
| STEEL (PSF) | 0.75 | 1.10 | 1.28 | 1.61 | 1.71 | | 1.04 | 1.67 | 1.96 | 2.46 | 3.62 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 310 | 853 | 1125 | 1494 | 1693 | 4.000 | 745 | 1535 | 1930 | 2467 | 2757 | 2.461 |
| STIR | #3- 77 | #3-130 | #3-140 | #3-159 | #4-164 | | #3- 94 | #3-114 | #4-142 | #4-151 | #5-148 | |
| 33'- 0" | 253 | 764 | 1019 | 1366 | 1554 | 4.523 | 662 | 1405 | 1776 | 2281 | 2554 | 2.784 |
| STIR | #3- 75 | #3-131 | #3-146 | #3-163 | #4-168 | | #3- 93 | #3-121 | #3-144 | #4-154 | #5-152 | |
| 34'- 0" | 201 | 682 | 922 | 1249 | 1426 | 5.097 | 586 | 1286 | 1636 | 2111 | 2368 | 3.137 |
| STIR | #3- 73 | #3-132 | #3-148 | #3-165 | #4-171 | | #3- 93 | #3-129 | #3-147 | #4-157 | #4-155 | |
| 35'- 0" | 153 | 607 | 834 | 1143 | 1309 | 5.724 | 517 | 1177 | 1507 | 1956 | 2198 | 3.522 |
| STIR | #3- 70 | #3-132 | #3-149 | #3-168 | #3-174 | | #3- 92 | #3-135 | #3-149 | #4-160 | #4-161 | |
| 36'- 0" | 109 | 538 | 753 | 1045 | 1202 | 6.407 | 453 | 1077 | 1389 | 1813 | 2043 | 3.942 |
| STIR | #3- 67 | #3-133 | #3-151 | #3-147 | #3-176 | | #3- 91 | #3-137 | #3-151 | #4-163 | #4-167 | |
| 37'- 0" | 69 | 475 | 678 | 954 | 1103 | 7.149 | 394 | 985 | 1280 | 1682 | 1899 | 4.399 |
| STIR | #3- 63 | #3-133 | #3-152 | #3-155 | #3-180 | | #3- 90 | #3-139 | #3-153 | #4-166 | #4-171 | |
| 38'- 0" | 32 | 417 | 609 | 871 | 1013 | 7.953 | 340 | 901 | 1180 | 1561 | 1767 | 4.894 |
| STIR | #3- 59 | #3-133 | #3-153 | #3-164 | #3-182 | | #3- 89 | #3-140 | #3-136 | #4-168 | #4-175 | |
| 39'- 0" | | 363 | 546 | 794 | 929 | 8.824 | 290 | 822 | 1088 | 1449 | 1645 | 5.430 |
| STIR | | #3-133 | #3-155 | #3-172 | #3-185 | | #3- 87 | #3-141 | #3-143 | #4-171 | #4-177 | |
| 40'- 0" | | 313 | 487 | 723 | 851 | 9.765 | 244 | 750 | 1002 | 1346 | 1532 | 6.009 |
| STIR | | #3-133 | #3-155 | #3-176 | #3-166 | | #3- 86 | #3-142 | #3-151 | #3-174 | #4-181 | |
| 41'- 0" | | 267 | 432 | 657 | 779 | 10.778 | 201 | 682 | 923 | 1250 | 1427 | 6.633 |
| STIR | | #3-133 | #3-156 | #3-178 | #3-174 | | #3- 84 | #3-143 | #3-158 | #3-177 | #4-183 | |
| 42'- 0" | | 224 | 381 | 596 | 711 | 11.869 | 161 | 620 | 849 | 1161 | 1329 | 7.304 |
| STIR | | #3-132 | #3-157 | #3-180 | #3-183 | | #3- 82 | #3-144 | #3-161 | #3-179 | #4-186 | |
| 43'- 0" | | 184 | 334 | 539 | 649 | 13.040 | 124 | 562 | 780 | 1078 | 1238 | 8.025 |
| STIR | | #3-131 | #3-157 | #3-181 | #3-191 | | #3- 80 | #3-145 | #3-162 | #3-182 | #4-188 | |
| 44'- 0" | | 147 | 290 | 485 | 591 | 14.296 | 89 | 507 | 716 | 1000 | 1153 | 8.798 |
| STIR | | #3-130 | #3-158 | #3-183 | #3-193 | | #3- 77 | #3-146 | #3-164 | #3-183 | #4-191 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.24 | 1.65 | 2.02 | 2.56 | 2.75 | | 1.38 | 2.26 | 2.75 | 3.41 | 6.20 | |
| ACTUAL STEEL % | 0.510 | 0.680 | 0.835 | 1.058 | 1.133 | | 0.567 | 0.933 | 1.133 | 1.412 | 2.576 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.31 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.25 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.131 | 0.165 | 0.191 | 0.229 | 0.240 | | 0.142 | 0.208 | 0.240 | 0.279 | 0.413 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | |
| ACTUAL STEEL % | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | |
| EFF. DEPTH, IN. | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | |
| $+I_{cr}/I_{gr}$ | 0.123 | 0.187 | 0.218 | 0.259 | 0.281 | | 0.123 | 0.187 | 0.218 | 0.259 | 0.281 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**53″ Forms + 10″ Ribs @ 63″ c.-c.**
19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 6 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 7 | 9 | 7.5 | 9 | | 8.5 | 8 | 9.5 | 10 | 7 | |
| BOTTOM BARS NO | 2# 5 | 2# 6 | 2# 6 | 2# 6 | 2# 8 | | 2# 5 | 2# 6 | 2# 6 | 2# 6 | 2# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 2# 7 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 2# 7 | 1# 8 | |
| STEEL (PSF) | 0.74 | 1.16 | 1.42 | 1.66 | 1.87 | | 1.06 | 1.76 | 2.14 | 2.63 | 3.37 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 336 | 924 | 1226 | 1564 | 1862 | 4.000 | 797 | 1653 | 2092 | 2583 | 3016 | 2.461 |
| STIR | #3- 73 | #3-128 | #3-143 | #3-156 | #4-165 | | #3- 91 | #3-117 | #4-141 | #4-149 | #5-154 | |
| 33'- 0" | 276 | 829 | 1113 | 1431 | 1710 | 4.523 | 709 | 1514 | 1926 | 2389 | 2796 | 2.784 |
| STIR | #3- 70 | #3-128 | #3-145 | #3-159 | #4-167 | | #3- 90 | #3-124 | #4-143 | #4-152 | #5-158 | |
| 34'- 0" | 221 | 741 | 1009 | 1308 | 1572 | 5.097 | 629 | 1387 | 1776 | 2211 | 2595 | 3.137 |
| STIR | #3- 67 | #3-129 | #3-146 | #3-162 | #4-170 | | #3- 89 | #3-132 | #3-146 | #4-156 | #5-161 | |
| 35'- 0" | 170 | 662 | 914 | 1196 | 1445 | 5.724 | 555 | 1270 | 1637 | 2048 | 2410 | 3.522 |
| STIR | #3- 64 | #3-130 | #3-148 | #3-145 | #4-174 | | #3- 89 | #3-134 | #3-148 | #4-158 | #4-165 | |
| 36'- 0" | 124 | 588 | 827 | 1094 | 1329 | 6.407 | 488 | 1164 | 1511 | 1899 | 2241 | 3.942 |
| STIR | #3- 61 | #3-130 | #3-149 | #3-153 | #3-177 | | #3- 87 | #3-135 | #3-151 | #4-161 | #4-168 | |
| 37'- 0" | 81 | 521 | 747 | 999 | 1222 | 7.149 | 426 | 1065 | 1394 | 1762 | 2086 | 4.399 |
| STIR | #3- 57 | #3-130 | #3-151 | #3-162 | #3-179 | | #3- 86 | #3-137 | #3-131 | #4-164 | #4-171 | |
| 38'- 0" | 42 | 458 | 673 | 912 | 1123 | 7.953 | 368 | 975 | 1286 | 1635 | 1942 | 4.894 |
| STIR | #3- 53 | #3-130 | #3-152 | #3-169 | #3-182 | | #3- 85 | #3-138 | #3-138 | #4-167 | #4-174 | |
| 39'- 0" | 5 | 401 | 604 | 832 | 1032 | 8.824 | 315 | 891 | 1187 | 1518 | 1809 | 5.430 |
| STIR | #3- 49 | #3-130 | #3-153 | #3-170 | #3-184 | | #3- 83 | #3-139 | #3-145 | #4-169 | #4-177 | |
| 40'- 0" | | 348 | 541 | 757 | 948 | 9.765 | 266 | 814 | 1095 | 1409 | 1687 | 6.009 |
| STIR | | #3-130 | #3-153 | #3-172 | #3-166 | | #3- 81 | #3-140 | #3-153 | #3-171 | #4-179 | |
| 41'- 0" | | 298 | 482 | 688 | 869 | 10.778 | 221 | 742 | 1009 | 1309 | 1573 | 6.633 |
| STIR | | #3-129 | #3-154 | #3-174 | #3-175 | | #3- 79 | #3-141 | #3-158 | #3-174 | #4-183 | |
| 42'- 0" | | 252 | 428 | 624 | 797 | 11.869 | 179 | 675 | 930 | 1215 | 1467 | 7.304 |
| STIR | | #3-128 | #3-155 | #3-175 | #3-183 | | #3- 77 | #3-142 | #3-160 | #3-176 | #4-185 | |
| 43'- 0" | | 210 | 377 | 564 | 729 | 13.040 | 139 | 613 | 856 | 1128 | 1368 | 8.025 |
| STIR | | #3-127 | #3-155 | #3-176 | #3-191 | | #3- 74 | #3-142 | #3-161 | #3-178 | #4-188 | |
| 44'- 0" | | 170 | 329 | 508 | 666 | 14.296 | 103 | 555 | 787 | 1047 | 1276 | 8.798 |
| STIR | | #3-126 | #3-155 | #3-178 | #3-193 | | #3- 71 | #3-143 | #3-163 | #3-180 | #4-190 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.26 | 1.80 | 2.17 | 2.60 | 3.08 | | 1.48 | 2.44 | 2.92 | 3.78 | 5.40 | |
| ACTUAL STEEL % | 0.475 | 0.678 | 0.820 | 0.984 | 1.168 | | 0.558 | 0.923 | 1.106 | 1.438 | 2.054 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.31 | 22.31 | 22.25 | | 22.38 | 22.31 | 22.25 | 22.19 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.126 | 0.167 | 0.192 | 0.221 | 0.248 | | 0.143 | 0.210 | 0.239 | 0.286 | 0.365 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.93 | 1.48 | 1.76 | 2.08 | 2.37 | | 0.93 | 1.48 | 1.76 | 2.08 | 2.37 | |
| ACTUAL STEEL % | 0.336 | 0.537 | 0.638 | 0.755 | 0.863 | | 0.336 | 0.537 | 0.638 | 0.755 | 0.863 | |
| EFF. DEPTH, IN. | 22.69 | 22.60 | 22.62 | 22.59 | 22.50 | | 22.69 | 22.60 | 22.62 | 22.59 | 22.50 | |
| $+I_{cr}/I_{gr}$ | 0.122 | 0.185 | 0.218 | 0.253 | 0.282 | | 0.122 | 0.185 | 0.218 | 0.253 | 0.282 | |

SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**53″ Forms + 7″ Ribs @ 60″ c.-c.**
23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 7 | 8.5 | 7.5 | | 8.5 | 8 | 6 | 4 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 8 | 1# 9 | | 1# 6 | 1# 7 | 1# 8 | 1# 9 | |
| BARS NO | 1# 6 | 1# 8 | 1# 9 | 1# 9 | | 1# 6 | 1# 8 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.77 | 1.15 | 1.49 | 1.69 | | 1.09 | 1.75 | 2.30 | 3.07 | |
| CLEAR SPAN | END SPAN | | | | | INTERIOR SPAN | | | | |
| 37'- 0" (3) | 204 | 684 | 1057 | 1252 | 7.149 | 588 | 1286 | 1828 | 2111 | 4.399 |
| STIR | #3- 93 | #3-152 | #3-177 | #3-185 | | #3-111 | #3-129 | #4-169 | #4-175 | |
| 38'- 0" | 161 | 616 | 969 | 1154 | 7.953 | 524 | 1186 | 1700 | 1968 | 4.894 |
| STIR | #3- 91 | #3-153 | #3-154 | #3-188 | | #3-110 | #3-136 | #4-172 | #4-178 | |
| 39'- 0" | 120 | 552 | 888 | 1063 | 8.824 | 465 | 1093 | 1581 | 1836 | 5.430 |
| STIR | #3- 88 | #3-154 | #3-162 | #3-192 | | #3-110 | #3-143 | #4-175 | #4-181 | |
| 40'- 0" | 83 | 493 | 812 | 979 | 9.765 | 411 | 1008 | 1472 | 1714 | 6.009 |
| STIR | #3- 86 | #3-155 | #3-171 | #3-194 | | #3-110 | #3-151 | #4-178 | #4-185 | |
| 41'- 0" | 48 | 439 | 742 | 901 | 10.778 | 360 | 928 | 1370 | 1601 | 6.633 |
| STIR | #3- 83 | #3-156 | #3-179 | #3-197 | | #3-109 | #3-158 | #3-181 | #4-188 | |
| 42'- 0" | 16 | 388 | 677 | 828 | 11.869 | 313 | 855 | 1276 | 1495 | 7.304 |
| STIR | #3- 80 | #3-157 | #3-186 | #3-199 | | #3-108 | #3-161 | #3-184 | #4-190 | |
| 43'- 0" | | 341 | 617 | 761 | 13.040 | 269 | 786 | 1188 | 1397 | 8.025 |
| STIR | | #3-157 | #3-188 | #3-177 | | #3-107 | #3-163 | #3-186 | #4-194 | |
| 44'- 0" | | 297 | 560 | 698 | 14.296 | 228 | 722 | 1106 | 1306 | 8.798 |
| STIR | | #3-157 | #3-190 | #3-185 | | #3-106 | #3-164 | #3-188 | #4-197 | |
| 45'- 0" | | 256 | 508 | 639 | 15.641 | 190 | 662 | 1029 | 1220 | 9.625 |
| STIR | | #3-157 | #3-192 | #3-194 | | #3-105 | #3-165 | #3-191 | #4-199 | |
| 46'- 0" | | 217 | 458 | 584 | 17.078 | 155 | 606 | 957 | 1140 | 10.510 |
| STIR | | #3-157 | #3-193 | #3-202 | | #3-103 | #3-167 | #3-193 | #3-201 | |
| 47'- 0" | | 181 | 412 | 533 | 18.613 | 121 | 554 | 890 | 1065 | 11.454 |
| STIR | | #3-157 | #3-194 | #3-208 | | #3-102 | #3-168 | #3-195 | #3-204 | |
| 48'- 0" | | 147 | 369 | 485 | 20.248 | 90 | 505 | 827 | 995 | 12.460 |
| STIR | | #3-157 | #3-196 | #3-210 | | #3-100 | #3-169 | #3-197 | #3-207 | |
| 49'- 0" | | 116 | 328 | 439 | 21.989 | 61 | 459 | 768 | 929 | 13.532 |
| STIR | | #3-156 | #3-197 | #3-212 | | #3- 98 | #3-170 | #3-176 | #3-209 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.71 CF/SF) | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.20 | 1.71 | 2.19 | 2.48 | | 1.41 | 2.33 | 3.10 | 4.65 | |
| ACTUAL STEEL % | 0.495 | 0.707 | 0.905 | 1.025 | | 0.582 | 0.961 | 1.282 | 1.922 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.31 | 26.31 | | 26.38 | 26.31 | 26.31 | 26.31 | |
| $-I_{cr}/I_{gr}$ | 0.131 | 0.174 | 0.209 | 0.229 | | 0.149 | 0.218 | 0.269 | 0.356 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.79 | 2.00 | | 0.88 | 1.39 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.347 | 0.549 | 0.709 | 0.792 | | 0.347 | 0.549 | 0.709 | 0.792 | |
| EFF. DEPTH, IN. | 26.62 | 26.53 | 26.46 | 26.44 | | 26.62 | 26.53 | 26.46 | 26.44 | |
| $+I_{cr}/I_{gr}$ | 0.129 | 0.196 | 0.247 | 0.272 | | 0.129 | 0.196 | 0.247 | 0.272 | |

SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 8″ Ribs @ 61″ c.-c.<br>23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 6 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 8.5 | 9.5 | 8 | | 8 | 7 | 9 | 5 | 5 | |
| BOTTOM BARS NO | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | |
| BARS NO | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | |
| STEEL (PSF) | 0.75 | 1.29 | 1.47 | 1.87 | 2.16 | | 1.11 | 1.99 | 2.23 | 3.47 | 4.42 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 219 | 827 | 1022 | 1465 | 1713 | 7.149 | 624 | 1509 | 1793 | 2438 | 2799 | 4.399 |
| STIR | #3- 85 | #3-155 | #3-162 | #4-187 | #4-195 | | #3-105 | #3-155 | #4-163 | #5-176 | #5-171 | |
| 38'- 0" | 172 | 749 | 934 | 1354 | 1589 | 7.953 | 557 | 1395 | 1665 | 2276 | 2618 | 4.894 |
| STIR | #3- 83 | #3-156 | #3-168 | #4-190 | #4-198 | | #3-105 | #3-133 | #4-166 | #4-179 | #5-174 | |
| 39'- 0" | 129 | 677 | 852 | 1252 | 1475 | 8.824 | 495 | 1291 | 1546 | 2127 | 2452 | 5.430 |
| STIR | #3- 80 | #3-157 | #3-170 | #3-193 | #4-202 | | #3-104 | #3-140 | #3-169 | #4-183 | #5-178 | |
| 40'- 0" | 90 | 610 | 777 | 1156 | 1369 | 9.765 | 437 | 1194 | 1437 | 1989 | 2297 | 6.009 |
| STIR | #3- 77 | #3-158 | #3-172 | #3-196 | #4-204 | | #3-103 | #3-147 | #3-171 | #4-186 | #5-180 | |
| 41'- 0" | 53 | 548 | 707 | 1068 | 1270 | 10.778 | 383 | 1104 | 1335 | 1860 | 2154 | 6.633 |
| STIR | #3- 74 | #3-159 | #3-174 | #3-198 | #4-208 | | #3-102 | #3-155 | #3-173 | #4-189 | #5-185 | |
| 42'- 0" | 19 | 491 | 642 | 986 | 1179 | 11.869 | 334 | 1020 | 1240 | 1741 | 2021 | 7.304 |
| STIR | #3- 70 | #3-160 | #3-175 | #3-201 | #4-211 | | #3-101 | #3-162 | #3-175 | #4-192 | #5-191 | |
| 43'- 0" | | 437 | 581 | 910 | 1094 | 13.040 | 287 | 942 | 1152 | 1630 | 1897 | 8.025 |
| STIR | | #3-160 | #3-176 | #3-204 | #4-214 | | #3-100 | #3-165 | #3-178 | #4-195 | #4-198 | |
| 44'- 0" | | 387 | 525 | 839 | 1014 | 14.296 | 244 | 869 | 1070 | 1526 | 1782 | 8.798 |
| STIR | | #3-161 | #3-177 | #3-181 | #3-216 | | #3- 98 | #3-166 | #3-157 | #4-198 | #4-204 | |
| 45'- 0" | | 340 | 472 | 772 | 940 | 15.641 | 204 | 802 | 994 | 1430 | 1674 | 9.625 |
| STIR | | #3-161 | #3-179 | #3-189 | #3-220 | | #3- 97 | #3-168 | #3-164 | #4-200 | #4-209 | |
| 46'- 0" | | 297 | 423 | 710 | 870 | 17.078 | 166 | 738 | 922 | 1339 | 1573 | 10.510 |
| STIR | | #3-161 | #3-179 | #3-198 | #3-222 | | #3- 95 | #3-169 | #3-172 | #4-203 | #4-212 | |
| 47'- 0" | | 256 | 377 | 652 | 805 | 18.613 | 131 | 679 | 855 | 1254 | 1478 | 11.454 |
| STIR | | #3-161 | #3-180 | #3-206 | #3-225 | | #3- 93 | #3-170 | #3-179 | #4-206 | #4-214 | |
| 48'- 0" | | 218 | 334 | 597 | 744 | 20.248 | 97 | 623 | 792 | 1175 | 1389 | 12.460 |
| STIR | | #3-161 | #3-181 | #3-213 | #3-227 | | #3- 91 | #3-171 | #3-185 | #4-209 | #4-218 | |
| 49'- 0" | | 181 | 293 | 546 | 687 | 21.989 | 66 | 570 | 732 | 1100 | 1306 | 13.532 |
| STIR | | #3-161 | #3-181 | #3-214 | #3-229 | | #3- 89 | #3-173 | #3-187 | #4-211 | #4-220 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.22 | 1.89 | 2.22 | 2.83 | 3.36 | | 1.52 | 2.70 | 2.98 | 5.37 | 7.32 | |
| ACTUAL STEEL % | 0.454 | 0.705 | 0.830 | 1.056 | 1.255 | | 0.567 | 1.007 | 1.115 | 2.007 | 2.745 | |
| EFF. DEPTH, IN. | 26.38 | 26.31 | 26.31 | 26.25 | 26.25 | | 26.38 | 26.31 | 26.25 | 26.25 | 26.19 | |
| $-I_{cr}/I_{gr}$ | 0.125 | 0.176 | 0.200 | 0.237 | 0.269 | | 0.149 | 0.231 | 0.247 | 0.372 | 0.450 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | |
| ACTUAL STEEL % | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | |
| EFF. DEPTH, IN. | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | |
| $+I_{cr}/I_{gr}$ | 0.125 | 0.202 | 0.226 | 0.279 | 0.308 | | 0.125 | 0.202 | 0.226 | 0.279 | 0.308 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 9″ Ribs @ 62″ c.-c.<br>23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 6 | # 7 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9.5 | 8 | 9 | 10 | | 7.5 | 7 | 8 | 9 | 6 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | |
| BARS NO | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | |
| STEEL (PSF) | 0.80 | 1.28 | 1.58 | 1.89 | 2.24 | | 1.20 | 1.96 | 2.46 | 2.93 | 4.71 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 270 | 852 | 1179 | 1532 | 1919 | 7.149 | 715 | 1563 | 2038 | 2551 | 3114 | 4.399 |
| STIR | #3- 85 | #3-149 | #3-160 | #4-183 | #4-195 | | #3-105 | #3-133 | #4-164 | #5-174 | #5-171 | |
| 38'- 0" | 219 | 771 | 1081 | 1416 | 1782 | 7.953 | 641 | 1444 | 1895 | 2382 | 2915 | 4.894 |
| STIR | #3- 82 | #3-150 | #3-168 | #4-187 | #4-199 | | #3-105 | #3-140 | #4-167 | #4-177 | #5-174 | |
| 39'- 0" | 172 | 696 | 990 | 1308 | 1656 | 8.824 | 573 | 1335 | 1763 | 2225 | 2731 | 5.430 |
| STIR | #3- 80 | #3-151 | #3-172 | #3-189 | #4-202 | | #3-104 | #3-148 | #4-170 | #4-181 | #5-177 | |
| 40'- 0" | 128 | 627 | 906 | 1208 | 1539 | 9.765 | 510 | 1234 | 1641 | 2080 | 2562 | 6.009 |
| STIR | #3- 77 | #3-152 | #3-173 | #3-192 | #4-205 | | #3-103 | #3-155 | #4-172 | #4-183 | #5-180 | |
| 41'- 0" | 88 | 562 | 829 | 1116 | 1431 | 10.778 | 451 | 1141 | 1528 | 1946 | 2404 | 6.633 |
| STIR | #3- 73 | #3-152 | #3-175 | #3-195 | #4-208 | | #3-102 | #3-157 | #3-175 | #4-186 | #5-184 | |
| 42'- 0" | 51 | 503 | 756 | 1030 | 1330 | 11.869 | 396 | 1054 | 1423 | 1821 | 2257 | 7.304 |
| STIR | #3- 70 | #3-153 | #3-177 | #3-173 | #4-211 | | #3-101 | #3-158 | #3-176 | #4-189 | #5-190 | |
| 43'- 0" | 16 | 447 | 689 | 950 | 1236 | 13.040 | 345 | 973 | 1325 | 1705 | 2121 | 8.025 |
| STIR | #3- 66 | #3-153 | #3-178 | #3-181 | #4-214 | | #3-100 | #3-159 | #3-179 | #4-192 | #5-197 | |
| 44'- 0" | | 395 | 626 | 875 | 1149 | 14.296 | 298 | 897 | 1233 | 1596 | 1994 | 8.798 |
| STIR | | #3-153 | #3-179 | #3-190 | #4-217 | | #3- 98 | #3-161 | #3-155 | #4-194 | #5-203 | |
| 45'- 0" | | 346 | 567 | 806 | 1067 | 15.641 | 254 | 826 | 1148 | 1495 | 1875 | 9.625 |
| STIR | | #3-153 | #3-180 | #3-198 | #4-220 | | #3- 97 | #3-162 | #3-162 | #4-197 | #5-209 | |
| 46'- 0" | | 301 | 512 | 741 | 991 | 17.078 | 212 | 760 | 1068 | 1400 | 1764 | 10.510 |
| STIR | | #3-153 | #3-181 | #3-203 | #4-222 | | #3- 95 | #3-163 | #3-169 | #4-200 | #4-212 | |
| 47'- 0" | | 258 | 461 | 680 | 919 | 18.613 | 173 | 698 | 993 | 1311 | 1660 | 11.454 |
| STIR | | #3-152 | #3-182 | #3-205 | #3-225 | | #3- 93 | #3-164 | #3-177 | #4-203 | #4-214 | |
| 48'- 0" | | 218 | 413 | 622 | 852 | 20.248 | 137 | 640 | 923 | 1228 | 1562 | 12.460 |
| STIR | | #3-152 | #3-183 | #3-207 | #3-228 | | #3- 91 | #3-165 | #3-184 | #4-205 | #4-218 | |
| 49'- 0" | | 181 | 367 | 568 | 789 | 21.989 | 103 | 586 | 857 | 1149 | 1470 | 13.532 |
| STIR | | #3-151 | #3-184 | #3-208 | #3-230 | | #3- 88 | #3-166 | #3-188 | #4-207 | #4-220 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.76 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.24 | 2.02 | 2.40 | 3.03 | 3.72 | | 1.65 | 2.75 | 3.41 | 4.13 | 8.16 | |
| ACTUAL STEEL % | 0.420 | 0.687 | 0.816 | 1.032 | 1.270 | | 0.560 | 0.932 | 1.161 | 1.411 | 2.796 | |
| EFF. DEPTH, IN. | 26.38 | 26.31 | 26.31 | 26.25 | 26.19 | | 26.38 | 26.31 | 26.25 | 26.19 | 26.12 | |
| $-I_{cr}/I_{gr}$ | 0.119 | 0.176 | 0.201 | 0.238 | 0.275 | | 0.151 | 0.222 | 0.260 | 0.296 | 0.461 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | |
| ACTUAL STEEL % | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | |
| EFF. DEPTH, IN. | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | |
| $+I_{cr}/I_{gr}$ | 0.127 | 0.195 | 0.232 | 0.271 | 0.313 | | 0.127 | 0.195 | 0.232 | 0.271 | 0.313 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE ONE-WAY JOISTS MULTIPLE SPANS (1)

**53″ Forms + 10″ Ribs @ 63″ c.-c.**
**23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth**
**FACTORED USABLE SUPERIMPOSED LOAD (PLF)**

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 9 | 9 | 7 | 9 | 10 | | 10 | 9.5 | 10 | 8.5 | 6 | |
| BOTTOM BARS NO | 1# 5 | 1# 8 | 1# 7 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 7 | 1#10 | 1#10 | |
| BARS NO | 2# 6 | 1# 9 | 2# 8 | 1#10 | 1#11 | | 2# 6 | 1# 9 | 2# 8 | 1#10 | 1#11 | |
| STEEL (PSF) | 0.90 | 1.41 | 1.69 | 2.04 | 2.31 | | 1.38 | 2.13 | 2.62 | 3.17 | 4.03 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 394 | 951 | 1321 | 1643 | 1908 | 7.149 | 911 | 1722 | 2260 | 2729 | 3114 | 4.399 |
| STIR | #3- 96 | #3-149 | #3-159 | #4-182 | #4-189 | | #3-113 | #3-133 | #4-165 | #5-173 | #5-178 | |
| 38'- 0" | 334 | 863 | 1213 | 1519 | 1770 | 7.953 | 825 | 1594 | 2104 | 2548 | 2913 | 4.894 |
| STIR | #3- 94 | #3-150 | #3-168 | #4-185 | #4-193 | | #3-113 | #3-140 | #4-167 | #5-176 | #5-182 | |
| 39'- 0" | 280 | 782 | 1114 | 1404 | 1643 | 8.824 | 746 | 1476 | 1959 | 2382 | 2728 | 5.430 |
| STIR | #3- 92 | #3-151 | #3-172 | #4-188 | #4-196 | | #3-113 | #3-148 | #4-170 | #5-179 | #5-185 | |
| 40'- 0" | 229 | 706 | 1022 | 1298 | 1525 | 9.765 | 672 | 1366 | 1826 | 2227 | 2557 | 6.009 |
| STIR | #3- 89 | #3-151 | #3-174 | #3-190 | #4-199 | | #3-112 | #3-155 | #4-172 | #4-182 | #5-188 | |
| 41'- 0" | 182 | 636 | 937 | 1200 | 1415 | 10.778 | 604 | 1264 | 1702 | 2084 | 2398 | 6.633 |
| STIR | #3- 87 | #3-152 | #3-175 | #3-168 | #4-202 | | #3-112 | #3-156 | #4-175 | #4-185 | #5-191 | |
| 42'- 0" | 139 | 571 | 858 | 1108 | 1314 | 11.869 | 540 | 1170 | 1587 | 1951 | 2250 | 7.304 |
| STIR | #3- 84 | #3-152 | #3-177 | #3-177 | #4-205 | | #3-111 | #3-158 | #4-177 | #4-187 | #5-194 | |
| 43'- 0" | 98 | 511 | 784 | 1023 | 1219 | 13.040 | 481 | 1082 | 1480 | 1827 | 2112 | 8.025 |
| STIR | #3- 81 | #3-152 | #3-178 | #3-185 | #4-207 | | #3-110 | #3-159 | #3-179 | #4-190 | #5-198 | |
| 44'- 0" | 60 | 454 | 715 | 944 | 1131 | 14.296 | 426 | 1000 | 1380 | 1711 | 1984 | 8.798 |
| STIR | #3- 77 | #3-153 | #3-180 | #3-194 | #3-210 | | #3-109 | #3-161 | #3-182 | #4-193 | #4-200 | |
| 45'- 0" | 25 | 401 | 651 | 869 | 1048 | 15.641 | 375 | 923 | 1286 | 1603 | 1864 | 9.625 |
| STIR | #3- 74 | #3-152 | #3-181 | #3-199 | #3-212 | | #3-108 | #3-162 | #3-161 | #4-195 | #4-204 | |
| 46'- 0" | | 352 | 591 | 800 | 971 | 17.078 | 326 | 851 | 1199 | 1502 | 1751 | 10.510 |
| STIR | | #3-152 | #3-182 | #3-201 | #3-190 | | #3-107 | #3-163 | #3-168 | #4-199 | #4-206 | |
| 47'- 0" | | 306 | 535 | 735 | 899 | 18.613 | 281 | 784 | 1117 | 1408 | 1646 | 11.454 |
| STIR | | #3-152 | #3-183 | #3-202 | #3-199 | | #3-105 | #3-164 | #3-175 | #4-201 | #4-209 | |
| 48'- 0" | | 263 | 482 | 674 | 831 | 20.248 | 239 | 721 | 1040 | 1319 | 1548 | 12.460 |
| STIR | | #3-151 | #3-184 | #3-204 | #3-207 | | #3-104 | #3-165 | #3-183 | #4-203 | #4-212 | |
| 49'- 0" | | 222 | 433 | 616 | 767 | 21.989 | 199 | 662 | 968 | 1236 | 1455 | 13.532 |
| STIR | | #3-150 | #3-184 | #3-206 | #3-216 | | #3-102 | #3-166 | #3-189 | #4-205 | #4-215 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.79 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.40 | 2.17 | 2.79 | 3.08 | 3.78 | | 1.95 | 2.92 | 3.78 | 4.45 | 6.30 | |
| ACTUAL STEEL % | 0.435 | 0.676 | 0.870 | 0.963 | 1.185 | | 0.609 | 0.912 | 1.185 | 1.394 | 1.975 | |
| EFF. DEPTH, IN. | 26.38 | 26.31 | 26.31 | 26.25 | 26.19 | | 26.31 | 26.25 | 26.19 | 26.19 | 26.19 | |
| $-I_{cr}/I_{gr}$ | 0.125 | 0.177 | 0.215 | 0.231 | 0.267 | | 0.163 | 0.221 | 0.267 | 0.300 | 0.380 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 1.19 | 1.79 | 2.18 | 2.54 | 2.83 | | 1.19 | 1.79 | 2.18 | 2.54 | 2.83 | |
| ACTUAL STEEL % | 0.356 | 0.539 | 0.656 | 0.767 | 0.856 | | 0.356 | 0.539 | 0.656 | 0.767 | 0.856 | |
| EFF. DEPTH, IN. | 26.64 | 26.46 | 26.52 | 26.36 | 26.33 | | 26.64 | 26.46 | 26.52 | 26.36 | 26.33 | |
| $+I_{cr}/I_{gr}$ | 0.136 | 0.196 | 0.235 | 0.267 | 0.293 | | 0.136 | 0.196 | 0.235 | 0.267 | 0.293 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE ONE-WAY JOISTS MULTIPLE SPANS (1)

**66″ Forms + 6″ Ribs @ 72″ c.-c.**
**13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth**
**FACTORED USABLE SUPERIMPOSED LOAD (PLF)**

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 5 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 10 | 10 | 10 | | 10 | 10 | 9.5 | 9.5 | |
| BOTTOM BARS NO | 1# 4 | 1# 5 | 1# 6 | 1# 6 | | 1# 4 | 1# 5 | 1# 6 | 1# 6 | |
| BARS NO | 1# 5 | 1# 6 | 1# 6 | 1# 7 | | 1# 5 | 1# 6 | 1# 6 | 1# 7 | |
| STEEL (PSF) | 0.48 | 0.60 | 0.68 | 0.75 | | 0.72 | 0.84 | 0.94 | 1.30 | |
| CLEAR SPAN | END SPAN | | | | | INTERIOR SPAN | | | | |
| 24'- 0" (3) | 159 | 497 | 678 | 901 | 1.265 | 491 | 982 | 1246 | 1569 | 0.779 |
| STIR | #3- 73 | #3-102 | #3- 99 | #3-122 | | #3- 80 | #3-103 | #3-110 | #3-115 | |
| 25'- 0" | 102 | 413 | 580 | 785 | 1.490 | 407 | 860 | 1104 | 1401 | 0.917 |
| STIR | #3- 72 | #3-104 | #3-108 | #3-125 | | #3- 81 | #3-105 | #3-112 | #3-118 | |
| 26'- 0" | 51 | 339 | 494 | 683 | 1.743 | 334 | 752 | 977 | 1253 | 1.073 |
| STIR | #3- 70 | #3-105 | #3-116 | #3-128 | | #3- 81 | #3- 94 | #3-114 | #3-122 | |
| 27'- 0" | 6 | 273 | 416 | 592 | 2.027 | 268 | 656 | 865 | 1120 | 1.247 |
| STIR | #3- 68 | #3-106 | #3-118 | #3-131 | | #3- 81 | #3-101 | #3-118 | #3-124 | |
| 28'- 0" | | 213 | 347 | 510 | 2.344 | 209 | 570 | 764 | 1002 | 1.443 |
| STIR | | #3-107 | #3-119 | #3-133 | | #3- 81 | #3-109 | #3-120 | #3-128 | |
| 29'- 0" | | 160 | 285 | 437 | 2.698 | 156 | 493 | 674 | 895 | 1.660 |
| STIR | | #3-107 | #3-121 | #3-123 | | #3- 81 | #3-110 | #3-122 | #3-130 | |
| 30'- 0" | | 112 | 229 | 371 | 3.090 | 109 | 423 | 592 | 799 | 1.901 |
| STIR | | #3-108 | #3-122 | #3-131 | | #3- 80 | #3-112 | #3-107 | #3-133 | |
| 31'- 0" | | 69 | 178 | 311 | 3.523 | 65 | 360 | 518 | 712 | 2.168 |
| STIR | | #3-108 | #3-123 | #3-137 | | #3- 79 | #3-113 | #3-114 | #3-135 | |
| 32'- 0" | | 30 | 132 | 257 | 4.000 | 26 | 302 | 451 | 633 | 2.461 |
| STIR | | #3-108 | #3-124 | #3-139 | | #3- 78 | #3-114 | #3-121 | #3-139 | |
| 33'- 0" | | | 90 | 207 | 4.523 | | 250 | 390 | 561 | 2.784 |
| STIR | | | #3-125 | #3-141 | | | #3-115 | #3-128 | #3-141 | |
| 34'- 0" | | | 52 | 162 | 5.097 | | 203 | 335 | 496 | 3.137 |
| STIR | | | #3-125 | #3-142 | | | #3-116 | #3-129 | #3-143 | |
| 35'- 0" | | | 17 | 121 | 5.724 | | 159 | 284 | 435 | 3.522 |
| STIR | | | #3-126 | #3-143 | | | #3-117 | #3-131 | #3-145 | |
| 36'- 0" | | | | 83 | 6.407 | | 119 | 237 | 380 | 3.942 |
| STIR | | | | #3-145 | | | #3-118 | #3-132 | #3-148 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.53 CF/SF) | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.44 | 1.44 | 1.44 | 1.44 | | 1.44 | 1.44 | 1.52 | 2.35 | |
| ACTUAL STEEL % | 1.194 | 1.194 | 1.194 | 1.194 | | 1.194 | 1.194 | 1.257 | 1.957 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.38 | | 16.38 | 16.38 | 16.38 | 16.31 | |
| $-I_{cr}/I_{gr}$ | 0.198 | 0.198 | 0.198 | 0.198 | | 0.198 | 0.198 | 0.205 | 0.275 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.51 | 0.75 | 0.88 | 1.04 | | 0.51 | 0.75 | 0.88 | 1.04 | |
| ACTUAL STEEL % | 0.397 | 0.585 | 0.688 | 0.814 | | 0.397 | 0.585 | 0.688 | 0.814 | |
| EFF. DEPTH, IN. | 16.71 | 16.65 | 16.62 | 16.59 | | 16.71 | 16.65 | 16.62 | 16.59 | |
| $+I_{cr}/I_{gr}$ | 0.118 | 0.169 | 0.195 | 0.227 | | 0.118 | 0.169 | 0.195 | 0.227 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 7″ Ribs @ 73″ c.-c.<br>13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 4 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | 9.5 | 8 | | 10 | 10 | 8 | 7 | 8 | |
| BOTTOM BARS NO | 1# 4 | 1# 6 | 1# 6 | 1# 7 | 1# 7 | | 1# 4 | 1# 6 | 1# 6 | 1# 7 | 1# 7 | |
| BARS NO | 1# 5 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | | 1# 5 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | |
| STEEL (PSF) | 0.48 | 0.67 | 0.74 | 0.84 | 0.97 | | 0.72 | 0.91 | 1.10 | 1.28 | 2.02 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 136 | 655 | 878 | 1099 | 1360 | 1.265 | 468 | 1223 | 1546 | 1869 | 2249 | 0.779 |
| STIR | #3- 60 | #3-104 | #3-116 | #3-122 | #3-128 | | #3- 72 | #3-104 | #3-110 | #3-116 | #4-120 | |
| 25'- 0" | 79 | 557 | 762 | 966 | 1207 | 1.490 | 384 | 1081 | 1379 | 1676 | 2026 | 0.917 |
| STIR | #3- 58 | #3-106 | #3-104 | #3-125 | #3-132 | | #3- 71 | #3-106 | #3-114 | #3-118 | #4-114 | |
| 26'- 0" | 28 | 471 | 660 | 849 | 1071 | 1.743 | 311 | 954 | 1230 | 1504 | 1828 | 1.073 |
| STIR | #3- 55 | #3-107 | #3-112 | #3-129 | #3-136 | | #3- 71 | #3-109 | #3-116 | #3-121 | #4-117 | |
| 27'- 0" | | 393 | 569 | 744 | 950 | 2.027 | 245 | 842 | 1097 | 1352 | 1652 | 1.247 |
| STIR | | #3-108 | #3-120 | #3-131 | #3-138 | | #3- 70 | #3- 98 | #3-118 | #3-125 | #4-122 | |
| 28'- 0" | | 324 | 487 | 650 | 842 | 2.344 | 186 | 741 | 979 | 1215 | 1494 | 1.443 |
| STIR | | #3-109 | #3-122 | #3-133 | #3-142 | | #3- 69 | #3-105 | #3-122 | #3-128 | #3-127 | |
| 29'- 0" | | 262 | 414 | 566 | 745 | 2.698 | 133 | 651 | 872 | 1093 | 1353 | 1.660 |
| STIR | | #3-110 | #3-124 | #3-121 | #3-145 | | #3- 68 | #3-112 | #3-124 | #3-131 | #3-133 | |
| 30'- 0" | | 206 | 348 | 490 | 657 | 3.090 | 85 | 569 | 776 | 982 | 1225 | 1.901 |
| STIR | | #3-111 | #3-125 | #3-130 | #3-148 | | #3- 66 | #3-114 | #3-126 | #3-134 | #3-139 | |
| 31'- 0" | | 155 | 288 | 421 | 577 | 3.523 | 42 | 495 | 689 | 882 | 1110 | 2.168 |
| STIR | | #3-111 | #3-127 | #3-138 | #3-150 | | #3- 65 | #3-115 | #3-129 | #3-137 | #3-144 | |
| 32'- 0" | | 109 | 234 | 358 | 505 | 4.000 | 3 | 428 | 610 | 791 | 1005 | 2.461 |
| STIR | | #3-111 | #3-128 | #3-140 | #3-153 | | #3- 63 | #3-117 | #3-117 | #3-139 | #3-146 | |
| 33'- 0" | | 67 | 184 | 302 | 440 | 4.523 | | 367 | 538 | 709 | 910 | 2.784 |
| STIR | | #3-111 | #3-129 | #3-142 | #3-155 | | | #3-118 | #3-124 | #3-141 | #3-150 | |
| 34'- 0" | | 29 | 139 | 250 | 380 | 5.097 | | 312 | 473 | 633 | 822 | 3.137 |
| STIR | | #3-110 | #3-129 | #3-143 | #3-144 | | | #3-119 | #3-132 | #3-144 | #3-153 | |
| 35'- 0" | | | 98 | 202 | 325 | 5.724 | | 261 | 412 | 564 | 743 | 3.522 |
| STIR | | | #3-130 | #3-145 | #3-153 | | | #3-120 | #3-134 | #3-145 | #3-155 | |
| 36'- 0" | | | 60 | 159 | 275 | 6.407 | | 214 | 357 | 501 | 669 | 3.942 |
| STIR | | | #3-130 | #3-146 | #3-160 | | | #3-121 | #3-135 | #3-147 | #3-157 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.54 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.46 | 1.46 | 1.46 | 1.54 | 1.83 | | 1.46 | 1.46 | 1.83 | 2.09 | 4.01 | |
| ACTUAL STEEL % | 1.066 | 1.066 | 1.066 | 1.122 | 1.332 | | 1.066 | 1.066 | 1.332 | 1.523 | 2.958 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.38 | 16.38 | | 16.38 | 16.38 | 16.38 | 16.38 | 16.25 | |
| $-I_{cr}/I_{gr}$ | 0.186 | 0.186 | 0.186 | 0.193 | 0.219 | | 0.186 | 0.186 | 0.219 | 0.241 | 0.362 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.88 | 1.04 | 1.20 | 1.39 | | 0.51 | 0.88 | 1.04 | 1.20 | 1.39 | |
| ACTUAL STEEL % | 0.351 | 0.609 | 0.721 | 0.832 | 0.966 | | 0.351 | 0.609 | 0.721 | 0.832 | 0.966 | |
| EFF. DEPTH, IN. | 16.71 | 16.62 | 16.59 | 16.56 | 16.53 | | 16.71 | 16.62 | 16.59 | 16.56 | 16.53 | |
| $+I_{cr}/I_{gr}$ | 0.106 | 0.175 | 0.203 | 0.231 | 0.264 | | 0.106 | 0.175 | 0.203 | 0.231 | 0.264 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 8″ Ribs @ 74″ c.-c.<br>13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 4 | # 4 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | 10 | 8.5 | | 10 | 10 | 8.5 | 7 | 5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 1# 6 | 1# 5 | 1# 7 | | 2# 4 | 1# 6 | 1# 6 | 1# 5 | 1# 7 | |
| BARS NO | 1# 4 | 1# 6 | 1# 7 | 2# 6 | 1# 8 | | 1# 4 | 1# 6 | 1# 7 | 2# 6 | 1# 8 | |
| STEEL (PSF) | 0.51 | 0.67 | 0.73 | 0.77 | 0.94 | | 0.75 | 0.91 | 1.06 | 1.22 | 1.62 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 243 | 632 | 855 | 1070 | 1337 | 1.265 | 634 | 1200 | 1523 | 1837 | 2226 | 0.779 |
| STIR | #3- 65 | #3- 97 | #3-107 | #3-117 | #3-124 | | #3- 75 | #3- 87 | #3-106 | #3-112 | #4-116 | |
| 25'- 0" | 176 | 534 | 739 | 938 | 1184 | 1.490 | 536 | 1058 | 1356 | 1645 | 2003 | 0.917 |
| STIR | #3- 63 | #3- 98 | #3-109 | #3-119 | #3-127 | | #3- 75 | #3- 94 | #3-109 | #3-114 | #4-120 | |
| 26'- 0" | 116 | 448 | 637 | 821 | 1048 | 1.743 | 449 | 931 | 1207 | 1474 | 1805 | 1.073 |
| STIR | #3- 61 | #3- 98 | #3-111 | #3-110 | #3-130 | | #3- 75 | #3-101 | #3-112 | #3-118 | #4-122 | |
| 27'- 0" | 63 | 370 | 546 | 716 | 927 | 2.027 | 371 | 819 | 1074 | 1322 | 1629 | 1.247 |
| STIR | #3- 59 | #3- 99 | #3-112 | #3-118 | #3-133 | | #3- 75 | #3-102 | #3-113 | #3-120 | #3-127 | |
| 28'- 0" | 15 | 301 | 464 | 623 | 819 | 2.344 | 302 | 718 | 956 | 1186 | 1472 | 1.443 |
| STIR | #3- 56 | #3- 99 | #3-114 | #3-124 | #3-136 | | #3- 74 | #3-104 | #3-100 | #3-123 | #3-129 | |
| 29'- 0" | | 239 | 391 | 539 | 722 | 2.698 | 240 | 628 | 849 | 1064 | 1330 | 1.660 |
| STIR | | #3- 99 | #3-115 | #3-126 | #3-138 | | #3- 73 | #3-105 | #3-108 | #3-125 | #3-132 | |
| 30'- 0" | | 183 | 325 | 463 | 634 | 3.090 | 184 | 546 | 753 | 954 | 1202 | 1.901 |
| STIR | | #3- 99 | #3-115 | #3-127 | #3-126 | | #3- 72 | #3-106 | #3-115 | #3-127 | #3-135 | |
| 31'- 0" | | 132 | 265 | 394 | 554 | 3.523 | 133 | 472 | 666 | 854 | 1087 | 2.168 |
| STIR | | #3- 98 | #3-116 | #3-129 | #3-134 | | #3- 71 | #3-107 | #3-119 | #3-130 | #3-138 | |
| 32'- 0" | | 86 | 211 | 332 | 482 | 4.000 | 87 | 405 | 587 | 764 | 982 | 2.461 |
| STIR | | #3- 98 | #3-116 | #3-130 | #3-142 | | #3- 69 | #3-108 | #3-121 | #3-132 | #3-141 | |
| 33'- 0" | | 44 | 161 | 275 | 417 | 4.523 | 45 | 344 | 515 | 681 | 887 | 2.784 |
| STIR | | #3- 97 | #3-117 | #3-131 | #3-144 | | #3- 67 | #3-108 | #3-122 | #3-121 | #3-143 | |
| 34'- 0" | | 6 | 116 | 224 | 357 | 5.097 | 6 | 288 | 450 | 606 | 799 | 3.137 |
| STIR | | #3- 95 | #3-117 | #3-132 | #3-146 | | #3- 65 | #3-109 | #3-123 | #3-129 | #3-145 | |
| 35'- 0" | | | 75 | 176 | 302 | 5.724 | | 237 | 389 | 537 | 720 | 3.522 |
| STIR | | | #3-116 | #3-133 | #3-148 | | | #3-109 | #3-124 | #3-135 | #3-148 | |
| 36'- 0" | | | 37 | 133 | 252 | 6.407 | | 191 | 334 | 474 | 646 | 3.942 |
| STIR | | | #3-116 | #3-133 | #3-149 | | | #3-109 | #3-125 | #3-137 | #3-150 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.48 | 1.48 | 1.48 | 1.48 | 1.74 | | 1.48 | 1.48 | 1.74 | 2.11 | 2.96 | |
| ACTUAL STEEL % | 0.965 | 0.965 | 0.965 | 0.965 | 1.135 | | 0.965 | 0.965 | 1.135 | 1.379 | 1.930 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.38 | 16.38 | | 16.38 | 16.38 | 16.38 | 16.38 | 16.38 | |
| $-I_{cr}/I_{gr}$ | 0.177 | 0.177 | 0.177 | 0.177 | 0.199 | | 0.177 | 0.177 | 0.199 | 0.229 | 0.289 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 0.88 | 1.04 | 1.19 | 1.39 | | 0.60 | 0.88 | 1.04 | 1.19 | 1.39 | |
| ACTUAL STEEL % | 0.370 | 0.546 | 0.646 | 0.737 | 0.867 | | 0.370 | 0.546 | 0.646 | 0.737 | 0.867 | |
| EFF. DEPTH, IN. | 16.75 | 16.62 | 16.59 | 16.64 | 16.53 | | 16.75 | 16.62 | 16.59 | 16.64 | 16.53 | |
| $+I_{cr}/I_{gr}$ | 0.113 | 0.159 | 0.185 | 0.211 | 0.240 | | 0.113 | 0.159 | 0.185 | 0.211 | 0.240 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 9″ Ribs @ 75″ c.-c.<br>13″ Deep Rib + 5.0″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | 9 | 7.5 | | 10 | 9 | 7.5 | 10 | 7.5 | |
| BOTTOM BARS NO | 2# 4 | 2# 4 | 1# 5 | 2# 6 | 1# 8 | | 2# 4 | 2# 4 | 1# 5 | 2# 6 | 1# 8 | |
| BARS NO | 1# 4 | 2# 5 | 2# 6 | 1# 6 | 1# 8 | | 1# 4 | 2# 5 | 2# 6 | 1# 6 | 1# 8 | |
| STEEL (PSF) | 0.51 | 0.70 | 0.77 | 0.87 | 1.07 | | 0.75 | 1.00 | 1.17 | 1.35 | 2.19 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 220 | 814 | 1047 | 1228 | 1575 | 1.265 | 611 | 1475 | 1814 | 2077 | 2582 | 0.779 |
| STIR | #3- 54 | #3-100 | #3-103 | #3-117 | #3-125 | | #3- 68 | #3-102 | #3-107 | #3-111 | #4-111 | |
| 25'- 0" | 152 | 700 | 915 | 1082 | 1401 | 1.490 | 513 | 1310 | 1622 | 1864 | 2329 | 0.917 |
| STIR | #3- 52 | #3-101 | #3-111 | #3-119 | #3-129 | | #3- 67 | #3- 90 | #3-110 | #3-115 | #4-115 | |
| 26'- 0" | 93 | 599 | 798 | 952 | 1247 | 1.743 | 426 | 1162 | 1451 | 1675 | 2105 | 1.073 |
| STIR | #3- 49 | #3-102 | #3-113 | #3-110 | #3-132 | | #3- 66 | #3- 97 | #3-113 | #3-117 | #4-119 | |
| 27'- 0" | 39 | 509 | 693 | 836 | 1110 | 2.027 | 348 | 1031 | 1299 | 1507 | 1906 | 1.247 |
| STIR | #3- 45 | #3-103 | #3-115 | #3-118 | #3-134 | | #3- 65 | #3-104 | #3-115 | #3-120 | #4-125 | |
| 28'- 0" | | 428 | 600 | 733 | 987 | 2.344 | 279 | 914 | 1163 | 1356 | 1727 | 1.443 |
| STIR | | #3-104 | #3-116 | #3-124 | #3-137 | | #3- 64 | #3-107 | #3-118 | #3-123 | #4-130 | |
| 29'- 0" | | 356 | 516 | 639 | 877 | 2.698 | 217 | 809 | 1041 | 1221 | 1567 | 1.660 |
| STIR | | #3-104 | #3-118 | #3-126 | #3-139 | | #3- 62 | #3-108 | #3-104 | #3-125 | #3-134 | |
| 30'- 0" | | 291 | 440 | 556 | 778 | 3.090 | 161 | 714 | 931 | 1099 | 1422 | 1.901 |
| STIR | | #3-104 | #3-119 | #3-127 | #3-142 | | #3- 60 | #3-110 | #3-111 | #3-128 | #3-136 | |
| 31'- 0" | | 232 | 371 | 480 | 688 | 3.523 | 110 | 628 | 831 | 989 | 1291 | 2.168 |
| STIR | | #3-104 | #3-119 | #3-129 | #3-131 | | #3- 58 | #3-111 | #3-119 | #3-130 | #3-140 | |
| 32'- 0" | | 178 | 309 | 411 | 606 | 4.000 | 64 | 550 | 741 | 888 | 1172 | 2.461 |
| STIR | | #3-104 | #3-120 | #3-130 | #3-140 | | #3- 56 | #3-112 | #3-123 | #3-132 | #3-143 | |
| 33'- 0" | | 129 | 252 | 348 | 532 | 4.523 | 22 | 479 | 658 | 797 | 1064 | 2.784 |
| STIR | | #3-103 | #3-121 | #3-131 | #3-146 | | #3- 53 | #3-113 | #3-125 | #3-121 | #3-145 | |
| 34'- 0" | | 85 | 201 | 291 | 464 | 5.097 | | 414 | 583 | 714 | 965 | 3.137 |
| STIR | | #3-102 | #3-121 | #3-132 | #3-148 | | | #3-113 | #3-126 | #3-128 | #3-148 | |
| 35'- 0" | | 44 | 153 | 238 | 401 | 5.724 | | 355 | 514 | 638 | 875 | 3.522 |
| STIR | | #3-101 | #3-121 | #3-133 | #3-150 | | | #3-114 | #3-127 | #3-136 | #3-150 | |
| 36'- 0" | | 6 | 110 | 190 | 344 | 6.407 | | 300 | 451 | 568 | 792 | 3.942 |
| STIR | | #3-100 | #3-121 | #3-133 | #3-151 | | | #3-114 | #3-128 | #3-137 | #3-152 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.57 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.50 | 1.50 | 1.50 | 1.67 | 2.00 | | 1.50 | 1.67 | 2.00 | 2.33 | 4.40 | |
| ACTUAL STEEL % | 0.884 | 0.884 | 0.884 | 0.982 | 1.178 | | 0.884 | 0.982 | 1.178 | 1.376 | 2.615 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.38 | 16.38 | | 16.38 | 16.38 | 16.38 | 16.31 | 16.25 | |
| $-I_{cr}/I_{gr}$ | 0.169 | 0.169 | 0.169 | 0.183 | 0.209 | | 0.169 | 0.183 | 0.209 | 0.231 | 0.351 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 1.02 | 1.19 | 1.32 | 1.58 | | 0.60 | 1.02 | 1.19 | 1.32 | 1.58 | |
| ACTUAL STEEL % | 0.335 | 0.571 | 0.669 | 0.742 | 0.894 | | 0.335 | 0.571 | 0.669 | 0.742 | 0.894 | |
| EFF. DEPTH, IN. | 16.75 | 16.71 | 16.64 | 16.62 | 16.50 | | 16.75 | 16.71 | 16.64 | 16.62 | 16.50 | |
| $+I_{cr}/I_{gr}$ | 0.104 | 0.170 | 0.194 | 0.213 | 0.247 | | 0.104 | 0.170 | 0.194 | 0.213 | 0.247 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 6″ Ribs @ 72″ c.-c.<br>15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | | | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | | | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | | | | 10 | 9.5 | 8 | | | |
| BOTTOM BARS NO | 1# 4 | 1# 6 | 1# 6 | | | | 1# 4 | 1# 6 | 1# 6 | | | |
| BARS NO | 1# 5 | 1# 6 | 1# 7 | | | | 1# 5 | 1# 6 | 1# 7 | | | |
| STEEL (PSF) | 0.48 | 0.68 | 0.75 | | | | 0.72 | 0.94 | 1.11 | | | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 105 | 601 | 814 | | | 1.743 | 421 | 1144 | 1453 | | | 1.073 |
| STIR | #3- 67 | #3-114 | #3-126 | | | | #3- 79 | #3-113 | #3-121 | | | |
| 27'- 0" | 54 | 515 | 712 | | | 2.027 | 348 | 1018 | 1305 | | | 1.247 |
| STIR | #3- 65 | #3-116 | #3-129 | | | | #3- 79 | #3-117 | #3-123 | | | |
| 28'- 0" | 9 | 437 | 620 | | | 2.344 | 282 | 905 | 1171 | | | 1.443 |
| STIR | #3- 63 | #3-118 | #3-117 | | | | #3- 79 | #3-118 | #3-126 | | | |
| 29'- 0" | | 367 | 538 | | | 2.698 | 223 | 803 | 1052 | | | 1.660 |
| STIR | | #3-119 | #3-126 | | | | #3- 78 | #3-102 | #3-129 | | | |
| 30'- 0" | | 304 | 464 | | | 3.090 | 169 | 712 | 944 | | | 1.901 |
| STIR | | #3-120 | #3-133 | | | | #3- 78 | #3-109 | #3-132 | | | |
| 31'- 0" | | 248 | 397 | | | 3.523 | 121 | 629 | 847 | | | 2.168 |
| STIR | | #3-121 | #3-135 | | | | #3- 77 | #3-116 | #3-134 | | | |
| 32'- 0" | | 196 | 336 | | | 4.000 | 77 | 554 | 758 | | | 2.461 |
| STIR | | #3-122 | #3-137 | | | | #3- 75 | #3-124 | #3-136 | | | |
| 33'- 0" | | 149 | 281 | | | 4.523 | 37 | 486 | 678 | | | 2.784 |
| STIR | | #3-122 | #3-139 | | | | #3- 74 | #3-126 | #3-139 | | | |
| 34'- 0" | | 106 | 230 | | | 5.097 | 1 | 423 | 604 | | | 3.137 |
| STIR | | #3-123 | #3-140 | | | | #3- 72 | #3-127 | #3-141 | | | |
| 35'- 0" | | 67 | 184 | | | 5.724 | | 366 | 537 | | | 3.522 |
| STIR | | #3-123 | #3-141 | | | | | #3-129 | #3-126 | | | |
| 36'- 0" | | 31 | 142 | | | 6.407 | | 314 | 475 | | | 3.942 |
| STIR | | #3-123 | #3-142 | | | | | #3-130 | #3-133 | | | |
| 37'- 0" | | | 102 | | | 7.149 | | 265 | 418 | | | 4.399 |
| STIR | | | #3-143 | | | | | #3-131 | #3-141 | | | |
| 38'- 0" | | | 66 | | | 7.953 | | 221 | 366 | | | 4.894 |
| STIR | | | #3-144 | | | | | #3-132 | #3-147 | | | |
| PROPERTIES FOR DESIGN (CONCRETE 0.55 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.44 | 1.44 | 1.44 | | | | 1.44 | 1.52 | 1.80 | | | |
| ACTUAL STEEL % | 1.041 | 1.041 | 1.041 | | | | 1.041 | 1.095 | 1.301 | | | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | | | | 18.38 | 18.38 | 18.38 | | | |
| $-I_{cr}/I_{gr}$ | 0.188 | 0.188 | 0.188 | | | | 0.188 | 0.195 | 0.221 | | | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.88 | 1.04 | | | | 0.51 | 0.88 | 1.04 | | | |
| ACTUAL STEEL % | 0.347 | 0.601 | 0.711 | | | | 0.347 | 0.601 | 0.711 | | | |
| EFF. DEPTH, IN. | 18.71 | 18.62 | 18.59 | | | | 18.71 | 18.62 | 18.59 | | | |
| $+I_{cr}/I_{gr}$ | 0.109 | 0.180 | 0.210 | | | | 0.109 | 0.180 | 0.210 | | | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 7″ Ribs @ 73″ c.-c.<br>15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 4 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 9.5 | 8 | 7 | | 10 | 10 | 7 | 4 | 7 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | | 2# 4 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | |
| BARS NO | 1# 4 | 1# 6 | 1# 7 | 1# 8 | 1# 8 | | 1# 4 | 1# 6 | 1# 7 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.52 | 0.67 | 0.84 | 0.97 | 1.11 | | 0.76 | 0.91 | 1.28 | 1.87 | 2.31 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 203 | 576 | 1001 | 1251 | 1501 | 1.743 | 576 | 1118 | 1737 | 2101 | 2464 | 1.073 |
| STIR | #3- 72 | #3-106 | #3-128 | #3-134 | #3-140 | | #3- 82 | #3- 93 | #3-121 | #4-124 | #4-130 | |
| 27'- 0" | 144 | 489 | 883 | 1115 | 1347 | 2.027 | 489 | 992 | 1565 | 1903 | 2240 | 1.247 |
| STIR | #3- 70 | #3-107 | #3-130 | #3-138 | #3-144 | | #3- 82 | #3-100 | #3-124 | #4-127 | #4-124 | |
| 28'- 0" | 90 | 412 | 778 | 994 | 1209 | 2.344 | 412 | 879 | 1412 | 1726 | 2039 | 1.443 |
| STIR | #3- 68 | #3-108 | #3-115 | #3-141 | #3-147 | | #3- 82 | #3-108 | #3-127 | #4-130 | #4-127 | |
| 29'- 0" | 42 | 342 | 683 | 885 | 1085 | 2.698 | 342 | 778 | 1275 | 1567 | 1859 | 1.660 |
| STIR | #3- 66 | #3-108 | #3-124 | #3-143 | #3-151 | | #3- 82 | #3-111 | #3-130 | #3-136 | #4-130 | |
| 30'- 0" | | 279 | 598 | 786 | 974 | 3.090 | 279 | 686 | 1151 | 1424 | 1697 | 1.901 |
| STIR | | #3-109 | #3-132 | #3-147 | #3-154 | | #3- 82 | #3-113 | #3-132 | #3-139 | #4-134 | |
| 31'- 0" | | 222 | 521 | 697 | 873 | 3.523 | 222 | 604 | 1038 | 1295 | 1550 | 2.168 |
| STIR | | #3-109 | #3-137 | #3-149 | #3-157 | | #3- 81 | #3-114 | #3-135 | #3-142 | #4-141 | |
| 32'- 0" | | 170 | 451 | 616 | 781 | 4.000 | 171 | 528 | 937 | 1177 | 1417 | 2.461 |
| STIR | | #3-109 | #3-138 | #3-151 | #3-160 | | #3- 80 | #3-115 | #3-138 | #3-145 | #4-147 | |
| 33'- 0" | | 123 | 387 | 543 | 698 | 4.523 | 124 | 460 | 844 | 1070 | 1295 | 2.784 |
| STIR | | #3-108 | #3-140 | #3-139 | #3-162 | | #3- 79 | #3-116 | #3-140 | #3-149 | #4-153 | |
| 34'- 0" | | 80 | 329 | 475 | 621 | 5.097 | 81 | 398 | 759 | 972 | 1184 | 3.137 |
| STIR | | #3-108 | #3-141 | #3-147 | #3-166 | | #3- 77 | #3-117 | #3-142 | #3-150 | #3-158 | |
| 35'- 0" | | 41 | 276 | 414 | 552 | 5.724 | 41 | 340 | 682 | 882 | 1083 | 3.522 |
| STIR | | #3-107 | #3-143 | #3-156 | #3-169 | | #3- 76 | #3-118 | #3-144 | #3-153 | #3-161 | |
| 36'- 0" | | 5 | 227 | 357 | 487 | 6.407 | 5 | 288 | 610 | 800 | 990 | 3.942 |
| STIR | | #3-106 | #3-144 | #3-158 | #3-170 | | #3- 74 | #3-119 | #3-131 | #3-157 | #3-164 | |
| 37'- 0" | | | 182 | 305 | 429 | 7.149 | | 240 | 545 | 725 | 904 | 4.399 |
| STIR | | | #3-145 | #3-160 | #3-154 | | | #3-119 | #3-138 | #3-159 | #3-167 | |
| 38'- 0" | | | 140 | 257 | 374 | 7.953 | | 195 | 485 | 655 | 825 | 4.894 |
| STIR | | | #3-146 | #3-161 | #3-162 | | | #3-119 | #3-146 | #3-160 | #3-170 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.46 | 1.46 | 1.54 | 1.83 | 2.09 | | 1.46 | 1.46 | 2.09 | 3.65 | 4.59 | |
| ACTUAL STEEL % | 0.931 | 0.931 | 0.980 | 1.164 | 1.330 | | 0.931 | 0.931 | 1.330 | 2.328 | 2.951 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.38 | 18.38 | | 18.38 | 18.38 | 18.38 | 18.38 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.177 | 0.177 | 0.184 | 0.208 | 0.229 | | 0.177 | 0.177 | 0.229 | 0.335 | 0.380 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 0.88 | 1.20 | 1.39 | 1.58 | | 0.60 | 0.88 | 1.20 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.361 | 0.533 | 0.729 | 0.846 | 0.962 | | 0.361 | 0.533 | 0.729 | 0.846 | 0.962 | |
| EFF. DEPTH, IN. | 18.75 | 18.62 | 18.56 | 18.53 | 18.50 | | 18.75 | 18.62 | 18.56 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.114 | 0.162 | 0.214 | 0.244 | 0.274 | | 0.114 | 0.162 | 0.214 | 0.244 | 0.274 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 8″ Ribs @ 74″ c.-c.<br>15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | 8.5 | 7.5 | | 10 | 8.5 | 7.5 | 9.5 | 7.5 | |
| BOTTOM BARS NO | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.54 | 0.73 | 0.77 | 0.94 | 1.08 | | 0.78 | 1.06 | 1.18 | 1.45 | 2.20 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 202 | 763 | 969 | 1226 | 1476 | 1.743 | 586 | 1402 | 1702 | 2075 | 2439 | 1.073 |
| STIR | #3- 63 | #3-110 | #3-112 | #3-129 | #3-135 | | #3- 76 | #3-110 | #3-116 | #4-122 | #4-122 | |
| 27'- 0" | 141 | 661 | 852 | 1090 | 1322 | 2.027 | 497 | 1254 | 1531 | 1878 | 2214 | 1.247 |
| STIR | #3- 60 | #3-111 | #3-120 | #3-132 | #3-139 | | #3- 76 | #3- 95 | #3-119 | #4-125 | #4-126 | |
| 28'- 0" | 86 | 569 | 747 | 968 | 1184 | 2.344 | 417 | 1121 | 1379 | 1701 | 2014 | 1.443 |
| STIR | #3- 57 | #3-112 | #3-123 | #3-135 | #3-142 | | #3- 75 | #3-102 | #3-121 | #3-129 | #4-129 | |
| 29'- 0" | 36 | 487 | 653 | 859 | 1060 | 2.698 | 345 | 1001 | 1242 | 1542 | 1834 | 1.660 |
| STIR | #3- 54 | #3-113 | #3-124 | #3-120 | #3-145 | | #3- 74 | #3-110 | #3-124 | #3-131 | #4-134 | |
| 30'- 0" | | 413 | 568 | 761 | 948 | 3.090 | 280 | 893 | 1118 | 1399 | 1672 | 1.901 |
| STIR | | #3-114 | #3-126 | #3-128 | #3-147 | | #3- 73 | #3-116 | #3-126 | #3-134 | #4-140 | |
| 31'- 0" | | 346 | 491 | 672 | 847 | 3.523 | 222 | 796 | 1006 | 1269 | 1525 | 2.168 |
| STIR | | #3-114 | #3-127 | #3-137 | #3-150 | | #3- 72 | #3-118 | #3-109 | #3-137 | #4-144 | |
| 32'- 0" | | 285 | 421 | 591 | 756 | 4.000 | 168 | 707 | 905 | 1151 | 1391 | 2.461 |
| STIR | | #3-114 | #3-128 | #3-141 | #3-153 | | #3- 70 | #3-119 | #3-116 | #3-140 | #3-146 | |
| 33'- 0" | | 230 | 358 | 517 | 672 | 4.523 | 120 | 627 | 812 | 1044 | 1270 | 2.784 |
| STIR | | #3-115 | #3-129 | #3-143 | #3-137 | | #3- 68 | #3-121 | #3-124 | #3-142 | #3-150 | |
| 34'- 0" | | 179 | 300 | 450 | 596 | 5.097 | 76 | 553 | 728 | 947 | 1159 | 3.137 |
| STIR | | #3-114 | #3-130 | #3-144 | #3-145 | | #3- 66 | #3-122 | #3-131 | #3-145 | #3-152 | |
| 35'- 0" | | 133 | 247 | 388 | 526 | 5.724 | 35 | 486 | 651 | 857 | 1057 | 3.522 |
| STIR | | #3-114 | #3-131 | #3-146 | #3-154 | | #3- 64 | #3-123 | #3-134 | #3-146 | #3-155 | |
| 36'- 0" | | 90 | 198 | 332 | 462 | 6.407 | | 424 | 580 | 775 | 964 | 3.942 |
| STIR | | #3-114 | #3-131 | #3-147 | #3-159 | | | #3-124 | #3-136 | #3-149 | #3-157 | |
| 37'- 0" | | 51 | 153 | 280 | 403 | 7.149 | | 367 | 515 | 699 | 879 | 4.399 |
| STIR | | #3-113 | #3-131 | #3-148 | #3-161 | | | #3-124 | #3-137 | #3-133 | #3-160 | |
| 38'- 0" | | 15 | 112 | 232 | 349 | 7.953 | | 314 | 455 | 630 | 800 | 4.894 |
| STIR | | #3-112 | #3-131 | #3-149 | #3-163 | | | #3-125 | #3-138 | #3-141 | #3-163 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.48 | 1.48 | 1.48 | 1.74 | 1.97 | | 1.48 | 1.74 | 1.97 | 2.41 | 4.34 | |
| ACTUAL STEEL % | 0.845 | 0.845 | 0.845 | 0.994 | 1.127 | | 0.845 | 0.994 | 1.127 | 1.384 | 2.499 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.38 | 18.38 | | 18.38 | 18.38 | 18.38 | 18.31 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.167 | 0.167 | 0.167 | 0.189 | 0.208 | | 0.167 | 0.189 | 0.208 | 0.238 | 0.351 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | |
| EFF. DEPTH, IN. | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.107 | 0.171 | 0.195 | 0.222 | 0.249 | | 0.107 | 0.171 | 0.195 | 0.222 | 0.249 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 9″ Ribs @ 75″ c.-c.<br>15″ Deep Rib + 5.0″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 9 | 7.5 | 10 | | 10 | 7.5 | 10 | 8.5 | 6.5 | |
| BOTTOM BARS NO | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.57 | 0.77 | 0.87 | 1.07 | 1.21 | | 0.81 | 1.17 | 1.35 | 1.63 | 2.50 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 300 | 944 | 1117 | 1450 | 1724 | 1.743 | 741 | 1676 | 1928 | 2413 | 2811 | 1.073 |
| STIR | #3- 67 | #3-112 | #3-111 | #3-130 | #4-136 | | #3- 79 | #3-112 | #3-117 | #4-124 | #4-121 | |
| 27'- 0" | 230 | 826 | 987 | 1296 | 1550 | 2.027 | 638 | 1506 | 1739 | 2189 | 2558 | 1.247 |
| STIR | #3- 65 | #3-114 | #3-120 | #3-133 | #3-140 | | #3- 79 | #3-115 | #3-120 | #4-127 | #4-125 | |
| 28'- 0" | 167 | 721 | 871 | 1158 | 1394 | 2.344 | 547 | 1353 | 1570 | 1989 | 2332 | 1.443 |
| STIR | #3- 62 | #3-115 | #3-123 | #3-136 | #3-143 | | #3- 78 | #3- 98 | #3-122 | #4-130 | #4-127 | |
| 29'- 0" | 110 | 627 | 766 | 1034 | 1254 | 2.698 | 464 | 1216 | 1419 | 1809 | 2129 | 1.660 |
| STIR | #3- 60 | #3-116 | #3-124 | #3-139 | #3-146 | | #3- 78 | #3-106 | #3-124 | #4-132 | #4-133 | |
| 30'- 0" | 59 | 542 | 672 | 923 | 1128 | 3.090 | 390 | 1093 | 1282 | 1646 | 1945 | 1.901 |
| STIR | #3- 57 | #3-117 | #3-126 | #3-125 | #3-149 | | #3- 77 | #3-113 | #3-127 | #3-136 | #4-139 | |
| 31'- 0" | 13 | 465 | 587 | 822 | 1014 | 3.523 | 323 | 981 | 1158 | 1499 | 1779 | 2.168 |
| STIR | #3- 53 | #3-118 | #3-127 | #3-133 | #3-152 | | #3- 76 | #3-120 | #3-128 | #3-139 | #4-144 | |
| 32'- 0" | | 396 | 510 | 730 | 911 | 4.000 | 262 | 879 | 1046 | 1366 | 1629 | 2.461 |
| STIR | | #3-118 | #3-128 | #3-142 | #3-154 | | #3- 75 | #3-122 | #3-116 | #3-142 | #4-147 | |
| 33'- 0" | | 332 | 440 | 647 | 817 | 4.523 | 206 | 787 | 943 | 1244 | 1492 | 2.784 |
| STIR | | #3-119 | #3-129 | #3-145 | #3-157 | | #3- 73 | #3-123 | #3-123 | #3-144 | #4-151 | |
| 34'- 0" | | 274 | 375 | 570 | 730 | 5.097 | 156 | 703 | 850 | 1134 | 1366 | 3.137 |
| STIR | | #3-119 | #3-130 | #3-147 | #3-141 | | #3- 71 | #3-125 | #3-130 | #3-146 | #4-153 | |
| 35'- 0" | | 221 | 317 | 501 | 652 | 5.724 | 109 | 625 | 764 | 1032 | 1252 | 3.522 |
| STIR | | #3-119 | #3-131 | #3-148 | #3-150 | | #3- 69 | #3-126 | #3-134 | #3-148 | #3-156 | |
| 36'- 0" | | 172 | 263 | 437 | 579 | 6.407 | 67 | 554 | 686 | 939 | 1147 | 3.942 |
| STIR | | #3-118 | #3-131 | #3-150 | #3-158 | | #3- 67 | #3-127 | #3-136 | #3-151 | #3-159 | |
| 37'- 0" | | 127 | 213 | 378 | 513 | 7.149 | 27 | 489 | 614 | 853 | 1050 | 4.399 |
| STIR | | #3-118 | #3-131 | #3-151 | #3-163 | | #3- 65 | #3-128 | #3-137 | #3-153 | #3-162 | |
| 38'- 0" | | 86 | 167 | 323 | 451 | 7.953 | | 429 | 547 | 774 | 961 | 4.894 |
| STIR | | #3-117 | #3-131 | #3-152 | #3-165 | | | #3-129 | #3-139 | #3-137 | #3-164 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.50 | 1.50 | 1.67 | 2.00 | 2.33 | | 1.50 | 2.00 | 2.33 | 2.74 | 5.08 | |
| ACTUAL STEEL % | 0.775 | 0.775 | 0.861 | 1.034 | 1.206 | | 0.775 | 1.034 | 1.206 | 1.419 | 2.644 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.38 | 18.31 | | 18.38 | 18.38 | 18.31 | 18.31 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.160 | 0.160 | 0.173 | 0.199 | 0.220 | | 0.160 | 0.199 | 0.220 | 0.248 | 0.371 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | |
| EFF. DEPTH, IN. | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | |
| $+I_{cr}/I_{gr}$ | 0.112 | 0.180 | 0.197 | 0.230 | 0.256 | | 0.112 | 0.180 | 0.197 | 0.230 | 0.256 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 6″ Ribs @ 72″ c.-c.<br>19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | | | | End Span Defl. Coeff. (2) | # 4 | # 4 | | | | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | | | | | 10 | 8 | | | | |
| BOTTOM BARS NO | 1# 5 | 1# 6 | | | | | 1# 5 | 1# 6 | | | | |
| BARS NO | 1# 5 | 1# 7 | | | | | 1# 5 | 1# 7 | | | | |
| STEEL (PSF) | 0.54 | 0.75 | | | | | 0.79 | 1.11 | | | | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 249 | 839 | | | | 2.344 | 651 | 1509 | | | | 1.443 |
| STIR | #3- 81 | #3-122 | | | | | #3- 91 | #3-124 | | | | |
| 29'- 0" | 189 | 739 | | | | 2.698 | 564 | 1364 | | | | 1.660 |
| STIR | #3- 80 | #3-128 | | | | | #3- 92 | #3-127 | | | | |
| 30'- 0" | 135 | 648 | | | | 3.090 | 485 | 1232 | | | | 1.901 |
| STIR | #3- 78 | #3-130 | | | | | #3- 92 | #3-130 | | | | |
| 31'- 0" | 86 | 567 | | | | 3.523 | 414 | 1114 | | | | 2.168 |
| STIR | #3- 76 | #3-132 | | | | | #3- 92 | #3-132 | | | | |
| 32'- 0" | 41 | 493 | | | | 4.000 | 349 | 1006 | | | | 2.461 |
| STIR | #3- 74 | #3-133 | | | | | #3- 92 | #3-134 | | | | |
| 33'- 0" | 1 | 425 | | | | 4.523 | 291 | 908 | | | | 2.784 |
| STIR | #3- 72 | #3-135 | | | | | #3- 91 | #3-117 | | | | |
| 34'- 0" | | 364 | | | | 5.097 | 237 | 819 | | | | 3.137 |
| STIR | | #3-136 | | | | | #3- 90 | #3-124 | | | | |
| 35'- 0" | | 308 | | | | 5.724 | 188 | 737 | | | | 3.522 |
| STIR | | #3-137 | | | | | #3- 90 | #3-131 | | | | |
| 36'- 0" | | 256 | | | | 6.407 | 142 | 661 | | | | 3.942 |
| STIR | | #3-137 | | | | | #3- 89 | #3-139 | | | | |
| 37'- 0" | | 208 | | | | 7.149 | 101 | 592 | | | | 4.399 |
| STIR | | #3-138 | | | | | #3- 87 | #3-142 | | | | |
| 38'- 0" | | 164 | | | | 7.953 | 63 | 528 | | | | 4.894 |
| STIR | | #3-138 | | | | | #3- 86 | #3-143 | | | | |
| 39'- 0" | | 124 | | | | 8.824 | 27 | 469 | | | | 5.430 |
| STIR | | #3-139 | | | | | #3- 84 | #3-145 | | | | |
| 40'- 0" | | 86 | | | | 9.765 | | 415 | | | | 6.009 |
| STIR | | #3-139 | | | | | | #3-146 | | | | |
| PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.44 | 1.44 | | | | | 1.44 | 1.80 | | | | |
| ACTUAL STEEL % | 0.818 | 0.818 | | | | | 0.818 | 1.023 | | | | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | | | | | 22.38 | 22.38 | | | | |
| $-I_{cr}/I_{gr}$ | 0.169 | 0.169 | | | | | 0.169 | 0.200 | | | | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.62 | 1.04 | | | | | 0.62 | 1.04 | | | | |
| ACTUAL STEEL % | 0.334 | 0.561 | | | | | 0.334 | 0.561 | | | | |
| EFF. DEPTH, IN. | 22.69 | 22.59 | | | | | 22.69 | 22.59 | | | | |
| $+I_{cr}/I_{gr}$ | 0.112 | 0.181 | | | | | 0.112 | 0.181 | | | | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 7″ Ribs @ 73″ c.-c.<br>19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 8.5 | 7.5 | 10 | | 10 | 7 | 9.5 | 8 | 6.5 | |
| BOTTOM BARS NO | 2# 4 | 1# 7 | 1# 7 | 1# 8 | 1# 8 | | 2# 4 | 1# 7 | 1# 7 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 1# 8 | 1# 8 | 1# 9 | | 1# 5 | 1# 7 | 1# 8 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.58 | 0.83 | 0.95 | 1.09 | 1.23 | | 0.82 | 1.28 | 1.46 | 1.71 | 2.52 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'- 0" (3) | 217 | 813 | 1042 | 1272 | 1523 | 3.090 | 619 | 1485 | 1819 | 2153 | 2519 | 1.901 |
| STIR | #3- 80 | #3-132 | #3-144 | #3-152 | #4-159 | | #3- 93 | #3-131 | #3-138 | #4-143 | #4-143 | |
| 31'- 0" | 161 | 719 | 934 | 1149 | 1384 | 3.523 | 537 | 1348 | 1662 | 1974 | 2317 | 2.168 |
| STIR | #3- 79 | #3-134 | #3-127 | #3-155 | #4-162 | | #3- 93 | #3-133 | #3-140 | #4-146 | #4-146 | |
| 32'- 0" | 110 | 633 | 835 | 1037 | 1258 | 4.000 | 463 | 1224 | 1518 | 1811 | 2133 | 2.461 |
| STIR | #3- 77 | #3-135 | #3-135 | #3-158 | #3-166 | | #3- 93 | #3-136 | #3-143 | #4-149 | #4-150 | |
| 33'- 0" | 64 | 556 | 746 | 935 | 1143 | 4.523 | 396 | 1112 | 1388 | 1663 | 1966 | 2.784 |
| STIR | #3- 74 | #3-136 | #3-144 | #3-160 | #3-168 | | #3- 93 | #3-115 | #3-146 | #4-152 | #4-152 | |
| 34'- 0" | 21 | 485 | 664 | 842 | 1038 | 5.097 | 334 | 1009 | 1269 | 1528 | 1813 | 3.137 |
| STIR | #3- 72 | #3-138 | #3-151 | #3-163 | #3-172 | | #3- 92 | #3-122 | #3-149 | #4-156 | #4-156 | |
| 35'- 0" | | 420 | 589 | 757 | 942 | 5.724 | 278 | 914 | 1160 | 1405 | 1674 | 3.522 |
| STIR | | #3-139 | #3-153 | #3-143 | #3-175 | | #3- 92 | #3-129 | #3-151 | #3-159 | #4-162 | |
| 36'- 0" | | 360 | 520 | 679 | 854 | 6.407 | 226 | 828 | 1060 | 1291 | 1545 | 3.942 |
| STIR | | #3-140 | #3-154 | #3-151 | #3-177 | | #3- 91 | #3-136 | #3-154 | #3-162 | #4-168 | |
| 37'- 0" | | 306 | 457 | 608 | 773 | 7.149 | 178 | 748 | 968 | 1187 | 1427 | 4.399 |
| STIR | | #3-140 | #3-156 | #3-159 | #3-180 | | #3- 90 | #3-143 | #3-156 | #3-165 | #4-172 | |
| 38'- 0" | | 255 | 398 | 541 | 698 | 7.953 | 134 | 674 | 883 | 1091 | 1319 | 4.894 |
| STIR | | #3-141 | #3-157 | #3-168 | #3-182 | | #3- 88 | #3-145 | #3-159 | #3-168 | #4-175 | |
| 39'- 0" | | 208 | 344 | 480 | 629 | 8.824 | 94 | 606 | 804 | 1002 | 1218 | 5.430 |
| STIR | | #3-141 | #3-159 | #3-172 | #3-185 | | #3- 87 | #3-146 | #3-138 | #3-170 | #4-177 | |
| 40'- 0" | | 165 | 295 | 424 | 565 | 9.765 | 56 | 544 | 732 | 919 | 1125 | 6.009 |
| STIR | | #3-142 | #3-160 | #3-174 | #3-164 | | #3- 85 | #3-148 | #3-145 | #3-172 | #3-181 | |
| 41'- 0" | | 125 | 248 | 371 | 506 | 10.778 | 21 | 485 | 664 | 843 | 1039 | 6.633 |
| STIR | | #3-142 | #3-161 | #3-175 | #3-173 | | #3- 83 | #3-149 | #3-152 | #3-174 | #3-184 | |
| 42'- 0" | | 88 | 205 | 322 | 451 | 11.869 | | 431 | 602 | 772 | 958 | 7.304 |
| STIR | | #3-141 | #3-161 | #3-177 | #3-181 | | | #3-150 | #3-160 | #3-177 | #3-186 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.46 | 1.46 | 1.72 | 1.95 | 2.26 | | 1.46 | 2.09 | 2.38 | 2.83 | 4.94 | |
| ACTUAL STEEL % | 0.736 | 0.736 | 0.866 | 0.981 | 1.145 | | 0.736 | 1.052 | 1.205 | 1.431 | 2.508 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.38 | 22.38 | 22.31 | | 22.38 | 22.38 | 22.31 | 22.31 | 22.25 | |
| $-I_{cr}/I_{gr}$ | 0.159 | 0.159 | 0.180 | 0.198 | 0.220 | | 0.159 | 0.209 | 0.228 | 0.258 | 0.371 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.71 | 1.20 | 1.39 | 1.58 | 1.79 | | 0.71 | 1.20 | 1.39 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.340 | 0.578 | 0.670 | 0.763 | 0.865 | | 0.340 | 0.578 | 0.670 | 0.763 | 0.865 | |
| EFF. DEPTH, IN. | 22.72 | 22.56 | 22.53 | 22.50 | 22.46 | | 22.72 | 22.56 | 22.53 | 22.50 | 22.46 | |
| $+I_{cr}/I_{gr}$ | 0.115 | 0.186 | 0.213 | 0.239 | 0.267 | | 0.115 | 0.186 | 0.213 | 0.239 | 0.267 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 8″ Ribs @ 74″ c.-c.<br>19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 8 | 10 | 9 | | 10 | 10 | 9 | 7.5 | 6 | |
| BOTTOM BARS NO | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | |
| BARS NO | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.60 | 0.88 | 1.00 | 1.22 | 1.38 | | 0.84 | 1.36 | 1.53 | 1.85 | 2.77 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'- 0" (3) | 322 | 934 | 1128 | 1493 | 1744 | 3.090 | 785 | 1675 | 1957 | 2489 | 2854 | 1.901 |
| STIR | #3- 85 | #3-131 | #3-124 | #3-153 | #4-159 | | #3- 96 | #3-130 | #4-136 | #4-143 | #5-143 | |
| 31'- 0" | 257 | 830 | 1012 | 1354 | 1589 | 3.523 | 691 | 1524 | 1789 | 2286 | 2629 | 2.168 |
| STIR | #3- 83 | #3-133 | #3-132 | #3-156 | #4-162 | | #3- 97 | #3-133 | #3-139 | #4-147 | #4-147 | |
| 32'- 0" | 198 | 736 | 907 | 1228 | 1448 | 4.000 | 606 | 1388 | 1636 | 2103 | 2424 | 2.461 |
| STIR | #3- 82 | #3-134 | #3-141 | #3-158 | #4-165 | | #3- 97 | #3-135 | #3-141 | #4-150 | #4-151 | |
| 33'- 0" | 145 | 650 | 811 | 1113 | 1320 | 4.523 | 528 | 1263 | 1497 | 1936 | 2238 | 2.784 |
| STIR | #3- 80 | #3-136 | #3-145 | #3-162 | #4-169 | | #3- 97 | #3-115 | #3-144 | #4-153 | #4-153 | |
| 34'- 0" | 96 | 572 | 723 | 1008 | 1203 | 5.097 | 457 | 1150 | 1369 | 1783 | 2067 | 3.137 |
| STIR | #3- 77 | #3-137 | #3-147 | #3-164 | #3-172 | | #3- 96 | #3-122 | #3-146 | #4-156 | #4-157 | |
| 35'- 0" | 51 | 501 | 643 | 912 | 1096 | 5.724 | 392 | 1046 | 1253 | 1643 | 1912 | 3.522 |
| STIR | #3- 75 | #3-138 | #3-149 | #3-167 | #3-175 | | #3- 96 | #3-130 | #3-149 | #4-160 | #4-162 | |
| 36'- 0" | 10 | 435 | 570 | 824 | 998 | 6.407 | 332 | 950 | 1146 | 1515 | 1769 | 3.942 |
| STIR | #3- 72 | #3-139 | #3-150 | #3-148 | #3-178 | | #3- 95 | #3-137 | #3-151 | #4-162 | #4-168 | |
| 37'- 0" | | 375 | 502 | 743 | 908 | 7.149 | 277 | 862 | 1048 | 1397 | 1637 | 4.399 |
| STIR | | #3-139 | #3-152 | #3-157 | #3-181 | | #3- 94 | #3-143 | #3-153 | #4-165 | #4-172 | |
| 38'- 0" | | 319 | 440 | 668 | 824 | 7.953 | 227 | 781 | 957 | 1288 | 1516 | 4.894 |
| STIR | | #3-140 | #3-153 | #3-165 | #3-183 | | #3- 93 | #3-144 | #3-136 | #3-168 | #4-175 | |
| 39'- 0" | | 268 | 382 | 599 | 747 | 8.824 | 180 | 706 | 873 | 1188 | 1404 | 5.430 |
| STIR | | #3-140 | #3-154 | #3-174 | #3-185 | | #3- 92 | #3-146 | #3-144 | #3-171 | #4-177 | |
| 40'- 0" | | 220 | 329 | 535 | 676 | 9.765 | 137 | 637 | 796 | 1095 | 1300 | 6.009 |
| STIR | | #3-140 | #3-155 | #3-175 | #3-188 | | #3- 91 | #3-147 | #3-151 | #3-173 | #4-181 | |
| 41'- 0" | | 176 | 280 | 475 | 610 | 10.778 | 96 | 573 | 724 | 1008 | 1204 | 6.633 |
| STIR | | #3-140 | #3-155 | #3-177 | #3-172 | | #3- 89 | #3-149 | #3-159 | #3-175 | #4-183 | |
| 42'- 0" | | 135 | 234 | 420 | 548 | 11.869 | 59 | 513 | 657 | 928 | 1114 | 7.304 |
| STIR | | #3-140 | #3-156 | #3-179 | #3-181 | | #3- 87 | #3-150 | #3-161 | #3-178 | #4-186 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.48 | 1.64 | 1.85 | 2.29 | 2.55 | | 1.48 | 2.29 | 2.55 | 3.06 | 5.43 | |
| ACTUAL STEEL % | 0.671 | 0.745 | 0.838 | 1.043 | 1.159 | | 0.671 | 1.043 | 1.159 | 1.390 | 2.475 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.38 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.31 | 22.25 | |
| $-I_{cr}/I_{gr}$ | 0.151 | 0.164 | 0.179 | 0.210 | 0.227 | | 0.151 | 0.210 | 0.227 | 0.258 | 0.376 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | |
| EFF. DEPTH, IN. | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | |
| $+I_{cr}/I_{gr}$ | 0.120 | 0.187 | 0.207 | 0.244 | 0.269 | | 0.120 | 0.187 | 0.207 | 0.244 | 0.269 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**66″ Forms + 9″ Ribs @ 75″ c.-c.**
**19″ Deep Rib + 5.0″ Top Slab = 24.5″ Total Depth**
**FACTORED USABLE SUPERIMPOSED LOAD (PLF)**

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 9 | 7.5 | 9.5 | 8.5 | | 10 | 10 | 8.5 | 9.5 | 7.5 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | |
| BARS NO | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | |
| STEEL (PSF) | 0.66 | 0.91 | 1.05 | 1.31 | 1.41 | | 0.90 | 1.40 | 1.61 | 2.06 | 2.93 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'- 0" (3) | 362 | 981 | 1291 | 1713 | 1941 | 3.090 | 857 | 1759 | 2209 | 2822 | 3154 | 1.901 |
| STIR | #3- 81 | #3-127 | #3-124 | #4-153 | #4-158 | | #3- 94 | #3-127 | #4-136 | #4-144 | #5-143 | |
| 31'- 0" | 293 | 873 | 1163 | 1558 | 1771 | 3.523 | 757 | 1601 | 2022 | 2597 | 2908 | 2.168 |
| STIR | #3- 79 | #3-129 | #3-132 | #4-157 | #4-162 | | #3- 94 | #3-107 | #4-139 | #4-148 | #5-146 | |
| 32'- 0" | 230 | 774 | 1046 | 1417 | 1618 | 4.000 | 665 | 1457 | 1853 | 2393 | 2684 | 2.461 |
| STIR | #3- 77 | #3-130 | #3-140 | #3-160 | #4-165 | | #3- 94 | #3-114 | #4-142 | #4-151 | #5-150 | |
| 33'- 0" | 173 | 685 | 941 | 1289 | 1478 | 4.523 | 582 | 1327 | 1699 | 2206 | 2480 | 2.784 |
| STIR | #3- 75 | #3-131 | #3-146 | #3-162 | #4-168 | | #3- 93 | #3-121 | #3-145 | #4-154 | #5-152 | |
| 34'- 0" | 120 | 603 | 844 | 1172 | 1350 | 5.097 | 506 | 1208 | 1558 | 2036 | 2294 | 3.137 |
| STIR | #3- 73 | #3-132 | #3-148 | #3-165 | #4-172 | | #3- 93 | #3-128 | #3-147 | #4-157 | #4-156 | |
| 35'- 0" | 73 | 528 | 755 | 1065 | 1233 | 5.724 | 437 | 1099 | 1430 | 1880 | 2124 | 3.522 |
| STIR | #3- 70 | #3-132 | #3-149 | #3-168 | #3-174 | | #3- 92 | #3-136 | #3-149 | #4-160 | #4-162 | |
| 36'- 0" | 29 | 459 | 674 | 967 | 1125 | 6.407 | 373 | 999 | 1311 | 1738 | 1968 | 3.942 |
| STIR | #3- 67 | #3-133 | #3-151 | #3-171 | #3-177 | | #3- 91 | #3-137 | #3-151 | #4-164 | #4-168 | |
| 37'- 0" | | 396 | 599 | 877 | 1026 | 7.149 | 314 | 907 | 1203 | 1606 | 1824 | 4.399 |
| STIR | | #3-133 | #3-152 | #3-155 | #3-180 | | #3- 90 | #3-139 | #3-154 | #4-166 | #4-171 | |
| 38'- 0" | | 337 | 530 | 793 | 935 | 7.953 | 260 | 822 | 1102 | 1485 | 1691 | 4.894 |
| STIR | | #3-133 | #3-153 | #3-163 | #3-182 | | #3- 89 | #3-140 | #3-136 | #4-169 | #4-174 | |
| 39'- 0" | | 283 | 467 | 716 | 851 | 8.824 | 210 | 743 | 1010 | 1373 | 1569 | 5.430 |
| STIR | | #3-133 | #3-154 | #3-172 | #3-185 | | #3- 88 | #3-141 | #3-143 | #4-172 | #4-178 | |
| 40'- 0" | | 233 | 408 | 645 | 773 | 9.765 | 164 | 671 | 924 | 1269 | 1456 | 6.009 |
| STIR | | #3-133 | #3-155 | #3-177 | #3-165 | | #3- 86 | #3-142 | #3-150 | #4-174 | #4-180 | |
| 41'- 0" | | 187 | 353 | 579 | 701 | 10.778 | 121 | 603 | 844 | 1173 | 1350 | 6.633 |
| STIR | | #3-133 | #3-156 | #3-178 | #3-174 | | #3- 84 | #3-143 | #3-158 | #3-176 | #4-183 | |
| 42'- 0" | | 144 | 302 | 517 | 634 | 11.869 | 81 | 541 | 770 | 1083 | 1253 | 7.304 |
| STIR | | #3-132 | #3-157 | #3-180 | #3-182 | | #3- 82 | #3-144 | #3-161 | #3-179 | #4-186 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.50 | 1.67 | 2.00 | 2.45 | 2.74 | | 1.50 | 2.33 | 2.74 | 3.47 | 6.00 | |
| ACTUAL STEEL % | 0.617 | 0.686 | 0.823 | 1.010 | 1.129 | | 0.617 | 0.960 | 1.129 | 1.438 | 2.493 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.38 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.25 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.144 | 0.156 | 0.180 | 0.209 | 0.227 | | 0.144 | 0.201 | 0.227 | 0.267 | 0.382 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | |
| ACTUAL STEEL % | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | |
| EFF. DEPTH, IN. | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | |
| $+I_{cr}/I_{gr}$ | 0.118 | 0.179 | 0.210 | 0.249 | 0.270 | | 0.118 | 0.179 | 0.210 | 0.249 | 0.270 | |

SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**66″ Forms + 7″ Ribs @ 73″ c.-c.**
**23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth**
**FACTORED USABLE SUPERIMPOSED LOAD (PLF)**

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 8.5 | 10 | 9 | | 10 | 10 | 7.5 | 6 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 8 | 1# 9 | | 1# 6 | 1# 7 | 1# 8 | 1# 9 | |
| BARS NO | 1# 6 | 1# 8 | 1# 9 | 1# 9 | | 1# 6 | 1# 8 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.67 | 0.95 | 1.23 | 1.40 | | 0.91 | 1.42 | 1.86 | 2.78 | |
| CLEAR SPAN | END SPAN | | | | | INTERIOR SPAN | | | | |
| 35'- 0" (3) | 223 | 761 | 1179 | 1397 | 5.724 | 652 | 1434 | 2042 | 2359 | 3.522 |
| STIR | #3- 96 | #3-149 | #3-172 | #4-179 | | #3-110 | #3-149 | #4-163 | #4-168 | |
| 36'- 0" | 171 | 680 | 1075 | 1281 | 6.407 | 577 | 1316 | 1890 | 2191 | 3.942 |
| STIR | #3- 95 | #3-151 | #3-175 | #3-183 | | #3-111 | #3-152 | #4-166 | #4-171 | |
| 37'- 0" | 124 | 605 | 979 | 1174 | 7.149 | 507 | 1207 | 1751 | 2035 | 4.399 |
| STIR | #3- 93 | #3-152 | #3-177 | #3-186 | | #3-111 | #3-129 | #4-170 | #4-174 | |
| 38'- 0" | 80 | 536 | 891 | 1076 | 7.953 | 444 | 1107 | 1623 | 1892 | 4.894 |
| STIR | #3- 91 | #3-153 | #3-154 | #3-189 | | #3-111 | #3-136 | #4-172 | #4-178 | |
| 39'- 0" | 40 | 472 | 809 | 985 | 8.824 | 385 | 1014 | 1504 | 1760 | 5.430 |
| STIR | #3- 89 | #3-154 | #3-162 | #3-191 | | #3-110 | #3-143 | #4-176 | #4-182 | |
| 40'- 0" | 2 | 414 | 734 | 901 | 9.765 | 330 | 929 | 1394 | 1638 | 6.009 |
| STIR | #3- 86 | #3-155 | #3-170 | #3-194 | | #3-110 | #3-150 | #4-178 | #4-185 | |
| 41'- 0" | | 359 | 664 | 823 | 10.778 | 280 | 849 | 1292 | 1524 | 6.633 |
| STIR | | #3-156 | #3-179 | #3-197 | | #3-109 | #3-158 | #3-180 | #4-188 | |
| 42'- 0" | | 308 | 599 | 750 | 11.869 | 233 | 776 | 1198 | 1418 | 7.304 |
| STIR | | #3-157 | #3-187 | #3-199 | | #3-108 | #3-161 | #3-183 | #4-191 | |
| 43'- 0" | | 261 | 538 | 683 | 13.040 | 189 | 707 | 1110 | 1320 | 8.025 |
| STIR | | #3-157 | #3-188 | #3-177 | | #3-107 | #3-163 | #3-186 | #4-193 | |
| 44'- 0" | | 217 | 481 | 620 | 14.296 | 148 | 643 | 1027 | 1228 | 8.798 |
| STIR | | #3-157 | #3-190 | #3-185 | | #3-106 | #3-164 | #3-188 | #4-197 | |
| 45'- 0" | | 176 | 429 | 561 | 15.641 | 110 | 583 | 951 | 1143 | 9.625 |
| STIR | | #3-158 | #3-192 | #3-193 | | #3-105 | #3-165 | #3-190 | #4-200 | |
| 46'- 0" | | 137 | 379 | 506 | 17.078 | 74 | 527 | 879 | 1063 | 10.510 |
| STIR | | #3-158 | #3-193 | #3-202 | | #3-103 | #3-167 | #3-193 | #4-202 | |
| 47'- 0" | | 101 | 333 | 454 | 18.613 | 41 | 474 | 811 | 988 | 11.454 |
| STIR | | #3-157 | #3-195 | #3-208 | | #3-102 | #3-168 | #3-195 | #3-205 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF) | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.46 | 1.72 | 2.26 | 2.51 | | 1.46 | 2.26 | 3.02 | 5.35 | |
| ACTUAL STEEL % | 0.602 | 0.708 | 0.936 | 1.040 | | 0.602 | 0.936 | 1.247 | 2.220 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.31 | 26.31 | | 26.38 | 26.31 | 26.31 | 26.25 | |
| $-I_{cr}/I_{gr}$ | 0.145 | 0.165 | 0.202 | 0.219 | | 0.145 | 0.202 | 0.250 | 0.366 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.79 | 2.00 | | 0.88 | 1.39 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.347 | 0.549 | 0.709 | 0.792 | | 0.347 | 0.549 | 0.709 | 0.792 | |
| EFF. DEPTH, IN. | 26.62 | 26.53 | 26.46 | 26.44 | | 26.62 | 26.53 | 26.46 | 26.44 | |
| $+I_{cr}/I_{gr}$ | 0.123 | 0.188 | 0.237 | 0.262 | | 0.123 | 0.188 | 0.237 | 0.262 | |

SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 8″ Ribs @ 74″ c.-c.<br>23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 10 | 8 | 7 | | 10 | 8.5 | 7.5 | 6 | 6 | |
| BOTTOM BARS NO | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | |
| BARS NO | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | |
| STEEL (PSF) | 0.66 | 1.08 | 1.22 | 1.54 | 1.76 | | 0.90 | 1.64 | 1.85 | 2.88 | 3.67 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 35'- 0" (3) | 243 | 924 | 1143 | 1641 | 1919 | 5.724 | 697 | 1688 | 2006 | 2730 | 3135 | 3.522 |
| STIR | #3- 89 | #3-151 | #3-145 | #4-181 | #4-187 | | #3-106 | #3-151 | #4-158 | #5-169 | #5-174 | |
| 36'- 0" | 188 | 832 | 1039 | 1510 | 1773 | 6.407 | 618 | 1554 | 1855 | 2539 | 2922 | 3.942 |
| STIR | #3- 87 | #3-153 | #3-153 | #4-185 | #4-191 | | #3-106 | #3-153 | #4-161 | #5-173 | #5-168 | |
| 37'- 0" | 138 | 748 | 943 | 1389 | 1638 | 7.149 | 544 | 1431 | 1716 | 2364 | 2726 | 4.399 |
| STIR | #3- 85 | #3-155 | #3-162 | #4-187 | #4-195 | | #3-105 | #3-155 | #4-163 | #5-176 | #5-171 | |
| 38'- 0" | 92 | 670 | 855 | 1277 | 1514 | 7.953 | 477 | 1317 | 1587 | 2202 | 2545 | 4.894 |
| STIR | #3- 83 | #3-156 | #3-169 | #4-190 | #4-198 | | #3-105 | #3-133 | #4-166 | #4-180 | #5-174 | |
| 39'- 0" | 49 | 597 | 774 | 1175 | 1399 | 8.824 | 414 | 1212 | 1469 | 2052 | 2378 | 5.430 |
| STIR | #3- 80 | #3-157 | #3-170 | #3-193 | #4-202 | | #3-104 | #3-140 | #3-169 | #4-183 | #5-178 | |
| 40'- 0" | 9 | 531 | 698 | 1079 | 1292 | 9.765 | 357 | 1115 | 1359 | 1913 | 2223 | 6.009 |
| STIR | #3- 77 | #3-158 | #3-172 | #3-196 | #4-204 | | #3-104 | #3-147 | #3-171 | #4-186 | #5-180 | |
| 41'- 0" | | 469 | 628 | 991 | 1194 | 10.778 | 303 | 1025 | 1257 | 1785 | 2080 | 6.633 |
| STIR | | #3-159 | #3-174 | #3-198 | #4-208 | | #3-103 | #3-154 | #3-174 | #4-189 | #5-185 | |
| 42'- 0" | | 411 | 563 | 909 | 1102 | 11.869 | 253 | 941 | 1162 | 1665 | 1946 | 7.304 |
| STIR | | #3-160 | #3-175 | #3-201 | #4-211 | | #3-101 | #3-162 | #3-175 | #4-192 | #5-190 | |
| 43'- 0" | | 357 | 502 | 832 | 1017 | 13.040 | 207 | 863 | 1074 | 1554 | 1822 | 8.025 |
| STIR | | #3-160 | #3-176 | #3-204 | #4-214 | | #3-100 | #3-165 | #3-150 | #4-195 | #4-196 | |
| 44'- 0" | | 307 | 446 | 761 | 937 | 14.296 | 164 | 791 | 992 | 1450 | 1706 | 8.798 |
| STIR | | #3-161 | #3-178 | #3-181 | #3-216 | | #3- 99 | #3-166 | #3-157 | #4-198 | #4-202 | |
| 45'- 0" | | 261 | 393 | 694 | 863 | 15.641 | 123 | 723 | 915 | 1353 | 1598 | 9.625 |
| STIR | | #3-161 | #3-179 | #3-189 | #3-220 | | #3- 97 | #3-168 | #3-164 | #4-201 | #4-208 | |
| 46'- 0" | | 217 | 344 | 632 | 793 | 17.078 | 85 | 659 | 843 | 1262 | 1497 | 10.510 |
| STIR | | #3-161 | #3-180 | #3-198 | #3-222 | | #3- 95 | #3-169 | #3-172 | #4-204 | #4-212 | |
| 47'- 0" | | 176 | 297 | 573 | 728 | 18.613 | 50 | 599 | 776 | 1177 | 1402 | 11.454 |
| STIR | | #3-161 | #3-180 | #3-206 | #3-224 | | #3- 93 | #3-170 | #3-179 | #4-207 | #4-215 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.48 | 1.97 | 2.29 | 2.87 | 3.28 | | 1.48 | 2.70 | 3.06 | 5.43 | 7.40 | |
| ACTUAL STEEL % | 0.550 | 0.734 | 0.855 | 1.069 | 1.222 | | 0.550 | 1.006 | 1.140 | 2.029 | 2.775 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.31 | 26.31 | 26.31 | | 26.38 | 26.31 | 26.31 | 26.25 | 26.19 | |
| $-I_{cr}/I_{gr}$ | 0.137 | 0.173 | 0.193 | 0.228 | 0.251 | | 0.137 | 0.218 | 0.239 | 0.353 | 0.427 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | |
| ACTUAL STEEL % | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | |
| EFF. DEPTH, IN. | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | |
| $+I_{cr}/I_{gr}$ | 0.120 | 0.194 | 0.217 | 0.268 | 0.296 | | 0.120 | 0.194 | 0.217 | 0.268 | 0.296 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 9″ Ribs @ 75″ c.-c.<br>23″ Deep Rib + 5.0″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 9.5 | 8 | 9 | | 9 | 8.5 | 7 | 8 | 4 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | |
| BARS NO | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | |
| STEEL (PSF) | 0.70 | 1.05 | 1.31 | 1.54 | 1.84 | | 1.00 | 1.61 | 1.99 | 2.42 | 3.95 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 35'- 0" (3) | 305 | 957 | 1324 | 1720 | 2154 | 5.724 | 803 | 1752 | 2285 | 2861 | 3493 | 3.522 |
| STIR | #3- 89 | #3-146 | #3-143 | #4-177 | #5-188 | | #3-106 | #3-147 | #4-158 | #5-167 | #5-174 | |
| 36'- 0" | 245 | 862 | 1208 | 1582 | 1993 | 6.407 | 716 | 1613 | 2117 | 2661 | 3258 | 3.942 |
| STIR | #3- 87 | #3-148 | #3-151 | #4-181 | #4-191 | | #3-106 | #3-126 | #4-161 | #5-171 | #5-167 | |
| 37'- 0" | 190 | 774 | 1101 | 1456 | 1844 | 7.149 | 635 | 1485 | 1962 | 2477 | 3042 | 4.399 |
| STIR | #3- 85 | #3-149 | #3-159 | #4-183 | #4-194 | | #3-105 | #3-133 | #4-164 | #5-173 | #5-170 | |
| 38'- 0" | 139 | 692 | 1003 | 1339 | 1708 | 7.953 | 561 | 1367 | 1819 | 2307 | 2843 | 4.894 |
| STIR | #3- 83 | #3-150 | #3-168 | #4-187 | #4-199 | | #3-105 | #3-140 | #4-167 | #4-177 | #5-173 | |
| 39'- 0" | 92 | 617 | 912 | 1231 | 1581 | 8.824 | 493 | 1257 | 1687 | 2151 | 2659 | 5.430 |
| STIR | #3- 80 | #3-151 | #3-172 | #3-189 | #4-202 | | #3-104 | #3-147 | #4-169 | #4-181 | #5-177 | |
| 40'- 0" | 48 | 548 | 828 | 1131 | 1464 | 9.765 | 429 | 1156 | 1564 | 2005 | 2489 | 6.009 |
| STIR | #3- 77 | #3-152 | #3-174 | #3-192 | #4-205 | | #3-103 | #3-155 | #4-172 | #4-183 | #5-179 | |
| 41'- 0" | 8 | 483 | 750 | 1039 | 1355 | 10.778 | 371 | 1062 | 1451 | 1871 | 2331 | 6.633 |
| STIR | #3- 74 | #3-152 | #3-175 | #3-195 | #4-208 | | #3-102 | #3-157 | #3-175 | #4-186 | #5-185 | |
| 42'- 0" | | 423 | 678 | 953 | 1254 | 11.869 | 316 | 975 | 1345 | 1745 | 2184 | 7.304 |
| STIR | | #3-152 | #3-177 | #3-173 | #4-211 | | #3-101 | #3-158 | #3-176 | #4-189 | #5-191 | |
| 43'- 0" | | 367 | 610 | 873 | 1160 | 13.040 | 265 | 894 | 1247 | 1629 | 2047 | 8.025 |
| STIR | | #3-153 | #3-178 | #3-181 | #4-214 | | #3-100 | #3-160 | #3-179 | #4-192 | #5-196 | |
| 44'- 0" | | 315 | 547 | 798 | 1073 | 14.296 | 218 | 818 | 1156 | 1520 | 1920 | 8.798 |
| STIR | | #3-153 | #3-179 | #3-190 | #4-217 | | #3- 99 | #3-161 | #3-155 | #4-194 | #5-202 | |
| 45'- 0" | | 267 | 488 | 728 | 991 | 15.641 | 173 | 747 | 1070 | 1418 | 1801 | 9.625 |
| STIR | | #3-153 | #3-181 | #3-198 | #4-220 | | #3- 97 | #3-162 | #3-162 | #4-197 | #5-208 | |
| 46'- 0" | | 221 | 433 | 663 | 914 | 17.078 | 132 | 681 | 990 | 1323 | 1689 | 10.510 |
| STIR | | #3-152 | #3-182 | #3-203 | #4-222 | | #3- 95 | #3-163 | #3-169 | #4-200 | #4-212 | |
| 47'- 0" | | 179 | 382 | 601 | 842 | 18.613 | 93 | 619 | 915 | 1234 | 1585 | 11.454 |
| STIR | | #3-152 | #3-183 | #3-205 | #3-225 | | #3- 93 | #3-164 | #3-177 | #4-203 | #4-215 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.50 | 2.00 | 2.45 | 2.91 | 3.67 | | 1.67 | 2.74 | 3.32 | 4.12 | 8.25 | |
| ACTUAL STEEL % | 0.508 | 0.677 | 0.831 | 0.987 | 1.249 | | 0.564 | 0.929 | 1.128 | 1.405 | 2.809 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.31 | 26.31 | 26.25 | | 26.38 | 26.31 | 26.31 | 26.25 | 26.25 | |
| $-I_{cr}/I_{gr}$ | 0.131 | 0.165 | 0.192 | 0.219 | 0.258 | | 0.143 | 0.209 | 0.241 | 0.280 | 0.443 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | |
| ACTUAL STEEL % | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | |
| EFF. DEPTH, IN. | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | |
| $+I_{cr}/I_{gr}$ | 0.121 | 0.187 | 0.222 | 0.260 | 0.301 | | 0.121 | 0.187 | 0.222 | 0.260 | 0.301 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>11″ Deep Rib + 5.5″ Top Slab = 16.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 9 | 7.5 | 10 | | 10 | 7.5 | 10 | 8 | 7 | |
| BOTTOM BARS NO | 1# 4 | 1# 5 | 1# 6 | 1# 6 | 1# 5 | | 1# 4 | 1# 5 | 1# 6 | 1# 6 | 1# 5 | |
| BARS NO | 1# 5 | 1# 6 | 1# 6 | 1# 7 | 2# 6 | | 1# 5 | 1# 6 | 1# 6 | 1# 7 | 2# 6 | |
| STEEL (PSF) | 0.60 | 0.78 | 0.92 | 1.08 | 1.20 | | 0.84 | 1.18 | 1.41 | 1.70 | 1.90 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 188 | 482 | 641 | 834 | 1022 | 1.265 | 479 | 907 | 1138 | 1419 | 1692 | 0.779 |
| STIR | #3- 49 | #3- 86 | #3- 98 | #3-106 | #3-118 | | #3- 64 | #3- 90 | #3- 85 | #3-107 | #3-112 | |
| 25'- 0" | 137 | 409 | 555 | 733 | 906 | 1.490 | 406 | 801 | 1013 | 1272 | 1524 | 0.917 |
| STIR | #3- 46 | #3- 86 | #3- 99 | #3-110 | #3-121 | | #3- 63 | #3- 91 | #3- 92 | #3-110 | #3-115 | |
| 26'- 0" | 93 | 344 | 479 | 643 | 804 | 1.743 | 341 | 706 | 903 | 1142 | 1375 | 1.073 |
| STIR | #3- 43 | #3- 86 | #3-100 | #3-112 | #3-108 | | #3- 62 | #3- 92 | #3-100 | #3-112 | #3-118 | |
| 27'- 0" | 53 | 286 | 411 | 564 | 712 | 2.027 | 283 | 622 | 804 | 1026 | 1242 | 1.247 |
| STIR | #3- 39 | #3- 86 | #3-100 | #3-113 | #3-116 | | #3- 61 | #3- 93 | #3-103 | #3-115 | #3-121 | |
| 28'- 0" | 18 | 234 | 350 | 492 | 631 | 2.344 | 232 | 547 | 716 | 922 | 1123 | 1.443 |
| STIR | #3- 34 | #3- 85 | #3-101 | #3-115 | #3-125 | | #3- 59 | #3- 94 | #3-105 | #3-116 | #3-123 | |
| 29'- 0" | | 188 | 296 | 428 | 557 | 2.698 | 185 | 479 | 637 | 829 | 1016 | 1.660 |
| STIR | | #3- 84 | #3-101 | #3-116 | #3-127 | | #3- 57 | #3- 94 | #3-106 | #3-106 | #3-126 | |
| 30'- 0" | | 146 | 247 | 370 | 491 | 3.090 | 143 | 418 | 565 | 745 | 920 | 1.901 |
| STIR | | #3- 82 | #3-101 | #3-117 | #3-129 | | #3- 55 | #3- 95 | #3-107 | #3-113 | #3-129 | |
| 31'- 0" | | 108 | 202 | 318 | 431 | 3.523 | 105 | 362 | 500 | 669 | 833 | 2.168 |
| STIR | | #3- 81 | #3-100 | #3-117 | #3-130 | | #3- 52 | #3- 95 | #3-108 | #3-120 | #3-131 | |
| 32'- 0" | | 73 | 162 | 271 | 377 | 4.000 | 71 | 312 | 442 | 600 | 754 | 2.461 |
| STIR | | #3- 79 | #3-100 | #3-118 | #3-132 | | #3- 49 | #3- 95 | #3-109 | #3-122 | #3-133 | |
| 33'- 0" | | 42 | 125 | 228 | 327 | 4.523 | 40 | 267 | 388 | 537 | 682 | 2.784 |
| STIR | | #3- 77 | #3- 99 | #3-118 | #3-133 | | #3- 46 | #3- 94 | #3-110 | #3-123 | #3-135 | |
| 34'- 0" | | 13 | 92 | 188 | 282 | 5.097 | 11 | 225 | 340 | 480 | 616 | 3.137 |
| STIR | | #3- 74 | #3- 98 | #3-118 | #3-134 | | #3- 43 | #3- 94 | #3-111 | #3-125 | #3-126 | |
| 35'- 0" | | | 61 | 152 | 240 | 5.724 | | 187 | 295 | 427 | 556 | 3.522 |
| STIR | | | #3- 96 | #3-118 | #3-135 | | | #3- 93 | #3-111 | #3-126 | #3-134 | |
| 36'- 0" | | | 33 | 119 | 202 | 6.407 | | 152 | 254 | 379 | 500 | 3.942 |
| STIR | | | #3- 95 | #3-118 | #3-135 | | | #3- 93 | #3-111 | #3-127 | #3-138 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.96 | 0.96 | 1.07 | 1.28 | 1.49 | | 0.96 | 1.28 | 1.49 | 1.86 | 2.13 | |
| ACTUAL STEEL % | 0.726 | 0.726 | 0.807 | 0.968 | 1.131 | | 0.726 | 0.968 | 1.131 | 1.414 | 1.616 | |
| EFF. DEPTH, IN. | 14.38 | 14.38 | 14.38 | 14.38 | 14.31 | | 14.38 | 14.38 | 14.31 | 14.31 | 14.31 | |
| $-I_{cr}/I_{gr}$ | 0.151 | 0.151 | 0.164 | 0.189 | 0.209 | | 0.151 | 0.189 | 0.209 | 0.246 | 0.270 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.51 | 0.75 | 0.88 | 1.04 | 1.19 | | 0.51 | 0.75 | 0.88 | 1.04 | 1.19 | |
| ACTUAL STEEL % | 0.364 | 0.537 | 0.631 | 0.748 | 0.853 | | 0.364 | 0.537 | 0.631 | 0.748 | 0.853 | |
| EFF. DEPTH, IN. | 14.71 | 14.65 | 14.62 | 14.59 | 14.64 | | 14.71 | 14.65 | 14.62 | 14.59 | 14.64 | |
| $+I_{cr}/I_{gr}$ | 0.115 | 0.164 | 0.189 | 0.218 | 0.248 | | 0.115 | 0.164 | 0.189 | 0.218 | 0.248 | |
| SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>11″ Deep Rib + 5.5″ Top Slab = 16.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 7.5 | 10 | 9 | | 10 | 7 | 8.5 | 7.5 | 9 | |
| BOTTOM BARS NO | 1# 4 | 1# 4 | 2# 4 | 1# 5 | 2# 6 | | 1# 4 | 1# 4 | 2# 4 | 1# 5 | 2# 6 | |
| BARS NO | 1# 5 | 2# 5 | 2# 5 | 2# 6 | 1# 6 | | 1# 5 | 2# 5 | 2# 5 | 2# 6 | 1# 6 | |
| STEEL (PSF) | 0.60 | 0.79 | 1.03 | 1.18 | 1.34 | | 0.84 | 1.23 | 1.59 | 1.81 | 2.12 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 167 | 552 | 800 | 1002 | 1158 | 1.265 | 458 | 1018 | 1379 | 1672 | 1900 | 0.779 |
| STIR | #3- 36 | #3- 85 | #3-101 | #3-102 | #3-118 | | #3- 56 | #3- 89 | #3-102 | #3-108 | #3-112 | |
| 25'- 0" | 117 | 472 | 700 | 886 | 1030 | 1.490 | 385 | 901 | 1233 | 1504 | 1714 | 0.917 |
| STIR | #3- 32 | #3- 85 | #3-102 | #3-110 | #3-120 | | #3- 54 | #3- 90 | #3-104 | #3-111 | #3-116 | |
| 26'- 0" | 72 | 400 | 611 | 783 | 917 | 1.743 | 320 | 797 | 1105 | 1355 | 1549 | 1.073 |
| STIR | #3- 28 | #3- 85 | #3-104 | #3-114 | #3-108 | | #3- 52 | #3- 91 | #3- 95 | #3-113 | #3-118 | |
| 27'- 0" | 33 | 337 | 532 | 692 | 816 | 2.027 | 263 | 705 | 990 | 1222 | 1402 | 1.247 |
| STIR | #3- 23 | #3- 84 | #3-104 | #3-116 | #3-116 | | #3- 50 | #3- 92 | #3-103 | #3-116 | #3-121 | |
| 28'- 0" | | 280 | 462 | 610 | 725 | 2.344 | 211 | 622 | 887 | 1103 | 1270 | 1.443 |
| STIR | | #3- 84 | #3-105 | #3-118 | #3-125 | | #3- 47 | #3- 93 | #3-108 | #3-118 | #3-124 | |
| 29'- 0" | | 229 | 398 | 537 | 644 | 2.698 | 165 | 548 | 795 | 996 | 1152 | 1.660 |
| STIR | | #3- 82 | #3-105 | #3-119 | #3-127 | | #3- 44 | #3- 93 | #3-110 | #3-120 | #3-126 | |
| 30'- 0" | | 183 | 341 | 471 | 571 | 3.090 | 123 | 481 | 712 | 900 | 1046 | 1.901 |
| STIR | | #3- 81 | #3-106 | #3-120 | #3-129 | | #3- 41 | #3- 94 | #3-111 | #3-109 | #3-128 | |
| 31'- 0" | | 141 | 290 | 411 | 504 | 3.523 | 85 | 420 | 637 | 813 | 949 | 2.168 |
| STIR | | #3- 79 | #3-106 | #3-121 | #3-130 | | #3- 38 | #3- 94 | #3-112 | #3-117 | #3-131 | |
| 32'- 0" | | 103 | 243 | 356 | 444 | 4.000 | 51 | 365 | 568 | 733 | 862 | 2.461 |
| STIR | | #3- 77 | #3-105 | #3-122 | #3-131 | | #3- 34 | #3- 94 | #3-113 | #3-124 | #3-133 | |
| 33'- 0" | | 69 | 200 | 307 | 390 | 4.523 | 19 | 315 | 506 | 661 | 782 | 2.784 |
| STIR | | #3- 75 | #3-105 | #3-122 | #3-133 | | #3- 30 | #3- 93 | #3-114 | #3-126 | #3-135 | |
| 34'- 0" | | 37 | 161 | 261 | 339 | 5.097 | | 270 | 449 | 596 | 709 | 3.137 |
| STIR | | #3- 72 | #3-104 | #3-123 | #3-134 | | | #3- 93 | #3-115 | #3-127 | #3-126 | |
| 35'- 0" | | 9 | 125 | 220 | 294 | 5.724 | | 228 | 397 | 535 | 642 | 3.522 |
| STIR | | #3- 70 | #3-103 | #3-123 | #3-134 | | | #3- 92 | #3-116 | #3-129 | #3-134 | |
| 36'- 0" | | | 92 | 182 | 252 | 6.407 | | 189 | 350 | 480 | 581 | 3.942 |
| STIR | | | #3-102 | #3-123 | #3-135 | | | #3- 91 | #3-116 | #3-130 | #3-139 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.98 | 0.98 | 1.31 | 1.52 | 1.69 | | 0.98 | 1.40 | 1.79 | 2.03 | 2.40 | |
| ACTUAL STEEL % | 0.669 | 0.669 | 0.891 | 1.041 | 1.157 | | 0.669 | 0.955 | 1.225 | 1.388 | 1.650 | |
| EFF. DEPTH, IN. | 14.38 | 14.38 | 14.38 | 14.31 | 14.31 | | 14.38 | 14.38 | 14.31 | 14.31 | 14.25 | |
| $-I_{cr}/I_{gr}$ | 0.145 | 0.145 | 0.181 | 0.201 | 0.218 | | 0.145 | 0.191 | 0.227 | 0.248 | 0.277 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.51 | 0.82 | 1.02 | 1.19 | 1.32 | | 0.51 | 0.82 | 1.02 | 1.19 | 1.32 | |
| ACTUAL STEEL % | 0.329 | 0.530 | 0.659 | 0.772 | 0.857 | | 0.329 | 0.530 | 0.659 | 0.772 | 0.857 | |
| EFF. DEPTH, IN. | 14.71 | 14.70 | 14.71 | 14.64 | 14.62 | | 14.71 | 14.70 | 14.71 | 14.64 | 14.62 | |
| $+I_{cr}/I_{gr}$ | 0.106 | 0.165 | 0.201 | 0.229 | 0.250 | | 0.106 | 0.165 | 0.201 | 0.229 | 0.250 | |
| SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>11″ Deep Rib + 5.5″ Top Slab = 16.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 7.5 | 10 | 8 | | 10 | 10 | 8.5 | 7 | 6 | |
| BOTTOM BARS NO | 2# 4 | 2# 5 | 2# 5 | 2# 5 | 2# 6 | | 2# 4 | 2# 5 | 2# 5 | 2# 5 | 2# 6 | |
| BARS NO | 1# 4 | 1# 5 | 1# 6 | 2# 5 | 1# 7 | | 1# 4 | 1# 5 | 1# 6 | 2# 5 | 1# 7 | |
| STEEL (PSF) | 0.64 | 0.89 | 1.06 | 1.25 | 1.50 | | 0.88 | 1.38 | 1.62 | 1.95 | 2.28 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 261 | 666 | 824 | 1047 | 1329 | 1.265 | 604 | 1194 | 1424 | 1748 | 2158 | 0.779 |
| STIR | #3- 45 | #3- 88 | #3- 97 | #3-107 | #3-119 | | #3- 62 | #3- 91 | #3- 86 | #3-107 | #4-113 | |
| 25'- 0" | 202 | 575 | 721 | 927 | 1186 | 1.490 | 518 | 1062 | 1273 | 1572 | 1950 | 0.917 |
| STIR | #3- 42 | #3- 88 | #3- 98 | #3-109 | #3-121 | | #3- 61 | #3- 92 | #3- 93 | #3-109 | #3-116 | |
| 26'- 0" | 149 | 495 | 629 | 819 | 1060 | 1.743 | 441 | 944 | 1140 | 1417 | 1766 | 1.073 |
| STIR | #3- 38 | #3- 88 | #3- 99 | #3-111 | #3-124 | | #3- 59 | #3- 94 | #3-101 | #3-111 | #3-118 | |
| 27'- 0" | 102 | 423 | 547 | 724 | 947 | 2.027 | 373 | 840 | 1021 | 1278 | 1602 | 1.247 |
| STIR | #3- 34 | #3- 87 | #3- 99 | #3-112 | #3-114 | | #3- 57 | #3- 95 | #3-103 | #3-113 | #3-122 | |
| 28'- 0" | 60 | 358 | 474 | 638 | 845 | 2.344 | 313 | 746 | 915 | 1153 | 1455 | 1.443 |
| STIR | #3- 29 | #3- 87 | #3-100 | #3-114 | #3-123 | | #3- 55 | #3- 96 | #3-104 | #3-116 | #3-124 | |
| 29'- 0" | 23 | 301 | 409 | 562 | 755 | 2.698 | 258 | 662 | 819 | 1042 | 1322 | 1.660 |
| STIR | #3- 24 | #3- 86 | #3-100 | #3-115 | #3-128 | | #3- 53 | #3- 96 | #3-106 | #3-107 | #3-127 | |
| 30'- 0" | | 249 | 350 | 492 | 673 | 3.090 | 209 | 586 | 733 | 941 | 1203 | 1.901 |
| STIR | | #3- 85 | #3- 99 | #3-116 | #3-130 | | #3- 51 | #3- 97 | #3-107 | #3-115 | #3-129 | |
| 31'- 0" | | 201 | 296 | 430 | 599 | 3.523 | 164 | 518 | 655 | 850 | 1096 | 2.168 |
| STIR | | #3- 83 | #3- 99 | #3-116 | #3-132 | | #3- 48 | #3- 97 | #3-108 | #3-119 | #3-132 | |
| 32'- 0" | | 159 | 247 | 373 | 531 | 4.000 | 123 | 455 | 584 | 767 | 998 | 2.461 |
| STIR | | #3- 82 | #3- 98 | #3-117 | #3-133 | | #3- 45 | #3- 97 | #3-109 | #3-121 | #3-134 | |
| 33'- 0" | | 120 | 203 | 321 | 470 | 4.523 | 87 | 399 | 520 | 692 | 909 | 2.784 |
| STIR | | #3- 80 | #3- 97 | #3-117 | #3-134 | | #3- 41 | #3- 97 | #3-109 | #3-122 | #3-136 | |
| 34'- 0" | | 84 | 163 | 274 | 414 | 5.097 | 53 | 347 | 461 | 623 | 827 | 3.137 |
| STIR | | #3- 77 | #3- 96 | #3-117 | #3-135 | | #3- 38 | #3- 97 | #3-110 | #3-123 | #3-124 | |
| 35'- 0" | | 51 | 126 | 231 | 363 | 5.724 | 22 | 300 | 407 | 560 | 753 | 3.522 |
| STIR | | #3- 75 | #3- 95 | #3-117 | #3-136 | | #3- 34 | #3- 96 | #3-110 | #3-125 | #3-132 | |
| 36'- 0" | | 22 | 92 | 191 | 316 | 6.407 | | 256 | 358 | 502 | 685 | 3.942 |
| STIR | | #3- 72 | #3- 93 | #3-116 | #3-137 | | | #3- 96 | #3-110 | #3-126 | #3-139 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.00 | 1.11 | 1.33 | 1.55 | 1.94 | | 1.00 | 1.55 | 1.82 | 2.21 | 2.58 | |
| ACTUAL STEEL % | 0.621 | 0.690 | 0.828 | 0.968 | 1.209 | | 0.621 | 0.968 | 1.138 | 1.382 | 1.613 | |
| EFF. DEPTH, IN. | 14.38 | 14.38 | 14.38 | 14.31 | 14.31 | | 14.38 | 14.31 | 14.31 | 14.31 | 14.31 | |
| $-I_{cr}/I_{gr}$ | 0.140 | 0.152 | 0.175 | 0.195 | 0.230 | | 0.140 | 0.195 | 0.220 | 0.253 | 0.282 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 0.93 | 1.06 | 1.24 | 1.48 | | 0.60 | 0.93 | 1.06 | 1.24 | 1.48 | |
| ACTUAL STEEL % | 0.353 | 0.549 | 0.627 | 0.732 | 0.879 | | 0.353 | 0.549 | 0.627 | 0.732 | 0.879 | |
| EFF. DEPTH, IN. | 14.75 | 14.69 | 14.66 | 14.69 | 14.60 | | 14.75 | 14.69 | 14.66 | 14.69 | 14.60 | |
| $+I_{cr}/I_{gr}$ | 0.116 | 0.171 | 0.192 | 0.222 | 0.257 | | 0.116 | 0.171 | 0.192 | 0.222 | 0.257 | |
| SINGLE LEG STIRRUP AT 6 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 7.5 | 10 | 8.5 | | 10 | 10 | 8.5 | 7 | 5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 1# 6 | 1# 5 | 1# 7 | | 2# 4 | 1# 6 | 1# 6 | 1# 5 | 1# 7 | |
| BARS NO | 1# 4 | 1# 6 | 1# 7 | 2# 6 | 1# 8 | | 1# 4 | 1# 6 | 1# 7 | 2# 6 | 1# 8 | |
| STEEL (PSF) | 0.66 | 0.92 | 1.08 | 1.20 | 1.45 | | 0.90 | 1.41 | 1.64 | 1.90 | 2.51 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 380 | 767 | 987 | 1201 | 1466 | 1.265 | 770 | 1333 | 1654 | 1965 | 2349 | 0.779 |
| STIR | #3- 65 | #3- 97 | #3-107 | #3-117 | #3-124 | | #3- 75 | #3- 87 | #3-106 | #3-112 | #4-116 | |
| 25'- 0" | 313 | 669 | 873 | 1070 | 1313 | 1.490 | 672 | 1191 | 1486 | 1773 | 2127 | 0.917 |
| STIR | #3- 63 | #3- 97 | #3-109 | #3-119 | #3-127 | | #3- 75 | #3- 94 | #3-109 | #3-114 | #4-120 | |
| 26'- 0" | 253 | 583 | 771 | 953 | 1178 | 1.743 | 585 | 1065 | 1338 | 1603 | 1931 | 1.073 |
| STIR | #3- 61 | #3- 98 | #3-111 | #3-110 | #3-130 | | #3- 75 | #3-101 | #3-112 | #3-118 | #4-123 | |
| 27'- 0" | 200 | 506 | 680 | 849 | 1058 | 2.027 | 508 | 953 | 1206 | 1452 | 1756 | 1.247 |
| STIR | #3- 59 | #3- 99 | #3-112 | #3-118 | #3-132 | | #3- 75 | #3-102 | #3-113 | #3-120 | #3-126 | |
| 28'- 0" | 152 | 437 | 599 | 756 | 950 | 2.344 | 439 | 852 | 1088 | 1317 | 1599 | 1.443 |
| STIR | #3- 56 | #3- 99 | #3-113 | #3-124 | #3-135 | | #3- 74 | #3-104 | #3-100 | #3-123 | #3-129 | |
| 29'- 0" | 110 | 375 | 526 | 672 | 853 | 2.698 | 377 | 762 | 982 | 1195 | 1458 | 1.660 |
| STIR | #3- 53 | #3- 99 | #3-114 | #3-126 | #3-138 | | #3- 73 | #3-105 | #3-108 | #3-125 | #3-132 | |
| 30'- 0" | 71 | 319 | 460 | 597 | 766 | 3.090 | 321 | 681 | 886 | 1085 | 1331 | 1.901 |
| STIR | #3- 49 | #3- 99 | #3-115 | #3-127 | #3-126 | | #3- 72 | #3-106 | #3-115 | #3-127 | #3-135 | |
| 31'- 0" | 36 | 268 | 400 | 529 | 687 | 3.523 | 270 | 607 | 800 | 986 | 1216 | 2.168 |
| STIR | #3- 45 | #3- 98 | #3-116 | #3-129 | #3-134 | | #3- 70 | #3-107 | #3-119 | #3-129 | #3-138 | |
| 32'- 0" | 5 | 222 | 346 | 467 | 615 | 4.000 | 224 | 541 | 721 | 896 | 1112 | 2.461 |
| STIR | #3- 41 | #3- 97 | #3-116 | #3-130 | #3-142 | | #3- 69 | #3-108 | #3-121 | #3-132 | #3-141 | |
| 33'- 0" | | 180 | 297 | 410 | 550 | 4.523 | 182 | 480 | 649 | 814 | 1017 | 2.784 |
| STIR | | #3- 96 | #3-116 | #3-131 | #3-144 | | #3- 67 | #3-108 | #3-122 | #3-121 | #3-143 | |
| 34'- 0" | | 142 | 252 | 359 | 490 | 5.097 | 144 | 424 | 584 | 739 | 931 | 3.137 |
| STIR | | #3- 95 | #3-116 | #3-132 | #3-146 | | #3- 65 | #3-109 | #3-123 | #3-129 | #3-145 | |
| 35'- 0" | | 107 | 211 | 312 | 436 | 5.724 | 109 | 373 | 524 | 671 | 851 | 3.522 |
| STIR | | #3- 93 | #3-116 | #3-133 | #3-147 | | #3- 62 | #3-109 | #3-124 | #3-135 | #3-148 | |
| 36'- 0" | | 75 | 173 | 268 | 386 | 6.407 | 77 | 327 | 469 | 608 | 778 | 3.942 |
| STIR | | #3- 92 | #3-115 | #3-133 | #3-149 | | #3- 60 | #3-109 | #3-125 | #3-137 | #3-150 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.96 | 1.07 | 1.28 | 1.49 | 1.75 | | 0.96 | 1.49 | 1.75 | 2.13 | 2.98 | |
| ACTUAL STEEL % | 0.626 | 0.696 | 0.835 | 0.975 | 1.147 | | 0.626 | 0.975 | 1.147 | 1.392 | 1.949 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.31 | 16.31 | | 16.38 | 16.31 | 16.31 | 16.31 | 16.31 | |
| $-I_{cr}/I_{gr}$ | 0.143 | 0.155 | 0.179 | 0.199 | 0.224 | | 0.143 | 0.199 | 0.224 | 0.258 | 0.325 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 0.88 | 1.04 | 1.19 | 1.39 | | 0.60 | 0.88 | 1.04 | 1.19 | 1.39 | |
| ACTUAL STEEL % | 0.370 | 0.546 | 0.646 | 0.737 | 0.867 | | 0.370 | 0.546 | 0.646 | 0.737 | 0.867 | |
| EFF. DEPTH, IN. | 16.75 | 16.62 | 16.59 | 16.64 | 16.53 | | 16.75 | 16.62 | 16.59 | 16.64 | 16.53 | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.174 | 0.202 | 0.229 | 0.260 | | 0.124 | 0.174 | 0.202 | 0.229 | 0.260 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8 | 10 | 9 | 7.5 | | 10 | 9 | 7.5 | 9.5 | 5 | |
| BOTTOM BARS NO | 2# 4 | 2# 4 | 1# 5 | 2# 6 | 1# 8 | | 2# 4 | 2# 4 | 1# 5 | 2# 6 | 1# 8 | |
| BARS NO | 1# 4 | 2# 5 | 2# 6 | 1# 6 | 1# 8 | | 1# 4 | 2# 5 | 2# 6 | 1# 6 | 1# 8 | |
| STEEL (PSF) | 0.65 | 1.01 | 1.18 | 1.34 | 1.64 | | 0.89 | 1.54 | 1.81 | 2.06 | 3.31 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 230 | 733 | 930 | 1083 | 1375 | 1.743 | 562 | 1294 | 1581 | 1803 | 2228 | 1.073 |
| STIR | #3- 48 | #3-102 | #3-113 | #3-110 | #3-131 | | #3- 66 | #3- 97 | #3-113 | #3-117 | #4-120 | |
| 27'- 0" | 177 | 644 | 826 | 968 | 1238 | 2.027 | 485 | 1164 | 1429 | 1635 | 2029 | 1.247 |
| STIR | #3- 45 | #3-103 | #3-115 | #3-118 | #3-134 | | #3- 65 | #3-104 | #3-115 | #3-120 | #4-126 | |
| 28'- 0" | 129 | 563 | 733 | 865 | 1116 | 2.344 | 416 | 1047 | 1294 | 1485 | 1852 | 1.443 |
| STIR | #3- 41 | #3-103 | #3-116 | #3-124 | #3-136 | | #3- 64 | #3-107 | #3-118 | #3-123 | #4-130 | |
| 29'- 0" | 86 | 491 | 649 | 772 | 1007 | 2.698 | 354 | 942 | 1172 | 1351 | 1692 | 1.660 |
| STIR | #3- 37 | #3-104 | #3-118 | #3-126 | #3-139 | | #3- 62 | #3-108 | #3-104 | #3-126 | #3-133 | |
| 30'- 0" | 48 | 426 | 574 | 688 | 908 | 3.090 | 298 | 847 | 1063 | 1229 | 1548 | 1.901 |
| STIR | #3- 32 | #3-104 | #3-119 | #3-127 | #3-142 | | #3- 60 | #3-110 | #3-111 | #3-128 | #3-137 | |
| 31'- 0" | 13 | 367 | 506 | 613 | 818 | 3.523 | 247 | 762 | 963 | 1119 | 1418 | 2.168 |
| STIR | #3- 27 | #3-104 | #3-119 | #3-129 | #3-131 | | #3- 58 | #3-111 | #3-119 | #3-130 | #3-139 | |
| 32'- 0" | | 314 | 444 | 544 | 737 | 4.000 | 201 | 684 | 873 | 1020 | 1300 | 2.461 |
| STIR | | #3-103 | #3-120 | #3-130 | #3-140 | | #3- 55 | #3-112 | #3-123 | #3-132 | #3-142 | |
| 33'- 0" | | 265 | 387 | 482 | 663 | 4.523 | 159 | 613 | 791 | 929 | 1193 | 2.784 |
| STIR | | #3-103 | #3-120 | #3-131 | #3-146 | | #3- 53 | #3-113 | #3-125 | #3-121 | #3-144 | |
| 34'- 0" | | 221 | 336 | 425 | 596 | 5.097 | 121 | 549 | 716 | 846 | 1095 | 3.137 |
| STIR | | #3-102 | #3-121 | #3-132 | #3-148 | | #3- 50 | #3-113 | #3-126 | #3-128 | #3-147 | |
| 35'- 0" | | 180 | 289 | 373 | 534 | 5.724 | 86 | 490 | 648 | 770 | 1005 | 3.522 |
| STIR | | #3-101 | #3-121 | #3-133 | #3-150 | | #3- 46 | #3-114 | #3-127 | #3-136 | #3-150 | |
| 36'- 0" | | 143 | 245 | 325 | 477 | 6.407 | 54 | 435 | 585 | 701 | 922 | 3.942 |
| STIR | | #3- 99 | #3-121 | #3-133 | #3-151 | | #3- 43 | #3-114 | #3-128 | #3-137 | #3-151 | |
| 37'- 0" | | 108 | 206 | 281 | 425 | 7.149 | 24 | 385 | 527 | 636 | 846 | 4.399 |
| STIR | | #3- 98 | #3-120 | #3-133 | #3-153 | | #3- 39 | #3-115 | #3-129 | #3-139 | #3-154 | |
| 38'- 0" | | 77 | 169 | 240 | 377 | 7.953 | | 339 | 473 | 577 | 776 | 4.894 |
| STIR | | #3- 96 | #3-120 | #3-134 | #3-154 | | | #3-115 | #3-130 | #3-140 | #3-156 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.98 | 1.23 | 1.52 | 1.69 | 2.03 | | 0.98 | 1.69 | 2.03 | 2.27 | 4.31 | |
| ACTUAL STEEL % | 0.577 | 0.722 | 0.899 | 0.999 | 1.199 | | 0.577 | 0.999 | 1.199 | 1.349 | 2.563 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.31 | 16.31 | 16.31 | | 16.38 | 16.31 | 16.31 | 16.25 | 16.25 | |
| $-I_{cr}/I_{gr}$ | 0.137 | 0.163 | 0.191 | 0.207 | 0.237 | | 0.137 | 0.207 | 0.237 | 0.255 | 0.392 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.60 | 1.02 | 1.19 | 1.32 | 1.58 | | 0.60 | 1.02 | 1.19 | 1.32 | 1.58 | |
| ACTUAL STEEL % | 0.335 | 0.571 | 0.669 | 0.742 | 0.894 | | 0.335 | 0.571 | 0.669 | 0.742 | 0.894 | |
| EFF. DEPTH, IN. | 16.75 | 16.71 | 16.64 | 16.62 | 16.50 | | 16.75 | 16.71 | 16.64 | 16.62 | 16.50 | |
| $+I_{cr}/I_{gr}$ | 0.114 | 0.186 | 0.212 | 0.232 | 0.268 | | 0.114 | 0.186 | 0.212 | 0.232 | 0.268 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8 | 10 | 8.5 | 7.5 | | 8.5 | 9 | 7.5 | 6 | 7.5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 5 | 2# 6 | 1# 6 | | 2# 4 | 1# 6 | 2# 5 | 2# 6 | 1# 6 | |
| BARS NO | 1# 5 | 1# 7 | 2# 5 | 1# 7 | 2# 7 | | 1# 5 | 1# 7 | 2# 5 | 1# 7 | 2# 7 | |
| STEEL (PSF) | 0.73 | 1.03 | 1.25 | 1.47 | 1.60 | | 1.06 | 1.56 | 1.88 | 2.28 | 2.54 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 339 | 725 | 971 | 1246 | 1432 | 1.743 | 731 | 1293 | 1651 | 2051 | 2321 | 1.073 |
| STIR | #3- 58 | #3- 96 | #3-110 | #3-108 | #3-129 | | #3- 73 | #3- 99 | #3-111 | #3-118 | #4-122 | |
| 27'- 0" | 276 | 634 | 862 | 1118 | 1290 | 2.027 | 640 | 1161 | 1493 | 1864 | 2114 | 1.247 |
| STIR | #3- 55 | #3- 96 | #3-111 | #3-116 | #3-131 | | #3- 72 | #3-100 | #3-113 | #3-121 | #4-125 | |
| 28'- 0" | 220 | 553 | 765 | 1002 | 1162 | 2.344 | 558 | 1043 | 1351 | 1696 | 1929 | 1.443 |
| STIR | #3- 52 | #3- 96 | #3-112 | #3-125 | #3-134 | | #3- 71 | #3-102 | #3-102 | #3-124 | #4-129 | |
| 29'- 0" | 169 | 480 | 678 | 899 | 1048 | 2.698 | 485 | 936 | 1224 | 1546 | 1763 | 1.660 |
| STIR | #3- 48 | #3- 96 | #3-113 | #3-127 | #3-121 | | #3- 70 | #3-103 | #3-109 | #3-126 | #3-131 | |
| 30'- 0" | 124 | 414 | 599 | 806 | 945 | 3.090 | 418 | 841 | 1109 | 1410 | 1613 | 1.901 |
| STIR | #3- 45 | #3- 95 | #3-114 | #3-129 | #3-129 | | #3- 69 | #3-104 | #3-116 | #3-129 | #3-134 | |
| 31'- 0" | 83 | 354 | 528 | 721 | 852 | 3.523 | 359 | 754 | 1006 | 1287 | 1477 | 2.168 |
| STIR | #3- 40 | #3- 94 | #3-115 | #3-130 | #3-138 | | #3- 67 | #3-105 | #3-118 | #3-131 | #3-137 | |
| 32'- 0" | 45 | 300 | 463 | 645 | 767 | 4.000 | 304 | 675 | 912 | 1176 | 1354 | 2.461 |
| STIR | #3- 36 | #3- 93 | #3-115 | #3-132 | #3-140 | | #3- 65 | #3-105 | #3-120 | #3-133 | #3-139 | |
| 33'- 0" | 11 | 251 | 404 | 575 | 690 | 4.523 | 255 | 604 | 826 | 1074 | 1242 | 2.784 |
| STIR | #3- 31 | #3- 92 | #3-115 | #3-133 | #3-142 | | #3- 63 | #3-106 | #3-121 | #3-119 | #3-141 | |
| 34'- 0" | | 206 | 350 | 511 | 620 | 5.097 | 210 | 538 | 748 | 982 | 1140 | 3.137 |
| STIR | | #3- 91 | #3-115 | #3-134 | #3-143 | | #3- 61 | #3-106 | #3-122 | #3-126 | #3-144 | |
| 35'- 0" | | 165 | 301 | 453 | 555 | 5.724 | 168 | 478 | 676 | 897 | 1046 | 3.522 |
| STIR | | #3- 89 | #3-115 | #3-135 | #3-145 | | #3- 58 | #3-106 | #3-123 | #3-134 | #3-146 | |
| 36'- 0" | | 127 | 256 | 399 | 496 | 6.407 | 130 | 424 | 610 | 819 | 960 | 3.942 |
| STIR | | #3- 87 | #3-114 | #3-135 | #3-146 | | #3- 55 | #3-106 | #3-124 | #3-139 | #3-149 | |
| 37'- 0" | | 93 | 214 | 350 | 442 | 7.149 | 95 | 373 | 550 | 747 | 881 | 4.399 |
| STIR | | #3- 85 | #3-114 | #3-136 | #3-147 | | #3- 52 | #3-106 | #3-125 | #3-140 | #3-135 | |
| 38'- 0" | | 61 | 176 | 305 | 391 | 7.953 | 63 | 326 | 494 | 681 | 808 | 4.894 |
| STIR | | #3- 82 | #3-113 | #3-136 | #3-148 | | #3- 49 | #3-105 | #3-125 | #3-142 | #3-142 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.00 | 1.25 | 1.55 | 1.82 | 2.07 | | 1.18 | 1.72 | 2.07 | 2.58 | 2.93 | |
| ACTUAL STEEL % | 0.537 | 0.672 | 0.836 | 0.984 | 1.115 | | 0.632 | 0.929 | 1.115 | 1.394 | 1.590 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.31 | 16.31 | 16.31 | | 16.38 | 16.31 | 16.31 | 16.31 | 16.25 | |
| $-I_{cr}/I_{gr}$ | 0.131 | 0.157 | 0.184 | 0.209 | 0.229 | | 0.150 | 0.200 | 0.229 | 0.269 | 0.292 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.71 | 1.04 | 1.24 | 1.48 | 1.64 | | 0.71 | 1.04 | 1.24 | 1.48 | 1.64 | |
| ACTUAL STEEL % | 0.363 | 0.536 | 0.635 | 0.762 | 0.845 | | 0.363 | 0.536 | 0.635 | 0.762 | 0.845 | |
| EFF. DEPTH, IN. | 16.72 | 16.59 | 16.69 | 16.60 | 16.58 | | 16.72 | 16.59 | 16.69 | 16.60 | 16.58 | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.173 | 0.205 | 0.238 | 0.260 | | 0.124 | 0.173 | 0.205 | 0.238 | 0.260 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 10 | 8.5 | 7.5 | | 9.5 | 8.5 | 7.5 | 9 | 5 | |
| BOTTOM BARS NO | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.70 | 1.08 | 1.20 | 1.45 | 1.67 | | 0.96 | 1.64 | 1.83 | 2.21 | 3.33 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 223 | 704 | 880 | 1100 | 1313 | 2.344 | 554 | 1253 | 1509 | 1828 | 2138 | 1.443 |
| STIR | #3- 57 | #3-112 | #3-123 | #3-135 | #3-142 | | #3- 75 | #3-102 | #3-121 | #3-129 | #4-129 | |
| 29'- 0" | 174 | 622 | 786 | 991 | 1189 | 2.698 | 482 | 1134 | 1373 | 1670 | 1959 | 1.660 |
| STIR | #3- 54 | #3-113 | #3-124 | #3-120 | #3-145 | | #3- 74 | #3-109 | #3-124 | #3-131 | #4-135 | |
| 30'- 0" | 129 | 548 | 702 | 893 | 1078 | 3.090 | 417 | 1027 | 1250 | 1528 | 1798 | 1.901 |
| STIR | #3- 51 | #3-113 | #3-126 | #3-128 | #3-147 | | #3- 73 | #3-116 | #3-126 | #3-134 | #4-140 | |
| 31'- 0" | 89 | 482 | 625 | 804 | 978 | 3.523 | 359 | 930 | 1139 | 1399 | 1652 | 2.168 |
| STIR | #3- 47 | #3-114 | #3-127 | #3-137 | #3-150 | | #3- 72 | #3-118 | #3-109 | #3-137 | #4-143 | |
| 32'- 0" | 53 | 421 | 556 | 724 | 887 | 4.000 | 306 | 841 | 1038 | 1282 | 1519 | 2.461 |
| STIR | #3- 43 | #3-114 | #3-128 | #3-141 | #3-153 | | #3- 70 | #3-119 | #3-116 | #3-140 | #3-146 | |
| 33'- 0" | 19 | 366 | 493 | 650 | 804 | 4.523 | 257 | 761 | 946 | 1175 | 1398 | 2.784 |
| STIR | #3- 38 | #3-114 | #3-129 | #3-143 | #3-137 | | #3- 68 | #3-121 | #3-124 | #3-142 | #3-149 | |
| 34'- 0" | | 315 | 435 | 584 | 728 | 5.097 | 213 | 688 | 861 | 1078 | 1288 | 3.137 |
| STIR | | #3-114 | #3-130 | #3-144 | #3-145 | | #3- 66 | #3-122 | #3-131 | #3-145 | #3-152 | |
| 35'- 0" | | 269 | 382 | 522 | 659 | 5.724 | 173 | 621 | 785 | 989 | 1187 | 3.522 |
| STIR | | #3-114 | #3-130 | #3-146 | #3-154 | | #3- 64 | #3-123 | #3-134 | #3-147 | #3-155 | |
| 36'- 0" | | 227 | 333 | 466 | 595 | 6.407 | 136 | 559 | 714 | 907 | 1094 | 3.942 |
| STIR | | #3-113 | #3-131 | #3-147 | #3-159 | | #3- 61 | #3-124 | #3-136 | #3-149 | #3-157 | |
| 37'- 0" | | 188 | 289 | 414 | 536 | 7.149 | 102 | 502 | 649 | 832 | 1009 | 4.399 |
| STIR | | #3-112 | #3-131 | #3-148 | #3-161 | | #3- 59 | #3-124 | #3-137 | #3-133 | #3-160 | |
| 38'- 0" | | 152 | 248 | 367 | 482 | 7.953 | 70 | 450 | 589 | 762 | 931 | 4.894 |
| STIR | | #3-111 | #3-131 | #3-149 | #3-163 | | #3- 55 | #3-125 | #3-138 | #3-141 | #3-162 | |
| 39'- 0" | | 119 | 210 | 323 | 432 | 8.824 | 41 | 402 | 534 | 698 | 858 | 5.430 |
| STIR | | #3-110 | #3-131 | #3-150 | #3-164 | | #3- 52 | #3-125 | #3-139 | #3-148 | #3-164 | |
| 40'- 0" | | 88 | 174 | 282 | 386 | 9.765 | 14 | 357 | 483 | 639 | 791 | 6.009 |
| STIR | | #3-109 | #3-131 | #3-151 | #3-166 | | #3- 49 | #3-126 | #3-140 | #3-155 | #3-167 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.70 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.96 | 1.28 | 1.49 | 1.75 | 1.98 | | 1.01 | 1.75 | 1.98 | 2.35 | 4.22 | |
| ACTUAL STEEL % | 0.548 | 0.731 | 0.853 | 1.004 | 1.137 | | 0.577 | 1.004 | 1.137 | 1.351 | 2.431 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.31 | 18.31 | 18.31 | | 18.38 | 18.31 | 18.31 | 18.25 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.135 | 0.169 | 0.189 | 0.213 | 0.234 | | 0.140 | 0.213 | 0.234 | 0.262 | 0.390 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | |
| EFF. DEPTH, IN. | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.117 | 0.187 | 0.213 | 0.242 | 0.271 | | 0.117 | 0.187 | 0.213 | 0.242 | 0.271 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 9.5 | 7.5 | 9.5 | | 8.5 | 5 | 4.5 | 8 | 6 | |
| BOTTOM BARS NO | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.74 | 1.18 | 1.31 | 1.64 | 1.85 | | 1.07 | 1.77 | 1.99 | 2.50 | 3.73 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 304 | 855 | 1003 | 1288 | 1521 | 2.344 | 683 | 1484 | 1699 | 2114 | 2453 | 1.443 |
| STIR | #3- 62 | #3-115 | #3-123 | #3-136 | #3-143 | | #3- 78 | #3- 99 | #3-121 | #4-130 | #4-128 | |
| 29'- 0" | 248 | 761 | 899 | 1164 | 1382 | 2.698 | 601 | 1348 | 1548 | 1934 | 2251 | 1.660 |
| STIR | #3- 59 | #3-116 | #3-124 | #3-138 | #3-146 | | #3- 78 | #3-106 | #3-124 | #4-132 | #4-133 | |
| 30'- 0" | 197 | 676 | 805 | 1053 | 1257 | 3.090 | 527 | 1225 | 1412 | 1773 | 2068 | 1.901 |
| STIR | #3- 56 | #3-117 | #3-126 | #3-125 | #3-149 | | #3- 77 | #3-113 | #3-127 | #3-136 | #4-140 | |
| 31'- 0" | 150 | 600 | 721 | 953 | 1143 | 3.523 | 460 | 1113 | 1289 | 1627 | 1903 | 2.168 |
| STIR | #3- 53 | #3-118 | #3-127 | #3-133 | #3-152 | | #3- 76 | #3-120 | #3-109 | #3-139 | #4-144 | |
| 32'- 0" | 109 | 530 | 644 | 862 | 1040 | 4.000 | 399 | 1012 | 1177 | 1494 | 1754 | 2.461 |
| STIR | #3- 49 | #3-118 | #3-128 | #3-142 | #3-155 | | #3- 74 | #3-122 | #3-117 | #3-141 | #4-147 | |
| 33'- 0" | 71 | 467 | 574 | 779 | 947 | 4.523 | 343 | 920 | 1075 | 1373 | 1617 | 2.784 |
| STIR | #3- 45 | #3-119 | #3-129 | #3-145 | #3-157 | | #3- 73 | #3-123 | #3-124 | #3-144 | #4-151 | |
| 34'- 0" | 36 | 409 | 510 | 703 | 861 | 5.097 | 293 | 836 | 982 | 1263 | 1493 | 3.137 |
| STIR | #3- 41 | #3-119 | #3-130 | #3-147 | #3-142 | | #3- 71 | #3-124 | #3-131 | #3-146 | #4-153 | |
| 35'- 0" | 4 | 357 | 451 | 633 | 783 | 5.724 | 246 | 759 | 897 | 1162 | 1379 | 3.522 |
| STIR | #3- 36 | #3-119 | #3-131 | #3-148 | #3-150 | | #3- 69 | #3-126 | #3-134 | #3-149 | #3-156 | |
| 36'- 0" | | 308 | 397 | 570 | 711 | 6.407 | 204 | 689 | 819 | 1069 | 1275 | 3.942 |
| STIR | | #3-118 | #3-131 | #3-150 | #3-159 | | #3- 67 | #3-127 | #3-135 | #3-150 | #3-159 | |
| 37'- 0" | | 263 | 348 | 511 | 645 | 7.149 | 165 | 624 | 747 | 984 | 1178 | 4.399 |
| STIR | | #3-118 | #3-131 | #3-151 | #3-163 | | #3- 64 | #3-128 | #3-137 | #3-153 | #3-161 | |
| 38'- 0" | | 222 | 302 | 457 | 584 | 7.953 | 129 | 564 | 681 | 905 | 1090 | 4.894 |
| STIR | | #3-117 | #3-131 | #3-152 | #3-165 | | #3- 62 | #3-128 | #3-138 | #3-137 | #3-163 | |
| 39'- 0" | | 184 | 260 | 407 | 527 | 8.824 | 95 | 508 | 619 | 833 | 1008 | 5.430 |
| STIR | | #3-116 | #3-131 | #3-153 | #3-167 | | #3- 59 | #3-129 | #3-139 | #3-145 | #3-166 | |
| 40'- 0" | | 149 | 221 | 361 | 475 | 9.765 | 65 | 457 | 563 | 766 | 932 | 6.009 |
| STIR | | #3-115 | #3-131 | #3-154 | #3-168 | | #3- 56 | #3-129 | #3-140 | #3-152 | #3-168 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.98 | 1.52 | 1.60 | 2.03 | 2.27 | | 1.15 | 1.96 | 2.18 | 2.69 | 4.90 | |
| ACTUAL STEEL % | 0.506 | 0.788 | 0.830 | 1.051 | 1.182 | | 0.596 | 1.013 | 1.125 | 1.404 | 2.562 | |
| EFF. DEPTH, IN. | 18.38 | 18.31 | 18.31 | 18.31 | 18.25 | | 18.38 | 18.38 | 18.38 | 18.25 | 18.19 | |
| $-I_{cr}/I_{gr}$ | 0.129 | 0.181 | 0.189 | 0.225 | 0.243 | | 0.147 | 0.222 | 0.240 | 0.275 | 0.407 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | |
| EFF. DEPTH, IN. | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | |
| $+I_{cr}/I_{gr}$ | 0.123 | 0.196 | 0.215 | 0.250 | 0.278 | | 0.123 | 0.196 | 0.215 | 0.250 | 0.278 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**40″ Forms + 10″ Ribs @ 50″ c.-c.**
15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 7 | 8.5 | 7.5 | 6 | | 8.5 | 8 | 6 | 8 | 4 | |
| BOTTOM BARS NO | 3# 3 | 1# 5 | 2# 6 | 1# 6 | 2# 7 | | 3# 3 | 1# 5 | 2# 6 | 1# 6 | 2# 7 | |
| BARS NO | 2# 4 | 2# 6 | 1# 7 | 2# 7 | 1# 8 | | 2# 4 | 2# 6 | 1# 7 | 2# 7 | 1# 8 | |
| STEEL (PSF) | 0.75 | 1.13 | 1.47 | 1.60 | 2.00 | | 1.08 | 1.73 | 2.28 | 2.45 | 4.08 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 304 | 830 | 1158 | 1339 | 1730 | 2.344 | 695 | 1459 | 1937 | 2199 | 2768 | 1.443 |
| STIR | #3- 54 | #3-107 | #3-124 | #3-115 | #4-144 | | #3- 73 | #3-108 | #3-123 | #4-128 | #4-128 | |
| 29'- 0" | 246 | 736 | 1042 | 1210 | 1575 | 2.698 | 610 | 1323 | 1768 | 2013 | 2543 | 1.660 |
| STIR | #3- 51 | #3-108 | #3-126 | #3-123 | #3-147 | | #3- 72 | #3-111 | #3-126 | #4-130 | #4-133 | |
| 30'- 0" | 194 | 651 | 938 | 1095 | 1435 | 3.090 | 534 | 1199 | 1616 | 1844 | 2340 | 1.901 |
| STIR | #3- 47 | #3-108 | #3-128 | #3-131 | #3-150 | | #3- 70 | #3-113 | #3-128 | #3-133 | #4-139 | |
| 31'- 0" | 146 | 575 | 843 | 990 | 1309 | 3.523 | 465 | 1088 | 1478 | 1692 | 2156 | 2.168 |
| STIR | #3- 43 | #3-108 | #3-129 | #3-137 | #3-152 | | #3- 69 | #3-114 | #3-130 | #3-135 | #4-145 | |
| 32'- 0" | 103 | 505 | 757 | 895 | 1194 | 4.000 | 402 | 987 | 1353 | 1554 | 1990 | 2.461 |
| STIR | #3- 39 | #3-108 | #3-130 | #3-139 | #3-155 | | #3- 67 | #3-115 | #3-114 | #3-139 | #4-148 | |
| 33'- 0" | 64 | 442 | 678 | 808 | 1090 | 4.523 | 345 | 895 | 1239 | 1428 | 1838 | 2.784 |
| STIR | #3- 34 | #3-108 | #3-131 | #3-141 | #3-158 | | #3- 65 | #3-116 | #3-121 | #3-141 | #4-151 | |
| 34'- 0" | 28 | 384 | 607 | 729 | 995 | 5.097 | 293 | 811 | 1135 | 1313 | 1699 | 3.137 |
| STIR | #3- 29 | #3-107 | #3-132 | #3-142 | #3-160 | | #3- 63 | #3-117 | #3-128 | #3-143 | #4-154 | |
| 35'- 0" | | 331 | 542 | 657 | 907 | 5.724 | 245 | 734 | 1040 | 1208 | 1572 | 3.522 |
| STIR | | #3-106 | #3-133 | #3-143 | #3-148 | | #3- 60 | #3-118 | #3-136 | #3-145 | #4-157 | |
| 36'- 0" | | 283 | 481 | 590 | 827 | 6.407 | 201 | 663 | 953 | 1111 | 1455 | 3.942 |
| STIR | | #3-105 | #3-134 | #3-145 | #3-157 | | #3- 58 | #3-118 | #3-137 | #3-130 | #4-160 | |
| 37'- 0" | | 238 | 426 | 529 | 753 | 7.149 | 161 | 598 | 872 | 1022 | 1348 | 4.399 |
| STIR | | #3-104 | #3-134 | #3-146 | #3-165 | | #3- 55 | #3-119 | #3-139 | #3-137 | #3-163 | |
| 38'- 0" | | 197 | 375 | 473 | 685 | 7.953 | 124 | 538 | 798 | 940 | 1249 | 4.894 |
| STIR | | #3-103 | #3-134 | #3-146 | #3-166 | | #3- 51 | #3-119 | #3-140 | #3-144 | #3-165 | |
| 39'- 0" | | 159 | 328 | 421 | 623 | 8.824 | 89 | 483 | 730 | 865 | 1158 | 5.430 |
| STIR | | #3-101 | #3-134 | #3-147 | #3-168 | | #3- 48 | #3-119 | #3-142 | #3-151 | #3-167 | |
| 40'- 0" | | 123 | 284 | 373 | 564 | 9.765 | 57 | 432 | 666 | 795 | 1073 | 6.009 |
| STIR | | #3- 99 | #3-134 | #3-148 | #3-170 | | #3- 44 | #3-119 | #3-143 | #3-152 | #3-170 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.00 | 1.43 | 1.82 | 2.07 | 2.58 | | 1.18 | 1.94 | 2.58 | 2.75 | 5.50 | |
| ACTUAL STEEL % | 0.472 | 0.674 | 0.864 | 0.979 | 1.224 | | 0.555 | 0.918 | 1.224 | 1.308 | 2.616 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.31 | 18.31 | 18.31 | | 18.38 | 18.31 | 18.31 | 18.25 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.124 | 0.165 | 0.198 | 0.218 | 0.257 | | 0.142 | 0.208 | 0.257 | 0.267 | 0.426 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.73 | 1.19 | 1.48 | 1.64 | 1.99 | | 0.73 | 1.19 | 1.48 | 1.64 | 1.99 | |
| ACTUAL STEEL % | 0.328 | 0.538 | 0.671 | 0.744 | 0.904 | | 0.328 | 0.538 | 0.671 | 0.744 | 0.904 | |
| EFF. DEPTH, IN. | 18.78 | 18.64 | 18.60 | 18.58 | 18.54 | | 18.78 | 18.64 | 18.60 | 18.58 | 18.54 | |
| $+I_{cr}/I_{gr}$ | 0.118 | 0.183 | 0.222 | 0.243 | 0.287 | | 0.118 | 0.183 | 0.222 | 0.243 | 0.287 | |

SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**40″ Forms + 8″ Ribs @ 48″ c.-c.**
17″ Deep Rib + 5.5″ Top Slab = 22.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 6 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 10 | 9 | 7.5 | 9.5 | | 8.5 | 7.5 | 9.5 | 10 | 6 | |
| BOTTOM BARS NO | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.75 | 1.20 | 1.36 | 1.67 | 1.87 | | 1.08 | 1.83 | 2.08 | 2.64 | 3.76 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 176 | 644 | 770 | 1013 | 1212 | 4.000 | 497 | 1178 | 1361 | 1715 | 2004 | 2.461 |
| STIR | #3- 63 | #3-126 | #3-136 | #3-131 | #3-160 | | #3- 84 | #3-118 | #3-136 | #4-146 | #4-149 | |
| 33'- 0" | 134 | 574 | 692 | 921 | 1108 | 4.523 | 436 | 1076 | 1248 | 1581 | 1852 | 2.784 |
| STIR | #3- 60 | #3-127 | #3-137 | #3-139 | #3-163 | | #3- 83 | #3-126 | #3-138 | #3-148 | #4-155 | |
| 34'- 0" | 95 | 510 | 621 | 837 | 1013 | 5.097 | 380 | 983 | 1145 | 1458 | 1714 | 3.137 |
| STIR | #3- 56 | #3-128 | #3-138 | #3-148 | #3-165 | | #3- 82 | #3-131 | #3-120 | #3-151 | #4-158 | |
| 35'- 0" | 60 | 451 | 557 | 760 | 926 | 5.724 | 329 | 898 | 1051 | 1346 | 1588 | 3.522 |
| STIR | #3- 52 | #3-128 | #3-140 | #3-156 | #3-168 | | #3- 80 | #3-133 | #3-127 | #3-154 | #4-161 | |
| 36'- 0" | 28 | 398 | 497 | 689 | 846 | 6.407 | 282 | 820 | 964 | 1243 | 1472 | 3.942 |
| STIR | #3- 48 | #3-129 | #3-140 | #3-158 | #3-170 | | #3- 79 | #3-134 | #3-135 | #3-156 | #4-163 | |
| 37'- 0" | | 348 | 442 | 624 | 773 | 7.149 | 238 | 748 | 884 | 1149 | 1365 | 4.399 |
| STIR | | #3-129 | #3-141 | #3-159 | #3-154 | | #3- 77 | #3-135 | #3-142 | #3-159 | #3-166 | |
| 38'- 0" | | 302 | 392 | 564 | 705 | 7.953 | 198 | 681 | 811 | 1062 | 1267 | 4.894 |
| STIR | | #3-129 | #3-142 | #3-161 | #3-163 | | #3- 75 | #3-137 | #3-146 | #3-161 | #3-169 | |
| 39'- 0" | | 260 | 345 | 509 | 642 | 8.824 | 161 | 620 | 743 | 981 | 1176 | 5.430 |
| STIR | | #3-129 | #3-142 | #3-162 | #3-171 | | #3- 73 | #3-138 | #3-147 | #3-164 | #3-172 | |
| 40'- 0" | | 221 | 302 | 457 | 584 | 9.765 | 127 | 563 | 680 | 906 | 1091 | 6.009 |
| STIR | | #3-128 | #3-142 | #3-164 | #3-177 | | #3- 70 | #3-139 | #3-149 | #3-166 | #3-175 | |
| 41'- 0" | | 185 | 262 | 410 | 531 | 10.778 | 96 | 510 | 622 | 837 | 1013 | 6.633 |
| STIR | | #3-127 | #3-143 | #3-165 | #3-179 | | #3- 68 | #3-139 | #3-150 | #3-147 | #3-177 | |
| 42'- 0" | | 151 | 224 | 365 | 481 | 11.869 | 66 | 461 | 568 | 773 | 940 | 7.304 |
| STIR | | #3-127 | #3-142 | #3-166 | #3-180 | | #3- 65 | #3-140 | #3-151 | #3-154 | #3-179 | |
| 43'- 0" | | 120 | 190 | 324 | 434 | 13.040 | 39 | 416 | 517 | 713 | 873 | 8.025 |
| STIR | | #3-126 | #3-142 | #3-167 | #3-182 | | #3- 62 | #3-141 | #3-153 | #3-161 | #3-182 | |
| 44'- 0" | | 91 | 157 | 286 | 391 | 14.296 | 13 | 373 | 470 | 657 | 810 | 8.798 |
| STIR | | #3-124 | #3-142 | #3-167 | #3-184 | | #3- 58 | #3-141 | #3-153 | #3-169 | #3-185 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.96 | 1.49 | 1.65 | 1.98 | 2.22 | | 1.13 | 1.98 | 2.22 | 2.88 | 4.80 | |
| ACTUAL STEEL % | 0.486 | 0.756 | 0.840 | 1.008 | 1.133 | | 0.572 | 1.008 | 1.133 | 1.473 | 2.456 | |
| EFF. DEPTH, IN. | 20.38 | 20.31 | 20.31 | 20.31 | 20.25 | | 20.38 | 20.31 | 20.25 | 20.19 | 20.19 | |
| $-I_{cr}/I_{gr}$ | 0.127 | 0.179 | 0.194 | 0.223 | 0.241 | | 0.145 | 0.223 | 0.241 | 0.288 | 0.405 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.342 | 0.575 | 0.638 | 0.768 | 0.871 | | 0.342 | 0.575 | 0.638 | 0.768 | 0.871 | |
| EFF. DEPTH, IN. | 20.72 | 20.64 | 20.62 | 20.50 | 20.46 | | 20.72 | 20.64 | 20.62 | 20.50 | 20.46 | |
| $+I_{cr}/I_{gr}$ | 0.124 | 0.199 | 0.218 | 0.253 | 0.282 | | 0.124 | 0.199 | 0.218 | 0.253 | 0.282 | |

SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>17″ Deep Rib + 5.5″ Top Slab = 22.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 8.5 | 9.5 | 8.5 | | 8 | 5 | 4 | 7 | 4 | |
| BOTTOM BARS NO | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 2# 7 | | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 2# 7 | |
| BARS NO | 1# 6 | 1# 7 | 1# 7 | 1# 9 | 1# 8 | | 1# 6 | 1# 7 | 1# 7 | 1# 9 | 1# 8 | |
| STEEL (PSF) | 0.77 | 1.25 | 1.49 | 1.85 | 2.04 | | 1.13 | 1.84 | 2.25 | 2.82 | 4.11 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 185 | 622 | 896 | 1184 | 1382 | 4.000 | 523 | 1158 | 1557 | 1976 | 2265 | 2.461 |
| STIR | #3- 55 | #3-117 | #3-137 | #3-153 | #3-161 | | #3- 78 | #3-121 | #3-136 | #4-146 | #4-148 | |
| 33'- 0" | 141 | 551 | 809 | 1080 | 1267 | 4.523 | 459 | 1056 | 1431 | 1825 | 2096 | 2.784 |
| STIR | #3- 51 | #3-117 | #3-138 | #3-136 | #3-163 | | #3- 77 | #3-122 | #3-139 | #4-149 | #4-154 | |
| 34'- 0" | 100 | 487 | 730 | 985 | 1161 | 5.097 | 400 | 962 | 1316 | 1687 | 1942 | 3.137 |
| STIR | #3- 47 | #3-117 | #3-140 | #3-144 | #3-166 | | #3- 76 | #3-123 | #3-119 | #4-152 | #4-158 | |
| 35'- 0" | 63 | 428 | 657 | 898 | 1064 | 5.724 | 346 | 876 | 1210 | 1560 | 1802 | 3.522 |
| STIR | #3- 43 | #3-117 | #3-141 | #3-152 | #3-169 | | #3- 74 | #3-125 | #3-127 | #3-155 | #4-160 | |
| 36'- 0" | 29 | 374 | 591 | 818 | 975 | 6.407 | 296 | 798 | 1113 | 1444 | 1672 | 3.942 |
| STIR | #3- 38 | #3-117 | #3-142 | #3-160 | #3-171 | | #3- 72 | #3-126 | #3-134 | #3-157 | #4-164 | |
| 37'- 0" | | 324 | 529 | 745 | 893 | 7.149 | 251 | 725 | 1024 | 1337 | 1553 | 4.399 |
| STIR | | #3-116 | #3-143 | #3-162 | #3-153 | | #3- 70 | #3-126 | #3-141 | #3-160 | #4-166 | |
| 38'- 0" | | 278 | 473 | 677 | 818 | 7.953 | 208 | 659 | 942 | 1239 | 1444 | 4.894 |
| STIR | | #3-116 | #3-143 | #3-164 | #3-161 | | #3- 67 | #3-127 | #3-146 | #3-163 | #4-169 | |
| 39'- 0" | | 236 | 421 | 615 | 748 | 8.824 | 170 | 597 | 866 | 1148 | 1342 | 5.430 |
| STIR | | #3-115 | #3-144 | #3-165 | #3-170 | | #3- 65 | #3-128 | #3-148 | #3-165 | #4-172 | |
| 40'- 0" | | 197 | 372 | 557 | 684 | 9.765 | 134 | 540 | 795 | 1064 | 1248 | 6.009 |
| STIR | | #3-113 | #3-144 | #3-167 | #3-178 | | #3- 62 | #3-128 | #3-149 | #3-167 | #3-175 | |
| 41'- 0" | | 160 | 327 | 503 | 624 | 10.778 | 100 | 487 | 730 | 986 | 1161 | 6.633 |
| STIR | | #3-112 | #3-144 | #3-168 | #3-180 | | #3- 59 | #3-128 | #3-151 | #3-170 | #3-177 | |
| 42'- 0" | | 126 | 286 | 453 | 568 | 11.869 | 69 | 438 | 670 | 913 | 1080 | 7.304 |
| STIR | | #3-110 | #3-144 | #3-169 | #3-182 | | #3- 56 | #3-129 | #3-152 | #3-151 | #3-179 | |
| 43'- 0" | | 95 | 247 | 406 | 516 | 13.040 | 40 | 392 | 613 | 845 | 1005 | 8.025 |
| STIR | | #3-109 | #3-144 | #3-170 | #3-183 | | #3- 52 | #3-129 | #3-153 | #3-158 | #3-182 | |
| 44'- 0" | | 66 | 211 | 363 | 468 | 14.296 | 14 | 349 | 560 | 782 | 935 | 8.798 |
| STIR | | #3-107 | #3-144 | #3-171 | #3-185 | | #3- 48 | #3-128 | #3-154 | #3-165 | #3-185 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.76 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.98 | 1.52 | 1.79 | 2.27 | 2.54 | | 1.23 | 1.96 | 2.45 | 3.08 | 5.39 | |
| ACTUAL STEEL % | 0.450 | 0.699 | 0.823 | 1.049 | 1.172 | | 0.562 | 0.899 | 1.124 | 1.423 | 2.491 | |
| EFF. DEPTH, IN. | 20.38 | 20.31 | 20.31 | 20.25 | 20.25 | | 20.38 | 20.38 | 20.38 | 20.25 | 20.25 | |
| $-I_{cr}/I_{gr}$ | 0.122 | 0.172 | 0.195 | 0.232 | 0.252 | | 0.146 | 0.211 | 0.249 | 0.290 | 0.422 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.75 | 1.20 | 1.48 | 1.79 | 1.99 | | 0.75 | 1.20 | 1.48 | 1.79 | 1.99 | |
| ACTUAL STEEL % | 0.329 | 0.529 | 0.651 | 0.792 | 0.878 | | 0.329 | 0.529 | 0.651 | 0.792 | 0.878 | |
| EFF. DEPTH, IN. | 20.65 | 20.56 | 20.60 | 20.46 | 20.54 | | 20.65 | 20.56 | 20.60 | 20.46 | 20.54 | |
| $+I_{cr}/I_{gr}$ | 0.120 | 0.183 | 0.223 | 0.261 | 0.289 | | 0.120 | 0.183 | 0.223 | 0.261 | 0.289 | |
| SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>17″ Deep Rib + 5.5″ Top Slab = 22.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9.5 | 8 | 9 | 8 | | 7.5 | 7 | 6 | 6.5 | 4 | |
| BOTTOM BARS NO | 1# 4 | 2# 6 | 1# 8 | 2# 7 | 1# 7 | | 1# 4 | 2# 6 | 1# 8 | 2# 7 | 1# 7 | |
| BARS NO | 2# 5 | 1# 6 | 1# 8 | 1# 8 | 2# 8 | | 2# 5 | 1# 6 | 1# 8 | 1# 8 | 2# 8 | |
| STEEL (PSF) | 0.78 | 1.30 | 1.59 | 1.98 | 2.13 | | 1.18 | 1.97 | 2.37 | 3.04 | 4.16 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 228 | 714 | 958 | 1355 | 1535 | 4.000 | 598 | 1306 | 1660 | 2238 | 2499 | 2.461 |
| STIR | #3- 55 | #3-118 | #3-134 | #3-154 | #4-161 | | #3- 79 | #3-122 | #3-135 | #4-147 | #4-149 | |
| 33'- 0" | 179 | 637 | 865 | 1239 | 1408 | 4.523 | 528 | 1193 | 1526 | 2069 | 2315 | 2.784 |
| STIR | #3- 52 | #3-118 | #3-136 | #3-157 | #3-163 | | #3- 77 | #3-123 | #3-138 | #4-151 | #4-155 | |
| 34'- 0" | 135 | 566 | 781 | 1133 | 1292 | 5.097 | 463 | 1090 | 1403 | 1915 | 2147 | 3.137 |
| STIR | #3- 48 | #3-118 | #3-137 | #3-141 | #3-166 | | #3- 76 | #3-124 | #3-123 | #4-153 | #4-158 | |
| 35'- 0" | 94 | 501 | 704 | 1036 | 1187 | 5.724 | 404 | 995 | 1291 | 1774 | 1993 | 3.522 |
| STIR | #3- 43 | #3-118 | #3-138 | #3-150 | #3-169 | | #3- 74 | #3-126 | #3-130 | #4-156 | #4-160 | |
| 36'- 0" | 57 | 441 | 633 | 947 | 1089 | 6.407 | 350 | 909 | 1188 | 1645 | 1851 | 3.942 |
| STIR | #3- 39 | #3-118 | #3-139 | #3-158 | #3-171 | | #3- 72 | #3-127 | #3-137 | #4-159 | #4-164 | |
| 37'- 0" | 23 | 386 | 568 | 866 | 1000 | 7.149 | 300 | 829 | 1093 | 1526 | 1721 | 4.399 |
| STIR | #3- 34 | #3-117 | #3-139 | #3-164 | #3-153 | | #3- 70 | #3-128 | #3-143 | #4-161 | #4-166 | |
| 38'- 0" | | 336 | 508 | 790 | 918 | 7.953 | 254 | 755 | 1006 | 1416 | 1602 | 4.894 |
| STIR | | #3-117 | #3-140 | #3-165 | #3-161 | | #3- 68 | #3-128 | #3-144 | #3-163 | #4-169 | |
| 39'- 0" | | 289 | 453 | 720 | 841 | 8.824 | 211 | 687 | 926 | 1315 | 1491 | 5.430 |
| STIR | | #3-116 | #3-140 | #3-167 | #3-170 | | #3- 65 | #3-129 | #3-146 | #3-166 | #4-172 | |
| 40'- 0" | | 246 | 402 | 656 | 771 | 9.765 | 172 | 624 | 851 | 1221 | 1388 | 6.009 |
| STIR | | #3-115 | #3-140 | #3-169 | #3-178 | | #3- 62 | #3-129 | #3-147 | #3-168 | #4-175 | |
| 41'- 0" | | 206 | 354 | 596 | 706 | 10.778 | 135 | 566 | 782 | 1134 | 1293 | 6.633 |
| STIR | | #3-113 | #3-140 | #3-170 | #3-180 | | #3- 59 | #3-130 | #3-148 | #3-171 | #3-177 | |
| 42'- 0" | | 168 | 310 | 540 | 645 | 11.869 | 101 | 512 | 717 | 1053 | 1205 | 7.304 |
| STIR | | #3-112 | #3-140 | #3-171 | #3-181 | | #3- 56 | #3-130 | #3-149 | #3-173 | #3-180 | |
| 43'- 0" | | 134 | 268 | 489 | 588 | 13.040 | 70 | 461 | 657 | 977 | 1122 | 8.025 |
| STIR | | #3-110 | #3-140 | #3-173 | #3-183 | | #3- 52 | #3-130 | #3-150 | #3-155 | #3-182 | |
| 44'- 0" | | 101 | 230 | 440 | 535 | 14.296 | 40 | 414 | 601 | 907 | 1045 | 8.798 |
| STIR | | #3-108 | #3-139 | #3-174 | #3-185 | | #3- 49 | #3-130 | #3-151 | #3-162 | #3-185 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.78 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.00 | 1.63 | 1.94 | 2.44 | 2.75 | | 1.33 | 2.21 | 2.58 | 3.38 | 5.50 | |
| ACTUAL STEEL % | 0.420 | 0.687 | 0.816 | 1.033 | 1.162 | | 0.559 | 0.932 | 1.088 | 1.430 | 2.324 | |
| EFF. DEPTH, IN. | 20.38 | 20.31 | 20.31 | 20.25 | 20.25 | | 20.38 | 20.31 | 20.31 | 20.25 | 20.25 | |
| $-I_{cr}/I_{gr}$ | 0.117 | 0.173 | 0.198 | 0.234 | 0.256 | | 0.148 | 0.219 | 0.246 | 0.297 | 0.412 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.82 | 1.32 | 1.58 | 1.99 | 2.18 | | 0.82 | 1.32 | 1.58 | 1.99 | 2.18 | |
| ACTUAL STEEL % | 0.329 | 0.532 | 0.640 | 0.805 | 0.882 | | 0.329 | 0.532 | 0.640 | 0.805 | 0.882 | |
| EFF. DEPTH, IN. | 20.70 | 20.62 | 20.50 | 20.54 | 20.52 | | 20.70 | 20.62 | 20.50 | 20.54 | 20.52 | |
| $+I_{cr}/I_{gr}$ | 0.122 | 0.187 | 0.218 | 0.269 | 0.291 | | 0.122 | 0.187 | 0.218 | 0.269 | 0.291 | |
| SINGLE LEG STIRRUP AT 9 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 6 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 8 | 9.5 | 8.5 | | 7 | 4 | 6 | 6.5 | 7 | |
| BOTTOM BARS NO | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | |
| BARS NO | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.80 | 1.36 | 1.54 | 1.87 | 2.12 | | 1.25 | 2.14 | 2.33 | 2.97 | 4.23 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 34'- 0" (3) | 234 | 707 | 857 | 1139 | 1332 | 5.097 | 594 | 1282 | 1500 | 1910 | 2191 | 3.137 |
| STIR | #3- 77 | #3-137 | #3-147 | #3-165 | #3-171 | | #3- 96 | #3-123 | #3-146 | #4-156 | #4-157 | |
| 35'- 0" | 189 | 636 | 777 | 1043 | 1225 | 5.724 | 529 | 1178 | 1384 | 1771 | 2036 | 3.522 |
| STIR | #3- 75 | #3-138 | #3-149 | #3-166 | #3-174 | | #3- 96 | #3-130 | #3-148 | #4-160 | #4-161 | |
| 36'- 0" | 148 | 570 | 704 | 955 | 1128 | 6.407 | 469 | 1083 | 1278 | 1643 | 1894 | 3.942 |
| STIR | #3- 72 | #3-139 | #3-150 | #3-149 | #3-177 | | #3- 95 | #3-138 | #3-151 | #4-162 | #4-167 | |
| 37'- 0" | 111 | 510 | 637 | 875 | 1038 | 7.149 | 414 | 996 | 1180 | 1526 | 1763 | 4.399 |
| STIR | #3- 69 | #3-139 | #3-152 | #3-157 | #3-180 | | #3- 94 | #3-142 | #3-130 | #4-165 | #4-172 | |
| 38'- 0" | 76 | 455 | 575 | 800 | 955 | 7.953 | 364 | 915 | 1090 | 1418 | 1643 | 4.894 |
| STIR | #3- 65 | #3-140 | #3-153 | #3-165 | #3-183 | | #3- 93 | #3-144 | #3-137 | #3-168 | #4-175 | |
| 39'- 0" | 44 | 403 | 517 | 731 | 878 | 8.824 | 317 | 840 | 1006 | 1317 | 1531 | 5.430 |
| STIR | #3- 62 | #3-140 | #3-154 | #3-173 | #3-185 | | #3- 92 | #3-145 | #3-144 | #3-170 | #4-178 | |
| 40'- 0" | 14 | 356 | 464 | 668 | 807 | 9.765 | 274 | 771 | 929 | 1225 | 1428 | 6.009 |
| STIR | #3- 58 | #3-140 | #3-155 | #3-175 | #3-165 | | #3- 90 | #3-147 | #3-152 | #3-173 | #4-181 | |
| 41'- 0" | | 312 | 415 | 609 | 742 | 10.778 | 234 | 707 | 857 | 1139 | 1332 | 6.633 |
| STIR | | #3-140 | #3-155 | #3-177 | #3-173 | | #3- 89 | #3-148 | #3-159 | #3-176 | #4-183 | |
| 42'- 0" | | 271 | 369 | 554 | 680 | 11.869 | 197 | 648 | 791 | 1059 | 1243 | 7.304 |
| STIR | | #3-140 | #3-156 | #3-179 | #3-181 | | #3- 87 | #3-149 | #3-160 | #3-178 | #4-186 | |
| 43'- 0" | | 233 | 327 | 503 | 623 | 13.040 | 162 | 592 | 729 | 985 | 1161 | 8.025 |
| STIR | | #3-140 | #3-156 | #3-180 | #3-190 | | #3- 85 | #3-150 | #3-162 | #3-180 | #3-189 | |
| 44'- 0" | | 197 | 287 | 455 | 570 | 14.296 | 130 | 541 | 671 | 915 | 1083 | 8.798 |
| STIR | | #3-139 | #3-157 | #3-182 | #3-194 | | #3- 82 | #3-151 | #3-163 | #3-183 | #3-191 | |
| 45'- 0" | | 164 | 250 | 410 | 521 | 15.641 | 99 | 492 | 617 | 851 | 1011 | 9.625 |
| STIR | | #3-138 | #3-157 | #3-183 | #3-196 | | #3- 80 | #3-152 | #3-165 | #3-184 | #3-194 | |
| 46'- 0" | | 133 | 215 | 369 | 474 | 17.078 | 71 | 447 | 566 | 790 | 944 | 10.510 |
| STIR | | #3-137 | #3-157 | #3-184 | #3-198 | | #3- 78 | #3-152 | #3-166 | #3-167 | #3-197 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 0.96 | 1.65 | 1.86 | 2.22 | 2.48 | | 1.37 | 2.40 | 2.48 | 3.25 | 5.42 | |
| ACTUAL STEEL % | 0.435 | 0.752 | 0.846 | 1.014 | 1.133 | | 0.621 | 1.087 | 1.127 | 1.482 | 2.487 | |
| EFF. DEPTH, IN. | 22.38 | 22.31 | 22.31 | 22.25 | 22.25 | | 22.38 | 22.38 | 22.31 | 22.25 | 22.12 | |
| $-I_{cr}/I_{gr}$ | 0.121 | 0.185 | 0.203 | 0.231 | 0.250 | | 0.161 | 0.247 | 0.252 | 0.303 | 0.420 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | |
| EFF. DEPTH, IN. | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | |
| $+I_{cr}/I_{gr}$ | 0.133 | 0.204 | 0.226 | 0.265 | 0.292 | | 0.133 | 0.204 | 0.226 | 0.265 | 0.292 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 6 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 9.5 | 9 | 7.5 | 6 | 8 | | 7 | 4 | 7.5 | 8.5 | 5 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | |
| BARS NO | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | |
| STEEL (PSF) | 0.90 | 1.41 | 1.62 | 2.03 | 2.16 | | 1.33 | 2.19 | 2.56 | 3.14 | 4.42 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 34'- 0" (3) | 258 | 737 | 976 | 1301 | 1477 | 5.097 | 643 | 1340 | 1687 | 2160 | 2415 | 3.137 |
| STIR | #3- 72 | #3-132 | #3-148 | #3-165 | #4-171 | | #3- 93 | #3-129 | #3-147 | #4-157 | #4-157 | |
| 35'- 0" | 210 | 662 | 888 | 1195 | 1360 | 5.724 | 573 | 1231 | 1559 | 2005 | 2246 | 3.522 |
| STIR | #3- 69 | #3-132 | #3-149 | #3-167 | #3-174 | | #3- 92 | #3-135 | #3-150 | #4-160 | #4-162 | |
| 36'- 0" | 166 | 594 | 807 | 1097 | 1253 | 6.407 | 510 | 1132 | 1442 | 1863 | 2091 | 3.942 |
| STIR | #3- 66 | #3-133 | #3-151 | #3-147 | #3-177 | | #3- 91 | #3-137 | #3-151 | #4-163 | #4-167 | |
| 37'- 0" | 126 | 531 | 733 | 1007 | 1155 | 7.149 | 451 | 1040 | 1333 | 1733 | 1948 | 4.399 |
| STIR | #3- 63 | #3-133 | #3-152 | #3-156 | #3-180 | | #3- 90 | #3-138 | #3-154 | #4-166 | #4-171 | |
| 38'- 0" | 89 | 473 | 664 | 924 | 1065 | 7.953 | 397 | 955 | 1233 | 1612 | 1816 | 4.894 |
| STIR | #3- 59 | #3-133 | #3-153 | #3-164 | #3-182 | | #3- 89 | #3-139 | #3-136 | #4-168 | #4-174 | |
| 39'- 0" | 55 | 419 | 601 | 848 | 981 | 8.824 | 347 | 877 | 1141 | 1501 | 1694 | 5.430 |
| STIR | #3- 55 | #3-133 | #3-154 | #3-173 | #3-185 | | #3- 87 | #3-141 | #3-143 | #4-171 | #4-177 | |
| 40'- 0" | 23 | 369 | 542 | 777 | 903 | 9.765 | 301 | 805 | 1056 | 1397 | 1582 | 6.009 |
| STIR | #3- 51 | #3-133 | #3-155 | #3-176 | #3-166 | | #3- 86 | #3-142 | #3-151 | #4-174 | #4-180 | |
| 41'- 0" | | 323 | 487 | 711 | 832 | 10.778 | 258 | 738 | 977 | 1302 | 1477 | 6.633 |
| STIR | | #3-133 | #3-156 | #3-178 | #3-174 | | #3- 84 | #3-143 | #3-158 | #3-177 | #4-183 | |
| 42'- 0" | | 280 | 437 | 650 | 765 | 11.869 | 218 | 675 | 903 | 1213 | 1380 | 7.304 |
| STIR | | #3-132 | #3-156 | #3-180 | #3-183 | | #3- 82 | #3-144 | #3-161 | #3-179 | #4-186 | |
| 43'- 0" | | 240 | 390 | 593 | 702 | 13.040 | 181 | 617 | 834 | 1130 | 1289 | 8.025 |
| STIR | | #3-131 | #3-157 | #3-181 | #3-191 | | #3- 79 | #3-144 | #3-162 | #3-182 | #4-189 | |
| 44'- 0" | | 203 | 346 | 540 | 644 | 14.296 | 147 | 563 | 770 | 1053 | 1205 | 8.798 |
| STIR | | #3-131 | #3-157 | #3-182 | #3-193 | | #3- 77 | #3-145 | #3-164 | #3-183 | #4-191 | |
| 45'- 0" | | 168 | 305 | 490 | 590 | 15.641 | 114 | 512 | 711 | 981 | 1126 | 9.625 |
| STIR | | #3-129 | #3-157 | #3-184 | #3-195 | | #3- 74 | #3-145 | #3-165 | #3-186 | #3-193 | |
| 46'- 0" | | 136 | 266 | 444 | 540 | 17.078 | 84 | 465 | 655 | 913 | 1052 | 10.510 |
| STIR | | #3-128 | #3-157 | #3-185 | #3-197 | | #3- 71 | #3-146 | #3-167 | #3-188 | #3-195 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.80 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.03 | 1.69 | 2.03 | 2.53 | 2.69 | | 1.40 | 2.45 | 2.87 | 3.46 | 5.88 | |
| ACTUAL STEEL % | 0.424 | 0.697 | 0.836 | 1.045 | 1.116 | | 0.576 | 1.008 | 1.190 | 1.437 | 2.443 | |
| EFF. DEPTH, IN. | 22.38 | 22.31 | 22.31 | 22.31 | 22.25 | | 22.38 | 22.38 | 22.25 | 22.19 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.121 | 0.178 | 0.205 | 0.243 | 0.253 | | 0.155 | 0.239 | 0.265 | 0.301 | 0.429 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | |
| ACTUAL STEEL % | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | |
| EFF. DEPTH, IN. | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | |
| $+I_{cr}/I_{gr}$ | 0.130 | 0.196 | 0.229 | 0.272 | 0.294 | | 0.130 | 0.196 | 0.229 | 0.272 | 0.294 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 9 | 8.5 | 7 | 6 | 7.5 | | 10 | 9 | 10 | 8.5 | 6 | |
| BOTTOM BARS NO | 2# 5 | 2# 6 | 2# 6 | 2# 6 | 2# 8 | | 2# 5 | 2# 6 | 2# 6 | 2# 6 | 2# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 2# 7 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 2# 7 | 1# 8 | |
| STEEL (PSF) | 0.89 | 1.47 | 1.80 | 2.08 | 2.32 | | 1.38 | 2.23 | 2.73 | 3.19 | 4.05 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 34'- 0" (3) | 278 | 796 | 1062 | 1360 | 1622 | 5.097 | 685 | 1440 | 1827 | 2259 | 2640 | 3.137 |
| STIR | #3- 67 | #3-129 | #3-146 | #3-161 | #4-171 | | #3- 90 | #3-131 | #3-145 | #4-155 | #5-161 | |
| 35'- 0" | 227 | 717 | 968 | 1248 | 1495 | 5.724 | 612 | 1324 | 1689 | 2097 | 2457 | 3.522 |
| STIR | #3- 64 | #3-130 | #3-148 | #3-145 | #4-174 | | #3- 89 | #3-134 | #3-148 | #4-158 | #4-164 | |
| 36'- 0" | 181 | 643 | 881 | 1146 | 1380 | 6.407 | 544 | 1217 | 1562 | 1949 | 2288 | 3.942 |
| STIR | #3- 61 | #3-130 | #3-149 | #3-154 | #3-176 | | #3- 88 | #3-135 | #3-151 | #4-160 | #4-167 | |
| 37'- 0" | 138 | 576 | 801 | 1052 | 1273 | 7.149 | 482 | 1119 | 1446 | 1812 | 2133 | 4.399 |
| STIR | #3- 57 | #3-130 | #3-150 | #3-162 | #3-179 | | #3- 86 | #3-137 | #3-131 | #4-163 | #4-170 | |
| 38'- 0" | 99 | 514 | 727 | 965 | 1175 | 7.953 | 425 | 1029 | 1339 | 1685 | 1990 | 4.894 |
| STIR | #3- 53 | #3-130 | #3-151 | #3-168 | #3-182 | | #3- 85 | #3-138 | #3-138 | #4-166 | #4-174 | |
| 39'- 0" | 62 | 457 | 659 | 885 | 1084 | 8.824 | 372 | 946 | 1240 | 1569 | 1858 | 5.430 |
| STIR | #3- 49 | #3-130 | #3-152 | #3-170 | #3-184 | | #3- 83 | #3-139 | #3-145 | #4-168 | #4-177 | |
| 40'- 0" | 29 | 403 | 596 | 811 | 1000 | 9.765 | 323 | 868 | 1148 | 1461 | 1736 | 6.009 |
| STIR | #3- 44 | #3-130 | #3-153 | #3-172 | #3-167 | | #3- 81 | #3-140 | #3-153 | #3-171 | #4-180 | |
| 41'- 0" | | 354 | 537 | 742 | 922 | 10.778 | 278 | 797 | 1063 | 1360 | 1622 | 6.633 |
| STIR | | #3-129 | #3-154 | #3-173 | #3-175 | | #3- 79 | #3-141 | #3-158 | #3-173 | #4-182 | |
| 42'- 0" | | 308 | 483 | 678 | 849 | 11.869 | 236 | 730 | 984 | 1267 | 1517 | 7.304 |
| STIR | | #3-129 | #3-154 | #3-175 | #3-184 | | #3- 77 | #3-142 | #3-160 | #3-176 | #4-185 | |
| 43'- 0" | | 266 | 432 | 618 | 782 | 13.040 | 196 | 668 | 910 | 1181 | 1419 | 8.025 |
| STIR | | #3-128 | #3-155 | #3-176 | #3-191 | | #3- 74 | #3-142 | #3-161 | #3-178 | #4-187 | |
| 44'- 0" | | 226 | 385 | 562 | 719 | 14.296 | 160 | 610 | 841 | 1100 | 1327 | 8.798 |
| STIR | | #3-127 | #3-155 | #3-177 | #3-192 | | #3- 72 | #3-143 | #3-163 | #3-157 | #4-191 | |
| 45'- 0" | | 189 | 341 | 511 | 660 | 15.641 | 125 | 556 | 777 | 1024 | 1241 | 9.625 |
| STIR | | #3-125 | #3-155 | #3-178 | #3-194 | | #3- 69 | #3-143 | #3-164 | #3-164 | #4-193 | |
| 46'- 0" | | 154 | 299 | 462 | 605 | 17.078 | 93 | 506 | 717 | 953 | 1161 | 10.510 |
| STIR | | #3-124 | #3-155 | #3-179 | #3-196 | | #3- 66 | #3-144 | #3-165 | #3-171 | #3-195 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.83 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.11 | 1.82 | 2.21 | 2.58 | 2.93 | | 1.55 | 2.44 | 3.00 | 3.53 | 5.00 | |
| ACTUAL STEEL % | 0.419 | 0.689 | 0.837 | 0.976 | 1.112 | | 0.586 | 0.927 | 1.141 | 1.342 | 1.902 | |
| EFF. DEPTH, IN. | 22.38 | 22.31 | 22.31 | 22.31 | 22.25 | | 22.31 | 22.25 | 22.19 | 22.19 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.121 | 0.180 | 0.210 | 0.236 | 0.257 | | 0.158 | 0.225 | 0.260 | 0.292 | 0.372 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.48 | 1.76 | 2.08 | 2.37 | | 0.93 | 1.48 | 1.76 | 2.08 | 2.37 | |
| ACTUAL STEEL % | 0.336 | 0.537 | 0.638 | 0.755 | 0.863 | | 0.336 | 0.537 | 0.638 | 0.755 | 0.863 | |
| EFF. DEPTH, IN. | 22.69 | 22.60 | 22.62 | 22.59 | 22.50 | | 22.69 | 22.60 | 22.62 | 22.59 | 22.50 | |
| $+I_{cr}/I_{gr}$ | 0.128 | 0.195 | 0.229 | 0.265 | 0.295 | | 0.128 | 0.195 | 0.229 | 0.265 | 0.295 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>21″ Deep Rib + 5.5″ Top Slab = 26.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 6 | # 7 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 9 | 9 | 7.5 | 6 | 7.5 | | 7 | 4 | 7.5 | 8 | 6 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 6 | 1# 9 | 1# 9 | | 1# 6 | 1# 7 | 1# 6 | 1# 9 | 1# 9 | |
| BARS NO | 1# 6 | 1# 8 | 2# 7 | 1# 9 | 1#10 | | 1# 6 | 1# 8 | 2# 7 | 1# 9 | 1#10 | |
| STEEL (PSF) | 0.92 | 1.43 | 1.64 | 2.11 | 2.38 | | 1.34 | 2.21 | 2.58 | 3.33 | 4.86 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 192 | 633 | 853 | 1154 | 1382 | 7.149 | 546 | 1188 | 1508 | 1945 | 2276 | 4.399 |
| STIR | #3- 78 | #3-143 | #3-160 | #3-179 | #4-188 | | #3-100 | #3-141 | #3-159 | #4-170 | #4-169 | |
| 38'- 0" | 152 | 570 | 778 | 1064 | 1279 | 7.953 | 487 | 1096 | 1399 | 1814 | 2128 | 4.894 |
| STIR | #3- 75 | #3-143 | #3-162 | #3-181 | #4-192 | | #3- 99 | #3-146 | #3-162 | #4-174 | #4-174 | |
| 39'- 0" | 114 | 512 | 709 | 980 | 1185 | 8.824 | 433 | 1011 | 1298 | 1692 | 1990 | 5.430 |
| STIR | #3- 72 | #3-144 | #3-163 | #3-159 | #3-194 | | #3- 99 | #3-148 | #3-163 | #4-176 | #4-179 | |
| 40'- 0" | 80 | 457 | 645 | 903 | 1098 | 9.765 | 382 | 932 | 1205 | 1580 | 1863 | 6.009 |
| STIR | #3- 68 | #3-144 | #3-164 | #3-168 | #3-197 | | #3- 97 | #3-149 | #3-166 | #4-180 | #4-185 | |
| 41'- 0" | 47 | 407 | 586 | 831 | 1016 | 10.778 | 336 | 859 | 1119 | 1475 | 1745 | 6.633 |
| STIR | #3- 65 | #3-144 | #3-166 | #3-176 | #3-199 | | #3- 96 | #3-151 | #3-146 | #4-183 | #4-190 | |
| 42'- 0" | 18 | 360 | 531 | 764 | 941 | 11.869 | 292 | 791 | 1039 | 1378 | 1635 | 7.304 |
| STIR | #3- 61 | #3-144 | #3-167 | #3-185 | #3-202 | | #3- 95 | #3-152 | #3-153 | #4-185 | #4-194 | |
| 43'- 0" | | 317 | 479 | 702 | 871 | 13.040 | 252 | 727 | 964 | 1288 | 1533 | 8.025 |
| STIR | | #3-144 | #3-168 | #3-190 | #3-205 | | #3- 93 | #3-153 | #3-161 | #3-188 | #4-196 | |
| 44'- 0" | | 276 | 432 | 644 | 805 | 14.296 | 214 | 668 | 894 | 1204 | 1438 | 8.798 |
| STIR | | #3-144 | #3-168 | #3-192 | #3-208 | | #3- 91 | #3-154 | #3-168 | #3-190 | #4-199 | |
| 45'- 0" | | 238 | 387 | 590 | 744 | 15.641 | 179 | 613 | 829 | 1125 | 1349 | 9.625 |
| STIR | | #3-143 | #3-169 | #3-194 | #3-187 | | #3- 89 | #3-155 | #3-173 | #3-192 | #4-202 | |
| 46'- 0" | | 203 | 345 | 540 | 687 | 17.078 | 146 | 562 | 768 | 1051 | 1266 | 10.510 |
| STIR | | #3-143 | #3-170 | #3-195 | #3-195 | | #3- 87 | #3-156 | #3-175 | #3-195 | #4-205 | |
| 47'- 0" | | 170 | 306 | 492 | 633 | 18.613 | 115 | 513 | 711 | 983 | 1188 | 11.454 |
| STIR | | #3-142 | #3-170 | #3-197 | #3-204 | | #3- 85 | #3-157 | #3-177 | #3-197 | #4-208 | |
| 48'- 0" | | 138 | 269 | 448 | 583 | 20.248 | 86 | 468 | 658 | 918 | 1115 | 12.460 |
| STIR | | #3-141 | #3-170 | #3-198 | #3-213 | | #3- 82 | #3-157 | #3-178 | #3-199 | #4-211 | |
| 49'- 0" | | 109 | 234 | 406 | 536 | 21.989 | 59 | 425 | 608 | 857 | 1046 | 13.532 |
| STIR | | #3-140 | #3-170 | #3-199 | #3-216 | | #3- 80 | #3-158 | #3-179 | #3-202 | #4-213 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.81 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.07 | 1.65 | 1.98 | 2.48 | 2.82 | | 1.37 | 2.40 | 2.82 | 3.60 | 6.32 | |
| ACTUAL STEEL % | 0.436 | 0.678 | 0.814 | 1.017 | 1.159 | | 0.561 | 0.982 | 1.159 | 1.486 | 2.617 | |
| EFF. DEPTH, IN. | 24.38 | 24.31 | 24.31 | 24.31 | 24.25 | | 24.38 | 24.38 | 24.25 | 24.19 | 24.12 | |
| $-I_{cr}/I_{gr}$ | 0.125 | 0.177 | 0.204 | 0.242 | 0.264 | | 0.154 | 0.237 | 0.264 | 0.312 | 0.450 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.64 | 2.00 | 2.27 | | 0.88 | 1.39 | 1.64 | 2.00 | 2.27 | |
| ACTUAL STEEL % | 0.345 | 0.546 | 0.644 | 0.788 | 0.896 | | 0.345 | 0.546 | 0.644 | 0.788 | 0.896 | |
| EFF. DEPTH, IN. | 24.62 | 24.53 | 24.58 | 24.44 | 24.40 | | 24.62 | 24.53 | 24.58 | 24.44 | 24.40 | |
| $+I_{cr}/I_{gr}$ | 0.132 | 0.200 | 0.234 | 0.276 | 0.308 | | 0.132 | 0.200 | 0.234 | 0.276 | 0.308 | |
| SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>21″ Deep Rib + 5.5″ Top Slab = 26.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 8 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 9 | 8.5 | 7 | 8 | 10 | | 10 | 9 | 10 | 10 | 6 | |
| BOTTOM BARS NO | 2# 5 | 2# 6 | 1# 8 | 1# 7 | 2# 8 | | 2# 5 | 2# 6 | 1# 8 | 1# 7 | 2# 8 | |
| BARS NO | 1# 5 | 1# 7 | 1# 9 | 2# 8 | 1# 8 | | 1# 5 | 1# 7 | 1# 9 | 2# 8 | 1# 8 | |
| STEEL (PSF) | 0.91 | 1.49 | 1.81 | 2.16 | 2.37 | | 1.39 | 2.25 | 2.75 | 3.40 | 4.84 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 205 | 683 | 943 | 1282 | 1443 | 7.149 | 580 | 1274 | 1653 | 2146 | 2381 | 4.399 |
| STIR | #3- 71 | #3-139 | #3-159 | #3-178 | #4-185 | | #3- 96 | #3-143 | #3-158 | #4-171 | #5-170 | |
| 38'- 0" | 162 | 615 | 862 | 1183 | 1336 | 7.953 | 517 | 1176 | 1535 | 2003 | 2225 | 4.894 |
| STIR | #3- 68 | #3-140 | #3-160 | #3-181 | #4-188 | | #3- 95 | #3-144 | #3-161 | #4-173 | #4-176 | |
| 39'- 0" | 123 | 552 | 787 | 1092 | 1237 | 8.824 | 460 | 1085 | 1426 | 1870 | 2081 | 5.430 |
| STIR | #3- 64 | #3-140 | #3-162 | #3-160 | #3-190 | | #3- 94 | #3-146 | #3-163 | #4-177 | #4-181 | |
| 40'- 0" | 86 | 495 | 717 | 1007 | 1146 | 9.765 | 407 | 1001 | 1325 | 1747 | 1948 | 6.009 |
| STIR | #3- 60 | #3-140 | #3-163 | #3-168 | #3-193 | | #3- 92 | #3-147 | #3-141 | #4-179 | #4-184 | |
| 41'- 0" | 52 | 441 | 653 | 929 | 1060 | 10.778 | 357 | 923 | 1231 | 1633 | 1824 | 6.633 |
| STIR | #3- 56 | #3-140 | #3-164 | #3-177 | #3-195 | | #3- 91 | #3-148 | #3-148 | #4-182 | #4-187 | |
| 42'- 0" | 20 | 391 | 593 | 856 | 981 | 11.869 | 311 | 850 | 1144 | 1527 | 1709 | 7.304 |
| STIR | #3- 52 | #3-140 | #3-165 | #3-185 | #3-198 | | #3- 89 | #3-150 | #3-155 | #4-185 | #4-190 | |
| 43'- 0" | | 345 | 537 | 788 | 908 | 13.040 | 268 | 783 | 1063 | 1428 | 1602 | 8.025 |
| STIR | | #3-140 | #3-166 | #3-190 | #3-179 | | #3- 87 | #3-151 | #3-162 | #4-187 | #4-193 | |
| 44'- 0" | | 301 | 485 | 725 | 839 | 14.296 | 229 | 720 | 988 | 1336 | 1502 | 8.798 |
| STIR | | #3-139 | #3-167 | #3-192 | #3-187 | | #3- 85 | #3-152 | #3-170 | #4-189 | #4-195 | |
| 45'- 0" | | 261 | 437 | 666 | 775 | 15.641 | 191 | 661 | 917 | 1250 | 1409 | 9.625 |
| STIR | | #3-138 | #3-167 | #3-193 | #3-196 | | #3- 83 | #3-152 | #3-172 | #3-193 | #4-198 | |
| 46'- 0" | | 223 | 391 | 611 | 715 | 17.078 | 156 | 606 | 851 | 1170 | 1322 | 10.510 |
| STIR | | #3-137 | #3-168 | #3-195 | #3-204 | | #3- 81 | #3-153 | #3-174 | #3-194 | #4-201 | |
| 47'- 0" | | 187 | 349 | 559 | 659 | 18.613 | 124 | 554 | 789 | 1095 | 1240 | 11.454 |
| STIR | | #3-136 | #3-168 | #3-196 | #3-207 | | #3- 78 | #3-154 | #3-175 | #3-197 | #4-203 | |
| 48'- 0" | | 154 | 309 | 510 | 606 | 20.248 | 93 | 506 | 731 | 1024 | 1163 | 12.460 |
| STIR | | #3-135 | #3-168 | #3-198 | #3-209 | | #3- 75 | #3-154 | #3-177 | #3-200 | #4-207 | |
| 49'- 0" | | 123 | 271 | 465 | 557 | 21.989 | 64 | 460 | 676 | 958 | 1091 | 13.532 |
| STIR | | #3-134 | #3-168 | #3-199 | #3-210 | | #3- 72 | #3-154 | #3-178 | #3-202 | #4-209 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.84 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.09 | 1.79 | 2.17 | 2.69 | 2.94 | | 1.52 | 2.40 | 2.94 | 3.87 | 6.45 | |
| ACTUAL STEEL % | 0.405 | 0.667 | 0.809 | 1.008 | 1.103 | | 0.567 | 0.896 | 1.103 | 1.457 | 2.429 | |
| EFF. DEPTH, IN. | 24.38 | 24.31 | 24.31 | 24.25 | 24.19 | | 24.31 | 24.25 | 24.19 | 24.12 | 24.12 | |
| $-I_{cr}/I_{gr}$ | 0.120 | 0.178 | 0.208 | 0.243 | 0.258 | | 0.157 | 0.223 | 0.258 | 0.312 | 0.439 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.48 | 1.79 | 2.18 | 2.37 | | 0.93 | 1.48 | 1.79 | 2.18 | 2.37 | |
| ACTUAL STEEL % | 0.332 | 0.529 | 0.643 | 0.782 | 0.850 | | 0.332 | 0.529 | 0.643 | 0.782 | 0.850 | |
| EFF. DEPTH, IN. | 24.69 | 24.60 | 24.46 | 24.52 | 24.50 | | 24.69 | 24.60 | 24.46 | 24.52 | 24.50 | |
| $+I_{cr}/I_{gr}$ | 0.130 | 0.198 | 0.232 | 0.278 | 0.299 | | 0.130 | 0.198 | 0.232 | 0.278 | 0.299 | |
| SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 10″ Ribs @ 50″ c.-c.<br>21″ Deep Rib + 5.5″ Top Slab = 26.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 6 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 8 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 8 | 8 | 9 | 8 | 9 | | 9.5 | 8 | 9 | 10 | 7.5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 7 | 1# 9 | 2# 8 | | 2# 4 | 1# 6 | 2# 7 | 1# 9 | 2# 8 | |
| BARS NO | 2# 5 | 2# 7 | 1# 8 | 1#10 | 1# 9 | | 2# 5 | 2# 7 | 1# 8 | 1#10 | 1# 9 | |
| STEEL (PSF) | 1.00 | 1.57 | 1.98 | 2.27 | 2.59 | | 1.49 | 2.45 | 3.01 | 3.51 | 4.34 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 252 | 788 | 1088 | 1317 | 1588 | 7.149 | 663 | 1442 | 1879 | 2212 | 2607 | 4.399 |
| STIR | #3- 72 | #3-141 | #3-161 | #3-152 | #4-184 | | #3- 97 | #3-143 | #4-160 | #4-167 | #5-175 | |
| 38'- 0" | 205 | 713 | 997 | 1215 | 1472 | 7.953 | 595 | 1334 | 1747 | 2063 | 2437 | 4.894 |
| STIR | #3- 69 | #3-141 | #3-163 | #3-160 | #4-187 | | #3- 96 | #3-146 | #4-162 | #4-171 | #5-178 | |
| 39'- 0" | 162 | 644 | 914 | 1120 | 1364 | 8.824 | 532 | 1233 | 1626 | 1926 | 2281 | 5.430 |
| STIR | #3- 65 | #3-142 | #3-164 | #3-168 | #4-190 | | #3- 95 | #3-147 | #3-165 | #4-173 | #5-181 | |
| 40'- 0" | 121 | 580 | 836 | 1032 | 1265 | 9.765 | 473 | 1140 | 1513 | 1798 | 2136 | 6.009 |
| STIR | #3- 62 | #3-142 | #3-166 | #3-177 | #3-192 | | #3- 93 | #3-149 | #3-167 | #4-175 | #4-184 | |
| 41'- 0" | 84 | 520 | 765 | 951 | 1172 | 10.778 | 419 | 1054 | 1409 | 1680 | 2002 | 6.633 |
| STIR | #3- 58 | #3-142 | #3-167 | #3-181 | #3-195 | | #3- 92 | #3-150 | #3-145 | #4-178 | #4-187 | |
| 42'- 0" | 49 | 465 | 698 | 876 | 1086 | 11.869 | 369 | 973 | 1312 | 1571 | 1877 | 7.304 |
| STIR | #3- 53 | #3-142 | #3-168 | #3-182 | #3-198 | | #3- 90 | #3-151 | #3-152 | #4-181 | #4-190 | |
| 43'- 0" | 17 | 414 | 636 | 806 | 1006 | 13.040 | 322 | 899 | 1222 | 1468 | 1760 | 8.025 |
| STIR | #3- 49 | #3-142 | #3-169 | #3-184 | #3-179 | | #3- 88 | #3-152 | #3-159 | #4-183 | #4-192 | |
| 44'- 0" | | 366 | 578 | 740 | 932 | 14.296 | 278 | 829 | 1137 | 1373 | 1652 | 8.798 |
| STIR | | #3-141 | #3-170 | #3-186 | #3-188 | | #3- 86 | #3-153 | #3-166 | #3-186 | #4-195 | |
| 45'- 0" | | 321 | 524 | 679 | 862 | 15.641 | 237 | 764 | 1059 | 1284 | 1551 | 9.625 |
| STIR | | #3-141 | #3-171 | #3-187 | #3-196 | | #3- 84 | #3-154 | #3-174 | #3-188 | #4-198 | |
| 46'- 0" | | 279 | 473 | 622 | 797 | 17.078 | 199 | 703 | 985 | 1201 | 1456 | 10.510 |
| STIR | | #3-140 | #3-171 | #3-188 | #3-204 | | #3- 82 | #3-155 | #3-176 | #3-190 | #4-201 | |
| 47'- 0" | | 240 | 426 | 568 | 736 | 18.613 | 163 | 646 | 916 | 1123 | 1367 | 11.454 |
| STIR | | #3-139 | #3-172 | #3-189 | #3-206 | | #3- 79 | #3-155 | #3-178 | #3-167 | #4-203 | |
| 48'- 0" | | 203 | 381 | 518 | 679 | 20.248 | 129 | 592 | 851 | 1050 | 1284 | 12.460 |
| STIR | | #3-138 | #3-172 | #3-191 | #3-208 | | #3- 76 | #3-156 | #3-179 | #3-174 | #4-206 | |
| 49'- 0" | | 169 | 340 | 470 | 625 | 21.989 | 98 | 542 | 791 | 981 | 1206 | 13.532 |
| STIR | | #3-137 | #3-172 | #3-191 | #3-210 | | #3- 73 | #3-156 | #3-180 | #3-182 | #4-209 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.87 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.25 | 1.94 | 2.44 | 2.75 | 3.33 | | 1.63 | 2.75 | 3.33 | 3.95 | 5.27 | |
| ACTUAL STEEL % | 0.426 | 0.663 | 0.839 | 0.943 | 1.147 | | 0.558 | 0.943 | 1.147 | 1.363 | 1.818 | |
| EFF. DEPTH, IN. | 24.38 | 24.31 | 24.25 | 24.25 | 24.19 | | 24.31 | 24.25 | 24.19 | 24.12 | 24.12 | |
| $-I_{cr}/I_{gr}$ | 0.128 | 0.181 | 0.216 | 0.236 | 0.270 | | 0.158 | 0.236 | 0.270 | 0.304 | 0.371 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.02 | 1.64 | 1.99 | 2.27 | 2.58 | | 1.02 | 1.64 | 1.99 | 2.27 | 2.58 | |
| ACTUAL STEEL % | 0.334 | 0.539 | 0.656 | 0.751 | 0.852 | | 0.334 | 0.539 | 0.656 | 0.751 | 0.852 | |
| EFF. DEPTH, IN. | 24.71 | 24.58 | 24.54 | 24.40 | 24.48 | | 24.71 | 24.58 | 24.54 | 24.40 | 24.48 | |
| $+I_{cr}/I_{gr}$ | 0.132 | 0.202 | 0.240 | 0.266 | 0.301 | | 0.132 | 0.202 | 0.240 | 0.266 | 0.301 | |
| SINGLE LEG STIRRUP AT 11 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 8″ Ribs @ 48″ c.-c.<br>23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 6 | # 6 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 8.5 | 5 | 4 | 7.5 | 9 | | 10 | 8 | 7 | 4.5 | 5 | |
| BOTTOM BARS NO | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | |
| BARS NO | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | |
| STEEL (PSF) | 0.93 | 1.65 | 1.91 | 2.38 | 2.70 | | 1.40 | 2.52 | 2.85 | 4.06 | 5.73 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 276 | 882 | 1076 | 1517 | 1763 | 7.149 | 681 | 1562 | 1845 | 2486 | 2844 | 4.399 |
| STIR | #3- 85 | #3-154 | #3-163 | #4-187 | #4-194 | | #3-105 | #3-155 | #4-164 | #5-176 | #5-169 | |
| 38'- 0" | 230 | 804 | 988 | 1406 | 1639 | 7.953 | 614 | 1449 | 1717 | 2325 | 2664 | 4.894 |
| STIR | #3- 82 | #3-155 | #3-168 | #4-190 | #4-198 | | #3-105 | #3-133 | #4-166 | #4-180 | #5-173 | |
| 39'- 0" | 187 | 732 | 907 | 1304 | 1525 | 8.824 | 552 | 1345 | 1599 | 2176 | 2498 | 5.430 |
| STIR | #3- 80 | #3-157 | #3-170 | #3-193 | #4-201 | | #3-104 | #3-140 | #3-168 | #4-183 | #5-176 | |
| 40'- 0" | 147 | 666 | 832 | 1209 | 1419 | 9.765 | 494 | 1248 | 1490 | 2038 | 2345 | 6.009 |
| STIR | #3- 77 | #3-158 | #3-171 | #3-195 | #4-204 | | #3-104 | #3-147 | #3-170 | #4-186 | #5-178 | |
| 41'- 0" | 111 | 604 | 762 | 1121 | 1321 | 10.778 | 441 | 1158 | 1388 | 1910 | 2202 | 6.633 |
| STIR | #3- 73 | #3-159 | #3-173 | #3-199 | #4-208 | | #3-103 | #3-154 | #3-173 | #4-189 | #5-184 | |
| 42'- 0" | 76 | 546 | 697 | 1039 | 1230 | 11.869 | 391 | 1075 | 1294 | 1791 | 2069 | 7.304 |
| STIR | #3- 70 | #3-159 | #3-174 | #3-201 | #4-211 | | #3-102 | #3-162 | #3-176 | #4-192 | #5-191 | |
| 43'- 0" | 45 | 493 | 637 | 963 | 1145 | 13.040 | 345 | 997 | 1206 | 1681 | 1946 | 8.025 |
| STIR | #3- 66 | #3-160 | #3-176 | #3-203 | #4-213 | | #3-100 | #3-165 | #3-150 | #4-195 | #4-197 | |
| 44'- 0" | 15 | 443 | 581 | 892 | 1066 | 14.296 | 302 | 924 | 1124 | 1578 | 1831 | 8.798 |
| STIR | #3- 62 | #3-160 | #3-177 | #3-182 | #3-216 | | #3- 99 | #3-166 | #3-157 | #4-198 | #4-203 | |
| 45'- 0" | | 397 | 528 | 826 | 992 | 15.641 | 261 | 857 | 1048 | 1481 | 1723 | 9.625 |
| STIR | | #3-160 | #3-178 | #3-190 | #3-219 | | #3- 97 | #3-168 | #3-165 | #4-201 | #4-209 | |
| 46'- 0" | | 353 | 479 | 764 | 923 | 17.078 | 224 | 793 | 976 | 1391 | 1623 | 10.510 |
| STIR | | #3-161 | #3-179 | #3-198 | #3-221 | | #3- 95 | #3-169 | #3-172 | #4-204 | #4-212 | |
| 47'- 0" | | 312 | 433 | 706 | 858 | 18.613 | 188 | 734 | 909 | 1307 | 1528 | 11.454 |
| STIR | | #3-161 | #3-179 | #3-207 | #3-224 | | #3- 93 | #3-170 | #3-180 | #4-206 | #4-214 | |
| 48'- 0" | | 274 | 389 | 651 | 798 | 20.248 | 155 | 678 | 846 | 1227 | 1440 | 12.460 |
| STIR | | #3-160 | #3-180 | #3-212 | #3-227 | | #3- 91 | #3-172 | #3-185 | #4-209 | #4-218 | |
| 49'- 0" | | 238 | 349 | 600 | 741 | 21.989 | 124 | 626 | 787 | 1153 | 1357 | 13.532 |
| STIR | | #3-160 | #3-181 | #3-214 | #3-229 | | #3- 89 | #3-173 | #3-187 | #4-211 | #4-220 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.85 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.13 | 1.92 | 2.40 | 2.82 | 3.20 | | 1.49 | 2.64 | 3.02 | 4.69 | 7.58 | |
| ACTUAL STEEL % | 0.420 | 0.714 | 0.892 | 1.053 | 1.200 | | 0.555 | 0.987 | 1.128 | 1.755 | 2.852 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.38 | 26.25 | 26.19 | | 26.31 | 26.25 | 26.25 | 26.25 | 26.12 | |
| $-I_{cr}/I_{gr}$ | 0.125 | 0.192 | 0.228 | 0.254 | 0.277 | | 0.156 | 0.242 | 0.267 | 0.365 | 0.490 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | |
| ACTUAL STEEL % | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | |
| EFF. DEPTH, IN. | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | |
| $+I_{cr}/I_{gr}$ | 0.132 | 0.213 | 0.238 | 0.293 | 0.323 | | 0.132 | 0.213 | 0.238 | 0.293 | 0.323 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 40″ Forms + 9″ Ribs @ 49″ c.-c.<br>23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 8 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 8 | 5 | 4 | 7 | 8 | | 9.5 | 8 | 8.5 | 9.5 | 5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | |
| BARS NO | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | |
| STEEL (PSF) | 1.01 | 1.60 | 2.01 | 2.41 | 2.82 | | 1.50 | 2.47 | 3.14 | 3.66 | 5.75 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 327 | 907 | 1232 | 1583 | 1967 | 7.149 | 772 | 1616 | 2089 | 2599 | 3157 | 4.399 |
| STIR | #3- 85 | #3-149 | #3-161 | #4-184 | #4-195 | | #3-105 | #3-133 | #4-164 | #5-173 | #5-173 | |
| 38'- 0" | 276 | 826 | 1135 | 1467 | 1831 | 7.953 | 698 | 1498 | 1946 | 2430 | 2959 | 4.894 |
| STIR | #3- 82 | #3-150 | #3-169 | #4-186 | #4-198 | | #3-105 | #3-140 | #4-167 | #4-177 | #5-176 | |
| 39'- 0" | 229 | 752 | 1044 | 1360 | 1705 | 8.824 | 630 | 1389 | 1815 | 2274 | 2776 | 5.430 |
| STIR | #3- 79 | #3-150 | #3-171 | #3-189 | #4-202 | | #3-104 | #3-148 | #4-170 | #4-181 | #5-180 | |
| 40'- 0" | 186 | 682 | 961 | 1261 | 1589 | 9.765 | 566 | 1289 | 1693 | 2129 | 2607 | 6.009 |
| STIR | #3- 76 | #3-151 | #3-173 | #3-191 | #4-205 | | #3-103 | #3-155 | #4-172 | #4-183 | #5-182 | |
| 41'- 0" | 146 | 618 | 883 | 1168 | 1481 | 10.778 | 508 | 1195 | 1580 | 1995 | 2450 | 6.633 |
| STIR | #3- 73 | #3-152 | #3-174 | #3-194 | #4-208 | | #3-103 | #3-157 | #3-175 | #4-186 | #5-186 | |
| 42'- 0" | 108 | 558 | 811 | 1083 | 1381 | 11.869 | 453 | 1108 | 1475 | 1871 | 2304 | 7.304 |
| STIR | #3- 70 | #3-152 | #3-176 | #3-173 | #4-211 | | #3-101 | #3-158 | #3-176 | #4-189 | #5-192 | |
| 43'- 0" | 73 | 503 | 743 | 1003 | 1287 | 13.040 | 402 | 1027 | 1377 | 1755 | 2168 | 8.025 |
| STIR | #3- 66 | #3-152 | #3-177 | #3-182 | #4-214 | | #3-100 | #3-160 | #3-179 | #4-192 | #5-197 | |
| 44'- 0" | 41 | 451 | 681 | 929 | 1200 | 14.296 | 355 | 952 | 1286 | 1647 | 2042 | 8.798 |
| STIR | #3- 62 | #3-152 | #3-179 | #3-190 | #4-217 | | #3- 99 | #3-161 | #3-155 | #4-194 | #5-203 | |
| 45'- 0" | 10 | 402 | 622 | 859 | 1119 | 15.641 | 311 | 881 | 1201 | 1546 | 1923 | 9.625 |
| STIR | #3- 58 | #3-152 | #3-180 | #3-199 | #4-219 | | #3- 97 | #3-162 | #3-162 | #4-197 | #5-208 | |
| 46'- 0" | | 357 | 567 | 794 | 1043 | 17.078 | 269 | 816 | 1121 | 1451 | 1812 | 10.510 |
| STIR | | #3-152 | #3-181 | #3-203 | #3-222 | | #3- 95 | #3-163 | #3-169 | #4-200 | #4-212 | |
| 47'- 0" | | 315 | 516 | 733 | 971 | 18.613 | 231 | 754 | 1047 | 1363 | 1709 | 11.454 |
| STIR | | #3-151 | #3-181 | #3-205 | #3-225 | | #3- 93 | #3-164 | #3-177 | #4-203 | #4-215 | |
| 48'- 0" | | 275 | 468 | 676 | 904 | 20.248 | 194 | 696 | 977 | 1280 | 1611 | 12.460 |
| STIR | | #3-151 | #3-182 | #3-206 | #3-227 | | #3- 91 | #3-165 | #3-184 | #4-205 | #4-217 | |
| 49'- 0" | | 237 | 423 | 623 | 842 | 21.989 | 160 | 641 | 911 | 1202 | 1520 | 13.532 |
| STIR | | #3-150 | #3-183 | #3-208 | #3-230 | | #3- 89 | #3-166 | #3-188 | #4-207 | #4-221 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.89 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.23 | 1.96 | 2.45 | 3.08 | 3.68 | | 1.60 | 2.69 | 3.46 | 4.07 | 7.74 | |
| ACTUAL STEEL % | 0.415 | 0.664 | 0.830 | 1.049 | 1.255 | | 0.543 | 0.918 | 1.181 | 1.395 | 2.651 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.38 | 26.25 | 26.19 | | 26.31 | 26.25 | 26.19 | 26.12 | 26.12 | |
| $-I_{cr}/I_{gr}$ | 0.127 | 0.185 | 0.220 | 0.259 | 0.293 | | 0.157 | 0.234 | 0.280 | 0.313 | 0.479 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | |
| ACTUAL STEEL % | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | |
| EFF. DEPTH, IN. | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | |
| $+I_{cr}/I_{gr}$ | 0.134 | 0.205 | 0.244 | 0.284 | 0.327 | | 0.134 | 0.205 | 0.244 | 0.284 | 0.327 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**40″ Forms + 10″ Ribs @ 50″ c.-c.**
23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 5 | # 6 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 8 | # 8 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 7 | 7 | 8 | 7 | 8.5 | | 8 | 7.5 | 8 | 9 | 6 | |
| BOTTOM BARS NO | 1# 5 | 1# 8 | 1# 7 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 7 | 1#10 | 1#10 | |
| BARS NO | 2# 6 | 1# 9 | 2# 8 | 1#10 | 1#11 | | 2# 6 | 1# 9 | 2# 8 | 1#10 | 1#11 | |
| STEEL (PSF) | 1.13 | 1.79 | 2.13 | 2.58 | 2.85 | | 1.73 | 2.69 | 3.29 | 3.94 | 5.19 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 450 | 1006 | 1373 | 1693 | 1956 | 7.149 | 967 | 1775 | 2309 | 2775 | 3157 | 4.399 |
| STIR | #3- 95 | #3-148 | #3-159 | #4-182 | #4-190 | | #3-113 | #3-133 | #4-164 | #5-173 | #5-178 | |
| 38'- 0" | 391 | 918 | 1266 | 1570 | 1819 | 7.953 | 881 | 1647 | 2154 | 2595 | 2958 | 4.894 |
| STIR | #3- 94 | #3-149 | #3-168 | #4-184 | #4-193 | | #3-113 | #3-141 | #4-167 | #5-176 | #5-181 | |
| 39'- 0" | 337 | 836 | 1167 | 1455 | 1692 | 8.824 | 802 | 1529 | 2010 | 2429 | 2773 | 5.430 |
| STIR | #3- 91 | #3-150 | #3-172 | #3-187 | #4-196 | | #3-112 | #3-148 | #4-169 | #4-179 | #5-185 | |
| 40'- 0" | 286 | 761 | 1076 | 1350 | 1574 | 9.765 | 729 | 1419 | 1877 | 2275 | 2602 | 6.009 |
| STIR | #3- 89 | #3-151 | #3-174 | #3-190 | #4-199 | | #3-112 | #3-155 | #4-173 | #4-182 | #5-187 | |
| 41'- 0" | 239 | 691 | 991 | 1252 | 1465 | 10.778 | 660 | 1318 | 1753 | 2133 | 2444 | 6.633 |
| STIR | #3- 86 | #3-152 | #3-175 | #3-169 | #4-202 | | #3-112 | #3-156 | #4-175 | #4-185 | #5-191 | |
| 42'- 0" | 196 | 627 | 912 | 1160 | 1364 | 11.869 | 597 | 1224 | 1638 | 2000 | 2296 | 7.304 |
| STIR | #3- 83 | #3-152 | #3-177 | #3-177 | #4-204 | | #3-111 | #3-158 | #4-177 | #4-188 | #5-195 | |
| 43'- 0" | 155 | 566 | 838 | 1075 | 1270 | 13.040 | 538 | 1136 | 1532 | 1877 | 2159 | 8.025 |
| STIR | #3- 80 | #3-152 | #3-178 | #3-186 | #4-207 | | #3-110 | #3-159 | #3-179 | #4-190 | #5-198 | |
| 44'- 0" | 117 | 510 | 770 | 996 | 1182 | 14.296 | 483 | 1054 | 1432 | 1761 | 2031 | 8.798 |
| STIR | #3- 77 | #3-152 | #3-180 | #3-195 | #3-210 | | #3-109 | #3-160 | #3-154 | #4-193 | #4-200 | |
| 45'- 0" | 82 | 457 | 706 | 922 | 1100 | 15.641 | 431 | 977 | 1339 | 1654 | 1912 | 9.625 |
| STIR | #3- 74 | #3-152 | #3-181 | #3-198 | #3-212 | | #3-108 | #3-162 | #3-161 | #4-195 | #4-204 | |
| 46'- 0" | 49 | 408 | 646 | 853 | 1023 | 17.078 | 383 | 906 | 1252 | 1553 | 1800 | 10.510 |
| STIR | #3- 70 | #3-152 | #3-182 | #3-200 | #3-191 | | #3-107 | #3-163 | #3-169 | #4-199 | #4-206 | |
| 47'- 0" | 18 | 362 | 590 | 788 | 951 | 18.613 | 338 | 839 | 1170 | 1459 | 1695 | 11.454 |
| STIR | #3- 66 | #3-151 | #3-183 | #3-202 | #3-199 | | #3-105 | #3-164 | #3-176 | #4-201 | #4-209 | |
| 48'- 0" | | 319 | 537 | 727 | 883 | 20.248 | 296 | 776 | 1093 | 1370 | 1597 | 12.460 |
| STIR | | #3-151 | #3-184 | #3-204 | #3-208 | | #3-103 | #3-165 | #3-183 | #4-203 | #4-212 | |
| 49'- 0" | | 278 | 488 | 670 | 820 | 21.989 | 256 | 717 | 1021 | 1287 | 1505 | 13.532 |
| STIR | | #3-150 | #3-184 | #3-205 | #3-217 | | #3-102 | #3-165 | #3-189 | #4-205 | #4-215 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.92 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.43 | 2.21 | 2.75 | 3.14 | 3.53 | | 1.94 | 2.93 | 3.75 | 4.39 | 6.58 | |
| ACTUAL STEEL % | 0.444 | 0.690 | 0.860 | 0.982 | 1.106 | | 0.604 | 0.917 | 1.175 | 1.380 | 2.069 | |
| EFF. DEPTH, IN. | 26.38 | 26.31 | 26.25 | 26.25 | 26.19 | | 26.31 | 26.25 | 26.19 | 26.12 | 26.12 | |
| $-I_{cr}/I_{gr}$ | 0.136 | 0.193 | 0.227 | 0.251 | 0.272 | | 0.174 | 0.239 | 0.285 | 0.317 | 0.418 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.19 | 1.79 | 2.18 | 2.54 | 2.83 | | 1.19 | 1.79 | 2.18 | 2.54 | 2.83 | |
| ACTUAL STEEL % | 0.356 | 0.539 | 0.656 | 0.767 | 0.856 | | 0.356 | 0.539 | 0.656 | 0.767 | 0.856 | |
| EFF. DEPTH, IN. | 26.64 | 26.46 | 26.52 | 26.36 | 26.33 | | 26.64 | 26.46 | 26.52 | 26.36 | 26.33 | |
| $+I_{cr}/I_{gr}$ | 0.143 | 0.206 | 0.247 | 0.279 | 0.307 | | 0.143 | 0.206 | 0.247 | 0.279 | 0.307 | |

SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**53″ Forms + 7″ Ribs @ 60″ c.-c.**
15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 10 | 8 | 10 | 9 | | 10 | 8 | 9 | 7 | 8 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | | 2# 4 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | |
| BARS NO | 1# 4 | 1# 6 | 1# 7 | 1# 8 | 1# 8 | | 1# 4 | 1# 6 | 1# 7 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.57 | 0.77 | 1.02 | 1.18 | 1.35 | | 0.81 | 1.13 | 1.55 | 2.35 | 2.77 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 139 | 460 | 825 | 1040 | 1255 | 2.344 | 461 | 927 | 1459 | 1771 | 2083 | 1.443 |
| STIR | #3- 68 | #3-107 | #3-116 | #3-141 | #3-147 | | #3- 82 | #3-108 | #3-127 | #4-130 | #4-128 | |
| 29'- 0" | 91 | 390 | 731 | 931 | 1131 | 2.698 | 391 | 826 | 1321 | 1613 | 1903 | 1.660 |
| STIR | #3- 66 | #3-108 | #3-124 | #3-144 | #3-151 | | #3- 82 | #3-111 | #3-130 | #3-136 | #4-131 | |
| 30'- 0" | 48 | 327 | 646 | 833 | 1020 | 3.090 | 328 | 734 | 1197 | 1470 | 1741 | 1.901 |
| STIR | #3- 63 | #3-108 | #3-133 | #3-147 | #3-154 | | #3- 81 | #3-113 | #3-133 | #3-140 | #4-135 | |
| 31'- 0" | 9 | 271 | 569 | 744 | 919 | 3.523 | 271 | 652 | 1085 | 1340 | 1595 | 2.168 |
| STIR | #3- 60 | #3-109 | #3-136 | #3-149 | #3-157 | | #3- 81 | #3-114 | #3-135 | #3-143 | #4-141 | |
| 32'- 0" | | 219 | 499 | 663 | 828 | 4.000 | 220 | 577 | 984 | 1223 | 1462 | 2.461 |
| STIR | | #3-108 | #3-138 | #3-152 | #3-160 | | #3- 80 | #3-115 | #3-137 | #3-145 | #4-147 | |
| 33'- 0" | | 172 | 435 | 590 | 744 | 4.523 | 173 | 508 | 891 | 1116 | 1341 | 2.784 |
| STIR | | #3-108 | #3-140 | #3-138 | #3-163 | | #3- 79 | #3-116 | #3-140 | #3-148 | #4-153 | |
| 34'- 0" | | 129 | 377 | 523 | 668 | 5.097 | 130 | 446 | 806 | 1019 | 1230 | 3.137 |
| STIR | | #3-108 | #3-141 | #3-147 | #3-166 | | #3- 77 | #3-117 | #3-143 | #3-151 | #3-158 | |
| 35'- 0" | | 90 | 324 | 461 | 599 | 5.724 | 90 | 389 | 729 | 929 | 1129 | 3.522 |
| STIR | | #3-107 | #3-142 | #3-155 | #3-168 | | #3- 76 | #3-118 | #3-145 | #3-154 | #3-161 | |
| 36'- 0" | | 54 | 275 | 405 | 535 | 6.407 | 54 | 337 | 658 | 847 | 1036 | 3.942 |
| STIR | | #3-106 | #3-144 | #3-158 | #3-171 | | #3- 74 | #3-118 | #3-131 | #3-157 | #3-164 | |
| 37'- 0" | | 21 | 230 | 353 | 476 | 7.149 | 21 | 288 | 593 | 772 | 950 | 4.399 |
| STIR | | #3-105 | #3-145 | #3-160 | #3-173 | | #3- 72 | #3-119 | #3-138 | #3-159 | #3-167 | |
| 38'- 0" | | | 189 | 305 | 422 | 7.953 | | 244 | 532 | 702 | 871 | 4.894 |
| STIR | | | #3-145 | #3-161 | #3-162 | | | #3-119 | #3-146 | #3-162 | #3-170 | |
| 39'- 0" | | | 150 | 261 | 372 | 8.824 | | 203 | 477 | 638 | 799 | 5.430 |
| STIR | | | #3-146 | #3-163 | #3-170 | | | #3-119 | #3-150 | #3-163 | #3-172 | |
| 40'- 0" | | | 115 | 220 | 325 | 9.765 | | 165 | 425 | 578 | 731 | 6.009 |
| STIR | | | #3-146 | #3-164 | #3-178 | | | #3-119 | #3-152 | #3-166 | #3-175 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.20 | 1.20 | 1.50 | 1.86 | 2.07 | | 1.20 | 1.50 | 2.07 | 3.77 | 4.50 | |
| ACTUAL STEEL % | 0.765 | 0.765 | 0.957 | 1.191 | 1.324 | | 0.765 | 0.957 | 1.324 | 2.425 | 2.906 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.31 | 18.31 | | 18.38 | 18.38 | 18.31 | 18.25 | 18.19 | |
| $-I_{cr}/I_{gr}$ | 0.160 | 0.160 | 0.190 | 0.221 | 0.238 | | 0.160 | 0.190 | 0.238 | 0.354 | 0.392 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 0.88 | 1.20 | 1.39 | 1.58 | | 0.60 | 0.88 | 1.20 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.361 | 0.533 | 0.729 | 0.846 | 0.962 | | 0.361 | 0.533 | 0.729 | 0.846 | 0.962 | |
| EFF. DEPTH, IN. | 18.75 | 18.62 | 18.56 | 18.53 | 18.50 | | 18.75 | 18.62 | 18.56 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.119 | 0.168 | 0.222 | 0.253 | 0.283 | | 0.119 | 0.168 | 0.222 | 0.253 | 0.283 | |

SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 8″ Ribs @ 61″ c.-c.<br>15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9.5 | 8 | 7 | 9.5 | | 10 | 7 | 9.5 | 8 | 6 | |
| BOTTOM BARS NO | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.60 | 0.85 | 0.95 | 1.14 | 1.31 | | 0.84 | 1.28 | 1.44 | 1.73 | 2.72 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 135 | 617 | 794 | 1015 | 1229 | 2.344 | 466 | 1168 | 1425 | 1746 | 2058 | 1.443 |
| STIR | #3- 57 | #3-112 | #3-122 | #3-134 | #3-141 | | #3- 75 | #3-102 | #3-122 | #3-129 | #4-128 | |
| 29'- 0" | 85 | 535 | 700 | 906 | 1106 | 2.698 | 394 | 1048 | 1288 | 1587 | 1878 | 1.660 |
| STIR | #3- 54 | #3-113 | #3-124 | #3-120 | #3-145 | | #3- 74 | #3-110 | #3-124 | #3-131 | #4-134 | |
| 30'- 0" | 41 | 461 | 615 | 808 | 994 | 3.090 | 329 | 941 | 1165 | 1445 | 1716 | 1.901 |
| STIR | #3- 51 | #3-114 | #3-126 | #3-128 | #3-148 | | #3- 73 | #3-116 | #3-127 | #3-134 | #4-140 | |
| 31'- 0" | 1 | 394 | 539 | 719 | 894 | 3.523 | 271 | 843 | 1053 | 1315 | 1570 | 2.168 |
| STIR | #3- 47 | #3-114 | #3-127 | #3-137 | #3-150 | | #3- 72 | #3-118 | #3-129 | #3-137 | #4-143 | |
| 32'- 0" | | 334 | 469 | 638 | 802 | 4.000 | 217 | 755 | 952 | 1198 | 1437 | 2.461 |
| STIR | | #3-114 | #3-128 | #3-141 | #3-152 | | #3- 70 | #3-119 | #3-116 | #3-139 | #3-146 | |
| 33'- 0" | | 278 | 406 | 565 | 719 | 4.523 | 169 | 675 | 860 | 1091 | 1315 | 2.784 |
| STIR | | #3-114 | #3-129 | #3-143 | #3-136 | | #3- 68 | #3-120 | #3-123 | #3-142 | #3-149 | |
| 34'- 0" | | 228 | 348 | 497 | 643 | 5.097 | 125 | 601 | 776 | 993 | 1205 | 3.137 |
| STIR | | #3-114 | #3-130 | #3-144 | #3-145 | | #3- 66 | #3-122 | #3-131 | #3-144 | #3-152 | |
| 35'- 0" | | 182 | 295 | 436 | 573 | 5.724 | 84 | 534 | 698 | 904 | 1103 | 3.522 |
| STIR | | #3-114 | #3-130 | #3-146 | #3-153 | | #3- 64 | #3-123 | #3-134 | #3-147 | #3-154 | |
| 36'- 0" | | 139 | 246 | 380 | 509 | 6.407 | 47 | 472 | 628 | 822 | 1011 | 3.942 |
| STIR | | #3-113 | #3-131 | #3-147 | #3-159 | | #3- 61 | #3-123 | #3-136 | #3-149 | #3-157 | |
| 37'- 0" | | 100 | 201 | 328 | 451 | 7.149 | 13 | 415 | 563 | 746 | 925 | 4.399 |
| STIR | | #3-113 | #3-131 | #3-148 | #3-161 | | #3- 59 | #3-124 | #3-137 | #3-134 | #3-160 | |
| 38'- 0" | | 64 | 160 | 280 | 396 | 7.953 | | 363 | 503 | 677 | 846 | 4.894 |
| STIR | | #3-112 | #3-131 | #3-149 | #3-163 | | | #3-125 | #3-138 | #3-141 | #3-162 | |
| 39'- 0" | | 31 | 122 | 236 | 346 | 8.824 | | 314 | 447 | 613 | 773 | 5.430 |
| STIR | | #3-110 | #3-131 | #3-150 | #3-164 | | | #3-125 | #3-140 | #3-148 | #3-165 | |
| 40'- 0" | | | 87 | 195 | 300 | 9.765 | | 270 | 396 | 553 | 706 | 6.009 |
| STIR | | | #3-130 | #3-151 | #3-166 | | | #3-126 | #3-141 | #3-154 | #3-167 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.65 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.22 | 1.28 | 1.52 | 1.74 | 1.99 | | 1.22 | 1.74 | 1.99 | 2.36 | 4.47 | |
| ACTUAL STEEL % | 0.697 | 0.733 | 0.871 | 0.995 | 1.141 | | 0.697 | 0.995 | 1.141 | 1.355 | 2.575 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.38 | 18.31 | | 18.38 | 18.38 | 18.31 | 18.31 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.152 | 0.158 | 0.180 | 0.200 | 0.219 | | 0.152 | 0.200 | 0.219 | 0.247 | 0.376 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | |
| EFF. DEPTH, IN. | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.111 | 0.178 | 0.203 | 0.231 | 0.258 | | 0.111 | 0.178 | 0.203 | 0.231 | 0.258 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 9″ Ribs @ 62″ c.-c.<br>15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8.5 | 7.5 | 9.5 | 8.5 | | 10 | 9.5 | 8.5 | 7 | 4 | |
| BOTTOM BARS NO | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.64 | 0.92 | 1.05 | 1.30 | 1.45 | | 0.88 | 1.43 | 1.61 | 1.98 | 2.89 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 216 | 769 | 918 | 1204 | 1439 | 2.344 | 595 | 1400 | 1616 | 2033 | 2374 | 1.443 |
| STIR | #3- 62 | #3-115 | #3-123 | #3-136 | #3-143 | | #3- 78 | #3- 98 | #3-122 | #4-130 | #4-130 | |
| 29'- 0" | 159 | 675 | 814 | 1081 | 1300 | 2.698 | 513 | 1263 | 1465 | 1853 | 2172 | 1.660 |
| STIR | #3- 60 | #3-116 | #3-124 | #3-139 | #3-146 | | #3- 78 | #3-105 | #3-124 | #4-132 | #4-134 | |
| 30'- 0" | 108 | 590 | 720 | 969 | 1174 | 3.090 | 439 | 1140 | 1328 | 1691 | 1989 | 1.901 |
| STIR | #3- 57 | #3-117 | #3-126 | #3-125 | #3-149 | | #3- 77 | #3-113 | #3-127 | #3-136 | #4-140 | |
| 31'- 0" | 62 | 513 | 635 | 868 | 1060 | 3.523 | 372 | 1028 | 1204 | 1544 | 1823 | 2.168 |
| STIR | #3- 53 | #3-118 | #3-127 | #3-133 | #3-152 | | #3- 76 | #3-120 | #3-129 | #3-139 | #4-144 | |
| 32'- 0" | 20 | 444 | 558 | 777 | 957 | 4.000 | 311 | 927 | 1092 | 1411 | 1673 | 2.461 |
| STIR | #3- 50 | #3-118 | #3-128 | #3-142 | #3-155 | | #3- 75 | #3-122 | #3-116 | #3-141 | #4-147 | |
| 33'- 0" | | 380 | 487 | 694 | 863 | 4.523 | 255 | 834 | 990 | 1290 | 1536 | 2.784 |
| STIR | | #3-119 | #3-129 | #3-145 | #3-157 | | #3- 73 | #3-124 | #3-123 | #3-144 | #4-150 | |
| 34'- 0" | | 322 | 423 | 617 | 777 | 5.097 | 205 | 750 | 897 | 1179 | 1411 | 3.137 |
| STIR | | #3-119 | #3-130 | #3-147 | #3-142 | | #3- 71 | #3-125 | #3-131 | #3-146 | #3-153 | |
| 35'- 0" | | 269 | 364 | 548 | 698 | 5.724 | 158 | 673 | 811 | 1078 | 1297 | 3.522 |
| STIR | | #3-119 | #3-131 | #3-149 | #3-150 | | #3- 69 | #3-126 | #3-134 | #3-149 | #3-155 | |
| 36'- 0" | | 221 | 311 | 484 | 626 | 6.407 | 116 | 602 | 733 | 985 | 1192 | 3.942 |
| STIR | | #3-118 | #3-131 | #3-150 | #3-159 | | #3- 67 | #3-127 | #3-136 | #3-150 | #3-158 | |
| 37'- 0" | | 176 | 261 | 425 | 560 | 7.149 | 76 | 537 | 661 | 900 | 1095 | 4.399 |
| STIR | | #3-118 | #3-131 | #3-151 | #3-163 | | #3- 65 | #3-128 | #3-137 | #3-152 | #3-161 | |
| 38'- 0" | | 135 | 215 | 371 | 498 | 7.953 | 40 | 477 | 595 | 821 | 1006 | 4.894 |
| STIR | | #3-117 | #3-131 | #3-152 | #3-165 | | #3- 62 | #3-129 | #3-139 | #3-137 | #3-164 | |
| 39'- 0" | | 96 | 173 | 321 | 442 | 8.824 | 7 | 422 | 533 | 748 | 924 | 5.430 |
| STIR | | #3-116 | #3-131 | #3-153 | #3-167 | | #3- 59 | #3-130 | #3-140 | #3-145 | #3-166 | |
| 40'- 0" | | 61 | 134 | 274 | 389 | 9.765 | | 370 | 476 | 680 | 848 | 6.009 |
| STIR | | #3-115 | #3-131 | #3-154 | #3-168 | | | #3-130 | #3-141 | #3-152 | #3-168 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.24 | 1.46 | 1.65 | 2.02 | 2.26 | | 1.24 | 2.02 | 2.26 | 2.75 | 4.80 | |
| ACTUAL STEEL % | 0.641 | 0.754 | 0.854 | 1.050 | 1.173 | | 0.641 | 1.050 | 1.173 | 1.424 | 2.493 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.31 | 18.31 | | 18.38 | 18.31 | 18.31 | 18.31 | 18.31 | |
| $-I_{cr}/I_{gr}$ | 0.145 | 0.165 | 0.181 | 0.210 | 0.228 | | 0.145 | 0.210 | 0.228 | 0.262 | 0.381 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | |
| EFF. DEPTH, IN. | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | |
| $+I_{cr}/I_{gr}$ | 0.117 | 0.187 | 0.205 | 0.238 | 0.265 | | 0.117 | 0.187 | 0.205 | 0.238 | 0.265 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**53″ Forms + 10″ Ribs @ 63″ c.-c.**
15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 7 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 8.5 | 7 | 9.5 | 7.5 | | 10 | 10 | 7.5 | 7 | 7 | |
| BOTTOM BARS NO | 3# 3 | 1# 5 | 2# 6 | 1# 6 | 2# 7 | | 3# 3 | 1# 5 | 2# 6 | 1# 6 | 2# 7 | |
| BARS NO | 2# 4 | 2# 6 | 1# 7 | 2# 7 | 1# 8 | | 2# 4 | 2# 6 | 1# 7 | 2# 7 | 1# 8 | |
| STEEL (PSF) | 0.65 | 0.91 | 1.16 | 1.27 | 1.59 | | 0.89 | 1.38 | 1.82 | 1.94 | 3.19 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 216 | 744 | 1074 | 1255 | 1650 | 2.344 | 607 | 1374 | 1855 | 2119 | 2692 | 1.443 |
| STIR | #3- 54 | #3-107 | #3-124 | #3-114 | #4-144 | | #3- 73 | #3-108 | #3-123 | #4-128 | #4-129 | |
| 29'- 0" | 158 | 649 | 958 | 1127 | 1494 | 2.698 | 523 | 1238 | 1686 | 1932 | 2466 | 1.660 |
| STIR | #3- 51 | #3-108 | #3-126 | #3-122 | #3-147 | | #3- 72 | #3-111 | #3-125 | #4-130 | #4-133 | |
| 30'- 0" | 105 | 565 | 853 | 1011 | 1354 | 3.090 | 446 | 1114 | 1533 | 1763 | 2262 | 1.901 |
| STIR | #3- 47 | #3-108 | #3-127 | #3-131 | #3-150 | | #3- 70 | #3-113 | #3-128 | #3-133 | #4-138 | |
| 31'- 0" | 58 | 488 | 758 | 906 | 1227 | 3.523 | 377 | 1003 | 1395 | 1610 | 2078 | 2.168 |
| STIR | #3- 43 | #3-108 | #3-129 | #3-137 | #3-153 | | #3- 69 | #3-114 | #3-130 | #3-135 | #4-145 | |
| 32'- 0" | 14 | 418 | 671 | 810 | 1112 | 4.000 | 314 | 901 | 1269 | 1471 | 1910 | 2.461 |
| STIR | #3- 39 | #3-108 | #3-130 | #3-139 | #3-155 | | #3- 67 | #3-115 | #3-113 | #3-139 | #4-149 | |
| 33'- 0" | | 355 | 593 | 723 | 1007 | 4.523 | 257 | 809 | 1155 | 1345 | 1758 | 2.784 |
| STIR | | #3-108 | #3-131 | #3-141 | #3-158 | | #3- 65 | #3-116 | #3-120 | #3-141 | #4-152 | |
| 34'- 0" | | 297 | 521 | 644 | 911 | 5.097 | 205 | 725 | 1051 | 1230 | 1619 | 3.137 |
| STIR | | #3-108 | #3-132 | #3-142 | #3-160 | | #3- 63 | #3-117 | #3-128 | #3-143 | #4-154 | |
| 35'- 0" | | 244 | 455 | 571 | 824 | 5.724 | 157 | 648 | 955 | 1124 | 1491 | 3.522 |
| STIR | | #3-107 | #3-133 | #3-144 | #3-147 | | #3- 61 | #3-118 | #3-135 | #3-146 | #4-157 | |
| 36'- 0" | | 195 | 395 | 505 | 743 | 6.407 | 113 | 577 | 868 | 1027 | 1374 | 3.942 |
| STIR | | #3-106 | #3-133 | #3-145 | #3-156 | | #3- 58 | #3-119 | #3-138 | #3-130 | #4-160 | |
| 37'- 0" | | 150 | 340 | 444 | 669 | 7.149 | 72 | 512 | 787 | 938 | 1266 | 4.399 |
| STIR | | #3-105 | #3-134 | #3-146 | #3-165 | | #3- 55 | #3-119 | #3-139 | #3-137 | #3-163 | |
| 38'- 0" | | 109 | 289 | 387 | 601 | 7.953 | 35 | 452 | 713 | 856 | 1167 | 4.894 |
| STIR | | #3-103 | #3-134 | #3-147 | #3-167 | | #3- 52 | #3-119 | #3-141 | #3-144 | #3-165 | |
| 39'- 0" | | 71 | 241 | 335 | 538 | 8.824 | 1 | 396 | 644 | 780 | 1075 | 5.430 |
| STIR | | #3-102 | #3-134 | #3-147 | #3-169 | | #3- 48 | #3-120 | #3-142 | #3-151 | #3-168 | |
| 40'- 0" | | 36 | 198 | 286 | 480 | 9.765 | | 345 | 580 | 710 | 991 | 6.009 |
| STIR | | #3-100 | #3-134 | #3-148 | #3-170 | | | #3-120 | #3-143 | #3-152 | #3-170 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.26 | 1.48 | 1.80 | 2.06 | 2.60 | | 1.26 | 1.95 | 2.60 | 2.79 | 5.40 | |
| ACTUAL STEEL % | 0.595 | 0.700 | 0.850 | 0.974 | 1.234 | | 0.595 | 0.925 | 1.234 | 1.322 | 2.578 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.31 | 18.31 | | 18.38 | 18.31 | 18.31 | 18.31 | 18.19 | |
| $-I_{cr}/I_{gr}$ | 0.139 | 0.158 | 0.184 | 0.202 | 0.241 | | 0.139 | 0.194 | 0.241 | 0.253 | 0.389 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.73 | 1.19 | 1.48 | 1.64 | 1.99 | | 0.73 | 1.19 | 1.48 | 1.64 | 1.99 | |
| ACTUAL STEEL % | 0.328 | 0.538 | 0.671 | 0.744 | 0.904 | | 0.328 | 0.538 | 0.671 | 0.744 | 0.904 | |
| EFF. DEPTH, IN. | 18.78 | 18.64 | 18.60 | 18.58 | 18.54 | | 18.78 | 18.64 | 18.60 | 18.58 | 18.54 | |
| $+I_{cr}/I_{gr}$ | 0.112 | 0.174 | 0.211 | 0.231 | 0.274 | | 0.112 | 0.174 | 0.211 | 0.231 | 0.274 | |

SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**53″ Forms + 7″ Ribs @ 60″ c.-c.**
19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 8 | 7 | 9.5 | 8 | | 10 | 9 | 8 | 9.5 | 7 | |
| BOTTOM BARS NO | 2# 4 | 1# 7 | 1# 7 | 1# 8 | 1# 8 | | 2# 4 | 1# 7 | 1# 7 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 1# 8 | 1# 8 | 1# 9 | | 1# 5 | 1# 7 | 1# 8 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.65 | 1.02 | 1.15 | 1.33 | 1.51 | | 0.89 | 1.55 | 1.75 | 2.07 | 3.15 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 159 | 682 | 883 | 1084 | 1304 | 4.000 | 512 | 1272 | 1565 | 1857 | 2177 | 2.461 |
| STIR | #3- 77 | #3-135 | #3-136 | #3-157 | #3-166 | | #3- 93 | #3-136 | #3-143 | #4-150 | #4-148 | |
| 33'- 0" | 113 | 604 | 794 | 982 | 1190 | 4.523 | 445 | 1159 | 1435 | 1709 | 2011 | 2.784 |
| STIR | #3- 74 | #3-136 | #3-144 | #3-161 | #3-168 | | #3- 93 | #3-114 | #3-146 | #4-153 | #4-151 | |
| 34'- 0" | 71 | 533 | 712 | 890 | 1085 | 5.097 | 383 | 1056 | 1316 | 1574 | 1858 | 3.137 |
| STIR | #3- 72 | #3-138 | #3-151 | #3-163 | #3-171 | | #3- 92 | #3-121 | #3-149 | #4-156 | #4-155 | |
| 35'- 0" | 32 | 469 | 637 | 805 | 989 | 5.724 | 327 | 962 | 1207 | 1451 | 1719 | 3.522 |
| STIR | #3- 69 | #3-139 | #3-153 | #3-143 | #3-174 | | #3- 92 | #3-128 | #3-151 | #3-159 | #4-161 | |
| 36'- 0" | | 409 | 568 | 727 | 901 | 6.407 | 275 | 876 | 1107 | 1338 | 1591 | 3.942 |
| STIR | | #3-139 | #3-154 | #3-151 | #3-178 | | #3- 91 | #3-136 | #3-154 | #3-162 | #4-167 | |
| 37'- 0" | | 354 | 505 | 655 | 820 | 7.149 | 228 | 796 | 1015 | 1234 | 1473 | 4.399 |
| STIR | | #3-140 | #3-156 | #3-159 | #3-180 | | #3- 89 | #3-143 | #3-156 | #3-164 | #4-172 | |
| 38'- 0" | | 304 | 447 | 589 | 745 | 7.953 | 184 | 723 | 930 | 1137 | 1365 | 4.894 |
| STIR | | #3-141 | #3-157 | #3-168 | #3-183 | | #3- 88 | #3-145 | #3-158 | #3-167 | #4-175 | |
| 39'- 0" | | 257 | 393 | 528 | 676 | 8.824 | 143 | 655 | 852 | 1049 | 1264 | 5.430 |
| STIR | | #3-141 | #3-158 | #3-172 | #3-186 | | #3- 87 | #3-147 | #3-138 | #3-169 | #4-177 | |
| 40'- 0" | | 214 | 343 | 472 | 613 | 9.765 | 106 | 592 | 779 | 966 | 1171 | 6.009 |
| STIR | | #3-141 | #3-160 | #3-174 | #3-165 | | #3- 85 | #3-148 | #3-145 | #3-173 | #3-181 | |
| 41'- 0" | | 174 | 297 | 419 | 553 | 10.778 | 71 | 534 | 712 | 890 | 1085 | 6.633 |
| STIR | | #3-141 | #3-160 | #3-175 | #3-173 | | #3- 83 | #3-149 | #3-152 | #3-175 | #3-183 | |
| 42'- 0" | | 137 | 254 | 370 | 498 | 11.869 | 39 | 480 | 650 | 819 | 1005 | 7.304 |
| STIR | | #3-141 | #3-161 | #3-177 | #3-181 | | #3- 81 | #3-150 | #3-160 | #3-177 | #3-186 | |
| 43'- 0" | | 102 | 214 | 325 | 447 | 13.040 | 8 | 429 | 591 | 753 | 931 | 8.025 |
| STIR | | #3-141 | #3-162 | #3-178 | #3-190 | | #3- 79 | #3-152 | #3-166 | #3-179 | #3-189 | |
| 44'- 0" | | 70 | 176 | 283 | 399 | 14.296 | | 382 | 537 | 692 | 861 | 8.798 |
| STIR | | #3-140 | #3-162 | #3-180 | #3-194 | | | #3-153 | #3-168 | #3-181 | #3-191 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.20 | 1.50 | 1.71 | 1.96 | 2.33 | | 1.20 | 2.07 | 2.33 | 2.78 | 5.14 | |
| ACTUAL STEEL % | 0.605 | 0.756 | 0.864 | 0.990 | 1.176 | | 0.605 | 1.045 | 1.176 | 1.411 | 2.619 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.38 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.25 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.144 | 0.171 | 0.190 | 0.208 | 0.236 | | 0.144 | 0.217 | 0.236 | 0.267 | 0.398 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.71 | 1.20 | 1.39 | 1.58 | 1.79 | | 0.71 | 1.20 | 1.39 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.340 | 0.578 | 0.670 | 0.763 | 0.865 | | 0.340 | 0.578 | 0.670 | 0.763 | 0.865 | |
| EFF. DEPTH, IN. | 22.72 | 22.56 | 22.53 | 22.50 | 22.46 | | 22.72 | 22.56 | 22.53 | 22.50 | 22.46 | |
| $+I_{cr}/I_{gr}$ | 0.120 | 0.193 | 0.220 | 0.247 | 0.276 | | 0.120 | 0.193 | 0.220 | 0.247 | 0.276 | |

SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 8″ Ribs @ 61″ c.-c.<br>19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 10 | 8.5 | 7.5 | | 9.5 | 8.5 | 7.5 | 6 | 5 | |
| BOTTOM BARS NO | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | |
| BARS NO | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.68 | 1.06 | 1.22 | 1.47 | 1.67 | | 0.95 | 1.62 | 1.85 | 2.28 | 3.33 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 248 | 784 | 954 | 1274 | 1494 | 4.000 | 655 | 1435 | 1682 | 2147 | 2467 | 2.461 |
| STIR | #3- 82 | #3-134 | #3-141 | #3-159 | #4-166 | | #3- 97 | #3-135 | #3-141 | #4-150 | #4-151 | |
| 33'- 0" | 194 | 699 | 858 | 1159 | 1366 | 4.523 | 577 | 1310 | 1543 | 1980 | 2281 | 2.784 |
| STIR | #3- 80 | #3-135 | #3-146 | #3-161 | #4-168 | | #3- 96 | #3-115 | #3-144 | #4-153 | #4-153 | |
| 34'- 0" | 146 | 621 | 771 | 1055 | 1249 | 5.097 | 506 | 1197 | 1416 | 1828 | 2111 | 3.137 |
| STIR | #3- 77 | #3-137 | #3-147 | #3-164 | #3-172 | | #3- 96 | #3-122 | #3-147 | #4-156 | #4-157 | |
| 35'- 0" | 101 | 549 | 691 | 959 | 1142 | 5.724 | 441 | 1093 | 1300 | 1689 | 1956 | 3.522 |
| STIR | #3- 75 | #3-138 | #3-149 | #3-166 | #3-174 | | #3- 96 | #3-130 | #3-149 | #4-160 | #4-162 | |
| 36'- 0" | 60 | 484 | 618 | 871 | 1044 | 6.407 | 381 | 998 | 1193 | 1561 | 1813 | 3.942 |
| STIR | #3- 72 | #3-138 | #3-151 | #3-149 | #3-177 | | #3- 95 | #3-137 | #3-151 | #4-162 | #4-168 | |
| 37'- 0" | 22 | 423 | 550 | 790 | 954 | 7.149 | 326 | 910 | 1095 | 1443 | 1682 | 4.399 |
| STIR | #3- 69 | #3-139 | #3-152 | #3-157 | #3-180 | | #3- 94 | #3-143 | #3-154 | #4-165 | #4-172 | |
| 38'- 0" | | 368 | 488 | 715 | 871 | 7.953 | 276 | 829 | 1004 | 1334 | 1561 | 4.894 |
| STIR | | #3-140 | #3-153 | #3-165 | #3-183 | | #3- 93 | #3-144 | #3-137 | #3-168 | #4-174 | |
| 39'- 0" | | 316 | 431 | 646 | 794 | 8.824 | 229 | 754 | 921 | 1234 | 1449 | 5.430 |
| STIR | | #3-140 | #3-154 | #3-173 | #3-185 | | #3- 92 | #3-146 | #3-144 | #3-170 | #4-177 | |
| 40'- 0" | | 269 | 378 | 582 | 723 | 9.765 | 186 | 685 | 843 | 1141 | 1346 | 6.009 |
| STIR | | #3-140 | #3-155 | #3-175 | #3-164 | | #3- 90 | #3-147 | #3-151 | #3-173 | #4-180 | |
| 41'- 0" | | 225 | 328 | 523 | 657 | 10.778 | 146 | 621 | 772 | 1055 | 1250 | 6.633 |
| STIR | | #3-140 | #3-156 | #3-177 | #3-173 | | #3- 89 | #3-148 | #3-159 | #3-176 | #4-184 | |
| 42'- 0" | | 183 | 282 | 468 | 595 | 11.869 | 108 | 561 | 705 | 975 | 1160 | 7.304 |
| STIR | | #3-140 | #3-156 | #3-179 | #3-181 | | #3- 87 | #3-149 | #3-160 | #3-178 | #4-186 | |
| 43'- 0" | | 145 | 239 | 417 | 538 | 13.040 | 74 | 506 | 643 | 900 | 1077 | 8.025 |
| STIR | | #3-139 | #3-157 | #3-180 | #3-190 | | #3- 85 | #3-151 | #3-162 | #3-180 | #3-188 | |
| 44'- 0" | | 110 | 200 | 369 | 485 | 14.296 | 41 | 454 | 585 | 831 | 1000 | 8.798 |
| STIR | | #3-139 | #3-157 | #3-182 | #3-194 | | #3- 83 | #3-151 | #3-163 | #3-183 | #3-192 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.71 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.22 | 1.63 | 1.89 | 2.22 | 2.52 | | 1.28 | 2.22 | 2.52 | 3.15 | 5.37 | |
| ACTUAL STEEL % | 0.553 | 0.737 | 0.860 | 1.011 | 1.146 | | 0.582 | 1.011 | 1.146 | 1.433 | 2.448 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.31 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.31 | 22.25 | |
| $-I_{cr}/I_{gr}$ | 0.136 | 0.171 | 0.191 | 0.216 | 0.237 | | 0.142 | 0.216 | 0.237 | 0.278 | 0.394 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | |
| EFF. DEPTH, IN. | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | |
| $+I_{cr}/I_{gr}$ | 0.125 | 0.194 | 0.215 | 0.252 | 0.278 | | 0.125 | 0.194 | 0.215 | 0.252 | 0.278 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 9″ Ribs @ 62″ c.-c.<br>19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 9.5 | 7.5 | 7 | | 9 | 8.5 | 7 | 8 | 6 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | |
| BARS NO | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | |
| STEEL (PSF) | 0.75 | 1.10 | 1.28 | 1.61 | 1.71 | | 1.04 | 1.67 | 1.96 | 2.46 | 3.62 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 279 | 822 | 1093 | 1463 | 1662 | 4.000 | 714 | 1504 | 1899 | 2436 | 2726 | 2.461 |
| STIR | #3- 77 | #3-130 | #3-140 | #3-159 | #4-164 | | #3- 94 | #3-114 | #4-142 | #4-151 | #5-148 | |
| 33'- 0" | 222 | 733 | 988 | 1335 | 1522 | 4.523 | 631 | 1374 | 1745 | 2250 | 2523 | 2.784 |
| STIR | #3- 75 | #3-131 | #3-146 | #3-163 | #4-168 | | #3- 93 | #3-121 | #3-144 | #4-154 | #5-152 | |
| 34'- 0" | 170 | 651 | 891 | 1218 | 1395 | 5.097 | 555 | 1255 | 1604 | 2080 | 2337 | 3.137 |
| STIR | #3- 73 | #3-132 | #3-148 | #3-165 | #4-171 | | #3- 93 | #3-129 | #3-147 | #4-157 | #4-155 | |
| 35'- 0" | 122 | 576 | 803 | 1111 | 1278 | 5.724 | 486 | 1146 | 1476 | 1925 | 2167 | 3.522 |
| STIR | #3- 70 | #3-132 | #3-149 | #3-168 | #3-174 | | #3- 92 | #3-135 | #3-149 | #4-160 | #4-161 | |
| 36'- 0" | 78 | 507 | 722 | 1013 | 1171 | 6.407 | 422 | 1046 | 1358 | 1782 | 2011 | 3.942 |
| STIR | #3- 67 | #3-133 | #3-151 | #3-147 | #3-176 | | #3- 91 | #3-137 | #3-151 | #4-163 | #4-167 | |
| 37'- 0" | 38 | 444 | 647 | 923 | 1072 | 7.149 | 363 | 954 | 1249 | 1651 | 1868 | 4.399 |
| STIR | #3- 63 | #3-133 | #3-152 | #3-155 | #3-180 | | #3- 90 | #3-139 | #3-153 | #4-166 | #4-171 | |
| 38'- 0" | 1 | 386 | 578 | 840 | 981 | 7.953 | 309 | 869 | 1149 | 1530 | 1736 | 4.894 |
| STIR | #3- 59 | #3-133 | #3-153 | #3-164 | #3-182 | | #3- 89 | #3-140 | #3-136 | #4-168 | #4-175 | |
| 39'- 0" | | 332 | 515 | 763 | 897 | 8.824 | 259 | 791 | 1057 | 1418 | 1614 | 5.430 |
| STIR | | #3-133 | #3-155 | #3-172 | #3-185 | | #3- 87 | #3-141 | #3-143 | #4-171 | #4-177 | |
| 40'- 0" | | 282 | 456 | 692 | 820 | 9.765 | 213 | 719 | 971 | 1315 | 1500 | 6.009 |
| STIR | | #3-133 | #3-155 | #3-176 | #3-166 | | #3- 86 | #3-142 | #3-151 | #3-174 | #4-181 | |
| 41'- 0" | | 236 | 401 | 626 | 747 | 10.778 | 170 | 651 | 892 | 1219 | 1395 | 6.633 |
| STIR | | #3-133 | #3-156 | #3-178 | #3-174 | | #3- 84 | #3-143 | #3-158 | #3-177 | #4-183 | |
| 42'- 0" | | 193 | 350 | 565 | 680 | 11.869 | 130 | 589 | 818 | 1130 | 1298 | 7.304 |
| STIR | | #3-132 | #3-157 | #3-180 | #3-183 | | #3- 82 | #3-144 | #3-161 | #3-179 | #4-186 | |
| 43'- 0" | | 153 | 303 | 507 | 618 | 13.040 | 93 | 530 | 749 | 1046 | 1207 | 8.025 |
| STIR | | #3-131 | #3-157 | #3-181 | #3-191 | | #3- 80 | #3-145 | #3-162 | #3-182 | #4-188 | |
| 44'- 0" | | 115 | 259 | 454 | 560 | 14.296 | 58 | 476 | 685 | 969 | 1122 | 8.798 |
| STIR | | #3-130 | #3-158 | #3-183 | #3-193 | | #3- 77 | #3-146 | #3-164 | #3-183 | #4-191 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.73 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.24 | 1.65 | 2.02 | 2.56 | 2.75 | | 1.38 | 2.26 | 2.75 | 3.41 | 6.20 | |
| ACTUAL STEEL % | 0.510 | 0.680 | 0.835 | 1.058 | 1.133 | | 0.567 | 0.933 | 1.133 | 1.412 | 2.576 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.31 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.25 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.130 | 0.164 | 0.191 | 0.228 | 0.240 | | 0.142 | 0.207 | 0.240 | 0.278 | 0.412 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | |
| ACTUAL STEEL % | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | |
| EFF. DEPTH, IN. | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | |
| $+I_{cr}/I_{gr}$ | 0.123 | 0.186 | 0.217 | 0.258 | 0.280 | | 0.123 | 0.186 | 0.217 | 0.258 | 0.280 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**53″ Forms + 10″ Ribs @ 63″ c.-c.**
19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 6 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 7 | 9 | 7.5 | 9 | | 8.5 | 8 | 9.5 | 10 | 7 | |
| BOTTOM BARS NO | 2# 5 | 2# 6 | 2# 6 | 2# 6 | 2# 8 | | 2# 5 | 2# 6 | 2# 6 | 2# 6 | 2# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 2# 7 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 2# 7 | 1# 8 | |
| STEEL (PSF) | 0.74 | 1.16 | 1.42 | 1.66 | 1.87 | | 1.06 | 1.76 | 2.14 | 2.63 | 3.37 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 32'- 0" (3) | 305 | 893 | 1195 | 1533 | 1831 | 4.000 | 766 | 1621 | 2061 | 2552 | 2985 | 2.461 |
| STIR | #3- 73 | #3-128 | #3-143 | #3-156 | #4-165 | | #3- 91 | #3-117 | #4-141 | #4-149 | #5-154 | |
| 33'- 0" | 245 | 798 | 1082 | 1399 | 1679 | 4.523 | 678 | 1482 | 1895 | 2358 | 2765 | 2.784 |
| STIR | #3- 70 | #3-128 | #3-145 | #3-159 | #4-167 | | #3- 90 | #3-124 | #4-143 | #4-152 | #5-158 | |
| 34'- 0" | 190 | 710 | 978 | 1277 | 1541 | 5.097 | 598 | 1355 | 1744 | 2180 | 2564 | 3.137 |
| STIR | #3- 67 | #3-129 | #3-146 | #3-162 | #4-170 | | #3- 89 | #3-132 | #3-146 | #4-156 | #5-161 | |
| 35'- 0" | 139 | 630 | 883 | 1165 | 1414 | 5.724 | 524 | 1239 | 1606 | 2017 | 2379 | 3.522 |
| STIR | #3- 64 | #3-130 | #3-148 | #3-145 | #4-174 | | #3- 89 | #3-134 | #3-148 | #4-158 | #4-165 | |
| 36'- 0" | 93 | 557 | 796 | 1063 | 1298 | 6.407 | 457 | 1132 | 1479 | 1868 | 2210 | 3.942 |
| STIR | #3- 61 | #3-130 | #3-149 | #3-153 | #3-177 | | #3- 87 | #3-135 | #3-151 | #4-161 | #4-168 | |
| 37'- 0" | 50 | 490 | 715 | 968 | 1191 | 7.149 | 395 | 1034 | 1363 | 1730 | 2054 | 4.399 |
| STIR | #3- 57 | #3-130 | #3-151 | #3-162 | #3-179 | | #3- 86 | #3-137 | #3-131 | #4-164 | #4-171 | |
| 38'- 0" | 10 | 427 | 641 | 881 | 1092 | 7.953 | 337 | 944 | 1255 | 1604 | 1911 | 4.894 |
| STIR | #3- 53 | #3-130 | #3-152 | #3-169 | #3-182 | | #3- 85 | #3-138 | #3-138 | #4-167 | #4-174 | |
| 39'- 0" | | 370 | 573 | 801 | 1001 | 8.824 | 284 | 860 | 1156 | 1487 | 1778 | 5.430 |
| STIR | | #3-130 | #3-153 | #3-170 | #3-184 | | #3- 83 | #3-139 | #3-145 | #4-169 | #4-177 | |
| 40'- 0" | | 317 | 510 | 726 | 917 | 9.765 | 235 | 783 | 1064 | 1378 | 1655 | 6.009 |
| STIR | | #3-130 | #3-153 | #3-172 | #3-166 | | #3- 81 | #3-140 | #3-153 | #3-171 | #4-179 | |
| 41'- 0" | | 267 | 451 | 657 | 838 | 10.778 | 190 | 711 | 978 | 1278 | 1542 | 6.633 |
| STIR | | #3-129 | #3-154 | #3-174 | #3-175 | | #3- 79 | #3-141 | #3-158 | #3-174 | #4-183 | |
| 42'- 0" | | 221 | 396 | 593 | 766 | 11.869 | 148 | 644 | 899 | 1184 | 1436 | 7.304 |
| STIR | | #3-128 | #3-155 | #3-175 | #3-183 | | #3- 77 | #3-142 | #3-160 | #3-176 | #4-185 | |
| 43'- 0" | | 178 | 346 | 533 | 698 | 13.040 | 108 | 582 | 825 | 1097 | 1337 | 8.025 |
| STIR | | #3-127 | #3-155 | #3-176 | #3-191 | | #3- 74 | #3-142 | #3-161 | #3-178 | #4-188 | |
| 44'- 0" | | 139 | 298 | 477 | 635 | 14.296 | 71 | 524 | 756 | 1016 | 1245 | 8.798 |
| STIR | | #3-126 | #3-155 | #3-178 | #3-193 | | #3- 71 | #3-143 | #3-163 | #3-180 | #4-190 | |

### PROPERTIES FOR DESIGN (CONCRETE 0.75 CF/SF)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.26 | 1.80 | 2.17 | 2.60 | 3.08 | | 1.48 | 2.44 | 2.92 | 3.78 | 5.40 | |
| ACTUAL STEEL % | 0.475 | 0.678 | 0.820 | 0.984 | 1.168 | | 0.558 | 0.923 | 1.106 | 1.438 | 2.054 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.31 | 22.31 | 22.25 | | 22.38 | 22.31 | 22.25 | 22.19 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.125 | 0.167 | 0.191 | 0.220 | 0.247 | | 0.143 | 0.209 | 0.238 | 0.285 | 0.363 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.48 | 1.76 | 2.08 | 2.37 | | 0.93 | 1.48 | 1.76 | 2.08 | 2.37 | |
| ACTUAL STEEL % | 0.336 | 0.537 | 0.638 | 0.755 | 0.863 | | 0.336 | 0.537 | 0.638 | 0.755 | 0.863 | |
| EFF. DEPTH, IN. | 22.69 | 22.60 | 22.62 | 22.59 | 22.50 | | 22.69 | 22.60 | 22.62 | 22.59 | 22.50 | |
| $+I_{cr}/I_{gr}$ | 0.121 | 0.185 | 0.217 | 0.251 | 0.280 | | 0.121 | 0.185 | 0.217 | 0.251 | 0.280 | |

### SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

## WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS

**53″ Forms + 7″ Ribs @ 60″ c.-c.**
23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth
FACTORED USABLE SUPERIMPOSED LOAD (PLF)

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | Int. Span Defl. Coeff. (2) |
|---|---|---|---|---|---|---|---|---|---|---|
| AT | 10 | 7 | 8.5 | 7.5 | | 8.5 | 8 | 6 | 4 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 8 | 1# 9 | | 1# 6 | 1# 7 | 1# 8 | 1# 9 | |
| BARS NO | 1# 6 | 1# 8 | 1# 9 | 1# 9 | | 1# 6 | 1# 8 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.77 | 1.15 | 1.49 | 1.69 | | 1.09 | 1.75 | 2.30 | 3.07 | |
| CLEAR SPAN | END SPAN | | | | | INTERIOR SPAN | | | | |
| 37'- 0" (3) | 174 | 654 | 1026 | 1221 | 7.149 | 557 | 1255 | 1797 | 2080 | 4.399 |
| STIR | #3- 93 | #3-152 | #3-177 | #3-185 | | #3-111 | #3-129 | #4-169 | #4-175 | |
| 38'- 0" | 130 | 585 | 938 | 1123 | 7.953 | 493 | 1155 | 1669 | 1938 | 4.894 |
| STIR | #3- 91 | #3-153 | #3-154 | #3-188 | | #3-110 | #3-136 | #4-172 | #4-178 | |
| 39'- 0" | 89 | 521 | 857 | 1032 | 8.824 | 434 | 1063 | 1551 | 1806 | 5.430 |
| STIR | #3- 88 | #3-154 | #3-162 | #3-192 | | #3-110 | #3-143 | #4-175 | #4-181 | |
| 40'- 0" | 52 | 463 | 782 | 948 | 9.765 | 380 | 977 | 1441 | 1683 | 6.009 |
| STIR | #3- 86 | #3-155 | #3-171 | #3-194 | | #3-110 | #3-151 | #4-178 | #4-185 | |
| 41'- 0" | 17 | 408 | 712 | 870 | 10.778 | 329 | 898 | 1339 | 1570 | 6.633 |
| STIR | #3- 83 | #3-156 | #3-179 | #3-197 | | #3-109 | #3-158 | #3-181 | #4-188 | |
| 42'- 0" | | 357 | 647 | 798 | 11.869 | 282 | 824 | 1245 | 1465 | 7.304 |
| STIR | | #3-157 | #3-186 | #3-199 | | #3-108 | #3-161 | #3-184 | #4-190 | |
| 43'- 0" | | 310 | 586 | 730 | 13.040 | 239 | 755 | 1157 | 1367 | 8.025 |
| STIR | | #3-157 | #3-188 | #3-177 | | #3-107 | #3-163 | #3-186 | #4-194 | |
| 44'- 0" | | 266 | 530 | 667 | 14.296 | 198 | 691 | 1075 | 1275 | 8.798 |
| STIR | | #3-157 | #3-190 | #3-185 | | #3-106 | #3-164 | #3-188 | #4-197 | |
| 45'- 0" | | 225 | 477 | 609 | 15.641 | 160 | 632 | 998 | 1190 | 9.625 |
| STIR | | #3-157 | #3-192 | #3-194 | | #3-105 | #3-165 | #3-191 | #4-199 | |
| 46'- 0" | | 187 | 428 | 554 | 17.078 | 124 | 576 | 926 | 1110 | 10.510 |
| STIR | | #3-157 | #3-193 | #3-202 | | #3-103 | #3-167 | #3-193 | #3-201 | |
| 47'- 0" | | 151 | 382 | 502 | 18.613 | 91 | 523 | 859 | 1035 | 11.454 |
| STIR | | #3-157 | #3-194 | #3-208 | | #3-102 | #3-168 | #3-195 | #3-204 | |
| 48'- 0" | | 117 | 338 | 454 | 20.248 | 59 | 474 | 796 | 965 | 12.460 |
| STIR | | #3-157 | #3-196 | #3-210 | | #3-100 | #3-169 | #3-197 | #3-207 | |
| 49'- 0" | | 85 | 298 | 409 | 21.989 | 30 | 428 | 737 | 899 | 13.532 |
| STIR | | #3-156 | #3-197 | #3-212 | | #3- 98 | #3-170 | #3-176 | #3-209 | |

### PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF)

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| NEGATIVE MOMENT | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.20 | 1.71 | 2.19 | 2.48 | | 1.41 | 2.33 | 3.10 | 4.65 | |
| ACTUAL STEEL % | 0.495 | 0.707 | 0.905 | 1.025 | | 0.582 | 0.961 | 1.282 | 1.922 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.31 | 26.31 | | 26.38 | 26.31 | 26.31 | 26.31 | |
| $-I_{cr}/I_{gr}$ | 0.130 | 0.173 | 0.207 | 0.228 | | 0.149 | 0.217 | 0.268 | 0.354 | |
| POSITIVE MOMENT | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.79 | 2.00 | | 0.88 | 1.39 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.347 | 0.549 | 0.709 | 0.792 | | 0.347 | 0.549 | 0.709 | 0.792 | |
| EFF. DEPTH, IN. | 26.62 | 26.53 | 26.46 | 26.44 | | 26.62 | 26.53 | 26.46 | 26.44 | |
| $+I_{cr}/I_{gr}$ | 0.129 | 0.195 | 0.245 | 0.271 | | 0.129 | 0.195 | 0.245 | 0.271 | |

### SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.)

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 8″ Ribs @ 61″ c.-c.<br>23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 6 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 8.5 | 9.5 | 8 | | 8 | 7 | 9 | 5 | 5 | |
| BOTTOM BARS NO | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | |
| BARS NO | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | |
| STEEL (PSF) | 0.75 | 1.29 | 1.47 | 1.87 | 2.16 | | 1.11 | 1.99 | 2.23 | 3.47 | 4.42 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 188 | 796 | 991 | 1435 | 1683 | 7.149 | 594 | 1478 | 1762 | 2407 | 2768 | 4.399 |
| STIR | #3- 85 | #3-155 | #3-162 | #4-187 | #4-195 | | #3-105 | #3-155 | #4-163 | #5-176 | #5-171 | |
| 38'- 0" | 142 | 718 | 903 | 1323 | 1559 | 7.953 | 526 | 1365 | 1634 | 2246 | 2588 | 4.894 |
| STIR | #3- 83 | #3-156 | #3-168 | #4-190 | #4-198 | | #3-105 | #3-133 | #4-166 | #4-179 | #5-174 | |
| 39'- 0" | 99 | 646 | 822 | 1221 | 1444 | 8.824 | 464 | 1260 | 1515 | 2096 | 2421 | 5.430 |
| STIR | #3- 80 | #3-157 | #3-170 | #3-193 | #4-202 | | #3-104 | #3-140 | #3-169 | #4-183 | #5-178 | |
| 40'- 0" | 59 | 579 | 746 | 1126 | 1338 | 9.765 | 406 | 1163 | 1406 | 1958 | 2267 | 6.009 |
| STIR | #3- 77 | #3-158 | #3-172 | #3-196 | #4-204 | | #3-103 | #3-147 | #3-171 | #4-186 | #5-180 | |
| 41'- 0" | 22 | 517 | 676 | 1038 | 1240 | 10.778 | 353 | 1073 | 1304 | 1830 | 2123 | 6.633 |
| STIR | #3- 74 | #3-159 | #3-174 | #3-198 | #4-208 | | #3-102 | #3-155 | #3-173 | #4-189 | #5-185 | |
| 42'- 0" | | 460 | 611 | 956 | 1148 | 11.869 | 303 | 989 | 1210 | 1710 | 1990 | 7.304 |
| STIR | | #3-160 | #3-175 | #3-201 | #4-211 | | #3-101 | #3-162 | #3-175 | #4-192 | #5-191 | |
| 43'- 0" | | 406 | 551 | 879 | 1063 | 13.040 | 257 | 911 | 1122 | 1599 | 1866 | 8.025 |
| STIR | | #3-160 | #3-176 | #3-204 | #4-214 | | #3-100 | #3-165 | #3-178 | #4-195 | #4-198 | |
| 44'- 0" | | 356 | 494 | 808 | 983 | 14.296 | 213 | 839 | 1040 | 1496 | 1751 | 8.798 |
| STIR | | #3-161 | #3-177 | #3-181 | #3-216 | | #3- 98 | #3-166 | #3-157 | #4-198 | #4-204 | |
| 45'- 0" | | 310 | 442 | 742 | 909 | 15.641 | 173 | 771 | 963 | 1399 | 1643 | 9.625 |
| STIR | | #3-161 | #3-179 | #3-189 | #3-220 | | #3- 97 | #3-168 | #3-164 | #4-200 | #4-209 | |
| 46'- 0" | | 266 | 392 | 679 | 840 | 17.078 | 135 | 707 | 891 | 1309 | 1542 | 10.510 |
| STIR | | #3-161 | #3-179 | #3-198 | #3-222 | | #3- 95 | #3-169 | #3-172 | #4-203 | #4-212 | |
| 47'- 0" | | 225 | 346 | 621 | 775 | 18.613 | 100 | 648 | 824 | 1224 | 1447 | 11.454 |
| STIR | | #3-161 | #3-180 | #3-206 | #3-225 | | #3- 93 | #3-170 | #3-179 | #4-206 | #4-214 | |
| 48'- 0" | | 187 | 303 | 566 | 714 | 20.248 | 67 | 592 | 761 | 1144 | 1359 | 12.460 |
| STIR | | #3-161 | #3-181 | #3-213 | #3-227 | | #3- 91 | #3-171 | #3-185 | #4-209 | #4-218 | |
| 49'- 0" | | 151 | 262 | 515 | 656 | 21.989 | 36 | 540 | 702 | 1070 | 1275 | 13.532 |
| STIR | | #3-161 | #3-181 | #3-214 | #3-229 | | #3- 89 | #3-173 | #3-187 | #4-211 | #4-220 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.77 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.22 | 1.89 | 2.22 | 2.83 | 3.36 | | 1.52 | 2.70 | 2.98 | 5.37 | 7.32 | |
| ACTUAL STEEL % | 0.454 | 0.705 | 0.830 | 1.056 | 1.255 | | 0.567 | 1.007 | 1.115 | 2.007 | 2.745 | |
| EFF. DEPTH, IN. | 26.38 | 26.31 | 26.31 | 26.25 | 26.25 | | 26.38 | 26.31 | 26.25 | 26.25 | 26.19 | |
| $-I_{cr}/I_{gr}$ | 0.124 | 0.175 | 0.198 | 0.236 | 0.267 | | 0.148 | 0.229 | 0.245 | 0.369 | 0.447 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | |
| ACTUAL STEEL % | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | |
| EFF. DEPTH, IN. | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | |
| $+I_{cr}/I_{gr}$ | 0.125 | 0.201 | 0.225 | 0.278 | 0.307 | | 0.125 | 0.201 | 0.225 | 0.278 | 0.307 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 9″ Ribs @ 62″ c.-c.<br>23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 6 | # 7 | # 8 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9.5 | 8 | 9 | 10 | | 7.5 | 7 | 8 | 9 | 6 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | |
| BARS NO | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | |
| STEEL (PSF) | 0.80 | 1.28 | 1.58 | 1.89 | 2.24 | | 1.20 | 1.96 | 2.46 | 2.93 | 4.71 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 239 | 822 | 1149 | 1501 | 1888 | 7.149 | 685 | 1532 | 2007 | 2520 | 3083 | 4.399 |
| STIR | #3- 85 | #3-149 | #3-160 | #4-183 | #4-195 | | #3-105 | #3-133 | #4-164 | #5-174 | #5-171 | |
| 38'- 0" | 188 | 741 | 1050 | 1385 | 1752 | 7.953 | 611 | 1414 | 1864 | 2351 | 2884 | 4.894 |
| STIR | #3- 82 | #3-150 | #3-168 | #4-187 | #4-199 | | #3-105 | #3-140 | #4-167 | #4-177 | #5-174 | |
| 39'- 0" | 141 | 666 | 960 | 1277 | 1625 | 8.824 | 542 | 1305 | 1733 | 2195 | 2701 | 5.430 |
| STIR | #3- 80 | #3-151 | #3-172 | #3-189 | #4-202 | | #3-104 | #3-148 | #4-170 | #4-181 | #5-177 | |
| 40'- 0" | 98 | 596 | 876 | 1178 | 1509 | 9.765 | 479 | 1204 | 1610 | 2050 | 2531 | 6.009 |
| STIR | #3- 77 | #3-152 | #3-173 | #3-192 | #4-205 | | #3-103 | #3-155 | #4-172 | #4-183 | #5-180 | |
| 41'- 0" | 57 | 532 | 798 | 1085 | 1400 | 10.778 | 420 | 1110 | 1497 | 1915 | 2373 | 6.633 |
| STIR | #3- 73 | #3-152 | #3-175 | #3-195 | #4-208 | | #3-102 | #3-157 | #3-175 | #4-186 | #5-184 | |
| 42'- 0" | 20 | 472 | 725 | 999 | 1299 | 11.869 | 365 | 1023 | 1392 | 1790 | 2227 | 7.304 |
| STIR | #3- 70 | #3-153 | #3-177 | #3-173 | #4-211 | | #3-101 | #3-158 | #3-176 | #4-189 | #5-190 | |
| 43'- 0" | | 416 | 658 | 919 | 1206 | 13.040 | 315 | 942 | 1294 | 1674 | 2090 | 8.025 |
| STIR | | #3-153 | #3-178 | #3-181 | #4-214 | | #3-100 | #3-159 | #3-179 | #4-192 | #5-197 | |
| 44'- 0" | | 364 | 595 | 845 | 1118 | 14.296 | 267 | 866 | 1202 | 1565 | 1963 | 8.798 |
| STIR | | #3-153 | #3-179 | #3-190 | #4-217 | | #3- 98 | #3-161 | #3-155 | #4-194 | #5-203 | |
| 45'- 0" | | 316 | 537 | 775 | 1036 | 15.641 | 223 | 796 | 1117 | 1464 | 1844 | 9.625 |
| STIR | | #3-153 | #3-180 | #3-198 | #4-220 | | #3- 97 | #3-162 | #3-162 | #4-197 | #5-209 | |
| 46'- 0" | | 270 | 482 | 710 | 960 | 17.078 | 181 | 730 | 1037 | 1369 | 1733 | 10.510 |
| STIR | | #3-153 | #3-181 | #3-203 | #4-222 | | #3- 95 | #3-163 | #3-169 | #4-200 | #4-212 | |
| 47'- 0" | | 228 | 430 | 649 | 888 | 18.613 | 143 | 668 | 962 | 1280 | 1629 | 11.454 |
| STIR | | #3-152 | #3-182 | #3-205 | #3-225 | | #3- 93 | #3-164 | #3-177 | #4-203 | #4-214 | |
| 48'- 0" | | 188 | 382 | 592 | 821 | 20.248 | 106 | 610 | 892 | 1197 | 1531 | 12.460 |
| STIR | | #3-152 | #3-183 | #3-207 | #3-228 | | #3- 91 | #3-165 | #3-184 | #4-205 | #4-218 | |
| 49'- 0" | | 150 | 337 | 538 | 758 | 21.989 | 72 | 555 | 826 | 1119 | 1439 | 13.532 |
| STIR | | #3-151 | #3-184 | #3-208 | #3-230 | | #3- 88 | #3-166 | #3-188 | #4-207 | #4-220 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.80 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.24 | 2.02 | 2.40 | 3.03 | 3.72 | | 1.65 | 2.75 | 3.41 | 4.13 | 8.16 | |
| ACTUAL STEEL % | 0.420 | 0.687 | 0.816 | 1.032 | 1.270 | | 0.560 | 0.932 | 1.161 | 1.411 | 2.796 | |
| EFF. DEPTH, IN. | 26.38 | 26.31 | 26.31 | 26.25 | 26.19 | | 26.38 | 26.31 | 26.25 | 26.19 | 26.12 | |
| $-I_{cr}/I_{gr}$ | 0.118 | 0.175 | 0.200 | 0.237 | 0.273 | | 0.150 | 0.221 | 0.258 | 0.294 | 0.458 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | |
| ACTUAL STEEL % | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | |
| EFF. DEPTH, IN. | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | |
| $+I_{cr}/I_{gr}$ | 0.126 | 0.194 | 0.231 | 0.269 | 0.311 | | 0.126 | 0.194 | 0.231 | 0.269 | 0.311 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 53″ Forms + 10″ Ribs @ 63″ c.-c.<br>23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 5 | # 5 | # 6 | # 7 | End Span Defl. Coeff. (2) | # 5 | # 6 | # 7 | # 7 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 9 | 9 | 7 | 9 | 10 | | 10 | 9.5 | 10 | 8.5 | 6 | |
| BOTTOM BARS NO | 1# 5 | 1# 8 | 1# 7 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 7 | 1#10 | 1#10 | |
| BARS NO | 2# 6 | 1# 9 | 2# 8 | 1#10 | 1#11 | | 2# 6 | 1# 9 | 2# 8 | 1#10 | 1#11 | |
| STEEL (PSF) | 0.90 | 1.41 | 1.69 | 2.04 | 2.31 | | 1.38 | 2.13 | 2.62 | 3.17 | 4.03 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 37'- 0" (3) | 363 | 920 | 1290 | 1612 | 1877 | 7.149 | 881 | 1692 | 2229 | 2698 | 3083 | 4.399 |
| STIR | #3- 96 | #3-149 | #3-159 | #4-182 | #4-189 | | #3-113 | #3-133 | #4-165 | #5-173 | #5-178 | |
| 38'- 0" | 304 | 832 | 1183 | 1488 | 1739 | 7.953 | 795 | 1563 | 2073 | 2518 | 2883 | 4.894 |
| STIR | #3- 94 | #3-150 | #3-168 | #4-185 | #4-193 | | #3-113 | #3-140 | #4-167 | #5-176 | #5-182 | |
| 39'- 0" | 249 | 751 | 1083 | 1374 | 1612 | 8.824 | 715 | 1445 | 1929 | 2351 | 2697 | 5.430 |
| STIR | #3- 92 | #3-151 | #3-172 | #4-188 | #4-196 | | #3-113 | #3-148 | #4-170 | #5-179 | #5-185 | |
| 40'- 0" | 198 | 675 | 992 | 1268 | 1494 | 9.765 | 641 | 1335 | 1795 | 2197 | 2526 | 6.009 |
| STIR | #3- 89 | #3-151 | #3-174 | #3-190 | #4-199 | | #3-112 | #3-155 | #4-172 | #4-182 | #5-188 | |
| 41'- 0" | 151 | 605 | 906 | 1169 | 1385 | 10.778 | 573 | 1234 | 1671 | 2053 | 2367 | 6.633 |
| STIR | #3- 87 | #3-152 | #3-175 | #3-168 | #4-202 | | #3-112 | #3-156 | #4-175 | #4-185 | #5-191 | |
| 42'- 0" | 108 | 540 | 827 | 1078 | 1283 | 11.869 | 510 | 1139 | 1556 | 1920 | 2219 | 7.304 |
| STIR | #3- 84 | #3-152 | #3-177 | #3-177 | #4-205 | | #3-111 | #3-158 | #4-177 | #4-187 | #5-194 | |
| 43'- 0" | 67 | 480 | 754 | 992 | 1188 | 13.040 | 451 | 1051 | 1449 | 1796 | 2081 | 8.025 |
| STIR | #3- 81 | #3-152 | #3-178 | #3-185 | #4-207 | | #3-110 | #3-159 | #3-179 | #4-190 | #5-198 | |
| 44'- 0" | 29 | 423 | 685 | 913 | 1100 | 14.296 | 395 | 969 | 1349 | 1681 | 1953 | 8.798 |
| STIR | #3- 77 | #3-153 | #3-180 | #3-194 | #3-210 | | #3-109 | #3-161 | #3-182 | #4-193 | #4-200 | |
| 45'- 0" | | 371 | 621 | 839 | 1018 | 15.641 | 344 | 892 | 1255 | 1573 | 1833 | 9.625 |
| STIR | | #3-152 | #3-181 | #3-199 | #3-212 | | #3-108 | #3-162 | #3-161 | #4-195 | #4-204 | |
| 46'- 0" | | 321 | 561 | 769 | 940 | 17.078 | 296 | 820 | 1168 | 1472 | 1721 | 10.510 |
| STIR | | #3-152 | #3-182 | #3-201 | #3-190 | | #3-107 | #3-163 | #3-168 | #4-199 | #4-206 | |
| 47'- 0" | | 275 | 504 | 704 | 868 | 18.613 | 251 | 753 | 1086 | 1377 | 1616 | 11.454 |
| STIR | | #3-152 | #3-183 | #3-202 | #3-199 | | #3-105 | #3-164 | #3-175 | #4-201 | #4-209 | |
| 48'- 0" | | 232 | 451 | 643 | 800 | 20.248 | 208 | 690 | 1009 | 1288 | 1517 | 12.460 |
| STIR | | #3-151 | #3-184 | #3-204 | #3-207 | | #3-104 | #3-165 | #3-183 | #4-203 | #4-212 | |
| 49'- 0" | | 191 | 402 | 586 | 737 | 21.989 | 169 | 631 | 937 | 1205 | 1424 | 13.532 |
| STIR | | #3-150 | #3-184 | #3-206 | #3-216 | | #3-102 | #3-166 | #3-189 | #4-205 | #4-215 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.82 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.40 | 2.17 | 2.79 | 3.08 | 3.78 | | 1.95 | 2.92 | 3.78 | 4.45 | 6.30 | |
| ACTUAL STEEL % | 0.435 | 0.676 | 0.870 | 0.963 | 1.185 | | 0.609 | 0.912 | 1.185 | 1.394 | 1.975 | |
| EFF. DEPTH, IN. | 26.38 | 26.31 | 26.31 | 26.25 | 26.19 | | 26.31 | 26.25 | 26.19 | 26.19 | 26.19 | |
| $-I_{cr}/I_{gr}$ | 0.124 | 0.176 | 0.213 | 0.229 | 0.265 | | 0.162 | 0.220 | 0.265 | 0.297 | 0.378 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 1.19 | 1.79 | 2.18 | 2.54 | 2.83 | | 1.19 | 1.79 | 2.18 | 2.54 | 2.83 | |
| ACTUAL STEEL % | 0.356 | 0.539 | 0.656 | 0.767 | 0.856 | | 0.356 | 0.539 | 0.656 | 0.767 | 0.856 | |
| EFF. DEPTH, IN. | 26.64 | 26.46 | 26.52 | 26.36 | 26.33 | | 26.64 | 26.46 | 26.52 | 26.36 | 26.33 | |
| $+I_{cr}/I_{gr}$ | 0.135 | 0.194 | 0.233 | 0.265 | 0.291 | | 0.135 | 0.194 | 0.233 | 0.265 | 0.291 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 6″ Ribs @ 72″ c.-c.<br>13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 5 | | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | 10 | | | 10 | 10 | 9.5 | 9.5 | | |
| BOTTOM BARS NO | 1# 4 | 1# 5 | 1# 6 | 1# 6 | | | 1# 4 | 1# 5 | 1# 6 | 1# 6 | | |
| BARS NO | 1# 5 | 1# 6 | 1# 6 | 1# 7 | | | 1# 5 | 1# 6 | 1# 6 | 1# 7 | | |
| STEEL (PSF) | 0.48 | 0.60 | 0.68 | 0.75 | | | 0.72 | 0.84 | 0.94 | 1.30 | | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 119 | 457 | 639 | 861 | | 1.265 | 451 | 942 | 1206 | 1529 | | 0.779 |
| STIR | #3- 73 | #3-102 | #3- 99 | #3-122 | | | #3- 80 | #3-103 | #3-110 | #3-115 | | |
| 25'- 0" | 62 | 373 | 541 | 745 | | 1.490 | 368 | 820 | 1064 | 1362 | | 0.917 |
| STIR | #3- 72 | #3-104 | #3-108 | #3-125 | | | #3- 81 | #3-105 | #3-112 | #3-118 | | |
| 26'- 0" | 11 | 299 | 454 | 643 | | 1.743 | 294 | 712 | 938 | 1213 | | 1.073 |
| STIR | #3- 70 | #3-105 | #3-116 | #3-128 | | | #3- 81 | #3- 94 | #3-114 | #3-122 | | |
| 27'- 0" | | 233 | 376 | 552 | | 2.027 | 228 | 616 | 825 | 1080 | | 1.247 |
| STIR | | #3-106 | #3-118 | #3-131 | | | #3- 81 | #3-101 | #3-118 | #3-124 | | |
| 28'- 0" | | 174 | 307 | 470 | | 2.344 | 169 | 530 | 724 | 962 | | 1.443 |
| STIR | | #3-107 | #3-119 | #3-133 | | | #3- 81 | #3-109 | #3-120 | #3-128 | | |
| 29'- 0" | | 120 | 245 | 397 | | 2.698 | 116 | 453 | 634 | 855 | | 1.660 |
| STIR | | #3-107 | #3-121 | #3-123 | | | #3- 81 | #3-110 | #3-122 | #3-130 | | |
| 30'- 0" | | 72 | 189 | 331 | | 3.090 | 69 | 383 | 552 | 759 | | 1.901 |
| STIR | | #3-108 | #3-122 | #3-131 | | | #3- 80 | #3-112 | #3-107 | #3-133 | | |
| 31'- 0" | | 29 | 138 | 271 | | 3.523 | 26 | 320 | 478 | 672 | | 2.168 |
| STIR | | #3-108 | #3-123 | #3-137 | | | #3- 79 | #3-113 | #3-114 | #3-135 | | |
| 32'- 0" | | | 92 | 217 | | 4.000 | | 263 | 411 | 593 | | 2.461 |
| STIR | | | #3-124 | #3-139 | | | | #3-114 | #3-121 | #3-139 | | |
| 33'- 0" | | | 50 | 168 | | 4.523 | | 210 | 350 | 521 | | 2.784 |
| STIR | | | #3-125 | #3-141 | | | | #3-115 | #3-128 | #3-141 | | |
| 34'- 0" | | | 12 | 122 | | 5.097 | | 163 | 295 | 456 | | 3.137 |
| STIR | | | #3-125 | #3-142 | | | | #3-116 | #3-129 | #3-143 | | |
| 35'- 0" | | | | 81 | | 5.724 | | 119 | 244 | 396 | | 3.522 |
| STIR | | | | #3-143 | | | | #3-117 | #3-131 | #3-145 | | |
| 36'- 0" | | | | 43 | | 6.407 | | 79 | 197 | 341 | | 3.942 |
| STIR | | | | #3-145 | | | | #3-118 | #3-132 | #3-148 | | |
| PROPERTIES FOR DESIGN (CONCRETE 0.56 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.44 | 1.44 | 1.44 | 1.44 | | | 1.44 | 1.44 | 1.52 | 2.35 | | |
| ACTUAL STEEL % | 1.194 | 1.194 | 1.194 | 1.194 | | | 1.194 | 1.194 | 1.257 | 1.957 | | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.38 | | | 16.38 | 16.38 | 16.38 | 16.31 | | |
| $-I_{cr}/I_{gr}$ | 0.197 | 0.197 | 0.197 | 0.197 | | | 0.197 | 0.197 | 0.205 | 0.275 | | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.51 | 0.75 | 0.88 | 1.04 | | | 0.51 | 0.75 | 0.88 | 1.04 | | |
| ACTUAL STEEL % | 0.397 | 0.585 | 0.688 | 0.814 | | | 0.397 | 0.585 | 0.688 | 0.814 | | |
| EFF. DEPTH, IN. | 16.71 | 16.65 | 16.62 | 16.59 | | | 16.71 | 16.65 | 16.62 | 16.59 | | |
| $+I_{cr}/I_{gr}$ | 0.118 | 0.168 | 0.195 | 0.226 | | | 0.118 | 0.168 | 0.195 | 0.226 | | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 7″ Ribs @ 73″ c.-c.<br>13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 4 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | 9.5 | 8 | | 10 | 10 | 8 | 7 | 8 | |
| BOTTOM BARS NO | 1# 4 | 1# 6 | 1# 6 | 1# 7 | 1# 7 | | 1# 4 | 1# 6 | 1# 6 | 1# 7 | 1# 7 | |
| BARS NO | 1# 5 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | | 1# 5 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | |
| STEEL (PSF) | 0.48 | 0.67 | 0.74 | 0.84 | 0.97 | | 0.72 | 0.91 | 1.10 | 1.28 | 2.02 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 96 | 615 | 838 | 1059 | 1320 | 1.265 | 428 | 1183 | 1506 | 1829 | 2209 | 0.779 |
| STIR | #3- 60 | #3-104 | #3-116 | #3-122 | #3-128 | | #3- 72 | #3-104 | #3-110 | #3-116 | #4-120 | |
| 25'- 0" | 39 | 518 | 722 | 927 | 1167 | 1.490 | 345 | 1041 | 1339 | 1636 | 1986 | 0.917 |
| STIR | #3- 58 | #3-106 | #3-104 | #3-125 | #3-132 | | #3- 71 | #3-106 | #3-114 | #3-118 | #4-114 | |
| 26'- 0" | | 431 | 620 | 809 | 1031 | 1.743 | 271 | 915 | 1190 | 1465 | 1788 | 1.073 |
| STIR | | #3-107 | #3-112 | #3-129 | #3-136 | | #3- 71 | #3-109 | #3-116 | #3-121 | #4-117 | |
| 27'- 0" | | 353 | 529 | 704 | 910 | 2.027 | 205 | 802 | 1057 | 1312 | 1612 | 1.247 |
| STIR | | #3-108 | #3-120 | #3-131 | #3-138 | | #3- 70 | #3- 98 | #3-118 | #3-125 | #4-122 | |
| 28'- 0" | | 284 | 447 | 610 | 802 | 2.344 | 146 | 701 | 939 | 1176 | 1455 | 1.443 |
| STIR | | #3-109 | #3-122 | #3-133 | #3-142 | | #3- 69 | #3-105 | #3-122 | #3-128 | #3-127 | |
| 29'- 0" | | 222 | 374 | 526 | 705 | 2.698 | 93 | 611 | 832 | 1053 | 1313 | 1.660 |
| STIR | | #3-110 | #3-124 | #3-121 | #3-145 | | #3- 68 | #3-112 | #3-124 | #3-131 | #3-133 | |
| 30'- 0" | | 166 | 308 | 450 | 617 | 3.090 | 46 | 529 | 736 | 942 | 1185 | 1.901 |
| STIR | | #3-111 | #3-125 | #3-130 | #3-148 | | #3- 66 | #3-114 | #3-126 | #3-134 | #3-139 | |
| 31'- 0" | | 115 | 248 | 381 | 538 | 3.523 | 2 | 455 | 649 | 842 | 1070 | 2.168 |
| STIR | | #3-111 | #3-127 | #3-138 | #3-150 | | #3- 65 | #3-115 | #3-129 | #3-137 | #3-144 | |
| 32'- 0" | | 69 | 194 | 319 | 465 | 4.000 | | 388 | 570 | 751 | 965 | 2.461 |
| STIR | | #3-111 | #3-128 | #3-140 | #3-153 | | | #3-117 | #3-117 | #3-139 | #3-146 | |
| 33'- 0" | | 27 | 145 | 262 | 400 | 4.523 | | 327 | 498 | 669 | 870 | 2.784 |
| STIR | | #3-111 | #3-129 | #3-142 | #3-155 | | | #3-118 | #3-124 | #3-141 | #3-150 | |
| 34'- 0" | | | 99 | 210 | 340 | 5.097 | | 272 | 433 | 593 | 783 | 3.137 |
| STIR | | | #3-129 | #3-143 | #3-144 | | | #3-119 | #3-132 | #3-144 | #3-153 | |
| 35'- 0" | | | 58 | 162 | 285 | 5.724 | | 221 | 373 | 524 | 703 | 3.522 |
| STIR | | | #3-130 | #3-145 | #3-153 | | | #3-120 | #3-134 | #3-145 | #3-155 | |
| 36'- 0" | | | 20 | 119 | 235 | 6.407 | | 174 | 317 | 461 | 630 | 3.942 |
| STIR | | | #3-130 | #3-146 | #3-160 | | | #3-121 | #3-135 | #3-147 | #3-157 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.46 | 1.46 | 1.46 | 1.54 | 1.83 | | 1.46 | 1.46 | 1.83 | 2.09 | 4.01 | |
| ACTUAL STEEL % | 1.066 | 1.066 | 1.066 | 1.122 | 1.332 | | 1.066 | 1.066 | 1.332 | 1.523 | 2.958 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.38 | 16.38 | | 16.38 | 16.38 | 16.38 | 16.38 | 16.25 | |
| $-I_{cr}/I_{gr}$ | 0.186 | 0.186 | 0.186 | 0.193 | 0.219 | | 0.186 | 0.186 | 0.219 | 0.240 | 0.362 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.88 | 1.04 | 1.20 | 1.39 | | 0.51 | 0.88 | 1.04 | 1.20 | 1.39 | |
| ACTUAL STEEL % | 0.351 | 0.609 | 0.721 | 0.832 | 0.966 | | 0.351 | 0.609 | 0.721 | 0.832 | 0.966 | |
| EFF. DEPTH, IN. | 16.71 | 16.62 | 16.59 | 16.56 | 16.53 | | 16.71 | 16.62 | 16.59 | 16.56 | 16.53 | |
| $+I_{cr}/I_{gr}$ | 0.106 | 0.175 | 0.203 | 0.231 | 0.263 | | 0.106 | 0.175 | 0.203 | 0.231 | 0.263 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 8″ Ribs @ 74″ c.-c.<br>13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 4 | # 4 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | 10 | 8.5 | | 10 | 10 | 8.5 | 7 | 5 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 1# 6 | 1# 5 | 1# 7 | | 2# 4 | 1# 6 | 1# 6 | 1# 5 | 1# 7 | |
| BARS NO | 1# 4 | 1# 6 | 1# 7 | 2# 6 | 1# 8 | | 1# 4 | 1# 6 | 1# 7 | 2# 6 | 1# 8 | |
| STEEL (PSF) | 0.51 | 0.67 | 0.73 | 0.77 | 0.94 | | 0.75 | 0.91 | 1.06 | 1.22 | 1.62 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 203 | 592 | 815 | 1030 | 1298 | 1.265 | 594 | 1160 | 1484 | 1797 | 2186 | 0.779 |
| STIR | #3- 65 | #3- 97 | #3-107 | #3-117 | #3-124 | | #3- 75 | #3- 87 | #3-106 | #3-112 | #4-116 | |
| 25'- 0" | 136 | 495 | 699 | 898 | 1144 | 1.490 | 496 | 1018 | 1316 | 1605 | 1963 | 0.917 |
| STIR | #3- 63 | #3- 98 | #3-109 | #3-119 | #3-127 | | #3- 75 | #3- 94 | #3-109 | #3-114 | #4-120 | |
| 26'- 0" | 76 | 408 | 597 | 781 | 1008 | 1.743 | 409 | 892 | 1167 | 1434 | 1765 | 1.073 |
| STIR | #3- 61 | #3- 98 | #3-111 | #3-110 | #3-130 | | #3- 75 | #3-101 | #3-112 | #3-118 | #4-122 | |
| 27'- 0" | 23 | 330 | 506 | 676 | 887 | 2.027 | 331 | 779 | 1034 | 1282 | 1589 | 1.247 |
| STIR | #3- 59 | #3- 99 | #3-112 | #3-118 | #3-133 | | #3- 75 | #3-102 | #3-113 | #3-120 | #3-127 | |
| 28'- 0" | | 261 | 424 | 583 | 779 | 2.344 | 262 | 678 | 916 | 1146 | 1432 | 1.443 |
| STIR | | #3- 99 | #3-114 | #3-124 | #3-136 | | #3- 74 | #3-104 | #3-100 | #3-123 | #3-129 | |
| 29'- 0" | | 199 | 351 | 499 | 682 | 2.698 | 200 | 588 | 809 | 1024 | 1290 | 1.660 |
| STIR | | #3- 99 | #3-115 | #3-126 | #3-138 | | #3- 73 | #3-105 | #3-108 | #3-125 | #3-132 | |
| 30'- 0" | | 143 | 285 | 423 | 594 | 3.090 | 144 | 506 | 713 | 914 | 1163 | 1.901 |
| STIR | | #3- 99 | #3-115 | #3-127 | #3-126 | | #3- 72 | #3-106 | #3-115 | #3-127 | #3-135 | |
| 31'- 0" | | 92 | 225 | 354 | 515 | 3.523 | 93 | 432 | 626 | 814 | 1047 | 2.168 |
| STIR | | #3- 98 | #3-116 | #3-129 | #3-134 | | #3- 71 | #3-107 | #3-119 | #3-130 | #3-138 | |
| 32'- 0" | | 46 | 171 | 292 | 442 | 4.000 | 47 | 365 | 547 | 724 | 942 | 2.461 |
| STIR | | #3- 98 | #3-116 | #3-130 | #3-142 | | #3- 69 | #3-108 | #3-121 | #3-132 | #3-141 | |
| 33'- 0" | | 4 | 121 | 236 | 377 | 4.523 | 5 | 304 | 475 | 641 | 847 | 2.784 |
| STIR | | #3- 97 | #3-117 | #3-131 | #3-144 | | #3- 67 | #3-108 | #3-122 | #3-121 | #3-143 | |
| 34'- 0" | | | 76 | 184 | 317 | 5.097 | | 249 | 410 | 566 | 760 | 3.137 |
| STIR | | | #3-117 | #3-132 | #3-146 | | | #3-109 | #3-123 | #3-129 | #3-145 | |
| 35'- 0" | | | 35 | 137 | 262 | 5.724 | | 198 | 350 | 497 | 680 | 3.522 |
| STIR | | | #3-116 | #3-133 | #3-148 | | | #3-109 | #3-124 | #3-135 | #3-148 | |
| 36'- 0" | | | | 93 | 212 | 6.407 | | 151 | 294 | 434 | 607 | 3.942 |
| STIR | | | | #3-133 | #3-149 | | | #3-109 | #3-125 | #3-137 | #3-150 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.59 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.48 | 1.48 | 1.48 | 1.48 | 1.74 | | 1.48 | 1.48 | 1.74 | 2.11 | 2.96 | |
| ACTUAL STEEL % | 0.965 | 0.965 | 0.965 | 0.965 | 1.135 | | 0.965 | 0.965 | 1.135 | 1.379 | 1.930 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.38 | 16.38 | | 16.38 | 16.38 | 16.38 | 16.38 | 16.38 | |
| $-I_{cr}/I_{gr}$ | 0.177 | 0.177 | 0.177 | 0.177 | 0.199 | | 0.177 | 0.177 | 0.199 | 0.229 | 0.289 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 0.88 | 1.04 | 1.19 | 1.39 | | 0.60 | 0.88 | 1.04 | 1.19 | 1.39 | |
| ACTUAL STEEL % | 0.370 | 0.546 | 0.646 | 0.737 | 0.867 | | 0.370 | 0.546 | 0.646 | 0.737 | 0.867 | |
| EFF. DEPTH, IN. | 16.75 | 16.62 | 16.59 | 16.64 | 16.53 | | 16.75 | 16.62 | 16.59 | 16.64 | 16.53 | |
| $+I_{cr}/I_{gr}$ | 0.113 | 0.159 | 0.185 | 0.211 | 0.240 | | 0.113 | 0.159 | 0.185 | 0.211 | 0.240 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 9″ Ribs @ 75″ c.-c.<br>13″ Deep Rib + 5.5″ Top Slab = 18.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | 9 | 7.5 | | 10 | 9 | 7.5 | 10 | 7.5 | |
| BOTTOM BARS NO | 2# 4 | 2# 4 | 1# 5 | 2# 6 | 1# 8 | | 2# 4 | 2# 4 | 1# 5 | 2# 6 | 1# 8 | |
| BARS NO | 1# 4 | 2# 5 | 2# 6 | 1# 6 | 1# 8 | | 1# 4 | 2# 5 | 2# 6 | 1# 6 | 1# 8 | |
| STEEL (PSF) | 0.51 | 0.70 | 0.77 | 0.87 | 1.07 | | 0.75 | 1.00 | 1.17 | 1.35 | 2.19 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 24'- 0" (3) | 180 | 774 | 1008 | 1188 | 1535 | 1.265 | 571 | 1436 | 1775 | 2038 | 2542 | 0.779 |
| STIR | #3- 54 | #3-100 | #3-103 | #3-117 | #3-125 | | #3- 68 | #3-102 | #3-107 | #3-111 | #4-111 | |
| 25'- 0" | 113 | 660 | 875 | 1042 | 1362 | 1.490 | 473 | 1270 | 1582 | 1824 | 2289 | 0.917 |
| STIR | #3- 52 | #3-101 | #3-111 | #3-119 | #3-129 | | #3- 67 | #3- 90 | #3-110 | #3-115 | #4-115 | |
| 26'- 0" | 53 | 559 | 758 | 912 | 1207 | 1.743 | 386 | 1123 | 1411 | 1636 | 2065 | 1.073 |
| STIR | #3- 49 | #3-102 | #3-113 | #3-110 | #3-132 | | #3- 66 | #3- 97 | #3-113 | #3-117 | #4-119 | |
| 27'- 0" | | 469 | 653 | 796 | 1070 | 2.027 | 308 | 992 | 1259 | 1467 | 1866 | 1.247 |
| STIR | | #3-103 | #3-115 | #3-118 | #3-134 | | #3- 65 | #3-104 | #3-115 | #3-120 | #4-125 | |
| 28'- 0" | | 389 | 560 | 693 | 947 | 2.344 | 239 | 874 | 1123 | 1317 | 1687 | 1.443 |
| STIR | | #3-104 | #3-116 | #3-124 | #3-137 | | #3- 64 | #3-107 | #3-118 | #3-123 | #4-130 | |
| 29'- 0" | | 316 | 476 | 600 | 837 | 2.698 | 177 | 769 | 1001 | 1181 | 1527 | 1.660 |
| STIR | | #3-104 | #3-118 | #3-126 | #3-139 | | #3- 62 | #3-108 | #3-104 | #3-125 | #3-134 | |
| 30'- 0" | | 251 | 400 | 516 | 738 | 3.090 | 121 | 674 | 891 | 1059 | 1382 | 1.901 |
| STIR | | #3-104 | #3-119 | #3-127 | #3-142 | | #3- 60 | #3-110 | #3-111 | #3-128 | #3-136 | |
| 31'- 0" | | 192 | 331 | 440 | 648 | 3.523 | 70 | 588 | 791 | 949 | 1251 | 2.168 |
| STIR | | #3-104 | #3-119 | #3-129 | #3-131 | | #3- 58 | #3-111 | #3-119 | #3-130 | #3-140 | |
| 32'- 0" | | 138 | 269 | 371 | 566 | 4.000 | 24 | 510 | 701 | 849 | 1132 | 2.461 |
| STIR | | #3-104 | #3-120 | #3-130 | #3-140 | | #3- 56 | #3-112 | #3-123 | #3-132 | #3-143 | |
| 33'- 0" | | 89 | 213 | 308 | 492 | 4.523 | | 439 | 618 | 757 | 1024 | 2.784 |
| STIR | | #3-103 | #3-121 | #3-131 | #3-146 | | | #3-113 | #3-125 | #3-121 | #3-145 | |
| 34'- 0" | | 45 | 161 | 251 | 424 | 5.097 | | 374 | 543 | 674 | 925 | 3.137 |
| STIR | | #3-102 | #3-121 | #3-132 | #3-148 | | | #3-113 | #3-126 | #3-128 | #3-148 | |
| 35'- 0" | | 4 | 113 | 198 | 362 | 5.724 | | 315 | 474 | 598 | 835 | 3.522 |
| STIR | | #3-101 | #3-121 | #3-133 | #3-150 | | | #3-114 | #3-127 | #3-136 | #3-150 | |
| 36'- 0" | | | 70 | 150 | 305 | 6.407 | | 260 | 411 | 528 | 752 | 3.942 |
| STIR | | | #3-121 | #3-133 | #3-151 | | | #3-114 | #3-128 | #3-137 | #3-152 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.50 | 1.50 | 1.50 | 1.67 | 2.00 | | 1.50 | 1.67 | 2.00 | 2.33 | 4.40 | |
| ACTUAL STEEL % | 0.884 | 0.884 | 0.884 | 0.982 | 1.178 | | 0.884 | 0.982 | 1.178 | 1.376 | 2.615 | |
| EFF. DEPTH, IN. | 16.38 | 16.38 | 16.38 | 16.38 | 16.38 | | 16.38 | 16.38 | 16.38 | 16.31 | 16.25 | |
| $-I_{cr}/I_{gr}$ | 0.169 | 0.169 | 0.169 | 0.183 | 0.209 | | 0.169 | 0.183 | 0.209 | 0.231 | 0.351 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 1.02 | 1.19 | 1.32 | 1.58 | | 0.60 | 1.02 | 1.19 | 1.32 | 1.58 | |
| ACTUAL STEEL % | 0.335 | 0.571 | 0.669 | 0.742 | 0.894 | | 0.335 | 0.571 | 0.669 | 0.742 | 0.894 | |
| EFF. DEPTH, IN. | 16.75 | 16.71 | 16.64 | 16.62 | 16.50 | | 16.75 | 16.71 | 16.64 | 16.62 | 16.50 | |
| $+I_{cr}/I_{gr}$ | 0.104 | 0.170 | 0.194 | 0.213 | 0.247 | | 0.104 | 0.170 | 0.194 | 0.213 | 0.247 | |
| SINGLE LEG STIRRUP AT 7 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 6″ Ribs @ 72″ c.-c.<br>15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | | | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | | | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | | | | 10 | 9.5 | 8 | | | |
| BOTTOM BARS NO | 1# 4 | 1# 6 | 1# 6 | | | | 1# 4 | 1# 6 | 1# 6 | | | |
| BARS NO | 1# 5 | 1# 6 | 1# 7 | | | | 1# 5 | 1# 6 | 1# 7 | | | |
| STEEL (PSF) | 0.48 | 0.68 | 0.75 | | | | 0.72 | 0.94 | 1.11 | | | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 65 | 562 | 774 | | | 1.743 | 382 | 1104 | 1414 | | | 1.073 |
| STIR | #3- 67 | #3-114 | #3-126 | | | | #3- 79 | #3-113 | #3-121 | | | |
| 27'- 0" | 14 | 475 | 672 | | | 2.027 | 308 | 978 | 1265 | | | 1.247 |
| STIR | #3- 65 | #3-116 | #3-129 | | | | #3- 79 | #3-117 | #3-123 | | | |
| 28'- 0" | | 397 | 581 | | | 2.344 | 242 | 865 | 1132 | | | 1.443 |
| STIR | | #3-118 | #3-117 | | | | #3- 79 | #3-118 | #3-126 | | | |
| 29'- 0" | | 328 | 499 | | | 2.698 | 183 | 764 | 1012 | | | 1.660 |
| STIR | | #3-119 | #3-126 | | | | #3- 78 | #3-102 | #3-129 | | | |
| 30'- 0" | | 265 | 425 | | | 3.090 | 129 | 672 | 905 | | | 1.901 |
| STIR | | #3-120 | #3-133 | | | | #3- 78 | #3-109 | #3-132 | | | |
| 31'- 0" | | 208 | 358 | | | 3.523 | 81 | 589 | 807 | | | 2.168 |
| STIR | | #3-121 | #3-135 | | | | #3- 77 | #3-116 | #3-134 | | | |
| 32'- 0" | | 156 | 297 | | | 4.000 | 37 | 514 | 719 | | | 2.461 |
| STIR | | #3-122 | #3-137 | | | | #3- 75 | #3-124 | #3-136 | | | |
| 33'- 0" | | 109 | 241 | | | 4.523 | | 446 | 638 | | | 2.784 |
| STIR | | #3-122 | #3-139 | | | | | #3-126 | #3-139 | | | |
| 34'- 0" | | 66 | 191 | | | 5.097 | | 383 | 564 | | | 3.137 |
| STIR | | #3-123 | #3-140 | | | | | #3-127 | #3-141 | | | |
| 35'- 0" | | 27 | 144 | | | 5.724 | | 326 | 497 | | | 3.522 |
| STIR | | #3-123 | #3-141 | | | | | #3-129 | #3-126 | | | |
| 36'- 0" | | | 102 | | | 6.407 | | 274 | 435 | | | 3.942 |
| STIR | | | #3-142 | | | | | #3-130 | #3-133 | | | |
| 37'- 0" | | | 63 | | | 7.149 | | 226 | 378 | | | 4.399 |
| STIR | | | #3-143 | | | | | #3-131 | #3-141 | | | |
| 38'- 0" | | | 27 | | | 7.953 | | 181 | 326 | | | 4.894 |
| STIR | | | #3-144 | | | | | #3-132 | #3-147 | | | |
| PROPERTIES FOR DESIGN (CONCRETE 0.58 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.44 | 1.44 | 1.44 | | | | 1.44 | 1.52 | 1.80 | | | |
| ACTUAL STEEL % | 1.041 | 1.041 | 1.041 | | | | 1.041 | 1.095 | 1.301 | | | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | | | | 18.38 | 18.38 | 18.38 | | | |
| $-I_{cr}/I_{gr}$ | 0.188 | 0.188 | 0.188 | | | | 0.188 | 0.195 | 0.221 | | | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.51 | 0.88 | 1.04 | | | | 0.51 | 0.88 | 1.04 | | | |
| ACTUAL STEEL % | 0.347 | 0.601 | 0.711 | | | | 0.347 | 0.601 | 0.711 | | | |
| EFF. DEPTH, IN. | 18.71 | 18.62 | 18.59 | | | | 18.71 | 18.62 | 18.59 | | | |
| $+I_{cr}/I_{gr}$ | 0.109 | 0.180 | 0.210 | | | | 0.109 | 0.180 | 0.210 | | | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 7″ Ribs @ 73″ c.-c.<br>15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 4 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 9.5 | 8 | 7 | | 10 | 10 | 7 | 4 | 7 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | | 2# 4 | 1# 6 | 1# 7 | 1# 7 | 1# 8 | |
| BARS NO | 1# 4 | 1# 6 | 1# 7 | 1# 8 | 1# 8 | | 1# 4 | 1# 6 | 1# 7 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.52 | 0.67 | 0.84 | 0.97 | 1.11 | | 0.76 | 0.91 | 1.28 | 1.87 | 2.31 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 164 | 536 | 961 | 1212 | 1461 | 1.743 | 537 | 1079 | 1697 | 2061 | 2424 | 1.073 |
| STIR | #3- 72 | #3-106 | #3-128 | #3-134 | #3-140 | | #3- 82 | #3- 93 | #3-121 | #4-124 | #4-130 | |
| 27'- 0" | 104 | 449 | 844 | 1076 | 1307 | 2.027 | 450 | 952 | 1526 | 1863 | 2200 | 1.247 |
| STIR | #3- 70 | #3-107 | #3-130 | #3-138 | #3-144 | | #3- 82 | #3-100 | #3-124 | #4-127 | #4-124 | |
| 28'- 0" | 50 | 372 | 738 | 954 | 1169 | 2.344 | 372 | 840 | 1373 | 1687 | 2000 | 1.443 |
| STIR | #3- 68 | #3-108 | #3-115 | #3-141 | #3-147 | | #3- 82 | #3-108 | #3-127 | #4-130 | #4-127 | |
| 29'- 0" | 3 | 302 | 644 | 845 | 1046 | 2.698 | 302 | 738 | 1235 | 1528 | 1820 | 1.660 |
| STIR | #3- 66 | #3-108 | #3-124 | #3-143 | #3-151 | | #3- 82 | #3-111 | #3-130 | #3-136 | #4-130 | |
| 30'- 0" | | 239 | 558 | 746 | 934 | 3.090 | 239 | 647 | 1111 | 1384 | 1657 | 1.901 |
| STIR | | #3-109 | #3-132 | #3-147 | #3-154 | | #3- 82 | #3-113 | #3-132 | #3-139 | #4-134 | |
| 31'- 0" | | 182 | 481 | 657 | 833 | 3.523 | 183 | 564 | 999 | 1255 | 1510 | 2.168 |
| STIR | | #3-109 | #3-137 | #3-149 | #3-157 | | #3- 81 | #3-114 | #3-135 | #3-142 | #4-141 | |
| 32'- 0" | | 131 | 411 | 577 | 741 | 4.000 | 131 | 489 | 897 | 1137 | 1377 | 2.461 |
| STIR | | #3-109 | #3-138 | #3-151 | #3-160 | | #3- 80 | #3-115 | #3-138 | #3-145 | #4-147 | |
| 33'- 0" | | 84 | 348 | 503 | 658 | 4.523 | 84 | 420 | 804 | 1030 | 1256 | 2.784 |
| STIR | | #3-108 | #3-140 | #3-139 | #3-162 | | #3- 79 | #3-116 | #3-140 | #3-149 | #4-153 | |
| 34'- 0" | | 41 | 289 | 436 | 582 | 5.097 | 41 | 358 | 719 | 932 | 1145 | 3.137 |
| STIR | | #3-108 | #3-141 | #3-147 | #3-166 | | #3- 77 | #3-117 | #3-142 | #3-150 | #3-158 | |
| 35'- 0" | | 1 | 236 | 374 | 512 | 5.724 | 2 | 301 | 642 | 843 | 1043 | 3.522 |
| STIR | | #3-107 | #3-143 | #3-156 | #3-169 | | #3- 76 | #3-118 | #3-144 | #3-153 | #3-161 | |
| 36'- 0" | | | 187 | 318 | 448 | 6.407 | | 248 | 571 | 761 | 950 | 3.942 |
| STIR | | | #3-144 | #3-158 | #3-170 | | | #3-119 | #3-131 | #3-157 | #3-164 | |
| 37'- 0" | | | 142 | 266 | 389 | 7.149 | | 200 | 505 | 685 | 864 | 4.399 |
| STIR | | | #3-145 | #3-160 | #3-154 | | | #3-119 | #3-138 | #3-159 | #3-167 | |
| 38'- 0" | | | 101 | 218 | 335 | 7.953 | | 156 | 445 | 615 | 785 | 4.894 |
| STIR | | | #3-146 | #3-161 | #3-162 | | | #3-119 | #3-146 | #3-160 | #3-170 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.60 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.46 | 1.46 | 1.54 | 1.83 | 2.09 | | 1.46 | 1.46 | 2.09 | 3.65 | 4.59 | |
| ACTUAL STEEL % | 0.931 | 0.931 | 0.980 | 1.164 | 1.330 | | 0.931 | 0.931 | 1.330 | 2.328 | 2.951 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.38 | 18.38 | | 18.38 | 18.38 | 18.38 | 18.38 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.177 | 0.177 | 0.183 | 0.208 | 0.229 | | 0.177 | 0.177 | 0.229 | 0.335 | 0.380 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.60 | 0.88 | 1.20 | 1.39 | 1.58 | | 0.60 | 0.88 | 1.20 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.361 | 0.533 | 0.729 | 0.846 | 0.962 | | 0.361 | 0.533 | 0.729 | 0.846 | 0.962 | |
| EFF. DEPTH, IN. | 18.75 | 18.62 | 18.56 | 18.53 | 18.50 | | 18.75 | 18.62 | 18.56 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.114 | 0.162 | 0.214 | 0.244 | 0.274 | | 0.114 | 0.162 | 0.214 | 0.244 | 0.274 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 8″ Ribs @ 74″ c.-c.<br>15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 4 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 4 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 10 | 8.5 | 7.5 | | 10 | 8.5 | 7.5 | 9.5 | 7.5 | |
| BOTTOM BARS NO | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | | 1# 5 | 1# 6 | 1# 5 | 1# 7 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | | 1# 5 | 1# 7 | 2# 6 | 1# 8 | 1# 8 | |
| STEEL (PSF) | 0.54 | 0.73 | 0.77 | 0.94 | 1.08 | | 0.78 | 1.06 | 1.18 | 1.45 | 2.20 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 162 | 723 | 929 | 1186 | 1436 | 1.743 | 546 | 1363 | 1662 | 2036 | 2399 | 1.073 |
| STIR | #3- 63 | #3-110 | #3-112 | #3-129 | #3-135 | | #3- 76 | #3-110 | #3-116 | #4-122 | #4-122 | |
| 27'- 0" | 101 | 621 | 812 | 1050 | 1282 | 2.027 | 457 | 1214 | 1492 | 1838 | 2175 | 1.247 |
| STIR | #3- 60 | #3-111 | #3-120 | #3-132 | #3-139 | | #3- 76 | #3- 95 | #3-119 | #4-125 | #4-126 | |
| 28'- 0" | 46 | 530 | 707 | 929 | 1144 | 2.344 | 377 | 1081 | 1339 | 1661 | 1974 | 1.443 |
| STIR | #3- 57 | #3-112 | #3-123 | #3-135 | #3-142 | | #3- 75 | #3-102 | #3-121 | #3-129 | #4-129 | |
| 29'- 0" | | 448 | 613 | 820 | 1020 | 2.698 | 305 | 961 | 1202 | 1502 | 1794 | 1.660 |
| STIR | | #3-113 | #3-124 | #3-120 | #3-145 | | #3- 74 | #3-110 | #3-124 | #3-131 | #4-134 | |
| 30'- 0" | | 374 | 528 | 721 | 909 | 3.090 | 241 | 854 | 1078 | 1359 | 1632 | 1.901 |
| STIR | | #3-114 | #3-126 | #3-128 | #3-147 | | #3- 73 | #3-116 | #3-126 | #3-134 | #4-140 | |
| 31'- 0" | | 306 | 451 | 632 | 808 | 3.523 | 182 | 756 | 967 | 1229 | 1485 | 2.168 |
| STIR | | #3-114 | #3-127 | #3-137 | #3-150 | | #3- 72 | #3-118 | #3-109 | #3-137 | #4-144 | |
| 32'- 0" | | 246 | 381 | 551 | 716 | 4.000 | 129 | 668 | 865 | 1112 | 1352 | 2.461 |
| STIR | | #3-114 | #3-128 | #3-141 | #3-153 | | #3- 70 | #3-119 | #3-116 | #3-140 | #3-146 | |
| 33'- 0" | | 190 | 318 | 477 | 632 | 4.523 | 80 | 587 | 773 | 1005 | 1230 | 2.784 |
| STIR | | #3-115 | #3-129 | #3-143 | #3-137 | | #3- 68 | #3-121 | #3-124 | #3-142 | #3-150 | |
| 34'- 0" | | 140 | 260 | 410 | 556 | 5.097 | 36 | 513 | 688 | 907 | 1119 | 3.137 |
| STIR | | #3-114 | #3-130 | #3-144 | #3-145 | | #3- 66 | #3-122 | #3-131 | #3-145 | #3-152 | |
| 35'- 0" | | 93 | 207 | 349 | 486 | 5.724 | | 446 | 611 | 817 | 1018 | 3.522 |
| STIR | | #3-114 | #3-131 | #3-146 | #3-154 | | | #3-123 | #3-134 | #3-146 | #3-155 | |
| 36'- 0" | | 51 | 158 | 292 | 422 | 6.407 | | 384 | 540 | 735 | 925 | 3.942 |
| STIR | | #3-114 | #3-131 | #3-147 | #3-159 | | | #3-124 | #3-136 | #3-149 | #3-157 | |
| 37'- 0" | | 12 | 113 | 240 | 363 | 7.149 | | 327 | 475 | 660 | 839 | 4.399 |
| STIR | | #3-113 | #3-131 | #3-148 | #3-161 | | | #3-124 | #3-137 | #3-133 | #3-160 | |
| 38'- 0" | | | 72 | 192 | 309 | 7.953 | | 275 | 415 | 590 | 760 | 4.894 |
| STIR | | | #3-131 | #3-149 | #3-163 | | | #3-125 | #3-138 | #3-141 | #3-163 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.61 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.48 | 1.48 | 1.48 | 1.74 | 1.97 | | 1.48 | 1.74 | 1.97 | 2.41 | 4.34 | |
| ACTUAL STEEL % | 0.845 | 0.845 | 0.845 | 0.994 | 1.127 | | 0.845 | 0.994 | 1.127 | 1.384 | 2.499 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.38 | 18.38 | | 18.38 | 18.38 | 18.38 | 18.31 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.167 | 0.167 | 0.167 | 0.189 | 0.208 | | 0.167 | 0.189 | 0.208 | 0.238 | 0.351 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | | 0.62 | 1.04 | 1.19 | 1.39 | 1.58 | |
| ACTUAL STEEL % | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | | 0.337 | 0.567 | 0.647 | 0.760 | 0.865 | |
| EFF. DEPTH, IN. | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | | 18.69 | 18.59 | 18.64 | 18.53 | 18.50 | |
| $+I_{cr}/I_{gr}$ | 0.107 | 0.171 | 0.195 | 0.222 | 0.249 | | 0.107 | 0.171 | 0.195 | 0.222 | 0.249 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 9″ Ribs @ 75″ c.-c.<br>15″ Deep Rib + 5.5″ Top Slab = 20.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 9 | 7.5 | 10 | | 10 | 7.5 | 10 | 8.5 | 6.5 | |
| BOTTOM BARS NO | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | | 2# 4 | 1# 5 | 2# 6 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | | 1# 5 | 2# 6 | 1# 6 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.57 | 0.77 | 0.87 | 1.07 | 1.21 | | 0.81 | 1.17 | 1.35 | 1.63 | 2.50 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 26'- 0" (3) | 261 | 904 | 1077 | 1411 | 1684 | 1.743 | 701 | 1637 | 1888 | 2374 | 2772 | 1.073 |
| STIR | #3- 67 | #3-112 | #3-111 | #3-130 | #4-136 | | #3- 79 | #3-112 | #3-117 | #4-124 | #4-121 | |
| 27'- 0" | 190 | 787 | 947 | 1256 | 1510 | 2.027 | 599 | 1466 | 1700 | 2150 | 2519 | 1.247 |
| STIR | #3- 65 | #3-114 | #3-120 | #3-133 | #3-140 | | #3- 79 | #3-115 | #3-120 | #4-127 | #4-125 | |
| 28'- 0" | 127 | 682 | 831 | 1119 | 1355 | 2.344 | 507 | 1314 | 1531 | 1949 | 2292 | 1.443 |
| STIR | #3- 62 | #3-115 | #3-123 | #3-136 | #3-143 | | #3- 78 | #3- 98 | #3-122 | #4-130 | #4-127 | |
| 29'- 0" | 71 | 588 | 727 | 995 | 1215 | 2.698 | 425 | 1177 | 1379 | 1769 | 2089 | 1.660 |
| STIR | #3- 60 | #3-116 | #3-124 | #3-139 | #3-146 | | #3- 78 | #3-106 | #3-124 | #4-132 | #4-133 | |
| 30'- 0" | 20 | 503 | 633 | 883 | 1089 | 3.090 | 350 | 1053 | 1242 | 1607 | 1906 | 1.901 |
| STIR | #3- 57 | #3-117 | #3-126 | #3-125 | #3-149 | | #3- 77 | #3-113 | #3-127 | #3-136 | #4-139 | |
| 31'- 0" | | 426 | 547 | 782 | 975 | 3.523 | 283 | 941 | 1118 | 1460 | 1740 | 2.168 |
| STIR | | #3-118 | #3-127 | #3-133 | #3-152 | | #3- 76 | #3-120 | #3-128 | #3-139 | #4-144 | |
| 32'- 0" | | 356 | 470 | 690 | 871 | 4.000 | 222 | 840 | 1006 | 1326 | 1589 | 2.461 |
| STIR | | #3-118 | #3-128 | #3-142 | #3-154 | | #3- 75 | #3-122 | #3-116 | #3-142 | #4-147 | |
| 33'- 0" | | 292 | 400 | 607 | 777 | 4.523 | 167 | 747 | 904 | 1205 | 1452 | 2.784 |
| STIR | | #3-119 | #3-129 | #3-145 | #3-157 | | #3- 73 | #3-123 | #3-123 | #3-144 | #4-151 | |
| 34'- 0" | | 234 | 336 | 531 | 691 | 5.097 | 116 | 663 | 810 | 1094 | 1327 | 3.137 |
| STIR | | #3-119 | #3-130 | #3-147 | #3-141 | | #3- 71 | #3-125 | #3-130 | #3-146 | #4-153 | |
| 35'- 0" | | 181 | 277 | 461 | 612 | 5.724 | 70 | 586 | 725 | 992 | 1212 | 3.522 |
| STIR | | #3-119 | #3-131 | #3-148 | #3-150 | | #3- 69 | #3-126 | #3-134 | #3-148 | #3-156 | |
| 36'- 0" | | 133 | 223 | 397 | 540 | 6.407 | 27 | 515 | 646 | 899 | 1107 | 3.942 |
| STIR | | #3-118 | #3-131 | #3-150 | #3-158 | | #3- 67 | #3-127 | #3-136 | #3-151 | #3-159 | |
| 37'- 0" | | 88 | 173 | 338 | 473 | 7.149 | | 450 | 574 | 814 | 1010 | 4.399 |
| STIR | | #3-118 | #3-131 | #3-151 | #3-163 | | | #3-128 | #3-137 | #3-153 | #3-162 | |
| 38'- 0" | | 46 | 127 | 284 | 412 | 7.953 | | 389 | 507 | 734 | 921 | 4.894 |
| STIR | | #3-117 | #3-131 | #3-152 | #3-165 | | | #3-129 | #3-139 | #3-137 | #3-164 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.50 | 1.50 | 1.67 | 2.00 | 2.33 | | 1.50 | 2.00 | 2.33 | 2.74 | 5.08 | |
| ACTUAL STEEL % | 0.775 | 0.775 | 0.861 | 1.034 | 1.206 | | 0.775 | 1.034 | 1.206 | 1.419 | 2.644 | |
| EFF. DEPTH, IN. | 18.38 | 18.38 | 18.38 | 18.38 | 18.31 | | 18.38 | 18.38 | 18.31 | 18.31 | 18.25 | |
| $-I_{cr}/I_{gr}$ | 0.160 | 0.160 | 0.173 | 0.199 | 0.220 | | 0.160 | 0.199 | 0.220 | 0.248 | 0.371 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | | 0.71 | 1.19 | 1.32 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | | 0.349 | 0.588 | 0.652 | 0.785 | 0.891 | |
| EFF. DEPTH, IN. | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | | 18.72 | 18.64 | 18.62 | 18.50 | 18.46 | |
| $+I_{cr}/I_{gr}$ | 0.112 | 0.180 | 0.197 | 0.230 | 0.256 | | 0.112 | 0.180 | 0.197 | 0.230 | 0.256 | |
| SINGLE LEG STIRRUP AT 8 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 6″ Ribs @ 72″ c.-c.<br>19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | | | | End Span Defl. Coeff. (2) | # 4 | # 4 | | | | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | | | | | 10 | 8 | | | | |
| BOTTOM BARS NO | 1# 5 | 1# 6 | | | | | 1# 5 | 1# 6 | | | | |
| BARS NO | 1# 5 | 1# 7 | | | | | 1# 5 | 1# 7 | | | | |
| STEEL (PSF) | 0.54 | 0.75 | | | | | 0.79 | 1.11 | | | | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 28'- 0" (3) | 210 | 799 | | | | 2.344 | 612 | 1470 | | | | 1.443 |
| STIR | #3- 81 | #3-122 | | | | | #3- 91 | #3-124 | | | | |
| 29'- 0" | 150 | 699 | | | | 2.698 | 525 | 1324 | | | | 1.660 |
| STIR | #3- 80 | #3-128 | | | | | #3- 92 | #3-127 | | | | |
| 30'- 0" | 95 | 609 | | | | 3.090 | 446 | 1193 | | | | 1.901 |
| STIR | #3- 78 | #3-130 | | | | | #3- 92 | #3-130 | | | | |
| 31'- 0" | 47 | 528 | | | | 3.523 | 375 | 1075 | | | | 2.168 |
| STIR | #3- 76 | #3-132 | | | | | #3- 92 | #3-132 | | | | |
| 32'- 0" | 2 | 454 | | | | 4.000 | 310 | 967 | | | | 2.461 |
| STIR | #3- 74 | #3-133 | | | | | #3- 92 | #3-134 | | | | |
| 33'- 0" | | 386 | | | | 4.523 | 251 | 869 | | | | 2.784 |
| STIR | | #3-135 | | | | | #3- 91 | #3-117 | | | | |
| 34'- 0" | | 325 | | | | 5.097 | 198 | 779 | | | | 3.137 |
| STIR | | #3-136 | | | | | #3- 90 | #3-124 | | | | |
| 35'- 0" | | 268 | | | | 5.724 | 148 | 697 | | | | 3.522 |
| STIR | | #3-137 | | | | | #3- 90 | #3-131 | | | | |
| 36'- 0" | | 217 | | | | 6.407 | 103 | 622 | | | | 3.942 |
| STIR | | #3-137 | | | | | #3- 89 | #3-139 | | | | |
| 37'- 0" | | 169 | | | | 7.149 | 62 | 553 | | | | 4.399 |
| STIR | | #3-138 | | | | | #3- 87 | #3-142 | | | | |
| 38'- 0" | | 125 | | | | 7.953 | 23 | 489 | | | | 4.894 |
| STIR | | #3-138 | | | | | #3- 86 | #3-143 | | | | |
| 39'- 0" | | 85 | | | | 8.824 | | 430 | | | | 5.430 |
| STIR | | #3-139 | | | | | | #3-145 | | | | |
| 40'- 0" | | 47 | | | | 9.765 | | 376 | | | | 6.009 |
| STIR | | #3-139 | | | | | | #3-146 | | | | |
| PROPERTIES FOR DESIGN (CONCRETE 0.63 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.44 | 1.44 | | | | | 1.44 | 1.80 | | | | |
| ACTUAL STEEL % | 0.818 | 0.818 | | | | | 0.818 | 1.023 | | | | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | | | | | 22.38 | 22.38 | | | | |
| $-I_{cr}/I_{gr}$ | 0.169 | 0.169 | | | | | 0.169 | 0.200 | | | | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.62 | 1.04 | | | | | 0.62 | 1.04 | | | | |
| ACTUAL STEEL % | 0.334 | 0.561 | | | | | 0.334 | 0.561 | | | | |
| EFF. DEPTH, IN. | 22.69 | 22.59 | | | | | 22.69 | 22.59 | | | | |
| $+I_{cr}/I_{gr}$ | 0.112 | 0.181 | | | | | 0.112 | 0.181 | | | | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 7″ Ribs @ 73″ c.-c.<br>19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 4 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 4 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 10 | 8.5 | 7.5 | 10 | | 10 | 7 | 9.5 | 8 | 6.5 | |
| BOTTOM BARS NO | 2# 4 | 1# 7 | 1# 7 | 1# 8 | 1# 8 | | 2# 4 | 1# 7 | 1# 7 | 1# 8 | 1# 8 | |
| BARS NO | 1# 5 | 1# 7 | 1# 8 | 1# 8 | 1# 9 | | 1# 5 | 1# 7 | 1# 8 | 1# 8 | 1# 9 | |
| STEEL (PSF) | 0.58 | 0.83 | 0.95 | 1.09 | 1.23 | | 0.82 | 1.28 | 1.46 | 1.71 | 2.52 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'- 0" (3) | 178 | 773 | 1003 | 1232 | 1484 | 3.090 | 580 | 1446 | 1780 | 2114 | 2480 | 1.901 |
| STIR | #3- 80 | #3-132 | #3-144 | #3-152 | #4-159 | | #3- 93 | #3-131 | #3-138 | #4-143 | #4-143 | |
| 31'- 0" | 122 | 679 | 895 | 1109 | 1345 | 3.523 | 498 | 1309 | 1622 | 1935 | 2277 | 2.168 |
| STIR | #3- 79 | #3-134 | #3-127 | #3-155 | #4-162 | | #3- 93 | #3-133 | #3-140 | #4-146 | #4-146 | |
| 32'- 0" | 71 | 594 | 796 | 998 | 1219 | 4.000 | 424 | 1185 | 1479 | 1772 | 2094 | 2.461 |
| STIR | #3- 77 | #3-135 | #3-135 | #3-158 | #3-166 | | #3- 93 | #3-136 | #3-143 | #4-149 | #4-150 | |
| 33'- 0" | 24 | 517 | 706 | 896 | 1104 | 4.523 | 356 | 1072 | 1349 | 1624 | 1927 | 2.784 |
| STIR | #3- 74 | #3-136 | #3-144 | #3-160 | #3-168 | | #3- 93 | #3-115 | #3-146 | #4-152 | #4-152 | |
| 34'- 0" | | 446 | 625 | 803 | 999 | 5.097 | 295 | 969 | 1229 | 1489 | 1774 | 3.137 |
| STIR | | #3-138 | #3-151 | #3-163 | #3-172 | | #3- 92 | #3-122 | #3-149 | #4-156 | #4-156 | |
| 35'- 0" | | 381 | 550 | 718 | 903 | 5.724 | 238 | 875 | 1120 | 1366 | 1634 | 3.522 |
| STIR | | #3-139 | #3-153 | #3-143 | #3-175 | | #3- 92 | #3-129 | #3-151 | #3-159 | #4-162 | |
| 36'- 0" | | 321 | 481 | 640 | 815 | 6.407 | 187 | 788 | 1020 | 1252 | 1506 | 3.942 |
| STIR | | #3-140 | #3-154 | #3-151 | #3-177 | | #3- 91 | #3-136 | #3-154 | #3-162 | #4-168 | |
| 37'- 0" | | 266 | 418 | 568 | 734 | 7.149 | 139 | 709 | 928 | 1148 | 1388 | 4.399 |
| STIR | | #3-140 | #3-156 | #3-159 | #3-180 | | #3- 90 | #3-143 | #3-156 | #3-165 | #4-172 | |
| 38'- 0" | | 216 | 359 | 502 | 659 | 7.953 | 95 | 635 | 843 | 1051 | 1279 | 4.894 |
| STIR | | #3-141 | #3-157 | #3-168 | #3-182 | | #3- 88 | #3-145 | #3-159 | #3-168 | #4-175 | |
| 39'- 0" | | 169 | 305 | 441 | 590 | 8.824 | 55 | 567 | 765 | 962 | 1179 | 5.430 |
| STIR | | #3-141 | #3-159 | #3-172 | #3-185 | | #3- 87 | #3-146 | #3-138 | #3-170 | #4-177 | |
| 40'- 0" | | 126 | 255 | 384 | 526 | 9.765 | 17 | 504 | 692 | 880 | 1086 | 6.009 |
| STIR | | #3-142 | #3-160 | #3-174 | #3-164 | | #3- 85 | #3-148 | #3-145 | #3-172 | #3-181 | |
| 41'- 0" | | 86 | 209 | 332 | 466 | 10.778 | | 446 | 625 | 804 | 999 | 6.633 |
| STIR | | #3-142 | #3-161 | #3-175 | #3-173 | | | #3-149 | #3-152 | #3-174 | #3-184 | |
| 42'- 0" | | 49 | 166 | 283 | 411 | 11.869 | | 392 | 562 | 732 | 919 | 7.304 |
| STIR | | #3-141 | #3-161 | #3-177 | #3-181 | | | #3-150 | #3-160 | #3-177 | #3-186 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.64 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.46 | 1.46 | 1.72 | 1.95 | 2.26 | | 1.46 | 2.09 | 2.38 | 2.83 | 4.94 | |
| ACTUAL STEEL % | 0.736 | 0.736 | 0.866 | 0.981 | 1.145 | | 0.736 | 1.052 | 1.205 | 1.431 | 2.508 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.38 | 22.38 | 22.31 | | 22.38 | 22.38 | 22.31 | 22.31 | 22.25 | |
| $-I_{cr}/I_{gr}$ | 0.159 | 0.159 | 0.180 | 0.198 | 0.220 | | 0.159 | 0.208 | 0.228 | 0.258 | 0.371 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.71 | 1.20 | 1.39 | 1.58 | 1.79 | | 0.71 | 1.20 | 1.39 | 1.58 | 1.79 | |
| ACTUAL STEEL % | 0.340 | 0.578 | 0.670 | 0.763 | 0.865 | | 0.340 | 0.578 | 0.670 | 0.763 | 0.865 | |
| EFF. DEPTH, IN. | 22.72 | 22.56 | 22.53 | 22.50 | 22.46 | | 22.72 | 22.56 | 22.53 | 22.50 | 22.46 | |
| $+I_{cr}/I_{gr}$ | 0.115 | 0.186 | 0.212 | 0.238 | 0.266 | | 0.115 | 0.186 | 0.212 | 0.238 | 0.266 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 8″ Ribs @ 74″ c.-c.<br>19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 5 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 8 | 10 | 9 | | 10 | 10 | 9 | 7.5 | 6 | |
| BOTTOM BARS NO | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | | 1# 4 | 2# 6 | 2# 6 | 1# 8 | 1# 9 | |
| BARS NO | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | | 2# 5 | 1# 6 | 1# 7 | 1# 9 | 1# 9 | |
| STEEL (PSF) | 0.60 | 0.88 | 1.00 | 1.22 | 1.38 | | 0.84 | 1.36 | 1.53 | 1.85 | 2.77 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'- 0" (3) | 283 | 894 | 1088 | 1454 | 1705 | 3.090 | 746 | 1636 | 1918 | 2449 | 2815 | 1.901 |
| STIR | #3- 85 | #3-131 | #3-124 | #3-153 | #4-159 | | #3- 96 | #3-130 | #4-136 | #4-143 | #5-143 | |
| 31'- 0" | 218 | 791 | 973 | 1315 | 1550 | 3.523 | 652 | 1485 | 1750 | 2247 | 2589 | 2.168 |
| STIR | #3- 83 | #3-133 | #3-132 | #3-156 | #4-162 | | #3- 97 | #3-133 | #3-139 | #4-147 | #4-147 | |
| 32'- 0" | 159 | 697 | 867 | 1188 | 1409 | 4.000 | 566 | 1348 | 1597 | 2064 | 2385 | 2.461 |
| STIR | #3- 82 | #3-134 | #3-141 | #3-158 | #4-165 | | #3- 97 | #3-135 | #3-141 | #4-150 | #4-151 | |
| 33'- 0" | 106 | 611 | 772 | 1074 | 1281 | 4.523 | 489 | 1224 | 1457 | 1896 | 2198 | 2.784 |
| STIR | #3- 80 | #3-136 | #3-145 | #3-162 | #4-169 | | #3- 97 | #3-115 | #3-144 | #4-153 | #4-153 | |
| 34'- 0" | 57 | 533 | 684 | 969 | 1164 | 5.097 | 418 | 1110 | 1330 | 1744 | 2028 | 3.137 |
| STIR | #3- 77 | #3-137 | #3-147 | #3-164 | #3-172 | | #3- 96 | #3-122 | #3-146 | #4-156 | #4-157 | |
| 35'- 0" | 12 | 462 | 604 | 873 | 1057 | 5.724 | 353 | 1006 | 1214 | 1604 | 1872 | 3.522 |
| STIR | #3- 75 | #3-138 | #3-149 | #3-167 | #3-175 | | #3- 96 | #3-130 | #3-149 | #4-160 | #4-162 | |
| 36'- 0" | | 396 | 531 | 784 | 959 | 6.407 | 293 | 911 | 1107 | 1476 | 1730 | 3.942 |
| STIR | | #3-139 | #3-150 | #3-148 | #3-178 | | #3- 95 | #3-137 | #3-151 | #4-162 | #4-168 | |
| 37'- 0" | | 335 | 463 | 703 | 868 | 7.149 | 238 | 823 | 1009 | 1358 | 1598 | 4.399 |
| STIR | | #3-139 | #3-152 | #3-157 | #3-181 | | #3- 94 | #3-143 | #3-153 | #4-165 | #4-172 | |
| 38'- 0" | | 280 | 401 | 628 | 785 | 7.953 | 187 | 742 | 918 | 1249 | 1477 | 4.894 |
| STIR | | #3-140 | #3-153 | #3-165 | #3-183 | | #3- 93 | #3-144 | #3-136 | #3-168 | #4-175 | |
| 39'- 0" | | 228 | 343 | 559 | 708 | 8.824 | 141 | 667 | 834 | 1149 | 1365 | 5.430 |
| STIR | | #3-140 | #3-154 | #3-174 | #3-185 | | #3- 92 | #3-146 | #3-144 | #3-171 | #4-177 | |
| 40'- 0" | | 181 | 290 | 495 | 637 | 9.765 | 97 | 598 | 757 | 1055 | 1261 | 6.009 |
| STIR | | #3-140 | #3-155 | #3-175 | #3-188 | | #3- 91 | #3-147 | #3-151 | #3-173 | #4-181 | |
| 41'- 0" | | 136 | 240 | 436 | 570 | 10.778 | 57 | 533 | 685 | 969 | 1165 | 6.633 |
| STIR | | #3-140 | #3-155 | #3-177 | #3-172 | | #3- 89 | #3-149 | #3-159 | #3-175 | #4-183 | |
| 42'- 0" | | 95 | 194 | 381 | 509 | 11.869 | 20 | 474 | 618 | 889 | 1075 | 7.304 |
| STIR | | #3-140 | #3-156 | #3-179 | #3-181 | | #3- 87 | #3-150 | #3-161 | #3-178 | #4-186 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.66 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.48 | 1.64 | 1.85 | 2.29 | 2.55 | | 1.48 | 2.29 | 2.55 | 3.06 | 5.43 | |
| ACTUAL STEEL % | 0.671 | 0.745 | 0.838 | 1.043 | 1.159 | | 0.671 | 1.043 | 1.159 | 1.390 | 2.475 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.38 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.31 | 22.25 | |
| $-I_{cr}/I_{gr}$ | 0.151 | 0.164 | 0.179 | 0.209 | 0.226 | | 0.151 | 0.209 | 0.226 | 0.258 | 0.376 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | | 0.82 | 1.32 | 1.48 | 1.79 | 2.00 | |
| ACTUAL STEEL % | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | | 0.354 | 0.572 | 0.642 | 0.780 | 0.873 | |
| EFF. DEPTH, IN. | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | | 22.70 | 22.62 | 22.60 | 22.46 | 22.44 | |
| $+I_{cr}/I_{gr}$ | 0.120 | 0.186 | 0.207 | 0.243 | 0.268 | | 0.120 | 0.186 | 0.207 | 0.243 | 0.268 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 9″ Ribs @ 75″ c.-c.<br>19″ Deep Rib + 5.5″ Top Slab = 24.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 4 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 9 | 7.5 | 9.5 | 8.5 | | 10 | 10 | 8.5 | 9.5 | 7.5 | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | | 1# 6 | 1# 7 | 1# 6 | 2# 7 | 1# 7 | |
| BARS NO | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | | 1# 6 | 1# 8 | 2# 7 | 1# 8 | 2# 8 | |
| STEEL (PSF) | 0.66 | 0.91 | 1.05 | 1.31 | 1.41 | | 0.90 | 1.40 | 1.61 | 2.06 | 2.93 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 30'- 0" (3) | 323 | 942 | 1252 | 1674 | 1902 | 3.090 | 818 | 1719 | 2170 | 2783 | 3115 | 1.901 |
| STIR | #3- 81 | #3-127 | #3-124 | #4-153 | #4-158 | | #3- 94 | #3-127 | #4-136 | #4-144 | #5-143 | |
| 31'- 0" | 253 | 834 | 1124 | 1519 | 1732 | 3.523 | 717 | 1561 | 1983 | 2558 | 2868 | 2.168 |
| STIR | #3- 79 | #3-129 | #3-132 | #4-157 | #4-162 | | #3- 94 | #3-107 | #4-139 | #4-148 | #5-146 | |
| 32'- 0" | 191 | 735 | 1007 | 1378 | 1578 | 4.000 | 626 | 1418 | 1814 | 2353 | 2645 | 2.461 |
| STIR | #3- 77 | #3-130 | #3-140 | #3-160 | #4-165 | | #3- 94 | #3-114 | #4-142 | #4-151 | #5-150 | |
| 33'- 0" | 133 | 645 | 901 | 1250 | 1438 | 4.523 | 543 | 1288 | 1660 | 2167 | 2441 | 2.784 |
| STIR | #3- 75 | #3-131 | #3-146 | #3-162 | #4-168 | | #3- 93 | #3-121 | #3-145 | #4-154 | #5-152 | |
| 34'- 0" | 81 | 564 | 805 | 1133 | 1311 | 5.097 | 467 | 1169 | 1519 | 1997 | 2255 | 3.137 |
| STIR | #3- 73 | #3-132 | #3-148 | #3-165 | #4-172 | | #3- 93 | #3-128 | #3-147 | #4-157 | #4-156 | |
| 35'- 0" | 33 | 489 | 716 | 1026 | 1193 | 5.724 | 397 | 1060 | 1390 | 1841 | 2085 | 3.522 |
| STIR | #3- 70 | #3-132 | #3-149 | #3-168 | #3-174 | | #3- 92 | #3-136 | #3-149 | #4-160 | #4-162 | |
| 36'- 0" | | 420 | 635 | 928 | 1086 | 6.407 | 334 | 959 | 1272 | 1698 | 1929 | 3.942 |
| STIR | | #3-133 | #3-151 | #3-171 | #3-177 | | #3- 91 | #3-137 | #3-151 | #4-164 | #4-168 | |
| 37'- 0" | | 356 | 560 | 837 | 987 | 7.149 | 275 | 867 | 1163 | 1567 | 1785 | 4.399 |
| STIR | | #3-133 | #3-152 | #3-155 | #3-180 | | #3- 90 | #3-139 | #3-154 | #4-166 | #4-171 | |
| 38'- 0" | | 298 | 491 | 754 | 896 | 7.953 | 221 | 782 | 1063 | 1446 | 1652 | 4.894 |
| STIR | | #3-133 | #3-153 | #3-163 | #3-182 | | #3- 89 | #3-140 | #3-136 | #4-169 | #4-174 | |
| 39'- 0" | | 244 | 427 | 677 | 812 | 8.824 | 171 | 704 | 970 | 1334 | 1530 | 5.430 |
| STIR | | #3-133 | #3-154 | #3-172 | #3-185 | | #3- 88 | #3-141 | #3-143 | #4-172 | #4-178 | |
| 40'- 0" | | 194 | 368 | 606 | 734 | 9.765 | 124 | 631 | 885 | 1230 | 1416 | 6.009 |
| STIR | | #3-133 | #3-155 | #3-177 | #3-165 | | #3- 86 | #3-142 | #3-150 | #4-174 | #4-180 | |
| 41'- 0" | | 148 | 314 | 539 | 662 | 10.778 | 81 | 564 | 805 | 1134 | 1311 | 6.633 |
| STIR | | #3-133 | #3-156 | #3-178 | #3-174 | | #3- 84 | #3-143 | #3-158 | #3-176 | #4-183 | |
| 42'- 0" | | 105 | 263 | 478 | 594 | 11.869 | 41 | 501 | 731 | 1044 | 1213 | 7.304 |
| STIR | | #3-132 | #3-157 | #3-180 | #3-182 | | #3- 82 | #3-144 | #3-161 | #3-179 | #4-186 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.68 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.50 | 1.67 | 2.00 | 2.45 | 2.74 | | 1.50 | 2.33 | 2.74 | 3.47 | 6.00 | |
| ACTUAL STEEL % | 0.617 | 0.686 | 0.823 | 1.010 | 1.129 | | 0.617 | 0.960 | 1.129 | 1.438 | 2.493 | |
| EFF. DEPTH, IN. | 22.38 | 22.38 | 22.38 | 22.31 | 22.31 | | 22.38 | 22.31 | 22.31 | 22.25 | 22.19 | |
| $-I_{cr}/I_{gr}$ | 0.144 | 0.156 | 0.180 | 0.208 | 0.226 | | 0.144 | 0.200 | 0.226 | 0.267 | 0.382 | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | | 0.88 | 1.39 | 1.64 | 1.99 | 2.18 | |
| ACTUAL STEEL % | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | | 0.347 | 0.551 | 0.648 | 0.788 | 0.864 | |
| EFF. DEPTH, IN. | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | | 22.62 | 22.53 | 22.58 | 22.54 | 22.52 | |
| $+I_{cr}/I_{gr}$ | 0.117 | 0.179 | 0.209 | 0.249 | 0.270 | | 0.117 | 0.179 | 0.209 | 0.249 | 0.270 | |
| SINGLE LEG STIRRUP AT 10 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 7″ Ribs @ 73″ c.-c.<br>23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | | Int. Span Defl. Coeff. (2) |
| AT | 10 | 8.5 | 10 | 9 | | | 10 | 10 | 7.5 | 6 | | |
| BOTTOM BARS NO | 1# 6 | 1# 7 | 1# 8 | 1# 9 | | | 1# 6 | 1# 7 | 1# 8 | 1# 9 | | |
| BARS NO | 1# 6 | 1# 8 | 1# 9 | 1# 9 | | | 1# 6 | 1# 8 | 1# 9 | 1# 9 | | |
| STEEL (PSF) | 0.67 | 0.95 | 1.23 | 1.40 | | | 0.91 | 1.42 | 1.86 | 2.78 | | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 35'- 0" (3) | 184 | 722 | 1140 | 1358 | | 5.724 | 613 | 1395 | 2003 | 2320 | | 3.522 |
| STIR | #3- 96 | #3-149 | #3-172 | #4-179 | | | #3-110 | #3-149 | #4-163 | #4-168 | | |
| 36'- 0" | 133 | 641 | 1036 | 1242 | | 6.407 | 538 | 1277 | 1851 | 2152 | | 3.942 |
| STIR | #3- 95 | #3-151 | #3-175 | #3-183 | | | #3-111 | #3-152 | #4-166 | #4-171 | | |
| 37'- 0" | 85 | 566 | 940 | 1136 | | 7.149 | 469 | 1168 | 1712 | 1997 | | 4.399 |
| STIR | #3- 93 | #3-152 | #3-177 | #3-186 | | | #3-111 | #3-129 | #4-170 | #4-174 | | |
| 38'- 0" | 41 | 497 | 852 | 1037 | | 7.953 | 405 | 1068 | 1584 | 1853 | | 4.894 |
| STIR | #3- 91 | #3-153 | #3-154 | #3-189 | | | #3-111 | #3-136 | #4-172 | #4-178 | | |
| 39'- 0" | 1 | 434 | 770 | 946 | | 8.824 | 346 | 976 | 1465 | 1721 | | 5.430 |
| STIR | #3- 89 | #3-154 | #3-162 | #3-191 | | | #3-110 | #3-143 | #4-176 | #4-182 | | |
| 40'- 0" | | 375 | 695 | 862 | | 9.765 | 291 | 890 | 1356 | 1599 | | 6.009 |
| STIR | | #3-155 | #3-170 | #3-194 | | | #3-110 | #3-150 | #4-178 | #4-185 | | |
| 41'- 0" | | 320 | 625 | 784 | | 10.778 | 241 | 811 | 1254 | 1485 | | 6.633 |
| STIR | | #3-156 | #3-179 | #3-197 | | | #3-109 | #3-158 | #3-180 | #4-188 | | |
| 42'- 0" | | 269 | 560 | 711 | | 11.869 | 194 | 737 | 1159 | 1380 | | 7.304 |
| STIR | | #3-157 | #3-187 | #3-199 | | | #3-108 | #3-161 | #3-183 | #4-191 | | |
| 43'- 0" | | 222 | 499 | 644 | | 13.040 | 150 | 668 | 1071 | 1281 | | 8.025 |
| STIR | | #3-157 | #3-188 | #3-177 | | | #3-107 | #3-163 | #3-186 | #4-193 | | |
| 44'- 0" | | 178 | 443 | 581 | | 14.296 | 109 | 604 | 989 | 1190 | | 8.798 |
| STIR | | #3-157 | #3-190 | #3-185 | | | #3-106 | #3-164 | #3-188 | #4-197 | | |
| 45'- 0" | | 137 | 390 | 522 | | 15.641 | 71 | 544 | 912 | 1104 | | 9.625 |
| STIR | | #3-158 | #3-192 | #3-193 | | | #3-105 | #3-165 | #3-190 | #4-200 | | |
| 46'- 0" | | 98 | 340 | 467 | | 17.078 | 35 | 488 | 840 | 1024 | | 10.510 |
| STIR | | #3-158 | #3-193 | #3-202 | | | #3-103 | #3-167 | #3-193 | #4-202 | | |
| 47'- 0" | | 62 | 294 | 415 | | 18.613 | 2 | 435 | 773 | 949 | | 11.454 |
| STIR | | #3-157 | #3-195 | #3-208 | | | #3-102 | #3-168 | #3-195 | #3-205 | | |
| PROPERTIES FOR DESIGN (CONCRETE 0.69 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT STEEL AREA (SQ. IN.) | 1.46 | 1.72 | 2.26 | 2.51 | | | 1.46 | 2.26 | 3.02 | 5.35 | | |
| ACTUAL STEEL % | 0.602 | 0.708 | 0.936 | 1.040 | | | 0.602 | 0.936 | 1.247 | 2.220 | | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.31 | 26.31 | | | 26.38 | 26.31 | 26.31 | 26.25 | | |
| $-I_{cr}/I_{gr}$ | 0.144 | 0.164 | 0.201 | 0.218 | | | 0.144 | 0.201 | 0.249 | 0.365 | | |
| POSITIVE MOMENT STEEL AREA (SQ. IN.) | 0.88 | 1.39 | 1.79 | 2.00 | | | 0.88 | 1.39 | 1.79 | 2.00 | | |
| ACTUAL STEEL % | 0.347 | 0.549 | 0.709 | 0.792 | | | 0.347 | 0.549 | 0.709 | 0.792 | | |
| EFF. DEPTH, IN. | 26.62 | 26.53 | 26.46 | 26.44 | | | 26.62 | 26.53 | 26.46 | 26.44 | | |
| $+I_{cr}/I_{gr}$ | 0.123 | 0.187 | 0.236 | 0.261 | | | 0.123 | 0.187 | 0.236 | 0.261 | | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 8″ Ribs @ 74″ c.-c.<br>23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 5 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 7 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 10 | 8 | 7 | | 10 | 8.5 | 7.5 | 6 | 6 | |
| BOTTOM BARS NO | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | | 2# 5 | 1# 8 | 1# 8 | 1# 9 | 1#10 | |
| BARS NO | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | | 1# 5 | 1# 8 | 1# 9 | 1#10 | 1#10 | |
| STEEL (PSF) | 0.66 | 1.08 | 1.22 | 1.54 | 1.76 | | 0.90 | 1.64 | 1.85 | 2.88 | 3.67 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 35'- 0" (3) | 204 | 886 | 1104 | 1602 | 1881 | 5.724 | 658 | 1649 | 1967 | 2691 | 3096 | 3.522 |
| STIR | #3- 89 | #3-151 | #3-145 | #4-181 | #4-187 | | #3-106 | #3-151 | #4-158 | #5-169 | #5-174 | |
| 36'- 0" | 150 | 793 | 1000 | 1471 | 1734 | 6.407 | 579 | 1515 | 1816 | 2500 | 2883 | 3.942 |
| STIR | #3- 87 | #3-153 | #3-153 | #4-185 | #4-191 | | #3-106 | #3-153 | #4-161 | #5-173 | #5-168 | |
| 37'- 0" | 99 | 709 | 905 | 1350 | 1599 | 7.149 | 506 | 1392 | 1677 | 2325 | 2687 | 4.399 |
| STIR | #3- 85 | #3-155 | #3-162 | #4-187 | #4-195 | | #3-105 | #3-155 | #4-163 | #5-176 | #5-171 | |
| 38'- 0" | 53 | 631 | 816 | 1239 | 1475 | 7.953 | 438 | 1279 | 1549 | 2163 | 2506 | 4.894 |
| STIR | #3- 83 | #3-156 | #3-169 | #4-190 | #4-198 | | #3-105 | #3-133 | #4-166 | #4-180 | #5-174 | |
| 39'- 0" | 10 | 559 | 735 | 1136 | 1360 | 8.824 | 376 | 1174 | 1430 | 2013 | 2339 | 5.430 |
| STIR | #3- 80 | #3-157 | #3-170 | #3-193 | #4-202 | | #3-104 | #3-140 | #3-169 | #4-183 | #5-178 | |
| 40'- 0" | | 492 | 659 | 1040 | 1254 | 9.765 | 318 | 1076 | 1320 | 1874 | 2185 | 6.009 |
| STIR | | #3-158 | #3-172 | #3-196 | #4-204 | | #3-104 | #3-147 | #3-171 | #4-186 | #5-180 | |
| 41'- 0" | | 430 | 589 | 952 | 1155 | 10.778 | 264 | 986 | 1218 | 1746 | 2041 | 6.633 |
| STIR | | #3-159 | #3-174 | #3-198 | #4-208 | | #3-103 | #3-154 | #3-174 | #4-189 | #5-185 | |
| 42'- 0" | | 372 | 524 | 870 | 1063 | 11.869 | 214 | 902 | 1124 | 1626 | 1908 | 7.304 |
| STIR | | #3-160 | #3-175 | #3-201 | #4-211 | | #3-101 | #3-162 | #3-175 | #4-192 | #5-190 | |
| 43'- 0" | | 319 | 464 | 793 | 978 | 13.040 | 168 | 824 | 1035 | 1515 | 1783 | 8.025 |
| STIR | | #3-160 | #3-176 | #3-204 | #4-214 | | #3-100 | #3-165 | #3-150 | #4-195 | #4-196 | |
| 44'- 0" | | 269 | 407 | 722 | 898 | 14.296 | 125 | 752 | 953 | 1411 | 1668 | 8.798 |
| STIR | | #3-161 | #3-178 | #3-181 | #3-216 | | #3- 99 | #3-166 | #3-157 | #4-198 | #4-202 | |
| 45'- 0" | | 222 | 354 | 655 | 824 | 15.641 | 84 | 684 | 876 | 1314 | 1559 | 9.625 |
| STIR | | #3-161 | #3-179 | #3-189 | #3-220 | | #3- 97 | #3-168 | #3-164 | #4-201 | #4-208 | |
| 46'- 0" | | 178 | 305 | 593 | 754 | 17.078 | 47 | 620 | 805 | 1224 | 1458 | 10.510 |
| STIR | | #3-161 | #3-180 | #3-198 | #3-222 | | #3- 95 | #3-169 | #3-172 | #4-204 | #4-212 | |
| 47'- 0" | | 137 | 259 | 535 | 689 | 18.613 | 11 | 561 | 737 | 1139 | 1363 | 11.454 |
| STIR | | #3-161 | #3-180 | #3-206 | #3-224 | | #3- 93 | #3-170 | #3-179 | #4-207 | #4-215 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.72 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.48 | 1.97 | 2.29 | 2.87 | 3.28 | | 1.48 | 2.70 | 3.06 | 5.43 | 7.40 | |
| ACTUAL STEEL % | 0.550 | 0.734 | 0.855 | 1.069 | 1.222 | | 0.550 | 1.006 | 1.140 | 2.029 | 2.775 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.31 | 26.31 | 26.31 | | 26.38 | 26.31 | 26.31 | 26.25 | 26.19 | |
| $-I_{cr}/I_{gr}$ | 0.137 | 0.172 | 0.192 | 0.227 | 0.250 | | 0.137 | 0.217 | 0.238 | 0.351 | 0.425 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | | 0.93 | 1.58 | 1.79 | 2.27 | 2.54 | |
| ACTUAL STEEL % | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | | 0.331 | 0.566 | 0.641 | 0.815 | 0.913 | |
| EFF. DEPTH, IN. | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | | 26.69 | 26.50 | 26.46 | 26.40 | 26.36 | |
| $+I_{cr}/I_{gr}$ | 0.119 | 0.193 | 0.216 | 0.267 | 0.295 | | 0.119 | 0.193 | 0.216 | 0.267 | 0.295 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

| WIDE-MODULE (1) ONE-WAY JOISTS MULTIPLE SPANS | 66″ Forms + 9″ Ribs @ 75″ c.-c.<br>23″ Deep Rib + 5.5″ Top Slab = 28.5″ Total Depth<br>FACTORED USABLE SUPERIMPOSED LOAD (PLF) | | | | | | $f'_c$ = 4,000 psi<br>$f_y$ = 60,000 psi | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOP BARS NO | # 4 | # 4 | # 5 | # 5 | # 6 | End Span Defl. Coeff. (2) | # 4 | # 5 | # 5 | # 6 | # 6 | Int. Span Defl. Coeff. (2) |
| AT | 10 | 7.5 | 9.5 | 8 | 9 | | 9 | 8.5 | 7 | 8 | 4 | |
| BOTTOM BARS NO | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | | 2# 4 | 1# 6 | 2# 7 | 2# 8 | 1# 8 | |
| BARS NO | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | | 2# 5 | 2# 7 | 1# 8 | 1# 8 | 2# 9 | |
| STEEL (PSF) | 0.70 | 1.05 | 1.31 | 1.54 | 1.84 | | 1.00 | 1.61 | 1.99 | 2.42 | 3.95 | |
| CLEAR SPAN | END SPAN | | | | | | INTERIOR SPAN | | | | | |
| 35'- 0" (3) | 266 | 919 | 1285 | 1681 | 2115 | 5.724 | 764 | 1713 | 2247 | 2823 | 3454 | 3.522 |
| STIR | #3- 89 | #3-146 | #3-143 | #4-177 | #5-188 | | #3-106 | #3-147 | #4-158 | #5-167 | #5-174 | |
| 36'- 0" | 206 | 823 | 1169 | 1544 | 1954 | 6.407 | 677 | 1574 | 2078 | 2622 | 3220 | 3.942 |
| STIR | #3- 87 | #3-148 | #3-151 | #4-181 | #4-191 | | #3-106 | #3-126 | #4-161 | #5-171 | #5-167 | |
| 37'- 0" | 151 | 735 | 1063 | 1417 | 1806 | 7.149 | 597 | 1446 | 1923 | 2438 | 3004 | 4.399 |
| STIR | #3- 85 | #3-149 | #3-159 | #4-183 | #4-194 | | #3-105 | #3-133 | #4-164 | #5-173 | #5-170 | |
| 38'- 0" | 100 | 653 | 964 | 1300 | 1669 | 7.953 | 522 | 1328 | 1780 | 2269 | 2804 | 4.894 |
| STIR | #3- 83 | #3-150 | #3-168 | #4-187 | #4-199 | | #3-105 | #3-140 | #4-167 | #4-177 | #5-173 | |
| 39'- 0" | 53 | 578 | 874 | 1192 | 1542 | 8.824 | 454 | 1218 | 1648 | 2112 | 2620 | 5.430 |
| STIR | #3- 80 | #3-151 | #3-172 | #3-189 | #4-202 | | #3-104 | #3-147 | #4-169 | #4-181 | #5-177 | |
| 40'- 0" | 9 | 509 | 789 | 1093 | 1425 | 9.765 | 391 | 1117 | 1526 | 1967 | 2450 | 6.009 |
| STIR | #3- 77 | #3-152 | #3-174 | #3-192 | #4-205 | | #3-103 | #3-155 | #4-172 | #4-183 | #5-179 | |
| 41'- 0" | | 444 | 711 | 1000 | 1316 | 10.778 | 332 | 1023 | 1412 | 1832 | 2292 | 6.633 |
| STIR | | #3-152 | #3-175 | #3-195 | #4-208 | | #3-102 | #3-157 | #3-175 | #4-186 | #5-185 | |
| 42'- 0" | | 384 | 639 | 914 | 1215 | 11.869 | 277 | 936 | 1307 | 1707 | 2145 | 7.304 |
| STIR | | #3-152 | #3-177 | #3-173 | #4-211 | | #3-101 | #3-158 | #3-176 | #4-189 | #5-191 | |
| 43'- 0" | | 329 | 571 | 834 | 1121 | 13.040 | 226 | 855 | 1208 | 1590 | 2008 | 8.025 |
| STIR | | #3-153 | #3-178 | #3-181 | #4-214 | | #3-100 | #3-160 | #3-179 | #4-192 | #5-196 | |
| 44'- 0" | | 276 | 508 | 759 | 1034 | 14.296 | 179 | 779 | 1117 | 1481 | 1881 | 8.798 |
| STIR | | #3-153 | #3-179 | #3-190 | #4-217 | | #3- 99 | #3-161 | #3-155 | #4-194 | #5-202 | |
| 45'- 0" | | 228 | 450 | 689 | 952 | 15.641 | 134 | 709 | 1031 | 1380 | 1762 | 9.625 |
| STIR | | #3-153 | #3-181 | #3-198 | #4-220 | | #3- 97 | #3-162 | #3-162 | #4-197 | #5-208 | |
| 46'- 0" | | 182 | 395 | 624 | 875 | 17.078 | 93 | 642 | 951 | 1285 | 1650 | 10.510 |
| STIR | | #3-152 | #3-182 | #3-203 | #4-222 | | #3- 95 | #3-163 | #3-169 | #4-200 | #4-212 | |
| 47'- 0" | | 140 | 343 | 563 | 803 | 18.613 | 54 | 580 | 876 | 1196 | 1546 | 11.454 |
| STIR | | #3-152 | #3-183 | #3-205 | #3-225 | | #3- 93 | #3-164 | #3-177 | #4-203 | #4-215 | |
| PROPERTIES FOR DESIGN (CONCRETE 0.74 CF/SF) | | | | | | | | | | | | |
| NEGATIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.50 | 2.00 | 2.45 | 2.91 | 3.67 | | 1.67 | 2.74 | 3.32 | 4.12 | 8.25 | |
| ACTUAL STEEL % | 0.508 | 0.677 | 0.831 | 0.987 | 1.249 | | 0.564 | 0.929 | 1.128 | 1.405 | 2.809 | |
| EFF. DEPTH, IN. | 26.38 | 26.38 | 26.31 | 26.31 | 26.25 | | 26.38 | 26.31 | 26.31 | 26.25 | 26.25 | |
| $-I_{cr}/I_{gr}$ | 0.130 | 0.164 | 0.191 | 0.217 | 0.256 | | 0.142 | 0.208 | 0.240 | 0.279 | 0.440 | |
| POSITIVE MOMENT | | | | | | | | | | | | |
| STEEL AREA (SQ. IN.) | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | | 1.02 | 1.64 | 1.99 | 2.37 | 2.79 | |
| ACTUAL STEEL % | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | | 0.331 | 0.535 | 0.650 | 0.775 | 0.913 | |
| EFF. DEPTH, IN. | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | | 26.71 | 26.58 | 26.54 | 26.50 | 26.45 | |
| $+I_{cr}/I_{gr}$ | 0.120 | 0.186 | 0.221 | 0.259 | 0.299 | | 0.120 | 0.186 | 0.221 | 0.259 | 0.299 | |
| SINGLE LEG STIRRUP AT 12 IN. CONSTANT SPACING-DISTANCE (IN.) | | | | | | | | | | | | |

(1) For gross section properties, see Tables 8-3(a), 8-3(b), and 8-3(c).
(2) Computation of deflection is not required above horizontal line (thickness ≥ $\ell_n/18.5$ for end spans, $\ell_n/21$ for interior spans).
(3) Single leg stirrup size space at X in. c.-c. Distance over which stirrups must extend from face of support at each end (in.).

# CHAPTER 9 – SOLID TWO-WAY FLAT PLATES — SQUARE PANELS

**General.** The tabulated designs presented in this Chapter are for flat plates defined as solid uniform depth concrete slabs, reinforced in two directions to transfer loads directly to supporting columns without capitals, beams, or drop panels. Spandrel edges of the flat plate are assumed to extend at least to the outer face of the edge and corner columns. Where architectural or construction considerations permit cantilevered edges, this modification can be performed for moderate span cantilevers with minor adjustments of the reinforcement tabulated, and will improve the structural performance of the flat plate.

**Flat Plate Advantages.** The two-way flat plate is one of the most efficient structural systems for economy. Flat plates can be constructed in minimum time with minimum field labor because the flat plate utilizes the simplest possible formwork and reinforcing steel layout. Flat plates result in minimum story height for required clear headroom, and provide for greatest flexibility in layout of columns, partitions, small openings, etc. Where requirements of the project permit direct application of the ceiling finish to the flat plate soffit, elimination of ceiling construction permits additional substantial cost and construction time savings compared to other structural systems.

Flat plates have become increasingly economical and widely used as the cost of field labor has increased relative to materials. They have been applied with particular advantage to multi-story motel, hotel, hospital, dormitory, and apartment buildings. The principal limitation on use of flat plate construction is imposed by the shear area, the perimeter about the column-plus-plate depth, times the plate depth available. For industrial loads or longer spans, the solid flat slab (with capitals or drop panels or both) may be preferable. See Chapter 10. For long spans, the reduced dead load and increased stiffness of the waffle flat slab will usually result in overall economy. See Chapter 11.

Since the span and load limits for maximum economy vary with local costs and may depend upon other requirements of the project, the tabulated designs in this Handbook cover the partly overlapping practicable ranges of span and load for each of the three principal two-way structural systems.

**Design Considerations.** In Chapter 13 of the ACI Building Code, design requirements are combined for all types of two-way slab construction, since the fundamental behavior is the same for all. Chapter 13 applies to flat plates; flat slabs with capitals, drop panels, or both; waffle flat slabs; and two-way slabs supported on monolithic beams. The requirements for distribution of reinforcement are made dependent by elastic analysis upon the relative stiffness of all participating structural elements. Rather complex provisions for calculation of stiffness include for flat plates assumption of infinite column stiffness at the joints within the depth of the plate, increased slab stiffness within the column at the joints, and torsional stiffness of the portion of the plate within and at right angles to the width of the column. Even the *Direct Design Method* provides for adjustment of moments based on the results of three-dimensional stiffness calculations.

The most critical problem in the design, however, is not the distribution of reinforcement in the flat plate for elastic analysis. If the proper total area of reinforcement (based on $M_o$, the total static moment for a span) is provided, redistribution before failure load is reached will usually ensure its effectiveness. The Code permits a 10 percent adjustment of negative and positive factored moments, provided the total static moment, $M_o$, for a panel in the direction considered is not less than $q_u \ell_2 \ell_n^2/8$ (ACI 13.6.7). Shear transfer of gravity load and moment, however, is not capable of such redistribution. The Code requires that shear developed by transfer of balanced gravity loads be combined with shear created by transfer of a portion of the moment due to unbalanced gravity loads and horizontal forces. This shear and the transmission of remaining moment through flexure to the columns by properly anchored flexural reinforcement are the critical elements for a safe design.

All prescribed design methods, including the Direct Design Method, the Equivalent Frame Method, and the provision for use of any rational method, including limit design, consist essentially of reviewing a trial design. If additional trials are necessary due to a change in any dimension (stiffness) of any participating structural element, the entire process must be repeated. The time required for a completely manual design, probably through several trials, makes use of a computer or a computer-produced set of design tables the logical procedure for any routine structure.

**Scope of Flat Plate Tabulated Designs.** In this Chapter, tabulated designs for flat plates are presented for typical square exterior edge and interior floor panels. (Types E and I in location diagram, Fig. 9-1).

Corner panels (C) and first interior panels (IC, EC, IE) require combinations of appropriate exterior panel reinforcement. To present the entire range considered practicable for flat plates, complete designs are tabulated for spans from 12′-0″ to 31′-0″; factored superimposed loads from 50 psf to 350 psf; plate (slab) thicknesses from 5 to 10 inches. Minimum size square columns satisfying Code requirements for shear transfer are included with each load and span combination.

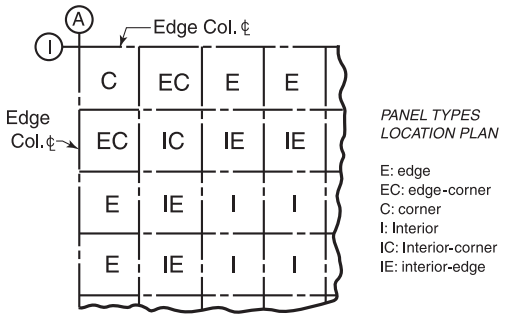
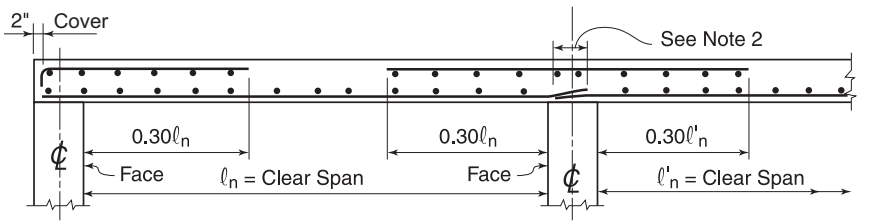



**Figure 9-1 Panel Nomenclature**

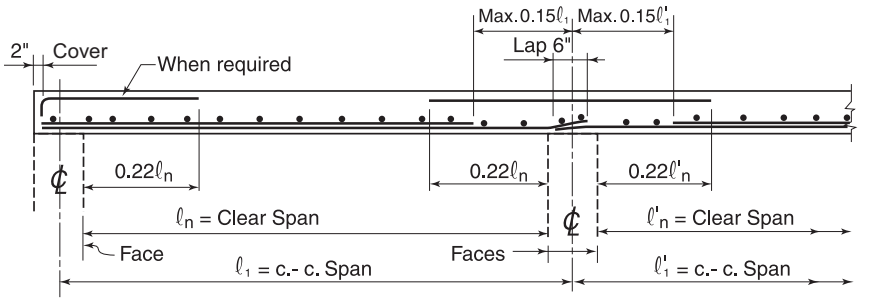
All tabulated designs conform to ACI 318 minimum requirements for shear without use of shearhead reinforcement.

To aid in quantity estimates for cost comparisons of alternative designs, concrete and reinforcing steel average quantities per square foot are given in the tabulated designs for the six panel types identified in Fig. 9-1. Reinforcing steel quantities include all reinforcement in the flat plate, except integrity steel (ACI 13.3.8.5).

**Basis of Tabulated Designs.** All tabulated designs are prepared for normal-weight concrete, $f'_c$ = 4,000 psi, and Grade 60 reinforcing bars with $f_y$ = 60,000 psi. The tabulated designs use load factors (1.2*D* and 1.6*L*) and $\phi$-factors as prescribed in the 2008 Code, and follow the "Direct Design Method" of ACI 13.6. All designs tabulated satisfy the minimum thickness requirements of ACI 9.5.3.2 so that deflection calculations are not required by the Code. Crack control requirements of ACI 13.3.2 have been satisfied by the spacing of reinforcing bars. Anchorage and development requirements were applied to select bar sizes for full development when anchored and cut-off per the recommended reinforcement details. See Fig. 9-2.




(a) Column Strip




(b) Middle Strip

Notes:

1. Top bars must be concentrated within width of the column plus 1.5*h* on each side of the column (ACI 13.5.3.2 and 13.5.3.4).
2. Integrity reinforcement is required (ACI 13.3.8.5). All bottom bars in the column strip must be continuous or spliced over the support with Class B tension lap splices. At least two of the column strip bottom bars in each direction must pass within the column core and be anchored at exterior supports.

**Figure 9-2 Typical Bar Length Details**

The tabulated designs are applicable within the following limitations established for the Direct Design Method, Section 13.6.1:

1. Minimum of three spans continuous in each direction.
2. Ratio of panel length to width not to exceed 2.0.
3. Successive span lengths (in the same direction) to differ not more than one-third the longer span.
4. Individual column centers not to be offset more than 10 percent of the span in the direction of the offset, in either direction from the grid of lines connecting centers of successive columns.
5. Service live load cannot exceed two times service dead load (i.e., Actual loads before application of load factors).

## USE OF FLAT PLATE TABULATED DESIGNS

**Direct Applications Within Dimensional Limitations of Tabulated Designs.** Limitations within the tables are:

1. Square column sizes as tabulated
2. Square panels
3. Minimum three panels continuous
4. Equal spans
5. Edge of slab flush with outer face of edge column
6. Live load $\leq 2 \times$ dead load (unfactored loads)
7. Uniformly distributed gravity loads only. See Section 13.6.1.5 (Code and Commentary). For lateral load analyses, see "Equivalent Frame Method," Sections 13.5.1, 13.5.3, 13.7, and Commentary Section R13.7.

**Example 1:** *Preliminary Selection.* Compare alternate designs in order to make a preliminary selection for a flat plate intermediate floor, which is subjected to a 100 psf superimposed factored load on square panels 20 feet center-to-center of columns. Lay out the reinforcement for the design selected.

**Solution:** Read "Square Edge Panel" only since minimum required size of interior columns here is less than exterior columns.

| Slab Thickness, $h$ (inches) | Min. Edge Col., $c_1 = c_2$ (inches) | Reinforcing Steel Edge Panel, $E$ |
|---|---|---|
| 7 | 20 | 2.04 psf |
| 7½ | 18 | 2.08 psf |
| 8 | 17 | 2.08 psf |
| 8½ | 16 | 2.09 psf |

If the 16-in. square column is inadequate for vertical loads from upper floors, the next choice would be the 8-in. plate with 17 in. $\times$ 17 in. square columns. If this column size proves adequate for loads from above, and the size fits architectural requirements, the tabulated designs can be used directly. Note that total reinforcing steel quantities are given for three types of exterior and interior panels. See Fig. 9-1, Panel Nomenclature. Not only should these data make preliminary estimates more accurate, but it should serve as a reminder that tabulated reinforcement for exterior panels runs both ways in corner panels and that the first interior column top bars tabulated under "Edge" panels will be used at both ends of the center panel in a three-bay frame, etc.

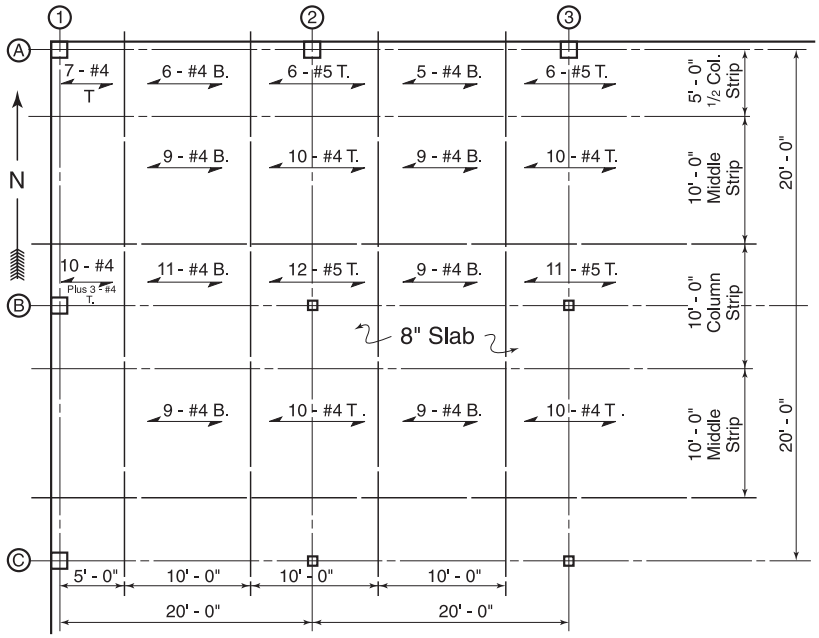



**Figure 9-3 Plan – East-West Bars (North-South Bars Same) – Example 1**

The reinforcement required for the 8-in. slab is listed in the tabulated design on Page 9-26. The layout of the required reinforcement is shown in Fig. 9-3. Concentration of top reinforcement over edge columns may be achieved by closer spacing within width of the column plus 1.5*h* on each side of the column (ACI 13.5.3.2). See Fig. 9-3.

**Adjustment of Tabulated Designs to Project Conditions.** In practice, the usual variations from the limitations of the tabulated designs will occur in one or more of the following areas:

1. Non-square panels
2. Non-equal consecutive spans
3. Minor cantilevers
4. Major cantilevers

*Moment.* Adjustments up to 10 percent are permitted by the Code in negative and positive factored moments, provided the total factored static moment for a span in each direction, $M_o$, is not reduced.

*Shear.* Adjustments to accomodate a number of the usual variations should not require a new shear analysis at the exterior column. Non-square panels, non-equal consecutive spans, cantilevers of any type, will generally reduce critical shear. Use of larger than minimum size square columns (where $v_c = 4\sqrt{f'_c}$), may require a new shear analysis if ACI Eq. 11-32 controls shear strength, i.e., when $(\alpha_s d/b_o + 2) < 4$. With major cantilevers, a new shear analysis will be desirable as it will usually allow use of smaller exterior columns, and facilitate use of straight bar embedment to satisfy "structural integrity" requirements of the ACI Building Code. See the "Manual Example" for the complete shear analysis required. A cantilever sufficiently loaded to develop a minimum (dead load) moment at the exterior column centerline equal to that at interior column centerlines will generally permit use of the interior span design, including the minimum size interior column.

**Example 2:** *Non-square Panels.* Consider the same conditions as in Example 1 (100 psf superimposed load on an intermediate floor) except with $\ell_1 = 20'\text{-}0''$; $\ell_2 = 18'\text{-}0''$. As the ratio of spans in opposite directions, $\ell_2/\ell_1$, varies from 1.0 for square panels, the ACI Building Code provides for varying distribution of moment to the column and middle strips only where beams are used.

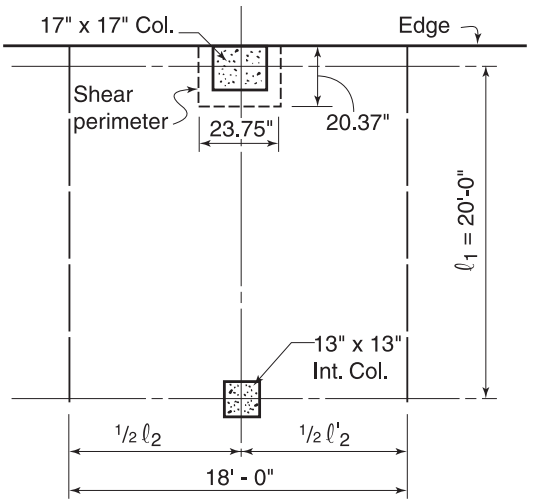
For ratios $\ell_2/\ell_1$ close to 1.0, the simplest adjustment is to provide reinforcing steel and minimum column size as tabulated for the larger span in both directions in the flat plate.

*Moment* – Compare tabulated reinforcing steel for $\ell_1 = 20'\text{-}0''$ and $\ell_2 = 18'\text{-}0''$ assuming square panels in both directions:

| Location | | $\ell_1 = 20'\text{-}0''$ | $\ell_2 = 18'\text{-}0''$ |
|---|---|---|---|
| *End Panel* | | | |
| Col. strip | Top Ext. | 10-#4 plus 3-#4 | 9-#4 plus 3-#4 |
| | Bot. | 11-#4 | 8-#4 |
| | Top Int. | 12-#5 | 13-#4 |
| Middle strip | Bot. | 9-#4 | 8-#4 |
| | Top Int. | 10-#4 | 9-#4 |
| *Interior Panel* | | | |
| Col. strip | Top | 11-#5 | 12-#4 |
| | Bot. | 9-#4 | 8-#4 |
| Middle strip | Top | 10-#4 | 9-#4 |
| | Bot. | 9-#4 | 8-#4 |

Note that changes in reinforcement are too minor to justify making two designs for less than about this ratio of $\ell_2/\ell_1 = 18/20$. At this ratio, the reinforcing steel in the short span direction could be reduced in the bottom of the column strip in the end span; in the top of the column strip at the first interior column and at other interior columns; and by one bar at other locations. See Fig. 9-4.

Possible reduction of the size of the interior column would be too slight to justify the attempt by inspection. The exterior column dimension in the $\ell_2$ direction could be reduced slightly without a new shear analysis. The




Read "Minimum Square Column"

| Minimum Column | $\ell_1 = \ell_2 =$ 20′-0″ | $\ell_1 = \ell_2 =$ 18′-0″ |
|---|---|---|
| Exterior | 17 in. | 13 in. |
| Interior | 13 in. | 11 in. |

**Figure 9-4 Non-Square Panel (Example 2)**

total shear and the total exterior panel moment are now reduced 18/20. It will be possible to reduce the column to 17 in. × 15 in. ($c_1$ = 17 in. and $c_2$ = 15 in.) which reduces the critical shear section area and the moment of inertia of same less than 10 percent.

**Example 3:** *Non-equal consecutive spans.* Exterior span $\ell_1$ = 20′-0″; first interior span $\ell_1$ = 18′-0″, both panels, $\ell_2$ = 20′-0″. Tabulated bottom reinforcing steel does not need to be changed. Top reinforcing steel at the centerline of a common (interior) support must be that required for the larger span (ACI 13.6.3.4). Thus, top reinforcement for both column and middle strip must be provided as tabulated for the larger span. From the comparison in Example 2, provide 12-#5 bars Top in the column strip and 10-#4 bars Top in the middle strip over the first interior column centerline.

**Example 4:** *Minor cantilevers.* On the flat plate in Example 1, a small "eyebrow" cantilever for shade is desired, extending 4′-0″ outside the building edge which is flush with the outer face of the edge columns. The overall depth of this cantilever is 8 inches. Any cantilever will reduce the unbalanced moment to be transferred to the exterior column. For small cantilevers of this type, re-calculation of the entire column shear analysis is seldom justifiable in terms of reduced column size, savings in reinforcing steel, etc. It will usually be sufficiently accurate and always safe merely to extend all top bars from the exterior column strip straight into the cantilever and as near to the edge as concrete cover requirements permit (2 inches for exposed edges). The hooked ends of the top bars required for flush edges, see Fig. 9-2, will be eliminated as the cantilever extension gives ample development length for anchorage.

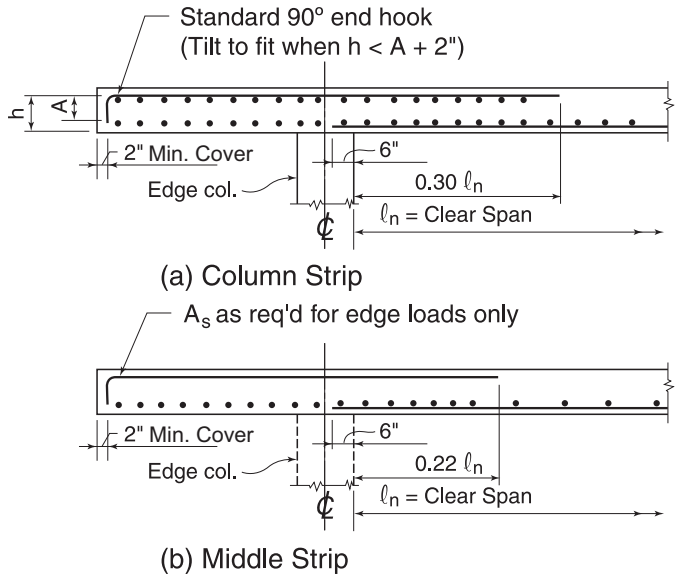



**Figure 9-5 Cantilever Details**

The one addition to tabulated reinforcement will be top bars into the cantilever from the middle strip. The dead load of the slab ($h$ = 8 inches) is 100 psf. The factored dead load $D$ = 1.2 × 100 = 120 psf. Assume the specified service live load equals 30 psf. The factored live load $L$ = 1.6 × 30 = 48 psf. The total factored load = 120 + 48 = 168 psf. The factored moment:

$$M_u = \frac{168(4)^2}{2}(12/1000)/(10) = 161 \text{ in.-kips for the } 10'\text{-}0'' \text{ wide middle strip}$$

$$\text{Req'd } A_s = \frac{1.7 f_c' bd}{2 f_y} - \frac{1}{2}\sqrt{\frac{2.89(f_c' bd)^2}{(f_y)^2} - \frac{6.8 f_c' b M_u}{\phi (f_y)^2}}^{*}$$

$$= \frac{1.7(4)(120)(6.5)}{2(60)} - \frac{1}{2}\sqrt{\frac{2.89((4)(120)(6.5))^2}{(60)^2} - \frac{6.8(4)(120)(161)}{0.90(60)^2}}$$

$$= 0.46 \text{ in.}^2$$

Min. $A_s = 0.0018bh = (0.0018)(8)(10)(12) = 1.73$ in.$^2$ at maximum spacing 5$h$ or 18 inches.

Use 10-#4 bars spaced at 12 inches on center. These bars must extend inward beyond the outer face of the edge column only 19 inches for full development at the face of the cantilever (see Chapter 5, Table 5-2(b)), but should extend 0.22 $\ell_n$ into the span past the inner face of the column to ensure anchorage past the negative moment area. See Fig. 9-5. Note that these bars are marked "When required," as in this example. The Code does not require top bars at the edge of the middle strip unless cantilever, spandrel wall loads, etc., are present. Note that top and bottom bars in the $\ell_2$ span half column strip are merely repeated (same size and spacing) in the cantilever.

**Example 5:** *Major cantilevers.* A major cantilever is defined for purposes of these examples as one that will justify a complete new shear analysis to reduce the size of the exterior column. The simplest illustration is a cantilever just sufficient to produce the same dead load moment at the edge column centerline as the minimum negative moment at an interior column. For this condition, the shear analysis at the interior column will apply and all columns, edge and interior.

* The expression is from Chapter 5.

For the design in Example 1, $\ell_1 = \ell_2 = 20'\text{-}0''$; the factored live load $q_{Lu}$ = 100 psf; $h$ = 8 inches; the minimum cantilever to create interior column conditions is easily calculated. See "Edge Panel" load table on Page 9-26. Read "$-M$ at 1st Interior Column"; $-M_{int}$ = 135 ft-kips. The dead load fraction of this factored moment cannot exceed

$$\frac{100 \times 1.2}{100 + 100 \times 1.2} = \frac{120}{220} \times \text{the total factored panel moment.}$$

The cantilever moment cannot exceed:

$$-M = \frac{120}{220} \times 135 = -74 \text{ ft-kips}$$

Assume the 8-in. plate thickness is unchanged in the cantilever and a light spandrel beam weighing 125 plf (factored dead load = 150 plf) is present.

$$-M_{\text{cant}} = \frac{(20)(0.120)}{2} \ell_c^2 + (20)(0.150)\,\ell_c = -74 \text{ ft-kips}$$

where $\ell_c$ = clear cantilever span

Solving for $\ell_c$: $-M_{\text{cant}} = 1.2(\ell_c)^2 + 3.0\,\ell_c = -74$ ft-kips; $\ell_c$ = 6.7 feet

*Caution:*

The design shear strength of the concrete for two-way action is the smallest of the values computed from ACI Eqs. 11-31 to 11-33:

$$\phi V_c = \phi(2 + 4/\beta)\sqrt{f'_c}\, b_o d \quad \text{(ACI Eq. 11-31)}$$

$$\phi V_c = \phi(\alpha_s d/b_o + 2)\sqrt{f'_c}\, b_o d \quad \text{(ACI Eq. 11-32)}$$

$$\phi V_c = \phi 4\sqrt{f'_c}\, b_o d \quad \text{(ACI Eq. 11-33)}$$

Since all tabulated designs in this Chapter use square columns, the governing $\phi V_c$ is the smaller of the values computed from Eq. 11-32 and Eq. 11-33. For two-way slab systems with rectangular columns, Eq. 11-31 must also be included in the determination of the governing value of $\phi V_c$. Design shear strength will be sharply reduced by Eq. 11-31, for example, in two-way slabs at long narrow (wall-like) rectangular columns. In Eq. 11-31, $\beta$ = ratio of long/short sides of column. Note that nominal unit shear strength, $v_c = 4\sqrt{f'_c}$ applies up to $\beta = 2$, and that the equation gradually reduces shear strength until about equal (at section $d$/2 from face of support) to that for one-way shear (at section $d$ from face of support).

ACI Eq. 11-32 accounts for a reduction in shear strength where the ratio $b_o/d$ increases. Design shear strength, $\phi V_c$, of two-way slabs will be controlled by Eq. 11-32, particularly for combinations of relatively shallow slabs and large columns.

## DIRECT DESIGN OF FLAT PLATES

The procedure presented in the 2008 ACI Building Code and Commentary has been used in the preparation of the tabulated designs in this Chapter. The following outline presents the major steps in this procedure:

1. Select slab thicknesses within minimum prescribed thicknesses to avoid deflection calculations. See Fig. 9-6.
2. Compute factored load $U = 1.2D + 1.6L$.
3. Select first trial square column size. A minimum of 10 inches, or previously tabulated size in table, whichever is greater.
4. Calculate the total factored static moment,

$$M_o = \frac{q_u \ell_2 (\ell_n)^2}{8} \quad \text{(ACI Eq. 13-4)}$$

5. Calculate the exterior panel moments: $-M_{int} = k_1 M_o$ and $+M = k_2 M_o$; and $-M_{ext} = k_3 M_o$.

Calculate interior panel moments: $-M = 0.65 M_o$ and $+M = 0.35 M_o$.

6. Select flexural reinforcement. Use largest size (minimum number) of reinforcing bars which will satisfy steel areas required for flexure and minimum reinforcement (for temperature and shrinkage) within maximum spacing limits. See Fig. 9-2 "Typical Bar Length Details."
7. Compute shear constants for moment transferred by eccentricity of shear at exterior and interior columns ($A_c$, $J$, $C_{AB}$ and $C_{CD}$).

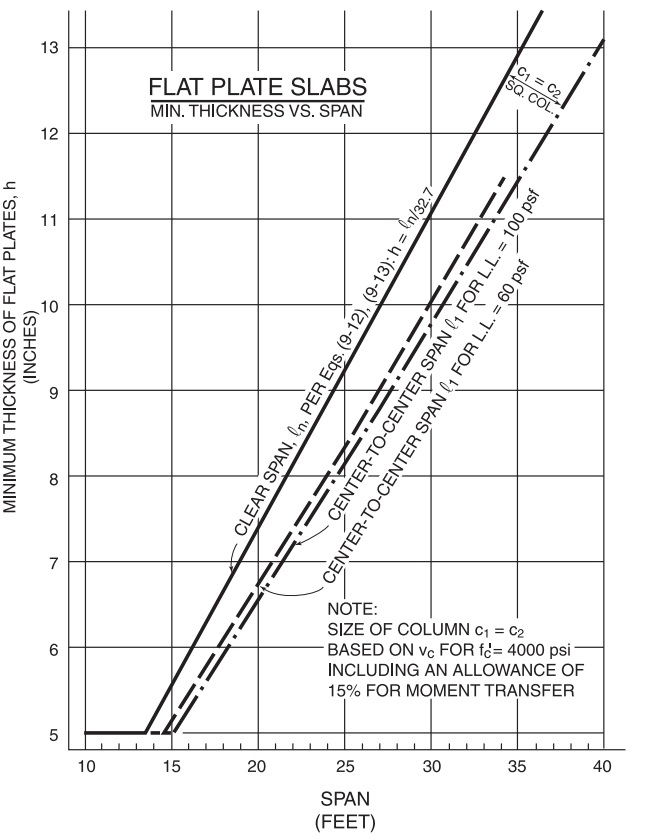



**Figure 9-6 Minimum Thickness**

8. Compute shear and unbalanced moment at centroid of column shear area, $A_c$.

9. Compute fraction of unbalanced moment transferred to column by shear, $\gamma_v$, for interior and edge columns. At edge columns, the unbalanced moment transferred by eccentricity of shear between the slab and edge column is $0.3M_o$ (ACI 13.6.3.6). At interior columns, the unbalanced moment is determined from ACI Eq. 13-7.

At interior columns, compute the maximum shear stress, $v_u$, for two conditions: (1) full load, and (2) maximum unbalanced moment plus load causing same. Repeat Steps 3 through 8 if necessary until $v_u \leqq v_c$ in Step 9, where $v_c$ is based on $(\alpha_s d/b_o + 2)\sqrt{f'_c}$ or $4\sqrt{f'_c}$, whichever is smaller.

10. At exterior columns, compute the additional top reinforcement required to resist the fraction at the unbalanced moment within the "effective width" ($1.5h + C_2$) in the column strip.

11. Compute average weights of reinforcing steel (psf) for various panels.

*Note on Computation Procedure.* Minimum sizes of edge and interior columns were calculated separately.

## ACI 318 MOMENT COEFFICIENTS FOR DISTRIBUTING $M_o$ IN END SPAN

Coefficients for distributing $M_o$ in an end span are given in ACI 13.6.3.3 for five conditions:

| Condition / Negative and Positive Factored Moments | Exterior edge unrestrained | Slab with beams between all supports | Slab without beams between Interior supports | | Exterior edge fully restrained |
|---|---|---|---|---|---|
| | | | Without edge beam | With edge beam | |
| Interior negative factored moment, $k_1$ | 0.75 | 0.70 | 0.70 | 0.70 | 0.65 |
| Positive factored moment, $k_2$ | 0.63 | 0.57 | 0.52 | 0.50 | 0.35 |
| Exterior negative factored moment, $k_3$ | 0.00 | 0.16 | 0.26 | 0.30 | 0.65 |

## MANUAL EXAMPLE

Review the tabulated design for an intermediate flat plate floor, which is subjected to a superimposed factored live load of 200 psf on an 8-in. thick slab in a square panel: $\ell_1 = \ell_2 = 22'\text{-}0''$. Specified strengths of the concrete and reinforcing bars are $f'_c$ = 4,000 psi (150 pcf) and $f_y$ = 60,000 psi. The minimum columns shown are 30-in. square (exterior) and 26-in. square (interior).

*End Span*

From table on Page 9-27:

Column Strip Reinforcement:
- Top Ext = 16 - #4 bars (with 5 additional bars)
- Bottom = 12 - #5 bars
- Top 1st Int = 15 - #6 bars

Middle Strip Reinforcement:
- Bottom = 12 - #4 bars
- Top 1st Int = 11 - #4 bars

$q_u = q_{Du} + q_{Lu} = 1.2\,(100) + 200 = 320$ psf $= 0.320$ ksf

$\ell_n = 22 - (30/2 + 26/2)/12 = 19.667$ ft

$M_o = q_u \ell_2 (\ell_n)^2/8 = 0.320(22)(19.667)^2/8$
$= 340.376$ ft-kips

Factored Moments (ACI 13.6.3.3):
- Ext Col = 0.26 (340.376) = –88.498 ft-kips (tabulated: 88)
- Bottom = 0.52 (340.376) = +176.996 ft-kips (tabulated: 177)
- 1st Int Col = 0.70 (340.376) = –238.263 ft-kips (tabulated: 238)

Required Flexural Reinforcement in End Span:

$$\text{Required } A_s = \frac{1.7 f'_c bd}{2 f_y} - \frac{1}{2}\sqrt{\frac{2.89(f'_c bd)^2}{(f_y)^2} - \frac{6.8 f'_c b M_u}{\phi (f_y)^2}}$$

For $f'_c$ = 4,000 psi, $f_y$ = 60,000 psi, and $\phi$ = 0.90:

$A_s = 0.680\,d - \sqrt{0.462d^2 - 0.0252\,M_u}$

where $M_u$ is in units of in.-kips/ft and $A_s$ is in units of in.$^2$/ft

Slab thickness, $h$ = 8 in.

$d = h$ – (concrete cover + $d_b$) = 8 – 1.5 = 6.5 in.

Exterior Column (Top Bars):

$M_u = 12\,(88.498)/11 = 96.543$ in.-kips/ft

$A_s = 0.680\,(6.5) - \sqrt{0.462\,(6.5)^2 - 0.0252\,(96.543)}$
$= 0.286$ in.$^2$/ft

$A_{s(total)} = 0.286\,(11) = 3.146$ in.$^2$

All reinforcement in column strip = 3.146 in.$^2$ (tabulated: 16 - #4 bars; $A_s$ = 3.20 in.$^2$)

Verify section is tension-controlled so that $\phi = 0.90$:
From Page 5-4 with $f'_c$ = 4,000 psi and $f_y$ = 60,000 psi, max $\rho = 0.0181$ for $\varepsilon_t = 0.005$.

Actual $\rho = A_s/bd = \dfrac{3.20}{11(12)(6.5)} = 0.0037 < \rho_{max}$; $\phi = 0.90$

Bottom Bars:

Column strip $M_u = 0.60\ (176.996) = 106.198$ ft-kips
$M_u = 12\ (106.198)/11 = 115.852$ in.-kips/ft

$$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(115.852)}$$
$$= 0.346 \text{ in.}^2\text{/ft}$$

$A_{s(total)} = 0.346(11) = 3.806$ in.$^2$
(tabulated: 12 - #5 bars; $A_s = 3.72$ in.$^2$)

Actual $\rho = \dfrac{A_s}{bd} = \dfrac{3.72}{11(12)(6.5)} = 0.0043 < \rho_{max}$; $\phi = 0.90$

Middle strip $M_u = 0.40\ (176.996) = 70.798$ ft-kips
$M_u = 12(70.798)/11 = 77.234$ in.-kips/ft

$$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(77.234)}$$
$$= 0.228 \text{ in.}^2\text{/ft}$$

$A_{s(total)} = 0.228(11) = 2.508$ in.$^2$
(tabulated: 12 - #4 bars; $A_s = 2.40$ in.$^2$)

Actual $\rho = \dfrac{A_s}{bd} = \dfrac{2.40}{11(12)(6.5)} = 0.0028 < \rho_{max}$; $\phi = 0.90$

First Interior Column (Top Bars):

Column strip $M_u = 0.75\ (238.263) = 178.697$ ft-kips
$M_u = 12(178.697)/11 = 194.942$ in.-kips/ft

$$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(194.942)}$$
$$= 0.598 \text{ in.}^2\text{/ft}$$

$A_{s(total)} = 0.598(11) = 6.578$ in.$^2$
(tabulated: 15 - #6 bars; $A_s = 6.60$ in.$^2$)

Actual $\rho = \dfrac{A_s}{bd} = \dfrac{6.60}{11(12)(6.5)} = 0.0077 < \rho_{max}$; $\phi = 0.90$

Middle strip $M_u = (1–0.75)(238.263) = 59.566$ ft-kips
$M_u = 12(59.566)/11 = 64.981$ in.-kips/ft

$$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(64.981)}$$
$$= 0.191 \text{ in.}^2\text{/ft}$$

$A_{s(total)} = 0.191(11) = 2.101$ in.$^2$
(tabulated: 11 - #4 bars; $A_s = 2.20$ in.$^2$)

Actual $\rho = \dfrac{A_s}{bd} = \dfrac{2.20}{11(12)(6.5)} = 0.0026 < \rho_{max}$; $\phi = 0.90$

Shear Constants at Exterior Column (ACI R11.11.7.2):

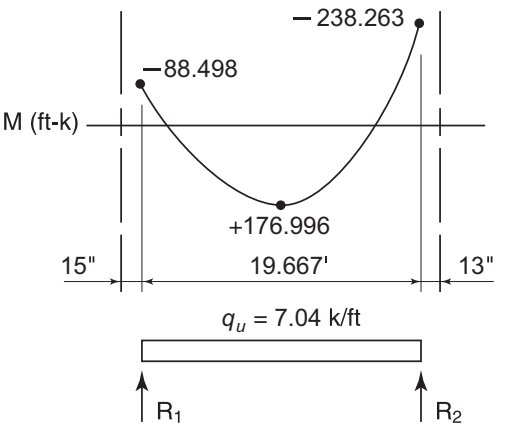
$b_1 = 30 + 6.5/2 = 33.25$ in.
$b_2 = 30 + 6.5 = 36.5$ in.
$A_c = (2 \times 33.25 + 36.5)\ 6.5 = 669.5$ in.$^2$
$C_{AB} = (33.25)^2(6.5/669.5) = 10.734$ in.
$C_{CD} = 33.25 - 10.734 = 22.516$ in.

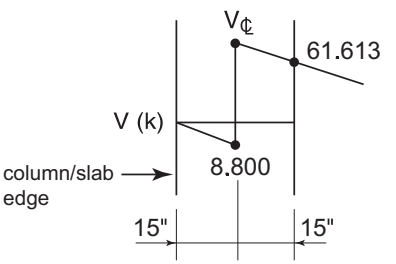
$$J = \frac{b_1 d^3}{6} + \frac{2d\ (C_{AB}^3 + C_{CD}^3)}{3} + b_2 d\ C_{AB}^2$$

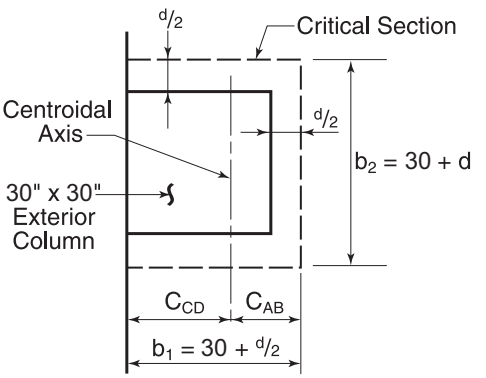
$$J = \frac{33.25(6.5)^3}{6} + \frac{2(6.5)(10.734^3 + 22.516^3)}{3}$$
$$+ 36.5(6.5)(10.734)^2$$
$$= 1{,}522 + 54{,}824 + 27{,}336$$
$$= 83{,}682 \text{ in.}^4$$

Factored Moments and Shears at Column Centerline

$$R_1 = \frac{7.04(19.667)}{2} - \frac{(238.263 - 88.498)}{19.667}$$
$$= 69.228 - 7.615 = 61.613 \text{ kips}$$
$R_2 = 69.228 + 7.615 = 76.843$ kips




$V_{ext} = 61.613 + 7.04\ (30)/12 = 79.213$ kips

Unbalanced moment transferred by shear is $0.3M_o$ (ACI 13.6.3.6).

$M_{unb} = 0.3\ (340.376) = 102.113$ ft kips

$\gamma_f = 1/(1 + (2/3)\sqrt{b_1/b_2})$

$= 1/(1 + (2/3)\sqrt{33.25/36.5}) = 0.611$

$\gamma_v = 1 - \gamma_f = 1 - 0.611 = 0.389$

Maximum shear stress, $v_u$:

$$v_u = \frac{V_{ext}}{A_c} + \frac{\gamma_v M_{unb} C_{AB}}{J}$$

$$= \frac{79.213}{669.5} + \frac{0.389(102.113 \times 12)(10.734)}{83{,}682}$$

$= 0.118 + 0.061 = 0.179$ ksi

$b_o = 2b_1 + b_2 = 2(33.25) + 36.5 = 103.0$ in.

For square columns:

$v_c = (\alpha_s d/b_o + 2)\sqrt{f'_c} \le 4\sqrt{f'_c}$

$= [(30)(6.5)/103.0 + 2]\sqrt{f'_c} = 3.893\sqrt{f'_c} < 4\sqrt{f'_c}$

$\phi v_c = 0.75(3.893)\sqrt{4000}/1000 = 0.185$ ksi

$v_u < \phi v_c$, Okay

Determine the Number of Extra Bars Required in Column Strip at Exterior Column:

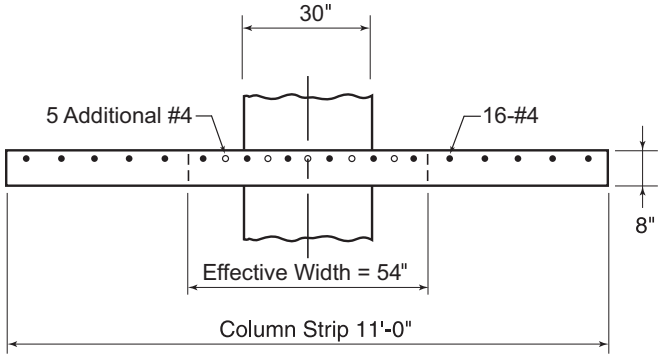
$M_{unb} = 88.498$ ft-kips

$M_u = \gamma_f M_{unb}$

$= 0.611(88.498) = 54.072$ ft-kips

"Effective Width" $= 30 + 1.5\ (8)2 = 54$ in.

Bar Layout:




Bar spacing $= 11 \times 12/16 = 8.25$ in.

Try 5 additional bars (as per tabulated design on Page 9-27) for a total of 11-#4 bars in "effective width"

$A_s = 2.20$ in.$^2$ for 11-#4 bars

$a = A_s f_y/(0.85 f'_c b) = 2.20(60)/(0.85)(4)(54)$

$= 0.719$ in.

$\phi M_n = \phi A_s f_y (d - a/2)$

$= 0.90(2.20)(60)(6.5 - \frac{0.719}{2})/12$

$= 60.791$ ft-kips

$\phi M_n > \gamma_f M_{unb}$, Okay

Actual $\rho = \frac{A_s}{bd} = \frac{2.20}{54(6.5)} = 0.0063 < \rho_{max}$; $\phi = 0.90$

*Interior Span*

From table on Page 9-27:

Column Strip Reinforcement:
Bottom = 13-#4 bars
Top = 11-#7 bars
Middle Strip Reinforcement:
Bottom = 10-#4 bars
Top = 11-#4 bars

$q_u = 0.320$ ksf

$\ell_n = 22 - (26)/12 = 19.833$ ft

$M_o = 0.320(22)(19.833)^2/8 = 346.146$ ft-kips

Factored Moments (ACI 13.6.3.2):
Bottom $= 0.35(346.146) = 121.151$ ft-kips
Top $= 0.65(346.146) = 224.994$ ft-kips

Required Flexural Reinforcement:
$d = 6.5$ in.

Bottom Bars:
Column Strip: $M_u = 0.60(121.151)$
$= 72.691$ ft-kips

$M_u = 12(72.691)/11 = 79.299$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(79.299)}$

$= 0.232$ in.$^2$/ft

$A_{s(total)} = 0.232(11) = 2.552$ in.$^2$

(tabulated: 13-#4 bars; $A_s = 2.60$ in.$^2$)

Actual $\rho = \frac{A_s}{bd} = \frac{2.60}{11(12)(6.5)} = 0.0030 < \rho_{max}$;
$\phi = 0.90$

Middle Strip: $M_u = 0.40(121.151) = 48.460$ ft-kips

$M_u = 12(48.460)/11 = 52.866$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(52.866)}$

$= 0.155$ in.$^2$/ft

$A_{s(total)} = 0.155(11) = 1.705$ in.$^2$

(tabulated: 10-#4 bars; $A_s = 2.00$ in.$^2$)

Min $A_s = 0.0018\ bh = 0.0018\ (11 \times 12)(8)$

$= 1.90$ in.$^2$

Top Bars:

Column Strip: $M_u = 0.75(224.994) = 168.746$ ft-kips

$M_u = 12(168.746)/11 = 184.087$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(184.087)}$

$= 0.563$ in.$^2$/ft

$A_{s(total)} = 0.563(11) = 6.193$ in.$^2$

(tabulated: 11-#7 bars; $A_s = 6.60$ in.$^2$)

Actual $\rho = \dfrac{A_s}{bd} = \dfrac{6.60}{11(12)(6.5)} = 0.0077 < \rho_{max}$;

$\phi = 0.90$

Middle Strip: $M_u = 0.25\ (224.994) = 56.249$ ft-kips

$M_u = 12(56.249)/11 = 61.363$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(61.363)}$

$= 0.181$ in.$^2$/ft

$A_{s(total)} = 0.181(11) = 1.991$ in.$^2$

(tabulated: 11-#4 bars; $A_s = 2.20$ in.$^2$)

By inspection, actual $\rho < \rho_{max}$; $\phi = 0.90$

Shear Constants:

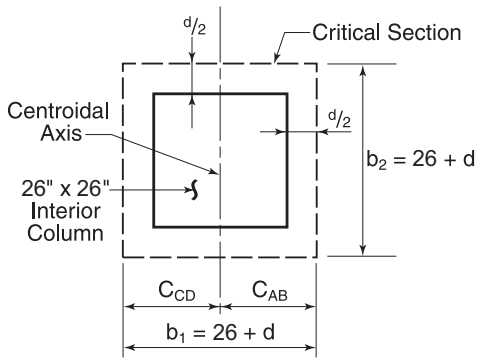
$b_1 = b_2 = 26 + 6.5 = 32.5$ in.

$A_c = 4\ (32.5)\ 6.5 = 845.0$ in.$^2$

$C_{AB} = C_{CD} = 32.5/2 = 16.25$ in.

$$J = \frac{b_1 d^3}{6} + \frac{d(b_1)^3}{6} + \frac{d(b_1)^3}{2} = \frac{d\,b_1}{6}(d^2 + 4\,b_1^2)$$

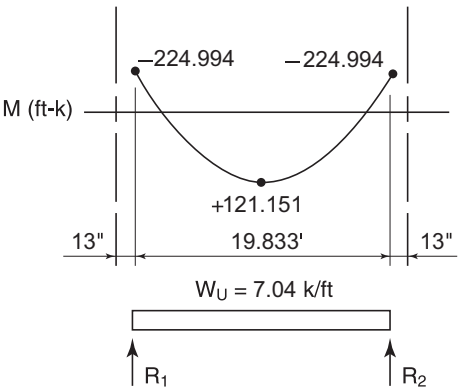
$$J = \frac{6.5\,(32.5)}{6}(6.5^2 + 4\,(32.5)^2) = 150{,}243 \text{ in.}^4$$




Factored Moments and Shears at Column Centerline:

$$R_1 = R_2 = 76.843 + \frac{7.04(19.833)}{2} + \frac{7.04(26)}{12}$$

$= 76.843 + 69.812 + 15.253 = 161.908$ kips




$M_{int} = 0.07\ [(q_{Du} + 0.5\ q_{Lu})\ \ell_2\ (\ell_n)^2 - q'_{Du}\ \ell'_2\ (\ell'_n)^2]$... (ACI Eq. 13-4)

Where $q'_{Du}$, $\ell'_2$ and $\ell'_n$ refer to the shorter span

$M_{int} = 0.07\ [(0.120 + 0.100)(22)(19.833)^2$

$- 0.120\ (22)\ (19.833)^2]$

$= 0.07\,[1{,}903.804 - 1{,}038.438] = 60.576$ ft-kips

Maximum Shear Stress:

$b_o = 4b_1 = 4\,(32.5) = 130.0$ in.

$V_{int} = 161.908$ kips,

$M_{int} = 60.576$ ft-kips (i.e., full load on one side, dead load only on other side)

With moment, $V = q_u\ \ell/2 + q_{Du}\ \ell/2$

$= 7.04(22)/2 + 2.64(22)/2 = 106.480$ kips

$\gamma_f = 1/(1 + (2/3)\sqrt{b_1/b_2}) = 0.600$

$\gamma_v = 1 - \gamma_f = 0.400$

$$v_u = \frac{V}{A_c} + \frac{\gamma_v MC_{AB}}{J}$$

$$v_u = \frac{106.480}{845.0} + \frac{0.400\,(12 \times 60.576)\,16.25}{150{,}243}$$

$= 0.126 + 0.032 = 0.158$ ksi

$$v_c = (\alpha_s d/b_o + 2)\sqrt{f'_c} \le 4\sqrt{f'_c}$$

$$v_c = [40\ (6.5)/130.0 + 2]\sqrt{f'_c} \le 4\sqrt{f'_c}$$

$= 4\sqrt{f'_c}$

Use $v_c = 4\sqrt{f'_c}$

$\phi v_c = 0.75(4)\sqrt{4000}/1000 = 0.190$ ksi

$\phi v_c > v_u$, Okay

With $V_{int} = 161.908$ kips and $M = 0$ (i.e., full load on both sides of column)

$$v_u = \frac{V_{int}}{A_c} = \frac{161.908}{845.0} = 0.192 \text{ ksi}$$

$\phi v_c = 0.190$ ksi $\approx v_u$, Okay within 15%

## TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 10 | 5 | 2.94 | 82 | 1,200 | 3.73 | 130 | 2,100 | 6.75 | 189 | 5,800 |
| | 6 | 3.06 | 110 | 1,800 | 3.85 | 176 | 3,100 | 7.25 | 261 | 9,400 |
| | 7 | 3.19 | 140 | 2,600 | 3.96 | 226 | 4,400 | 7.75 | 341 | 14,100 |
| | 8 | 3.31 | 172 | 3,500 | 4.08 | 280 | 6,000 | 8.25 | 429 | 20,200 |
| | 9 | 3.44 | 206 | 4,500 | 4.20 | 338 | 8,000 | 8.75 | 525 | 28,000 |
| | 10 | 3.56 | 242 | 5,900 | 4.32 | 400 | 10,400 | 9.25 | 629 | 37,800 |
| | 11 | 3.69 | 280 | 7,400 | 4.44 | 466 | 13,300 | 9.75 | 741 | 49,700 |
| | 12 | 3.81 | 320 | 9,200 | 4.56 | 536 | 16,600 | 10.25 | 861 | 64,300 |
| | 13 | 3.94 | 362 | 11,400 | 4.68 | 610 | 20,600 | 10.75 | 989 | 81,600 |
| | 14 | 4.06 | 406 | 13,800 | 4.80 | 688 | 25,200 | 11.25 | 1,125 | 102,200 |
| | 15 | 4.19 | 452 | 16,700 | 4.92 | 770 | 30,500 | 11.75 | 1,269 | 126,400 |
| | 16 | 4.31 | 500 | 19,900 | 5.04 | 856 | 36,600 | 12.25 | 1,421 | 154,600 |
| | 17 | 4.44 | 550 | 23,600 | 5.16 | 946 | 43,600 | 12.75 | 1,581 | 187,200 |
| | 18 | 4.56 | 602 | 27,700 | 5.29 | 1,040 | 51,500 | 13.25 | 1,749 | 224,500 |
| | 19 | 4.69 | 656 | 32,400 | 5.41 | 1,138 | 60,400 | 13.75 | 1,925 | 267,200 |
| | 20 | 4.81 | 712 | 37,700 | 5.53 | 1,240 | 70,400 | 14.25 | 2,109 | 315,600 |
| | 21 | 4.94 | 770 | 43,500 | 5.65 | 1,346 | 81,600 | 14.75 | 2,301 | 370,200 |
| | 22 | 5.06 | 830 | 50,000 | 5.78 | 1,456 | 94,000 | 15.25 | 2,501 | 431,600 |
| | 23 | 5.19 | 892 | 57,200 | 5.90 | 1,570 | 107,800 | 15.75 | 2,709 | 500,200 |
| | 24 | 5.31 | 956 | 65,200 | 6.02 | 1,688 | 123,100 | 16.25 | 2,925 | 576,600 |
| 12 | 5 | 3.44 | 96 | 1,900 | 4.40 | 151 | 3,300 | 7.75 | 217 | 8,800 |
| | 6 | 3.56 | 128 | 2,800 | 4.51 | 203 | 4,800 | 8.25 | 297 | 13,700 |
| | 7 | 3.69 | 162 | 3,900 | 4.63 | 259 | 6,600 | 8.75 | 385 | 20,100 |
| | 8 | 3.81 | 198 | 5,200 | 4.75 | 319 | 8,900 | 9.25 | 481 | 28,300 |
| | 9 | 3.94 | 236 | 6,700 | 4.86 | 383 | 11,600 | 9.75 | 585 | 38,400 |
| | 10 | 4.06 | 276 | 8,400 | 4.98 | 451 | 14,800 | 10.25 | 697 | 50,900 |
| | 11 | 4.19 | 318 | 10,500 | 5.10 | 523 | 18,600 | 10.75 | 817 | 66,000 |
| | 12 | 4.31 | 362 | 12,900 | 5.22 | 599 | 22,900 | 11.25 | 945 | 84,100 |
| | 13 | 4.44 | 408 | 15,600 | 5.34 | 679 | 28,000 | 11.75 | 1,081 | 105,500 |
| | 14 | 4.56 | 456 | 18,800 | 5.46 | 763 | 33,900 | 12.25 | 1,225 | 130,500 |
| | 15 | 4.69 | 506 | 22,400 | 5.58 | 851 | 40,500 | 12.75 | 1,377 | 159,700 |
| | 16 | 4.81 | 558 | 26,400 | 5.70 | 943 | 48,100 | 13.25 | 1,537 | 193,400 |
| | 17 | 4.94 | 612 | 31,000 | 5.82 | 1,039 | 56,700 | 13.75 | 1,705 | 232,000 |
| | 18 | 5.06 | 668 | 36,100 | 5.94 | 1,139 | 66,300 | 14.25 | 1,881 | 276,000 |
| | 19 | 5.19 | 726 | 41,800 | 6.06 | 1,243 | 77,100 | 14.75 | 2,065 | 325,900 |
| | 20 | 5.31 | 786 | 48,200 | 6.19 | 1,351 | 89,100 | 15.25 | 2,257 | 382,100 |
| | 21 | 5.44 | 848 | 55,200 | 6.31 | 1,463 | 102,500 | 15.75 | 2,457 | 445,300 |
| | 22 | 5.56 | 912 | 63,000 | 6.43 | 1,579 | 117,200 | 16.25 | 2,665 | 515,800 |
| | 23 | 5.69 | 978 | 71,600 | 6.55 | 1,699 | 133,500 | 16.75 | 2,881 | 594,400 |
| | 24 | 5.81 | 1,046 | 81,000 | 6.67 | 1,823 | 151,500 | 17.25 | 3,105 | 681,500 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.


## TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS


| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 14 | 5 | 3.94 | 110 | 2,900 | 5.06 | 172 | 4,800 | 8.75 | 245 | 12,600 |
| | 6 | 4.06 | 146 | 4,100 | 5.18 | 230 | 7,000 | 9.25 | 333 | 19,300 |
| | 7 | 4.19 | 184 | 5,600 | 5.29 | 292 | 9,500 | 9.75 | 429 | 27,700 |
| | 8 | 4.31 | 224 | 7,300 | 5.41 | 358 | 12,600 | 10.25 | 533 | 38,300 |
| | 9 | 4.44 | 266 | 9,400 | 5.53 | 428 | 16,100 | 10.75 | 645 | 51,200 |
| | 10 | 4.56 | 310 | 11,700 | 5.65 | 502 | 20,300 | 11.25 | 765 | 66,800 |
| | 11 | 4.69 | 356 | 14,400 | 5.76 | 580 | 25,200 | 11.75 | 893 | 85,600 |
| | 12 | 4.81 | 404 | 17,500 | 5.88 | 662 | 30,800 | 12.25 | 1,029 | 107,700 |
| | 13 | 4.94 | 454 | 21,000 | 6.00 | 748 | 37,100 | 12.75 | 1,173 | 133,600 |
| | 14 | 5.06 | 506 | 24,900 | 6.12 | 838 | 44,400 | 13.25 | 1,325 | 163,700 |
| | 15 | 5.19 | 560 | 29,400 | 6.24 | 932 | 52,600 | 13.75 | 1,485 | 198,400 |
| | 16 | 5.31 | 616 | 34,400 | 6.36 | 1,030 | 61,900 | 14.25 | 1,653 | 238,300 |
| | 17 | 5.44 | 674 | 40,000 | 6.48 | 1,132 | 72,300 | 14.75 | 1,829 | 283,600 |
| | 18 | 5.56 | 734 | 46,200 | 6.60 | 1,238 | 83,900 | 15.25 | 2,013 | 334,900 |
| | 19 | 5.69 | 796 | 53,100 | 6.72 | 1,348 | 96,800 | 15.75 | 2,205 | 392,800 |
| | 20 | 5.81 | 860 | 60,700 | 6.84 | 1,462 | 111,100 | 16.25 | 2,405 | 457,700 |
| | 21 | 5.94 | 926 | 69,100 | 6.96 | 1,580 | 126,900 | 16.75 | 2,613 | 530,100 |
| | 22 | 6.06 | 994 | 78,300 | 7.09 | 1,702 | 144,300 | 17.25 | 2,829 | 610,700 |
| | 23 | 6.19 | 1,064 | 88,400 | 7.21 | 1,828 | 163,400 | 17.75 | 3,053 | 700,100 |
| | 24 | 6.31 | 1,136 | 99,400 | 7.33 | 1,958 | 184,300 | 18.25 | 3,285 | 798,700 |
| 16 | 5 | 4.44 | 124 | 4,100 | 5.73 | 193 | 6,900 | 9.75 | 273 | 17,400 |
| | 6 | 4.56 | 164 | 5,800 | 5.84 | 257 | 9,800 | 10.25 | 369 | 26,200 |
| | 7 | 4.69 | 206 | 7,800 | 5.96 | 325 | 13,200 | 10.75 | 473 | 37,000 |
| | 8 | 4.81 | 250 | 10,100 | 6.07 | 397 | 17,200 | 11.25 | 585 | 50,400 |
| | 9 | 4.94 | 296 | 12,700 | 6.19 | 473 | 21,800 | 11.75 | 705 | 66,500 |
| | 10 | 5.06 | 344 | 15,700 | 6.31 | 553 | 27,100 | 12.25 | 833 | 85,800 |
| | 11 | 5.19 | 394 | 19,200 | 6.43 | 637 | 33,300 | 12.75 | 969 | 108,700 |
| | 12 | 5.31 | 446 | 23,000 | 6.54 | 725 | 40,200 | 13.25 | 1,113 | 135,400 |
| | 13 | 5.44 | 500 | 27,400 | 6.66 | 817 | 48,100 | 13.75 | 1,265 | 166,400 |
| | 14 | 5.56 | 556 | 32,300 | 6.78 | 913 | 57,100 | 14.25 | 1,425 | 202,200 |
| | 15 | 5.69 | 614 | 37,800 | 6.90 | 1,013 | 67,100 | 14.75 | 1,593 | 243,100 |
| | 16 | 5.81 | 674 | 43,900 | 7.02 | 1,117 | 78,300 | 15.25 | 1,769 | 289,800 |
| | 17 | 5.94 | 736 | 50,600 | 7.14 | 1,225 | 90,700 | 15.75 | 1,953 | 342,500 |
| | 18 | 6.06 | 800 | 58,100 | 7.26 | 1,337 | 104,600 | 16.25 | 2,145 | 401,900 |
| | 19 | 6.19 | 866 | 66,300 | 7.38 | 1,453 | 119,900 | 16.75 | 2,345 | 468,500 |
| | 20 | 6.31 | 934 | 75,400 | 7.50 | 1,573 | 136,700 | 17.25 | 2,553 | 542,900 |
| | 21 | 6.44 | 1,004 | 85,300 | 7.62 | 1,697 | 155,200 | 17.75 | 2,769 | 625,500 |
| | 22 | 6.56 | 1,076 | 96,100 | 7.74 | 1,825 | 175,500 | 18.25 | 2,993 | 717,000 |
| | 23 | 6.69 | 1,150 | 107,900 | 7.86 | 1,957 | 197,700 | 18.75 | 3,225 | 818,000 |
| | 24 | 6.81 | 1,226 | 120,700 | 7.98 | 2,093 | 221,900 | 19.25 | 3,465 | 929,100 |


*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

## TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 18 | 5 | 4.94 | 138 | 5,700 | 6.39 | 214 | 9,400 | 10.75 | 301 | 23,300 |
| | 6 | 5.06 | 182 | 7,900 | 6.51 | 284 | 13,200 | 11.25 | 405 | 34,500 |
| | 7 | 5.19 | 228 | 10,500 | 6.62 | 358 | 17,600 | 11.75 | 517 | 48,200 |
| | 8 | 5.31 | 276 | 13,500 | 6.74 | 436 | 22,800 | 12.25 | 637 | 64,800 |
| | 9 | 5.44 | 326 | 16,800 | 6.86 | 518 | 28,700 | 12.75 | 765 | 84,700 |
| | 10 | 5.56 | 378 | 20,600 | 6.97 | 604 | 35,400 | 13.25 | 901 | 108,200 |
| | 11 | 5.69 | 432 | 24,900 | 7.09 | 694 | 43,000 | 13.75 | 1,045 | 135,600 |
| | 12 | 5.81 | 488 | 29,700 | 7.21 | 788 | 51,600 | 14.25 | 1,197 | 167,500 |
| | 13 | 5.94 | 546 | 35,100 | 7.33 | 886 | 61,200 | 14.75 | 1,357 | 204,300 |
| | 14 | 6.06 | 606 | 41,100 | 7.44 | 988 | 72,000 | 15.25 | 1,525 | 246,400 |
| | 15 | 6.19 | 668 | 47,700 | 7.56 | 1,094 | 84,100 | 15.75 | 1,701 | 294,200 |
| | 16 | 6.31 | 732 | 55,000 | 7.68 | 1,204 | 97,400 | 16.25 | 1,885 | 348,400 |
| | 17 | 6.44 | 798 | 63,100 | 7.80 | 1,318 | 112,200 | 16.75 | 2,077 | 409,300 |
| | 18 | 6.56 | 866 | 72,000 | 7.92 | 1,436 | 128,600 | 17.25 | 2,277 | 477,500 |
| | 19 | 6.69 | 936 | 81,700 | 8.04 | 1,558 | 146,500 | 17.75 | 2,485 | 553,700 |
| | 20 | 6.81 | 1,008 | 92,400 | 8.16 | 1,684 | 166,200 | 18.25 | 2,701 | 638,300 |
| | 21 | 6.94 | 1,082 | 104,000 | 8.28 | 1,814 | 187,800 | 18.75 | 2,925 | 731,900 |
| | 22 | 7.06 | 1,158 | 116,600 | 8.40 | 1,948 | 211,200 | 19.25 | 3,157 | 835,200 |
| | 23 | 7.19 | 1,236 | 130,300 | 8.52 | 2,086 | 236,800 | 19.75 | 3,397 | 948,800 |
| | 24 | 7.31 | 1,316 | 145,100 | 8.64 | 2,228 | 264,500 | 20.25 | 3,645 | 1,073,300 |
| 20 | 5 | 5.44 | 152 | 7,600 | 7.06 | 235 | 12,500 | 11.75 | 329 | 30,400 |
| | 6 | 5.56 | 200 | 10,500 | 7.17 | 311 | 17,400 | 12.25 | 441 | 44,500 |
| | 7 | 5.69 | 250 | 13,800 | 7.29 | 391 | 23,100 | 12.75 | 561 | 61,500 |
| | 8 | 5.81 | 302 | 17,600 | 7.40 | 475 | 29,500 | 13.25 | 689 | 81,900 |
| | 9 | 5.94 | 356 | 21,800 | 7.52 | 563 | 36,800 | 13.75 | 825 | 105,900 |
| | 10 | 6.06 | 412 | 26,500 | 7.64 | 655 | 45,100 | 14.25 | 969 | 134,100 |
| | 11 | 6.19 | 470 | 31,800 | 7.75 | 751 | 54,400 | 14.75 | 1,121 | 166,800 |
| | 12 | 6.31 | 530 | 37,700 | 7.87 | 851 | 64,900 | 15.25 | 1,281 | 204,500 |
| | 13 | 6.44 | 592 | 44,200 | 7.99 | 955 | 76,500 | 15.75 | 1,449 | 247,600 |
| | 14 | 6.56 | 656 | 51,400 | 8.11 | 1,063 | 89,500 | 16.25 | 1,625 | 296,600 |
| | 15 | 6.69 | 722 | 59,300 | 8.22 | 1,175 | 103,800 | 16.75 | 1,809 | 352,100 |
| | 16 | 6.81 | 790 | 68,000 | 8.34 | 1,291 | 119,600 | 17.25 | 2,001 | 414,500 |
| | 17 | 6.94 | 860 | 77,600 | 8.46 | 1,411 | 137,000 | 17.75 | 2,201 | 484,300 |
| | 18 | 7.06 | 932 | 88,100 | 8.58 | 1,535 | 156,100 | 18.25 | 2,409 | 562,200 |
| | 19 | 7.19 | 1,006 | 99,500 | 8.70 | 1,663 | 177,100 | 18.75 | 2,625 | 648,700 |
| | 20 | 7.31 | 1,082 | 111,900 | 8.82 | 1,795 | 199,900 | 19.25 | 2,849 | 744,400 |
| | 21 | 7.44 | 1,160 | 125,400 | 8.94 | 1,931 | 224,800 | 19.75 | 3,081 | 850,000 |
| | 22 | 7.56 | 1,240 | 139,900 | 9.06 | 2,071 | 251,800 | 20.25 | 3,321 | 966,000 |
| | 23 | 7.69 | 1,322 | 155,700 | 9.18 | 2,215 | 281,100 | 20.75 | 3,569 | 1,093,200 |
| | 24 | 7.81 | 1,406 | 172,700 | 9.30 | 2,363 | 312,700 | 21.25 | 3,825 | 1,232,200 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 22 | 5 | 5.94 | 166 | 9,900 | 7.73 | 256 | 16,200 | 12.75 | 357 | 38,900 |
| | 6 | 6.06 | 218 | 13,600 | 7.84 | 338 | 22,400 | 13.25 | 477 | 56,200 |
| | 7 | 6.19 | 272 | 17,700 | 7.96 | 424 | 29,500 | 13.75 | 605 | 77,000 |
| | 8 | 6.31 | 328 | 22,400 | 8.07 | 514 | 37,500 | 14.25 | 741 | 101,600 |
| | 9 | 6.44 | 386 | 27,600 | 8.19 | 608 | 46,500 | 14.75 | 885 | 130,400 |
| | 10 | 6.56 | 446 | 33,400 | 8.30 | 706 | 56,600 | 15.25 | 1,037 | 163,900 |
| | 11 | 6.69 | 508 | 39,800 | 8.42 | 808 | 67,800 | 15.75 | 1,197 | 202,500 |
| | 12 | 6.81 | 572 | 46,900 | 8.54 | 914 | 80,400 | 16.25 | 1,365 | 246,600 |
| | 13 | 6.94 | 638 | 54,700 | 8.65 | 1,024 | 94,200 | 16.75 | 1,541 | 296,700 |
| | 14 | 7.06 | 706 | 63,300 | 8.77 | 1,138 | 109,600 | 17.25 | 1,725 | 353,400 |
| | 15 | 7.19 | 776 | 72,700 | 8.89 | 1,256 | 126,500 | 17.75 | 1,917 | 417,200 |
| | 16 | 7.31 | 848 | 83,000 | 9.01 | 1,378 | 145,000 | 18.25 | 2,117 | 488,600 |
| | 17 | 7.44 | 922 | 94,300 | 9.12 | 1,504 | 165,400 | 18.75 | 2,325 | 568,200 |
| | 18 | 7.56 | 998 | 106,500 | 9.24 | 1,634 | 187,600 | 19.25 | 2,541 | 656,600 |
| | 19 | 7.69 | 1,076 | 119,700 | 9.36 | 1,768 | 211,800 | 19.75 | 2,765 | 754,300 |
| | 20 | 7.81 | 1,156 | 134,100 | 9.48 | 1,906 | 238,100 | 20.25 | 2,997 | 862,000 |
| | 21 | 7.94 | 1,238 | 149,600 | 9.60 | 2,048 | 266,600 | 20.75 | 3,237 | 980,400 |
| | 22 | 8.06 | 1,322 | 166,400 | 9.72 | 2,194 | 297,500 | 21.25 | 3,485 | 1,110,200 |
| | 23 | 8.19 | 1,408 | 184,500 | 9.84 | 2,344 | 330,800 | 21.75 | 3,741 | 1,251,900 |
| | 24 | 8.31 | 1,496 | 203,900 | 9.96 | 2,498 | 366,800 | 22.25 | 4,005 | 1,406,300 |
| 24 | 5 | 6.44 | 180 | 12,500 | 8.39 | 277 | 20,500 | 13.75 | 385 | 48,700 |
| | 6 | 6.56 | 236 | 17,200 | 8.51 | 365 | 28,300 | 14.25 | 513 | 69,900 |
| | 7 | 6.69 | 294 | 22,300 | 8.62 | 457 | 37,000 | 14.75 | 649 | 95,000 |
| | 8 | 6.81 | 354 | 28,000 | 8.74 | 553 | 46,800 | 15.25 | 793 | 124,300 |
| | 9 | 6.94 | 416 | 34,400 | 8.85 | 653 | 57,700 | 15.75 | 945 | 158,500 |
| | 10 | 7.06 | 480 | 41,400 | 8.97 | 757 | 69,800 | 16.25 | 1,105 | 197,900 |
| | 11 | 7.19 | 546 | 49,100 | 9.08 | 865 | 83,300 | 16.75 | 1,273 | 242,900 |
| | 12 | 7.31 | 614 | 57,600 | 9.20 | 977 | 98,200 | 17.25 | 1,449 | 294,100 |
| | 13 | 7.44 | 684 | 66,900 | 9.32 | 1,093 | 114,600 | 17.75 | 1,633 | 352,000 |
| | 14 | 7.56 | 756 | 77,000 | 9.43 | 1,213 | 132,600 | 18.25 | 1,825 | 417,100 |
| | 15 | 7.69 | 830 | 88,100 | 9.55 | 1,337 | 152,400 | 18.75 | 2,025 | 490,000 |
| | 16 | 7.81 | 906 | 100,100 | 9.67 | 1,465 | 174,000 | 19.25 | 2,233 | 571,200 |
| | 17 | 7.94 | 984 | 113,200 | 9.79 | 1,597 | 197,500 | 19.75 | 2,449 | 661,400 |
| | 18 | 8.06 | 1,064 | 127,400 | 9.91 | 1,733 | 223,100 | 20.25 | 2,673 | 761,100 |
| | 19 | 8.19 | 1,146 | 142,700 | 10.02 | 1,873 | 250,900 | 20.75 | 2,905 | 870,900 |
| | 20 | 8.31 | 1,230 | 159,200 | 10.14 | 2,017 | 281,000 | 21.25 | 3,145 | 991,600 |
| | 21 | 8.44 | 1,316 | 177,000 | 10.26 | 2,165 | 313,500 | 21.75 | 3,393 | 1,123,800 |
| | 22 | 8.56 | 1,404 | 196,200 | 10.38 | 2,317 | 348,600 | 22.25 | 3,649 | 1,268,200 |
| | 23 | 8.69 | 1,494 | 216,700 | 10.50 | 2,473 | 386,400 | 22.75 | 3,913 | 1,425,500 |
| | 24 | 8.81 | 1,586 | 238,800 | 10.62 | 2,633 | 427,000 | 23.25 | 4,185 | 1,596,400 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

## TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 26 | 5 | 6.94 | 194 | 15,700 | 9.06 | 298 | 25,600 | 14.75 | 413 | 60,100 |
| | 6 | 7.06 | 254 | 21,400 | 9.17 | 392 | 35,100 | 15.25 | 549 | 85,600 |
| | 7 | 7.19 | 316 | 27,600 | 9.29 | 490 | 45,700 | 15.75 | 693 | 115,500 |
| | 8 | 7.31 | 380 | 34,600 | 9.40 | 592 | 57,500 | 16.25 | 845 | 150,200 |
| | 9 | 7.44 | 446 | 42,200 | 9.52 | 698 | 70,600 | 16.75 | 1,005 | 190,300 |
| | 10 | 7.56 | 514 | 50,600 | 9.63 | 808 | 85,000 | 17.25 | 1,173 | 236,200 |
| | 11 | 7.69 | 584 | 59,700 | 9.75 | 922 | 101,000 | 17.75 | 1,349 | 288,400 |
| | 12 | 7.81 | 656 | 69,800 | 9.86 | 1,040 | 118,500 | 18.25 | 1,533 | 347,400 |
| | 13 | 7.94 | 730 | 80,700 | 9.98 | 1,162 | 137,700 | 18.75 | 1,725 | 413,800 |
| | 14 | 8.06 | 806 | 92,600 | 10.10 | 1,288 | 158,700 | 19.25 | 1,925 | 488,100 |
| | 15 | 8.19 | 884 | 105,500 | 10.21 | 1,418 | 181,700 | 19.75 | 2,133 | 570,900 |
| | 16 | 8.31 | 964 | 119,500 | 10.33 | 1,552 | 206,600 | 20.25 | 2,349 | 662,700 |
| | 17 | 8.44 | 1,046 | 134,600 | 10.45 | 1,690 | 233,700 | 20.75 | 2,573 | 764,300 |
| | 18 | 8.56 | 1,130 | 150,900 | 10.57 | 1,832 | 263,000 | 21.25 | 2,805 | 876,200 |
| | 19 | 8.69 | 1,216 | 168,500 | 10.69 | 1,978 | 294,800 | 21.75 | 3,045 | 999,200 |
| | 20 | 8.81 | 1,304 | 187,400 | 10.80 | 2,128 | 329,000 | 22.25 | 3,293 | 1,133,800 |
| | 21 | 8.94 | 1,394 | 207,700 | 10.92 | 2,282 | 365,900 | 22.75 | 3,549 | 1,280,800 |
| | 22 | 9.06 | 1,486 | 229,500 | 11.04 | 2,440 | 405,600 | 23.25 | 3,813 | 1,440,900 |
| | 23 | 9.19 | 1,580 | 252,800 | 11.16 | 2,602 | 448,200 | 23.75 | 4,085 | 1,614,800 |
| | 24 | 9.31 | 1,676 | 277,600 | 11.28 | 2,768 | 493,800 | 24.25 | 4,365 | 1,803,300 |
| 28 | 5 | 7.44 | 208 | 19,300 | 9.73 | 319 | 31,500 | 15.75 | 441 | 73,200 |
| | 6 | 7.56 | 272 | 26,200 | 9.84 | 419 | 43,000 | 16.25 | 585 | 103,500 |
| | 7 | 7.69 | 338 | 33,700 | 9.95 | 523 | 55,700 | 16.75 | 737 | 138,800 |
| | 8 | 7.81 | 406 | 42,000 | 10.07 | 631 | 69,800 | 17.25 | 897 | 179,500 |
| | 9 | 7.94 | 476 | 51,100 | 10.18 | 743 | 85,300 | 17.75 | 1,065 | 226,200 |
| | 10 | 8.06 | 548 | 61,000 | 10.30 | 859 | 102,300 | 18.25 | 1,241 | 279,300 |
| | 11 | 8.19 | 622 | 71,900 | 10.41 | 979 | 121,000 | 18.75 | 1,425 | 339,300 |
| | 12 | 8.31 | 698 | 83,600 | 10.53 | 1,103 | 141,500 | 19.25 | 1,617 | 406,900 |
| | 13 | 8.44 | 776 | 96,400 | 10.65 | 1,231 | 163,800 | 19.75 | 1,817 | 482,500 |
| | 14 | 8.56 | 856 | 110,200 | 10.76 | 1,363 | 188,200 | 20.25 | 2,025 | 566,800 |
| | 15 | 8.69 | 938 | 125,100 | 10.88 | 1,499 | 214,600 | 20.75 | 2,241 | 660,300 |
| | 16 | 8.81 | 1,022 | 141,300 | 11.00 | 1,639 | 243,200 | 21.25 | 2,465 | 763,700 |
| | 17 | 8.94 | 1,108 | 158,600 | 11.11 | 1,783 | 274,200 | 21.75 | 2,697 | 877,600 |
| | 18 | 9.06 | 1,196 | 177,300 | 11.23 | 1,931 | 307,600 | 22.25 | 2,937 | 1,002,600 |
| | 19 | 9.19 | 1,286 | 197,400 | 11.35 | 2,083 | 343,600 | 22.75 | 3,185 | 1,139,600 |
| | 20 | 9.31 | 1,378 | 218,900 | 11.47 | 2,239 | 382,400 | 23.25 | 3,441 | 1,289,100 |
| | 21 | 9.44 | 1,472 | 241,900 | 11.59 | 2,399 | 424,000 | 23.75 | 3,705 | 1,451,900 |
| | 22 | 9.56 | 1,568 | 266,500 | 11.70 | 2,563 | 468,700 | 24.25 | 3,977 | 1,628,800 |
| | 23 | 9.69 | 1,666 | 292,700 | 11.82 | 2,731 | 516,500 | 24.75 | 4,257 | 1,820,400 |
| | 24 | 9.81 | 1,766 | 320,700 | 11.94 | 2,903 | 567,600 | 25.25 | 4,545 | 2,027,700 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.


## TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS


| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 30 | 5 | 7.94 | 222 | 23,500 | 10.39 | 340 | 38,200 | 16.75 | 469 | 88,000 |
| | 6 | 8.06 | 290 | 31,700 | 10.51 | 446 | 51,900 | 17.25 | 621 | 123,700 |
| | 7 | 8.19 | 360 | 40,700 | 10.62 | 556 | 67,100 | 17.75 | 781 | 165,000 |
| | 8 | 8.31 | 432 | 50,500 | 10.73 | 670 | 83,700 | 18.25 | 949 | 212,400 |
| | 9 | 8.44 | 506 | 61,300 | 10.85 | 788 | 101,900 | 18.75 | 1,125 | 266,300 |
| | 10 | 8.56 | 582 | 72,900 | 10.96 | 910 | 121,900 | 19.25 | 1,309 | 327,300 |
| | 11 | 8.69 | 660 | 85,500 | 11.08 | 1,036 | 143,600 | 19.75 | 1,501 | 396,000 |
| | 12 | 8.81 | 740 | 99,200 | 11.19 | 1,166 | 167,400 | 20.25 | 1,701 | 472,800 |
| | 13 | 8.94 | 822 | 114,000 | 11.31 | 1,300 | 193,100 | 20.75 | 1,909 | 558,500 |
| | 14 | 9.06 | 906 | 129,900 | 11.43 | 1,438 | 221,100 | 21.25 | 2,125 | 653,500 |
| | 15 | 9.19 | 992 | 147,100 | 11.54 | 1,580 | 251,300 | 21.75 | 2,349 | 758,700 |
| | 16 | 9.31 | 1,080 | 165,600 | 11.66 | 1,726 | 284,000 | 22.25 | 2,581 | 874,400 |
| | 17 | 9.44 | 1,170 | 185,400 | 11.78 | 1,876 | 319,200 | 22.75 | 2,821 | 1,001,600 |
| | 18 | 9.56 | 1,262 | 206,700 | 11.89 | 2,030 | 357,100 | 23.25 | 3,069 | 1,140,800 |
| | 19 | 9.69 | 1,356 | 229,400 | 12.01 | 2,188 | 397,800 | 23.75 | 3,325 | 1,292,800 |
| | 20 | 9.81 | 1,452 | 253,800 | 12.13 | 2,350 | 441,500 | 24.25 | 3,589 | 1,458,200 |
| | 21 | 9.94 | 1,550 | 279,700 | 12.25 | 2,516 | 488,200 | 24.75 | 3,861 | 1,637,900 |
| | 22 | 10.06 | 1,650 | 307,400 | 12.37 | 2,686 | 538,200 | 25.25 | 4,141 | 1,832,600 |
| | 23 | 10.19 | 1,752 | 336,800 | 12.49 | 2,860 | 591,600 | 25.75 | 4,429 | 2,043,100 |
| | 24 | 10.31 | 1,856 | 368,200 | 12.60 | 3,038 | 648,600 | 26.25 | 4,725 | 2,270,200 |
| 32 | 5 | 8.44 | 236 | 28,200 | 11.06 | 361 | 45,900 | 17.75 | 497 | 104,600 |
| | 6 | 8.56 | 308 | 37,900 | 11.17 | 473 | 62,100 | 18.25 | 657 | 146,400 |
| | 7 | 8.69 | 382 | 48,600 | 11.29 | 589 | 79,900 | 18.75 | 825 | 194,400 |
| | 8 | 8.81 | 458 | 60,100 | 11.40 | 709 | 99,300 | 19.25 | 1,001 | 249,100 |
| | 9 | 8.94 | 536 | 72,600 | 11.51 | 833 | 120,600 | 19.75 | 1,185 | 310,900 |
| | 10 | 9.06 | 616 | 86,200 | 11.63 | 961 | 143,800 | 20.25 | 1,377 | 380,600 |
| | 11 | 9.19 | 698 | 100,900 | 11.74 | 1,093 | 168,900 | 20.75 | 1,577 | 458,600 |
| | 12 | 9.31 | 782 | 116,700 | 11.86 | 1,229 | 196,200 | 21.25 | 1,785 | 545,600 |
| | 13 | 9.44 | 868 | 133,700 | 11.98 | 1,369 | 225,800 | 21.75 | 2,001 | 642,100 |
| | 14 | 9.56 | 956 | 152,000 | 12.09 | 1,513 | 257,700 | 22.25 | 2,225 | 748,800 |
| | 15 | 9.69 | 1,046 | 171,600 | 12.21 | 1,661 | 292,100 | 22.75 | 2,457 | 866,400 |
| | 16 | 9.81 | 1,138 | 192,600 | 12.32 | 1,813 | 329,200 | 23.25 | 2,697 | 995,600 |
| | 17 | 9.94 | 1,232 | 215,200 | 12.44 | 1,969 | 369,000 | 23.75 | 2,945 | 1,136,900 |
| | 18 | 10.06 | 1,328 | 239,200 | 12.56 | 2,129 | 411,700 | 24.25 | 3,201 | 1,291,200 |
| | 19 | 10.19 | 1,426 | 264,900 | 12.68 | 2,293 | 457,500 | 24.75 | 3,465 | 1,459,200 |
| | 20 | 10.31 | 1,526 | 292,300 | 12.79 | 2,461 | 506,500 | 25.25 | 3,737 | 1,641,700 |
| | 21 | 10.44 | 1,628 | 321,400 | 12.91 | 2,633 | 558,800 | 25.75 | 4,017 | 1,839,300 |
| | 22 | 10.56 | 1,732 | 352,400 | 13.03 | 2,809 | 614,600 | 26.25 | 4,305 | 2,053,000 |
| | 23 | 10.69 | 1,838 | 385,400 | 13.15 | 2,989 | 674,000 | 26.75 | 4,601 | 2,283,500 |
| | 24 | 10.81 | 1,946 | 420,300 | 13.27 | 3,173 | 737,300 | 27.25 | 4,905 | 2,531,600 |


*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

## TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 34 | 5 | 8.94 | 250 | 33,400 | 11.73 | 382 | 54,400 | 18.75 | 525 | 123,300 |
| | 6 | 9.06 | 326 | 44,900 | 11.84 | 500 | 73,500 | 19.25 | 693 | 171,800 |
| | 7 | 9.19 | 404 | 57,400 | 11.95 | 622 | 94,200 | 19.75 | 869 | 227,100 |
| | 8 | 9.31 | 484 | 70,800 | 12.07 | 748 | 116,900 | 20.25 | 1,053 | 289,700 |
| | 9 | 9.44 | 566 | 85,400 | 12.18 | 878 | 141,500 | 20.75 | 1,245 | 360,300 |
| | 10 | 9.56 | 650 | 101,100 | 12.29 | 1,012 | 168,100 | 21.25 | 1,445 | 439,400 |
| | 11 | 9.69 | 736 | 117,900 | 12.41 | 1,150 | 197,000 | 21.75 | 1,653 | 527,500 |
| | 12 | 9.81 | 824 | 136,100 | 12.52 | 1,292 | 228,200 | 22.25 | 1,869 | 625,400 |
| | 13 | 9.94 | 914 | 155,500 | 12.64 | 1,438 | 261,900 | 22.75 | 2,093 | 733,700 |
| | 14 | 10.06 | 1,006 | 176,400 | 12.76 | 1,588 | 298,200 | 23.25 | 2,325 | 853,000 |
| | 15 | 10.19 | 1,100 | 198,700 | 12.87 | 1,742 | 337,100 | 23.75 | 2,565 | 984,000 |
| | 16 | 10.31 | 1,196 | 222,500 | 12.99 | 1,900 | 379,000 | 24.25 | 2,813 | 1,127,500 |
| | 17 | 10.44 | 1,294 | 248,000 | 13.11 | 2,062 | 423,800 | 24.75 | 3,069 | 1,284,000 |
| | 18 | 10.56 | 1,394 | 275,100 | 13.22 | 2,228 | 471,800 | 25.25 | 3,333 | 1,454,500 |
| | 19 | 10.69 | 1,496 | 303,900 | 13.34 | 2,398 | 523,000 | 25.75 | 3,605 | 1,639,600 |
| | 20 | 10.81 | 1,600 | 334,600 | 13.46 | 2,572 | 577,700 | 26.25 | 3,885 | 1,840,100 |
| | 21 | 10.94 | 1,706 | 367,200 | 13.57 | 2,750 | 636,000 | 26.75 | 4,173 | 2,056,800 |
| | 22 | 11.06 | 1,814 | 401,800 | 13.69 | 2,932 | 698,000 | 27.25 | 4,469 | 2,290,600 |
| | 23 | 11.19 | 1,924 | 438,500 | 13.81 | 3,118 | 764,000 | 27.75 | 4,773 | 2,542,300 |
| | 24 | 11.31 | 2,036 | 477,300 | 13.93 | 3,308 | 834,000 | 28.25 | 5,085 | 2,812,700 |
| 36 | 5 | 9.44 | 264 | 39,400 | 12.39 | 403 | 64,000 | 19.75 | 553 | 144,100 |
| | 6 | 9.56 | 344 | 52,800 | 12.50 | 527 | 86,100 | 20.25 | 729 | 199,900 |
| | 7 | 9.69 | 426 | 67,200 | 12.62 | 655 | 110,200 | 20.75 | 913 | 263,200 |
| | 8 | 9.81 | 510 | 82,800 | 12.73 | 787 | 136,300 | 21.25 | 1,105 | 334,600 |
| | 9 | 9.94 | 596 | 99,500 | 12.85 | 923 | 164,600 | 21.75 | 1,305 | 414,600 |
| | 10 | 10.06 | 684 | 117,500 | 12.96 | 1,063 | 195,200 | 22.25 | 1,513 | 503,900 |
| | 11 | 10.19 | 774 | 136,800 | 13.08 | 1,207 | 228,100 | 22.75 | 1,729 | 603,100 |
| | 12 | 10.31 | 866 | 157,500 | 13.19 | 1,355 | 263,600 | 23.25 | 1,953 | 712,800 |
| | 13 | 10.44 | 960 | 179,600 | 13.31 | 1,507 | 301,800 | 23.75 | 2,185 | 833,700 |
| | 14 | 10.56 | 1,056 | 203,300 | 13.42 | 1,663 | 342,800 | 24.25 | 2,425 | 966,500 |
| | 15 | 10.69 | 1,154 | 228,500 | 13.54 | 1,823 | 386,700 | 24.75 | 2,673 | 1,111,900 |
| | 16 | 10.81 | 1,254 | 255,400 | 13.65 | 1,987 | 433,700 | 25.25 | 2,929 | 1,270,600 |
| | 17 | 10.94 | 1,356 | 284,000 | 13.77 | 2,155 | 483,900 | 25.75 | 3,193 | 1,443,400 |
| | 18 | 11.06 | 1,460 | 314,400 | 13.89 | 2,327 | 537,600 | 26.25 | 3,465 | 1,631,000 |
| | 19 | 11.19 | 1,566 | 346,700 | 14.00 | 2,503 | 594,700 | 26.75 | 3,745 | 1,834,300 |
| | 20 | 11.31 | 1,674 | 381,000 | 14.12 | 2,683 | 655,600 | 27.25 | 4,033 | 2,054,000 |
| | 21 | 11.44 | 1,784 | 417,300 | 14.24 | 2,867 | 720,200 | 27.75 | 4,329 | 2,291,000 |
| | 22 | 11.56 | 1,896 | 455,700 | 14.36 | 3,055 | 788,900 | 28.25 | 4,633 | 2,546,100 |
| | 23 | 11.69 | 2,010 | 496,400 | 14.47 | 3,247 | 861,800 | 28.75 | 4,945 | 2,820,100 |
| | 24 | 11.81 | 2,126 | 539,300 | 14.59 | 3,443 | 939,000 | 29.25 | 5,265 | 3,114,100 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 38 | 5 | 9.94 | 278 | 45,900 | 13.06 | 424 | 74,600 | 20.75 | 581 | 167,100 |
| | 6 | 10.06 | 362 | 61,400 | 13.17 | 554 | 100,200 | 21.25 | 765 | 230,900 |
| | 7 | 10.19 | 448 | 78,100 | 13.28 | 688 | 127,900 | 21.75 | 957 | 303,000 |
| | 8 | 10.31 | 536 | 96,000 | 13.40 | 826 | 157,900 | 22.25 | 1,157 | 383,900 |
| | 9 | 10.44 | 626 | 115,200 | 13.51 | 968 | 190,200 | 22.75 | 1,365 | 474,200 |
| | 10 | 10.56 | 718 | 135,700 | 13.63 | 1,114 | 224,900 | 23.25 | 1,581 | 574,500 |
| | 11 | 10.69 | 812 | 157,700 | 13.74 | 1,264 | 262,400 | 23.75 | 1,805 | 685,500 |
| | 12 | 10.81 | 908 | 181,100 | 13.86 | 1,418 | 302,500 | 24.25 | 2,037 | 807,900 |
| | 13 | 10.94 | 1,006 | 206,200 | 13.97 | 1,576 | 345,600 | 24.75 | 2,277 | 942,400 |
| | 14 | 11.06 | 1,106 | 232,800 | 14.09 | 1,738 | 391,700 | 25.25 | 2,525 | 1,089,700 |
| | 15 | 11.19 | 1,208 | 261,200 | 14.20 | 1,904 | 440,900 | 25.75 | 2,781 | 1,250,400 |
| | 16 | 11.31 | 1,312 | 291,400 | 14.32 | 2,074 | 493,500 | 26.25 | 3,045 | 1,425,500 |
| | 17 | 11.44 | 1,418 | 323,400 | 14.43 | 2,248 | 549,600 | 26.75 | 3,317 | 1,615,600 |
| | 18 | 11.56 | 1,526 | 357,400 | 14.55 | 2,426 | 609,300 | 27.25 | 3,597 | 1,821,500 |
| | 19 | 11.69 | 1,636 | 393,400 | 14.67 | 2,608 | 672,800 | 27.75 | 3,885 | 2,044,000 |
| | 20 | 11.81 | 1,748 | 431,500 | 14.79 | 2,794 | 740,200 | 28.25 | 4,181 | 2,284,100 |
| | 21 | 11.94 | 1,862 | 471,800 | 14.90 | 2,984 | 811,800 | 28.75 | 4,485 | 2,542,500 |
| | 22 | 12.06 | 1,978 | 514,400 | 15.02 | 3,178 | 887,600 | 29.25 | 4,797 | 2,820,100 |
| | 23 | 12.19 | 2,096 | 559,300 | 15.14 | 3,376 | 967,900 | 29.75 | 5,117 | 3,117,800 |
| | 24 | 12.31 | 2,216 | 606,700 | 15.26 | 3,578 | 1,052,800 | 30.25 | 5,445 | 3,436,500 |
| 40 | 5 | 10.44 | 292 | 53,200 | 13.72 | 445 | 86,400 | 21.75 | 609 | 192,400 |
| | 6 | 10.56 | 380 | 71,000 | 13.84 | 581 | 115,700 | 22.25 | 801 | 265,000 |
| | 7 | 10.69 | 470 | 90,100 | 13.95 | 721 | 147,400 | 22.75 | 1,001 | 346,600 |
| | 8 | 10.81 | 562 | 110,500 | 14.06 | 865 | 181,600 | 23.25 | 1,209 | 437,800 |
| | 9 | 10.94 | 656 | 132,400 | 14.18 | 1,013 | 218,200 | 23.75 | 1,425 | 539,200 |
| | 10 | 11.06 | 752 | 155,700 | 14.29 | 1,165 | 257,600 | 24.25 | 1,649 | 651,400 |
| | 11 | 11.19 | 850 | 180,600 | 14.41 | 1,321 | 299,900 | 24.75 | 1,881 | 775,200 |
| | 12 | 11.31 | 950 | 207,000 | 14.52 | 1,481 | 345,100 | 25.25 | 2,121 | 911,300 |
| | 13 | 11.44 | 1,052 | 235,200 | 14.64 | 1,645 | 393,400 | 25.75 | 2,369 | 1,060,300 |
| | 14 | 11.56 | 1,156 | 265,200 | 14.75 | 1,813 | 445,000 | 26.25 | 2,625 | 1,222,900 |
| | 15 | 11.69 | 1,262 | 297,000 | 14.87 | 1,985 | 500,100 | 26.75 | 2,889 | 1,400,100 |
| | 16 | 11.81 | 1,370 | 330,700 | 14.98 | 2,161 | 558,700 | 27.25 | 3,161 | 1,592,500 |
| | 17 | 11.94 | 1,480 | 366,400 | 15.10 | 2,341 | 621,000 | 27.75 | 3,441 | 1,801,000 |
| | 18 | 12.06 | 1,592 | 404,200 | 15.22 | 2,525 | 687,200 | 28.25 | 3,729 | 2,026,300 |
| | 19 | 12.19 | 1,706 | 444,200 | 15.33 | 2,713 | 757,500 | 28.75 | 4,025 | 2,269,300 |
| | 20 | 12.31 | 1,822 | 486,400 | 15.45 | 2,905 | 832,000 | 29.25 | 4,329 | 2,530,900 |
| | 21 | 12.44 | 1,940 | 531,000 | 15.57 | 3,101 | 910,900 | 29.75 | 4,641 | 2,811,900 |
| | 22 | 12.56 | 2,060 | 578,000 | 15.68 | 3,301 | 994,400 | 30.25 | 4,961 | 3,113,300 |
| | 23 | 12.69 | 2,182 | 627,500 | 15.80 | 3,505 | 1,082,600 | 30.75 | 5,289 | 3,435,900 |
| | 24 | 12.81 | 2,306 | 679,600 | 15.92 | 3,713 | 1,175,700 | 31.25 | 5,625 | 3,780,800 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

## TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 42 | 5 | 10.94 | 306 | 61,200 | 14.39 | 466 | 99,300 | 22.75 | 637 | 220,100 |
| | 6 | 11.06 | 398 | 81,600 | 14.50 | 608 | 132,800 | 23.25 | 837 | 302,300 |
| | 7 | 11.19 | 492 | 103,300 | 14.62 | 754 | 168,800 | 23.75 | 1,045 | 394,300 |
| | 8 | 11.31 | 588 | 126,500 | 14.73 | 904 | 207,500 | 24.25 | 1,261 | 496,600 |
| | 9 | 11.44 | 686 | 151,200 | 14.84 | 1,058 | 249,000 | 24.75 | 1,485 | 609,900 |
| | 10 | 11.56 | 786 | 177,600 | 14.96 | 1,216 | 293,400 | 25.25 | 1,717 | 735,000 |
| | 11 | 11.69 | 888 | 205,600 | 15.07 | 1,378 | 340,800 | 25.75 | 1,957 | 872,400 |
| | 12 | 11.81 | 992 | 235,300 | 15.19 | 1,544 | 391,500 | 26.25 | 2,205 | 1,023,100 |
| | 13 | 11.94 | 1,098 | 266,900 | 15.30 | 1,714 | 445,600 | 26.75 | 2,461 | 1,187,600 |
| | 14 | 12.06 | 1,206 | 300,400 | 15.42 | 1,888 | 503,100 | 27.25 | 2,725 | 1,366,700 |
| | 15 | 12.19 | 1,316 | 335,800 | 15.53 | 2,066 | 564,400 | 27.75 | 2,997 | 1,561,300 |
| | 16 | 12.31 | 1,428 | 373,400 | 15.65 | 2,248 | 629,400 | 28.25 | 3,277 | 1,772,200 |
| | 17 | 12.44 | 1,542 | 413,100 | 15.76 | 2,434 | 698,500 | 28.75 | 3,565 | 2,000,200 |
| | 18 | 12.56 | 1,658 | 455,000 | 15.88 | 2,624 | 771,700 | 29.25 | 3,861 | 2,246,000 |
| | 19 | 12.69 | 1,776 | 499,200 | 16.00 | 2,818 | 849,200 | 29.75 | 4,165 | 2,510,700 |
| | 20 | 12.81 | 1,896 | 545,900 | 16.11 | 3,016 | 931,300 | 30.25 | 4,477 | 2,795,000 |
| | 21 | 12.94 | 2,018 | 595,000 | 16.23 | 3,218 | 1,018,000 | 30.75 | 4,797 | 3,099,900 |
| | 22 | 13.06 | 2,142 | 646,700 | 16.35 | 3,424 | 1,109,600 | 31.25 | 5,125 | 3,426,300 |
| | 23 | 13.19 | 2,268 | 701,100 | 16.46 | 3,634 | 1,206,200 | 31.75 | 5,461 | 3,775,200 |
| | 24 | 13.31 | 2,396 | 758,300 | 16.58 | 3,848 | 1,308,000 | 32.25 | 5,805 | 4,147,500 |
| 44 | 5 | 11.44 | 320 | 70,000 | 15.06 | 487 | 113,500 | 23.75 | 665 | 250,400 |
| | 6 | 11.56 | 416 | 93,100 | 15.17 | 635 | 151,500 | 24.25 | 873 | 343,000 |
| | 7 | 11.69 | 514 | 117,700 | 15.28 | 787 | 192,200 | 24.75 | 1,089 | 446,100 |
| | 8 | 11.81 | 614 | 143,900 | 15.40 | 943 | 235,800 | 25.25 | 1,313 | 560,400 |
| | 9 | 11.94 | 716 | 171,800 | 15.51 | 1,103 | 282,500 | 25.75 | 1,545 | 686,600 |
| | 10 | 12.06 | 820 | 201,400 | 15.62 | 1,267 | 332,300 | 26.25 | 1,785 | 825,400 |
| | 11 | 12.19 | 926 | 232,800 | 15.74 | 1,435 | 385,400 | 26.75 | 2,033 | 977,500 |
| | 12 | 12.31 | 1,034 | 266,100 | 15.85 | 1,607 | 442,000 | 27.25 | 2,289 | 1,143,700 |
| | 13 | 12.44 | 1,144 | 301,300 | 15.97 | 1,783 | 502,100 | 27.75 | 2,553 | 1,324,700 |
| | 14 | 12.56 | 1,256 | 338,600 | 16.08 | 1,963 | 566,100 | 28.25 | 2,825 | 1,521,400 |
| | 15 | 12.69 | 1,370 | 378,000 | 16.20 | 2,147 | 634,000 | 28.75 | 3,105 | 1,734,600 |
| | 16 | 12.81 | 1,486 | 419,700 | 16.31 | 2,335 | 706,000 | 29.25 | 3,393 | 1,965,000 |
| | 17 | 12.94 | 1,604 | 463,600 | 16.43 | 2,527 | 782,200 | 29.75 | 3,689 | 2,213,600 |
| | 18 | 13.06 | 1,724 | 509,900 | 16.55 | 2,723 | 862,900 | 30.25 | 3,993 | 2,481,200 |
| | 19 | 13.19 | 1,846 | 558,700 | 16.66 | 2,923 | 948,200 | 30.75 | 4,305 | 2,768,700 |
| | 20 | 13.31 | 1,970 | 610,100 | 16.78 | 3,127 | 1,038,300 | 31.25 | 4,625 | 3,077,000 |
| | 21 | 13.44 | 2,096 | 664,100 | 16.90 | 3,335 | 1,133,300 | 31.75 | 4,953 | 3,407,100 |
| | 22 | 13.56 | 2,224 | 720,800 | 17.01 | 3,547 | 1,233,600 | 32.25 | 5,289 | 3,759,900 |
| | 23 | 13.69 | 2,354 | 780,400 | 17.13 | 3,763 | 1,339,100 | 32.75 | 5,633 | 4,136,300 |
| | 24 | 13.81 | 2,486 | 843,000 | 17.25 | 3,983 | 1,450,200 | 33.25 | 5,985 | 4,537,400 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

## TABLE 9-1 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 46 | 5 | 11.94 | 334 | 79,600 | 15.72 | 508 | 128,900 | 24.75 | 693 | 283,400 |
| | 6 | 12.06 | 434 | 105,700 | 15.84 | 662 | 171,800 | 25.25 | 909 | 387,100 |
| | 7 | 12.19 | 536 | 133,400 | 15.95 | 820 | 217,700 | 25.75 | 1,133 | 502,300 |
| | 8 | 12.31 | 640 | 162,900 | 16.06 | 982 | 266,700 | 26.25 | 1,365 | 629,400 |
| | 9 | 12.44 | 746 | 194,100 | 16.18 | 1,148 | 318,900 | 26.75 | 1,605 | 769,400 |
| | 10 | 12.56 | 854 | 227,300 | 16.29 | 1,318 | 374,500 | 27.25 | 1,853 | 922,900 |
| | 11 | 12.69 | 964 | 262,300 | 16.40 | 1,492 | 433,700 | 27.75 | 2,109 | 1,090,600 |
| | 12 | 12.81 | 1,076 | 299,400 | 16.52 | 1,670 | 496,600 | 28.25 | 2,373 | 1,273,400 |
| | 13 | 12.94 | 1,190 | 338,600 | 16.63 | 1,852 | 563,400 | 28.75 | 2,645 | 1,472,100 |
| | 14 | 13.06 | 1,306 | 380,000 | 16.75 | 2,038 | 634,200 | 29.25 | 2,925 | 1,687,400 |
| | 15 | 13.19 | 1,424 | 423,600 | 16.86 | 2,228 | 709,200 | 29.75 | 3,213 | 1,920,200 |
| | 16 | 13.31 | 1,544 | 469,700 | 16.98 | 2,422 | 788,500 | 30.25 | 3,509 | 2,171,400 |
| | 17 | 13.44 | 1,666 | 518,100 | 17.10 | 2,620 | 872,500 | 30.75 | 3,813 | 2,441,800 |
| | 18 | 13.56 | 1,790 | 569,100 | 17.21 | 2,822 | 961,100 | 31.25 | 4,125 | 2,732,300 |
| | 19 | 13.69 | 1,916 | 622,800 | 17.33 | 3,028 | 1,054,700 | 31.75 | 4,445 | 3,043,900 |
| | 20 | 13.81 | 2,044 | 679,200 | 17.44 | 3,238 | 1,153,300 | 32.25 | 4,773 | 3,377,500 |
| | 21 | 13.94 | 2,174 | 738,400 | 17.56 | 3,452 | 1,257,200 | 32.75 | 5,109 | 3,734,100 |
| | 22 | 14.06 | 2,306 | 800,500 | 17.68 | 3,670 | 1,366,600 | 33.25 | 5,453 | 4,114,600 |
| | 23 | 14.19 | 2,440 | 865,600 | 17.79 | 3,892 | 1,481,600 | 33.75 | 5,805 | 4,520,000 |
| | 24 | 14.31 | 2,576 | 933,900 | 17.91 | 4,118 | 1,602,500 | 34.25 | 6,165 | 4,951,300 |
| 48 | 5 | 12.44 | 348 | 90,000 | 16.39 | 529 | 145,700 | 25.75 | 721 | 319,100 |
| | 6 | 12.56 | 452 | 119,300 | 16.50 | 689 | 193,900 | 26.25 | 945 | 434,900 |
| | 7 | 12.69 | 558 | 150,500 | 16.62 | 853 | 245,300 | 26.75 | 1,177 | 563,000 |
| | 8 | 12.81 | 666 | 183,500 | 16.73 | 1,021 | 300,000 | 27.25 | 1,417 | 704,000 |
| | 9 | 12.94 | 776 | 218,400 | 16.84 | 1,193 | 358,300 | 27.75 | 1,665 | 858,700 |
| | 10 | 13.06 | 888 | 255,300 | 16.96 | 1,369 | 420,200 | 28.25 | 1,921 | 1,027,800 |
| | 11 | 13.19 | 1,002 | 294,300 | 17.07 | 1,549 | 485,900 | 28.75 | 2,185 | 1,212,200 |
| | 12 | 13.31 | 1,118 | 335,400 | 17.19 | 1,733 | 555,600 | 29.25 | 2,457 | 1,412,700 |
| | 13 | 13.44 | 1,236 | 378,900 | 17.30 | 1,921 | 629,400 | 29.75 | 2,737 | 1,630,000 |
| | 14 | 13.56 | 1,356 | 424,600 | 17.41 | 2,113 | 707,500 | 30.25 | 3,025 | 1,865,100 |
| | 15 | 13.69 | 1,478 | 472,800 | 17.53 | 2,309 | 790,100 | 30.75 | 3,321 | 2,118,700 |
| | 16 | 13.81 | 1,602 | 523,500 | 17.64 | 2,509 | 877,400 | 31.25 | 3,625 | 2,391,800 |
| | 17 | 13.94 | 1,728 | 576,800 | 17.76 | 2,713 | 969,500 | 31.75 | 3,937 | 2,685,200 |
| | 18 | 14.06 | 1,856 | 632,900 | 17.88 | 2,921 | 1,066,600 | 32.25 | 4,257 | 3,000,000 |
| | 19 | 14.19 | 1,986 | 691,700 | 17.99 | 3,133 | 1,168,900 | 32.75 | 4,585 | 3,337,000 |
| | 20 | 14.31 | 2,118 | 753,400 | 18.11 | 3,349 | 1,276,700 | 33.25 | 4,921 | 3,697,200 |
| | 21 | 14.44 | 2,252 | 818,100 | 18.22 | 3,569 | 1,390,000 | 33.75 | 5,265 | 4,081,500 |
| | 22 | 14.56 | 2,388 | 885,900 | 18.34 | 3,793 | 1,509,000 | 34.25 | 5,617 | 4,491,100 |
| | 23 | 14.69 | 2,526 | 956,900 | 18.46 | 4,021 | 1,634,100 | 34.75 | 5,977 | 4,926,900 |
| | 24 | 14.81 | 2,666 | 1,031,200 | 18.57 | 4,253 | 1,765,300 | 35.25 | 6,345 | 5,389,900 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

| SQUARE EDGE PANEL | | | | | | | | | | | | | | | SQUARE INTERIOR PANEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) | (3) | (1) | Reinforcing Bars | | | | Steel (psf) | | |
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | | | | | | Location of Panel | | | Span c.-c. | Load | Min. Sq. Col. | | | | | | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | E | EC | C | (ft) | (psf) | (in.) | Top | Bottom | Top | Bottom | I | IE | IC |
| 5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.417 c.f./s.f. | 5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.417 c.f./s.f. |
| 12 | 50 | 10 | 0.831 | 6 | 12 | 16 | 10-#4 0 | 8-#3 | 10-#4 | 8-#3 | 8-#4 | 1.96 | 1.96 | 1.94 | 12 | 50 | 10 | 10-#4 | 8-#3 | 8-#4 | 8-#3 | 1.99 | 1.99 | 1.99 |
| 12 | 100 | 10 | 0.870 | 8 | 17 | 23 | 10-#4 0 | 8-#3 | 10-#4 | 8-#3 | 8-#4 | 1.97 | 1.97 | 1.95 | 12 | 100 | 11 | 10-#4 | 8-#3 | 8-#4 | 8-#3 | 2.00 | 2.00 | 2.00 |
| 12 | 150 | 12 | 0.845 | 11 | 21 | 29 | 10-#4 0 | 8-#3 | 10-#4 | 8-#3 | 8-#4 | 1.97 | 1.97 | 1.94 | 12 | 150 | 12 | 10-#4 | 8-#3 | 8-#4 | 8-#3 | 2.00 | 2.00 | 2.00 |
| 12 | 200 | 15 | 0.778 | 13 | 25 | 34 | 10-#4 0 | 9-#3 | 10-#4 | 8-#3 | 8-#4 | 2.00 | 2.00 | 1.97 | 12 | 200 | 13 | 10-#4 | 8-#3 | 8-#4 | 8-#3 | 2.01 | 2.01 | 2.01 |
| 12 | 250 | 17 | 0.778 | 14 | 29 | 39 | 10-#4 0 | 10-#3 | 10-#4 | 8-#3 | 8-#4 | 2.04 | 2.04 | 2.04 | 12 | 250 | 16 | 10-#4 | 8-#3 | 8-#4 | 8-#3 | 2.03 | 2.03 | 2.03 |
| 12 | 300 | 21 | 0.725 | 15 | 31 | 41 | 10-#4 0 | 11-#3 | 10-#4 | 8-#3 | 8-#4 | 2.11 | 2.11 | 2.14 | 12 | 300 | 21 | 10-#4 | 8-#3 | 8-#4 | 8-#3 | 2.06 | 2.06 | 2.06 |
| 13 | 50 | 10 | 0.861 | 8 | 16 | 21 | 11-#4 0 | 8-#3 | 11-#4 | 8-#3 | 8-#4 | 1.86 | 1.86 | 1.83 | 13 | 50 | 10 | 11-#4 | 8-#3 | 8-#4 | 8-#3 | 1.90 | 1.90 | 1.90 |
| 13 | 100 | 12 | 0.855 | 11 | 21 | 29 | 11-#4 1 | 8-#3 | 11-#4 | 8-#3 | 8-#4 | 1.86 | 1.86 | 1.82 | 13 | 100 | 11 | 11-#4 | 8-#3 | 8-#4 | 8-#3 | 1.90 | 1.90 | 1.90 |
| 13 | 150 | 14 | 0.825 | 13 | 27 | 36 | 11-#4 0 | 9-#3 | 11-#4 | 8-#3 | 8-#4 | 1.92 | 1.92 | 1.92 | 13 | 150 | 12 | 11-#4 | 8-#3 | 8-#4 | 8-#3 | 1.91 | 1.91 | 1.91 |
| 13 | 200 | 18 | 0.769 | 16 | 31 | 42 | 11-#4 0 | 11-#3 | 11-#4 | 8-#3 | 8-#4 | 1.99 | 1.99 | 2.01 | 13 | 200 | 16 | 11-#4 | 8-#3 | 8-#4 | 8-#3 | 1.93 | 1.93 | 1.93 |
| 13 | 250 | 22 | 0.730 | 17 | 34 | 46 | 11-#4 0 | 12-#3 | 12-#4 | 8-#3 | 8-#4 | 2.04 | 2.05 | 2.15 | 13 | 250 | 22 | 11-#4 | 8-#3 | 8-#4 | 8-#3 | 1.97 | 1.98 | 2.00 |
| 13 | 300 | 27 | 0.657 | 18 | 36 | 49 | 11-#4 0 | 12-#3 | 12-#4 | 8-#3 | 8-#4 | 2.08 | 2.08 | 2.19 | 13 | 300 | 28 | 11-#4 | 8-#3 | 8-#4 | 8-#3 | 2.00 | 2.02 | 2.04 |
| 14 | 50 | 10 | 0.888 | 10 | 20 | 27 | 12-#4 0 | 9-#3 | 12-#4 | 9-#3 | 9-#4 | 1.95 | 1.95 | 1.92 | 14 | 50 | 10 | 12-#4 | 9-#3 | 9-#4 | 9-#3 | 1.97 | 1.97 | 1.97 |
| 14 | 100 | 14 | 0.818 | 13 | 27 | 36 | 12-#4 0 | 9-#3 | 12-#4 | 9-#3 | 9-#4 | 1.95 | 1.95 | 1.92 | 14 | 100 | 11 | 12-#4 | 9-#3 | 9-#4 | 9-#3 | 1.98 | 1.97 | 1.97 |
| 14 | 150 | 18 | 0.787 | 16 | 33 | 44 | 12-#4 1 | 11-#3 | 12-#4 | 9-#3 | 9-#4 | 2.03 | 2.03 | 2.01 | 14 | 150 | 14 | 12-#4 | 9-#3 | 9-#4 | 9-#3 | 1.99 | 1.99 | 1.99 |
| 14 | 200 | 23 | 0.714 | 19 | 37 | 50 | 12-#4 0 | 13-#3 | 13-#4 | 9-#3 | 9-#4 | 2.14 | 2.14 | 2.17 | 14 | 200 | 21 | 12-#4 | 9-#3 | 9-#4 | 9-#3 | 2.03 | 2.05 | 2.06 |
| 14 | 250 | 28 | 0.657 | 20 | 40 | 54 | 12-#4 0 | 14-#3 | 14-#4 | 9-#3 | 9-#4 | 2.20 | 2.21 | 2.29 | 14 | 250 | 28 | 13-#4 | 9-#3 | 9-#4 | 9-#3 | 2.13 | 2.15 | 2.17 |
| 14 | 300 | 32 | 0.634 | 21 | 43 | 58 | 12-#4 0 | 9-#4 | 15-#4 | 10-#3 | 9-#4 | 2.32 | 2.35 | 2.44 | 14 | 300 | 35 | 13-#4 | 10-#3 | 9-#4 | 9-#3 | 2.21 | 2.25 | 2.28 |
| 15 | 50 | 12 | 0.849 | 12 | 24 | 33 | 12-#4 0 | 9-#3 | 12-#4 | 9-#3 | 9-#4 | 1.83 | 1.83 | 1.83 | 15 | 50 | 10 | 12-#4 | 9-#3 | 9-#4 | 9-#3 | 1.83 | 1.83 | 1.83 |
| 15 | 100 | 16 | 0.804 | 16 | 33 | 44 | 12-#4 1 | 11-#3 | 12-#4 | 9-#3 | 9-#4 | 1.91 | 1.91 | 1.93 | 15 | 100 | 12 | 12-#4 | 9-#3 | 9-#4 | 9-#3 | 1.84 | 1.84 | 1.84 |
| 15 | 150 | 22 | 0.736 | 19 | 39 | 52 | 12-#4 1 | 13-#3 | 13-#4 | 9-#3 | 9-#4 | 1.99 | 1.99 | 2.03 | 15 | 150 | 19 | 12-#4 | 9-#3 | 9-#4 | 9-#3 | 1.88 | 1.89 | 1.91 |
| 15 | 200 | 27 | 0.671 | 22 | 44 | 59 | 12-#4 0 | 9-#4 | 15-#4 | 10-#3 | 9-#4 | 2.16 | 2.18 | 2.29 | 15 | 200 | 27 | 14-#4 | 10-#3 | 9-#4 | 9-#3 | 2.07 | 2.09 | 2.10 |
| 15 | 250 | 33 | 0.606 | 23 | 47 | 63 | 12-#4 0 | 9-#4 | 16-#4 | 11-#3 | 9-#4 | 2.29 | 2.31 | 2.46 | 15 | 250 | 35 | 15-#4 | 11-#3 | 9-#4 | 9-#3 | 2.22 | 2.24 | 2.26 |
| 15 | 300 | 39 | 0.605 | 25 | 49 | 67 | 12-#4 0 | 10-#4 | 17-#4 | 11-#3 | 9-#4 | 2.38 | 2.41 | 2.57 | 15 | 300 | 42 | 15-#4 | 11-#3 | 9-#4 | 9-#3 | 2.26 | 2.29 | 2.33 |
| 16 | 50 | 14 | 0.842 | 15 | 29 | 39 | 13-#4 2 | 10-#3 | 13-#4 | 10-#3 | 10-#4 | 1.86 | 1.86 | 1.84 | 16 | 50 | 10 | 13-#4 | 10-#3 | 10-#4 | 10-#3 | 1.88 | 1.88 | 1.87 |
| 16 | 100 | 19 | 0.785 | 19 | 39 | 52 | 13-#4 1 | 13-#3 | 13-#4 | 10-#3 | 10-#4 | 1.94 | 1.93 | 1.95 | 16 | 100 | 15 | 13-#4 | 10-#3 | 10-#4 | 10-#3 | 1.90 | 1.90 | 1.90 |
| 16 | 150 | 26 | 0.706 | 23 | 45 | 61 | 13-#4 1 | 15-#3 | 15-#4 | 10-#3 | 10-#4 | 2.08 | 2.09 | 2.18 | 16 | 150 | 24 | 14-#4 | 10-#3 | 10-#4 | 10-#3 | 2.00 | 2.01 | 2.02 |
| 16 | 200 | 33 | 0.606 | 25 | 50 | 68 | 13-#4 0 | 10-#4 | 17-#4 | 11-#3 | 10-#4 | 2.24 | 2.26 | 2.38 | 16 | 200 | 33 | 16-#4 | 11-#3 | 10-#4 | 10-#3 | 2.20 | 2.21 | 2.23 |
| 16 | 250 | 39 | 0.605 | 27 | 54 | 73 | 13-#4 0 | 18-#3 | 18-#4 | 12-#3 | 10-#4 | 2.36 | 2.38 | 2.51 | 16 | 250 | 42 | 17-#4 | 12-#3 | 10-#4 | 10-#3 | 2.34 | 2.35 | 2.37 |
| 16 | 300 | 45 | 0.604 | 28 | 57 | 76 | 13-#4 0 | 11-#4 | 13-#5 | 13-#3 | 10-#4 | 2.51 | 2.54 | 2.67 | 16 | 300 | 50 | 17-#4 | 12-#3 | 10-#4 | 10-#3 | 2.38 | 2.43 | 2.48 |

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANEL

| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | |
| | | | | | | | | | | | | Location of Panel | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | –M Ext. (ft-kip) | +M Int. (ft-kip) | –M 1st int. (ft-kip) | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | E | EC | C |
| 5.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.458 c.f./s.f. |
| 12 | 50 | 10 | 0.791 | 6 | 13 | 17 | 9-#4 0 | 7-#3 | 9-#4 | 7-#3 | 7-#4 | 1.74 | 1.74 | 1.71 |
| 12 | 100 | 10 | 0.830 | 9 | 18 | 24 | 9-#4 0 | 7-#3 | 9-#4 | 7-#3 | 7-#4 | 1.75 | 1.75 | 1.71 |
| 12 | 150 | 11 | 0.833 | 11 | 22 | 30 | 9-#4 0 | 7-#3 | 9-#4 | 7-#3 | 7-#4 | 1.79 | 1.79 | 1.79 |
| 12 | 200 | 13 | 0.817 | 13 | 26 | 35 | 9-#4 1 | 8-#3 | 9-#4 | 7-#3 | 7-#4 | 1.82 | 1.82 | 1.87 |
| 12 | 250 | 15 | 0.782 | 15 | 30 | 40 | 9-#4 1 | 9-#3 | 9-#4 | 7-#3 | 7-#4 | 1.85 | 1.85 | 1.89 |
| 12 | 300 | 17 | 0.718 | 17 | 34 | 46 | 9-#4 0 | 10-#3 | 10-#4 | 7-#3 | 7-#4 | 1.92 | 1.93 | 1.98 |
| 13 | 50 | 10 | 0.827 | 8 | 17 | 22 | 10-#4 0 | 8-#3 | 10-#4 | 8-#3 | 8-#4 | 1.78 | 1.78 | 1.74 |
| 13 | 100 | 10 | 0.869 | 11 | 23 | 31 | 10-#4 0 | 8-#3 | 10-#4 | 8-#3 | 8-#4 | 1.79 | 1.79 | 1.74 |
| 13 | 150 | 13 | 0.810 | 14 | 28 | 38 | 10-#4 0 | 8-#3 | 10-#4 | 8-#3 | 8-#4 | 1.82 | 1.82 | 1.79 |
| 13 | 200 | 15 | 0.782 | 17 | 33 | 45 | 10-#4 0 | 10-#3 | 10-#4 | 8-#3 | 8-#4 | 1.87 | 1.87 | 1.89 |
| 13 | 250 | 17 | 0.775 | 19 | 38 | 51 | 10-#4 1 | 11-#3 | 11-#4 | 8-#3 | 8-#4 | 1.92 | 1.93 | 1.93 |
| 13 | 300 | 21 | 0.720 | 21 | 41 | 55 | 10-#4 1 | 12-#3 | 12-#4 | 8-#3 | 8-#4 | 2.02 | 2.02 | 2.10 |
| 14 | 50 | 10 | 0.859 | 10 | 21 | 28 | 11-#4 0 | 8-#3 | 11-#4 | 8-#3 | 8-#4 | 1.72 | 1.72 | 1.70 |
| 14 | 100 | 12 | 0.855 | 14 | 28 | 38 | 11-#4 1 | 9-#3 | 11-#4 | 8-#3 | 8-#4 | 1.75 | 1.75 | 1.72 |
| 14 | 150 | 15 | 0.789 | 17 | 35 | 47 | 11-#4 0 | 10-#3 | 11-#4 | 8-#3 | 8-#4 | 1.78 | 1.78 | 1.78 |
| 14 | 200 | 18 | 0.738 | 20 | 41 | 55 | 11-#4 0 | 12-#3 | 12-#4 | 8-#3 | 8-#4 | 1.88 | 1.88 | 2.00 |
| 14 | 250 | 22 | 0.695 | 23 | 45 | 61 | 11-#4 0 | 8-#4 | 13-#4 | 9-#3 | 8-#4 | 2.01 | 2.03 | 2.16 |
| 14 | 300 | 26 | 0.653 | 24 | 48 | 65 | 11-#4 0 | 8-#4 | 14-#4 | 10-#3 | 8-#4 | 2.13 | 2.14 | 2.28 |
| 15 | 50 | 11 | 0.858 | 13 | 26 | 35 | 11-#4 1 | 9-#3 | 11-#4 | 9-#3 | 9-#4 | 1.77 | 1.77 | 1.76 |
| 15 | 100 | 14 | 0.830 | 17 | 35 | 47 | 11-#4 2 | 10-#3 | 11-#4 | 9-#3 | 9-#4 | 1.80 | 1.80 | 1.82 |
| 15 | 150 | 17 | 0.751 | 21 | 43 | 57 | 11-#4 0 | 13-#3 | 12-#4 | 9-#3 | 9-#4 | 1.90 | 1.90 | 1.95 |
| 15 | 200 | 22 | 0.683 | 24 | 48 | 65 | 11-#4 0 | 14-#3 | 14-#4 | 10-#3 | 9-#4 | 2.02 | 2.04 | 2.12 |
| 15 | 250 | 27 | 0.618 | 26 | 53 | 71 | 11-#4 0 | 9-#4 | 16-#4 | 11-#3 | 9-#4 | 2.19 | 2.22 | 2.31 |
| 15 | 300 | 32 | 0.607 | 28 | 56 | 76 | 11-#4 0 | 10-#4 | 11-#5 | 11-#3 | 9-#4 | 2.32 | 2.35 | 2.49 |
| 16 | 50 | 12 | 0.848 | 16 | 31 | 42 | 12-#4 0 | 9-#3 | 12-#4 | 9-#3 | 9-#4 | 1.70 | 1.70 | 1.68 |
| 16 | 100 | 16 | 0.793 | 21 | 42 | 56 | 12-#4 1 | 12-#3 | 12-#4 | 9-#3 | 9-#4 | 1.79 | 1.79 | 1.82 |
| 16 | 150 | 21 | 0.747 | 25 | 50 | 68 | 12-#4 2 | 9-#4 | 15-#4 | 10-#3 | 9-#4 | 2.00 | 2.00 | 2.09 |
| 16 | 200 | 27 | 0.627 | 28 | 56 | 76 | 12-#4 0 | 10-#4 | 17-#4 | 11-#3 | 9-#4 | 2.18 | 2.19 | 2.34 |
| 16 | 250 | 32 | 0.607 | 31 | 61 | 82 | 12-#4 0 | 18-#3 | 12-#5 | 12-#3 | 9-#4 | 2.29 | 2.32 | 2.42 |
| 16 | 300 | 38 | 0.606 | 32 | 64 | 86 | 12-#4 0 | 11-#4 | 13-#5 | 13-#3 | 9-#4 | 2.45 | 2.49 | 2.65 |
| 17 | 50 | 14 | 0.841 | 19 | 37 | 50 | 13-#4 2 | 11-#3 | 13-#4 | 10-#3 | 10-#4 | 1.77 | 1.77 | 1.76 |
| 17 | 100 | 18 | 0.779 | 25 | 49 | 66 | 13-#4 1 | 15-#3 | 14-#4 | 10-#3 | 10-#4 | 1.88 | 1.88 | 1.92 |
| 17 | 150 | 25 | 0.696 | 29 | 58 | 78 | 13-#4 1 | 10-#4 | 17-#4 | 12-#3 | 10-#4 | 2.11 | 2.13 | 2.27 |
| 17 | 200 | 31 | 0.611 | 32 | 65 | 87 | 13-#4 0 | 11-#4 | 13-#5 | 13-#3 | 10-#4 | 2.30 | 2.33 | 2.45 |
| 17 | 250 | 38 | 0.606 | 35 | 69 | 94 | 13-#4 0 | 12-#4 | 14-#5 | 14-#3 | 10-#4 | 2.51 | 2.52 | 2.63 |
| 17 | 300 | 44 | 0.605 | 37 | 73 | 99 | 13-#4 0 | 13-#4 | 15-#5 | 15-#3 | 10-#4 | 2.63 | 2.66 | 2.79 |

## SQUARE INTERIOR PANEL

| (2) Span c.-c. (ft) | (3) Load (psf) | (1) Min. Sq. Col. (in.) | Reinforcing Bars | | | | Steel (psf) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | Top | Bottom | Top | Bottom | I | IE | IC |
| 5.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.458 c.f./s.f. |
| 12 | 50 | 10 | 9-#4 | 7-#3 | 7-#4 | 7-#3 | 1.78 | 1.78 | 1.78 |
| 12 | 100 | 11 | 9-#4 | 7-#3 | 7-#4 | 7-#3 | 1.78 | 1.78 | 1.78 |
| 12 | 150 | 13 | 9-#4 | 7-#3 | 7-#4 | 7-#3 | 1.79 | 1.79 | 1.80 |
| 12 | 200 | 14 | 9-#4 | 7-#3 | 7-#4 | 7-#3 | 1.80 | 1.80 | 1.80 |
| 12 | 250 | 15 | 9-#4 | 7-#3 | 7-#4 | 7-#3 | 1.81 | 1.81 | 1.81 |
| 12 | 300 | 15 | 9-#4 | 7-#3 | 7-#4 | 7-#3 | 1.81 | 1.82 | 1.84 |
| 13 | 50 | 10 | 10-#4 | 8-#3 | 8-#4 | 8-#3 | 1.83 | 1.83 | 1.83 |
| 13 | 100 | 11 | 10-#4 | 8-#3 | 8-#4 | 8-#3 | 1.84 | 1.84 | 1.84 |
| 13 | 150 | 13 | 10-#4 | 8-#3 | 8-#4 | 8-#3 | 1.85 | 1.85 | 1.85 |
| 13 | 200 | 14 | 10-#4 | 8-#3 | 8-#4 | 8-#3 | 1.85 | 1.85 | 1.85 |
| 13 | 250 | 16 | 10-#4 | 8-#3 | 8-#4 | 8-#3 | 1.87 | 1.88 | 1.90 |
| 13 | 300 | 20 | 11-#4 | 8-#3 | 8-#4 | 8-#3 | 1.96 | 1.97 | 1.99 |
| 14 | 50 | 10 | 11-#4 | 8-#3 | 8-#4 | 8-#3 | 1.76 | 1.76 | 1.76 |
| 14 | 100 | 11 | 11-#4 | 8-#3 | 8-#4 | 8-#3 | 1.76 | 1.76 | 1.76 |
| 14 | 150 | 13 | 11-#4 | 8-#3 | 8-#4 | 8-#3 | 1.77 | 1.77 | 1.77 |
| 14 | 200 | 15 | 11-#4 | 8-#3 | 8-#4 | 8-#3 | 1.78 | 1.80 | 1.81 |
| 14 | 250 | 21 | 12-#4 | 9-#3 | 8-#4 | 8-#3 | 1.93 | 1.94 | 1.96 |
| 14 | 300 | 27 | 13-#4 | 10-#3 | 8-#4 | 8-#3 | 2.06 | 2.08 | 2.09 |
| 15 | 50 | 10 | 11-#4 | 9-#3 | 9-#4 | 9-#3 | 1.78 | 1.78 | 1.78 |
| 15 | 100 | 11 | 11-#4 | 9-#3 | 9-#4 | 9-#3 | 1.78 | 1.78 | 1.78 |
| 15 | 150 | 14 | 12-#4 | 9-#3 | 9-#4 | 9-#3 | 1.85 | 1.85 | 1.85 |
| 15 | 200 | 20 | 13-#4 | 10-#3 | 9-#4 | 9-#3 | 1.98 | 1.99 | 2.01 |
| 15 | 250 | 27 | 14-#4 | 11-#3 | 9-#4 | 9-#3 | 2.12 | 2.15 | 2.18 |
| 15 | 300 | 33 | 15-#4 | 11-#3 | 9-#4 | 9-#3 | 2.21 | 2.25 | 2.28 |
| 16 | 50 | 10 | 12-#4 | 9-#3 | 9-#4 | 9-#3 | 1.72 | 1.72 | 1.72 |
| 16 | 100 | 13 | 12-#4 | 9-#3 | 9-#4 | 9-#3 | 1.73 | 1.73 | 1.73 |
| 16 | 150 | 17 | 14-#4 | 10-#3 | 9-#4 | 9-#3 | 1.89 | 1.90 | 1.91 |
| 16 | 200 | 25 | 16-#4 | 11-#3 | 9-#4 | 9-#3 | 2.08 | 2.09 | 2.11 |
| 16 | 250 | 33 | 17-#4 | 12-#3 | 9-#4 | 9-#3 | 2.21 | 2.24 | 2.26 |
| 16 | 300 | 41 | 17-#4 | 13-#3 | 9-#4 | 9-#3 | 2.30 | 2.35 | 2.39 |
| 17 | 50 | 10 | 13-#4 | 10-#3 | 10-#4 | 10-#3 | 1.76 | 1.76 | 1.76 |
| 17 | 100 | 15 | 14-#4 | 10-#3 | 10-#4 | 10-#3 | 1.83 | 1.83 | 1.83 |
| 17 | 150 | 22 | 16-#4 | 12-#3 | 10-#4 | 10-#3 | 2.04 | 2.05 | 2.06 |
| 17 | 200 | 31 | 18-#4 | 13-#3 | 10-#4 | 10-#3 | 2.23 | 2.26 | 2.29 |
| 17 | 250 | 40 | 13-#5 | 14-#3 | 10-#4 | 10-#3 | 2.43 | 2.45 | 2.47 |
| 17 | 300 | 48 | 13-#5 | 14-#3 | 10-#4 | 10-#3 | 2.47 | 2.52 | 2.56 |

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

## SQUARE EDGE PANEL

## SQUARE INTERIOR PANEL

$f'_c$ = 4,000 psi
Grade 60 Bars

| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) | (3) | (1) | Reinforcing Bars | | | | Steel (psf) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | –M Ext. | +M Int. | –M 1st int. | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | | | | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | Location of Panel | | | | | | | | | | | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | E | EC | C | Span c.-c. (ft) | Load (psf) | Min. Sq. Col. (in.) | Top | Bottom | Top | Bottom | I | IE | IC |
| 6 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.500 c.f./s.f. | 6 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.500 c.f./s.f. |
| 12 | 50 | 10 | 0.742 | 7 | 14 | 18 | 8-#4 0 | 8-#3 | 8-#4 | 8-#3 | 7-#4 | 1.79 | 1.79 | 1.79 | 12 | 50 | 10 | 8-#4 | 8-#3 | 7-#4 | 8-#3 | 1.80 | 1.80 | 1.80 |
| 12 | 100 | 10 | 0.782 | 9 | 18 | 25 | 8-#4 0 | 8-#3 | 8-#4 | 8-#3 | 7-#4 | 1.80 | 1.80 | 1.79 | 12 | 100 | 11 | 8-#4 | 8-#3 | 7-#4 | 8-#3 | 1.80 | 1.80 | 1.80 |
| 12 | 150 | 11 | 0.780 | 11 | 23 | 30 | 8-#4 0 | 8-#3 | 8-#4 | 8-#3 | 7-#4 | 1.78 | 1.78 | 1.76 | 12 | 150 | 13 | 8-#4 | 8-#3 | 7-#4 | 8-#3 | 1.81 | 1.81 | 1.82 |
| 12 | 200 | 12 | 0.778 | 13 | 27 | 36 | 8-#4 0 | 7-#3 | 8-#4 | 8-#3 | 7-#4 | 1.78 | 1.78 | 1.76 | 12 | 200 | 14 | 8-#4 | 8-#3 | 7-#4 | 8-#3 | 1.82 | 1.82 | 1.82 |
| 12 | 250 | 13 | 0.779 | 16 | 31 | 42 | 8-#4 0 | 8-#3 | 8-#4 | 8-#3 | 7-#4 | 1.81 | 1.81 | 1.79 | 12 | 250 | 15 | 8-#4 | 8-#3 | 7-#4 | 8-#3 | 1.82 | 1.83 | 1.83 |
| 12 | 300 | 15 | 0.731 | 17 | 35 | 47 | 8-#4 0 | 9-#3 | 9-#4 | 8-#3 | 7-#4 | 1.85 | 1.86 | 1.83 | 12 | 300 | 16 | 8-#4 | 8-#3 | 7-#4 | 8-#3 | 1.83 | 1.85 | 1.87 |
| 12 | 350 | 16 | 0.733 | 19 | 39 | 52 | 8-#4 0 | 6-#4 | 10-#4 | 7-#3 | 7-#4 | 1.90 | 1.93 | 1.94 | 12 | 350 | 17 | 9-#4 | 7-#3 | 7-#4 | 8-#3 | 1.86 | 1.88 | 1.90 |
| 13 | 50 | 10 | 0.788 | 9 | 18 | 24 | 9-#4 0 | 8-#3 | 9-#4 | 8-#3 | 7-#4 | 1.70 | 1.70 | 1.68 | 13 | 50 | 10 | 9-#4 | 8-#3 | 7-#4 | 8-#3 | 1.72 | 1.72 | 1.72 |
| 13 | 100 | 10 | 0.830 | 12 | 24 | 32 | 9-#4 0 | 8-#3 | 9-#4 | 8-#3 | 7-#4 | 1.71 | 1.71 | 1.68 | 13 | 100 | 11 | 9-#4 | 8-#3 | 7-#4 | 8-#3 | 1.72 | 1.72 | 1.72 |
| 13 | 150 | 11 | 0.852 | 15 | 29 | 39 | 9-#4 1 | 8-#3 | 9-#4 | 8-#3 | 7-#4 | 1.71 | 1.71 | 1.68 | 13 | 150 | 13 | 9-#4 | 8-#3 | 7-#4 | 8-#3 | 1.73 | 1.73 | 1.74 |
| 13 | 200 | 13 | 0.822 | 17 | 35 | 47 | 9-#4 1 | 9-#3 | 9-#4 | 8-#3 | 7-#4 | 1.77 | 1.77 | 1.78 | 13 | 200 | 14 | 9-#4 | 8-#3 | 7-#4 | 8-#3 | 1.74 | 1.74 | 1.74 |
| 13 | 250 | 15 | 0.809 | 20 | 40 | 53 | 9-#4 2 | 11-#3 | 10-#4 | 8-#3 | 7-#4 | 1.86 | 1.86 | 1.89 | 13 | 250 | 15 | 10-#4 | 8-#3 | 7-#4 | 8-#3 | 1.81 | 1.81 | 1.81 |
| 13 | 300 | 18 | 0.680 | 22 | 44 | 60 | 9-#4 0 | 7-#4 | 12-#4 | 8-#3 | 7-#4 | 1.94 | 1.97 | 2.09 | 13 | 300 | 16 | 11-#4 | 8-#3 | 7-#4 | 8-#3 | 1.88 | 1.90 | 1.91 |
| 13 | 350 | 20 | 0.646 | 24 | 48 | 65 | 9-#4 0 | 13-#3 | 13-#4 | 9-#3 | 7-#4 | 2.07 | 2.07 | 2.14 | 13 | 350 | 18 | 12-#4 | 9-#3 | 7-#4 | 8-#3 | 2.01 | 2.03 | 2.05 |
| 14 | 50 | 10 | 0.826 | 11 | 22 | 30 | 10-#4 0 | 9-#3 | 10-#4 | 9-#3 | 7-#4 | 1.76 | 1.76 | 1.76 | 14 | 50 | 10 | 10-#4 | 9-#3 | 7-#4 | 9-#3 | 1.76 | 1.76 | 1.76 |
| 14 | 100 | 11 | 0.836 | 15 | 30 | 40 | 10-#4 0 | 9-#3 | 10-#4 | 9-#3 | 7-#4 | 1.76 | 1.76 | 1.76 | 14 | 100 | 11 | 10-#4 | 9-#3 | 7-#4 | 9-#3 | 1.76 | 1.76 | 1.76 |
| 14 | 150 | 13 | 0.812 | 18 | 36 | 49 | 10-#4 0 | 10-#3 | 10-#4 | 9-#3 | 7-#4 | 1.79 | 1.79 | 1.82 | 14 | 150 | 13 | 10-#4 | 9-#3 | 7-#4 | 9-#3 | 1.77 | 1.77 | 1.77 |
| 14 | 200 | 16 | 0.767 | 21 | 43 | 58 | 10-#4 1 | 7-#4 | 11-#4 | 9-#3 | 7-#4 | 1.88 | 1.88 | 1.84 | 14 | 200 | 14 | 11-#4 | 9-#3 | 7-#4 | 9-#3 | 1.84 | 1.84 | 1.84 |
| 14 | 250 | 18 | 0.741 | 24 | 49 | 66 | 10-#4 1 | 13-#3 | 13-#4 | 9-#3 | 7-#4 | 1.99 | 2.00 | 2.01 | 14 | 250 | 16 | 12-#4 | 9-#3 | 7-#4 | 9-#3 | 1.91 | 1.92 | 1.94 |
| 14 | 300 | 21 | 0.692 | 27 | 54 | 72 | 10-#4 1 | 8-#4 | 14-#4 | 10-#3 | 7-#4 | 2.09 | 2.11 | 2.18 | 14 | 300 | 20 | 13-#4 | 10-#3 | 7-#4 | 9-#3 | 2.03 | 2.05 | 2.06 |
| 14 | 350 | 25 | 0.609 | 28 | 57 | 77 | 10-#4 0 | 9-#4 | 10-#5 | 10-#3 | 7-#4 | 2.21 | 2.24 | 2.34 | 14 | 350 | 25 | 14-#4 | 10-#3 | 7-#4 | 9-#3 | 2.12 | 2.15 | 2.17 |
| 15 | 50 | 10 | 0.844 | 14 | 27 | 37 | 10-#4 0 | 9-#3 | 10-#4 | 9-#3 | 8-#4 | 1.66 | 1.66 | 1.65 | 15 | 50 | 10 | 10-#4 | 9-#3 | 8-#4 | 9-#3 | 1.68 | 1.68 | 1.68 |
| 15 | 100 | 13 | 0.790 | 18 | 36 | 49 | 10-#4 0 | 10-#3 | 10-#4 | 9-#3 | 8-#4 | 1.70 | 1.70 | 1.67 | 15 | 100 | 11 | 10-#4 | 9-#3 | 8-#4 | 9-#3 | 1.69 | 1.69 | 1.69 |
| 15 | 150 | 16 | 0.751 | 22 | 45 | 60 | 10-#4 1 | 12-#3 | 12-#4 | 9-#3 | 8-#4 | 1.79 | 1.80 | 1.82 | 15 | 150 | 13 | 11-#4 | 9-#3 | 8-#4 | 9-#3 | 1.75 | 1.76 | 1.78 |
| 15 | 200 | 18 | 0.733 | 26 | 52 | 70 | 10-#4 1 | 8-#4 | 14-#4 | 9-#3 | 8-#4 | 1.94 | 1.96 | 1.99 | 15 | 200 | 16 | 13-#4 | 10-#3 | 8-#4 | 9-#3 | 1.91 | 1.93 | 1.94 |
| 15 | 250 | 22 | 0.690 | 29 | 58 | 78 | 10-#4 2 | 9-#4 | 10-#5 | 10-#3 | 8-#4 | 2.08 | 2.11 | 2.20 | 15 | 250 | 20 | 14-#4 | 11-#3 | 8-#4 | 9-#3 | 2.04 | 2.06 | 2.08 |
| 15 | 300 | 26 | 0.649 | 31 | 63 | 84 | 10-#4 2 | 10-#4 | 16-#4 | 11-#3 | 8-#4 | 2.24 | 2.25 | 2.41 | 15 | 300 | 26 | 10-#5 | 11-#3 | 8-#4 | 9-#3 | 2.16 | 2.17 | 2.18 |
| 15 | 350 | 30 | 0.608 | 33 | 66 | 89 | 10-#4 0 | 10-#4 | 17-#4 | 12-#3 | 8-#4 | 2.32 | 2.33 | 2.43 | 15 | 350 | 32 | 16-#4 | 12-#3 | 8-#4 | 9-#3 | 2.26 | 2.27 | 2.29 |
| 16 | 50 | 11 | 0.858 | 17 | 33 | 45 | 11-#4 1 | 10-#3 | 11-#4 | 10-#3 | 8-#4 | 1.69 | 1.69 | 1.67 | 16 | 50 | 10 | 11-#4 | 10-#3 | 8-#4 | 10-#3 | 1.69 | 1.69 | 1.69 |
| 16 | 100 | 15 | 0.798 | 22 | 44 | 59 | 11-#4 2 | 12-#3 | 11-#4 | 10-#3 | 8-#4 | 1.74 | 1.74 | 1.74 | 16 | 100 | 11 | 11-#4 | 10-#3 | 8-#4 | 10-#3 | 1.70 | 1.70 | 1.70 |
| 16 | 150 | 18 | 0.710 | 27 | 53 | 72 | 11-#4 0 | 8-#4 | 14-#4 | 10-#3 | 8-#4 | 1.86 | 1.88 | 1.93 | 16 | 150 | 15 | 13-#4 | 10-#3 | 8-#4 | 10-#3 | 1.82 | 1.83 | 1.84 |
| 16 | 200 | 22 | 0.675 | 31 | 62 | 83 | 11-#4 1 | 9-#4 | 16-#4 | 11-#3 | 8-#4 | 2.02 | 2.03 | 2.11 | 16 | 200 | 19 | 15-#4 | 11-#3 | 8-#4 | 10-#3 | 1.99 | 2.00 | 2.01 |
| 16 | 250 | 26 | 0.644 | 34 | 68 | 91 | 11-#4 1 | 10-#4 | 12-#5 | 12-#3 | 8-#4 | 2.21 | 2.24 | 2.35 | 16 | 250 | 26 | 16-#4 | 12-#3 | 8-#4 | 10-#3 | 2.11 | 2.15 | 2.18 |
| 16 | 300 | 32 | 0.608 | 36 | 72 | 96 | 11-#4 1 | 11-#4 | 13-#5 | 13-#3 | 8-#4 | 2.37 | 2.40 | 2.52 | 16 | 300 | 33 | 17-#4 | 13-#3 | 8-#4 | 10-#3 | 2.24 | 2.29 | 2.34 |
| 16 | 350 | 36 | 0.607 | 38 | 76 | 102 | 11-#4 0 | 8-#5 | 13-#5 | 13-#3 | 8-#4 | 2.48 | 2.51 | 2.64 | 16 | 350 | 39 | 12-#5 | 13-#3 | 8-#4 | 10-#3 | 2.37 | 2.40 | 2.42 |

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANEL

| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) Location of Panel | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | E | EC | C |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | | | |
| 6 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.500 c.f./s.f. |
| 17 | 50 | 13 | 0.828 | 20 | 40 | 54 | 12-#4 1 | 11-#3 | 12-#4 | 11-#3 | 9-#4 | 1.75 | 1.75 | 1.73 |
| 17 | 100 | 17 | 0.773 | 26 | 52 | 70 | 12-#4 2 | 14-#3 | 13-#4 | 11-#3 | 9-#4 | 1.84 | 1.84 | 1.84 |
| 17 | 150 | 20 | 0.760 | 32 | 63 | 85 | 12-#4 3 | 10-#4 | 17-#4 | 11-#3 | 9-#4 | 2.04 | 2.05 | 2.08 |
| 17 | 200 | 26 | 0.620 | 36 | 71 | 96 | 12-#4 0 | 11-#4 | 13-#5 | 13-#3 | 9-#4 | 2.26 | 2.29 | 2.36 |
| 17 | 250 | 32 | 0.608 | 39 | 77 | 104 | 12-#4 1 | 12-#4 | 20-#4 | 14-#3 | 9-#4 | 2.41 | 2.42 | 2.53 |
| 17 | 300 | 37 | 0.607 | 41 | 82 | 110 | 12-#4 1 | 13-#4 | 15-#5 | 9-#4 | 9-#4 | 2.60 | 2.63 | 2.71 |
| 17 | 350 | 43 | 0.606 | 43 | 85 | 115 | 12-#4 0 | 13-#4 | 15-#5 | 9-#4 | 9-#4 | 2.65 | 2.69 | 2.85 |
| 18 | 50 | 14 | 0.830 | 24 | 47 | 64 | 12-#4 2 | 13-#3 | 12-#4 | 11-#3 | 9-#4 | 1.69 | 1.69 | 1.71 |
| 18 | 100 | 19 | 0.734 | 31 | 61 | 82 | 12-#4 2 | 9-#4 | 16-#4 | 11-#3 | 9-#4 | 1.87 | 1.89 | 1.95 |
| 18 | 150 | 24 | 0.709 | 37 | 73 | 98 | 12-#4 3 | 11-#4 | 13-#5 | 13-#3 | 9-#4 | 2.14 | 2.16 | 2.23 |
| 18 | 200 | 31 | 0.608 | 41 | 81 | 109 | 12-#4 1 | 12-#4 | 14-#5 | 14-#3 | 9-#4 | 2.30 | 2.32 | 2.42 |
| 18 | 250 | 37 | 0.607 | 44 | 88 | 118 | 12-#4 1 | 13-#4 | 15-#5 | 9-#4 | 9-#4 | 2.48 | 2.50 | 2.66 |
| 18 | 300 | 43 | 0.606 | 46 | 93 | 125 | 12-#4 2 | 14-#4 | 16-#5 | 9-#4 | 9-#4 | 2.64 | 2.66 | 2.84 |
| 18 | 350 | 50 | 0.605 | 48 | 96 | 129 | 12-#4 0 | 10-#5 | 12-#6 | 10-#4 | 9-#4 | 2.82 | 2.85 | 2.93 |
| 19 | 50 | 16 | 0.814 | 27 | 55 | 74 | 13-#4 3 | 15-#3 | 14-#4 | 12-#3 | 10-#4 | 1.77 | 1.77 | 1.79 |
| 19 | 100 | 21 | 0.733 | 36 | 71 | 96 | 13-#4 2 | 11-#4 | 18-#4 | 13-#3 | 10-#4 | 1.99 | 2.01 | 2.10 |
| 19 | 150 | 29 | 0.629 | 41 | 83 | 111 | 13-#4 2 | 13-#4 | 15-#5 | 15-#3 | 10-#4 | 2.27 | 2.31 | 2.38 |
| 19 | 200 | 36 | 0.607 | 46 | 92 | 123 | 13-#4 1 | 14-#4 | 16-#5 | 16-#3 | 10-#4 | 2.48 | 2.50 | 2.64 |
| 19 | 250 | 43 | 0.606 | 49 | 99 | 133 | 13-#4 1 | 10-#5 | 13-#6 | 10-#4 | 10-#4 | 2.74 | 2.77 | 2.85 |
| 19 | 300 | 50 | 0.605 | 52 | 104 | 139 | 13-#4 2 | 16-#4 | 18-#5 | 18-#3 | 10-#4 | 2.82 | 2.85 | 3.01 |
| 19 | 350 | 57 | 0.604 | 53 | 107 | 143 | 14-#4 0 | 16-#4 | 14-#6 | 11-#4 | 10-#4 | 2.95 | 3.00 | 3.17 |

## SQUARE INTERIOR PANEL

| (2) Span c.-c. | (3) Load | (1) Min. Sq. Col. | Reinforcing Bars | | | | Steel (psf) Location of Panel | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Column Strip | | Middle Strip | | | | |
| (ft) | (psf) | (in.) | Top | Bottom | Top | Bottom | I | IE | IC |
| 6 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.500 c.f./s.f. |
| 17 | 50 | 10 | 12-#4 | 11-#3 | 9-#4 | 11-#3 | 1.77 | 1.77 | 1.76 |
| 17 | 100 | 13 | 13-#4 | 11-#3 | 9-#4 | 11-#3 | 1.83 | 1.83 | 1.82 |
| 17 | 150 | 17 | 16-#4 | 12-#3 | 9-#4 | 11-#3 | 2.03 | 2.04 | 2.05 |
| 17 | 200 | 24 | 17-#4 | 13-#3 | 9-#4 | 11-#3 | 2.15 | 2.19 | 2.23 |
| 17 | 250 | 32 | 13-#5 | 14-#3 | 9-#4 | 11-#3 | 2.39 | 2.39 | 2.38 |
| 17 | 300 | 40 | 13-#5 | 14-#3 | 9-#4 | 11-#3 | 2.43 | 2.47 | 2.52 |
| 17 | 350 | 47 | 20-#4 | 15-#3 | 9-#4 | 10-#3 | 2.45 | 2.50 | 2.55 |
| 18 | 50 | 10 | 12-#4 | 11-#3 | 9-#4 | 11-#3 | 1.67 | 1.67 | 1.66 |
| 18 | 100 | 15 | 15-#4 | 11-#3 | 9-#4 | 11-#3 | 1.82 | 1.83 | 1.84 |
| 18 | 150 | 21 | 12-#5 | 13-#3 | 9-#4 | 11-#3 | 2.09 | 2.11 | 2.13 |
| 18 | 200 | 30 | 13-#5 | 15-#3 | 9-#4 | 11-#3 | 2.28 | 2.30 | 2.32 |
| 18 | 250 | 39 | 14-#5 | 15-#3 | 9-#4 | 10-#3 | 2.36 | 2.38 | 2.40 |
| 18 | 300 | 47 | 15-#5 | 9-#4 | 9-#4 | 11-#3 | 2.56 | 2.58 | 2.60 |
| 18 | 350 | 55 | 15-#5 | 10-#4 | 9-#4 | 11-#3 | 2.65 | 2.70 | 2.75 |
| 19 | 50 | 12 | 13-#4 | 12-#3 | 10-#4 | 12-#3 | 1.72 | 1.73 | 1.74 |
| 19 | 100 | 17 | 17-#4 | 13-#3 | 10-#4 | 12-#3 | 1.95 | 1.96 | 1.97 |
| 19 | 150 | 26 | 20-#4 | 15-#3 | 10-#4 | 12-#3 | 2.19 | 2.23 | 2.26 |
| 19 | 200 | 36 | 15-#5 | 16-#3 | 10-#4 | 11-#3 | 2.39 | 2.41 | 2.43 |
| 19 | 250 | 45 | 16-#5 | 10-#4 | 10-#4 | 12-#3 | 2.60 | 2.65 | 2.70 |
| 19 | 300 | 54 | 17-#5 | 10-#4 | 10-#4 | 12-#3 | 2.72 | 2.74 | 2.76 |
| 19 | 350 | 63 | 17-#5 | 18-#3 | 10-#4 | 12-#3 | 2.77 | 2.83 | 2.90 |

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

| SQUARE EDGE PANEL | | | | | | | | | | | | | | | SQUARE INTERIOR PANEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) Span c.-c. | (3) | (1) Min. Sq. Col. | Reinforcing Bars | | | | Steel (psf) | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | Each Column Strip | | | Each Middle Strip | | Steel (psf) Location of Panel | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | | | | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | E | EC | C | | | | Top | Bottom | Top | Bottom | I | IE | IC |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | | | | (ft) | (psf) | (in.) | | | | | | | |
| 6.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.542 c.f./s.f. | 6.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.542 c.f./s.f. |
| 13 | 50 | 10 | 0.739 | 9 | 18 | 25 | 8-#4 0 | 9-#3 | 8-#4 | 9-#3 | 7-#4 | 1.77 | 1.77 | 1.76 | 13 | 50 | 10 | 8-#4 | 9-#3 | 7-#4 | 9-#3 | 1.77 | 1.77 | 1.77 |
| 13 | 100 | 10 | 0.782 | 12 | 25 | 33 | 8-#4 0 | 9-#3 | 8-#4 | 9-#3 | 7-#4 | 1.77 | 1.77 | 1.76 | 13 | 100 | 11 | 8-#4 | 9-#3 | 7-#4 | 9-#3 | 1.78 | 1.78 | 1.78 |
| 13 | 150 | 12 | 0.736 | 15 | 30 | 40 | 8-#4 0 | 9-#3 | 8-#4 | 9-#3 | 7-#4 | 1.78 | 1.78 | 1.76 | 13 | 150 | 14 | 8-#4 | 9-#3 | 7-#4 | 9-#3 | 1.79 | 1.79 | 1.79 |
| 13 | 200 | 13 | 0.738 | 18 | 35 | 47 | 8-#4 0 | 9-#3 | 8-#4 | 9-#3 | 7-#4 | 1.78 | 1.78 | 1.76 | 13 | 200 | 15 | 8-#4 | 9-#3 | 7-#4 | 9-#3 | 1.79 | 1.79 | 1.80 |
| 13 | 250 | 14 | 0.741 | 20 | 41 | 55 | 8-#4 0 | 6-#4 | 10-#4 | 9-#3 | 7-#4 | 1.87 | 1.88 | 1.88 | 13 | 250 | 16 | 9-#4 | 9-#3 | 7-#4 | 9-#3 | 1.86 | 1.88 | 1.90 |
| 13 | 300 | 16 | 0.692 | 23 | 45 | 61 | 8-#4 0 | 6-#4 | 11-#4 | 9-#3 | 7-#4 | 1.93 | 1.94 | 1.86 | 13 | 300 | 17 | 10-#4 | 9-#3 | 7-#4 | 9-#3 | 1.94 | 1.95 | 1.97 |
| 13 | 350 | 17 | 0.730 | 25 | 51 | 68 | 8-#4 1 | 7-#4 | 8-#5 | 8-#3 | 7-#4 | 2.00 | 2.03 | 2.04 | 13 | 350 | 17 | 11-#4 | 8-#3 | 7-#4 | 9-#3 | 1.95 | 1.97 | 2.00 |
| 14 | 50 | 10 | 0.786 | 12 | 23 | 31 | 9-#4 0 | 9-#3 | 9-#4 | 9-#3 | 7-#4 | 1.69 | 1.69 | 1.67 | 14 | 50 | 10 | 9-#4 | 9-#3 | 7-#4 | 9-#3 | 1.70 | 1.70 | 1.70 |
| 14 | 100 | 10 | 0.830 | 15 | 31 | 42 | 9-#4 0 | 9-#3 | 9-#4 | 9-#3 | 7-#4 | 1.69 | 1.69 | 1.67 | 14 | 100 | 11 | 9-#4 | 9-#3 | 7-#4 | 9-#3 | 1.70 | 1.71 | 1.71 |
| 14 | 150 | 12 | 0.819 | 19 | 38 | 51 | 9-#4 1 | 9-#3 | 9-#4 | 9-#3 | 7-#4 | 1.71 | 1.71 | 1.71 | 14 | 150 | 14 | 9-#4 | 9-#3 | 7-#4 | 9-#3 | 1.72 | 1.72 | 1.72 |
| 14 | 200 | 14 | 0.808 | 22 | 44 | 60 | 9-#4 2 | 11-#3 | 10-#4 | 9-#3 | 7-#4 | 1.82 | 1.82 | 1.83 | 14 | 200 | 15 | 10-#4 | 9-#3 | 7-#4 | 9-#3 | 1.78 | 1.78 | 1.78 |
| 14 | 250 | 16 | 0.779 | 25 | 51 | 68 | 9-#4 2 | 7-#4 | 12-#4 | 9-#3 | 7-#4 | 1.90 | 1.93 | 1.97 | 14 | 250 | 16 | 11-#4 | 9-#3 | 7-#4 | 9-#3 | 1.85 | 1.86 | 1.88 |
| 14 | 300 | 18 | 0.695 | 28 | 57 | 77 | 9-#4 0 | 8-#4 | 13-#4 | 9-#3 | 7-#4 | 2.00 | 2.03 | 2.09 | 14 | 300 | 17 | 12-#4 | 9-#3 | 7-#4 | 9-#3 | 1.91 | 1.93 | 1.94 |
| 14 | 350 | 21 | 0.612 | 31 | 62 | 83 | 9-#4 0 | 9-#4 | 10-#5 | 10-#3 | 7-#4 | 2.18 | 2.19 | 2.27 | 14 | 350 | 19 | 9-#5 | 10-#3 | 7-#4 | 9-#3 | 2.09 | 2.11 | 2.14 |
| 15 | 50 | 10 | 0.824 | 14 | 29 | 39 | 10-#4 0 | 10-#3 | 10-#4 | 10-#3 | 8-#4 | 1.74 | 1.74 | 1.73 | 15 | 50 | 10 | 10-#4 | 10-#3 | 8-#4 | 10-#3 | 1.75 | 1.75 | 1.75 |
| 15 | 100 | 11 | 0.837 | 19 | 38 | 51 | 10-#4 0 | 10-#3 | 10-#4 | 10-#3 | 8-#4 | 1.74 | 1.74 | 1.73 | 15 | 100 | 11 | 10-#4 | 10-#3 | 8-#4 | 10-#3 | 1.76 | 1.76 | 1.76 |
| 15 | 150 | 14 | 0.796 | 23 | 46 | 62 | 10-#4 1 | 11-#3 | 11-#4 | 10-#3 | 8-#4 | 1.79 | 1.79 | 1.77 | 15 | 150 | 14 | 10-#4 | 10-#3 | 8-#4 | 10-#3 | 1.77 | 1.79 | 1.80 |
| 15 | 200 | 17 | 0.730 | 27 | 54 | 73 | 10-#4 1 | 13-#3 | 13-#4 | 10-#3 | 8-#4 | 1.91 | 1.92 | 1.90 | 15 | 200 | 15 | 12-#4 | 10-#3 | 8-#4 | 10-#3 | 1.89 | 1.90 | 1.92 |
| 15 | 250 | 19 | 0.728 | 31 | 62 | 83 | 10-#4 2 | 9-#4 | 10-#5 | 10-#3 | 8-#4 | 2.08 | 2.09 | 2.11 | 15 | 250 | 17 | 14-#4 | 10-#3 | 8-#4 | 10-#3 | 2.01 | 2.03 | 2.06 |
| 15 | 300 | 21 | 0.704 | 34 | 68 | 92 | 10-#4 2 | 10-#4 | 16-#4 | 11-#3 | 8-#4 | 2.18 | 2.21 | 2.25 | 15 | 300 | 20 | 10-#5 | 11-#3 | 8-#4 | 10-#3 | 2.17 | 2.17 | 2.18 |
| 15 | 350 | 25 | 0.643 | 36 | 73 | 98 | 10-#4 2 | 10-#4 | 17-#4 | 7-#4 | 8-#4 | 2.32 | 2.34 | 2.42 | 15 | 350 | 25 | 16-#4 | 7-#4 | 8-#4 | 10-#3 | 2.28 | 2.30 | 2.31 |
| 16 | 50 | 10 | 0.844 | 18 | 35 | 48 | 10-#4 0 | 11-#3 | 10-#4 | 11-#3 | 8-#4 | 1.72 | 1.72 | 1.71 | 16 | 50 | 10 | 10-#4 | 11-#3 | 8-#4 | 11-#3 | 1.74 | 1.74 | 1.74 |
| 16 | 100 | 13 | 0.810 | 23 | 46 | 62 | 10-#4 1 | 11-#3 | 11-#4 | 11-#3 | 8-#4 | 1.73 | 1.74 | 1.72 | 16 | 100 | 11 | 10-#4 | 11-#3 | 8-#4 | 11-#3 | 1.74 | 1.75 | 1.77 |
| 16 | 150 | 16 | 0.755 | 28 | 56 | 75 | 10-#4 1 | 13-#3 | 13-#4 | 11-#3 | 8-#4 | 1.85 | 1.86 | 1.85 | 16 | 150 | 14 | 12-#4 | 11-#3 | 8-#4 | 11-#3 | 1.86 | 1.87 | 1.88 |
| 16 | 200 | 19 | 0.718 | 33 | 65 | 88 | 10-#4 2 | 9-#4 | 10-#5 | 11-#3 | 8-#4 | 2.03 | 2.04 | 2.04 | 16 | 200 | 16 | 14-#4 | 11-#3 | 8-#4 | 11-#3 | 1.97 | 1.99 | 2.01 |
| 16 | 250 | 22 | 0.661 | 37 | 73 | 99 | 10-#4 2 | 10-#4 | 17-#4 | 12-#3 | 8-#4 | 2.17 | 2.18 | 2.30 | 16 | 250 | 20 | 16-#4 | 12-#3 | 8-#4 | 11-#3 | 2.13 | 2.14 | 2.16 |
| 16 | 300 | 26 | 0.620 | 40 | 80 | 107 | 10-#4 2 | 11-#4 | 13-#5 | 13-#3 | 8-#4 | 2.37 | 2.39 | 2.43 | 16 | 300 | 25 | 12-#5 | 13-#3 | 8-#4 | 11-#3 | 2.35 | 2.37 | 2.39 |
| 16 | 350 | 30 | 0.609 | 42 | 84 | 113 | 10-#4 0 | 8-#5 | 13-#5 | 13-#3 | 8-#4 | 2.46 | 2.49 | 2.61 | 16 | 350 | 32 | 12-#5 | 13-#3 | 8-#4 | 11-#3 | 2.38 | 2.41 | 2.43 |
| 17 | 50 | 12 | 0.839 | 21 | 42 | 57 | 11-#4 2 | 11-#3 | 11-#4 | 11-#3 | 9-#4 | 1.71 | 1.71 | 1.70 | 17 | 50 | 10 | 11-#4 | 11-#3 | 9-#4 | 11-#3 | 1.72 | 1.72 | 1.72 |
| 17 | 100 | 15 | 0.813 | 28 | 55 | 74 | 11-#4 3 | 13-#3 | 13-#4 | 11-#3 | 9-#4 | 1.79 | 1.80 | 1.78 | 17 | 100 | 11 | 12-#4 | 11-#3 | 9-#4 | 11-#3 | 1.77 | 1.78 | 1.79 |
| 17 | 150 | 18 | 0.737 | 33 | 67 | 90 | 11-#4 1 | 9-#4 | 16-#4 | 11-#3 | 9-#4 | 1.97 | 1.99 | 2.02 | 17 | 150 | 15 | 15-#4 | 11-#3 | 9-#4 | 11-#3 | 1.93 | 1.95 | 1.96 |
| 17 | 200 | 22 | 0.644 | 38 | 77 | 103 | 11-#4 1 | 18-#3 | 12-#5 | 12-#3 | 9-#4 | 2.14 | 2.16 | 2.23 | 17 | 200 | 19 | 11-#5 | 13-#3 | 9-#4 | 11-#3 | 2.14 | 2.15 | 2.17 |
| 17 | 250 | 26 | 0.640 | 42 | 85 | 114 | 11-#4 2 | 8-#5 | 13-#5 | 8-#4 | 9-#4 | 2.39 | 2.40 | 2.50 | 17 | 250 | 25 | 12-#5 | 8-#4 | 9-#4 | 11-#3 | 2.28 | 2.30 | 2.32 |
| 17 | 300 | 31 | 0.609 | 45 | 91 | 122 | 11-#4 2 | 8-#5 | 14-#5 | 8-#4 | 9-#4 | 2.49 | 2.50 | 2.58 | 17 | 300 | 32 | 13-#5 | 8-#4 | 9-#4 | 11-#3 | 2.40 | 2.42 | 2.44 |
| 17 | 350 | 36 | 0.608 | 48 | 95 | 128 | 11-#4 2 | 13-#4 | 11-#6 | 9-#4 | 9-#4 | 2.63 | 2.66 | 2.78 | 17 | 350 | 39 | 14-#5 | 15-#3 | 9-#4 | 11-#3 | 2.55 | 2.59 | 2.63 |

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

## SQUARE EDGE PANEL

## SQUARE INTERIOR PANEL

$f'_c$ = 4,000 psi
Grade 60 Bars

| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) | (3) | (1) | Reinforcing Bars | | | | Steel (psf) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | –M Ext. | +M Int. | –M 1st int. | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | | | |
| | | | | | | | | | | | | Location of Panel | | | | | | | | | | Location of Panel | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | E | EC | C | Span c.-c. (ft) | Load (psf) | Min. Sq. Col. (in.) | Top | Bottom | Top | Bottom | I | IE | IC |
| 6.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.542 c.f./s.f. | 6.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.542 c.f./s.f. |
| 18 | 50 | 13 | 0.828 | 25 | 50 | 67 | 12-#4 1 | 12-#3 | 12-#4 | 12-#3 | 9-#4 | 1.72 | 1.72 | 1.71 | 18 | 50 | 10 | 12-#4 | 12-#3 | 9-#4 | 12-#3 | 1.73 | 1.73 | 1.73 |
| 18 | 100 | 17 | 0.775 | 32 | 65 | 87 | 12-#4 2 | 9-#4 | 15-#4 | 12-#3 | 9-#4 | 1.88 | 1.89 | 1.87 | 18 | 100 | 13 | 14-#4 | 12-#3 | 9-#4 | 12-#3 | 1.83 | 1.84 | 1.85 |
| 18 | 150 | 21 | 0.718 | 39 | 78 | 105 | 12-#4 3 | 11-#4 | 12-#5 | 13-#3 | 9-#4 | 2.08 | 2.10 | 2.17 | 18 | 150 | 17 | 17-#4 | 13-#3 | 9-#4 | 12-#3 | 2.03 | 2.04 | 2.06 |
| 18 | 200 | 26 | 0.614 | 44 | 89 | 119 | 12-#4 1 | 12-#4 | 14-#5 | 14-#3 | 9-#4 | 2.29 | 2.32 | 2.40 | 18 | 200 | 23 | 13-#5 | 15-#3 | 9-#4 | 12-#3 | 2.28 | 2.30 | 2.31 |
| 18 | 250 | 31 | 0.609 | 48 | 97 | 130 | 12-#4 1 | 13-#4 | 15-#5 | 9-#4 | 9-#4 | 2.48 | 2.50 | 2.58 | 18 | 250 | 31 | 14-#5 | 9-#4 | 9-#4 | 12-#3 | 2.43 | 2.45 | 2.47 |
| 18 | 300 | 37 | 0.607 | 51 | 102 | 138 | 12-#4 2 | 14-#4 | 16-#5 | 9-#4 | 9-#4 | 2.62 | 2.64 | 2.82 | 18 | 300 | 39 | 15-#5 | 9-#4 | 9-#4 | 12-#3 | 2.55 | 2.57 | 2.59 |
| 18 | 350 | 43 | 0.606 | 53 | 107 | 144 | 12-#4 2 | 10-#5 | 12-#6 | 10-#4 | 9-#4 | 2.77 | 2.81 | 2.93 | 18 | 350 | 46 | 15-#5 | 10-#4 | 9-#4 | 11-#3 | 2.61 | 2.65 | 2.70 |
| 19 | 50 | 15 | 0.799 | 29 | 59 | 79 | 12-#4 2 | 14-#3 | 14-#4 | 13-#3 | 10-#4 | 1.77 | 1.78 | 1.77 | 19 | 50 | 10 | 13-#4 | 13-#3 | 10-#4 | 13-#3 | 1.79 | 1.80 | 1.81 |
| 19 | 100 | 19 | 0.752 | 38 | 75 | 102 | 12-#4 3 | 10-#4 | 12-#5 | 12-#3 | 10-#4 | 1.97 | 1.99 | 2.02 | 19 | 100 | 15 | 17-#4 | 12-#3 | 10-#4 | 13-#3 | 1.94 | 1.96 | 1.98 |
| 19 | 150 | 24 | 0.698 | 45 | 90 | 121 | 12-#4 4 | 12-#4 | 14-#5 | 14-#3 | 10-#4 | 2.21 | 2.23 | 2.31 | 19 | 150 | 20 | 13-#5 | 15-#3 | 10-#4 | 13-#3 | 2.22 | 2.23 | 2.25 |
| 19 | 200 | 30 | 0.609 | 50 | 101 | 135 | 12-#4 2 | 9-#5 | 16-#5 | 9-#4 | 10-#4 | 2.44 | 2.45 | 2.54 | 19 | 200 | 29 | 15-#5 | 9-#4 | 10-#4 | 13-#3 | 2.44 | 2.45 | 2.47 |
| 19 | 250 | 37 | 0.607 | 54 | 109 | 146 | 12-#4 2 | 10-#5 | 17-#5 | 10-#4 | 10-#4 | 2.65 | 2.68 | 2.80 | 19 | 250 | 37 | 16-#5 | 10-#4 | 10-#4 | 13-#3 | 2.60 | 2.62 | 2.63 |
| 19 | 300 | 43 | 0.606 | 57 | 115 | 155 | 13-#4 2 | 16-#4 | 13-#6 | 18-#3 | 10-#4 | 2.79 | 2.83 | 2.97 | 19 | 300 | 46 | 12-#6 | 10-#4 | 10-#4 | 12-#3 | 2.70 | 2.72 | 2.75 |
| 19 | 350 | 49 | 0.606 | 60 | 120 | 161 | 14-#4 1 | 11-#5 | 14-#6 | 11-#4 | 10-#4 | 2.99 | 3.05 | 3.14 | 19 | 350 | 54 | 12-#6 | 11-#4 | 10-#4 | 13-#3 | 2.85 | 2.90 | 2.96 |
| 20 | 50 | 17 | 0.796 | 34 | 68 | 91 | 13-#4 4 | 16-#3 | 16-#4 | 13-#3 | 10-#4 | 1.82 | 1.83 | 1.84 | 20 | 50 | 12 | 15-#4 | 13-#3 | 10-#4 | 13-#3 | 1.79 | 1.80 | 1.81 |
| 20 | 100 | 21 | 0.731 | 44 | 87 | 117 | 13-#4 3 | 12-#4 | 20-#4 | 14-#3 | 10-#4 | 2.06 | 2.07 | 2.12 | 20 | 100 | 17 | 13-#5 | 14-#3 | 10-#4 | 13-#3 | 2.05 | 2.05 | 2.05 |
| 20 | 150 | 28 | 0.646 | 51 | 102 | 138 | 13-#4 3 | 14-#4 | 16-#5 | 16-#3 | 10-#4 | 2.34 | 2.36 | 2.42 | 20 | 150 | 24 | 15-#5 | 10-#4 | 10-#4 | 13-#3 | 2.34 | 2.35 | 2.37 |
| 20 | 200 | 35 | 0.608 | 56 | 113 | 152 | 13-#4 4 | 10-#5 | 13-#6 | 10-#4 | 10-#4 | 2.57 | 2.61 | 2.73 | 20 | 200 | 35 | 16-#5 | 10-#4 | 10-#4 | 13-#3 | 2.45 | 2.50 | 2.54 |
| 20 | 250 | 42 | 0.607 | 61 | 122 | 164 | 14-#4 1 | 11-#5 | 14-#6 | 11-#4 | 10-#4 | 2.80 | 2.84 | 2.97 | 20 | 250 | 44 | 26-#4 | 11-#4 | 10-#4 | 13-#3 | 2.60 | 2.66 | 2.73 |
| 20 | 300 | 49 | 0.606 | 64 | 128 | 173 | 15-#4 1 | 12-#5 | 20-#5 | 12-#4 | 10-#4 | 2.99 | 3.04 | 3.15 | 20 | 300 | 53 | 13-#6 | 12-#4 | 10-#4 | 13-#3 | 2.84 | 2.86 | 2.89 |
| 20 | 350 | 56 | 0.605 | 66 | 132 | 178 | 15-#4 1 | 12-#5 | 15-#6 | 12-#4 | 10-#4 | 3.12 | 3.16 | 3.33 | 20 | 350 | 62 | 14-#6 | 12-#4 | 10-#4 | 14-#3 | 3.01 | 3.04 | 3.07 |

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

| SQUARE EDGE PANEL | | | | | | | | | | | | | | | SQUARE INTERIOR PANEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) | (3) | (1) | Reinforcing Bars | | | | Steel (psf) | | |
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | | | | | | Location of Panel | | | | | | | | | | | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | E | EC | C | Span c.-c. (ft) | Load (psf) | Min. Sq. Col. (in.) | Top | Bottom | Top | Bottom | I | IE | IC |
| 7 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.583 c.f./s.f. | 7 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.583 c.f./s.f. |
| 14 | 50 | 10 | 0.734 | 12 | 24 | 33 | 8-#4 0 | 6-#4 | 8-#4 | 6-#4 | 7-#4 | 1.77 | 1.77 | 1.76 | 14 | 50 | 10 | 8-#4 | 6-#4 | 7-#4 | 6-#4 | 1.78 | 1.78 | 1.78 |
| 14 | 100 | 10 | 0.805 | 16 | 32 | 43 | 8-#4 1 | 6-#4 | 8-#4 | 6-#4 | 7-#4 | 1.78 | 1.78 | 1.76 | 14 | 100 | 11 | 8-#4 | 6-#4 | 7-#4 | 6-#4 | 1.78 | 1.78 | 1.78 |
| 14 | 150 | 12 | 0.740 | 19 | 39 | 52 | 8-#4 0 | 6-#4 | 8-#4 | 6-#4 | 7-#4 | 1.78 | 1.78 | 1.76 | 14 | 150 | 14 | 8-#4 | 6-#4 | 7-#4 | 6-#4 | 1.80 | 1.80 | 1.80 |
| 14 | 200 | 13 | 0.745 | 23 | 46 | 62 | 8-#4 0 | 6-#4 | 10-#4 | 6-#4 | 7-#4 | 1.82 | 1.85 | 1.81 | 14 | 200 | 15 | 9-#4 | 6-#4 | 7-#4 | 6-#4 | 1.86 | 1.88 | 1.89 |
| 14 | 250 | 15 | 0.700 | 26 | 52 | 70 | 8-#4 0 | 7-#4 | 11-#4 | 6-#4 | 7-#4 | 1.93 | 1.94 | 1.92 | 14 | 250 | 16 | 10-#4 | 6-#4 | 7-#4 | 6-#4 | 1.93 | 1.94 | 1.96 |
| 14 | 300 | 17 | 0.653 | 29 | 58 | 79 | 8-#4 0 | 7-#4 | 8-#5 | 6-#4 | 7-#4 | 2.02 | 2.02 | 1.96 | 14 | 300 | 17 | 8-#5 | 6-#4 | 7-#4 | 6-#4 | 2.08 | 2.08 | 2.08 |
| 14 | 350 | 19 | 0.643 | 32 | 64 | 87 | 8-#4 1 | 8-#4 | 9-#5 | 6-#4 | 7-#4 | 2.09 | 2.11 | 2.08 | 14 | 350 | 18 | 13-#4 | 6-#4 | 7-#4 | 6-#4 | 2.12 | 2.13 | 2.15 |
| 15 | 50 | 10 | 0.783 | 15 | 30 | 41 | 9-#4 0 | 11-#3 | 9-#4 | 11-#3 | 8-#4 | 1.76 | 1.76 | 1.74 | 15 | 50 | 10 | 9-#4 | 11-#3 | 8-#4 | 11-#3 | 1.80 | 1.80 | 1.80 |
| 15 | 100 | 10 | 0.848 | 20 | 40 | 54 | 9-#4 1 | 11-#3 | 9-#4 | 11-#3 | 8-#4 | 1.77 | 1.77 | 1.74 | 15 | 100 | 11 | 9-#4 | 11-#3 | 8-#4 | 11-#3 | 1.80 | 1.80 | 1.80 |
| 15 | 150 | 13 | 0.784 | 24 | 48 | 64 | 9-#4 1 | 11-#3 | 10-#4 | 11-#3 | 8-#4 | 1.78 | 1.80 | 1.77 | 15 | 150 | 14 | 9-#4 | 11-#3 | 8-#4 | 11-#3 | 1.82 | 1.83 | 1.84 |
| 15 | 200 | 15 | 0.776 | 28 | 56 | 76 | 9-#4 2 | 7-#4 | 12-#4 | 11-#3 | 8-#4 | 1.92 | 1.94 | 1.90 | 15 | 200 | 15 | 11-#4 | 11-#3 | 8-#4 | 11-#3 | 1.93 | 1.95 | 1.96 |
| 15 | 250 | 17 | 0.768 | 32 | 64 | 86 | 9-#4 3 | 8-#4 | 9-#5 | 11-#3 | 8-#4 | 2.04 | 2.06 | 2.02 | 15 | 250 | 16 | 13-#4 | 11-#3 | 8-#4 | 11-#3 | 2.05 | 2.06 | 2.08 |
| 15 | 300 | 19 | 0.657 | 36 | 72 | 96 | 9-#4 0 | 9-#4 | 10-#5 | 11-#3 | 8-#4 | 2.15 | 2.18 | 2.20 | 15 | 300 | 18 | 14-#4 | 11-#3 | 8-#4 | 11-#3 | 2.12 | 2.14 | 2.16 |
| 15 | 350 | 22 | 0.613 | 39 | 78 | 105 | 9-#4 1 | 10-#4 | 11-#5 | 11-#3 | 8-#4 | 2.29 | 2.30 | 2.39 | 15 | 350 | 20 | 10-#5 | 7-#4 | 8-#4 | 11-#3 | 2.29 | 2.31 | 2.33 |
| 16 | 50 | 10 | 0.823 | 19 | 37 | 50 | 10-#4 0 | 11-#3 | 10-#4 | 11-#3 | 8-#4 | 1.74 | 1.74 | 1.76 | 16 | 50 | 10 | 10-#4 | 11-#3 | 8-#4 | 11-#3 | 1.74 | 1.74 | 1.74 |
| 16 | 100 | 12 | 0.819 | 24 | 48 | 65 | 10-#4 1 | 11-#3 | 10-#4 | 11-#3 | 8-#4 | 1.74 | 1.74 | 1.75 | 16 | 100 | 11 | 10-#4 | 11-#3 | 8-#4 | 11-#3 | 1.74 | 1.74 | 1.74 |
| 16 | 150 | 15 | 0.761 | 29 | 58 | 78 | 10-#4 1 | 7-#4 | 12-#4 | 11-#3 | 8-#4 | 1.81 | 1.83 | 1.83 | 16 | 150 | 14 | 11-#4 | 11-#3 | 8-#4 | 11-#3 | 1.80 | 1.82 | 1.83 |
| 16 | 200 | 17 | 0.760 | 34 | 68 | 92 | 10-#4 2 | 9-#4 | 14-#4 | 11-#3 | 8-#4 | 2.00 | 2.01 | 2.00 | 16 | 200 | 15 | 14-#4 | 11-#3 | 8-#4 | 11-#3 | 1.97 | 1.97 | 1.96 |
| 16 | 250 | 20 | 0.696 | 38 | 77 | 103 | 10-#4 2 | 10-#4 | 16-#4 | 11-#3 | 8-#4 | 2.13 | 2.15 | 2.13 | 16 | 250 | 18 | 10-#5 | 7-#4 | 8-#4 | 11-#3 | 2.13 | 2.13 | 2.14 |
| 16 | 300 | 22 | 0.697 | 43 | 85 | 114 | 10-#4 3 | 7-#5 | 12-#5 | 7-#4 | 8-#4 | 2.27 | 2.29 | 2.34 | 16 | 300 | 21 | 11-#5 | 7-#4 | 8-#4 | 11-#3 | 2.22 | 2.25 | 2.27 |
| 16 | 350 | 25 | 0.620 | 46 | 92 | 123 | 10-#4 2 | 8-#5 | 13-#5 | 13-#3 | 8-#4 | 2.43 | 2.46 | 2.55 | 16 | 350 | 25 | 12-#5 | 8-#4 | 8-#4 | 11-#3 | 2.39 | 2.41 | 2.43 |
| 17 | 50 | 10 | 0.843 | 22 | 45 | 60 | 10-#4 0 | 12-#3 | 10-#4 | 12-#3 | 9-#4 | 1.73 | 1.73 | 1.72 | 17 | 50 | 10 | 10-#4 | 12-#3 | 9-#4 | 12-#3 | 1.73 | 1.73 | 1.73 |
| 17 | 100 | 14 | 0.774 | 29 | 58 | 78 | 10-#4 1 | 13-#3 | 12-#4 | 12-#3 | 9-#4 | 1.79 | 1.81 | 1.78 | 17 | 100 | 11 | 12-#4 | 12-#3 | 9-#4 | 12-#3 | 1.83 | 1.83 | 1.83 |
| 17 | 150 | 17 | 0.740 | 35 | 70 | 94 | 10-#4 2 | 9-#4 | 10-#5 | 12-#3 | 9-#4 | 1.95 | 1.97 | 1.93 | 17 | 150 | 14 | 14-#4 | 12-#3 | 9-#4 | 12-#3 | 1.94 | 1.96 | 1.98 |
| 17 | 200 | 20 | 0.682 | 40 | 81 | 108 | 10-#4 2 | 10-#4 | 11-#5 | 12-#3 | 9-#4 | 2.09 | 2.09 | 2.16 | 17 | 200 | 17 | 16-#4 | 12-#3 | 9-#4 | 12-#3 | 2.06 | 2.07 | 2.08 |
| 17 | 250 | 23 | 0.617 | 45 | 91 | 122 | 10-#4 2 | 11-#4 | 13-#5 | 13-#3 | 9-#4 | 2.27 | 2.29 | 2.28 | 17 | 250 | 20 | 12-#5 | 8-#4 | 9-#4 | 12-#3 | 2.29 | 2.31 | 2.33 |
| 17 | 300 | 26 | 0.622 | 50 | 99 | 133 | 10-#4 3 | 8-#5 | 10-#6 | 8-#4 | 9-#4 | 2.42 | 2.46 | 2.54 | 17 | 300 | 25 | 13-#5 | 8-#4 | 9-#4 | 12-#3 | 2.39 | 2.42 | 2.45 |
| 17 | 350 | 31 | 0.609 | 52 | 104 | 141 | 11-#4 2 | 13-#4 | 11-#6 | 9-#4 | 9-#4 | 2.63 | 2.65 | 2.69 | 17 | 350 | 31 | 10-#6 | 15-#3 | 9-#4 | 12-#3 | 2.57 | 2.60 | 2.63 |
| 18 | 50 | 12 | 0.839 | 26 | 53 | 71 | 11-#4 2 | 13-#3 | 11-#4 | 13-#3 | 9-#4 | 1.75 | 1.75 | 1.72 | 18 | 50 | 10 | 11-#4 | 13-#3 | 9-#4 | 13-#3 | 1.76 | 1.76 | 1.76 |
| 18 | 100 | 16 | 0.782 | 34 | 68 | 91 | 11-#4 3 | 9-#4 | 14-#4 | 13-#3 | 9-#4 | 1.91 | 1.92 | 1.88 | 18 | 100 | 12 | 14-#4 | 13-#3 | 9-#4 | 13-#3 | 1.91 | 1.91 | 1.91 |
| 18 | 150 | 19 | 0.721 | 41 | 82 | 110 | 11-#4 2 | 10-#4 | 17-#4 | 13-#3 | 9-#4 | 2.04 | 2.04 | 2.09 | 18 | 150 | 16 | 16-#4 | 12-#3 | 9-#4 | 13-#3 | 1.98 | 1.99 | 2.00 |
| 18 | 200 | 22 | 0.673 | 47 | 94 | 127 | 11-#4 2 | 8-#5 | 13-#5 | 8-#4 | 9-#4 | 2.28 | 2.29 | 2.31 | 18 | 200 | 20 | 13-#5 | 8-#4 | 9-#4 | 13-#3 | 2.28 | 2.27 | 2.27 |
| 18 | 250 | 26 | 0.611 | 53 | 105 | 142 | 11-#4 2 | 13-#4 | 11-#6 | 9-#4 | 9-#4 | 2.50 | 2.51 | 2.55 | 18 | 250 | 24 | 14-#5 | 9-#4 | 9-#4 | 13-#3 | 2.44 | 2.47 | 2.51 |
| 18 | 300 | 31 | 0.609 | 56 | 112 | 151 | 12-#4 2 | 9-#5 | 16-#5 | 9-#4 | 9-#4 | 2.64 | 2.65 | 2.74 | 18 | 300 | 32 | 11-#6 | 9-#4 | 9-#4 | 13-#3 | 2.62 | 2.62 | 2.63 |
| 18 | 350 | 37 | 0.608 | 59 | 117 | 158 | 12-#4 2 | 10-#5 | 12-#6 | 10-#4 | 9-#4 | 2.79 | 2.82 | 2.94 | 18 | 350 | 39 | 11-#6 | 10-#4 | 9-#4 | 13-#3 | 2.71 | 2.74 | 2.77 |

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANEL

| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) Location of Panel | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | E | EC | C |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | | | |
| 7 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.583 c.f./s.f. |
| 19 | 50 | 14 | 0.810 | 31 | 62 | 83 | 11-#4 3 | 14-#3 | 13-#4 | 14-#3 | 10-#4 | 1.78 | 1.79 | 1.77 |
| 19 | 100 | 18 | 0.758 | 40 | 79 | 106 | 11-#4 4 | 10-#4 | 11-#5 | 14-#3 | 10-#4 | 1.96 | 1.98 | 1.95 |
| 19 | 150 | 21 | 0.683 | 48 | 95 | 128 | 11-#4 2 | 12-#4 | 13-#5 | 14-#3 | 10-#4 | 2.16 | 2.17 | 2.18 |
| 19 | 200 | 26 | 0.611 | 54 | 109 | 147 | 11-#4 3 | 9-#5 | 23-#4 | 9-#4 | 10-#4 | 2.43 | 2.43 | 2.45 |
| 19 | 250 | 31 | 0.609 | 59 | 119 | 160 | 12-#4 2 | 10-#5 | 12-#6 | 10-#4 | 10-#4 | 2.63 | 2.67 | 2.80 |
| 19 | 300 | 37 | 0.608 | 63 | 126 | 170 | 13-#4 2 | 16-#4 | 13-#6 | 18-#3 | 10-#4 | 2.78 | 2.79 | 2.87 |
| 19 | 350 | 43 | 0.607 | 66 | 131 | 177 | 14-#4 1 | 16-#4 | 11-#7 | 11-#4 | 10-#4 | 2.95 | 3.02 | 3.10 |
| 20 | 50 | 16 | 0.766 | 36 | 72 | 97 | 12-#4 2 | 9-#4 | 15-#4 | 14-#3 | 10-#4 | 1.80 | 1.81 | 1.76 |
| 20 | 100 | 20 | 0.736 | 46 | 91 | 123 | 12-#4 4 | 11-#4 | 13-#5 | 14-#3 | 10-#4 | 2.04 | 2.05 | 2.01 |
| 20 | 150 | 24 | 0.672 | 55 | 109 | 147 | 12-#4 4 | 9-#5 | 23-#4 | 9-#4 | 10-#4 | 2.31 | 2.31 | 2.35 |
| 20 | 200 | 30 | 0.610 | 61 | 123 | 165 | 13-#4 3 | 10-#5 | 17-#5 | 10-#4 | 10-#4 | 2.52 | 2.55 | 2.70 |
| 20 | 250 | 36 | 0.608 | 66 | 133 | 179 | 14-#4 3 | 11-#5 | 14-#6 | 11-#4 | 10-#4 | 2.76 | 2.82 | 2.93 |
| 20 | 300 | 43 | 0.607 | 70 | 140 | 189 | 15-#4 1 | 12-#5 | 20-#5 | 12-#4 | 10-#4 | 2.99 | 3.01 | 3.14 |
| 20 | 350 | 49 | 0.606 | 73 | 146 | 196 | 15-#4 1 | 12-#5 | 15-#6 | 12-#4 | 10-#4 | 3.10 | 3.13 | 3.24 |
| 21 | 50 | 17 | 0.772 | 41 | 83 | 112 | 12-#4 3 | 10-#4 | 17-#4 | 9-#4 | 11-#4 | 1.92 | 1.92 | 1.91 |
| 21 | 100 | 22 | 0.697 | 52 | 105 | 141 | 12-#4 4 | 13-#4 | 15-#5 | 9-#4 | 11-#4 | 2.17 | 2.20 | 2.20 |
| 21 | 150 | 28 | 0.637 | 62 | 124 | 167 | 13-#4 4 | 10-#5 | 26-#4 | 10-#4 | 11-#4 | 2.45 | 2.46 | 2.56 |
| 21 | 200 | 35 | 0.608 | 68 | 137 | 184 | 14-#4 3 | 11-#5 | 14-#6 | 11-#4 | 11-#4 | 2.73 | 2.76 | 2.85 |
| 21 | 250 | 42 | 0.607 | 74 | 148 | 199 | 15-#4 3 | 12-#5 | 15-#6 | 12-#4 | 11-#4 | 2.92 | 2.96 | 3.05 |
| 21 | 300 | 49 | 0.606 | 78 | 155 | 209 | 16-#4 2 | 9-#6 | 12-#7 | 13-#4 | 11-#4 | 3.15 | 3.20 | 3.36 |
| 21 | 350 | 56 | 0.605 | 81 | 161 | 217 | 17-#4 0 | 20-#4 | 13-#7 | 13-#4 | 11-#4 | 3.26 | 3.34 | 3.53 |
| 22 | 50 | 19 | 0.771 | 47 | 94 | 127 | 13-#4 5 | 12-#4 | 13-#5 | 16-#3 | 11-#4 | 1.99 | 2.00 | 1.97 |
| 22 | 100 | 24 | 0.680 | 60 | 119 | 160 | 13-#4 4 | 10-#5 | 17-#5 | 10-#4 | 11-#4 | 2.32 | 2.33 | 2.39 |
| 22 | 150 | 32 | 0.609 | 69 | 138 | 186 | 14-#4 3 | 17-#4 | 14-#6 | 11-#4 | 11-#4 | 2.57 | 2.59 | 2.65 |
| 22 | 200 | 40 | 0.607 | 76 | 152 | 205 | 16-#4 2 | 13-#5 | 16-#6 | 13-#4 | 11-#4 | 2.90 | 2.95 | 3.04 |
| 22 | 250 | 48 | 0.606 | 81 | 163 | 219 | 17-#4 2 | 20-#4 | 13-#7 | 14-#4 | 11-#4 | 3.12 | 3.17 | 3.26 |
| 22 | 300 | 55 | 0.606 | 86 | 172 | 231 | 18-#4 2 | 10-#6 | 14-#7 | 14-#4 | 12-#4 | 3.35 | 3.42 | 3.53 |
| 22 | 350 | 63 | 0.605 | 88 | 176 | 237 | 18-#4 0 | 11-#6 | 14-#7 | 10-#5 | 12-#4 | 3.61 | 3.63 | 3.72 |

## SQUARE INTERIOR PANEL

| (2) Span c.-c. | (3) Load | (1) Min. Sq. Col. | Reinforcing Bars | | | | Steel (psf) Location of Panel | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Column Strip | | Middle Strip | | | | |
| (ft) | (psf) | (in.) | Top | Bottom | Top | Bottom | I | IE | IC |
| 7 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.583 c.f./s.f. |
| 19 | 50 | 10 | 12-#4 | 14-#3 | 10-#4 | 14-#3 | 1.80 | 1.81 | 1.82 |
| 19 | 100 | 14 | 16-#4 | 14-#3 | 10-#4 | 14-#3 | 1.99 | 2.00 | 2.02 |
| 19 | 150 | 18 | 13-#5 | 14-#3 | 10-#4 | 14-#3 | 2.20 | 2.20 | 2.20 |
| 19 | 200 | 22 | 11-#6 | 9-#4 | 10-#4 | 14-#3 | 2.49 | 2.47 | 2.45 |
| 19 | 250 | 30 | 16-#5 | 10-#4 | 10-#4 | 14-#3 | 2.59 | 2.61 | 2.64 |
| 19 | 300 | 38 | 12-#6 | 18-#3 | 10-#4 | 14-#3 | 2.73 | 2.76 | 2.79 |
| 19 | 350 | 46 | 17-#5 | 11-#4 | 10-#4 | 14-#3 | 2.81 | 2.90 | 2.99 |
| 20 | 50 | 11 | 14-#4 | 14-#3 | 10-#4 | 14-#3 | 1.80 | 1.81 | 1.82 |
| 20 | 100 | 16 | 12-#5 | 14-#3 | 10-#4 | 14-#3 | 2.01 | 2.03 | 2.04 |
| 20 | 150 | 20 | 15-#5 | 9-#4 | 10-#4 | 14-#3 | 2.30 | 2.29 | 2.28 |
| 20 | 200 | 28 | 16-#5 | 10-#4 | 10-#4 | 14-#3 | 2.45 | 2.46 | 2.48 |
| 20 | 250 | 37 | 26-#4 | 11-#4 | 10-#4 | 14-#3 | 2.60 | 2.66 | 2.72 |
| 20 | 300 | 45 | 13-#6 | 12-#4 | 10-#4 | 14-#3 | 2.83 | 2.85 | 2.87 |
| 20 | 350 | 54 | 14-#6 | 12-#4 | 10-#4 | 14-#3 | 2.97 | 3.00 | 3.03 |
| 21 | 50 | 12 | 17-#4 | 15-#3 | 11-#4 | 15-#3 | 1.93 | 1.93 | 1.93 |
| 21 | 100 | 18 | 14-#5 | 9-#4 | 11-#4 | 15-#3 | 2.18 | 2.19 | 2.21 |
| 21 | 150 | 23 | 12-#6 | 11-#4 | 11-#4 | 15-#3 | 2.52 | 2.50 | 2.49 |
| 21 | 200 | 34 | 13-#6 | 12-#4 | 11-#4 | 15-#3 | 2.70 | 2.73 | 2.75 |
| 21 | 250 | 43 | 14-#6 | 12-#4 | 11-#4 | 14-#3 | 2.80 | 2.83 | 2.85 |
| 21 | 300 | 53 | 20-#5 | 13-#4 | 11-#4 | 15-#3 | 2.94 | 3.00 | 3.06 |
| 21 | 350 | 61 | 15-#6 | 13-#4 | 11-#4 | 15-#3 | 3.09 | 3.16 | 3.23 |
| 22 | 50 | 14 | 13-#5 | 16-#3 | 11-#4 | 16-#3 | 2.02 | 2.02 | 2.02 |
| 22 | 100 | 20 | 16-#5 | 10-#4 | 11-#4 | 16-#3 | 2.27 | 2.29 | 2.30 |
| 22 | 150 | 29 | 13-#6 | 12-#4 | 11-#4 | 16-#3 | 2.58 | 2.60 | 2.62 |
| 22 | 200 | 40 | 20-#5 | 13-#4 | 11-#4 | 15-#3 | 2.74 | 2.79 | 2.83 |
| 22 | 250 | 50 | 21-#5 | 14-#4 | 11-#4 | 16-#3 | 2.92 | 2.99 | 3.06 |
| 22 | 300 | 60 | 16-#6 | 14-#4 | 11-#4 | 16-#3 | 3.09 | 3.18 | 3.26 |
| 22 | 350 | 70 | 13-#7 | 14-#4 | 11-#4 | 10-#4 | 3.36 | 3.40 | 3.45 |

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

| SQUARE EDGE PANEL | | | | | | | | | | | | | | | SQUARE INTERIOR PANEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) | (3) | (1) | Reinforcing Bars | | | | Steel (psf) | | |
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | | | | | | Location of Panel | | | Span c.-c. | Load | Min. Sq. Col. | | | | | | | |
| | | | | | | | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | | | | | | | Top | Bottom | Top | Bottom | | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | E | EC | C | (ft) | (psf) | (in.) | | | | | I | IE | IC |
| 7.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.625 c.f./s.f. | 7.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.625 c.f./s.f. |
| 15 | 50 | 10 | 0.761 | 16 | 32 | 43 | 8-#4 1 | 7-#4 | 8-#4 | 7-#4 | 8-#4 | 1.87 | 1.87 | 1.88 | 15 | 50 | 10 | 8-#4 | 7-#4 | 8-#4 | 7-#4 | 1.88 | 1.88 | 1.88 |
| 15 | 100 | 10 | 0.826 | 21 | 41 | 56 | 8-#4 2 | 7-#4 | 8-#4 | 7-#4 | 8-#4 | 1.87 | 1.87 | 1.88 | 15 | 100 | 11 | 8-#4 | 7-#4 | 8-#4 | 7-#4 | 1.88 | 1.88 | 1.88 |
| 15 | 150 | 12 | 0.745 | 25 | 50 | 67 | 8-#4 0 | 7-#4 | 10-#4 | 7-#4 | 8-#4 | 1.92 | 1.92 | 1.90 | 15 | 150 | 14 | 9-#4 | 7-#4 | 8-#4 | 7-#4 | 1.95 | 1.97 | 1.98 |
| 15 | 200 | 13 | 0.781 | 29 | 58 | 78 | 8-#4 1 | 7-#4 | 11-#4 | 7-#4 | 8-#4 | 1.97 | 1.98 | 1.94 | 15 | 200 | 16 | 10-#4 | 7-#4 | 8-#4 | 7-#4 | 2.02 | 2.03 | 2.05 |
| 15 | 250 | 16 | 0.695 | 33 | 66 | 88 | 8-#4 1 | 8-#4 | 13-#4 | 7-#4 | 8-#4 | 2.10 | 2.10 | 2.02 | 15 | 250 | 17 | 8-#5 | 7-#4 | 8-#4 | 7-#4 | 2.16 | 2.17 | 2.18 |
| 15 | 300 | 18 | 0.653 | 37 | 73 | 99 | 8-#4 1 | 6-#5 | 14-#4 | 7-#4 | 8-#4 | 2.17 | 2.19 | 2.11 | 15 | 300 | 18 | 13-#4 | 7-#4 | 8-#4 | 7-#4 | 2.19 | 2.21 | 2.22 |
| 15 | 350 | 20 | 0.615 | 41 | 81 | 109 | 8-#4 1 | 6-#5 | 16-#4 | 6-#4 | 8-#4 | 2.22 | 2.24 | 2.20 | 15 | 350 | 18 | 10-#5 | 7-#4 | 8-#4 | 7-#4 | 2.34 | 2.35 | 2.35 |
| 16 | 50 | 10 | 0.782 | 19 | 39 | 52 | 9-#4 0 | 7-#4 | 9-#4 | 7-#4 | 8-#4 | 1.79 | 1.79 | 1.79 | 16 | 50 | 10 | 9-#4 | 7-#4 | 8-#4 | 7-#4 | 1.81 | 1.81 | 1.81 |
| 16 | 100 | 11 | 0.814 | 25 | 50 | 68 | 9-#4 1 | 7-#4 | 10-#4 | 7-#4 | 8-#4 | 1.82 | 1.83 | 1.82 | 16 | 100 | 11 | 9-#4 | 7-#4 | 8-#4 | 7-#4 | 1.81 | 1.83 | 1.84 |
| 16 | 150 | 13 | 0.808 | 30 | 60 | 81 | 9-#4 2 | 7-#4 | 12-#4 | 7-#4 | 8-#4 | 1.89 | 1.90 | 1.87 | 16 | 150 | 14 | 11-#4 | 7-#4 | 8-#4 | 7-#4 | 1.93 | 1.94 | 1.96 |
| 16 | 200 | 16 | 0.742 | 35 | 70 | 94 | 9-#4 2 | 8-#4 | 9-#5 | 7-#4 | 8-#4 | 2.00 | 2.02 | 2.02 | 16 | 200 | 16 | 13-#4 | 7-#4 | 8-#4 | 7-#4 | 2.04 | 2.06 | 2.07 |
| 16 | 250 | 18 | 0.738 | 40 | 80 | 107 | 9-#4 3 | 9-#4 | 10-#5 | 7-#4 | 8-#4 | 2.10 | 2.13 | 2.14 | 16 | 250 | 17 | 14-#4 | 7-#4 | 8-#4 | 7-#4 | 2.10 | 2.12 | 2.14 |
| 16 | 300 | 21 | 0.614 | 44 | 89 | 119 | 9-#4 1 | 10-#4 | 17-#4 | 7-#4 | 8-#4 | 2.21 | 2.22 | 2.27 | 16 | 300 | 18 | 16-#4 | 7-#4 | 8-#4 | 7-#4 | 2.21 | 2.22 | 2.24 |
| 16 | 350 | 23 | 0.613 | 48 | 97 | 130 | 9-#4 1 | 11-#4 | 9-#6 | 8-#4 | 8-#4 | 2.42 | 2.44 | 2.43 | 16 | 350 | 21 | 12-#5 | 8-#4 | 8-#4 | 7-#4 | 2.44 | 2.46 | 2.47 |
| 17 | 50 | 10 | 0.823 | 23 | 47 | 63 | 10-#4 0 | 7-#4 | 10-#4 | 7-#4 | 9-#4 | 1.76 | 1.76 | 1.73 | 17 | 50 | 10 | 10-#4 | 7-#4 | 9-#4 | 7-#4 | 1.79 | 1.79 | 1.79 |
| 17 | 100 | 13 | 0.785 | 30 | 60 | 81 | 10-#4 1 | 7-#4 | 12-#4 | 7-#4 | 9-#4 | 1.82 | 1.82 | 1.80 | 17 | 100 | 11 | 11-#4 | 7-#4 | 9-#4 | 7-#4 | 1.84 | 1.85 | 1.86 |
| 17 | 150 | 15 | 0.785 | 36 | 72 | 97 | 10-#4 2 | 8-#4 | 14-#4 | 7-#4 | 9-#4 | 1.93 | 1.95 | 1.98 | 17 | 150 | 14 | 13-#4 | 7-#4 | 9-#4 | 7-#4 | 1.95 | 1.96 | 1.97 |
| 17 | 200 | 18 | 0.727 | 42 | 84 | 113 | 10-#4 2 | 10-#4 | 16-#4 | 7-#4 | 9-#4 | 2.12 | 2.14 | 2.09 | 17 | 200 | 16 | 10-#5 | 7-#4 | 9-#4 | 7-#4 | 2.09 | 2.09 | 2.10 |
| 17 | 250 | 21 | 0.687 | 47 | 95 | 127 | 10-#4 3 | 7-#5 | 12-#5 | 7-#4 | 9-#4 | 2.25 | 2.27 | 2.23 | 17 | 250 | 18 | 17-#4 | 8-#4 | 9-#4 | 7-#4 | 2.22 | 2.24 | 2.27 |
| 17 | 300 | 23 | 0.667 | 52 | 104 | 140 | 10-#4 3 | 8-#5 | 20-#4 | 8-#4 | 9-#4 | 2.44 | 2.44 | 2.50 | 17 | 300 | 22 | 13-#5 | 8-#4 | 9-#4 | 7-#4 | 2.41 | 2.41 | 2.40 |
| 17 | 350 | 26 | 0.612 | 57 | 113 | 152 | 11-#4 2 | 13-#4 | 11-#6 | 9-#4 | 9-#4 | 2.65 | 2.67 | 2.65 | 17 | 350 | 25 | 10-#6 | 9-#4 | 9-#4 | 7-#4 | 2.61 | 2.64 | 2.67 |
| 18 | 50 | 11 | 0.825 | 28 | 56 | 75 | 10-#4 1 | 8-#4 | 11-#4 | 8-#4 | 9-#4 | 1.82 | 1.82 | 1.83 | 18 | 50 | 10 | 10-#4 | 8-#4 | 9-#4 | 8-#4 | 1.79 | 1.81 | 1.82 |
| 18 | 100 | 14 | 0.795 | 36 | 72 | 96 | 10-#4 2 | 8-#4 | 14-#4 | 8-#4 | 9-#4 | 1.91 | 1.91 | 1.88 | 18 | 100 | 11 | 13-#4 | 8-#4 | 9-#4 | 8-#4 | 1.94 | 1.95 | 1.96 |
| 18 | 150 | 18 | 0.704 | 43 | 85 | 115 | 10-#4 2 | 10-#4 | 11-#5 | 8-#4 | 9-#4 | 2.07 | 2.09 | 2.02 | 18 | 150 | 14 | 10-#5 | 8-#4 | 9-#4 | 8-#4 | 2.07 | 2.08 | 2.10 |
| 18 | 200 | 21 | 0.671 | 49 | 98 | 132 | 10-#4 3 | 11-#4 | 13-#5 | 8-#4 | 9-#4 | 2.22 | 2.23 | 2.16 | 18 | 200 | 18 | 12-#5 | 8-#4 | 9-#4 | 8-#4 | 2.23 | 2.25 | 2.26 |
| 18 | 250 | 24 | 0.613 | 55 | 110 | 148 | 11-#4 2 | 13-#4 | 10-#6 | 9-#4 | 9-#4 | 2.42 | 2.45 | 2.48 | 18 | 250 | 21 | 20-#4 | 9-#4 | 9-#4 | 8-#4 | 2.38 | 2.40 | 2.43 |
| 18 | 300 | 26 | 0.626 | 61 | 122 | 164 | 12-#4 2 | 9-#5 | 16-#5 | 9-#4 | 9-#4 | 2.61 | 2.62 | 2.65 | 18 | 300 | 25 | 11-#6 | 10-#4 | 9-#4 | 8-#4 | 2.68 | 2.68 | 2.68 |
| 18 | 350 | 31 | 0.610 | 64 | 129 | 173 | 12-#4 2 | 10-#5 | 12-#6 | 10-#4 | 9-#4 | 2.77 | 2.81 | 2.96 | 18 | 350 | 31 | 23-#4 | 10-#4 | 9-#4 | 8-#4 | 2.62 | 2.67 | 2.72 |
| 19 | 50 | 13 | 0.822 | 33 | 65 | 88 | 11-#4 3 | 8-#4 | 13-#4 | 8-#4 | 10-#4 | 1.79 | 1.81 | 1.79 | 19 | 50 | 10 | 12-#4 | 8-#4 | 10-#4 | 8-#4 | 1.82 | 1.83 | 1.84 |
| 19 | 100 | 16 | 0.799 | 42 | 83 | 112 | 11-#4 4 | 10-#4 | 16-#4 | 8-#4 | 10-#4 | 1.96 | 1.98 | 1.93 | 19 | 100 | 12 | 15-#4 | 8-#4 | 10-#4 | 8-#4 | 1.96 | 1.97 | 1.98 |
| 19 | 150 | 20 | 0.686 | 50 | 99 | 134 | 11-#4 2 | 11-#4 | 13-#5 | 8-#4 | 10-#4 | 2.13 | 2.14 | 2.07 | 19 | 150 | 16 | 12-#5 | 8-#4 | 10-#4 | 8-#4 | 2.13 | 2.15 | 2.17 |
| 19 | 200 | 23 | 0.661 | 57 | 114 | 154 | 11-#4 3 | 13-#4 | 11-#6 | 9-#4 | 10-#4 | 2.35 | 2.38 | 2.41 | 19 | 200 | 20 | 14-#5 | 9-#4 | 10-#4 | 8-#4 | 2.36 | 2.39 | 2.42 |
| 19 | 250 | 26 | 0.612 | 64 | 128 | 172 | 12-#4 2 | 10-#5 | 12-#6 | 10-#4 | 10-#4 | 2.60 | 2.63 | 2.71 | 19 | 250 | 24 | 23-#4 | 10-#4 | 10-#4 | 8-#4 | 2.48 | 2.53 | 2.57 |
| 19 | 300 | 32 | 0.610 | 68 | 137 | 184 | 13-#4 2 | 16-#4 | 13-#6 | 10-#4 | 10-#4 | 2.74 | 2.77 | 2.88 | 19 | 300 | 31 | 12-#6 | 11-#4 | 10-#4 | 8-#4 | 2.76 | 2.79 | 2.82 |
| 19 | 350 | 37 | 0.609 | 72 | 143 | 193 | 14-#4 1 | 16-#4 | 11-#7 | 11-#4 | 10-#4 | 2.95 | 3.03 | 3.12 | 19 | 350 | 39 | 12-#6 | 11-#4 | 10-#4 | 8-#4 | 2.80 | 2.88 | 2.96 |

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

### SQUARE EDGE PANEL

| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) Location of Panel | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | E | EC | C |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | | | |
| 7.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.625 c.f./s.f. |
| 20 | 50 | 14 | 0.824 | 38 | 76 | 103 | 11-#4 4 | 9-#4 | 15-#4 | 9-#4 | 10-#4 | 1.91 | 1.93 | 1.88 |
| 20 | 100 | 18 | 0.776 | 48 | 96 | 130 | 11-#4 5 | 11-#4 | 12-#5 | 9-#4 | 10-#4 | 2.08 | 2.09 | 2.07 |
| 20 | 150 | 22 | 0.669 | 57 | 114 | 154 | 11-#4 3 | 13-#4 | 11-#6 | 9-#4 | 10-#4 | 2.28 | 2.31 | 2.30 |
| 20 | 200 | 26 | 0.653 | 66 | 131 | 176 | 13-#4 4 | 10-#5 | 12-#6 | 10-#4 | 10-#4 | 2.57 | 2.59 | 2.61 |
| 20 | 250 | 31 | 0.612 | 72 | 144 | 193 | 14-#4 3 | 16-#4 | 11-#7 | 11-#4 | 10-#4 | 2.74 | 2.78 | 2.84 |
| 20 | 300 | 37 | 0.609 | 76 | 153 | 206 | 15-#4 3 | 12-#5 | 20-#5 | 8-#5 | 10-#4 | 3.00 | 3.04 | 3.11 |
| 20 | 350 | 43 | 0.608 | 80 | 160 | 215 | 15-#4 1 | 12-#5 | 15-#6 | 8-#5 | 10-#4 | 3.17 | 3.18 | 3.26 |
| 21 | 50 | 16 | 0.783 | 44 | 88 | 118 | 12-#4 3 | 10-#4 | 17-#4 | 9-#4 | 11-#4 | 1.93 | 1.94 | 1.89 |
| 21 | 100 | 21 | 0.703 | 55 | 110 | 148 | 12-#4 4 | 13-#4 | 14-#5 | 9-#4 | 11-#4 | 2.17 | 2.17 | 2.17 |
| 21 | 150 | 25 | 0.655 | 65 | 130 | 176 | 12-#4 5 | 10-#5 | 12-#6 | 10-#4 | 11-#4 | 2.44 | 2.46 | 2.47 |
| 21 | 200 | 30 | 0.610 | 74 | 148 | 199 | 14-#4 3 | 11-#5 | 14-#6 | 11-#4 | 11-#4 | 2.75 | 2.76 | 2.73 |
| 21 | 250 | 36 | 0.609 | 80 | 160 | 216 | 15-#4 3 | 12-#5 | 15-#6 | 12-#4 | 11-#4 | 2.93 | 2.95 | 3.04 |
| 21 | 300 | 43 | 0.608 | 85 | 169 | 228 | 16-#4 2 | 9-#6 | 12-#7 | 13-#4 | 11-#4 | 3.11 | 3.16 | 3.33 |
| 21 | 350 | 49 | 0.607 | 89 | 177 | 238 | 17-#4 2 | 20-#4 | 13-#7 | 9-#5 | 11-#4 | 3.28 | 3.33 | 3.42 |
| 22 | 50 | 18 | 0.755 | 50 | 100 | 134 | 12-#4 4 | 11-#4 | 13-#5 | 9-#4 | 11-#4 | 1.99 | 1.99 | 1.93 |
| 22 | 100 | 23 | 0.681 | 63 | 125 | 168 | 12-#4 5 | 14-#4 | 16-#5 | 10-#4 | 11-#4 | 2.24 | 2.25 | 2.23 |
| 22 | 150 | 28 | 0.611 | 74 | 148 | 200 | 14-#4 3 | 11-#5 | 14-#6 | 11-#4 | 11-#4 | 2.58 | 2.60 | 2.61 |
| 22 | 200 | 35 | 0.609 | 82 | 164 | 221 | 16-#4 4 | 9-#6 | 21-#5 | 13-#4 | 11-#4 | 2.88 | 2.90 | 2.98 |
| 22 | 250 | 42 | 0.608 | 88 | 177 | 238 | 17-#4 2 | 13-#5 | 13-#7 | 13-#4 | 11-#4 | 3.09 | 3.15 | 3.26 |
| 22 | 300 | 49 | 0.607 | 93 | 187 | 251 | 12-#5 2 | 10-#6 | 13-#7 | 14-#4 | 12-#4 | 3.34 | 3.38 | 3.52 |
| 22 | 350 | 56 | 0.606 | 97 | 194 | 261 | 12-#5 0 | 11-#6 | 14-#7 | 10-#5 | 12-#4 | 3.59 | 3.61 | 3.72 |
| 23 | 50 | 20 | 0.712 | 57 | 113 | 152 | 13-#4 3 | 13-#4 | 15-#5 | 10-#4 | 12-#4 | 2.09 | 2.11 | 2.08 |
| 23 | 100 | 25 | 0.642 | 71 | 142 | 191 | 13-#4 4 | 16-#4 | 13-#6 | 11-#4 | 12-#4 | 2.37 | 2.39 | 2.45 |
| 23 | 150 | 32 | 0.619 | 82 | 165 | 222 | 16-#4 4 | 13-#5 | 21-#5 | 13-#4 | 12-#4 | 2.77 | 2.78 | 2.87 |
| 23 | 200 | 40 | 0.608 | 91 | 181 | 244 | 17-#4 4 | 10-#6 | 13-#7 | 14-#4 | 12-#4 | 3.07 | 3.12 | 3.21 |
| 23 | 250 | 47 | 0.607 | 98 | 196 | 263 | 19-#4 3 | 11-#6 | 14-#7 | 10-#5 | 13-#4 | 3.39 | 3.43 | 3.52 |
| 23 | 300 | 55 | 0.606 | 102 | 204 | 275 | 19-#4 2 | 23-#4 | 15-#7 | 10-#5 | 13-#4 | 3.48 | 3.54 | 3.72 |
| 23 | 350 | 63 | 0.605 | 106 | 212 | 285 | 13-#5 0 | 16-#5 | 15-#7 | 16-#4 | 14-#4 | 3.63 | 3.72 | 3.85 |

### SQUARE INTERIOR PANEL

| (2) Span c.-c. | (3) Load | (1) Min. Sq. Col. | Reinforcing Bars | | | | Steel (psf) Location of Panel | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | Column Strip | | Middle Strip | | | | |
| | | | Top | Bottom | Top | Bottom | I | IE | IC |
| (ft) | (psf) | (in.) | | | | | | | |
| 7.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.625 c.f./s.f. |
| 20 | 50 | 10 | 14-#4 | 9-#4 | 10-#4 | 9-#4 | 1.94 | 1.95 | 1.96 |
| 20 | 100 | 14 | 12-#5 | 9-#4 | 10-#4 | 9-#4 | 2.15 | 2.15 | 2.15 |
| 20 | 150 | 19 | 14-#5 | 9-#4 | 10-#4 | 9-#4 | 2.30 | 2.33 | 2.36 |
| 20 | 200 | 23 | 16-#5 | 10-#4 | 10-#4 | 9-#4 | 2.50 | 2.52 | 2.54 |
| 20 | 250 | 30 | 17-#5 | 11-#4 | 10-#4 | 9-#4 | 2.66 | 2.74 | 2.82 |
| 20 | 300 | 38 | 13-#6 | 8-#5 | 10-#4 | 9-#4 | 2.90 | 2.92 | 2.94 |
| 20 | 350 | 46 | 11-#7 | 8-#5 | 10-#4 | 9-#4 | 3.14 | 3.14 | 3.14 |
| 21 | 50 | 11 | 16-#4 | 9-#4 | 11-#4 | 9-#4 | 1.96 | 1.97 | 1.98 |
| 21 | 100 | 16 | 13-#5 | 9-#4 | 11-#4 | 9-#4 | 2.15 | 2.16 | 2.17 |
| 21 | 150 | 21 | 16-#5 | 10-#4 | 11-#4 | 9-#4 | 2.40 | 2.42 | 2.44 |
| 21 | 200 | 27 | 13-#6 | 12-#4 | 11-#4 | 9-#4 | 2.71 | 2.73 | 2.75 |
| 21 | 250 | 36 | 14-#6 | 12-#4 | 11-#4 | 9-#4 | 2.84 | 2.87 | 2.89 |
| 21 | 300 | 45 | 20-#5 | 13-#4 | 11-#4 | 9-#4 | 2.94 | 3.00 | 3.06 |
| 21 | 350 | 53 | 15-#6 | 13-#4 | 11-#4 | 9-#4 | 3.08 | 3.15 | 3.22 |
| 22 | 50 | 13 | 12-#5 | 9-#4 | 11-#4 | 9-#4 | 1.98 | 1.99 | 2.00 |
| 22 | 100 | 18 | 15-#5 | 10-#4 | 11-#4 | 9-#4 | 2.22 | 2.23 | 2.24 |
| 22 | 150 | 23 | 13-#6 | 12-#4 | 11-#4 | 9-#4 | 2.56 | 2.58 | 2.60 |
| 22 | 200 | 33 | 20-#5 | 13-#4 | 11-#4 | 9-#4 | 2.74 | 2.76 | 2.77 |
| 22 | 250 | 43 | 15-#6 | 9-#5 | 11-#4 | 9-#4 | 2.95 | 3.01 | 3.07 |
| 22 | 300 | 52 | 12-#7 | 9-#5 | 11-#4 | 9-#4 | 3.11 | 3.15 | 3.19 |
| 22 | 350 | 61 | 13-#7 | 10-#5 | 11-#4 | 10-#4 | 3.39 | 3.44 | 3.48 |
| 23 | 50 | 14 | 14-#5 | 10-#4 | 12-#4 | 10-#4 | 2.12 | 2.13 | 2.14 |
| 23 | 100 | 20 | 17-#5 | 11-#4 | 12-#4 | 10-#4 | 2.36 | 2.39 | 2.41 |
| 23 | 150 | 28 | 20-#5 | 13-#4 | 12-#4 | 10-#4 | 2.67 | 2.68 | 2.69 |
| 23 | 200 | 39 | 16-#6 | 14-#4 | 12-#4 | 10-#4 | 2.94 | 2.97 | 3.01 |
| 23 | 250 | 49 | 13-#7 | 10-#5 | 12-#4 | 10-#4 | 3.21 | 3.25 | 3.29 |
| 23 | 300 | 60 | 13-#7 | 10-#5 | 12-#4 | 10-#4 | 3.26 | 3.33 | 3.41 |
| 23 | 350 | 69 | 14-#7 | 16-#4 | 12-#4 | 11-#4 | 3.51 | 3.56 | 3.61 |

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

| SQUARE EDGE PANEL | | | | | | | | | | | | | | | SQUARE INTERIOR PANEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) | (3) | (1) | Reinforcing Bars | | | | Steel (psf) | | |
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | | | | | | Location of Panel | | | | | | | | | | | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | E | EC | C | Span c.-c. (ft) | Load (psf) | Min. Sq. Col. (in.) | Top | Bottom | Top | Bottom | I | IE | IC |
| 8 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.667 c.f./s.f. | 8 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.667 c.f./s.f. |
| 16 | 50 | 10 | 0.759 | 20 | 41 | 55 | 8-#4 1 | 7-#4 | 8-#4 | 7-#4 | 8-#4 | 1.75 | 1.75 | 1.76 | 16 | 50 | 10 | 8-#4 | 7-#4 | 8-#4 | 7-#4 | 1.76 | 1.76 | 1.76 |
| 16 | 100 | 10 | 0.827 | 26 | 52 | 70 | 8-#4 2 | 7-#4 | 9-#4 | 7-#4 | 8-#4 | 1.78 | 1.78 | 1.77 | 16 | 100 | 11 | 9-#4 | 7-#4 | 8-#4 | 7-#4 | 1.81 | 1.81 | 1.82 |
| 16 | 150 | 12 | 0.778 | 31 | 62 | 84 | 8-#4 1 | 7-#4 | 11-#4 | 7-#4 | 8-#4 | 1.85 | 1.85 | 1.82 | 16 | 150 | 15 | 10-#4 | 7-#4 | 8-#4 | 7-#4 | 1.88 | 1.90 | 1.91 |
| 16 | 200 | 14 | 0.746 | 36 | 72 | 97 | 8-#4 1 | 8-#4 | 13-#4 | 7-#4 | 8-#4 | 1.99 | 1.99 | 1.92 | 16 | 200 | 16 | 8-#5 | 7-#4 | 8-#4 | 7-#4 | 2.02 | 2.02 | 2.03 |
| 16 | 250 | 17 | 0.657 | 41 | 82 | 110 | 8-#4 1 | 6-#5 | 10-#5 | 7-#4 | 8-#4 | 2.15 | 2.16 | 2.10 | 16 | 250 | 17 | 9-#5 | 7-#4 | 8-#4 | 7-#4 | 2.10 | 2.12 | 2.15 |
| 16 | 300 | 19 | 0.616 | 46 | 91 | 123 | 8-#4 1 | 10-#4 | 16-#4 | 7-#4 | 8-#4 | 2.22 | 2.22 | 2.22 | 16 | 300 | 18 | 10-#5 | 7-#4 | 8-#4 | 7-#4 | 2.19 | 2.20 | 2.20 |
| 16 | 350 | 21 | 0.615 | 50 | 100 | 135 | 9-#4 1 | 7-#5 | 12-#5 | 7-#4 | 8-#4 | 2.34 | 2.35 | 2.31 | 16 | 350 | 19 | 8-#6 | 7-#4 | 8-#4 | 7-#4 | 2.32 | 2.33 | 2.34 |
| 17 | 50 | 10 | 0.802 | 25 | 49 | 66 | 9-#4 1 | 8-#4 | 9-#4 | 8-#4 | 9-#4 | 1.85 | 1.85 | 1.85 | 17 | 50 | 10 | 9-#4 | 8-#4 | 9-#4 | 8-#4 | 1.85 | 1.85 | 1.85 |
| 17 | 100 | 11 | 0.833 | 31 | 63 | 85 | 9-#4 2 | 8-#4 | 11-#4 | 8-#4 | 9-#4 | 1.91 | 1.92 | 1.89 | 17 | 100 | 11 | 10-#4 | 8-#4 | 9-#4 | 8-#4 | 1.91 | 1.92 | 1.93 |
| 17 | 150 | 14 | 0.794 | 37 | 74 | 100 | 9-#4 3 | 8-#4 | 13-#4 | 8-#4 | 9-#4 | 1.99 | 2.00 | 1.94 | 17 | 150 | 15 | 12-#4 | 8-#4 | 9-#4 | 8-#4 | 2.02 | 2.03 | 2.04 |
| 17 | 200 | 17 | 0.732 | 43 | 86 | 116 | 9-#4 3 | 9-#4 | 10-#5 | 8-#4 | 9-#4 | 2.10 | 2.13 | 2.05 | 17 | 200 | 16 | 14-#4 | 8-#4 | 9-#4 | 8-#4 | 2.12 | 2.14 | 2.16 |
| 17 | 250 | 19 | 0.729 | 49 | 98 | 132 | 9-#4 4 | 10-#4 | 12-#5 | 8-#4 | 9-#4 | 2.25 | 2.26 | 2.24 | 17 | 250 | 17 | 11-#5 | 8-#4 | 9-#4 | 8-#4 | 2.28 | 2.30 | 2.32 |
| 17 | 300 | 22 | 0.661 | 54 | 109 | 146 | 10-#4 3 | 8-#5 | 9-#6 | 8-#4 | 9-#4 | 2.41 | 2.42 | 2.37 | 17 | 300 | 19 | 12-#5 | 8-#4 | 9-#4 | 8-#4 | 2.37 | 2.39 | 2.41 |
| 17 | 350 | 24 | 0.635 | 59 | 118 | 159 | 11-#4 2 | 8-#5 | 10-#6 | 8-#4 | 9-#4 | 2.51 | 2.54 | 2.57 | 17 | 350 | 22 | 13-#5 | 9-#4 | 9-#4 | 8-#4 | 2.54 | 2.57 | 2.59 |
| 18 | 50 | 10 | 0.839 | 29 | 59 | 79 | 9-#4 2 | 8-#4 | 11-#4 | 8-#4 | 9-#4 | 1.78 | 1.80 | 1.79 | 18 | 50 | 10 | 10-#4 | 8-#4 | 9-#4 | 8-#4 | 1.79 | 1.81 | 1.82 |
| 18 | 100 | 13 | 0.807 | 37 | 74 | 100 | 9-#4 3 | 8-#4 | 13-#4 | 8-#4 | 9-#4 | 1.87 | 1.88 | 1.85 | 18 | 100 | 11 | 12-#4 | 8-#4 | 9-#4 | 8-#4 | 1.89 | 1.90 | 1.91 |
| 18 | 150 | 16 | 0.754 | 44 | 88 | 119 | 9-#4 3 | 9-#4 | 16-#4 | 8-#4 | 9-#4 | 2.01 | 2.03 | 1.97 | 18 | 150 | 15 | 10-#5 | 8-#4 | 9-#4 | 8-#4 | 2.07 | 2.08 | 2.08 |
| 18 | 200 | 19 | 0.716 | 51 | 102 | 138 | 9-#4 4 | 7-#5 | 12-#5 | 8-#4 | 9-#4 | 2.15 | 2.17 | 2.15 | 18 | 200 | 16 | 17-#4 | 8-#4 | 9-#4 | 8-#4 | 2.14 | 2.16 | 2.18 |
| 18 | 250 | 22 | 0.654 | 57 | 115 | 155 | 10-#4 3 | 8-#5 | 10-#6 | 8-#4 | 9-#4 | 2.33 | 2.35 | 2.39 | 18 | 250 | 19 | 9-#6 | 8-#4 | 9-#4 | 8-#4 | 2.31 | 2.33 | 2.36 |
| 18 | 300 | 25 | 0.613 | 63 | 126 | 170 | 11-#4 2 | 13-#4 | 11-#6 | 9-#4 | 9-#4 | 2.51 | 2.52 | 2.56 | 18 | 300 | 22 | 10-#6 | 9-#4 | 9-#4 | 8-#4 | 2.50 | 2.52 | 2.55 |
| 18 | 350 | 27 | 0.612 | 69 | 137 | 185 | 12-#4 2 | 7-#6 | 16-#5 | 10-#4 | 9-#4 | 2.75 | 2.76 | 2.83 | 18 | 350 | 26 | 11-#6 | 10-#4 | 9-#4 | 8-#4 | 2.68 | 2.68 | 2.69 |
| 19 | 50 | 12 | 0.791 | 34 | 69 | 92 | 10-#4 1 | 9-#4 | 12-#4 | 9-#4 | 10-#4 | 1.90 | 1.91 | 1.90 | 19 | 50 | 10 | 11-#4 | 9-#4 | 10-#4 | 9-#4 | 1.92 | 1.93 | 1.94 |
| 19 | 100 | 15 | 0.762 | 44 | 87 | 117 | 10-#4 2 | 9-#4 | 10-#5 | 9-#4 | 10-#4 | 2.03 | 2.03 | 1.96 | 19 | 100 | 11 | 10-#5 | 9-#4 | 10-#4 | 9-#4 | 2.12 | 2.12 | 2.12 |
| 19 | 150 | 18 | 0.733 | 52 | 104 | 139 | 10-#4 3 | 11-#4 | 12-#5 | 9-#4 | 10-#4 | 2.17 | 2.19 | 2.15 | 19 | 150 | 15 | 17-#4 | 9-#4 | 10-#4 | 9-#4 | 2.19 | 2.21 | 2.23 |
| 19 | 200 | 22 | 0.635 | 59 | 119 | 160 | 11-#4 2 | 8-#5 | 10-#6 | 8-#4 | 10-#4 | 2.31 | 2.33 | 2.31 | 19 | 200 | 18 | 13-#5 | 9-#4 | 10-#4 | 9-#4 | 2.35 | 2.38 | 2.40 |
| 19 | 250 | 25 | 0.613 | 66 | 133 | 179 | 12-#4 2 | 9-#5 | 16-#5 | 9-#4 | 10-#4 | 2.53 | 2.54 | 2.52 | 19 | 250 | 22 | 11-#6 | 10-#4 | 10-#4 | 9-#4 | 2.62 | 2.62 | 2.63 |
| 19 | 300 | 28 | 0.612 | 73 | 146 | 196 | 13-#4 3 | 10-#5 | 17-#5 | 10-#4 | 10-#4 | 2.72 | 2.75 | 2.83 | 19 | 300 | 26 | 16-#5 | 11-#4 | 10-#4 | 9-#4 | 2.72 | 2.74 | 2.75 |
| 19 | 350 | 31 | 0.618 | 78 | 156 | 210 | 14-#4 3 | 8-#6 | 10-#7 | 11-#4 | 10-#4 | 2.99 | 3.03 | 3.04 | 19 | 350 | 32 | 17-#5 | 11-#4 | 10-#4 | 9-#4 | 2.82 | 2.87 | 2.92 |
| 20 | 50 | 13 | 0.796 | 40 | 80 | 108 | 10-#4 2 | 9-#4 | 14-#4 | 9-#4 | 10-#4 | 1.86 | 1.88 | 1.85 | 20 | 50 | 10 | 13-#4 | 9-#4 | 10-#4 | 9-#4 | 1.90 | 1.91 | 1.92 |
| 20 | 100 | 17 | 0.737 | 50 | 101 | 135 | 10-#4 3 | 11-#4 | 12-#5 | 9-#4 | 10-#4 | 2.08 | 2.10 | 2.06 | 20 | 100 | 13 | 11-#5 | 9-#4 | 10-#4 | 9-#4 | 2.08 | 2.10 | 2.11 |
| 20 | 150 | 21 | 0.649 | 60 | 119 | 160 | 11-#4 2 | 8-#5 | 10-#6 | 9-#4 | 10-#4 | 2.25 | 2.27 | 2.24 | 20 | 150 | 17 | 13-#5 | 9-#4 | 10-#4 | 9-#4 | 2.23 | 2.25 | 2.27 |
| 20 | 200 | 24 | 0.690 | 68 | 137 | 184 | 12-#4 5 | 14-#4 | 16-#5 | 10-#4 | 10-#4 | 2.45 | 2.46 | 2.42 | 20 | 200 | 21 | 11-#6 | 10-#4 | 10-#4 | 9-#4 | 2.48 | 2.48 | 2.48 |
| 20 | 250 | 27 | 0.650 | 76 | 153 | 206 | 13-#4 4 | 16-#4 | 10-#7 | 11-#4 | 10-#4 | 2.69 | 2.73 | 2.80 | 20 | 250 | 25 | 12-#6 | 11-#4 | 10-#4 | 9-#4 | 2.66 | 2.70 | 2.74 |
| 20 | 300 | 32 | 0.617 | 82 | 165 | 222 | 10-#5 2 | 17-#4 | 11-#7 | 8-#5 | 10-#4 | 2.96 | 3.01 | 3.07 | 20 | 300 | 31 | 10-#7 | 8-#5 | 10-#4 | 9-#4 | 2.92 | 2.96 | 2.99 |
| 20 | 350 | 37 | 0.609 | 87 | 173 | 233 | 10-#5 1 | 12-#5 | 11-#7 | 8-#5 | 10-#4 | 3.13 | 3.14 | 3.23 | 20 | 350 | 39 | 11-#7 | 8-#5 | 10-#4 | 9-#4 | 3.10 | 3.10 | 3.10 |

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

### SQUARE EDGE PANEL

| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) | (3) | (1) | Reinforcing Bars | | | | Steel (psf) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | –M Ext. | +M Int. | –M 1st int. | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | | | | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | Location of Panel | | | | | | | | | | | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | E | EC | C | Span c.-c. (ft) | Load (psf) | Min. Sq. Col. (in.) | Top | Bottom | Top | Bottom | I | IE | IC |
| 8 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.667 c.f./s.f. | 8 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.667 c.f./s.f. |
| 21 | 50 | 15 | 0.795 | 46 | 92 | 124 | 11-#4 4 | 10-#4 | 16-#4 | 10-#4 | 11-#4 | 1.98 | 2.00 | 1.94 | 21 | 50 | 10 | 16-#4 | 10-#4 | 11-#4 | 10-#4 | 2.05 | 2.05 | 2.05 |
| 21 | 100 | 19 | 0.747 | 58 | 115 | 155 | 11-#4 5 | 8-#5 | 14-#5 | 10-#4 | 11-#4 | 2.20 | 2.21 | 2.17 | 21 | 100 | 15 | 13-#5 | 10-#4 | 11-#4 | 10-#4 | 2.23 | 2.25 | 2.26 |
| 21 | 150 | 23 | 0.696 | 68 | 137 | 184 | 12-#4 5 | 14-#4 | 16-#5 | 10-#4 | 11-#4 | 2.38 | 2.38 | 2.33 | 21 | 150 | 19 | 11-#6 | 10-#4 | 11-#4 | 10-#4 | 2.43 | 2.43 | 2.43 |
| 21 | 200 | 27 | 0.622 | 78 | 156 | 209 | 14-#4 3 | 16-#4 | 11-#7 | 11-#4 | 11-#4 | 2.64 | 2.69 | 2.73 | 21 | 200 | 24 | 17-#5 | 11-#4 | 11-#4 | 10-#4 | 2.58 | 2.65 | 2.72 |
| 21 | 250 | 31 | 0.611 | 86 | 172 | 232 | 15-#4 3 | 12-#5 | 11-#7 | 8-#5 | 11-#4 | 2.94 | 2.97 | 3.01 | 21 | 250 | 30 | 11-#7 | 8-#5 | 11-#4 | 10-#4 | 2.98 | 2.98 | 2.97 |
| 21 | 300 | 37 | 0.609 | 92 | 183 | 247 | 16-#4 2 | 9-#6 | 12-#7 | 13-#4 | 11-#4 | 3.12 | 3.17 | 3.26 | 21 | 300 | 38 | 20-#5 | 13-#4 | 11-#4 | 10-#4 | 2.95 | 3.01 | 3.06 |
| 21 | 350 | 43 | 0.608 | 96 | 192 | 258 | 11-#5 2 | 20-#4 | 13-#7 | 9-#5 | 11-#4 | 3.28 | 3.34 | 3.44 | 21 | 350 | 46 | 15-#6 | 13-#4 | 11-#4 | 10-#4 | 3.09 | 3.16 | 3.23 |
| 22 | 50 | 17 | 0.768 | 53 | 106 | 142 | 11-#4 5 | 11-#4 | 12-#5 | 10-#4 | 11-#4 | 1.99 | 2.00 | 1.93 | 22 | 50 | 11 | 12-#5 | 10-#4 | 11-#4 | 10-#4 | 2.06 | 2.06 | 2.06 |
| 22 | 100 | 21 | 0.725 | 66 | 131 | 177 | 12-#4 5 | 9-#5 | 23-#4 | 10-#4 | 11-#4 | 2.25 | 2.24 | 2.21 | 22 | 100 | 17 | 11-#6 | 10-#4 | 11-#4 | 10-#4 | 2.31 | 2.29 | 2.27 |
| 22 | 150 | 25 | 0.681 | 78 | 155 | 209 | 14-#4 4 | 16-#4 | 13-#6 | 11-#4 | 11-#4 | 2.48 | 2.50 | 2.56 | 22 | 150 | 22 | 17-#5 | 11-#4 | 11-#4 | 10-#4 | 2.45 | 2.48 | 2.50 |
| 22 | 200 | 30 | 0.657 | 88 | 177 | 238 | 16-#4 5 | 12-#5 | 15-#6 | 12-#4 | 11-#4 | 2.80 | 2.82 | 2.88 | 22 | 200 | 26 | 11-#7 | 13-#4 | 11-#4 | 10-#4 | 2.85 | 2.85 | 2.85 |
| 22 | 250 | 36 | 0.610 | 96 | 191 | 257 | 11-#5 2 | 13-#5 | 13-#7 | 13-#4 | 11-#4 | 3.05 | 3.11 | 3.27 | 22 | 250 | 36 | 15-#6 | 9-#5 | 11-#4 | 10-#4 | 2.96 | 3.02 | 3.08 |
| 22 | 300 | 43 | 0.608 | 101 | 202 | 272 | 12-#5 2 | 10-#6 | 13-#7 | 14-#4 | 12-#4 | 3.30 | 3.34 | 3.52 | 22 | 300 | 45 | 12-#7 | 14-#4 | 11-#4 | 10-#4 | 3.10 | 3.14 | 3.18 |
| 22 | 350 | 49 | 0.607 | 106 | 212 | 285 | 12-#5 2 | 11-#6 | 11-#8 | 10-#5 | 13-#4 | 3.56 | 3.61 | 3.73 | 22 | 350 | 53 | 13-#7 | 10-#5 | 11-#4 | 10-#4 | 3.35 | 3.42 | 3.48 |
| 23 | 50 | 19 | 0.724 | 60 | 119 | 161 | 12-#4 4 | 13-#4 | 14-#5 | 10-#4 | 12-#4 | 2.04 | 2.05 | 2.01 | 23 | 50 | 13 | 13-#5 | 10-#4 | 12-#4 | 10-#4 | 2.06 | 2.07 | 2.08 |
| 23 | 100 | 23 | 0.704 | 74 | 149 | 200 | 13-#4 5 | 10-#5 | 13-#6 | 10-#4 | 12-#4 | 2.31 | 2.33 | 2.37 | 23 | 100 | 19 | 12-#6 | 11-#4 | 12-#4 | 10-#4 | 2.38 | 2.40 | 2.41 |
| 23 | 150 | 28 | 0.663 | 88 | 175 | 236 | 15-#4 6 | 12-#5 | 15-#6 | 12-#4 | 12-#4 | 2.66 | 2.69 | 2.74 | 23 | 150 | 24 | 14-#6 | 13-#4 | 12-#4 | 10-#4 | 2.66 | 2.68 | 2.70 |
| 23 | 200 | 35 | 0.610 | 98 | 195 | 263 | 17-#4 4 | 10-#6 | 13-#7 | 9-#5 | 12-#4 | 3.03 | 3.06 | 3.19 | 23 | 200 | 32 | 12-#7 | 9-#5 | 12-#4 | 10-#4 | 2.95 | 2.97 | 3.00 |
| 23 | 250 | 42 | 0.608 | 105 | 210 | 283 | 12-#5 2 | 11-#6 | 14-#7 | 10-#5 | 12-#4 | 3.33 | 3.38 | 3.53 | 23 | 250 | 42 | 13-#7 | 10-#5 | 12-#4 | 10-#4 | 3.18 | 3.21 | 3.24 |
| 23 | 300 | 49 | 0.607 | 111 | 222 | 298 | 19-#4 2 | 23-#4 | 19-#6 | 10-#5 | 13-#4 | 3.42 | 3.44 | 3.56 | 23 | 300 | 52 | 13-#7 | 10-#5 | 12-#4 | 10-#4 | 3.22 | 3.26 | 3.30 |
| 23 | 350 | 56 | 0.606 | 115 | 231 | 311 | 20-#4 1 | 16-#5 | 12-#8 | 16-#4 | 9-#5 | 3.63 | 3.70 | 3.85 | 23 | 350 | 61 | 14-#7 | 16-#4 | 12-#4 | 11-#4 | 3.47 | 3.54 | 3.61 |
| 24 | 50 | 20 | 0.771 | 67 | 135 | 181 | 13-#4 7 | 9-#5 | 16-#5 | 11-#4 | 13-#4 | 2.18 | 2.20 | 2.16 | 24 | 50 | 15 | 15-#5 | 11-#4 | 13-#4 | 11-#4 | 2.22 | 2.23 | 2.24 |
| 24 | 100 | 26 | 0.664 | 83 | 167 | 224 | 15-#4 5 | 12-#5 | 14-#6 | 12-#4 | 13-#4 | 2.56 | 2.57 | 2.55 | 24 | 100 | 21 | 14-#6 | 12-#4 | 13-#4 | 11-#4 | 2.56 | 2.56 | 2.56 |
| 24 | 150 | 32 | 0.613 | 98 | 195 | 263 | 17-#4 4 | 10-#6 | 13-#7 | 9-#5 | 13-#4 | 2.95 | 2.98 | 3.00 | 24 | 150 | 27 | 12-#7 | 9-#5 | 13-#4 | 11-#4 | 2.88 | 2.91 | 2.93 |
| 24 | 200 | 40 | 0.609 | 107 | 215 | 289 | 19-#4 3 | 11-#6 | 14-#7 | 10-#5 | 13-#4 | 3.21 | 3.26 | 3.40 | 24 | 200 | 38 | 13-#7 | 10-#5 | 13-#4 | 11-#4 | 3.10 | 3.13 | 3.16 |
| 24 | 250 | 47 | 0.607 | 115 | 231 | 311 | 13-#5 2 | 16-#5 | 12-#8 | 16-#4 | 9-#5 | 3.47 | 3.50 | 3.57 | 24 | 250 | 49 | 14-#7 | 16-#4 | 13-#4 | 11-#4 | 3.29 | 3.34 | 3.40 |
| 24 | 300 | 55 | 0.606 | 121 | 243 | 327 | 14-#5 1 | 9-#7 | 13-#8 | 11-#5 | 14-#4 | 3.73 | 3.81 | 3.95 | 24 | 300 | 59 | 19-#6 | 11-#5 | 13-#4 | 11-#4 | 3.40 | 3.49 | 3.59 |
| 24 | 350 | 63 | 0.606 | 125 | 251 | 338 | 22-#4 0 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 4.01 | 4.04 | 4.15 | 24 | 350 | 69 | 12-#8 | 17-#4 | 13-#4 | 12-#4 | 3.67 | 3.74 | 3.80 |
| 25 | 50 | 22 | 0.746 | 75 | 151 | 203 | 13-#4 8 | 16-#4 | 13-#6 | 11-#4 | 13-#4 | 2.24 | 2.26 | 2.25 | 25 | 50 | 17 | 17-#5 | 11-#4 | 13-#4 | 11-#4 | 2.24 | 2.26 | 2.28 |
| 25 | 100 | 28 | 0.646 | 94 | 187 | 252 | 16-#4 5 | 13-#5 | 16-#6 | 13-#4 | 13-#4 | 2.64 | 2.66 | 2.70 | 25 | 100 | 23 | 15-#6 | 13-#4 | 13-#4 | 11-#4 | 2.59 | 2.61 | 2.63 |
| 25 | 150 | 36 | 0.633 | 108 | 216 | 290 | 19-#4 6 | 11-#6 | 14-#7 | 10-#5 | 13-#4 | 3.08 | 3.11 | 3.24 | 25 | 150 | 32 | 13-#7 | 10-#5 | 13-#4 | 11-#4 | 2.95 | 2.97 | 3.00 |
| 25 | 200 | 44 | 0.608 | 118 | 237 | 319 | 14-#5 3 | 12-#6 | 13-#8 | 11-#5 | 14-#4 | 3.47 | 3.51 | 3.54 | 25 | 200 | 44 | 14-#7 | 11-#5 | 13-#4 | 11-#4 | 3.19 | 3.28 | 3.36 |
| 25 | 250 | 53 | 0.607 | 126 | 252 | 339 | 22-#4 2 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 3.75 | 3.81 | 3.93 | 25 | 250 | 56 | 15-#7 | 12-#5 | 14-#4 | 12-#4 | 3.48 | 3.55 | 3.62 |
| 25 | 300 | 61 | 0.606 | 132 | 264 | 355 | 15-#5 1 | 10-#7 | 14-#8 | 12-#5 | 10-#5 | 3.98 | 4.05 | 4.20 | 25 | 300 | 67 | 13-#8 | 12-#5 | 14-#4 | 12-#4 | 3.75 | 3.81 | 3.86 |
| 25 | 350 | 69 | 0.605 | 137 | 273 | 368 | 16-#5 0 | 14-#6 | 14-#8 | 19-#4 | 16-#4 | 4.10 | 4.14 | 4.27 | 25 | 350 | 77 | 13-#8 | 12-#5 | 14-#4 | 12-#4 | 3.81 | 3.86 | 3.92 |

### SQUARE INTERIOR PANEL

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

| SQUARE EDGE PANEL | | | | | | | | | | | | | | | SQUARE INTERIOR PANEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) | (3) | (1) | Reinforcing Bars | | | | Steel (psf) | | |
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | | | | | | Location of Panel | | | Span c.-c. | Load | Min. Sq. Col. | | | | | | | |
| | | | | | | | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | | | | | | | Top | Bottom | Top | Bottom | | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | E | EC | C | (ft) | (psf) | (in.) | | | | | I | IE | IC |
| 8.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.708 c.f./s.f. | 8.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.708 c.f./s.f. |
| 17 | 50 | 10 | 0.782 | 26 | 51 | 69 | 9-#4 1 | 8-#4 | 9-#4 | 8-#4 | 6-#5 | 1.86 | 1.86 | 1.85 | 17 | 50 | 10 | 9-#4 | 8-#4 | 6-#5 | 8-#4 | 1.87 | 1.87 | 1.87 |
| 17 | 100 | 10 | 0.845 | 33 | 66 | 88 | 9-#4 2 | 8-#4 | 11-#4 | 8-#4 | 6-#5 | 1.91 | 1.92 | 1.89 | 17 | 100 | 10 | 10-#4 | 8-#4 | 6-#5 | 8-#4 | 1.92 | 1.93 | 1.94 |
| 17 | 150 | 13 | 0.786 | 38 | 77 | 103 | 9-#4 2 | 8-#4 | 13-#4 | 8-#4 | 6-#5 | 2.00 | 2.00 | 1.94 | 17 | 150 | 15 | 8-#5 | 8-#4 | 6-#5 | 8-#4 | 2.06 | 2.06 | 2.07 |
| 17 | 200 | 15 | 0.780 | 44 | 89 | 120 | 9-#4 3 | 6-#5 | 10-#5 | 8-#4 | 6-#5 | 2.12 | 2.13 | 2.03 | 17 | 200 | 17 | 9-#5 | 8-#4 | 6-#5 | 8-#4 | 2.14 | 2.16 | 2.18 |
| 17 | 250 | 18 | 0.711 | 50 | 100 | 135 | 9-#4 3 | 10-#4 | 8-#6 | 8-#4 | 6-#5 | 2.22 | 2.24 | 2.19 | 17 | 250 | 18 | 10-#5 | 8-#4 | 6-#5 | 8-#4 | 2.22 | 2.25 | 2.28 |
| 17 | 300 | 20 | 0.620 | 56 | 112 | 150 | 9-#4 1 | 7-#5 | 12-#5 | 8-#4 | 6-#5 | 2.30 | 2.32 | 2.27 | 17 | 300 | 19 | 8-#6 | 8-#4 | 6-#5 | 8-#4 | 2.35 | 2.36 | 2.37 |
| 17 | 350 | 22 | 0.676 | 61 | 123 | 165 | 10-#4 3 | 8-#5 | 10-#6 | 8-#4 | 6-#5 | 2.48 | 2.49 | 2.51 | 17 | 350 | 20 | 9-#6 | 8-#4 | 6-#5 | 8-#4 | 2.47 | 2.49 | 2.52 |
| 18 | 50 | 10 | 0.820 | 31 | 61 | 82 | 9-#4 2 | 9-#4 | 10-#4 | 9-#4 | 9-#4 | 1.91 | 1.93 | 1.92 | 18 | 50 | 10 | 9-#4 | 9-#4 | 9-#4 | 9-#4 | 1.90 | 1.91 | 1.92 |
| 18 | 100 | 12 | 0.818 | 39 | 78 | 105 | 9-#4 3 | 9-#4 | 13-#4 | 9-#4 | 9-#4 | 2.00 | 2.01 | 1.97 | 18 | 100 | 10 | 12-#4 | 9-#4 | 9-#4 | 9-#4 | 2.03 | 2.05 | 2.06 |
| 18 | 150 | 15 | 0.763 | 46 | 91 | 123 | 9-#4 3 | 9-#4 | 10-#5 | 9-#4 | 9-#4 | 2.09 | 2.11 | 2.05 | 18 | 150 | 15 | 9-#5 | 9-#4 | 9-#4 | 9-#4 | 2.15 | 2.17 | 2.18 |
| 18 | 200 | 18 | 0.722 | 52 | 105 | 141 | 9-#4 4 | 10-#4 | 17-#4 | 9-#4 | 9-#4 | 2.20 | 2.21 | 2.19 | 18 | 200 | 17 | 16-#4 | 9-#4 | 9-#4 | 9-#4 | 2.25 | 2.26 | 2.27 |
| 18 | 250 | 20 | 0.701 | 60 | 119 | 160 | 10-#4 3 | 8-#5 | 13-#5 | 9-#4 | 9-#4 | 2.38 | 2.40 | 2.35 | 18 | 250 | 18 | 12-#5 | 9-#4 | 9-#4 | 9-#4 | 2.38 | 2.40 | 2.41 |
| 18 | 300 | 23 | 0.632 | 66 | 131 | 177 | 11-#4 2 | 13-#4 | 11-#6 | 9-#4 | 9-#4 | 2.56 | 2.59 | 2.51 | 18 | 300 | 20 | 10-#6 | 9-#4 | 9-#4 | 9-#4 | 2.56 | 2.59 | 2.62 |
| 18 | 350 | 25 | 0.636 | 72 | 143 | 193 | 12-#4 2 | 9-#5 | 16-#5 | 9-#4 | 9-#4 | 2.66 | 2.67 | 2.65 | 18 | 350 | 23 | 11-#6 | 10-#4 | 9-#4 | 9-#4 | 2.74 | 2.74 | 2.75 |
| 19 | 50 | 11 | 0.807 | 36 | 72 | 97 | 10-#4 1 | 9-#4 | 12-#4 | 9-#4 | 10-#4 | 1.90 | 1.90 | 1.89 | 19 | 50 | 10 | 11-#4 | 9-#4 | 10-#4 | 9-#4 | 1.92 | 1.93 | 1.94 |
| 19 | 100 | 14 | 0.775 | 46 | 91 | 123 | 10-#4 2 | 9-#4 | 10-#5 | 9-#4 | 10-#4 | 2.01 | 2.02 | 1.96 | 19 | 100 | 10 | 14-#4 | 9-#4 | 10-#4 | 9-#4 | 2.05 | 2.06 | 2.08 |
| 19 | 150 | 17 | 0.741 | 53 | 107 | 144 | 10-#4 3 | 7-#5 | 12-#5 | 9-#4 | 10-#4 | 2.21 | 2.22 | 2.16 | 19 | 150 | 15 | 11-#5 | 9-#4 | 10-#4 | 9-#4 | 2.20 | 2.22 | 2.24 |
| 19 | 200 | 20 | 0.685 | 62 | 123 | 166 | 10-#4 3 | 8-#5 | 20-#4 | 9-#4 | 10-#4 | 2.31 | 2.32 | 2.29 | 19 | 200 | 17 | 9-#6 | 9-#4 | 10-#4 | 9-#4 | 2.35 | 2.34 | 2.34 |
| 19 | 250 | 23 | 0.649 | 69 | 138 | 186 | 11-#4 3 | 9-#5 | 11-#6 | 9-#4 | 10-#4 | 2.50 | 2.52 | 2.47 | 19 | 250 | 20 | 10-#6 | 9-#4 | 10-#4 | 9-#4 | 2.46 | 2.48 | 2.51 |
| 19 | 300 | 26 | 0.613 | 76 | 152 | 204 | 12-#4 2 | 7-#6 | 9-#7 | 10-#4 | 10-#4 | 2.70 | 2.72 | 2.72 | 19 | 300 | 23 | 16-#5 | 10-#4 | 10-#4 | 9-#4 | 2.64 | 2.67 | 2.69 |
| 19 | 350 | 28 | 0.613 | 82 | 165 | 222 | 9-#5 1 | 16-#4 | 10-#7 | 7-#5 | 10-#4 | 2.86 | 2.89 | 2.96 | 19 | 350 | 27 | 9-#7 | 7-#5 | 10-#4 | 9-#4 | 2.84 | 2.88 | 2.91 |
| 20 | 50 | 12 | 0.810 | 42 | 84 | 113 | 10-#4 2 | 10-#4 | 14-#4 | 10-#4 | 10-#4 | 1.98 | 1.98 | 1.96 | 20 | 50 | 10 | 13-#4 | 10-#4 | 10-#4 | 10-#4 | 2.00 | 2.01 | 2.02 |
| 20 | 100 | 16 | 0.748 | 53 | 105 | 142 | 10-#4 3 | 10-#4 | 17-#4 | 10-#4 | 10-#4 | 2.09 | 2.09 | 2.02 | 20 | 100 | 11 | 11-#5 | 10-#4 | 10-#4 | 10-#4 | 2.17 | 2.17 | 2.17 |
| 20 | 150 | 19 | 0.720 | 62 | 125 | 168 | 10-#4 4 | 8-#5 | 10-#6 | 10-#4 | 10-#4 | 2.27 | 2.29 | 2.22 | 20 | 150 | 15 | 13-#5 | 10-#4 | 10-#4 | 10-#4 | 2.32 | 2.34 | 2.36 |
| 20 | 200 | 23 | 0.673 | 71 | 142 | 191 | 12-#4 4 | 9-#5 | 11-#6 | 9-#4 | 10-#4 | 2.45 | 2.46 | 2.40 | 20 | 200 | 19 | 11-#6 | 10-#4 | 10-#4 | 10-#4 | 2.52 | 2.52 | 2.52 |
| 20 | 250 | 26 | 0.645 | 79 | 158 | 213 | 13-#4 4 | 10-#5 | 26-#4 | 10-#4 | 10-#4 | 2.61 | 2.63 | 2.71 | 20 | 250 | 23 | 16-#5 | 11-#4 | 10-#4 | 10-#4 | 2.61 | 2.62 | 2.63 |
| 20 | 300 | 29 | 0.612 | 87 | 173 | 233 | 14-#4 3 | 8-#6 | 11-#7 | 11-#4 | 10-#4 | 2.95 | 2.97 | 2.96 | 20 | 300 | 27 | 10-#7 | 8-#5 | 10-#4 | 10-#4 | 2.95 | 2.98 | 3.01 |
| 20 | 350 | 32 | 0.637 | 93 | 187 | 251 | 10-#5 3 | 12-#5 | 11-#7 | 8-#5 | 10-#4 | 3.14 | 3.14 | 3.25 | 20 | 350 | 32 | 11-#7 | 8-#5 | 10-#4 | 10-#4 | 3.11 | 3.11 | 3.11 |
| 21 | 50 | 14 | 0.809 | 48 | 97 | 130 | 11-#4 4 | 10-#4 | 16-#4 | 10-#4 | 11-#4 | 1.98 | 1.99 | 1.94 | 21 | 50 | 10 | 10-#5 | 10-#4 | 11-#4 | 10-#4 | 2.03 | 2.04 | 2.04 |
| 21 | 100 | 18 | 0.756 | 60 | 121 | 162 | 11-#4 5 | 8-#5 | 13-#5 | 10-#4 | 11-#4 | 2.18 | 2.19 | 2.10 | 21 | 100 | 13 | 13-#5 | 10-#4 | 11-#4 | 10-#4 | 2.23 | 2.23 | 2.22 |
| 21 | 150 | 22 | 0.700 | 71 | 142 | 191 | 12-#4 5 | 9-#5 | 11-#6 | 10-#4 | 11-#4 | 2.38 | 2.39 | 2.35 | 21 | 150 | 18 | 11-#6 | 10-#4 | 11-#4 | 10-#4 | 2.42 | 2.42 | 2.42 |
| 21 | 200 | 25 | 0.662 | 81 | 162 | 218 | 13-#4 4 | 16-#4 | 10-#7 | 11-#4 | 11-#4 | 2.60 | 2.64 | 2.68 | 21 | 200 | 22 | 12-#6 | 11-#4 | 11-#4 | 10-#4 | 2.59 | 2.63 | 2.66 |
| 21 | 250 | 28 | 0.679 | 91 | 181 | 244 | 10-#5 3 | 12-#5 | 20-#5 | 8-#5 | 11-#4 | 2.88 | 2.91 | 2.97 | 21 | 250 | 26 | 10-#7 | 8-#5 | 11-#4 | 10-#4 | 2.83 | 2.84 | 2.84 |
| 21 | 300 | 32 | 0.611 | 99 | 197 | 265 | 16-#4 2 | 9-#6 | 12-#7 | 13-#4 | 11-#4 | 3.09 | 3.13 | 3.19 | 21 | 300 | 31 | 20-#5 | 13-#4 | 11-#4 | 10-#4 | 2.92 | 2.97 | 3.03 |
| 21 | 350 | 38 | 0.610 | 103 | 206 | 278 | 11-#5 2 | 13-#5 | 10-#8 | 13-#4 | 11-#4 | 3.24 | 3.30 | 3.41 | 21 | 350 | 39 | 15-#6 | 9-#5 | 11-#4 | 10-#4 | 3.12 | 3.19 | 3.25 |

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANEL

| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) Location of Panel | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | E | EC | C |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | | | |
| 8.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.708 c.f./s.f. |
| 22 | 50 | 16 | 0.781 | 56 | 111 | 149 | 11-#4 5 | 11-#4 | 12-#5 | 11-#4 | 11-#4 | 2.07 | 2.08 | 2.03 |
| 22 | 100 | 20 | 0.733 | 69 | 137 | 185 | 11-#4 6 | 13-#4 | 11-#6 | 11-#4 | 11-#4 | 2.26 | 2.28 | 2.23 |
| 22 | 150 | 24 | 0.665 | 81 | 161 | 217 | 13-#4 4 | 16-#4 | 13-#6 | 11-#4 | 11-#4 | 2.51 | 2.54 | 2.55 |
| 22 | 200 | 28 | 0.613 | 92 | 184 | 248 | 15-#4 3 | 12-#5 | 20-#5 | 8-#5 | 11-#4 | 2.81 | 2.82 | 2.83 |
| 22 | 250 | 32 | 0.611 | 102 | 204 | 275 | 11-#5 2 | 13-#5 | 12-#7 | 13-#4 | 11-#4 | 3.06 | 3.09 | 3.14 |
| 22 | 300 | 38 | 0.610 | 108 | 217 | 292 | 12-#5 2 | 10-#6 | 13-#7 | 9-#5 | 8-#5 | 3.29 | 3.33 | 3.39 |
| 22 | 350 | 44 | 0.609 | 114 | 227 | 306 | 12-#5 2 | 8-#7 | 11-#8 | 10-#5 | 8-#5 | 3.56 | 3.61 | 3.65 |
| 23 | 50 | 18 | 0.737 | 63 | 126 | 169 | 12-#4 4 | 12-#4 | 14-#5 | 11-#4 | 12-#4 | 2.08 | 2.10 | 2.06 |
| 23 | 100 | 22 | 0.694 | 78 | 155 | 209 | 13-#4 4 | 10-#5 | 12-#6 | 11-#4 | 12-#4 | 2.36 | 2.38 | 2.31 |
| 23 | 150 | 26 | 0.699 | 91 | 183 | 246 | 15-#4 6 | 12-#5 | 20-#5 | 12-#4 | 12-#4 | 2.67 | 2.68 | 2.70 |
| 23 | 200 | 30 | 0.654 | 104 | 208 | 280 | 11-#5 3 | 20-#4 | 13-#7 | 9-#5 | 12-#4 | 3.00 | 3.04 | 3.07 |
| 23 | 250 | 37 | 0.610 | 112 | 225 | 303 | 12-#5 2 | 11-#6 | 11-#8 | 10-#5 | 12-#4 | 3.37 | 3.40 | 3.47 |
| 23 | 300 | 43 | 0.609 | 119 | 239 | 322 | 19-#4 4 | 23-#4 | 11-#8 | 10-#5 | 13-#4 | 3.35 | 3.40 | 3.58 |
| 23 | 350 | 50 | 0.608 | 124 | 249 | 335 | 20-#4 3 | 16-#5 | 12-#8 | 16-#4 | 9-#5 | 3.63 | 3.68 | 3.84 |
| 24 | 50 | 19 | 0.744 | 71 | 142 | 191 | 13-#4 4 | 9-#5 | 23-#4 | 12-#4 | 13-#4 | 2.22 | 2.22 | 2.10 |
| 24 | 100 | 24 | 0.718 | 88 | 175 | 236 | 14-#4 7 | 11-#5 | 14-#6 | 11-#4 | 13-#4 | 2.45 | 2.47 | 2.43 |
| 24 | 150 | 29 | 0.635 | 102 | 205 | 276 | 17-#4 4 | 13-#5 | 12-#7 | 13-#4 | 13-#4 | 2.82 | 2.83 | 2.81 |
| 24 | 200 | 35 | 0.610 | 115 | 230 | 309 | 12-#5 2 | 11-#6 | 14-#7 | 10-#5 | 13-#4 | 3.22 | 3.25 | 3.33 |
| 24 | 250 | 42 | 0.609 | 124 | 247 | 333 | 13-#5 2 | 16-#5 | 12-#8 | 16-#4 | 9-#5 | 3.41 | 3.45 | 3.55 |
| 24 | 300 | 49 | 0.608 | 131 | 261 | 352 | 14-#5 1 | 9-#7 | 12-#8 | 11-#5 | 14-#4 | 3.62 | 3.67 | 3.81 |
| 24 | 350 | 56 | 0.607 | 136 | 272 | 367 | 22-#4 2 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 3.97 | 4.03 | 4.12 |
| 25 | 50 | 21 | 0.717 | 80 | 159 | 214 | 13-#4 5 | 10-#5 | 17-#5 | 12-#4 | 13-#4 | 2.25 | 2.25 | 2.18 |
| 25 | 100 | 26 | 0.699 | 98 | 196 | 264 | 16-#4 6 | 9-#6 | 12-#7 | 13-#4 | 13-#4 | 2.60 | 2.65 | 2.66 |
| 25 | 150 | 32 | 0.671 | 115 | 229 | 308 | 12-#5 5 | 11-#6 | 14-#7 | 10-#5 | 13-#4 | 3.05 | 3.08 | 3.12 |
| 25 | 200 | 40 | 0.609 | 126 | 252 | 339 | 20-#4 5 | 16-#5 | 12-#8 | 16-#4 | 9-#5 | 3.28 | 3.31 | 3.41 |
| 25 | 250 | 47 | 0.608 | 135 | 271 | 364 | 22-#4 4 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 3.71 | 3.80 | 3.95 |
| 25 | 300 | 55 | 0.607 | 142 | 285 | 383 | 15-#5 1 | 10-#7 | 17-#7 | 12-#5 | 10-#5 | 3.88 | 3.94 | 4.12 |
| 25 | 350 | 63 | 0.606 | 148 | 295 | 397 | 16-#5 0 | 14-#6 | 14-#8 | 9-#6 | 16-#4 | 4.09 | 4.16 | 4.34 |
| 26 | 50 | 23 | 0.720 | 89 | 178 | 239 | 14-#4 7 | 17-#4 | 14-#6 | 12-#4 | 13-#4 | 2.28 | 2.30 | 2.26 |
| 26 | 100 | 29 | 0.675 | 109 | 218 | 293 | 18-#4 7 | 10-#6 | 13-#7 | 14-#4 | 13-#4 | 2.75 | 2.77 | 2.85 |
| 26 | 150 | 36 | 0.612 | 126 | 252 | 339 | 20-#4 5 | 16-#5 | 15-#7 | 16-#4 | 14-#4 | 3.09 | 3.13 | 3.24 |
| 26 | 200 | 44 | 0.609 | 138 | 276 | 372 | 22-#4 5 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 3.59 | 3.66 | 3.74 |
| 26 | 250 | 53 | 0.607 | 147 | 295 | 397 | 16-#5 2 | 14-#6 | 14-#8 | 19-#4 | 16-#4 | 3.88 | 3.95 | 4.11 |
| 26 | 300 | 61 | 0.606 | 154 | 309 | 415 | 25-#4 3 | 20-#5 | 15-#8 | 13-#5 | 11-#5 | 4.10 | 4.14 | 4.23 |
| 26 | 350 | 70 | 0.606 | 159 | 319 | 429 | 17-#5 0 | 11-#7 | 15-#8 | 10-#6 | 17-#4 | 4.29 | 4.32 | 4.48 |

## SQUARE INTERIOR PANEL

| (2) Span c.-c. (ft) | (3) Load (psf) | (1) Min. Sq. Col. (in.) | Reinforcing Bars Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Steel (psf) Location of Panel I | IE | IC |
|---|---|---|---|---|---|---|---|---|---|
| 8.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.708 c.f./s.f. |
| 22 | 50 | 10 | 17-#4 | 11-#4 | 11-#4 | 11-#4 | 2.11 | 2.13 | 2.14 |
| 22 | 100 | 15 | 14-#5 | 11-#4 | 11-#4 | 11-#4 | 2.31 | 2.34 | 2.36 |
| 22 | 150 | 20 | 12-#6 | 11-#4 | 11-#4 | 11-#4 | 2.52 | 2.54 | 2.56 |
| 22 | 200 | 24 | 11-#7 | 8-#5 | 11-#4 | 11-#4 | 2.87 | 2.84 | 2.82 |
| 22 | 250 | 29 | 15-#6 | 9-#5 | 11-#4 | 11-#4 | 2.99 | 3.01 | 3.04 |
| 22 | 300 | 38 | 12-#7 | 14-#4 | 11-#4 | 11-#4 | 3.13 | 3.18 | 3.22 |
| 22 | 350 | 46 | 13-#7 | 10-#5 | 8-#5 | 11-#4 | 3.43 | 3.47 | 3.52 |
| 23 | 50 | 12 | 13-#5 | 11-#4 | 12-#4 | 11-#4 | 2.17 | 2.18 | 2.19 |
| 23 | 100 | 17 | 16-#5 | 11-#4 | 12-#4 | 11-#4 | 2.36 | 2.37 | 2.39 |
| 23 | 150 | 22 | 11-#7 | 12-#4 | 12-#4 | 11-#4 | 2.73 | 2.71 | 2.69 |
| 23 | 200 | 27 | 12-#7 | 9-#5 | 12-#4 | 11-#4 | 2.98 | 3.01 | 3.04 |
| 23 | 250 | 36 | 13-#7 | 10-#5 | 12-#4 | 11-#4 | 3.21 | 3.25 | 3.29 |
| 23 | 300 | 45 | 13-#7 | 10-#5 | 12-#4 | 11-#4 | 3.25 | 3.30 | 3.35 |
| 23 | 350 | 54 | 11-#8 | 16-#4 | 12-#4 | 11-#4 | 3.48 | 3.54 | 3.59 |
| 24 | 50 | 14 | 15-#5 | 12-#4 | 13-#4 | 12-#4 | 2.30 | 2.29 | 2.29 |
| 24 | 100 | 19 | 13-#6 | 12-#4 | 13-#4 | 12-#4 | 2.52 | 2.53 | 2.55 |
| 24 | 150 | 25 | 15-#6 | 9-#5 | 13-#4 | 12-#4 | 2.81 | 2.83 | 2.86 |
| 24 | 200 | 32 | 13-#7 | 10-#5 | 13-#4 | 12-#4 | 3.12 | 3.14 | 3.17 |
| 24 | 250 | 42 | 14-#7 | 16-#4 | 13-#4 | 12-#4 | 3.29 | 3.35 | 3.40 |
| 24 | 300 | 52 | 19-#6 | 11-#5 | 13-#4 | 11-#4 | 3.36 | 3.42 | 3.48 |
| 24 | 350 | 61 | 12-#8 | 12-#5 | 9-#5 | 12-#4 | 3.74 | 3.79 | 3.85 |
| 25 | 50 | 15 | 12-#6 | 12-#4 | 13-#4 | 12-#4 | 2.33 | 2.32 | 2.32 |
| 25 | 100 | 21 | 20-#5 | 13-#4 | 13-#4 | 12-#4 | 2.54 | 2.58 | 2.63 |
| 25 | 150 | 27 | 13-#7 | 10-#5 | 13-#4 | 12-#4 | 2.97 | 2.99 | 3.01 |
| 25 | 200 | 38 | 14-#7 | 11-#5 | 13-#4 | 12-#4 | 3.20 | 3.25 | 3.30 |
| 25 | 250 | 49 | 12-#8 | 12-#5 | 9-#5 | 12-#4 | 3.52 | 3.57 | 3.62 |
| 25 | 300 | 59 | 12-#8 | 12-#5 | 14-#4 | 12-#4 | 3.57 | 3.62 | 3.67 |
| 25 | 350 | 69 | 13-#8 | 19-#4 | 10-#5 | 13-#4 | 3.89 | 3.93 | 3.97 |
| 26 | 50 | 17 | 13-#6 | 12-#4 | 13-#4 | 12-#4 | 2.31 | 2.33 | 2.34 |
| 26 | 100 | 24 | 16-#6 | 10-#5 | 13-#4 | 12-#4 | 2.71 | 2.74 | 2.77 |
| 26 | 150 | 32 | 14-#7 | 11-#5 | 13-#4 | 12-#4 | 3.05 | 3.08 | 3.11 |
| 26 | 200 | 44 | 13-#8 | 12-#5 | 14-#4 | 12-#4 | 3.49 | 3.50 | 3.51 |
| 26 | 250 | 55 | 13-#8 | 19-#4 | 10-#5 | 13-#4 | 3.66 | 3.69 | 3.73 |
| 26 | 300 | 67 | 13-#8 | 13-#5 | 10-#5 | 13-#4 | 3.78 | 3.86 | 3.94 |
| 26 | 350 | 77 | 14-#8 | 20-#4 | 10-#5 | 14-#4 | 3.98 | 4.03 | 4.08 |

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

| SQUARE EDGE PANEL | | | | | | | | | | | | | | | SQUARE INTERIOR PANEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) | (3) | (1) | Reinforcing Bars | | | | Steel (psf) | | |
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | Location of Panel | | | Span c.-c. | Load | Min. Sq. Col. | Top | Bottom | Top | Bottom | | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | E | EC | C | (ft) | (psf) | (in.) | | | | | I | IE | IC |
| 9 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.750 c.f./s.f. | 9 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.750 c.f./s.f. |
| 18 | 50 | 10 | 0.782 | 32 | 64 | 86 | 9-#4 1 | 6-#5 | 10-#4 | 6-#5 | 6-#5 | 1.93 | 1.94 | 1.90 | 18 | 50 | 10 | 9-#4 | 6-#5 | 6-#5 | 6-#5 | 1.94 | 1.95 | 1.96 |
| 18 | 100 | 11 | 0.830 | 40 | 81 | 109 | 9-#4 3 | 6-#5 | 8-#5 | 6-#5 | 6-#5 | 2.03 | 2.04 | 1.99 | 18 | 100 | 10 | 8-#5 | 6-#5 | 6-#5 | 6-#5 | 2.10 | 2.10 | 2.10 |
| 18 | 150 | 14 | 0.774 | 47 | 94 | 127 | 9-#4 3 | 6-#5 | 10-#5 | 6-#5 | 6-#5 | 2.10 | 2.12 | 2.07 | 18 | 150 | 15 | 13-#4 | 6-#5 | 6-#5 | 6-#5 | 2.14 | 2.17 | 2.20 |
| 18 | 200 | 16 | 0.769 | 54 | 108 | 146 | 9-#4 4 | 10-#4 | 8-#6 | 6-#5 | 6-#5 | 2.25 | 2.27 | 2.20 | 18 | 200 | 17 | 10-#5 | 6-#5 | 6-#5 | 6-#5 | 2.27 | 2.30 | 2.32 |
| 18 | 250 | 19 | 0.704 | 61 | 122 | 164 | 9-#4 4 | 11-#4 | 9-#6 | 6-#5 | 6-#5 | 2.36 | 2.37 | 2.26 | 18 | 250 | 18 | 12-#5 | 6-#5 | 6-#5 | 6-#5 | 2.42 | 2.44 | 2.45 |
| 18 | 300 | 21 | 0.701 | 68 | 136 | 183 | 10-#4 4 | 8-#5 | 10-#6 | 6-#5 | 6-#5 | 2.50 | 2.52 | 2.45 | 18 | 300 | 19 | 13-#5 | 6-#5 | 6-#5 | 6-#5 | 2.50 | 2.52 | 2.55 |
| 18 | 350 | 24 | 0.615 | 74 | 148 | 199 | 11-#4 2 | 9-#5 | 8-#7 | 6-#5 | 6-#5 | 2.64 | 2.66 | 2.62 | 18 | 350 | 21 | 10-#6 | 6-#5 | 6-#5 | 6-#5 | 2.61 | 2.63 | 2.65 |
| 19 | 50 | 10 | 0.822 | 38 | 75 | 102 | 10-#4 1 | 10-#4 | 12-#4 | 10-#4 | 10-#4 | 2.02 | 2.02 | 2.02 | 19 | 50 | 10 | 11-#4 | 10-#4 | 10-#4 | 10-#4 | 2.02 | 2.03 | 2.04 |
| 19 | 100 | 13 | 0.787 | 47 | 94 | 127 | 10-#4 2 | 10-#4 | 10-#5 | 10-#4 | 10-#4 | 2.11 | 2.12 | 2.09 | 19 | 100 | 10 | 9-#5 | 10-#4 | 10-#4 | 10-#4 | 2.15 | 2.17 | 2.18 |
| 19 | 150 | 16 | 0.751 | 55 | 110 | 149 | 10-#4 3 | 10-#4 | 11-#5 | 10-#4 | 10-#4 | 2.20 | 2.21 | 2.13 | 19 | 150 | 15 | 16-#4 | 10-#4 | 10-#4 | 10-#4 | 2.25 | 2.27 | 2.28 |
| 19 | 200 | 19 | 0.691 | 63 | 127 | 171 | 10-#4 3 | 8-#5 | 9-#6 | 10-#4 | 10-#4 | 2.36 | 2.38 | 2.27 | 19 | 200 | 17 | 12-#5 | 10-#4 | 10-#4 | 10-#4 | 2.38 | 2.40 | 2.41 |
| 19 | 250 | 21 | 0.695 | 72 | 144 | 193 | 11-#4 3 | 13-#4 | 11-#6 | 10-#4 | 10-#4 | 2.50 | 2.52 | 2.42 | 19 | 250 | 18 | 10-#6 | 10-#4 | 10-#4 | 10-#4 | 2.55 | 2.58 | 2.60 |
| 19 | 300 | 24 | 0.631 | 78 | 157 | 211 | 12-#4 2 | 14-#4 | 16-#5 | 10-#4 | 10-#4 | 2.60 | 2.62 | 2.64 | 19 | 300 | 22 | 11-#6 | 10-#4 | 10-#4 | 10-#4 | 2.67 | 2.67 | 2.68 |
| 19 | 350 | 26 | 0.636 | 85 | 171 | 230 | 13-#4 2 | 10-#5 | 10-#7 | 10-#4 | 10-#4 | 2.79 | 2.83 | 2.86 | 19 | 350 | 25 | 16-#5 | 7-#5 | 10-#4 | 10-#4 | 2.77 | 2.83 | 2.89 |
| 20 | 50 | 11 | 0.824 | 44 | 88 | 118 | 10-#4 2 | 10-#4 | 9-#5 | 10-#4 | 10-#4 | 2.00 | 2.00 | 1.98 | 20 | 50 | 10 | 13-#4 | 10-#4 | 10-#4 | 10-#4 | 2.00 | 2.01 | 2.02 |
| 20 | 100 | 15 | 0.760 | 55 | 110 | 148 | 10-#4 3 | 10-#4 | 11-#5 | 10-#4 | 10-#4 | 2.05 | 2.07 | 2.03 | 20 | 100 | 10 | 16-#4 | 10-#4 | 10-#4 | 10-#4 | 2.12 | 2.13 | 2.14 |
| 20 | 150 | 18 | 0.729 | 64 | 129 | 173 | 10-#4 4 | 8-#5 | 13-#5 | 10-#4 | 10-#4 | 2.24 | 2.25 | 2.16 | 20 | 150 | 15 | 12-#5 | 10-#4 | 10-#4 | 10-#4 | 2.25 | 2.27 | 2.28 |
| 20 | 200 | 21 | 0.677 | 74 | 148 | 199 | 11-#4 3 | 9-#5 | 11-#6 | 10-#4 | 10-#4 | 2.43 | 2.44 | 2.33 | 20 | 200 | 17 | 10-#6 | 10-#4 | 10-#4 | 10-#4 | 2.42 | 2.44 | 2.46 |
| 20 | 250 | 24 | 0.684 | 82 | 164 | 221 | 13-#4 4 | 7-#6 | 9-#7 | 10-#4 | 10-#4 | 2.59 | 2.61 | 2.61 | 20 | 250 | 21 | 16-#5 | 10-#4 | 10-#4 | 10-#4 | 2.54 | 2.56 | 2.59 |
| 20 | 300 | 27 | 0.614 | 90 | 180 | 242 | 9-#5 1 | 16-#4 | 10-#7 | 7-#5 | 10-#4 | 2.71 | 2.75 | 2.82 | 20 | 300 | 25 | 17-#5 | 11-#4 | 10-#4 | 10-#4 | 2.69 | 2.73 | 2.77 |
| 20 | 350 | 30 | 0.613 | 97 | 195 | 262 | 10-#5 2 | 12-#5 | 20-#5 | 8-#5 | 10-#4 | 3.00 | 3.04 | 3.11 | 20 | 350 | 28 | 10-#7 | 8-#5 | 10-#4 | 10-#4 | 2.96 | 2.96 | 2.97 |
| 21 | 50 | 13 | 0.821 | 51 | 101 | 137 | 11-#4 4 | 7-#5 | 10-#5 | 7-#5 | 7-#5 | 2.10 | 2.10 | 2.06 | 21 | 50 | 10 | 10-#5 | 7-#5 | 7-#5 | 7-#5 | 2.16 | 2.16 | 2.16 |
| 21 | 100 | 17 | 0.767 | 63 | 126 | 169 | 11-#4 5 | 8-#5 | 13-#5 | 7-#5 | 7-#5 | 2.25 | 2.26 | 2.17 | 21 | 100 | 12 | 12-#5 | 7-#5 | 7-#5 | 7-#5 | 2.29 | 2.30 | 2.32 |
| 21 | 150 | 20 | 0.689 | 74 | 148 | 199 | 11-#4 3 | 9-#5 | 11-#6 | 7-#5 | 7-#5 | 2.40 | 2.43 | 2.37 | 21 | 150 | 16 | 10-#6 | 7-#5 | 7-#5 | 7-#5 | 2.45 | 2.47 | 2.49 |
| 21 | 200 | 24 | 0.664 | 84 | 168 | 226 | 13-#4 4 | 7-#6 | 17-#5 | 7-#5 | 7-#5 | 2.60 | 2.61 | 2.53 | 21 | 200 | 20 | 16-#5 | 7-#5 | 7-#5 | 7-#5 | 2.57 | 2.58 | 2.60 |
| 21 | 250 | 27 | 0.618 | 94 | 187 | 252 | 14-#4 3 | 8-#6 | 11-#7 | 11-#4 | 7-#5 | 2.86 | 2.88 | 2.80 | 21 | 250 | 24 | 10-#7 | 8-#5 | 7-#5 | 7-#5 | 2.89 | 2.92 | 2.95 |
| 21 | 300 | 30 | 0.635 | 103 | 205 | 276 | 10-#5 3 | 12-#5 | 15-#6 | 8-#5 | 7-#5 | 3.04 | 3.05 | 3.11 | 21 | 300 | 28 | 11-#7 | 13-#4 | 7-#5 | 7-#5 | 3.07 | 3.07 | 3.07 |
| 21 | 350 | 33 | 0.612 | 111 | 222 | 298 | 11-#5 2 | 7-#7 | 10-#8 | 9-#5 | 11-#4 | 3.31 | 3.37 | 3.49 | 21 | 350 | 32 | 15-#6 | 9-#5 | 7-#5 | 7-#5 | 3.15 | 3.21 | 3.28 |
| 22 | 50 | 15 | 0.780 | 58 | 116 | 156 | 11-#4 4 | 11-#4 | 12-#5 | 11-#4 | 11-#4 | 2.07 | 2.08 | 2.02 | 22 | 50 | 10 | 11-#5 | 11-#4 | 11-#4 | 11-#4 | 2.12 | 2.13 | 2.15 |
| 22 | 100 | 19 | 0.743 | 71 | 143 | 192 | 11-#4 6 | 13-#4 | 11-#6 | 11-#4 | 11-#4 | 2.29 | 2.31 | 2.24 | 22 | 100 | 14 | 10-#6 | 11-#4 | 11-#4 | 11-#4 | 2.33 | 2.35 | 2.37 |
| 22 | 150 | 23 | 0.671 | 84 | 168 | 226 | 13-#4 4 | 10-#5 | 12-#6 | 11-#4 | 11-#4 | 2.48 | 2.49 | 2.42 | 22 | 150 | 18 | 16-#5 | 11-#4 | 11-#4 | 11-#4 | 2.44 | 2.46 | 2.48 |
| 22 | 200 | 26 | 0.689 | 95 | 191 | 257 | 10-#5 3 | 8-#6 | 11-#7 | 8-#5 | 11-#4 | 2.79 | 2.81 | 2.77 | 22 | 200 | 23 | 10-#7 | 8-#5 | 11-#4 | 11-#4 | 2.75 | 2.77 | 2.80 |
| 22 | 250 | 30 | 0.632 | 106 | 212 | 285 | 16-#4 5 | 9-#6 | 12-#7 | 13-#4 | 11-#4 | 2.99 | 3.01 | 3.06 | 22 | 250 | 27 | 11-#7 | 13-#4 | 11-#4 | 11-#4 | 2.92 | 2.94 | 2.97 |
| 22 | 300 | 33 | 0.617 | 116 | 233 | 313 | 12-#5 2 | 10-#6 | 10-#8 | 9-#5 | 8-#5 | 3.28 | 3.31 | 3.39 | 22 | 300 | 31 | 12-#7 | 14-#4 | 11-#4 | 11-#4 | 3.10 | 3.14 | 3.18 |
| 22 | 350 | 38 | 0.610 | 122 | 245 | 330 | 12-#5 2 | 8-#7 | 11-#8 | 10-#5 | 8-#5 | 3.56 | 3.59 | 3.69 | 22 | 350 | 39 | 10-#8 | 10-#5 | 8-#5 | 11-#4 | 3.40 | 3.44 | 3.48 |

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

## SQUARE EDGE PANEL

## SQUARE INTERIOR PANEL

$f'_c$ = 4,000 psi
Grade 60 Bars

| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) | (3) | (1) | Reinforcing Bars | | | | Steel (psf) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | –M Ext. | +M Int. | –M 1st int. | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | | | | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | Location of Panel | | | | | | | | | | | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | E | EC | C | Span c.-c. (ft) | Load (psf) | Min. Sq. Col. (in.) | Top | Bottom | Top | Bottom | I | IE | IC |
| 9 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.750 c.f./s.f. | 9 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.750 c.f./s.f. |
| 23 | 50 | 17 | 0.751 | 66 | 132 | 177 | 12-#4 4 | 8-#5 | 13-#5 | 8-#5 | 8-#5 | 2.20 | 2.20 | 2.12 | 23 | 50 | 11 | 13-#5 | 8-#5 | 8-#5 | 8-#5 | 2.31 | 2.31 | 2.31 |
| 23 | 100 | 21 | 0.704 | 81 | 162 | 218 | 12-#4 5 | 10-#5 | 12-#6 | 8-#5 | 8-#5 | 2.43 | 2.44 | 2.33 | 23 | 100 | 16 | 11-#6 | 8-#5 | 8-#5 | 8-#5 | 2.49 | 2.51 | 2.53 |
| 23 | 150 | 25 | 0.655 | 95 | 189 | 255 | 14-#4 4 | 8-#6 | 11-#7 | 8-#5 | 8-#5 | 2.67 | 2.69 | 2.61 | 23 | 150 | 21 | 13-#6 | 8-#5 | 8-#5 | 8-#5 | 2.67 | 2.71 | 2.75 |
| 23 | 200 | 29 | 0.641 | 108 | 216 | 290 | 16-#4 5 | 13-#5 | 12-#7 | 13-#4 | 8-#5 | 2.89 | 2.91 | 2.93 | 23 | 200 | 25 | 11-#7 | 13-#4 | 8-#5 | 8-#5 | 2.88 | 2.91 | 2.94 |
| 23 | 250 | 33 | 0.612 | 119 | 239 | 322 | 12-#5 2 | 8-#7 | 13-#7 | 10-#5 | 8-#5 | 3.30 | 3.31 | 3.35 | 23 | 250 | 30 | 13-#7 | 10-#5 | 8-#5 | 8-#5 | 3.26 | 3.26 | 3.26 |
| 23 | 300 | 38 | 0.610 | 128 | 256 | 344 | 19-#4 4 | 23-#4 | 11-#8 | 10-#5 | 13-#4 | 3.38 | 3.42 | 3.50 | 23 | 300 | 38 | 13-#7 | 10-#5 | 8-#5 | 8-#5 | 3.30 | 3.34 | 3.38 |
| 23 | 350 | 44 | 0.609 | 134 | 268 | 360 | 20-#4 3 | 16-#5 | 12-#8 | 16-#4 | 9-#5 | 3.63 | 3.66 | 3.82 | 23 | 350 | 47 | 11-#8 | 16-#4 | 8-#5 | 8-#5 | 3.52 | 3.57 | 3.63 |
| 24 | 50 | 18 | 0.757 | 74 | 149 | 200 | 13-#4 4 | 9-#5 | 11-#6 | 8-#5 | 8-#5 | 2.23 | 2.25 | 2.14 | 24 | 50 | 13 | 14-#5 | 8-#5 | 8-#5 | 8-#5 | 2.28 | 2.30 | 2.32 |
| 24 | 100 | 23 | 0.726 | 91 | 182 | 245 | 14-#4 7 | 8-#6 | 13-#6 | 8-#5 | 8-#5 | 2.49 | 2.50 | 2.46 | 24 | 100 | 18 | 13-#6 | 8-#5 | 8-#5 | 8-#5 | 2.55 | 2.55 | 2.54 |
| 24 | 150 | 27 | 0.688 | 107 | 214 | 287 | 16-#4 6 | 9-#6 | 12-#7 | 13-#4 | 8-#5 | 2.77 | 2.78 | 2.82 | 24 | 150 | 23 | 11-#7 | 13-#4 | 8-#5 | 8-#5 | 2.75 | 2.78 | 2.80 |
| 24 | 200 | 31 | 0.691 | 121 | 243 | 326 | 12-#5 5 | 8-#7 | 11-#8 | 10-#5 | 8-#5 | 3.19 | 3.22 | 3.25 | 24 | 200 | 28 | 13-#7 | 10-#5 | 8-#5 | 8-#5 | 3.11 | 3.14 | 3.18 |
| 24 | 250 | 37 | 0.633 | 132 | 265 | 357 | 13-#5 4 | 16-#5 | 12-#8 | 16-#4 | 9-#5 | 3.39 | 3.43 | 3.53 | 24 | 250 | 35 | 11-#8 | 16-#4 | 13-#4 | 8-#5 | 3.32 | 3.37 | 3.41 |
| 24 | 300 | 44 | 0.609 | 140 | 279 | 376 | 14-#5 3 | 9-#7 | 12-#8 | 8-#6 | 14-#4 | 3.65 | 3.71 | 3.85 | 24 | 300 | 45 | 11-#8 | 8-#6 | 13-#4 | 8-#5 | 3.47 | 3.51 | 3.56 |
| 24 | 350 | 50 | 0.608 | 146 | 293 | 394 | 22-#4 2 | 8-#8 | 13-#8 | 12-#5 | 10-#5 | 3.98 | 4.04 | 4.15 | 24 | 350 | 54 | 12-#8 | 12-#5 | 9-#5 | 8-#5 | 3.73 | 3.78 | 3.83 |
| 25 | 50 | 20 | 0.729 | 84 | 167 | 225 | 13-#4 5 | 10-#5 | 12-#6 | 13-#4 | 13-#4 | 2.31 | 2.33 | 2.26 | 25 | 50 | 14 | 16-#5 | 13-#4 | 13-#4 | 13-#4 | 2.36 | 2.38 | 2.39 |
| 25 | 100 | 25 | 0.706 | 102 | 204 | 275 | 16-#4 6 | 12-#5 | 15-#6 | 12-#4 | 13-#4 | 2.57 | 2.59 | 2.54 | 25 | 100 | 20 | 14-#6 | 13-#4 | 13-#4 | 13-#4 | 2.60 | 2.62 | 2.63 |
| 25 | 150 | 30 | 0.665 | 119 | 238 | 320 | 12-#5 4 | 10-#6 | 13-#7 | 14-#4 | 13-#4 | 2.94 | 2.96 | 2.99 | 25 | 150 | 26 | 13-#7 | 10-#5 | 13-#4 | 13-#4 | 3.02 | 3.01 | 3.01 |
| 25 | 200 | 35 | 0.619 | 135 | 269 | 363 | 20-#4 5 | 16-#5 | 12-#8 | 16-#4 | 9-#5 | 3.27 | 3.32 | 3.38 | 25 | 200 | 31 | 14-#7 | 11-#5 | 13-#4 | 13-#4 | 3.22 | 3.27 | 3.32 |
| 25 | 250 | 42 | 0.609 | 145 | 289 | 389 | 22-#4 4 | 26-#4 | 13-#8 | 12-#5 | 10-#5 | 3.57 | 3.63 | 3.72 | 25 | 250 | 42 | 12-#8 | 12-#5 | 9-#5 | 13-#4 | 3.54 | 3.59 | 3.63 |
| 25 | 300 | 50 | 0.608 | 152 | 304 | 410 | 15-#5 3 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 3.81 | 3.87 | 4.10 | 25 | 300 | 52 | 12-#8 | 12-#5 | 14-#4 | 12-#4 | 3.54 | 3.58 | 3.63 |
| 25 | 350 | 57 | 0.607 | 158 | 317 | 426 | 16-#5 2 | 14-#6 | 14-#8 | 9-#6 | 16-#4 | 4.11 | 4.13 | 4.29 | 25 | 350 | 62 | 13-#8 | 19-#4 | 10-#5 | 13-#4 | 3.85 | 3.89 | 3.93 |
| 26 | 50 | 22 | 0.731 | 93 | 186 | 251 | 14-#4 7 | 11-#5 | 14-#6 | 13-#4 | 13-#4 | 2.38 | 2.40 | 2.34 | 26 | 50 | 16 | 13-#6 | 13-#4 | 13-#4 | 13-#4 | 2.41 | 2.43 | 2.44 |
| 26 | 100 | 27 | 0.711 | 114 | 228 | 307 | 17-#4 8 | 10-#6 | 13-#7 | 9-#5 | 13-#4 | 2.77 | 2.80 | 2.79 | 26 | 100 | 22 | 12-#7 | 9-#5 | 13-#4 | 13-#4 | 2.72 | 2.75 | 2.77 |
| 26 | 150 | 32 | 0.660 | 133 | 266 | 358 | 13-#5 4 | 16-#5 | 12-#8 | 16-#4 | 9-#5 | 3.15 | 3.19 | 3.22 | 26 | 150 | 28 | 14-#7 | 11-#5 | 13-#4 | 13-#4 | 3.08 | 3.13 | 3.18 |
| 26 | 200 | 40 | 0.610 | 147 | 294 | 396 | 22-#4 4 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 3.53 | 3.58 | 3.69 | 26 | 200 | 37 | 12-#8 | 12-#5 | 9-#5 | 13-#4 | 3.38 | 3.42 | 3.46 |
| 26 | 250 | 48 | 0.608 | 157 | 315 | 424 | 16-#5 2 | 10-#7 | 14-#8 | 19-#4 | 16-#4 | 3.84 | 3.86 | 3.99 | 26 | 250 | 48 | 13-#8 | 19-#4 | 10-#5 | 13-#4 | 3.62 | 3.66 | 3.69 |
| 26 | 300 | 56 | 0.607 | 165 | 331 | 445 | 25-#4 3 | 20-#5 | 15-#8 | 13-#5 | 11-#5 | 3.98 | 4.06 | 4.23 | 26 | 300 | 59 | 13-#8 | 13-#5 | 10-#5 | 13-#4 | 3.74 | 3.82 | 3.90 |
| 26 | 350 | 63 | 0.607 | 172 | 344 | 464 | 17-#5 2 | 9-#8 | 15-#8 | 10-#6 | 12-#5 | 4.38 | 4.41 | 4.57 | 26 | 350 | 69 | 14-#8 | 10-#6 | 16-#4 | 9-#5 | 4.08 | 4.13 | 4.19 |
| 27 | 50 | 24 | 0.707 | 104 | 207 | 279 | 16-#4 6 | 9-#6 | 15-#6 | 9-#5 | 9-#5 | 2.50 | 2.52 | 2.45 | 27 | 50 | 18 | 14-#6 | 9-#5 | 9-#5 | 9-#5 | 2.52 | 2.53 | 2.55 |
| 27 | 100 | 30 | 0.650 | 126 | 253 | 340 | 19-#4 6 | 11-#6 | 14-#7 | 10-#5 | 9-#5 | 2.88 | 2.91 | 2.91 | 27 | 100 | 24 | 13-#7 | 16-#4 | 9-#5 | 9-#5 | 2.87 | 2.89 | 2.91 |
| 27 | 150 | 36 | 0.647 | 147 | 293 | 395 | 22-#4 7 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 3.40 | 3.44 | 3.55 | 27 | 150 | 31 | 12-#8 | 12-#5 | 9-#5 | 9-#5 | 3.27 | 3.31 | 3.35 |
| 27 | 200 | 45 | 0.609 | 160 | 320 | 431 | 16-#5 2 | 14-#6 | 14-#8 | 19-#4 | 16-#4 | 3.65 | 3.71 | 3.88 | 27 | 200 | 43 | 13-#8 | 13-#5 | 10-#5 | 9-#5 | 3.56 | 3.60 | 3.63 |
| 27 | 250 | 53 | 0.608 | 171 | 342 | 460 | 12-#6 2 | 9-#8 | 15-#8 | 10-#6 | 17-#4 | 4.09 | 4.14 | 4.26 | 27 | 250 | 55 | 14-#8 | 10-#6 | 16-#4 | 9-#5 | 3.85 | 3.89 | 3.93 |
| 27 | 300 | 62 | 0.607 | 179 | 358 | 482 | 13-#6 1 | 9-#8 | 16-#8 | 10-#6 | 12-#5 | 4.29 | 4.33 | 4.48 | 27 | 300 | 66 | 14-#8 | 10-#6 | 11-#5 | 14-#4 | 3.92 | 4.00 | 4.08 |
| 27 | 350 | 70 | 0.606 | 185 | 371 | 499 | 28-#4 2 | 12-#7 | 16-#8 | 22-#4 | 9-#6 | 4.37 | 4.43 | 4.62 | 27 | 350 | 77 | 15-#8 | 22-#4 | 11-#5 | 10-#5 | 4.16 | 4.21 | 4.27 |
| 28 | 50 | 26 | 0.707 | 115 | 229 | 308 | 17-#4 8 | 10-#6 | 13-#7 | 14-#4 | 14-#4 | 2.56 | 2.59 | 2.58 | 28 | 50 | 20 | 16-#6 | 14-#4 | 14-#4 | 14-#4 | 2.54 | 2.57 | 2.59 |
| 28 | 100 | 32 | 0.690 | 140 | 279 | 376 | 14-#5 6 | 12-#6 | 13-#8 | 11-#5 | 14-#4 | 3.06 | 3.11 | 3.18 | 28 | 100 | 27 | 15-#7 | 17-#4 | 14-#4 | 14-#4 | 2.99 | 3.03 | 3.08 |
| 28 | 150 | 41 | 0.614 | 159 | 318 | 428 | 16-#5 4 | 10-#7 | 14-#8 | 19-#4 | 16-#4 | 3.49 | 3.54 | 3.63 | 28 | 150 | 37 | 13-#8 | 13-#5 | 10-#5 | 14-#4 | 3.39 | 3.42 | 3.45 |
| 28 | 200 | 50 | 0.608 | 173 | 346 | 466 | 17-#5 4 | 11-#7 | 15-#8 | 10-#6 | 12-#5 | 3.94 | 3.96 | 4.07 | 28 | 200 | 50 | 14-#8 | 10-#6 | 16-#4 | 14-#4 | 3.66 | 3.71 | 3.76 |
| 28 | 250 | 59 | 0.607 | 185 | 369 | 497 | 13-#6 1 | 12-#7 | 16-#8 | 22-#4 | 13-#5 | 4.20 | 4.25 | 4.44 | 28 | 250 | 62 | 15-#8 | 22-#4 | 11-#5 | 10-#5 | 3.92 | 3.98 | 4.03 |
| 28 | 300 | 68 | 0.606 | 193 | 386 | 520 | 19-#5 1 | 10-#8 | 17-#8 | 23-#4 | 13-#5 | 4.48 | 4.55 | 4.80 | 28 | 300 | 74 | 15-#8 | 11-#6 | 12-#5 | 10-#5 | 4.15 | 4.23 | 4.30 |
| 28 | 350 | 77 | 0.605 | 199 | 399 | 537 | 20-#5 1 | 10-#8 | 18-#8 | 16-#5 | 13-#5 | 4.65 | 4.73 | 4.86 | 28 | 350 | 85 | 16-#8 | 11-#6 | 12-#5 | 10-#5 | 4.33 | 4.42 | 4.50 |

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

| SQUARE EDGE PANEL | | | | | | | | | | | | | | | SQUARE INTERIOR PANEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) Span c.-c. | (3) Load | (1) Min. Sq. Col. | Reinforcing Bars | | | | Steel (psf) | | |
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | Location of Panel | | | | | | Top | Bottom | Top | Bottom | | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | E | EC | C | (ft) | (psf) | (in.) | | | | | I | IE | IC |
| 9.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.792 c.f./s.f. | 9.5 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.792 c.f./s.f. |
| 19 | 50 | 10 | 0.859 | 39 | 78 | 106 | 9-#5 1 | 7-#5 | 9-#5 | 7-#5 | 7-#5 | 2.33 | 2.33 | 2.35 | 19 | 50 | 10 | 9-#5 | 7-#5 | 7-#5 | 7-#5 | 2.32 | 2.32 | 2.32 |
| 19 | 100 | 12 | 0.844 | 49 | 98 | 132 | 9-#5 1 | 7-#5 | 9-#5 | 7-#5 | 7-#5 | 2.33 | 2.33 | 2.34 | 19 | 100 | 10 | 9-#5 | 7-#5 | 7-#5 | 7-#5 | 2.32 | 2.32 | 2.32 |
| 19 | 150 | 15 | 0.817 | 57 | 114 | 153 | 9-#5 2 | 7-#5 | 11-#5 | 7-#5 | 7-#5 | 2.42 | 2.43 | 2.40 | 19 | 150 | 15 | 10-#5 | 7-#5 | 7-#5 | 7-#5 | 2.41 | 2.43 | 2.44 |
| 19 | 200 | 17 | 0.801 | 65 | 131 | 176 | 9-#5 2 | 8-#5 | 9-#6 | 7-#5 | 7-#5 | 2.58 | 2.58 | 2.51 | 19 | 200 | 17 | 12-#5 | 7-#5 | 7-#5 | 7-#5 | 2.56 | 2.57 | 2.59 |
| 19 | 250 | 20 | 0.771 | 73 | 146 | 197 | 9-#5 3 | 8-#5 | 10-#6 | 7-#5 | 7-#5 | 2.62 | 2.64 | 2.66 | 19 | 250 | 19 | 13-#5 | 7-#5 | 7-#5 | 7-#5 | 2.63 | 2.66 | 2.68 |
| 19 | 300 | 22 | 0.754 | 81 | 163 | 219 | 9-#5 3 | 9-#5 | 11-#6 | 7-#5 | 7-#5 | 2.77 | 2.78 | 2.79 | 19 | 300 | 20 | 11-#6 | 7-#5 | 7-#5 | 7-#5 | 2.84 | 2.84 | 2.83 |
| 19 | 350 | 25 | 0.643 | 88 | 176 | 237 | 9-#5 1 | 7-#6 | 9-#7 | 7-#5 | 7-#5 | 2.88 | 2.92 | 2.98 | 19 | 350 | 23 | 16-#5 | 7-#5 | 7-#5 | 7-#5 | 2.86 | 2.89 | 2.92 |
| 20 | 50 | 11 | 0.849 | 46 | 92 | 123 | 9-#5 1 | 7-#5 | 9-#5 | 7-#5 | 7-#5 | 2.21 | 2.21 | 2.23 | 20 | 50 | 10 | 9-#5 | 7-#5 | 7-#5 | 7-#5 | 2.21 | 2.21 | 2.20 |
| 20 | 100 | 14 | 0.826 | 57 | 114 | 153 | 9-#5 2 | 7-#5 | 11-#5 | 7-#5 | 7-#5 | 2.29 | 2.30 | 2.28 | 20 | 100 | 10 | 10-#5 | 7-#5 | 7-#5 | 7-#5 | 2.27 | 2.28 | 2.30 |
| 20 | 150 | 17 | 0.785 | 66 | 132 | 178 | 9-#5 2 | 8-#5 | 9-#6 | 7-#5 | 7-#5 | 2.40 | 2.43 | 2.42 | 20 | 150 | 15 | 12-#5 | 7-#5 | 7-#5 | 7-#5 | 2.42 | 2.43 | 2.45 |
| 20 | 200 | 20 | 0.759 | 76 | 152 | 204 | 9-#5 3 | 9-#5 | 11-#6 | 7-#5 | 7-#5 | 2.57 | 2.60 | 2.63 | 20 | 200 | 17 | 10-#6 | 7-#5 | 7-#5 | 7-#5 | 2.58 | 2.60 | 2.63 |
| 20 | 250 | 23 | 0.712 | 85 | 170 | 229 | 9-#5 3 | 7-#6 | 16-#5 | 7-#5 | 7-#5 | 2.68 | 2.70 | 2.71 | 20 | 250 | 19 | 11-#6 | 7-#5 | 7-#5 | 7-#5 | 2.69 | 2.69 | 2.69 |
| 20 | 300 | 25 | 0.641 | 93 | 186 | 251 | 9-#5 1 | 8-#6 | 10-#7 | 7-#5 | 7-#5 | 2.92 | 2.95 | 2.94 | 20 | 300 | 23 | 9-#7 | 7-#5 | 7-#5 | 7-#5 | 2.82 | 2.85 | 2.89 |
| 20 | 350 | 28 | 0.674 | 101 | 202 | 272 | 10-#5 3 | 8-#6 | 9-#8 | 8-#5 | 7-#5 | 3.13 | 3.18 | 3.31 | 20 | 350 | 26 | 10-#7 | 8-#5 | 7-#5 | 7-#5 | 3.05 | 3.10 | 3.16 |
| 21 | 50 | 12 | 0.853 | 53 | 106 | 143 | 10-#5 1 | 7-#5 | 10-#5 | 7-#5 | 7-#5 | 2.18 | 2.18 | 2.21 | 21 | 50 | 10 | 10-#5 | 7-#5 | 7-#5 | 7-#5 | 2.16 | 2.16 | 2.16 |
| 21 | 100 | 16 | 0.791 | 65 | 131 | 176 | 10-#5 1 | 8-#5 | 13-#5 | 7-#5 | 7-#5 | 2.30 | 2.32 | 2.32 | 21 | 100 | 11 | 12-#5 | 7-#5 | 7-#5 | 7-#5 | 2.29 | 2.30 | 2.31 |
| 21 | 150 | 19 | 0.771 | 77 | 153 | 206 | 10-#5 2 | 9-#5 | 11-#6 | 7-#5 | 7-#5 | 2.51 | 2.53 | 2.53 | 21 | 150 | 15 | 10-#6 | 7-#5 | 7-#5 | 7-#5 | 2.45 | 2.47 | 2.49 |
| 21 | 200 | 22 | 0.731 | 87 | 175 | 235 | 10-#5 2 | 7-#6 | 12-#6 | 7-#5 | 7-#5 | 2.66 | 2.67 | 2.70 | 21 | 200 | 18 | 11-#6 | 7-#5 | 7-#5 | 7-#5 | 2.55 | 2.57 | 2.59 |
| 21 | 250 | 25 | 0.711 | 97 | 194 | 262 | 10-#5 3 | 8-#6 | 10-#7 | 7-#5 | 7-#5 | 2.88 | 2.87 | 2.82 | 21 | 250 | 22 | 10-#7 | 8-#5 | 7-#5 | 7-#5 | 2.88 | 2.88 | 2.87 |
| 21 | 300 | 28 | 0.668 | 106 | 212 | 286 | 10-#5 3 | 12-#5 | 11-#7 | 8-#5 | 7-#5 | 3.03 | 3.04 | 3.16 | 21 | 300 | 26 | 10-#7 | 8-#5 | 7-#5 | 7-#5 | 2.90 | 2.93 | 2.96 |
| 21 | 350 | 31 | 0.623 | 115 | 230 | 310 | 11-#5 2 | 7-#7 | 12-#7 | 9-#5 | 7-#5 | 3.26 | 3.31 | 3.36 | 21 | 350 | 29 | 11-#7 | 9-#5 | 7-#5 | 7-#5 | 3.13 | 3.16 | 3.19 |
| 22 | 50 | 14 | 0.818 | 61 | 121 | 163 | 10-#5 1 | 8-#5 | 12-#5 | 8-#5 | 8-#5 | 2.31 | 2.31 | 2.32 | 22 | 50 | 10 | 11-#5 | 8-#5 | 8-#5 | 8-#5 | 2.30 | 2.31 | 2.33 |
| 22 | 100 | 18 | 0.774 | 74 | 149 | 200 | 10-#5 2 | 9-#5 | 10-#6 | 8-#5 | 8-#5 | 2.45 | 2.47 | 2.44 | 22 | 100 | 13 | 13-#5 | 8-#5 | 8-#5 | 8-#5 | 2.43 | 2.45 | 2.47 |
| 22 | 150 | 21 | 0.760 | 87 | 174 | 235 | 10-#5 3 | 10-#5 | 12-#6 | 8-#5 | 8-#5 | 2.60 | 2.63 | 2.63 | 22 | 150 | 17 | 11-#6 | 8-#5 | 8-#5 | 8-#5 | 2.61 | 2.63 | 2.65 |
| 22 | 200 | 25 | 0.691 | 99 | 198 | 266 | 10-#5 3 | 8-#6 | 10-#7 | 8-#5 | 8-#5 | 2.82 | 2.82 | 2.74 | 22 | 200 | 21 | 10-#7 | 8-#5 | 8-#5 | 8-#5 | 2.85 | 2.85 | 2.85 |
| 22 | 250 | 28 | 0.653 | 110 | 220 | 296 | 10-#5 3 | 9-#6 | 15-#6 | 8-#5 | 8-#5 | 3.02 | 3.02 | 3.07 | 22 | 250 | 25 | 11-#7 | 9-#5 | 8-#5 | 8-#5 | 3.08 | 3.08 | 3.08 |
| 22 | 300 | 31 | 0.613 | 120 | 241 | 324 | 11-#5 2 | 10-#6 | 10-#8 | 9-#5 | 8-#5 | 3.24 | 3.29 | 3.41 | 22 | 300 | 29 | 12-#7 | 9-#5 | 8-#5 | 8-#5 | 3.22 | 3.25 | 3.28 |
| 22 | 350 | 34 | 0.612 | 130 | 260 | 350 | 12-#5 2 | 8-#7 | 11-#8 | 10-#5 | 8-#5 | 3.55 | 3.58 | 3.62 | 22 | 350 | 33 | 10-#8 | 10-#5 | 8-#5 | 8-#5 | 3.44 | 3.48 | 3.51 |
| 23 | 50 | 16 | 0.826 | 69 | 138 | 186 | 11-#5 3 | 8-#5 | 13-#5 | 8-#5 | 8-#5 | 2.29 | 2.29 | 2.27 | 23 | 50 | 10 | 13-#5 | 8-#5 | 8-#5 | 8-#5 | 2.31 | 2.31 | 2.31 |
| 23 | 100 | 20 | 0.789 | 84 | 168 | 226 | 11-#5 4 | 10-#5 | 16-#5 | 8-#5 | 8-#5 | 2.49 | 2.49 | 2.43 | 23 | 100 | 15 | 11-#6 | 8-#5 | 8-#5 | 8-#5 | 2.49 | 2.49 | 2.49 |
| 23 | 150 | 23 | 0.729 | 99 | 197 | 266 | 11-#5 2 | 8-#6 | 11-#7 | 8-#5 | 8-#5 | 2.73 | 2.74 | 2.67 | 23 | 150 | 19 | 13-#6 | 8-#5 | 8-#5 | 8-#5 | 2.66 | 2.70 | 2.74 |
| 23 | 200 | 27 | 0.664 | 112 | 224 | 302 | 11-#5 2 | 9-#6 | 12-#7 | 9-#5 | 8-#5 | 2.94 | 2.97 | 3.07 | 23 | 200 | 23 | 20-#5 | 9-#5 | 8-#5 | 8-#5 | 2.84 | 2.89 | 2.94 |
| 23 | 250 | 31 | 0.621 | 124 | 248 | 333 | 12-#5 2 | 10-#6 | 13-#7 | 9-#5 | 8-#5 | 3.13 | 3.18 | 3.28 | 23 | 250 | 28 | 12-#7 | 10-#5 | 8-#5 | 8-#5 | 3.14 | 3.16 | 3.19 |
| 23 | 300 | 34 | 0.658 | 136 | 271 | 365 | 13-#5 4 | 8-#7 | 11-#8 | 10-#5 | 9-#5 | 3.44 | 3.48 | 3.58 | 23 | 300 | 32 | 13-#7 | 10-#5 | 8-#5 | 8-#5 | 3.27 | 3.32 | 3.37 |
| 23 | 350 | 39 | 0.618 | 143 | 286 | 385 | 14-#5 3 | 16-#5 | 12-#8 | 8-#6 | 9-#5 | 3.70 | 3.72 | 3.78 | 23 | 350 | 40 | 11-#8 | 8-#6 | 9-#5 | 8-#5 | 3.63 | 3.67 | 3.71 |

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

| SQUARE EDGE PANEL | | | | | | | | | | | | | | | SQUARE INTERIOR PANEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) | (3) | (1) | Reinforcing Bars | | | | Steel (psf) | | |
| | | | | | | | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | –M Ext. | +M Int. | –M 1st int. | | | | | | Location of Panel | | | | | | | | | | | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | E | EC | C | Span c.-c. (ft) | Load (psf) | Min. Sq. Col. (in.) | Top | Bottom | Top | Bottom | I | IE | IC |
| 9.5 in. = TOTAL THICKNESS OF SLAB | | | 0.792 c.f./s.f. | | | | | | | | | | | | 9.5 in. = TOTAL THICKNESS OF SLAB | | | | | | 0.792 c.f./s.f. | | |
| 24 | 50 | 17 | 0.819 | 78 | 156 | 210 | 11-#5 3 | 9-#5 | 11-#6 | 8-#5 | 8-#5 | 2.29 | 2.31 | 2.28 | 24 | 50 | 12 | 14-#5 | 8-#5 | 8-#5 | 8-#5 | 2.27 | 2.30 | 2.32 |
| 24 | 100 | 22 | 0.759 | 95 | 189 | 255 | 11-#5 4 | 8-#6 | 13-#6 | 8-#5 | 8-#5 | 2.52 | 2.55 | 2.56 | 24 | 100 | 17 | 12-#6 | 8-#5 | 8-#5 | 8-#5 | 2.47 | 2.48 | 2.50 |
| 24 | 150 | 26 | 0.664 | 111 | 222 | 298 | 11-#5 2 | 9-#6 | 15-#6 | 8-#5 | 8-#5 | 2.75 | 2.76 | 2.87 | 24 | 150 | 21 | 20-#5 | 9-#5 | 8-#5 | 8-#5 | 2.71 | 2.73 | 2.75 |
| 24 | 200 | 30 | 0.672 | 125 | 251 | 338 | 12-#5 4 | 10-#6 | 13-#7 | 10-#5 | 8-#5 | 3.03 | 3.08 | 3.18 | 24 | 200 | 26 | 12-#7 | 10-#5 | 8-#5 | 8-#5 | 2.99 | 3.02 | 3.04 |
| 24 | 250 | 34 | 0.615 | 139 | 278 | 374 | 13-#5 3 | 11-#6 | 11-#8 | 8-#6 | 9-#5 | 3.43 | 3.45 | 3.53 | 24 | 250 | 31 | 11-#8 | 8-#6 | 8-#5 | 8-#5 | 3.39 | 3.40 | 3.41 |
| 24 | 300 | 39 | 0.611 | 149 | 298 | 402 | 14-#5 3 | 9-#7 | 12-#8 | 8-#6 | 10-#5 | 3.70 | 3.76 | 3.95 | 24 | 300 | 38 | 11-#8 | 8-#6 | 9-#5 | 8-#5 | 3.46 | 3.51 | 3.56 |
| 24 | 350 | 45 | 0.609 | 156 | 312 | 421 | 15-#5 2 | 8-#8 | 13-#8 | 12-#5 | 10-#5 | 4.01 | 4.07 | 4.31 | 24 | 350 | 47 | 12-#8 | 12-#5 | 9-#5 | 8-#5 | 3.69 | 3.74 | 3.79 |
| 25 | 50 | 19 | 0.800 | 88 | 175 | 236 | 12-#5 3 | 10-#5 | 12-#6 | 9-#5 | 9-#5 | 2.48 | 2.50 | 2.45 | 25 | 50 | 13 | 16-#5 | 9-#5 | 9-#5 | 9-#5 | 2.49 | 2.51 | 2.52 |
| 25 | 100 | 24 | 0.745 | 106 | 212 | 286 | 12-#5 4 | 12-#5 | 20-#5 | 9-#5 | 9-#5 | 2.70 | 2.72 | 2.78 | 25 | 100 | 19 | 14-#6 | 9-#5 | 9-#5 | 9-#5 | 2.73 | 2.72 | 2.72 |
| 25 | 150 | 28 | 0.717 | 124 | 248 | 334 | 12-#5 5 | 10-#6 | 13-#7 | 9-#5 | 9-#5 | 2.97 | 3.01 | 3.04 | 25 | 150 | 24 | 12-#7 | 10-#5 | 9-#5 | 9-#5 | 2.99 | 3.01 | 3.03 |
| 25 | 200 | 33 | 0.638 | 140 | 280 | 376 | 13-#5 4 | 11-#6 | 19-#6 | 11-#5 | 9-#5 | 3.31 | 3.33 | 3.35 | 25 | 200 | 29 | 14-#7 | 11-#5 | 9-#5 | 9-#5 | 3.30 | 3.29 | 3.29 |
| 25 | 250 | 38 | 0.611 | 153 | 306 | 412 | 14-#5 3 | 9-#7 | 13-#8 | 12-#5 | 10-#5 | 3.66 | 3.72 | 3.85 | 25 | 250 | 36 | 12-#8 | 12-#5 | 9-#5 | 9-#5 | 3.57 | 3.61 | 3.66 |
| 25 | 300 | 44 | 0.610 | 163 | 326 | 439 | 15-#5 3 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 3.84 | 3.89 | 4.12 | 25 | 300 | 45 | 12-#8 | 12-#5 | 10-#5 | 9-#5 | 3.65 | 3.69 | 3.73 |
| 25 | 350 | 51 | 0.608 | 170 | 340 | 458 | 16-#5 2 | 14-#6 | 14-#8 | 9-#6 | 11-#5 | 4.13 | 4.17 | 4.32 | 25 | 350 | 54 | 13-#8 | 9-#6 | 10-#5 | 9-#5 | 3.93 | 3.97 | 4.02 |
| 26 | 50 | 21 | 0.782 | 98 | 195 | 263 | 12-#5 4 | 11-#5 | 13-#6 | 9-#5 | 9-#5 | 2.50 | 2.51 | 2.51 | 26 | 50 | 15 | 13-#6 | 9-#5 | 9-#5 | 9-#5 | 2.53 | 2.53 | 2.53 |
| 26 | 100 | 26 | 0.716 | 118 | 237 | 319 | 12-#5 4 | 13-#5 | 12-#7 | 9-#5 | 9-#5 | 2.76 | 2.78 | 2.75 | 26 | 100 | 21 | 15-#6 | 9-#5 | 9-#5 | 9-#5 | 2.70 | 2.72 | 2.74 |
| 26 | 150 | 31 | 0.662 | 138 | 276 | 371 | 13-#5 4 | 11-#6 | 14-#7 | 10-#5 | 9-#5 | 3.12 | 3.13 | 3.15 | 26 | 150 | 26 | 14-#7 | 11-#5 | 9-#5 | 9-#5 | 3.15 | 3.15 | 3.15 |
| 26 | 200 | 35 | 0.643 | 156 | 312 | 420 | 15-#5 3 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 3.59 | 3.65 | 3.78 | 26 | 200 | 32 | 12-#8 | 12-#5 | 9-#5 | 9-#5 | 3.41 | 3.45 | 3.49 |
| 26 | 250 | 43 | 0.610 | 167 | 335 | 450 | 16-#5 2 | 10-#7 | 14-#8 | 9-#6 | 11-#5 | 3.83 | 3.89 | 4.06 | 26 | 250 | 42 | 13-#8 | 9-#6 | 10-#5 | 9-#5 | 3.71 | 3.75 | 3.79 |
| 26 | 300 | 50 | 0.609 | 177 | 354 | 476 | 12-#6 2 | 20-#5 | 15-#8 | 13-#5 | 11-#5 | 4.04 | 4.08 | 4.21 | 26 | 300 | 52 | 13-#8 | 13-#5 | 10-#5 | 9-#5 | 3.75 | 3.83 | 3.91 |
| 26 | 350 | 57 | 0.608 | 184 | 369 | 496 | 17-#5 2 | 9-#8 | 15-#8 | 10-#6 | 12-#5 | 4.32 | 4.38 | 4.64 | 26 | 350 | 62 | 14-#8 | 10-#6 | 11-#5 | 9-#5 | 4.07 | 4.12 | 4.17 |
| 27 | 50 | 23 | 0.749 | 108 | 217 | 292 | 12-#5 4 | 12-#5 | 15-#6 | 9-#5 | 9-#5 | 2.54 | 2.57 | 2.58 | 27 | 50 | 17 | 14-#6 | 9-#5 | 9-#5 | 9-#5 | 2.51 | 2.53 | 2.55 |
| 27 | 100 | 28 | 0.703 | 132 | 263 | 354 | 12-#5 5 | 11-#6 | 14-#7 | 10-#5 | 9-#5 | 2.93 | 2.96 | 3.03 | 27 | 100 | 23 | 13-#7 | 10-#5 | 9-#5 | 9-#5 | 2.85 | 2.87 | 2.89 |
| 27 | 150 | 33 | 0.656 | 153 | 306 | 412 | 14-#5 4 | 9-#7 | 12-#8 | 12-#5 | 10-#5 | 3.35 | 3.36 | 3.51 | 27 | 150 | 29 | 12-#8 | 12-#5 | 9-#5 | 9-#5 | 3.26 | 3.27 | 3.28 |
| 27 | 200 | 40 | 0.643 | 170 | 340 | 458 | 16-#5 5 | 14-#6 | 14-#8 | 9-#6 | 11-#5 | 3.70 | 3.75 | 3.94 | 27 | 200 | 37 | 13-#8 | 13-#5 | 10-#5 | 9-#5 | 3.54 | 3.58 | 3.62 |
| 27 | 250 | 48 | 0.609 | 182 | 364 | 491 | 12-#6 2 | 11-#7 | 15-#8 | 10-#6 | 12-#5 | 4.06 | 4.08 | 4.17 | 27 | 250 | 48 | 14-#8 | 10-#6 | 11-#5 | 9-#5 | 3.84 | 3.89 | 3.93 |
| 27 | 300 | 56 | 0.608 | 192 | 383 | 516 | 13-#6 1 | 9-#8 | 16-#8 | 10-#6 | 12-#5 | 4.31 | 4.35 | 4.51 | 27 | 300 | 59 | 14-#8 | 10-#6 | 11-#5 | 10-#5 | 3.95 | 4.03 | 4.11 |
| 27 | 350 | 64 | 0.607 | 198 | 396 | 534 | 19-#5 1 | 12-#7 | 16-#8 | 11-#6 | 9-#6 | 4.47 | 4.53 | 4.73 | 27 | 350 | 70 | 15-#8 | 11-#6 | 11-#5 | 10-#5 | 4.25 | 4.31 | 4.37 |
| 28 | 50 | 25 | 0.732 | 120 | 240 | 323 | 13-#5 4 | 10-#6 | 13-#7 | 10-#5 | 10-#5 | 2.73 | 2.75 | 2.70 | 28 | 50 | 19 | 16-#6 | 10-#5 | 10-#5 | 10-#5 | 2.71 | 2.73 | 2.76 |
| 28 | 100 | 31 | 0.695 | 145 | 291 | 391 | 14-#5 6 | 16-#5 | 15-#7 | 11-#5 | 10-#5 | 3.02 | 3.04 | 3.10 | 28 | 100 | 25 | 14-#7 | 11-#5 | 10-#5 | 10-#5 | 3.00 | 3.03 | 3.05 |
| 28 | 150 | 36 | 0.669 | 169 | 337 | 454 | 16-#5 5 | 10-#7 | 14-#8 | 13-#5 | 11-#5 | 3.55 | 3.60 | 3.79 | 28 | 150 | 32 | 13-#8 | 13-#5 | 10-#5 | 10-#5 | 3.44 | 3.48 | 3.51 |
| 28 | 200 | 45 | 0.609 | 185 | 369 | 497 | 17-#5 4 | 11-#7 | 15-#8 | 10-#6 | 12-#5 | 3.91 | 3.93 | 4.03 | 28 | 200 | 43 | 14-#8 | 10-#6 | 11-#5 | 10-#5 | 3.73 | 3.77 | 3.81 |
| 28 | 250 | 54 | 0.608 | 197 | 393 | 529 | 13-#6 1 | 12-#7 | 16-#8 | 11-#6 | 12-#5 | 4.28 | 4.31 | 4.45 | 28 | 250 | 55 | 15-#8 | 11-#6 | 12-#5 | 10-#5 | 4.05 | 4.09 | 4.12 |
| 28 | 300 | 62 | 0.607 | 206 | 412 | 555 | 19-#5 1 | 10-#8 | 17-#8 | 11-#6 | 13-#5 | 4.51 | 4.57 | 4.72 | 28 | 300 | 67 | 15-#8 | 11-#6 | 12-#5 | 10-#5 | 4.11 | 4.19 | 4.27 |
| 28 | 350 | 70 | 0.606 | 214 | 427 | 575 | 20-#5 1 | 10-#8 | 18-#8 | 16-#5 | 10-#6 | 4.68 | 4.76 | 4.93 | 28 | 350 | 78 | 16-#8 | 11-#6 | 12-#5 | 11-#5 | 4.37 | 4.47 | 4.56 |
| 29 | 50 | 27 | 0.699 | 133 | 265 | 357 | 13-#5 4 | 11-#6 | 14-#7 | 10-#5 | 10-#5 | 2.77 | 2.79 | 2.84 | 29 | 50 | 20 | 13-#7 | 10-#5 | 10-#5 | 10-#5 | 2.72 | 2.74 | 2.76 |
| 29 | 100 | 33 | 0.684 | 161 | 321 | 432 | 15-#5 6 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 3.26 | 3.29 | 3.40 | 29 | 100 | 27 | 13-#8 | 12-#5 | 10-#5 | 10-#5 | 3.22 | 3.22 | 3.22 |
| 29 | 150 | 41 | 0.616 | 183 | 367 | 494 | 17-#5 4 | 11-#7 | 15-#8 | 10-#6 | 12-#5 | 3.74 | 3.77 | 3.90 | 29 | 150 | 36 | 14-#8 | 10-#6 | 11-#5 | 10-#5 | 3.56 | 3.60 | 3.64 |
| 29 | 200 | 50 | 0.609 | 200 | 399 | 538 | 19-#5 3 | 12-#7 | 16-#8 | 11-#6 | 13-#5 | 4.13 | 4.15 | 4.29 | 29 | 200 | 49 | 15-#8 | 11-#6 | 12-#5 | 10-#5 | 3.88 | 3.92 | 3.96 |
| 29 | 250 | 59 | 0.607 | 212 | 425 | 572 | 14-#6 1 | 10-#8 | 17-#8 | 16-#5 | 13-#5 | 4.41 | 4.46 | 4.59 | 29 | 250 | 62 | 16-#8 | 16-#5 | 12-#5 | 11-#5 | 4.13 | 4.17 | 4.22 |
| 29 | 300 | 68 | 0.606 | 222 | 444 | 598 | 15-#6 0 | 11-#8 | 18-#8 | 12-#6 | 10-#6 | 4.72 | 4.78 | 4.93 | 29 | 300 | 74 | 17-#8 | 12-#6 | 13-#5 | 11-#5 | 4.43 | 4.48 | 4.53 |
| 29 | 350 | 77 | 0.606 | 229 | 458 | 616 | 16-#6 0 | 11-#8 | 19-#8 | 12-#6 | 14-#5 | 4.91 | 4.98 | 5.28 | 29 | 350 | 86 | 17-#8 | 12-#6 | 13-#5 | 11-#5 | 4.50 | 4.58 | 4.65 |

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

$f'_c$ = 4,000 psi
Grade 60 Bars

| SQUARE EDGE PANEL | | | | | | | | | | | | | | | SQUARE INTERIOR PANEL | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) Span c.-c. | (3) Load | (1) Min. Sq. Col. | Reinforcing Bars | | | | Steel (psf) | | |
| | | | | −M Ext. | +M Int. | −M 1st int. | Each Column Strip | | | Each Middle Strip | | Steel (psf) Location of Panel | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | | | | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | E | EC | C | | | | Top | Bottom | Top | Bottom | I | IE | IC |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | | | | (ft) | (psf) | (in.) | | | | | | | |
| 10 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.833 c.f./s.f. | 10 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.833 c.f./s.f. |
| 20 | 50 | 10 | 0.860 | 48 | 96 | 129 | 9-#5 1 | 7-#5 | 9-#5 | 7-#5 | 7-#5 | 2.22 | 2.22 | 2.23 | 20 | 50 | 10 | 9-#5 | 7-#5 | 7-#5 | 7-#5 | 2.21 | 2.21 | 2.21 |
| 20 | 100 | 13 | 0.836 | 59 | 118 | 159 | 9-#5 2 | 7-#5 | 11-#5 | 7-#5 | 7-#5 | 2.26 | 2.28 | 2.28 | 20 | 100 | 10 | 10-#5 | 7-#5 | 7-#5 | 7-#5 | 2.27 | 2.28 | 2.30 |
| 20 | 150 | 16 | 0.794 | 68 | 137 | 184 | 9-#5 2 | 7-#5 | 12-#5 | 7-#5 | 7-#5 | 2.34 | 2.36 | 2.36 | 20 | 150 | 15 | 12-#5 | 7-#5 | 7-#5 | 7-#5 | 2.42 | 2.42 | 2.42 |
| 20 | 200 | 18 | 0.797 | 78 | 156 | 210 | 9-#5 3 | 8-#5 | 10-#6 | 7-#5 | 7-#5 | 2.53 | 2.55 | 2.57 | 20 | 200 | 18 | 9-#6 | 7-#5 | 7-#5 | 7-#5 | 2.49 | 2.52 | 2.54 |
| 20 | 250 | 21 | 0.752 | 87 | 175 | 235 | 9-#5 3 | 9-#5 | 11-#6 | 7-#5 | 7-#5 | 2.68 | 2.69 | 2.65 | 20 | 250 | 19 | 11-#6 | 7-#5 | 7-#5 | 7-#5 | 2.69 | 2.68 | 2.68 |
| 20 | 300 | 24 | 0.643 | 96 | 192 | 259 | 9-#5 1 | 10-#5 | 9-#7 | 7-#5 | 7-#5 | 2.79 | 2.82 | 2.82 | 20 | 300 | 21 | 16-#5 | 7-#5 | 7-#5 | 7-#5 | 2.70 | 2.73 | 2.76 |
| 20 | 350 | 26 | 0.623 | 104 | 209 | 281 | 9-#5 1 | 8-#6 | 10-#7 | 8-#5 | 7-#5 | 3.05 | 3.07 | 3.03 | 20 | 350 | 24 | 10-#7 | 8-#5 | 7-#5 | 7-#5 | 3.04 | 3.04 | 3.04 |
| 21 | 50 | 11 | 0.864 | 55 | 111 | 149 | 10-#5 1 | 8-#5 | 10-#5 | 8-#5 | 8-#5 | 2.33 | 2.33 | 2.31 | 21 | 50 | 10 | 10-#5 | 8-#5 | 8-#5 | 8-#5 | 2.35 | 2.35 | 2.35 |
| 21 | 100 | 15 | 0.802 | 68 | 136 | 183 | 10-#5 1 | 8-#5 | 12-#5 | 8-#5 | 8-#5 | 2.43 | 2.45 | 2.45 | 21 | 100 | 10 | 12-#5 | 8-#5 | 8-#5 | 8-#5 | 2.47 | 2.47 | 2.47 |
| 21 | 150 | 18 | 0.780 | 79 | 158 | 212 | 10-#5 2 | 9-#5 | 10-#6 | 8-#5 | 8-#5 | 2.57 | 2.59 | 2.56 | 21 | 150 | 15 | 13-#5 | 8-#5 | 8-#5 | 8-#5 | 2.55 | 2.57 | 2.59 |
| 21 | 200 | 21 | 0.738 | 90 | 179 | 241 | 10-#5 2 | 7-#6 | 16-#5 | 8-#5 | 8-#5 | 2.72 | 2.73 | 2.65 | 21 | 200 | 18 | 11-#6 | 8-#5 | 8-#5 | 8-#5 | 2.74 | 2.74 | 2.74 |
| 21 | 250 | 24 | 0.714 | 100 | 201 | 270 | 10-#5 3 | 8-#6 | 10-#7 | 8-#5 | 8-#5 | 2.89 | 2.92 | 2.87 | 21 | 250 | 20 | 12-#6 | 8-#5 | 8-#5 | 8-#5 | 2.84 | 2.88 | 2.91 |
| 21 | 300 | 26 | 0.704 | 110 | 220 | 296 | 10-#5 3 | 12-#5 | 11-#7 | 8-#5 | 8-#5 | 3.01 | 3.05 | 3.18 | 21 | 300 | 24 | 10-#7 | 8-#5 | 8-#5 | 8-#5 | 3.00 | 3.04 | 3.07 |
| 21 | 350 | 29 | 0.656 | 119 | 238 | 320 | 11-#5 2 | 7-#7 | 12-#7 | 9-#5 | 8-#5 | 3.28 | 3.31 | 3.35 | 21 | 350 | 27 | 20-#5 | 9-#5 | 8-#5 | 8-#5 | 3.14 | 3.20 | 3.25 |
| 22 | 50 | 13 | 0.830 | 63 | 127 | 170 | 10-#5 1 | 8-#5 | 11-#5 | 8-#5 | 8-#5 | 2.29 | 2.29 | 2.31 | 22 | 50 | 10 | 11-#5 | 8-#5 | 8-#5 | 8-#5 | 2.30 | 2.30 | 2.30 |
| 22 | 100 | 17 | 0.785 | 77 | 155 | 208 | 10-#5 2 | 8-#5 | 10-#6 | 8-#5 | 8-#5 | 2.40 | 2.41 | 2.37 | 22 | 100 | 12 | 13-#5 | 8-#5 | 8-#5 | 8-#5 | 2.42 | 2.44 | 2.46 |
| 22 | 150 | 20 | 0.747 | 91 | 181 | 244 | 10-#5 2 | 10-#5 | 16-#5 | 8-#5 | 8-#5 | 2.58 | 2.59 | 2.52 | 22 | 150 | 15 | 11-#6 | 8-#5 | 8-#5 | 8-#5 | 2.60 | 2.60 | 2.60 |
| 22 | 200 | 23 | 0.730 | 103 | 205 | 276 | 10-#5 3 | 8-#6 | 10-#7 | 8-#5 | 8-#5 | 2.75 | 2.78 | 2.75 | 22 | 200 | 19 | 17-#5 | 8-#5 | 8-#5 | 8-#5 | 2.69 | 2.72 | 2.76 |
| 22 | 250 | 26 | 0.691 | 114 | 228 | 307 | 10-#5 3 | 12-#5 | 11-#7 | 8-#5 | 8-#5 | 2.95 | 2.95 | 3.03 | 22 | 250 | 23 | 11-#7 | 8-#5 | 8-#5 | 8-#5 | 2.98 | 2.98 | 2.97 |
| 22 | 300 | 29 | 0.673 | 124 | 249 | 335 | 11-#5 3 | 13-#5 | 12-#7 | 9-#5 | 8-#5 | 3.12 | 3.16 | 3.27 | 22 | 300 | 27 | 11-#7 | 9-#5 | 8-#5 | 8-#5 | 3.09 | 3.12 | 3.15 |
| 22 | 350 | 32 | 0.632 | 134 | 268 | 361 | 12-#5 2 | 10-#6 | 10-#8 | 10-#5 | 8-#5 | 3.41 | 3.44 | 3.54 | 22 | 350 | 31 | 12-#7 | 10-#5 | 8-#5 | 8-#5 | 3.30 | 3.33 | 3.36 |
| 23 | 50 | 15 | 0.836 | 72 | 144 | 194 | 11-#5 3 | 9-#5 | 13-#5 | 9-#5 | 9-#5 | 2.47 | 2.49 | 2.48 | 23 | 50 | 10 | 12-#5 | 9-#5 | 9-#5 | 9-#5 | 2.48 | 2.49 | 2.50 |
| 23 | 100 | 19 | 0.798 | 88 | 175 | 236 | 11-#5 4 | 9-#5 | 11-#6 | 9-#5 | 9-#5 | 2.62 | 2.62 | 2.53 | 23 | 100 | 13 | 11-#6 | 9-#5 | 9-#5 | 9-#5 | 2.70 | 2.70 | 2.70 |
| 23 | 150 | 22 | 0.737 | 102 | 204 | 275 | 11-#5 2 | 8-#6 | 13-#6 | 9-#5 | 9-#5 | 2.81 | 2.83 | 2.80 | 23 | 150 | 18 | 17-#5 | 9-#5 | 9-#5 | 9-#5 | 2.79 | 2.81 | 2.83 |
| 23 | 200 | 26 | 0.668 | 115 | 231 | 311 | 11-#5 2 | 12-#5 | 11-#7 | 9-#5 | 9-#5 | 3.00 | 3.00 | 3.02 | 23 | 200 | 22 | 11-#7 | 9-#5 | 9-#5 | 9-#5 | 3.06 | 3.06 | 3.06 |
| 23 | 250 | 29 | 0.656 | 128 | 256 | 345 | 11-#5 3 | 10-#6 | 13-#7 | 9-#5 | 9-#5 | 3.20 | 3.23 | 3.26 | 23 | 250 | 26 | 12-#7 | 9-#5 | 9-#5 | 9-#5 | 3.20 | 3.22 | 3.25 |
| 23 | 300 | 32 | 0.620 | 140 | 280 | 378 | 12-#5 2 | 8-#7 | 11-#8 | 10-#5 | 8-#5 | 3.47 | 3.49 | 3.47 | 23 | 300 | 30 | 13-#7 | 10-#5 | 9-#5 | 9-#5 | 3.40 | 3.42 | 3.45 |
| 23 | 350 | 36 | 0.612 | 151 | 301 | 406 | 13-#5 2 | 16-#5 | 12-#8 | 8-#6 | 9-#5 | 3.70 | 3.73 | 3.76 | 23 | 350 | 34 | 11-#8 | 8-#6 | 9-#5 | 9-#5 | 3.69 | 3.73 | 3.77 |
| 24 | 50 | 17 | 0.804 | 81 | 163 | 219 | 11-#5 3 | 9-#5 | 11-#6 | 9-#5 | 9-#5 | 2.46 | 2.48 | 2.43 | 24 | 50 | 11 | 14-#5 | 9-#5 | 9-#5 | 9-#5 | 2.48 | 2.51 | 2.53 |
| 24 | 100 | 21 | 0.769 | 99 | 197 | 266 | 11-#5 4 | 8-#6 | 13-#6 | 9-#5 | 9-#5 | 2.69 | 2.71 | 2.71 | 24 | 100 | 15 | 12-#6 | 9-#5 | 9-#5 | 9-#5 | 2.67 | 2.69 | 2.71 |
| 24 | 150 | 24 | 0.727 | 115 | 230 | 310 | 11-#5 3 | 12-#5 | 11-#7 | 9-#5 | 9-#5 | 2.84 | 2.85 | 2.90 | 24 | 150 | 20 | 11-#7 | 9-#5 | 9-#5 | 9-#5 | 2.92 | 2.92 | 2.92 |
| 24 | 200 | 28 | 0.723 | 130 | 260 | 350 | 12-#5 5 | 10-#6 | 13-#7 | 9-#5 | 9-#5 | 3.10 | 3.13 | 3.16 | 24 | 200 | 24 | 12-#7 | 10-#5 | 9-#5 | 9-#5 | 3.11 | 3.14 | 3.16 |
| 24 | 250 | 32 | 0.667 | 144 | 287 | 387 | 13-#5 4 | 8-#7 | 11-#8 | 10-#5 | 9-#5 | 3.35 | 3.37 | 3.40 | 24 | 250 | 29 | 13-#7 | 10-#5 | 9-#5 | 9-#5 | 3.24 | 3.28 | 3.32 |
| 24 | 300 | 35 | 0.641 | 157 | 315 | 423 | 14-#5 3 | 9-#7 | 12-#8 | 8-#6 | 9-#5 | 3.71 | 3.74 | 3.78 | 24 | 300 | 33 | 11-#8 | 8-#6 | 9-#5 | 9-#5 | 3.53 | 3.56 | 3.60 |
| 24 | 350 | 40 | 0.611 | 167 | 333 | 448 | 15-#5 2 | 8-#8 | 13-#8 | 12-#5 | 10-#5 | 3.97 | 4.02 | 4.13 | 24 | 350 | 40 | 12-#8 | 12-#5 | 9-#5 | 9-#5 | 3.74 | 3.79 | 3.84 |
| 25 | 50 | 18 | 0.810 | 92 | 183 | 247 | 12-#5 3 | 10-#5 | 16-#5 | 9-#5 | 9-#5 | 2.46 | 2.47 | 2.44 | 25 | 50 | 12 | 16-#5 | 9-#5 | 9-#5 | 9-#5 | 2.49 | 2.49 | 2.49 |
| 25 | 100 | 23 | 0.753 | 111 | 221 | 298 | 12-#5 4 | 12-#5 | 14-#6 | 9-#5 | 9-#5 | 2.73 | 2.75 | 2.69 | 25 | 100 | 17 | 14-#6 | 9-#5 | 9-#5 | 9-#5 | 2.72 | 2.72 | 2.72 |
| 25 | 150 | 27 | 0.704 | 128 | 257 | 346 | 12-#5 4 | 10-#6 | 13-#7 | 9-#5 | 9-#5 | 2.97 | 3.01 | 3.04 | 25 | 150 | 22 | 12-#7 | 9-#5 | 9-#5 | 9-#5 | 2.91 | 2.94 | 2.96 |
| 25 | 200 | 31 | 0.671 | 145 | 290 | 390 | 13-#5 4 | 11-#6 | 14-#7 | 10-#5 | 9-#5 | 3.23 | 3.25 | 3.29 | 25 | 200 | 27 | 13-#7 | 11-#5 | 9-#5 | 9-#5 | 3.18 | 3.21 | 3.23 |
| 25 | 250 | 35 | 0.617 | 160 | 321 | 432 | 14-#5 3 | 9-#7 | 12-#8 | 11-#5 | 10-#5 | 3.58 | 3.60 | 3.75 | 25 | 250 | 32 | 12-#8 | 12-#5 | 9-#5 | 9-#5 | 3.55 | 3.56 | 3.57 |
| 25 | 300 | 39 | 0.611 | 173 | 346 | 466 | 15-#5 3 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 3.84 | 3.89 | 4.14 | 25 | 300 | 39 | 12-#8 | 12-#5 | 10-#5 | 9-#5 | 3.62 | 3.66 | 3.69 |
| 25 | 350 | 46 | 0.610 | 181 | 361 | 486 | 16-#5 2 | 10-#7 | 14-#8 | 9-#6 | 11-#5 | 4.10 | 4.13 | 4.28 | 25 | 350 | 48 | 13-#8 | 9-#6 | 10-#5 | 9-#5 | 3.89 | 3.94 | 3.99 |

(Continued on next Page)

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# FLAT PLATE SYSTEM
## (WITHOUT SHEARHEADS)

## SQUARE EDGE PANEL

## SQUARE INTERIOR PANEL

$f'_c$ = 4,000 psi
Grade 60 Bars

| SPAN c.-c. Cols. $\ell_1 = \ell_2$ | Factored Superim-posed Load | (1) Min. Square Column | | Total Panel Moments | | | Reinforcing Bars | | | | | End Panel | | | (2) | (3) | (1) | Reinforcing Bars | | | | Steel (psf) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | –M Ext. | +M Int. | –M 1st int. | Each Column Strip | | | Each Middle Strip | | Steel (psf) | | | | | | Column Strip | | Middle Strip | | Location of Panel | | |
| | | | | | | | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | Location of Panel | | | | | | | | | | | | |
| (ft) | (psf) | (in.) | $\gamma_f$ | (ft-kip) | (ft-kip) | (ft-kip) | | | | | | E | EC | C | Span c.-c. (ft) | Load (psf) | Min. Sq. Col. (in.) | Top | Bottom | Top | Bottom | I | IE | IC |
| 10 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | | | | | | 0.833 c.f./s.f. | 10 in. = TOTAL THICKNESS OF SLAB | | | | | | | | | 0.833 c.f./s.f. |
| 26 | 50 | 20 | 0.791 | 102 | 204 | 275 | 12-#5 4 | 11-#5 | 13-#6 | 10-#5 | 10-#5 | 2.59 | 2.61 | 2.55 | 26 | 50 | 14 | 17-#5 | 10-#5 | 10-#5 | 10-#5 | 2.60 | 2.62 | 2.64 |
| 26 | 100 | 25 | 0.723 | 123 | 247 | 332 | 12-#5 4 | 13-#5 | 12-#7 | 10-#5 | 10-#5 | 2.84 | 2.85 | 2.79 | 26 | 100 | 19 | 15-#6 | 10-#5 | 10-#5 | 10-#5 | 2.85 | 2.87 | 2.89 |
| 26 | 150 | 29 | 0.696 | 143 | 286 | 385 | 13-#5 4 | 11-#6 | 14-#7 | 10-#5 | 10-#5 | 3.11 | 3.13 | 3.13 | 26 | 150 | 25 | 13-#7 | 10-#5 | 10-#5 | 10-#5 | 3.06 | 3.09 | 3.11 |
| 26 | 200 | 34 | 0.617 | 161 | 322 | 434 | 14-#5 3 | 9-#7 | 12-#8 | 11-#5 | 10-#5 | 3.46 | 3.48 | 3.61 | 26 | 200 | 30 | 12-#8 | 12-#5 | 10-#5 | 10-#5 | 3.49 | 3.49 | 3.49 |
| 26 | 250 | 38 | 0.658 | 178 | 355 | 478 | 16-#5 5 | 10-#7 | 17-#7 | 9-#6 | 11-#5 | 3.81 | 3.84 | 4.05 | 26 | 250 | 36 | 13-#8 | 9-#6 | 10-#5 | 10-#5 | 3.73 | 3.74 | 3.75 |
| 26 | 300 | 45 | 0.610 | 188 | 376 | 507 | 12-#6 2 | 14-#6 | 14-#8 | 13-#5 | 11-#5 | 3.99 | 4.02 | 4.20 | 26 | 300 | 45 | 13-#8 | 13-#5 | 10-#5 | 10-#5 | 3.78 | 3.82 | 3.86 |
| 26 | 350 | 52 | 0.609 | 196 | 392 | 528 | 17-#5 2 | 9-#8 | 15-#8 | 10-#6 | 12-#5 | 4.32 | 4.37 | 4.43 | 26 | 350 | 55 | 14-#8 | 10-#6 | 11-#5 | 10-#5 | 4.09 | 4.14 | 4.19 |
| 27 | 50 | 22 | 0.760 | 113 | 227 | 305 | 12-#5 4 | 12-#5 | 20-#5 | 10-#5 | 10-#5 | 2.60 | 2.62 | 2.61 | 27 | 50 | 16 | 14-#6 | 10-#5 | 10-#5 | 10-#5 | 2.66 | 2.66 | 2.65 |
| 27 | 100 | 27 | 0.710 | 137 | 274 | 369 | 12-#5 5 | 11-#6 | 13-#7 | 10-#5 | 10-#5 | 2.92 | 2.93 | 2.91 | 27 | 100 | 21 | 13-#7 | 10-#5 | 10-#5 | 10-#5 | 2.93 | 2.93 | 2.93 |
| 27 | 150 | 32 | 0.639 | 159 | 317 | 427 | 14-#5 3 | 9-#7 | 12-#8 | 11-#5 | 10-#5 | 3.26 | 3.28 | 3.29 | 27 | 150 | 27 | 19-#6 | 12-#5 | 10-#5 | 10-#5 | 3.18 | 3.22 | 3.26 |
| 27 | 200 | 36 | 0.671 | 179 | 358 | 481 | 16-#5 5 | 10-#7 | 14-#8 | 9-#6 | 11-#5 | 3.69 | 3.74 | 3.93 | 27 | 200 | 33 | 13-#8 | 9-#6 | 10-#5 | 10-#5 | 3.58 | 3.62 | 3.66 |
| 27 | 250 | 43 | 0.610 | 193 | 386 | 520 | 12-#6 2 | 11-#7 | 15-#8 | 10-#6 | 12-#5 | 4.04 | 4.10 | 4.26 | 27 | 250 | 42 | 14-#8 | 10-#6 | 11-#5 | 10-#5 | 3.87 | 3.91 | 3.95 |
| 27 | 300 | 51 | 0.609 | 204 | 407 | 548 | 13-#6 1 | 9-#8 | 16-#8 | 10-#6 | 12-#5 | 4.24 | 4.31 | 4.55 | 27 | 300 | 52 | 14-#8 | 11-#6 | 11-#5 | 10-#5 | 4.03 | 4.10 | 4.18 |
| 27 | 350 | 58 | 0.608 | 212 | 423 | 570 | 19-#5 1 | 12-#7 | 16-#8 | 11-#6 | 9-#6 | 4.47 | 4.52 | 4.72 | 27 | 350 | 63 | 15-#8 | 11-#6 | 12-#5 | 10-#5 | 4.26 | 4.30 | 4.35 |
| 28 | 50 | 24 | 0.743 | 126 | 252 | 339 | 13-#5 4 | 13-#5 | 16-#6 | 10-#5 | 10-#5 | 2.64 | 2.65 | 2.63 | 28 | 50 | 17 | 15-#6 | 10-#5 | 10-#5 | 10-#5 | 2.63 | 2.65 | 2.66 |
| 28 | 100 | 29 | 0.698 | 151 | 303 | 407 | 13-#5 5 | 16-#5 | 15-#7 | 11-#5 | 10-#5 | 3.01 | 3.03 | 3.07 | 28 | 100 | 24 | 14-#7 | 11-#5 | 10-#5 | 10-#5 | 3.00 | 3.02 | 3.04 |
| 28 | 150 | 34 | 0.686 | 175 | 350 | 472 | 15-#5 6 | 10-#7 | 13-#8 | 12-#5 | 10-#5 | 3.42 | 3.44 | 3.54 | 28 | 150 | 30 | 13-#8 | 13-#5 | 10-#5 | 10-#5 | 3.43 | 3.43 | 3.43 |
| 28 | 200 | 41 | 0.611 | 195 | 390 | 525 | 17-#5 4 | 11-#7 | 15-#8 | 10-#6 | 12-#5 | 3.88 | 3.90 | 4.03 | 28 | 200 | 37 | 14-#8 | 10-#6 | 11-#5 | 10-#5 | 3.70 | 3.74 | 3.78 |
| 28 | 250 | 48 | 0.609 | 209 | 418 | 563 | 13-#6 1 | 12-#7 | 16-#8 | 11-#6 | 12-#5 | 4.19 | 4.24 | 4.46 | 28 | 250 | 49 | 15-#8 | 11-#6 | 12-#5 | 10-#5 | 4.02 | 4.06 | 4.09 |
| 28 | 300 | 56 | 0.608 | 220 | 440 | 592 | 19-#5 3 | 10-#8 | 17-#8 | 11-#6 | 13-#5 | 4.40 | 4.47 | 4.68 | 28 | 300 | 60 | 15-#8 | 11-#6 | 12-#5 | 10-#5 | 4.08 | 4.15 | 4.23 |
| 28 | 350 | 64 | 0.607 | 229 | 457 | 616 | 20-#5 1 | 10-#8 | 18-#8 | 16-#5 | 10-#6 | 4.67 | 4.75 | 4.93 | 28 | 350 | 70 | 16-#8 | 16-#5 | 12-#5 | 11-#5 | 4.33 | 4.42 | 4.52 |
| 29 | 50 | 26 | 0.711 | 139 | 277 | 373 | 13-#5 4 | 11-#6 | 13-#7 | 11-#5 | 11-#5 | 2.85 | 2.86 | 2.85 | 29 | 50 | 19 | 13-#7 | 11-#5 | 11-#5 | 11-#5 | 2.90 | 2.89 | 2.89 |
| 29 | 100 | 32 | 0.674 | 167 | 333 | 448 | 15-#5 5 | 10-#7 | 13-#8 | 12-#5 | 11-#5 | 3.29 | 3.32 | 3.38 | 29 | 100 | 26 | 15-#7 | 12-#5 | 11-#5 | 11-#5 | 3.15 | 3.19 | 3.24 |
| 29 | 150 | 37 | 0.638 | 192 | 385 | 518 | 17-#5 4 | 20-#5 | 15-#8 | 10-#6 | 11-#5 | 3.71 | 3.74 | 3.82 | 29 | 150 | 33 | 14-#8 | 10-#6 | 11-#5 | 11-#5 | 3.62 | 3.65 | 3.68 |
| 29 | 200 | 45 | 0.610 | 212 | 423 | 570 | 19-#5 3 | 12-#7 | 16-#8 | 11-#6 | 13-#5 | 4.07 | 4.12 | 4.31 | 29 | 200 | 43 | 15-#8 | 11-#6 | 12-#5 | 11-#5 | 3.92 | 3.96 | 4.00 |
| 29 | 250 | 54 | 0.608 | 226 | 451 | 607 | 14-#6 3 | 10-#8 | 17-#8 | 16-#5 | 13-#5 | 4.34 | 4.39 | 4.55 | 29 | 250 | 55 | 16-#8 | 16-#5 | 12-#5 | 11-#5 | 4.10 | 4.14 | 4.18 |
| 29 | 300 | 63 | 0.607 | 236 | 472 | 635 | 15-#6 0 | 11-#8 | 18-#8 | 12-#6 | 10-#6 | 4.72 | 4.77 | 4.94 | 29 | 300 | 67 | 17-#8 | 12-#6 | 13-#5 | 11-#5 | 4.40 | 4.45 | 4.49 |
| 29 | 350 | 71 | 0.607 | 245 | 490 | 659 | 16-#6 0 | 11-#8 | 19-#8 | 17-#5 | 11-#6 | 4.90 | 4.97 | 5.18 | 29 | 350 | 78 | 17-#8 | 12-#6 | 13-#5 | 11-#5 | 4.46 | 4.55 | 4.65 |
| 30 | 50 | 28 | 0.724 | 152 | 305 | 410 | 14-#5 6 | 16-#5 | 15-#7 | 11-#5 | 11-#5 | 2.92 | 2.94 | 2.90 | 30 | 50 | 21 | 14-#7 | 11-#5 | 11-#5 | 11-#5 | 2.89 | 2.91 | 2.93 |
| 30 | 100 | 34 | 0.665 | 183 | 366 | 493 | 16-#5 5 | 14-#6 | 14-#8 | 13-#5 | 11-#5 | 3.37 | 3.42 | 3.55 | 30 | 100 | 28 | 17-#7 | 13-#5 | 11-#5 | 11-#5 | 3.29 | 3.32 | 3.34 |
| 30 | 150 | 41 | 0.663 | 210 | 420 | 565 | 19-#5 6 | 12-#7 | 16-#8 | 11-#6 | 13-#5 | 3.96 | 3.97 | 4.00 | 30 | 150 | 36 | 15-#8 | 11-#6 | 12-#5 | 11-#5 | 3.76 | 3.79 | 3.83 |
| 30 | 200 | 50 | 0.609 | 228 | 457 | 615 | 20-#5 5 | 10-#8 | 18-#8 | 16-#5 | 10-#6 | 4.19 | 4.26 | 4.44 | 30 | 200 | 49 | 16-#8 | 16-#5 | 13-#5 | 11-#5 | 3.96 | 4.03 | 4.10 |
| 30 | 250 | 60 | 0.608 | 242 | 484 | 652 | 15-#6 3 | 11-#8 | 19-#8 | 12-#6 | 10-#6 | 4.57 | 4.64 | 4.81 | 30 | 250 | 62 | 17-#8 | 12-#6 | 13-#5 | 11-#5 | 4.22 | 4.29 | 4.36 |
| 30 | 300 | 69 | 0.607 | 254 | 507 | 683 | 16-#6 2 | 11-#8 | 20-#8 | 10-#7 | 11-#6 | 4.93 | 4.99 | 5.25 | 30 | 300 | 74 | 18-#8 | 10-#7 | 10-#6 | 12-#5 | 4.64 | 4.72 | 4.79 |
| 30 | 350 | 78 | 0.606 | 262 | 523 | 704 | 23-#5 1 | 10-#9 | 20-#8 | 10-#7 | 11-#6 | 5.16 | 5.23 | 5.60 | 30 | 350 | 86 | 18-#8 | 10-#7 | 10-#6 | 12-#5 | 4.70 | 4.78 | 4.86 |
| 31 | 50 | 30 | 0.708 | 167 | 334 | 450 | 15-#5 6 | 13-#6 | 16-#7 | 12-#5 | 11-#5 | 3.03 | 3.04 | 3.11 | 31 | 50 | 23 | 15-#7 | 12-#5 | 11-#5 | 11-#5 | 2.93 | 2.95 | 2.97 |
| 31 | 100 | 36 | 0.695 | 200 | 401 | 540 | 18-#5 7 | 15-#6 | 15-#8 | 14-#5 | 12-#5 | 3.51 | 3.57 | 3.70 | 31 | 100 | 31 | 14-#8 | 14-#5 | 11-#5 | 11-#5 | 3.35 | 3.38 | 3.42 |
| 31 | 150 | 46 | 0.610 | 226 | 452 | 608 | 14-#6 3 | 13-#7 | 17-#8 | 16-#5 | 13-#5 | 4.01 | 4.03 | 4.18 | 31 | 150 | 42 | 16-#8 | 16-#5 | 13-#5 | 11-#5 | 3.80 | 3.82 | 3.85 |
| 31 | 200 | 56 | 0.608 | 245 | 489 | 658 | 16-#6 2 | 11-#8 | 19-#8 | 12-#6 | 11-#6 | 4.45 | 4.52 | 4.71 | 31 | 200 | 56 | 17-#8 | 17-#5 | 13-#5 | 12-#5 | 4.08 | 4.17 | 4.25 |
| 31 | 250 | 66 | 0.607 | 259 | 519 | 699 | 23-#5 3 | 12-#8 | 20-#8 | 13-#6 | 11-#6 | 4.79 | 4.86 | 5.13 | 31 | 250 | 69 | 18-#8 | 13-#6 | 14-#5 | 12-#5 | 4.40 | 4.48 | 4.55 |
| 31 | 300 | 75 | 0.606 | 271 | 542 | 730 | 17-#6 2 | 12-#8 | 21-#8 | 14-#6 | 16-#5 | 5.05 | 5.12 | 5.45 | 31 | 300 | 82 | 19-#8 | 14-#6 | 11-#6 | 13-#5 | 4.79 | 4.85 | 4.92 |
| 31 | 350 | 85 | 0.606 | 279 | 558 | 752 | 18-#6 0 | 13-#8 | 22-#8 | 14-#6 | 12-#6 | 5.33 | 5.42 | 5.72 | 31 | 350 | 94 | 19-#8 | 14-#6 | 11-#6 | 13-#5 | 4.85 | 4.96 | 5.07 |

(1) Columns same above and below plate.

(2) Center-to-center of columns; $\ell_1 = \ell_2$.

(3) Superimposed factored load (factored dead load has been deducted).

# CHAPTER 10 – TWO-WAY SOLID FLAT SLABS – SQUARE PANELS WITH DROPS

**General.** Two-way solid flat slabs under the provisions of Chapter 13 in the ACI 318 Building Code, include two-way reinforced slabs with capitals or brackets, drop panels, or both. The use of both capitals and drop panels, commonly used in the early years of two-way slab construction, is less favored today because of the higher formwork costs. In this Chapter, therefore, the tabulated designs presented are for two-way reinforced solid slabs with drop panels only. Capitals and brackets could also be used to provide the necessary critical shear section for transfer of heavy loads from slab to column, but the entire structural analysis and subsequent determination of the required flexural reinforcement would have to be revised. For the tabulated designs in this Chapter, required column sizes were kept to a maximum of $0.083\ell_n$ by increasing the depth of the drop panel for simpler forming and maximum economy for the negative reinforcement. Normal-weight concrete, with $f'_c$ = 4,000 psi, and Grade 60 ($f_y$ = 60,000 psi) reinforcing bars are used in the tabulated designs.

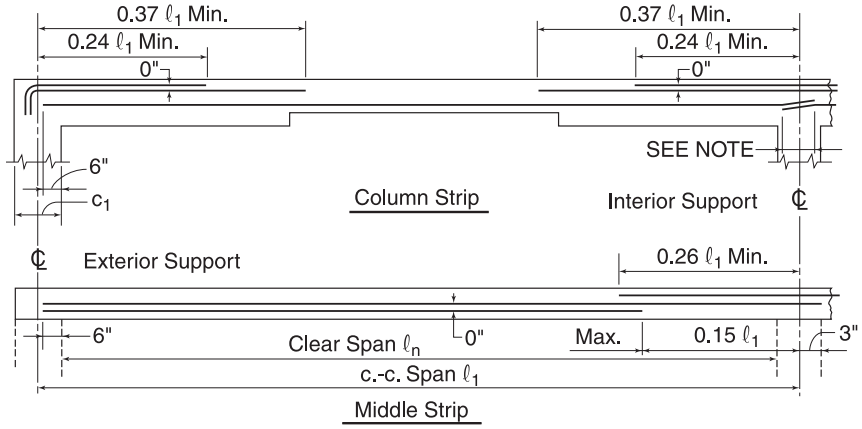
**Flat Slab Advantages.** The two-way flat slab designs in this Chapter are heavy duty designs, compared to the flat plates of Chapter 9. For the combination of heavier loads and longer spans, the flat slab with adjustment of drop panel depth will require less concrete and reinforcement and can utilize smaller columns than the flat plate for the slight added cost of forming drop panels. These designs are most efficient for square or nearly square panels. For parking garages, storage buildings, or industrial structures, the drop panel soffit is usually an acceptable exposed ceiling. For longer spans, the waffle flat slab (Chapter 11) will provide increased stiffness with less dead weight for overall economy. The choice of a two-way system, however, usually depends upon varying conditions of the structure and other requirements. For this reason, the tabulated designs in Chapters 9, 10, and 11 cover the practicable range of load and span combinations for each, overlapping somewhat.

**Design Considerations.** All design requirements for flat plates apply equally to flat slabs. Only the design considerations in addition to those described in Chapter 9, applicable because of the drop panels, will be presented in this Chapter.

**Column Sizes.** The minimum column size for the flat slab designs in this Chapter was taken as 12 inches square. Only square columns are included in the tabulated designs. The Code permits conversion of round columns to square columns of equivalent area for calculation of clear span, but actual round column cross-sections should be used for the critical shear sections. Minimum size interior and exterior columns are established separately.

**Drop Panels.** The tabulated designs presented begin with the minimum size drop panel (ACI 13.3.7) extending one-third of the span length from the column centerline and projecting 2-1/4 in. below for slab thicknesses of 9 in. or less; for slab thicknesses greater than 9 in., the projection below starts at 4-1/4 in. As shear on the critical section around the column becomes critical with heavier loads, column size is increased up to the maximum considered practical, $0.083\ell_n$. With further





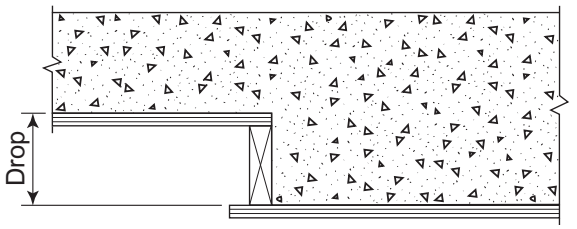

NOTE: Integrity reinforcement is required (ACI 13.3.8.5). All bottom bars in the column strip must be continuous or spliced over the support with Class B tension lap splices. At least two of the column strip bottom bars in each direction must pass within the column core and be anchored at exterior supports.

**Figure 10-1 Recommeded Bar Details for Two-Way Solid Flat Slabs**

increases in load, shear around the column ("punching" shear $v_c = \left(\frac{\alpha_s d}{b_o} + 2\right)\sqrt{f'_c}$ governed by ACI Eq. 11-32 or $v_c = 4\sqrt{f'_c}$ governed by ACI Eq. 11-33) becomes larger and drop panel depth is increased. Simultaneously, shear around the edge of the drop panel ("beam" shear, $v_c = 2\sqrt{f'_c}$) increases, and drop panel extension into the span is increased in one increment to forty percent of the span, when $v_u > v_c$. Note: The modification factor, $\lambda$, for lightweight concrete is excluded from the expressions for $v_c$, because the tabulated designs in this Chapter are based on normal-weight concrete.

**Drop Panels—Projections Below Slab Based on Standard Nominal Lumber Dimensions.**

| Nominal Size | Actual Size (in.) | Add for Thickness of Plywood (in.) | Total Drop Panel Projection |
|---|---|---|---|
| 2x | 1 ½ | ¾ | 2 ¼ |
| 4x | 3 ½ | ¾ | 4 ¼ |
| 6x | 5 ½ | ¾ | 6 ¼ |




**Control of Deflections (or Minimum Slab Thickness).** Minimum thickness/span ratios were observed in preparation of the tabulated designs so that extremely complex deflection calculations in routine designs can be avoided. See Table 10-1, "Minimum Thickness of Two-Way Slabs," for which no deflection calculations are required (ACI 9.5.3).

**Flexural Reinforcement.** Flexural reinforcement has been selected with the limitations of maximum $\rho < 0.75\rho_b$ and maximum spacing $s \le 2h$, based on overall slab thickness, $h$ (ACI 13.3.2). Bar sizes have been selected for the area of steel required so that the spacing of bars is not less than 3 inches: nor greater than the maximum permitted. For top reinforcement, CRSI recommends a minimum of #4 bars spaced at 12 inches on center for rigidity under construction for traffic. The tabulated reinforcing steel weight per square foot is based on the bar lengths shown in Fig. 10-1. The bar lengths suggested in Fig. 10-1 as standard details are applicable to ratios of adjoining spans up to 1.50 under uniform load. "Integrity reinforcement" is required by ACI 318 (ACI 13.3.8.5). The tabulated reinforcing steel weights do not include "integrity reinforcement."

**Table 10-1 Minimum Thickness, *h*, of Two-Way Slabs***

(Expressed as fraction of longer clear span, $\ell_n$)

1. Slabs without Interior Beams or with Interior Beams with $\alpha_{fm} \le 0.2$

   a. Flat Plates+ (no drop panels) Min. $h$ = 5 inches
   Interior panels . . . . . $\ell_n/33$
   Exterior panels, no edge beams . . . . . $\ell_n/33$
   Exterior panels, with edge beams*** . . . . $\ell_n/33$

   b. Flat Slab+ (with drop panels) Min. $h$ = 4 inches
   Interior panels . . . . . $\ell_n/36$
   Exterior panels, no edge beams . . . . . $\ell_n/33$
   Exterior panels, with edge beams*** . . . . $\ell_n/36$

2. Slabs with Interior Beams with $\alpha_{fm} > 0.2$**

   a. $\alpha_{fm} \le 2.0$ Min. $h$ = 5 inches

   $h = \left(\frac{1.1}{36 + 5\beta(\alpha_{fm} - 0.2)}\right)\ell_n$ ACI Equation 9-12 with $f_y$ = 60,000 psi

   b. $\alpha_{fm} > 2.0$ Min. $h$ = 3.5 inches

   $h = \left(\frac{1.1}{36 + 9\beta}\right)\ell_n$ ACI Equation 9-13 with $f_y$ = 60,000 psi

where $\beta$ = ratio of clear spans in long to short direction

Minimum $h$ expressions for different values of $\alpha_{fm}$ and $\beta$ are as follows:

| | Minimum $h$ for different $\beta$ | | | | | |
|---|---|---|---|---|---|---|
| $\alpha_{fm}$ | 1.0 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 |
| 0.3 | $\ell_n/33.2$ | $\ell_n/33.3$ | $\ell_n/33.4$ | $\ell_n/33.5$ | $\ell_n/33.5$ | $\ell_n/33.6$ |
| 0.4 | $\ell_n/33.6$ | $\ell_n/33.8$ | $\ell_n/34.0$ | $\ell_n/34.2$ | $\ell_n/34.4$ | $\ell_n/34.5$ |
| 0.6 | $\ell_n/34.5$ | $\ell_n/34.9$ | $\ell_n/35.3$ | $\ell_n/35.6$ | $\ell_n/36.02$ | $\ell_n/36.4$ |
| 0.8 | $\ell_n/35.5$ | $\ell_n/36.0$ | $\ell_n/36.5$ | $\ell_n/37.1$ | $\ell_n/37.6$ | $\ell_n/38.2$ |
| 1.0 | $\ell_n/36.4$ | $\ell_n/37.1$ | $\ell_n/37.8$ | $\ell_n/38.5$ | $\ell_n/39.3$ | $\ell_n/40.0$ |
| 1.2 | $\ell_n/37.3$ | $\ell_n/38.2$ | $\ell_n/39.1$ | $\ell_n/40.0$ | $\ell_n/40.9$ | $\ell_n/41.8$ |
| 1.4 | $\ell_n/38.2$ | $\ell_n/39.3$ | $\ell_n/40.4$ | $\ell_n/41.5$ | $\ell_n/42.5$ | $\ell_n/43.6$ |
| 1.6 | $\ell_n/39.1$ | $\ell_n/40.4$ | $\ell_n/41.6$ | $\ell_n/42.9$ | $\ell_n/44.2$ | $\ell_n/45.5$ |
| 1.8 | $\ell_n/40.0$ | $\ell_n/41.5$ | $\ell_n/42.9$ | $\ell_n/44.4$ | $\ell_n/45.8$ | $\ell_n/47.3$ |
| 2.0 | $\ell_n/40.9$ | $\ell_n/42.5$ | $\ell_n/44.2$ | $\ell_n/45.8$ | $\ell_n/47.5$ | $\ell_n/49.1$ |
| >2.0 | $\ell_n/40.9$ | $\ell_n/42.5$ | $\ell_n/44.2$ | $\ell_n/45.8$ | $\ell_n/47.5$ | $\ell_n/49.1$ |

* Minimum thickness unless deflection is computed, and is within maximim allowable computed deflection (ACI 9.5.3). Grade 60 reinforcing bars assumed.

** For exterior panel, $\alpha_f$ for edge beams not less than 0.8. Otherwise, minimum $h$ must be increased at least 10 percent.

\+ Ratio of long to short span not greater than 2.

*** Slabs with beams along exterior edges. Value of $\alpha_f$ for edge beams not less than 0.8.

## USE OF FLAT SLAB TABULATED DESIGNS

### Direct Applications Within Dimensional Limitations of Tables

These limitations are:

1. Square column sizes as tabulated
2. Square panels
3. Minimum three panels continuous
4. Equal spans
5. Edge of slab flush with outer face of edge column
6. Live load $\leq 2 \times$ dead load (unfactored loads)
7. Concrete in slab, $f'_c = 4{,}000$ psi: normal-weight, $w = 150$ pcf
8. No edge beams
9. Uniformly distributed gravity loads only

**Example 1.** ***Preliminary Selection.*** Compare alternate designs to make a preliminary selection of a flat slab intermediate floor with square panels 20 feet center-to-center of columns; the superimposed factored load is 400 psf.

| Slab Thickness | Drop Panel | Min Square Column $c_1 = c_2$ | | Concrete c.f. per s.f. | Reinforcing Steel | |
|---|---|---|---|---|---|---|
| | | Edge | Interior | | Edge Panel | Interior Panel |
| 8″ | 6¼″x 6′-8″ | 18″ | 20″ | 0.725 | 3.24 psf | 2.78 psf |
| 8½″ | 4¼″x 6′-8″ | 18″ | 20″ | 0.748 | 3.06 psf | 2.71 psf |
| 9″ | 4¼″x 6′-8″ | 19″ | 20″ | 0.789 | 3.03 psf | 2.68 psf |

No meaningful reduction in the required amount of reinforcing steel is gained by increasing the slab thickness beyond 8 inches. Concrete quantities, of course, increase. Column and drop panel sizes are essentially the same. Use the 8-inch slab design.

For direct applications within the limitations of the tabulated designs, the tabulated reinforcement can be transferred directly from the tables to the design drawings. Concentration of top reinforcement over edge columns may be achieved by closer spacing, up to 50 percent of the column strip top bars, within the center third of the width of the column strip. Note that one special detail must be developed for the top bars at flush corner columns to ensure that a critical section cannot develop diagonal to the grid. Concentration of reinforcement over the corner column is achieved by addition of bars, top and bottom, in each direction, within the width of the column.

*Preliminary Estimates*

Preliminary estimates of reinforcing steel and concrete quantities for various structural systems are often required to make a selection. The tabulated designs in this Handbook permit rapid estimates of reinforcing steel and concrete quantities for various systems to support a required load.

### Adjustment of Tabulated Designs to Project Conditions

In practice, the usual variations from the limitations of the tabulated designs will occur in one of the following areas:

Variations *within* limitations of the Direct Design Method:

1. Non-square panels where $\ell_2/\ell_1 > 2.0$
2. Non-equal consecutive spans where $\ell'_1/\ell_1 < 1.50$
3. Cantilevers
4. Use of edge beams

Variation *outside* limitations of the Direct Design Method:

5. Entire superimposed load is a movable type of live load (warehouse, storage, etc.) and the service live load, $L >$ two times the service dead load, $D$, i.e., $L > 2D$.
6. Consecutive spans or non-square panels exceed the limits of 1.50 or 2.0, respectively.

Variations of the first three types listed are illustrated by the examples in Chapter 9 for flat plate design and will require similar treatment for flat slab design.

## MANUAL EXAMPLE

To illustrate the design assumptions, applicable Code requirements, and the procedures used in the preparation of the flat slab tabulated designs, one of the designs will be reviewed with detailed calculations performed.This review will assist or guide any user wishing to extend the scope of the designs to longer spans or heavier loads.

Review the tabulated design (Page 10-18) for an intermediate flat slab floor with square panels; $\ell_1 = \ell_2 = 20'\text{-}0''$; the floor has an 8-in. slab plus 4.25-in. drop panels; factored live load = 300 psf; normal-weight concrete, $f'_c$ = 4,000 psi; Grade 60 reinforcing bars, $f_y$ = 60,000 psi. The spans and the dimensions of the columns and drop panels are shown in Fig. 10-2.

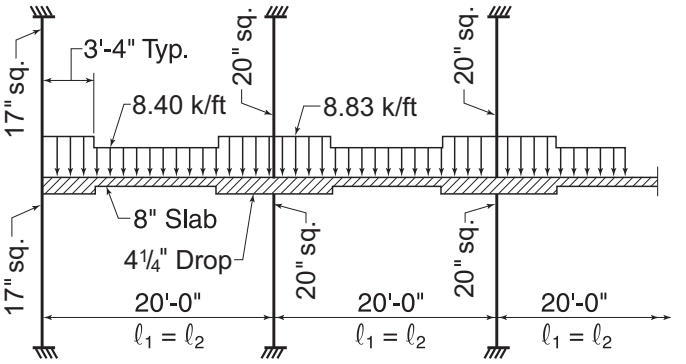



**Figure 10-2 Factored Loads and Dimensions of Frame**

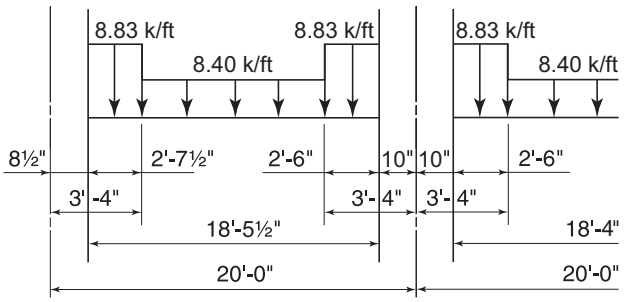
Ratio of Service Live Load to Service Dead Load:

$$L/D = \frac{300/1.6}{100} = 1.875 < 2.0, \text{ Okay}$$

*Factored Loads*

$q_{Du}$ = 1.2(8/12)(150) = 120 psf = 0.120 ksf (slab)
$q_{Du}$ = 1.2(4.25/12)(150) = 64 psf
= 0.064 ksf (drop panel)
Total $q_{Du}$ = 20(0.120) + (20/3) (0.064)
= 2.40 + 0.43 = 2.83 kips/ft (floor)
$q_{Lu}$ = 20(0.300) = 6.00 kips/ft (floor)
$q_u$ = 2.83 + 6.00 = 8.83 kips/ft (drop panel)
$q_u$ = 2.40 + 6.00 = 8.40 kips/ft (slab)

*End Span*




Total Static Moment, $M_o$ :

$M_o$ = 8.40(18.458)$^2$/8 = 357.746 ft-kips (slab)
$M_o$ = (8.83 – 8.40)(2.6)$^2$/2
= 1.453 ft-kips (drop panel)
$M_o$ = 357.746 + 1.453 = 359.199 ft-kips

*Panel Moments (ACI 13.6.3.3)*

Exterior Column (Negative Factored Moment)
$M_u$ = 0.26(359.199) = 93.392 ft-kips
Column strip resists 100% of $M_u$; 1.00(93.392)
= 93.392 ft-kips
(tabulated: 93.4) (ACI 13.6.4.2)
Bottom (Positive Factored Moment)
$M_u$ = 0.52(359.199) = 186.783 ft-kips
(tabulated: 186.8)
Column strip resists 60% of $M_u$; 0.60(186.783)
= 112.070 ft-kips (ACI 13.6.4.4)
Middle strip resists 40% of $M_u$; 0.40(186.783)
= 74.713 ft-kips
First Interior Column (Negative Factored Moment)
$M_u$ = 0.70(359.199) = 251.439 ft-kips
(tabulated: 251.4)
Column strip resists 75% of $M_u$; 0.75(251.439)
= 188.579 ft-kips (ACI 13.6.4.1)
Middle strip resists 25% of $M_u$; 0.25(251.439)
= 62.860 ft-kips

*Flexural Reinforcement*

For $f'_c$ = 4,000 psi and $f_y$ = 60,000 psi:
Required $A_s = 0.680\, d - \sqrt{0.462d^2 - 0.0252\, M_u}$
where $M_u$ is in units of in.-kips/ft and $A_s$ is in units of in.$^2$/ft. See Chapter 5.
At support, $h$ = 8 + 4.25 = 12.25 in.
$d$ = 12.25 – 0.75 (concrete cover) – 0.75 (avg. $d_b$)
= 10.75 in. (drop panel)
Slab thickness, $h$ = 8 in.
$d$ = 8 – 0.75 (concrete cover) – 0.75 (avg. $d_b$)
= 6.5 in. (slab)

*Exterior Column*

Column Strip Top Bars ($d$ = 10.75 in.)

$M_u$ = 12(93.392)/10 = 112.070 in.-kips/ft

$A_s = 0.680(10.75) - \sqrt{0.462(10.75)^2 - 0.0252(112.070)}$

= 0.199 in.$^2$/ft

Total $A_s$ = 0.199(10) = 1.99 in.$^2$

(tabulated: 10–#4 bars; $A_s$ = 2.00 in.$^2$)

Column Strip Bottom Bars ($d$ = 6.5 in.)

$M_u$ = 12(112.070)/10 = 134.484 in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(134.484)}$

= 0.404 in.$^2$/ft

Total $A_s$ = 0.404(10) = 4.04 in.$^2$

(tabulated: 13–#5 bars; $A_s$ = 4.03 in.$^2$)

Middle Strip Bottom Bars ($d$ = 6.5 in.)

$M_u$ = 12(74.713)/10 = 89.656 in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(89.656)}$

= 0.265 in.$^2$/ft

Total $A_s$ = 0.265(10) = 2.65 in.$^2$

(tabulated: 13–#4 bars ; $A_s$ = 2.60 in.$^2$)

*First Interior Column*

Column Strip Top Bars ($d$ = 10.75 in.)

$M_u$ = 12(188.579)/10 = 226.295 in.-kips/ft

$A_s = 0.680(10.75) - \sqrt{0.462(10.75)^2 - 0.0252(226.295)}$

= 0.404 in.$^2$/ft

Total $A_s$ = 0.404(10) = 4.04 in.$^2$

(tabulated: 13–#5 bars; $A_s$ = 4.03 in.$^2$)

Middle Strip Top Bars ($d$ = 6.5 in.)

$M_u$ = 12(62.860)/10 = 75.432 in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(75.432)}$

= 0.223 in.$^2$/ft

Total $A_s$ = 0.223(10) = 2.23 in.$^2$

(tabulated: 11–#4 bars; $A_s$ = 2.22 in.$^2$)

**Summary – Flexural Reinforcement – End Span**

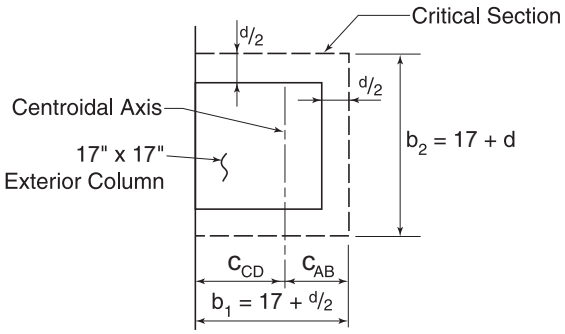
| Location | Size-No. | $A_s$ | $d$ | $b$ | $\rho = A_s/bd$ | Max. $\rho$ | $\phi$ = 0.90 | Min. $A_s$ |
|---|---|---|---|---|---|---|---|---|
| Column Strip | | | | | | | | |
| Exterior Top Bars | 10-#4 | 2.00 | 10.75 | 120 | 0.0016 | 0.0181 | Yes | 2.65 |
| Bottom Bars | 13-#5 | 4.03 | 6.50 | 120 | 0.0052 | 0.0181 | Yes | 1.73 |
| Interior Top Bars | 13-#5 | 4.03 | 10.75 | 120 | 0.0031 | 0.0181 | Yes | 2.65 |
| Middle Strip | | | | | | | | |
| Bottom Bars | 13-#4 | 2.60 | 6.50 | 120 | 0.0033 | 0.0181 | Yes | 1.73 |
| Interior Top Bars | 11-#4 | 2.22 | 6.50 | 120 | 0.0029 | 0.0181 | Yes | 1.73 |

Min. $A_s = 0.0018bh$ { For $h$ = 12.25 in., Min. $A_s$ = 0.0018(120)(12.25) = 2.65 in.$^2$ ; For $h$ = 8.00 in., Min. $A_s$ = 0.0018(120)(8.00) = 1.73 in.$^2$

For transfer of unbalanced moment by flexure, 3-#4 bars are required within effective width; hence, $A_s$ in column strip is 2.60 in.$^2$, which is ≈ Min. $A_s$ of 2.65 in.$^2$

With $f'_c$ = 4,000 psi and $f_y$ = 60,000 psi, Max. $\rho$ = 0.0181 for $\epsilon_t$ = 0.005 (Page 5-4).

*Shear Constants at Exterior Column (ACI R11.11.7.2):*




$b_1$ = 17 + 10.75/2 = 22.38 in.

$b_2$ = 17 + 10.75 = 27.75 in.

$b_o$ = 2(22.38) + 27.75 = 72.5 in.

$A_c$ = 72.5(10.75) = 779.38 in.$^2$

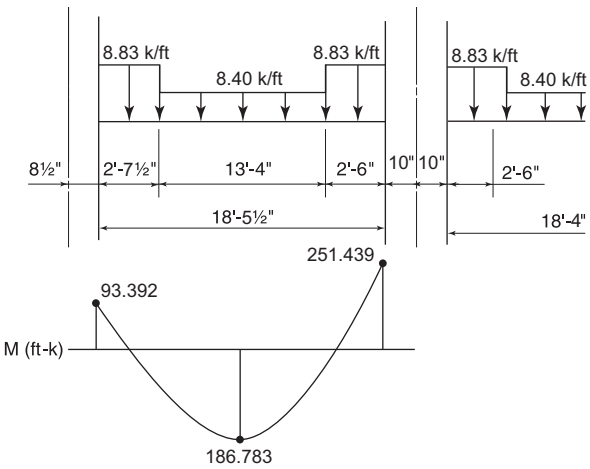
$c_{AB} = (22.38)^2\ (10.75/779.38)$ = 6.91 in.

$c_{CD}$ = 22.38 – 6.91 = 15.47 in.

$J = 22.38(10.75)^3/6 + 2(10.75)(6.91^3 + 15.47^3)/3 + 27.75(10.75)(6.91)^2$

= 4,634 + 28,898 + 14,244 = 47,776 in.$^4$

*Factored Moments and Shears at Face of Exterior Column*




$V_u$ (at ext col face) = 8.40(18.458)/2

+ (8.83 – 8.40)(5.125)/2

– (251.439 – 93.392)/18.458

= 77.524 + 1.102 – 8.562

= 70.064 kips

$V_u$ (at C.L. ext col) = 70.064 + 8.83(8.5/12)

= 76.319 kips

$V_{ext}$ = 70.064 + 8.83(17/12) = 82.573 kips

*Shear Check at Exterior Column*

$v_c = (\alpha_s d/b_o + 2)\sqrt{f'_c} \le 4\sqrt{f'_c}$

$v_c = (30 \times 10.75/72.5 + 2)\sqrt{f'_c} = 6.45\sqrt{f'_c}$

Use $v_c = 4\sqrt{f'_c}$

$\gamma_f = 1/[1 + (2/3)\sqrt{b_1/b_2}]$

$= 1/[1 + (2/3)\sqrt{22.38/27.75}] = 0.626$

(tabulated: 0.626)

$\gamma_v = 1 - \gamma_f = 1 - 0.626 = 0.374$

$v_u = V_{ext}/A_c + \gamma_v Mc_{AB}/J$

Where $M = 0.3M_o$ (ACI 13.6.3.6)

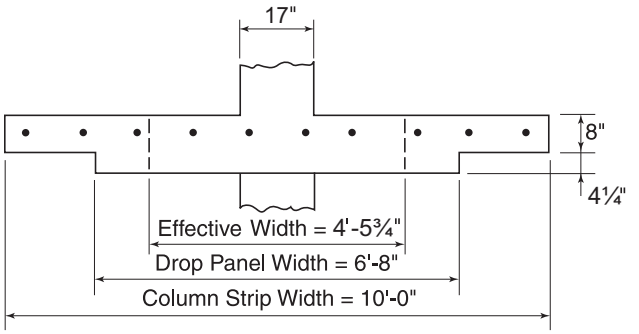
$= 0.3(359.199) = 107.760$ ft-kips

$v_u = 82.573/779.38 + 0.374(107.760 \times 12 \times 6.91)/47{,}776$

$v_u = 0.106 + 0.070 = 0.176$ ksi or 176 psi

$\phi v_c = 0.75\ (4)\sqrt{4000} = 190$ psi $> v_u$, Okay

*Determine the Number of Extra Bars Required in Column Strip at Exterior Column*




$\gamma_f M_u = 0.626(93.392) = 58.463$ ft-kips

"Effective Width" = 17 + 1.5(12.25)2 = 53.75 in.

10–#4 bars are required to resist exterior $-M_u$ in column strip

Note: 4 bars are located where $d = 6.5$ in. and 6 bars are located where $d = 10.75$ in.

Try 3 additional bars (as per tabulated design) for a total of 7 bars in the effective width

$A_s = 7(0.20) = 1.40$ in.$^2$ for 7–#4 bars

$a = A_s f_y/0.85 f'_c\ b = 1.40(60)/0.85(4)(54)$

$= 0.458$ in.

$$\phi M_n = \phi A_s f_y \left(d - \frac{a}{2}\right)$$

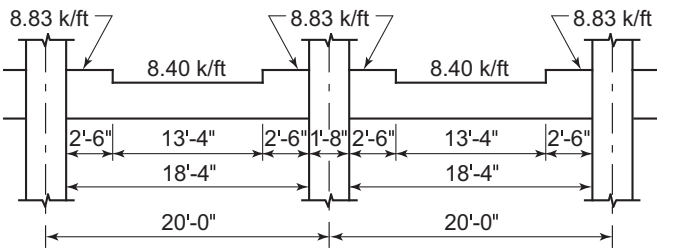
$\phi M_n = 0.90(1.40)(60)(10.75 - 0.458/2)/12$

$\phi M_n = 66.282$ ft-kips $> \gamma_f M_u$, Okay

Actual $\rho = \dfrac{A_s}{bd} = \dfrac{1.40}{(53.75)(10.75)}$

$\rho = 0.0024 < \rho_{max}$; $\phi = 0.90$

*Interior Span*




Total Static Moment, $M_o$:

$M_o = 8.40(18.333)^2/8 = 352.904$ ft-kips (slab)

$M_o = (8.83 - 8.40)(2.5)^2/2$

$= 1.344$ ft-kips (drop panel)

$M_o = 352.904 + 1.344 = 354.248$ ft-kips

*Panel Moments*

Bottom (Positive Factored Moment)

$M_u = 0.35(354.248) = 123.987$ ft-kips

Column strip resists 60% of $M_u$; 0.60(123.987)

$= 74.392$ ft-kips (ACI 13.6.4.4)

Middle strip resists 40% of $M_u$; 0.40(123.987)

$= 49.595$ ft-kips

Top (Negative Factored Moment)

$M_u = 0.65(354.248) = 230.261$ ft-kips

Column strip resists 75% of $M_u$; 0.75(230.261)

$= 172.696$ ft-kips (ACI 13.6.4.1)

Middle strip resists 25% of $M_u$; 0.25(230.261)

$= 57.565$ ft-kips

*Flexural Reinforcement*

Column Strip Bottom Bars ($d = 6.5$ in.)

$M_u = 12(74.392)/10 = 89.270$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(89.270)}$

$= 0.264$ in.$^2$/ft

Total $A_s = 0.264(10) = 2.64$ in.$^2$

(tabulated: 13–#4 bars; $A_s = 2.60$ in.$^2$)

Middle Strip Bottom Bars ($d = 6.5$ in.)

$M_u = 12(49.595)/10 = 59.514$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(59.514)}$

$= 0.175$ in.$^2$/ft

Total $A_s = 0.175(10) = 1.75$ in.$^2$

(tabulated: 9–#4 bars ; $A_s = 1.80$ in.$^2$)

Column Strip Top Bars ($d = 10.75$ in.)

$M_u = 12(172.696)/10 = 207.235$ in.-kips/ft

$A_s = 0.680(10.75) - \sqrt{0.462(10.75)^2 - 0.0252(207.235)}$

$= 0.370$ in.$^2$/ft

Total $A_s = 0.370(10) = 3.70$ in.$^2$

(tabulated: 12–#5 bars; $A_s = 3.72$ in.$^2$)

Middle Strip Top Bars ($d = 6.5$ in.)

$M_u = 12(57.565)/10 = 69.078$ in.-kips/ft

$A_s = 0.680(6.5) - \sqrt{0.462(6.5)^2 - 0.0252(69.078)}$

$= 0.204$ in.$^2$/ft

Total $A_s = 0.204(10) = 2.04$ in.$^2$

(tabulated: 10–#4 bars; $A_s = 2.00$ in.$^2$)

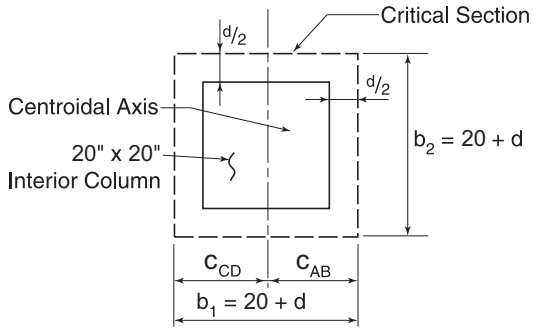
**Summary – Flexural Reinforcement – Interior Span**

| Location | Size-No. | $A_s$ | $d$ | $b$ | $\rho = A_s/bd$ | Max. $\rho$ | $\phi = 0.90$ | Min. $A_s$ |
|---|---|---|---|---|---|---|---|---|
| Column Strip | | | | | | | | |
| Top Bars | 12-#5 | 3.72 | 10.75 | 120 | 0.0029 | 0.0181 | Yes | 2.65 |
| Bottom Bars | 13-#4 | 2.60 | 6.50 | 120 | 0.0033 | 0.0181 | Yes | 1.73 |
| Middle Strip | | | | | | | | |
| Top Bars | 10-#4 | 2.00 | 6.50 | 120 | 0.0026 | 0.0181 | Yes | 1.73 |
| Bottom Bars | 9-#4 | 1.80 | 6.50 | 120 | 0.0023 | 0.0181 | Yes | 1.73 |

Min. $A_s = 0.0018bh$ { For $h$ = 12.25 in., Min. $A_s = 0.0018(120)(12.25) = 2.65$ in.$^2$ ; For $h$ = 8.00 in., Min. $A_s = 0.0018(120)(8.00) = 1.73$ in.$^2$

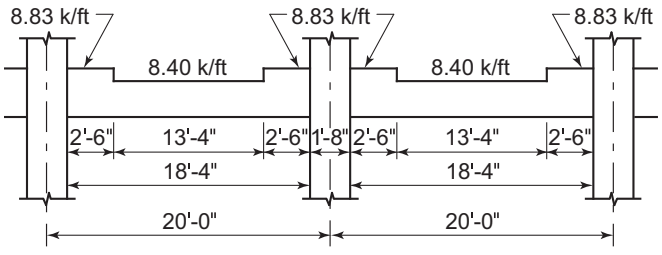
With $f'_c$ = 4,000 psi and $f_y$ = 60,000 psi, Max. $\rho$ = 0.0181 for $\epsilon_t$ = 0.005 (Page 5-4).

*Shear Constants*




$b_1 = b_2 = 20 + 10.75 = 30.75$ in.
$b_o = 4(30.75) = 123$ in.
$A_c = 123(10.75) = 1{,}322$ in.$^2$
$c_{AB} = c_{CD} = 30.75/2 = 15.38$ in.
$J = d b_1 (d^2 + 4b_1^2)/6$
$= 10.75(30.75)((10.75)^2 + 4(30.75)^2)/6$
$= 214{,}745$ in.$^4$

*Factored Moments and Shears at Centerline of Interior Column*




Maximum factored shear, $V_u$, and no unbalanced moment (full factored load on adjacent spans)

$V_u = 8.40(18.33) + (8.83 - 8.40)(2.5 + 2.5 + 20/12)$
$V_u = 153.972 + 2.867 = 156.839$ kips

For checking shear due to combined effects (i.e., direct shear plus transfer of unbalanced moment) the factored moment:

$M_{int} = 0.07\,[(q_{Du} + 0.5q_{Lu})\,\ell_2\,\ell_n^2 - q'_{Du}\,\ell'_2(\ell'_n)^2]$ . . . . (ACI Eq. 13-7)

where $q'_{Du}$, $\ell'_2$ and $\ell'_n$ refer to the shorter span

$M_{int} = 0.07[(0.120 + 0.150)(20)(18.333)^2 - 0.120(20)(18.333)^2]$
$= 0.07[1{,}814.934 - 806.637] = 70.581$ ft-kips

With factored moment $M_{int}$ = 70.581 ft-kips, the factored shear is:

$V_u = q_u\,\ell/2 + q_{Du}\,\ell/2$ (i.e., full factored load on one span and factored dead load only on other span)
$V_u = 8.40(20)/2 + (8.83 - 8.40)(2.5) + 2.40(20)/2 + 0.43(2.5)$
$= 84.0 + 1.075 + 24.0 + 1.075 = 110.150$ kips

*Shear Check at Interior Column*

$v_c = (\alpha_s\, d/b_o + 2)\sqrt{f'_c} \le 4\sqrt{f'_c}$
$v_c = (40 \times 10.75/123 + 2)\sqrt{f'_c} = 5.496\sqrt{f'_c}$
Use $v_c = 4\sqrt{f'_c}$

For factored shear $V_{int}$ = 156.839 kips and no unbalanced moment

$v_u = V_u/A_c$
$v_u = 156.839/1{,}322 = 0.119$ ksi or 119 psi
$\phi v_c = 0.75(4)\sqrt{4000} = 190$ psi > $v_u$, Okay

For factored shear $V_u$ = 110.150 kips and factored moment $M_{int}$ = 70.581 ft-kips

$\gamma_f = 1/[1 + (2/3)\sqrt{b_1/b_2}]$
$= 1/[1 + (2/3)\sqrt{30.75/30.75}] = 0.60$
$\gamma_v = 1 - \gamma_f = 1 - 0.60 = 0.40$
$v_u = V_u/A_c + \gamma_v\, M_{int}\, c_{AB}/J$
$= 110.150/1{,}322 + 0.40(70.581 \times 12)(15.38)/(214{,}745)$
$v_u = 0.083 + 0.024 = 0.107$ ksi or 107 psi
$\phi v_c = 190$ psi > $v_u$, Okay

Check one-way shear at distance $d$ beyond edge of drop panel. The section for checking one-way shear is located 2.500 + 6.5/12 = 3.042 ft from the face of the left or right column.

$V_u = (18.333/2 - 3.042)(8.40) = 51.446$ kips
$\phi V_n = \phi 2\sqrt{f'_c}\, b_w d$
$= 0.75(2)\sqrt{4000}(20 \times 12)(6.5)/1{,}000$
$= 147.994$ kips
$\phi V_n > V_u$, Okay

## TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 10 | 8.25 | 3.34 | 181 | 3,700 | 4.11 | 294 | 6,500 | 8.38 | 452 | 22,000 |
| | 9.25 | 3.47 | 215 | 4,900 | 4.23 | 353 | 8,600 | 8.88 | 550 | 30,300 |
| | 10.25 | 3.59 | 252 | 6,200 | 4.35 | 416 | 11,100 | 9.38 | 656 | 40,500 |
| | 11.25 | 3.72 | 290 | 7,800 | 4.47 | 483 | 14,000 | 9.88 | 770 | 53,100 |
| | 12.25 | 3.84 | 331 | 9,700 | 4.59 | 554 | 17,600 | 10.38 | 892 | 68,300 |
| | 13.25 | 3.97 | 373 | 11,900 | 4.71 | 629 | 21,700 | 10.88 | 1,022 | 86,500 |
| | 14.25 | 4.09 | 418 | 14,500 | 4.83 | 708 | 26,500 | 11.38 | 1,160 | 107,900 |
| | 15.25 | 4.22 | 464 | 17,400 | 4.95 | 791 | 32,000 | 11.88 | 1,306 | 133,100 |
| | 16.25 | 4.34 | 513 | 20,800 | 5.07 | 878 | 38,300 | 12.38 | 1,460 | 162,300 |
| | 17.25 | 4.47 | 563 | 24,600 | 5.20 | 969 | 45,500 | 12.88 | 1,622 | 196,000 |
| | 18.25 | 4.59 | 616 | 28,800 | 5.32 | 1,064 | 53,600 | 13.38 | 1,792 | 234,700 |
| | 19.25 | 4.72 | 670 | 33,700 | 5.44 | 1,163 | 62,800 | 13.88 | 1,970 | 278,700 |
| | 20.25 | 4.84 | 727 | 39,100 | 5.56 | 1,266 | 73,100 | 14.38 | 2,156 | 328,600 |
| | 21.25 | 4.97 | 785 | 45,100 | 5.68 | 1,373 | 84,500 | 14.88 | 2,350 | 384,900 |
| | 22.25 | 5.09 | 846 | 51,700 | 5.81 | 1,484 | 97,300 | 15.38 | 2,552 | 448,000 |
| | 23.25 | 5.22 | 908 | 59,100 | 5.93 | 1,599 | 111,500 | 15.88 | 2,762 | 518,500 |
| | 24.25 | 5.34 | 973 | 67,300 | 6.05 | 1,718 | 127,200 | 16.38 | 2,980 | 597,000 |
| | 25.25 | 5.47 | 1,039 | 76,200 | 6.17 | 1,841 | 144,400 | 16.88 | 3,206 | 684,000 |
| | 26.25 | 5.59 | 1,108 | 86,000 | 6.30 | 1,968 | 163,300 | 17.38 | 3,440 | 780,200 |
| 12 | 8.25 | 3.84 | 208 | 5,500 | 4.78 | 334 | 9,500 | 9.38 | 506 | 30,600 |
| | 9.25 | 3.97 | 246 | 7,100 | 4.89 | 399 | 12,300 | 9.88 | 612 | 41,300 |
| | 10.25 | 4.09 | 287 | 8,900 | 5.01 | 468 | 15,700 | 10.38 | 726 | 54,400 |
| | 11.25 | 4.22 | 329 | 11,100 | 5.13 | 541 | 19,600 | 10.88 | 848 | 70,200 |
| | 12.25 | 4.34 | 374 | 13,500 | 5.25 | 618 | 24,200 | 11.38 | 978 | 89,100 |
| | 13.25 | 4.47 | 420 | 16,400 | 5.37 | 699 | 29,400 | 11.88 | 1,116 | 111,400 |
| | 14.25 | 4.59 | 469 | 19,700 | 5.49 | 784 | 35,400 | 12.38 | 1,262 | 137,400 |
| | 15.25 | 4.72 | 519 | 23,400 | 5.61 | 873 | 42,300 | 12.88 | 1,416 | 167,700 |
| | 16.25 | 4.84 | 572 | 27,500 | 5.73 | 966 | 50,100 | 13.38 | 1,578 | 202,500 |
| | 17.25 | 4.97 | 626 | 32,200 | 5.85 | 1,063 | 59,000 | 13.88 | 1,748 | 242,400 |
| | 18.25 | 5.09 | 683 | 37,500 | 5.97 | 1,164 | 68,900 | 14.38 | 1,926 | 287,900 |
| | 19.25 | 5.22 | 741 | 43,400 | 6.09 | 1,269 | 80,000 | 14.88 | 2,112 | 339,300 |
| | 20.25 | 5.34 | 802 | 49,900 | 6.22 | 1,378 | 92,300 | 15.38 | 2,306 | 397,200 |
| | 21.25 | 5.47 | 864 | 57,100 | 6.34 | 1,491 | 106,000 | 15.88 | 2,508 | 462,200 |
| | 22.25 | 5.59 | 929 | 65,100 | 6.46 | 1,608 | 121,200 | 16.38 | 2,718 | 534,700 |
| | 23.25 | 5.72 | 995 | 73,900 | 6.58 | 1,729 | 137,900 | 16.88 | 2,936 | 615,300 |
| | 24.25 | 5.84 | 1,064 | 83,500 | 6.70 | 1,854 | 156,200 | 17.38 | 3,162 | 704,600 |
| | 25.25 | 5.97 | 1,134 | 94,000 | 6.83 | 1,983 | 176,400 | 17.88 | 3,396 | 803,300 |
| | 26.25 | 6.09 | 1,207 | 105,500 | 6.95 | 2,116 | 198,400 | 18.38 | 3,638 | 911,800 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 14 | 8.25 | 4.34 | 235 | 7,800 | 5.44 | 375 | 13,400 | 10.38 | 560 | 41,300 |
| | 9.25 | 4.47 | 277 | 9,900 | 5.56 | 446 | 17,100 | 10.88 | 674 | 54,800 |
| | 10.25 | 4.59 | 322 | 12,300 | 5.67 | 521 | 21,500 | 11.38 | 796 | 71,200 |
| | 11.25 | 4.72 | 368 | 15,100 | 5.79 | 600 | 26,500 | 11.88 | 926 | 90,700 |
| | 12.25 | 4.84 | 417 | 18,300 | 5.91 | 683 | 32,300 | 12.38 | 1,064 | 113,800 |
| | 13.25 | 4.97 | 467 | 21,900 | 6.03 | 770 | 38,900 | 12.88 | 1,210 | 140,700 |
| | 14.25 | 5.09 | 520 | 26,000 | 6.15 | 861 | 46,400 | 13.38 | 1,364 | 171,900 |
| | 15.25 | 5.22 | 574 | 30,600 | 6.27 | 956 | 54,900 | 13.88 | 1,526 | 207,900 |
| | 16.25 | 5.34 | 631 | 35,700 | 6.39 | 1,055 | 64,400 | 14.38 | 1,696 | 249,100 |
| | 17.25 | 5.47 | 689 | 41,500 | 6.51 | 1,158 | 75,100 | 14.88 | 1,874 | 295,800 |
| | 18.25 | 5.59 | 750 | 47,900 | 6.63 | 1,265 | 87,000 | 15.38 | 2,060 | 348,800 |
| | 19.25 | 5.72 | 812 | 54,900 | 6.75 | 1,376 | 100,300 | 15.88 | 2,254 | 408,300 |
| | 20.25 | 5.84 | 877 | 62,700 | 6.87 | 1,491 | 114,900 | 16.38 | 2,456 | 475,100 |
| | 21.25 | 5.97 | 943 | 71,300 | 6.99 | 1,610 | 131,100 | 16.88 | 2,666 | 549,500 |
| | 22.25 | 6.09 | 1,012 | 80,800 | 7.12 | 1,733 | 148,900 | 17.38 | 2,884 | 632,200 |
| | 23.25 | 6.22 | 1,082 | 91,100 | 7.24 | 1,860 | 168,400 | 17.88 | 3,110 | 723,800 |
| | 24.25 | 6.34 | 1,155 | 102,300 | 7.36 | 1,991 | 189,800 | 18.38 | 3,344 | 824,900 |
| | 25.25 | 6.47 | 1,229 | 114,600 | 7.48 | 2,126 | 213,100 | 18.88 | 3,586 | 936,100 |
| | 26.25 | 6.59 | 1,306 | 127,900 | 7.60 | 2,265 | 238,500 | 19.38 | 3,836 | 1,058,000 |
| 16 | 8.25 | 4.84 | 262 | 10,700 | 6.10 | 415 | 18,300 | 11.38 | 614 | 54,200 |
| | 9.25 | 4.97 | 308 | 13,400 | 6.22 | 492 | 23,100 | 11.88 | 736 | 71,100 |
| | 10.25 | 5.09 | 357 | 16,600 | 6.34 | 573 | 28,600 | 12.38 | 866 | 91,200 |
| | 11.25 | 5.22 | 407 | 20,100 | 6.46 | 658 | 34,900 | 12.88 | 1,004 | 115,000 |
| | 12.25 | 5.34 | 460 | 24,100 | 6.57 | 747 | 42,100 | 13.38 | 1,150 | 142,700 |
| | 13.25 | 5.47 | 514 | 28,600 | 6.69 | 840 | 50,300 | 13.88 | 1,304 | 174,900 |
| | 14.25 | 5.59 | 571 | 33,600 | 6.81 | 937 | 59,500 | 14.38 | 1,466 | 211,900 |
| | 15.25 | 5.72 | 629 | 39,200 | 6.93 | 1,038 | 69,800 | 14.88 | 1,636 | 254,300 |
| | 16.25 | 5.84 | 690 | 45,500 | 7.05 | 1,143 | 81,300 | 15.38 | 1,814 | 302,400 |
| | 17.25 | 5.97 | 752 | 52,400 | 7.17 | 1,252 | 94,100 | 15.88 | 2,000 | 356,700 |
| | 18.25 | 6.09 | 817 | 60,100 | 7.29 | 1,365 | 108,300 | 16.38 | 2,194 | 417,900 |
| | 19.25 | 6.22 | 883 | 68,500 | 7.41 | 1,482 | 123,900 | 16.88 | 2,396 | 486,400 |
| | 20.25 | 6.34 | 952 | 77,800 | 7.53 | 1,603 | 141,200 | 17.38 | 2,606 | 562,700 |
| | 21.25 | 6.47 | 1,022 | 87,900 | 7.65 | 1,728 | 160,100 | 17.88 | 2,824 | 647,500 |
| | 22.25 | 6.59 | 1,095 | 99,000 | 7.77 | 1,857 | 180,900 | 18.38 | 3,050 | 741,300 |
| | 23.25 | 6.72 | 1,169 | 111,000 | 7.89 | 1,990 | 203,500 | 18.88 | 3,284 | 844,800 |
| | 24.25 | 6.84 | 1,246 | 124,100 | 8.01 | 2,127 | 228,200 | 19.38 | 3,526 | 958,500 |
| | 25.25 | 6.97 | 1,324 | 138,300 | 8.14 | 2,268 | 255,000 | 19.88 | 3,776 | 1,083,200 |
| | 26.25 | 7.09 | 1,405 | 153,600 | 8.26 | 2,413 | 284,100 | 20.38 | 4,034 | 1,219,500 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

## TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 18 | 8.25 | 5.34 | 289 | 14,300 | 6.77 | 456 | 24,200 | 12.38 | 668 | 69,500 |
| | 9.25 | 5.47 | 339 | 17,700 | 6.89 | 539 | 30,200 | 12.88 | 798 | 90,200 |
| | 10.25 | 5.59 | 392 | 21,700 | 7.00 | 626 | 37,200 | 13.38 | 936 | 114,600 |
| | 11.25 | 5.72 | 446 | 26,100 | 7.12 | 717 | 45,000 | 13.88 | 1,082 | 143,200 |
| | 12.25 | 5.84 | 503 | 31,000 | 7.24 | 812 | 53,900 | 14.38 | 1,236 | 176,300 |
| | 13.25 | 5.97 | 561 | 36,500 | 7.36 | 911 | 63,800 | 14.88 | 1,398 | 214,300 |
| | 14.25 | 6.09 | 622 | 42,700 | 7.47 | 1,014 | 74,900 | 15.38 | 1,568 | 257,800 |
| | 15.25 | 6.22 | 684 | 49,500 | 7.59 | 1,121 | 87,300 | 15.88 | 1,746 | 307,100 |
| | 16.25 | 6.34 | 749 | 57,000 | 7.71 | 1,232 | 101,000 | 16.38 | 1,932 | 362,900 |
| | 17.25 | 6.47 | 815 | 65,300 | 7.83 | 1,347 | 116,200 | 16.88 | 2,126 | 425,600 |
| | 18.25 | 6.59 | 884 | 74,400 | 7.95 | 1,466 | 132,900 | 17.38 | 2,328 | 495,800 |
| | 19.25 | 6.72 | 954 | 84,300 | 8.07 | 1,589 | 151,300 | 17.88 | 2,538 | 574,000 |
| | 20.25 | 6.84 | 1,027 | 95,200 | 8.19 | 1,716 | 171,400 | 18.38 | 2,756 | 660,800 |
| | 21.25 | 6.97 | 1,101 | 107,000 | 8.31 | 1,847 | 193,400 | 18.88 | 2,982 | 756,800 |
| | 22.25 | 7.09 | 1,178 | 119,900 | 8.43 | 1,982 | 217,400 | 19.38 | 3,216 | 862,600 |
| | 23.25 | 7.22 | 1,256 | 133,800 | 8.55 | 2,121 | 243,500 | 19.88 | 3,458 | 978,900 |
| | 24.25 | 7.34 | 1,337 | 149,000 | 8.67 | 2,264 | 271,800 | 20.38 | 3,708 | 1,106,300 |
| | 25.25 | 7.47 | 1,419 | 165,300 | 8.79 | 2,411 | 302,500 | 20.88 | 3,966 | 1,245,500 |
| | 26.25 | 7.59 | 1,504 | 182,900 | 8.91 | 2,562 | 335,600 | 21.38 | 4,232 | 1,397,100 |
| 20 | 8.25 | 5.84 | 316 | 18,600 | 7.43 | 496 | 31,300 | 13.38 | 722 | 87,500 |
| | 9.25 | 5.97 | 370 | 22,900 | 7.55 | 585 | 38,800 | 13.88 | 860 | 112,600 |
| | 10.25 | 6.09 | 427 | 27,800 | 7.67 | 678 | 47,300 | 14.38 | 1,006 | 141,800 |
| | 11.25 | 6.22 | 485 | 33,200 | 7.78 | 775 | 56,900 | 14.88 | 1,160 | 175,700 |
| | 12.25 | 6.34 | 546 | 39,200 | 7.90 | 876 | 67,700 | 15.38 | 1,322 | 214,700 |
| | 13.25 | 6.47 | 608 | 45,900 | 8.02 | 981 | 79,600 | 15.88 | 1,492 | 259,300 |
| | 14.25 | 6.59 | 673 | 53,300 | 8.14 | 1,090 | 92,900 | 16.38 | 1,670 | 309,900 |
| | 15.25 | 6.72 | 739 | 61,400 | 8.25 | 1,203 | 107,600 | 16.88 | 1,856 | 367,000 |
| | 16.25 | 6.84 | 808 | 70,400 | 8.37 | 1,320 | 123,800 | 17.38 | 2,050 | 431,200 |
| | 17.25 | 6.97 | 878 | 80,100 | 8.49 | 1,441 | 141,600 | 17.88 | 2,252 | 503,000 |
| | 18.25 | 7.09 | 951 | 90,800 | 8.61 | 1,566 | 161,200 | 18.38 | 2,462 | 583,000 |
| | 19.25 | 7.22 | 1,025 | 102,500 | 8.73 | 1,695 | 182,600 | 18.88 | 2,680 | 671,800 |
| | 20.25 | 7.34 | 1,102 | 115,100 | 8.85 | 1,828 | 205,900 | 19.38 | 2,906 | 769,900 |
| | 21.25 | 7.47 | 1,180 | 128,900 | 8.97 | 1,965 | 231,300 | 19.88 | 3,140 | 878,000 |
| | 22.25 | 7.59 | 1,261 | 143,800 | 9.09 | 2,106 | 258,900 | 20.38 | 3,382 | 996,800 |
| | 23.25 | 7.72 | 1,343 | 159,800 | 9.21 | 2,251 | 288,700 | 20.88 | 3,632 | 1,126,800 |
| | 24.25 | 7.84 | 1,428 | 177,200 | 9.33 | 2,400 | 321,000 | 21.38 | 3,890 | 1,268,800 |
| | 25.25 | 7.97 | 1,514 | 195,800 | 9.45 | 2,553 | 355,900 | 21.88 | 4,156 | 1,423,600 |
| | 26.25 | 8.09 | 1,603 | 215,900 | 9.57 | 2,710 | 393,400 | 22.38 | 4,430 | 1,591,700 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 22 | 8.25 | 6.34 | 343 | 23,600 | 8.10 | 537 | 39,600 | 14.38 | 776 | 108,400 |
| | 9.25 | 6.47 | 401 | 29,000 | 8.21 | 632 | 48,900 | 14.88 | 922 | 138,300 |
| | 10.25 | 6.59 | 462 | 34,900 | 8.33 | 731 | 59,300 | 15.38 | 1,076 | 173,000 |
| | 11.25 | 6.72 | 524 | 41,500 | 8.45 | 834 | 70,800 | 15.88 | 1,238 | 212,900 |
| | 12.25 | 6.84 | 589 | 48,800 | 8.56 | 941 | 83,700 | 16.38 | 1,408 | 258,500 |
| | 13.25 | 6.97 | 655 | 56,800 | 8.68 | 1,052 | 97,900 | 16.88 | 1,586 | 310,300 |
| | 14.25 | 7.09 | 724 | 65,600 | 8.80 | 1,167 | 113,700 | 17.38 | 1,772 | 368,700 |
| | 15.25 | 7.22 | 794 | 75,200 | 8.92 | 1,286 | 131,000 | 17.88 | 1,966 | 434,300 |
| | 16.25 | 7.34 | 867 | 85,700 | 9.04 | 1,409 | 150,000 | 18.38 | 2,168 | 507,700 |
| | 17.25 | 7.47 | 941 | 97,200 | 9.15 | 1,536 | 170,700 | 18.88 | 2,378 | 589,400 |
| | 18.25 | 7.59 | 1,018 | 109,700 | 9.27 | 1,667 | 193,400 | 19.38 | 2,596 | 680,100 |
| | 19.25 | 7.72 | 1,096 | 123,200 | 9.39 | 1,802 | 218,100 | 19.88 | 2,822 | 780,300 |
| | 20.25 | 7.84 | 1,177 | 137,900 | 9.51 | 1,941 | 245,000 | 20.38 | 3,056 | 890,600 |
| | 21.25 | 7.97 | 1,259 | 153,700 | 9.63 | 2,084 | 274,100 | 20.88 | 3,298 | 1,011,800 |
| | 22.25 | 8.09 | 1,344 | 170,800 | 9.75 | 2,231 | 305,600 | 21.38 | 3,548 | 1,144,400 |
| | 23.25 | 8.22 | 1,430 | 189,200 | 9.87 | 2,382 | 339,600 | 21.88 | 3,806 | 1,289,300 |
| | 24.25 | 8.34 | 1,519 | 208,900 | 9.99 | 2,537 | 376,200 | 22.38 | 4,072 | 1,447,000 |
| | 25.25 | 8.47 | 1,609 | 230,200 | 10.11 | 2,696 | 415,600 | 22.88 | 4,346 | 1,618,300 |
| | 26.25 | 8.59 | 1,702 | 252,900 | 10.23 | 2,859 | 457,900 | 23.38 | 4,628 | 1,804,000 |
| 24 | 8.25 | 6.84 | 370 | 29,600 | 8.76 | 577 | 49,400 | 15.38 | 830 | 132,400 |
| | 9.25 | 6.97 | 432 | 36,100 | 8.88 | 678 | 60,600 | 15.88 | 984 | 167,800 |
| | 10.25 | 7.09 | 497 | 43,200 | 9.00 | 783 | 73,100 | 16.38 | 1,146 | 208,600 |
| | 11.25 | 7.22 | 563 | 51,100 | 9.11 | 892 | 86,900 | 16.88 | 1,316 | 255,100 |
| | 12.25 | 7.34 | 632 | 59,800 | 9.23 | 1,005 | 102,100 | 17.38 | 1,494 | 307,900 |
| | 13.25 | 7.47 | 702 | 69,300 | 9.35 | 1,122 | 118,900 | 17.88 | 1,680 | 367,600 |
| | 14.25 | 7.59 | 775 | 79,700 | 9.46 | 1,243 | 137,400 | 18.38 | 1,874 | 434,600 |
| | 15.25 | 7.72 | 849 | 91,000 | 9.58 | 1,368 | 157,600 | 18.88 | 2,076 | 509,500 |
| | 16.25 | 7.84 | 926 | 103,300 | 9.70 | 1,497 | 179,700 | 19.38 | 2,286 | 592,900 |
| | 17.25 | 7.97 | 1,004 | 116,600 | 9.82 | 1,630 | 203,700 | 19.88 | 2,504 | 685,400 |
| | 18.25 | 8.09 | 1,085 | 131,100 | 9.93 | 1,767 | 229,900 | 20.38 | 2,730 | 787,500 |
| | 19.25 | 8.22 | 1,167 | 146,700 | 10.05 | 1,908 | 258,200 | 20.88 | 2,964 | 900,100 |
| | 20.25 | 8.34 | 1,252 | 163,600 | 10.17 | 2,053 | 288,900 | 21.38 | 3,206 | 1,023,600 |
| | 21.25 | 8.47 | 1,338 | 181,700 | 10.29 | 2,202 | 322,100 | 21.88 | 3,456 | 1,158,800 |
| | 22.25 | 8.59 | 1,427 | 201,200 | 10.41 | 2,355 | 357,800 | 22.38 | 3,714 | 1,306,300 |
| | 23.25 | 8.72 | 1,517 | 222,100 | 10.53 | 2,512 | 396,300 | 22.88 | 3,980 | 1,466,900 |
| | 24.25 | 8.84 | 1,610 | 244,500 | 10.65 | 2,673 | 437,600 | 23.38 | 4,254 | 1,641,400 |
| | 25.25 | 8.97 | 1,704 | 268,500 | 10.77 | 2,838 | 481,900 | 23.88 | 4,536 | 1,830,400 |
| | 26.25 | 9.09 | 1,801 | 294,100 | 10.89 | 3,007 | 529,400 | 24.38 | 4,826 | 2,034,800 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

## TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 26 | 8.25 | 7.34 | 397 | 36,400 | 9.43 | 618 | 60,600 | 16.38 | 884 | 159,700 |
| | 9.25 | 7.47 | 463 | 44,200 | 9.55 | 725 | 74,100 | 16.88 | 1,046 | 201,200 |
| | 10.25 | 7.59 | 532 | 52,800 | 9.66 | 836 | 88,900 | 17.38 | 1,216 | 248,700 |
| | 11.25 | 7.72 | 602 | 62,200 | 9.78 | 951 | 105,200 | 17.88 | 1,394 | 302,500 |
| | 12.25 | 7.84 | 675 | 72,400 | 9.89 | 1,070 | 123,100 | 18.38 | 1,580 | 363,300 |
| | 13.25 | 7.97 | 749 | 83,600 | 10.01 | 1,193 | 142,800 | 18.88 | 1,774 | 431,600 |
| | 14.25 | 8.09 | 826 | 95,700 | 10.13 | 1,320 | 164,300 | 19.38 | 1,976 | 508,000 |
| | 15.25 | 8.22 | 904 | 108,900 | 10.24 | 1,451 | 187,700 | 19.88 | 2,186 | 593,000 |
| | 16.25 | 8.34 | 985 | 123,200 | 10.36 | 1,586 | 213,200 | 20.38 | 2,404 | 687,200 |
| | 17.25 | 8.47 | 1,067 | 138,600 | 10.48 | 1,725 | 240,800 | 20.88 | 2,630 | 791,300 |
| | 18.25 | 8.59 | 1,152 | 155,200 | 10.60 | 1,868 | 270,700 | 21.38 | 2,864 | 905,900 |
| | 19.25 | 8.72 | 1,238 | 173,100 | 10.72 | 2,015 | 303,100 | 21.88 | 3,106 | 1,031,700 |
| | 20.25 | 8.84 | 1,327 | 192,400 | 10.83 | 2,166 | 338,000 | 22.38 | 3,356 | 1,169,300 |
| | 21.25 | 8.97 | 1,417 | 213,000 | 10.95 | 2,321 | 375,600 | 22.88 | 3,614 | 1,319,500 |
| | 22.25 | 9.09 | 1,510 | 235,100 | 11.07 | 2,480 | 416,000 | 23.38 | 3,880 | 1,483,000 |
| | 23.25 | 9.22 | 1,604 | 258,800 | 11.19 | 2,643 | 459,300 | 23.88 | 4,154 | 1,660,500 |
| | 24.25 | 9.34 | 1,701 | 284,100 | 11.31 | 2,810 | 505,700 | 24.38 | 4,436 | 1,852,800 |
| | 25.25 | 9.47 | 1,799 | 311,100 | 11.43 | 2,981 | 555,400 | 24.88 | 4,726 | 2,060,700 |
| | 26.25 | 9.59 | 1,900 | 339,900 | 11.55 | 3,156 | 608,400 | 25.38 | 5,024 | 2,284,900 |
| 28 | 8.25 | 7.84 | 424 | 44,200 | 10.10 | 658 | 73,500 | 17.38 | 938 | 190,600 |
| | 9.25 | 7.97 | 494 | 53,500 | 10.21 | 771 | 89,400 | 17.88 | 1,108 | 238,800 |
| | 10.25 | 8.09 | 567 | 63,700 | 10.33 | 888 | 106,900 | 18.38 | 1,286 | 293,600 |
| | 11.25 | 8.22 | 641 | 74,700 | 10.44 | 1,009 | 126,000 | 18.88 | 1,472 | 355,500 |
| | 12.25 | 8.34 | 718 | 86,700 | 10.56 | 1,134 | 146,900 | 19.38 | 1,666 | 425,000 |
| | 13.25 | 8.47 | 796 | 99,700 | 10.67 | 1,263 | 169,700 | 19.88 | 1,868 | 502,700 |
| | 14.25 | 8.59 | 877 | 113,800 | 10.79 | 1,396 | 194,600 | 20.38 | 2,078 | 589,300 |
| | 15.25 | 8.72 | 959 | 129,100 | 10.91 | 1,533 | 221,500 | 20.88 | 2,296 | 685,200 |
| | 16.25 | 8.84 | 1,044 | 145,500 | 11.03 | 1,674 | 250,700 | 21.38 | 2,522 | 791,100 |
| | 17.25 | 8.97 | 1,130 | 163,200 | 11.14 | 1,819 | 282,300 | 21.88 | 2,756 | 907,800 |
| | 18.25 | 9.09 | 1,219 | 182,200 | 11.26 | 1,968 | 316,400 | 22.38 | 2,998 | 1,035,700 |
| | 19.25 | 9.22 | 1,309 | 202,600 | 11.38 | 2,121 | 353,100 | 22.88 | 3,248 | 1,175,800 |
| | 20.25 | 9.34 | 1,402 | 224,500 | 11.50 | 2,278 | 392,500 | 23.38 | 3,506 | 1,328,500 |
| | 21.25 | 9.47 | 1,496 | 247,900 | 11.62 | 2,439 | 434,900 | 23.88 | 3,772 | 1,494,800 |
| | 22.25 | 9.59 | 1,593 | 272,900 | 11.73 | 2,604 | 480,300 | 24.38 | 4,046 | 1,675,300 |
| | 23.25 | 9.72 | 1,691 | 299,500 | 11.85 | 2,773 | 528,900 | 24.88 | 4,328 | 1,870,800 |
| | 24.25 | 9.84 | 1,792 | 328,000 | 11.97 | 2,946 | 580,900 | 25.38 | 4,618 | 2,082,000 |
| | 25.25 | 9.97 | 1,894 | 358,200 | 12.09 | 3,123 | 636,300 | 25.88 | 4,916 | 2,309,900 |
| | 26.25 | 10.09 | 1,999 | 390,400 | 12.21 | 3,304 | 695,300 | 26.38 | 5,222 | 2,555,200 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 30 | 8.25 | 8.34 | 451 | 53,100 | 10.76 | 699 | 88,100 | 18.38 | 992 | 225,200 |
| | 9.25 | 8.47 | 525 | 64,100 | 10.88 | 818 | 106,700 | 18.88 | 1,170 | 280,900 |
| | 10.25 | 8.59 | 602 | 76,000 | 10.99 | 941 | 127,100 | 19.38 | 1,356 | 343,700 |
| | 11.25 | 8.72 | 680 | 88,900 | 11.11 | 1,068 | 149,400 | 19.88 | 1,550 | 414,400 |
| | 12.25 | 8.84 | 761 | 102,800 | 11.22 | 1,199 | 173,600 | 20.38 | 1,752 | 493,400 |
| | 13.25 | 8.97 | 843 | 117,900 | 11.34 | 1,334 | 199,900 | 20.88 | 1,962 | 581,300 |
| | 14.25 | 9.09 | 928 | 134,100 | 11.46 | 1,473 | 228,400 | 21.38 | 2,180 | 678,900 |
| | 15.25 | 9.22 | 1,014 | 151,600 | 11.57 | 1,616 | 259,200 | 21.88 | 2,406 | 786,600 |
| | 16.25 | 9.34 | 1,103 | 170,400 | 11.69 | 1,763 | 292,500 | 22.38 | 2,640 | 905,100 |
| | 17.25 | 9.47 | 1,193 | 190,600 | 11.81 | 1,914 | 328,400 | 22.88 | 2,882 | 1,035,200 |
| | 18.25 | 9.59 | 1,286 | 212,200 | 11.92 | 2,069 | 367,000 | 23.38 | 3,132 | 1,177,600 |
| | 19.25 | 9.72 | 1,380 | 235,400 | 12.04 | 2,228 | 408,400 | 23.88 | 3,390 | 1,332,800 |
| | 20.25 | 9.84 | 1,477 | 260,100 | 12.16 | 2,391 | 452,900 | 24.38 | 3,656 | 1,501,800 |
| | 21.25 | 9.97 | 1,575 | 286,500 | 12.28 | 2,558 | 500,400 | 24.88 | 3,930 | 1,685,100 |
| | 22.25 | 10.09 | 1,676 | 314,600 | 12.40 | 2,729 | 551,300 | 25.38 | 4,212 | 1,883,700 |
| | 23.25 | 10.22 | 1,778 | 344,500 | 12.52 | 2,904 | 605,500 | 25.88 | 4,502 | 2,098,300 |
| | 24.25 | 10.34 | 1,883 | 376,300 | 12.63 | 3,083 | 663,400 | 26.38 | 4,800 | 2,329,700 |
| | 25.25 | 10.47 | 1,989 | 410,100 | 12.75 | 3,266 | 725,000 | 26.88 | 5,106 | 2,578,700 |
| | 26.25 | 10.59 | 2,098 | 445,900 | 12.87 | 3,453 | 790,500 | 27.38 | 5,420 | 2,846,300 |
| 32 | 8.25 | 8.84 | 478 | 63,200 | 11.43 | 739 | 104,500 | 19.38 | 1,046 | 263,800 |
| | 9.25 | 8.97 | 556 | 75,900 | 11.54 | 864 | 126,200 | 19.88 | 1,232 | 327,600 |
| | 10.25 | 9.09 | 637 | 89,800 | 11.66 | 993 | 149,800 | 20.38 | 1,426 | 399,300 |
| | 11.25 | 9.22 | 719 | 104,700 | 11.77 | 1,126 | 175,500 | 20.88 | 1,628 | 479,500 |
| | 12.25 | 9.34 | 804 | 120,800 | 11.89 | 1,263 | 203,400 | 21.38 | 1,838 | 568,800 |
| | 13.25 | 9.47 | 890 | 138,100 | 12.00 | 1,404 | 233,500 | 21.88 | 2,056 | 667,800 |
| | 14.25 | 9.59 | 979 | 156,700 | 12.12 | 1,549 | 266,000 | 22.38 | 2,282 | 777,200 |
| | 15.25 | 9.72 | 1,069 | 176,700 | 12.24 | 1,698 | 301,100 | 22.88 | 2,516 | 897,600 |
| | 16.25 | 9.84 | 1,162 | 198,100 | 12.35 | 1,851 | 338,800 | 23.38 | 2,758 | 1,029,700 |
| | 17.25 | 9.97 | 1,256 | 221,000 | 12.47 | 2,008 | 379,400 | 23.88 | 3,008 | 1,174,300 |
| | 18.25 | 10.09 | 1,353 | 245,500 | 12.59 | 2,169 | 422,900 | 24.38 | 3,266 | 1,331,900 |
| | 19.25 | 10.22 | 1,451 | 271,600 | 12.71 | 2,334 | 469,400 | 24.88 | 3,532 | 1,503,500 |
| | 20.25 | 10.34 | 1,552 | 299,400 | 12.82 | 2,503 | 519,200 | 25.38 | 3,806 | 1,689,600 |
| | 21.25 | 10.47 | 1,654 | 329,000 | 12.94 | 2,676 | 572,400 | 25.88 | 4,088 | 1,891,200 |
| | 22.25 | 10.59 | 1,759 | 360,500 | 13.06 | 2,853 | 629,100 | 26.38 | 4,378 | 2,109,000 |
| | 23.25 | 10.72 | 1,865 | 393,900 | 13.18 | 3,034 | 689,500 | 26.88 | 4,676 | 2,343,800 |
| | 24.25 | 10.84 | 1,974 | 429,300 | 13.30 | 3,219 | 753,700 | 27.38 | 4,982 | 2,596,500 |
| | 25.25 | 10.97 | 2,084 | 466,900 | 13.41 | 3,408 | 821,900 | 27.88 | 5,296 | 2,868,000 |
| | 26.25 | 11.09 | 2,197 | 506,600 | 13.53 | 3,601 | 894,300 | 28.38 | 5,618 | 3,159,100 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

## TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 34 | 8.25 | 9.34 | 505 | 74,400 | 12.09 | 780 | 122,800 | 20.38 | 1,100 | 306,600 |
| | 9.25 | 9.47 | 587 | 89,200 | 12.21 | 911 | 147,900 | 20.88 | 1,294 | 379,200 |
| | 10.25 | 9.59 | 672 | 105,200 | 12.32 | 1,046 | 175,100 | 21.38 | 1,496 | 460,500 |
| | 11.25 | 9.72 | 758 | 122,300 | 12.44 | 1,185 | 204,600 | 21.88 | 1,706 | 551,100 |
| | 12.25 | 9.84 | 847 | 140,800 | 12.55 | 1,328 | 236,400 | 22.38 | 1,924 | 651,500 |
| | 13.25 | 9.97 | 937 | 160,600 | 12.67 | 1,475 | 270,700 | 22.88 | 2,150 | 762,500 |
| | 14.25 | 10.09 | 1,030 | 181,800 | 12.79 | 1,626 | 307,700 | 23.38 | 2,384 | 884,600 |
| | 15.25 | 10.22 | 1,124 | 204,500 | 12.90 | 1,781 | 347,300 | 23.88 | 2,626 | 1,018,700 |
| | 16.25 | 10.34 | 1,221 | 228,700 | 13.02 | 1,940 | 389,900 | 24.38 | 2,876 | 1,165,300 |
| | 17.25 | 10.47 | 1,319 | 254,600 | 13.13 | 2,103 | 435,500 | 24.88 | 3,134 | 1,325,300 |
| | 18.25 | 10.59 | 1,420 | 282,100 | 13.25 | 2,270 | 484,300 | 25.38 | 3,400 | 1,499,300 |
| | 19.25 | 10.72 | 1,522 | 311,400 | 13.37 | 2,441 | 536,400 | 25.88 | 3,674 | 1,688,200 |
| | 20.25 | 10.84 | 1,627 | 342,600 | 13.49 | 2,616 | 592,000 | 26.38 | 3,956 | 1,892,700 |
| | 21.25 | 10.97 | 1,733 | 375,700 | 13.60 | 2,795 | 651,200 | 26.88 | 4,246 | 2,113,600 |
| | 22.25 | 11.09 | 1,842 | 410,800 | 13.72 | 2,978 | 714,200 | 27.38 | 4,544 | 2,351,800 |
| | 23.25 | 11.22 | 1,952 | 448,000 | 13.84 | 3,165 | 781,100 | 27.88 | 4,850 | 2,608,100 |
| | 24.25 | 11.34 | 2,065 | 487,300 | 13.96 | 3,356 | 852,100 | 28.38 | 5,164 | 2,883,300 |
| | 25.25 | 11.47 | 2,179 | 528,900 | 14.08 | 3,551 | 927,400 | 28.88 | 5,486 | 3,178,400 |
| | 26.25 | 11.59 | 2,296 | 572,900 | 14.20 | 3,750 | 1,007,200 | 29.38 | 5,816 | 3,494,300 |
| 36 | 8.25 | 9.84 | 532 | 86,900 | 12.76 | 820 | 143,200 | 21.38 | 1,154 | 353,800 |
| | 9.25 | 9.97 | 618 | 103,900 | 12.87 | 957 | 172,000 | 21.88 | 1,356 | 436,100 |
| | 10.25 | 10.09 | 707 | 122,200 | 12.99 | 1,098 | 203,200 | 22.38 | 1,566 | 527,700 |
| | 11.25 | 10.22 | 797 | 141,900 | 13.10 | 1,243 | 236,800 | 22.88 | 1,784 | 629,500 |
| | 12.25 | 10.34 | 890 | 162,900 | 13.22 | 1,392 | 272,900 | 23.38 | 2,010 | 741,900 |
| | 13.25 | 10.47 | 984 | 185,400 | 13.33 | 1,545 | 311,800 | 23.88 | 2,244 | 865,700 |
| | 14.25 | 10.59 | 1,081 | 209,400 | 13.45 | 1,702 | 353,500 | 24.38 | 2,486 | 1,001,600 |
| | 15.25 | 10.72 | 1,179 | 235,100 | 13.57 | 1,863 | 398,100 | 24.88 | 2,736 | 1,150,300 |
| | 16.25 | 10.84 | 1,280 | 262,400 | 13.68 | 2,028 | 445,900 | 25.38 | 2,994 | 1,312,500 |
| | 17.25 | 10.97 | 1,382 | 291,400 | 13.80 | 2,197 | 497,000 | 25.88 | 3,260 | 1,488,900 |
| | 18.25 | 11.09 | 1,487 | 322,300 | 13.92 | 2,370 | 551,500 | 26.38 | 3,534 | 1,680,400 |
| | 19.25 | 11.22 | 1,593 | 355,100 | 14.03 | 2,547 | 609,600 | 26.88 | 3,816 | 1,887,700 |
| | 20.25 | 11.34 | 1,702 | 389,900 | 14.15 | 2,728 | 671,400 | 27.38 | 4,106 | 2,111,600 |
| | 21.25 | 11.47 | 1,812 | 426,700 | 14.27 | 2,913 | 737,000 | 27.88 | 4,404 | 2,353,000 |
| | 22.25 | 11.59 | 1,925 | 465,700 | 14.39 | 3,102 | 806,800 | 28.38 | 4,710 | 2,612,800 |
| | 23.25 | 11.72 | 2,039 | 506,900 | 14.50 | 3,295 | 880,700 | 28.88 | 5,024 | 2,891,700 |
| | 24.25 | 11.84 | 2,156 | 550,400 | 14.62 | 3,492 | 959,000 | 29.38 | 5,346 | 3,190,800 |
| | 25.25 | 11.97 | 2,274 | 596,400 | 14.74 | 3,693 | 1,041,900 | 29.88 | 5,676 | 3,510,800 |
| | 26.25 | 12.09 | 2,395 | 644,800 | 14.86 | 3,898 | 1,129,600 | 30.38 | 6,014 | 3,852,800 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

## TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 38 | 8.25 | 10.34 | 559 | 100,700 | 13.43 | 861 | 165,700 | 22.38 | 1,208 | 405,600 |
| | 9.25 | 10.47 | 649 | 120,200 | 13.54 | 1,004 | 198,600 | 22.88 | 1,418 | 498,300 |
| | 10.25 | 10.59 | 742 | 141,100 | 13.66 | 1,151 | 234,000 | 23.38 | 1,636 | 601,200 |
| | 11.25 | 10.72 | 836 | 163,400 | 13.77 | 1,302 | 272,100 | 23.88 | 1,862 | 715,100 |
| | 12.25 | 10.84 | 933 | 187,300 | 13.88 | 1,457 | 313,000 | 24.38 | 2,096 | 840,400 |
| | 13.25 | 10.97 | 1,031 | 212,700 | 14.00 | 1,616 | 356,800 | 24.88 | 2,338 | 978,000 |
| | 14.25 | 11.09 | 1,132 | 239,800 | 14.12 | 1,779 | 403,700 | 25.38 | 2,588 | 1,128,600 |
| | 15.25 | 11.22 | 1,234 | 268,600 | 14.23 | 1,946 | 453,800 | 25.88 | 2,846 | 1,292,800 |
| | 16.25 | 11.34 | 1,339 | 299,200 | 14.35 | 2,117 | 507,200 | 26.38 | 3,112 | 1,471,600 |
| | 17.25 | 11.47 | 1,445 | 331,700 | 14.46 | 2,292 | 564,200 | 26.88 | 3,386 | 1,665,500 |
| | 18.25 | 11.59 | 1,554 | 366,200 | 14.58 | 2,471 | 624,800 | 27.38 | 3,668 | 1,875,500 |
| | 19.25 | 11.72 | 1,664 | 402,700 | 14.70 | 2,654 | 689,300 | 27.88 | 3,958 | 2,102,400 |
| | 20.25 | 11.84 | 1,777 | 441,400 | 14.81 | 2,841 | 757,700 | 28.38 | 4,256 | 2,346,900 |
| | 21.25 | 11.97 | 1,891 | 482,200 | 14.93 | 3,032 | 830,300 | 28.88 | 4,562 | 2,610,000 |
| | 22.25 | 12.09 | 2,008 | 525,400 | 15.05 | 3,227 | 907,300 | 29.38 | 4,876 | 2,892,600 |
| | 23.25 | 12.22 | 2,126 | 570,900 | 15.17 | 3,426 | 988,700 | 29.88 | 5,198 | 3,195,500 |
| | 24.25 | 12.34 | 2,247 | 619,000 | 15.28 | 3,629 | 1,074,800 | 30.38 | 5,528 | 3,519,600 |
| | 25.25 | 12.47 | 2,369 | 669,500 | 15.40 | 3,836 | 1,165,800 | 30.88 | 5,866 | 3,865,900 |
| | 26.25 | 12.59 | 2,494 | 722,800 | 15.52 | 4,047 | 1,261,700 | 31.38 | 6,212 | 4,235,400 |
| 40 | 8.25 | 10.84 | 586 | 115,900 | 14.09 | 901 | 190,500 | 23.38 | 1,262 | 462,200 |
| | 9.25 | 10.97 | 680 | 138,100 | 14.21 | 1,050 | 227,800 | 23.88 | 1,480 | 566,200 |
| | 10.25 | 11.09 | 777 | 161,800 | 14.32 | 1,203 | 267,900 | 24.38 | 1,706 | 681,300 |
| | 11.25 | 11.22 | 875 | 187,000 | 14.44 | 1,360 | 310,900 | 24.88 | 1,940 | 808,100 |
| | 12.25 | 11.34 | 976 | 213,900 | 14.55 | 1,521 | 356,900 | 25.38 | 2,182 | 947,300 |
| | 13.25 | 11.47 | 1,078 | 242,500 | 14.67 | 1,686 | 406,000 | 25.88 | 2,432 | 1,099,600 |
| | 14.25 | 11.59 | 1,183 | 272,900 | 14.78 | 1,855 | 458,500 | 26.38 | 2,690 | 1,265,900 |
| | 15.25 | 11.72 | 1,289 | 305,200 | 14.90 | 2,028 | 514,400 | 26.88 | 2,956 | 1,446,800 |
| | 16.25 | 11.84 | 1,398 | 339,400 | 15.01 | 2,205 | 573,900 | 27.38 | 3,230 | 1,643,100 |
| | 17.25 | 11.97 | 1,508 | 375,600 | 15.13 | 2,386 | 637,200 | 27.88 | 3,512 | 1,855,700 |
| | 18.25 | 12.09 | 1,621 | 414,000 | 15.25 | 2,571 | 704,400 | 28.38 | 3,802 | 2,085,300 |
| | 19.25 | 12.22 | 1,735 | 454,500 | 15.36 | 2,760 | 775,800 | 28.88 | 4,100 | 2,332,900 |
| | 20.25 | 12.34 | 1,852 | 497,300 | 15.48 | 2,953 | 851,300 | 29.38 | 4,406 | 2,599,300 |
| | 21.25 | 12.47 | 1,970 | 542,500 | 15.60 | 3,150 | 931,400 | 29.88 | 4,720 | 2,885,300 |
| | 22.25 | 12.59 | 2,091 | 590,100 | 15.71 | 3,351 | 1,016,000 | 30.38 | 5,042 | 3,191,900 |
| | 23.25 | 12.72 | 2,213 | 640,300 | 15.83 | 3,556 | 1,105,400 | 30.88 | 5,372 | 3,520,000 |
| | 24.25 | 12.84 | 2,338 | 693,100 | 15.95 | 3,765 | 1,199,800 | 31.38 | 5,710 | 3,870,600 |
| | 25.25 | 12.97 | 2,464 | 748,600 | 16.07 | 3,978 | 1,299,300 | 31.88 | 6,056 | 4,244,500 |
| | 26.25 | 13.09 | 2,593 | 807,000 | 16.18 | 4,195 | 1,404,200 | 32.38 | 6,410 | 4,642,800 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

## TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 42 | 8.25 | 11.34 | 613 | 132,500 | 14.76 | 942 | 217,600 | 24.38 | 1,316 | 523,900 |
| | 9.25 | 11.47 | 711 | 157,700 | 14.87 | 1,097 | 259,800 | 24.88 | 1,542 | 640,100 |
| | 10.25 | 11.59 | 812 | 184,400 | 14.99 | 1,256 | 304,900 | 25.38 | 1,776 | 768,100 |
| | 11.25 | 11.72 | 914 | 212,800 | 15.10 | 1,419 | 353,200 | 25.88 | 2,018 | 908,800 |
| | 12.25 | 11.84 | 1,019 | 243,000 | 15.22 | 1,586 | 404,700 | 26.38 | 2,268 | 1,062,800 |
| | 13.25 | 11.97 | 1,125 | 275,100 | 15.33 | 1,757 | 459,600 | 26.88 | 2,526 | 1,230,900 |
| | 14.25 | 12.09 | 1,234 | 309,100 | 15.45 | 1,932 | 518,100 | 27.38 | 2,792 | 1,413,900 |
| | 15.25 | 12.22 | 1,344 | 345,000 | 15.56 | 2,111 | 580,300 | 27.88 | 3,066 | 1,612,500 |
| | 16.25 | 12.34 | 1,457 | 383,100 | 15.68 | 2,294 | 646,300 | 28.38 | 3,348 | 1,827,600 |
| | 17.25 | 12.47 | 1,571 | 423,300 | 15.79 | 2,481 | 716,400 | 28.88 | 3,638 | 2,059,900 |
| | 18.25 | 12.59 | 1,688 | 465,800 | 15.91 | 2,672 | 790,700 | 29.38 | 3,936 | 2,310,400 |
| | 19.25 | 12.72 | 1,806 | 510,600 | 16.03 | 2,867 | 869,300 | 29.88 | 4,242 | 2,579,900 |
| | 20.25 | 12.84 | 1,927 | 557,900 | 16.14 | 3,066 | 952,500 | 30.38 | 4,556 | 2,869,300 |
| | 21.25 | 12.97 | 2,049 | 607,700 | 16.26 | 3,269 | 1,040,500 | 30.88 | 4,878 | 3,179,500 |
| | 22.25 | 13.09 | 2,174 | 660,100 | 16.38 | 3,476 | 1,133,300 | 31.38 | 5,208 | 3,511,400 |
| | 23.25 | 13.22 | 2,300 | 715,200 | 16.49 | 3,687 | 1,231,200 | 31.88 | 5,546 | 3,866,000 |
| | 24.25 | 13.34 | 2,429 | 773,100 | 16.61 | 3,902 | 1,334,300 | 32.38 | 5,892 | 4,244,300 |
| | 25.25 | 13.47 | 2,559 | 833,900 | 16.73 | 4,121 | 1,443,000 | 32.88 | 6,246 | 4,647,300 |
| | 26.25 | 13.59 | 2,692 | 897,700 | 16.85 | 4,344 | 1,557,200 | 33.38 | 6,608 | 5,075,900 |
| 44 | 8.25 | 11.84 | 640 | 150,700 | 15.43 | 982 | 247,200 | 25.38 | 1,370 | 590,800 |
| | 9.25 | 11.97 | 742 | 179,000 | 15.54 | 1,143 | 294,600 | 25.88 | 1,604 | 720,100 |
| | 10.25 | 12.09 | 847 | 209,100 | 15.65 | 1,308 | 345,200 | 26.38 | 1,846 | 862,100 |
| | 11.25 | 12.22 | 953 | 240,900 | 15.77 | 1,477 | 399,200 | 26.88 | 2,096 | 1,017,700 |
| | 12.25 | 12.34 | 1,062 | 274,700 | 15.88 | 1,650 | 456,700 | 27.38 | 2,354 | 1,187,500 |
| | 13.25 | 12.47 | 1,172 | 310,400 | 16.00 | 1,827 | 517,800 | 27.88 | 2,620 | 1,372,400 |
| | 14.25 | 12.59 | 1,285 | 348,300 | 16.11 | 2,008 | 582,700 | 28.38 | 2,894 | 1,573,100 |
| | 15.25 | 12.72 | 1,399 | 388,200 | 16.23 | 2,193 | 651,600 | 28.88 | 3,176 | 1,790,500 |
| | 16.25 | 12.84 | 1,516 | 430,400 | 16.34 | 2,382 | 724,600 | 29.38 | 3,466 | 2,025,400 |
| | 17.25 | 12.97 | 1,634 | 474,900 | 16.46 | 2,575 | 802,000 | 29.88 | 3,764 | 2,278,700 |
| | 18.25 | 13.09 | 1,755 | 521,900 | 16.57 | 2,772 | 883,800 | 30.38 | 4,070 | 2,551,200 |
| | 19.25 | 13.22 | 1,877 | 571,300 | 16.69 | 2,973 | 970,300 | 30.88 | 4,384 | 2,843,800 |
| | 20.25 | 13.34 | 2,002 | 623,300 | 16.81 | 3,178 | 1,061,600 | 31.38 | 4,706 | 3,157,500 |
| | 21.25 | 13.47 | 2,128 | 678,000 | 16.92 | 3,387 | 1,157,900 | 31.88 | 5,036 | 3,493,100 |
| | 22.25 | 13.59 | 2,257 | 735,500 | 17.04 | 3,600 | 1,259,400 | 32.38 | 5,374 | 3,851,700 |
| | 23.25 | 13.72 | 2,387 | 795,800 | 17.16 | 3,817 | 1,366,400 | 32.88 | 5,720 | 4,234,300 |
| | 24.25 | 13.84 | 2,520 | 859,100 | 17.28 | 4,038 | 1,478,800 | 33.38 | 6,074 | 4,641,700 |
| | 25.25 | 13.97 | 2,654 | 925,500 | 17.39 | 4,263 | 1,597,100 | 33.88 | 6,436 | 5,075,100 |
| | 26.25 | 14.09 | 2,791 | 995,100 | 17.51 | 4,492 | 1,721,400 | 34.38 | 6,806 | 5,535,400 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

TABLE 10-2 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $C_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 46 | 8.25 | 12.34 | 667 | 170,500 | 16.09 | 1,023 | 279,400 | 26.38 | 1,424 | 663,200 |
| | 9.25 | 12.47 | 773 | 202,200 | 16.21 | 1,190 | 332,500 | 26.88 | 1,666 | 806,500 |
| | 10.25 | 12.59 | 882 | 235,800 | 16.32 | 1,361 | 389,000 | 27.38 | 1,916 | 963,500 |
| | 11.25 | 12.72 | 992 | 271,400 | 16.43 | 1,536 | 449,100 | 27.88 | 2,174 | 1,134,900 |
| | 12.25 | 12.84 | 1,105 | 309,000 | 16.55 | 1,715 | 512,900 | 28.38 | 2,440 | 1,321,600 |
| | 13.25 | 12.97 | 1,219 | 348,700 | 16.66 | 1,898 | 580,700 | 28.88 | 2,714 | 1,524,300 |
| | 14.25 | 13.09 | 1,336 | 390,700 | 16.78 | 2,085 | 652,500 | 29.38 | 2,996 | 1,743,900 |
| | 15.25 | 13.22 | 1,454 | 434,900 | 16.89 | 2,276 | 728,600 | 29.88 | 3,286 | 1,981,200 |
| | 16.25 | 13.34 | 1,575 | 481,500 | 17.01 | 2,471 | 809,100 | 30.38 | 3,584 | 2,237,100 |
| | 17.25 | 13.47 | 1,697 | 530,600 | 17.12 | 2,670 | 894,200 | 30.88 | 3,890 | 2,512,500 |
| | 18.25 | 13.59 | 1,822 | 582,300 | 17.24 | 2,873 | 984,000 | 31.38 | 4,204 | 2,808,200 |
| | 19.25 | 13.72 | 1,948 | 636,600 | 17.36 | 3,080 | 1,078,800 | 31.88 | 4,526 | 3,125,200 |
| | 20.25 | 13.84 | 2,077 | 693,700 | 17.47 | 3,291 | 1,178,800 | 32.38 | 4,856 | 3,464,500 |
| | 21.25 | 13.97 | 2,207 | 753,600 | 17.59 | 3,506 | 1,284,000 | 32.88 | 5,194 | 3,826,900 |
| | 22.25 | 14.09 | 2,340 | 816,500 | 17.71 | 3,725 | 1,394,800 | 33.38 | 5,540 | 4,213,500 |
| | 23.25 | 14.22 | 2,474 | 882,400 | 17.82 | 3,948 | 1,511,300 | 33.88 | 5,894 | 4,625,300 |
| | 24.25 | 14.34 | 2,611 | 951,500 | 17.94 | 4,175 | 1,633,700 | 34.38 | 6,256 | 5,063,300 |
| | 25.25 | 14.47 | 2,749 | 1,023,800 | 18.06 | 4,406 | 1,762,100 | 34.88 | 6,626 | 5,528,600 |
| | 26.25 | 14.59 | 2,890 | 1,099,400 | 18.17 | 4,641 | 1,896,900 | 35.38 | 7,004 | 6,022,100 |
| 48 | 8.25 | 12.84 | 694 | 192,000 | 16.76 | 1,063 | 314,300 | 27.38 | 1,478 | 741,300 |
| | 9.25 | 12.97 | 804 | 227,400 | 16.87 | 1,236 | 373,400 | 27.88 | 1,728 | 899,600 |
| | 10.25 | 13.09 | 917 | 264,800 | 16.99 | 1,413 | 436,200 | 28.38 | 1,986 | 1,072,500 |
| | 11.25 | 13.22 | 1,031 | 304,400 | 17.10 | 1,594 | 502,900 | 28.88 | 2,252 | 1,260,800 |
| | 12.25 | 13.34 | 1,148 | 346,100 | 17.21 | 1,779 | 573,600 | 29.38 | 2,526 | 1,465,400 |
| | 13.25 | 13.47 | 1,266 | 390,100 | 17.33 | 1,968 | 648,500 | 29.88 | 2,808 | 1,687,100 |
| | 14.25 | 13.59 | 1,387 | 436,400 | 17.44 | 2,161 | 727,700 | 30.38 | 3,098 | 1,926,700 |
| | 15.25 | 13.72 | 1,509 | 485,200 | 17.56 | 2,358 | 811,500 | 30.88 | 3,396 | 2,185,100 |
| | 16.25 | 13.84 | 1,634 | 536,600 | 17.67 | 2,559 | 900,000 | 31.38 | 3,702 | 2,463,200 |
| | 17.25 | 13.97 | 1,760 | 590,600 | 17.79 | 2,764 | 993,300 | 31.88 | 4,016 | 2,761,900 |
| | 18.25 | 14.09 | 1,889 | 647,300 | 17.91 | 2,973 | 1,091,700 | 32.38 | 4,338 | 3,082,100 |
| | 19.25 | 14.22 | 2,019 | 706,800 | 18.02 | 3,186 | 1,195,400 | 32.88 | 4,668 | 3,424,800 |
| | 20.25 | 14.34 | 2,152 | 769,300 | 18.14 | 3,403 | 1,304,500 | 33.38 | 5,006 | 3,790,900 |
| | 21.25 | 14.47 | 2,286 | 834,800 | 18.25 | 3,624 | 1,419,200 | 33.88 | 5,352 | 4,181,500 |
| | 22.25 | 14.59 | 2,423 | 903,400 | 18.37 | 3,849 | 1,539,700 | 34.38 | 5,706 | 4,597,500 |
| | 23.25 | 14.72 | 2,561 | 975,200 | 18.49 | 4,078 | 1,666,300 | 34.88 | 6,068 | 5,040,000 |
| | 24.25 | 14.84 | 2,702 | 1,050,300 | 18.60 | 4,311 | 1,799,100 | 35.38 | 6,438 | 5,510,000 |
| | 25.25 | 14.97 | 2,844 | 1,128,900 | 18.72 | 4,548 | 1,938,400 | 35.88 | 6,816 | 6,008,600 |
| | 26.25 | 15.09 | 2,989 | 1,211,000 | 18.84 | 4,789 | 2,084,300 | 36.38 | 7,202 | 6,536,900 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.5 inches.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superim-posed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip [1] Top Ext. + | Column Strip Bottom | Column Strip Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superim-posed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 6 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 6 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 15 | 100 | 2.25 | 5.00 | 12 | 0.634 | 10-#4 0 | 10-#3 | 10-#4 | 9-#3 | 8-#4 | 1.60 | 18.2 | 36.5 | 49.1 | 100 | 12 | 10-#4 | 9-#3 | 8-#4 | 9-#3 | 1.60 | 0.521 |
| 15 | 200 | 2.25 | 5.00 | 13 | 0.700 | 10-#4 0 | 8-#4 | 10-#4 | 10-#3 | 8-#4 | 1.75 | 27.1 | 54.3 | 73.1 | 200 | 15 | 10-#4 | 10-#3 | 8-#4 | 9-#3 | 1.65 | 0.521 |
| 15 | 300 | 2.25 | 5.00 | 14 | 0.799 | 10-#4 1 | 8-#5 | 13-#4 | 8-#4 | 8-#4 | 2.23 | 36.2 | 81.0 | 97.6 | 300 | 15 | 12-#4 | 8-#4 | 8-#4 | 10-#3 | 1.96 | 0.521 |
| 15 | 400 | 4.25 | 5.00 | 15 | 0.624 | 10-#4 0 | 17-#4 | 12-#4 | 11-#4 | 8-#4 | 2.66 | 45.3 | 109.6 | 122.0 | 400 | 15 | 11-#4 | 11-#4 | 8-#4 | 13-#3 | 2.27 | 0.539 |
| 16 | 100 | 2.25 | 5.33 | 12 | 0.695 | 11-#4 0 | 12-#3 | 11-#4 | 10-#3 | 8-#4 | 1.65 | 22.3 | 44.7 | 60.1 | 100 | 12 | 11-#4 | 10-#3 | 8-#4 | 10-#3 | 1.62 | 0.521 |
| 16 | 200 | 2.25 | 5.33 | 13 | 0.769 | 11-#4 0 | 10-#4 | 12-#4 | 12-#3 | 8-#4 | 1.87 | 33.3 | 66.6 | 89.6 | 200 | 15 | 11-#4 | 12-#3 | 8-#4 | 10-#3 | 1.71 | 0.521 |
| 16 | 300 | 4.25 | 5.33 | 15 | 0.624 | 11-#4 0 | 15-#4 | 12-#4 | 10-#4 | 8-#4 | 2.33 | 44.1 | 97.1 | 118.6 | 300 | 16 | 11-#4 | 10-#4 | 8-#4 | 12-#3 | 2.01 | 0.539 |
| 16 | 400 | 4.25 | 5.33 | 16 | 0.623 | 11-#4 0 | 13-#5 | 15-#4 | 13-#4 | 10-#4 | 2.97 | 55.0 | 126.9 | 148.0 | 400 | 16 | 14-#4 | 13-#4 | 9-#4 | 15-#3 | 2.51 | 0.539 |
| 17 | 100 | 2.25 | 5.67 | 12 | 0.746 | 12-#4 0 | 14-#3 | 12-#4 | 11-#3 | 9-#4 | 1.71 | 27.0 | 54.0 | 72.7 | 100 | 12 | 12-#4 | 11-#3 | 9-#4 | 11-#3 | 1.67 | 0.521 |
| 17 | 200 | 2.25 | 5.67 | 14 | 0.833 | 12-#4 2 | 12-#4 | 14-#4 | 14-#3 | 9-#4 | 2.03 | 39.9 | 79.7 | 107.3 | 200 | 16 | 13-#4 | 14-#3 | 9-#4 | 11-#3 | 1.84 | 0.521 |
| 17 | 300 | 4.25 | 5.67 | 15 | 0.651 | 12-#4 0 | 11-#5 | 14-#4 | 11-#4 | 9-#4 | 2.47 | 53.1 | 109.4 | 143.0 | 300 | 17 | 13-#4 | 11-#4 | 9-#4 | 13-#3 | 2.12 | 0.539 |
| 17 | 400 | 4.25 | 6.80 | 17 | 0.742 | 12-#4 1 | 16-#5 | 12-#5 | 10-#5 | 11-#4 | 3.26 | 66.2 | 149.3 | 178.1 | 400 | 17 | 16-#4 | 10-#5 | 11-#4 | 10-#4 | 2.74 | 0.557 |
| 18 | 100 | 2.25 | 6.00 | 12 | 0.790 | 12-#4 1 | 10-#4 | 12-#4 | 11-#3 | 9-#4 | 1.70 | 32.3 | 64.6 | 86.9 | 100 | 12 | 12-#4 | 12-#3 | 9-#4 | 11-#3 | 1.60 | 0.521 |
| 18 | 200 | 4.25 | 6.00 | 14 | 0.634 | 12-#4 0 | 15-#4 | 13-#4 | 10-#4 | 9-#4 | 2.11 | 47.9 | 95.8 | 128.9 | 200 | 16 | 12-#4 | 10-#4 | 9-#4 | 11-#3 | 1.81 | 0.539 |
| 18 | 300 | 4.25 | 6.00 | 15 | 0.701 | 12-#4 0 | 13-#5 | 17-#4 | 13-#4 | 11-#4 | 2.71 | 63.3 | 126.6 | 170.5 | 300 | 18 | 15-#4 | 13-#4 | 10-#4 | 15-#3 | 2.30 | 0.539 |
| 18 | 400 | 6.25 | 7.20 | 17 | 0.626 | 12-#4 0 | 19-#5 | 17-#4 | 12-#5 | 9-#5 | 3.53 | 79.2 | 176.2 | 213.1 | 400 | 18 | 16-#4 | 12-#5 | 13-#4 | 12-#4 | 2.96 | 0.583 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

# FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

# SQUARE INTERIOR PANEL

With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 6.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 6.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 15 | 100 | 2.25 | 5.00 | 12 | 0.625 | 10-#4 0 | 10-#3 | 10-#4 | 10-#3 | 8-#4 | 1.66 | 19.0 | 37.9 | 51.0 | 100 | 12 | 10-#4 | 10-#3 | 8-#4 | 10-#3 | 1.68 | 0.562 |
| 15 | 200 | 2.25 | 5.00 | 13 | 0.655 | 10-#4 0 | 8-#4 | 10-#4 | 10-#3 | 8-#4 | 1.77 | 27.8 | 57.2 | 74.9 | 200 | 15 | 10-#4 | 10-#3 | 8-#4 | 10-#3 | 1.69 | 0.562 |
| 15 | 300 | 2.25 | 5.00 | 15 | 0.690 | 10-#4 0 | 12-#4 | 12-#4 | 8-#4 | 8-#4 | 2.16 | 36.7 | 84.1 | 98.8 | 300 | 15 | 11-#4 | 8-#4 | 8-#4 | 10-#3 | 1.92 | 0.562 |
| 15 | 400 | 4.25 | 5.00 | 15 | 0.625 | 10-#4 0 | 16-#4 | 12-#4 | 18-#3 | 8-#4 | 2.57 | 46.0 | 113.8 | 123.8 | 400 | 15 | 11-#4 | 7-#5 | 8-#4 | 12-#3 | 2.25 | 0.581 |
| 16 | 100 | 2.25 | 5.33 | 12 | 0.634 | 10-#4 0 | 11-#3 | 10-#4 | 11-#3 | 8-#4 | 1.64 | 23.2 | 46.4 | 62.5 | 100 | 12 | 10-#4 | 11-#3 | 8-#4 | 11-#3 | 1.65 | 0.562 |
| 16 | 200 | 2.25 | 5.33 | 13 | 0.696 | 10-#4 0 | 9-#4 | 11-#4 | 11-#3 | 8-#4 | 1.77 | 33.9 | 67.9 | 91.4 | 200 | 16 | 10-#4 | 11-#3 | 8-#4 | 11-#3 | 1.66 | 0.562 |
| 16 | 300 | 2.25 | 5.33 | 15 | 0.795 | 10-#4 2 | 13-#4 | 14-#4 | 9-#4 | 8-#4 | 2.20 | 44.8 | 97.1 | 120.6 | 300 | 16 | 13-#4 | 9-#4 | 8-#4 | 10-#3 | 1.95 | 0.562 |
| 16 | 400 | 4.25 | 5.33 | 16 | 0.624 | 10-#4 0 | 19-#4 | 14-#4 | 8-#5 | 9-#4 | 2.75 | 55.8 | 133.2 | 150.3 | 400 | 16 | 13-#4 | 12-#4 | 8-#4 | 8-#4 | 2.32 | 0.581 |
| 17 | 100 | 2.25 | 5.67 | 12 | 0.696 | 11-#4 0 | 8-#4 | 11-#4 | 11-#3 | 9-#4 | 1.68 | 28.1 | 56.1 | 75.6 | 100 | 12 | 11-#4 | 11-#3 | 9-#4 | 11-#3 | 1.64 | 0.562 |
| 17 | 200 | 2.25 | 5.67 | 13 | 0.766 | 11-#4 0 | 11-#4 | 13-#4 | 13-#3 | 9-#4 | 1.91 | 41.1 | 82.2 | 110.7 | 200 | 16 | 12-#4 | 13-#3 | 9-#4 | 11-#3 | 1.76 | 0.562 |
| 17 | 300 | 4.25 | 5.67 | 16 | 0.624 | 11-#4 0 | 16-#4 | 14-#4 | 18-#3 | 9-#4 | 2.35 | 53.8 | 114.9 | 144.9 | 300 | 17 | 13-#4 | 11-#4 | 9-#4 | 12-#3 | 2.07 | 0.581 |
| 17 | 400 | 4.25 | 5.67 | 16 | 0.672 | 11-#4 1 | 14-#5 | 11-#5 | 14-#4 | 10-#4 | 3.02 | 67.3 | 153.5 | 181.3 | 400 | 17 | 16-#4 | 14-#4 | 10-#4 | 9-#4 | 2.59 | 0.581 |
| 18 | 100 | 2.25 | 6.00 | 12 | 0.747 | 12-#4 0 | 9-#4 | 12-#4 | 12-#3 | 9-#4 | 1.70 | 33.6 | 67.1 | 90.3 | 100 | 12 | 12-#4 | 12-#3 | 9-#4 | 12-#3 | 1.63 | 0.562 |
| 18 | 200 | 4.25 | 6.00 | 14 | 0.626 | 12-#4 0 | 13-#4 | 12-#4 | 9-#4 | 9-#4 | 1.99 | 48.9 | 97.7 | 131.6 | 200 | 17 | 12-#4 | 9-#4 | 9-#4 | 12-#3 | 1.78 | 0.581 |
| 18 | 300 | 4.25 | 6.00 | 16 | 0.624 | 12-#4 0 | 18-#4 | 16-#4 | 12-#4 | 10-#4 | 2.49 | 64.2 | 128.4 | 172.9 | 300 | 18 | 15-#4 | 12-#4 | 9-#4 | 14-#3 | 2.17 | 0.581 |
| 18 | 400 | 6.25 | 6.00 | 17 | 0.626 | 12-#4 0 | 9-#7 | 16-#4 | 16-#4 | 12-#4 | 3.31 | 80.0 | 178.3 | 215.4 | 400 | 18 | 15-#4 | 11-#5 | 11-#4 | 11-#4 | 2.78 | 0.600 |
| 19 | 100 | 2.25 | 6.33 | 12 | 0.791 | 12-#4 1 | 11-#4 | 13-#4 | 13-#3 | 10-#4 | 1.76 | 39.7 | 79.4 | 106.9 | 100 | 12 | 12-#4 | 13-#3 | 10-#4 | 13-#3 | 1.65 | 0.562 |
| 19 | 200 | 4.25 | 6.33 | 14 | 0.676 | 12-#4 1 | 16-#4 | 15-#4 | 11-#4 | 10-#4 | 2.15 | 57.9 | 115.9 | 156.0 | 200 | 17 | 13-#4 | 18-#3 | 10-#4 | 12-#3 | 1.82 | 0.581 |
| 19 | 300 | 4.25 | 6.33 | 16 | 0.701 | 12-#4 1 | 21-#4 | 19-#4 | 9-#5 | 12-#4 | 2.78 | 76.2 | 152.4 | 205.2 | 300 | 18 | 12-#5 | 9-#5 | 11-#4 | 9-#4 | 2.47 | 0.581 |
| 19 | 400 | 6.25 | 7.60 | 18 | 0.625 | 12-#4 0 | 14-#6 | 19-#4 | 19-#4 | 10-#5 | 3.52 | 94.5 | 208.3 | 254.4 | 400 | 19 | 12-#5 | 19-#4 | 13-#4 | 22-#3 | 2.95 | 0.625 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

# FLAT SLAB SYSTEM

## SQUARE EDGE PANEL — With Drop Panels — No Beams

# SQUARE INTERIOR PANEL

## With Drop Panels(2) — No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 7 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 7 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 15 | 100 | 2.25 | 5.00 | 12 | 0.626 | 9-#4 0 | 11-#3 | 9-#4 | 11-#3 | 8-#4 | 1.71 | 19.7 | 39.4 | 53.0 | 100 | 12 | 9-#4 | 11-#3 | 8-#4 | 11-#3 | 1.73 | 0.604 |
| 15 | 200 | 2.25 | 5.00 | 14 | 0.623 | 9-#4 0 | 13-#3 | 9-#4 | 11-#3 | 8-#4 | 1.77 | 28.4 | 59.6 | 76.4 | 200 | 15 | 9-#4 | 11-#3 | 8-#4 | 11-#3 | 1.74 | 0.604 |
| 15 | 300 | 2.25 | 5.00 | 15 | 0.622 | 9-#4 0 | 7-#5 | 11-#4 | 7-#4 | 8-#4 | 2.06 | 37.4 | 87.2 | 100.7 | 300 | 15 | 11-#4 | 7-#4 | 8-#4 | 11-#3 | 1.90 | 0.604 |
| 15 | 400 | 2.25 | 5.00 | 15 | 0.725 | 9-#4 0 | 14-#4 | 9-#5 | 10-#4 | 8-#4 | 2.49 | 46.6 | 114.4 | 125.5 | 400 | 15 | 13-#4 | 10-#4 | 8-#4 | 11-#3 | 2.22 | 0.604 |
| 15 | 500 | 4.25 | 5.00 | 15 | 0.626 | 9-#4 0 | 12-#5 | 13-#4 | 8-#5 | 8-#4 | 2.89 | 55.9 | 142.3 | 150.5 | 500 | 15 | 12-#4 | 12-#4 | 8-#4 | 8-#4 | 2.43 | 0.623 |
| 16 | 100 | 2.25 | 5.33 | 12 | 0.626 | 10-#4 0 | 11-#3 | 10-#4 | 11-#3 | 8-#4 | 1.64 | 24.1 | 48.2 | 64.9 | 100 | 12 | 10-#4 | 11-#3 | 8-#4 | 11-#3 | 1.65 | 0.604 |
| 16 | 200 | 2.25 | 5.33 | 14 | 0.623 | 10-#4 0 | 15-#3 | 10-#4 | 11-#3 | 8-#4 | 1.73 | 34.6 | 69.2 | 93.2 | 200 | 16 | 10-#4 | 11-#3 | 8-#4 | 11-#3 | 1.66 | 0.604 |
| 16 | 300 | 2.25 | 5.33 | 15 | 0.723 | 10-#4 1 | 13-#4 | 14-#4 | 15-#3 | 8-#4 | 2.19 | 45.7 | 101.6 | 122.9 | 300 | 16 | 13-#4 | 15-#3 | 8-#4 | 11-#3 | 1.97 | 0.604 |
| 16 | 400 | 4.25 | 5.33 | 16 | 0.625 | 10-#4 0 | 17-#4 | 14-#4 | 8-#5 | 8-#4 | 2.67 | 56.7 | 137.5 | 152.6 | 400 | 16 | 13-#4 | 12-#4 | 8-#4 | 8-#4 | 2.32 | 0.623 |
| 16 | 500 | 4.25 | 5.33 | 16 | 0.625 | 10-#4 0 | 10-#6 | 16-#4 | 9-#5 | 10-#4 | 3.20 | 67.9 | 167.5 | 182.7 | 500 | 16 | 10-#5 | 14-#4 | 9-#4 | 9-#4 | 2.70 | 0.623 |
| 17 | 100 | 2.25 | 5.67 | 12 | 0.637 | 10-#4 0 | 13-#3 | 10-#4 | 12-#3 | 9-#4 | 1.65 | 29.1 | 58.3 | 78.4 | 100 | 12 | 10-#4 | 12-#3 | 9-#4 | 12-#3 | 1.65 | 0.604 |
| 17 | 200 | 2.25 | 5.67 | 14 | 0.693 | 10-#4 1 | 18-#3 | 13-#4 | 12-#3 | 9-#4 | 1.84 | 41.9 | 83.8 | 112.9 | 200 | 16 | 12-#4 | 12-#3 | 9-#4 | 12-#3 | 1.75 | 0.604 |
| 17 | 300 | 2.25 | 5.67 | 16 | 0.791 | 10-#4 3 | 14-#4 | 16-#4 | 10-#4 | 9-#4 | 2.31 | 54.7 | 114.9 | 147.4 | 300 | 17 | 10-#5 | 10-#4 | 9-#4 | 12-#3 | 2.12 | 0.604 |
| 17 | 400 | 4.25 | 5.67 | 17 | 0.624 | 10-#4 1 | 13-#5 | 16-#4 | 13-#4 | 10-#4 | 2.83 | 68.0 | 158.8 | 183.0 | 400 | 17 | 10-#5 | 13-#4 | 9-#4 | 9-#4 | 2.47 | 0.623 |
| 17 | 500 | 4.25 | 6.80 | 17 | 0.755 | 10-#4 4 | 9-#7 | 19-#4 | 8-#6 | 8-#5 | 3.60 | 81.6 | 197.9 | 219.6 | 500 | 17 | 12-#5 | 11-#5 | 11-#4 | 11-#4 | 3.03 | 0.640 |
| 18 | 100 | 2.25 | 6.00 | 12 | 0.699 | 11-#4 0 | 15-#3 | 11-#4 | 13-#3 | 9-#4 | 1.70 | 34.8 | 69.6 | 93.8 | 100 | 12 | 11-#4 | 13-#3 | 9-#4 | 13-#3 | 1.68 | 0.604 |
| 18 | 200 | 2.25 | 6.00 | 14 | 0.759 | 11-#4 1 | 8-#5 | 15-#4 | 8-#4 | 9-#4 | 1.99 | 50.2 | 100.4 | 135.2 | 200 | 16 | 14-#4 | 8-#4 | 9-#4 | 13-#3 | 1.85 | 0.604 |
| 18 | 300 | 4.25 | 6.00 | 16 | 0.625 | 11-#4 0 | 11-#5 | 16-#4 | 11-#4 | 9-#4 | 2.36 | 65.4 | 135.1 | 176.1 | 300 | 18 | 14-#4 | 11-#4 | 9-#4 | 13-#3 | 2.03 | 0.623 |
| 18 | 400 | 4.25 | 6.00 | 17 | 0.678 | 11-#4 2 | 15-#5 | 19-#4 | 10-#5 | 11-#4 | 3.10 | 81.1 | 180.7 | 218.3 | 400 | 18 | 12-#5 | 15-#4 | 11-#4 | 10-#4 | 2.70 | 0.623 |
| 18 | 500 | 6.25 | 7.20 | 18 | 0.626 | 11-#4 1 | 20-#5 | 19-#4 | 13-#5 | 9-#5 | 3.79 | 97.1 | 233.2 | 261.3 | 500 | 18 | 12-#5 | 13-#5 | 13-#4 | 13-#4 | 3.24 | 0.667 |
| 19 | 100 | 2.25 | 6.33 | 12 | 0.772 | 11-#4 2 | 10-#4 | 12-#4 | 14-#3 | 10-#4 | 1.73 | 41.2 | 82.4 | 111.0 | 100 | 12 | 11-#4 | 14-#3 | 10-#4 | 14-#3 | 1.67 | 0.604 |
| 19 | 200 | 4.25 | 6.33 | 14 | 0.627 | 11-#4 0 | 15-#4 | 14-#4 | 10-#4 | 10-#4 | 2.09 | 59.4 | 118.8 | 159.9 | 200 | 17 | 13-#4 | 10-#4 | 10-#4 | 14-#3 | 1.88 | 0.623 |
| 19 | 300 | 4.25 | 6.33 | 16 | 0.638 | 11-#4 1 | 19-#4 | 12-#5 | 13-#4 | 11-#4 | 2.56 | 77.3 | 154.5 | 208.0 | 300 | 19 | 11-#5 | 13-#4 | 10-#4 | 15-#3 | 2.27 | 0.623 |
| 19 | 400 | 6.25 | 6.33 | 18 | 0.626 | 11-#4 1 | 18-#5 | 12-#5 | 17-#4 | 13-#4 | 3.24 | 95.5 | 208.1 | 257.1 | 400 | 19 | 17-#4 | 18-#4 | 12-#4 | 20-#3 | 2.76 | 0.641 |
| 19 | 500 | 6.25 | 7.60 | 18 | 0.661 | 11-#4 3 | 17-#6 | 15-#5 | 15-#5 | 16-#4 | 4.23 | 114.7 | 264.5 | 308.9 | 500 | 19 | 14-#5 | 15-#5 | 10-#5 | 10-#5 | 3.59 | 0.667 |
| 20 | 100 | 2.25 | 6.67 | 12 | 0.811 | 12-#4 2 | 12-#4 | 14-#4 | 14-#3 | 10-#4 | 1.77 | 48.3 | 96.7 | 130.1 | 100 | 12 | 13-#4 | 14-#3 | 10-#4 | 14-#3 | 1.66 | 0.604 |
| 20 | 200 | 4.25 | 6.67 | 14 | 0.712 | 12-#4 2 | 17-#4 | 17-#4 | 20-#3 | 10-#4 | 2.18 | 69.8 | 139.6 | 187.9 | 200 | 17 | 15-#4 | 20-#3 | 10-#4 | 14-#3 | 1.92 | 0.623 |
| 20 | 300 | 4.25 | 6.67 | 17 | 0.700 | 12-#4 2 | 15-#5 | 14-#5 | 10-#5 | 13-#4 | 2.88 | 90.1 | 180.1 | 242.5 | 300 | 20 | 13-#5 | 15-#4 | 12-#4 | 10-#4 | 2.52 | 0.623 |
| 20 | 400 | 6.25 | 8.00 | 18 | 0.626 | 12-#4 1 | 11-#7 | 22-#4 | 20-#4 | 16-#4 | 3.57 | 112.3 | 242.0 | 302.4 | 400 | 20 | 13-#5 | 20-#4 | 14-#4 | 13-#4 | 3.00 | 0.667 |
| 20 | 500 | 8.25 | 8.00 | 19 | 0.628 | 12-#4 1 | 19-#6 | 15-#5 | 9-#7 | 19-#4 | 4.46 | 134.1 | 302.4 | 361.0 | 500 | 20 | 14-#5 | 17-#5 | 17-#4 | 11-#5 | 3.72 | 0.693 |
| 21 | 100 | 4.25 | 7.00 | 12 | 0.686 | 12-#4 1 | 9-#5 | 13-#4 | 9-#4 | 11-#4 | 1.84 | 56.5 | 113.0 | 152.1 | 100 | 12 | 12-#4 | 10-#4 | 11-#4 | 15-#3 | 1.70 | 0.623 |
| 21 | 200 | 4.25 | 7.00 | 14 | 0.782 | 12-#4 4 | 20-#4 | 19-#4 | 9-#5 | 11-#4 | 2.43 | 81.3 | 162.7 | 219.0 | 200 | 17 | 12-#5 | 13-#4 | 11-#4 | 9-#4 | 2.14 | 0.623 |
| 21 | 300 | 6.25 | 7.00 | 17 | 0.627 | 12-#4 1 | 18-#5 | 14-#5 | 12-#5 | 10-#5 | 3.07 | 105.3 | 210.6 | 283.5 | 300 | 20 | 19-#4 | 17-#4 | 9-#5 | 20-#3 | 2.57 | 0.641 |
| 21 | 400 | 6.25 | 8.40 | 18 | 0.749 | 13-#4 5 | 16-#6 | 12-#6 | 22-#4 | 12-#5 | 3.83 | 130.6 | 264.3 | 351.5 | 400 | 21 | 16-#5 | 22-#4 | 11-#5 | 10-#5 | 3.34 | 0.667 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL

With Drop Panels(2)
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *h* = 7.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | *h* = 7.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 15 | 100 | 2.25 | 5.00 | 12 | 0.627 | 8-#4 0 | 7-#4 | 8-#4 | 7-#4 | 8-#4 | 1.78 | 20.4 | 40.8 | 54.9 | 100 | 12 | 8-#4 | 7-#4 | 8-#4 | 7-#4 | 1.79 | 0.646 |
| 15 | 200 | 2.25 | 5.00 | 14 | 0.624 | 8-#4 0 | 7-#4 | 8-#4 | 7-#4 | 8-#4 | 1.79 | 29.1 | 62.1 | 78.2 | 200 | 15 | 8-#4 | 7-#4 | 8-#4 | 7-#4 | 1.81 | 0.646 |
| 15 | 300 | 2.25 | 5.00 | 15 | 0.623 | 8-#4 0 | 10-#4 | 11-#4 | 7-#4 | 8-#4 | 2.00 | 38.1 | 89.9 | 102.6 | 300 | 15 | 10-#4 | 7-#4 | 8-#4 | 7-#4 | 1.91 | 0.646 |
| 15 | 400 | 2.25 | 5.00 | 15 | 0.662 | 8-#4 1 | 9-#5 | 13-#4 | 6-#5 | 8-#4 | 2.42 | 47.3 | 117.2 | 127.4 | 400 | 15 | 8-#5 | 9-#4 | 8-#4 | 7-#4 | 2.18 | 0.646 |
| 15 | 500 | 4.25 | 5.00 | 15 | 0.627 | 8-#4 0 | 11-#5 | 13-#4 | 11-#4 | 8-#4 | 2.72 | 56.6 | 145.8 | 152.4 | 500 | 15 | 8-#5 | 11-#4 | 8-#4 | 8-#4 | 2.38 | 0.664 |
| 16 | 100 | 2.25 | 5.33 | 12 | 0.627 | 9-#4 0 | 7-#4 | 9-#4 | 7-#4 | 8-#4 | 1.72 | 25.0 | 49.9 | 67.2 | 100 | 12 | 9-#4 | 7-#4 | 8-#4 | 7-#4 | 1.73 | 0.646 |
| 16 | 200 | 2.25 | 5.33 | 14 | 0.624 | 9-#4 0 | 8-#4 | 10-#4 | 7-#4 | 8-#4 | 1.78 | 35.5 | 71.7 | 95.4 | 200 | 16 | 9-#4 | 7-#4 | 8-#4 | 7-#4 | 1.75 | 0.646 |
| 16 | 300 | 2.25 | 5.33 | 16 | 0.622 | 9-#4 0 | 12-#4 | 13-#4 | 8-#4 | 8-#4 | 2.10 | 46.2 | 104.9 | 124.5 | 300 | 16 | 12-#4 | 8-#4 | 8-#4 | 7-#4 | 1.94 | 0.646 |
| 16 | 400 | 2.25 | 5.33 | 16 | 0.732 | 9-#4 1 | 16-#4 | 16-#4 | 7-#5 | 8-#4 | 2.59 | 57.4 | 137.8 | 154.6 | 400 | 16 | 10-#5 | 7-#5 | 8-#4 | 7-#4 | 2.34 | 0.646 |
| 16 | 500 | 4.25 | 5.33 | 16 | 0.626 | 9-#4 0 | 13-#5 | 10-#5 | 13-#4 | 9-#4 | 2.94 | 68.7 | 172.5 | 184.9 | 500 | 16 | 14-#4 | 13-#4 | 8-#4 | 9-#4 | 2.51 | 0.664 |
| 17 | 100 | 2.25 | 5.67 | 12 | 0.627 | 10-#4 0 | 7-#4 | 10-#4 | 7-#4 | 9-#4 | 1.68 | 30.2 | 60.4 | 81.3 | 100 | 12 | 10-#4 | 7-#4 | 9-#4 | 7-#4 | 1.69 | 0.646 |
| 17 | 200 | 2.25 | 5.67 | 14 | 0.624 | 10-#4 0 | 10-#4 | 12-#4 | 7-#4 | 9-#4 | 1.84 | 42.7 | 85.4 | 115.0 | 200 | 17 | 11-#4 | 7-#4 | 9-#4 | 7-#4 | 1.77 | 0.646 |
| 17 | 300 | 2.25 | 5.67 | 16 | 0.723 | 10-#4 2 | 9-#5 | 10-#5 | 9-#4 | 9-#4 | 2.27 | 55.8 | 120.4 | 150.1 | 300 | 17 | 10-#5 | 9-#4 | 9-#4 | 7-#4 | 2.09 | 0.646 |
| 17 | 400 | 4.25 | 5.67 | 17 | 0.625 | 10-#4 0 | 9-#6 | 10-#5 | 8-#5 | 9-#4 | 2.81 | 69.0 | 163.6 | 185.7 | 400 | 17 | 10-#5 | 13-#4 | 9-#4 | 9-#4 | 2.47 | 0.664 |
| 17 | 500 | 4.25 | 5.67 | 17 | 0.625 | 10-#4 0 | 11-#6 | 12-#5 | 10-#5 | 7-#5 | 3.32 | 82.4 | 200.7 | 221.8 | 500 | 17 | 11-#5 | 10-#5 | 10-#4 | 10-#4 | 2.84 | 0.664 |
| 18 | 100 | 2.25 | 6.00 | 12 | 0.640 | 10-#4 0 | 8-#4 | 10-#4 | 8-#4 | 9-#4 | 1.70 | 36.1 | 72.2 | 97.2 | 100 | 12 | 10-#4 | 8-#4 | 9-#4 | 8-#4 | 1.70 | 0.646 |
| 18 | 200 | 2.25 | 6.00 | 14 | 0.697 | 10-#4 1 | 12-#4 | 14-#4 | 8-#4 | 9-#4 | 1.95 | 51.2 | 102.4 | 137.8 | 200 | 17 | 13-#4 | 8-#4 | 9-#4 | 8-#4 | 1.85 | 0.646 |
| 18 | 300 | 4.25 | 6.00 | 16 | 0.626 | 10-#4 1 | 16-#4 | 10-#5 | 11-#4 | 9-#4 | 2.31 | 66.6 | 141.6 | 179.4 | 300 | 18 | 14-#4 | 11-#4 | 9-#4 | 8-#4 | 2.06 | 0.664 |
| 18 | 400 | 4.25 | 6.00 | 17 | 0.625 | 10-#4 2 | 14-#5 | 12-#5 | 14-#4 | 11-#4 | 2.90 | 82.3 | 187.3 | 221.6 | 400 | 18 | 11-#5 | 14-#4 | 10-#4 | 10-#4 | 2.55 | 0.664 |
| 18 | 500 | 6.25 | 6.00 | 18 | 0.627 | 10-#4 0 | 18-#5 | 12-#5 | 12-#5 | 8-#5 | 3.52 | 97.9 | 234.7 | 263.6 | 500 | 18 | 11-#5 | 18-#4 | 8-#5 | 8-#5 | 3.03 | 0.683 |
| 19 | 100 | 2.25 | 6.33 | 12 | 0.752 | 11-#4 2 | 10-#4 | 12-#4 | 8-#4 | 10-#4 | 1.75 | 42.7 | 85.4 | 115.0 | 100 | 12 | 11-#4 | 8-#4 | 10-#4 | 8-#4 | 1.69 | 0.646 |
| 19 | 200 | 2.25 | 6.33 | 15 | 0.752 | 11-#4 2 | 9-#5 | 11-#5 | 9-#4 | 10-#4 | 2.10 | 60.4 | 120.8 | 162.6 | 200 | 17 | 16-#4 | 9-#4 | 10-#4 | 8-#4 | 1.95 | 0.646 |
| 19 | 300 | 4.25 | 6.33 | 16 | 0.626 | 11-#4 1 | 18-#4 | 12-#5 | 8-#5 | 10-#4 | 2.43 | 78.7 | 157.4 | 211.9 | 300 | 19 | 16-#4 | 12-#4 | 10-#4 | 8-#4 | 2.12 | 0.664 |
| 19 | 400 | 4.25 | 6.33 | 18 | 0.684 | 11-#4 3 | 16-#5 | 14-#5 | 16-#4 | 8-#5 | 3.16 | 96.8 | 209.3 | 260.5 | 400 | 19 | 13-#5 | 16-#4 | 8-#5 | 11-#4 | 2.80 | 0.664 |
| 19 | 500 | 6.25 | 7.60 | 19 | 0.626 | 11-#4 2 | 12-#7 | 14-#5 | 10-#6 | 10-#5 | 4.03 | 115.6 | 274.2 | 311.1 | 500 | 19 | 13-#5 | 10-#6 | 9-#5 | 9-#5 | 3.38 | 0.708 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip [1] Top Ext. + | Column Strip Bottom | Column Strip Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 7.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 7.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 20 | 100 | 2.25 | 6.67 | 12 | 0.793 | 11-#4 3 | 11-#4 | 14-#4 | 9-#4 | 10-#4 | 1.83 | 50.1 | 100.2 | 134.9 | 100 | 12 | 13-#4 | 9-#4 | 10-#4 | 9-#4 | 1.79 | 0.646 |
| 20 | 200 | 4.25 | 6.67 | 15 | 0.627 | 11-#4 0 | 16-#4 | 16-#4 | 11-#4 | 10-#4 | 2.16 | 71.2 | 142.3 | 191.6 | 200 | 17 | 15-#4 | 11-#4 | 10-#4 | 9-#4 | 1.99 | 0.664 |
| 20 | 300 | 4.25 | 6.67 | 16 | 0.714 | 11-#4 3 | 21-#4 | 14-#5 | 9-#5 | 8-#5 | 2.66 | 92.6 | 185.1 | 249.2 | 300 | 19 | 19-#4 | 9-#5 | 11-#4 | 9-#4 | 2.36 | 0.664 |
| 20 | 400 | 6.25 | 6.67 | 18 | 0.627 | 11-#4 2 | 19-#5 | 14-#5 | 12-#5 | 10-#5 | 3.34 | 113.5 | 240.1 | 305.6 | 400 | 20 | 13-#5 | 18-#4 | 13-#4 | 8-#5 | 2.85 | 0.683 |
| 20 | 500 | 6.25 | 8.00 | 19 | 0.668 | 13-#4 2 | 13-#7 | 12-#6 | 16-#5 | 17-#4 | 4.30 | 135.4 | 308.4 | 364.6 | 500 | 20 | 11-#6 | 16-#5 | 16-#4 | 16-#4 | 3.65 | 0.708 |
| 21 | 100 | 4.25 | 7.00 | 12 | 0.666 | 12-#4 1 | 13-#4 | 13-#4 | 9-#4 | 11-#4 | 1.80 | 58.5 | 117.1 | 157.6 | 100 | 12 | 12-#4 | 9-#4 | 11-#4 | 9-#4 | 1.69 | 0.664 |
| 21 | 200 | 4.25 | 7.00 | 15 | 0.705 | 12-#4 3 | 19-#4 | 12-#5 | 13-#4 | 11-#4 | 2.33 | 83.0 | 165.9 | 223.3 | 200 | 17 | 17-#4 | 13-#4 | 11-#4 | 9-#4 | 2.08 | 0.664 |
| 21 | 300 | 6.25 | 7.00 | 17 | 0.628 | 12-#4 1 | 9-#7 | 13-#5 | 16-#4 | 9-#5 | 2.92 | 107.2 | 214.5 | 288.7 | 300 | 20 | 12-#5 | 16-#4 | 13-#4 | 11-#4 | 2.47 | 0.683 |
| 21 | 400 | 6.25 | 7.00 | 18 | 0.627 | 12-#4 2 | 11-#7 | 16-#5 | 13-#5 | 11-#5 | 3.60 | 131.9 | 263.8 | 355.2 | 400 | 21 | 15-#5 | 13-#5 | 10-#5 | 13-#4 | 3.08 | 0.683 |
| 21 | 500 | 8.25 | 8.40 | 20 | 0.628 | 13-#4 1 | 15-#7 | 25-#4 | 10-#7 | 13-#5 | 4.62 | 157.1 | 350.7 | 422.9 | 500 | 21 | 15-#5 | 13-#6 | 12-#5 | 12-#5 | 3.86 | 0.735 |
| 22 | 100 | 4.25 | 7.33 | 12 | 0.715 | 12-#4 2 | 15-#4 | 15-#4 | 10-#4 | 11-#4 | 1.86 | 67.6 | 135.2 | 182.0 | 100 | 12 | 14-#4 | 10-#4 | 11-#4 | 9-#4 | 1.72 | 0.664 |
| 22 | 200 | 4.25 | 7.33 | 15 | 0.772 | 12-#4 5 | 22-#4 | 14-#5 | 10-#5 | 12-#4 | 2.53 | 96.0 | 192.0 | 258.4 | 200 | 17 | 13-#5 | 15-#4 | 11-#4 | 10-#4 | 2.23 | 0.664 |
| 22 | 300 | 6.25 | 7.33 | 17 | 0.628 | 12-#4 2 | 19-#5 | 15-#5 | 19-#4 | 16-#4 | 3.16 | 124.2 | 248.4 | 334.4 | 300 | 20 | 14-#5 | 19-#4 | 10-#5 | 13-#4 | 2.77 | 0.683 |
| 22 | 400 | 8.25 | 8.80 | 19 | 0.629 | 12-#4 2 | 13-#7 | 16-#5 | 16-#5 | 13-#5 | 3.91 | 152.7 | 311.4 | 411.0 | 400 | 22 | 15-#5 | 16-#5 | 12-#5 | 16-#4 | 3.35 | 0.735 |
| 22 | 500 | 8.25 | 8.80 | 20 | 0.646 | 15-#4 3 | 22-#6 | 14-#6 | 14-#6 | 23-#4 | 4.84 | 181.3 | 384.1 | 488.2 | 500 | 22 | 18-#5 | 14-#6 | 10-#6 | 13-#5 | 4.15 | 0.735 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL
With Drop Panels(2)
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 8 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 8 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 16 | 100 | 2.25 | 5.33 | 12 | 0.628 | 8-#4 0 | 7-#4 | 8-#4 | 7-#4 | 8-#4 | 1.66 | 25.8 | 51.7 | 69.6 | 100 | 12 | 8-#4 | 7-#4 | 8-#4 | 7-#4 | 1.67 | 0.688 |
| 16 | 200 | 2.25 | 5.33 | 14 | 0.625 | 8-#4 0 | 8-#4 | 10-#4 | 7-#4 | 8-#4 | 1.76 | 36.3 | 74.9 | 97.7 | 200 | 16 | 9-#4 | 7-#4 | 8-#4 | 7-#4 | 1.75 | 0.688 |
| 16 | 300 | 2.25 | 5.33 | 16 | 0.623 | 8-#4 0 | 12-#4 | 8-#5 | 8-#4 | 8-#4 | 2.08 | 47.1 | 108.1 | 126.7 | 300 | 16 | 8-#5 | 8-#4 | 8-#4 | 7-#4 | 1.97 | 0.688 |
| 16 | 400 | 2.25 | 5.33 | 16 | 0.635 | 8-#4 1 | 15-#4 | 10-#5 | 10-#4 | 8-#4 | 2.41 | 58.3 | 141.4 | 156.9 | 400 | 16 | 14-#4 | 10-#4 | 8-#4 | 7-#4 | 2.17 | 0.688 |
| 16 | 500 | 4.25 | 5.33 | 16 | 0.627 | 8-#4 1 | 9-#6 | 10-#5 | 8-#5 | 8-#4 | 2.91 | 69.5 | 176.9 | 187.2 | 500 | 16 | 9-#5 | 13-#4 | 8-#4 | 6-#5 | 2.54 | 0.706 |
| 17 | 100 | 2.25 | 5.67 | 12 | 0.628 | 9-#4 0 | 8-#4 | 9-#4 | 8-#4 | 9-#4 | 1.77 | 31.3 | 62.5 | 84.1 | 100 | 12 | 9-#4 | 8-#4 | 9-#4 | 8-#4 | 1.78 | 0.688 |
| 17 | 200 | 2.25 | 5.67 | 14 | 0.625 | 9-#4 1 | 9-#4 | 12-#4 | 8-#4 | 9-#4 | 1.89 | 43.7 | 87.5 | 117.8 | 200 | 17 | 11-#4 | 8-#4 | 9-#4 | 8-#4 | 1.88 | 0.688 |
| 17 | 300 | 2.25 | 5.67 | 16 | 0.623 | 9-#4 0 | 13-#4 | 10-#5 | 9-#4 | 9-#4 | 2.21 | 56.8 | 124.9 | 152.8 | 300 | 17 | 9-#5 | 9-#4 | 9-#4 | 8-#4 | 2.09 | 0.688 |
| 17 | 400 | 4.25 | 5.67 | 17 | 0.626 | 9-#4 0 | 12-#5 | 10-#5 | 8-#5 | 9-#4 | 2.63 | 70.0 | 167.8 | 188.4 | 400 | 17 | 9-#5 | 12-#4 | 9-#4 | 8-#4 | 2.27 | 0.706 |
| 17 | 500 | 4.25 | 5.67 | 17 | 0.626 | 9-#4 1 | 15-#5 | 12-#5 | 7-#6 | 10-#4 | 3.20 | 83.4 | 206.8 | 224.5 | 500 | 17 | 11-#5 | 15-#4 | 9-#4 | 10-#4 | 2.73 | 0.706 |
| 18 | 100 | 2.25 | 6.00 | 12 | 0.636 | 9-#4 1 | 8-#4 | 10-#4 | 8-#4 | 9-#4 | 1.67 | 37.4 | 74.7 | 100.6 | 100 | 12 | 9-#4 | 8-#4 | 9-#4 | 8-#4 | 1.67 | 0.688 |
| 18 | 200 | 2.25 | 6.00 | 14 | 0.683 | 9-#4 2 | 7-#5 | 9-#5 | 8-#4 | 9-#4 | 1.91 | 52.4 | 104.8 | 141.1 | 200 | 17 | 13-#4 | 8-#4 | 9-#4 | 8-#4 | 1.85 | 0.688 |
| 18 | 300 | 2.25 | 6.00 | 16 | 0.759 | 9-#4 4 | 15-#4 | 12-#5 | 10-#4 | 9-#4 | 2.31 | 67.7 | 141.2 | 182.3 | 300 | 18 | 11-#5 | 10-#4 | 9-#4 | 8-#4 | 2.15 | 0.688 |
| 18 | 400 | 4.25 | 6.00 | 18 | 0.625 | 9-#4 1 | 10-#6 | 12-#5 | 9-#5 | 10-#4 | 2.89 | 83.1 | 192.2 | 223.7 | 400 | 18 | 11-#5 | 9-#5 | 9-#4 | 9-#4 | 2.49 | 0.706 |
| 18 | 500 | 4.25 | 6.00 | 18 | 0.660 | 11-#4 2 | 7-#8 | 10-#6 | 8-#6 | 8-#5 | 3.58 | 99.0 | 237.9 | 266.5 | 500 | 18 | 9-#6 | 11-#5 | 7-#5 | 11-#4 | 3.01 | 0.706 |
| 19 | 100 | 2.25 | 6.33 | 12 | 0.645 | 10-#4 0 | 9-#4 | 12-#4 | 9-#4 | 10-#4 | 1.80 | 44.2 | 88.4 | 119.0 | 100 | 12 | 11-#4 | 9-#4 | 10-#4 | 9-#4 | 1.81 | 0.688 |
| 19 | 200 | 2.25 | 6.33 | 14 | 0.735 | 10-#4 2 | 13-#4 | 16-#4 | 9-#4 | 10-#4 | 2.06 | 62.1 | 124.3 | 167.3 | 200 | 17 | 10-#5 | 9-#4 | 10-#4 | 9-#4 | 2.01 | 0.688 |
| 19 | 300 | 4.25 | 6.33 | 17 | 0.626 | 10-#4 2 | 17-#4 | 11-#5 | 8-#5 | 10-#4 | 2.40 | 79.7 | 163.3 | 214.7 | 300 | 19 | 10-#5 | 12-#4 | 10-#4 | 9-#4 | 2.18 | 0.706 |
| 19 | 400 | 4.25 | 6.33 | 18 | 0.625 | 11-#4 2 | 15-#5 | 10-#6 | 10-#5 | 8-#5 | 3.01 | 98.2 | 217.4 | 264.3 | 400 | 19 | 13-#5 | 15-#4 | 11-#4 | 10-#4 | 2.62 | 0.706 |
| 19 | 500 | 6.25 | 6.33 | 19 | 0.627 | 11-#4 2 | 14-#6 | 10-#6 | 9-#6 | 9-#5 | 3.74 | 116.6 | 275.8 | 313.8 | 500 | 19 | 13-#5 | 13-#5 | 13-#4 | 13-#4 | 3.21 | 0.725 |
| 20 | 100 | 2.25 | 6.67 | 12 | 0.708 | 10-#4 1 | 11-#4 | 14-#4 | 9-#4 | 10-#4 | 1.82 | 51.9 | 103.7 | 139.6 | 100 | 12 | 13-#4 | 9-#4 | 10-#4 | 9-#4 | 1.79 | 0.688 |
| 20 | 200 | 4.25 | 6.67 | 15 | 0.628 | 10-#4 1 | 15-#4 | 10-#5 | 10-#4 | 10-#4 | 2.03 | 72.5 | 145.1 | 195.3 | 200 | 18 | 14-#4 | 10-#4 | 10-#4 | 9-#4 | 1.89 | 0.706 |
| 20 | 300 | 4.25 | 6.67 | 17 | 0.626 | 10-#4 3 | 13-#5 | 13-#5 | 13-#4 | 11-#4 | 2.52 | 93.4 | 186.8 | 251.4 | 300 | 20 | 12-#5 | 13-#4 | 10-#4 | 9-#4 | 2.23 | 0.706 |
| 20 | 400 | 6.25 | 6.67 | 18 | 0.628 | 10-#4 1 | 18-#5 | 10-#6 | 12-#5 | 9-#5 | 3.24 | 115.2 | 249.8 | 310.1 | 400 | 20 | 19-#4 | 18-#4 | 8-#5 | 8-#5 | 2.78 | 0.725 |
| 20 | 500 | 6.25 | 8.00 | 20 | 0.626 | 12-#4 2 | 17-#6 | 16-#5 | 8-#7 | 16-#4 | 4.09 | 136.4 | 319.6 | 367.3 | 500 | 20 | 15-#5 | 15-#5 | 10-#5 | 10-#5 | 3.48 | 0.750 |
| 21 | 100 | 2.25 | 7.00 | 12 | 0.812 | 11-#4 4 | 13-#4 | 16-#4 | 10-#4 | 11-#4 | 1.94 | 60.3 | 120.7 | 162.4 | 100 | 12 | 15-#4 | 10-#4 | 11-#4 | 10-#4 | 1.89 | 0.688 |
| 21 | 200 | 4.25 | 7.00 | 15 | 0.628 | 11-#4 1 | 18-#4 | 12-#5 | 8-#5 | 11-#4 | 2.28 | 84.6 | 169.1 | 227.7 | 200 | 18 | 11-#5 | 12-#4 | 11-#4 | 10-#4 | 2.09 | 0.706 |
| 21 | 300 | 4.25 | 7.00 | 17 | 0.688 | 12-#4 2 | 15-#5 | 15-#5 | 10-#5 | 13-#4 | 2.78 | 109.0 | 217.9 | 293.4 | 300 | 20 | 14-#5 | 15-#4 | 8-#5 | 10-#4 | 2.45 | 0.706 |
| 21 | 400 | 6.25 | 7.00 | 18 | 0.628 | 12-#4 2 | 8-#8 | 11-#6 | 19-#4 | 16-#4 | 3.43 | 133.8 | 274.2 | 360.3 | 400 | 21 | 22-#4 | 19-#4 | 10-#5 | 13-#4 | 2.92 | 0.725 |
| 21 | 500 | 6.25 | 8.40 | 20 | 0.728 | 14-#4 5 | 11-#8 | 14-#6 | 9-#7 | 19-#4 | 4.54 | 158.6 | 356.7 | 427.1 | 500 | 21 | 17-#5 | 9-#7 | 17-#4 | 8-#6 | 3.83 | 0.750 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superim-posed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip [1] Top Ext. + | Column Strip Bottom | Column Strip Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superim-posed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 8 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 8 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 22 | 100 | 4.25 | 7.33 | 12 | 0.632 | 11-#4 0 | 15-#4 | 15-#4 | 10-#4 | 11-#4 | 1.88 | 70.0 | 140.0 | 188.4 | 100 | 12 | 14-#4 | 10-#4 | 11-#4 | 10-#4 | 1.76 | 0.706 |
| 22 | 200 | 4.25 | 7.33 | 15 | 0.667 | 11-#4 2 | 21-#4 | 14-#5 | 9-#5 | 12-#4 | 2.42 | 97.9 | 195.7 | 263.5 | 200 | 18 | 19-#4 | 9-#5 | 11-#4 | 10-#4 | 2.16 | 0.706 |
| 22 | 300 | 6.25 | 7.33 | 17 | 0.629 | 11-#4 3 | 18-#5 | 15-#5 | 12-#5 | 10-#5 | 3.02 | 126.4 | 252.9 | 340.4 | 300 | 20 | 14-#5 | 18-#4 | 9-#5 | 12-#4 | 2.62 | 0.725 |
| 22 | 400 | 6.25 | 7.33 | 18 | 0.743 | 14-#4 5 | 22-#5 | 18-#5 | 22-#4 | 12-#5 | 3.66 | 154.4 | 308.9 | 415.8 | 400 | 22 | 12-#6 | 14-#5 | 11-#5 | 14-#4 | 3.21 | 0.725 |
| 22 | 500 | 8.25 | 8.80 | 20 | 0.628 | 14-#4 1 | 16-#7 | 14-#6 | 19-#5 | 22-#4 | 4.64 | 183.5 | 405.2 | 494.1 | 500 | 22 | 12-#6 | 19-#5 | 13-#5 | 19-#4 | 3.89 | 0.777 |
| 23 | 100 | 4.25 | 7.67 | 12 | 0.741 | 12-#4 3 | 11-#5 | 17-#4 | 11-#4 | 12-#4 | 1.98 | 80.3 | 160.6 | 216.2 | 100 | 12 | 16-#4 | 11-#4 | 12-#4 | 10-#4 | 1.82 | 0.706 |
| 23 | 200 | 6.25 | 7.67 | 15 | 0.631 | 12-#4 1 | 16-#5 | 13-#5 | 16-#4 | 13-#4 | 2.54 | 112.8 | 225.6 | 303.7 | 200 | 18 | 12-#5 | 16-#4 | 12-#4 | 11-#4 | 2.20 | 0.725 |
| 23 | 300 | 6.25 | 7.67 | 17 | 0.686 | 13-#4 4 | 11-#7 | 12-#6 | 20-#4 | 11-#5 | 3.31 | 145.4 | 290.9 | 391.6 | 300 | 20 | 16-#5 | 20-#4 | 16-#4 | 9-#5 | 2.86 | 0.725 |
| 23 | 400 | 8.25 | 9.20 | 20 | 0.628 | 14-#4 3 | 18-#6 | 18-#5 | 9-#7 | 10-#6 | 4.00 | 176.9 | 353.7 | 476.2 | 400 | 23 | 25-#4 | 9-#7 | 19-#4 | 11-#5 | 3.45 | 0.777 |
| 23 | 500 | 8.25 | 9.20 | 20 | 0.668 | 16-#4 3 | 23-#6 | 15-#6 | 11-#7 | 9-#7 | 4.98 | 210.5 | 441.4 | 566.7 | 500 | 23 | 14-#6 | 11-#7 | 15-#5 | 10-#6 | 4.30 | 0.777 |
| 24 | 100 | 4.25 | 8.00 | 12 | 0.780 | 13-#4 3 | 19-#4 | 13-#5 | 13-#4 | 13-#4 | 2.15 | 91.6 | 183.2 | 246.6 | 100 | 12 | 12-#5 | 13-#4 | 13-#4 | 11-#4 | 1.99 | 0.706 |
| 24 | 200 | 6.25 | 8.00 | 15 | 0.665 | 13-#4 3 | 18-#5 | 15-#5 | 12-#5 | 10-#5 | 2.77 | 128.8 | 257.7 | 346.9 | 200 | 18 | 14-#5 | 18-#4 | 9-#5 | 12-#4 | 2.38 | 0.725 |
| 24 | 300 | 6.25 | 8.00 | 18 | 0.724 | 15-#4 4 | 23-#5 | 14-#6 | 15-#5 | 19-#4 | 3.56 | 165.0 | 330.0 | 444.2 | 300 | 21 | 18-#5 | 15-#5 | 12-#5 | 10-#5 | 3.14 | 0.725 |
| 24 | 400 | 8.25 | 9.60 | 20 | 0.628 | 16-#4 2 | 12-#8 | 15-#6 | 10-#7 | 16-#5 | 4.42 | 202.4 | 404.8 | 544.9 | 400 | 23 | 14-#6 | 10-#7 | 22-#4 | 19-#4 | 3.78 | 0.777 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

# FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

# SQUARE INTERIOR PANEL

With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 8.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 8.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 17 | 100 | 2.25 | 5.67 | 12 | 0.629 | 9-#4 0 | 8-#4 | 9-#4 | 8-#4 | 6-#5 | 1.78 | 32.3 | 64.6 | 87.0 | 100 | 12 | 9-#4 | 8-#4 | 6-#5 | 8-#4 | 1.79 | 0.729 |
| 17 | 200 | 2.25 | 5.67 | 15 | 0.625 | 9-#4 0 | 9-#4 | 11-#4 | 8-#4 | 6-#5 | 1.86 | 44.5 | 89.1 | 119.9 | 200 | 17 | 10-#4 | 8-#4 | 6-#5 | 8-#4 | 1.84 | 0.729 |
| 17 | 300 | 2.25 | 5.67 | 17 | 0.623 | 9-#4 0 | 8-#5 | 14-#4 | 6-#5 | 6-#5 | 2.17 | 57.5 | 128.3 | 154.7 | 300 | 17 | 13-#4 | 9-#4 | 6-#5 | 8-#4 | 2.05 | 0.729 |
| 17 | 400 | 2.25 | 5.67 | 17 | 0.648 | 9-#4 1 | 11-#5 | 12-#5 | 7-#5 | 6-#5 | 2.62 | 70.9 | 168.3 | 190.8 | 400 | 17 | 8-#6 | 11-#4 | 6-#5 | 8-#4 | 2.38 | 0.729 |
| 17 | 500 | 4.25 | 5.67 | 17 | 0.626 | 9-#4 1 | 10-#6 | 8-#6 | 9-#5 | 6-#5 | 3.04 | 84.4 | 211.7 | 227.2 | 500 | 17 | 16-#4 | 9-#5 | 6-#5 | 6-#5 | 2.61 | 0.748 |
| 17 | 600 | 4.25 | 5.67 | 17 | 0.627 | 10-#4 1 | 16-#5 | 13-#5 | 16-#4 | 7-#5 | 3.47 | 97.8 | 248.2 | 263.4 | 600 | 17 | 12-#5 | 11-#5 | 10-#4 | 7-#5 | 3.08 | 0.748 |
| 18 | 100 | 2.25 | 6.00 | 12 | 0.629 | 9-#4 0 | 9-#4 | 10-#4 | 9-#4 | 9-#4 | 1.81 | 38.6 | 77.3 | 104.0 | 100 | 12 | 9-#4 | 9-#4 | 9-#4 | 9-#4 | 1.80 | 0.729 |
| 18 | 200 | 2.25 | 6.00 | 15 | 0.625 | 9-#4 2 | 7-#5 | 13-#4 | 9-#4 | 9-#4 | 1.98 | 53.4 | 106.7 | 143.7 | 200 | 17 | 12-#4 | 9-#4 | 9-#4 | 9-#4 | 1.94 | 0.729 |
| 18 | 300 | 2.25 | 6.00 | 17 | 0.623 | 9-#4 1 | 14-#4 | 11-#5 | 10-#4 | 9-#4 | 2.27 | 68.6 | 146.0 | 184.6 | 300 | 18 | 16-#4 | 10-#4 | 9-#4 | 9-#4 | 2.17 | 0.729 |
| 18 | 400 | 4.25 | 6.00 | 18 | 0.625 | 9-#4 1 | 9-#6 | 11-#5 | 13-#4 | 9-#4 | 2.68 | 84.3 | 197.5 | 226.9 | 400 | 18 | 16-#4 | 13-#4 | 9-#4 | 9-#4 | 2.34 | 0.748 |
| 18 | 500 | 4.25 | 6.00 | 18 | 0.625 | 10-#4 1 | 16-#5 | 10-#6 | 16-#4 | 7-#5 | 3.24 | 100.2 | 244.6 | 269.7 | 500 | 18 | 19-#4 | 16-#4 | 10-#4 | 7-#5 | 2.82 | 0.748 |
| 18 | 600 | 6.25 | 6.00 | 18 | 0.628 | 10-#4 1 | 8-#8 | 13-#5 | 9-#6 | 13-#4 | 3.94 | 116.2 | 291.3 | 312.9 | 600 | 18 | 12-#5 | 9-#6 | 8-#5 | 13-#4 | 3.34 | 0.766 |
| 19 | 100 | 2.25 | 6.33 | 12 | 0.629 | 10-#4 0 | 9-#4 | 12-#4 | 9-#4 | 10-#4 | 1.80 | 45.7 | 91.4 | 123.1 | 100 | 12 | 11-#4 | 9-#4 | 10-#4 | 9-#4 | 1.81 | 0.729 |
| 19 | 200 | 2.25 | 6.33 | 15 | 0.629 | 10-#4 1 | 12-#4 | 16-#4 | 9-#4 | 10-#4 | 2.03 | 63.3 | 126.6 | 170.4 | 200 | 17 | 10-#5 | 9-#4 | 10-#4 | 9-#4 | 2.01 | 0.729 |
| 19 | 300 | 2.25 | 6.33 | 17 | 0.747 | 10-#4 4 | 16-#4 | 13-#5 | 7-#5 | 10-#4 | 2.39 | 81.0 | 162.8 | 218.1 | 300 | 19 | 12-#5 | 7-#5 | 10-#4 | 9-#4 | 2.26 | 0.729 |
| 19 | 400 | 4.25 | 6.33 | 18 | 0.625 | 10-#4 3 | 15-#5 | 20-#4 | 7-#6 | 7-#5 | 2.93 | 99.6 | 224.6 | 268.1 | 400 | 19 | 19-#4 | 15-#4 | 10-#4 | 10-#4 | 2.53 | 0.748 |
| 19 | 500 | 4.25 | 6.33 | 19 | 0.670 | 12-#4 2 | 13-#6 | 16-#5 | 12-#5 | 13-#4 | 3.63 | 117.8 | 278.5 | 317.2 | 500 | 19 | 15-#5 | 12-#5 | 8-#5 | 8-#5 | 3.19 | 0.748 |
| 19 | 600 | 6.25 | 7.60 | 19 | 0.627 | 12-#4 2 | 12-#7 | 11-#6 | 8-#7 | 7-#6 | 4.24 | 137.1 | 340.5 | 369.1 | 600 | 19 | 22-#4 | 15-#5 | 9-#5 | 7-#6 | 3.58 | 0.792 |
| 20 | 100 | 2.25 | 6.67 | 12 | 0.685 | 10-#4 1 | 11-#4 | 13-#4 | 10-#4 | 10-#4 | 1.87 | 53.6 | 107.2 | 144.4 | 100 | 12 | 12-#4 | 10-#4 | 10-#4 | 10-#4 | 1.84 | 0.729 |
| 20 | 200 | 2.25 | 6.67 | 15 | 0.728 | 10-#4 3 | 15-#4 | 12-#5 | 10-#4 | 10-#4 | 2.15 | 74.4 | 148.8 | 200.3 | 200 | 17 | 11-#5 | 10-#4 | 10-#4 | 10-#4 | 2.07 | 0.729 |
| 20 | 300 | 4.25 | 6.67 | 17 | 0.626 | 10-#4 2 | 12-#5 | 13-#5 | 8-#5 | 11-#4 | 2.45 | 95.0 | 190.1 | 255.9 | 300 | 20 | 12-#5 | 12-#4 | 10-#4 | 10-#4 | 2.23 | 0.748 |
| 20 | 400 | 4.25 | 6.67 | 18 | 0.673 | 12-#4 2 | 16-#5 | 11-#6 | 16-#4 | 13-#4 | 3.06 | 116.7 | 250.9 | 314.1 | 400 | 20 | 22-#4 | 16-#4 | 8-#5 | 11-#4 | 2.71 | 0.748 |
| 20 | 500 | 6.25 | 6.67 | 20 | 0.626 | 12-#4 2 | 15-#6 | 11-#6 | 10-#6 | 10-#5 | 3.84 | 137.6 | 320.2 | 370.5 | 500 | 20 | 22-#4 | 14-#5 | 9-#5 | 9-#5 | 3.28 | 0.766 |
| 20 | 600 | 6.25 | 8.00 | 20 | 0.651 | 14-#4 1 | 11-#8 | 18-#5 | 9-#7 | 12-#5 | 4.70 | 159.9 | 385.6 | 430.5 | 600 | 20 | 12-#6 | 12-#6 | 16-#4 | 8-#6 | 3.93 | 0.792 |
| 21 | 100 | 2.25 | 7.00 | 12 | 0.779 | 11-#4 3 | 12-#4 | 10-#5 | 10-#4 | 11-#4 | 1.89 | 62.4 | 124.8 | 168.0 | 100 | 12 | 14-#4 | 10-#4 | 11-#4 | 10-#4 | 1.85 | 0.729 |
| 21 | 200 | 4.25 | 7.00 | 15 | 0.629 | 11-#4 1 | 11-#5 | 12-#5 | 11-#4 | 11-#4 | 2.18 | 86.5 | 173.1 | 233.0 | 200 | 18 | 16-#4 | 11-#4 | 11-#4 | 10-#4 | 1.99 | 0.748 |
| 21 | 300 | 4.25 | 7.00 | 17 | 0.657 | 11-#4 3 | 15-#5 | 15-#5 | 10-#5 | 8-#5 | 2.73 | 110.9 | 221.8 | 298.6 | 300 | 20 | 10-#6 | 14-#4 | 11-#4 | 10-#4 | 2.38 | 0.748 |
| 21 | 400 | 6.25 | 7.00 | 19 | 0.627 | 12-#4 2 | 19-#5 | 11-#6 | 12-#5 | 10-#5 | 3.29 | 135.2 | 284.6 | 363.9 | 400 | 21 | 10-#6 | 12-#5 | 9-#5 | 8-#5 | 2.87 | 0.766 |
| 21 | 500 | 6.25 | 8.40 | 21 | 0.625 | 14-#4 1 | 10-#8 | 18-#5 | 16-#5 | 12-#5 | 4.17 | 159.8 | 368.2 | 430.3 | 500 | 21 | 12-#6 | 16-#5 | 16-#4 | 16-#4 | 3.54 | 0.792 |
| 21 | 600 | 8.25 | 8.40 | 21 | 0.628 | 14-#4 1 | 16-#7 | 18-#5 | 19-#5 | 10-#6 | 4.86 | 185.5 | 441.0 | 499.4 | 600 | 21 | 12-#6 | 14-#6 | 19-#4 | 19-#4 | 4.12 | 0.818 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip [1] Top Ext. + | Column Strip [1] Bottom | Column Strip [1] Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 8.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 8.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 22 | 100 | 4.25 | 7.33 | 12 | 0.633 | 11-#4 0 | 9-#5 | 15-#4 | 11-#4 | 11-#4 | 1.94 | 72.3 | 144.7 | 194.8 | 100 | 12 | 14-#4 | 11-#4 | 11-#4 | 11-#4 | 1.87 | 0.748 |
| 22 | 200 | 4.25 | 7.33 | 15 | 0.641 | 11-#4 2 | 13-#5 | 14-#5 | 13-#4 | 11-#4 | 2.36 | 100.2 | 200.3 | 269.6 | 200 | 18 | 12-#5 | 13-#4 | 11-#4 | 11-#4 | 2.14 | 0.748 |
| 22 | 300 | 4.25 | 7.33 | 18 | 0.743 | 13-#4 5 | 9-#7 | 12-#6 | 8-#6 | 9-#5 | 3.05 | 127.4 | 254.8 | 343.0 | 300 | 21 | 11-#6 | 11-#5 | 13-#4 | 11-#4 | 2.65 | 0.748 |
| 22 | 400 | 6.25 | 7.33 | 19 | 0.638 | 14-#4 3 | 11-#7 | 18-#5 | 20-#4 | 8-#6 | 3.49 | 156.0 | 312.0 | 420.0 | 400 | 22 | 16-#5 | 20-#4 | 10-#5 | 9-#5 | 3.00 | 0.766 |
| 22 | 500 | 6.25 | 8.80 | 21 | 0.716 | 16-#4 4 | 15-#7 | 11-#7 | 8-#8 | 20-#4 | 4.68 | 184.5 | 407.7 | 496.8 | 500 | 22 | 14-#6 | 13-#6 | 12-#5 | 12-#5 | 3.95 | 0.792 |
| 22 | 600 | 8.25 | 8.80 | 21 | 0.628 | 16-#4 2 | 14-#8 | 11-#7 | 9-#8 | 11-#6 | 5.49 | 214.2 | 490.5 | 576.6 | 600 | 22 | 14-#6 | 9-#8 | 8-#7 | 10-#6 | 4.70 | 0.818 |
| 23 | 100 | 4.25 | 7.67 | 12 | 0.702 | 12-#4 2 | 16-#4 | 11-#5 | 11-#4 | 12-#4 | 1.98 | 83.0 | 166.0 | 223.5 | 100 | 12 | 16-#4 | 11-#4 | 12-#4 | 11-#4 | 1.88 | 0.748 |
| 23 | 200 | 4.25 | 7.67 | 15 | 0.763 | 12-#4 5 | 15-#5 | 11-#6 | 10-#5 | 13-#4 | 2.56 | 115.1 | 230.2 | 309.9 | 200 | 18 | 14-#5 | 15-#4 | 12-#4 | 11-#4 | 2.26 | 0.748 |
| 23 | 300 | 6.25 | 7.67 | 18 | 0.628 | 13-#4 3 | 19-#5 | 12-#6 | 19-#4 | 16-#4 | 3.08 | 146.9 | 293.7 | 395.4 | 300 | 21 | 15-#5 | 19-#4 | 10-#5 | 13-#4 | 2.71 | 0.766 |
| 23 | 400 | 8.25 | 7.67 | 19 | 0.630 | 13-#4 2 | 17-#6 | 18-#5 | 11-#6 | 13-#5 | 3.75 | 179.1 | 358.3 | 482.3 | 400 | 23 | 16-#5 | 15-#5 | 12-#5 | 10-#5 | 3.19 | 0.785 |
| 23 | 500 | 8.25 | 9.20 | 21 | 0.628 | 16-#4 2 | 13-#8 | 11-#7 | 20-#5 | 11-#6 | 4.79 | 212.2 | 460.7 | 571.2 | 500 | 23 | 14-#6 | 20-#5 | 10-#6 | 13-#5 | 4.07 | 0.818 |
| 24 | 100 | 4.25 | 8.00 | 12 | 0.764 | 13-#4 3 | 12-#5 | 19-#4 | 12-#4 | 13-#4 | 2.11 | 94.7 | 189.4 | 254.9 | 100 | 12 | 12-#5 | 12-#4 | 13-#4 | 12-#4 | 1.98 | 0.748 |
| 24 | 200 | 6.25 | 8.00 | 16 | 0.630 | 13-#4 3 | 9-#7 | 15-#5 | 11-#5 | 14-#4 | 2.68 | 130.8 | 261.7 | 352.3 | 200 | 19 | 14-#5 | 11-#5 | 13-#4 | 11-#4 | 2.30 | 0.766 |
| 24 | 300 | 6.25 | 8.00 | 18 | 0.682 | 15-#4 3 | 22-#5 | 14-#6 | 22-#4 | 12-#5 | 3.42 | 167.9 | 335.9 | 452.1 | 300 | 21 | 18-#5 | 22-#4 | 11-#5 | 10-#5 | 3.01 | 0.766 |
| 24 | 400 | 8.25 | 8.00 | 19 | 0.630 | 15-#4 3 | 15-#7 | 20-#5 | 10-#7 | 15-#5 | 4.27 | 205.0 | 409.9 | 551.8 | 400 | 23 | 28-#4 | 18-#5 | 10-#6 | 12-#5 | 3.59 | 0.785 |
| 24 | 500 | 8.25 | 9.60 | 21 | 0.720 | 18-#4 5 | 14-#8 | 13-#7 | 9-#8 | 10-#7 | 5.20 | 241.9 | 498.6 | 651.3 | 500 | 24 | 12-#7 | 9-#8 | 16-#5 | 10-#6 | 4.45 | 0.818 |
| 25 | 100 | 6.25 | 8.33 | 12 | 0.636 | 13-#4 1 | 21-#4 | 12-#5 | 9-#5 | 13-#4 | 2.15 | 107.8 | 215.7 | 290.3 | 100 | 12 | 17-#4 | 9-#5 | 13-#4 | 12-#4 | 1.95 | 0.766 |
| 25 | 200 | 6.25 | 8.33 | 16 | 0.658 | 13-#4 4 | 19-#5 | 12-#6 | 19-#4 | 16-#4 | 2.84 | 148.7 | 297.3 | 400.3 | 200 | 19 | 16-#5 | 19-#4 | 10-#5 | 13-#4 | 2.51 | 0.766 |
| 25 | 300 | 8.25 | 8.33 | 18 | 0.631 | 14-#4 3 | 18-#6 | 14-#6 | 9-#7 | 10-#6 | 3.79 | 191.3 | 382.6 | 515.0 | 300 | 21 | 12-#6 | 9-#7 | 19-#4 | 11-#5 | 3.29 | 0.785 |
| 25 | 400 | 8.25 | 10.00 | 20 | 0.690 | 17-#4 5 | 22-#6 | 12-#7 | 20-#5 | 9-#7 | 4.43 | 232.7 | 465.4 | 626.5 | 400 | 24 | 15-#6 | 20-#5 | 23-#4 | 13-#5 | 3.83 | 0.818 |
| 25 | 500 | 10.25 | 10.00 | 21 | 0.630 | 18-#4 2 | 20-#7 | 13-#7 | 10-#8 | 20-#5 | 5.40 | 274.9 | 549.9 | 740.2 | 500 | 25 | 12-#7 | 10-#8 | 10-#7 | 11-#6 | 4.69 | 0.845 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL

With Drop Panels(2)
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 9 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 9 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 18 | 100 | 2.25 | 6.00 | 12 | 0.630 | 9-#4 0 | 9-#4 | 10-#4 | 6-#5 | 6-#5 | 1.83 | 39.9 | 79.8 | 107.4 | 100 | 12 | 9-#4 | 9-#4 | 6-#5 | 6-#5 | 1.83 | 0.771 |
| 18 | 200 | 2.25 | 6.00 | 15 | 0.626 | 9-#4 0 | 10-#4 | 13-#4 | 6-#5 | 6-#5 | 1.98 | 54.3 | 108.6 | 146.2 | 200 | 18 | 8-#5 | 9-#4 | 6-#5 | 6-#5 | 1.99 | 0.771 |
| 18 | 300 | 2.25 | 6.00 | 17 | 0.624 | 9-#4 1 | 9-#5 | 8-#6 | 6-#5 | 6-#5 | 2.24 | 69.8 | 151.1 | 187.8 | 300 | 18 | 10-#5 | 9-#4 | 6-#5 | 6-#5 | 2.12 | 0.771 |
| 18 | 400 | 2.25 | 6.00 | 18 | 0.701 | 10-#4 3 | 12-#5 | 13-#5 | 8-#5 | 6-#5 | 2.69 | 85.3 | 198.1 | 229.8 | 400 | 18 | 12-#5 | 12-#4 | 6-#5 | 6-#5 | 2.42 | 0.771 |
| 18 | 500 | 4.25 | 6.00 | 18 | 0.626 | 10-#4 1 | 15-#5 | 13-#5 | 7-#6 | 7-#5 | 3.09 | 101.4 | 249.6 | 273.0 | 500 | 18 | 12-#5 | 15-#4 | 10-#4 | 10-#4 | 2.66 | 0.789 |
| 18 | 600 | 4.25 | 6.00 | 18 | 0.705 | 12-#4 2 | 13-#6 | 8-#7 | 12-#5 | 8-#5 | 3.78 | 117.3 | 294.0 | 315.8 | 600 | 18 | 10-#6 | 12-#5 | 11-#4 | 8-#5 | 3.27 | 0.789 |
| 19 | 100 | 2.25 | 6.33 | 12 | 0.630 | 10-#4 0 | 10-#4 | 11-#4 | 10-#4 | 10-#4 | 1.88 | 47.2 | 94.4 | 127.1 | 100 | 12 | 10-#4 | 10-#4 | 10-#4 | 10-#4 | 1.87 | 0.771 |
| 19 | 200 | 2.25 | 6.33 | 15 | 0.626 | 10-#4 1 | 12-#4 | 10-#5 | 10-#4 | 10-#4 | 2.09 | 64.4 | 128.9 | 173.5 | 200 | 18 | 9-#5 | 10-#4 | 10-#4 | 10-#4 | 2.06 | 0.771 |
| 19 | 300 | 2.25 | 6.33 | 17 | 0.681 | 10-#4 3 | 10-#5 | 9-#6 | 10-#4 | 10-#4 | 2.35 | 82.4 | 169.6 | 221.9 | 300 | 19 | 12-#5 | 10-#4 | 10-#4 | 10-#4 | 2.24 | 0.771 |
| 19 | 400 | 4.25 | 6.33 | 19 | 0.625 | 10-#4 1 | 10-#6 | 9-#6 | 9-#5 | 10-#4 | 2.83 | 100.5 | 230.0 | 270.6 | 400 | 19 | 12-#5 | 9-#5 | 10-#4 | 10-#4 | 2.49 | 0.789 |
| 19 | 500 | 4.25 | 6.33 | 19 | 0.633 | 12-#4 2 | 13-#6 | 15-#5 | 8-#6 | 8-#5 | 3.54 | 119.2 | 285.2 | 321.0 | 500 | 19 | 10-#6 | 12-#5 | 11-#4 | 8-#5 | 3.09 | 0.789 |
| 19 | 600 | 6.25 | 6.33 | 19 | 0.628 | 12-#4 2 | 15-#6 | 15-#5 | 10-#6 | 14-#4 | 4.01 | 138.1 | 341.8 | 371.8 | 600 | 19 | 10-#6 | 14-#5 | 13-#4 | 9-#5 | 3.44 | 0.808 |
| 20 | 100 | 2.25 | 6.67 | 12 | 0.661 | 10-#4 1 | 10-#4 | 13-#4 | 10-#4 | 10-#4 | 1.84 | 55.4 | 110.8 | 149.1 | 100 | 12 | 12-#4 | 10-#4 | 10-#4 | 10-#4 | 1.84 | 0.771 |
| 20 | 200 | 2.25 | 6.67 | 15 | 0.674 | 10-#4 2 | 9-#5 | 12-#5 | 10-#4 | 10-#4 | 2.10 | 75.7 | 151.5 | 203.9 | 200 | 18 | 16-#4 | 10-#4 | 10-#4 | 10-#4 | 2.01 | 0.771 |
| 20 | 300 | 4.25 | 6.67 | 17 | 0.627 | 10-#4 2 | 12-#5 | 19-#4 | 8-#5 | 10-#4 | 2.40 | 96.7 | 195.0 | 260.3 | 300 | 20 | 17-#4 | 12-#4 | 10-#4 | 10-#4 | 2.17 | 0.789 |
| 20 | 400 | 4.25 | 6.67 | 19 | 0.625 | 12-#4 2 | 11-#6 | 15-#5 | 16-#4 | 8-#5 | 3.03 | 117.8 | 258.5 | 317.1 | 400 | 20 | 10-#6 | 16-#4 | 11-#4 | 7-#5 | 2.68 | 0.789 |
| 20 | 500 | 6.25 | 6.67 | 20 | 0.627 | 12-#4 2 | 11-#7 | 15-#5 | 13-#5 | 14-#4 | 3.71 | 139.2 | 328.1 | 374.9 | 500 | 20 | 10-#6 | 13-#5 | 13-#4 | 9-#5 | 3.18 | 0.808 |
| 20 | 600 | 6.25 | 8.00 | 20 | 0.627 | 9-#5 1 | 10-#8 | 18-#5 | 16-#5 | 8-#6 | 4.35 | 161.6 | 396.2 | 435.0 | 600 | 20 | 25-#4 | 16-#5 | 10-#5 | 16-#4 | 3.64 | 0.833 |
| 21 | 100 | 2.25 | 7.00 | 12 | 0.761 | 11-#4 3 | 12-#4 | 10-#5 | 7-#5 | 7-#5 | 1.99 | 64.4 | 128.9 | 173.5 | 100 | 12 | 14-#4 | 7-#5 | 7-#5 | 7-#5 | 1.98 | 0.771 |
| 21 | 200 | 4.25 | 7.00 | 15 | 0.629 | 11-#4 1 | 16-#4 | 17-#4 | 7-#5 | 7-#5 | 2.16 | 88.5 | 177.0 | 238.3 | 200 | 18 | 16-#4 | 7-#5 | 7-#5 | 7-#5 | 2.07 | 0.789 |
| 21 | 300 | 4.25 | 7.00 | 17 | 0.627 | 11-#4 2 | 10-#6 | 22-#4 | 9-#5 | 8-#5 | 2.67 | 112.4 | 224.7 | 302.5 | 300 | 21 | 13-#5 | 9-#5 | 7-#5 | 7-#5 | 2.40 | 0.789 |
| 21 | 400 | 4.25 | 7.00 | 19 | 0.678 | 13-#4 2 | 17-#5 | 18-#5 | 17-#4 | 9-#5 | 3.16 | 136.9 | 285.7 | 368.6 | 400 | 21 | 16-#5 | 17-#4 | 13-#4 | 8-#5 | 2.82 | 0.789 |
| 21 | 500 | 6.25 | 7.00 | 20 | 0.627 | 14-#4 1 | 12-#7 | 18-#5 | 8-#7 | 8-#6 | 4.04 | 161.9 | 367.7 | 435.9 | 500 | 21 | 25-#4 | 15-#5 | 7-#6 | 7-#6 | 3.46 | 0.808 |
| 21 | 600 | 6.25 | 8.40 | 21 | 0.675 | 10-#5 1 | 15-#7 | 11-#7 | 8-#8 | 9-#6 | 4.89 | 187.0 | 445.1 | 503.5 | 600 | 21 | 10-#7 | 13-#6 | 12-#5 | 12-#5 | 4.11 | 0.833 |
| 22 | 100 | 2.25 | 7.33 | 12 | 0.800 | 11-#4 4 | 9-#5 | 12-#5 | 11-#4 | 11-#4 | 2.00 | 74.4 | 148.8 | 200.4 | 100 | 12 | 16-#4 | 11-#4 | 11-#4 | 11-#4 | 1.94 | 0.771 |
| 22 | 200 | 4.25 | 7.33 | 15 | 0.629 | 11-#4 2 | 12-#5 | 13-#5 | 8-#5 | 11-#4 | 2.27 | 102.4 | 204.9 | 275.8 | 200 | 18 | 12-#5 | 12-#4 | 11-#4 | 11-#4 | 2.10 | 0.789 |
| 22 | 300 | 4.25 | 7.33 | 17 | 0.754 | 13-#4 5 | 11-#6 | 12-#6 | 16-#4 | 13-#4 | 2.83 | 130.2 | 260.3 | 350.4 | 300 | 21 | 15-#5 | 16-#4 | 8-#5 | 11-#4 | 2.51 | 0.789 |
| 22 | 400 | 6.25 | 7.33 | 19 | 0.628 | 13-#4 2 | 8-#8 | 17-#5 | 13-#5 | 16-#4 | 3.44 | 158.2 | 322.9 | 426.0 | 400 | 22 | 16-#5 | 9-#6 | 10-#5 | 13-#4 | 3.00 | 0.808 |
| 22 | 500 | 6.25 | 8.80 | 21 | 0.638 | 10-#5 1 | 11-#8 | 11-#7 | 9-#7 | 19-#4 | 4.45 | 186.7 | 419.6 | 502.7 | 500 | 22 | 10-#7 | 9-#7 | 12-#5 | 8-#6 | 3.82 | 0.833 |
| 22 | 600 | 8.25 | 8.80 | 22 | 0.628 | 10-#5 1 | 13-#8 | 11-#7 | 11-#7 | 8-#7 | 5.18 | 215.4 | 505.9 | 580.0 | 600 | 22 | 10-#7 | 11-#7 | 10-#6 | 10-#6 | 4.45 | 0.860 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

# FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

# SQUARE INTERIOR PANEL

With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip [1] Top Ext. + | Column Strip Bottom | Column Strip Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 9 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 9 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 23 | 100 | 4.25 | 7.67 | 12 | 0.683 | 12-#4 2 | 10-#5 | 11-#5 | 8-#5 | 8-#5 | 2.07 | 85.7 | 171.5 | 230.8 | 100 | 12 | 16-#4 | 12-#4 | 8-#5 | 8-#5 | 2.00 | 0.789 |
| 23 | 200 | 4.25 | 7.67 | 15 | 0.742 | 12-#4 5 | 10-#6 | 15-#5 | 14-#4 | 8-#5 | 2.50 | 117.7 | 235.5 | 317.0 | 200 | 18 | 14-#5 | 14-#4 | 8-#5 | 8-#5 | 2.30 | 0.789 |
| 23 | 300 | 6.25 | 7.67 | 18 | 0.629 | 12-#4 2 | 18-#5 | 16-#5 | 12-#5 | 10-#5 | 2.94 | 149.4 | 298.8 | 402.3 | 300 | 21 | 15-#5 | 18-#4 | 9-#5 | 8-#5 | 2.59 | 0.808 |
| 23 | 400 | 6.25 | 7.67 | 19 | 0.701 | 15-#4 4 | 9-#8 | 14-#6 | 8-#7 | 12-#5 | 3.78 | 181.4 | 362.8 | 488.4 | 400 | 23 | 18-#5 | 15-#5 | 8-#6 | 10-#5 | 3.27 | 0.808 |
| 23 | 500 | 8.25 | 9.20 | 22 | 0.628 | 16-#4 2 | 12-#8 | 11-#7 | 19-#5 | 8-#7 | 4.55 | 213.8 | 473.1 | 575.6 | 500 | 23 | 14-#6 | 19-#5 | 13-#5 | 19-#4 | 3.87 | 0.860 |
| 23 | 600 | 8.25 | 9.20 | 22 | 0.646 | 18-#4 2 | 15-#8 | 13-#7 | 12-#7 | 9-#7 | 5.66 | 247.2 | 559.0 | 665.5 | 600 | 23 | 12-#7 | 10-#8 | 11-#6 | 8-#7 | 4.93 | 0.860 |
| 24 | 100 | 4.25 | 8.00 | 12 | 0.730 | 13-#4 2 | 18-#4 | 19-#4 | 8-#5 | 8-#5 | 2.10 | 97.8 | 195.6 | 263.2 | 100 | 12 | 12-#5 | 12-#4 | 8-#5 | 8-#5 | 1.99 | 0.789 |
| 24 | 200 | 4.25 | 8.00 | 16 | 0.754 | 13-#4 5 | 16-#5 | 12-#6 | 16-#4 | 9-#5 | 2.64 | 133.5 | 267.0 | 359.4 | 200 | 19 | 11-#6 | 16-#4 | 8-#5 | 8-#5 | 2.39 | 0.789 |
| 24 | 300 | 6.25 | 8.00 | 18 | 0.636 | 14-#4 3 | 11-#7 | 14-#6 | 10-#6 | 17-#4 | 3.32 | 170.9 | 341.7 | 460.0 | 300 | 21 | 12-#6 | 21-#4 | 16-#4 | 9-#5 | 2.84 | 0.808 |
| 24 | 400 | 8.25 | 8.00 | 20 | 0.629 | 15-#4 3 | 18-#6 | 14-#6 | 9-#7 | 10-#6 | 4.00 | 207.1 | 414.1 | 557.5 | 400 | 23 | 18-#5 | 9-#7 | 19-#4 | 8-#6 | 3.51 | 0.826 |
| 24 | 500 | 8.25 | 9.60 | 21 | 0.646 | 18-#4 2 | 17-#7 | 23-#5 | 11-#7 | 9-#7 | 4.87 | 244.8 | 516.9 | 659.0 | 500 | 24 | 15-#6 | 11-#7 | 8-#7 | 10-#6 | 4.23 | 0.860 |
| 25 | 100 | 4.25 | 8.33 | 12 | 0.785 | 13-#4 4 | 13-#5 | 14-#5 | 13-#4 | 13-#4 | 2.21 | 110.9 | 221.8 | 298.6 | 100 | 12 | 13-#5 | 9-#5 | 13-#4 | 13-#4 | 2.11 | 0.789 |
| 25 | 200 | 6.25 | 8.33 | 16 | 0.631 | 13-#4 3 | 18-#5 | 25-#4 | 12-#5 | 10-#5 | 2.69 | 152.0 | 304.1 | 409.4 | 200 | 19 | 15-#5 | 18-#4 | 14-#4 | 12-#4 | 2.34 | 0.808 |
| 25 | 300 | 6.25 | 8.33 | 18 | 0.760 | 16-#4 7 | 17-#6 | 15-#6 | 11-#6 | 13-#5 | 3.63 | 194.3 | 388.5 | 523.0 | 300 | 21 | 14-#6 | 11-#6 | 12-#5 | 10-#5 | 3.18 | 0.808 |
| 25 | 400 | 8.25 | 8.33 | 20 | 0.629 | 17-#4 2 | 12-#8 | 12-#7 | 10-#7 | 16-#5 | 4.34 | 235.6 | 471.1 | 634.2 | 400 | 23 | 15-#6 | 19-#5 | 22-#4 | 19-#4 | 3.70 | 0.826 |
| 25 | 500 | 10.25 | 10.00 | 22 | 0.630 | 18-#4 2 | 15-#8 | 23-#5 | 10-#8 | 10-#7 | 5.23 | 277.2 | 569.2 | 746.2 | 500 | 25 | 15-#6 | 10-#8 | 9-#7 | 15-#5 | 4.47 | 0.887 |
| 26 | 100 | 6.25 | 8.67 | 12 | 0.653 | 13-#4 2 | 15-#5 | 14-#5 | 10-#5 | 13-#4 | 2.26 | 125.7 | 251.3 | 338.3 | 100 | 12 | 13-#5 | 15-#4 | 13-#4 | 13-#4 | 2.05 | 0.808 |
| 26 | 200 | 6.25 | 8.67 | 16 | 0.691 | 14-#4 4 | 11-#7 | 14-#6 | 10-#6 | 12-#5 | 3.07 | 171.9 | 343.7 | 462.7 | 200 | 19 | 12-#6 | 21-#4 | 16-#4 | 9-#5 | 2.61 | 0.808 |
| 26 | 300 | 8.25 | 8.67 | 18 | 0.631 | 16-#4 2 | 19-#6 | 15-#6 | 10-#7 | 22-#4 | 3.90 | 219.4 | 438.7 | 590.6 | 300 | 22 | 14-#6 | 18-#5 | 10-#6 | 12-#5 | 3.39 | 0.826 |
| 26 | 400 | 8.25 | 10.40 | 21 | 0.704 | 19-#4 5 | 14-#8 | 18-#6 | 21-#5 | 10-#7 | 4.66 | 265.2 | 530.4 | 714.0 | 400 | 25 | 12-#7 | 15-#6 | 16-#5 | 10-#6 | 3.99 | 0.860 |
| 26 | 500 | 10.25 | 10.40 | 22 | 0.636 | 13-#5 2 | 21-#7 | 26-#5 | 18-#6 | 15-#6 | 5.42 | 312.7 | 625.5 | 842.0 | 500 | 26 | 13-#7 | 18-#6 | 19-#5 | 9-#7 | 4.73 | 0.887 |
| 27 | 100 | 6.25 | 9.00 | 12 | 0.753 | 14-#4 5 | 9-#7 | 16-#5 | 11-#5 | 14-#4 | 2.45 | 141.2 | 282.3 | 380.0 | 100 | 12 | 14-#5 | 11-#5 | 9-#5 | 9-#5 | 2.17 | 0.808 |
| 27 | 200 | 8.25 | 9.00 | 16 | 0.634 | 14-#4 3 | 17-#6 | 28-#4 | 11-#6 | 13-#5 | 3.20 | 193.8 | 387.7 | 521.9 | 200 | 19 | 12-#6 | 24-#4 | 12-#5 | 10-#5 | 2.74 | 0.826 |
| 27 | 300 | 8.25 | 9.00 | 18 | 0.710 | 18-#4 5 | 16-#7 | 13-#7 | 14-#6 | 9-#7 | 4.18 | 246.9 | 493.8 | 664.8 | 300 | 22 | 15-#6 | 14-#6 | 15-#5 | 13-#5 | 3.59 | 0.826 |
| 27 | 400 | 10.25 | 10.80 | 21 | 0.631 | 19-#4 4 | 16-#8 | 18-#6 | 24-#5 | 20-#5 | 4.99 | 299.6 | 599.3 | 806.7 | 400 | 25 | 12-#7 | 10-#8 | 10-#7 | 16-#5 | 4.31 | 0.887 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip [1] Top Ext. + | Column Strip [1] Bottom | Column Strip [1] Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 9.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 9.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 19 | 100 | 2.25 | 6.33 | 12 | 0.700 | 9-#5 0 | 7-#5 | 9-#5 | 7-#5 | 7-#5 | 2.22 | 48.7 | 97.4 | 131.2 | 100 | 12 | 9-#5 | 7-#5 | 7-#5 | 7-#5 | 2.22 | 0.812 |
| 19 | 200 | 2.25 | 6.33 | 15 | 0.701 | 9-#5 1 | 8-#5 | 10-#5 | 7-#5 | 7-#5 | 2.29 | 65.9 | 131.7 | 177.3 | 200 | 18 | 9-#5 | 7-#5 | 7-#5 | 7-#5 | 2.24 | 0.812 |
| 19 | 300 | 2.25 | 6.33 | 17 | 0.678 | 9-#5 0 | 7-#6 | 9-#6 | 7-#5 | 7-#5 | 2.54 | 83.8 | 175.8 | 225.7 | 300 | 19 | 12-#5 | 7-#5 | 7-#5 | 7-#5 | 2.42 | 0.812 |
| 19 | 400 | 2.25 | 6.33 | 19 | 0.740 | 9-#5 1 | 13-#5 | 15-#5 | 9-#5 | 7-#5 | 2.97 | 101.8 | 230.7 | 274.0 | 400 | 19 | 10-#6 | 9-#5 | 7-#5 | 7-#5 | 2.74 | 0.812 |
| 19 | 500 | 4.25 | 6.33 | 19 | 0.626 | 9-#5 0 | 7-#8 | 15-#5 | 8-#6 | 8-#5 | 3.51 | 120.6 | 291.2 | 324.8 | 500 | 19 | 10-#6 | 11-#5 | 7-#5 | 8-#5 | 3.00 | 0.831 |
| 19 | 600 | 6.25 | 6.33 | 19 | 0.629 | 9-#5 0 | 11-#7 | 15-#5 | 13-#5 | 9-#5 | 3.94 | 139.5 | 349.6 | 375.6 | 600 | 19 | 10-#6 | 13-#5 | 8-#5 | 9-#5 | 3.34 | 0.850 |
| 20 | 100 | 2.25 | 6.67 | 12 | 0.722 | 9-#5 0 | 7-#5 | 9-#5 | 7-#5 | 7-#5 | 2.10 | 57.1 | 114.3 | 153.8 | 100 | 12 | 9-#5 | 7-#5 | 7-#5 | 7-#5 | 2.10 | 0.812 |
| 20 | 200 | 2.25 | 6.67 | 15 | 0.757 | 9-#5 2 | 9-#5 | 12-#5 | 7-#5 | 7-#5 | 2.31 | 77.4 | 154.9 | 208.5 | 200 | 18 | 11-#5 | 7-#5 | 7-#5 | 7-#5 | 2.24 | 0.812 |
| 20 | 300 | 2.25 | 6.67 | 17 | 0.795 | 9-#5 3 | 11-#5 | 15-#5 | 8-#5 | 7-#5 | 2.60 | 98.2 | 196.4 | 264.4 | 300 | 20 | 13-#5 | 8-#5 | 7-#5 | 7-#5 | 2.45 | 0.812 |
| 20 | 400 | 4.25 | 6.67 | 19 | 0.626 | 9-#5 0 | 15-#5 | 15-#5 | 7-#6 | 8-#5 | 3.03 | 119.4 | 266.5 | 321.5 | 400 | 20 | 10-#6 | 7-#6 | 7-#5 | 7-#5 | 2.72 | 0.831 |
| 20 | 500 | 4.25 | 6.67 | 20 | 0.663 | 9-#5 1 | 10-#7 | 9-#7 | 9-#6 | 9-#5 | 3.74 | 140.7 | 329.2 | 378.8 | 500 | 20 | 16-#5 | 9-#6 | 8-#5 | 9-#5 | 3.29 | 0.831 |
| 20 | 600 | 6.25 | 6.67 | 20 | 0.628 | 9-#5 1 | 10-#8 | 9-#7 | 8-#7 | 10-#5 | 4.35 | 162.7 | 397.6 | 438.1 | 600 | 20 | 16-#5 | 15-#5 | 7-#6 | 7-#6 | 3.63 | 0.850 |
| 21 | 100 | 2.25 | 7.00 | 12 | 0.760 | 10-#5 0 | 8-#5 | 10-#5 | 7-#5 | 7-#5 | 2.08 | 66.5 | 133.0 | 179.0 | 100 | 12 | 10-#5 | 7-#5 | 7-#5 | 7-#5 | 2.03 | 0.812 |
| 21 | 200 | 2.25 | 7.00 | 15 | 0.797 | 10-#5 2 | 10-#5 | 13-#5 | 7-#5 | 7-#5 | 2.29 | 90.3 | 180.5 | 243.0 | 200 | 18 | 12-#5 | 7-#5 | 7-#5 | 7-#5 | 2.17 | 0.812 |
| 21 | 300 | 4.25 | 7.00 | 18 | 0.627 | 10-#5 1 | 9-#6 | 10-#6 | 9-#5 | 7-#5 | 2.65 | 113.8 | 227.6 | 306.4 | 300 | 21 | 13-#5 | 9-#5 | 7-#5 | 7-#5 | 2.40 | 0.831 |
| 21 | 400 | 4.25 | 7.00 | 19 | 0.705 | 10-#5 2 | 7-#8 | 12-#6 | 8-#6 | 9-#5 | 3.29 | 138.8 | 296.3 | 373.7 | 400 | 21 | 11-#6 | 11-#5 | 8-#5 | 8-#5 | 2.84 | 0.831 |
| 21 | 500 | 6.25 | 7.00 | 21 | 0.627 | 10-#5 0 | 9-#8 | 12-#6 | 10-#6 | 10-#5 | 3.92 | 163.1 | 375.6 | 439.1 | 500 | 21 | 16-#5 | 14-#5 | 7-#6 | 7-#6 | 3.37 | 0.850 |
| 21 | 600 | 6.25 | 8.40 | 21 | 0.642 | 10-#5 1 | 11-#8 | 14-#6 | 17-#5 | 12-#5 | 4.65 | 188.9 | 457.5 | 508.6 | 600 | 21 | 10-#7 | 13-#6 | 8-#6 | 12-#5 | 4.09 | 0.875 |
| 22 | 100 | 2.25 | 7.33 | 12 | 0.803 | 10-#5 1 | 9-#5 | 11-#5 | 8-#5 | 8-#5 | 2.21 | 76.8 | 153.6 | 206.7 | 100 | 12 | 11-#5 | 8-#5 | 8-#5 | 8-#5 | 2.19 | 0.812 |
| 22 | 200 | 4.25 | 7.33 | 16 | 0.629 | 10-#5 0 | 12-#5 | 13-#5 | 8-#5 | 8-#5 | 2.40 | 103.9 | 207.7 | 279.6 | 200 | 19 | 12-#5 | 8-#5 | 8-#5 | 8-#5 | 2.25 | 0.831 |
| 22 | 300 | 4.25 | 7.33 | 18 | 0.691 | 10-#5 2 | 15-#5 | 16-#5 | 10-#5 | 8-#5 | 2.82 | 131.8 | 263.7 | 355.0 | 300 | 21 | 15-#5 | 10-#5 | 8-#5 | 8-#5 | 2.58 | 0.831 |
| 22 | 400 | 6.25 | 7.33 | 20 | 0.628 | 10-#5 0 | 10-#7 | 12-#6 | 9-#6 | 10-#5 | 3.43 | 159.8 | 333.9 | 430.1 | 400 | 22 | 11-#6 | 9-#6 | 9-#5 | 9-#5 | 3.02 | 0.850 |
| 22 | 500 | 6.25 | 7.33 | 21 | 0.627 | 10-#5 1 | 17-#6 | 14-#6 | 11-#6 | 12-#5 | 4.15 | 188.3 | 416.8 | 506.9 | 500 | 22 | 10-#7 | 16-#5 | 8-#6 | 8-#6 | 3.71 | 0.850 |
| 22 | 600 | 8.25 | 8.80 | 22 | 0.628 | 10-#5 1 | 16-#7 | 20-#5 | 8-#8 | 10-#6 | 4.91 | 217.6 | 520.9 | 585.9 | 600 | 22 | 10-#7 | 11-#7 | 9-#6 | 13-#5 | 4.28 | 0.902 |
| 23 | 100 | 4.25 | 7.67 | 12 | 0.714 | 11-#5 0 | 10-#5 | 11-#5 | 8-#5 | 8-#5 | 2.17 | 88.4 | 176.9 | 238.1 | 100 | 12 | 11-#5 | 8-#5 | 8-#5 | 8-#5 | 2.08 | 0.831 |
| 23 | 200 | 4.25 | 7.67 | 16 | 0.669 | 11-#5 0 | 10-#6 | 15-#5 | 9-#5 | 8-#5 | 2.57 | 119.4 | 238.8 | 321.5 | 200 | 19 | 14-#5 | 9-#5 | 8-#5 | 8-#5 | 2.32 | 0.831 |
| 23 | 300 | 4.25 | 7.67 | 18 | 0.755 | 11-#5 2 | 9-#7 | 14-#6 | 8-#6 | 10-#5 | 3.08 | 151.7 | 303.4 | 408.4 | 300 | 21 | 12-#6 | 11-#5 | 9-#5 | 8-#5 | 2.68 | 0.831 |
| 23 | 400 | 6.25 | 7.67 | 20 | 0.628 | 11-#5 1 | 11-#7 | 14-#6 | 10-#6 | 12-#5 | 3.61 | 183.2 | 366.4 | 493.2 | 400 | 23 | 18-#5 | 14-#5 | 8-#6 | 9-#5 | 3.14 | 0.850 |
| 23 | 500 | 8.25 | 7.67 | 21 | 0.629 | 11-#5 2 | 19-#6 | 14-#6 | 8-#8 | 10-#6 | 4.42 | 216.2 | 467.1 | 582.1 | 500 | 23 | 13-#6 | 18-#5 | 9-#6 | 12-#5 | 3.76 | 0.868 |
| 23 | 600 | 8.25 | 9.20 | 23 | 0.627 | 12-#5 1 | 14-#8 | 12-#7 | 9-#8 | 11-#6 | 5.37 | 248.7 | 576.5 | 669.5 | 600 | 23 | 11-#7 | 9-#8 | 8-#7 | 8-#7 | 4.67 | 0.902 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 9.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 9.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 24 | 100 | 4.25 | 8.00 | 12 | 0.735 | 11-#5 0 | 11-#5 | 13-#5 | 8-#5 | 8-#5 | 2.16 | 100.9 | 201.7 | 271.6 | 100 | 12 | 12-#5 | 8-#5 | 8-#5 | 8-#5 | 2.03 | 0.831 |
| 24 | 200 | 4.25 | 8.00 | 16 | 0.731 | 11-#5 1 | 15-#5 | 12-#6 | 10-#5 | 9-#5 | 2.63 | 136.5 | 272.9 | 367.4 | 200 | 19 | 11-#6 | 10-#5 | 8-#5 | 8-#5 | 2.39 | 0.831 |
| 24 | 300 | 6.25 | 8.00 | 18 | 0.630 | 11-#5 1 | 8-#8 | 18-#5 | 13-#5 | 8-#6 | 3.26 | 173.1 | 346.3 | 466.1 | 300 | 22 | 12-#6 | 9-#6 | 10-#5 | 9-#5 | 2.85 | 0.850 |
| 24 | 400 | 6.25 | 8.00 | 20 | 0.713 | 11-#5 3 | 17-#6 | 12-#7 | 11-#6 | 13-#5 | 3.89 | 209.6 | 419.3 | 564.4 | 400 | 23 | 20-#5 | 11-#6 | 12-#5 | 8-#6 | 3.44 | 0.850 |
| 24 | 500 | 8.25 | 9.60 | 22 | 0.628 | 11-#5 2 | 13-#8 | 12-#7 | 20-#5 | 11-#6 | 4.66 | 246.7 | 531.5 | 664.1 | 500 | 24 | 11-#7 | 20-#5 | 10-#6 | 13-#5 | 3.99 | 0.902 |
| 24 | 600 | 8.25 | 9.60 | 23 | 0.698 | 13-#5 2 | 20-#7 | 26-#5 | 10-#8 | 8-#8 | 5.67 | 283.6 | 633.2 | 763.6 | 600 | 24 | 13-#7 | 10-#8 | 9-#7 | 16-#5 | 4.93 | 0.902 |
| 25 | 100 | 4.25 | 8.33 | 12 | 0.815 | 12-#5 2 | 9-#6 | 14-#5 | 9-#5 | 9-#5 | 2.34 | 114.4 | 228.8 | 308.0 | 100 | 12 | 13-#5 | 9-#5 | 9-#5 | 9-#5 | 2.19 | 0.831 |
| 25 | 200 | 6.25 | 8.33 | 16 | 0.632 | 12-#5 0 | 18-#5 | 16-#5 | 12-#5 | 10-#5 | 2.82 | 155.4 | 310.9 | 418.5 | 200 | 19 | 15-#5 | 12-#5 | 9-#5 | 9-#5 | 2.49 | 0.850 |
| 25 | 300 | 6.25 | 8.33 | 18 | 0.722 | 12-#5 2 | 12-#7 | 15-#6 | 15-#5 | 9-#6 | 3.54 | 196.9 | 393.7 | 530.0 | 300 | 22 | 14-#6 | 15-#5 | 11-#5 | 10-#5 | 3.07 | 0.850 |
| 25 | 400 | 8.25 | 8.33 | 20 | 0.630 | 12-#5 1 | 15-#7 | 12-#7 | 10-#7 | 15-#5 | 4.22 | 238.0 | 476.0 | 640.7 | 400 | 24 | 14-#6 | 18-#5 | 10-#6 | 12-#5 | 3.55 | 0.868 |
| 25 | 500 | 8.25 | 10.00 | 22 | 0.694 | 13-#5 2 | 14-#8 | 26-#5 | 9-#8 | 10-#7 | 5.06 | 279.8 | 573.7 | 753.2 | 500 | 25 | 13-#7 | 9-#8 | 16-#5 | 10-#6 | 4.37 | 0.902 |
| 26 | 100 | 6.25 | 8.67 | 12 | 0.721 | 12-#5 1 | 15-#5 | 14-#5 | 10-#5 | 9-#5 | 2.37 | 129.6 | 259.2 | 349.0 | 100 | 12 | 13-#5 | 10-#5 | 9-#5 | 9-#5 | 2.16 | 0.850 |
| 26 | 200 | 6.25 | 8.67 | 16 | 0.739 | 12-#5 3 | 14-#6 | 13-#6 | 13-#5 | 11-#5 | 2.97 | 175.7 | 351.4 | 473.0 | 200 | 19 | 12-#6 | 13-#5 | 10-#5 | 9-#5 | 2.58 | 0.850 |
| 26 | 300 | 8.25 | 8.67 | 19 | 0.631 | 12-#5 1 | 18-#6 | 15-#6 | 9-#7 | 10-#6 | 3.77 | 222.3 | 444.7 | 598.6 | 300 | 22 | 14-#6 | 9-#7 | 9-#6 | 11-#5 | 3.31 | 0.868 |
| 26 | 400 | 8.25 | 8.67 | 20 | 0.689 | 12-#5 3 | 13-#8 | 13-#7 | 20-#5 | 9-#7 | 4.47 | 269.4 | 538.7 | 725.2 | 400 | 24 | 12-#7 | 20-#5 | 11-#6 | 13-#5 | 3.82 | 0.868 |
| 26 | 500 | 10.25 | 10.40 | 22 | 0.630 | 13-#5 1 | 15-#8 | 26-#5 | 10-#8 | 20-#5 | 5.24 | 316.4 | 632.8 | 851.8 | 500 | 26 | 13-#7 | 10-#8 | 10-#7 | 11-#6 | 4.61 | 0.928 |
| 27 | 100 | 6.25 | 9.00 | 12 | 0.761 | 12-#5 2 | 16-#5 | 15-#5 | 11-#5 | 9-#5 | 2.41 | 145.6 | 291.2 | 392.0 | 100 | 12 | 14-#5 | 11-#5 | 9-#5 | 9-#5 | 2.17 | 0.850 |
| 27 | 200 | 6.25 | 9.00 | 16 | 0.781 | 12-#5 4 | 22-#5 | 15-#6 | 15-#5 | 9-#6 | 3.21 | 197.6 | 395.3 | 532.1 | 200 | 19 | 14-#6 | 15-#5 | 12-#5 | 10-#5 | 2.85 | 0.850 |
| 27 | 300 | 8.25 | 9.00 | 19 | 0.631 | 12-#5 2 | 12-#8 | 12-#7 | 10-#7 | 11-#6 | 4.06 | 250.3 | 500.6 | 673.9 | 300 | 22 | 15-#6 | 19-#5 | 15-#5 | 9-#6 | 3.50 | 0.868 |
| 27 | 400 | 10.25 | 10.80 | 21 | 0.631 | 12-#5 2 | 15-#8 | 13-#7 | 10-#8 | 19-#5 | 4.86 | 303.8 | 607.5 | 817.9 | 400 | 25 | 12-#7 | 12-#7 | 10-#7 | 15-#5 | 4.13 | 0.928 |
| 27 | 500 | 10.25 | 10.80 | 22 | 0.735 | 15-#5 4 | 18-#8 | 12-#8 | 11-#8 | 12-#7 | 5.71 | 356.6 | 713.1 | 959.9 | 500 | 26 | 14-#7 | 11-#8 | 11-#7 | 18-#5 | 4.84 | 0.928 |
| 28 | 100 | 6.25 | 9.33 | 12 | 0.796 | 13-#5 2 | 18-#5 | 17-#5 | 12-#5 | 10-#5 | 2.57 | 162.8 | 325.7 | 438.4 | 100 | 12 | 16-#5 | 12-#5 | 10-#5 | 10-#5 | 2.31 | 0.850 |
| 28 | 200 | 8.25 | 9.33 | 16 | 0.684 | 13-#5 2 | 18-#6 | 15-#6 | 12-#6 | 10-#6 | 3.46 | 221.9 | 443.8 | 597.4 | 200 | 19 | 14-#6 | 12-#6 | 13-#5 | 11-#5 | 3.00 | 0.868 |
| 28 | 300 | 8.25 | 9.33 | 19 | 0.751 | 13-#5 5 | 17-#7 | 26-#5 | 15-#6 | 10-#7 | 4.33 | 280.5 | 561.1 | 755.3 | 300 | 22 | 13-#7 | 21-#5 | 16-#5 | 10-#6 | 3.75 | 0.868 |
| 28 | 400 | 10.25 | 11.20 | 21 | 0.700 | 14-#5 4 | 21-#7 | 15-#7 | 11-#8 | 12-#7 | 5.23 | 340.7 | 681.4 | 917.2 | 400 | 25 | 18-#6 | 11-#8 | 14-#6 | 12-#6 | 4.49 | 0.928 |
| 28 | 500 | 12.25 | 11.20 | 23 | 0.632 | 15-#5 3 | 20-#8 | 16-#7 | 16-#7 | 18-#6 | 5.98 | 398.3 | 796.5 | 1072.3 | 500 | 27 | 14-#7 | 16-#7 | 23-#5 | 14-#6 | 5.03 | 0.955 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL

With Drop Panels(2)
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 10 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 10 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 20 | 100 | 2.25 | 6.67 | 12 | 0.703 | 9-#5 0 | 7-#5 | 9-#5 | 7-#5 | 7-#5 | 2.10 | 58.9 | 117.8 | 158.6 | 100 | 12 | 9-#5 | 7-#5 | 7-#5 | 7-#5 | 2.10 | 0.854 |
| 20 | 200 | 2.25 | 6.67 | 16 | 0.672 | 9-#5 1 | 9-#5 | 11-#5 | 7-#5 | 7-#5 | 2.26 | 78.8 | 157.5 | 212.1 | 200 | 18 | 10-#5 | 7-#5 | 7-#5 | 7-#5 | 2.17 | 0.854 |
| 20 | 300 | 2.25 | 6.67 | 18 | 0.652 | 9-#5 0 | 11-#5 | 10-#6 | 7-#5 | 7-#5 | 2.50 | 99.4 | 201.6 | 267.6 | 300 | 20 | 9-#6 | 7-#5 | 7-#5 | 7-#5 | 2.37 | 0.854 |
| 20 | 400 | 2.25 | 6.67 | 20 | 0.725 | 9-#5 1 | 10-#6 | 9-#7 | 7-#6 | 7-#5 | 3.09 | 120.3 | 266.1 | 324.0 | 400 | 20 | 11-#6 | 7-#6 | 7-#5 | 7-#5 | 2.82 | 0.854 |
| 20 | 500 | 4.25 | 6.67 | 20 | 0.630 | 9-#5 1 | 13-#6 | 9-#7 | 12-#5 | 9-#5 | 3.53 | 142.4 | 336.6 | 383.3 | 500 | 20 | 11-#6 | 12-#5 | 8-#5 | 8-#5 | 3.07 | 0.873 |
| 20 | 600 | 6.25 | 6.67 | 20 | 0.628 | 9-#5 1 | 9-#8 | 9-#7 | 8-#7 | 7-#6 | 4.21 | 164.4 | 406.9 | 442.5 | 600 | 20 | 11-#6 | 15-#5 | 9-#5 | 7-#6 | 3.58 | 0.891 |
| 20 | 700 | 6.25 | 8.00 | 20 | 0.635 | 10-#5 0 | 11-#8 | 10-#7 | 7-#8 | 8-#6 | 4.77 | 186.7 | 472.5 | 502.6 | 700 | 20 | 18-#5 | 12-#6 | 10-#5 | 8-#6 | 3.96 | 0.917 |
| 21 | 100 | 2.25 | 7.00 | 12 | 0.742 | 10-#5 0 | 8-#5 | 10-#5 | 8-#5 | 8-#5 | 2.23 | 68.5 | 137.1 | 184.5 | 100 | 12 | 10-#5 | 8-#5 | 8-#5 | 8-#5 | 2.23 | 0.854 |
| 21 | 200 | 2.25 | 7.00 | 15 | 0.756 | 10-#5 1 | 7-#6 | 13-#5 | 8-#5 | 8-#5 | 2.45 | 92.2 | 184.5 | 248.3 | 200 | 18 | 12-#5 | 8-#5 | 8-#5 | 8-#5 | 2.36 | 0.854 |
| 21 | 300 | 2.25 | 7.00 | 18 | 0.788 | 10-#5 3 | 12-#5 | 16-#5 | 8-#5 | 8-#5 | 2.66 | 115.5 | 231.0 | 311.0 | 300 | 21 | 15-#5 | 8-#5 | 8-#5 | 8-#5 | 2.56 | 0.854 |
| 21 | 400 | 4.25 | 7.00 | 20 | 0.638 | 10-#5 2 | 16-#5 | 12-#6 | 8-#6 | 9-#5 | 3.14 | 140.1 | 304.6 | 377.2 | 400 | 21 | 15-#5 | 11-#5 | 8-#5 | 8-#5 | 2.79 | 0.873 |
| 21 | 500 | 4.25 | 7.00 | 21 | 0.625 | 10-#5 0 | 11-#7 | 14-#6 | 13-#5 | 7-#6 | 3.83 | 164.8 | 376.7 | 443.7 | 500 | 21 | 18-#5 | 7-#7 | 9-#5 | 9-#5 | 3.37 | 0.873 |
| 21 | 600 | 6.25 | 7.00 | 21 | 0.627 | 10-#5 0 | 11-#8 | 14-#6 | 16-#5 | 8-#6 | 4.57 | 190.3 | 459.0 | 512.3 | 600 | 21 | 18-#5 | 12-#6 | 8-#6 | 8-#6 | 3.95 | 0.891 |
| 21 | 700 | 8.25 | 8.40 | 21 | 0.630 | 10-#5 0 | 16-#7 | 10-#7 | 8-#8 | 9-#6 | 5.00 | 216.5 | 542.6 | 582.8 | 700 | 21 | 18-#5 | 14-#6 | 12-#5 | 9-#6 | 4.23 | 0.943 |
| 22 | 100 | 2.25 | 7.33 | 12 | 0.788 | 10-#5 1 | 9-#5 | 11-#5 | 8-#5 | 8-#5 | 2.18 | 79.2 | 158.3 | 213.1 | 100 | 12 | 10-#5 | 8-#5 | 8-#5 | 8-#5 | 2.12 | 0.854 |
| 22 | 200 | 2.25 | 7.33 | 16 | 0.776 | 10-#5 2 | 11-#5 | 15-#5 | 8-#5 | 8-#5 | 2.45 | 105.9 | 211.7 | 285.0 | 200 | 19 | 10-#6 | 8-#5 | 8-#5 | 8-#5 | 2.38 | 0.854 |
| 22 | 300 | 4.25 | 7.33 | 18 | 0.634 | 10-#5 1 | 10-#6 | 16-#5 | 10-#5 | 8-#5 | 2.80 | 134.1 | 268.1 | 360.9 | 300 | 21 | 15-#5 | 10-#5 | 8-#5 | 8-#5 | 2.58 | 0.873 |
| 22 | 400 | 4.25 | 7.33 | 20 | 0.715 | 10-#5 3 | 13-#6 | 10-#7 | 12-#5 | 10-#5 | 3.32 | 161.7 | 335.2 | 435.4 | 400 | 22 | 18-#5 | 12-#5 | 9-#5 | 8-#5 | 2.93 | 0.873 |
| 22 | 500 | 6.25 | 7.33 | 21 | 0.627 | 10-#5 0 | 17-#6 | 14-#6 | 8-#7 | 8-#6 | 3.99 | 190.5 | 428.2 | 512.8 | 500 | 22 | 18-#5 | 15-#5 | 8-#6 | 10-#5 | 3.43 | 0.891 |
| 22 | 600 | 6.25 | 8.80 | 22 | 0.715 | 11-#5 3 | 15-#7 | 12-#7 | 8-#8 | 13-#5 | 4.85 | 219.4 | 524.5 | 590.7 | 600 | 22 | 11-#7 | 10-#7 | 12-#5 | 9-#6 | 4.23 | 0.917 |
| 22 | 700 | 8.25 | 8.80 | 22 | 0.629 | 11-#5 0 | 11-#9 | 12-#7 | 9-#8 | 8-#7 | 5.61 | 248.9 | 609.0 | 670.1 | 700 | 22 | 11-#7 | 9-#8 | 10-#6 | 8-#7 | 4.84 | 0.943 |
| 23 | 100 | 2.25 | 7.67 | 12 | 0.852 | 11-#5 3 | 10-#5 | 13-#5 | 9-#5 | 9-#5 | 2.37 | 90.8 | 181.6 | 244.5 | 100 | 12 | 12-#5 | 9-#5 | 9-#5 | 9-#5 | 2.33 | 0.854 |
| 23 | 200 | 4.25 | 7.67 | 16 | 0.648 | 11-#5 0 | 9-#6 | 15-#5 | 9-#5 | 9-#5 | 2.57 | 122.0 | 244.0 | 328.5 | 200 | 19 | 13-#5 | 9-#5 | 9-#5 | 9-#5 | 2.41 | 0.873 |
| 23 | 300 | 4.25 | 7.67 | 18 | 0.733 | 11-#5 2 | 16-#5 | 18-#5 | 8-#6 | 9-#5 | 3.00 | 154.3 | 308.5 | 415.3 | 300 | 21 | 12-#6 | 11-#5 | 9-#5 | 9-#5 | 2.77 | 0.873 |
| 23 | 400 | 6.25 | 7.67 | 20 | 0.628 | 11-#5 1 | 11-#7 | 14-#6 | 13-#5 | 8-#6 | 3.46 | 185.7 | 376.4 | 500.0 | 400 | 23 | 17-#5 | 13-#5 | 10-#5 | 9-#5 | 2.96 | 0.891 |
| 23 | 500 | 6.25 | 7.67 | 21 | 0.698 | 11-#5 3 | 18-#6 | 12-#7 | 9-#7 | 13-#5 | 4.33 | 218.5 | 470.7 | 588.2 | 500 | 23 | 11-#7 | 9-#7 | 12-#5 | 8-#6 | 3.87 | 0.891 |
| 23 | 600 | 8.25 | 9.20 | 23 | 0.628 | 11-#5 0 | 11-#9 | 12-#7 | 15-#6 | 8-#7 | 5.16 | 251.2 | 593.6 | 676.2 | 600 | 23 | 11-#7 | 15-#6 | 10-#6 | 10-#6 | 4.36 | 0.943 |
| 23 | 700 | 8.25 | 9.20 | 23 | 0.699 | 13-#5 2 | 13-#9 | 18-#6 | 8-#9 | 9-#7 | 6.09 | 284.4 | 676.3 | 765.7 | 700 | 23 | 13-#7 | 8-#9 | 11-#6 | 16-#5 | 5.17 | 0.943 |
| 24 | 100 | 4.25 | 8.00 | 12 | 0.719 | 11-#5 0 | 11-#5 | 12-#5 | 9-#5 | 9-#5 | 2.29 | 104.0 | 207.9 | 279.9 | 100 | 12 | 12-#5 | 9-#5 | 9-#5 | 9-#5 | 2.23 | 0.873 |
| 24 | 200 | 4.25 | 8.00 | 16 | 0.711 | 11-#5 1 | 15-#5 | 12-#6 | 10-#5 | 9-#5 | 2.67 | 139.4 | 278.9 | 375.4 | 200 | 19 | 15-#5 | 10-#5 | 9-#5 | 9-#5 | 2.47 | 0.873 |
| 24 | 300 | 6.25 | 8.00 | 18 | 0.630 | 11-#5 1 | 19-#5 | 18-#5 | 9-#6 | 8-#6 | 3.13 | 176.0 | 352.1 | 474.0 | 300 | 22 | 12-#6 | 12-#5 | 10-#5 | 9-#5 | 2.76 | 0.891 |
| 24 | 400 | 6.25 | 8.00 | 20 | 0.661 | 11-#5 2 | 12-#7 | 12-#7 | 8-#7 | 9-#6 | 3.75 | 211.7 | 423.4 | 570.0 | 400 | 24 | 14-#6 | 15-#5 | 8-#6 | 10-#5 | 3.24 | 0.891 |
| 24 | 500 | 8.25 | 8.00 | 21 | 0.630 | 11-#5 2 | 15-#7 | 12-#7 | 8-#8 | 8-#7 | 4.52 | 249.4 | 523.7 | 671.4 | 500 | 24 | 11-#7 | 13-#6 | 10-#6 | 12-#5 | 3.88 | 0.910 |
| 24 | 600 | 8.25 | 9.60 | 23 | 0.673 | 13-#5 2 | 12-#9 | 18-#6 | 8-#9 | 9-#7 | 5.70 | 286.5 | 655.4 | 771.3 | 600 | 24 | 13-#7 | 8-#9 | 11-#6 | 11-#6 | 4.94 | 0.943 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL
With Drop Panels(2)
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superim-posed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superim-posed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 10 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 10 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 25 | 100 | 4.25 | 8.33 | 12 | 0.802 | 12-#5 2 | 9-#6 | 14-#5 | 9-#5 | 9-#5 | 2.34 | 117.9 | 235.9 | 317.5 | 100 | 12 | 13-#5 | 9-#5 | 9-#5 | 9-#5 | 2.19 | 0.873 |
| 25 | 200 | 4.25 | 8.33 | 16 | 0.813 | 12-#5 4 | 9-#7 | 14-#6 | 11-#5 | 10-#5 | 2.85 | 158.4 | 316.8 | 426.5 | 200 | 19 | 12-#6 | 11-#5 | 9-#5 | 9-#5 | 2.53 | 0.873 |
| 25 | 300 | 6.25 | 8.33 | 18 | 0.675 | 12-#5 1 | 15-#6 | 20-#5 | 10-#6 | 12-#5 | 3.35 | 200.2 | 400.4 | 539.0 | 300 | 22 | 13-#6 | 14-#5 | 11-#5 | 10-#5 | 2.95 | 0.891 |
| 25 | 400 | 8.25 | 8.33 | 20 | 0.631 | 12-#5 1 | 11-#8 | 12-#7 | 9-#7 | 10-#6 | 4.07 | 241.3 | 482.5 | 649.5 | 400 | 24 | 14-#6 | 9-#7 | 13-#5 | 11-#5 | 3.47 | 0.910 |
| 25 | 500 | 8.25 | 10.00 | 22 | 0.646 | 13-#5 1 | 17-#7 | 18-#6 | 11-#7 | 9-#7 | 4.77 | 283.0 | 592.9 | 761.9 | 500 | 25 | 12-#7 | 11-#7 | 11-#6 | 10-#6 | 4.14 | 0.943 |
| 25 | 600 | 10.25 | 10.00 | 24 | 0.629 | 13-#5 1 | 17-#8 | 26-#5 | 9-#9 | 19-#5 | 5.93 | 324.4 | 728.2 | 873.3 | 600 | 25 | 13-#7 | 11-#8 | 10-#7 | 9-#7 | 5.10 | 0.970 |
| 26 | 100 | 4.25 | 8.67 | 12 | 0.833 | 12-#5 3 | 10-#6 | 16-#5 | 10-#5 | 10-#5 | 2.48 | 133.1 | 266.2 | 358.3 | 100 | 12 | 15-#5 | 10-#5 | 10-#5 | 10-#5 | 2.34 | 0.873 |
| 26 | 200 | 6.25 | 8.67 | 16 | 0.722 | 12-#5 3 | 19-#5 | 18-#5 | 9-#6 | 11-#5 | 2.94 | 179.5 | 359.0 | 483.3 | 200 | 19 | 12-#6 | 9-#6 | 10-#5 | 10-#5 | 2.66 | 0.891 |
| 26 | 300 | 6.25 | 8.67 | 19 | 0.704 | 12-#5 2 | 17-#6 | 12-#7 | 16-#5 | 13-#5 | 3.61 | 225.7 | 451.3 | 607.5 | 300 | 22 | 15-#6 | 16-#5 | 12-#5 | 11-#5 | 3.20 | 0.891 |
| 26 | 400 | 8.25 | 8.67 | 20 | 0.640 | 12-#5 2 | 12-#8 | 13-#7 | 19-#5 | 16-#5 | 4.28 | 273.1 | 546.1 | 735.1 | 400 | 24 | 12-#7 | 19-#5 | 15-#5 | 9-#6 | 3.72 | 0.910 |
| 26 | 500 | 8.25 | 10.40 | 23 | 0.753 | 14-#5 5 | 12-#9 | 12-#8 | 12-#7 | 10-#7 | 5.12 | 318.2 | 636.4 | 856.7 | 500 | 26 | 26-#5 | 12-#7 | 17-#5 | 15-#5 | 4.31 | 0.943 |
| 26 | 600 | 10.25 | 10.40 | 24 | 0.629 | 15-#5 0 | 18-#8 | 12-#8 | 12-#8 | 9-#8 | 6.07 | 366.1 | 789.3 | 985.7 | 600 | 26 | 14-#7 | 15-#7 | 20-#5 | 10-#7 | 5.15 | 0.970 |
| 27 | 100 | 6.25 | 9.00 | 12 | 0.749 | 12-#5 2 | 16-#5 | 15-#5 | 11-#5 | 10-#5 | 2.47 | 150.1 | 300.1 | 404.0 | 100 | 12 | 14-#5 | 11-#5 | 10-#5 | 10-#5 | 2.26 | 0.891 |
| 27 | 200 | 6.25 | 9.00 | 16 | 0.766 | 12-#5 4 | 9-#8 | 15-#6 | 10-#6 | 12-#5 | 3.19 | 201.9 | 403.8 | 543.6 | 200 | 19 | 14-#6 | 14-#5 | 11-#5 | 10-#5 | 2.76 | 0.891 |
| 27 | 300 | 8.25 | 9.00 | 19 | 0.632 | 12-#5 1 | 9-#9 | 12-#7 | 10-#7 | 15-#5 | 3.94 | 254.5 | 509.0 | 685.2 | 300 | 22 | 15-#6 | 18-#5 | 10-#6 | 12-#5 | 3.34 | 0.910 |
| 27 | 400 | 8.25 | 9.00 | 21 | 0.735 | 14-#5 4 | 11-#9 | 27-#5 | 9-#8 | 10-#7 | 4.83 | 305.5 | 610.9 | 822.4 | 400 | 25 | 13-#7 | 9-#8 | 9-#7 | 10-#6 | 4.20 | 0.910 |
| 27 | 500 | 10.25 | 10.80 | 23 | 0.630 | 14-#5 1 | 13-#9 | 12-#8 | 18-#6 | 15-#6 | 5.36 | 358.2 | 716.4 | 964.4 | 500 | 27 | 26-#5 | 18-#6 | 14-#6 | 9-#7 | 4.60 | 0.970 |
| 28 | 100 | 6.25 | 9.33 | 12 | 0.785 | 13-#5 2 | 18-#5 | 17-#5 | 12-#5 | 10-#5 | 2.57 | 167.8 | 335.6 | 451.8 | 100 | 12 | 16-#5 | 12-#5 | 10-#5 | 10-#5 | 2.31 | 0.891 |
| 28 | 200 | 6.25 | 9.33 | 17 | 0.778 | 13-#5 4 | 17-#6 | 16-#6 | 16-#5 | 13-#5 | 3.34 | 224.7 | 449.4 | 604.9 | 200 | 20 | 15-#6 | 16-#5 | 12-#5 | 11-#5 | 2.95 | 0.891 |
| 28 | 300 | 8.25 | 9.33 | 19 | 0.718 | 13-#5 4 | 22-#6 | 18-#6 | 20-#5 | 12-#6 | 4.11 | 285.3 | 570.5 | 768.0 | 300 | 22 | 13-#7 | 20-#5 | 11-#6 | 13-#5 | 3.61 | 0.910 |
| 28 | 400 | 10.25 | 9.33 | 21 | 0.637 | 14-#5 3 | 20-#7 | 27-#5 | 10-#8 | 20-#5 | 4.98 | 343.1 | 686.2 | 923.7 | 400 | 25 | 13-#7 | 10-#8 | 10-#7 | 16-#5 | 4.36 | 0.928 |
| 28 | 500 | 10.25 | 11.20 | 23 | 0.724 | 16-#5 4 | 18-#8 | 13-#8 | 12-#8 | 10-#8 | 5.88 | 401.9 | 803.9 | 1082.2 | 500 | 27 | 16-#7 | 12-#8 | 12-#7 | 10-#7 | 5.15 | 0.970 |
| 29 | 100 | 6.25 | 9.67 | 12 | 0.816 | 13-#5 3 | 14-#6 | 14-#6 | 13-#5 | 11-#5 | 2.75 | 186.9 | 373.9 | 503.3 | 100 | 12 | 18-#5 | 13-#5 | 11-#5 | 11-#5 | 2.47 | 0.891 |
| 29 | 200 | 8.25 | 9.67 | 17 | 0.686 | 13-#5 3 | 11-#8 | 16-#6 | 10-#7 | 15-#5 | 3.61 | 251.3 | 502.6 | 676.5 | 200 | 20 | 15-#6 | 18-#5 | 10-#6 | 12-#5 | 3.08 | 0.910 |
| 29 | 300 | 10.25 | 9.67 | 19 | 0.634 | 13-#5 3 | 14-#8 | 18-#6 | 12-#7 | 10-#7 | 4.34 | 318.0 | 635.9 | 856.1 | 300 | 23 | 23-#5 | 22-#5 | 17-#5 | 15-#5 | 3.65 | 0.928 |
| 29 | 400 | 10.25 | 11.60 | 22 | 0.704 | 15-#5 4 | 14-#9 | 16-#7 | 12-#8 | 12-#7 | 5.43 | 383.2 | 766.5 | 1031.8 | 400 | 26 | 15-#7 | 11-#8 | 11-#7 | 18-#5 | 4.59 | 0.970 |
| 29 | 500 | 12.25 | 11.60 | 23 | 0.632 | 16-#5 2 | 17-#9 | 13-#8 | 17-#7 | 11-#8 | 6.26 | 450.1 | 900.3 | 1211.9 | 500 | 27 | 16-#7 | 17-#7 | 10-#8 | 15-#6 | 5.32 | 0.997 |
| 30 | 100 | 8.25 | 10.00 | 12 | 0.732 | 14-#5 1 | 22-#5 | 14-#6 | 15-#5 | 12-#5 | 2.84 | 208.3 | 416.5 | 560.7 | 100 | 12 | 17-#5 | 15-#5 | 12-#5 | 11-#5 | 2.49 | 0.910 |
| 30 | 200 | 8.25 | 10.00 | 17 | 0.732 | 14-#5 3 | 16-#7 | 18-#6 | 14-#6 | 12-#6 | 3.78 | 279.2 | 558.5 | 751.8 | 200 | 20 | 16-#6 | 14-#6 | 15-#5 | 13-#5 | 3.24 | 0.910 |
| 30 | 300 | 10.25 | 10.00 | 19 | 0.693 | 14-#5 4 | 13-#9 | 15-#7 | 18-#6 | 11-#7 | 4.82 | 353.6 | 707.1 | 951.9 | 300 | 23 | 26-#5 | 18-#6 | 10-#7 | 12-#6 | 4.07 | 0.928 |
| 30 | 400 | 12.25 | 12.00 | 22 | 0.633 | 15-#5 3 | 16-#9 | 16-#7 | 10-#9 | 18-#6 | 5.71 | 427.6 | 855.2 | 1151.2 | 400 | 26 | 15-#7 | 10-#9 | 23-#5 | 20-#5 | 4.83 | 0.997 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

# FLAT SLAB SYSTEM

## SQUARE EDGE PANEL With Drop Panels

No Beams

# SQUARE INTERIOR PANEL

## With Drop Panels(2)

No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel | | (3) Square Column | | REINFORCING BARS (E. W.) | | | | | | MOMENTS | | | Factored Superimposed Load (psf) | (3) Square Column | REINFORCING BARS (E. W.) | | | | | Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Column Strip (1) | | | Middle Strip | | | | | | | | Column Strip | | Middle Strip | | | |
| | | Depth (in.) | Width (ft) | Size (in.) | $\gamma_f$ | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | Total Steel (psf) | Edge (–) (ft-k) | Bot. (+) (ft-k) | Int. (–) (ft-k) | | Size (in.) | Top | Bottom | Top | Bottom | Total Steel (psf) | |
| $h$ = 10.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 10.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 21 | 100 | 2.25 | 7.00 | 12 | 0.725 | 10-#5 0 | 8-#5 | 10-#5 | 8-#5 | 8-#5 | 2.23 | 70.6 | 141.1 | 190.0 | 100 | 12 | 10-#5 | 8-#5 | 8-#5 | 8-#5 | 2.23 | 0.896 |
| 21 | 200 | 2.25 | 7.00 | 16 | 0.699 | 10-#5 1 | 7-#6 | 13-#5 | 8-#5 | 8-#5 | 2.45 | 93.8 | 187.6 | 252.6 | 200 | 18 | 12-#5 | 8-#5 | 8-#5 | 8-#5 | 2.36 | 0.896 |
| 21 | 300 | 2.25 | 7.00 | 18 | 0.745 | 10-#5 2 | 12-#5 | 11-#6 | 8-#5 | 8-#5 | 2.66 | 117.4 | 234.9 | 316.2 | 300 | 21 | 15-#5 | 8-#5 | 8-#5 | 8-#5 | 2.56 | 0.896 |
| 21 | 400 | 4.25 | 7.00 | 20 | 0.626 | 10-#5 0 | 11-#6 | 16-#5 | 8-#6 | 8-#5 | 3.12 | 142.0 | 312.5 | 382.3 | 400 | 21 | 15-#5 | 11-#5 | 8-#5 | 8-#5 | 2.79 | 0.914 |
| 21 | 500 | 4.25 | 7.00 | 21 | 0.625 | 10-#5 0 | 8-#8 | 10-#7 | 9-#6 | 7-#6 | 3.72 | 166.7 | 385.6 | 448.8 | 500 | 21 | 18-#5 | 13-#5 | 9-#5 | 9-#5 | 3.25 | 0.914 |
| 21 | 600 | 6.25 | 7.00 | 21 | 0.628 | 10-#5 0 | 8-#9 | 10-#7 | 11-#6 | 8-#6 | 4.38 | 192.2 | 467.2 | 517.4 | 600 | 21 | 18-#5 | 16-#5 | 7-#6 | 8-#6 | 3.74 | 0.933 |
| 21 | 700 | 6.25 | 8.40 | 21 | 0.666 | 11-#5 0 | 15-#7 | 12-#7 | 8-#8 | 12-#5 | 4.93 | 218.0 | 545.4 | 586.9 | 700 | 21 | 14-#6 | 13-#6 | 8-#6 | 12-#5 | 4.12 | 0.958 |
| 22 | 100 | 2.25 | 7.33 | 12 | 0.747 | 10-#5 0 | 9-#5 | 11-#5 | 9-#5 | 9-#5 | 2.35 | 81.5 | 163.0 | 219.5 | 100 | 12 | 10-#5 | 9-#5 | 9-#5 | 9-#5 | 2.34 | 0.896 |
| 22 | 200 | 2.25 | 7.33 | 16 | 0.755 | 10-#5 2 | 11-#5 | 15-#5 | 9-#5 | 9-#5 | 2.62 | 108.6 | 217.2 | 292.3 | 200 | 18 | 10-#6 | 9-#5 | 9-#5 | 9-#5 | 2.59 | 0.896 |
| 22 | 300 | 4.25 | 7.33 | 18 | 0.628 | 10-#5 1 | 10-#6 | 11-#6 | 9-#5 | 9-#5 | 2.79 | 135.7 | 271.5 | 365.4 | 300 | 22 | 10-#6 | 9-#5 | 9-#5 | 9-#5 | 2.61 | 0.914 |
| 22 | 400 | 4.25 | 7.33 | 20 | 0.660 | 10-#5 2 | 13-#6 | 10-#7 | 8-#6 | 9-#5 | 3.31 | 163.9 | 345.6 | 441.3 | 400 | 22 | 12-#6 | 8-#6 | 9-#5 | 9-#5 | 2.98 | 0.914 |
| 22 | 500 | 6.25 | 7.33 | 21 | 0.628 | 10-#5 0 | 9-#8 | 10-#7 | 8-#7 | 8-#6 | 3.91 | 192.7 | 438.7 | 518.7 | 500 | 22 | 18-#5 | 15-#5 | 10-#5 | 10-#5 | 3.36 | 0.933 |
| 22 | 600 | 6.25 | 7.33 | 22 | 0.627 | 11-#5 0 | 11-#8 | 12-#7 | 8-#8 | 9-#6 | 4.76 | 220.9 | 522.4 | 594.9 | 600 | 22 | 20-#5 | 13-#6 | 8-#6 | 12-#5 | 4.02 | 0.933 |
| 22 | 700 | 8.25 | 8.80 | 22 | 0.629 | 11-#5 0 | 13-#8 | 12-#7 | 11-#7 | 10-#6 | 5.18 | 251.1 | 622.1 | 676.0 | 700 | 22 | 20-#5 | 15-#6 | 13-#5 | 10-#6 | 4.39 | 0.985 |
| 23 | 100 | 2.25 | 7.67 | 12 | 0.793 | 11-#5 0 | 9-#5 | 13-#5 | 9-#5 | 9-#5 | 2.33 | 93.5 | 187.1 | 251.8 | 100 | 12 | 12-#5 | 9-#5 | 9-#5 | 9-#5 | 2.33 | 0.896 |
| 23 | 200 | 4.25 | 7.67 | 16 | 0.630 | 11-#5 0 | 9-#6 | 14-#5 | 9-#5 | 9-#5 | 2.56 | 124.6 | 249.2 | 335.5 | 200 | 19 | 13-#5 | 9-#5 | 9-#5 | 9-#5 | 2.41 | 0.914 |
| 23 | 300 | 4.25 | 7.67 | 18 | 0.684 | 11-#5 1 | 11-#6 | 18-#5 | 8-#6 | 9-#5 | 2.94 | 156.2 | 312.4 | 420.6 | 300 | 22 | 16-#5 | 10-#5 | 9-#5 | 9-#5 | 2.64 | 0.914 |
| 23 | 400 | 6.25 | 7.67 | 20 | 0.629 | 11-#5 1 | 8-#8 | 13-#6 | 9-#6 | 8-#6 | 3.43 | 188.2 | 388.4 | 506.8 | 400 | 23 | 12-#6 | 9-#6 | 10-#5 | 9-#5 | 2.99 | 0.933 |
| 23 | 500 | 6.25 | 7.67 | 21 | 0.644 | 11-#5 2 | 8-#9 | 12-#7 | 16-#5 | 9-#6 | 4.15 | 221.0 | 484.3 | 595.0 | 500 | 23 | 14-#6 | 16-#5 | 8-#6 | 8-#6 | 3.57 | 0.933 |
| 23 | 600 | 6.25 | 9.20 | 23 | 0.728 | 12-#5 3 | 16-#7 | 13-#7 | 8-#8 | 10-#6 | 4.89 | 253.2 | 592.8 | 681.6 | 600 | 23 | 12-#7 | 11-#7 | 13-#5 | 13-#5 | 4.29 | 0.958 |
| 23 | 700 | 8.25 | 9.20 | 23 | 0.647 | 13-#5 1 | 12-#9 | 13-#7 | 8-#9 | 16-#5 | 5.88 | 286.9 | 693.3 | 772.4 | 700 | 23 | 12-#7 | 8-#9 | 8-#7 | 11-#6 | 5.05 | 0.985 |
| 24 | 100 | 4.25 | 8.00 | 12 | 0.703 | 11-#5 0 | 11-#5 | 12-#5 | 9-#5 | 9-#5 | 2.27 | 107.1 | 214.1 | 288.2 | 100 | 12 | 11-#5 | 9-#5 | 9-#5 | 9-#5 | 2.19 | 0.914 |
| 24 | 200 | 4.25 | 8.00 | 16 | 0.691 | 11-#5 1 | 10-#6 | 16-#5 | 10-#5 | 9-#5 | 2.64 | 142.4 | 284.8 | 383.4 | 200 | 19 | 15-#5 | 10-#5 | 9-#5 | 9-#5 | 2.47 | 0.914 |
| 24 | 300 | 4.25 | 8.00 | 19 | 0.736 | 11-#5 3 | 18-#5 | 20-#5 | 12-#5 | 10-#5 | 3.08 | 178.0 | 356.0 | 479.2 | 300 | 22 | 13-#6 | 12-#5 | 9-#5 | 9-#5 | 2.80 | 0.914 |
| 24 | 400 | 6.25 | 8.00 | 20 | 0.636 | 11-#5 2 | 9-#8 | 11-#7 | 10-#6 | 12-#5 | 3.63 | 214.6 | 429.2 | 577.8 | 400 | 24 | 14-#6 | 14-#5 | 8-#6 | 10-#5 | 3.17 | 0.933 |
| 24 | 500 | 6.25 | 8.00 | 22 | 0.710 | 12-#5 3 | 11-#8 | 13-#7 | 8-#8 | 10-#6 | 4.47 | 251.0 | 525.7 | 675.8 | 500 | 24 | 12-#7 | 18-#5 | 9-#6 | 12-#5 | 3.81 | 0.933 |
| 24 | 600 | 8.25 | 9.60 | 24 | 0.628 | 13-#5 1 | 14-#8 | 13-#7 | 9-#8 | 16-#5 | 5.22 | 288.2 | 666.9 | 775.9 | 600 | 24 | 12-#7 | 12-#7 | 8-#7 | 8-#7 | 4.53 | 0.985 |
| 24 | 700 | 8.25 | 9.60 | 24 | 0.716 | 14-#5 2 | 13-#9 | 12-#8 | 9-#9 | 8-#8 | 6.22 | 326.0 | 765.1 | 877.6 | 700 | 24 | 26-#5 | 11-#8 | 9-#7 | 9-#7 | 5.26 | 0.985 |
| 25 | 100 | 4.25 | 8.33 | 12 | 0.790 | 12-#5 2 | 12-#5 | 14-#5 | 10-#5 | 10-#5 | 2.42 | 121.4 | 242.9 | 326.9 | 100 | 12 | 13-#5 | 10-#5 | 10-#5 | 10-#5 | 2.35 | 0.914 |
| 25 | 200 | 4.25 | 8.33 | 16 | 0.797 | 12-#5 4 | 16-#5 | 18-#5 | 11-#5 | 10-#5 | 2.80 | 161.8 | 323.6 | 435.6 | 200 | 19 | 12-#6 | 11-#5 | 10-#5 | 10-#5 | 2.63 | 0.914 |
| 25 | 300 | 6.25 | 8.33 | 19 | 0.630 | 12-#5 1 | 11-#7 | 14-#6 | 10-#6 | 11-#5 | 3.32 | 202.8 | 405.5 | 545.9 | 300 | 22 | 18-#5 | 14-#5 | 11-#5 | 10-#5 | 2.90 | 0.933 |
| 25 | 400 | 6.25 | 8.33 | 20 | 0.732 | 12-#5 3 | 10-#8 | 13-#7 | 16-#5 | 10-#6 | 3.93 | 244.2 | 488.4 | 657.4 | 400 | 24 | 12-#7 | 16-#5 | 9-#6 | 11-#5 | 3.46 | 0.933 |
| 25 | 500 | 8.25 | 8.33 | 22 | 0.629 | 12-#5 2 | 12-#8 | 13-#7 | 19-#5 | 16-#5 | 4.46 | 285.0 | 581.0 | 767.3 | 500 | 25 | 12-#7 | 19-#5 | 15-#5 | 9-#6 | 3.89 | 0.951 |
| 25 | 600 | 8.25 | 10.00 | 24 | 0.687 | 14-#5 2 | 13-#9 | 12-#8 | 10-#8 | 10-#7 | 5.64 | 327.0 | 730.7 | 880.3 | 600 | 25 | 26-#5 | 10-#8 | 9-#7 | 16-#5 | 4.72 | 0.985 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

# FLAT SLAB SYSTEM

## SQUARE EDGE PANEL With Drop Panels

No Beams

# SQUARE INTERIOR PANEL

## With Drop Panels[2]

No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip [1] Top Ext. + | Column Strip Bottom | Column Strip Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | Bot. (+) (ft-k) | Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 10.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 10.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 26 | 100 | 4.25 | 8.67 | 12 | 0.822 | 12-#5 3 | 10-#6 | 16-#5 | 10-#5 | 10-#5 | 2.48 | 137.0 | 274.1 | 369.0 | 100 | 12 | 15-#5 | 10-#5 | 10-#5 | 10-#5 | 2.34 | 0.914 |
| 26 | 200 | 6.25 | 8.67 | 16 | 0.633 | 12-#5 0 | 18-#5 | 18-#5 | 12-#5 | 10-#5 | 2.82 | 183.3 | 366.6 | 493.5 | 200 | 19 | 12-#6 | 12-#5 | 10-#5 | 10-#5 | 2.58 | 0.933 |
| 26 | 300 | 6.25 | 8.67 | 19 | 0.683 | 12-#5 2 | 17-#6 | 12-#7 | 15-#5 | 9-#6 | 3.50 | 229.4 | 458.8 | 617.6 | 300 | 22 | 15-#6 | 15-#5 | 12-#5 | 10-#5 | 3.06 | 0.933 |
| 26 | 400 | 8.25 | 8.67 | 21 | 0.630 | 12-#5 2 | 9-#9 | 13-#7 | 10-#7 | 15-#5 | 4.17 | 274.8 | 549.6 | 739.9 | 400 | 25 | 12-#7 | 18-#5 | 10-#6 | 12-#5 | 3.56 | 0.951 |
| 26 | 500 | 8.25 | 10.40 | 23 | 0.659 | 14-#5 1 | 11-#9 | 12-#8 | 9-#8 | 10-#7 | 4.99 | 321.8 | 654.6 | 866.5 | 500 | 26 | 18-#6 | 9-#8 | 9-#7 | 15-#5 | 4.31 | 0.985 |
| 26 | 600 | 10.25 | 10.40 | 24 | 0.630 | 14-#5 1 | 14-#9 | 12-#8 | 9-#9 | 11-#7 | 5.97 | 369.7 | 810.3 | 995.4 | 600 | 26 | 14-#7 | 9-#9 | 10-#7 | 18-#5 | 5.08 | 1.012 |
| 27 | 100 | 6.25 | 9.00 | 12 | 0.736 | 12-#5 2 | 15-#5 | 15-#5 | 10-#5 | 10-#5 | 2.36 | 154.5 | 309.0 | 416.0 | 100 | 12 | 14-#5 | 10-#5 | 10-#5 | 10-#5 | 2.20 | 0.933 |
| 27 | 200 | 6.25 | 9.00 | 16 | 0.751 | 12-#5 4 | 11-#7 | 20-#5 | 10-#6 | 12-#5 | 3.08 | 206.2 | 412.4 | 555.2 | 200 | 19 | 13-#6 | 14-#5 | 11-#5 | 10-#5 | 2.71 | 0.933 |
| 27 | 300 | 8.25 | 9.00 | 19 | 0.632 | 12-#5 1 | 11-#8 | 12-#7 | 9-#7 | 15-#5 | 3.79 | 257.9 | 515.7 | 694.2 | 300 | 23 | 15-#6 | 9-#7 | 13-#5 | 11-#5 | 3.26 | 0.951 |
| 27 | 400 | 8.25 | 9.00 | 21 | 0.651 | 13-#5 2 | 13-#8 | 14-#7 | 11-#7 | 9-#7 | 4.56 | 309.6 | 619.2 | 833.6 | 400 | 25 | 13-#7 | 11-#7 | 16-#5 | 10-#6 | 4.01 | 0.951 |
| 27 | 500 | 10.25 | 10.80 | 23 | 0.631 | 14-#5 1 | 13-#9 | 12-#8 | 10-#8 | 20-#5 | 5.24 | 362.3 | 724.6 | 975.4 | 500 | 27 | 18-#6 | 10-#8 | 10-#7 | 16-#5 | 4.42 | 1.012 |
| 27 | 600 | 10.25 | 10.80 | 24 | 0.716 | 16-#5 4 | 15-#9 | 13-#8 | 12-#8 | 10-#8 | 6.17 | 415.4 | 871.9 | 1118.3 | 600 | 27 | 12-#8 | 12-#8 | 9-#8 | 19-#5 | 5.27 | 1.012 |
| 28 | 100 | 6.25 | 9.33 | 12 | 0.773 | 13-#5 2 | 17-#5 | 17-#5 | 12-#5 | 11-#5 | 2.60 | 172.8 | 345.6 | 465.2 | 100 | 12 | 16-#5 | 12-#5 | 11-#5 | 11-#5 | 2.42 | 0.933 |
| 28 | 200 | 6.25 | 9.33 | 16 | 0.791 | 13-#5 4 | 17-#6 | 16-#6 | 15-#5 | 13-#5 | 3.28 | 230.9 | 461.9 | 621.8 | 200 | 19 | 15-#6 | 15-#5 | 12-#5 | 11-#5 | 2.89 | 0.933 |
| 28 | 300 | 8.25 | 9.33 | 19 | 0.700 | 13-#5 4 | 12-#8 | 13-#7 | 10-#7 | 16-#5 | 3.98 | 289.0 | 578.1 | 778.2 | 300 | 23 | 23-#5 | 19-#5 | 15-#5 | 13-#5 | 3.42 | 0.951 |
| 28 | 400 | 10.25 | 9.33 | 21 | 0.632 | 14-#5 3 | 12-#9 | 14-#7 | 10-#8 | 14-#6 | 4.92 | 347.7 | 695.4 | 936.2 | 400 | 25 | 13-#7 | 17-#6 | 10-#7 | 15-#5 | 4.18 | 0.970 |
| 28 | 500 | 10.25 | 11.20 | 23 | 0.688 | 16-#5 3 | 17-#8 | 13-#8 | 11-#8 | 12-#7 | 5.51 | 406.5 | 813.1 | 1094.5 | 500 | 27 | 15-#7 | 11-#8 | 11-#7 | 18-#5 | 4.76 | 1.012 |
| 29 | 100 | 6.25 | 9.67 | 12 | 0.806 | 13-#5 3 | 19-#5 | 14-#6 | 13-#5 | 11-#5 | 2.71 | 192.5 | 385.0 | 518.2 | 100 | 12 | 18-#5 | 13-#5 | 11-#5 | 11-#5 | 2.47 | 0.933 |
| 29 | 200 | 8.25 | 9.67 | 17 | 0.645 | 13-#5 2 | 11-#8 | 16-#6 | 12-#6 | 10-#6 | 3.47 | 256.6 | 513.2 | 690.9 | 200 | 20 | 15-#6 | 12-#6 | 13-#5 | 11-#5 | 2.97 | 0.951 |
| 29 | 300 | 8.25 | 9.67 | 19 | 0.764 | 14-#5 5 | 11-#9 | 15-#7 | 12-#7 | 10-#7 | 4.41 | 322.6 | 645.3 | 868.6 | 300 | 23 | 18-#6 | 21-#5 | 12-#6 | 10-#6 | 3.67 | 0.951 |
| 29 | 400 | 10.25 | 9.67 | 21 | 0.678 | 15-#5 3 | 21-#7 | 16-#7 | 11-#8 | 12-#7 | 5.24 | 388.3 | 776.6 | 1045.5 | 400 | 25 | 15-#7 | 11-#8 | 14-#6 | 12-#6 | 4.60 | 0.970 |
| 29 | 500 | 12.25 | 11.60 | 23 | 0.632 | 16-#5 2 | 16-#9 | 13-#8 | 10-#9 | 18-#6 | 6.05 | 453.8 | 907.6 | 1221.8 | 500 | 28 | 16-#7 | 10-#9 | 10-#8 | 14-#6 | 5.19 | 1.038 |
| 30 | 100 | 8.25 | 10.00 | 12 | 0.719 | 14-#5 1 | 15-#6 | 14-#6 | 10-#6 | 12-#5 | 2.77 | 214.4 | 428.8 | 577.2 | 100 | 12 | 17-#5 | 14-#5 | 11-#5 | 11-#5 | 2.40 | 0.951 |
| 30 | 200 | 8.25 | 10.00 | 17 | 0.717 | 14-#5 3 | 12-#8 | 18-#6 | 10-#7 | 16-#5 | 3.70 | 285.2 | 570.3 | 767.8 | 200 | 20 | 16-#6 | 19-#5 | 15-#5 | 13-#5 | 3.16 | 0.951 |
| 30 | 300 | 10.25 | 10.00 | 19 | 0.655 | 14-#5 3 | 12-#9 | 15-#7 | 10-#8 | 20-#5 | 4.61 | 359.4 | 718.8 | 967.6 | 300 | 23 | 18-#6 | 17-#6 | 10-#7 | 16-#5 | 3.92 | 0.970 |
| 30 | 400 | 10.25 | 12.00 | 22 | 0.760 | 17-#5 6 | 15-#9 | 14-#8 | 12-#8 | 10-#8 | 5.60 | 432.2 | 864.3 | 1163.5 | 400 | 26 | 16-#7 | 12-#8 | 12-#7 | 10-#7 | 4.79 | 1.012 |
| 30 | 500 | 12.25 | 12.00 | 23 | 0.676 | 18-#5 2 | 18-#9 | 15-#8 | 14-#8 | 12-#8 | 6.52 | 505.1 | 1010.2 | 1359.9 | 500 | 28 | 17-#7 | 11-#9 | 11-#8 | 12-#7 | 5.55 | 1.038 |
| 31 | 100 | 8.25 | 10.33 | 12 | 0.757 | 14-#5 2 | 17-#6 | 15-#6 | 11-#6 | 13-#5 | 2.98 | 237.1 | 474.2 | 638.4 | 100 | 12 | 14-#6 | 16-#5 | 12-#5 | 12-#5 | 2.61 | 0.951 |
| 31 | 200 | 8.25 | 10.33 | 17 | 0.772 | 14-#5 5 | 13-#8 | 27-#5 | 11-#7 | 13-#6 | 3.93 | 315.8 | 631.6 | 850.2 | 200 | 20 | 18-#6 | 11-#7 | 16-#5 | 14-#5 | 3.41 | 0.951 |
| 31 | 300 | 10.25 | 10.33 | 19 | 0.725 | 15-#5 4 | 17-#8 | 16-#7 | 11-#8 | 12-#7 | 4.98 | 398.2 | 796.3 | 1072.0 | 300 | 23 | 15-#7 | 11-#8 | 20-#5 | 18-#5 | 4.31 | 0.970 |
| 31 | 400 | 12.25 | 12.40 | 22 | 0.633 | 17-#5 2 | 17-#9 | 14-#8 | 17-#7 | 11-#8 | 5.87 | 480.4 | 960.8 | 1293.3 | 400 | 26 | 16-#7 | 17-#7 | 13-#7 | 15-#6 | 4.95 | 1.038 |
| 31 | 500 | 12.25 | 12.40 | 24 | 0.756 | 19-#5 6 | 20-#9 | 16-#8 | 13-#9 | 13-#8 | 7.12 | 558.5 | 1117.0 | 1503.6 | 500 | 28 | 15-#8 | 13-#9 | 12-#8 | 13-#7 | 6.11 | 1.038 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL
With Drop Panels(2)
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 22 | 100 | 2.25 | 7.33 | 12 | 0.730 | 10-#5 0 | 9-#5 | 11-#5 | 9-#5 | 9-#5 | 2.35 | 83.9 | 167.8 | 225.8 | 100 | 12 | 10-#5 | 9-#5 | 9-#5 | 9-#5 | 2.34 | 0.938 |
| 22 | 200 | 2.25 | 7.33 | 16 | 0.710 | 10-#5 1 | 11-#5 | 10-#6 | 9-#5 | 9-#5 | 2.58 | 110.4 | 220.8 | 297.2 | 200 | 19 | 13-#5 | 9-#5 | 9-#5 | 9-#5 | 2.53 | 0.938 |
| 22 | 300 | 2.25 | 7.33 | 18 | 0.780 | 10-#5 3 | 13-#5 | 18-#5 | 9-#5 | 9-#5 | 2.79 | 138.3 | 276.6 | 372.3 | 300 | 21 | 16-#5 | 9-#5 | 9-#5 | 9-#5 | 2.69 | 0.938 |
| 22 | 400 | 4.25 | 7.33 | 20 | 0.633 | 10-#5 2 | 9-#7 | 18-#5 | 8-#6 | 9-#5 | 3.22 | 166.1 | 355.2 | 447.3 | 400 | 22 | 12-#6 | 11-#5 | 9-#5 | 9-#5 | 2.91 | 0.956 |
| 22 | 500 | 4.25 | 7.33 | 21 | 0.738 | 11-#5 3 | 11-#7 | 15-#6 | 10-#6 | 10-#5 | 3.80 | 194.6 | 440.1 | 524.0 | 500 | 22 | 14-#6 | 14-#5 | 10-#5 | 9-#5 | 3.34 | 0.956 |
| 22 | 600 | 6.25 | 7.33 | 22 | 0.628 | 11-#5 0 | 11-#8 | 11-#7 | 9-#7 | 12-#5 | 4.57 | 223.1 | 532.1 | 600.7 | 600 | 22 | 14-#6 | 9-#7 | 8-#6 | 8-#6 | 3.94 | 0.975 |
| 22 | 700 | 8.25 | 8.80 | 22 | 0.630 | 11-#5 0 | 10-#9 | 15-#6 | 11-#7 | 10-#6 | 5.16 | 253.2 | 633.8 | 681.8 | 700 | 22 | 14-#6 | 11-#7 | 9-#6 | 10-#6 | 4.41 | 1.027 |
| 23 | 100 | 2.25 | 7.67 | 12 | 0.777 | 11-#5 0 | 9-#5 | 12-#5 | 9-#5 | 9-#5 | 2.32 | 96.2 | 192.5 | 259.1 | 100 | 12 | 12-#5 | 9-#5 | 9-#5 | 9-#5 | 2.33 | 0.938 |
| 23 | 200 | 2.25 | 7.67 | 16 | 0.785 | 11-#5 2 | 12-#5 | 16-#5 | 9-#5 | 9-#5 | 2.59 | 126.9 | 253.9 | 341.7 | 200 | 19 | 15-#5 | 9-#5 | 9-#5 | 9-#5 | 2.52 | 0.938 |
| 23 | 300 | 4.25 | 7.67 | 19 | 0.628 | 11-#5 1 | 15-#5 | 17-#5 | 10-#5 | 9-#5 | 2.82 | 158.1 | 316.3 | 425.8 | 300 | 22 | 16-#5 | 10-#5 | 9-#5 | 9-#5 | 2.64 | 0.956 |
| 23 | 400 | 4.25 | 7.67 | 20 | 0.733 | 11-#5 3 | 13-#6 | 11-#7 | 12-#5 | 10-#5 | 3.32 | 190.5 | 388.8 | 512.9 | 400 | 23 | 14-#6 | 12-#5 | 9-#5 | 9-#5 | 3.00 | 0.956 |
| 23 | 500 | 6.25 | 7.67 | 22 | 0.628 | 11-#5 2 | 8-#9 | 11-#7 | 11-#6 | 12-#5 | 4.13 | 222.6 | 494.8 | 599.4 | 500 | 23 | 14-#6 | 11-#6 | 8-#6 | 8-#6 | 3.59 | 0.975 |
| 23 | 600 | 6.25 | 7.67 | 23 | 0.659 | 12-#5 2 | 15-#7 | 24-#5 | 8-#8 | 10-#6 | 4.83 | 255.0 | 590.0 | 686.4 | 600 | 23 | 12-#7 | 10-#7 | 9-#6 | 9-#6 | 4.27 | 0.975 |
| 23 | 700 | 8.25 | 9.20 | 23 | 0.629 | 12-#5 0 | 14-#8 | 13-#7 | 12-#7 | 8-#7 | 5.42 | 289.4 | 708.5 | 779.1 | 700 | 23 | 12-#7 | 12-#7 | 10-#6 | 8-#7 | 4.68 | 1.027 |
| 24 | 100 | 2.25 | 8.00 | 12 | 0.845 | 11-#5 3 | 11-#5 | 14-#5 | 10-#5 | 10-#5 | 2.48 | 109.8 | 219.5 | 295.5 | 100 | 12 | 13-#5 | 10-#5 | 10-#5 | 10-#5 | 2.45 | 0.938 |
| 24 | 200 | 4.25 | 8.00 | 16 | 0.637 | 11-#5 0 | 10-#6 | 16-#5 | 10-#5 | 10-#5 | 2.70 | 145.4 | 290.7 | 391.4 | 200 | 19 | 15-#5 | 10-#5 | 10-#5 | 10-#5 | 2.57 | 0.956 |
| 24 | 300 | 4.25 | 8.00 | 19 | 0.691 | 11-#5 2 | 9-#7 | 14-#6 | 8-#6 | 10-#5 | 3.08 | 180.9 | 361.8 | 487.0 | 300 | 22 | 18-#5 | 8-#6 | 10-#5 | 10-#5 | 2.85 | 0.956 |
| 24 | 400 | 6.25 | 8.00 | 21 | 0.629 | 11-#5 2 | 11-#7 | 11-#7 | 10-#6 | 8-#6 | 3.55 | 216.6 | 433.3 | 583.3 | 400 | 24 | 14-#6 | 14-#5 | 8-#6 | 10-#5 | 3.17 | 0.975 |
| 24 | 500 | 6.25 | 8.00 | 22 | 0.661 | 12-#5 2 | 11-#8 | 13-#7 | 9-#7 | 10-#6 | 4.37 | 253.9 | 541.6 | 683.5 | 500 | 24 | 12-#7 | 9-#7 | 9-#6 | 8-#6 | 3.82 | 0.975 |
| 24 | 600 | 8.25 | 9.60 | 24 | 0.628 | 12-#5 2 | 11-#9 | 13-#7 | 9-#8 | 8-#7 | 5.19 | 291.0 | 679.8 | 783.6 | 600 | 24 | 12-#7 | 9-#8 | 10-#6 | 8-#7 | 4.48 | 1.027 |
| 24 | 700 | 8.25 | 9.60 | 24 | 0.689 | 14-#5 2 | 13-#9 | 11-#8 | 9-#9 | 8-#8 | 6.16 | 328.8 | 784.6 | 885.2 | 700 | 24 | 26-#5 | 11-#8 | 16-#5 | 9-#7 | 5.19 | 1.027 |
| 25 | 100 | 4.25 | 8.33 | 12 | 0.777 | 12-#5 2 | 12-#5 | 14-#5 | 10-#5 | 10-#5 | 2.42 | 124.9 | 249.9 | 336.4 | 100 | 12 | 13-#5 | 10-#5 | 10-#5 | 10-#5 | 2.35 | 0.956 |
| 25 | 200 | 4.25 | 8.33 | 16 | 0.767 | 12-#5 3 | 11-#6 | 18-#5 | 11-#5 | 10-#5 | 2.80 | 165.2 | 330.3 | 444.7 | 200 | 19 | 12-#6 | 11-#5 | 10-#5 | 10-#5 | 2.63 | 0.956 |
| 25 | 300 | 6.25 | 8.33 | 19 | 0.630 | 12-#5 1 | 14-#6 | 14-#6 | 9-#6 | 11-#5 | 3.17 | 206.1 | 412.2 | 554.8 | 300 | 22 | 18-#5 | 9-#6 | 10-#5 | 10-#5 | 2.82 | 0.975 |
| 25 | 400 | 6.25 | 8.33 | 21 | 0.649 | 12-#5 2 | 17-#6 | 13-#7 | 11-#6 | 13-#5 | 3.79 | 246.6 | 493.1 | 663.8 | 400 | 24 | 12-#7 | 11-#6 | 12-#5 | 10-#5 | 3.36 | 0.975 |
| 25 | 500 | 8.25 | 8.33 | 22 | 0.630 | 12-#5 2 | 12-#8 | 13-#7 | 10-#7 | 15-#5 | 4.51 | 288.2 | 599.8 | 776.0 | 500 | 25 | 12-#7 | 10-#7 | 10-#6 | 9-#6 | 3.97 | 0.993 |
| 25 | 600 | 8.25 | 10.00 | 24 | 0.638 | 14-#5 1 | 12-#9 | 12-#8 | 10-#8 | 10-#7 | 5.49 | 330.2 | 747.0 | 888.9 | 600 | 25 | 26-#5 | 10-#8 | 16-#5 | 11-#6 | 4.66 | 1.027 |
| 25 | 700 | 10.25 | 10.00 | 25 | 0.630 | 14-#5 1 | 14-#9 | 12-#8 | 12-#8 | 14-#6 | 6.23 | 372.2 | 875.1 | 1002.2 | 700 | 25 | 26-#5 | 15-#7 | 10-#7 | 10-#7 | 5.28 | 1.053 |
| 26 | 100 | 4.25 | 8.67 | 12 | 0.795 | 12-#5 2 | 13-#5 | 15-#5 | 10-#5 | 10-#5 | 2.39 | 141.0 | 282.0 | 379.6 | 100 | 12 | 14-#5 | 10-#5 | 10-#5 | 10-#5 | 2.29 | 0.956 |
| 26 | 200 | 6.25 | 8.67 | 16 | 0.634 | 12-#5 0 | 18-#5 | 18-#5 | 12-#5 | 10-#5 | 2.79 | 187.1 | 374.3 | 503.8 | 200 | 19 | 16-#5 | 12-#5 | 10-#5 | 10-#5 | 2.52 | 0.975 |
| 26 | 300 | 6.25 | 8.67 | 19 | 0.632 | 12-#5 1 | 9-#8 | 12-#7 | 15-#5 | 12-#5 | 3.40 | 233.1 | 466.3 | 627.7 | 300 | 22 | 20-#5 | 15-#5 | 11-#5 | 10-#5 | 2.93 | 0.975 |
| 26 | 400 | 8.25 | 8.67 | 21 | 0.631 | 12-#5 2 | 11-#8 | 13-#7 | 10-#7 | 15-#5 | 4.08 | 278.5 | 557.0 | 749.8 | 400 | 25 | 15-#6 | 18-#5 | 10-#6 | 12-#5 | 3.49 | 0.993 |
| 26 | 500 | 8.25 | 8.67 | 22 | 0.647 | 14-#5 1 | 13-#8 | 12-#8 | 11-#7 | 9-#7 | 4.79 | 325.2 | 650.4 | 875.6 | 500 | 26 | 13-#7 | 11-#7 | 11-#6 | 10-#6 | 4.18 | 0.993 |
| 26 | 600 | 10.25 | 10.40 | 24 | 0.630 | 14-#5 1 | 17-#8 | 12-#8 | 9-#9 | 14-#6 | 5.77 | 373.4 | 829.7 | 1005.2 | 600 | 26 | 26-#5 | 11-#8 | 10-#7 | 18-#5 | 4.90 | 1.053 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

# FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

# SQUARE INTERIOR PANEL

With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superim-posed Load (psf) | Square Drop Panel | | (3) Square Column | | REINFORCING BARS (E. W.) | | | | | | MOMENTS | | | Factored Superim-posed Load (psf) | (3) Square Column | REINFORCING BARS (E. W.) | | | | | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Column Strip [1] | | | Middle Strip | | | | | | | | Column Strip | | Middle Strip | | | |
| | | Depth (in.) | Width (ft) | Size (in.) | $\gamma_f$ | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | Total Steel (psf) | Edge (–) (ft-k) | Bot. (+) (ft-k) | Int. (–) (ft-k) | | Size (in.) | Top | Bottom | Top | Bottom | Total Steel (psf) | |
| *h* = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | *h* = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 27 | 100 | 4.25 | 9.00 | 12 | 0.839 | 12-#5 4 | 15-#5 | 12-#6 | 11-#5 | 11-#5 | 2.56 | 158.4 | 316.8 | 426.4 | 100 | 12 | 16-#5 | 11-#5 | 11-#5 | 11-#5 | 2.46 | 0.956 |
| 27 | 200 | 6.25 | 9.00 | 16 | 0.668 | 12-#5 1 | 14-#6 | 14-#6 | 13-#5 | 11-#5 | 2.96 | 210.5 | 421.0 | 566.8 | 200 | 19 | 18-#5 | 13-#5 | 11-#5 | 11-#5 | 2.68 | 0.975 |
| 27 | 300 | 6.25 | 9.00 | 19 | 0.772 | 13-#5 5 | 18-#6 | 13-#7 | 9-#7 | 10-#6 | 3.76 | 262.5 | 524.9 | 706.6 | 300 | 22 | 12-#7 | 9-#7 | 9-#6 | 11-#5 | 3.33 | 0.975 |
| 27 | 400 | 8.25 | 9.00 | 21 | 0.631 | 13-#5 2 | 16-#7 | 14-#7 | 14-#6 | 9-#7 | 4.31 | 313.8 | 627.5 | 844.7 | 400 | 25 | 13-#7 | 14-#6 | 15-#5 | 13-#5 | 3.78 | 0.993 |
| 27 | 500 | 8.25 | 10.80 | 23 | 0.766 | 15-#5 5 | 12-#9 | 16-#7 | 10-#8 | 19-#5 | 5.16 | 365.6 | 731.2 | 984.3 | 500 | 27 | 12-#8 | 12-#7 | 10-#7 | 15-#5 | 4.46 | 1.027 |
| 27 | 600 | 10.25 | 10.80 | 24 | 0.677 | 16-#5 3 | 18-#8 | 13-#8 | 12-#8 | 9-#8 | 6.03 | 419.4 | 896.1 | 1129.2 | 600 | 27 | 12-#8 | 12-#8 | 11-#7 | 10-#7 | 5.24 | 1.053 |
| 28 | 100 | 6.25 | 9.33 | 12 | 0.760 | 13-#5 2 | 12-#6 | 17-#5 | 11-#5 | 11-#5 | 2.56 | 177.8 | 355.5 | 478.6 | 100 | 12 | 16-#5 | 11-#5 | 11-#5 | 11-#5 | 2.36 | 0.975 |
| 28 | 200 | 6.25 | 9.33 | 16 | 0.777 | 13-#5 4 | 12-#7 | 16-#6 | 15-#5 | 13-#5 | 3.25 | 235.8 | 471.5 | 634.7 | 200 | 19 | 15-#6 | 15-#5 | 12-#5 | 11-#5 | 2.89 | 0.975 |
| 28 | 300 | 8.25 | 9.33 | 19 | 0.661 | 13-#5 3 | 15-#7 | 13-#7 | 10-#7 | 11-#6 | 3.88 | 293.7 | 587.5 | 790.8 | 300 | 23 | 16-#6 | 13-#6 | 10-#6 | 12-#5 | 3.33 | 0.993 |
| 28 | 400 | 8.25 | 9.33 | 21 | 0.750 | 15-#5 4 | 11-#9 | 16-#7 | 12-#7 | 10-#7 | 4.77 | 351.9 | 703.7 | 947.3 | 400 | 25 | 19-#6 | 12-#7 | 12-#6 | 15-#5 | 4.14 | 0.993 |
| 28 | 500 | 10.25 | 11.20 | 23 | 0.687 | 15-#5 4 | 13-#9 | 22-#6 | 11-#8 | 12-#7 | 5.41 | 409.8 | 819.5 | 1103.2 | 500 | 28 | 15-#7 | 11-#8 | 14-#6 | 12-#6 | 4.67 | 1.053 |
| 28 | 600 | 10.25 | 11.20 | 25 | 0.726 | 18-#5 3 | 19-#8 | 15-#8 | 10-#9 | 10-#8 | 6.19 | 467.6 | 954.2 | 1259.0 | 600 | 28 | 13-#8 | 16-#7 | 12-#7 | 20-#5 | 5.32 | 1.053 |
| 29 | 100 | 6.25 | 9.67 | 12 | 0.794 | 13-#5 3 | 19-#5 | 14-#6 | 13-#5 | 12-#5 | 2.76 | 198.0 | 396.1 | 533.1 | 100 | 12 | 18-#5 | 13-#5 | 12-#5 | 12-#5 | 2.55 | 0.975 |
| 29 | 200 | 8.25 | 9.67 | 17 | 0.635 | 13-#5 2 | 10-#8 | 16-#6 | 12-#6 | 10-#6 | 3.37 | 261.9 | 523.9 | 705.2 | 200 | 20 | 20-#5 | 12-#6 | 13-#5 | 12-#5 | 2.94 | 0.993 |
| 29 | 300 | 8.25 | 9.67 | 19 | 0.733 | 14-#5 4 | 13-#8 | 15-#7 | 11-#7 | 17-#5 | 4.21 | 327.9 | 655.8 | 882.7 | 300 | 23 | 18-#6 | 21-#5 | 16-#5 | 10-#6 | 3.62 | 0.993 |
| 29 | 400 | 10.25 | 9.67 | 21 | 0.660 | 15-#5 3 | 20-#7 | 16-#7 | 10-#8 | 11-#7 | 4.93 | 393.5 | 787.0 | 1059.4 | 400 | 25 | 27-#5 | 10-#8 | 10-#7 | 12-#6 | 4.33 | 1.012 |
| 29 | 500 | 10.25 | 11.60 | 23 | 0.741 | 17-#5 4 | 15-#9 | 14-#8 | 12-#8 | 10-#8 | 5.86 | 457.9 | 915.8 | 1232.8 | 500 | 28 | 13-#8 | 12-#8 | 12-#7 | 10-#7 | 5.07 | 1.053 |
| 30 | 100 | 8.25 | 10.00 | 12 | 0.707 | 14-#5 1 | 11-#7 | 14-#6 | 10-#6 | 12-#5 | 2.81 | 220.6 | 441.1 | 593.8 | 100 | 12 | 17-#5 | 14-#5 | 12-#5 | 12-#5 | 2.48 | 0.993 |
| 30 | 200 | 8.25 | 10.00 | 17 | 0.702 | 14-#5 3 | 15-#7 | 18-#6 | 10-#7 | 15-#5 | 3.57 | 291.1 | 582.2 | 783.7 | 200 | 20 | 16-#6 | 18-#5 | 10-#6 | 12-#5 | 3.02 | 0.993 |
| 30 | 300 | 10.25 | 10.00 | 20 | 0.634 | 14-#5 3 | 12-#9 | 15-#7 | 12-#7 | 10-#7 | 4.50 | 364.1 | 728.2 | 980.3 | 300 | 23 | 18-#6 | 12-#7 | 10-#7 | 15-#5 | 3.84 | 1.012 |
| 30 | 400 | 10.25 | 10.00 | 21 | 0.715 | 16-#5 4 | 14-#9 | 14-#8 | 12-#8 | 10-#8 | 5.46 | 437.7 | 875.5 | 1178.5 | 400 | 25 | 16-#7 | 15-#7 | 15-#6 | 18-#5 | 4.62 | 1.012 |
| 30 | 500 | 12.25 | 12.00 | 24 | 0.632 | 17-#5 2 | 17-#9 | 14-#8 | 17-#7 | 11-#8 | 6.12 | 509.2 | 1018.4 | 1371.0 | 500 | 28 | 17-#7 | 17-#7 | 10-#8 | 15-#6 | 5.23 | 1.080 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

# FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels

No Beams

# SQUARE INTERIOR PANEL

With Drop Panels(2)

No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel | | (3) Square Column | | REINFORCING BARS (E. W.) | | | | | | MOMENTS | | | Factored Superimposed Load (psf) | (3) Square Column | REINFORCING BARS (E. W.) | | | | | Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Column Strip (1) | | | Middle Strip | | | | | | | | Column Strip | | Middle Strip | | | |
| | | Depth (in.) | Width (ft) | Size (in.) | $\gamma_f$ | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | Total Steel (psf) | Edge (–) (ft-k) | Bot. (+) (ft-k) | Int. (–) (ft-k) | | Size (in.) | Top | Bottom | Top | Bottom | Total Steel (psf) | |
| $h$ = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 11 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 31 | 100 | 8.25 | 10.33 | 12 | 0.746 | 14-#5 2 | 12-#7 | 15-#6 | 15-#5 | 13-#5 | 2.93 | 243.9 | 487.8 | 656.7 | 100 | 12 | 14-#6 | 11-#6 | 12-#5 | 12-#5 | 2.62 | 0.993 |
| 31 | 200 | 8.25 | 10.33 | 17 | 0.745 | 14-#5 4 | 22-#6 | 14-#7 | 20-#5 | 12-#6 | 3.74 | 322.3 | 644.7 | 867.8 | 200 | 20 | 18-#6 | 20-#5 | 11-#6 | 14-#5 | 3.29 | 0.993 |
| 31 | 300 | 10.25 | 10.33 | 20 | 0.660 | 15-#5 3 | 13-#9 | 16-#7 | 18-#6 | 15-#6 | 4.76 | 403.4 | 806.9 | 1086.2 | 300 | 23 | 15-#7 | 18-#6 | 14-#6 | 12-#6 | 4.10 | 1.012 |
| 31 | 400 | 12.25 | 12.40 | 22 | 0.634 | 17-#5 2 | 16-#9 | 14-#8 | 22-#6 | 11-#8 | 5.63 | 485.3 | 970.6 | 1306.6 | 400 | 27 | 16-#7 | 22-#6 | 13-#7 | 20-#5 | 4.77 | 1.080 |
| 31 | 500 | 12.25 | 12.40 | 24 | 0.728 | 19-#5 5 | 19-#9 | 16-#8 | 12-#9 | 16-#7 | 6.82 | 564.8 | 1129.5 | 1520.5 | 500 | 28 | 15-#8 | 12-#9 | 12-#8 | 13-#7 | 5.94 | 1.080 |
| 32 | 100 | 8.25 | 10.67 | 12 | 0.794 | 15-#5 4 | 18-#6 | 16-#6 | 12-#6 | 14-#5 | 3.11 | 268.9 | 537.7 | 723.9 | 100 | 12 | 15-#6 | 12-#6 | 13-#5 | 13-#5 | 2.76 | 0.993 |
| 32 | 200 | 10.25 | 10.67 | 17 | 0.637 | 15-#5 2 | 11-#9 | 19-#6 | 12-#7 | 19-#5 | 4.06 | 356.6 | 713.2 | 960.1 | 200 | 20 | 18-#6 | 12-#7 | 17-#5 | 15-#5 | 3.50 | 1.012 |
| 32 | 300 | 10.25 | 10.67 | 20 | 0.754 | 17-#5 6 | 14-#9 | 18-#7 | 12-#8 | 13-#7 | 5.16 | 445.5 | 891.0 | 1199.4 | 300 | 23 | 16-#7 | 15-#7 | 12-#7 | 19-#5 | 4.43 | 1.012 |
| 32 | 400 | 12.25 | 12.80 | 22 | 0.716 | 18-#5 5 | 18-#9 | 15-#8 | 14-#8 | 12-#8 | 6.13 | 536.2 | 1072.4 | 1443.7 | 400 | 27 | 18-#7 | 11-#9 | 11-#8 | 12-#7 | 5.24 | 1.080 |
| 32 | 500 | 12.25 | 12.80 | 26 | 0.765 | 15-#6 5 | 21-#9 | 17-#8 | 13-#9 | 11-#9 | 7.19 | 620.6 | 1241.2 | 1670.9 | 500 | 28 | 16-#8 | 13-#9 | 16-#7 | 11-#8 | 6.16 | 1.080 |
| 33 | 100 | 10.25 | 11.00 | 12 | 0.731 | 15-#5 3 | 15-#7 | 16-#6 | 13-#6 | 11-#6 | 3.24 | 296.5 | 593.1 | 798.4 | 100 | 12 | 15-#6 | 19-#5 | 15-#5 | 13-#5 | 2.80 | 1.012 |
| 33 | 200 | 10.25 | 11.00 | 17 | 0.717 | 15-#5 4 | 20-#7 | 16-#7 | 13-#7 | 11-#7 | 4.24 | 392.3 | 784.6 | 1056.2 | 200 | 20 | 27-#5 | 13-#7 | 19-#5 | 16-#5 | 3.63 | 1.012 |
| 33 | 300 | 12.25 | 11.00 | 20 | 0.656 | 17-#5 4 | 16-#9 | 18-#7 | 22-#6 | 11-#8 | 5.37 | 491.3 | 982.6 | 1322.7 | 300 | 23 | 16-#7 | 22-#6 | 13-#7 | 11-#7 | 4.57 | 1.030 |
| 33 | 400 | 12.25 | 13.20 | 23 | 0.746 | 20-#5 5 | 19-#9 | 16-#8 | 13-#9 | 13-#8 | 6.60 | 588.9 | 1177.9 | 1585.6 | 400 | 27 | 15-#8 | 13-#9 | 12-#8 | 13-#7 | 5.72 | 1.080 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL
With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip [1] Top Ext. + | Column Strip Bottom | Column Strip Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | Bot. (+) (ft-k) | Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 11.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 11.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 23 | 100 | 2.25 | 7.67 | 12 | 0.760 | 11-#5 | 0 | 10-#5 | 12-#5 | 10-#5 | 10-#5 | 2.48 | 99.0 | 197.9 | 266.4 | 100 | 12 | 11-#5 | 10-#5 | 10-#5 | 10-#5 | 2.47 | 0.979 |
| 23 | 200 | 2.25 | 7.67 | 16 | 0.746 | 11-#5 | 1 | 12-#5 | 16-#5 | 10-#5 | 10-#5 | 2.73 | 129.5 | 259.1 | 348.7 | 200 | 19 | 15-#5 | 10-#5 | 10-#5 | 10-#5 | 2.69 | 0.979 |
| 23 | 300 | 4.25 | 7.67 | 19 | 0.629 | 11-#5 | 1 | 15-#5 | 12-#6 | 10-#5 | 10-#5 | 2.89 | 160.7 | 321.4 | 432.6 | 300 | 22 | 11-#6 | 10-#5 | 10-#5 | 10-#5 | 2.75 | 0.998 |
| 23 | 400 | 4.25 | 7.67 | 20 | 0.685 | 11-#5 | 2 | 13-#6 | 20-#5 | 12-#5 | 10-#5 | 3.35 | 193.0 | 400.2 | 519.7 | 400 | 23 | 14-#6 | 12-#5 | 10-#5 | 10-#5 | 3.11 | 0.998 |
| 23 | 500 | 6.25 | 7.67 | 22 | 0.628 | 11-#5 | 2 | 12-#7 | 11-#7 | 8-#7 | 8-#6 | 3.88 | 225.1 | 506.3 | 606.1 | 500 | 23 | 14-#6 | 15-#5 | 8-#6 | 10-#5 | 3.38 | 1.016 |
| 23 | 600 | 6.25 | 7.67 | 23 | 0.629 | 12-#5 | 2 | 9-#9 | 13-#7 | 8-#8 | 9-#6 | 4.74 | 257.5 | 601.7 | 693.1 | 600 | 23 | 12-#7 | 13-#6 | 12-#5 | 12-#5 | 4.03 | 1.016 |
| 23 | 700 | 8.25 | 9.20 | 23 | 0.630 | 12-#5 | 0 | 11-#9 | 13-#7 | 9-#8 | 8-#7 | 5.43 | 291.9 | 722.1 | 785.8 | 700 | 23 | 12-#7 | 9-#8 | 10-#6 | 8-#7 | 4.69 | 1.068 |
| 24 | 100 | 2.25 | 8.00 | 12 | 0.802 | 11-#5 | 1 | 10-#5 | 14-#5 | 10-#5 | 10-#5 | 2.44 | 112.9 | 225.7 | 303.9 | 100 | 12 | 13-#5 | 10-#5 | 10-#5 | 10-#5 | 2.45 | 0.979 |
| 24 | 200 | 4.25 | 8.00 | 16 | 0.632 | 11-#5 | 0 | 13-#5 | 11-#6 | 10-#5 | 10-#5 | 2.62 | 148.3 | 296.7 | 399.4 | 200 | 19 | 14-#5 | 10-#5 | 10-#5 | 10-#5 | 2.52 | 0.998 |
| 24 | 300 | 4.25 | 8.00 | 19 | 0.638 | 11-#5 | 1 | 9-#7 | 14-#6 | 8-#6 | 10-#5 | 3.06 | 183.8 | 367.6 | 494.8 | 300 | 22 | 18-#5 | 11-#5 | 10-#5 | 10-#5 | 2.79 | 0.998 |
| 24 | 400 | 4.25 | 8.00 | 21 | 0.740 | 12-#5 | 3 | 8-#8 | 12-#7 | 13-#5 | 8-#6 | 3.48 | 219.2 | 438.4 | 590.2 | 400 | 24 | 11-#7 | 13-#5 | 10-#5 | 10-#5 | 3.13 | 0.998 |
| 24 | 500 | 6.25 | 8.00 | 22 | 0.633 | 12-#5 | 2 | 11-#8 | 13-#7 | 9-#7 | 9-#6 | 4.33 | 256.7 | 556.3 | 691.1 | 500 | 24 | 12-#7 | 9-#7 | 12-#5 | 8-#6 | 3.78 | 1.016 |
| 24 | 600 | 8.25 | 8.00 | 23 | 0.630 | 12-#5 | 2 | 10-#9 | 13-#7 | 11-#7 | 8-#7 | 5.00 | 293.9 | 674.9 | 791.3 | 600 | 24 | 12-#7 | 11-#7 | 10-#6 | 10-#6 | 4.37 | 1.035 |
| 24 | 700 | 8.25 | 9.60 | 24 | 0.640 | 14-#5 | 1 | 12-#9 | 27-#5 | 8-#9 | 9-#7 | 5.72 | 331.6 | 802.1 | 892.8 | 700 | 24 | 18-#6 | 8-#9 | 11-#6 | 16-#5 | 4.94 | 1.068 |
| 25 | 100 | 4.25 | 8.33 | 12 | 0.743 | 12-#5 | 1 | 12-#5 | 14-#5 | 11-#5 | 11-#5 | 2.57 | 128.5 | 256.9 | 345.8 | 100 | 12 | 13-#5 | 11-#5 | 11-#5 | 11-#5 | 2.54 | 0.998 |
| 25 | 200 | 4.25 | 8.33 | 16 | 0.683 | 12-#5 | 0 | 15-#5 | 18-#5 | 11-#5 | 11-#5 | 2.80 | 168.6 | 337.1 | 453.8 | 200 | 19 | 16-#5 | 11-#5 | 11-#5 | 11-#5 | 2.69 | 0.998 |
| 25 | 300 | 4.25 | 8.33 | 19 | 0.732 | 12-#5 | 2 | 10-#7 | 12-#7 | 9-#6 | 11-#5 | 3.30 | 209.0 | 418.1 | 562.8 | 300 | 22 | 20-#5 | 9-#6 | 11-#5 | 11-#5 | 3.04 | 0.998 |
| 25 | 400 | 6.25 | 8.33 | 21 | 0.629 | 12-#5 | 2 | 9-#8 | 12-#7 | 15-#5 | 9-#6 | 3.67 | 248.9 | 497.8 | 670.1 | 400 | 25 | 15-#6 | 15-#5 | 12-#5 | 11-#5 | 3.29 | 1.016 |
| 25 | 500 | 6.25 | 8.33 | 22 | 0.731 | 13-#5 | 3 | 9-#9 | 14-#7 | 10-#7 | 15-#5 | 4.48 | 291.1 | 603.8 | 783.8 | 500 | 25 | 13-#7 | 13-#6 | 10-#6 | 12-#5 | 3.90 | 1.016 |
| 25 | 600 | 8.25 | 10.00 | 24 | 0.629 | 14-#5 | 1 | 12-#9 | 27-#5 | 12-#7 | 9-#7 | 5.31 | 333.4 | 762.1 | 897.5 | 600 | 25 | 18-#6 | 10-#8 | 11-#6 | 15-#5 | 4.59 | 1.068 |
| 25 | 700 | 8.25 | 10.00 | 25 | 0.706 | 15-#5 | 2 | 17-#8 | 16-#7 | 9-#9 | 10-#7 | 6.20 | 374.8 | 883.0 | 1009.1 | 700 | 25 | 12-#8 | 11-#8 | 10-#7 | 10-#7 | 5.45 | 1.068 |
| 26 | 100 | 4.25 | 8.67 | 12 | 0.782 | 12-#5 | 2 | 9-#6 | 15-#5 | 11-#5 | 11-#5 | 2.53 | 145.0 | 289.9 | 390.3 | 100 | 12 | 14-#5 | 11-#5 | 11-#5 | 11-#5 | 2.47 | 0.998 |
| 26 | 200 | 4.25 | 8.67 | 16 | 0.792 | 12-#5 | 4 | 9-#7 | 14-#6 | 12-#5 | 11-#5 | 2.92 | 190.5 | 381.0 | 512.9 | 200 | 19 | 13-#6 | 11-#5 | 11-#5 | 11-#5 | 2.72 | 0.998 |
| 26 | 300 | 6.25 | 8.67 | 19 | 0.631 | 12-#5 | 1 | 15-#6 | 12-#7 | 10-#6 | 12-#5 | 3.32 | 236.1 | 472.1 | 635.5 | 300 | 23 | 14-#6 | 14-#5 | 11-#5 | 11-#5 | 2.97 | 1.016 |
| 26 | 400 | 6.25 | 8.67 | 21 | 0.696 | 13-#5 | 2 | 18-#6 | 26-#5 | 9-#7 | 10-#6 | 3.97 | 281.8 | 563.6 | 758.7 | 400 | 25 | 13-#7 | 9-#7 | 9-#6 | 11-#5 | 3.59 | 1.016 |
| 26 | 500 | 8.25 | 8.67 | 23 | 0.630 | 13-#5 | 2 | 16-#7 | 14-#7 | 14-#6 | 9-#7 | 4.49 | 327.7 | 662.1 | 882.3 | 500 | 26 | 13-#7 | 14-#6 | 15-#5 | 13-#5 | 3.94 | 1.035 |
| 26 | 600 | 8.25 | 10.40 | 24 | 0.709 | 15-#5 | 2 | 13-#9 | 16-#7 | 18-#6 | 10-#7 | 5.67 | 376.3 | 831.3 | 1013.1 | 600 | 26 | 12-#8 | 18-#6 | 10-#7 | 9-#7 | 4.97 | 1.068 |
| 26 | 700 | 10.25 | 10.40 | 26 | 0.629 | 16-#5 | 0 | 15-#9 | 22-#6 | 12-#8 | 15-#6 | 6.34 | 422.3 | 980.2 | 1137.0 | 700 | 26 | 12-#8 | 16-#7 | 14-#6 | 14-#6 | 5.47 | 1.095 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL

With Drop Panels(2)
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 11.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 11.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 27 | 100 | 4.25 | 9.00 | 12 | 0.815 | 12-#5 3 | 15-#5 | 12-#6 | 11-#5 | 11-#5 | 2.56 | 162.8 | 325.7 | 438.4 | 100 | 12 | 16-#5 | 11-#5 | 11-#5 | 11-#5 | 2.46 | 0.998 |
| 27 | 200 | 6.25 | 9.00 | 16 | 0.648 | 12-#5 1 | 10-#7 | 14-#6 | 9-#6 | 11-#5 | 2.96 | 214.8 | 429.6 | 578.3 | 200 | 19 | 18-#5 | 9-#6 | 11-#5 | 11-#5 | 2.70 | 1.016 |
| 27 | 300 | 6.25 | 9.00 | 19 | 0.702 | 12-#5 3 | 17-#6 | 13-#7 | 16-#5 | 13-#5 | 3.54 | 265.8 | 531.6 | 715.6 | 300 | 23 | 12-#7 | 11-#6 | 12-#5 | 11-#5 | 3.16 | 1.016 |
| 27 | 400 | 8.25 | 9.00 | 21 | 0.631 | 13-#5 2 | 12-#8 | 26-#5 | 10-#7 | 16-#5 | 4.25 | 317.9 | 635.8 | 855.9 | 400 | 25 | 13-#7 | 10-#7 | 15-#5 | 9-#6 | 3.78 | 1.035 |
| 27 | 500 | 8.25 | 9.00 | 23 | 0.720 | 15-#5 4 | 11-#9 | 12-#8 | 9-#8 | 10-#7 | 5.02 | 368.1 | 736.2 | 991.0 | 500 | 27 | 12-#8 | 9-#8 | 9-#7 | 15-#5 | 4.47 | 1.035 |
| 27 | 600 | 10.25 | 10.80 | 25 | 0.630 | 16-#5 2 | 14-#9 | 22-#6 | 9-#9 | 15-#6 | 5.85 | 422.1 | 915.3 | 1136.3 | 600 | 27 | 12-#8 | 9-#9 | 14-#6 | 18-#5 | 5.04 | 1.095 |
| 27 | 700 | 10.25 | 10.80 | 25 | 0.737 | 17-#5 4 | 17-#9 | 14-#8 | 17-#7 | 10-#8 | 6.85 | 476.2 | 1070.2 | 1282.0 | 700 | 27 | 13-#8 | 11-#9 | 9-#8 | 15-#6 | 5.93 | 1.095 |
| 28 | 100 | 6.25 | 9.33 | 12 | 0.728 | 13-#5 1 | 16-#5 | 17-#5 | 12-#5 | 12-#5 | 2.62 | 182.7 | 365.5 | 492.0 | 100 | 12 | 16-#5 | 12-#5 | 12-#5 | 12-#5 | 2.51 | 1.016 |
| 28 | 200 | 6.25 | 9.33 | 16 | 0.762 | 13-#5 4 | 12-#7 | 16-#6 | 10-#6 | 12-#5 | 3.18 | 240.6 | 481.1 | 647.7 | 200 | 19 | 20-#5 | 14-#5 | 12-#5 | 12-#5 | 2.81 | 1.016 |
| 28 | 300 | 6.25 | 9.33 | 20 | 0.773 | 14-#5 5 | 11-#8 | 27-#5 | 10-#7 | 15-#5 | 3.89 | 297.0 | 593.9 | 799.5 | 300 | 23 | 13-#7 | 18-#5 | 10-#6 | 12-#5 | 3.38 | 1.016 |
| 28 | 400 | 8.25 | 9.33 | 21 | 0.731 | 15-#5 4 | 17-#7 | 16-#7 | 15-#6 | 10-#7 | 4.48 | 356.5 | 713.0 | 959.8 | 400 | 25 | 14-#7 | 15-#6 | 16-#5 | 10-#6 | 3.90 | 1.035 |
| 28 | 500 | 10.25 | 11.20 | 24 | 0.631 | 15-#5 3 | 13-#9 | 16-#7 | 10-#8 | 11-#7 | 5.16 | 413.0 | 826.0 | 1111.9 | 500 | 28 | 15-#7 | 10-#8 | 10-#7 | 16-#5 | 4.43 | 1.095 |
| 28 | 600 | 10.25 | 11.20 | 25 | 0.689 | 17-#5 3 | 15-#9 | 14-#8 | 12-#8 | 10-#8 | 6.09 | 472.2 | 981.8 | 1271.2 | 600 | 28 | 13-#8 | 12-#8 | 12-#7 | 14-#6 | 5.29 | 1.095 |
| 29 | 100 | 6.25 | 9.67 | 12 | 0.783 | 13-#5 3 | 18-#5 | 14-#6 | 12-#5 | 12-#5 | 2.65 | 203.6 | 407.1 | 548.1 | 100 | 12 | 17-#5 | 12-#5 | 12-#5 | 12-#5 | 2.46 | 1.016 |
| 29 | 200 | 6.25 | 9.67 | 17 | 0.774 | 13-#5 5 | 17-#6 | 13-#7 | 16-#5 | 13-#5 | 3.30 | 266.6 | 533.3 | 717.9 | 200 | 20 | 16-#6 | 16-#5 | 12-#5 | 12-#5 | 2.94 | 1.016 |
| 29 | 300 | 8.25 | 9.67 | 20 | 0.665 | 14-#5 3 | 16-#7 | 19-#6 | 14-#6 | 12-#6 | 4.00 | 332.1 | 664.2 | 894.1 | 300 | 23 | 13-#7 | 14-#6 | 15-#5 | 13-#5 | 3.49 | 1.035 |
| 29 | 400 | 10.25 | 9.67 | 22 | 0.632 | 15-#5 2 | 12-#9 | 16-#7 | 10-#8 | 14-#6 | 4.85 | 396.2 | 792.4 | 1066.7 | 400 | 26 | 14-#7 | 17-#6 | 10-#7 | 11-#6 | 4.15 | 1.053 |
| 29 | 500 | 10.25 | 11.60 | 24 | 0.658 | 17-#5 2 | 14-#9 | 14-#8 | 12-#8 | 10-#8 | 5.63 | 461.5 | 923.1 | 1242.6 | 500 | 28 | 22-#6 | 12-#8 | 15-#6 | 18-#5 | 4.82 | 1.095 |
| 29 | 600 | 12.25 | 11.60 | 25 | 0.632 | 18-#5 1 | 20-#8 | 14-#8 | 13-#8 | 11-#8 | 6.22 | 527.0 | 1064.6 | 1419.0 | 600 | 29 | 13-#8 | 13-#8 | 10-#8 | 11-#7 | 5.43 | 1.122 |
| 30 | 100 | 6.25 | 10.00 | 12 | 0.813 | 14-#5 3 | 20-#5 | 15-#6 | 10-#6 | 13-#5 | 2.88 | 225.9 | 451.8 | 608.2 | 100 | 12 | 14-#6 | 14-#5 | 13-#5 | 13-#5 | 2.70 | 1.016 |
| 30 | 200 | 8.25 | 10.00 | 17 | 0.665 | 14-#5 2 | 11-#8 | 17-#6 | 10-#7 | 15-#5 | 3.56 | 297.0 | 594.0 | 799.7 | 200 | 20 | 16-#6 | 18-#5 | 10-#6 | 13-#5 | 3.09 | 1.035 |
| 30 | 300 | 8.25 | 10.00 | 20 | 0.734 | 15-#5 4 | 11-#9 | 16-#7 | 12-#7 | 10-#7 | 4.47 | 369.3 | 738.6 | 994.2 | 300 | 23 | 15-#7 | 12-#7 | 12-#6 | 15-#5 | 3.92 | 1.035 |
| 30 | 400 | 10.25 | 10.00 | 22 | 0.645 | 16-#5 3 | 17-#8 | 17-#7 | 11-#8 | 12-#7 | 5.22 | 440.8 | 881.6 | 1186.8 | 400 | 26 | 16-#7 | 11-#8 | 20-#5 | 18-#5 | 4.54 | 1.053 |
| 30 | 500 | 12.25 | 12.00 | 24 | 0.633 | 17-#5 2 | 16-#9 | 14-#8 | 10-#9 | 11-#8 | 5.89 | 513.3 | 1026.6 | 1382.0 | 500 | 29 | 22-#6 | 10-#9 | 10-#8 | 20-#5 | 5.01 | 1.122 |
| 30 | 600 | 12.25 | 12.00 | 25 | 0.700 | 19-#5 3 | 18-#9 | 16-#8 | 12-#9 | 12-#8 | 6.91 | 585.0 | 1170.0 | 1575.0 | 600 | 30 | 15-#8 | 12-#9 | 11-#8 | 10-#8 | 6.06 | 1.122 |
| 31 | 100 | 8.25 | 10.33 | 12 | 0.733 | 14-#5 2 | 12-#7 | 15-#6 | 15-#5 | 13-#5 | 2.95 | 250.7 | 501.4 | 675.0 | 100 | 12 | 14-#6 | 15-#5 | 13-#5 | 13-#5 | 2.66 | 1.035 |
| 31 | 200 | 8.25 | 10.33 | 17 | 0.731 | 14-#5 4 | 12-#8 | 14-#7 | 14-#6 | 12-#6 | 3.71 | 328.9 | 657.8 | 885.5 | 200 | 20 | 18-#6 | 14-#6 | 15-#5 | 13-#5 | 3.24 | 1.035 |
| 31 | 300 | 10.25 | 10.33 | 20 | 0.642 | 15-#5 3 | 20-#7 | 16-#7 | 13-#7 | 11-#7 | 4.58 | 409.9 | 819.8 | 1103.6 | 300 | 23 | 15-#7 | 13-#7 | 19-#5 | 16-#5 | 3.99 | 1.053 |
| 31 | 400 | 10.25 | 10.33 | 22 | 0.760 | 18-#5 6 | 15-#9 | 15-#8 | 12-#8 | 13-#7 | 5.58 | 488.7 | 977.3 | 1315.7 | 400 | 26 | 14-#8 | 21-#6 | 12-#7 | 19-#5 | 4.78 | 1.053 |
| 31 | 500 | 12.25 | 12.40 | 24 | 0.712 | 19-#5 5 | 18-#9 | 16-#8 | 14-#8 | 12-#8 | 6.38 | 569.4 | 1138.7 | 1532.9 | 500 | 29 | 14-#8 | 14-#8 | 11-#8 | 12-#7 | 5.45 | 1.122 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

# FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

# SQUARE INTERIOR PANEL

With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superim-posed Load (psf) | Square Drop Panel | | (3) Square Column | | REINFORCING BARS (E. W.) | | | | | | MOMENTS | | | Factored Superim-posed Load (psf) | (3) Square Column | REINFORCING BARS (E. W.) | | | | | Concrete $\left(\frac{\text{cu. ft}}{\text{sq. ft}}\right)$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Column Strip [1] | | | Middle Strip | | | | | | | | Column Strip | | Middle Strip | | | |
| | | Depth (in.) | Width (ft) | Size (in.) | $\gamma_f$ | Top Ext. + | Bottom | Top Int. | Bottom | Top Int. | Total Steel (psf) | Edge (–) (ft-k) | Bot. (+) (ft-k) | Int. (–) (ft-k) | | Size (in.) | Top | Bottom | Top | Bottom | Total Steel (psf) | |
| $h$ = 11.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 11.5 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 32 | 100 | 8.25 | 10.67 | 12 | 0.784 | 15-#5 4 | 13-#7 | 16-#6 | 12-#6 | 14-#5 | 3.10 | 276.4 | 552.7 | 744.0 | 100 | 12 | 15-#6 | 12-#6 | 13-#5 | 13-#5 | 2.76 | 1.035 |
| 32 | 200 | 10.25 | 10.67 | 17 | 0.637 | 15-#5 2 | 11-#9 | 19-#6 | 12-#7 | 13-#6 | 4.00 | 363.8 | 727.7 | 979.6 | 200 | 20 | 18-#6 | 22-#5 | 12-#6 | 15-#5 | 3.39 | 1.053 |
| 32 | 300 | 10.25 | 10.67 | 20 | 0.726 | 17-#5 5 | 17-#8 | 18-#7 | 11-#8 | 12-#7 | 4.92 | 452.6 | 905.2 | 1218.6 | 300 | 23 | 16-#7 | 11-#8 | 11-#7 | 18-#5 | 4.27 | 1.053 |
| 32 | 400 | 12.25 | 12.80 | 23 | 0.656 | 18-#5 4 | 17-#9 | 15-#8 | 11-#9 | 11-#8 | 5.99 | 541.7 | 1083.3 | 1458.3 | 400 | 27 | 18-#7 | 11-#9 | 18-#6 | 12-#7 | 5.17 | 1.122 |
| 32 | 500 | 12.25 | 12.80 | 25 | 0.773 | 15-#6 5 | 19-#9 | 17-#8 | 13-#9 | 13-#8 | 6.90 | 627.5 | 1255.0 | 1689.5 | 500 | 29 | 16-#8 | 13-#9 | 12-#8 | 13-#7 | 5.99 | 1.122 |
| 33 | 100 | 8.25 | 11.00 | 12 | 0.831 | 15-#5 6 | 11-#8 | 18-#6 | 13-#6 | 15-#5 | 3.23 | 303.7 | 607.4 | 817.6 | 100 | 12 | 23-#5 | 18-#5 | 14-#5 | 14-#5 | 2.82 | 1.035 |
| 33 | 200 | 10.25 | 11.00 | 17 | 0.685 | 15-#5 3 | 12-#9 | 16-#7 | 13-#7 | 14-#6 | 4.21 | 400.3 | 800.6 | 1077.7 | 200 | 20 | 19-#6 | 17-#6 | 13-#6 | 16-#5 | 3.56 | 1.053 |
| 33 | 300 | 12.25 | 11.00 | 20 | 0.640 | 17-#5 4 | 15-#9 | 18-#7 | 12-#8 | 18-#6 | 5.13 | 497.8 | 995.5 | 1340.1 | 300 | 24 | 16-#7 | 21-#6 | 12-#7 | 14-#6 | 4.35 | 1.072 |
| 33 | 400 | 12.25 | 13.20 | 23 | 0.731 | 20-#5 5 | 18-#9 | 16-#8 | 12-#9 | 16-#7 | 6.32 | 596.6 | 1193.3 | 1606.3 | 400 | 27 | 15-#8 | 12-#9 | 12-#8 | 13-#7 | 5.57 | 1.122 |
| 33 | 500 | 12.25 | 13.20 | 28 | 0.721 | 16-#6 4 | 21-#9 | 15-#9 | 14-#9 | 14-#8 | 7.33 | 685.7 | 1371.4 | 1846.1 | 500 | 29 | 17-#8 | 14-#9 | 13-#8 | 12-#8 | 6.41 | 1.122 |
| 34 | 100 | 10.25 | 11.33 | 12 | 0.737 | 16-#5 3 | 16-#7 | 18-#6 | 14-#6 | 12-#6 | 3.36 | 334.0 | 667.9 | 899.1 | 100 | 12 | 16-#6 | 14-#6 | 16-#5 | 14-#5 | 2.89 | 1.053 |
| 34 | 200 | 10.25 | 11.33 | 17 | 0.756 | 16-#5 6 | 13-#9 | 17-#7 | 14-#7 | 12-#7 | 4.47 | 439.1 | 878.2 | 1182.1 | 200 | 20 | 16-#7 | 14-#7 | 20-#5 | 17-#5 | 3.84 | 1.053 |
| 34 | 300 | 12.25 | 11.33 | 20 | 0.704 | 18-#5 5 | 17-#9 | 19-#7 | 14-#8 | 12-#8 | 5.70 | 546.3 | 1092.7 | 1470.9 | 300 | 24 | 18-#7 | 14-#8 | 18-#6 | 12-#7 | 4.92 | 1.072 |
| 34 | 400 | 12.25 | 13.60 | 25 | 0.745 | 22-#5 6 | 20-#9 | 18-#8 | 13-#9 | 14-#8 | 6.65 | 651.7 | 1303.4 | 1754.5 | 400 | 27 | 16-#8 | 13-#9 | 16-#7 | 14-#7 | 5.72 | 1.122 |
| 34 | 500 | 12.25 | 13.60 | 31 | 0.680 | 18-#6 2 | 23-#9 | 16-#9 | 15-#9 | 13-#9 | 7.74 | 745.3 | 1490.7 | 2006.7 | 500 | 30 | 19-#8 | 15-#9 | 12-#9 | 16-#7 | 6.76 | 1.122 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

# FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

# SQUARE INTERIOR PANEL

With Drop Panels[2]
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 24 | 100 | 2.25 | 8.00 | 12 | 0.787 | 11-#5 1 | 11-#5 | 14-#5 | 8-#6 | 8-#6 | 2.67 | 116.0 | 231.9 | 312.2 | 100 | 12 | 13-#5 | 11-#5 | 8-#6 | 8-#6 | 2.69 | 1.021 |
| 24 | 200 | 2.25 | 8.00 | 16 | 0.778 | 11-#5 2 | 9-#6 | 18-#5 | 8-#6 | 8-#6 | 2.89 | 151.0 | 302.0 | 406.5 | 200 | 19 | 16-#5 | 11-#5 | 8-#6 | 8-#6 | 2.86 | 1.021 |
| 24 | 300 | 4.25 | 8.00 | 19 | 0.629 | 11-#5 1 | 16-#5 | 14-#6 | 8-#6 | 8-#6 | 3.07 | 186.0 | 372.0 | 500.8 | 300 | 23 | 17-#5 | 11-#5 | 8-#6 | 8-#6 | 2.93 | 1.039 |
| 24 | 400 | 4.25 | 8.00 | 21 | 0.695 | 11-#5 3 | 10-#7 | 12-#7 | 9-#6 | 8-#6 | 3.52 | 222.1 | 445.7 | 597.9 | 400 | 24 | 11-#7 | 9-#6 | 8-#6 | 8-#6 | 3.33 | 1.039 |
| 24 | 500 | 6.25 | 8.00 | 22 | 0.629 | 12-#5 2 | 8-#9 | 12-#7 | 16-#5 | 9-#6 | 4.03 | 259.6 | 570.0 | 698.8 | 500 | 24 | 15-#6 | 16-#5 | 8-#6 | 8-#6 | 3.50 | 1.058 |
| 24 | 600 | 6.25 | 8.00 | 23 | 0.687 | 13-#5 2 | 12-#8 | 11-#8 | 8-#8 | 10-#6 | 4.82 | 296.5 | 678.2 | 798.2 | 600 | 24 | 13-#7 | 14-#6 | 13-#5 | 9-#6 | 4.21 | 1.058 |
| 24 | 700 | 8.25 | 9.60 | 24 | 0.629 | 13-#5 2 | 12-#9 | 11-#8 | 8-#9 | 16-#5 | 5.71 | 334.4 | 815.0 | 900.4 | 700 | 24 | 13-#7 | 8-#9 | 8-#7 | 11-#6 | 4.93 | 1.110 |
| 25 | 100 | 2.25 | 8.33 | 12 | 0.848 | 12-#5 3 | 11-#5 | 16-#5 | 11-#5 | 11-#5 | 2.60 | 131.5 | 263.1 | 354.1 | 100 | 12 | 15-#5 | 11-#5 | 11-#5 | 11-#5 | 2.63 | 1.021 |
| 25 | 200 | 4.25 | 8.33 | 16 | 0.662 | 12-#5 0 | 15-#5 | 18-#5 | 11-#5 | 11-#5 | 2.80 | 171.9 | 343.9 | 462.9 | 200 | 19 | 16-#5 | 11-#5 | 11-#5 | 11-#5 | 2.69 | 1.039 |
| 25 | 300 | 4.25 | 8.33 | 19 | 0.710 | 12-#5 2 | 13-#6 | 12-#7 | 12-#5 | 11-#5 | 3.19 | 211.6 | 423.1 | 569.6 | 300 | 23 | 14-#6 | 12-#5 | 11-#5 | 11-#5 | 2.97 | 1.039 |
| 25 | 400 | 6.25 | 8.33 | 21 | 0.630 | 12-#5 1 | 9-#8 | 12-#7 | 10-#6 | 12-#5 | 3.58 | 252.1 | 504.3 | 678.9 | 400 | 25 | 15-#6 | 14-#5 | 11-#5 | 11-#5 | 3.19 | 1.058 |
| 25 | 500 | 6.25 | 8.33 | 22 | 0.686 | 13-#5 2 | 11-#8 | 26-#5 | 10-#7 | 10-#6 | 4.37 | 294.4 | 621.2 | 792.5 | 500 | 25 | 13-#7 | 13-#6 | 9-#6 | 12-#5 | 3.85 | 1.058 |
| 25 | 600 | 8.25 | 8.33 | 24 | 0.629 | 13-#5 2 | 9-#10 | 14-#7 | 9-#8 | 16-#5 | 5.21 | 335.4 | 752.9 | 902.9 | 600 | 25 | 13-#7 | 9-#8 | 15-#5 | 10-#6 | 4.46 | 1.076 |
| 25 | 700 | 8.25 | 10.00 | 25 | 0.660 | 15-#5 1 | 13-#9 | 12-#8 | 9-#9 | 10-#7 | 6.07 | 378.0 | 899.3 | 1017.7 | 700 | 25 | 12-#8 | 11-#8 | 9-#7 | 9-#7 | 5.25 | 1.110 |
| 26 | 100 | 4.25 | 8.67 | 12 | 0.768 | 12-#5 2 | 9-#6 | 15-#5 | 11-#5 | 11-#5 | 2.53 | 148.9 | 297.9 | 401.0 | 100 | 12 | 14-#5 | 11-#5 | 11-#5 | 11-#5 | 2.47 | 1.039 |
| 26 | 200 | 4.25 | 8.67 | 16 | 0.776 | 12-#5 4 | 9-#7 | 14-#6 | 11-#5 | 11-#5 | 2.87 | 194.3 | 388.7 | 523.2 | 200 | 19 | 18-#5 | 11-#5 | 11-#5 | 11-#5 | 2.67 | 1.039 |
| 26 | 300 | 6.25 | 8.67 | 19 | 0.632 | 12-#5 1 | 11-#7 | 15-#6 | 10-#6 | 12-#5 | 3.31 | 239.8 | 479.6 | 645.6 | 300 | 23 | 14-#6 | 14-#5 | 11-#5 | 11-#5 | 2.97 | 1.058 |
| 26 | 400 | 6.25 | 8.67 | 21 | 0.673 | 13-#5 2 | 10-#8 | 18-#6 | 16-#5 | 10-#6 | 3.78 | 285.5 | 570.9 | 768.6 | 400 | 25 | 23-#5 | 16-#5 | 9-#6 | 11-#5 | 3.31 | 1.058 |
| 26 | 500 | 8.25 | 8.67 | 23 | 0.630 | 13-#5 2 | 12-#8 | 14-#7 | 14-#6 | 16-#5 | 4.46 | 331.4 | 682.3 | 892.1 | 500 | 26 | 13-#7 | 14-#6 | 15-#5 | 9-#6 | 3.95 | 1.076 |
| 26 | 600 | 8.25 | 10.40 | 25 | 0.629 | 15-#5 1 | 12-#9 | 12-#8 | 10-#8 | 10-#7 | 5.42 | 378.6 | 846.0 | 1019.2 | 600 | 26 | 12-#8 | 10-#8 | 9-#7 | 16-#5 | 4.74 | 1.110 |
| 26 | 700 | 10.25 | 10.40 | 26 | 0.630 | 15-#5 1 | 12-#10 | 16-#7 | 12-#8 | 11-#7 | 6.33 | 425.9 | 999.4 | 1146.7 | 700 | 26 | 12-#8 | 12-#8 | 10-#7 | 10-#7 | 5.38 | 1.137 |
| 27 | 100 | 4.25 | 9.00 | 12 | 0.803 | 12-#5 3 | 10-#6 | 12-#6 | 12-#5 | 12-#5 | 2.66 | 167.3 | 334.6 | 450.4 | 100 | 12 | 16-#5 | 12-#5 | 12-#5 | 12-#5 | 2.60 | 1.039 |
| 27 | 200 | 6.25 | 9.00 | 16 | 0.635 | 12-#5 1 | 10-#7 | 14-#6 | 9-#6 | 12-#5 | 3.01 | 219.1 | 438.2 | 589.9 | 200 | 19 | 18-#5 | 9-#6 | 12-#5 | 12-#5 | 2.79 | 1.058 |
| 27 | 300 | 6.25 | 9.00 | 19 | 0.658 | 12-#5 2 | 17-#6 | 13-#7 | 15-#5 | 9-#6 | 3.49 | 270.0 | 540.0 | 726.9 | 300 | 23 | 12-#7 | 15-#5 | 12-#5 | 12-#5 | 3.14 | 1.058 |
| 27 | 400 | 6.25 | 9.00 | 22 | 0.755 | 14-#5 5 | 9-#9 | 12-#8 | 10-#7 | 15-#5 | 4.14 | 319.4 | 638.9 | 860.0 | 400 | 26 | 26-#5 | 18-#5 | 10-#6 | 12-#5 | 3.53 | 1.058 |
| 27 | 500 | 8.25 | 9.00 | 23 | 0.681 | 15-#5 3 | 13-#8 | 12-#8 | 15-#6 | 10-#7 | 4.67 | 372.2 | 744.4 | 1002.0 | 500 | 27 | 27-#5 | 11-#7 | 16-#5 | 10-#6 | 4.08 | 1.076 |
| 27 | 600 | 10.25 | 10.80 | 25 | 0.630 | 15-#5 1 | 17-#8 | 16-#7 | 9-#9 | 11-#7 | 5.68 | 426.1 | 935.9 | 1147.2 | 600 | 27 | 12-#8 | 11-#8 | 10-#7 | 18-#5 | 4.91 | 1.137 |
| 27 | 700 | 10.25 | 10.80 | 26 | 0.700 | 12-#6 3 | 13-#10 | 14-#8 | 13-#8 | 12-#7 | 6.67 | 478.6 | 1090.5 | 1288.5 | 700 | 27 | 13-#8 | 13-#8 | 15-#6 | 11-#7 | 5.68 | 1.137 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM
SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL
With Drop Panels(2)
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 28 | 100 | 6.25 | 9.33 | 12 | 0.714 | 13-#5 1 | 16-#5 | 17-#5 | 12-#5 | 12-#5 | 2.62 | 187.7 | 375.4 | 505.4 | 100 | 12 | 16-#5 | 12-#5 | 12-#5 | 12-#5 | 2.51 | 1.058 |
| 28 | 200 | 6.25 | 9.33 | 16 | 0.731 | 13-#5 3 | 11-#7 | 16-#6 | 10-#6 | 12-#5 | 3.12 | 245.4 | 490.7 | 660.6 | 200 | 19 | 20-#5 | 14-#5 | 12-#5 | 12-#5 | 2.81 | 1.058 |
| 28 | 300 | 6.25 | 9.33 | 19 | 0.783 | 14-#5 5 | 11-#8 | 14-#7 | 12-#6 | 15-#5 | 3.78 | 302.6 | 605.2 | 814.7 | 300 | 23 | 13-#7 | 12-#6 | 13-#5 | 12-#5 | 3.31 | 1.058 |
| 28 | 400 | 8.25 | 9.33 | 22 | 0.643 | 14-#5 3 | 10-#9 | 15-#7 | 11-#7 | 12-#6 | 4.41 | 358.8 | 717.6 | 966.0 | 400 | 26 | 26-#5 | 11-#7 | 11-#6 | 10-#6 | 3.86 | 1.076 |
| 28 | 500 | 10.25 | 9.33 | 23 | 0.632 | 15-#5 1 | 12-#9 | 16-#7 | 10-#8 | 14-#6 | 5.09 | 418.1 | 836.2 | 1125.6 | 500 | 27 | 15-#7 | 17-#6 | 10-#7 | 11-#6 | 4.41 | 1.095 |
| 28 | 600 | 10.25 | 11.20 | 25 | 0.648 | 17-#5 2 | 18-#8 | 14-#8 | 12-#8 | 12-#7 | 5.91 | 476.7 | 1007.3 | 1283.4 | 600 | 28 | 13-#8 | 12-#8 | 11-#7 | 10-#7 | 5.19 | 1.137 |
| 28 | 700 | 12.25 | 11.20 | 26 | 0.631 | 18-#5 1 | 14-#10 | 14-#8 | 14-#8 | 11-#8 | 6.88 | 536.3 | 1197.3 | 1444.0 | 700 | 28 | 13-#8 | 14-#8 | 10-#8 | 12-#7 | 5.87 | 1.163 |
| 29 | 100 | 6.25 | 9.67 | 12 | 0.754 | 13-#5 2 | 18-#5 | 13-#6 | 13-#5 | 13-#5 | 2.76 | 209.1 | 418.2 | 563.0 | 100 | 12 | 17-#5 | 13-#5 | 13-#5 | 13-#5 | 2.62 | 1.058 |
| 29 | 200 | 6.25 | 9.67 | 16 | 0.787 | 13-#5 5 | 17-#6 | 13-#7 | 11-#6 | 13-#5 | 3.35 | 273.7 | 547.3 | 736.8 | 200 | 19 | 16-#6 | 11-#6 | 13-#5 | 13-#5 | 3.05 | 1.058 |
| 29 | 300 | 8.25 | 9.67 | 20 | 0.633 | 13-#5 2 | 12-#8 | 14-#7 | 10-#7 | 16-#5 | 3.90 | 337.3 | 674.6 | 908.2 | 300 | 23 | 13-#7 | 19-#5 | 15-#5 | 13-#5 | 3.40 | 1.076 |
| 29 | 400 | 8.25 | 9.67 | 22 | 0.723 | 16-#5 4 | 14-#8 | 13-#8 | 12-#7 | 10-#7 | 4.73 | 402.0 | 804.1 | 1082.4 | 400 | 25 | 16-#7 | 12-#7 | 10-#7 | 15-#5 | 4.22 | 1.076 |
| 29 | 500 | 10.25 | 11.60 | 24 | 0.637 | 17-#5 2 | 17-#8 | 14-#8 | 11-#8 | 12-#7 | 5.39 | 465.1 | 930.3 | 1252.3 | 500 | 29 | 16-#7 | 11-#8 | 11-#7 | 18-#5 | 4.67 | 1.137 |
| 29 | 600 | 12.25 | 11.60 | 25 | 0.632 | 17-#5 2 | 13-#10 | 14-#8 | 13-#8 | 18-#6 | 6.29 | 532.1 | 1095.0 | 1432.6 | 600 | 29 | 13-#8 | 13-#8 | 10-#8 | 11-#7 | 5.43 | 1.163 |
| 30 | 100 | 6.25 | 10.00 | 12 | 0.790 | 14-#5 2 | 14-#6 | 15-#6 | 13-#5 | 13-#5 | 2.83 | 232.1 | 464.1 | 624.8 | 100 | 12 | 14-#6 | 13-#5 | 13-#5 | 13-#5 | 2.64 | 1.058 |
| 30 | 200 | 8.25 | 10.00 | 17 | 0.649 | 14-#5 2 | 11-#8 | 17-#6 | 12-#6 | 15-#5 | 3.46 | 302.9 | 605.9 | 815.6 | 200 | 20 | 16-#6 | 12-#6 | 13-#5 | 13-#5 | 3.02 | 1.076 |
| 30 | 300 | 8.25 | 10.00 | 20 | 0.719 | 15-#5 4 | 13-#8 | 16-#7 | 15-#6 | 10-#7 | 4.23 | 375.1 | 750.2 | 1009.9 | 300 | 23 | 15-#7 | 15-#6 | 12-#6 | 10-#6 | 3.74 | 1.076 |
| 30 | 400 | 10.25 | 10.00 | 22 | 0.633 | 16-#5 2 | 10-#10 | 17-#7 | 18-#6 | 15-#6 | 4.97 | 446.6 | 893.1 | 1202.3 | 400 | 26 | 16-#7 | 18-#6 | 14-#6 | 12-#6 | 4.32 | 1.095 |
| 30 | 500 | 10.25 | 12.00 | 24 | 0.754 | 19-#5 5 | 12-#10 | 15-#8 | 12-#8 | 10-#8 | 5.80 | 517.8 | 1035.7 | 1394.2 | 500 | 29 | 14-#8 | 12-#8 | 12-#7 | 14-#6 | 5.01 | 1.137 |
| 30 | 600 | 12.25 | 12.00 | 25 | 0.663 | 19-#5 2 | 17-#9 | 16-#8 | 11-#9 | 12-#8 | 6.51 | 590.6 | 1181.3 | 1590.2 | 600 | 30 | 14-#8 | 11-#9 | 11-#8 | 12-#7 | 5.65 | 1.163 |
| 31 | 100 | 8.25 | 10.33 | 12 | 0.700 | 14-#5 1 | 12-#7 | 15-#6 | 15-#5 | 13-#5 | 2.95 | 257.5 | 515.0 | 693.3 | 100 | 12 | 14-#6 | 15-#5 | 13-#5 | 13-#5 | 2.66 | 1.076 |
| 31 | 200 | 8.25 | 10.33 | 17 | 0.717 | 14-#5 4 | 15-#7 | 14-#7 | 19-#5 | 16-#5 | 3.58 | 335.4 | 670.9 | 903.1 | 200 | 20 | 18-#6 | 19-#5 | 15-#5 | 13-#5 | 3.16 | 1.076 |
| 31 | 300 | 10.25 | 10.33 | 20 | 0.635 | 15-#5 3 | 12-#9 | 16-#7 | 13-#7 | 14-#6 | 4.50 | 415.1 | 830.3 | 1117.7 | 300 | 24 | 27-#5 | 17-#6 | 13-#6 | 11-#6 | 3.81 | 1.095 |
| 31 | 400 | 10.25 | 10.33 | 22 | 0.733 | 18-#5 5 | 14-#9 | 15-#8 | 12-#8 | 13-#7 | 5.43 | 495.0 | 990.1 | 1332.8 | 400 | 26 | 17-#7 | 15-#7 | 12-#7 | 19-#5 | 4.69 | 1.095 |
| 31 | 500 | 12.25 | 12.40 | 24 | 0.681 | 19-#5 4 | 17-#9 | 15-#8 | 11-#9 | 12-#8 | 6.24 | 575.6 | 1151.2 | 1549.7 | 500 | 29 | 14-#8 | 11-#9 | 18-#6 | 12-#7 | 5.38 | 1.163 |
| 31 | 600 | 12.25 | 12.40 | 26 | 0.774 | 15-#6 5 | 15-#10 | 14-#9 | 13-#9 | 13-#8 | 7.16 | 653.3 | 1306.6 | 1758.9 | 600 | 30 | 16-#8 | 13-#9 | 12-#8 | 13-#7 | 6.20 | 1.163 |
| 32 | 100 | 8.25 | 10.67 | 12 | 0.774 | 15-#5 4 | 13-#7 | 16-#6 | 16-#5 | 14-#5 | 3.06 | 283.9 | 567.7 | 764.2 | 100 | 12 | 15-#6 | 16-#5 | 14-#5 | 14-#5 | 2.76 | 1.076 |
| 32 | 200 | 8.25 | 10.67 | 17 | 0.745 | 15-#5 4 | 13-#8 | 16-#7 | 11-#7 | 13-#6 | 3.88 | 370.2 | 740.4 | 996.7 | 200 | 20 | 19-#6 | 11-#7 | 16-#5 | 14-#5 | 3.36 | 1.076 |
| 32 | 300 | 10.25 | 10.67 | 20 | 0.659 | 16-#5 3 | 13-#9 | 18-#7 | 11-#8 | 12-#7 | 4.84 | 458.4 | 916.9 | 1234.3 | 300 | 24 | 16-#7 | 11-#8 | 20-#5 | 17-#5 | 4.18 | 1.095 |
| 32 | 400 | 12.25 | 10.67 | 22 | 0.651 | 18-#5 4 | 13-#10 | 15-#8 | 13-#8 | 11-#8 | 5.83 | 547.7 | 1095.3 | 1474.5 | 400 | 26 | 17-#7 | 13-#8 | 13-#7 | 11-#7 | 4.97 | 1.113 |
| 32 | 500 | 12.25 | 12.80 | 24 | 0.781 | 15-#6 5 | 15-#10 | 17-#8 | 12-#9 | 16-#7 | 6.71 | 636.2 | 1272.5 | 1713.0 | 500 | 29 | 16-#8 | 12-#9 | 12-#8 | 13-#7 | 5.83 | 1.163 |

(Continued on next Page)

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

$f'_c$ = 4,000 psi
Grade 60 Bars

## FLAT SLAB SYSTEM

SQUARE EDGE PANEL With Drop Panels
No Beams

## SQUARE INTERIOR PANEL

With Drop Panels(2)
No Beams

| SPAN c.-c. $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | Square Drop Panel Depth (in.) | Square Drop Panel Width (ft) | (3) Square Column Size (in.) | (3) Square Column $\gamma_f$ | REINFORCING BARS (E. W.) Column Strip (1) Top Ext. + | Column Strip (1) Bottom | Column Strip (1) Top Int. | Middle Strip Bottom | Middle Strip Top Int. | Total Steel (psf) | MOMENTS Edge (–) (ft-k) | MOMENTS Bot. (+) (ft-k) | MOMENTS Int. (–) (ft-k) | Factored Superimposed Load (psf) | (3) Square Column Size (in.) | REINFORCING BARS (E. W.) Column Strip Top | Column Strip Bottom | Middle Strip Top | Middle Strip Bottom | Total Steel (psf) | Concrete (cu. ft / sq. ft) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $h$ = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | | | | | | | | | $h$ = 12 in. = TOTAL SLAB DEPTH BETWEEN DROP PANELS | | | | | | | |
| 33 | 100 | 8.25 | 11.00 | 12 | 0.813 | 15-#5 5 | 11-#8 | 18-#6 | 13-#6 | 15-#5 | 3.23 | 311.9 | 623.9 | 839.8 | 100 | 12 | 23-#5 | 18-#5 | 14-#5 | 14-#5 | 2.82 | 1.076 |
| 33 | 200 | 10.25 | 11.00 | 17 | 0.671 | 15-#5 3 | 12-#9 | 16-#7 | 13-#7 | 14-#6 | 4.21 | 408.2 | 816.5 | 1099.1 | 200 | 20 | 19-#6 | 17-#6 | 13-#6 | 11-#6 | 3.57 | 1.095 |
| 33 | 300 | 10.25 | 11.00 | 20 | 0.766 | 18-#5 6 | 18-#8 | 15-#8 | 12-#8 | 13-#7 | 5.11 | 504.7 | 1009.4 | 1358.7 | 300 | 24 | 18-#7 | 15-#7 | 12-#7 | 19-#5 | 4.43 | 1.095 |
| 33 | 400 | 12.25 | 11.00 | 22 | 0.716 | 20-#5 4 | 14-#10 | 16-#8 | 14-#8 | 12-#8 | 6.12 | 603.1 | 1206.2 | 1623.8 | 400 | 26 | 15-#8 | 14-#8 | 11-#8 | 12-#7 | 5.29 | 1.113 |
| 33 | 500 | 12.25 | 13.20 | 27 | 0.730 | 16-#6 4 | 16-#10 | 15-#9 | 13-#9 | 11-#9 | 7.03 | 695.2 | 1390.4 | 1871.6 | 500 | 29 | 17-#8 | 13-#9 | 22-#6 | 11-#8 | 6.10 | 1.163 |
| 34 | 100 | 10.25 | 11.33 | 12 | 0.727 | 16-#5 3 | 12-#8 | 18-#6 | 19-#5 | 16-#5 | 3.32 | 343.0 | 686.0 | 923.4 | 100 | 12 | 16-#6 | 14-#6 | 15-#5 | 15-#5 | 2.92 | 1.095 |
| 34 | 200 | 10.25 | 11.33 | 17 | 0.745 | 16-#5 6 | 13-#9 | 17-#7 | 18-#6 | 15-#6 | 4.37 | 447.8 | 895.6 | 1205.7 | 200 | 20 | 16-#7 | 18-#6 | 14-#6 | 12-#6 | 3.75 | 1.095 |
| 34 | 300 | 12.25 | 11.33 | 20 | 0.674 | 18-#5 4 | 13-#10 | 19-#7 | 13-#8 | 14-#7 | 5.47 | 554.9 | 1109.8 | 1494.0 | 300 | 24 | 18-#7 | 13-#8 | 13-#7 | 15-#6 | 4.70 | 1.113 |
| 34 | 400 | 12.25 | 13.60 | 24 | 0.763 | 22-#5 7 | 19-#9 | 18-#8 | 13-#9 | 13-#8 | 6.50 | 661.9 | 1323.7 | 1781.9 | 400 | 27 | 16-#8 | 13-#9 | 12-#8 | 18-#6 | 5.62 | 1.163 |
| 34 | 500 | 12.25 | 13.60 | 30 | 0.690 | 18-#6 2 | 18-#10 | 16-#9 | 18-#8 | 12-#9 | 7.48 | 757.6 | 1515.3 | 2039.8 | 500 | 29 | 19-#8 | 18-#8 | 14-#8 | 12-#8 | 6.49 | 1.163 |
| 35 | 100 | 10.25 | 11.67 | 12 | 0.773 | 16-#5 5 | 13-#8 | 19-#6 | 15-#6 | 13-#6 | 3.51 | 374.8 | 749.6 | 1009.1 | 100 | 12 | 18-#6 | 15-#6 | 12-#6 | 15-#5 | 3.05 | 1.095 |
| 35 | 200 | 12.25 | 11.67 | 17 | 0.663 | 16-#5 5 | 14-#9 | 17-#7 | 12-#8 | 23-#5 | 4.64 | 491.0 | 982.1 | 1322.0 | 200 | 20 | 16-#7 | 15-#7 | 12-#7 | 13-#6 | 4.00 | 1.113 |
| 35 | 300 | 12.25 | 11.67 | 20 | 0.766 | 20-#5 7 | 14-#10 | 16-#8 | 14-#8 | 12-#8 | 5.72 | 607.4 | 1214.7 | 1635.2 | 300 | 24 | 19-#7 | 14-#8 | 14-#7 | 12-#7 | 4.89 | 1.113 |
| 35 | 400 | 12.25 | 14.00 | 27 | 0.724 | 23-#5 6 | 17-#10 | 19-#8 | 14-#9 | 14-#8 | 6.97 | 719.2 | 1438.3 | 1936.2 | 400 | 27 | 18-#8 | 14-#9 | 13-#8 | 12-#8 | 6.09 | 1.163 |
| 35 | 500 | 12.25 | 14.00 | 33 | 0.667 | 26-#5 4 | 19-#10 | 17-#9 | 13-#10 | 13-#9 | 7.98 | 817.2 | 1634.5 | 2200.2 | 500 | 32 | 16-#9 | 13-#10 | 12-#9 | 13-#8 | 7.01 | 1.163 |
| 36 | 100 | 10.25 | 12.00 | 12 | 0.801 | 16-#5 6 | 12-#9 | 16-#7 | 23-#5 | 19-#5 | 3.73 | 408.6 | 817.1 | 1100.0 | 100 | 12 | 19-#6 | 23-#5 | 13-#6 | 16-#5 | 3.16 | 1.095 |
| 36 | 200 | 12.25 | 12.00 | 17 | 0.719 | 17-#5 6 | 12-#10 | 19-#7 | 16-#7 | 18-#6 | 4.83 | 535.7 | 1071.5 | 1442.4 | 200 | 20 | 17-#7 | 16-#7 | 13-#7 | 20-#5 | 4.15 | 1.113 |
| 36 | 300 | 12.25 | 12.00 | 22 | 0.744 | 21-#5 7 | 15-#10 | 18-#8 | 13-#9 | 13-#8 | 6.12 | 659.7 | 1319.4 | 1776.1 | 300 | 24 | 16-#8 | 20-#7 | 12-#8 | 18-#6 | 5.18 | 1.113 |
| 36 | 400 | 12.25 | 14.40 | 29 | 0.732 | 18-#6 5 | 18-#10 | 17-#9 | 12-#10 | 13-#9 | 7.33 | 781.7 | 1563.4 | 2104.5 | 400 | 27 | 19-#8 | 12-#10 | 12-#9 | 16-#7 | 6.38 | 1.163 |

NOTES: (1) 50 percent of these bars may be placed in the middle third of column strip. (2) Drop panels same size as for edge panels. (3) Same column size above and below slab.

# CHAPTER 11 – WAFFLE FLAT SLABS — SQUARE PANELS

## GENERAL CONSIDERATIONS

**Description.** Waffle flat slabs, as illustrated in Fig. 11-1, consist of rows of concrete joists at right angles to each other with solid heads at the columns. The joists are commonly formed by using standard square "dome" forms of the sizes described in the following section on "Standard Dome Data," and the domes are omitted around the columns to form the "solid heads." The top slab over the dome forms is usually reinforced with welded wire reinforcement and can be of various thicknesses. Standard dome forms provide waffle panels in modules of either 2 feet, 2.5 feet, or 3 feet. Depending on required size of solid head, there will either be a joist or a row of domes on the column centerline according to whether the number of joists framing into the solid head is odd or even. The column size selected must be of sufficient size to keep factored shear in the solid head within design strength values or supplemental shear capacity must be provided. Alternatives are headed shear stud reinforcement (ACI 11.11.5), shear reinforcement consisting of bars or wires and single-leg or multiple-leg stirrups (ACI 11.11.3), or structural steel shearheads (ACI 11.11.4).

For design purposes, waffle slabs are considered as flat slabs, with the solid heads acting as drop panels. Joists in each direction are divided into two bands or strips—a column strip including all joists that frame into the solid head, and a middle strip filling in between consecutive column strips. A second set of similar strips of joists runs at right angles to the first. Each joist rib typically contains two bottom bars. Straight bars are provided over column centerlines for negative factored moment.

Stirrups can be used in the joist ribs, as necessary.

**Advantages of Waffle Flat Slabs.** Waffle flat slabs allow a considerable reduction in dead load as compared to conventional solid flat slabs. See Table 11-1. Thus, it is particularly advantageous where the use of longer spans and/or heavier loads are desired without the use of deepened drop panels or support beams. The geometrical shape formed by the joist ribs is often architecturally desirable, as is the resulting flush soffit. Also, waffle flat slabs provide for relatively easy accommodation of electrical and mechanical utilities. See Fig.11-1.

**Standard Dome Data.** The square "dome" forms used for the waffle slabs designs tabulated in this Handbook are designed to meet the recommendations of the "Concrete Joist Construction — Recommended Industry Practice", CRSI *Manual of Standard Practice* for domes up to 20-inch depths. The standard domes are:

(1) 30-inch × 30-inch square domes with 3-inch flanges; from which 6-inch wide joist ribs at 36-inch centers are formed: These are available in standard depths of 8, 10, 12, 14, 16 and 20 inches.

(2) 24-inch × 24-inch square domes with 3-inch flanges; from which 6-inch wide joist ribs at 30-inch centers are formed. These are available in standard depths of 8, 10, 12, 14, 16 and 20 inches.

(3) 19-inch × 19-inch square domes with 2½-inch flanges, from which 5-inch wide joist ribs at 24-inch centers are formed. These are available in standard depths of 8, 10, 12 , 14 and 16 inches.

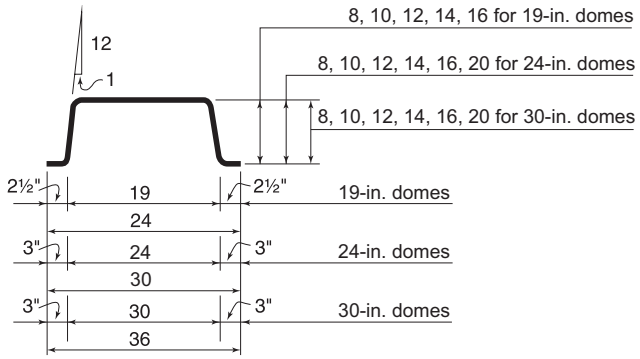
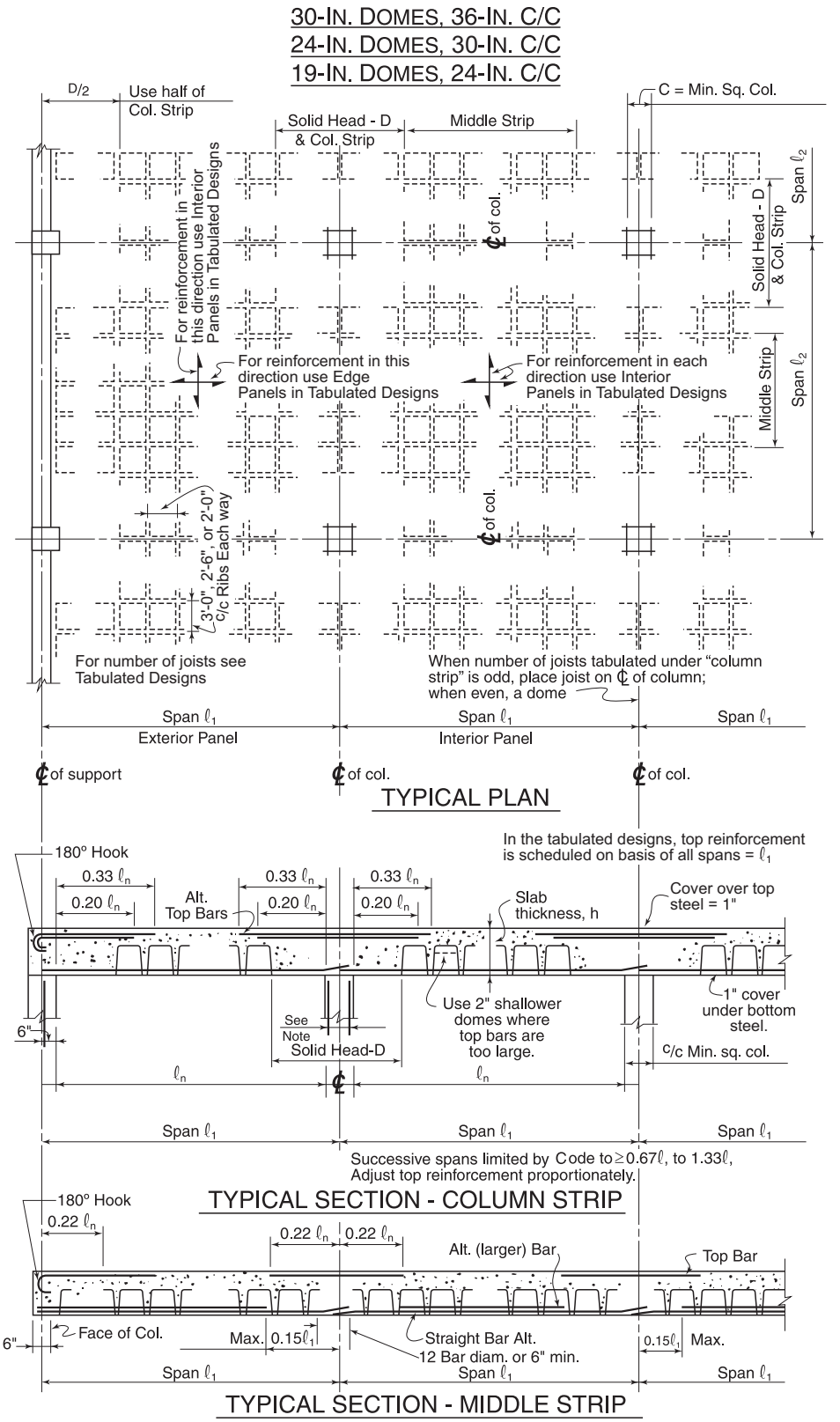



Table 11-1 Standard Dome Dimensions and Other Data

| Dome Size | Dome Depth (in.) | Volume of Dome ($ft^3$) | Floor Dead Load (psf) per Slab Thickness | | | |
|---|---|---|---|---|---|---|
| | | | 3 in. | 4 in. | 4.5 in. | 5 in. |
| 19-in. | 8 | 1.56 | 79 | 92 | 98 | 104 |
| | 10 | 1.91 | 91 | 103 | 110 | 116 |
| | 12 | 2.25 | 103 | 116 | 122 | 128 |
| | 14 | 2.58 | 116 | 128 | 134 | 141 |
| | 16 | 2.90 | 129 | 141 | 148 | 154 |
| 24-in. | 8 | 2.52 | 77 | 89 | 96 | 102 |
| | 10 | 3.11 | 88 | 100 | 107 | 113 |
| | 12 | 3.68 | 99 | 112 | 118 | 124 |
| | 14 | 4.23 | 111 | 124 | 130 | 136 |
| | 16 | 4.76 | 123 | 136 | 142 | 148 |
| | 20 | 5.78 | 149 | 161 | 167 | 174 |
| 30-in. | 8 | 3.98 | 71 | 84 | 90 | 96 |
| | 10 | 4.92 | 80 | 93 | 99 | 105 |
| | 12 | 5.84 | 90 | 103 | 109 | 115 |
| | 14 | 6.74 | 100 | 113 | 119 | 125 |
| | 16 | 7.61 | 111 | 123 | 129 | 136 |
| | 20 | 9.30 | 132 | 145 | 151 | 157 |




NOTE: Integrity reinforcement is required (ACI 13.3.8.5). All bottom bars in the column strip must be continuous or spliced over the support with Class B tension lap splices. At least two of the column strip bottom bars in each direction must pass within the column core and be anchored at exterior supports. For other end support conditions; see Figs. 11-2 and 11-3.

**Figure 11-1 Reinforcing Bar Details and Layout of Joists and Domes**

## DESIGN CONSIDERATIONS IN WAFFLE FLAT SLAB CONSTRUCTION

**Economy.** In order to maintain maximum economy, it is important that a uniform depth and the same size dome forms be used throughout a floor system, or structure, if possible. Construction costs will also be reduced by selecting a floor system that has sufficient design shear strength to resist the required factored loads without using joist stirrups and with the smallest size solid head. The amount of flexural reinforcement and, if necessary, the top slab thickness can be changed to provide the required design moment strengths for different spans, areas, or floors of a structure.

**Alternate Dome Layouts.**

1. For layouts that do not meet the standard 2-foot, 2.5-foot, or 3-foot modules, it is preferable that the required additional width be obtained by increasing the width of the ribs framing into the solid column head. If the off-modular amount is small (less than 6 inches), the forms for one rib only can be spaced farther apart to make up the necessary bay width. Special filler size domes are also available on a limited basis to fill out column spacings that are not multiples of 3 feet, 2.5 feet, or 2 feet. Sketching the spacings for a typical panel, correlated with the column spacings, should be a part of the early planning.

2. In some designs, large size top bars are required. To obtain sufficient concrete cover, shallower standard domes may be used around the solid head.

**Service Load Deflections.** The tabulated designs of waffle flat slabs are based on strength (safety) requirements for superimposed factored loads ranging from 50 psf to 500 psf. All waffle flat slab tabulated designs are within a maximum span-depth ratio of 33 for exterior panels and 36 for interior panels (ACI 9.5.3.2). In this range, the Code does not require deflection computations. Waffle flat slabs, due to their lighter dead weight, provide considerably more depth and stiffness than economically comparable solid flat slabs. Where conditions of the structure impose limitations on acceptable deflection, the deflection should be estimated to determine if it is acceptable for the conditions of the structure under consideration. For relatively high ratios of permanent load to total load, calculated creep deflections may be reduced by extending the top straight bars sufficiently to act in compression.

An example of calculating approximate deflections for waffle flat slabs is given in Chapter 6. The term "$t_e$", (average equivalent thickness) represents the thickness of a solid flat plate having the computed equivalent stiffness of the waffle slab; "$t_e$" can be computed as the average of the gross moments of inertia of the solid head area and ribbed area. Since all solid head areas tabulated are within one rib module of $L/3$, the area of solid head can be taken as 1/9 the total bay area. Assume the solid head area twice as effective, as it is in the area of maximum moment. "$t_e$" required for the deflection formula can then be calculated from:

$$(t_e)^3 = \frac{1}{10}\left[\, 2(t_s)^3 + 8(t_r)^3 \right]$$

where:

$t_s$ = thickness of the solid head

$t_r$ = equivalent thickness of ribbed area

Values of $t_e$ for various standard dome sizes and top slab thicknesses calculated as above, are tabulated in Tables 11-2 through 11-4.

Tables 11-2 through 11-4 also give the maximum span and load for various rib and top slab combinations within the limit of $\Delta = L/360$. The maximum span and load values based on the gross moment of inertia, $I_g$, were calculated using the equation for slab deflection given in Chapter 6, which is in terms of $wL^4/(t_e)^3$.

Code deflection limits are also expressed as fractions of the span, $L$.

It is, therefore, possible to solve for a limiting unit load, $w$, at any given $L/t_e$ ratio which results in a deflection of $L/360$.

Setting $\Delta_{max}$ = the deflection limit $= \dfrac{L}{360} = \dfrac{kqL^4}{E_c(t_e)^3}$

where $k = 0.1028$ (see Chapter 6)

$w = 144q$, load in psf

$q$ = load in psi

$E_c = 3.5 \times 10^6$ psi

and solving for $w_{max}$:

$$w_{max} = \frac{(3.5 \times 10^6)(144)}{(0.1028)(L/t_e)^3(360)}$$

$$w_{max} = 13.6 \times 10^6\ (t_e/L)^3 \text{ for } \Delta = L/360$$

Direct comparison by inspection of the required service live load versus the maximum load for $L/360$ or $L/180$ deflection limits should aid in the selection of tabulated designs meeting deflection criteria applicable to the structure under consideration. If creep deflection must be limited to $L/360$, the sum of service live load plus two times the estimated long-term service loads should be used for this comparison. (Creep factor = 2.0, ACI 9.5.2.5) If detailed estimates are required, such as for camber, for construction loads, or when $E_c$ is lower, the tabulated equivalent thicknesses will save computations.

For heavily reinforced waffle slabs, more refined calculations are required. The Code requires using the transformed (cracked) section moment of inertia and the gross section moment of inertia to determine the *effective* moment of inertia. Usually $I_e \approx I_g$ except in ribbed areas in which case the transformed section moment of inertia of the ribbed area must be combined with the gross moment of inertia to determine equivalent thickness.

*Caution:* All deflection serviceability criteria are based upon *service*, not *factored* loads. Actual loads are to be used except in computing long-term deflection where a creep factor, *not a load factor*, is required for long-term loads.

The effective moment of inertia, $I_e$, is computed as:

$I_e = (M_{cr}/M_a)^3 I_g + [1 - (M_{cr}/M_a)^3] I_{cr}$ . . (ACI Eq. 9-8)

in which:

Cracking moment, $M_{cr} = f_r I_g / y_t$

Modulus of rupture, $f_r = 7.5\sqrt{f'_c}$ for normal-weight concrete

Actual moment, $M_a =$ maximum moment of service load $(D + L)$

and $y_t =$ distance from centroid to extreme tension fiber of gross section.

**Table 11-2 Waffle Flat Slabs (19″ x 19″ Domes at 2′-0″)—Equivalent Thickness and Maximum Load Based on *L*/360 Deflection**

| Rib+Slab Depths (in.) | Equiv. Thickness $t_e$* (in.) | Max. Span in Tables (ft.) | Maximum Span Limited by *L*/360 Deflection for Load Shown Below | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | $L/t_e$=30 | $L/t_e$=31 | $L/t_e$=32 | $L/t_e$=33 | $L/t_e$=34 | $L/t_e$=35 | $L/t_e$=36 |
| 8 + 3 | 8.89 | 30 | 22′-2″ | 22′-11″ | 23′-8″ | 24′-5″ | 25′-2″ | 25′-11″ | 26′-7″ |
| 8 + 4 | 9.70 | 32 | 24′-3″ | 25′-0″ | 25′-10″ | 26′-8″ | 27′-5″ | 28′-3″ | 29′-1″ |
| 8 + 4½ | 10.11 | 34 | 25′-3″ | 26′-1″ | 26′-11″ | 27′-9″ | 28′-7″ | 29′-5″ | 30′-4″ |
| 8 + 5 | 10.52 | 36 | 26′-3″ | 27′-2″ | 28′-0″ | 28′-11″ | 29′-9″ | 30′-8″ | 31′-6″ |
| 10 + 3 | 10.51 | 36 | 26′-3″ | 27′-1″ | 28′-0″ | 28′-10″ | 29′-9″ | 30′-7″ | 31′-6″ |
| 10 + 4 | 11.34 | 38 | 28′-4″ | 29′-3″ | 30′-2″ | 31′-2″ | 32′-1″ | 33′-0″ | 34′-0″ |
| 10 + 4½ | 11.75 | 38 | 29′-4″ | 30′-4″ | 31′-3″ | 32′-3″ | 33′-3″ | 34′-3″ | 35′-2″ |
| 10 + 5 | 12.16 | 38 | 30′-4″ | 31′-4″ | 32′-4″ | 33′-5″ | 34′-5″ | 35′-5″ | 36′-5″ |
| 12 + 3 | 12.12 | 38 | 30′-3″ | 31′-3″ | 32′-3″ | 33′-3″ | 34′-3″ | 35′-4″ | 36′-4″ |
| 12 + 4 | 12.97 | 38 | 32′-4″ | 33′-5″ | 34′-6″ | 35′-7″ | 36′-8″ | 37′-9″ | 38′-10″ |
| 12 + 4½ | 13.38 | 38 | 33′-5″ | 34′-6″ | 35′-8″ | 36′-9″ | 37′-11″ | 39′-0″ | 40′-1″ |
| 12 + 5 | 13.80 | 38 | 34′-5″ | 35′-7″ | 36′-9″ | 37′-11″ | 39′-1″ | 40′-2″ | 41′-4″ |
| 14 + 3 | 13.72 | 38 | 34′-3″ | 35′-5″ | 36′-6″ | 37′-8″ | 38′-10″ | 40′-0″ | 41′-1″ |
| 14 + 4 | 14.59 | 38 | 36′-5″ | 37′-8″ | 38′-10″ | 40′-1″ | 41′-4″ | 42′-6″ | 43′-9″ |
| 14 + 4½ | 15.02 | 38 | 37′-6″ | 38′-9″ | 40′-0″ | 41′-3″ | 42′-6″ | 43′-9″ | 45′-0″ |
| 14 + 5 | 15.43 | 38 | 38′-7″ | 39′-10″ | 41′-1″ | 42′-5″ | 43′-8″ | 45′-0″ | 46′-3″ |
| 16 + 3 | 15.31 | 38 | 38′-3″ | 39′-6″ | 40′-10″ | 42′-1″ | 43′-4″ | 44′-7″ | 45′-11″ |
| 16 + 4 | 16.21 | 38 | 40′-6″ | 41′-10″ | 43′-2″ | 44′-6″ | 45′-11″ | 47′-3″ | 48′-7″ |
| 16 + 4½ | 16.64 | 38 | 41′-7″ | 42′-11″ | 44′-4″ | 45′-9″ | 47′-1″ | 48′-6″ | 49′-11″ |
| 16 + 5 | 17.07 | 38 | 42′-8″ | 44′-1″ | 45′-6″ | 46′-11″ | 48′-4″ | 49′-9″ | 51′-2″ |
| Maximum Load (psf) for Immediate (Elastic) Deflection of *L*/360** | | | 504 | 457 | 416 | 379 | 346 | 318 | 292 |

* Based on gross moment of inertia.

** For long-term (creep) deflection limited to *L*/360, multiply the long-term loads, including the waffle slab weight, times 2; deduct from loads shown above. Result is maximum superimposed service live load.

**Bar Spacing.** For crack control in two-way slabs, the spacing of reinforcing bars is limited to 2*h* (ACI 13.3.2). This limit does not apply to waffle slabs (ACI Commentary R13.3.2). Spacing of top bars cannot exceed 5*h* nor 18 inches (ACI 7.12). In the tabulated designs, bar sizes have been selected for the area of steel required so that their spacing is not less than 3 inches nor greater than the maximum permitted.

CRSI recommends a minimum of #4 bars spaced at 12 inches on center for rigidity under construction traffic.

**Openings.** Outside the solid head in waffle flat slabs, small openings may be located anywhere through the thin top slab between joists. The space available in one such dome will usually accommodate most service openings for electrical, plumbing, etc., needs. The Code

Table 11-3 Waffle Flat Slabs (24″ x 24″ Domes at 2′- 6″)—Equivalent Thickness and Maximum Load Based on *L*/360 Deflection

| Rib+Slab Depths (in.) | Equiv. Thickness $t_e$* (in.) | Max. Span in Tables (ft.) | Maximum Span Limited by *L*/360 Deflection for Load Shown Below | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | $L/t_e$=30 | $L/t_e$=31 | $L/t_e$=32 | $L/t_e$=33 | $L/t_e$=34 | $L/t_e$=35 | $L/t_e$=36 |
| 8 + 3 | 8.82 | 30 | 22′-2″ | 22′-9″ | 23′-6″ | 24′-3″ | 25′-0″ | 25′-8″ | 26′-5″ |
| 8 + 4 | 9.63 | 32.5 | 24′-1″ | 24′-10″ | 25′-8″ | 26′-5″ | 27′-3″ | 28′-1″ | 28′-10″ |
| 8 + 4½ | 10.04 | 35 | 25′-1″ | 25′-11″ | 26′-9″ | 27′-7″ | 28′-5″ | 29′-3″ | 30′-1″ |
| 8 + 5 | 10.45 | 35 | 26′-1″ | 26′-11″ | 27′-10″ | 28′-8″ | 29′-7″ | 30′-5″ | 31′-4″ |
| 10 + 3 | 10.43 | 35 | 26′-0″ | 26′-11″ | 27′-9″ | 28′-8″ | 29′-6″ | 30′-5″ | 31′-3″ |
| 10 + 4 | 11.25 | 37.5 | 28′-1″ | 29′-0″ | 30′-0″ | 30′-11″ | 31′-10″ | 32′-9″ | 33′-9″ |
| 10 + 4½ | 11.66 | 40 | 29′-1″ | 30′-1″ | 31′-1″ | 32′-0″ | 33′-0″ | 34′-0″ | 34′-11″ |
| 10 + 5 | 12.06 | 40 | 30′-1″ | 31′-2″ | 32′-2″ | 33′-2″ | 34′-2″ | 35′-2″ | 36′-2″ |
| 12 + 3 | 12.03 | 40 | 30′-0″ | 31′-0″ | 32′-0″ | 33′-0″ | 34′-0″ | 35′-1″ | 36′-1″ |
| 12 + 4 | 12.87 | 42.5 | 32′-2″ | 33′-2″ | 34′-3″ | 35′-4″ | 36′-5″ | 37′-6″ | 38′-7″ |
| 12 + 4½ | 13.28 | 45 | 33′-2″ | 34′-3″ | 35′-5″ | 36′-6″ | 37′-7″ | 38′-8″ | 39′-10″ |
| 12 + 5 | 13.69 | 45 | 34′-2″ | 35′-4″ | 36′-6″ | 37′-7″ | 38′-9″ | 39′-11″ | 41′-0″ |
| 14 + 3 | 13.62 | 45 | 34′-0″ | 35′-2″ | 36′-3″ | 37′-5″ | 38′-6″ | 39′-8″ | 40′-10″ |
| 14 + 4 | 14.48 | 47.5 | 36′-2″ | 37′-4″ | 38′-7″ | 39′-9″ | 41′-0″ | 42′-2″ | 43′-5″ |
| 14 + 4½ | 14.90 | 47.5 | 37′-3″ | 38′-5″ | 39′-8″ | 40′-11″ | 42′-2″ | 43′-5″ | 44′-8″ |
| 14 + 5 | 15.31 | 47.5 | 38′-3″ | 39′-6″ | 40′-10″ | 42′-1″ | 43′-4″ | 44′-8″ | 45′-11″ |
| 16 + 3 | 15.20 | 47.5 | 37′-11″ | 39′-3″ | 40′-6″ | 41′-9″ | 43′-0″ | 44′-3″ | 45′-7″ |
| 16 + 4 | 16.09 | 47.5 | 40′-2″ | 41′-6″ | 42′-10″ | 44′-2″ | 45′-6″ | 46′-10″ | 48′-3″ |
| 16 + 4½ | 16.51 | 47.5 | 41′-3″ | 42′-7″ | 44′-0″ | 45′-4″ | 46′-9″ | 48′-1″ | 49′-6″ |
| 16 + 5 | 16.94 | 47.5 | 42′-4″ | 43′-9″ | 45′-1″ | 46′-6″ | 47′-11″ | 49′-4″ | 50′-9″ |
| 20 + 3 | 18.34 | 47.5 | 45′-10″ | 47′-4″ | 48′-10″ | 50′-5″ | 51′-11″ | 53′-6″ | 55′-0″ |
| 20 + 4 | 19.28 | 47.5 | 48′-2″ | 49′-9″ | 51′-4″ | 53′-0″ | 54′-7″ | 56′-2″ | 57′-10″ |
| 20 + 4½ | 19.73 | 47.5 | 49′-3″ | 50′-11″ | 52′-7″ | 54′-2″ | 55′-10″ | 57′-6″ | 59′-2″ |
| 20 + 5 | 20.16 | 47.5 | 50′-4″ | 52′-1″ | 53′-9″ | 55′-5″ | 57′-1″ | 58′-9″ | 60′-5″ |
| Maximum Load (psf) for Immediate (Elastic) Deflection of *L*/360** | | | 504 | 457 | 416 | 379 | 346 | 318 | 292 |

* Based on gross moment of inertia.

** For long-term (creep) deflection limited to *L*/360, multiply the long-term loads, including the waffle slab weight, times 2; deduct from loads shown above. Result is maximum superimposed service live load.

requirement for total area of flexural reinforcement is maintained by the reinforcement in the joists. Larger openings must be treated as provided in the Code (ACI 13.4).

**Edge Conditions.** Joists parallel to the discontinuous edge may be selected from the tabulated designs for interior panels as these joists are continuous. For the design strips perpendicular to the discontinuous edge, joists may be selected from the tabulated designs for exterior panels, provided that the exterior edge frames integrally into columns as shown in the tabulated designs.

For corner panels, joists in the design strips in both directions may be selected from the tabulated designs for end panels under the same edge conditions as for other discontinuous joists. See Fig. 11-2.

Table 11-4 Waffle Flat Slabs (30″ x 30″ Domes at 3′- 0″)—Equivalent Thickness and Maximum Load Based on *L*/360 Deflection

| Rib+Slab Depths (in.) | Equiv. Thickness $t_e$* (in.) | Max. Span in Tables (ft.) | Maximum Span Limited by *L*/360 Deflection for Load Shown Below | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | $L/t_e$=30 | $L/t_e$=31 | $L/t_e$=32 | $L/t_e$=33 | $L/t_e$=34 | $L/t_e$=35 | $L/t_e$=36 |
| 8 + 3 | 8.61 | 30 | 21′-6″ | 22′-2″ | 22′-11″ | 23′-8″ | 24′-4″ | 25′-1″ | 25′-9″ |
| 8 + 4 | 9.40 | 33 | 23′-5″ | 24′-3″ | 25′-0″ | 25′-10″ | 26′-7″ | 27′-4″ | 28′-2″ |
| 8 + 4½ | 9.79 | 33 | 24′-5″ | 25′-3″ | 26′-1″ | 26′-11″ | 27′-8″ | 28′-6″ | 29′-4″ |
| 8 + 5 | 10.20 | 36 | 25′-5″ | 26′-4″ | 27′-2″ | 28′-0″ | 28′-10″ | 29′-8″ | 30′-7″ |
| 10 + 3 | 10.18 | 36 | 25′-5″ | 26′-3″ | 27′-1″ | 27′-11″ | 28′-10″ | 29′-8″ | 30′-6″ |
| 10 + 4 | 10.98 | 39 | 27′-5″ | 28′-4″ | 29′-3″ | 30′-2″ | 31′-1″ | 32′-0″ | 32′-11″ |
| 10 + 4½ | 11.37 | 39 | 28′-5″ | 29′-4″ | 30′-3″ | 31′-3″ | 32′-2″ | 33′-1″ | 34′-1″ |
| 10 + 5 | 11.77 | 39 | 29′-5″ | 30′-4″ | 31′-4″ | 32′-4″ | 33′-4″ | 34′-3″ | 35′-3″ |
| 12 + 3 | 11.74 | 39 | 29′-4″ | 30′-4″ | 31′-3″ | 32′-3″ | 33′-3″ | 34′-3″ | 35′-2″ |
| 12 + 4 | 12.56 | 42 | 31′-4″ | 32′-5″ | 33′-5″ | 34′-6″ | 35′-6″ | 36′-7″ | 37′-8″ |
| 12 + 4½ | 12.95 | 45 | 32′-4″ | 33′-5″ | 34′-6″ | 35′-7″ | 36′-8″ | 37′-9″ | 38′-10″ |
| 12 + 5 | 13.35 | 45 | 33′-4″ | 34′-5″ | 35′-7″ | 36′-8″ | 37′-9″ | 38′-11″ | 40′-0″ |
| 14 + 3 | 13.30 | 45 | 33′-2″ | 34′-4″ | 35′-5″ | 36′-6″ | 37′-8″ | 38′-9″ | 39′-10″ |
| 14 + 4 | 14.13 | 48 | 35′-3″ | 36′-6″ | 37′-8″ | 38′-10″ | 40′-0″ | 41′-2″ | 42′-4″ |
| 14 + 4½ | 14.54 | 51 | 36′-4″ | 37′-6″ | 38′-9″ | 39′-11″ | 41′-2″ | 42′-4″ | 43′-7″ |
| 14 + 5 | 14.94 | 51 | 37′-4″ | 38′-7″ | 39′-10″ | 41′-0″ | 42′-3″ | 43′-6″ | 44′-9″ |
| 16 + 3 | 14.85 | 51 | 37′-1″ | 38′-4″ | 39′-7″ | 40′-9″ | 42′-0″ | 43′-3″ | 44′-6″ |
| 16 + 4 | 15.70 | 54 | 39′-3″ | 40′-6″ | 41′-10″ | 43′-2″ | 44′-5″ | 45′-9″ | 47′-1″ |
| 16 + 4½ | 16.12 | 54 | 40′-3″ | 41′-7″ | 42′-11″ | 44′-3″ | 45′-7″ | 47′-0″ | 48′-4″ |
| 16 + 5 | 16.52 | 57 | 41′-3″ | 42′-8″ | 44′-0″ | 45′-5″ | 46′-9″ | 48′-2″ | 49′-6″ |
| 20 + 3 | 17.92 | 57 | 44′-9″ | 46′-3″ | 47′-9″ | 49′-3″ | 50′-9″ | 52′-3″ | 53′-9″ |
| 20 + 4 | 18.83 | 57 | 47′-0″ | 48′-7″ | 50′-2″ | 51′-9″ | 53′-4″ | 54′-11″ | 56′-5″ |
| 20 + 4½ | 19.26 | 57 | 48′-1″ | 49′-9″ | 51′-4″ | 52′-11″ | 54′-6″ | 56′-2″ | 57′-9″ |
| 20 + 5 | 19.69 | 57 | 49′-2″ | 50′-10″ | 52′-5″ | 54′-1″ | 55′-9″ | 57′-4″ | 59′-0″ |
| Maximum Load (psf) for Immediate (Elastic) Deflection of *L*/360** | | | 504 | 457 | 416 | 379 | 346 | 318 | 292 |

* Based on gross moment of inertia.

** For long-term (creep) deflection limited to *L*/360, multiply the long-term loads, including the waffle slab weight, times 2; deduct from loads shown above. Result is maximum superimposed service live load.

**Cantilever Edges.** Architectural or construction requirements frequently make cantilevered edges necessary. "Balanced" negative edge moments under full uniform load are often advantageous for: (1) many architectural exterior conditions require that exterior columns be set back from light outer cladding of other materials; and (2) often continuous "eyebrow" canopies are used to block direct sunlight. The variation in loads, spans, and thicknesses encountered in such cantilevered edge conditions precludes any standard detail or design recommendation. Reinforcement for these negative cantilever moments can be combined with top reinforcement from exterior panel strips and will usually improve performance of the waffle flat slab. Gravity loads on the exterior columns are nearly balanced, reducing gravity moments in the columns and positive moments and deflections in the exterior panel. See Fig. 11-3.

The simplest detail for full-depth waffle slab cantilevered edges is to extend top bars, anchored at the edge with end hooks, and add top bars similarly anchored to meet area of steel required for negative factored moment. For cantilever spans long enough to involve deflection limits, bottom bars may be extended as compression reinforcement to reduce creep deflections, and to ensure development of at least two bars past the edge column centerline.

**Stirrups.** When factored shears exceed the relatively low values prescribed for the concrete shear strength, stirrups are required as indicated in the tabulated designs. The notation used to describe the stirrups required for rib depths to 20 inches is explained in the notes on Page 11-24. Regarding the last character in the stirrup notation, a "one" indicates that single vertical bars properly anchored at spacing < 0.5*d* are necessary in the joist ribs from the face of the solid head area to the first cross rib. This distance is equal to the length of one dome form. For convenience in placing, stirrups are assembled in units. When the last character in the stirrup notation is a "two," it indicates that stirrups are required in the joist ribs to the second cross rib from the face of the solid head. Sizes and spacings of stirrup legs are: #3 bars spaced at 4 inches (see Fig. 11-4) for joist ribs 8 inches and 10 inches deep; and #4 bars spaced at 6 inches for ribs 12, 14, and 16 inches deep. For the 20-inch rib depths, the size, spacing, and arrangement of the stirrups must be specified.

## DESCRIPTION OF TABULATED DESIGNS

**Scope.** Tabulated designs are presented for waffle flat slab floor construction using the standard 19-inch × 19-inch, 24-inch × 24-inch, and 30-inch × 30-inch domes as described on Page 11-1. For each of the standard dome depths, tabulated designs are given for 3-inch, 4-inch, 4.5-inch, and 5-inch top slabs. Spans range from 15 feet to 57 feet for 30-inch domes, 15 feet to 47.5 feet for 24-inch domes, and 14 feet to 38 feet for 19-inch domes, for superimposed factored loads up to the maximum (shear) strength, for both typical square interior panels and for strips perpendicular to the wall in square edge panels that are built integrally with exterior columns.

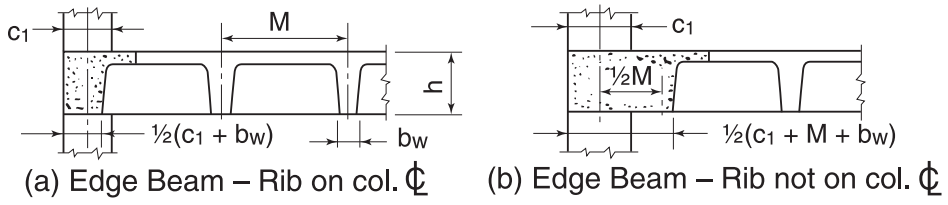



**Figure 11-2 Edge Conditions for Tabulated Designs**

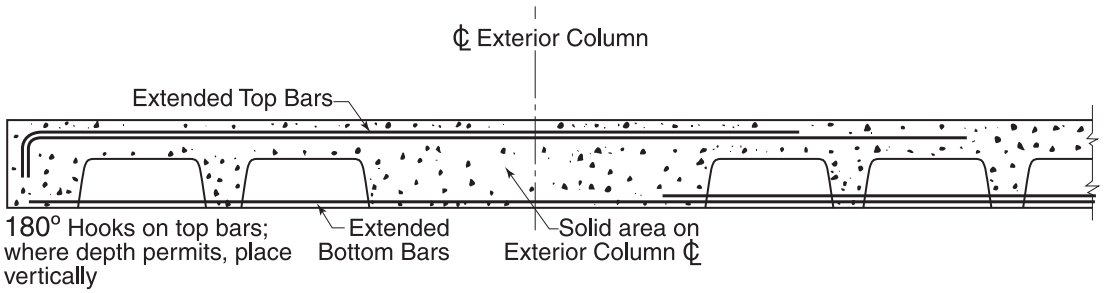


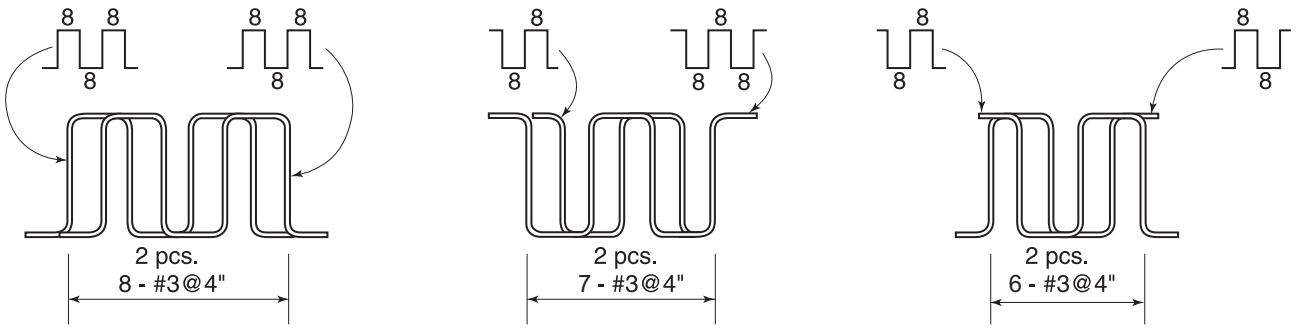

**Figure 11-3 Cantilever Edge Reinforcement**

The tabulated designs are based on the use of square columns, with the exterior columns located flush with the edge. Total slab thickness, size of solid head (drop panel), minimum size of column, reinforcing bars required, and average weight of reinforcing steel and volume of concrete per square foot of floor area are given in the tabulated designs. The Code requires "integrity reinforcement" (ACI 13.3.8.5). The tabulated values of reinforcing steel weight do not include integrity reinforcement. Under "Edge Panels," all total factored panel moments are given to serve as an aid in modifying the flush column design to any location of edge columns.

**Organization.** The tabulated designs are presented in three parts; first, 19-inch × 19-inch domes for a 24-inch module, then, 24-inch × 24-inch domes for a 30-inch module, and last, 30-inch × 30-inch domes for a 36-inch module. In each part, the 3-inch top slab designs are given first, followed by 4-inch, 4.5-inch, and 5-inch top slab designs, each in order of total depth, beginning with the shallowest.

**Explanation.** For a sample preliminary design and comparisons of material quantities for cost estimating, see Fig. 11-5. The data "Total Weight of Reinforcing Steel" (psf) and "Concrete" (cf/sf ) are given for each separate tabulated design (one line across the page) for convenient plotting, as in Fig. 11-5. See Fig. 11-1 for the bar lengths and bending details, which are used as a basis for the tabulated weight of reinforcing steel. The tabulated design shows reinforcing bars in one direction. "Total Weight of Reinforcing Steel" includes identical bars both ways for square interior panels, and includes one set of interior bars, plus one set of edge panel bars, for the square edge panel. Integrity reinforcement is not included in the reinforcing steel quantity. Stirrups, shear reinforcement at columns, and any welded wire reinforcement used in the top slab are not included as these items are usually estimated separately. The concrete quantities are for the waffle slab and solid head only. They do not include concrete in columns or any added beams.

The tabulated designs give the "Square Column" side dimensions in inches which is the minimum size of support that will keep punching shear stress equal to or less than $4\sqrt{f'_c}$ (ACI 11.11.2.1, Eq. 11-33) and $(\alpha_s d/b_o + 2)\sqrt{f'_c}$ (ACI Eq. 11-32) for use without shear reinforcement. For moderate loads and spans, the column sizes tabulated are not excessive, but for heavier loads or longer spans, maximum column size was limited to $\ell/15$. These sizes, marked by an asterisk, "*", require




*Alternate detail:* Plain or deformed welded wire reinforcement "ladder style" stirrups. Size and spacing of vertical legs to provide equivalent areas to reinforcing bar stirrups. Welded wire reinforcement ladders must include two longitudinal anchor wires top and bottom. (ACI 12.13.2.4)

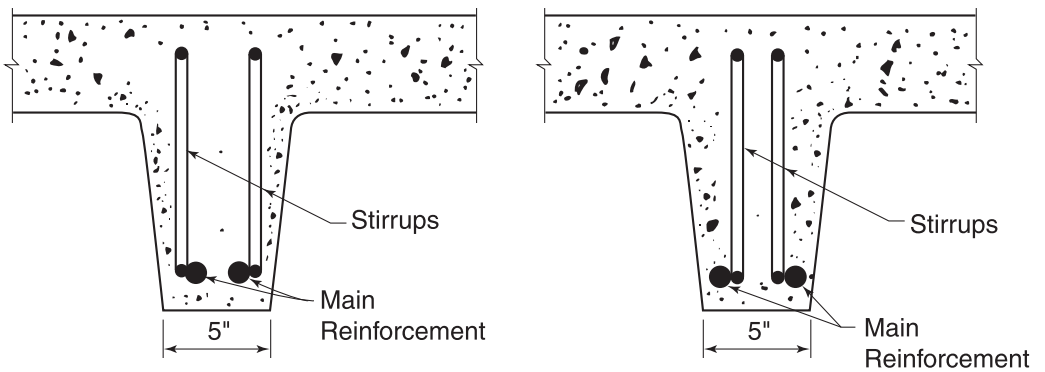



**Figure 11-4 Typical Stirrups for Tabulated Designs (Minimum Width Rib Shown)**

the use of headed shear stud reinforcement (ACI 11.11.5), or other types of shear reinforcement, or concrete caps or brackets to reduce column size. If equivalent stiffness round columns are used and caps are desirable, standard conical cap forms are available with diameters in multiples of 6 inches. Columns are shown square as they are usually more easily fitted into wall construction. See Fig. 11-6. If square shear caps are used, the minimum effective angle of slope with the horizontal is 45 degrees (ACI 13.1.2), and so the depth below the solid head should be equal or larger than the projection beyond the faces of the column on all sides.

The tabulated designs are for square panels only. For the design of rectangular panels (with the $\ell_1/\ell_2$ limitation of 2.0), the factored superimposed load values tabulated for the longer span may be used, and tabulated reinforcement adjusted in both directions. All loads tabulated are factored superimposed loads. "Factored superimposed load" consists of live load, floor finishes, partition allowance, and everything except the weight of the structural concrete, multiplied by the appropriate load factors.

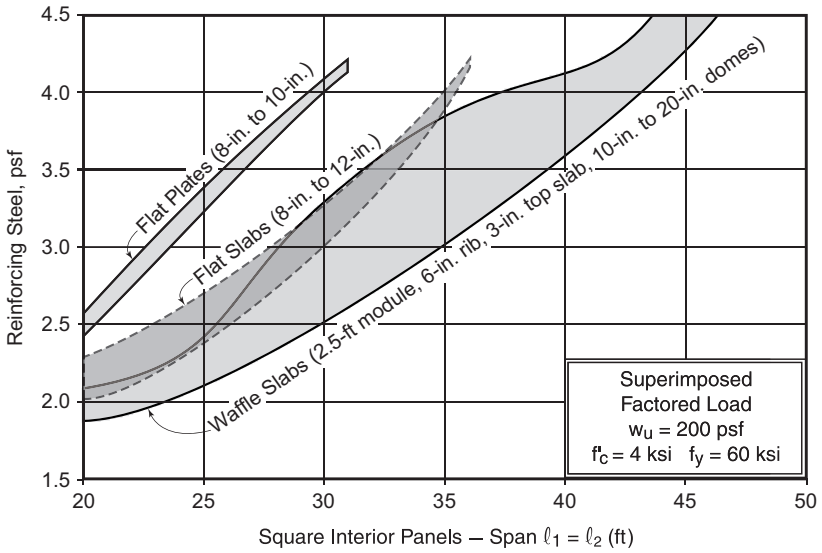



**Figure 11-5 Preliminary Design and Material Quantity Estimates for Flat Plates, Flat Slabs, and Waffle Flat Slabs from Tabulated Designs**

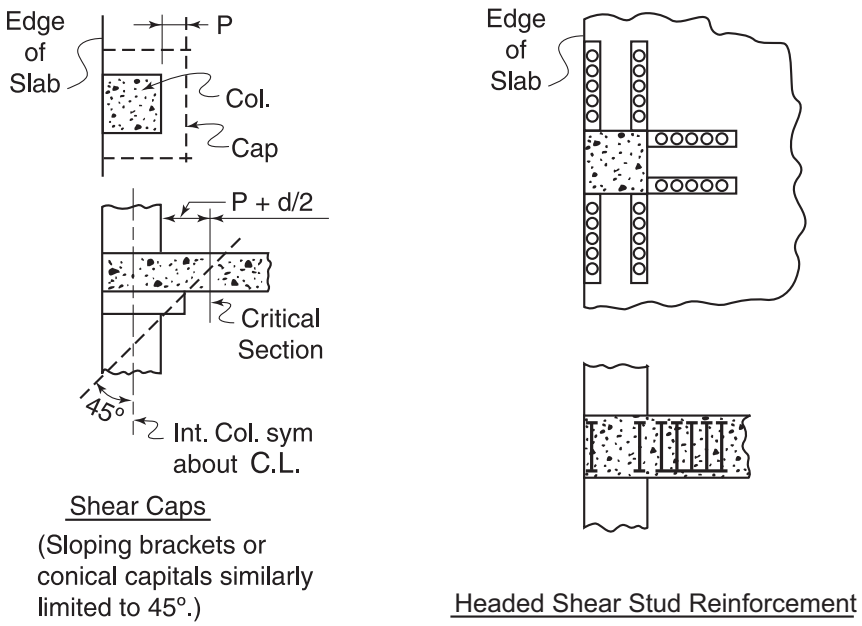



**Figure 11-6 Alternate Punching Shear Designs at Columns Marked "*"**

Dead weight of the waffle flat slab (based on 150 pounds per cubic foot) has been deducted. Strength-reduction factors, "$\phi$-factors" (ACI 9.3), have been applied. Total load to be distributed to supporting columns, beams, and walls will consist of superimposed factored load, plus the factored dead load of the waffle slab itself (1.2 × actual weight).

## BASIS OF TABULATED DESIGNS

**General.** All waffle flat slab tabulated designs presented in this Chapter are based on the "Strength Design" method and the "Direct Design Method" of analysis (ACI 13.6). Limitations of the Direct Design Method and the tabulated designs are: (1) at least three continuous panels in each direction, (2) ratio of length to width of panels not to exceed 2.0, (3) successive span lengths cannot vary more than 33 percent of the longer span, (4) ratio of live to dead (actual) load not to exceed two, and (5) uniformly distributed gravity loads only (ACI 13.6.1).

**Design Assumptions.** In applying the Direct Design Method, it is assumed that a waffle slab panel is composed of column strips and a middle strip, similar to those used in ordinary flat slab design. The column strip consists of the joist ribs and adjacent top slab framing directly into the solid head section. The remaining ribs and top slab comprise the middle strip of the panel. The solid head over columns is treated as if it were a drop panel in conventional flat slab construction. The individual ribs are designed as joists. Each rib contains two straight bottom bars. In the middle strips, one of the bottom bars, the larger if two sizes are used, is cut off and the other is extended, as shown in Fig. 11-1. Straight top bars are used and are generally of two lengths in the column strips to provide the negative moment reinforcement (ACI 13.3.8).

A layer of 6 × 6 – W3 × W3 welded wire reinforcement is assumed to be placed in the top slab over the domes in all cases.

The effective depth, *d*, of the waffle flat slab is computed on the basis of 1 inch of concrete cover for both the top and bottom reinforcement, plus an allowance of one bar diameter because the bars cross each other; thus, *d* equals the total depth minus 1.75 inches. For square panels, therefore, it is not necessary to specify the placing sequence as it is immaterial in which direction bars are at the greater depth as long as the design is based on the smaller effective depth.

The recommended reinforcing bar details shown in Fig. 11-1 conform to minimum lengths required by the Code (ACI 13.3.8). Based on practice, some minimum anchorages were increased to be practicable for usual conditions. For unusually high ratios of movable live load to dead-plus-fixed-live load, moving loads, concentrated loads, or openings, special analyses should be made and bar lengths increased as required. Integrity reinforcement has to be provided (ACI 13.3.8.5). If moment reversals are anticipated (due to moving live load or unfavorable ratios of adjacent spans), some bars should be continuous in both top and bottom. For waffle flat slabs with only two continuous spans, the amount, distribution, and lengths of reinforcing bars will require adjustment determined by a special analysis.

## USE OF TABULATED DESIGNS

The first step is to select the module, 2-feet, 2.5-feet, or 3-feet, best suited to the span and depth within span ranges given in the *Scope* (Page 11-7). Requirements for fire resistance in the legally adopted building code or project requirements for embedded conduits may require the 5-inch top slab; if not, a thinner top slab will be slightly more economical. The next step is to enter the appropriate tabulated design with the center-to-center span of columns and factored superimposed loads. See Chapter 5 for load factors and load combinations.

For preliminary design and material quantity estimates, see Fig. 11-5.

For the same span and loads, end span positive factored moments and negative factored moment (at first interior column) are larger. The basic design can be selected from either the edge or interior panel tablulated designs, depending on which type predominates in the actual building layout. The preliminary selection of sizes should be adequate for the required superimposed factored load with minimum use of stirrups in the ribs or shear reinforcement at columns. If a special long span or heavy load condition exists in a small area of the total layout, the shear reinforcement may be used to advantage in this area to avoid increasing depth in the entire layout. The same size forms should be used throughout a building for maximum economy.

If the basic design is selected from the interior span (interior panel) tabulated design, the corresponding tabulated design of the end span (edge panel) should also be checked to ensure that the end span will provide the required strength.

The tabulated designs furnish pertinent design and estimating data, including the sizes and the number of

reinforcing bars, weight of reinforcing steel per square foot, and average quantity of concrete per square foot. If reinforcing bar detailing information for a particular tabulated design is desired, Fig. 11-1 should be useful.

**Adaptation of Tabulated Designs to Non-Standard Situations.** For tabulated designs requiring modification, necessary additional data are presented for convenience in making adjustments. Factored moments for the exterior panel are tabulated for use in adjusting designs requiring top slab thicknesses other than the standard thicknesses tabulated, concrete compressive strengths, $f_c'$, other than 4,000 psi, or in deflection calculations.

See Chapters 9 and 10 for examples illustrating some of these adjustments. Chapter 9, "Flat Plates," presents the fundamental approach to "Direct Design" of two-way slabs under the ACI Building Code for the simplest application. Chapter 10, "Flat Slabs with Drop Panels," illustrates the additional computations required by the presence of the drop panels. This Chapter emphasizes solution of requirements to accommodate the two-way joists. To avoid duplication, the various design aids and explanations are not repeated in each Chapter. The three Chapters should be studied as a unit for full utilization of the tabulated designs, explanations for adjustment to project conditions, and use of the various design aids.

Other special conditions outside the range of the tabulated design include: (1) lateral load analysis on unbraced waffle slab-column frames and (2) rectanglar columns where ratio $c_1/c_2 = \beta_c > 2$. For two-way slabs that are required to resist moments due to lateral loads in frames not braced against side-sway, factored moments and required bar lengths must be determined by special analyses rather than those for gravity load alone (ACI 13.3.8.4). For rectangular columns where $\beta_c > 2$, or for square or rectangular columns where $\alpha_s d/b_o < 2$, the nominal shear strength of concrete, $v_c$, in two-way slabs is reduced, i.e., less than $4\sqrt{f_c'}$ (ACI 11.11.2).

For unbraced frames otherwise within limitations for the Direct Design Method (ACI 13.6), gravity load moments in the tabulated designs may be combined with lateral load moments from a separate analysis with suitable load factors applied (ACI 9.2).

## TABULATED DESIGNS—EXAMPLES

The following examples will illustrate use of the tabulated designs.

**Example 1.** Select a tabulated design of a waffle flat slab floor system with center-to-center spans of columns $\ell_1 = \ell_2 = 30'\text{-}0''$ for a service live load of 100 psf plus ceiling and floor finish of 20 psf. Maximum column size preferred is 16-in. square. Normal-weight concrete with $f_c' = 4{,}000$ psi will be used with Grade 60 ($f_y = 60{,}000$ psi) reinforcing bars. A 3-in. thick top slab will satisfy fire rating requirements. Factored superimposed load $w_u = 1.2D + 1.6L = 1.2 \times 20 + 1.6 \times 100 = 184$ psf. Use 30 in. $\times$ 30 in. dome forms for a $3'\text{-}0''$ module.

From the tabulated designs on Page 11-84 for the span and dome size, select the 12 + 3 waffle flat slab with solid head $12'\text{-}6''$ square. Stirrups are required for a distance of one module to the first cross rib from the solid head. (Where depth is available, maximum economy is usually achieved with depth adequate to enable use of the solid head tabulated without stirrups.) The factored superimposed load = 200 psf > 184 psf, okay.

To complete the final design, see Page 11-84 for the reinforcement, minimum column sizes required, and average quantities of reinforcing steel and concrete per square foot. Minimum column sizes are: exterior 15 in.* square and interior 15 in.* square. Reinforcing steel: 3.07 pounds per square foot (psf), exterior panels; and 2.79 pounds per square foot (psf), interior panels. Concrete: 0.705 cubic feet per square foot (cf/sf).

Note that this design will provide a floor system with a total depth of 15 in. (which is a reasonable minimum) and the (square) column sizes are within the preliminary limit established of 16 in. square. To achieve these limits, however, shear reinforcement (*) is noted around the exterior and interior columns, and stirrups are required in the ribs around the drop head at interior columns.

Minimum size columns are part of the architectural requirements and so provisions for shear reinforcement are required. The last character in the stirrup notation, i.e., the "one" indicates that such stirrups extend from the face of the solid head to the first cross rib (36 in.). See Fig. 11-4 for details and note that the vertical legs of stirrups are #4 bars spaced at 6 in.

Providing a shear cap is one option for satisfying the two-way shear requirements ($v_u \le v_c$) at the exterior columns. Assume that it satisfies architectural requirements here. The asterisk (*) after minimum size square exterior column ($c_1 = c_2 = 15$ in.*) indicates that $4\sqrt{f_c'} < v_u \le 6\sqrt{f_c'}$.

*Proportioning shear cap.* A shear cap will stiffen the exterior column, very slightly increasing $-M_{ext}$. It will reduce clear span very slightly, reducing $-M_{ext}$. It will usually be within acceptable limits of accuracy to neglect these minor effects as though the increases were equal to the decreases since the shear cap will be proportioned to the next higher dimension in integral inch-units. A direct solution for the minimum size shear cap is difficult, but trial solutions with the benefit of the peripheral shear constants in Table 11-5 are relatively simple.

Total factored load = superimposed factored load
+ (1.2) (0.705 × 150)
= 184 + 127
$w_u$ = 311 psf

Take (conservatively) $V_u = (0.311)(30 \times ½ \times 30) = 140$ kips

Try a shear cap projecting 11 in. (11-in. depth) which will add 11 in. to column dimensions. Use $c'_1 = c'_2 = 26$ in. The peripheral shear constraints, from Table 11-5, for $c'_1 = c'_2 = 26$ in. and $h = 15$ in., are:

$c_{AB} = 10.19$ in.; $A_c = 1{,}385$ in.$^2$ and $J_c = 175{,}700$ in.$^4$

Read on Page 11-84: $M_{edge} = -254$ ft-kips; $M_{bot} = +611$ ft-kips and $M_{int} = -683$ ft-kips

$M_o = (254 + 683)/2 + 611 = 1{,}080$ ft-kips

Unbalanced gravity load moment transferred by shear = $0.3M_o$ (ACI 13.6.3.6).
$0.3M_o = 0.3(1{,}080) = 324$ ft-kips

Take shear transfer coefficient (conservatively), $\gamma_v = 0.40$ (ACI 11.11.7.1).

$$v_u = \frac{V_u}{A_c} + \frac{\gamma_v M c_{AB}}{J_c}$$

$$v_u = \frac{140{,}000}{1{,}385} + \frac{(0.40)(324)(12)(1{,}000)(10.19)}{(175{,}700)}$$

$v_u = 101 + 90 = 191$ psi

$\phi v_c = (0.75)(4)\sqrt{4{,}000}$

$\phi v_c = 190$ psi $\approx v_u$, okay

Nominal shear strength of concrete ($v_c = 4\sqrt{f'_c}$) is controlled by ACI Eq. 11-33, because in ACI Eq. 11-32, $(\alpha_s d/b_o + 2) = (30 \times 14)/109 + 2 = 5.85 > 4$.

An 11-in. deep shear cap projecting 11 in. from the column will be adequate. Note that the shear analysis was actually made for a square column head 26 × 26 in., whereas the face of the shear cap will be at $c_1 + 11$ in. = 26 in. deep and $c_2 + (2)(11) = 37$ in. wide. See Fig. 11-7.

Complete Example 1 by reading the required flexural reinforcement from the tabulated design on Page 11-84:

*Edge panel*

Strips parallel to edge same as interior panels.
Strips at right angles to edge,

Column strip
13-#5 plus 4-#5 in 60-in. effective width; Top bars at edge
1-#7, 1-#8 } Bottom bars per rib in 5 ribs
20-#6 Top bars at first interior column

Middle strip
No top bars required at edge (ACI 13.6.6.1)
2-#6 Bottom bars per rib in 5 ribs
14-#5 Top bars at first interior column centerline

*Interior panels*

Column strip – 18-#6 Top bars at other interior columns
2-#6 Bottom bars per rib in 5 ribs

Middle strip – 14-#5 Top bars on other column centerlines
2-#5 Bottom bars per rib in 5 ribs

Stirrups #4 bars spaced at 6 in. extending 36 in. in (20) ribs at all interior column solid heads.

**Example 2.** Select a waffle flat slab floor system with square panels and center-to-center spans of columns $\ell_1 = \ell_2 = 36'\text{-}0''$ for a superimposed factored load $w_u$ = 150 psf.

In the tabulated designs on Page 11-84, read for $\ell_1 = \ell_2 = 36'\text{-}0''$ and $w_u = 150$ psf:

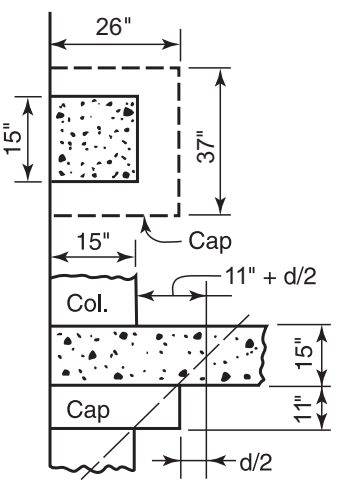



**Figure 11-7 Shear Cap**

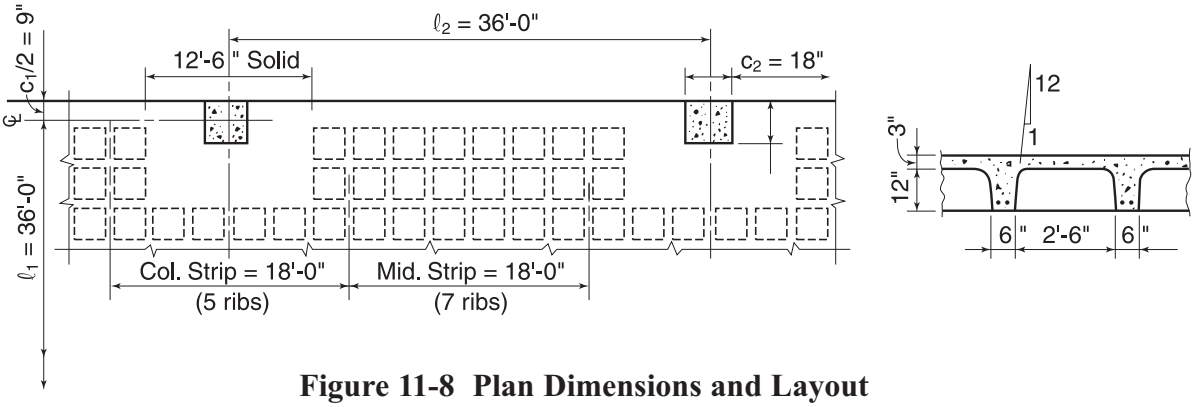



**Figure 11-8 Plan Dimensions and Layout**

12″ + 3″, 6-in. ribs @ 36 in. This design requires square exterior columns $c_1 = c_2 = 20$ in.*

*Shear reinforcement is required at exterior columns. Interior columns are 18 in.* square. Stirrups are required at interior columns. If these column dimensions are satisfactory, this design should suffice.

## SPECIAL DETAILS

Examples 1 and 2 illustrate the various adjustments required for designs outside the conditions tabulated. For these and similar adjustments, the design aids (tables, curves, etc.) of this Chapter and Chapters 9 and 10 should reduce design time to a minimum.

Special details will have to be developed to complete the design of an actual project. It is impossible to tabulate designs for the variety of edge conditions which may be required. As noted, cantilever edges are structurally desirable and will simplify design. Minimum solid sections as flush depth edge beams are shown in Fig. 11-2. These beams must be investigated for torsion, as well as flexure and vertical shear. Whenever architectural requirements preclude cantilever edges and permit spandrel edge beams projecting below the slab, the use of such spandrel beams will stiffen edges for better structural performance.

Where use of headed shear stud reinforcement is desirable to maintain uniform floor depth or column size for a few panels with longer spans or heavier loads than the remainder of a floor system, a special design will be required. Design of headed shear stud reinforcement is prescribed by the Code (ACI 11.11.5 and Commentary). Other types of shear reinforcement are stirrups (ACI 11.11.3) and structural steel shearheads (ACI 11.11.4). For total depth of solid head less than 12 inches, the feasibility of fabricating and placing shear reinforcement, other than headed shear stud reinforcement, should be investigated.

## MANUAL EXAMPLE

To illustrate the design assumptions, applicable Code requirements, and the procedures used in the preparation of the waffle flat slab tabulated designs, one of the tabulated designs will be reviewed with all calculations performed longhand. This review should also provide guidance to extend the scope of the tabulated designs to longer spans or heaver loads; to use other compressive strengths of concrete; or conditions of support other than the tabulated size square colums.

Review the tabulated design, on Page 11-84, for an intermediate waffle flat slab floor with square panels; $\ell_1 = \ell_2 = 36'\text{-}0''$; 12-in. deep ribs plus 3-in. top slab depth; 6-in. wide ribs at a 3′-0″ module; superimposed factored live load = 100 psf; normal-weight concrete; $f'_c$ = 4,000 psi; Grade 60 reinforcing bars, $f_y$ = 60,000 psi; 18-in. square columns (exterior and interior). For plan dimensions and layout, see Fig 11-8.

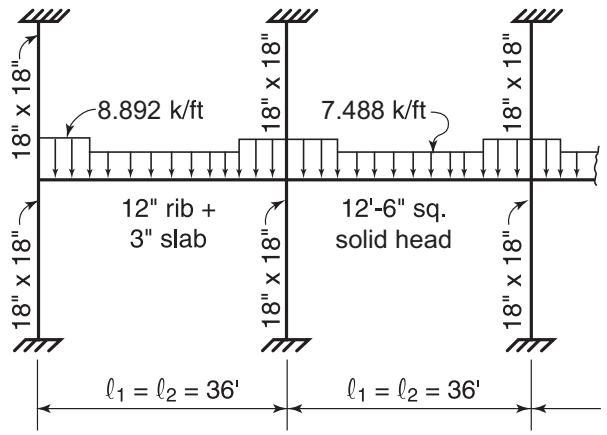



**Figure 11-9 Schematic of Waffle Flat Slab Frame and Factored Loads**

**Factored Loads**

Floor (joist) dead load = 90 psf (Table 11-1)

Joist $w_D$ = 1.2 (90) = 108 psf = 0.108 ksf

Solid head $w_D$ = 1.2 (15/12) 150 = 225 psf = 0.225 ksf

$w_L$ = 100 psf = 0.100 ksf

Floor $w_D$ = 36 (0.108) + (1/3)(36)(0.225 – 0.108)
= 3.888 + 1.404 = 5.292 kips/ft

Floor $w_L$ = 36(0.100) = 3.6 kips/ft

$w_D + w_L$ = 5.292 + 3.6 = 8.892 kips/ft (solid head)

$w_D + w_L$ = 3.888 + 3.6 = 7.488 kips/ft (outside head)

Ratio of Service Live Load to Service Dead Load:

$L/D$ = [100/1.6]/90 = 0.69 < 2, Okay... (ACI 13.6.1.5)

**End Span**

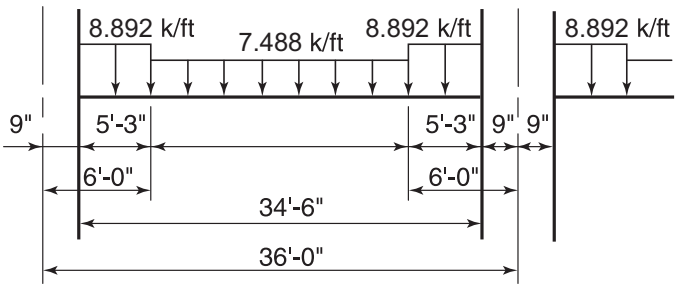
Total Static Moment, $M_o$:

$M_o$ (outside head) = $7.488(34.5)^2/8$ = 1,114.074 ft-kips

$M_o$ (head) = $(8.892 - 7.488)(5.25)^2/2$ = 19.349 ft-kips

$M_o$ = 1,114.074 + 19.349 = 1,133.423 ft-kips

**Panel Moments (ACI 13.6.3.3)**




Exterior Column (Negative Factored Moment)

$M_u$ = 0.26(1,133.423) = 294.690 ft-kips
(tabulated: 295)

Column strip resists 100% of $M_u$; 1.00(294.690) = 294.690 ft-kips (ACI 13.6.4.2)

Bottom (Positive Factored Moment)

$M_u$ = 0.52(1,133.423) = 589.380 ft-kips
(tabulated: 590)

Column strip resists 60% of $M_u$; 0.60(589.380) = 353.628 ft-kips (ACI 13.6.4.4)

Middle strip resists 40% of $M_u$; 0.40(589.380) = 235.752 ft-kips

First Interior Column (Negative Factored Moment)

$M_u$ = 0.70(1,133.423) = 793.396 ft-kips
(tabulated: 794)

Column strip resists 75% of $M_u$; 0.75(793.396) = 595.047 ft-kips (ACI 13.6.4.1)

Middle strip resists 25% of $M_u$; 0.25(793.396) = 198.349 ft-kips

**Flexural Reinforcement**

$$\text{Required } A_s = \frac{1.7 f_c' bd}{2 f_y} - \frac{1}{2}\sqrt{\frac{2.89(f_c' bd)^2}{(f_y)^2} - \frac{6.8 f_c' b M_u}{\phi (f_y)^2}}$$

For $f_c'$ = 4,000 psi, $f_y$ = 60,000 psi and $\phi$ = 0.90:

Required $A_s = 0.680d - \sqrt{0.462d^2 - 0.0252 M_u}$ where $M_u$ is in units of in.-kips/ft and $A_s$ is in units of in.$^2$/ft

$d$ = (3 + 12) – 1 (concrete cover) – 0.75 (avg. $d_b$)
= 13.25 in.

**Exterior Column (Column Strip Top Bars)**

$M_u$ = 12(294.690)/12 = 294.690 in.-kips/ft

$A_s = 0.680(13.25)^2 - \sqrt{0.462(13.25)^2 - 0.0252(294.690)}$
= 0.426 in.$^2$/ft

Total $A_s$ = 0.426(12) = 5.11 in.$^2$

(tabulated: 11–#6 bars; $A_s$ = 4.84 in.$^2$)

Column Strip Bottom Bars

$M_u$ = 12(353.628)/12 = 353.628 in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(353.628)}$
= 0.513 in.$^2$/ft

Total $A_s$ = 0.513(12) = 6.16 in.$^2$

(tabulated: 5–#7 bars and 5-#8 bars;
$A_s$ = 6.95 in.$^2$)

Middle Strip Bottom Bars

$M_u$ = 12(235.752)/24 = 117.876 in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(117.876)}$
= 0.170 in.$^2$/ft

Total $A_s$ = 0.170(24) = 4.08 in.$^2$

(tabulated: 14–#5 bars; $A_s$ = 4.34 in.$^2$)

**First Interior Column (Column Strip Top Bars)**

$M_u$ = 12(595.047)/12 = 595.047 in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(595.047)}$
= 0.879 in.$^2$/ft

Total $A_s$ = 0.879(12) = 10.55 in.$^2$

(tabulated: 23–#6 bars; $A_s$ = 10.12 in.$^2$)

**First Interior Column (Middle Strip Top Bars)**

$M_u = 12(198.349)/24 = 99.175$ in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(99.175)}$
$= 0.144$ in.$^2$/ft

Total $A_s = 0.144(24) = 3.46$ in.$^2$

(tabulated: 19–#5 bars; $A_s = 5.89$ in.$^2$)

The maximum spacing of the top bars in the middle strip is limited to 18 in. (ACI 13.3.2). The calculated total required $A_s = 3.46$ in.$^2$; 12-#5 bars would provide an $A_s = 3.72$ in.$^2$ But the spacing of the 12-#5 bars in the 24′-0″ wide middle strip would be 288/11 = 26 in. > 18 in., which exceeds the Code limit.

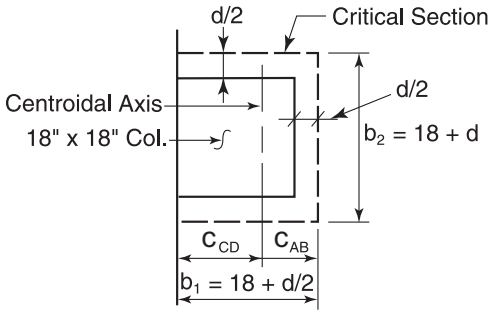
The computer program prescribes 19-#5 bars whose spacing is 288/19 = 15 in. < 18 in., Okay

Verify $\phi = 0.90$ for flexure; for $f'_c = 4{,}000$ psi and $f_y = 60{,}000$ psi, maximum $\rho = 0.0181$ for $\varepsilon_t = 0.005$ and $\phi = 0.90$.

| Location | Tabulated Design | $A_s$, in.$^2$ | $b$, in. | $d$, in. | $\rho$ |
|---|---|---|---|---|---|
| Column strip top bars at exterior column | 11-#6 | 4.84 | 144 | 13.25 | 0.0025 |
| Column strip bottom bars | 5-#7 and 5-#8 | 6.95 | 144 | 13.25 | 0.0036 |
| Middle strip bottom bars | 14-#5 | 4.34 | 288 | 13.25 | 0.0011 |
| First Interior Column strip top bars | 23-#6 | 10.12 | 144 | 13.25 | 0.0053 |
| Middle strip top bars | 19-#5 | 5.89 | 42 | 13.25 | 0.0106 |

In all cases, actual $\rho <$ maximum $\rho$, so $\phi = 0.90$.

**Shear Constants at Exterior Column (ACI R11.12.6.2):**




$b_1 = 18 + 13.25/2 = 24.625$ in.

$b_2 = 18 + 13.25 = 31.25$ in.

$b_0 = 2 \times 24.625 + 31.25 = 80.50$ in.$^2$

$A_c = 80.50 \times 13.25 = 1{,}066.625$ in.$^2$

(tabulated in Table 11-5; $A_c = 1{,}067$ in.$^2$)

$c_{AB} = (2)(13.25)(24.625)^2/2 = 7.533$ in.

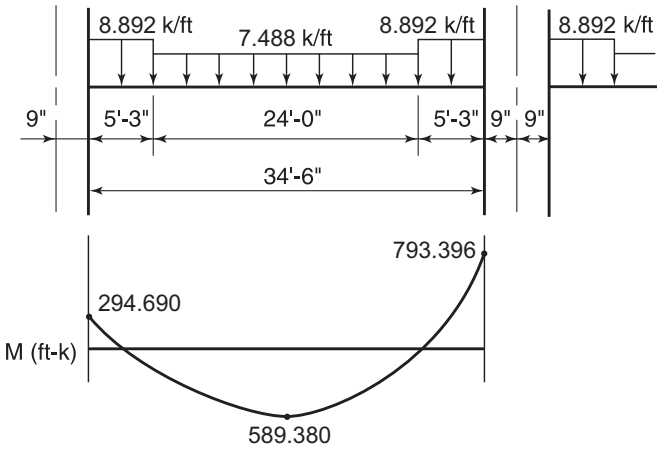
(tabulated in Table 11-5; $c_{AB} = 7.53$ in.)

$c_{CD} = 24.625 - 7.533 = 17.092$ in.

$J_c = b_1 d^3/6 + 2d[(c_{AB})^3 + (c_{CD})^3]/3 + b_2 d c_{AB}$
$= 24.625(13.25)^3/6 + 2(13.25)[(7.533)^3 + 17.092^3)]/3$
$+ 31.25(13.25)(7.533)^3$
$= 9{,}547.125 + 47{,}882.539 + 23{,}496.428$
$= 80{,}926$ in.$^4$

(tabulated in Table 11-5; $J_c = 80{,}900$ in.$^4$)

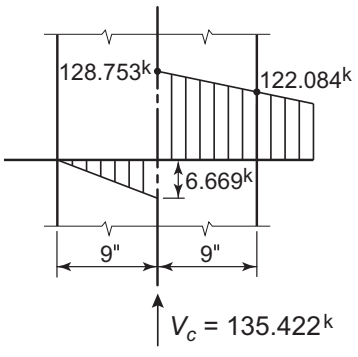
**Factored Moments in End Span:**




**Calculate Factored Shear, $V_u$, at Centerline of Exterior Column**

$V_u$ (at exterior column face)
$= 7.488(34.5)/2 + (8.892 - 7.488)(5.25)$
$- (793.396 - 294.690)/34.5$
$= 122.084$ kips

$V_u$ (at centerline exterior column)
$= 122.084 + 8.892(18/12)$
$= 135.422$ kips




Exterior Column

Shear Check at Exterior Column:

$v_c = (\alpha_s d/b_0 + 2)\sqrt{f'_c} \le 4\sqrt{f'_c}$ (ACI Eq. 11-32)
$= (30 \times 13.25/80.50 + 2)\sqrt{f'_c} = 6.94\sqrt{f'_c}$

ACI Eq. 11-35 governs: use $v_c = 4\sqrt{f'_c} = 4\sqrt{4{,}000} = 253$ psi

$\phi v_c = 0.75(253) = 190$ psi or 0.191 ksi

$$v_u = \frac{V_u}{A_c} + \frac{\gamma_v M_u c_{AB}}{J_c} \quad \text{(ACI R11.11.7.2)}$$

where:

$\gamma_v = (1 - \gamma_f)$ (ACI Eq. 11-37)

$\gamma_f = 1/(1 + (2/3)\sqrt{b_1/b_2})$ (ACI Eq. 13-1)

$= 1/(1 + (2/3)\sqrt{24.625/31.25} = 0.628$

$\gamma_v = 1 - \gamma_f = 1 - 0.628 = 0.372$

Where $M_u = 0.3M_o$ (ACI 13.6.3.6)

$M_u = 0.3(1{,}133.423) = 340.027$ ft-kips

$v_u = 135.422/1{,}066.625 + 0.372(12 \times 340.027) \times (7.533/80{,}926) = 0.127 + 0.141$

$= 0.268$ ksi, $> \phi v_c$, N.G.

An option would be to use headed shear stud reinforcement to provide the required design shear strength (ACI 11.11.5).

Another option is to use the provisions in ACI 13.5.3.3: If $0.75V_c > V_u$, $\gamma_f$ can be adjusted up to 1.0.

$0.75\phi V_c = 0.75\phi(4\sqrt{f'_c})b_o d$

$= 0.75(0.75)(4\sqrt{4{,}000})(80.50)(13.25)/1{,}000$

$0.75\phi V_c = 151.783$ kips $> V_u$, so $\gamma_f$ can be adjusted up to 1.0

For $\gamma_v = 0.372$, total $v_u = 0.268$ ksi $> 0.190$ ksi, N.G.

Therefore, limit total $v_u$ to 0.190 ksi and solving for required $\gamma_v$.

$0.190 = 135.422/1{,}066.625 + \gamma_v(12 \times 340.027)(7.533)/80{,}926$

$\gamma_v = 0.166$

$\gamma_f = 1 - \gamma_v = 1 - 0.166 = 0.834$

The computer program optimizes $\gamma_f$ to 0.882; thus, $\gamma_v = 1 - 0.882 = 0.118$

Shear check for $\gamma_v = 0.118$

$v_u = 135.422/1{,}066.625 + 0.118(12 \times 340.027)(7.533)/80{,}926$

$v_u = 0.127 + 0.045$

$v_u = 0.172$ ksi $< \phi v_c$, Okay

Determine Number of Extra Top Bars Required in Column Strip at Exterior Column:

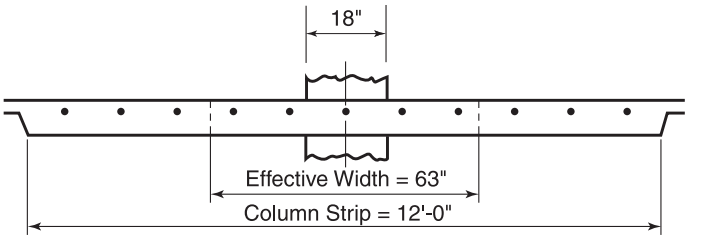
Unbalanced $M_u = 0.26M_o = 0.26(1{,}133.423) = 294.690$ ft-kips

$\gamma_f M_u = 0.882(294.690) = 259.917$ ft-kips

Effective Width = 18 + 1.5(15)2 = 63 in.

Bar Layout: 11 – #6 top bars are required to resist exterior $-M_u$ in column strip

Bar spacing = 12 × 12/11 ≈ 13 in.




Try 6-#6 additional top bars (as per tabulated design) for a total of 11 – #6 reinforcing bars in the effective width

Calculate design moment strength, $\phi M_n$

$A_s = (11)(0.44) = 4.84$ in.$^2$ for 11–#6 top bars

$a = A_s f_y/(0.85f'_c b) = 4.84(60)/(0.85(4)63) = 1.356$ in.

$\phi M_n = \phi A_s f_y(d - a/2)$

$= 0.90(4.84)(60)(13.25 - 1.356/2)/12$

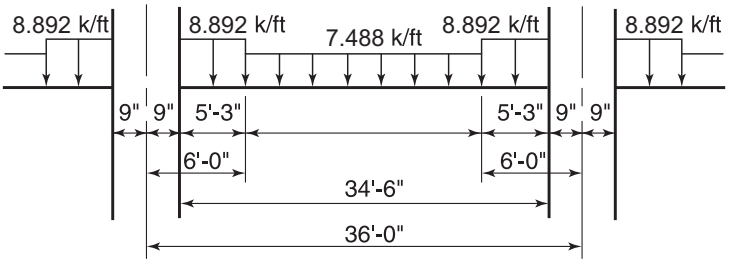
$\phi M_n = 273.818$ ft-kips $> \gamma_f M_u$, Okay

ACI 13.5.3.3 limits the amount of flexural reinforcement in the effective width so that $\varepsilon_t \geq 0.010$. For $f'_c = 4{,}000$ psi and $f_y = 60{,}000$ psi, a value of $\varepsilon_t = 0.010$ corresponds to $\rho_{max} = 0.011$. For the 11-#6 top bars in the effective width:

$$\rho = \frac{A_s}{bd} = \frac{4.84}{63(13.25)} = 0.0058$$

$\rho < \rho_{max}$, Okay

**Interior Span**




Total Static Moment, $M_o$:

$M_o = 1{,}133.423$ ft-kips (the same value as in the end span)

**Panel Moments**

Bottom (Positive Factored Moment)

$M_u$ = 0.35(1,133.423) = 396.698 ft-kips

Column strip resists 60% of $M_u$;
0.60(396.698) = 238.019 ft-kips (ACI 13.6.4.4)

Middle strip resists 40% of $M_u$;
0.40(396.698) = 158.679 ft-kips

Top (Negative Factored Moment)

$M_u$ = 0.65(1,133.423) = 736.725 ft-kips

Column strip resists 75% of $M_u$;
0.75(736.725) = 552.544 ft-kips (ACI 13.6.4.1)

Middle strip resists 25% of $M_u$;
0.25(736.725) = 184.181 ft-kips

**Flexural Reinforcement**

Column Strip Bottom Bars

$M_u$ = 12(238.019)/12 = 238.019 in-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(238.019)}$
= 0.343 in.$^2$/ft

Total $A_s$ = 0.343(12) = 4.12 in.$^2$
(tabulated: 10–#6 bars; $A_s$ = 4.40 in.$^2$)

Middle Strip Bottom Bars

$M_u$ = 12(158.679)/24 = 79.340 in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(79.340)}$
= 0.116 in.$^2$/ft

Total $A_s$ = 0.116(24) = 2.78 in.$^2$
(tabulated: 14–#4 bars; $A_s$ = 2.80 in.$^2$)

Column Strip Top Bars

$M_u$ = 12(552.544)/12 = 552.544 in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(552.544)}$
= 0.813 in.$^2$/ft

Total $A_s$ = 0.813(12) = 9.76 in.$^2$
(tabulated: 30–#5 bars; $A_s$ = 9.30 in.$^2$)

Middle Strip Top Bars

$M_u$ = 12(184.181)/24 = 92.091 in.-kips/ft

$A_s = 0.680(13.25) - \sqrt{0.462(13.25)^2 - 0.0252(92.091)}$
= 0.134 in.$^2$/ft

Total $A_s$ = 0.134(24) = 3.22 in.$^2$
(tabulated: 19–#5 bars; $A_s$ = 5.89 in.$^2$)

Verify $\phi$ = 0.90 for flexure; for $f'_c$ = 4,000 psi and $f_y$ = 60,000 psi, maximum $\rho$ = 0.0181 for $\varepsilon_t$ = 0.005 and $\phi$ = 0.90.

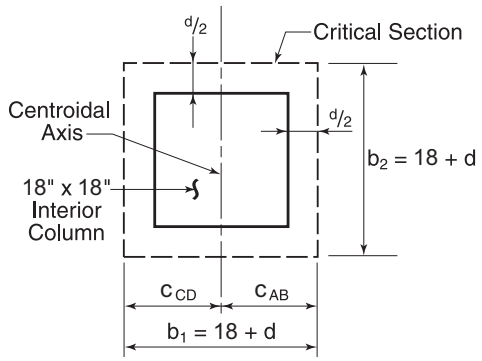
| Location | Tabulated Design | $A_s$, in.$^2$ | $b$, in. | $d$, in. | $\rho$ |
|---|---|---|---|---|---|
| Column strip bottom bars | 10-#6 | 4.40 | 144 | 13.25 | 0.0023 |
| Middle strip bottom bars | 14-#4 | 2.80 | 288 | 13.25 | 0.0007 |
| Column strip top bars | 30-#5 | 9.30 | 144 | 13.25 | 0.0049 |
| Middle strip top bars | 19-#5 | 5.89 | 42 | 13.25 | 0.0106 |

In all cases, actual $\rho$ < maximum $\rho$, so $\phi$ = 0.90.

The maximum spacing of the top bars in the middle strip is limited to 18 in. (ACI 13.3.2). The calculated total required $A_s$ = 3.22 in.$^2$; 11-#5 bars would provide an $A_s$ = 3.41 in.$^2$ But the spacing of the 11-#5 bars in the 24'-0" wide middle strip would be 288/11 = 26 in. > 18 in., which exceeds the Code limit.

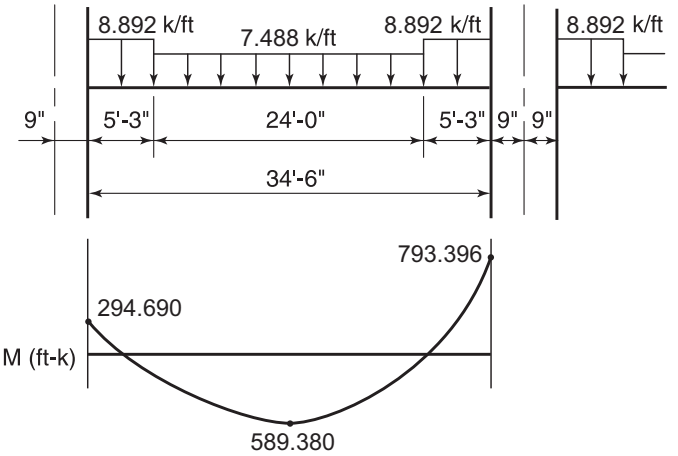
The computer program prescribes 19-#5 bars whose spacing is 288/19 = 15 in. < 18 in., Okay

**Shear Constants at Interior Column (ACI R11.12.6.2):**




$b_1$ = $b_2$ = 18 + 13.25 = 31.25 in.
$b_0$ = 4 × 31.25 = 125 in.
$A_s$ = 125 × 13.25 = 1,656.250 in.$^2$
(tabulated in Table 11-5; $A_c$ = 1,656 in.$^2$)
$c_{AB}$ = $c_{CD}$ = 31.25/2 = 15.625 in.
(tabulated in Table 11-5; $c_{AB}$ = 15.63 in.)
$J_c$ = $(db_1/6)[d^2 + 4b_1^2]$
$J_c$ = (13.25(31.25)/6)[(13.25)$^2$ + 4(31.25)$^2$]
= 281,688 in.$^4$
(tabulated in Table 11-5; $J_c$ = 281,700 in.$^4$)

**Factored Moments in End Span**




Calculate Factored Shear, $V_u$ at Centerline of First Interior Column:

$V_u$ (at first interior column face) = 7.488(34.5)/2
+ (8.892 – 7.488)(5.25) + (793.396 – 294.690)/34.5
= 150.994 kips

$V_u$ (at centerline first interior column)

= 150.994 + 7.488(34.5)/2
+ (8.892 – 7.488)(5.25) + 8.892(18/12)
= 300.871 kips

For checking shear due to combined effects (i.e., direct shear plus transfer of unbalanced moment), the factored moment is:

$M_{int} = 0.07[(w_D + 0.5\,w_L)\,\ell_2\,\ell_n^2 - w_D'\ell_2'(\ell_n')^2]$. . . . . (ACI Eq. 13-7)

where $w_D'$, $\ell_2'$ and $\ell_n'$ refer to the shorter span

$M_{int} = 0.07\,[(0.126 + 0.050)36(34.5)^2 - 0.126(36)(34.5)^2]$
= 0.07 [7,541.424 – 5,398.974]
= 149.972 ft-kips

Shear Check:

With factored moment $M_{int}$ = 149.972 ft-kips, the factored shear, $V_u$, is:

$V_u = w_u\ell/2 + w_D\ell/2$ (i.e., full factored load on one span and factored dead load only on other span)

$V_u$ = 7.488(36)/2 + (8.892 – 7.488)5.25
+ 3.888(36)/2 + 1.404(5.25)
= 134.784 + 7.371 + 69.984 + 7.371
$V_u$ = 219.510 kips

**Shear Check at First Interior Column**

$v_c = (\alpha_s d/b_o + 2)\sqrt{f_c'} \le 4\sqrt{f_c'}$ (ACI Eq. 11-32)

$v_c = (40 \times 13.25/125 + 2)\sqrt{f_c'} = 6.24\sqrt{f_c'}$

ACI Eq. 11-33 governs: use $v_c = 4\sqrt{f_c'} = 4\sqrt{4{,}000} = 253$ psi

$\phi v_c = 0.75(253) = 190$ psi

Case 1: For factored shear $V_{int}$ = 300.871 kips and no unbalanced moment

$v_u$ = 300.871/1,656.250 = 0.182 ksi or 182 psi

$\phi v_c$ = 190 psi > $v_u$, Okay

Case 2: For factored shear $V_u$ = 219.510 kips and factored moment $M_{int}$ = 149.972 ft-kips

$\gamma_f = 1/(1 + 2/3\sqrt{b_1/b_2})$ (ACI Eq. 13-1)
$= 1/(1 + 2/3\sqrt{31.25/31.25}) = 0.60$

$\gamma_v = 1 - \gamma_f = 1 - 0.60 = 0.40$

$v_u = V_u/A_c + \gamma_v\,M_{int}\,c_{AB}/J_c$

$v_u$ = 219.510/1,656.250 + 0.40(149.972 × 12) ×
15.625/281,668 = 0.133 + 0.040
= 0.173 ksi or 173 psi

$\phi v_c$ = 190 psi > $v_u$, Okay

## TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 10 | 6 | 3.03 | 103 | 1,700 | 3.82 | 164 | 2,800 | 7.13 | 242 | 8,400 |
| | 7 | 3.16 | 133 | 2,400 | 3.94 | 213 | 4,100 | 7.63 | 320 | 12,800 |
| | 8 | 3.28 | 164 | 3,200 | 4.05 | 266 | 5,600 | 8.13 | 406 | 18,500 |
| | 9 | 3.41 | 198 | 4,300 | 4.17 | 323 | 7,500 | 8.63 | 500 | 25,900 |
| | 10 | 3.53 | 233 | 5,500 | 4.29 | 384 | 9,800 | 9.13 | 602 | 35,100 |
| | 11 | 3.66 | 271 | 7,000 | 4.41 | 449 | 12,500 | 9.63 | 712 | 46,500 |
| | 12 | 3.78 | 310 | 8,700 | 4.53 | 518 | 15,700 | 10.13 | 830 | 60,400 |
| | 13 | 3.91 | 352 | 10,800 | 4.65 | 591 | 19,500 | 10.63 | 956 | 77,000 |
| | 14 | 4.03 | 395 | 13,200 | 4.77 | 668 | 24,000 | 11.13 | 1,090 | 96,800 |
| | 15 | 4.16 | 441 | 15,900 | 4.89 | 749 | 29,100 | 11.63 | 1,232 | 120,000 |
| | 16 | 4.28 | 488 | 19,000 | 5.01 | 834 | 35,000 | 12.13 | 1,382 | 147,200 |
| | 17 | 4.41 | 538 | 22,600 | 5.13 | 923 | 41,800 | 12.63 | 1,540 | 178,600 |
| | 18 | 4.53 | 589 | 26,600 | 5.26 | 1,016 | 49,400 | 13.13 | 1,706 | 214,700 |
| | 19 | 4.66 | 643 | 31,200 | 5.38 | 1,113 | 58,100 | 13.63 | 1,880 | 256,000 |
| | 20 | 4.78 | 698 | 36,300 | 5.50 | 1,214 | 67,800 | 14.13 | 2,062 | 302,900 |
| | 21 | 4.91 | 756 | 42,000 | 5.62 | 1,319 | 78,600 | 14.63 | 2,252 | 355,900 |
| | 22 | 5.03 | 815 | 48,300 | 5.74 | 1,428 | 90,800 | 15.13 | 2,450 | 415,600 |
| | 23 | 5.16 | 877 | 55,300 | 5.87 | 1,541 | 104,200 | 15.63 | 2,656 | 482,300 |
| | 24 | 5.28 | 940 | 63,100 | 5.99 | 1,658 | 119,100 | 16.13 | 2,870 | 556,700 |
| 12 | 6 | 3.53 | 120 | 2,600 | 4.48 | 189 | 4,400 | 8.13 | 276 | 12,400 |
| | 7 | 3.66 | 154 | 3,600 | 4.60 | 244 | 6,100 | 8.63 | 362 | 18,400 |
| | 8 | 3.78 | 189 | 4,800 | 4.72 | 303 | 8,300 | 9.13 | 456 | 26,100 |
| | 9 | 3.91 | 227 | 6,300 | 4.83 | 366 | 10,900 | 9.63 | 558 | 35,700 |
| | 10 | 4.03 | 266 | 8,000 | 4.95 | 433 | 13,900 | 10.13 | 668 | 47,600 |
| | 11 | 4.16 | 308 | 10,000 | 5.07 | 504 | 17,600 | 10.63 | 786 | 62,000 |
| | 12 | 4.28 | 351 | 12,300 | 5.19 | 579 | 21,800 | 11.13 | 912 | 79,300 |
| | 13 | 4.41 | 397 | 14,900 | 5.31 | 658 | 26,700 | 11.63 | 1,046 | 99,800 |
| | 14 | 4.53 | 444 | 18,000 | 5.43 | 741 | 32,300 | 12.13 | 1,188 | 123,900 |
| | 15 | 4.66 | 494 | 21,400 | 5.55 | 828 | 38,800 | 12.63 | 1,338 | 152,000 |
| | 16 | 4.78 | 545 | 25,400 | 5.67 | 919 | 46,100 | 13.13 | 1,496 | 184,500 |
| | 17 | 4.91 | 599 | 29,800 | 5.79 | 1,014 | 54,400 | 13.63 | 1,662 | 221,800 |
| | 18 | 5.03 | 654 | 34,800 | 5.91 | 1,113 | 63,800 | 14.13 | 1,836 | 264,400 |
| | 19 | 5.16 | 712 | 40,400 | 6.03 | 1,216 | 74,300 | 14.63 | 2,018 | 312,800 |
| | 20 | 5.28 | 771 | 46,500 | 6.16 | 1,323 | 86,000 | 15.13 | 2,208 | 367,400 |
| | 21 | 5.41 | 833 | 53,400 | 6.28 | 1,434 | 99,000 | 15.63 | 2,406 | 428,800 |
| | 22 | 5.53 | 896 | 61,000 | 6.40 | 1,549 | 113,400 | 16.13 | 2,612 | 497,400 |
| | 23 | 5.66 | 962 | 69,400 | 6.52 | 1,668 | 129,300 | 16.63 | 2,826 | 573,900 |
| | 24 | 5.78 | 1,029 | 78,600 | 6.64 | 1,791 | 146,800 | 17.13 | 3,048 | 658,800 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 14 | 6 | 4.03 | 137 | 3,800 | 5.15 | 215 | 6,400 | 9.13 | 310 | 17,500 |
| | 7 | 4.16 | 175 | 5,200 | 5.26 | 276 | 8,800 | 9.63 | 404 | 25,400 |
| | 8 | 4.28 | 214 | 6,900 | 5.38 | 341 | 11,800 | 10.13 | 506 | 35,400 |
| | 9 | 4.41 | 256 | 8,800 | 5.50 | 410 | 15,200 | 10.63 | 616 | 47,700 |
| | 10 | 4.53 | 299 | 11,100 | 5.62 | 483 | 19,200 | 11.13 | 734 | 62,700 |
| | 11 | 4.66 | 345 | 13,700 | 5.73 | 560 | 23,900 | 11.63 | 860 | 80,600 |
| | 12 | 4.78 | 392 | 16,700 | 5.85 | 641 | 29,300 | 12.13 | 994 | 101,800 |
| | 13 | 4.91 | 442 | 20,000 | 5.97 | 726 | 35,500 | 12.63 | 1,136 | 126,700 |
| | 14 | 5.03 | 493 | 23,900 | 6.09 | 815 | 42,500 | 13.13 | 1,286 | 155,800 |
| | 15 | 5.16 | 547 | 28,200 | 6.21 | 908 | 50,500 | 13.63 | 1,444 | 189,300 |
| | 16 | 5.28 | 602 | 33,100 | 6.33 | 1,005 | 59,500 | 14.13 | 1,610 | 227,800 |
| | 17 | 5.41 | 660 | 38,500 | 6.45 | 1,106 | 69,600 | 14.63 | 1,784 | 271,700 |
| | 18 | 5.53 | 719 | 44,600 | 6.57 | 1,211 | 80,900 | 15.13 | 1,966 | 321,500 |
| | 19 | 5.66 | 781 | 51,300 | 6.69 | 1,320 | 93,500 | 15.63 | 2,156 | 377,700 |
| | 20 | 5.78 | 844 | 58,700 | 6.81 | 1,433 | 107,400 | 16.13 | 2,354 | 440,800 |
| | 21 | 5.91 | 910 | 66,900 | 6.93 | 1,550 | 122,800 | 16.63 | 2,560 | 511,300 |
| | 22 | 6.03 | 977 | 75,900 | 7.05 | 1,671 | 139,800 | 17.13 | 2,774 | 589,800 |
| | 23 | 6.16 | 1,047 | 85,800 | 7.18 | 1,796 | 158,500 | 17.63 | 2,996 | 676,900 |
| | 24 | 6.28 | 1,118 | 96,600 | 7.30 | 1,925 | 178,900 | 18.13 | 3,226 | 773,100 |
| 16 | 6 | 4.53 | 154 | 5,400 | 5.81 | 240 | 9,000 | 10.13 | 344 | 23,800 |
| | 7 | 4.66 | 196 | 7,300 | 5.93 | 307 | 12,300 | 10.63 | 446 | 34,100 |
| | 8 | 4.78 | 239 | 9,500 | 6.05 | 378 | 16,100 | 11.13 | 556 | 46,800 |
| | 9 | 4.91 | 285 | 12,000 | 6.16 | 453 | 20,600 | 11.63 | 674 | 62,200 |
| | 10 | 5.03 | 332 | 15,000 | 6.28 | 532 | 25,700 | 12.13 | 800 | 80,700 |
| | 11 | 5.16 | 382 | 18,300 | 6.40 | 615 | 31,700 | 12.63 | 934 | 102,600 |
| | 12 | 5.28 | 433 | 22,000 | 6.51 | 702 | 38,400 | 13.13 | 1,076 | 128,300 |
| | 13 | 5.41 | 487 | 26,300 | 6.63 | 793 | 46,100 | 13.63 | 1,226 | 158,200 |
| | 14 | 5.53 | 542 | 31,000 | 6.75 | 888 | 54,700 | 14.13 | 1,384 | 192,800 |
| | 15 | 5.66 | 600 | 36,400 | 6.87 | 987 | 64,500 | 14.63 | 1,550 | 232,400 |
| | 16 | 5.78 | 659 | 42,300 | 6.99 | 1,090 | 75,400 | 15.13 | 1,724 | 277,600 |
| | 17 | 5.91 | 721 | 48,900 | 7.11 | 1,197 | 87,500 | 15.63 | 1,906 | 328,700 |
| | 18 | 6.03 | 784 | 56,200 | 7.23 | 1,308 | 101,000 | 16.13 | 2,096 | 386,400 |
| | 19 | 6.16 | 850 | 64,200 | 7.35 | 1,423 | 115,900 | 16.63 | 2,294 | 451,200 |
| | 20 | 6.28 | 917 | 73,000 | 7.47 | 1,542 | 132,400 | 17.13 | 2,500 | 523,500 |
| | 21 | 6.41 | 987 | 82,700 | 7.59 | 1,665 | 150,400 | 17.63 | 2,714 | 604,000 |
| | 22 | 6.53 | 1,058 | 93,300 | 7.71 | 1,792 | 170,300 | 18.13 | 2,936 | 693,200 |
| | 23 | 6.66 | 1,132 | 104,800 | 7.83 | 1,923 | 192,000 | 18.63 | 3,166 | 791,800 |
| | 24 | 6.78 | 1,207 | 117,400 | 7.95 | 2,058 | 215,600 | 19.13 | 3,404 | 900,300 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

## TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 18 | 6 | 5.03 | 171 | 7,300 | 6.48 | 266 | 12,200 | 11.13 | 378 | 31,500 |
| | 7 | 5.16 | 217 | 9,800 | 6.60 | 339 | 16,500 | 11.63 | 488 | 44,500 |
| | 8 | 5.28 | 264 | 12,700 | 6.71 | 416 | 21,400 | 12.13 | 606 | 60,400 |
| | 9 | 5.41 | 314 | 16,000 | 6.83 | 497 | 27,100 | 12.63 | 732 | 79,400 |
| | 10 | 5.53 | 365 | 19,700 | 6.94 | 582 | 33,600 | 13.13 | 866 | 101,900 |
| | 11 | 5.66 | 419 | 23,800 | 7.06 | 671 | 41,000 | 13.63 | 1,008 | 128,400 |
| | 12 | 5.78 | 474 | 28,500 | 7.18 | 764 | 49,300 | 14.13 | 1,158 | 159,100 |
| | 13 | 5.91 | 532 | 33,700 | 7.30 | 861 | 58,700 | 14.63 | 1,316 | 194,600 |
| | 14 | 6.03 | 591 | 39,500 | 7.41 | 962 | 69,200 | 15.13 | 1,482 | 235,300 |
| | 15 | 6.16 | 653 | 46,000 | 7.53 | 1,067 | 80,900 | 15.63 | 1,656 | 281,700 |
| | 16 | 6.28 | 716 | 53,100 | 7.65 | 1,176 | 94,000 | 16.13 | 1,838 | 334,200 |
| | 17 | 6.41 | 782 | 61,000 | 7.77 | 1,289 | 108,400 | 16.63 | 2,028 | 393,400 |
| | 18 | 6.53 | 849 | 69,700 | 7.89 | 1,406 | 124,300 | 17.13 | 2,226 | 459,700 |
| | 19 | 6.66 | 919 | 79,200 | 8.01 | 1,527 | 141,900 | 17.63 | 2,432 | 533,900 |
| | 20 | 6.78 | 990 | 89,600 | 8.13 | 1,652 | 161,100 | 18.13 | 2,646 | 616,300 |
| | 21 | 6.91 | 1,064 | 101,000 | 8.25 | 1,781 | 182,200 | 18.63 | 2,868 | 707,600 |
| | 22 | 7.03 | 1,139 | 113,300 | 8.37 | 1,914 | 205,200 | 19.13 | 3,098 | 808,400 |
| | 23 | 7.16 | 1,217 | 126,700 | 8.49 | 2,051 | 230,200 | 19.63 | 3,336 | 919,400 |
| | 24 | 7.28 | 1,296 | 141,300 | 8.61 | 2,192 | 257,400 | 20.13 | 3,582 | 1,041,100 |
| 20 | 6 | 5.53 | 188 | 9,700 | 7.15 | 291 | 16,100 | 12.13 | 412 | 40,700 |
| | 7 | 5.66 | 238 | 12,900 | 7.26 | 370 | 21,600 | 12.63 | 530 | 57,000 |
| | 8 | 5.78 | 289 | 16,600 | 7.38 | 453 | 27,800 | 13.13 | 656 | 76,400 |
| | 9 | 5.91 | 343 | 20,700 | 7.49 | 540 | 34,900 | 13.63 | 790 | 99,500 |
| | 10 | 6.03 | 398 | 25,300 | 7.61 | 631 | 43,000 | 14.13 | 932 | 126,600 |
| | 11 | 6.16 | 456 | 30,400 | 7.72 | 726 | 52,000 | 14.63 | 1,082 | 158,200 |
| | 12 | 6.28 | 515 | 36,100 | 7.84 | 825 | 62,100 | 15.13 | 1,240 | 194,600 |
| | 13 | 6.41 | 577 | 42,500 | 7.96 | 928 | 73,500 | 15.63 | 1,406 | 236,300 |
| | 14 | 6.53 | 640 | 49,500 | 8.08 | 1,035 | 86,100 | 16.13 | 1,580 | 283,800 |
| | 15 | 6.66 | 706 | 57,300 | 8.20 | 1,146 | 100,100 | 16.63 | 1,762 | 337,600 |
| | 16 | 6.78 | 773 | 65,800 | 8.31 | 1,261 | 115,500 | 17.13 | 1,952 | 398,200 |
| | 17 | 6.91 | 843 | 75,100 | 8.43 | 1,380 | 132,500 | 17.63 | 2,150 | 466,100 |
| | 18 | 7.03 | 914 | 85,400 | 8.55 | 1,503 | 151,200 | 18.13 | 2,356 | 542,000 |
| | 19 | 7.16 | 988 | 96,500 | 8.67 | 1,630 | 171,700 | 18.63 | 2,570 | 626,300 |
| | 20 | 7.28 | 1,063 | 108,700 | 8.79 | 1,761 | 194,000 | 19.13 | 2,792 | 719,600 |
| | 21 | 7.41 | 1,141 | 121,900 | 8.91 | 1,896 | 218,400 | 19.63 | 3,022 | 822,700 |
| | 22 | 7.53 | 1,220 | 136,200 | 9.03 | 2,035 | 244,800 | 20.13 | 3,260 | 936,000 |
| | 23 | 7.66 | 1,302 | 151,600 | 9.15 | 2,178 | 273,500 | 20.63 | 3,506 | 1,060,300 |
| | 24 | 7.78 | 1,385 | 168,300 | 9.27 | 2,325 | 304,600 | 21.13 | 3,760 | 1,196,300 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 22 | 6 | 6.03 | 205 | 12,600 | 7.81 | 317 | 20,800 | 13.13 | 446 | 51,600 |
| | 7 | 6.16 | 259 | 16,600 | 7.93 | 402 | 27,600 | 13.63 | 572 | 71,500 |
| | 8 | 6.28 | 314 | 21,200 | 8.04 | 491 | 35,400 | 14.13 | 706 | 95,100 |
| | 9 | 6.41 | 372 | 26,200 | 8.16 | 584 | 44,100 | 14.63 | 848 | 122,800 |
| | 10 | 6.53 | 431 | 31,900 | 8.27 | 681 | 53,900 | 15.13 | 998 | 155,100 |
| | 11 | 6.66 | 493 | 38,100 | 8.39 | 782 | 64,900 | 15.63 | 1,156 | 192,300 |
| | 12 | 6.78 | 556 | 45,100 | 8.51 | 887 | 77,100 | 16.13 | 1,322 | 235,000 |
| | 13 | 6.91 | 622 | 52,700 | 8.62 | 996 | 90,600 | 16.63 | 1,496 | 283,600 |
| | 14 | 7.03 | 689 | 61,100 | 8.74 | 1,109 | 105,600 | 17.13 | 1,678 | 338,600 |
| | 15 | 7.16 | 759 | 70,300 | 8.86 | 1,226 | 122,100 | 17.63 | 1,868 | 400,600 |
| | 16 | 7.28 | 830 | 80,400 | 8.98 | 1,347 | 140,200 | 18.13 | 2,066 | 470,000 |
| | 17 | 7.41 | 904 | 91,400 | 9.09 | 1,472 | 160,100 | 18.63 | 2,272 | 547,500 |
| | 18 | 7.53 | 979 | 103,300 | 9.21 | 1,601 | 181,800 | 19.13 | 2,486 | 633,600 |
| | 19 | 7.66 | 1,057 | 116,300 | 9.33 | 1,734 | 205,500 | 19.63 | 2,708 | 728,900 |
| | 20 | 7.78 | 1,136 | 130,400 | 9.45 | 1,871 | 231,300 | 20.13 | 2,938 | 834,100 |
| | 21 | 7.91 | 1,218 | 145,600 | 9.57 | 2,012 | 259,200 | 20.63 | 3,176 | 949,800 |
| | 22 | 8.03 | 1,301 | 162,100 | 9.69 | 2,157 | 289,500 | 21.13 | 3,422 | 1,076,600 |
| | 23 | 8.16 | 1,387 | 179,800 | 9.81 | 2,306 | 322,200 | 21.63 | 3,676 | 1,215,300 |
| | 24 | 8.28 | 1,474 | 198,900 | 9.93 | 2,459 | 357,500 | 22.13 | 3,938 | 1,366,500 |
| 24 | 6 | 6.53 | 222 | 16,000 | 8.48 | 342 | 26,300 | 14.13 | 480 | 64,200 |
| | 7 | 6.66 | 280 | 21,000 | 8.59 | 433 | 34,700 | 14.63 | 614 | 88,300 |
| | 8 | 6.78 | 339 | 26,500 | 8.71 | 528 | 44,200 | 15.13 | 756 | 116,600 |
| | 9 | 6.91 | 401 | 32,700 | 8.82 | 627 | 54,800 | 15.63 | 906 | 149,500 |
| | 10 | 7.03 | 464 | 39,600 | 8.94 | 730 | 66,700 | 16.13 | 1,064 | 187,500 |
| | 11 | 7.16 | 530 | 47,100 | 9.05 | 837 | 79,800 | 16.63 | 1,230 | 231,100 |
| | 12 | 7.28 | 597 | 55,400 | 9.17 | 948 | 94,300 | 17.13 | 1,404 | 280,700 |
| | 13 | 7.41 | 667 | 64,500 | 9.29 | 1,063 | 110,300 | 17.63 | 1,586 | 336,900 |
| | 14 | 7.53 | 738 | 74,400 | 9.40 | 1,182 | 127,900 | 18.13 | 1,776 | 400,100 |
| | 15 | 7.66 | 812 | 85,200 | 9.52 | 1,305 | 147,300 | 18.63 | 1,974 | 471,000 |
| | 16 | 7.78 | 887 | 97,000 | 9.64 | 1,432 | 168,400 | 19.13 | 2,180 | 550,100 |
| | 17 | 7.91 | 965 | 109,800 | 9.76 | 1,563 | 191,400 | 19.63 | 2,394 | 637,900 |
| | 18 | 8.03 | 1,044 | 123,700 | 9.88 | 1,698 | 216,500 | 20.13 | 2,616 | 735,200 |
| | 19 | 8.16 | 1,126 | 138,800 | 9.99 | 1,837 | 243,800 | 20.63 | 2,846 | 842,500 |
| | 20 | 8.28 | 1,209 | 155,000 | 10.11 | 1,980 | 273,300 | 21.13 | 3,084 | 960,400 |
| | 21 | 8.41 | 1,295 | 172,500 | 10.23 | 2,127 | 305,200 | 21.63 | 3,330 | 1,089,700 |
| | 22 | 8.53 | 1,382 | 191,300 | 10.35 | 2,278 | 339,600 | 22.13 | 3,584 | 1,230,900 |
| | 23 | 8.66 | 1,472 | 211,500 | 10.47 | 2,433 | 376,700 | 22.63 | 3,846 | 1,384,900 |
| | 24 | 8.78 | 1,563 | 233,100 | 10.59 | 2,592 | 416,600 | 23.13 | 4,116 | 1,552,400 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

## TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 26 | 6 | 7.03 | 239 | 19,900 | 9.14 | 368 | 32,700 | 15.13 | 514 | 78,800 |
| | 7 | 7.16 | 301 | 26,000 | 9.26 | 465 | 43,000 | 15.63 | 656 | 107,600 |
| | 8 | 7.28 | 364 | 32,800 | 9.37 | 566 | 54,400 | 16.13 | 806 | 141,100 |
| | 9 | 7.41 | 430 | 40,200 | 9.49 | 671 | 67,200 | 16.63 | 964 | 179,800 |
| | 10 | 7.53 | 497 | 48,400 | 9.60 | 780 | 81,300 | 17.13 | 1,130 | 224,200 |
| | 11 | 7.66 | 567 | 57,400 | 9.72 | 893 | 96,800 | 17.63 | 1,304 | 274,800 |
| | 12 | 7.78 | 638 | 67,200 | 9.84 | 1,010 | 114,000 | 18.13 | 1,486 | 332,000 |
| | 13 | 7.91 | 712 | 77,900 | 9.95 | 1,131 | 132,800 | 18.63 | 1,676 | 396,500 |
| | 14 | 8.03 | 787 | 89,500 | 10.07 | 1,256 | 153,300 | 19.13 | 1,874 | 468,700 |
| | 15 | 8.16 | 865 | 102,200 | 10.19 | 1,385 | 175,700 | 19.63 | 2,080 | 549,300 |
| | 16 | 8.28 | 944 | 115,900 | 10.30 | 1,518 | 200,200 | 20.13 | 2,294 | 638,900 |
| | 17 | 8.41 | 1,026 | 130,700 | 10.42 | 1,655 | 226,700 | 20.63 | 2,516 | 738,000 |
| | 18 | 8.53 | 1,109 | 146,700 | 10.54 | 1,796 | 255,500 | 21.13 | 2,746 | 847,300 |
| | 19 | 8.66 | 1,195 | 164,000 | 10.66 | 1,941 | 286,600 | 21.63 | 2,984 | 967,400 |
| | 20 | 8.78 | 1,282 | 182,600 | 10.78 | 2,090 | 320,200 | 22.13 | 3,230 | 1,099,000 |
| | 21 | 8.91 | 1,372 | 202,500 | 10.89 | 2,243 | 356,400 | 22.63 | 3,484 | 1,242,800 |
| | 22 | 9.03 | 1,463 | 223,900 | 11.01 | 2,400 | 395,400 | 23.13 | 3,746 | 1,399,600 |
| | 23 | 9.16 | 1,557 | 246,800 | 11.13 | 2,561 | 437,300 | 23.63 | 4,016 | 1,570,000 |
| | 24 | 9.28 | 1,652 | 271,300 | 11.25 | 2,726 | 482,100 | 24.13 | 4,294 | 1,754,800 |
| 28 | 6 | 7.53 | 256 | 24,400 | 9.81 | 393 | 40,000 | 16.13 | 548 | 95,400 |
| | 7 | 7.66 | 322 | 31,800 | 9.92 | 496 | 52,400 | 16.63 | 698 | 129,500 |
| | 8 | 7.78 | 389 | 39,900 | 10.04 | 603 | 66,100 | 17.13 | 856 | 168,800 |
| | 9 | 7.91 | 459 | 48,800 | 10.15 | 714 | 81,300 | 17.63 | 1,022 | 213,900 |
| | 10 | 8.03 | 530 | 58,500 | 10.27 | 829 | 97,900 | 18.13 | 1,196 | 265,400 |
| | 11 | 8.16 | 604 | 69,100 | 10.38 | 948 | 116,200 | 18.63 | 1,378 | 323,600 |
| | 12 | 8.28 | 679 | 80,600 | 10.50 | 1,071 | 136,200 | 19.13 | 1,568 | 389,300 |
| | 13 | 8.41 | 757 | 93,100 | 10.62 | 1,198 | 158,100 | 19.63 | 1,766 | 462,800 |
| | 14 | 8.53 | 836 | 106,600 | 10.73 | 1,329 | 181,900 | 20.13 | 1,972 | 544,900 |
| | 15 | 8.66 | 918 | 121,300 | 10.85 | 1,464 | 207,800 | 20.63 | 2,186 | 636,000 |
| | 16 | 8.78 | 1,001 | 137,100 | 10.97 | 1,603 | 235,800 | 21.13 | 2,408 | 736,900 |
| | 17 | 8.91 | 1,087 | 154,200 | 11.08 | 1,746 | 266,200 | 21.63 | 2,638 | 848,100 |
| | 18 | 9.03 | 1,174 | 172,500 | 11.20 | 1,893 | 299,000 | 22.13 | 2,876 | 970,300 |
| | 19 | 9.16 | 1,264 | 192,200 | 11.32 | 2,044 | 334,400 | 22.63 | 3,122 | 1,104,200 |
| | 20 | 9.28 | 1,355 | 213,400 | 11.44 | 2,199 | 372,500 | 23.13 | 3,376 | 1,250,500 |
| | 21 | 9.41 | 1,449 | 236,000 | 11.56 | 2,358 | 413,400 | 23.63 | 3,638 | 1,409,900 |
| | 22 | 9.53 | 1,544 | 260,200 | 11.67 | 2,521 | 457,200 | 24.13 | 3,908 | 1,583,200 |
| | 23 | 9.66 | 1,642 | 286,000 | 11.79 | 2,688 | 504,200 | 24.63 | 4,186 | 1,771,100 |
| | 24 | 9.78 | 1,741 | 313,500 | 11.91 | 2,859 | 554,500 | 25.13 | 4,472 | 1,974,400 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 30 | 6 | 8.03 | 273 | 29,600 | 10.48 | 419 | 48,400 | 17.13 | 582 | 114,300 |
| | 7 | 8.16 | 343 | 38,400 | 10.59 | 528 | 63,100 | 17.63 | 740 | 154,200 |
| | 8 | 8.28 | 414 | 48,000 | 10.71 | 641 | 79,400 | 18.13 | 906 | 200,000 |
| | 9 | 8.41 | 488 | 58,500 | 10.82 | 758 | 97,200 | 18.63 | 1,080 | 252,200 |
| | 10 | 8.53 | 563 | 69,900 | 10.93 | 879 | 116,700 | 19.13 | 1,262 | 311,400 |
| | 11 | 8.66 | 641 | 82,300 | 11.05 | 1,004 | 138,000 | 19.63 | 1,452 | 378,100 |
| | 12 | 8.78 | 720 | 95,700 | 11.17 | 1,133 | 161,200 | 20.13 | 1,650 | 452,800 |
| | 13 | 8.91 | 802 | 110,200 | 11.28 | 1,266 | 186,500 | 20.63 | 1,856 | 536,200 |
| | 14 | 9.03 | 885 | 125,800 | 11.40 | 1,403 | 213,900 | 21.13 | 2,070 | 628,900 |
| | 15 | 9.16 | 971 | 142,700 | 11.51 | 1,544 | 243,500 | 21.63 | 2,292 | 731,400 |
| | 16 | 9.28 | 1,058 | 160,900 | 11.63 | 1,689 | 275,600 | 22.13 | 2,522 | 844,500 |
| | 17 | 9.41 | 1,148 | 180,300 | 11.75 | 1,838 | 310,100 | 22.63 | 2,760 | 968,700 |
| | 18 | 9.53 | 1,239 | 201,200 | 11.87 | 1,991 | 347,300 | 23.13 | 3,006 | 1,104,800 |
| | 19 | 9.66 | 1,333 | 223,600 | 11.98 | 2,148 | 387,300 | 23.63 | 3,260 | 1,253,500 |
| | 20 | 9.78 | 1,428 | 247,500 | 12.10 | 2,309 | 430,300 | 24.13 | 3,522 | 1,415,600 |
| | 21 | 9.91 | 1,526 | 273,100 | 12.22 | 2,474 | 476,200 | 24.63 | 3,792 | 1,591,600 |
| | 22 | 10.03 | 1,625 | 300,300 | 12.34 | 2,643 | 525,400 | 25.13 | 4,070 | 1,782,500 |
| | 23 | 10.16 | 1,727 | 329,300 | 12.46 | 2,816 | 578,000 | 25.63 | 4,356 | 1,989,000 |
| | 24 | 10.28 | 1,830 | 360,200 | 12.57 | 2,993 | 634,000 | 26.13 | 4,650 | 2,211,800 |
| 32 | 6 | 8.53 | 290 | 35,400 | 11.14 | 444 | 57,900 | 18.13 | 616 | 135,400 |
| | 7 | 8.66 | 364 | 45,800 | 11.26 | 559 | 75,300 | 18.63 | 782 | 181,800 |
| | 8 | 8.78 | 439 | 57,100 | 11.37 | 678 | 94,300 | 19.13 | 956 | 234,700 |
| | 9 | 8.91 | 517 | 69,400 | 11.49 | 801 | 115,100 | 19.63 | 1,138 | 294,800 |
| | 10 | 9.03 | 596 | 82,700 | 11.60 | 928 | 137,800 | 20.13 | 1,328 | 362,400 |
| | 11 | 9.16 | 678 | 97,100 | 11.72 | 1,059 | 162,400 | 20.63 | 1,526 | 438,300 |
| | 12 | 9.28 | 761 | 112,600 | 11.83 | 1,194 | 189,200 | 21.13 | 1,732 | 522,900 |
| | 13 | 9.41 | 847 | 129,300 | 11.95 | 1,333 | 218,100 | 21.63 | 1,946 | 617,000 |
| | 14 | 9.53 | 934 | 147,300 | 12.06 | 1,476 | 249,500 | 22.13 | 2,168 | 721,200 |
| | 15 | 9.66 | 1,024 | 166,600 | 12.18 | 1,623 | 283,200 | 22.63 | 2,398 | 836,000 |
| | 16 | 9.78 | 1,115 | 187,200 | 12.30 | 1,774 | 319,600 | 23.13 | 2,636 | 962,200 |
| | 17 | 9.91 | 1,209 | 209,400 | 12.41 | 1,929 | 358,800 | 23.63 | 2,882 | 1,100,400 |
| | 18 | 10.03 | 1,304 | 233,100 | 12.53 | 2,088 | 400,700 | 24.13 | 3,136 | 1,251,400 |
| | 19 | 10.16 | 1,402 | 258,300 | 12.65 | 2,251 | 445,800 | 24.63 | 3,398 | 1,415,900 |
| | 20 | 10.28 | 1,501 | 285,300 | 12.76 | 2,418 | 493,900 | 25.13 | 3,668 | 1,594,700 |
| | 21 | 10.41 | 1,603 | 314,000 | 12.88 | 2,589 | 545,400 | 25.63 | 3,946 | 1,788,400 |
| | 22 | 10.53 | 1,706 | 344,500 | 13.00 | 2,764 | 600,300 | 26.13 | 4,232 | 1,998,000 |
| | 23 | 10.66 | 1,812 | 376,900 | 13.12 | 2,943 | 658,800 | 26.63 | 4,526 | 2,224,200 |
| | 24 | 10.78 | 1,919 | 411,400 | 13.24 | 3,126 | 721,100 | 27.13 | 4,828 | 2,467,900 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

## TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 34 | 6 | 9.03 | 307 | 42,000 | 11.81 | 470 | 68,500 | 19.13 | 650 | 159,000 |
| | 7 | 9.16 | 385 | 54,200 | 11.92 | 591 | 88,900 | 19.63 | 824 | 212,600 |
| | 8 | 9.28 | 464 | 67,400 | 12.04 | 716 | 111,000 | 20.13 | 1,006 | 273,300 |
| | 9 | 9.41 | 546 | 81,600 | 12.15 | 845 | 135,100 | 20.63 | 1,196 | 341,900 |
| | 10 | 9.53 | 629 | 97,000 | 12.27 | 978 | 161,300 | 21.13 | 1,394 | 418,800 |
| | 11 | 9.66 | 715 | 113,600 | 12.38 | 1,115 | 189,600 | 21.63 | 1,600 | 504,600 |
| | 12 | 9.78 | 802 | 131,400 | 12.50 | 1,256 | 220,200 | 22.13 | 1,814 | 600,000 |
| | 13 | 9.91 | 892 | 150,500 | 12.61 | 1,401 | 253,300 | 22.63 | 2,036 | 705,600 |
| | 14 | 10.03 | 983 | 171,000 | 12.73 | 1,550 | 288,900 | 23.13 | 2,266 | 822,100 |
| | 15 | 10.16 | 1,077 | 193,000 | 12.84 | 1,703 | 327,100 | 23.63 | 2,504 | 950,100 |
| | 16 | 10.28 | 1,172 | 216,400 | 12.96 | 1,860 | 368,200 | 24.13 | 2,750 | 1,090,400 |
| | 17 | 10.41 | 1,270 | 241,400 | 13.08 | 2,021 | 412,300 | 24.63 | 3,004 | 1,243,600 |
| | 18 | 10.53 | 1,369 | 268,100 | 13.19 | 2,186 | 459,500 | 25.13 | 3,266 | 1,410,500 |
| | 19 | 10.66 | 1,471 | 296,600 | 13.31 | 2,355 | 509,900 | 25.63 | 3,536 | 1,591,900 |
| | 20 | 10.78 | 1,574 | 326,800 | 13.43 | 2,528 | 563,700 | 26.13 | 3,814 | 1,788,500 |
| | 21 | 10.91 | 1,680 | 358,900 | 13.55 | 2,705 | 621,100 | 26.63 | 4,100 | 2,001,100 |
| | 22 | 11.03 | 1,787 | 393,000 | 13.66 | 2,886 | 682,200 | 27.13 | 4,394 | 2,230,500 |
| | 23 | 11.16 | 1,897 | 429,100 | 13.78 | 3,071 | 747,100 | 27.63 | 4,696 | 2,477,600 |
| | 24 | 11.28 | 2,008 | 467,400 | 13.90 | 3,260 | 816,100 | 28.13 | 5,006 | 2,743,300 |
| 36 | 6 | 9.53 | 324 | 49,300 | 12.48 | 495 | 80,400 | 20.13 | 684 | 185,300 |
| | 7 | 9.66 | 406 | 63,500 | 12.59 | 622 | 104,000 | 20.63 | 866 | 246,700 |
| | 8 | 9.78 | 489 | 78,800 | 12.70 | 753 | 129,600 | 21.13 | 1,056 | 316,000 |
| | 9 | 9.91 | 575 | 95,200 | 12.82 | 888 | 157,300 | 21.63 | 1,254 | 393,800 |
| | 10 | 10.03 | 662 | 112,900 | 12.93 | 1,027 | 187,300 | 22.13 | 1,460 | 480,700 |
| | 11 | 10.16 | 752 | 131,900 | 13.05 | 1,170 | 219,600 | 22.63 | 1,674 | 577,300 |
| | 12 | 10.28 | 843 | 152,200 | 13.16 | 1,317 | 254,500 | 23.13 | 1,896 | 684,300 |
| | 13 | 10.41 | 937 | 174,000 | 13.28 | 1,468 | 292,000 | 23.63 | 2,126 | 802,400 |
| | 14 | 10.53 | 1,032 | 197,200 | 13.39 | 1,623 | 332,300 | 24.13 | 2,364 | 932,100 |
| | 15 | 10.66 | 1,130 | 222,000 | 13.51 | 1,782 | 375,400 | 24.63 | 2,610 | 1,074,300 |
| | 16 | 10.78 | 1,229 | 248,500 | 13.62 | 1,945 | 421,600 | 25.13 | 2,864 | 1,229,600 |
| | 17 | 10.91 | 1,331 | 276,700 | 13.74 | 2,112 | 471,100 | 25.63 | 3,126 | 1,398,800 |
| | 18 | 11.03 | 1,434 | 306,600 | 13.86 | 2,283 | 523,800 | 26.13 | 3,396 | 1,582,700 |
| | 19 | 11.16 | 1,540 | 338,400 | 13.97 | 2,458 | 580,100 | 26.63 | 3,674 | 1,782,000 |
| | 20 | 11.28 | 1,647 | 372,200 | 14.09 | 2,637 | 640,000 | 27.13 | 3,960 | 1,997,500 |
| | 21 | 11.41 | 1,757 | 408,000 | 14.21 | 2,820 | 703,700 | 27.63 | 4,254 | 2,230,100 |
| | 22 | 11.53 | 1,868 | 445,900 | 14.33 | 3,007 | 771,400 | 28.13 | 4,556 | 2,480,600 |
| | 23 | 11.66 | 1,982 | 486,000 | 14.44 | 3,198 | 843,200 | 28.63 | 4,866 | 2,749,800 |
| | 24 | 11.78 | 2,097 | 528,400 | 14.56 | 3,393 | 919,300 | 29.13 | 5,184 | 3,038,700 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 38 | 6 | 10.03 | 341 | 57,500 | 13.14 | 521 | 93,600 | 21.13 | 718 | 214,200 |
| | 7 | 10.16 | 427 | 73,800 | 13.26 | 654 | 120,800 | 21.63 | 908 | 284,200 |
| | 8 | 10.28 | 514 | 91,400 | 13.37 | 791 | 150,200 | 22.13 | 1,106 | 362,800 |
| | 9 | 10.41 | 604 | 110,300 | 13.48 | 932 | 181,900 | 22.63 | 1,312 | 450,700 |
| | 10 | 10.53 | 695 | 130,500 | 13.60 | 1,077 | 216,000 | 23.13 | 1,526 | 548,500 |
| | 11 | 10.66 | 789 | 152,100 | 13.71 | 1,226 | 252,700 | 23.63 | 1,748 | 656,700 |
| | 12 | 10.78 | 884 | 175,100 | 13.83 | 1,379 | 292,200 | 24.13 | 1,978 | 776,200 |
| | 13 | 10.91 | 982 | 199,800 | 13.94 | 1,536 | 334,500 | 24.63 | 2,216 | 907,600 |
| | 14 | 11.03 | 1,081 | 226,000 | 14.06 | 1,697 | 379,800 | 25.13 | 2,462 | 1,051,600 |
| | 15 | 11.16 | 1,183 | 254,000 | 14.17 | 1,862 | 428,300 | 25.63 | 2,716 | 1,208,900 |
| | 16 | 11.28 | 1,286 | 283,700 | 14.29 | 2,031 | 480,000 | 26.13 | 2,978 | 1,380,300 |
| | 17 | 11.41 | 1,392 | 315,200 | 14.41 | 2,204 | 535,200 | 26.63 | 3,248 | 1,566,600 |
| | 18 | 11.53 | 1,499 | 348,700 | 14.52 | 2,381 | 594,000 | 27.13 | 3,526 | 1,768,500 |
| | 19 | 11.66 | 1,609 | 384,200 | 14.64 | 2,562 | 656,500 | 27.63 | 3,812 | 1,986,800 |
| | 20 | 11.78 | 1,720 | 421,800 | 14.76 | 2,747 | 723,000 | 28.13 | 4,106 | 2,222,400 |
| | 21 | 11.91 | 1,834 | 461,500 | 14.87 | 2,936 | 793,500 | 28.63 | 4,408 | 2,476,100 |
| | 22 | 12.03 | 1,949 | 503,500 | 14.99 | 3,129 | 868,300 | 29.13 | 4,718 | 2,748,800 |
| | 23 | 12.16 | 2,067 | 547,900 | 15.11 | 3,326 | 947,400 | 29.63 | 5,036 | 3,041,400 |
| | 24 | 12.28 | 2,186 | 594,600 | 15.23 | 3,527 | 1,031,200 | 30.13 | 5,362 | 3,354,800 |
| 40 | 6 | 10.53 | 358 | 66,500 | 13.81 | 546 | 108,200 | 22.13 | 752 | 246,100 |
| | 7 | 10.66 | 448 | 85,200 | 13.92 | 685 | 139,300 | 22.63 | 950 | 325,400 |
| | 8 | 10.78 | 539 | 105,300 | 14.04 | 828 | 172,800 | 23.13 | 1,156 | 414,100 |
| | 9 | 10.91 | 633 | 126,800 | 14.15 | 975 | 208,800 | 23.63 | 1,370 | 512,900 |
| | 10 | 11.03 | 728 | 149,700 | 14.26 | 1,126 | 247,500 | 24.13 | 1,592 | 622,300 |
| | 11 | 11.16 | 826 | 174,200 | 14.38 | 1,281 | 289,000 | 24.63 | 1,822 | 743,200 |
| | 12 | 11.28 | 925 | 200,300 | 14.49 | 1,440 | 333,500 | 25.13 | 2,060 | 876,100 |
| | 13 | 11.41 | 1,027 | 228,000 | 14.61 | 1,603 | 381,000 | 25.63 | 2,306 | 1,021,700 |
| | 14 | 11.53 | 1,130 | 257,500 | 14.72 | 1,770 | 431,800 | 26.13 | 2,560 | 1,180,900 |
| | 15 | 11.66 | 1,236 | 288,800 | 14.84 | 1,941 | 486,000 | 26.63 | 2,822 | 1,354,400 |
| | 16 | 11.78 | 1,343 | 322,100 | 14.95 | 2,116 | 543,700 | 27.13 | 3,092 | 1,542,900 |
| | 17 | 11.91 | 1,453 | 357,300 | 15.07 | 2,295 | 605,100 | 27.63 | 3,370 | 1,747,300 |
| | 18 | 12.03 | 1,564 | 394,500 | 15.19 | 2,478 | 670,300 | 28.13 | 3,656 | 1,968,300 |
| | 19 | 12.16 | 1,678 | 434,000 | 15.30 | 2,665 | 739,600 | 28.63 | 3,950 | 2,206,800 |
| | 20 | 12.28 | 1,793 | 475,600 | 15.42 | 2,856 | 813,000 | 29.13 | 4,252 | 2,463,700 |
| | 21 | 12.41 | 1,911 | 519,600 | 15.54 | 3,051 | 890,800 | 29.63 | 4,562 | 2,739,800 |
| | 22 | 12.53 | 2,030 | 566,000 | 15.65 | 3,250 | 973,100 | 30.13 | 4,880 | 3,036,000 |
| | 23 | 12.66 | 2,152 | 614,900 | 15.77 | 3,453 | 1,060,100 | 30.63 | 5,206 | 3,353,200 |
| | 24 | 12.78 | 2,275 | 666,400 | 15.89 | 3,660 | 1,152,000 | 31.13 | 5,540 | 3,692,400 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

## TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS

| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 42 | 6 | 11.03 | 375 | 76,400 | 14.48 | 572 | 124,200 | 23.13 | 786 | 280,900 |
| | 7 | 11.16 | 469 | 97,700 | 14.59 | 717 | 159,600 | 23.63 | 992 | 370,300 |
| | 8 | 11.28 | 564 | 120,600 | 14.70 | 866 | 197,600 | 24.13 | 1,206 | 470,000 |
| | 9 | 11.41 | 662 | 144,900 | 14.82 | 1,019 | 238,300 | 24.63 | 1,428 | 580,500 |
| | 10 | 11.53 | 761 | 170,800 | 14.93 | 1,176 | 282,000 | 25.13 | 1,658 | 702,600 |
| | 11 | 11.66 | 863 | 198,400 | 15.04 | 1,337 | 328,700 | 25.63 | 1,896 | 836,900 |
| | 12 | 11.78 | 966 | 227,700 | 15.16 | 1,502 | 378,500 | 26.13 | 2,142 | 984,100 |
| | 13 | 11.91 | 1,072 | 258,800 | 15.27 | 1,671 | 431,700 | 26.63 | 2,396 | 1,145,100 |
| | 14 | 12.03 | 1,179 | 291,800 | 15.39 | 1,844 | 488,400 | 27.13 | 2,658 | 1,320,500 |
| | 15 | 12.16 | 1,289 | 326,800 | 15.50 | 2,021 | 548,700 | 27.63 | 2,928 | 1,511,200 |
| | 16 | 12.28 | 1,400 | 363,800 | 15.62 | 2,202 | 612,800 | 28.13 | 3,206 | 1,717,900 |
| | 17 | 12.41 | 1,514 | 402,900 | 15.74 | 2,387 | 680,800 | 28.63 | 3,492 | 1,941,500 |
| | 18 | 12.53 | 1,629 | 444,300 | 15.85 | 2,576 | 753,000 | 29.13 | 3,786 | 2,182,800 |
| | 19 | 12.66 | 1,747 | 487,900 | 15.97 | 2,769 | 829,400 | 29.63 | 4,088 | 2,442,700 |
| | 20 | 12.78 | 1,866 | 534,000 | 16.08 | 2,966 | 910,300 | 30.13 | 4,398 | 2,722,000 |
| | 21 | 12.91 | 1,988 | 582,500 | 16.20 | 3,167 | 995,900 | 30.63 | 4,716 | 3,021,700 |
| | 22 | 13.03 | 2,111 | 633,500 | 16.32 | 3,372 | 1,086,200 | 31.13 | 5,042 | 3,342,700 |
| | 23 | 13.16 | 2,237 | 687,300 | 16.44 | 3,581 | 1,181,600 | 31.63 | 5,376 | 3,685,800 |
| | 24 | 13.28 | 2,364 | 743,800 | 16.55 | 3,794 | 1,282,100 | 32.13 | 5,718 | 4,052,200 |
| 44 | 6 | 11.53 | 392 | 87,200 | 15.14 | 597 | 141,700 | 24.13 | 820 | 318,900 |
| | 7 | 11.66 | 490 | 111,400 | 15.26 | 748 | 181,800 | 24.63 | 1,034 | 419,300 |
| | 8 | 11.78 | 589 | 137,200 | 15.37 | 903 | 224,700 | 25.13 | 1,256 | 530,700 |
| | 9 | 11.91 | 691 | 164,700 | 15.48 | 1,062 | 270,500 | 25.63 | 1,486 | 653,900 |
| | 10 | 12.03 | 794 | 193,800 | 15.60 | 1,225 | 319,500 | 26.13 | 1,724 | 789,400 |
| | 11 | 12.16 | 900 | 224,800 | 15.71 | 1,392 | 371,800 | 26.63 | 1,970 | 938,200 |
| | 12 | 12.28 | 1,007 | 257,600 | 15.82 | 1,563 | 427,500 | 27.13 | 2,224 | 1,100,800 |
| | 13 | 12.41 | 1,117 | 292,300 | 15.94 | 1,738 | 486,700 | 27.63 | 2,486 | 1,278,000 |
| | 14 | 12.53 | 1,228 | 329,100 | 16.05 | 1,917 | 549,700 | 28.13 | 2,756 | 1,470,700 |
| | 15 | 12.66 | 1,342 | 368,000 | 16.17 | 2,100 | 616,600 | 28.63 | 3,034 | 1,679,700 |
| | 16 | 12.78 | 1,457 | 409,000 | 16.29 | 2,287 | 687,600 | 29.13 | 3,320 | 1,905,700 |
| | 17 | 12.91 | 1,575 | 452,400 | 16.40 | 2,478 | 762,700 | 29.63 | 3,614 | 2,149,700 |
| | 18 | 13.03 | 1,694 | 498,100 | 16.52 | 2,673 | 842,300 | 30.13 | 3,916 | 2,412,500 |
| | 19 | 13.16 | 1,816 | 546,300 | 16.63 | 2,872 | 926,400 | 30.63 | 4,226 | 2,694,900 |
| | 20 | 13.28 | 1,939 | 597,000 | 16.75 | 3,075 | 1,015,300 | 31.13 | 4,544 | 2,997,900 |
| | 21 | 13.41 | 2,065 | 650,300 | 16.87 | 3,282 | 1,109,100 | 31.63 | 4,870 | 3,322,500 |
| | 22 | 13.53 | 2,192 | 706,400 | 16.98 | 3,493 | 1,208,000 | 32.13 | 5,204 | 3,669,500 |
| | 23 | 13.66 | 2,322 | 765,300 | 17.10 | 3,708 | 1,312,200 | 32.63 | 5,546 | 4,039,900 |
| | 24 | 13.78 | 2,453 | 827,100 | 17.22 | 3,927 | 1,421,900 | 33.13 | 5,896 | 4,434,800 |

*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.


## TABLE 11-5 PERIPHERAL SHEAR CONSTANTS AT COLUMNS


| | | Corner Column | | | Edge Column | | | Interior Column | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Square Column (in.) | Slab or Drop* (in.) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) | $c_{AB} = y_t$ (in.) | $A_c = b_o d$ (in.$^2$) | $J_c$ (in.$^4$) |
| 46 | 6 | 12.03 | 409 | 99,000 | 15.81 | 623 | 160,800 | 25.13 | 854 | 360,100 |
| | 7 | 12.16 | 511 | 126,300 | 15.92 | 780 | 205,900 | 25.63 | 1,076 | 472,400 |
| | 8 | 12.28 | 614 | 155,400 | 16.03 | 941 | 254,100 | 26.13 | 1,306 | 596,500 |
| | 9 | 12.41 | 720 | 186,200 | 16.15 | 1,106 | 305,500 | 26.63 | 1,544 | 733,200 |
| | 10 | 12.53 | 827 | 218,800 | 16.26 | 1,275 | 360,300 | 27.13 | 1,790 | 883,200 |
| | 11 | 12.66 | 937 | 253,400 | 16.38 | 1,448 | 418,600 | 27.63 | 2,044 | 1,047,300 |
| | 12 | 12.78 | 1,048 | 289,900 | 16.49 | 1,625 | 480,500 | 28.13 | 2,306 | 1,226,300 |
| | 13 | 12.91 | 1,162 | 328,600 | 16.61 | 1,806 | 546,300 | 28.63 | 2,576 | 1,420,900 |
| | 14 | 13.03 | 1,277 | 369,400 | 16.72 | 1,991 | 616,100 | 29.13 | 2,854 | 1,632,000 |
| | 15 | 13.16 | 1,395 | 412,500 | 16.84 | 2,180 | 690,000 | 29.63 | 3,140 | 1,860,300 |
| | 16 | 13.28 | 1,514 | 457,900 | 16.95 | 2,373 | 768,300 | 30.13 | 3,434 | 2,106,800 |
| | 17 | 13.41 | 1,636 | 505,800 | 17.07 | 2,570 | 851,100 | 30.63 | 3,736 | 2,372,300 |
| | 18 | 13.53 | 1,759 | 556,100 | 17.18 | 2,771 | 938,500 | 31.13 | 4,046 | 2,657,800 |
| | 19 | 13.66 | 1,885 | 609,100 | 17.30 | 2,976 | 1,030,800 | 31.63 | 4,364 | 2,964,000 |
| | 20 | 13.78 | 2,012 | 664,800 | 17.41 | 3,185 | 1,128,200 | 32.13 | 4,690 | 3,292,000 |
| | 21 | 13.91 | 2,142 | 723,300 | 17.53 | 3,398 | 1,230,700 | 32.63 | 5,024 | 3,642,800 |
| | 22 | 14.03 | 2,273 | 784,700 | 17.65 | 3,615 | 1,338,700 | 33.13 | 5,366 | 4,017,200 |
| | 23 | 14.16 | 2,407 | 849,100 | 17.76 | 3,836 | 1,452,300 | 33.63 | 5,716 | 4,416,200 |
| | 24 | 14.28 | 2,542 | 916,500 | 17.88 | 4,061 | 1,571,700 | 34.13 | 6,074 | 4,841,000 |
| 48 | 6 | 12.53 | 426 | 111,800 | 16.48 | 648 | 181,500 | 26.13 | 888 | 404,800 |
| | 7 | 12.66 | 532 | 142,500 | 16.59 | 811 | 232,100 | 26.63 | 1,118 | 529,800 |
| | 8 | 12.78 | 639 | 175,000 | 16.70 | 978 | 286,000 | 27.13 | 1,356 | 667,500 |
| | 9 | 12.91 | 749 | 209,500 | 16.81 | 1,149 | 343,400 | 27.63 | 1,602 | 818,700 |
| | 10 | 13.03 | 860 | 245,900 | 16.93 | 1,324 | 404,400 | 28.13 | 1,856 | 984,100 |
| | 11 | 13.16 | 974 | 284,300 | 17.04 | 1,503 | 469,100 | 28.63 | 2,118 | 1,164,700 |
| | 12 | 13.28 | 1,089 | 324,900 | 17.16 | 1,686 | 537,800 | 29.13 | 2,388 | 1,361,000 |
| | 13 | 13.41 | 1,207 | 367,800 | 17.27 | 1,873 | 610,500 | 29.63 | 2,666 | 1,574,100 |
| | 14 | 13.53 | 1,326 | 412,900 | 17.39 | 2,064 | 687,600 | 30.13 | 2,952 | 1,804,600 |
| | 15 | 13.66 | 1,448 | 460,500 | 17.50 | 2,259 | 769,000 | 30.63 | 3,246 | 2,053,500 |
| | 16 | 13.78 | 1,571 | 510,600 | 17.62 | 2,458 | 855,100 | 31.13 | 3,548 | 2,321,600 |
| | 17 | 13.91 | 1,697 | 563,300 | 17.73 | 2,661 | 946,000 | 31.63 | 3,858 | 2,609,900 |
| | 18 | 14.03 | 1,824 | 618,600 | 17.85 | 2,868 | 1,041,900 | 32.13 | 4,176 | 2,919,300 |
| | 19 | 14.16 | 1,954 | 676,700 | 17.96 | 3,079 | 1,142,900 | 32.63 | 4,502 | 3,250,600 |
| | 20 | 14.28 | 2,085 | 737,700 | 18.08 | 3,294 | 1,249,200 | 33.13 | 4,836 | 3,604,900 |
| | 21 | 14.41 | 2,219 | 801,700 | 18.20 | 3,513 | 1,361,100 | 33.63 | 5,178 | 3,983,100 |
| | 22 | 14.53 | 2,354 | 868,700 | 18.31 | 3,736 | 1,478,700 | 34.13 | 5,528 | 4,386,300 |
| | 23 | 14.66 | 2,492 | 938,900 | 18.43 | 3,963 | 1,602,300 | 34.63 | 5,886 | 4,815,400 |
| | 24 | 14.78 | 2,631 | 1,012,400 | 18.55 | 4,194 | 1,731,900 | 35.13 | 6,252 | 5,271,500 |


*Slab, drop panel, or solid head (for waffle slabs) at the column.
Note: Effective depth equals total depth minus 1.75 inches.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 11 in. | Rib Depth = 8 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | |
| 14'-0" | 50 | 2.05 | 12 | 0.629 | | 6-#5+ 0 | 4 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 7-#5 | 11 | 23 | 31 |
| D = 6.417 | 100 | 2.05 | 12 | 0.629 | | 6-#5+ 0 | 4 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 7-#5 | 15 | 33 | 41 |
| RIB NOT ON | 150 | 2.05 | 12 | 0.629 | | 6-#5+ 0 | 4 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 7-#5 | 19 | 45 | 52 |
| COLUMN LINE | 200 | 2.05 | 12 | 0.629 | | 6-#5+ 0 | 4 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 7-#5 | 23 | 57 | 62 |
| 0.599 CF/SF | 300 | 2.05 | 12 | 0.629 | | 6-#5+ 0 | 4 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 7-#5 | 31 | 81 | 83 |
| | 400 | 2.05 | 12 | 0.679 | | 6-#5+ 0 | 4 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 7-#5 | 38 | 104 | 103 |
| 16'-0" | 50 | 2.07 | 12 | 0.629 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 4 | #4 | #4 | 8-#5 | 17 | 35 | 47 |
| D = 6.417 | 100 | 2.07 | 12 | 0.629 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 4 | #4 | #4 | 8-#5 | 23 | 49 | 62 |
| RIB NOT ON | 150 | 2.07 | 12 | 0.629 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 4 | #4 | #4 | 8-#5 | 29 | 68 | 78 |
| COLUMN LINE | 200 | 2.07 | 12 | 0.661 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 4 | #4 | #4 | 8-#5 | 35 | 86 | 94 |
| 0.582 CF/SF | 300 | 2.16 | 12 | 0.736 | | 7-#5+ 0 | 4 | #4 | #5 | 7-#5 | 4 | #4 | #4 | 8-#5 | 47 | 122 | 125 |
| | 400 | 2.29 | 12 * | 0.811 | | 7-#5+ 0 | 4 | #5 | #5 | 6-#6 | 4 | #4 | #4 | 8-#5 | 58 | 157 | 157 |
| 18'-0" | 50 | 2.10 | 12 | 0.629 | | 8-#5+ 0 | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 | 25 | 50 | 67 |
| D = 6.417 | 100 | 2.10 | 12 | 0.671 | | 8-#5+ 0 | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 | 33 | 70 | 90 |
| RIB NOT ON | 150 | 2.10 | 12 | 0.712 | | 8-#5+ 0 | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 | 42 | 98 | 112 |
| COLUMN LINE | 200 | 2.18 | 12 | 0.754 | | 8-#5+ 0 | 4 | #4 | #5 | 8-#5 | 5 | #4 | #4 | 10-#5 | 50 | 124 | 135 |
| 0.571 CF/SF | 300 | 2.54 | 12 * | 0.855 | | 8-#5+ 1 | 4 | #5 | #6 | 7-#6 | 5 | #4 | #4 | 10-#5 | 67 | 176 | 181 |
| | 400 | 2.89 | 12 * | 0.630 | | 8-#5+ 1 | 4 | #6 | #6 | 9-#6 | 5 | #4 | #5 | 10-#5 | 84 | 227 | 226 |
| 20'-0" | 50 | 1.99 | 12 | 0.660 | | 8-#5+ 0 | 5 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 | 35 | 70 | 94 |
| D = 8.417 | 100 | 1.99 | 12 | 0.711 | | 8-#5+ 0 | 5 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 | 47 | 99 | 126 |
| RIB ON | 150 | 2.01 | 12 | 0.762 | | 8-#5+ 0 | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 | 58 | 137 | 157 |
| COLUMN LINE | 200 | 2.18 | 12 * | 0.833 | | 8-#5+ 1 | 5 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 70 | 174 | 189 |
| 0.590 CF/SF | 300 | 2.65 | 12 * | 0.630 | | 8-#5+ 1 | 5 | #5 | #6 | 10-#6 | 5 | #4 | #5 | 10-#5 | 94 | 246 | 252 |
| | 400 | 3.22 | 15 * | 0.626 | | 9-#5+ 1 | 5 | #6 | #7 | 18-#5 | 5 | #5 | #5 | 10-#5 | 115 | 308 | 310 |
| 22'-0" | 50 | 2.01 | 12 | 0.724 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 | 47 | 93 | 125 |
| D = 8.417 | 100 | 2.01 | 12 | 0.780 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 | 62 | 132 | 168 |
| RIB ON | 150 | 2.25 | 12 * | 0.851 | | 9-#5+ 1 | 5 | #5 | #5 | 8-#6 | 6 | #4 | #4 | 11-#5 | 78 | 183 | 210 |
| COLUMN LINE | 200 | 2.52 | 12 * | 0.909 | | 9-#5+ 2 | 5 | #5 | #6 | 10-#6 | 6 | #4 | #4 | 11-#5 | 94 | 233 | 253 |
| 0.579 CF/SF | 300 | 3.25 | 16 * | 0.625 | | 9-#5+ 2 | 5 | #6 | #7 | 14-#6 | 6 | #5 | #5 | 11-#5 | 123 | 324 | 332 |
| 24'-0" | 50 | 2.05 | 12 | 0.779 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 | 61 | 121 | 163 |
| D = 8.417 | 100 | 2.18 | 12 * | 0.864 | | 10-#5+ 2 | 5 | #4 | #5 | 9-#6 | 7 | #4 | #4 | 13-#5 | 81 | 172 | 219 |
| RIB ON | 150 | 2.51 | 12 * | 0.926 | | 10-#5+ 4 | 5 | #5 | #6 | 11-#6 | 7 | #4 | #4 | 13-#5 | 102 | 239 | 275 |
| COLUMN LINE | 200 | 2.98 | 14 * | 0.627 | | 10-#5+ 3 | 5 | #6 | #7 | 14-#6 | 7 | #4 | #5 | 13-#5 | 122 | 301 | 328 |
| 0.571 CF/SF | | | | | | | | | | | | | | | | | |
| 26'-0" | 50 | 2.03 | 13 | 0.799 | | 11-#5+ 0 | 6 | #4 | #4 | 12-#5 | 7 | #4 | #4 | 13-#5 | 78 | 156 | 210 |
| D = 10.417 | 100 | 2.31 | 13 * | 0.893 | | 11-#5+ 3 | 6 | #5 | #5 | 11-#6 | 7 | #4 | #4 | 13-#5 | 104 | 215 | 280 |
| RIB NOT ON | 150 | 2.70 | 15 * | 0.917 | | 11-#5+ 5 | 6 | #5 | #6 | 15-#6 | 7 | #4 | #5 | 13-#5 | 129 | 298 | 348 |
| COLUMN LINE | 200 | 3.10 | 19 * | 0.622 | | 12-#5+ 4 | 6 | #6 | #7 | 17-#6 | 7 | #4 | #5 | 13-#5 | 153 | 364 | 411 |
| 0.585 CF/SF | | | | | | | | | | | | | | | | | |
| 28'-0" | 50 | 2.20 | 14 * | 0.852 | | 12-#5+ 3 | 6 | #4 | #5 | 15-#5 | 8 | #4 | #4 | 15-#5 | 97 | 193 | 260 |
| D = 10.417 | 100 | 2.58 | 14 * | 0.925 | | 12-#5+ 6 | 6 | #5 | #6 | 15-#6 | 8 | #4 | #4 | 15-#5 | 130 | 259 | 349 |
| RIB NOT ON | 150 | 3.07 | 19 * | 0.622 | | 12-#5+ 5 | 6 | #6 | #7 | 18-#6 | 8 | #4 | #5 | 15-#5 | 160 | 357 | 430 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.577 CF/SF | | | | | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.32 | 15 * | 0.873 | | 9-#6+ 3 | 6 | #5 | #5 | 13-#6 | 9 | #4 | #4 | 16-#5 | 119 | 237 | 319 |
| D = 10.417 | 100 | 2.81 | 17 * | 0.923 | | 9-#6+ 6 | 6 | #6 | #6 | 18-#6 | 9 | #4 | #4 | 16-#5 | 158 | 316 | 425 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.571 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 11 in. | | | Rib Depth = 8 in. | | | | Total Slab Depth = 3 in. | | | |
| 2.07 | 12 | | 4 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 7-#5 |
| 2.07 | 12 | | 4 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 7-#5 |
| 2.07 | 12 | | 4 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 7-#5 |
| 2.07 | 12 | | 4 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 7-#5 |
| 2.07 | 12 | | 4 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 7-#5 |
| 2.07 | 12 | | 4 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 7-#5 |
| 2.10 | 12 | | 4 | #4 | #4 | 7-#5 | 4 | #4 | #4 | 8-#5 |
| 2.10 | 12 | | 4 | #4 | #4 | 7-#5 | 4 | #4 | #4 | 8-#5 |
| 2.10 | 12 | | 4 | #4 | #4 | 7-#5 | 4 | #4 | #4 | 8-#5 |
| 2.10 | 12 | | 4 | #4 | #4 | 7-#5 | 4 | #4 | #4 | 8-#5 |
| 2.10 | 12 | | 4 | #4 | #4 | 7-#5 | 4 | #4 | #4 | 8-#5 |
| 2.16 | 12 | 3 S 4 1 | 4 | #4 | #4 | 8-#5 | 4 | #4 | #4 | 8-#5 |
| 2.15 | 12 | | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 |
| 2.15 | 12 | | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 |
| 2.15 | 12 | | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 |
| 2.15 | 12 | | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 |
| 2.45 | 12 | 3 S 4 1 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 2.69 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 12-#5 | 5 | #4 | #4 | 10-#5 |
| 2.03 | 12 | | 5 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 |
| 2.03 | 12 | | 5 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 |
| 2.03 | 12 | | 5 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 |
| 2.17 | 12 | | 5 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 2.47 | 12 * | 3 S 4 1 | 5 | #4 | #5 | 9-#6 | 5 | #4 | #4 | 10-#5 |
| 2.85 | 13 * | 3 S 4 1 | 5 | #5 | #5 | 12-#6 | 5 | #4 | #4 | 10-#5 |
| 2.05 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 |
| 2.05 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 |
| 2.17 | 12 | | 5 | #4 | #4 | 8-#6 | 6 | #4 | #4 | 11-#5 |
| 2.45 | 12 * | 3 S 4 1 | 5 | #4 | #5 | 10-#6 | 6 | #4 | #4 | 11-#5 |
| 2.98 | 12 * | 3 S 4 1 | 5 | #5 | #6 | 13-#6 | 6 | #4 | #4 | 11-#5 |
| 2.11 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 |
| 2.16 | 12 | | 5 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 13-#5 |
| 2.42 | 12 * | 3 S 4 1 | 5 | #4 | #5 | 10-#6 | 7 | #4 | #4 | 13-#5 |
| 2.71 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 18-#5 | 7 | #4 | #4 | 13-#5 |
| 2.06 | 13 | | 6 | #4 | #4 | 11-#5 | 7 | #4 | #4 | 13-#5 |
| 2.24 | 13 * | | 6 | #4 | #4 | 15-#5 | 7 | #4 | #4 | 13-#5 |
| 2.53 | 13 * | 3 S 4 1 | 6 | #4 | #5 | 13-#6 | 7 | #4 | #4 | 13-#5 |
| 2.84 | 14* | 3 S 4 1 | 6 | #5 | #5 | 16-#6 | 7 | #4 | #4 | 13-#5 |
| 2.19 | 14 | | 6 | #4 | #4 | 10-#6 | 8 | #4 | #4 | 15-#5 |
| 2.50 | 14 * | 3 S 4 1 | 6 | #4 | #5 | 13-#6 | 8 | #4 | #4 | 15-#5 |
| 2.86 | 14 * | 3 S 4 1 | 6 | #5 | #5 | 17-#6 | 8 | #4 | #4 | 15-#5 |
| 2.26 | 15 | | 6 | #4 | #4 | 12-#6 | 9 | #4 | #4 | 16-#5 |
| 2.78 | 15 * | 3 S 4 1 | 6 | #5 | #5 | 17-#6 | 9 | #4 | #4 | 16-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 6″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments $-M$ Edge (ft-k) | Moments $+M$ Bot. (ft-k) | Moments $-M$ Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 13 in. | Rib Depth = 10 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | | Total Depth = 13 in. | Rib Depth = 10 in. | Total Slab Depth = 3 in. | | | | | | | | |
| 18'-0" | 50 | 2.10 | 12 | 0.633 | | 8-#5+ 0 | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 | 27 | 55 | 73 | 2.15 | 12 | | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 |
| D = 6.417 | 100 | 2.10 | 12 | 0.633 | | 8-#5+ 0 | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 | 36 | 74 | 96 | 2.15 | 12 | | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 |
| RIB NOT ON | 150 | 2.10 | 12 | 0.633 | | 8-#5+ 0 | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 | 44 | 103 | 119 | 2.15 | 12 | | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.10 | 12 | 0.651 | | 8-#5+ 0 | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 | 53 | 130 | 142 | 2.15 | 12 | | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 |
| 0.659 CF/SF | 300 | 2.27 | 12 | 0.726 | | 8-#5+ 0 | 4 | #5 | #5 | 6-#6 | 5 | #4 | #4 | 10-#5 | 70 | 182 | 187 | 2.15 | 12 | 3 S 4 1 | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 10-#5 |
| | 400 | 2.56 | 12 * | 0.802 | | 8-#5+ 0 | 4 | #5 | #6 | 8-#6 | 5 | #4 | #4 | 10-#5 | 86 | 233 | 233 | 2.45 | 12 | 3 S 4 1 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| | 500 | 2.89 | 12 * | 0.634 | | 8-#5+ 0 | 4 | #6 | #6 | 9-#6 | 5 | #4 | #5 | 10-#5 | 103 | 284 | 278 | 2.69 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 12-#5 | 5 | #4 | #4 | 10-#5 |
| 20'-0" | 50 | 2.07 | 12 | 0.633 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 | 38 | 77 | 103 | 2.10 | 12 | | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 |
| D = 8.417 | 100 | 2.07 | 12 | 0.656 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 | 50 | 105 | 135 | 2.10 | 12 | | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 |
| RIB ON | 150 | 2.07 | 12 | 0.698 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 | 62 | 144 | 167 | 2.10 | 12 | | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.15 | 12 | 0.739 | | 9-#5+ 0 | 5 | #4 | #5 | 9-#5 | 5 | #4 | #4 | 10-#5 | 74 | 181 | 198 | 2.10 | 12 | | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 |
| 0.682 CF/SF | 300 | 2.41 | 12 * | 0.840 | | 9-#5+ 1 | 5 | #5 | #5 | 12-#5 | 5 | #4 | #4 | 10-#5 | 97 | 254 | 261 | 2.37 | 12 | | 5 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| | 400 | 2.98 | 12 * | 0.634 | | 9-#5+ 0 | 5 | #6 | #6 | 15-#5 | 5 | #5 | #5 | 10-#5 | 121 | 325 | 325 | 2.68 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 10-#6 | 5 | #4 | #4 | 10-#5 |
| | 500 | 3.49 | 13 * | 0.632 | | 9-#5+ 1 | 5 | #6 | #7 | 13-#6 | 5 | #5 | #6 | 10-#5 | 143 | 394 | 386 | 3.15 | 12 * | 3 S 4 1 | 5 | #5 | #6 | 12-#6 | 5 | #4 | #5 | 10-#5 |
| 22'-0" | 50 | 2.01 | 12 | 0.643 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 | 51 | 102 | 138 | 2.05 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 |
| D = 8.417 | 100 | 2.01 | 12 | 0.693 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 | 67 | 140 | 180 | 2.05 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 |
| RIB ON | 150 | 2.13 | 12 | 0.743 | | 9-#5+ 0 | 5 | #4 | #5 | 7-#6 | 6 | #4 | #4 | 11-#5 | 83 | 193 | 223 | 2.11 | 12 | | 5 | #4 | #4 | 7-#6 | 6 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.26 | 12 * | 0.813 | | 9-#5+ 1 | 5 | #5 | #5 | 12-#5 | 6 | #4 | #4 | 11-#5 | 99 | 243 | 265 | 2.17 | 12 | | 5 | #4 | #4 | 8-#6 | 6 | #4 | #4 | 11-#5 |
| 0.669 CF/SF | 300 | 2.82 | 12 * | 0.634 | | 9-#5+ 1 | 5 | #6 | #6 | 12-#6 | 6 | #4 | #5 | 11-#5 | 130 | 340 | 350 | 2.62 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 15-#5 | 6 | #4 | #4 | 11-#5 |
| | 400 | 3.43 | 14 * | 0.631 | 3 S 4 1 | 10-#5+ 1 | 5 | #7 | #7 | 15-#6 | 6 | #5 | #5 | 11-#5 | 160 | 432 | 432 | 3.04 | 12 * | 3 S 4 1 | 5 | #5 | #6 | 14-#6 | 6 | #4 | #4 | 11-#5 |
| | 500 | 3.98 | 18 * | 0.626 | 3 S 4 1 | 8-#6+ 2 | 5 | #7 | #8 | 17-#6 | 6 | #5 | #6 | 11-#5 | 185 | 489 | 499 | 3.51 | 16 * | 3 S 4 2 | 5 | #6 | #6 | 16-#6 | 6 | #4 | #5 | 11-#5 |
| 24'-0" | 50 | 2.05 | 12 | 0.705 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 | 67 | 133 | 180 | 2.11 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 |
| D = 8.417 | 100 | 2.14 | 12 | 0.759 | | 10-#5+ 0 | 5 | #4 | #5 | 8-#6 | 7 | #4 | #4 | 13-#5 | 87 | 182 | 235 | 2.11 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 |
| RIB ON | 150 | 2.31 | 12 * | 0.813 | | 10-#5+ 0 | 5 | #5 | #5 | 10-#6 | 7 | #4 | #4 | 13-#5 | 108 | 251 | 291 | 2.25 | 12 | | 5 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 2.62 | 12 * | 0.888 | | 10-#5+ 2 | 5 | #6 | #6 | 12-#6 | 7 | #4 | #4 | 13-#5 | 129 | 316 | 346 | 2.46 | 12 * | 3 S 4 1 | 5 | #4 | #5 | 15-#5 | 7 | #4 | #4 | 13-#5 |
| 0.659 CF/SF | 300 | 3.29 | 14 * | 0.631 | 3 S 4 1 | 10-#5+ 1 | 5 | #7 | #7 | 16-#6 | 7 | #4 | #5 | 13-#5 | 169 | 441 | 454 | 3.06 | 12 * | 3 S 4 2 | 5 | #5 | #6 | 15-#6 | 7 | #4 | #4 | 13-#5 |
| | 400 | 3.82 | 18 * | 0.626 | 3 S 4 1 | 9-#6+ 1 | 5 | #7 | #8 | 19-#6 | 7 | #5 | #5 | 13-#5 | 203 | 525 | 548 | 3.42 | 16 * | 3 S 4 2 | 5 | #6 | #6 | 18-#6 | 7 | #4 | #4 | 13-#5 |
| 26'-0" | 50 | 2.02 | 13 | 0.728 | | 11-#5+ 0 | 6 | #4 | #4 | 11-#5 | 7 | #4 | #4 | 13-#5 | 86 | 171 | 231 | 2.06 | 13 | | 6 | #4 | #4 | 11-#5 | 7 | #4 | #4 | 13-#5 |
| D = 10.417 | 100 | 2.18 | 13 * | 0.805 | | 11-#5+ 1 | 6 | #4 | #5 | 10-#6 | 7 | #4 | #4 | 13-#5 | 112 | 229 | 301 | 2.15 | 13 | | 6 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 13-#5 |
| RIB NOT ON | 150 | 2.50 | 13 * | 0.887 | | 11-#5+ 4 | 6 | #5 | #6 | 12-#6 | 7 | #4 | #4 | 13-#5 | 138 | 318 | 372 | 2.40 | 13 * | | 6 | #4 | #5 | 16-#5 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 2.89 | 13 * | 0.632 | | 11-#5+ 2 | 6 | #6 | #6 | 15-#6 | 7 | #4 | #5 | 13-#5 | 164 | 400 | 442 | 2.71 | 13 * | 3 S 4 1 | 6 | #5 | #5 | 14-#6 | 7 | #4 | #4 | 13-#5 |
| 0.676 CF/SF | 300 | 3.59 | 18 * | 0.626 | | 9-#6+ 2 | 6 | #7 | #7 | 20-#6 | 7 | #5 | #5 | 13-#5 | 212 | 536 | 570 | 3.28 | 15 * | 3 S 4 1 | 6 | #5 | #6 | 18-#6 | 7 | #4 | #5 | 13-#5 |

(Continued on next page)

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 6″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 13 in. | Rib Depth = 10 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | | Total Depth = 13 in. | Rib Depth = 10 in. | Total Slab Depth = 3 in. | | | | | | | | |
| 28'-0" | 50 | 2.13 | 14 | 0.749 | | 12-#5+ 0 | 6 | #4 | #5 | 9-#6 | 8 | #4 | #4 | 15-#5 | 106 | 213 | 286 | 2.09 | 14 | | 6 | #4 | #4 | 12-#5 | 8 | #4 | #4 | 15-#5 |
| D = 10.417 | 100 | 2.35 | 14 * | 0.841 | | 12-#5+ 2 | 6 | #5 | #5 | 18-#5 | 8 | #4 | #4 | 15-#5 | 139 | 278 | 375 | 2.31 | 14 | | 6 | #4 | #4 | 12-#6 | 8 | #4 | #4 | 15-#5 |
| RIB NOT ON | 150 | 2.79 | 14 * | 0.915 | | 12-#5+ 5 | 6 | #6 | #6 | 16-#6 | 8 | #4 | #4 | 15-#5 | 172 | 388 | 463 | 2.74 | 14 * | 3 S 4 1 | 6 | #5 | #5 | 15-#6 | 8 | #4 | #4 | 15-#5 |
| COLUMN LINE | 200 | 3.20 | 16 * | 0.628 | | 9-#6+ 3 | 6 | #6 | #7 | 19-#6 | 8 | #4 | #5 | 15-#5 | 203 | 487 | 547 | 3.05 | 14 * | 3 S 4 1 | 6 | #5 | #6 | 18-#6 | 8 | #4 | #4 | 15-#5 |
| 0.666 CF/SF | 300 | 3.78 | 23 * | 0.622 | | 11-#6+ 3 | 6 | #7 | #7 | 25-#6 | 8 | #5 | #5 | 15-#5 | 258 | 567 | 693 | 3.54 | 20 * | 3 S 4 2 | 6 | #6 | #6 | 23-#6 | 8 | #4 | #4 | 15-#5 |
| 30'-0" | 50 | 2.27 | 15 | 0.807 | | 9-#6+ 2 | 6 | #5 | #5 | 12-#6 | 9 | #4 | #4 | 16-#5 | 130 | 261 | 351 | 2.19 | 15 | | 6 | #4 | #4 | 15-#5 | 9 | #4 | #4 | 16-#5 |
| D = 10.417 | 100 | 2.55 | 15 * | 0.895 | | 9-#6+ 5 | 6 | #5 | #6 | 16-#6 | 9 | #4 | #4 | 16-#5 | 171 | 341 | 459 | 2.49 | 15 * | 3 S 4 1 | 6 | #4 | #5 | 14-#6 | 9 | #4 | #4 | 16-#5 |
| RIB NOT ON | 150 | 3.12 | 16 * | 0.628 | | 9-#6+ 4 | 6 | #6 | #7 | 20-#6 | 9 | #4 | #5 | 16-#5 | 210 | 463 | 566 | 2.96 | 15 * | 3 S 4 1 | 6 | #5 | #6 | 18-#6 | 9 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 3.59 | 20 * | 0.625 | | 11-#6+ 3 | 6 | #7 | #7 | 24-#6 | 9 | #5 | #5 | 16-#5 | 247 | 580 | 666 | 3.32 | 15 * | 3 S 4 2 | 6 | #6 | #6 | 22-#6 | 9 | #4 | #4 | 16-#5 |
| 0.659 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32'-0" | 50 | 2.32 | 16 * | 0.839 | | 10-#6+ 3 | 7 | #5 | #5 | 14-#6 | 9 | #4 | #4 | 16-#5 | 159 | 319 | 429 | 2.25 | 16 | | 7 | #4 | #4 | 13-#6 | 9 | #4 | #4 | 16-#5 |
| D = 12.417 | 100 | 2.66 | 16 * | 0.917 | | 10-#6+ 6 | 7 | #5 | #6 | 19-#6 | 9 | #4 | #4 | 16-#5 | 208 | 416 | 561 | 2.62 | 16 * | | 7 | #4 | #5 | 18-#6 | 9 | #4 | #4 | 16-#5 |
| RIB ON | 150 | 3.25 | 20 * | 0.625 | | 11-#6+ 3 | 7 | #6 | #7 | 24-#6 | 9 | #4 | #5 | 16-#5 | 254 | 547 | 685 | 3.10 | 16 * | 3 S 4 1 | 7 | #5 | #6 | 22-#6 | 9 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 3.56 | 26 * | 0.620 | | 13-#6+ 4 | 7 | #6 | #7 | 28-#6 | 9 | #5 | #5 | 16-#5 | 293 | 587 | 790 | 3.33 | 21 * | 3 S 4 2 | 7 | #5 | #6 | 26-#6 | 9 | #4 | #4 | 16-#5 |
| 0.673 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34'-0" | 50 | 2.54 | 17 * | 0.854 | | 10-#6+ 4 | 7 | #5 | #6 | 17-#6 | 10 | #4 | #4 | 18-#5 | 190 | 381 | 512 | 2.49 | 17 | | 7 | #4 | #5 | 16-#6 | 10 | #4 | #4 | 18-#5 |
| D = 12.417 | 100 | 2.91 | 18 * | 0.918 | | 11-#6+ 6 | 7 | #6 | #6 | 23-#6 | 10 | #4 | #4 | 18-#5 | 248 | 497 | 668 | 2.90 | 17 * | 3 S 4 1 | 7 | #5 | #5 | 22-#6 | 10 | #4 | #4 | 18-#5 |
| RIB ON | 150 | 3.49 | 25 * | 0.621 | | 13-#6+ 4 | 7 | #7 | #7 | 29-#6 | 10 | #4 | #5 | 18-#5 | 301 | 623 | 811 | 3.29 | 17 * | 3 S 4 2 | 7 | #5 | #6 | 27-#6 | 10 | #4 | #4 | 18-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.665 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.75 | 18 * | 0.877 | | 11-#6+ 5 | 7 | #6 | #6 | 21-#6 | 11 | #4 | #4 | 19-#5 | 225 | 450 | 606 | 2.70 | 18 * | 3 S 4 1 | 7 | #5 | #5 | 19-#6 | 11 | #4 | #4 | 19-#5 |
| D = 12.417 | 100 | 3.25 | 22 * | 0.916 | | 18-#5+11 | 7 | #6 | #7 | 28-#6 | 11 | #4 | #5 | 19-#5 | 292 | 584 | 786 | 3.14 | 18 * | 3 S 4 1 | 7 | #5 | #6 | 26-#6 | 11 | #4 | #4 | 19-#5 |
| RIB ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.659 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation “3 S 4 1” for the stirrups: the first character “3” is the bar size, i.e., #3; the “S” stands for “stirrup”; and the “4” is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the “1” denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a “2” indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 12 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | |
| 20'-0" | 50 | 2.07 | 12 | 0.636 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 | 42 | 84 | 113 |
| D = 8.417 | 100 | 2.07 | 12 | 0.636 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 | 54 | 110 | 145 |
| RIB ON | 150 | 2.07 | 12 | 0.636 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 | 66 | 150 | 176 |
| COLUMN LINE | 200 | 2.07 | 12 | 0.643 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 | 77 | 188 | 208 |
| 0.777 CF/SF | 300 | 2.28 | 12 | 0.720 | | 9-#5+ 0 | 5 | #5 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 101 | 261 | 271 |
| | 400 | 2.62 | 12 * | 0.817 | | 9-#5+ 1 | 5 | #5 | #6 | 9-#6 | 5 | #4 | #5 | 10-#5 | 124 | 333 | 334 |
| | 500 | 3.00 | 12 * | 0.637 | | 9-#5+ 1 | 5 | #6 | #6 | 11-#6 | 5 | #5 | #5 | 10-#5 | 148 | 404 | 397 |
| 22'-0" | 50 | 2.01 | 12 | 0.636 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 | 56 | 112 | 151 |
| D = 8.417 | 100 | 2.01 | 12 | 0.636 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 | 72 | 146 | 193 |
| RIB ON | 150 | 2.09 | 12 | 0.648 | | 9-#5+ 0 | 5 | #4 | #5 | 9-#5 | 6 | #4 | #4 | 11-#5 | 88 | 201 | 236 |
| COLUMN LINE | 200 | 2.15 | 12 | 0.695 | | 9-#5+ 0 | 5 | #4 | #5 | 8-#6 | 6 | #4 | #4 | 11-#5 | 103 | 251 | 278 |
| 0.761 CF/SF | 300 | 2.49 | 12 * | 0.827 | | 9-#5+ 2 | 5 | #5 | #6 | 10-#6 | 6 | #4 | #4 | 11-#5 | 135 | 350 | 363 |
| | 400 | 3.00 | 12 * | 0.637 | | 9-#5+ 1 | 5 | #6 | #7 | 18-#5 | 6 | #4 | #5 | 11-#5 | 166 | 446 | 448 |
| | 500 | 3.51 | 13 * | 0.635 | 4 S 6 1 | 10-#5+ 1 | 5 | #7 | #7 | 15-#6 | 6 | #5 | #5 | 11-#5 | 197 | 540 | 531 |
| 24'-0" | 50 | 2.05 | 12 | 0.636 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 | 73 | 146 | 196 |
| D = 8.417 | 100 | 2.05 | 12 | 0.677 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 | 94 | 191 | 252 |
| RIB ON | 150 | 2.24 | 12 | 0.727 | | 10-#5+ 0 | 5 | #5 | #5 | 12-#5 | 7 | #4 | #4 | 13-#5 | 114 | 261 | 307 |
| COLUMN LINE | 200 | 2.46 | 12 | 0.777 | | 10-#5+ 0 | 5 | #5 | #6 | 10-#6 | 7 | #4 | #4 | 13-#5 | 135 | 328 | 363 |
| 0.749 CF/SF | 300 | 3.07 | 12 * | 0.637 | | 10-#5+ 1 | 5 | #6 | #7 | 14-#6 | 7 | #4 | #5 | 13-#5 | 176 | 456 | 474 |
| | 400 | 3.68 | 13 * | 0.635 | 4 S 6 1 | 8-#6+ 2 | 5 | #7 | #8 | 17-#6 | 7 | #5 | #5 | 13-#5 | 217 | 580 | 583 |
| | 500 | 4.27 | 17 * | 0.630 | 4 S 6 1 | 9-#6+ 2 | 5 | #8 | #8 | 20-#6 | 7 | #5 | #6 | 13-#5 | 252 | 682 | 679 |
| 26'-0" | 50 | 2.02 | 13 | 0.654 | | 11-#5+ 0 | 6 | #4 | #4 | 11-#5 | 7 | #4 | #4 | 13-#5 | 94 | 187 | 252 |
| D = 10.417 | 100 | 2.14 | 13 | 0.709 | | 11-#5+ 0 | 6 | #4 | #5 | 9-#6 | 7 | #4 | #4 | 13-#5 | 120 | 241 | 323 |
| RIB NOT ON | 150 | 2.30 | 13 | 0.800 | | 11-#5+ 2 | 6 | #5 | #5 | 11-#6 | 7 | #4 | #4 | 13-#5 | 146 | 332 | 394 |
| COLUMN LINE | 200 | 2.55 | 13 * | 0.867 | | 11-#5+ 4 | 6 | #5 | #6 | 13-#6 | 7 | #4 | #4 | 13-#5 | 172 | 416 | 464 |
| 0.770 CF/SF | 300 | 3.29 | 13 * | 0.635 | | 12-#5+ 2 | 6 | #6 | #7 | 18-#6 | 7 | #5 | #5 | 13-#5 | 225 | 579 | 605 |
| | 400 | 4.00 | 18 * | 0.629 | | 10-#6+ 1 | 6 | #7 | #8 | 21-#6 | 7 | #5 | #6 | 13-#5 | 271 | 712 | 729 |
| 28'-0" | 50 | 2.04 | 14 | 0.679 | | 12-#5+ 0 | 6 | #4 | #4 | 12-#5 | 8 | #4 | #4 | 15-#5 | 116 | 233 | 313 |
| D = 10.417 | 100 | 2.21 | 14 | 0.759 | | 12-#5+ 1 | 6 | #4 | #5 | 11-#6 | 8 | #4 | #4 | 15-#5 | 149 | 298 | 401 |
| RIB NOT ON | 150 | 2.54 | 14 * | 0.839 | | 12-#5+ 3 | 6 | #5 | #6 | 14-#6 | 8 | #4 | #4 | 15-#5 | 182 | 407 | 490 |
| COLUMN LINE | 200 | 2.90 | 14 * | 0.901 | | 12-#5+ 5 | 6 | #6 | #6 | 17-#6 | 8 | #4 | #5 | 15-#5 | 215 | 512 | 578 |
| 0.759 CF/SF | 300 | 3.84 | 17 * | 0.630 | | 10-#6+ 3 | 6 | #7 | #8 | 22-#6 | 8 | #5 | #5 | 15-#5 | 278 | 709 | 747 |
| | 400 | 4.40 | 22 * | 0.626 | | 18-#5+ 2 | 6 | #8 | #8 | 27-#6 | 8 | #5 | #6 | 15-#5 | 332 | 822 | 893 |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 12 in. | Total Slab Depth = 3 in. | | | | | | | | |
| 2.10 | 12 | | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 |
| 2.10 | 12 | | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 |
| 2.10 | 12 | | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 |
| 2.10 | 12 | | 5 | #4 | #4 | 9-#5 | 5 | #4 | #4 | 10-#5 |
| 2.17 | 12 | | 5 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 2.40 | 12 | 4 S 6 1 | 5 | #4 | #5 | 12-#5 | 5 | #4 | #4 | 10-#5 |
| 2.68 | 12 * | 4 S 6 1 | 5 | #5 | #5 | 10-#6 | 5 | #4 | #4 | 10-#5 |
| 2.05 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 |
| 2.05 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 |
| 2.05 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 |
| 2.11 | 12 | | 5 | #4 | #4 | 7-#6 | 6 | #4 | #4 | 11-#5 |
| 2.39 | 12 | 4 S 6 1 | 5 | #4 | #5 | 9-#6 | 6 | #4 | #4 | 11-#5 |
| 2.73 | 12 * | 4 S 6 1 | 5 | #5 | #5 | 12-#6 | 6 | #4 | #4 | 11-#5 |
| 3.18 | 12 * | 4 S 62 | 5 | #5 | #6 | 14-#6 | 6 | #4 | #5 | 11-#5 |
| 2.11 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 |
| 2.11 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 |
| 2.16 | 12 | | 5 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 13-#5 |
| 2.37 | 12 | 4 S 6 1 | 5 | #4 | #5 | 9-#6 | 7 | #4 | #4 | 13-#5 |
| 2.87 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 18-#5 | 7 | #4 | #4 | 13-#5 |
| 3.26 | 12 * | 4 S 6 2 | 5 | #6 | #6 | 16-#6 | 7 | #4 | #4 | 13-#5 |
| 3.86 | 14 * | 4 S 6 2 | 5 | #6 | #7 | 19-#6 | 7 | #4 | #5 | 13-#5 |
| 2.06 | 13 | | 6 | #4 | #4 | 11-#5 | 7 | #4 | #4 | 13-#5 |
| 2.09 | 13 | | 6 | #4 | #4 | 12-#5 | 7 | #4 | #4 | 13-#5 |
| 2.20 | 13 | | 6 | #4 | #4 | 10-#6 | 7 | #4 | #4 | 13-#5 |
| 2.46 | 13 | | 6 | #4 | #5 | 12-#6 | 7 | #4 | #4 | 13-#5 |
| 3.00 | 13 * | 4 S 6 1 | 6 | #5 | #6 | 16-#6 | 7 | #4 | #4 | 13-#5 |
| 3.56 | 15 * | 4 S 6 2 | 6 | #6 | #6 | 20-#6 | 7 | #4 | #5 | 13-#5 |
| 2.09 | 14 | | 6 | #4 | #4 | 12-#5 | 8 | #4 | #4 | 15-#5 |
| 2.19 | 14 | | 6 | #4 | #4 | 10-#6 | 8 | #4 | #4 | 15-#5 |
| 2.46 | 14 | | 6 | #4 | #5 | 18-#5 | 8 | #4 | #4 | 15-#5 |
| 2.74 | 14 * | 4 S 6 1 | 6 | #5 | #5 | 15-#6 | 8 | #4 | #4 | 15-#5 |
| 3.54 | 14 * | 4 S 6 2 | 6 | #6 | #6 | 21-#6 | 8 | #4 | #5 | 15-#5 |
| 3.98 | 19 * | 4 S 6 2 | 6 | #6 | #7 | 25-#6 | 8 | #4 | #5 | 15-#5 |

(Continued on next page)

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 12 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | | Total Depth = 15 in. | Rib Depth = 12 in. | Total Slab Depth = 3 in. | | | | | | | | |
| 30'-0" | 50 | 2.17 | 15 | 0.697 | | 9-#6+ 0 | 6 | #4 | #5 | 15-#5 | 9 | #4 | #4 | 16-#5 | 142 | 285 | 384 | 2.15 | 15 | | 6 | #4 | #4 | 10-#6 | 9 | #4 | #4 | 16-#5 |
| D = 10.417 | 100 | 2.40 | 15 * | 0.787 | | 9-#6+ 1 | 6 | #5 | #5 | 14-#6 | 9 | #4 | #4 | 16-#5 | 183 | 366 | 492 | 2.40 | 15 | | 6 | #4 | #5 | 18-#5 | 9 | #4 | #4 | 16-#5 |
| RIB NOT ON | 150 | 2.76 | 15 * | 0.873 | | 9-#6+ 3 | 6 | #6 | #6 | 17-#6 | 9 | #4 | #4 | 16-#5 | 223 | 490 | 601 | 2.71 | 15 * | 4 S 6 1 | 6 | #5 | #5 | 16-#6 | 9 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 3.28 | 15 * | 0.633 | | 10-#6+ 3 | 6 | #7 | #7 | 21-#6 | 9 | #4 | #5 | 16-#5 | 263 | 618 | 709 | 3.03 | 15 * | 4 S 6 1 | 6 | #5 | #6 | 19-#6 | 9 | #4 | #4 | 16-#5 |
| 0.749 CF/SF | 300 | 4.26 | 21 * | 0.626 | | 18-#5+ 2 | 6 | #8 | #8 | 27-#6 | 9 | #5 | #6 | 16-#5 | 336 | 823 | 904 | 3.85 | 17 * | 4 S 6 2 | 6 | #6 | #7 | 25-#6 | 9 | #4 | #5 | 16-#5 |
| 32'-0" | 50 | 2.21 | 16 | 0.772 | | 10-#6+ 2 | 7 | #4 | #5 | 13-#6 | 9 | #4 | #4 | 16-#5 | 174 | 349 | 469 | 2.19 | 16 | | 7 | #4 | #4 | 12-#6 | 9 | #4 | #4 | 16-#5 |
| D = 12.417 | 100 | 2.58 | 16 * | 0.855 | | 10-#6+ 4 | 7 | #5 | #6 | 17-#6 | 9 | #4 | #4 | 16-#5 | 223 | 446 | 601 | 2.51 | 16 | | 7 | #4 | #5 | 16-#6 | 9 | #4 | #4 | 16-#5 |
| RIB ON | 150 | 2.97 | 16 * | 0.917 | | 10-#6+ 6 | 7 | #6 | #6 | 21-#6 | 9 | #4 | #5 | 16-#5 | 272 | 587 | 733 | 2.84 | 16 * | 4 S 6 1 | 7 | #5 | #5 | 20-#6 | 9 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 3.54 | 19 * | 0.628 | | 12-#6+ 2 | 7 | #7 | #7 | 25-#6 | 9 | #5 | #5 | 16-#5 | 318 | 737 | 857 | 3.20 | 16 * | 4 S 6 1 | 7 | #5 | #6 | 24-#6 | 9 | #4 | #4 | 16-#5 |
| 0.766 CF/SF | 300 | 4.24 | 25 * | 0.624 | 4 S 6 1 | 15-#6+ 3 | 7 | #7 | #8 | 33-#6 | 9 | #5 | #6 | 16-#5 | 402 | 859 | 1081 | 3.84 | 22 * | 4 S 6 2 | 7 | #6 | #6 | 30-#6 | 9 | #4 | #5 | 16-#5 |
| 34'-0" | 50 | 2.37 | 17 * | 0.792 | | 10-#6+ 3 | 7 | #5 | #5 | 16-#6 | 10 | #4 | #4 | 18-#5 | 208 | 416 | 560 | 2.34 | 17 | | 7 | #4 | #4 | 15-#6 | 10 | #4 | #4 | 18-#5 |
| D = 12.417 | 100 | 2.81 | 17 * | 0.882 | | 10-#6+ 6 | 7 | #6 | #6 | 21-#6 | 10 | #4 | #4 | 18-#5 | 267 | 534 | 718 | 2.76 | 17 * | 4 S 6 1 | 7 | #5 | #5 | 19-#6 | 10 | #4 | #4 | 18-#5 |
| RIB ON | 150 | 3.27 | 18 * | 0.629 | | 12-#6+ 3 | 7 | #6 | #7 | 26-#6 | 10 | #4 | #5 | 18-#5 | 325 | 681 | 874 | 3.14 | 17 * | 4 S 6 1 | 7 | #5 | #6 | 24-#6 | 10 | #4 | #4 | 18-#5 |
| COLUMN LINE | 200 | 3.84 | 22 * | 0.626 | | 14-#6+ 4 | 7 | #7 | #8 | 31-#6 | 10 | #5 | #5 | 18-#5 | 379 | 857 | 1021 | 3.46 | 17 * | 4 S 6 2 | 7 | #6 | #6 | 40-#5 | 10 | #4 | #4 | 18-#5 |
| 0.757 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.57 | 18 * | 0.810 | | 11-#6+ 3 | 7 | #5 | #6 | 19-#6 | 11 | #4 | #4 | 19-#5 | 246 | 492 | 663 | 2.53 | 18 | | 7 | #4 | #5 | 18-#6 | 11 | #4 | #4 | 19-#5 |
| D = 12.417 | 100 | 2.99 | 18 * | 0.905 | | 12-#6+ 6 | 7 | #6 | #7 | 25-#6 | 11 | #4 | #4 | 19-#5 | 316 | 632 | 850 | 2.88 | 18 * | 4 S 6 1 | 7 | #5 | #5 | 23-#6 | 11 | #4 | #4 | 19-#5 |
| RIB ON | 150 | 3.56 | 21 * | 0.626 | | 15-#6+ 3 | 7 | #7 | #7 | 31-#6 | 11 | #4 | #5 | 19-#5 | 383 | 775 | 1030 | 3.43 | 18 * | 4 S 6 2 | 7 | #6 | #6 | 29-#6 | 11 | #4 | #4 | 19-#5 |
| COLUMN LINE | 200 | 4.06 | 27 * | 0.622 | 4 S 6 1 | 17-#6+ 2 | 7 | #7 | #8 | 36-#6 | 11 | #5 | #5 | 19-#5 | 443 | 906 | 1192 | 3.82 | 20 * | 4 S 6 2 | 7 | #6 | #7 | 34-#6 | 11 | #4 | #4 | 19-#5 |
| 0.749 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.65 | 19 * | 0.857 | | 12-#6+ 6 | 8 | #5 | #6 | 23-#6 | 11 | #4 | #4 | 19- #5 | 292 | 583 | 785 | 2.61 | 19 | | 8 | #4 | #5 | 21-#6 | 11 | #4 | #4 | 19-#5 |
| D = 14.417 | 100 | 3.30 | 20 * | 0.920 | | 14-#6+ 8 | 8 | #6 | #7 | 30-#6 | 11 | #4 | #5 | 19-#5 | 373 | 745 | 1003 | 3.17 | 19 * | 4 S 6 1 | 8 | #5 | #6 | 28-#6 | 11 | #4 | #4 | 19-#5 |
| RIB NOT ON | 150 | 3.81 | 26 * | 0.623 | | 17-#6+ 5 | 8 | #7 | #7 | 36-#6 | 11 | #5 | #5 | 19-#5 | 448 | 896 | 1206 | 3.57 | 19 * | 4 S 6 2 | 8 | #6 | #6 | 34-#6 | 11 | #4 | #4 | 19-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.763 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 17 in. | Rib Depth = 14 in. | | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | Total Depth = 17 in. | Rib Depth = 14 in. | | Total Slab Depth = 3 in. | | | | | | | |
| 22'-0" | 50 | 2.01 | 12 | 0.639 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 | 61 | 122 | 164 | 2.05 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 |
| D = 8.417 | 100 | 2.01 | 12 | 0.639 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 | 77 | 154 | 207 | 2.05 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 |
| RIB ON | 150 | 2.01 | 12 | 0.639 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 | 93 | 208 | 249 | 2.05 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.10 | 12 | 0.639 | | 9-#5+ 0 | 5 | #4 | #5 | 7-#6 | 6 | #4 | #4 | 11-#5 | 108 | 259 | 292 | 2.05 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 11-#5 |
| 0.857 CF/SF | 300 | 2.43 | 12 | 0.683 | | 9-#5+ 0 | 5 | #5 | #6 | 9-#6 | 6 | #4 | #4 | 11-#5 | 140 | 359 | 377 | 2.30 | 12 | | 5 | #4 | #5 | 8-#6 | 6 | #4 | #4 | 11-#5 |
| | 400 | 2.79 | 12 * | 0.813 | | 9-#5+ 2 | 5 | #6 | #6 | 11-#6 | 6 | #4 | #5 | 11-#5 | 171 | 456 | 461 | 2.58 | 12 | 4 S 6 1 | 5 | #5 | #5 | 10-#6 | 6 | #4 | #4 | 11-#5 |
| | 500 | 3.23 | 12 * | 0.640 | | 9-#5+ 2 | 5 | #6 | #7 | 14-#6 | 6 | #5 | #5 | 11-#5 | 203 | 552 | 546 | 2.93 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 18-#5 | 6 | #4 | #4 | 11-#5 |
| 24'-0" | 50 | 2.05 | 12 | 0.639 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 | 79 | 159 | 214 | 2.11 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 |
| D = 8.417 | 100 | 2.05 | 12 | 0.639 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 | 100 | 200 | 269 | 2.11 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 |
| RIB ON | 150 | 2.14 | 12 | 0.639 | | 10-#5+ 0 | 5 | #4 | #5 | 8-#6 | 7 | #4 | #4 | 13-#5 | 121 | 270 | 325 | 2.11 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 2.25 | 12 | 0.685 | | 10-#5+ 0 | 5 | #5 | #5 | 9-#6 | 7 | #4 | #4 | 13-#5 | 141 | 338 | 380 | 2.16 | 12 | | 5 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 13-#5 |
| 0.843 CF/SF | 300 | 2.70 | 12 * | 0.817 | | 10-#5+ 2 | 5 | #6 | #6 | 12-#6 | 7 | #4 | #4 | 13-#5 | 183 | 468 | 492 | 2.62 | 12 | 4 S 6 1 | 5 | #5 | #5 | 11-#6 | 7 | #4 | #4 | 13-#5 |
| | 400 | 3.24 | 12 * | 0.640 | | 10-#5+ 1 | 5 | #7 | #7 | 15-#6 | 7 | #4 | #5 | 13-#5 | 224 | 595 | 603 | 2.98 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 14-#6 | 7 | #4 | #4 | 13-#5 |
| | 500 | 3.81 | 12 * | 0.640 | 4 S 6 1 | 8-#6+ 2 | 5 | #7 | #8 | 18-#6 | 7 | #5 | #5 | 13-#5 | 265 | 721 | 714 | 3.50 | 12 * | 4 S 6 2 | 5 | #6 | #6 | 17-#6 | 7 | #4 | #5 | 13-#5 |
| 26'-0" | 50 | 2.02 | 13 | 0.637 | | 11-#5+ 0 | 6 | #4 | #4 | 11-#5 | 7 | #4 | #4 | 13-#5 | 102 | 204 | 275 | 2.06 | 13 | | 6 | #4 | #4 | 11-#5 | 7 | #4 | #4 | 13-#5 |
| D = 10.417 | 100 | 2.03 | 13 | 0.637 | | 11-#5+ 0 | 6 | #4 | #4 | 12-#5 | 7 | #4 | #4 | 13-#5 | 128 | 257 | 345 | 2.06 | 13 | | 6 | #4 | #4 | 11-#5 | 7 | #4 | #4 | 13-#5 |
| RIB NOT ON | 150 | 2.18 | 13 | 0.706 | | 11-#5+ 1 | 6 | #4 | #5 | 10-#6 | 7 | #4 | #4 | 13-#5 | 155 | 344 | 416 | 2.15 | 13 | | 6 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 2.50 | 13 | 0.773 | | 11-#5+ 2 | 6 | #5 | #6 | 12-#6 | 7 | #4 | #4 | 13-#5 | 181 | 430 | 487 | 2.41 | 13 | | 6 | #4 | #5 | 11-#6 | 7 | #4 | #4 | 13-#5 |
| 0.867 CF/SF | 300 | 3.01 | 13 * | 0.894 | | 11-#5+ 6 | 6 | #6 | #7 | 16-#6 | 7 | #4 | #5 | 13-#5 | 233 | 595 | 628 | 2.71 | 13 * | 4 S 6 1 | 6 | #5 | #5 | 14-#6 | 7 | #4 | #4 | 13-#5 |
| | 400 | 3.76 | 13 * | 0.638 | | 9-#6+ 2 | 6 | #7 | #7 | 19-#6 | 7 | #5 | #6 | 13-#5 | 286 | 757 | 769 | 3.43 | 13 * | 4 S 6 1 | 6 | #6 | #6 | 18-#6 | 7 | #4 | #5 | 13-#5 |
| | 500 | 4.39 | 17 * | 0.633 | | 15-#5+ 2 | 6 | #7 | #8 | 23-#6 | 7 | #6 | #6 | 13-#5 | 332 | 897 | 895 | 4.03 | 14 * | 4 S 6 2 | 6 | #6 | #7 | 21-#6 | 7 | #5 | #5 | 13-#5 |
| 28'-0" | 50 | 2.04 | 14 | 0.636 | | 12-#5+ 0 | 6 | #4 | #4 | 12-#5 | 8 | #4 | #4 | 15-#5 | 127 | 253 | 341 | 2.09 | 14 | | 6 | #4 | #4 | 12-#5 | 8 | #4 | #4 | 15-#5 |
| D = 10.417 | 100 | 2.19 | 14 | 0.662 | | 12-#5+ 0 | 6 | #4 | #5 | 10-#6 | 8 | #4 | #4 | 15-#5 | 159 | 319 | 429 | 2.19 | 14 | | 6 | #4 | #4 | 10-#6 | 8 | #4 | #4 | 15-#5 |
| RIB NOT ON | 150 | 2.41 | 14 | 0.741 | | 12-#5+ 1 | 6 | #5 | #5 | 18-#5 | 8 | #4 | #4 | 15-#5 | 192 | 423 | 518 | 2.43 | 14 | | 6 | #4 | #5 | 12-#6 | 8 | #4 | #4 | 15-#5 |
| COLUMN LINE | 200 | 2.74 | 14 * | 0.821 | | 12-#5+ 3 | 6 | #6 | #6 | 15-#6 | 8 | #4 | #4 | 15-#5 | 225 | 531 | 606 | 2.67 | 14 | | 6 | #5 | #5 | 14-#6 | 8 | #4 | #4 | 15-#5 |
| 0.854 CF/SF | 300 | 3.43 | 14 * | 0.637 | | 9-#6+ 2 | 6 | #7 | #7 | 20-#6 | 8 | #5 | #5 | 15-#5 | 291 | 736 | 782 | 3.05 | 14 * | 4 S 6 1 | 6 | #5 | #6 | 18-#6 | 8 | #4 | #4 | 15-#5 |
| | 400 | 4.26 | 17 * | 0.633 | | 11-#6+ 3 | 6 | #8 | #8 | 24-#6 | 8 | #5 | #6 | 15-#5 | 353 | 929 | 950 | 3.84 | 14 * | 4 S 6 2 | 6 | #6 | #7 | 23-#6 | 8 | #4 | #5 | 15-#5 |
| 30'-0" | 50 | 2.14 | 15 | 0.634 | | 9-#6+ 0 | 6 | #4 | #5 | 10-#6 | 9 | #4 | #4 | 16-#5 | 155 | 310 | 418 | 2.11 | 15 | | 6 | #4 | #4 | 9-#6 | 9 | #4 | #4 | 16-#5 |
| D = 10.417 | 100 | 2.31 | 15 | 0.688 | | 9-#6+ 0 | 6 | #5 | #5 | 18-#5 | 9 | #4 | #4 | 16-#5 | 195 | 391 | 526 | 2.26 | 15 | | 6 | #4 | #4 | 12-#6 | 9 | #4 | #4 | 16-#5 |
| RIB NOT ON | 150 | 2.67 | 15 * | 0.796 | | 9-#6+ 2 | 6 | #6 | #6 | 16-#6 | 9 | #4 | #4 | 16-#5 | 236 | 511 | 635 | 2.55 | 15 | | 6 | #4 | #5 | 15-#6 | 9 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 3.09 | 15 * | 0.871 | | 9-#6+ 4 | 6 | #6 | #7 | 19-#6 | 9 | #4 | #5 | 16-#5 | 276 | 644 | 743 | 2.92 | 15 * | 4 S 6 1 | 6 | #5 | #6 | 17-#6 | 9 | #4 | #4 | 16-#5 |
| 0.843 CF/SF | 300 | 3.85 | 16 * | 0.634 | | 16-#5+ 3 | 6 | #7 | #8 | 25-#6 | 9 | #5 | #5 | 16-#5 | 356 | 893 | 957 | 3.57 | 15 * | 4 S 6 2 | 6 | #6 | #7 | 23-#6 | 9 | #4 | #4 | 16-#5 |
| 32'-0" | 50 | 2.17 | 16 | 0.692 | | 10-#6+ 1 | 7 | #4 | #5 | 12-#6 | 9 | #4 | #4 | 16-#5 | 190 | 380 | 511 | 2.14 | 16 | | 7 | #4 | #4 | 16-#5 | 9 | #4 | #4 | 16-#5 |
| D = 12.417 | 100 | 2.40 | 16 | 0.790 | | 10-#6+ 3 | 7 | #5 | #5 | 16-#6 | 9 | #4 | #4 | 16-#5 | 239 | 478 | 643 | 2.35 | 16 | | 7 | #4 | #4 | 15-#6 | 9 | #4 | #4 | 16-#5 |
| RIB ON | 150 | 2.81 | 16 * | 0.862 | | 10-#6+ 5 | 7 | #6 | #6 | 19-#6 | 9 | #4 | #4 | 16-#5 | 288 | 615 | 775 | 2.74 | 16 | | 7 | #5 | #5 | 18-#6 | 9 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 3.23 | 16 * | 0.634 | | 11-#6+ 3 | 7 | #6 | #7 | 23-#6 | 9 | #4 | #5 | 16-#5 | 337 | 777 | 906 | 3.06 | 16 * | 4 S 6 1 | 7 | #5 | #6 | 21-#6 | 9 | #4 | #4 | 16-#5 |
| 0.862 CF/SF | 300 | 4.32 | 20 * | 0.630 | | 14-#6+ 4 | 7 | #8 | #8 | 30-#6 | 9 | #5 | #6 | 16-#5 | 430 | 1070 | 1157 | 3.88 | 16 * | 4 S 6 2 | 7 | #6 | #7 | 28-#6 | 9 | #4 | #5 | 16-#5 |
| 34'-0" | 50 | 2.33 | 17 | 0.718 | | 10-#6+ 2 | 7 | #5 | #5 | 15-#6 | 10 | #4 | #4 | 18-#5 | 227 | 453 | 610 | 2.28 | 17 | | 7 | #4 | #4 | 14-#6 | 10 | #4 | #4 | 18-#5 |
| D = 12.417 | 100 | 2.61 | 17 * | 0.813 | | 10-#6+ 4 | 7 | #5 | #6 | 19-#6 | 10 | #4 | #4 | 18-#5 | 285 | 571 | 768 | 2.59 | 17 | | 7 | #4 | #5 | 18-#6 | 10 | #4 | #4 | 18-#5 |
| RIB ON | 150 | 3.11 | 17 * | 0.891 | | 11-#6+ 6 | 7 | #6 | #7 | 23-#6 | 10 | #4 | #5 | 18-#5 | 344 | 719 | 926 | 2.90 | 17 * | 4 S 6 1 | 7 | #5 | #5 | 22-#6 | 10 | #4 | #4 | 18-#5 |
| COLUMN LINE | 200 | 3.64 | 17 * | 0.633 | | 13-#6+ 4 | 7 | #7 | #7 | 28-#6 | 10 | #5 | #5 | 18-#5 | 403 | 913 | 1084 | 3.38 | 17 * | 4 S 6 1 | 7 | #6 | #6 | 26-#6 | 10 | #4 | #4 | 18-#5 |
| 0.852 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.54 | 18 | 0.742 | | 11-#6+ 2 | 7 | #5 | #6 | 18-#6 | 11 | #4 | #4 | 19-#5 | 268 | 536 | 722 | 2.50 | 18 | | 7 | #4 | #5 | 17-#6 | 11 | #4 | #4 | 19-#5 |
| D = 12.417 | 100 | 2.82 | 18 * | 0.846 | | 11-#6+ 5 | 7 | #6 | #6 | 23-#6 | 11 | #4 | #4 | 19-#5 | 338 | 675 | 909 | 2.79 | 18 | 4 S 6 1 | 7 | #5 | #5 | 21-#6 | 11 | #4 | #4 | 19-#5 |
| RIB ON | 150 | 3.36 | 18 * | 0.632 | | 13-#6+ 2 | 7 | #7 | #7 | 28-#6 | 11 | #4 | #5 | 19-#5 | 407 | 828 | 1097 | 3.14 | 18 * | 4 S 6 1 | 7 | #5 | #6 | 26-#6 | 11 | #4 | #4 | 19-#5 |
| COLUMN LINE | 200 | 3.93 | 21 * | 0.629 | | 22-#5+ 5 | 7 | #7 | #8 | 33-#6 | 11 | #5 | #5 | 19-#5 | 473 | 1051 | 1275 | 3.68 | 18 * | 4 S 6 2 | 7 | #6 | #7 | 31-#6 | 11 | #4 | #4 | 19-#5 |
| 0.843 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.60 | 19 * | 0.806 | | 12-#6+ 5 | 8 | #5 | #6 | 21-#6 | 11 | #4 | #4 | 19-#5 | 318 | 635 | 855 | 2.56 | 19 | | 8 | #4 | #5 | 20-#6 | 11 | #4 | #4 | 19-#5 |
| D = 14.417 | 100 | 3.12 | 19 * | 0.884 | | 18-#5+10 | 8 | #6 | #7 | 27-#6 | 11 | #4 | #5 | 19-#5 | 399 | 799 | 1075 | 2.90 | 19 * | | 8 | #5 | #5 | 25-#6 | 11 | #4 | #4 | 19-#5 |
| RIB NOT ON | 150 | 3.62 | 21 * | 0.629 | | 22-#5+ 5 | 8 | #7 | #7 | 33-#6 | 11 | #5 | #5 | 19-#5 | 479 | 958 | 1290 | 3.31 | 19 * | 4 S 6 1 | 8 | #5 | #6 | 31-#6 | 11 | #4 | #4 | 19-#5 |
| COLUMN LINE | 200 | 4.28 | 25 * | 0.626 | | 18-#6+ 4 | 8 | #7 | #8 | 39-#6 | 11 | #5 | #6 | 19-#5 | 555 | 1209 | 1495 | 3.98 | 19 * | 4 S 6 2 | 8 | #6 | #7 | 36-#6 | 11 | #4 | #5 | 19-#5 |
| 0.859 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | Square Edge Column $\gamma_f$ | Square Edge Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | Rib Depth = 16 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | |
| 26'-0" | 50 | 2.02 | 13 | 0.640 | | 11-#5+ 0 | 6 | #4 | #4 | 11-#5 | 7 | #4 | #4 | 13-#5 | 111 | 222 | 298 |
| D = 10.417 | 100 | 2.02 | 13 | 0.640 | | 11-#5+ 0 | 6 | #4 | #4 | 11-#5 | 7 | #4 | #4 | 13-#5 | 137 | 274 | 369 |
| RIB NOT ON | 150 | 2.14 | 13 | 0.640 | | 11-#5+ 0 | 6 | #4 | #5 | 9-#6 | 7 | #4 | #4 | 13-#5 | 163 | 356 | 439 |
| COLUMN LINE | 200 | 2.30 | 13 | 0.642 | | 11-#5+ 0 | 6 | #5 | #5 | 11-#6 | 7 | #4 | #4 | 13-#5 | 189 | 444 | 510 |
| 0.967 CF/SF | 300 | 2.84 | 13 | 0.764 | | 11-#5+ 1 | 6 | #6 | #6 | 14-#6 | 7 | #4 | #5 | 13-#5 | 242 | 610 | 651 |
| | 400 | 3.28 | 13 * | 0.641 | | 12-#5+ 2 | 6 | #6 | #7 | 17-#6 | 7 | #5 | #5 | 13-#5 | 294 | 773 | 793 |
| | 500 | 3.97 | 13 * | 0.641 | | 10-#6+ 1 | 6 | #7 | #8 | 21-#6 | 7 | #5 | #6 | 13-#5 | 347 | 933 | 934 |
| 28'-0" | 50 | 2.04 | 14 | 0.638 | | 12-#5+ 0 | 6 | #4 | #4 | 12-#5 | 8 | #4 | #4 | 15-#5 | 137 | 275 | 370 |
| D = 10.417 | 100 | 2.17 | 14 | 0.638 | | 12-#5+ 0 | 6 | #4 | #5 | 10-#6 | 8 | #4 | #4 | 15-#5 | 170 | 340 | 458 |
| RIB NOT ON | 150 | 2.32 | 14 | 0.638 | | 12-#5+ 0 | 6 | #5 | #5 | 12-#6 | 8 | #4 | #4 | 15-#5 | 203 | 438 | 546 |
| COLUMN LINE | 200 | 2.54 | 14 | 0.733 | | 12-#5+ 2 | 6 | #5 | #6 | 14-#6 | 8 | #4 | #4 | 15-#5 | 236 | 548 | 635 |
| 0.952 CF/SF | 300 | 3.15 | 14 * | 0.857 | | 12-#5+ 5 | 6 | #6 | #7 | 18-#6 | 8 | #4 | #5 | 15-#5 | 301 | 756 | 811 |
| | 400 | 3.91 | 14 * | 0.639 | | 10-#6+ 2 | 6 | #7 | #8 | 22-#6 | 8 | #5 | #6 | 15-#5 | 367 | 959 | 987 |
| | 500 | 4.46 | 16 * | 0.636 | | 12-#6+ 1 | 6 | #8 | #8 | 26-#6 | 8 | #6 | #6 | 15-#5 | 430 | 1151 | 1157 |
| 30'-0" | 50 | 2.14 | 15 | 0.637 | | 9-#6+ 0 | 6 | #4 | #5 | 10-#6 | 9 | #4 | #4 | 16-#5 | 168 | 336 | 453 |
| D = 10.417 | 100 | 2.29 | 15 | 0.637 | | 9-#6+ 0 | 6 | #5 | #5 | 12-#6 | 9 | #4 | #4 | 16-#5 | 209 | 417 | 561 |
| RIB NOT ON | 150 | 2.54 | 15 | 0.670 | | 9-#6+ 0 | 6 | #5 | #6 | 15-#6 | 9 | #4 | #4 | 16-#5 | 249 | 530 | 670 |
| COLUMN LINE | 200 | 2.76 | 15 * | 0.779 | | 9-#6+ 2 | 6 | #6 | #6 | 17-#6 | 9 | #4 | #4 | 16-#5 | 289 | 666 | 778 |
| 0.940 CF/SF | 300 | 3.65 | 15 * | 0.638 | | 15-#5+ 2 | 6 | #7 | #8 | 22-#6 | 9 | #5 | #5 | 16-#5 | 370 | 920 | 995 |
| | 400 | 4.35 | 16 * | 0.636 | | 18-#5+ 3 | 6 | #8 | #8 | 27-#6 | 9 | #5 | #6 | 16-#5 | 449 | 1166 | 1209 |
| 32'-0" | 50 | 2.17 | 16 | 0.635 | | 10-#6+ 0 | 7 | #4 | #5 | 12-#6 | 9 | #4 | #4 | 16-#5 | 206 | 412 | 555 |
| D = 12.417 | 100 | 2.35 | 16 | 0.712 | | 10-#6+ 2 | 7 | #5 | #5 | 15-#6 | 9 | #4 | #4 | 16-#5 | 255 | 510 | 686 |
| RIB ON | 150 | 2.62 | 16 | 0.798 | | 10-#6+ 4 | 7 | #5 | #6 | 18-#6 | 9 | #4 | #4 | 16-#5 | 304 | 640 | 818 |
| COLUMN LINE | 200 | 3.06 | 16 * | 0.862 | | 10-#6+ 6 | 7 | #6 | #7 | 21-#6 | 9 | #4 | #5 | 16-#5 | 353 | 806 | 950 |
| 0.961 CF/SF | 300 | 3.99 | 16 * | 0.636 | | 18-#5+ 5 | 7 | #7 | #8 | 27-#6 | 9 | #5 | #6 | 16-#5 | 451 | 1114 | 1213 |
| 34'-0" | 50 | 2.29 | 17 | 0.634 | | 10-#6+ 1 | 7 | #5 | #5 | 14-#6 | 10 | #4 | #4 | 18-#5 | 246 | 492 | 662 |
| D = 12.417 | 100 | 2.58 | 17 | 0.741 | | 10-#6+ 3 | 7 | #5 | #6 | 18-#6 | 10 | #4 | #4 | 18-#5 | 305 | 609 | 820 |
| RIB ON | 150 | 2.84 | 17 * | 0.835 | | 10-#6+ 6 | 7 | #6 | #6 | 22-#6 | 10 | #4 | #4 | 18-#5 | 363 | 751 | 978 |
| COLUMN LINE | 200 | 3.36 | 17 * | 0.894 | | 12-#6+ 6 | 7 | #7 | #7 | 25-#6 | 10 | #4 | #5 | 18-#5 | 422 | 951 | 1136 |
| 0.950 CF/SF | 300 | 4.35 | 19 * | 0.633 | | 22-#5+ 3 | 7 | #8 | #8 | 33-#6 | 10 | #5 | #6 | 18-#5 | 536 | 1312 | 1444 |
| 36'-0" | 50 | 2.50 | 18 | 0.661 | | 11-#6+ 1 | 7 | #5 | #6 | 17-#6 | 11 | #4 | #4 | 19-#5 | 291 | 581 | 783 |
| D = 12.417 | 100 | 2.78 | 18 * | 0.784 | | 11-#6+ 4 | 7 | #6 | #6 | 22-#6 | 11 | #4 | #4 | 19-#5 | 360 | 721 | 970 |
| RIB ON | 150 | 3.18 | 18 * | 0.866 | | 12-#6+ 6 | 7 | #6 | #7 | 26-#6 | 11 | #4 | #5 | 19-#5 | 430 | 869 | 1158 |
| COLUMN LINE | 200 | 3.73 | 18 * | 0.634 | | 14-#6+ 2 | 7 | #7 | #8 | 30-#6 | 11 | #5 | #5 | 19-#5 | 500 | 1107 | 1345 |
| 0.940 CF/SF | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.57 | 19 | 0.713 | | 12-#6+ 2 | 8 | #5 | #6 | 20-#6 | 11 | #4 | #4 | 19-#5 | 344 | 689 | 927 |
| D = 14.417 | 100 | 2.88 | 19 * | 0.819 | | 12-#6+ 5 | 8 | #6 | #6 | 26-#6 | 11 | #4 | #4 | 19-#5 | 426 | 853 | 1148 |
| RIB NOT ON | 150 | 3.33 | 19 * | 0.908 | | 15-#6+ 8 | 8 | #6 | #7 | 31-#6 | 11 | #4 | #5 | 19-#5 | 508 | 1016 | 1368 |
| COLUMN LINE | 200 | 3.99 | 20 * | 0.632 | | 17-#6+ 5 | 8 | #7 | #8 | 36-#6 | 11 | #5 | #5 | 19-#5 | 589 | 1285 | 1585 |
| 0.958 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | | Rib Depth = 16 in. | | Total Slab Depth = 3 in. | | | | | | | |
| 26'-0" | 2.06 | 13 | | 6 | #4 | #4 | 11-#5 | 7 | #4 | #4 | 13-#5 |
| D = 10.417 | 2.06 | 13 | | 6 | #4 | #4 | 11-#5 | 7 | #4 | #4 | 13-#5 |
| RIB NOT ON | 2.09 | 13 | | 6 | #4 | #4 | 12-#5 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 2.20 | 13 | | 6 | #4 | #4 | 10-#6 | 7 | #4 | #4 | 13-#5 |
| 0.967 CF/SF | 2.66 | 13 | | 6 | #5 | #5 | 13-#6 | 7 | #4 | #4 | 13-#5 |
| | 3.00 | 13 * | 4 S 6 1 | 6 | #5 | #6 | 16-#6 | 7 | #4 | #4 | 13-#5 |
| | 3.50 | 13 * | 4 S 6 1 | 6 | #6 | #6 | 19-#6 | 7 | #4 | #5 | 13-#5 |
| 28'-0" | 2.09 | 14 | | 6 | #4 | #4 | 12-#5 | 8 | #4 | #4 | 15-#5 |
| D = 10.417 | 2.15 | 14 | | 6 | #4 | #4 | 9-#6 | 8 | #4 | #4 | 15-#5 |
| RIB NOT ON | 2.26 | 14 | | 6 | #4 | #4 | 11-#6 | 8 | #4 | #4 | 15-#5 |
| COLUMN LINE | 2.46 | 14 | | 6 | #4 | #5 | 18-#5 | 8 | #4 | #4 | 15-#5 |
| 0.952 CF/SF | 3.01 | 14 * | 4 S 6 1 | 6 | #5 | #6 | 17-#6 | 8 | #4 | #4 | 15-#5 |
| | 3.47 | 14 * | 4 S 6 1 | 6 | #6 | #6 | 20-#6 | 8 | #4 | #5 | 15-#5 |
| | 3.88 | 14 * | 4 S 6 2 | 6 | #6 | #7 | 24-#6 | 8 | #4 | #5 | 15-#5 |
| 30'-0" | 2.11 | 15 | | 6 | #4 | #4 | 9-#6 | 9 | #4 | #4 | 16-#5 |
| D = 10.417 | 2.22 | 15 | | 6 | #4 | #4 | 11-#6 | 9 | #4 | #4 | 16-#5 |
| RIB NOT ON | 2.49 | 15 | | 6 | #4 | #5 | 14-#6 | 9 | #4 | #4 | 16-#5 |
| COLUMN LINE | 2.71 | 15 | 4 S 6 1 | 6 | #5 | #5 | 16-#6 | 9 | #4 | #4 | 16-#5 |
| 0.940 CF/SF | 3.28 | 15 * | 4 S 6 1 | 6 | #6 | #6 | 21-#6 | 9 | #4 | #4 | 16-#5 |
| | 4.01 | 15 * | 4 S 6 2 | 6 | #7 | #7 | 25-#6 | 9 | #4 | #5 | 16-#5 |
| 32'-0" | 2.15 | 16 | | 7 | #4 | #4 | 11-#6 | 9 | #4 | #4 | 16-#5 |
| D = 12.417 | 2.29 | 16 | | 7 | #4 | #4 | 14-#6 | 9 | #4 | #4 | 16-#5 |
| RIB ON | 2.58 | 16 | | 7 | #4 | #5 | 17-#6 | 9 | #4 | #4 | 16-#5 |
| COLUMN LINE | 2.80 | 16 | | 7 | #5 | #5 | 19-#6 | 9 | #4 | #4 | 16-#5 |
| 0.961 CF/SF | 3.56 | 16 * | 4 S 6 1 | 7 | #6 | #6 | 25-#6 | 9 | #4 | #5 | 16-#5 |
| 34'-0" | 2.24 | 17 | | 7 | #4 | #4 | 13-#6 | 10 | #4 | #4 | 18-#5 |
| D = 12.417 | 2.55 | 17 | | 7 | #4 | #5 | 17-#6 | 10 | #4 | #4 | 18-#5 |
| RIB ON | 2.80 | 17 | | 7 | #5 | #5 | 20-#6 | 10 | #4 | #4 | 18-#5 |
| COLUMN LINE | 3.14 | 17 * | 4 S 6 1 | 7 | #5 | #6 | 24-#6 | 10 | #4 | #4 | 18-#5 |
| 0.950 CF/SF | 3.95 | 17 * | 4 S 6 2 | 7 | #6 | #7 | 31-#6 | 10 | #4 | #5 | 18-#5 |
| 36'-0" | 2.44 | 18 | | 7 | #4 | #5 | 16-#6 | 11 | #4 | #4 | 19-#5 |
| D = 12.417 | 2.74 | 18 | | 7 | #5 | #5 | 20-#6 | 11 | #4 | #4 | 19-#5 |
| RIB ON | 3.05 | 18 * | 4 S 6 1 | 7 | #5 | #6 | 24-#6 | 11 | #4 | #4 | 19-#5 |
| COLUMN LINE | 3.37 | 18 * | 4 S 6 1 | 7 | #6 | #6 | 28-#6 | 11 | #4 | #4 | 19-#5 |
| 0.940 CF/SF | | | | | | | | | | | |
| 38'-0" | 2.52 | 19 | | 8 | #4 | #5 | 19-#6 | 11 | #4 | #4 | 19-#5 |
| D = 14.417 | 2.85 | 19 | | 8 | #5 | #5 | 24-#6 | 11 | #4 | #4 | 19-#5 |
| RIB NOT ON | 3.17 | 19 * | 4 S 6 1 | 8 | #5 | #6 | 28-#6 | 11 | #4 | #4 | 19-#5 |
| COLUMN LINE | 3.69 | 19 * | 4 S 6 1 | 8 | #6 | #6 | 33-#6 | 11 | #4 | #5 | 19-#5 |
| 0.958 CF/SF | | | | | | | | | | | |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 12 in. | Rib Depth = 8 in. | | Total Slab Depth = 4 in. | | | | | | | | | | | | | | | Total Depth = 12 in. | Rib Depth = 8 in. | | Total Slab Depth = 4 in. | | | | | | | |
| 16'-0" | 50 | 2.04 | 12 | 0.631 | | 7-#5+ 0 | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 | 19 | 38 | 51 | 2.06 | 12 | | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 |
| D = 6.417 | 100 | 2.04 | 12 | 0.631 | | 7-#5+ 0 | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 | 25 | 51 | 67 | 2.06 | 12 | | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 |
| RIB NOT ON | 150 | 2.04 | 12 | 0.631 | | 7-#5+ 0 | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 | 31 | 71 | 83 | 2.06 | 12 | | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 |
| COLUMN LINE | 200 | 2.04 | 12 | 0.631 | | 7-#5+ 0 | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 | 37 | 89 | 99 | 2.06 | 12 | | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 |
| 0.666 CF/SF | 300 | 2.13 | 12 | 0.681 | | 7-#5+ 0 | 4 | #4 | #5 | 5-#6 | 4 | #4 | #4 | 7-#5 | 48 | 126 | 130 | 2.06 | 12 | | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 |
| | 400 | 2.22 | 12 | 0.752 | | 7-#5+ 0 | 4 | #5 | #5 | 8-#5 | 4 | #4 | #4 | 7-#5 | 60 | 161 | 162 | 2.06 | 12 | 3 S 4 1 | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 |
| | 500 | 2.56 | 12 * | 0.823 | | 7-#5+ 0 | 4 | #5 | #6 | 5-#7 | 4 | #4 | #5 | 7-#5 | 72 | 196 | 193 | 2.29 | 12 * | 3 S 4 1 | 4 | #4 | #5 | 6-#6 | 4 | #4 | #4 | 7-#5 |
| 18'-0" | 50 | 1.99 | 12 | 0.631 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 27 | 55 | 74 | 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| D = 6.417 | 100 | 1.99 | 12 | 0.631 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 36 | 73 | 96 | 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| RIB NOT ON | 150 | 1.99 | 12 | 0.631 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 44 | 102 | 119 | 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| COLUMN LINE | 200 | 2.07 | 12 | 0.673 | | 5-#6+ 0 | 4 | #4 | #5 | 5-#6 | 5 | #4 | #4 | 8-#5 | 53 | 129 | 142 | 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 0.654 CF/SF | 300 | 2.22 | 12 | 0.762 | | 5-#6+ 0 | 4 | #5 | #5 | 5-#7 | 5 | #4 | #4 | 8-#5 | 70 | 181 | 188 | 2.08 | 12 | 3 S 4 1 | 4 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| | 400 | 2.68 | 12 * | 0.632 | | 5-#6+ 0 | 4 | #6 | #6 | 6-#7 | 5 | #4 | #4 | 8-#5 | 87 | 232 | 233 | 2.56 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 6-#7 | 5 | #4 | #4 | 8-#5 |
| | 500 | 3.08 | 12 * | 0.632 | | 5-#6+ 1 | 4 | #6 | #7 | 10-#6 | 5 | #4 | #5 | 8-#5 | 103 | 282 | 279 | 2.86 | 12 * | 3 S 4 2 | 4 | #5 | #6 | 5-#8 | 5 | #4 | #4 | 8-#5 |
| 20'-0" | 50 | 1.92 | 12 | 0.631 | | 8-#5+ 0 | 5 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 8-#5 | 38 | 77 | 103 | 1.93 | 12 | | 5 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 8-#5 |
| D = 8.417 | 100 | 1.92 | 12 | 0.671 | | 8-#5+ 0 | 5 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 8-#5 | 50 | 103 | 135 | 1.93 | 12 | | 5 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 8-#5 |
| RIB ON | 150 | 1.92 | 12 | 0.719 | | 8-#5+ 0 | 5 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 8-#5 | 62 | 143 | 167 | 1.93 | 12 | | 5 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 8-#5 |
| COLUMN LINE | 200 | 2.05 | 12 | 0.793 | | 8-#5+ 1 | 5 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 8-#5 | 74 | 180 | 198 | 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 0.673 CF/SF | 300 | 2.53 | 12 * | 0.901 | | 8-#5+ 3 | 5 | #5 | #6 | 7-#7 | 5 | #4 | #5 | 8-#5 | 97 | 253 | 261 | 2.29 | 12 * | 3 S 4 1 | 5 | #4 | #5 | 6-#7 | 5 | #4 | #4 | 8-#5 |
| | 400 | 2.96 | 13 * | 0.630 | | 8-#5+ 2 | 5 | #6 | #6 | 7-#8 | 5 | #5 | #5 | 8-#5 | 120 | 322 | 323 | 2.64 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 6-#8 | 5 | #4 | #4 | 8-#5 |
| | 500 | 3.46 | 16 * | 0.627 | 3 S 4 1 | 9-#5+ 2 | 5 | #6 | #7 | 6-#9 | 5 | #5 | #6 | 8-#5 | 140 | 376 | 377 | 3.13 | 14 * | 3 S 4 1 | 5 | #5 | #6 | 7-#8 | 5 | #4 | #5 | 8-#5 |
| 22'-0" | 50 | 1.98 | 12 | 0.693 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 51 | 103 | 138 | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| D = 8.417 | 100 | 1.98 | 12 | 0.745 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 67 | 138 | 181 | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| RIB ON | 150 | 2.12 | 12 * | 0.797 | | 9-#5+ 0 | 5 | #4 | #5 | 6-#7 | 6 | #4 | #4 | 10-#5 | 83 | 191 | 223 | 2.07 | 12 | | 5 | #4 | #4 | 7-#6 | 6 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.46 | 12 * | 0.876 | | 9-#5+ 2 | 5 | #5 | #6 | 7-#7 | 6 | #4 | #4 | 10-#5 | 99 | 241 | 266 | 2.35 | 12 * | 3 S 4 1 | 5 | #4 | #5 | 9-#6 | 6 | #4 | #4 | 10-#5 |
| 0.662 CF/SF | 300 | 3.01 | 13 * | 0.630 | | 9-#5+ 1 | 5 | #6 | #7 | 7-#8 | 6 | #4 | #5 | 10-#5 | 130 | 337 | 349 | 2.75 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 7-#8 | 6 | #4 | #4 | 10-#5 |
| | 400 | 3.45 | 17 * | 0.626 | 3 S 4 1 | 7-#6+ 2 | 5 | #7 | #7 | 7-#9 | 6 | #5 | #5 | 10-#5 | 157 | 405 | 421 | 3.03 | 15 * | 3 S 4 2 | 5 | #5 | #6 | 8-#8 | 6 | #4 | #4 | 10-#5 |
| 24'-0" | 50 | 1.99 | 12 | 0.751 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 67 | 134 | 180 | 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| D = 8.417 | 100 | 2.11 | 12 * | 0.839 | | 10-#5+ 2 | 5 | #4 | #5 | 6-#7 | 7 | #4 | #4 | 11-#5 | 88 | 179 | 236 | 2.09 | 12 | | 5 | #4 | #4 | 6-#7 | 7 | #4 | #4 | 11-#5 |
| RIB ON | 150 | 2.43 | 12 * | 0.902 | | 10-#5+ 4 | 5 | #5 | #6 | 6-#8 | 7 | #4 | #4 | 11-#5 | 108 | 249 | 291 | 2.33 | 12 * | 3 S 4 1 | 5 | #4 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.71 | 12 * | 0.632 | | 10-#5+ 2 | 5 | #6 | #6 | 7-#8 | 7 | #4 | #4 | 11-#5 | 129 | 314 | 347 | 2.65 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| 0.654 CF/SF | 300 | 3.53 | 17 * | 0.626 | 3 S 4 1 | 6-#7+ 0 | 5 | #7 | #7 | 8-#9 | 7 | #5 | #5 | 11-#5 | 166 | 419 | 446 | 3.22 | 14 * | 3 S 4 2 | 5 | #6 | #6 | 7-#9 | 7 | #4 | #4 | 11-#5 |
| 26'-0" | 50 | 1.98 | 13 | 0.780 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 86 | 171 | 231 | 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| D = 10.417 | 100 | 2.16 | 13 * | 0.858 | | 8-#6+ 1 | 6 | #4 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 | 112 | 225 | 301 | 2.11 | 13 | | 6 | #4 | #4 | 7-#7 | 7 | #4 | #4 | 11-#5 |
| RIB NOT ON | 150 | 2.54 | 13 * | 0.630 | | 8-#6+ 1 | 6 | #5 | #6 | 8-#8 | 7 | #4 | #4 | 11-#5 | 138 | 314 | 372 | 2.44 | 13 * | 3 S 4 1 | 6 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.89 | 16 * | 0.627 | | 8-#6+ 2 | 6 | #6 | #6 | 7-#9 | 7 | #4 | #5 | 11-#5 | 163 | 392 | 438 | 2.72 | 13 * | 3 S 4 1 | 6 | #5 | #5 | 11-#7 | 7 | #4 | #4 | 11-#5 |
| 0.668 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 28'-0" | 50 | 2.10 | 14 * | 0.806 | | 8-#6+ 1 | 6 | #4 | #5 | 10-#6 | 8 | #4 | #4 | 12-#5 | 107 | 213 | 287 | 2.08 | 14 | | 6 | #4 | #4 | 7-#7 | 8 | #4 | #4 | 12-#5 |
| D = 10.417 | 100 | 2.38 | 14 * | 0.894 | | 8-#6+ 3 | 6 | #5 | #5 | 8-#8 | 8 | #4 | #4 | 12-#5 | 139 | 279 | 375 | 2.38 | 14 * | 3 S 4 1 | 6 | #4 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.86 | 16 * | 0.627 | | 8-#6+ 2 | 6 | #6 | #6 | 8-#9 | 8 | #4 | #5 | 12-#5 | 171 | 379 | 460 | 2.70 | 14 * | 3 S 4 1 | 6 | #5 | #5 | 7-#9 | 8 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 3.35 | 19 * | 0.624 | | 7-#7+ 2 | 6 | #7 | #7 | 9-#9 | 8 | #4 | #5 | 12-#5 | 201 | 462 | 541 | 3.12 | 15 * | 3 S 4 2 | 6 | #5 | #6 | 9-#9 | 8 | #4 | #4 | 12-#5 |
| 0.660 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.29 | 15 * | 0.857 | | 9-#6+ 3 | 6 | #5 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 | 131 | 261 | 352 | 2.25 | 15 | | 6 | #4 | #4 | 7-#8 | 9 | #4 | #4 | 14-#5 |
| D = 10.417 | 100 | 2.68 | 15 * | 0.932 | | 9-#6+ 6 | 6 | #6 | #6 | 8-#9 | 9 | #4 | #4 | 14-#5 | 171 | 342 | 460 | 2.55 | 15 * | 3 S 4 1 | 6 | #4 | #5 | 7-#9 | 9 | #4 | #4 | 14-#5 |
| RIB NOT ON | 150 | 3.18 | 19 * | 0.624 | | 7-#7+ 2 | 6 | #6 | #7 | 12-#8 | 9 | #4 | #5 | 14-#5 | 209 | 448 | 562 | 3.05 | 15 * | 3 S 4 2 | 6 | #5 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.654 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32'-0" | 50 | 2.36 | 16 * | 0.883 | | 10-#6+ 4 | 7 | #5 | #5 | 9-#8 | 9 | #4 | #4 | 14-#5 | 160 | 319 | 430 | 2.29 | 16 | | 7 | #4 | #4 | 11-#7 | 9 | #4 | #4 | 14-#5 |
| D = 12.417 | 100 | 2.86 | 18 * | 0.925 | | 10-#6+ 7 | 7 | #6 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 | 207 | 415 | 558 | 2.83 | 16 * | 3 S 4 1 | 7 | #5 | #5 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| RIB ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.666 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 in. | Rib Depth = 10 in. | | Total Slab Depth = 4 in. | | | | | | | | | | | | | | |
| 18'-0" | 50 | 1.99 | 12 | 0.634 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 30 | 60 | 80 |
| D = 6.417 | 100 | 1.99 | 12 | 0.634 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 38 | 77 | 103 |
| RIB NOT ON | 150 | 1.99 | 12 | 0.634 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 47 | 106 | 126 |
| COLUMN LINE | 200 | 1.99 | 12 | 0.634 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 55 | 133 | 149 |
| 0.742 CF/SF | 300 | 2.08 | 12 | 0.635 | | 5-#6+ 0 | 4 | #4 | #5 | 8-#5 | 5 | #4 | #4 | 8-#5 | 72 | 186 | 194 |
| | 400 | 2.41 | 12 | 0.717 | | 5-#6+ 0 | 4 | #5 | #6 | 5-#7 | 5 | #4 | #4 | 8-#5 | 89 | 238 | 240 |
| | 500 | 2.77 | 12 * | 0.832 | | 5-#6+ 1 | 4 | #6 | #6 | 6-#7 | 5 | #4 | #5 | 8-#5 | 106 | 289 | 285 |
| 20'-0" | 50 | 1.96 | 12 | 0.634 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 42 | 84 | 113 |
| D = 8.417 | 100 | 1.96 | 12 | 0.634 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 54 | 109 | 144 |
| RIB ON | 150 | 1.96 | 12 | 0.638 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 65 | 149 | 176 |
| COLUMN LINE | 200 | 2.04 | 12 | 0.680 | | 6-#6+ 0 | 5 | #4 | #5 | 6-#6 | 5 | #4 | #4 | 8-#5 | 77 | 187 | 208 |
| 0.765 CF/SF | 300 | 2.22 | 12 | 0.765 | | 6-#6+ 0 | 5 | #5 | #5 | 6-#7 | 5 | #4 | #4 | 8-#5 | 101 | 260 | 271 |
| | 400 | 2.59 | 12 * | 0.870 | | 6-#6+ 1 | 5 | #5 | #6 | 7-#7 | 5 | #4 | #5 | 8-#5 | 124 | 332 | 334 |
| | 500 | 3.10 | 12 * | 0.635 | | 6-#6+ 0 | 5 | #6 | #7 | 7-#8 | 5 | #5 | #5 | 8-#5 | 148 | 403 | 397 |
| 22'-0" | 50 | 1.98 | 12 | 0.634 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 56 | 112 | 151 |
| D = 8.417 | 100 | 1.98 | 12 | 0.655 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 72 | 145 | 193 |
| RIB ON | 150 | 2.07 | 12 | 0.703 | | 9-#5+ 0 | 5 | #4 | #5 | 7-#6 | 6 | #4 | #4 | 10-#5 | 87 | 199 | 236 |
| COLUMN LINE | 200 | 2.23 | 12 | 0.751 | | 9-#5+ 0 | 5 | #5 | #5 | 6-#7 | 6 | #4 | #4 | 10-#5 | 103 | 250 | 278 |
| 0.752 CF/SF | 300 | 2.74 | 12 * | 0.885 | | 9-#5+ 3 | 5 | #6 | #6 | 6-#8 | 6 | #4 | #5 | 10-#5 | 135 | 348 | 363 |
| | 400 | 3.21 | 12 * | 0.635 | | 9-#5+ 2 | 5 | #6 | #7 | 6-#9 | 6 | #5 | #5 | 10-#5 | 166 | 445 | 448 |
| | 500 | 3.90 | 15 * | 0.631 | 3 S 4 1 | 6-#7+ 0 | 5 | #7 | #8 | 7-#9 | 6 | #5 | #6 | 10-#5 | 195 | 529 | 524 |
| 24'-0" | 50 | 1.99 | 12 | 0.674 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 73 | 146 | 196 |
| D = 8.417 | 100 | 2.06 | 12 | 0.726 | | 10-#5+ 0 | 5 | #4 | #5 | 7-#6 | 7 | #4 | #4 | 11-#5 | 94 | 189 | 252 |
| RIB ON | 150 | 2.20 | 12 | 0.778 | | 10-#5+ 0 | 5 | #5 | #5 | 9-#6 | 7 | #4 | #4 | 11-#5 | 114 | 260 | 307 |
| COLUMN LINE | 200 | 2.43 | 12 * | 0.845 | | 10-#5+ 1 | 5 | #5 | #6 | 6-#8 | 7 | #4 | #4 | 11-#5 | 135 | 326 | 363 |
| 0.742 CF/SF | 300 | 3.04 | 12 * | 0.635 | | 10-#5+ 1 | 5 | #6 | #7 | 6-#9 | 7 | #4 | #5 | 11-#5 | 176 | 454 | 474 |
| | 400 | 3.71 | 16 * | 0.630 | 3 S 4 1 | 6-#7+ 1 | 5 | #7 | #8 | 8-#9 | 7 | #5 | #5 | 11-#5 | 213 | 566 | 574 |
| | 500 | 4.31 | 20 * | 0.626 | 3 S 4 1 | 7-#7+ 0 | 5 | #8 | #8 | 9-#9 | 7 | #5 | #6 | 11-#5 | 245 | 629 | 661 |
| 26'-0" | 50 | 1.98 | 13 | 0.710 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 94 | 187 | 252 |
| D = 10.417 | 100 | 2.12 | 13 | 0.765 | | 8-#6+ 0 | 6 | #4 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 | 120 | 239 | 322 |
| RIB NOT ON | 150 | 2.30 | 13 * | 0.856 | | 8-#6+ 2 | 6 | #5 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 | 146 | 329 | 393 |
| COLUMN LINE | 200 | 2.72 | 13 * | 0.909 | | 8-#6+ 3 | 6 | #6 | #6 | 8-#8 | 7 | #4 | #5 | 11-#5 | 172 | 413 | 464 |
| 0.760 CF/SF | 300 | 3.43 | 16 * | 0.630 | | 9-#6+ 1 | 6 | #7 | #7 | 8-#9 | 7 | #5 | #5 | 11-#5 | 222 | 570 | 599 |
| | 400 | 4.01 | 20 * | 0.626 | | 15-#5+ 4 | 6 | #7 | #8 | 10-#9 | 7 | #5 | #6 | 11-#5 | 266 | 663 | 716 |
| 28'-0" | 50 | 2.05 | 14 | 0.708 | | 8-#6+ 0 | 6 | #4 | #5 | 9-#6 | 8 | #4 | #4 | 12-#5 | 116 | 232 | 313 |
| D = 10.417 | 100 | 2.24 | 14 * | 0.819 | | 8-#6+ 2 | 6 | #5 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 | 149 | 298 | 401 |
| RIB NOT ON | 150 | 2.51 | 14 * | 0.883 | | 8-#6+ 3 | 6 | #5 | #6 | 8-#8 | 8 | #4 | #4 | 12-#5 | 182 | 402 | 489 |
| COLUMN LINE | 200 | 3.05 | 14 * | 0.632 | | 12-#5+ 3 | 6 | #6 | #7 | 8-#9 | 8 | #4 | #5 | 12-#5 | 214 | 507 | 577 |
| 0.750 CF/SF | 300 | 3.79 | 20 * | 0.626 | | 8-#7+ 2 | 6 | #7 | #8 | 10-#9 | 8 | #5 | #5 | 12-#5 | 273 | 673 | 735 |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 in. | Rib Depth = 10 in. | Total Slab Depth = 4 in. | | | | | | | | |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.27 | 12 | 3 S 4 1 | 4 | #4 | #5 | 9-#5 | 5 | #4 | #4 | 8-#5 |
| 2.56 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 6-#7 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 2.07 | 12 | | 5 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 8-#5 |
| 2.38 | 12 * | 3 S 4 1 | 5 | #4 | #5 | 9-#6 | 5 | #4 | #4 | 8-#5 |
| 2.64 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 6-#8 | 5 | #4 | #4 | 8-#5 |
| 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| 2.14 | 12 | | 5 | #4 | #4 | 6-#7 | 6 | #4 | #4 | 10-#5 |
| 2.52 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 7-#7 | 6 | #4 | #4 | 10-#5 |
| 2.91 | 12 * | 3 S 4 1 | 5 | #5 | #6 | 7-#8 | 6 | #4 | #4 | 10-#5 |
| 3.40 | 13 * | 3 S 4 2 | 5 | #6 | #6 | 11-#7 | 6 | #4 | #5 | 10-#5 |
| 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| 2.09 | 12 | | 5 | #4 | #4 | 6-#7 | 7 | #4 | #4 | 11-#5 |
| 2.33 | 12 | 3 S 4 1 | 5 | #4 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 |
| 2.87 | 12 * | 3 S 4 1 | 5 | #5 | #6 | 6-#9 | 7 | #4 | #4 | 11-#5 |
| 3.33 | 13 * | 3 S 4 2 | 5 | #6 | #6 | 8-#9 | 7 | #4 | #4 | 11-#5 |
| 3.91 | 18 * | 3 S 4 2 | 5 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 11-#5 |
| 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| 2.08 | 13 | | 6 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 11-#5 |
| 2.18 | 13 | | 6 | #4 | #4 | 8-#7 | 7 | #4 | #4 | 11-#5 |
| 2.44 | 13 * | 3 S 4 1 | 6 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| 3.06 | 13 * | 3 S 4 1 | 6 | #5 | #6 | 8-#9 | 7 | #4 | #4 | 11-#5 |
| 3.56 | 18 * | 3 S 4 2 | 6 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 11-#5 |
| 1.99 | 14 | | 6 | #4 | #4 | 12-#5 | 8 | #4 | #4 | 12-#5 |
| 2.14 | 14 | | 6 | #4 | #4 | 8-#7 | 8 | #4 | #4 | 12-#5 |
| 2.46 | 14 * | 3 S 4 1 | 6 | #4 | #5 | 8-#8 | 8 | #4 | #4 | 12-#5 |
| 2.85 | 14 * | 3 S 4 1 | 6 | #5 | #6 | 7-#9 | 8 | #4 | #4 | 12-#5 |
| 3.45 | 16 * | 3 S 4 2 | 6 | #6 | #6 | 12-#8 | 8 | #4 | #5 | 12-#5 |

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 in. | Rib Depth = 10 in. | | Total Slab Depth = 4 in. | | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.24 | 15 | 0.741 | | 9-#6+ 0 | 6 | #5 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 | 142 | 285 | 383 |
| D = 10.417 | 100 | 2.50 | 15 * | 0.845 | | 9-#6+ 2 | 6 | #5 | #6 | 11-#7 | 9 | #4 | #4 | 14-#5 | 183 | 365 | 492 |
| RIB NOT ON | 150 | 2.88 | 15 * | 0.631 | | 9-#6+ 1 | 6 | #6 | #7 | 8-#9 | 9 | #4 | #4 | 14-#5 | 223 | 483 | 600 |
| COLUMN LINE | 200 | 3.37 | 18 * | 0.628 | | 15-#5+ 3 | 6 | #7 | #7 | 10-#9 | 9 | #4 | #5 | 14-#5 | 261 | 605 | 702 |
| 0.742 CF/SF | | | | | | | | | | | | | | | | | |
| 32'-0" | 50 | 2.28 | 16 * | 0.809 | | 10-#6+ 2 | 7 | #5 | #5 | 14-#6 | 9 | #4 | #4 | 14-#5 | 174 | 348 | 468 |
| D = 12.417 | 100 | 2.63 | 16 * | 0.896 | | 10-#6+ 5 | 7 | #5 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 | 223 | 446 | 600 |
| RIB ON | 150 | 3.10 | 18 * | 0.628 | | 11-#6+ 3 | 7 | #6 | #7 | 10-#9 | 9 | #4 | #5 | 14-#5 | 270 | 573 | 728 |
| COLUMN LINE | 200 | 3.64 | 21 * | 0.625 | | 9-#7+ 4 | 7 | #7 | #7 | 12-#9 | 9 | #5 | #5 | 14-#5 | 315 | 702 | 849 |
| 0.756 CF/SF | | | | | | | | | | | | | | | | | |
| 34'-0" | 50 | 2.49 | 17 * | 0.840 | | 10-#6+ 4 | 7 | #5 | #6 | 10-#8 | 10 | #4 | #4 | 15-#5 | 208 | 416 | 560 |
| D = 12.417 | 100 | 2.81 | 17 * | 0.925 | | 15-#5+11 | 7 | #6 | #6 | 10-#9 | 10 | #4 | #4 | 15-#5 | 267 | 533 | 718 |
| RIB ON | 150 | 3.42 | 21 * | 0.625 | | 10-#7+ 3 | 7 | #7 | #7 | 12-#9 | 10 | #4 | #5 | 15-#5 | 322 | 659 | 866 |
| COLUMN LINE | 200 | 3.80 | 27 * | 0.621 | 3 S 4 1 | 11-#7+ 3 | 7 | #7 | #7 | 18-#8 | 10 | #5 | #5 | 15-#5 | 369 | 738 | 993 |
| 0.748 CF/SF | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.73 | 18 * | 0.865 | | 11-#6+ 5 | 7 | #6 | #6 | 9-#9 | 11 | #4 | #4 | 16-#5 | 246 | 492 | 662 |
| D = 12.417 | 100 | 3.17 | 20 * | 0.922 | | 9-#7+ 7 | 7 | #6 | #7 | 12-#9 | 11 | #4 | #5 | 16-#5 | 314 | 628 | 846 |
| RIB ON | 150 | 3.71 | 26 * | 0.622 | | 11-#7+ 3 | 7 | #7 | #8 | 15-#9 | 11 | #4 | #5 | 16-#5 | 377 | 754 | 1014 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.742 CF/SF | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.79 | 19 * | 0.898 | | 12-#6+ 8 | 8 | #6 | #6 | 11-#9 | 11 | #4 | #4 | 16-#5 | 291 | 582 | 783 |
| D = 14.417 | 100 | 3.42 | 23 * | 0.624 | | 11-#7+ 3 | 8 | #7 | #7 | 14-#9 | 11 | #4 | #5 | 16-#5 | 369 | 739 | 995 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.754 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 in. | Rib Depth = 10 in. | Total Slab Depth = 4 in. | | | | | | | | |
| 2.14 | 15 | | 6 | #4 | #4 | 8-#7 | 9 | #4 | #4 | 14-#5 |
| 2.43 | 15 | 3 S 4 1 | 6 | #4 | #5 | 8-#8 | 9 | #4 | #4 | 14-#5 |
| 2.76 | 15 * | 3 S 4 1 | 6 | #5 | #5 | 8-#9 | 9 | #4 | #4 | 14-#5 |
| 3.19 | 15 * | 3 S 4 2 | 6 | #6 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| 2.21 | 16 | | 7 | #4 | #4 | 10-#7 | 9 | #4 | #4 | 14-#5 |
| 2.55 | 16 * | | 7 | #4 | #5 | 10-#8 | 9 | #4 | #4 | 14-#5 |
| 2.85 | 16 * | 3 S 4 1 | 7 | #5 | #5 | 12-#8 | 9 | #4 | #4 | 14-#5 |
| 3.37 | 17 * | 3 S 4 2 | 7 | #6 | #6 | 11-#9 | 9 | #4 | #4 | 14-#5 |
| 2.42 | 17 | | 7 | #4 | #5 | 9-#8 | 10 | #4 | #4 | 15-#5 |
| 2.76 | 17 * | 3 S 4 1 | 7 | #5 | #5 | 9-#9 | 10 | #4 | #4 | 15-#5 |
| 3.21 | 17 * | 3 S 4 1 | 7 | #5 | #6 | 12-#9 | 10 | #4 | #4 | 15-#5 |
| 3.59 | 22 * | 3 S 4 2 | 7 | #6 | #6 | 14-#9 | 10 | #4 | #4 | 15-#5 |
| 2.70 | 18 | | 7 | #5 | #5 | 9-#9 | 11 | #4 | #4 | 16-#5 |
| 3.04 | 18 * | 3 S 4 1 | 7 | #5 | #6 | 11-#9 | 11 | #4 | #4 | 16-#5 |
| 3.46 | 19 * | 3 S 4 2 | 7 | #6 | #6 | 14-#9 | 11 | #4 | #4 | 16-#5 |
| 2.71 | 19 * | | 8 | #5 | #5 | 10-#9 | 11 | #4 | #4 | 16-#5 |
| 3.17 | 19 * | 3 S 4 1 | 8 | #5 | #6 | 13-#9 | 11 | #4 | #4 | 16-#5 |

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 16 in. | Rib Depth = 12 in. | | Total Slab Depth = 4 in. | | | | | | | | | | | | | | |
| 22'-0" | 50 | 1.98 | 12 | 0.637 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 61 | 122 | 164 |
| D = 8.417 | 100 | 1.98 | 12 | 0.637 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 77 | 153 | 206 |
| RIB ON | 150 | 1.98 | 12 | 0.637 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 92 | 206 | 249 |
| COLUMN LINE | 200 | 2.10 | 12 | 0.651 | | 9-#5+ 0 | 5 | #4 | #5 | 7-#6 | 6 | #4 | #4 | 10-#5 | 108 | 258 | 291 |
| 0.845 CF/SF | 300 | 2.46 | 12 | 0.768 | | 9-#5+ 1 | 5 | #5 | #6 | 7-#7 | 6 | #4 | #4 | 10-#5 | 140 | 357 | 376 |
| | 400 | 2.81 | 12 * | 0.875 | | 9-#5+ 3 | 5 | #6 | #6 | 7-#8 | 6 | #4 | #5 | 10-#5 | 171 | 454 | 461 |
| | 500 | 3.33 | 12 * | 0.638 | | 10-#5+ 1 | 5 | #7 | #7 | 6-#9 | 6 | #5 | #5 | 10-#5 | 203 | 550 | 546 |
| 24'-0" | 50 | 1.99 | 12 | 0.637 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 79 | 158 | 213 |
| D = 8.417 | 100 | 1.99 | 12 | 0.641 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 100 | 200 | 269 |
| RIB ON | 150 | 2.11 | 12 | 0.690 | | 10-#5+ 0 | 5 | #4 | #5 | 6-#7 | 7 | #4 | #4 | 11-# 5 | 120 | 269 | 324 |
| COLUMN LINE | 200 | 2.39 | 12 | 0.739 | | 10-#5+ 0 | 5 | #5 | #6 | 7-#7 | 7 | #4 | #4 | 11-#5 | 141 | 337 | 380 |
| 0.833 CF/SF | 300 | 2.92 | 12 * | 0.874 | | 10-#5+ 3 | 5 | #6 | #7 | 7-#8 | 7 | #4 | #5 | 11-#5 | 182 | 466 | 491 |
| | 400 | 3.42 | 12 * | 0.638 | 4 S 6 1 | 6-#7+ 0 | 5 | #7 | #7 | 7-#9 | 7 | #5 | #5 | 11-#5 | 224 | 593 | 602 |
| | 500 | 4.14 | 15 * | 0.634 | 4 S 6 1 | 9-#6+ 2 | 5 | #8 | #8 | 8-#9 | 7 | #5 | #6 | 11-#5 | 262 | 711 | 705 |
| 26'-0" | 50 | 1.98 | 13 | 0.636 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 102 | 203 | 273 |
| D = 10.417 | 100 | 2.00 | 13 | 0.687 | | 8-#6+ 0 | 6 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 11-#5 | 128 | 256 | 344 |
| RIB NOT ON | 150 | 2.24 | 13 | 0.768 | | 8-#6+ 1 | 6 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 | 154 | 342 | 415 |
| COLUMN LINE | 200 | 2.52 | 13 * | 0.833 | | 8-#6+ 2 | 6 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 11-#5 | 180 | 428 | 485 |
| 0.854 CF/SF | 300 | 3.19 | 13 * | 0.637 | | 8-#6+ 2 | 6 | #6 | #7 | 7-#9 | 7 | #5 | #5 | 11-#5 | 233 | 593 | 627 |
| | 400 | 3.87 | 16 * | 0.633 | | 7-#7+ 2 | 6 | #7 | #8 | 9-#9 | 7 | #5 | #6 | 11-#5 | 282 | 746 | 760 |
| | 500 | 4.54 | 19 * | 0.630 | | 8-#7+ 2 | 6 | #8 | #8 | 13-#8 | 7 | #6 | #6 | 11-#5 | 326 | 858 | 879 |
| 28'-0" | 50 | 1.95 | 14 | 0.634 | | 8-#6+ 0 | 6 | #4 | #4 | 12-#5 | 8 | #4 | #4 | 12-#5 | 126 | 252 | 340 |
| D = 10.417 | 100 | 2.12 | 14 | 0.693 | | 8-#6+ 0 | 6 | #4 | #5 | 8-#7 | 8 | #4 | #4 | 12-#5 | 159 | 318 | 428 |
| RIB NOT ON | 150 | 2.47 | 14 * | 0.803 | | 8-#6+ 2 | 6 | #5 | #6 | 8-#8 | 8 | #4 | #4 | 12-#5 | 192 | 419 | 516 |
| COLUMN LINE | 200 | 2.78 | 14 * | 0.877 | | 8-#6+ 4 | 6 | #6 | #6 | 7-#9 | 8 | #4 | #5 | 12-#5 | 224 | 527 | 604 |
| 0.842 CF/SF | 300 | 3.53 | 15 * | 0.634 | | 7-#7+ 2 | 6 | #7 | #7 | 9-#9 | 8 | #5 | #5 | 12-#5 | 289 | 730 | 778 |
| | 400 | 4.23 | 20 * | 0.629 | | 12-#6+ 2 | 6 | #8 | #8 | 11-#9 | 8 | #5 | #6 | 12-#5 | 347 | 895 | 933 |
| 30'-0" | 50 | 2.12 | 15 | 0.671 | | 9-#6+ 0 | 6 | #4 | #5 | 8-#7 | 9 | #4 | #4 | 14-#5 | 155 | 309 | 416 |
| D = 10.417 | 100 | 2.37 | 15 | 0.762 | | 9-#6+ 1 | 6 | #5 | #5 | 8-#8 | 9 | #4 | #4 | 14-#5 | 195 | 390 | 525 |
| RIB NOT ON | 150 | 2.68 | 15 * | 0.850 | | 9-#6+ 3 | 6 | #6 | #6 | 7-#9 | 9 | #4 | #4 | 14-#5 | 235 | 506 | 633 |
| COLUMN LINE | 200 | 3.09 | 15 * | 0.634 | | 9-#6+ 2 | 6 | #6 | #7 | 9-#9 | 9 | #4 | #5 | 14-#5 | 275 | 638 | 742 |
| 0.833 CF/SF | 300 | 4.09 | 19 * | 0.630 | | 12-#6+ 3 | 6 | #8 | #8 | 12-#9 | 9 | #5 | #5 | 14-#5 | 352 | 879 | 947 |
| 32'-0" | 50 | 2.18 | 16 | 0.754 | | 10-#6+ 2 | 7 | #4 | #5 | 10-#7 | 9 | #4 | #4 | 14-#5 | 189 | 378 | 509 |
| D = 12.417 | 100 | 2.54 | 16 * | 0.838 | | 10-#6+ 4 | 7 | #5 | #6 | 9-#8 | 9 | #4 | #4 | 14-#5 | 238 | 476 | 641 |
| RIB ON | 150 | 2.95 | 16 * | 0.901 | | 10-#6+ 6 | 7 | #6 | #6 | 9-#9 | 9 | #4 | #5 | 14-#5 | 287 | 607 | 772 |
| COLUMN LINE | 200 | 3.47 | 17 * | 0.632 | | 12-#6+ 2 | 7 | #7 | #7 | 11-#9 | 9 | #5 | #5 | 14-#5 | 335 | 766 | 901 |
| 0.849 CF/SF | 300 | 4.34 | 23 * | 0.626 | 4 S 6 1 | 11-#7+ 3 | 7 | #8 | #8 | 14-#9 | 9 | #5 | #6 | 14-#5 | 422 | 992 | 1135 |
| 34'-0" | 50 | 2.37 | 17 | 0.775 | | 10-#6+ 3 | 7 | #5 | #5 | 9-#8 | 10 | #4 | #4 | 15-#5 | 226 | 451 | 608 |
| D = 12.417 | 100 | 2.78 | 17 * | 0.858 | | 10-#6+ 5 | 7 | #6 | #6 | 9-#9 | 10 | #4 | #4 | 15-#5 | 284 | 569 | 766 |
| RIB ON | 150 | 3.17 | 17 * | 0.632 | | 12-#6+ 2 | 7 | #6 | #7 | 11-#9 | 10 | #4 | #5 | 15-#5 | 343 | 708 | 924 |
| COLUMN LINE | 200 | 3.74 | 20 * | 0.629 | | 10-#7+ 3 | 7 | #7 | #8 | 13-#9 | 10 | #5 | #5 | 15-#5 | 399 | 894 | 1073 |
| 0.840 CF/SF | 300 | 4.57 | 27 * | 0.624 | 4 S 6 1 | 10-#8+ 1 | 7 | #8 | #8 | 17-#9 | 10 | #5 | #6 | 17-#5 | 496 | 993 | 1336 |
| 36'-0" | 50 | 2.52 | 18 * | 0.796 | | 11-#6+ 3 | 7 | #5 | #6 | 9-#9 | 11 | #4 | #4 | 16-#5 | 267 | 534 | 719 |
| D = 12.417 | 100 | 2.92 | 18 * | 0.892 | | 12-#6+ 6 | 7 | #6 | #7 | 11-#9 | 11 | #4 | #4 | 16-#5 | 337 | 673 | 906 |
| RIB ON | 150 | 3.35 | 20 * | 0.629 | | 10-#7+ 3 | 7 | #7 | #7 | 13-#9 | 11 | #4 | #5 | 16-#5 | 404 | 809 | 1089 |
| COLUMN LINE | 200 | 4.11 | 24 * | 0.625 | 4 S 6 1 | 9-#8+ 2 | 7 | #8 | #8 | 16-#9 | 11 | #5 | #5 | 16-#5 | 469 | 1026 | 1263 |
| 0.833 CF/SF | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.67 | 19 * | 0.846 | | 12-#6+ 6 | 8 | #6 | #6 | 10-#9 | 11 | #4 | #4 | 16-#5 | 316 | 632 | 851 |
| D = 14.417 | 100 | 3.20 | 19 * | 0.926 | | 10-#7+ 7 | 8 | #6 | #7 | 16-#8 | 11 | #4 | #5 | 16-#5 | 398 | 796 | 1071 |
| RIB NOT ON | 150 | 3.76 | 23 * | 0.626 | | 12-#7+ 5 | 8 | #7 | #7 | 16-#9 | 11 | #5 | #5 | 16-#5 | 475 | 951 | 1280 |
| COLUMN LINE | 200 | 4.38 | 29 * | 0.622 | | 14-#7+ 4 | 8 | #7 | #8 | 18-#9 | 11 | #5 | #6 | 19-#5 | 545 | 1090 | 1467 |
| 0.847 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 16 in. | Rib Depth = 12 in. | | Total Slab Depth = 4 in. | | | | | | | | | |
| 22'-0" | 50 | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| D = 8.417 | 100 | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| RIB ON | 150 | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.07 | 12 | | 5 | #4 | #4 | 7-#6 | 6 | #4 | #4 | 10-#5 |
| 0.845 CF/SF | 300 | 2.35 | 12 | | 5 | #4 | #5 | 9-#6 | 6 | #4 | #4 | 10-#5 |
| | 400 | 2.58 | 12 * | 4 S 6 1 | 5 | #5 | #5 | 6-#8 | 6 | #4 | #4 | 10-#5 |
| | 500 | 2.91 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 7-#8 | 6 | #4 | #4 | 10-#5 |
| 24'-0" | 50 | 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| D = 8.417 | 100 | 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| RIB ON | 150 | 2.09 | 12 | | 5 | #4 | #4 | 6-#7 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.29 | 12 | | 5 | #4 | #5 | 9-#6 | 7 | #4 | #4 | 11-#5 |
| 0.833 CF/SF | 300 | 2.65 | 12 * | 4 S 6 1 | 5 | #5 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| | 400 | 3.06 | 12 * | 4 S 6 2 | 5 | #6 | #6 | 8-#8 | 7 | #4 | #4 | 11-#5 |
| | 500 | 3.69 | 12 * | 4 S 6 2 | 5 | #6 | #7 | 8-#9 | 7 | #4 | #5 | 11-#5 |
| 26'-0" | 50 | 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| D = 10.417 | 100 | 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| RIB NOT ON | 150 | 2.11 | 13 | | 6 | #4 | #4 | 7-#7 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.44 | 13 | | 6 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| 0.854 CF/SF | 300 | 2.88 | 13 * | 4 S 6 1 | 6 | #5 | #6 | 11-#7 | 7 | #4 | #4 | 11-#5 |
| | 400 | 3.36 | 13 * | 4 S 6 1 | 6 | #6 | #6 | 8-#9 | 7 | #4 | #5 | 11-#5 |
| | 500 | 4.06 | 17 * | 4 S 6 2 | 6 | #6 | #7 | 10-#9 | 7 | #5 | #5 | 11-#5 |
| 28'-0" | 50 | 1.97 | 14 | | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 |
| D = 10.417 | 100 | 2.09 | 14 | | 6 | #4 | #4 | 10-#6 | 8 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.38 | 14 | | 6 | #4 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.58 | 14 * | 4 S 6 1 | 6 | #5 | #5 | 8-#8 | 8 | #4 | #4 | 12-#5 |
| 0.842 CF/SF | 300 | 3.27 | 14 * | 4 S 6 1 | 6 | #6 | #6 | 9-#9 | 8 | #4 | #4 | 12-#5 |
| | 400 | 3.76 | 16 * | 4 S 6 2 | 6 | #6 | #7 | 13-#8 | 8 | #4 | #5 | 12-#5 |
| 30'-0" | 50 | 2.08 | 15 | | 6 | #4 | #4 | 7-#7 | 9 | #4 | #4 | 14-#5 |
| D = 10.417 | 100 | 2.36 | 15 | | 6 | #4 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 |
| RIB NOT ON | 150 | 2.61 | 15 | 4 S 6 1 | 6 | #5 | #5 | 11-#7 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | 200 | 2.90 | 15 * | 4 S 6 1 | 6 | #5 | #6 | 8-#9 | 9 | #4 | #4 | 14-#5 |
| 0.833 CF/SF | 300 | 3.79 | 15 * | 4 S 6 2 | 6 | #6 | #7 | 11-#9 | 9 | #4 | #5 | 14-#5 |
| 32'-0" | 50 | 2.15 | 16 | | 7 | #4 | #4 | 9-#7 | 9 | #4 | #4 | 14-#5 |
| D = 12.417 | 100 | 2.48 | 16 | | 7 | #4 | #5 | 9-#8 | 9 | #4 | #4 | 14-#5 |
| RIB ON | 150 | 2.83 | 16 * | 4 S 6 1 | 7 | #5 | #5 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | 200 | 3.07 | 16* | 4 S 6 1 | 7 | #5 | #6 | 10-#9 | 9 | #4 | #4 | 14-#5 |
| 0.849 CF/SF | 300 | 3.86 | 19 * | 4 S 6 2 | 7 | #6 | #7 | 16-#8 | 9 | #4 | #5 | 14-#5 |
| 34'-0" | 50 | 2.37 | 17 | | 7 | #4 | #5 | 11-#7 | 10 | #4 | #4 | 15-#5 |
| D = 12.417 | 100 | 2.76 | 17 | | 7 | #5 | #5 | 9-#9 | 10 | #4 | #4 | 15-#5 |
| RIB ON | 150 | 2.99 | 17 * | 4 S 6 1 | 7 | #5 | #6 | 10-#9 | 10 | #4 | #4 | 15-#5 |
| COLUMN LINE | 200 | 3.35 | 17 * | 4 S 6 2 | 7 | #6 | #6 | 12-#9 | 10 | #4 | #4 | 15-#5 |
| 0.840 CF/SF | 300 | 4.17 | 24 * | 4 S 6 2 | 7 | #6 | #7 | 16-#9 | 10 | #4 | #5 | 16-#5 |
| 36'-0" | 50 | 2.44 | 18 | | 7 | #4 | #5 | 10-#8 | 11 | #4 | #4 | 16-#5 |
| D = 12.417 | 100 | 2.78 | 18 * | 4 S 6 1 | 7 | #5 | #5 | 10-#9 | 11 | #4 | #4 | 16-#5 |
| RIB ON | 150 | 3.12 | 18 * | 4 S 6 2 | 7 | #5 | #6 | 12-#9 | 11 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 3.75 | 18 * | 4 S 6 2 | 7 | #6 | #7 | 15-#9 | 11 | #4 | #4 | 16-#5 |
| 0.833 CF/SF | | | | | | | | | | | | |
| 38'-0" | 50 | 2.54 | 19 | | 8 | #4 | #5 | 12-#8 | 11 | #4 | #4 | 16-#5 |
| D = 14.417 | 100 | 3.05 | 19 * | 4 S 6 1 | 8 | #5 | #6 | 12-#9 | 11 | #4 | #4 | 16-#5 |
| RIB NOT ON | 150 | 3.52 | 19 * | 4 S 6 1 | 8 | #6 | #6 | 15-#9 | 11 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 4.10 | 22 * | 4 S 6 2 | 8 | #6 | #7 | 17-#9 | 11 | #4 | #5 | 18-#5 |
| 0.847 CF/SF | | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 in. | Rib Depth = 14 in. | | Total Slab Depth = 4 in. | | | | | | | | | | | | | | | Total Depth = 18 in. | Rib Depth = 14 in. | | Total Slab Depth = 4 in. | | | | | | | |
| 24'-0" | 50 | 1.99 | 12 | 0.640 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 86 | 171 | 230 | 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| D = 8.417 | 100 | 1.99 | 12 | 0.640 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 106 | 212 | 286 | 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| RIB ON | 150 | 2.08 | 12 | 0.640 | | 10-#5+ 0 | 5 | #4 | #5 | 6-#7 | 7 | #4 | #4 | 11-#5 | 127 | 278 | 342 | 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.18 | 12 | 0.644 | | 10-#5+ 0 | 5 | #5 | #5 | 6-#7 | 7 | #4 | #4 | 11-#5 | 148 | 347 | 397 | 2.09 | 12 | | 5 | #4 | #4 | 6-#7 | 7 | #4 | #4 | 11-#5 |
| 0.927 CF/SF | 300 | 2.60 | 12 | 0.762 | | 10-#5+ 1 | 5 | #6 | #6 | 6-#8 | 7 | #4 | #4 | 11-#5 | 189 | 478 | 508 | 2.50 | 12 | 4 S 6 1 | 5 | #5 | #5 | 6-#8 | 7 | #4 | #4 | 11-#5 |
| | 400 | 3.01 | 12 * | 0.641 | | 10-#5+ 1 | 5 | #6 | #7 | 6-#9 | 7 | #4 | #5 | 11-#5 | 230 | 605 | 619 | 2.82 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| | 500 | 3.65 | 12 * | 0.641 | 4 S 6 1 | 6-#7+ 1 | 5 | #7 | #8 | 8-#9 | 7 | #5 | #5 | 11-#5 | 271 | 732 | 730 | 3.21 | 12 * | 4 S 6 2 | 5 | #6 | #6 | 7-#9 | 7 | #4 | #4 | 11-#5 |
| 26'-0" | 50 | 1.98 | 13 | 0.638 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 110 | 220 | 296 | 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| D = 10.417 | 100 | 1.98 | 13 | 0.638 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 136 | 272 | 367 | 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| RIB NOT ON | 150 | 2.12 | 13 | 0.654 | | 8-#6+ 0 | 6 | #4 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 | 162 | 353 | 437 | 2.08 | 13 | | 6 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.33 | 13 | 0.736 | | 8-#6+ 1 | 6 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 | 189 | 441 | 508 | 2.31 | 13 | | 6 | #4 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 |
| 0.950 CF/SF | 300 | 2.83 | 13 * | 0.856 | | 8-#6+ 3 | 6 | #6 | #6 | 8-#8 | 7 | #4 | #5 | 11-#5 | 241 | 608 | 649 | 2.65 | 13 | 4 S 6 1 | 6 | #5 | #5 | 8-#8 | 7 | #4 | #4 | 11-#5 |
| | 400 | 3.45 | 13 * | 0.639 | | 9-#6+ 1 | 6 | #7 | #7 | 8-#9 | 7 | #5 | #5 | 11-#5 | 294 | 770 | 790 | 3.09 | 13 * | 4 S 6 1 | 6 | #5 | #6 | 7-#9 | 7 | #4 | #5 | 11-#5 |
| | 500 | 3.97 | 14 * | 0.638 | | 10-#6+ 1 | 6 | #7 | #8 | 12-#8 | 7 | #5 | #6 | 11-#5 | 345 | 928 | 928 | 3.53 | 13 * | 4 S 6 2 | 6 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 11-#5 |
| 28'-0" | 50 | 1.95 | 14 | 0.637 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 | 137 | 273 | 368 | 1.97 | 14 | | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 |
| D = 10.417 | 100 | 2.10 | 14 | 0.637 | | 8-#6+ 0 | 6 | #4 | #5 | 10-#6 | 8 | #4 | #4 | 12-#5 | 169 | 339 | 456 | 2.08 | 14 | | 6 | #4 | #4 | 7-#7 | 8 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.24 | 14 | 0.704 | | 8-#6+ 1 | 6 | #5 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 | 202 | 435 | 544 | 2.14 | 14 | | 6 | #4 | #4 | 8-#7 | 8 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.55 | 14 | 0.781 | | 8-#6+ 2 | 6 | #6 | #6 | 8-#8 | 8 | #4 | #4 | 12-#5 | 235 | 545 | 632 | 2.38 | 14 | | 6 | #4 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 |
| 0.937 CF/SF | 300 | 3.32 | 14 * | 0.638 | | 9-#6+ 2 | 6 | #7 | #7 | 8-#9 | 8 | #5 | #5 | 12-#5 | 300 | 752 | 809 | 2.96 | 14 * | 4 S 6 1 | 6 | #5 | #6 | 8-#9 | 8 | #4 | #4 | 12-#5 |
| | 400 | 3.99 | 15 * | 0.637 | | 8-#7+ 2 | 6 | #7 | #8 | 10-#9 | 8 | #5 | #6 | 12-#5 | 365 | 952 | 982 | 3.62 | 14 * | 4 S 6 2 | 6 | #6 | #7 | 12-#8 | 8 | #4 | #5 | 12-#5 |
| 30'-0" | 50 | 2.09 | 15 | 0.636 | | 9-#6+ 0 | 6 | #4 | #5 | 7-#7 | 9 | #4 | #4 | 14-#5 | 167 | 334 | 450 | 2.05 | 15 | | 6 | #4 | #4 | 9-#6 | 9 | #4 | #4 | 14-#5 |
| D = 10.417 | 100 | 2.29 | 15 | 0.659 | | 9-#6+ 0 | 6 | #5 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 | 207 | 415 | 559 | 2.25 | 15 | | 6 | #4 | #4 | 7-#8 | 9 | #4 | #4 | 14-#5 |
| RIB NOT ON | 150 | 2.50 | 15 | 0.748 | | 9-#6+ 1 | 6 | #5 | #6 | 11-#7 | 9 | #4 | #4 | 14-#5 | 248 | 526 | 667 | 2.43 | 15 | | 6 | #4 | #5 | 8-#8 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | 200 | 2.93 | 15 * | 0.836 | | 9-#6+ 3 | 6 | #6 | #7 | 8-#9 | 9 | #4 | #5 | 14-#5 | 288 | 662 | 776 | 2.67 | 15 | 4 S 6 1 | 6 | #5 | #5 | 7-#9 | 9 | #4 | #4 | 14-#5 |
| 0.927 CF/SF | 300 | 3.63 | 15 * | 0.637 | | 8-#7+ 2 | 6 | #7 | #8 | 10-#9 | 9 | #5 | #5 | 14-#5 | 369 | 916 | 993 | 3.22 | 15 * | 4 S 6 2 | 6 | #6 | #6 | 12-#8 | 9 | #4 | #4 | 14-#5 |
| 32'-0" | 50 | 2.17 | 16 | 0.669 | | 10-#6+ 1 | 7 | #4 | #5 | 9-#7 | 9 | #4 | #4 | 14-#5 | 205 | 409 | 551 | 2.15 | 16 | | 7 | #4 | #4 | 9-#7 | 9 | #4 | #4 | 14-#5 |
| D = 12.417 | 100 | 2.36 | 16 | 0.769 | | 10-#6+ 3 | 7 | #5 | #5 | 9-#8 | 9 | #4 | #4 | 14-#5 | 253 | 507 | 682 | 2.29 | 16 | | 7 | #4 | #4 | 11-#7 | 9 | #4 | #4 | 14-#5 |
| RIB ON | 150 | 2.72 | 16 * | 0.843 | | 10-#6+ 5 | 7 | #6 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 | 302 | 634 | 814 | 2.55 | 16 | | 7 | #4 | #5 | 10-#8 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | 200 | 3.14 | 16 * | 0.895 | | 15-#5+ 8 | 7 | #6 | #7 | 12-#8 | 9 | #4 | #5 | 14-#5 | 351 | 799 | 946 | 2.98 | 16 * | 4 S 6 1 | 7 | #5 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| 0.946 CF/SF | 300 | 4.11 | 18 * | 0.633 | | 10-#7+ 3 | 7 | #7 | #8 | 16-#8 | 9 | #5 | #6 | 14-#5 | 447 | 1101 | 1202 | 3.78 | 16 * | 4 S 6 2 | 7 | #6 | #7 | 12-#9 | 9 | #4 | #5 | 14-#5 |
| 34'-0" | 50 | 2.25 | 17 | 0.698 | | 10-#6+ 2 | 7 | #5 | #5 | 11-#7 | 10 | #4 | #4 | 15-#5 | 244 | 489 | 658 | 2.17 | 17 | | 7 | #4 | #4 | 10-#7 | 10 | #4 | #4 | 15-#5 |
| D = 12.417 | 100 | 2.56 | 17 * | 0.794 | | 10-#6+ 4 | 7 | #5 | #6 | 9-#9 | 10 | #4 | #4 | 15-#5 | 303 | 606 | 816 | 2.49 | 17 | | 7 | #4 | #5 | 10-#8 | 10 | #4 | #4 | 15-#5 |
| RIB ON | 150 | 3.01 | 17 * | 0.874 | | 11-#6+ 6 | 7 | #6 | #7 | 10-#9 | 10 | #4 | #5 | 15-#5 | 362 | 742 | 973 | 2.76 | 17 * | 4 S 6 1 | 7 | #5 | #5 | 9-#9 | 10 | #4 | #4 | 15-#5 |
| COLUMN LINE | 200 | 3.54 | 17 * | 0.634 | | 9-#7+ 2 | 7 | #7 | #7 | 12-#9 | 10 | #5 | #5 | 15-#5 | 420 | 942 | 1131 | 3.26 | 17 * | 4 S 6 1 | 7 | #6 | #6 | 11-#9 | 10 | #4 | #4 | 15-#5 |
| 0.935 CF/SF | 300 | 4.43 | 22 * | 0.629 | 4 S 6 1 | 9-#8+ 1 | 7 | #8 | #8 | 15-#9 | 10 | #5 | #6 | 16-#5 | 529 | 1272 | 1425 | 4.06 | 18 * | 4 S 6 2 | 7 | #7 | #7 | 14-#9 | 10 | #4 | #5 | 15-#5 |
| 36'-0" | 50 | 2.45 | 18 | 0.724 | | 11-#6+ 2 | 7 | #5 | #6 | 10-#8 | 11 | #4 | #4 | 16-#5 | 289 | 578 | 778 | 2.38 | 18 | | 7 | #4 | #5 | 9-#8 | 11 | #4 | #4 | 16-#5 |
| D = 12.417 | 100 | 2.75 | 18 * | 0.829 | | 11-#6+ 5 | 7 | #6 | #6 | 10-#9 | 11 | #4 | #4 | 16-#5 | 359 | 717 | 965 | 2.70 | 18 | 4 S 6 1 | 7 | #5 | #5 | 9-#9 | 11 | #4 | #4 | 16-#5 |
| RIB ON | 150 | 3.19 | 18 * | 0.914 | | 10-#7+ 6 | 7 | #6 | #7 | 12-#9 | 11 | #4 | #5 | 16-#5 | 428 | 857 | 1153 | 3.04 | 18 * | 4 S 6 1 | 7 | #5 | #6 | 11-#9 | 11 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 3.75 | 19 * | 0.632 | | 11-#7+ 3 | 7 | #7 | #8 | 14-#9 | 11 | #5 | #5 | 16-#5 | 497 | 1092 | 1337 | 3.38 | 18 * | 4 S 6 2 | 7 | #6 | #6 | 13-#9 | 11 | #4 | #4 | 16-#5 |
| 0.927 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.54 | 19 * | 0.766 | | 12-#6+ 3 | 8 | #5 | #6 | 12-#8 | 11 | #4 | #4 | 16-#5 | 342 | 684 | 921 | 2.48 | 19 | | 8 | #4 | #5 | 11-#8 | 11 | #4 | #4 | 16-#5 |
| D = 14.417 | 100 | 3.06 | 19 * | 0.867 | | 18-#5+ 9 | 8 | #6 | #7 | 12-#9 | 11 | #4 | #5 | 16-#5 | 424 | 848 | 1141 | 2.83 | 19 * | | 8 | #5 | #5 | 11-#9 | 11 | #4 | #4 | 16-#5 |
| RIB NOT ON | 150 | 3.42 | 19 * | 0.632 | | 11-#7+ 3 | 8 | #7 | #7 | 14-#9 | 11 | #4 | #5 | 16-#5 | 506 | 1012 | 1362 | 3.17 | 19 * | 4 S 6 1 | 8 | #5 | #6 | 13-#9 | 11 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 4.24 | 23 * | 0.628 | | 10-#8+ 3 | 8 | #7 | #8 | 17-#9 | 11 | #5 | #6 | 17-#5 | 582 | 1259 | 1568 | 3.91 | 19 * | 4 S 6 2 | 8 | #6 | #7 | 16-#9 | 11 | #4 | #5 | 16-#5 |
| 0.942 CF/SF | 300 | 4.81 | 30 * | 0.624 | | 32-#5+ 5 | 8 | #8 | #8 | 21-#9 | 11 | #5 | #6 | 16-#6 | 719 | 1437 | 1935 | 4.45 | 27 * | 4 S 6 2 | 8 | #6 | #7 | 20-#9 | 11 | #4 | #5 | 20-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments $-M$ Edge (ft-k) | Moments $+M$ Bot. (ft-k) | Moments $-M$ Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 20 in. | Rib Depth = 16 in. | Total Slab Depth = 4 in. | | | | | | | | | | | | | | | |
| 26'-0" | 50 | 1.98 | 13 | 0.641 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 119 | 237 | 319 |
| D = 10.417 | 100 | 1.98 | 13 | 0.641 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 145 | 290 | 390 |
| RIB NOT ON | 150 | 2.09 | 13 | 0.641 | | 8-#6+ 0 | 6 | #4 | #5 | 9-#6 | 7 | #4 | #4 | 11-#5 | 171 | 364 | 461 |
| COLUMN LINE | 200 | 2.24 | 13 | 0.641 | | 8-#6+ 0 | 6 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 | 197 | 454 | 531 |
| 1.050 CF/SF | 300 | 2.78 | 13 | 0.767 | | 8-#6+ 2 | 6 | #6 | #6 | 8-#8 | 7 | #4 | #5 | 11-#5 | 250 | 622 | 672 |
| | 400 | 3.19 | 13 * | 0.870 | | 8-#6+ 4 | 6 | #6 | #7 | 7-#9 | 7 | #5 | #5 | 11-#5 | 302 | 786 | 814 |
| | 500 | 3.73 | 13 * | 0.642 | | 9-#6+ 2 | 6 | #7 | #7 | 9-#9 | 7 | #5 | #6 | 11-#5 | 355 | 947 | 955 |
| 28'-0" | 50 | 1.95 | 14 | 0.639 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 | 147 | 295 | 396 |
| D = 10.417 | 100 | 2.08 | 14 | 0.639 | | 8-#6+ 0 | 6 | #4 | #5 | 7-#7 | 8 | #4 | #4 | 12-#5 | 180 | 360 | 485 |
| RIB NOT ON | 150 | 2.22 | 14 | 0.639 | | 8-#6+ 0 | 6 | #5 | #5 | 8-#7 | 8 | #4 | #4 | 12-#5 | 213 | 449 | 573 |
| COLUMN LINE | 200 | 2.45 | 14 | 0.673 | | 8-#6+ 1 | 6 | #5 | #6 | 7-#8 | 8 | #4 | #4 | 12-#5 | 246 | 561 | 661 |
| 1.035 CF/SF | 300 | 3.04 | 14 * | 0.830 | | 8-#6+ 4 | 6 | #6 | #7 | 8-#9 | 8 | #4 | #5 | 12-#5 | 311 | 771 | 837 |
| | 400 | 3.66 | 14 * | 0.640 | | 7-#7+ 0 | 6 | #7 | #8 | 9-#9 | 8 | #5 | #5 | 12-#5 | 377 | 975 | 1014 |
| | 500 | 4.21 | 14 * | 0.640 | | 12-#6+ 1 | 6 | #8 | #8 | 11-#9 | 8 | #5 | #6 | 12-#5 | 442 | 1176 | 1190 |
| 30'-0" | 50 | 2.09 | 15 | 0.638 | | 9-#6+ 0 | 6 | #4 | #5 | 7-#7 | 9 | #4 | #4 | 14-#5 | 180 | 361 | 485 |
| D = 10.417 | 100 | 2.24 | 15 | 0.638 | | 9-#6+ 0 | 6 | #5 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 | 221 | 441 | 594 |
| RIB NOT ON | 150 | 2.45 | 15 | 0.638 | | 9-#6+ 0 | 6 | #5 | #6 | 8-#8 | 9 | #4 | #4 | 14-#5 | 261 | 544 | 702 |
| COLUMN LINE | 200 | 2.68 | 15 | 0.750 | | 9-#6+ 2 | 6 | #6 | #6 | 7-#9 | 9 | #4 | #4 | 14-#5 | 301 | 682 | 811 |
| 1.023 CF/SF | 300 | 3.45 | 15 * | 0.863 | | 7-#7+ 2 | 6 | #7 | #7 | 9-#9 | 9 | #5 | #5 | 14-#5 | 382 | 940 | 1028 |
| | 400 | 4.23 | 15 * | 0.639 | | 7-#8+ 0 | 6 | #8 | #8 | 12-#9 | 9 | #5 | #6 | 14-#5 | 462 | 1190 | 1245 |
| 32'-0" | 50 | 2.13 | 16 | 0.637 | | 10-#6+ 0 | 7 | #4 | #5 | 9-#7 | 9 | #4 | #4 | 14-#5 | 221 | 441 | 594 |
| D = 12.417 | 100 | 2.30 | 16 | 0.637 | | 10-#6+ 0 | 7 | #5 | #5 | 11-#7 | 9 | #4 | #4 | 14-#5 | 270 | 539 | 726 |
| RIB ON | 150 | 2.55 | 16 | 0.717 | | 10-#6+ 1 | 7 | #5 | #6 | 10-#8 | 9 | #4 | #4 | 14-#5 | 318 | 657 | 857 |
| COLUMN LINE | 200 | 2.95 | 16 * | 0.808 | | 10-#6+ 3 | 7 | #6 | #6 | 9-#9 | 9 | #4 | #5 | 14-#5 | 367 | 825 | 989 |
| 1.045 CF/SF | 300 | 3.95 | 16 * | 0.638 | | 9-#7+ 2 | 7 | #7 | #8 | 12-#9 | 9 | #5 | #6 | 14-#5 | 465 | 1138 | 1252 |
| | 400 | 4.61 | 19 * | 0.634 | | 11-#7+ 3 | 7 | #8 | #8 | 14-#9 | 9 | #6 | #6 | 15-#5 | 558 | 1430 | 1503 |
| 34'-0" | 50 | 2.25 | 17 | 0.635 | | 10-#6+ 0 | 7 | #5 | #5 | 11-#7 | 10 | #4 | #4 | 15-#5 | 263 | 527 | 709 |
| D = 12.417 | 100 | 2.49 | 17 | 0.636 | | 10-#6+ 0 | 7 | #5 | #6 | 10-#8 | 10 | #4 | #4 | 15-#5 | 322 | 644 | 867 |
| RIB ON | 150 | 2.78 | 17 * | 0.774 | | 10-#6+ 3 | 7 | #6 | #6 | 9-#9 | 10 | #4 | #4 | 15-#5 | 381 | 772 | 1025 |
| COLUMN LINE | 200 | 3.26 | 17 * | 0.869 | | 12-#6+ 5 | 7 | #7 | #7 | 11-#9 | 10 | #4 | #5 | 15-#5 | 439 | 975 | 1183 |
| 1.033 CF/SF | 300 | 4.25 | 17 * | 0.636 | | 11-#7+ 3 | 7 | #8 | #8 | 14-#9 | 10 | #5 | #6 | 15-#5 | 557 | 1349 | 1499 |
| 36'-0" | 50 | 2.45 | 18 | 0.639 | | 11-#6+ 1 | 7 | #5 | #6 | 10-#8 | 11 | #4 | #4 | 16-#5 | 312 | 623 | 839 |
| D = 12.417 | 100 | 2.73 | 18 | 0.765 | | 11-#6+ 4 | 7 | #6 | #6 | 9-#9 | 11 | #4 | #4 | 16-#5 | 381 | 762 | 1026 |
| RIB ON | 150 | 2.99 | 18 * | 0.841 | | 12-#6+ 5 | 7 | #6 | #7 | 11-#9 | 11 | #4 | #4 | 16-#5 | 451 | 902 | 1214 |
| COLUMN LINE | 200 | 3.53 | 18 * | 0.635 | | 10-#7+ 1 | 7 | #7 | #8 | 13-#9 | 11 | #4 | #5 | 16-#5 | 520 | 1136 | 1401 |
| 1.023 CF/SF | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.53 | 19 | 0.672 | | 12-#6+ 1 | 8 | #5 | #6 | 11-#8 | 11 | #4 | #4 | 16-#5 | 369 | 738 | 993 |
| D = 14.417 | 100 | 2.79 | 19 * | 0.803 | | 12-#6+ 5 | 8 | #6 | #6 | 11-#9 | 11 | #4 | #4 | 16-#5 | 451 | 902 | 1214 |
| RIB NOT ON | 150 | 3.24 | 19 * | 0.889 | | 11-#7+ 5 | 8 | #6 | #7 | 13-#9 | 11 | #4 | #5 | 16-#5 | 533 | 1066 | 1434 |
| COLUMN LINE | 200 | 3.81 | 19 * | 0.634 | | 12-#7+ 3 | 8 | #7 | #8 | 16-#9 | 11 | #5 | #5 | 16-#5 | 615 | 1324 | 1655 |
| 1.041 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 20 in. | Rib Depth = 16 in. | Total Slab Depth = 4 in. | | | | | | | | |
| 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| 2.02 | 13 | | 6 | #4 | #4 | 12-#5 | 7 | #4 | #4 | 11-#5 |
| 2.11 | 13 | | 6 | #4 | #4 | 7-#7 | 7 | #4 | #4 | 11-#5 |
| 2.57 | 13 | | 6 | #5 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| 2.88 | 13 * | 4 S 6 1 | 6 | #5 | #6 | 11-#7 | 7 | #4 | #4 | 11-#5 |
| 3.36 | 13 * | 4 S 6 1 | 6 | #6 | #6 | 8-#9 | 7 | #4 | #5 | 11-#5 |
| 1.97 | 14 | | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 |
| 2.04 | 14 | | 6 | #4 | #4 | 9-#6 | 8 | #4 | #4 | 12-#5 |
| 2.14 | 14 | | 6 | #4 | #4 | 8-#7 | 8 | #4 | #4 | 12-#5 |
| 2.38 | 14 | | 6 | #4 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 |
| 2.85 | 14 | 4 S 6 1 | 6 | #5 | #6 | 7-#9 | 8 | #4 | #4 | 12-#5 |
| 3.27 | 14 * | 4 S 6 1 | 6 | #6 | #6 | 9-#9 | 8 | #4 | #4 | 12-#5 |
| 3.70 | 14 * | 4 S 6 2 | 6 | #6 | #7 | 10-#9 | 8 | #4 | #5 | 12-#5 |
| 2.05 | 15 | | 6 | #4 | #4 | 9-#6 | 9 | #4 | #4 | 14-#5 |
| 2.14 | 15 | | 6 | #4 | #4 | 8-#7 | 9 | #4 | #4 | 14-#5 |
| 2.36 | 15 | | 6 | #4 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 |
| 2.61 | 15 | 4 S 6 1 | 6 | #5 | #5 | 11-#7 | 9 | #4 | #4 | 14-#5 |
| 3.19 | 15 * | 4 S 6 1 | 6 | #6 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| 3.79 | 15 * | 4 S 6 2 | 6 | #6 | #7 | 11-#9 | 9 | #4 | #5 | 14-#5 |
| 2.09 | 16 | | 7 | #4 | #4 | 11-#6 | 9 | #4 | #4 | 14-#5 |
| 2.21 | 16 | | 7 | #4 | #4 | 10-#7 | 9 | #4 | #4 | 14-#5 |
| 2.48 | 16 | | 7 | #4 | #5 | 9-#8 | 9 | #4 | #4 | 14-#5 |
| 2.83 | 16 | | 7 | #5 | #5 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| 3.51 | 16 * | 4 S 6 1 | 7 | #6 | #6 | 11-#9 | 9 | #4 | #5 | 14-#5 |
| 4.14 | 16 * | 4 S 6 2 | 7 | #6 | #7 | 13-#9 | 9 | #5 | #5 | 14-#5 |
| 2.17 | 17 | | 7 | #4 | #4 | 10-#7 | 10 | #4 | #4 | 15-#5 |
| 2.42 | 17 | | 7 | #4 | #5 | 9-#8 | 10 | #4 | #4 | 15-#5 |
| 2.76 | 17 | | 7 | #5 | #5 | 9-#9 | 10 | #4 | #4 | 15-#5 |
| 2.99 | 17 * | 4 S 6 1 | 7 | #5 | #6 | 10-#9 | 10 | #4 | #4 | 15-#5 |
| 3.80 | 17 * | 4 S 6 2 | 7 | #6 | #7 | 13-#9 | 10 | #4 | #5 | 15-#5 |
| 2.38 | 18 | | 7 | #4 | #5 | 9-#8 | 11 | #4 | #4 | 16-#5 |
| 2.70 | 18 | | 7 | #5 | #5 | 9-#9 | 11 | #4 | #4 | 16-#5 |
| 2.91 | 18 | 4 S 6 1 | 7 | #5 | #6 | 10-#9 | 11 | #4 | #4 | 16-#5 |
| 3.25 | 18 * | 4 S 6 1 | 7 | #6 | #6 | 12-#9 | 11 | #4 | #4 | 16-#5 |
| 2.48 | 19 | | 8 | #4 | #5 | 11-#8 | 11 | #4 | #4 | 16-#5 |
| 2.71 | 19 | | 8 | #5 | #5 | 10-#9 | 11 | #4 | #4 | 16-#5 |
| 3.05 | 19 * | 4 S 6 1 | 8 | #5 | #6 | 12-#9 | 11 | #4 | #4 | 16-#5 |
| 3.39 | 19 * | 4 S 6 1 | 8 | #6 | #6 | 14-#9 | 11 | #4 | #4 | 16-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 12 ½ in. | Rib Depth = 8 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | | | |
| 16'-0" | 50 | 2.04 | 12 | 0.632 | | 7-#5+ 0 | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 | 20 | 40 | 54 |
| D = 6.417 | 100 | 2.04 | 12 | 0.632 | | 7-#5+ 0 | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 | 26 | 52 | 69 |
| RIB NOT ON | 150 | 2.04 | 12 | 0.632 | | 7-#5+ 0 | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 | 32 | 72 | 85 |
| COLUMN LINE | 200 | 2.04 | 12 | 0.632 | | 7-#5+ 0 | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 | 37 | 91 | 101 |
| 0.707 CF/SF | 300 | 2.04 | 12 | 0.653 | | 7-#5+ 0 | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 | 49 | 127 | 132 |
| | 400 | 2.13 | 12 | 0.723 | | 7-#5+ 0 | 4 | #4 | #5 | 5-#6 | 4 | #4 | #4 | 7-#5 | 61 | 163 | 164 |
| | 500 | 2.54 | 12 | 0.792 | | 7-#5+ 0 | 4 | #5 | #6 | 9-#5 | 4 | #4 | #5 | 7-#5 | 73 | 198 | 195 |
| 18'-0" | 50 | 1.99 | 12 | 0.632 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 29 | 57 | 77 |
| D = 6.417 | 100 | 1.99 | 12 | 0.632 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 37 | 75 | 100 |
| RIB NOT ON | 150 | 1.99 | 12 | 0.632 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 46 | 104 | 123 |
| COLUMN LINE | 200 | 2.07 | 12 | 0.647 | | 5-#6+ 0 | 4 | #4 | #5 | 5-#6 | 5 | #4 | #4 | 8-#5 | 54 | 131 | 145 |
| 0.696 CF/SF | 300 | 2.20 | 12 | 0.734 | | 5-#6+ 0 | 4 | #5 | #5 | 6-#6 | 5 | #4 | #4 | 8-#5 | 71 | 183 | 191 |
| | 400 | 2.47 | 12 * | 0.850 | | 5-#6+ 1 | 4 | #5 | #6 | 6-#7 | 5 | #4 | #4 | 8-#5 | 88 | 235 | 236 |
| | 500 | 2.96 | 12 * | 0.633 | | 5-#6+ 1 | 4 | #6 | #7 | 5-#8 | 5 | #4 | #5 | 8-#5 | 105 | 285 | 282 |
| 20'-0" | 50 | 1.96 | 12 | 0.632 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 40 | 80 | 108 |
| D = 8.417 | 100 | 1.96 | 12 | 0.671 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 52 | 105 | 140 |
| RIB ON | 150 | 1.96 | 12 | 0.756 | | 6-#6+ 1 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 64 | 146 | 171 |
| COLUMN LINE | 200 | 2.07 | 12 | 0.794 | | 6-#6+ 1 | 5 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 8-#5 | 75 | 183 | 203 |
| 0.715 CF/SF | 300 | 2.53 | 12 * | 0.899 | | 6-#6+ 3 | 5 | #5 | #6 | 9-#6 | 5 | #4 | #5 | 8-#5 | 99 | 256 | 266 |
| | 400 | 2.93 | 12 * | 0.633 | | 6-#6+ 2 | 5 | #6 | #6 | 6-#8 | 5 | #5 | #5 | 8-#5 | 122 | 327 | 329 |
| | 500 | 3.45 | 15 * | 0.629 | 3 S 4 1 | 6-#6+ 1 | 5 | #6 | #7 | 6-#9 | 5 | #5 | #6 | 8-#5 | 143 | 388 | 386 |
| 22'-0" | 50 | 1.98 | 12 | 0.676 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 54 | 107 | 145 |
| D = 8.417 | 100 | 1.98 | 12 | 0.727 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 69 | 141 | 187 |
| RIB ON | 150 | 2.12 | 12 | 0.778 | | 9-#5+ 0 | 5 | #4 | #5 | 6-#7 | 6 | #4 | #4 | 10-#5 | 85 | 194 | 229 |
| COLUMN LINE | 200 | 2.31 | 12 * | 0.846 | | 9-#5+ 1 | 5 | #5 | #5 | 9-#6 | 6 | #4 | #4 | 10-#5 | 101 | 244 | 272 |
| 0.704 CF/SF | 300 | 2.81 | 12 * | 0.633 | | 9-#5+ 1 | 5 | #6 | #6 | 7-#8 | 6 | #4 | #5 | 10-#5 | 133 | 342 | 357 |
| | 400 | 3.41 | 16 * | 0.628 | 3 S 4 1 | 10-#5+ 1 | 5 | #7 | #7 | 7-#9 | 6 | #5 | #5 | 10-#5 | 161 | 426 | 433 |
| 24'-0" | 50 | 1.99 | 12 | 0.737 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 70 | 140 | 188 |
| D = 8.417 | 100 | 2.11 | 12 | 0.826 | | 10-#5+ 2 | 5 | #4 | #5 | 6-#7 | 7 | #4 | #4 | 11-#5 | 91 | 183 | 244 |
| RIB ON | 150 | 2.42 | 12 * | 0.881 | | 10-#5+ 3 | 5 | #5 | #6 | 10-#6 | 7 | #4 | #4 | 11-#5 | 111 | 253 | 300 |
| COLUMN LINE | 200 | 2.64 | 12 * | 0.633 | | 10-#5+ 2 | 5 | #6 | #6 | 7-#8 | 7 | #4 | #4 | 11-#5 | 132 | 319 | 355 |
| 0.696 CF/SF | 300 | 3.38 | 16 * | 0.628 | 3 S 4 1 | 6-#7+ 0 | 5 | #7 | #7 | 7-#9 | 7 | #5 | #5 | 11-#5 | 170 | 434 | 458 |
| | 400 | 3.80 | 20 * | 0.624 | 3 S 4 1 | 9-#6+ 2 | 5 | #7 | #8 | 9-#9 | 7 | #5 | #5 | 11-#5 | 203 | 475 | 546 |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 12 ½ in. | Rib Depth = 8 in. | Total Slab Depth = 4 ½ in. | | | | | | | | |
| 2.06 | 12 | | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 |
| 2.06 | 12 | | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 |
| 2.06 | 12 | | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 |
| 2.06 | 12 | | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 |
| 2.06 | 12 | | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 |
| 2.06 | 12 | 3 S 4 1 | 4 | #4 | #4 | 5-#6 | 4 | #4 | #4 | 7-#5 |
| 2.29 | 12 | 3 S 4 1 | 4 | #4 | #5 | 6-#6 | 4 | #4 | #4 | 7-#5 |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.08 | 12 | 3 S 4 1 | 4 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 2.33 | 12 * | 3 S 4 1 | 4 | #4 | #5 | 5-#7 | 5 | #4 | #4 | 8-#5 |
| 2.66 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 5-#8 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 2.29 | 12 * | 3 S 4 1 | 5 | #4 | #5 | 6-#7 | 5 | #4 | #4 | 8-#5 |
| 2.64 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 6-#8 | 5 | #4 | #4 | 8-#5 |
| 3.13 | 13 * | 3 S 4 1 | 5 | #5 | #6 | 7-#8 | 5 | #4 | #5 | 8-#5 |
| 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| 2.07 | 12 | | 5 | #4 | #4 | 7-#6 | 6 | #4 | #4 | 10-#5 |
| 2.27 | 12 | 3 S 4 1 | 5 | #4 | #5 | 6-#7 | 6 | #4 | #4 | 10-#5 |
| 2.58 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 6-#8 | 6 | #4 | #4 | 10-#5 |
| 2.97 | 13 * | 3 S 4 2 | 5 | #5 | #6 | 6-#9 | 6 | #4 | #4 | 10-#5 |
| 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| 2.09 | 12 | | 5 | #4 | #4 | 6-#7 | 7 | #4 | #4 | 11-#5 |
| 2.33 | 12 | 3 S 4 1 | 5 | #4 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 |
| 2.50 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 6-#8 | 7 | #4 | #4 | 11-#5 |
| 2.99 | 13 * | 3 S 4 2 | 5 | #5 | #6 | 11-#7 | 7 | #4 | #4 | 11-#5 |
| 3.37 | 19 * | 3 S 4 2 | 5 | #6 | #6 | 8-#9 | 7 | #4 | #4 | 11-#5 |

(Continued on next page)

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 12 ½ in. | Rib Depth = 8 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | | | | Total Depth = 12 ½ in. | Rib Depth = 8 in. | Total Slab Depth = 4 ½ in. | | | | | | | | |
| 26'-0" | 50 | 1.98 | 13 | 0.768 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 90 | 179 | 241 | 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| D = 10.417 | 100 | 2.16 | 13 * | 0.845 | | 8-#6+ 1 | 6 | #4 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 | 116 | 232 | 312 | 2.11 | 13 | | 6 | #4 | #4 | 7-#7 | 7 | #4 | #4 | 11-#5 |
| RIB NOT ON | 150 | 2.54 | 13 * | 0.916 | | 8-#6+ 3 | 6 | #5 | #6 | 8-#8 | 7 | #4 | #4 | 11-#5 | 142 | 320 | 383 | 2.44 | 13 * | 3 S 4 1 | 6 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.86 | 15 * | 0.629 | | 8-#6+ 2 | 6 | #6 | #6 | 7-#9 | 7 | #4 | #5 | 11-#5 | 167 | 400 | 450 | 2.65 | 13 * | 3 S 4 1 | 6 | #5 | #5 | 8-#8 | 7 | #4 | #4 | 11-#5 |
| 0.710 CF/SF | 300 | 3.66 | 20 * | 0.624 | | 7-#7+ 2 | 6 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 11-#5 | 213 | 506 | 573 | 3.40 | 17 * | 3 S 4 2 | 6 | #5 | #6 | 9-#9 | 7 | #4 | #5 | 11-#5 |
| 28'-0" | 50 | 2.10 | 14 | 0.795 | | 8-#6+ 1 | 6 | #4 | #5 | 10-#6 | 8 | #4 | #4 | 12-#5 | 111 | 223 | 300 | 2.08 | 14 | | 6 | #4 | #4 | 7-#7 | 8 | #4 | #4 | 12-#5 |
| D = 10.417 | 100 | 2.32 | 14 * | 0.883 | | 8-#6+ 3 | 6 | #5 | #5 | 8-#8 | 8 | #4 | #4 | 12-#5 | 144 | 289 | 388 | 2.26 | 14 * | | 6 | #4 | #4 | 7-#8 | 8 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.77 | 15 * | 0.629 | | 8-#6+ 2 | 6 | #6 | #6 | 8-#9 | 8 | #4 | #4 | 12-#5 | 176 | 388 | 475 | 2.70 | 14 * | 3 S 4 1 | 6 | #5 | #5 | 7-#9 | 8 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 3.26 | 18 * | 0.626 | | 7-#7+ 2 | 6 | #7 | #7 | 9-#9 | 8 | #4 | #5 | 12-#5 | 207 | 486 | 558 | 2.96 | 14 * | 3 S 4 1 | 6 | #5 | #6 | 8-#9 | 8 | #4 | #4 | 12-#5 |
| 0.702 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.29 | 15 * | 0.849 | | 9-#6+ 3 | 6 | #5 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 | 137 | 273 | 368 | 2.25 | 15 | | 6 | #4 | #4 | 7-#8 | 9 | #4 | #4 | 14-#5 |
| D = 10.417 | 100 | 2.60 | 15 * | 0.924 | | 9-#6+ 6 | 6 | #5 | #6 | 8-#9 | 9 | #4 | #4 | 14-#5 | 177 | 354 | 476 | 2.55 | 15 * | 3 S 4 1 | 6 | #4 | #5 | 7-#9 | 9 | #4 | #4 | 14-#5 |
| RIB NOT ON | 150 | 3.17 | 18 * | 0.626 | | 7-#7+ 2 | 6 | #6 | #7 | 9-#9 | 9 | #4 | #5 | 14-#5 | 215 | 460 | 580 | 3.05 | 15 * | 3 S 4 1 | 6 | #5 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | 200 | 3.40 | 24 * | 0.621 | | 8-#7+ 2 | 6 | #7 | #7 | 11-#9 | 9 | #4 | #5 | 14-#5 | 249 | 509 | 669 | 3.16 | 18 * | 3 S 4 2 | 6 | #5 | #6 | 10-#9 | 9 | #4 | #4 | 14-#5 |
| 0.696 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32'-0" | 50 | 2.36 | 16 * | 0.876 | | 10-#6+ 4 | 7 | #5 | #5 | 9-#8 | 9 | #4 | #4 | 14-#5 | 167 | 334 | 449 | 2.29 | 16 | | 7 | #4 | #4 | 11-#7 | 9 | #4 | #4 | 14-#5 |
| D = 12.417 | 100 | 2.86 | 18 * | 0.911 | | 10-#6+ 6 | 7 | #6 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 | 215 | 429 | 578 | 2.83 | 16 * | 3 S 4 1 | 7 | #5 | #5 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| RIB ON | 150 | 3.33 | 23 * | 0.622 | | 12-#6+ 4 | 7 | #6 | #7 | 11-#9 | 9 | #4 | #5 | 14-#5 | 259 | 518 | 697 | 3.22 | 17 * | 3 S 4 1 | 7 | #5 | #6 | 11-#9 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.707 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34'-0" | 50 | 2.56 | 17 * | 0.890 | | 10-#6+ 5 | 7 | #5 | #6 | 9-#9 | 10 | #4 | #4 | 15-#5 | 199 | 399 | 537 | 2.49 | 17 * | | 7 | #4 | #5 | 10-#8 | 10 | #4 | #4 | 15-#5 |
| D = 12.417 | 100 | 3.11 | 21 * | 0.623 | | 12-#6+ 4 | 7 | #6 | #7 | 11-#9 | 10 | #4 | #5 | 15-#5 | 255 | 511 | 688 | 2.89 | 17 * | 3 S 4 1 | 7 | #5 | #5 | 13-#8 | 10 | #4 | #4 | 15-#5 |
| RIB ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.701 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 24″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 ½ in. | Rib Depth = 10 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | | | | Total Depth = 14 ½ in. | Rib Depth = 10 in. | Total Slab Depth = 4 ½ in. | | | | | | | | |
| 20'-0" | 50 | 1.96 | 12 | 0.635 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 44 | 87 | 118 | 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| D = 8.417 | 100 | 1.96 | 12 | 0.635 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 55 | 111 | 149 | 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| RIB ON | 150 | 1.96 | 12 | 0.635 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 67 | 151 | 181 | 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| COLUMN LINE | 200 | 1.96 | 12 | 0.658 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 79 | 190 | 212 | 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 0.807 CF/SF | 300 | 2.22 | 12 | 0.741 | | 6-#6+ 0 | 5 | #5 | #5 | 6-#7 | 5 | #4 | #4 | 8-#5 | 102 | 263 | 276 | 2.07 | 12 | | 5 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 8-#5 |
| | 400 | 2.59 | 12 * | 0.849 | | 6-#6+ 1 | 5 | #5 | #6 | 7-#7 | 5 | #4 | #5 | 8-#5 | 126 | 335 | 339 | 2.38 | 12 * | 3 S 4 1 | 5 | #4 | #5 | 9-#6 | 5 | #4 | #4 | 8-#5 |
| | 500 | 2.98 | 12 * | 0.636 | | 6-#6+ 0 | 5 | #6 | #6 | 7-#8 | 5 | #5 | #5 | 8-#5 | 149 | 406 | 402 | 2.64 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 6-#8 | 5 | #4 | #4 | 8-#5 |
| 22'-0" | 50 | 1.98 | 12 | 0.635 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 58 | 117 | 157 | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| D = 8 .417 | 100 | 1.98 | 12 | 0.636 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 74 | 148 | 199 | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| RIB ON | 150 | 2.07 | 12 | 0.683 | | 9-#5+ 0 | 5 | #4 | #5 | 7-#6 | 6 | #4 | #4 | 10-#5 | 90 | 202 | 242 | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.23 | 12 | 0.731 | | 9-#5+ 0 | 5 | #5 | #5 | 6-#7 | 6 | #4 | #4 | 10-#5 | 106 | 253 | 284 | 2.14 | 12 | | 5 | #4 | #4 | 6-#7 | 6 | #4 | #4 | 10-#5 |
| 0.794 CF/SF | 300 | 2.67 | 12 * | 0.857 | | 9-#5+ 2 | 5 | #6 | #6 | 6-#8 | 6 | #4 | #5 | 10-#5 | 137 | 352 | 369 | 2.39 | 12 * | 3 S 4 1 | 5 | #4 | #5 | 7-#7 | 6 | #4 | #4 | 10-#5 |
| | 400 | 3.21 | 12 * | 0.636 | | 9-#5+ 2 | 5 | #6 | #7 | 6-#9 | 6 | #5 | #5 | 10-#5 | 169 | 449 | 454 | 2.91 | 12 * | 3 S 4 1 | 5 | #5 | #6 | 7-#8 | 6 | #4 | #4 | 10-#5 |
| | 500 | 3.72 | 14 * | 0.633 | 3 S 4 1 | 6-#7+ 0 | 5 | #7 | #7 | 7-#9 | 6 | #5 | #6 | 10-#5 | 199 | 540 | 535 | 3.31 | 12 * | 3 S 4 2 | 5 | #6 | #6 | 8-#8 | 6 | #4 | #5 | 10-#5 |
| 24'-0" | 50 | 1.99 | 12 | 0.658 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 76 | 152 | 205 | 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| D = 8.417 | 100 | 2.06 | 12 | 0.709 | | 10-#5+ 0 | 5 | #4 | #5 | 7-#6 | 7 | #4 | #4 | 11-#5 | 97 | 193 | 260 | 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| RIB ON | 150 | 2.20 | 12 | 0.760 | | 10-#5+ 0 | 5 | #5 | #5 | 9-#6 | 7 | #4 | #4 | 11-#5 | 117 | 264 | 316 | 2.09 | 12 | | 5 | #4 | #4 | 6-#7 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.43 | 12 * | 0.828 | | 10-#5+ 1 | 5 | #5 | #6 | 6-#8 | 7 | #4 | #4 | 11-#5 | 138 | 331 | 371 | 2.33 | 12 | 3 S 4 1 | 5 | #4 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 |
| 0.784 CF/SF | 300 | 3.01 | 12 * | 0.636 | | 10-#5+ 1 | 5 | #6 | #7 | 6-#9 | 7 | #4 | #5 | 11-#5 | 179 | 460 | 482 | 2.82 | 12 * | 3 S 4 1 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| | 400 | 3.65 | 15 * | 0.632 | 3 S 4 1 | 6-#7+ 1 | 5 | #7 | #8 | 8-#9 | 7 | #5 | #5 | 11-#5 | 218 | 580 | 587 | 3.21 | 12 * | 3 S 4 2 | 5 | #6 | #6 | 7-#9 | 7 | #4 | #4 | 11-#5 |
| | 500 | 4.31 | 19 * | 0.628 | 3 S 4 1 | 7-#7+ 0 | 5 | #8 | #8 | 9-#9 | 7 | #5 | #6 | 11-#5 | 251 | 662 | 676 | 3.90 | 16 * | 3 S 4 2 | 5 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 11-#5 |
| 26'-0" | 50 | 1.98 | 13 | 0.696 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 97 | 195 | 262 | 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| D = 10.417 | 100 | 2.12 | 13 | 0.751 | | 8-#6+ 0 | 6 | #4 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 | 124 | 247 | 333 | 2.08 | 13 | | 6 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 11-#5 |
| RIB NOT ON | 150 | 2.30 | 13 * | 0.843 | | 8-#6+ 2 | 6 | #5 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 | 150 | 334 | 404 | 2.18 | 13 | | 6 | #4 | #4 | 8-#7 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.63 | 13 * | 0.897 | | 8-#6+ 3 | 6 | #5 | #6 | 8-#8 | 7 | #4 | #5 | 11-#5 | 176 | 419 | 474 | 2.44 | 13 * | 3 S 4 1 | 6 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| 0.801 CF/SF | 300 | 3.41 | 15 * | 0.632 | | 12-#5+ 3 | 6 | #7 | #7 | 8-#9 | 7 | #5 | #5 | 11-#5 | 227 | 579 | 611 | 3.06 | 13 * | 3 S 4 1 | 6 | #5 | #6 | 8-#9 | 7 | #4 | #4 | 11-#5 |
| | 400 | 4.00 | 19 * | 0.628 | | 15-#5+ 3 | 6 | #7 | #8 | 10-#9 | 7 | #5 | #6 | 11-#5 | 273 | 701 | 734 | 3.55 | 16 * | 3 S 4 2 | 6 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 11-#5 |
| 28'-0" | 50 | 2.05 | 14 | 0.695 | | 8-#6+ 0 | 6 | #4 | #5 | 9-#6 | 8 | #4 | #4 | 12-#5 | 121 | 242 | 326 | 1.99 | 14 | | 6 | #4 | #4 | 12-#5 | 8 | #4 | #4 | 12-#5 |
| D = 10.417 | 100 | 2.24 | 14 * | 0.786 | | 8-#6+ 1 | 6 | #5 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 | 154 | 308 | 414 | 2.14 | 14 | | 6 | #4 | #4 | 8-#7 | 8 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.51 | 14 * | 0.872 | | 8-#6+ 3 | 6 | #5 | #6 | 8-#8 | 8 | #4 | #4 | 12-#5 | 187 | 409 | 502 | 2.46 | 14 * | 3 S 4 1 | 6 | #4 | #5 | 8-#8 | 8 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.97 | 14 * | 0.633 | | 8-#6+ 2 | 6 | #6 | #7 | 8-#9 | 8 | #4 | #5 | 12-#5 | 219 | 515 | 591 | 2.70 | 14 * | 3 S 4 1 | 6 | #5 | #5 | 7-#9 | 8 | #4 | #4 | 12-#5 |
| 0.791 CF/SF | 300 | 3.79 | 19 * | 0.628 | | 8-#7+ 2 | 6 | #7 | #8 | 10-#9 | 8 | #5 | #5 | 12-#5 | 280 | 697 | 753 | 3.45 | 15 * | 3 S 4 2 | 6 | #6 | #6 | 12-#8 | 8 | #4 | #5 | 12-#5 |

(Continued on next page)

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 24″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 ½ in. | | Rib Depth = 10 in. | | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.24 | 15 | 0.730 | | 9-#6+ 0 | 6 | #5 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 | 148 | 297 | 400 |
| D = 10.417 | 100 | 2.49 | 15 * | 0.834 | | 9-#6+ 2 | 6 | #5 | #6 | 8-#8 | 9 | #4 | #4 | 14-#5 | 189 | 377 | 508 |
| RIB NOT ON | 150 | 2.78 | 15 * | 0.907 | | 9-#6+ 4 | 6 | #6 | #6 | 8-#9 | 9 | #4 | #4 | 14-#5 | 229 | 491 | 617 |
| COLUMN LINE | 200 | 3.28 | 17 * | 0.630 | | 10-#6+ 3 | 6 | #7 | #7 | 12-#8 | 9 | #4 | #5 | 14-#5 | 268 | 618 | 721 |
| 0.784 CF/SF | 300 | 4.19 | 23 * | 0.624 | | 7-#8+ 2 | 6 | #8 | #8 | 16-#8 | 9 | #5 | #5 | 14-#5 | 338 | 774 | 909 |
| 32'-0" | 50 | 2.28 | 16 * | 0.800 | | 10-#6+ 2 | 7 | #5 | #5 | 14-#6 | 9 | #4 | #4 | 14-#5 | 181 | 363 | 488 |
| D = 12.417 | 100 | 2.59 | 16 * | 0.888 | | 10-#6+ 5 | 7 | #5 | #6 | 10-#8 | 9 | #4 | #4 | 14-#5 | 230 | 460 | 620 |
| RIB ON | 150 | 3.08 | 17 * | 0.630 | | 15-#5+ 4 | 7 | #6 | #7 | 10-#9 | 9 | #4 | #5 | 14-#5 | 278 | 585 | 749 |
| COLUMN LINE | 200 | 3.64 | 21 * | 0.626 | | 9-#7+ 4 | 7 | #7 | #7 | 12-#9 | 9 | #5 | #5 | 14-#5 | 324 | 735 | 871 |
| 0.798 CF/SF | | | | | | | | | | | | | | | | | |
| 34'-0" | 50 | 2.49 | 17 * | 0.833 | | 10-#6+ 4 | 7 | #5 | #6 | 10-#8 | 10 | #4 | #4 | 15-#5 | 217 | 433 | 583 |
| D = 12.417 | 100 | 2.81 | 17 * | 0.908 | | 15-#5+ 8 | 7 | #6 | #6 | 10-#9 | 10 | #4 | #4 | 15-#5 | 275 | 551 | 741 |
| RIB ON | 150 | 3.36 | 20 * | 0.627 | | 9-#7+ 4 | 7 | #7 | #7 | 12-#9 | 10 | #4 | #5 | 15-#5 | 331 | 674 | 892 |
| COLUMN LINE | 200 | 3.86 | 24 * | 0.624 | 3 S 4 1 | 11-#7+ 3 | 7 | #7 | #8 | 14-#9 | 10 | #5 | #5 | 15-#5 | 383 | 796 | 1032 |
| 0.790 CF/SF | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.73 | 18 * | 0.859 | | 11-#6+ 5 | 7 | #6 | #6 | 9-#9 | 11 | #4 | #4 | 16-#5 | 256 | 513 | 690 |
| D = 12.417 | 100 | 3.18 | 19 * | 0.628 | | 9-#7+ 4 | 7 | #6 | #7 | 12-#9 | 11 | #4 | #5 | 16-#5 | 325 | 651 | 876 |
| RIB ON | 150 | 3.71 | 24 * | 0.624 | | 11-#7+ 3 | 7 | #7 | #8 | 15-#9 | 11 | #4 | #5 | 16-#5 | 390 | 780 | 1050 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.784 CF/SF | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.79 | 19 * | 0.894 | | 12-#6+ 8 | 8 | #6 | #6 | 11-#9 | 11 | #4 | #4 | 16-#5 | 303 | 607 | 817 |
| D = 14.417 | 100 | 3.32 | 22 * | 0.625 | | 11-#7+ 3 | 8 | #6 | #7 | 14-#9 | 11 | #4 | #5 | 16-#5 | 382 | 765 | 1030 |
| RIB NOT ON | 150 | 3.98 | 31 * | 0.620 | | 10-#8+ 3 | 8 | #7 | #8 | 17-#9 | 11 | #5 | #5 | 17-#5 | 449 | 897 | 1208 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.795 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 ½ in. | | | Rib Depth = 10 in. | | | | Total Slab Depth = 4 ½ in. | | | |
| 2.14 | 15 | | 6 | #4 | #4 | 8-#7 | 9 | #4 | #4 | 14-#5 |
| 2.43 | 15 | 3 S 4 1 | 6 | #4 | #5 | 8-#8 | 9 | #4 | #4 | 14-#5 |
| 2.76 | 15 * | 3 S 4 1 | 6 | #5 | #5 | 8-#9 | 9 | #4 | #4 | 14-#5 |
| 3.05 | 15 * | 3 S 4 2 | 6 | #5 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| 3.90 | 19 * | 3 S 4 2 | 6 | #6 | #7 | 12-#9 | 9 | #4 | #5 | 14-#5 |
| 2.21 | 16 | | 7 | #4 | #4 | 10-#7 | 9 | #4 | #4 | 14-#5 |
| 2.55 | 16 * | | 7 | #4 | #5 | 10-#8 | 9 | #4 | #4 | 14-#5 |
| 2.83 | 16 * | 3 S 4 1 | 7 | #5 | #5 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| 3.36 | 16* | 3 S 4 1 | 7 | #6 | #6 | 11-#9 | 9 | #4 | #4 | 14-#5 |
| 2.42 | 17 | | 7 | #4 | #5 | 9-#8 | 10 | #4 | #4 | 15-#5 |
| 2.76 | 17 * | 3 S 4 1 | 7 | #5 | #5 | 9-#9 | 10 | #4 | #4 | 15-#5 |
| 3.12 | 17 * | 3 S 4 1 | 7 | #5 | #6 | 11-#9 | 10 | #4 | #4 | 15-#5 |
| 3.49 | 19 * | 3 S 4 2 | 7 | #6 | #6 | 13-#9 | 10 | #4 | #4 | 15-#5 |
| 2.70 | 18 | | 7 | #5 | #5 | 9-#9 | 11 | #4 | #4 | 16-#5 |
| 3.04 | 18 * | 3 S 4 1 | 7 | #5 | #6 | 11-#9 | 11 | #4 | #4 | 16-#5 |
| 3.46 | 18 * | 3 S 4 2 | 7 | #6 | #6 | 14-#9 | 11 | #4 | #4 | 16-#5 |
| 2.71 | 19 * | | 8 | #5 | #5 | 10-#9 | 11 | #4 | #4 | 16-#5 |
| 3.17 | 19 * | 3 S 4 1 | 8 | #5 | #6 | 13-#9 | 11 | #4 | #4 | 16-#5 |
| 3.61 | 24 * | 3 S 4 2 | 8 | #6 | #6 | 16-#9 | 11 | #4 | #4 | 16-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 16 ½ in. | Rib Depth = 12 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | | | | Total Depth = 16 ½ in. | Rib Depth = 12 in. | Total Slab Depth = 4 ½ in. | | | | | | | | |
| 22'-0" | 50 | 1.98 | 12 | 0.638 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 63 | 126 | 170 | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| D = 8.417 | 100 | 1.98 | 12 | 0.638 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 79 | 158 | 212 | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| RIB ON | 150 | 1.98 | 12 | 0.638 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 95 | 209 | 255 | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.10 | 12 | 0.638 | | 9-#5+ 0 | 5 | #4 | #5 | 7-#6 | 6 | #4 | #4 | 10-#5 | 110 | 262 | 297 | 2.07 | 12 | | 5 | #4 | #4 | 7-#6 | 6 | #4 | #4 | 10-#5 |
| 0.886 CF/SF | 300 | 2.42 | 12 | 0.747 | | 9-#5+ 1 | 5 | #5 | #6 | 7-#7 | 6 | #4 | #4 | 10-#5 | 142 | 361 | 382 | 2.27 | 12 | | 5 | #4 | #5 | 6-#7 | 6 | #4 | #4 | 10-#5 |
| | 400 | 2.81 | 12 * | 0.857 | | 9-#5+ 3 | 5 | #6 | #6 | 7-#8 | 6 | #4 | #5 | 10-#5 | 173 | 458 | 467 | 2.58 | 12 * | 4 S 6 1 | 5 | #5 | #5 | 6-#8 | 6 | #4 | #4 | 10-#5 |
| | 500 | 3.22 | 12 * | 0.639 | | 10-#5+ 1 | 5 | #6 | #7 | 6-#9 | 6 | #5 | #5 | 10-#5 | 205 | 555 | 552 | 2.91 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 7-#8 | 6 | #4 | #4 | 10-#5 |
| 24'-0" | 50 | 1.99 | 12 | 0.638 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 82 | 164 | 221 | 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| D = 8.417 | 100 | 1.99 | 12 | 0.638 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 103 | 206 | 277 | 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| RIB ON | 150 | 2.11 | 12 | 0.671 | | 10-#5+ 0 | 5 | #4 | #5 | 6-#7 | 7 | #4 | #4 | 11-#5 | 123 | 273 | 332 | 2.09 | 12 | | 5 | #4 | #4 | 6-#7 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.30 | 12 | 0.719 | | 10-#5+ 0 | 5 | #5 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 | 144 | 341 | 388 | 2.29 | 12 | | 5 | #4 | #5 | 9-#6 | 7 | #4 | #4 | 11-#5 |
| 0.874 CF/SF | 300 | 2.73 | 12 * | 0.846 | | 10-#5+ 2 | 5 | #6 | #6 | 7-#8 | 7 | #4 | #5 | 11-#5 | 185 | 471 | 499 | 2.50 | 12 | 4 S 6 1 | 5 | #5 | #5 | 6-#8 | 7 | #4 | #4 | 11-#5 |
| | 400 | 3.30 | 12 * | 0.639 | | 7-#6+ 1 | 5 | #7 | #7 | 7-#9 | 7 | #5 | #5 | 11-#5 | 227 | 599 | 610 | 2.87 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 6-#9 | 7 | #4 | #4 | 11-#5 |
| | 500 | 4.00 | 14 * | 0.636 | 4 S 6 1 | 6-#7+ 1 | 5 | #7 | #8 | 8-#9 | 7 | #5 | #6 | 11-#5 | 266 | 719 | 716 | 3.69 | 12 * | 4 S 6 2 | 5 | #6 | #7 | 8-#9 | 7 | #4 | #5 | 11-#5 |
| 26'-0" | 50 | 1.98 | 13 | 0.636 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 106 | 211 | 284 | 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| D = 10.417 | 100 | 2.00 | 13 | 0.670 | | 8-#6+ 0 | 6 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 11-#5 | 132 | 263 | 355 | 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| RIB NOT ON | 150 | 2.24 | 13 | 0.722 | | 8-#6+ 0 | 6 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 | 158 | 346 | 425 | 2.11 | 13 | | 6 | #4 | #4 | 7-#7 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 200 | 2.46 | 13 * | 0.818 | | 8-#6+ 2 | 6 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 11-#5 | 184 | 434 | 496 | 2.31 | 13 | | 6 | #4 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 |
| 0.895 CF/SF | 300 | 3.07 | 13 * | 0.637 | | 8-#6+ 2 | 6 | #6 | #7 | 7-#9 | 7 | #5 | #5 | 11-#5 | 237 | 599 | 637 | 2.65 | 13 * | 4 S 6 1 | 6 | #5 | #5 | 8-#8 | 7 | #4 | #4 | 11-#5 |
| | 400 | 3.75 | 14 * | 0.636 | | 7-#7+ 2 | 6 | #7 | #7 | 9-#9 | 7 | #5 | #6 | 11-#5 | 288 | 758 | 776 | 3.36 | 13 * | 4 S 6 1 | 6 | #6 | #6 | 8-#9 | 7 | #4 | #5 | 11-#5 |
| | 500 | 4.48 | 18 * | 0.631 | | 8-#7+ 2 | 6 | #8 | #8 | 10-#9 | 7 | #6 | #6 | 11-#5 | 332 | 880 | 895 | 3.97 | 16 * | 4 S 6 2 | 6 | #6 | #7 | 12-#8 | 7 | #5 | #5 | 11-#5 |
| 28'-0" | 50 | 1.97 | 14 | 0.635 | | 8-#6+ 0 | 6 | #4 | #4 | 9-#6 | 8 | #4 | #4 | 12-#5 | 131 | 262 | 353 | 1.97 | 14 | | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 |
| D = 10.417 | 100 | 2.11 | 14 | 0.677 | | 8-#6+ 0 | 6 | #4 | #5 | 8-#7 | 8 | #4 | #4 | 12-#5 | 164 | 328 | 441 | 2.08 | 14 | | 6 | #4 | #4 | 7-#7 | 8 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.45 | 14 | 0.790 | | 8-#6+ 2 | 6 | #5 | #6 | 7-#8 | 8 | #4 | #4 | 12-#5 | 197 | 425 | 529 | 2.38 | 14 | | 6 | #4 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.78 | 14 * | 0.853 | | 8-#6+ 3 | 6 | #6 | #6 | 7-#9 | 8 | #4 | #5 | 12-#5 | 229 | 535 | 618 | 2.58 | 14 | 4 S 6 1 | 6 | #5 | #5 | 8-#8 | 8 | #4 | #4 | 12-#5 |
| 0.884 CF/SF | 300 | 3.45 | 14 * | 0.636 | | 7-#7+ 2 | 6 | #7 | #7 | 9-#9 | 8 | #5 | #5 | 12-#5 | 295 | 740 | 794 | 3.10 | 14 * | 4 S 6 1 | 6 | #6 | #6 | 8-#9 | 8 | #4 | #4 | 12-#5 |
| | 400 | 4.20 | 19 * | 0.630 | | 12-#6+ 2 | 6 | #8 | #8 | 11-#9 | 8 | #5 | #6 | 12-#5 | 354 | 918 | 952 | 3.70 | 15 * | 4 S 6 2 | 6 | #6 | #7 | 10-#9 | 8 | #4 | #5 | 12-#5 |
| 30'-0" | 50 | 2.12 | 15 | 0.658 | | 9-#6+ 0 | 6 | #4 | #5 | 8-#7 | 9 | #4 | #4 | 14-#5 | 161 | 321 | 432 | 2.08 | 15 | | 6 | #4 | #4 | 7-#7 | 9 | #4 | #4 | 14-#5 |
| D = 10.417 | 100 | 2.37 | 15 | 0.749 | | 9-#6+ 1 | 6 | #5 | #5 | 8-#8 | 9 | #4 | #4 | 14-#5 | 201 | 402 | 541 | 2.36 | 15 | | 6 | #4 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 |
| RIB NOT ON | 150 | 2.68 | 15 * | 0.839 | | 9-#6+ 3 | 6 | #6 | #6 | 7-#9 | 9 | #4 | #4 | 14-#5 | 241 | 513 | 649 | 2.61 | 15 | 4 S 6 1 | 6 | #5 | #5 | 11-#7 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | 200 | 3.09 | 15 * | 0.896 | | 9-#6+ 4 | 6 | #6 | #7 | 9-#9 | 9 | #4 | #5 | 14-#5 | 281 | 648 | 758 | 2.90 | 15 * | 4 S 6 1 | 6 | #5 | #6 | 8-#9 | 9 | #4 | #4 | 14-#5 |
| 0.874 CF/SF | 300 | 4.02 | 18 * | 0.631 | | 12-#6+ 2 | 6 | #8 | #8 | 11-#9 | 9 | #5 | #5 | 14-#5 | 359 | 892 | 966 | 3.68 | 15 * | 4 S 6 2 | 6 | #6 | #7 | 13-#8 | 9 | #4 | #5 | 14-#5 |
| 32'-0" | 50 | 2.18 | 16 | 0.720 | | 10-#6+ 1 | 7 | #4 | #5 | 10-#7 | 9 | #4 | #4 | 14-#5 | 196 | 393 | 529 | 2.15 | 16 | | 7 | #4 | #4 | 9-#7 | 9 | #4 | #4 | 14-#5 |
| D = 12.417 | 100 | 2.51 | 16 * | 0.828 | | 10-#6+ 4 | 7 | #5 | #6 | 9-#8 | 9 | #4 | #4 | 14-#5 | 245 | 490 | 660 | 2.42 | 16 | | 7 | #4 | #5 | 11-#7 | 9 | #4 | #4 | 14-#5 |
| RIB ON | 150 | 2.95 | 16 * | 0.891 | | 10-#6+ 6 | 7 | #6 | #6 | 9-#9 | 9 | #4 | #5 | 14-#5 | 294 | 617 | 792 | 2.83 | 16 * | 4 S 6 1 | 7 | #5 | #5 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | 200 | 3.45 | 16 * | 0.633 | | 16-#5+ 3 | 7 | #7 | #7 | 11-#9 | 9 | #5 | #5 | 14-#5 | 343 | 781 | 924 | 3.07 | 16 * | 4 S 6 1 | 7 | #5 | #6 | 10-#9 | 9 | #4 | #4 | 14-#5 |
| 0.891 CF/SF | 300 | 4.33 | 22 * | 0.628 | | 11-#7+ 3 | 7 | #8 | #8 | 14-#9 | 9 | #5 | #6 | 14-#5 | 431 | 1032 | 1161 | 3.86 | 18 * | 4 S 6 2 | 7 | #6 | #7 | 16-#8 | 9 | #4 | #5 | 14-#5 |
| 34'-0" | 50 | 2.37 | 17 | 0.766 | | 10-#6+ 3 | 7 | #5 | #5 | 9-#8 | 10 | #4 | #4 | 15-#5 | 235 | 469 | 631 | 2.37 | 17 | | 7 | #4 | #5 | 11-#7 | 10 | #4 | #4 | 15-#5 |
| D = 12.417 | 100 | 2.78 | 17 * | 0.849 | | 10-#6+ 5 | 7 | #6 | #6 | 9-#9 | 10 | #4 | #4 | 15-#5 | 293 | 586 | 789 | 2.76 | 17 | | 7 | #5 | #5 | 9-#9 | 10 | #4 | #4 | 15-#5 |
| RIB ON | 150 | 3.17 | 17 * | 0.632 | | 12-#6+ 2 | 7 | #6 | #7 | 11-#9 | 10 | #4 | #5 | 15-#5 | 352 | 719 | 947 | 2.99 | 17 * | 4 S 6 1 | 7 | #5 | #6 | 10-#9 | 10 | #4 | #4 | 15-#5 |
| COLUMN LINE | 200 | 3.73 | 19 * | 0.630 | | 10-#7+ 3 | 7 | #7 | #8 | 16-#8 | 10 | #5 | #5 | 15-#5 | 408 | 912 | 1099 | 3.35 | 17 * | 4 S 6 2 | 7 | #6 | #6 | 12-#9 | 10 | #4 | #4 | 15-#5 |
| 0.882 CF/SF | 300 | 4.52 | 26 * | 0.625 | 4 S 6 1 | 10-#8+ 1 | 7 | #8 | #8 | 17-#9 | 10 | #5 | #6 | 17-#5 | 510 | 1135 | 1373 | 4.07 | 21 * | 4 S 6 2 | 7 | #6 | #7 | 15-#9 | 10 | #4 | #5 | 16-#5 |
| 36'-0" | 50 | 2.52 | 18 * | 0.787 | | 11-#6+ 3 | 7 | #5 | #6 | 9-#9 | 11 | #4 | #4 | 16-#5 | 278 | 555 | 747 | 2.44 | 18 | | 7 | #4 | #5 | 10-#8 | 11 | #4 | #4 | 16-#5 |
| D = 12.417 | 100 | 2.92 | 18 * | 0.877 | | 12-#6+ 5 | 7 | #6 | #7 | 11-#9 | 11 | #4 | #4 | 16-#5 | 347 | 694 | 935 | 2.78 | 18 * | 4 S 6 1 | 7 | #5 | #5 | 10-#9 | 11 | #4 | #4 | 16-#5 |
| RIB ON | 150 | 3.35 | 19 * | 0.630 | | 10-#7+ 3 | 7 | #7 | #7 | 13-#9 | 11 | #4 | #5 | 16-#5 | 416 | 831 | 1119 | 3.12 | 18 * | 4 S 6 1 | 7 | #5 | #6 | 12-#9 | 11 | #4 | #4 | 16-#5 |
| COLUMN LINE 0.874 CF/SF | 200 | 4.04 | 23 * | 0.627 | 4 S 6 1 | 9-#8+ 1 | 7 | #8 | #8 | 16-#9 | 11 | #5 | #5 | 16-#5 | 480 | 1049 | 1293 | 3.62 | 18 * | 4 S 6 2 | 7 | #6 | #7 | 14-#9 | 11 | #4 | #4 | 16-#5 |
| 38'-0" | 50 | 2.67 | 19 * | 0.839 | | 12-#6+ 6 | 8 | #6 | #6 | 10-#9 | 11 | #4 | #4 | 16-#5 | 328 | 657 | 884 | 2.54 | 19 | | 8 | #4 | #5 | 12-#8 | 11 | #4 | #4 | 16-#5 |
| D = 14.417 | 100 | 3.20 | 19 * | 0.915 | | 10-#7+ 6 | 8 | #6 | #7 | 16-#8 | 11 | #4 | #5 | 16-#5 | 410 | 821 | 1105 | 3.05 | 19 * | 4 S 6 1 | 8 | #5 | #6 | 12-#9 | 11 | #4 | #4 | 16-#5 |
| RIB NOT ON | 150 | 3.70 | 23 * | 0.627 | | 12-#7+ 2 | 8 | #7 | #7 | 16-#9 | 11 | #5 | #5 | 16-#5 | 488 | 975 | 1313 | 3.41 | 19 * | 4 S 6 1 | 8 | #6 | #6 | 18-#8 | 11 | #4 | #4 | 16-#5 |
| COLUMN LINE 0.888 CF/SF | 200 | 4.37 | 27 * | 0.624 | | 14-#7+ 4 | 8 | #7 | #8 | 18-#9 | 11 | #5 | #6 | 19-#5 | 561 | 1123 | 1509 | 4.09 | 21 * | 4 S 6 2 | 8 | #6 | #7 | 17-#9 | 11 | #4 | #5 | 18-#5 |

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 ½ in. | | Rib Depth = 14 in. | | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | |
| 24'-0" | 50 | 1.99 | 12 | 0.641 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 89 | 177 | 239 |
| D = 8.417 | 100 | 1.99 | 12 | 0.641 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 109 | 219 | 294 |
| RIB ON | 150 | 2.08 | 12 | 0.641 | | 10-#5+ 0 | 5 | #4 | #5 | 6-#7 | 7 | #4 | #4 | 11-#5 | 130 | 281 | 350 |
| COLUMN LINE | 200 | 2.18 | 12 | 0.641 | | 10-#5+ 0 | 5 | #5 | #5 | 6-#7 | 7 | #4 | #4 | 11-#5 | 151 | 351 | 405 |
| 0.968 CF/SF | 300 | 2.60 | 12 | 0.717 | | 10-#5+ 0 | 5 | #6 | #6 | 6-#8 | 7 | #4 | #4 | 11-#5 | 192 | 482 | 517 |
| | 400 | 3.01 | 12 * | 0.853 | | 10-#5+ 3 | 5 | #6 | #7 | 6-#9 | 7 | #4 | #5 | 11-#5 | 233 | 610 | 628 |
| | 500 | 3.59 | 12 * | 0.642 | 4 S 6 1 | 6-#7+ 0 | 5 | #7 | #8 | 7-#9 | 7 | #5 | #5 | 11-#5 | 274 | 737 | 739 |
| 26'-0" | 50 | 1.98 | 13 | 0.639 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 114 | 228 | 307 |
| D = 10.417 | 100 | 1.98 | 13 | 0.639 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 140 | 280 | 377 |
| RIB NOT ON | 150 | 2.12 | 13 | 0.639 | | 8-#6+ 0 | 6 | #4 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 | 166 | 358 | 448 |
| COLUMN LINE | 200 | 2.27 | 13 | 0.720 | | 8-#6+ 1 | 6 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 | 193 | 446 | 519 |
| 0.992 CF/SF | 300 | 2.83 | 13 * | 0.842 | | 8-#6+ 3 | 6 | #6 | #6 | 8-#8 | 7 | #4 | #5 | 11-#5 | 245 | 614 | 660 |
| | 400 | 3.36 | 13 * | 0.640 | | 12-#5+ 3 | 6 | #7 | #7 | 8-#9 | 7 | #5 | #5 | 11-#5 | 298 | 777 | 801 |
| | 500 | 3.97 | 13 * | 0.640 | | 7-#7+ 3 | 6 | #7 | #8 | 12-#8 | 7 | #5 | #6 | 11-#5 | 350 | 938 | 942 |
| 28'-0" | 50 | 1.95 | 14 | 0.637 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 | 141 | 283 | 381 |
| D = 10.417 | 100 | 2.10 | 14 | 0.637 | | 8-#6+ 0 | 6 | #4 | #5 | 7-#7 | 8 | #4 | #4 | 12-#5 | 174 | 348 | 469 |
| RIB NOT ON | 150 | 2.24 | 14 | 0.687 | | 8-#6+ 1 | 6 | #5 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 | 207 | 440 | 557 |
| COLUMN LINE | 200 | 2.47 | 14 | 0.765 | | 8-#6+ 2 | 6 | #5 | #6 | 8-#8 | 8 | #4 | #4 | 12-#5 | 240 | 551 | 645 |
| 0.979 CF/SF | 300 | 3.11 | 14 * | 0.638 | | 9-#6+ 1 | 6 | #6 | #7 | 8-#9 | 8 | #4 | #5 | 12-#5 | 305 | 760 | 822 |
| | 400 | 3.89 | 14 * | 0.638 | | 8-#7+ 2 | 6 | #7 | #8 | 10-#9 | 8 | #5 | #6 | 12-#5 | 371 | 963 | 998 |
| 30'-0" | 50 | 2.09 | 15 | 0.636 | | 9-#6+ 0 | 6 | #4 | #5 | 7-#7 | 9 | #4 | #4 | 14-#5 | 173 | 346 | 466 |
| D = 10.417 | 100 | 2.29 | 15 | 0.642 | | 9-#6+ 0 | 6 | #5 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 | 214 | 427 | 575 |
| RIB NOT ON | 150 | 2.50 | 15 | 0.733 | | 9-#6+ 1 | 6 | #5 | #6 | 11-#7 | 9 | #4 | #4 | 14-#5 | 254 | 533 | 683 |
| COLUMN LINE | 200 | 2.84 | 15 * | 0.823 | | 9-#6+ 3 | 6 | #6 | #7 | 8-#9 | 9 | #4 | #4 | 14-#5 | 294 | 670 | 792 |
| 0.968 CF/SF | 300 | 3.61 | 15 * | 0.637 | | 8-#7+ 2 | 6 | #7 | #8 | 10-#9 | 9 | #5 | #5 | 14-#5 | 375 | 925 | 1009 |
| 32'-0" | 50 | 2.17 | 16 | 0.658 | | 10-#6+ 1 | 7 | #4 | #5 | 9-#7 | 9 | #4 | #4 | 14-#5 | 212 | 424 | 571 |
| D = 12.417 | 100 | 2.36 | 16 | 0.739 | | 10-#6+ 2 | 7 | #5 | #5 | 9-#8 | 9 | #4 | #4 | 14-#5 | 261 | 522 | 702 |
| RIB ON | 150 | 2.59 | 16 * | 0.822 | | 10-#6+ 4 | 7 | #5 | #6 | 10-#8 | 9 | #4 | #4 | 14-#5 | 310 | 642 | 834 |
| COLUMN LINE | 200 | 3.14 | 16 * | 0.880 | | 15-#5+ 7 | 7 | #6 | #7 | 12-#8 | 9 | #4 | #5 | 14-#5 | 359 | 809 | 965 |
| 0.987 CF/SF | 300 | 4.03 | 17 * | 0.635 | | 10-#7+ 3 | 7 | #7 | #8 | 16-#8 | 9 | #5 | #6 | 14-#5 | 455 | 1116 | 1225 |
| 34'-0" | 50 | 2.25 | 17 | 0.688 | | 10-#6+ 2 | 7 | #5 | #5 | 11-#7 | 10 | #4 | #4 | 15-#5 | 253 | 506 | 681 |
| D = 12.417 | 100 | 2.56 | 17 | 0.785 | | 10-#6+ 4 | 7 | #5 | #6 | 9-#9 | 10 | #4 | #4 | 15-#5 | 312 | 623 | 839 |
| RIB ON | 150 | 2.82 | 17 * | 0.858 | | 11-#6+ 5 | 7 | #6 | #6 | 10-#9 | 10 | #4 | #4 | 15-#5 | 370 | 753 | 997 |
| COLUMN LINE | 200 | 3.36 | 17 * | 0.635 | | 9-#7+ 2 | 7 | #7 | #7 | 12-#9 | 10 | #4 | #5 | 15-#5 | 429 | 954 | 1155 |
| 0.977 CF/SF | 300 | 4.43 | 21 * | 0.631 | 4 S 6 1 | 9-#8+ 1 | 7 | #8 | #8 | 15-#9 | 10 | #5 | #6 | 16-#5 | 541 | 1311 | 1456 |
| 36'-0" | 50 | 2.45 | 18 | 0.715 | | 11-#6+ 2 | 7 | #5 | #6 | 10-#8 | 11 | #4 | #4 | 16-#5 | 299 | 599 | 806 |
| D = 12.417 | 100 | 2.75 | 18 * | 0.821 | | 11-#6+ 5 | 7 | #6 | #6 | 10-#9 | 11 | #4 | #4 | 16-#5 | 369 | 738 | 993 |
| RIB ON | 150 | 3.18 | 18 * | 0.887 | | 9-#7+ 4 | 7 | #6 | #7 | 12-#9 | 11 | #4 | #5 | 16-#5 | 439 | 877 | 1181 |
| COLUMN LINE | 200 | 3.75 | 18 * | 0.634 | | 11-#7+ 3 | 7 | #7 | #8 | 14-#9 | 11 | #5 | #5 | 16-#5 | 508 | 1110 | 1368 |
| 0.968 CF/SF | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.54 | 19 | 0.758 | | 12-#6+ 3 | 8 | #5 | #6 | 12-#8 | 11 | #4 | #4 | 16-#5 | 354 | 709 | 954 |
| D = 14.417 | 100 | 3.06 | 19 * | 0.860 | | 18-#5+ 9 | 8 | #6 | #7 | 12-#9 | 11 | #4 | #5 | 16-#5 | 436 | 873 | 1175 |
| RIB NOT ON | 150 | 3.42 | 19 * | 0.633 | | 11-#7+ 3 | 8 | #7 | #7 | 14-#9 | 11 | #4 | #5 | 16-#5 | 518 | 1036 | 1395 |
| COLUMN LINE | 200 | 4.15 | 22 * | 0.630 | | 10-#8+ 3 | 8 | #7 | #8 | 17-#9 | 11 | #5 | #6 | 17-#5 | 596 | 1280 | 1604 |
| 0.984 CF/SF | 300 | 4.80 | 29 * | 0.625 | | 12-#8+ 3 | 8 | #8 | #8 | 21-#9 | 11 | #5 | #6 | 16-#6 | 736 | 1471 | 1980 |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 ½ in. | | | Rib Depth = 14 in. | | | | Total Slab Depth = 4 ½ in. | | | |
| 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| 2.09 | 12 | | 5 | #4 | #4 | 6-#7 | 7 | #4 | #4 | 11-#5 |
| 2.50 | 12 | 4 S 6 1 | 5 | #5 | #5 | 6-#8 | 7 | #4 | #4 | 11-#5 |
| 2.82 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| 3.13 | 12 * | 4 S 6 2 | 5 | #6 | #6 | 11-#7 | 7 | #4 | #4 | 11-#5 |
| 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| 2.08 | 13 | | 6 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 11-#5 |
| 2.18 | 13 | | 6 | #4 | #4 | 8-#7 | 7 | #4 | #4 | 11-#5 |
| 2.65 | 13 | | 6 | #5 | #5 | 8-#8 | 7 | #4 | #4 | 11-#5 |
| 2.95 | 13 * | 4 S 6 1 | 6 | #5 | #6 | 7-#9 | 7 | #4 | #4 | 11-#5 |
| 3.53 | 13 * | 4 S 6 1 | 6 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 11-#5 |
| 1.97 | 14 | | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 |
| 2.08 | 14 | | 6 | #4 | #4 | 7-#7 | 8 | #4 | #4 | 12-#5 |
| 2.14 | 14 | | 6 | #4 | #4 | 8-#7 | 8 | #4 | #4 | 12-#5 |
| 2.38 | 14 | | 6 | #4 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 |
| 2.96 | 14 * | 4 S 6 1 | 6 | #5 | #6 | 8-#9 | 8 | #4 | #4 | 12-#5 |
| 3.42 | 14 * | 4 S 6 2 | 6 | #6 | #6 | 9-#9 | 8 | #4 | #5 | 12-#5 |
| 2.05 | 15 | | 6 | #4 | #4 | 9-#6 | 9 | #4 | #4 | 14-#5 |
| 2.25 | 15 | | 6 | #4 | #4 | 7-#8 | 9 | #4 | #4 | 14-#5 |
| 2.43 | 15 | | 6 | #4 | #5 | 8-#8 | 9 | #4 | #4 | 14-#5 |
| 2.67 | 15 | 4 S 6 1 | 6 | #5 | #5 | 7-#9 | 9 | #4 | #4 | 14-#5 |
| 3.19 | 15 * | 4 S 6 2 | 6 | #6 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| 2.15 | 16 | | 7 | #4 | #4 | 9-#7 | 9 | #4 | #4 | 14-#5 |
| 2.29 | 16 | | 7 | #4 | #4 | 11-#7 | 9 | #4 | #4 | 14-#5 |
| 2.55 | 16 | | 7 | #4 | #5 | 10-#8 | 9 | #4 | #4 | 14-#5 |
| 2.98 | 16 * | 4 S 6 1 | 7 | #5 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| 3.60 | 16 * | 4 S 6 1 | 7 | #6 | #6 | 12-#9 | 9 | #4 | #5 | 14-#5 |
| 2.17 | 17 | | 7 | #4 | #4 | 10-#7 | 10 | #4 | #4 | 15-#5 |
| 2.49 | 17 | | 7 | #4 | #5 | 10-#8 | 10 | #4 | #4 | 15-#5 |
| 2.76 | 17 | 4 S 6 1 | 7 | #5 | #5 | 9-#9 | 10 | #4 | #4 | 15-#5 |
| 3.12 | 17 * | 4 S 6 1 | 7 | #5 | #6 | 11-#9 | 10 | #4 | #4 | 15-#5 |
| 4.06 | 17 * | 4 S 6 2 | 7 | #7 | #7 | 14-#9 | 10 | #4 | #5 | 15-#5 |
| 2.38 | 18 | | 7 | #4 | #5 | 9-#8 | 11 | #4 | #4 | 16-#5 |
| 2.70 | 18 | 4 S 6 1 | 7 | #5 | #5 | 9-#9 | 11 | #4 | #4 | 16-#5 |
| 3.04 | 18 * | 4 S 6 1 | 7 | #5 | #6 | 11-#9 | 11 | #4 | #4 | 16-#5 |
| 3.38 | 18 * | 4 S 6 2 | 7 | #6 | #6 | 13-#9 | 11 | #4 | #4 | 16-#5 |
| 2.48 | 19 | | 8 | #4 | #5 | 11-#8 | 11 | #4 | #4 | 16-#5 |
| 2.83 | 19 * | | 8 | #5 | #5 | 11-#9 | 11 | #4 | #4 | 16-#5 |
| 3.17 | 19 * | 4 S 6 1 | 8 | #5 | #6 | 13-#9 | 11 | #4 | #4 | 16-#5 |
| 3.74 | 19 * | 4 S 6 2 | 8 | #6 | #6 | 16-#9 | 11 | #4 | #5 | 16-#5 |
| 4.44 | 25 * | 4 S 6 2 | 8 | #6 | #7 | 20-#9 | 11 | #4 | #5 | 20-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 20 ½ in. | Rib Depth = 16 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | | | | Total Depth = 20 ½ in. | Rib Depth = 16 in. | Total Slab Depth = 4 ½ in. | | | | | | | | |
| 28'-0" | 50 | 1.95 | 14 | 0.640 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 | 152 | 304 | 410 | 1.97 | 14 | | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 |
| D = 10.417 | 100 | 2.08 | 14 | 0.640 | | 8-#6+ 0 | 6 | #4 | #5 | 7-#7 | 8 | #4 | #4 | 12-#5 | 185 | 370 | 498 | 2.04 | 14 | | 6 | #4 | #4 | 9-#6 | 8 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.22 | 14 | 0.640 | | 8-#6+ 0 | 6 | #5 | #5 | 8-#7 | 8 | #4 | #4 | 12-#5 | 218 | 454 | 586 | 2.14 | 14 | | 6 | #4 | #4 | 8-#7 | 8 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.45 | 14 | 0.656 | | 8-#6+ 1 | 6 | #5 | #6 | 7-#8 | 8 | #4 | #4 | 12-#5 | 250 | 567 | 674 | 2.38 | 14 | | 6 | #4 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 |
| 1.077 CF/SF | 300 | 3.02 | 14 * | 0.800 | | 8-#6+ 3 | 6 | #6 | #7 | 7-#9 | 8 | #4 | #5 | 12-#5 | 316 | 778 | 851 | 2.85 | 14 | 4 S 6 1 | 6 | #5 | #6 | 7-#9 | 8 | #4 | #4 | 12-#5 |
| | 400 | 3.45 | 14 * | 0.641 | | 7-#7+ 0 | 6 | #7 | #7 | 9-#9 | 8 | #5 | #5 | 12-#5 | 382 | 983 | 1027 | 3.10 | 14 * | 4 S 6 1 | 6 | #6 | #6 | 8-#9 | 8 | #4 | #4 | 12-#5 |
| | 500 | 4.21 | 14 * | 0.641 | | 12-#6+ 0 | 6 | #8 | #8 | 11-#9 | 8 | #5 | #6 | 12-#5 | 447 | 1185 | 1204 | 3.70 | 14 * | 4 S 6 2 | 6 | #6 | #7 | 10-#9 | 8 | #4 | #5 | 12-#5 |
| 30'-0" | 50 | 2.09 | 15 | 0.638 | | 9-#6+ 0 | 6 | #4 | #5 | 7-#7 | 9 | #4 | #4 | 14-#5 | 186 | 373 | 502 | 2.05 | 15 | | 6 | #4 | #4 | 9-#6 | 9 | #4 | #4 | 14-#5 |
| D = 10.417 | 100 | 2.24 | 15 | 0.638 | | 9-#6+ 0 | 6 | #5 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 | 227 | 453 | 610 | 2.14 | 15 | | 6 | #4 | #4 | 8-#7 | 9 | #4 | #4 | 14-#5 |
| RIB NOT ON | 150 | 2.45 | 15 | 0.638 | | 9-#6+ 0 | 6 | #5 | #6 | 8-#8 | 9 | #4 | #4 | 14-#5 | 267 | 551 | 719 | 2.36 | 15 | | 6 | #4 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | 200 | 2.65 | 15 | 0.709 | | 9-#6+ 1 | 6 | #6 | #6 | 7-#9 | 9 | #4 | #4 | 14-#5 | 307 | 689 | 827 | 2.55 | 15 | | 6 | #5 | #5 | 8-#8 | 9 | #4 | #4 | 14-#5 |
| 1.065 CF/SF | 300 | 3.34 | 15 * | 0.849 | | 7-#7+ 2 | 6 | #7 | #7 | 9-#9 | 9 | #4 | #5 | 14-#5 | 388 | 949 | 1044 | 3.19 | 15 * | 4 S 6 1 | 6 | #6 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| | 400 | 4.14 | 15 * | 0.639 | | 12-#6+ 1 | 6 | #8 | #8 | 11-#9 | 9 | #5 | #6 | 14-#5 | 468 | 1200 | 1261 | 3.68 | 15 * | 4 S 6 2 | 6 | #6 | #7 | 13-#8 | 9 | #4 | #5 | 14-#5 |
| 32'-0" | 50 | 2.13 | 16 | 0.637 | | 10-#6+ 0 | 7 | #4 | #5 | 9-#7 | 9 | #4 | #4 | 14-#5 | 228 | 456 | 614 | 2.09 | 16 | | 7 | #4 | #4 | 11-#6 | 9 | #4 | #4 | 14-#5 |
| D = 12.417 | 100 | 2.30 | 16 | 0.637 | | 10-#6+ 0 | 7 | #5 | #5 | 11-#7 | 9 | #4 | #4 | 14-#5 | 277 | 554 | 746 | 2.21 | 16 | | 7 | #4 | #4 | 10-#7 | 9 | #4 | #4 | 14-#5 |
| RIB ON | 150 | 2.55 | 16 | 0.702 | | 10-#6+ 1 | 7 | #5 | #6 | 10-#8 | 9 | #4 | #4 | 14-#5 | 326 | 665 | 877 | 2.48 | 16 | | 7 | #4 | #5 | 9-#8 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | 200 | 2.87 | 16 * | 0.795 | | 10-#6+ 3 | 7 | #6 | #6 | 9-#9 | 9 | #4 | #5 | 14-#5 | 375 | 834 | 1009 | 2.67 | 16 | | 7 | #5 | #5 | 10-#8 | 9 | #4 | #4 | 14-#5 |
| 1.086 CF/SF | 300 | 3.76 | 16 * | 0.638 | | 12-#6+ 3 | 7 | #7 | #8 | 11-#9 | 9 | #5 | #5 | 14-#5 | 473 | 1150 | 1272 | 3.41 | 16 * | 4 S 6 1 | 7 | #6 | #6 | 13-#8 | 9 | #4 | #5 | 14-#5 |
| | 400 | 4.58 | 18 * | 0.636 | | 11-#7+ 3 | 7 | #8 | #8 | 14-#9 | 9 | #6 | #6 | 15-#5 | 567 | 1447 | 1527 | 4.06 | 16 * | 4 S 6 2 | 7 | #6 | #7 | 16-#8 | 9 | #5 | #5 | 14-#5 |
| 34'-0" | 50 | 2.25 | 17 | 0.636 | | 10-#6+ 0 | 7 | #5 | #5 | 11-#7 | 10 | #4 | #4 | 15-#5 | 272 | 544 | 733 | 2.17 | 17 | | 7 | #4 | #4 | 10-#7 | 10 | #4 | #4 | 15-#5 |
| D = 12.417 | 100 | 2.49 | 17 | 0.636 | | 10-#6+ 0 | 7 | #5 | #6 | 10-#8 | 10 | #4 | #4 | 15-#5 | 331 | 662 | 891 | 2.42 | 17 | | 7 | #4 | #5 | 9-#8 | 10 | #4 | #4 | 15-#5 |
| RIB ON | 150 | 2.78 | 17 * | 0.744 | | 10-#6+ 2 | 7 | #6 | #6 | 9-#9 | 10 | #4 | #4 | 15-#5 | 390 | 782 | 1049 | 2.76 | 17 | | 7 | #5 | #5 | 9-#9 | 10 | #4 | #4 | 15-#5 |
| COLUMN LINE | 200 | 3.17 | 17 * | 0.860 | | 12-#6+ 5 | 7 | #6 | #7 | 11-#9 | 10 | #4 | #5 | 15-#5 | 448 | 986 | 1207 | 2.99 | 17 * | 4 S 6 1 | 7 | #5 | #6 | 10-#9 | 10 | #4 | #4 | 15-#5 |
| 1.075 CF/SF | 300 | 4.21 | 17 * | 0.637 | | 11-#7+ 3 | 7 | #8 | #8 | 14-#9 | 10 | #5 | #6 | 15-#5 | 566 | 1363 | 1523 | 3.73 | 17 * | 4 S 6 2 | 7 | #6 | #7 | 16-#8 | 10 | #4 | #5 | 15-#5 |
| 36'-0" | 50 | 2.45 | 18 | 0.635 | | 11-#6+ 1 | 7 | #5 | #6 | 10-#8 | 11 | #4 | #4 | 16-#5 | 322 | 644 | 867 | 2.38 | 18 | | 7 | #4 | #5 | 9-#8 | 11 | #4 | #4 | 16-#5 |
| D = 12.417 | 100 | 2.73 | 18 | 0.739 | | 11-#6+ 3 | 7 | #6 | #6 | 9-#9 | 11 | #4 | #4 | 16-#5 | 392 | 783 | 1054 | 2.70 | 18 | | 7 | #5 | #5 | 9-#9 | 11 | #4 | #4 | 16-#5 |
| RIB ON | 150 | 2.99 | 18 * | 0.832 | | 12-#6+ 5 | 7 | #6 | #7 | 11-#9 | 11 | #4 | #4 | 16-#5 | 461 | 923 | 1242 | 2.91 | 18 | 4 S 6 1 | 7 | #5 | #6 | 10-#9 | 11 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 3.42 | 18 * | 0.636 | | 10-#7+ 1 | 7 | #7 | #7 | 13-#9 | 11 | #4 | #5 | 16-#5 | 531 | 1150 | 1429 | 3.25 | 18 * | 4 S 6 1 | 7 | #6 | #6 | 12-#9 | 11 | #4 | #4 | 16-#5 |
| 1.065 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.54 | 19 | 0.662 | | 12-#6+ 1 | 8 | #5 | #6 | 12-#8 | 11 | #4 | #4 | 16-#5 | 381 | 763 | 1026 | 2.48 | 19 | | 8 | #4 | #5 | 11-#8 | 11 | #4 | #4 | 16-#5 |
| D = 14.417 | 100 | 2.79 | 19 * | 0.795 | | 12-#6+ 5 | 8 | #6 | #6 | 11-#9 | 11 | #4 | #4 | 16-#5 | 463 | 926 | 1247 | 2.71 | 19 | | 8 | #5 | #5 | 10-#9 | 11 | #4 | #4 | 16-#5 |
| RIB NOT ON | 150 | 3.22 | 19 * | 0.883 | | 14-#6+ 8 | 8 | #6 | #7 | 13-#9 | 11 | #4 | #5 | 16-#5 | 545 | 1090 | 1467 | 3.05 | 19 * | 4 S 6 1 | 8 | #5 | #6 | 12-#9 | 11 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 3.80 | 19 * | 0.635 | | 12-#7+ 3 | 8 | #7 | #8 | 15-#9 | 11 | #5 | #5 | 16-#5 | 627 | 1340 | 1688 | 3.39 | 19 * | 4 S 6 1 | 8 | #6 | #6 | 14-#9 | 11 | #4 | #4 | 16-#5 |
| 1.083 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 13 in. | Rib Depth = 8 in. | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | |
| 18'-0" | 50 | 1.99 | 12 | 0.633 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 30 | 60 | 81 |
| D = 6.417 | 100 | 1.99 | 12 | 0.633 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 38 | 77 | 103 |
| RIB NOT ON | 150 | 1.99 | 12 | 0.633 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 47 | 106 | 126 |
| COLUMN LINE | 200 | 1.99 | 12 | 0.633 | | 5-#6+ 0 | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 | 55 | 133 | 149 |
| 0.737 CF/SF | 300 | 2.18 | 12 | 0.706 | | 5-#6+ 0 | 4 | #5 | #5 | 6-#6 | 5 | #4 | #4 | 8-#5 | 72 | 185 | 194 |
| | 400 | 2.47 | 12 * | 0.825 | | 5-#6+ 1 | 4 | #5 | #6 | 6-#7 | 5 | #4 | #4 | 8-#5 | 89 | 237 | 240 |
| | 500 | 2.79 | 12 * | 0.634 | | 5-#6+ 1 | 4 | #6 | #6 | 5-#8 | 5 | #4 | #5 | 8-#5 | 106 | 288 | 285 |
| 20'-0" | 50 | 1.96 | 12 | 0.633 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 42 | 84 | 113 |
| D = 8.417 | 100 | 1.96 | 12 | 0.651 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 54 | 107 | 145 |
| RIB ON | 150 | 1.96 | 12 | 0.695 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 65 | 148 | 176 |
| COLUMN LINE | 200 | 2.07 | 12 | 0.739 | | 6-#6+ 0 | 5 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 8-#5 | 77 | 186 | 208 |
| 0.756 CF/SF | 300 | 2.41 | 12 * | 0.826 | | 6-#6+ 0 | 5 | #5 | #5 | 6-#7 | 5 | #4 | #5 | 8-#5 | 101 | 259 | 271 |
| | 400 | 2.90 | 12 * | 0.634 | | 6-#6+ 0 | 5 | #6 | #6 | 6-#8 | 5 | #5 | #5 | 8-#5 | 124 | 330 | 334 |
| | 500 | 3.43 | 14 * | 0.631 | | 6-#6+ 1 | 5 | #6 | #7 | 7-#8 | 5 | #5 | #6 | 8-#5 | 146 | 398 | 394 |
| 22'-0" | 50 | 1.98 | 12 | 0.659 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 56 | 112 | 151 |
| D = 8.417 | 100 | 1.98 | 12 | 0.709 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 72 | 144 | 193 |
| RIB ON | 150 | 2.12 | 12 | 0.759 | | 9-#5+ 0 | 5 | #4 | #5 | 6-#7 | 6 | #4 | #4 | 10-#5 | 88 | 198 | 236 |
| COLUMN LINE | 200 | 2.25 | 12 * | 0.828 | | 9-#5+ 1 | 5 | #5 | #5 | 9-#6 | 6 | #4 | #4 | 10-#5 | 103 | 248 | 278 |
| 0.746 CF/SF | 300 | 2.81 | 12 * | 0.634 | | 9-#5+ 1 | 5 | #6 | #6 | 7-#8 | 6 | #4 | #5 | 10-#5 | 135 | 346 | 363 |
| | 400 | 3.36 | 15 * | 0.630 | 3 S 4 1 | 10-#5+ 1 | 5 | #7 | #7 | 8-#8 | 6 | #5 | #5 | 10-#5 | 164 | 438 | 443 |
| | 500 | 3.98 | 18 * | 0.626 | 3 S 4 1 | 6-#7+ 1 | 5 | #7 | #8 | 8-#9 | 6 | #5 | #6 | 10-#5 | 190 | 497 | 512 |
| 24'-0" | 50 | 1.99 | 12 | 0.722 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 73 | 146 | 197 |
| D = 8.417 | 100 | 2.11 | 12 | 0.776 | | 10-#5+ 0 | 5 | #4 | #5 | 6-#7 | 7 | #4 | #4 | 11-#5 | 94 | 187 | 252 |
| RIB ON | 150 | 2.30 | 12 * | 0.845 | | 10-#5+ 1 | 5 | #5 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 | 114 | 258 | 308 |
| COLUMN LINE | 200 | 2.64 | 12 * | 0.910 | | 10-#5+ 3 | 5 | #6 | #6 | 7-#8 | 7 | #4 | #4 | 11-#5 | 135 | 324 | 363 |
| 0.737 CF/SF | 300 | 3.23 | 15 * | 0.630 | 3 S 4 1 | 6-#7+ 0 | 5 | #7 | #7 | 7-#9 | 7 | #4 | #5 | 11-#5 | 174 | 447 | 469 |
| | 400 | 3.86 | 19 * | 0.625 | 3 S 4 1 | 9-#6+ 2 | 5 | #7 | #8 | 9-#9 | 7 | #5 | #5 | 11-#5 | 209 | 529 | 562 |
| 26'-0" | 50 | 1.98 | 13 | 0.755 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 94 | 187 | 252 |
| D = 10.417 | 100 | 2.16 | 13 * | 0.833 | | 8-#6+ 1 | 6 | #4 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 | 120 | 240 | 323 |
| RIB NOT ON | 150 | 2.52 | 13 * | 0.905 | | 8-#6+ 3 | 6 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 11-#5 | 146 | 325 | 393 |
| COLUMN LINE | 200 | 2.86 | 14 * | 0.631 | | 8-#6+ 2 | 6 | #6 | #6 | 7-#9 | 7 | #4 | #5 | 11-#5 | 172 | 408 | 462 |
| 0.752 CF/SF | 300 | 3.56 | 19 * | 0.625 | | 7-#7+ 2 | 6 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 11-#5 | 219 | 542 | 589 |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 13 in. | Rib Depth = 8 in. | Total Slab Depth = 5 in. | | | | | | | | |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.01 | 12 | | 4 | #4 | #4 | 5-#6 | 5 | #4 | #4 | 8-#5 |
| 2.04 | 12 | 3 S 4 1 | 4 | #4 | #4 | 8-#5 | 5 | #4 | #4 | 8-#5 |
| 2.33 | 12 | 3 S 4 1 | 4 | #4 | #5 | 5-#7 | 5 | #4 | #4 | 8-#5 |
| 2.56 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 6-#7 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 2.29 | 12 | 3 S 4 1 | 5 | #4 | #5 | 6-#7 | 5 | #4 | #4 | 8-#5 |
| 2.58 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 10-#6 | 5 | #4 | #4 | 8-#5 |
| 3.12 | 12 * | 3 S 4 1 | 5 | #5 | #6 | 7-#8 | 5 | #4 | #5 | 8-#5 |
| 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| 2.07 | 12 | | 5 | #4 | #4 | 7-#6 | 6 | #4 | #4 | 10-#5 |
| 2.14 | 12 | 3 S 4 1 | 5 | #4 | #4 | 6-#7 | 6 | #4 | #4 | 10-#5 |
| 2.58 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 6-#8 | 6 | #4 | #4 | 10-#5 |
| 2.96 | 12 * | 3 S 4 2 | 5 | #5 | #6 | 6-#9 | 6 | #4 | #4 | 10-#5 |
| 3.50 | 16 * | 3 S 4 2 | 5 | #6 | #6 | 7-#9 | 6 | #4 | #5 | 10-#5 |
| 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| 2.09 | 12 | | 5 | #4 | #4 | 6-#7 | 7 | #4 | #4 | 11-#5 |
| 2.29 | 12 | 3 S 4 1 | 5 | #4 | #5 | 9-#6 | 7 | #4 | #4 | 11-#5 |
| 2.50 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 6-#8 | 7 | #4 | #4 | 11-#5 |
| 2.91 | 12 * | 3 S 4 2 | 5 | #5 | #6 | 8-#8 | 7 | #4 | #4 | 11-#5 |
| 3.50 | 16 * | 3 S 4 2 | 5 | #6 | #6 | 8-#9 | 7 | #4 | #5 | 11-#5 |
| 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| 2.11 | 13 | | 6 | #4 | #4 | 7-#7 | 7 | #4 | #4 | 11-#5 |
| 2.44 | 13 * | | 6 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| 2.65 | 13 * | 3 S 4 1 | 6 | #5 | #5 | 8-#8 | 7 | #4 | #4 | 11-#5 |
| 3.21 | 15 * | 3 S 4 2 | 6 | #5 | #6 | 8-#9 | 7 | #4 | #5 | 11-#5 |

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments $-M$ Edge (ft-k) | Moments $+M$ Bot. (ft-k) | Moments $-M$ Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 13 in. | Rib Depth = 8 in. | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | | Total Depth = 13 in. | Rib Depth = 8 in. | Total Slab Depth = 5 in. | | | | | | | | |
| 28'-0" | 50 | 2.10 | 14 | 0.784 | | 8-#6+ 1 | 6 | #4 | #5 | 10-#6 | 8 | #4 | #4 | 12-#5 | 116 | 233 | 313 | 2.08 | 14 | | 6 | #4 | #4 | 7-#7 | 8 | #4 | #4 | 12-#5 |
| D = 10.417 | 100 | 2.32 | 14 * | 0.860 | | 8-#6+ 2 | 6 | #5 | #5 | 8-#8 | 8 | #4 | #4 | 12-#5 | 149 | 298 | 402 | 2.26 | 14 | | 6 | #4 | #4 | 7-#8 | 8 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.72 | 14 * | 0.631 | | 8-#6+ 2 | 6 | #6 | #6 | 7-#9 | 8 | #4 | #4 | 12-#5 | 182 | 396 | 490 | 2.64 | 14 * | 3 S 4 1 | 6 | #5 | #5 | 11-#7 | 8 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 3.15 | 17 * | 0.627 | | 9-#6+ 2 | 6 | #6 | #7 | 9-#9 | 8 | #4 | #5 | 12-#5 | 213 | 496 | 573 | 2.96 | 14 * | 3 S 4 1 | 6 | #5 | #6 | 8-#9 | 8 | #4 | #4 | 12-#5 |
| 0.744 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.29 | 15 * | 0.840 | | 9-#6+ 3 | 6 | #5 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 | 143 | 285 | 384 | 2.25 | 15 | | 6 | #4 | #4 | 7-#8 | 9 | #4 | #4 | 14-#5 |
| D = 10.417 | 100 | 2.55 | 15 * | 0.910 | | 9-#6+ 5 | 6 | #5 | #6 | 7-#9 | 9 | #4 | #4 | 14-#5 | 183 | 366 | 493 | 2.49 | 15 * | 3 S 4 1 | 6 | #4 | #5 | 11-#7 | 9 | #4 | #4 | 14-#5 |
| RIB NOT ON | 150 | 3.17 | 17 * | 0.627 | | 7-#7+ 2 | 6 | #6 | #7 | 9-#9 | 9 | #4 | #5 | 14-#5 | 222 | 470 | 598 | 3.05 | 15 * | 3 S 4 1 | 6 | #5 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | 200 | 3.47 | 21 * | 0.624 | | 8-#7+ 2 | 6 | #7 | #7 | 11-#9 | 9 | #4 | #5 | 14-#5 | 258 | 573 | 695 | 3.29 | 16 * | 3 S 4 2 | 6 | #6 | #6 | 10-#9 | 9 | #4 | #4 | 14-#5 |
| 0.737 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 32'-0" | 50 | 2.36 | 16 * | 0.867 | | 10-#6+ 4 | 7 | #5 | #5 | 9-#8 | 9 | #4 | #4 | 14-#5 | 174 | 348 | 469 | 2.29 | 16 | | 7 | #4 | #4 | 11-#7 | 9 | #4 | #4 | 14-#5 |
| D = 12.417 | 100 | 2.86 | 17 * | 0.918 | | 10-#6+ 6 | 7 | #6 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 | 222 | 445 | 599 | 2.83 | 16 * | 3 S 4 1 | 7 | #5 | #5 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| RIB ON | 150 | 3.28 | 21 * | 0.624 | | 12-#6+ 4 | 7 | #6 | #7 | 11-#9 | 9 | #4 | #5 | 14-#5 | 268 | 554 | 722 | 3.12 | 16 * | 3 S 4 1 | 7 | #5 | #6 | 13-#8 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.749 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 34'-0" | 50 | 2.56 | 17 * | 0.883 | | 10-#6+ 5 | 7 | #5 | #6 | 9-#9 | 10 | #4 | #4 | 15-#5 | 208 | 417 | 561 | 2.49 | 17 * | | 7 | #4 | #5 | 10-#8 | 10 | #4 | #4 | 15-#5 |
| D = 12.417 | 100 | 3.09 | 20 * | 0.922 | | 12-#6+ 8 | 7 | #6 | #7 | 11-#9 | 10 | #4 | #5 | 15-#5 | 265 | 530 | 713 | 2.84 | 17 * | 3 S 4 1 | 7 | #5 | #5 | 10-#9 | 10 | #4 | #4 | 15-#5 |
| RIB ON | 150 | 3.49 | 28 * | 0.619 | | 10-#7+ 3 | 7 | #7 | #7 | 13-#9 | 10 | #4 | #5 | 15-#5 | 313 | 626 | 843 | 3.28 | 21 * | 3 S 4 2 | 7 | #5 | #6 | 16-#8 | 10 | #4 | #4 | 15-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.743 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.75 | 18 * | 0.904 | | 11-#6+ 6 | 7 | #6 | #6 | 10-#9 | 11 | #4 | #4 | 16-#5 | 247 | 493 | 664 | 2.70 | 18 * | 3 S 4 1 | 7 | #5 | #5 | 9-#9 | 11 | #4 | #4 | 16-#5 |
| D = 12.417 | 100 | 3.35 | 25 * | 0.621 | | 10-#7+ 3 | 7 | #7 | #7 | 13-#9 | 11 | #4 | #5 | 16-#5 | 311 | 622 | 837 | 3.12 | 18 * | 3 S 4 2 | 7 | #5 | #6 | 12-#9 | 11 | #4 | #4 | 16-#5 |
| RIB ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.737 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 10 in. | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | |
| 20'-0" | 50 | 1.96 | 12 | 0.636 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 45 | 91 | 122 |
| D = 8.417 | 100 | 1.96 | 12 | 0.636 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 57 | 114 | 154 |
| RIB ON | 150 | 1.96 | 12 | 0.636 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 69 | 154 | 186 |
| COLUMN LINE | 200 | 1.96 | 12 | 0.636 | | 6-#6+ 0 | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 | 81 | 192 | 217 |
| 0.849 CF/SF | 300 | 2.22 | 12 | 0.717 | | 6-#6+ 0 | 5 | #5 | #5 | 6-#7 | 5 | #4 | #4 | 8-#5 | 104 | 266 | 280 |
| | 400 | 2.55 | 12 * | 0.799 | | 6-#6+ 0 | 5 | #5 | #6 | 7-#7 | 5 | #4 | #5 | 8-#5 | 128 | 338 | 343 |
| | 500 | 2.93 | 12 * | 0.637 | | 6-#6+ 0 | 5 | #6 | #6 | 6-#8 | 5 | #5 | #5 | 8-#5 | 151 | 410 | 407 |
| 22'-0" | 50 | 1.98 | 12 | 0.636 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 61 | 121 | 163 |
| D = 8.417 | 100 | 1.98 | 12 | 0.636 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 76 | 153 | 206 |
| RIB ON | 150 | 2.07 | 12 | 0.663 | | 9-#5+ 0 | 5 | #4 | #5 | 7-#6 | 6 | #4 | #4 | 10-#5 | 92 | 205 | 248 |
| COLUMN LINE | 200 | 2.19 | 12 | 0.710 | | 9-#5+ 0 | 5 | #5 | #5 | 6-#7 | 6 | #4 | #4 | 10-#5 | 108 | 257 | 291 |
| 0.835 CF/SF | 300 | 2.50 | 12 * | 0.839 | | 9-#5+ 2 | 5 | #5 | #6 | 6-#8 | 6 | #4 | #4 | 10-#5 | 140 | 356 | 376 |
| | 400 | 3.01 | 12 * | 0.637 | | 9-#5+ 2 | 5 | #6 | #7 | 7-#8 | 6 | #4 | #5 | 10-#5 | 171 | 453 | 461 |
| | 500 | 3.57 | 13 * | 0.635 | 3 S 4 1 | 7-#6+ 1 | 5 | #7 | #7 | 7-#9 | 6 | #5 | #5 | 10-#5 | 202 | 547 | 543 |
| 24'-0" | 50 | 1.99 | 12 | 0.642 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 79 | 158 | 213 |
| D = 8.417 | 100 | 1.99 | 12 | 0.692 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 100 | 199 | 268 |
| RIB ON | 150 | 2.20 | 12 | 0.742 | | 10-#5+ 0 | 5 | #5 | #5 | 9-#6 | 7 | #4 | #4 | 11-#5 | 120 | 267 | 324 |
| COLUMN LINE | 200 | 2.43 | 12 * | 0.811 | | 10-#5+ 1 | 5 | #5 | #6 | 6-#8 | 7 | #4 | #4 | 11-#5 | 141 | 335 | 380 |
| 0.825 CF/SF | 300 | 3.01 | 12 * | 0.637 | | 10-#5+ 1 | 5 | #6 | #7 | 6-#9 | 7 | #4 | #5 | 11-#5 | 182 | 465 | 491 |
| | 400 | 3.65 | 14 * | 0.634 | 3 S 4 1 | 6-#7+ 1 | 5 | #7 | #8 | 8-#9 | 7 | #5 | #5 | 11-#5 | 222 | 587 | 597 |
| | 500 | 4.21 | 17 * | 0.630 | 3 S 4 1 | 7-#7+ 0 | 5 | #8 | #8 | 9-#9 | 7 | #5 | #6 | 11-#5 | 257 | 683 | 692 |
| 26'-0" | 50 | 1.98 | 13 | 0.681 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 101 | 203 | 273 |
| D = 10.417 | 100 | 2.12 | 13 | 0.735 | | 8-#6+ 0 | 6 | #4 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 | 128 | 255 | 344 |
| RIB NOT ON | 150 | 2.30 | 13 * | 0.811 | | 8-#6+ 1 | 6 | #5 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 | 154 | 339 | 414 |
| COLUMN LINE | 200 | 2.63 | 13 * | 0.884 | | 8-#6+ 3 | 6 | #5 | #6 | 8-#8 | 7 | #4 | #5 | 11-#5 | 180 | 425 | 485 |
| 0.843 CF/SF | 300 | 3.25 | 14 * | 0.634 | | 12-#5+ 3 | 6 | #6 | #7 | 8-#9 | 7 | #5 | #5 | 11-#5 | 232 | 587 | 624 |
| | 400 | 3.97 | 18 * | 0.629 | | 10-#6+ 1 | 6 | #7 | #8 | 12-#8 | 7 | #5 | #6 | 11-#5 | 278 | 722 | 749 |
| 28'-0" | 50 | 2.05 | 14 | 0.680 | | 8-#6+ 0 | 6 | #4 | #5 | 9-#6 | 8 | #4 | #4 | 12-#5 | 126 | 252 | 339 |
| D = 10.417 | 100 | 2.24 | 14 | 0.772 | | 8-#6+ 1 | 6 | #5 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 | 159 | 318 | 427 |
| RIB NOT ON | 150 | 2.51 | 14 * | 0.860 | | 8-#6+ 3 | 6 | #5 | #6 | 8-#8 | 8 | #4 | #4 | 12-#5 | 192 | 415 | 516 |
| COLUMN LINE | 200 | 2.97 | 14 * | 0.634 | | 8-#6+ 2 | 6 | #6 | #7 | 8-#9 | 8 | #4 | #5 | 12-#5 | 224 | 523 | 604 |
| 0.833 CF/SF | 300 | 3.76 | 18 * | 0.629 | | 15-#5+ 4 | 6 | #7 | #8 | 10-#9 | 8 | #5 | #5 | 12-#5 | 286 | 718 | 770 |
| | 400 | 4.34 | 23 * | 0.625 | 3 S 4 1 | 7-#8+ 2 | 6 | #8 | #8 | 12-#9 | 8 | #5 | #6 | 12-#5 | 340 | 828 | 915 |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 10 in. | Total Slab Depth = 5 in. | | | | | | | | |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 5 | #4 | #4 | 6-#6 | 5 | #4 | #4 | 8-#5 |
| 2.07 | 12 | | 5 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 8-#5 |
| 2.29 | 12 | 3 S 4 1 | 5 | #4 | #5 | 6-#7 | 5 | #4 | #4 | 8-#5 |
| 2.64 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 6-#8 | 5 | #4 | #4 | 8-#5 |
| 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| 2.07 | 12 | | 5 | #4 | #4 | 7-#6 | 6 | #4 | #4 | 10-#5 |
| 2.39 | 12 | 3 S 4 1 | 5 | #4 | #5 | 7-#7 | 6 | #4 | #4 | 10-#5 |
| 2.75 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 7-#8 | 6 | #4 | #4 | 10-#5 |
| 3.26 | 12 * | 3 S 4 2 | 5 | #6 | #6 | 6-#9 | 6 | #4 | #5 | 10-#5 |
| 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| 2.09 | 12 | | 5 | #4 | #4 | 6-#7 | 7 | #4 | #4 | 11-#5 |
| 2.33 | 12 | 3 S 4 1 | 5 | #4 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 |
| 2.82 | 12* | 3 S 4 1 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| 3.21 | 12 * | 3 S 4 2 | 5 | #6 | #6 | 7-#9 | 7 | #4 | #4 | 11-#5 |
| 3.70 | 15 * | 3 S 4 2 | 5 | #6 | #7 | 8-#9 | 7 | #4 | #5 | 11-#5 |
| 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| 2.08 | 13 | | 6 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 11-#5 |
| 2.18 | 13 | | 6 | #4 | #4 | 8-#7 | 7 | #4 | #4 | 11-#5 |
| 2.44 | 13 * | | 6 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| 2.95 | 13 * | 3 S 4 1 | 6 | #5 | #6 | 7-#9 | 7 | #4 | #4 | 11-#5 |
| 3.54 | 15 * | 3 S 4 2 | 6 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 11-#5 |
| 1.99 | 14 | | 6 | #4 | #4 | 12-#5 | 8 | #4 | #4 | 12-#5 |
| 2.14 | 14 | | 6 | #4 | #4 | 8-#7 | 8 | #4 | #4 | 12-#5 |
| 2.46 | 14 | 3 S 4 1 | 6 | #4 | #5 | 8-#8 | 8 | #4 | #4 | 12-#5 |
| 2.70 | 14 * | 3 S 4 1 | 6 | #5 | #5 | 7-#9 | 8 | #4 | #4 | 12-#5 |
| 3.42 | 14 * | 3 S 4 2 | 6 | #6 | #6 | 9-#9 | 8 | #4 | #5 | 12-#5 |
| 3.89 | 19 * | 3 S 4 2 | 6 | #6 | #7 | 11-#9 | 8 | #4 | #5 | 12-#5 |

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 10 in. | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.24 | 15 | 0.717 | | 9-#6+ 0 | 6 | #5 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 | 154 | 309 | 416 |
| D = 10.417 | 100 | 2.49 | 15 * | 0.823 | | 9-#6+ 2 | 6 | #5 | #6 | 8-#8 | 9 | #4 | #4 | 14-#5 | 195 | 389 | 524 |
| RIB NOT ON | 150 | 2.74 | 15 * | 0.897 | | 9-#6+ 4 | 6 | #6 | #6 | 8-#9 | 9 | #4 | #4 | 14-#5 | 235 | 499 | 633 |
| COLUMN LINE | 200 | 3.28 | 16 * | 0.631 | | 7-#7+ 3 | 6 | #7 | #7 | 12-#8 | 9 | #4 | #5 | 14-#5 | 275 | 630 | 739 |
| 0.825 CF/SF | 300 | 4.17 | 22 * | 0.626 | | 7-#8+ 2 | 6 | #8 | #8 | 12-#9 | 9 | #5 | #5 | 14-#5 | 346 | 813 | 930 |
| 32'-0" | 50 | 2.28 | 16 | 0.790 | | 10-#6+ 2 | 7 | #5 | #5 | 14-#6 | 9 | #4 | #4 | 14-#5 | 189 | 377 | 508 |
| D = 12.417 | 100 | 2.55 | 16 * | 0.879 | | 10-#6+ 5 | 7 | #5 | #6 | 10-#8 | 9 | #4 | #4 | 14-#5 | 238 | 475 | 640 |
| RIB ON | 150 | 2.98 | 16 * | 0.631 | | 15-#5+ 4 | 7 | #6 | #6 | 10-#9 | 9 | #4 | #5 | 14-#5 | 286 | 597 | 771 |
| COLUMN LINE | 200 | 3.56 | 20 * | 0.627 | | 12-#6+ 3 | 7 | #7 | #7 | 12-#9 | 9 | #5 | #5 | 14-#5 | 332 | 750 | 893 |
| 0.839 CF/SF | | | | | | | | | | | | | | | | | |
| 34'-0" | 50 | 2.49 | 17 * | 0.824 | | 10-#6+ 4 | 7 | #5 | #6 | 10-#8 | 10 | #4 | #4 | 15-#5 | 225 | 451 | 607 |
| D = 12.417 | 100 | 2.79 | 17 * | 0.899 | | 15-#5+ 8 | 7 | #6 | #6 | 12-#8 | 10 | #4 | #4 | 15-#5 | 284 | 568 | 765 |
| RIB ON | 150 | 3.26 | 19 * | 0.628 | | 9-#7+ 4 | 7 | #6 | #7 | 12-#9 | 10 | #4 | #5 | 15-#5 | 341 | 688 | 918 |
| COLUMN LINE | 200 | 3.86 | 23 * | 0.625 | | 11-#7+ 3 | 7 | #7 | #8 | 14-#9 | 10 | #5 | #5 | 15-#5 | 394 | 847 | 1061 |
| 0.832 CF/SF | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.73 | 18 * | 0.842 | | 11-#6+ 4 | 7 | #6 | #6 | 9-#9 | 11 | #4 | #4 | 16-#5 | 267 | 534 | 719 |
| D = 12.417 | 100 | 3.18 | 18 * | 0.629 | | 9-#7+ 4 | 7 | #6 | #7 | 12-#9 | 11 | #4 | #5 | 16-#5 | 337 | 673 | 906 |
| RIB ON | 150 | 3.52 | 23 * | 0.625 | | 11-#7+ 3 | 7 | #7 | #7 | 14-#9 | 11 | #4 | #5 | 16-#5 | 401 | 802 | 1080 |
| COLUMN LINE | 200 | 4.11 | 29 * | 0.621 | 3 S 4 1 | 10-#8+ 3 | 7 | #7 | #8 | 17-#9 | 11 | #5 | #5 | 17-#5 | 457 | 915 | 1231 |
| 0.825 CF/SF | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.79 | 19 * | 0.888 | | 12-#6+ 8 | 8 | #6 | #6 | 11-#9 | 11 | #4 | #4 | 16-#5 | 316 | 631 | 850 |
| D = 14.417 | 100 | 3.28 | 22 * | 0.914 | | 11-#7+ 6 | 8 | #6 | #7 | 14-#9 | 11 | #4 | #5 | 16-#5 | 395 | 789 | 1063 |
| RIB NOT ON | 150 | 3.96 | 28 * | 0.622 | | 10-#8+ 3 | 8 | #7 | #8 | 17-#9 | 11 | #5 | #5 | 17-#5 | 468 | 936 | 1261 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.837 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 10 in. | Total Slab Depth = 5 in. | | | | | | | | |
| 2.14 | 15 | | 6 | #4 | #4 | 8-#7 | 9 | #4 | #4 | 14-#5 |
| 2.43 | 15 | | 6 | #4 | #5 | 8-#8 | 9 | #4 | #4 | 14-#5 |
| 2.67 | 15 * | 3 S 4 1 | 6 | #5 | #5 | 7-#9 | 9 | #4 | #4 | 14-#5 |
| 3.05 | 15 * | 3 S 4 1 | 6 | #5 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| 3.90 | 18 * | 3 S 4 2 | 6 | #6 | #7 | 12-#9 | 9 | #4 | #5 | 14-#5 |
| 2.21 | 16 | | 7 | #4 | #4 | 10-#7 | 9 | #4 | #4 | 14-#5 |
| 2.48 | 16 | | 7 | #4 | #5 | 9-#8 | 9 | #4 | #4 | 14-#5 |
| 2.83 | 16 * | 3 S 4 1 | 7 | #5 | #5 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| 3.21 | 16 * | 3 S 4 1 | 7 | #5 | #6 | 11-#9 | 9 | #4 | #4 | 14-#5 |
| 2.42 | 17 | | 7 | #4 | #5 | 9-#8 | 10 | #4 | #4 | 15-#5 |
| 2.76 | 17 * | 3 S 4 1 | 7 | #5 | #5 | 9-#9 | 10 | #4 | #4 | 15-#5 |
| 3.12 | 17 * | 3 S 4 1 | 7 | #5 | #6 | 11-#9 | 10 | #4 | #4 | 15-#5 |
| 3.49 | 18 * | 3 S 4 2 | 7 | #6 | #6 | 13-#9 | 10 | #4 | #4 | 15-#5 |
| 2.70 | 18 | | 7 | #5 | #5 | 9-#9 | 11 | #4 | #4 | 16-#5 |
| 3.04 | 18 * | 3 S 4 1 | 7 | #5 | #6 | 11-#9 | 11 | #4 | #4 | 16-#5 |
| 3.38 | 18 * | 3 S 4 2 | 7 | #6 | #6 | 13-#9 | 11 | #4 | #4 | 16-#5 |
| 3.85 | 23 * | 3 S 4 2 | 7 | #6 | #7 | 16-#9 | 11 | #4 | #4 | 16-#5 |
| 2.71 | 19 * | | 8 | #5 | #5 | 10-#9 | 11 | #4 | #4 | 16-#5 |
| 3.11 | 19 * | 3 S 4 1 | 8 | #5 | #6 | 16-#8 | 11 | #4 | #4 | 16-#5 |
| 3.60 | 20 * | 3 S 4 2 | 8 | #6 | #6 | 16-#9 | 11 | #4 | #4 | 16-#5 |

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments $-M$ Edge (ft-k) | Moments $+M$ Bot. (ft-k) | Moments $-M$ Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 17 in. | Rib Depth = 12 in. | | Total Slab Depth = 5 in. | | | | | | | | | | | | | | |
| 22'-0" | 50 | 1.98 | 12 | 0.639 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 66 | 131 | 176 |
| D = 8.417 | 100 | 1.98 | 12 | 0.639 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 81 | 163 | 219 |
| RIB ON | 150 | 1.98 | 12 | 0.639 | | 9-#5+ 0 | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 | 97 | 212 | 261 |
| COLUMN LINE | 200 | 2.10 | 12 | 0.639 | | 9-#5+ 0 | 5 | #4 | #5 | 7-#6 | 6 | #4 | #4 | 10-#5 | 113 | 265 | 304 |
| 0.928 CF/SF | 300 | 2.41 | 12 | 0.696 | | 9-#5+ 0 | 5 | #5 | #6 | 9-#6 | 6 | #4 | #4 | 10-#5 | 144 | 365 | 389 |
| | 400 | 2.77 | 12 * | 0.824 | | 9-#5+ 2 | 5 | #6 | #6 | 6-#8 | 6 | #4 | #5 | 10-#5 | 176 | 462 | 473 |
| | 500 | 3.21 | 12 * | 0.640 | | 9-#5+ 2 | 5 | #6 | #7 | 6-#9 | 6 | #5 | #5 | 10-#5 | 207 | 559 | 558 |
| 24'-0" | 50 | 1.99 | 12 | 0.639 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 85 | 171 | 230 |
| D = 8.417 | 100 | 1.99 | 12 | 0.639 | | 10-#5+ 0 | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 | 106 | 212 | 285 |
| RIB ON | 150 | 2.11 | 12 | 0.652 | | 10-#5+ 0 | 5 | #4 | #5 | 6-#7 | 7 | #4 | #4 | 11-#5 | 127 | 276 | 341 |
| COLUMN LINE | 200 | 2.27 | 12 | 0.700 | | 10-#5+ 0 | 5 | #5 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 | 147 | 345 | 396 |
| 0.916 CF/SF | 300 | 2.64 | 12 * | 0.829 | | 10-#5+ 2 | 5 | #6 | #6 | 7-#8 | 7 | #4 | #4 | 11-#5 | 188 | 476 | 507 |
| | 400 | 3.17 | 12 * | 0.640 | | 10-#5+ 2 | 5 | #7 | #7 | 11-#7 | 7 | #4 | #5 | 11-#5 | 230 | 604 | 619 |
| | 500 | 3.73 | 12 * | 0.640 | 4 S 6 1 | 6-#7+ 1 | 5 | #7 | #8 | 8-#9 | 7 | #5 | #5 | 11-#5 | 271 | 730 | 730 |
| 26'-0" | 50 | 1.98 | 13 | 0.637 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 109 | 219 | 295 |
| D = 10.417 | 100 | 2.00 | 13 | 0.654 | | 8-#6+ 0 | 6 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 11-#5 | 136 | 271 | 365 |
| RIB NOT ON | 150 | 2.24 | 13 | 0.705 | | 8-#6+ 0 | 6 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 | 162 | 351 | 436 |
| COLUMN LINE | 200 | 2.46 | 13 | 0.782 | | 8-#6+ 1 | 6 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 11-#5 | 188 | 439 | 507 |
| 0.937 CF/SF | 300 | 2.97 | 13 * | 0.638 | | 8-#6+ 2 | 6 | #6 | #7 | 7-#9 | 7 | #4 | #5 | 11-#5 | 241 | 605 | 648 |
| | 400 | 3.73 | 13 * | 0.638 | | 9-#6+ 2 | 6 | #7 | #7 | 9-#9 | 7 | #5 | #6 | 11-#5 | 293 | 768 | 789 |
| | 500 | 4.35 | 17 * | 0.633 | | 8-#7+ 2 | 6 | #7 | #8 | 10-#9 | 7 | #6 | #6 | 11-#5 | 340 | 908 | 915 |
| 28'-0" | 50 | 1.97 | 14 | 0.636 | | 8-#6+ 0 | 6 | #4 | #4 | 9-#6 | 8 | #4 | #4 | 12-#5 | 136 | 272 | 366 |
| D = 10.417 | 100 | 2.11 | 14 | 0.661 | | 8-#6+ 0 | 6 | #4 | #5 | 8-#7 | 8 | #4 | #4 | 12-#5 | 169 | 338 | 454 |
| RIB NOT ON | 150 | 2.45 | 14 | 0.776 | | 8-#6+ 2 | 6 | #5 | #6 | 7-#8 | 8 | #4 | #4 | 12-#5 | 202 | 431 | 543 |
| COLUMN LINE | 200 | 2.67 | 14 * | 0.840 | | 8-#6+ 3 | 6 | #6 | #6 | 11-#7 | 8 | #4 | #4 | 12-#5 | 234 | 542 | 631 |
| 0.925 CF/SF | 300 | 3.38 | 14 * | 0.637 | | 7-#7+ 2 | 6 | #7 | #7 | 9-#9 | 8 | #5 | #5 | 12-#5 | 300 | 748 | 807 |
| | 400 | 4.20 | 18 * | 0.632 | | 12-#6+ 2 | 6 | #8 | #8 | 11-#9 | 8 | #5 | #6 | 12-#5 | 361 | 939 | 971 |
| 30'-0" | 50 | 2.12 | 15 | 0.643 | | 9-#6+ 0 | 6 | #4 | #5 | 8-#7 | 9 | #4 | #4 | 14-#5 | 167 | 333 | 449 |
| D = 10.417 | 100 | 2.37 | 15 | 0.706 | | 9-#6+ 0 | 6 | #5 | #5 | 8-#8 | 9 | #4 | #4 | 14-#5 | 207 | 414 | 557 |
| RIB NOT ON | 150 | 2.65 | 15 * | 0.811 | | 9-#6+ 2 | 6 | #6 | #6 | 7-#9 | 9 | #4 | #4 | 14-#5 | 247 | 521 | 666 |
| COLUMN LINE | 200 | 3.09 | 15 * | 0.884 | | 9-#6+ 4 | 6 | #6 | #7 | 9-#9 | 9 | #4 | #5 | 14-#5 | 288 | 657 | 774 |
| 0.916 CF/SF | 300 | 3.81 | 17 * | 0.633 | | 12-#6+ 2 | 6 | #7 | #8 | 11-#9 | 9 | #5 | #5 | 14-#5 | 366 | 905 | 985 |
| 32'-0" | 50 | 2.25 | 16 | 0.710 | | 10-#6+ 1 | 7 | #5 | #5 | 10-#7 | 9 | #4 | #4 | 14-#5 | 204 | 407 | 548 |
| D = 12.417 | 100 | 2.51 | 16 * | 0.805 | | 10-#6+ 3 | 7 | #5 | #6 | 9-#8 | 9 | #4 | #4 | 14-#5 | 253 | 505 | 680 |
| RIB ON | 150 | 2.87 | 16 * | 0.883 | | 10-#6+ 6 | 7 | #6 | #6 | 9-#9 | 9 | #4 | #5 | 14-#5 | 301 | 626 | 812 |
| COLUMN LINE | 200 | 3.29 | 16 * | 0.634 | | 11-#6+ 3 | 7 | #6 | #7 | 13-#8 | 9 | #5 | #5 | 14-#5 | 350 | 792 | 943 |
| 0.933 CF/SF | 300 | 4.31 | 21 * | 0.629 | | 14-#6+ 4 | 7 | #8 | #8 | 14-#9 | 9 | #5 | #6 | 14-#5 | 441 | 1067 | 1187 |
| | 400 | 4.88 | 26 * | 0.625 | 4 S 6 1 | 17-#6+ 3 | 7 | #8 | #8 | 16-#9 | 9 | #6 | #6 | 17-#5 | 521 | 1178 | 1402 |
| 34'-0" | 50 | 2.37 | 17 | 0.757 | | 10-#6+ 3 | 7 | #5 | #5 | 9-#8 | 10 | #4 | #4 | 15-#5 | 243 | 487 | 655 |
| D = 12.417 | 100 | 2.65 | 17 * | 0.841 | | 10-#6+ 5 | 7 | #6 | #6 | 9-#9 | 10 | #4 | #4 | 15-#5 | 302 | 604 | 813 |
| RIB ON | 150 | 3.09 | 17 * | 0.910 | | 12-#6+ 6 | 7 | #6 | #7 | 11-#9 | 10 | #4 | #5 | 15-#5 | 361 | 731 | 971 |
| COLUMN LINE | 200 | 3.61 | 18 * | 0.632 | | 10-#7+ 3 | 7 | #7 | #7 | 16-#8 | 10 | #5 | #5 | 15-#5 | 418 | 928 | 1126 |
| 0.924 CF/SF | 300 | 4.55 | 25 * | 0.626 | 4 S 6 1 | 17-#6+ 3 | 7 | #8 | #8 | 16-#9 | 10 | #5 | #6 | 17-#5 | 521 | 1191 | 1404 |
| 36'-0" | 50 | 2.52 | 18 * | 0.779 | | 11-#6+ 3 | 7 | #5 | #6 | 9-#9 | 11 | #4 | #4 | 16-#5 | 288 | 576 | 775 |
| D = 12.417 | 100 | 2.92 | 18 * | 0.870 | | 12-#6+ 5 | 7 | #6 | #7 | 11-#9 | 11 | #4 | #4 | 16-#5 | 358 | 715 | 963 |
| RIB ON | 150 | 3.35 | 18 * | 0.632 | | 10-#7+ 3 | 7 | #7 | #7 | 13-#9 | 11 | #4 | #5 | 16-#5 | 427 | 854 | 1150 |
| COLUMN LINE | 200 | 4.03 | 22 * | 0.628 | 4 S 6 1 | 9-#8+ 1 | 7 | #8 | #8 | 15-#9 | 11 | #5 | #5 | 16-#5 | 492 | 1069 | 1325 |
| 0.916 CF/SF | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.67 | 19 * | 0.834 | | 12-#6+ 6 | 8 | #6 | #6 | 10-#9 | 11 | #4 | #4 | 16-#5 | 341 | 681 | 917 |
| D = 14.417 | 100 | 3.20 | 19 * | 0.909 | | 10-#7+ 6 | 8 | #6 | #7 | 16-#8 | 11 | #4 | #5 | 16-#5 | 423 | 845 | 1138 |
| RIB NOT ON | 150 | 3.68 | 22 * | 0.628 | | 12-#7+ 2 | 8 | #7 | #7 | 15-#9 | 11 | #5 | #5 | 16-#5 | 501 | 1002 | 1349 |
| COLUMN LINE | 200 | 4.36 | 26 * | 0.625 | | 14-#7+ 4 | 8 | #7 | #8 | 18-#9 | 11 | #5 | #6 | 19-#5 | 575 | 1192 | 1549 |
| 0.930 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 17 in. | | Rib Depth = 12 in. | | Total Slab Depth = 5 in. | | | | | | | |
| 22'-0" | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| D = 8.417 | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| RIB ON | 2.01 | 12 | | 5 | #4 | #4 | 9-#5 | 6 | #4 | #4 | 10-#5 |
| COLUMN LINE | 2.07 | 12 | | 5 | #4 | #4 | 7-#6 | 6 | #4 | #4 | 10-#5 |
| 0.928 CF/SF | 2.27 | 12 | | 5 | #4 | #5 | 6-#7 | 6 | #4 | #4 | 10-#5 |
| | 2.58 | 12 | 4 S 6 1 | 5 | #5 | #5 | 6-#8 | 6 | #4 | #4 | 10-#5 |
| | 2.91 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 7-#8 | 6 | #4 | #4 | 10-#5 |
| 24'-0" | 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| D = 8.417 | 2.03 | 12 | | 5 | #4 | #4 | 7-#6 | 7 | #4 | #4 | 11-#5 |
| RIB ON | 2.09 | 12 | | 5 | #4 | #4 | 6-#7 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 2.21 | 12 | | 5 | #4 | #5 | 6-#7 | 7 | #4 | #4 | 11-#5 |
| 0.916 CF/SF | 2.50 | 12 | 4 S 6 1 | 5 | #5 | #5 | 6-#8 | 7 | #4 | #4 | 11-#5 |
| | 2.87 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 6-#9 | 7 | #4 | #4 | 11-#5 |
| | 3.36 | 12 * | 4 S 6 2 | 5 | #6 | #6 | 7-#9 | 7 | #4 | #5 | 11-#5 |
| 26'-0" | 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| D = 10.417 | 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| RIB NOT ON | 2.11 | 13 | | 6 | #4 | #4 | 7-#7 | 7 | #4 | #4 | 11-#5 |
| COLUMN LINE | 2.31 | 13 | | 6 | #4 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 |
| 0.937 CF/SF | 2.65 | 13 * | 4 S 6 1 | 6 | #5 | #5 | 8-#8 | 7 | #4 | #4 | 11-#5 |
| | 3.36 | 13 * | 4 S 6 1 | 6 | #6 | #6 | 8-#9 | 7 | #4 | #5 | 11-#5 |
| | 3.96 | 14 * | 4 S 6 2 | 6 | #6 | #7 | 12-#8 | 7 | #5 | #5 | 11-#5 |
| 28'-0" | 1.97 | 14 | | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 |
| D = 10.417 | 2.08 | 14 | | 6 | #4 | #4 | 7-#7 | 8 | #4 | #4 | 12-#5 |
| RIB NOT ON | 2.38 | 14 | | 6 | #4 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 |
| COLUMN LINE | 2.58 | 14 | 4 S 6 1 | 6 | #5 | #5 | 8-#8 | 8 | #4 | #4 | 12-#5 |
| 0.925 CF/SF | 2.96 | 14 * | 4 S 6 1 | 6 | #5 | #6 | 8-#9 | 8 | #4 | #4 | 12-#5 |
| | 3.70 | 14 * | 4 S 6 2 | 6 | #6 | #7 | 10-#9 | 8 | #4 | #5 | 12-#5 |
| 30'-0" | 2.08 | 15 | | 6 | #4 | #4 | 7-#7 | 9 | #4 | #4 | 14-#5 |
| D = 10.417 | 2.36 | 15 | | 6 | #4 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 |
| RIB NOT ON | 2.55 | 15 | 4 S 6 1 | 6 | #5 | #5 | 8-#8 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | 2.90 | 15 * | 4 S 6 1 | 6 | #5 | #6 | 8-#9 | 9 | #4 | #4 | 14-#5 |
| 0.916 CF/SF | 3.48 | 15 * | 4 S 6 2 | 6 | #6 | #7 | 10-#9 | 9 | #4 | #4 | 14-#5 |
| 32'-0" | 2.15 | 16 | | 7 | #4 | #4 | 9-#7 | 9 | #4 | #4 | 14-#5 |
| D = 12.417 | 2.42 | 16 | | 7 | #4 | #5 | 11-#7 | 9 | #4 | #4 | 14-#5 |
| RIB ON | 2.67 | 16 * | | 7 | #5 | #5 | 10-#8 | 9 | #4 | #4 | 14-#5 |
| COLUMN LINE | 3.00 | 16 * | 4 S 6 1 | 7 | #5 | #6 | 12-#8 | 9 | #4 | #4 | 14-#5 |
| 0.933 CF/SF | 3.85 | 17 * | 4 S 6 2 | 7 | #6 | #7 | 16-#8 | 9 | #4 | #5 | 14-#5 |
| | 4.47 | 23 * | 4 S 6 2 | 7 | #6 | #7 | 15-#9 | 9 | #5 | #5 | 16-#5 |
| 34'-0" | 2.37 | 17 | | 7 | #4 | #5 | 11-#7 | 10 | #4 | #4 | 15-#5 |
| D = 12.417 | 2.49 | 17 | | 7 | #4 | #5 | 10-#8 | 10 | #4 | #4 | 15-#5 |
| RIB ON | 2.84 | 17 * | 4 S 6 1 | 7 | #5 | #5 | 10-#9 | 10 | #4 | #4 | 15-#5 |
| COLUMN LINE | 3.35 | 17 * | 4 S 6 1 | 7 | #6 | #6 | 12-#9 | 10 | #4 | #4 | 15-#5 |
| 0.924 CF/SF | 4.23 | 20 * | 4 S 6 2 | 7 | #7 | #7 | 15-#9 | 10 | #4 | #5 | 16-#5 |
| 36'-0" | 2.44 | 18 | | 7 | #4 | #5 | 10-#8 | 11 | #4 | #4 | 16-#5 |
| D = 12.417 | 2.78 | 18 * | 4 S 6 1 | 7 | #5 | #5 | 10-#9 | 11 | #4 | #4 | 16-#5 |
| RIB ON | 3.12 | 18 * | 4 S 6 1 | 7 | #5 | #6 | 12-#9 | 11 | #4 | #4 | 16-#5 |
| COLUMN LINE | 3.62 | 18 * | 4 S 6 2 | 7 | #6 | #7 | 14-#9 | 11 | #4 | #4 | 16-#5 |
| 0.916 CF/SF | | | | | | | | | | | |
| 38'-0" | 2.54 | 19 | | 8 | #4 | #5 | 12-#8 | 11 | #4 | #4 | 16-#5 |
| D = 14.417 | 3.05 | 19 * | 4 S 6 1 | 8 | #5 | #6 | 12-#9 | 11 | #4 | #4 | 16-#5 |
| RIB NOT ON | 3.39 | 19 * | 4 S 6 1 | 8 | #6 | #6 | 14-#9 | 11 | #4 | #4 | 16-#5 |
| COLUMN LINE | 4.07 | 20 * | 4 S 6 2 | 8 | #6 | #7 | 17-#9 | 11 | #4 | #5 | 17-#5 |
| 0.930 CF/SF | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | Rib Depth = 14 in. | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | |
| 26'-0" | 50 | 1.98 | 13 | 0.640 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 118 | 236 | 317 |
| D = 10.417 | 100 | 1.98 | 13 | 0.640 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 | 144 | 288 | 388 |
| RIB NOT ON | 150 | 2.12 | 13 | 0.640 | | 8-#6+ 0 | 6 | #4 | #5 | 7-#7 | 7 | #4 | #4 | 11-#5 | 170 | 362 | 458 |
| COLUMN LINE | 200 | 2.27 | 13 | 0.667 | | 8-#6+ 0 | 6 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 11-#5 | 197 | 451 | 529 |
| 1.034 CF/SF | 300 | 2.78 | 13 * | 0.828 | | 8-#6+ 3 | 6 | #6 | #6 | 8-#8 | 7 | #4 | #5 | 11-#5 | 249 | 620 | 670 |
| | 400 | 3.25 | 13 * | 0.641 | | 8-#6+ 2 | 6 | #6 | #7 | 8-#9 | 7 | #5 | #5 | 11-#5 | 301 | 783 | 812 |
| | 500 | 3.96 | 13 * | 0.641 | | 7-#7+ 2 | 6 | #7 | #8 | 9-#9 | 7 | #5 | #6 | 11-#5 | 354 | 944 | 953 |
| 28'-0" | 50 | 1.95 | 14 | 0.638 | | 8-#6+ 0 | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 | 146 | 293 | 394 |
| D = 10.417 | 100 | 2.10 | 14 | 0.638 | | 8-#6+ 0 | 6 | #4 | #5 | 7-#7 | 8 | #4 | #4 | 12-#5 | 179 | 358 | 482 |
| RIB NOT ON | 150 | 2.24 | 14 | 0.671 | | 8-#6+ 1 | 6 | #5 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 | 212 | 446 | 570 |
| COLUMN LINE | 200 | 2.47 | 14 | 0.750 | | 8-#6+ 2 | 6 | #5 | #6 | 8-#8 | 8 | #4 | #4 | 12-#5 | 245 | 558 | 659 |
| 1.021 CF/SF | 300 | 3.06 | 14 * | 0.879 | | 9-#6+ 4 | 6 | #6 | #7 | 8-#9 | 8 | #4 | #5 | 12-#5 | 310 | 767 | 835 |
| | 400 | 3.88 | 14 * | 0.639 | | 15-#5+ 2 | 6 | #7 | #8 | 10-#9 | 8 | #5 | #6 | 12-#5 | 376 | 971 | 1011 |
| | 500 | 4.66 | 17 * | 0.635 | | 7-#8+ 0 | 6 | #8 | #8 | 12-#9 | 8 | #6 | #6 | 12-#5 | 437 | 1161 | 1177 |
| 30'-0" | 50 | 2.10 | 15 | 0.637 | | 9-#6+ 0 | 6 | #4 | #5 | 7-#7 | 9 | #4 | #4 | 14-#5 | 179 | 359 | 483 |
| D = 10.417 | 100 | 2.29 | 15 | 0.637 | | 9-#6+ 0 | 6 | #5 | #5 | 7-#8 | 9 | #4 | #4 | 14-#5 | 220 | 439 | 591 |
| RIB NOT ON | 150 | 2.49 | 15 | 0.718 | | 9-#6+ 1 | 6 | #5 | #6 | 8-#8 | 9 | #4 | #4 | 14-#5 | 260 | 540 | 700 |
| COLUMN LINE | 200 | 2.84 | 15 * | 0.810 | | 9-#6+ 3 | 6 | #6 | #7 | 8-#9 | 9 | #4 | #4 | 14-#5 | 300 | 678 | 808 |
| 1.010 CF/SF | 300 | 3.61 | 15 * | 0.638 | | 8-#7+ 2 | 6 | #7 | #8 | 10-#9 | 9 | #5 | #5 | 14-#5 | 381 | 935 | 1025 |
| 32'-0" | 50 | 2.17 | 16 | 0.645 | | 10-#6+ 1 | 7 | #4 | #5 | 9-#7 | 9 | #4 | #4 | 14-#5 | 219 | 438 | 590 |
| D = 12.417 | 100 | 2.36 | 16 | 0.727 | | 10-#6+ 2 | 7 | #5 | #5 | 9-#8 | 9 | #4 | #4 | 14-#5 | 268 | 536 | 722 |
| RIB ON | 150 | 2.59 | 16 * | 0.811 | | 10-#6+ 4 | 7 | #5 | #6 | 10-#8 | 9 | #4 | #4 | 14-#5 | 317 | 651 | 854 |
| COLUMN LINE | 200 | 3.06 | 16 * | 0.874 | | 10-#6+ 6 | 7 | #6 | #7 | 12-#8 | 9 | #4 | #5 | 14-#5 | 366 | 819 | 985 |
| 1.029 CF/SF | 300 | 3.97 | 16 * | 0.636 | | 10-#7+ 3 | 7 | #7 | #8 | 12-#9 | 9 | #5 | #6 | 14-#5 | 464 | 1131 | 1249 |
| 34'-0" | 50 | 2.25 | 17 | 0.676 | | 10-#6+ 2 | 7 | #5 | #5 | 11-#7 | 10 | #4 | #4 | 15-#5 | 262 | 524 | 705 |
| D = 12.417 | 100 | 2.56 | 17 | 0.774 | | 10-#6+ 4 | 7 | #5 | #6 | 9-#9 | 10 | #4 | #4 | 15-#5 | 321 | 641 | 863 |
| RIB ON | 150 | 2.81 | 17 * | 0.843 | | 15-#5+ 7 | 7 | #6 | #6 | 10-#9 | 10 | #4 | #4 | 15-#5 | 379 | 763 | 1021 |
| COLUMN LINE | 200 | 3.36 | 17 * | 0.635 | | 9-#7+ 2 | 7 | #7 | #7 | 12-#9 | 10 | #4 | #5 | 15-#5 | 438 | 966 | 1179 |
| 1.019 CF/SF | 300 | 4.34 | 20 * | 0.632 | | 9-#8+ 1 | 7 | #8 | #8 | 15-#9 | 10 | #5 | #6 | 15-#5 | 551 | 1329 | 1483 |
| 36'-0" | 50 | 2.45 | 18 | 0.705 | | 11-#6+ 2 | 7 | #5 | #6 | 10-#8 | 11 | #4 | #4 | 16-#5 | 310 | 620 | 834 |
| D = 12.417 | 100 | 2.75 | 18 * | 0.812 | | 11-#6+ 5 | 7 | #6 | #6 | 10-#9 | 11 | #4 | #4 | 16-#5 | 379 | 759 | 1022 |
| RIB ON | 150 | 3.18 | 18 * | 0.878 | | 9-#7+ 4 | 7 | #6 | #7 | 12-#9 | 11 | #4 | #5 | 16-#5 | 449 | 898 | 1209 |
| COLUMN LINE | 200 | 3.72 | 18 * | 0.634 | | 11-#7+ 3 | 7 | #7 | #8 | 14-#9 | 11 | #5 | #5 | 16-#5 | 519 | 1124 | 1397 |
| 1.010 CF/SF | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.54 | 19 | 0.750 | | 12-#6+ 3 | 8 | #5 | #6 | 12-#8 | 11 | #4 | #4 | 16-#5 | 367 | 733 | 987 |
| D = 14.417 | 100 | 3.06 | 19 * | 0.852 | | 18-#5+ 9 | 8 | #6 | #7 | 12-#9 | 11 | #4 | #5 | 16-#5 | 449 | 897 | 1208 |
| RIB NOT ON | 150 | 3.42 | 19 * | 0.633 | | 11-#7+ 3 | 8 | #7 | #7 | 14-#9 | 11 | #4 | #5 | 16-#5 | 530 | 1061 | 1428 |
| COLUMN LINE | 200 | 4.01 | 21 * | 0.631 | | 10-#8+ 3 | 8 | #7 | #8 | 17-#9 | 11 | #5 | #5 | 17-#5 | 609 | 1300 | 1641 |
| 1.026 CF/SF | 300 | 4.83 | 28 * | 0.626 | | 12-#8+ 2 | 8 | #8 | #8 | 21-#9 | 11 | #5 | #6 | 21-#5 | 751 | 1565 | 2022 |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | Rib Depth = 14 in. | Total Slab Depth = 5 in. | | | | | | | | |
| 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| 2.00 | 13 | | 6 | #4 | #4 | 8-#6 | 7 | #4 | #4 | 11-#5 |
| 2.08 | 13 | | 6 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 11-#5 |
| 2.18 | 13 | | 6 | #4 | #4 | 8-#7 | 7 | #4 | #4 | 11-#5 |
| 2.57 | 13 | | 6 | #5 | #5 | 7-#8 | 7 | #4 | #4 | 11-#5 |
| 2.95 | 13 * | 4 S 6 1 | 6 | #5 | #6 | 7-#9 | 7 | #4 | #4 | 11-#5 |
| 3.53 | 13 * | 4 S 6 1 | 6 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 11-#5 |
| 1.97 | 14 | | 6 | #4 | #4 | 8-#6 | 8 | #4 | #4 | 12-#5 |
| 2.08 | 14 | | 6 | #4 | #4 | 7-#7 | 8 | #4 | #4 | 12-#5 |
| 2.14 | 14 | | 6 | #4 | #4 | 8-#7 | 8 | #4 | #4 | 12-#5 |
| 2.38 | 14 | | 6 | #4 | #5 | 7-#8 | 8 | #4 | #4 | 12-#5 |
| 2.85 | 14 * | 4 S 6 1 | 6 | #5 | #6 | 7-#9 | 8 | #4 | #4 | 12-#5 |
| 3.42 | 14 * | 4 S 6 2 | 6 | #6 | #6 | 9-#9 | 8 | #4 | #5 | 12-#5 |
| 4.26 | 14 * | 4 S 6 2 | 6 | #7 | #7 | 11-#9 | 8 | #5 | #5 | 12-#5 |
| 2.08 | 15 | | 6 | #4 | #4 | 7-#7 | 9 | #4 | #4 | 14-#5 |
| 2.25 | 15 | | 6 | #4 | #4 | 7-#8 | 9 | #4 | #4 | 14-#5 |
| 2.43 | 15 | | 6 | #4 | #5 | 8-#8 | 9 | #4 | #4 | 14-#5 |
| 2.67 | 15 | 4 S 6 1 | 6 | #5 | #5 | 7-#9 | 9 | #4 | #4 | 14-#5 |
| 3.19 | 15 * | 4 S 6 1 | 6 | #6 | #6 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| 2.15 | 16 | | 7 | #4 | #4 | 9-#7 | 9 | #4 | #4 | 14-#5 |
| 2.29 | 16 | | 7 | #4 | #4 | 11-#7 | 9 | #4 | #4 | 14-#5 |
| 2.55 | 16 | | 7 | #4 | #5 | 10-#8 | 9 | #4 | #4 | 14-#5 |
| 2.83 | 16 * | 4 S 6 1 | 7 | #5 | #5 | 9-#9 | 9 | #4 | #4 | 14-#5 |
| 3.51 | 16 * | 4 S 6 1 | 7 | #6 | #6 | 11-#9 | 9 | #4 | #5 | 14-#5 |
| 2.17 | 17 | | 7 | #4 | #4 | 10-#7 | 10 | #4 | #4 | 15-#5 |
| 2.49 | 17 | | 7 | #4 | #5 | 10-#8 | 10 | #4 | #4 | 15-#5 |
| 2.76 | 17 | 4 S 6 1 | 7 | #5 | #5 | 9-#9 | 10 | #4 | #4 | 15-#5 |
| 3.12 | 17 * | 4 S 6 1 | 7 | #5 | #6 | 11-#9 | 10 | #4 | #4 | 15-#5 |
| 3.89 | 17 * | 4 S 6 2 | 7 | #6 | #7 | 14-#9 | 10 | #4 | #5 | 15-#5 |
| 2.38 | 18 | | 7 | #4 | #5 | 9-#8 | 11 | #4 | #4 | 16-#5 |
| 2.70 | 18 | | 7 | #5 | #5 | 9-#9 | 11 | #4 | #4 | 16-#5 |
| 3.04 | 18 * | 4 S 6 1 | 7 | #5 | #6 | 11-#9 | 11 | #4 | #4 | 16-#5 |
| 3.31 | 18 * | 4 S 6 2 | 7 | #6 | #6 | 16-#8 | 11 | #4 | #4 | 16-#5 |
| 2.48 | 19 | | 8 | #4 | #5 | 11-#8 | 11 | #4 | #4 | 16-#5 |
| 2.83 | 19 | | 8 | #5 | #5 | 11-#9 | 11 | #4 | #4 | 16-#5 |
| 3.17 | 19 * | 4 S 6 1 | 8 | #5 | #6 | 13-#9 | 11 | #4 | #4 | 16-#5 |
| 3.67 | 19 * | 4 S 6 1 | 8 | #6 | #6 | 15-#9 | 11 | #4 | #5 | 16-#5 |
| 4.53 | 24 * | 4 S 6 2 | 8 | #7 | #7 | 19-#9 | 11 | #4 | #5 | 20-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 19″ × 19″ Domes: 5″ Ribs @ 24″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments $-M$ Edge (ft-k) | Moments $+M$ Bot. (ft-k) | Moments $-M$ Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 21 in. | Rib Depth = 16 in. | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | |
| 28'-0" | 50 | 2.24 | 14 | 0.640 | | 8-#6+ 0 | 6 | #4 | #5 | 8-#6 | 8 | #4 | #5 | 12-#5 | 157 | 314 | 423 |
| D = 10.417 | 100 | 2.31 | 14 | 0.640 | | 8-#6+ 0 | 6 | #4 | #5 | 7-#7 | 8 | #4 | #5 | 12-#5 | 190 | 380 | 511 |
| RIB NOT ON | 150 | 2.44 | 14 | 0.640 | | 8-#6+ 0 | 6 | #5 | #5 | 8-#7 | 8 | #4 | #5 | 12-#5 | 223 | 459 | 599 |
| COLUMN LINE | 200 | 2.61 | 14 | 0.640 | | 8-#6+ 1 | 6 | #5 | #6 | 7-#8 | 8 | #4 | #5 | 12-#5 | 255 | 573 | 688 |
| 1.118 CF/SF | 300 | 2.99 | 14 | 0.784 | | 8-#6+ 3 | 6 | #6 | #7 | 7-#9 | 8 | #4 | #5 | 12-#5 | 321 | 785 | 864 |
| | 400 | 3.53 | 14 * | 0.641 | | 7-#7+ 0 | 6 | #7 | #7 | 9-#9 | 8 | #5 | #5 | 12-#5 | 386 | 991 | 1040 |
| | 500 | 4.19 | 14 * | 0.641 | | 8-#7+ 2 | 6 | #8 | #8 | 11-#9 | 8 | #5 | #6 | 12-#5 | 452 | 1193 | 1217 |
| 30'-0" | 50 | 2.32 | 15 | 0.639 | | 9-#6+ 0 | 6 | #4 | #5 | 7-#7 | 9 | #4 | #5 | 14-#5 | 192 | 385 | 518 |
| D = 10.417 | 100 | 2.47 | 15 | 0.639 | | 9-#6+ 0 | 6 | #5 | #5 | 7-#8 | 9 | #4 | #5 | 14-#5 | 233 | 465 | 626 |
| RIB NOT ON | 150 | 2.62 | 15 | 0.639 | | 9-#6+ 0 | 6 | #5 | #6 | 8-#8 | 9 | #4 | #5 | 14-#5 | 273 | 557 | 735 |
| COLUMN LINE | 200 | 2.83 | 15 | 0.693 | | 9-#6+ 1 | 6 | #6 | #6 | 7-#9 | 9 | #4 | #5 | 14-#5 | 313 | 697 | 843 |
| 1.107 CF/SF | 300 | 3.34 | 15 * | 0.835 | | 7-#7+ 2 | 6 | #7 | #7 | 9-#9 | 9 | #4 | #5 | 14-#5 | 394 | 958 | 1060 |
| | 400 | 4.12 | 15 * | 0.640 | | 12-#6+ 1 | 6 | #8 | #8 | 11-#9 | 9 | #5 | #6 | 14-#5 | 474 | 1210 | 1277 |
| 32'-0" | 50 | 2.36 | 16 | 0.638 | | 10-#6+ 0 | 7 | #4 | #5 | 9-#7 | 9 | #4 | #5 | 14-#5 | 235 | 471 | 634 |
| D = 12.417 | 100 | 2.52 | 16 | 0.638 | | 10-#6+ 0 | 7 | #5 | #5 | 11-#7 | 9 | #4 | #5 | 14-#5 | 284 | 568 | 765 |
| RIB ON | 150 | 2.72 | 16 | 0.658 | | 10-#6+ 0 | 7 | #5 | #6 | 10-#8 | 9 | #4 | #5 | 14-#5 | 333 | 673 | 897 |
| COLUMN LINE | 200 | 2.94 | 16 * | 0.765 | | 10-#6+ 2 | 7 | #6 | #6 | 9-#9 | 9 | #4 | #5 | 14-#5 | 382 | 844 | 1029 |
| 1.128 CF/SF | 300 | 3.62 | 16 * | 0.639 | | 12-#6+ 3 | 7 | #7 | #7 | 11-#9 | 9 | #5 | #5 | 14-#5 | 480 | 1161 | 1292 |
| | 400 | 4.46 | 17 * | 0.637 | | 11-#7+ 3 | 7 | #8 | #8 | 14-#9 | 9 | #6 | #6 | 14-#5 | 576 | 1463 | 1551 |
| 34'-0" | 50 | 2.48 | 17 | 0.636 | | 10-#6+ 0 | 7 | #5 | #5 | 11-#7 | 10 | #4 | #5 | 15-#5 | 281 | 562 | 757 |
| D = 12.417 | 100 | 2.66 | 17 | 0.636 | | 10-#6+ 0 | 7 | #5 | #6 | 10-#8 | 10 | #4 | #5 | 15-#5 | 340 | 679 | 915 |
| RIB ON | 150 | 2.95 | 17 | 0.730 | | 10-#6+ 2 | 7 | #6 | #6 | 9-#9 | 10 | #4 | #5 | 15-#5 | 398 | 797 | 1072 |
| COLUMN LINE | 200 | 3.24 | 17 * | 0.850 | | 12-#6+ 5 | 7 | #6 | #7 | 11-#9 | 10 | #4 | #5 | 15-#5 | 457 | 997 | 1230 |
| 1.116 CF/SF | 300 | 4.21 | 17 * | 0.637 | | 11-#7+ 3 | 7 | #8 | #8 | 14-#9 | 10 | #5 | #6 | 15-#5 | 574 | 1377 | 1546 |
| 36'-0" | 50 | 2.63 | 18 | 0.635 | | 11-#6+ 1 | 7 | #5 | #6 | 10-#8 | 11 | #4 | #5 | 16-#5 | 332 | 665 | 895 |
| D = 12.417 | 100 | 2.90 | 18 | 0.728 | | 11-#6+ 3 | 7 | #6 | #6 | 9-#9 | 11 | #4 | #5 | 16-#5 | 402 | 804 | 1083 |
| RIB ON | 150 | 3.16 | 18 * | 0.822 | | 12-#6+ 5 | 7 | #6 | #7 | 11-#9 | 11 | #4 | #5 | 16-#5 | 472 | 943 | 1270 |
| COLUMN LINE | 200 | 3.48 | 18 * | 0.884 | | 10-#7+ 4 | 7 | #7 | #7 | 16-#8 | 11 | #4 | #5 | 16-#5 | 541 | 1164 | 1457 |
| 1.107 CF/SF | | | | | | | | | | | | | | | | | |
| 38'-0" | 50 | 2.71 | 19 | 0.651 | | 12-#6+ 1 | 8 | #5 | #6 | 12-#8 | 11 | #4 | #5 | 16-#5 | 394 | 787 | 1060 |
| D = 14.417 | 100 | 2.95 | 19 * | 0.773 | | 12-#6+ 4 | 8 | #6 | #6 | 11-#9 | 11 | #4 | #5 | 16-#5 | 475 | 951 | 1280 |
| RIB NOT ON | 150 | 3.30 | 19 * | 0.875 | | 10-#7+ 6 | 8 | #6 | #7 | 13-#9 | 11 | #4 | #5 | 16-#5 | 557 | 1115 | 1501 |
| COLUMN LINE | 200 | 3.87 | 19 * | 0.635 | | 12-#7+ 3 | 8 | #7 | #8 | 15-#9 | 11 | #5 | #5 | 16-#5 | 639 | 1356 | 1721 |
| 1.124 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 21 in. | Rib Depth = 16 in. | Total Slab Depth = 5 in. | | | | | | | | |
| 2.24 | 14 | | 6 | #4 | #5 | 8-#6 | 8 | #4 | #5 | 12-#5 |
| 2.31 | 14 | | 6 | #4 | #5 | 9-#6 | 8 | #4 | #5 | 12-#5 |
| 2.41 | 14 | | 6 | #4 | #5 | 8-#7 | 8 | #4 | #5 | 12-#5 |
| 2.53 | 14 | | 6 | #4 | #5 | 7-#8 | 8 | #4 | #5 | 12-#5 |
| 2.79 | 14 | 4 S 6 1 | 6 | #5 | #5 | 11-#7 | 8 | #4 | #5 | 12-#5 |
| 3.25 | 14 * | 4 S 6 1 | 6 | #6 | #6 | 8-#9 | 8 | #4 | #5 | 12-#5 |
| 3.70 | 14 * | 4 S 6 2 | 6 | #6 | #7 | 10-#9 | 8 | #4 | #5 | 12-#5 |
| 2.32 | 15 | | 6 | #4 | #5 | 9-#6 | 9 | #4 | #5 | 14-#5 |
| 2.41 | 15 | | 6 | #4 | #5 | 8-#7 | 9 | #4 | #5 | 14-#5 |
| 2.52 | 15 | | 6 | #4 | #5 | 7-#8 | 9 | #4 | #5 | 14-#5 |
| 2.70 | 15 | | 6 | #5 | #5 | 8-#8 | 9 | #4 | #5 | 14-#5 |
| 3.20 | 15 * | 4 S 6 1 | 6 | #6 | #6 | 8-#9 | 9 | #4 | #5 | 14-#5 |
| 3.63 | 15 * | 4 S 6 2 | 6 | #6 | #7 | 10-#9 | 9 | #4 | #5 | 14-#5 |
| 2.36 | 16 | | 7 | #4 | #5 | 11-#6 | 9 | #4 | #5 | 14-#5 |
| 2.48 | 16 | | 7 | #4 | #5 | 10-#7 | 9 | #4 | #5 | 14-#5 |
| 2.62 | 16 | | 7 | #4 | #5 | 9-#8 | 9 | #4 | #5 | 14-#5 |
| 2.82 | 16 | | 7 | #5 | #5 | 10-#8 | 9 | #4 | #5 | 14-#5 |
| 3.37 | 16 * | 4 S 6 1 | 7 | #6 | #6 | 10-#9 | 9 | #4 | #5 | 14-#5 |
| 3.85 | 16 * | 4 S 6 2 | 7 | #6 | #7 | 16-#8 | 9 | #4 | #5 | 14-#5 |
| 2.44 | 17 | | 7 | #4 | #5 | 10-#7 | 10 | #4 | #5 | 15-#5 |
| 2.58 | 17 | | 7 | #4 | #5 | 9-#8 | 10 | #4 | #5 | 15-#5 |
| 2.91 | 17 | | 7 | #5 | #5 | 9-#9 | 10 | #4 | #5 | 15-#5 |
| 3.14 | 17 | 4 S 6 1 | 7 | #5 | #6 | 10-#9 | 10 | #4 | #5 | 15-#5 |
| 3.73 | 17 * | 4 S 6 2 | 7 | #6 | #7 | 16-#8 | 10 | #4 | #5 | 15-#5 |
| 2.54 | 18 | | 7 | #4 | #5 | 9-#8 | 11 | #4 | #5 | 16-#5 |
| 2.86 | 18 | | 7 | #5 | #5 | 9-#9 | 11 | #4 | #5 | 16-#5 |
| 3.07 | 18 | 4 S 6 1 | 7 | #5 | #6 | 10-#9 | 11 | #4 | #5 | 16-#5 |
| 3.41 | 18 * | 4 S 6 1 | 7 | #6 | #6 | 12-#9 | 11 | #4 | #5 | 16-#5 |
| 2.63 | 19 | | 8 | #4 | #5 | 11-#8 | 11 | #4 | #5 | 16-#5 |
| 2.86 | 19 | | 8 | #5 | #5 | 10-#9 | 11 | #4 | #5 | 16-#5 |
| 3.21 | 19 * | 4 S 6 1 | 8 | #5 | #6 | 12-#9 | 11 | #4 | #5 | 16-#5 |
| 3.55 | 19 * | 4 S 6 1 | 8 | #6 | #6 | 14-#9 | 11 | #4 | #5 | 16-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 11 in. | Rib Depth = 8 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | |
| 15'-0" | 50 | 1.82 | 12 | 0.629 | | 6-#5+ 0 | 3 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 8-#5 | 14 | 28 | 37 |
| D = 5.500 | 100 | 1.82 | 12 | 0.629 | | 6-#5+ 0 | 3 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 8-#5 | 19 | 40 | 50 |
| RIB ON | 150 | 1.82 | 12 | 0.629 | | 6-#5+ 0 | 3 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 8-#5 | 23 | 55 | 63 |
| COLUMN LINE | 200 | 1.82 | 12 | 0.629 | | 6-#5+ 0 | 3 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 8-#5 | 28 | 70 | 76 |
| 0.558 CF/SF | 300 | 1.89 | 12 | 0.648 | | 6-#5+ 0 | 3 | #4 | #5 | 6-#5 | 3 | #4 | #4 | 8-#5 | 38 | 99 | 101 |
| | 400 | 2.12 | 12 | 0.725 | | 6-#5+ 0 | 3 | #5 | #5 | 5-#6 | 3 | #4 | #5 | 8-#5 | 47 | 128 | 127 |
| 17'-6" | 50 | 1.75 | 12 | 0.629 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 | 23 | 46 | 61 |
| D = 8.000 | 100 | 1.75 | 12 | 0.629 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 | 31 | 65 | 82 |
| RIB NOT ON | 150 | 1.75 | 12 | 0.659 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 | 38 | 91 | 103 |
| COLUMN LINE | 200 | 1.83 | 12 | 0.704 | | 7-#5+ 0 | 4 | #4 | #5 | 7-#5 | 3 | #4 | #4 | 8-#5 | 46 | 115 | 124 |
| 0.587 CF/SF | 300 | 2.12 | 12 * | 0.838 | | 7-#5+ 2 | 4 | #5 | #5 | 9-#5 | 3 | #5 | #5 | 8-#5 | 62 | 162 | 166 |
| | 400 | 2.59 | 12 * | 0.630 | | 7-#5+ 1 | 4 | #6 | #6 | 8-#6 | 3 | #5 | #6 | 8-#5 | 77 | 209 | 207 |
| 20'-0" | 50 | 1.76 | 12 | 0.657 | | 8-#5+ 0 | 4 | #4 | #4 | 8-#5 | 4 | #4 | #4 | 10-#5 | 34 | 68 | 92 |
| D = 8.000 | 100 | 1.76 | 12 | 0.708 | | 8-#5+ 0 | 4 | #4 | #4 | 8-#5 | 4 | #4 | #4 | 10-#5 | 46 | 98 | 124 |
| RIB NOT ON | 150 | 1.85 | 12 | 0.759 | | 8-#5+ 0 | 4 | #4 | #5 | 9-#5 | 4 | #4 | #4 | 10-#5 | 58 | 136 | 155 |
| COLUMN LINE | 200 | 2.20 | 12 * | 0.831 | | 8-#5+ 1 | 4 | #5 | #6 | 7-#6 | 4 | #4 | #5 | 10-#5 | 69 | 173 | 187 |
| 0.570 CF/SF | 300 | 2.66 | 12 * | 0.630 | | 8-#5+ 1 | 4 | #6 | #7 | 10-#6 | 4 | #5 | #5 | 10-#5 | 93 | 244 | 250 |
| | 400 | 3.28 | 15 * | 0.626 | | 8-#5+ 2 | 4 | #7 | #7 | 18-#5 | 4 | #6 | #6 | 10-#5 | 114 | 306 | 308 |
| 22'-6" | 50 | 1.85 | 12 | 0.755 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 | 49 | 98 | 132 |
| D = 8.000 | 100 | 1.91 | 12 | 0.824 | | 10-#5+ 1 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 12-#5 | 66 | 140 | 177 |
| RIB NOT ON | 150 | 2.17 | 12 * | 0.882 | | 10-#5+ 2 | 4 | #5 | #6 | 9-#6 | 5 | #4 | #4 | 12-#5 | 83 | 195 | 223 |
| COLUMN LINE | 200 | 2.56 | 12 * | 0.630 | | 10-#5+ 2 | 4 | #6 | #7 | 11-#6 | 5 | #4 | #5 | 12-#5 | 100 | 247 | 268 |
| 0.558 CF/SF | 300 | 3.34 | 16 * | 0.625 | | 10-#5+ 1 | 4 | #7 | #8 | 15-#6 | 5 | #5 | #6 | 12-#5 | 131 | 339 | 352 |
| 25'-0" | 50 | 1.79 | 12 | 0.838 | | 11-#5+ 2 | 5 | #4 | #4 | 11-#5 | 5 | #4 | #4 | 12-#5 | 69 | 137 | 185 |
| D = 10.500 | 100 | 2.01 | 12 * | 0.902 | | 11-#5+ 4 | 5 | #5 | #5 | 10-#6 | 5 | #4 | #4 | 12-#5 | 92 | 197 | 248 |
| RIB ON | 150 | 2.55 | 13 * | 0.629 | | 11-#5+ 1 | 5 | #6 | #6 | 18-#5 | 5 | #5 | #5 | 12-#5 | 115 | 272 | 309 |
| COLUMN LINE | 200 | 2.95 | 16 * | 0.625 | | 11-#5+ 2 | 5 | #6 | #7 | 15-#6 | 5 | #5 | #6 | 12-#5 | 137 | 341 | 368 |
| 0.578 CF/SF | | | | | | | | | | | | | | | | | |
| 27'-6" | 50 | 1.97 | 13 * | 0.866 | | 12-#5+ 3 | 5 | #5 | #5 | 10-#6 | 6 | #4 | #4 | 14-#5 | 91 | 181 | 244 |
| D = 10.500 | 100 | 2.25 | 13 * | 0.933 | | 12-#5+ 6 | 5 | #5 | #6 | 14-#6 | 6 | #4 | #4 | 14-#5 | 122 | 252 | 328 |
| RIB ON | 150 | 2.91 | 17 * | 0.624 | | 12-#5+ 4 | 5 | #7 | #7 | 17-#6 | 6 | #5 | #5 | 14-#5 | 151 | 349 | 407 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.567 CF/SF | | | | | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.18 | 15 * | 0.870 | | 9-#6+ 3 | 5 | #5 | #6 | 18-#5 | 7 | #4 | #4 | 16-#5 | 117 | 233 | 314 |
| D = 10.500 | 100 | 2.63 | 17 * | 0.921 | | 9-#6+ 6 | 5 | #6 | #7 | 18-#6 | 7 | #4 | #5 | 16-#5 | 156 | 312 | 420 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.558 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 11 in. | Rib Depth = 8 in. | Total Slab Depth = 3 in. | | | | | | | | |
| 1.87 | 12 | | 3 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 8-#5 |
| 1.87 | 12 | | 3 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 8-#5 |
| 1.87 | 12 | | 3 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 8-#5 |
| 1.87 | 12 | | 3 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 8-#5 |
| 1.87 | 12 | | 3 | #4 | #4 | 6-#5 | 3 | #4 | #4 | 8-#5 |
| 2.01 | 12 | 3 S 4 1 | 3 | #4 | #5 | 6-#5 | 3 | #4 | #4 | 8-#5 |
| 1.78 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 |
| 1.78 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 |
| 1.78 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 |
| 1.78 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 |
| 1.92 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 2.29 | 12 * | 3 S 4 1 | 4 | #4 | #5 | 8-#6 | 3 | #4 | #5 | 8-#5 |
| 1.81 | 12 | | 4 | #4 | #4 | 8-#5 | 4 | #4 | #4 | 10-#5 |
| 1.81 | 12 | | 4 | #4 | #4 | 8-#5 | 4 | #4 | #4 | 10-#5 |
| 1.81 | 12 | | 4 | #4 | #4 | 8-#5 | 4 | #4 | #4 | 10-#5 |
| 2.06 | 12 | | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| 2.34 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 9-#6 | 4 | #4 | #4 | 10-#5 |
| 2.96 | 13 * | 3 S 4 1 | 4 | #6 | #6 | 12-#6 | 4 | #4 | #5 | 10-#5 |
| 1.92 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| 1.92 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| 2.08 | 12 | 3 S 4 1 | 4 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 12-#5 |
| 2.32 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 10-#6 | 5 | #4 | #4 | 12-#5 |
| 3.01 | 13 * | 3 S 4 1 | 4 | #6 | #6 | 14-#6 | 5 | #4 | #5 | 12-#5 |
| 1.84 | 12 | | 5 | #4 | #4 | 11-#5 | 5 | #4 | #4 | 12-#5 |
| 1.93 | 12 | | 5 | #4 | #4 | 9-#6 | 5 | #4 | #4 | 12-#5 |
| 2.34 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 12-#6 | 5 | #4 | #4 | 12-#5 |
| 2.71 | 12 * | 3 S 4 1 | 5 | #5 | #6 | 14-#6 | 5 | #4 | #5 | 12-#5 |
| 1.91 | 13 | | 5 | #4 | #4 | 9-#6 | 6 | #4 | #4 | 14-#5 |
| 2.21 | 13 * | 3 S 4 1 | 5 | #4 | #5 | 18-#5 | 6 | #4 | #4 | 14-#5 |
| 2.64 | 13 * | 3 S 4 1 | 5 | #5 | #6 | 16-#6 | 6 | #4 | #4 | 14-#5 |
| 2.14 | 15 | | 5 | #4 | #5 | 12-#6 | 7 | #4 | #4 | 16-#5 |
| 2.46 | 15 * | 3 S 4 1 | 5 | #5 | #5 | 23-#5 | 7 | #4 | #4 | 16-#5 |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 13 in. | Rib Depth = 10 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | |
| 17'-6" | 50 | 1.75 | 12 | 0.633 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 | 25 | 50 | 67 |
| D = 8.000 | 100 | 1.75 | 12 | 0.633 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 | 33 | 69 | 88 |
| RIB NOT ON | 150 | 1.75 | 12 | 0.633 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 | 40 | 95 | 109 |
| COLUMN LINE | 200 | 1.75 | 12 | 0.633 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 | 48 | 120 | 130 |
| 0.677 CF/SF | 300 | 1.89 | 12 | 0.668 | | 7-#5+ 0 | 4 | #4 | #5 | 8-#5 | 3 | #4 | #5 | 8-#5 | 64 | 167 | 172 |
| | 400 | 2.30 | 12 | 0.804 | | 7-#5+ 2 | 4 | #5 | #5 | 8-#5 | 3 | #5 | #5 | 8-#5 | 79 | 215 | 213 |
| | 500 | 2.66 | 12 * | 0.880 | | 7-#5+ 3 | 4 | #6 | #6 | 8-#6 | 3 | #5 | #6 | 8-#5 | 95 | 261 | 255 |
| 20'-0" | 50 | 1.84 | 12 | 0.633 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 | 37 | 75 | 101 |
| D = 8.000 | 100 | 1.84 | 12 | 0.653 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 | 49 | 104 | 132 |
| RIB NOT ON | 150 | 1.90 | 12 | 0.695 | | 9-#5+ 0 | 4 | #4 | #5 | 9-#5 | 4 | #4 | #4 | 10-#5 | 61 | 143 | 164 |
| COLUMN LINE | 200 | 1.97 | 12 | 0.736 | | 9-#5+ 0 | 4 | #5 | #5 | 9-#5 | 4 | #4 | #4 | 10-#5 | 73 | 180 | 195 |
| 0.656 CF/SF | 300 | 2.36 | 12 * | 0.837 | | 9-#5+ 1 | 4 | #6 | #6 | 12-#5 | 4 | #4 | #5 | 10-#5 | 96 | 252 | 259 |
| | 400 | 2.92 | 12 * | 0.634 | | 9-#5+ 0 | 4 | #6 | #7 | 15-#5 | 4 | #5 | #6 | 10-#5 | 120 | 323 | 322 |
| | 500 | 3.51 | 13 * | 0.632 | | 9-#5+ 1 | 4 | #7 | #8 | 13-#6 | 4 | #6 | #6 | 10-#5 | 142 | 392 | 383 |
| 22'-6" | 50 | 1.85 | 12 | 0.681 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 | 53 | 107 | 144 |
| D = 8.000 | 100 | 1.91 | 12 | 0.728 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 12-#5 | 70 | 148 | 190 |
| RIB NOT ON | 150 | 2.04 | 12 | 0.775 | | 10-#5+ 0 | 4 | #5 | #5 | 8-#6 | 5 | #4 | #4 | 12-#5 | 87 | 204 | 235 |
| COLUMN LINE | 200 | 2.37 | 12 * | 0.823 | | 10-#5+ 0 | 4 | #6 | #6 | 9-#6 | 5 | #4 | #5 | 12-#5 | 104 | 257 | 281 |
| 0.641 CF/SF | 300 | 2.90 | 12 * | 0.634 | | 10-#5+ 0 | 4 | #7 | #7 | 18-#5 | 5 | #5 | #5 | 12-#5 | 138 | 362 | 372 |
| | 400 | 3.60 | 15 * | 0.630 | | 7-#6+ 2 | 4 | #8 | #8 | 16-#6 | 5 | #5 | #6 | 12-#5 | 170 | 459 | 457 |
| 25'-0" | 50 | 1.79 | 12 | 0.742 | | 11-#5+ 0 | 5 | #4 | #4 | 11-#5 | 5 | #4 | #4 | 12-#5 | 75 | 150 | 202 |
| D = 10.500 | 100 | 1.87 | 12 | 0.812 | | 11-#5+ 1 | 5 | #4 | #5 | 12-#5 | 5 | #4 | #4 | 12-#5 | 99 | 208 | 265 |
| RIB ON | 150 | 2.25 | 12 * | 0.871 | | 11-#5+ 2 | 5 | #5 | #6 | 11-#6 | 5 | #4 | #5 | 12-#5 | 122 | 286 | 328 |
| COLUMN LINE | 200 | 2.57 | 12 * | 0.634 | | 11-#5+ 2 | 5 | #6 | #6 | 13-#6 | 5 | #5 | #5 | 12-#5 | 145 | 360 | 391 |
| 0.666 CF/SF | 300 | 3.51 | 16 * | 0.628 | | 12-#5+ 2 | 5 | #7 | #8 | 17-#6 | 5 | #6 | #6 | 12-#5 | 189 | 492 | 508 |
| 27'-6" | 50 | 1.86 | 13 | 0.799 | | 12-#5+ 2 | 5 | #4 | #5 | 12-#5 | 6 | #4 | #4 | 14-#5 | 99 | 199 | 267 |
| D = 10.500 | 100 | 2.17 | 13 * | 0.870 | | 12-#5+ 4 | 5 | #5 | #6 | 12-#6 | 6 | #4 | #4 | 14-#5 | 130 | 269 | 351 |
| RIB ON | 150 | 2.60 | 13 * | 0.925 | | 12-#5+ 6 | 5 | #6 | #7 | 15-#6 | 6 | #4 | #5 | 14-#5 | 162 | 374 | 435 |
| COLUMN LINE | 200 | 3.14 | 15 * | 0.630 | | 12-#5+ 2 | 5 | #7 | #7 | 18-#6 | 6 | #5 | #6 | 14-#5 | 192 | 468 | 516 |
| 0.652 CF/SF | 300 | 3.90 | 21 * | 0.624 | 3 S 4 1 | 15-#5+ 4 | 5 | #8 | #8 | 23-#6 | 6 | #6 | #6 | 14-#5 | 245 | 599 | 661 |
| 30'-0" | 50 | 2.05 | 15 | 0.803 | | 9-#6+ 2 | 5 | #5 | #5 | 11-#6 | 7 | #4 | #4 | 16-#5 | 128 | 255 | 343 |
| D = 10.500 | 100 | 2.38 | 15 * | 0.884 | | 9-#6+ 4 | 5 | #6 | #6 | 15-#6 | 7 | #4 | #4 | 16-#5 | 168 | 336 | 452 |
| RIB ON | 150 | 2.93 | 16 * | 0.628 | | 9-#6+ 4 | 5 | #7 | #7 | 19-#6 | 7 | #5 | #5 | 16-#5 | 208 | 459 | 559 |
| COLUMN LINE | 200 | 3.58 | 20 * | 0.625 | 3 S 4 1 | 15-#5+ 4 | 5 | #8 | #8 | 23-#6 | 7 | #5 | #6 | 16-#5 | 245 | 576 | 659 |
| 0.641 CF/SF | | | | | | | | | | | | | | | | | |
| 32'-6" | 50 | 2.20 | 16 * | 0.852 | | 14-#5+ 6 | 6 | #5 | #6 | 15-#6 | 7 | #4 | #4 | 16-#5 | 164 | 328 | 442 |
| D = 13.000 | 100 | 2.56 | 16 * | 0.924 | | 14-#5+10 | 6 | #6 | #6 | 20-#6 | 7 | #4 | #5 | 16-#5 | 215 | 431 | 580 |
| RIB NOT ON | 150 | 3.31 | 20 * | 0.625 | | 12-#6+ 4 | 6 | #7 | #7 | 25-#6 | 7 | #5 | #6 | 16-#5 | 264 | 571 | 710 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.660 CF/SF | | | | | | | | | | | | | | | | | |
| 35'-0" | 50 | 2.40 | 17 * | 0.880 | | 15-#5+ 8 | 6 | #6 | #6 | 19-#6 | 8 | #4 | #4 | 18-#5 | 204 | 408 | 549 |
| D = 13.000 | 100 | 3.01 | 20 * | 0.915 | | 12-#6+ 8 | 6 | #7 | #7 | 25-#6 | 8 | #5 | #5 | 18-#5 | 266 | 532 | 716 |
| RIB NOT ON | 150 | 3.63 | 28 * | 0.619 | | 14-#6+ 4 | 6 | #7 | #8 | 31-#6 | 8 | #5 | #6 | 18-#5 | 320 | 639 | 861 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.650 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 13 in. | Rib Depth = 10 in. | Total Slab Depth = 3 in. | | | | | | | | |
| 1.78 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 |
| 1.78 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 |
| 1.78 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 |
| 1.78 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 |
| 1.78 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 8-#5 |
| 2.04 | 12 | | 4 | #4 | #5 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 2.42 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 8-#6 | 3 | #4 | #5 | 8-#5 |
| 1.88 | 12 | | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 |
| 1.88 | 12 | | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 |
| 1.88 | 12 | | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 |
| 1.88 | 12 | | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 |
| 2.13 | 12 | 3 S 4 1 | 4 | #4 | #5 | 8-#6 | 4 | #4 | #4 | 10-#5 |
| 2.65 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 10-#6 | 4 | #4 | #5 | 10-#5 |
| 3.11 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 12-#6 | 4 | #5 | #5 | 10-#5 |
| 1.92 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| 1.92 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| 2.02 | 12 | | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| 2.20 | 12 | 3 S 4 1 | 4 | #5 | #5 | 12-#5 | 5 | #4 | #4 | 12-#5 |
| 2.61 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 12-#6 | 5 | #4 | #4 | 12-#5 |
| 3.27 | 12 * | 3 S 4 2 | 4 | #6 | #7 | 15-#6 | 5 | #4 | #5 | 12-#5 |
| 1.84 | 12 | | 5 | #4 | #4 | 11-#5 | 5 | #4 | #4 | 12-#5 |
| 1.84 | 12 | | 5 | #4 | #4 | 11-#5 | 5 | #4 | #4 | 12-#5 |
| 2.10 | 12 | | 5 | #4 | #5 | 10-#6 | 5 | #4 | #4 | 12-#5 |
| 2.34 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 12-#6 | 5 | #4 | #4 | 12-#5 |
| 3.14 | 13 * | 3 S 4 1 | 5 | #6 | #6 | 16-#6 | 5 | #5 | #5 | 12-#5 |
| 1.86 | 13 | | 5 | #4 | #4 | 12-#5 | 6 | #4 | #4 | 14-#5 |
| 2.09 | 13 | | 5 | #4 | #5 | 15-#5 | 6 | #4 | #4 | 14-#5 |
| 2.40 | 13 * | 3 S 4 1 | 5 | #5 | #5 | 14-#6 | 6 | #4 | #4 | 14-#5 |
| 2.89 | 13 * | 3 S 4 1 | 5 | #6 | #6 | 23-#5 | 6 | #4 | #5 | 14-#5 |
| 3.58 | 17 * | 3 S 4 2 | 5 | #6 | #7 | 22-#6 | 6 | #5 | #5 | 14-#5 |
| 2.06 | 15 | | 5 | #4 | #5 | 15-#5 | 7 | #4 | #4 | 16-#5 |
| 2.34 | 15 | 3 S 4 1 | 5 | #5 | #5 | 14-#6 | 7 | #4 | #4 | 16-#5 |
| 2.68 | 15 * | 3 S 4 1 | 5 | #5 | #6 | 18-#6 | 7 | #4 | #4 | 16-#5 |
| 3.29 | 15 * | 3 S 4 2 | 5 | #6 | #7 | 22-#6 | 7 | #4 | #5 | 16-#5 |
| 2.15 | 16 | | 6 | #4 | #5 | 14-#6 | 7 | #4 | #4 | 16-#5 |
| 2.46 | 16 * | | 6 | #5 | #5 | 18-#6 | 7 | #4 | #4 | 16-#5 |
| 3.09 | 16 * | 3 S 4 1 | 6 | #6 | #6 | 23-#6 | 7 | #4 | #5 | 16-#5 |
| 2.37 | 17 | | 6 | #5 | #5 | 17-#6 | 8 | #4 | #4 | 18-#5 |
| 2.77 | 17 * | 3 S 4 1 | 6 | #5 | #6 | 23-#6 | 8 | #4 | #4 | 18-#5 |
| 3.45 | 21 * | 3 S 4 1 | 6 | #6 | #7 | 29-#6 | 8 | #4 | #5 | 18-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 12 in. | | Total Slab Depth = 3 in. | | | | | | | | | | | | | | |
| 20'-0" | 50 | 1.84 | 12 | 0.636 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 | 41 | 82 | 110 |
| D = 8.000 | 100 | 1.84 | 12 | 0.636 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 | 53 | 108 | 141 |
| RIB NOT ON | 150 | 1.84 | 12 | 0.636 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 | 64 | 148 | 173 |
| COLUMN LINE | 200 | 1.90 | 12 | 0.639 | | 9-#5+ 0 | 4 | #4 | #5 | 9-#5 | 4 | #4 | #4 | 10-#5 | 76 | 186 | 205 |
| 0.745 CF/SF | 300 | 2.22 | 12 | 0.716 | | 9-#5+ 0 | 4 | #5 | #6 | 7-#6 | 4 | #4 | #5 | 10-#5 | 99 | 259 | 268 |
| | 400 | 2.52 | 12 * | 0.814 | | 9-#5+ 1 | 4 | #6 | #6 | 9-#6 | 4 | #5 | #5 | 10-#5 | 123 | 331 | 331 |
| | 500 | 3.03 | 12 * | 0.637 | | 9-#5+ 1 | 4 | #7 | #7 | 11-#6 | 4 | #5 | #6 | 10-#5 | 146 | 402 | 394 |
| 22'-6" | 50 | 1.85 | 12 | 0.636 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 | 58 | 117 | 157 |
| D = 8.000 | 100 | 1.85 | 12 | 0.645 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 | 75 | 155 | 202 |
| RIB NOT ON | 150 | 1.97 | 12 | 0.689 | | 10-#5+ 0 | 4 | #5 | #5 | 7-#6 | 5 | #4 | #4 | 12-#5 | 92 | 212 | 248 |
| COLUMN LINE | 200 | 2.11 | 12 | 0.733 | | 10-#5+ 0 | 4 | #5 | #6 | 8-#6 | 5 | #4 | #4 | 12-#5 | 109 | 266 | 293 |
| 0.727 CF/SF | 300 | 2.63 | 12 * | 0.838 | | 10-#5+ 1 | 4 | #6 | #7 | 11-#6 | 5 | #4 | #5 | 12-#5 | 143 | 372 | 384 |
| | 400 | 3.27 | 12 * | 0.637 | | 10-#5+ 1 | 4 | #7 | #8 | 14-#6 | 5 | #5 | #6 | 12-#5 | 177 | 475 | 475 |
| | 500 | 3.80 | 14 * | 0.634 | | 8-#6+ 2 | 4 | #8 | #8 | 16-#6 | 5 | #6 | #6 | 12-#5 | 209 | 573 | 562 |
| 25'-0" | 50 | 1.79 | 12 | 0.670 | | 11-#5+ 0 | 5 | #4 | #4 | 11-#5 | 5 | #4 | #4 | 12-#5 | 82 | 164 | 221 |
| D = 10.500 | 100 | 1.86 | 12 | 0.720 | | 11-#5+ 0 | 5 | #4 | #5 | 11-#5 | 5 | #4 | #4 | 12-#5 | 105 | 218 | 284 |
| RIB ON | 150 | 2.01 | 12 | 0.788 | | 11-#5+ 1 | 5 | #5 | #5 | 10-#6 | 5 | #4 | #4 | 12-#5 | 129 | 298 | 347 |
| COLUMN LINE | 200 | 2.35 | 12 * | 0.857 | | 11-#5+ 3 | 5 | #6 | #6 | 16-#5 | 5 | #4 | #5 | 12-#5 | 152 | 373 | 410 |
| 0.756 CF/SF | 300 | 3.05 | 12 * | 0.637 | | 11-#5+ 3 | 5 | #7 | #7 | 15-#6 | 5 | #5 | #6 | 12-#5 | 199 | 518 | 536 |
| | 400 | 3.80 | 15 * | 0.633 | | 9-#6+ 2 | 5 | #7 | #8 | 19-#6 | 5 | #6 | #7 | 12-#5 | 243 | 655 | 655 |
| | 500 | 4.24 | 19 * | 0.628 | 4 S 6 1 | 10-#6+ 1 | 5 | #8 | #8 | 22-#6 | 5 | #6 | #7 | 12-#5 | 280 | 741 | 755 |
| 27'-6" | 50 | 1.86 | 13 | 0.698 | | 12-#5+ 0 | 5 | #4 | #5 | 12-#5 | 6 | #4 | #4 | 14-#5 | 108 | 216 | 291 |
| D = 10.500 | 100 | 2.00 | 13 | 0.755 | | 12-#5+ 0 | 5 | #5 | #5 | 15-#5 | 6 | #4 | #4 | 14-#5 | 139 | 283 | 375 |
| RIB ON | 150 | 2.42 | 13 * | 0.838 | | 12-#5+ 2 | 5 | #6 | #6 | 13-#6 | 6 | #4 | #5 | 14-#5 | 171 | 390 | 459 |
| COLUMN LINE | 200 | 2.75 | 13 * | 0.906 | | 12-#5+ 5 | 5 | #6 | #7 | 16-#6 | 6 | #5 | #5 | 14-#5 | 202 | 489 | 543 |
| 0.740 CF/SF | 300 | 3.77 | 16 * | 0.631 | | 10-#6+ 3 | 5 | #8 | #8 | 21-#6 | 6 | #6 | #6 | 14-#5 | 262 | 677 | 704 |
| | 400 | 4.39 | 21 * | 0.626 | 4 S 6 1 | 12-#6+ 2 | 5 | #8 | #9 | 25-#6 | 6 | #6 | #7 | 14-#5 | 314 | 809 | 846 |
| 30'-0" | 50 | 1.97 | 15 | 0.691 | | 9-#6+ 0 | 5 | #5 | #5 | 10-#6 | 7 | #4 | #4 | 16-#5 | 139 | 278 | 374 |
| D = 10.500 | 100 | 2.21 | 15 * | 0.782 | | 9-#6+ 1 | 5 | #5 | #6 | 14-#6 | 7 | #4 | #4 | 16-#5 | 179 | 358 | 483 |
| RIB ON | 150 | 2.68 | 15 * | 0.868 | | 9-#6+ 3 | 5 | #6 | #7 | 17-#6 | 7 | #4 | #5 | 16-#5 | 220 | 486 | 591 |
| COLUMN LINE | 200 | 3.16 | 15 * | 0.633 | | 10-#6+ 3 | 5 | #7 | #8 | 21-#6 | 7 | #5 | #5 | 16-#5 | 260 | 614 | 700 |
| 0.727 CF/SF | 300 | 4.15 | 21 * | 0.626 | 4 S 6 1 | 18-#5+ 2 | 5 | #8 | #9 | 27-#6 | 7 | #6 | #6 | 16-#5 | 332 | 819 | 895 |
| 32'-6" | 50 | 2.02 | 16 | 0.759 | | 14-#5+ 2 | 6 | #5 | #5 | 14-#6 | 7 | #4 | #4 | 16-#5 | 179 | 358 | 482 |
| D = 13.000 | 100 | 2.48 | 16 * | 0.858 | | 14-#5+ 6 | 6 | #6 | #6 | 18-#6 | 7 | #4 | #5 | 16-#5 | 230 | 460 | 620 |
| RIB NOT ON | 150 | 2.97 | 16 * | 0.631 | | 15-#5+ 5 | 6 | #7 | #7 | 22-#6 | 7 | #5 | #5 | 16-#5 | 281 | 614 | 758 |
| COLUMN LINE | 200 | 3.62 | 19 * | 0.628 | | 12-#6+ 5 | 6 | #7 | #8 | 26-#6 | 7 | #6 | #6 | 16-#5 | 330 | 769 | 889 |
| 0.749 CF/SF | | | | | | | | | | | | | | | | | |
| 35'-0" | 50 | 2.30 | 17 * | 0.823 | | 15-#5+ 6 | 6 | #6 | #6 | 17-#6 | 8 | #4 | #4 | 18-#5 | 222 | 445 | 598 |
| D = 13.000 | 100 | 2.76 | 17 * | 0.901 | | 15-#5+10 | 6 | #6 | #7 | 23-#6 | 8 | #4 | #5 | 18-#5 | 286 | 573 | 771 |
| RIB NOT ON | 150 | 3.43 | 20 * | 0.627 | | 13-#6+ 4 | 6 | #7 | #8 | 28-#6 | 8 | #5 | #6 | 18-#5 | 348 | 738 | 937 |
| COLUMN LINE | 200 | 4.18 | 24 * | 0.624 | | 15-#6+ 4 | 6 | #8 | #9 | 33-#6 | 8 | #6 | #6 | 18-#5 | 406 | 901 | 1094 |
| 0.737 CF/SF | | | | | | | | | | | | | | | | | |
| 37'-6" | 50 | 2.59 | 18 * | 0.854 | | 16-#5+ 8 | 6 | #6 | #7 | 21-#6 | 9 | #4 | #5 | 20-#5 | 272 | 545 | 733 |
| D = 13.000 | 100 | 3.19 | 19 * | 0.922 | | 13-#6+ 9 | 6 | #7 | #8 | 28-#6 | 9 | #5 | #5 | 20-#5 | 350 | 701 | 944 |
| RIB NOT ON | 150 | 3.72 | 24 * | 0.624 | | 16-#6+ 3 | 6 | #8 | #8 | 34-#6 | 9 | #5 | #6 | 20-#5 | 424 | 868 | 1142 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.727 CF/SF | | | | | | | | | | | | | | | | | |
| 40'-0" | 50 | 2.75 | 20 * | 0.874 | | 18-#5+11 | 7 | #6 | #7 | 26-#6 | 9 | #4 | #5 | 20-#5 | 332 | 665 | 895 |
| D = 15.500 | 100 | 3.50 | 23 * | 0.915 | | 16-#6+10 | 7 | #7 | #8 | 34-#6 | 9 | #5 | #6 | 20-#5 | 425 | 850 | 1144 |
| RIB ON | 150 | 4.12 | 32 * | 0.620 | | 19-#6+ 6 | 7 | #8 | #8 | 41-#6 | 9 | #6 | #6 | 20-#5 | 505 | 1009 | 1359 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.745 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 12 in. | Total Slab Depth = 3 in. | | | | | | | | |
| 1.88 | 12 | | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 |
| 1.88 | 12 | | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 |
| 1.88 | 12 | | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 |
| 1.88 | 12 | | 4 | #4 | #4 | 9-#5 | 4 | #4 | #4 | 10-#5 |
| 2.06 | 12 | | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| 2.27 | 12 | 4 S 6 1 | 4 | #5 | #5 | 12-#5 | 4 | #4 | #4 | 10-#5 |
| 2.65 | 12 * | 4 S 6 1 | 4 | #5 | #6 | 10-#6 | 4 | #4 | #5 | 10-#5 |
| 1.92 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| 1.92 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| 1.92 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| 2.02 | 12 | | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| 2.47 | 12 | 4 S 6 1 | 4 | #5 | #6 | 10-#6 | 5 | #4 | #4 | 12-#5 |
| 2.90 | 12 * | 4 S 6 1 | 4 | #6 | #6 | 18-#5 | 5 | #4 | #5 | 12-#5 |
| 3.44 | 12 * | 4 S 6 2 | 4 | #6 | #7 | 15-#6 | 5 | #5 | #5 | 12-#5 |
| 1.84 | 12 | | 5 | #4 | #4 | 11-#5 | 5 | #4 | #4 | 12-#5 |
| 1.84 | 12 | | 5 | #4 | #4 | 11-#5 | 5 | #4 | #4 | 12-#5 |
| 1.93 | 12 | | 5 | #4 | #4 | 9-#6 | 5 | #4 | #4 | 12-#5 |
| 2.13 | 12 | | 5 | #4 | #5 | 15-#5 | 5 | #4 | #4 | 12-#5 |
| 2.71 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 14-#6 | 5 | #4 | #5 | 12-#5 |
| 3.43 | 12 * | 4 S 6 1 | 5 | #6 | #7 | 18-#6 | 5 | #5 | #5 | 12-#5 |
| 3.96 | 17 * | 4 S 6 2 | 5 | #7 | #7 | 21-#6 | 5 | #5 | #6 | 12-#5 |
| 1.86 | 13 | | 5 | #4 | #4 | 12-#5 | 6 | #4 | #4 | 14-#5 |
| 1.96 | 13 | | 5 | #4 | #4 | 10-#6 | 6 | #4 | #4 | 14-#5 |
| 2.28 | 13 | | 5 | #5 | #5 | 12-#6 | 6 | #4 | #4 | 14-#5 |
| 2.52 | 13 * | 4 S 6 1 | 5 | #5 | #6 | 14-#6 | 6 | #4 | #4 | 14-#5 |
| 3.39 | 13 * | 4 S 6 1 | 5 | #6 | #7 | 19-#6 | 6 | #5 | #5 | 14-#5 |
| 3.99 | 17 * | 4 S 6 2 | 5 | #7 | #7 | 24-#6 | 6 | #5 | #6 | 14-#5 |
| 1.93 | 15 | | 5 | #4 | #4 | 10-#6 | 7 | #4 | #4 | 16-#5 |
| 2.17 | 15 | | 5 | #4 | #5 | 18-#5 | 7 | #4 | #4 | 16-#5 |
| 2.57 | 15 * | 4 S 6 1 | 5 | #5 | #6 | 16-#6 | 7 | #4 | #4 | 16-#5 |
| 2.86 | 15 * | 4 S 6 1 | 5 | #6 | #6 | 19-#6 | 7 | #4 | #4 | 16-#5 |
| 3.79 | 17 * | 4 S 6 2 | 5 | #7 | #7 | 25-#6 | 7 | #5 | #5 | 16-#5 |
| 1.97 | 16 | | 6 | #4 | #4 | 18-#5 | 7 | #4 | #4 | 16-#5 |
| 2.36 | 16 | | 6 | #5 | #5 | 16-#6 | 7 | #4 | #4 | 16-#5 |
| 2.69 | 16 * | 4 S 6 1 | 6 | #5 | #6 | 20-#6 | 7 | #4 | #4 | 16-#5 |
| 3.28 | 16 * | 4 S 6 1 | 6 | #6 | #7 | 24-#6 | 7 | #4 | #5 | 16-#5 |
| 2.21 | 17 | | 6 | #4 | #5 | 16-#6 | 8 | #4 | #4 | 18-#5 |
| 2.67 | 17 * | 4 S 6 1 | 6 | #5 | #6 | 21-#6 | 8 | #4 | #4 | 18-#5 |
| 3.14 | 17 * | 4 S 6 1 | 6 | #6 | #6 | 26-#6 | 8 | #4 | #5 | 18-#5 |
| 3.84 | 18 * | 4 S 6 2 | 6 | #7 | #7 | 31-#6 | 8 | #5 | #5 | 18-#5 |
| 2.44 | 18 | | 6 | #5 | #5 | 20-#6 | 9 | #4 | #4 | 20-#5 |
| 2.93 | 18 * | 4 S 6 1 | 6 | #6 | #6 | 26-#6 | 9 | #4 | #4 | 20-#5 |
| 3.45 | 18 * | 4 S 6 2 | 6 | #6 | #7 | 32-#6 | 9 | #4 | #5 | 20-#5 |
| 2.66 | 20 * | | 7 | #5 | #6 | 24-#6 | 9 | #4 | #4 | 20-#5 |
| 3.23 | 20 * | 4 S 6 1 | 7 | #6 | #6 | 32-#6 | 9 | #4 | #5 | 20-#5 |
| 3.85 | 24 * | 4 S 6 2 | 7 | #6 | #7 | 39-#6 | 9 | #5 | #5 | 20-#5 |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 17 in. | Rib Depth = 14 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | | Total Depth = 17 in. | Rib Depth = 14 in. | Total Slab Depth = 3 in. | | | | | | | | |
| 22'-6" | 50 | 1.85 | 12 | 0.639 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 | 63 | 126 | 170 | 1.92 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| D = 8.000 | 100 | 1.85 | 12 | 0.639 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 | 80 | 161 | 216 | 1.92 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 1.91 | 12 | 0.639 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 12-#5 | 97 | 220 | 261 | 1.92 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.02 | 12 | 0.641 | | 10-#5+ 0 | 4 | #5 | #5 | 7-#6 | 5 | #4 | #4 | 12-#5 | 114 | 275 | 307 | 2.02 | 12 | | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 12-#5 |
| 0.815 CF/SF | 300 | 2.42 | 12 | 0.725 | | 10-#5+ 0 | 4 | #6 | #6 | 10-#6 | 5 | #4 | #5 | 12-#5 | 148 | 381 | 398 | 2.27 | 12 | 4 S 6 1 | 4 | #5 | #5 | 9-#6 | 5 | #4 | #4 | 12-#5 |
| | 400 | 2.86 | 12 * | 0.841 | | 10-#5+ 2 | 4 | #7 | #7 | 12-#6 | 5 | #5 | #5 | 12-#5 | 182 | 485 | 489 | 2.56 | 12 | 4 S 6 1 | 4 | #5 | #6 | 11-#6 | 5 | #4 | #4 | 12-#5 |
| | 500 | 3.29 | 12 * | 0.640 | | 10-#5+ 1 | 4 | #7 | #8 | 14-#6 | 5 | #5 | #6 | 12-#5 | 215 | 587 | 580 | 2.95 | 12 * | 4 S 6 1 | 4 | #6 | #6 | 13-#6 | 5 | #4 | #5 | 12-#5 |
| 25'-0" | 50 | 1.79 | 12 | 0.639 | | 11-#5+ 0 | 5 | #4 | #4 | 11-#5 | 5 | #4 | #4 | 12-#5 | 89 | 178 | 240 | 1.84 | 12 | | 5 | #4 | #4 | 11-#5 | 5 | #4 | #4 | 12-#5 |
| D = 10.500 | 100 | 1.79 | 12 | 0.640 | | 11-#5+ 0 | 5 | #4 | #4 | 11-#5 | 5 | #4 | #4 | 12-#5 | 112 | 226 | 303 | 1.84 | 12 | | 5 | #4 | #4 | 11-#5 | 5 | #4 | #4 | 12-#5 |
| RIB ON | 150 | 1.97 | 12 | 0.687 | | 11-#5+ 0 | 5 | #5 | #5 | 9-#6 | 5 | #4 | #4 | 12-#5 | 136 | 308 | 366 | 1.87 | 12 | | 5 | #4 | #4 | 12-#5 | 5 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.23 | 12 | 0.756 | | 11-#5+ 1 | 5 | #5 | #6 | 10-#6 | 5 | #4 | #5 | 12-#5 | 159 | 384 | 429 | 2.10 | 12 | | 5 | #4 | #5 | 10-#6 | 5 | #4 | #4 | 12-#5 |
| 0.848 CF/SF | 300 | 2.89 | 12 * | 0.874 | | 11-#5+ 4 | 5 | #6 | #7 | 14-#6 | 5 | #5 | #6 | 12-#5 | 206 | 531 | 555 | 2.62 | 12 * | | 5 | #5 | #6 | 18-#5 | 5 | #4 | #5 | 12-#5 |
| | 400 | 3.50 | 12 * | 0.640 | | 11-#5+ 3 | 5 | #7 | #8 | 17-#6 | 5 | #6 | #6 | 12-#5 | 253 | 675 | 681 | 3.14 | 12 * | 4 S 6 1 | 5 | #6 | #6 | 16-#6 | 5 | #5 | #5 | 12-#5 |
| | 500 | 4.04 | 14 * | 0.637 | | 10-#6+ 1 | 5 | #8 | #8 | 20-#6 | 5 | #6 | #7 | 12-#5 | 297 | 812 | 801 | 3.64 | 12 * | 4 S 6 1 | 5 | #6 | #7 | 19-#6 | 5 | #5 | #6 | 12-#5 |
| 27'-6" | 50 | 1.86 | 13 | 0.637 | | 12-#5+ 0 | 5 | #4 | #5 | 12-#5 | 6 | #4 | #4 | 14-#5 | 117 | 235 | 316 | 1.86 | 13 | | 5 | #4 | #4 | 12-#5 | 6 | #4 | #4 | 14-#5 |
| D = 10.500 | 100 | 1.97 | 13 | 0.680 | | 12-#5+ 0 | 5 | #5 | #5 | 10-#6 | 6 | #4 | #4 | 14-#5 | 149 | 297 | 400 | 1.91 | 13 | | 5 | #4 | #4 | 9-#6 | 6 | #4 | #4 | 14-#5 |
| RIB ON | 150 | 2.19 | 13 | 0.753 | | 12-#5+ 1 | 5 | #5 | #6 | 12-#6 | 6 | #4 | #4 | 14-#5 | 180 | 404 | 484 | 2.13 | 13 | | 5 | #4 | #5 | 11-#6 | 6 | #4 | #4 | 14-#5 |
| COLUMN LINE | 200 | 2.53 | 13 * | 0.829 | | 12-#5+ 3 | 5 | #6 | #7 | 14-#6 | 6 | #4 | #5 | 14-#5 | 211 | 506 | 568 | 2.31 | 13 | | 5 | #5 | #5 | 18-#5 | 6 | #4 | #4 | 14-#5 |
| 0.830 CF/SF | 300 | 3.28 | 13 * | 0.638 | | 12-#5+ 3 | 5 | #7 | #8 | 26-#5 | 6 | #5 | #6 | 14-#5 | 273 | 701 | 736 | 2.96 | 13 * | 4 S 6 1 | 5 | #6 | #6 | 17-#6 | 6 | #4 | #5 | 14-#5 |
| | 400 | 4.07 | 16 * | 0.634 | 4 S 6 1 | 15-#5+ 4 | 5 | #8 | #9 | 23-#6 | 6 | #6 | #6 | 14-#5 | 333 | 884 | 895 | 3.66 | 13 * | 4 S 6 1 | 5 | #7 | #7 | 21-#6 | 6 | #5 | #5 | 14-#5 |
| | 500 | 4.68 | 20 * | 0.630 | 4 S 6 1 | 18-#5+ 2 | 5 | #9 | #9 | 27-#6 | 6 | #6 | #7 | 14-#5 | 384 | 1018 | 1034 | 4.26 | 17 * | 4 S 6 2 | 5 | #7 | #8 | 25-#6 | 6 | #5 | #6 | 14-#5 |
| 30'-0" | 50 | 1.95 | 15 | 0.634 | | 9-#6+ 0 | 5 | #5 | #5 | 10-#6 | 7 | #4 | #4 | 16-#5 | 151 | 301 | 406 | 1.89 | 15 | | 5 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 16-#5 |
| D = 10.500 | 100 | 2.18 | 15 | 0.681 | | 9-#6+ 0 | 5 | #5 | #6 | 18-#5 | 7 | #4 | #4 | 16-#5 | 191 | 382 | 514 | 2.14 | 15 | | 5 | #4 | #5 | 12-#6 | 7 | #4 | #4 | 16-#5 |
| RIB ON | 150 | 2.54 | 15 * | 0.790 | | 9-#6+ 2 | 5 | #6 | #7 | 15-#6 | 7 | #4 | #5 | 16-#5 | 231 | 507 | 623 | 2.34 | 15 | 4 S 6 1 | 5 | #5 | #5 | 14-#6 | 7 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 2.95 | 15 * | 0.855 | | 9-#6+ 3 | 5 | #7 | #7 | 18-#6 | 7 | #5 | #5 | 16-#5 | 272 | 638 | 731 | 2.75 | 15 * | 4 S 6 1 | 5 | #6 | #6 | 17-#6 | 7 | #4 | #4 | 16-#5 |
| 0.815 CF/SF | 300 | 3.91 | 16 * | 0.634 | 4 S 6 1 | 11-#6+ 3 | 5 | #8 | #9 | 24-#6 | 7 | #6 | #6 | 16-#5 | 351 | 887 | 945 | 3.43 | 15 * | 4 S 6 2 | 5 | #7 | #7 | 22-#6 | 7 | #4 | #5 | 16-#5 |
| | 400 | 4.82 | 21 * | 0.629 | 4 S 6 1 | 14-#6+ 2 | 5 | #9 | #10 | 30-#6 | 7 | #6 | #7 | 16-#5 | 423 | 1089 | 1138 | 4.28 | 17 * | 4 S 6 2 | 5 | #7 | #8 | 28-#6 | 7 | #5 | #6 | 16-#5 |
| 32'-6" | 50 | 1.99 | 16 | 0.680 | | 14-#5+ 1 | 6 | #5 | #5 | 18-#5 | 7 | #4 | #4 | 16-#5 | 194 | 388 | 523 | 1.95 | 16 | | 6 | #4 | #4 | 12-#6 | 7 | #4 | #4 | 16-#5 |
| D = 13.000 | 100 | 2.31 | 16 | 0.787 | | 14-#5+ 4 | 6 | #5 | #6 | 16-#6 | 7 | #4 | #5 | 16-#5 | 245 | 491 | 661 | 2.22 | 16 | | 6 | #4 | #5 | 15-#6 | 7 | #4 | #4 | 16-#5 |
| RIB NOT ON | 150 | 2.79 | 16 * | 0.863 | | 14-#5+ 7 | 6 | #6 | #7 | 20-#6 | 7 | #5 | #5 | 16-#5 | 297 | 642 | 799 | 2.59 | 16 | | 6 | #5 | #6 | 26-#5 | 7 | #4 | #4 | 16-#5 |
| COLUMN LINE | 200 | 3.36 | 16 * | 0.634 | | 11-#6+ 3 | 6 | #7 | #8 | 24-#6 | 7 | #5 | #6 | 16-#5 | 348 | 810 | 937 | 3.03 | 16 * | 4 S 6 1 | 6 | #6 | #6 | 22-#6 | 7 | #4 | #5 | 16-#5 |
| 0.840 CF/SF | 300 | 4.40 | 21 * | 0.629 | | 15-#6+ 3 | 6 | #8 | #9 | 31-#6 | 7 | #6 | #7 | 16-#5 | 445 | 1114 | 1197 | 4.00 | 16 * | 4 S 6 1 | 6 | #7 | #7 | 29-#6 | 7 | #5 | #6 | 16-#5 |
| | 400 | 5.02 | 26 * | 0.625 | | 18-#6+ 4 | 6 | #9 | #9 | 37-#6 | 7 | #7 | #7 | 17-#5 | 528 | 1222 | 1421 | 4.52 | 23 * | 4 S 6 2 | 6 | #7 | #8 | 35-#6 | 7 | #5 | #6 | 16-#5 |

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 17 in. | Rib Depth = 14 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | |
| 35'-0" | 50 | 2.20 | 17 | 0.725 | | 15-#5+ 2 | 6 | #5 | #6 | 16-#6 | 8 | #4 | #4 | 18-#5 | 241 | 482 | 649 |
| D = 13.000 | 100 | 2.63 | 17 * | 0.832 | | 15-#5+ 6 | 6 | #6 | #7 | 21-#6 | 8 | #4 | #5 | 18-#5 | 305 | 611 | 822 |
| RIB NOT ON | 150 | 3.08 | 17 * | 0.907 | | 12-#6+ 6 | 6 | #7 | #7 | 25-#6 | 8 | #5 | #5 | 18-#5 | 369 | 782 | 995 |
| COLUMN LINE | 200 | 3.67 | 19 * | 0.631 | | 14-#6+ 4 | 6 | #8 | #8 | 30-#6 | 8 | #5 | #6 | 18-#5 | 431 | 986 | 1161 |
| 0.827 CF/SF | 300 | 4.76 | 26 * | 0.625 | | 18-#6+ 4 | 6 | #9 | #9 | 38-#6 | 8 | #6 | #7 | 18-#5 | 544 | 1242 | 1463 |
| 37'-6" | 50 | 2.38 | 18 * | 0.763 | | 16-#5+ 3 | 6 | #6 | #6 | 20-#6 | 9 | #4 | #4 | 20-#5 | 295 | 591 | 795 |
| D = 13.000 | 100 | 2.87 | 18 * | 0.877 | | 12-#6+ 6 | 6 | #7 | #7 | 26-#6 | 9 | #4 | #5 | 20-#5 | 374 | 749 | 1008 |
| RIB NOT ON | 150 | 3.53 | 19 * | 0.631 | | 15-#6+ 3 | 6 | #8 | #8 | 31-#6 | 9 | #5 | #5 | 20-#5 | 452 | 931 | 1218 |
| COLUMN LINE | 200 | 4.32 | 23 * | 0.627 | | 17-#6+ 3 | 6 | #9 | #9 | 37-#6 | 9 | #6 | #6 | 20-#5 | 526 | 1176 | 1416 |
| 0.815 CF/SF | | | | | | | | | | | | | | | | | |
| 40'-0" | 50 | 2.65 | 20 * | 0.825 | | 18-#5+ 9 | 7 | #6 | #7 | 24-#6 | 9 | #4 | #5 | 20-#5 | 361 | 721 | 971 |
| D = 15.500 | 100 | 3.17 | 20 * | 0.912 | | 15-#6+10 | 7 | #7 | #7 | 31-#6 | 9 | #5 | #5 | 20-#5 | 456 | 912 | 1228 |
| RIB ON | 150 | 3.82 | 24 * | 0.627 | | 18-#6+ 4 | 7 | #8 | #8 | 38-#6 | 9 | #5 | #6 | 20-#5 | 547 | 1093 | 1472 |
| COLUMN LINE | 200 | 4.43 | 28 * | 0.624 | | 21-#6+ 5 | 7 | #8 | #9 | 45-#6 | 9 | #6 | #6 | 21-#5 | 633 | 1265 | 1704 |
| 0.835 CF/SF | | | | | | | | | | | | | | | | | |
| 42'-6" | 50 | 2.88 | 21 * | 0.851 | | 14-#6+ 7 | 7 | #7 | #7 | 30-#6 | 10 | #4 | #5 | 22-#5 | 431 | 861 | 1160 |
| D = 15.500 | 100 | 3.70 | 22 * | 0.628 | | 18-#6+ 4 | 7 | #8 | #8 | 38-#6 | 10 | #5 | #6 | 22-#5 | 544 | 1088 | 1465 |
| RIB ON | 150 | 4.34 | 28 * | 0.624 | | 22-#6+ 5 | 7 | #8 | #9 | 46-#6 | 10 | #6 | #6 | 22-#5 | 650 | 1301 | 1751 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.825 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.23 | 22 * | 0.889 | | 17-#6+ 9 | 7 | #7 | #8 | 35-#6 | 11 | #5 | #5 | 24-#5 | 510 | 1019 | 1372 |
| D = 15.500 | 100 | 3.99 | 26 * | 0.625 | | 21-#6+ 5 | 7 | #8 | #9 | 45-#6 | 11 | #5 | #6 | 24-#5 | 641 | 1282 | 1725 |
| RIB ON | 150 | 4.65 | 36 * | 0.620 | 4 S 6 1 | 25-#6+ 6 | 7 | #9 | #9 | 54-#6 | 11 | #6 | #6 | 24-#5 | 751 | 1503 | 2023 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.815 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 17 in. | Rib Depth = 14 in. | Total Slab Depth = 3 in. | | | | | | | | |
| 2.18 | 17 | | 6 | #4 | #5 | 15-#6 | 8 | #4 | #4 | 18-#5 |
| 2.46 | 17 | | 6 | #5 | #5 | 19-#6 | 8 | #4 | #4 | 18-#5 |
| 2.89 | 17 * | 4 S 6 1 | 6 | #6 | #6 | 23-#6 | 8 | #4 | #4 | 18-#5 |
| 3.37 | 17 * | 4 S 6 1 | 6 | #6 | #7 | 28-#6 | 8 | #4 | #5 | 18-#5 |
| 4.39 | 21 * | 4 S 6 2 | 6 | #7 | #8 | 36-#6 | 8 | #5 | #6 | 18-#5 |
| 2.36 | 18 | | 6 | #5 | #5 | 18-#6 | 9 | #4 | #4 | 20-#5 |
| 2.73 | 18 * | 4 S 6 1 | 6 | #5 | #6 | 24-#6 | 9 | #4 | #4 | 20-#5 |
| 3.33 | 18 * | 4 S 6 1 | 6 | #6 | #7 | 29-#6 | 9 | #4 | #5 | 20-#5 |
| 3.90 | 18 * | 4 S 6 2 | 6 | #7 | #7 | 35-#6 | 9 | #5 | #5 | 20-#5 |
| 2.50 | 20 | | 7 | #5 | #5 | 23-#6 | 9 | #4 | #4 | 20-#5 |
| 2.99 | 20 * | 4 S 6 1 | 7 | #6 | #6 | 29-#6 | 9 | #4 | #4 | 20-#5 |
| 3.53 | 20 * | 4 S 6 1 | 7 | #6 | #7 | 36-#6 | 9 | #4 | #5 | 20-#5 |
| 4.10 | 22 * | 4 S 6 2 | 7 | #7 | #7 | 42-#6 | 9 | #5 | #5 | 20-#5 |
| 2.72 | 21 | | 7 | #5 | #6 | 27-#6 | 10 | #4 | #4 | 22-#5 |
| 3.41 | 21 * | 4 S 6 1 | 7 | #6 | #7 | 35-#6 | 10 | #4 | #5 | 22-#5 |
| 4.03 | 21 * | 4 S 6 2 | 7 | #7 | #7 | 43-#6 | 10 | #5 | #5 | 22-#5 |
| 2.99 | 22 * | 4 S 6 1 | 7 | #6 | #6 | 33-#6 | 11 | #4 | #4 | 24-#5 |
| 3.70 | 22 * | 4 S 6 2 | 7 | #7 | #7 | 42-#6 | 11 | #4 | #5 | 24-#5 |
| 4.34 | 28 * | 4 S 6 2 | 7 | #7 | #8 | 50-#6 | 11 | #5 | #5 | 24-#5 |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments $-M$ Edge (ft-k) | $+M$ Bot. (ft-k) | $-M$ Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | Rib Depth = 16 in. | | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | Total Depth = 19 in. | Rib Depth = 16 in. | | Total Slab Depth = 3 in. | | | | | | | |
| 25'-0" | 50 | 2.03 | 12 | 0.641 | | 11-#5+ 0 | 5 | #4 | #5 | 11-#5 | 5 | #4 | #5 | 12-#5 | 96 | 192 | 259 | 2.05 | 12 | | 5 | #4 | #5 | 11-#5 | 5 | #4 | #5 | 12-#5 |
| D = 10.500 | 100 | 2.03 | 12 | 0.641 | | 11-#5+ 0 | 5 | #4 | #5 | 11-#5 | 5 | #4 | #5 | 12-#5 | 120 | 239 | 322 | 2.05 | 12 | | 5 | #4 | #5 | 11-#5 | 5 | #4 | #5 | 12-#5 |
| RIB ON | 150 | 2.04 | 12 | 0.641 | | 11-#5+ 0 | 5 | #4 | #5 | 12-#5 | 5 | #4 | #5 | 12-#5 | 143 | 317 | 385 | 2.05 | 12 | | 5 | #4 | #5 | 11-#5 | 5 | #4 | #5 | 12-#5 |
| COLUMN LINE | 200 | 2.18 | 12 | 0.646 | | 11-#5+ 0 | 5 | #5 | #5 | 10-#6 | 5 | #4 | #5 | 12-#5 | 166 | 395 | 448 | 2.15 | 12 | | 5 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 12-#5 |
| 0.943 CF/SF | 300 | 2.57 | 12 | 0.736 | | 11-#5+ 0 | 5 | #6 | #6 | 12-#6 | 5 | #5 | #5 | 12-#5 | 213 | 544 | 574 | 2.39 | 12 | | 5 | #5 | #5 | 11-#6 | 5 | #4 | #5 | 12-#5 |
| | 400 | 3.05 | 12 * | 0.864 | | 11-#5+ 3 | 5 | #7 | #7 | 15-#6 | 5 | #5 | #6 | 12-#5 | 260 | 689 | 700 | 2.71 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 14-#6 | 5 | #4 | #5 | 12-#5 |
| | 500 | 3.56 | 12 * | 0.642 | | 12-#5+ 3 | 5 | #7 | #8 | 18-#6 | 5 | #6 | #6 | 12-#5 | 307 | 832 | 826 | 3.22 | 12 * | 4 S 6 1 | 5 | #6 | #6 | 17-#6 | 5 | #5 | #5 | 12-#5 |
| 27'-6" | 50 | 2.04 | 13 | 0.640 | | 12-#5+ 0 | 5 | #4 | #5 | 12-#5 | 6 | #4 | #5 | 14-#5 | 127 | 254 | 342 | 2.07 | 13 | | 5 | #4 | #5 | 12-#5 | 6 | #4 | #5 | 14-#5 |
| D = 10 .500 | 100 | 2.05 | 13 | 0.640 | | 12-#5+ 0 | 5 | #4 | #5 | 9-#6 | 6 | #4 | #5 | 14-#5 | 158 | 316 | 426 | 2.07 | 13 | | 5 | #4 | #5 | 12-#5 | 6 | #4 | #5 | 14-#5 |
| RIB ON | 150 | 2.26 | 13 | 0.652 | | 12-#5+ 0 | 5 | #5 | #6 | 11-#6 | 6 | #4 | #5 | 14-#5 | 189 | 417 | 510 | 2.17 | 13 | | 5 | #4 | #5 | 10-#6 | 6 | #4 | #5 | 14-#5 |
| COLUMN LINE | 200 | 2.47 | 13 | 0.726 | | 12-#5+ 1 | 5 | #6 | #6 | 18-#5 | 6 | #4 | #5 | 14-#5 | 220 | 521 | 594 | 2.39 | 13 | | 5 | #5 | #5 | 12-#6 | 6 | #4 | #5 | 14-#5 |
| 0.922 CF/SF | 300 | 3.01 | 13 * | 0.863 | | 12-#5+ 5 | 5 | #7 | #7 | 17-#6 | 6 | #5 | #5 | 14-#5 | 283 | 718 | 762 | 2.84 | 13 | 4 S 6 1 | 5 | #6 | #6 | 15-#6 | 6 | #4 | #5 | 14-#5 |
| | 400 | 3.77 | 13 * | 0.641 | | 10-#6+ 1 | 5 | #8 | #8 | 21-#6 | 6 | #6 | #6 | 14-#5 | 345 | 911 | 929 | 3.39 | 13 * | 4 S 6 1 | 5 | #6 | #7 | 19-#6 | 6 | #5 | #5 | 14-#5 |
| | 500 | 4.36 | 15 * | 0.638 | 4 S 6 1 | 12-#6+ 2 | 5 | #8 | #9 | 25-#6 | 6 | #6 | #7 | 14-#5 | 405 | 1094 | 1090 | 3.92 | 13 * | 4 S 6 2 | 5 | #7 | #7 | 23-#6 | 6 | #5 | #6 | 14-#5 |
| 30'-0" | 50 | 2.07 | 15 | 0.637 | | 9-# 6+ 0 | 5 | #4 | #5 | 9-#6 | 7 | #4 | #5 | 16-#5 | 163 | 326 | 438 | 2.11 | 15 | | 5 | #4 | #5 | 9-#6 | 7 | #4 | #5 | 16-#5 |
| D = 10.500 | 100 | 2.28 | 15 | 0.637 | | 9-#6+ 0 | 5 | #5 | #6 | 12-#6 | 7 | #4 | #5 | 16-#5 | 203 | 406 | 547 | 2.22 | 15 | | 5 | #4 | #5 | 11-#6 | 7 | #4 | #5 | 16-#5 |
| RIB ON | 150 | 2.48 | 15 | 0.662 | | 9-#6+ 0 | 5 | #6 | #6 | 14-#6 | 7 | #4 | #5 | 16-#5 | 243 | 525 | 655 | 2.42 | 15 | | 5 | #5 | #5 | 13-#6 | 7 | #4 | #5 | 16-#5 |
| COLUMN LINE | 200 | 2.82 | 15 | 0.772 | | 9-#6+ 2 | 5 | #7 | #7 | 17-#6 | 7 | #4 | #5 | 16-#5 | 284 | 660 | 764 | 2.69 | 15 | 4 S 6 1 | 5 | #5 | #6 | 16-#6 | 7 | #4 | #5 | 16-#5 |
| 0.906 CF/SF | 300 | 3.51 | 15 * | 0.638 | | 10-#6+ 1 | 5 | #8 | #8 | 22-#6 | 7 | #5 | #6 | 16-#5 | 364 | 913 | 981 | 3.18 | 15 * | 4 S 6 1 | 5 | #6 | #7 | 20-#6 | 7 | #4 | #5 | 16-#5 |
| | 400 | 4.35 | 16 * | 0.636 | 4 S 6 1 | 18-#5+ 3 | 5 | #9 | #9 | 27-#6 | 7 | #6 | #6 | 16-#5 | 444 | 1159 | 1194 | 3.97 | 15 * | 4 S 6 2 | 5 | #7 | #8 | 25-#6 | 7 | #5 | #5 | 16-#5 |
| | 500 | 5.00 | 20 * | 0.632 | 4 S 6 1 | 15-#6+ 1 | 5 | #9 | #10 | 32-#6 | 7 | #6 | #7 | 16-#5 | 515 | 1361 | 1386 | 4.56 | 17 * | 4 S 6 2 | 5 | #8 | #8 | 30-#6 | 7 | #5 | #6 | 16-#5 |
| 32'-6" | 50 | 2.14 | 16 | 0.635 | | 14-#5+ 0 | 6 | #5 | #5 | 12-#6 | 7 | #4 | #5 | 16-#5 | 210 | 420 | 565 | 2.13 | 16 | | 6 | #4 | #5 | 11-#6 | 7 | #4 | #5 | 16-#5 |
| D = 13.000 | 100 | 2.33 | 16 | 0.695 | | 14-#5+ 2 | 6 | #5 | #6 | 15-#6 | 7 | #4 | #5 | 16-#5 | 261 | 522 | 703 | 2.27 | 16 | | 6 | #4 | #5 | 14-#6 | 7 | #4 | #5 | 16-#5 |
| RIB NOT ON | 150 | 2.57 | 16 * | 0.791 | | 14-#5+ 5 | 6 | #6 | #6 | 18-#6 | 7 | #4 | #5 | 16-#5 | 313 | 667 | 841 | 2.53 | 16 | | 6 | #5 | #5 | 17-#6 | 7 | #4 | #5 | 16-#5 |
| COLUMN LINE | 200 | 3.11 | 16 * | 0.861 | | 15-#5+ 7 | 6 | #7 | #7 | 22-#6 | 7 | #5 | #6 | 16-#5 | 364 | 840 | 980 | 2.80 | 16 * | | 6 | #5 | #6 | 20-#6 | 7 | #4 | #5 | 16-#5 |
| 0.934 CF/SF | 300 | 3.90 | 16 * | 0.636 | | 13-#6+ 2 | 6 | #8 | #8 | 28-#6 | 7 | #6 | #6 | 16-#5 | 466 | 1162 | 1256 | 3.55 | 16 * | 4 S 6 1 | 6 | #6 | #7 | 26-#6 | 7 | #5 | #5 | 16-#5 |
| | 400 | 4.85 | 22 * | 0.630 | | 16-#6+ 3 | 6 | #9 | #9 | 34-#6 | 7 | #7 | #7 | 16-#5 | 557 | 1423 | 1499 | 4.32 | 18 * | 4 S 6 2 | 6 | #7 | #8 | 32-#6 | 7 | #5 | #6 | 16-#5 |
| | 500 | 5.49 | 26 * | 0.627 | | 19-#6+ 2 | 6 | #9 | #10 | 40-#6 | 7 | #7 | #7 | 18-#5 | 641 | 1576 | 1726 | 5.02 | 23 * | 4 S 6 2 | 6 | #8 | #8 | 37-#6 | 7 | #6 | #6 | 17-#5 |
| 35'-0" | 50 | 2.30 | 17 | 0.634 | | 15-#5+ 0 | 6 | #5 | #6 | 15-#6 | 8 | #4 | #5 | 18-#5 | 261 | 521 | 702 | 2.24 | 17 | | 6 | #4 | #5 | 14-#6 | 8 | #4 | #5 | 18-#5 |
| D = 13.000 | 100 | 2.56 | 17 | 0.757 | | 15-#5+ 4 | 6 | #6 | #6 | 19-#6 | 8 | #4 | #5 | 18-#5 | 325 | 650 | 874 | 2.52 | 17 | | 6 | #5 | #5 | 18-#6 | 8 | #4 | #5 | 18-#5 |
| RIB NOT ON | 150 | 3.01 | 17 * | 0.845 | | 11-#6+ 5 | 6 | #7 | #7 | 23-#6 | 8 | #5 | #5 | 18-#5 | 389 | 815 | 1047 | 2.83 | 17 | 4 S 6 1 | 6 | #5 | #6 | 22-#6 | 8 | #4 | #5 | 18-#5 |
| COLUMN LINE | 200 | 3.47 | 17 * | 0.635 | | 13-#6+ 2 | 6 | #7 | #8 | 27-#6 | 8 | #5 | #6 | 18-#5 | 453 | 1031 | 1220 | 3.24 | 17 * | 4 S 6 1 | 6 | #6 | #7 | 25-#6 | 8 | #4 | #5 | 18-#5 |
| 0.919 CF/SF | 300 | 4.64 | 21 * | 0.631 | | 17-#6+ 2 | 6 | #9 | #9 | 35-#6 | 8 | #6 | #7 | 18-#5 | 575 | 1418 | 1549 | 4.24 | 17 * | 4 S 6 2 | 6 | #7 | #8 | 33-#6 | 8 | #5 | #6 | 18-#5 |
| | 400 | 5.29 | 27 * | 0.627 | 4 S 6 1 | 20-#6+ 3 | 6 | #9 | #10 | 42-#6 | 8 | #7 | #7 | 19-#5 | 681 | 1605 | 1834 | 4.75 | 23 * | 4 S 6 2 | 6 | #8 | #8 | 40-#6 | 8 | #5 | #6 | 18-#5 |

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | Rib Depth = 16 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | |
| 37'-6" | 50 | 2.49 | 18 | 0.692 | | 16-#5+ 2 | 6 | #6 | #6 | 19-#6 | 9 | #4 | #5 | 20-#5 | 319 | 638 | 859 |
| D = 13.000 | 100 | 2.85 | 18 * | 0.806 | | 16-#5+ 6 | 6 | #7 | #7 | 24-#6 | 9 | #4 | #5 | 20-#5 | 398 | 796 | 1072 |
| RIB NOT ON | 150 | 3.30 | 18 * | 0.904 | | 14-#6+ 8 | 6 | #7 | #8 | 29-#6 | 9 | #5 | #5 | 20-#5 | 477 | 978 | 1285 |
| COLUMN LINE | 200 | 3.90 | 19 * | 0.633 | | 16-#6+ 3 | 6 | #8 | #9 | 34-#6 | 9 | #5 | #6 | 20-#5 | 555 | 1242 | 1494 |
| 0.906 CF/SF | 300 | 5.04 | 26 * | 0.627 | | 29-#5+ 4 | 6 | #9 | #10 | 43-#6 | 9 | #6 | #7 | 20-#5 | 696 | 1605 | 1873 |
| 40'-0" | 50 | 2.58 | 20 | 0.747 | | 18-#5+ 5 | 7 | #6 | #6 | 23-#6 | 9 | #4 | #5 | 20-#5 | 390 | 780 | 1049 |
| D = 15.500 | 100 | 3.09 | 20 * | 0.856 | | 14-#6+ 7 | 7 | #7 | #7 | 29-#6 | 9 | #5 | #5 | 20-#5 | 485 | 971 | 1307 |
| RIB ON | 150 | 3.56 | 20 * | 0.632 | | 17-#6+ 5 | 7 | #7 | #8 | 35-#6 | 9 | #5 | #6 | 20-#5 | 581 | 1162 | 1564 |
| COLUMN LINE | 200 | 4.29 | 23 * | 0.630 | | 20-#6+ 5 | 7 | #8 | #9 | 41-#6 | 9 | #6 | #6 | 20-#5 | 672 | 1453 | 1809 |
| 0.928 CF/SF | 300 | 5.13 | 31 * | 0.624 | 4 S 6 1 | 25-#6+ 5 | 7 | #9 | #9 | 52-#6 | 9 | #6 | #7 | 24-#5 | 835 | 1670 | 2248 |
| 42'-6" | 50 | 2.89 | 21 * | 0.804 | | 13-#6+ 7 | 7 | #7 | #7 | 28-#6 | 10 | #4 | #5 | 22-#5 | 466 | 931 | 1253 |
| D = 15.500 | 100 | 3.38 | 21 * | 0.897 | | 17-#6+ 9 | 7 | #7 | #8 | 35-#6 | 10 | #5 | #5 | 22-#5 | 580 | 1160 | 1562 |
| RIB ON | 150 | 4.03 | 23 * | 0.630 | | 20-#6+ 6 | 7 | #8 | #9 | 43-#6 | 10 | #5 | #6 | 22-#5 | 692 | 1384 | 1863 |
| COLUMN LINE | 200 | 4.63 | 28 * | 0.626 | | 33-#5+ 7 | 7 | #9 | #9 | 50-#6 | 10 | #6 | #6 | 23-#5 | 796 | 1624 | 2143 |
| 0.916 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.23 | 22 * | 0.852 | | 16-#6+ 9 | 7 | #7 | #8 | 33-#6 | 11 | #5 | #5 | 24-#5 | 551 | 1101 | 1483 |
| D = 15.500 | 100 | 3.80 | 22 * | 0.630 | | 20-#6+ 6 | 7 | #8 | #8 | 42-#6 | 11 | #5 | #6 | 24-#5 | 687 | 1374 | 1850 |
| RIB ON | 150 | 4.54 | 28 * | 0.626 | | 24-#6+ 6 | 7 | #9 | #9 | 51-#6 | 11 | #6 | #6 | 24-#5 | 813 | 1627 | 2190 |
| COLUMN LINE | 200 | 5.16 | 33 * | 0.623 | 4 S 6 1 | 28-#6+ 4 | 7 | #9 | #10 | 59-#6 | 11 | #6 | #7 | 27-#5 | 931 | 1862 | 2507 |
| 0.906 CF/SF | | | | | | | | | | | | | | | | | |
| 47'-6" | 50 | 3.38 | 23 * | 0.888 | | 19-#6+11 | 8 | #7 | #8 | 40-#6 | 11 | #5 | #5 | 24-#5 | 654 | 1307 | 1760 |
| D = 18.000 | 100 | 4.28 | 27 * | 0.917 | | 24-#6+14 | 8 | #8 | #9 | 50-#6 | 11 | #6 | #6 | 24-#5 | 808 | 1615 | 2175 |
| RIB NOT ON | 150 | 4.91 | 33 * | 0.623 | | 28-#6+ 7 | 8 | #9 | #9 | 60-#6 | 11 | #6 | #7 | 27-#5 | 952 | 1905 | 2564 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.925 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | Rib Depth = 16 in. | Total Slab Depth = 3 in. | | | | | | | | |
| 2.45 | 18 | | 6 | #5 | #5 | 17-#6 | 9 | #4 | #5 | 20-#5 |
| 2.77 | 18 | 4 S 6 1 | 6 | #5 | #6 | 22-#6 | 9 | #4 | #5 | 20-#5 |
| 3.11 | 18 * | 4 S 6 1 | 6 | #6 | #6 | 27-#6 | 9 | #4 | #5 | 20-#5 |
| 3.58 | 18 * | 4 S 6 1 | 6 | #7 | #7 | 32-#6 | 9 | #4 | #5 | 20-#5 |
| 4.65 | 21 * | 4 S 6 2 | 6 | #8 | #8 | 41-#6 | 9 | #5 | #6 | 20-#5 |
| 2.54 | 20 | | 7 | #5 | #5 | 21-#6 | 9 | #4 | #5 | 20-#5 |
| 2.91 | 20 | | 7 | #5 | #6 | 27-#6 | 9 | #4 | #5 | 20-#5 |
| 3.28 | 20 * | 4 S 6 1 | 7 | #6 | #6 | 33-#6 | 9 | #4 | #5 | 20-#5 |
| 3.93 | 20* | 4 S 6 1 | 7 | #7 | #7 | 38-#6 | 9 | #5 | #5 | 20-#5 |
| 4.80 | 26 * | 4 S 6 2 | 7 | #7 | #8 | 49-#6 | 9 | #5 | #6 | 23-#5 |
| 2.80 | 21 | | 7 | #5 | #6 | 26-#6 | 10 | #4 | #5 | 22-#5 |
| 3.19 | 21 * | 4 S 6 1 | 7 | #6 | #6 | 33-#6 | 10 | #4 | #5 | 22-#5 |
| 3.72 | 21 * | 4 S 6 1 | 7 | #7 | #7 | 40-#6 | 10 | #4 | #5 | 22-#5 |
| 4.30 | 22 * | 4 S 6 2 | 7 | #7 | #8 | 46-#6 | 10 | #5 | #5 | 22-#5 |
| 3.05 | 22 | 4 S 6 1 | 7 | #6 | #6 | 31-#6 | 11 | #4 | #5 | 24-#5 |
| 3.59 | 22 * | 4 S 6 1 | 7 | #7 | #7 | 39-#6 | 11 | #4 | #5 | 24-#5 |
| 4.22 | 22 * | 4 S 6 2 | 7 | #7 | #8 | 47-#6 | 11 | #5 | #5 | 24-#5 |
| 4.70 | 26 * | 4 S 6 2 | 7 | #8 | #8 | 55-#6 | 11 | #5 | #5 | 25-#5 |
| 3.19 | 23 * | | 8 | #6 | #6 | 37-#6 | 11 | #4 | #5 | 24-#5 |
| 3.94 | 23 * | 4 S 6 1 | 8 | #7 | #7 | 46-#6 | 11 | #5 | #5 | 24-#5 |
| 4.50 | 25 * | 4 S 6 2 | 8 | #7 | #8 | 56-#6 | 11 | #5 | #5 | 26-#5 |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 23 in. | | Rib Depth = 20 in. | | Total Slab Depth = 3 in. | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.35 | 15 | 0.641 | | 9-#6+ 0 | 5 | #5 | #5 | 9-#6 | 7 | #5 | #5 | 16-#5 | 188 | 376 | 507 |
| D = 10.500 | 100 | 2.39 | 15 | 0.641 | | 9-#6+ 0 | 5 | #5 | #5 | 15-#5 | 7 | #5 | #5 | 16-#5 | 229 | 457 | 615 |
| RIB ON | 150 | 2.53 | 15 | 0.641 | | 9-#6+ 0 | 5 | #5 | #6 | 18-#5 | 7 | #5 | #5 | 16-#5 | 269 | 558 | 724 |
| COLUMN LINE | 200 | 2.78 | 15 | 0.641 | | 9-#6+ 0 | 5 | #6 | #7 | 15-#6 | 7 | #5 | #5 | 16-#5 | 309 | 697 | 832 |
| 1.094 CF/SF | 300 | 3.21 | 15 | 0.655 | | 9-#6+ 0 | 5 | #7 | #8 | 19-#6 | 7 | #5 | #5 | 16-#5 | 390 | 957 | 1049 |
| | 400 | 3.67 | 15 * | 0.850 | | 11-#6+ 3 | 5 | #8 | #8 | 23-#6 | 7 | #5 | #6 | 16-#5 | 470 | 1209 | 1266 |
| | 500 | 4.46 | 15 * | 0.642 | 5 S 8 1 | 18-#5+ 1 | 5 | #9 | #9 | 27-#6 | 7 | #6 | #7 | 16-#5 | 551 | 1457 | 1483 |
| 32'-6" | 50 | 2.33 | 16 | 0.640 | | 14-#5+ 0 | 6 | #5 | #5 | 11-#6 | 7 | #5 | #5 | 16-#5 | 243 | 486 | 654 |
| D = 13.000 | 100 | 2.42 | 16 | 0.640 | | 14-#5+ 0 | 6 | #5 | #5 | 14-#6 | 7 | #5 | #5 | 16-#5 | 294 | 588 | 792 |
| RIB NOT ON | 150 | 2.66 | 16 | 0.640 | | 14-#5+ 0 | 6 | #6 | #6 | 16-#6 | 7 | #5 | #5 | 16-#5 | 345 | 712 | 930 |
| COLUMN LINE | 200 | 2.92 | 16 | 0.642 | | 14-#5+ 1 | 6 | #6 | #7 | 19-#6 | 7 | #5 | #5 | 16-#5 | 397 | 889 | 1068 |
| 1.128 CF/SF | 300 | 3.44 | 16 * | 0.841 | | 16-#5+ 7 | 6 | #7 | #8 | 24-#6 | 7 | #5 | #6 | 16-#5 | 499 | 1221 | 1344 |
| | 400 | 4.32 | 16 * | 0.641 | | 14-#6+ 2 | 6 | #8 | #9 | 29-#6 | 7 | #6 | #7 | 16-#5 | 602 | 1542 | 1621 |
| | 500 | 5.13 | 17 * | 0.639 | | 17-#6+ 2 | 6 | #9 | #10 | 35-#6 | 7 | #7 | #7 | 16-#5 | 703 | 1853 | 1892 |
| 35'-0" | 50 | 2.49 | 17 | 0.638 | | 15-#5+ 0 | 6 | #5 | #6 | 14-#6 | 8 | #5 | #5 | 18-#5 | 301 | 603 | 811 |
| D = 13.000 | 100 | 2.66 | 17 | 0.638 | | 15-#5+ 0 | 6 | #6 | #6 | 17-#6 | 8 | #5 | #5 | 18-#5 | 366 | 731 | 984 |
| RIB NOT ON | 150 | 2.86 | 17 | 0.638 | | 15-#5+ 1 | 6 | #6 | #7 | 21-#6 | 8 | #5 | #5 | 18-#5 | 430 | 873 | 1157 |
| COLUMN LINE | 200 | 3.17 | 17 | 0.738 | | 11-#6+ 2 | 6 | #7 | #7 | 24-#6 | 8 | #5 | #5 | 18-#5 | 494 | 1096 | 1329 |
| 1.109 CF/SF | 300 | 4.07 | 17 * | 0.639 | | 15-#6+ 1 | 6 | #8 | #9 | 30-#6 | 8 | #6 | #6 | 18-#5 | 622 | 1510 | 1675 |
| | 400 | 4.84 | 17 * | 0.639 | | 18-#6+ 2 | 6 | #9 | #10 | 37-#6 | 8 | #6 | #7 | 18-#5 | 750 | 1910 | 2020 |
| | 500 | 5.65 | 22 * | 0.634 | | 29-#5+ 2 | 6 | #10 | #10 | 43-#6 | 8 | #7 | #7 | 20-#5 | 863 | 2236 | 2324 |
| 37'-6" | 50 | 2.63 | 18 | 0.637 | | 16-#5+ 1 | 6 | #6 | #6 | 18-#6 | 9 | #5 | #5 | 20-#5 | 369 | 738 | 993 |
| D = 13.000 | 100 | 2.89 | 18 | 0.637 | | 16-#5+ 2 | 6 | #6 | #7 | 22-#6 | 9 | #5 | #5 | 20-#5 | 448 | 896 | 1206 |
| RIB NOT ON | 150 | 3.11 | 18 | 0.763 | | 12-#6+ 4 | 6 | #7 | #7 | 26-#6 | 9 | #5 | #5 | 20-#5 | 527 | 1054 | 1419 |
| COLUMN LINE | 200 | 3.64 | 18 * | 0.844 | | 14-#6+ 5 | 6 | #8 | #8 | 30-#6 | 9 | #5 | #6 | 20-#5 | 606 | 1328 | 1631 |
| 1.094 CF/SF | 300 | 4.43 | 18 * | 0.638 | | 18-#6+ 2 | 6 | #9 | #9 | 38-#6 | 9 | #6 | #6 | 20-#5 | 764 | 1837 | 2057 |
| | 400 | 5.50 | 23 * | 0.633 | | 22-#6+ 3 | 6 | #10 | #10 | 46-#6 | 9 | #7 | #7 | 21-#5 | 911 | 2301 | 2453 |
| 40'-0" | 50 | 2.71 | 20 | 0.635 | | 18-#5+ 2 | 7 | #6 | #6 | 22-#6 | 9 | #5 | #5 | 20-#5 | 451 | 902 | 1214 |
| D = 15.500 | 100 | 2.98 | 20 | 0.720 | | 18-#5+ 6 | 7 | #6 | #7 | 26-#6 | 9 | #5 | #5 | 20-#5 | 546 | 1093 | 1471 |
| RIB ON | 150 | 3.31 | 20 * | 0.821 | | 15-#6+ 6 | 7 | #7 | #7 | 31-#6 | 9 | #5 | #5 | 20-#5 | 642 | 1284 | 1728 |
| COLUMN LINE | 200 | 3.82 | 20 * | 0.889 | | 17-#6+ 8 | 7 | #8 | #8 | 36-#6 | 9 | #5 | #6 | 20-#5 | 737 | 1576 | 1985 |
| 1.121 CF/SF | 300 | 4.98 | 22 * | 0.634 | | 22-#6+ 5 | 7 | #9 | #10 | 46-#6 | 9 | #6 | #7 | 21-#5 | 924 | 2181 | 2488 |
| | 400 | 6.02 | 28 * | 0.630 | 5 S 8 1 | 26-#6+ 3 | 7 | #10 | #10 | 55-#6 | 9 | #7 | #8 | 25-#5 | 1090 | 2566 | 2934 |
| 42'-6" | 50 | 2.93 | 21 | 0.634 | | 13-#6+ 2 | 7 | #6 | #7 | 26-#6 | 10 | #5 | #5 | 22-#5 | 538 | 1076 | 1449 |
| D = 15.500 | 100 | 3.25 | 21 * | 0.790 | | 15-#6+ 6 | 7 | #7 | #7 | 32-#6 | 10 | #5 | #5 | 22-#5 | 653 | 1306 | 1758 |
| RIB ON | 150 | 3.79 | 21 * | 0.878 | | 18-#6+ 9 | 7 | #8 | #8 | 38-#6 | 10 | #5 | #6 | 22-#5 | 768 | 1535 | 2067 |
| COLUMN LINE | 200 | 4.25 | 21 * | 0.635 | | 21-#6+ 3 | 7 | #8 | #9 | 44-#6 | 10 | #6 | #6 | 22-#5 | 882 | 1847 | 2375 |
| 1.107 CF/SF | 300 | 5.60 | 27 * | 0.630 | 5 S 8 1 | 26-#6+ 3 | 7 | #10 | #10 | 55-#6 | 10 | #7 | #7 | 25-#5 | 1098 | 2551 | 2955 |
| 45'-0" | 50 | 3.17 | 22 | 0.733 | | 15-#6+ 5 | 7 | #7 | #7 | 31-#6 | 11 | #5 | #5 | 24-#5 | 637 | 1273 | 1714 |
| D = 15.500 | 100 | 3.60 | 22 * | 0.850 | | 18-#6+ 9 | 7 | #8 | #8 | 38-#6 | 11 | #5 | #5 | 24-#5 | 773 | 1546 | 2081 |
| RIB ON | 150 | 4.09 | 22 * | 0.634 | | 22-#6+ 5 | 7 | #8 | #9 | 45-#6 | 11 | #5 | #6 | 24-#5 | 909 | 1818 | 2448 |
| COLUMN LINE | 200 | 4.58 | 24 * | 0.633 | | 25-#6+ 4 | 7 | #9 | #9 | 52-#6 | 11 | #6 | #6 | 24-#5 | 1041 | 2127 | 2803 |
| 1.094 CF/SF | | | | | | | | | | | | | | | | | |
| 47'-6" | 50 | 3.38 | 23 * | 0.797 | | 18-#6+ 7 | 8 | #7 | #8 | 37-#6 | 11 | #5 | #5 | 24-#5 | 756 | 1511 | 2035 |
| D = 18.000 | 100 | 3.87 | 23 * | 0.891 | | 22-#6+11 | 8 | #8 | #8 | 45-#6 | 11 | #5 | #6 | 24-#5 | 916 | 1832 | 2466 |
| RIB NOT ON | 150 | 4.40 | 24 * | 0.633 | | 36-#5+ 8 | 8 | #8 | #9 | 54-#6 | 11 | #6 | #6 | 25-#5 | 1074 | 2149 | 2893 |
| COLUMN LINE | 200 | 5.17 | 29 * | 0.629 | | 29-#6+ 6 | 8 | #9 | #10 | 61-#6 | 11 | #6 | #7 | 28-#5 | 1223 | 2450 | 3292 |
| 1.117 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 23 in. | | | Rib Depth = 20 in. | | | | Total Slab Depth = 3 in. | | | |
| 2.38 | 15 | | 5 | #5 | #5 | 9-#6 | 7 | #5 | #5 | 16-#5 |
| 2.42 | 15 | | 5 | #5 | #5 | 10-#6 | 7 | #5 | #5 | 16-#5 |
| 2.53 | 15 | | 5 | #5 | #5 | 12-#6 | 7 | #5 | #5 | 16-#5 |
| 2.64 | 15 | | 5 | #5 | #5 | 14-#6 | 7 | #5 | #5 | 16-#5 |
| 3.05 | 15 | 5 S 8 1 | 5 | #6 | #6 | 17-#6 | 7 | #5 | #5 | 16-#5 |
| 3.43 | 15 * | 5 S 8 1 | 5 | #6 | #7 | 21-#6 | 7 | #5 | #5 | 16-#5 |
| 3.97 | 15 * | 5 S 8 2 | 5 | #7 | #8 | 25-#6 | 7 | #5 | #5 | 16-#5 |
| 2.36 | 16 | | 6 | #5 | #5 | 15-#5 | 7 | #5 | #5 | 16-#5 |
| 2.46 | 16 | | 6 | #5 | #5 | 18-#5 | 7 | #5 | #5 | 16-#5 |
| 2.60 | 16 | | 6 | #5 | #5 | 15-#6 | 7 | #5 | #5 | 16-#5 |
| 2.86 | 16 | | 6 | #5 | #6 | 18-#6 | 7 | #5 | #5 | 16-#5 |
| 3.19 | 16 | 5 S 8 1 | 6 | #6 | #6 | 22-#6 | 7 | #5 | #5 | 16-#5 |
| 3.90 | 16 * | 5 S 8 1 | 6 | #7 | #7 | 27-#6 | 7 | #5 | #6 | 16-#5 |
| 4.52 | 16 * | 5 S 8 2 | 6 | #7 | #8 | 32-#6 | 7 | #6 | #6 | 16-#5 |
| 2.47 | 17 | | 6 | #5 | #5 | 13-#6 | 8 | #5 | #5 | 18-#5 |
| 2.60 | 17 | | 6 | #5 | #5 | 16-#6 | 8 | #5 | #5 | 18-#5 |
| 2.76 | 17 | | 6 | #5 | #5 | 19-#6 | 8 | #5 | #5 | 18-#5 |
| 3.12 | 17 | | 6 | #6 | #6 | 22-#6 | 8 | #5 | #5 | 18-#5 |
| 3.68 | 17 * | 5 S 8 1 | 6 | #7 | #7 | 28-#6 | 8 | #5 | #5 | 18-#5 |
| 4.27 | 17 * | 5 S 8 2 | 6 | #7 | #8 | 34-#6 | 8 | #5 | #6 | 18-#5 |
| 5.15 | 19 * | 5 S 8 2 | 6 | #8 | #9 | 40-#6 | 8 | #6 | #6 | 18-#5 |
| 2.58 | 18 | | 6 | #5 | #5 | 16-#6 | 9 | #5 | #5 | 20-#5 |
| 2.86 | 18 | | 6 | #5 | #6 | 20-#6 | 9 | #5 | #5 | 20-#5 |
| 3.04 | 18 | 5 S 8 1 | 6 | #5 | #6 | 24-#6 | 9 | #5 | #5 | 20-#5 |
| 3.42 | 18 | 5 S 8 1 | 6 | #6 | #7 | 27-#6 | 9 | #5 | #5 | 20-#5 |
| 4.07 | 18 * | 5 S 8 2 | 6 | #7 | #8 | 35-#6 | 9 | #5 | #5 | 20-#5 |
| 4.93 | 18 * | 5 S 8 2 | 6 | #8 | #9 | 43-#6 | 9 | #5 | #6 | 20-#5 |
| 2.66 | 20 | | 7 | #5 | #5 | 20-#6 | 9 | #5 | #5 | 20-#5 |
| 2.95 | 20 | | 7 | #5 | #6 | 24-#6 | 9 | #5 | #5 | 20-#5 |
| 3.28 | 20 | | 7 | #6 | #6 | 29-#6 | 9 | #5 | #5 | 20-#5 |
| 3.59 | 20 * | 5 S 8 1 | 7 | #6 | #7 | 33-#6 | 9 | #5 | #5 | 20-#5 |
| 4.45 | 20 * | 5 S 8 2 | 7 | #7 | #8 | 43-#6 | 9 | #5 | #6 | 20-#5 |
| 5.47 | 24 * | 5 S 8 2 | 7 | #8 | #9 | 51-#6 | 9 | #6 | #6 | 24-#5 |
| 2.90 | 21 | | 7 | #5 | #6 | 24-#6 | 10 | #5 | #5 | 22-#5 |
| 3.22 | 21 | | 7 | #6 | #6 | 29-#6 | 10 | #5 | #5 | 22-#5 |
| 3.58 | 21 * | 5 S 8 1 | 7 | #6 | #7 | 35-#6 | 10 | #5 | #5 | 22-#5 |
| 3.90 | 21 * | 5 S 8 1 | 7 | #7 | #7 | 40-#6 | 10 | #5 | #5 | 22-#5 |
| 5.06 | 21 * | 5 S 8 2 | 7 | #8 | #9 | 52-#6 | 10 | #5 | #6 | 24-#5 |
| 3.16 | 22 | | 7 | #6 | #6 | 29-#6 | 11 | #5 | #5 | 24-#5 |
| 3.51 | 22 | 5 S 8 1 | 7 | #6 | #7 | 35-#6 | 11 | #5 | #5 | 24-#5 |
| 3.88 | 22 * | 5 S 8 1 | 7 | #7 | #7 | 42-#6 | 11 | #5 | #5 | 24-#5 |
| 4.25 | 22 * | 5 S 8 2 | 7 | #7 | #8 | 48-#6 | 11 | #5 | #5 | 24-#5 |
| 3.25 | 23 | | 8 | #6 | #6 | 34-#6 | 11 | #5 | #5 | 24-#5 |
| 3.67 | 23 * | 5 S 8 1 | 8 | #6 | #7 | 42-#6 | 11 | #5 | #5 | 24-#5 |
| 4.08 | 23 * | 5 S 8 1 | 8 | #7 | #7 | 50-#6 | 11 | #5 | #5 | 24-#5 |
| 4.70 | 23 * | 5 S 8 2 | 8 | #7 | #8 | 57-#6 | 11 | #5 | #6 | 27-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 12 in. | Rib Depth = 8 in. | Total Slab Depth = 4 in. | | | | | | | | | | | | | | | |
| 17'-6" | 50 | 1.71 | 12 | 0.631 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 | 25 | 50 | 68 |
| D = 8.000 | 100 | 1.71 | 12 | 0.631 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 | 33 | 68 | 88 |
| RIB NOT ON | 150 | 1.71 | 12 | 0.631 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 | 41 | 94 | 109 |
| COLUMN LINE | 200 | 1.71 | 12 | 0.653 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 | 48 | 119 | 130 |
| 0.671 CF/SF | 300 | 1.96 | 12 | 0.770 | | 7-#5+ 1 | 4 | #5 | #5 | 6-#6 | 3 | #4 | #5 | 7-#5 | 64 | 167 | 172 |
| | 400 | 2.36 | 12 * | 0.861 | | 7-#5+ 2 | 4 | #5 | #6 | 6-#7 | 3 | #5 | #5 | 7-#5 | 79 | 214 | 214 |
| | 500 | 2.73 | 12 * | 0.632 | | 7-#5+ 2 | 4 | #6 | #6 | 9-#6 | 3 | #6 | #6 | 7-#5 | 95 | 260 | 255 |
| 20'-0" | 50 | 1.69 | 12 | 0.631 | | 8-#5+ 0 | 4 | #4 | #4 | 8-#5 | 4 | #4 | #4 | 8-#5 | 38 | 75 | 101 |
| D = 8.000 | 100 | 1.69 | 12 | 0.668 | | 8-#5+ 0 | 4 | #4 | #4 | 8-#5 | 4 | #4 | #4 | 8-#5 | 49 | 102 | 133 |
| RIB NOT ON | 150 | 1.76 | 12 | 0.717 | | 8-#5+ 0 | 4 | #4 | #5 | 8-#5 | 4 | #4 | #4 | 8-#5 | 61 | 142 | 165 |
| COLUMN LINE | 200 | 1.88 | 12 | 0.765 | | 8-#5+ 0 | 4 | #5 | #5 | 7-#6 | 4 | #4 | #4 | 8-#5 | 73 | 179 | 196 |
| 0.653 CF/SF | 300 | 2.42 | 12 * | 0.899 | | 8-#5+ 3 | 4 | #6 | #6 | 9-#6 | 4 | #5 | #5 | 8-#5 | 96 | 251 | 259 |
| | 400 | 3.00 | 13 * | 0.630 | | 8-#5+ 2 | 4 | #7 | #7 | 7-#8 | 4 | #5 | #6 | 8-#5 | 119 | 321 | 321 |
| | 500 | 3.49 | 16 * | 0.627 | | 9-#5+ 2 | 4 | #7 | #8 | 6-#9 | 4 | #6 | #6 | 8-#5 | 139 | 374 | 376 |
| 22'-6" | 50 | 1.79 | 12 | 0.727 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 | 54 | 108 | 145 |
| D = 8.000 | 100 | 1.85 | 12 | 0.776 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 71 | 146 | 191 |
| RIB NOT ON | 150 | 2.09 | 12 * | 0.826 | | 10-#5+ 0 | 4 | #5 | #6 | 6-#7 | 5 | #4 | #4 | 10-#5 | 88 | 203 | 236 |
| COLUMN LINE | 200 | 2.38 | 12 * | 0.886 | | 10-#5+ 1 | 4 | #6 | #6 | 10-#6 | 5 | #4 | #5 | 10-#5 | 105 | 256 | 282 |
| 0.641 CF/SF | 300 | 3.20 | 14 * | 0.629 | | 10-#5+ 1 | 4 | #7 | #8 | 6-#9 | 5 | #5 | #6 | 10-#5 | 137 | 357 | 370 |
| | 400 | 3.83 | 18 * | 0.625 | | 6-#7+ 0 | 4 | #8 | #8 | 8-#9 | 5 | #6 | #6 | 10-#5 | 166 | 430 | 448 |
| 25'-0" | 50 | 1.75 | 12 | 0.792 | | 8-#6+ 0 | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 | 76 | 151 | 203 |
| D = 10.500 | 100 | 1.95 | 12 * | 0.863 | | 8-#6+ 1 | 5 | #5 | #5 | 7-#7 | 5 | #4 | #4 | 10-#5 | 99 | 205 | 266 |
| RIB ON | 150 | 2.34 | 12 * | 0.919 | | 8-#6+ 2 | 5 | #6 | #6 | 7-#8 | 5 | #4 | #5 | 10-#5 | 122 | 284 | 329 |
| COLUMN LINE | 200 | 2.82 | 14 * | 0.629 | | 8-#6+ 1 | 5 | #6 | #7 | 8-#8 | 5 | #5 | #5 | 10-#5 | 145 | 355 | 390 |
| 0.661 CF/SF | 300 | 3.56 | 19 * | 0.624 | | 9-#6+ 3 | 5 | #7 | #8 | 8-#9 | 5 | #6 | #6 | 10-#5 | 185 | 454 | 499 |
| 27'-6" | 50 | 1.91 | 13 * | 0.821 | | 8-#6+ 1 | 5 | #5 | #5 | 7-#7 | 6 | #4 | #4 | 12-#5 | 100 | 200 | 269 |
| D = 10.500 | 100 | 2.19 | 13 * | 0.902 | | 8-#6+ 3 | 5 | #5 | #6 | 7-#8 | 6 | #4 | #4 | 12-#5 | 131 | 264 | 353 |
| RIB ON | 150 | 2.71 | 15 * | 0.628 | | 8-#6+ 2 | 5 | #6 | #7 | 7-#9 | 6 | #5 | #5 | 12-#5 | 161 | 367 | 434 |
| COLUMN LINE | 200 | 3.31 | 18 * | 0.625 | | 9-#6+ 4 | 5 | #7 | #8 | 9-#9 | 6 | #5 | #6 | 12-#5 | 190 | 449 | 511 |
| 0.650 CF/SF | | | | | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.13 | 15 * | 0.854 | | 9-#6+ 3 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 13-#5 | 129 | 257 | 346 |
| D = 10.500 | 100 | 2.57 | 15 * | 0.929 | | 9-#6+ 6 | 5 | #6 | #7 | 8-#9 | 7 | #4 | #5 | 13-#5 | 169 | 338 | 455 |
| RIB ON | 150 | 3.13 | 19 * | 0.624 | | 7-#7+ 2 | 5 | #7 | #8 | 12-#8 | 7 | #5 | #5 | 13-#5 | 207 | 445 | 557 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.641 CF/SF | | | | | | | | | | | | | | | | | |
| 32'-6" | 50 | 2.26 | 16 * | 0.886 | | 10-#6+ 4 | 6 | #5 | #6 | 9-#8 | 7 | #4 | #5 | 13-#5 | 165 | 330 | 445 |
| D = 13.000 | 100 | 2.82 | 19 * | 0.920 | | 10-#6+ 7 | 6 | #6 | #7 | 12-#8 | 7 | #5 | #5 | 13-#5 | 215 | 429 | 578 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.656 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 12 in. | | | Rib Depth = 8 in. | | | | Total Slab Depth = 4 in. | | | |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.78 | 12 | | 4 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 7-#5 |
| 2.16 | 12 * | 3 S 4 1 | 4 | #4 | #5 | 7-#6 | 3 | #4 | #5 | 7-#5 |
| 2.38 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 6-#7 | 3 | #4 | #5 | 7-#5 |
| 1.71 | 12 | | 4 | #4 | #4 | 8-#5 | 4 | #4 | #4 | 8-#5 |
| 1.71 | 12 | | 4 | #4 | #4 | 8-#5 | 4 | #4 | #4 | 8-#5 |
| 1.71 | 12 | | 4 | #4 | #4 | 8-#5 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 2.16 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 6-#7 | 4 | #4 | #4 | 8-#5 |
| 2.61 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 6-#8 | 4 | #4 | #5 | 8-#5 |
| 3.09 | 14 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 4 | #5 | #5 | 8-#5 |
| 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 2.00 | 12 | 3 S 4 1 | 4 | #4 | #5 | 6-#7 | 5 | #4 | #4 | 10-#5 |
| 2.23 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 7-#7 | 5 | #4 | #4 | 10-#5 |
| 2.83 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 5 | #4 | #5 | 10-#5 |
| 3.46 | 15 * | 3 S 4 2 | 4 | #6 | #7 | 7-#9 | 5 | #5 | #5 | 10-#5 |
| 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| 1.85 | 12 | | 5 | #4 | #4 | 9-#6 | 5 | #4 | #4 | 10-#5 |
| 2.08 | 12 * | | 5 | #4 | #5 | 8-#7 | 5 | #4 | #4 | 10-#5 |
| 2.65 | 12 * | 3 S 4 1 | 5 | #5 | #6 | 8-#8 | 5 | #4 | #5 | 10-#5 |
| 3.22 | 16 * | 3 S 4 1 | 5 | #6 | #6 | 8-#9 | 5 | #5 | #5 | 10-#5 |
| 1.84 | 13 | | 5 | #4 | #4 | 9-#6 | 6 | #4 | #4 | 12-#5 |
| 2.16 | 13 * | | 5 | #4 | #5 | 7-#8 | 6 | #4 | #4 | 12-#5 |
| 2.47 | 13 * | 3 S 4 1 | 5 | #5 | #6 | 8-#8 | 6 | #4 | #4 | 12-#5 |
| 2.94 | 14 * | 3 S 4 1 | 5 | #6 | #6 | 8-#9 | 6 | #4 | #5 | 12-#5 |
| 2.09 | 15 | | 5 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 13-#5 |
| 2.38 | 15 * | 3 S 4 1 | 5 | #5 | #5 | 7-#9 | 7 | #4 | #4 | 13-#5 |
| 2.85 | 15 * | 3 S 4 1 | 5 | #6 | #6 | 9-#9 | 7 | #4 | #4 | 13-#5 |
| 2.13 | 16 * | | 6 | #4 | #5 | 11-#7 | 7 | #4 | #4 | 13-#5 |
| 2.65 | 16 * | 3 S 4 1 | 6 | #5 | #6 | 9-#9 | 7 | #4 | #4 | 13-#5 |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 in. | Rib Depth = 10 in. | | Total Slab Depth = 4 in. | | | | | | | | | | | | | | |
| 20'-0" | 50 | 1.73 | 12 | 0.634 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 41 | 82 | 110 |
| D = 8.000 | 100 | 1.73 | 12 | 0.634 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 53 | 108 | 142 |
| RIB NOT ON | 150 | 1.73 | 12 | 0.635 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 64 | 148 | 173 |
| COLUMN LINE | 200 | 1.80 | 12 | 0.677 | | 6-#6+ 0 | 4 | #4 | #5 | 6-#6 | 4 | #4 | #4 | 8-#5 | 76 | 185 | 205 |
| 0.739 CF/SF | 300 | 2.16 | 12 | 0.761 | | 6-#6+ 0 | 4 | #5 | #6 | 6-#7 | 4 | #4 | #5 | 8-#5 | 100 | 258 | 268 |
| | 400 | 2.59 | 12 * | 0.867 | | 6-#6+ 1 | 4 | #6 | #7 | 7-#7 | 4 | #5 | #5 | 8-#5 | 123 | 330 | 331 |
| | 500 | 3.01 | 12 * | 0.635 | | 6-#6+ 0 | 4 | #7 | #7 | 7-#8 | 4 | #5 | #6 | 8-#5 | 147 | 401 | 394 |
| 22'-6" | 50 | 1.79 | 12 | 0.648 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 | 59 | 117 | 158 |
| D = 8.000 | 100 | 1.85 | 12 | 0.694 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 75 | 154 | 203 |
| RIB NOT ON | 150 | 1.91 | 12 | 0.740 | | 10-#5+ 0 | 4 | #5 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 92 | 211 | 249 |
| COLUMN LINE | 200 | 2.09 | 12 | 0.785 | | 10-#5+ 0 | 4 | #5 | #6 | 6-#7 | 5 | #4 | #4 | 10-#5 | 109 | 265 | 294 |
| 0.725 CF/SF | 300 | 2.79 | 12 * | 0.635 | | 10-#5+ 0 | 4 | #7 | #7 | 7-#8 | 5 | #5 | #5 | 10-#5 | 143 | 371 | 385 |
| | 400 | 3.33 | 13 * | 0.634 | | 10-#5+ 1 | 4 | #7 | #8 | 8-#8 | 5 | #5 | #6 | 10-#5 | 176 | 472 | 474 |
| | 500 | 4.04 | 16 * | 0.630 | | 6-#7+ 1 | 4 | #8 | #9 | 8-#9 | 5 | #6 | #6 | 10-#5 | 206 | 555 | 554 |
| 25'-0" | 50 | 1.75 | 12 | 0.723 | | 8-#6+ 0 | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 | 82 | 164 | 221 |
| D = 10.500 | 100 | 1.82 | 12 | 0.773 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 10-#5 | 106 | 216 | 284 |
| RIB ON | 150 | 2.19 | 12 * | 0.842 | | 8-#6+ 1 | 5 | #5 | #6 | 8-#7 | 5 | #4 | #5 | 10-#5 | 129 | 296 | 347 |
| COLUMN LINE | 200 | 2.54 | 12 * | 0.897 | | 8-#6+ 2 | 5 | #6 | #6 | 7-#8 | 5 | #5 | #5 | 10-#5 | 152 | 371 | 410 |
| 0.749 CF/SF | 300 | 3.22 | 14 * | 0.632 | | 8-#6+ 2 | 5 | #7 | #7 | 7-#9 | 5 | #6 | #6 | 10-#5 | 198 | 513 | 532 |
| | 400 | 3.90 | 18 * | 0.628 | | 7-#7+ 2 | 5 | #8 | #8 | 9-#9 | 5 | #6 | #7 | 10-#5 | 238 | 624 | 641 |
| 27'-6" | 50 | 1.81 | 13 | 0.729 | | 8-#6+ 0 | 5 | #4 | #5 | 9-#6 | 6 | #4 | #4 | 12-#5 | 109 | 217 | 293 |
| D = 10.500 | 100 | 2.03 | 13 * | 0.813 | | 8-#6+ 1 | 5 | #5 | #5 | 8-#7 | 6 | #4 | #4 | 12-#5 | 140 | 280 | 377 |
| RIB ON | 150 | 2.41 | 13 * | 0.892 | | 8-#6+ 3 | 5 | #6 | #6 | 8-#8 | 6 | #4 | #5 | 12-#5 | 171 | 387 | 460 |
| COLUMN LINE | 200 | 2.86 | 13 * | 0.634 | | 8-#6+ 2 | 5 | #7 | #7 | 7-#9 | 6 | #5 | #5 | 12-#5 | 202 | 487 | 544 |
| 0.735 CF/SF | 300 | 3.77 | 19 * | 0.627 | 3 S 4 1 | 10-#6+ 3 | 5 | #8 | #8 | 12-#8 | 6 | #6 | #6 | 12-#5 | 258 | 648 | 694 |
| 30'-0" | 50 | 1.98 | 15 | 0.737 | | 9-#6+ 0 | 5 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 13-#5 | 140 | 279 | 376 |
| D = 10.500 | 100 | 2.30 | 15 * | 0.841 | | 9-#6+ 2 | 5 | #6 | #6 | 8-#8 | 7 | #4 | #4 | 13-#5 | 180 | 360 | 484 |
| RIB ON | 150 | 2.76 | 15 * | 0.631 | | 9-#6+ 1 | 5 | #7 | #7 | 8-#9 | 7 | #4 | #5 | 13-#5 | 220 | 480 | 593 |
| COLUMN LINE | 200 | 3.36 | 18 * | 0.628 | | 10-#6+ 3 | 5 | #7 | #8 | 12-#8 | 7 | #5 | #6 | 13-#5 | 258 | 602 | 695 |
| 0.725 CF/SF | 300 | 3.97 | 24 * | 0.623 | 3 S 4 1 | 7-#8+ 2 | 5 | #8 | #9 | 16-#8 | 7 | #5 | #6 | 13-#5 | 326 | 694 | 878 |
| 32'-6" | 50 | 2.13 | 16 * | 0.826 | | 10-#6+ 3 | 6 | #5 | #6 | 11-#7 | 7 | #4 | #4 | 13-#5 | 179 | 359 | 483 |
| D = 13.000 | 100 | 2.50 | 16 * | 0.906 | | 10-#6+ 6 | 6 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 13-#5 | 231 | 462 | 621 |
| RIB NOT ON | 150 | 3.13 | 19 * | 0.627 | | 11-#6+ 3 | 6 | #7 | #7 | 13-#8 | 7 | #5 | #6 | 13-#5 | 280 | 598 | 753 |
| COLUMN LINE | 200 | 3.87 | 22 * | 0.624 | | 10-#7+ 3 | 6 | #8 | #8 | 16-#8 | 7 | #6 | #6 | 13-#5 | 327 | 732 | 880 |
| 0.743 CF/SF | | | | | | | | | | | | | | | | | |
| 35'-0" | 50 | 2.41 | 17 * | 0.863 | | 15-#5+ 7 | 6 | #6 | #6 | 10-#8 | 8 | #4 | #5 | 15-#5 | 223 | 446 | 601 |
| D = 13.000 | 100 | 2.94 | 18 * | 0.927 | | 12-#6+ 8 | 6 | #7 | #7 | 11-#9 | 8 | #5 | #5 | 15-#5 | 287 | 573 | 772 |
| RIB NOT ON | 150 | 3.52 | 23 * | 0.624 | | 10-#7+ 3 | 6 | #7 | #8 | 13-#9 | 8 | #5 | #6 | 15-#5 | 346 | 715 | 932 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.733 CF/SF | | | | | | | | | | | | | | | | | |
| 37'-6" | 50 | 2.63 | 18 * | 0.894 | | 16-#5+10 | 6 | #6 | #7 | 10-#9 | 9 | #4 | #5 | 17-#5 | 274 | 547 | 737 |
| D = 13.000 | 100 | 3.23 | 22 * | 0.918 | | 14-#6+ 9 | 6 | #7 | #8 | 14-#9 | 9 | #5 | #5 | 17-#5 | 349 | 699 | 941 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.725 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 in. | Rib Depth = 10 in. | | Total Slab Depth = 4 in. | | | | | | | |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 8-#5 |
| 2.24 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 9-#6 | 4 | #4 | #4 | 8-#5 |
| 2.61 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 6-#8 | 4 | #4 | #5 | 8-#5 |
| 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 2.00 | 12 | 3 S 4 1 | 4 | #4 | #5 | 6-#7 | 5 | #4 | #4 | 10-#5 |
| 2.43 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 6-#8 | 5 | #4 | #4 | 10-#5 |
| 3.07 | 12 * | 3 S 4 1 | 4 | #6 | #7 | 6-#9 | 5 | #4 | #5 | 10-#5 |
| 3.61 | 14 * | 3 S 4 2 | 4 | #7 | #7 | 7-#9 | 5 | #5 | #5 | 10-#5 |
| 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| 2.01 | 12 | | 5 | #4 | #5 | 7-#7 | 5 | #4 | #4 | 10-#5 |
| 2.32 | 12 * | | 5 | #5 | #5 | 7-#8 | 5 | #4 | #4 | 10-#5 |
| 2.86 | 12 * | 3 S 4 1 | 5 | #6 | #6 | 11-#7 | 5 | #4 | #5 | 10-#5 |
| 3.38 | 15 * | 3 S 4 1 | 5 | #6 | #7 | 8-#9 | 5 | #5 | #5 | 10-#5 |
| 1.77 | 13 | | 5 | #4 | #4 | 8-#6 | 6 | #4 | #4 | 12-#5 |
| 2.04 | 13 | | 5 | #4 | #5 | 8-#7 | 6 | #4 | #4 | 12-#5 |
| 2.26 | 13 * | 3 S 4 1 | 5 | #5 | #5 | 7-#8 | 6 | #4 | #4 | 12-#5 |
| 2.60 | 13 * | 3 S 4 1 | 5 | #5 | #6 | 7-#9 | 6 | #4 | #4 | 12-#5 |
| 3.43 | 15 * | 3 S 4 1 | 5 | #6 | #7 | 9-#9 | 6 | #5 | #5 | 12-#5 |
| 1.98 | 15 | | 5 | #4 | #5 | 8-#7 | 7 | #4 | #4 | 13-#5 |
| 2.26 | 15 | 3 S 4 1 | 5 | #5 | #5 | 8-#8 | 7 | #4 | #4 | 13-#5 |
| 2.59 | 15 * | 3 S 4 1 | 5 | #5 | #6 | 8-#9 | 7 | #4 | #4 | 13-#5 |
| 3.13 | 15 * | 3 S 4 1 | 5 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| 3.65 | 21 * | 3 S 4 2 | 5 | #7 | #7 | 12-#9 | 7 | #4 | #5 | 13-#5 |
| 2.04 | 16 | | 6 | #4 | #5 | 10-#7 | 7 | #4 | #4 | 13-#5 |
| 2.36 | 16 * | | 6 | #5 | #5 | 10-#8 | 7 | #4 | #4 | 13-#5 |
| 2.85 | 16 * | 3 S 4 1 | 6 | #5 | #6 | 10-#9 | 7 | #4 | #5 | 13-#5 |
| 3.52 | 17 * | 3 S 4 1 | 6 | #6 | #7 | 12-#9 | 7 | #5 | #5 | 13-#5 |
| 2.31 | 17 | | 6 | #5 | #5 | 10-#8 | 8 | #4 | #4 | 15-#5 |
| 2.66 | 17 * | 3 S 4 1 | 6 | #5 | #6 | 10-#9 | 8 | #4 | #4 | 15-#5 |
| 3.31 | 17 * | 3 S 4 1 | 6 | #6 | #7 | 16-#8 | 8 | #4 | #5 | 15-#5 |
| 2.54 | 18 * | 3 S 4 1 | 6 | #5 | #6 | 12-#8 | 9 | #4 | #4 | 17-#5 |
| 2.96 | 18 * | 3 S 4 1 | 6 | #6 | #6 | 16-#8 | 9 | #4 | #4 | 17-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 16 in. | Rib Depth = 12 in. | | Total Slab Depth = 4 in. | | | | | | | | | | | | | | | Total Depth = 16 in. | Rib Depth = 12 in. | | Total Slab Depth = 4 in. | | | | | | | |
| 22'-6" | 50 | 1.79 | 12 | 0.637 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 | 63 | 127 | 171 | 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| D = 8.000 | 100 | 1.79 | 12 | 0.637 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 | 80 | 160 | 216 | 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| RIB NOT ON | 150 | 1.91 | 12 | 0.651 | | 10-#5+ 0 | 4 | #5 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 97 | 219 | 262 | 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.05 | 12 | 0.694 | | 10-#5+ 0 | 4 | #5 | #6 | 6-#7 | 5 | #4 | #4 | 10-#5 | 114 | 274 | 307 | 1.93 | 12 | | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 0.811 CF/SF | 300 | 2.47 | 12 | 0.780 | | 10-#5+ 0 | 4 | #6 | #7 | 10-#6 | 5 | #4 | #5 | 10-#5 | 148 | 380 | 398 | 2.23 | 12 | 4 S 6 1 | 4 | #5 | #5 | 7-#7 | 5 | #4 | #4 | 10-#5 |
| | 400 | 3.00 | 12 * | 0.638 | | 10-#5+ 0 | 4 | #7 | #7 | 7-#8 | 5 | #5 | #5 | 10-#5 | 182 | 484 | 489 | 2.83 | 12 * | 4 S 6 1 | 4 | #6 | #6 | 7-#8 | 5 | #4 | #5 | 10-#5 |
| | 500 | 3.45 | 12 * | 0.638 | | 10-#5+ 2 | 4 | #8 | #8 | 11-#7 | 5 | #5 | #6 | 10-#5 | 215 | 587 | 580 | 3.07 | 12 * | 4 S 6 1 | 4 | #6 | #7 | 6-#9 | 5 | #4 | #5 | 10-#5 |
| 25'-0" | 50 | 1.75 | 12 | 0.651 | | 8-#6+ 0 | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 | 89 | 178 | 240 | 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| D = 10.500 | 100 | 1.82 | 12 | 0.697 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 10-#5 | 112 | 225 | 303 | 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| RIB ON | 150 | 1.92 | 12 | 0.744 | | 8-#6+ 0 | 5 | #5 | #5 | 9-#6 | 5 | #4 | #4 | 10-#5 | 136 | 306 | 366 | 1.80 | 12 | | 5 | #4 | #4 | 12-#5 | 5 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.20 | 12 | 0.814 | | 8-#6+ 1 | 5 | #5 | #6 | 8-#7 | 5 | #4 | #5 | 10-#5 | 159 | 383 | 429 | 2.02 | 12 | | 5 | #4 | #5 | 10-#6 | 5 | #4 | #4 | 10-#5 |
| 0.839 CF/SF | 300 | 2.90 | 12 * | 0.638 | | 8-#6+ 1 | 5 | #6 | #7 | 8-#8 | 5 | #5 | #6 | 10-#5 | 206 | 530 | 555 | 2.65 | 12* | 4 S 6 1 | 5 | #5 | #6 | 8-#8 | 5 | #4 | #5 | 10-#5 |
| | 400 | 3.48 | 13 * | 0.637 | | 12-#5+ 3 | 5 | #7 | #8 | 8-#9 | 5 | #6 | #6 | 10-#5 | 252 | 671 | 678 | 3.08 | 12 * | 4 S 6 1 | 5 | #6 | #6 | 7-#9 | 5 | #5 | #5 | 10-#5 |
| | 500 | 4.05 | 17 * | 0.632 | | 7-#7+ 2 | 5 | #8 | #8 | 9-#9 | 5 | #6 | #7 | 10-#5 | 292 | 789 | 787 | 3.68 | 14 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 5 | #5 | #6 | 10-#5 |
| 27'-6" | 50 | 1.79 | 13 | 0.654 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 6 | #4 | #4 | 12-#5 | 118 | 235 | 317 | 1.77 | 13 | | 5 | #4 | #4 | 8-#6 | 6 | #4 | #4 | 12-#5 |
| D = 10.500 | 100 | 1.93 | 13 | 0.712 | | 8-#6+ 0 | 5 | #5 | #5 | 10-#6 | 6 | #4 | #4 | 12-#5 | 149 | 298 | 401 | 1.88 | 13 | | 5 | #4 | #4 | 7-#7 | 6 | #4 | #4 | 12-#5 |
| RIB ON | 150 | 2.33 | 13 * | 0.815 | | 8-#6+ 2 | 5 | #6 | #6 | 7-#8 | 6 | #4 | #5 | 12-#5 | 180 | 402 | 484 | 2.16 | 13 | | 5 | #4 | #5 | 7-#8 | 6 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.68 | 13 * | 0.874 | | 8-#6+ 3 | 5 | #6 | #7 | 8-#8 | 6 | #5 | #5 | 12-#5 | 211 | 504 | 568 | 2.47 | 13 * | 4 S 6 1 | 5 | #5 | #6 | 8-#8 | 6 | #4 | #4 | 12-#5 |
| 0.823 CF/SF | 300 | 3.38 | 14 * | 0.635 | | 9-#6+ 2 | 5 | #7 | #8 | 9-#9 | 6 | #5 | #6 | 12-#5 | 273 | 697 | 734 | 3.09 | 13 * | 4 S 6 1 | 5 | #6 | #7 | 8-#9 | 6 | #4 | #5 | 12-#5 |
| | 400 | 4.21 | 18 * | 0.631 | 4 S 6 1 | 8-#7+ 2 | 5 | #8 | #9 | 11-#9 | 6 | #6 | #7 | 12-#5 | 328 | 859 | 884 | 3.68 | 15 * | 4 S 6 2 | 5 | #7 | #7 | 10-#9 | 6 | #5 | #5 | 12-#5 |
| 30'-0" | 50 | 1.91 | 15 | 0.665 | | 9-#6+ 0 | 5 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 13-#5 | 151 | 302 | 407 | 1.83 | 15 | | 5 | #4 | #4 | 7-#7 | 7 | #4 | #4 | 13-#5 |
| D = 10.500 | 100 | 2.15 | 15 | 0.756 | | 9-#6+ 1 | 5 | #5 | #6 | 8-#8 | 7 | #4 | #4 | 13-#5 | 191 | 383 | 515 | 2.09 | 15 | | 5 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 13-#5 |
| RIB ON | 150 | 2.57 | 15 * | 0.845 | | 9-#6+ 3 | 5 | #6 | #7 | 7-#9 | 7 | #4 | #5 | 13-#5 | 232 | 502 | 624 | 2.43 | 15 | 4 S 6 1 | 5 | #5 | #6 | 11-#7 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 3.04 | 15 * | 0.634 | | 9-#6+ 2 | 5 | #7 | #8 | 9-#9 | 7 | #5 | #5 | 13-#5 | 272 | 634 | 732 | 2.70 | 15 * | 4 S 6 1 | 5 | #6 | #6 | 8-#9 | 7 | #4 | #4 | 13-#5 |
| 0.811 CF/SF | 300 | 4.04 | 19 * | 0.630 | 4 S 6 1 | 12-#6+ 3 | 5 | #8 | #9 | 11-#9 | 7 | #6 | #6 | 13-#5 | 348 | 874 | 938 | 3.70 | 15 * | 4 S 6 2 | 5 | #7 | #7 | 11-#9 | 7 | #5 | #5 | 13-#5 |
| | 400 | 4.73 | 24 * | 0.625 | 4 S 6 1 | 8-#8+ 2 | 5 | #9 | #10 | 14-#9 | 7 | #6 | #7 | 14-#5 | 415 | 1009 | 1119 | 4.08 | 20 * | 4 S 6 2 | 5 | #7 | #8 | 16-#8 | 7 | #5 | #5 | 13-#5 |
| 32'-6" | 50 | 2.01 | 16 | 0.756 | | 10-#6+ 2 | 6 | #5 | #5 | 10-#7 | 7 | #4 | #4 | 13-#5 | 194 | 389 | 523 | 1.99 | 16 | | 6 | #4 | #5 | 9-#7 | 7 | #4 | #4 | 13-#5 |
| D = 13.000 | 100 | 2.43 | 16 * | 0.841 | | 10-#6+ 4 | 6 | #6 | #6 | 10-#8 | 7 | #4 | #5 | 13-#5 | 246 | 491 | 661 | 2.29 | 16 | | 6 | #5 | #5 | 9-#8 | 7 | #4 | #4 | 13-#5 |
| RIB NOT ON | 150 | 2.82 | 16 * | 0.905 | | 10-#6+ 6 | 6 | #6 | #7 | 9-#9 | 7 | #5 | #5 | 13-#5 | 297 | 635 | 799 | 2.65 | 16 * | 4 S 6 1 | 6 | #5 | #6 | 9-#9 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 3.34 | 18 * | 0.631 | | 12-#6+ 2 | 6 | #7 | #8 | 11-#9 | 7 | #5 | #6 | 13-#5 | 346 | 798 | 932 | 2.97 | 16 * | 4 S 6 1 | 6 | #6 | #6 | 10-#9 | 7 | #4 | #5 | 13-#5 |
| 0.832 CF/SF | 300 | 4.45 | 24 * | 0.625 | | 11-#7+ 3 | 6 | #8 | #9 | 18-#8 | 7 | #6 | #7 | 15-#5 | 437 | 1035 | 1177 | 4.08 | 19 * | 4 S 6 2 | 6 | #7 | #7 | 14-#9 | 7 | #5 | #6 | 14-#5 |
| 35'-0" | 50 | 2.26 | 17 * | 0.778 | | 15-#5+ 3 | 6 | #6 | #6 | 10-#8 | 8 | #4 | #4 | 15-#5 | 242 | 483 | 650 | 2.15 | 17 | | 6 | #4 | #5 | 9-#8 | 8 | #4 | #4 | 15-#5 |
| D = 13.000 | 100 | 2.67 | 17 * | 0.873 | | 15-#5+ 7 | 6 | #6 | #7 | 12-#8 | 8 | #4 | #5 | 15-#5 | 306 | 611 | 823 | 2.58 | 17 * | 4 S 6 1 | 6 | #5 | #6 | 9-#9 | 8 | #4 | #4 | 15-#5 |
| RIB NOT ON | 150 | 3.25 | 18 * | 0.631 | | 9-#7+ 4 | 6 | #7 | #8 | 12-#9 | 8 | #5 | #5 | 15-#5 | 369 | 768 | 993 | 3.03 | 17 * | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 8 | #4 | #5 | 15-#5 |
| COLUMN LINE | 200 | 3.96 | 22 * | 0.627 | | 11-#7+ 3 | 6 | #8 | #8 | 14-#9 | 8 | #6 | #6 | 15-#5 | 428 | 967 | 1154 | 3.69 | 17 * | 4 S 6 1 | 6 | #7 | #7 | 13-#9 | 8 | #5 | #5 | 15-#5 |
| 0.820 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 37'-6" | 50 | 2.60 | 18 * | 0.836 | | 16-#5+ 7 | 6 | #6 | #7 | 9-#9 | 9 | #4 | #5 | 17-#5 | 296 | 592 | 797 | 2.52 | 18 | | 6 | #5 | #6 | 9-#9 | 9 | #4 | #4 | 17-#5 |
| D = 13.000 | 100 | 3.11 | 18 * | 0.924 | | 10-#7+ 6 | 6 | #7 | #8 | 12-#9 | 9 | #5 | #5 | 17-#5 | 375 | 750 | 1010 | 2.82 | 18 * | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 9 | #4 | #4 | 17-#5 |
| RIB NOT ON | 150 | 3.67 | 22 * | 0.627 | | 9-#8+ 1 | 6 | #8 | #8 | 15-#9 | 9 | #5 | #6 | 17-#5 | 450 | 907 | 1211 | 3.36 | 18 * | 4 S 6 2 | 6 | #6 | #7 | 14-#9 | 9 | #4 | #5 | 17-#5 |
| COLUMN LINE | 200 | 4.05 | 26 * | 0.624 | | 10-#8+ 3 | 6 | #8 | #9 | 18-#9 | 9 | #5 | #6 | 18-#5 | 519 | 1038 | 1398 | 3.70 | 21 * | 4 S 6 2 | 6 | #7 | #7 | 16-#9 | 9 | #4 | #5 | 17-#5 |
| 0.811 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40'-0" | 50 | 2.74 | 20 * | 0.865 | | 18-#5+11 | 7 | #6 | #7 | 12-#9 | 9 | #4 | #5 | 17-#5 | 361 | 722 | 972 | 2.64 | 20 | | 7 | #5 | #6 | 11-#9 | 9 | #4 | #4 | 17-#5 |
| D = 15.500 | 100 | 3.45 | 22 * | 0.920 | | 12-#7+ 8 | 7 | #7 | #8 | 15-#9 | 9 | #5 | #6 | 17-#5 | 454 | 909 | 1223 | 3.14 | 20 * | 4 S 6 1 | 7 | #6 | #6 | 14-#9 | 9 | #4 | #5 | 17-#5 |
| RIB ON | 150 | 4.08 | 27 * | 0.624 | | 14-#7+ 4 | 7 | #8 | #8 | 18-#9 | 9 | #6 | #6 | 19-#5 | 543 | 1087 | 1463 | 3.78 | 20 * | 4 S 6 1 | 7 | #6 | #7 | 17-#9 | 9 | #5 | #5 | 18-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.828 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 42'-6" | 50 | 3.01 | 21 * | 0.892 | | 11-#7+ 6 | 7 | #7 | #7 | 14-#9 | 10 | #5 | #5 | 18-#5 | 431 | 863 | 1161 | 2.79 | 21 * | 4 S 6 1 | 7 | #6 | #6 | 16-#8 | 10 | #4 | #4 | 18-#5 |
| D = 15.500 | 100 | 3.75 | 25 * | 0.625 | | 14-#7+ 4 | 7 | #8 | #8 | 18-#9 | 10 | #5 | #6 | 19-#5 | 541 | 1083 | 1458 | 3.46 | 21 * | 4 S 6 1 | 7 | #6 | #7 | 17-#9 | 10 | #4 | #5 | 18-#5 |
| RIB ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.818 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 in. | Rib Depth = 14 in. | Total Slab Depth = 4 in. | | | | | | | | | | | | | | | | Total Depth = 18 in. | Rib Depth = 14 in. | Total Slab Depth = 4 in. | | | | | | | | |
| 25'-0" | 50 | 1.75 | 12 | 0.640 | | 8-#6+ 0 | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 | 96 | 192 | 258 | 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| D = 10.500 | 100 | 1.75 | 12 | 0.640 | | 8-#6+ 0 | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 | 119 | 239 | 321 | 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| RIB ON | 150 | 1.89 | 12 | 0.662 | | 8-#6+ 0 | 5 | #5 | #5 | 12-#5 | 5 | #4 | #4 | 10-#5 | 143 | 316 | 384 | 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.16 | 12 | 0.707 | | 8-#6+ 0 | 5 | #5 | #6 | 7-#7 | 5 | #4 | #5 | 10-#5 | 166 | 394 | 447 | 1.97 | 12 | | 5 | #4 | #5 | 9-#6 | 5 | #4 | #4 | 10-#5 |
| 0.932 CF/SF | 300 | 2.63 | 12 * | 0.837 | | 8-#6+ 2 | 5 | #6 | #7 | 7-#8 | 5 | #5 | #5 | 10-#5 | 213 | 542 | 573 | 2.32 | 12 | | 5 | #5 | #5 | 7-#8 | 5 | #4 | #4 | 10-#5 |
| | 400 | 3.19 | 12 * | 0.641 | | 8-#6+ 2 | 5 | #7 | #7 | 7-#9 | 5 | #6 | #6 | 10-#5 | 260 | 687 | 699 | 2.79 | 12 * | 4 S 6 1 | 5 | #6 | #6 | 8-#8 | 5 | #4 | #5 | 10-#5 |
| | 500 | 3.89 | 12 * | 0.641 | | 9-#6+ 2 | 5 | #8 | #8 | 9-#9 | 5 | #6 | #7 | 10-#5 | 307 | 830 | 825 | 3.36 | 12 * | 4 S 6 1 | 5 | #6 | #7 | 8-#9 | 5 | #5 | #5 | 10-#5 |
| 27'-6" | 50 | 1.79 | 13 | 0.638 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 6 | #4 | #4 | 12-#5 | 127 | 254 | 341 | 1.77 | 13 | | 5 | #4 | #4 | 8-#6 | 6 | #4 | #4 | 12-#5 |
| D = 10.500 | 100 | 1.91 | 13 | 0.638 | | 8-#6+ 0 | 5 | #5 | #5 | 7-#7 | 6 | #4 | #4 | 12-#5 | 158 | 316 | 425 | 1.84 | 13 | | 5 | #4 | #4 | 9-#6 | 6 | #4 | #4 | 12-#5 |
| RIB ON | 150 | 2.10 | 13 | 0.719 | | 8-#6+ 1 | 5 | #5 | #6 | 8-#7 | 6 | #4 | #4 | 12-#5 | 189 | 415 | 509 | 2.04 | 13 | | 5 | #4 | #5 | 8-#7 | 6 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.41 | 13 | 0.791 | | 8-#6+ 2 | 5 | #6 | #6 | 8-#8 | 6 | #4 | #5 | 12-#5 | 220 | 519 | 593 | 2.26 | 13 | | 5 | #5 | #5 | 7-#8 | 6 | #4 | #4 | 12-#5 |
| 0.913 CF/SF | 300 | 3.20 | 13 * | 0.639 | | 8-#6+ 2 | 5 | #7 | #8 | 8-#9 | 6 | #5 | #6 | 12-#5 | 283 | 716 | 761 | 2.84 | 13 * | 4 S 6 1 | 5 | #6 | #6 | 7-#9 | 6 | #4 | #5 | 12-#5 |
| | 400 | 3.77 | 14 * | 0.638 | | 10-#6+ 1 | 5 | #8 | #8 | 12-#8 | 6 | #6 | #6 | 12-#5 | 344 | 906 | 926 | 3.42 | 13 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 6 | #5 | #5 | 12-#5 |
| | 500 | 4.53 | 17 * | 0.634 | 4 S 6 1 | 12-#6+ 3 | 5 | #9 | #9 | 11-#9 | 6 | #6 | #7 | 12-#5 | 400 | 1068 | 1076 | 4.07 | 15 * | 4 S 6 2 | 5 | #7 | #8 | 13-#8 | 6 | #5 | #6 | 12-#5 |
| 30'-0" | 50 | 1.88 | 15 | 0.636 | | 9-#6+ 0 | 5 | #5 | #5 | 7-#7 | 7 | #4 | #4 | 13-#5 | 163 | 326 | 438 | 1.80 | 15 | | 5 | #4 | #4 | 9-#6 | 7 | #4 | #4 | 13-#5 |
| D = 10.500 | 100 | 2.08 | 15 | 0.652 | | 9-#6+ 0 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 13-#5 | 203 | 406 | 547 | 1.98 | 15 | | 5 | #4 | #5 | 8-#7 | 7 | #4 | #4 | 13-#5 |
| RIB ON | 150 | 2.37 | 15 | 0.742 | | 9-#6+ 1 | 5 | #6 | #6 | 8-#8 | 7 | #4 | #5 | 13-#5 | 243 | 522 | 655 | 2.26 | 15 | | 5 | #5 | #5 | 8-#8 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 2.80 | 15 * | 0.831 | | 9-#6+ 3 | 5 | #7 | #7 | 8-#9 | 7 | #5 | #5 | 13-#5 | 284 | 657 | 764 | 2.49 | 15 | 4 S 6 1 | 5 | #5 | #6 | 7-#9 | 7 | #4 | #4 | 13-#5 |
| 0.899 CF/SF | 300 | 3.49 | 15 * | 0.637 | | 8-#7+ 2 | 5 | #8 | #8 | 10-#9 | 7 | #5 | #6 | 13-#5 | 364 | 910 | 981 | 3.13 | 15 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| | 400 | 4.46 | 19 * | 0.632 | 4 S 6 1 | 7-#8+ 0 | 5 | #9 | #9 | 16-#8 | 7 | #6 | #7 | 13-#5 | 440 | 1145 | 1184 | 3.98 | 15 * | 4 S 6 2 | 5 | #7 | #8 | 12-#9 | 7 | #5 | #5 | 13-#5 |
| | 500 | 5.06 | 23 * | 0.628 | 4 S 6 1 | 11-#7+ 1 | 5 | #9 | #10 | 15-#9 | 7 | #6 | #7 | 15-#5 | 506 | 1287 | 1361 | 4.60 | 20 * | 4 S 6 2 | 5 | #8 | #8 | 14-#9 | 7 | #5 | #6 | 14-#5 |
| 32'-6" | 50 | 1.95 | 16 | 0.670 | | 10-#6+ 1 | 6 | #5 | #5 | 9-#7 | 7 | #4 | #4 | 13-#5 | 210 | 419 | 564 | 1.89 | 16 | | 6 | #4 | #4 | 9-#7 | 7 | #4 | #4 | 13-#5 |
| D = 13.000 | 100 | 2.26 | 16 | 0.771 | | 10-#6+ 3 | 6 | #5 | #6 | 9-#8 | 7 | #4 | #5 | 13-#5 | 261 | 522 | 702 | 2.13 | 16 | | 6 | #4 | #5 | 11-#7 | 7 | #4 | #4 | 13-#5 |
| RIB NOT ON | 150 | 2.67 | 16 * | 0.846 | | 10-#6+ 5 | 6 | #6 | #7 | 9-#9 | 7 | #5 | #5 | 13-#5 | 312 | 661 | 840 | 2.36 | 16 | | 6 | #5 | #5 | 10-#8 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 3.15 | 16 * | 0.904 | | 11-#6+ 6 | 6 | #7 | #7 | 10-#9 | 7 | #5 | #6 | 13-#5 | 363 | 834 | 979 | 2.89 | 16 * | 4 S 6 1 | 6 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| 0.924 CF/SF | 300 | 4.19 | 19 * | 0.632 | | 10-#7+ 3 | 6 | #8 | #9 | 13-#9 | 7 | #6 | #7 | 14-#5 | 462 | 1146 | 1245 | 3.67 | 16 * | 4 S 6 1 | 6 | #7 | #7 | 12-#9 | 7 | #5 | #5 | 13-#5 |
| | 400 | 4.95 | 24 * | 0.628 | | 9-#8+ 2 | 6 | #9 | #9 | 16-#9 | 7 | #7 | #7 | 17-#5 | 549 | 1335 | 1477 | 4.44 | 21 * | 4 S 6 2 | 6 | #7 | #8 | 15-#9 | 7 | #5 | #6 | 15-#5 |
| 35'-0" | 50 | 2.15 | 17 | 0.705 | | 15-#5+ 2 | 6 | #5 | #6 | 9-#8 | 8 | #4 | #4 | 15-#5 | 260 | 521 | 701 | 2.10 | 17 | | 6 | #4 | #5 | 11-#7 | 8 | #4 | #4 | 15-#5 |
| D = 13.000 | 100 | 2.60 | 17 * | 0.805 | | 15-#5+ 5 | 6 | #6 | #7 | 9-#9 | 8 | #4 | #5 | 15-#5 | 325 | 649 | 874 | 2.46 | 17 | | 6 | #5 | #5 | 9-#9 | 8 | #4 | #4 | 15-#5 |
| RIB NOT ON | 150 | 3.00 | 17 * | 0.891 | | 12-#6+ 6 | 6 | #7 | #7 | 11-#9 | 8 | #5 | #5 | 15-#5 | 389 | 807 | 1046 | 2.78 | 17 * | 4 S 6 1 | 6 | #6 | #6 | 10-#9 | 8 | #4 | #4 | 15-#5 |
| COLUMN LINE | 200 | 3.57 | 17 * | 0.634 | | 10-#7+ 3 | 6 | #8 | #8 | 16-#8 | 8 | #5 | #6 | 15-#5 | 453 | 1023 | 1219 | 3.25 | 17 * | 4 S 6 1 | 6 | #6 | #7 | 12-#9 | 8 | #4 | #5 | 15-#5 |
| 0.910 CF/SF | 300 | 4.70 | 24 * | 0.628 | | 10-#8+ 1 | 6 | #9 | #9 | 17-#9 | 8 | #6 | #7 | 17-#5 | 568 | 1351 | 1529 | 4.25 | 19 * | 4 S 6 2 | 6 | #7 | #8 | 15-#9 | 8 | #5 | #6 | 16-#5 |

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 in. | Rib Depth = 14 in. | Total Slab Depth = 4 in. | | | | | | | | | | | | | | | |
| 37'-6" | 50 | 2.40 | 18 | 0.747 | | 16-#5+ 3 | 6 | #6 | #7 | 9-#9 | 9 | #4 | #4 | 17-#5 | 319 | 638 | 859 |
| D = 13.000 | 100 | 2.78 | 18 * | 0.855 | | 12-#6+ 5 | 6 | #7 | #7 | 11-#9 | 9 | #4 | #5 | 17-#5 | 398 | 796 | 1072 |
| RIB NOT ON | 150 | 3.32 | 18 * | 0.633 | | 11-#7+ 3 | 6 | #7 | #8 | 14-#9 | 9 | #5 | #5 | 17-#5 | 477 | 965 | 1284 |
| COLUMN LINE | 200 | 4.04 | 22 * | 0.629 | | 9-#8+ 2 | 6 | #8 | #9 | 16-#9 | 9 | #6 | #6 | 17-#5 | 551 | 1221 | 1483 |
| 0.899 CF/SF | 300 | 4.89 | 29 * | 0.624 | 4 S 6 1 | 9-#9+ 2 | 6 | #9 | #10 | 20-#9 | 9 | #6 | #6 | 21-#5 | 686 | 1415 | 1846 |
| 40'-0" | 50 | 2.61 | 20 * | 0.813 | | 12-#6+ 7 | 7 | #6 | #7 | 11-#9 | 9 | #4 | #5 | 17-#5 | 389 | 779 | 1048 |
| D = 15.500 | 100 | 3.11 | 20 * | 0.895 | | 11-#7+ 6 | 7 | #7 | #7 | 14-#9 | 9 | #5 | #5 | 17-#5 | 485 | 970 | 1305 |
| RIB ON | 150 | 3.74 | 22 * | 0.629 | | 13-#7+ 4 | 7 | #8 | #8 | 17-#9 | 9 | #5 | #6 | 17-#5 | 578 | 1155 | 1555 |
| COLUMN LINE | 200 | 4.37 | 26 * | 0.626 | | 12-#8+ 2 | 7 | #8 | #9 | 19-#9 | 9 | #6 | #6 | 20-#5 | 667 | 1422 | 1795 |
| 0.919 CF/SF | | | | | | | | | | | | | | | | | |
| 42'-6" | 50 | 2.90 | 21 * | 0.842 | | 14-#6+ 7 | 7 | #7 | #7 | 13-#9 | 10 | #5 | #5 | 18-#5 | 465 | 930 | 1252 |
| D = 15.500 | 100 | 3.63 | 21 * | 0.630 | | 13-#7+ 4 | 7 | #8 | #8 | 17-#9 | 10 | #5 | #6 | 18-#5 | 580 | 1160 | 1561 |
| RIB ON | 150 | 4.30 | 26 * | 0.626 | | 12-#8+ 2 | 7 | #8 | #9 | 20-#9 | 10 | #6 | #6 | 21-#5 | 687 | 1374 | 1850 |
| COLUMN LINE | 200 | 4.78 | 32 * | 0.623 | 4 S 6 1 | 11-#9+ 2 | 7 | #9 | #9 | 23-#9 | 10 | #6 | #6 | 24-#5 | 784 | 1568 | 2111 |
| 0.908 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.14 | 22 * | 0.888 | | 12-#7+ 8 | 7 | #7 | #8 | 16-#9 | 11 | #5 | #5 | 20-#5 | 551 | 1101 | 1482 |
| D = 15.500 | 100 | 3.93 | 25 * | 0.627 | | 12-#8+ 2 | 7 | #8 | #9 | 20-#9 | 11 | #5 | #6 | 21-#5 | 683 | 1365 | 1838 |
| RIB ON | 150 | 4.64 | 31 * | 0.623 | 4 S 6 1 | 11-#9+ 3 | 7 | #9 | #9 | 24-#9 | 11 | #6 | #6 | 25-#5 | 807 | 1614 | 2172 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.899 CF/SF | | | | | | | | | | | | | | | | | |
| 47'-6" | 50 | 3.57 | 23 * | 0.924 | | 12-#8+ 8 | 8 | #7 | #8 | 19-#9 | 11 | #5 | #6 | 20-#5 | 653 | 1305 | 1757 |
| D = 18.000 | 100 | 4.39 | 30 * | 0.624 | | 14-#8+ 4 | 8 | #8 | #9 | 24-#9 | 11 | #6 | #6 | 24-#5 | 802 | 1605 | 2160 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.915 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 in. | Rib Depth = 14 in. | Total Slab Depth = 4 in. | | | | | | | | |
| 2.27 | 18 | | 6 | #5 | #5 | 10-#8 | 9 | #4 | #4 | 17-#5 |
| 2.59 | 18 | 4 S 6 1 | 6 | #5 | #6 | 10-#9 | 9 | #4 | #4 | 17-#5 |
| 3.09 | 18 * | 4 S 6 1 | 6 | #6 | #7 | 16-#8 | 9 | #4 | #4 | 17-#5 |
| 3.61 | 18 * | 4 S 6 2 | 6 | #7 | #7 | 15-#9 | 9 | #4 | #5 | 17-#5 |
| 4.46 | 24 * | 4 S 6 2 | 6 | #7 | #8 | 19-#9 | 9 | #5 | #5 | 20-#5 |
| 2.44 | 20 | | 7 | #5 | #5 | 13-#8 | 9 | #4 | #4 | 17-#5 |
| 2.89 | 20 * | 4 S 6 1 | 7 | #6 | #6 | 16-#8 | 9 | #4 | #4 | 17-#5 |
| 3.40 | 20 * | 4 S 6 1 | 7 | #6 | #7 | 15-#9 | 9 | #4 | #5 | 17-#5 |
| 4.02 | 20 * | 4 S 6 2 | 7 | #7 | #7 | 18-#9 | 9 | #5 | #5 | 19-#5 |
| 2.63 | 21 | | 7 | #5 | #6 | 12-#9 | 10 | #4 | #4 | 18-#5 |
| 3.29 | 21 * | 4 S 6 1 | 7 | #6 | #7 | 15-#9 | 10 | #4 | #5 | 18-#5 |
| 3.97 | 21 * | 4 S 6 2 | 7 | #7 | #7 | 19-#9 | 10 | #5 | #5 | 19-#5 |
| 4.46 | 25 * | 4 S 6 2 | 7 | #7 | #8 | 22-#9 | 10 | #5 | #5 | 22-#5 |
| 2.86 | 22 * | 4 S 6 1 | 7 | #6 | #6 | 18-#8 | 11 | #4 | #4 | 20-#5 |
| 3.58 | 22 * | 4 S 6 2 | 7 | #7 | #7 | 23-#8 | 11 | #4 | #5 | 20-#5 |
| 4.29 | 23 * | 4 S 6 2 | 7 | #7 | #8 | 28-#8 | 11 | #5 | #5 | 23-#5 |
| 3.31 | 23 * | 4 S 6 1 | 8 | #6 | #7 | 17-#9 | 11 | #4 | #5 | 20-#5 |
| 4.06 | 23 * | 4 S 6 1 | 8 | #7 | #7 | 22-#9 | 11 | #5 | #5 | 23-#5 |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 20 in. | | Rib Depth = 16 in. | | | Total Slab Depth = 4 in. | | | | | | | | | | | | |
| 27'-6" | 50 | 1.97 | 13 | 0.641 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 6 | #4 | #5 | 12-#5 | 136 | 273 | 367 |
| D = 10.500 | 100 | 1.99 | 13 | 0.641 | | 8-#6+ 0 | 5 | #4 | #5 | 9-#6 | 6 | #4 | #5 | 12-#5 | 167 | 335 | 451 |
| RIB ON | 150 | 2.20 | 13 | 0.641 | | 8-#6+ 0 | 5 | #5 | #6 | 8-#7 | 6 | #4 | #5 | 12-#5 | 199 | 428 | 535 |
| COLUMN LINE | 200 | 2.38 | 13 | 0.687 | | 8-#6+ 1 | 5 | #6 | #6 | 7-#8 | 6 | #4 | #5 | 12-#5 | 230 | 533 | 619 |
| 1.005 CF/SF | 300 | 2.85 | 13 * | 0.822 | | 8-#6+ 3 | 5 | #7 | #7 | 7-#9 | 6 | #5 | #5 | 12-#5 | 292 | 732 | 787 |
| | 400 | 3.59 | 13 * | 0.642 | | 9-#6+ 2 | 5 | #8 | #8 | 9-#9 | 6 | #6 | #6 | 12-#5 | 355 | 926 | 955 |
| | 500 | 4.13 | 13 * | 0.642 | 4 S 6 1 | 8-#7+ 2 | 5 | #8 | #9 | 10-#9 | 6 | #6 | #7 | 12-#5 | 417 | 1118 | 1123 |
| 30'-0" | 50 | 2.05 | 15 | 0.638 | | 9-#6+ 0 | 5 | #5 | #5 | 9-#6 | 7 | #4 | #5 | 13-#5 | 175 | 350 | 471 |
| D = 10 .500 | 100 | 2.21 | 15 | 0.638 | | 9-#6+ 0 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #5 | 13-#5 | 215 | 430 | 579 |
| RIB ON | 150 | 2.40 | 15 | 0.638 | | 9-#6+ 0 | 5 | #6 | #6 | 8-#8 | 7 | #4 | #5 | 13-#5 | 256 | 539 | 688 |
| COLUMN LINE | 200 | 2.61 | 15 | 0.718 | | 9-#6+ 1 | 5 | #6 | #7 | 7-#9 | 7 | #4 | #5 | 13-#5 | 296 | 676 | 796 |
| 0.989 CF/SF | 300 | 3.45 | 15 * | 0.857 | | 7-#7+ 2 | 5 | #8 | #8 | 9-#9 | 7 | #5 | #6 | 13-#5 | 376 | 933 | 1013 |
| | 400 | 4.13 | 15 * | 0.639 | 4 S 6 1 | 12-#6+ 1 | 5 | #9 | #9 | 12-#9 | 7 | #6 | #6 | 13-#5 | 457 | 1183 | 1230 |
| | 500 | 4.88 | 18 * | 0.635 | 4 S 6 1 | 8-#8+ 2 | 5 | #9 | #10 | 14-#9 | 7 | #6 | #7 | 14-#5 | 533 | 1417 | 1435 |
| 32'-6" | 50 | 2.09 | 16 | 0.637 | | 10-# 6+ 1 | 6 | #5 | #5 | 9-#7 | 7 | #4 | #5 | 13-#5 | 225 | 451 | 607 |
| D = 13.000 | 100 | 2.26 | 16 | 0.690 | | 10-#6+ 2 | 6 | #5 | #6 | 11-#7 | 7 | #4 | #5 | 13-#5 | 277 | 553 | 745 |
| RIB NOT ON | 150 | 2.49 | 16 | 0.780 | | 10-#6+ 4 | 6 | #6 | #6 | 10-#8 | 7 | #4 | #5 | 13-#5 | 328 | 685 | 883 |
| COLUMN LINE | 200 | 2.96 | 16 * | 0.847 | | 10-#6+ 6 | 6 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 13-#5 | 379 | 861 | 1021 |
| 1.017 CF/SF | 300 | 3.81 | 16 * | 0.638 | | 10-#7+ 3 | 6 | #8 | #8 | 12-#9 | 7 | #6 | #6 | 13-#5 | 482 | 1187 | 1297 |
| | 400 | 4.81 | 20 * | 0.633 | | 9-#8+ 1 | 6 | #9 | #9 | 15-#9 | 7 | #7 | #7 | 15-#5 | 578 | 1489 | 1556 |
| | 500 | 5.54 | 24 * | 0.630 | | 10-#8+ 1 | 6 | #9 | #10 | 17-#9 | 7 | #7 | #8 | 13-#6 | 663 | 1681 | 1785 |
| 35'-0" | 50 | 2.23 | 17 | 0.635 | | 15-#5+ 1 | 6 | #5 | #6 | 11-#7 | 8 | #4 | #5 | 15-#5 | 280 | 560 | 754 |
| D = 13.000 | 100 | 2.51 | 17 | 0.722 | | 15-#5+ 3 | 6 | #6 | #6 | 9-#9 | 8 | #4 | #5 | 15-#5 | 344 | 688 | 926 |
| RIB NOT ON | 150 | 2.92 | 17 * | 0.827 | | 11-#6+ 5 | 6 | #7 | #7 | 10-#9 | 8 | #5 | #5 | 15-#5 | 408 | 839 | 1099 |
| COLUMN LINE | 200 | 3.34 | 17 * | 0.886 | | 9-#7+ 4 | 6 | #7 | #8 | 12-#9 | 8 | #5 | #6 | 15-#5 | 472 | 1058 | 1272 |
| 1.002 CF/SF | 300 | 4.46 | 19 * | 0.634 | | 9-#8+ 2 | 6 | #9 | #9 | 15-#9 | 8 | #6 | #7 | 16-#5 | 598 | 1458 | 1609 |
| | 400 | 5.24 | 25 * | 0.629 | | 14-#7+ 2 | 6 | #9 | #10 | 18-#9 | 8 | #7 | #7 | 19-#5 | 707 | 1727 | 1903 |
| 37'-6" | 50 | 2.46 | 18 | 0.654 | | 16-#5+ 1 | 6 | #6 | #6 | 9-#9 | 9 | #4 | #5 | 17-#5 | 343 | 686 | 923 |
| D = 13.000 | 100 | 2.77 | 18 * | 0.789 | | 16-#5+ 6 | 6 | #7 | #7 | 10-#9 | 9 | #4 | #5 | 17-#5 | 422 | 844 | 1136 |
| RIB NOT ON | 150 | 3.23 | 18 * | 0.875 | | 10-#7+ 4 | 6 | #7 | #8 | 16-#8 | 9 | #5 | #5 | 17-#5 | 501 | 1007 | 1348 |
| COLUMN LINE | 200 | 3.85 | 18 * | 0.635 | | 9-#8+ 1 | 6 | #8 | #9 | 15-#9 | 9 | #5 | #6 | 17-#5 | 580 | 1279 | 1561 |
| 0.989 CF/SF | 300 | 5.00 | 24 * | 0.630 | | 11-#8+ 3 | 6 | #9 | #10 | 19-#9 | 9 | #6 | #7 | 19-#5 | 726 | 1726 | 1954 |
| | 400 | 5.60 | 30 * | 0.626 | 4 S 6 1 | 10-#9+ 1 | 6 | #10 | #10 | 28-#8 | 9 | #6 | #7 | 23-#5 | 854 | 1847 | 2299 |
| 40'-0" | 50 | 2.61 | 20 | 0.711 | | 12-#6+ 3 | 7 | #6 | #7 | 13-#8 | 9 | #4 | #5 | 17-#5 | 418 | 837 | 1127 |
| D = 15.500 | 100 | 3.03 | 20 * | 0.843 | | 14-#6+ 7 | 7 | #7 | #7 | 16-#8 | 9 | #5 | #5 | 17-#5 | 514 | 1028 | 1384 |
| RIB ON | 150 | 3.46 | 20 * | 0.909 | | 12-#7+ 6 | 7 | #7 | #8 | 15-#9 | 9 | #5 | #6 | 17-#5 | 609 | 1219 | 1641 |
| COLUMN LINE | 200 | 4.25 | 22 * | 0.631 | | 14-#7+ 4 | 7 | #8 | #9 | 18-#9 | 9 | #6 | #6 | 19-#5 | 702 | 1499 | 1890 |
| 1.012 CF/SF | 300 | 5.22 | 29 * | 0.626 | 4 S 6 1 | 13-#8+ 2 | 7 | #9 | #10 | 23-#9 | 9 | #6 | #7 | 17-#6 | 870 | 1870 | 2343 |
| 42'-6" | 50 | 2.84 | 21 * | 0.774 | | 19-#5+ 7 | 7 | #7 | #7 | 12-#9 | 10 | #4 | #5 | 18-#5 | 500 | 1000 | 1346 |
| D = 15.500 | 100 | 3.28 | 21 * | 0.881 | | 12-#7+ 6 | 7 | #7 | #8 | 16-#9 | 10 | #5 | #5 | 18-#5 | 615 | 1229 | 1655 |
| RIB ON | 150 | 3.86 | 22 * | 0.631 | | 11-#8+ 3 | 7 | #8 | #8 | 19-#9 | 10 | #5 | #6 | 19-#5 | 728 | 1455 | 1959 |
| COLUMN LINE | 200 | 4.61 | 26 * | 0.628 | | 13-#8+ 2 | 7 | #9 | #9 | 22-#9 | 10 | #6 | #6 | 22-#5 | 835 | 1738 | 2248 |
| 1.000 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.19 | 22 * | 0.832 | | 12-#7+ 5 | 7 | #7 | #8 | 15-#9 | 11 | #5 | #5 | 20-#5 | 592 | 1183 | 1593 |
| D = 15.500 | 100 | 3.75 | 22 * | 0.918 | | 11-#8+ 6 | 7 | #8 | #8 | 19-#9 | 11 | #5 | #6 | 20-#5 | 728 | 1456 | 1960 |
| RIB ON | 150 | 4.51 | 26 * | 0.628 | | 13-#8+ 2 | 7 | #9 | #9 | 22-#9 | 11 | #6 | #6 | 23-#5 | 857 | 1715 | 2308 |
| COLUMN LINE | 200 | 5.13 | 31 * | 0.625 | 4 S 6 1 | 12-#9+ 2 | 7 | #9 | #10 | 26-#9 | 11 | #6 | #7 | 27-#5 | 979 | 1957 | 2635 |
| 0.989 CF/SF | | | | | | | | | | | | | | | | | |
| 47'-6" | 50 | 3.40 | 23 * | 0.882 | | 14-#7+ 8 | 8 | #7 | #8 | 18-#9 | 11 | #5 | #6 | 20-#5 | 702 | 1403 | 1889 |
| D = 18.000 | 100 | 4.28 | 26 * | 0.919 | | 13-#8+ 8 | 8 | #8 | #9 | 22-#9 | 11 | #6 | #6 | 23-#5 | 857 | 1714 | 2308 |
| RIB NOT ON | 150 | 4.92 | 31 * | 0.625 | | 12-#9+ 2 | 8 | #9 | #9 | 26-#9 | 11 | #6 | #7 | 27-#5 | 1005 | 2010 | 2706 |
| COLUMN LINE | 200 | 5.51 | 38 * | 0.622 | | 14-#9+ 3 | 8 | #9 | #10 | 30-#9 | 11 | #6 | #7 | 22-#6 | 1130 | 2260 | 3042 |
| 1.008 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 20 in. | | | Rib Depth = 16 in. | | | | Total Slab Depth = 4 in. | | | |
| 1.98 | 13 | | 5 | #4 | #5 | 8-#6 | 6 | #4 | #5 | 12-#5 |
| 1.98 | 13 | | 5 | #4 | #5 | 8-#6 | 6 | #4 | #5 | 12-#5 |
| 2.09 | 13 | | 5 | #4 | #5 | 7-#7 | 6 | #4 | #5 | 12-#5 |
| 2.26 | 13 | | 5 | #5 | #5 | 8-#7 | 6 | #4 | #5 | 12-#5 |
| 2.58 | 13 | 4 S 6 1 | 5 | #5 | #6 | 8-#8 | 6 | #4 | #5 | 12-#5 |
| 3.09 | 13 * | 4 S 6 1 | 5 | #6 | #7 | 8-#9 | 6 | #4 | #5 | 12-#5 |
| 3.60 | 13 * | 4 S 6 1 | 5 | #7 | #7 | 12-#8 | 6 | #5 | #5 | 12-#5 |
| 2.01 | 15 | | 5 | #4 | #5 | 9-#6 | 7 | #4 | #5 | 13-#5 |
| 2.10 | 15 | | 5 | #4 | #5 | 8-#7 | 7 | #4 | #5 | 13-#5 |
| 2.30 | 15 | | 5 | #5 | #5 | 7-#8 | 7 | #4 | #5 | 13-#5 |
| 2.50 | 15 | 4 S 6 1 | 5 | #5 | #6 | 8-#8 | 7 | #4 | #5 | 13-#5 |
| 3.13 | 15 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| 3.59 | 15 * | 4 S 6 2 | 5 | #7 | #7 | 13-#8 | 7 | #5 | #5 | 13-#5 |
| 4.36 | 15 * | 4 S 6 2 | 5 | #8 | #8 | 16-#8 | 7 | #5 | #6 | 13-#5 |
| 2.04 | 16 | | 6 | #4 | #5 | 11-#6 | 7 | #4 | #5 | 13-#5 |
| 2.16 | 16 | | 6 | #4 | #5 | 10-#7 | 7 | #4 | #5 | 13-#5 |
| 2.40 | 16 | | 6 | #5 | #5 | 9-#8 | 7 | #4 | #5 | 13-#5 |
| 2.76 | 16 | | 6 | #5 | #6 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| 3.43 | 16 * | 4 S 6 1 | 6 | #6 | #7 | 11-#9 | 7 | #5 | #5 | 13-#5 |
| 4.24 | 16 * | 4 S 6 2 | 6 | #7 | #8 | 14-#9 | 7 | #5 | #6 | 14-#5 |
| 4.96 | 21 * | 4 S 6 2 | 6 | #8 | #8 | 16-#9 | 7 | #6 | #6 | 17-#5 |
| 2.14 | 17 | | 6 | #4 | #5 | 10-#7 | 8 | #4 | #5 | 15-#5 |
| 2.43 | 17 | | 6 | #5 | #5 | 10-#8 | 8 | #4 | #5 | 15-#5 |
| 2.70 | 17 | 4 S 6 1 | 6 | #5 | #6 | 9-#9 | 8 | #4 | #5 | 15-#5 |
| 3.03 | 17 * | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 8 | #4 | #5 | 15-#5 |
| 3.94 | 17 * | 4 S 6 2 | 6 | #7 | #8 | 14-#9 | 8 | #5 | #5 | 15-#5 |
| 4.69 | 21 * | 4 S 6 2 | 6 | #8 | #8 | 17-#9 | 8 | #5 | #6 | 18-#5 |
| 2.39 | 18 | | 6 | #5 | #5 | 10-#8 | 9 | #4 | #5 | 17-#5 |
| 2.66 | 18 | | 6 | #5 | #6 | 12-#8 | 9 | #4 | #5 | 17-#5 |
| 3.03 | 18 * | 4 S 6 1 | 6 | #6 | #6 | 12-#9 | 9 | #4 | #5 | 17-#5 |
| 3.49 | 18 * | 4 S 6 1 | 6 | #7 | #7 | 14-#9 | 9 | #4 | #5 | 17-#5 |
| 4.57 | 19 * | 4 S 6 2 | 6 | #8 | #8 | 18-#9 | 9 | #5 | #6 | 18-#5 |
| 5.24 | 26 * | 4 S 6 2 | 6 | #8 | #9 | 21-#9 | 9 | #5 | #6 | 22-#5 |
| 2.47 | 20 | | 7 | #5 | #5 | 12-#8 | 9 | #4 | #5 | 17-#5 |
| 2.83 | 20 | | 7 | #5 | #6 | 12-#9 | 9 | #4 | #5 | 17-#5 |
| 3.14 | 20 * | 4 S 6 1 | 7 | #6 | #6 | 14-#9 | 9 | #4 | #5 | 17-#5 |
| 3.90 | 20 * | 4 S 6 1 | 7 | #7 | #7 | 17-#9 | 9 | #5 | #5 | 17-#5 |
| 4.72 | 24 * | 4 S 6 2 | 7 | #7 | #8 | 21-#9 | 9 | #5 | #6 | 22-#5 |
| 2.75 | 21 | | 7 | #5 | #6 | 12-#9 | 10 | #4 | #5 | 18-#5 |
| 3.04 | 21 * | 4 S 6 1 | 7 | #6 | #6 | 14-#9 | 10 | #4 | #5 | 18-#5 |
| 3.59 | 21 * | 4 S 6 1 | 7 | #7 | #7 | 17-#9 | 10 | #4 | #5 | 18-#5 |
| 4.24 | 21 * | 4 S 6 2 | 7 | #7 | #8 | 20-#9 | 10 | #5 | #5 | 21-#5 |
| 2.98 | 22 | 4 S 6 1 | 7 | #6 | #6 | 14-#9 | 11 | #4 | #5 | 20-#5 |
| 3.50 | 22 * | 4 S 6 1 | 7 | #7 | #7 | 17-#9 | 11 | #4 | #5 | 20-#5 |
| 4.18 | 22 * | 4 S 6 2 | 7 | #7 | #8 | 21-#9 | 11 | #5 | #5 | 21-#5 |
| 4.66 | 24 * | 4 S 6 2 | 7 | #8 | #8 | 24-#9 | 11 | #5 | #5 | 25-#5 |
| 3.07 | 23 * | | 8 | #6 | #6 | 16-#9 | 11 | #4 | #5 | 20-#5 |
| 3.95 | 23 * | 4 S 6 1 | 8 | #7 | #7 | 21-#9 | 11 | #5 | #5 | 21-#5 |
| 4.53 | 24 * | 4 S 6 2 | 8 | #7 | #8 | 25-#9 | 11 | #5 | #5 | 26-#5 |
| 5.15 | 32 * | 4 S 6 2 | 8 | #8 | #8 | 28-#9 | 11 | #5 | #6 | 20-#6 |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 24 in. | Rib Depth = 20 in. | | Total Slab Depth = 4 in. | | | | | | | | | | | | | | |
| 32'-6" | 50 | 2.27 | 16 | 0.640 | | 10-#6+ 0 | 6 | #5 | #5 | 11-#6 | 7 | #5 | #5 | 13-#5 | 258 | 516 | 695 |
| D = 13.000 | 100 | 2.35 | 16 | 0.640 | | 10-#6+ 0 | 6 | #5 | #5 | 10-#7 | 7 | #5 | #5 | 13-#5 | 309 | 619 | 833 |
| RIB NOT ON | 150 | 2.53 | 16 | 0.640 | | 10-#6+ 0 | 6 | #5 | #6 | 9-#8 | 7 | #5 | #5 | 13-#5 | 361 | 728 | 971 |
| COLUMN LINE | 200 | 2.77 | 16 | 0.640 | | 10-#6+ 1 | 6 | #6 | #7 | 10-#8 | 7 | #5 | #5 | 13-#5 | 412 | 908 | 1109 |
| 1.212 CF/SF | 300 | 3.34 | 16 * | 0.789 | | 11-#6+ 3 | 6 | #7 | #8 | 10-#9 | 7 | #5 | #6 | 13-#5 | 515 | 1244 | 1386 |
| | 400 | 4.17 | 16 * | 0.641 | | 10-#7+ 1 | 6 | #8 | #9 | 16-#8 | 7 | #6 | #7 | 13-#5 | 617 | 1566 | 1662 |
| | 500 | 4.83 | 16 * | 0.641 | | 9-#8+ 1 | 6 | #9 | #9 | 15-#9 | 7 | #7 | #7 | 16-#5 | 720 | 1884 | 1938 |
| 35'-0" | 50 | 2.43 | 17 | 0.639 | | 15-#5+ 0 | 6 | #5 | #6 | 14-#6 | 8 | #5 | #5 | 15-#5 | 321 | 641 | 863 |
| D = 13.000 | 100 | 2.61 | 17 | 0.639 | | 15-#5+ 0 | 6 | #6 | #6 | 10-#8 | 8 | #5 | #5 | 15-#5 | 385 | 770 | 1036 |
| RIB NOT ON | 150 | 2.83 | 17 | 0.639 | | 15-#5+ 1 | 6 | #6 | #7 | 9-#9 | 8 | #5 | #5 | 15-#5 | 449 | 898 | 1209 |
| COLUMN LINE | 200 | 3.07 | 17 | 0.711 | | 11-#6+ 2 | 6 | #7 | #7 | 10-#9 | 8 | #5 | #5 | 15-#5 | 513 | 1119 | 1381 |
| 1.193 CF/SF | 300 | 3.97 | 17 * | 0.877 | | 10-#7+ 4 | 6 | #8 | #9 | 13-#9 | 8 | #6 | #6 | 15-#5 | 641 | 1539 | 1727 |
| | 400 | 4.79 | 17 * | 0.640 | | 17-#6+ 3 | 6 | #9 | #10 | 16-#9 | 8 | #6 | #7 | 17-#5 | 770 | 1942 | 2072 |
| | 500 | 5.63 | 20 * | 0.637 | | 11-#8+ 1 | 6 | #10 | #10 | 19-#9 | 8 | #7 | #7 | 20-#5 | 891 | 2321 | 2399 |
| 37'-6" | 50 | 2.58 | 18 | 0.638 | | 16-#5+ 0 | 6 | #6 | #6 | 10-#8 | 9 | #5 | #5 | 17-#5 | 393 | 785 | 1057 |
| D = 13.000 | 100 | 2.84 | 18 | 0.638 | | 16-#5+ 0 | 6 | #6 | #7 | 9-#9 | 9 | #5 | #5 | 17-#5 | 472 | 943 | 1270 |
| RIB NOT ON | 150 | 3.02 | 18 | 0.743 | | 12-#6+ 4 | 6 | #7 | #7 | 11-#9 | 9 | #5 | #5 | 17-#5 | 551 | 1101 | 1482 |
| COLUMN LINE | 200 | 3.47 | 18 * | 0.814 | | 10-#7+ 3 | 6 | #8 | #8 | 16-#8 | 9 | #5 | #5 | 17-#5 | 630 | 1358 | 1695 |
| 1.177 CF/SF | 300 | 4.34 | 18 * | 0.639 | | 10-#8+ 1 | 6 | #9 | #9 | 16-#9 | 9 | #6 | #6 | 17-#5 | 788 | 1875 | 2120 |
| | 400 | 5.42 | 21 * | 0.636 | | 9-#9+ 2 | 6 | #10 | #10 | 20-#9 | 9 | #7 | #7 | 21-#5 | 939 | 2352 | 2528 |
| 40'-0" | 50 | 2.64 | 20 | 0.636 | | 12-#6+ 2 | 7 | #6 | #6 | 12-#8 | 9 | #5 | #5 | 17-#5 | 479 | 959 | 1291 |
| D = 15.500 | 100 | 2.96 | 20 | 0.689 | | 18-#5+ 5 | 7 | #6 | #7 | 12-#9 | 9 | #5 | #5 | 17-#5 | 575 | 1150 | 1548 |
| RIB ON | 150 | 3.25 | 20 * | 0.813 | | 11-#7+ 5 | 7 | #7 | #7 | 14-#9 | 9 | #5 | #5 | 17-#5 | 670 | 1341 | 1805 |
| COLUMN LINE | 200 | 3.74 | 20 * | 0.871 | | 17-#6+ 7 | 7 | #8 | #8 | 16-#9 | 9 | #5 | #6 | 17-#5 | 766 | 1613 | 2062 |
| 1.205 CF/SF | 300 | 4.77 | 20 * | 0.637 | | 12-#8+ 2 | 7 | #9 | #9 | 20-#9 | 9 | #6 | #7 | 21-#5 | 957 | 2239 | 2577 |
| | 400 | 5.98 | 26 * | 0.632 | 5 S 8 1 | 11-#9+ 3 | 7 | #10 | #10 | 24-#9 | 9 | #7 | #8 | 18-#6 | 1128 | 2726 | 3036 |
| 42'-6" | 50 | 2.90 | 21 | 0.635 | | 13-#6+ 2 | 7 | #6 | #7 | 12-#9 | 10 | #5 | #5 | 18-#5 | 573 | 1145 | 1542 |
| D = 15.500 | 100 | 3.16 | 21 * | 0.784 | | 11-#7+ 5 | 7 | #7 | #7 | 14-#9 | 10 | #5 | #5 | 18-#5 | 687 | 1375 | 1850 |
| RIB ON | 150 | 3.72 | 21 * | 0.854 | | 13-#7+ 5 | 7 | #8 | #8 | 17-#9 | 10 | #5 | #6 | 18-#5 | 802 | 1604 | 2159 |
| COLUMN LINE | 200 | 4.20 | 21 * | 0.636 | | 11-#8+ 3 | 7 | #8 | #9 | 19-#9 | 10 | #6 | #6 | 20-#5 | 917 | 1894 | 2468 |
| 1.190 CF/SF | 300 | 5.46 | 25 * | 0.633 | 5 S 8 1 | 11-#9+ 3 | 7 | #10 | #10 | 24-#9 | 10 | #7 | #7 | 18-#6 | 1136 | 2623 | 3060 |
| 45'-0" | 50 | 3.10 | 22 | 0.727 | | 11-#7+ 4 | 7 | #7 | #7 | 14-#9 | 11 | #5 | #5 | 20-#5 | 677 | 1355 | 1824 |
| D = 15.500 | 100 | 3.57 | 22 * | 0.824 | | 13-#7+ 5 | 7 | #8 | #8 | 17-#9 | 11 | #5 | #5 | 20-#5 | 814 | 1627 | 2191 |
| RIB ON | 150 | 4.01 | 22 * | 0.906 | | 12-#8+ 6 | 7 | #8 | #9 | 20-#9 | 11 | #5 | #6 | 21-#5 | 950 | 1900 | 2558 |
| COLUMN LINE | 200 | 4.58 | 22 * | 0.635 | | 11-#9+ 3 | 7 | #9 | #9 | 23-#9 | 11 | #6 | #6 | 24-#5 | 1086 | 2193 | 2925 |
| 1.177 CF/SF | | | | | | | | | | | | | | | | | |
| 47'-6" | 50 | 3.34 | 23 * | 0.796 | | 13-#7+ 6 | 8 | #7 | #8 | 17-#9 | 11 | #5 | #5 | 20-#5 | 804 | 1608 | 2164 |
| D = 18.000 | 100 | 3.80 | 23 * | 0.881 | | 12-#8+ 6 | 8 | #8 | #8 | 20-#9 | 11 | #5 | #6 | 21-#5 | 964 | 1928 | 2596 |
| RIB NOT ON | 150 | 4.40 | 23 * | 0.634 | | 14-#8+ 4 | 8 | #8 | #9 | 24-#9 | 11 | #6 | #6 | 25-#5 | 1125 | 2249 | 3028 |
| COLUMN LINE | 200 | 5.03 | 27 * | 0.631 | | 16-#8+ 3 | 8 | #9 | #9 | 27-#9 | 11 | #6 | #7 | 20-#6 | 1275 | 2551 | 3434 |
| 1.200 CF/SF | 300 | 6.26 | 36 * | 0.626 | | 16-#9+ 3 | 8 | #10 | #10 | 33-#9 | 11 | #7 | #7 | 24-#6 | 1546 | 3092 | 4162 |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 24 in. | Rib Depth = 20 in. | Total Slab Depth = 4 in. | | | | | | | | |
| 2.27 | 16 | | 6 | #5 | #5 | 15-#5 | 7 | #5 | #5 | 13-#5 |
| 2.37 | 16 | | 6 | #5 | #5 | 9-#7 | 7 | #5 | #5 | 13-#5 |
| 2.51 | 16 | | 6 | #5 | #5 | 11-#7 | 7 | #5 | #5 | 13-#5 |
| 2.64 | 16 | | 6 | #5 | #5 | 10-#8 | 7 | #5 | #5 | 13-#5 |
| 3.07 | 16 | 5 S 8 1 | 6 | #6 | #6 | 12-#8 | 7 | #5 | #5 | 13-#5 |
| 3.67 | 16 * | 5 S 8 1 | 6 | #7 | #7 | 12-#9 | 7 | #5 | #5 | 13-#5 |
| 4.24 | 16 * | 5 S 8 2 | 6 | #7 | #8 | 14-#9 | 7 | #5 | #6 | 14-#5 |
| 2.41 | 17 | | 6 | #5 | #5 | 10-#7 | 8 | #5 | #5 | 15-#5 |
| 2.54 | 17 | | 6 | #5 | #5 | 9-#8 | 8 | #5 | #5 | 15-#5 |
| 2.75 | 17 | | 6 | #5 | #5 | 9-#9 | 8 | #5 | #5 | 15-#5 |
| 3.01 | 17 | | 6 | #6 | #6 | 12-#8 | 8 | #5 | #5 | 15-#5 |
| 3.56 | 17 * | 5 S 8 1 | 6 | #7 | #7 | 12-#9 | 8 | #5 | #5 | 15-#5 |
| 4.21 | 17 * | 5 S 8 2 | 6 | #7 | #8 | 15-#9 | 8 | #5 | #6 | 15-#5 |
| 5.09 | 17 * | 5 S 8 2 | 6 | #8 | #9 | 17-#9 | 8 | #6 | #6 | 18-#5 |
| 2.52 | 18 | | 6 | #5 | #5 | 9-#8 | 9 | #5 | #5 | 17-#5 |
| 2.82 | 18 | | 6 | #5 | #6 | 9-#9 | 9 | #5 | #5 | 17-#5 |
| 2.90 | 18 | 5 S 8 1 | 6 | #5 | #6 | 10-#9 | 9 | #5 | #5 | 17-#5 |
| 3.34 | 18 | 5 S 8 1 | 6 | #6 | #7 | 12-#9 | 9 | #5 | #5 | 17-#5 |
| 3.96 | 18 * | 5 S 8 2 | 6 | #7 | #8 | 15-#9 | 9 | #5 | #5 | 17-#5 |
| 4.79 | 18 * | 5 S 8 2 | 6 | #8 | #9 | 18-#9 | 9 | #5 | #6 | 19-#5 |
| 2.59 | 20 | | 7 | #5 | #5 | 11-#8 | 9 | #5 | #5 | 17-#5 |
| 2.93 | 20 | | 7 | #5 | #6 | 11-#9 | 9 | #5 | #5 | 17-#5 |
| 3.18 | 20 | | 7 | #6 | #6 | 16-#8 | 9 | #5 | #5 | 17-#5 |
| 3.47 | 20 * | 5 S 8 1 | 7 | #6 | #7 | 18-#8 | 9 | #5 | #5 | 17-#5 |
| 4.33 | 20 * | 5 S 8 2 | 7 | #7 | #8 | 18-#9 | 9 | #5 | #6 | 19-#5 |
| 5.37 | 22 * | 5 S 8 2 | 7 | #8 | #9 | 22-#9 | 9 | #6 | #6 | 23-#5 |
| 2.86 | 21 | | 7 | #5 | #6 | 11-#9 | 10 | #5 | #5 | 18-#5 |
| 3.10 | 21 | | 7 | #6 | #6 | 16-#8 | 10 | #5 | #5 | 18-#5 |
| 3.46 | 21 * | 5 S 8 1 | 7 | #6 | #7 | 15-#9 | 10 | #5 | #5 | 18-#5 |
| 3.84 | 21 * | 5 S 8 1 | 7 | #7 | #7 | 18-#9 | 10 | #5 | #5 | 18-#5 |
| 4.77 | 21 * | 5 S 8 2 | 7 | #8 | #8 | 22-#9 | 10 | #5 | #6 | 23-#5 |
| 3.05 | 22 | | 7 | #6 | #6 | 16-#8 | 11 | #5 | #5 | 20-#5 |
| 3.46 | 22 | 5 S 8 1 | 7 | #6 | #7 | 16-#9 | 11 | #5 | #5 | 20-#5 |
| 3.75 | 22 * | 5 S 8 1 | 7 | #7 | #7 | 18-#9 | 11 | #5 | #5 | 20-#5 |
| 4.21 | 22 * | 5 S 8 2 | 7 | #7 | #8 | 21-#9 | 11 | #5 | #5 | 22-#5 |
| 3.19 | 23 | | 8 | #6 | #6 | 15-#9 | 11 | #5 | #5 | 20-#5 |
| 3.56 | 23 * | 5 S 8 1 | 8 | #6 | #7 | 23-#8 | 11 | #5 | #5 | 20-#5 |
| 4.06 | 23 * | 5 S 8 1 | 8 | #7 | #7 | 22-#9 | 11 | #5 | #5 | 23-#5 |
| 4.68 | 23 * | 5 S 8 2 | 8 | #7 | #8 | 25-#9 | 11 | #5 | #6 | 26-#5 |
| 5.89 | 30 * | 5 S 8 2 | 8 | #8 | #9 | 31-#9 | 11 | #6 | #6 | 23-#6 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 12 ½ in. | | Rib Depth = 8 in. | | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | |
| 17'-6" | 50 | 1.71 | 12 | 0.632 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 | 26 | 53 | 71 |
| D = 8.000 | 100 | 1.71 | 12 | 0.632 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 | 34 | 70 | 92 |
| RIB NOT ON | 150 | 1.71 | 12 | 0.632 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 | 42 | 96 | 112 |
| COLUMN LINE | 200 | 1.71 | 12 | 0.632 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 | 50 | 121 | 133 |
| 0.712 CF/SF | 300 | 1.95 | 12 | 0.745 | | 7-#5+ 1 | 4 | #5 | #5 | 8-#5 | 3 | #4 | #5 | 7-#5 | 65 | 169 | 175 |
| | 400 | 2.29 | 12 * | 0.838 | | 7-#5+ 2 | 4 | #5 | #6 | 7-#6 | 3 | #5 | #5 | 7-#5 | 80 | 216 | 217 |
| | 500 | 2.65 | 12 * | 0.633 | | 7-#5+ 2 | 4 | #6 | #6 | 9-#6 | 3 | #5 | #6 | 7-#5 | 96 | 262 | 258 |
| 20'-0" | 50 | 1.73 | 12 | 0.632 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 39 | 79 | 106 |
| D = 8.000 | 100 | 1.73 | 12 | 0.668 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 51 | 104 | 138 |
| RIB NOT ON | 150 | 1.80 | 12 | 0.713 | | 6-#6+ 0 | 4 | #4 | #5 | 6-#6 | 4 | #4 | #4 | 8-#5 | 63 | 144 | 169 |
| COLUMN LINE | 200 | 1.89 | 12 | 0.758 | | 6-#6+ 0 | 4 | #5 | #5 | 7-#6 | 4 | #4 | #4 | 8-#5 | 75 | 181 | 201 |
| 0.695 CF/SF | 300 | 2.43 | 12 * | 0.869 | | 6-#6+ 1 | 4 | #6 | #6 | 9-#6 | 4 | #5 | #5 | 8-#5 | 98 | 254 | 264 |
| | 400 | 2.97 | 12 * | 0.633 | | 6-#6+ 0 | 4 | #7 | #7 | 6-#8 | 4 | #5 | #6 | 8-#5 | 122 | 326 | 327 |
| | 500 | 3.48 | 15 * | 0.629 | | 6-#6+ 1 | 4 | #7 | #8 | 6-#9 | 4 | #6 | #6 | 8-#5 | 142 | 386 | 384 |
| 22'-6" | 50 | 1.79 | 12 | 0.712 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 | 56 | 113 | 152 |
| D = 8.000 | 100 | 1.85 | 12 | 0.760 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 73 | 149 | 198 |
| RIB NOT ON | 150 | 2.09 | 12 | 0.809 | | 10-#5+ 0 | 4 | #5 | #6 | 6-#7 | 5 | #4 | #4 | 10-#5 | 90 | 207 | 243 |
| COLUMN LINE | 200 | 2.35 | 12 * | 0.870 | | 10-#5+ 1 | 4 | #6 | #6 | 7-#7 | 5 | #4 | #5 | 10-#5 | 107 | 260 | 289 |
| 0.683 CF/SF | 300 | 3.01 | 13 * | 0.631 | | 10-#5+ 1 | 4 | #7 | #7 | 6-#9 | 5 | #5 | #5 | 10-#5 | 140 | 363 | 378 |
| | 400 | 3.67 | 17 * | 0.627 | | 6-#7+ 0 | 4 | #8 | #8 | 7-#9 | 5 | #6 | #6 | 10-#5 | 170 | 446 | 458 |
| 25'-0" | 50 | 1.75 | 12 | 0.780 | | 8-#6+ 0 | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 | 79 | 158 | 213 |
| D = 10.500 | 100 | 1.95 | 12 * | 0.851 | | 8-#6+ 1 | 5 | #5 | #5 | 7-#7 | 5 | #4 | #4 | 10-#5 | 102 | 209 | 276 |
| RIB ON | 150 | 2.26 | 12 * | 0.907 | | 8-#6+ 2 | 5 | #5 | #6 | 7-#8 | 5 | #4 | #5 | 10-#5 | 126 | 289 | 339 |
| COLUMN LINE | 200 | 2.65 | 13 * | 0.631 | | 8-#6+ 1 | 5 | #6 | #7 | 8-#8 | 5 | #5 | #5 | 10-#5 | 149 | 362 | 400 |
| 0.703 CF/SF | 300 | 3.54 | 18 * | 0.626 | | 12-#5+ 3 | 5 | #7 | #8 | 8-#9 | 5 | #6 | #6 | 10-#5 | 190 | 474 | 511 |
| 27'-6" | 50 | 1.91 | 13 | 0.788 | | 8-#6+ 0 | 5 | #5 | #5 | 7-#7 | 6 | #4 | #4 | 12-#5 | 105 | 209 | 282 |
| D = 10.500 | 100 | 2.19 | 13 * | 0.882 | | 8-#6+ 2 | 5 | #5 | #6 | 7-#8 | 6 | #4 | #4 | 12-#5 | 136 | 272 | 366 |
| RIB ON | 150 | 2.71 | 14 * | 0.630 | | 8-#6+ 2 | 5 | #6 | #7 | 7-#9 | 6 | #5 | #5 | 12-#5 | 167 | 376 | 448 |
| COLUMN LINE | 200 | 3.26 | 17 * | 0.627 | | 9-#6+ 3 | 5 | #7 | #8 | 8-#9 | 6 | #5 | #6 | 12-#5 | 196 | 469 | 527 |
| 0.692 CF/SF | | | | | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.13 | 15 * | 0.846 | | 9-#6+ 3 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 13-#5 | 135 | 269 | 363 |
| D = 10.500 | 100 | 2.52 | 15 * | 0.916 | | 9-#6+ 5 | 5 | #6 | #7 | 7-#9 | 7 | #4 | #5 | 13-#5 | 175 | 350 | 471 |
| RIB ON | 150 | 3.02 | 18 * | 0.626 | | 7-#7+ 2 | 5 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 13-#5 | 213 | 457 | 574 |
| COLUMN LINE | 200 | 3.32 | 23 * | 0.622 | 3 S 4 1 | 8-#7+ 2 | 5 | #7 | #8 | 11-#9 | 7 | #5 | #5 | 13-#5 | 247 | 508 | 666 |
| 0.683 CF/SF | | | | | | | | | | | | | | | | | |
| 32'-6" | 50 | 2.26 | 16 * | 0.879 | | 10-#6+ 4 | 6 | #5 | #6 | 9-#8 | 7 | #4 | #5 | 13-#5 | 173 | 346 | 465 |
| D = 13.000 | 100 | 2.82 | 18 * | 0.921 | | 10-#6+ 7 | 6 | #6 | #7 | 12-#8 | 7 | #5 | #5 | 13-#5 | 223 | 446 | 600 |
| RIB NOT ON | 150 | 3.33 | 25 * | 0.620 | | 12-#6+ 5 | 6 | #7 | #7 | 12-#9 | 7 | #5 | #6 | 13-#5 | 267 | 534 | 719 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.698 CF/SF | | | | | | | | | | | | | | | | | |
| 35'-0" | 50 | 2.60 | 17 * | 0.911 | | 15-#5+ 9 | 6 | #6 | #7 | 9-#9 | 8 | #4 | #5 | 15-#5 | 215 | 430 | 579 |
| D = 13.000 | 100 | 3.09 | 24 * | 0.621 | | 9-#7+ 4 | 6 | #7 | #7 | 12-#9 | 8 | #5 | #5 | 15-#5 | 274 | 549 | 739 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.690 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 12 ½ in. | | | Rib Depth = 8 in. | | | | Total Slab Depth = 4 ½ in. | | | |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.78 | 12 | | 4 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 7-#5 |
| 2.07 | 12 | 3 S 4 1 | 4 | #4 | #5 | 7-#6 | 3 | #4 | #4 | 7-#5 |
| 2.38 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 6-#7 | 3 | #4 | #5 | 7-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 2.16 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 6-#7 | 4 | #4 | #4 | 8-#5 |
| 2.61 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 6-#8 | 4 | #4 | #5 | 8-#5 |
| 3.08 | 13 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 4 | #5 | #5 | 8-#5 |
| 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 2.00 | 12 | | 4 | #4 | #5 | 6-#7 | 5 | #4 | #4 | 10-#5 |
| 2.18 | 12 | 3 S 4 1 | 4 | #5 | #5 | 9-#6 | 5 | #4 | #4 | 10-#5 |
| 2.83 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 5 | #4 | #5 | 10-#5 |
| 3.20 | 14 * | 3 S 4 2 | 4 | #6 | #7 | 11-#7 | 5 | #4 | #5 | 10-#5 |
| 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| 1.85 | 12 | | 5 | #4 | #4 | 9-#6 | 5 | #4 | #4 | 10-#5 |
| 2.08 | 12 * | | 5 | #4 | #5 | 8-#7 | 5 | #4 | #4 | 10-#5 |
| 2.32 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 7-#8 | 5 | #4 | #4 | 10-#5 |
| 3.21 | 15 * | 3 S 4 1 | 5 | #6 | #6 | 8-#9 | 5 | #5 | #5 | 10-#5 |
| 1.84 | 13 | | 5 | #4 | #4 | 9-#6 | 6 | #4 | #4 | 12-#5 |
| 2.16 | 13 * | | 5 | #4 | #5 | 7-#8 | 6 | #4 | #4 | 12-#5 |
| 2.47 | 13 * | 3 S 4 1 | 5 | #5 | #6 | 8-#8 | 6 | #4 | #4 | 12-#5 |
| 2.94 | 13 * | 3 S 4 1 | 5 | #6 | #6 | 8-#9 | 6 | #4 | #5 | 12-#5 |
| 2.09 | 15 | | 5 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 13-#5 |
| 2.32 | 15 * | 3 S 4 1 | 5 | #5 | #5 | 11-#7 | 7 | #4 | #4 | 13-#5 |
| 2.85 | 15 * | 3 S 4 1 | 5 | #6 | #6 | 9-#9 | 7 | #4 | #4 | 13-#5 |
| 3.09 | 18 * | 3 S 4 2 | 5 | #6 | #6 | 10-#9 | 7 | #4 | #5 | 13-#5 |
| 2.13 | 16 | | 6 | #4 | #5 | 11-#7 | 7 | #4 | #4 | 13-#5 |
| 2.65 | 16 * | 3 S 4 1 | 6 | #5 | #6 | 9-#9 | 7 | #4 | #4 | 13-#5 |
| 3.12 | 18 * | 3 S 4 1 | 6 | #6 | #6 | 11-#9 | 7 | #4 | #5 | 13-#5 |
| 2.46 | 17 * | 3 S 4 1 | 6 | #5 | #5 | 9-#9 | 8 | #4 | #4 | 15-#5 |
| 2.91 | 17 * | 3 S 4 1 | 6 | #6 | #6 | 11-#9 | 8 | #4 | #4 | 15-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 ½ in. | Rib Depth = 10 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | | | | Total Depth = 14 ½ in. | Rib Depth = 10 in. | Total Slab Depth = 4 ½ in. | | | | | | | | |
| 20'-0" | 50 | 1.73 | 12 | 0.635 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 43 | 85 | 115 | 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| D = 8.000 | 100 | 1.73 | 12 | 0.635 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 54 | 109 | 147 | 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| RIB NOT ON | 150 | 1.73 | 12 | 0.635 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 66 | 150 | 178 | 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| COLUMN LINE | 200 | 1.80 | 12 | 0.655 | | 6-#6+ 0 | 4 | #4 | #5 | 6-#6 | 4 | #4 | #4 | 8-#5 | 78 | 188 | 210 | 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 0.781 CF/SF | 300 | 2.16 | 12 | 0.738 | | 6-#6+ 0 | 4 | #5 | #6 | 6-#7 | 4 | #4 | #5 | 8-#5 | 101 | 261 | 273 | 1.97 | 12 | | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 8-#5 |
| | 400 | 2.59 | 12 * | 0.846 | | 6-#6+ 1 | 4 | #6 | #7 | 7-#7 | 4 | #5 | #5 | 8-#5 | 125 | 333 | 336 | 2.24 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 9-#6 | 4 | #4 | #4 | 8-#5 |
| | 500 | 3.01 | 12 * | 0.636 | | 6-#6+ 0 | 4 | #7 | #7 | 7-#8 | 4 | #5 | #6 | 8-#5 | 148 | 404 | 399 | 2.61 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 6-#8 | 4 | #4 | #5 | 8-#5 |
| 22'-6" | 50 | 1.79 | 12 | 0.635 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 | 61 | 122 | 164 | 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| D = 8.000 | 100 | 1.85 | 12 | 0.677 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 78 | 156 | 210 | 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| RIB NOT ON | 150 | 1.91 | 12 | 0.722 | | 10-#5+ 0 | 4 | #5 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 95 | 215 | 255 | 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.09 | 12 | 0.767 | | 10-#5+ 0 | 4 | #5 | #6 | 6-#7 | 5 | #4 | #4 | 10-#5 | 112 | 269 | 301 | 2.00 | 12 | | 4 | #4 | #5 | 6-#7 | 5 | #4 | #4 | 10-#5 |
| 0.766 CF/SF | 300 | 2.67 | 12 * | 0.880 | | 10-#5+ 2 | 4 | #6 | #7 | 6-#8 | 5 | #5 | #5 | 10-#5 | 146 | 375 | 392 | 2.43 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 6-#8 | 5 | #4 | #4 | 10-#5 |
| | 400 | 3.21 | 12 * | 0.636 | | 10-#5+ 1 | 4 | #7 | #8 | 6-#9 | 5 | #5 | #6 | 10-#5 | 179 | 478 | 483 | 2.83 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 5 | #4 | #5 | 10-#5 |
| | 500 | 3.91 | 15 * | 0.632 | | 6-#7+ 0 | 4 | #8 | #8 | 8-#9 | 5 | #6 | #6 | 10-#5 | 210 | 569 | 565 | 3.60 | 13 * | 3 S 4 2 | 4 | #7 | #7 | 7-#9 | 5 | #5 | #5 | 10-#5 |
| 25'-0" | 50 | 1.75 | 12 | 0.710 | | 8-#6+ 0 | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 | 86 | 171 | 231 | 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| D = 10.500 | 100 | 1.82 | 12 | 0.759 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 10-#5 | 109 | 219 | 294 | 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| RIB ON | 150 | 2.18 | 12 * | 0.828 | | 8-#6+ 1 | 5 | #5 | #6 | 10-#6 | 5 | #4 | #5 | 10-#5 | 132 | 300 | 357 | 2.01 | 12 | | 5 | #4 | #5 | 7-#7 | 5 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.47 | 12 * | 0.884 | | 8-#6+ 2 | 5 | #6 | #6 | 7-#8 | 5 | #5 | #5 | 10-#5 | 156 | 376 | 420 | 2.19 | 12 * | | 5 | #5 | #5 | 8-#7 | 5 | #4 | #4 | 10-#5 |
| 0.791 CF/SF | 300 | 3.03 | 13 * | 0.635 | | 8-#6+ 2 | 5 | #7 | #7 | 7-#9 | 5 | #5 | #6 | 10-#5 | 202 | 521 | 544 | 2.65 | 12 * | 3 S 4 1 | 5 | #5 | #6 | 8-#8 | 5 | #4 | #5 | 10-#5 |
| | 400 | 3.88 | 17 * | 0.630 | | 9-#6+ 2 | 5 | #8 | #8 | 9-#9 | 5 | #6 | #7 | 10-#5 | 243 | 641 | 655 | 3.37 | 14 * | 3 S 4 1 | 5 | #6 | #7 | 8-#9 | 5 | #5 | #5 | 10-#5 |
| 27'-6" | 50 | 1.81 | 13 | 0.715 | | 8-#6+ 0 | 5 | #4 | #5 | 9-#6 | 6 | #4 | #4 | 12-#5 | 113 | 227 | 305 | 1.77 | 13 | | 5 | #4 | #4 | 8-#6 | 6 | #4 | #4 | 12-#5 |
| D = 10.500 | 100 | 2.03 | 13 | 0.801 | | 8-#6+ 1 | 5 | #5 | #5 | 8-#7 | 6 | #4 | #4 | 12-#5 | 145 | 289 | 389 | 2.04 | 13 | | 5 | #4 | #5 | 8-#7 | 6 | #4 | #4 | 12-#5 |
| RIB ON | 150 | 2.41 | 13 * | 0.881 | | 8-#6+ 3 | 5 | #6 | #6 | 8-#8 | 6 | #4 | #5 | 12-#5 | 176 | 393 | 473 | 2.26 | 13 * | 3 S 4 1 | 5 | #5 | #5 | 7-#8 | 6 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.83 | 13 * | 0.635 | | 8-#6+ 2 | 5 | #7 | #7 | 7-#9 | 6 | #5 | #5 | 12-#5 | 207 | 494 | 557 | 2.53 | 13 * | 3 S 4 1 | 5 | #5 | #6 | 11-#7 | 6 | #4 | #4 | 12-#5 |
| 0.777 CF/SF | 300 | 3.77 | 18 * | 0.629 | | 7-#7+ 2 | 5 | #8 | #8 | 12-#8 | 6 | #6 | #6 | 12-#5 | 264 | 669 | 711 | 3.43 | 14 * | 3 S 4 1 | 5 | #6 | #7 | 9-#9 | 6 | #5 | #5 | 12-#5 |
| | 400 | 4.34 | 22 * | 0.625 | 3 S 4 1 | 12-#6+ 3 | 5 | #8 | #9 | 12-#9 | 6 | #6 | #7 | 12-#5 | 316 | 772 | 851 | 3.87 | 19 * | 3 S 4 2 | 5 | #7 | #7 | 11-#9 | 6 | #5 | #5 | 12-#5 |
| 30'-0" | 50 | 1.98 | 15 | 0.725 | | 9-#6+ 0 | 5 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 13-#5 | 146 | 291 | 392 | 1.98 | 15 | | 5 | #4 | #5 | 8-#7 | 7 | #4 | #4 | 13-#5 |
| D = 10.500 | 100 | 2.30 | 15 * | 0.830 | | 9-#6+ 2 | 5 | #6 | #6 | 8-#8 | 7 | #4 | #4 | 13-#5 | 186 | 372 | 501 | 2.26 | 15 | 3 S 4 1 | 5 | #5 | #5 | 8-#8 | 7 | #4 | #4 | 13-#5 |
| RIB ON | 150 | 2.71 | 15 * | 0.904 | | 9-#6+ 4 | 5 | #7 | #7 | 8-#9 | 7 | #4 | #5 | 13-#5 | 226 | 488 | 609 | 2.49 | 15 * | 3 S 4 1 | 5 | #5 | #6 | 7-#9 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 3.27 | 17 * | 0.630 | | 7-#7+ 3 | 5 | #7 | #8 | 12-#8 | 7 | #5 | #5 | 13-#5 | 265 | 614 | 713 | 3.13 | 15 * | 3 S 4 1 | 5 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| 0.766 CF/SF | 300 | 4.16 | 22 * | 0.625 | 3 S 4 1 | 7-#8+ 2 | 5 | #8 | #9 | 16-#8 | 7 | #6 | #6 | 13-#5 | 336 | 773 | 905 | 3.81 | 19 * | 3 S 4 2 | 5 | #7 | #7 | 12-#9 | 7 | #5 | #5 | 13-#5 |
| 32'-6" | 50 | 2.13 | 16 * | 0.818 | | 10-#6+ 3 | 6 | #5 | #6 | 11-#7 | 7 | #4 | #4 | 13-#5 | 187 | 374 | 504 | 2.04 | 16 | | 6 | #4 | #5 | 10-#7 | 7 | #4 | #4 | 13-#5 |
| D = 13.000 | 100 | 2.50 | 16 * | 0.892 | | 10-#6+ 5 | 6 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 13-#5 | 238 | 477 | 642 | 2.36 | 16 * | | 6 | #5 | #5 | 10-#8 | 7 | #4 | #4 | 13-#5 |
| RIB NOT ON | 150 | 3.01 | 18 * | 0.629 | | 11-#6+ 3 | 6 | #7 | #7 | 10-#9 | 7 | #5 | #5 | 13-#5 | 288 | 610 | 776 | 2.78 | 16 * | 3 S 4 1 | 6 | #5 | #6 | 12-#8 | 7 | #4 | #5 | 13-#5 |
| COLUMN LINE | 200 | 3.85 | 21 * | 0.626 | | 10-#7+ 3 | 6 | #8 | #8 | 12-#9 | 7 | #6 | #6 | 13-#5 | 336 | 768 | 906 | 3.52 | 16 * | 3 S 4 1 | 6 | #6 | #7 | 12-#9 | 7 | #5 | #5 | 13-#5 |
| 0.785 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 35'-0" | 50 | 2.41 | 17 * | 0.857 | | 15-#5+ 7 | 6 | #6 | #6 | 10-#8 | 8 | #4 | #5 | 15-#5 | 233 | 466 | 627 | 2.31 | 17 | | 6 | #5 | #5 | 10-#8 | 8 | #4 | #4 | 15-#5 |
| D = 13.000 | 100 | 2.93 | 17 * | 0.630 | | 16-#5+ 5 | 6 | #7 | #7 | 11-#9 | 8 | #5 | #5 | 15-#5 | 297 | 594 | 800 | 2.66 | 17 * | 3 S 4 1 | 6 | #5 | #6 | 10-#9 | 8 | #4 | #4 | 15-#5 |
| RIB NOT ON | 150 | 3.49 | 22 * | 0.625 | | 10-#7+ 3 | 6 | #7 | #8 | 13-#9 | 8 | #5 | #6 | 15-#5 | 357 | 731 | 960 | 3.25 | 17 * | 3 S 4 1 | 6 | #6 | #7 | 12-#9 | 8 | #4 | #5 | 15-#5 |
| COLUMN LINE | 200 | 3.81 | 28 * | 0.621 | | 9-#8+ 1 | 6 | #8 | #8 | 15-#9 | 8 | #5 | #6 | 16-#5 | 408 | 816 | 1099 | 3.48 | 22 * | 3 S 4 2 | 6 | #6 | #7 | 14-#9 | 8 | #4 | #5 | 15-#5 |
| 0.775 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 37'-6" | 50 | 2.63 | 18 * | 0.885 | | 16-#5+ 9 | 6 | #6 | #7 | 10-#9 | 9 | #4 | #5 | 17-#5 | 286 | 571 | 769 | 2.54 | 18 * | 3 S 4 1 | 6 | #5 | #6 | 12-#8 | 9 | #4 | #4 | 17-#5 |
| D = 13.000 | 100 | 3.21 | 21 * | 0.923 | | 10-#7+ 7 | 6 | #7 | #8 | 13-#9 | 9 | #5 | #5 | 17-#5 | 362 | 724 | 974 | 2.96 | 18 * | 3 S 4 1 | 6 | #6 | #6 | 16-#8 | 9 | #4 | #4 | 17-#5 |
| RIB NOT ON | 150 | 3.83 | 29 * | 0.621 | | 17-#6+ 5 | 6 | #8 | #8 | 16-#9 | 9 | #5 | #6 | 17-#5 | 430 | 860 | 1158 | 3.62 | 20 * | 3 S 4 2 | 6 | #7 | #7 | 15-#9 | 9 | #4 | #5 | 17-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.766 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40'-0" | 50 | 2.96 | 20 * | 0.906 | | 19-#5+12 | 7 | #7 | #7 | 16-#8 | 9 | #5 | #5 | 17-#5 | 348 | 696 | 936 | 2.71 | 20 * | | 7 | #5 | #6 | 12-#9 | 9 | #4 | #4 | 17-#5 |
| D = 15.500 | 100 | 3.61 | 27 * | 0.622 | | 17-#6+ 5 | 7 | #7 | #8 | 16-#9 | 9 | #5 | #6 | 17-#5 | 436 | 873 | 1175 | 3.40 | 20 * | 3 S 4 1 | 7 | #6 | #7 | 15-#9 | 9 | #4 | #5 | 17-#5 |
| RIB ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.781 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 16 ½ in. | Rib Depth = 12 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | | | | Total Depth = 16 ½ in. | Rib Depth = 12 in. | Total Slab Depth = 4 ½ in. | | | | | | | | |
| 22'-6" | 50 | 1.79 | 12 | 0.638 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 | 66 | 132 | 177 | 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| D = 8.000 | 100 | 1.79 | 12 | 0.638 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 | 83 | 166 | 223 | 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| RIB NOT ON | 150 | 1.85 | 12 | 0.638 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 100 | 222 | 268 | 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.05 | 12 | 0.675 | | 10-#5+ 0 | 4 | #5 | #6 | 6-#7 | 5 | #4 | #4 | 10-#5 | 117 | 278 | 314 | 1.93 | 12 | | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 0.852 CF/SF | 300 | 2.44 | 12 | 0.760 | | 10-#5+ 0 | 4 | #6 | #7 | 7-#7 | 5 | #4 | #5 | 10-#5 | 150 | 384 | 405 | 2.18 | 12 | 4 S 6 1 | 4 | #5 | #5 | 9-#6 | 5 | #4 | #4 | 10-#5 |
| | 400 | 2.86 | 12 * | 0.870 | | 10-#5+ 2 | 4 | #7 | #7 | 7-#8 | 5 | #5 | #5 | 10-#5 | 184 | 488 | 496 | 2.56 | 12 * | 4 S 6 1 | 4 | #6 | #6 | 6-#8 | 5 | #4 | #4 | 10-#5 |
| | 500 | 3.44 | 12 * | 0.639 | | 10-#5+ 1 | 4 | #8 | #8 | 8-#8 | 5 | #5 | #6 | 10-#5 | 218 | 591 | 587 | 3.07 | 12 * | 4 S 6 1 | 4 | #6 | #7 | 6-#9 | 5 | #4 | #5 | 10-#5 |
| 25'-0" | 50 | 1.75 | 12 | 0.638 | | 8-#6+ 0 | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 | 92 | 185 | 249 | 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| D = 10.500 | 100 | 1.82 | 12 | 0.682 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 10-#5 | 116 | 232 | 312 | 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| RIB ON | 150 | 1.92 | 12 | 0.728 | | 8-#6+ 0 | 5 | #5 | #5 | 9-#6 | 5 | #4 | #4 | 10-#5 | 139 | 311 | 375 | 1.80 | 12 | | 5 | #4 | #4 | 12-#5 | 5 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.19 | 12 | 0.799 | | 8-#6+ 1 | 5 | #5 | #6 | 8-#7 | 5 | #4 | #5 | 10-#5 | 163 | 388 | 438 | 2.01 | 12 | | 5 | #4 | #5 | 7-#7 | 5 | #4 | #4 | 10-#5 |
| 0.881 CF/SF | 300 | 2.85 | 12 * | 0.639 | | 8-#6+ 1 | 5 | #6 | #7 | 8-#8 | 5 | #5 | #6 | 10-#5 | 209 | 535 | 564 | 2.56 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 7-#8 | 5 | #4 | #5 | 10-#5 |
| | 400 | 3.48 | 12 * | 0.639 | | 8-#6+ 2 | 5 | #7 | #8 | 8-#9 | 5 | #6 | #6 | 10-#5 | 256 | 680 | 690 | 3.08 | 12 * | 4 S 6 1 | 5 | #6 | #6 | 7-#9 | 5 | #5 | #5 | 10-#5 |
| | 500 | 4.05 | 16 * | 0.633 | | 7-#7+ 2 | 5 | #8 | #8 | 9-#9 | 5 | #6 | #7 | 10-#5 | 298 | 805 | 802 | 3.68 | 13 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 5 | #5 | #6 | 10-#5 |
| 27'-6" | 50 | 1.79 | 13 | 0.638 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 6 | #4 | #4 | 12-#5 | 122 | 245 | 329 | 1.77 | 13 | | 5 | #4 | #4 | 8-#6 | 6 | #4 | #4 | 12-#5 |
| D = 10.500 | 100 | 1.93 | 13 | 0.695 | | 8-#6+ 0 | 5 | #5 | #5 | 10-#6 | 6 | #4 | #4 | 12-#5 | 153 | 307 | 413 | 1.88 | 13 | | 5 | #4 | #4 | 7-#7 | 6 | #4 | #4 | 12-#5 |
| RIB ON | 150 | 2.20 | 13 | 0.801 | | 8-#6+ 2 | 5 | #5 | #6 | 7-#8 | 6 | #4 | #5 | 12-#5 | 185 | 408 | 497 | 2.04 | 13 | | 5 | #4 | #5 | 8-#7 | 6 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.68 | 13 * | 0.861 | | 8-#6+ 3 | 5 | #6 | #7 | 8-#8 | 6 | #5 | #5 | 12-#5 | 216 | 511 | 581 | 2.47 | 13 | 4 S 6 1 | 5 | #5 | #6 | 8-#8 | 6 | #4 | #4 | 12-#5 |
| 0.865 CF/SF | 300 | 3.31 | 13 * | 0.637 | | 9-#6+ 2 | 5 | #7 | #8 | 9-#9 | 6 | #5 | #6 | 12-#5 | 278 | 707 | 749 | 2.94 | 13 * | 4 S 6 1 | 5 | #6 | #6 | 8-#9 | 6 | #4 | #5 | 12-#5 |
| | 400 | 4.14 | 17 * | 0.632 | 4 S 6 1 | 8-#7+ 2 | 5 | #8 | #9 | 13-#8 | 6 | #6 | #7 | 12-#5 | 335 | 879 | 902 | 3.60 | 14 * | 4 S 6 2 | 5 | #7 | #7 | 12-#8 | 6 | #5 | #5 | 12-#5 |
| | 500 | 4.66 | 21 * | 0.628 | 4 S 6 1 | 7-#8+ 2 | 5 | #9 | #9 | 12-#9 | 6 | #6 | #7 | 13-#5 | 385 | 987 | 1037 | 4.21 | 19 * | 4 S 6 2 | 5 | #7 | #8 | 11-#9 | 6 | #5 | #6 | 12-#5 |
| 30'-0" | 50 | 1.91 | 15 | 0.652 | | 9-#6+ 0 | 5 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 13-#5 | 157 | 314 | 423 | 1.83 | 15 | | 5 | #4 | #4 | 7-#7 | 7 | #4 | #4 | 13-#5 |
| D = 10.500 | 100 | 2.13 | 15 | 0.716 | | 9-#6+ 0 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 13-#5 | 197 | 395 | 531 | 2.09 | 15 | | 5 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 13-#5 |
| RIB ON | 150 | 2.55 | 15 * | 0.820 | | 9-#6+ 2 | 5 | #6 | #7 | 7-#9 | 7 | #4 | #5 | 13-#5 | 238 | 510 | 640 | 2.37 | 15 | 4 S 6 1 | 5 | #5 | #6 | 8-#8 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 2.94 | 15 * | 0.892 | | 9-#6+ 4 | 5 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 13-#5 | 278 | 643 | 748 | 2.70 | 15 * | 4 S 6 1 | 5 | #6 | #6 | 8-#9 | 7 | #4 | #4 | 13-#5 |
| 0.852 CF/SF | 300 | 3.97 | 18 * | 0.631 | 4 S 6 1 | 12-#6+ 2 | 5 | #8 | #9 | 11-#9 | 7 | #6 | #6 | 13-#5 | 355 | 887 | 957 | 3.54 | 15 * | 4 S 6 2 | 5 | #7 | #7 | 10-#9 | 7 | #5 | #5 | 13-#5 |
| | 400 | 4.73 | 23 * | 0.627 | 4 S 6 1 | 8-#8+ 2 | 5 | #9 | #10 | 14-#9 | 7 | #6 | #7 | 14-#5 | 424 | 1049 | 1141 | 4.07 | 19 * | 4 S 6 2 | 5 | #7 | #8 | 16-#8 | 7 | #5 | #5 | 13-#5 |
| 32'-6" | 50 | 2.01 | 16 | 0.745 | | 10-#6+ 2 | 6 | #5 | #5 | 10-#7 | 7 | #4 | #4 | 13-#5 | 202 | 404 | 544 | 1.99 | 16 | | 6 | #4 | #5 | 9-#7 | 7 | #4 | #4 | 13-#5 |
| D = 13.000 | 100 | 2.43 | 16 * | 0.831 | | 10-#6+ 4 | 6 | #6 | #6 | 10-#8 | 7 | #4 | #5 | 13-#5 | 253 | 507 | 682 | 2.29 | 16 | | 6 | #5 | #5 | 9-#8 | 7 | #4 | #4 | 13-#5 |
| RIB NOT ON | 150 | 2.82 | 16 * | 0.895 | | 10-#6+ 6 | 6 | #6 | #7 | 9-#9 | 7 | #5 | #5 | 13-#5 | 305 | 644 | 820 | 2.65 | 16 * | 4 S 6 1 | 6 | #5 | #6 | 9-#9 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 3.34 | 17 * | 0.632 | | 12-#6+ 2 | 6 | #7 | #8 | 11-#9 | 7 | #5 | #6 | 13-#5 | 355 | 813 | 956 | 2.97 | 16 * | 4 S 6 1 | 6 | #6 | #6 | 10-#9 | 7 | #4 | #5 | 13-#5 |
| 0.874 CF/SF | 300 | 4.40 | 23 * | 0.627 | | 11-#7+ 3 | 6 | #8 | #9 | 14-#9 | 7 | #6 | #7 | 15-#5 | 447 | 1076 | 1204 | 3.99 | 18 * | 4 S 6 2 | 6 | #7 | #7 | 13-#9 | 7 | #5 | #6 | 14-#5 |

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 16 ½ in. | | Rib Depth = 12 in. | | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | |
| 35'-0" | 50 | 2.26 | 17 | 0.769 | | 15-#5+ 3 | 6 | #6 | #6 | 10-#8 | 8 | #4 | #4 | 15-#5 | 251 | 502 | 676 |
| D = 13.000 | 100 | 2.67 | 17 * | 0.864 | | 15-#5+ 7 | 6 | #6 | #7 | 12-#8 | 8 | #4 | #5 | 15-#5 | 315 | 631 | 849 |
| RIB NOT ON | 150 | 3.19 | 17 * | 0.632 | | 9-#7+ 4 | 6 | #7 | #8 | 12-#9 | 8 | #5 | #5 | 15-#5 | 379 | 783 | 1022 |
| COLUMN LINE | 200 | 3.76 | 21 * | 0.628 | | 11-#7+ 3 | 6 | #8 | #8 | 14-#9 | 8 | #6 | #6 | 15-#5 | 439 | 986 | 1182 |
| 0.862 CF/SF | 300 | 4.50 | 28 * | 0.623 | | 10-#8+ 3 | 6 | #8 | #9 | 18-#9 | 8 | #6 | #6 | 18-#5 | 546 | 1092 | 1470 |
| 37'-6" | 50 | 2.60 | 18 * | 0.829 | | 16-#5+ 7 | 6 | #6 | #7 | 9-#9 | 9 | #4 | #5 | 17-#5 | 308 | 616 | 829 |
| D = 13.000 | 100 | 3.02 | 18 * | 0.917 | | 10-#7+ 6 | 6 | #7 | #7 | 12-#9 | 9 | #5 | #5 | 17-#5 | 387 | 774 | 1042 |
| RIB NOT ON | 150 | 3.65 | 21 * | 0.628 | | 22-#5+ 5 | 6 | #8 | #8 | 15-#9 | 9 | #5 | #6 | 17-#5 | 463 | 925 | 1245 |
| COLUMN LINE | 200 | 4.13 | 25 * | 0.625 | | 10-#8+ 3 | 6 | #8 | #9 | 17-#9 | 9 | #6 | #6 | 18-#5 | 533 | 1104 | 1436 |
| 0.852 CF/SF | | | | | | | | | | | | | | | | | |
| 40'-0" | 50 | 2.74 | 20 * | 0.859 | | 18-#5+11 | 7 | #6 | #7 | 12-#9 | 9 | #4 | #5 | 17-#5 | 375 | 750 | 1010 |
| D = 15.500 | 100 | 3.46 | 21 * | 0.926 | | 12-#7+ 8 | 7 | #7 | #8 | 15-#9 | 9 | #5 | #6 | 17-#5 | 470 | 939 | 1265 |
| RIB ON | 150 | 4.07 | 26 * | 0.625 | | 14-#7+ 4 | 7 | #8 | #8 | 18-#9 | 9 | #6 | #6 | 19-#5 | 559 | 1117 | 1504 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.870 CF/SF | | | | | | | | | | | | | | | | | |
| 42'-6" | 50 | 3.04 | 21 * | 0.887 | | 11-#7+ 6 | 7 | #7 | #7 | 14-#9 | 10 | #5 | #5 | 18-#5 | 449 | 897 | 1208 |
| D = 15.500 | 100 | 3.75 | 25 * | 0.916 | | 14-#7+ 8 | 7 | #8 | #8 | 18-#9 | 10 | #5 | #6 | 19-#5 | 559 | 1117 | 1504 |
| RIB ON | 150 | 4.40 | 33 * | 0.621 | | 32-#5+ 7 | 7 | #8 | #9 | 21-#9 | 10 | #6 | #6 | 22-#5 | 655 | 1311 | 1764 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.860 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.41 | 22 * | 0.924 | | 13-#7+ 9 | 7 | #8 | #8 | 17-#9 | 11 | #5 | #5 | 20-#5 | 531 | 1062 | 1430 |
| D = 15.500 | 100 | 4.06 | 30 * | 0.622 | | 32-#5+ 7 | 7 | #8 | #9 | 22-#9 | 11 | #5 | #6 | 22-#5 | 657 | 1314 | 1768 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.852 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 16 ½ in. | | | Rib Depth = 12 in. | | | | Total Slab Depth = 4 ½ in. | | | |
| 2.15 | 17 | | 6 | #4 | #5 | 9-#8 | 8 | #4 | #4 | 15-#5 |
| 2.58 | 17 * | 4 S 6 1 | 6 | #5 | #6 | 9-#9 | 8 | #4 | #4 | 15-#5 |
| 2.91 | 17 * | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 8 | #4 | #4 | 15-#5 |
| 3.31 | 17 * | 4 S 6 1 | 6 | #6 | #7 | 16-#8 | 8 | #4 | #5 | 15-#5 |
| 4.21 | 24 * | 4 S 6 2 | 6 | #7 | #7 | 17-#9 | 8 | #5 | #5 | 17-#5 |
| 2.52 | 18 | | 6 | #5 | #6 | 9-#9 | 9 | #4 | #4 | 17-#5 |
| 2.82 | 18 * | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 9 | #4 | #4 | 17-#5 |
| 3.36 | 18 * | 4 S 6 2 | 6 | #6 | #7 | 14-#9 | 9 | #4 | #5 | 17-#5 |
| 3.69 | 20 * | 4 S 6 2 | 6 | #7 | #7 | 16-#9 | 9 | #4 | #5 | 17-#5 |
| 2.64 | 20 | | 7 | #5 | #6 | 11-#9 | 9 | #4 | #4 | 17-#5 |
| 3.14 | 20 * | 4 S 6 1 | 7 | #6 | #6 | 14-#9 | 9 | #4 | #5 | 17-#5 |
| 3.75 | 20 * | 4 S 6 1 | 7 | #6 | #7 | 17-#9 | 9 | #5 | #5 | 17-#5 |
| 2.85 | 21 * | 4 S 6 1 | 7 | #6 | #6 | 13-#9 | 10 | #4 | #4 | 18-#5 |
| 3.46 | 21 * | 4 S 6 1 | 7 | #6 | #7 | 17-#9 | 10 | #4 | #5 | 18-#5 |
| 4.10 | 25 * | 4 S 6 2 | 7 | #7 | #7 | 20-#9 | 10 | #5 | #5 | 21-#5 |
| 3.14 | 22 * | 4 S 6 1 | 7 | #6 | #7 | 16-#9 | 11 | #4 | #4 | 20-#5 |
| 3.75 | 22 * | 4 S 6 2 | 7 | #7 | #7 | 20-#9 | 11 | #4 | #5 | 21-#5 |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 ½ in. | | Rib Depth = 14 in. | | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | |
| 25'-0" | 50 | 1.99 | 12 | 0.641 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 10-#5 | 99 | 199 | 268 |
| D = 10.500 | 100 | 1.99 | 12 | 0.641 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 10-#5 | 123 | 246 | 331 |
| RIB ON | 150 | 2.06 | 12 | 0.645 | | 8-#6+ 0 | 5 | #5 | #5 | 12-#5 | 5 | #4 | #5 | 10-#5 | 146 | 320 | 394 |
| COLUMN LINE | 200 | 2.21 | 12 | 0.689 | | 8-#6+ 0 | 5 | #5 | #6 | 7-#7 | 5 | #4 | #5 | 10-#5 | 170 | 399 | 457 |
| 0.973 CF/SF | 300 | 2.68 | 12 | 0.822 | | 8-#6+ 2 | 5 | #6 | #7 | 7-#8 | 5 | #5 | #5 | 10-#5 | 216 | 548 | 583 |
| | 400 | 3.10 | 12 * | 0.642 | | 8-#6+ 2 | 5 | #7 | #7 | 7-#9 | 5 | #5 | #6 | 10-#5 | 263 | 693 | 709 |
| | 500 | 3.73 | 12 * | 0.642 | | 9-#6+ 2 | 5 | #7 | #8 | 8-#9 | 5 | #6 | #7 | 10-#5 | 310 | 836 | 835 |
| 27'-6" | 50 | 1.97 | 13 | 0.639 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 6 | #4 | #5 | 12-#5 | 131 | 263 | 354 |
| D = 10 .500 | 100 | 2.09 | 13 | 0.639 | | 8-#6+ 0 | 5 | #5 | #5 | 7-#7 | 6 | #4 | #5 | 12-#5 | 163 | 325 | 438 |
| RIB ON | 150 | 2.23 | 13 | 0.667 | | 8-#6+ 0 | 5 | #5 | #6 | 8-#7 | 6 | #4 | #5 | 12-#5 | 194 | 421 | 522 |
| COLUMN LINE | 200 | 2.44 | 13 | 0.777 | | 8-#6+ 2 | 5 | #6 | #6 | 7-#8 | 6 | #4 | #5 | 12-#5 | 225 | 525 | 606 |
| 0.955 CF/SF | 300 | 3.09 | 13 * | 0.887 | | 8-#6+ 4 | 5 | #7 | #7 | 8-#9 | 6 | #5 | #6 | 12-#5 | 287 | 723 | 774 |
| | 400 | 3.77 | 13 * | 0.640 | | 7-#7+ 3 | 5 | #8 | #8 | 9-#9 | 6 | #6 | #6 | 12-#5 | 350 | 917 | 942 |
| | 500 | 4.51 | 16 * | 0.636 | 4 S 6 1 | 12-#6+ 2 | 5 | #9 | #9 | 11-#9 | 6 | #6 | #7 | 12-#5 | 407 | 1089 | 1095 |
| 30'-0" | 50 | 2.06 | 15 | 0.636 | | 9-# 6+ 0 | 5 | #5 | #5 | 7-#7 | 7 | #4 | #5 | 13-#5 | 169 | 338 | 455 |
| D = 10.500 | 100 | 2.21 | 15 | 0.636 | | 9-#6+ 0 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #5 | 13-#5 | 209 | 418 | 563 |
| RIB ON | 150 | 2.44 | 15 | 0.727 | | 9-#6+ 1 | 5 | #6 | #6 | 8-#8 | 7 | #4 | #5 | 13-#5 | 249 | 529 | 672 |
| COLUMN LINE | 200 | 2.77 | 15 * | 0.817 | | 9-#6+ 3 | 5 | #7 | #7 | 8-#9 | 7 | #4 | #5 | 13-#5 | 290 | 665 | 780 |
| 0.940 CF/SF | 300 | 3.49 | 15 * | 0.637 | | 8-#7+ 2 | 5 | #8 | #8 | 10-#9 | 7 | #5 | #6 | 13-#5 | 370 | 919 | 997 |
| | 400 | 4.44 | 18 * | 0.634 | 4 S 6 1 | 7-#8+ 0 | 5 | #9 | #9 | 12-#9 | 7 | #6 | #7 | 13-#5 | 447 | 1159 | 1203 |
| | 500 | 5.02 | 22 * | 0.630 | 4 S 6 1 | 11-#7+ 1 | 5 | #9 | #10 | 18-#8 | 7 | #6 | #7 | 15-#5 | 514 | 1324 | 1385 |
| 32'-6" | 50 | 2.12 | 16 | 0.659 | | 10-#6+ 1 | 6 | #5 | #5 | 9-#7 | 7 | #4 | #5 | 13-#5 | 217 | 435 | 585 |
| D = 13.000 | 100 | 2.32 | 16 | 0.761 | | 10-#6+ 3 | 6 | #5 | #6 | 9-#8 | 7 | #4 | #5 | 13-#5 | 269 | 537 | 723 |
| RIB NOT ON | 150 | 2.65 | 16 * | 0.837 | | 10-#6+ 5 | 6 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 13-#5 | 320 | 671 | 861 |
| COLUMN LINE | 200 | 3.15 | 16 * | 0.895 | | 11-#6+ 6 | 6 | #7 | #7 | 10-#9 | 7 | #5 | #6 | 13-#5 | 371 | 845 | 999 |
| 0.965 CF/SF | 300 | 4.17 | 18 * | 0.634 | | 10-#7+ 3 | 6 | #8 | #9 | 16-#8 | 7 | #6 | #7 | 14-#5 | 471 | 1162 | 1269 |
| | 400 | 4.88 | 23 * | 0.629 | | 9-#8+ 2 | 6 | #9 | #9 | 16-#9 | 7 | #7 | #7 | 16-#5 | 559 | 1381 | 1506 |
| 35'-0" | 50 | 2.28 | 17 | 0.677 | | 15-#5+ 1 | 6 | #5 | #6 | 9-#8 | 8 | #4 | #5 | 15-#5 | 270 | 540 | 727 |
| D = 13.000 | 100 | 2.59 | 17 * | 0.796 | | 15-#5+ 5 | 6 | #6 | #7 | 9-#9 | 8 | #4 | #5 | 15-#5 | 334 | 668 | 900 |
| RIB NOT ON | 150 | 3.00 | 17 * | 0.877 | | 12-#6+ 5 | 6 | #7 | #7 | 11-#9 | 8 | #5 | #5 | 15-#5 | 398 | 819 | 1072 |
| COLUMN LINE | 200 | 3.57 | 17 * | 0.635 | | 10-#7+ 3 | 6 | #8 | #8 | 16-#8 | 8 | #5 | #6 | 15-#5 | 462 | 1037 | 1245 |
| 0.952 CF/SF | 300 | 4.65 | 23 * | 0.629 | | 17-#6+ 3 | 6 | #9 | #9 | 16-#9 | 8 | #6 | #7 | 17-#5 | 580 | 1397 | 1562 |

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 ½ in. | | Rib Depth = 14 in. | | Total Slab Depth = 4 ½ in. | | | | | | | |
| 25'-0" | 1.99 | 12 | | 5 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 10-#5 |
| D = 10.500 | 1.99 | 12 | | 5 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 10-#5 |
| RIB ON | 1.99 | 12 | | 5 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 10-#5 |
| COLUMN LINE | 2.07 | 12 | | 5 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 10-#5 |
| 0.973 CF/SF | 2.42 | 12 | | 5 | #5 | #5 | 7-#8 | 5 | #4 | #5 | 10-#5 |
| | 2.79 | 12 * | 4 S 6 1 | 5 | #6 | #6 | 8-#8 | 5 | #4 | #5 | 10-#5 |
| | 3.36 | 12 * | 4 S 6 1 | 5 | #6 | #7 | 8-#9 | 5 | #5 | #5 | 10-#5 |
| 27'-6" | 1.98 | 13 | | 5 | #4 | #5 | 8-#6 | 6 | #4 | #5 | 12-#5 |
| D = 10 .500 | 2.06 | 13 | | 5 | #4 | #5 | 9-#6 | 6 | #4 | #5 | 12-#5 |
| RIB ON | 2.15 | 13 | | 5 | #4 | #5 | 8-#7 | 6 | #4 | #5 | 12-#5 |
| COLUMN LINE | 2.37 | 13 | | 5 | #5 | #5 | 7-#8 | 6 | #4 | #5 | 12-#5 |
| 0.955 CF/SF | 2.84 | 13 * | 4 S 6 1 | 5 | #6 | #6 | 7-#9 | 6 | #4 | #5 | 12-#5 |
| | 3.42 | 13 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 6 | #5 | #5 | 12-#5 |
| | 4.01 | 14 * | 4 S 6 2 | 5 | #7 | #8 | 10-#9 | 6 | #5 | #6 | 12-#5 |
| 30'-0" | 2.01 | 15 | | 5 | #4 | #5 | 9-#6 | 7 | #4 | #5 | 13-#5 |
| D = 10.500 | 2.10 | 15 | | 5 | #4 | #5 | 8-#7 | 7 | #4 | #5 | 13-#5 |
| RIB ON | 2.38 | 15 | | 5 | #5 | #5 | 8-#8 | 7 | #4 | #5 | 13-#5 |
| COLUMN LINE | 2.61 | 15 | 4 S 6 1 | 5 | #5 | #6 | 7-#9 | 7 | #4 | #5 | 13-#5 |
| 0.940 CF/SF | 3.13 | 15 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| | 3.98 | 15 * | 4 S 6 2 | 5 | #7 | #8 | 12-#9 | 7 | #5 | #5 | 13-#5 |
| | 4.60 | 19 * | 4 S 6 2 | 5 | #8 | #8 | 14-#9 | 7 | #5 | #6 | 14-#5 |
| 32'-6" | 2.10 | 16 | | 6 | #4 | #5 | 9-#7 | 7 | #4 | #5 | 13-#5 |
| D = 13.000 | 2.24 | 16 | | 6 | #4 | #5 | 11-#7 | 7 | #4 | #5 | 13-#5 |
| RIB NOT ON | 2.47 | 16 | | 6 | #5 | #5 | 10-#8 | 7 | #4 | #5 | 13-#5 |
| COLUMN LINE | 2.89 | 16 * | 4 S 6 1 | 6 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| 0.965 CF/SF | 3.67 | 16 * | 4 S 6 1 | 6 | #7 | #7 | 12-#9 | 7 | #5 | #5 | 13-#5 |
| | 4.30 | 20 * | 4 S 6 2 | 6 | #7 | #8 | 18-#8 | 7 | #5 | #6 | 15-#5 |
| 35'-0" | 2.22 | 17 | | 6 | #4 | #5 | 11-#7 | 8 | #4 | #5 | 15-#5 |
| D = 13.000 | 2.43 | 17 | | 6 | #5 | #5 | 10-#8 | 8 | #4 | #5 | 15-#5 |
| RIB NOT ON | 2.78 | 17 * | 4 S 6 1 | 6 | #5 | #6 | 10-#9 | 8 | #4 | #5 | 15-#5 |
| COLUMN LINE | 3.25 | 17 * | 4 S 6 1 | 6 | #6 | #7 | 12-#9 | 8 | #4 | #5 | 15-#5 |
| 0.952 CF/SF | 4.25 | 18 * | 4 S 6 2 | 6 | #7 | #8 | 15-#9 | 8 | #5 | #6 | 16-#5 |

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 ½ in. | Rib Depth = 14 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | | | |
| 37'-6" | 50 | 2.54 | 18 | 0.739 | | 16-#5+ 3 | 6 | #6 | #7 | 9-#9 | 9 | #4 | #5 | 17-#5 | 331 | 662 | 891 |
| D = 13.000 | 100 | 2.84 | 18 * | 0.848 | | 12-#6+ 5 | 6 | #7 | #7 | 11-#9 | 9 | #4 | #5 | 17-#5 | 410 | 820 | 1104 |
| RIB NOT ON | 150 | 3.38 | 18 * | 0.634 | | 11-#7+ 3 | 6 | #7 | #8 | 14-#9 | 9 | #5 | #5 | 17-#5 | 489 | 980 | 1316 |
| COLUMN LINE | 200 | 3.93 | 21 * | 0.631 | | 9-#8+ 2 | 6 | #8 | #9 | 16-#9 | 9 | #5 | #6 | 17-#5 | 564 | 1242 | 1518 |
| 0.940 CF/SF | 300 | 5.06 | 28 * | 0.626 | 4 S 6 1 | 9-#9+ 2 | 6 | #9 | #10 | 20-#9 | 9 | #6 | #7 | 21-#5 | 700 | 1504 | 1886 |
| 40'-0" | 50 | 2.67 | 20 * | 0.808 | | 12-#6+ 7 | 7 | #6 | #7 | 11-#9 | 9 | #4 | #5 | 17-#5 | 404 | 807 | 1087 |
| D = 15.500 | 100 | 3.17 | 20 * | 0.890 | | 11-#7+ 6 | 7 | #7 | #7 | 14-#9 | 9 | #5 | #5 | 17-#5 | 499 | 998 | 1344 |
| RIB ON | 150 | 3.75 | 21 * | 0.631 | | 13-#7+ 4 | 7 | #8 | #8 | 17-#9 | 9 | #5 | #6 | 17-#5 | 593 | 1187 | 1597 |
| COLUMN LINE | 200 | 4.36 | 25 * | 0.628 | | 11-#8+ 3 | 7 | #8 | #9 | 19-#9 | 9 | #6 | #6 | 20-#5 | 682 | 1447 | 1837 |
| 0.960 CF/SF | | | | | | | | | | | | | | | | | |
| 42'-6" | 50 | 2.96 | 21 * | 0.837 | | 14-#6+ 7 | 7 | #7 | #7 | 13-#9 | 10 | #5 | #5 | 18-#5 | 482 | 965 | 1299 |
| D = 15.500 | 100 | 3.63 | 21 * | 0.631 | | 13-#7+ 4 | 7 | #8 | #8 | 17-#9 | 10 | #5 | #6 | 18-#5 | 597 | 1194 | 1607 |
| RIB ON | 150 | 4.30 | 25 * | 0.628 | | 12-#8+ 2 | 7 | #8 | #9 | 20-#9 | 10 | #6 | #6 | 21-#5 | 706 | 1411 | 1900 |
| COLUMN LINE | 200 | 4.78 | 30 * | 0.624 | 4 S 6 1 | 11-#9+ 2 | 7 | #9 | #9 | 23-#9 | 10 | #6 | #6 | 24-#5 | 806 | 1611 | 2169 |
| 0.950 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.32 | 22 * | 0.879 | | 17-#6+ 9 | 7 | #7 | #8 | 16-#9 | 11 | #5 | #5 | 20-#5 | 571 | 1142 | 1537 |
| D = 15.500 | 100 | 3.92 | 24 * | 0.628 | | 12-#8+ 2 | 7 | #8 | #9 | 20-#9 | 11 | #5 | #6 | 21-#5 | 704 | 1409 | 1897 |
| RIB ON | 150 | 4.63 | 30 * | 0.624 | 4 S 6 1 | 11-#9+ 3 | 7 | #9 | #9 | 24-#9 | 11 | #6 | #6 | 24-#5 | 829 | 1657 | 2231 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.940 CF/SF | | | | | | | | | | | | | | | | | |
| 47'-6" | 50 | 3.66 | 23 * | 0.922 | | 12-#8+ 8 | 8 | #8 | #8 | 19-#9 | 11 | #5 | #6 | 20-#5 | 677 | 1354 | 1822 |
| D = 18.000 | 100 | 4.39 | 29 * | 0.625 | | 14-#8+ 4 | 8 | #8 | #9 | 24-#9 | 11 | #6 | #6 | 24-#5 | 828 | 1655 | 2228 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.957 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 ½ in. | Rib Depth = 14 in. | Total Slab Depth = 4 ½ in. | | | | | | | | |
| 2.39 | 18 | | 6 | #5 | #5 | 10-#8 | 9 | #4 | #5 | 17-#5 |
| 2.72 | 18 | 4 S 6 1 | 6 | #5 | #6 | 10-#9 | 9 | #4 | #5 | 17-#5 |
| 3.21 | 18 * | 4 S 6 1 | 6 | #6 | #7 | 16-#8 | 9 | #4 | #5 | 17-#5 |
| 3.61 | 18 * | 4 S 6 2 | 6 | #7 | #7 | 15-#9 | 9 | #4 | #5 | 17-#5 |
| 4.58 | 23 * | 4 S 6 2 | 6 | #8 | #8 | 19-#9 | 9 | #5 | #5 | 19-#5 |
| 2.56 | 20 | | 7 | #5 | #5 | 13-#8 | 9 | #4 | #5 | 17-#5 |
| 3.01 | 20 * | 4 S 6 1 | 7 | #6 | #6 | 16-#8 | 9 | #4 | #5 | 17-#5 |
| 3.40 | 20 * | 4 S 6 1 | 7 | #6 | #7 | 15-#9 | 9 | #4 | #5 | 17-#5 |
| 4.02 | 20* | 4 S 6 2 | 7 | #7 | #7 | 18-#9 | 9 | #5 | #5 | 19-#5 |
| 2.75 | 21 | | 7 | #5 | #6 | 12-#9 | 10 | #4 | #5 | 18-#5 |
| 3.29 | 21 * | 4 S 6 1 | 7 | #6 | #7 | 15-#9 | 10 | #4 | #5 | 18-#5 |
| 3.97 | 21 * | 4 S 6 2 | 7 | #7 | #7 | 19-#9 | 10 | #5 | #5 | 19-#5 |
| 4.45 | 24 * | 4 S 6 2 | 7 | #7 | #8 | 22-#9 | 10 | #5 | #5 | 22-#5 |
| 3.21 | 22 * | 4 S 6 1 | 7 | #6 | #7 | 15-#9 | 11 | #4 | #5 | 20-#5 |
| 3.56 | 22 * | 4 S 6 1 | 7 | #7 | #7 | 18-#9 | 11 | #4 | #5 | 20-#5 |
| 4.30 | 23 * | 4 S 6 2 | 7 | #7 | #8 | 22-#9 | 11 | #5 | #5 | 23-#5 |
| 3.31 | 23 * | 4 S 6 1 | 8 | #6 | #7 | 17-#9 | 11 | #4 | #5 | 20-#5 |
| 4.06 | 23 * | 4 S 6 1 | 8 | #7 | #7 | 22-#9 | 11 | #5 | #5 | 23-#5 |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 20 ½ in. | | Rib Depth = 16 in. | | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | |
| 27'-6" | 50 | 1.97 | 13 | 0.641 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 6 | #4 | #5 | 12-#5 | 141 | 282 | 380 |
| D = 10.500 | 100 | 1.99 | 13 | 0.641 | | 8-#6+ 0 | 5 | #4 | #5 | 9-#6 | 6 | #4 | #5 | 12-#5 | 172 | 344 | 463 |
| RIB ON | 150 | 2.13 | 13 | 0.641 | | 8-#6+ 0 | 5 | #5 | #5 | 8-#7 | 6 | #4 | #5 | 12-#5 | 203 | 433 | 547 |
| COLUMN LINE | 200 | 2.38 | 13 | 0.669 | | 8-#6+ 1 | 5 | #6 | #6 | 7-#8 | 6 | #4 | #5 | 12-#5 | 235 | 539 | 631 |
| 1.047 CF/SF | 300 | 2.85 | 13 | 0.806 | | 8-#6+ 3 | 5 | #7 | #7 | 7-#9 | 6 | #5 | #5 | 12-#5 | 297 | 739 | 799 |
| | 400 | 3.38 | 13 * | 0.642 | | 9-#6+ 2 | 5 | #7 | #8 | 9-#9 | 6 | #5 | #6 | 12-#5 | 359 | 934 | 967 |
| | 500 | 4.11 | 13 * | 0.642 | | 8-#7+ 2 | 5 | #8 | #9 | 10-#9 | 6 | #6 | #7 | 12-#5 | 422 | 1126 | 1135 |
| 30'-0" | 50 | 2.06 | 15 | 0.638 | | 9-#6+ 0 | 5 | #5 | #5 | 7-#7 | 7 | #4 | #5 | 13-#5 | 181 | 362 | 487 |
| D = 10.500 | 100 | 2.21 | 15 | 0.638 | | 9-#6+ 0 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #5 | 13-#5 | 221 | 443 | 596 |
| RIB ON | 150 | 2.40 | 15 | 0.638 | | 9-#6+ 0 | 5 | #6 | #6 | 8-#8 | 7 | #4 | #5 | 13-#5 | 262 | 546 | 704 |
| COLUMN LINE | 200 | 2.61 | 15 | 0.702 | | 9-#6+ 1 | 5 | #6 | #7 | 7-#9 | 7 | #4 | #5 | 13-#5 | 302 | 684 | 813 |
| 1.031 CF/SF | 300 | 3.28 | 15 * | 0.843 | | 7-#7+ 2 | 5 | #7 | #8 | 9-#9 | 7 | #5 | #6 | 13-#5 | 382 | 942 | 1030 |
| | 400 | 3.97 | 15 * | 0.639 | 4 S 6 1 | 12-#6+ 1 | 5 | #8 | #9 | 11-#9 | 7 | #6 | #6 | 13-#5 | 463 | 1193 | 1247 |
| | 500 | 4.82 | 17 * | 0.637 | 4 S 6 1 | 8-#8+ 2 | 5 | #9 | #10 | 13-#9 | 7 | #6 | #7 | 14-#5 | 540 | 1432 | 1455 |
| 32'-6" | 50 | 2.09 | 16 | 0.637 | | 10-#6+ 1 | 6 | #5 | #5 | 9-#7 | 7 | #4 | #5 | 13-#5 | 233 | 466 | 627 |
| D = 13.000 | 100 | 2.26 | 16 | 0.678 | | 10-#6+ 2 | 6 | #5 | #6 | 11-#7 | 7 | #4 | #5 | 13-#5 | 284 | 569 | 765 |
| RIB NOT ON | 150 | 2.49 | 16 | 0.751 | | 10-#6+ 3 | 6 | #6 | #6 | 10-#8 | 7 | #4 | #5 | 13-#5 | 336 | 694 | 904 |
| COLUMN LINE | 200 | 2.96 | 16 * | 0.826 | | 10-#6+ 5 | 6 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 13-#5 | 387 | 870 | 1042 |
| 1.059 CF/SF | 300 | 3.80 | 16 * | 0.638 | | 9-#7+ 2 | 6 | #8 | #8 | 12-#9 | 7 | #6 | #6 | 13-#5 | 490 | 1199 | 1318 |
| | 400 | 4.76 | 19 * | 0.635 | | 11-#7+ 3 | 6 | #9 | #9 | 18-#8 | 7 | #7 | #7 | 15-#5 | 587 | 1506 | 1581 |
| | 500 | 5.53 | 23 * | 0.631 | | 10-#8+ 1 | 6 | #9 | #10 | 17-#9 | 7 | #7 | #8 | 13-#6 | 674 | 1726 | 1815 |
| 35'-0" | 50 | 2.24 | 17 | 0.636 | | 15-#5+ 1 | 6 | #5 | #6 | 11-#7 | 8 | #4 | #5 | 15-#5 | 290 | 579 | 779 |
| D = 13.000 | 100 | 2.51 | 17 | 0.712 | | 15-#5+ 3 | 6 | #6 | #6 | 9-#9 | 8 | #4 | #5 | 15-#5 | 354 | 707 | 952 |
| RIB NOT ON | 150 | 2.75 | 17 * | 0.818 | | 11-#6+ 5 | 6 | #6 | #7 | 10-#9 | 8 | #4 | #5 | 15-#5 | 418 | 850 | 1125 |
| COLUMN LINE | 200 | 3.34 | 17 * | 0.878 | | 9-#7+ 4 | 6 | #7 | #8 | 12-#9 | 8 | #5 | #6 | 15-#5 | 482 | 1071 | 1298 |
| 1.044 CF/SF | 300 | 4.47 | 18 * | 0.636 | | 9-#8+ 1 | 6 | #9 | #9 | 15-#9 | 8 | #6 | #7 | 16-#5 | 609 | 1477 | 1639 |
| | 400 | 5.23 | 24 * | 0.630 | | 14-#7+ 2 | 6 | #9 | #10 | 18-#9 | 8 | #7 | #7 | 19-#5 | 720 | 1778 | 1938 |
| 37'-6" | 50 | 2.46 | 18 | 0.644 | | 16-#5+ 1 | 6 | #6 | #6 | 9-#9 | 9 | #4 | #5 | 17-#5 | 355 | 710 | 955 |
| D = 13.000 | 100 | 2.77 | 18 * | 0.781 | | 16-#5+ 6 | 6 | #7 | #7 | 10-#9 | 9 | #4 | #5 | 17-#5 | 434 | 867 | 1168 |
| RIB NOT ON | 150 | 3.23 | 18 * | 0.858 | | 10-#7+ 3 | 6 | #7 | #8 | 16-#8 | 9 | #5 | #5 | 17-#5 | 513 | 1025 | 1380 |
| COLUMN LINE | 200 | 3.79 | 18 * | 0.636 | | 22-#5+ 3 | 6 | #8 | #9 | 15-#9 | 9 | #5 | #6 | 17-#5 | 592 | 1295 | 1593 |
| 1.031 CF/SF | 300 | 4.96 | 23 * | 0.631 | | 11-#8+ 3 | 6 | #9 | #10 | 19-#9 | 9 | #6 | #7 | 19-#5 | 741 | 1777 | 1994 |
| | 400 | 5.72 | 29 * | 0.627 | 4 S 6 1 | 10-#9+ 1 | 6 | #10 | #10 | 22-#9 | 9 | #7 | #7 | 23-#5 | 870 | 1943 | 2341 |
| 40'-0" | 50 | 2.61 | 20 | 0.703 | | 12-#6+ 3 | 7 | #6 | #7 | 13-#8 | 9 | #4 | #5 | 17-#5 | 433 | 866 | 1165 |
| D = 15.500 | 100 | 3.03 | 20 * | 0.837 | | 14-#6+ 7 | 7 | #7 | #7 | 16-#8 | 9 | #5 | #5 | 17-#5 | 528 | 1057 | 1422 |
| RIB ON | 150 | 3.46 | 20 * | 0.903 | | 12-#7+ 6 | 7 | #7 | #8 | 15-#9 | 9 | #5 | #6 | 17-#5 | 624 | 1248 | 1680 |
| COLUMN LINE | 200 | 4.25 | 21 * | 0.633 | | 14-#7+ 4 | 7 | #8 | #9 | 18-#9 | 9 | #6 | #6 | 19-#5 | 718 | 1522 | 1932 |
| 1.053 CF/SF | 300 | 5.38 | 28 * | 0.628 | 4 S 6 1 | 13-#8+ 2 | 7 | #9 | #10 | 28-#8 | 9 | #7 | #7 | 23-#5 | 888 | 1961 | 2391 |
| 42'-6" | 50 | 2.85 | 21 * | 0.769 | | 19-#5+ 7 | 7 | #7 | #7 | 16-#8 | 10 | #4 | #5 | 18-#5 | 517 | 1034 | 1392 |
| D = 15.500 | 100 | 3.28 | 21 * | 0.876 | | 12-#7+ 6 | 7 | #7 | #8 | 16-#9 | 10 | #5 | #5 | 18-#5 | 632 | 1264 | 1701 |
| RIB ON | 150 | 3.86 | 21 * | 0.633 | | 11-#8+ 3 | 7 | #8 | #8 | 19-#9 | 10 | #5 | #6 | 19-#5 | 746 | 1493 | 2010 |
| COLUMN LINE | 200 | 4.61 | 25 * | 0.630 | | 13-#8+ 2 | 7 | #9 | #9 | 22-#9 | 10 | #6 | #6 | 22-#5 | 854 | 1766 | 2299 |
| 1.041 CF/SF | 300 | 5.52 | 33 * | 0.625 | 4 S 6 1 | 16-#8+ 3 | 7 | #9 | #10 | 27-#9 | 10 | #6 | #7 | 20-#6 | 1048 | 2095 | 2821 |
| 45'-0" | 50 | 3.19 | 22 * | 0.828 | | 12-#7+ 5 | 7 | #7 | #8 | 15-#9 | 11 | #5 | #5 | 20-#5 | 612 | 1224 | 1648 |
| D = 15.500 | 100 | 3.75 | 22 * | 0.915 | | 11-#8+ 6 | 7 | #8 | #8 | 19-#9 | 11 | #5 | #6 | 20-#5 | 748 | 1497 | 2015 |
| RIB ON | 150 | 4.51 | 25 * | 0.630 | | 13-#8+ 2 | 7 | #9 | #9 | 22-#9 | 11 | #6 | #6 | 23-#5 | 879 | 1759 | 2367 |
| COLUMN LINE | 200 | 5.02 | 30 * | 0.626 | 4 S 6 1 | 12-#9+ 2 | 7 | #9 | #10 | 26-#9 | 11 | #6 | #6 | 26-#5 | 1001 | 2001 | 2694 |
| 1.031 CF/SF | | | | | | | | | | | | | | | | | |
| 47'-6" | 50 | 3.45 | 23 * | 0.878 | | 14-#7+ 8 | 8 | #7 | #8 | 18-#9 | 11 | #5 | #6 | 20-#5 | 726 | 1451 | 1954 |
| D = 18.000 | 100 | 4.28 | 25 * | 0.630 | | 13-#8+ 4 | 8 | #8 | #9 | 22-#9 | 11 | #6 | #6 | 23-#5 | 883 | 1765 | 2377 |
| RIB NOT ON | 150 | 4.92 | 30 * | 0.626 | | 12-#9+ 2 | 8 | #9 | #9 | 26-#9 | 11 | #6 | #7 | 27-#5 | 1033 | 2065 | 2780 |
| COLUMN LINE | 200 | 5.51 | 36 * | 0.623 | | 14-#9+ 3 | 8 | #9 | #10 | 30-#9 | 11 | #6 | #7 | 22-#6 | 1166 | 2333 | 3140 |
| 1.050 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 20 ½ in. | | Rib Depth = 16 in. | | Total Slab Depth = 4 ½ in. | | | | | | | |
| 27'-6" | 1.98 | 13 | | 5 | #4 | #5 | 8-#6 | 6 | #4 | #5 | 12-#5 |
| D = 10.500 | 1.98 | 13 | | 5 | #4 | #5 | 8-#6 | 6 | #4 | #5 | 12-#5 |
| RIB ON | 2.09 | 13 | | 5 | #4 | #5 | 7-#7 | 6 | #4 | #5 | 12-#5 |
| COLUMN LINE | 2.26 | 13 | | 5 | #5 | #5 | 8-#7 | 6 | #4 | #5 | 12-#5 |
| 1.047 CF/SF | 2.58 | 13 | 4 S 6 1 | 5 | #5 | #6 | 8-#8 | 6 | #4 | #5 | 12-#5 |
| | 3.09 | 13 * | 4 S 6 1 | 5 | #6 | #7 | 8-#9 | 6 | #4 | #5 | 12-#5 |
| | 3.57 | 13 * | 4 S 6 1 | 5 | #7 | #7 | 9-#9 | 6 | #5 | #5 | 12-#5 |
| 30'-0" | 2.01 | 15 | | 5 | #4 | #5 | 9-#6 | 7 | #4 | #5 | 13-#5 |
| D = 10.500 | 2.10 | 15 | | 5 | #4 | #5 | 8-#7 | 7 | #4 | #5 | 13-#5 |
| RIB ON | 2.30 | 15 | | 5 | #5 | #5 | 7-#8 | 7 | #4 | #5 | 13-#5 |
| COLUMN LINE | 2.50 | 15 | 4 S 6 1 | 5 | #5 | #6 | 8-#8 | 7 | #4 | #5 | 13-#5 |
| 1.031 CF/SF | 2.98 | 15* | 4 S 6 1 | 5 | #6 | #7 | 8-#9 | 7 | #4 | #5 | 13-#5 |
| | 3.54 | 15 * | 4 S 6 2 | 5 | #7 | #7 | 10-#9 | 7 | #5 | #5 | 13-#5 |
| | 4.29 | 15 * | 4 S 6 2 | 5 | #8 | #8 | 12-#9 | 7 | #5 | #6 | 13-#5 |
| 32'-6" | 2.04 | 16 | | 6 | #4 | #5 | 11-#6 | 7 | #4 | #5 | 13-#5 |
| D = 13.000 | 2.16 | 16 | | 6 | #4 | #5 | 10-#7 | 7 | #4 | #5 | 13-#5 |
| RIB NOT ON | 2.40 | 16 | | 6 | #5 | #5 | 9-#8 | 7 | #4 | #5 | 13-#5 |
| COLUMN LINE | 2.76 | 16 | | 6 | #5 | #6 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| 1.059 CF/SF | 3.43 | 16 * | 4 S 6 1 | 6 | #6 | #7 | 11-#9 | 7 | #5 | #5 | 13-#5 |
| | 4.24 | 16 * | 4 S 6 2 | 6 | #7 | #8 | 14-#9 | 7 | #5 | #6 | 14-#5 |
| | 4.92 | 20 * | 4 S 6 2 | 6 | #8 | #8 | 16-#9 | 7 | #6 | #6 | 16-#5 |
| 35'-0" | 2.16 | 17 | | 6 | #4 | #5 | 14-#6 | 8 | #4 | #5 | 15-#5 |
| D = 13.000 | 2.43 | 17 | | 6 | #5 | #5 | 10-#8 | 8 | #4 | #5 | 15-#5 |
| RIB NOT ON | 2.70 | 17 | | 6 | #5 | #6 | 9-#9 | 8 | #4 | #5 | 15-#5 |
| COLUMN LINE | 3.03 | 17 * | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 8 | #4 | #5 | 15-#5 |
| 1.044 CF/SF | 3.94 | 17 * | 4 S 6 2 | 6 | #7 | #8 | 14-#9 | 8 | #5 | #5 | 15-#5 |
| | 4.69 | 20 * | 4 S 6 2 | 6 | #8 | #8 | 17-#9 | 8 | #5 | #6 | 18-#5 |
| 37'-6" | 2.39 | 18 | | 6 | #5 | #5 | 10-#8 | 9 | #4 | #5 | 17-#5 |
| D = 13.000 | 2.66 | 18 | | 6 | #5 | #6 | 12-#8 | 9 | #4 | #5 | 17-#5 |
| RIB NOT ON | 3.03 | 18 * | 4 S 6 1 | 6 | #6 | #6 | 12-#9 | 9 | #4 | #5 | 17-#5 |
| COLUMN LINE | 3.41 | 18 * | 4 S 6 1 | 6 | #7 | #7 | 13-#9 | 9 | #4 | #5 | 17-#5 |
| 1.031 CF/SF | 4.49 | 18 * | 4 S 6 2 | 6 | #8 | #8 | 17-#9 | 9 | #5 | #6 | 18-#5 |
| | 5.20 | 25 * | 4 S 6 2 | 6 | #8 | #9 | 21-#9 | 9 | #5 | #6 | 21-#5 |
| 40'-0" | 2.47 | 20 | | 7 | #5 | #5 | 12-#8 | 9 | #4 | #5 | 17-#5 |
| D = 15.500 | 2.83 | 20 | | 7 | #5 | #6 | 12-#9 | 9 | #4 | #5 | 17-#5 |
| RIB ON | 3.14 | 20 * | 4 S 6 1 | 7 | #6 | #6 | 14-#9 | 9 | #4 | #5 | 17-#5 |
| COLUMN LINE | 3.90 | 20 * | 4 S 6 1 | 7 | #7 | #7 | 17-#9 | 9 | #5 | #5 | 17-#5 |
| 1.053 CF/SF | 4.88 | 23 * | 4 S 6 2 | 7 | #8 | #8 | 21-#9 | 9 | #5 | #6 | 22-#5 |
| 42'-6" | 2.75 | 21 | | 7 | #5 | #6 | 12-#9 | 10 | #4 | #5 | 18-#5 |
| D = 15.500 | 3.04 | 21 * | 4 S 6 1 | 7 | #6 | #6 | 14-#9 | 10 | #4 | #5 | 18-#5 |
| RIB ON | 3.59 | 21 * | 4 S 6 1 | 7 | #7 | #7 | 17-#9 | 10 | #4 | #5 | 18-#5 |
| COLUMN LINE | 4.24 | 21 * | 4 S 6 2 | 7 | #7 | #8 | 20-#9 | 10 | #5 | #5 | 21-#5 |
| 1.041 CF/SF | 5.15 | 28 * | 4 S 6 2 | 7 | #8 | #8 | 25-#9 | 10 | #5 | #6 | 18-#6 |
| 45'-0" | 2.98 | 22 | 4 S 6 1 | 7 | #6 | #6 | 14-#9 | 11 | #4 | #5 | 20-#5 |
| D = 15.500 | 3.50 | 22 * | 4 S 6 1 | 7 | #7 | #7 | 17-#9 | 11 | #4 | #5 | 20-#5 |
| RIB ON | 4.18 | 22 * | 4 S 6 2 | 7 | #7 | #8 | 21-#9 | 11 | #5 | #5 | 21-#5 |
| COLUMN LINE | 4.66 | 24 * | 4 S 6 2 | 7 | #8 | #8 | 24-#9 | 11 | #5 | #5 | 25-#5 |
| 1.031 CF/SF | | | | | | | | | | | |
| 47'-6" | 3.17 | 23 * | | 8 | #6 | #6 | 17-#9 | 11 | #4 | #5 | 20-#5 |
| D = 18.000 | 3.95 | 23 * | 4 S 6 1 | 8 | #7 | #7 | 21-#9 | 11 | #5 | #5 | 21-#5 |
| RIB NOT ON | 4.53 | 23 * | 4 S 6 2 | 8 | #7 | #8 | 25-#9 | 11 | #5 | #5 | 26-#5 |
| COLUMN LINE | 5.16 | 28 * | 4 S 6 2 | 8 | #8 | #8 | 28-#9 | 11 | #5 | #6 | 21-#6 |
| 1.050 CF/SF | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 24 ½ in. | | Rib Depth = 20 in. | | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | |
| 32'-6" | 50 | 2.29 | 16 | 0.641 | | 10-#6+ 0 | 6 | #5 | #5 | 9-#7 | 7 | #5 | #5 | 13-#5 | 266 | 532 | 716 |
| D = 13.000 | 100 | 2.43 | 16 | 0.641 | | 10-#6+ 0 | 6 | #5 | #6 | 10-#7 | 7 | #5 | #5 | 13-#5 | 317 | 634 | 854 |
| RIB NOT ON | 150 | 2.53 | 16 | 0.641 | | 10-#6+ 0 | 6 | #5 | #6 | 9-#8 | 7 | #5 | #5 | 13-#5 | 368 | 737 | 992 |
| COLUMN LINE | 200 | 2.77 | 16 | 0.641 | | 10-#6+ 1 | 6 | #6 | #7 | 10-#8 | 7 | #5 | #5 | 13-#5 | 420 | 917 | 1130 |
| 1.253 CF/SF | 300 | 3.33 | 16 | 0.759 | | 11-#6+ 2 | 6 | #7 | #8 | 10-#9 | 7 | #5 | #6 | 13-#5 | 522 | 1255 | 1406 |
| | 400 | 4.10 | 16 * | 0.642 | | 10-#7+ 1 | 6 | #8 | #9 | 12-#9 | 7 | #6 | #7 | 13-#5 | 625 | 1578 | 1683 |
| | 500 | 4.82 | 16 * | 0.642 | | 9-#8+ 1 | 6 | #9 | #9 | 15-#9 | 7 | #7 | #7 | 15-#5 | 728 | 1897 | 1959 |
| 35'-0" | 50 | 2.45 | 17 | 0.640 | | 15-#5+ 0 | 6 | #5 | #6 | 11-#7 | 8 | #5 | #5 | 15-#5 | 330 | 660 | 889 |
| D = 13.000 | 100 | 2.61 | 17 | 0.640 | | 15-#5+ 0 | 6 | #6 | #6 | 10-#8 | 8 | #5 | #5 | 15-#5 | 394 | 789 | 1062 |
| RIB NOT ON | 150 | 2.76 | 17 | 0.640 | | 15-#5+ 1 | 6 | #6 | #7 | 9-#9 | 8 | #5 | #5 | 15-#5 | 459 | 917 | 1235 |
| COLUMN LINE | 200 | 3.01 | 17 | 0.674 | | 11-#6+ 1 | 6 | #7 | #7 | 10-#9 | 8 | #5 | #5 | 15-#5 | 523 | 1131 | 1407 |
| 1.234 CF/SF | 300 | 3.77 | 17 * | 0.868 | | 10-#7+ 4 | 6 | #8 | #8 | 16-#8 | 8 | #6 | #6 | 15-#5 | 651 | 1554 | 1753 |
| | 400 | 4.57 | 17 * | 0.641 | | 9-#8+ 2 | 6 | #9 | #9 | 16-#9 | 8 | #6 | #7 | 16-#5 | 779 | 1957 | 2098 |
| | 500 | 5.59 | 19 * | 0.638 | | 11-#8+ 1 | 6 | #10 | #10 | 18-#9 | 8 | #7 | #7 | 19-#5 | 903 | 2343 | 2431 |
| 37'-6" | 50 | 2.58 | 18 | 0.639 | | 16-#5+ 0 | 6 | #6 | #6 | 10-#8 | 9 | #5 | #5 | 17-#5 | 405 | 809 | 1089 |
| D = 13.000 | 100 | 2.84 | 18 | 0.639 | | 16-#5+ 0 | 6 | #6 | #7 | 9-#9 | 9 | #5 | #5 | 17-#5 | 484 | 967 | 1302 |
| RIB NOT ON | 150 | 3.02 | 18 | 0.672 | | 12-#6+ 1 | 6 | #7 | #7 | 11-#9 | 9 | #5 | #5 | 17-#5 | 562 | 1125 | 1514 |
| COLUMN LINE | 200 | 3.39 | 18 * | 0.805 | | 10-#7+ 3 | 6 | #7 | #8 | 16-#8 | 9 | #5 | #5 | 17-#5 | 641 | 1372 | 1727 |
| 1.219 CF/SF | 300 | 4.34 | 18 * | 0.640 | | 10-#8+ 1 | 6 | #9 | #9 | 16-#9 | 9 | #6 | #6 | 17-#5 | 799 | 1893 | 2152 |
| | 400 | 5.42 | 20 * | 0.637 | | 9-#9+ 2 | 6 | #10 | #10 | 20-#9 | 9 | #7 | #7 | 20-#5 | 953 | 2377 | 2565 |
| 40'-0" | 50 | 2.64 | 20 | 0.636 | | 12-#6+ 2 | 7 | #6 | #6 | 12-#8 | 9 | #5 | #5 | 17-#5 | 494 | 988 | 1329 |
| D = 15.500 | 100 | 2.96 | 20 | 0.649 | | 18-#5+ 3 | 7 | #6 | #7 | 12-#9 | 9 | #5 | #5 | 17-#5 | 589 | 1179 | 1587 |
| RIB ON | 150 | 3.25 | 20 * | 0.805 | | 11-#7+ 5 | 7 | #7 | #7 | 14-#9 | 9 | #5 | #5 | 17-#5 | 685 | 1370 | 1844 |
| COLUMN LINE | 200 | 3.73 | 20 * | 0.866 | | 12-#7+ 6 | 7 | #8 | #8 | 16-#9 | 9 | #5 | #6 | 17-#5 | 780 | 1631 | 2101 |
| 1.246 CF/SF | 300 | 4.77 | 20 * | 0.637 | | 12-#8+ 2 | 7 | #9 | #9 | 20-#9 | 9 | #6 | #7 | 21-#5 | 971 | 2263 | 2615 |
| | 400 | 5.96 | 25 * | 0.633 | 5 S 8 1 | 11-#9+ 3 | 7 | #10 | #10 | 24-#9 | 9 | #7 | #8 | 17-#6 | 1147 | 2795 | 3088 |
| 42'-6" | 50 | 2.90 | 21 | 0.636 | | 13-#6+ 2 | 7 | #6 | #7 | 12-#9 | 10 | #5 | #5 | 18-#5 | 590 | 1180 | 1588 |
| D = 15.500 | 100 | 3.25 | 21 | 0.763 | | 11-#7+ 4 | 7 | #7 | #8 | 14-#9 | 10 | #5 | #5 | 18-#5 | 704 | 1409 | 1897 |
| RIB ON | 150 | 3.72 | 21 * | 0.848 | | 13-#7+ 5 | 7 | #8 | #8 | 17-#9 | 10 | #5 | #6 | 18-#5 | 819 | 1638 | 2205 |
| COLUMN LINE | 200 | 4.20 | 21 * | 0.637 | | 11-#8+ 3 | 7 | #8 | #9 | 19-#9 | 10 | #6 | #6 | 20-#5 | 934 | 1916 | 2514 |
| 1.232 CF/SF | 300 | 5.46 | 24 * | 0.634 | 5 S 8 1 | 11-#9+ 3 | 7 | #10 | #10 | 24-#9 | 10 | #7 | #7 | 18-#6 | 1156 | 2658 | 3112 |
| 45'-0" | 50 | 3.10 | 22 | 0.721 | | 11-#7+ 4 | 7 | #7 | #7 | 14-#9 | 11 | #5 | #5 | 20-#5 | 698 | 1396 | 1879 |
| D = 15.500 | 100 | 3.57 | 22 * | 0.819 | | 13-#7+ 5 | 7 | #8 | #8 | 17-#9 | 11 | #5 | #5 | 20-#5 | 834 | 1668 | 2246 |
| RIB ON | 150 | 4.01 | 22 * | 0.902 | | 12-#8+ 6 | 7 | #8 | #9 | 20-#9 | 11 | #5 | #6 | 21-#5 | 970 | 1941 | 2613 |
| COLUMN LINE | 200 | 4.58 | 22 * | 0.636 | | 11-#9+ 3 | 7 | #9 | #9 | 23-#9 | 11 | #6 | #6 | 24-#5 | 1107 | 2220 | 2980 |
| 1.219 CF/SF | | | | | | | | | | | | | | | | | |
| 47'-6" | 50 | 3.34 | 23 * | 0.791 | | 13-#7+ 6 | 8 | #7 | #8 | 17-#9 | 11 | #5 | #5 | 20-#5 | 828 | 1656 | 2229 |
| D = 18.000 | 100 | 3.80 | 23 * | 0.877 | | 12-#8+ 6 | 8 | #8 | #8 | 20-#9 | 11 | #5 | #6 | 21-#5 | 988 | 1977 | 2661 |
| RIB NOT ON | 150 | 4.40 | 23 * | 0.635 | | 14-#8+ 4 | 8 | #8 | #9 | 24-#9 | 11 | #6 | #6 | 25-#5 | 1149 | 2297 | 3093 |
| COLUMN LINE | 200 | 5.03 | 27 * | 0.632 | | 16-#8+ 3 | 8 | #9 | #9 | 27-#9 | 11 | #6 | #7 | 20-#6 | 1299 | 2598 | 3498 |
| 1.242 CF/SF | 300 | 6.26 | 35 * | 0.627 | | 16-#9+ 2 | 8 | #10 | #10 | 33-#9 | 11 | #7 | #7 | 24-#6 | 1575 | 3150 | 4241 |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 24 ½ in. | | Rib Depth = 20 in. | | Total Slab Depth = 4 ½ in. | | | | | | |
| 2.27 | 16 | | 6 | #5 | #5 | 15-#5 | 7 | #5 | #5 | 13-#5 |
| 2.37 | 16 | | 6 | #5 | #5 | 9-#7 | 7 | #5 | #5 | 13-#5 |
| 2.51 | 16 | | 6 | #5 | #5 | 11-#7 | 7 | #5 | #5 | 13-#5 |
| 2.64 | 16 | | 6 | #5 | #5 | 10-#8 | 7 | #5 | #5 | 13-#5 |
| 3.05 | 16 | | 6 | #6 | #6 | 9-#9 | 7 | #5 | #5 | 13-#5 |
| 3.58 | 16 * | 5 S 8 1 | 6 | #7 | #7 | 11-#9 | 7 | #5 | #5 | 13-#5 |
| 4.24 | 16 * | 5 S 8 1 | 6 | #7 | #8 | 14-#9 | 7 | #5 | #6 | 14-#5 |
| 2.41 | 17 | | 6 | #5 | #5 | 10-#7 | 8 | #5 | #5 | 15-#5 |
| 2.54 | 17 | | 6 | #5 | #5 | 9-#8 | 8 | #5 | #5 | 15-#5 |
| 2.61 | 17 | | 6 | #5 | #5 | 10-#8 | 8 | #5 | #5 | 15-#5 |
| 2.87 | 17 | | 6 | #5 | #6 | 9-#9 | 8 | #5 | #5 | 15-#5 |
| 3.42 | 17 * | 5 S 8 1 | 6 | #6 | #7 | 12-#9 | 8 | #5 | #5 | 15-#5 |
| 4.10 | 17 * | 5 S 8 2 | 6 | #7 | #8 | 18-#8 | 8 | #5 | #6 | 15-#5 |
| 5.09 | 17 * | 5 S 8 2 | 6 | #8 | #9 | 17-#9 | 8 | #6 | #6 | 18-#5 |
| 2.52 | 18 | | 6 | #5 | #5 | 9-#8 | 9 | #5 | #5 | 17-#5 |
| 2.82 | 18 | | 6 | #5 | #6 | 9-#9 | 9 | #5 | #5 | 17-#5 |
| 2.90 | 18 | | 6 | #5 | #6 | 10-#9 | 9 | #5 | #5 | 17-#5 |
| 3.34 | 18 | 5 S 8 1 | 6 | #6 | #7 | 12-#9 | 9 | #5 | #5 | 17-#5 |
| 3.96 | 18 * | 5 S 8 2 | 6 | #7 | #8 | 15-#9 | 9 | #5 | #5 | 17-#5 |
| 4.79 | 18 * | 5 S 8 2 | 6 | #8 | #9 | 18-#9 | 9 | #5 | #6 | 19-#5 |
| 2.59 | 20 | | 7 | #5 | #5 | 11-#8 | 9 | #5 | #5 | 17-#5 |
| 2.93 | 20 | | 7 | #5 | #6 | 11-#9 | 9 | #5 | #5 | 17-#5 |
| 3.18 | 20 | | 7 | #6 | #6 | 16-#8 | 9 | #5 | #5 | 17-#5 |
| 3.45 | 20 * | 5 S 8 1 | 7 | #6 | #7 | 14-#9 | 9 | #5 | #5 | 17-#5 |
| 4.33 | 20 * | 5 S 8 2 | 7 | #7 | #8 | 18-#9 | 9 | #5 | #6 | 19-#5 |
| 5.37 | 21 * | 5 S 8 2 | 7 | #8 | #9 | 22-#9 | 9 | #6 | #6 | 23-#5 |
| 2.86 | 21 | | 7 | #5 | #6 | 11-#9 | 10 | #5 | #5 | 18-#5 |
| 3.10 | 21 | | 7 | #6 | #6 | 16-#8 | 10 | #5 | #5 | 18-#5 |
| 3.46 | 21 * | 5 S 8 1 | 7 | #6 | #7 | 15-#9 | 10 | #5 | #5 | 18-#5 |
| 3.84 | 21 * | 5 S 8 1 | 7 | #7 | #7 | 18-#9 | 10 | #5 | #5 | 18-#5 |
| 4.77 | 21 * | 5 S 8 2 | 7 | #8 | #8 | 22-#9 | 10 | #5 | #6 | 23-#5 |
| 3.05 | 22 | | 7 | #6 | #6 | 16-#8 | 11 | #5 | #5 | 20-#5 |
| 3.46 | 22 | 5 S 8 1 | 7 | #6 | #7 | 16-#9 | 11 | #5 | #5 | 20-#5 |
| 3.75 | 22 * | 5 S 8 1 | 7 | #7 | #7 | 18-#9 | 11 | #5 | #5 | 20-#5 |
| 4.21 | 22 * | 5 S 8 2 | 7 | #7 | #8 | 21-#9 | 11 | #5 | #5 | 22-#5 |
| 3.19 | 23 | | 8 | #6 | #6 | 15-#9 | 11 | #5 | #5 | 20-#5 |
| 3.56 | 23 * | 5 S 8 1 | 8 | #6 | #7 | 23-#8 | 11 | #5 | #5 | 20-#5 |
| 4.06 | 23 * | 5 S 8 1 | 8 | #7 | #7 | 22-#9 | 11 | #5 | #5 | 23-#5 |
| 4.68 | 23 * | 5 S 8 2 | 8 | #7 | #8 | 25-#9 | 11 | #5 | #6 | 26-#5 |
| 5.88 | 29 * | 5 S 8 2 | 8 | #8 | #9 | 31-#9 | 11 | #6 | #6 | 23-#6 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 13 in. | Rib Depth = 8 in. | | Total Slab Depth = 5 in. | | | | | | | | | | | | | | |
| 17'-6" | 50 | 1.71 | 12 | 0.633 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 | 27 | 55 | 74 |
| D = 8.000 | 100 | 1.71 | 12 | 0.633 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 | 35 | 71 | 95 |
| RIB NOT ON | 150 | 1.71 | 12 | 0.633 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 | 43 | 98 | 116 |
| COLUMN LINE | 200 | 1.71 | 12 | 0.633 | | 7-#5+ 0 | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 | 51 | 122 | 136 |
| 0.754 CF/SF | 300 | 1.85 | 12 | 0.681 | | 7-#5+ 0 | 4 | #4 | #5 | 8-#5 | 3 | #4 | #5 | 7-#5 | 66 | 171 | 178 |
| | 400 | 2.25 | 12 | 0.815 | | 7-#5+ 2 | 4 | #5 | #5 | 7-#6 | 3 | #5 | #5 | 7-#5 | 82 | 218 | 220 |
| | 500 | 2.63 | 12 * | 0.634 | | 7-#5+ 1 | 4 | #6 | #6 | 6-#7 | 3 | #5 | #6 | 7-#5 | 97 | 265 | 261 |
| 20'-0" | 50 | 1.73 | 12 | 0.633 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 41 | 82 | 111 |
| D = 8.000 | 100 | 1.73 | 12 | 0.649 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 53 | 106 | 143 |
| RIB NOT ON | 150 | 1.80 | 12 | 0.692 | | 6-#6+ 0 | 4 | #4 | #5 | 6-#6 | 4 | #4 | #4 | 8-#5 | 65 | 147 | 174 |
| COLUMN LINE | 200 | 1.87 | 12 | 0.736 | | 6-#6+ 0 | 4 | #5 | #5 | 9-#5 | 4 | #4 | #4 | 8-#5 | 76 | 184 | 206 |
| 0.737 CF/SF | 300 | 2.34 | 12 * | 0.824 | | 6-#6+ 0 | 4 | #6 | #6 | 6-#7 | 4 | #4 | #5 | 8-#5 | 100 | 257 | 269 |
| | 400 | 2.84 | 12 * | 0.634 | | 6-#6+ 0 | 4 | #6 | #7 | 6-#8 | 4 | #5 | #6 | 8-#5 | 123 | 329 | 332 |
| | 500 | 3.46 | 14 * | 0.631 | | 6-#6+ 1 | 4 | #7 | #8 | 7-#8 | 4 | #6 | #6 | 8-#5 | 145 | 396 | 392 |
| 22'-6" | 50 | 1.79 | 12 | 0.697 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 | 59 | 118 | 159 |
| D = 8.000 | 100 | 1.85 | 12 | 0.744 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 76 | 152 | 204 |
| RIB NOT ON | 150 | 2.09 | 12 | 0.791 | | 10-#5+ 0 | 4 | #5 | #6 | 6-#7 | 5 | #4 | #4 | 10-#5 | 93 | 210 | 250 |
| COLUMN LINE | 200 | 2.35 | 12 * | 0.853 | | 10-#5+ 1 | 4 | #6 | #6 | 7-#7 | 5 | #4 | #5 | 10-#5 | 110 | 264 | 295 |
| 0.725 CF/SF | 300 | 2.87 | 12 * | 0.634 | | 10-#5+ 0 | 4 | #7 | #7 | 7-#8 | 5 | #5 | #5 | 10-#5 | 144 | 369 | 386 |
| | 400 | 3.53 | 16 * | 0.628 | | 6-#7+ 0 | 4 | #8 | #8 | 7-#9 | 5 | #5 | #6 | 10-#5 | 174 | 459 | 468 |
| 25'-0" | 50 | 1.75 | 12 | 0.767 | | 8-#6+ 0 | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 | 83 | 165 | 222 |
| D = 10.500 | 100 | 1.85 | 12 * | 0.839 | | 8-#6+ 1 | 5 | #4 | #5 | 9-#6 | 5 | #4 | #4 | 10-#5 | 106 | 213 | 285 |
| RIB ON | 150 | 2.23 | 12 * | 0.896 | | 8-#6+ 2 | 5 | #5 | #6 | 8-#7 | 5 | #4 | #5 | 10-#5 | 129 | 294 | 348 |
| COLUMN LINE | 200 | 2.65 | 12 * | 0.634 | | 8-#6+ 1 | 5 | #6 | #7 | 8-#8 | 5 | #5 | #5 | 10-#5 | 153 | 369 | 411 |
| 0.744 CF/SF | 300 | 3.47 | 17 * | 0.627 | | 8-#6+ 2 | 5 | #7 | #8 | 8-#9 | 5 | #6 | #6 | 10-#5 | 195 | 499 | 526 |
| 27'-6" | 50 | 1.91 | 13 | 0.775 | | 8-#6+ 0 | 5 | #5 | #5 | 7-#7 | 6 | #4 | #4 | 12-#5 | 109 | 219 | 295 |
| D = 10.500 | 100 | 2.19 | 13 * | 0.871 | | 8-#6+ 2 | 5 | #5 | #6 | 7-#8 | 6 | #4 | #4 | 12-#5 | 141 | 281 | 378 |
| RIB ON | 150 | 2.56 | 13 * | 0.632 | | 8-#6+ 2 | 5 | #6 | #7 | 7-#9 | 6 | #4 | #5 | 12-#5 | 172 | 383 | 462 |
| COLUMN LINE | 200 | 3.14 | 16 * | 0.628 | | 12-#5+ 3 | 5 | #7 | #7 | 8-#9 | 6 | #5 | #6 | 12-#5 | 201 | 478 | 541 |
| 0.733 CF/SF | 300 | 3.80 | 22 * | 0.623 | 3 S 4 1 | 8-#7+ 2 | 5 | #8 | #8 | 13-#8 | 6 | #6 | #6 | 12-#5 | 253 | 563 | 680 |
| 30'-0" | 50 | 2.13 | 15 * | 0.837 | | 9-#6+ 3 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 13-#5 | 141 | 281 | 379 |
| D = 10.500 | 100 | 2.43 | 15 * | 0.908 | | 9-#6+ 5 | 5 | #6 | #6 | 7-#9 | 7 | #4 | #5 | 13-#5 | 181 | 362 | 487 |
| RIB ON | 150 | 2.95 | 17 * | 0.627 | | 7-#7+ 2 | 5 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 13-#5 | 220 | 468 | 592 |
| COLUMN LINE | 200 | 3.57 | 21 * | 0.624 | 3 S 4 1 | 8-#7+ 2 | 5 | #8 | #8 | 11-#9 | 7 | #5 | #6 | 13-#5 | 256 | 570 | 690 |
| 0.725 CF/SF | | | | | | | | | | | | | | | | | |
| 32'-6" | 50 | 2.26 | 16 * | 0.871 | | 10-#6+ 4 | 6 | #5 | #6 | 9-#8 | 7 | #4 | #5 | 13-#5 | 181 | 361 | 486 |
| D = 13.000 | 100 | 2.76 | 17 * | 0.927 | | 10-#6+ 7 | 6 | #6 | #7 | 12-#8 | 7 | #5 | #5 | 13-#5 | 231 | 462 | 622 |
| RIB NOT ON | 150 | 3.32 | 22 * | 0.623 | | 12-#6+ 5 | 6 | #7 | #7 | 12-#9 | 7 | #5 | #6 | 13-#5 | 279 | 578 | 750 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.740 CF/SF | | | | | | | | | | | | | | | | | |
| 35'-0" | 50 | 2.60 | 17 * | 0.904 | | 15-#5+ 9 | 6 | #6 | #7 | 9-#9 | 8 | #4 | #5 | 15-#5 | 225 | 450 | 605 |
| D = 13.000 | 100 | 3.09 | 21 * | 0.624 | | 9-#7+ 4 | 6 | #7 | #7 | 12-#9 | 8 | #5 | #5 | 15-#5 | 286 | 572 | 770 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.731 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 13 in. | | | Rib Depth = 8 in. | | | Total Slab Depth = 5 in. | | | | |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.73 | 12 | | 4 | #4 | #4 | 7-#5 | 3 | #4 | #4 | 7-#5 |
| 1.99 | 12 | | 4 | #4 | #5 | 9-#5 | 3 | #4 | #4 | 7-#5 |
| 2.38 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 6-#7 | 3 | #4 | #5 | 7-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 2.16 | 12 | 3 S 4 1 | 4 | #5 | #5 | 6-#7 | 4 | #4 | #4 | 8-#5 |
| 2.55 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 10-#6 | 4 | #4 | #5 | 8-#5 |
| 3.08 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 4 | #5 | #5 | 8-#5 |
| 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 2.00 | 12 | | 4 | #4 | #5 | 6-#7 | 5 | #4 | #4 | 10-#5 |
| 2.18 | 12 | 3 S 4 1 | 4 | #5 | #5 | 9-#6 | 5 | #4 | #4 | 10-#5 |
| 2.59 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 7-#8 | 5 | #4 | #4 | 10-#5 |
| 3.12 | 13 * | 3 S 4 2 | 4 | #6 | #7 | 8-#8 | 5 | #4 | #5 | 10-#5 |
| 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| 1.80 | 12 | | 5 | #4 | #4 | 12-#5 | 5 | #4 | #4 | 10-#5 |
| 2.08 | 12 * | | 5 | #4 | #5 | 8-#7 | 5 | #4 | #4 | 10-#5 |
| 2.32 | 12 * | 3 S 4 1 | 5 | #5 | #5 | 7-#8 | 5 | #4 | #4 | 10-#5 |
| 3.09 | 13 * | 3 S 4 1 | 5 | #6 | #6 | 7-#9 | 5 | #5 | #5 | 10-#5 |
| 1.84 | 13 | | 5 | #4 | #4 | 9-#6 | 6 | #4 | #4 | 12-#5 |
| 2.16 | 13 | | 5 | #4 | #5 | 7-#8 | 6 | #4 | #4 | 12-#5 |
| 2.34 | 13 * | 3 S 4 1 | 5 | #5 | #5 | 8-#8 | 6 | #4 | #4 | 12-#5 |
| 2.94 | 13 * | 3 S 4 1 | 5 | #6 | #6 | 8-#9 | 6 | #4 | #5 | 12-#5 |
| 3.39 | 19 * | 3 S 4 2 | 5 | #6 | #7 | 10-#9 | 6 | #4 | #5 | 12-#5 |
| 2.09 | 15 | | 5 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 13-#5 |
| 2.32 | 15 * | 3 S 4 1 | 5 | #5 | #5 | 11-#7 | 7 | #4 | #4 | 13-#5 |
| 2.70 | 15 * | 3 S 4 1 | 5 | #6 | #6 | 8-#9 | 7 | #4 | #4 | 13-#5 |
| 3.23 | 16 * | 3 S 4 2 | 5 | #6 | #7 | 10-#9 | 7 | #4 | #5 | 13-#5 |
| 2.13 | 16 | | 6 | #4 | #5 | 11-#7 | 7 | #4 | #4 | 13-#5 |
| 2.52 | 16 * | 3 S 4 1 | 6 | #5 | #5 | 9-#9 | 7 | #4 | #4 | 13-#5 |
| 3.12 | 16 * | 3 S 4 1 | 6 | #6 | #6 | 11-#9 | 7 | #4 | #5 | 13-#5 |
| 2.46 | 17 * | 3 S 4 1 | 6 | #5 | #5 | 9-#9 | 8 | #4 | #4 | 15-#5 |
| 2.91 | 17 * | 3 S 4 1 | 6 | #6 | #6 | 11-#9 | 8 | #4 | #4 | 15-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 10 in. | | Total Slab Depth = 5 in. | | | | | | | | | | | | | | |
| 20'-0" | 50 | 1.73 | 12 | 0.636 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 44 | 89 | 120 |
| D = 8.000 | 100 | 1.73 | 12 | 0.636 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 56 | 112 | 151 |
| RIB NOT ON | 150 | 1.73 | 12 | 0.636 | | 6-#6+ 0 | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 | 68 | 152 | 183 |
| COLUMN LINE | 200 | 1.80 | 12 | 0.636 | | 6-#6+ 0 | 4 | #4 | #5 | 6-#6 | 4 | #4 | #4 | 8-#5 | 80 | 190 | 214 |
| 0.823 CF/SF | 300 | 2.16 | 12 | 0.714 | | 6-#6+ 0 | 4 | #5 | #6 | 6-#7 | 4 | #4 | #5 | 8-#5 | 103 | 264 | 278 |
| | 400 | 2.45 | 12 * | 0.796 | | 6-#6+ 0 | 4 | #6 | #6 | 7-#7 | 4 | #5 | #5 | 8-#5 | 127 | 336 | 341 |
| | 500 | 2.97 | 12 * | 0.637 | | 6-#6+ 0 | 4 | #7 | #7 | 6-#8 | 4 | #5 | #6 | 8-#5 | 150 | 408 | 404 |
| 22'-6" | 50 | 1.79 | 12 | 0.636 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 | 64 | 127 | 171 |
| D = 8.000 | 100 | 1.85 | 12 | 0.659 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 81 | 161 | 217 |
| RIB NOT ON | 150 | 1.91 | 12 | 0.704 | | 10-#5+ 0 | 4 | #5 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 97 | 218 | 262 |
| COLUMN LINE | 200 | 2.09 | 12 | 0.748 | | 10-#5+ 0 | 4 | #5 | #6 | 6-#7 | 5 | #4 | #4 | 10-#5 | 114 | 273 | 308 |
| 0.808 CF/SF | 300 | 2.64 | 12 * | 0.851 | | 10-#5+ 1 | 4 | #6 | #7 | 6-#8 | 5 | #5 | #5 | 10-#5 | 148 | 379 | 399 |
| | 400 | 3.21 | 12 * | 0.637 | | 10-#5+ 1 | 4 | #7 | #8 | 6-#9 | 5 | #5 | #6 | 10-#5 | 182 | 483 | 490 |
| | 500 | 3.79 | 14 * | 0.634 | | 6-#7+ 0 | 4 | #8 | #8 | 7-#9 | 5 | #6 | #6 | 10-#5 | 214 | 581 | 576 |
| 25'-0" | 50 | 1.75 | 12 | 0.696 | | 8-#6+ 0 | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 | 89 | 178 | 240 |
| D = 10.500 | 100 | 1.82 | 12 | 0.744 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 10-#5 | 113 | 225 | 303 |
| RIB ON | 150 | 2.07 | 12 | 0.815 | | 8-#6+ 1 | 5 | #5 | #5 | 7-#7 | 5 | #4 | #5 | 10-#5 | 136 | 305 | 366 |
| COLUMN LINE | 200 | 2.47 | 12 * | 0.871 | | 8-#6+ 2 | 5 | #6 | #6 | 7-#8 | 5 | #5 | #5 | 10-#5 | 159 | 381 | 429 |
| 0.832 CF/SF | 300 | 3.03 | 12 * | 0.637 | | 8-#6+ 2 | 5 | #7 | #7 | 7-#9 | 5 | #5 | #6 | 10-#5 | 206 | 528 | 555 |
| | 400 | 3.77 | 16 * | 0.631 | | 9-#6+ 2 | 5 | #7 | #8 | 9-#9 | 5 | #6 | #7 | 10-#5 | 249 | 657 | 669 |
| | 500 | 4.32 | 20 * | 0.627 | 3 S 4 1 | 15-#5+ 4 | 5 | #8 | #9 | 10-#9 | 5 | #6 | #7 | 11-#5 | 286 | 748 | 771 |
| 27'-6" | 50 | 1.81 | 13 | 0.701 | | 8-#6+ 0 | 5 | #4 | #5 | 9-#6 | 6 | #4 | #4 | 12-#5 | 118 | 236 | 318 |
| D = 10.500 | 100 | 2.00 | 13 | 0.787 | | 8-#6+ 1 | 5 | #5 | #5 | 8-#7 | 6 | #4 | #4 | 12-#5 | 149 | 298 | 402 |
| RIB ON | 150 | 2.41 | 13 * | 0.869 | | 8-#6+ 3 | 5 | #6 | #6 | 8-#8 | 6 | #4 | #5 | 12-#5 | 180 | 399 | 486 |
| COLUMN LINE | 200 | 2.71 | 13 * | 0.635 | | 8-#6+ 2 | 5 | #6 | #7 | 7-#9 | 6 | #5 | #5 | 12-#5 | 212 | 501 | 570 |
| 0.819 CF/SF | 300 | 3.76 | 17 * | 0.630 | | 7-#7+ 2 | 5 | #8 | #8 | 9-#9 | 6 | #6 | #6 | 12-#5 | 270 | 687 | 728 |
| | 400 | 4.31 | 21 * | 0.626 | 3 S 4 1 | 12-#6+ 2 | 5 | #8 | #9 | 11-#9 | 6 | #6 | #7 | 12-#5 | 322 | 804 | 868 |
| 30'-0" | 50 | 1.98 | 15 | 0.713 | | 9-#6+ 0 | 5 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 13-#5 | 152 | 303 | 409 |
| D = 10.500 | 100 | 2.30 | 15 * | 0.819 | | 9-#6+ 2 | 5 | #6 | #6 | 8-#8 | 7 | #4 | #4 | 13-#5 | 192 | 384 | 517 |
| RIB ON | 150 | 2.63 | 15 * | 0.894 | | 9-#6+ 4 | 5 | #6 | #7 | 8-#9 | 7 | #4 | #5 | 13-#5 | 232 | 496 | 625 |
| COLUMN LINE | 200 | 3.19 | 16 * | 0.631 | | 7-#7+ 2 | 5 | #7 | #8 | 9-#9 | 7 | #5 | #5 | 13-#5 | 272 | 626 | 732 |
| 0.808 CF/SF | 300 | 4.14 | 21 * | 0.626 | 3 S 4 1 | 7-#8+ 2 | 5 | #8 | #9 | 12-#9 | 7 | #6 | #6 | 13-#5 | 345 | 831 | 929 |
| 32'-6" | 50 | 2.13 | 16 * | 0.809 | | 10-#6+ 3 | 6 | #5 | #6 | 11-#7 | 7 | #4 | #4 | 13-#5 | 195 | 390 | 525 |
| D = 13.000 | 100 | 2.50 | 16 * | 0.883 | | 10-#6+ 5 | 6 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 13-#5 | 246 | 492 | 663 |
| RIB NOT ON | 150 | 2.95 | 17 * | 0.630 | | 11-#6+ 3 | 6 | #7 | #7 | 10-#9 | 7 | #5 | #5 | 13-#5 | 297 | 623 | 799 |
| COLUMN LINE | 200 | 3.69 | 20 * | 0.627 | | 9-#7+ 4 | 6 | #7 | #8 | 12-#9 | 7 | #6 | #6 | 13-#5 | 345 | 784 | 929 |
| 0.826 CF/SF | | | | | | | | | | | | | | | | | |
| 35'-0" | 50 | 2.41 | 17 * | 0.849 | | 15-#5+ 7 | 6 | #6 | #6 | 10-#8 | 8 | #4 | #5 | 15-#5 | 242 | 485 | 653 |
| D = 13.000 | 100 | 2.90 | 17 * | 0.919 | | 11-#6+ 7 | 6 | #7 | #7 | 11-#9 | 8 | #5 | #5 | 15-#5 | 307 | 613 | 825 |
| RIB NOT ON | 150 | 3.41 | 21 * | 0.626 | | 10-#7+ 3 | 6 | #7 | #8 | 16-#8 | 8 | #5 | #6 | 15-#5 | 367 | 746 | 988 |
| COLUMN LINE | 200 | 3.80 | 25 * | 0.624 | | 9-#8+ 1 | 6 | #8 | #8 | 15-#9 | 8 | #5 | #6 | 16-#5 | 423 | 848 | 1139 |
| 0.816 CF/SF | | | | | | | | | | | | | | | | | |
| 37'-6" | 50 | 2.63 | 18 * | 0.879 | | 16-#5+ 9 | 6 | #6 | #7 | 10-#9 | 9 | #4 | #5 | 17-#5 | 297 | 595 | 801 |
| D = 13.000 | 100 | 3.18 | 20 * | 0.627 | | 10-#7+ 3 | 6 | #7 | #8 | 13-#9 | 9 | #5 | #5 | 17-#5 | 375 | 749 | 1009 |
| RIB NOT ON | 150 | 3.82 | 26 * | 0.623 | | 9-#8+ 2 | 6 | #8 | #8 | 16-#9 | 9 | #5 | #6 | 17-#5 | 446 | 891 | 1200 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.808 CF/SF | | | | | | | | | | | | | | | | | |
| 40'-0" | 50 | 2.96 | 20 * | 0.900 | | 19-#5+12 | 7 | #7 | #7 | 16-#8 | 9 | #5 | #5 | 17-#5 | 362 | 724 | 975 |
| D = 15.500 | 100 | 3.61 | 25 * | 0.624 | | 17-#6+ 5 | 7 | #7 | #8 | 16-#9 | 9 | #5 | #6 | 17-#5 | 453 | 905 | 1218 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.823 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 10 in. | | Total Slab Depth = 5 in. | | | | | | | |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.75 | 12 | | 4 | #4 | #4 | 6-#6 | 4 | #4 | #4 | 8-#5 |
| 1.97 | 12 | | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 8-#5 |
| 2.16 | 12 | 3 S 4 1 | 4 | #5 | #5 | 6-#7 | 4 | #4 | #4 | 8-#5 |
| 2.61 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 6-#8 | 4 | #4 | #5 | 8-#5 |
| 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 2.00 | 12 | | 4 | #4 | #5 | 6-#7 | 5 | #4 | #4 | 10-#5 |
| 2.38 | 12 | 3 S 4 1 | 4 | #5 | #6 | 10-#6 | 5 | #4 | #4 | 10-#5 |
| 2.83 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 5 | #4 | #5 | 10-#5 |
| 3.44 | 12 * | 3 S 4 2 | 4 | #6 | #7 | 7-#9 | 5 | #5 | #5 | 10-#5 |
| 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| 1.97 | 12 | | 5 | #4 | #5 | 9-#6 | 5 | #4 | #4 | 10-#5 |
| 2.19 | 12 | | 5 | #5 | #5 | 8-#7 | 5 | #4 | #4 | 10-#5 |
| 2.65 | 12 * | 3 S 4 1 | 5 | #5 | #6 | 8-#8 | 5 | #4 | #5 | 10-#5 |
| 3.37 | 13 * | 3 S 4 1 | 5 | #6 | #7 | 8-#9 | 5 | #5 | #5 | 10-#5 |
| 3.86 | 17 * | 3 S 4 2 | 5 | #7 | #7 | 9-#9 | 5 | #5 | #6 | 10-#5 |
| 1.77 | 13 | | 5 | #4 | #4 | 8-#6 | 6 | #4 | #4 | 12-#5 |
| 1.99 | 13 | | 5 | #4 | #5 | 10-#6 | 6 | #4 | #4 | 12-#5 |
| 2.26 | 13 | | 5 | #5 | #5 | 7-#8 | 6 | #4 | #4 | 12-#5 |
| 2.47 | 13 * | 3 S 4 1 | 5 | #5 | #6 | 8-#8 | 6 | #4 | #4 | 12-#5 |
| 3.42 | 13 * | 3 S 4 1 | 5 | #6 | #7 | 9-#9 | 6 | #5 | #5 | 12-#5 |
| 3.87 | 18 * | 3 S 4 2 | 5 | #7 | #7 | 11-#9 | 6 | #5 | #5 | 12-#5 |
| 1.98 | 15 | | 5 | #4 | #5 | 8-#7 | 7 | #4 | #4 | 13-#5 |
| 2.26 | 15 | 3 S 4 1 | 5 | #5 | #5 | 8-#8 | 7 | #4 | #4 | 13-#5 |
| 2.49 | 15 * | 3 S 4 1 | 5 | #5 | #6 | 7-#9 | 7 | #4 | #4 | 13-#5 |
| 2.98 | 15 * | 3 S 4 1 | 5 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| 3.80 | 17 * | 3 S 4 2 | 5 | #7 | #7 | 12-#9 | 7 | #5 | #5 | 13-#5 |
| 2.04 | 16 | | 6 | #4 | #5 | 10-#7 | 7 | #4 | #4 | 13-#5 |
| 2.36 | 16 * | | 6 | #5 | #5 | 10-#8 | 7 | #4 | #4 | 13-#5 |
| 2.67 | 16 * | 3 S 4 1 | 6 | #5 | #6 | 12-#8 | 7 | #4 | #4 | 13-#5 |
| 3.43 | 16 * | 3 S 4 1 | 6 | #6 | #7 | 11-#9 | 7 | #5 | #5 | 13-#5 |
| 2.31 | 17 | | 6 | #5 | #5 | 10-#8 | 8 | #4 | #4 | 15-#5 |
| 2.60 | 17 * | 3 S 4 1 | 6 | #5 | #6 | 12-#8 | 8 | #4 | #4 | 15-#5 |
| 3.11 | 17 * | 3 S 4 1 | 6 | #6 | #6 | 12-#9 | 8 | #4 | #5 | 15-#5 |
| 3.47 | 20 * | 3 S 4 2 | 6 | #6 | #7 | 14-#9 | 8 | #4 | #5 | 15-#5 |
| 2.54 | 18 * | 3 S 4 1 | 6 | #5 | #6 | 12-#8 | 9 | #4 | #4 | 17-#5 |
| 2.90 | 18 * | 3 S 4 1 | 6 | #6 | #6 | 12-#9 | 9 | #4 | #4 | 17-#5 |
| 3.61 | 19 * | 3 S 4 2 | 6 | #7 | #7 | 15-#9 | 9 | #4 | #5 | 17-#5 |
| 2.71 | 20 * | | 7 | #5 | #6 | 12-#9 | 9 | #4 | #4 | 17-#5 |
| 3.40 | 20 * | 3 S 4 1 | 7 | #6 | #7 | 15-#9 | 9 | #4 | #5 | 17-#5 |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 17 in. | Rib Depth = 12 in. | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | | Total Depth = 17 in. | Rib Depth = 12 in. | Total Slab Depth = 5 in. | | | | | | | | |
| 22'-6" | 50 | 1.79 | 12 | 0.639 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 | 68 | 137 | 184 | 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| D = 8.000 | 100 | 1.79 | 12 | 0.639 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 | 85 | 171 | 230 | 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| RIB NOT ON | 150 | 1.85 | 12 | 0.639 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 | 102 | 225 | 275 | 1.83 | 12 | | 4 | #4 | #4 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 1.98 | 12 | 0.654 | | 10-#5+ 0 | 4 | #5 | #5 | 6-#7 | 5 | #4 | #4 | 10-#5 | 119 | 281 | 321 | 1.93 | 12 | | 4 | #4 | #5 | 7-#6 | 5 | #4 | #4 | 10-#5 |
| 0.894 CF/SF | 300 | 2.35 | 12 | 0.739 | | 10-#5+ 0 | 4 | #6 | #6 | 7-#7 | 5 | #4 | #5 | 10-#5 | 153 | 388 | 412 | 2.18 | 12 | 4 S 6 1 | 4 | #5 | #5 | 9-#6 | 5 | #4 | #4 | 10-#5 |
| | 400 | 2.79 | 12 * | 0.852 | | 10-#5+ 2 | 4 | #7 | #7 | 7-#8 | 5 | #5 | #5 | 10-#5 | 187 | 492 | 503 | 2.43 | 12 * | 4 S 6 1 | 4 | #5 | #6 | 6-#8 | 5 | #4 | #4 | 10-#5 |
| | 500 | 3.32 | 12 * | 0.640 | | 10-#5+ 1 | 4 | #7 | #8 | 6-#9 | 5 | #5 | #6 | 10-#5 | 221 | 596 | 594 | 3.07 | 12 * | 4 S 6 1 | 4 | #6 | #7 | 6-#9 | 5 | #4 | #5 | 10-#5 |
| 25'-0" | 50 | 1.75 | 12 | 0.639 | | 8-#6+ 0 | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 | 96 | 192 | 258 | 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| D = 10.500 | 100 | 1.82 | 12 | 0.666 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 10-#5 | 119 | 239 | 321 | 1.77 | 12 | | 5 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 10-#5 |
| RIB ON | 150 | 1.92 | 12 | 0.711 | | 8-#6+ 0 | 5 | #5 | #5 | 9-#6 | 5 | #4 | #4 | 10-#5 | 143 | 315 | 384 | 1.80 | 12 | | 5 | #4 | #4 | 12-#5 | 5 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.19 | 12 | 0.784 | | 8-#6+ 1 | 5 | #5 | #6 | 8-#7 | 5 | #4 | #5 | 10-#5 | 166 | 393 | 447 | 2.01 | 12 | | 5 | #4 | #5 | 7-#7 | 5 | #4 | #4 | 10-#5 |
| 0.923 CF/SF | 300 | 2.85 | 12 * | 0.889 | | 8-#6+ 3 | 5 | #6 | #7 | 8-#8 | 5 | #5 | #6 | 10-#5 | 213 | 541 | 573 | 2.56 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 7-#8 | 5 | #4 | #5 | 10-#5 |
| | 400 | 3.48 | 12 * | 0.640 | | 8-#6+ 2 | 5 | #7 | #8 | 8-#9 | 5 | #6 | #6 | 10-#5 | 260 | 686 | 699 | 3.08 | 12 * | 4 S 6 1 | 5 | #6 | #6 | 7-#9 | 5 | #5 | #5 | 10-#5 |
| | 500 | 3.96 | 15 * | 0.635 | | 7-#7+ 2 | 5 | #8 | #8 | 9-#9 | 5 | #6 | #7 | 10-#5 | 303 | 820 | 817 | 3.49 | 12 * | 4 S 6 1 | 5 | #6 | #7 | 8-#9 | 5 | #5 | #6 | 10-#5 |
| 27'-6" | 50 | 1.79 | 13 | 0.637 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 6 | #4 | #4 | 12-#5 | 127 | 254 | 342 | 1.77 | 13 | | 5 | #4 | #4 | 8-#6 | 6 | #4 | #4 | 12-#5 |
| D = 10.500 | 100 | 1.93 | 13 | 0.680 | | 8-#6+ 0 | 5 | #5 | #5 | 7-#7 | 6 | #4 | #4 | 12-#5 | 158 | 316 | 426 | 1.88 | 13 | | 5 | #4 | #4 | 7-#7 | 6 | #4 | #4 | 12-#5 |
| RIB ON | 150 | 2.13 | 13 | 0.765 | | 8-#6+ 1 | 5 | #5 | #6 | 7-#8 | 6 | #4 | #4 | 12-#5 | 189 | 413 | 510 | 2.04 | 13 | | 5 | #4 | #5 | 8-#7 | 6 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.49 | 13 * | 0.849 | | 8-#6+ 3 | 5 | #6 | #7 | 8-#8 | 6 | #4 | #5 | 12-#5 | 220 | 517 | 594 | 2.26 | 13 | 4 S 6 1 | 5 | #5 | #5 | 7-#8 | 6 | #4 | #4 | 12-#5 |
| 0.906 CF/SF | 300 | 3.27 | 13 * | 0.638 | | 9-#6+ 2 | 5 | #7 | #8 | 8-#9 | 6 | #5 | #6 | 12-#5 | 283 | 714 | 762 | 2.94 | 13 * | 4 S 6 1 | 5 | #6 | #6 | 8-#9 | 6 | #4 | #5 | 12-#5 |
| | 400 | 4.12 | 16 * | 0.634 | 4 S 6 1 | 8-#7+ 2 | 5 | #8 | #9 | 10-#9 | 6 | #6 | #7 | 12-#5 | 342 | 898 | 921 | 3.60 | 13 * | 4 S 6 2 | 5 | #7 | #7 | 12-#8 | 6 | #5 | #5 | 12-#5 |
| | 500 | 4.66 | 20 * | 0.630 | 4 S 6 1 | 7-#8+ 2 | 5 | #9 | #9 | 12-#9 | 6 | #6 | #7 | 13-#5 | 392 | 1017 | 1056 | 4.20 | 18 * | 4 S 6 2 | 5 | #7 | #8 | 11-#9 | 6 | #5 | #6 | 12-#5 |
| 30'-0" | 50 | 1.91 | 15 | 0.637 | | 9-#6+ 0 | 5 | #5 | #5 | 8-#7 | 7 | #4 | #4 | 13-#5 | 163 | 326 | 439 | 1.83 | 15 | | 5 | #4 | #4 | 7-#7 | 7 | #4 | #4 | 13-#5 |
| D = 10.500 | 100 | 2.13 | 15 | 0.701 | | 9-#6+ 0 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #4 | 13-#5 | 203 | 407 | 548 | 2.09 | 15 | | 5 | #4 | #5 | 7-#8 | 7 | #4 | #4 | 13-#5 |
| RIB ON | 150 | 2.49 | 15 * | 0.806 | | 9-#6+ 2 | 5 | #6 | #7 | 7-#9 | 7 | #4 | #5 | 13-#5 | 244 | 517 | 656 | 2.26 | 15 | 4 S 6 1 | 5 | #5 | #5 | 8-#8 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 2.90 | 15 * | 0.880 | | 9-#6+ 4 | 5 | #7 | #7 | 8-#9 | 7 | #5 | #5 | 13-#5 | 284 | 653 | 765 | 2.70 | 15 * | 4 S 6 1 | 5 | #6 | #6 | 8-#9 | 7 | #4 | #4 | 13-#5 |
| 0.894 CF/SF | 300 | 3.88 | 17 * | 0.633 | 4 S 6 1 | 12-#6+ 2 | 5 | #8 | #9 | 11-#9 | 7 | #6 | #6 | 13-#5 | 362 | 900 | 976 | 3.37 | 15 * | 4 S 6 2 | 5 | #7 | #7 | 10-#9 | 7 | #4 | #5 | 13-#5 |
| | 400 | 4.69 | 21 * | 0.629 | 4 S 6 1 | 10-#7+ 1 | 5 | #9 | #10 | 13-#9 | 7 | #6 | #7 | 14-#5 | 433 | 1088 | 1167 | 4.07 | 18 * | 4 S 6 2 | 5 | #7 | #8 | 16-#8 | 7 | #5 | #5 | 13-#5 |
| 32'-6" | 50 | 2.01 | 16 | 0.736 | | 10-#6+ 2 | 6 | #5 | #5 | 10-#7 | 7 | #4 | #4 | 13-#5 | 210 | 419 | 565 | 1.99 | 16 | | 6 | #4 | #5 | 9-#7 | 7 | #4 | #4 | 13-#5 |
| D = 13.000 | 100 | 2.43 | 16 * | 0.822 | | 10-#6+ 4 | 6 | #6 | #6 | 10-#8 | 7 | #4 | #5 | 13-#5 | 261 | 522 | 703 | 2.29 | 16 | | 6 | #5 | #5 | 9-#8 | 7 | #4 | #4 | 13-#5 |
| RIB NOT ON | 150 | 2.82 | 16 * | 0.887 | | 10-#6+ 6 | 6 | #6 | #7 | 9-#9 | 7 | #5 | #5 | 13-#5 | 312 | 654 | 841 | 2.65 | 16 * | | 6 | #5 | #6 | 9-#9 | 7 | #4 | #4 | 13-#5 |
| COLUMN LINE | 200 | 3.34 | 16 * | 0.634 | | 12-#6+ 2 | 6 | #7 | #8 | 11-#9 | 7 | #5 | #6 | 13-#5 | 364 | 827 | 979 | 2.97 | 16 * | 4 S 6 1 | 6 | #6 | #6 | 10-#9 | 7 | #4 | #5 | 13-#5 |
| 0.916 CF/SF | 300 | 4.39 | 22 * | 0.628 | | 11-#7+ 3 | 6 | #8 | #9 | 14-#9 | 7 | #6 | #7 | 15-#5 | 457 | 1112 | 1231 | 3.98 | 17 * | 4 S 6 2 | 6 | #7 | #7 | 13-#9 | 7 | #5 | #6 | 14-#5 |

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 17 in. | Rib Depth = 12 in. | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | |
| 35'-0" | 50 | 2.31 | 17 | 0.760 | | 15-#5+ 3 | 6 | #6 | #6 | 10-#8 | 8 | #4 | #4 | 15-#5 | 261 | 522 | 702 |
| D = 13.000 | 100 | 2.67 | 17 * | 0.856 | | 15-#5+ 7 | 6 | #6 | #7 | 12-#8 | 8 | #4 | #5 | 15-#5 | 325 | 650 | 875 |
| RIB NOT ON | 150 | 3.10 | 17 * | 0.633 | | 9-#7+ 4 | 6 | #7 | #7 | 12-#9 | 8 | #5 | #5 | 15-#5 | 389 | 795 | 1047 |
| COLUMN LINE | 200 | 3.66 | 20 * | 0.630 | | 11-#7+ 3 | 6 | #8 | #8 | 14-#9 | 8 | #5 | #6 | 15-#5 | 450 | 1005 | 1211 |
| 0.904 CF/SF | 300 | 4.72 | 27 * | 0.625 | | 10-#8+ 1 | 6 | #9 | #9 | 18-#9 | 8 | #6 | #7 | 18-#5 | 560 | 1213 | 1507 |
| 37'-6" | 50 | 2.60 | 18 * | 0.806 | | 16-#5+ 5 | 6 | #6 | #7 | 12-#8 | 9 | #4 | #5 | 17-#5 | 320 | 639 | 861 |
| D = 13.000 | 100 | 3.01 | 18 * | 0.912 | | 9-#7+ 7 | 6 | #7 | #7 | 12-#9 | 9 | #5 | #5 | 17-#5 | 399 | 797 | 1073 |
| RIB NOT ON | 150 | 3.57 | 20 * | 0.630 | | 11-#7+ 3 | 6 | #8 | #8 | 15-#9 | 9 | #5 | #5 | 17-#5 | 475 | 951 | 1280 |
| COLUMN LINE | 200 | 4.22 | 25 * | 0.626 | | 10-#8+ 3 | 6 | #8 | #9 | 17-#9 | 9 | #6 | #6 | 18-#5 | 546 | 1165 | 1471 |
| 0.894 CF/SF | | | | | | | | | | | | | | | | | |
| 40'-0" | 50 | 2.74 | 20 * | 0.855 | | 18-#5+11 | 7 | #6 | #7 | 12-#9 | 9 | #4 | #5 | 17-#5 | 390 | 779 | 1049 |
| D = 15.500 | 100 | 3.46 | 20 * | 0.630 | | 12-#7+ 4 | 7 | #7 | #8 | 15-#9 | 9 | #5 | #6 | 17-#5 | 485 | 970 | 1306 |
| RIB ON | 150 | 3.98 | 25 * | 0.626 | | 14-#7+ 4 | 7 | #8 | #8 | 18-#9 | 9 | #6 | #6 | 19-#5 | 574 | 1148 | 1546 |
| COLUMN LINE | 200 | 4.51 | 30 * | 0.623 | | 12-#8+ 2 | 7 | #8 | #9 | 21-#9 | 9 | #6 | #6 | 21-#5 | 655 | 1310 | 1764 |
| 0.911 CF/SF | | | | | | | | | | | | | | | | | |
| 42'-6" | 50 | 3.04 | 21 * | 0.883 | | 11-#7+ 6 | 7 | #7 | #7 | 14-#9 | 10 | #5 | #5 | 18-#5 | 466 | 932 | 1254 |
| D = 15.500 | 100 | 3.74 | 24 * | 0.627 | | 14-#7+ 4 | 7 | #8 | #8 | 18-#9 | 10 | #5 | #6 | 18-#5 | 577 | 1154 | 1553 |
| RIB ON | 150 | 4.39 | 30 * | 0.623 | | 32-#5+ 7 | 7 | #8 | #9 | 21-#9 | 10 | #6 | #6 | 22-#5 | 679 | 1358 | 1829 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.902 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.41 | 22 * | 0.920 | | 13-#7+ 9 | 7 | #8 | #8 | 17-#9 | 11 | #5 | #5 | 20-#5 | 552 | 1103 | 1485 |
| D = 15.500 | 100 | 4.04 | 28 * | 0.624 | | 32-#5+ 7 | 7 | #8 | #9 | 21-#9 | 11 | #5 | #6 | 22-#5 | 680 | 1359 | 1830 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.894 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 17 in. | Rib Depth = 12 in. | Total Slab Depth = 5 in. | | | | | | | | |
| 2.25 | 17 | | 6 | #5 | #5 | 9-#8 | 8 | #4 | #4 | 15-#5 |
| 2.58 | 17 | 4 S 6 1 | 6 | #5 | #6 | 9-#9 | 8 | #4 | #4 | 15-#5 |
| 2.91 | 17 * | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 8 | #4 | #4 | 15-#5 |
| 3.31 | 17 * | 4 S 6 1 | 6 | #6 | #7 | 16-#8 | 8 | #4 | #5 | 15-#5 |
| 4.23 | 22 * | 4 S 6 2 | 6 | #7 | #8 | 16-#9 | 8 | #5 | #5 | 17-#5 |
| 2.52 | 18 | | 6 | #5 | #6 | 9-#9 | 9 | #4 | #4 | 17-#5 |
| 2.82 | 18 * | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 9 | #4 | #4 | 17-#5 |
| 3.36 | 18 * | 4 S 6 1 | 6 | #6 | #7 | 14-#9 | 9 | #4 | #5 | 17-#5 |
| 3.87 | 19 * | 4 S 6 2 | 6 | #7 | #7 | 16-#9 | 9 | #5 | #5 | 17-#5 |
| 2.64 | 20 | | 7 | #5 | #6 | 11-#9 | 9 | #4 | #4 | 17-#5 |
| 3.14 | 20 * | 4 S 6 1 | 7 | #6 | #6 | 14-#9 | 9 | #4 | #5 | 17-#5 |
| 3.58 | 20 * | 4 S 6 1 | 7 | #6 | #7 | 17-#9 | 9 | #4 | #5 | 17-#5 |
| 4.17 | 24 * | 4 S 6 2 | 7 | #7 | #7 | 19-#9 | 9 | #5 | #5 | 20-#5 |
| 2.85 | 21 * | 4 S 6 1 | 7 | #6 | #6 | 13-#9 | 10 | #4 | #4 | 18-#5 |
| 3.46 | 21 * | 4 S 6 1 | 7 | #6 | #7 | 17-#9 | 10 | #4 | #5 | 18-#5 |
| 4.09 | 23 * | 4 S 6 2 | 7 | #7 | #7 | 20-#9 | 10 | #5 | #5 | 21-#5 |
| 3.14 | 22 * | 4 S 6 1 | 7 | #6 | #7 | 16-#9 | 11 | #4 | #4 | 20-#5 |
| 3.75 | 22 * | 4 S 6 2 | 7 | #7 | #7 | 20-#9 | 11 | #4 | #5 | 21-#5 |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | Rib Depth = 14 in. | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | | Total Depth = 19 in. | Rib Depth = 14 in. | Total Slab Depth = 5 in. | | | | | | | | |
| 25'-0" | 50 | 1.99 | 12 | 0.641 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 10-#5 | 103 | 206 | 277 | 1.99 | 12 | | 5 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 10-#5 |
| D = 10.500 | 100 | 1.99 | 12 | 0.641 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 10-#5 | 126 | 253 | 340 | 1.99 | 12 | | 5 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 10-#5 |
| RIB ON | 150 | 2.00 | 12 | 0.641 | | 8-#6+ 0 | 5 | #4 | #5 | 12-#5 | 5 | #4 | #5 | 10-#5 | 150 | 324 | 403 | 1.99 | 12 | | 5 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 10-#5 |
| COLUMN LINE | 200 | 2.21 | 12 | 0.670 | | 8-#6+ 0 | 5 | #5 | #6 | 7-#7 | 5 | #4 | #5 | 10-#5 | 173 | 403 | 466 | 2.07 | 12 | | 5 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 10-#5 |
| 1.015 CF/SF | 300 | 2.59 | 12 | 0.806 | | 8-#6+ 2 | 5 | #6 | #6 | 7-#8 | 5 | #5 | #5 | 10-#5 | 220 | 553 | 592 | 2.42 | 12 | | 5 | #5 | #5 | 7-#8 | 5 | #4 | #5 | 10-#5 |
| | 400 | 3.01 | 12 * | 0.642 | | 8-#6+ 2 | 5 | #7 | #7 | 11-#7 | 5 | #5 | #6 | 10-#5 | 267 | 698 | 718 | 2.65 | 12 * | 4 S 6 1 | 5 | #5 | #6 | 8-#8 | 5 | #4 | #5 | 10-#5 |
| | 500 | 3.67 | 12 * | 0.642 | | 9-#6+ 2 | 5 | #7 | #8 | 8-#9 | 5 | #6 | #7 | 10-#5 | 314 | 842 | 844 | 3.25 | 12 * | 4 S 6 1 | 5 | #6 | #7 | 7-#9 | 5 | #5 | #5 | 10-#5 |
| 27'-6" | 50 | 1.97 | 13 | 0.640 | | 8-#6+ 0 | 5 | #4 | #5 | 8-#6 | 6 | #4 | #5 | 12-#5 | 136 | 272 | 367 | 1.98 | 13 | | 5 | #4 | #5 | 8-#6 | 6 | #4 | #5 | 12-#5 |
| D = 10 .500 | 100 | 2.09 | 13 | 0.640 | | 8-#6+ 0 | 5 | #5 | #5 | 7-#7 | 6 | #4 | #5 | 12-#5 | 167 | 335 | 451 | 2.06 | 13 | | 5 | #4 | #5 | 9-#6 | 6 | #4 | #5 | 12-#5 |
| RIB ON | 150 | 2.23 | 13 | 0.649 | | 8-#6+ 0 | 5 | #5 | #6 | 8-#7 | 6 | #4 | #5 | 12-#5 | 199 | 426 | 534 | 2.15 | 13 | | 5 | #4 | #5 | 8-#7 | 6 | #4 | #5 | 12-#5 |
| COLUMN LINE | 200 | 2.44 | 13 | 0.762 | | 8-#6+ 2 | 5 | #6 | #6 | 7-#8 | 6 | #4 | #5 | 12-#5 | 230 | 531 | 618 | 2.37 | 13 | | 5 | #5 | #5 | 7-#8 | 6 | #4 | #5 | 12-#5 |
| 0.996 CF/SF | 300 | 3.09 | 13 * | 0.874 | | 8-#6+ 4 | 5 | #7 | #7 | 8-#9 | 6 | #5 | #6 | 12-#5 | 292 | 730 | 786 | 2.84 | 13 * | 4 S 6 1 | 5 | #6 | #6 | 7-#9 | 6 | #4 | #5 | 12-#5 |
| | 400 | 3.77 | 13 * | 0.641 | | 7-#7+ 2 | 5 | #8 | #8 | 9-#9 | 6 | #6 | #6 | 12-#5 | 354 | 924 | 954 | 3.42 | 13 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 6 | #5 | #5 | 12-#5 |
| | 500 | 4.41 | 15 * | 0.638 | 4 S 6 1 | 12-#6+ 2 | 5 | #9 | #9 | 11-#9 | 6 | #6 | #7 | 12-#5 | 414 | 1108 | 1115 | 3.81 | 13 * | 4 S 6 2 | 5 | #7 | #7 | 10-#9 | 6 | #5 | #6 | 12-#5 |
| 30'-0" | 50 | 2.06 | 15 | 0.637 | | 9-# 6+ 0 | 5 | #5 | #5 | 7-#7 | 7 | #4 | #5 | 13-#5 | 175 | 350 | 471 | 2.01 | 15 | | 5 | #4 | #5 | 9-#6 | 7 | #4 | #5 | 13-#5 |
| D = 10.500 | 100 | 2.21 | 15 | 0.637 | | 9-#6+ 0 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #5 | 13-#5 | 215 | 430 | 579 | 2.10 | 15 | | 5 | #4 | #5 | 8-#7 | 7 | #4 | #5 | 13-#5 |
| RIB ON | 150 | 2.44 | 15 | 0.712 | | 9-#6+ 1 | 5 | #6 | #6 | 8-#8 | 7 | #4 | #5 | 13-#5 | 255 | 536 | 688 | 2.38 | 15 | | 5 | #5 | #5 | 8-#8 | 7 | #4 | #5 | 13-#5 |
| COLUMN LINE | 200 | 2.77 | 15 * | 0.787 | | 9-#6+ 2 | 5 | #7 | #7 | 8-#9 | 7 | #4 | #5 | 13-#5 | 296 | 673 | 796 | 2.61 | 15 | 4 S 6 1 | 5 | #5 | #6 | 7-#9 | 7 | #4 | #5 | 13-#5 |
| 0.982 CF/SF | 300 | 3.48 | 15 * | 0.638 | | 15-#5+ 2 | 5 | #8 | #8 | 10-#9 | 7 | #5 | #6 | 13-#5 | 376 | 929 | 1013 | 3.13 | 15 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| | 400 | 4.29 | 17 * | 0.635 | 4 S 6 1 | 7-#8+ 0 | 5 | #9 | #9 | 12-#9 | 7 | #6 | #6 | 13-#5 | 454 | 1172 | 1223 | 3.88 | 15 * | 4 S 6 2 | 5 | #7 | #8 | 11-#9 | 7 | #5 | #5 | 13-#5 |
| | 500 | 4.95 | 21 * | 0.631 | 4 S 6 1 | 8-#8+ 2 | 5 | #9 | #10 | 14-#9 | 7 | #6 | #7 | 15-#5 | 523 | 1358 | 1409 | 4.49 | 18 * | 4 S 6 2 | 5 | #8 | #8 | 13-#9 | 7 | #5 | #6 | 14-#5 |
| 32'-6" | 50 | 2.14 | 16 | 0.646 | | 10-#6+ 1 | 6 | #5 | #5 | 10-#7 | 7 | #4 | #5 | 13-#5 | 225 | 450 | 606 | 2.10 | 16 | | 6 | #4 | #5 | 9-#7 | 7 | #4 | #5 | 13-#5 |
| D = 13.000 | 100 | 2.32 | 16 | 0.750 | | 10-#6+ 3 | 6 | #5 | #6 | 9-#8 | 7 | #4 | #5 | 13-#5 | 276 | 553 | 744 | 2.24 | 16 | | 6 | #4 | #5 | 11-#7 | 7 | #4 | #5 | 13-#5 |
| RIB NOT ON | 150 | 2.65 | 16 * | 0.827 | | 10-#6+ 5 | 6 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 13-#5 | 328 | 680 | 882 | 2.47 | 16 | | 6 | #5 | #5 | 10-#8 | 7 | #4 | #5 | 13-#5 |
| COLUMN LINE | 200 | 3.13 | 16 * | 0.880 | | 15-#5+ 8 | 6 | #7 | #7 | 10-#9 | 7 | #5 | #6 | 13-#5 | 379 | 855 | 1020 | 2.89 | 16 * | 4 S 6 1 | 6 | #6 | #6 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| 1.007 CF/SF | 300 | 4.05 | 17 * | 0.635 | | 10-#7+ 3 | 6 | #8 | #8 | 16-#8 | 7 | #6 | #7 | 13-#5 | 480 | 1178 | 1293 | 3.67 | 16 * | 4 S 6 1 | 6 | #7 | #7 | 12-#9 | 7 | #5 | #5 | 13-#5 |
| | 400 | 4.86 | 22 * | 0.630 | | 9-#8+ 2 | 6 | #9 | #9 | 16-#9 | 7 | #7 | #7 | 16-#5 | 571 | 1442 | 1538 | 4.28 | 18 * | 4 S 6 2 | 6 | #7 | #8 | 14-#9 | 7 | #5 | #6 | 15-#5 |
| 35'-0" | 50 | 2.28 | 17 | 0.665 | | 15-#5+ 1 | 6 | #5 | #6 | 9-#8 | 8 | #4 | #5 | 15-#5 | 280 | 559 | 753 | 2.22 | 17 | | 6 | #4 | #5 | 11-#7 | 8 | #4 | #5 | 15-#5 |
| D = 13.000 | 100 | 2.59 | 17 * | 0.786 | | 15-#5+ 5 | 6 | #6 | #7 | 9-#9 | 8 | #4 | #5 | 15-#5 | 344 | 688 | 926 | 2.43 | 17 | | 6 | #5 | #5 | 10-#8 | 8 | #4 | #5 | 15-#5 |
| RIB NOT ON | 150 | 3.00 | 17 * | 0.868 | | 12-#6+ 5 | 6 | #7 | #7 | 11-#9 | 8 | #5 | #5 | 15-#5 | 408 | 830 | 1098 | 2.78 | 17 * | 4 S 6 1 | 6 | #5 | #6 | 10-#9 | 8 | #4 | #5 | 15-#5 |
| COLUMN LINE | 200 | 3.57 | 17 * | 0.635 | | 10-#7+ 3 | 6 | #8 | #8 | 16-#8 | 8 | #5 | #6 | 15-#5 | 472 | 1050 | 1271 | 3.25 | 17 * | 4 S 6 1 | 6 | #6 | #7 | 12-#9 | 8 | #4 | #5 | 15-#5 |
| 0.993 CF/SF | 300 | 4.65 | 22 * | 0.630 | | 17-#6+ 3 | 6 | #9 | #9 | 16-#9 | 8 | #6 | #7 | 17-#5 | 593 | 1438 | 1596 | 4.24 | 17 * | 4 S 6 2 | 6 | #7 | #8 | 15-#9 | 8 | #5 | #6 | 16-#5 |
| | 400 | 5.36 | 28 * | 0.626 | 4 S 6 1 | 11-#8+ 3 | 6 | #9 | #10 | 19-#9 | 8 | #7 | #7 | 20-#5 | 696 | 1572 | 1874 | 4.82 | 24 * | 4 S 6 2 | 6 | #8 | #8 | 18-#9 | 8 | #5 | #6 | 19-#5 |

(Continued on next page)

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments $-M$ Edge (ft-k) | Moments $+M$ Bot. (ft-k) | Moments $-M$ Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | Rib Depth = 14 in. | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | |
| 37'-6" | 50 | 2.54 | 18 | 0.729 | | 16-#5+ 3 | 6 | #6 | #7 | 9-#9 | 9 | #4 | #5 | 17-#5 | 343 | 686 | 923 |
| D = 13.000 | 100 | 2.84 | 18 * | 0.840 | | 12-#6+ 5 | 6 | #7 | #7 | 11-#9 | 9 | #4 | #5 | 17-#5 | 422 | 844 | 1136 |
| RIB NOT ON | 150 | 3.25 | 18 * | 0.634 | | 14-#6+ 4 | 6 | #7 | #8 | 13-#9 | 9 | #5 | #5 | 17-#5 | 501 | 1002 | 1348 |
| COLUMN LINE | 200 | 3.87 | 20 * | 0.632 | | 9-#8+ 2 | 6 | #8 | #9 | 16-#9 | 9 | #5 | #6 | 17-#5 | 577 | 1261 | 1553 |
| 0.982 CF/SF | 300 | 5.08 | 27 * | 0.627 | 4 S 6 1 | 9-#9+ 1 | 6 | #9 | #10 | 20-#9 | 9 | #6 | #7 | 20-#5 | 715 | 1582 | 1926 |
| 40'-0" | 50 | 2.73 | 20 * | 0.790 | | 12-#6+ 6 | 7 | #6 | #7 | 11-#9 | 9 | #4 | #5 | 17-#5 | 418 | 836 | 1125 |
| D = 15.500 | 100 | 3.17 | 20 * | 0.884 | | 11-#7+ 6 | 7 | #7 | #7 | 14-#9 | 9 | #5 | #5 | 17-#5 | 513 | 1027 | 1382 |
| RIB ON | 150 | 3.72 | 20 * | 0.632 | | 13-#7+ 4 | 7 | #8 | #8 | 16-#9 | 9 | #5 | #6 | 17-#5 | 609 | 1218 | 1639 |
| COLUMN LINE | 200 | 4.36 | 25 * | 0.628 | | 11-#8+ 3 | 7 | #8 | #9 | 19-#9 | 9 | #6 | #6 | 20-#5 | 697 | 1468 | 1875 |
| 1.002 CF/SF | 300 | 5.20 | 32 * | 0.624 | 4 S 6 1 | 11-#9+ 3 | 7 | #9 | #9 | 24-#9 | 9 | #6 | #7 | 17-#6 | 854 | 1708 | 2300 |
| 42'-6" | 50 | 3.02 | 21 * | 0.832 | | 14-#6+ 7 | 7 | #7 | #7 | 13-#9 | 10 | #5 | #5 | 18-#5 | 500 | 999 | 1345 |
| D = 15.500 | 100 | 3.63 | 21 * | 0.920 | | 13-#7+ 8 | 7 | #8 | #8 | 17-#9 | 10 | #5 | #6 | 18-#5 | 614 | 1228 | 1654 |
| RIB ON | 150 | 4.15 | 25 * | 0.628 | | 12-#8+ 2 | 7 | #8 | #9 | 20-#9 | 10 | #6 | #6 | 21-#5 | 723 | 1446 | 1946 |
| COLUMN LINE | 200 | 4.74 | 29 * | 0.625 | 4 S 6 1 | 11-#9+ 2 | 7 | #9 | #9 | 23-#9 | 10 | #6 | #6 | 24-#5 | 826 | 1652 | 2224 |
| 0.991 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.32 | 22 * | 0.875 | | 17-#6+ 9 | 7 | #7 | #8 | 16-#9 | 11 | #5 | #5 | 20-#5 | 591 | 1183 | 1592 |
| D = 15.500 | 100 | 3.91 | 24 * | 0.629 | | 12-#8+ 2 | 7 | #8 | #9 | 20-#9 | 11 | #5 | #6 | 20-#5 | 725 | 1450 | 1951 |
| RIB ON | 150 | 4.63 | 29 * | 0.625 | 4 S 6 1 | 11-#9+ 3 | 7 | #9 | #9 | 24-#9 | 11 | #6 | #6 | 24-#5 | 852 | 1704 | 2294 |
| COLUMN LINE | 200 | 5.25 | 36 * | 0.622 | 4 S 6 1 | 16-#8+ 3 | 7 | #9 | #10 | 27-#9 | 11 | #6 | #7 | 20-#6 | 959 | 1918 | 2582 |
| 0.982 CF/SF | | | | | | | | | | | | | | | | | |
| 47'-6" | 50 | 3.69 | 23 * | 0.920 | | 12-#8+ 8 | 8 | #8 | #8 | 19-#9 | 11 | #5 | #6 | 20-#5 | 701 | 1402 | 1887 |
| D = 18.000 | 100 | 4.39 | 28 * | 0.626 | | 14-#8+ 4 | 8 | #8 | #9 | 24-#9 | 11 | #6 | #6 | 24-#5 | 853 | 1706 | 2297 |
| RIB NOT ON | 150 | 5.23 | 36 * | 0.622 | | 16-#8+ 5 | 8 | #9 | #10 | 28-#9 | 11 | #6 | #7 | 20-#6 | 989 | 1978 | 2663 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.999 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | Rib Depth = 14 in. | Total Slab Depth = 5 in. | | | | | | | | |
| 2.39 | 18 | | 6 | #5 | #5 | 10-#8 | 9 | #4 | #5 | 17-#5 |
| 2.72 | 18 | 4 S 6 1 | 6 | #5 | #6 | 10-#9 | 9 | #4 | #5 | 17-#5 |
| 3.03 | 18 * | 4 S 6 1 | 6 | #6 | #6 | 12-#9 | 9 | #4 | #5 | 17-#5 |
| 3.50 | 18 * | 4 S 6 2 | 6 | #7 | #7 | 18-#8 | 9 | #4 | #5 | 17-#5 |
| 4.63 | 22 * | 4 S 6 2 | 6 | #8 | #8 | 23-#8 | 9 | #5 | #6 | 19-#5 |
| 2.68 | 20 | | 7 | #5 | #6 | 13-#8 | 9 | #4 | #5 | 17-#5 |
| 3.01 | 20 * | 4 S 6 1 | 7 | #6 | #6 | 16-#8 | 9 | #4 | #5 | 17-#5 |
| 3.40 | 20 * | 4 S 6 1 | 7 | #6 | #7 | 15-#9 | 9 | #4 | #5 | 17-#5 |
| 4.02 | 20 * | 4 S 6 2 | 7 | #7 | #7 | 18-#9 | 9 | #5 | #5 | 19-#5 |
| 4.84 | 29 * | 4 S 6 2 | 7 | #7 | #8 | 22-#9 | 9 | #5 | #6 | 23-#5 |
| 2.87 | 21 | | 7 | #6 | #6 | 12-#9 | 10 | #4 | #5 | 18-#5 |
| 3.29 | 21 * | 4 S 6 1 | 7 | #6 | #7 | 15-#9 | 10 | #4 | #5 | 18-#5 |
| 3.69 | 21 * | 4 S 6 2 | 7 | #7 | #7 | 18-#9 | 10 | #4 | #5 | 19-#5 |
| 4.38 | 23 * | 4 S 6 2 | 7 | #7 | #8 | 21-#9 | 10 | #5 | #5 | 22-#5 |
| 3.21 | 22 * | 4 S 6 1 | 7 | #6 | #7 | 15-#9 | 11 | #4 | #5 | 20-#5 |
| 3.56 | 22 * | 4 S 6 1 | 7 | #7 | #7 | 18-#9 | 11 | #4 | #5 | 20-#5 |
| 4.29 | 22 * | 4 S 6 2 | 7 | #7 | #8 | 22-#9 | 11 | #5 | #5 | 23-#5 |
| 4.80 | 29 * | 4 S 6 2 | 7 | #8 | #8 | 25-#9 | 11 | #5 | #5 | 26-#5 |
| 3.37 | 23 * | 4 S 6 1 | 8 | #6 | #7 | 18-#9 | 11 | #4 | #5 | 20-#5 |
| 4.06 | 23 * | 4 S 6 1 | 8 | #7 | #7 | 22-#9 | 11 | #5 | #5 | 23-#5 |
| 4.77 | 27 * | 4 S 6 2 | 8 | #7 | #8 | 26-#9 | 11 | #5 | #6 | 27-#5 |

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 21 in. | | Rib Depth = 16 in. | | Total Slab Depth = 5 in. | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.06 | 15 | 0.639 | | 9-#6+ 0 | 5 | #5 | #5 | 7-#7 | 7 | #4 | #5 | 13-#5 | 187 | 374 | 504 |
| D = 10.500 | 100 | 2.21 | 15 | 0.639 | | 9-#6+ 0 | 5 | #5 | #6 | 7-#8 | 7 | #4 | #5 | 13-#5 | 227 | 455 | 612 |
| RIB ON | 150 | 2.40 | 15 | 0.639 | | 9-#6+ 0 | 5 | #6 | #6 | 8-#8 | 7 | #4 | #5 | 13-#5 | 268 | 553 | 721 |
| COLUMN LINE | 200 | 2.61 | 15 | 0.686 | | 9-#6+ 1 | 5 | #6 | #7 | 7-#9 | 7 | #4 | #5 | 13-#5 | 308 | 691 | 829 |
| 1.073 CF/SF | 300 | 3.28 | 15 * | 0.829 | | 7-#7+ 2 | 5 | #7 | #8 | 9-#9 | 7 | #5 | #6 | 13-#5 | 388 | 951 | 1046 |
| | 400 | 3.97 | 15 * | 0.640 | 4 S 6 1 | 12-#6+ 1 | 5 | #8 | #9 | 11-#9 | 7 | #6 | #6 | 13-#5 | 469 | 1203 | 1263 |
| | 500 | 4.81 | 16 * | 0.639 | 4 S 6 1 | 10-#7+ 1 | 5 | #9 | #10 | 13-#9 | 7 | #6 | #7 | 14-#5 | 548 | 1446 | 1476 |
| 32'-6" | 50 | 2.09 | 16 | 0.638 | | 10-#6+ 0 | 6 | #5 | #5 | 9-#7 | 7 | #4 | #5 | 13-#5 | 241 | 481 | 648 |
| D = 13.000 | 100 | 2.26 | 16 | 0.638 | | 10-#6+ 0 | 6 | #5 | #6 | 11-#7 | 7 | #4 | #5 | 13-#5 | 292 | 584 | 786 |
| RIB NOT ON | 150 | 2.49 | 16 | 0.692 | | 10-#6+ 1 | 6 | #6 | #6 | 10-#8 | 7 | #4 | #5 | 13-#5 | 343 | 702 | 924 |
| COLUMN LINE | 200 | 2.87 | 16 * | 0.788 | | 10-#6+ 3 | 6 | #6 | #7 | 9-#9 | 7 | #5 | #5 | 13-#5 | 395 | 880 | 1062 |
| 1.101 CF/SF | 300 | 3.80 | 16 * | 0.639 | | 9-#7+ 2 | 6 | #8 | #8 | 12-#9 | 7 | #6 | #6 | 13-#5 | 497 | 1211 | 1339 |
| | 400 | 4.60 | 17 * | 0.637 | | 11-#7+ 3 | 6 | #9 | #9 | 14-#9 | 7 | #6 | #7 | 15-#5 | 598 | 1527 | 1610 |
| | 500 | 5.35 | 22 * | 0.632 | | 10-#8+ 1 | 6 | #9 | #10 | 17-#9 | 7 | #7 | #7 | 17-#5 | 685 | 1767 | 1845 |
| 35'-0" | 50 | 2.27 | 17 | 0.636 | | 15-#5+ 1 | 6 | #5 | #6 | 11-#7 | 8 | #4 | #5 | 15-#5 | 299 | 598 | 805 |
| D = 13.000 | 100 | 2.51 | 17 | 0.700 | | 15-#5+ 3 | 6 | #6 | #6 | 9-#9 | 8 | #4 | #5 | 15-#5 | 363 | 727 | 978 |
| RIB NOT ON | 150 | 2.75 | 17 * | 0.808 | | 11-#6+ 5 | 6 | #6 | #7 | 10-#9 | 8 | #4 | #5 | 15-#5 | 427 | 860 | 1151 |
| COLUMN LINE | 200 | 3.34 | 17 * | 0.868 | | 9-#7+ 4 | 6 | #7 | #8 | 12-#9 | 8 | #5 | #6 | 15-#5 | 492 | 1083 | 1323 |
| 1.085 CF/SF | 300 | 4.28 | 17 * | 0.637 | | 9-#8+ 1 | 6 | #9 | #9 | 15-#9 | 8 | #6 | #6 | 16-#5 | 620 | 1496 | 1669 |
| | 400 | 5.22 | 23 * | 0.632 | | 14-#7+ 2 | 6 | #9 | #10 | 18-#9 | 8 | #7 | #7 | 19-#5 | 733 | 1825 | 1974 |
| | 500 | 5.87 | 28 * | 0.628 | 4 S 6 1 | 12-#8+ 0 | 6 | #10 | #10 | 21-#9 | 8 | #7 | #7 | 15-#6 | 835 | 1972 | 2248 |
| 37' -6" | 50 | 2.46 | 18 | 0.635 | | 16-#5+ 1 | 6 | #6 | #6 | 9-#9 | 9 | #4 | #5 | 17-#5 | 367 | 733 | 987 |
| D = 13.000 | 100 | 2.77 | 18 * | 0.761 | | 16-#5+ 5 | 6 | #7 | #7 | 10-#9 | 9 | #4 | #5 | 17-#5 | 446 | 891 | 1200 |
| RIB NOT ON | 150 | 3.18 | 18 * | 0.849 | | 10-#7+ 3 | 6 | #7 | #8 | 12-#9 | 9 | #5 | #5 | 17-#5 | 525 | 1049 | 1412 |
| COLUMN LINE | 200 | 3.59 | 18 * | 0.636 | | 11-#7+ 3 | 6 | #8 | #8 | 14-#9 | 9 | #5 | #6 | 17-#5 | 604 | 1310 | 1625 |
| 1.073 CF/SF | 300 | 4.93 | 22 * | 0.632 | | 11-#8+ 3 | 6 | #9 | #10 | 18-#9 | 9 | #6 | #7 | 19-#5 | 754 | 1801 | 2031 |
| | 400 | 5.71 | 28 * | 0.628 | 4 S 6 1 | 10-#9+ 1 | 6 | #10 | #10 | 22-#9 | 9 | #7 | #7 | 23-#5 | 885 | 2029 | 2383 |
| 40'-0" | 50 | 2.61 | 20 | 0.694 | | 12-#6+ 3 | 7 | #6 | #7 | 13-#8 | 9 | #4 | #5 | 17-#5 | 447 | 894 | 1204 |
| D = 15.500 | 100 | 3.03 | 20 * | 0.830 | | 14-#6+ 7 | 7 | #7 | #7 | 16-#8 | 9 | #5 | #5 | 17-#5 | 543 | 1085 | 1461 |
| RIB ON | 150 | 3.46 | 20 * | 0.896 | | 12-#7+ 6 | 7 | #7 | #8 | 15-#9 | 9 | #5 | #6 | 17-#5 | 638 | 1276 | 1718 |
| COLUMN LINE | 200 | 4.20 | 20 * | 0.634 | | 14-#7+ 4 | 7 | #8 | #9 | 18-#9 | 9 | #6 | #6 | 19-#5 | 734 | 1545 | 1975 |
| 1.095 CF/SF | 300 | 5.38 | 27 * | 0.629 | 4 S 6 1 | 13-#8+ 2 | 7 | #9 | #10 | 22-#9 | 9 | #7 | #7 | 23-#5 | 906 | 2043 | 2440 |
| 42'-6" | 50 | 2.86 | 21 * | 0.781 | | 14-#6+ 6 | 7 | #7 | #7 | 16-#8 | 10 | #4 | #5 | 18-#5 | 534 | 1069 | 1439 |
| D = 15.500 | 100 | 3.28 | 21 * | 0.870 | | 12-#7+ 6 | 7 | #7 | #8 | 16-#9 | 10 | #5 | #5 | 18-#5 | 649 | 1298 | 1747 |
| RIB ON | 150 | 3.77 | 21 * | 0.633 | | 11-#8+ 3 | 7 | #8 | #8 | 23-#8 | 10 | #5 | #6 | 19-#5 | 764 | 1527 | 2056 |
| COLUMN LINE | 200 | 4.59 | 25 * | 0.630 | | 13-#8+ 2 | 7 | #9 | #9 | 21-#9 | 10 | #6 | #6 | 22-#5 | 871 | 1790 | 2345 |
| 1.083 CF/SF | 300 | 5.50 | 32 * | 0.626 | 4 S 6 1 | 12-#9+ 3 | 7 | #9 | #10 | 27-#9 | 10 | #6 | #7 | 19-#6 | 1069 | 2137 | 2877 |
| 45'-0" | 50 | 3.19 | 22 * | 0.823 | | 12-#7+ 5 | 7 | #7 | #8 | 15-#9 | 11 | #5 | #5 | 20-#5 | 632 | 1265 | 1703 |
| D = 15.500 | 100 | 3.75 | 22 * | 0.910 | | 11-#8+ 6 | 7 | #8 | #8 | 19-#9 | 11 | #5 | #6 | 20-#5 | 769 | 1537 | 2070 |
| RIB ON | 150 | 4.51 | 25 * | 0.630 | | 13-#8+ 2 | 7 | #9 | #9 | 22-#9 | 11 | #6 | #6 | 23-#5 | 900 | 1799 | 2422 |
| COLUMN LINE | 200 | 5.01 | 29 * | 0.627 | 4 S 6 1 | 12-#9+ 2 | 7 | #9 | #10 | 26-#9 | 11 | #6 | #6 | 26-#5 | 1025 | 2050 | 2759 |
| 1.073 CF/SF | | | | | | | | | | | | | | | | | |
| 47'-6" | 50 | 3.52 | 23 * | 0.875 | | 14-#7+ 8 | 8 | #7 | #8 | 18-#9 | 11 | #5 | #6 | 20-#5 | 750 | 1500 | 2019 |
| D = 18.000 | 100 | 4.28 | 24 * | 0.631 | | 13-#8+ 4 | 8 | #8 | #9 | 22-#9 | 11 | #6 | #6 | 23-#5 | 908 | 1817 | 2446 |
| RIB NOT ON | 150 | 4.86 | 30 * | 0.627 | | 12-#9+ 2 | 8 | #9 | #9 | 26-#9 | 11 | #6 | #7 | 27-#5 | 1056 | 2113 | 2844 |
| COLUMN LINE | 200 | 5.50 | 34 * | 0.625 | | 14-#9+ 3 | 8 | #9 | #10 | 30-#9 | 11 | #6 | #7 | 22-#6 | 1194 | 2388 | 3215 |
| 1.091 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 21 in. | | Rib Depth = 16 in. | | Total Slab Depth = 5 in. | | | | | | | |
| 30'-0" | 2.01 | 15 | | 5 | #4 | #5 | 9-#6 | 7 | #4 | #5 | 13-#5 |
| D = 10.500 | 2.10 | 15 | | 5 | #4 | #5 | 8-#7 | 7 | #4 | #5 | 13-#5 |
| RIB ON | 2.30 | 15 | | 5 | #5 | #5 | 7-#8 | 7 | #4 | #5 | 13-#5 |
| COLUMN LINE | 2.50 | 15 | | 5 | #5 | #6 | 8-#8 | 7 | #4 | #5 | 13-#5 |
| 1.073 CF/SF | 2.98 | 15 | 4 S 6 1 | 5 | #6 | #7 | 8-#9 | 7 | #4 | #5 | 13-#5 |
| | 3.54 | 15 * | 4 S 6 2 | 5 | #7 | #7 | 10-#9 | 7 | #5 | #5 | 13-#5 |
| | 4.29 | 15 * | 4 S 6 2 | 5 | #8 | #8 | 12-#9 | 7 | #5 | #6 | 13-#5 |
| 32'-6" | 2.03 | 16 | | 6 | #4 | #5 | 16-#5 | 7 | #4 | #5 | 13-#5 |
| D = 13.000 | 2.16 | 16 | | 6 | #4 | #5 | 10-#7 | 7 | #4 | #5 | 13-#5 |
| RIB NOT ON | 2.40 | 16 | | 6 | #5 | #5 | 9-#8 | 7 | #4 | #5 | 13-#5 |
| COLUMN LINE | 2.76 | 16 | | 6 | #5 | #6 | 9-#9 | 7 | #4 | #5 | 13-#5 |
| 1.101 CF/SF | 3.43 | 16 * | 4 S 6 1 | 6 | #6 | #7 | 11-#9 | 7 | #5 | #5 | 13-#5 |
| | 4.15 | 16 * | 4 S 6 1 | 6 | #7 | #8 | 13-#9 | 7 | #5 | #6 | 14-#5 |
| | 4.83 | 19 * | 4 S 6 2 | 6 | #8 | #8 | 15-#9 | 7 | #6 | #6 | 16-#5 |
| 35'-0" | 2.22 | 17 | | 6 | #4 | #5 | 11-#7 | 8 | #4 | #5 | 15-#5 |
| D = 13.000 | 2.43 | 17 | | 6 | #5 | #5 | 10-#8 | 8 | #4 | #5 | 15-#5 |
| RIB NOT ON | 2.70 | 17 | | 6 | #5 | #6 | 9-#9 | 8 | #4 | #5 | 15-#5 |
| COLUMN LINE | 3.03 | 17 * | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 8 | #4 | #5 | 15-#5 |
| 1.085 CF/SF | 3.78 | 17 * | 4 S 6 2 | 6 | #7 | #7 | 14-#9 | 8 | #5 | #5 | 15-#5 |
| | 4.65 | 19 * | 4 S 6 2 | 6 | #8 | #8 | 17-#9 | 8 | #5 | #6 | 17-#5 |
| | 5.40 | 25 * | 4 S 6 2 | 6 | #8 | #9 | 19-#9 | 8 | #6 | #6 | 20-#5 |
| 37' -6" | 2.39 | 18 | | 6 | #5 | #5 | 10-#8 | 9 | #4 | #5 | 17-#5 |
| D = 13.000 | 2.66 | 18 | | 6 | #5 | #6 | 12-#8 | 9 | #4 | #5 | 17-#5 |
| RIB NOT ON | 2.95 | 18 * | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 9 | #4 | #5 | 17-#5 |
| COLUMN LINE | 3.28 | 18 * | 4 S 6 1 | 6 | #6 | #7 | 13-#9 | 9 | #4 | #5 | 17-#5 |
| 1.073 CF/SF | 4.49 | 18 * | 4 S 6 2 | 6 | #8 | #8 | 17-#9 | 9 | #5 | #6 | 18-#5 |
| | 5.20 | 24 * | 4 S 6 2 | 6 | #8 | #9 | 21-#9 | 9 | #5 | #6 | 21-#5 |
| 40'-0" | 2.47 | 20 | | 7 | #5 | #5 | 12-#8 | 9 | #4 | #5 | 17-#5 |
| D = 15.500 | 2.83 | 20 | | 7 | #5 | #6 | 12-#9 | 9 | #4 | #5 | 17-#5 |
| RIB ON | 3.14 | 20 * | 4 S 6 1 | 7 | #6 | #6 | 14-#9 | 9 | #4 | #5 | 17-#5 |
| COLUMN LINE | 3.78 | 20 * | 4 S 6 1 | 7 | #7 | #7 | 16-#9 | 9 | #5 | #5 | 17-#5 |
| 1.095 CF/SF | 4.87 | 22 * | 4 S 6 2 | 7 | #8 | #8 | 21-#9 | 9 | #5 | #6 | 22-#5 |
| 42'-6" | 2.75 | 21 | | 7 | #5 | #6 | 12-#9 | 10 | #4 | #5 | 18-#5 |
| D = 15.500 | 3.04 | 21 * | 4 S 6 1 | 7 | #6 | #6 | 14-#9 | 10 | #4 | #5 | 18-#5 |
| RIB ON | 3.46 | 21 * | 4 S 6 1 | 7 | #6 | #7 | 17-#9 | 10 | #4 | #5 | 18-#5 |
| COLUMN LINE | 4.24 | 21 * | 4 S 6 2 | 7 | #7 | #8 | 20-#9 | 10 | #5 | #5 | 21-#5 |
| 1.083 CF/SF | 5.15 | 27 * | 4 S 6 2 | 7 | #8 | #8 | 25-#9 | 10 | #5 | #6 | 18-#6 |
| 45'-0" | 2.98 | 22 | 4 S 6 1 | 7 | #6 | #6 | 14-#9 | 11 | #4 | #5 | 20-#5 |
| D = 15.500 | 3.50 | 22 * | 4 S 6 1 | 7 | #7 | #7 | 17-#9 | 11 | #4 | #5 | 20-#5 |
| RIB ON | 4.18 | 22 * | 4 S 6 2 | 7 | #7 | #8 | 21-#9 | 11 | #5 | #5 | 21-#5 |
| COLUMN LINE | 4.65 | 23 * | 4 S 6 2 | 7 | #8 | #8 | 24-#9 | 11 | #5 | #5 | 25-#5 |
| 1.073 CF/SF | | | | | | | | | | | |
| 47'-6" | 3.31 | 23 * | | 8 | #6 | #7 | 17-#9 | 11 | #4 | #5 | 20-#5 |
| D = 18.000 | 3.95 | 23 * | 4 S 6 1 | 8 | #7 | #7 | 21-#9 | 11 | #5 | #5 | 21-#5 |
| RIB NOT ON | 4.41 | 23 * | 4 S 6 2 | 8 | #7 | #8 | 24-#9 | 11 | #5 | #5 | 25-#5 |
| COLUMN LINE | 5.13 | 28 * | 4 S 6 2 | 8 | #8 | #8 | 28-#9 | 11 | #5 | #6 | 20-#6 |
| 1.091 CF/SF | | | | | | | | | | | |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 24″ × 24″ Domes: 6″ Ribs @ 30″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 25 in. | Rib Depth = 20 in. | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | |
| 35'-0" | 50 | 2.45 | 17 | 0.640 | | 15-#5+ 0 | 6 | #5 | #6 | 11-#7 | 8 | #5 | #5 | 15-#5 | 340 | 680 | 915 |
| D = 13.000 | 100 | 2.61 | 17 | 0.640 | | 15-#5+ 0 | 6 | #6 | #6 | 10-#8 | 8 | #5 | #5 | 15-#5 | 404 | 808 | 1088 |
| RIB NOT ON | 150 | 2.76 | 17 | 0.640 | | 15-#5+ 1 | 6 | #6 | #7 | 9-#9 | 8 | #5 | #5 | 15-#5 | 468 | 936 | 1260 |
| COLUMN LINE | 200 | 3.01 | 17 | 0.658 | | 11-#6+ 1 | 6 | #7 | #7 | 10-#9 | 8 | #5 | #5 | 15-#5 | 532 | 1142 | 1433 |
| 1.276 CF/SF | 300 | 3.77 | 17 * | 0.857 | | 10-#7+ 4 | 6 | #8 | #8 | 16-#8 | 8 | #6 | #6 | 15-#5 | 661 | 1568 | 1779 |
| | 400 | 4.56 | 17 * | 0.641 | | 9-#8+ 2 | 6 | #9 | #9 | 16-#9 | 8 | #6 | #7 | 16-#5 | 789 | 1972 | 2124 |
| | 500 | 5.47 | 18 * | 0.640 | | 14-#7+ 2 | 6 | #10 | #10 | 18-#9 | 8 | #7 | #7 | 19-#5 | 915 | 2365 | 2463 |
| 37'-6" | 50 | 2.58 | 18 | 0.639 | | 16-#5+ 0 | 6 | #6 | #6 | 10-#8 | 9 | #5 | #5 | 17-#5 | 416 | 833 | 1121 |
| D = 13.000 | 100 | 2.84 | 18 | 0.639 | | 16-#5+ 0 | 6 | #6 | #7 | 9-#9 | 9 | #5 | #5 | 17-#5 | 495 | 991 | 1334 |
| RIB NOT ON | 150 | 3.02 | 18 | 0.659 | | 12-#6+ 1 | 6 | #7 | #7 | 11-#9 | 9 | #5 | #5 | 17-#5 | 574 | 1149 | 1546 |
| COLUMN LINE | 200 | 3.39 | 18 * | 0.795 | | 10-#7+ 3 | 6 | #7 | #8 | 16-#8 | 9 | #5 | #5 | 17-#5 | 653 | 1386 | 1759 |
| 1.261 CF/SF | 300 | 4.32 | 18 * | 0.640 | | 17-#6+ 1 | 6 | #9 | #9 | 16-#9 | 9 | #6 | #6 | 17-#5 | 811 | 1911 | 2184 |
| | 400 | 5.40 | 19 * | 0.639 | | 9-#9+ 2 | 6 | #10 | #10 | 19-#9 | 9 | #7 | #7 | 20-#5 | 967 | 2402 | 2603 |
| 40'-0" | 50 | 2.64 | 20 | 0.637 | | 12-#6+ 2 | 7 | #6 | #6 | 12-#8 | 9 | #5 | #5 | 17-#5 | 508 | 1016 | 1368 |
| D = 15.500 | 100 | 2.96 | 20 | 0.639 | | 18-#5+ 3 | 7 | #6 | #7 | 12-#9 | 9 | #5 | #5 | 17-#5 | 604 | 1207 | 1625 |
| RIB ON | 150 | 3.25 | 20 * | 0.785 | | 11-#7+ 4 | 7 | #7 | #7 | 14-#9 | 9 | #5 | #5 | 17-#5 | 699 | 1398 | 1882 |
| COLUMN LINE | 200 | 3.63 | 20 * | 0.859 | | 12-#7+ 6 | 7 | #7 | #8 | 16-#9 | 9 | #5 | #6 | 17-#5 | 795 | 1648 | 2139 |
| 1.288 CF/SF | 300 | 4.77 | 20 * | 0.638 | | 12-#8+ 2 | 7 | #9 | #9 | 20-#9 | 9 | #6 | #7 | 21-#5 | 986 | 2286 | 2654 |
| | 400 | 5.96 | 24 * | 0.634 | 5 S 8 1 | 11-#9+ 3 | 7 | #10 | #10 | 24-#9 | 9 | #7 | #8 | 17-#6 | 1166 | 2858 | 3140 |
| 42'-6" | 50 | 2.90 | 21 | 0.636 | | 13-#6+ 2 | 7 | #6 | #7 | 12-#9 | 10 | #5 | #5 | 18-#5 | 607 | 1214 | 1634 |
| D = 15.500 | 100 | 3.28 | 21 | 0.755 | | 11-#7+ 4 | 7 | #7 | #8 | 14-#9 | 10 | #5 | #5 | 18-#5 | 722 | 1443 | 1943 |
| RIB ON | 150 | 3.69 | 21 * | 0.841 | | 13-#7+ 5 | 7 | #8 | #8 | 16-#9 | 10 | #5 | #6 | 18-#5 | 836 | 1673 | 2252 |
| COLUMN LINE | 200 | 4.06 | 21 * | 0.637 | | 11-#8+ 3 | 7 | #8 | #9 | 19-#9 | 10 | #5 | #6 | 20-#5 | 951 | 1937 | 2561 |
| 1.273 CF/SF | 300 | 5.46 | 23 * | 0.635 | 5 S 8 1 | 11-#9+ 3 | 7 | #10 | #10 | 24-#9 | 10 | #7 | #7 | 18-#6 | 1175 | 2692 | 3165 |
| 45'-0" | 50 | 3.10 | 22 | 0.714 | | 11-#7+ 4 | 7 | #7 | #7 | 14-#9 | 11 | #5 | #5 | 20-#5 | 718 | 1437 | 1934 |
| D = 15.500 | 100 | 3.57 | 22 * | 0.813 | | 13-#7+ 5 | 7 | #8 | #8 | 17-#9 | 11 | #5 | #5 | 20-#5 | 855 | 1709 | 2301 |
| RIB ON | 150 | 4.01 | 22 * | 0.896 | | 12-#8+ 6 | 7 | #8 | #9 | 20-#9 | 11 | #5 | #6 | 21-#5 | 991 | 1982 | 2668 |
| COLUMN LINE | 200 | 4.58 | 22 * | 0.636 | | 11-#9+ 3 | 7 | #9 | #9 | 23-#9 | 11 | #6 | #6 | 24-#5 | 1127 | 2254 | 3035 |
| 1.261 CF/SF | | | | | | | | | | | | | | | | | |
| 47'-6" | 50 | 3.34 | 23 * | 0.786 | | 13-#7+ 6 | 8 | #7 | #8 | 17-#9 | 11 | #5 | #5 | 20-#5 | 852 | 1704 | 2294 |
| D = 18.000 | 100 | 3.84 | 23 * | 0.865 | | 12-#8+ 5 | 8 | #8 | #8 | 20-#9 | 11 | #5 | #6 | 21-#5 | 1012 | 2025 | 2726 |
| RIB NOT ON | 150 | 4.40 | 23 * | 0.635 | | 14-#8+ 4 | 8 | #8 | #9 | 24-#9 | 11 | #6 | #6 | 25-#5 | 1173 | 2345 | 3157 |
| COLUMN LINE | 200 | 5.04 | 26 * | 0.633 | | 16-#8+ 3 | 8 | #9 | #9 | 27-#9 | 11 | #6 | #7 | 20-#6 | 1326 | 2651 | 3569 |
| 1.284 CF/SF | 300 | 6.25 | 34 * | 0.628 | | 16-#9+ 2 | 8 | #10 | #10 | 33-#9 | 11 | #7 | #7 | 24-#6 | 1605 | 3209 | 4320 |

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 25 in. | | Rib Depth = 20 in. | | Total Slab Depth = 5 in. | | | | | | | |
| 35'-0" | 2.41 | 17 | | 6 | #5 | #5 | 10-#7 | 8 | #5 | #5 | 15-#5 |
| D = 13.000 | 2.54 | 17 | | 6 | #5 | #5 | 9-#8 | 8 | #5 | #5 | 15-#5 |
| RIB NOT ON | 2.61 | 17 | | 6 | #5 | #5 | 10-#8 | 8 | #5 | #5 | 15-#5 |
| COLUMN LINE | 2.87 | 17 | | 6 | #5 | #6 | 9-#9 | 8 | #5 | #5 | 15-#5 |
| 1.276 CF/SF | 3.42 | 17 * | 5 S 8 1 | 6 | #6 | #7 | 12-#9 | 8 | #5 | #5 | 15-#5 |
| | 4.08 | 17 * | 5 S 8 2 | 6 | #7 | #8 | 14-#9 | 8 | #5 | #6 | 15-#5 |
| | 4.88 | 17 * | 5 S 8 2 | 6 | #8 | #8 | 17-#9 | 8 | #6 | #6 | 18-#5 |
| 37'-6" | 2.52 | 18 | | 6 | #5 | #5 | 9-#8 | 9 | #5 | #5 | 17-#5 |
| D = 13.000 | 2.82 | 18 | | 6 | #5 | #6 | 9-#9 | 9 | #5 | #5 | 17-#5 |
| RIB NOT ON | 2.90 | 18 | | 6 | #5 | #6 | 10-#9 | 9 | #5 | #5 | 17-#5 |
| COLUMN LINE | 3.34 | 18 | 5 S 8 1 | 6 | #6 | #7 | 12-#9 | 9 | #5 | #5 | 17-#5 |
| 1.261 CF/SF | 3.96 | 18 * | 5 S 8 2 | 6 | #7 | #8 | 15-#9 | 9 | #5 | #5 | 17-#5 |
| | 4.79 | 18 * | 5 S 8 2 | 6 | #8 | #9 | 18-#9 | 9 | #5 | #6 | 19-#5 |
| 40'-0" | 2.59 | 20 | | 7 | #5 | #5 | 11-#8 | 9 | #5 | #5 | 17-#5 |
| D = 15.500 | 2.93 | 20 | | 7 | #5 | #6 | 11-#9 | 9 | #5 | #5 | 17-#5 |
| RIB ON | 3.18 | 20 | | 7 | #6 | #6 | 16-#8 | 9 | #5 | #5 | 17-#5 |
| COLUMN LINE | 3.45 | 20 * | 5 S 8 1 | 7 | #6 | #7 | 14-#9 | 9 | #5 | #5 | 17-#5 |
| 1.288 CF/SF | 4.33 | 20 * | 5 S 8 1 | 7 | #7 | #8 | 18-#9 | 9 | #5 | #6 | 19-#5 |
| | 5.36 | 20 * | 5 S 8 2 | 7 | #8 | #9 | 22-#9 | 9 | #6 | #6 | 23-#5 |
| 42'-6" | 2.86 | 21 | | 7 | #5 | #6 | 11-#9 | 10 | #5 | #5 | 18-#5 |
| D = 15.500 | 3.15 | 21 | | 7 | #6 | #6 | 13-#9 | 10 | #5 | #5 | 18-#5 |
| RIB ON | 3.46 | 21 | 5 S 8 1 | 7 | #6 | #7 | 15-#9 | 10 | #5 | #5 | 18-#5 |
| COLUMN LINE | 3.77 | 21 * | 5 S 8 1 | 7 | #7 | #7 | 17-#9 | 10 | #5 | #5 | 18-#5 |
| 1.273 CF/SF | 4.77 | 21 * | 5 S 8 2 | 7 | #8 | #8 | 22-#9 | 10 | #5 | #6 | 23-#5 |
| 45'-0" | 3.05 | 22 | | 7 | #6 | #6 | 16-#8 | 11 | #5 | #5 | 20-#5 |
| D = 15.500 | 3.46 | 22 | 5 S 8 1 | 7 | #6 | #7 | 16-#9 | 11 | #5 | #5 | 20-#5 |
| RIB ON | 3.75 | 22 * | 5 S 8 1 | 7 | #7 | #7 | 18-#9 | 11 | #5 | #5 | 20-#5 |
| COLUMN LINE | 4.21 | 22 * | 5 S 8 2 | 7 | #7 | #8 | 21-#9 | 11 | #5 | #5 | 22-#5 |
| 1.261 CF/SF | | | | | | | | | | | |
| 47'-6" | 3.19 | 23 | | 8 | #6 | #6 | 15-#9 | 11 | #5 | #5 | 20-#5 |
| D = 18.000 | 3.64 | 23 * | 5 S 8 1 | 8 | #6 | #7 | 19-#9 | 11 | #5 | #5 | 20-#5 |
| RIB NOT ON | 4.06 | 23 * | 5 S 8 1 | 8 | #7 | #7 | 22-#9 | 11 | #5 | #5 | 23-#5 |
| COLUMN LINE | 4.68 | 23 * | 5 S 8 2 | 8 | #7 | #8 | 25-#9 | 11 | #5 | #6 | 26-#5 |
| 1.284 CF/SF | 5.88 | 28 * | 5 S 8 2 | 8 | #8 | #9 | 31-#9 | 11 | #6 | #6 | 23-#6 |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 11 in. | Rib Depth = 8 in. | | Total Slab Depth = 3 in. | | | | | | | | | | | | | | |
| 15'-0" | 50 | 1.60 | 12 | 0.629 | | 6-#5+ 0 | 3 | #4 | #4 | 6-#5 | 2 | #4 | #4 | 7-#5 | 13 | 27 | 36 |
| D = 6.500 | 100 | 1.60 | 12 | 0.629 | | 6-#5+ 0 | 3 | #4 | #4 | 6-#5 | 2 | #4 | #4 | 7-#5 | 18 | 39 | 49 |
| RIB ON | 150 | 1.60 | 12 | 0.629 | | 6-#5+ 0 | 3 | #4 | #4 | 6-#5 | 2 | #4 | #4 | 7-#5 | 23 | 55 | 62 |
| COLUMN LINE | 200 | 1.60 | 12 | 0.629 | | 6-#5+ 0 | 3 | #4 | #4 | 6-#5 | 2 | #4 | #4 | 7-#5 | 28 | 70 | 74 |
| 0.545 CF/SF | 300 | 1.71 | 12 | 0.644 | | 6-#5+ 0 | 3 | #4 | #5 | 6-#5 | 2 | #4 | #5 | 7-#5 | 37 | 99 | 100 |
| | 400 | 1.94 | 12 | 0.721 | | 6-#5+ 0 | 3 | #5 | #5 | 7-#5 | 2 | #5 | #5 | 7-#5 | 47 | 127 | 126 |
| 18'-0" | 50 | 1.71 | 12 | 0.629 | | 8-#5+ 0 | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 | 23 | 47 | 63 |
| D = 6.500 | 100 | 1.71 | 12 | 0.663 | | 8-#5+ 0 | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 | 32 | 69 | 85 |
| RIB ON | 150 | 1.77 | 12 | 0.704 | | 8-#5+ 0 | 3 | #4 | #5 | 8-#5 | 3 | #4 | #4 | 10-#5 | 40 | 96 | 108 |
| COLUMN LINE | 200 | 1.83 | 12 | 0.746 | | 8-#5+ 0 | 3 | #5 | #5 | 8-#5 | 3 | #4 | #4 | 10-#5 | 49 | 122 | 131 |
| 0.523 CF/SF | 300 | 2.25 | 12 * | 0.848 | | 8-#5+ 1 | 3 | #6 | #6 | 7-#6 | 3 | #5 | #5 | 10-#5 | 66 | 173 | 176 |
| | 400 | 2.74 | 12 * | 0.630 | 3 S 4 1 | 8-#5+ 1 | 3 | #7 | #7 | 9-#6 | 3 | #5 | #6 | 10-#5 | 82 | 223 | 222 |
| 21'-0" | 50 | 1.63 | 12 | 0.701 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 | 38 | 77 | 103 |
| D = 9.500 | 100 | 1.69 | 12 | 0.776 | | 9-#5+ 1 | 4 | #4 | #5 | 9-#5 | 3 | #4 | #4 | 10-#5 | 52 | 114 | 140 |
| RIB NOT ON | 150 | 1.81 | 12 | 0.837 | | 9-#5+ 2 | 4 | #5 | #5 | 10-#5 | 3 | #4 | #5 | 10-#5 | 66 | 158 | 177 |
| COLUMN LINE | 200 | 2.18 | 12 * | 0.888 | | 9-#5+ 3 | 4 | #5 | #6 | 12-#5 | 3 | #5 | #6 | 10-#5 | 79 | 200 | 214 |
| 0.555 CF/SF | 300 | 2.92 | 13 * | 0.629 | | 9-#5+ 3 | 4 | #7 | #7 | 12-#6 | 3 | #6 | #7 | 10-#5 | 106 | 282 | 286 |
| | 400 | 3.40 | 17 * | 0.624 | | 10-#5+ 3 | 4 | #7 | #8 | 15-#6 | 3 | #7 | #7 | 10-#5 | 129 | 328 | 347 |
| 24'-0" | 50 | 1.67 | 12 | 0.768 | | 10-#5+ 0 | 4 | #4 | #5 | 10-#5 | 4 | #4 | #4 | 12-#5 | 57 | 115 | 154 |
| D = 9.500 | 100 | 1.88 | 12 * | 0.855 | | 10-#5+ 2 | 4 | #5 | #5 | 8-#6 | 4 | #4 | #5 | 12-#5 | 78 | 170 | 210 |
| RIB NOT ON | 150 | 2.24 | 12 * | 0.918 | | 10-#5+ 4 | 4 | #6 | #6 | 15-#5 | 4 | #5 | #5 | 12-#5 | 99 | 235 | 265 |
| COLUMN LINE | 200 | 2.68 | 14 * | 0.627 | | 10-#5+ 2 | 4 | #7 | #7 | 13-#6 | 4 | #5 | #6 | 12-#5 | 118 | 297 | 319 |
| 0.536 CF/SF | | | | | | | | | | | | | | | | | |
| 27'-0" | 50 | 1.75 | 13 * | 0.806 | | 8-#6+ 0 | 4 | #5 | #5 | 12-#5 | 5 | #4 | #4 | 14-#5 | 81 | 162 | 219 |
| D = 9.500 | 100 | 2.17 | 13 * | 0.899 | | 8-#6+ 2 | 4 | #6 | #6 | 12-#6 | 5 | #4 | #5 | 14-#5 | 111 | 233 | 298 |
| RIB NOT ON | 150 | 2.88 | 16 * | 0.912 | | 8-#6+ 4 | 4 | #7 | #8 | 16-#6 | 5 | #5 | #6 | 14-#5 | 139 | 323 | 374 |
| COLUMN LINE | 200 | 3.26 | 21 * | 0.621 | | 12-#5+ 3 | 4 | #8 | #8 | 19-#6 | 5 | #6 | #6 | 14-#5 | 164 | 382 | 442 |
| 0.523 CF/SF | | | | | | | | | | | | | | | | | |
| 30'-0" | 50 | 1.99 | 15 * | 0.854 | | 13-#5+ 3 | 5 | #5 | #6 | 12-#6 | 5 | #4 | #5 | 14-#5 | 113 | 225 | 303 |
| D = 12.500 | 100 | 2.45 | 16 * | 0.919 | | 13-#5+ 7 | 5 | #6 | #7 | 17-#6 | 5 | #5 | #5 | 14-#5 | 152 | 305 | 411 |
| RIB ON | 150 | 2.93 | 24 * | 0.619 | | 10-#6+ 3 | 5 | #7 | #7 | 21-#6 | 5 | #5 | #6 | 14-#5 | 186 | 373 | 502 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.545 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 11 in. | | Rib Depth = 8 in. | | Total Slab Depth = 3 in. | | | | | | | |
| 15'-0" | 1.64 | 12 | | 3 | #4 | #4 | 6-#5 | 2 | #4 | #4 | 7-#5 |
| D = 6.500 | 1.64 | 12 | | 3 | #4 | #4 | 6-#5 | 2 | #4 | #4 | 7-#5 |
| RIB ON | 1.64 | 12 | | 3 | #4 | #4 | 6-#5 | 2 | #4 | #4 | 7-#5 |
| COLUMN LINE | 1.64 | 12 | | 3 | #4 | #4 | 6-#5 | 2 | #4 | #4 | 7-#5 |
| 0.545 CF/SF | 1.64 | 12 | | 3 | #4 | #4 | 6-#5 | 2 | #4 | #4 | 7-#5 |
| | 1.83 | 12 | 3 S 4 1 | 3 | #4 | #5 | 6-#5 | 2 | #4 | #5 | 7-#5 |
| 18'-0" | 1.78 | 12 | | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 |
| D = 6.500 | 1.78 | 12 | | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 |
| RIB ON | 1.78 | 12 | | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 |
| COLUMN LINE | 1.78 | 12 | 3 S 4 1 | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 |
| 0.523 CF/SF | 2.03 | 12 | 3 S 4 1 | 3 | #5 | #5 | 6-#6 | 3 | #4 | #4 | 10-#5 |
| | 2.44 | 12 * | 3 S 4 1 | 3 | #5 | #6 | 8-#6 | 3 | #4 | #5 | 10-#5 |
| 21'-0" | 1.68 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 |
| D = 9.500 | 1.68 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 |
| RIB NOT ON | 1.68 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 |
| COLUMN LINE | 1.99 | 12 * | | 4 | #4 | #5 | 8-#6 | 3 | #4 | #5 | 10-#5 |
| 0.555 CF/SF | 2.54 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 15-#5 | 3 | #5 | #5 | 10-#5 |
| | 2.99 | 16 * | 3 S 4 1 | 4 | #6 | #6 | 13-#6 | 3 | #5 | #6 | 10-#5 |
| 24'-0" | 1.68 | 12 | | 4 | #4 | #4 | 10-#5 | 4 | #4 | #4 | 12-#5 |
| D = 9.500 | 1.84 | 12 | | 4 | #4 | #5 | 8-#6 | 4 | #4 | #4 | 12-#5 |
| RIB NOT ON | 2.08 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 10-#6 | 4 | #4 | #4 | 12-#5 |
| COLUMN LINE | 2.42 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 12-#6 | 4 | #4 | #5 | 12-#5 |
| 0.536 CF/SF | | | | | | | | | | | |
| 27'-0" | 1.71 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 14-#5 |
| D = 9.500 | 2.07 | 13 * | 3 S 4 1 | 4 | #5 | #5 | 11-#6 | 5 | #4 | #4 | 14-#5 |
| RIB NOT ON | 2.63 | 13 * | 3 S 4 1 | 4 | #6 | #6 | 15-#6 | 5 | #4 | #5 | 14-#5 |
| COLUMN LINE | 2.95 | 15 * | 3 S 4 2 | 4 | #6 | #7 | 18-#6 | 5 | #4 | #5 | 14-#5 |
| 0.523 CF/SF | | | | | | | | | | | |
| 30'-0" | 1.88 | 15 | | 5 | #4 | #5 | 11-#6 | 5 | #4 | #4 | 14-#5 |
| D = 12.500 | 2.24 | 15 * | 3 S 4 1 | 5 | #5 | #5 | 16-#6 | 5 | #4 | #4 | 14-#5 |
| RIB ON | 2.78 | 18 * | 3 S 4 1 | 5 | #6 | #6 | 20-#6 | 5 | #4 | #5 | 14-#5 |
| COLUMN LINE | | | | | | | | | | | |
| 0.545 CF/SF | | | | | | | | | | | |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 13 in. | Rib Depth = 10 in. | | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | Total Depth = 13 in. | Rib Depth = 10 in. | | Total Slab Depth = 3 in. | | | | | | |
| 18'-0" | 50 | 1.71 | 12 | 0.633 | | 8-#5+ 0 | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 | 25 | 51 | 68 | 1.78 | 12 | | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 |
| D = 6.500 | 100 | 1.71 | 12 | 0.633 | | 8-#5+ 0 | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 | 34 | 73 | 91 | 1.78 | 12 | | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 |
| RIB ON | 150 | 1.71 | 12 | 0.633 | | 8-#5+ 0 | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 | 42 | 100 | 113 | 1.78 | 12 | | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 1.77 | 12 | 0.641 | | 8-#5+ 0 | 3 | #4 | #5 | 8-#5 | 3 | #4 | #4 | 10-#5 | 51 | 127 | 136 | 1.78 | 12 | | 3 | #4 | #4 | 8-#5 | 3 | #4 | #4 | 10-#5 |
| 0.597 CF/SF | 300 | 2.01 | 12 | 0.717 | | 8-#5+ 0 | 3 | #5 | #6 | 8-#5 | 3 | #4 | #5 | 10-#5 | 68 | 179 | 182 | 1.89 | 12 | 3 S 4 1 | 3 | #4 | #5 | 8-#5 | 3 | #4 | #4 | 10-#5 |
| | 400 | 2.44 | 12 | 0.793 | | 8-#5+ 0 | 3 | #6 | #7 | 7-#6 | 3 | #5 | #5 | 10-#5 | 84 | 230 | 227 | 2.23 | 12 | 3 S 4 1 | 3 | #5 | #5 | 7-#6 | 3 | #4 | #5 | 10-#5 |
| 21'-0" | 50 | 1.63 | 12 | 0.633 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 | 42 | 84 | 113 | 1.68 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 |
| D = 9.500 | 100 | 1.63 | 12 | 0.664 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 | 55 | 120 | 149 | 1.68 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 |
| RIB NOT ON | 150 | 1.74 | 12 | 0.709 | | 9-#5+ 0 | 4 | #4 | #5 | 9-#5 | 3 | #4 | #5 | 10-#5 | 69 | 165 | 186 | 1.68 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 1.92 | 12 | 0.755 | | 9-#5+ 0 | 4 | #5 | #5 | 10-#5 | 3 | #5 | #5 | 10-#5 | 83 | 208 | 223 | 1.79 | 12 | | 4 | #4 | #5 | 9-#5 | 3 | #4 | #4 | 10-#5 |
| 0.637 CF/SF | 300 | 2.60 | 12 * | 0.874 | | 9-#5+ 2 | 4 | #6 | #7 | 10-#6 | 3 | #6 | #6 | 10-#5 | 110 | 292 | 296 | 2.30 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 9-#6 | 3 | #5 | #5 | 10-#5 |
| | 400 | 3.05 | 12 * | 0.634 | | 9-#5+ 1 | 4 | #7 | #7 | 12-#6 | 3 | #6 | #7 | 10-#5 | 137 | 375 | 370 | 2.81 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 16-#5 | 3 | #5 | #6 | 10-#5 |
| 24'-0" | 50 | 1.62 | 12 | 0.692 | | 10-#5+ 0 | 4 | #4 | #4 | 10-#5 | 4 | #4 | #4 | 12-#5 | 62 | 125 | 168 | 1.68 | 12 | | 4 | #4 | #4 | 10-#5 | 4 | #4 | #4 | 12-#5 |
| D = 9.500 | 100 | 1.73 | 12 | 0.769 | | 10-#5+ 1 | 4 | #5 | #5 | 10-#5 | 4 | #4 | #4 | 12-#5 | 83 | 179 | 223 | 1.68 | 12 | | 4 | #4 | #4 | 10-#5 | 4 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 1.97 | 12 * | 0.833 | | 10-#5+ 2 | 4 | #5 | #6 | 9-#6 | 4 | #4 | #5 | 12-#5 | 104 | 247 | 279 | 1.84 | 12 | | 4 | #4 | #5 | 8-#6 | 4 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.43 | 12 * | 0.895 | | 10-#5+ 4 | 4 | #6 | #7 | 11-#6 | 4 | #5 | #5 | 12-#5 | 124 | 311 | 334 | 2.28 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 10-#6 | 4 | #4 | #5 | 12-#5 |
| 0.613 CF/SF | 300 | 3.15 | 14 * | 0.631 | | 10-#5+ 3 | 4 | #7 | #8 | 15-#6 | 4 | #6 | #6 | 12-#5 | 164 | 435 | 442 | 2.93 | 12 * | 3 S 4 1 | 4 | #6 | #7 | 14-#6 | 4 | #5 | #5 | 12-#5 |
| | 400 | 3.86 | 18 * | 0.626 | | 12-#5+ 3 | 4 | #8 | #9 | 19-#6 | 4 | #7 | #7 | 12-#5 | 200 | 529 | 538 | 3.41 | 15 * | 3 S 4 1 | 4 | #7 | #7 | 17-#6 | 4 | #5 | #6 | 12-#5 |
| 27'-0" | 50 | 1.75 | 13 | 0.735 | | 8-#6+ 0 | 4 | #5 | #5 | 8-#6 | 5 | #4 | #4 | 14-#5 | 88 | 176 | 237 | 1.71 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 14-#5 |
| D = 9.500 | 100 | 1.95 | 13 * | 0.819 | | 8-#6+ 1 | 4 | #5 | #6 | 15-#5 | 5 | #4 | #4 | 14-#5 | 118 | 248 | 317 | 1.92 | 13 | 3 S 4 1 | 4 | #4 | #5 | 10-#6 | 5 | #4 | #4 | 14-#5 |
| RIB NOT ON | 150 | 2.48 | 13 * | 0.897 | | 8-#6+ 3 | 4 | #7 | #7 | 13-#6 | 5 | #5 | #5 | 14-#5 | 147 | 344 | 396 | 2.23 | 13 * | 3 S 4 1 | 4 | #5 | #6 | 12-#6 | 5 | #4 | #4 | 14-#5 |
| COLUMN LINE | 200 | 2.95 | 14 * | 0.631 | | 8-#6+ 2 | 4 | #7 | #8 | 16-#6 | 5 | #5 | #6 | 14-#5 | 176 | 435 | 474 | 2.77 | 13 * | 3 S 4 1 | 4 | #6 | #7 | 15-#6 | 5 | #4 | #5 | 14-#5 |
| 0.597 CF/SF | 300 | 3.82 | 20 * | 0.625 | | 10-#6+ 1 | 4 | #9 | #9 | 22-#6 | 5 | #6 | #7 | 14-#5 | 228 | 570 | 613 | 3.34 | 16 * | 3 S 4 2 | 4 | #7 | #7 | 20-#6 | 5 | #5 | #5 | 14-#5 |
| 30'-0" | 50 | 1.78 | 15 | 0.785 | | 13-#5+ 2 | 5 | #5 | #5 | 11-#6 | 5 | #4 | #4 | 14-#5 | 123 | 245 | 330 | 1.72 | 15 | | 5 | #4 | #4 | 10-#6 | 5 | #4 | #4 | 14-#5 |
| D = 12.500 | 100 | 2.29 | 15 * | 0.872 | | 13-#5+ 5 | 5 | #6 | #6 | 15-#6 | 5 | #5 | #5 | 14-#5 | 163 | 327 | 438 | 2.13 | 15 | | 5 | #5 | #5 | 14-#6 | 5 | #4 | #4 | 14-#5 |
| RIB ON | 150 | 2.74 | 16 * | 0.918 | | 13-#5+ 8 | 5 | #7 | #7 | 26-#5 | 5 | #5 | #6 | 14-#5 | 202 | 458 | 545 | 2.51 | 15 * | 3 S 4 1 | 5 | #5 | #6 | 17-#6 | 5 | #4 | #5 | 14-#5 |
| COLUMN LINE | 200 | 3.51 | 19 * | 0.625 | | 15-#5+ 5 | 5 | #8 | #8 | 23-#6 | 5 | #6 | #7 | 14-#5 | 241 | 577 | 648 | 3.21 | 15 * | 3 S 4 1 | 5 | #6 | #7 | 21-#6 | 5 | #5 | #6 | 14-#5 |
| 0.624 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 33'-0" | 50 | 2.18 | 16 * | 0.835 | | 10-#6+ 3 | 5 | #6 | #6 | 15-#6 | 6 | #4 | #5 | 17-#5 | 162 | 324 | 436 | 2.09 | 16 | | 5 | #5 | #5 | 14-#6 | 6 | #4 | #4 | 17-#5 |
| D = 12.500 | 100 | 2.60 | 16 * | 0.917 | | 10-#6+ 6 | 5 | #7 | #7 | 20-#6 | 6 | #5 | #5 | 17-#5 | 216 | 431 | 581 | 2.39 | 16 * | 3 S 4 1 | 5 | #5 | #6 | 18-#6 | 6 | #4 | #4 | 17-#5 |
| RIB ON | 150 | 3.39 | 20 * | 0.625 | | 12-#6+ 4 | 5 | #8 | #8 | 25-#6 | 6 | #6 | #6 | 17-#5 | 267 | 582 | 718 | 3.15 | 16 * | 3 S 4 1 | 5 | #6 | #7 | 24-#6 | 6 | #5 | #5 | 17-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.609 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.38 | 18 * | 0.852 | | 11-#6+ 4 | 5 | #6 | #7 | 19-#6 | 7 | #4 | #5 | 19-#5 | 208 | 417 | 561 | 2.31 | 18 | 3 S 4 1 | 5 | #5 | #6 | 18-#6 | 7 | #4 | #4 | 19-#5 |
| D = 12.500 | 100 | 3.05 | 20 * | 0.921 | | 12-#6+ 9 | 5 | #7 | #8 | 26-#6 | 7 | #5 | #6 | 19-#5 | 277 | 553 | 744 | 2.90 | 18 * | 3 S 4 1 | 5 | #6 | #7 | 24-#6 | 7 | #4 | #5 | 19-#5 |
| RIB ON | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.597 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 12 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | |
| 21'-0" | 50 | 1.63 | 12 | 0.636 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 | 45 | 91 | 122 |
| D = 9.500 | 100 | 1.63 | 12 | 0.636 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 | 59 | 126 | 159 |
| RIB NOT ON | 150 | 1.69 | 12 | 0.636 | | 9-#5+ 0 | 4 | #4 | #5 | 9-#5 | 3 | #4 | #4 | 10-#5 | 73 | 172 | 196 |
| COLUMN LINE | 200 | 1.80 | 12 | 0.656 | | 9-#5+ 0 | 4 | #5 | #5 | 9-#5 | 3 | #4 | #5 | 10-#5 | 86 | 215 | 232 |
| 0.720 CF/SF | 300 | 2.25 | 12 | 0.741 | | 9-#5+ 0 | 4 | #6 | #6 | 8-#6 | 3 | #5 | #6 | 10-#5 | 114 | 300 | 306 |
| | 400 | 2.71 | 12 * | 0.857 | | 9-#5+ 2 | 4 | #6 | #7 | 15-#5 | 3 | #6 | #6 | 10-#5 | 141 | 383 | 379 |
| | 500 | 3.28 | 12 * | 0.637 | | 9-#5+ 1 | 4 | #7 | #8 | 18-#5 | 3 | #7 | #7 | 10-#5 | 168 | 465 | 453 |
| 24'-0" | 50 | 1.62 | 12 | 0.636 | | 10-#5+ 0 | 4 | #4 | #4 | 10-#5 | 4 | #4 | #4 | 12-#5 | 67 | 135 | 182 |
| D = 9.500 | 100 | 1.67 | 12 | 0.662 | | 10-#5+ 0 | 4 | #4 | #5 | 10-#5 | 4 | #4 | #4 | 12-#5 | 88 | 187 | 237 |
| RIB NOT ON | 150 | 1.95 | 12 | 0.712 | | 10-#5+ 0 | 4 | #5 | #6 | 8-#6 | 4 | #4 | #5 | 12-#5 | 109 | 256 | 293 |
| COLUMN LINE | 200 | 2.20 | 12 | 0.762 | | 10-#5+ 0 | 4 | #6 | #6 | 10-#6 | 4 | #5 | #5 | 12-#5 | 129 | 321 | 348 |
| 0.692 CF/SF | 300 | 2.81 | 12 * | 0.894 | | 10-#5+ 3 | 4 | #7 | #7 | 13-#6 | 4 | #6 | #6 | 12-#5 | 171 | 449 | 459 |
| | 400 | 3.45 | 13 * | 0.635 | | 8-#6+ 2 | 4 | #8 | #8 | 16-#6 | 4 | #6 | #7 | 12-#5 | 211 | 573 | 568 |
| | 500 | 4.10 | 17 * | 0.630 | | 9-#6+ 2 | 4 | #9 | #9 | 20-#6 | 4 | #7 | #7 | 12-#5 | 247 | 673 | 664 |
| 27'-0" | 50 | 1.70 | 13 | 0.661 | | 8-#6+ 0 | 4 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 14-#5 | 95 | 191 | 257 |
| D = 9.500 | 100 | 1.88 | 13 | 0.718 | | 8-#6+ 0 | 4 | #5 | #6 | 9-#6 | 5 | #4 | #4 | 14-#5 | 125 | 260 | 336 |
| RIB NOT ON | 150 | 2.22 | 13 * | 0.801 | | 8-#6+ 1 | 4 | #6 | #7 | 12-#6 | 5 | #4 | #5 | 14-#5 | 154 | 359 | 415 |
| COLUMN LINE | 200 | 2.63 | 13 * | 0.878 | | 8-#6+ 3 | 4 | #7 | #7 | 14-#6 | 5 | #5 | #5 | 14-#5 | 184 | 452 | 495 |
| 0.673 CF/SF | 300 | 3.51 | 15 * | 0.633 | | 9-#6+ 1 | 4 | #8 | #9 | 19-#6 | 5 | #6 | #6 | 14-#5 | 241 | 630 | 649 |
| | 400 | 4.31 | 19 * | 0.628 | | 11-#6+ 1 | 4 | #9 | #10 | 24-#6 | 5 | #7 | #7 | 14-#5 | 293 | 768 | 788 |
| 30'-0" | 50 | 1.74 | 15 | 0.682 | | 13-#5+ 0 | 5 | #5 | #5 | 10-#6 | 5 | #4 | #4 | 14-#5 | 133 | 265 | 357 |
| D = 12.500 | 100 | 2.03 | 15 | 0.795 | | 13-#5+ 3 | 5 | #5 | #6 | 13-#6 | 5 | #4 | #5 | 14-#5 | 173 | 348 | 466 |
| RIB ON | 150 | 2.58 | 15 * | 0.872 | | 13-#5+ 6 | 5 | #6 | #7 | 16-#6 | 5 | #5 | #6 | 14-#5 | 213 | 485 | 574 |
| COLUMN LINE | 200 | 3.07 | 15 * | 0.633 | | 13-#5+ 4 | 5 | #7 | #8 | 20-#6 | 5 | #6 | #6 | 14-#5 | 254 | 611 | 683 |
| 0.705 CF/SF | 300 | 4.00 | 20 * | 0.627 | 4 S 6 1 | 12-#6+ 3 | 5 | #8 | #9 | 26-#6 | 5 | #7 | #7 | 14-#5 | 328 | 834 | 884 |
| 33'-0" | 50 | 1.94 | 16 | 0.765 | | 10-#6+ 2 | 5 | #5 | #6 | 13-#6 | 6 | #4 | #4 | 17-#5 | 175 | 351 | 472 |
| D = 12.500 | 100 | 2.46 | 16 * | 0.853 | | 10-#6+ 4 | 5 | #6 | #7 | 18-#6 | 6 | #5 | #5 | 17-#5 | 229 | 458 | 617 |
| RIB ON | 150 | 2.97 | 16 * | 0.631 | | 15-#5+ 3 | 5 | #7 | #8 | 22-#6 | 6 | #5 | #6 | 17-#5 | 283 | 627 | 761 |
| COLUMN LINE | 200 | 3.70 | 19 * | 0.628 | | 18-#5+ 4 | 5 | #8 | #9 | 27-#6 | 6 | #6 | #7 | 17-#5 | 334 | 788 | 899 |
| 0.687 CF/SF | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.26 | 18 * | 0.773 | | 11-#6+ 2 | 5 | #6 | #7 | 17-#6 | 7 | #4 | #5 | 19-#5 | 225 | 451 | 606 |
| D = 12.500 | 100 | 2.76 | 18 * | 0.882 | | 11-#6+ 6 | 5 | #7 | #8 | 23-#6 | 7 | #5 | #5 | 19-#5 | 295 | 590 | 794 |
| RIB ON | 150 | 3.41 | 20 * | 0.627 | 4 S 6 1 | 19-#5+ 4 | 5 | #8 | #9 | 29-#6 | 7 | #5 | #6 | 19-#5 | 363 | 756 | 977 |
| COLUMN LINE | 200 | 4.06 | 25 * | 0.624 | 4 S 6 1 | 16-#6+ 3 | 5 | #9 | #9 | 35-#6 | 7 | #6 | #7 | 19-#5 | 426 | 922 | 1146 |
| 0.673 CF/SF | | | | | | | | | | | | | | | | | |
| 39'-0" | 50 | 2.51 | 19 * | 0.856 | | 17-#5+10 | 6 | #6 | #7 | 23-#6 | 7 | #5 | #5 | 19-#5 | 291 | 582 | 783 |
| D = 15.500 | 100 | 3.07 | 21 * | 0.910 | | 14-#6+10 | 6 | #7 | #8 | 30-#6 | 7 | #5 | #6 | 19-#5 | 378 | 756 | 1017 |
| RIB NOT ON | 150 | 3.88 | 27 * | 0.622 | | 18-#6+ 6 | 6 | #8 | #9 | 37-#6 | 7 | #6 | #7 | 19-#5 | 460 | 934 | 1238 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.697 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | | Rib Depth = 12 in. | | Total Slab Depth = 3 in. | | | | | | | |
| 21'-0" | 1.68 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 |
| D = 9.500 | 1.68 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 |
| RIB NOT ON | 1.68 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 |
| COLUMN LINE | 1.68 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 10-#5 |
| 0.720 CF/SF | 1.99 | 12 | | 4 | #4 | #5 | 8-#6 | 3 | #4 | #5 | 10-#5 |
| | 2.49 | 12 * | 4 S 6 1 | 4 | #5 | #6 | 10-#6 | 3 | #5 | #5 | 10-#5 |
| | 2.88 | 12 * | 4 S 6 1 | 4 | #6 | #6 | 12-#6 | 3 | #5 | #6 | 10-#5 |
| 24'-0" | 1.68 | 12 | | 4 | #4 | #4 | 10-#5 | 4 | #4 | #4 | 12-#5 |
| D = 9.500 | 1.68 | 12 | | 4 | #4 | #4 | 10-#5 | 4 | #4 | #4 | 12-#5 |
| RIB NOT ON | 1.84 | 12 | | 4 | #4 | #5 | 8-#6 | 4 | #4 | #4 | 12-#5 |
| COLUMN LINE | 2.02 | 12 | | 4 | #5 | #5 | 9-#6 | 4 | #4 | #4 | 12-#5 |
| 0.692 CF/SF | 2.53 | 12 * | 4 S 6 1 | 4 | #6 | #6 | 12-#6 | 4 | #4 | #5 | 12-#5 |
| | 3.12 | 12 * | 4 S 6 1 | 4 | #6 | #7 | 15-#6 | 4 | #5 | #6 | 12-#5 |
| | 3.62 | 14 * | 4 S 6 2 | 4 | #7 | #7 | 18-#6 | 4 | #6 | #6 | 12-#5 |
| 27'-0" | 1.71 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 14-#5 |
| D = 9.500 | 1.81 | 13 | | 4 | #4 | #5 | 12-#5 | 5 | #4 | #4 | 14-#5 |
| RIB NOT ON | 2.03 | 13 | 4 S 6 1 | 4 | #5 | #5 | 15-#5 | 5 | #4 | #4 | 14-#5 |
| COLUMN LINE | 2.51 | 13 * | 4 S 6 1 | 4 | #6 | #6 | 13-#6 | 5 | #4 | #5 | 14-#5 |
| 0.673 CF/SF | 3.21 | 13 * | 4 S 6 1 | 4 | #7 | #7 | 18-#6 | 5 | #5 | #5 | 14-#5 |
| | 3.75 | 16 * | 4 S 6 2 | 4 | #7 | #8 | 22-#6 | 5 | #5 | #6 | 14-#5 |
| 30'-0" | 1.67 | 15 | | 5 | #4 | #4 | 13-#5 | 5 | #4 | #4 | 14-#5 |
| D = 12.500 | 1.92 | 15 | | 5 | #4 | #5 | 12-#6 | 5 | #4 | #4 | 14-#5 |
| RIB ON | 2.39 | 15 | 4 S 6 1 | 5 | #5 | #6 | 15-#6 | 5 | #4 | #5 | 14-#5 |
| COLUMN LINE | 2.79 | 15 * | 4 S 6 1 | 5 | #6 | #6 | 18-#6 | 5 | #5 | #5 | 14-#5 |
| 0.705 CF/SF | 3.66 | 16 * | 4 S 6 1 | 5 | #7 | #7 | 24-#6 | 5 | #6 | #6 | 14-#5 |
| 33'-0" | 1.90 | 16 | | 5 | #4 | #5 | 12-#6 | 6 | #4 | #4 | 17-#5 |
| D = 12.500 | 2.29 | 16 | 4 S 6 1 | 5 | #5 | #6 | 16-#6 | 6 | #4 | #4 | 17-#5 |
| RIB ON | 2.75 | 16 * | 4 S 6 1 | 5 | #6 | #6 | 21-#6 | 6 | #4 | #5 | 17-#5 |
| COLUMN LINE | 3.34 | 16 * | 4 S 6 1 | 5 | #7 | #7 | 25-#6 | 6 | #5 | #5 | 17-#5 |
| 0.687 CF/SF | | | | | | | | | | | |
| 36'-0" | 2.12 | 18 | | 5 | #5 | #5 | 16-#6 | 7 | #4 | #4 | 19-#5 |
| D = 12.500 | 2.54 | 18 * | 4 S 6 1 | 5 | #6 | #6 | 30-#5 | 7 | #4 | #4 | 19-#5 |
| RIB ON | 3.16 | 18 * | 4 S 6 2 | 5 | #7 | #7 | 27-#6 | 7 | #4 | #5 | 19-#5 |
| COLUMN LINE | 3.73 | 19 * | 4 S 6 2 | 5 | #7 | #8 | 33-#6 | 7 | #5 | #5 | 19-#5 |
| 0.673 CF/SF | | | | | | | | | | | |
| 39'-0" | 2.37 | 19 | | 6 | #5 | #6 | 21-#6 | 7 | #4 | #4 | 19-#5 |
| D = 15.500 | 2.85 | 19 * | 4 S 6 1 | 6 | #6 | #6 | 28-#6 | 7 | #4 | #5 | 19-#5 |
| RIB NOT ON | 3.54 | 19 * | 4 S 6 1 | 6 | #7 | #7 | 35-#6 | 7 | #5 | #5 | 19-#5 |
| COLUMN LINE | | | | | | | | | | | |
| 0.697 CF/SF | | | | | | | | | | | |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 17 in. | Rib Depth = 14 in. | Total Slab Depth = 3 in. | | | | | | | | | | | | | | | |
| 24'-0" | 50 | 1.62 | 12 | 0.639 | | 10-#5+ 0 | 4 | #4 | #4 | 10-#5 | 4 | #4 | #4 | 12-#5 | 73 | 146 | 196 |
| D = 9.500 | 100 | 1.67 | 12 | 0.639 | | 10-#5+ 0 | 4 | #4 | #5 | 10-#5 | 4 | #4 | #4 | 12-#5 | 93 | 194 | 251 |
| RIB NOT ON | 150 | 1.73 | 12 | 0.639 | | 10-#5+ 0 | 4 | #5 | #5 | 10-#5 | 4 | #4 | #4 | 12-#5 | 114 | 265 | 307 |
| COLUMN LINE | 200 | 1.96 | 12 | 0.668 | | 10-#5+ 0 | 4 | #5 | #6 | 12-#5 | 4 | #4 | #5 | 12-#5 | 135 | 331 | 363 |
| 0.773 CF/SF | 300 | 2.53 | 12 | 0.785 | | 10-#5+ 1 | 4 | #6 | #7 | 12-#6 | 4 | #5 | #6 | 12-#5 | 176 | 459 | 474 |
| | 400 | 3.05 | 12 * | 0.640 | | 10-#5+ 1 | 4 | #7 | #8 | 15-#6 | 4 | #6 | #6 | 12-#5 | 217 | 586 | 585 |
| | 500 | 3.79 | 12 * | 0.640 | | 8-#6+ 2 | 4 | #8 | #9 | 18-#6 | 4 | #7 | #7 | 12-#5 | 258 | 711 | 696 |
| 27'-0" | 50 | 1.70 | 13 | 0.637 | | 8-#6+ 0 | 4 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 14-#5 | 103 | 206 | 277 |
| D = 9.500 | 100 | 1.75 | 13 | 0.637 | | 8-#6+ 0 | 4 | #5 | #5 | 12-#5 | 5 | #4 | #4 | 14-#5 | 132 | 271 | 356 |
| RIB NOT ON | 150 | 2.11 | 13 | 0.692 | | 8-#6+ 0 | 4 | #6 | #6 | 15-#5 | 5 | #4 | #5 | 14-#5 | 162 | 372 | 435 |
| COLUMN LINE | 200 | 2.47 | 13 | 0.797 | | 8-#6+ 2 | 4 | #7 | #7 | 18-#5 | 5 | #5 | #5 | 14-#5 | 191 | 466 | 515 |
| 0.751 CF/SF | 300 | 3.24 | 13 * | 0.638 | | 8-#6+ 2 | 4 | #8 | #8 | 17-#6 | 5 | #6 | #6 | 14-#5 | 250 | 649 | 673 |
| | 400 | 3.95 | 14 * | 0.637 | | 10-#6+ 1 | 4 | #9 | #9 | 21-#6 | 5 | #6 | #7 | 14-#5 | 308 | 827 | 829 |
| | 500 | 4.66 | 18 * | 0.632 | 4 S 6 1 | 12-#6+ 0 | 4 | #10 | #10 | 25-#6 | 5 | #7 | #7 | 14-#5 | 360 | 974 | 968 |
| 30'-0" | 50 | 1.67 | 15 | 0.634 | | 13-#5+ 0 | 5 | #4 | #5 | 13-#5 | 5 | #4 | #4 | 14-#5 | 143 | 287 | 386 |
| D = 12.500 | 100 | 1.99 | 15 | 0.714 | | 13-#5+ 2 | 5 | #5 | #6 | 12-#6 | 5 | #4 | #5 | 14-#5 | 184 | 367 | 494 |
| RIB ON | 150 | 2.37 | 15 | 0.795 | | 13-#5+ 4 | 5 | #6 | #7 | 15-#6 | 5 | #5 | #5 | 14-#5 | 224 | 505 | 603 |
| COLUMN LINE | 200 | 2.76 | 15 * | 0.859 | | 13-#5+ 6 | 5 | #7 | #7 | 18-#6 | 5 | #5 | #6 | 14-#5 | 264 | 633 | 711 |
| 0.788 CF/SF | 300 | 3.83 | 15 * | 0.635 | | 11-#6+ 3 | 5 | #8 | #9 | 24-#6 | 5 | #7 | #7 | 14-#5 | 345 | 884 | 928 |
| | 400 | 4.56 | 20 * | 0.630 | 4 S 6 1 | 19-#5+ 4 | 5 | #9 | #10 | 29-#6 | 5 | #7 | #8 | 14-#5 | 417 | 1088 | 1121 |
| 33'-0" | 50 | 1.91 | 16 | 0.682 | | 10-#6+ 1 | 5 | #5 | #6 | 12-#6 | 6 | #4 | #4 | 17-#5 | 189 | 378 | 509 |
| D = 12.500 | 100 | 2.22 | 16 | 0.785 | | 10-#6+ 3 | 5 | #6 | #6 | 16-#6 | 6 | #4 | #5 | 17-#5 | 243 | 486 | 654 |
| RIB ON | 150 | 2.78 | 16 * | 0.861 | | 10-#6+ 5 | 5 | #7 | #7 | 20-#6 | 6 | #5 | #6 | 17-#5 | 297 | 657 | 799 |
| COLUMN LINE | 200 | 3.32 | 16 * | 0.634 | | 11-#6+ 3 | 5 | #8 | #8 | 24-#6 | 6 | #6 | #6 | 17-#5 | 350 | 828 | 943 |
| 0.767 CF/SF | 300 | 4.50 | 21 * | 0.629 | 4 S 6 1 | 15-#6+ 3 | 5 | #9 | #10 | 31-#6 | 6 | #7 | #7 | 17-#5 | 451 | 1129 | 1213 |
| | 400 | 5.04 | 27 * | 0.625 | 4 S 6 1 | 18-#6+ 2 | 5 | #10 | #10 | 38-#6 | 6 | #7 | #8 | 18-#5 | 538 | 1252 | 1450 |
| 36'-0" | 50 | 2.17 | 18 | 0.694 | | 11-#6+ 1 | 5 | #6 | #6 | 16-#6 | 7 | #4 | #5 | 19-#5 | 243 | 486 | 654 |
| D = 12.500 | 100 | 2.59 | 18 * | 0.813 | | 11-#6+ 4 | 5 | #7 | #7 | 21-#6 | 7 | #5 | #5 | 19-#5 | 312 | 625 | 841 |
| RIB ON | 150 | 3.13 | 18 * | 0.894 | | 12-#6+ 6 | 5 | #8 | #8 | 26-#6 | 7 | #5 | #6 | 19-#5 | 382 | 807 | 1029 |
| COLUMN LINE | 200 | 3.83 | 20 * | 0.630 | 4 S 6 1 | 15-#6+ 3 | 5 | #9 | #9 | 31-#6 | 7 | #6 | #6 | 19-#5 | 449 | 1021 | 1210 |
| 0.751 CF/SF | 300 | 4.85 | 27 * | 0.625 | 4 S 6 1 | 19-#6+ 4 | 5 | #10 | #10 | 41-#6 | 7 | #7 | #7 | 19-#5 | 572 | 1280 | 1540 |
| 39'-0" | 50 | 2.41 | 19 * | 0.776 | | 17-#5+ 5 | 6 | #6 | #7 | 21-#6 | 7 | #5 | #5 | 19-#5 | 314 | 628 | 845 |
| D = 15.500 | 100 | 2.98 | 19 * | 0.885 | | 13-#6+ 8 | 6 | #7 | #8 | 27-#6 | 7 | #5 | #6 | 19-#5 | 403 | 805 | 1084 |
| RIB NOT ON | 150 | 3.50 | 21 * | 0.629 | | 16-#6+ 5 | 6 | #8 | #8 | 34-#6 | 7 | #6 | #6 | 19-#5 | 489 | 1013 | 1317 |
| COLUMN LINE | 200 | 4.29 | 26 * | 0.625 | | 19-#6+ 6 | 6 | #9 | #9 | 40-#6 | 7 | #7 | #7 | 19-#5 | 571 | 1275 | 1537 |
| 0.779 CF/SF | | | | | | | | | | | | | | | | | |
| 42'-0" | 50 | 2.66 | 21 * | 0.819 | | 18-#5+10 | 6 | #7 | #7 | 26-#6 | 8 | #5 | #5 | 22-#5 | 388 | 776 | 1044 |
| D = 15.500 | 100 | 3.28 | 21 * | 0.912 | | 16-#6+10 | 6 | #8 | #8 | 35-#6 | 8 | #5 | #6 | 22-#5 | 499 | 997 | 1342 |
| RIB NOT ON | 150 | 4.10 | 26 * | 0.625 | | 20-#6+ 6 | 6 | #9 | #9 | 42-#6 | 8 | #6 | #7 | 22-#5 | 603 | 1205 | 1622 |
| COLUMN LINE | 200 | 4.58 | 34 * | 0.621 | | 23-#6+ 4 | 6 | #9 | #10 | 49-#6 | 8 | #6 | #7 | 23-#5 | 692 | 1384 | 1864 |
| 0.763 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.03 | 22 * | 0.867 | | 22-#5+13 | 6 | #8 | #8 | 33-#6 | 9 | #5 | #5 | 24-#5 | 475 | 951 | 1280 |
| D = 15.500 | 100 | 3.89 | 25 * | 0.915 | | 20-#6+12 | 6 | #9 | #9 | 43-#6 | 9 | #6 | #6 | 24-#5 | 608 | 1216 | 1636 |
| RIB NOT ON | 150 | 4.51 | 34 * | 0.621 | | 24-#6+ 6 | 6 | #9 | #10 | 52-#6 | 9 | #6 | #7 | 24-#5 | 727 | 1454 | 1957 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.751 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 17 in. | Rib Depth = 14 in. | Total Slab Depth = 3 in. | | | | | | | | |
| 1.68 | 12 | | 4 | #4 | #4 | 10-#5 | 4 | #4 | #4 | 12-#5 |
| 1.68 | 12 | | 4 | #4 | #4 | 10-#5 | 4 | #4 | #4 | 12-#5 |
| 1.68 | 12 | | 4 | #4 | #4 | 10-#5 | 4 | #4 | #4 | 12-#5 |
| 1.84 | 12 | | 4 | #4 | #5 | 8-#6 | 4 | #4 | #4 | 12-#5 |
| 2.32 | 12 | 4 S 6 1 | 4 | #5 | #6 | 15-#5 | 4 | #4 | #5 | 12-#5 |
| 2.74 | 12 * | 4 S 6 1 | 4 | #6 | #6 | 13-#6 | 4 | #5 | #5 | 12-#5 |
| 3.31 | 12 * | 4 S 6 1 | 4 | #7 | #7 | 16-#6 | 4 | #5 | #6 | 12-#5 |
| 1.71 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 14-#5 |
| 1.71 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 14-#5 |
| 2.00 | 13 | | 4 | #5 | #5 | 10-#6 | 5 | #4 | #4 | 14-#5 |
| 2.23 | 13 | 4 S 6 1 | 4 | #5 | #6 | 12-#6 | 5 | #4 | #4 | 14-#5 |
| 2.96 | 13 * | 4 S 6 1 | 4 | #6 | #7 | 16-#6 | 5 | #5 | #5 | 14-#5 |
| 3.62 | 13 * | 4 S 6 2 | 4 | #7 | #8 | 20-#6 | 5 | #5 | #6 | 14-#5 |
| 4.15 | 15 * | 4 S 6 2 | 4 | #8 | #8 | 23-#6 | 5 | #6 | #6 | 14-#5 |
| 1.67 | 15 | | 5 | #4 | #4 | 13-#5 | 5 | #4 | #4 | 14-#5 |
| 1.88 | 15 | | 5 | #4 | #5 | 11-#6 | 5 | #4 | #4 | 14-#5 |
| 2.13 | 15 | | 5 | #5 | #5 | 14-#6 | 5 | #4 | #4 | 14-#5 |
| 2.55 | 15 | 4 S 6 1 | 5 | #6 | #6 | 16-#6 | 5 | #4 | #5 | 14-#5 |
| 3.39 | 15 * | 4 S 6 1 | 5 | #7 | #7 | 22-#6 | 5 | #5 | #6 | 14-#5 |
| 4.00 | 17 * | 4 S 6 2 | 5 | #7 | #8 | 27-#6 | 5 | #6 | #6 | 14-#5 |
| 1.86 | 16 | | 5 | #4 | #5 | 11-#6 | 6 | #4 | #4 | 17-#5 |
| 2.15 | 16 | | 5 | #5 | #5 | 15-#6 | 6 | #4 | #4 | 17-#5 |
| 2.59 | 16 | 4 S 6 1 | 5 | #6 | #6 | 26-#5 | 6 | #4 | #5 | 17-#5 |
| 3.05 | 16 * | 4 S 6 1 | 5 | #6 | #7 | 22-#6 | 6 | #5 | #5 | 17-#5 |
| 4.11 | 17 * | 4 S 6 2 | 5 | #8 | #8 | 29-#6 | 6 | #6 | #6 | 17-#5 |
| 4.48 | 23 * | 4 S 6 2 | 5 | #8 | #8 | 36-#6 | 6 | #6 | #6 | 17-#5 |
| 2.09 | 18 | | 5 | #5 | #5 | 15-#6 | 7 | #4 | #4 | 19-#5 |
| 2.40 | 18 | 4 S 6 1 | 5 | #5 | #6 | 20-#6 | 7 | #4 | #4 | 19-#5 |
| 2.90 | 18 * | 4 S 6 1 | 5 | #6 | #7 | 24-#6 | 7 | #4 | #5 | 19-#5 |
| 3.55 | 18 * | 4 S 6 2 | 5 | #7 | #8 | 29-#6 | 7 | #5 | #5 | 19-#5 |
| 4.40 | 22 * | 4 S 6 2 | 5 | #8 | #9 | 38-#6 | 7 | #5 | #6 | 19-#5 |
| 2.21 | 19 | | 6 | #5 | #5 | 20-#6 | 7 | #4 | #4 | 19-#5 |
| 2.74 | 19 * | 4 S 6 1 | 6 | #6 | #6 | 25-#6 | 7 | #4 | #5 | 19-#5 |
| 3.25 | 19 * | 4 S 6 1 | 6 | #6 | #7 | 31-#6 | 7 | #5 | #5 | 19-#5 |
| 3.89 | 19 * | 4 S 6 2 | 6 | #7 | #8 | 37-#6 | 7 | #5 | #6 | 19-#5 |
| 2.53 | 21 | | 6 | #6 | #6 | 24-#6 | 8 | #4 | #4 | 22-#5 |
| 3.06 | 21 * | 4 S 6 1 | 6 | #6 | #7 | 32-#6 | 8 | #4 | #5 | 22-#5 |
| 3.77 | 21 * | 4 S 6 2 | 6 | #7 | #8 | 40-#6 | 8 | #5 | #5 | 22-#5 |
| 4.28 | 26 * | 4 S 6 2 | 6 | #8 | #8 | 46-#6 | 8 | #5 | #6 | 22-#5 |
| 2.89 | 22 | 4 S 6 1 | 6 | #6 | #7 | 30-#6 | 9 | #4 | #5 | 24-#5 |
| 3.64 | 22 * | 4 S 6 2 | 6 | #7 | #8 | 40-#6 | 9 | #5 | #5 | 24-#5 |
| 4.24 | 24 * | 4 S 6 2 | 6 | #8 | #8 | 49-#6 | 9 | #5 | #6 | 24-#5 |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments $-M$ Edge (ft-k) | Moments $+M$ Bot. (ft-k) | Moments $-M$ Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | Rib Depth = 16 in. | | Total Slab Depth = 3 in. | | | | | | | | | | | | | | |
| 27'-0" | 50 | 1.85 | 13 | 0.640 | | 8-#6+ 0 | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 14-#5 | 110 | 221 | 297 |
| D = 9.500 | 100 | 1.89 | 13 | 0.640 | | 8-#6+ 0 | 4 | #5 | #5 | 8-#6 | 5 | #4 | #5 | 14-#5 | 140 | 280 | 377 |
| RIB NOT ON | 150 | 2.02 | 13 | 0.640 | | 8-#6+ 0 | 4 | #5 | #6 | 10-#6 | 5 | #4 | #5 | 14-#5 | 169 | 383 | 456 |
| COLUMN LINE | 200 | 2.31 | 13 | 0.657 | | 8-#6+ 0 | 4 | #6 | #7 | 16-#5 | 5 | #4 | #5 | 14-#5 | 199 | 479 | 535 |
| 0.831 CF/SF | 300 | 2.83 | 13 * | 0.826 | | 8-#6+ 3 | 4 | #7 | #8 | 15-#6 | 5 | #5 | #6 | 14-#5 | 258 | 664 | 694 |
| | 400 | 3.60 | 13 * | 0.641 | | 9-#6+ 2 | 4 | #8 | #9 | 19-#6 | 5 | #6 | #7 | 14-#5 | 317 | 845 | 853 |
| | 500 | 4.26 | 13 * | 0.641 | | 15-#5+ 2 | 4 | #9 | #10 | 23-#6 | 5 | #7 | #7 | 14-#5 | 376 | 1024 | 1012 |
| 30'-0" | 50 | 1.82 | 15 | 0.637 | | 13-#5+ 0 | 5 | #4 | #5 | 13-#5 | 5 | #4 | #5 | 14-#5 | 154 | 308 | 415 |
| D = 12.500 | 100 | 1.92 | 15 | 0.637 | | 13-#5+ 0 | 5 | #5 | #5 | 11-#6 | 5 | #4 | #5 | 14-#5 | 194 | 389 | 523 |
| RIB ON | 150 | 2.27 | 15 | 0.651 | | 13-#5+ 0 | 5 | #6 | #6 | 14-#6 | 5 | #5 | #5 | 14-#5 | 235 | 522 | 632 |
| COLUMN LINE | 200 | 2.58 | 15 | 0.748 | | 13-#5+ 2 | 5 | #6 | #7 | 16-#6 | 5 | #5 | #6 | 14-#5 | 275 | 654 | 740 |
| 0.873 CF/SF | 300 | 3.45 | 15 * | 0.901 | | 10-#6+ 6 | 5 | #8 | #8 | 21-#6 | 5 | #6 | #7 | 14-#5 | 356 | 907 | 957 |
| | 400 | 4.27 | 16 * | 0.636 | | 12-#6+ 3 | 5 | #9 | #9 | 26-#6 | 5 | #7 | #8 | 14-#5 | 435 | 1151 | 1171 |
| | 500 | 4.93 | 20 * | 0.632 | 4 S 6 1 | 15-#6+ 3 | 5 | #9 | #10 | 31-#6 | 5 | #8 | #8 | 15-#5 | 506 | 1354 | 1363 |
| 33'-0" | 50 | 2.00 | 16 | 0.635 | | 10-#6+ 0 | 5 | #5 | #6 | 12-#6 | 6 | #4 | #5 | 17-#5 | 203 | 407 | 547 |
| D = 12.500 | 100 | 2.23 | 16 | 0.704 | | 10-#6+ 2 | 5 | #6 | #6 | 15-#6 | 6 | #4 | #5 | 17-#5 | 257 | 514 | 692 |
| RIB ON | 150 | 2.61 | 16 | 0.794 | | 10-#6+ 4 | 5 | #7 | #7 | 18-#6 | 6 | #5 | #5 | 17-#5 | 311 | 681 | 837 |
| COLUMN LINE | 200 | 2.99 | 16 * | 0.862 | | 10-#6+ 6 | 5 | #7 | #8 | 22-#6 | 6 | #5 | #6 | 17-#5 | 365 | 857 | 982 |
| 0.849 CF/SF | 300 | 4.11 | 16 * | 0.636 | 4 S 6 1 | 19-#5+ 4 | 5 | #9 | #9 | 29-#6 | 6 | #7 | #7 | 17-#5 | 472 | 1193 | 1271 |
| | 400 | 4.99 | 22 * | 0.630 | 4 S 6 1 | 17-#6+ 2 | 5 | #10 | #10 | 35-#6 | 6 | #7 | #8 | 17-#5 | 567 | 1464 | 1527 |
| 36'-0" | 50 | 2.18 | 18 | 0.633 | | 11-#6+ 0 | 5 | #6 | #6 | 15-#6 | 7 | #4 | #5 | 19-#5 | 261 | 522 | 703 |
| D = 12.500 | 100 | 2.50 | 18 | 0.742 | | 11-#6+ 3 | 5 | #7 | #7 | 20-#6 | 7 | #4 | #5 | 19-#5 | 331 | 661 | 890 |
| RIB ON | 150 | 2.97 | 18 * | 0.827 | | 11-#6+ 5 | 5 | #7 | #8 | 24-#6 | 7 | #5 | #6 | 19-#5 | 400 | 844 | 1078 |
| COLUMN LINE | 200 | 3.53 | 18 * | 0.905 | | 19-#5+10 | 5 | #8 | #9 | 40-#5 | 7 | #6 | #6 | 19-#5 | 470 | 1071 | 1265 |
| 0.831 CF/SF | 300 | 4.80 | 22 * | 0.630 | 4 S 6 1 | 18-#6+ 2 | 5 | #10 | #10 | 37-#6 | 7 | #7 | #7 | 19-#5 | 603 | 1488 | 1624 |
| 39'-0" | 50 | 2.26 | 19 | 0.712 | | 17-#5+ 4 | 6 | #6 | #6 | 20-#6 | 7 | #4 | #5 | 19-#5 | 338 | 675 | 909 |
| D = 15.500 | 100 | 2.78 | 19 * | 0.815 | | 17-#5+ 8 | 6 | #7 | #7 | 26-#6 | 7 | #5 | #6 | 19-#5 | 426 | 853 | 1148 |
| RIB NOT ON | 150 | 3.42 | 19 * | 0.902 | | 15-#6+ 8 | 6 | #8 | #8 | 31-#6 | 7 | #6 | #6 | 19-#5 | 515 | 1069 | 1387 |
| COLUMN LINE | 200 | 4.08 | 21 * | 0.631 | | 17-#6+ 5 | 6 | #9 | #9 | 37-#6 | 7 | #6 | #7 | 19-#5 | 601 | 1352 | 1618 |
| 0.862 CF/SF | 300 | 5.09 | 28 * | 0.626 | | 22-#6+ 5 | 6 | #10 | #10 | 47-#6 | 7 | #7 | #8 | 22-#5 | 758 | 1704 | 2041 |
| 42'-0" | 50 | 2.63 | 21 | 0.729 | | 18-#5+ 5 | 6 | #7 | #7 | 25-#6 | 8 | #5 | #5 | 22-#5 | 417 | 834 | 1123 |
| D = 15.500 | 100 | 3.20 | 21 * | 0.855 | | 15-#6+ 7 | 6 | #8 | #8 | 32-#6 | 8 | #5 | #6 | 22-#5 | 528 | 1055 | 1421 |
| RIB NOT ON | 150 | 3.73 | 21 * | 0.631 | | 26-#5+ 8 | 6 | #8 | #9 | 39-#6 | 8 | #6 | #6 | 22-#5 | 638 | 1276 | 1718 |
| COLUMN LINE | 200 | 4.57 | 26 * | 0.627 | | 22-#6+ 5 | 6 | #9 | #10 | 46-#6 | 8 | #7 | #7 | 22-#5 | 741 | 1583 | 1994 |
| 0.845 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 2.90 | 22 * | 0.804 | | 15-#6+ 6 | 6 | #7 | #8 | 31-#6 | 9 | #5 | #5 | 24-#5 | 511 | 1022 | 1375 |
| D = 15.500 | 100 | 3.58 | 22 * | 0.907 | | 19-#6+10 | 6 | #8 | #9 | 40-#6 | 9 | #6 | #6 | 24-#5 | 647 | 1294 | 1742 |
| RIB NOT ON | 150 | 4.31 | 26 * | 0.627 | | 32-#5+ 8 | 6 | #9 | #10 | 48-#6 | 9 | #6 | #7 | 24-#5 | 777 | 1554 | 2092 |
| COLUMN LINE | 200 | 4.98 | 31 * | 0.624 | 4 S 6 1 | 27-#6+ 5 | 6 | #10 | #10 | 57-#6 | 9 | #7 | #7 | 26-#5 | 900 | 1799 | 2422 |
| 0.831 CF/SF | | | | | | | | | | | | | | | | | |
| 48'-0" | 50 | 3.23 | 24 * | 0.858 | | 18-#6+11 | 7 | #8 | #8 | 38-#6 | 9 | #5 | #6 | 24-#5 | 626 | 1252 | 1685 |
| D = 18.500 | 100 | 4.10 | 26 * | 0.915 | | 23-#6+14 | 7 | #9 | #9 | 49-#6 | 9 | #6 | #7 | 24-#5 | 788 | 1576 | 2121 |
| RIB ON | 150 | 4.78 | 32 * | 0.624 | | 28-#6+ 6 | 7 | #9 | #10 | 59-#6 | 9 | #7 | #7 | 28-#5 | 942 | 1883 | 2535 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.856 CF/SF | | | | | | | | | | | | | | | | | |
| 51'-0" | 50 | 3.65 | 25 * | 0.894 | | 22-#6+13 | 7 | #8 | #9 | 46-#6 | 10 | #6 | #6 | 26-#5 | 747 | 1494 | 2012 |
| D = 18.500 | 100 | 4.47 | 30 * | 0.922 | | 28-#6+18 | 7 | #9 | #10 | 58-#6 | 10 | #6 | #7 | 27-#5 | 937 | 1874 | 2523 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.843 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | Rib Depth = 16 in. | | Total Slab Depth = 3 in. | | | | | | | |
| 1.89 | 13 | | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 14-#5 |
| 1.89 | 13 | | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 14-#5 |
| 1.97 | 13 | | 4 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 14-#5 |
| 2.24 | 13 | 4 S 6 1 | 4 | #5 | #6 | 15-#5 | 5 | #4 | #5 | 14-#5 |
| 2.55 | 13 | 4 S 6 1 | 4 | #6 | #6 | 14-#6 | 5 | #4 | #5 | 14-#5 |
| 3.21 | 13 * | 4 S 6 1 | 4 | #7 | #7 | 18-#6 | 5 | #5 | #5 | 14-#5 |
| 3.69 | 13 * | 4 S 6 2 | 4 | #7 | #8 | 21-#6 | 5 | #5 | #6 | 14-#5 |
| 1.85 | 15 | | 5 | #4 | #5 | 13-#5 | 5 | #4 | #5 | 14-#5 |
| 1.90 | 15 | | 5 | #4 | #5 | 10-#6 | 5 | #4 | #5 | 14-#5 |
| 2.13 | 15 | | 5 | #5 | #5 | 18-#5 | 5 | #4 | #5 | 14-#5 |
| 2.39 | 15 | | 5 | #5 | #6 | 15-#6 | 5 | #4 | #5 | 14-#5 |
| 3.14 | 15 * | 4 S 6 1 | 5 | #6 | #7 | 20-#6 | 5 | #5 | #6 | 14-#5 |
| 3.81 | 15 * | 4 S 6 1 | 5 | #7 | #8 | 24-#6 | 5 | #6 | #6 | 14-#5 |
| 4.39 | 17 * | 4 S 6 2 | 5 | #8 | #8 | 29-#6 | 5 | #6 | #7 | 14-#5 |
| 1.93 | 16 | | 5 | #4 | #5 | 15-#5 | 6 | #4 | #5 | 17-#5 |
| 2.18 | 16 | | 5 | #5 | #5 | 14-#6 | 6 | #4 | #5 | 17-#5 |
| 2.45 | 16 | 4 S 6 1 | 5 | #5 | #6 | 17-#6 | 6 | #4 | #5 | 17-#5 |
| 2.81 | 16 | 4 S 6 1 | 5 | #6 | #7 | 20-#6 | 6 | #4 | #5 | 17-#5 |
| 3.70 | 16 * | 4 S 6 1 | 5 | #7 | #8 | 27-#6 | 6 | #5 | #6 | 17-#5 |
| 4.50 | 18 * | 4 S 6 2 | 5 | #8 | #9 | 33-#6 | 6 | #6 | #6 | 17-#5 |
| 2.13 | 18 | | 5 | #5 | #5 | 14-#6 | 7 | #4 | #5 | 19-#5 |
| 2.41 | 18 | 4 S 6 1 | 5 | #5 | #6 | 18-#6 | 7 | #4 | #5 | 19-#5 |
| 2.81 | 18 | 4 S 6 1 | 5 | #6 | #7 | 22-#6 | 7 | #4 | #5 | 19-#5 |
| 3.25 | 18 * | 4 S 6 1 | 5 | #7 | #7 | 26-#6 | 7 | #5 | #5 | 19-#5 |
| 4.44 | 18 * | 4 S 6 2 | 5 | #8 | #9 | 35-#6 | 7 | #6 | #6 | 19-#5 |
| 2.22 | 19 | | 6 | #5 | #5 | 18-#6 | 7 | #4 | #5 | 19-#5 |
| 2.58 | 19 | | 6 | #5 | #6 | 24-#6 | 7 | #4 | #5 | 19-#5 |
| 3.17 | 19 * | 4 S 6 1 | 6 | #6 | #7 | 29-#6 | 7 | #5 | #5 | 19-#5 |
| 3.75 | 19 * | 4 S 6 1 | 6 | #7 | #8 | 34-#6 | 7 | #5 | #6 | 19-#5 |
| 4.56 | 23 * | 4 S 6 2 | 6 | #8 | #8 | 44-#6 | 7 | #6 | #6 | 21-#5 |
| 2.50 | 21 | | 6 | #5 | #6 | 23-#6 | 8 | #4 | #5 | 22-#5 |
| 2.98 | 21 * | 4 S 6 1 | 6 | #6 | #7 | 30-#6 | 8 | #4 | #5 | 22-#5 |
| 3.48 | 21 * | 4 S 6 1 | 6 | #7 | #7 | 36-#6 | 8 | #5 | #5 | 22-#5 |
| 4.15 | 21 * | 4 S 6 2 | 6 | #8 | #8 | 43-#6 | 8 | #5 | #6 | 22-#5 |
| 2.80 | 22 | 4 S 6 1 | 6 | #6 | #7 | 40-#5 | 9 | #4 | #5 | 24-#5 |
| 3.26 | 22 * | 4 S 6 1 | 6 | #7 | #7 | 37-#6 | 9 | #4 | #5 | 24-#5 |
| 3.95 | 22 * | 4 S 6 2 | 6 | #8 | #8 | 45-#6 | 9 | #5 | #5 | 24-#5 |
| 4.56 | 24 * | 4 S 6 2 | 6 | #8 | #9 | 53-#6 | 9 | #5 | #6 | 25-#5 |
| 3.00 | 24 | 4 S 6 1 | 7 | #6 | #7 | 35-#6 | 9 | #4 | #5 | 24-#5 |
| 3.74 | 24 * | 4 S 6 1 | 7 | #7 | #8 | 45-#6 | 9 | #5 | #5 | 24-#5 |
| 4.38 | 24 * | 4 S 6 2 | 7 | #8 | #8 | 55-#6 | 9 | #5 | #6 | 26-#5 |
| 3.39 | 25 * | 4 S 6 1 | 7 | #7 | #7 | 42-#6 | 10 | #5 | #5 | 26-#5 |
| 4.16 | 25 * | 4 S 6 2 | 7 | #8 | #8 | 54-#6 | 10 | #5 | #6 | 26-#5 |

See the notes on Page 11-84.

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 23 in. | | Rib Depth = 20 in. | | Total Slab Depth = 3 in. | | | | | | | | | | | | | |
| 30'-0" | 50 | 2.05 | 15 | 0.641 | | 13-#5+ 0 | 5 | #5 | #5 | 13-#5 | 5 | #5 | #5 | 14-#5 | 177 | 354 | 476 |
| D = 12.500 | 100 | 2.06 | 15 | 0.641 | | 13-#5+ 0 | 5 | #5 | #5 | 10-#6 | 5 | #5 | #5 | 14-#5 | 217 | 434 | 584 |
| RIB ON | 150 | 2.21 | 15 | 0.641 | | 13-#5+ 0 | 5 | #5 | #6 | 12-#6 | 5 | #5 | #5 | 14-#5 | 257 | 554 | 693 |
| COLUMN LINE | 200 | 2.36 | 15 | 0.641 | | 13-#5+ 0 | 5 | #6 | #6 | 14-#6 | 5 | #5 | #5 | 14-#5 | 298 | 690 | 801 |
| 1.048 CF/SF | 300 | 3.03 | 15 | 0.688 | | 13-#5+ 2 | 5 | #7 | #8 | 18-#6 | 5 | #6 | #6 | 14-#5 | 378 | 947 | 1018 |
| | 400 | 3.47 | 15 * | 0.838 | | 15-#5+ 5 | 5 | #8 | #8 | 22-#6 | 5 | #6 | #7 | 14-#5 | 459 | 1198 | 1235 |
| | 500 | 4.28 | 15 * | 0.642 | | 18-#5+ 2 | 5 | #9 | #9 | 26-#6 | 5 | #7 | #8 | 14-#5 | 539 | 1445 | 1452 |
| 33'-0" | 50 | 2.09 | 16 | 0.640 | | 10-#6+ 0 | 5 | #5 | #5 | 15-#5 | 6 | #5 | #5 | 17-#5 | 233 | 466 | 627 |
| D = 12.500 | 100 | 2.24 | 16 | 0.640 | | 10-#6+ 0 | 5 | #5 | #6 | 14-#6 | 6 | #5 | #5 | 17-#5 | 287 | 574 | 772 |
| RIB ON | 150 | 2.48 | 16 | 0.640 | | 10-#6+ 0 | 5 | #6 | #7 | 16-#6 | 6 | #5 | #5 | 17-#5 | 341 | 725 | 917 |
| COLUMN LINE | 200 | 2.81 | 16 | 0.646 | | 10-#6+ 1 | 5 | #7 | #7 | 19-#6 | 6 | #5 | #6 | 17-#5 | 394 | 907 | 1062 |
| 1.020 CF/SF | 300 | 3.61 | 16 * | 0.844 | | 12-#6+ 5 | 5 | #8 | #9 | 24-#6 | 6 | #6 | #7 | 17-#5 | 502 | 1249 | 1351 |
| | 400 | 4.28 | 16 * | 0.641 | 5 S 8 1 | 14-#6+ 2 | 5 | #9 | #10 | 30-#6 | 6 | #7 | #7 | 17-#5 | 609 | 1583 | 1641 |
| | 500 | 5.06 | 17 * | 0.639 | 5 S 8 1 | 17-#6+ 3 | 5 | #10 | #10 | 35-#6 | 6 | #7 | #8 | 17-#5 | 715 | 1907 | 1925 |
| 36'-0" | 50 | 2.29 | 18 | 0.637 | | 11-#6+ 0 | 5 | #6 | #6 | 14-#6 | 7 | #5 | #5 | 19-#5 | 299 | 598 | 805 |
| D = 12.500 | 100 | 2.52 | 18 | 0.637 | | 11-#6+ 0 | 5 | #6 | #7 | 18-#6 | 7 | #5 | #5 | 19-#5 | 369 | 737 | 992 |
| RIB ON | 150 | 2.76 | 18 | 0.637 | | 11-#6+ 0 | 5 | #7 | #7 | 21-#6 | 7 | #5 | #5 | 19-#5 | 438 | 907 | 1180 |
| COLUMN LINE | 200 | 3.18 | 18 | 0.765 | | 12-#6+ 4 | 5 | #8 | #8 | 25-#6 | 7 | #5 | #6 | 19-#5 | 508 | 1144 | 1367 |
| 0.998 CF/SF | 300 | 4.11 | 18 * | 0.638 | 5 S 8 1 | 15-#6+ 2 | 5 | #9 | #10 | 32-#6 | 7 | #6 | #7 | 19-#5 | 647 | 1584 | 1742 |
| 39'-0" | 50 | 2.36 | 19 | 0.636 | | 17-#5+ 0 | 6 | #6 | #6 | 18-#6 | 7 | #5 | #5 | 19-#5 | 387 | 774 | 1042 |
| D = 15.500 | 100 | 2.62 | 19 | 0.636 | | 17-#5+ 2 | 6 | #6 | #7 | 23-#6 | 7 | #5 | #5 | 19-#5 | 476 | 952 | 1281 |
| RIB NOT ON | 150 | 3.04 | 19 * | 0.762 | | 13-#6+ 4 | 6 | #7 | #8 | 27-#6 | 7 | #5 | #6 | 19-#5 | 565 | 1155 | 1520 |
| COLUMN LINE | 200 | 3.58 | 19 * | 0.857 | | 15-#6+ 7 | 6 | #8 | #8 | 32-#6 | 7 | #6 | #7 | 19-#5 | 653 | 1459 | 1759 |
| 1.036 CF/SF | 300 | 4.71 | 19 * | 0.637 | | 20-#6+ 3 | 6 | #9 | #10 | 41-#6 | 7 | #7 | #8 | 19-#5 | 831 | 2020 | 2237 |
| 42'-0" | 50 | 2.59 | 21 | 0.634 | | 13-#6+ 1 | 6 | #6 | #7 | 23-#6 | 8 | #5 | #5 | 22-#5 | 478 | 956 | 1287 |
| D = 15.500 | 100 | 2.94 | 21 | 0.737 | | 14-#6+ 5 | 6 | #7 | #8 | 29-#6 | 8 | #5 | #5 | 22-#5 | 589 | 1177 | 1585 |
| RIB NOT ON | 150 | 3.34 | 21 * | 0.831 | | 16-#6+ 7 | 6 | #8 | #8 | 34-#6 | 8 | #5 | #6 | 22-#5 | 699 | 1398 | 1882 |
| COLUMN LINE | 200 | 4.02 | 21 * | 0.904 | | 19-#6+10 | 6 | #9 | #9 | 40-#6 | 8 | #6 | #7 | 22-#5 | 810 | 1748 | 2180 |
| 1.015 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 2.85 | 22 | 0.676 | | 14-#6+ 4 | 6 | #7 | #8 | 28-#6 | 9 | #5 | #5 | 24-#5 | 585 | 1170 | 1575 |
| D = 15.500 | 100 | 3.28 | 22 * | 0.793 | | 17-#6+ 5 | 6 | #8 | #8 | 35-#6 | 9 | #5 | #6 | 24-#5 | 721 | 1443 | 1942 |
| RIB NOT ON | 150 | 3.87 | 22 * | 0.888 | | 20-#6+ 9 | 6 | #9 | #9 | 42-#6 | 9 | #6 | #6 | 24-#5 | 858 | 1715 | 2309 |
| COLUMN LINE | 200 | 4.54 | 23 * | 0.633 | | 24-#6+ 4 | 6 | #10 | #10 | 50-#6 | 9 | #6 | #7 | 24-#5 | 992 | 2090 | 2671 |
| 0.998 CF/SF | | | | | | | | | | | | | | | | | |
| 48'-0" | 50 | 3.07 | 24 * | 0.743 | | 17-#6+ 6 | 7 | #7 | #8 | 35-#6 | 9 | #5 | #6 | 24-#5 | 718 | 1435 | 1932 |
| D = 18.500 | 100 | 3.69 | 24 * | 0.858 | | 21-#6+10 | 7 | #8 | #9 | 43-#6 | 9 | #6 | #6 | 24-#5 | 883 | 1765 | 2376 |
| RIB ON | 150 | 4.25 | 24 * | 0.633 | | 25-#6+ 6 | 7 | #9 | #9 | 52-#6 | 9 | #6 | #7 | 24-#5 | 1048 | 2095 | 2821 |
| COLUMN LINE | 200 | 5.02 | 28 * | 0.630 | | 29-#6+ 6 | 7 | #10 | #10 | 60-#6 | 9 | #7 | #7 | 28-#5 | 1204 | 2427 | 3241 |
| 1.028 CF/SF | | | | | | | | | | | | | | | | | |
| 51'-0" | 50 | 3.38 | 25 * | 0.815 | | 20-#6+10 | 7 | #8 | #8 | 42-#6 | 10 | #5 | #6 | 26-#5 | 856 | 1713 | 2305 |
| D = 18.500 | 100 | 4.07 | 25 * | 0.901 | | 25-#6+13 | 7 | #9 | #9 | 52-#6 | 10 | #6 | #7 | 26-#5 | 1055 | 2109 | 2839 |
| RIB ON | 150 | 4.83 | 28 * | 0.630 | | 30-#6+ 6 | 7 | #10 | #10 | 63-#6 | 10 | #7 | #7 | 29-#5 | 1246 | 2493 | 3355 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.012 CF/SF | | | | | | | | | | | | | | | | | |
| 54'-0" | 50 | 3.82 | 27 * | 0.846 | | 24-#6+12 | 7 | #9 | #9 | 50-#6 | 11 | #6 | #6 | 29-#5 | 1009 | 2018 | 2717 |
| D = 18.500 | 100 | 4.57 | 27 * | 0.630 | | 30-#6+ 8 | 7 | #10 | #10 | 62-#6 | 11 | #6 | #7 | 29-#5 | 1244 | 2488 | 3349 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.998 CF/SF | | | | | | | | | | | | | | | | | |
| 57'-0" | 50 | 4.12 | 28 * | 0.890 | | 29-#6+16 | 8 | #9 | #9 | 60-#6 | 11 | #6 | #7 | 29-#5 | 1201 | 2402 | 3234 |
| D =21.500 | 100 | 5.13 | 33 * | 0.914 | | 35-#6+21 | 8 | #10 | #10 | 74-#6 | 11 | #7 | #7 | 34-#5 | 1466 | 2932 | 3947 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.023 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 23 in. | | | Rib Depth = 20 in. | | | | Total Slab Depth = 3 in. | | | |
| 2.07 | 15 | | 5 | #5 | #5 | 13-#5 | 5 | #5 | #5 | 14-#5 |
| 2.07 | 15 | | 5 | #5 | #5 | 13-#5 | 5 | #5 | #5 | 14-#5 |
| 2.19 | 15 | | 5 | #5 | #5 | 11-#6 | 5 | #5 | #5 | 14-#5 |
| 2.30 | 15 | | 5 | #5 | #5 | 13-#6 | 5 | #5 | #5 | 14-#5 |
| 2.75 | 15 | | 5 | #6 | #6 | 17-#6 | 5 | #5 | #5 | 14-#5 |
| 3.14 | 15 * | 5 S 8 1 | 5 | #6 | #7 | 20-#6 | 5 | #5 | #6 | 14-#5 |
| 3.81 | 15 * | 5 S 8 1 | 5 | #7 | #8 | 24-#6 | 5 | #6 | #6 | 14-#5 |
| 2.12 | 16 | | 5 | #5 | #5 | 10-#6 | 6 | #5 | #5 | 17-#5 |
| 2.22 | 16 | | 5 | #5 | #5 | 12-#6 | 6 | #5 | #5 | 17-#5 |
| 2.38 | 16 | | 5 | #5 | #5 | 15-#6 | 6 | #5 | #5 | 17-#5 |
| 2.69 | 16 | | 5 | #6 | #6 | 17-#6 | 6 | #5 | #5 | 17-#5 |
| 3.24 | 16 | 5 S 8 1 | 5 | #7 | #7 | 23-#6 | 6 | #5 | #5 | 17-#5 |
| 3.74 | 16 * | 5 S 8 2 | 5 | #7 | #8 | 28-#6 | 6 | #5 | #6 | 17-#5 |
| 4.63 | 16 * | 5 S 8 2 | 5 | #8 | #9 | 33-#6 | 6 | #6 | #7 | 17-#5 |
| 2.25 | 18 | | 5 | #5 | #5 | 13-#6 | 7 | #5 | #5 | 19-#5 |
| 2.47 | 18 | | 5 | #5 | #6 | 16-#6 | 7 | #5 | #5 | 19-#5 |
| 2.75 | 18 | 5 S 8 1 | 5 | #6 | #6 | 20-#6 | 7 | #5 | #5 | 19-#5 |
| 3.01 | 18 | 5 S 8 1 | 5 | #6 | #7 | 23-#6 | 7 | #5 | #5 | 19-#5 |
| 3.67 | 18 * | 5 S 8 2 | 5 | #7 | #8 | 29-#6 | 7 | #5 | #6 | 19-#5 |
| 2.32 | 19 | | 6 | #5 | #5 | 17-#6 | 7 | #5 | #5 | 19-#5 |
| 2.60 | 19 | | 6 | #5 | #6 | 21-#6 | 7 | #5 | #5 | 19-#5 |
| 2.87 | 19 | | 6 | #6 | #6 | 25-#6 | 7 | #5 | #5 | 19-#5 |
| 3.29 | 19 * | 5 S 8 1 | 6 | #7 | #7 | 29-#6 | 7 | #5 | #5 | 19-#5 |
| 4.23 | 19 * | 5 S 8 2 | 6 | #8 | #8 | 38-#6 | 7 | #6 | #6 | 19-#5 |
| 2.57 | 21 | | 6 | #5 | #6 | 21-#6 | 8 | #5 | #5 | 22-#5 |
| 2.85 | 21 | | 6 | #6 | #6 | 26-#6 | 8 | #5 | #5 | 22-#5 |
| 3.20 | 21 | 5 S 8 1 | 6 | #6 | #7 | 32-#6 | 8 | #5 | #5 | 22-#5 |
| 3.66 | 21 * | 5 S 8 1 | 6 | #7 | #8 | 37-#6 | 8 | #5 | #5 | 22-#5 |
| 2.78 | 22 | | 6 | #6 | #6 | 26-#6 | 9 | #5 | #5 | 24-#5 |
| 3.16 | 22 | 5 S 8 1 | 6 | #6 | #7 | 33-#6 | 9 | #5 | #5 | 24-#5 |
| 3.61 | 22 * | 5 S 8 1 | 6 | #7 | #8 | 39-#6 | 9 | #5 | #5 | 24-#5 |
| 4.11 | 22 * | 5 S 8 2 | 6 | #8 | #8 | 46-#6 | 9 | #5 | #6 | 24-#5 |
| 2.91 | 24 | | 7 | #6 | #6 | 32-#6 | 9 | #5 | #5 | 24-#5 |
| 3.42 | 24 * | 5 S 8 1 | 7 | #7 | #7 | 40-#6 | 9 | #5 | #5 | 24-#5 |
| 3.95 | 24 * | 5 S 8 1 | 7 | #7 | #8 | 48-#6 | 9 | #5 | #6 | 24-#5 |
| 4.58 | 24 * | 5 S 8 2 | 7 | #8 | #8 | 56-#6 | 9 | #6 | #6 | 26-#5 |
| 3.30 | 25 | 5 S 8 1 | 7 | #7 | #7 | 39-#6 | 10 | #5 | #5 | 26-#5 |
| 3.71 | 25 * | 5 S 8 1 | 7 | #7 | #8 | 48-#6 | 10 | #5 | #5 | 26-#5 |
| 4.31 | 25 * | 5 S 8 2 | 7 | #8 | #8 | 58-#6 | 10 | #5 | #6 | 27-#5 |
| 3.57 | 27 | 5 S 8 1 | 7 | #7 | #8 | 46-#6 | 11 | #5 | #5 | 29-#5 |
| 4.19 | 27 * | 5 S 8 2 | 7 | #8 | #8 | 58-#6 | 11 | #5 | #6 | 29-#5 |
| 3.77 | 28 * | 5 S 8 1 | 8 | #7 | #8 | 55-#6 | 11 | #5 | #5 | 29-#5 |
| 4.81 | 28 * | 5 S 8 2 | 8 | #8 | #9 | 69-#6 | 11 | #6 | #6 | 32-#5 |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 12 in. | Rib Depth = 8 in. | | Total Slab Depth = 4 in. | | | | | | | | | | | | | | | Total Depth = 12 in. | Rib Depth = 8 in. | | Total Slab Depth = 4 in. | | | | | | | |
| 18'-0" | 50 | 1.60 | 12 | 0.631 | | 5-#6+ 0 | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 | 26 | 52 | 69 | 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| D = 6.500 | 100 | 1.60 | 12 | 0.631 | | 5-#6+ 0 | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 | 34 | 72 | 92 | 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| RIB ON | 150 | 1.66 | 12 | 0.631 | | 5-#6+ 0 | 3 | #4 | #5 | 5-#6 | 3 | #4 | #4 | 8-#5 | 43 | 100 | 115 | 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| COLUMN LINE | 200 | 1.72 | 12 | 0.664 | | 5-#6+ 0 | 3 | #5 | #5 | 5-#6 | 3 | #4 | #4 | 8-#5 | 51 | 126 | 138 | 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| 0.606 CF/SF | 300 | 2.14 | 12 | 0.753 | | 5-#6+ 0 | 3 | #6 | #6 | 9-#5 | 3 | #5 | #5 | 8-#5 | 68 | 178 | 183 | 1.92 | 12 | 3 S 4 1 | 3 | #5 | #5 | 6-#6 | 3 | #4 | #4 | 8-#5 |
| | 400 | 2.55 | 12 * | 0.868 | 3 S 4 1 | 5-#6+ 1 | 3 | #6 | #7 | 6-#7 | 3 | #5 | #6 | 8-#5 | 85 | 229 | 229 | 2.35 | 12 * | 3 S 4 1 | 3 | #5 | #6 | 6-#7 | 3 | #4 | #5 | 8-#5 |
| 21'-0" | 50 | 1.56 | 12 | 0.669 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 43 | 85 | 114 | 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| D = 9 .500 | 100 | 1.56 | 12 | 0.717 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 56 | 119 | 151 | 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| RIB NOT ON | 150 | 1.73 | 12 | 0.788 | | 9-#5+ 1 | 4 | #5 | #5 | 9-#5 | 3 | #4 | #5 | 8-#5 | 70 | 164 | 188 | 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| COLUMN LINE | 200 | 1.98 | 12 * | 0.858 | | 9-#5+ 3 | 4 | #5 | #6 | 8-#6 | 3 | #5 | #5 | 8-#5 | 83 | 207 | 225 | 1.76 | 12 | | 4 | #4 | #5 | 7-#6 | 3 | #4 | #4 | 8-#5 |
| 0.639 CF/SF | 300 | 2.64 | 12 * | 0.632 | | 9-#5+ 3 | 4 | #6 | #7 | 8-#7 | 3 | #6 | #6 | 8-#5 | 111 | 291 | 298 | 2.39 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 7-#7 | 3 | #5 | #5 | 8-#5 |
| | 400 | 3.27 | 15 * | 0.628 | | 9-#5+ 2 | 4 | #7 | #8 | 8-#8 | 3 | #7 | #7 | 8-#5 | 136 | 369 | 367 | 2.85 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 3 | #5 | #6 | 8-#5 |
| 24'-0" | 50 | 1.63 | 12 | 0.741 | | 10-# 5+ 0 | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 | 64 | 127 | 171 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| D = 9.500 | 100 | 1.70 | 12 | 0.815 | | 10-#5+ 1 | 4 | #5 | #5 | 8-#6 | 4 | #4 | #4 | 10-#5 | 84 | 177 | 227 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| RIB NOT ON | 150 | 2.17 | 12 * | 0.887 | | 10-#5+ 3 | 4 | #6 | #6 | 10-#6 | 4 | #5 | #5 | 10-#5 | 105 | 245 | 282 | 1.98 | 12 | 3 S 4 1 | 4 | #5 | #5 | 7-#7 | 4 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.57 | 12 * | 0.632 | | 10-#5+ 2 | 4 | #7 | #7 | 7-#8 | 4 | #5 | #6 | 10-#5 | 125 | 310 | 338 | 2.26 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 8-#7 | 4 | #4 | #5 | 10-#5 |
| 0.620 CF/SF | 300 | 3.39 | 17 * | 0.626 | | 8-#6+ 2 | 4 | #8 | #8 | 7-#9 | 4 | #6 | #7 | 10-#5 | 163 | 422 | 439 | 3.05 | 13 * | 3 S 4 1 | 4 | #6 | #7 | 11-#7 | 4 | #5 | #6 | 10-#5 |
| 27'-0" | 50 | 1.70 | 13 | 0.782 | | 8-#6+ 0 | 4 | #5 | #5 | 12-#5 | 5 | #4 | #4 | 12-#5 | 90 | 180 | 242 | 1.64 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 12-#5 |
| D = 9.500 | 100 | 2.12 | 13 * | 0.877 | | 8-#6+ 2 | 4 | #6 | #6 | 7-#8 | 5 | #4 | #5 | 12-#5 | 120 | 244 | 322 | 1.98 | 13 | 3 S 4 1 | 4 | #5 | #5 | 8-#7 | 5 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.56 | 14 * | 0.629 | | 8-#6+ 1 | 4 | #7 | #7 | 8-#8 | 5 | #5 | #5 | 12-#5 | 149 | 340 | 400 | 2.40 | 13 * | 3 S 4 1 | 4 | #6 | #6 | 8-#8 | 5 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 3.13 | 17 * | 0.626 | | 8-#6+ 2 | 4 | #8 | #8 | 8-#9 | 5 | #6 | #6 | 12-#5 | 176 | 427 | 474 | 2.77 | 13 * | 3 S 4 1 | 4 | #6 | #7 | 7-#9 | 5 | #4 | #5 | 12-#5 |
| 0.606 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30'-0" | 50 | 1.95 | 15 * | 0.847 | | 9-#6+ 3 | 5 | #5 | #6 | 9-#7 | 5 | #4 | #5 | 12-#5 | 125 | 249 | 336 | 1.81 | 15 | | 5 | #4 | #5 | 11-#6 | 5 | #4 | #4 | 12-#5 |
| D = 12.500 | 100 | 2.29 | 15 * | 0.918 | | 9-#6+ 5 | 5 | #6 | #6 | 9-#8 | 5 | #5 | #5 | 12-#5 | 165 | 330 | 444 | 2.13 | 15 * | 3 S 4 1 | 5 | #5 | #5 | 11-#7 | 5 | #4 | #4 | 12-#5 |
| RIB ON | 150 | 3.13 | 19 * | 0.624 | | 10-#6+ 3 | 5 | #7 | #8 | 9-#9 | 5 | #6 | #6 | 12-#5 | 203 | 444 | 546 | 2.88 | 15 * | 3 S 4 1 | 5 | #6 | #6 | 9-#9 | 5 | #5 | #5 | 12-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.628 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 33'-0" | 50 | 2.16 | 16 * | 0.883 | | 10-#6+ 4 | 5 | #6 | #6 | 9-#8 | 6 | #4 | #5 | 14-#5 | 165 | 330 | 445 | 2.06 | 16 | 3 S 4 1 | 5 | #5 | #5 | 11-#7 | 6 | #4 | #4 | 14-#5 |
| D = 12.500 | 100 | 2.82 | 19 * | 0.925 | | 15-#5+11 | 5 | #7 | #7 | 10-#9 | 6 | #5 | #6 | 14-#5 | 217 | 434 | 585 | 2.65 | 16 * | 3 S 4 1 | 5 | #6 | #6 | 9-#9 | 6 | #4 | #5 | 14-#5 |
| RIB ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.616 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 in. | Rib Depth = 10 in. | | Total Slab Depth = 4 in. | | | | | | | | | | | | | | | Total Depth = 14 in. | Rib Depth = 10 in. | | Total Slab Depth = 4 in. | | | | | | |
| 18'-0" | 50 | 1.60 | 12 | 0.634 | | 5-#6+ 0 | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 | 28 | 56 | 75 | 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| D = 6.500 | 100 | 1.60 | 12 | 0.634 | | 5-#6+ 0 | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 | 36 | 75 | 98 | 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| RIB ON | 150 | 1.60 | 12 | 0.634 | | 5-#6+ 0 | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 | 45 | 104 | 120 | 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| COLUMN LINE | 200 | 1.66 | 12 | 0.634 | | 5-#6+ 0 | 3 | #4 | #5 | 5-#6 | 3 | #4 | #4 | 8-#5 | 53 | 131 | 143 | 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| 0.680 CF/SF | 300 | 1.90 | 12 | 0.634 | | 5-#6+ 0 | 3 | #5 | #6 | 5-#6 | 3 | #4 | #5 | 8-#5 | 70 | 183 | 189 | 1.75 | 12 | 3 S 4 1 | 3 | #4 | #5 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| | 400 | 2.16 | 12 | 0.707 | | 5-#6+ 0 | 3 | #6 | #6 | 5-#7 | 3 | #5 | #5 | 8-#5 | 87 | 234 | 234 | 1.92 | 12 | 3 S 4 1 | 3 | #5 | #5 | 6-#6 | 3 | #4 | #4 | 8-#5 |
| | 500 | 2.64 | 12 * | 0.824 | 3 S 4 1 | 5-#6+ 1 | 3 | #7 | #7 | 6-#7 | 3 | #5 | #6 | 8-#5 | 104 | 285 | 280 | 2.35 | 12 | 3 S 4 1 | 3 | #5 | #6 | 6-#7 | 3 | #4 | #5 | 8-#5 |
| 21'-0" | 50 | 1.56 | 12 | 0.634 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 46 | 92 | 124 | 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| D = 9.500 | 100 | 1.56 | 12 | 0.634 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 60 | 125 | 160 | 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| RIB NOT ON | 150 | 1.67 | 12 | 0.669 | | 9-#5+ 0 | 4 | #4 | #5 | 9-#5 | 3 | #4 | #5 | 8-#5 | 73 | 171 | 197 | 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| COLUMN LINE | 200 | 1.80 | 12 | 0.713 | | 9-#5+ 0 | 4 | #5 | #5 | 7-#6 | 3 | #5 | #5 | 8-#5 | 87 | 214 | 234 | 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 0.720 CF/SF | 300 | 2.27 | 12 * | 0.821 | | 9-#5+ 1 | 4 | #6 | #6 | 9-#6 | 3 | #5 | #6 | 8-#5 | 114 | 299 | 307 | 2.03 | 12 | 3 S 4 1 | 4 | #5 | #5 | 12-#5 | 3 | #4 | #5 | 8-#5 |
| | 400 | 2.92 | 12 * | 0.635 | | 9-#5+ 1 | 4 | #7 | #7 | 7-#8 | 3 | #6 | #7 | 8-#5 | 141 | 382 | 381 | 2.56 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 8-#7 | 3 | #5 | #6 | 8-#5 |
| | 500 | 3.34 | 13 * | 0.634 | | 9-#5+ 2 | 4 | #7 | #8 | 8-#8 | 3 | #7 | #7 | 8-#5 | 168 | 462 | 453 | 2.98 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 3 | #6 | #6 | 8-#5 |
| 24'-0" | 50 | 1.57 | 12 | 0.662 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 | 68 | 137 | 184 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| D = 9.500 | 100 | 1.63 | 12 | 0.714 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 | 89 | 186 | 240 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| RIB NOT ON | 150 | 1.91 | 12 | 0.804 | | 10-#5+ 2 | 4 | #5 | #6 | 9-#6 | 4 | #4 | #5 | 10-#5 | 110 | 256 | 295 | 1.76 | 12 | | 4 | #4 | #5 | 8-#6 | 4 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.26 | 12 * | 0.858 | | 10-#5+ 3 | 4 | #6 | #7 | 8-#7 | 4 | #5 | #5 | 10-#5 | 130 | 321 | 351 | 1.98 | 12 | 3 S 4 1 | 4 | #5 | #5 | 7-#7 | 4 | #4 | #4 | 10-#5 |
| 0.696 CF/SF | 300 | 2.96 | 12 * | 0.635 | | 10-#5+ 3 | 4 | #7 | #8 | 8-#8 | 4 | #6 | #6 | 10-#5 | 172 | 449 | 462 | 2.64 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 4 | #5 | #5 | 10-#5 |
| | 400 | 3.74 | 16 * | 0.630 | | 8-#6+ 2 | 4 | #8 | #9 | 8-#9 | 4 | #7 | #7 | 10-#5 | 209 | 560 | 563 | 3.26 | 13 * | 3 S 4 1 | 4 | #7 | #7 | 7-#9 | 4 | #5 | #6 | 10-#5 |
| | 500 | 4.28 | 20 * | 0.626 | | 7-#7+ 2 | 4 | #9 | #9 | 9-#9 | 4 | #7 | #7 | 10-#5 | 242 | 633 | 652 | 3.94 | 17 * | 3 S 4 2 | 4 | #7 | #8 | 9-#9 | 4 | #6 | #6 | 10-#5 |
| 27'-0" | 50 | 1.69 | 13 | 0.710 | | 8-#6+ 0 | 4 | #5 | #5 | 8-#6 | 5 | #4 | #4 | 12-#5 | 97 | 194 | 261 | 1.64 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 12-#5 |
| D = 9.500 | 100 | 1.88 | 13 | 0.795 | | 8-#6+ 1 | 4 | #5 | #6 | 10-#6 | 5 | #4 | #4 | 12-#5 | 126 | 258 | 340 | 1.83 | 13 | | 4 | #4 | #5 | 7-#7 | 5 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.38 | 13 * | 0.863 | | 8-#6+ 2 | 4 | #6 | #7 | 7-#8 | 5 | #5 | #5 | 12-#5 | 156 | 358 | 420 | 2.21 | 13 | 3 S 4 1 | 4 | #5 | #6 | 7-#8 | 5 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.79 | 13 * | 0.634 | | 8-#6+ 1 | 4 | #7 | #8 | 11-#7 | 5 | #5 | #6 | 12-#5 | 185 | 451 | 499 | 2.50 | 13 * | 3 S 4 1 | 4 | #6 | #6 | 8-#8 | 5 | #4 | #5 | 12-#5 |
| 0.680 CF/SF | 300 | 3.83 | 17 * | 0.629 | | 7-#7+ 2 | 4 | #9 | #9 | 9-#9 | 5 | #6 | #7 | 12-#5 | 241 | 625 | 649 | 3.43 | 13 * | 3 S 4 2 | 4 | #7 | #7 | 9-#9 | 5 | #5 | #6 | 12-#5 |
| | 400 | 4.32 | 22 * | 0.624 | 3 S 4 1 | 12-#6+ 2 | 4 | #9 | #10 | 11-#9 | 5 | #7 | #7 | 12-#5 | 289 | 704 | 777 | 3.74 | 19 * | 3 S 4 2 | 4 | #7 | #8 | 10-#9 | 5 | #5 | #6 | 12-#5 |
| 30'-0" | 50 | 1.73 | 15 | 0.774 | | 9-#6+ 2 | 5 | #5 | #5 | 11-#6 | 5 | #4 | #4 | 12-#5 | 135 | 269 | 362 | 1.65 | 15 | | 5 | #4 | #4 | 10-#6 | 5 | #4 | #4 | 12-#5 |
| D = 12.500 | 100 | 2.17 | 15 * | 0.857 | | 9-#6+ 4 | 5 | #6 | #6 | 11-#7 | 5 | #4 | #5 | 12-#5 | 175 | 350 | 471 | 2.04 | 15 | | 5 | #5 | #5 | 10-#7 | 5 | #4 | #4 | 12-#5 |
| RIB ON | 150 | 2.67 | 15 * | 0.918 | | 9-#6+ 6 | 5 | #7 | #7 | 10-#8 | 5 | #5 | #6 | 12-#5 | 215 | 480 | 579 | 2.40 | 15 * | 3 S 4 1 | 5 | #5 | #6 | 9-#8 | 5 | #4 | #5 | 12-#5 |
| COLUMN LINE | 200 | 3.28 | 17 * | 0.629 | | 10-#6+ 3 | 5 | #7 | #8 | 12-#8 | 5 | #6 | #7 | 12-#5 | 254 | 602 | 684 | 3.02 | 15 * | 3 S 4 1 | 5 | #6 | #7 | 9-#9 | 5 | #5 | #5 | 12-#5 |
| 0.707 CF/SF | 300 | 4.02 | 24 * | 0.623 | 3 S 4 1 | 10-#7+ 3 | 5 | #8 | #9 | 12-#9 | 5 | #7 | #7 | 13-#5 | 322 | 731 | 868 | 3.63 | 20 * | 3 S 4 2 | 5 | #7 | #7 | 12-#9 | 5 | #5 | #6 | 12-#5 |
| 33'-0" | 50 | 2.11 | 16 * | 0.821 | | 10-#6+ 3 | 5 | #6 | #6 | 11-#7 | 6 | #4 | #5 | 14-#5 | 178 | 356 | 479 | 1.98 | 16 | | 5 | #5 | #5 | 10-#7 | 6 | #4 | #4 | 14-#5 |
| D = 12.500 | 100 | 2.47 | 16 * | 0.903 | | 10-#6+ 6 | 5 | #6 | #7 | 9-#9 | 6 | #5 | #5 | 14-#5 | 232 | 464 | 624 | 2.29 | 16 * | 3 S 4 1 | 5 | #5 | #6 | 10-#8 | 6 | #4 | #4 | 14-#5 |
| RIB ON | 150 | 3.22 | 19 * | 0.627 | | 11-#6+ 3 | 5 | #8 | #8 | 11-#9 | 6 | #6 | #6 | 14-#5 | 283 | 614 | 763 | 2.86 | 16 * | 3 S 4 1 | 5 | #6 | #7 | 10-#9 | 6 | #4 | #5 | 14-#5 |
| COLUMN LINE | 200 | 3.78 | 22 * | 0.624 | 3 S 4 1 | 10-#7+ 3 | 5 | #8 | #9 | 16-#8 | 6 | #6 | #7 | 14-#5 | 333 | 750 | 897 | 3.47 | 17 * | 3 S 4 2 | 5 | #7 | #7 | 12-#9 | 6 | #5 | #6 | 14-#5 |
| 0.692 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.33 | 18 * | 0.840 | | 11-#6+ 4 | 5 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 16-#5 | 229 | 458 | 617 | 2.22 | 18 | 3 S 4 1 | 5 | #5 | #6 | 10-#8 | 7 | #4 | #4 | 16-#5 |
| D = 12.500 | 100 | 2.97 | 19 * | 0.920 | | 12-#6+ 9 | 5 | #7 | #8 | 11-#9 | 7 | #5 | #6 | 16-#5 | 298 | 596 | 802 | 2.79 | 18 * | 3 S 4 1 | 5 | #6 | #7 | 13-#8 | 7 | #4 | #5 | 16-#5 |
| RIB ON | 150 | 3.62 | 24 * | 0.623 | 3 S 4 1 | 11-#7+ 3 | 5 | #8 | #9 | 14-#9 | 7 | #6 | #6 | 16-#5 | 363 | 728 | 977 | 3.35 | 18 * | 3 S 4 2 | 5 | #7 | #7 | 13-#9 | 7 | #5 | #5 | 16-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.680 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 39'-0" | 50 | 2.64 | 19 * | 0.894 | | 12-#6+ 8 | 6 | #7 | #7 | 11-#9 | 7 | #5 | #5 | 16-#5 | 295 | 590 | 795 | 2.48 | 19 * | 3 S 4 1 | 6 | #5 | #6 | 13-#8 | 7 | #4 | #5 | 16-#5 |
| D = 15.500 | 100 | 3.45 | 25 * | 0.918 | | 11-#7+ 9 | 6 | #8 | #8 | 15-#9 | 7 | #6 | #6 | 16-#5 | 379 | 757 | 1019 | 3.20 | 19 * | 3 S 4 1 | 6 | #6 | #7 | 14-#9 | 7 | #5 | #5 | 16-#5 |
| RIB NOT ON | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.700 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 16 in. | Rib Depth = 12 in. | Total Slab Depth = 4 in. | | | | | | | | | | | | | | | |
| 21'-0" | 50 | 1.56 | 12 | 0.637 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 49 | 99 | 133 |
| D = 9.500 | 100 | 1.56 | 12 | 0.637 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 63 | 130 | 170 |
| RIB NOT ON | 150 | 1.63 | 12 | 0.637 | | 9-#5+ 0 | 4 | #4 | #5 | 9-#5 | 3 | #4 | #4 | 8-#5 | 77 | 177 | 207 |
| COLUMN LINE | 200 | 1.73 | 12 | 0.637 | | 9-#5+ 0 | 4 | #5 | #5 | 9-#5 | 3 | #4 | #5 | 8-#5 | 90 | 221 | 243 |
| 0.803 CF/SF | 300 | 2.07 | 12 | 0.695 | | 9-#5+ 0 | 4 | #5 | #6 | 8-#6 | 3 | #5 | #6 | 8-#5 | 118 | 306 | 317 |
| | 400 | 2.53 | 12 * | 0.800 | | 9-#5+ 1 | 4 | #6 | #7 | 7-#7 | 3 | #6 | #6 | 8-#5 | 145 | 390 | 390 |
| | 500 | 2.99 | 12 * | 0.638 | | 9-#5+ 1 | 4 | #7 | #7 | 7-#8 | 3 | #6 | #7 | 8-#5 | 172 | 473 | 464 |
| 24'-0" | 50 | 1.57 | 12 | 0.637 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 | 74 | 147 | 198 |
| D = 9.500 | 100 | 1.63 | 12 | 0.637 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 | 94 | 193 | 254 |
| RIB NOT ON | 150 | 1.80 | 12 | 0.675 | | 10-#5+ 0 | 4 | #5 | #5 | 8-#6 | 4 | #4 | #5 | 10-#5 | 115 | 264 | 309 |
| COLUMN LINE | 200 | 2.10 | 12 | 0.724 | | 10-#5+ 0 | 4 | #6 | #6 | 9-#6 | 4 | #5 | #5 | 10-#5 | 136 | 331 | 365 |
| 0.775 CF/SF | 300 | 2.57 | 12 * | 0.851 | | 10-#5+ 2 | 4 | #7 | #7 | 7-#8 | 4 | #5 | #6 | 10-#5 | 177 | 459 | 476 |
| | 400 | 3.29 | 12 * | 0.638 | | 7-#6+ 3 | 4 | #8 | #8 | 7-#9 | 4 | #6 | #7 | 10-#5 | 218 | 586 | 587 |
| | 500 | 3.90 | 14 * | 0.635 | | 9-#6+ 1 | 4 | #8 | #9 | 8-#9 | 4 | #7 | #7 | 10-#5 | 257 | 706 | 693 |
| 27'-0" | 50 | 1.64 | 13 | 0.636 | | 8-#6+ 0 | 4 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 12-#5 | 104 | 208 | 281 |
| D = 9.500 | 100 | 1.82 | 13 | 0.689 | | 8-#6+ 0 | 4 | #5 | #6 | 9-#6 | 5 | #4 | #4 | 12-#5 | 134 | 270 | 360 |
| RIB NOT ON | 150 | 2.09 | 13 | 0.773 | | 8-#6+ 1 | 4 | #6 | #6 | 8-#7 | 5 | #4 | #5 | 12-#5 | 163 | 371 | 439 |
| COLUMN LINE | 200 | 2.47 | 13 * | 0.840 | | 8-#6+ 2 | 4 | #7 | #7 | 8-#8 | 5 | #5 | #5 | 12-#5 | 193 | 466 | 519 |
| 0.756 CF/SF | 300 | 3.38 | 13 * | 0.637 | | 12-#5+ 3 | 4 | #8 | #9 | 8-#9 | 5 | #6 | #6 | 12-#5 | 252 | 649 | 677 |
| | 400 | 4.18 | 17 * | 0.632 | | 15-#5+ 1 | 4 | #9 | #10 | 10-#9 | 5 | #7 | #7 | 12-#5 | 305 | 811 | 822 |
| | 500 | 4.71 | 21 * | 0.628 | 4 S 6 1 | 12-#6+ 1 | 4 | #10 | #10 | 12-#9 | 5 | #7 | #7 | 12-#5 | 354 | 924 | 953 |
| 30'-0" | 50 | 1.70 | 15 | 0.686 | | 9-#6+ 1 | 5 | #5 | #5 | 10-#6 | 5 | #4 | #4 | 12-#5 | 145 | 290 | 390 |
| D = 12.500 | 100 | 2.00 | 15 | 0.786 | | 9-#6+ 3 | 5 | #5 | #6 | 10-#7 | 5 | #4 | #5 | 12-#5 | 185 | 370 | 498 |
| RIB ON | 150 | 2.54 | 15 * | 0.848 | | 9-#6+ 4 | 5 | #6 | #7 | 9-#8 | 5 | #5 | #6 | 12-#5 | 225 | 501 | 607 |
| COLUMN LINE | 200 | 3.03 | 15 * | 0.907 | | 9-#6+ 6 | 5 | #7 | #8 | 9-#9 | 5 | #6 | #6 | 12-#5 | 266 | 630 | 715 |
| 0.788 CF/SF | 300 | 3.82 | 18 * | 0.631 | | 12-#6+ 2 | 5 | #8 | #9 | 11-#9 | 5 | #7 | #7 | 12-#5 | 343 | 873 | 924 |
| | 400 | 4.63 | 23 * | 0.626 | 4 S 6 1 | 14-#6+ 4 | 5 | #9 | #10 | 14-#9 | 5 | #7 | #8 | 14-#5 | 411 | 1013 | 1106 |
| 33'-0" | 50 | 1.90 | 16 | 0.749 | | 10-#6+ 2 | 5 | #5 | #6 | 10-#7 | 6 | #4 | #4 | 14-#5 | 191 | 383 | 515 |
| D = 12.500 | 100 | 2.35 | 16 * | 0.836 | | 10-#6+ 4 | 5 | #6 | #7 | 10-#8 | 6 | #5 | #5 | 14-#5 | 245 | 490 | 660 |
| RIB ON | 150 | 2.88 | 16 * | 0.902 | | 10-#6+ 6 | 5 | #7 | #8 | 12-#8 | 6 | #5 | #6 | 14-#5 | 299 | 651 | 805 |
| COLUMN LINE | 200 | 3.48 | 18 * | 0.631 | | 12-#6+ 3 | 5 | #8 | #9 | 11-#9 | 6 | #6 | #6 | 14-#5 | 351 | 817 | 945 |
| 0.770 CF/SF | 300 | 4.42 | 24 * | 0.625 | 4 S 6 1 | 22-#5+ 5 | 5 | #9 | #10 | 15-#9 | 6 | #7 | #7 | 16-#5 | 446 | 1036 | 1200 |
| 36'-0" | 50 | 2.27 | 18 | 0.758 | | 11-#6+ 2 | 5 | #6 | #7 | 10-#8 | 7 | #4 | #5 | 16-#5 | 246 | 492 | 663 |
| D = 12.500 | 100 | 2.69 | 18 * | 0.869 | | 11-#6+ 6 | 5 | #7 | #8 | 10-#9 | 7 | #5 | #5 | 16-#5 | 316 | 632 | 850 |
| RIB ON | 150 | 3.19 | 19 * | 0.630 | | 10-#7+ 3 | 5 | #8 | #8 | 16-#8 | 7 | #5 | #6 | 16-#5 | 384 | 791 | 1035 |
| COLUMN LINE | 200 | 3.97 | 23 * | 0.626 | 4 S 6 1 | 9-#8+ 1 | 5 | #9 | #9 | 15-#9 | 7 | #6 | #7 | 16-#5 | 449 | 1000 | 1210 |
| 0.756 CF/SF | | | | | | | | | | | | | | | | | |
| 39'-0" | 50 | 2.46 | 19 * | 0.839 | | 12-#6+ 6 | 6 | #6 | #7 | 13-#8 | 7 | #5 | #5 | 16-#5 | 318 | 635 | 855 |
| D = 15.500 | 100 | 3.00 | 19 * | 0.922 | | 14-#6+ 9 | 6 | #7 | #8 | 13-#9 | 7 | #5 | #6 | 16-#5 | 406 | 812 | 1094 |
| RIB NOT ON | 150 | 3.80 | 24 * | 0.625 | | 17-#6+ 5 | 6 | #8 | #9 | 16-#9 | 7 | #6 | #7 | 17-#5 | 489 | 983 | 1317 |
| COLUMN LINE | 200 | 4.34 | 31 * | 0.621 | | 11-#8+ 3 | 6 | #9 | #9 | 19-#9 | 7 | #6 | #7 | 20-#5 | 561 | 1122 | 1511 |
| 0.780 CF/SF | | | | | | | | | | | | | | | | | |
| 42'-0" | 50 | 2.82 | 21 * | 0.861 | | 14-#6+ 7 | 6 | #7 | #8 | 16-#8 | 8 | #5 | #5 | 18-#5 | 393 | 786 | 1058 |
| D = 15.500 | 100 | 3.63 | 24 * | 0.912 | | 13-#7+ 8 | 6 | #8 | #9 | 17-#9 | 8 | #6 | #6 | 18-#5 | 500 | 1000 | 1347 |
| RIB NOT ON | 150 | 4.25 | 32 * | 0.621 | | 12-#8+ 2 | 6 | #9 | #9 | 20-#9 | 8 | #6 | #7 | 21-#5 | 597 | 1194 | 1608 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.767 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 16 in. | Rib Depth = 12 in. | Total Slab Depth = 4 in. | | | | | | | | |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.83 | 12 | | 4 | #4 | #5 | 7-#6 | 3 | #4 | #5 | 8-#5 |
| 2.21 | 12 | 4 S 6 1 | 4 | #5 | #5 | 9-#6 | 3 | #5 | #5 | 8-#5 |
| 2.69 | 12 * | 4 S 6 1 | 4 | #6 | #6 | 8-#7 | 3 | #5 | #6 | 8-#5 |
| 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| 1.71 | 12 | | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| 1.88 | 12 | | 4 | #5 | #5 | 12-#5 | 4 | #4 | #4 | 10-#5 |
| 2.26 | 12 * | 4 S 6 1 | 4 | #5 | #6 | 8-#7 | 4 | #4 | #5 | 10-#5 |
| 2.87 | 12 * | 4 S 6 1 | 4 | #6 | #7 | 8-#8 | 4 | #5 | #5 | 10-#5 |
| 3.53 | 12 * | 4 S 6 1 | 4 | #7 | #7 | 8-#9 | 4 | #6 | #6 | 10-#5 |
| 1.64 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 12-#5 |
| 1.74 | 13 | | 4 | #4 | #5 | 12-#5 | 5 | #4 | #4 | 12-#5 |
| 1.98 | 13 | 4 S 6 1 | 4 | #5 | #5 | 8-#7 | 5 | #4 | #4 | 12-#5 |
| 2.21 | 13 | 4 S 6 1 | 4 | #5 | #6 | 7-#8 | 5 | #4 | #4 | 12-#5 |
| 3.03 | 13 * | 4 S 6 1 | 4 | #7 | #7 | 7-#9 | 5 | #5 | #5 | 12-#5 |
| 3.60 | 14 * | 4 S 6 2 | 4 | #7 | #8 | 9-#9 | 5 | #5 | #6 | 12-#5 |
| 4.22 | 18 * | 4 S 6 2 | 4 | #8 | #8 | 11-#9 | 5 | #6 | #6 | 12-#5 |
| 1.61 | 15 | | 5 | #4 | #4 | 9-#6 | 5 | #4 | #4 | 12-#5 |
| 1.89 | 15 | | 5 | #4 | #5 | 9-#7 | 5 | #4 | #4 | 12-#5 |
| 2.33 | 15 | | 5 | #5 | #6 | 11-#7 | 5 | #4 | #5 | 12-#5 |
| 2.71 | 15 * | 4 S 6 1 | 5 | #6 | #6 | 10-#8 | 5 | #5 | #5 | 12-#5 |
| 3.36 | 15 * | 4 S 6 1 | 5 | #7 | #7 | 10-#9 | 5 | #5 | #6 | 12-#5 |
| 4.05 | 20 * | 4 S 6 2 | 5 | #7 | #8 | 16-#8 | 5 | #6 | #6 | 13-#5 |
| 1.84 | 16 | | 5 | #4 | #5 | 9-#7 | 6 | #4 | #4 | 14-#5 |
| 2.12 | 16 | 4 S 6 1 | 5 | #5 | #5 | 9-#8 | 6 | #4 | #4 | 14-#5 |
| 2.65 | 16 * | 4 S 6 1 | 5 | #6 | #6 | 9-#9 | 6 | #4 | #5 | 14-#5 |
| 3.16 | 16 * | 4 S 6 1 | 5 | #7 | #7 | 13-#8 | 6 | #5 | #5 | 14-#5 |
| 3.88 | 20 * | 4 S 6 2 | 5 | #7 | #8 | 14-#9 | 6 | #5 | #6 | 15-#5 |
| 2.16 | 18 | | 5 | #5 | #6 | 9-#8 | 7 | #4 | #4 | 16-#5 |
| 2.46 | 18 * | 4 S 6 1 | 5 | #6 | #6 | 9-#9 | 7 | #4 | #4 | 16-#5 |
| 2.96 | 18 * | 4 S 6 1 | 5 | #6 | #7 | 12-#9 | 7 | #4 | #5 | 16-#5 |
| 3.58 | 18 * | 4 S 6 2 | 5 | #7 | #8 | 14-#9 | 7 | #5 | #5 | 16-#5 |
| 2.30 | 19 | | 6 | #5 | #6 | 12-#8 | 7 | #4 | #4 | 16-#5 |
| 2.74 | 19 * | 4 S 6 1 | 6 | #6 | #6 | 12-#9 | 7 | #4 | #5 | 16-#5 |
| 3.44 | 19 * | 4 S 6 1 | 6 | #7 | #7 | 15-#9 | 7 | #5 | #5 | 16-#5 |
| 4.06 | 24 * | 4 S 6 2 | 6 | #7 | #8 | 18-#9 | 7 | #5 | #6 | 19-#5 |
| 2.66 | 21 | 4 S 6 1 | 6 | #6 | #6 | 12-#9 | 8 | #4 | #5 | 18-#5 |
| 3.33 | 21 * | 4 S 6 1 | 6 | #7 | #7 | 15-#9 | 8 | #5 | #5 | 18-#5 |
| 3.99 | 23 * | 4 S 6 2 | 6 | #7 | #8 | 19-#9 | 8 | #5 | #6 | 20-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 in. | Rib Depth = 14 in. | | Total Slab Depth = 4 in. | | | | | | | | | | | | | | | Total Depth = 18 in. | Rib Depth = 14 in. | | Total Slab Depth = 4 in. | | | | | | | |
| 24'-0" | 50 | 1.57 | 12 | 0.640 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 | 79 | 158 | 213 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| D = 9.500 | 100 | 1.63 | 12 | 0.640 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 | 100 | 200 | 268 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| RIB NOT ON | 150 | 1.68 | 12 | 0.640 | | 10-#5+ 0 | 4 | #5 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 | 120 | 272 | 324 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 1.90 | 12 | 0.640 | | 10-#5+ 0 | 4 | #5 | #6 | 12-#5 | 4 | #4 | #5 | 10-#5 | 141 | 340 | 379 | 1.76 | 12 | | 4 | #4 | #5 | 8-#6 | 4 | #4 | #4 | 10-#5 |
| 0.856 CF/SF | 300 | 2.43 | 12 | 0.721 | | 10-#5+ 0 | 4 | #6 | #7 | 8-#7 | 4 | #5 | #6 | 10-#5 | 182 | 469 | 490 | 2.20 | 12 | 4 S 6 1 | 4 | #5 | #6 | 10-#6 | 4 | #4 | #5 | 10-#5 |
| | 400 | 2.96 | 12 * | 0.857 | | 10-#5+ 3 | 4 | #7 | #8 | 8-#8 | 4 | #6 | #6 | 10-#5 | 223 | 596 | 601 | 2.64 | 12 * | 4 S 6 1 | 4 | #6 | #6 | 7-#8 | 4 | #5 | #5 | 10-#5 |
| | 500 | 3.40 | 12 * | 0.641 | | 8-#6+ 2 | 4 | #8 | #8 | 7-#9 | 4 | #6 | #7 | 10-#5 | 265 | 722 | 712 | 3.05 | 12 * | 4 S 6 1 | 4 | #6 | #7 | 11-#7 | 4 | #5 | #6 | 10-#5 |
| 27'-0" | 50 | 1.64 | 13 | 0.638 | | 8-#6+ 0 | 4 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 12-#5 | 112 | 223 | 301 | 1.64 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 12-#5 |
| D = 9.500 | 100 | 1.70 | 13 | 0.638 | | 8-#6+ 0 | 4 | #5 | #5 | 12-#5 | 5 | #4 | #4 | 12-#5 | 141 | 282 | 380 | 1.64 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.04 | 13 | 0.658 | | 8-#6+ 0 | 4 | #6 | #6 | 10-#6 | 5 | #4 | #5 | 12-#5 | 171 | 383 | 459 | 1.92 | 13 | | 4 | #5 | #5 | 7-#7 | 5 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.32 | 13 | 0.743 | | 8-#6+ 1 | 4 | #6 | #7 | 7-#8 | 5 | #5 | #5 | 12-#5 | 200 | 479 | 539 | 2.09 | 13 | 4 S 6 1 | 4 | #5 | #6 | 8-#7 | 5 | #4 | #4 | 12-#5 |
| 0.834 CF/SF | 300 | 2.96 | 13 * | 0.878 | | 8-#6+ 4 | 4 | #8 | #8 | 7-#9 | 5 | #5 | #6 | 12-#5 | 259 | 664 | 697 | 2.64 | 13 * | 4 S 6 1 | 4 | #6 | #7 | 8-#8 | 5 | #4 | #5 | 12-#5 |
| | 400 | 3.75 | 13 * | 0.639 | | 7-#7+ 0 | 4 | #9 | #9 | 9-#9 | 5 | #6 | #7 | 12-#5 | 318 | 845 | 856 | 3.26 | 13 * | 4 S 6 2 | 4 | #7 | #7 | 8-#9 | 5 | #5 | #6 | 12-#5 |
| | 500 | 4.42 | 16 * | 0.635 | | 8-#7+ 2 | 4 | #9 | #10 | 13-#8 | 5 | #7 | #7 | 12-#5 | 373 | 1014 | 1005 | 4.03 | 13 * | 4 S 6 2 | 4 | #8 | #8 | 10-#9 | 5 | #6 | #6 | 12-#5 |
| 30'-0" | 50 | 1.63 | 15 | 0.636 | | 9-#6+ 0 | 5 | #4 | #5 | 9-#6 | 5 | #4 | #4 | 12-#5 | 155 | 311 | 418 | 1.61 | 15 | | 5 | #4 | #4 | 9-#6 | 5 | #4 | #4 | 12-#5 |
| D = 12.500 | 100 | 1.95 | 15 | 0.637 | | 9-#6+ 0 | 5 | #5 | #6 | 9-#7 | 5 | #4 | #5 | 12-#5 | 196 | 391 | 527 | 1.81 | 15 | | 5 | #4 | #5 | 11-#6 | 5 | #4 | #4 | 12-#5 |
| RIB ON | 150 | 2.23 | 15 | 0.728 | | 9-#6+ 1 | 5 | #6 | #6 | 11-#7 | 5 | #5 | #5 | 12-#5 | 236 | 520 | 635 | 2.04 | 15 | | 5 | #5 | #5 | 10-#7 | 5 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.67 | 15 * | 0.819 | | 9-#6+ 3 | 5 | #7 | #7 | 10-#8 | 5 | #5 | #6 | 12-#5 | 276 | 652 | 744 | 2.40 | 15 | 4 S 6 1 | 5 | #5 | #6 | 9-#8 | 5 | #4 | #5 | 12-#5 |
| 0.871 CF/SF | 300 | 3.45 | 15 * | 0.637 | | 15-#5+ 4 | 5 | #8 | #8 | 10-#9 | 5 | #6 | #7 | 12-#5 | 357 | 904 | 961 | 3.13 | 15 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 5 | #5 | #6 | 12-#5 |
| | 400 | 4.31 | 18 * | 0.633 | 4 S 6 1 | 10-#7+ 3 | 5 | #9 | #9 | 12-#9 | 5 | #7 | #8 | 13-#5 | 434 | 1142 | 1167 | 3.82 | 15 * | 4 S 6 1 | 5 | #7 | #8 | 11-#9 | 5 | #6 | #6 | 12-#5 |
| | 500 | 4.96 | 23 * | 0.628 | 4 S 6 1 | 11-#7+ 3 | 5 | #9 | #10 | 14-#9 | 5 | #8 | #8 | 15-#5 | 498 | 1285 | 1342 | 4.45 | 20 * | 4 S 6 2 | 5 | #8 | #8 | 13-#9 | 5 | #6 | #7 | 14-#5 |
| 33'-0" | 50 | 1.88 | 16 | 0.661 | | 10-#6+ 1 | 5 | #5 | #6 | 9-#7 | 6 | #4 | #4 | 14-#5 | 205 | 410 | 552 | 1.84 | 16 | | 5 | #4 | #5 | 9-#7 | 6 | #4 | #4 | 14-#5 |
| D = 12.500 | 100 | 2.16 | 16 | 0.765 | | 10-#6+ 3 | 5 | #6 | #6 | 9-#8 | 6 | #4 | #5 | 14-#5 | 259 | 518 | 697 | 2.06 | 16 | | 5 | #5 | #5 | 11-#7 | 6 | #4 | #4 | 14-#5 |
| RIB ON | 150 | 2.64 | 16 * | 0.842 | | 10-#6+ 5 | 5 | #7 | #7 | 9-#9 | 6 | #5 | #5 | 14-#5 | 313 | 677 | 842 | 2.49 | 16 | 4 S 6 1 | 5 | #6 | #6 | 10-#8 | 6 | #4 | #5 | 14-#5 |
| COLUMN LINE | 200 | 3.21 | 16 * | 0.901 | | 11-#6+ 6 | 5 | #8 | #8 | 10-#9 | 6 | #6 | #6 | 14-#5 | 366 | 853 | 987 | 2.91 | 16 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 6 | #5 | #5 | 14-#5 |
| 0.850 CF/SF | 300 | 4.22 | 19 * | 0.632 | 4 S 6 1 | 14-#6+ 4 | 5 | #9 | #10 | 13-#9 | 6 | #7 | #7 | 14-#5 | 470 | 1179 | 1266 | 3.67 | 16 * | 4 S 6 2 | 5 | #7 | #8 | 16-#8 | 6 | #5 | #6 | 14-#5 |
| | 400 | 5.02 | 25 * | 0.627 | 4 S 6 1 | 17-#6+ 3 | 5 | #10 | #10 | 16-#9 | 6 | #7 | #8 | 17-#5 | 560 | 1369 | 1508 | 4.55 | 21 * | 4 S 6 2 | 5 | #8 | #9 | 15-#9 | 6 | #6 | #6 | 16-#5 |
| 36'-0" | 50 | 2.11 | 18 | 0.675 | | 11-#6+ 1 | 5 | #6 | #6 | 9-#8 | 7 | #4 | #5 | 16-#5 | 264 | 527 | 710 | 2.01 | 18 | | 5 | #5 | #5 | 11-#7 | 7 | #4 | #4 | 16-#5 |
| D = 12.500 | 100 | 2.54 | 18 * | 0.797 | | 11-#6+ 4 | 5 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 16-#5 | 333 | 667 | 897 | 2.36 | 18 | 4 S 6 1 | 5 | #5 | #6 | 9-#9 | 7 | #4 | #4 | 16-#5 |
| RIB ON | 150 | 3.05 | 18 * | 0.878 | | 12-#6+ 6 | 5 | #8 | #8 | 11-#9 | 7 | #5 | #6 | 16-#5 | 403 | 835 | 1085 | 2.79 | 18 * | 4 S 6 1 | 5 | #6 | #7 | 13-#8 | 7 | #4 | #5 | 16-#5 |
| COLUMN LINE | 200 | 3.76 | 18 * | 0.633 | 4 S 6 1 | 11-#7+ 3 | 5 | #9 | #9 | 14-#9 | 7 | #6 | #6 | 16-#5 | 473 | 1063 | 1272 | 3.43 | 18 * | 4 S 6 2 | 5 | #7 | #8 | 16-#8 | 7 | #5 | #5 | 16-#5 |
| 0.834 CF/SF | 300 | 4.84 | 25 * | 0.627 | 4 S 6 1 | 10-#8+ 1 | 5 | #10 | #10 | 18-#9 | 7 | #7 | #7 | 18-#5 | 598 | 1409 | 1611 | 4.44 | 20 * | 4 S 6 2 | 5 | #8 | #9 | 16-#9 | 7 | #6 | #6 | 17-#5 |
| 39'-0" | 50 | 2.41 | 19 * | 0.783 | | 12-#6+ 5 | 6 | #6 | #7 | 12-#8 | 7 | #5 | #5 | 16-#5 | 340 | 681 | 917 | 2.24 | 19 | | 6 | #5 | #6 | 11-#8 | 7 | #4 | #4 | 16-#5 |
| D = 15.500 | 100 | 2.92 | 19 * | 0.873 | | 13-#6+ 8 | 6 | #7 | #8 | 12-#9 | 7 | #5 | #6 | 16-#5 | 429 | 858 | 1156 | 2.67 | 19 * | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 7 | #4 | #5 | 16-#5 |
| RIB NOT ON | 150 | 3.47 | 20 * | 0.631 | | 12-#7+ 4 | 6 | #8 | #8 | 15-#9 | 7 | #6 | #6 | 16-#5 | 517 | 1051 | 1391 | 3.20 | 19 * | 4 S 6 1 | 6 | #6 | #7 | 14-#9 | 7 | #5 | #5 | 16-#5 |
| COLUMN LINE | 200 | 4.21 | 24 * | 0.628 | | 26-#5+ 8 | 6 | #9 | #9 | 17-#9 | 7 | #7 | #7 | 18-#5 | 600 | 1329 | 1615 | 3.80 | 19 * | 4 S 6 2 | 6 | #7 | #8 | 16-#9 | 7 | #5 | #6 | 17-#5 |
| 0.862 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 42'-0" | 50 | 2.63 | 21 * | 0.795 | | 18-#5+ 8 | 6 | #7 | #7 | 12-#9 | 8 | #5 | #5 | 18-#5 | 421 | 842 | 1134 | 2.49 | 21 | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 8 | #4 | #4 | 18-#5 |
| D = 15.500 | 100 | 3.20 | 21 * | 0.908 | | 12-#7+ 8 | 6 | #8 | #8 | 15-#9 | 8 | #5 | #6 | 18-#5 | 532 | 1063 | 1431 | 2.96 | 21 * | 4 S 6 1 | 6 | #6 | #7 | 14-#9 | 8 | #4 | #5 | 18-#5 |
| RIB NOT ON | 150 | 4.01 | 24 * | 0.628 | | 11-#8+ 3 | 6 | #9 | #9 | 23-#8 | 8 | #6 | #7 | 19-#5 | 638 | 1276 | 1718 | 3.64 | 21 * | 4 S 6 2 | 6 | #7 | #8 | 17-#9 | 8 | #5 | #5 | 18-#5 |
| COLUMN LINE | 200 | 4.56 | 29 * | 0.624 | | 13-#8+ 4 | 6 | #9 | #10 | 22-#9 | 8 | #6 | #7 | 23-#5 | 737 | 1474 | 1984 | 4.22 | 23 * | 4 S 6 2 | 6 | #8 | #8 | 20-#9 | 8 | #5 | #6 | 21-#5 |
| 0.847 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.10 | 22 * | 0.867 | | 12-#7+ 7 | 6 | #8 | #8 | 15-#9 | 9 | #5 | #6 | 20-#5 | 516 | 1032 | 1390 | 2.86 | 22 | 4 S 6 1 | 6 | #6 | #7 | 14-#9 | 9 | #4 | #5 | 20-#5 |
| D = 15.500 | 100 | 3.84 | 24 * | 0.915 | | 11-#8+ 6 | 6 | #9 | #9 | 19-#9 | 9 | #6 | #6 | 20-#5 | 650 | 1300 | 1749 | 3.58 | 22 * | 4 S 6 2 | 6 | #7 | #8 | 18-#9 | 9 | #5 | #5 | 20-#5 |
| RIB NOT ON | 150 | 4.52 | 29 * | 0.624 | | 11-#9+ 2 | 6 | #9 | #10 | 23-#9 | 9 | #6 | #7 | 24-#5 | 778 | 1555 | 2094 | 4.21 | 22 * | 4 S 6 2 | 6 | #8 | #8 | 22-#9 | 9 | #5 | #6 | 22-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.834 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 48'-0" | 50 | 3.42 | 24 * | 0.897 | | 14-#7+10 | 7 | #8 | #8 | 18-#9 | 9 | #6 | #6 | 20-#5 | 632 | 1263 | 1700 | 3.19 | 24 * | 4 S 6 1 | 7 | #6 | #7 | 17-#9 | 9 | #5 | #5 | 20-#5 |
| D = 18.500 | 100 | 4.27 | 29 * | 0.916 | | 14-#8+ 8 | 7 | #9 | #9 | 23-#9 | 9 | #6 | #7 | 24-#5 | 789 | 1578 | 2124 | 4.00 | 24 * | 4 S 6 2 | 7 | #7 | #8 | 22-#9 | 9 | #5 | #6 | 23-#5 |
| RIB ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.856 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 20 in. | | Rib Depth = 16 in. | | | Total Slab Depth = 4 in. | | | | | | | | | | | | |
| 27'-0" | 50 | 1.79 | 13 | 0.641 | | 8-#6+ 0 | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 | 119 | 239 | 321 |
| D = 9.500 | 100 | 1.84 | 13 | 0.641 | | 8-#6+ 0 | 4 | #5 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 | 149 | 298 | 401 |
| RIB NOT ON | 150 | 1.97 | 13 | 0.641 | | 8-#6+ 0 | 4 | #5 | #6 | 7-#7 | 5 | #4 | #5 | 12-#5 | 178 | 393 | 480 |
| COLUMN LINE | 200 | 2.21 | 13 | 0.641 | | 8-#6+ 0 | 4 | #6 | #7 | 8-#7 | 5 | #4 | #5 | 12-#5 | 208 | 491 | 559 |
| 0.915 CF/SF | 300 | 2.77 | 13 | 0.722 | | 8-#6+ 0 | 4 | #7 | #8 | 8-#8 | 5 | #5 | #6 | 12-#5 | 267 | 678 | 718 |
| | 400 | 3.38 | 13 * | 0.642 | | 12-#5+ 1 | 4 | #8 | #9 | 8-#9 | 5 | #6 | #6 | 12-#5 | 326 | 860 | 877 |
| | 500 | 3.93 | 13 * | 0.642 | | 10-#6+ 1 | 4 | #9 | #9 | 12-#8 | 5 | #6 | #7 | 12-#5 | 385 | 1040 | 1035 |
| 30'-0" | 50 | 1.77 | 15 | 0.638 | | 9-#6+ 0 | 5 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 12-#5 | 166 | 332 | 447 |
| D = 12.500 | 100 | 1.88 | 15 | 0.638 | | 9-#6+ 0 | 5 | #5 | #5 | 11-#6 | 5 | #4 | #5 | 12-#5 | 206 | 413 | 556 |
| RIB ON | 150 | 2.22 | 15 | 0.638 | | 9-#6+ 0 | 5 | #6 | #6 | 10-#7 | 5 | #5 | #5 | 12-#5 | 247 | 536 | 664 |
| COLUMN LINE | 200 | 2.54 | 15 | 0.703 | | 9-#6+ 1 | 5 | #6 | #7 | 9-#8 | 5 | #5 | #6 | 12-#5 | 287 | 671 | 773 |
| 0.956 CF/SF | 300 | 3.37 | 15 * | 0.853 | | 10-#6+ 3 | 5 | #8 | #8 | 9-#9 | 5 | #6 | #7 | 12-#5 | 368 | 926 | 990 |
| | 400 | 4.01 | 15 * | 0.639 | | 12-#6+ 3 | 5 | #9 | #9 | 11-#9 | 5 | #7 | #7 | 12-#5 | 448 | 1175 | 1207 |
| | 500 | 4.80 | 18 * | 0.635 | 4 S 6 1 | 10-#7+ 1 | 5 | #9 | #10 | 13-#9 | 5 | #8 | #8 | 14-#5 | 524 | 1408 | 1411 |
| 33'-0" | 50 | 1.96 | 16 | 0.637 | | 10-#6+ 0 | 5 | #5 | #6 | 9-#7 | 6 | #4 | #5 | 14-#5 | 219 | 439 | 591 |
| D = 12.500 | 100 | 2.15 | 16 | 0.637 | | 10-#6+ 0 | 5 | #6 | #6 | 11-#7 | 6 | #4 | #5 | 14-#5 | 273 | 546 | 735 |
| RIB ON | 150 | 2.52 | 16 | 0.714 | | 10-#6+ 1 | 5 | #7 | #7 | 10-#8 | 6 | #5 | #5 | 14-#5 | 327 | 701 | 880 |
| COLUMN LINE | 200 | 2.87 | 16 * | 0.808 | | 10-#6+ 3 | 5 | #7 | #8 | 9-#9 | 6 | #5 | #6 | 14-#5 | 381 | 881 | 1025 |
| 0.932 CF/SF | 300 | 3.89 | 16 * | 0.638 | | 10-#7+ 1 | 5 | #9 | #9 | 12-#9 | 6 | #6 | #7 | 14-#5 | 488 | 1219 | 1315 |
| | 400 | 4.80 | 20 * | 0.633 | 4 S 6 1 | 9-#8+ 1 | 5 | #10 | #10 | 15-#9 | 6 | #7 | #8 | 16-#5 | 589 | 1535 | 1587 |
| 36'-0" | 50 | 2.12 | 18 | 0.634 | | 11-#6+ 1 | 5 | #6 | #6 | 11-#7 | 7 | #4 | #5 | 16-#5 | 282 | 564 | 759 |
| D = 12.500 | 100 | 2.45 | 18 | 0.702 | | 11-#6+ 2 | 5 | #7 | #7 | 9-#9 | 7 | #4 | #5 | 16-#5 | 352 | 703 | 946 |
| RIB ON | 150 | 2.75 | 18 * | 0.808 | | 11-#6+ 5 | 5 | #7 | #8 | 10-#9 | 7 | #5 | #5 | 16-#5 | 421 | 870 | 1134 |
| COLUMN LINE | 200 | 3.45 | 18 * | 0.873 | | 10-#7+ 3 | 5 | #8 | #9 | 12-#9 | 7 | #6 | #6 | 16-#5 | 491 | 1105 | 1321 |
| 0.915 CF/SF | 300 | 4.53 | 20 * | 0.633 | 4 S 6 1 | 17-#6+ 3 | 5 | #10 | #10 | 16-#9 | 7 | #7 | #7 | 17-#5 | 627 | 1532 | 1688 |
| 39'-0" | 50 | 2.32 | 19 | 0.656 | | 12-#6+ 1 | 6 | #6 | #7 | 11-#8 | 7 | #4 | #5 | 16-#5 | 364 | 728 | 981 |
| D = 15.500 | 100 | 2.71 | 19 * | 0.794 | | 12-#6+ 5 | 6 | #7 | #7 | 11-#9 | 7 | #5 | #6 | 16-#5 | 453 | 906 | 1219 |
| RIB NOT ON | 150 | 3.27 | 19 * | 0.890 | | 11-#7+ 6 | 6 | #7 | #8 | 14-#9 | 7 | #6 | #6 | 16-#5 | 542 | 1103 | 1458 |
| COLUMN LINE | 200 | 3.86 | 19 * | 0.634 | | 17-#6+ 5 | 6 | #8 | #9 | 16-#9 | 7 | #6 | #7 | 17-#5 | 630 | 1404 | 1697 |
| 0.946 CF/SF | 300 | 5.20 | 26 * | 0.628 | | 12-#8+ 2 | 6 | #10 | #10 | 20-#9 | 7 | #7 | #8 | 16-#6 | 791 | 1856 | 2130 |
| 42'-0" | 50 | 2.57 | 21 | 0.716 | | 18-#5+ 5 | 6 | #7 | #7 | 11-#9 | 8 | #5 | #5 | 18-#5 | 450 | 900 | 1212 |
| D = 15.500 | 100 | 3.13 | 21 * | 0.843 | | 11-#7+ 5 | 6 | #8 | #8 | 14-#9 | 8 | #5 | #6 | 18-#5 | 561 | 1122 | 1510 |
| RIB NOT ON | 150 | 3.66 | 21 * | 0.632 | | 18-#6+ 5 | 6 | #8 | #9 | 17-#9 | 8 | #6 | #6 | 18-#5 | 671 | 1343 | 1808 |
| COLUMN LINE | 200 | 4.43 | 24 * | 0.630 | | 12-#8+ 2 | 6 | #9 | #10 | 20-#9 | 8 | #6 | #7 | 21-#5 | 777 | 1654 | 2092 |
| 0.929 CF/SF | 300 | 5.45 | 32 * | 0.625 | 4 S 6 1 | 12-#9+ 2 | 6 | #10 | #10 | 26-#9 | 8 | #7 | #8 | 19-#6 | 967 | 1934 | 2604 |
| 45'-0" | 50 | 2.86 | 22 * | 0.803 | | 11-#7+ 5 | 6 | #7 | #8 | 14-#9 | 9 | #5 | #5 | 20-#5 | 552 | 1103 | 1485 |
| D = 15.500 | 100 | 3.50 | 22 * | 0.902 | | 14-#7+ 8 | 6 | #8 | #9 | 18-#9 | 9 | #6 | #6 | 20-#5 | 688 | 1376 | 1852 |
| RIB NOT ON | 150 | 4.27 | 25 * | 0.629 | | 32-#5+ 7 | 6 | #9 | #10 | 21-#9 | 9 | #6 | #7 | 22-#5 | 819 | 1638 | 2206 |
| COLUMN LINE | 200 | 4.96 | 30 * | 0.626 | | 12-#9+ 2 | 6 | #10 | #10 | 25-#9 | 9 | #7 | #7 | 26-#5 | 943 | 1887 | 2540 |
| 0.915 CF/SF | | | | | | | | | | | | | | | | | |
| 48'-0" | 50 | 3.19 | 24 * | 0.848 | | 26-#5+14 | 7 | #8 | #8 | 17-#9 | 9 | #5 | #6 | 20-#5 | 675 | 1351 | 1818 |
| D = 18.500 | 100 | 4.07 | 25 * | 0.920 | | 13-#8+ 8 | 7 | #9 | #9 | 22-#9 | 9 | #6 | #7 | 23-#5 | 839 | 1678 | 2259 |
| RIB ON | 150 | 4.75 | 30 * | 0.626 | | 15-#8+ 3 | 7 | #9 | #10 | 26-#9 | 9 | #7 | #7 | 27-#5 | 994 | 1988 | 2677 |
| COLUMN LINE | 200 | 5.50 | 37 * | 0.622 | 4 S 6 1 | 14-#9+ 3 | 7 | #10 | #10 | 30-#9 | 9 | #7 | #8 | 22-#6 | 1129 | 2258 | 3040 |
| 0.940 CF/SF | | | | | | | | | | | | | | | | | |
| 51'-0" | 50 | 3.64 | 25 * | 0.892 | | 16-#7+10 | 7 | #8 | #9 | 21-#9 | 10 | #6 | #6 | 22-#5 | 807 | 1613 | 2172 |
| D = 18.500 | 100 | 4.47 | 29 * | 0.626 | | 20-#7+ 6 | 7 | #9 | #10 | 26-#9 | 10 | #6 | #7 | 27-#5 | 998 | 1996 | 2687 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.926 CF/SF | | | | | | | | | | | | | | | | | |
| 54'-0" | 50 | 4.05 | 27 * | 0.918 | | 15-#8+10 | 7 | #9 | #10 | 25-#9 | 11 | #6 | #6 | 26-#5 | 951 | 1903 | 2561 |
| D = 18.500 | | | | | | | | | | | | | | | | | |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.915 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 20 in. | | | Rib Depth = 16 in. | | | | Total Slab Depth = 4 in. | | | |
| 1.82 | 13 | | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 |
| 1.82 | 13 | | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 |
| 1.89 | 13 | | 4 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 12-#5 |
| 2.08 | 13 | | 4 | #5 | #5 | 8-#7 | 5 | #4 | #5 | 12-#5 |
| 2.50 | 13 | 4 S 6 1 | 4 | #6 | #6 | 8-#8 | 5 | #4 | #5 | 12-#5 |
| 3.03 | 13 * | 4 S 6 1 | 4 | #7 | #7 | 7-#9 | 5 | #5 | #5 | 12-#5 |
| 3.60 | 13 * | 4 S 6 2 | 4 | #7 | #8 | 9-#9 | 5 | #5 | #6 | 12-#5 |
| 1.79 | 15 | | 5 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 12-#5 |
| 1.83 | 15 | | 5 | #4 | #5 | 10-#6 | 5 | #4 | #5 | 12-#5 |
| 2.07 | 15 | | 5 | #5 | #5 | 9-#7 | 5 | #4 | #5 | 12-#5 |
| 2.33 | 15 | | 5 | #5 | #6 | 11-#7 | 5 | #4 | #5 | 12-#5 |
| 3.02 | 15 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 5 | #5 | #5 | 12-#5 |
| 3.51 | 15 * | 4 S 6 1 | 5 | #7 | #7 | 10-#9 | 5 | #6 | #6 | 12-#5 |
| 4.23 | 15 * | 4 S 6 2 | 5 | #8 | #8 | 12-#9 | 5 | #6 | #7 | 13-#5 |
| 1.87 | 16 | | 5 | #4 | #5 | 11-#6 | 6 | #4 | #5 | 14-#5 |
| 2.08 | 16 | | 5 | #5 | #5 | 10-#7 | 6 | #4 | #5 | 14-#5 |
| 2.32 | 16 | 4 S 6 1 | 5 | #5 | #6 | 9-#8 | 6 | #4 | #5 | 14-#5 |
| 2.65 | 16 | 4 S 6 1 | 5 | #6 | #6 | 9-#9 | 6 | #4 | #5 | 14-#5 |
| 3.52 | 16 * | 4 S 6 1 | 5 | #7 | #8 | 11-#9 | 6 | #5 | #6 | 14-#5 |
| 4.17 | 16 * | 4 S 6 2 | 5 | #8 | #8 | 14-#9 | 6 | #6 | #6 | 15-#5 |
| 2.05 | 18 | | 5 | #5 | #5 | 14-#6 | 7 | #4 | #5 | 16-#5 |
| 2.32 | 18 | 4 S 6 1 | 5 | #5 | #6 | 10-#8 | 7 | #4 | #5 | 16-#5 |
| 2.58 | 18 | 4 S 6 1 | 5 | #6 | #6 | 12-#8 | 7 | #4 | #5 | 16-#5 |
| 3.14 | 18 * | 4 S 6 1 | 5 | #7 | #7 | 11-#9 | 7 | #5 | #5 | 16-#5 |
| 3.96 | 18 * | 4 S 6 2 | 5 | #8 | #8 | 15-#9 | 7 | #5 | #6 | 16-#5 |
| 2.23 | 19 | | 6 | #5 | #5 | 11-#8 | 7 | #4 | #5 | 16-#5 |
| 2.48 | 19 | | 6 | #5 | #6 | 13-#8 | 7 | #4 | #5 | 16-#5 |
| 3.06 | 19 * | 4 S 6 1 | 6 | #6 | #7 | 16-#8 | 7 | #5 | #5 | 16-#5 |
| 3.55 | 19 * | 4 S 6 1 | 6 | #7 | #7 | 15-#9 | 7 | #5 | #6 | 16-#5 |
| 4.81 | 21 * | 4 S 6 2 | 6 | #8 | #9 | 19-#9 | 7 | #6 | #7 | 20-#5 |
| 2.42 | 21 | | 6 | #5 | #6 | 13-#8 | 8 | #4 | #5 | 18-#5 |
| 2.89 | 21 | 4 S 6 1 | 6 | #6 | #7 | 13-#9 | 8 | #4 | #5 | 18-#5 |
| 3.39 | 21 * | 4 S 6 1 | 6 | #7 | #7 | 16-#9 | 8 | #5 | #5 | 18-#5 |
| 4.12 | 21 * | 4 S 6 2 | 6 | #8 | #8 | 19-#9 | 8 | #5 | #6 | 20-#5 |
| 5.04 | 27 * | 4 S 6 2 | 6 | #8 | #9 | 24-#9 | 8 | #6 | #6 | 18-#6 |
| 2.74 | 22 | 4 S 6 1 | 6 | #6 | #7 | 16-#8 | 9 | #4 | #5 | 20-#5 |
| 3.14 | 22 * | 4 S 6 1 | 6 | #7 | #7 | 16-#9 | 9 | #4 | #5 | 20-#5 |
| 3.89 | 22 * | 4 S 6 2 | 6 | #8 | #8 | 20-#9 | 9 | #5 | #5 | 21-#5 |
| 4.51 | 23 * | 4 S 6 2 | 6 | #8 | #9 | 23-#9 | 9 | #5 | #6 | 24-#5 |
| 2.95 | 24 | 4 S 6 1 | 7 | #6 | #7 | 16-#9 | 9 | #4 | #5 | 20-#5 |
| 3.68 | 24 * | 4 S 6 1 | 7 | #7 | #8 | 20-#9 | 9 | #5 | #5 | 21-#5 |
| 4.35 | 24 * | 4 S 6 2 | 7 | #8 | #8 | 24-#9 | 9 | #5 | #6 | 26-#5 |
| 5.11 | 30 * | 4 S 6 2 | 7 | #8 | #9 | 28-#9 | 9 | #6 | #6 | 21-#6 |
| 3.37 | 25 * | 4 S 6 1 | 7 | #7 | #7 | 19-#9 | 10 | #5 | #5 | 22-#5 |
| 4.16 | 25 * | 4 S 6 2 | 7 | #8 | #8 | 24-#9 | 10 | #5 | #6 | 25-#5 |
| 3.68 | 27 * | 4 S 6 2 | 7 | #7 | #8 | 23-#9 | 11 | #5 | #5 | 24-#5 |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 24 in. | Rib Depth = 20 in. | | Total Slab Depth = 4 in. | | | | | | | | | | | | | | |
| 33'-0" | 50 | 2.03 | 16 | 0.640 | | 10-#6+ 0 | 5 | #5 | #5 | 11-#6 | 6 | #5 | #5 | 14-#5 | 249 | 498 | 671 |
| D = 12.500 | 100 | 2.18 | 16 | 0.640 | | 10-#6+ 0 | 5 | #5 | #6 | 10-#7 | 6 | #5 | #5 | 14-#5 | 303 | 606 | 815 |
| RIB ON | 150 | 2.42 | 16 | 0.640 | | 10-#6+ 0 | 5 | #6 | #7 | 9-#8 | 6 | #5 | #5 | 14-#5 | 357 | 742 | 960 |
| COLUMN LINE | 200 | 2.67 | 16 | 0.640 | | 10-#6+ 1 | 5 | #7 | #7 | 10-#8 | 6 | #5 | #5 | 14-#5 | 410 | 927 | 1105 |
| 1.103 CF/SF | 300 | 3.28 | 16 * | 0.784 | | 11-#6+ 3 | 5 | #8 | #8 | 10-#9 | 6 | #6 | #6 | 14-#5 | 518 | 1274 | 1395 |
| | 400 | 4.18 | 16 * | 0.641 | | 10-#7+ 1 | 5 | #9 | #10 | 16-#8 | 6 | #7 | #7 | 14-#5 | 626 | 1609 | 1684 |
| | 500 | 4.90 | 16 * | 0.641 | 5 S 8 1 | 9-#8+ 2 | 5 | #10 | #10 | 15-#9 | 6 | #7 | #8 | 16-#5 | 733 | 1940 | 1974 |
| 36'-0" | 50 | 2.24 | 18 | 0.638 | | 11-#6+ 0 | 5 | #6 | #6 | 14-#6 | 7 | #5 | #5 | 16-#5 | 320 | 640 | 861 |
| D = 12.500 | 100 | 2.46 | 18 | 0.638 | | 11-#6+ 0 | 5 | #6 | #7 | 10-#8 | 7 | #5 | #5 | 16-#5 | 390 | 779 | 1049 |
| RIB ON | 150 | 2.72 | 18 | 0.638 | | 11-#6+ 0 | 5 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 16-#5 | 459 | 930 | 1236 |
| COLUMN LINE | 200 | 3.11 | 18 | 0.686 | | 12-#6+ 1 | 5 | #8 | #8 | 11-#9 | 7 | #5 | #6 | 16-#5 | 529 | 1171 | 1424 |
| 1.081 CF/SF | 300 | 4.03 | 18 * | 0.865 | | 11-#7+ 3 | 5 | #9 | #10 | 14-#9 | 7 | #6 | #7 | 16-#5 | 668 | 1618 | 1799 |
| 39'-0" | 50 | 2.34 | 19 | 0.637 | | 12-#6+ 1 | 6 | #6 | #6 | 11-#8 | 7 | #5 | #5 | 16-#5 | 414 | 827 | 1114 |
| D = 15.500 | 100 | 2.57 | 19 | 0.637 | | 12-#6+ 2 | 6 | #6 | #7 | 13-#8 | 7 | #5 | #5 | 16-#5 | 502 | 1005 | 1353 |
| RIB NOT ON | 150 | 2.99 | 19 | 0.727 | | 13-#6+ 3 | 6 | #7 | #8 | 12-#9 | 7 | #5 | #6 | 16-#5 | 591 | 1184 | 1592 |
| COLUMN LINE | 200 | 3.36 | 19 * | 0.841 | | 11-#7+ 5 | 6 | #8 | #8 | 14-#9 | 7 | #6 | #6 | 16-#5 | 680 | 1494 | 1831 |
| 1.119 CF/SF | 300 | 4.63 | 19 * | 0.638 | | 14-#7+ 4 | 6 | #9 | #10 | 18-#9 | 7 | #7 | #8 | 19-#5 | 857 | 2064 | 2308 |
| 42'-0" | 50 | 2.53 | 21 | 0.635 | | 13-#6+ 1 | 6 | #6 | #7 | 13-#8 | 8 | #5 | #5 | 18-#5 | 511 | 1022 | 1376 |
| D = 15.500 | 100 | 2.96 | 21 | 0.671 | | 14-#6+ 2 | 6 | #7 | #8 | 16-#8 | 8 | #5 | #6 | 18-#5 | 622 | 1243 | 1674 |
| RIB NOT ON | 150 | 3.28 | 21 * | 0.819 | | 12-#7+ 5 | 6 | #8 | #8 | 15-#9 | 8 | #5 | #6 | 18-#5 | 732 | 1465 | 1972 |
| COLUMN LINE | 200 | 3.92 | 21 * | 0.880 | | 14-#7+ 5 | 6 | #9 | #9 | 17-#9 | 8 | #6 | #7 | 18-#5 | 843 | 1792 | 2269 |
| 1.098 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 2.81 | 22 | 0.634 | | 14-#6+ 2 | 6 | #7 | #8 | 16-#8 | 9 | #5 | #5 | 20-#5 | 626 | 1252 | 1686 |
| D = 15.500 | 100 | 3.25 | 22 * | 0.792 | | 12-#7+ 5 | 6 | #8 | #8 | 16-#9 | 9 | #5 | #6 | 20-#5 | 762 | 1525 | 2052 |
| RIB NOT ON | 150 | 3.81 | 22 * | 0.884 | | 11-#8+ 6 | 6 | #9 | #9 | 19-#9 | 9 | #6 | #6 | 20-#5 | 899 | 1797 | 2419 |
| COLUMN LINE | 200 | 4.38 | 22 * | 0.635 | | 13-#8+ 2 | 6 | #9 | #10 | 22-#9 | 9 | #6 | #7 | 23-#5 | 1035 | 2150 | 2786 |
| 1.081 CF/SF | | | | | | | | | | | | | | | | | |
| 48'-0" | 50 | 3.08 | 24 | 0.744 | | 17-#6+ 7 | 7 | #7 | #8 | 16-#9 | 9 | #5 | #6 | 20-#5 | 767 | 1534 | 2065 |
| D = 18.500 | 100 | 3.64 | 24 * | 0.846 | | 15-#7+ 7 | 7 | #8 | #9 | 19-#9 | 9 | #6 | #6 | 20-#5 | 932 | 1864 | 2510 |
| RIB ON | 150 | 4.24 | 24 * | 0.634 | | 14-#8+ 4 | 7 | #9 | #9 | 23-#9 | 9 | #6 | #7 | 24-#5 | 1097 | 2194 | 2954 |
| COLUMN LINE | 200 | 4.94 | 27 * | 0.631 | | 16-#8+ 3 | 7 | #9 | #10 | 27-#9 | 9 | #7 | #7 | 20-#6 | 1255 | 2510 | 3379 |
| 1.112 CF/SF | | | | | | | | | | | | | | | | | |
| 51'-0" | 50 | 3.45 | 25 * | 0.800 | | 15-#7+ 6 | 7 | #8 | #9 | 19-#9 | 10 | #5 | #6 | 22-#5 | 916 | 1832 | 2466 |
| D = 18.500 | 100 | 4.07 | 25 * | 0.899 | | 14-#8+ 8 | 7 | #9 | #9 | 23-#9 | 10 | #6 | #7 | 25-#5 | 1114 | 2228 | 3000 |
| RIB ON | 150 | 4.85 | 27 * | 0.631 | | 13-#9+ 4 | 7 | #10 | #10 | 28-#9 | 10 | #7 | #7 | 29-#5 | 1308 | 2616 | 3521 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.095 CF/SF | | | | | | | | | | | | | | | | | |
| 54'-0" | 50 | 3.82 | 27 * | 0.842 | | 14-#8+ 6 | 7 | #9 | #9 | 23-#9 | 11 | #6 | #6 | 24-#5 | 1080 | 2159 | 2907 |
| D = 18.500 | 100 | 4.58 | 27 * | 0.631 | | 13-#9+ 4 | 7 | #10 | #10 | 28-#9 | 11 | #6 | #7 | 29-#5 | 1315 | 2629 | 3539 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.081 CF/SF | | | | | | | | | | | | | | | | | |
| 57'-0" | 50 | 4.19 | 28 * | 0.891 | | 16-#8+10 | 8 | #9 | #9 | 27-#9 | 11 | #6 | #7 | 28-#5 | 1284 | 2568 | 3457 |
| D =21.500 | 100 | 5.18 | 32 * | 0.628 | | 16-#9+ 5 | 8 | #10 | #10 | 33-#9 | 11 | #7 | #7 | 24-#6 | 1551 | 3102 | 4175 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.107 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 24 in. | Rib Depth = 20 in. | | Total Slab Depth = 4 in. | | | | | | | |
| 2.03 | 16 | | 5 | #5 | #5 | 10-#6 | 6 | #5 | #5 | 14-#5 |
| 2.16 | 16 | | 5 | #5 | #5 | 9-#7 | 6 | #5 | #5 | 14-#5 |
| 2.30 | 16 | | 5 | #5 | #5 | 11-#7 | 6 | #5 | #5 | 14-#5 |
| 2.63 | 16 | | 5 | #6 | #6 | 10-#8 | 6 | #5 | #5 | 14-#5 |
| 3.06 | 16 | 5 S 8 1 | 5 | #7 | #7 | 12-#8 | 6 | #5 | #5 | 14-#5 |
| 3.61 | 16 * | 5 S 8 1 | 5 | #7 | #8 | 12-#9 | 6 | #5 | #6 | 14-#5 |
| 4.35 | 16 * | 5 S 8 2 | 5 | #8 | #9 | 14-#9 | 6 | #6 | #6 | 15-#5 |
| 2.18 | 18 | | 5 | #5 | #5 | 10-#7 | 7 | #5 | #5 | 16-#5 |
| 2.41 | 18 | | 5 | #5 | #6 | 9-#8 | 7 | #5 | #5 | 16-#5 |
| 2.71 | 18 | 5 S 8 1 | 5 | #6 | #6 | 9-#9 | 7 | #5 | #5 | 16-#5 |
| 2.90 | 18 | 5 S 8 1 | 5 | #6 | #7 | 10-#9 | 7 | #5 | #5 | 16-#5 |
| 3.55 | 18* | 5 S 8 2 | 5 | #7 | #8 | 16-#8 | 7 | #5 | #6 | 16-#5 |
| 2.28 | 19 | | 6 | #5 | #5 | 13-#7 | 7 | #5 | #5 | 16-#5 |
| 2.53 | 19 | | 6 | #5 | #6 | 12-#8 | 7 | #5 | #5 | 16-#5 |
| 2.81 | 19 | | 6 | #6 | #6 | 11-#9 | 7 | #5 | #5 | 16-#5 |
| 3.06 | 19 | 5 S 8 1 | 6 | #6 | #7 | 16-#8 | 7 | #5 | #5 | 16-#5 |
| 4.11 | 19 * | 5 S 8 1 | 6 | #8 | #8 | 16-#9 | 7 | #6 | #6 | 17-#5 |
| 2.48 | 21 | | 6 | #5 | #6 | 12-#8 | 8 | #5 | #5 | 18-#5 |
| 2.81 | 21 | | 6 | #6 | #6 | 12-#9 | 8 | #5 | #5 | 18-#5 |
| 3.10 | 21 | 5 S 8 1 | 6 | #6 | #7 | 14-#9 | 8 | #5 | #5 | 18-#5 |
| 3.53 | 21 * | 5 S 8 1 | 6 | #7 | #8 | 16-#9 | 8 | #5 | #5 | 18-#5 |
| 2.74 | 22 | | 6 | #6 | #6 | 12-#9 | 9 | #5 | #5 | 20-#5 |
| 3.12 | 22 | 5 S 8 1 | 6 | #7 | #7 | 14-#9 | 9 | #5 | #5 | 20-#5 |
| 3.52 | 22 * | 5 S 8 1 | 6 | #7 | #8 | 17-#9 | 9 | #5 | #5 | 20-#5 |
| 4.02 | 22 * | 5 S 8 2 | 6 | #8 | #8 | 20-#9 | 9 | #5 | #6 | 21-#5 |
| 2.95 | 24 | | 7 | #6 | #7 | 18-#8 | 9 | #5 | #5 | 20-#5 |
| 3.37 | 24 * | 5 S 8 1 | 7 | #7 | #7 | 18-#9 | 9 | #5 | #5 | 20-#5 |
| 3.92 | 24 * | 5 S 8 1 | 7 | #7 | #8 | 21-#9 | 9 | #5 | #6 | 22-#5 |
| 4.62 | 24 * | 5 S 8 2 | 7 | #8 | #8 | 25-#9 | 9 | #6 | #6 | 26-#5 |
| 3.28 | 25 | 5 S 8 1 | 7 | #7 | #7 | 18-#9 | 10 | #5 | #5 | 22-#5 |
| 3.72 | 25 * | 5 S 8 1 | 7 | #7 | #8 | 22-#9 | 10 | #5 | #5 | 23-#5 |
| 4.34 | 25 * | 5 S 8 2 | 7 | #8 | #8 | 26-#9 | 10 | #5 | #6 | 27-#5 |
| 3.54 | 27 | 5 S 8 1 | 7 | #7 | #8 | 21-#9 | 11 | #5 | #5 | 24-#5 |
| 4.18 | 27 * | 5 S 8 2 | 7 | #8 | #8 | 26-#9 | 11 | #5 | #6 | 27-#5 |
| 3.90 | 28 * | 5 S 8 1 | 8 | #7 | #8 | 25-#9 | 11 | #5 | #6 | 26-#5 |
| 4.86 | 28 * | 5 S 8 2 | 8 | #8 | #9 | 31-#9 | 11 | #6 | #6 | 32-#5 |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 12 ½ in. | Rib Depth = 8 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | | | | Total Depth = 12 ½ in. | Rib Depth = 8 in. | Total Slab Depth = 4 ½ in. | | | | | | | | |
| 18'-0" | 50 | 1.60 | 12 | 0.632 | | 5-#6+ 0 | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 | 27 | 54 | 73 | 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| D = 6.500 | 100 | 1.60 | 12 | 0.632 | | 5-#6+ 0 | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 | 36 | 73 | 96 | 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| RIB ON | 150 | 1.66 | 12 | 0.632 | | 5-#6+ 0 | 3 | #4 | #5 | 5-#6 | 3 | #4 | #4 | 8-#5 | 44 | 102 | 118 | 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| COLUMN LINE | 200 | 1.72 | 12 | 0.639 | | 5-#6+ 0 | 3 | #5 | #5 | 5-#6 | 3 | #4 | #4 | 8-#5 | 52 | 128 | 141 | 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| 0.648 CF/SF | 300 | 2.00 | 12 | 0.726 | | 5-#6+ 0 | 3 | #6 | #6 | 6-#6 | 3 | #4 | #5 | 8-#5 | 69 | 180 | 187 | 1.78 | 12 | 3 S 4 1 | 3 | #4 | #5 | 8-#5 | 3 | #4 | #4 | 8-#5 |
| | 400 | 2.50 | 12 * | 0.843 | | 5-#6+ 1 | 3 | #6 | #7 | 6-#7 | 3 | #5 | #6 | 8-#5 | 86 | 232 | 232 | 2.25 | 12 * | 3 S 4 1 | 3 | #5 | #6 | 5-#7 | 3 | #4 | #5 | 8-#5 |
| | 500 | 3.02 | 12 * | 0.633 | 3 S 4 1 | 5-#6+ 1 | 3 | #7 | #8 | 5-#8 | 3 | #6 | #6 | 8-#5 | 103 | 282 | 278 | 2.71 | 12 * | 3 S 4 1 | 3 | #6 | #6 | 5-#8 | 3 | #5 | #5 | 8-#5 |
| 21'-0" | 50 | 1.56 | 12 | 0.653 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 45 | 89 | 120 | 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| D = 9.500 | 100 | 1.56 | 12 | 0.699 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 58 | 121 | 157 | 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| RIB NOT ON | 150 | 1.73 | 12 | 0.771 | | 9-#5+ 1 | 4 | #5 | #5 | 9-#5 | 3 | #4 | #5 | 8-#5 | 72 | 167 | 194 | 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| COLUMN LINE | 200 | 1.98 | 12 | 0.829 | | 9-#5+ 2 | 4 | #5 | #6 | 8-#6 | 3 | #5 | #5 | 8-#5 | 86 | 210 | 230 | 1.76 | 12 | | 4 | #4 | #5 | 7-#6 | 3 | #4 | #4 | 8-#5 |
| 0.680 CF/SF | 300 | 2.58 | 12 * | 0.633 | | 9-#5+ 2 | 4 | #6 | #7 | 8-#7 | 3 | #6 | #6 | 8-#5 | 113 | 295 | 304 | 2.26 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 7-#7 | 3 | #5 | #5 | 8-#5 |
| | 400 | 3.25 | 14 * | 0.630 | | 9-#5+ 2 | 4 | #7 | #8 | 7-#8 | 3 | #7 | #7 | 8-#5 | 139 | 374 | 374 | 2.85 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 3 | #5 | #6 | 8-#5 |
| | 500 | 3.71 | 17 * | 0.627 | | 10-#5+ 3 | 4 | #8 | #8 | 7-#9 | 3 | #7 | #8 | 8-#5 | 162 | 430 | 436 | 3.26 | 15 * | 3 S 4 1 | 4 | #6 | #7 | 8-#8 | 3 | #6 | #6 | 8-#5 |
| 24'-0" | 50 | 1.63 | 12 | 0.727 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 | 67 | 133 | 179 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| D = 9.500 | 100 | 1.70 | 12 | 0.801 | | 10-#5+ 1 | 4 | #5 | #5 | 8-#6 | 4 | #4 | #4 | 10-#5 | 87 | 181 | 235 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| RIB NOT ON | 150 | 2.14 | 12 * | 0.874 | | 10-#5+ 3 | 4 | #6 | #6 | 7-#7 | 4 | #5 | #5 | 10-#5 | 108 | 250 | 290 | 1.94 | 12 | 3 S 4 1 | 4 | #5 | #5 | 9-#6 | 4 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 2.50 | 12 * | 0.633 | | 10-#5+ 2 | 4 | #6 | #7 | 7-#8 | 4 | #5 | #6 | 10-#5 | 129 | 315 | 346 | 2.26 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 8-#7 | 4 | #4 | #5 | 10-#5 |
| 0.661 CF/SF | 300 | 3.30 | 16 * | 0.628 | | 8-#6+ 2 | 4 | #8 | #8 | 7-#9 | 4 | #6 | #7 | 10-#5 | 167 | 436 | 450 | 2.87 | 12 * | 3 S 4 1 | 4 | #6 | #7 | 8-#8 | 4 | #5 | #5 | 10-#5 |
| | 400 | 3.89 | 20 * | 0.624 | | 9-#6+ 2 | 4 | #8 | #9 | 9-#9 | 4 | #7 | #7 | 10-#5 | 200 | 489 | 539 | 3.41 | 18 * | 3 S 4 2 | 4 | #7 | #7 | 8-#9 | 4 | #5 | #6 | 10-#5 |
| 27'-0" | 50 | 1.70 | 13 | 0.770 | | 8-#6+ 0 | 4 | #5 | #5 | 12-#5 | 5 | #4 | #4 | 12-#5 | 94 | 189 | 254 | 1.64 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 12-#5 |
| D = 9.500 | 100 | 2.12 | 13 * | 0.866 | | 8-#6+ 2 | 4 | #6 | #6 | 7-#8 | 5 | #4 | #5 | 12-#5 | 124 | 249 | 334 | 1.98 | 13 | 3 S 4 1 | 4 | #5 | #5 | 8-#7 | 5 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.51 | 13 * | 0.631 | | 8-#6+ 1 | 4 | #7 | #7 | 8-#8 | 5 | #5 | #5 | 12-#5 | 153 | 349 | 413 | 2.29 | 13 * | 3 S 4 1 | 4 | #5 | #6 | 8-#8 | 5 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 3.05 | 16 * | 0.628 | | 8-#6+ 2 | 4 | #8 | #8 | 8-#9 | 5 | #5 | #6 | 12-#5 | 181 | 436 | 488 | 2.77 | 13 * | 3 S 4 1 | 4 | #6 | #7 | 7-#9 | 5 | #4 | #5 | 12-#5 |
| 0.648 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 30'-0" | 50 | 1.95 | 15 * | 0.839 | | 9-#6+ 3 | 5 | #5 | #6 | 9-#7 | 5 | #4 | #5 | 12-#5 | 131 | 262 | 352 | 1.81 | 15 | | 5 | #4 | #5 | 11-#6 | 5 | #4 | #4 | 12-#5 |
| D = 12.500 | 100 | 2.29 | 15 * | 0.910 | | 9-#6+ 5 | 5 | #6 | #6 | 9-#8 | 5 | #5 | #5 | 12-#5 | 171 | 342 | 461 | 2.13 | 15 * | 3 S 4 1 | 5 | #5 | #5 | 11-#7 | 5 | #4 | #4 | 12-#5 |
| RIB ON | 150 | 3.04 | 18 * | 0.626 | | 10-#6+ 3 | 5 | #7 | #7 | 9-#9 | 5 | #6 | #6 | 12-#5 | 209 | 457 | 564 | 2.88 | 15 * | 3 S 4 1 | 5 | #6 | #6 | 9-#9 | 5 | #5 | #5 | 12-#5 |
| COLUMN LINE | 200 | 3.49 | 23 * | 0.622 | | 11-#6+ 3 | 5 | #8 | #8 | 11-#9 | 5 | #6 | #7 | 12-#5 | 244 | 534 | 658 | 3.12 | 17 * | 3 S 4 1 | 5 | #6 | #7 | 10-#9 | 5 | #5 | #5 | 12-#5 |
| 0.670 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 33'-0" | 50 | 2.16 | 16 * | 0.876 | | 10-#6+ 4 | 5 | #6 | #6 | 9-#8 | 6 | #4 | #5 | 14-#5 | 173 | 347 | 466 | 2.06 | 16 | 3 S 4 1 | 5 | #5 | #5 | 11-#7 | 6 | #4 | #4 | 14-#5 |
| D = 12.500 | 100 | 2.80 | 18 * | 0.920 | | 10-#6+ 7 | 5 | #7 | #7 | 12-#8 | 6 | #5 | #6 | 14-#5 | 226 | 452 | 608 | 2.65 | 16 * | 3 S 4 1 | 5 | #6 | #6 | 9-#9 | 6 | #4 | #5 | 14-#5 |
| RIB ON | 150 | 3.40 | 26 * | 0.620 | 3 S 4 1 | 9-#7+ 4 | 5 | #8 | #8 | 12-#9 | 6 | #6 | #6 | 14-#5 | 272 | 544 | 732 | 3.14 | 18 * | 3 S 4 2 | 5 | #6 | #7 | 11-#9 | 6 | #5 | #5 | 14-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.658 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 ½ in. | | Rib Depth = 10 in. | | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | |
| 21'-0" | 50 | 1.56 | 12 | 0.635 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 48 | 96 | 129 |
| D = 9.500 | 100 | 1.56 | 12 | 0.635 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 62 | 127 | 166 |
| RIB NOT ON | 150 | 1.63 | 12 | 0.649 | | 9-#5+ 0 | 4 | #4 | #5 | 9-#5 | 3 | #4 | #4 | 8-#5 | 75 | 174 | 203 |
| COLUMN LINE | 200 | 1.75 | 12 | 0.693 | | 9-#5+ 0 | 4 | #5 | #5 | 7-#6 | 3 | #4 | #5 | 8-#5 | 89 | 217 | 239 |
| 0.762 CF/SF | 300 | 2.26 | 12 | 0.801 | | 9-#5+ 1 | 4 | #6 | #6 | 9-#6 | 3 | #5 | #6 | 8-#5 | 116 | 302 | 313 |
| | 400 | 2.80 | 12 * | 0.636 | | 9-#5+ 1 | 4 | #7 | #7 | 8-#7 | 3 | #6 | #7 | 8-#5 | 144 | 386 | 386 |
| | 500 | 3.28 | 12 * | 0.636 | | 9-#5+ 2 | 4 | #7 | #8 | 8-#8 | 3 | #7 | #7 | 8-#5 | 171 | 468 | 460 |
| 24'-0" | 50 | 1.57 | 12 | 0.646 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 | 72 | 143 | 193 |
| D = 9.500 | 100 | 1.63 | 12 | 0.697 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 | 92 | 189 | 248 |
| RIB NOT ON | 150 | 1.91 | 12 | 0.771 | | 10-#5+ 1 | 4 | #5 | #6 | 9-#6 | 4 | #4 | #5 | 10-#5 | 113 | 260 | 304 |
| COLUMN LINE | 200 | 2.17 | 12 * | 0.845 | | 10-#5+ 3 | 4 | #6 | #6 | 10-#6 | 4 | #5 | #5 | 10-#5 | 133 | 326 | 359 |
| 0.738 CF/SF | 300 | 2.96 | 12 * | 0.636 | | 10-#5+ 3 | 4 | #7 | #8 | 8-#8 | 4 | #6 | #6 | 10-#5 | 175 | 454 | 470 |
| | 400 | 3.53 | 15 * | 0.632 | | 8-#6+ 2 | 4 | #8 | #8 | 8-#9 | 4 | #6 | #7 | 10-#5 | 214 | 574 | 575 |
| | 500 | 4.18 | 18 * | 0.629 | | 7-#7+ 2 | 4 | #9 | #9 | 9-#9 | 4 | #7 | #7 | 10-#5 | 248 | 658 | 667 |
| 27'-0" | 50 | 1.69 | 13 | 0.696 | | 8-#6+ 0 | 4 | #5 | #5 | 8-#6 | 5 | #4 | #4 | 12-#5 | 101 | 203 | 273 |
| D = 9.500 | 100 | 1.86 | 13 | 0.755 | | 8-#6+ 0 | 4 | #5 | #6 | 7-#7 | 5 | #4 | #4 | 12-#5 | 131 | 263 | 352 |
| RIB NOT ON | 150 | 2.31 | 13 * | 0.851 | | 8-#6+ 2 | 4 | #6 | #7 | 7-#8 | 5 | #4 | #5 | 12-#5 | 160 | 364 | 432 |
| COLUMN LINE | 200 | 2.79 | 13 * | 0.915 | | 8-#6+ 4 | 4 | #7 | #8 | 11-#7 | 5 | #5 | #6 | 12-#5 | 190 | 458 | 511 |
| 0.722 CF/SF | 300 | 3.59 | 16 * | 0.631 | | 7-#7+ 2 | 4 | #8 | #9 | 9-#9 | 5 | #6 | #7 | 12-#5 | 246 | 634 | 663 |
| | 400 | 4.30 | 21 * | 0.626 | 3 S 4 1 | 8-#7+ 2 | 4 | #9 | #10 | 11-#9 | 5 | #7 | #7 | 12-#5 | 295 | 736 | 794 |
| 30'-0" | 50 | 1.73 | 15 | 0.765 | | 9-#6+ 2 | 5 | #5 | #5 | 11-#6 | 5 | #4 | #4 | 12-#5 | 141 | 281 | 379 |
| D = 12.500 | 100 | 2.10 | 15 * | 0.848 | | 9-#6+ 4 | 5 | #6 | #6 | 14-#6 | 5 | #4 | #5 | 12-#5 | 181 | 362 | 487 |
| RIB ON | 150 | 2.67 | 15 * | 0.909 | | 9-#6+ 6 | 5 | #7 | #7 | 10-#8 | 5 | #5 | #6 | 12-#5 | 221 | 488 | 596 |
| COLUMN LINE | 200 | 3.20 | 16 * | 0.631 | | 10-#6+ 3 | 5 | #7 | #8 | 9-#9 | 5 | #6 | #6 | 12-#5 | 261 | 614 | 702 |
| 0.749 CF/SF | 300 | 4.05 | 22 * | 0.625 | 3 S 4 1 | 10-#7+ 3 | 5 | #8 | #9 | 12-#9 | 5 | #7 | #7 | 13-#5 | 332 | 797 | 894 |
| 33'-0" | 50 | 2.11 | 16 * | 0.813 | | 10-#6+ 3 | 5 | #6 | #6 | 11-#7 | 6 | #4 | #5 | 14-#5 | 186 | 372 | 501 |
| D = 12.500 | 100 | 2.47 | 16 * | 0.889 | | 10-#6+ 5 | 5 | #6 | #7 | 9-#9 | 6 | #5 | #5 | 14-#5 | 240 | 480 | 646 |
| RIB ON | 150 | 2.99 | 18 * | 0.629 | | 11-#6+ 3 | 5 | #7 | #8 | 13-#8 | 6 | #5 | #6 | 14-#5 | 292 | 627 | 786 |
| COLUMN LINE | 200 | 3.77 | 22 * | 0.625 | 3 S 4 1 | 10-#7+ 3 | 5 | #8 | #9 | 16-#8 | 6 | #6 | #7 | 14-#5 | 342 | 786 | 920 |
| 0.734 CF/SF | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.33 | 18 * | 0.834 | | 11-#6+ 4 | 5 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 16-#5 | 240 | 479 | 645 |
| D = 12.500 | 100 | 2.88 | 18 * | 0.927 | | 12-#6+ 9 | 5 | #7 | #8 | 11-#9 | 7 | #5 | #5 | 16-#5 | 309 | 618 | 833 |
| RIB ON | 150 | 3.55 | 23 * | 0.624 | 3 S 4 1 | 11-#7+ 3 | 5 | #8 | #9 | 14-#9 | 7 | #6 | #6 | 16-#5 | 374 | 748 | 1007 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.722 CF/SF | | | | | | | | | | | | | | | | | |
| 39'-0" | 50 | 2.64 | 19 * | 0.890 | | 12-#6+ 8 | 6 | #7 | #7 | 11-#9 | 7 | #5 | #5 | 16-#5 | 309 | 617 | 831 |
| D = 15.500 | 100 | 3.43 | 23 * | 0.923 | | 11-#7+ 9 | 6 | #8 | #8 | 18-#8 | 7 | #6 | #6 | 16-#5 | 394 | 787 | 1060 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.742 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 14 ½ in. | | | Rib Depth = 10 in. | | | | Total Slab Depth = 4 ½ in. | | | |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 2.00 | 12 | | 4 | #5 | #5 | 8-#6 | 3 | #4 | #5 | 8-#5 |
| 2.40 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 10-#6 | 3 | #5 | #5 | 8-#5 |
| 2.85 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 3 | #5 | #6 | 8-#5 |
| 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| 1.76 | 12 | | 4 | #4 | #5 | 8-#6 | 4 | #4 | #4 | 10-#5 |
| 1.98 | 12 | 3 S 4 1 | 4 | #5 | #5 | 7-#7 | 4 | #4 | #4 | 10-#5 |
| 2.64 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 4 | #5 | #5 | 10-#5 |
| 3.26 | 12 * | 3 S 4 1 | 4 | #7 | #7 | 7-#9 | 4 | #5 | #6 | 10-#5 |
| 3.74 | 16 * | 3 S 4 2 | 4 | #7 | #8 | 8-#9 | 4 | #6 | #6 | 10-#5 |
| 1.64 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 12-#5 |
| 1.80 | 13 | | 4 | #4 | #5 | 9-#6 | 5 | #4 | #4 | 12-#5 |
| 2.21 | 13 | 3 S 4 1 | 4 | #5 | #6 | 7-#8 | 5 | #4 | #4 | 12-#5 |
| 2.50 | 13 * | 3 S 4 1 | 4 | #6 | #6 | 8-#8 | 5 | #4 | #5 | 12-#5 |
| 3.14 | 13 * | 3 S 4 2 | 4 | #7 | #7 | 8-#9 | 5 | #5 | #5 | 12-#5 |
| 3.73 | 18 * | 3 S 4 2 | 4 | #7 | #8 | 10-#9 | 5 | #5 | #6 | 12-#5 |
| 1.65 | 15 | | 5 | #4 | #4 | 10-#6 | 5 | #4 | #4 | 12-#5 |
| 1.95 | 15 | | 5 | #4 | #5 | 10-#7 | 5 | #4 | #4 | 12-#5 |
| 2.40 | 15 * | 3 S 4 1 | 5 | #5 | #6 | 9-#8 | 5 | #4 | #5 | 12-#5 |
| 3.02 | 15 * | 3 S 4 1 | 5 | #6 | #7 | 9-#9 | 5 | #5 | #5 | 12-#5 |
| 3.68 | 18 * | 3 S 4 2 | 5 | #7 | #7 | 11-#9 | 5 | #6 | #6 | 12-#5 |
| 1.98 | 16 | | 5 | #5 | #5 | 10-#7 | 6 | #4 | #4 | 14-#5 |
| 2.29 | 16 * | 3 S 4 1 | 5 | #5 | #6 | 10-#8 | 6 | #4 | #4 | 14-#5 |
| 2.79 | 16 * | 3 S 4 1 | 5 | #6 | #7 | 12-#8 | 6 | #4 | #5 | 14-#5 |
| 3.46 | 16 * | 3 S 4 2 | 5 | #7 | #7 | 12-#9 | 6 | #5 | #6 | 14-#5 |
| 2.22 | 18 | 3 S 4 1 | 5 | #5 | #6 | 10-#8 | 7 | #4 | #4 | 16-#5 |
| 2.75 | 18 * | 3 S 4 1 | 5 | #6 | #7 | 10-#9 | 7 | #4 | #5 | 16-#5 |
| 3.20 | 18 * | 3 S 4 2 | 5 | #7 | #7 | 13-#9 | 7 | #4 | #5 | 16-#5 |
| 2.48 | 19 * | 3 S 4 1 | 6 | #5 | #6 | 13-#8 | 7 | #4 | #5 | 16-#5 |
| 3.20 | 19 * | 3 S 4 1 | 6 | #6 | #7 | 14-#9 | 7 | #5 | #5 | 16-#5 |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 16 ½ in. | | Rib Depth = 12 in. | | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | |
| 24'-0" | 50 | 1.57 | 12 | 0.638 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 | 77 | 153 | 207 |
| D = 9.500 | 100 | 1.63 | 12 | 0.638 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 | 97 | 196 | 262 |
| RIB NOT ON | 150 | 1.74 | 12 | 0.657 | | 10-#5+ 0 | 4 | #5 | #5 | 8-#6 | 4 | #4 | #4 | 10-#5 | 118 | 268 | 318 |
| COLUMN LINE | 200 | 1.99 | 12 | 0.705 | | 10-#5+ 0 | 4 | #6 | #6 | 9-#6 | 4 | #4 | #5 | 10-#5 | 139 | 335 | 373 |
| 0.817 CF/SF | 300 | 2.57 | 12 * | 0.834 | | 10-#5+ 2 | 4 | #7 | #7 | 7-#8 | 4 | #5 | #6 | 10-#5 | 180 | 464 | 484 |
| | 400 | 3.25 | 12 * | 0.639 | | 10-#5+ 2 | 4 | #8 | #8 | 8-#8 | 4 | #6 | #7 | 10-#5 | 221 | 591 | 595 |
| | 500 | 3.74 | 13 * | 0.637 | | 12-#5+ 3 | 4 | #8 | #9 | 8-#9 | 4 | #7 | #7 | 10-#5 | 261 | 714 | 704 |
| 27'-0" | 50 | 1.64 | 13 | 0.636 | | 8-#6+ 0 | 4 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 12-#5 | 109 | 217 | 292 |
| D = 9.500 | 100 | 1.82 | 13 | 0.673 | | 8-#6+ 0 | 4 | #5 | #6 | 9-#6 | 5 | #4 | #4 | 12-#5 | 138 | 276 | 372 |
| RIB NOT ON | 150 | 2.09 | 13 | 0.758 | | 8-#6+ 1 | 4 | #6 | #6 | 8-#7 | 5 | #4 | #5 | 12-#5 | 168 | 376 | 451 |
| COLUMN LINE | 200 | 2.45 | 13 * | 0.826 | | 8-#6+ 2 | 4 | #7 | #7 | 7-#8 | 5 | #5 | #5 | 12-#5 | 197 | 472 | 530 |
| 0.798 CF/SF | 300 | 3.21 | 13 * | 0.637 | | 8-#6+ 2 | 4 | #8 | #8 | 8-#9 | 5 | #6 | #6 | 12-#5 | 256 | 656 | 689 |
| | 400 | 3.92 | 16 * | 0.633 | | 10-#6+ 1 | 4 | #9 | #9 | 12-#8 | 5 | #6 | #7 | 12-#5 | 312 | 829 | 840 |
| | 500 | 4.68 | 20 * | 0.629 | 4 S 6 1 | 12-#6+ 0 | 4 | #10 | #10 | 11-#9 | 5 | #7 | #7 | 12-#5 | 361 | 951 | 971 |
| 30'-0" | 50 | 1.70 | 15 | 0.674 | | 9-#6+ 1 | 5 | #5 | #5 | 10-#6 | 5 | #4 | #4 | 12-#5 | 151 | 302 | 406 |
| D = 12.500 | 100 | 2.00 | 15 | 0.776 | | 9-#6+ 3 | 5 | #5 | #6 | 10-#7 | 5 | #4 | #5 | 12-#5 | 191 | 382 | 515 |
| RIB ON | 150 | 2.47 | 15 * | 0.838 | | 9-#6+ 4 | 5 | #6 | #7 | 9-#8 | 5 | #5 | #5 | 12-#5 | 231 | 509 | 623 |
| COLUMN LINE | 200 | 2.94 | 15 * | 0.898 | | 9-#6+ 6 | 5 | #7 | #7 | 9-#9 | 5 | #6 | #6 | 12-#5 | 272 | 640 | 732 |
| 0.830 CF/SF | 300 | 3.83 | 17 * | 0.632 | | 12-#6+ 2 | 5 | #8 | #9 | 11-#9 | 5 | #7 | #7 | 12-#5 | 350 | 886 | 943 |
| | 400 | 4.56 | 22 * | 0.628 | 4 S 6 1 | 10-#7+ 3 | 5 | #9 | #10 | 13-#9 | 5 | #7 | #8 | 14-#5 | 419 | 1051 | 1128 |
| 33'-0" | 50 | 1.90 | 16 | 0.716 | | 10-#6+ 1 | 5 | #5 | #6 | 10-#7 | 6 | #4 | #4 | 14-#5 | 199 | 399 | 537 |
| D = 12.500 | 100 | 2.28 | 16 * | 0.827 | | 10-#6+ 4 | 5 | #6 | #7 | 10-#8 | 6 | #4 | #5 | 14-#5 | 253 | 506 | 682 |
| RIB ON | 150 | 2.87 | 16 * | 0.893 | | 10-#6+ 6 | 5 | #7 | #8 | 9-#9 | 6 | #5 | #6 | 14-#5 | 307 | 661 | 827 |
| COLUMN LINE | 200 | 3.36 | 17 * | 0.632 | | 12-#6+ 3 | 5 | #8 | #8 | 11-#9 | 6 | #6 | #6 | 14-#5 | 360 | 833 | 969 |
| 0.812 CF/SF | 300 | 4.45 | 23 * | 0.627 | 4 S 6 1 | 11-#7+ 3 | 5 | #9 | #10 | 18-#8 | 6 | #7 | #7 | 15-#5 | 456 | 1083 | 1227 |
| 36'-0" | 50 | 2.27 | 18 | 0.750 | | 11-#6+ 2 | 5 | #6 | #7 | 10-#8 | 7 | #4 | #5 | 16-#5 | 257 | 513 | 691 |
| D = 12.500 | 100 | 2.69 | 18 * | 0.852 | | 11-#6+ 5 | 5 | #7 | #8 | 10-#9 | 7 | #5 | #5 | 16-#5 | 326 | 652 | 878 |
| RIB ON | 150 | 3.19 | 18 * | 0.631 | | 10-#7+ 3 | 5 | #8 | #8 | 16-#8 | 7 | #5 | #6 | 16-#5 | 396 | 807 | 1066 |
| COLUMN LINE | 200 | 3.95 | 22 * | 0.628 | 4 S 6 1 | 22-#5+ 5 | 5 | #9 | #9 | 15-#9 | 7 | #6 | #7 | 16-#5 | 461 | 1021 | 1241 |
| 0.798 CF/SF | | | | | | | | | | | | | | | | | |
| 39'-0" | 50 | 2.46 | 19 * | 0.833 | | 12-#6+ 6 | 6 | #6 | #7 | 13-#8 | 7 | #5 | #5 | 16-#5 | 331 | 662 | 891 |
| D = 15.500 | 100 | 3.00 | 19 * | 0.913 | | 14-#6+ 8 | 6 | #7 | #8 | 13-#9 | 7 | #5 | #6 | 16-#5 | 420 | 839 | 1130 |
| RIB NOT ON | 150 | 3.80 | 23 * | 0.627 | | 17-#6+ 5 | 6 | #8 | #9 | 16-#9 | 7 | #6 | #7 | 17-#5 | 504 | 1007 | 1356 |
| COLUMN LINE | 200 | 4.34 | 28 * | 0.623 | | 11-#8+ 3 | 6 | #9 | #9 | 19-#9 | 7 | #6 | #7 | 20-#5 | 581 | 1161 | 1563 |
| 0.822 CF/SF | | | | | | | | | | | | | | | | | |
| 42'-0" | 50 | 2.82 | 21 * | 0.856 | | 14-#6+ 7 | 6 | #7 | #8 | 16-#8 | 8 | #5 | #5 | 18-#5 | 409 | 819 | 1102 |
| D = 15.500 | 100 | 3.63 | 23 * | 0.919 | | 13-#7+ 8 | 6 | #8 | #9 | 17-#9 | 8 | #6 | #6 | 18-#5 | 518 | 1036 | 1394 |
| RIB NOT ON | 150 | 4.25 | 29 * | 0.623 | | 12-#8+ 2 | 6 | #9 | #9 | 20-#9 | 8 | #6 | #7 | 21-#5 | 620 | 1240 | 1669 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.809 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.23 | 22 * | 0.903 | | 17-#6+10 | 6 | #8 | #8 | 16-#9 | 9 | #5 | #6 | 20-#5 | 502 | 1004 | 1352 |
| D = 15.500 | 100 | 4.06 | 28 * | 0.623 | | 12-#8+ 2 | 6 | #9 | #10 | 21-#9 | 9 | #6 | #6 | 21-#5 | 631 | 1262 | 1698 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.798 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 16 ½ in. | | | | Rib Depth = 12 in. | | | | Total Slab Depth = 4 ½ in. | | | |
| 24'-0" | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| D = 9.500 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| RIB NOT ON | 1.71 | 12 | | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| COLUMN LINE | 1.79 | 12 | | 4 | #4 | #5 | 12-#5 | 4 | #4 | #4 | 10-#5 |
| 0.817 CF/SF | 2.26 | 12 | 4 S 6 1 | 4 | #5 | #6 | 8-#7 | 4 | #4 | #5 | 10-#5 |
| | 2.87 | 12 * | 4 S 6 1 | 4 | #6 | #7 | 8-#8 | 4 | #5 | #5 | 10-#5 |
| | 3.26 | 12 * | 4 S 6 1 | 4 | #7 | #7 | 7-#9 | 4 | #5 | #6 | 10-#5 |
| 27'-0" | 1.64 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 12-#5 |
| D = 9.500 | 1.74 | 13 | | 4 | #4 | #5 | 12-#5 | 5 | #4 | #4 | 12-#5 |
| RIB NOT ON | 1.98 | 13 | 4 S 6 1 | 4 | #5 | #5 | 8-#7 | 5 | #4 | #4 | 12-#5 |
| COLUMN LINE | 2.21 | 13 | 4 S 6 1 | 4 | #5 | #6 | 7-#8 | 5 | #4 | #4 | 12-#5 |
| 0.798 CF/SF | 2.91 | 13 * | 4 S 6 1 | 4 | #6 | #7 | 7-#9 | 5 | #5 | #5 | 12-#5 |
| | 3.60 | 13 * | 4 S 6 2 | 4 | #7 | #8 | 9-#9 | 5 | #5 | #6 | 12-#5 |
| | 4.22 | 17 * | 4 S 6 2 | 4 | #8 | #8 | 11-#9 | 5 | #6 | #6 | 12-#5 |
| 30'-0" | 1.61 | 15 | | 5 | #4 | #4 | 9-#6 | 5 | #4 | #4 | 12-#5 |
| D = 12.500 | 1.89 | 15 | | 5 | #4 | #5 | 9-#7 | 5 | #4 | #4 | 12-#5 |
| RIB ON | 2.33 | 15 | | 5 | #5 | #6 | 11-#7 | 5 | #4 | #5 | 12-#5 |
| COLUMN LINE | 2.71 | 15 * | 4 S 6 1 | 5 | #6 | #6 | 10-#8 | 5 | #5 | #5 | 12-#5 |
| 0.830 CF/SF | 3.36 | 15 * | 4 S 6 1 | 5 | #7 | #7 | 10-#9 | 5 | #5 | #6 | 12-#5 |
| | 3.97 | 19 * | 4 S 6 2 | 5 | #7 | #8 | 12-#9 | 5 | #6 | #6 | 13-#5 |
| 33'-0" | 1.84 | 16 | | 5 | #4 | #5 | 9-#7 | 6 | #4 | #4 | 14-#5 |
| D = 12.500 | 2.12 | 16 | 4 S 6 1 | 5 | #5 | #5 | 9-#8 | 6 | #4 | #4 | 14-#5 |
| RIB ON | 2.65 | 16 * | 4 S 6 1 | 5 | #6 | #6 | 9-#9 | 6 | #4 | #5 | 14-#5 |
| COLUMN LINE | 3.12 | 16 * | 4 S 6 1 | 5 | #7 | #7 | 10-#9 | 6 | #5 | #5 | 14-#5 |
| 0.812 CF/SF | 4.02 | 19 * | 4 S 6 2 | 5 | #7 | #8 | 14-#9 | 6 | #6 | #6 | 14-#5 |
| 36'-0" | 2.16 | 18 | | 5 | #5 | #6 | 9-#8 | 7 | #4 | #4 | 16-#5 |
| D = 12.500 | 2.46 | 18 | 4 S 6 1 | 5 | #6 | #6 | 9-#9 | 7 | #4 | #4 | 16-#5 |
| RIB ON | 2.96 | 18 * | 4 S 6 1 | 5 | #6 | #7 | 12-#9 | 7 | #4 | #5 | 16-#5 |
| COLUMN LINE | 3.58 | 18 * | 4 S 6 2 | 5 | #7 | #8 | 14-#9 | 7 | #5 | #5 | 16-#5 |
| 0.798 CF/SF | | | | | | | | | | | |
| 39'-0" | 2.30 | 19 | | 6 | #5 | #6 | 12-#8 | 7 | #4 | #4 | 16-#5 |
| D = 15.500 | 2.74 | 19 * | 4 S 6 1 | 6 | #6 | #6 | 12-#9 | 7 | #4 | #5 | 16-#5 |
| RIB NOT ON | 3.44 | 19 * | 4 S 6 1 | 6 | #7 | #7 | 15-#9 | 7 | #5 | #5 | 16-#5 |
| COLUMN LINE | 4.05 | 22 * | 4 S 6 2 | 6 | #7 | #8 | 18-#9 | 7 | #5 | #6 | 19-#5 |
| 0.822 CF/SF | | | | | | | | | | | |
| 42'-0" | 2.66 | 21 | 4 S 6 1 | 6 | #6 | #6 | 12-#9 | 8 | #4 | #5 | 18-#5 |
| D = 15.500 | 3.33 | 21 * | 4 S 6 1 | 6 | #7 | #7 | 15-#9 | 8 | #5 | #5 | 18-#5 |
| RIB NOT ON | 3.98 | 21 * | 4 S 6 2 | 6 | #7 | #8 | 19-#9 | 8 | #5 | #6 | 20-#5 |
| COLUMN LINE | | | | | | | | | | | |
| 0.809 CF/SF | | | | | | | | | | | |
| 45'-0" | 3.07 | 22 * | 4 S 6 1 | 6 | #7 | #7 | 15-#9 | 9 | #4 | #5 | 20-#5 |
| D = 15.500 | 3.68 | 22 * | 4 S 6 2 | 6 | #7 | #8 | 19-#9 | 9 | #5 | #5 | 20-#5 |
| RIB NOT ON | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | |
| 0.798 CF/SF | | | | | | | | | | | |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 ½ in. | Rib Depth = 14 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | | | | Total Depth = 18 ½ in. | Rib Depth = 14 in. | Total Slab Depth = 4 ½ in. | | | | | | | | |
| 24'-0" | 50 | 1.77 | 12 | 0.641 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 4 | #4 | #5 | 10-#5 | 82 | 164 | 221 | 1.80 | 12 | | 4 | #4 | #5 | 7-#6 | 4 | #4 | #5 | 10-#5 |
| D = 9.500 | 100 | 1.77 | 12 | 0.641 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 4 | #4 | #5 | 10-#5 | 103 | 205 | 276 | 1.80 | 12 | | 4 | #4 | #5 | 7-#6 | 4 | #4 | #5 | 10-#5 |
| RIB NOT ON | 150 | 1.83 | 12 | 0.641 | | 10-#5+ 0 | 4 | #5 | #5 | 7-#6 | 4 | #4 | #5 | 10-#5 | 123 | 276 | 332 | 1.80 | 12 | | 4 | #4 | #5 | 7-#6 | 4 | #4 | #5 | 10-#5 |
| COLUMN LINE | 200 | 1.93 | 12 | 0.641 | | 10-#5+ 0 | 4 | #5 | #6 | 8-#6 | 4 | #4 | #5 | 10-#5 | 144 | 344 | 388 | 1.85 | 12 | | 4 | #4 | #5 | 8-#6 | 4 | #4 | #5 | 10-#5 |
| 0.898 CF/SF | 300 | 2.43 | 12 | 0.700 | | 10-#5+ 0 | 4 | #6 | #7 | 8-#7 | 4 | #5 | #6 | 10-#5 | 185 | 474 | 499 | 2.19 | 12 | 4 S 6 1 | 4 | #5 | #6 | 7-#7 | 4 | #4 | #5 | 10-#5 |
| | 400 | 2.96 | 12 * | 0.840 | | 10-#5+ 3 | 4 | #7 | #8 | 8-#8 | 4 | #6 | #6 | 10-#5 | 226 | 601 | 610 | 2.64 | 12 | 4 S 6 1 | 4 | #6 | #6 | 7-#8 | 4 | #5 | #5 | 10-#5 |
| | 500 | 3.36 | 12 * | 0.642 | | 8-#6+ 2 | 4 | #8 | #8 | 7-#9 | 4 | #6 | #7 | 10-#5 | 268 | 727 | 721 | 2.97 | 12 * | 4 S 6 1 | 4 | #6 | #7 | 8-#8 | 4 | #5 | #6 | 10-#5 |
| 27'-0" | 50 | 1.79 | 13 | 0.639 | | 8-#6+ 0 | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 | 116 | 232 | 312 | 1.82 | 13 | | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 |
| D = 9.500 | 100 | 1.85 | 13 | 0.639 | | 8-#6+ 0 | 4 | #5 | #5 | 12-#5 | 5 | #4 | #5 | 12-#5 | 146 | 291 | 392 | 1.82 | 13 | | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 |
| RIB NOT ON | 150 | 2.09 | 13 | 0.640 | | 8-#6+ 0 | 4 | #6 | #6 | 10-#6 | 5 | #4 | #5 | 12-#5 | 175 | 388 | 471 | 2.02 | 13 | | 4 | #5 | #5 | 7-#7 | 5 | #4 | #5 | 12-#5 |
| COLUMN LINE | 200 | 2.37 | 13 | 0.727 | | 8-#6+ 1 | 4 | #6 | #7 | 7-#8 | 5 | #5 | #5 | 12-#5 | 204 | 485 | 550 | 2.19 | 13 | 4 S 6 1 | 4 | #5 | #6 | 8-#7 | 5 | #4 | #5 | 12-#5 |
| 0.876 CF/SF | 300 | 2.88 | 13 * | 0.853 | | 8-#6+ 3 | 4 | #7 | #8 | 7-#9 | 5 | #5 | #6 | 12-#5 | 263 | 671 | 709 | 2.64 | 13 | 4 S 6 1 | 4 | #6 | #7 | 8-#8 | 5 | #4 | #5 | 12-#5 |
| | 400 | 3.58 | 13 * | 0.640 | | 9-#6+ 2 | 4 | #8 | #9 | 9-#9 | 5 | #6 | #7 | 12-#5 | 322 | 852 | 868 | 3.14 | 13 * | 4 S 6 1 | 4 | #7 | #7 | 8-#9 | 5 | #5 | #5 | 12-#5 |
| | 500 | 4.28 | 15 * | 0.637 | | 8-#7+ 2 | 4 | #9 | #10 | 10-#9 | 5 | #7 | #7 | 12-#5 | 379 | 1025 | 1020 | 3.77 | 13 * | 4 S 6 2 | 4 | #8 | #8 | 12-#8 | 5 | #5 | #6 | 12-#5 |
| 30'-0" | 50 | 1.83 | 15 | 0.636 | | 9-#6+ 0 | 5 | #5 | #5 | 9-#6 | 5 | #4 | #5 | 12-#5 | 161 | 323 | 434 | 1.79 | 15 | | 5 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 12-#5 |
| D = 12.500 | 100 | 2.00 | 15 | 0.636 | | 9-#6+ 0 | 5 | #5 | #6 | 9-#7 | 5 | #4 | #5 | 12-#5 | 202 | 403 | 543 | 1.90 | 15 | | 5 | #4 | #5 | 11-#6 | 5 | #4 | #5 | 12-#5 |
| RIB ON | 150 | 2.27 | 15 | 0.713 | | 9-#6+ 1 | 5 | #6 | #6 | 11-#7 | 5 | #5 | #5 | 12-#5 | 242 | 527 | 651 | 2.13 | 15 | | 5 | #5 | #5 | 10-#7 | 5 | #4 | #5 | 12-#5 |
| COLUMN LINE | 200 | 2.65 | 15 * | 0.789 | | 9-#6+ 2 | 5 | #7 | #7 | 9-#8 | 5 | #5 | #6 | 12-#5 | 282 | 661 | 760 | 2.40 | 15 | 4 S 6 1 | 5 | #5 | #6 | 9-#8 | 5 | #4 | #5 | 12-#5 |
| 0.913 CF/SF | 300 | 3.43 | 15 * | 0.637 | | 15-#5+ 4 | 5 | #8 | #8 | 12-#8 | 5 | #6 | #7 | 12-#5 | 363 | 914 | 977 | 3.13 | 15 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 5 | #5 | #6 | 12-#5 |
| | 400 | 4.31 | 17 * | 0.635 | 4 S 6 1 | 10-#7+ 3 | 5 | #9 | #9 | 12-#9 | 5 | #7 | #8 | 13-#5 | 441 | 1156 | 1187 | 3.82 | 15 * | 4 S 6 1 | 5 | #7 | #8 | 11-#9 | 5 | #6 | #6 | 12-#5 |
| | 500 | 4.96 | 22 * | 0.630 | 4 S 6 1 | 11-#7+ 3 | 5 | #9 | #10 | 14-#9 | 5 | #8 | #8 | 15-#5 | 507 | 1321 | 1365 | 4.44 | 19 * | 4 S 6 2 | 5 | #8 | #8 | 13-#9 | 5 | #6 | #7 | 14-#5 |
| 33'-0" | 50 | 1.99 | 16 | 0.650 | | 10-#6+ 1 | 5 | #5 | #6 | 9-#7 | 6 | #4 | #5 | 14-#5 | 213 | 426 | 574 | 1.94 | 16 | | 5 | #4 | #5 | 9-#7 | 6 | #4 | #5 | 14-#5 |
| D = 12.500 | 100 | 2.21 | 16 | 0.756 | | 10-#6+ 3 | 5 | #6 | #6 | 9-#8 | 6 | #4 | #5 | 14-#5 | 267 | 534 | 719 | 2.16 | 16 | | 5 | #5 | #5 | 11-#7 | 6 | #4 | #5 | 14-#5 |
| RIB ON | 150 | 2.59 | 16 * | 0.833 | | 10-#6+ 5 | 5 | #7 | #7 | 9-#9 | 6 | #5 | #5 | 14-#5 | 321 | 687 | 864 | 2.39 | 16 | 4 S 6 1 | 5 | #5 | #6 | 10-#8 | 6 | #4 | #5 | 14-#5 |
| COLUMN LINE | 200 | 3.21 | 16 * | 0.893 | | 11-#6+ 6 | 5 | #8 | #8 | 10-#9 | 6 | #6 | #6 | 14-#5 | 375 | 866 | 1008 | 2.91 | 16 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 6 | #5 | #5 | 14-#5 |
| 0.892 CF/SF | 300 | 4.06 | 18 * | 0.634 | 4 S 6 1 | 10-#7+ 3 | 5 | #9 | #9 | 13-#9 | 6 | #7 | #7 | 14-#5 | 480 | 1196 | 1291 | 3.61 | 16 * | 4 S 6 2 | 5 | #7 | #8 | 12-#9 | 6 | #5 | #6 | 14-#5 |
| | 400 | 5.02 | 24 * | 0.628 | 4 S 6 1 | 17-#6+ 3 | 5 | #10 | #10 | 16-#9 | 6 | #7 | #8 | 17-#5 | 571 | 1419 | 1537 | 4.54 | 20 * | 4 S 6 2 | 5 | #8 | #9 | 15-#9 | 6 | #6 | #6 | 16-#5 |
| 36'-0" | 50 | 2.23 | 18 | 0.665 | | 11-#6+ 1 | 5 | #6 | #7 | 9-#8 | 7 | #4 | #5 | 16-#5 | 274 | 548 | 738 | 2.11 | 18 | | 5 | #5 | #5 | 11-#7 | 7 | #4 | #5 | 16-#5 |
| D = 12.500 | 100 | 2.59 | 18 * | 0.788 | | 11-#6+ 4 | 5 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 16-#5 | 344 | 688 | 926 | 2.46 | 18 | 4 S 6 1 | 5 | #5 | #6 | 9-#9 | 7 | #4 | #5 | 16-#5 |
| RIB ON | 150 | 3.03 | 18 * | 0.871 | | 12-#6+ 6 | 5 | #8 | #8 | 11-#9 | 7 | #5 | #6 | 16-#5 | 413 | 848 | 1113 | 2.75 | 18 * | 4 S 6 1 | 5 | #6 | #7 | 10-#9 | 7 | #4 | #5 | 16-#5 |
| COLUMN LINE | 200 | 3.62 | 18 * | 0.634 | 4 S 6 1 | 14-#6+ 4 | 5 | #9 | #9 | 13-#9 | 7 | #6 | #6 | 16-#5 | 483 | 1080 | 1301 | 3.22 | 18 * | 4 S 6 2 | 5 | #7 | #7 | 12-#9 | 7 | #5 | #5 | 16-#5 |
| 0.876 CF/SF | 300 | 4.81 | 24 * | 0.628 | 4 S 6 1 | 10-#8+ 1 | 5 | #10 | #10 | 17-#9 | 7 | #7 | #7 | 18-#5 | 612 | 1463 | 1647 | 4.44 | 19 * | 4 S 6 2 | 5 | #8 | #9 | 16-#9 | 7 | #6 | #6 | 17-#5 |

(Continued on next page)

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments $-M$ Edge (ft-k) | Moments $+M$ Bot. (ft-k) | Moments $-M$ Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 ½ in. | | Rib Depth = 14 in. | | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | |
| 39'-0" | 50 | 2.45 | 19 | 0.777 | | 12-#6+ 5 | 6 | #6 | #7 | 12-#8 | 7 | #5 | #5 | 16-#5 | 354 | 708 | 953 |
| D = 15.500 | 100 | 2.92 | 19 * | 0.861 | | 13-#6+ 7 | 6 | #7 | #8 | 12-#9 | 7 | #5 | #6 | 16-#5 | 443 | 885 | 1191 |
| RIB NOT ON | 150 | 3.47 | 19 * | 0.633 | | 12-#7+ 4 | 6 | #8 | #8 | 15-#9 | 7 | #6 | #6 | 16-#5 | 531 | 1070 | 1430 |
| COLUMN LINE | 200 | 4.22 | 23 * | 0.629 | | 18-#6+ 5 | 6 | #9 | #9 | 17-#9 | 7 | #7 | #7 | 18-#5 | 614 | 1355 | 1654 |
| 0.904 CF/SF | 300 | 5.09 | 30 * | 0.624 | | 13-#8+ 4 | 6 | #9 | #10 | 22-#9 | 7 | #7 | #8 | 16-#6 | 767 | 1563 | 2064 |
| 42'-0" | 50 | 2.68 | 21 * | 0.790 | | 18-#5+ 8 | 6 | #7 | #7 | 12-#9 | 8 | #5 | #5 | 18-#5 | 438 | 875 | 1178 |
| D = 15.500 | 100 | 3.20 | 21 * | 0.904 | | 12-#7+ 8 | 6 | #8 | #8 | 15-#9 | 8 | #5 | #6 | 18-#5 | 548 | 1097 | 1476 |
| RIB NOT ON | 150 | 3.99 | 24 * | 0.628 | | 14-#7+ 4 | 6 | #9 | #9 | 18-#9 | 8 | #6 | #7 | 19-#5 | 655 | 1309 | 1762 |
| COLUMN LINE | 200 | 4.56 | 28 * | 0.626 | | 13-#8+ 4 | 6 | #9 | #10 | 22-#9 | 8 | #6 | #7 | 23-#5 | 756 | 1527 | 2036 |
| 0.888 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.10 | 22 * | 0.848 | | 12-#7+ 5 | 6 | #8 | #8 | 15-#9 | 9 | #5 | #6 | 20-#5 | 537 | 1073 | 1445 |
| D = 15.500 | 100 | 3.85 | 23 * | 0.629 | | 11-#8+ 3 | 6 | #9 | #9 | 19-#9 | 9 | #6 | #6 | 20-#5 | 671 | 1343 | 1808 |
| RIB NOT ON | 150 | 4.49 | 29 * | 0.625 | | 11-#9+ 2 | 6 | #9 | #10 | 23-#9 | 9 | #6 | #7 | 24-#5 | 798 | 1596 | 2148 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.876 CF/SF | | | | | | | | | | | | | | | | | |
| 48'-0" | 50 | 3.42 | 24 * | 0.885 | | 14-#7+ 8 | 7 | #8 | #8 | 18-#9 | 9 | #6 | #6 | 20-#5 | 656 | 1313 | 1767 |
| D = 18.500 | 100 | 4.27 | 28 * | 0.921 | | 14-#8+ 8 | 7 | #9 | #9 | 23-#9 | 9 | #6 | #7 | 24-#5 | 815 | 1630 | 2195 |
| RIB ON | 150 | 5.10 | 38 * | 0.621 | 4 S 6 1 | 16-#8+ 5 | 7 | #10 | #10 | 27-#9 | 9 | #7 | #7 | 20-#6 | 952 | 1903 | 2562 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.898 CF/SF | | | | | | | | | | | | | | | | | |
| 51'-0" | 50 | 3.85 | 26 * | 0.912 | | 13-#8+ 8 | 7 | #9 | #9 | 22-#9 | 10 | #6 | #6 | 23-#5 | 783 | 1566 | 2108 |
| D = 18.500 | 100 | 4.83 | 35 * | 0.622 | 4 S 6 1 | 16-#8+ 5 | 7 | #10 | #10 | 28-#9 | 10 | #7 | #7 | 29-#5 | 965 | 1931 | 2599 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.886 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 18 ½ in. | | | Rib Depth = 14 in. | | | | Total Slab Depth = 4 ½ in. | | | |
| 2.33 | 19 | | 6 | #5 | #6 | 11-#8 | 7 | #4 | #5 | 16-#5 |
| 2.67 | 19 * | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 7 | #4 | #5 | 16-#5 |
| 3.20 | 19 * | 4 S 6 1 | 6 | #6 | #7 | 14-#9 | 7 | #5 | #5 | 16-#5 |
| 3.80 | 19 * | 4 S 6 2 | 6 | #7 | #8 | 16-#9 | 7 | #5 | #6 | 17-#5 |
| 4.67 | 25 * | 4 S 6 2 | 6 | #8 | #8 | 20-#9 | 7 | #6 | #6 | 16-#6 |
| 2.59 | 21 | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 8 | #4 | #5 | 18-#5 |
| 2.96 | 21 * | 4 S 6 1 | 6 | #6 | #7 | 14-#9 | 8 | #4 | #5 | 18-#5 |
| 3.64 | 21 * | 4 S 6 2 | 6 | #7 | #8 | 17-#9 | 8 | #5 | #5 | 18-#5 |
| 4.21 | 22 * | 4 S 6 2 | 6 | #8 | #8 | 20-#9 | 8 | #5 | #6 | 21-#5 |
| 2.86 | 22 | 4 S 6 1 | 6 | #6 | #7 | 14-#9 | 9 | #4 | #5 | 20-#5 |
| 3.58 | 22 * | 4 S 6 2 | 6 | #7 | #8 | 18-#9 | 9 | #5 | #5 | 20-#5 |
| 4.14 | 22 * | 4 S 6 2 | 6 | #8 | #8 | 21-#9 | 9 | #5 | #6 | 22-#5 |
| 3.19 | 24 * | 4 S 6 1 | 7 | #6 | #7 | 17-#9 | 9 | #5 | #5 | 20-#5 |
| 4.00 | 24 * | 4 S 6 2 | 7 | #7 | #8 | 22-#9 | 9 | #5 | #6 | 23-#5 |
| 4.72 | 29 * | 4 S 6 2 | 7 | #8 | #8 | 26-#9 | 9 | #6 | #6 | 27-#5 |
| 3.55 | 25 * | 4 S 6 1 | 7 | #7 | #8 | 20-#9 | 10 | #5 | #5 | 22-#5 |
| 4.34 | 25 * | 4 S 6 2 | 7 | #8 | #8 | 26-#9 | 10 | #5 | #6 | 27-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 20 ½ in. | Rib Depth = 16 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | | | | Total Depth = 20 ½ in. | Rib Depth = 16 in. | Total Slab Depth = 4 ½ in. | | | | | | | | |
| 27'-0" | 50 | 1.79 | 13 | 0.641 | | 8-#6+ 0 | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 | 124 | 247 | 333 | 1.82 | 13 | | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 |
| D = 9.500 | 100 | 1.84 | 13 | 0.641 | | 8-#6+ 0 | 4 | #5 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 | 153 | 306 | 412 | 1.82 | 13 | | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 |
| RIB NOT ON | 150 | 1.97 | 13 | 0.641 | | 8-#6+ 0 | 4 | #5 | #6 | 7-#7 | 5 | #4 | #5 | 12-#5 | 183 | 398 | 492 | 1.89 | 13 | | 4 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 12-#5 |
| COLUMN LINE | 200 | 2.18 | 13 | 0.641 | | 8-#6+ 0 | 4 | #6 | #7 | 8-#7 | 5 | #4 | #5 | 12-#5 | 212 | 497 | 571 | 2.03 | 13 | | 4 | #5 | #5 | 10-#6 | 5 | #4 | #5 | 12-#5 |
| 0.956 CF/SF | 300 | 2.73 | 13 | 0.701 | | 8-#6+ 0 | 4 | #7 | #8 | 8-#8 | 5 | #5 | #6 | 12-#5 | 271 | 684 | 730 | 2.41 | 13 | 4 S 6 1 | 4 | #6 | #6 | 7-#8 | 5 | #4 | #5 | 12-#5 |
| | 400 | 3.38 | 13 * | 0.851 | | 12-#5+ 3 | 4 | #8 | #9 | 8-#9 | 5 | #6 | #6 | 12-#5 | 330 | 867 | 889 | 3.03 | 13 * | 4 S 6 1 | 4 | #7 | #7 | 7-#9 | 5 | #5 | #5 | 12-#5 |
| | 500 | 3.92 | 13 * | 0.642 | | 7-#7+ 1 | 4 | #9 | #9 | 9-#9 | 5 | #6 | #7 | 12-#5 | 389 | 1047 | 1047 | 3.60 | 13 * | 4 S 6 2 | 4 | #7 | #8 | 9-#9 | 5 | #5 | #6 | 12-#5 |
| 30'-0" | 50 | 1.77 | 15 | 0.638 | | 9-#6+ 0 | 5 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 12-#5 | 172 | 344 | 464 | 1.79 | 15 | | 5 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 12-#5 |
| D = 12 .500 | 100 | 1.88 | 15 | 0.638 | | 9-#6+ 0 | 5 | #5 | #5 | 11-#6 | 5 | #4 | #5 | 12-#5 | 213 | 425 | 572 | 1.83 | 15 | | 5 | #4 | #5 | 10-#6 | 5 | #4 | #5 | 12-#5 |
| RIB ON | 150 | 2.22 | 15 | 0.638 | | 9-#6+ 0 | 5 | #6 | #6 | 10-#7 | 5 | #5 | #5 | 12-#5 | 253 | 543 | 681 | 2.07 | 15 | | 5 | #5 | #5 | 9-#7 | 5 | #4 | #5 | 12-#5 |
| COLUMN LINE | 200 | 2.54 | 15 | 0.687 | | 9-#6+ 1 | 5 | #6 | #7 | 9-#8 | 5 | #5 | #6 | 12-#5 | 293 | 679 | 789 | 2.33 | 15 | | 5 | #5 | #6 | 11-#7 | 5 | #4 | #5 | 12-#5 |
| 0.998 CF/SF | 300 | 3.19 | 15 * | 0.839 | | 10-#6+ 3 | 5 | #7 | #8 | 9-#9 | 5 | #6 | #7 | 12-#5 | 374 | 935 | 1006 | 2.85 | 15 * | 4 S 6 1 | 5 | #6 | #7 | 10-#8 | 5 | #5 | #5 | 12-#5 |
| | 400 | 3.91 | 15 * | 0.639 | | 12-#6+ 2 | 5 | #8 | #9 | 11-#9 | 5 | #7 | #7 | 12-#5 | 454 | 1185 | 1223 | 3.51 | 15 * | 4 S 6 1 | 5 | #7 | #7 | 10-#9 | 5 | #6 | #6 | 12-#5 |
| | 500 | 4.80 | 17 * | 0.637 | 4 S 6 1 | 10-#7+ 1 | 5 | #9 | #10 | 13-#9 | 5 | #8 | #8 | 14-#5 | 532 | 1423 | 1432 | 4.23 | 15 * | 4 S 6 2 | 5 | #8 | #8 | 12-#9 | 5 | #6 | #7 | 13-#5 |
| 33'-0" | 50 | 1.96 | 16 | 0.637 | | 10-# 6+ 0 | 5 | #5 | #6 | 9-#7 | 6 | #4 | #5 | 14-#5 | 227 | 455 | 612 | 1.87 | 16 | | 5 | #4 | #5 | 11-#6 | 6 | #4 | #5 | 14-#5 |
| D = 12.500 | 100 | 2.15 | 16 | 0.637 | | 10-#6+ 0 | 5 | #6 | #6 | 11-#7 | 6 | #4 | #5 | 14-#5 | 281 | 562 | 757 | 2.08 | 16 | | 5 | #5 | #5 | 10-#7 | 6 | #4 | #5 | 14-#5 |
| RIB ON | 150 | 2.45 | 16 | 0.699 | | 10-#6+ 1 | 5 | #6 | #7 | 10-#8 | 6 | #5 | #5 | 14-#5 | 335 | 710 | 902 | 2.32 | 16 | | 5 | #5 | #6 | 9-#8 | 6 | #4 | #5 | 14-#5 |
| COLUMN LINE | 200 | 2.87 | 16 * | 0.795 | | 10-#6+ 3 | 5 | #7 | #8 | 9-#9 | 6 | #5 | #6 | 14-#5 | 389 | 892 | 1047 | 2.65 | 16 | 4 S 6 1 | 5 | #6 | #6 | 9-#9 | 6 | #4 | #5 | 14-#5 |
| 0.974 CF/SF | 300 | 3.89 | 16 * | 0.638 | | 10-#7+ 1 | 5 | #9 | #9 | 12-#9 | 6 | #6 | #7 | 14-#5 | 496 | 1232 | 1336 | 3.52 | 16 * | 4 S 6 1 | 5 | #7 | #8 | 11-#9 | 6 | #5 | #6 | 14-#5 |
| | 400 | 4.80 | 19 * | 0.635 | 4 S 6 1 | 9-#8+ 1 | 5 | #10 | #10 | 15-#9 | 6 | #7 | #8 | 16-#5 | 599 | 1552 | 1613 | 4.17 | 16 * | 4 S 6 2 | 5 | #8 | #8 | 14-#9 | 6 | #6 | #6 | 15-#5 |
| 36'-0" | 50 | 2.16 | 18 | 0.635 | | 11-#6+ 1 | 5 | #6 | #6 | 9-#8 | 7 | #4 | #5 | 16-#5 | 292 | 585 | 787 | 2.11 | 18 | | 5 | #5 | #5 | 11-#7 | 7 | #4 | #5 | 16-#5 |
| D = 12.500 | 100 | 2.45 | 18 | 0.692 | | 11-#6+ 2 | 5 | #7 | #7 | 9-#9 | 7 | #4 | #5 | 16-#5 | 362 | 724 | 974 | 2.32 | 18 | 4 S 6 1 | 5 | #5 | #6 | 10-#8 | 7 | #4 | #5 | 16-#5 |
| RIB ON | 150 | 2.75 | 18 * | 0.800 | | 11-#6+ 5 | 5 | #7 | #8 | 10-#9 | 7 | #5 | #5 | 16-#5 | 432 | 883 | 1162 | 2.58 | 18 | 4 S 6 1 | 5 | #6 | #6 | 12-#8 | 7 | #4 | #5 | 16-#5 |
| COLUMN LINE | 200 | 3.45 | 18 * | 0.865 | | 10-#7+ 3 | 5 | #8 | #9 | 12-#9 | 7 | #6 | #6 | 16-#5 | 501 | 1120 | 1349 | 3.14 | 18 * | 4 S 6 1 | 5 | #7 | #7 | 11-#9 | 7 | #5 | #5 | 16-#5 |
| 0.956 CF/SF | 300 | 4.53 | 19 * | 0.635 | 4 S 6 1 | 9-#8+ 2 | 5 | #10 | #10 | 16-#9 | 7 | #7 | #7 | 17-#5 | 639 | 1553 | 1720 | 3.96 | 18 * | 4 S 6 2 | 5 | #8 | #8 | 15-#9 | 7 | #5 | #6 | 16-#5 |
| 39'-0" | 50 | 2.39 | 19 | 0.647 | | 12-#6+ 1 | 6 | #6 | #7 | 11-#8 | 7 | #5 | #5 | 16-#5 | 378 | 755 | 1016 | 2.23 | 19 | | 6 | #5 | #5 | 11-#8 | 7 | #4 | #5 | 16-#5 |
| D = 15.500 | 100 | 2.77 | 19 * | 0.773 | | 12-#6+ 4 | 6 | #7 | #7 | 11-#9 | 7 | #5 | #6 | 16-#5 | 466 | 932 | 1255 | 2.59 | 19 | | 6 | #6 | #6 | 13-#8 | 7 | #4 | #5 | 16-#5 |
| RIB NOT ON | 150 | 3.27 | 19 * | 0.878 | | 11-#7+ 5 | 6 | #7 | #8 | 14-#9 | 7 | #6 | #6 | 16-#5 | 555 | 1118 | 1494 | 3.06 | 19 * | 4 S 6 1 | 6 | #6 | #7 | 16-#8 | 7 | #5 | #5 | 16-#5 |
| COLUMN LINE | 200 | 3.86 | 19 * | 0.635 | | 17-#6+ 5 | 6 | #8 | #9 | 16-#9 | 7 | #6 | #7 | 17-#5 | 644 | 1423 | 1733 | 3.55 | 19 * | 4 S 6 1 | 6 | #7 | #7 | 15-#9 | 7 | #5 | #6 | 16-#5 |
| 0.987 CF/SF | 300 | 5.18 | 26 * | 0.629 | | 12-#8+ 2 | 6 | #10 | #10 | 20-#9 | 7 | #7 | #8 | 21-#5 | 806 | 1916 | 2170 | 4.80 | 20 * | 4 S 6 2 | 6 | #8 | #9 | 19-#9 | 7 | #6 | #7 | 20-#5 |
| | 400 | 5.58 | 32 * | 0.625 | 4 S 6 1 | 11-#9+ 3 | 6 | #10 | #10 | 24-#9 | 7 | #7 | #8 | 18-#6 | 949 | 1965 | 2555 | 5.22 | 28 * | 4 S 6 2 | 6 | #8 | #9 | 28-#8 | 7 | #6 | #7 | 17-#6 |

(Continued on next page)

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column | | | Reinforcing Bars—Each Direction | | | | | | | | | Moments | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Column Strip | | | | | Middle Strip | | | | | | |
| | | | | | | Top | Bottom | | | Top | Bottom | | | Top | | | |
| | | | $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Edge No.-size + | No. Ribs | Long Bars | Short Bars | Interior No.-size | No. Ribs | Long Bars | Short Bars | Interior No.-size | –M Edge (ft-k) | +M Bot. (ft-k) | –M Int. (ft-k) |
| Total Depth = 20 ½ in. | | | Rib Depth = 16 in. | | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | |
| 42'-0" | 50 | 2.63 | 21 | 0.738 | | 13-#6+ 5 | 6 | #7 | #7 | 11-#9 | 8 | #5 | #5 | 18-#5 | 467 | 934 | 1257 |
| D = 15.500 | 100 | 3.13 | 21 * | 0.837 | | 11-#7+ 5 | 6 | #8 | #8 | 14-#9 | 8 | #5 | #6 | 18-#5 | 577 | 1155 | 1555 |
| RIB NOT ON | 150 | 3.66 | 21 * | 0.633 | | 13-#7+ 4 | 6 | #8 | #9 | 17-#9 | 8 | #6 | #6 | 18-#5 | 688 | 1376 | 1852 |
| COLUMN LINE | 200 | 4.31 | 24 * | 0.630 | | 12-#8+ 2 | 6 | #9 | #10 | 20-#9 | 8 | #6 | #7 | 21-#5 | 793 | 1679 | 2136 |
| 0.970 CF/SF | 300 | 5.43 | 31 * | 0.626 | 4 S 6 1 | 12-#9+ 2 | 6 | #10 | #10 | 25-#9 | 8 | #7 | #8 | 19-#6 | 987 | 1996 | 2659 |
| 45'-0" | 50 | 2.93 | 22 * | 0.798 | | 11-#7+ 5 | 6 | #8 | #8 | 14-#9 | 9 | #5 | #5 | 20-#5 | 572 | 1144 | 1540 |
| D = 15.500 | 100 | 3.50 | 22 * | 0.899 | | 14-#7+ 8 | 6 | #8 | #9 | 18-#9 | 9 | #6 | #6 | 20-#5 | 708 | 1417 | 1907 |
| RIB NOT ON | 150 | 4.20 | 24 * | 0.630 | | 32-#5+ 7 | 6 | #9 | #10 | 21-#9 | 9 | #6 | #7 | 22-#5 | 841 | 1682 | 2265 |
| COLUMN LINE | 200 | 4.96 | 29 * | 0.627 | | 12-#9+ 2 | 6 | #10 | #10 | 25-#9 | 9 | #7 | #7 | 26-#5 | 967 | 1985 | 2604 |
| 0.956 CF/SF | | | | | | | | | | | | | | | | | |
| 48'-0" | 50 | 3.20 | 24 * | 0.847 | | 14-#7+ 7 | 7 | #8 | #8 | 17-#9 | 9 | #5 | #6 | 20-#5 | 700 | 1400 | 1885 |
| D = 18.500 | 100 | 4.08 | 24 * | 0.630 | | 13-#8+ 4 | 7 | #9 | #9 | 22-#9 | 9 | #6 | #7 | 23-#5 | 865 | 1730 | 2329 |
| RIB ON | 150 | 4.74 | 30 * | 0.626 | | 15-#8+ 3 | 7 | #9 | #10 | 26-#9 | 9 | #7 | #7 | 27-#5 | 1019 | 2037 | 2743 |
| COLUMN LINE | 200 | 5.49 | 35 * | 0.624 | 4 S 6 1 | 14-#9+ 3 | 7 | #10 | #10 | 30-#9 | 9 | #7 | #8 | 22-#6 | 1162 | 2324 | 3128 |
| 0.981 CF/SF | | | | | | | | | | | | | | | | | |
| 51'-0" | 50 | 3.64 | 25 * | 0.890 | | 16-#7+10 | 7 | #8 | #9 | 21-#9 | 10 | #6 | #6 | 22-#5 | 836 | 1673 | 2252 |
| D = 18.500 | 100 | 4.47 | 29 * | 0.919 | | 20-#7+12 | 7 | #9 | #10 | 26-#9 | 10 | #6 | #7 | 27-#5 | 1027 | 2055 | 2766 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.968 CF/SF | | | | | | | | | | | | | | | | | |
| 54'-0" | 50 | 4.05 | 27 * | 0.916 | | 15-#8+10 | 7 | #9 | #10 | 25-#9 | 11 | #6 | #6 | 26-#5 | 987 | 1973 | 2656 |
| D = 18.500 | | | | | | | | | | | | | | | | | |
| RIB ON | | | | | | | | | | | | | | | | | |
| 0.956 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column | | Reinforcing Bars—Each Direction | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Column Strip | | | | Middle Strip | | | |
| | | | Bottom | | | Top | Bottom | | | Top |
| | $c_1 = c_2$ (in.) | (2) Stirrups | No. Ribs | Long Bars | Short Bars | Interior No.-size | No. Ribs | Long Bars | Short Bars | Interior No.-size |
| Total Depth = 20 ½ in. | | | Rib Depth = 16 in. | | | | Total Slab Depth = 4 ½ in. | | | |
| 2.52 | 21 | | 6 | #6 | #6 | 13-#8 | 8 | #4 | #5 | 18-#5 |
| 2.89 | 21 | 4 S 6 1 | 6 | #6 | #7 | 13-#9 | 8 | #4 | #5 | 18-#5 |
| 3.39 | 21 * | 4 S 6 1 | 6 | #7 | #7 | 16-#9 | 8 | #5 | #5 | 18-#5 |
| 3.87 | 21 * | 4 S 6 2 | 6 | #7 | #8 | 23-#8 | 8 | #5 | #6 | 19-#5 |
| 5.04 | 26 * | 4 S 6 2 | 6 | #8 | #9 | 24-#9 | 8 | #6 | #6 | 18-#6 |
| 2.74 | 22 | 4 S 6 1 | 6 | #6 | #7 | 16-#8 | 9 | #4 | #5 | 20-#5 |
| 3.14 | 22 * | 4 S 6 1 | 6 | #7 | #7 | 16-#9 | 9 | #4 | #5 | 20-#5 |
| 3.75 | 22 * | 4 S 6 2 | 6 | #7 | #8 | 20-#9 | 9 | #5 | #5 | 20-#5 |
| 4.51 | 22* | 4 S 6 2 | 6 | #8 | #9 | 23-#9 | 9 | #5 | #6 | 24-#5 |
| 2.95 | 24 | 4 S 6 1 | 7 | #6 | #7 | 16-#9 | 9 | #4 | #5 | 20-#5 |
| 3.68 | 24 * | 4 S 6 1 | 7 | #7 | #8 | 20-#9 | 9 | #5 | #5 | 21-#5 |
| 4.33 | 24 * | 4 S 6 2 | 7 | #8 | #8 | 24-#9 | 9 | #5 | #6 | 25-#5 |
| 5.10 | 28 * | 4 S 6 2 | 7 | #8 | #9 | 28-#9 | 9 | #6 | #6 | 21-#6 |
| 3.37 | 25 * | 4 S 6 1 | 7 | #7 | #7 | 19-#9 | 10 | #5 | #5 | 22-#5 |
| 4.16 | 25 * | 4 S 6 2 | 7 | #8 | #8 | 24-#9 | 10 | #5 | #6 | 25-#5 |
| 3.68 | 27 * | 4 S 6 2 | 7 | #7 | #8 | 23-#9 | 11 | #5 | #5 | 24-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 24 ½ in. | Rib Depth = 20 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | | | | | | |
| 33'-0" | 50 | 2.03 | 16 | 0.641 | | 10-#6+ 0 | 5 | #5 | #5 | 11-#6 | 6 | #5 | #5 | 14-#5 | 257 | 514 | 692 |
| D = 12.500 | 100 | 2.18 | 16 | 0.641 | | 10-#6+ 0 | 5 | #5 | #6 | 10-#7 | 6 | #5 | #5 | 14-#5 | 311 | 622 | 837 |
| RIB ON | 150 | 2.42 | 16 | 0.641 | | 10-#6+ 0 | 5 | #6 | #7 | 9-#8 | 6 | #5 | #5 | 14-#5 | 365 | 751 | 982 |
| COLUMN LINE | 200 | 2.62 | 16 | 0.641 | | 10-#6+ 1 | 5 | #7 | #7 | 10-#8 | 6 | #5 | #5 | 14-#5 | 419 | 937 | 1127 |
| 1.145 CF/SF | 300 | 3.22 | 16 | 0.754 | | 11-#6+ 2 | 5 | #8 | #8 | 10-#9 | 6 | #6 | #6 | 14-#5 | 526 | 1286 | 1416 |
| | 400 | 4.05 | 16 * | 0.642 | | 10-#7+ 1 | 5 | #9 | #9 | 16-#8 | 6 | #7 | #7 | 14-#5 | 634 | 1622 | 1706 |
| | 500 | 4.90 | 16 * | 0.642 | 5 S 8 1 | 9-#8+ 1 | 5 | #10 | #10 | 15-#9 | 6 | #7 | #8 | 16-#5 | 741 | 1954 | 1995 |
| 36'-0" | 50 | 2.26 | 18 | 0.639 | | 11-#6+ 0 | 5 | #6 | #6 | 11-#7 | 7 | #5 | #5 | 16-#5 | 330 | 661 | 889 |
| D = 12.500 | 100 | 2.46 | 18 | 0.639 | | 11-#6+ 0 | 5 | #6 | #7 | 10-#8 | 7 | #5 | #5 | 16-#5 | 400 | 800 | 1077 |
| RIB ON | 150 | 2.67 | 18 | 0.639 | | 11-#6+ 0 | 5 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 16-#5 | 470 | 941 | 1264 |
| COLUMN LINE | 200 | 3.08 | 18 | 0.646 | | 12-#6+ 0 | 5 | #8 | #8 | 11-#9 | 7 | #5 | #6 | 16-#5 | 539 | 1184 | 1452 |
| 1.123 CF/SF | 300 | 3.85 | 18 * | 0.856 | | 11-#7+ 3 | 5 | #9 | #9 | 14-#9 | 7 | #6 | #7 | 16-#5 | 678 | 1634 | 1827 |
| | 400 | 4.76 | 18 * | 0.640 | 5 S 8 1 | 10-#8+ 1 | 5 | #10 | #10 | 17-#9 | 7 | #7 | #7 | 17-#5 | 818 | 2068 | 2202 |
| 39'-0" | 50 | 2.34 | 19 | 0.637 | | 12-#6+ 1 | 6 | #6 | #6 | 11-#8 | 7 | #5 | #5 | 16-#5 | 427 | 854 | 1150 |
| D = 15.500 | 100 | 2.57 | 19 | 0.637 | | 12-#6+ 2 | 6 | #6 | #7 | 13-#8 | 7 | #5 | #5 | 16-#5 | 516 | 1032 | 1389 |
| RIB NOT ON | 150 | 2.99 | 19 | 0.717 | | 13-#6+ 3 | 6 | #7 | #8 | 12-#9 | 7 | #5 | #6 | 16-#5 | 605 | 1209 | 1628 |
| COLUMN LINE | 200 | 3.36 | 19 * | 0.833 | | 11-#7+ 5 | 6 | #8 | #8 | 14-#9 | 7 | #6 | #6 | 16-#5 | 693 | 1510 | 1866 |
| 1.161 CF/SF | 300 | 4.54 | 19 * | 0.638 | | 14-#7+ 4 | 6 | #9 | #10 | 18-#9 | 7 | #7 | #7 | 19-#5 | 871 | 2085 | 2344 |
| 42'-0" | 50 | 2.59 | 21 | 0.636 | | 13-#6+ 1 | 6 | #7 | #7 | 13-#8 | 8 | #5 | #5 | 18-#5 | 528 | 1056 | 1421 |
| D = 15.500 | 100 | 2.96 | 21 | 0.662 | | 14-#6+ 2 | 6 | #7 | #8 | 16-#8 | 8 | #5 | #6 | 18-#5 | 638 | 1277 | 1719 |
| RIB NOT ON | 150 | 3.28 | 21 * | 0.813 | | 12-#7+ 5 | 6 | #8 | #8 | 15-#9 | 8 | #5 | #6 | 18-#5 | 749 | 1498 | 2016 |
| COLUMN LINE | 200 | 3.92 | 21 * | 0.874 | | 14-#7+ 5 | 6 | #9 | #9 | 17-#9 | 8 | #6 | #7 | 18-#5 | 859 | 1813 | 2314 |
| 1.140 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 2.81 | 22 | 0.635 | | 14-#6+ 2 | 6 | #7 | #8 | 16-#8 | 9 | #5 | #5 | 20-#5 | 646 | 1293 | 1741 |
| D = 15.500 | 100 | 3.26 | 22 * | 0.776 | | 17-#6+ 5 | 6 | #8 | #8 | 16-#9 | 9 | #5 | #6 | 20-#5 | 783 | 1565 | 2107 |
| RIB NOT ON | 150 | 3.81 | 22 * | 0.880 | | 11-#8+ 6 | 6 | #9 | #9 | 19-#9 | 9 | #6 | #6 | 20-#5 | 919 | 1838 | 2474 |
| COLUMN LINE | 200 | 4.38 | 22 * | 0.636 | | 13-#8+ 2 | 6 | #9 | #10 | 22-#9 | 9 | #6 | #7 | 23-#5 | 1055 | 2177 | 2841 |
| 1.123 CF/SF | | | | | | | | | | | | | | | | | |
| 48'-0" | 50 | 3.12 | 24 | 0.739 | | 17-#6+ 7 | 7 | #7 | #8 | 16-#9 | 9 | #5 | #6 | 20-#5 | 792 | 1584 | 2132 |
| D = 18.500 | 100 | 3.64 | 24 * | 0.841 | | 15-#7+ 7 | 7 | #8 | #9 | 19-#9 | 9 | #6 | #6 | 20-#5 | 957 | 1914 | 2576 |
| RIB ON | 150 | 4.24 | 24 * | 0.634 | | 14-#8+ 4 | 7 | #9 | #9 | 23-#9 | 9 | #6 | #7 | 24-#5 | 1122 | 2244 | 3021 |
| COLUMN LINE | 200 | 4.91 | 26 * | 0.632 | | 16-#8+ 3 | 7 | #9 | #10 | 26-#9 | 9 | #7 | #7 | 20-#6 | 1282 | 2564 | 3452 |
| 1.153 CF/SF | | | | | | | | | | | | | | | | | |
| 51'-0" | 50 | 3.45 | 25 * | 0.797 | | 15-#7+ 6 | 7 | #8 | #9 | 19-#9 | 10 | #5 | #6 | 22-#5 | 946 | 1891 | 2546 |
| D = 18.500 | 100 | 4.07 | 25 * | 0.896 | | 14-#8+ 8 | 7 | #9 | #9 | 23-#9 | 10 | #6 | #7 | 25-#5 | 1144 | 2288 | 3080 |
| RIB ON | 150 | 4.85 | 26 * | 0.632 | | 13-#9+ 4 | 7 | #10 | #10 | 28-#9 | 10 | #7 | #7 | 29-#5 | 1340 | 2680 | 3607 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.137 CF/SF | | | | | | | | | | | | | | | | | |
| 54'-0" | 50 | 3.82 | 27 * | 0.847 | | 14-#8+ 7 | 7 | #9 | #9 | 23-#9 | 11 | #6 | #6 | 24-#5 | 1115 | 2230 | 3002 |
| D = 18.500 | 100 | 4.58 | 27 * | 0.632 | | 13-#9+ 4 | 7 | #10 | #10 | 28-#9 | 11 | #6 | #7 | 29-#5 | 1350 | 2700 | 3634 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.123 CF/SF | | | | | | | | | | | | | | | | | |
| 57'-0" | 50 | 4.30 | 28 * | 0.890 | | 16-#8+10 | 8 | #9 | #10 | 27-#9 | 11 | #6 | #7 | 29-#5 | 1326 | 2651 | 3569 |
| D =21.500 | 100 | 5.19 | 31 * | 0.629 | | 16-#9+ 5 | 8 | #10 | #10 | 33-#9 | 11 | #7 | #7 | 25-#6 | 1595 | 3189 | 4293 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.148 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 24 ½ in. | Rib Depth = 20 in. | Total Slab Depth = 4 ½ in. | | | | | | | | | | |
| 33'-0" | 50 | 2.03 | 16 | | 5 | #5 | #5 | 10-#6 | 6 | #5 | #5 | 14-#5 |
| D = 12.500 | 100 | 2.16 | 16 | | 5 | #5 | #5 | 9-#7 | 6 | #5 | #5 | 14-#5 |
| RIB ON | 150 | 2.30 | 16 | | 5 | #5 | #5 | 11-#7 | 6 | #5 | #5 | 14-#5 |
| COLUMN LINE | 200 | 2.53 | 16 | | 5 | #5 | #6 | 10-#8 | 6 | #5 | #5 | 14-#5 |
| 1.145 CF/SF | 300 | 2.93 | 16 | 5 S 8 1 | 5 | #6 | #7 | 12-#8 | 6 | #5 | #5 | 14-#5 |
| | 400 | 3.61 | 16 * | 5 S 8 1 | 5 | #7 | #8 | 12-#9 | 6 | #5 | #6 | 14-#5 |
| | 500 | 4.35 | 16 * | 5 S 8 2 | 5 | #8 | #9 | 14-#9 | 6 | #6 | #6 | 15-#5 |
| 36'-0" | 50 | 2.18 | 18 | | 5 | #5 | #5 | 10-#7 | 7 | #5 | #5 | 16-#5 |
| D = 12.500 | 100 | 2.41 | 18 | | 5 | #5 | #6 | 9-#8 | 7 | #5 | #5 | 16-#5 |
| RIB ON | 150 | 2.61 | 18 | 5 S 8 1 | 5 | #5 | #6 | 9-#9 | 7 | #5 | #5 | 16-#5 |
| COLUMN LINE | 200 | 2.84 | 18 | 5 S 8 1 | 5 | #6 | #7 | 12-#8 | 7 | #5 | #5 | 16-#5 |
| 1.123 CF/SF | 300 | 3.43 | 18 * | 5 S 8 2 | 5 | #7 | #8 | 16-#8 | 7 | #5 | #5 | 16-#5 |
| | 400 | 4.32 | 18 * | 5 S 8 2 | 5 | #8 | #9 | 15-#9 | 7 | #6 | #6 | 16-#5 |
| 39'-0" | 50 | 2.28 | 19 | | 6 | #5 | #5 | 13-#7 | 7 | #5 | #5 | 16-#5 |
| D = 15.500 | 100 | 2.53 | 19 | | 6 | #5 | #6 | 12-#8 | 7 | #5 | #5 | 16-#5 |
| RIB NOT ON | 150 | 2.81 | 19 | | 6 | #6 | #6 | 11-#9 | 7 | #5 | #5 | 16-#5 |
| COLUMN LINE | 200 | 3.06 | 19 | 5 S 8 1 | 6 | #6 | #7 | 16-#8 | 7 | #5 | #5 | 16-#5 |
| 1.161 CF/SF | 300 | 4.11 | 19 * | 5 S 8 1 | 6 | #8 | #8 | 16-#9 | 7 | #6 | #6 | 17-#5 |
| 42'-0" | 50 | 2.48 | 21 | | 6 | #5 | #6 | 12-#8 | 8 | #5 | #5 | 18-#5 |
| D = 15.500 | 100 | 2.81 | 21 | | 6 | #6 | #6 | 12-#9 | 8 | #5 | #5 | 18-#5 |
| RIB NOT ON | 150 | 3.10 | 21 | 5 S 8 1 | 6 | #6 | #7 | 14-#9 | 8 | #5 | #5 | 18-#5 |
| COLUMN LINE | 200 | 3.53 | 21 * | 5 S 8 1 | 6 | #7 | #8 | 16-#9 | 8 | #5 | #5 | 18-#5 |
| 1.140 CF/SF | | | | | | | | | | | | |
| 45'-0" | 50 | 2.74 | 22 | | 6 | #6 | #6 | 12-#9 | 9 | #5 | #5 | 20-#5 |
| D = 15.500 | 100 | 3.13 | 22 | 5 S 8 1 | 6 | #7 | #7 | 18-#8 | 9 | #5 | #5 | 20-#5 |
| RIB NOT ON | 150 | 3.52 | 22 * | 5 S 8 1 | 6 | #7 | #8 | 17-#9 | 9 | #5 | #5 | 20-#5 |
| COLUMN LINE | 200 | 4.02 | 22 * | 5 S 8 2 | 6 | #8 | #8 | 20-#9 | 9 | #5 | #6 | 21-#5 |
| 1.123 CF/SF | | | | | | | | | | | | |
| 48'-0" | 50 | 3.03 | 24 | | 7 | #6 | #7 | 15-#9 | 9 | #5 | #5 | 20-#5 |
| D = 18.500 | 100 | 3.37 | 24 | 5 S 8 1 | 7 | #7 | #7 | 18-#9 | 9 | #5 | #5 | 20-#5 |
| RIB ON | 150 | 3.92 | 24 * | 5 S 8 1 | 7 | #7 | #8 | 21-#9 | 9 | #5 | #6 | 22-#5 |
| COLUMN LINE | 200 | 4.62 | 24 * | 5 S 8 2 | 7 | #8 | #8 | 25-#9 | 9 | #6 | #6 | 26-#5 |
| 1.153 CF/SF | | | | | | | | | | | | |
| 51'-0" | 50 | 3.28 | 25 | 5 S 8 1 | 7 | #7 | #7 | 18-#9 | 10 | #5 | #5 | 22-#5 |
| D = 18.500 | 100 | 3.72 | 25 * | 5 S 8 1 | 7 | #7 | #8 | 22-#9 | 10 | #5 | #5 | 23-#5 |
| RIB ON | 150 | 4.34 | 25 * | 5 S 8 2 | 7 | #8 | #8 | 26-#9 | 10 | #5 | #6 | 27-#5 |
| COLUMN LINE | | | | | | | | | | | | |
| 1.137 CF/SF | | | | | | | | | | | | |
| 54'-0" | 50 | 3.54 | 27 | 5 S 8 1 | 7 | #7 | #8 | 21-#9 | 11 | #5 | #5 | 24-#5 |
| D = 18.500 | 100 | 4.18 | 27 * | 5 S 8 2 | 7 | #8 | #8 | 26-#9 | 11 | #5 | #6 | 27-#5 |
| RIB ON | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | |
| 1.123 CF/SF | | | | | | | | | | | | |
| 57'-0" | 50 | 3.90 | 28 * | 5 S 8 1 | 8 | #7 | #8 | 25-#9 | 11 | #5 | #6 | 26-#5 |
| D =21.500 | 100 | 4.86 | 28 * | 5 S 8 2 | 8 | #8 | #9 | 31-#9 | 11 | #6 | #6 | 32-#5 |
| RIB NOT ON | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | |
| 1.148 CF/SF | | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Superimposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 13 in. | Rib Depth = 8 in. | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | |
| 18'-0" | 50 | 1.60 | 12 | 0.633 | | 5-#6+ 0 | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 | 28 | 57 | 76 |
| D = 6.500 | 100 | 1.60 | 12 | 0.633 | | 5-#6+ 0 | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 | 37 | 75 | 99 |
| RIB ON | 150 | 1.66 | 12 | 0.633 | | 5-#6+ 0 | 3 | #4 | #5 | 5-#6 | 3 | #4 | #4 | 8-#5 | 45 | 104 | 122 |
| COLUMN LINE | 200 | 1.72 | 12 | 0.633 | | 5-#6+ 0 | 3 | #5 | #5 | 5-#6 | 3 | #4 | #4 | 8-#5 | 54 | 130 | 145 |
| 0.690 CF/SF | 300 | 1.93 | 12 | 0.698 | | 5-#6+ 0 | 3 | #5 | #6 | 6-#6 | 3 | #4 | #5 | 8-#5 | 71 | 183 | 190 |
| | 400 | 2.44 | 12 * | 0.819 | | 5-#6+ 1 | 3 | #6 | #7 | 6-#7 | 3 | #5 | #5 | 8-#5 | 88 | 234 | 236 |
| | 500 | 2.80 | 12 * | 0.634 | 3 S 4 1 | 5-#6+ 1 | 3 | #7 | #7 | 5-#8 | 3 | #6 | #6 | 8-#5 | 104 | 285 | 281 |
| 21'-0" | 50 | 1.56 | 12 | 0.635 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 47 | 93 | 126 |
| D = 9.500 | 100 | 1.56 | 12 | 0.681 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 60 | 124 | 162 |
| RIB NOT ON | 150 | 1.67 | 12 | 0.726 | | 9-#5+ 0 | 4 | #4 | #5 | 9-#5 | 3 | #4 | #5 | 8-#5 | 74 | 170 | 199 |
| COLUMN LINE | 200 | 1.98 | 12 | 0.772 | | 9-#5+ 0 | 4 | #5 | #6 | 8-#6 | 3 | #5 | #5 | 8-#5 | 88 | 214 | 236 |
| 0.722 CF/SF | 300 | 2.53 | 12 * | 0.888 | | 9-#5+ 2 | 4 | #6 | #7 | 7-#7 | 3 | #6 | #6 | 8-#5 | 115 | 298 | 309 |
| | 400 | 3.07 | 13 * | 0.632 | | 9-#5+ 1 | 4 | #7 | #7 | 7-#8 | 3 | #6 | #7 | 8-#5 | 142 | 380 | 381 |
| | 500 | 3.67 | 16 * | 0.628 | | 10-#5+ 3 | 4 | #8 | #8 | 8-#8 | 3 | #7 | #8 | 8-#5 | 165 | 445 | 445 |
| 24'-0" | 50 | 1.63 | 12 | 0.713 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 | 70 | 139 | 188 |
| D = 9.500 | 100 | 1.70 | 12 | 0.787 | | 10-#5+ 1 | 4 | #5 | #5 | 8-#6 | 4 | #4 | #4 | 10-#5 | 90 | 184 | 243 |
| RIB NOT ON | 150 | 2.03 | 12 * | 0.861 | | 10-#5+ 3 | 4 | #6 | #6 | 7-#7 | 4 | #4 | #5 | 10-#5 | 111 | 255 | 299 |
| COLUMN LINE | 200 | 2.50 | 12 * | 0.909 | | 10-#5+ 4 | 4 | #6 | #7 | 7-#8 | 4 | #5 | #6 | 10-#5 | 132 | 320 | 354 |
| 0.703 CF/SF | 300 | 3.19 | 15 * | 0.630 | | 7-#6+ 2 | 4 | #7 | #8 | 7-#9 | 4 | #6 | #7 | 10-#5 | 171 | 443 | 460 |
| | 400 | 3.88 | 19 * | 0.625 | | 9-#6+ 1 | 4 | #8 | #9 | 9-#9 | 4 | #7 | #7 | 10-#5 | 206 | 525 | 553 |
| 27'-0" | 50 | 1.70 | 13 | 0.758 | | 8-#6+ 0 | 4 | #5 | #5 | 12-#5 | 5 | #4 | #4 | 12-#5 | 99 | 198 | 266 |
| D = 9.500 | 100 | 2.09 | 13 * | 0.855 | | 8-#6+ 2 | 4 | #6 | #6 | 8-#7 | 5 | #4 | #5 | 12-#5 | 128 | 257 | 346 |
| RIB NOT ON | 150 | 2.47 | 13 * | 0.914 | | 8-#6+ 3 | 4 | #7 | #7 | 8-#8 | 5 | #5 | #5 | 12-#5 | 158 | 356 | 425 |
| COLUMN LINE | 200 | 2.96 | 15 * | 0.630 | | 8-#6+ 2 | 4 | #7 | #8 | 8-#9 | 5 | #5 | #6 | 12-#5 | 186 | 445 | 501 |
| 0.690 CF/SF | 300 | 3.72 | 20 * | 0.625 | | 15-#5+ 3 | 4 | #8 | #9 | 10-#9 | 5 | #6 | #7 | 12-#5 | 237 | 564 | 639 |
| 30'-0" | 50 | 1.95 | 15 * | 0.831 | | 9-#6+ 3 | 5 | #5 | #6 | 9-#7 | 5 | #4 | #5 | 12-#5 | 137 | 274 | 368 |
| D = 12.500 | 100 | 2.29 | 15 * | 0.902 | | 9-#6+ 5 | 5 | #6 | #6 | 9-#8 | 5 | #5 | #5 | 12-#5 | 177 | 354 | 477 |
| RIB ON | 150 | 2.88 | 17 * | 0.627 | | 9-#6+ 4 | 5 | #7 | #7 | 9-#9 | 5 | #6 | #6 | 12-#5 | 216 | 469 | 582 |
| COLUMN LINE | 200 | 3.43 | 20 * | 0.625 | | 11-#6+ 3 | 5 | #8 | #8 | 13-#8 | 5 | #6 | #7 | 12-#5 | 253 | 572 | 682 |
| 0.711 CF/SF | | | | | | | | | | | | | | | | | |
| 33'-0" | 50 | 2.16 | 16 * | 0.868 | | 10-#6+ 4 | 5 | #6 | #6 | 9-#8 | 6 | #4 | #5 | 14-#5 | 181 | 363 | 488 |
| D = 12.500 | 100 | 2.73 | 17 * | 0.926 | | 10-#6+ 7 | 5 | #7 | #7 | 12-#8 | 6 | #5 | #5 | 14-#5 | 234 | 469 | 631 |
| RIB ON | 150 | 3.39 | 23 * | 0.622 | 3 S 4 1 | 9-#7+ 4 | 5 | #8 | #8 | 12-#9 | 6 | #6 | #6 | 14-#5 | 283 | 593 | 763 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.699 CF/SF | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.60 | 18 * | 0.885 | | 11-#6+ 5 | 5 | #7 | #7 | 12-#8 | 7 | #5 | #5 | 16-#5 | 234 | 467 | 629 |
| D = 12.500 | 100 | 3.19 | 23 * | 0.622 | 3 S 4 1 | 10-#7+ 3 | 5 | #8 | #8 | 16-#8 | 7 | #5 | #6 | 16-#5 | 300 | 599 | 806 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.690 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | Square Interior Column (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 13 in. | Rib Depth = 8 in. | Total Slab Depth = 5 in. | | | | | | | | |
| 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| 1.64 | 12 | | 3 | #4 | #4 | 5-#6 | 3 | #4 | #4 | 8-#5 |
| 1.78 | 12 | 3 S 4 1 | 3 | #4 | #5 | 8-#5 | 3 | #4 | #4 | 8-#5 |
| 2.25 | 12 | 3 S 4 1 | 3 | #5 | #6 | 5-#7 | 3 | #4 | #5 | 8-#5 |
| 2.47 | 12 * | 3 S 4 1 | 3 | #6 | #6 | 6-#7 | 3 | #4 | #5 | 8-#5 |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.76 | 12 | | 4 | #4 | #5 | 7-#6 | 3 | #4 | #4 | 8-#5 |
| 2.21 | 12 * | 3 S 4 1 | 4 | #5 | #5 | 9-#6 | 3 | #5 | #5 | 8-#5 |
| 2.85 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 3 | #5 | #6 | 8-#5 |
| 3.26 | 14 * | 3 S 4 1 | 4 | #6 | #7 | 8-#8 | 3 | #6 | #6 | 8-#5 |
| 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| 1.85 | 12 | 3 S 4 1 | 4 | #4 | #5 | 9-#6 | 4 | #4 | #4 | 10-#5 |
| 2.26 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 8-#7 | 4 | #4 | #5 | 10-#5 |
| 2.87 | 12 * | 3 S 4 1 | 4 | #6 | #7 | 8-#8 | 4 | #5 | #5 | 10-#5 |
| 3.40 | 16 * | 3 S 4 2 | 4 | #7 | #7 | 8-#9 | 4 | #5 | #6 | 10-#5 |
| 1.64 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 12-#5 |
| 1.98 | 13 | 3 S 4 1 | 4 | #5 | #5 | 8-#7 | 5 | #4 | #4 | 12-#5 |
| 2.21 | 13 * | 3 S 4 1 | 4 | #5 | #6 | 7-#8 | 5 | #4 | #4 | 12-#5 |
| 2.77 | 13 * | 3 S 4 1 | 4 | #6 | #7 | 7-#9 | 5 | #4 | #5 | 12-#5 |
| 3.33 | 17 * | 3 S 4 2 | 4 | #7 | #7 | 9-#9 | 5 | #5 | #5 | 12-#5 |
| 1.81 | 15 | | 5 | #4 | #5 | 11-#6 | 5 | #4 | #4 | 12-#5 |
| 2.13 | 15 * | 3 S 4 1 | 5 | #5 | #5 | 11-#7 | 5 | #4 | #4 | 12-#5 |
| 2.59 | 15 * | 3 S 4 1 | 5 | #6 | #6 | 10-#8 | 5 | #4 | #5 | 12-#5 |
| 3.05 | 16 * | 3 S 4 1 | 5 | #6 | #7 | 12-#8 | 5 | #5 | #5 | 12-#5 |
| 2.06 | 16 | 3 S 4 1 | 5 | #5 | #5 | 11-#7 | 6 | #4 | #4 | 14-#5 |
| 2.65 | 16 * | 3 S 4 1 | 5 | #6 | #6 | 9-#9 | 6 | #4 | #5 | 14-#5 |
| 3.14 | 16 * | 3 S 4 1 | 5 | #6 | #7 | 11-#9 | 6 | #5 | #5 | 14-#5 |
| 2.46 | 18 * | 3 S 4 1 | 5 | #6 | #6 | 9-#9 | 7 | #4 | #4 | 16-#5 |
| 2.96 | 18 * | 3 S 4 2 | 5 | #6 | #7 | 12-#9 | 7 | #4 | #5 | 16-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 10 in. | | Total Slab Depth = 5 in. | | | | | | | | | | | | | | |
| 21'-0" | 50 | 1.56 | 12 | 0.636 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 50 | 100 | 135 |
| D = 9.500 | 100 | 1.56 | 12 | 0.636 | | 9-#5+ 0 | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 | 64 | 129 | 171 |
| RIB NOT ON | 150 | 1.63 | 12 | 0.636 | | 9-#5+ 0 | 4 | #4 | #5 | 9-#5 | 3 | #4 | #4 | 8-#5 | 77 | 176 | 208 |
| COLUMN LINE | 200 | 1.75 | 12 | 0.671 | | 9-#5+ 0 | 4 | #5 | #5 | 7-#6 | 3 | #4 | #5 | 8-#5 | 91 | 220 | 245 |
| 0.803 CF/SF | 300 | 2.26 | 12 | 0.757 | | 9-#5+ 0 | 4 | #6 | #6 | 9-#6 | 3 | #5 | #6 | 8-#5 | 118 | 306 | 318 |
| | 400 | 2.71 | 12 * | 0.881 | | 9-#5+ 3 | 4 | #6 | #7 | 8-#7 | 3 | #6 | #7 | 8-#5 | 146 | 390 | 392 |
| | 500 | 3.25 | 12 * | 0.637 | | 9-#5+ 2 | 4 | #7 | #8 | 7-#8 | 3 | #7 | #7 | 8-#5 | 173 | 472 | 465 |
| 24'-0" | 50 | 1.57 | 12 | 0.636 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 | 75 | 149 | 201 |
| D = 9.500 | 100 | 1.63 | 12 | 0.680 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 | 95 | 192 | 257 |
| RIB NOT ON | 150 | 1.90 | 12 | 0.730 | | 10-#5+ 0 | 4 | #5 | #6 | 12-#5 | 4 | #4 | #5 | 10-#5 | 116 | 264 | 312 |
| COLUMN LINE | 200 | 2.17 | 12 * | 0.781 | | 10-#5+ 0 | 4 | #6 | #6 | 10-#6 | 4 | #5 | #5 | 10-#5 | 137 | 330 | 368 |
| 0.780 CF/SF | 300 | 2.86 | 12 * | 0.637 | | 10-#5+ 1 | 4 | #7 | #7 | 8-#8 | 4 | #6 | #6 | 10-#5 | 178 | 459 | 479 |
| | 400 | 3.43 | 14 * | 0.634 | | 8-#6+ 2 | 4 | #8 | #8 | 7-#9 | 4 | #6 | #7 | 10-#5 | 217 | 581 | 586 |
| | 500 | 4.07 | 17 * | 0.630 | | 9-#6+ 2 | 4 | #9 | #9 | 9-#9 | 4 | #7 | #7 | 10-#5 | 253 | 677 | 681 |
| 27'-0" | 50 | 1.69 | 13 | 0.682 | | 8-#6+ 0 | 4 | #5 | #5 | 8-#6 | 5 | #4 | #4 | 12-#5 | 106 | 212 | 285 |
| D = 9.500 | 100 | 1.86 | 13 | 0.740 | | 8-#6+ 0 | 4 | #5 | #6 | 7-#7 | 5 | #4 | #4 | 12-#5 | 135 | 271 | 364 |
| RIB NOT ON | 150 | 2.25 | 13 * | 0.837 | | 8-#6+ 2 | 4 | #6 | #7 | 7-#8 | 5 | #4 | #5 | 12-#5 | 165 | 370 | 444 |
| COLUMN LINE | 200 | 2.77 | 13 * | 0.894 | | 8-#6+ 3 | 4 | #7 | #8 | 8-#8 | 5 | #5 | #6 | 12-#5 | 194 | 465 | 523 |
| 0.764 CF/SF | 300 | 3.49 | 15 * | 0.633 | | 9-#6+ 2 | 4 | #8 | #9 | 9-#9 | 5 | #6 | #6 | 12-#5 | 252 | 644 | 677 |
| | 400 | 4.30 | 20 * | 0.627 | 3 S 4 1 | 8-#7+ 2 | 4 | #9 | #10 | 11-#9 | 5 | #7 | #7 | 12-#5 | 301 | 764 | 811 |
| 30'-0" | 50 | 1.73 | 15 | 0.755 | | 9-#6+ 2 | 5 | #5 | #5 | 11-#6 | 5 | #4 | #4 | 12-#5 | 147 | 293 | 395 |
| D = 12.500 | 100 | 2.10 | 15 * | 0.839 | | 9-#6+ 4 | 5 | #6 | #6 | 10-#7 | 5 | #4 | #5 | 12-#5 | 187 | 374 | 503 |
| RIB ON | 150 | 2.59 | 15 * | 0.901 | | 9-#6+ 6 | 5 | #6 | #7 | 10-#8 | 5 | #5 | #6 | 12-#5 | 227 | 496 | 612 |
| COLUMN LINE | 200 | 3.13 | 15 * | 0.633 | | 10-#6+ 3 | 5 | #7 | #8 | 9-#9 | 5 | #6 | #6 | 12-#5 | 268 | 626 | 720 |
| 0.790 CF/SF | 300 | 4.02 | 21 * | 0.626 | 3 S 4 1 | 9-#7+ 4 | 5 | #8 | #9 | 12-#9 | 5 | #7 | #7 | 13-#5 | 340 | 830 | 915 |
| 33'-0" | 50 | 2.11 | 16 | 0.805 | | 10-#6+ 3 | 5 | #6 | #6 | 11-#7 | 6 | #4 | #5 | 14-#5 | 194 | 388 | 523 |
| D = 12.500 | 100 | 2.47 | 16 * | 0.881 | | 10-#6+ 5 | 5 | #6 | #7 | 9-#9 | 6 | #5 | #5 | 14-#5 | 248 | 496 | 668 |
| RIB ON | 150 | 3.00 | 17 * | 0.630 | | 11-#6+ 3 | 5 | #7 | #8 | 13-#8 | 6 | #5 | #6 | 14-#5 | 301 | 640 | 810 |
| COLUMN LINE | 200 | 3.70 | 21 * | 0.626 | 3 S 4 1 | 10-#7+ 3 | 5 | #8 | #9 | 12-#9 | 6 | #6 | #7 | 14-#5 | 351 | 802 | 944 |
| 0.775 CF/SF | | | | | | | | | | | | | | | | | |
| 36'-0" | 50 | 2.33 | 18 * | 0.826 | | 11-#6+ 4 | 5 | #6 | #7 | 9-#9 | 7 | #4 | #5 | 16-#5 | 250 | 500 | 673 |
| D = 12.500 | 100 | 2.82 | 18 * | 0.908 | | 12-#6+ 6 | 5 | #7 | #8 | 11-#9 | 7 | #5 | #5 | 16-#5 | 320 | 639 | 861 |
| RIB ON | 150 | 3.52 | 22 * | 0.626 | 3 S 4 1 | 11-#7+ 3 | 5 | #8 | #9 | 14-#9 | 7 | #6 | #6 | 16-#5 | 385 | 771 | 1038 |
| COLUMN LINE | 200 | 3.98 | 27 * | 0.622 | 3 S 4 1 | 9-#8+ 2 | 5 | #9 | #9 | 16-#9 | 7 | #6 | #6 | 17-#5 | 445 | 891 | 1199 |
| 0.764 CF/SF | | | | | | | | | | | | | | | | | |
| 39'-0" | 50 | 2.64 | 19 * | 0.885 | | 12-#6+ 8 | 6 | #7 | #7 | 11-#9 | 7 | #5 | #5 | 16-#5 | 322 | 644 | 867 |
| D = 15.500 | 100 | 3.39 | 22 * | 0.927 | | 11-#7+ 9 | 6 | #8 | #8 | 14-#9 | 7 | #6 | #6 | 16-#5 | 408 | 816 | 1098 |
| RIB NOT ON | 150 | 3.96 | 30 * | 0.621 | | 18-#6+ 4 | 6 | #8 | #9 | 17-#9 | 7 | #6 | #7 | 18-#5 | 483 | 967 | 1301 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.784 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 15 in. | Rib Depth = 10 in. | | Total Slab Depth = 5 in. | | | | | | | |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 1.59 | 12 | | 4 | #4 | #4 | 9-#5 | 3 | #4 | #4 | 8-#5 |
| 2.00 | 12 | | 4 | #5 | #5 | 8-#6 | 3 | #4 | #5 | 8-#5 |
| 2.39 | 12 * | 3 S 4 1 | 4 | #5 | #6 | 7-#7 | 3 | #5 | #5 | 8-#5 |
| 2.85 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 3 | #5 | #6 | 8-#5 |
| 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| 1.76 | 12 | | 4 | #4 | #5 | 8-#6 | 4 | #4 | #4 | 10-#5 |
| 1.98 | 12 | 3 S 4 1 | 4 | #5 | #5 | 7-#7 | 4 | #4 | #4 | 10-#5 |
| 2.64 | 12 * | 3 S 4 1 | 4 | #6 | #6 | 7-#8 | 4 | #5 | #5 | 10-#5 |
| 3.12 | 12 * | 3 S 4 1 | 4 | #6 | #7 | 7-#9 | 4 | #5 | #6 | 10-#5 |
| 3.55 | 15 * | 3 S 4 2 | 4 | #7 | #7 | 8-#9 | 4 | #6 | #6 | 10-#5 |
| 1.64 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 12-#5 |
| 1.80 | 13 | | 4 | #4 | #5 | 9-#6 | 5 | #4 | #4 | 12-#5 |
| 2.09 | 13 | 3 S 4 1 | 4 | #5 | #6 | 8-#7 | 5 | #4 | #4 | 12-#5 |
| 2.50 | 13 * | 3 S 4 1 | 4 | #6 | #6 | 8-#8 | 5 | #4 | #5 | 12-#5 |
| 3.14 | 13 * | 3 S 4 2 | 4 | #7 | #7 | 8-#9 | 5 | #5 | #5 | 12-#5 |
| 3.73 | 17 * | 3 S 4 2 | 4 | #7 | #8 | 10-#9 | 5 | #5 | #6 | 12-#5 |
| 1.65 | 15 | | 5 | #4 | #4 | 10-#6 | 5 | #4 | #4 | 12-#5 |
| 1.95 | 15 | | 5 | #4 | #5 | 10-#7 | 5 | #4 | #4 | 12-#5 |
| 2.40 | 15 * | 3 S 4 1 | 5 | #5 | #6 | 9-#8 | 5 | #4 | #5 | 12-#5 |
| 2.88 | 15 * | 3 S 4 1 | 5 | #6 | #6 | 9-#9 | 5 | #5 | #5 | 12-#5 |
| 3.68 | 17 * | 3 S 4 2 | 5 | #7 | #7 | 11-#9 | 5 | #6 | #6 | 12-#5 |
| 1.98 | 16 | | 5 | #5 | #5 | 10-#7 | 6 | #4 | #4 | 14-#5 |
| 2.29 | 16 * | 3 S 4 1 | 5 | #5 | #6 | 10-#8 | 6 | #4 | #4 | 14-#5 |
| 2.79 | 16 * | 3 S 4 1 | 5 | #6 | #7 | 12-#8 | 6 | #4 | #5 | 14-#5 |
| 3.35 | 16 * | 3 S 4 2 | 5 | #7 | #7 | 12-#9 | 6 | #5 | #5 | 14-#5 |
| 2.22 | 18 | 3 S 4 1 | 5 | #5 | #6 | 10-#8 | 7 | #4 | #4 | 16-#5 |
| 2.64 | 18 * | 3 S 4 1 | 5 | #6 | #6 | 10-#9 | 7 | #4 | #5 | 16-#5 |
| 3.13 | 18 * | 3 S 4 2 | 5 | #7 | #7 | 16-#8 | 7 | #4 | #5 | 16-#5 |
| 3.72 | 21 * | 3 S 4 2 | 5 | #7 | #8 | 15-#9 | 7 | #5 | #5 | 16-#5 |
| 2.48 | 19 * | 3 S 4 1 | 6 | #5 | #6 | 13-#8 | 7 | #4 | #5 | 16-#5 |
| 3.12 | 19 * | 3 S 4 1 | 6 | #6 | #7 | 13-#9 | 7 | #5 | #5 | 16-#5 |
| 3.66 | 22 * | 3 S 4 2 | 6 | #7 | #7 | 16-#9 | 7 | #5 | #6 | 17-#5 |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 17 in. | Rib Depth = 12 in. | | Total Slab Depth = 5 in. | | | | | | | | | | | | | | | Total Depth = 17 in. | Rib Depth = 12 in. | | Total Slab Depth = 5 in. | | | | | | | |
| 24'-0" | 50 | 1.57 | 12 | 0.639 | | 10-#5+ 0 | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 | 80 | 160 | 215 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| D = 9.500 | 100 | 1.63 | 12 | 0.639 | | 10-#5+ 0 | 4 | #4 | #5 | 7-#6 | 4 | #4 | #4 | 10-#5 | 100 | 201 | 270 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| RIB NOT ON | 150 | 1.70 | 12 | 0.639 | | 10-#5+ 0 | 4 | #5 | #5 | 8-#6 | 4 | #4 | #4 | 10-#5 | 121 | 272 | 326 | 1.62 | 12 | | 4 | #4 | #4 | 7-#6 | 4 | #4 | #4 | 10-#5 |
| COLUMN LINE | 200 | 1.98 | 12 | 0.685 | | 10-#5+ 0 | 4 | #6 | #6 | 9-#6 | 4 | #4 | #5 | 10-#5 | 142 | 339 | 382 | 1.76 | 12 | | 4 | #4 | #5 | 8-#6 | 4 | #4 | #4 | 10-#5 |
| 0.859 CF/SF | 300 | 2.57 | 12 * | 0.817 | | 10-#5+ 2 | 4 | #7 | #7 | 7-#8 | 4 | #5 | #6 | 10-#5 | 183 | 469 | 493 | 2.26 | 12 | 4 S 6 1 | 4 | #5 | #6 | 8-#7 | 4 | #4 | #5 | 10-#5 |
| | 400 | 3.16 | 12 * | 0.640 | | 10-#5+ 1 | 4 | #7 | #8 | 8-#8 | 4 | #6 | #7 | 10-#5 | 224 | 596 | 604 | 2.87 | 12 * | 4 S 6 1 | 4 | #6 | #7 | 8-#8 | 4 | #5 | #5 | 10-#5 |
| | 500 | 3.74 | 12 * | 0.640 | | 8-#6+ 2 | 4 | #8 | #9 | 8-#9 | 4 | #7 | #7 | 10-#5 | 266 | 722 | 715 | 3.26 | 12 * | 4 S 6 1 | 4 | #7 | #7 | 7-#9 | 4 | #5 | #6 | 10-#5 |
| 27'-0" | 50 | 1.64 | 13 | 0.637 | | 8-#6+ 0 | 4 | #4 | #5 | 8-#6 | 5 | #4 | #4 | 12-#5 | 113 | 226 | 304 | 1.64 | 13 | | 4 | #4 | #4 | 8-#6 | 5 | #4 | #4 | 12-#5 |
| D = 9.500 | 100 | 1.82 | 13 | 0.657 | | 8-#6+ 0 | 4 | #5 | #6 | 9-#6 | 5 | #4 | #4 | 12-#5 | 143 | 285 | 384 | 1.74 | 13 | | 4 | #4 | #5 | 12-#5 | 5 | #4 | #4 | 12-#5 |
| RIB NOT ON | 150 | 2.06 | 13 | 0.743 | | 8-#6+ 1 | 4 | #6 | #6 | 8-#7 | 5 | #4 | #5 | 12-#5 | 172 | 382 | 463 | 1.93 | 13 | 4 S 6 1 | 4 | #5 | #5 | 10-#6 | 5 | #4 | #4 | 12-#5 |
| COLUMN LINE | 200 | 2.45 | 13 * | 0.812 | | 8-#6+ 2 | 4 | #7 | #7 | 7-#8 | 5 | #5 | #5 | 12-#5 | 201 | 479 | 542 | 2.21 | 13 | 4 S 6 1 | 4 | #5 | #6 | 7-#8 | 5 | #4 | #4 | 12-#5 |
| 0.840 CF/SF | 300 | 3.21 | 13 * | 0.638 | | 8-#6+ 2 | 4 | #8 | #8 | 8-#9 | 5 | #6 | #6 | 12-#5 | 260 | 663 | 701 | 2.91 | 13 * | 4 S 6 1 | 4 | #6 | #7 | 7-#9 | 5 | #5 | #5 | 12-#5 |
| | 400 | 3.92 | 15 * | 0.635 | | 7-#7+ 1 | 4 | #9 | #9 | 12-#8 | 5 | #6 | #7 | 12-#5 | 317 | 839 | 854 | 3.60 | 13 * | 4 S 6 2 | 4 | #7 | #8 | 9-#9 | 5 | #5 | #6 | 12-#5 |
| | 500 | 4.60 | 19 * | 0.631 | 4 S 6 1 | 12-#6+ 0 | 4 | #10 | #10 | 11-#9 | 5 | #7 | #7 | 12-#5 | 367 | 975 | 989 | 4.04 | 16 * | 4 S 6 2 | 4 | #8 | #8 | 10-#9 | 5 | #6 | #6 | 12-#5 |
| 30'-0" | 50 | 1.70 | 15 | 0.662 | | 9-#6+ 1 | 5 | #5 | #5 | 10-#6 | 5 | #4 | #4 | 12-#5 | 157 | 314 | 422 | 1.61 | 15 | | 5 | #4 | #4 | 9-#6 | 5 | #4 | #4 | 12-#5 |
| D = 12.500 | 100 | 1.99 | 15 | 0.744 | | 9-#6+ 2 | 5 | #5 | #6 | 9-#7 | 5 | #4 | #5 | 12-#5 | 197 | 394 | 531 | 1.89 | 15 | | 5 | #4 | #5 | 9-#7 | 5 | #4 | #4 | 12-#5 |
| RIB ON | 150 | 2.41 | 15 * | 0.826 | | 9-#6+ 4 | 5 | #6 | #7 | 9-#8 | 5 | #5 | #5 | 12-#5 | 237 | 516 | 639 | 2.22 | 15 | | 5 | #5 | #5 | 11-#7 | 5 | #4 | #5 | 12-#5 |
| COLUMN LINE | 200 | 2.84 | 15 * | 0.887 | | 9-#6+ 6 | 5 | #7 | #7 | 10-#8 | 5 | #6 | #6 | 12-#5 | 278 | 649 | 748 | 2.59 | 15 * | 4 S 6 1 | 5 | #6 | #6 | 10-#8 | 5 | #4 | #5 | 12-#5 |
| 0.871 CF/SF | 300 | 3.83 | 16 * | 0.634 | | 12-#6+ 2 | 5 | #8 | #9 | 11-#9 | 5 | #7 | #7 | 12-#5 | 357 | 899 | 962 | 3.36 | 15 * | 4 S 6 1 | 5 | #7 | #7 | 10-#9 | 5 | #5 | #6 | 12-#5 |
| | 400 | 4.56 | 21 * | 0.629 | 4 S 6 1 | 10-#7+ 3 | 5 | #9 | #10 | 13-#9 | 5 | #7 | #8 | 14-#5 | 427 | 1086 | 1151 | 3.97 | 18 * | 4 S 6 2 | 5 | #7 | #8 | 12-#9 | 5 | #6 | #6 | 13-#5 |
| 33'-0" | 50 | 1.90 | 16 | 0.705 | | 10-#6+ 1 | 5 | #5 | #6 | 10-#7 | 6 | #4 | #4 | 14-#5 | 208 | 415 | 559 | 1.84 | 16 | | 5 | #4 | #5 | 9-#7 | 6 | #4 | #4 | 14-#5 |
| D = 12.500 | 100 | 2.28 | 16 * | 0.818 | | 10-#6+ 4 | 5 | #6 | #7 | 10-#8 | 6 | #4 | #5 | 14-#5 | 261 | 523 | 704 | 2.12 | 16 | 4 S 6 1 | 5 | #5 | #5 | 9-#8 | 6 | #4 | #4 | 14-#5 |
| RIB ON | 150 | 2.87 | 16 * | 0.885 | | 10-#6+ 6 | 5 | #7 | #8 | 9-#9 | 6 | #5 | #6 | 14-#5 | 315 | 671 | 848 | 2.65 | 16 * | 4 S 6 1 | 5 | #6 | #6 | 9-#9 | 6 | #4 | #5 | 14-#5 |
| COLUMN LINE | 200 | 3.30 | 16 * | 0.634 | | 12-#6+ 2 | 5 | #8 | #8 | 11-#9 | 6 | #6 | #6 | 14-#5 | 369 | 848 | 993 | 3.00 | 16 * | 4 S 6 1 | 5 | #6 | #7 | 10-#9 | 6 | #5 | #5 | 14-#5 |
| 0.853 CF/SF | 300 | 4.40 | 22 * | 0.628 | 4 S 6 1 | 11-#7+ 3 | 5 | #9 | #10 | 14-#9 | 6 | #7 | #7 | 15-#5 | 466 | 1125 | 1255 | 3.92 | 18 * | 4 S 6 2 | 5 | #7 | #8 | 13-#9 | 6 | #6 | #6 | 14-#5 |
| 36'-0" | 50 | 2.27 | 18 | 0.741 | | 11-#6+ 2 | 5 | #6 | #7 | 10-#8 | 7 | #4 | #5 | 16-#5 | 267 | 534 | 719 | 2.16 | 18 | | 5 | #5 | #6 | 9-#8 | 7 | #4 | #4 | 16-#5 |
| D = 12.500 | 100 | 2.69 | 18 * | 0.845 | | 11-#6+ 5 | 5 | #7 | #8 | 10-#9 | 7 | #5 | #5 | 16-#5 | 337 | 673 | 906 | 2.46 | 18 | 4 S 6 1 | 5 | #6 | #6 | 9-#9 | 7 | #4 | #4 | 16-#5 |
| RIB ON | 150 | 3.14 | 18 * | 0.632 | | 10-#7+ 3 | 5 | #8 | #8 | 12-#9 | 7 | #5 | #6 | 16-#5 | 406 | 821 | 1094 | 2.88 | 18 * | 4 S 6 1 | 5 | #6 | #7 | 11-#9 | 7 | #4 | #5 | 16-#5 |
| COLUMN LINE | 200 | 3.92 | 21 * | 0.629 | 4 S 6 1 | 11-#7+ 3 | 5 | #9 | #9 | 18-#8 | 7 | #6 | #7 | 16-#5 | 472 | 1043 | 1272 | 3.58 | 18 * | 4 S 6 2 | 5 | #7 | #8 | 14-#9 | 7 | #5 | #5 | 16-#5 |
| 0.840 CF/SF | 300 | 4.86 | 28 * | 0.624 | 4 S 6 1 | 11-#8+ 3 | 5 | #10 | #10 | 19-#9 | 7 | #7 | #7 | 20-#5 | 593 | 1235 | 1596 | 4.33 | 23 * | 4 S 6 2 | 5 | #8 | #8 | 18-#9 | 7 | #5 | #6 | 18-#5 |
| 39'-0" | 50 | 2.46 | 19 * | 0.828 | | 12-#6+ 6 | 6 | #6 | #7 | 13-#8 | 7 | #5 | #5 | 16-#5 | 344 | 688 | 926 | 2.30 | 19 | | 6 | #5 | #6 | 12-#8 | 7 | #4 | #4 | 16-#5 |
| D = 15.500 | 100 | 3.00 | 19 * | 0.908 | | 14-#6+ 8 | 6 | #7 | #8 | 13-#9 | 7 | #5 | #6 | 16-#5 | 433 | 866 | 1165 | 2.74 | 19 * | 4 S 6 1 | 6 | #6 | #6 | 12-#9 | 7 | #4 | #5 | 16-#5 |
| RIB NOT ON | 150 | 3.61 | 22 * | 0.628 | | 12-#7+ 5 | 6 | #8 | #8 | 16-#9 | 7 | #6 | #6 | 17-#5 | 518 | 1036 | 1395 | 3.44 | 19 * | 4 S 6 1 | 6 | #7 | #7 | 15-#9 | 7 | #5 | #5 | 16-#5 |
| COLUMN LINE | 200 | 4.26 | 27 * | 0.625 | | 11-#8+ 3 | 6 | #9 | #9 | 23-#8 | 7 | #6 | #7 | 20-#5 | 596 | 1216 | 1606 | 3.95 | 21 * | 4 S 6 2 | 6 | #7 | #8 | 17-#9 | 7 | #5 | #6 | 18-#5 |
| 0.864 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 42'-0" | 50 | 2.89 | 21 * | 0.852 | | 14-#6+ 7 | 6 | #7 | #8 | 16-#8 | 8 | #5 | #6 | 18-#5 | 426 | 852 | 1147 | 2.66 | 21 | 4 S 6 1 | 6 | #6 | #6 | 12-#9 | 8 | #4 | #5 | 18-#5 |
| D = 15.500 | 100 | 3.63 | 22 * | 0.628 | | 13-#7+ 4 | 6 | #8 | #9 | 17-#9 | 8 | #6 | #6 | 18-#5 | 535 | 1071 | 1442 | 3.33 | 21 * | 4 S 6 1 | 6 | #7 | #7 | 15-#9 | 8 | #5 | #5 | 18-#5 |
| RIB NOT ON | 150 | 4.25 | 28 * | 0.624 | | 12-#8+ 2 | 6 | #9 | #9 | 20-#9 | 8 | #6 | #7 | 21-#5 | 638 | 1275 | 1717 | 3.98 | 21 * | 4 S 6 2 | 6 | #7 | #8 | 19-#9 | 8 | #5 | #6 | 20-#5 |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.850 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.32 | 22 * | 0.899 | | 17-#6+10 | 6 | #8 | #9 | 16-#9 | 9 | #5 | #6 | 20-#5 | 523 | 1045 | 1407 | 3.07 | 22 * | 4 S 6 1 | 6 | #7 | #7 | 15-#9 | 9 | #4 | #5 | 20-#5 |
| D = 15.500 | 100 | 3.96 | 27 * | 0.625 | | 12-#8+ 2 | 6 | #9 | #9 | 21-#9 | 9 | #6 | #6 | 21-#5 | 652 | 1305 | 1756 | 3.68 | 22 * | 4 S 6 2 | 6 | #7 | #8 | 19-#9 | 9 | #5 | #5 | 20-#5 |
| RIB NOT ON | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 0.840 CF/SF | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | | Rib Depth = 14 in. | | Total Slab Depth = 5 in. | | | | | | | | | | | | | |
| 27'-0" | 50 | 1.79 | 13 | 0.640 | | 8-#6+ 0 | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 | 120 | 241 | 324 |
| D = 9.500 | 100 | 1.85 | 13 | 0.640 | | 8-#6+ 0 | 4 | #5 | #5 | 12-#5 | 5 | #4 | #5 | 12-#5 | 150 | 300 | 404 |
| RIB NOT ON | 150 | 2.09 | 13 | 0.640 | | 8-#6+ 0 | 4 | #6 | #6 | 10-#6 | 5 | #4 | #5 | 12-#5 | 179 | 393 | 483 |
| COLUMN LINE | 200 | 2.30 | 13 | 0.711 | | 8-#6+ 1 | 4 | #6 | #7 | 7-#8 | 5 | #4 | #5 | 12-#5 | 209 | 491 | 562 |
| 0.918 CF/SF | 300 | 2.88 | 13 * | 0.840 | | 8-#6+ 3 | 4 | #7 | #8 | 7-#9 | 5 | #5 | #6 | 12-#5 | 268 | 677 | 721 |
| | 400 | 3.58 | 13 * | 0.641 | | 9-#6+ 2 | 4 | #8 | #9 | 9-#9 | 5 | #6 | #7 | 12-#5 | 327 | 860 | 880 |
| | 500 | 4.27 | 14 * | 0.639 | | 8-#7+ 2 | 4 | #9 | #10 | 10-#9 | 5 | #7 | #7 | 12-#5 | 384 | 1036 | 1035 |
| 30'-0" | 50 | 1.84 | 15 | 0.637 | | 9-#6+ 0 | 5 | #5 | #5 | 10-#6 | 5 | #4 | #5 | 12-#5 | 167 | 335 | 451 |
| D = 12.500 | 100 | 2.00 | 15 | 0.637 | | 9-#6+ 0 | 5 | #5 | #6 | 9-#7 | 5 | #4 | #5 | 12-#5 | 208 | 415 | 559 |
| RIB ON | 150 | 2.27 | 15 | 0.666 | | 9-#6+ 0 | 5 | #6 | #6 | 11-#7 | 5 | #5 | #5 | 12-#5 | 248 | 534 | 668 |
| COLUMN LINE | 200 | 2.62 | 15 * | 0.775 | | 9-#6+ 2 | 5 | #7 | #7 | 9-#8 | 5 | #5 | #6 | 12-#5 | 288 | 669 | 776 |
| 0.954 CF/SF | 300 | 3.43 | 15 * | 0.638 | | 10-#6+ 4 | 5 | #8 | #8 | 12-#8 | 5 | #6 | #7 | 12-#5 | 369 | 924 | 993 |
| | 400 | 4.30 | 16 * | 0.636 | 4 S 6 1 | 9-#7+ 2 | 5 | #9 | #9 | 12-#9 | 5 | #7 | #8 | 13-#5 | 448 | 1170 | 1207 |
| | 500 | 4.92 | 21 * | 0.631 | 4 S 6 1 | 11-#7+ 3 | 5 | #9 | #10 | 14-#9 | 5 | #8 | #8 | 15-#5 | 516 | 1354 | 1389 |
| 33'-0" | 50 | 1.99 | 16 | 0.638 | | 10-#6+ 1 | 5 | #5 | #6 | 9-#7 | 6 | #4 | #5 | 14-#5 | 221 | 443 | 596 |
| D = 12.500 | 100 | 2.21 | 16 | 0.724 | | 10-#6+ 2 | 5 | #6 | #6 | 9-#8 | 6 | #4 | #5 | 14-#5 | 275 | 550 | 741 |
| RIB ON | 150 | 2.59 | 16 * | 0.823 | | 10-#6+ 5 | 5 | #7 | #7 | 9-#9 | 6 | #5 | #5 | 14-#5 | 329 | 696 | 885 |
| COLUMN LINE | 200 | 3.14 | 16 * | 0.884 | | 11-#6+ 6 | 5 | #8 | #8 | 10-#9 | 6 | #6 | #6 | 14-#5 | 383 | 878 | 1030 |
| 0.934 CF/SF | 300 | 4.06 | 17 * | 0.635 | 4 S 6 1 | 10-#7+ 3 | 5 | #9 | #9 | 13-#9 | 6 | #7 | #7 | 14-#5 | 489 | 1212 | 1316 |
| | 400 | 5.01 | 22 * | 0.630 | 4 S 6 1 | 9-#8+ 2 | 5 | #10 | #10 | 16-#9 | 6 | #7 | #8 | 17-#5 | 583 | 1467 | 1571 |
| 36'-0" | 50 | 2.23 | 18 | 0.655 | | 11-#6+ 1 | 5 | #6 | #7 | 9-#8 | 7 | #4 | #5 | 16-#5 | 285 | 569 | 766 |
| D = 12.500 | 100 | 2.59 | 18 | 0.779 | | 11-#6+ 4 | 5 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 16-#5 | 354 | 708 | 954 |
| RIB ON | 150 | 2.96 | 18 * | 0.854 | | 12-#6+ 5 | 5 | #7 | #8 | 11-#9 | 7 | #5 | #6 | 16-#5 | 424 | 861 | 1141 |
| COLUMN LINE | 200 | 3.53 | 18 * | 0.634 | 4 S 6 1 | 10-#7+ 1 | 5 | #8 | #9 | 13-#9 | 7 | #6 | #6 | 16-#5 | 494 | 1098 | 1329 |
| 0.918 CF/SF | 300 | 4.81 | 23 * | 0.630 | 4 S 6 1 | 10-#8+ 1 | 5 | #10 | #10 | 17-#9 | 7 | #7 | #7 | 18-#5 | 625 | 1512 | 1683 |
| 39'-0" | 50 | 2.45 | 19 | 0.770 | | 12-#6+ 5 | 6 | #6 | #7 | 12-#8 | 7 | #5 | #5 | 16-#5 | 367 | 734 | 988 |
| D = 15.500 | 100 | 2.92 | 19 * | 0.855 | | 13-#6+ 7 | 6 | #7 | #8 | 12-#9 | 7 | #5 | #6 | 16-#5 | 456 | 912 | 1227 |
| RIB NOT ON | 150 | 3.39 | 19 * | 0.633 | | 22-#5+ 7 | 6 | #8 | #8 | 18-#8 | 7 | #6 | #6 | 16-#5 | 545 | 1089 | 1466 |
| COLUMN LINE | 200 | 4.22 | 22 * | 0.630 | | 13-#7+ 4 | 6 | #9 | #9 | 17-#9 | 7 | #7 | #7 | 18-#5 | 629 | 1381 | 1693 |
| 0.945 CF/SF | 300 | 5.18 | 29 * | 0.625 | | 13-#8+ 2 | 6 | #10 | #10 | 22-#9 | 7 | #7 | #8 | 16-#6 | 783 | 1663 | 2109 |
| 42'-0" | 50 | 2.69 | 21 * | 0.791 | | 13-#6+ 6 | 6 | #7 | #7 | 12-#9 | 8 | #5 | #5 | 18-#5 | 454 | 909 | 1223 |
| D = 15.500 | 100 | 3.20 | 21 * | 0.888 | | 12-#7+ 6 | 6 | #8 | #8 | 15-#9 | 8 | #5 | #6 | 18-#5 | 565 | 1130 | 1521 |
| RIB NOT ON | 150 | 3.84 | 23 * | 0.630 | | 14-#7+ 4 | 6 | #9 | #9 | 18-#9 | 8 | #6 | #6 | 19-#5 | 673 | 1345 | 1811 |
| COLUMN LINE | 200 | 4.61 | 27 * | 0.627 | | 32-#5+ 8 | 6 | #9 | #10 | 21-#9 | 8 | #7 | #7 | 22-#5 | 776 | 1618 | 2089 |
| 0.930 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 3.10 | 22 * | 0.844 | | 12-#7+ 5 | 6 | #8 | #8 | 15-#9 | 9 | #5 | #6 | 20-#5 | 557 | 1114 | 1500 |
| D = 15.500 | 100 | 3.81 | 23 * | 0.918 | | 11-#8+ 6 | 6 | #9 | #9 | 19-#9 | 9 | #6 | #6 | 20-#5 | 692 | 1384 | 1863 |
| RIB NOT ON | 150 | 4.47 | 28 * | 0.626 | | 13-#8+ 4 | 6 | #9 | #10 | 23-#9 | 9 | #6 | #7 | 24-#5 | 820 | 1639 | 2207 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.918 CF/SF | | | | | | | | | | | | | | | | | |
| 48'-0" | 50 | 3.44 | 24 * | 0.892 | | 15-#7+ 9 | 7 | #8 | #8 | 18-#9 | 9 | #6 | #6 | 20-#5 | 681 | 1362 | 1834 |
| D = 18.500 | 100 | 4.24 | 28 * | 0.917 | | 14-#8+ 8 | 7 | #9 | #9 | 23-#9 | 9 | #6 | #7 | 24-#5 | 840 | 1679 | 2261 |
| RIB ON | 150 | 5.11 | 35 * | 0.622 | 4 S 6 1 | 16-#8+ 5 | 7 | #10 | #10 | 28-#9 | 9 | #7 | #7 | 20-#6 | 987 | 1973 | 2656 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.940 CF/SF | | | | | | | | | | | | | | | | | |
| 51'-0" | 50 | 3.90 | 26 * | 0.910 | | 13-#8+ 8 | 7 | #9 | #9 | 22-#9 | 10 | #6 | #6 | 23-#5 | 813 | 1625 | 2188 |
| D = 18.500 | 100 | 4.85 | 33 * | 0.623 | 4 S 6 1 | 13-#9+ 4 | 7 | #10 | #10 | 28-#9 | 10 | #7 | #7 | 29-#5 | 998 | 1996 | 2687 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.928 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 19 in. | | | Rib Depth = 14 in. | | | | Total Slab Depth = 5 in. | | | |
| 1.82 | 13 | | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 |
| 1.82 | 13 | | 4 | #4 | #5 | 8-#6 | 5 | #4 | #5 | 12-#5 |
| 2.02 | 13 | | 4 | #5 | #5 | 7-#7 | 5 | #4 | #5 | 12-#5 |
| 2.19 | 13 | 4 S 6 1 | 4 | #5 | #6 | 8-#7 | 5 | #4 | #5 | 12-#5 |
| 2.64 | 13 | 4 S 6 1 | 4 | #6 | #7 | 8-#8 | 5 | #4 | #5 | 12-#5 |
| 3.14 | 13 * | 4 S 6 1 | 4 | #7 | #7 | 8-#9 | 5 | #5 | #5 | 12-#5 |
| 3.75 | 13 * | 4 S 6 2 | 4 | #8 | #8 | 9-#9 | 5 | #5 | #6 | 12-#5 |
| 1.79 | 15 | | 5 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 12-#5 |
| 1.90 | 15 | | 5 | #4 | #5 | 11-#6 | 5 | #4 | #5 | 12-#5 |
| 2.13 | 15 | | 5 | #5 | #5 | 10-#7 | 5 | #4 | #5 | 12-#5 |
| 2.33 | 15 | | 5 | #5 | #6 | 11-#7 | 5 | #4 | #5 | 12-#5 |
| 3.13 | 15 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 5 | #5 | #6 | 12-#5 |
| 3.82 | 15 * | 4 S 6 1 | 5 | #7 | #8 | 11-#9 | 5 | #6 | #6 | 12-#5 |
| 4.35 | 18 * | 4 S 6 2 | 5 | #8 | #8 | 16-#8 | 5 | #6 | #7 | 14-#5 |
| 1.94 | 16 | | 5 | #4 | #5 | 9-#7 | 6 | #4 | #5 | 14-#5 |
| 2.16 | 16 | | 5 | #5 | #5 | 11-#7 | 6 | #4 | #5 | 14-#5 |
| 2.39 | 16 | 4 S 6 1 | 5 | #5 | #6 | 10-#8 | 6 | #4 | #5 | 14-#5 |
| 2.77 | 16 * | 4 S 6 1 | 5 | #6 | #7 | 9-#9 | 6 | #4 | #5 | 14-#5 |
| 3.61 | 16 * | 4 S 6 2 | 5 | #7 | #8 | 12-#9 | 6 | #5 | #6 | 14-#5 |
| 4.54 | 19 * | 4 S 6 2 | 5 | #8 | #9 | 15-#9 | 6 | #6 | #6 | 16-#5 |
| 2.11 | 18 | | 5 | #5 | #5 | 11-#7 | 7 | #4 | #5 | 16-#5 |
| 2.46 | 18 | 4 S 6 1 | 5 | #5 | #6 | 9-#9 | 7 | #4 | #5 | 16-#5 |
| 2.75 | 18 * | 4 S 6 1 | 5 | #6 | #7 | 10-#9 | 7 | #4 | #5 | 16-#5 |
| 3.22 | 18 * | 4 S 6 2 | 5 | #7 | #7 | 12-#9 | 7 | #5 | #5 | 16-#5 |
| 4.43 | 18 * | 4 S 6 2 | 5 | #8 | #9 | 16-#9 | 7 | #6 | #6 | 17-#5 |
| 2.33 | 19 | | 6 | #5 | #6 | 11-#8 | 7 | #4 | #5 | 16-#5 |
| 2.67 | 19 | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 7 | #4 | #5 | 16-#5 |
| 3.12 | 19 * | 4 S 6 1 | 6 | #6 | #7 | 13-#9 | 7 | #5 | #5 | 16-#5 |
| 3.80 | 19 * | 4 S 6 1 | 6 | #7 | #8 | 16-#9 | 7 | #5 | #6 | 17-#5 |
| 4.61 | 24 * | 4 S 6 2 | 6 | #8 | #8 | 20-#9 | 7 | #6 | #6 | 21-#5 |
| 2.59 | 21 | 4 S 6 1 | 6 | #6 | #6 | 11-#9 | 8 | #4 | #5 | 18-#5 |
| 2.96 | 21 * | 4 S 6 1 | 6 | #6 | #7 | 14-#9 | 8 | #4 | #5 | 18-#5 |
| 3.50 | 21 * | 4 S 6 2 | 6 | #7 | #7 | 17-#9 | 8 | #5 | #5 | 18-#5 |
| 4.21 | 21 * | 4 S 6 2 | 6 | #8 | #8 | 20-#9 | 8 | #5 | #6 | 21-#5 |
| 2.86 | 22 | 4 S 6 1 | 6 | #6 | #7 | 14-#9 | 9 | #4 | #5 | 20-#5 |
| 3.52 | 22 * | 4 S 6 2 | 6 | #7 | #8 | 17-#9 | 9 | #5 | #5 | 20-#5 |
| 4.14 | 22 * | 4 S 6 2 | 6 | #8 | #8 | 21-#9 | 9 | #5 | #6 | 22-#5 |
| 3.19 | 24 * | 4 S 6 1 | 7 | #6 | #7 | 17-#9 | 9 | #5 | #5 | 20-#5 |
| 3.94 | 24 * | 4 S 6 2 | 7 | #7 | #8 | 21-#9 | 9 | #5 | #6 | 23-#5 |
| 4.71 | 26 * | 4 S 6 2 | 7 | #8 | #8 | 26-#9 | 9 | #6 | #6 | 27-#5 |
| 3.64 | 25 * | 4 S 6 1 | 7 | #7 | #8 | 21-#9 | 10 | #5 | #5 | 22-#5 |
| 4.34 | 25 * | 4 S 6 2 | 7 | #8 | #8 | 26-#9 | 10 | #5 | #6 | 27-#5 |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 21 in. | | Rib Depth = 16 in. | | Total Slab Depth = 5 in. | | | | | | | | | | | | | |
| 30'-0" | 50 | 1.77 | 15 | 0.639 | | 9-#6+ 0 | 5 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 12-#5 | 178 | 357 | 480 |
| D = 12.500 | 100 | 1.88 | 15 | 0.639 | | 9-#6+ 0 | 5 | #5 | #5 | 11-#6 | 5 | #4 | #5 | 12-#5 | 219 | 437 | 588 |
| RIB ON | 150 | 2.16 | 15 | 0.639 | | 9-#6+ 0 | 5 | #6 | #6 | 10-#7 | 5 | #4 | #5 | 12-#5 | 259 | 550 | 697 |
| COLUMN LINE | 200 | 2.52 | 15 | 0.671 | | 9-#6+ 1 | 5 | #6 | #7 | 11-#7 | 5 | #5 | #6 | 12-#5 | 299 | 687 | 805 |
| 1.039 CF/SF | 300 | 3.19 | 15 * | 0.827 | | 10-#6+ 3 | 5 | #7 | #8 | 9-#9 | 5 | #6 | #7 | 12-#5 | 380 | 944 | 1022 |
| | 400 | 3.83 | 15 * | 0.640 | | 12-#6+ 2 | 5 | #8 | #9 | 11-#9 | 5 | #7 | #7 | 12-#5 | 460 | 1195 | 1239 |
| | 500 | 4.60 | 16 * | 0.639 | 4 S 6 1 | 10-#7+ 1 | 5 | #9 | #10 | 16-#8 | 5 | #7 | #8 | 14-#5 | 539 | 1438 | 1452 |
| 33'-0" | 50 | 1.96 | 16 | 0.638 | | 10-#6+ 0 | 5 | #5 | #6 | 9-#7 | 6 | #4 | #5 | 14-#5 | 236 | 471 | 634 |
| D = 12.500 | 100 | 2.15 | 16 | 0.638 | | 10-#6+ 0 | 5 | #6 | #6 | 11-#7 | 6 | #4 | #5 | 14-#5 | 289 | 579 | 779 |
| RIB ON | 150 | 2.45 | 16 | 0.655 | | 10-#6+ 0 | 5 | #6 | #7 | 10-#8 | 6 | #5 | #5 | 14-#5 | 343 | 719 | 924 |
| COLUMN LINE | 200 | 2.87 | 16 * | 0.784 | | 10-#6+ 3 | 5 | #7 | #8 | 9-#9 | 6 | #5 | #6 | 14-#5 | 397 | 902 | 1068 |
| 1.016 CF/SF | 300 | 3.80 | 16 * | 0.639 | | 9-#7+ 2 | 5 | #9 | #9 | 12-#9 | 6 | #6 | #7 | 14-#5 | 504 | 1244 | 1358 |
| | 400 | 4.78 | 18 * | 0.636 | 4 S 6 1 | 9-#8+ 1 | 5 | #10 | #10 | 15-#9 | 6 | #7 | #8 | 15-#5 | 609 | 1570 | 1639 |
| 36'-0" | 50 | 2.16 | 18 | 0.635 | | 11-#6+ 1 | 5 | #6 | #6 | 9-#8 | 7 | #4 | #5 | 16-#5 | 303 | 606 | 815 |
| D = 12.500 | 100 | 2.45 | 18 | 0.680 | | 11-#6+ 2 | 5 | #7 | #7 | 9-#9 | 7 | #4 | #5 | 16-#5 | 372 | 745 | 1003 |
| RIB ON | 150 | 2.75 | 18 * | 0.789 | | 11-#6+ 5 | 5 | #7 | #8 | 10-#9 | 7 | #5 | #5 | 16-#5 | 442 | 895 | 1190 |
| COLUMN LINE | 200 | 3.38 | 18 * | 0.855 | | 10-#7+ 3 | 5 | #8 | #9 | 12-#9 | 7 | #6 | #6 | 16-#5 | 512 | 1134 | 1378 |
| 0.998 CF/SF | 300 | 4.46 | 18 * | 0.636 | 4 S 6 1 | 9-#8+ 2 | 5 | #10 | #10 | 16-#9 | 7 | #7 | #7 | 16-#5 | 651 | 1574 | 1752 |
| 39'-0" | 50 | 2.39 | 19 | 0.637 | | 12-#6+ 1 | 6 | #6 | #7 | 11-#8 | 7 | #5 | #5 | 16-#5 | 391 | 782 | 1052 |
| D = 15.500 | 100 | 2.77 | 19 * | 0.764 | | 12-#6+ 4 | 6 | #7 | #7 | 11-#9 | 7 | #5 | #6 | 16-#5 | 480 | 959 | 1291 |
| RIB NOT ON | 150 | 3.16 | 19 * | 0.870 | | 11-#7+ 5 | 6 | #7 | #8 | 13-#9 | 7 | #6 | #6 | 16-#5 | 568 | 1137 | 1530 |
| COLUMN LINE | 200 | 3.80 | 19 * | 0.635 | | 12-#7+ 3 | 6 | #8 | #9 | 16-#9 | 7 | #6 | #7 | 17-#5 | 657 | 1441 | 1769 |
| 1.029 CF/SF | 300 | 5.18 | 25 * | 0.630 | | 12-#8+ 2 | 6 | #10 | #10 | 20-#9 | 7 | #7 | #8 | 21-#5 | 823 | 1974 | 2216 |
| 42'-0" | 50 | 2.63 | 21 | 0.731 | | 13-#6+ 5 | 6 | #7 | #7 | 11-#9 | 8 | #5 | #5 | 18-#5 | 483 | 967 | 1302 |
| D = 15.500 | 100 | 3.13 | 21 * | 0.831 | | 11-#7+ 5 | 6 | #8 | #8 | 14-#9 | 8 | #5 | #6 | 18-#5 | 594 | 1188 | 1599 |
| RIB NOT ON | 150 | 3.66 | 21 * | 0.911 | | 13-#7+ 8 | 6 | #8 | #9 | 17-#9 | 8 | #6 | #6 | 18-#5 | 705 | 1409 | 1897 |
| COLUMN LINE | 200 | 4.30 | 23 * | 0.632 | | 12-#8+ 2 | 6 | #9 | #10 | 20-#9 | 8 | #6 | #7 | 21-#5 | 812 | 1705 | 2185 |
| 1.012 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 2.96 | 22 * | 0.793 | | 11-#7+ 5 | 6 | #8 | #8 | 14-#9 | 9 | #5 | #5 | 20-#5 | 593 | 1185 | 1595 |
| D = 15.500 | 100 | 3.50 | 22 * | 0.894 | | 14-#7+ 8 | 6 | #8 | #9 | 18-#9 | 9 | #6 | #6 | 20-#5 | 729 | 1458 | 1962 |
| RIB NOT ON | 150 | 4.20 | 24 * | 0.631 | | 32-#5+ 7 | 6 | #9 | #10 | 21-#9 | 9 | #6 | #7 | 22-#5 | 862 | 1723 | 2320 |
| COLUMN LINE | 200 | 4.94 | 28 * | 0.628 | | 11-#9+ 3 | 6 | #10 | #10 | 25-#9 | 9 | #7 | #7 | 26-#5 | 989 | 2017 | 2664 |
| 0.998 CF/SF | | | | | | | | | | | | | | | | | |
| 48'-0" | 50 | 3.29 | 24 * | 0.844 | | 14-#7+ 7 | 7 | #8 | #8 | 17-#9 | 9 | #6 | #6 | 20-#5 | 725 | 1450 | 1952 |
| D = 18.500 | 100 | 4.08 | 24 * | 0.924 | | 13-#8+ 8 | 7 | #9 | #9 | 22-#9 | 9 | #6 | #7 | 23-#5 | 890 | 1780 | 2396 |
| RIB ON | 150 | 4.74 | 29 * | 0.627 | | 15-#8+ 3 | 7 | #9 | #10 | 26-#9 | 9 | #7 | #7 | 27-#5 | 1045 | 2090 | 2814 |
| COLUMN LINE | 200 | 5.49 | 34 * | 0.625 | 4 S 6 1 | 14-#9+ 3 | 7 | #10 | #10 | 30-#9 | 9 | #7 | #8 | 22-#6 | 1191 | 2381 | 3205 |
| 1.023 CF/SF | | | | | | | | | | | | | | | | | |
| 51'-0" | 50 | 3.64 | 25 * | 0.889 | | 32-#5+19 | 7 | #8 | #9 | 21-#9 | 10 | #6 | #6 | 22-#5 | 866 | 1732 | 2332 |
| D = 18.500 | 100 | 4.49 | 28 * | 0.628 | | 16-#8+ 5 | 7 | #9 | #10 | 26-#9 | 10 | #6 | #7 | 27-#5 | 1059 | 2118 | 2851 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.009 CF/SF | | | | | | | | | | | | | | | | | |
| 54'-0" | 50 | 4.11 | 27 * | 0.908 | | 15-#8+ 8 | 7 | #9 | #10 | 25-#9 | 11 | #6 | #6 | 26-#5 | 1022 | 2044 | 2751 |
| D = 18.500 | | | | | | | | | | | | | | | | | |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 0.998 CF/SF | | | | | | | | | | | | | | | | | |
| 57'-0" | 50 | 4.57 | 31 * | 0.918 | | 18-#8+12 | 8 | #9 | #10 | 30-#9 | 11 | #6 | #7 | 31-#5 | 1208 | 2416 | 3252 |
| D =21.500 | | | | | | | | | | | | | | | | | |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.019 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 21 in. | | Rib Depth = 16 in. | | Total Slab Depth = 5 in. | | | | | | | |
| 30'-0" | 1.79 | 15 | | 5 | #4 | #5 | 9-#6 | 5 | #4 | #5 | 12-#5 |
| D = 12.500 | 1.83 | 15 | | 5 | #4 | #5 | 10-#6 | 5 | #4 | #5 | 12-#5 |
| RIB ON | 2.07 | 15 | | 5 | #5 | #5 | 9-#7 | 5 | #4 | #5 | 12-#5 |
| COLUMN LINE | 2.33 | 15 | | 5 | #5 | #6 | 11-#7 | 5 | #4 | #5 | 12-#5 |
| 1.039 CF/SF | 2.85 | 15 | 4 S 6 1 | 5 | #6 | #7 | 10-#8 | 5 | #5 | #5 | 12-#5 |
| | 3.36 | 15 * | 4 S 6 1 | 5 | #7 | #7 | 10-#9 | 5 | #5 | #6 | 12-#5 |
| | 4.08 | 15 * | 4 S 6 2 | 5 | #7 | #8 | 12-#9 | 5 | #6 | #7 | 13-#5 |
| 33'-0" | 1.87 | 16 | | 5 | #4 | #5 | 11-#6 | 6 | #4 | #5 | 14-#5 |
| D = 12.500 | 2.08 | 16 | | 5 | #5 | #5 | 10-#7 | 6 | #4 | #5 | 14-#5 |
| RIB ON | 2.32 | 16 | | 5 | #5 | #6 | 9-#8 | 6 | #4 | #5 | 14-#5 |
| COLUMN LINE | 2.65 | 16 | 4 S 6 1 | 5 | #6 | #6 | 9-#9 | 6 | #4 | #5 | 14-#5 |
| 1.016 CF/SF | 3.38 | 16 * | 4 S 6 1 | 5 | #7 | #7 | 11-#9 | 6 | #5 | #6 | 14-#5 |
| | 4.14 | 16 * | 4 S 6 2 | 5 | #8 | #8 | 14-#9 | 6 | #6 | #6 | 14-#5 |
| 36'-0" | 2.11 | 18 | | 5 | #5 | #5 | 11-#7 | 7 | #4 | #5 | 16-#5 |
| D = 12.500 | 2.32 | 18 | 4 S 6 1 | 5 | #5 | #6 | 10-#8 | 7 | #4 | #5 | 16-#5 |
| RIB ON | 2.58 | 18 | 4 S 6 1 | 5 | #6 | #6 | 12-#8 | 7 | #4 | #5 | 16-#5 |
| COLUMN LINE | 2.99 | 18 * | 4 S 6 1 | 5 | #7 | #7 | 11-#9 | 7 | #4 | #5 | 16-#5 |
| 0.998 CF/SF | 3.85 | 18 * | 4 S 6 2 | 5 | #8 | #8 | 18-#8 | 7 | #5 | #6 | 16-#5 |
| 39'-0" | 2.23 | 19 | | 6 | #5 | #5 | 11-#8 | 7 | #4 | #5 | 16-#5 |
| D = 15.500 | 2.59 | 19 | | 6 | #6 | #6 | 13-#8 | 7 | #4 | #5 | 16-#5 |
| RIB NOT ON | 2.87 | 19 * | 4 S 6 1 | 6 | #6 | #7 | 12-#9 | 7 | #4 | #5 | 16-#5 |
| COLUMN LINE | 3.45 | 19 * | 4 S 6 1 | 6 | #7 | #7 | 18-#8 | 7 | #5 | #6 | 16-#5 |
| 1.029 CF/SF | 4.80 | 19 * | 4 S 6 2 | 6 | #8 | #9 | 19-#9 | 7 | #6 | #7 | 20-#5 |
| 42'-0" | 2.52 | 21 | | 6 | #6 | #6 | 13-#8 | 8 | #4 | #5 | 18-#5 |
| D = 15.500 | 2.89 | 21 | 4 S 6 1 | 6 | #6 | #7 | 13-#9 | 8 | #4 | #5 | 18-#5 |
| RIB NOT ON | 3.39 | 21 * | 4 S 6 1 | 6 | #7 | #7 | 16-#9 | 8 | #5 | #5 | 18-#5 |
| COLUMN LINE | 3.85 | 21 * | 4 S 6 2 | 6 | #7 | #8 | 18-#9 | 8 | #5 | #6 | 19-#5 |
| 1.012 CF/SF | | | | | | | | | | | |
| 45'-0" | 2.80 | 22 | 4 S 6 1 | 6 | #6 | #7 | 13-#9 | 9 | #4 | #5 | 20-#5 |
| D = 15.500 | 3.14 | 22 * | 4 S 6 1 | 6 | #7 | #7 | 16-#9 | 9 | #4 | #5 | 20-#5 |
| RIB NOT ON | 3.75 | 22 * | 4 S 6 2 | 6 | #7 | #8 | 20-#9 | 9 | #5 | #5 | 20-#5 |
| COLUMN LINE | 4.51 | 22 * | 4 S 6 2 | 6 | #8 | #9 | 23-#9 | 9 | #5 | #6 | 24-#5 |
| 0.998 CF/SF | | | | | | | | | | | |
| 48'-0" | 2.95 | 24 | 4 S 6 1 | 7 | #6 | #7 | 16-#9 | 9 | #4 | #5 | 20-#5 |
| D = 18.500 | 3.68 | 24 * | 4 S 6 1 | 7 | #7 | #8 | 20-#9 | 9 | #5 | #5 | 21-#5 |
| RIB ON | 4.33 | 24 * | 4 S 6 2 | 7 | #8 | #8 | 24-#9 | 9 | #5 | #6 | 25-#5 |
| COLUMN LINE | 5.09 | 27 * | 4 S 6 2 | 7 | #8 | #9 | 28-#9 | 9 | #6 | #6 | 21-#6 |
| 1.023 CF/SF | | | | | | | | | | | |
| 51'-0" | 3.37 | 25 * | 4 S 6 1 | 7 | #7 | #7 | 19-#9 | 10 | #5 | #5 | 22-#5 |
| D = 18.500 | 4.16 | 25 * | 4 S 6 2 | 7 | #8 | #8 | 24-#9 | 10 | #5 | #6 | 25-#5 |
| RIB ON | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | |
| 1.009 CF/SF | | | | | | | | | | | |
| 54'-0" | 3.80 | 27 * | 4 S 6 2 | 7 | #8 | #8 | 23-#9 | 11 | #5 | #5 | 24-#5 |
| D = 18.500 | | | | | | | | | | | |
| RIB ON | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | |
| 0.998 CF/SF | | | | | | | | | | | |
| 57'-0" | 4.26 | 28 * | 4 S 6 1 | 8 | #8 | #8 | 28-#9 | 11 | #5 | #6 | 29-#5 |
| D =21.500 | | | | | | | | | | | |
| RIB NOT ON | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | |
| 1.019 CF/SF | | | | | | | | | | | |

# WAFFLE FLAT SLAB SYSTEM 30″ × 30″ Domes: 6″ Ribs @ 36″

$f'_c$ = 4,000 psi
Grade 60 Bars

## SQUARE EDGE PANELS

| Span c.-c. Columns $\ell_1 = \ell_2$ (ft) | Factored Super-imposed Load (psf) | (1) Steel (psf) | Square Edge Column $c_1 = c_2$ (in.) | $\gamma_f$ | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Top Edge No.-size + | Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size | Moments –M Edge (ft-k) | Moments +M Bot. (ft-k) | Moments –M Int. (ft-k) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 25 in. | Rib Depth = 20 in. | | Total Slab Depth = 5 in. | | | | | | | | | | | | | | |
| 33'-0" | 50 | 2.03 | 16 | 0.641 | | 10-#6+ 0 | 5 | #5 | #5 | 11-#6 | 6 | #5 | #5 | 14-#5 | 265 | 530 | 714 |
| D = 12.500 | 100 | 2.18 | 16 | 0.641 | | 10-#6+ 0 | 5 | #5 | #6 | 10-#7 | 6 | #5 | #5 | 14-#5 | 319 | 638 | 859 |
| RIB ON | 150 | 2.35 | 16 | 0.641 | | 10-#6+ 0 | 5 | #6 | #6 | 9-#8 | 6 | #5 | #5 | 14-#5 | 373 | 759 | 1004 |
| COLUMN LINE | 200 | 2.59 | 16 | 0.641 | | 10-#6+ 1 | 5 | #7 | #7 | 10-#8 | 6 | #5 | #5 | 14-#5 | 427 | 946 | 1148 |
| 1.186 CF/SF | 300 | 3.21 | 16 | 0.740 | | 11-#6+ 2 | 5 | #8 | #8 | 10-#9 | 6 | #6 | #6 | 14-#5 | 534 | 1297 | 1438 |
| | 400 | 4.05 | 16 * | 0.642 | | 10-#7+ 1 | 5 | #9 | #9 | 16-#8 | 6 | #7 | #7 | 14-#5 | 642 | 1635 | 1728 |
| | 500 | 4.79 | 16 * | 0.642 | 5 S 8 1 | 9-#8+ 1 | 5 | #10 | #10 | 15-#9 | 6 | #7 | #8 | 16-#5 | 749 | 1967 | 2017 |
| 36'-0" | 50 | 2.26 | 18 | 0.639 | | 11-#6+ 0 | 5 | #6 | #6 | 11-#7 | 7 | #5 | #5 | 16-#5 | 341 | 682 | 917 |
| D = 12 .500 | 100 | 2.46 | 18 | 0.639 | | 11-#6+ 0 | 5 | #6 | #7 | 10-#8 | 7 | #5 | #5 | 16-#5 | 410 | 821 | 1105 |
| RIB ON | 150 | 2.67 | 18 | 0.639 | | 11-#6+ 0 | 5 | #7 | #7 | 9-#9 | 7 | #5 | #5 | 16-#5 | 480 | 960 | 1292 |
| COLUMN LINE | 200 | 3.05 | 18 | 0.639 | | 12-#6+ 0 | 5 | #8 | #8 | 13-#8 | 7 | #5 | #6 | 16-#5 | 550 | 1196 | 1480 |
| 1.165 CF/SF | 300 | 3.82 | 18 * | 0.845 | | 11-#7+ 3 | 5 | #9 | #9 | 14-#9 | 7 | #6 | #7 | 16-#5 | 689 | 1650 | 1855 |
| | 400 | 4.73 | 18 * | 0.640 | 5 S 8 1 | 10-#8+ 1 | 5 | #10 | #10 | 16-#9 | 7 | #7 | #7 | 17-#5 | 828 | 2085 | 2230 |
| 39'-0" | 50 | 2.34 | 19 | 0.638 | | 12-# 6+ 1 | 6 | #6 | #6 | 11-#8 | 7 | #5 | #5 | 16-#5 | 440 | 881 | 1186 |
| D = 15.500 | 100 | 2.57 | 19 | 0.638 | | 12-#6+ 2 | 6 | #6 | #7 | 13-#8 | 7 | #5 | #5 | 16-#5 | 529 | 1058 | 1424 |
| RIB NOT ON | 150 | 2.99 | 19 | 0.707 | | 13-#6+ 3 | 6 | #7 | #8 | 12-#9 | 7 | #5 | #6 | 16-#5 | 618 | 1236 | 1663 |
| COLUMN LINE | 200 | 3.36 | 19 * | 0.826 | | 11-#7+ 5 | 6 | #8 | #8 | 14-#9 | 7 | #6 | #6 | 16-#5 | 707 | 1526 | 1902 |
| 1.203 CF/SF | 300 | 4.45 | 19 * | 0.639 | | 14-#7+ 2 | 6 | #9 | #10 | 17-#9 | 7 | #7 | #7 | 19-#5 | 884 | 2105 | 2380 |
| 42'-0" | 50 | 2.59 | 21 | 0.636 | | 13-#6+ 1 | 6 | #7 | #7 | 13-#8 | 8 | #5 | #5 | 18-#5 | 544 | 1089 | 1466 |
| D = 15.500 | 100 | 2.96 | 21 | 0.652 | | 14-#6+ 2 | 6 | #7 | #8 | 16-#8 | 8 | #5 | #6 | 18-#5 | 655 | 1310 | 1763 |
| RIB NOT ON | 150 | 3.28 | 21 * | 0.793 | | 12-#7+ 4 | 6 | #8 | #8 | 15-#9 | 8 | #5 | #6 | 18-#5 | 765 | 1531 | 2061 |
| COLUMN LINE | 200 | 3.85 | 21 * | 0.867 | | 14-#7+ 5 | 6 | #9 | #9 | 17-#9 | 8 | #6 | #7 | 18-#5 | 876 | 1833 | 2359 |
| 1.182 CF/SF | | | | | | | | | | | | | | | | | |
| 45'-0" | 50 | 2.81 | 22 | 0.635 | | 14-#6+ 2 | 6 | #7 | #8 | 16-#8 | 9 | #5 | #5 | 20-#5 | 667 | 1334 | 1796 |
| D = 15.500 | 100 | 3.26 | 22 * | 0.769 | | 17-#6+ 5 | 6 | #8 | #8 | 16-#9 | 9 | #5 | #6 | 20-#5 | 803 | 1606 | 2162 |
| RIB NOT ON | 150 | 3.81 | 22 * | 0.874 | | 11-#8+ 6 | 6 | #9 | #9 | 19-#9 | 9 | #6 | #6 | 20-#5 | 939 | 1879 | 2529 |
| COLUMN LINE | 200 | 4.38 | 22 * | 0.636 | | 13-#8+ 2 | 6 | #9 | #10 | 22-#9 | 9 | #6 | #7 | 23-#5 | 1076 | 2202 | 2896 |
| 1.165 CF/SF | | | | | | | | | | | | | | | | | |
| 48'-0" | 50 | 3.12 | 24 | 0.734 | | 17-#6+ 7 | 7 | #7 | #8 | 16-#9 | 9 | #5 | #6 | 20-#5 | 817 | 1633 | 2199 |
| D = 18.500 | 100 | 3.64 | 24 * | 0.836 | | 15-#7+ 7 | 7 | #8 | #9 | 19-#9 | 9 | #6 | #6 | 20-#5 | 982 | 1963 | 2643 |
| RIB ON | 150 | 4.24 | 24 * | 0.913 | | 14-#8+ 8 | 7 | #9 | #9 | 23-#9 | 9 | #6 | #7 | 24-#5 | 1147 | 2293 | 3087 |
| COLUMN LINE | 200 | 4.87 | 25 * | 0.634 | | 16-#8+ 3 | 7 | #9 | #10 | 26-#9 | 9 | #7 | #7 | 20-#6 | 1309 | 2619 | 3525 |
| 1.195 CF/SF | | | | | | | | | | | | | | | | | |
| 51'-0" | 50 | 3.54 | 25 * | 0.794 | | 15-#7+ 6 | 7 | #8 | #9 | 19-#9 | 10 | #6 | #6 | 22-#5 | 975 | 1951 | 2626 |
| D = 18.500 | 100 | 4.07 | 25 * | 0.893 | | 14-#8+ 8 | 7 | #9 | #9 | 23-#9 | 10 | #6 | #7 | 25-#5 | 1174 | 2347 | 3160 |
| RIB ON | 150 | 4.85 | 26 * | 0.633 | | 13-#9+ 4 | 7 | #10 | #10 | 28-#9 | 10 | #7 | #7 | 29-#5 | 1369 | 2739 | 3687 |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.179 CF/SF | | | | | | | | | | | | | | | | | |
| 54'-0" | 50 | 3.82 | 27 * | 0.844 | | 14-#8+ 7 | 7 | #9 | #9 | 23-#9 | 11 | #6 | #6 | 24-#5 | 1150 | 2300 | 3096 |
| D = 18.500 | 100 | 4.58 | 27 * | 0.919 | | 13-#9+ 8 | 7 | #10 | #10 | 28-#9 | 11 | #6 | #7 | 29-#5 | 1385 | 2770 | 3729 |
| RIB ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.165 CF/SF | | | | | | | | | | | | | | | | | |
| 57'-0" | 50 | 4.33 | 28 * | 0.888 | | 17-#8+ 9 | 8 | #9 | #10 | 27-#9 | 11 | #6 | #7 | 29-#5 | 1367 | 2734 | 3681 |
| D =21.500 | 100 | 5.19 | 31 * | 0.630 | | 16-#9+ 5 | 8 | #10 | #10 | 33-#9 | 11 | #7 | #7 | 25-#6 | 1636 | 3272 | 4405 |
| RIB NOT ON | | | | | | | | | | | | | | | | | |
| COLUMN LINE | | | | | | | | | | | | | | | | | |
| 1.190 CF/SF | | | | | | | | | | | | | | | | | |

## SQUARE INTERIOR PANELS

| (1) Steel (psf) | Square Interior Column $c_1 = c_2$ (in.) | (2) Stirrups | Reinforcing Bars—Each Direction: Column Strip Bottom No. Ribs | Column Strip Bottom Long Bars | Column Strip Bottom Short Bars | Column Strip Top Interior No.-size | Middle Strip Bottom No. Ribs | Middle Strip Bottom Long Bars | Middle Strip Bottom Short Bars | Middle Strip Top Interior No.-size |
|---|---|---|---|---|---|---|---|---|---|---|
| Total Depth = 25 in. | Rib Depth = 20 in. | Total Slab Depth = 5 in. | | | | | | | | |
| 2.03 | 16 | | 5 | #5 | #5 | 10-#6 | 6 | #5 | #5 | 14-#5 |
| 2.16 | 16 | | 5 | #5 | #5 | 9-#7 | 6 | #5 | #5 | 14-#5 |
| 2.30 | 16 | | 5 | #5 | #5 | 11-#7 | 6 | #5 | #5 | 14-#5 |
| 2.46 | 16 | | 5 | #5 | #6 | 9-#8 | 6 | #5 | #5 | 14-#5 |
| 2.91 | 16 | 5 S 8 1 | 5 | #6 | #7 | 9-#9 | 6 | #5 | #5 | 14-#5 |
| 3.61 | 16 * | 5 S 8 1 | 5 | #7 | #8 | 12-#9 | 6 | #5 | #6 | 14-#5 |
| 4.14 | 16 * | 5 S 8 2 | 5 | #8 | #8 | 14-#9 | 6 | #6 | #6 | 14-#5 |
| 2.18 | 18 | | 5 | #5 | #5 | 10-#7 | 7 | #5 | #5 | 16-#5 |
| 2.41 | 18 | | 5 | #5 | #6 | 9-#8 | 7 | #5 | #5 | 16-#5 |
| 2.61 | 18 | 5 S 8 1 | 5 | #5 | #6 | 9-#9 | 7 | #5 | #5 | 16-#5 |
| 2.84 | 18 | 5 S 8 1 | 5 | #6 | #7 | 12-#8 | 7 | #5 | #5 | 16-#5 |
| 3.37 | 18 * | 5 S 8 1 | 5 | #7 | #8 | 12-#9 | 7 | #5 | #5 | 16-#5 |
| 4.32 | 18 * | 5 S 8 2 | 5 | #8 | #9 | 15-#9 | 7 | #6 | #6 | 16-#5 |
| 2.28 | 19 | | 6 | #5 | #5 | 13-#7 | 7 | #5 | #5 | 16-#5 |
| 2.53 | 19 | | 6 | #5 | #6 | 12-#8 | 7 | #5 | #5 | 16-#5 |
| 2.81 | 19 | | 6 | #6 | #6 | 11-#9 | 7 | #5 | #5 | 16-#5 |
| 3.06 | 19 | 5 S 8 1 | 6 | #6 | #7 | 16-#8 | 7 | #5 | #5 | 16-#5 |
| 3.96 | 19 * | 5 S 8 1 | 6 | #7 | #8 | 16-#9 | 7 | #6 | #6 | 17-#5 |
| 2.48 | 21 | | 6 | #5 | #6 | 12-#8 | 8 | #5 | #5 | 18-#5 |
| 2.81 | 21 | | 6 | #6 | #6 | 12-#9 | 8 | #5 | #5 | 18-#5 |
| 3.10 | 21 | 5 S 8 1 | 6 | #6 | #7 | 14-#9 | 8 | #5 | #5 | 18-#5 |
| 3.39 | 21 * | 5 S 8 1 | 6 | #7 | #7 | 16-#9 | 8 | #5 | #5 | 18-#5 |
| 2.74 | 22 | | 6 | #6 | #6 | 12-#9 | 9 | #5 | #5 | 20-#5 |
| 3.13 | 22 | 5 S 8 1 | 6 | #7 | #7 | 18-#8 | 9 | #5 | #5 | 20-#5 |
| 3.52 | 22 * | 5 S 8 1 | 6 | #7 | #8 | 17-#9 | 9 | #5 | #5 | 20-#5 |
| 4.02 | 22 * | 5 S 8 2 | 6 | #8 | #8 | 20-#9 | 9 | #5 | #6 | 21-#5 |
| 3.03 | 24 | | 7 | #6 | #7 | 15-#9 | 9 | #5 | #5 | 20-#5 |
| 3.37 | 24 | 5 S 8 1 | 7 | #7 | #7 | 18-#9 | 9 | #5 | #5 | 20-#5 |
| 3.92 | 24 * | 5 S 8 1 | 7 | #7 | #8 | 21-#9 | 9 | #5 | #6 | 22-#5 |
| 4.52 | 24 * | 5 S 8 2 | 7 | #8 | #8 | 24-#9 | 9 | #6 | #6 | 26-#5 |
| 3.28 | 25 | 5 S 8 1 | 7 | #7 | #7 | 18-#9 | 10 | #5 | #5 | 22-#5 |
| 3.72 | 25 * | 5 S 8 1 | 7 | #7 | #8 | 22-#9 | 10 | #5 | #5 | 23-#5 |
| 4.34 | 25 * | 5 S 8 2 | 7 | #8 | #8 | 26-#9 | 10 | #5 | #6 | 27-#5 |
| 3.54 | 27 | 5 S 8 1 | 7 | #7 | #8 | 21-#9 | 11 | #5 | #5 | 24-#5 |
| 4.18 | 27 * | 5 S 8 2 | 7 | #8 | #8 | 26-#9 | 11 | #5 | #6 | 27-#5 |
| 3.91 | 28 * | 5 S 8 1 | 8 | #7 | #8 | 25-#9 | 11 | #5 | #6 | 27-#5 |
| 4.86 | 28 * | 5 S 8 2 | 8 | #8 | #9 | 31-#9 | 11 | #6 | #6 | 32-#5 |

NOTES *Factored shear stress for the column size so designated is greater than $4\sqrt{f'_c}$ but less than $6\sqrt{f'_c}$. Headed shear stud reinforcement, shear reinforcement (bars or wires and single- or multiple-leg stirrups), structural steel shearheads, or shear caps must be provided with columns indicated.

(1) Average reinforcing steel weight (psf) includes twice the flexural reinforcement tabulated (tabulated reinforcement placed in each direction). Shrinkage and temperature reinforcement, integrity reinforcement, and shear reinforcement are not included.

(2) The notation "3 S 4 1" for the stirrups: the first character "3" is the bar size, i.e., #3; the "S" stands for "stirrup"; and the "4" is the spacing of the stirrups in inches. The last character indicates the length over which stirrups are required in each joist rib; the "1" denotes the length from the face of the solid head to the first cross rib, i.e., a length of one module; a "2" indicates stirrups are required to the second cross rib from the face of the solid head, i.e., a length of two modules.

# CHAPTER 12 – BEAMS

## INTRODUCTION

**General.** The tabulated designs of rectangular beams in this Chapter are based on the Strength Design Method in the ACI Building Code. Appropriate load factors must be applied to service dead and live loads before using the tabulated designs. In the tabulated designs, the nominal design strength has been reduced to a usable factored load capacity by the prescribed strength-reduction $\phi$-factors.

The tabulated designs are based on $f'_c$ = 4,000 psi and $f_y$ = 60,000 psi (Grade 60 reinforcing bars). Variations in $f'_c$ between 3,000 psi and 5,000 psi will not significantly affect load capacity for flexural design strength nor the flexural reinforcement required. For $f'_c$ > 4,000 psi, the minor reductions in stirrup requirements can usually be neglected since the potential reduction, $(2\sqrt{f'_c} - 63)$ psi, is sharply limited by the maximum spacing requirements (ACI 11.4.5) and minimum stirrup requirements (ACI 11.4.6).

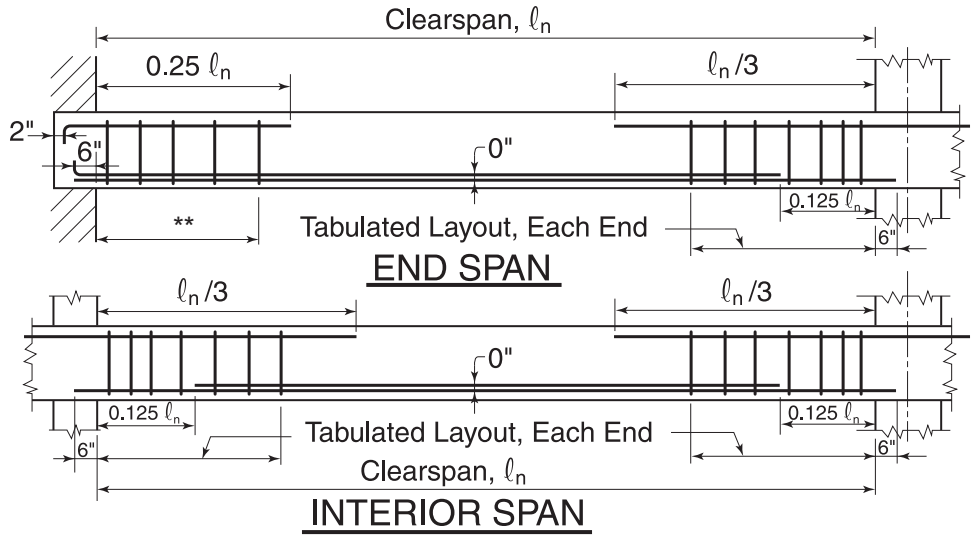
Unlike the other tabulated designs in this Handbook, the factored dead weight of the beam has not been deducted. The total load capacities have been reduced by strength-reduction or $\phi$-factors with no deduction for dead weight of the beam. Most of the dead weight of a floor system is in the tributary slabs or joists; therefore, selfweight of a beam is typically only a small part of the dead load it must support.

Complete beam designs for uniformly distributed loads are presented on two lines in the tabulated designs. The first line is for open U-stirrups where torsion is negligible. The second line is for closed stirrups required to resist combined torsion and shear. Load capacity, torsional moment strength with open stirrups, and torsional moment strength with closed stirrups are tabulated for the usual range of suitable spans. Deflection for all tabulated loads meets the ACI Code general limit, $\ell$/360, (ACI 9.5.2.6).*

**Scope.** Two sets of beam designs are tabulated. One set utilizes "normal" proportions. See Pages 12-22 to 12-81. The other set matches the depths of standard joist construction but considers the wide beam widths commonly required for uniform depth joist-beam floor or roof construction. See Pages 12-82 to 12-109.

Both sets of tabulated designs, beams of normal proportions and joist-band (wide) beams for joist construction, are further subdivided into "Exterior Span" and "Interior Span" beams for the different moment conditions present. See Fig. 12-1 "Recommended Bar Details for Beams." Figs. 12-2 and 12-3 "Typical Beam Section at Support" and "Typical Girder Section at Support" show adjustments required to apply the beam designs tabulated for use as girders where effective depth is reduced so that the girder reinforcing steel fits under crossing beam bars. For stirrup details, see Fig. 12-4.

*Exceptions are noted *, X, or Y. See footnotes on tables.




** See Note 5 in tabulated designs.

**Figure 12-1 Recommended Bar Details for Beams**

Spans range from 12 to 54 feet, utilizing widths approximately one-half to two-thirds the depth, for the beams of normal proportions. For the joist-band (wide) beams for use with joists, depths range from 12.5 inches in increments the same as those for standard joists with 4.5-inch top slabs to 28.5 inches, utilizing widths from 24 to 48 inches.

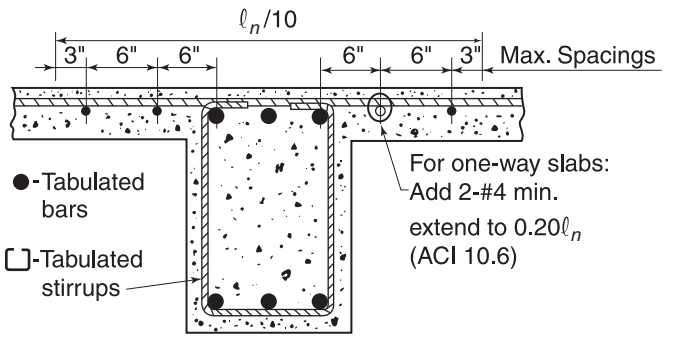
Note that eight different clear span lengths are provided for each combination of beam depth and width and that the tabulated designs are divided into two pages. The first page is for the first four spans and the second page is for the last four spans. The specific beam overall depths, widths, and clear spans used in the tabulated designs are as follows:

**BEAMS OF NORMAL PROPORTIONS**

| *Depth, h, (in.)* | *Widths, b, (in)* | *Clear Spans (ft)* |
|---|---|---|
| 12 | 8, 10, 12 | 12, 14, 16, 18, 20, 22, 24, 26 |
| 14 | 8, 10, 12, 14 | 12, 14, 16, 18, 20, 22, 24, 26 |
| 16 | 10, 12, 14, 16 | 16, 18, 20, 22, 24, 26, 28, 30 |
| 18 | 10, 12, 14, 16 | 16, 18, 20, 22, 24, 26, 28, 30 |
| 20 | 10, 12, 14, 16 | 20, 22, 24, 26, 28, 30, 32, 34 |
| 22 | 12, 14, 16, 18 | 20, 22, 24, 26, 28, 30, 32, 34 |
| 24 | 12, 14, 16, 18 | 24, 26, 28, 30, 32, 34, 36, 38 |
| 26 | 14, 16, 18, 20 | 24, 26, 28, 30, 32, 34, 36, 38 |
| 28 | 14, 16, 18, 20 | 26, 28, 30, 32, 34, 36, 38, 40 |
| 30 | 14, 16, 18, 20 | 26, 28, 30, 32, 34, 36, 38, 40 |
| 32 | 16, 18, 20, 24 | 32, 34, 36, 38, 40, 42, 44, 46 |
| 34 | 16, 18, 20, 24 | 32, 34, 36, 38, 40, 42, 44, 46 |
| 36 | 16, 18, 20, 24 | 36, 38, 40, 42, 44, 46, 48, 50 |
| 42 | 20, 24, 30, 36 | 36, 38, 40, 42, 44, 46, 48, 50 |
| 48 | 24, 30, 36, 42 | 40, 42, 44, 46, 48, 50, 52, 54 |

**JOIST-BAND (WIDE) BEAMS**

| *Depth, h, (in.)* | *Widths, b, (in.)* | *Clear Spans (ft)* |
|---|---|---|
| 12.5 | 24, 36, 48 | 12, 14, 16, 18, 20, 22, 24, 26 |
| 14.5 | 24, 36, 48 | 12, 14, 16, 18, 20, 22, 24, 26 |
| 16.5 | 24, 36, 48 | 16, 18, 20, 22, 24, 26 ,28, 30 |
| 18.5 | 24, 36, 48 | 16, 18, 20, 22, 24, 26 ,28, 30 |
| 20.5 | 24, 36, 48 | 20, 22, 24, 26, 28, 30, 32, 34 |
| 24.5 | 24, 36, 48 | 20, 22, 24, 26, 28, 30, 32, 34 |
| 28.5 | 24, 36, 48 | 22, 24, 26, 28, 30, 32, 34, 36 |




(Bot. and shrinkage-temperature bars in slab not shown.)

**Figure 12-2 Typical Beam Section at Support**

**Selection of Beam Sizes.** One of the main advantages of reinforced concrete construction is the wide range of possible sizes for the structural members. Reinforced concrete beams may be wide and shallow or narrow and deep. For uniform depth joist-beam construction, using a single flat bottom form for a level ceiling that facilitates construction, the beams will be shallow and require more flexural reinforcement. Ordinarily, these shallow beams are proportioned to a width that eliminates or minimizes shear reinforcement, which is costlier per pound than the larger flexural reinforcing bars. For minimum flexural reinforcement, the Code requires that $A_s = 3\sqrt{f'_c}\ b_w d/f_y \geq 200\ b_w d/f_y$ (ACI 10.5.1). With shallow beams, deflections are more critical and must be carefully controlled.

**Criteria for Selection of Flexural Reinforcement Area.** The ratio of flexural steel, $\rho = A_s/bd$, used in these designs lies between minimum and maximum limits set by the Code (ACI 10.5.1) and (ACI 10.3.4), respectively. The ratio, $\rho$, is based on the web width, $b_w$, of the rectangular section so that the tabulated designs are conservative for the positive design moment strength when slabs are on one or both sides, and slabs may be of any depth.

The values of $\rho$ used to develop the tables for the designs of each beam cross section ($h$ by $b_w$) are:

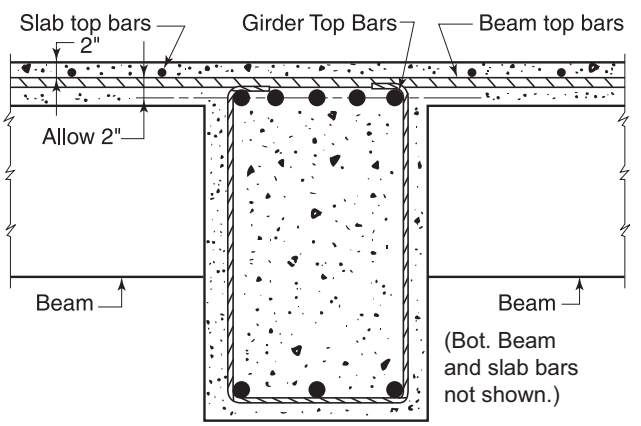
a. Minimum $\rho = 0.0033$ (ACI 10.5.1)

b. $\rho = 0.21\rho_b = 0.0060$

c. $\rho = 0.42\rho_b = 0.0120$

d. Maximum $\rho = 0.63\ \rho_b = 0.0181$ (ACI 10.3.4)

Where $\rho_b$ is the balanced ratio ($\rho_b = 0.0285$ for $f'_c$ = 4,000 psi and $f_y$ = 60,000 psi).




Note: Top bars of beam and slab form two-way mat for crack control (ACI 10.6).

**Figure 12-3 Typical Girder Section at Support**

**Stirrups.** The ACI Building Code provides an upper limit on the factored torsional moment, $T_u$, due to the continuity of the slab and spandrel beam, where open stirrups are permitted (ACI 11.5.2.2). This upper limit on the factored torsional moment is:

$$T_u \leq \phi 4\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right)$$

The stress $4\sqrt{f'_c}$ is equal to the assumed cracking stress. When $T_u$ is more than:

$$T_u > \phi \sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right)$$

Closed stirrups are required to resist combined shear and torsion.

Beams are exempt from the minimum stirrup requirements if total depth, $h$, does not exceed 10 in. (ACI 11.4.6.1-d); and for beams monolithic with slabs if $h$ does not exceed 24 in. and $h$ is not greater than the larger of 2.5 times thickness of flange, or one-half the width of the web (ACI 11.4.6.1-e). This latter provision greatly reduces stirrup requirements in the shallow joist-band (wide) beam sizes.

**Special Design Data.** In addition to the load capacity and stirrup (open or closed) requirements for the usual range of spans, the tabulated designs include design data for making short-cut design adjustments for: (1) spans outside the ranges tabulated, (2) design of girders with concentrated load patterns, (3) adjustment of flexural reinforcement for unusual end restraint conditions, and (4) actual deflection predictions where necessary for fit of other materials, and camber. The tabulated designs include values of:

$+\phi M_n$ = positive design moment strength as individual beams

$-\phi M_n$ = negative design moment strength as individual beams

$C$ = deflection coefficient such that $\Delta = (C \times 10^{-9})(w\ell_n^4)$

The tabulated designs also include the total weight of the steel reinforcement (flexural reinforcement and stirrups).

## BASIS FOR DESIGN

**Load Capacities.** The tabulated designs are based on uniformly distributed loads. Moments and shears are calculated using simplified coefficients (ACI 8.3.3). Materials are normal-weight concrete, $w_c \simeq 150$ pcf, with $f'_c$ = 4,000 psi, and reinforcing bars with $f_y$ = 60,000 psi. The design moment strengths were computed using the rectangular stress block specified in the Code (ACI 10.2.7).

**Flexure.** See Chapter 5 for a general explanation of moment coefficient analyses. The general limitations of the moment coefficients are of particular interest in the design of beams. The tabulated designs in this Chapter will require adjustments when the particular project conditions of adjacent span lengths exceed the limit 1.20 for long/short span; live load, L, exceeds three times dead load, 3D, unfactored; or where concentrated loads occur as in girder design.

**Concentrated Loads.** Girder design can be simplified by use of the tabulated beam designs, but the concentrated beam loads must be combined for flexure with the uniform load moments. Both positive and negative design moment strengths are listed (in the second-to-last column) for each tabulated beam design. In using the tabulated designs to select a girder design, use ($h$ – 2 inches) to allow for lowered top bars; that is, for a girder with overall depth 30 inches, select a tabulated design for $h$ = 28 inches. This adjustment should result in the correct negative design moment strength. Positive moment strength should be based on the overall depth of $h$ = 30 inches. See the girder design (Example 2) under "Beam Tables–Examples of Use." See Fig. 12-3.

**Variable Span Lengths**. At the ends of beams, continuous over interior supports, the total area of top reinforcement, used as a basis for computing negative moment design strength, is shown as straight top bars. When designs selected for adjoining spans do not provide the same area of top bars, adjustment of the total top reinforcement should be made by varying the size or number of top bars in proportion to the average of the two spans. End span reinforcement governs at the first interior support where spans are equal.

**Shear.** Shear has been computed assuming the load capacity shown is uniformly distributed along the entire length of the beam. For concentrated loads or partial loadings (uniform distribution on part of the beam), the shear capacity should be checked even though these loads may produce bending moments equivalent to those for the tabulated uniform load capacity.

The quickest solution to take into account concentrated loads, as on girders, is to compute the sum of the concentrated load shear and the uniform load shear, and select a tabulated stirrup pattern for the same size beam under uniform load generating shear equal to this sum.

For girders supporting a single beam at the center, flexural design will control. The tabulated stirrup design for an equivalent uniform load moment will suffice at the support, and a stirrup pattern for a lower uniform load may be selected and extended from the support throughout the span. For girders resisting loads from two or more beam loads, the stirrup pattern for a heavier load (than equivalent for moment) will be required. In either case, the design time to determine a tabulated stirrup size and spacing at the support for the combined shear will be less than for complete manual computation of the required stirrups. See the girder design (Example 2) under "How to Use Tabulated Designs." Concentrated loads may require an essentially uniform stirrup spacing between face of the support and the load point.

Partial loadings in particular may require stirrups beyond the pattern required for full uniform load. In many cases, it will suffice to provide an arbitrary extension of stirrup reinforcement across the span between the points where shear calculations based on only full uniform load indicate stirrups are no longer required.

All of these adjustments can usually be made without separate calculations, by visual selection of tabulated stirrup patterns as illustrated in the examples.

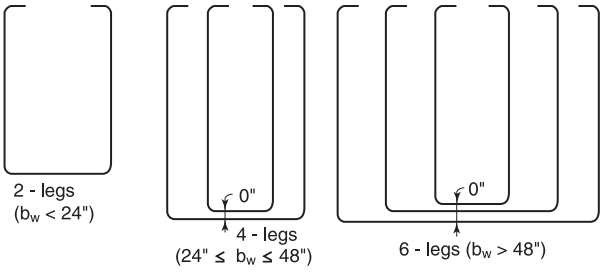
The first line of each tabulated design shows open U-stirrups required with negligible torsion. See Fig. 12-4, "Typical Open Stirrups and Closed Stirrups." These designs suffice for vertical shear due to tabulated load capacity, including a factored torsional moment

$T_u \le \phi\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right)$ (ACI 11.5.1a).

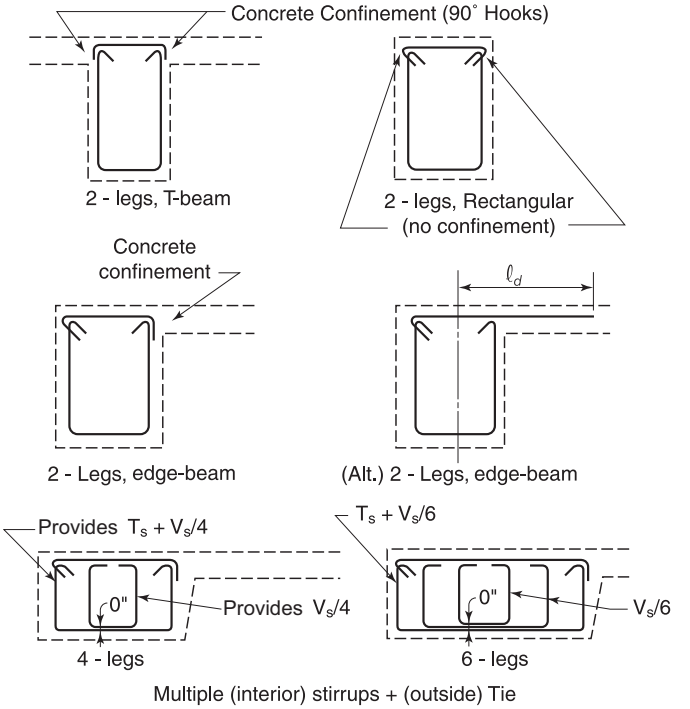
**Torsion.** Closed stirrups for shear plus maximum torsion are shown on the second line of each tabulated design. See Fig. 12-4 for details appropriate for *two-piece* closed stirrups, necessary for practicable field assembly. These designs are for $T_u \le \phi 4\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right)$

This torsional moment is the maximum required for the common case where torsion (as in a spandrel) results from the interior of the (statically indeterminate) structure (ACI 11.5.2.2). It is assumed that minor cracking at this stress with stirrups yielding will reduce torsional stiffness, like a hinge, precluding any increase in torsion load. Statically determinate torsion effects requiring torsional moment strength for stability to maintain equilibrium, as in cantilever supports, where the required torsional resistance is equal to the factored torsional moment (ACI 11.5.2.1). Such designs must be "custom made" if $T_u$ required exceeds $\phi 4\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right)$.

For such designs, where multiple closed stirrups are required, note that only the outer two legs are proportioned for torsion. All interior legs resist only vertical shear. See Fig. 12-4.




**(a) Open stirrups for shear plus torsion; $T_u \le \phi\sqrt{f'c}\,(A^2_{cp}/p_{cp})$**




**(b) Various closed two-piece "stirrups"; required only with torsion where; $\phi\sqrt{f'c}\,(A^2_{cp}/p_{cp}) < T_u \le \phi\ 4\sqrt{f'c}\,(A^2_{cp}/p_{cp})$. For $b_w \ge 24$", add interior open stirrups as required above.**

NOTE: In the absence of specific ACI Code limitations on maximum beam widths for 2-leg, 4-leg, or 6-leg stirrup combinations, the limits shown above were applied by CRSI. Users of this Handbook should apply their best judgment to set maximum width limits for their designs. Also see ACI R11.4.7.

**Figure 12-4 Typical Open Stirrups and Closed Stirrups**

**Development of Flexural Reinforcement.** See Fig. 12-1. The recommended detail at free ends in the end spans of beams consists of straight extension of all bottom bars and properly anchored top bars. The recommended details and bar sizes are compatible for uniform loads and spans that vary by no more than 20 percent, the limitation of coefficients for design (ACI 8.3.3). Where a short span is located between two long spans at or near $\ell_{n1} = 1.2\ \ell_{n2}$ and the expected live load varies from zero to 100 percent, approximately 20 percent of the top reinforcement should be made continuous across the shorter span because a negative bending moment can develop across the entire shorter span. At other cases of long-short spans near the limit 1.20, it will suffice to extend top bars in the shorter span to $0.40\ \ell_{n2}$ where $\ell_{n2}$ is the short span.

The tabulated designs were prepared with optimum bar sizes selected for the recommended details in Fig. 12-1. The computer program computes the "exact" steel area required for flexure. Steel areas furnished are by the least number of largest bars that could be developed, as well as steel areas for the next lower sizes, down to #4. The number of bars required in each size was then compared to the minimum number required for crack control and to the maximum number allowed for fit. Unsuitable sizes were rejected. The bar size selected was the largest size whose area did not exceed the area of the smaller usable size by more than 5 percent, for economy in placing.

Thus, for project conditions within the stated limitations, the tabulated beam designs herein can be used as the basis for a tentative design. Commonly, however, it may be expected that conditions special or even unique to a particular project will occur. In these cases, the tabulated designs must be appropriately adjusted. Adjustments may or may not require a change in the required steel areas. If so, these adjustments for moment conditions other than those used for the tables (see "Flexure" on Page 12-3) are straightforward arithmetic.

The "art" of design in reinforced concrete begins after this straightforward arithmetic. The selection of bar sizes and detail arrangements is a vital part of this art. The most frequent adjustment of tabulated designs (or converting theoretically required steel areas to actual bars) occurs when said bars must fit *between* other bars. If column bars are spaced to provide four spaces through which beam bars must pass, and tabulated beam designs show numbers higher than four, an adjustment is required. In some cases, column bar sizes may be revised or column bars may be bundled to provide clearances. (Bundling of beam bars is also permitted, but may be counterproductive as bundled bars in flexural tension areas involve further Code restrictions.) In cases where only the top bars tabulated cause fitting problems, the excess above those fitting through the column may be located outside the column in the beam flange. See "Crack Control" on Page 12-11.

In remaining cases, a change in tabulated number of bars will be required. If a larger bar size is necessary, the development length of the larger bars must be checked. Conformance to development requirements in the Code may require longer extensions.

The "Recommended Bar Details for Beams" (Fig. 12-1) are for general use (by CRSI). They satisfy Code requirements for development with uniform beam loading, common girder loadings combining some uniform load and one or more concentrated beam loads (excepting the case of "pure" third point concentrated loads).

## HOW TO USE TABULATED DESIGNS

Steps in selecting a tabulated design and adjusting it to special conditions of a project are reviewed below:

*Beam Dimensions*

*Step 1.* Consider an entire floor building layout, comparing conditions along the entire length of continuous beams in one direction. Decide whether conditions are similar enough to justify one width for all interior beams and one for all spandrel beams. A width for minimum stirrups will be most economical. Depth of all beams should normally be held uniform for practical reasons (head room and formwork economy). Take the controlling span conditions (highest shear); with equal spans, it is usually the first interior support on the end span side.

Enter END SPAN beam tables with controlling load (kips/foot) and clear span (feet) for the interior beam lines for cases where spans are not equal. Select width-depth combination within established architectural limits for near-to-minimum stirrups. If possible for the controlling condition, use width-depth combination adequate on second or third line in tables, since all other spans will require less than the controlling condition. Record flexural reinforcement bar sizes as tentative choices, and stirrup pattern designation number.

*Step 2.* Continue selections in INTERIOR SPAN tables for remainder of the continuous line of beams. Enter for same width/depth combination with load and span data for each (the span, and often load, may be same as for end span). Record flexural reinforcement bottom bar sizes and number as tentative choices, as

well as stirrup designation number for each span. For top bars, if adjacent spans vary, average spans on both sides of support and enter tables with average span and load for each end of the span considered.

*Step 3.* Reconcile tentative design. Check size and location of spaces between the column vertical bars and the space outside same in beam if the beam is wider than the column for bottom bars, and possible location outside the column vertical bars in slab adjacent to the column for top bars. Be sure bars selected will fit in these spaces. If possible use the same size bars throughout as bottom bars; then, similarly for top bars. If two bar sizes are tabulated for bottom bars for say, END SPAN, try to use the same two sizes throughout.

*Step 4.* Adjust the basic design as necessary where project conditions lie outside Code limits on moment coefficients and shears. Adjust factored moments and shears, adjust bar lengths and sizes, and note conditions where factored shear is higher or non-uniform. For higher factored shear, select stirrup pattern from other beam designs having required design shear strength instead of stirrup pattern tabulated for beam selected. Be sure space is available for bars selected. Record flexural reinforcement, and stirrup patterns for design drawings.

*Step 5.* Consider torsion. Closed stirrups for torsion are seldom necessary for beams supporting slabs on both sides. If slab loading is unequal, or if interior openings are present only on one side, compute factored torsional moment, $T_u$, as the difference in end moments from the slabs with live load on one side only. If $T_u \le \phi\sqrt{f'_c}(A^2_{cp}/p_{cp})$, neglect torsion. Where larger $T_u$ exists, beam has to be designed for combined shear and torsion.

*Step 6.* Structurally detail the reinforcement to comply with the requirements for structural integrity (ACI 7.13).

**Exterior Line Spandrel Beams**

Same steps as for interior lines of beams except:

*Step 1.* In addition to factored gravity loads and spans, design data to enter the tabulated designs should include factored torsional moment, $T_u$. Factored torsional moment may be actual factored end moments from continuity or $T_u \le \phi\, 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$, whichever is less; or actual cantilever type factored torsional moment required for equilibrium if larger than the lesser of $\phi 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$ or continuity end moment torsion. Two values of design torsional moment strength, $\phi T_n$, are given in the tabulated designs. The value on the first line corresponds to $\phi T_n = \phi\sqrt{f'_c}(A^2_{cp}/p_{cp})$. The value of $\phi T_n$ on the second line corresponds to $\phi\, 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$.

Where $T_u > \phi\, 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$, use a larger beam section if possible; otherwise a special design is required, and torsional reinforcement could be very costly. For $\phi\sqrt{f'_c}(A^2_{cp}/p_{cp}) < T_u \le \phi\, 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$, use the tabulated designs. Try to select beam dimensions where $T_u \le \phi\sqrt{f'_c}(A^2_{cp}/p_{cp})$ so that no (closed) stirrups are required for torsion, except perhaps where only one span in a long series of spandrel spans has to resist a special factored torsional moment, and it would require a disproportionately large beam section.

*Step 2, 3, and 4.* Same as for interior beams, unless factored torsional moment, $T_u > \phi\, 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$. In this case, record T-designations for closed stirrups.

*Step 5.* Sketch cross-sections of the spandrel beams and fit flexural reinforcement inside an appropriate closed stirrup shape. Each closed stirrup should be formed in two pieces for facilitating field assembly. See suggested shapes, Fig. 12-4. Finally, add tabulated additional longitudinal face reinforcement ($A_\ell$) bars inside the closed stirrups. These bars, with a nominal diameter at least 1/24 of the stirrup spacing, must be distributed around the perimeter of the beam spaced not more than 12 inches apart (around the perimeter) with at least one bar, principal or added, in each corner of the stirrups (ACI 11.5.6.2).

*Step 6.* Structurally detail the reinforcement to comply with the requirements for structural integrity (ACI 7.13).

*Girders*

All steps listed for beams apply to girders. One additional consideration here is that the effective depth of the girder should be taken as 2 inches less than the actual depth, $h$, to allow space for beam bars to cross above top girder bars.

The main difference between beams and girders is in the variable load patterns commonly associated with girders. To apply the tabulated uniformly loaded beam designs herein to girders with one or more concentrated loads, equivalent uniform beam loadings must be selected separately for factored shear and moment. Alternatively, total factored moment may be used as a basis for design. See next to last column of tables for design moment strengths, $-\phi M_n$ and $+\phi M_n$. If width/depth dimensions are selected for factored moment requiring flexural reinforcement on the fourth

line (heaviest) for each size, the stirrup pattern from one of the preceding lines will often suffice for the girder shear.

## BEAM TABLES–EXAMPLES OF USE

**Example 1.** Design Beam B1. See Fig. 12-5 for plan dimensions. Service live load = 150 psf. In addition to floor loads, make allowance for a future partition; a service line load of 200 plf. $f'_c$ = 4,000 psi. $f_y$ = 60,000 psi. Conditions permit use of total depth, $h$ = 30 in. Clear span, $\ell_n$ = 30 ft.

*Actual Loads*

Slab: (6/12)(150) = 75 psf
Ceiling and floor finish = 10 psf
85 psf

Estimate weight of beam stem:
(18 × 24)(150)/(144) = 450 plf

*Factored Loads*

Contributory area *DL* = 1.2(85)(14) = 1,428 plf
Contributory area *LL* = 1.6(150)(14) = 3,360
4,788 plf
Beam stem *DL* = 1.2(450) = 540
Future partition = 1.2(200) = 240
$w_u$ = 5,568 plf

*Step 1.* Enter End Span tables for Beam B1 (end span) on Page 12-40. Enter tables for $h = 30''$ and $\ell_n = 30'$.
Read: • 14 × 30, capacity = 5.70 kips/ft > 5.57
Top: 3-#11 bars; Bottom: 2-#14 bars; #5 stirrups
• 16 × 30, capacity = 6.36 kips/ft > 5.57
Top: 4-#11 bars; Bottom: 3-#11 bars; #5 stirrups
• 18 × 30, capacity = 8.05 kips/ft > 5.57
Top: 3-#14 bars; Bottom: 3-#14 bars; #5 stirrups
• 20 × 30, capacity = 5.90 kips/ft > 5.57
Top: 3-#11 bars; Bottom: 3-#11 bars; #4 stirrups

Compare designs:

Any one of the designs can be selected.

16 × 30 design avoids use of #14 bars required in 18 × 30 design.

Both the 16 × 30 and the 20 × 30 designs use #11 flexural reinforcement, but the 20 × 30 design uses #4 open stirrups while the 16 × 30 design uses #5 open stirrups.

The 14 × 30 design is selected for this example.

Flexural reinforcement is tabulated for load capacity = 5.70 kips/ft and factored load is 5.568 kips/ft. Reduction is possible in the ratio (5.57/5.70) = 0.98, but 2% is insignificant.

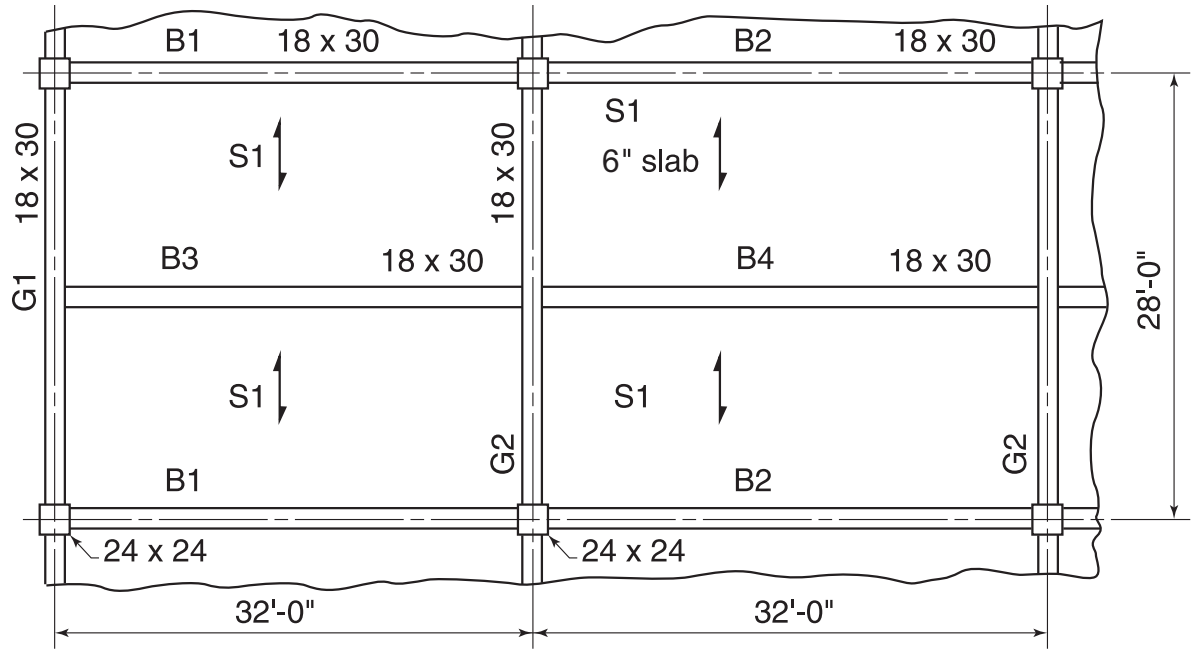



**Figure 12-5 Plan Dimensions – Examples 1 and 2**

At discontinuous end, $-M_u$ = (11/16) ($-M_u$ for interior column).

Bottom bars: 2-#14

Top bars: 3-#11. (Over first interior column, $A_s$ = 4.68 in.$^2$)

At discontinuous end, required $A_s$ = (11/16)(4.68) = 3.22 in.$^2$ Use 4-#8 bars with standard 90° end hooks.

Adjustment of open stirrup quantities or pattern by 98% is not feasible since stirrups are nearly spaced at max $s$; $d$ = 27.2″; max $s = d/2$ = 13.6″ ≈ 13″. Stirrup pattern is 145K; see Page 12-14; 14-#5: 1 @ 2″ and 13 at each end (EE).

**Example 2.** See Fig. 12-5. Design interior girder, G2. In addition to loads from beams, a line load (partition) of 200 plf is supported by the girder. Clear span, $\ell_n$ = 26 ft. Assume overall depth, $h$, not to exceed 30 in.

*Step 1.* Convert to uniform loads.

Concentrated load at center = 5.568 kips/ft (32 ft) = 178.2 kips. Assume stem width = 18″:

Uniform Loads:

| | | |
|---|---|---|
| Stem | (18 × 24)(150/144) = 450 plf | × 1.2 = 540 plf |
| Partition | = 200 | × 1.2 = 240 plf |
| | Factored total load = | 780 plf |

Concentrated load factored moment, $M$ = (178.2 × 26)/8 = 579 ft-kips. Equivalent uniform load, $w = (11 \times M)/\ell_n^2$ for end moment, $w = 11(579)/(26)^2$ = 9.42 kips/ft

Total equivalent factored uniform load (for $-M_u$), $w_u$ = 9.42 + 0.78 = 10.20 kips/ft

Factored positive moment, $+M_u = 579 + 0.78(26)^2/16$ = 612 ft-kips

Or total equivalent uniform load (for $+M_u$), $w_u = (16 \times 579)/(26)^2 + 0.78$ = 14.48 kips/ft

*Step 2.* Enter Interior Span Tables. See Page 12-68. Enter tables for $h$ = 28″ under "Interior Spans." Read for $\ell_n$ = 26 ft:

18 × 28, capacity = 10.80 kips/ft > 10.20, Okay

Bottom bars: 3-#11

Top bars: 3-#14

Stirrup designations: 145GeJ and 315C

Torsional design moment strength (with open stirrups) = 13 ft-kips

Estimate $T_u$ for G2 with live load on one side only:

$w_u$ (live load) = 1.6(0.150)(14) = 3.36 kips/ft

$$T_u = \frac{1}{11}(3.36)(30.5)^2 = 284 \text{ ft-kips}$$

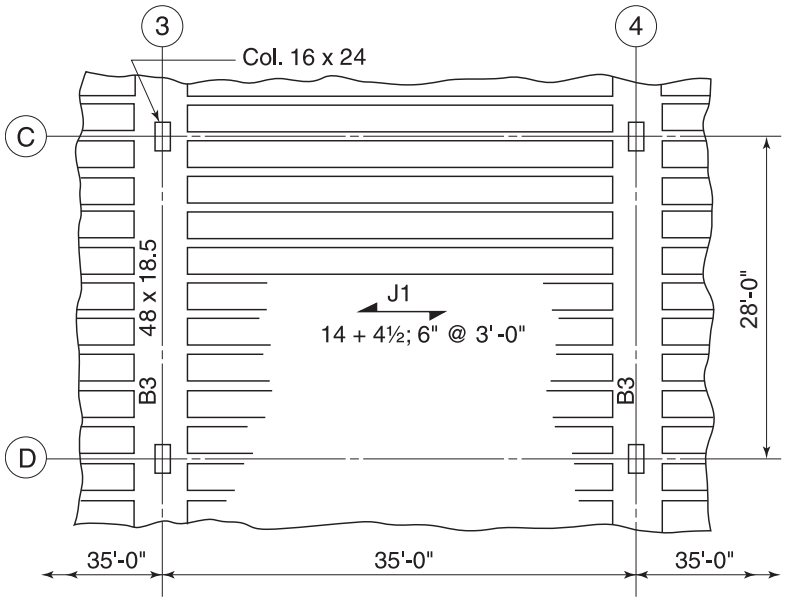



**Figure 12-6 Plan Dimensions Joist-Band Beam Floor**

This total unbalanced torsional moment will be distributed (see Fig. 12-5) among the B3-B4 tee-beams, which have an estimated flexural stiffness, $2K_b$ = $1{,}700E_c$; and to two sides of girder G2, which have an estimated torsional stiffness $(60E_c)2 = 120E_c$.

$$T_u \text{ in G2} = \frac{K_t}{2K_t + 2K_b}(284)$$
$$= \frac{60}{1820}(284) = 9 \text{ ft-kips} < 13$$

Closed stirrups and additional longitudinal bars for torsion are not required.

Check shear: Max $V_u = (178.2/2) + (0.78 \times 13) = 99.2$ kips

Equivalent $w_u$ for shear = (99.2/13) = 7.63 kips/ft < 10.80. Initial stirrup spacing — Okay

*Step 3.* Bottom bars; equivalent $w_u$ = 14.48 kips/ft and $+M_u$ = 612 ft-kips. See Page 12-70; use $h$ = 30″. For $\ell_n$ = 26′-0″, a beam 20″ × 30″ with 3-#14 ($A_s$ = 6.75 in.$^2$) bottom bars capacity = 15.28 kips/ft and $+\phi M_u$ = 734 ft-kips. Reduction in $A_s$ is possible in the ratio (734–612)/734 = 0.17, but is not pursued. Use 3-#14.

*Step 4.* Adjust initial stirrup spacing for equivalent $w_u$ = 7.63 kips/ft for full span. For the tabulated design above the one selected for negative design moment strength, the shear strength = 7.88 kips/ft, stirrup pattern 125J. See Page 12-68: 12-#5, 1 @ 2″, 10 @ 12″ each end (EE).

**Example 3.** See Fig. 12-6. Design a joist-band beam, B3, for typical interior clear spans, $\ell_n$, = 26′-0″, with $f'_c$ = 4,000 psi and $f_y$ = 60,000 psi for the following loads: partitions 20 psf, floor plus ceiling finish, 5 psf, and a specified service live load = 50 psf. Overall depth, $h$ = 18.5″.

*Step 1.* Compute factored loads:

| | | |
|---|---|---|
| Joist-slab system | | |
| (0.61 c.f.)(150) | = | 92 |
| Partitions | = | 20 |
| Floor and ceiling finishes | = | 5 |
| Factored dead load (total) | = | 117 psf × 1.2 = 141 psf |
| Factored live load | = | 50 psf × 1.6 = 80 psf |
| | | Area factored load, $q_u$ = 221 psf |

*Step 2.*

For beam width b = 48″. Added line load for beam stem:

(1.2) [18.5 – (0.61)(12)](48)(150/144) = 671 plf

$w_u = (0.221 \times 35) + 0.671 = 8.41$ kips/ft

*Step 3.* Enter Interior Span tables for joist-band beams, Page 12-103, for $\ell_n$ = 26 ft., h = 18 in. and $b$ = 48 in.

Read for third design: capacity = 11.02 kips/ft > 8.41. Okay

Open stirrups: 184E

See Fig. 12-4: 4 stirrup legs are required.

See Page 12-14. “184E” is 18-#4, 1 @ 2″, 17 @ 7″ at each end (E.E.)

Spacing of 7″ ≈ 0.5$d$ so no real reduction in stirrups is possible.

Flexural reinforcement:

Top: 7-#11 bars; Bottom: 6-#10 bars

It is possible to reduce the top flexural reinforcement by 8.41/11.02 = 0.76, but the 24% reduction is not made here.

Top: use 7-#11 bars
Bottom: use 6-#10 bars
} See Fig. 12-7

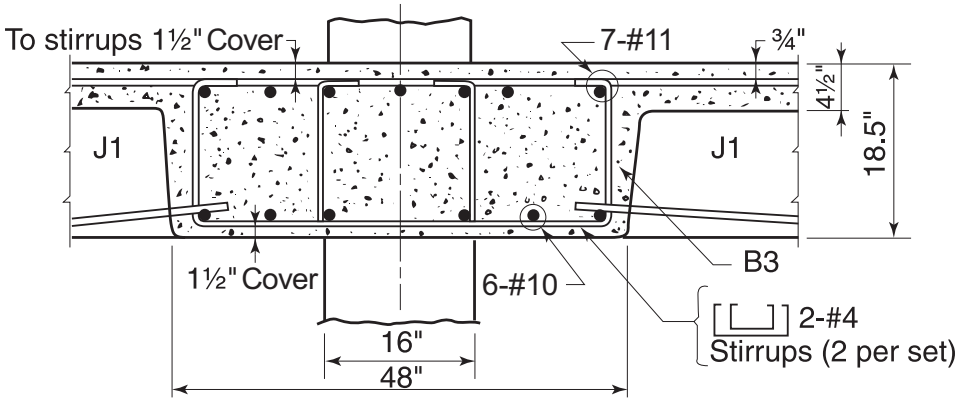



**Figure 12-7 Joist-Band Beam B3**

## Table 12-1 Moments of Inertia, in.$^4$ per 12 in. Width*

| $t$ for $I_g$ / $d$ for $I_{cr}$ | $I_g = t^3$ | $I_{cr}$ – Moment of Inertia, in.$^4$ per foot of width, Cracked Transformed Section | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Reinforcement ratio, $\rho$ (Average top and bottom $\rho$ for end and interior span) | | | | | | | | | |
| | | 0.009 | 0.010 | 0.011 | 0.012 | 0.013 | 0.014 | 0.015 | 0.016 | 0.017 | 0.018 |
| 10” | 1,000 | 530 | 574 | 617 | 658 | 697 | 735 | 772 | 808 | 843 | 877 |
| 12” | 1,728 | 916 | 993 | 1,066 | 1,137 | 1,205 | 1,271 | 1,335 | 1,397 | 1,457 | 1,515 |
| 14” | 2,744 | 1,455 | 1,576 | 1,693 | 1,806 | 1,914 | 2,019 | 2,120 | 2,219 | 2,314 | 2,406 |
| 16” | 4,096 | 2,172 | 2,353 | 2,528 | 2,695 | 2,857 | 3,014 | 3,165 | 3,312 | 3,454 | 3,592 |
| 18” | 5,832 | 3,093 | 3,351 | 3,599 | 3,838 | 4,069 | 4,291 | 4,507 | 4,716 | 4,919 | 5,115 |
| 20” | 8,000 | 4,243 | 4,597 | 4,937 | 5,265 | 5,581 | 5,887 | 6,183 | 6,469 | 6,747 | 7,017 |
| 22” | 10,648 | 5,648 | 6,119 | 6,572 | 7,008 | 7,429 | 7,836 | 8,229 | 8,611 | 8,981 | 9,340 |
| 24” | 13,824 | 7,332 | 7,944 | 8,532 | 9,098 | 9,645 | 10,173 | 10,684 | 11,179 | 11,660 | 12,126 |
| 26” | 17,576 | 9,322 | 10,100 | 10,848 | 11,568 | 12,263 | 12,934 | 13,584 | 14,214 | 14,824 | 15,417 |
| 28” | 21,952 | 11,644 | 12,615 | 13,548 | 14,448 | 15,316 | 16,155 | 16,966 | 17,753 | 18,515 | 19,255 |
| 30” | 27,000 | 14,321 | 15,516 | 16,664 | 17,770 | 18,838 | 19,870 | 20,868 | 21,835 | 22,773 | 23,683 |
| 32” | 32,768 | 17,381 | 18,830 | 20,224 | 21,567 | 22,863 | 24,115 | 25,326 | 26,500 | 27,638 | 28,743 |
| 34” | 39,304 | 20,848 | 22,586 | 24,258 | 25,869 | 27,423 | 28,925 | 30,378 | 31,786 | 33,151 | 34,476 |
| 36” | 46,656 | 24,747 | 26,811 | 28,796 | 30,708 | 32,553 | 34,335 | 36,060 | 37,731 | 39,352 | 40,925 |
| 38” | 54,872 | 29,105 | 31,533 | 33,867 | 36,115 | 38,285 | 40,382 | 42,411 | 44,376 | 46,282 | 48,132 |
| 40” | 64,000 | 33,947 | 36,778 | 39,501 | 42,123 | 44,654 | 47,099 | 49,466 | 51,758 | 53,981 | 56,139 |
| 42” | 74,088 | 39,298 | 42,576 | 45,727 | 48,763 | 51,693 | 54,523 | 57,263 | 59,916 | 62,490 | 64,988 |
| | $C$ | 0.530 | 0.575 | 0.617 | 0.658 | 0.698 | 0.736 | 0.773 | 0.809 | 0.843 | 0.877 |
| | $k$ | 0.314 | 0.328 | 0.341 | 0.353 | 0.364 | 0.374 | 0.384 | 0.394 | 0.403 | 0.412 |

$k = \sqrt{2\rho n + (\rho n)^2} - \rho n$ $\quad C = [4k^3 + 12n\rho\,(1-k)^2]$ $\quad I_{cr} = Cd^3$

*These coefficients are based on $E$ = 3,605,000 psi for normal-weight concrete with $f'_c$ = 4,000 psi. They are applicable, however, for most purposes for 3000 psi < $f'_c$ < 5,000 psi.

## DESIGN FOR SERVICEABILITY

**Control of Deflections.** For routine use of the tabulated beam designs, it should not be necessary to compute live load deflection. Unless marked with an *, X, or Y, to footnote references, all the tabulated load capacities with 100 percent of the live load cause deflection less than $\ell$/360. Thus, live load deflection automatically conforms to the usual limit required (ACI 9.5.2.6). Where necessary, the coefficients tabulated for each beam design should be helpful in computing the deflection for any special requirements such as stricter deflection limits, or to subtract superimposed dead loads. When long-term (creep) deflections must be determined, it will be necessary to compute the sum of the service dead load and long-term portion of the service live load, as well as the proper coefficient for creep since these values vary with type of loading considered. Where conditions require that an estimated deflection for a particular beam be prepared, the coefficients in Table 12-1 will be convenient for determination of gross and cracked moments of inertia required.

## COEFFICIENTS FOR DEFLECTION COMPUTATIONS

If live load is limited by the requirement that immediate deflection is not to exceed 1/360 times the span, the following formulas may be used to determine maximum load:

Single Span $\quad W = 5{,}250\, I/L^3$
End Span $\quad W = 8{,}050\, I/L^3$
Interior Span $\quad W = 13{,}050\, I/L^3$

in which $W$ = actual load(not multiplied by load factors) in plf
$L$ = span in feet
$I$ = average effective moment of inertia in in.$^4$

Moment of inertia for a reinforced concrete member can involve complex manual computations. The Code permits use of the *average* of positive and negative moment sections, that is, midspan and face of support (ACI 9.5.2.4).

The *effective* moment of inertia, $I_e$, is

$$I_e = \left(\frac{M_{cr}}{M_a}\right)^3 I_g + \left[1 - \left(\frac{M_{cr}}{M_a}\right)^3\right] I_{cr} \qquad \text{(ACI Eq. 9-8)}$$

in which the cracking moment for normal-weight concrete, $M_{cr} = 7.5\sqrt{f'_c}\, I_g/y_t$ and $M_a$ = actual service load moment. Values of $I_g$ per foot of width are equal to $t^3$, where $t$ is the overall depth of the member. The transformed moment of inertia:

$$I_{cr} = d^3\,[4k^3 + 12\,n\rho\,(1-k)^2]$$

where: $n = E_s/E_c$

$$k = \sqrt{2\rho n + (\rho n)^2} - \rho n$$

is tabulated in Table 12-1 for $0.009 \le \rho \le 0.018$. For $\rho < 0.009$, a conservative solution is to use $I_{cr}$ for $\rho = 0.009$ and ( $M_{cr}/M_a$) = 0.5.

Note: For intermediate values of depth or reinforcement ratio, straight line interpolation is sufficiently accurate. For depths beyond the range tabulated, use value of *C* (bottom line) for computation of $I_{cr}$.

**Crack Control.** Chapter 6 in this Handbook includes a discussion of Code requirements for crack control. All tabulated designs here comply with crack control requirements for beam stems (ACI 10.6).

Top bars in beams, and also in girders, must be physically located above the beam stem in usual situations where the beam supports the slab and girders support the beams. Crack control at the top surface is mainly dependent upon the one or two layers of slab bars above the top beam bars, and both slab and beam bars above top girder bars. Tabulated designs provide number of top bars accordingly.

For isolated T-beams, I-beams, or other flanged shapes, top bars must be spaced across the width of flanges in tension (ACI 10.6.6).

The Code requirements for crack control with Grade 60 reinforcing bars (distribution of flexural reinforcement in beams—ACI 10.6) are:

1. Only deformed bars may be used.
2. Tension reinforcement must be well distributed in zones of **maximum** concrete tension.
3. Where flanges are in tension, part of the main tension reinforcement shall be distributed in the effective flange width or a width equal to 1/10 of the span, whichever is smaller.
4. Spacing of reinforcing bars must not exceed

$$s = 15\left(\frac{40{,}000}{f_s}\right) - 2.5c_c \quad \text{(ACI Eq. 10-4)}$$

but not greater than

$$12\left(\frac{40{,}000}{f_s}\right)$$

where $f_s = (2/3)\, f_y$, psi (assumed)

$c_c$ = concrete cover, in.

Maximum spacing of reinforcing bars, computed by ACI Eq. 10-4 and assuming $f_y$ = 60,000 psi (Grade 60 reinforcing bars) and 1½ inches concrete cover, is as follows:

#3 stirrups - 10¼ in.
#4 stirrups - 10 in.
#5 stirrups - 9½ in.

When the effective depth, *d*, of a beam exceeds 36 inches, skin reinforcement is also required for crack control (ACI 10.6.7). In the tabulated designs in this Chapter, only the beams with overall depths, *h*, of 42 inches and 48 inches will require skin reinforcement, $A_{sk}$. For *h* = 42 inches or 48 inches, 3-#3 reinforcing bars in each face of the web would provide the required $A_{sk}$. Skin reinforcement is not listed in the tabulated designs. For beams with rather large cross sections, as in these cases for *h* = 42 inches or 48 inches, the recommended minimum longitudinal bar size is a #5.

## MAXIMUM NUMBER OF BARS IN BEAM STEMS

The practical problem of physically fitting the reinforcing bars into the width of stem available between stirrups at Code-required concrete cover and clear spacings between bars limits the *maximum* number of given size bars in a single layer. These Code requirements, for minimum concrete cover and spacing, are based on practical problems of placing concrete, weather, and fire resistance (ACI 7.6.1, 7.6.2, and 7.7.1). The ACI Building Code concrete cover requirements and the concrete cover used in the tabulated designs are shown in Fig. 12-8. Maximum number of bars in beam stems are based on concrete cover and clear spacings (Fig. 12-9) and overall (not nominal) bar diameter.

Tables 12-2(a) and 12-2(b) give the minimum and maximum number of reinforcing bars in a single layer in beam stems. The values in the tables are based on combining the Code requirements for crack control and the provisions for clear spacings. An "N.A." in the tables indicates that the maximum number of reinforcing bars, based on the required clear spacing including aggregate size and concrete cover, is less than the minimum number of bars which are required for crack control.

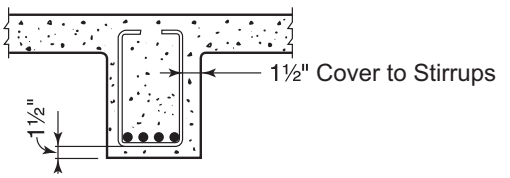



**Figure 12-8 Concrete Cover Requirements for Cast-in-Place Beams**

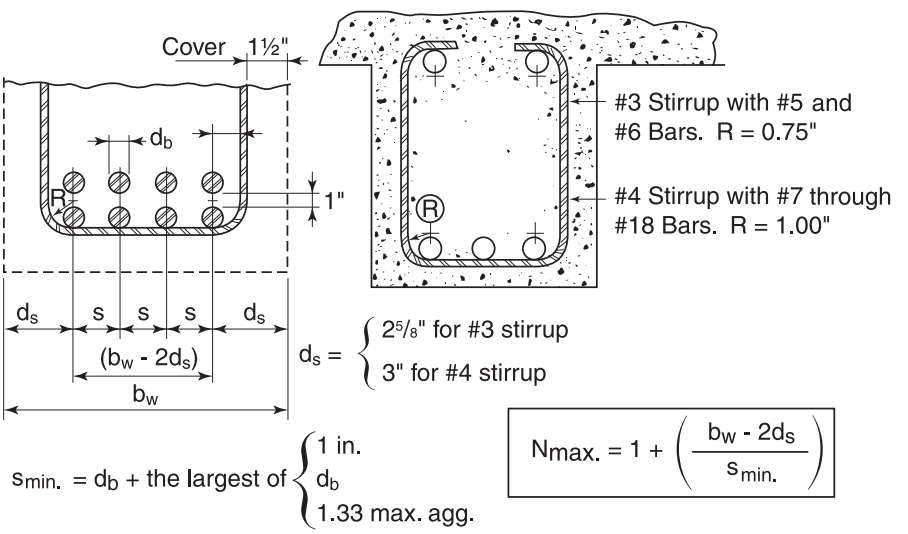



**Figure 12-9 Maximum Number of Bars in Beam Stems**

**Table 12-2(a) – Minimum and Maximum Number of Bars in a Beam (Single Layer)**
Concrete Cover = 1.5 in. #4 Stirrups Maximum Size Coarse Aggregate = ¾ in.

| Beam Width, in. | Minimum, Maximum Number of Bars Per Bar Size | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | #5 | | #6 | | #7 | | #8 | | #9 | | #10 | | #11 | | #14 | | #18 | |
| | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| 8 | 2 | 2 | 2 | 2 | 2 | 2 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 10 | 2 | 3 | 2 | 3 | 2 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | N/A | N/A |
| 12 | 2 | 4 | 2 | 4 | 2 | 5 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| 14 | 2 | 5 | 2 | 5 | 2 | 6 | 2 | 4 | 2 | 4 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| 16 | 2 | 6 | 2 | 6 | 2 | 7 | 3 | 5 | 2 | 5 | 2 | 4 | 2 | 4 | 2 | 3 | 2 | 2 |
| 18 | 3 | 8 | 3 | 7 | 3 | 8 | 3 | 6 | 3 | 5 | 3 | 5 | 3 | 4 | 3 | 4 | 3 | 3 |
| 20 | 3 | 9 | 3 | 8 | 3 | 9 | 3 | 7 | 3 | 6 | 3 | 5 | 3 | 5 | 3 | 4 | 3 | 3 |
| 22 | 3 | 10 | 3 | 9 | 3 | 10 | 3 | 8 | 3 | 7 | 3 | 6 | 3 | 5 | 3 | 5 | 3 | 4 |
| 24 | 3 | 11 | 3 | 10 | 3 | 11 | 3 | 9 | 3 | 8 | 3 | 7 | 3 | 6 | 3 | 5 | 3 | 4 |
| 26 | 3 | 12 | 3 | 11 | 3 | 12 | 4 | 9 | 3 | 9 | 3 | 7 | 3 | 7 | 3 | 6 | 3 | 4 |
| 28 | 4 | 14 | 4 | 12 | 4 | 13 | 4 | 10 | 4 | 9 | 4 | 8 | 4 | 7 | 4 | 6 | 4 | 5 |
| 30 | 4 | 15 | 4 | 13 | 4 | 14 | 4 | 11 | 4 | 10 | 4 | 9 | 4 | 8 | 4 | 7 | 4 | 5 |
| 32 | 4 | 16 | 4 | 14 | 4 | 15 | 4 | 12 | 4 | 11 | 4 | 10 | 4 | 9 | 4 | 7 | 4 | 6 |
| 34 | 4 | 17 | 4 | 15 | 4 | 16 | 4 | 13 | 4 | 12 | 4 | 10 | 4 | 9 | 4 | 8 | 4 | 6 |
| 36 | 4 | 18 | 4 | 17 | 4 | 17 | 5 | 14 | 4 | 13 | 4 | 11 | 4 | 10 | 4 | 9 | 4 | 6 |
| 38 | 5 | 19 | 5 | 18 | 5 | 18 | 5 | 15 | 5 | 13 | 5 | 12 | 5 | 10 | 5 | 9 | 5 | 7 |
| 40 | 5 | 21 | 5 | 19 | 5 | 19 | 5 | 16 | 5 | 14 | 5 | 12 | 5 | 11 | 5 | 10 | 5 | 7 |
| 42 | 5 | 22 | 5 | 20 | 5 | 20 | 5 | 17 | 5 | 15 | 5 | 13 | 5 | 12 | 5 | 10 | 5 | 8 |
| 44 | 5 | 23 | 5 | 21 | 5 | 21 | 5 | 17 | 5 | 16 | 5 | 14 | 5 | 12 | 5 | 11 | 5 | 8 |
| 46 | 5 | 24 | 5 | 22 | 5 | 22 | 6 | 18 | 5 | 17 | 5 | 14 | 5 | 13 | 5 | 11 | 5 | 8 |
| 48 | 6 | 25 | 6 | 23 | 6 | 23 | 6 | 19 | 6 | 17 | 6 | 15 | 6 | 13 | 6 | 12 | 6 | 9 |

1. Minimum number of bars is based on crack control requirements of ACI 10.6.
2. Maximum number of bars is based on clear spacing requirements of ACI 3.3.2(c) and ACI 7.6.1.
3. Overall bar diameter, rather than nominal bar diameter, was used in calculating the maximum number of bars.

**Table 12-2(b) – Minimum and Maximum Number of Bars in a Beam (Single Layer)**
Concrete Cover = 1.5 in. #4 Stirrups Maximum Size Coarse Aggregate = 1 in.

| Beam Width, in. | Minimum, Maximum Number of Bars Per Bar Size | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | #5 | | #6 | | #7 | | #8 | | #9 | | #10 | | #11 | | #14 | | #18 | |
| | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. | Min. | Max. |
| 8 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A |
| 10 | 2 | 2 | 2 | 2 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | N/A | N/A |
| 12 | 2 | 3 | 2 | 3 | 2 | 4 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 | 2 | 2 | 2 | 2 |
| 14 | 2 | 4 | 2 | 4 | 2 | 5 | 2 | 4 | 2 | 4 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 2 |
| 16 | 2 | 5 | 2 | 5 | 2 | 6 | 3 | 5 | 2 | 4 | 2 | 4 | 2 | 4 | 2 | 3 | 2 | 2 |
| 18 | 3 | 6 | 3 | 6 | 3 | 7 | 3 | 5 | 3 | 5 | 3 | 5 | 3 | 4 | 3 | 4 | 3 | 3 |
| 20 | 3 | 7 | 3 | 7 | 3 | 7 | 3 | 6 | 3 | 6 | 3 | 5 | 3 | 5 | 3 | 4 | 3 | 3 |
| 22 | 3 | 8 | 3 | 8 | 3 | 8 | 3 | 7 | 3 | 7 | 3 | 6 | 3 | 5 | 3 | 5 | 3 | 4 |
| 24 | 3 | 9 | 3 | 9 | 3 | 9 | 3 | 8 | 3 | 7 | 3 | 7 | 3 | 6 | 3 | 5 | 3 | 4 |
| 26 | 3 | 10 | 3 | 10 | 3 | 10 | 4 | 9 | 3 | 8 | 3 | 7 | 3 | 7 | 3 | 6 | 3 | 4 |
| 28 | 4 | 11 | 4 | 10 | 4 | 11 | 4 | 9 | 4 | 9 | 4 | 8 | 4 | 7 | 4 | 6 | 4 | 5 |
| 30 | 4 | 12 | 4 | 11 | 4 | 12 | 4 | 10 | 4 | 10 | 4 | 9 | 4 | 8 | 4 | 7 | 4 | 5 |
| 32 | 4 | 13 | 4 | 12 | 4 | 13 | 4 | 11 | 4 | 11 | 4 | 10 | 4 | 9 | 4 | 7 | 4 | 6 |
| 34 | 4 | 14 | 4 | 13 | 4 | 13 | 4 | 12 | 4 | 11 | 4 | 10 | 4 | 9 | 4 | 8 | 4 | 6 |
| 36 | 4 | 15 | 4 | 14 | 4 | 14 | 5 | 13 | 4 | 12 | 4 | 11 | 4 | 10 | 4 | 9 | 4 | 6 |
| 38 | 5 | 16 | 5 | 15 | 5 | 15 | 5 | 14 | 5 | 13 | 5 | 12 | 5 | 10 | 5 | 9 | 5 | 7 |
| 40 | 5 | 17 | 5 | 16 | 5 | 16 | 5 | 14 | 5 | 14 | 5 | 12 | 5 | 11 | 5 | 10 | 5 | 7 |
| 42 | 5 | 18 | 5 | 17 | 5 | 17 | 5 | 15 | 5 | 14 | 5 | 13 | 5 | 12 | 5 | 10 | 5 | 8 |
| 44 | 5 | 19 | 5 | 18 | 5 | 18 | 5 | 16 | 5 | 15 | 5 | 14 | 5 | 12 | 5 | 11 | 5 | 8 |
| 46 | 5 | 20 | 5 | 19 | 5 | 19 | 6 | 17 | 5 | 16 | 5 | 14 | 5 | 13 | 5 | 11 | 5 | 8 |
| 48 | 6 | 21 | 6 | 20 | 6 | 19 | 6 | 18 | 6 | 17 | 6 | 15 | 6 | 13 | 6 | 12 | 6 | 9 |

1. Minimum number of bars is based on crack control requirements of ACI 10.6.
2. Maximum number of bars is based on clear spacing requirements of ACI 3.3.2(c) and ACI 7.6.1.
3. Overall bar diameter, rather than nominal bar diameter, was used in calculating the maximum number of bars.

## STIRRUP DESIGNATION NOTATION

Stirrup layout pattern is in the following format:

N1 N2 S3 S4 S5 where:

N1 is a two digit number denoting the number of stirrups at each end of the beam.

N2 is a one digit number representing the size designation of the reinforcing bar.

S3 definition depends on whether S4 and S5 are also listed. If S4 and S5 are not listed, then S3 is the symbol for the maximum spacing of the stirrups (inches).

If S4 and S5 are listed, then S3 is the symbol for the intermediate spacing of the stirrups, required at a distance *d* from the face of the support (inches).

S4 is the symbol for the number of stirrups at the intermediate spacing.

S5 is the symbol for the spacing of the remainder of the stirrups (inches).

Note that first stirrup is always 2 inches from the face of the support.

The physical meaning of symbols S3, S4 and S5 are as follows:

**S3, S5 (Stirrup Spacings)**

| Symbol | Spacing | Symbol | Spacing |
|---|---|---|---|
| A | 3″ | 0 | 16″ |
| B | 4″ | P | 17″ |
| C | 5″ | Q | 18″ |
| D | 6″ | R | 19″ |
| E | 7″ | S | 20″ |
| F | 8″ | T | 21″ |
| G | 9″ | U | 22″ |
| H | 10″ | V | 23″ |
| I | 11″ | W | 24″ |
| J | 12″ | X | 25″ |
| K | 13″ | Y | 26″ |
| M | 14″ | Z | 27″ |
| N | 15″ | | |

**S4 (Stirrup Number)**

| Symbol | No. | Symbol | No. | Symbol | No. | Symbol | No. |
|---|---|---|---|---|---|---|---|
| a | 1 | n | 14 | A | 27 | N | 40 |
| b | 2 | o | 15 | B | 28 | 0 | 41 |
| c | 3 | p | 16 | C | 29 | P | 42 |
| d | 4 | q | 17 | D | 30 | Q | 43 |
| e | 5 | r | 18 | E | 31 | R | 44 |
| f | 6 | s | 19 | F | 32 | S | 45 |
| g | 7 | t | 20 | G | 33 | T | 46 |
| h | 8 | u | 21 | H | 34 | U | 47 |
| i | 9 | v | 22 | I | 35 | V | 48 |
| j | 10 | w | 23 | J | 36 | W | 49 |
| k | 11 | x | 24 | K | 37 | X | 50 |
| l | 12 | y | 25 | L | 38 | Y | 51 |
| m | 13 | z | 26 | M | 39 | Z | 52 |

Examples:

294B means 29-#4: 1 @ 2″, 28 @ 4″ Each End

175K means 17-#5: 1 @ 2″, 16 @ 13″ Each End

275CgF means 27-#5: 1 @ 2″, 7 @ 5″, 19 @ 8″ Each End

305CqH means 30-#5: 1 @ 2″, 17 @ 5″, 12 @ 10″ Each End

## SPECIAL STIRRUP LAYOUT REQUIREMENTS

For deep, narrow beam cross sections, closed stirrup requirements for full design torsional moment strength, $\phi T_n \geq T_u \geq \phi 4\sqrt{f'_c}(A^2_{cp}/p_{cp})$, plus high shear may become impracticable for placing reinforcement. Similarly, in shallow beams heavily reinforced for flexure in cases of short spans and high vertical shear, the limited depth precludes use of larger sizes for closed stirrups and the full $\phi T_n \geq T_u$ cannot be developed. These situations indicate that a larger section should be used or that a special design is required (perhaps full $\phi T_n \geq T_u$ is more than required, etc.).

Some intermediate situations may also arise, particularly where a large number of closed stirrups for full $\phi T_n \geq T_u$ are required at a very small intermediate spacing. These layouts are outside the range of the standardized notation in this Chapter for stirrup patterns and must be considered a special case design.

## SELECTION OF OPEN STIRRUPS/CLOSED STIRRUPS FOR FLEXURAL MEMBERS UNDER SHEAR OR COMBINED SHEAR AND TORSION

Three principal points that should be kept in mind are:
(1) For structural safety, adequate shear and torsion reinforcement is very important, since the failure mode is brittle. The Code provisions are, properly, conservative to avoid failure with no warning signs as in the ductile flexural mode, that is, cracking, deflection, etc.
(2) For economy in construction, the selection of shear-torsion reinforcement is also important. Per pound, the small pieces of small bars require disproportionately large amounts of high cost shop labor and field labor in placing.
(3) For economy in design time, a complete step-by-step procedure to meet each applicable Code requirement is prohibitive—design aids to avoid all the Code calculations are essential.

Structural analysis can usually be done quickly to establish maximum shear and torsion at the section located a distance, $d$, from face of supports. The coefficients (ACI 8.3.3) for shear are generally applicable for uniform loads, and are reasonable even where a triangular loaded slab area contributes shear load to the beam. The former assumption results in a linear decrease in shear from face of the support toward midspan. Similarly, torsion from slabs under uniform load is also generally assumed to decrease linearly from the same critical section, $d$, from face of support.

A refinement used only with heavy live loads (warehouse loads, etc.) when a real probability of partial load exists is to consider a minimum live load shear at interior midspans equal to $w_{v\ell}\,\ell/8$. Usually, shear at midspan is taken as zero.

A corollary of the three points made is that design time is more cost-effective applied to a quick, conservative analysis than a meticulous "minimum weight" layout of an intricate pattern of stirrup spacings. An "exact" minimum weight solution for stirrups with an intricate layout pattern closely following the linear decrease in total shear can be run off from a computer. It is merely a valuable time-saving start in the design process. Adjustment into a simpler pattern can be performed. If necessary to use the maximum spacing, $d/2$, larger size stirrup substitutions may be made, e.g., #4 for #3 at double spacing, #5 for #4 at 1.5 times spacing.

The stirrup layout patterns shown in this Handbook are "minimum cost" solutions. Minimum cost solutions for simple placing of reinforcement were limited to three spacings: the first stirrup located 2 inches from face of support as a minimum clearance, an intermediate spacing, and finally a maximum spacing, usually $d/2$ for open stirrups, and $d/4$ for closed stirrups.

In all cases, the largest practical reinforcing bar size as limited by width or depth of the beam was used. See the following tabulation for minimum width of beam to allow for bend radii at corners of stirrups.

| Stirrup | Minimum Width of Beam |
|---|---|
| #3 | 10 in. |
| #4 | 12 in. – 14 in. |
| #5 | 14 in. |

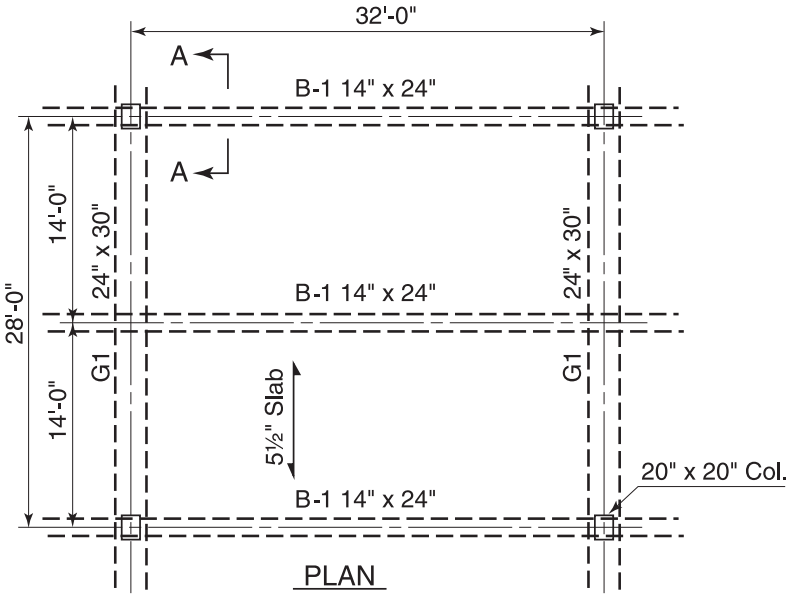
The applicable Code provisions were considered in stirrup selections presented in this Chapter. These requirements affecting both size and *layout* (spacings) of stirrup patterns are listed as follows:

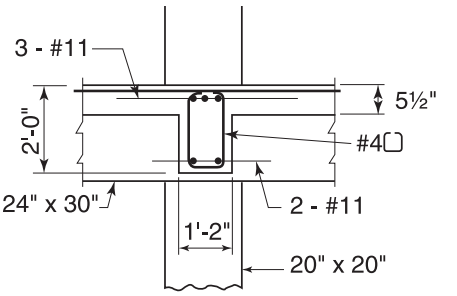
*Code Requirements for Stirrup Size and Layout*

| | |
|---|---|
| 11.4.4 | Extend $(d - d')$ and anchor per 12.13. |
| 11.4.5.1 | Maximum spacing, $s = 0.5d$. |
| 11.4.5.3 | When $V_s > 4\sqrt{f'_c}\ b_w d$, maximum $s = 0.25d$. |
| 11.5.6.1 | Closed stirrups – maximum spacing is $p_h/8 < 12$ in. |
| 12.13.2.1 | For #5 or smaller, a standard hook (90° or 135°) enclosing a longitudinal bar. Stirrups used in tabulated designs are #3, #4, or #5. (Anchorage of #6, #7, and #8 stirrups must conform to 12.13.2.2.) |

Figs. 12-1 and 12-4 show typical details recommended for flexural reinforcement and shear/torsion, respectively.

## MANUAL EXAMPLE – BEAM B-1
(TORSION NEGLIGIBLE)




**MATERIALS**
$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

**FLOOR LOAD**
5½″ slab = 69 psf
Ceilings = 4
Partitions = 20
93 psf
Service live load = 125 psf
$q_u$ = 1.2(93) + 1.6(125) = 312 psf

**BEAM B-1** (Spanning between girders, G1)

*Loads*
Floor (0.312) (14) = 4.37
Beam Stem ((18.5 (14)/144) (0.15) (1.2) = 0.32
$w_u$ = 4.69 kips/ft

See tables on Page 12-64: For $\ell_n$ = 30′-0″, $h$ = 24 in. and $b_w$ = 14 in.; select third tabulated design with load capacity = 4.72 kips/ft – Okay

Review tabulated design

*Flexure*
$+M_u = w_u \ell_n^2/16$
$+M_u$ = (4.69) $(30)^2/16$ = 263.8 ft-kips
$d$ = 24 – (1.5 + 0.5[#4 stirrup] + 1.41/2) = 21.3 in.

$$\text{Required } A_s = \frac{1.7 f'_c b_w d}{2 f_y} - \frac{1}{2}\sqrt{\frac{2.89(f'_c b_w d)^2}{(f_y)^2} - \frac{6.8 f'_c b_w M_u}{\phi (f_y)^2}}$$

$$= \frac{1.7\ (4)\ (14)\ (21.3)}{2(60)} - \frac{1}{2}\sqrt{\frac{2.89(4 \times 14 \times 21.3)^2}{(60)^2} - \frac{6.8(4)\ (14)\ (263.8 \times 12)}{(0.90)\ (60)^2}}$$

Required $A_s$ = 3.02 in.$^2$

Bottom bars tabulated: 2-#11
$A_s$ provided = 2(1.56) = 3.12 in.$^2$ > 3.02 - Okay

Confirm section is tension-controlled so $\phi$ = 0.90

$$\text{Actual } \rho = \frac{A_s}{b_w d} = \frac{3.12}{(14)(21.3)} = 0.0105$$

From Chapter 5; for $f'_c$ = 4,000 psi and $f_y$ = 60,000 psi:

Max $\rho$ = 0.0181 for $\phi$ = 0.90
Actual $\rho$ = 0.0105 < max $\rho$ ; hence, $\phi$ = 0.90

$-M_u = w_u \ell_n^2/11$

$-M_u$ = (4.69) $(30)^2/11$ = 383.7 ft-kips

$d$ = 24 – (1.5 + 0.5 + 1.41/2) = 21.3 in.

$$\text{Required } A_s = \frac{1.7\ (4)\ (14)\ (21.3)}{2(60)} - \frac{1}{2}\sqrt{\frac{2.89\ (4 \times 14 \times 21.3)^2}{(60)^2} - \frac{6.8\ (4)\ (14)\ (383.7 \times 12)}{(0.90)\ (60)^2}}$$

Required $A_s$ = 4.64 in.$^2$

Top bars tabulated: 3-#11

$A_s$ provided = 3(1.56) = 4.68 in.$^2$ > 4.64 – Okay

Confirm section is tension-controlled so $\phi$ = 0.90

$$\text{Actual } \rho = \frac{A_s}{b_w d} = \frac{4.68}{(14)(21.3)} = 0.0157$$

Max $\rho$ = 0.0181 for $\phi$ = 0.90
Actual $\rho$ = 0.0157 < max $\rho$ ; hence, $\phi$ = 0.90

**Torsion**

Assume Beam B-1 fixed at both ends. Conservatively, slab width = 30 ft.

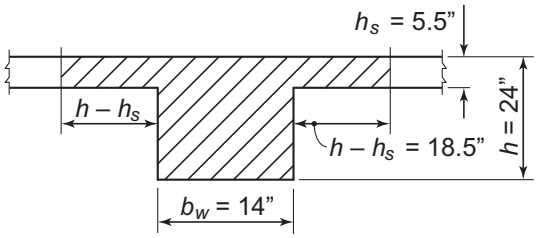
Gross moment of inertia of slab,

$I_g = 360\ (5.5)^3/12 = 4{,}990\ \text{in.}^4$

Flexural stiffness of slab,

$$K_s = \frac{4I_gE_c}{\ell} = \frac{4(4{,}990)\ E_c}{(14)\ (12)} = 118.8\ E_c$$

Torsional moment of inertia, $J$, of Beam B-1,




**Beam Section for Calculating *J***

$J = (b_w)^3(h)/3 - (b_w)^4/5 + 2\ [(h_s)^3(h - h_s)/3 - (h_s)^4/5]$

$J = (14)^3\ (24)/3 - (14)^4/5 + 2[(5.5)^3(18.5)/3 - (5.5)^4/5]$
$= 15{,}955\ \text{in.}^4$

Torsional stiffness of Beam B-1,

$$K_t = \frac{GJ}{\ell} = \frac{(0.45E_c)\ (15{,}955)}{(30)(12)} = 19.9E_c$$

Assume slab live loads and partitions in alternate panels.

Fixed-end moment:

$-M_u = w_u(\ell_n)^2/12$

$-M_u = (1.6 \times 0.125 + 1.2 \times 0.020)\ (14)^2/12 = 3.66$ ft-kips/ft

$\Sigma K_s = (118.8\ E_c)\ (2) = 237.6\ E_c$ Slabs = 92%

$K_t =$ $19.9\ E_c$ Beam = 8%

$257.5\ E_c$ Total = 100%

$T_u = (3.66)\ (15 - 21.3/12)\ (0.08) = 3.87$ ft-kips at each end of B-1

Compare $T_u$ vs. $\phi\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right)$

$A_{cp} = 14 \times 24 = 336\ \text{in.}^2$

$p_{cp} = 2(14 + 24) = 76$ in.

$$\phi\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right) = 0.75\ \sqrt{4{,}000}\ (336)^2/76$$
$$= 70{,}462\ \text{in.-lb}$$
$$= 5.87\ \text{ft-kips}$$

$T_u = 3.87$ ft-kips < 5.87 ft-kips, so torsion is resisted by concrete and no torsion reinforcement is required.

**Shear**

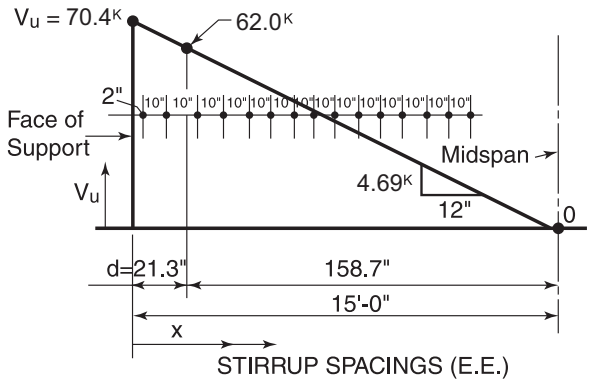
$\phi V_c = \phi\, 2\sqrt{f'_c}\, b_w d = 0.75(2)\sqrt{4{,}000}\ (14)\ (21.3)/1{,}000$
$= 28.3$ kips

At $d = 21.3$ in. from face of support

$V_u = 4.69\ (15 - 21.3/12) = 62.0$ kips

Maximum size stirrups, see Page 12-15.

For $b = 14$ in., #4 stirrups




Use #4 U-shaped stirrups; determine required spacing:

$$s = \frac{\phi A_v f_y d}{(V_u - \phi V_c)} = \frac{(0.75)(0.40)(60)(21.3)}{(62.0 - 28.3)} = 11.4'' > d/2 = 10''$$

Extend stirrups until $V_u = 0.5\ \phi V_c = 0.5(28.3) = 14.2$ k

Extend to (14.2 kips/4.69 kips/ft) = 3.03 ft from midspan

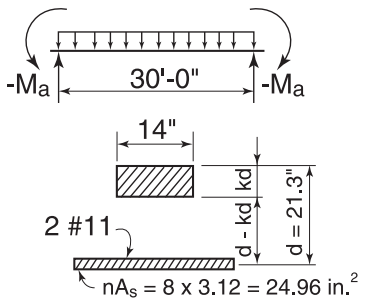
Spaced at 10″, (15 – 3.03)12/10 = 15 spaces are required

Use: 16-#4; 1 @ 2″, 15 @ 10″ at each end of beam

See Page 12-64; read "164H". See Page 12-14 for pattern.

**Deflection**

Calculate $I_{cr}$ for positive moment section



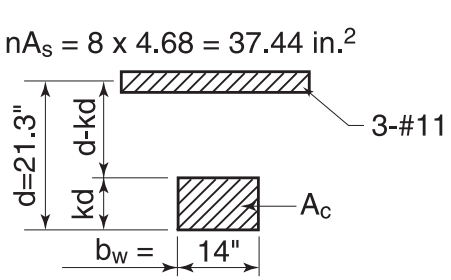

$n = E_s/E_c = 29 \times 10^6/57{,}000\ \sqrt{4{,}000} = 8$

$14(kd)^2/2 = 24.96(21.3 - kd)$

Solving: $kd = 7.11$ in.

$I_{cr} = 14(7.11)^3/3 + 24.96(21.3 - 7.11)^2 = 6{,}703\ \text{in.}^4$

Calculate $I_{cr}$ for negative moment section



$14(kd)^2/2 = 37.44\ (21.3 - kd)$

Solving: $kd = 8.33$ in.

$I_{cr} = 14(8.33)^3/3 + 37.44\ (21.3 - 8.33)^2 = 8{,}996$ in.$^4$

$I_g = b_w h^3/12 = 14(24)^3/12 = 16{,}128$ in.$^4$

Take average service load as (1.2D + 1.6L)/1.4, conservatively.

Average service load = 4.69/1.4 = 3.35 kips/ft

$\pm M_a = w(\ell_n)^2/16 = 3.35(30)^2/16 = 188.4$ ft-kips

$$I_e = \left(\frac{M_{cr}}{M_a}\right)^3 I_g + \left[1 - \left(\frac{M_{cr}}{M_a}\right)^3\right] I_{cr} \quad \text{(ACI Eq. 9-8)}$$

Where:

$$M_{cr} = 7.5\sqrt{f'_c}\, I_g/y_t = \frac{7.5\sqrt{4{,}000}\,(16{,}128)}{12(12{,}000)} = 53.1 \text{ ft-kips}$$

$$I_e = \left(\frac{53.1}{188.4}\right)^3 (16{,}128) + \left[1 - \left(\frac{53.1}{188.4}\right)^3\right]\left(\frac{6{,}703 + 8{,}996}{2}\right)$$
$$= 8{,}035 \text{ in.}^4$$

**Deflection**

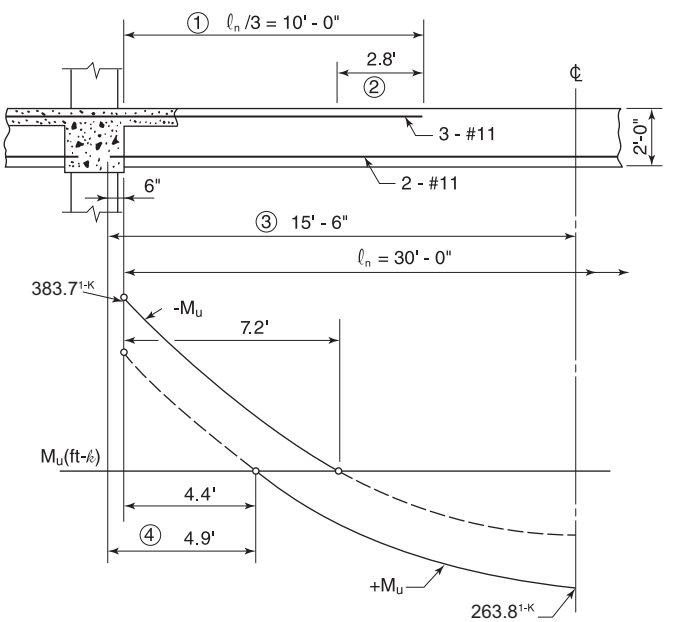
$$\Delta = \frac{2w\,(\ell_n)^4}{384 E_c I_e} = \frac{2(3{,}350/12)\,(360)^4}{(384)(57{,}000\sqrt{4{,}000})(8{,}035)} = 0.84 \text{ in.}$$

Compare calculated $\Delta = 0.84$ in. with tabulated deflection coefficient, $C = 311$.

Deflection based on $C = \Delta_c$
$= (C \times 10^{-9})$ ($w$ in kips/ft) ($\ell_n$ in ft)$^4$

Thus, $C$ corresponding to calculated $\Delta = 0.84$ in. is:

$$C = \frac{0.84 \times 10^9}{(3.35)\,(30)^4} = 310 \text{ (tabulated } C = 311)$$




**Development**

Top bars: 3-#11

Concrete cover = 1.5 + 0.5 (#4 stirrups) = 2 in. = 2/1.41 or $1.4d_b$;

Chapter 5; from Table 5-2(b), Case 1;
$\ell_d = 87$ in. $= 7.25$ ft

Dimension ① = $10.0' > \ell_d = 7.25'$, okay

Dimension ② = $2.8' > 12d_b = 1.41'$, okay
$> d = 1.78'$, okay
$> \ell_n/16 = 1.88'$, okay
} (ACI 12.10.3 and 12.12.3)

Bottom bars: 2-#11

Concrete cover = 2 in. or $1.4d_b$ as for the #11 top bars

Chapter 5; from Table 5-2(b), Case 1;
$\ell_d = 67$ in. $= 5.58$ ft

At inflection point, check $\ell_d \le M_n/V_u + \ell_a$ (ACI Eq. 12-5)

$a = A_s f_y/0.85 f'_c\, b_w$

$a = 3.12\ (60)/0.85(4)\ (14) = 3.93$ in.

$M_n = A_s f_y (d - a/2)$

$M_n = 3.12\ (60)\ (21.3 - 3.93/2)/12 = 301.6$ ft-kips

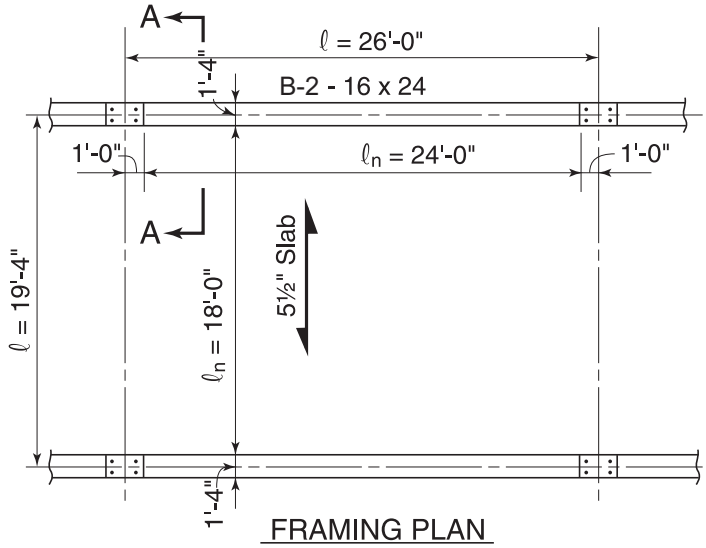
$V_u = 70.4 - 4.69\ (4.4) = 49.8$ kips

$\ell_a$ is larger of $12d_b = 16.9''$ or $d = 21.3''$

$M_n/V_u + \ell_a = 301.6(12)/49.8 + 21.3 = 94.0''$
$> \ell_d = 67''$, okay.

Dimension ③ = $15.5' > \ell_d = 5.58'$, okay
Dimension ④ = $4.9' > 12d_b = 1.41'$, okay
$> d = 1.77'$, okay
} (ACI 12.10.3)

Since closed stirrups are not provided, structural integrity (ACI 7.13.2.5) would require lap splicing (Class B) of at least 25 percent of the bottom $A_s$ required at midspan to the bottom bars in the adjacent spans. Hence, the above check on Dimension ④ would be affected.




FRAMING PLAN

Review the tabulated design of an interior span of a continuous beam, designated as Beam B-2 in this example, for combined shear and torsion only. Beam B-2, a spandrel beam, is subjected to uniformly distributed factored gravity loads, and a uniformly distributed factored torsional moment over its clear span, $\ell_n = 24'\text{-}0''$.

Assume Beam B-2 with $b_w$ = 16 in. and $h$ = 24 in. This is the first tabulated design on Page 12-64 with a load capacity = 4.07 kips/ft.

Reinforcement tabulated:

Top bars: 3-#8, $A_s$ = 2.37 in.$^2$

Bottom bars: 2-#8, $A_s$ = 1.58 in.$^2$

Stirrup pattern for shear and negligible torsion: 113H

Stirrup pattern for combined shear and maximum torsion: 184F

**Torsion**

The effects of torsion can be neglected when

$$T_u < \phi\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right) \text{ (ACI 11.5.1-a)}$$

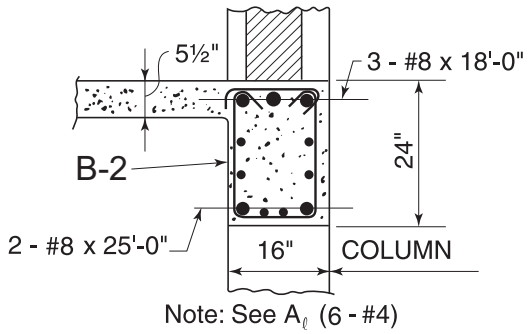
For Beam B-2:

$A_{cp} = 16 \times 24 = 384$ in.$^2$

$p_{cp} = 2(16 + 24) = 80$ in.

$T_u = 0.75\sqrt{(4000)}(384)^2/(80)(12{,}000) = 7.3$ ft-kips

For a uniformly distributed factored torsional moment applied over the 24-ft clear span, the computed value, $T_u$ = 7.3 ft-kips, would be the (total) factored torsional moment at a distance, $d$, from the face of the support where open stirrups could be used.




SECTION A-A

The effective depth, $d$, for the 3-#8 top bars and #4 stirrups:

$d = 24 - (1.5 + 0.500 + 1.000/2) = 21.5$ in. or 1.79 ft

The tabulated value of $T_u$ is the (total) factored torsional moment at the face of the support.

For Beam B-2 (at face of support):
$T_u = 12/(12 - 1.79)(7.3) = 8.6$ ft-kips (tabulated = 9), okay

Closed stirrup capacity:

When a beam uses closed stirrups, the beam can be designed for:

$$\text{Max } T_u = \phi 4\sqrt{f'_c}\left(\frac{A^2_{cp}}{p_{cp}}\right) \text{ (ACI 11.5.2.2-a)}$$

For Beam B-2 (at a distance $d$ from face of support):

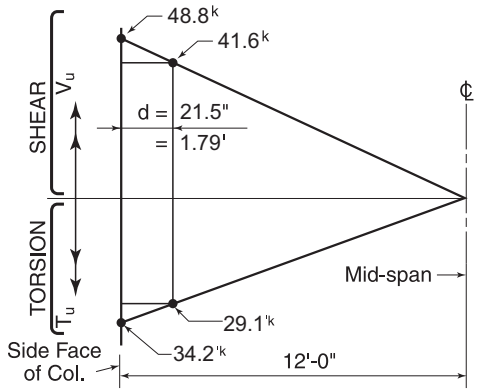
Max $T_u = (0.75)(4)\sqrt{4{,}000}(384)^2/(80)(12{,}000) = 29.1$ ft-kips

For Beam B-2 (at face of support):

Max $T_u$ = 12/10.21 (29.1) = 34.2 ft-kips (tabulated = 34), okay

Combined shear and torsion considerations:

Reinforcement required for combined shear and torsion:




At distance $d$ from face of support:
$V_u = 4.07\ (12 - 1.79) = 41.6$ kips
$T_u = 29.1$ ft-kips (previously calculated)

Check adequacy of cross-sectional dimensions

$$\sqrt{\left(\frac{V_u}{b_w d}\right)^2 + \left(\frac{T_u p_h}{1.7 A_{oh}^2}\right)^2} \le \phi\left(\frac{V_c}{b_w d} + 8\sqrt{f'_c}\right) \text{(ACI Eq. 11-18)}$$

Where:

$\rho_h = 2(x_1 + y_1) = 2(12.500 + 20.500)$

$\rho_h = 66.0$ in.

$A_{oh} = (x_1)(y_1) = (12.500)(20.500)$

$A_{oh} = 256$ in.$^2$

$$\sqrt{\left(\frac{41{,}600}{16(21.5)}\right)^2 + \left(\frac{29.1 \times 12{,}000\,(66.0)}{1.7\ (256)^2}\right)^2} = 240 \text{ psi}$$

Compute maximum shear and torsion capacity for this cross section:

$0.75\ (2\sqrt{4{,}000} + 8\sqrt{4{,}000}) = 474$ psi

$240 < 474$, okay

Stirrups required for shear.
$\phi V_s = V_u - \phi V_c$

Where:
$\phi V_c = \phi 2\sqrt{f'_c}\, bd = 0.75(2)\sqrt{4{,}000}(16)(21.5)/1000$
$= 32.6$ kips
$\phi V_s = 41.6 - 32.6 = 9.0$ kips

Required $A_v = \left(\dfrac{V_s s}{\phi f_{yt} d}\right)$ (ACI Eq. 11-15)

For shear, max $s = d/2 \approx 10$ in.

For combined shear and torsion, max $s = p_h/8$ or 12 in.

Max $s = 66.0/8 = 8.25$ in. $< 12$ in., use 8 in.

For $s = 8$ in., required $A_v = \dfrac{(9.0)(8)}{(0.75)(60)(21.5)} = 0.074$ in.$^2$

Vertical stirrups required for torsion:

$$T_n = \frac{2A_o A_t f_{yt}}{s} \cot\theta \text{ (ACI Eq. 11-21)}$$

$A_o = 0.85\ A_{oh} = 0.85\ (256) = 218$ in.$^2$

$$A_t = \frac{T_n s}{\phi 2\ A_o f_{yt} \cot\theta}$$

$$\text{Required } A_t = \frac{29{,}100\ (12)\ (8)}{0.75(2)\ (218)\ (60{,}000)\ (1)} = 0.142 \text{ in.}^2$$

For combined shear and torsion, the required area of stirrups spaced at 8 in.:

$A_v/2 + A_t = 0.074/2 + 0.142$
$= 0.18$ in.$^2 <$ #4 (0.20 in.$^2$), okay

Min area of closed stirrups,

$$A_v + 2A_t = 0.75\sqrt{f'_c}\ \frac{b_w s}{f_{yt}} \ge \frac{50 b_w s}{f_{yv}} \text{ (ACI Eq. 11-23)}$$

$$\frac{50 b_w s}{f_{yt}} = \frac{50\,(16)\,(8)}{60{,}000} = 0.11 \text{ in.}^2 < 0.20 \text{ in.}^2\text{, okay}$$

Longitudinal bar area required for torsion:

$$A_\ell = \frac{A_t}{s} p_h \frac{f_{yt}}{f_y} \cot^2\theta \text{ (ACI Eq. 11-22)}$$

$$A_\ell = \left(\frac{0.142}{8}\right)(66.0)(1)(1)$$
$= 1.17$ in.$^2$ (tabulated = 1.3), okay

$$\text{Min } A_\ell = \frac{5\sqrt{f'_c}\ A_{cp}}{f_y} - \frac{A_t}{s} p_h \frac{f_{yt}}{f_{y\ell}} \text{ (ACI Eq. 11-24)}$$

where $A_t/s \ge 25\ b_w/f_{yt}$

$25\ b_w/f_{yt} = 25\ (16)/60{,}000 = 0.007$

$A_t/s = (0.142/8) = 0.018 > 0.007$, Okay

$$\text{Min } A_\ell = \frac{5\sqrt{4{,}000}\,(384)}{60{,}000} - \left(\frac{0.142}{8}\right)(66.0)\frac{60{,}000}{60{,}000} = 0.85 \text{ in.}^2$$

Torsion reinforcement must be provided for a distance ($b_t$ + $d$) past the point where theoretically required (ACI 11.5.6.3):

$b_t + d = 16 + 21.5 = 37.5$ in. or 3.13 ft

Torsion reinforcement is not required where $T_u \leq 7.3$ ft-kips. The point where $T_u = 7.3$ ft-kips is 9.44′ from face of support. Since 9.44 + 3.13 = 12.57′ > 12.0′, torsion reinforcement is required over the entire span of Beam B-2.

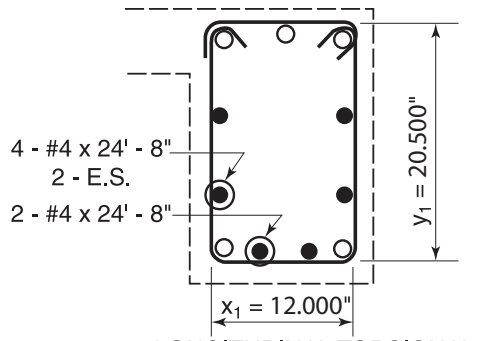
Stirrup pattern tabulated is 184F, stirrups extend 2″ + 17(8) = 138″ each side of midspan (within 6″ of midspan), okay.

6-#4 = 6 × 0.20 = 1.20 in.$^2$ > 1.17 okay

Auxiliary longitudinal reinforcement for torsion, $A_\ell$: ●

Main flexural reinforcement, $A_s$: ○

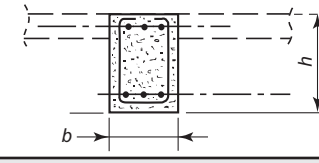
$A_\ell$ length – 2[136″ (extension into span)
+ 24″ (column)] = 296″ = 24′–8″

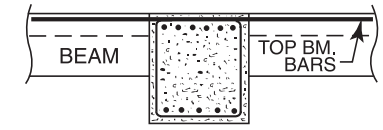


LONGITUDINAL TORSIONAL REINFORCEMENT, $A_\ell$

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 12 ft | | | | | SPAN, $\ell_n$ = 14 ft. | | | | | SPAN, $\ell_n$ = 16 ft. | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 12 | 8 | 2# 4 | | 1 | 2# 4 | 1.16 | 123B | 1 | - | 56 | 0.85 | 123B | 1 | - | 60 | 0.65 | 123B | 1 | - | 65 | 0.52 | 113B | 1 | - | 67 | 16 | 7661 |
| | | | | 1 | | | 243A | 4 | 0.4 | 108 | | 283A | 4 | 0.4 | 125 | | 323A | 4 | 0.4 | 143 | | 363A | 4 | 0.4 | 160 | 16 | |
| | | 2# 3 | 2# 3 | 2 | 2# 5 | 1.31 | 143B | 1 | - | 67 | 0.96 | 143B | 1 | - | 72 | 0.74 | 143B | 1 | - | 78 | 0.58 | 143B | 1 | - | 83 | 17 | 8777 |
| | | | | 1 | | | 243A | 4 | 0.4 | 115 | | 283A | 4 | 0.4 | 133 | | 323A | 4 | 0.4 | 151 | | 363A | 4 | 0.4 | 170 | 25 | |
| | | 2# 4 | 2# 4 | 2 | 2# 6 | 2.23 | 173B | 1 | - | 97 | 1.64* | 193B | 1 | - | 110 | 1.26* | 203B | 1 | - | 121 | 0.99* | 223B | 1 | - | 134 | 29 | 10707 |
| | | | | 1 | | | 243A | 4 | 0.4 | 138 | | 283A | 4 | 0.4 | 160 | | 323A | 4 | 0.4 | 182 | | 363A | 4 | 0.4 | 203 | 34 | |
| | | 2# 4 | 2# 4 | 2 | 3# 5 | 2.23 | 173B | 1 | - | 98 | 1.64* | 193B | 1 | - | 111 | 1.26* | 203B | 1 | - | 122 | 0.99* | 223B | 1 | - | 135 | 29 | 11089 |
| | | | | 2 | | | 243A | 4 | 0.4 | 139 | | 283A | 4 | 0.4 | 161 | | 323A | 4 | 0.4 | 183 | | 363A | 4 | 0.4 | 204 | 33 | |
| | 10 | 2# 4 | | 1 | 2# 4 | 1.17 | 103B | 1 | - | 53 | 0.86 | 093B | 1 | - | 55 | 0.66 | 083B | 1 | - | 57 | 0.52 | 053B | 1 | - | 54 | 16 | 4035 |
| | | | | 1 | | | 183B | 6 | 0.4 | 93 | | 213B | 6 | 0.4 | 108 | | 243B | 6 | 0.4 | 123 | | 273B | 6 | 0.4 | 138 | 16 | |
| | | 2# 5 | | 1 | 2# 5 | 1.77 | 143B | 1 | - | 78 | 1.30 | 153B | 1 | - | 87 | 1.00 | 153B | 1 | - | 94 | 0.79 | 153B | 1 | - | 100 | 25 | 7792 |
| | | | | 1 | | | 183B | 6 | 0.4 | 109 | | 213B | 6 | 0.4 | 126 | | 243B | 6 | 0.4 | 143 | | 273B | 6 | 0.4 | 160 | 25 | |
| | | 2# 6 | | 1 | 3# 5 | 2.58 | 163B | 1 | - | 104 | 1.89 | 183B | 1 | - | 118 | 1.45* | 193B | 1 | - | 130 | 1.15* | 203B | 1 | - | 142 | 35 | 8570 |
| | | | | 1 | | | 183B | 6 | 0.4 | 130 | | 213B | 6 | 0.4 | 150 | | 243B | 6 | 0.4 | 170 | | 273B | 6 | 0.4 | 190 | 37 | |
| | | 3# 4 | 2# 4 | 2 | 2# 7 | 2.84 | 173B | 1 | - | 119 | 2.09* | 193B | 1 | - | 135 | 1.60* | 203B | 1 | - | 148 | 1.26* | 223B | 1 | - | 164 | 37 | 8293 |
| | | | | 1 | | | 183B | 6 | 0.4 | 143 | | 213B | 6 | 0.4 | 164 | | 243B | 6 | 0.4 | 186 | | 273B | 6 | 0.4 | 208 | 45 | |
| | 12 | 2# 5 | | 1 | 2# 5 | 1.79 | 123B | 2 | - | 75 | 1.31 | 133B | 2 | - | 84 | 1.01 | 123B | 2 | - | 88 | 0.79 | 113B | 2 | - | 92 | 25 | 5316 |
| | | | | 1 | | | 183B | 8 | 0.5 | 113 | | 213B | 8 | 0.5 | 131 | | 243B | 7 | 0.5 | 149 | | 273B | 7 | 0.5 | 167 | 25 | |
| | | 2# 6 | | 1 | 2# 6 | 2.47 | 153B | 2 | - | 103 | 1.81 | 163B | 2 | - | 115 | 1.39 | 173B | 2 | - | 127 | 1.10 | 173B | 2 | - | 136 | 35 | 7079 |
| | | | | 1 | | | 183B | 8 | 0.5 | 134 | | 213B | 8 | 0.5 | 155 | | 243B | 7 | 0.5 | 175 | | 273B | 7 | 0.5 | 196 | 35 | |
| | | 2# 5 | 2# 5 | 1 | 2# 7 | 3.26 | 173B | 2 | - | 129 | 2.39 | 183B | 2 | - | 144 | 1.83* | 203B | 2 | - | 162 | 1.45* | 213B | 2 | - | 177 | 48 | 6800 |
| | | | | 1 | | | 183B | 8 | 0.5 | 155 | | 213B | 8 | 0.5 | 179 | | 243B | 7 | 0.5 | 203 | | 273B | 7 | 0.5 | 227 | 46 | |
| | | 2# 6 | 1# 6 | 1 | 2# 8 | 3.93 | 183B | 2 | - | 149 | 2.89* | 193B | 2 | - | 167 | 2.21* | 213B | 2 | - | 186 | 1.75* | 233B | 2 | - | 206 | 51 | 6439 |
| | | | | 1 | | | 184B | 8 | 0.5 | 246 | | 213B | 8 | 0.5 | 199 | | 243B | 7 | 0.5 | 225 | | 273B | 7 | 0.5 | 252 | 59 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

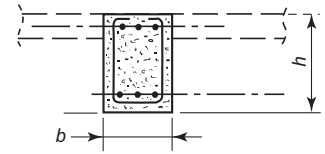
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

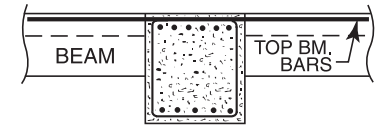
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | | |
| $h$ in. | $b$ in. | BOTTOM $\ell_n$ + 12 in. | BOTTOM 0.875 $\ell_n$ | Layers (2) | TOP | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 12 | 8 | 2# 4 | | 1 | 2# 4 | 0.42 | 093B | 1 | - | 67 | 0.35 | 073B | 1 | - | 67 | 0.29 | 043B | 1 | - | 65 | 0.25 | N/A | 1 | - | 60 | 16 | 7661 |
| | | | | 1 | | | 403A | 4 | 0.4 | 178 | | 443A | 4 | 0.4 | 195 | | 483A | 4 | 0.4 | 212 | | 523A | 4 | 0.4 | 230 | 16 | |
| | | 2# 5 | | 1 | 2# 5 | 0.63* | 183B | 1 | - | 111 | 0.52* | 183B | 1 | - | 118 | 0.44* | 173B | 1 | - | 122 | 0.37* | 163B | 1 | - | 127 | 25 | 10675 |
| | | | | 1 | | | 403A | 4 | 0.4 | 202 | | 443A | 4 | 0.4 | 222 | | 483A | 4 | 0.4 | 242 | | 523A | 4 | 0.4 | 261 | 25 | |
| | | 2# 6 | | 1 | 3# 5 | 0.85* | 233B | 1 | - | 156 | 0.70X | 233B | 1 | - | 165 | 0.59X | 243B | 1 | - | 177 | 0.50X | 243B | 1 | - | 187 | 34 | 10248 |
| | | | | 2 | | | 403A | 4 | 0.4 | 236 | | 443A | 4 | 0.4 | 258 | | 483A | 4 | 0.4 | 281 | | 523A | 4 | 0.4 | 304 | 33 | |
| | | 2# 5 | 2# 5 | 2 | 2# 7 | 1.11X | 263B | 1 | - | 195 | 0.92X | 283B | 1 | - | 212 | 0.77Y | 293B | 1 | - | 227 | 0.66Y | 303B | 1 | - | 241 | 41 | 9101 |
| | | | | 1 | | | 403A | 4 | 0.4 | 268 | | 443A | 4 | 0.4 | 294 | | 483A | 4 | 0.4 | 320 | | 523A | 4 | 0.4 | 345 | 44 | |
| | 10 | 2# 5 | | 1 | 2# 5 | 0.64 | 143B | 1 | - | 104 | 0.53 | 133B | 1 | - | 109 | 0.44* | 113B | 1 | - | 111 | 0.38* | 093B | 1 | - | 113 | 25 | 7792 |
| | | | | 1 | | | 303B | 6 | 0.4 | 177 | | 333B | 6 | 0.4 | 194 | | 363B | 5 | 0.4 | 212 | | 393B | 5 | 0.4 | 229 | 25 | |
| | | 2# 6 | | 1 | 2# 6 | 0.88* | 203B | 1 | - | 151 | 0.72* | 203B | 1 | - | 160 | 0.61X | 203B | 1 | - | 170 | 0.52X | 193B | 1 | - | 177 | 35 | 8551 |
| | | | | 1 | | | 303B | 6 | 0.4 | 209 | | 333B | 6 | 0.4 | 229 | | 363B | 5 | 0.4 | 250 | | 393B | 5 | 0.4 | 270 | 35 | |
| | | 2# 7 | | 1 | 2# 7 | 1.15X | 243B | 1 | - | 198 | 0.95X | 253B | 1 | - | 213 | 0.80X | 253B | 1 | - | 226 | 0.68X | 263B | 1 | - | 242 | 45 | 7713 |
| | | | | 1 | | | 303B | 6 | 0.4 | 248 | | 333B | 6 | 0.4 | 271 | | 363B | 5 | 0.4 | 295 | | 393B | 5 | 0.4 | 318 | 45 | |
| | | 2# 6 | 1# 6 | 1 | 2# 8 | 1.38X | 263B | 1 | - | 225 | 1.14X | 273B | 1 | - | 242 | 0.96X | 283B | 1 | - | 260 | 0.82Y | 293B | 1 | - | 277 | 50 | 6966 |
| | | | | 1 | | | 303B | 6 | 0.4 | 270 | | 333B | 6 | 0.4 | 296 | | 363B | 5 | 0.4 | 321 | | 393B | 5 | 0.4 | 346 | 57 | |
| | 12 | 2# 5 | | 1 | 2# 5 | 0.64 | 103B | 2 | - | 96 | 0.53 | 083B | 2 | - | 98 | 0.45 | 053B | 2 | - | 97 | 0.38 | N/A | 2 | - | 92 | 25 | 5316 |
| | | | | 1 | | | 303B | 7 | 0.5 | 185 | | 333B | 7 | 0.5 | 203 | | 363B | 7 | 0.5 | 221 | | 393B | 7 | 0.5 | 238 | 25 | |
| | | 2# 6 | | 1 | 2# 6 | 0.89* | 173B | 2 | - | 146 | 0.73* | 173B | 2 | - | 155 | 0.62* | 163B | 2 | - | 162 | 0.53* | 153B | 2 | - | 169 | 35 | 7079 |
| | | | | 1 | | | 303B | 7 | 0.5 | 217 | | 333B | 7 | 0.5 | 238 | | 363B | 7 | 0.5 | 259 | | 393B | 7 | 0.5 | 279 | 35 | |
| | | 2# 7 | | 1 | 2# 8 | 1.29* | 233B | 2 | - | 217 | 1.07X | 243B | 2 | - | 234 | 0.90X | 243B | 2 | - | 248 | 0.76X | 243B | 2 | - | 262 | 46 | 6559 |
| | | | | 1 | | | 303B | 7 | 0.5 | 273 | | 333B | 7 | 0.5 | 299 | | 363B | 7 | 0.5 | 325 | | 393B | 7 | 0.5 | 350 | 59 | |
| | | 2# 8 | | 1 | 2# 9 | 1.63X | 263B | 2 | - | 272 | 1.35X | 273B | 2 | - | 293 | 1.13X | 283B | 2 | - | 314 | 0.96Y | 293B | 2 | - | 335 | 59 | 5817 |
| | | | | 1 | | | 303B | 7 | 0.5 | 321 | | 333B | 7 | 0.5 | 351 | | 363B | 7 | 0.5 | 381 | | 393B | 7 | 0.5 | 411 | 71 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

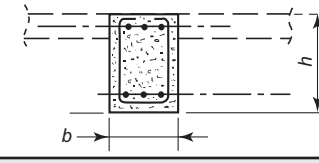
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

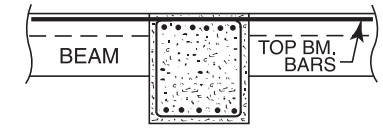
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 12 ft | | | | | SPAN, $\ell_n$ = 14 ft. | | | | | SPAN, $\ell_n$ = 16 ft. | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 14 | 8 | 2# 4 | | 1 | 2# 4 | 1.41 | 103C | 1 | - | 54 | 1.04 | 103C | 1 | - | 59 | 0.80 | 103C | 1 | - | 63 | 0.63 | 093C | 1 | - | 65 | 20 | 3909 |
| | | | | 1 | | | 183B | 5 | 0.5 | 93 | | 213B | 5 | 0.4 | 108 | | 243B | 5 | 0.4 | 123 | | 273B | 5 | 0.4 | 138 | 20 | |
| | | 2# 4 | 1# 4 | 2 | 2# 5 | 2.13 | 133C | 1 | - | 76 | 1.57 | 143C | 1 | - | 84 | 1.20 | 153C | 1 | - | 93 | 0.95 | 153C | 1 | - | 100 | 28 | 6571 |
| | | | | 1 | | | 183B | 5 | 0.4 | 107 | | 213B | 5 | 0.4 | 124 | | 243B | 5 | 0.4 | 141 | | 273B | 5 | 0.4 | 158 | 30 | |
| | | 2# 4 | 2# 4 | 2 | 2# 6 | 2.78 | 143C | 1 | - | 94 | 2.04 | 163C | 1 | - | 108 | 1.57 | 173C | 1 | - | 119 | 1.24* | 183C | 1 | - | 130 | 36 | 6679 |
| | | | | 1 | | | 183B | 5 | 0.4 | 123 | | 213B | 5 | 0.4 | 142 | | 243B | 5 | 0.4 | 162 | | 273B | 5 | 0.4 | 181 | 42 | |
| | | 2# 4 | 2# 4 | 2 | 3# 5 | 2.78 | 143C | 1 | - | 95 | 2.04 | 163C | 1 | - | 109 | 1.57 | 173C | 1 | - | 120 | 1.24* | 183C | 1 | - | 131 | 36 | 6836 |
| | | | | 2 | | | 183B | 5 | 0.4 | 124 | | 213B | 5 | 0.4 | 143 | | 243B | 5 | 0.4 | 163 | | 273B | 5 | 0.4 | 182 | 42 | |
| | 10 | 2# 4 | | 1 | 2# 5 | 1.57 | 093C | 2 | - | 59 | 1.15 | 093C | 2 | - | 65 | 0.88 | 083C | 2 | - | 67 | 0.70 | 073C | 2 | - | 70 | 20 | 2401 |
| | | | | 1 | | | 183B | 8 | 0.5 | 104 | | 213B | 7 | 0.5 | 120 | | 243B | 7 | 0.5 | 137 | | 273B | 7 | 0.5 | 153 | 31 | |
| | | 2# 5 | | 1 | 2# 5 | 2.16 | 113C | 2 | - | 74 | 1.59 | 123C | 2 | - | 83 | 1.21 | 123C | 2 | - | 90 | 0.96 | 123C | 2 | - | 96 | 31 | 4309 |
| | | | | 1 | | | 183B | 8 | 0.5 | 113 | | 213B | 7 | 0.5 | 131 | | 243B | 7 | 0.5 | 149 | | 273B | 7 | 0.5 | 167 | 31 | |
| | | 2# 6 | | 1 | 3# 5 | 3.16 | 133C | 2 | - | 100 | 2.32 | 153C | 2 | - | 115 | 1.78 | 163C | 2 | - | 127 | 1.40 | 173C | 2 | - | 139 | 42 | 5314 |
| | | | | 1 | | | 183B | 8 | 0.5 | 134 | | 213B | 7 | 0.5 | 155 | | 243B | 7 | 0.5 | 176 | | 273B | 7 | 0.5 | 197 | 45 | |
| | | 3# 4 | 2# 4 | 2 | 2# 7 | 3.53 | 143C | 2 | - | 115 | 2.59 | 163C | 2 | - | 132 | 1.99 | 173C | 2 | - | 146 | 1.57* | 183C | 2 | - | 160 | 46 | 5187 |
| | | | | 1 | | | 183B | 7 | 0.5 | 147 | | 213B | 7 | 0.5 | 170 | | 243B | 7 | 0.5 | 192 | | 273B | 7 | 0.5 | 215 | 56 | |
| | 12 | 2# 5 | | 1 | 2# 5 | 2.18 | 103C | 2 | - | 72 | 1.60 | 103C | 2 | - | 79 | 1.22 | 103C | 2 | - | 86 | 0.97 | 093C | 2 | - | 90 | 31 | 2742 |
| | | | | 1 | | | 143C | 10 | 0.6 | 102 | | 173C | 10 | 0.6 | 120 | | 193C | 10 | 0.6 | 135 | | 223C | 9 | 0.6 | 154 | 31 | |
| | | 2# 6 | | 1 | 2# 6 | 3.02 | 123C | 2 | - | 98 | 2.22 | 133C | 2 | - | 111 | 1.70 | 143C | 2 | - | 123 | 1.34 | 143C | 2 | - | 132 | 43 | 4138 |
| | | | | 1 | | | 143C | 10 | 0.6 | 122 | | 173C | 10 | 0.6 | 144 | | 193C | 10 | 0.6 | 161 | | 223C | 9 | 0.6 | 183 | 43 | |
| | | 2# 5 | 2# 5 | 1 | 2# 7 | 4.01 | 143C | 2 | - | 125 | 2.94 | 153C | 2 | - | 141 | 2.25 | 163C | 2 | - | 156 | 1.78 | 173C | 2 | - | 171 | 60 | 4261 |
| | | | | 1 | | | 144C | 10 | 0.6 | 203 | | 173C | 10 | 0.6 | 168 | | 193C | 10 | 0.6 | 189 | | 223C | 9 | 0.6 | 214 | 57 | |
| | | 2# 6 | 1# 6 | 1 | 2# 8 | 4.83 | 143C | 2 | - | 143 | 3.55 | 163C | 2 | - | 163 | 2.72 | 173C | 2 | - | 181 | 2.15* | 193C | 2 | - | 201 | 63 | 4097 |
| | | | | 1 | | | 144C | 10 | 0.6 | 221 | | 174C | 10 | 0.6 | 261 | | 194C | 10 | 0.6 | 292 | | 223C | 9 | 0.6 | 238 | 73 | |
| | 14 | 2# 5 | | 1 | 3# 4 | 2.13 | 093C | 3 | - | 70 | 1.57 | 093C | 3 | - | 77 | 1.20 | 083C | 3 | - | 81 | 0.95 | 063C | 3 | - | 82 | 31 | 1615 |
| | | | | 1 | | | 143C | 13 | 0.7 | 105 | | 173C | 12 | 0.7 | 124 | | 193C | 12 | 0.7 | 139 | | 223C | 12 | 0.7 | 158 | 30 | |
| | | 2# 6 | | 1 | 3# 5 | 3.23 | 123C | 3 | - | 101 | 2.37 | 133C | 3 | - | 113 | 1.81 | 133C | 3 | - | 123 | 1.43 | 133C | 3 | - | 132 | 43 | 3343 |
| | | | | 1 | | | 143C | 13 | 0.7 | 126 | | 173C | 12 | 0.7 | 149 | | 193C | 12 | 0.7 | 167 | | 223C | 12 | 0.7 | 189 | 46 | |
| | | 2# 6 | 1# 6 | 1 | 3# 6 | 4.45 | 133C | 3 | - | 133 | 3.27 | 153C | 3 | - | 152 | 2.50 | 163C | 3 | - | 169 | 1.98 | 173C | 3 | - | 186 | 64 | 3736 |
| | | | | 1 | | | 144C | 13 | 0.7 | 218 | | 174C | 12 | 0.7 | 258 | | 193C | 12 | 0.7 | 205 | | 223C | 12 | 0.7 | 232 | 64 | |
| | | 3# 5 | 2# 5 | 1 | 3# 7 | 5.71 | 143C | 3 | - | 159 | 4.19 | 163C | 3 | - | 182 | 3.21 | 173C | 3 | - | 202 | 2.54* | 193C | 3 | - | 225 | 74 | 3505 |
| | | | | 1 | | | 144C | 13 | 0.7 | 242 | | 174C | 12 | 0.7 | 285 | | 194C | 12 | 0.7 | 320 | | 224C | 12 | 0.7 | 363 | 84 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

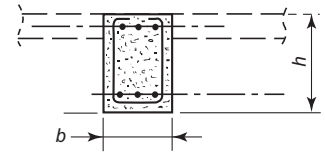
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

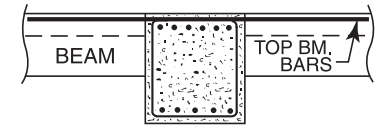
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 14 | 8 | 2# 4 | | 1 | 2# 5 | 0.56 | 103C | 1 | - | 81 | 0.46 | 083C | 1 | - | 82 | 0.39 | 073C | 1 | - | 85 | 0.33 | 053C | 1 | - | 85 | 20 | 4510 |
| | | | | 1 | | | 303B | 5 | 0.4 | 162 | | 333B | 5 | 0.4 | 178 | | 363B | 5 | 0.4 | 194 | | 393B | 5 | 0.4 | 209 | 30 | |
| | | 2# 5 | | 1 | 2# 6 | 0.84 | 163C | 1 | - | 124 | 0.70 | 163C | 1 | - | 132 | 0.59* | 163C | 1 | - | 139 | 0.50* | 163C | 1 | - | 147 | 30 | 6253 |
| | | | | 1 | | | 303B | 5 | 0.4 | 190 | | 333B | 5 | 0.4 | 208 | | 363B | 5 | 0.4 | 227 | | 393B | 5 | 0.4 | 245 | 42 | |
| | | 2# 5 | 2# 5 | 2 | 2# 7 | 1.38* | 223C | 1 | - | 192 | 1.14* | 233C | 1 | - | 207 | 0.96X | 243C | 1 | - | 222 | 0.82X | 253C | 1 | - | 237 | 53 | 5746 |
| | | | | 1 | | | 303B | 5 | 0.4 | 243 | | 333B | 5 | 0.4 | 266 | | 363B | 5 | 0.4 | 289 | | 393B | 5 | 0.4 | 313 | 55 | |
| | | 2# 6 | 1# 6 | 2 | 2# 8 | 1.57* | 223C | 1 | - | 219 | 1.29X | 243C | 1 | - | 238 | 1.09X | 253C | 1 | - | 256 | 0.93X | 263C | 1 | - | 273 | 56 | 5110 |
| | | | | 1 | | | 303B | 5 | 0.4 | 270 | | 333B | 5 | 0.4 | 296 | | 363B | 5 | 0.4 | 321 | | 393B | 5 | 0.4 | 346 | 69 | |
| | 10 | 2# 5 | | 1 | 2# 5 | 0.78 | 123C | 2 | - | 103 | 0.64 | 113C | 2 | - | 107 | 0.54 | 103C | 2 | - | 111 | 0.46 | 083C | 2 | - | 112 | 31 | 4309 |
| | | | | 1 | | | 303B | 7 | 0.5 | 185 | | 333B | 7 | 0.5 | 203 | | 363B | 7 | 0.5 | 221 | | 393B | 7 | 0.5 | 238 | 31 | |
| | | 2# 6 | | 1 | 2# 6 | 1.07 | 163C | 2 | - | 145 | 0.89* | 173C | 2 | - | 157 | 0.75* | 163C | 2 | - | 164 | 0.64* | 163C | 2 | - | 174 | 42 | 5242 |
| | | | | 1 | | | 303B | 7 | 0.5 | 217 | | 333B | 7 | 0.5 | 238 | | 363B | 7 | 0.5 | 259 | | 393B | 7 | 0.5 | 279 | 42 | |
| | | 2# 7 | | 1 | 2# 8 | 1.56* | 203C | 2 | - | 212 | 1.29* | 213C | 2 | - | 229 | 1.08* | 223C | 2 | - | 246 | 0.92X | 233C | 2 | - | 263 | 56 | 4570 |
| | | | | 1 | | | 303B | 7 | 0.5 | 273 | | 333B | 7 | 0.5 | 299 | | 363B | 7 | 0.5 | 325 | | 393B | 7 | 0.5 | 350 | 71 | |
| | | 2# 8 | | 1 | 2# 9 | 1.98* | 223C | 2 | - | 265 | 1.63* | 233C | 2 | - | 286 | 1.37X | 253C | 2 | - | 310 | 1.17X | 263C | 2 | - | 331 | 71 | 3990 |
| | | | | 1 | | | 303B | 7 | 0.5 | 321 | | 333B | 7 | 0.5 | 351 | | 363B | 7 | 0.5 | 381 | | 393B | 7 | 0.5 | 411 | 87 | |
| | 12 | 2# 6 | | 1 | 2# 6 | 1.09 | 143C | 2 | - | 142 | 0.90 | 143C | 2 | - | 151 | 0.75 | 133C | 2 | - | 158 | 0.64* | 123C | 2 | - | 165 | 43 | 4138 |
| | | | | 1 | | | 243C | 9 | 0.6 | 200 | | 263C | 9 | 0.6 | 218 | | 293C | 9 | 0.6 | 239 | | 313C | 9 | 0.6 | 257 | 43 | |
| | | 2# 7 | | 1 | 2# 7 | 1.44* | 183C | 2 | - | 191 | 1.19* | 183C | 2 | - | 204 | 1.00* | 183C | 2 | - | 217 | 0.85* | 183C | 2 | - | 230 | 57 | 4346 |
| | | | | 1 | | | 243C | 9 | 0.6 | 239 | | 263C | 9 | 0.6 | 260 | | 293C | 9 | 0.6 | 285 | | 313C | 9 | 0.6 | 306 | 57 | |
| | | 2# 8 | | 1 | 2# 9 | 2.02* | 213C | 2 | - | 265 | 1.67* | 223C | 2 | - | 286 | 1.40X | 233C | 2 | - | 308 | 1.20X | 243C | 2 | - | 329 | 73 | 3710 |
| | | | | 1 | | | 243C | 9 | 0.6 | 305 | | 263C | 9 | 0.6 | 331 | | 293C | 9 | 0.6 | 362 | | 313C | 9 | 0.6 | 389 | 89 | |
| | | 2# 9 | | 1 | 2#10 | 2.47* | 223C | 2 | - | 326 | 2.04X | 243C | 2 | - | 355 | 1.71X | 253C | 2 | - | 381 | 1.46X | 263C | 2 | - | 407 | 89 | 3254 |
| | | | | 1 | | | 244C | 9 | 0.6 | 465 | | 264C | 9 | 0.6 | 505 | | 294C | 9 | 0.6 | 553 | | 313C | 9 | 0.6 | 462 | 106 | |
| | 14 | 2# 6 | | 1 | 3# 5 | 1.16 | 133C | 3 | - | 142 | 0.96 | 123C | 3 | - | 149 | 0.81 | 113C | 3 | - | 156 | 0.69 | 103C | 3 | - | 163 | 43 | 3343 |
| | | | | 1 | | | 243C | 12 | 0.7 | 208 | | 263C | 12 | 0.6 | 226 | | 293C | 12 | 0.6 | 248 | | 313C | 12 | 0.6 | 266 | 46 | |
| | | 2# 7 | | 1 | 3# 6 | 1.60* | 173C | 3 | - | 195 | 1.32* | 183C | 3 | - | 212 | 1.11* | 183C | 3 | - | 225 | 0.95* | 183C | 3 | - | 238 | 58 | 3857 |
| | | | | 1 | | | 243C | 12 | 0.7 | 250 | | 263C | 12 | 0.6 | 272 | | 293C | 12 | 0.6 | 298 | | 313C | 12 | 0.6 | 320 | 64 | |
| | | 2# 9 | | 1 | 3# 8 | 2.52* | 213C | 3 | - | 314 | 2.08* | 233C | 3 | - | 343 | 1.75X | 243C | 3 | - | 369 | 1.49X | 253C | 3 | - | 394 | 91 | 3099 |
| | | | | 1 | | | 244C | 12 | 0.7 | 464 | | 264C | 12 | 0.6 | 504 | | 293C | 12 | 0.6 | 424 | | 313C | 12 | 0.6 | 456 | 106 | |
| | | 2#10 | | 1 | 3# 8 | 2.67* | 223C | 3 | - | 355 | 2.20* | 233C | 3 | - | 384 | 1.85X | 243C | 3 | - | 414 | 1.58X | 263C | 3 | - | 446 | 111 | 2896 |
| | | | | 1 | | | 244C | 12 | 0.7 | 502 | | 264C | 12 | 0.6 | 546 | | 294C | 12 | 0.6 | 599 | | 313C | 12 | 0.6 | 505 | 106 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

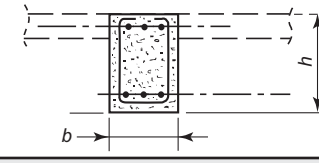
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

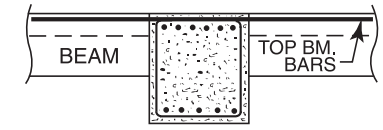
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 16 ft | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | SPAN, $\ell_n$ = 20 ft. | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 16 | 10 | 2# 6 | | 1 | 2# 6 | 1.99 | 133D | 2 | - | 122 | 1.57 | 143D | 2 | - | 134 | 1.27 | 143D | 2 | - | 144 | 1.05 | 143D | 2 | - | 153 | 50 | 3376 |
| | | | | 1 | | | 193C | 9 | 0.6 | 161 | | 223C | 9 | 0.6 | 183 | | 243C | 9 | 0.6 | 200 | | 263C | 9 | 0.6 | 218 | 50 | |
| | | 2# 7 | | 1 | 2# 7 | 2.64 | 153D | 2 | - | 159 | 2.08 | 163D | 2 | - | 175 | 1.69 | 173D | 2 | - | 190 | 1.40* | 173D | 2 | - | 203 | 67 | 3323 |
| | | | | 1 | | | 193C | 9 | 0.6 | 193 | | 223C | 9 | 0.6 | 218 | | 243C | 9 | 0.6 | 239 | | 263C | 9 | 0.6 | 260 | 67 | |
| | | 2# 8 | | 1 | 2# 9 | 3.70 | 163D | 2 | - | 216 | 2.92* | 173D | 2 | - | 238 | 2.37* | 193D | 2 | - | 262 | 1.96* | 203D | 2 | - | 284 | 86 | 2740 |
| | | | | 1 | | | 323A | 9 | 0.6 | 300 | | 363A | 9 | 0.6 | 334 | | 403A | 9 | 0.6 | 369 | | 263C | 9 | 0.6 | 331 | 105 | |
| | | 3# 5 | 3# 5 | 2 | 2# 9 | 4.04 | 163D | 2 | - | 224 | 3.19* | 183D | 2 | - | 249 | 2.59* | 193D | 2 | - | 272 | 2.14* | 213D | 2 | - | 297 | 94 | 2746 |
| | | | | 1 | | | 323A | 9 | 0.6 | 307 | | 363A | 9 | 0.6 | 343 | | 403A | 9 | 0.6 | 379 | | 443A | 9 | 0.6 | 415 | 105 | |
| | 12 | 2# 6 | | 1 | 2# 6 | 2.01 | 123D | 3 | - | 120 | 1.59 | 123D | 3 | - | 130 | 1.28 | 123D | 3 | - | 139 | 1.06 | 123D | 3 | - | 149 | 51 | 2523 |
| | | | | 1 | | | 193C | 12 | 0.7 | 166 | | 223C | 12 | 0.7 | 188 | | 243C | 12 | 0.7 | 206 | | 263C | 11 | 0.7 | 224 | 51 | |
| | | 2# 7 | | 1 | 2# 8 | 2.94 | 143D | 3 | - | 173 | 2.32 | 153D | 3 | - | 190 | 1.88 | 163D | 3 | - | 208 | 1.56 | 173D | 3 | - | 225 | 68 | 2776 |
| | | | | 1 | | | 193C | 12 | 0.7 | 213 | | 223C | 12 | 0.7 | 240 | | 243C | 12 | 0.7 | 263 | | 263C | 11 | 0.7 | 286 | 87 | |
| | | 3# 5 | 3# 5 | 2 | 2# 9 | 4.14 | 163D | 3 | - | 226 | 3.27* | 173D | 3 | - | 249 | 2.65* | 193D | 3 | - | 274 | 2.19* | 203D | 3 | - | 297 | 96 | 2555 |
| | | | | 1 | | | 194C | 12 | 0.7 | 345 | | 224C | 12 | 0.7 | 390 | | 244C | 11 | 0.7 | 428 | | 264C | 11 | 0.6 | 465 | 107 | |
| | | 4# 5 | 3# 5 | 2 | 2#10 | 4.78 | 164D | 3 | - | 313 | 3.78* | 183D | 3 | - | 297 | 3.06* | 193D | 3 | - | 323 | 2.53* | 213D | 3 | - | 353 | 111 | 2253 |
| | | | | 1 | | | 194C | 12 | 0.7 | 385 | | 224C | 12 | 0.7 | 435 | | 244C | 11 | 0.7 | 477 | | 264C | 11 | 0.6 | 518 | 131 | |
| | 14 | 2# 7 | | 1 | 3# 6 | 2.97 | 133D | 4 | - | 160 | 2.35 | 143D | 4 | - | 177 | 1.90 | 153D | 4 | - | 193 | 1.57 | 153D | 4 | - | 207 | 69 | 2516 |
| | | | | 1 | | | 164D | 15 | 0.8 | 267 | | 183D | 15 | 0.8 | 215 | | 203D | 15 | 0.7 | 238 | | 223D | 15 | 0.7 | 260 | 75 | |
| | | 2# 8 | | 1 | 3# 7 | 3.82 | 153D | 4 | - | 207 | 3.02 | 163D | 4 | - | 228 | 2.44* | 173D | 4 | - | 249 | 2.02* | 183D | 4 | - | 270 | 88 | 2400 |
| | | | | 1 | | | 164D | 15 | 0.8 | 308 | | 184D | 15 | 0.8 | 344 | | 204D | 15 | 0.7 | 380 | | 224D | 15 | 0.7 | 417 | 100 | |
| | | 2# 8 | 1# 8 | 1 | 3# 8 | 5.00 | 164D | 4 | - | 320 | 3.95 | 173D | 4 | - | 300 | 3.20* | 193D | 4 | - | 331 | 2.65* | 203D | 4 | - | 358 | 128 | 2012 |
| | | | | 1 | | | 165D | 15 | 0.8 | 468 | | 184D | 15 | 0.7 | 413 | | 204D | 15 | 0.7 | 456 | | 224D | 15 | 0.7 | 499 | 128 | |
| | | 5# 5 | 4# 5 | 2 | 3# 9 | 6.05 | 164D | 4 | - | 367 | 4.78* | 184D | 4 | - | 409 | 3.87* | 204D | 4 | - | 451 | 3.20* | 213D | 4 | - | 423 | 140 | 1864 |
| | | | | 1 | | | 165D | 15 | 0.8 | 515 | | 185D | 15 | 0.7 | 575 | | 205D | 15 | 0.7 | 635 | | 224D | 14 | 0.7 | 561 | 155 | |
| | 16 | 2# 7 | | 1 | 3# 6 | 2.99 | 133D | 5 | - | 162 | 2.36 | 133D | 5 | - | 176 | 1.92 | 133D | 4 | - | 189 | 1.58 | 133D | 4 | - | 202 | 69 | 2105 |
| | | | | 1 | | | 164D | 18 | 0.9 | 275 | | 183D | 18 | 0.9 | 220 | | 203D | 18 | 0.8 | 243 | | 223D | 18 | 0.8 | 266 | 76 | |
| | | 2# 8 | | 1 | 3# 7 | 3.86 | 143D | 5 | - | 206 | 3.05 | 153D | 5 | - | 227 | 2.47 | 163D | 4 | - | 248 | 2.04* | 163D | 4 | - | 266 | 89 | 2182 |
| | | | | 1 | | | 164D | 18 | 0.9 | 315 | | 184D | 18 | 0.9 | 353 | | 204D | 18 | 0.8 | 390 | | 223D | 18 | 0.8 | 320 | 101 | |
| | | 2# 8 | 1# 8 | 1 | 3# 9 | 5.59 | 164D | 5 | - | 351 | 4.41 | 173D | 5 | - | 332 | 3.58* | 183D | 4 | - | 362 | 2.96* | 203D | 4 | - | 396 | 130 | 1781 |
| | | | | 1 | | | 165D | 18 | 0.9 | 506 | | 184D | 18 | 0.8 | 451 | | 204D | 18 | 0.8 | 497 | | 224D | 18 | 0.8 | 544 | 159 | |
| | | 5# 5 | 5# 5 | 2 | 3#10 | 6.69 | 164D | 5 | - | 420 | 5.29* | 184D | 5 | - | 468 | 4.28* | 204D | 4 | - | 515 | 3.54* | 214D | 4 | - | 556 | 155 | 1602 |
| | | | | 1 | | | 165D | 18 | 0.8 | 575 | | 185D | 18 | 0.8 | 642 | | 205D | 18 | 0.8 | 709 | | 225D | 18 | 0.8 | 775 | 193 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

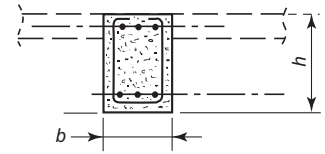
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

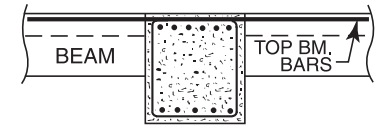
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 24 ft | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 16 | 10 | 2# 6 | | 1 | 2# 6 | 0.88 | 143D | 2 | - | 163 | 0.75 | 143D | 2 | - | 172 | 0.65* | 133D | 2 | - | 179 | 0.57* | 133D | 2 | - | 188 | 50 | 3376 |
| | | | | 1 | | | 293C | 8 | 0.6 | 239 | | 313C | 8 | 0.6 | 257 | | 343C | 8 | 0.6 | 279 | | 363C | 8 | 0.5 | 296 | 50 | |
| | | 2# 7 | | 1 | 2# 7 | 1.17* | 183D | 2 | - | 219 | 1.00* | 183D | 2 | - | 232 | 0.86* | 183D | 2 | - | 245 | 0.75* | 193D | 2 | - | 261 | 67 | 3323 |
| | | | | 1 | | | 293C | 8 | 0.6 | 285 | | 313C | 8 | 0.6 | 306 | | 343C | 8 | 0.6 | 331 | | 363C | 8 | 0.5 | 352 | 67 | |
| | | 2# 8 | | 1 | 2# 9 | 1.64* | 213D | 2 | - | 305 | 1.40* | 223D | 2 | - | 326 | 1.21X | 233D | 2 | - | 348 | 1.05X | 233D | 2 | - | 366 | 86 | 2740 |
| | | | | 1 | | | 293C | 8 | 0.6 | 362 | | 313C | 8 | 0.6 | 389 | | 343C | 8 | 0.6 | 419 | | 363C | 8 | 0.5 | 446 | 105 | |
| | | 2# 9 | | 1 | 2# 9 | 1.82* | 223D | 2 | - | 344 | 1.55X | 233D | 2 | - | 369 | 1.34X | 243D | 2 | - | 393 | 1.17X | 253D | 2 | - | 417 | 105 | 2564 |
| | | | | 1 | | | 483A | 8 | 0.6 | 475 | | 313C | 8 | 0.6 | 428 | | 343C | 8 | 0.6 | 462 | | 363C | 8 | 0.5 | 491 | 105 | |
| | 12 | 2# 6 | | 1 | 2# 6 | 0.89 | 113D | 3 | - | 156 | 0.76 | 113D | 3 | - | 165 | 0.66 | 103D | 3 | - | 172 | 0.57 | 093D | 3 | - | 178 | 51 | 2523 |
| | | | | 1 | | | 293C | 11 | 0.6 | 247 | | 313C | 11 | 0.6 | 265 | | 343C | 11 | 0.6 | 287 | | 363C | 11 | 0.6 | 305 | 51 | |
| | | 2# 7 | | 1 | 2# 8 | 1.31* | 173D | 3 | - | 239 | 1.11* | 173D | 3 | - | 254 | 0.96* | 173D | 3 | - | 268 | 0.84* | 173D | 3 | - | 283 | 68 | 2776 |
| | | | | 1 | | | 293C | 11 | 0.6 | 313 | | 313C | 11 | 0.6 | 336 | | 343C | 11 | 0.6 | 363 | | 363C | 11 | 0.6 | 386 | 87 | |
| | | 2# 9 | | 1 | 2# 9 | 1.87* | 213D | 3 | - | 344 | 1.59* | 213D | 3 | - | 366 | 1.37X | 223D | 3 | - | 390 | 1.20X | 233D | 3 | - | 415 | 107 | 2393 |
| | | | | 1 | | | 293C | 11 | 0.6 | 406 | | 313C | 11 | 0.6 | 436 | | 343C | 11 | 0.6 | 470 | | 363C | 11 | 0.6 | 500 | 107 | |
| | | 2#10 | | 1 | 2#10 | 2.28* | 223D | 3 | - | 424 | 1.94X | 233D | 3 | - | 454 | 1.68X | 243D | 3 | - | 484 | 1.46X | 253D | 3 | - | 514 | 131 | 2084 |
| | | | | 1 | | | 294C | 11 | 0.6 | 612 | | 314C | 11 | 0.6 | 656 | | 344C | 11 | 0.6 | 710 | | 363C | 11 | 0.6 | 594 | 131 | |
| | 14 | 2# 7 | | 1 | 3# 6 | 1.32 | 153D | 4 | - | 220 | 1.12* | 153D | 4 | - | 234 | 0.97* | 153D | 4 | - | 247 | 0.84* | 143D | 4 | - | 258 | 69 | 2516 |
| | | | | 1 | | | 243D | 14 | 0.7 | 283 | | 263D | 14 | 0.7 | 305 | | 283D | 14 | 0.7 | 327 | | 303D | 14 | 0.7 | 350 | 75 | |
| | | 2# 8 | | 1 | 3# 7 | 1.70* | 183D | 4 | - | 288 | 1.45* | 193D | 4 | - | 309 | 1.25* | 193D | 4 | - | 327 | 1.09X | 193D | 4 | - | 344 | 88 | 2400 |
| | | | | 1 | | | 243D | 14 | 0.7 | 341 | | 263D | 14 | 0.7 | 368 | | 283D | 14 | 0.7 | 395 | | 303D | 14 | 0.7 | 421 | 100 | |
| | | 2#10 | | 1 | 3# 8 | 2.22* | 213D | 4 | - | 410 | 1.89* | 223D | 4 | - | 440 | 1.63X | 223D | 4 | - | 467 | 1.42X | 233D | 4 | - | 496 | 134 | 1986 |
| | | | | 1 | | | 244D | 14 | 0.7 | 566 | | 264D | 14 | 0.7 | 611 | | 284D | 14 | 0.7 | 656 | | 304D | 14 | 0.7 | 701 | 128 | |
| | | 2#10 | | 1 | 3# 9 | 2.57* | 223D | 4 | - | 451 | 2.19X | 233D | 4 | - | 483 | 1.89X | 243D | 4 | - | 515 | 1.64X | 253D | 4 | - | 548 | 134 | 1858 |
| | | | | 1 | | | 244D | 14 | 0.7 | 604 | | 264D | 14 | 0.7 | 651 | | 284D | 14 | 0.7 | 699 | | 304D | 14 | 0.7 | 746 | 155 | |
| | 16 | 2# 7 | | 1 | 3# 6 | 1.33 | 133D | 4 | - | 216 | 1.13 | 133D | 4 | - | 229 | 0.98 | 123D | 4 | - | 240 | 0.85* | 113D | 4 | - | 250 | 69 | 2105 |
| | | | | 1 | | | 243D | 18 | 0.8 | 289 | | 263D | 18 | 0.8 | 312 | | 283D | 17 | 0.8 | 335 | | 303D | 17 | 0.8 | 357 | 76 | |
| | | 2# 9 | | 1 | 3# 7 | 1.77* | 173D | 4 | - | 323 | 1.51* | 183D | 4 | - | 347 | 1.30* | 183D | 4 | - | 368 | 1.13* | 183D | 4 | - | 389 | 110 | 2066 |
| | | | | 1 | | | 243D | 18 | 0.8 | 383 | | 263D | 18 | 0.8 | 414 | | 283D | 17 | 0.8 | 444 | | 303D | 17 | 0.8 | 474 | 101 | |
| | | 2#10 | | 1 | 3# 9 | 2.61* | 213D | 4 | - | 451 | 2.23* | 223D | 4 | - | 483 | 1.92X | 233D | 4 | - | 515 | 1.67X | 243D | 4 | - | 548 | 136 | 1767 |
| | | | | 1 | | | 244D | 18 | 0.8 | 615 | | 264D | 17 | 0.8 | 663 | | 284D | 17 | 0.8 | 711 | | 304D | 17 | 0.8 | 760 | 159 | |
| | | 2#11 | | 1 | 3#10 | 3.10* | 223D | 4 | - | 551 | 2.64X | 233D | 4 | - | 591 | 2.28X | 253D | 4 | - | 634 | 1.99X | 263D | 4 | - | 673 | 162 | 1551 |
| | | | | 1 | | | 244D | 18 | 0.8 | 712 | | 264D | 17 | 0.8 | 768 | | 284D | 17 | 0.8 | 823 | | 304D | 17 | 0.8 | 879 | 193 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

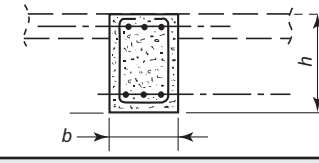
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

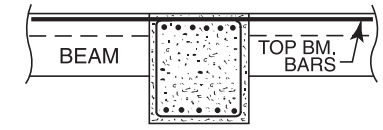
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 16 ft | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | SPAN, $\ell_n$ = 20 ft. | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 18 | 10 | 2# 6 | | 1 | 2# 6 | 2.30 | 113E | 3 | - | 119 | 1.81 | 123E | 3 | - | 131 | 1.47 | 123E | 3 | - | 141 | 1.21 | 123E | 3 | - | 150 | 58 | 2240 |
| | | | | 1 | | | 193C | 11 | 0.7 | 166 | | 223C | 10 | 0.7 | 188 | | 243C | 10 | 0.6 | 206 | | 263C | 10 | 0.6 | 224 | 58 | |
| | | 2# 7 | | 1 | 2# 7 | 3.06 | 133E | 3 | - | 156 | 2.42 | 143E | 3 | - | 172 | 1.96 | 143E | 3 | - | 185 | 1.62 | 153E | 3 | - | 201 | 78 | 2347 |
| | | | | 1 | | | 193C | 11 | 0.7 | 197 | | 223C | 10 | 0.7 | 223 | | 243C | 10 | 0.6 | 245 | | 263C | 10 | 0.6 | 266 | 78 | |
| | | 2# 8 | | 1 | 2# 9 | 4.31 | 143E | 3 | - | 214 | 3.41 | 153E | 3 | - | 236 | 2.76 | 163E | 3 | - | 258 | 2.28* | 173E | 3 | - | 279 | 100 | 1981 |
| | | | | 1 | | | 323A | 11 | 0.7 | 308 | | 363A | 10 | 0.7 | 343 | | 403A | 10 | 0.6 | 379 | | 443A | 10 | 0.6 | 415 | 123 | |
| | | 3# 5 | 3# 5 | 2 | 2#10 | 4.76 | 163BeE | 3 | - | 251 | 3.76 | 163E | 3 | - | 273 | 3.05 | 173E | 3 | - | 298 | 2.52* | 183E | 3 | - | 323 | 110 | 1816 |
| | | | | 1 | | | 323A | 11 | 0.7 | 338 | | 363A | 10 | 0.7 | 377 | | 403A | 10 | 0.6 | 416 | | 443A | 10 | 0.6 | 455 | 150 | |
| | 12 | 2# 6 | | 1 | 2# 7 | 2.55 | 113E | 4 | - | 133 | 2.01 | 113E | 4 | - | 144 | 1.63 | 123E | 3 | - | 158 | 1.35 | 123E | 3 | - | 169 | 59 | 1722 |
| | | | | 1 | | | 163D | 14 | 0.8 | 170 | | 183D | 14 | 0.8 | 190 | | 203D | 14 | 0.7 | 210 | | 223D | 14 | 0.7 | 230 | 79 | |
| | | 2# 8 | | 1 | 2# 8 | 3.98 | 133E | 4 | - | 195 | 3.15 | 143E | 4 | - | 215 | 2.55 | 153E | 3 | - | 235 | 2.11 | 163E | 3 | - | 255 | 101 | 1915 |
| | | | | 1 | | | 164D | 14 | 0.8 | 300 | | 184D | 14 | 0.8 | 335 | | 204D | 14 | 0.7 | 370 | | 224D | 14 | 0.7 | 406 | 101 | |
| | | 3# 5 | 3# 5 | 2 | 2#10 | 4.86 | 144E | 4 | - | 290 | 3.84 | 153E | 3 | - | 272 | 3.11 | 163E | 3 | - | 297 | 2.57 | 173E | 3 | - | 322 | 113 | 1684 |
| | | | | 1 | | | 164D | 14 | 0.8 | 349 | | 184D | 14 | 0.8 | 389 | | 204D | 14 | 0.7 | 429 | | 224D | 14 | 0.7 | 469 | 154 | |
| | | 4# 5 | 4# 5 | 2 | 2#10 | 6.03 | 144E | 4 | - | 323 | 4.76 | 164E | 3 | - | 362 | 3.86* | 174E | 3 | - | 394 | 3.19* | 183E | 3 | - | 370 | 145 | 1572 |
| | | | | 1 | | | 324A | 14 | 0.8 | 528 | | 364A | 14 | 0.7 | 591 | | 204D | 14 | 0.7 | 470 | | 224D | 14 | 0.7 | 514 | 154 | |
| | 14 | 2# 7 | | 1 | 3# 6 | 3.43 | 123E | 5 | - | 160 | 2.71 | 123E | 4 | - | 174 | 2.20 | 133E | 4 | - | 191 | 1.82 | 133E | 4 | - | 204 | 79 | 1695 |
| | | | | 1 | | | 164D | 18 | 0.9 | 275 | | 184D | 18 | 0.9 | 307 | | 203D | 18 | 0.8 | 243 | | 223D | 17 | 0.8 | 266 | 87 | |
| | | 2# 8 | | 1 | 3# 7 | 4.43 | 133E | 5 | - | 204 | 3.50 | 143E | 4 | - | 226 | 2.84 | 153E | 4 | - | 247 | 2.34 | 153E | 4 | - | 265 | 103 | 1700 |
| | | | | 1 | | | 164D | 18 | 0.9 | 315 | | 184D | 18 | 0.9 | 353 | | 204D | 18 | 0.8 | 390 | | 224D | 17 | 0.8 | 427 | 116 | |
| | | 2# 8 | 1# 8 | 1 | 3# 9 | 6.42 | 144E | 5 | - | 342 | 5.07 | 154E | 4 | - | 376 | 4.11 | 173E | 4 | - | 361 | 3.39* | 183E | 4 | - | 392 | 149 | 1357 |
| | | | | 1 | | | 165D | 18 | 0.9 | 506 | | 185D | 18 | 0.9 | 565 | | 204D | 18 | 0.8 | 497 | | 224D | 17 | 0.8 | 544 | 182 | |
| | | 5# 5 | 4# 5 | 2 | 3# 9 | 7.12 | 144E | 5 | - | 361 | 5.63 | 164E | 4 | - | 404 | 4.56* | 174E | 4 | - | 440 | 3.77* | 184E | 4 | - | 476 | 165 | 1343 |
| | | | | 1 | | | 165D | 18 | 0.9 | 526 | | 185D | 18 | 0.8 | 587 | | 205D | 18 | 0.8 | 649 | | 224D | 17 | 0.8 | 571 | 182 | |
| | 16 | 2# 7 | | 1 | 3# 6 | 3.46 | 113E | 6 | - | 158 | 2.73 | 123E | 6 | - | 175 | 2.21 | 123E | 5 | - | 189 | 1.83 | 123E | 5 | - | 202 | 80 | 1365 |
| | | | | 1 | | | 144E | 22 | 1.0 | 262 | | 164E | 22 | 1.0 | 295 | | 174E | 22 | 1.0 | 319 | | 193E | 21 | 0.9 | 256 | 88 | |
| | | 2# 8 | | 1 | 3# 8 | 4.47 | 123E | 6 | - | 226 | 3.53 | 133E | 6 | - | 249 | 2.86 | 143E | 5 | - | 273 | 2.36 | 143E | 5 | - | 293 | 104 | 1395 |
| | | | | 1 | | | 144E | 22 | 1.0 | 325 | | 164E | 22 | 1.0 | 366 | | 174E | 22 | 1.0 | 396 | | 194E | 21 | 0.9 | 436 | 151 | |
| | | 2# 7 | 2# 7 | 1 | 3# 9 | 6.61 | 144E | 6 | - | 344 | 5.22 | 154E | 6 | - | 378 | 4.23 | 163E | 5 | - | 359 | 3.50* | 173E | 5 | - | 390 | 153 | 1277 |
| | | | | 1 | | | 145E | 22 | 1.0 | 483 | | 165E | 22 | 1.0 | 544 | | 175E | 22 | 0.9 | 588 | | 194E | 21 | 0.9 | 523 | 186 | |
| | | 5# 5 | 5# 5 | 2 | 3#10 | 7.89 | 145E | 6 | - | 473 | 6.24 | 164E | 5 | - | 462 | 5.05 | 174E | 5 | - | 504 | 4.17* | 184E | 5 | - | 545 | 183 | 1151 |
| | | | | 1 | | | 245B | 22 | 1.0 | 720 | | 165E | 22 | 0.9 | 621 | | 175E | 22 | 0.9 | 672 | | 195E | 21 | 0.9 | 740 | 227 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

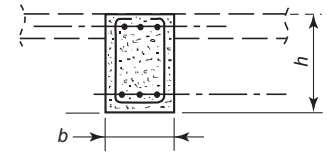
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

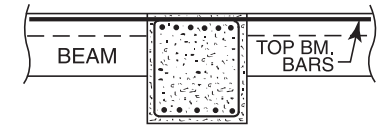
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 24 ft | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 18 | 10 | 2# 6 | | 1 | 2# 6 | 1.02 | 123E | 3 | - | 160 | 0.87 | 123E | 3 | - | 170 | 0.75 | 123E | 2 | - | 179 | 0.65 | 113E | 2 | - | 185 | 58 | 2240 |
| | | | | 1 | | | 293C | 10 | 0.6 | 247 | | 313C | 10 | 0.6 | 265 | | 343C | 10 | 0.6 | 287 | | 363C | 10 | 0.6 | 305 | 58 | |
| | | 2# 7 | | 1 | 2# 8 | 1.50 | 163E | 3 | - | 239 | 1.27* | 173E | 3 | - | 256 | 1.10* | 173E | 2 | - | 270 | 0.96* | 183E | 2 | - | 288 | 78 | 2226 |
| | | | | 1 | | | 293C | 10 | 0.6 | 313 | | 313C | 10 | 0.6 | 336 | | 343C | 10 | 0.6 | 363 | | 363C | 10 | 0.6 | 386 | 100 | |
| | | 2# 9 | | 1 | 2# 9 | 2.14* | 193E | 3 | - | 341 | 1.82* | 203E | 3 | - | 365 | 1.57* | 213E | 2 | - | 390 | 1.37* | 223E | 2 | - | 414 | 123 | 1856 |
| | | | | 1 | | | 483A | 10 | 0.6 | 487 | | 313C | 10 | 0.6 | 436 | | 343C | 10 | 0.6 | 470 | | 363C | 10 | 0.6 | 500 | 123 | |
| | | 2#10 | | 1 | 2#10 | 2.60* | 203E | 3 | - | 420 | 2.22* | 213E | 3 | - | 451 | 1.91* | 223E | 2 | - | 481 | 1.67X | 233E | 2 | - | 511 | 150 | 1606 |
| | | | | 1 | | | 483A | 10 | 0.6 | 563 | | 523A | 10 | 0.6 | 608 | | 563A | 10 | 0.6 | 652 | | 603A | 10 | 0.6 | 696 | 150 | |
| | 12 | 2# 7 | | 1 | 2# 7 | 1.38 | 143E | 3 | - | 213 | 1.17 | 143E | 3 | - | 226 | 1.01 | 143E | 3 | - | 239 | 0.88* | 143E | 3 | - | 252 | 79 | 1964 |
| | | | | 1 | | | 243D | 14 | 0.7 | 277 | | 263D | 13 | 0.7 | 299 | | 283D | 13 | 0.7 | 321 | | 303D | 13 | 0.7 | 342 | 79 | |
| | | 2# 8 | | 1 | 2# 8 | 1.77* | 163E | 3 | - | 272 | 1.51* | 173E | 3 | - | 292 | 1.30* | 173E | 3 | - | 309 | 1.13* | 173E | 3 | - | 326 | 101 | 1915 |
| | | | | 1 | | | 243D | 14 | 0.7 | 329 | | 263D | 13 | 0.7 | 355 | | 283D | 13 | 0.7 | 381 | | 303D | 13 | 0.7 | 407 | 101 | |
| | | 2#10 | | 1 | 2#10 | 2.68* | 193E | 3 | - | 420 | 2.28* | 203E | 3 | - | 450 | 1.97* | 213E | 3 | - | 480 | 1.71* | 223E | 3 | - | 511 | 154 | 1506 |
| | | | | 1 | | | 244D | 14 | 0.7 | 579 | | 264D | 13 | 0.7 | 625 | | 284D | 13 | 0.7 | 670 | | 304D | 13 | 0.7 | 716 | 154 | |
| | | 2#10 | | 1 | 2#11 | 2.95* | 203E | 3 | - | 458 | 2.51* | 213E | 3 | - | 491 | 2.16* | 223E | 3 | - | 524 | 1.89X | 233E | 3 | - | 557 | 154 | 1415 |
| | | | | 1 | | | 244D | 14 | 0.7 | 615 | | 264D | 13 | 0.7 | 663 | | 284D | 13 | 0.7 | 711 | | 304D | 13 | 0.7 | 759 | 182 | |
| | 14 | 2# 7 | | 1 | 3# 6 | 1.53 | 133E | 4 | - | 217 | 1.30 | 133E | 4 | - | 231 | 1.12 | 133E | 4 | - | 244 | 0.98 | 133E | 4 | - | 258 | 79 | 1695 |
| | | | | 1 | | | 243D | 17 | 0.8 | 289 | | 263D | 17 | 0.8 | 312 | | 283D | 17 | 0.8 | 335 | | 303D | 17 | 0.8 | 357 | 87 | |
| | | 2# 9 | | 1 | 3# 7 | 2.03 | 163E | 4 | - | 322 | 1.73* | 173E | 4 | - | 346 | 1.49* | 173E | 4 | - | 367 | 1.30* | 173E | 4 | - | 388 | 127 | 1602 |
| | | | | 1 | | | 244D | 17 | 0.8 | 500 | | 263D | 17 | 0.8 | 414 | | 283D | 17 | 0.8 | 444 | | 303D | 17 | 0.8 | 474 | 116 | |
| | | 2#10 | | 1 | 3# 9 | 3.00* | 193E | 4 | - | 447 | 2.56* | 203E | 4 | - | 479 | 2.21* | 213E | 4 | - | 511 | 1.92* | 223E | 4 | - | 544 | 157 | 1344 |
| | | | | 1 | | | 244D | 17 | 0.8 | 615 | | 264D | 17 | 0.8 | 663 | | 284D | 17 | 0.8 | 711 | | 304D | 17 | 0.8 | 760 | 182 | |
| | | 2#11 | | 1 | 3#10 | 3.57* | 204E | 4 | - | 612 | 3.05* | 213E | 4 | - | 587 | 2.63* | 223E | 4 | - | 627 | 2.29X | 233E | 4 | - | 666 | 187 | 1174 |
| | | | | 1 | | | 244D | 17 | 0.8 | 712 | | 264D | 17 | 0.8 | 768 | | 284D | 17 | 0.8 | 823 | | 304D | 17 | 0.8 | 879 | 222 | |
| | 16 | 2# 8 | | 1 | 3# 7 | 1.99 | 153E | 5 | - | 284 | 1.69 | 153E | 5 | - | 302 | 1.46* | 153E | 5 | - | 320 | 1.27* | 153E | 5 | - | 338 | 104 | 1515 |
| | | | | 1 | | | 214E | 21 | 0.9 | 445 | | 224E | 21 | 0.9 | 472 | | 243E | 21 | 0.9 | 389 | | 263E | 21 | 0.9 | 416 | 118 | |
| | | 2# 9 | | 1 | 3# 8 | 2.46* | 173E | 5 | - | 359 | 2.10* | 173E | 5 | - | 382 | 1.81* | 183E | 5 | - | 409 | 1.58* | 183E | 5 | - | 432 | 128 | 1427 |
| | | | | 1 | | | 214E | 21 | 0.9 | 513 | | 224E | 21 | 0.9 | 546 | | 244E | 21 | 0.9 | 589 | | 264E | 21 | 0.9 | 632 | 151 | |
| | | 2#11 | | 1 | 3# 9 | 3.23* | 193E | 5 | - | 499 | 2.75* | 203E | 5 | - | 536 | 2.37* | 203E | 5 | - | 569 | 2.07* | 213E | 5 | - | 606 | 190 | 1203 |
| | | | | 1 | | | 214E | 21 | 0.9 | 646 | | 224E | 21 | 0.9 | 689 | | 244E | 21 | 0.9 | 742 | | 264E | 21 | 0.9 | 796 | 186 | |
| | | 2#10 | 1#10 | 1 | 3#10 | 3.95* | 204E | 5 | - | 658 | 3.36* | 214E | 5 | - | 705 | 2.90* | 223E | 5 | - | 679 | 2.53X | 233E | 5 | - | 722 | 227 | 1047 |
| | | | | 1 | | | 215E | 21 | 0.9 | 874 | | 225E | 21 | 0.9 | 930 | | 245E | 21 | 0.9 | 1003 | | 264E | 21 | 0.9 | 905 | 227 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

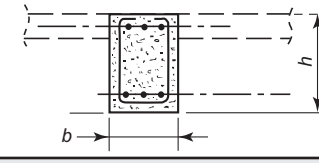
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

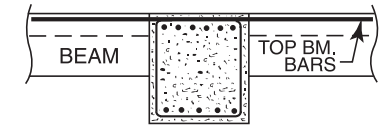
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 20 | 10 | 2# 6 | | 1 | 2# 7 | 1.83 | 123F | 3 | - | 159 | 1.52 | 123F | 3 | - | 170 | 1.27 | 123F | 3 | - | 181 | 1.09 | 123F | 3 | - | 192 | 66 | 1585 |
| | | | | 1 | | | 203D | 12 | 0.7 | 210 | | 223D | 12 | 0.7 | 230 | | 243D | 12 | 0.7 | 249 | | 263D | 12 | 0.7 | 269 | 89 | |
| | | 2# 8 | | 1 | 2# 8 | 2.86 | 143F | 3 | - | 233 | 2.37 | 153F | 3 | - | 254 | 1.99 | 163F | 3 | - | 274 | 1.69* | 163F | 3 | - | 291 | 114 | 1581 |
| | | | | 1 | | | 403A | 12 | 0.7 | 367 | | 443A | 12 | 0.7 | 402 | | 483A | 12 | 0.7 | 437 | | 263D | 12 | 0.7 | 355 | 114 | |
| | | 2# 9 | | 1 | 2#10 | 3.88 | 173CdF | 3 | - | 323 | 3.21 | 163F | 3 | - | 343 | 2.69* | 173F | 3 | - | 370 | 2.30* | 183F | 3 | - | 397 | 141 | 1297 |
| | | | | 1 | | | 403A | 12 | 0.7 | 447 | | 443A | 12 | 0.7 | 489 | | 483A | 12 | 0.7 | 530 | | 523A | 12 | 0.7 | 572 | 172 | |
| | | 2#10 | | 1 | 2#11 | 4.75 | 193CiF | 3 | - | 398 | 3.93* | 193CgF | 3 | - | 428 | 3.30* | 203CfF | 3 | - | 461 | 2.81* | 213CdF | 3 | - | 494 | 172 | 1133 |
| | | | | 1 | | | 403A | 12 | 0.7 | 516 | | 443A | 12 | 0.7 | 563 | | 483A | 12 | 0.7 | 611 | | 523A | 12 | 0.7 | 659 | 204 | |
| | 12 | 2# 7 | | 1 | 2# 7 | 2.25 | 123F | 4 | - | 184 | 1.86 | 123F | 4 | - | 197 | 1.56 | 123F | 4 | - | 210 | 1.33 | 123F | 4 | - | 223 | 90 | 1375 |
| | | | | 1 | | | 203D | 16 | 0.8 | 238 | | 223D | 16 | 0.8 | 260 | | 243D | 16 | 0.8 | 283 | | 263D | 16 | 0.8 | 305 | 90 | |
| | | 2# 8 | | 1 | 2# 9 | 3.19 | 143F | 4 | - | 257 | 2.64 | 153F | 4 | - | 279 | 2.22 | 153F | 4 | - | 297 | 1.89 | 163F | 4 | - | 319 | 116 | 1351 |
| | | | | 1 | | | 204D | 16 | 0.8 | 401 | | 224D | 16 | 0.8 | 439 | | 244D | 16 | 0.8 | 477 | | 264D | 16 | 0.8 | 515 | 143 | |
| | | 2#10 | | 1 | 2#11 | 4.87 | 154F | 4 | - | 437 | 4.03 | 174F | 4 | - | 480 | 3.38* | 184F | 4 | - | 516 | 2.88* | 193F | 4 | - | 490 | 177 | 1064 |
| | | | | 1 | | | 404A | 16 | 0.8 | 721 | | 224D | 16 | 0.8 | 577 | | 244D | 16 | 0.8 | 626 | | 264D | 16 | 0.8 | 675 | 210 | |
| | | 4# 6 | 3# 6 | 2 | 2#11 | 5.27 | 154F | 4 | - | 463 | 4.35* | 174F | 4 | - | 509 | 3.66* | 184F | 4 | - | 548 | 3.12* | 194F | 4 | - | 587 | 202 | 1032 |
| | | | | 1 | | | 404A | 16 | 0.8 | 747 | | 444A | 16 | 0.8 | 818 | | 244D | 16 | 0.8 | 658 | | 264D | 16 | 0.8 | 709 | 210 | |
| | 14 | 2# 8 | | 1 | 3# 6 | 2.49 | 123F | 5 | - | 217 | 2.06 | 123F | 5 | - | 233 | 1.73 | 123F | 5 | - | 248 | 1.48 | 123F | 5 | - | 264 | 117 | 1102 |
| | | | | 1 | | | 174E | 21 | 1.0 | 345 | | 194E | 21 | 0.9 | 381 | | 213E | 20 | 0.9 | 311 | | 223E | 20 | 0.9 | 332 | 99 | |
| | | 2# 9 | | 1 | 3# 8 | 4.00 | 143F | 5 | - | 305 | 3.31 | 153F | 5 | - | 331 | 2.78 | 163F | 5 | - | 358 | 2.37* | 163F | 5 | - | 381 | 145 | 1143 |
| | | | | 1 | | | 174E | 21 | 0.9 | 426 | | 194E | 21 | 0.9 | 470 | | 214E | 20 | 0.9 | 513 | | 224E | 20 | 0.9 | 546 | 170 | |
| | | 2# 9 | 1# 9 | 1 | 3# 9 | 5.25 | 154F | 5 | - | 453 | 4.34 | 164F | 5 | - | 492 | 3.64* | 174F | 5 | - | 530 | 3.10* | 183F | 5 | - | 507 | 209 | 955 |
| | | | | 1 | | | 175E | 21 | 0.9 | 632 | | 195E | 21 | 0.9 | 697 | | 215E | 20 | 0.9 | 762 | | 224E | 20 | 0.9 | 665 | 209 | |
| | | 2#10 | 1#10 | 1 | 3#10 | 6.41 | 155F | 5 | - | 613 | 5.30 | 174F | 5 | - | 602 | 4.45* | 184F | 5 | - | 649 | 3.80* | 194F | 5 | - | 696 | 256 | 824 |
| | | | | 1 | | | 175E | 21 | 0.9 | 727 | | 195E | 21 | 0.9 | 800 | | 215E | 20 | 0.9 | 874 | | 225E | 20 | 0.9 | 930 | 256 | |
| | 16 | 2# 8 | | 1 | 3# 7 | 3.25 | 123F | 6 | - | 241 | 2.69 | 133F | 6 | - | 263 | 2.26 | 133F | 6 | - | 281 | 1.92 | 133F | 6 | - | 299 | 118 | 1078 |
| | | | | 1 | | | 174E | 26 | 1.1 | 376 | | 194E | 25 | 1.1 | 415 | | 214E | 25 | 1.0 | 454 | | 224E | 25 | 1.0 | 483 | 134 | |
| | | 2#10 | | 1 | 3# 8 | 4.32 | 143F | 6 | - | 345 | 3.57 | 153F | 6 | - | 375 | 3.00 | 153F | 6 | - | 401 | 2.55 | 163F | 6 | - | 432 | 182 | 1000 |
| | | | | 1 | | | 174E | 26 | 1.1 | 472 | | 194E | 25 | 1.0 | 520 | | 214E | 25 | 1.0 | 568 | | 224E | 25 | 1.0 | 605 | 172 | |
| | | 2#10 | 1#10 | 1 | 3#10 | 6.54 | 155F | 6 | - | 618 | 5.41 | 174F | 6 | - | 606 | 4.54* | 184F | 6 | - | 653 | 3.87* | 194F | 6 | - | 700 | 261 | 788 |
| | | | | 1 | | | 175E | 26 | 1.1 | 739 | | 195E | 25 | 1.0 | 814 | | 215E | 25 | 1.0 | 888 | | 225E | 25 | 1.0 | 945 | 261 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 7.20 | 155F | 6 | - | 665 | 5.95* | 175F | 6 | - | 731 | 5.00* | 184F | 6 | - | 707 | 4.26* | 194F | 6 | - | 757 | 261 | 738 |
| | | | | 1 | | | 305B | 26 | 1.1 | 1012 | | 195E | 25 | 1.0 | 864 | | 215E | 25 | 1.0 | 942 | | 225E | 25 | 1.0 | 1002 | 309 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

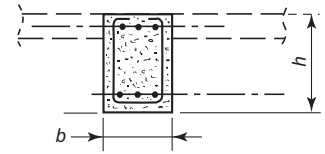
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

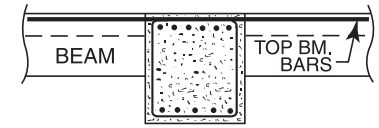
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 28 ft | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | | |
| $h$ in. | $b$ in. | BOTTOM $\ell_n$ + 12 in. | BOTTOM 0.875 $\ell_n$ | Layers (2) | TOP | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 20 | 10 | 2# 6 | | 1 | 2# 7 | 0.94 | 123F | 3 | - | 203 | 0.82 | 123F | 3 | - | 213 | 0.72 | 113F | 3 | - | 221 | 0.63 | 113F | 3 | - | 232 | 66 | 1585 |
| | | | | 1 | | | 283D | 12 | 0.7 | 289 | | 303D | 12 | 0.7 | 309 | | 323D | 11 | 0.7 | 329 | | 343D | 11 | 0.7 | 348 | 89 | |
| | | 2# 8 | | 1 | 2# 8 | 1.46* | 173F | 3 | - | 311 | 1.27* | 173F | 3 | - | 328 | 1.12* | 183F | 3 | - | 348 | 0.99* | 183F | 3 | - | 365 | 114 | 1581 |
| | | | | 1 | | | 283D | 12 | 0.7 | 381 | | 303D | 12 | 0.7 | 407 | | 323D | 11 | 0.7 | 433 | | 343D | 11 | 0.7 | 459 | 114 | |
| | | 2# 9 | | 1 | 2#10 | 1.98* | 193F | 3 | - | 424 | 1.72* | 203F | 3 | - | 451 | 1.52* | 213F | 3 | - | 478 | 1.34* | 213F | 3 | - | 502 | 141 | 1297 |
| | | | | 1 | | | 563A | 12 | 0.7 | 614 | | 603A | 12 | 0.7 | 655 | | 643A | 11 | 0.7 | 697 | | 683A | 11 | 0.7 | 739 | 172 | |
| | | 2#10 | | 1 | 2#11 | 2.43* | 203F | 3 | - | 520 | 2.11* | 213F | 3 | - | 553 | 1.86* | 223F | 3 | - | 586 | 1.64X | 233F | 3 | - | 619 | 172 | 1133 |
| | | | | 1 | | | 563A | 12 | 0.7 | 706 | | 603A | 12 | 0.7 | 754 | | 643A | 11 | 0.7 | 802 | | 683A | 11 | 0.7 | 849 | 204 | |
| | 12 | 2# 7 | | 1 | 2# 7 | 1.15 | 123F | 4 | - | 236 | 1.00 | 123F | 4 | - | 248 | 0.88 | 123F | 4 | - | 261 | 0.78 | 113F | 4 | - | 271 | 90 | 1375 |
| | | | | 1 | | | 283D | 16 | 0.8 | 328 | | 303D | 16 | 0.8 | 350 | | 323D | 15 | 0.8 | 372 | | 343D | 15 | 0.8 | 395 | 90 | |
| | | 2# 8 | | 1 | 2# 9 | 1.63* | 163F | 4 | - | 338 | 1.42* | 173F | 4 | - | 360 | 1.25* | 173F | 4 | - | 379 | 1.11* | 173F | 4 | - | 397 | 116 | 1351 |
| | | | | 1 | | | 283D | 16 | 0.8 | 416 | | 303D | 16 | 0.8 | 444 | | 323D | 15 | 0.8 | 473 | | 343D | 15 | 0.8 | 501 | 143 | |
| | | 2#10 | | 1 | 2#11 | 2.49* | 193F | 4 | - | 519 | 2.16* | 203F | 4 | - | 552 | 1.90* | 213F | 4 | - | 585 | 1.69X | 223F | 4 | - | 618 | 177 | 1064 |
| | | | | 1 | | | 284D | 16 | 0.8 | 723 | | 304D | 16 | 0.8 | 772 | | 324D | 15 | 0.8 | 821 | | 344D | 15 | 0.8 | 870 | 210 | |
| | | 2#11 | | 1 | 2#11 | 2.69* | 203F | 4 | - | 581 | 2.34* | 213F | 4 | - | 618 | 2.06* | 223F | 4 | - | 655 | 1.82X | 223F | 4 | - | 689 | 210 | 1000 |
| | | | | 1 | | | 284D | 16 | 0.8 | 782 | | 304D | 16 | 0.8 | 835 | | 324D | 15 | 0.8 | 888 | | 344D | 15 | 0.8 | 941 | 210 | |
| | 14 | 2# 8 | | 1 | 3# 6 | 1.27 | 123F | 5 | - | 280 | 1.11 | 113F | 5 | - | 293 | 0.97 | 113F | 5 | - | 309 | 0.86 | 103F | 5 | - | 321 | 117 | 1102 |
| | | | | 1 | | | 243E | 20 | 0.9 | 358 | | 263E | 20 | 0.9 | 384 | | 283E | 20 | 0.9 | 410 | | 293E | 20 | 0.9 | 431 | 99 | |
| | | 2# 9 | | 1 | 3# 8 | 2.04* | 173F | 5 | - | 407 | 1.78* | 173F | 5 | - | 430 | 1.56* | 183F | 5 | - | 457 | 1.39* | 183F | 5 | - | 480 | 145 | 1143 |
| | | | | 1 | | | 244E | 20 | 0.9 | 589 | | 264E | 20 | 0.9 | 632 | | 284E | 20 | 0.9 | 675 | | 294E | 20 | 0.9 | 708 | 170 | |
| | | 2#11 | | 1 | 3# 9 | 2.68* | 193F | 5 | - | 568 | 2.33* | 203F | 5 | - | 605 | 2.05* | 203F | 5 | - | 638 | 1.82* | 213F | 5 | - | 675 | 215 | 951 |
| | | | | 1 | | | 244E | 20 | 0.9 | 742 | | 264E | 20 | 0.9 | 796 | | 284E | 20 | 0.9 | 849 | | 294E | 20 | 0.9 | 892 | 209 | |
| | | 2#10 | 1#10 | 1 | 3#10 | 3.27* | 204F | 5 | - | 743 | 2.85* | 214F | 5 | - | 789 | 2.51* | 223F | 5 | - | 761 | 2.22X | 233F | 5 | - | 804 | 256 | 824 |
| | | | | 1 | | | 245E | 20 | 0.9 | 1003 | | 265E | 20 | 0.9 | 1076 | | 284E | 20 | 0.9 | 965 | | 294E | 20 | 0.9 | 1015 | 256 | |
| | 16 | 2# 8 | | 1 | 3# 7 | 1.66 | 133F | 6 | - | 316 | 1.45 | 133F | 6 | - | 334 | 1.27 | 133F | 6 | - | 352 | 1.13* | 133F | 6 | - | 370 | 118 | 1078 |
| | | | | 1 | | | 243E | 25 | 1.0 | 395 | | 263E | 25 | 1.0 | 423 | | 283E | 24 | 1.0 | 451 | | 293E | 24 | 1.0 | 474 | 134 | |
| | | 2#10 | | 1 | 3# 8 | 2.20* | 163F | 6 | - | 458 | 1.92* | 173F | 6 | - | 489 | 1.69* | 173F | 6 | - | 515 | 1.49* | 173F | 6 | - | 542 | 182 | 1000 |
| | | | | 1 | | | 244E | 25 | 1.0 | 652 | | 264E | 25 | 1.0 | 700 | | 284E | 24 | 1.0 | 748 | | 294E | 24 | 1.0 | 785 | 172 | |
| | | 2#11 | | 1 | 3#10 | 3.07* | 193F | 6 | - | 624 | 2.67* | 203F | 6 | - | 664 | 2.35* | 203F | 6 | - | 700 | 2.08* | 213F | 6 | - | 740 | 218 | 842 |
| | | | | 1 | | | 244E | 25 | 1.0 | 807 | | 264E | 25 | 1.0 | 864 | | 284E | 24 | 1.0 | 922 | | 294E | 24 | 1.0 | 969 | 261 | |
| | | 2#14 | | 1 | 3#11 | 3.95* | 204F | 6 | - | 894 | 3.44* | 214F | 6 | - | 951 | 3.03X | 224F | 6 | - | 1007 | 2.68X | 234F | 6 | - | 1064 | 297 | 710 |
| | | | | 1 | | | 245E | 25 | 1.0 | 1167 | | 265E | 25 | 1.0 | 1251 | | 285E | 24 | 1.0 | 1335 | | 295E | 24 | 1.0 | 1402 | 309 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

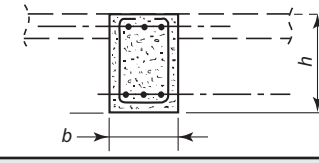
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

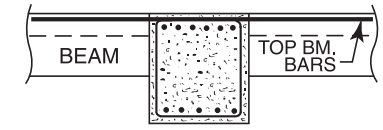
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 22 | 12 | 2# 7 | | 1 | 2# 8 | 2.77 | 113G | 5 | - | 201 | 2.29 | 123G | 5 | - | 219 | 1.93 | 123G | 5 | - | 234 | 1.64 | 123G | 5 | - | 248 | 100 | 1012 |
| | | | | 1 | | | 174E | 19 | 0.9 | 332 | | 194E | 19 | 0.9 | 367 | | 214E | 18 | 0.9 | 401 | | 223E | 18 | 0.9 | 314 | 130 | |
| | | 2# 9 | | 1 | 2# 9 | 4.04 | 133G | 5 | - | 287 | 3.34 | 143G | 5 | - | 312 | 2.81 | 143G | 5 | - | 334 | 2.39 | 153G | 5 | - | 359 | 161 | 992 |
| | | | | 1 | | | 174E | 19 | 0.9 | 411 | | 194E | 19 | 0.9 | 452 | | 214E | 18 | 0.9 | 494 | | 224E | 18 | 0.9 | 526 | 161 | |
| | | 2#10 | | 1 | 2#11 | 5.50 | 144G | 5 | - | 436 | 4.55 | 154G | 5 | - | 473 | 3.82 | 164G | 5 | - | 510 | 3.25* | 174G | 5 | - | 547 | 199 | 825 |
| | | | | 1 | | | 304B | 19 | 0.9 | 638 | | 334B | 19 | 0.9 | 698 | | 364B | 18 | 0.9 | 758 | | 224E | 18 | 0.9 | 646 | 238 | |
| | | 4# 6 | 3# 6 | 2 | 3#10 | 6.33 | 154DdG | 5 | - | 501 | 5.23 | 154G | 5 | - | 536 | 4.40 | 164G | 5 | - | 578 | 3.75* | 174G | 5 | - | 620 | 230 | 740 |
| | | | | 1 | | | 304B | 19 | 0.9 | 695 | | 334B | 19 | 0.9 | 761 | | 364B | 18 | 0.9 | 826 | | 394B | 18 | 0.9 | 891 | 283 | |
| | 14 | 2# 8 | | 1 | 3# 7 | 3.62 | 123G | 6 | - | 243 | 2.99 | 123G | 6 | - | 261 | 2.51 | 133G | 6 | - | 282 | 2.14 | 133G | 6 | - | 300 | 131 | 922 |
| | | | | 1 | | | 174E | 24 | 1.1 | 376 | | 194E | 24 | 1.0 | 415 | | 214E | 24 | 1.0 | 454 | | 224E | 23 | 1.0 | 483 | 149 | |
| | | 2#10 | | 1 | 3# 8 | 4.80 | 134G | 6 | - | 390 | 3.97 | 143G | 6 | - | 373 | 3.33 | 153G | 6 | - | 403 | 2.84 | 153G | 6 | - | 430 | 203 | 826 |
| | | | | 1 | | | 175E | 24 | 1.1 | 588 | | 194E | 24 | 1.0 | 520 | | 214E | 24 | 1.0 | 568 | | 224E | 23 | 1.0 | 605 | 192 | |
| | | 2# 9 | 1# 9 | 1 | 3#10 | 6.51 | 144G | 6 | - | 494 | 5.38 | 154G | 6 | - | 536 | 4.52 | 164G | 6 | - | 578 | 3.85 | 174G | 6 | - | 620 | 236 | 688 |
| | | | | 1 | | | 175E | 24 | 1.1 | 685 | | 195E | 24 | 1.0 | 754 | | 215E | 24 | 1.0 | 824 | | 225E | 23 | 1.0 | 876 | 290 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 8.00 | 304B | 6 | - | 714 | 6.61 | 155G | 6 | - | 713 | 5.55 | 165G | 6 | - | 769 | 4.73* | 184G | 6 | - | 754 | 290 | 599 |
| | | | | 1 | | | 304B | 24 | 1.1 | 807 | | 195E | 24 | 1.0 | 864 | | 215E | 24 | 1.0 | 942 | | 225E | 23 | 1.0 | 1002 | 344 | |
| | 16 | 2# 9 | | 1 | 3# 7 | 3.76 | 113G | 8 | - | 271 | 3.11 | 123G | 7 | - | 296 | 2.61 | 123G | 7 | - | 317 | 2.23 | 123G | 7 | - | 337 | 164 | 761 |
| | | | | 1 | | | 154F | 30 | 1.2 | 393 | | 174F | 30 | 1.2 | 436 | | 184F | 29 | 1.2 | 467 | | 204F | 29 | 1.1 | 510 | 150 | |
| | | 2#10 | | 1 | 3# 9 | 5.65 | 134G | 7 | - | 425 | 4.67 | 144G | 7 | - | 462 | 3.92 | 153G | 7 | - | 443 | 3.34 | 153G | 7 | - | 472 | 205 | 736 |
| | | | | 1 | | | 155F | 30 | 1.2 | 596 | | 175F | 30 | 1.2 | 662 | | 185F | 29 | 1.1 | 709 | | 205F | 29 | 1.1 | 774 | 240 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 8.14 | 145G | 7 | - | 663 | 6.73 | 155G | 7 | - | 719 | 5.65 | 165G | 7 | - | 774 | 4.82* | 174G | 7 | - | 751 | 295 | 573 |
| | | | | 1 | | | 245C | 30 | 1.2 | 924 | | 265C | 30 | 1.2 | 1003 | | 295C | 29 | 1.1 | 1101 | | 205F | 29 | 1.1 | 982 | 351 | |
| | | 5# 6 | 5# 6 | 2 | 3#11 | 8.80 | 304B | 7 | - | 755 | 7.27 | 155G | 7 | - | 757 | 6.11* | 165G | 7 | - | 816 | 5.21* | 185G | 7 | - | 887 | 323 | 567 |
| | | | | 1 | | | 305B | 30 | 1.2 | 1067 | | 265C | 29 | 1.1 | 1042 | | 295C | 29 | 1.1 | 1143 | | 315C | 29 | 1.1 | 1225 | 351 | |
| | 18 | 2# 7 | 1# 7 | 1 | 3# 8 | 4.16 | 113G | 9 | - | 280 | 3.44 | 123G | 9 | - | 305 | 2.89 | 123G | 9 | - | 326 | 2.46 | 123G | 9 | - | 347 | 151 | 674 |
| | | | | 1 | | | 154F | 36 | 1.3 | 407 | | 194E | 36 | 1.3 | 474 | | 214E | 35 | 1.3 | 518 | | 224E | 35 | 1.3 | 550 | 195 | |
| | | 2# 9 | 1# 9 | 1 | 3# 9 | 6.06 | 134G | 9 | - | 451 | 5.01 | 144G | 9 | - | 491 | 4.21 | 143G | 9 | - | 468 | 3.59 | 153G | 9 | - | 504 | 242 | 661 |
| | | | | 1 | | | 155F | 36 | 1.3 | 630 | | 175F | 36 | 1.3 | 699 | | 185F | 35 | 1.3 | 749 | | 205F | 35 | 1.3 | 818 | 242 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 8.25 | 145G | 9 | - | 668 | 6.82 | 155G | 9 | - | 724 | 5.73 | 164G | 9 | - | 703 | 4.88* | 174G | 9 | - | 755 | 299 | 550 |
| | | | | 1 | | | 245C | 36 | 1.3 | 941 | | 265C | 36 | 1.3 | 1022 | | 295C | 35 | 1.3 | 1121 | | 205F | 35 | 1.3 | 996 | 358 | |
| | | 2#10 | 2#10 | 1 | 4#11 | 10.61 | 304B | 9 | - | 882 | 8.77 | 165DdG | 9 | - | 905 | 7.37 | 165G | 9 | - | 962 | 6.28* | 185G | 9 | - | 1044 | 385 | 455 |
| | | | | 1 | | | 305B | 36 | 1.3 | 1208 | | 265C | 36 | 1.3 | 1190 | | 295C | 35 | 1.3 | 1303 | | 315C | 35 | 1.3 | 1398 | 455 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

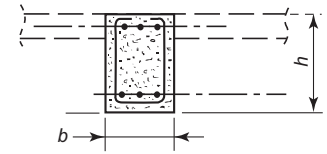
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

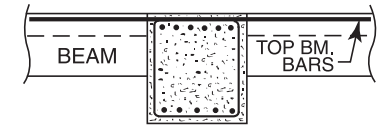
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 28 ft | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 22 | 12 | 2# 7 | | 1 | 2# 8 | 1.42 | 123G | 5 | - | 263 | 1.23 | 123G | 4 | - | 277 | 1.08 | 123G | 4 | - | 291 | 0.96 | 123G | 4 | - | 306 | 100 | 1012 |
| | | | | 1 | | | 243E | 18 | 0.9 | 339 | | 263E | 18 | 0.9 | 363 | | 283E | 18 | 0.9 | 387 | | 293E | 18 | 0.9 | 407 | 130 | |
| | | 2# 9 | | 1 | 2# 9 | 2.06 | 163G | 5 | - | 384 | 1.80* | 163G | 4 | - | 406 | 1.58* | 163G | 4 | - | 428 | 1.40* | 173G | 4 | - | 453 | 161 | 992 |
| | | | | 1 | | | 244E | 18 | 0.9 | 567 | | 264E | 18 | 0.9 | 609 | | 284E | 18 | 0.9 | 651 | | 294E | 18 | 0.9 | 683 | 161 | |
| | | 2#11 | | 1 | 2#11 | 3.04* | 184G | 5 | - | 642 | 2.65* | 193G | 4 | - | 616 | 2.33* | 203G | 4 | - | 654 | 2.06* | 203G | 4 | - | 687 | 238 | 776 |
| | | | | 1 | | | 244E | 18 | 0.9 | 754 | | 264E | 18 | 0.9 | 808 | | 284E | 18 | 0.9 | 862 | | 294E | 18 | 0.9 | 906 | 238 | |
| | | 2#11 | | 1 | 3#10 | 3.35* | 184G | 5 | - | 684 | 2.92* | 194G | 4 | - | 727 | 2.56* | 203G | 4 | - | 700 | 2.27* | 213G | 4 | - | 740 | 238 | 722 |
| | | | | 1 | | | 424B | 18 | 0.9 | 978 | | 454B | 18 | 0.9 | 1044 | | 284E | 18 | 0.9 | 909 | | 294E | 18 | 0.9 | 955 | 283 | |
| | 14 | 2# 8 | | 1 | 3# 7 | 1.85 | 133G | 6 | - | 318 | 1.61 | 143G | 6 | - | 340 | 1.41 | 143G | 6 | - | 357 | 1.25 | 143G | 6 | - | 375 | 131 | 922 |
| | | | | 1 | | | 244E | 23 | 1.0 | 521 | | 264E | 23 | 1.0 | 560 | | 283E | 23 | 1.0 | 451 | | 293E | 23 | 1.0 | 474 | 149 | |
| | | 2#10 | | 1 | 3# 8 | 2.45 | 163G | 6 | - | 460 | 2.13* | 163G | 6 | - | 487 | 1.88* | 173G | 6 | - | 517 | 1.66* | 173G | 6 | - | 544 | 203 | 826 |
| | | | | 1 | | | 244E | 23 | 1.0 | 652 | | 264E | 23 | 1.0 | 700 | | 284E | 23 | 1.0 | 748 | | 294E | 23 | 1.0 | 785 | 192 | |
| | | 2#11 | | 1 | 3#10 | 3.41* | 184G | 6 | - | 688 | 2.97* | 193G | 6 | - | 663 | 2.61* | 193G | 6 | - | 699 | 2.32* | 203G | 6 | - | 739 | 243 | 685 |
| | | | | 1 | | | 245E | 23 | 1.0 | 971 | | 264E | 23 | 1.0 | 864 | | 284E | 23 | 1.0 | 922 | | 294E | 23 | 1.0 | 969 | 290 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 4.08* | 194G | 6 | - | 805 | 3.55* | 194G | 6 | - | 848 | 3.12* | 204G | 6 | - | 899 | 2.77* | 214G | 6 | - | 950 | 290 | 599 |
| | | | | 1 | | | 245E | 23 | 1.0 | 1081 | | 265E | 23 | 1.0 | 1159 | | 285E | 23 | 1.0 | 1237 | | 295E | 23 | 1.0 | 1298 | 344 | |
| | 16 | 2# 9 | | 1 | 3# 7 | 1.92 | 123G | 7 | - | 358 | 1.67 | 133G | 7 | - | 383 | 1.47 | 123G | 7 | - | 400 | 1.30 | 123G | 7 | - | 420 | 164 | 761 |
| | | | | 1 | | | 214F | 29 | 1.1 | 542 | | 234F | 28 | 1.1 | 585 | | 244F | 28 | 1.1 | 616 | | 263F | 28 | 1.1 | 516 | 150 | |
| | | 2#10 | | 1 | 3# 9 | 2.88 | 163G | 7 | - | 505 | 2.51* | 163G | 7 | - | 534 | 2.21* | 173G | 7 | - | 567 | 1.95* | 173G | 7 | - | 596 | 205 | 736 |
| | | | | 1 | | | 214F | 29 | 1.1 | 673 | | 234F | 28 | 1.1 | 724 | | 244F | 28 | 1.1 | 764 | | 264F | 28 | 1.1 | 815 | 240 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 4.15* | 184G | 7 | - | 802 | 3.62* | 194G | 7 | - | 853 | 3.18* | 204G | 7 | - | 904 | 2.82* | 203G | 7 | - | 872 | 295 | 573 |
| | | | | 1 | | | 215F | 29 | 1.1 | 1043 | | 235F | 28 | 1.1 | 1123 | | 245F | 28 | 1.1 | 1184 | | 265F | 28 | 1.1 | 1263 | 351 | |
| | | 2#14 | | 1 | 3#11 | 4.49* | 184G | 7 | - | 888 | 3.91* | 194G | 7 | - | 945 | 3.44* | 204G | 7 | - | 1002 | 3.04* | 214G | 7 | - | 1059 | 337 | 550 |
| | | | | 1 | | | 215F | 29 | 1.1 | 1130 | | 235F | 28 | 1.1 | 1215 | | 245F | 28 | 1.1 | 1282 | | 265F | 28 | 1.1 | 1368 | 351 | |
| | 18 | 2# 7 | 1# 7 | 1 | 3# 8 | 2.12 | 123G | 9 | - | 368 | 1.85 | 123G | 9 | - | 389 | 1.63 | 123G | 9 | - | 410 | 1.44 | 123G | 8 | - | 431 | 151 | 674 |
| | | | | 1 | | | 244E | 34 | 1.3 | 594 | | 263E | 34 | 1.3 | 490 | | 283E | 34 | 1.2 | 523 | | 293E | 34 | 1.2 | 550 | 195 | |
| | | 2# 9 | 1# 9 | 1 | 3# 9 | 3.09 | 163G | 9 | - | 540 | 2.69* | 163G | 9 | - | 571 | 2.37* | 163G | 8 | - | 602 | 2.10* | 173G | 8 | - | 638 | 242 | 661 |
| | | | | 1 | | | 214F | 34 | 1.3 | 715 | | 234F | 34 | 1.2 | 770 | | 284E | 34 | 1.2 | 858 | | 294E | 34 | 1.2 | 901 | 242 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 4.57* | 184G | 9 | - | 890 | 3.98* | 194G | 9 | - | 947 | 3.50* | 204G | 8 | - | 1004 | 3.10* | 204G | 8 | - | 1053 | 358 | 517 |
| | | | | 1 | | | 215F | 34 | 1.2 | 1141 | | 235F | 34 | 1.2 | 1228 | | 245F | 34 | 1.2 | 1296 | | 265F | 34 | 1.2 | 1383 | 358 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 5.02* | 185G | 9 | - | 1078 | 4.38* | 194G | 9 | - | 1055 | 3.85* | 204G | 8 | - | 1118 | 3.41* | 214G | 8 | - | 1181 | 358 | 468 |
| | | | | 1 | | | 345C | 34 | 1.2 | 1488 | | 235F | 34 | 1.2 | 1336 | | 245F | 34 | 1.2 | 1411 | | 265F | 34 | 1.2 | 1503 | 455 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b - 2''$).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

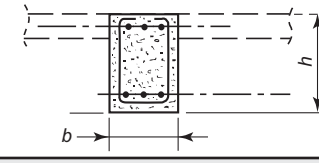
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

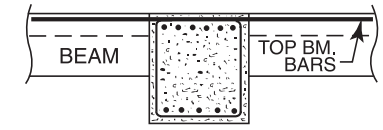
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w/1.4$.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 24 ft | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 24 | 12 | 2# 8 | | 1 | 2# 8 | 2.51 | 123H | 5 | - | 268 | 2.14 | 123H | 5 | - | 285 | 1.84 | 133H | 5 | - | 306 | 1.61 | 133H | 5 | - | 323 | 144 | 806 |
| | | | | 1 | | | 214E | 21 | 1.0 | 442 | | 224E | 21 | 1.0 | 470 | | 244E | 20 | 1.0 | 508 | | 264E | 20 | 1.0 | 546 | 144 | |
| | | 2# 9 | | 1 | 2#10 | 3.43 | 143H | 5 | - | 369 | 2.92 | 143H | 5 | - | 393 | 2.52 | 153H | 5 | - | 420 | 2.20 | 153H | 5 | - | 444 | 179 | 737 |
| | | | | 1 | | | 214E | 21 | 1.0 | 535 | | 224E | 21 | 1.0 | 569 | | 244E | 20 | 1.0 | 614 | | 264E | 20 | 1.0 | 659 | 222 | |
| | | 2#11 | | 1 | 2#11 | 4.63 | 154H | 5 | - | 560 | 3.95 | 164H | 5 | - | 602 | 3.40 | 164H | 5 | - | 635 | 2.96* | 174H | 5 | - | 677 | 266 | 617 |
| | | | | 1 | | | 364B | 21 | 1.0 | 825 | | 394B | 21 | 1.0 | 890 | | 244E | 20 | 1.0 | 765 | | 264E | 20 | 1.0 | 820 | 266 | |
| | | 4# 6 | 4# 6 | 2 | 2#14 | 5.49 | 164EeH | 5 | - | 666 | 4.68 | 174EdH | 5 | - | 714 | 4.04* | 174H | 5 | - | 755 | 3.52* | 184H | 5 | - | 803 | 287 | 541 |
| | | | | 1 | | | 364B | 21 | 1.0 | 923 | | 394B | 21 | 1.0 | 995 | | 424B | 20 | 1.0 | 1067 | | 454B | 20 | 1.0 | 1139 | 361 | |
| | 14 | 2# 8 | | 1 | 3# 7 | 2.78 | 123H | 7 | - | 282 | 2.37 | 123H | 7 | - | 299 | 2.05 | 123H | 7 | - | 317 | 1.78 | 123H | 7 | - | 335 | 145 | 696 |
| | | | | 1 | | | 184F | 27 | 1.1 | 431 | | 204F | 27 | 1.1 | 471 | | 214F | 26 | 1.1 | 499 | | 234F | 26 | 1.1 | 539 | 165 | |
| | | 2#10 | | 1 | 3# 9 | 4.31 | 144H | 7 | - | 494 | 3.68 | 153H | 7 | - | 474 | 3.17 | 153H | 7 | - | 503 | 2.76 | 163H | 7 | - | 536 | 225 | 620 |
| | | | | 1 | | | 185F | 27 | 1.1 | 709 | | 205F | 27 | 1.1 | 774 | | 215F | 26 | 1.1 | 821 | | 234F | 26 | 1.1 | 724 | 263 | |
| | | 2#10 | 1#10 | 1 | 3#10 | 5.64 | 155H | 7 | - | 714 | 4.81 | 164H | 7 | - | 690 | 4.15 | 174H | 7 | - | 737 | 3.61* | 174H | 7 | - | 777 | 325 | 510 |
| | | | | 1 | | | 185F | 27 | 1.1 | 849 | | 205F | 27 | 1.1 | 925 | | 215F | 26 | 1.1 | 982 | | 235F | 26 | 1.1 | 1058 | 325 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 6.71 | 155H | 7 | - | 839 | 5.72 | 165H | 7 | - | 901 | 4.93* | 175H | 7 | - | 963 | 4.29* | 184H | 7 | - | 939 | 386 | 447 |
| | | | | 1 | | | 295C | 27 | 1.1 | 1173 | | 315C | 27 | 1.1 | 1259 | | 215F | 26 | 1.1 | 1127 | | 235F | 26 | 1.1 | 1212 | 386 | |
| | 16 | 2# 9 | | 1 | 3# 8 | 3.49 | 123H | 8 | - | 351 | 2.98 | 133H | 8 | - | 378 | 2.57 | 133H | 8 | - | 401 | 2.24 | 133H | 8 | - | 424 | 182 | 610 |
| | | | | 1 | | | 184F | 33 | 1.3 | 507 | | 204F | 33 | 1.3 | 553 | | 214F | 33 | 1.3 | 588 | | 234F | 33 | 1.2 | 633 | 215 | |
| | | 2#11 | | 1 | 3# 9 | 4.64 | 144H | 8 | - | 548 | 3.95 | 143H | 8 | - | 526 | 3.41 | 153H | 8 | - | 563 | 2.97 | 153H | 8 | - | 596 | 274 | 550 |
| | | | | 1 | | | 185F | 33 | 1.3 | 772 | | 205F | 33 | 1.3 | 843 | | 215F | 33 | 1.2 | 895 | | 234F | 32 | 1.2 | 797 | 267 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 6.84 | 155H | 8 | - | 844 | 5.83 | 165H | 8 | - | 907 | 5.03* | 175H | 8 | - | 969 | 4.38* | 184H | 8 | - | 943 | 394 | 428 |
| | | | | 1 | | | 295C | 33 | 1.3 | 1193 | | 315C | 33 | 1.2 | 1280 | | 215F | 33 | 1.2 | 1141 | | 235F | 32 | 1.2 | 1228 | 394 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 7.53 | 155H | 8 | - | 934 | 6.41 | 165H | 8 | - | 1003 | 5.53* | 175H | 8 | - | 1071 | 4.82* | 185H | 8 | - | 1139 | 394 | 387 |
| | | | | 1 | | | 295C | 33 | 1.3 | 1283 | | 315C | 33 | 1.2 | 1376 | | 345C | 33 | 1.2 | 1488 | | 365C | 32 | 1.2 | 1581 | 496 | |
| | 18 | 2# 8 | 1# 8 | 1 | 3# 8 | 3.77 | 123H | 10 | - | 374 | 3.21 | 123H | 10 | - | 398 | 2.77 | 133H | 10 | - | 427 | 2.41 | 133H | 10 | - | 452 | 216 | 537 |
| | | | | 1 | | | 165G | 40 | 1.4 | 633 | | 184G | 40 | 1.4 | 561 | | 194G | 40 | 1.4 | 598 | | 264E | 39 | 1.4 | 706 | 216 | |
| | | 2# 9 | 1# 9 | 1 | 3#10 | 5.15 | 144H | 10 | - | 576 | 4.39 | 143H | 10 | - | 554 | 3.78 | 153H | 10 | - | 593 | 3.29 | 153H | 10 | - | 627 | 269 | 491 |
| | | | | 1 | | | 165G | 40 | 1.4 | 770 | | 185G | 40 | 1.4 | 844 | | 195G | 40 | 1.4 | 898 | | 205G | 39 | 1.4 | 952 | 334 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 6.95 | 155H | 10 | - | 850 | 5.92 | 165H | 10 | - | 912 | 5.10 | 164H | 10 | - | 881 | 4.45* | 174H | 10 | - | 939 | 400 | 411 |
| | | | | 1 | | | 245D | 40 | 1.4 | 1116 | | 265D | 40 | 1.4 | 1204 | | 285D | 39 | 1.4 | 1292 | | 305D | 39 | 1.4 | 1380 | 400 | |
| | | 2#11 | 2#11 | 1 | 3#14 | 9.41 | 295C | 10 | - | 1278 | 8.02* | 175EeH | 10 | - | 1184 | 6.91* | 185EdH | 10 | - | 1264 | 6.02* | 185H | 10 | - | 1331 | 512 | 333 |
| | | | | 1 | | | 295C | 40 | 1.4 | 1455 | | 315C | 40 | 1.4 | 1560 | | 285D | 39 | 1.4 | 1569 | | 305D | 39 | 1.4 | 1674 | 542 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

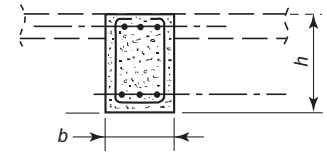
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

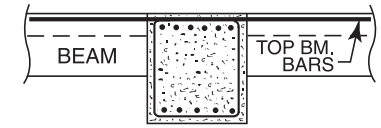
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 32 ft | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) $\times 10^{-9}$ |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | in. |
| 24 | 12 | 2# 8 | | 1 | 2# 8 | 1.41 | 133H | 5 | - | 340 | 1.25 | 133H | 5 | - | 357 | 1.12 | 133H | 5 | - | 374 | 1.00 | 133H | 5 | - | 390 | 144 | 806 |
| | | | | 1 | | | 283E | 20 | 1.0 | 436 | | 293E | 20 | 1.0 | 458 | | 313E | 20 | 1.0 | 485 | | 333E | 20 | 1.0 | 513 | 144 | |
| | | 2# 9 | | 1 | 2#10 | 1.93 | 163H | 5 | - | 471 | 1.71* | 163H | 5 | - | 495 | 1.53* | 173H | 5 | - | 523 | 1.37* | 173H | 5 | - | 546 | 179 | 737 |
| | | | | 1 | | | 284E | 20 | 1.0 | 704 | | 294E | 20 | 1.0 | 738 | | 314E | 20 | 1.0 | 783 | | 334E | 20 | 1.0 | 827 | 222 | |
| | | 2#11 | | 1 | 2#11 | 2.61* | 183H | 5 | - | 651 | 2.31* | 183H | 5 | - | 684 | 2.06* | 193H | 5 | - | 722 | 1.85* | 203H | 5 | - | 760 | 266 | 617 |
| | | | | 1 | | | 284E | 20 | 1.0 | 875 | | 294E | 20 | 1.0 | 919 | | 314E | 20 | 1.0 | 974 | | 334E | 20 | 1.0 | 1029 | 266 | |
| | | 2#10 | 1#10 | 1 | 2#14 | 3.42* | 194H | 5 | - | 888 | 3.03* | 204H | 5 | - | 938 | 2.70* | 214H | 5 | - | 989 | 2.42* | 224H | 5 | - | 1039 | 318 | 513 |
| | | | | 1 | | | 484B | 20 | 1.0 | 1248 | | 514B | 20 | 1.0 | 1323 | | 544B | 20 | 0.9 | 1397 | | 334E | 20 | 0.9 | 1218 | 361 | |
| | 14 | 2# 8 | | 1 | 3# 7 | 1.57 | 123H | 7 | - | 353 | 1.39 | 123H | 6 | - | 371 | 1.24 | 123H | 6 | - | 389 | 1.11 | 123H | 6 | - | 406 | 145 | 696 |
| | | | | 1 | | | 244F | 26 | 1.1 | 568 | | 264F | 26 | 1.1 | 608 | | 274F | 26 | 1.1 | 637 | | 293F | 26 | 1.1 | 517 | 165 | |
| | | 2#10 | | 1 | 3# 9 | 2.43* | 163H | 7 | - | 565 | 2.15* | 173H | 6 | - | 598 | 1.92* | 173H | 6 | - | 627 | 1.72* | 183H | 6 | - | 661 | 225 | 620 |
| | | | | 1 | | | 244F | 26 | 1.1 | 764 | | 264F | 26 | 1.1 | 815 | | 274F | 26 | 1.1 | 855 | | 294F | 26 | 1.1 | 907 | 263 | |
| | | 2#10 | 1#10 | 1 | 3#10 | 3.18* | 184H | 7 | - | 825 | 2.81* | 194H | 6 | - | 873 | 2.51* | 193H | 6 | - | 839 | 2.25* | 203H | 6 | - | 883 | 325 | 510 |
| | | | | 1 | | | 245F | 26 | 1.1 | 1116 | | 265F | 26 | 1.1 | 1192 | | 275F | 26 | 1.1 | 1250 | | 294F | 26 | 1.1 | 1121 | 325 | |
| | | 2#14 | | 1 | 3#11 | 3.77* | 194H | 6 | - | 999 | 3.34* | 204H | 6 | - | 1056 | 2.98* | 204H | 6 | - | 1105 | 2.68* | 214H | 6 | - | 1162 | 370 | 457 |
| | | | | 1 | | | 245F | 26 | 1.1 | 1282 | | 265F | 26 | 1.1 | 1368 | | 275F | 26 | 1.1 | 1435 | | 295F | 26 | 1.1 | 1520 | 386 | |
| | 16 | 2# 9 | | 1 | 3# 8 | 1.97 | 133H | 8 | - | 447 | 1.74 | 143H | 8 | - | 474 | 1.55 | 143H | 8 | - | 497 | 1.39* | 143H | 8 | - | 520 | 182 | 610 |
| | | | | 1 | | | 244F | 32 | 1.2 | 668 | | 264F | 32 | 1.2 | 714 | | 274F | 32 | 1.2 | 748 | | 294F | 32 | 1.2 | 794 | 215 | |
| | | 2#11 | | 1 | 3# 9 | 2.61* | 163H | 8 | - | 634 | 2.31* | 163H | 8 | - | 667 | 2.06* | 173H | 8 | - | 704 | 1.85* | 173H | 8 | - | 737 | 274 | 550 |
| | | | | 1 | | | 244F | 32 | 1.2 | 842 | | 264F | 32 | 1.2 | 898 | | 274F | 32 | 1.2 | 943 | | 294F | 32 | 1.2 | 999 | 267 | |
| | | 2#14 | | 1 | 3#11 | 3.85* | 184H | 8 | - | 995 | 3.41* | 194H | 8 | - | 1052 | 3.04* | 204H | 8 | - | 1110 | 2.73* | 204H | 8 | - | 1159 | 378 | 437 |
| | | | | 1 | | | 245F | 32 | 1.2 | 1299 | | 265F | 32 | 1.2 | 1386 | | 275F | 32 | 1.2 | 1454 | | 295F | 32 | 1.2 | 1540 | 394 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 4.23* | 194H | 8 | - | 1115 | 3.75* | 204H | 8 | - | 1178 | 3.35* | 204H | 8 | - | 1234 | 3.00* | 214H | 8 | - | 1297 | 394 | 387 |
| | | | | 1 | | | 245F | 32 | 1.2 | 1411 | | 265F | 32 | 1.2 | 1503 | | 275F | 32 | 1.2 | 1578 | | 295F | 32 | 1.2 | 1670 | 496 | |
| | 18 | 2# 8 | 1# 8 | 1 | 3# 8 | 2.12 | 133H | 10 | - | 477 | 1.88 | 133H | 10 | - | 501 | 1.67 | 133H | 10 | - | 526 | 1.50 | 133H | 10 | - | 551 | 216 | 537 |
| | | | | 1 | | | 284E | 39 | 1.4 | 754 | | 294E | 39 | 1.4 | 791 | | 314E | 38 | 1.3 | 840 | | 333E | 38 | 1.3 | 693 | 216 | |
| | | 2# 9 | 1# 9 | 1 | 3#10 | 2.90 | 163H | 10 | - | 666 | 2.56* | 163H | 10 | - | 701 | 2.29* | 173H | 10 | - | 740 | 2.05* | 173H | 10 | - | 774 | 269 | 491 |
| | | | | 1 | | | 225G | 39 | 1.4 | 1025 | | 235G | 39 | 1.3 | 1079 | | 244G | 38 | 1.3 | 952 | | 264G | 38 | 1.3 | 1011 | 334 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 3.91* | 184H | 10 | - | 996 | 3.46* | 184H | 10 | - | 1045 | 3.09* | 194H | 10 | - | 1103 | 2.77* | 203H | 10 | - | 1079 | 400 | 411 |
| | | | | 1 | | | 225G | 39 | 1.3 | 1274 | | 235G | 39 | 1.3 | 1342 | | 245G | 38 | 1.3 | 1411 | | 265G | 38 | 1.3 | 1499 | 400 | |
| | | 2#11 | 2#11 | 1 | 3#14 | 5.29* | 195H | 10 | - | 1411 | 4.69* | 205H | 10 | - | 1491 | 4.18* | 215H | 10 | - | 1571 | 3.75* | 225H | 10 | - | 1651 | 512 | 333 |
| | | | | 1 | | | 325D | 39 | 1.3 | 1780 | | 345D | 39 | 1.3 | 1885 | | 365D | 38 | 1.3 | 1991 | | 385D | 38 | 1.3 | 2096 | 542 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

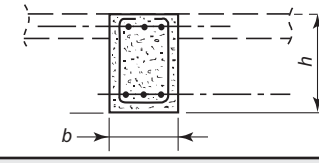
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

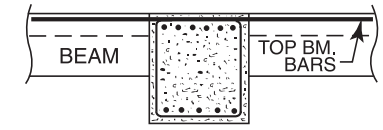
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 24 ft | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 26 | 14 | 2# 9 | | 1 | 3# 8 | 3.81 | 123I | 8 | - | 353 | 3.25 | 123I | 8 | - | 376 | 2.80 | 133I | 7 | - | 403 | 2.44 | 133I | 7 | - | 426 | 199 | 541 |
| | | | | 1 | | | 184F | 31 | 1.2 | 507 | | 204F | 30 | 1.2 | 553 | | 214F | 30 | 1.2 | 588 | | 234F | 30 | 1.2 | 633 | 234 | |
| | | 2#10 | | 1 | 3# 9 | 4.75 | 134I | 8 | - | 492 | 4.05 | 134I | 8 | - | 521 | 3.49 | 143I | 7 | - | 502 | 3.04 | 153I | 7 | - | 536 | 248 | 500 |
| | | | | 1 | | | 185F | 30 | 1.2 | 721 | | 205F | 30 | 1.2 | 788 | | 215F | 30 | 1.2 | 836 | | 234F | 30 | 1.2 | 735 | 290 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 6.86 | 135I | 8 | - | 751 | 5.85 | 145I | 8 | - | 807 | 5.04 | 165I | 7 | - | 878 | 4.39 | 164I | 7 | - | 841 | 359 | 387 |
| | | | | 1 | | | 295C | 30 | 1.2 | 1121 | | 205F | 30 | 1.2 | 996 | | 215F | 30 | 1.2 | 1058 | | 235F | 30 | 1.2 | 1139 | 428 | |
| | | 2#11 | 1#11 | 1 | 4#10 | 8.00 | 294C | 8 | - | 910 | 6.82 | 145I | 8 | - | 905 | 5.88 | 165I | 7 | - | 983 | 5.12* | 175I | 7 | - | 1047 | 428 | 352 |
| | | | | 1 | | | 295C | 30 | 1.2 | 1212 | | 315C | 30 | 1.2 | 1300 | | 345C | 30 | 1.2 | 1407 | | 365C | 30 | 1.2 | 1495 | 460 | |
| | 16 | 2# 9 | | 1 | 3# 8 | 3.84 | 113I | 9 | - | 350 | 3.27 | 123I | 9 | - | 377 | 2.82 | 123I | 9 | - | 400 | 2.46 | 123I | 9 | - | 423 | 200 | 474 |
| | | | | 1 | | | 165G | 38 | 1.4 | 612 | | 184G | 37 | 1.4 | 538 | | 194G | 37 | 1.4 | 573 | | 234F | 37 | 1.4 | 644 | 236 | |
| | | 2#11 | | 1 | 3#10 | 5.78 | 134I | 9 | - | 593 | 4.93 | 144I | 9 | - | 638 | 4.25 | 144I | 9 | - | 674 | 3.70 | 154I | 9 | - | 719 | 302 | 418 |
| | | | | 1 | | | 165G | 38 | 1.4 | 793 | | 185G | 37 | 1.4 | 868 | | 195G | 37 | 1.4 | 924 | | 205G | 37 | 1.3 | 979 | 364 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 7.57 | 135I | 9 | - | 827 | 6.45 | 145I | 9 | - | 890 | 5.56 | 155I | 9 | - | 953 | 4.85 | 165I | 9 | - | 1016 | 436 | 347 |
| | | | | 1 | | | 245D | 38 | 1.4 | 1116 | | 265D | 37 | 1.4 | 1204 | | 285D | 37 | 1.3 | 1292 | | 305D | 37 | 1.3 | 1380 | 436 | |
| | | 2#10 | 2#10 | 1 | 3#14 | 8.98 | 294C | 9 | - | 1046 | 7.65 | 165FdI | 9 | - | 1075 | 6.60 | 165I | 9 | - | 1134 | 5.75 | 175I | 9 | - | 1207 | 470 | 299 |
| | | | | 1 | | | 295C | 38 | 1.4 | 1361 | | 265D | 37 | 1.4 | 1361 | | 285D | 37 | 1.3 | 1459 | | 305D | 37 | 1.3 | 1557 | 586 | |
| | 18 | 2# 8 | 1# 8 | 1 | 3# 9 | 4.55 | 123I | 11 | - | 414 | 3.88 | 123I | 11 | - | 441 | 3.34 | 123I | 11 | - | 469 | 2.91 | 133I | 11 | - | 500 | 238 | 415 |
| | | | | 1 | | | 165G | 46 | 1.5 | 682 | | 185G | 45 | 1.5 | 749 | | 195G | 45 | 1.5 | 797 | | 204G | 44 | 1.5 | 689 | 296 | |
| | | 2#10 | 1#10 | 1 | 3#10 | 6.40 | 134I | 11 | - | 638 | 5.45 | 144I | 11 | - | 687 | 4.70 | 144I | 11 | - | 726 | 4.10 | 154I | 11 | - | 775 | 368 | 375 |
| | | | | 1 | | | 245D | 46 | 1.5 | 1007 | | 185G | 45 | 1.5 | 926 | | 195G | 45 | 1.5 | 986 | | 205G | 44 | 1.5 | 1046 | 368 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 8.45 | 145FcI | 11 | - | 936 | 7.20 | 145I | 11 | - | 991 | 6.21 | 155I | 11 | - | 1061 | 5.41 | 165I | 11 | - | 1130 | 442 | 302 |
| | | | | 1 | | | 245D | 46 | 1.5 | 1223 | | 265D | 45 | 1.5 | 1318 | | 285D | 45 | 1.5 | 1414 | | 305D | 44 | 1.5 | 1510 | 568 | |
| | | 2#11 | 2#11 | 1 | 3#14 | 10.46 | 295C | 11 | - | 1298 | 8.92 | 165FfI | 11 | - | 1182 | 7.69 | 175FeI | 11 | - | 1263 | 6.70* | 185FdI | 11 | - | 1343 | 568 | 270 |
| | | | | 1 | | | 295C | 46 | 1.5 | 1475 | | 315C | 45 | 1.5 | 1582 | | 345C | 45 | 1.5 | 1709 | | 305D | 44 | 1.5 | 1695 | 602 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3# 9 | 5.18 | 123I | 14 | - | 468 | 4.42 | 123I | 13 | - | 499 | 3.81 | 133I | 13 | - | 535 | 3.32 | 133I | 13 | - | 567 | 298 | 378 |
| | | | | 1 | | | 155H | 54 | 1.7 | 724 | | 165H | 53 | 1.7 | 777 | | 175H | 53 | 1.7 | 829 | | 185H | 52 | 1.6 | 881 | 298 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 7.10 | 135I | 14 | - | 764 | 6.05 | 144I | 13 | - | 747 | 5.22 | 144I | 13 | - | 790 | 4.54 | 154I | 13 | - | 843 | 371 | 338 |
| | | | | 1 | | | 215E | 54 | 1.7 | 1015 | | 225E | 53 | 1.7 | 1079 | | 245E | 53 | 1.6 | 1164 | | 265E | 52 | 1.6 | 1249 | 447 | |
| | | 2#11 | 2#11 | 1 | 3#14 | 10.64 | 165EgI | 14 | - | 1121 | 9.07 | 165FfI | 13 | - | 1188 | 7.82 | 175FeI | 13 | - | 1269 | 6.81* | 175FcI | 13 | - | 1335 | 576 | 261 |
| | | | | 1 | | | 295C | 54 | 1.7 | 1495 | | 315C | 53 | 1.7 | 1603 | | 285D | 53 | 1.6 | 1607 | | 305D | 52 | 1.6 | 1716 | 612 | |
| | | 2#11 | 2#11 | 1 | 5#11 | 11.02 | 165EhI | 14 | - | 1173 | 9.39 | 165FfI | 13 | - | 1244 | 8.09 | 175FeI | 13 | - | 1329 | 7.05* | 185FdI | 13 | - | 1415 | 576 | 246 |
| | | | | 1 | | | 295C | 54 | 1.7 | 1547 | | 315C | 53 | 1.7 | 1660 | | 345C | 53 | 1.6 | 1793 | | 305D | 52 | 1.6 | 1781 | 696 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

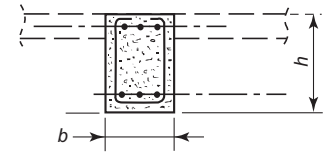
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

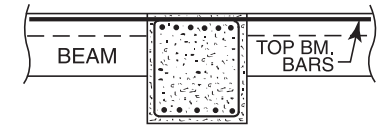
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS(1) | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$(3) | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 32 ft | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 26 | 14 | 2# 9 | | 1 | 3# 8 | 2.14 | 133I | 7 | - | 449 | 1.90 | 143I | 7 | - | 476 | 1.69 | 143I | 7 | - | 499 | 1.52 | 143I | 7 | - | 522 | 199 | 541 |
| | | | | 1 | | | 244F | 29 | 1.2 | 668 | | 264F | 29 | 1.2 | 714 | | 274F | 29 | 1.2 | 748 | | 294F | 29 | 1.2 | 794 | 234 | |
| | | 2#10 | | 1 | 3# 9 | 2.67 | 153I | 7 | - | 565 | 2.37 | 153I | 7 | - | 594 | 2.11* | 163I | 7 | - | 627 | 1.90* | 163I | 7 | - | 656 | 248 | 500 |
| | | | | 1 | | | 244F | 29 | 1.2 | 775 | | 264F | 29 | 1.2 | 827 | | 274F | 29 | 1.2 | 868 | | 294F | 29 | 1.2 | 920 | 290 | |
| | | 2#14 | | 1 | 3#11 | 4.18* | 175I | 7 | - | 1076 | 3.71* | 184I | 7 | - | 1048 | 3.31* | 194I | 7 | - | 1106 | 2.97* | 204I | 7 | - | 1163 | 411 | 371 |
| | | | | 1 | | | 245F | 29 | 1.2 | 1299 | | 265F | 29 | 1.2 | 1386 | | 275F | 29 | 1.2 | 1454 | | 295F | 29 | 1.2 | 1540 | 428 | |
| | | 2#14 | | 1 | 4#10 | 4.42* | 185I | 7 | - | 1113 | 3.91* | 185I | 7 | - | 1164 | 3.49* | 194I | 7 | - | 1133 | 3.13* | 204I | 7 | - | 1192 | 411 | 359 |
| | | | | 1 | | | 245F | 29 | 1.2 | 1323 | | 265F | 29 | 1.2 | 1411 | | 275F | 29 | 1.2 | 1481 | | 295F | 29 | 1.2 | 1569 | 460 | |
| | 16 | 2# 9 | | 1 | 3# 8 | 2.16 | 123I | 9 | - | 446 | 1.91 | 133I | 9 | - | 473 | 1.71 | 133I | 9 | - | 496 | 1.53 | 123I | 9 | - | 515 | 200 | 474 |
| | | | | 1 | | | 244F | 36 | 1.3 | 679 | | 264F | 36 | 1.3 | 726 | | 274F | 36 | 1.3 | 760 | | 294F | 36 | 1.3 | 807 | 236 | |
| | | 2#11 | | 1 | 3#10 | 3.25 | 153I | 9 | - | 693 | 2.88* | 163I | 9 | - | 734 | 2.57* | 163I | 9 | - | 770 | 2.31* | 173I | 9 | - | 811 | 302 | 418 |
| | | | | 1 | | | 225G | 36 | 1.3 | 1055 | | 235G | 36 | 1.3 | 1111 | | 245G | 36 | 1.3 | 1166 | | 265G | 36 | 1.3 | 1242 | 364 | |
| | | 2#14 | | 1 | 3#11 | 4.26* | 174I | 9 | - | 995 | 3.77* | 184I | 9 | - | 1052 | 3.37* | 184I | 9 | - | 1102 | 3.02* | 194I | 9 | - | 1159 | 418 | 355 |
| | | | | 1 | | | 325D | 36 | 1.3 | 1471 | | 235G | 36 | 1.3 | 1345 | | 245G | 36 | 1.3 | 1414 | | 265G | 36 | 1.3 | 1502 | 436 | |
| | | 2#10 | 2#10 | 1 | 3#14 | 5.05* | 185I | 9 | - | 1280 | 4.47* | 185I | 9 | - | 1339 | 3.99* | 195I | 9 | - | 1411 | 3.58* | 204I | 9 | - | 1382 | 470 | 299 |
| | | | | 1 | | | 325D | 36 | 1.3 | 1655 | | 345D | 36 | 1.3 | 1753 | | 365D | 36 | 1.3 | 1851 | | 385D | 36 | 1.3 | 1949 | 586 | |
| | 18 | 2# 8 | 1# 8 | 1 | 3# 9 | 2.56 | 133I | 11 | - | 528 | 2.27 | 133I | 11 | - | 555 | 2.02 | 133I | 11 | - | 582 | 1.81 | 133I | 11 | - | 609 | 238 | 415 |
| | | | | 1 | | | 284E | 44 | 1.5 | 815 | | 294E | 44 | 1.5 | 855 | | 314E | 43 | 1.5 | 907 | | 334E | 43 | 1.5 | 959 | 296 | |
| | | 2#10 | 1#10 | 1 | 3#10 | 3.60 | 153I | 11 | - | 751 | 3.19* | 163I | 11 | - | 795 | 2.84* | 163I | 11 | - | 835 | 2.55* | 173I | 11 | - | 880 | 368 | 375 |
| | | | | 1 | | | 225G | 44 | 1.5 | 1126 | | 235G | 44 | 1.5 | 1186 | | 245G | 43 | 1.5 | 1246 | | 265G | 43 | 1.5 | 1326 | 368 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 4.75* | 175I | 11 | - | 1199 | 4.21* | 174I | 11 | - | 1165 | 3.75* | 184I | 11 | - | 1230 | 3.37* | 194I | 11 | - | 1294 | 442 | 302 |
| | | | | 1 | | | 325D | 44 | 1.5 | 1605 | | 345D | 44 | 1.5 | 1701 | | 245G | 43 | 1.4 | 1555 | | 265G | 43 | 1.4 | 1650 | 568 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 5.89* | 185I | 11 | - | 1480 | 5.21* | 195I | 11 | - | 1564 | 4.65* | 195I | 11 | - | 1635 | 4.17* | 205I | 11 | - | 1720 | 602 | 265 |
| | | | | 1 | | | 325D | 44 | 1.5 | 1871 | | 345D | 44 | 1.5 | 1982 | | 365D | 43 | 1.4 | 2094 | | 385D | 43 | 1.4 | 2205 | 602 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3# 9 | 2.92 | 133I | 13 | - | 598 | 2.58 | 133I | 13 | - | 630 | 2.30 | 133I | 13 | - | 661 | 2.07 | 133I | 13 | - | 693 | 298 | 378 |
| | | | | 1 | | | 195H | 52 | 1.6 | 934 | | 215H | 52 | 1.6 | 1007 | | 224H | 51 | 1.6 | 883 | | 383D | 51 | 1.6 | 879 | 298 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 3.99 | 154I | 13 | - | 886 | 3.54* | 163I | 13 | - | 869 | 3.16* | 163I | 13 | - | 912 | 2.83* | 173I | 13 | - | 960 | 371 | 338 |
| | | | | 1 | | | 195H | 52 | 1.6 | 1146 | | 215H | 52 | 1.6 | 1231 | | 225H | 51 | 1.6 | 1296 | | 235H | 51 | 1.6 | 1360 | 447 | |
| | | 2#11 | 2#11 | 1 | 3#14 | 5.98* | 175I | 13 | - | 1402 | 5.30* | 185I | 13 | - | 1483 | 4.73* | 195I | 13 | - | 1564 | 4.24* | 195I | 13 | - | 1631 | 576 | 261 |
| | | | | 1 | | | 325D | 52 | 1.6 | 1824 | | 295E | 52 | 1.6 | 1828 | | 315E | 51 | 1.6 | 1937 | | 335E | 51 | 1.6 | 2045 | 612 | |
| | | 2#14 | 1#14 | 1 | 5#11 | 6.58* | 195Fdl | 13 | - | 1569 | 5.83* | 195Fcl | 13 | - | 1644 | 5.20* | 195I | 13 | - | 1719 | 4.67* | 205I | 13 | - | 1809 | 612 | 242 |
| | | | | 1 | | | 325D | 52 | 1.6 | 1963 | | 345D | 52 | 1.6 | 2080 | | 365D | 51 | 1.6 | 2196 | | 335E | 51 | 1.6 | 2209 | 696 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

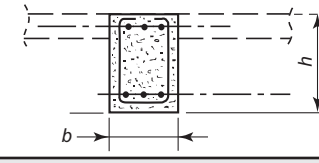
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

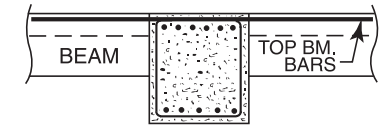
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 26 ft | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 28 | 14 | 2# 9 | | 1 | 3# 8 | 3.54 | 123J | 8 | - | 379 | 3.05 | 123J | 8 | - | 402 | 2.66 | 123J | 8 | - | 425 | 2.34 | 133J | 8 | - | 452 | 217 | 432 |
| | | | | 1 | | | 185G | 34 | 1.3 | 674 | | 194G | 33 | 1.3 | 573 | | 204G | 33 | 1.3 | 608 | | 224G | 33 | 1.3 | 655 | 256 | |
| | | 2#11 | | 1 | 3# 9 | 4.70 | 134J | 8 | - | 582 | 4.05 | 134J | 8 | - | 615 | 3.53 | 143J | 8 | - | 597 | 3.10 | 143J | 8 | - | 631 | 327 | 388 |
| | | | | 1 | | | 185G | 34 | 1.3 | 818 | | 195G | 33 | 1.3 | 870 | | 205G | 33 | 1.3 | 923 | | 225G | 33 | 1.3 | 995 | 317 | |
| | | 2#14 | | 1 | 3#11 | 6.96 | 135J | 8 | - | 884 | 6.00 | 145J | 8 | - | 947 | 5.23 | 155J | 8 | - | 1010 | 4.60 | 165J | 8 | - | 1074 | 451 | 306 |
| | | | | 1 | | | 265D | 34 | 1.3 | 1207 | | 285D | 33 | 1.3 | 1295 | | 305D | 33 | 1.3 | 1383 | | 325D | 33 | 1.3 | 1471 | 470 | |
| | | 4# 7 | 4# 7 | 2 | 4#11 | 7.59 | 145GdJ | 8 | - | 991 | 6.55 | 155GcJ | 8 | - | 1061 | 5.70 | 155J | 8 | - | 1116 | 5.01* | 165J | 8 | - | 1186 | 466 | 297 |
| | | | | 2 | | | 265D | 34 | 1.3 | 1301 | | 285D | 33 | 1.3 | 1395 | | 305D | 33 | 1.3 | 1489 | | 325D | 33 | 1.3 | 1584 | 560 | |
| | 16 | 2#10 | | 1 | 3# 8 | 3.82 | 113J | 10 | - | 424 | 3.29 | 123J | 10 | - | 455 | 2.87 | 123J | 10 | - | 482 | 2.52 | 123J | 10 | - | 509 | 273 | 369 |
| | | | | 1 | | | 185G | 42 | 1.5 | 736 | | 194G | 42 | 1.5 | 634 | | 204G | 41 | 1.5 | 673 | | 244F | 41 | 1.5 | 749 | 258 | |
| | | 2#11 | | 1 | 3#10 | 5.39 | 134J | 10 | - | 635 | 4.64 | 134J | 10 | - | 672 | 4.05 | 144J | 10 | - | 717 | 3.56 | 143J | 10 | - | 692 | 330 | 343 |
| | | | | 1 | | | 185G | 42 | 1.5 | 880 | | 195G | 41 | 1.5 | 937 | | 205G | 41 | 1.5 | 993 | | 225G | 41 | 1.4 | 1070 | 398 | |
| | | 2#14 | | 1 | 4#11 | 7.47 | 135J | 10 | - | 984 | 6.44 | 145J | 10 | - | 1054 | 5.61 | 155J | 10 | - | 1124 | 4.93 | 165J | 10 | - | 1194 | 459 | 264 |
| | | | | 1 | | | 265D | 42 | 1.5 | 1321 | | 285D | 41 | 1.5 | 1417 | | 305D | 41 | 1.4 | 1512 | | 325D | 41 | 1.4 | 1608 | 613 | |
| | | 2#11 | 2#11 | 1 | 3#14 | 9.63 | 265D | 10 | - | 1332 | 8.30 | 285D | 10 | - | 1427 | 7.23 | 175GeJ | 10 | - | 1335 | 6.36* | 175GdJ | 10 | - | 1402 | 613 | 232 |
| | | | | 1 | | | 525A | 42 | 1.5 | 2005 | | 565A | 41 | 1.5 | 2153 | | 305D | 41 | 1.4 | 1695 | | 325D | 41 | 1.4 | 1802 | 650 | |
| | 18 | 2# 9 | 1# 9 | 1 | 3# 9 | 4.79 | 123J | 13 | - | 501 | 4.13 | 123J | 13 | - | 532 | 3.59 | 133J | 12 | - | 569 | 3.16 | 133J | 12 | - | 600 | 323 | 332 |
| | | | | 1 | | | 165H | 51 | 1.7 | 777 | | 175H | 50 | 1.6 | 829 | | 185H | 50 | 1.6 | 881 | | 195H | 49 | 1.6 | 934 | 323 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 6.56 | 135J | 13 | - | 812 | 5.65 | 144J | 13 | - | 793 | 4.92 | 144J | 12 | - | 837 | 4.33 | 154J | 12 | - | 889 | 402 | 291 |
| | | | | 1 | | | 225E | 51 | 1.6 | 1079 | | 245E | 50 | 1.6 | 1164 | | 265E | 50 | 1.6 | 1249 | | 285E | 49 | 1.6 | 1334 | 484 | |
| | | 2#11 | 2#11 | 1 | 3#14 | 9.82 | 165FgJ | 13 | - | 1193 | 8.46 | 165GfJ | 13 | - | 1260 | 7.37 | 175GeJ | 12 | - | 1341 | 6.48* | 175GdJ | 12 | - | 1408 | 624 | 223 |
| | | | | 1 | | | 315C | 51 | 1.6 | 1603 | | 345C | 50 | 1.6 | 1733 | | 305D | 50 | 1.6 | 1716 | | 325D | 49 | 1.6 | 1824 | 663 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 9.82 | 165FgJ | 13 | - | 1250 | 8.46 | 165GfJ | 13 | - | 1321 | 7.37 | 175GeJ | 12 | - | 1407 | 6.48 | 175GdJ | 12 | - | 1477 | 663 | 219 |
| | | | | 1 | | | 315C | 51 | 1.6 | 1660 | | 345C | 50 | 1.6 | 1794 | | 305D | 50 | 1.6 | 1781 | | 325D | 49 | 1.6 | 1894 | 663 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3# 9 | 4.82 | 113J | 15 | - | 497 | 4.15 | 123J | 15 | - | 534 | 3.62 | 123J | 15 | - | 565 | 3.18 | 123J | 15 | - | 597 | 325 | 300 |
| | | | | 1 | | | 165H | 60 | 1.8 | 788 | | 175H | 59 | 1.8 | 841 | | 185H | 59 | 1.8 | 894 | | 195H | 58 | 1.8 | 947 | 325 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 7.24 | 135J | 15 | - | 895 | 6.24 | 145J | 15 | - | 959 | 5.44 | 144J | 15 | - | 930 | 4.78 | 154J | 15 | - | 988 | 489 | 263 |
| | | | | 1 | | | 225E | 60 | 1.8 | 1172 | | 245E | 59 | 1.8 | 1265 | | 265E | 59 | 1.8 | 1357 | | 285E | 58 | 1.8 | 1449 | 489 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 9.96 | 165FgJ | 15 | - | 1256 | 8.59 | 165GeJ | 15 | - | 1327 | 7.48 | 165GdJ | 15 | - | 1397 | 6.58 | 175GcJ | 15 | - | 1483 | 673 | 211 |
| | | | | 1 | | | 315C | 60 | 1.8 | 1682 | | 345C | 59 | 1.8 | 1817 | | 305D | 59 | 1.8 | 1802 | | 325D | 58 | 1.8 | 1916 | 673 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 10.96 | 175EiJ | 15 | - | 1412 | 9.45 | 175FhJ | 15 | - | 1492 | 8.23 | 175GfJ | 15 | - | 1571 | 7.24 | 185GeJ | 15 | - | 1666 | 673 | 191 |
| | | | | 1 | | | 395B | 60 | 1.8 | 1995 | | 345C | 59 | 1.8 | 1967 | | 365C | 59 | 1.8 | 2090 | | 325D | 58 | 1.8 | 2084 | 857 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

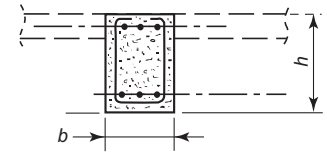
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

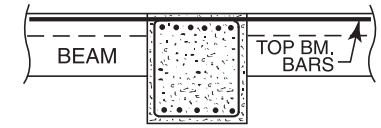
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 34 ft | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | SPAN, $\ell_n$ = 40 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 28 | 14 | 2# 9 | | 1 | 3# 8 | 2.07 | 133J | 8 | - | 475 | 1.85 | 133J | 8 | - | 498 | 1.66 | 133J | 8 | - | 521 | 1.50 | 133J | 8 | - | 544 | 217 | 432 |
| | | | | 1 | | | 234G | 32 | 1.3 | 690 | | 244G | 32 | 1.3 | 725 | | 264G | 32 | 1.3 | 772 | | 274G | 32 | 1.3 | 806 | 256 | |
| | | 2#11 | | 1 | 3# 9 | 2.75 | 153J | 8 | - | 668 | 2.45 | 153J | 8 | - | 702 | 2.20* | 163J | 8 | - | 739 | 1.99* | 163J | 8 | - | 772 | 327 | 388 |
| | | | | 1 | | | 235G | 32 | 1.3 | 1048 | | 245G | 32 | 1.3 | 1100 | | 264G | 32 | 1.3 | 976 | | 274G | 32 | 1.3 | 1021 | 317 | |
| | | 2#14 | | 1 | 3#11 | 4.07* | 174J | 8 | - | 1048 | 3.63* | 174J | 8 | - | 1097 | 3.26* | 184J | 8 | - | 1155 | 2.94* | 194J | 8 | - | 1213 | 451 | 306 |
| | | | | 1 | | | 235G | 32 | 1.3 | 1345 | | 245G | 32 | 1.3 | 1414 | | 265G | 32 | 1.3 | 1502 | | 275G | 32 | 1.3 | 1571 | 470 | |
| | | 2#10 | 2#10 | 1 | 4#11 | 4.82* | 175J | 8 | - | 1284 | 4.30* | 185J | 8 | - | 1355 | 3.86* | 195J | 8 | - | 1426 | 3.48* | 195J | 8 | - | 1483 | 506 | 282 |
| | | | | 2 | | | 345D | 32 | 1.3 | 1706 | | 365D | 32 | 1.3 | 1802 | | 385D | 32 | 1.3 | 1898 | | 275G | 32 | 1.2 | 1741 | 560 | |
| | 16 | 2#10 | | 1 | 3# 8 | 2.23 | 123J | 10 | - | 535 | 1.99 | 123J | 10 | - | 562 | 1.79 | 123J | 10 | - | 588 | 1.61 | 123J | 10 | - | 615 | 273 | 369 |
| | | | | 1 | | | 264F | 40 | 1.4 | 801 | | 274F | 40 | 1.4 | 840 | | 294F | 40 | 1.4 | 891 | | 304F | 40 | 1.4 | 930 | 258 | |
| | | 2#11 | | 1 | 3#10 | 3.15 | 153J | 10 | - | 733 | 2.81 | 153J | 10 | - | 770 | 2.52* | 163J | 10 | - | 811 | 2.28* | 163J | 10 | - | 847 | 330 | 343 |
| | | | | 1 | | | 235G | 40 | 1.4 | 1126 | | 245G | 40 | 1.4 | 1183 | | 265G | 40 | 1.4 | 1260 | | 274G | 40 | 1.4 | 1106 | 398 | |
| | | 2#14 | | 1 | 4#11 | 4.37 | 175J | 10 | - | 1263 | 3.90* | 174J | 10 | - | 1228 | 3.50* | 184J | 10 | - | 1292 | 3.16* | 184J | 10 | - | 1347 | 459 | 264 |
| | | | | 1 | | | 345D | 40 | 1.4 | 1704 | | 245G | 40 | 1.4 | 1558 | | 265G | 40 | 1.4 | 1653 | | 275G | 40 | 1.4 | 1729 | 613 | |
| | | 2#11 | 2#11 | 1 | 3#14 | 5.63* | 185GcJ | 10 | - | 1483 | 5.02* | 185J | 10 | - | 1550 | 4.51* | 195J | 10 | - | 1631 | 4.07* | 205J | 10 | - | 1712 | 613 | 232 |
| | | | | 1 | | | 345D | 40 | 1.4 | 1909 | | 365D | 40 | 1.4 | 2016 | | 385D | 40 | 1.4 | 2123 | | 405D | 40 | 1.4 | 2230 | 650 | |
| | 18 | 2# 9 | 1# 9 | 1 | 3# 9 | 2.80 | 133J | 12 | - | 631 | 2.50 | 133J | 12 | - | 663 | 2.24 | 133J | 12 | - | 694 | 2.02 | 143J | 12 | - | 731 | 323 | 332 |
| | | | | 1 | | | 215H | 49 | 1.6 | 1007 | | 225H | 49 | 1.6 | 1059 | | 234H | 48 | 1.6 | 927 | | 244H | 48 | 1.6 | 971 | 323 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 3.83 | 154J | 12 | - | 933 | 3.42 | 163J | 12 | - | 914 | 3.07* | 163J | 12 | - | 957 | 2.77* | 173J | 12 | - | 1005 | 402 | 291 |
| | | | | 1 | | | 215H | 49 | 1.6 | 1231 | | 225H | 49 | 1.6 | 1296 | | 235H | 48 | 1.6 | 1360 | | 245H | 48 | 1.6 | 1424 | 484 | |
| | | 2#11 | 2#11 | 1 | 3#14 | 5.74* | 175J | 12 | - | 1474 | 5.12* | 185J | 12 | - | 1556 | 4.60* | 185J | 12 | - | 1622 | 4.15* | 195J | 12 | - | 1704 | 624 | 223 |
| | | | | 1 | | | 295E | 49 | 1.6 | 1828 | | 315E | 49 | 1.6 | 1937 | | 335E | 48 | 1.6 | 2045 | | 345E | 48 | 1.6 | 2132 | 663 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 5.74* | 175J | 12 | - | 1548 | 5.12* | 185J | 12 | - | 1634 | 4.60* | 195J | 12 | - | 1719 | 4.15* | 195J | 12 | - | 1790 | 663 | 219 |
| | | | | 1 | | | 345D | 49 | 1.6 | 2006 | | 315E | 49 | 1.6 | 2014 | | 335E | 48 | 1.6 | 2127 | | 345E | 48 | 1.6 | 2218 | 663 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3# 9 | 2.82 | 123J | 14 | - | 628 | 2.51 | 123J | 14 | - | 660 | 2.25 | 123J | 14 | - | 691 | 2.03 | 123J | 14 | - | 722 | 325 | 300 |
| | | | | 1 | | | 215H | 58 | 1.8 | 1021 | | 224H | 58 | 1.7 | 893 | | 234H | 57 | 1.7 | 938 | | 403D | 57 | 1.7 | 934 | 325 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 4.23 | 154J | 14 | - | 1037 | 3.77 | 164J | 14 | - | 1096 | 3.39* | 163J | 14 | - | 1072 | 3.06* | 163J | 14 | - | 1121 | 489 | 263 |
| | | | | 1 | | | 295E | 58 | 1.7 | 1520 | | 225H | 58 | 1.7 | 1418 | | 235H | 57 | 1.7 | 1489 | | 245H | 57 | 1.7 | 1559 | 489 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 5.83* | 175J | 14 | - | 1554 | 5.20* | 175J | 14 | - | 1625 | 4.66* | 185J | 14 | - | 1711 | 4.21* | 195J | 14 | - | 1796 | 673 | 211 |
| | | | | 1 | | | 295E | 58 | 1.7 | 1922 | | 315E | 57 | 1.7 | 2036 | | 335E | 57 | 1.7 | 2150 | | 345E | 57 | 1.7 | 2242 | 673 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 6.41* | 185GdJ | 14 | - | 1746 | 5.72* | 195GcJ | 14 | - | 1841 | 5.13* | 195J | 14 | - | 1920 | 4.63* | 195J | 14 | - | 2000 | 673 | 191 |
| | | | | 1 | | | 345D | 58 | 1.7 | 2206 | | 365D | 57 | 1.7 | 2329 | | 335E | 57 | 1.7 | 2344 | | 345E | 57 | 1.7 | 2445 | 857 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

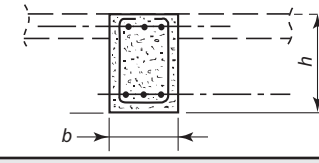
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

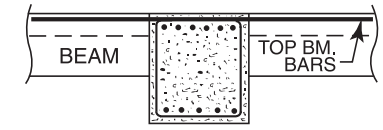
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 26 ft | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 30 | 14 | 2#10 | | 1 | 3# 8 | 4.10 | 113K | 9 | - | 426 | 3.54 | 113K | 9 | - | 452 | 3.08 | 123K | 9 | - | 484 | 2.71 | 123K | 9 | - | 510 | 294 | 341 |
| | | | | 1 | | | 185G | 37 | 1.4 | 736 | | 195G | 37 | 1.4 | 782 | | 204G | 37 | 1.4 | 673 | | 224G | 36 | 1.4 | 725 | 277 | |
| | | 2#11 | | 1 | 3#10 | 5.79 | 124K | 9 | - | 629 | 4.99 | 134K | 9 | - | 675 | 4.35 | 134K | 9 | - | 711 | 3.82 | 144K | 9 | - | 756 | 355 | 304 |
| | | | | 1 | | | 185G | 37 | 1.4 | 880 | | 195G | 37 | 1.4 | 937 | | 205G | 37 | 1.4 | 993 | | 225G | 36 | 1.4 | 1070 | 428 | |
| | | 2#14 | | 1 | 3#11 | 7.58 | 135HcK | 9 | - | 893 | 6.54 | 135K | 9 | - | 942 | 5.70 | 145K | 9 | - | 1006 | 5.01 | 155K | 9 | - | 1070 | 492 | 257 |
| | | | | 1 | | | 265D | 37 | 1.4 | 1225 | | 285D | 37 | 1.4 | 1315 | | 305D | 36 | 1.4 | 1404 | | 325D | 36 | 1.4 | 1494 | 512 | |
| | | 2#14 | 1#11 | 1 | 3#14 | 10.29 | 265D | 9 | - | 1344 | 8.87 | 285D | 9 | - | 1440 | 7.73 | 304D | 9 | - | 1371 | 6.79 | 324D | 9 | - | 1457 | 638 | 205 |
| | | | | 1 | | | 525A | 37 | 1.4 | 2008 | | 565A | 37 | 1.4 | 2155 | | 305D | 36 | 1.4 | 1698 | | 325D | 36 | 1.4 | 1805 | 695 | |
| | 16 | 2#10 | | 1 | 3# 9 | 4.83 | 113K | 12 | - | 467 | 4.16 | 123K | 12 | - | 501 | 3.63 | 123K | 11 | - | 530 | 3.19 | 123K | 11 | - | 559 | 296 | 306 |
| | | | | 1 | | | 165H | 47 | 1.6 | 746 | | 175H | 46 | 1.6 | 796 | | 185H | 46 | 1.6 | 846 | | 195H | 45 | 1.6 | 896 | 348 | |
| | | 2#11 | | 1 | 3#10 | 5.84 | 124K | 12 | - | 632 | 5.04 | 124K | 12 | - | 668 | 4.39 | 134K | 11 | - | 714 | 3.86 | 133K | 11 | - | 691 | 359 | 285 |
| | | | | 1 | | | 225E | 47 | 1.6 | 976 | | 175H | 46 | 1.6 | 908 | | 185H | 46 | 1.6 | 966 | | 195H | 45 | 1.6 | 1023 | 433 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 8.47 | 135HdK | 12 | - | 991 | 7.30 | 145HcK | 12 | - | 1061 | 6.36 | 145K | 11 | - | 1116 | 5.59 | 155K | 11 | - | 1187 | 520 | 217 |
| | | | | 1 | | | 265D | 47 | 1.6 | 1336 | | 245E | 46 | 1.6 | 1350 | | 265E | 46 | 1.6 | 1447 | | 285E | 45 | 1.6 | 1544 | 669 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 10.53 | 265D | 12 | - | 1407 | 9.08 | 285D | 12 | - | 1508 | 7.91 | 165GgK | 11 | - | 1397 | 6.95 | 165HeK | 11 | - | 1468 | 711 | 190 |
| | | | | 1 | | | 525A | 47 | 1.6 | 2099 | | 565A | 46 | 1.6 | 2253 | | 305D | 46 | 1.6 | 1781 | | 325D | 45 | 1.6 | 1894 | 711 | |
| | 18 | 2# 9 | 1# 9 | 1 | 3# 9 | 5.19 | 113K | 14 | - | 499 | 4.47 | 113K | 14 | - | 530 | 3.89 | 123K | 14 | - | 567 | 3.42 | 123K | 14 | - | 598 | 350 | 270 |
| | | | | 1 | | | 165H | 57 | 1.8 | 788 | | 175H | 56 | 1.8 | 841 | | 185H | 55 | 1.8 | 894 | | 195H | 55 | 1.7 | 947 | 350 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 7.11 | 125K | 14 | - | 806 | 6.13 | 135K | 14 | - | 865 | 5.34 | 134K | 14 | - | 833 | 4.70 | 144K | 14 | - | 887 | 437 | 243 |
| | | | | 1 | | | 225E | 57 | 1.8 | 1094 | | 245E | 56 | 1.8 | 1181 | | 265E | 55 | 1.7 | 1267 | | 285E | 55 | 1.7 | 1354 | 526 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 10.71 | 155FhK | 14 | - | 1246 | 9.24 | 155GgK | 14 | - | 1317 | 8.05 | 155HeK | 14 | - | 1387 | 7.07 | 165HeK | 14 | - | 1474 | 724 | 183 |
| | | | | 1 | | | 315C | 57 | 1.8 | 1682 | | 345C | 56 | 1.8 | 1817 | | 305D | 55 | 1.7 | 1802 | | 325D | 55 | 1.7 | 1916 | 724 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 11.79 | 265D | 14 | - | 1557 | 10.16 | 285D | 14 | - | 1668 | 8.85 | 175FhK | 14 | - | 1577 | 7.78 | 175GgK | 14 | - | 1657 | 724 | 165 |
| | | | | 1 | | | 525A | 57 | 1.8 | 2276 | | 565A | 56 | 1.8 | 2442 | | 365C | 55 | 1.7 | 2090 | | 385C | 55 | 1.7 | 2213 | 907 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3#10 | 5.74 | 113K | 17 | - | 550 | 4.95 | 113K | 17 | - | 585 | 4.31 | 123K | 16 | - | 625 | 3.79 | 123K | 16 | - | 659 | 352 | 240 |
| | | | | 1 | | | 205F | 67 | 2.0 | 938 | | 165I | 66 | 1.9 | 884 | | 175I | 66 | 1.9 | 941 | | 185I | 65 | 1.9 | 998 | 440 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 7.86 | 125K | 17 | - | 888 | 6.78 | 135K | 17 | - | 953 | 5.90 | 134K | 16 | - | 926 | 5.19 | 144K | 16 | - | 985 | 531 | 219 |
| | | | | 1 | | | 225E | 67 | 2.0 | 1188 | | 215F | 66 | 1.9 | 1214 | | 235F | 66 | 1.9 | 1308 | | 245F | 65 | 1.9 | 1380 | 531 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 10.86 | 155FhK | 17 | - | 1251 | 9.37 | 155GfK | 17 | - | 1322 | 8.16 | 155HeK | 16 | - | 1393 | 7.17 | 165HdK | 16 | - | 1479 | 734 | 177 |
| | | | | 1 | | | 315C | 67 | 2.0 | 1704 | | 345C | 66 | 1.9 | 1841 | | 305D | 66 | 1.9 | 1823 | | 325D | 65 | 1.9 | 1938 | 734 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 13.89 | 265D | 17 | - | 1744 | 11.98 | 285D | 17 | - | 1869 | 10.43 | 305D | 16 | - | 1993 | 9.17 | 205EkK | 16 | - | 1928 | 938 | 146 |
| | | | | 1 | | | 525A | 67 | 2.0 | 2490 | | 565A | 66 | 1.9 | 2672 | | 605A | 66 | 1.9 | 2854 | | 385C | 65 | 1.9 | 2457 | 938 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

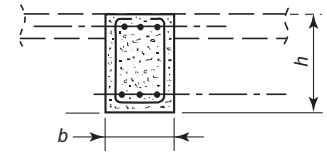
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

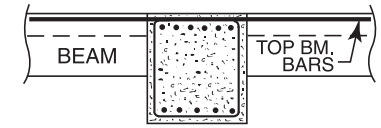
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 34 ft | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | SPAN, $\ell_n$ = 40 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 30 | 14 | 2#10 | | 1 | 3# 8 | 2.40 | 123K | 9 | - | 537 | 2.14 | 133K | 9 | - | 568 | 1.92 | 133K | 9 | - | 595 | 1.73 | 133K | 9 | - | 621 | 294 | 341 |
| | | | | 1 | | | 234G | 36 | 1.4 | 764 | | 244G | 36 | 1.4 | 803 | | 264G | 35 | 1.4 | 854 | | 274G | 35 | 1.4 | 893 | 277 | |
| | | 2#11 | | 1 | 3#10 | 3.38 | 144K | 9 | - | 793 | 3.02 | 153K | 9 | - | 771 | 2.71 | 153K | 9 | - | 808 | 2.44* | 163K | 9 | - | 849 | 355 | 304 |
| | | | | 1 | | | 235G | 36 | 1.4 | 1126 | | 245G | 36 | 1.4 | 1183 | | 265G | 35 | 1.4 | 1260 | | 275G | 35 | 1.4 | 1316 | 428 | |
| | | 2#14 | | 1 | 3#11 | 4.44 | 165K | 9 | - | 1134 | 3.96* | 164K | 9 | - | 1095 | 3.55* | 174K | 9 | - | 1154 | 3.20* | 174K | 9 | - | 1203 | 492 | 257 |
| | | | | 1 | | | 235G | 36 | 1.4 | 1361 | | 245G | 36 | 1.4 | 1431 | | 265G | 35 | 1.4 | 1520 | | 275G | 35 | 1.4 | 1590 | 512 | |
| | | 2#10 | 2#10 | 1 | 3#14 | 5.26 | 165K | 9 | - | 1328 | 4.69* | 175K | 9 | - | 1402 | 4.21* | 185K | 9 | - | 1476 | 3.80* | 185K | 9 | - | 1535 | 552 | 216 |
| | | | | 1 | | | 345D | 36 | 1.4 | 1777 | | 365D | 36 | 1.4 | 1876 | | 385D | 35 | 1.4 | 1976 | | 275G | 35 | 1.3 | 1813 | 695 | |
| | 16 | 2#10 | | 1 | 3# 9 | 2.82 | 133K | 11 | - | 593 | 2.52 | 133K | 11 | - | 623 | 2.26 | 133K | 11 | - | 652 | 2.04 | 133K | 11 | - | 681 | 296 | 306 |
| | | | | 1 | | | 215H | 45 | 1.6 | 967 | | 225H | 44 | 1.5 | 1017 | | 234H | 44 | 1.5 | 883 | | 244H | 44 | 1.5 | 925 | 348 | |
| | | 2#11 | | 1 | 3#10 | 3.42 | 143K | 11 | - | 732 | 3.05 | 143K | 11 | - | 768 | 2.74 | 153K | 11 | - | 810 | 2.47 | 153K | 11 | - | 846 | 359 | 285 |
| | | | | 1 | | | 215H | 45 | 1.6 | 1101 | | 225H | 44 | 1.5 | 1158 | | 235H | 44 | 1.5 | 1215 | | 245H | 44 | 1.5 | 1272 | 433 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 4.95 | 165K | 11 | - | 1257 | 4.42 | 165K | 11 | - | 1313 | 3.96* | 174K | 11 | - | 1288 | 3.58* | 174K | 11 | - | 1343 | 520 | 217 |
| | | | | 1 | | | 295E | 45 | 1.5 | 1620 | | 315E | 44 | 1.5 | 1717 | | 335E | 44 | 1.5 | 1814 | | 345E | 44 | 1.5 | 1891 | 669 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 6.16 | 175HdK | 11 | - | 1554 | 5.49* | 185HcK | 11 | - | 1640 | 4.93* | 185K | 11 | - | 1711 | 4.45* | 185K | 11 | - | 1781 | 711 | 190 |
| | | | | 1 | | | 345D | 45 | 1.5 | 2006 | | 315E | 44 | 1.5 | 2014 | | 335E | 44 | 1.5 | 2127 | | 345E | 44 | 1.5 | 2218 | 711 | |
| | 18 | 2# 9 | 1# 9 | 1 | 3# 9 | 3.03 | 123K | 14 | - | 630 | 2.70 | 123K | 13 | - | 661 | 2.43 | 133K | 13 | - | 698 | 2.19 | 133K | 13 | - | 729 | 350 | 270 |
| | | | | 1 | | | 215H | 54 | 1.7 | 1021 | | 225H | 54 | 1.7 | 1074 | | 234H | 54 | 1.7 | 938 | | 244H | 53 | 1.7 | 982 | 350 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 4.16 | 144K | 14 | - | 930 | 3.71 | 154K | 13 | - | 983 | 3.33 | 153K | 13 | - | 956 | 3.01* | 153K | 13 | - | 1000 | 437 | 243 |
| | | | | 1 | | | 215H | 54 | 1.7 | 1246 | | 225H | 54 | 1.7 | 1311 | | 235H | 54 | 1.7 | 1376 | | 245H | 53 | 1.7 | 1441 | 526 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 6.27 | 175HdK | 14 | - | 1560 | 5.59* | 175K | 13 | - | 1631 | 5.02* | 175K | 13 | - | 1701 | 4.53* | 185K | 13 | - | 1788 | 724 | 183 |
| | | | | 1 | | | 345D | 54 | 1.7 | 2030 | | 315E | 54 | 1.7 | 2036 | | 335E | 54 | 1.7 | 2150 | | 345E | 53 | 1.7 | 2242 | 724 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 6.89 | 175HfK | 14 | - | 1736 | 6.15* | 185HeK | 13 | - | 1832 | 5.52* | 195HdK | 13 | - | 1927 | 4.98* | 185K | 13 | - | 1991 | 724 | 165 |
| | | | | 1 | | | 345D | 54 | 1.7 | 2206 | | 365D | 54 | 1.7 | 2329 | | 385D | 54 | 1.7 | 2452 | | 345E | 53 | 1.7 | 2445 | 907 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3#10 | 3.35 | 123K | 16 | - | 694 | 2.99 | 123K | 16 | - | 729 | 2.69 | 133K | 16 | - | 768 | 2.42 | 133K | 16 | - | 803 | 352 | 240 |
| | | | | 1 | | | 195I | 64 | 1.9 | 1054 | | 205I | 64 | 1.9 | 1111 | | 215I | 64 | 1.9 | 1168 | | 225I | 63 | 1.9 | 1225 | 440 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 4.60 | 144K | 16 | - | 1034 | 4.10 | 154K | 16 | - | 1093 | 3.68 | 153K | 16 | - | 1071 | 3.32* | 153K | 16 | - | 1120 | 531 | 219 |
| | | | | 1 | | | 265F | 64 | 1.9 | 1473 | | 275F | 64 | 1.9 | 1545 | | 295F | 64 | 1.9 | 1638 | | 225I | 63 | 1.8 | 1532 | 531 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 6.35 | 165HcK | 16 | - | 1550 | 5.67* | 165K | 16 | - | 1621 | 5.09* | 175K | 16 | - | 1707 | 4.59* | 175K | 16 | - | 1778 | 734 | 177 |
| | | | | 1 | | | 345D | 64 | 1.9 | 2053 | | 315E | 64 | 1.9 | 2057 | | 335E | 63 | 1.9 | 2173 | | 305F | 63 | 1.8 | 2177 | 734 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 8.12 | 195FiK | 16 | - | 2005 | 7.24* | 195GhK | 16 | - | 2099 | 6.50* | 205GgK | 16 | - | 2207 | 5.87* | 205HeK | 16 | - | 2301 | 938 | 146 |
| | | | | 1 | | | 415C | 64 | 1.9 | 2617 | | 435C | 64 | 1.9 | 2755 | | 385D | 63 | 1.9 | 2737 | | 405D | 63 | 1.8 | 2874 | 938 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

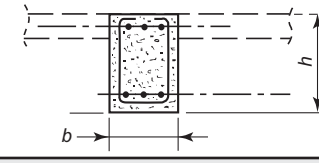
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

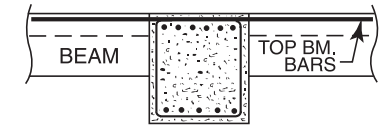
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 32 ft | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ | $b$ | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 32 | 16 | 2#10 | | 1 | 3# 9 | 3.43 | 123M | 12 | - | 562 | 3.04 | 123M | 12 | - | 591 | 2.71 | 123M | 12 | - | 621 | 2.43 | 123M | 12 | - | 650 | 319 | 251 |
| | | | | 1 | | | 195H | 50 | 1.7 | 909 | | 215H | 49 | 1.7 | 982 | | 225H | 49 | 1.7 | 1032 | | 235H | 49 | 1.6 | 1083 | 375 | |
| | | 2#11 | | 1 | 3#11 | 4.16 | 134M | 12 | - | 824 | 3.68 | 133M | 12 | - | 802 | 3.29 | 133M | 12 | - | 841 | 2.95 | 143M | 12 | - | 886 | 387 | 222 |
| | | | | 1 | | | 195H | 50 | 1.7 | 1104 | | 215H | 49 | 1.7 | 1187 | | 225H | 49 | 1.7 | 1248 | | 235H | 49 | 1.6 | 1309 | 562 | |
| | | 2#11 | 2#11 | 1 | 3#14 | 7.54 | 165HfM | 12 | - | 1410 | 6.68 | 165IeM | 12 | - | 1476 | 5.96 | 175IdM | 12 | - | 1559 | 5.35* | 175IcM | 12 | - | 1625 | 725 | 165 |
| | | | | 1 | | | 325D | 50 | 1.7 | 1846 | | 345D | 49 | 1.7 | 1956 | | 315E | 49 | 1.6 | 1958 | | 335E | 49 | 1.6 | 2068 | 772 | |
| | | 2#14 | 1#14 | 1 | 5#11 | 8.18 | 175GhM | 12 | - | 1564 | 7.25 | 175HgM | 12 | - | 1639 | 6.46* | 175IfM | 12 | - | 1714 | 5.80* | 185IeM | 12 | - | 1805 | 772 | 160 |
| | | | | 2 | | | 385C | 50 | 1.7 | 2114 | | 345D | 49 | 1.7 | 2103 | | 365D | 49 | 1.6 | 2221 | | 385D | 49 | 1.6 | 2339 | 837 | |
| | 18 | 2# 9 | 1# 9 | 1 | 3#10 | 4.06 | 123M | 15 | - | 661 | 3.59 | 123M | 15 | - | 696 | 3.20 | 123M | 15 | - | 730 | 2.88 | 133M | 15 | - | 770 | 377 | 218 |
| | | | | 1 | | | 185I | 61 | 1.9 | 998 | | 195I | 60 | 1.9 | 1054 | | 205I | 60 | 1.8 | 1111 | | 215I | 59 | 1.8 | 1168 | 471 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 5.55 | 135M | 15 | - | 1056 | 4.92 | 144M | 15 | - | 1038 | 4.39 | 144M | 15 | - | 1087 | 3.94 | 154M | 15 | - | 1146 | 568 | 194 |
| | | | | 1 | | | 245F | 60 | 1.9 | 1380 | | 265F | 60 | 1.8 | 1473 | | 275F | 59 | 1.8 | 1545 | | 295F | 59 | 1.8 | 1638 | 568 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 7.67 | 155IeM | 15 | - | 1469 | 6.79 | 165IdM | 15 | - | 1556 | 6.06 | 165IcM | 15 | - | 1626 | 5.44 | 165M | 15 | - | 1697 | 785 | 155 |
| | | | | 1 | | | 325D | 60 | 1.9 | 1938 | | 345D | 60 | 1.8 | 2053 | | 315E | 59 | 1.8 | 2057 | | 335E | 59 | 1.8 | 2173 | 785 | |
| | | 3#11 | 2#11 | 1 | 4#14 | 9.60 | 285E | 15 | - | 1952 | 8.51 | 195FjM | 15 | - | 1893 | 7.59* | 195GiM | 15 | - | 1979 | 6.81* | 195GhM | 15 | - | 2065 | 894 | 133 |
| | | | | 1 | | | 485B | 60 | 1.9 | 2568 | | 415C | 60 | 1.8 | 2498 | | 435C | 59 | 1.8 | 2629 | | 385D | 59 | 1.8 | 2604 | 1002 | |
| | 20 | 2#10 | 1#10 | 1 | 3#10 | 4.64 | 124M | 18 | - | 808 | 4.11 | 124M | 18 | - | 847 | 3.66 | 134M | 18 | - | 898 | 3.29 | 134M | 18 | - | 937 | 474 | 198 |
| | | | | 1 | | | 245F | 72 | 2.0 | 1233 | | 195I | 71 | 2.0 | 1158 | | 205I | 71 | 2.0 | 1221 | | 215I | 70 | 2.0 | 1284 | 474 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 5.60 | 134M | 18 | - | 981 | 4.96 | 134M | 18 | - | 1030 | 4.42 | 144M | 18 | - | 1090 | 3.97 | 144M | 18 | - | 1139 | 573 | 185 |
| | | | | 1 | | | 245F | 72 | 2.0 | 1396 | | 265F | 71 | 2.0 | 1491 | | 275F | 71 | 2.0 | 1563 | | 295F | 70 | 2.0 | 1658 | 573 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 8.54 | 165HfM | 18 | - | 1658 | 7.57 | 175HfM | 18 | - | 1754 | 6.75 | 175IeM | 18 | - | 1834 | 6.06 | 175IdM | 18 | - | 1914 | 795 | 135 |
| | | | | 1 | | | 385C | 72 | 2.0 | 2266 | | 345D | 71 | 2.0 | 2254 | | 365D | 71 | 2.0 | 2379 | | 385D | 70 | 2.0 | 2505 | 1019 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 9.96 | 205EIM | 18 | - | 1942 | 8.82 | 195FjM | 18 | - | 2019 | 7.87 | 195GiM | 18 | - | 2112 | 7.06* | 195GhM | 18 | - | 2205 | 1019 | 123 |
| | | | | 1 | | | 385C | 72 | 2.0 | 2484 | | 415C | 71 | 2.0 | 2646 | | 435C | 71 | 2.0 | 2785 | | 465C | 70 | 2.0 | 2947 | 1019 | |
| | 24 | 2#10 | 1#10 | 1 | 4#10 | 5.15 | 123M | 24 | - | 901 | 4.56 | 123M | 24 | - | 945 | 4.07 | 123M | 24 | - | 990 | 3.65 | 123M | 23 | - | 1035 | 479 | 161 |
| | | | | 1 | | | 225G | 96 | 2.4 | 1635 | | 175J | 95 | 2.4 | 1484 | | 185J | 94 | 2.4 | 1568 | | 235H | 94 | 2.4 | 1808 | 628 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 6.24 | 133M | 24 | - | 1097 | 5.53 | 133M | 24 | - | 1152 | 4.93 | 133M | 24 | - | 1208 | 4.42 | 143M | 23 | - | 1273 | 580 | 154 |
| | | | | 1 | | | 225G | 96 | 2.4 | 1820 | | 235G | 95 | 2.4 | 1915 | | 245G | 94 | 2.4 | 2009 | | 265G | 94 | 2.4 | 2143 | 758 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 10.22 | 145M | 24 | - | 2060 | 9.05 | 155M | 24 | - | 2185 | 8.08 | 165M | 24 | - | 2310 | 7.25 | 164M | 23 | - | 2214 | 1046 | 116 |
| | | | | 1 | | | 285E | 96 | 2.4 | 2707 | | 295E | 95 | 2.4 | 2839 | | 275F | 94 | 2.4 | 2854 | | 295F | 94 | 2.4 | 3025 | 1046 | |
| | | 3#14 | 2#14 | 1 | 5#14 | 12.37 | 155IdM | 24 | - | 2512 | 10.96 | 165IcM | 24 | - | 2661 | 9.77 | 165M | 24 | - | 2778 | 8.77* | 175M | 23 | - | 2928 | 1266 | 100 |
| | | | | 1 | | | 325D | 96 | 2.4 | 3284 | | 345D | 95 | 2.4 | 3479 | | 365D | 94 | 2.4 | 3675 | | 335E | 94 | 2.4 | 3675 | 1266 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

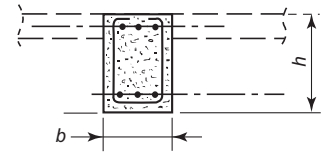
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

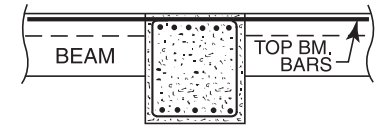
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 40 ft | | | | | SPAN, $\ell_n$ = 42 ft. | | | | | SPAN, $\ell_n$ = 44 ft. | | | | | SPAN, $\ell_n$ = 46 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 32 | 16 | 2#10 | | 1 | 3# 9 | 2.20 | 123M | 12 | - | 679 | 1.99 | 123M | 12 | - | 708 | 1.82 | 133M | 12 | - | 742 | 1.66 | 133M | 12 | - | 771 | 319 | 251 |
| | | | | 1 | | | 244H | 48 | 1.6 | 936 | | 254H | 48 | 1.6 | 978 | | 334F | 48 | 1.6 | 1114 | | 354F | 48 | 1.6 | 1169 | 375 | |
| | | 2#11 | | 1 | 3#11 | 2.66 | 143M | 12 | - | 926 | 2.41 | 143M | 12 | - | 966 | 2.20 | 143M | 12 | - | 1006 | 2.01 | 153M | 12 | - | 1051 | 387 | 222 |
| | | | | 1 | | | 245H | 48 | 1.6 | 1371 | | 255H | 48 | 1.6 | 1432 | | 275H | 48 | 1.6 | 1515 | | 285H | 48 | 1.6 | 1577 | 562 | |
| | | 2#11 | 2#11 | 1 | 3#14 | 4.83* | 175M | 12 | - | 1692 | 4.38* | 185M | 12 | - | 1775 | 3.99* | 185M | 12 | - | 1841 | 3.65* | 195M | 12 | - | 1924 | 725 | 165 |
| | | | | 1 | | | 345E | 48 | 1.6 | 2156 | | 365E | 48 | 1.6 | 2266 | | 385E | 48 | 1.6 | 2375 | | 405E | 48 | 1.6 | 2485 | 772 | |
| | | 2#14 | 1#14 | 1 | 5#11 | 5.24* | 185ldM | 12 | - | 1880 | 4.75* | 195lcM | 12 | - | 1971 | 4.33* | 195M | 12 | - | 2046 | 3.96* | 195M | 12 | - | 2121 | 772 | 160 |
| | | | | 2 | | | 345E | 48 | 1.6 | 2328 | | 365E | 48 | 1.6 | 2446 | | 385E | 48 | 1.6 | 2564 | | 405E | 48 | 1.6 | 2682 | 837 | |
| | 18 | 2# 9 | 1# 9 | 1 | 3#10 | 2.60 | 133M | 15 | - | 805 | 2.35 | 133M | 15 | - | 839 | 2.15 | 133M | 15 | - | 874 | 1.96 | 133M | 14 | - | 909 | 377 | 218 |
| | | | | 1 | | | 225I | 59 | 1.8 | 1225 | | 235I | 58 | 1.8 | 1282 | | 245I | 58 | 1.8 | 1339 | | 255I | 58 | 1.8 | 1396 | 471 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 3.55 | 154M | 15 | - | 1195 | 3.22 | 153M | 15 | - | 1171 | 2.94* | 163M | 15 | - | 1226 | 2.69* | 163M | 14 | - | 1275 | 568 | 194 |
| | | | | 1 | | | 305F | 59 | 1.8 | 1710 | | 235I | 58 | 1.8 | 1603 | | 245I | 58 | 1.8 | 1674 | | 255I | 58 | 1.8 | 1746 | 568 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 4.91* | 175M | 15 | - | 1784 | 4.45* | 175M | 15 | - | 1855 | 4.05* | 185M | 15 | - | 1942 | 3.71* | 185M | 14 | - | 2012 | 785 | 155 |
| | | | | 1 | | | 345E | 59 | 1.8 | 2266 | | 325F | 58 | 1.8 | 2292 | | 335F | 58 | 1.8 | 2385 | | 355F | 58 | 1.8 | 2500 | 785 | |
| | | 3#11 | 2#11 | 1 | 4#14 | 6.15* | 195HgM | 15 | - | 2152 | 5.58* | 195leM | 15 | - | 2238 | 5.08* | 205leM | 15 | - | 2340 | 4.65* | 205ldM | 14 | - | 2426 | 894 | 133 |
| | | | | 1 | | | 405D | 59 | 1.8 | 2734 | | 425D | 58 | 1.8 | 2865 | | 445D | 58 | 1.8 | 2996 | | 405E | 58 | 1.8 | 2993 | 1002 | |
| | 20 | 2#10 | 1#10 | 1 | 3#10 | 2.97 | 134M | 17 | - | 977 | 2.69 | 134M | 17 | - | 1017 | 2.45 | 134M | 17 | - | 1057 | 2.24 | 134M | 17 | - | 1097 | 474 | 198 |
| | | | | 1 | | | 225I | 70 | 2.0 | 1346 | | 235I | 69 | 2.0 | 1409 | | 245I | 69 | 2.0 | 1472 | | 255I | 69 | 2.0 | 1535 | 474 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 3.58 | 144M | 17 | - | 1188 | 3.25 | 154M | 17 | - | 1248 | 2.96* | 154M | 17 | - | 1297 | 2.71* | 154M | 17 | - | 1346 | 573 | 185 |
| | | | | 1 | | | 225I | 70 | 2.0 | 1547 | | 235I | 69 | 2.0 | 1619 | | 245I | 69 | 2.0 | 1691 | | 255I | 69 | 2.0 | 1763 | 573 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 5.47* | 175M | 17 | - | 1993 | 4.96* | 175M | 17 | - | 2073 | 4.52* | 185M | 17 | - | 2169 | 4.13* | 185M | 17 | - | 2249 | 795 | 135 |
| | | | | 1 | | | 345E | 70 | 2.0 | 2493 | | 365E | 69 | 2.0 | 2618 | | 385E | 69 | 2.0 | 2744 | | 355F | 69 | 1.9 | 2755 | 1019 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 6.37* | 195HgM | 17 | - | 2298 | 5.78* | 195leM | 17 | - | 2391 | 5.27* | 195ldM | 17 | - | 2484 | 4.82* | 205ldM | 17 | - | 2594 | 1019 | 123 |
| | | | | 1 | | | 405D | 70 | 2.0 | 2902 | | 425D | 69 | 2.0 | 3041 | | 445D | 69 | 2.0 | 3180 | | 405E | 69 | 1.9 | 3181 | 1019 | |
| | 24 | 2#10 | 1#10 | 1 | 4#10 | 3.30 | 123M | 23 | - | 1080 | 2.99 | 123M | 23 | - | 1125 | 2.72 | 133M | 23 | - | 1180 | 2.49 | 133M | 23 | - | 1225 | 479 | 161 |
| | | | | 1 | | | 245H | 93 | 2.4 | 1892 | | 255H | 93 | 2.3 | 1976 | | 275H | 92 | 2.3 | 2099 | | 285H | 92 | 2.3 | 2183 | 628 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 3.99 | 143M | 23 | - | 1329 | 3.62 | 143M | 23 | - | 1384 | 3.30 | 143M | 23 | - | 1439 | 3.02 | 153M | 23 | - | 1505 | 580 | 154 |
| | | | | 1 | | | 205J | 93 | 2.3 | 1964 | | 215J | 93 | 2.3 | 2058 | | 225J | 92 | 2.3 | 2153 | | 285H | 92 | 2.3 | 2443 | 758 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 6.54* | 174M | 23 | - | 2327 | 5.93* | 174M | 23 | - | 2420 | 5.41* | 184M | 23 | - | 2534 | 4.95* | 184M | 23 | - | 2627 | 1046 | 116 |
| | | | | 1 | | | 305F | 93 | 2.3 | 3157 | | 325F | 93 | 2.3 | 3329 | | 305G | 92 | 2.3 | 3344 | | 315G | 92 | 2.3 | 3476 | 1046 | |
| | | 3#14 | 2#14 | 1 | 5#14 | 7.92* | 175M | 23 | - | 3045 | 7.18* | 185M | 23 | - | 3194 | 6.54* | 195M | 23 | - | 3344 | 5.99* | 195M | 23 | - | 3461 | 1266 | 100 |
| | | | | 1 | | | 345E | 93 | 2.3 | 3831 | | 365E | 93 | 2.3 | 4027 | | 335F | 92 | 2.3 | 4027 | | 355F | 92 | 2.3 | 4222 | 1266 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

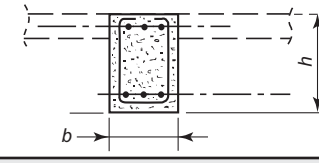
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

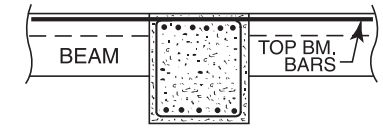
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 32 ft | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 34 | 16 | 2#11 | | 1 | 3# 9 | 3.93 | 113N | 14 | - | 627 | 3.48 | 123N | 13 | - | 665 | 3.10 | 123N | 13 | - | 698 | 2.78 | 123N | 13 | - | 731 | 415 | 205 |
| | | | | 1 | | | 185I | 55 | 1.8 | 967 | | 195I | 54 | 1.8 | 1023 | | 205I | 54 | 1.8 | 1078 | | 215I | 53 | 1.8 | 1133 | 402 | |
| | | 2#14 | | 1 | 3#11 | 5.91 | 135N | 14 | - | 1063 | 5.23 | 135N | 13 | - | 1112 | 4.67 | 144N | 13 | - | 1093 | 4.19 | 144N | 13 | - | 1142 | 580 | 178 |
| | | | | 1 | | | 245F | 54 | 1.8 | 1382 | | 265F | 54 | 1.8 | 1476 | | 275F | 54 | 1.8 | 1547 | | 295F | 53 | 1.7 | 1641 | 604 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 8.14 | 155HgN | 14 | - | 1474 | 7.21 | 165IfN | 13 | - | 1561 | 6.43 | 165JeN | 13 | - | 1632 | 5.77 | 165JdN | 13 | - | 1703 | 833 | 138 |
| | | | | 1 | | | 325D | 54 | 1.8 | 1938 | | 345D | 54 | 1.8 | 2053 | | 315E | 54 | 1.8 | 2057 | | 335E | 53 | 1.7 | 2173 | 833 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 8.95 | 175GiN | 14 | - | 1675 | 7.93 | 185GiN | 13 | - | 1771 | 7.07 | 175HgN | 13 | - | 1834 | 6.35* | 175IfN | 13 | - | 1914 | 833 | 134 |
| | | | | 2 | | | 385C | 54 | 1.8 | 2239 | | 345D | 54 | 1.8 | 2230 | | 365D | 54 | 1.8 | 2354 | | 385D | 53 | 1.7 | 2478 | 992 | |
| | 18 | 2# 9 | 1# 9 | 1 | 3#10 | 4.35 | 114N | 17 | - | 714 | 3.85 | 114N | 16 | - | 749 | 3.43 | 124N | 16 | - | 794 | 3.08 | 124N | 16 | - | 829 | 404 | 181 |
| | | | | 1 | | | 185I | 66 | 2.0 | 1010 | | 195I | 66 | 2.0 | 1068 | | 205I | 65 | 2.0 | 1125 | | 215I | 65 | 2.0 | 1183 | 505 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 5.96 | 135N | 17 | - | 1065 | 5.28 | 134N | 16 | - | 1033 | 4.71 | 134N | 16 | - | 1082 | 4.23 | 144N | 16 | - | 1142 | 610 | 166 |
| | | | | 1 | | | 245F | 66 | 2.0 | 1396 | | 265F | 66 | 2.0 | 1491 | | 275F | 65 | 2.0 | 1563 | | 295F | 65 | 1.9 | 1658 | 610 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 8.26 | 155IfN | 17 | - | 1479 | 7.32 | 155JeN | 16 | - | 1550 | 6.53 | 155JdN | 16 | - | 1621 | 5.86 | 165JcN | 16 | - | 1708 | 845 | 133 |
| | | | | 1 | | | 325D | 66 | 2.0 | 1960 | | 345D | 66 | 2.0 | 2077 | | 315E | 65 | 2.0 | 2079 | | 335E | 65 | 1.9 | 2196 | 845 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 10.58 | 285E | 17 | - | 2084 | 9.37 | 205FIN | 16 | - | 2042 | 8.36 | 205FkN | 16 | - | 2135 | 7.50 | 205GjN | 16 | - | 2228 | 1083 | 109 |
| | | | | 1 | | | 485B | 66 | 2.0 | 2713 | | 415C | 66 | 2.0 | 2646 | | 435C | 65 | 2.0 | 2785 | | 465C | 65 | 1.9 | 2947 | 1083 | |
| | 20 | 2#10 | 1#10 | 1 | 3#10 | 4.97 | 114N | 20 | - | 802 | 4.40 | 124N | 20 | - | 853 | 3.93 | 124N | 19 | - | 893 | 3.52 | 124N | 19 | - | 932 | 508 | 165 |
| | | | | 1 | | | 225G | 79 | 2.2 | 1202 | | 235G | 78 | 2.2 | 1266 | | 245G | 77 | 2.1 | 1329 | | 195J | 77 | 2.1 | 1251 | 508 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 6.01 | 124N | 20 | - | 976 | 5.33 | 134N | 20 | - | 1036 | 4.75 | 134N | 19 | - | 1085 | 4.26 | 134N | 19 | - | 1135 | 615 | 157 |
| | | | | 1 | | | 245F | 79 | 2.2 | 1413 | | 235G | 78 | 2.2 | 1438 | | 245G | 77 | 2.1 | 1511 | | 265G | 77 | 2.1 | 1608 | 615 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 9.19 | 155HgN | 20 | - | 1652 | 8.14 | 165IfN | 20 | - | 1749 | 7.26 | 165JeN | 19 | - | 1829 | 6.52 | 165JdN | 19 | - | 1908 | 855 | 116 |
| | | | | 1 | | | 385C | 79 | 2.2 | 2292 | | 345D | 78 | 2.2 | 2277 | | 365D | 77 | 2.1 | 2404 | | 385D | 77 | 2.1 | 2531 | 1100 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 11.83 | 315BiE | 20 | - | 2313 | 10.48 | 295E | 20 | - | 2381 | 9.34 | 225EnN | 19 | - | 2362 | 8.39 | 215FIN | 19 | - | 2447 | 1100 | 98 |
| | | | | 1 | | | 485B | 79 | 2.2 | 2914 | | 515B | 78 | 2.2 | 3087 | | 435C | 77 | 2.1 | 3000 | | 465C | 77 | 2.1 | 3173 | 1325 | |
| | 24 | 2#11 | 1#11 | 1 | 4#10 | 6.59 | 123N | 26 | - | 1002 | 5.83 | 123N | 26 | - | 1053 | 5.20 | 123N | 26 | - | 1103 | 4.67 | 133N | 26 | - | 1165 | 622 | 139 |
| | | | | 1 | | | 225G | 106 | 2.6 | 1761 | | 235G | 105 | 2.6 | 1852 | | 245G | 104 | 2.5 | 1943 | | 265G | 103 | 2.5 | 2075 | 674 | |
| | | 2#14 | 1#14 | 1 | 4#11 | 7.95 | 134N | 26 | - | 1455 | 7.04 | 134N | 26 | - | 1524 | 6.28 | 134N | 26 | - | 1593 | 5.64 | 143N | 26 | - | 1542 | 870 | 121 |
| | | | | 1 | | | 225G | 106 | 2.6 | 2072 | | 235G | 105 | 2.6 | 2181 | | 245G | 104 | 2.5 | 2290 | | 265G | 103 | 2.5 | 2440 | 814 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 11.01 | 135N | 26 | - | 2046 | 9.76 | 145N | 26 | - | 2172 | 8.70 | 155N | 26 | - | 2299 | 7.81 | 155N | 26 | - | 2392 | 1127 | 100 |
| | | | | 1 | | | 285E | 106 | 2.6 | 2746 | | 295E | 105 | 2.6 | 2879 | | 315E | 104 | 2.5 | 3054 | | 295F | 103 | 2.5 | 3066 | 1127 | |
| | | 3#14 | 2#14 | 1 | 5#14 | 13.36 | 145JeN | 26 | - | 2499 | 11.83 | 155JdN | 26 | - | 2650 | 10.55 | 155JcN | 26 | - | 2767 | 9.47 | 165N | 26 | - | 2918 | 1367 | 86 |
| | | | | 1 | | | 325D | 106 | 2.6 | 3328 | | 345D | 105 | 2.6 | 3526 | | 365D | 104 | 2.5 | 3725 | | 335E | 103 | 2.5 | 3720 | 1367 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

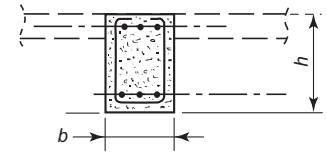
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

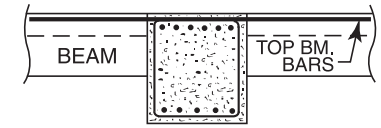
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 40 ft | | | | | SPAN, $\ell_n$ = 42 ft. | | | | | SPAN, $\ell_n$ = 44 ft. | | | | | SPAN, $\ell_n$ = 46 ft. | | | | | | |
| $h$ in. | $b$ in. | BOTTOM $\ell_n$ + 12 in. | BOTTOM 0.875 $\ell_n$ | Layers (2) | TOP | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 34 | 16 | 2#11 | | 1 | 3# 9 | 2.51 | 123N | 13 | - | 765 | 2.28 | 123N | 13 | - | 798 | 2.08 | 123N | 13 | - | 831 | 1.90 | 133N | 13 | - | 870 | 415 | 205 |
| | | | | 1 | | | 225I | 53 | 1.8 | 1189 | | 235I | 52 | 1.7 | 1244 | | 245I | 52 | 1.7 | 1300 | | 255I | 52 | 1.7 | 1355 | 402 | |
| | | 2#14 | | 1 | 3#11 | 3.78 | 154N | 13 | - | 1202 | 3.43 | 154N | 13 | - | 1251 | 3.12* | 164N | 13 | - | 1310 | 2.86* | 164N | 13 | - | 1360 | 580 | 178 |
| | | | | 1 | | | 305F | 53 | 1.7 | 1713 | | 325F | 52 | 1.7 | 1806 | | 245I | 52 | 1.7 | 1678 | | 255I | 52 | 1.7 | 1749 | 604 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 5.21 | 175JcN | 13 | - | 1790 | 4.72* | 175N | 13 | - | 1861 | 4.30* | 175N | 13 | - | 1931 | 3.94* | 185N | 13 | - | 2019 | 833 | 138 |
| | | | | 1 | | | 345E | 53 | 1.7 | 2266 | | 325F | 52 | 1.7 | 2292 | | 335F | 52 | 1.7 | 2385 | | 355F | 52 | 1.7 | 2500 | 833 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 5.73* | 175JeN | 13 | - | 1993 | 5.20* | 185JdN | 13 | - | 2089 | 4.73* | 185JcN | 13 | - | 2169 | 4.33* | 185N | 13 | - | 2249 | 833 | 134 |
| | | | | 2 | | | 345E | 53 | 1.7 | 2469 | | 365E | 52 | 1.7 | 2593 | | 385E | 52 | 1.7 | 2717 | | 405E | 52 | 1.7 | 2842 | 992 | |
| | 18 | 2# 9 | 1# 9 | 1 | 3#10 | 2.78 | 124N | 16 | - | 863 | 2.52 | 124N | 16 | - | 898 | 2.30 | 124N | 16 | - | 933 | 2.10 | 124N | 16 | - | 967 | 404 | 181 |
| | | | | 1 | | | 225I | 64 | 1.9 | 1240 | | 235I | 64 | 1.9 | 1298 | | 245I | 64 | 1.9 | 1355 | | 255I | 63 | 1.9 | 1413 | 505 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 3.82 | 144N | 16 | - | 1191 | 3.46 | 154N | 16 | - | 1251 | 3.15 | 154N | 16 | - | 1300 | 2.89* | 154N | 16 | - | 1349 | 610 | 166 |
| | | | | 1 | | | 305F | 64 | 1.9 | 1730 | | 235I | 64 | 1.9 | 1619 | | 245I | 63 | 1.9 | 1691 | | 255I | 63 | 1.9 | 1763 | 610 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 5.29 | 165N | 16 | - | 1779 | 4.79* | 165N | 16 | - | 1850 | 4.37* | 175N | 16 | - | 1937 | 4.00* | 175N | 16 | - | 2008 | 845 | 133 |
| | | | | 1 | | | 345E | 64 | 1.9 | 2289 | | 325F | 64 | 1.9 | 2314 | | 335F | 63 | 1.9 | 2408 | | 355F | 63 | 1.9 | 2525 | 845 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 6.77* | 195HhN | 16 | - | 2304 | 6.14* | 205HhN | 16 | - | 2414 | 5.59* | 195IfN | 16 | - | 2491 | 5.12* | 195JeN | 16 | - | 2584 | 1083 | 109 |
| | | | | 1 | | | 405D | 64 | 1.9 | 2902 | | 425D | 64 | 1.9 | 3041 | | 445D | 63 | 1.9 | 3180 | | 465D | 63 | 1.9 | 3319 | 1083 | |
| | 20 | 2#10 | 1#10 | 1 | 3#10 | 3.18 | 124N | 19 | - | 972 | 2.89 | 124N | 19 | - | 1012 | 2.63 | 134N | 19 | - | 1063 | 2.41 | 134N | 19 | - | 1103 | 508 | 165 |
| | | | | 1 | | | 205J | 76 | 2.1 | 1314 | | 215J | 76 | 2.1 | 1378 | | 225J | 75 | 2.1 | 1441 | | 235J | 75 | 2.1 | 1505 | 508 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 3.85 | 144N | 19 | - | 1195 | 3.49 | 144N | 19 | - | 1244 | 3.18 | 144N | 19 | - | 1293 | 2.91 | 144N | 19 | - | 1342 | 615 | 157 |
| | | | | 1 | | | 275G | 76 | 2.1 | 1680 | | 285G | 76 | 2.1 | 1753 | | 225J | 75 | 2.1 | 1660 | | 235J | 75 | 2.1 | 1733 | 615 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 5.88 | 165JcN | 19 | - | 1988 | 5.34 | 165N | 19 | - | 2068 | 4.86* | 175N | 19 | - | 2164 | 4.45* | 175N | 19 | - | 2244 | 855 | 116 |
| | | | | 1 | | | 345E | 76 | 2.1 | 2516 | | 365E | 76 | 2.1 | 2643 | | 385E | 75 | 2.1 | 2770 | | 355F | 75 | 2.1 | 2779 | 1100 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 7.57* | 205GjN | 19 | - | 2532 | 6.87* | 215GjN | 19 | - | 2651 | 6.26* | 205HhN | 19 | - | 2736 | 5.72* | 205IgN | 19 | - | 2838 | 1100 | 98 |
| | | | | 1 | | | 485C | 76 | 2.1 | 3322 | | 505C | 76 | 2.1 | 3472 | | 445D | 75 | 2.1 | 3432 | | 465D | 75 | 2.1 | 3581 | 1325 | |
| | 24 | 2#11 | 1#11 | 1 | 4#10 | 4.21 | 133N | 26 | - | 1216 | 3.82 | 133N | 25 | - | 1266 | 3.48 | 133N | 25 | - | 1317 | 3.19 | 143N | 25 | - | 1379 | 622 | 139 |
| | | | | 1 | | | 275G | 102 | 2.5 | 2166 | | 215J | 102 | 2.5 | 1973 | | 225J | 101 | 2.5 | 2065 | | 235J | 101 | 2.5 | 2156 | 674 | |
| | | 2#14 | 1#14 | 1 | 4#11 | 5.09 | 143N | 26 | - | 1610 | 4.62 | 153N | 25 | - | 1690 | 4.21 | 153N | 25 | - | 1759 | 3.85 | 153N | 25 | - | 1828 | 870 | 121 |
| | | | | 1 | | | 275G | 102 | 2.5 | 2550 | | 285G | 102 | 2.5 | 2659 | | 305G | 101 | 2.5 | 2809 | | 315G | 101 | 2.5 | 2918 | 814 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 7.05 | 164N | 26 | - | 2322 | 6.39* | 164N | 25 | - | 2415 | 5.82* | 174N | 25 | - | 2529 | 5.33* | 174N | 25 | - | 2622 | 1127 | 100 |
| | | | | 1 | | | 305F | 102 | 2.5 | 3199 | | 325F | 102 | 2.5 | 3373 | | 305G | 101 | 2.5 | 3385 | | 315G | 101 | 2.5 | 3519 | 1127 | |
| | | 3#14 | 2#14 | 1 | 5#14 | 8.55* | 165N | 26 | - | 3035 | 7.75* | 175N | 25 | - | 3186 | 7.06* | 185N | 25 | - | 3337 | 6.46* | 185N | 25 | - | 3454 | 1367 | 86 |
| | | | | 1 | | | 345E | 102 | 2.5 | 3878 | | 365E | 102 | 2.5 | 4077 | | 385E | 101 | 2.5 | 4275 | | 355F | 101 | 2.5 | 4271 | 1367 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

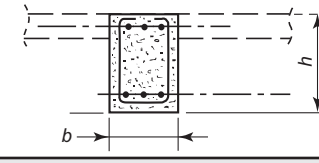
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

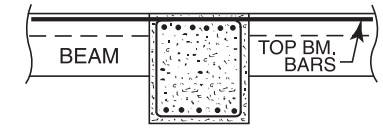
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 36 ft | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | SPAN, $\ell_n$ = 40 ft. | | | | | SPAN, $\ell_n$ = 42 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 36 | 16 | 2#11 | | 1 | 3#10 | 3.76 | 123O | 15 | - | 767 | 3.38 | 123O | 14 | - | 804 | 3.05 | 123O | 14 | - | 840 | 2.76 | 133O | 14 | - | 882 | 443 | 171 |
| | | | | 1 | | | 205I | 58 | 1.9 | 1158 | | 215I | 58 | 1.9 | 1217 | | 225I | 57 | 1.9 | 1276 | | 235I | 57 | 1.9 | 1336 | 536 | |
| | | 2#14 | | 1 | 3#11 | 4.99 | 135O | 15 | - | 1170 | 4.48 | 144O | 14 | - | 1148 | 4.04 | 144O | 14 | - | 1198 | 3.67 | 144O | 14 | - | 1247 | 621 | 153 |
| | | | | 1 | | | 275F | 58 | 1.9 | 1566 | | 295F | 58 | 1.9 | 1661 | | 305F | 57 | 1.9 | 1733 | | 325F | 57 | 1.8 | 1829 | 646 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 6.90 | 155JeO | 15 | - | 1626 | 6.19 | 155KdO | 14 | - | 1697 | 5.59 | 165KdO | 14 | - | 1784 | 5.07 | 165KcO | 14 | - | 1855 | 893 | 120 |
| | | | | 1 | | | 365D | 58 | 1.9 | 2194 | | 335E | 58 | 1.9 | 2196 | | 345E | 57 | 1.9 | 2289 | | 365E | 57 | 1.8 | 2406 | 893 | |
| | | 3#11 | 2#11 | 2 | 4#14 | 8.28 | 275F | 14 | - | 2137 | 7.43 | 195GkO | 14 | - | 2085 | 6.71* | 195HiO | 14 | - | 2171 | 6.08* | 195HiO | 14 | - | 2258 | 978 | 113 |
| | | | | 2 | | | 435C | 58 | 1.9 | 2659 | | 465C | 57 | 1.9 | 2814 | | 405D | 57 | 1.8 | 2762 | | 425D | 57 | 1.8 | 2894 | 1073 | |
| | 18 | 2#10 | 1#10 | 1 | 3#10 | 4.17 | 124O | 18 | - | 895 | 3.74 | 124O | 18 | - | 935 | 3.38 | 124O | 17 | - | 975 | 3.06 | 134O | 17 | - | 1026 | 540 | 153 |
| | | | | 1 | | | 245G | 71 | 2.1 | 1329 | | 195J | 70 | 2.1 | 1251 | | 205J | 70 | 2.1 | 1314 | | 215J | 69 | 2.1 | 1378 | 540 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 5.04 | 134O | 18 | - | 1088 | 4.52 | 134O | 18 | - | 1138 | 4.08 | 134O | 17 | - | 1187 | 3.70 | 144O | 17 | - | 1247 | 652 | 142 |
| | | | | 1 | | | 245G | 71 | 2.1 | 1511 | | 265G | 70 | 2.1 | 1608 | | 275G | 70 | 2.1 | 1680 | | 285G | 69 | 2.0 | 1753 | 652 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 7.69 | 165IgO | 18 | - | 1834 | 6.91 | 165JfO | 18 | - | 1914 | 6.23 | 165KeO | 17 | - | 1993 | 5.65 | 165KdO | 17 | - | 2073 | 906 | 104 |
| | | | | 1 | | | 365D | 71 | 2.1 | 2404 | | 385D | 70 | 2.1 | 2531 | | 345E | 70 | 2.1 | 2516 | | 365E | 69 | 2.0 | 2643 | 1164 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 8.98 | 205FlO | 18 | - | 2149 | 8.06 | 195GjO | 18 | - | 2225 | 7.28 | 195HiO | 17 | - | 2318 | 6.60 | 195HhO | 17 | - | 2411 | 1164 | 95 |
| | | | | 1 | | | 435C | 71 | 2.1 | 2815 | | 465C | 70 | 2.1 | 2979 | | 405D | 70 | 2.1 | 2930 | | 425D | 69 | 2.0 | 3070 | 1164 | |
| | 20 | 2#10 | 1#10 | 1 | 3#11 | 4.61 | 124O | 21 | - | 973 | 4.14 | 124O | 21 | - | 1016 | 3.73 | 124O | 21 | - | 1060 | 3.39 | 124O | 21 | - | 1103 | 543 | 137 |
| | | | | 1 | | | 245G | 85 | 2.3 | 1421 | | 265G | 84 | 2.3 | 1513 | | 275G | 83 | 2.3 | 1581 | | 215J | 83 | 2.2 | 1478 | 657 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 5.58 | 134O | 21 | - | 1267 | 5.01 | 134O | 21 | - | 1325 | 4.52 | 134O | 21 | - | 1382 | 4.10 | 144O | 21 | - | 1451 | 657 | 121 |
| | | | | 1 | | | 275F | 85 | 2.3 | 1777 | | 265G | 84 | 2.3 | 1810 | | 275G | 83 | 2.3 | 1892 | | 285G | 83 | 2.2 | 1973 | 916 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 9.12 | 185GjO | 21 | - | 2120 | 8.18 | 195GjO | 21 | - | 2231 | 7.39 | 185HhO | 21 | - | 2306 | 6.70 | 185IgO | 21 | - | 2399 | 1181 | 92 |
| | | | | 1 | | | 435C | 84 | 2.3 | 2844 | | 465C | 84 | 2.3 | 3011 | | 405D | 83 | 2.3 | 2958 | | 425D | 83 | 2.2 | 3099 | 1181 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 10.03 | 225EoO | 21 | - | 2377 | 9.00 | 215FmO | 21 | - | 2462 | 8.13 | 205GkO | 21 | - | 2546 | 7.37 | 215GkO | 21 | - | 2666 | 1181 | 85 |
| | | | | 1 | | | 435C | 84 | 2.3 | 3030 | | 465C | 84 | 2.3 | 3205 | | 485C | 83 | 2.3 | 3356 | | 505C | 83 | 2.2 | 3506 | 1427 | |
| | 24 | 2#11 | 1#11 | 1 | 4#10 | 5.56 | 123O | 28 | - | 1109 | 4.99 | 123O | 28 | - | 1160 | 4.50 | 123O | 28 | - | 1211 | 4.08 | 133O | 28 | - | 1273 | 664 | 118 |
| | | | | 1 | | | 245G | 114 | 2.7 | 1976 | | 265G | 113 | 2.7 | 2111 | | 275G | 112 | 2.7 | 2203 | | 285G | 111 | 2.6 | 2296 | 720 | |
| | | 2#14 | 1#14 | 1 | 4#11 | 6.72 | 134O | 28 | - | 1605 | 6.03 | 133O | 28 | - | 1537 | 5.44 | 133O | 28 | - | 1606 | 4.93 | 143O | 28 | - | 1686 | 931 | 104 |
| | | | | 1 | | | 245G | 114 | 2.7 | 2324 | | 265G | 113 | 2.7 | 2476 | | 275G | 112 | 2.7 | 2587 | | 285G | 111 | 2.6 | 2698 | 870 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 10.26 | 145O | 28 | - | 2470 | 9.21 | 155O | 28 | - | 2607 | 8.31 | 155O | 28 | - | 2709 | 7.54 | 165O | 28 | - | 2846 | 1208 | 80 |
| | | | | 1 | | | 315E | 114 | 2.7 | 3282 | | 335E | 113 | 2.7 | 3468 | | 345E | 112 | 2.7 | 3612 | | 325F | 111 | 2.6 | 3630 | 1469 | |
| | | 3#14 | 2#14 | 1 | 6#14 | 12.47 | 155JfO | 28 | - | 2974 | 11.19 | 165KeO | 28 | - | 3135 | 10.10 | 165KdO | 28 | - | 3261 | 9.16* | 175KcO | 28 | - | 3422 | 1469 | 69 |
| | | | | 1 | | | 365D | 114 | 2.7 | 3960 | | 385D | 113 | 2.7 | 4170 | | 405D | 112 | 2.7 | 4380 | | 365E | 111 | 2.6 | 4339 | 1712 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

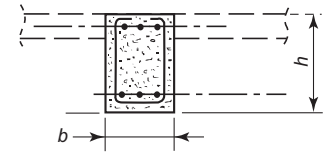
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

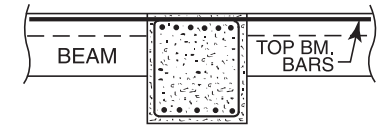
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 44 ft | | | | | SPAN, $\ell_n$ = 46 ft. | | | | | SPAN, $\ell_n$ = 48 ft. | | | | | SPAN, $\ell_n$ = 50 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) $\times 10^{-9}$ |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | in. |
| 36 | 16 | 2#11 | | 1 | 3#10 | 2.52 | 133O | 14 | - | 918 | 2.30 | 133O | 14 | - | 955 | 2.12 | 133O | 14 | - | 991 | 1.95 | 133O | 14 | - | 1027 | 443 | 171 |
| | | | | 1 | | | 245I | 57 | 1.8 | 1395 | | 255I | 56 | 1.8 | 1454 | | 265I | 56 | 1.8 | 1513 | | 285I | 56 | 1.8 | 1596 | 536 | |
| | | 2#14 | | 1 | 3#11 | 3.34 | 154O | 14 | - | 1307 | 3.06 | 154O | 14 | - | 1356 | 2.81* | 153O | 14 | - | 1327 | 2.59* | 163O | 14 | - | 1382 | 621 | 153 |
| | | | | 1 | | | 245I | 57 | 1.8 | 1694 | | 255I | 56 | 1.8 | 1766 | | 265I | 56 | 1.8 | 1838 | | 285I | 56 | 1.8 | 1934 | 646 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 4.62* | 165O | 14 | - | 1926 | 4.22* | 175O | 14 | - | 2014 | 3.88* | 175O | 14 | - | 2085 | 3.58* | 185O | 14 | - | 2173 | 893 | 120 |
| | | | | 1 | | | 335F | 57 | 1.8 | 2408 | | 355F | 56 | 1.8 | 2525 | | 365F | 56 | 1.8 | 2618 | | 385F | 56 | 1.8 | 2735 | 893 | |
| | | 3#11 | 2#11 | 2 | 4#14 | 5.54* | 195lgO | 14 | - | 2344 | 5.07* | 195JfO | 14 | - | 2430 | 4.66* | 195KeO | 14 | - | 2516 | 4.29* | 195KdO | 14 | - | 2602 | 978 | 113 |
| | | | | 2 | | | 445D | 56 | 1.8 | 3026 | | 405E | 56 | 1.8 | 3021 | | 415E | 56 | 1.8 | 3130 | | 435E | 56 | 1.8 | 3262 | 1073 | |
| | 18 | 2#10 | 1#10 | 1 | 3#10 | 2.79 | 134O | 17 | - | 1066 | 2.55 | 134O | 17 | - | 1106 | 2.34 | 134O | 17 | - | 1145 | 2.16 | 134O | 17 | - | 1185 | 540 | 153 |
| | | | | 1 | | | 225J | 69 | 2.0 | 1441 | | 235J | 69 | 2.0 | 1505 | | 245J | 68 | 2.0 | 1568 | | 255J | 68 | 2.0 | 1632 | 540 | |
| | | 2#11 | 1#11 | 1 | 3#11 | 3.37 | 144O | 17 | - | 1296 | 3.09 | 144O | 17 | - | 1345 | 2.83 | 154O | 17 | - | 1406 | 2.61 | 154O | 17 | - | 1455 | 652 | 142 |
| | | | | 1 | | | 305G | 69 | 2.0 | 1850 | | 315G | 69 | 2.0 | 1922 | | 245J | 68 | 2.0 | 1806 | | 255J | 68 | 2.0 | 1879 | 652 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 5.15 | 175KcO | 17 | - | 2170 | 4.71* | 175O | 17 | - | 2250 | 4.33* | 175O | 17 | - | 2330 | 3.99* | 185O | 17 | - | 2427 | 906 | 104 |
| | | | | 1 | | | 385E | 69 | 2.0 | 2770 | | 405E | 69 | 2.0 | 2897 | | 365F | 68 | 2.0 | 2882 | | 385F | 68 | 2.0 | 3009 | 1164 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 6.01* | 195lgO | 17 | - | 2504 | 5.50* | 195JfO | 17 | - | 2597 | 5.05* | 195KeO | 17 | - | 2690 | 4.66* | 195KdO | 17 | - | 2783 | 1164 | 95 |
| | | | | 1 | | | 445D | 69 | 2.0 | 3210 | | 465D | 69 | 2.0 | 3351 | | 415E | 68 | 2.0 | 3326 | | 435E | 68 | 2.0 | 3466 | 1164 | |
| | 20 | 2#10 | 1#10 | 1 | 3#11 | 3.09 | 134O | 21 | - | 1158 | 2.82 | 134O | 20 | - | 1201 | 2.59 | 134O | 20 | - | 1244 | 2.39 | 134O | 20 | - | 1288 | 543 | 137 |
| | | | | 1 | | | 225J | 82 | 2.2 | 1545 | | 235J | 82 | 2.2 | 1613 | | 245J | 81 | 2.2 | 1681 | | 255J | 81 | 2.2 | 1749 | 657 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 3.74 | 144O | 21 | - | 1508 | 3.42 | 144O | 20 | - | 1565 | 3.14 | 154O | 20 | - | 1634 | 2.89 | 154O | 20 | - | 1691 | 657 | 121 |
| | | | | 1 | | | 305G | 82 | 2.2 | 2079 | | 315G | 82 | 2.2 | 2161 | | 325G | 81 | 2.2 | 2243 | | 255J | 81 | 2.2 | 2130 | 916 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 6.10* | 185JfO | 21 | - | 2493 | 5.59* | 185KeO | 20 | - | 2586 | 5.13* | 185KdO | 20 | - | 2679 | 4.73* | 195KcO | 20 | - | 2790 | 1181 | 92 |
| | | | | 1 | | | 445D | 82 | 2.2 | 3241 | | 465D | 82 | 2.2 | 3383 | | 415E | 81 | 2.2 | 3354 | | 435E | 81 | 2.2 | 3496 | 1181 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 6.72* | 205HiO | 21 | - | 2750 | 6.14* | 205IhO | 20 | - | 2852 | 5.64* | 205lgO | 20 | - | 2954 | 5.20* | 205JfO | 20 | - | 3056 | 1181 | 85 |
| | | | | 1 | | | 445D | 82 | 2.2 | 3462 | | 465D | 82 | 2.2 | 3613 | | 485D | 81 | 2.2 | 3764 | | 505D | 81 | 2.2 | 3914 | 1427 | |
| | 24 | 2#11 | 1#11 | 1 | 4#10 | 3.72 | 133O | 28 | - | 1323 | 3.40 | 133O | 27 | - | 1374 | 3.13 | 133O | 27 | - | 1425 | 2.88 | 133O | 27 | - | 1475 | 664 | 118 |
| | | | | 1 | | | 225J | 110 | 2.6 | 2095 | | 235J | 110 | 2.6 | 2188 | | 245J | 109 | 2.6 | 2280 | | 305H | 109 | 2.6 | 2582 | 720 | |
| | | 2#14 | 1#14 | 1 | 4#11 | 4.50 | 143O | 28 | - | 1755 | 4.11 | 143O | 27 | - | 1824 | 3.78 | 153O | 27 | - | 1904 | 3.48 | 153O | 27 | - | 1973 | 931 | 104 |
| | | | | 1 | | | 305G | 110 | 2.6 | 2850 | | 315G | 110 | 2.6 | 2961 | | 325G | 109 | 2.6 | 3072 | | 345G | 109 | 2.6 | 3224 | 870 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 6.87* | 165O | 28 | - | 2948 | 6.28* | 174O | 27 | - | 2868 | 5.77* | 174O | 27 | - | 2970 | 5.32* | 184O | 27 | - | 3094 | 1208 | 80 |
| | | | | 1 | | | 335F | 110 | 2.6 | 3774 | | 355F | 110 | 2.6 | 3960 | | 365F | 109 | 2.6 | 4104 | | 345G | 109 | 2.6 | 4122 | 1469 | |
| | | 3#14 | 2#14 | 1 | 6#14 | 8.35* | 175O | 28 | - | 3548 | 7.64* | 185O | 27 | - | 3709 | 7.01* | 185O | 27 | - | 3835 | 6.46* | 195O | 27 | - | 3996 | 1469 | 69 |
| | | | | 1 | | | 385E | 110 | 2.6 | 4549 | | 405E | 110 | 2.6 | 4759 | | 415E | 109 | 2.6 | 4927 | | 435E | 109 | 2.6 | 5137 | 1712 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

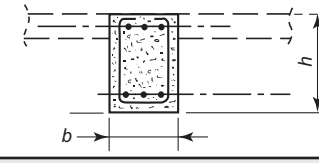
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

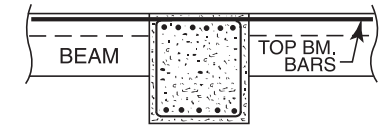
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 36 ft | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | SPAN, $\ell_n$ = 40 ft. | | | | | SPAN, $\ell_n$ = 42 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 42 | 20 | 2#11 | 1#11 | 1 | 3#11 | 6.05 | 114R | 27 | - | 1084 | 5.43 | 114R | 26 | - | 1133 | 4.90 | 114R | 26 | - | 1182 | 4.44 | 114R | 26 | - | 1231 | 784 | 86 |
| | | | | 1 | | | 245G | 107 | 2.7 | 1578 | | 265G | 106 | 2.7 | 1680 | | 275G | 105 | 2.7 | 1756 | | 285G | 104 | 2.7 | 1831 | 784 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 8.48 | 135MeR | 27 | - | 1627 | 7.61 | 135OdR | 26 | - | 1698 | 6.87 | 135OcR | 26 | - | 1769 | 6.23 | 135R | 26 | - | 1840 | 1098 | 75 |
| | | | | 1 | | | 365D | 107 | 2.7 | 2319 | | 335E | 106 | 2.7 | 2310 | | 345E | 105 | 2.7 | 2408 | | 365E | 104 | 2.7 | 2531 | 1098 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 12.09 | 225EqR | 27 | - | 2423 | 10.85 | 215FoR | 26 | - | 2505 | 9.80 | 205GmR | 26 | - | 2587 | 8.89 | 205GmR | 26 | - | 2689 | 1424 | 57 |
| | | | | 1 | | | 545B | 107 | 2.7 | 3410 | | 465C | 106 | 2.7 | 3301 | | 485C | 105 | 2.7 | 3456 | | 505C | 104 | 2.7 | 3611 | 1730 | |
| | | 3#14 | 2#14 | 1 | 6#14 | 14.69 | 295DoG | 27 | - | 3032 | 13.19 | 305DnG | 26 | - | 3178 | 11.90 | 315DmG | 26 | - | 3324 | 10.79 | 325DlG | 26 | - | 3471 | 1730 | 53 |
| | | | | 2 | | | 545B | 107 | 2.7 | 3879 | | 575B | 106 | 2.7 | 4084 | | 605B | 105 | 2.7 | 4290 | | 635B | 104 | 2.7 | 4495 | 1913 | |
| | 24 | 2#11 | 1#11 | 1 | 4#11 | 6.72 | 103R | 36 | - | 1201 | 6.03 | 113R | 36 | - | 1269 | 5.44 | 113R | 35 | - | 1325 | 4.93 | 113R | 35 | - | 1380 | 791 | 70 |
| | | | | 1 | | | 245G | 145 | 3.2 | 2176 | | 265G | 143 | 3.2 | 2324 | | 275G | 142 | 3.2 | 2425 | | 285G | 141 | 3.2 | 2527 | 1038 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 9.45 | 115R | 36 | - | 1981 | 8.49 | 124R | 36 | - | 1930 | 7.66 | 124R | 35 | - | 2010 | 6.95 | 134R | 35 | - | 2114 | 1113 | 63 |
| | | | | 1 | | | 275F | 144 | 3.2 | 2797 | | 295F | 143 | 3.2 | 2969 | | 305F | 142 | 3.2 | 3095 | | 285G | 141 | 3.2 | 3082 | 1451 | |
| | | 3#14 | 2#14 | 1 | 5#14 | 13.68 | 135MeR | 36 | - | 2773 | 12.28 | 135NeR | 36 | - | 2890 | 11.08 | 145OdR | 35 | - | 3046 | 10.05 | 145OcR | 35 | - | 3164 | 1772 | 50 |
| | | | | 1 | | | 365D | 144 | 3.2 | 3925 | | 385D | 143 | 3.2 | 4134 | | 405D | 142 | 3.2 | 4344 | | 365E | 141 | 3.2 | 4277 | 1772 | |
| | | 3#14 | 3#14 | 1 | 7#14 | 17.45 | 245G | 36 | - | 3817 | 15.66 | 265G | 36 | - | 4043 | 14.14 | 275G | 35 | - | 4231 | 12.82 | 285G | 35 | - | 4418 | 2077 | 44 |
| | | | | 2 | | | 435C | 144 | 3.2 | 4863 | | 465C | 143 | 3.2 | 5150 | | 485C | 142 | 3.2 | 5391 | | 425D | 141 | 3.2 | 5263 | 2261 | |
| | 30 | 2#11 | 2#11 | 1 | 4#11 | 8.12 | 104R | 52 | - | 1498 | 7.28 | 104R | 51 | - | 1562 | 6.57 | 114R | 51 | - | 1653 | 5.96 | 114R | 50 | - | 1717 | 1051 | 57 |
| | | | | 1 | | | 245G | 207 | 4.0 | 2405 | | 265G | 205 | 4.0 | 2566 | | 275G | 203 | 3.9 | 2679 | | 285G | 202 | 3.9 | 2793 | 1051 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 11.41 | 115R | 52 | - | 2242 | 10.24 | 125R | 51 | - | 2375 | 9.24 | 124R | 51 | - | 2292 | 8.38 | 124R | 50 | - | 2385 | 1478 | 53 |
| | | | | 1 | | | 315E | 207 | 4.0 | 3301 | | 335E | 205 | 3.9 | 3492 | | 345E | 203 | 3.9 | 3633 | | 325F | 202 | 3.9 | 3629 | 1478 | |
| | | 3#14 | 3#14 | 1 | 7#14 | 18.14 | 165HjR | 52 | - | 3528 | 16.28 | 165IiR | 51 | - | 3676 | 14.69 | 165JhR | 51 | - | 3825 | 13.33 | 165KgR | 50 | - | 3973 | 2137 | 39 |
| | | | | 1 | | | 435C | 207 | 4.0 | 4968 | | 465C | 205 | 3.9 | 5262 | | 485C | 203 | 3.9 | 5508 | | 505C | 202 | 3.9 | 5753 | 2446 | |
| | | 4#14 | 3#14 | 1 | 8#14 | 20.77 | 275DgG | 52 | - | 4440 | 18.64 | 265G | 51 | - | 4572 | 16.82 | 205GmR | 51 | - | 4503 | 15.26 | 195HkR | 50 | - | 4636 | 2446 | 35 |
| | | | | 1 | | | 545B | 207 | 4.0 | 5970 | | 575B | 205 | 3.9 | 6288 | | 485C | 203 | 3.9 | 6025 | | 505C | 202 | 3.9 | 6294 | 2742 | |
| | 36 | 2#14 | 2#14 | 1 | 5#11 | 10.12 | 104R | 69 | - | 1956 | 9.09 | 114R | 68 | - | 2071 | 8.20 | 114R | 68 | - | 2159 | 7.44 | 114R | 67 | - | 2248 | 1496 | 46 |
| | | | | 1 | | | 315E | 275 | 4.7 | 3269 | | 335E | 272 | 4.7 | 3459 | | 345E | 270 | 4.7 | 3599 | | 365E | 268 | 4.6 | 3789 | 1312 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 12.70 | 115R | 69 | - | 2442 | 11.40 | 115R | 68 | - | 2544 | 10.29 | 124R | 68 | - | 2507 | 9.33 | 124R | 67 | - | 2609 | 1496 | 45 |
| | | | | 1 | | | 365D | 275 | 4.7 | 3817 | | 335E | 272 | 4.7 | 3766 | | 345E | 270 | 4.7 | 3919 | | 365E | 268 | 4.6 | 4123 | 1842 | |
| | | 4#14 | 3#14 | 1 | 8#14 | 21.23 | 185GlR | 69 | - | 4102 | 19.06 | 195GlR | 68 | - | 4317 | 17.20 | 185HkR | 68 | - | 4448 | 15.60 | 175IiR | 67 | - | 4579 | 2501 | 33 |
| | | | | 1 | | | 545B | 275 | 4.7 | 6102 | | 575B | 272 | 4.7 | 6427 | | 485C | 270 | 4.7 | 6141 | | 505C | 268 | 4.6 | 6416 | 2814 | |
| | | 5#14 | 4#14 | 1 | 10#14 | 24.96 | 285DkG | 69 | - | 5418 | 22.40 | 295DjG | 68 | - | 5679 | 20.22 | 225FpR | 68 | - | 5607 | 18.34 | 235FpR | 67 | - | 5868 | 3115 | 30 |
| | | | | 2 | | | 545B | 275 | 4.7 | 7001 | | 575B | 272 | 4.7 | 7373 | | 605B | 270 | 4.7 | 7745 | | 635B | 268 | 4.6 | 8117 | 3234 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

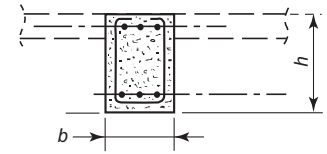
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

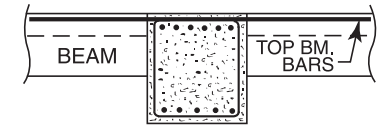
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 44 ft | | | | | SPAN, $\ell_n$ = 46 ft. | | | | | SPAN, $\ell_n$ = 48 ft. | | | | | SPAN, $\ell_n$ = 50 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) $\times 10^{-9}$ |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft.-kips | sq. in. | lb. | ft.-kip | in. |
| 42 | 20 | 2#11 | 1#11 | 1 | 3#11 | 4.05 | 124R | 26 | - | 1293 | 3.71 | 124R | 26 | - | 1342 | 3.40 | 124R | 26 | - | 1391 | 3.14 | 124R | 25 | - | 1441 | 784 | 86 |
| | | | | 1 | | | 305G | 103 | 2.7 | 1933 | | 315G | 103 | 2.6 | 2009 | | 245J | 102 | 2.6 | 1873 | | 255J | 102 | 2.6 | 1948 | 784 | |
| | | 2#14 | 1#14 | 1 | 3#14 | 5.68 | 135R | 26 | - | 1911 | 5.19 | 145R | 26 | - | 2001 | 4.77 | 145R | 26 | - | 2072 | 4.40 | 145R | 25 | - | 2143 | 1098 | 75 |
| | | | | 1 | | | 335F | 103 | 2.7 | 2523 | | 355F | 103 | 2.6 | 2646 | | 365F | 102 | 2.6 | 2743 | | 345G | 101 | 2.6 | 2761 | 1098 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 8.10 | 195HkR | 26 | - | 2771 | 7.41 | 195IjR | 26 | - | 2873 | 6.80 | 195IiR | 26 | - | 2975 | 6.27 | 195JhR | 25 | - | 3077 | 1424 | 57 |
| | | | | 1 | | | 535C | 103 | 2.7 | 3792 | | 465D | 103 | 2.6 | 3709 | | 485D | 102 | 2.6 | 3864 | | 505D | 101 | 2.6 | 4019 | 1730 | |
| | | 3#14 | 2#14 | 1 | 6#14 | 9.83 | 285EuR | 26 | - | 3517 | 9.00 | 255FrR | 26 | - | 3583 | 8.26* | 265FrR | 26 | - | 3729 | 7.62* | 255GpR | 25 | - | 3836 | 1730 | 53 |
| | | | | 2 | | | 665B | 103 | 2.7 | 4701 | | 555C | 103 | 2.6 | 4537 | | 585C | 102 | 2.6 | 4742 | | 605C | 101 | 2.6 | 4921 | 1913 | |
| | 24 | 2#11 | 1#11 | 1 | 4#11 | 4.50 | 113R | 35 | - | 1435 | 4.11 | 113R | 35 | - | 1491 | 3.78 | 113R | 35 | - | 1546 | 3.48 | 113R | 34 | - | 1601 | 791 | 70 |
| | | | | 1 | | | 305G | 140 | 3.1 | 2674 | | 315G | 139 | 3.1 | 2775 | | 245J | 138 | 3.1 | 2508 | | 255J | 137 | 3.1 | 2610 | 1038 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 6.33 | 134R | 35 | - | 2194 | 5.79 | 134R | 35 | - | 2274 | 5.32 | 143R | 35 | - | 2214 | 4.90 | 143R | 34 | - | 2293 | 1113 | 63 |
| | | | | 1 | | | 305G | 140 | 3.1 | 3254 | | 315G | 139 | 3.1 | 3380 | | 325G | 138 | 3.1 | 3505 | | 345G | 137 | 3.1 | 3677 | 1451 | |
| | | 3#14 | 2#14 | 1 | 5#14 | 9.16 | 145R | 35 | - | 3281 | 8.38 | 155R | 35 | - | 3437 | 7.69 | 155R | 35 | - | 3554 | 7.09 | 165R | 34 | - | 3711 | 1772 | 50 |
| | | | | 1 | | | 385E | 140 | 3.1 | 4486 | | 405E | 139 | 3.1 | 4696 | | 415E | 138 | 3.1 | 4859 | | 385F | 137 | 3.1 | 4838 | 1772 | |
| | | 3#14 | 3#14 | 1 | 7#14 | 11.68 | 175JhR | 35 | - | 4139 | 10.69 | 175KgR | 35 | - | 4287 | 9.82* | 175MfR | 35 | - | 4436 | 9.05* | 175NeR | 34 | - | 4584 | 2077 | 44 |
| | | | | 2 | | | 445D | 140 | 3.1 | 5504 | | 465D | 139 | 3.1 | 5744 | | 485D | 138 | 3.1 | 5985 | | 505D | 137 | 3.1 | 6226 | 2261 | |
| | 30 | 2#11 | 2#11 | 1 | 4#11 | 5.43 | 114R | 50 | - | 1782 | 4.97 | 114R | 50 | - | 1846 | 4.57 | 114R | 49 | - | 1911 | 4.21 | 114R | 49 | - | 1976 | 1051 | 57 |
| | | | | 1 | | | 305G | 200 | 3.9 | 2954 | | 315G | 199 | 3.8 | 3067 | | 325G | 198 | 3.8 | 3181 | | 345G | 197 | 3.8 | 3342 | 1051 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 7.64 | 134R | 50 | - | 2504 | 6.99 | 134R | 50 | - | 2597 | 6.42 | 134R | 49 | - | 2690 | 5.91 | 144R | 49 | - | 2809 | 1478 | 53 |
| | | | | 1 | | | 335F | 200 | 3.9 | 3771 | | 355F | 199 | 3.8 | 3961 | | 365F | 198 | 3.8 | 4102 | | 345G | 197 | 3.8 | 4098 | 1478 | |
| | | 3#14 | 3#14 | 1 | 7#14 | 12.14 | 165KfR | 50 | - | 4122 | 11.11 | 165MfR | 50 | - | 4270 | 10.20 | 165NeR | 49 | - | 4419 | 9.40 | 165OdR | 49 | - | 4568 | 2137 | 39 |
| | | | | 1 | | | 445D | 200 | 3.9 | 5611 | | 465D | 199 | 3.8 | 5856 | | 485D | 198 | 3.8 | 6102 | | 505D | 197 | 3.8 | 6347 | 2446 | |
| | | 4#14 | 3#14 | 1 | 8#14 | 13.90 | 185IjR | 50 | - | 4768 | 12.72 | 195IjR | 50 | - | 4981 | 11.68 | 195JiR | 49 | - | 5154 | 10.77* | 185KgR | 49 | - | 5286 | 2446 | 35 |
| | | | | 1 | | | 535C | 200 | 3.9 | 6613 | | 555C | 199 | 3.8 | 6882 | | 585C | 198 | 3.8 | 7201 | | 505D | 197 | 3.8 | 6985 | 2742 | |
| | 36 | 2#14 | 2#14 | 1 | 5#11 | 6.78 | 114R | 67 | - | 2336 | 6.20 | 114R | 66 | - | 2425 | 5.70 | 114R | 66 | - | 2513 | 5.25 | 124R | 65 | - | 2628 | 1496 | 46 |
| | | | | 1 | | | 385E | 266 | 4.6 | 3979 | | 405E | 264 | 4.6 | 4169 | | 415E | 263 | 4.5 | 4309 | | 305H | 261 | 4.5 | 3837 | 1312 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 8.50 | 124R | 67 | - | 2711 | 7.78 | 134R | 66 | - | 2839 | 7.14 | 134R | 66 | - | 2941 | 6.58 | 134R | 65 | - | 3043 | 1496 | 45 |
| | | | | 1 | | | 385E | 266 | 4.6 | 4327 | | 405E | 264 | 4.6 | 4531 | | 415E | 263 | 4.5 | 4684 | | 435E | 261 | 4.5 | 4888 | 1842 | |
| | | 4#14 | 3#14 | 1 | 8#14 | 14.21 | 175JhR | 67 | - | 4751 | 13.00 | 175KgR | 66 | - | 4924 | 11.94 | 185KgR | 66 | - | 5139 | 11.01* | 175MfR | 65 | - | 5270 | 2501 | 33 |
| | | | | 1 | | | 535C | 266 | 4.6 | 6742 | | 555C | 264 | 4.6 | 7016 | | 585C | 263 | 4.5 | 7342 | | 505D | 261 | 4.5 | 7107 | 2814 | |
| | | 5#14 | 4#14 | 1 | 10#14 | 16.71 | 225GnR | 67 | - | 6045 | 15.29 | 225GnR | 66 | - | 6264 | 14.04* | 215HlR | 66 | - | 6442 | 12.94* | 215IkR | 65 | - | 6661 | 3115 | 30 |
| | | | | 2 | | | 665B | 266 | 4.6 | 8489 | | 695B | 264 | 4.6 | 8861 | | 585C | 263 | 4.5 | 8520 | | 605C | 261 | 4.5 | 8841 | 3234 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

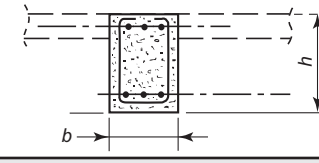
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

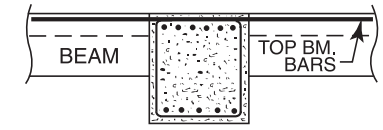
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 40 ft | | | | | SPAN, $\ell_n$ = 42 ft. | | | | | SPAN, $\ell_n$ = 44 ft. | | | | | SPAN, $\ell_n$ = 46 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 48 | 24 | 2#14 | 1#14 | 1 | 4#11 | 7.55 | 104U | 44 | - | 1731 | 6.85 | 104U | 43 | - | 1800 | 6.24 | 114U | 43 | - | 1896 | 5.71 | 114U | 42 | - | 1965 | 1296 | 47 |
| | | | | 1 | | | 275G | 174 | 3.7 | 2812 | | 285G | 173 | 3.7 | 2931 | | 305G | 171 | 3.7 | 3101 | | 315G | 170 | 3.6 | 3220 | 1207 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 8.91 | 114U | 44 | - | 2015 | 8.08 | 114U | 43 | - | 2095 | 7.36 | 114U | 43 | - | 2175 | 6.74 | 124U | 42 | - | 2282 | 1296 | 44 |
| | | | | 1 | | | 305F | 174 | 3.7 | 3220 | | 325F | 173 | 3.7 | 3400 | | 305G | 171 | 3.7 | 3379 | | 315G | 170 | 3.6 | 3509 | 1694 | |
| | | 3#14 | 3#14 | 1 | 6#14 | 15.26 | 155KhU | 44 | - | 3623 | 13.84 | 155MhU | 43 | - | 3762 | 12.61 | 155MgU | 43 | - | 3902 | 11.54 | 155NfU | 42 | - | 4042 | 2441 | 32 |
| | | | | 1 | | | 405D | 174 | 3.7 | 4986 | | 425D | 173 | 3.7 | 5226 | | 445D | 171 | 3.7 | 5466 | | 465D | 170 | 3.6 | 5706 | 2441 | |
| | | 4#14 | 3#14 | 2 | 8#14 | 18.47 | 275EhH | 43 | - | 4861 | 16.76 | 275EfH | 43 | - | 5033 | 15.27 | 275H | 43 | - | 5206 | 13.97 | 285H | 42 | - | 5422 | 2687 | 30 |
| | | | | 2 | | | 485C | 173 | 3.7 | 6108 | | 505C | 172 | 3.7 | 6381 | | 535C | 170 | 3.6 | 6705 | | 555C | 169 | 3.6 | 6978 | 2984 | |
| | 30 | 2#14 | 2#14 | 1 | 4#14 | 10.76 | 115U | 63 | - | 2474 | 9.76 | 114U | 62 | - | 2390 | 8.89 | 114U | 62 | - | 2483 | 8.14 | 124U | 61 | - | 2605 | 1721 | 37 |
| | | | | 1 | | | 345E | 251 | 4.6 | 3775 | | 365E | 249 | 4.5 | 3973 | | 335F | 247 | 4.5 | 3908 | | 355F | 245 | 4.5 | 4107 | 1721 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 11.84 | 115U | 63 | - | 2677 | 10.74 | 115U | 62 | - | 2779 | 9.78 | 125U | 62 | - | 2926 | 8.95 | 125U | 61 | - | 3028 | 1721 | 35 |
| | | | | 1 | | | 345E | 251 | 4.6 | 3978 | | 365E | 249 | 4.5 | 4186 | | 385E | 247 | 4.5 | 4393 | | 405E | 245 | 4.5 | 4600 | 2118 | |
| | | 4#14 | 3#14 | 1 | 8#14 | 19.74 | 185HmU | 63 | - | 4498 | 17.91 | 195HmU | 62 | - | 4715 | 16.32 | 185llU | 62 | - | 4843 | 14.93 | 185lkU | 61 | - | 5016 | 2871 | 25 |
| | | | | 1 | | | 605B | 251 | 4.6 | 6857 | | 505C | 249 | 4.5 | 6503 | | 535C | 247 | 4.5 | 6834 | | 555C | 245 | 4.5 | 7112 | 3228 | |
| | | 4#14 | 4#14 | 1 | 9#14 | 21.47 | 255FjI | 63 | - | 5284 | 19.47 | 265FiI | 62 | - | 5524 | 17.74 | 225GpU | 62 | - | 5541 | 16.23 | 215HnU | 61 | - | 5691 | 3228 | 24 |
| | | | | 2 | | | 605B | 251 | 4.6 | 7332 | | 635B | 249 | 4.5 | 7685 | | 535C | 247 | 4.5 | 7353 | | 555C | 245 | 4.5 | 7654 | 3434 | |
| | 36 | 2#14 | 2#14 | 1 | 5#14 | 11.96 | 105U | 84 | - | 2646 | 10.85 | 114U | 83 | - | 2612 | 9.88 | 114U | 83 | - | 2714 | 9.04 | 114U | 82 | - | 2816 | 1739 | 31 |
| | | | | 1 | | | 345E | 336 | 5.4 | 4061 | | 365E | 333 | 5.4 | 4273 | | 385E | 330 | 5.4 | 4486 | | 405E | 328 | 5.3 | 4698 | 2146 | |
| | | 3#14 | 2#14 | 1 | 5#14 | 13.41 | 115U | 84 | - | 3006 | 12.17 | 115U | 83 | - | 3123 | 11.09 | 115U | 83 | - | 3241 | 10.14 | 125U | 82 | - | 3404 | 2146 | 30 |
| | | | | 1 | | | 405D | 336 | 5.4 | 4705 | | 425D | 333 | 5.4 | 4933 | | 385E | 330 | 5.4 | 4830 | | 405E | 328 | 5.3 | 5057 | 2146 | |
| | | 4#14 | 4#14 | 1 | 9#14 | 22.69 | 225FqU | 84 | - | 5181 | 20.58 | 215GoU | 83 | - | 5330 | 18.75 | 195HmU | 83 | - | 5434 | 17.16 | 205HmU | 82 | - | 5675 | 3300 | 22 |
| | | | | 1 | | | 605B | 336 | 5.4 | 7478 | | 635B | 333 | 5.4 | 7838 | | 665B | 330 | 5.4 | 8199 | | 695B | 328 | 5.3 | 8559 | 3662 | |
| | | 5#14 | 5#14 | 2 | 11#14 | 26.14 | 315DpH | 83 | - | 6586 | 23.71 | 295EmH | 83 | - | 6736 | 21.60 | 315EmH | 82 | - | 7070 | 19.76 | 315ElH | 81 | - | 7311 | 3842 | 21 |
| | | | | 2 | | | 805A | 334 | 5.4 | 9572 | | 635B | 331 | 5.4 | 8877 | | 665B | 328 | 5.3 | 9284 | | 695B | 326 | 5.3 | 9691 | 4181 | |
| | 42 | 3#14 | 2#14 | 1 | 5#14 | 13.54 | 105U | 107 | - | 2974 | 12.28 | 114U | 106 | - | 2951 | 11.19 | 114U | 105 | - | 3069 | 10.24 | 114U | 104 | - | 3186 | 2166 | 27 |
| | | | | 1 | | | 485C | 427 | 6.3 | 5263 | | 505C | 423 | 6.3 | 5495 | | 535C | 419 | 6.2 | 5785 | | 555C | 416 | 6.2 | 6018 | 2166 | |
| | | 3#14 | 3#14 | 1 | 6#14 | 16.07 | 115RcU | 107 | - | 3496 | 14.57 | 125RcU | 106 | - | 3683 | 13.28 | 125U | 105 | - | 3823 | 12.15 | 125U | 104 | - | 3962 | 2570 | 26 |
| | | | | 1 | | | 485C | 427 | 6.3 | 5738 | | 505C | 423 | 6.3 | 5993 | | 535C | 419 | 6.2 | 6305 | | 555C | 416 | 6.2 | 6560 | 2570 | |
| | | 5#14 | 4#14 | 1 | 10#14 | 25.58 | 225FqU | 107 | - | 5729 | 23.20 | 235FqU | 106 | - | 5996 | 21.14 | 215GoU | 105 | - | 6120 | 19.34 | 225GoU | 104 | - | 6387 | 3726 | 19 |
| | | | | 1 | | | 605B | 427 | 6.3 | 8141 | | 635B | 423 | 6.3 | 8533 | | 665B | 419 | 6.2 | 8925 | | 695B | 416 | 6.2 | 9317 | 4093 | |
| | | 6#14 | 6#14 | 2 | 13#14 | 30.81 | 365CwH | 106 | - | 7858 | 27.94 | 335DsH | 105 | - | 8004 | 25.46 | 345DrH | 104 | - | 8340 | 23.29 | 355DqH | 103 | - | 8675 | 4591 | 17 |
| | | | | 2 | | | 805A | 424 | 6.3 | 10759 | | 845A | 420 | 6.2 | 11277 | | 885A | 417 | 6.2 | 11796 | | 925A | 414 | 6.1 | 12314 | 4928 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

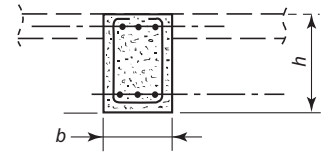
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

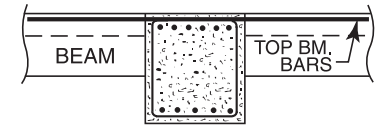
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 48 ft | | | | | SPAN, $\ell_n$ = 50 ft. | | | | | SPAN, $\ell_n$ = 52 ft. | | | | | SPAN, $\ell_n$ = 54 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) $\times 10^{-9}$ |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft.-kips | sq. in. | lb. | ft.-kip | in. |
| 48 | 24 | 2#14 | 1#14 | 1 | 4#11 | 5.24 | 114U | 42 | - | 2034 | 4.83 | 114U | 42 | - | 2103 | 4.47 | 114U | 42 | - | 2171 | 4.14 | 124U | 41 | - | 2268 | 1296 | 47 |
| | | | | 1 | | | 325G | 169 | 3.6 | 3339 | | 345G | 168 | 3.6 | 3508 | | 355G | 167 | 3.6 | 3627 | | 365G | 166 | 3.5 | 3746 | 1207 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 6.19 | 124U | 42 | - | 2362 | 5.70 | 124U | 42 | - | 2441 | 5.27 | 124U | 42 | - | 2521 | 4.89 | 134U | 41 | - | 2628 | 1296 | 44 |
| | | | | 1 | | | 325G | 169 | 3.6 | 3639 | | 345G | 168 | 3.6 | 3819 | | 355G | 167 | 3.6 | 3949 | | 365G | 166 | 3.5 | 4079 | 1694 | |
| | | 3#14 | 3#14 | 1 | 6#14 | 10.60 | 155OfU | 42 | - | 4181 | 9.77 | 155PeU | 42 | - | 4321 | 9.03 | 155QdU | 42 | - | 4461 | 8.37 | 165RdU | 41 | - | 4643 | 2441 | 32 |
| | | | | 1 | | | 485D | 169 | 3.6 | 5946 | | 435E | 168 | 3.6 | 5834 | | 455E | 167 | 3.6 | 6075 | | 465E | 166 | 3.5 | 6264 | 2441 | |
| | | 4#14 | 3#14 | 2 | 8#14 | 12.83 | 295H | 42 | - | 5638 | 11.82 | 195JkT | 42 | - | 5380 | 10.93 | 195KjT | 41 | - | 5552 | 10.14* | 195KiT | 41 | - | 5725 | 2687 | 30 |
| | | | | 2 | | | 585C | 168 | 3.6 | 7302 | | 505D | 167 | 3.6 | 7072 | | 525D | 166 | 3.5 | 7346 | | 545D | 165 | 3.5 | 7619 | 2984 | |
| | 30 | 2#14 | 2#14 | 1 | 4#14 | 7.47 | 124U | 61 | - | 2698 | 6.89 | 124U | 60 | - | 2791 | 6.37 | 124U | 60 | - | 2884 | 5.90 | 124U | 60 | - | 2977 | 1721 | 37 |
| | | | | 1 | | | 365F | 243 | 4.4 | 4253 | | 385F | 242 | 4.4 | 4451 | | 395F | 240 | 4.4 | 4597 | | 365G | 239 | 4.4 | 4532 | 1721 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 8.22 | 124U | 61 | - | 2937 | 7.57 | 124U | 60 | - | 3039 | 7.00 | 134U | 60 | - | 3169 | 6.49 | 134U | 60 | - | 3271 | 1721 | 35 |
| | | | | 1 | | | 365F | 243 | 4.4 | 4492 | | 385F | 242 | 4.4 | 4699 | | 395F | 240 | 4.4 | 4854 | | 415F | 239 | 4.4 | 5061 | 2118 | |
| | | 4#14 | 3#14 | 1 | 8#14 | 13.71 | 185JjU | 61 | - | 5189 | 12.64 | 185KiU | 60 | - | 5362 | 11.68 | 175MhU | 60 | - | 5490 | 10.83 | 175NgU | 60 | - | 5663 | 2871 | 25 |
| | | | | 1 | | | 585C | 243 | 4.4 | 7443 | | 605C | 242 | 4.4 | 7721 | | 625C | 240 | 4.4 | 7999 | | 545D | 239 | 4.4 | 7750 | 3228 | |
| | | 4#14 | 4#14 | 1 | 9#14 | 14.91 | 205lmU | 61 | - | 5842 | 13.74 | 205llU | 60 | - | 6037 | 12.70 | 205JkU | 60 | - | 6232 | 11.78 | 195KjU | 60 | - | 6383 | 3228 | 24 |
| | | | | 2 | | | 585C | 243 | 4.4 | 8007 | | 605C | 242 | 4.4 | 8307 | | 625C | 240 | 4.4 | 8608 | | 655C | 239 | 4.4 | 8961 | 3434 | |
| | 36 | 2#14 | 2#14 | 1 | 5#14 | 8.30 | 114U | 81 | - | 2918 | 7.65 | 124U | 81 | - | 3050 | 7.08 | 124U | 80 | - | 3152 | 6.56 | 124U | 80 | - | 3254 | 1739 | 31 |
| | | | | 1 | | | 415E | 325 | 5.3 | 4855 | | 435E | 323 | 5.2 | 5067 | | 455E | 321 | 5.2 | 5279 | | 465E | 320 | 5.2 | 5436 | 2146 | |
| | | 3#14 | 2#14 | 1 | 5#14 | 9.32 | 124U | 81 | - | 3323 | 8.59 | 124U | 81 | - | 3440 | 7.94 | 124U | 80 | - | 3557 | 7.36 | 134U | 80 | - | 3704 | 2146 | 30 |
| | | | | 1 | | | 415E | 325 | 5.3 | 5230 | | 435E | 323 | 5.2 | 5457 | | 455E | 321 | 5.2 | 5685 | | 465E | 320 | 5.2 | 5857 | 2146 | |
| | | 4#14 | 4#14 | 1 | 9#14 | 15.76 | 195llU | 81 | - | 5824 | 14.52 | 195JkU | 81 | - | 6019 | 13.42 | 195JjU | 80 | - | 6214 | 12.45 | 195KiU | 80 | - | 6409 | 3300 | 22 |
| | | | | 1 | | | 585C | 325 | 5.3 | 8148 | | 605C | 323 | 5.2 | 8453 | | 625C | 321 | 5.2 | 8759 | | 655C | 320 | 5.2 | 9119 | 3662 | |
| | | 5#14 | 5#14 | 2 | 11#14 | 18.15 | 265FtT | 81 | - | 7323 | 16.73 | 275FtT | 80 | - | 7611 | 15.47 | 255GqT | 80 | - | 7761 | 14.34* | 265GqT | 80 | - | 8048 | 3842 | 21 |
| | | | | 2 | | | 725B | 323 | 5.2 | 10098 | | 755B | 322 | 5.2 | 10505 | | 785B | 320 | 5.2 | 10912 | | 815B | 318 | 5.2 | 11319 | 4181 | |
| | 42 | 3#14 | 2#14 | 1 | 5#14 | 9.40 | 114U | 103 | - | 3303 | 8.66 | 114U | 103 | - | 3421 | 8.01 | 124U | 102 | - | 3568 | 7.43 | 124U | 102 | - | 3686 | 2166 | 27 |
| | | | | 1 | | | 585C | 413 | 6.1 | 6308 | | 605C | 411 | 6.1 | 6540 | | 625C | 408 | 6.0 | 6772 | | 415F | 406 | 6.0 | 5681 | 2166 | |
| | | 3#14 | 3#14 | 1 | 6#14 | 11.16 | 125U | 103 | - | 4102 | 10.28 | 125U | 103 | - | 4242 | 9.51 | 134U | 102 | - | 4207 | 8.82 | 134U | 102 | - | 4347 | 2570 | 26 |
| | | | | 1 | | | 585C | 413 | 6.1 | 6872 | | 605C | 411 | 6.1 | 7127 | | 625C | 408 | 6.0 | 7381 | | 655C | 406 | 6.0 | 7693 | 2570 | |
| | | 5#14 | 4#14 | 1 | 10#14 | 17.77 | 215HnU | 103 | - | 6559 | 16.37 | 215HmU | 103 | - | 6778 | 15.14 | 205llU | 102 | - | 6950 | 14.04 | 195JjU | 102 | - | 7122 | 3726 | 19 |
| | | | | 1 | | | 725B | 413 | 6.1 | 9709 | | 755B | 411 | 6.1 | 10101 | | 625C | 408 | 6.0 | 9572 | | 655C | 406 | 6.0 | 9964 | 4093 | |
| | | 6#14 | 6#14 | 2 | 13#14 | 21.39 | 305ExT | 103 | - | 8727 | 19.72 | 315ExT | 102 | - | 9062 | 18.23 | 315ExT | 102 | - | 9350 | 16.90* | 295FuT | 101 | - | 9544 | 4591 | 17 |
| | | | | 2 | | | 965A | 411 | 6.1 | 12832 | | 755B | 408 | 6.0 | 11912 | | 785B | 406 | 6.0 | 12373 | | 815B | 404 | 6.0 | 12833 | 4928 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

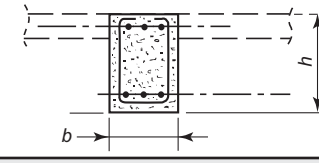
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

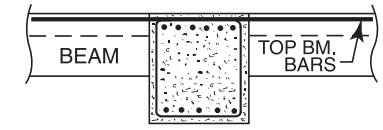
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 12 ft | | | | | SPAN, $\ell_n$ = 14 ft. | | | | | SPAN, $\ell_n$ = 16 ft. | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 12 | 8 | 2# 4 | | 1 | 2# 5 | 1.86 | 133B | 1 | - | 63 | 1.37 | 143B | 1 | - | 71 | 1.05 | 143B | 1 | - | 76 | 0.83 | 153B | 1 | - | 84 | 16 | 5187 |
| | | | | 1 | | | 243A | 4 | 0.4 | 113 | | 283A | 4 | 0.4 | 131 | | 323A | 4 | 0.4 | 150 | | 353A | 4 | 0.4 | 165 | 25 | |
| | | 2# 4 | | 1 | 2# 5 | 1.86 | 133B | 1 | - | 63 | 1.37 | 143B | 1 | - | 71 | 1.05 | 143B | 1 | - | 76 | 0.83 | 153B | 1 | - | 84 | 16 | 5187 |
| | | | | 1 | | | 243A | 4 | 0.4 | 113 | | 283A | 4 | 0.4 | 131 | | 323A | 4 | 0.4 | 150 | | 353A | 4 | 0.4 | 165 | 25 | |
| | | 2# 5 | | 1 | 2# 7 | 2.79 | 153B | 1 | - | 93 | 2.05 | 173B | 1 | - | 107 | 1.57 | 183B | 1 | - | 119 | 1.24 | 193B | 1 | - | 130 | 25 | 5703 |
| | | | | 1 | | | 243A | 4 | 0.4 | 138 | | 283A | 4 | 0.4 | 161 | | 323A | 4 | 0.4 | 183 | | 353A | 4 | 0.4 | 203 | 44 | |
| | | 2# 4 | 2# 4 | 2 | 2# 7 | 3.25 | 163B | 1 | - | 98 | 2.39 | 183B | 1 | - | 113 | 1.83 | 193B | 1 | - | 125 | 1.44* | 213B | 1 | - | 140 | 29 | 5936 |
| | | | | 1 | | | 243A | 4 | 0.4 | 141 | | 283A | 4 | 0.4 | 164 | | 313A | 4 | 0.4 | 185 | | 343A | 4 | 0.4 | 205 | 44 | |
| | 10 | 2# 4 | | 1 | 2# 5 | 1.88 | 123B | 1 | - | 62 | 1.38 | 123B | 1 | - | 68 | 1.06 | 123B | 1 | - | 73 | 0.84 | 113B | 1 | - | 77 | 16 | 2998 |
| | | | | 1 | | | 183B | 6 | 0.5 | 98 | | 213B | 6 | 0.4 | 114 | | 243B | 6 | 0.4 | 130 | | 273B | 6 | 0.4 | 146 | 25 | |
| | | 2# 5 | | 1 | 2# 6 | 2.68 | 143B | 1 | - | 84 | 1.97 | 153B | 1 | - | 94 | 1.51 | 163B | 1 | - | 105 | 1.19 | 163B | 1 | - | 113 | 25 | 4662 |
| | | | | 1 | | | 183B | 6 | 0.5 | 114 | | 213B | 6 | 0.4 | 133 | | 243B | 6 | 0.4 | 152 | | 273B | 6 | 0.4 | 170 | 35 | |
| | | 2# 6 | | 1 | 2# 7 | 3.51 | 153B | 1 | - | 107 | 2.58 | 173B | 1 | - | 123 | 1.97 | 183B | 1 | - | 136 | 1.56 | 193B | 1 | - | 150 | 35 | 4790 |
| | | | | 1 | | | 183B | 6 | 0.5 | 135 | | 213B | 6 | 0.4 | 157 | | 243B | 6 | 0.4 | 179 | | 273B | 6 | 0.4 | 201 | 45 | |
| | | 3# 4 | 2# 4 | 2 | 2# 8 | 4.13 | 163B | 1 | - | 119 | 3.04 | 183B | 1 | - | 137 | 2.33 | 193B | 1 | - | 153 | 1.84* | 213B | 1 | - | 171 | 37 | 4658 |
| | | | | 1 | | | 243A | 6 | 0.5 | 166 | | 213B | 6 | 0.4 | 169 | | 243B | 6 | 0.4 | 193 | | 273B | 6 | 0.4 | 217 | 57 | |
| | 12 | 2# 5 | | 1 | 2# 6 | 2.72 | 133B | 2 | - | 83 | 2.00 | 143B | 2 | - | 94 | 1.53 | 143B | 2 | - | 102 | 1.21 | 143B | 2 | - | 110 | 25 | 3353 |
| | | | | 1 | | | 183B | 8 | 0.5 | 119 | | 213B | 8 | 0.5 | 138 | | 243B | 8 | 0.5 | 158 | | 273B | 8 | 0.5 | 177 | 35 | |
| | | 2# 5 | | 1 | 2# 7 | 2.86 | 133B | 2 | - | 92 | 2.10 | 143B | 2 | - | 104 | 1.61 | 153B | 2 | - | 116 | 1.27 | 153B | 2 | - | 125 | 25 | 3423 |
| | | | | 1 | | | 183B | 8 | 0.5 | 128 | | 213B | 8 | 0.5 | 148 | | 243B | 8 | 0.5 | 169 | | 273B | 8 | 0.5 | 190 | 46 | |
| | | 2# 5 | 1# 5 | 1 | 2# 8 | 4.19 | 153B | 2 | - | 116 | 3.08 | 173B | 2 | - | 134 | 2.36 | 183B | 2 | - | 149 | 1.86 | 193B | 2 | - | 164 | 37 | 4002 |
| | | | | 1 | | | 183B | 8 | 0.5 | 147 | | 213B | 8 | 0.5 | 171 | | 243B | 8 | 0.5 | 195 | | 273B | 8 | 0.5 | 219 | 59 | |
| | | 2# 6 | 1# 6 | 1 | 2# 9 | 5.48 | 163B | 2 | - | 146 | 4.02 | 183B | 2 | - | 168 | 3.08 | 203B | 2 | - | 191 | 2.43* | 213B | 2 | - | 210 | 51 | 3653 |
| | | | | 1 | | | 184B | 8 | 0.5 | 247 | | 214B | 8 | 0.5 | 288 | | 243B | 8 | 0.5 | 232 | | 273B | 7 | 0.5 | 260 | 71 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

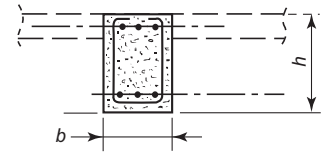
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

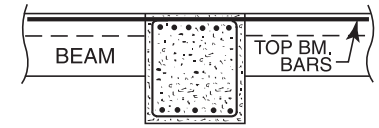
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) $\times 10^{-9}$ |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft.-kips | sq. in. | lb. | ft.-kip | in. |
| 12 | 8 | 2# 4 | | 1 | 2# 5 | 0.67 | 143B | 1 | - | 87 | 0.55 | 143B | 1 | - | 93 | 0.47 | 133B | 1 | - | 96 | 0.40 | 123B | 1 | - | 100 | 16 | 5187 |
| | | | | 1 | | | 383A | 4 | 0.4 | 181 | | 413A | 4 | 0.4 | 196 | | 443A | 4 | 0.4 | 211 | | 473A | 4 | 0.4 | 226 | 25 | |
| | | 2# 4 | | 1 | 2# 5 | 0.67 | 143B | 1 | - | 87 | 0.55 | 143B | 1 | - | 93 | 0.47 | 133B | 1 | - | 96 | 0.40 | 123B | 1 | - | 100 | 16 | 5187 |
| | | | | 1 | | | 383A | 4 | 0.4 | 181 | | 413A | 4 | 0.4 | 196 | | 443A | 4 | 0.4 | 211 | | 473A | 4 | 0.4 | 226 | 25 | |
| | | 2# 5 | | 1 | 2# 7 | 1.00 | 203B | 1 | - | 142 | 0.83* | 213B | 1 | - | 154 | 0.70* | 213B | 1 | - | 164 | 0.59* | 213B | 1 | - | 173 | 25 | 5703 |
| | | | | 1 | | | 383A | 4 | 0.4 | 222 | | 413A | 4 | 0.4 | 242 | | 443A | 4 | 0.4 | 261 | | 473A | 4 | 0.4 | 280 | 44 | |
| | | 2# 6 | | 1 | 2# 7 | 1.22* | 223B | 1 | - | 166 | 1.01* | 233B | 1 | - | 179 | 0.85* | 243B | 1 | - | 193 | 0.72X | 253B | 1 | - | 207 | 34 | 5525 |
| | | | | 1 | | | 383A | 4 | 0.4 | 241 | | 413A | 4 | 0.4 | 263 | | 443A | 4 | 0.4 | 284 | | 473A | 4 | 0.4 | 305 | 44 | |
| | 10 | 2# 4 | | 1 | 2# 5 | 0.68 | 103B | 1 | - | 80 | 0.56 | 093B | 1 | - | 83 | 0.47 | 073B | 1 | - | 84 | 0.40 | 053B | 1 | - | 85 | 16 | 2998 |
| | | | | 1 | | | 293B | 6 | 0.4 | 158 | | 313B | 6 | 0.4 | 171 | | 343B | 6 | 0.4 | 187 | | 363B | 6 | 0.4 | 200 | 25 | |
| | | 2# 5 | | 1 | 2# 6 | 0.96 | 173B | 1 | - | 123 | 0.80 | 173B | 1 | - | 131 | 0.67 | 163B | 1 | - | 137 | 0.57* | 163B | 1 | - | 145 | 25 | 4662 |
| | | | | 1 | | | 293B | 6 | 0.4 | 186 | | 313B | 6 | 0.4 | 201 | | 343B | 6 | 0.4 | 220 | | 363B | 6 | 0.4 | 235 | 35 | |
| | | 2# 6 | | 1 | 2# 7 | 1.26* | 203B | 1 | - | 164 | 1.04* | 213B | 1 | - | 178 | 0.88* | 213B | 1 | - | 189 | 0.75* | 223B | 1 | - | 203 | 35 | 4790 |
| | | | | 1 | | | 293B | 6 | 0.4 | 219 | | 313B | 6 | 0.4 | 238 | | 343B | 6 | 0.4 | 260 | | 363B | 6 | 0.4 | 278 | 45 | |
| | | 3# 4 | 2# 4 | 2 | 2# 8 | 1.49* | 223B | 1 | - | 186 | 1.23* | 233B | 1 | - | 202 | 1.03* | 243B | 1 | - | 217 | 0.88X | 253B | 1 | - | 233 | 37 | 4658 |
| | | | | 1 | | | 293B | 6 | 0.4 | 237 | | 313B | 6 | 0.4 | 257 | | 333B | 6 | 0.4 | 278 | | 363B | 5 | 0.4 | 301 | 57 | |
| | 12 | 2# 5 | | 1 | 2# 6 | 0.98 | 143B | 2 | - | 118 | 0.81 | 143B | 2 | - | 126 | 0.68 | 133B | 2 | - | 132 | 0.58 | 113B | 2 | - | 135 | 25 | 3353 |
| | | | | 1 | | | 303B | 7 | 0.5 | 197 | | 323B | 7 | 0.5 | 212 | | 343B | 7 | 0.5 | 228 | | 363B | 7 | 0.5 | 244 | 35 | |
| | | 2# 5 | | 1 | 2# 7 | 1.03 | 153B | 2 | - | 135 | 0.85 | 153B | 2 | - | 145 | 0.72 | 143B | 2 | - | 152 | 0.61 | 133B | 2 | - | 159 | 25 | 3423 |
| | | | | 1 | | | 303B | 7 | 0.5 | 211 | | 323B | 7 | 0.5 | 228 | | 343B | 7 | 0.5 | 245 | | 363B | 7 | 0.5 | 263 | 46 | |
| | | 2# 5 | 1# 5 | 1 | 2# 8 | 1.51* | 203B | 2 | - | 180 | 1.25* | 213B | 2 | - | 195 | 1.05* | 213B | 2 | - | 208 | 0.89* | 213B | 2 | - | 221 | 37 | 4002 |
| | | | | 1 | | | 303B | 7 | 0.5 | 243 | | 323B | 7 | 0.5 | 264 | | 343B | 7 | 0.5 | 284 | | 363B | 7 | 0.5 | 305 | 59 | |
| | | 2# 7 | | 1 | 2# 9 | 1.87* | 223B | 2 | - | 230 | 1.55* | 233B | 2 | - | 250 | 1.30* | 243B | 2 | - | 270 | 1.11X | 253B | 2 | - | 289 | 46 | 3742 |
| | | | | 1 | | | 293B | 7 | 0.5 | 286 | | 323B | 7 | 0.5 | 314 | | 343B | 7 | 0.5 | 339 | | 363B | 7 | 0.5 | 364 | 71 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

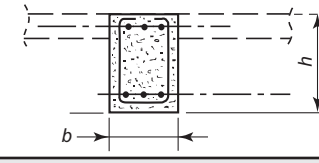
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

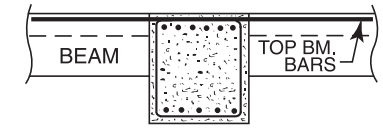
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 12 ft | | | | | SPAN, $\ell_n$ = 14 ft. | | | | | SPAN, $\ell_n$ = 16 ft. | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 14 | 8 | 2# 4 | | 1 | 2# 5 | 2.26 | 113C | 1 | - | 61 | 1.66 | 113C | 1 | - | 67 | 1.27 | 123C | 1 | - | 75 | 1.01 | 123C | 1 | - | 81 | 20 | 2775 |
| | | | | 1 | | | 183B | 5 | 0.5 | 98 | | 213B | 5 | 0.5 | 114 | | 243B | 5 | 0.4 | 130 | | 273B | 5 | 0.4 | 146 | 30 | |
| | | 2# 4 | 1# 4 | 2 | 2# 6 | 3.18 | 123C | 1 | - | 77 | 2.33 | 143C | 1 | - | 90 | 1.79 | 153C | 1 | - | 100 | 1.41 | 153C | 1 | - | 108 | 28 | 3774 |
| | | | | 1 | | | 183B | 5 | 0.5 | 111 | | 213B | 5 | 0.4 | 130 | | 243B | 5 | 0.4 | 148 | | 273B | 5 | 0.4 | 166 | 42 | |
| | | 2# 4 | 2# 4 | 2 | 2# 7 | 4.05 | 133C | 1 | - | 95 | 2.97 | 153C | 1 | - | 110 | 2.28 | 163C | 1 | - | 123 | 1.80 | 173C | 1 | - | 135 | 36 | 3707 |
| | | | | 1 | | | 183B | 5 | 0.5 | 126 | | 213B | 5 | 0.4 | 147 | | 243B | 5 | 0.4 | 168 | | 273B | 5 | 0.4 | 189 | 55 | |
| | | 2# 4 | 2# 4 | 2 | 3# 6 | 4.05 | 133C | 1 | - | 98 | 2.97 | 153C | 1 | - | 114 | 2.28 | 163C | 1 | - | 127 | 1.80 | 173C | 1 | - | 140 | 36 | 3776 |
| | | | | 2 | | | 183B | 5 | 0.5 | 129 | | 213B | 5 | 0.4 | 151 | | 243B | 5 | 0.4 | 172 | | 273B | 5 | 0.4 | 194 | 56 | |
| | 10 | 2# 4 | | 1 | 2# 5 | 2.28 | 103C | 2 | - | 60 | 1.67 | 103C | 2 | - | 66 | 1.28 | 103C | 2 | - | 71 | 1.01 | 093C | 2 | - | 74 | 20 | 1477 |
| | | | | 1 | | | 183B | 8 | 0.5 | 102 | | 213B | 8 | 0.5 | 119 | | 243B | 7 | 0.5 | 136 | | 273B | 7 | 0.5 | 153 | 31 | |
| | | 2# 5 | | 1 | 2# 6 | 3.28 | 113C | 2 | - | 79 | 2.41 | 123C | 2 | - | 90 | 1.85 | 133C | 2 | - | 101 | 1.46 | 143C | 2 | - | 112 | 31 | 2663 |
| | | | | 1 | | | 183B | 8 | 0.5 | 119 | | 213B | 7 | 0.5 | 138 | | 243B | 7 | 0.5 | 158 | | 273B | 7 | 0.5 | 177 | 42 | |
| | | 2# 6 | | 1 | 3# 6 | 4.75 | 133C | 2 | - | 109 | 3.49 | 143C | 2 | - | 123 | 2.67 | 153C | 2 | - | 138 | 2.11 | 163C | 2 | - | 152 | 42 | 2985 |
| | | | | 1 | | | 183B | 8 | 0.5 | 143 | | 213B | 7 | 0.5 | 166 | | 243B | 7 | 0.5 | 189 | | 273B | 7 | 0.5 | 213 | 62 | |
| | | 3# 4 | 2# 4 | 2 | 2# 8 | 5.13 | 133C | 2 | - | 115 | 3.77 | 153C | 2 | - | 134 | 2.89 | 163C | 2 | - | 150 | 2.28 | 173C | 2 | - | 166 | 46 | 2913 |
| | | | | 1 | | | 243A | 8 | 0.5 | 172 | | 213B | 7 | 0.5 | 174 | | 243B | 7 | 0.5 | 199 | | 273B | 7 | 0.5 | 223 | 71 | |
| | 12 | 2# 5 | | 1 | 2# 6 | 3.32 | 113C | 3 | - | 81 | 2.44 | 113C | 2 | - | 89 | 1.87 | 123C | 2 | - | 100 | 1.48 | 123C | 2 | - | 108 | 31 | 1793 |
| | | | | 1 | | | 143C | 10 | 0.6 | 107 | | 173C | 10 | 0.6 | 128 | | 193C | 10 | 0.6 | 144 | | 223C | 10 | 0.6 | 164 | 43 | |
| | | 2# 6 | | 1 | 2# 7 | 4.41 | 123C | 3 | - | 104 | 3.24 | 133C | 2 | - | 118 | 2.48 | 143C | 2 | - | 132 | 1.96 | 153C | 2 | - | 147 | 43 | 2387 |
| | | | | 1 | | | 144C | 10 | 0.6 | 187 | | 173C | 10 | 0.6 | 151 | | 193C | 10 | 0.6 | 171 | | 223C | 10 | 0.6 | 194 | 57 | |
| | | 2# 5 | 2# 5 | 1 | 2# 8 | 5.61 | 133C | 3 | - | 124 | 4.13 | 143C | 2 | - | 141 | 3.16 | 153C | 2 | - | 158 | 2.50 | 163C | 2 | - | 175 | 60 | 2384 |
| | | | | 1 | | | 144C | 10 | 0.6 | 204 | | 174C | 10 | 0.6 | 243 | | 194C | 10 | 0.6 | 274 | | 223C | 10 | 0.6 | 220 | 73 | |
| | | 2# 6 | 1# 6 | 1 | 2# 9 | 6.85 | 133C | 3 | - | 142 | 5.03 | 153C | 2 | - | 165 | 3.85 | 163C | 2 | - | 185 | 3.04 | 173C | 2 | - | 205 | 63 | 2321 |
| | | | | 1 | | | 144C | 10 | 0.6 | 223 | | 174C | 10 | 0.6 | 265 | | 194C | 10 | 0.6 | 298 | | 224C | 10 | 0.6 | 341 | 89 | |
| | 14 | 2# 5 | | 1 | 3# 5 | 3.50 | 103C | 3 | - | 80 | 2.57 | 113C | 3 | - | 92 | 1.97 | 113C | 3 | - | 100 | 1.56 | 113C | 3 | - | 108 | 31 | 1285 |
| | | | | 1 | | | 143C | 13 | 0.7 | 112 | | 173C | 13 | 0.7 | 133 | | 193C | 12 | 0.7 | 150 | | 223C | 12 | 0.7 | 171 | 46 | |
| | | 2# 6 | | 1 | 3# 6 | 4.87 | 123C | 3 | - | 109 | 3.58 | 133C | 3 | - | 124 | 2.74 | 143C | 3 | - | 139 | 2.16 | 143C | 3 | - | 151 | 43 | 2012 |
| | | | | 1 | | | 144C | 13 | 0.7 | 197 | | 173C | 13 | 0.7 | 160 | | 193C | 12 | 0.7 | 180 | | 223C | 12 | 0.7 | 205 | 64 | |
| | | 2# 6 | 1# 6 | 1 | 3# 7 | 6.45 | 133C | 3 | - | 138 | 4.74 | 143C | 3 | - | 158 | 3.63 | 153C | 3 | - | 177 | 2.87 | 163C | 3 | - | 196 | 64 | 2096 |
| | | | | 1 | | | 144C | 13 | 0.7 | 224 | | 174C | 13 | 0.7 | 266 | | 194C | 12 | 0.7 | 300 | | 223C | 12 | 0.7 | 245 | 84 | |
| | | 3# 5 | 2# 5 | 1 | 3# 8 | 8.15 | 134C | 3 | - | 197 | 5.99 | 153C | 3 | - | 186 | 4.59 | 163C | 3 | - | 209 | 3.62 | 183C | 3 | - | 234 | 74 | 1961 |
| | | | | 1 | | | 144C | 13 | 0.7 | 246 | | 174C | 13 | 0.7 | 292 | | 194C | 12 | 0.7 | 329 | | 224C | 12 | 0.7 | 375 | 106 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

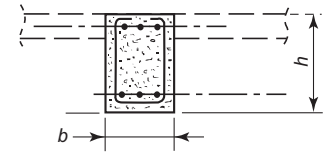
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

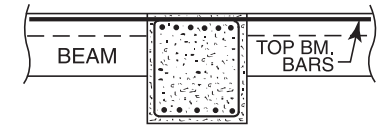
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 14 | 8 | 2# 4 | | 1 | 2# 5 | 0.81 | 123C | 1 | - | 86 | 0.67 | 123C | 1 | - | 92 | 0.57 | 113C | 1 | - | 95 | 0.48 | 103C | 1 | - | 98 | 20 | 2775 |
| | | | | 1 | | | 293B | 5 | 0.4 | 158 | | 313B | 5 | 0.4 | 171 | | 343B | 5 | 0.4 | 187 | | 363B | 5 | 0.4 | 200 | 30 | |
| | | 2# 5 | | 1 | 2# 6 | 1.16 | 163C | 1 | - | 123 | 0.96 | 163C | 1 | - | 131 | 0.81 | 173C | 1 | - | 142 | 0.69 | 173C | 1 | - | 150 | 30 | 3702 |
| | | | | 1 | | | 293B | 5 | 0.4 | 186 | | 313B | 5 | 0.4 | 201 | | 343B | 5 | 0.4 | 220 | | 363B | 5 | 0.4 | 235 | 42 | |
| | | 2# 6 | | 1 | 2# 7 | 1.52 | 183C | 1 | - | 162 | 1.26* | 193C | 1 | - | 175 | 1.06* | 203C | 1 | - | 189 | 0.90* | 213C | 1 | - | 203 | 42 | 3503 |
| | | | | 1 | | | 293B | 5 | 0.4 | 219 | | 313B | 5 | 0.4 | 238 | | 343B | 5 | 0.4 | 260 | | 363B | 5 | 0.4 | 278 | 55 | |
| | | 2# 5 | 2# 4 | 2 | 2# 8 | 1.83* | 203C | 1 | - | 185 | 1.51* | 213C | 1 | - | 200 | 1.27* | 223C | 1 | - | 216 | 1.08* | 233C | 1 | - | 232 | 45 | 3307 |
| | | | | 1 | | | 293B | 5 | 0.4 | 237 | | 313B | 5 | 0.4 | 258 | | 333B | 5 | 0.4 | 278 | | 363B | 5 | 0.4 | 302 | 69 | |
| | 10 | 2# 5 | | 1 | 2# 6 | 1.18 | 143C | 2 | - | 120 | 0.98 | 143C | 2 | - | 128 | 0.82 | 143C | 2 | - | 136 | 0.70 | 133C | 2 | - | 142 | 31 | 2663 |
| | | | | 1 | | | 303B | 7 | 0.5 | 197 | | 323B | 7 | 0.5 | 212 | | 343B | 7 | 0.5 | 228 | | 363B | 7 | 0.5 | 244 | 42 | |
| | | 2# 5 | | 1 | 2# 7 | 1.24 | 143C | 2 | - | 134 | 1.03 | 153C | 2 | - | 146 | 0.86 | 143C | 2 | - | 154 | 0.74 | 143C | 2 | - | 163 | 31 | 2650 |
| | | | | 1 | | | 303B | 7 | 0.5 | 211 | | 323B | 7 | 0.5 | 228 | | 343B | 7 | 0.5 | 245 | | 363B | 7 | 0.5 | 263 | 56 | |
| | | 2# 7 | | 1 | 2# 8 | 1.98 | 183C | 2 | - | 203 | 1.63* | 193C | 2 | - | 221 | 1.37* | 203C | 2 | - | 239 | 1.17* | 213C | 2 | - | 257 | 56 | 2738 |
| | | | | 1 | | | 303B | 7 | 0.5 | 270 | | 323B | 7 | 0.5 | 293 | | 343B | 7 | 0.5 | 315 | | 363B | 7 | 0.5 | 338 | 71 | |
| | | 2# 7 | | 1 | 2# 9 | 2.27* | 193C | 2 | - | 225 | 1.88* | 203C | 2 | - | 245 | 1.58* | 223C | 2 | - | 268 | 1.34* | 223C | 2 | - | 285 | 56 | 2597 |
| | | | | 1 | | | 303B | 7 | 0.5 | 289 | | 323B | 7 | 0.5 | 314 | | 343B | 7 | 0.5 | 339 | | 363B | 7 | 0.5 | 364 | 87 | |
| | 12 | 2# 5 | | 1 | 2# 6 | 1.20 | 123C | 2 | - | 116 | 0.99 | 113C | 2 | - | 122 | 0.83 | 113C | 2 | - | 130 | 0.71 | 103C | 2 | - | 135 | 31 | 1793 |
| | | | | 1 | | | 243C | 10 | 0.6 | 180 | | 263C | 9 | 0.6 | 196 | | 283C | 9 | 0.6 | 213 | | 303C | 9 | 0.6 | 229 | 43 | |
| | | 2# 6 | | 1 | 2# 7 | 1.59 | 153C | 2 | - | 158 | 1.31 | 153C | 2 | - | 169 | 1.10 | 153C | 2 | - | 181 | 0.94 | 153C | 2 | - | 192 | 43 | 2387 |
| | | | | 1 | | | 243C | 10 | 0.6 | 214 | | 263C | 9 | 0.6 | 233 | | 283C | 9 | 0.6 | 253 | | 303C | 9 | 0.6 | 272 | 57 | |
| | | 2# 7 | | 1 | 2# 9 | 2.31 | 183C | 2 | - | 225 | 1.91* | 193C | 2 | - | 245 | 1.60* | 203C | 2 | - | 265 | 1.37* | 213C | 2 | - | 285 | 57 | 2358 |
| | | | | 1 | | | 243C | 9 | 0.6 | 273 | | 263C | 9 | 0.6 | 298 | | 283C | 9 | 0.6 | 323 | | 303C | 9 | 0.6 | 349 | 89 | |
| | | 2# 8 | | 1 | 2#10 | 2.92* | 203C | 2 | - | 281 | 2.41* | 213C | 2 | - | 306 | 2.03* | 223C | 2 | - | 330 | 1.73* | 233C | 2 | - | 355 | 73 | 2107 |
| | | | | 1 | | | 244C | 9 | 0.6 | 425 | | 264C | 9 | 0.6 | 464 | | 284C | 9 | 0.6 | 502 | | 303C | 9 | 0.6 | 414 | 106 | |
| | 14 | 2# 6 | | 1 | 3# 6 | 1.75 | 153C | 3 | - | 165 | 1.45 | 153C | 3 | - | 177 | 1.22 | 153C | 3 | - | 189 | 1.04 | 143C | 3 | - | 199 | 43 | 2012 |
| | | | | 1 | | | 243C | 12 | 0.7 | 225 | | 263C | 12 | 0.7 | 246 | | 283C | 12 | 0.7 | 267 | | 303C | 12 | 0.6 | 287 | 64 | |
| | | 2# 7 | | 1 | 3# 7 | 2.32 | 173C | 3 | - | 216 | 1.92 | 183C | 3 | - | 235 | 1.61* | 183C | 3 | - | 251 | 1.37* | 193C | 3 | - | 270 | 58 | 2157 |
| | | | | 1 | | | 243C | 12 | 0.7 | 270 | | 263C | 12 | 0.7 | 295 | | 283C | 12 | 0.7 | 320 | | 303C | 12 | 0.6 | 345 | 84 | |
| | | 2# 8 | | 1 | 3# 8 | 2.93 | 193C | 3 | - | 273 | 2.43* | 203C | 3 | - | 297 | 2.04* | 213C | 3 | - | 321 | 1.74* | 223C | 3 | - | 345 | 74 | 1977 |
| | | | | 1 | | | 244C | 12 | 0.7 | 428 | | 264C | 12 | 0.7 | 467 | | 283C | 12 | 0.7 | 381 | | 303C | 12 | 0.6 | 411 | 106 | |
| | | 2# 7 | 1# 7 | 1 | 3# 9 | 3.38* | 203C | 3 | - | 309 | 2.79* | 213C | 3 | - | 337 | 2.35* | 223C | 3 | - | 364 | 2.00* | 233C | 3 | - | 392 | 84 | 1786 |
| | | | | 1 | | | 244C | 12 | 0.7 | 462 | | 264C | 12 | 0.7 | 504 | | 284C | 12 | 0.7 | 546 | | 304C | 12 | 0.6 | 588 | 125 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b - 2''$).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

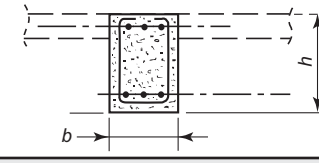
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

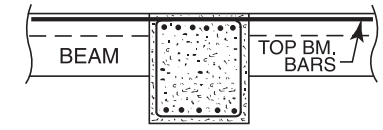
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w/1.4$.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 16 ft | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | SPAN, $\ell_n$ = 20 ft. | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 16 | 10 | 2# 5 | | 1 | 2# 6 | 2.19 | 113D | 2 | - | 99 | 1.73 | 123D | 2 | - | 110 | 1.40 | 123D | 2 | - | 118 | 1.16 | 123D | 2 | - | 126 | 36 | 1585 |
| | | | | 1 | | | 193C | 9 | 0.6 | 144 | | 223C | 9 | 0.6 | 164 | | 243C | 9 | 0.6 | 180 | | 263C | 9 | 0.6 | 196 | 50 | |
| | | 2# 6 | | 1 | 2# 7 | 2.90 | 133D | 2 | - | 131 | 2.29 | 143D | 2 | - | 146 | 1.86 | 143D | 2 | - | 157 | 1.53 | 153D | 2 | - | 171 | 50 | 1926 |
| | | | | 1 | | | 193C | 9 | 0.6 | 171 | | 223C | 9 | 0.6 | 194 | | 243C | 9 | 0.6 | 214 | | 263C | 9 | 0.6 | 233 | 67 | |
| | | 2# 7 | | 1 | 2# 9 | 4.22 | 143D | 2 | - | 182 | 3.33 | 153D | 2 | - | 202 | 2.70 | 163D | 2 | - | 222 | 2.23 | 173D | 2 | - | 242 | 67 | 1769 |
| | | | | 1 | | | 323A | 9 | 0.6 | 270 | | 363A | 9 | 0.6 | 304 | | 403A | 9 | 0.6 | 337 | | 263C | 9 | 0.6 | 298 | 105 | |
| | | 2# 8 | | 1 | 2#10 | 5.26 | 173AeD | 2 | - | 231 | 4.15 | 163D | 2 | - | 250 | 3.37 | 173D | 2 | - | 275 | 2.78 | 193D | 2 | - | 303 | 86 | 1552 |
| | | | | 1 | | | 323A | 9 | 0.6 | 311 | | 363A | 9 | 0.6 | 349 | | 403A | 9 | 0.6 | 387 | | 433A | 9 | 0.6 | 422 | 122 | |
| | 12 | 2# 6 | | 1 | 2# 7 | 2.94 | 123D | 3 | - | 130 | 2.32 | 123D | 3 | - | 141 | 1.88 | 133D | 3 | - | 156 | 1.56 | 133D | 3 | - | 167 | 51 | 1481 |
| | | | | 1 | | | 193C | 12 | 0.7 | 176 | | 223C | 12 | 0.7 | 200 | | 243C | 12 | 0.7 | 220 | | 263C | 12 | 0.7 | 240 | 68 | |
| | | 2# 7 | | 1 | 2# 8 | 3.77 | 133D | 3 | - | 165 | 2.98 | 143D | 3 | - | 183 | 2.41 | 153D | 3 | - | 201 | 1.99 | 153D | 3 | - | 217 | 68 | 1606 |
| | | | | 1 | | | 194C | 12 | 0.7 | 292 | | 223C | 12 | 0.7 | 236 | | 243C | 12 | 0.7 | 259 | | 263C | 12 | 0.7 | 283 | 87 | |
| | | 2# 8 | | 1 | 2#10 | 5.48 | 144D | 3 | - | 264 | 4.33 | 163D | 3 | - | 252 | 3.51 | 173D | 3 | - | 277 | 2.90 | 183D | 3 | - | 302 | 87 | 1439 |
| | | | | 1 | | | 194C | 12 | 0.7 | 348 | | 224C | 12 | 0.7 | 396 | | 244C | 12 | 0.7 | 436 | | 264C | 12 | 0.7 | 476 | 131 | |
| | | 2# 9 | | 1 | 2#11 | 6.25 | 154D | 3 | - | 317 | 4.94 | 164D | 3 | - | 350 | 4.00 | 173D | 3 | - | 335 | 3.31 | 193D | 3 | - | 368 | 107 | 1275 |
| | | | | 1 | | | 194C | 12 | 0.7 | 395 | | 224C | 12 | 0.7 | 448 | | 244C | 12 | 0.7 | 494 | | 264C | 12 | 0.7 | 539 | 145 | |
| | 14 | 2# 6 | | 1 | 3# 6 | 3.23 | 123D | 4 | - | 136 | 2.56 | 123D | 4 | - | 148 | 2.07 | 123D | 4 | - | 160 | 1.71 | 133D | 4 | - | 175 | 51 | 1214 |
| | | | | 1 | | | 164D | 15 | 0.8 | 246 | | 183D | 15 | 0.8 | 192 | | 203D | 15 | 0.8 | 213 | | 223D | 15 | 0.8 | 234 | 75 | |
| | | 2# 7 | | 1 | 3# 7 | 4.32 | 133D | 4 | - | 175 | 3.41 | 143D | 4 | - | 194 | 2.77 | 153D | 4 | - | 214 | 2.29 | 153D | 4 | - | 230 | 69 | 1419 |
| | | | | 1 | | | 164D | 15 | 0.8 | 282 | | 184D | 15 | 0.8 | 316 | | 204D | 15 | 0.8 | 351 | | 224D | 15 | 0.8 | 386 | 100 | |
| | | 2# 8 | | 1 | 3# 9 | 5.56 | 143D | 4 | - | 243 | 4.39 | 153D | 4 | - | 270 | 3.56 | 163D | 4 | - | 297 | 2.94 | 173D | 4 | - | 325 | 88 | 1241 |
| | | | | 1 | | | 164D | 15 | 0.8 | 346 | | 184D | 15 | 0.8 | 389 | | 204D | 15 | 0.8 | 432 | | 224D | 15 | 0.8 | 474 | 155 | |
| | | 2# 9 | | 1 | 3# 9 | 6.70 | 154D | 4 | - | 316 | 5.29 | 164D | 4 | - | 349 | 4.29 | 173D | 4 | - | 331 | 3.54 | 183D | 4 | - | 361 | 109 | 1203 |
| | | | | 1 | | | 165D | 15 | 0.8 | 469 | | 185D | 15 | 0.8 | 527 | | 204D | 15 | 0.8 | 462 | | 224D | 15 | 0.7 | 508 | 155 | |
| | 16 | 2# 7 | | 1 | 3# 7 | 4.35 | 123D | 5 | - | 173 | 3.44 | 133D | 5 | - | 193 | 2.79 | 143D | 5 | - | 212 | 2.30 | 143D | 5 | - | 229 | 69 | 1204 |
| | | | | 1 | | | 164D | 19 | 0.9 | 289 | | 184D | 19 | 0.9 | 325 | | 204D | 18 | 0.9 | 360 | | 223D | 18 | 0.8 | 289 | 101 | |
| | | 2# 8 | | 1 | 3# 8 | 5.59 | 133D | 5 | - | 218 | 4.41 | 153D | 5 | - | 246 | 3.58 | 153D | 5 | - | 267 | 2.96 | 163D | 5 | - | 291 | 89 | 1229 |
| | | | | 1 | | | 164D | 19 | 0.9 | 330 | | 184D | 19 | 0.9 | 371 | | 204D | 18 | 0.9 | 412 | | 224D | 18 | 0.8 | 452 | 130 | |
| | | 2# 9 | | 1 | 3# 9 | 6.83 | 144D | 5 | - | 313 | 5.40 | 153D | 5 | - | 300 | 4.37 | 173D | 5 | - | 333 | 3.61 | 183D | 5 | - | 364 | 110 | 1131 |
| | | | | 1 | | | 165D | 19 | 0.9 | 480 | | 185D | 18 | 0.9 | 539 | | 204D | 18 | 0.8 | 471 | | 224D | 18 | 0.8 | 518 | 159 | |
| | | 2# 8 | 1# 8 | 1 | 3#10 | 8.13 | 154D | 5 | - | 355 | 6.42 | 164D | 5 | - | 393 | 5.20 | 174D | 5 | - | 432 | 4.30 | 183D | 5 | - | 414 | 130 | 1009 |
| | | | | 1 | | | 165D | 19 | 0.9 | 516 | | 185D | 19 | 0.9 | 580 | | 205D | 18 | 0.8 | 644 | | 225D | 18 | 0.8 | 708 | 193 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

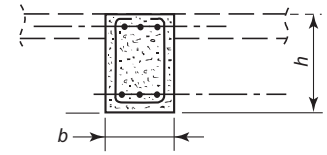
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

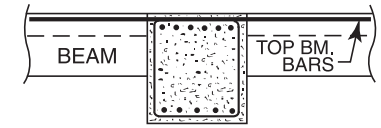
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 24 ft | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 16 | 10 | 2# 5 | | 1 | 2# 6 | 0.97 | 123D | 2 | - | 134 | 0.83 | 113D | 2 | - | 139 | 0.71 | 113D | 2 | - | 148 | 0.62 | 103D | 2 | - | 153 | 36 | 1585 |
| | | | | 1 | | | 283C | 9 | 0.6 | 213 | | 303C | 9 | 0.6 | 229 | | 323C | 8 | 0.6 | 245 | | 343C | 8 | 0.6 | 261 | 50 | |
| | | 2# 6 | | 1 | 2# 7 | 1.29 | 153D | 2 | - | 183 | 1.10 | 153D | 2 | - | 194 | 0.95 | 163D | 2 | - | 209 | 0.83 | 163D | 2 | - | 220 | 50 | 1926 |
| | | | | 1 | | | 283C | 9 | 0.6 | 253 | | 303C | 9 | 0.6 | 272 | | 323C | 8 | 0.6 | 292 | | 343C | 8 | 0.6 | 311 | 67 | |
| | | 2# 7 | | 1 | 2# 9 | 1.88 | 183D | 2 | - | 262 | 1.60* | 193D | 2 | - | 282 | 1.38* | 203D | 2 | - | 302 | 1.20* | 203D | 2 | - | 319 | 67 | 1769 |
| | | | | 1 | | | 283C | 9 | 0.6 | 323 | | 303C | 9 | 0.6 | 349 | | 323C | 8 | 0.6 | 374 | | 333C | 8 | 0.6 | 395 | 105 | |
| | | 2# 8 | | 1 | 2#10 | 2.34* | 203D | 2 | - | 328 | 1.99* | 213D | 2 | - | 353 | 1.72* | 223D | 2 | - | 378 | 1.50* | 233D | 2 | - | 403 | 86 | 1552 |
| | | | | 1 | | | 463A | 9 | 0.6 | 456 | | 493A | 9 | 0.6 | 490 | | 323C | 8 | 0.6 | 444 | | 333C | 8 | 0.6 | 470 | 122 | |
| | 12 | 2# 6 | | 1 | 2# 7 | 1.31 | 133D | 3 | - | 179 | 1.11 | 133D | 3 | - | 190 | 0.96 | 133D | 3 | - | 202 | 0.84 | 133D | 3 | - | 213 | 51 | 1481 |
| | | | | 1 | | | 293C | 11 | 0.7 | 264 | | 303C | 11 | 0.6 | 280 | | 323C | 11 | 0.6 | 300 | | 343C | 11 | 0.6 | 320 | 68 | |
| | | 2# 7 | | 1 | 2# 8 | 1.68 | 163D | 3 | - | 235 | 1.43 | 163D | 3 | - | 250 | 1.23 | 173D | 3 | - | 268 | 1.07 | 173D | 3 | - | 284 | 68 | 1606 |
| | | | | 1 | | | 283C | 11 | 0.7 | 307 | | 303C | 11 | 0.6 | 331 | | 323C | 11 | 0.6 | 355 | | 343C | 11 | 0.6 | 378 | 87 | |
| | | 2# 8 | | 1 | 2#10 | 2.44* | 193D | 3 | - | 327 | 2.08* | 203D | 3 | - | 352 | 1.79* | 213D | 3 | - | 377 | 1.56* | 213D | 3 | - | 400 | 87 | 1439 |
| | | | | 1 | | | 284C | 11 | 0.7 | 515 | | 303C | 11 | 0.6 | 421 | | 323C | 11 | 0.6 | 452 | | 343C | 11 | 0.6 | 483 | 131 | |
| | | 2# 9 | | 1 | 2#11 | 2.78* | 203D | 3 | - | 399 | 2.37* | 213D | 3 | - | 430 | 2.04* | 223D | 3 | - | 460 | 1.78* | 233D | 3 | - | 491 | 107 | 1275 |
| | | | | 1 | | | 284C | 11 | 0.7 | 584 | | 304C | 11 | 0.6 | 629 | | 324C | 11 | 0.6 | 674 | | 343C | 11 | 0.6 | 568 | 145 | |
| | 14 | 2# 6 | | 1 | 3# 6 | 1.44 | 133D | 4 | - | 187 | 1.23 | 123D | 4 | - | 196 | 1.06 | 123D | 4 | - | 208 | 0.92 | 123D | 4 | - | 220 | 51 | 1214 |
| | | | | 1 | | | 243D | 15 | 0.7 | 255 | | 263D | 14 | 0.7 | 277 | | 273D | 14 | 0.7 | 293 | | 293D | 14 | 0.7 | 314 | 75 | |
| | | 2# 7 | | 1 | 3# 7 | 1.92 | 163D | 4 | - | 249 | 1.64 | 163D | 4 | - | 266 | 1.41 | 163D | 4 | - | 282 | 1.23* | 173D | 4 | - | 302 | 69 | 1419 |
| | | | | 1 | | | 243D | 15 | 0.7 | 309 | | 263D | 14 | 0.7 | 334 | | 273D | 14 | 0.7 | 355 | | 293D | 14 | 0.7 | 380 | 100 | |
| | | 2# 8 | | 1 | 3# 9 | 2.47 | 183D | 4 | - | 352 | 2.10 | 193D | 4 | - | 379 | 1.81* | 193D | 4 | - | 404 | 1.58* | 203D | 4 | - | 431 | 88 | 1241 |
| | | | | 1 | | | 244D | 15 | 0.7 | 517 | | 264D | 14 | 0.7 | 559 | | 274D | 14 | 0.7 | 593 | | 293D | 14 | 0.7 | 500 | 155 | |
| | | 2# 9 | | 1 | 3# 9 | 2.98* | 193D | 4 | - | 392 | 2.54* | 203D | 4 | - | 422 | 2.19* | 213D | 4 | - | 452 | 1.90* | 223D | 4 | - | 482 | 109 | 1203 |
| | | | | 1 | | | 244D | 15 | 0.7 | 553 | | 264D | 14 | 0.7 | 599 | | 274D | 14 | 0.7 | 635 | | 294D | 14 | 0.7 | 681 | 155 | |
| | 16 | 2# 7 | | 1 | 3# 7 | 1.94 | 153D | 4 | - | 248 | 1.65 | 153D | 4 | - | 265 | 1.42 | 153D | 4 | - | 281 | 1.24 | 153D | 4 | - | 297 | 69 | 1204 |
| | | | | 1 | | | 243D | 18 | 0.8 | 315 | | 263D | 18 | 0.8 | 340 | | 283D | 18 | 0.8 | 366 | | 293D | 18 | 0.8 | 387 | 101 | |
| | | 2# 8 | | 1 | 3# 8 | 2.48 | 173D | 4 | - | 316 | 2.12 | 173D | 4 | - | 337 | 1.82* | 183D | 4 | - | 362 | 1.59* | 183D | 4 | - | 383 | 89 | 1229 |
| | | | | 1 | | | 244D | 18 | 0.8 | 493 | | 264D | 18 | 0.8 | 533 | | 283D | 18 | 0.8 | 438 | | 293D | 18 | 0.8 | 464 | 130 | |
| | | 2# 9 | | 1 | 3# 9 | 3.04* | 183D | 4 | - | 391 | 2.59* | 193D | 4 | - | 421 | 2.23* | 203D | 4 | - | 452 | 1.94* | 213D | 4 | - | 482 | 110 | 1131 |
| | | | | 1 | | | 244D | 18 | 0.8 | 564 | | 264D | 18 | 0.8 | 611 | | 284D | 18 | 0.8 | 657 | | 294D | 17 | 0.8 | 694 | 159 | |
| | | 2#10 | | 1 | 3#10 | 3.69* | 203D | 4 | - | 486 | 3.14* | 213D | 4 | - | 523 | 2.71* | 223D | 4 | - | 561 | 2.36* | 233D | 4 | - | 598 | 136 | 1000 |
| | | | | 1 | | | 244D | 18 | 0.8 | 653 | | 264D | 18 | 0.8 | 707 | | 284D | 18 | 0.8 | 760 | | 294D | 17 | 0.8 | 804 | 193 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b - 2''$).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

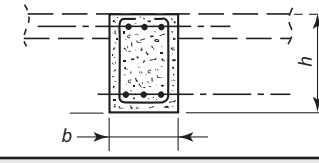
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

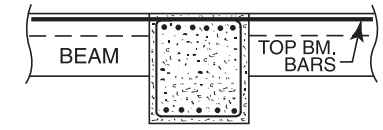
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w/1.4$.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 16 ft | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | SPAN, $\ell_n$ = 20 ft. | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 18 | 10 | 2# 5 | | 1 | 2# 7 | 2.64 | 103E | 3 | - | 110 | 2.09 | 113E | 3 | - | 122 | 1.69 | 113E | 3 | - | 132 | 1.40 | 113E | 3 | - | 142 | 42 | 1005 |
| | | | | 1 | | | 193C | 11 | 0.7 | 160 | | 223C | 11 | 0.7 | 182 | | 243C | 11 | 0.7 | 201 | | 263C | 10 | 0.7 | 219 | 78 | |
| | | 2# 6 | | 1 | 2# 8 | 3.68 | 113E | 3 | - | 142 | 2.90 | 123E | 3 | - | 158 | 2.35 | 133E | 3 | - | 174 | 1.94 | 143E | 3 | - | 190 | 58 | 1293 |
| | | | | 1 | | | 323A | 11 | 0.7 | 244 | | 223C | 11 | 0.7 | 215 | | 243C | 11 | 0.7 | 237 | | 263C | 10 | 0.7 | 258 | 100 | |
| | | 2# 8 | | 1 | 2# 9 | 5.29 | 133E | 3 | - | 203 | 4.18 | 143E | 3 | - | 226 | 3.38 | 153E | 3 | - | 249 | 2.80 | 163E | 3 | - | 272 | 100 | 1189 |
| | | | | 1 | | | 323A | 11 | 0.7 | 300 | | 363A | 11 | 0.7 | 336 | | 403A | 11 | 0.7 | 373 | | 443A | 10 | 0.7 | 410 | 123 | |
| | | 2# 8 | | 1 | 2#10 | 6.27 | 153BfE | 3 | - | 229 | 4.95 | 163BeE | 3 | - | 254 | 4.01 | 153E | 3 | - | 273 | 3.32 | 163E | 3 | - | 298 | 100 | 1121 |
| | | | | 1 | | | 323A | 11 | 0.7 | 319 | | 363A | 11 | 0.7 | 358 | | 403A | 11 | 0.7 | 397 | | 443A | 10 | 0.7 | 437 | 150 | |
| | 12 | 2# 6 | | 1 | 2# 7 | 3.41 | 103E | 4 | - | 127 | 2.69 | 113E | 4 | - | 141 | 2.18 | 113E | 4 | - | 153 | 1.80 | 123E | 3 | - | 167 | 59 | 945 |
| | | | | 1 | | | 164D | 15 | 0.8 | 241 | | 183D | 14 | 0.8 | 187 | | 203D | 14 | 0.8 | 208 | | 223D | 14 | 0.8 | 228 | 79 | |
| | | 2# 7 | | 1 | 2# 9 | 4.95 | 123E | 4 | - | 180 | 3.91 | 133E | 4 | - | 201 | 3.17 | 143E | 4 | - | 221 | 2.62 | 143E | 3 | - | 239 | 79 | 1108 |
| | | | | 1 | | | 164D | 15 | 0.8 | 289 | | 184D | 14 | 0.8 | 324 | | 204D | 14 | 0.8 | 360 | | 224D | 14 | 0.8 | 396 | 125 | |
| | | 2# 8 | | 1 | 2#10 | 6.37 | 134E | 4 | - | 265 | 5.03 | 143E | 4 | - | 249 | 4.08 | 153E | 4 | - | 275 | 3.37 | 163E | 3 | - | 300 | 101 | 1031 |
| | | | | 1 | | | 324A | 15 | 0.8 | 476 | | 184D | 14 | 0.8 | 370 | | 204D | 14 | 0.8 | 410 | | 224D | 14 | 0.8 | 451 | 154 | |
| | | 2# 9 | | 1 | 2#11 | 7.84 | 134E | 4 | - | 311 | 6.20 | 144E | 4 | - | 345 | 5.02 | 154E | 4 | - | 379 | 4.15 | 164E | 3 | - | 413 | 125 | 923 |
| | | | | 1 | | | 324A | 15 | 0.8 | 522 | | 364A | 14 | 0.8 | 587 | | 404A | 14 | 0.8 | 651 | | 224D | 14 | 0.7 | 514 | 182 | |
| | 14 | 2# 7 | | 1 | 3# 7 | 5.00 | 113E | 5 | - | 171 | 3.95 | 123E | 5 | - | 191 | 3.20 | 133E | 5 | - | 211 | 2.64 | 133E | 4 | - | 227 | 79 | 964 |
| | | | | 1 | | | 164D | 19 | 0.9 | 289 | | 184D | 18 | 0.9 | 325 | | 204D | 18 | 0.9 | 360 | | 224D | 18 | 0.9 | 396 | 116 | |
| | | 2# 8 | | 1 | 3# 8 | 6.42 | 124E | 5 | - | 255 | 5.07 | 133E | 5 | - | 241 | 4.11 | 143E | 5 | - | 265 | 3.39 | 153E | 4 | - | 290 | 103 | 954 |
| | | | | 1 | | | 164D | 19 | 0.9 | 330 | | 184D | 18 | 0.9 | 371 | | 204D | 18 | 0.9 | 412 | | 224D | 18 | 0.9 | 452 | 149 | |
| | | 2# 9 | | 1 | 3# 9 | 7.86 | 134E | 5 | - | 309 | 6.21 | 144E | 5 | - | 343 | 5.03 | 154E | 5 | - | 377 | 4.16 | 163E | 4 | - | 359 | 127 | 866 |
| | | | | 1 | | | 165D | 19 | 0.9 | 480 | | 185D | 18 | 0.9 | 539 | | 204D | 18 | 0.9 | 471 | | 224D | 18 | 0.8 | 518 | 182 | |
| | | 2# 8 | 1# 8 | 1 | 3#10 | 9.34 | 283A | 5 | - | 354 | 7.38 | 144E | 5 | - | 384 | 5.98 | 154E | 5 | - | 422 | 4.94 | 164E | 4 | - | 461 | 149 | 768 |
| | | | | 1 | | | 324A | 19 | 0.9 | 569 | | 185D | 18 | 0.9 | 580 | | 205D | 18 | 0.9 | 644 | | 225D | 18 | 0.8 | 708 | 222 | |
| | 16 | 2# 7 | | 1 | 3# 7 | 5.03 | 113E | 6 | - | 173 | 3.97 | 123E | 6 | - | 193 | 3.22 | 123E | 6 | - | 209 | 2.66 | 123E | 5 | - | 225 | 80 | 790 |
| | | | | 1 | | | 144E | 23 | 1.0 | 276 | | 164E | 23 | 1.0 | 313 | | 174E | 22 | 1.0 | 339 | | 194E | 22 | 1.0 | 376 | 118 | |
| | | 2# 8 | | 1 | 3# 8 | 6.50 | 123E | 6 | - | 218 | 5.14 | 133E | 6 | - | 242 | 4.16 | 143E | 6 | - | 267 | 3.44 | 143E | 5 | - | 289 | 104 | 858 |
| | | | | 1 | | | 145E | 23 | 1.0 | 410 | | 164E | 23 | 1.0 | 359 | | 174E | 22 | 1.0 | 390 | | 194E | 22 | 1.0 | 432 | 151 | |
| | | 2# 8 | 1# 8 | 1 | 3#10 | 9.46 | 135E | 6 | - | 403 | 7.47 | 144E | 6 | - | 387 | 6.05 | 154E | 6 | - | 426 | 5.00 | 164E | 5 | - | 464 | 151 | 727 |
| | | | | 1 | | | 245B | 23 | 1.0 | 661 | | 165E | 23 | 1.0 | 559 | | 175E | 22 | 1.0 | 608 | | 195E | 22 | 1.0 | 673 | 227 | |
| | | 2# 9 | 1# 9 | 1 | 3#11 | 11.02 | 293A | 6 | - | 426 | 8.71 | 145E | 6 | - | 520 | 7.05 | 164E | 6 | - | 515 | 5.83 | 174E | 5 | - | 561 | 186 | 642 |
| | | | | 1 | | | 324A | 23 | 1.0 | 649 | | 275B | 23 | 1.0 | 817 | | 175E | 22 | 1.0 | 690 | | 195E | 22 | 0.9 | 763 | 256 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

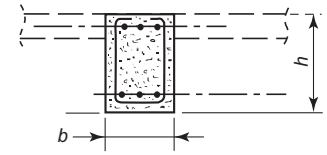
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

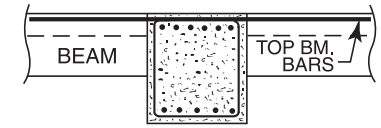
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 24 ft | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 18 | 10 | 2# 5 | | 1 | 2# 7 | 1.17 | 113E | 3 | - | 151 | 1.00 | 113E | 3 | - | 161 | 0.86 | 103E | 3 | - | 168 | 0.75 | 103E | 3 | - | 177 | 42 | 1005 |
| | | | | 1 | | | 293C | 10 | 0.6 | 241 | | 303C | 10 | 0.6 | 255 | | 323C | 10 | 0.6 | 273 | | 343C | 10 | 0.6 | 291 | 78 | |
| | | 2# 6 | | 1 | 2# 8 | 1.63 | 143E | 3 | - | 204 | 1.39 | 143E | 3 | - | 217 | 1.20 | 153E | 3 | - | 233 | 1.05 | 153E | 3 | - | 246 | 58 | 1293 |
| | | | | 1 | | | 293C | 10 | 0.6 | 284 | | 303C | 10 | 0.6 | 302 | | 323C | 10 | 0.6 | 323 | | 343C | 10 | 0.6 | 345 | 100 | |
| | | 2# 8 | | 1 | 2# 9 | 2.35 | 163E | 3 | - | 291 | 2.00 | 173E | 3 | - | 314 | 1.73 | 183E | 3 | - | 337 | 1.50* | 193E | 3 | - | 360 | 100 | 1189 |
| | | | | 1 | | | 293C | 10 | 0.6 | 366 | | 303C | 10 | 0.6 | 390 | | 323C | 10 | 0.6 | 418 | | 343C | 10 | 0.6 | 446 | 123 | |
| | | 2# 8 | | 1 | 2#10 | 2.79 | 173E | 3 | - | 323 | 2.37* | 183E | 3 | - | 349 | 2.05* | 193E | 3 | - | 374 | 1.78* | 203E | 3 | - | 399 | 100 | 1121 |
| | | | | 1 | | | 473A | 10 | 0.6 | 471 | | 503A | 10 | 0.6 | 506 | | 533A | 10 | 0.6 | 541 | | 343C | 10 | 0.6 | 483 | 150 | |
| | 12 | 2# 6 | | 1 | 2# 7 | 1.51 | 123E | 3 | - | 179 | 1.29 | 123E | 3 | - | 190 | 1.11 | 123E | 3 | - | 202 | 0.97 | 113E | 3 | - | 210 | 59 | 945 |
| | | | | 1 | | | 243D | 14 | 0.7 | 249 | | 263D | 14 | 0.7 | 269 | | 273D | 14 | 0.7 | 285 | | 293D | 13 | 0.7 | 306 | 79 | |
| | | 2# 7 | | 1 | 2# 9 | 2.20 | 153E | 3 | - | 259 | 1.88 | 153E | 3 | - | 276 | 1.62 | 163E | 3 | - | 297 | 1.41 | 163E | 3 | - | 314 | 79 | 1108 |
| | | | | 1 | | | 244D | 14 | 0.7 | 431 | | 263D | 14 | 0.7 | 346 | | 273D | 14 | 0.7 | 367 | | 293D | 13 | 0.7 | 394 | 125 | |
| | | 2# 8 | | 1 | 2#10 | 2.83 | 163E | 3 | - | 322 | 2.41 | 173E | 3 | - | 348 | 2.08* | 183E | 3 | - | 373 | 1.81* | 193E | 3 | - | 398 | 101 | 1031 |
| | | | | 1 | | | 244D | 14 | 0.7 | 491 | | 264D | 14 | 0.7 | 532 | | 274D | 14 | 0.7 | 563 | | 294D | 13 | 0.7 | 604 | 154 | |
| | | 2# 9 | | 1 | 2#11 | 3.49 | 173E | 3 | - | 394 | 2.97* | 183E | 3 | - | 425 | 2.56* | 193E | 3 | - | 456 | 2.23* | 203E | 3 | - | 487 | 125 | 923 |
| | | | | 1 | | | 244D | 14 | 0.7 | 560 | | 264D | 14 | 0.7 | 606 | | 274D | 14 | 0.7 | 643 | | 294D | 13 | 0.7 | 689 | 182 | |
| | 14 | 2# 7 | | 1 | 3# 7 | 2.22 | 143E | 4 | - | 247 | 1.89 | 143E | 4 | - | 263 | 1.63 | 143E | 4 | - | 280 | 1.42 | 143E | 4 | - | 296 | 79 | 964 |
| | | | | 1 | | | 243D | 18 | 0.8 | 315 | | 263D | 17 | 0.8 | 340 | | 283D | 17 | 0.8 | 366 | | 293D | 17 | 0.8 | 387 | 116 | |
| | | 2# 8 | | 1 | 3# 8 | 2.85 | 163E | 4 | - | 315 | 2.43 | 163E | 4 | - | 336 | 2.10 | 173E | 4 | - | 361 | 1.83* | 173E | 4 | - | 382 | 103 | 954 |
| | | | | 1 | | | 244D | 18 | 0.8 | 493 | | 264D | 17 | 0.8 | 533 | | 284D | 17 | 0.8 | 574 | | 294D | 17 | 0.8 | 605 | 149 | |
| | | 2# 9 | | 1 | 3# 9 | 3.49 | 173E | 4 | - | 390 | 2.98 | 183E | 4 | - | 420 | 2.57* | 183E | 4 | - | 447 | 2.23* | 193E | 4 | - | 478 | 127 | 866 |
| | | | | 1 | | | 244D | 18 | 0.8 | 564 | | 264D | 17 | 0.8 | 611 | | 284D | 17 | 0.8 | 657 | | 294D | 17 | 0.8 | 694 | 182 | |
| | | 2#10 | | 1 | 3#10 | 4.24 | 184E | 4 | - | 539 | 3.62* | 194E | 4 | - | 580 | 3.12* | 203E | 4 | - | 557 | 2.72* | 203E | 4 | - | 591 | 157 | 759 |
| | | | | 1 | | | 245D | 18 | 0.8 | 806 | | 264D | 17 | 0.8 | 707 | | 284D | 17 | 0.8 | 760 | | 294D | 17 | 0.8 | 804 | 222 | |
| | 16 | 2# 7 | | 1 | 3# 7 | 2.24 | 133E | 5 | - | 245 | 1.90 | 133E | 5 | - | 261 | 1.64 | 133E | 5 | - | 278 | 1.43 | 133E | 5 | - | 294 | 80 | 790 |
| | | | | 1 | | | 214E | 22 | 0.9 | 412 | | 223E | 21 | 0.9 | 327 | | 243E | 21 | 0.9 | 353 | | 263E | 21 | 0.9 | 380 | 118 | |
| | | 2# 8 | | 1 | 3# 8 | 2.89 | 153E | 5 | - | 313 | 2.46 | 153E | 5 | - | 335 | 2.12 | 163E | 5 | - | 360 | 1.85 | 163E | 5 | - | 381 | 104 | 858 |
| | | | | 1 | | | 214E | 22 | 0.9 | 474 | | 224E | 21 | 0.9 | 505 | | 244E | 21 | 0.9 | 547 | | 264E | 21 | 0.9 | 588 | 151 | |
| | | 2#10 | | 1 | 3#10 | 4.34 | 174E | 5 | - | 537 | 3.70* | 183E | 5 | - | 518 | 3.19* | 193E | 5 | - | 556 | 2.78* | 203E | 5 | - | 594 | 159 | 720 |
| | | | | 1 | | | 215E | 22 | 0.9 | 772 | | 225E | 21 | 0.9 | 823 | | 244E | 21 | 0.9 | 733 | | 264E | 21 | 0.9 | 787 | 227 | |
| | | 2#10 | | 1 | 3#11 | 4.43 | 174E | 5 | - | 585 | 3.78 | 183E | 5 | - | 571 | 3.26* | 193E | 5 | - | 613 | 2.84* | 203E | 5 | - | 654 | 159 | 671 |
| | | | | 1 | | | 215E | 22 | 0.9 | 821 | | 225E | 21 | 0.9 | 876 | | 245E | 21 | 0.9 | 948 | | 264E | 21 | 0.9 | 848 | 256 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

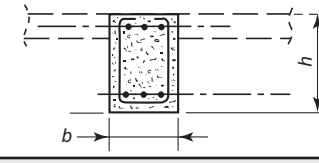
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

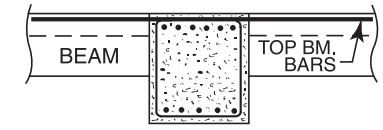
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 20 | 10 | 2# 6 | | 1 | 2# 7 | 2.45 | 113F | 3 | - | 154 | 2.03 | 123F | 3 | - | 169 | 1.70 | 123F | 3 | - | 180 | 1.45 | 123F | 3 | - | 192 | 66 | 890 |
| | | | | 1 | | | 203D | 12 | 0.7 | 208 | | 223D | 12 | 0.7 | 228 | | 243D | 12 | 0.7 | 249 | | 263D | 12 | 0.7 | 269 | 89 | |
| | | 2# 7 | | 1 | 2# 8 | 3.15 | 123F | 3 | - | 197 | 2.60 | 133F | 3 | - | 216 | 2.19 | 143F | 3 | - | 234 | 1.86 | 143F | 3 | - | 249 | 89 | 953 |
| | | | | 1 | | | 403A | 12 | 0.7 | 338 | | 443A | 12 | 0.7 | 371 | | 473A | 12 | 0.7 | 400 | | 263D | 12 | 0.7 | 320 | 114 | |
| | | 2# 8 | | 1 | 2#10 | 4.58 | 153CdF | 3 | - | 277 | 3.79 | 143F | 3 | - | 296 | 3.18 | 153F | 3 | - | 321 | 2.71 | 163F | 3 | - | 346 | 114 | 840 |
| | | | | 1 | | | 403A | 12 | 0.7 | 407 | | 443A | 12 | 0.7 | 448 | | 473A | 12 | 0.7 | 483 | | 503A | 12 | 0.7 | 519 | 172 | |
| | | 2# 9 | | 1 | 2#11 | 5.61 | 173ChF | 3 | - | 341 | 4.64 | 183CgF | 3 | - | 372 | 3.90 | 183CeF | 3 | - | 400 | 3.32 | 193CdF | 3 | - | 431 | 141 | 742 |
| | | | | 1 | | | 403A | 12 | 0.7 | 465 | | 443A | 12 | 0.7 | 511 | | 473A | 12 | 0.7 | 552 | | 503A | 12 | 0.7 | 593 | 204 | |
| | 12 | 2# 6 | | 1 | 2# 8 | 2.69 | 113F | 4 | - | 172 | 2.22 | 113F | 4 | - | 185 | 1.87 | 113F | 4 | - | 198 | 1.59 | 113F | 4 | - | 212 | 67 | 669 |
| | | | | 1 | | | 203D | 17 | 0.9 | 230 | | 223D | 16 | 0.8 | 252 | | 243D | 16 | 0.8 | 275 | | 263D | 16 | 0.8 | 297 | 116 | |
| | | 2# 7 | | 1 | 2# 9 | 3.60 | 123F | 4 | - | 218 | 2.98 | 133F | 4 | - | 239 | 2.50 | 133F | 4 | - | 256 | 2.13 | 143F | 4 | - | 276 | 90 | 797 |
| | | | | 1 | | | 204D | 17 | 0.9 | 369 | | 224D | 16 | 0.8 | 406 | | 244D | 16 | 0.8 | 442 | | 264D | 16 | 0.8 | 479 | 143 | |
| | | 2# 9 | | 1 | 2#11 | 5.75 | 144F | 4 | - | 379 | 4.75 | 154F | 4 | - | 414 | 3.99 | 164F | 4 | - | 448 | 3.40 | 163F | 4 | - | 423 | 143 | 692 |
| | | | | 1 | | | 404A | 17 | 0.8 | 670 | | 224D | 16 | 0.8 | 524 | | 244D | 16 | 0.8 | 571 | | 264D | 16 | 0.8 | 618 | 210 | |
| | | 2#10 | | 1 | 3#10 | 6.80 | 144F | 4 | - | 448 | 5.62 | 154F | 4 | - | 489 | 4.72 | 164F | 4 | - | 530 | 4.03 | 174F | 4 | - | 571 | 177 | 603 |
| | | | | 1 | | | 404A | 17 | 0.8 | 738 | | 444A | 16 | 0.8 | 811 | | 484A | 16 | 0.8 | 884 | | 264D | 16 | 0.8 | 707 | 247 | |
| | 14 | 2# 7 | | 1 | 3# 7 | 3.63 | 113F | 5 | - | 207 | 3.00 | 123F | 5 | - | 227 | 2.52 | 123F | 5 | - | 243 | 2.15 | 133F | 5 | - | 263 | 90 | 670 |
| | | | | 1 | | | 174E | 21 | 1.0 | 339 | | 194E | 21 | 1.0 | 376 | | 214E | 21 | 0.9 | 412 | | 224E | 21 | 0.9 | 439 | 133 | |
| | | 2# 8 | | 1 | 3# 8 | 4.69 | 133F | 5 | - | 265 | 3.88 | 133F | 5 | - | 287 | 3.26 | 143F | 5 | - | 312 | 2.78 | 143F | 5 | - | 333 | 117 | 699 |
| | | | | 1 | | | 174E | 21 | 1.0 | 390 | | 194E | 21 | 1.0 | 432 | | 214E | 21 | 0.9 | 474 | | 224E | 21 | 0.9 | 505 | 170 | |
| | | 2#10 | | 1 | 3#10 | 7.06 | 144F | 5 | - | 451 | 5.83 | 154F | 5 | - | 492 | 4.90 | 164F | 5 | - | 534 | 4.17 | 174F | 5 | - | 575 | 180 | 570 |
| | | | | 1 | | | 175E | 21 | 1.0 | 637 | | 195E | 21 | 0.9 | 704 | | 215E | 21 | 0.9 | 772 | | 225E | 21 | 0.9 | 823 | 256 | |
| | | 2#10 | | 1 | 3#11 | 7.21 | 144F | 5 | - | 491 | 5.96 | 154F | 5 | - | 537 | 5.01 | 164F | 5 | - | 582 | 4.26 | 174F | 5 | - | 628 | 180 | 530 |
| | | | | 1 | | | 175E | 21 | 1.0 | 677 | | 195E | 21 | 0.9 | 749 | | 215E | 21 | 0.9 | 821 | | 225E | 21 | 0.9 | 876 | 287 | |
| | 16 | 2# 7 | | 1 | 3# 7 | 3.65 | 113F | 7 | - | 208 | 3.02 | 113F | 6 | - | 225 | 2.54 | 113F | 6 | - | 241 | 2.16 | 113F | 6 | - | 257 | 91 | 528 |
| | | | | 1 | | | 174E | 26 | 1.1 | 347 | | 194E | 26 | 1.1 | 384 | | 214E | 26 | 1.1 | 422 | | 224E | 25 | 1.1 | 449 | 134 | |
| | | 2# 9 | | 1 | 3# 9 | 5.86 | 134F | 7 | - | 373 | 4.84 | 143F | 6 | - | 358 | 4.07 | 143F | 6 | - | 385 | 3.47 | 153F | 6 | - | 416 | 146 | 598 |
| | | | | 1 | | | 175E | 26 | 1.1 | 574 | | 195E | 26 | 1.1 | 636 | | 214E | 26 | 1.1 | 555 | | 224E | 25 | 1.0 | 592 | 213 | |
| | | 2#10 | | 1 | 3#10 | 7.20 | 144F | 7 | - | 454 | 5.95 | 144F | 6 | - | 488 | 5.00 | 154F | 6 | - | 530 | 4.26 | 164F | 6 | - | 572 | 182 | 539 |
| | | | | 1 | | | 175E | 26 | 1.1 | 648 | | 195E | 26 | 1.1 | 718 | | 215E | 26 | 1.1 | 787 | | 225E | 25 | 1.0 | 839 | 261 | |
| | | 2#11 | | 1 | 3#11 | 8.52 | 145F | 7 | - | 599 | 7.04 | 155F | 6 | - | 653 | 5.92 | 164F | 6 | - | 636 | 5.04 | 174F | 6 | - | 686 | 218 | 481 |
| | | | | 1 | | | 305B | 26 | 1.1 | 957 | | 195E | 26 | 1.1 | 808 | | 215E | 26 | 1.0 | 886 | | 225E | 25 | 1.0 | 946 | 309 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

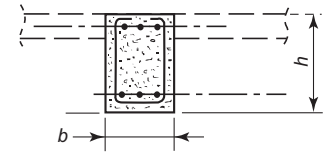
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

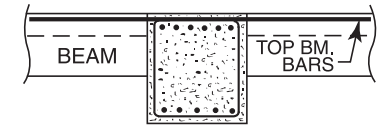
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 28 ft | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) $\times 10^{-9}$ |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft.-kips | sq. in. | lb. | ft.-kip | in. |
| 20 | 10 | 2# 6 | | 1 | 2# 7 | 1.25 | 123F | 3 | - | 203 | 1.09 | 123F | 3 | - | 215 | 0.96 | 123F | 3 | - | 226 | 0.85 | 123F | 3 | - | 238 | 66 | 890 |
| | | | | 1 | | | 283D | 12 | 0.7 | 290 | | 293D | 12 | 0.7 | 306 | | 313D | 12 | 0.7 | 326 | | 323D | 12 | 0.7 | 342 | 89 | |
| | | 2# 7 | | 1 | 2# 8 | 1.61 | 143F | 3 | - | 265 | 1.40 | 153F | 3 | - | 283 | 1.23 | 153F | 3 | - | 299 | 1.09 | 153F | 3 | - | 314 | 89 | 953 |
| | | | | 1 | | | 273D | 12 | 0.7 | 340 | | 293D | 12 | 0.7 | 364 | | 303D | 12 | 0.7 | 384 | | 323D | 12 | 0.7 | 409 | 114 | |
| | | 2# 8 | | 1 | 2#10 | 2.34 | 173F | 3 | - | 372 | 2.04 | 183F | 3 | - | 397 | 1.79* | 183F | 3 | - | 420 | 1.58* | 193F | 3 | - | 445 | 114 | 840 |
| | | | | 1 | | | 533A | 12 | 0.7 | 555 | | 563A | 12 | 0.7 | 590 | | 593A | 12 | 0.7 | 626 | | 623A | 12 | 0.7 | 662 | 172 | |
| | | 2# 9 | | 1 | 2#11 | 2.86* | 183F | 3 | - | 455 | 2.50* | 193F | 3 | - | 486 | 2.19* | 203F | 3 | - | 518 | 1.94* | 203F | 3 | - | 545 | 141 | 742 |
| | | | | 1 | | | 533A | 12 | 0.7 | 635 | | 563A | 12 | 0.7 | 676 | | 593A | 12 | 0.7 | 717 | | 623A | 12 | 0.7 | 759 | 204 | |
| | 12 | 2# 6 | | 1 | 2# 8 | 1.37 | 113F | 4 | - | 225 | 1.20 | 113F | 4 | - | 238 | 1.05 | 113F | 4 | - | 251 | 0.93 | 113F | 4 | - | 264 | 67 | 669 |
| | | | | 1 | | | 283D | 16 | 0.8 | 320 | | 293D | 16 | 0.8 | 338 | | 313D | 16 | 0.8 | 361 | | 323D | 16 | 0.8 | 379 | 116 | |
| | | 2# 7 | | 1 | 2# 9 | 1.84 | 143F | 4 | - | 294 | 1.60 | 143F | 4 | - | 311 | 1.41 | 153F | 4 | - | 332 | 1.25 | 153F | 4 | - | 349 | 90 | 797 |
| | | | | 1 | | | 283D | 16 | 0.8 | 379 | | 293D | 16 | 0.8 | 401 | | 313D | 16 | 0.8 | 428 | | 323D | 16 | 0.8 | 450 | 143 | |
| | | 2# 9 | | 1 | 2#11 | 2.93 | 173F | 4 | - | 454 | 2.55* | 183F | 4 | - | 485 | 2.25* | 193F | 4 | - | 517 | 1.99* | 193F | 4 | - | 544 | 143 | 692 |
| | | | | 1 | | | 284D | 16 | 0.8 | 665 | | 294D | 16 | 0.8 | 703 | | 314D | 16 | 0.8 | 750 | | 324D | 16 | 0.8 | 787 | 210 | |
| | | 2#10 | | 1 | 3#10 | 3.47 | 184F | 4 | - | 612 | 3.02* | 193F | 4 | - | 590 | 2.66* | 203F | 4 | - | 628 | 2.35* | 203F | 4 | - | 663 | 177 | 603 |
| | | | | 1 | | | 284D | 16 | 0.8 | 760 | | 294D | 16 | 0.8 | 804 | | 314D | 16 | 0.8 | 858 | | 324D | 16 | 0.8 | 902 | 247 | |
| | 14 | 2# 7 | | 1 | 3# 7 | 1.85 | 133F | 5 | - | 279 | 1.61 | 133F | 5 | - | 296 | 1.42 | 133F | 5 | - | 312 | 1.26 | 133F | 5 | - | 329 | 90 | 670 |
| | | | | 1 | | | 244E | 20 | 0.9 | 475 | | 263E | 20 | 0.9 | 380 | | 273E | 20 | 0.9 | 401 | | 283E | 20 | 0.9 | 422 | 133 | |
| | | 2# 8 | | 1 | 3# 8 | 2.39 | 153F | 5 | - | 358 | 2.09 | 153F | 5 | - | 379 | 1.83 | 163F | 5 | - | 404 | 1.62 | 163F | 5 | - | 426 | 117 | 699 |
| | | | | 1 | | | 244E | 20 | 0.9 | 547 | | 264E | 20 | 0.9 | 588 | | 274E | 20 | 0.9 | 620 | | 284E | 20 | 0.9 | 651 | 170 | |
| | | 2#10 | | 1 | 3#10 | 3.60 | 174F | 5 | - | 609 | 3.14* | 183F | 5 | - | 589 | 2.76* | 193F | 5 | - | 627 | 2.44* | 203F | 5 | - | 665 | 180 | 570 |
| | | | | 1 | | | 245E | 20 | 0.9 | 891 | | 264E | 20 | 0.9 | 787 | | 274E | 20 | 0.9 | 832 | | 284E | 20 | 0.9 | 876 | 256 | |
| | | 2#10 | | 1 | 3#11 | 3.68 | 184F | 5 | - | 673 | 3.20 | 183F | 5 | - | 650 | 2.82* | 193F | 5 | - | 692 | 2.49* | 203F | 5 | - | 734 | 180 | 530 |
| | | | | 1 | | | 245E | 20 | 0.9 | 948 | | 265E | 20 | 0.9 | 1019 | | 274E | 20 | 0.9 | 896 | | 284E | 20 | 0.9 | 945 | 287 | |
| | 16 | 2# 7 | | 1 | 3# 7 | 1.86 | 123F | 6 | - | 277 | 1.62 | 113F | 6 | - | 290 | 1.43 | 113F | 6 | - | 306 | 1.26 | 113F | 6 | - | 323 | 91 | 528 |
| | | | | 1 | | | 243E | 25 | 1.0 | 359 | | 263E | 25 | 1.0 | 386 | | 273E | 25 | 1.0 | 408 | | 283E | 25 | 1.0 | 429 | 134 | |
| | | 2# 9 | | 1 | 3# 9 | 2.99 | 163F | 6 | - | 447 | 2.60 | 163F | 6 | - | 474 | 2.29 | 173F | 6 | - | 505 | 2.03* | 173F | 6 | - | 532 | 146 | 598 |
| | | | | 1 | | | 244E | 25 | 1.0 | 641 | | 264E | 25 | 1.0 | 689 | | 274E | 25 | 1.0 | 727 | | 284E | 25 | 1.0 | 765 | 213 | |
| | | 2#10 | | 1 | 3#10 | 3.67 | 173F | 6 | - | 553 | 3.20 | 183F | 6 | - | 592 | 2.81* | 183F | 6 | - | 626 | 2.49* | 193F | 6 | - | 664 | 182 | 539 |
| | | | | 1 | | | 245E | 25 | 1.0 | 908 | | 264E | 25 | 1.0 | 799 | | 274E | 25 | 1.0 | 844 | | 284E | 25 | 1.0 | 889 | 261 | |
| | | 2#11 | | 1 | 3#11 | 4.35 | 184F | 6 | - | 736 | 3.79* | 194F | 6 | - | 785 | 3.33* | 194F | 6 | - | 828 | 2.95* | 203F | 6 | - | 807 | 218 | 481 |
| | | | | 1 | | | 245E | 25 | 1.0 | 1023 | | 265E | 25 | 1.0 | 1100 | | 275E | 25 | 1.0 | 1160 | | 285E | 25 | 1.0 | 1220 | 309 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

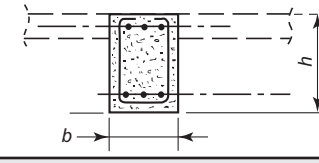
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

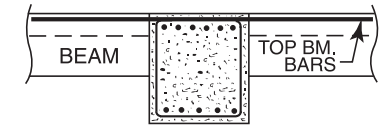
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 22 | 12 | 2# 7 | | 1 | 2# 8 | 3.59 | 103G | 5 | - | 194 | 2.96 | 113G | 5 | - | 213 | 2.49 | 113G | 5 | - | 228 | 2.12 | 123G | 5 | - | 247 | 100 | 554 |
| | | | | 1 | | | 174E | 19 | 1.0 | 329 | | 194E | 19 | 0.9 | 364 | | 214E | 19 | 0.9 | 400 | | 224E | 19 | 0.9 | 425 | 130 | |
| | | 2# 8 | | 1 | 2#10 | 5.22 | 124G | 5 | - | 314 | 4.31 | 133G | 5 | - | 297 | 3.62 | 133G | 5 | - | 319 | 3.09 | 143G | 5 | - | 345 | 130 | 583 |
| | | | | 1 | | | 304B | 19 | 1.0 | 530 | | 194E | 19 | 0.9 | 441 | | 214E | 19 | 0.9 | 483 | | 224E | 19 | 0.9 | 515 | 199 | |
| | | 2# 9 | | 1 | 2#11 | 6.47 | 124G | 5 | - | 371 | 5.35 | 134G | 5 | - | 406 | 4.49 | 144G | 5 | - | 441 | 3.83 | 154G | 5 | - | 476 | 161 | 534 |
| | | | | 1 | | | 304B | 19 | 0.9 | 587 | | 334B | 19 | 0.9 | 645 | | 364B | 19 | 0.9 | 703 | | 224E | 19 | 0.9 | 590 | 238 | |
| | | 2#10 | | 1 | 2#14 | 8.00 | 273B | 5 | - | 485 | 6.61 | 154DdG | 5 | - | 531 | 5.56 | 154G | 5 | - | 568 | 4.73 | 164G | 5 | - | 613 | 199 | 446 |
| | | | | 1 | | | 304B | 19 | 0.9 | 687 | | 334B | 19 | 0.9 | 755 | | 364B | 19 | 0.9 | 823 | | 394B | 19 | 0.9 | 891 | 302 | |
| | 14 | 2# 7 | | 1 | 3# 7 | 4.06 | 103G | 6 | - | 206 | 3.36 | 113G | 6 | - | 226 | 2.82 | 113G | 6 | - | 242 | 2.40 | 113G | 6 | - | 259 | 101 | 472 |
| | | | | 1 | | | 174E | 25 | 1.1 | 347 | | 194E | 24 | 1.1 | 384 | | 214E | 24 | 1.1 | 422 | | 224E | 24 | 1.0 | 449 | 149 | |
| | | 2# 9 | | 1 | 3# 9 | 6.51 | 124G | 6 | - | 368 | 5.38 | 134G | 6 | - | 403 | 4.52 | 133G | 6 | - | 383 | 3.85 | 143G | 6 | - | 414 | 163 | 496 |
| | | | | 1 | | | 175E | 25 | 1.1 | 574 | | 195E | 24 | 1.1 | 636 | | 215E | 24 | 1.0 | 698 | | 224E | 24 | 1.0 | 592 | 236 | |
| | | 2#10 | | 1 | 3#10 | 8.00 | 125G | 6 | - | 497 | 6.61 | 134G | 6 | - | 484 | 5.55 | 144G | 6 | - | 526 | 4.73 | 154G | 6 | - | 568 | 203 | 441 |
| | | | | 1 | | | 175E | 25 | 1.1 | 648 | | 195E | 24 | 1.1 | 718 | | 215E | 24 | 1.0 | 787 | | 225E | 24 | 1.0 | 839 | 290 | |
| | | 2#11 | | 1 | 3#11 | 9.47 | 274B | 6 | - | 637 | 7.82 | 145G | 6 | - | 646 | 6.57 | 155G | 6 | - | 701 | 5.60 | 164G | 6 | - | 682 | 243 | 391 |
| | | | | 1 | | | 304B | 25 | 1.1 | 752 | | 335B | 24 | 1.0 | 1052 | | 215E | 24 | 1.0 | 886 | | 225E | 24 | 1.0 | 946 | 344 | |
| | 16 | 2# 8 | | 1 | 3# 8 | 5.30 | 113G | 8 | - | 262 | 4.38 | 113G | 8 | - | 284 | 3.68 | 123G | 7 | - | 309 | 3.13 | 123G | 7 | - | 330 | 132 | 448 |
| | | | | 1 | | | 155F | 31 | 1.2 | 490 | | 174F | 30 | 1.2 | 427 | | 184F | 30 | 1.2 | 460 | | 204F | 29 | 1.2 | 503 | 194 | |
| | | 2# 9 | | 1 | 3# 9 | 6.60 | 124G | 8 | - | 371 | 5.45 | 124G | 8 | - | 398 | 4.58 | 133G | 7 | - | 385 | 3.91 | 143G | 7 | - | 416 | 164 | 453 |
| | | | | 1 | | | 155F | 31 | 1.2 | 550 | | 175F | 30 | 1.2 | 613 | | 185F | 30 | 1.2 | 659 | | 205F | 29 | 1.2 | 722 | 240 | |
| | | 2#11 | | 1 | 3#11 | 9.68 | 135G | 8 | - | 596 | 8.00 | 145G | 8 | - | 651 | 6.72 | 145G | 7 | - | 693 | 5.73 | 154G | 7 | - | 678 | 246 | 372 |
| | | | | 1 | | | 245C | 31 | 1.2 | 870 | | 265C | 30 | 1.2 | 948 | | 295C | 30 | 1.2 | 1045 | | 205F | 29 | 1.1 | 925 | 351 | |
| | | 2#10 | 1#10 | 1 | 4#10 | 10.41 | 135G | 8 | - | 635 | 8.61 | 145G | 8 | - | 694 | 7.23 | 155G | 7 | - | 753 | 6.16 | 155G | 7 | - | 800 | 295 | 338 |
| | | | | 1 | | | 245C | 31 | 1.2 | 909 | | 265C | 30 | 1.2 | 991 | | 295C | 30 | 1.2 | 1092 | | 315C | 29 | 1.1 | 1175 | 378 | |
| | 18 | 2# 7 | 1# 7 | 1 | 3# 8 | 5.38 | 103G | 9 | - | 264 | 4.44 | 113G | 9 | - | 290 | 3.73 | 113G | 9 | - | 312 | 3.18 | 123G | 9 | - | 338 | 151 | 369 |
| | | | | 1 | | | 155F | 37 | 1.3 | 505 | | 174F | 36 | 1.3 | 440 | | 214E | 36 | 1.3 | 508 | | 224E | 35 | 1.3 | 541 | 195 | |
| | | 2# 8 | 1# 8 | 1 | 3#10 | 7.82 | 124G | 9 | - | 419 | 6.47 | 134G | 9 | - | 459 | 5.43 | 134G | 9 | - | 491 | 4.63 | 143G | 9 | - | 477 | 195 | 389 |
| | | | | 1 | | | 155F | 37 | 1.3 | 606 | | 175F | 36 | 1.3 | 675 | | 185F | 36 | 1.3 | 726 | | 205F | 35 | 1.3 | 795 | 299 | |
| | | 2# 9 | 1# 9 | 1 | 3#11 | 9.70 | 125G | 9 | - | 559 | 8.02 | 135G | 9 | - | 611 | 6.74 | 144G | 9 | - | 597 | 5.74 | 154G | 9 | - | 645 | 242 | 356 |
| | | | | 1 | | | 245C | 37 | 1.3 | 857 | | 265C | 36 | 1.3 | 934 | | 295C | 36 | 1.3 | 1031 | | 205F | 35 | 1.3 | 902 | 358 | |
| | | 2#10 | 1#10 | 1 | 3#14 | 12.00 | 274B | 9 | - | 765 | 9.92 | 145G | 9 | - | 783 | 8.33 | 155G | 9 | - | 850 | 7.10 | 165G | 9 | - | 917 | 299 | 297 |
| | | | | 1 | | | 305B | 37 | 1.3 | 1114 | | 265C | 36 | 1.3 | 1094 | | 295C | 36 | 1.3 | 1204 | | 315C | 35 | 1.3 | 1296 | 453 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

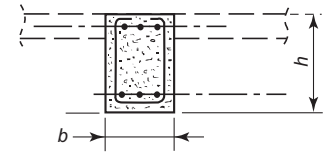
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

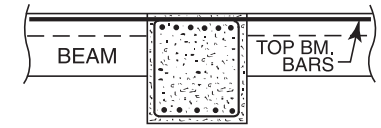
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 28 ft | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) $\times 10^{-9}$ |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft.-kips | sq. in. | lb. | ft.-kip | in. |
| 22 | 12 | 2# 7 | | 1 | 2# 8 | 1.83 | 123G | 5 | - | 263 | 1.59 | 123G | 5 | - | 278 | 1.40 | 123G | 5 | - | 293 | 1.24 | 123G | 4 | - | 308 | 100 | 554 |
| | | | | 1 | | | 244E | 18 | 0.9 | 460 | | 263E | 18 | 0.9 | 364 | | 273E | 18 | 0.9 | 384 | | 283E | 18 | 0.9 | 404 | 130 | |
| | | 2# 8 | | 1 | 2#10 | 2.66 | 143G | 5 | - | 367 | 2.32 | 153G | 5 | - | 393 | 2.04 | 153G | 5 | - | 415 | 1.80 | 163G | 4 | - | 441 | 130 | 583 |
| | | | | 1 | | | 244E | 18 | 0.9 | 558 | | 264E | 18 | 0.9 | 600 | | 274E | 18 | 0.9 | 632 | | 284E | 18 | 0.9 | 665 | 199 | |
| | | 2# 9 | | 1 | 2#11 | 3.30 | 153G | 5 | - | 451 | 2.87 | 163G | 5 | - | 482 | 2.53 | 173G | 5 | - | 514 | 2.24* | 173G | 4 | - | 542 | 161 | 534 |
| | | | | 1 | | | 244E | 18 | 0.9 | 638 | | 264E | 18 | 0.9 | 686 | | 274E | 18 | 0.9 | 724 | | 284E | 18 | 0.9 | 761 | 238 | |
| | | 2#10 | | 1 | 2#14 | 4.08 | 164G | 5 | - | 651 | 3.56 | 174G | 5 | - | 696 | 3.12 | 184G | 5 | - | 740 | 2.77* | 193G | 4 | - | 718 | 199 | 446 |
| | | | | 1 | | | 424B | 18 | 0.9 | 959 | | 444B | 18 | 0.9 | 1017 | | 274E | 18 | 0.9 | 883 | | 284E | 18 | 0.9 | 931 | 302 | |
| | 14 | 2# 7 | | 1 | 3# 7 | 2.07 | 123G | 6 | - | 279 | 1.81 | 123G | 6 | - | 295 | 1.59 | 123G | 6 | - | 312 | 1.41 | 123G | 6 | - | 328 | 101 | 472 |
| | | | | 1 | | | 244E | 24 | 1.0 | 486 | | 263E | 23 | 1.0 | 386 | | 273E | 23 | 1.0 | 408 | | 293E | 23 | 1.0 | 435 | 149 | |
| | | 2# 9 | | 1 | 3# 9 | 3.32 | 153G | 6 | - | 445 | 2.89 | 153G | 6 | - | 472 | 2.54 | 163G | 6 | - | 503 | 2.25 | 163G | 6 | - | 530 | 163 | 496 |
| | | | | 1 | | | 244E | 24 | 1.0 | 641 | | 264E | 23 | 1.0 | 689 | | 274E | 23 | 1.0 | 727 | | 294E | 23 | 1.0 | 775 | 236 | |
| | | 2#10 | | 1 | 3#10 | 4.08 | 164G | 6 | - | 610 | 3.55 | 164G | 6 | - | 644 | 3.12 | 173G | 6 | - | 624 | 2.77* | 183G | 6 | - | 663 | 203 | 441 |
| | | | | 1 | | | 245E | 24 | 1.0 | 908 | | 265E | 23 | 1.0 | 977 | | 274E | 23 | 1.0 | 844 | | 294E | 23 | 1.0 | 900 | 290 | |
| | | 2#11 | | 1 | 3#11 | 4.83 | 164G | 6 | - | 725 | 4.21 | 174G | 6 | - | 775 | 3.70* | 184G | 6 | - | 825 | 3.28* | 194G | 6 | - | 875 | 243 | 391 |
| | | | | 1 | | | 245E | 24 | 1.0 | 1023 | | 265E | 23 | 1.0 | 1100 | | 275E | 23 | 1.0 | 1160 | | 295E | 23 | 1.0 | 1237 | 344 | |
| | 16 | 2# 8 | | 1 | 3# 8 | 2.70 | 133G | 7 | - | 356 | 2.35 | 133G | 7 | - | 377 | 2.07 | 133G | 7 | - | 398 | 1.83 | 133G | 7 | - | 420 | 132 | 448 |
| | | | | 1 | | | 214F | 29 | 1.2 | 536 | | 234F | 29 | 1.1 | 579 | | 244F | 29 | 1.1 | 611 | | 254F | 29 | 1.1 | 644 | 194 | |
| | | 2# 9 | | 1 | 3# 9 | 3.37 | 143G | 7 | - | 443 | 2.93 | 153G | 7 | - | 474 | 2.58 | 153G | 7 | - | 501 | 2.28 | 153G | 7 | - | 528 | 164 | 453 |
| | | | | 1 | | | 214F | 29 | 1.1 | 619 | | 234F | 29 | 1.1 | 668 | | 244F | 29 | 1.1 | 706 | | 254F | 28 | 1.1 | 744 | 240 | |
| | | 2#11 | | 1 | 3#11 | 4.94 | 164G | 7 | - | 729 | 4.30 | 174G | 7 | - | 779 | 3.78 | 174G | 7 | - | 821 | 3.35* | 184G | 7 | - | 871 | 246 | 372 |
| | | | | 1 | | | 215F | 29 | 1.1 | 985 | | 235F | 29 | 1.1 | 1064 | | 245F | 29 | 1.1 | 1125 | | 255F | 28 | 1.1 | 1185 | 351 | |
| | | 2#10 | 1#10 | 1 | 4#10 | 5.31 | 164G | 7 | - | 784 | 4.63 | 174G | 7 | - | 838 | 4.07 | 184G | 7 | - | 893 | 3.60* | 194G | 7 | - | 947 | 295 | 338 |
| | | | | 1 | | | 215F | 29 | 1.1 | 1041 | | 235F | 29 | 1.1 | 1124 | | 245F | 29 | 1.1 | 1188 | | 255F | 28 | 1.1 | 1253 | 378 | |
| | 18 | 2# 7 | 1# 7 | 1 | 3# 8 | 2.74 | 123G | 9 | - | 360 | 2.39 | 123G | 9 | - | 382 | 2.10 | 123G | 9 | - | 404 | 1.86 | 123G | 9 | - | 426 | 151 | 369 |
| | | | | 1 | | | 244E | 35 | 1.3 | 586 | | 264E | 35 | 1.3 | 631 | | 284E | 35 | 1.3 | 676 | | 293E | 34 | 1.3 | 544 | 195 | |
| | | 2# 8 | 1# 8 | 1 | 3#10 | 3.99 | 143G | 9 | - | 509 | 3.48 | 153G | 9 | - | 545 | 3.06 | 153G | 9 | - | 577 | 2.71 | 163G | 9 | - | 613 | 195 | 389 |
| | | | | 1 | | | 215F | 35 | 1.3 | 846 | | 235F | 35 | 1.3 | 916 | | 244F | 34 | 1.3 | 791 | | 264F | 34 | 1.2 | 846 | 299 | |
| | | 2# 9 | 1# 9 | 1 | 3#11 | 4.95 | 154G | 9 | - | 685 | 4.31 | 164G | 9 | - | 733 | 3.79 | 173G | 9 | - | 715 | 3.36* | 173G | 9 | - | 755 | 242 | 356 |
| | | | | 1 | | | 215F | 35 | 1.3 | 960 | | 235F | 35 | 1.3 | 1038 | | 245F | 34 | 1.3 | 1097 | | 265F | 34 | 1.2 | 1174 | 358 | |
| | | 2#10 | 1#10 | 1 | 3#14 | 6.12 | 165G | 9 | - | 971 | 5.33 | 174G | 9 | - | 957 | 4.69 | 184G | 9 | - | 1019 | 4.15* | 194G | 9 | - | 1081 | 299 | 297 |
| | | | | 1 | | | 345C | 35 | 1.3 | 1407 | | 365C | 35 | 1.3 | 1498 | | 245F | 34 | 1.2 | 1327 | | 265F | 34 | 1.2 | 1419 | 453 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

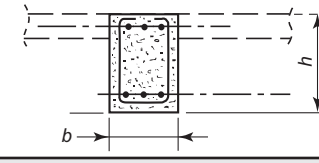
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

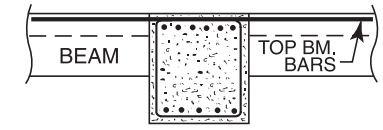
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 24 ft | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 24 | 12 | 2# 7 | | 1 | 2# 9 | 3.10 | 113H | 5 | - | 254 | 2.64 | 113H | 5 | - | 272 | 2.28 | 123H | 5 | - | 293 | 1.99 | 123H | 5 | - | 310 | 111 | 434 |
| | | | | 1 | | | 214E | 21 | 1.0 | 433 | | 224E | 21 | 1.0 | 460 | | 244E | 21 | 1.0 | 499 | | 264E | 21 | 1.0 | 537 | 179 | |
| | | 2# 8 | | 1 | 2#10 | 4.02 | 123H | 5 | - | 319 | 3.42 | 133H | 5 | - | 345 | 2.95 | 133H | 5 | - | 367 | 2.57 | 143H | 5 | - | 393 | 144 | 453 |
| | | | | 1 | | | 214E | 21 | 1.0 | 493 | | 224E | 21 | 1.0 | 525 | | 244E | 21 | 1.0 | 569 | | 264E | 21 | 1.0 | 612 | 222 | |
| | | 2#10 | | 1 | 3#10 | 6.08 | 134H | 5 | - | 522 | 5.18 | 144H | 5 | - | 564 | 4.47 | 154H | 5 | - | 606 | 3.89 | 164H | 5 | - | 648 | 222 | 372 |
| | | | | 1 | | | 364B | 21 | 1.0 | 801 | | 394B | 21 | 1.0 | 868 | | 424B | 21 | 1.0 | 934 | | 444B | 21 | 1.0 | 989 | 318 | |
| | | 2#11 | | 1 | 2#14 | 6.90 | 154EeH | 5 | - | 626 | 5.88 | 164EdH | 5 | - | 675 | 5.07 | 154H | 5 | - | 709 | 4.42 | 164H | 5 | - | 758 | 266 | 335 |
| | | | | 1 | | | 364B | 21 | 1.0 | 890 | | 394B | 21 | 1.0 | 964 | | 424B | 21 | 1.0 | 1037 | | 444B | 21 | 1.0 | 1100 | 361 | |
| | 14 | 2# 8 | | 1 | 3# 8 | 4.05 | 113H | 7 | - | 306 | 3.45 | 123H | 7 | - | 332 | 2.98 | 123H | 7 | - | 353 | 2.59 | 133H | 7 | - | 379 | 145 | 397 |
| | | | | 1 | | | 184F | 28 | 1.2 | 460 | | 204F | 27 | 1.1 | 503 | | 214F | 27 | 1.1 | 536 | | 234F | 27 | 1.1 | 579 | 213 | |
| | | 2# 9 | | 1 | 3# 9 | 5.04 | 124H | 7 | - | 428 | 4.29 | 133H | 7 | - | 413 | 3.70 | 133H | 7 | - | 441 | 3.22 | 143H | 7 | - | 472 | 181 | 388 |
| | | | | 1 | | | 185F | 28 | 1.2 | 659 | | 205F | 27 | 1.1 | 722 | | 215F | 27 | 1.1 | 767 | | 234F | 27 | 1.1 | 668 | 263 | |
| | | 2#11 | | 1 | 3#11 | 7.38 | 135H | 7 | - | 686 | 6.29 | 145H | 7 | - | 741 | 5.42 | 154H | 7 | - | 724 | 4.72 | 164H | 7 | - | 775 | 271 | 311 |
| | | | | 1 | | | 295C | 28 | 1.1 | 1045 | | 315C | 27 | 1.1 | 1124 | | 215F | 27 | 1.1 | 985 | | 235F | 27 | 1.1 | 1064 | 386 | |
| | | 2#11 | | 1 | 4#10 | 7.54 | 135H | 7 | - | 706 | 6.42 | 145H | 7 | - | 763 | 5.54 | 155H | 7 | - | 820 | 4.82 | 164H | 7 | - | 800 | 271 | 300 |
| | | | | 1 | | | 295C | 28 | 1.1 | 1065 | | 315C | 27 | 1.1 | 1146 | | 215F | 27 | 1.1 | 1009 | | 235F | 27 | 1.1 | 1089 | 415 | |
| | 16 | 2# 8 | | 1 | 3# 8 | 4.07 | 113H | 9 | - | 308 | 3.47 | 113H | 8 | - | 329 | 2.99 | 123H | 8 | - | 355 | 2.61 | 123H | 8 | - | 376 | 146 | 331 |
| | | | | 1 | | | 184F | 34 | 1.3 | 468 | | 204F | 34 | 1.3 | 512 | | 214F | 33 | 1.3 | 545 | | 234F | 33 | 1.3 | 589 | 215 | |
| | | 2#10 | | 1 | 3#10 | 6.31 | 134H | 9 | - | 528 | 5.37 | 134H | 8 | - | 562 | 4.63 | 144H | 8 | - | 605 | 4.04 | 143H | 8 | - | 584 | 228 | 327 |
| | | | | 1 | | | 185F | 34 | 1.3 | 760 | | 205F | 34 | 1.3 | 832 | | 215F | 33 | 1.3 | 885 | | 235F | 33 | 1.3 | 957 | 330 | |
| | | 2#11 | | 1 | 3#11 | 7.53 | 135H | 9 | - | 690 | 6.41 | 145H | 8 | - | 746 | 5.53 | 154H | 8 | - | 728 | 4.82 | 154H | 8 | - | 770 | 274 | 295 |
| | | | | 1 | | | 295C | 34 | 1.3 | 1065 | | 205F | 34 | 1.3 | 939 | | 215F | 33 | 1.3 | 1000 | | 235F | 33 | 1.3 | 1080 | 394 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 9.17 | 155EdH | 9 | - | 828 | 7.82 | 145H | 8 | - | 867 | 6.74 | 155H | 8 | - | 932 | 5.87 | 165H | 8 | - | 997 | 330 | 251 |
| | | | | 1 | | | 295C | 34 | 1.3 | 1177 | | 315C | 34 | 1.3 | 1267 | | 345C | 33 | 1.3 | 1375 | | 365C | 33 | 1.2 | 1465 | 496 | |
| | 18 | 2# 7 | 1# 7 | 1 | 3# 9 | 4.65 | 113H | 10 | - | 350 | 3.96 | 113H | 10 | - | 375 | 3.42 | 123H | 10 | - | 404 | 2.98 | 123H | 10 | - | 429 | 167 | 289 |
| | | | | 1 | | | 165G | 41 | 1.4 | 614 | | 185G | 41 | 1.4 | 677 | | 194G | 40 | 1.4 | 578 | | 204G | 40 | 1.4 | 615 | 269 | |
| | | 2# 8 | 1# 8 | 1 | 3#10 | 6.03 | 124H | 10 | - | 489 | 5.13 | 133H | 10 | - | 476 | 4.43 | 133H | 10 | - | 508 | 3.86 | 143H | 10 | - | 544 | 216 | 302 |
| | | | | 1 | | | 165G | 41 | 1.4 | 700 | | 185G | 41 | 1.4 | 770 | | 195G | 40 | 1.4 | 822 | | 205G | 40 | 1.4 | 873 | 334 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 9.29 | 135H | 10 | - | 807 | 7.91 | 145H | 10 | - | 872 | 6.82 | 155H | 10 | - | 937 | 5.94 | 165H | 10 | - | 1003 | 334 | 241 |
| | | | | 1 | | | 245D | 41 | 1.4 | 1100 | | 265D | 41 | 1.4 | 1191 | | 285D | 40 | 1.4 | 1282 | | 305D | 40 | 1.4 | 1373 | 512 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 10.35 | 155EeH | 10 | - | 929 | 8.82 | 165EdH | 10 | - | 1002 | 7.61 | 155H | 10 | - | 1049 | 6.62 | 165H | 10 | - | 1122 | 400 | 223 |
| | | | | 1 | | | 295C | 41 | 1.4 | 1293 | | 265D | 41 | 1.4 | 1295 | | 285D | 40 | 1.4 | 1393 | | 305D | 40 | 1.4 | 1492 | 542 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

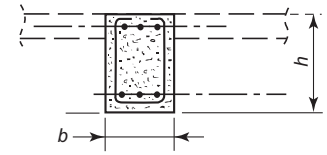
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

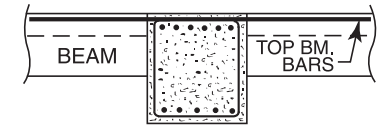
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 32 ft | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ | $b$ | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 24 | 12 | 2# 7 | | 1 | 2# 9 | 1.74 | 123H | 5 | - | 327 | 1.55 | 123H | 5 | - | 345 | 1.38 | 123H | 5 | - | 362 | 1.24 | 123H | 5 | - | 379 | 111 | 434 |
| | | | | 1 | | | 274E | 21 | 1.0 | 565 | | 293E | 20 | 1.0 | 450 | | 303E | 20 | 1.0 | 472 | | 313E | 20 | 1.0 | 495 | 179 | |
| | | 2# 8 | | 1 | 2#10 | 2.26 | 143H | 5 | - | 415 | 2.00 | 143H | 5 | - | 437 | 1.79 | 153H | 5 | - | 463 | 1.60 | 153H | 5 | - | 485 | 144 | 453 |
| | | | | 1 | | | 274E | 21 | 1.0 | 645 | | 294E | 20 | 1.0 | 688 | | 304E | 20 | 1.0 | 721 | | 314E | 20 | 1.0 | 753 | 222 | |
| | | 2#10 | | 1 | 3#10 | 3.42 | 164H | 5 | - | 682 | 3.03 | 174H | 5 | - | 724 | 2.70* | 173H | 5 | - | 695 | 2.42* | 183H | 5 | - | 734 | 222 | 372 |
| | | | | 1 | | | 274E | 20 | 1.0 | 844 | | 294E | 20 | 1.0 | 900 | | 304E | 20 | 1.0 | 945 | | 314E | 20 | 1.0 | 990 | 318 | |
| | | 2#11 | | 1 | 2#14 | 3.88 | 174H | 5 | - | 808 | 3.44 | 174H | 5 | - | 849 | 3.07* | 184H | 5 | - | 899 | 2.75* | 194H | 5 | - | 948 | 266 | 335 |
| | | | | 1 | | | 474B | 20 | 1.0 | 1173 | | 494B | 20 | 1.0 | 1236 | | 514B | 20 | 1.0 | 1298 | | 314E | 20 | 1.0 | 1129 | 361 | |
| | 14 | 2# 8 | | 1 | 3# 8 | 2.28 | 133H | 7 | - | 400 | 2.02 | 133H | 7 | - | 421 | 1.80 | 133H | 7 | - | 443 | 1.62 | 133H | 6 | - | 464 | 145 | 397 |
| | | | | 1 | | | 244F | 26 | 1.1 | 611 | | 254F | 26 | 1.1 | 644 | | 274F | 26 | 1.1 | 687 | | 284F | 26 | 1.1 | 719 | 213 | |
| | | 2# 9 | | 1 | 3# 9 | 2.83 | 143H | 7 | - | 499 | 2.51 | 153H | 7 | - | 530 | 2.24 | 153H | 7 | - | 558 | 2.01 | 163H | 6 | - | 589 | 181 | 388 |
| | | | | 1 | | | 244F | 26 | 1.1 | 706 | | 254F | 26 | 1.1 | 744 | | 274F | 26 | 1.1 | 794 | | 284F | 26 | 1.1 | 832 | 263 | |
| | | 2#11 | | 1 | 3#11 | 4.15 | 164H | 7 | - | 817 | 3.68 | 174H | 7 | - | 868 | 3.28* | 184H | 7 | - | 918 | 2.94* | 184H | 6 | - | 961 | 271 | 311 |
| | | | | 1 | | | 245F | 26 | 1.1 | 1125 | | 255F | 26 | 1.1 | 1185 | | 275F | 26 | 1.1 | 1264 | | 285F | 26 | 1.1 | 1324 | 386 | |
| | | 2#11 | | 1 | 4#10 | 4.24 | 164H | 7 | - | 844 | 3.76 | 174H | 7 | - | 897 | 3.35* | 184H | 7 | - | 949 | 3.01* | 184H | 6 | - | 993 | 271 | 300 |
| | | | | 1 | | | 245F | 26 | 1.1 | 1152 | | 255F | 26 | 1.1 | 1214 | | 275F | 26 | 1.1 | 1294 | | 285F | 26 | 1.1 | 1357 | 415 | |
| | 16 | 2# 8 | | 1 | 3# 8 | 2.29 | 123H | 8 | - | 397 | 2.03 | 123H | 8 | - | 419 | 1.81 | 123H | 8 | - | 440 | 1.63 | 123H | 8 | - | 462 | 146 | 331 |
| | | | | 1 | | | 244F | 33 | 1.3 | 622 | | 264F | 33 | 1.2 | 667 | | 274F | 32 | 1.2 | 699 | | 284F | 32 | 1.2 | 732 | 215 | |
| | | 2#10 | | 1 | 3#10 | 3.55 | 153H | 8 | - | 622 | 3.14 | 163H | 8 | - | 661 | 2.80 | 163H | 8 | - | 695 | 2.52 | 163H | 8 | - | 730 | 228 | 327 |
| | | | | 1 | | | 245F | 33 | 1.2 | 1010 | | 265F | 33 | 1.2 | 1082 | | 274F | 32 | 1.2 | 938 | | 284F | 32 | 1.2 | 984 | 330 | |
| | | 2#11 | | 1 | 3#11 | 4.23 | 164H | 8 | - | 821 | 3.75 | 174H | 8 | - | 872 | 3.35 | 174H | 8 | - | 914 | 3.00* | 183H | 8 | - | 894 | 274 | 295 |
| | | | | 1 | | | 245F | 33 | 1.2 | 1141 | | 265F | 33 | 1.2 | 1221 | | 275F | 32 | 1.2 | 1283 | | 285F | 32 | 1.2 | 1344 | 394 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 5.16 | 175H | 8 | - | 1062 | 4.57 | 174H | 8 | - | 1031 | 4.08* | 184H | 8 | - | 1091 | 3.66* | 194H | 8 | - | 1151 | 330 | 251 |
| | | | | 1 | | | 385C | 33 | 1.2 | 1554 | | 265F | 33 | 1.2 | 1381 | | 275F | 32 | 1.2 | 1452 | | 285F | 32 | 1.2 | 1522 | 496 | |
| | 18 | 2# 7 | 1# 7 | 1 | 3# 9 | 2.62 | 123H | 10 | - | 453 | 2.32 | 123H | 10 | - | 478 | 2.07 | 123H | 10 | - | 503 | 1.86 | 123H | 10 | - | 528 | 167 | 289 |
| | | | | 1 | | | 284E | 40 | 1.4 | 735 | | 294E | 39 | 1.4 | 772 | | 314E | 39 | 1.4 | 821 | | 324E | 39 | 1.4 | 858 | 269 | |
| | | 2# 8 | 1# 8 | 1 | 3#10 | 3.39 | 143H | 10 | - | 576 | 3.00 | 143H | 10 | - | 608 | 2.68 | 153H | 10 | - | 644 | 2.40 | 153H | 10 | - | 676 | 216 | 302 |
| | | | | 1 | | | 225G | 40 | 1.4 | 944 | | 235G | 39 | 1.4 | 995 | | 244G | 39 | 1.4 | 866 | | 254G | 39 | 1.4 | 910 | 334 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 5.22 | 164H | 10 | - | 975 | 4.63 | 174H | 10 | - | 1035 | 4.13 | 184H | 10 | - | 1095 | 3.70* | 184H | 10 | - | 1147 | 334 | 241 |
| | | | | 1 | | | 325D | 40 | 1.4 | 1464 | | 345D | 39 | 1.4 | 1555 | | 245G | 39 | 1.3 | 1412 | | 255G | 39 | 1.3 | 1483 | 512 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 5.82 | 175H | 10 | - | 1195 | 5.16 | 175H | 10 | - | 1255 | 4.60* | 184H | 10 | - | 1238 | 4.13* | 194H | 10 | - | 1306 | 400 | 223 |
| | | | | 1 | | | 325D | 40 | 1.4 | 1591 | | 345D | 39 | 1.4 | 1690 | | 365D | 39 | 1.3 | 1788 | | 375D | 39 | 1.3 | 1868 | 542 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b - 2''$).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

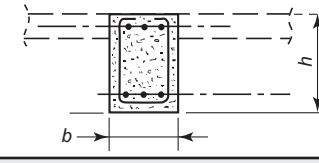
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

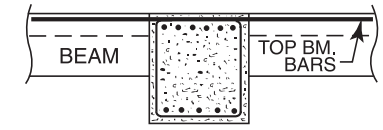
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w/1.4$.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 24 ft | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 26 | 14 | 2# 8 | | 1 | 3# 8 | 4.44 | 113I | 8 | - | 309 | 3.79 | 113I | 8 | - | 331 | 3.27 | 113I | 8 | - | 352 | 2.84 | 123I | 8 | - | 378 | 160 | 304 |
| | | | | 1 | | | 184F | 31 | 1.3 | 468 | | 204F | 31 | 1.3 | 512 | | 214F | 30 | 1.2 | 545 | | 234F | 30 | 1.2 | 589 | 234 | |
| | | 2# 9 | | 1 | 3# 9 | 5.54 | 114I | 8 | - | 425 | 4.72 | 123I | 8 | - | 412 | 4.07 | 123I | 8 | - | 439 | 3.55 | 133I | 8 | - | 471 | 199 | 308 |
| | | | | 1 | | | 185F | 31 | 1.3 | 671 | | 205F | 31 | 1.3 | 736 | | 215F | 30 | 1.2 | 782 | | 234F | 30 | 1.2 | 679 | 290 | |
| | | 2#11 | | 1 | 3#11 | 8.18 | 125I | 8 | - | 681 | 6.97 | 135I | 8 | - | 737 | 6.01 | 145I | 8 | - | 793 | 5.24 | 144I | 8 | - | 765 | 299 | 252 |
| | | | | 1 | | | 295C | 31 | 1.3 | 1065 | | 315C | 31 | 1.2 | 1145 | | 215F | 30 | 1.2 | 1000 | | 235F | 30 | 1.2 | 1080 | 428 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 9.22 | 145FdI | 8 | - | 820 | 7.85 | 135I | 8 | - | 859 | 6.77 | 145I | 8 | - | 924 | 5.90 | 155I | 8 | - | 989 | 359 | 231 |
| | | | | 2 | | | 295C | 31 | 1.3 | 1177 | | 315C | 31 | 1.2 | 1267 | | 345C | 30 | 1.2 | 1375 | | 365C | 30 | 1.2 | 1465 | 482 | |
| | 16 | 2# 9 | | 1 | 3# 9 | 5.58 | 113I | 10 | - | 382 | 4.76 | 113I | 10 | - | 409 | 4.10 | 123I | 9 | - | 441 | 3.57 | 123I | 9 | - | 468 | 200 | 272 |
| | | | | 1 | | | 165G | 39 | 1.4 | 645 | | 185G | 38 | 1.4 | 711 | | 195G | 38 | 1.4 | 758 | | 205G | 37 | 1.4 | 804 | 294 | |
| | | 2#10 | | 1 | 3#10 | 6.96 | 124I | 10 | - | 525 | 5.93 | 124I | 10 | - | 559 | 5.12 | 134I | 9 | - | 602 | 4.46 | 134I | 9 | - | 637 | 251 | 262 |
| | | | | 1 | | | 245D | 39 | 1.4 | 889 | | 185G | 38 | 1.4 | 807 | | 195G | 38 | 1.4 | 860 | | 205G | 37 | 1.4 | 914 | 364 | |
| | | 2#11 | | 1 | 4#10 | 8.41 | 125I | 10 | - | 706 | 7.17 | 135I | 10 | - | 764 | 6.18 | 135I | 9 | - | 808 | 5.38 | 144I | 9 | - | 794 | 302 | 230 |
| | | | | 1 | | | 245D | 39 | 1.4 | 1008 | | 265D | 38 | 1.4 | 1091 | | 285D | 38 | 1.4 | 1175 | | 305D | 37 | 1.4 | 1258 | 470 | |
| | | 2#14 | | 1 | 3#14 | 11.20 | 264C | 10 | - | 973 | 9.54 | 284C | 10 | - | 1052 | 8.23 | 155FdI | 9 | - | 1078 | 7.17 | 155I | 9 | - | 1139 | 418 | 192 |
| | | | | 1 | | | 295C | 39 | 1.4 | 1314 | | 315C | 38 | 1.4 | 1414 | | 285D | 38 | 1.4 | 1417 | | 305D | 37 | 1.4 | 1517 | 586 | |
| | 18 | 2# 8 | 1# 8 | 1 | 3# 9 | 5.66 | 113I | 12 | - | 395 | 4.83 | 113I | 12 | - | 423 | 4.16 | 113I | 11 | - | 452 | 3.62 | 123I | 11 | - | 485 | 238 | 228 |
| | | | | 1 | | | 165G | 47 | 1.6 | 667 | | 185G | 46 | 1.6 | 736 | | 195G | 46 | 1.5 | 784 | | 205G | 45 | 1.5 | 833 | 296 | |
| | | 2# 9 | 1# 9 | 1 | 3#11 | 8.24 | 125I | 12 | - | 655 | 7.02 | 124I | 12 | - | 632 | 6.05 | 134I | 11 | - | 681 | 5.27 | 144I | 11 | - | 730 | 296 | 225 |
| | | | | 1 | | | 245D | 47 | 1.6 | 970 | | 265D | 46 | 1.5 | 1050 | | 285D | 46 | 1.5 | 1131 | | 205G | 45 | 1.5 | 1009 | 442 | |
| | | 2#10 | 1#10 | 1 | 3#14 | 10.24 | 135FdI | 12 | - | 843 | 8.72 | 135I | 12 | - | 897 | 7.52 | 145I | 11 | - | 965 | 6.55 | 145I | 11 | - | 1020 | 368 | 190 |
| | | | | 1 | | | 245D | 47 | 1.6 | 1144 | | 265D | 46 | 1.5 | 1238 | | 285D | 46 | 1.5 | 1333 | | 305D | 45 | 1.5 | 1428 | 602 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 11.51 | 145FeI | 12 | - | 926 | 9.81 | 155FeI | 12 | - | 1000 | 8.46 | 155FdI | 11 | - | 1059 | 7.37 | 155I | 11 | - | 1119 | 442 | 181 |
| | | | | 1 | | | 295C | 47 | 1.6 | 1313 | | 315C | 46 | 1.5 | 1413 | | 285D | 46 | 1.5 | 1413 | | 305D | 45 | 1.5 | 1513 | 602 | |
| | 20 | 2# 8 | 1# 8 | 1 | 3#10 | 6.65 | 114I | 14 | - | 488 | 5.67 | 113I | 14 | - | 472 | 4.89 | 123I | 14 | - | 508 | 4.26 | 123I | 13 | - | 540 | 239 | 212 |
| | | | | 1 | | | 215E | 56 | 1.7 | 826 | | 165H | 55 | 1.7 | 754 | | 175H | 54 | 1.7 | 807 | | 185H | 53 | 1.7 | 859 | 371 | |
| | | 2# 9 | 1# 9 | 1 | 3#11 | 8.29 | 115I | 14 | - | 645 | 7.07 | 124I | 14 | - | 635 | 6.09 | 134I | 14 | - | 684 | 5.31 | 134I | 13 | - | 724 | 298 | 211 |
| | | | | 1 | | | 215E | 56 | 1.7 | 924 | | 225E | 55 | 1.7 | 985 | | 245E | 54 | 1.7 | 1067 | | 265E | 53 | 1.7 | 1148 | 447 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 11.70 | 145FeI | 14 | - | 930 | 9.97 | 145FdI | 14 | - | 990 | 8.60 | 155FcI | 13 | - | 1065 | 7.49 | 145I | 13 | - | 1110 | 447 | 174 |
| | | | | 1 | | | 295C | 55 | 1.7 | 1333 | | 315C | 55 | 1.7 | 1435 | | 285D | 54 | 1.7 | 1432 | | 305D | 53 | 1.7 | 1534 | 612 | |
| | | 2#10 | 2#10 | 1 | 4#14 | 13.41 | 265C | 14 | - | 1235 | 11.43 | 165EgI | 14 | - | 1161 | 9.85 | 165FeI | 13 | - | 1232 | 8.58 | 165FeI | 13 | - | 1303 | 482 | 153 |
| | | | | 1 | | | 485A | 55 | 1.7 | 1861 | | 315C | 55 | 1.7 | 1577 | | 345C | 54 | 1.7 | 1711 | | 365C | 53 | 1.7 | 1823 | 735 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

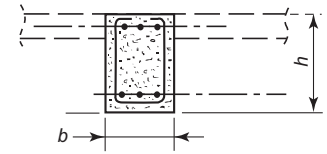
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

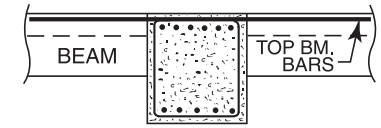
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS(1) | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$(3) | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 32 ft | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | | |
| $h$ in. | $b$ in. | BOTTOM $\ell_n$ + 12 in. | BOTTOM 0.875 $\ell_n$ | Layers (2) | TOP | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 26 | 14 | 2# 8 | | 1 | 3# 8 | 2.50 | 123I | 7 | - | 399 | 2.21 | 123I | 7 | - | 420 | 1.98 | 123I | 7 | - | 442 | 1.77 | 123I | 7 | - | 463 | 160 | 304 |
| | | | | 1 | | | 244F | 30 | 1.2 | 622 | | 264F | 30 | 1.2 | 667 | | 274F | 29 | 1.2 | 699 | | 284F | 29 | 1.2 | 732 | 234 | |
| | | 2# 9 | | 1 | 3# 9 | 3.12 | 133I | 7 | - | 498 | 2.76 | 143I | 7 | - | 530 | 2.46 | 143I | 7 | - | 557 | 2.21 | 143I | 7 | - | 584 | 199 | 308 |
| | | | | 1 | | | 244F | 30 | 1.2 | 717 | | 264F | 30 | 1.2 | 767 | | 274F | 29 | 1.2 | 806 | | 284F | 29 | 1.2 | 845 | 290 | |
| | | 2#11 | | 1 | 3#11 | 4.60 | 154I | 7 | - | 816 | 4.08 | 164I | 7 | - | 867 | 3.64 | 164I | 7 | - | 910 | 3.26 | 174I | 7 | - | 961 | 299 | 252 |
| | | | | 1 | | | 245F | 30 | 1.2 | 1141 | | 265F | 30 | 1.2 | 1221 | | 275F | 29 | 1.2 | 1283 | | 285F | 29 | 1.2 | 1344 | 428 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 5.19 | 165I | 7 | - | 1055 | 4.59 | 164I | 7 | - | 1027 | 4.10 | 174I | 7 | - | 1087 | 3.68 | 174I | 7 | - | 1139 | 359 | 231 |
| | | | | 2 | | | 245F | 30 | 1.2 | 1291 | | 265F | 30 | 1.2 | 1381 | | 275F | 29 | 1.2 | 1452 | | 285F | 29 | 1.2 | 1522 | 482 | |
| | 16 | 2# 9 | | 1 | 3# 9 | 3.14 | 133I | 9 | - | 500 | 2.78 | 133I | 9 | - | 527 | 2.48 | 133I | 9 | - | 554 | 2.23 | 133I | 9 | - | 581 | 200 | 272 |
| | | | | 1 | | | 225G | 37 | 1.4 | 870 | | 234G | 37 | 1.3 | 743 | | 244G | 37 | 1.3 | 783 | | 284F | 36 | 1.3 | 858 | 294 | |
| | | 2#10 | | 1 | 3#10 | 3.92 | 143I | 9 | - | 622 | 3.47 | 143I | 9 | - | 656 | 3.09 | 153I | 9 | - | 695 | 2.78 | 153I | 9 | - | 729 | 251 | 262 |
| | | | | 1 | | | 225G | 37 | 1.4 | 988 | | 235G | 37 | 1.3 | 1042 | | 245G | 37 | 1.3 | 1096 | | 255G | 36 | 1.3 | 1149 | 364 | |
| | | 2#11 | | 1 | 4#10 | 4.73 | 154I | 9 | - | 847 | 4.19 | 154I | 9 | - | 891 | 3.74 | 164I | 9 | - | 944 | 3.36 | 164I | 9 | - | 988 | 302 | 230 |
| | | | | 1 | | | 225G | 37 | 1.3 | 1146 | | 235G | 37 | 1.3 | 1210 | | 245G | 37 | 1.3 | 1274 | | 255G | 36 | 1.3 | 1337 | 470 | |
| | | 2#14 | | 1 | 3#14 | 6.30 | 165I | 9 | - | 1214 | 5.58 | 165I | 9 | - | 1275 | 4.98 | 175I | 9 | - | 1350 | 4.47* | 185I | 9 | - | 1425 | 418 | 192 |
| | | | | 1 | | | 325D | 37 | 1.3 | 1618 | | 345D | 37 | 1.3 | 1718 | | 365D | 36 | 1.3 | 1818 | | 375D | 36 | 1.3 | 1898 | 586 | |
| | 18 | 2# 8 | 1# 8 | 1 | 3# 9 | 3.19 | 123I | 11 | - | 513 | 2.82 | 123I | 11 | - | 541 | 2.52 | 123I | 11 | - | 569 | 2.26 | 123I | 11 | - | 598 | 238 | 228 |
| | | | | 1 | | | 224G | 45 | 1.5 | 730 | | 234G | 44 | 1.5 | 771 | | 314E | 44 | 1.5 | 898 | | 324E | 44 | 1.5 | 939 | 296 | |
| | | 2# 9 | 1# 9 | 1 | 3#11 | 4.63 | 144I | 11 | - | 770 | 4.10 | 154I | 11 | - | 818 | 3.66 | 153I | 11 | - | 795 | 3.29 | 153I | 11 | - | 835 | 296 | 225 |
| | | | | 1 | | | 225G | 45 | 1.5 | 1090 | | 235G | 44 | 1.5 | 1150 | | 245G | 44 | 1.5 | 1210 | | 265G | 44 | 1.5 | 1290 | 442 | |
| | | 2#10 | 1#10 | 1 | 3#14 | 5.76 | 155I | 11 | - | 1088 | 5.10 | 164I | 11 | - | 1072 | 4.55 | 164I | 11 | - | 1127 | 4.08 | 174I | 11 | - | 1190 | 368 | 190 |
| | | | | 1 | | | 325D | 45 | 1.5 | 1522 | | 345D | 44 | 1.5 | 1617 | | 365D | 44 | 1.5 | 1711 | | 265G | 44 | 1.5 | 1564 | 602 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 6.48 | 155I | 11 | - | 1179 | 5.74 | 165I | 11 | - | 1253 | 5.12 | 175I | 11 | - | 1327 | 4.59 | 175I | 11 | - | 1387 | 442 | 181 |
| | | | | 1 | | | 325D | 45 | 1.5 | 1613 | | 345D | 44 | 1.5 | 1713 | | 365D | 44 | 1.5 | 1813 | | 385D | 44 | 1.5 | 1913 | 602 | |
| | 20 | 2# 8 | 1# 8 | 1 | 3#10 | 3.74 | 123I | 13 | - | 572 | 3.31 | 133I | 13 | - | 609 | 2.96 | 133I | 13 | - | 641 | 2.65 | 133I | 13 | - | 672 | 239 | 212 |
| | | | | 1 | | | 195H | 53 | 1.7 | 912 | | 215H | 53 | 1.6 | 986 | | 225H | 52 | 1.6 | 1038 | | 235H | 52 | 1.6 | 1091 | 371 | |
| | | 2# 9 | 1# 9 | 1 | 3#11 | 4.66 | 143I | 13 | - | 712 | 4.13 | 143I | 13 | - | 752 | 3.69 | 143I | 13 | - | 792 | 3.31 | 153I | 13 | - | 836 | 298 | 211 |
| | | | | 1 | | | 195H | 53 | 1.6 | 1042 | | 215H | 53 | 1.6 | 1124 | | 225H | 52 | 1.6 | 1185 | | 235H | 52 | 1.6 | 1246 | 447 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 6.58 | 155I | 13 | - | 1184 | 5.83 | 165I | 13 | - | 1258 | 5.20 | 165I | 13 | - | 1318 | 4.67 | 174I | 13 | - | 1301 | 447 | 174 |
| | | | | 1 | | | 285E | 53 | 1.6 | 1552 | | 295E | 52 | 1.6 | 1633 | | 315E | 52 | 1.6 | 1734 | | 335E | 52 | 1.6 | 1836 | 612 | |
| | | 2#10 | 2#10 | 1 | 4#14 | 7.55 | 175Fdl | 13 | - | 1389 | 6.68 | 165I | 13 | - | 1445 | 5.96 | 175I | 13 | - | 1530 | 5.35 | 185I | 13 | - | 1616 | 482 | 153 |
| | | | | 1 | | | 325D | 53 | 1.6 | 1811 | | 345D | 52 | 1.6 | 1924 | | 315E | 52 | 1.6 | 1932 | | 335E | 52 | 1.6 | 2044 | 735 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

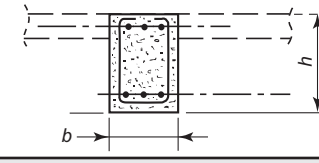
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

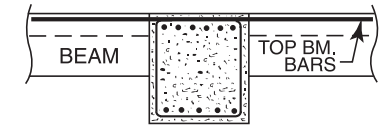
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 26 ft | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 28 | 14 | 2# 9 | | 1 | 3# 8 | 4.17 | 103J | 9 | - | 368 | 3.59 | 113J | 9 | - | 397 | 3.13 | 113J | 8 | - | 421 | 2.75 | 113J | 8 | - | 446 | 217 | 227 |
| | | | | 1 | | | 185G | 35 | 1.4 | 673 | | 194G | 34 | 1.3 | 573 | | 204G | 34 | 1.3 | 610 | | 224G | 33 | 1.3 | 658 | 256 | |
| | | 2#10 | | 1 | 3#10 | 6.41 | 124J | 9 | - | 562 | 5.52 | 124J | 9 | - | 596 | 4.81 | 134J | 8 | - | 640 | 4.23 | 134J | 8 | - | 674 | 271 | 230 |
| | | | | 1 | | | 185G | 35 | 1.4 | 807 | | 195G | 34 | 1.3 | 860 | | 205G | 34 | 1.3 | 914 | | 225G | 33 | 1.3 | 988 | 393 | |
| | | 2#11 | | 1 | 3#11 | 7.66 | 125J | 9 | - | 732 | 6.60 | 135J | 9 | - | 789 | 5.75 | 135J | 8 | - | 831 | 5.06 | 144J | 8 | - | 814 | 327 | 207 |
| | | | | 1 | | | 265D | 35 | 1.4 | 1069 | | 285D | 34 | 1.3 | 1151 | | 305D | 34 | 1.3 | 1232 | | 225G | 33 | 1.3 | 1119 | 470 | |
| | | 2#10 | 1#10 | 1 | 3#14 | 9.32 | 244D | 9 | - | 926 | 8.03 | 145GdJ | 9 | - | 965 | 7.00 | 145J | 8 | - | 1020 | 6.15 | 155J | 8 | - | 1088 | 393 | 172 |
| | | | | 1 | | | 265D | 35 | 1.4 | 1220 | | 285D | 34 | 1.3 | 1313 | | 305D | 34 | 1.3 | 1407 | | 325D | 33 | 1.3 | 1500 | 607 | |
| | 16 | 2# 9 | | 1 | 3# 9 | 5.18 | 113J | 11 | - | 412 | 4.47 | 113J | 11 | - | 439 | 3.89 | 113J | 10 | - | 466 | 3.42 | 123J | 10 | - | 498 | 218 | 214 |
| | | | | 1 | | | 185G | 43 | 1.5 | 723 | | 195G | 42 | 1.5 | 771 | | 205G | 42 | 1.5 | 818 | | 225G | 42 | 1.5 | 886 | 321 | |
| | | 2#10 | | 1 | 3#10 | 6.48 | 114J | 11 | - | 556 | 5.59 | 124J | 11 | - | 599 | 4.87 | 124J | 10 | - | 634 | 4.28 | 134J | 10 | - | 677 | 273 | 212 |
| | | | | 1 | | | 185G | 43 | 1.5 | 819 | | 195G | 42 | 1.5 | 874 | | 205G | 42 | 1.5 | 928 | | 225G | 42 | 1.5 | 1003 | 398 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 9.44 | 135GdJ | 11 | - | 872 | 8.14 | 135J | 11 | - | 924 | 7.09 | 145J | 10 | - | 991 | 6.23 | 145J | 10 | - | 1043 | 398 | 168 |
| | | | | 1 | | | 265D | 43 | 1.5 | 1209 | | 285D | 42 | 1.5 | 1301 | | 305D | 42 | 1.5 | 1394 | | 325D | 42 | 1.5 | 1486 | 613 | |
| | | 2#14 | | 1 | 3#14 | 10.59 | 245D | 11 | - | 1157 | 9.13 | 145GeJ | 11 | - | 1074 | 7.96 | 155GdJ | 10 | - | 1150 | 6.99 | 155GcJ | 10 | - | 1211 | 459 | 158 |
| | | | | 1 | | | 525A | 43 | 1.5 | 1859 | | 285D | 42 | 1.5 | 1437 | | 305D | 42 | 1.5 | 1538 | | 325D | 41 | 1.5 | 1640 | 650 | |
| | 18 | 2# 8 | 1# 8 | 1 | 3#10 | 6.14 | 114J | 13 | - | 522 | 5.30 | 113J | 13 | - | 505 | 4.61 | 123J | 13 | - | 542 | 4.06 | 123J | 13 | - | 574 | 259 | 188 |
| | | | | 1 | | | 165H | 52 | 1.7 | 754 | | 175H | 51 | 1.7 | 807 | | 185H | 51 | 1.7 | 859 | | 195H | 50 | 1.6 | 912 | 402 | |
| | | 2# 9 | 1# 9 | 1 | 3#11 | 7.66 | 115J | 13 | - | 689 | 6.60 | 124J | 13 | - | 678 | 5.75 | 134J | 13 | - | 727 | 5.06 | 134J | 13 | - | 767 | 323 | 183 |
| | | | | 1 | | | 225E | 52 | 1.7 | 985 | | 245E | 51 | 1.7 | 1067 | | 265E | 51 | 1.6 | 1148 | | 285E | 50 | 1.6 | 1230 | 484 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 10.80 | 145GeJ | 13 | - | 995 | 9.31 | 145GdJ | 13 | - | 1055 | 8.11 | 155GdJ | 13 | - | 1130 | 7.13 | 145J | 13 | - | 1175 | 484 | 149 |
| | | | | 1 | | | 315C | 52 | 1.7 | 1435 | | 285D | 51 | 1.7 | 1432 | | 305D | 51 | 1.6 | 1534 | | 285E | 50 | 1.6 | 1552 | 663 | |
| | | 2#11 | 1#11 | 1 | 5#11 | 11.47 | 145FfJ | 13 | - | 1058 | 9.89 | 145GeJ | 13 | - | 1122 | 8.61 | 155GdJ | 13 | - | 1202 | 7.57 | 155GdJ | 13 | - | 1267 | 484 | 140 |
| | | | | 1 | | | 315C | 52 | 1.7 | 1498 | | 345C | 51 | 1.7 | 1625 | | 305D | 51 | 1.6 | 1606 | | 325D | 50 | 1.6 | 1712 | 753 | |
| | 20 | 2# 8 | 1# 8 | 1 | 3#10 | 6.17 | 103J | 15 | - | 470 | 5.32 | 113J | 15 | - | 506 | 4.64 | 113J | 15 | - | 538 | 4.08 | 113J | 15 | - | 570 | 260 | 166 |
| | | | | 1 | | | 165H | 62 | 1.9 | 765 | | 175H | 61 | 1.8 | 818 | | 185H | 60 | 1.8 | 872 | | 195H | 60 | 1.8 | 925 | 406 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 7.96 | 115J | 15 | - | 759 | 6.86 | 124J | 15 | - | 752 | 5.98 | 124J | 15 | - | 797 | 5.26 | 134J | 15 | - | 851 | 406 | 162 |
| | | | | 1 | | | 225E | 62 | 1.9 | 1067 | | 245E | 61 | 1.8 | 1155 | | 265E | 60 | 1.8 | 1243 | | 285E | 60 | 1.8 | 1331 | 489 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 10.96 | 135GeJ | 15 | - | 985 | 9.45 | 145GdJ | 15 | - | 1060 | 8.23 | 135J | 15 | - | 1105 | 7.24 | 145J | 15 | - | 1179 | 489 | 143 |
| | | | | 1 | | | 315C | 62 | 1.9 | 1457 | | 285D | 61 | 1.8 | 1452 | | 305D | 60 | 1.8 | 1555 | | 285E | 59 | 1.8 | 1571 | 673 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 13.96 | 245D | 15 | - | 1387 | 12.04 | 175EiJ | 15 | - | 1360 | 10.49 | 165FgJ | 15 | - | 1422 | 9.22 | 175FgJ | 15 | - | 1516 | 632 | 119 |
| | | | | 1 | | | 525A | 62 | 1.9 | 2145 | | 425B | 61 | 1.8 | 2008 | | 365C | 60 | 1.8 | 1956 | | 385C | 59 | 1.8 | 2078 | 857 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

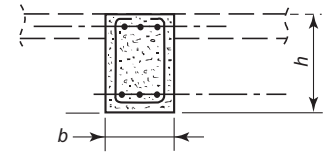
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

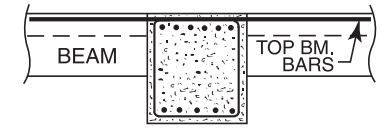
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 34 ft | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | SPAN, $\ell_n$ = 40 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 28 | 14 | 2# 9 | | 1 | 3# 8 | 2.44 | 113J | 8 | - | 470 | 2.17 | 123J | 8 | - | 499 | 1.95 | 123J | 8 | - | 523 | 1.76 | 123J | 8 | - | 547 | 217 | 227 |
| | | | | 1 | | | 234G | 33 | 1.3 | 694 | | 244G | 33 | 1.3 | 730 | | 254G | 33 | 1.3 | 766 | | 264G | 32 | 1.3 | 802 | 256 | |
| | | 2#10 | | 1 | 3#10 | 3.75 | 144J | 8 | - | 717 | 3.34 | 143J | 8 | - | 692 | 3.00 | 153J | 8 | - | 731 | 2.71 | 153J | 8 | - | 766 | 271 | 230 |
| | | | | 1 | | | 235G | 33 | 1.3 | 1042 | | 245G | 33 | 1.3 | 1096 | | 255G | 33 | 1.3 | 1149 | | 265G | 32 | 1.3 | 1203 | 393 | |
| | | 2#11 | | 1 | 3#11 | 4.48 | 154J | 8 | - | 866 | 3.99 | 154J | 8 | - | 908 | 3.58 | 164J | 8 | - | 959 | 3.24 | 164J | 8 | - | 1002 | 327 | 207 |
| | | | | 1 | | | 235G | 33 | 1.3 | 1181 | | 245G | 33 | 1.3 | 1243 | | 255G | 33 | 1.3 | 1305 | | 265G | 32 | 1.3 | 1367 | 470 | |
| | | 2#10 | 1#10 | 1 | 3#14 | 5.45 | 155J | 8 | - | 1142 | 4.86 | 165J | 8 | - | 1211 | 4.36 | 165J | 8 | - | 1265 | 3.94 | 174J | 8 | - | 1244 | 393 | 172 |
| | | | | 1 | | | 345D | 33 | 1.3 | 1593 | | 365D | 33 | 1.3 | 1686 | | 375D | 33 | 1.3 | 1760 | | 265G | 32 | 1.3 | 1600 | 607 | |
| | 16 | 2# 9 | | 1 | 3# 9 | 3.03 | 123J | 10 | - | 526 | 2.70 | 123J | 10 | - | 553 | 2.43 | 123J | 10 | - | 580 | 2.19 | 133J | 10 | - | 612 | 218 | 214 |
| | | | | 1 | | | 234G | 41 | 1.5 | 754 | | 244G | 41 | 1.5 | 794 | | 294F | 41 | 1.5 | 883 | | 304F | 40 | 1.4 | 922 | 321 | |
| | | 2#10 | | 1 | 3#10 | 3.79 | 133J | 10 | - | 655 | 3.38 | 143J | 10 | - | 694 | 3.04 | 143J | 10 | - | 728 | 2.74 | 143J | 10 | - | 763 | 273 | 212 |
| | | | | 1 | | | 235G | 41 | 1.5 | 1058 | | 245G | 41 | 1.5 | 1112 | | 265G | 41 | 1.4 | 1187 | | 275G | 40 | 1.4 | 1242 | 398 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 5.52 | 155J | 10 | - | 1109 | 4.92 | 155J | 10 | - | 1161 | 4.42 | 164J | 10 | - | 1142 | 3.99 | 174J | 10 | - | 1203 | 398 | 168 |
| | | | | 1 | | | 345D | 41 | 1.5 | 1578 | | 365D | 41 | 1.4 | 1671 | | 265G | 41 | 1.4 | 1521 | | 275G | 40 | 1.4 | 1593 | 613 | |
| | | 2#14 | | 1 | 3#14 | 6.19 | 155J | 10 | - | 1272 | 5.53 | 165J | 10 | - | 1348 | 4.96 | 165J | 10 | - | 1409 | 4.48 | 175J | 10 | - | 1485 | 459 | 158 |
| | | | | 1 | | | 345D | 41 | 1.5 | 1741 | | 365D | 41 | 1.4 | 1843 | | 385D | 41 | 1.4 | 1944 | | 395D | 40 | 1.4 | 2026 | 650 | |
| | 18 | 2# 8 | 1# 8 | 1 | 3#10 | 3.59 | 123J | 12 | - | 605 | 3.20 | 133J | 12 | - | 642 | 2.88 | 133J | 12 | - | 674 | 2.60 | 133J | 12 | - | 706 | 259 | 188 |
| | | | | 1 | | | 215H | 50 | 1.6 | 986 | | 225H | 49 | 1.6 | 1038 | | 235H | 49 | 1.6 | 1091 | | 245H | 49 | 1.6 | 1144 | 402 | |
| | | 2# 9 | 1# 9 | 1 | 3#11 | 4.48 | 134J | 12 | - | 807 | 3.99 | 143J | 12 | - | 793 | 3.58 | 143J | 12 | - | 833 | 3.24 | 153J | 12 | - | 878 | 323 | 183 |
| | | | | 1 | | | 215H | 50 | 1.6 | 1124 | | 225H | 49 | 1.6 | 1185 | | 235H | 49 | 1.6 | 1246 | | 245H | 49 | 1.6 | 1306 | 484 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 6.31 | 155J | 12 | - | 1249 | 5.63 | 155J | 12 | - | 1309 | 5.05 | 165J | 12 | - | 1384 | 4.56 | 175J | 12 | - | 1458 | 484 | 149 |
| | | | | 1 | | | 295E | 50 | 1.6 | 1633 | | 315E | 49 | 1.6 | 1734 | | 335E | 49 | 1.6 | 1836 | | 345E | 49 | 1.6 | 1916 | 663 | |
| | | 2#11 | 1#11 | 1 | 5#11 | 6.70 | 155J | 12 | - | 1331 | 5.98 | 165J | 12 | - | 1411 | 5.37 | 165J | 12 | - | 1475 | 4.84 | 175J | 12 | - | 1555 | 484 | 140 |
| | | | | 1 | | | 345D | 50 | 1.6 | 1819 | | 315E | 49 | 1.6 | 1821 | | 335E | 49 | 1.6 | 1927 | | 345E | 49 | 1.6 | 2013 | 753 | |
| | 20 | 2# 8 | 1# 8 | 1 | 3#10 | 3.61 | 123J | 15 | - | 607 | 3.22 | 123J | 15 | - | 639 | 2.89 | 123J | 15 | - | 671 | 2.61 | 123J | 14 | - | 703 | 260 | 166 |
| | | | | 1 | | | 215H | 59 | 1.8 | 1000 | | 225H | 59 | 1.8 | 1054 | | 235H | 58 | 1.8 | 1107 | | 244H | 58 | 1.7 | 963 | 406 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 4.66 | 134J | 15 | - | 896 | 4.15 | 143J | 15 | - | 886 | 3.73 | 143J | 15 | - | 931 | 3.36 | 143J | 14 | - | 976 | 406 | 162 |
| | | | | 1 | | | 215H | 59 | 1.8 | 1225 | | 225H | 59 | 1.8 | 1291 | | 235H | 58 | 1.8 | 1358 | | 245H | 58 | 1.7 | 1424 | 489 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 6.41 | 155J | 15 | - | 1254 | 5.72 | 155J | 15 | - | 1314 | 5.13 | 165J | 15 | - | 1389 | 4.63 | 164J | 14 | - | 1359 | 489 | 143 |
| | | | | 1 | | | 295E | 59 | 1.8 | 1653 | | 315E | 59 | 1.8 | 1756 | | 335E | 58 | 1.7 | 1859 | | 345E | 58 | 1.7 | 1940 | 673 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 8.16 | 175GfJ | 15 | - | 1594 | 7.28 | 175GeJ | 15 | - | 1672 | 6.54 | 185GdJ | 15 | - | 1765 | 5.90 | 175J | 14 | - | 1828 | 632 | 119 |
| | | | | 1 | | | 415C | 59 | 1.8 | 2220 | | 365D | 59 | 1.8 | 2190 | | 385D | 58 | 1.7 | 2312 | | 405D | 58 | 1.7 | 2433 | 857 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

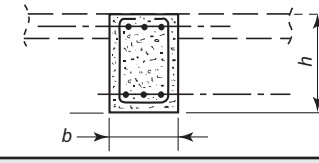
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

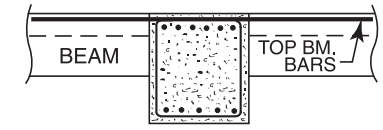
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 26 ft | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 30 | 14 | 2# 9 | | 1 | 3# 9 | 5.58 | 104K | 10 | - | 453 | 4.81 | 113K | 9 | - | 441 | 4.19 | 113K | 9 | - | 468 | 3.68 | 123K | 9 | - | 500 | 235 | 200 |
| | | | | 1 | | | 185G | 38 | 1.5 | 723 | | 195G | 38 | 1.5 | 771 | | 205G | 37 | 1.4 | 818 | | 225G | 37 | 1.4 | 886 | 344 | |
| | | 2#10 | | 1 | 3#10 | 6.96 | 115K | 10 | - | 619 | 6.01 | 114K | 9 | - | 593 | 5.23 | 124K | 9 | - | 636 | 4.60 | 124K | 9 | - | 671 | 294 | 191 |
| | | | | 1 | | | 185G | 38 | 1.5 | 819 | | 195G | 38 | 1.5 | 874 | | 205G | 37 | 1.4 | 928 | | 225G | 37 | 1.4 | 1003 | 428 | |
| | | 2#10 | 1#10 | 1 | 4#10 | 8.99 | 125HcK | 10 | - | 792 | 7.75 | 125K | 9 | - | 839 | 6.75 | 135K | 9 | - | 900 | 5.93 | 135K | 9 | - | 947 | 428 | 158 |
| | | | | 1 | | | 265D | 38 | 1.5 | 1139 | | 285D | 38 | 1.5 | 1226 | | 305D | 37 | 1.4 | 1313 | | 325D | 37 | 1.4 | 1400 | 552 | |
| | | 2#14 | | 1 | 3#14 | 11.32 | 245D | 10 | - | 1166 | 9.76 | 254D | 9 | - | 1104 | 8.50 | 274D | 9 | - | 1184 | 7.47 | 155HdK | 9 | - | 1216 | 492 | 139 |
| | | | | 1 | | | 525A | 38 | 1.5 | 1859 | | 285D | 38 | 1.4 | 1437 | | 305D | 37 | 1.4 | 1538 | | 325D | 37 | 1.4 | 1640 | 695 | |
| | 16 | 2# 9 | | 1 | 3# 9 | 5.61 | 103K | 12 | - | 410 | 4.84 | 103K | 12 | - | 437 | 4.21 | 113K | 12 | - | 469 | 3.70 | 113K | 12 | - | 496 | 236 | 170 |
| | | | | 1 | | | 165H | 48 | 1.7 | 694 | | 175H | 47 | 1.6 | 742 | | 185H | 47 | 1.6 | 790 | | 195H | 46 | 1.6 | 838 | 348 | |
| | | 2#11 | | 1 | 3#11 | 8.47 | 115K | 12 | - | 730 | 7.30 | 125K | 12 | - | 787 | 6.36 | 125K | 12 | - | 830 | 5.59 | 134K | 12 | - | 814 | 359 | 162 |
| | | | | 1 | | | 225E | 48 | 1.7 | 1022 | | 245E | 47 | 1.6 | 1106 | | 265E | 47 | 1.6 | 1191 | | 285E | 46 | 1.6 | 1275 | 520 | |
| | | 2#14 | | 1 | 3#14 | 11.58 | 245D | 12 | - | 1174 | 9.99 | 145GfK | 12 | - | 1084 | 8.70 | 145HeK | 12 | - | 1145 | 7.65 | 155HdK | 12 | - | 1221 | 499 | 132 |
| | | | | 1 | | | 525A | 48 | 1.6 | 1896 | | 285D | 47 | 1.6 | 1456 | | 305D | 47 | 1.6 | 1559 | | 325D | 46 | 1.6 | 1662 | 711 | |
| | | 2#14 | | 1 | 5#11 | 11.82 | 245D | 12 | - | 1237 | 10.20 | 145GfK | 12 | - | 1151 | 8.88 | 145HeK | 12 | - | 1217 | 7.81 | 155HdK | 12 | - | 1298 | 499 | 131 |
| | | | | 2 | | | 525A | 48 | 1.6 | 1958 | | 345C | 47 | 1.6 | 1649 | | 305D | 47 | 1.6 | 1631 | | 325D | 46 | 1.6 | 1739 | 767 | |
| | 18 | 2# 8 | 1# 8 | 1 | 3#10 | 6.65 | 104K | 15 | - | 517 | 5.73 | 103K | 14 | - | 503 | 4.99 | 113K | 14 | - | 540 | 4.39 | 113K | 14 | - | 572 | 280 | 151 |
| | | | | 1 | | | 165H | 58 | 1.8 | 765 | | 175H | 57 | 1.8 | 818 | | 185H | 57 | 1.8 | 872 | | 195H | 56 | 1.8 | 925 | 437 | |
| | | 2# 9 | 1# 9 | 1 | 3#11 | 8.30 | 115K | 15 | - | 696 | 7.15 | 114K | 14 | - | 673 | 6.23 | 124K | 14 | - | 723 | 5.48 | 124K | 14 | - | 763 | 350 | 151 |
| | | | | 1 | | | 225E | 58 | 1.8 | 1000 | | 245E | 57 | 1.8 | 1083 | | 265E | 57 | 1.8 | 1167 | | 285E | 56 | 1.8 | 1250 | 526 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 11.79 | 135GfK | 15 | - | 989 | 10.16 | 135HeK | 14 | - | 1049 | 8.85 | 145HdK | 14 | - | 1125 | 7.78 | 145HcK | 14 | - | 1184 | 526 | 125 |
| | | | | 1 | | | 315C | 58 | 1.8 | 1457 | | 285D | 57 | 1.8 | 1452 | | 305D | 57 | 1.8 | 1555 | | 325D | 56 | 1.8 | 1658 | 724 | |
| | | 2#10 | 2#10 | 1 | 4#14 | 13.46 | 245D | 15 | - | 1302 | 11.60 | 155FhK | 14 | - | 1234 | 10.11 | 155GfK | 14 | - | 1304 | 8.88 | 155HeK | 14 | - | 1375 | 568 | 109 |
| | | | | 1 | | | 525A | 58 | 1.8 | 2051 | | 345C | 57 | 1.8 | 1734 | | 365C | 57 | 1.8 | 1848 | | 325D | 56 | 1.8 | 1833 | 907 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3#10 | 7.17 | 104K | 17 | - | 573 | 6.18 | 103K | 17 | - | 562 | 5.38 | 113K | 17 | - | 603 | 4.73 | 113K | 17 | - | 639 | 352 | 133 |
| | | | | 1 | | | 205F | 69 | 2.0 | 919 | | 215F | 68 | 2.0 | 977 | | 235F | 67 | 2.0 | 1057 | | 185l | 66 | 1.9 | 982 | 440 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 8.65 | 115K | 17 | - | 767 | 7.46 | 114K | 17 | - | 747 | 6.49 | 124K | 17 | - | 802 | 5.71 | 124K | 17 | - | 847 | 440 | 132 |
| | | | | 1 | | | 225E | 69 | 2.0 | 1082 | | 215F | 68 | 2.0 | 1105 | | 235F | 67 | 2.0 | 1194 | | 245F | 66 | 1.9 | 1261 | 531 | |
| | | 2#11 | 1#11 | 1 | 5#11 | 12.58 | 135GfK | 17 | - | 1057 | 10.84 | 135HeK | 17 | - | 1121 | 9.45 | 145HdK | 17 | - | 1202 | 8.30 | 145HdK | 17 | - | 1266 | 531 | 113 |
| | | | | 1 | | | 315C | 69 | 2.0 | 1541 | | 345C | 68 | 2.0 | 1672 | | 305D | 67 | 2.0 | 1648 | | 325D | 66 | 1.9 | 1757 | 837 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 15.28 | 245D | 17 | - | 1472 | 13.17 | 255D | 17 | - | 1571 | 11.48 | 165FhK | 17 | - | 1512 | 10.09 | 175FhK | 17 | - | 1610 | 734 | 98 |
| | | | | 1 | | | 525A | 69 | 2.0 | 2250 | | 565A | 68 | 2.0 | 2422 | | 365C | 67 | 2.0 | 2059 | | 385C | 66 | 1.9 | 2187 | 938 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

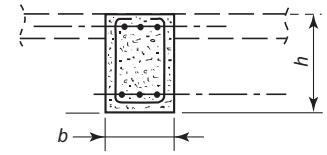
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

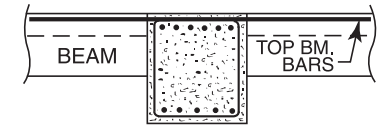
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 34 ft | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | SPAN, $\ell_n$ = 40 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 30 | 14 | 2# 9 | | 1 | 3# 9 | 3.26 | 123K | 9 | - | 527 | 2.91 | 123K | 9 | - | 554 | 2.61 | 123K | 9 | - | 582 | 2.36 | 133K | 9 | - | 614 | 235 | 200 |
| | | | | 1 | | | 235G | 37 | 1.4 | 933 | | 244G | 36 | 1.4 | 794 | | 264G | 36 | 1.4 | 846 | | 274G | 36 | 1.4 | 885 | 344 | |
| | | 2#10 | | 1 | 3#10 | 4.07 | 134K | 9 | - | 715 | 3.63 | 133K | 9 | - | 691 | 3.26 | 143K | 9 | - | 730 | 2.94 | 143K | 9 | - | 765 | 294 | 191 |
| | | | | 1 | | | 235G | 37 | 1.4 | 1058 | | 245G | 36 | 1.4 | 1112 | | 265G | 36 | 1.4 | 1187 | | 275G | 36 | 1.4 | 1242 | 428 | |
| | | 2#10 | 1#10 | 1 | 4#10 | 5.26 | 145K | 9 | - | 1008 | 4.69 | 144K | 9 | - | 978 | 4.21 | 154K | 9 | - | 1034 | 3.80 | 154K | 9 | - | 1080 | 428 | 158 |
| | | | | 1 | | | 345D | 37 | 1.4 | 1487 | | 245G | 36 | 1.4 | 1332 | | 265G | 36 | 1.4 | 1419 | | 275G | 36 | 1.4 | 1485 | 552 | |
| | | 2#14 | | 1 | 3#14 | 6.62 | 155HdK | 9 | - | 1277 | 5.90 | 155K | 9 | - | 1339 | 5.30 | 165K | 9 | - | 1415 | 4.78 | 165K | 9 | - | 1476 | 492 | 139 |
| | | | | 1 | | | 345D | 37 | 1.4 | 1741 | | 365D | 36 | 1.4 | 1843 | | 385D | 36 | 1.4 | 1944 | | 395D | 36 | 1.4 | 2026 | 695 | |
| | 16 | 2# 9 | | 1 | 3# 9 | 3.28 | 113K | 11 | - | 524 | 2.93 | 113K | 11 | - | 551 | 2.63 | 123K | 11 | - | 583 | 2.37 | 123K | 11 | - | 610 | 236 | 170 |
| | | | | 1 | | | 215H | 46 | 1.6 | 907 | | 225H | 45 | 1.6 | 955 | | 234H | 45 | 1.6 | 819 | | 244H | 45 | 1.5 | 859 | 348 | |
| | | 2#11 | | 1 | 3#11 | 4.95 | 134K | 11 | - | 857 | 4.42 | 144K | 11 | - | 909 | 3.96 | 144K | 11 | - | 951 | 3.58 | 144K | 11 | - | 994 | 359 | 162 |
| | | | | 1 | | | 295E | 46 | 1.6 | 1338 | | 225H | 45 | 1.6 | 1235 | | 235H | 45 | 1.5 | 1298 | | 245H | 45 | 1.5 | 1361 | 520 | |
| | | 2#14 | | 1 | 3#14 | 6.77 | 155HcK | 11 | - | 1283 | 6.04 | 155K | 11 | - | 1344 | 5.42 | 155K | 11 | - | 1405 | 4.89 | 165K | 11 | - | 1481 | 499 | 132 |
| | | | | 1 | | | 295E | 46 | 1.6 | 1661 | | 315E | 45 | 1.6 | 1764 | | 335E | 45 | 1.5 | 1866 | | 345E | 45 | 1.5 | 1949 | 711 | |
| | | 2#14 | | 1 | 5#11 | 6.91 | 155HcK | 11 | - | 1364 | 6.17 | 155K | 11 | - | 1431 | 5.54 | 155K | 11 | - | 1497 | 5.00 | 165K | 11 | - | 1578 | 499 | 131 |
| | | | | 2 | | | 295E | 46 | 1.6 | 1743 | | 315E | 45 | 1.6 | 1850 | | 335E | 45 | 1.5 | 1958 | | 345E | 45 | 1.5 | 2045 | 767 | |
| | 18 | 2# 8 | 1# 8 | 1 | 3#10 | 3.89 | 113K | 14 | - | 603 | 3.47 | 123K | 14 | - | 640 | 3.11 | 123K | 14 | - | 672 | 2.81 | 123K | 14 | - | 704 | 280 | 151 |
| | | | | 1 | | | 215H | 56 | 1.8 | 1000 | | 225H | 55 | 1.7 | 1054 | | 235H | 55 | 1.7 | 1107 | | 245H | 54 | 1.7 | 1161 | 437 | |
| | | 2# 9 | 1# 9 | 1 | 3#11 | 4.85 | 134K | 14 | - | 813 | 4.33 | 134K | 14 | - | 853 | 3.88 | 133K | 14 | - | 832 | 3.51 | 143K | 14 | - | 877 | 350 | 151 |
| | | | | 1 | | | 215H | 55 | 1.7 | 1139 | | 225H | 55 | 1.7 | 1200 | | 235H | 55 | 1.7 | 1262 | | 245H | 54 | 1.7 | 1323 | 526 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 6.89 | 145K | 14 | - | 1244 | 6.15 | 145K | 14 | - | 1304 | 5.52 | 155K | 14 | - | 1379 | 4.98 | 155K | 14 | - | 1439 | 526 | 125 |
| | | | | 1 | | | 295E | 55 | 1.7 | 1653 | | 315E | 55 | 1.7 | 1756 | | 335E | 55 | 1.7 | 1859 | | 345E | 54 | 1.7 | 1940 | 724 | |
| | | 2#10 | 2#10 | 1 | 4#14 | 7.87 | 155HeK | 14 | - | 1446 | 7.02 | 165HdK | 14 | - | 1533 | 6.30 | 155K | 14 | - | 1588 | 5.69 | 165K | 14 | - | 1675 | 568 | 109 |
| | | | | 1 | | | 345D | 55 | 1.7 | 1947 | | 365D | 55 | 1.7 | 2061 | | 335E | 55 | 1.7 | 2067 | | 345E | 54 | 1.7 | 2160 | 907 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3#10 | 4.19 | 113K | 16 | - | 675 | 3.74 | 123K | 16 | - | 716 | 3.35 | 123K | 16 | - | 752 | 3.03 | 123K | 16 | - | 787 | 352 | 133 |
| | | | | 1 | | | 195I | 66 | 1.9 | 1040 | | 205I | 65 | 1.9 | 1098 | | 215I | 65 | 1.9 | 1156 | | 225I | 64 | 1.9 | 1215 | 440 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 5.06 | 124K | 16 | - | 892 | 4.51 | 133K | 16 | - | 885 | 4.05 | 133K | 16 | - | 930 | 3.65 | 133K | 16 | - | 975 | 440 | 132 |
| | | | | 1 | | | 265F | 66 | 1.9 | 1351 | | 275F | 65 | 1.9 | 1418 | | 215I | 65 | 1.9 | 1329 | | 225I | 64 | 1.9 | 1396 | 531 | |
| | | 2#11 | 1#11 | 1 | 5#11 | 7.35 | 145K | 16 | - | 1331 | 6.56 | 145K | 16 | - | 1396 | 5.89 | 155K | 16 | - | 1476 | 5.31 | 155K | 16 | - | 1541 | 531 | 113 |
| | | | | 1 | | | 295E | 66 | 1.9 | 1755 | | 315E | 65 | 1.9 | 1864 | | 335E | 65 | 1.9 | 1973 | | 305F | 64 | 1.9 | 1971 | 837 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 8.93 | 175GgK | 16 | - | 1693 | 7.97 | 165HeK | 16 | - | 1760 | 7.15 | 175HeK | 16 | - | 1859 | 6.45 | 175HdK | 16 | - | 1942 | 734 | 98 |
| | | | | 1 | | | 415C | 66 | 1.9 | 2336 | | 365D | 65 | 1.9 | 2308 | | 385D | 65 | 1.9 | 2435 | | 405D | 64 | 1.9 | 2563 | 938 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

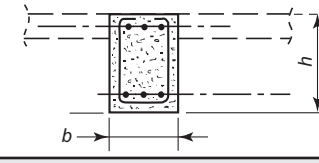
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

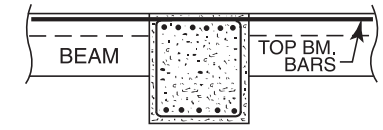
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 32 ft | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ | $b$ | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 32 | 16 | 2#10 | | 1 | 3#10 | 4.99 | 114M | 13 | - | 669 | 4.42 | 123M | 13 | - | 656 | 3.95 | 123M | 12 | - | 691 | 3.54 | 123M | 12 | - | 725 | 319 | 143 |
| | | | | 1 | | | 195H | 51 | 1.7 | 969 | | 215H | 50 | 1.7 | 1046 | | 225H | 50 | 1.7 | 1102 | | 235H | 50 | 1.7 | 1158 | 467 | |
| | | 2#11 | | 1 | 3#11 | 6.04 | 124M | 13 | - | 810 | 5.35 | 124M | 13 | - | 853 | 4.78 | 134M | 12 | - | 905 | 4.29 | 134M | 12 | - | 948 | 387 | 136 |
| | | | | 1 | | | 285E | 51 | 1.7 | 1294 | | 295E | 50 | 1.7 | 1358 | | 225H | 50 | 1.7 | 1250 | | 235H | 50 | 1.7 | 1314 | 562 | |
| | | 2#14 | | 1 | 3#14 | 8.30 | 145ldM | 13 | - | 1216 | 7.35 | 145ldM | 13 | - | 1277 | 6.56 | 145M | 12 | - | 1338 | 5.88 | 145M | 12 | - | 1400 | 540 | 112 |
| | | | | 1 | | | 325D | 51 | 1.7 | 1684 | | 295E | 50 | 1.7 | 1681 | | 315E | 50 | 1.7 | 1785 | | 335E | 50 | 1.7 | 1889 | 772 | |
| | | 2#10 | 2#10 | 1 | 4#14 | 9.31 | 155HfM | 13 | - | 1381 | 8.25 | 155HfM | 13 | - | 1452 | 7.36 | 155leM | 12 | - | 1522 | 6.60 | 165ldM | 12 | - | 1609 | 607 | 104 |
| | | | | 2 | | | 325D | 51 | 1.7 | 1833 | | 345D | 50 | 1.7 | 1947 | | 365D | 50 | 1.7 | 2061 | | 335E | 50 | 1.7 | 2067 | 867 | |
| | 18 | 2# 8 | 1# 8 | 1 | 3#10 | 4.72 | 103M | 15 | - | 569 | 4.18 | 113M | 15 | - | 606 | 3.73 | 113M | 15 | - | 638 | 3.35 | 113M | 15 | - | 670 | 302 | 121 |
| | | | | 1 | | | 185l | 62 | 1.9 | 916 | | 195l | 61 | 1.9 | 970 | | 205l | 61 | 1.9 | 1024 | | 215l | 60 | 1.9 | 1079 | 471 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 6.11 | 124M | 15 | - | 850 | 5.41 | 124M | 15 | - | 895 | 4.83 | 124M | 15 | - | 940 | 4.33 | 134M | 15 | - | 995 | 471 | 119 |
| | | | | 1 | | | 245F | 62 | 1.9 | 1261 | | 265F | 61 | 1.9 | 1351 | | 275F | 61 | 1.9 | 1418 | | 295F | 60 | 1.8 | 1507 | 568 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 8.43 | 135ldM | 15 | - | 1178 | 7.47 | 145lcM | 15 | - | 1254 | 6.66 | 145M | 15 | - | 1314 | 5.98 | 145M | 15 | - | 1374 | 568 | 105 |
| | | | | 1 | | | 325D | 62 | 1.9 | 1680 | | 295E | 61 | 1.9 | 1673 | | 315E | 61 | 1.9 | 1777 | | 335E | 60 | 1.8 | 1882 | 785 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 10.76 | 175FiM | 15 | - | 1533 | 9.53 | 175GhM | 15 | - | 1611 | 8.50 | 175GgM | 15 | - | 1689 | 7.63 | 175HfM | 15 | - | 1767 | 736 | 87 |
| | | | | 1 | | | 385C | 62 | 1.9 | 2104 | | 415C | 61 | 1.9 | 2249 | | 435C | 61 | 1.9 | 2371 | | 385D | 60 | 1.8 | 2338 | 1002 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3#11 | 5.93 | 114M | 18 | - | 761 | 5.25 | 114M | 18 | - | 801 | 4.69 | 124M | 18 | - | 851 | 4.21 | 124M | 18 | - | 891 | 379 | 113 |
| | | | | 1 | | | 245F | 74 | 2.1 | 1197 | | 265F | 73 | 2.1 | 1283 | | 205l | 72 | 2.0 | 1185 | | 215l | 72 | 2.0 | 1248 | 573 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 6.16 | 114M | 18 | - | 842 | 5.46 | 124M | 18 | - | 897 | 4.87 | 124M | 18 | - | 942 | 4.37 | 124M | 18 | - | 987 | 474 | 109 |
| | | | | 1 | | | 245F | 74 | 2.1 | 1278 | | 265F | 73 | 2.1 | 1369 | | 275F | 72 | 2.0 | 1437 | | 215l | 71 | 2.0 | 1344 | 573 | |
| | | 2#10 | 2#10 | 1 | 4#14 | 9.69 | 145HeM | 18 | - | 1375 | 8.58 | 145ldM | 18 | - | 1445 | 7.65 | 155ldM | 18 | - | 1533 | 6.87 | 145M | 18 | - | 1587 | 620 | 89 |
| | | | | 1 | | | 325D | 74 | 2.1 | 1878 | | 345D | 73 | 2.1 | 1994 | | 365D | 72 | 2.0 | 2111 | | 335E | 71 | 2.0 | 2113 | 1019 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 12.42 | 255E | 18 | - | 1917 | 11.00 | 205EIM | 18 | - | 1928 | 9.82 | 195FjM | 18 | - | 2004 | 8.81 | 195FiM | 18 | - | 2097 | 795 | 76 |
| | | | | 1 | | | 485B | 73 | 2.1 | 2606 | | 415C | 73 | 2.1 | 2538 | | 435C | 72 | 2.0 | 2677 | | 465C | 71 | 2.0 | 2839 | 1165 | |
| | 24 | 2#10 | 1#10 | 1 | 4#10 | 6.75 | 113M | 25 | - | 870 | 5.98 | 113M | 24 | - | 917 | 5.34 | 113M | 24 | - | 963 | 4.79 | 123M | 24 | - | 1021 | 479 | 93 |
| | | | | 1 | | | 225G | 98 | 2.5 | 1615 | | 235G | 97 | 2.4 | 1701 | | 245G | 96 | 2.4 | 1786 | | 195J | 96 | 2.4 | 1637 | 628 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 8.14 | 124M | 25 | - | 1174 | 7.21 | 123M | 24 | - | 1115 | 6.44 | 123M | 24 | - | 1173 | 5.78 | 133M | 24 | - | 1241 | 580 | 91 |
| | | | | 1 | | | 225G | 98 | 2.5 | 1792 | | 235G | 97 | 2.4 | 1889 | | 245G | 96 | 2.4 | 1985 | | 265G | 96 | 2.4 | 2121 | 758 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 11.24 | 135M | 25 | - | 1757 | 9.96 | 135M | 24 | - | 1840 | 8.88 | 144M | 24 | - | 1790 | 7.97 | 144M | 24 | - | 1872 | 810 | 77 |
| | | | | 1 | | | 285E | 98 | 2.5 | 2436 | | 295E | 97 | 2.4 | 2558 | | 275F | 96 | 2.4 | 2563 | | 295F | 95 | 2.4 | 2724 | 1046 | |
| | | 3#11 | 2#11 | 1 | 5#14 | 13.61 | 145lcM | 25 | - | 2045 | 12.05 | 145M | 24 | - | 2144 | 10.75 | 145M | 24 | - | 2242 | 9.65 | 155M | 24 | - | 2373 | 927 | 68 |
| | | | | 1 | | | 325D | 98 | 2.5 | 2849 | | 345D | 97 | 2.4 | 3026 | | 315E | 96 | 2.4 | 3007 | | 335E | 96 | 2.4 | 3184 | 1266 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

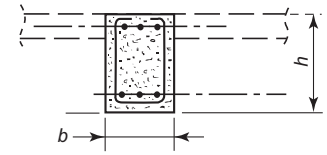
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

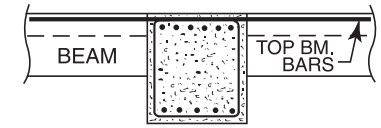
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 40 ft | | | | | SPAN, $\ell_n$ = 42 ft. | | | | | SPAN, $\ell_n$ = 44 ft. | | | | | SPAN, $\ell_n$ = 46 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 32 | 16 | 2#10 | | 1 | 3#10 | 3.20 | 133M | 12 | - | 765 | 2.90 | 133M | 12 | - | 799 | 2.64 | 133M | 12 | - | 834 | 2.42 | 133M | 12 | - | 868 | 319 | 143 |
| | | | | 1 | | | 245H | 49 | 1.7 | 1214 | | 255H | 49 | 1.7 | 1270 | | 265H | 49 | 1.6 | 1326 | | 275H | 48 | 1.6 | 1382 | 467 | |
| | | 2#11 | | 1 | 3#11 | 3.87 | 144M | 12 | - | 1000 | 3.51 | 143M | 12 | - | 976 | 3.20 | 143M | 12 | - | 1019 | 2.92 | 153M | 12 | - | 1066 | 387 | 136 |
| | | | | 1 | | | 245H | 49 | 1.7 | 1378 | | 255H | 49 | 1.7 | 1442 | | 265H | 49 | 1.6 | 1506 | | 275H | 48 | 1.6 | 1570 | 562 | |
| | | 2#14 | | 1 | 3#14 | 5.31 | 155M | 12 | - | 1477 | 4.82 | 155M | 12 | - | 1538 | 4.39 | 165M | 12 | - | 1615 | 4.02 | 165M | 12 | - | 1676 | 540 | 112 |
| | | | | 1 | | | 345E | 49 | 1.7 | 1972 | | 365E | 49 | 1.6 | 2076 | | 375E | 49 | 1.6 | 2159 | | 385E | 48 | 1.6 | 2242 | 772 | |
| | | 2#10 | 2#10 | 1 | 4#14 | 5.96 | 165lcM | 12 | - | 1680 | 5.41 | 165M | 12 | - | 1751 | 4.93 | 165M | 12 | - | 1822 | 4.51 | 175M | 12 | - | 1909 | 607 | 104 |
| | | | | 2 | | | 345E | 49 | 1.7 | 2160 | | 365E | 49 | 1.6 | 2274 | | 375E | 49 | 1.6 | 2366 | | 385E | 48 | 1.6 | 2459 | 867 | |
| | 18 | 2# 8 | 1# 8 | 1 | 3#10 | 3.02 | 113M | 15 | - | 702 | 2.74 | 113M | 15 | - | 734 | 2.50 | 123M | 15 | - | 771 | 2.29 | 123M | 15 | - | 803 | 302 | 121 |
| | | | | 1 | | | 225I | 60 | 1.8 | 1133 | | 235I | 59 | 1.8 | 1187 | | 245I | 59 | 1.8 | 1241 | | 255I | 59 | 1.8 | 1295 | 471 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 3.91 | 133M | 15 | - | 976 | 3.55 | 133M | 15 | - | 1021 | 3.23 | 143M | 15 | - | 1071 | 2.96 | 143M | 15 | - | 1116 | 471 | 119 |
| | | | | 1 | | | 225I | 60 | 1.8 | 1396 | | 235I | 59 | 1.8 | 1464 | | 245I | 59 | 1.8 | 1531 | | 255I | 59 | 1.8 | 1598 | 568 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 5.40 | 155M | 15 | - | 1450 | 4.90 | 155M | 15 | - | 1509 | 4.46 | 154M | 15 | - | 1480 | 4.08 | 164M | 15 | - | 1550 | 568 | 105 |
| | | | | 1 | | | 305F | 60 | 1.8 | 1875 | | 325F | 59 | 1.8 | 1979 | | 335F | 59 | 1.8 | 2061 | | 345F | 59 | 1.8 | 2143 | 785 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 6.89 | 165leM | 15 | - | 1829 | 6.25 | 175ldM | 15 | - | 1923 | 5.69 | 175ldM | 15 | - | 2001 | 5.21 | 175M | 15 | - | 2079 | 736 | 87 |
| | | | | 1 | | | 405D | 60 | 1.8 | 2460 | | 425D | 59 | 1.8 | 2583 | | 375E | 59 | 1.8 | 2550 | | 395E | 59 | 1.8 | 2672 | 1002 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3#11 | 3.80 | 124M | 18 | - | 931 | 3.44 | 124M | 18 | - | 971 | 3.14 | 134M | 18 | - | 1021 | 2.87 | 134M | 17 | - | 1061 | 379 | 113 |
| | | | | 1 | | | 225I | 71 | 2.0 | 1311 | | 235I | 71 | 2.0 | 1374 | | 245I | 70 | 2.0 | 1436 | | 255I | 70 | 2.0 | 1499 | 573 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 3.94 | 124M | 18 | - | 1032 | 3.58 | 134M | 18 | - | 1088 | 3.26 | 134M | 18 | - | 1132 | 2.98 | 134M | 17 | - | 1177 | 474 | 109 |
| | | | | 1 | | | 225I | 71 | 2.0 | 1412 | | 235I | 70 | 2.0 | 1480 | | 245I | 70 | 2.0 | 1548 | | 255I | 70 | 2.0 | 1615 | 573 | |
| | | 2#10 | 2#10 | 1 | 4#14 | 6.20 | 155M | 18 | - | 1675 | 5.62 | 155M | 18 | - | 1746 | 5.12 | 165M | 18 | - | 1833 | 4.69 | 165M | 17 | - | 1904 | 620 | 89 |
| | | | | 1 | | | 345E | 71 | 2.0 | 2207 | | 365E | 70 | 2.0 | 2324 | | 335F | 70 | 2.0 | 2326 | | 345F | 70 | 2.0 | 2420 | 1019 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 7.95 | 185GhM | 18 | - | 2174 | 7.21 | 185HgM | 18 | - | 2267 | 6.57 | 185leM | 18 | - | 2360 | 6.01 | 185leM | 17 | - | 2453 | 795 | 76 |
| | | | | 1 | | | 485C | 71 | 2.0 | 2978 | | 425D | 70 | 2.0 | 2934 | | 445D | 70 | 2.0 | 3073 | | 455D | 70 | 2.0 | 3189 | 1165 | |
| | 24 | 2#10 | 1#10 | 1 | 4#10 | 4.32 | 123M | 24 | - | 1067 | 3.92 | 123M | 24 | - | 1114 | 3.57 | 123M | 23 | - | 1160 | 3.27 | 123M | 23 | - | 1207 | 479 | 93 |
| | | | | 1 | | | 205J | 95 | 2.4 | 1723 | | 215J | 94 | 2.4 | 1809 | | 275H | 94 | 2.4 | 2090 | | 285H | 93 | 2.4 | 2176 | 628 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 5.21 | 133M | 24 | - | 1299 | 4.73 | 133M | 24 | - | 1356 | 4.31 | 143M | 23 | - | 1424 | 3.94 | 143M | 23 | - | 1482 | 580 | 91 |
| | | | | 1 | | | 275G | 95 | 2.4 | 2218 | | 285G | 94 | 2.4 | 2314 | | 305G | 94 | 2.4 | 2450 | | 235J | 93 | 2.3 | 2234 | 758 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 7.20 | 154M | 24 | - | 1976 | 6.53 | 154M | 24 | - | 2058 | 5.95 | 154M | 23 | - | 2141 | 5.44 | 164M | 23 | - | 2244 | 810 | 77 |
| | | | | 1 | | | 305F | 95 | 2.4 | 2846 | | 285G | 94 | 2.4 | 2851 | | 305G | 94 | 2.3 | 3012 | | 315G | 93 | 2.3 | 3134 | 1046 | |
| | | 3#11 | 2#11 | 1 | 5#14 | 8.71 | 155M | 24 | - | 2472 | 7.90 | 165M | 24 | - | 2603 | 7.20 | 164M | 23 | - | 2513 | 6.58 | 174M | 23 | - | 2632 | 927 | 68 |
| | | | | 1 | | | 345E | 95 | 2.4 | 3322 | | 325F | 94 | 2.4 | 3343 | | 335F | 94 | 2.4 | 3481 | | 355F | 93 | 2.3 | 3658 | 1266 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

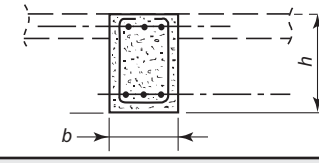
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

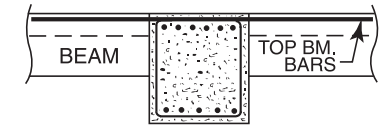
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 32 ft | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 34 | 16 | 2#10 | | 1 | 3#10 | 5.35 | 114N | 14 | - | 674 | 4.74 | 113N | 14 | - | 654 | 4.23 | 113N | 14 | - | 688 | 3.79 | 123N | 14 | - | 728 | 342 | 119 |
| | | | | 1 | | | 245F | 56 | 1.8 | 1093 | | 195I | 55 | 1.8 | 1017 | | 205I | 55 | 1.8 | 1073 | | 215I | 54 | 1.8 | 1130 | 501 | |
| | | 2#11 | | 1 | 3#11 | 6.49 | 115N | 14 | - | 872 | 5.75 | 124N | 14 | - | 858 | 5.13 | 124N | 14 | - | 901 | 4.60 | 124N | 14 | - | 943 | 415 | 115 |
| | | | | 1 | | | 245F | 56 | 1.8 | 1225 | | 265F | 55 | 1.8 | 1312 | | 275F | 55 | 1.8 | 1376 | | 295F | 54 | 1.8 | 1463 | 604 | |
| | | 2#14 | | 1 | 3#14 | 8.95 | 135IeN | 14 | - | 1209 | 7.93 | 135JdN | 14 | - | 1270 | 7.07 | 145JcN | 14 | - | 1348 | 6.35 | 145N | 14 | - | 1409 | 580 | 96 |
| | | | | 1 | | | 325D | 56 | 1.8 | 1707 | | 295E | 55 | 1.8 | 1701 | | 315E | 55 | 1.8 | 1807 | | 335E | 54 | 1.8 | 1912 | 833 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 10.66 | 255E | 14 | - | 1671 | 9.44 | 165GhN | 14 | - | 1601 | 8.42 | 165HgN | 14 | - | 1679 | 7.56 | 165IfN | 14 | - | 1757 | 782 | 83 |
| | | | | 2 | | | 485B | 56 | 1.8 | 2327 | | 345D | 55 | 1.8 | 2093 | | 365D | 55 | 1.8 | 2215 | | 385D | 54 | 1.8 | 2338 | 992 | |
| | 18 | 2# 9 | 1# 9 | 1 | 3#11 | 6.32 | 114N | 17 | - | 763 | 5.60 | 114N | 17 | - | 803 | 4.99 | 114N | 17 | - | 843 | 4.48 | 124N | 17 | - | 894 | 404 | 104 |
| | | | | 1 | | | 245F | 68 | 2.0 | 1197 | | 265F | 67 | 2.0 | 1283 | | 275F | 67 | 2.0 | 1345 | | 215I | 66 | 2.0 | 1248 | 610 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 6.56 | 114N | 17 | - | 845 | 5.81 | 114N | 17 | - | 890 | 5.18 | 124N | 17 | - | 945 | 4.65 | 124N | 17 | - | 990 | 505 | 100 |
| | | | | 1 | | | 245F | 68 | 2.0 | 1278 | | 265F | 67 | 2.0 | 1369 | | 275F | 67 | 2.0 | 1437 | | 295F | 66 | 2.0 | 1527 | 610 | |
| | | 2#10 | 2#10 | 1 | 4#14 | 10.31 | 145HfN | 17 | - | 1379 | 9.14 | 145IfN | 17 | - | 1450 | 8.15 | 145JeN | 17 | - | 1521 | 7.31 | 145JdN | 17 | - | 1592 | 660 | 79 |
| | | | | 1 | | | 325D | 68 | 2.0 | 1878 | | 345D | 67 | 2.0 | 1994 | | 365D | 67 | 2.0 | 2111 | | 385D | 66 | 2.0 | 2228 | 1083 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 11.63 | 175FjN | 17 | - | 1628 | 10.31 | 175GiN | 17 | - | 1711 | 9.19 | 175GhN | 17 | - | 1794 | 8.25 | 165HgN | 16 | - | 1860 | 845 | 73 |
| | | | | 1 | | | 385C | 68 | 2.0 | 2213 | | 415C | 67 | 2.0 | 2365 | | 435C | 67 | 2.0 | 2494 | | 385D | 66 | 2.0 | 2462 | 1083 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3#11 | 6.35 | 104N | 20 | - | 755 | 5.63 | 114N | 20 | - | 806 | 5.02 | 114N | 20 | - | 846 | 4.50 | 114N | 20 | - | 886 | 406 | 93 |
| | | | | 1 | | | 225G | 81 | 2.2 | 1166 | | 235G | 80 | 2.2 | 1230 | | 245G | 79 | 2.2 | 1293 | | 265G | 79 | 2.2 | 1381 | 615 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 9.19 | 125JdN | 20 | - | 1174 | 8.14 | 125N | 20 | - | 1234 | 7.26 | 125N | 20 | - | 1294 | 6.52 | 135N | 20 | - | 1371 | 615 | 86 |
| | | | | 1 | | | 325D | 81 | 2.2 | 1724 | | 295E | 80 | 2.2 | 1713 | | 315E | 79 | 2.2 | 1820 | | 335E | 78 | 2.2 | 1927 | 855 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 11.83 | 165FiN | 20 | - | 1534 | 10.48 | 165GhN | 20 | - | 1612 | 9.34 | 165HgN | 20 | - | 1690 | 8.39 | 155IfN | 20 | - | 1751 | 801 | 72 |
| | | | | 1 | | | 385C | 81 | 2.2 | 2157 | | 415C | 80 | 2.2 | 2306 | | 435C | 79 | 2.2 | 2431 | | 385D | 78 | 2.2 | 2391 | 1100 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 13.37 | 255E | 20 | - | 1935 | 11.85 | 195EIN | 20 | - | 1925 | 10.57 | 195FkN | 20 | - | 2018 | 9.48 | 185GiN | 20 | - | 2093 | 855 | 65 |
| | | | | 1 | | | 485B | 81 | 2.2 | 2639 | | 515B | 80 | 2.2 | 2803 | | 435C | 79 | 2.2 | 2707 | | 465C | 78 | 2.2 | 2871 | 1325 | |
| | 24 | 2#10 | 1#10 | 1 | 4#11 | 8.03 | 113N | 27 | - | 962 | 7.11 | 113N | 27 | - | 1014 | 6.34 | 113N | 27 | - | 1066 | 5.69 | 123N | 26 | - | 1129 | 513 | 77 |
| | | | | 1 | | | 225G | 108 | 2.6 | 1732 | | 235G | 107 | 2.6 | 1824 | | 245G | 106 | 2.6 | 1917 | | 265G | 105 | 2.6 | 2050 | 814 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 8.75 | 114N | 27 | - | 1164 | 7.75 | 113N | 27 | - | 1110 | 6.91 | 123N | 27 | - | 1179 | 6.20 | 123N | 26 | - | 1237 | 622 | 77 |
| | | | | 1 | | | 225G | 108 | 2.6 | 1823 | | 235G | 107 | 2.6 | 1921 | | 245G | 106 | 2.6 | 2019 | | 265G | 105 | 2.6 | 2157 | 814 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 13.61 | 125N | 27 | - | 1905 | 12.05 | 135N | 27 | - | 2031 | 10.75 | 135N | 27 | - | 2125 | 9.65 | 145N | 26 | - | 2251 | 870 | 61 |
| | | | | 1 | | | 325D | 108 | 2.6 | 2801 | | 295E | 107 | 2.6 | 2772 | | 315E | 106 | 2.6 | 2946 | | 335E | 105 | 2.6 | 3120 | 1367 | |
| | | 2#14 | 2#14 | 1 | 6#14 | 17.09 | 254E | 27 | - | 2379 | 15.14 | 264E | 27 | - | 2515 | 13.50 | 145JdN | 27 | - | 2548 | 12.12 | 155JdN | 26 | - | 2696 | 1127 | 53 |
| | | | | 1 | | | 485B | 108 | 2.6 | 3795 | | 515B | 107 | 2.6 | 4032 | | 365D | 106 | 2.6 | 3539 | | 385D | 105 | 2.6 | 3735 | 1591 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

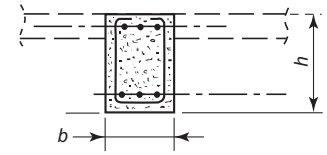
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

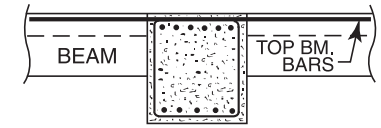
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 40 ft | | | | | SPAN, $\ell_n$ = 42 ft. | | | | | SPAN, $\ell_n$ = 44 ft. | | | | | SPAN, $\ell_n$ = 46 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) $\times 10^{-9}$ |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft.-kips | sq. in. | lb. | ft.-kip | in. |
| 34 | 16 | 2#10 | | 1 | 3#10 | 3.42 | 123N | 13 | - | 763 | 3.11 | 123N | 13 | - | 797 | 2.83 | 123N | 13 | - | 831 | 2.59 | 123N | 13 | - | 866 | 342 | 119 |
| | | | | 1 | | | 225I | 54 | 1.8 | 1187 | | 235I | 53 | 1.8 | 1243 | | 245I | 53 | 1.8 | 1300 | | 255I | 53 | 1.8 | 1357 | 501 | |
| | | 2#11 | | 1 | 3#11 | 4.15 | 134N | 13 | - | 996 | 3.77 | 134N | 13 | - | 1039 | 3.43 | 133N | 13 | - | 1017 | 3.14 | 143N | 13 | - | 1065 | 415 | 115 |
| | | | | 1 | | | 305F | 54 | 1.8 | 1528 | | 235I | 53 | 1.8 | 1415 | | 245I | 53 | 1.7 | 1480 | | 255I | 53 | 1.8 | 1544 | 604 | |
| | | 2#14 | | 1 | 3#14 | 5.73 | 145N | 13 | - | 1470 | 5.20 | 155N | 13 | - | 1548 | 4.73 | 155N | 13 | - | 1609 | 4.33 | 155N | 13 | - | 1671 | 580 | 96 |
| | | | | 1 | | | 305F | 54 | 1.8 | 1907 | | 325F | 53 | 1.8 | 2013 | | 335F | 53 | 1.7 | 2096 | | 345F | 53 | 1.7 | 2179 | 833 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 6.82 | 165JeN | 13 | - | 1835 | 6.19 | 165JdN | 13 | - | 1913 | 5.64 | 165JdN | 13 | - | 1991 | 5.16 | 165N | 13 | - | 2069 | 782 | 83 |
| | | | | 2 | | | 405D | 54 | 1.8 | 2460 | | 365E | 53 | 1.8 | 2449 | | 375E | 53 | 1.7 | 2550 | | 395E | 53 | 1.7 | 2672 | 992 | |
| | 18 | 2# 9 | 1# 9 | 1 | 3#11 | 4.05 | 124N | 16 | - | 934 | 3.67 | 124N | 16 | - | 974 | 3.34 | 134N | 16 | - | 1024 | 3.06 | 134N | 16 | - | 1064 | 404 | 104 |
| | | | | 1 | | | 225I | 66 | 2.0 | 1311 | | 235I | 65 | 2.0 | 1374 | | 245I | 65 | 2.0 | 1436 | | 255I | 64 | 1.9 | 1499 | 610 | |
| | | 2#10 | 1#10 | 1 | 3#11 | 4.20 | 124N | 16 | - | 1035 | 3.81 | 134N | 16 | - | 1091 | 3.47 | 134N | 16 | - | 1135 | 3.18 | 134N | 16 | - | 1180 | 505 | 100 |
| | | | | 1 | | | 225I | 66 | 2.0 | 1412 | | 235I | 65 | 2.0 | 1480 | | 245I | 65 | 2.0 | 1548 | | 255I | 64 | 1.9 | 1615 | 610 | |
| | | 2#10 | 2#10 | 1 | 4#14 | 6.60 | 155JcN | 16 | - | 1680 | 5.99 | 155N | 16 | - | 1751 | 5.46 | 155N | 16 | - | 1822 | 4.99 | 155N | 16 | - | 1893 | 660 | 79 |
| | | | | 1 | | | 345E | 66 | 2.0 | 2207 | | 365E | 65 | 2.0 | 2324 | | 385E | 65 | 1.9 | 2441 | | 345F | 64 | 1.9 | 2420 | 1083 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 7.45 | 165lfN | 16 | - | 1943 | 6.75 | 165JeN | 16 | - | 2025 | 6.15 | 165JdN | 16 | - | 2108 | 5.63 | 175JdN | 16 | - | 2208 | 845 | 73 |
| | | | | 1 | | | 405D | 65 | 2.0 | 2591 | | 425D | 65 | 1.9 | 2719 | | 385E | 65 | 1.9 | 2710 | | 395E | 64 | 1.9 | 2816 | 1083 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3#11 | 4.07 | 114N | 19 | - | 926 | 3.69 | 124N | 19 | - | 977 | 3.36 | 124N | 19 | - | 1016 | 3.07 | 124N | 19 | - | 1056 | 406 | 93 |
| | | | | 1 | | | 205J | 78 | 2.2 | 1279 | | 215J | 77 | 2.1 | 1342 | | 225J | 77 | 2.1 | 1406 | | 235J | 76 | 2.1 | 1469 | 615 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 5.88 | 135N | 19 | - | 1431 | 5.34 | 145N | 19 | - | 1508 | 4.86 | 144N | 19 | - | 1479 | 4.45 | 144N | 19 | - | 1539 | 615 | 86 |
| | | | | 1 | | | 305F | 78 | 2.2 | 1916 | | 325F | 77 | 2.1 | 2023 | | 305G | 77 | 2.1 | 2036 | | 315G | 76 | 2.1 | 2119 | 855 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 7.57 | 155JeN | 19 | - | 1829 | 6.87 | 165JdN | 19 | - | 1924 | 6.26 | 165JdN | 19 | - | 2002 | 5.72 | 165N | 19 | - | 2080 | 801 | 72 |
| | | | | 1 | | | 405D | 78 | 2.2 | 2516 | | 425D | 77 | 2.1 | 2641 | | 385E | 77 | 2.1 | 2625 | | 395E | 76 | 2.1 | 2726 | 1100 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 8.56 | 185GiN | 19 | - | 2187 | 7.76 | 175HgN | 19 | - | 2262 | 7.07 | 175lfN | 19 | - | 2356 | 6.47 | 185lfN | 19 | - | 2466 | 855 | 65 |
| | | | | 1 | | | 485C | 78 | 2.2 | 3012 | | 425D | 77 | 2.1 | 2963 | | 445D | 77 | 2.1 | 3103 | | 455D | 76 | 2.1 | 3220 | 1325 | |
| | 24 | 2#10 | 1#10 | 1 | 4#11 | 5.14 | 123N | 26 | - | 1181 | 4.66 | 123N | 26 | - | 1233 | 4.25 | 123N | 26 | - | 1285 | 3.88 | 123N | 26 | - | 1337 | 513 | 77 |
| | | | | 1 | | | 275G | 104 | 2.6 | 2142 | | 285G | 104 | 2.5 | 2235 | | 225J | 103 | 2.5 | 2044 | | 235J | 102 | 2.5 | 2136 | 814 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 5.60 | 123N | 26 | - | 1294 | 5.08 | 133N | 26 | - | 1363 | 4.63 | 133N | 26 | - | 1420 | 4.23 | 133N | 26 | - | 1478 | 622 | 77 |
| | | | | 1 | | | 275G | 104 | 2.5 | 2255 | | 285G | 104 | 2.5 | 2353 | | 305G | 103 | 2.5 | 2492 | | 315G | 102 | 2.5 | 2590 | 814 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 8.71 | 145N | 26 | - | 2344 | 7.90 | 154N | 26 | - | 2286 | 7.20 | 154N | 26 | - | 2379 | 6.59 | 154N | 26 | - | 2473 | 870 | 61 |
| | | | | 1 | | | 305F | 104 | 2.5 | 3092 | | 325F | 104 | 2.5 | 3266 | | 335F | 103 | 2.5 | 3400 | | 355F | 102 | 2.5 | 3574 | 1367 | |
| | | 2#14 | 2#14 | 1 | 6#14 | 10.94 | 155JcN | 26 | - | 2811 | 9.92 | 155N | 26 | - | 2926 | 9.04 | 165N | 26 | - | 3074 | 8.27 | 165N | 26 | - | 3189 | 1127 | 53 |
| | | | | 1 | | | 405D | 104 | 2.5 | 3930 | | 365E | 104 | 2.5 | 3883 | | 385E | 103 | 2.5 | 4079 | | 405E | 102 | 2.5 | 4275 | 1591 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

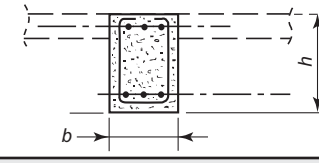
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

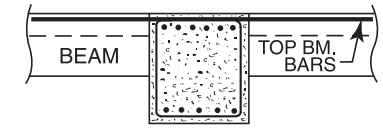
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 36 ft | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | SPAN, $\ell_n$ = 40 ft. | | | | | SPAN, $\ell_n$ = 42 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 36 | 16 | 2#10 | | 1 | 3#10 | 4.51 | 113O | 15 | - | 691 | 4.05 | 113O | 15 | - | 725 | 3.65 | 113O | 15 | - | 760 | 3.31 | 113O | 15 | - | 794 | 365 | 99 |
| | | | | 1 | | | 205I | 60 | 1.9 | 1087 | | 215I | 59 | 1.9 | 1145 | | 225I | 59 | 1.9 | 1202 | | 235I | 58 | 1.9 | 1259 | 536 | |
| | | 2#11 | | 1 | 3#11 | 5.47 | 114O | 15 | - | 896 | 4.91 | 124O | 15 | - | 949 | 4.43 | 124O | 15 | - | 991 | 4.02 | 124O | 15 | - | 1034 | 443 | 98 |
| | | | | 1 | | | 275F | 60 | 1.9 | 1395 | | 295F | 59 | 1.9 | 1484 | | 305F | 59 | 1.9 | 1549 | | 235I | 58 | 1.9 | 1431 | 646 | |
| | | 2#14 | | 1 | 3#14 | 7.59 | 135KdO | 15 | - | 1341 | 6.81 | 135KcO | 15 | - | 1402 | 6.15 | 135O | 15 | - | 1463 | 5.57 | 145O | 15 | - | 1541 | 621 | 83 |
| | | | | 1 | | | 315E | 60 | 1.9 | 1828 | | 335E | 59 | 1.9 | 1935 | | 305F | 59 | 1.9 | 1928 | | 325F | 58 | 1.9 | 2035 | 893 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 9.11 | 165HhO | 15 | - | 1690 | 8.17 | 155IgO | 15 | - | 1751 | 7.38 | 155JfO | 15 | - | 1829 | 6.69 | 155KeO | 15 | - | 1907 | 838 | 72 |
| | | | | 2 | | | 365D | 60 | 1.9 | 2241 | | 385D | 59 | 1.9 | 2364 | | 405D | 59 | 1.9 | 2488 | | 365E | 58 | 1.9 | 2474 | 1073 | |
| | 18 | 2# 9 | 1# 9 | 1 | 3#11 | 5.33 | 114O | 18 | - | 848 | 4.78 | 114O | 18 | - | 888 | 4.32 | 114O | 18 | - | 928 | 3.91 | 124O | 18 | - | 979 | 431 | 88 |
| | | | | 1 | | | 245G | 73 | 2.1 | 1293 | | 265G | 72 | 2.1 | 1381 | | 275G | 71 | 2.1 | 1444 | | 285G | 71 | 2.1 | 1508 | 652 | |
| | | 2#10 | 1#10 | 1 | 3#14 | 6.67 | 125O | 18 | - | 1196 | 5.98 | 125O | 18 | - | 1250 | 5.40 | 124O | 18 | - | 1227 | 4.90 | 134O | 18 | - | 1293 | 540 | 80 |
| | | | | 1 | | | 275F | 73 | 2.1 | 1624 | | 295F | 72 | 2.1 | 1725 | | 275G | 71 | 2.1 | 1732 | | 285G | 71 | 2.1 | 1810 | 906 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 9.88 | 175GiO | 18 | - | 1713 | 8.87 | 165HhO | 18 | - | 1773 | 8.00 | 165IfO | 18 | - | 1851 | 7.26 | 165JfO | 18 | - | 1929 | 849 | 65 |
| | | | | 1 | | | 435C | 73 | 2.1 | 2431 | | 385D | 72 | 2.1 | 2391 | | 405D | 71 | 2.1 | 2516 | | 425D | 71 | 2.1 | 2641 | 1164 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 10.94 | 195FlO | 18 | - | 2024 | 9.81 | 185GjO | 18 | - | 2100 | 8.86 | 185GjO | 18 | - | 2193 | 8.03 | 175HhO | 18 | - | 2268 | 906 | 62 |
| | | | | 2 | | | 435C | 73 | 2.1 | 2707 | | 465C | 72 | 2.1 | 2871 | | 485C | 71 | 2.1 | 3012 | | 425D | 71 | 2.1 | 2963 | 1288 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3#11 | 5.35 | 104O | 22 | - | 839 | 4.80 | 114O | 21 | - | 891 | 4.34 | 114O | 21 | - | 931 | 3.93 | 114O | 21 | - | 971 | 433 | 77 |
| | | | | 1 | | | 245G | 87 | 2.3 | 1310 | | 265G | 86 | 2.3 | 1399 | | 275G | 85 | 2.3 | 1463 | | 215J | 84 | 2.3 | 1357 | 657 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 7.78 | 125O | 22 | - | 1302 | 6.98 | 125O | 21 | - | 1362 | 6.30 | 135O | 21 | - | 1440 | 5.72 | 135O | 21 | - | 1500 | 657 | 74 |
| | | | | 1 | | | 315E | 87 | 2.3 | 1842 | | 335E | 86 | 2.3 | 1950 | | 305F | 85 | 2.3 | 1937 | | 325F | 84 | 2.3 | 2046 | 916 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 10.03 | 155HgO | 22 | - | 1776 | 9.00 | 155IfO | 21 | - | 1858 | 8.13 | 155IfO | 21 | - | 1941 | 7.37 | 155JeO | 21 | - | 2024 | 916 | 61 |
| | | | | 1 | | | 435C | 86 | 2.3 | 2554 | | 385D | 86 | 2.3 | 2515 | | 405D | 85 | 2.3 | 2646 | | 425D | 84 | 2.3 | 2778 | 1181 | |
| | | 3#11 | 2#11 | 1 | 5#14 | 12.11 | 215EnO | 22 | - | 2171 | 10.87 | 195FlO | 21 | - | 2234 | 9.81 | 205FlO | 21 | - | 2350 | 8.90 | 195GjO | 21 | - | 2431 | 1047 | 54 |
| | | | | 1 | | | 545B | 87 | 2.3 | 3109 | | 465C | 86 | 2.3 | 3013 | | 485C | 85 | 2.3 | 3160 | | 505C | 84 | 2.3 | 3308 | 1427 | |
| | 24 | 2#10 | 1#10 | 1 | 4#11 | 6.77 | 113O | 29 | - | 1071 | 6.07 | 113O | 29 | - | 1123 | 5.48 | 113O | 29 | - | 1175 | 4.97 | 113O | 28 | - | 1227 | 548 | 64 |
| | | | | 1 | | | 245G | 116 | 2.8 | 1950 | | 265G | 115 | 2.7 | 2086 | | 275G | 114 | 2.7 | 2180 | | 285G | 113 | 2.7 | 2274 | 870 | |
| | | 2#11 | 1#11 | 1 | 4#14 | 8.21 | 114O | 29 | - | 1513 | 7.37 | 124O | 29 | - | 1605 | 6.65 | 123O | 29 | - | 1549 | 6.03 | 123O | 28 | - | 1619 | 664 | 60 |
| | | | | 1 | | | 245G | 116 | 2.8 | 2276 | | 265G | 115 | 2.7 | 2430 | | 275G | 114 | 2.7 | 2542 | | 285G | 113 | 2.7 | 2654 | 1208 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 11.50 | 125O | 29 | - | 2108 | 10.32 | 135O | 29 | - | 2236 | 9.32 | 135O | 29 | - | 2329 | 8.45 | 145O | 28 | - | 2457 | 931 | 53 |
| | | | | 1 | | | 315E | 116 | 2.8 | 2989 | | 335E | 115 | 2.7 | 3166 | | 345E | 114 | 2.7 | 3301 | | 325F | 113 | 2.7 | 3310 | 1469 | |
| | | 2#14 | 2#14 | 1 | 6#14 | 14.54 | 145JeO | 29 | - | 2568 | 13.05 | 145KdO | 29 | - | 2682 | 11.77 | 155KdO | 29 | - | 2832 | 10.68 | 155KcO | 28 | - | 2947 | 1208 | 46 |
| | | | | 1 | | | 365D | 116 | 2.8 | 3589 | | 385D | 115 | 2.7 | 3788 | | 405D | 114 | 2.7 | 3986 | | 425D | 113 | 2.7 | 4185 | 1712 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

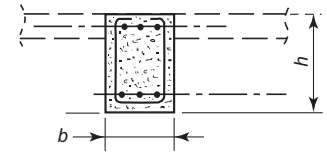
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

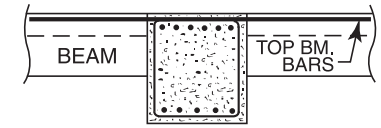
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 44 ft | | | | | SPAN, $\ell_n$ = 46 ft. | | | | | SPAN, $\ell_n$ = 48 ft. | | | | | SPAN, $\ell_n$ = 50 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 36 | 16 | 2#10 | | 1 | 3#10 | 3.02 | 123O | 14 | - | 834 | 2.76 | 123O | 14 | - | 869 | 2.54 | 123O | 14 | - | 903 | 2.34 | 123O | 14 | - | 938 | 365 | 99 |
| | | | | 1 | | | 245I | 58 | 1.9 | 1317 | | 255I | 57 | 1.9 | 1374 | | 265I | 57 | 1.9 | 1431 | | 275I | 57 | 1.9 | 1489 | 536 | |
| | | 2#11 | | 1 | 3#11 | 3.66 | 133O | 14 | - | 1020 | 3.35 | 133O | 14 | - | 1062 | 3.08 | 133O | 14 | - | 1105 | 2.84 | 133O | 14 | - | 1147 | 443 | 98 |
| | | | | 1 | | | 245I | 58 | 1.9 | 1496 | | 255I | 57 | 1.9 | 1562 | | 265I | 57 | 1.9 | 1627 | | 275I | 57 | 1.8 | 1693 | 646 | |
| | | 2#14 | | 1 | 3#14 | 5.08 | 145O | 14 | - | 1603 | 4.65 | 155O | 14 | - | 1681 | 4.27 | 155O | 14 | - | 1742 | 3.93 | 154O | 14 | - | 1709 | 621 | 83 |
| | | | | 1 | | | 335F | 58 | 1.9 | 2119 | | 345F | 57 | 1.9 | 2203 | | 355F | 57 | 1.8 | 2287 | | 375F | 57 | 1.8 | 2394 | 893 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 6.10 | 165KdO | 14 | - | 2002 | 5.58 | 165KdO | 14 | - | 2080 | 5.12 | 165KcO | 14 | - | 2158 | 4.72 | 165O | 14 | - | 2236 | 838 | 72 |
| | | | | 2 | | | 385E | 58 | 1.9 | 2598 | | 395E | 57 | 1.9 | 2699 | | 405E | 57 | 1.8 | 2800 | | 375F | 57 | 1.8 | 2809 | 1073 | |
| | 18 | 2# 9 | 1# 9 | 1 | 3#11 | 3.57 | 124O | 18 | - | 1019 | 3.26 | 124O | 17 | - | 1059 | 3.00 | 124O | 17 | - | 1099 | 2.76 | 124O | 17 | - | 1139 | 431 | 88 |
| | | | | 1 | | | 225J | 70 | 2.1 | 1406 | | 235J | 70 | 2.1 | 1469 | | 245J | 70 | 2.1 | 1533 | | 255J | 69 | 2.0 | 1597 | 652 | |
| | | 2#10 | 1#10 | 1 | 3#14 | 4.46 | 134O | 18 | - | 1347 | 4.08 | 134O | 17 | - | 1401 | 3.75 | 144O | 17 | - | 1467 | 3.46 | 144O | 17 | - | 1521 | 540 | 80 |
| | | | | 1 | | | 305G | 70 | 2.1 | 1912 | | 315G | 70 | 2.1 | 1990 | | 325G | 70 | 2.0 | 2068 | | 335G | 69 | 2.0 | 2145 | 906 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 6.61 | 165KeO | 18 | - | 2007 | 6.05 | 165KdO | 17 | - | 2085 | 5.56 | 165KcO | 17 | - | 2163 | 5.12 | 165O | 17 | - | 2241 | 849 | 65 |
| | | | | 1 | | | 445D | 70 | 2.1 | 2767 | | 395E | 70 | 2.1 | 2726 | | 415E | 70 | 2.0 | 2852 | | 425E | 69 | 2.0 | 2953 | 1164 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 7.32 | 185HhO | 18 | - | 2379 | 6.70 | 185IgO | 17 | - | 2472 | 6.15 | 175JfO | 17 | - | 2548 | 5.67 | 175KeO | 17 | - | 2641 | 906 | 62 |
| | | | | 2 | | | 445D | 70 | 2.1 | 3103 | | 465D | 70 | 2.1 | 3244 | | 475D | 69 | 2.0 | 3360 | | 425E | 69 | 2.0 | 3335 | 1288 | |
| | 20 | 2# 9 | 1# 9 | 1 | 3#11 | 3.58 | 114O | 21 | - | 1011 | 3.28 | 114O | 21 | - | 1051 | 3.01 | 114O | 21 | - | 1091 | 2.77 | 124O | 21 | - | 1142 | 433 | 77 |
| | | | | 1 | | | 225J | 84 | 2.3 | 1421 | | 235J | 83 | 2.3 | 1485 | | 245J | 83 | 2.3 | 1550 | | 255J | 82 | 2.2 | 1614 | 657 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 5.21 | 134O | 21 | - | 1474 | 4.76 | 144O | 21 | - | 1545 | 4.38 | 144O | 21 | - | 1605 | 4.03 | 144O | 21 | - | 1665 | 657 | 74 |
| | | | | 1 | | | 335F | 84 | 2.3 | 2130 | | 315G | 83 | 2.3 | 2141 | | 325G | 83 | 2.2 | 2225 | | 335G | 82 | 2.2 | 2309 | 916 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 6.72 | 155KdO | 21 | - | 2107 | 6.14 | 155KcO | 21 | - | 2190 | 5.64 | 155O | 21 | - | 2273 | 5.20 | 165O | 21 | - | 2374 | 916 | 61 |
| | | | | 1 | | | 445D | 84 | 2.3 | 2909 | | 405E | 83 | 2.3 | 2895 | | 415E | 83 | 2.2 | 3002 | | 425E | 82 | 2.2 | 3109 | 1181 | |
| | | 3#11 | 2#11 | 1 | 5#14 | 8.11 | 185HiO | 21 | - | 2512 | 7.42 | 185HhO | 21 | - | 2611 | 6.81 | 185IgO | 21 | - | 2710 | 6.28 | 185JfO | 21 | - | 2809 | 1047 | 54 |
| | | | | 1 | | | 535C | 84 | 2.3 | 3480 | | 465D | 83 | 2.3 | 3408 | | 475D | 83 | 2.2 | 3531 | | 495D | 82 | 2.2 | 3679 | 1427 | |
| | 24 | 2#10 | 1#10 | 1 | 4#11 | 4.53 | 123O | 28 | - | 1291 | 4.14 | 123O | 28 | - | 1343 | 3.81 | 123O | 28 | - | 1395 | 3.51 | 123O | 28 | - | 1447 | 548 | 64 |
| | | | | 1 | | | 305G | 113 | 2.7 | 2409 | | 235J | 112 | 2.7 | 2168 | | 245J | 111 | 2.7 | 2262 | | 255J | 111 | 2.6 | 2356 | 870 | |
| | | 2#11 | 1#11 | 1 | 4#14 | 5.50 | 133O | 28 | - | 1701 | 5.03 | 133O | 28 | - | 1771 | 4.62 | 133O | 28 | - | 1841 | 4.26 | 133O | 28 | - | 1911 | 664 | 60 |
| | | | | 1 | | | 305G | 113 | 2.7 | 2808 | | 315G | 112 | 2.7 | 2920 | | 325G | 111 | 2.7 | 3032 | | 345G | 111 | 2.6 | 3186 | 1208 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 7.70 | 144O | 28 | - | 2371 | 7.04 | 154O | 28 | - | 2486 | 6.47 | 154O | 28 | - | 2579 | 5.96 | 154O | 28 | - | 2672 | 931 | 53 |
| | | | | 1 | | | 335F | 112 | 2.7 | 3445 | | 355F | 112 | 2.7 | 3622 | | 325G | 111 | 2.6 | 3590 | | 345G | 111 | 2.6 | 3767 | 1469 | |
| | | 2#14 | 2#14 | 1 | 6#14 | 9.73 | 155O | 28 | - | 3061 | 8.90 | 155O | 28 | - | 3176 | 8.18 | 165O | 28 | - | 3326 | 7.54 | 165O | 28 | - | 3440 | 1208 | 46 |
| | | | | 1 | | | 385E | 112 | 2.7 | 4132 | | 405E | 112 | 2.7 | 4330 | | 415E | 111 | 2.6 | 4487 | | 435E | 111 | 2.6 | 4685 | 1712 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

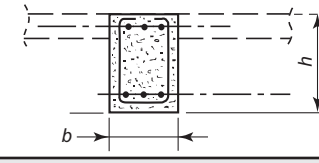
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

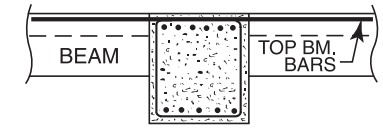
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 36 ft | | | | | SPAN, $\ell_n$ = 38 ft. | | | | | SPAN, $\ell_n$ = 40 ft. | | | | | SPAN, $\ell_n$ = 42 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 42 | 20 | 2#10 | 1#10 | 1 | 3#11 | 6.65 | 094R | 28 | - | 932 | 5.97 | 094R | 27 | - | 977 | 5.39 | 104R | 27 | - | 1034 | 4.89 | 104R | 27 | - | 1079 | 646 | 45 |
| | | | | 1 | | | 245G | 110 | 2.8 | 1451 | | 265G | 109 | 2.8 | 1549 | | 275G | 108 | 2.8 | 1620 | | 285G | 107 | 2.7 | 1692 | 784 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 9.33 | 115OcR | 27 | - | 1307 | 8.37 | 115R | 27 | - | 1367 | 7.55 | 115R | 27 | - | 1427 | 6.85 | 115R | 27 | - | 1487 | 784 | 48 |
| | | | | 1 | | | 315E | 110 | 2.8 | 1907 | | 335E | 109 | 2.8 | 2019 | | 345E | 108 | 2.8 | 2105 | | 325F | 107 | 2.7 | 2112 | 1098 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 13.57 | 195FmR | 27 | - | 2070 | 12.18 | 175GkR | 27 | - | 2124 | 10.99 | 185GkR | 27 | - | 2237 | 9.97 | 175HjR | 27 | - | 2310 | 1098 | 38 |
| | | | | 1 | | | 435C | 110 | 2.8 | 2827 | | 465C | 109 | 2.8 | 2999 | | 485C | 108 | 2.8 | 3145 | | 505C | 107 | 2.7 | 3291 | 1730 | |
| | | 2#14 | 2#14 | 1 | 6#14 | 16.24 | 265DlG | 27 | - | 2601 | 14.58 | 275DkG | 27 | - | 2735 | 13.16 | 235EqR | 27 | - | 2770 | 11.93 | 235EqR | 27 | - | 2885 | 1424 | 35 |
| | | | | 2 | | | 545B | 110 | 2.8 | 3508 | | 575B | 109 | 2.8 | 3702 | | 605B | 108 | 2.8 | 3896 | | 635B | 107 | 2.7 | 4090 | 1913 | |
| | 24 | 2#11 | 1#11 | 1 | 4#11 | 8.82 | 103R | 37 | - | 1177 | 7.91 | 103R | 37 | - | 1235 | 7.14 | 103R | 36 | - | 1292 | 6.48 | 103R | 36 | - | 1350 | 791 | 40 |
| | | | | 1 | | | 245G | 149 | 3.3 | 2152 | | 265G | 147 | 3.3 | 2302 | | 275G | 146 | 3.3 | 2406 | | 285G | 144 | 3.2 | 2509 | 1038 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 12.32 | 105R | 37 | - | 1896 | 11.06 | 115R | 37 | - | 2018 | 9.98 | 115R | 36 | - | 2101 | 9.05 | 124R | 36 | - | 2053 | 1113 | 38 |
| | | | | 1 | | | 315E | 149 | 3.3 | 2935 | | 335E | 147 | 3.3 | 3110 | | 305F | 145 | 3.3 | 3055 | | 325F | 144 | 3.2 | 3230 | 1451 | |
| | | 2#14 | 2#14 | 1 | 6#14 | 17.63 | 145JgR | 37 | - | 2626 | 15.82 | 145KfR | 37 | - | 2741 | 14.28 | 135MeR | 36 | - | 2817 | 12.95 | 145NeR | 36 | - | 2970 | 1451 | 31 |
| | | | | 1 | | | 365D | 149 | 3.3 | 3739 | | 385D | 147 | 3.3 | 3946 | | 405D | 145 | 3.3 | 4153 | | 425D | 144 | 3.2 | 4360 | 2077 | |
| | | 3#14 | 2#14 | 1 | 7#14 | 19.20 | 225G | 37 | - | 3404 | 17.23 | 235G | 37 | - | 3583 | 15.55 | 155JgR | 36 | - | 3412 | 14.10 | 155KfR | 36 | - | 3552 | 1772 | 28 |
| | | | | 2 | | | 435C | 149 | 3.3 | 4528 | | 465C | 147 | 3.3 | 4807 | | 405D | 145 | 3.3 | 4671 | | 425D | 144 | 3.2 | 4903 | 2261 | |
| | 30 | 2#11 | 2#11 | 1 | 4#14 | 12.55 | 104R | 53 | - | 1671 | 11.26 | 104R | 53 | - | 1749 | 10.16 | 114R | 52 | - | 1853 | 9.22 | 114R | 52 | - | 1931 | 1051 | 33 |
| | | | | 1 | | | 315E | 213 | 4.1 | 2918 | | 335E | 211 | 4.1 | 3093 | | 305F | 208 | 4.0 | 3025 | | 325F | 207 | 4.0 | 3200 | 1478 | |
| | | 2#11 | 2#11 | 1 | 5#14 | 12.99 | 105R | 53 | - | 2001 | 11.66 | 104R | 53 | - | 1943 | 10.52 | 114R | 52 | - | 2057 | 9.54 | 114R | 52 | - | 2145 | 1051 | 31 |
| | | | | 1 | | | 315E | 213 | 4.1 | 3102 | | 335E | 211 | 4.1 | 3287 | | 345E | 208 | 4.0 | 3423 | | 325F | 207 | 4.0 | 3415 | 1814 | |
| | | 3#14 | 2#14 | 1 | 7#14 | 20.77 | 145IhR | 53 | - | 3112 | 18.64 | 145JgR | 53 | - | 3252 | 16.82 | 155JgR | 52 | - | 3433 | 15.26 | 145KfR | 52 | - | 3533 | 1814 | 25 |
| | | | | 1 | | | 435C | 213 | 4.1 | 4633 | | 465C | 210 | 4.1 | 4919 | | 485C | 208 | 4.0 | 5156 | | 505C | 206 | 4.0 | 5393 | 2446 | |
| | | 3#14 | 3#14 | 1 | 9#14 | 24.51 | 255DgG | 53 | - | 4129 | 22.00 | 235G | 53 | - | 4221 | 19.85 | 195GlR | 52 | - | 4232 | 18.01 | 175HjR | 52 | - | 4323 | 2137 | 23 |
| | | | | 2 | | | 545B | 213 | 4.1 | 5740 | | 575B | 210 | 4.1 | 6058 | | 485C | 208 | 4.0 | 5793 | | 505C | 206 | 4.0 | 6063 | 2888 | |
| | 36 | 2#11 | 2#11 | 1 | 5#14 | 13.09 | 104R | 71 | - | 1864 | 11.75 | 104R | 70 | - | 1952 | 10.60 | 104R | 69 | - | 2040 | 9.62 | 104R | 69 | - | 2129 | 1060 | 25 |
| | | | | 1 | | | 315E | 283 | 4.9 | 3177 | | 335E | 280 | 4.8 | 3367 | | 345E | 277 | 4.8 | 3506 | | 365E | 275 | 4.7 | 3696 | 1842 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 15.64 | 105R | 71 | - | 2314 | 14.04 | 105R | 70 | - | 2419 | 12.67 | 115R | 69 | - | 2565 | 11.49 | 114R | 69 | - | 2503 | 1496 | 26 |
| | | | | 1 | | | 365D | 283 | 4.9 | 3731 | | 385D | 280 | 4.8 | 3937 | | 345E | 277 | 4.8 | 3838 | | 365E | 274 | 4.7 | 4044 | 1842 | |
| | | 3#14 | 3#14 | 1 | 8#14 | 23.88 | 155HiR | 71 | - | 3563 | 21.44 | 165HiR | 70 | - | 3767 | 19.35 | 155IhR | 69 | - | 3887 | 17.55 | 155JgR | 69 | - | 4049 | 2177 | 21 |
| | | | | 1 | | | 545B | 283 | 4.9 | 5688 | | 465C | 280 | 4.8 | 5442 | | 485C | 277 | 4.8 | 5706 | | 505C | 274 | 4.7 | 5970 | 2814 | |
| | | 4#14 | 3#14 | 1 | 10#14 | 27.45 | 255DiG | 71 | - | 4631 | 24.64 | 205FnR | 70 | - | 4620 | 22.24 | 185GlR | 69 | - | 4734 | 20.17 | 195GlR | 69 | - | 4973 | 2501 | 20 |
| | | | | 2 | | | 545B | 283 | 4.9 | 6338 | | 575B | 280 | 4.8 | 6689 | | 605B | 277 | 4.8 | 7039 | | 635B | 274 | 4.7 | 7390 | 3234 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

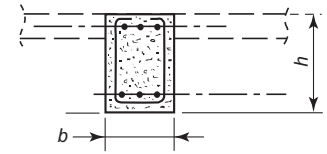
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

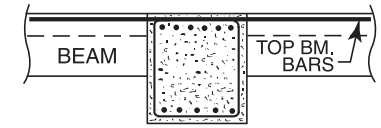
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 44 ft | | | | | SPAN, $\ell_n$ = 46 ft. | | | | | SPAN, $\ell_n$ = 48 ft. | | | | | SPAN, $\ell_n$ = 50 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 42 | 20 | 2#10 | 1#10 | 1 | 3#11 | 4.45 | 104R | 26 | - | 1124 | 4.08 | 104R | 26 | - | 1169 | 3.74 | 104R | 26 | - | 1214 | 3.45 | 104R | 26 | - | 1259 | 646 | 45 |
| | | | | 1 | | | 305G | 106 | 2.7 | 1789 | | 235J | 105 | 2.7 | 1649 | | 245J | 104 | 2.7 | 1721 | | 255J | 104 | 2.7 | 1792 | 784 | |
| | | 2#11 | 1#11 | 1 | 3#14 | 6.24 | 125R | 26 | - | 1567 | 5.71 | 125R | 26 | - | 1626 | 5.25 | 124R | 26 | - | 1599 | 4.83 | 124R | 26 | - | 1659 | 784 | 48 |
| | | | | 1 | | | 335F | 106 | 2.7 | 2199 | | 315G | 105 | 2.7 | 2206 | | 325G | 104 | 2.7 | 2292 | | 345G | 104 | 2.7 | 2405 | 1098 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 9.08 | 165IhR | 26 | - | 2383 | 8.31 | 165JgR | 26 | - | 2476 | 7.63 | 165KgR | 26 | - | 2569 | 7.03 | 165KfR | 26 | - | 2662 | 1098 | 38 |
| | | | | 1 | | | 445D | 106 | 2.7 | 3226 | | 465D | 105 | 2.7 | 3371 | | 485D | 104 | 2.7 | 3517 | | 505D | 103 | 2.7 | 3663 | 1730 | |
| | | 2#14 | 2#14 | 1 | 6#14 | 10.87 | 225FoR | 26 | - | 2980 | 9.95 | 225FoR | 26 | - | 3094 | 9.14 | 215GmR | 26 | - | 3189 | 8.42 | 205HlR | 26 | - | 3284 | 1424 | 35 |
| | | | | 2 | | | 535C | 106 | 2.7 | 3940 | | 555C | 105 | 2.7 | 4108 | | 585C | 104 | 2.7 | 4302 | | 605C | 103 | 2.7 | 4469 | 1913 | |
| | 24 | 2#11 | 1#11 | 1 | 4#11 | 5.90 | 113R | 36 | - | 1420 | 5.40 | 113R | 35 | - | 1478 | 4.96 | 113R | 35 | - | 1535 | 4.57 | 113R | 35 | - | 1593 | 791 | 40 |
| | | | | 1 | | | 305G | 143 | 3.2 | 2659 | | 315G | 142 | 3.2 | 2762 | | 325G | 141 | 3.2 | 2866 | | 345G | 140 | 3.1 | 3016 | 1038 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 8.25 | 124R | 36 | - | 2136 | 7.55 | 124R | 35 | - | 2219 | 6.93 | 124R | 35 | - | 2302 | 6.39 | 134R | 35 | - | 2409 | 1113 | 38 |
| | | | | 1 | | | 335F | 143 | 3.2 | 3359 | | 355F | 142 | 3.2 | 3534 | | 325G | 141 | 3.2 | 3478 | | 345G | 140 | 3.1 | 3653 | 1451 | |
| | | 2#14 | 2#14 | 1 | 6#14 | 11.80 | 145OdR | 36 | - | 3085 | 10.80 | 145OcR | 35 | - | 3200 | 9.92 | 145OcR | 35 | - | 3314 | 9.14 | 145R | 35 | - | 3429 | 1451 | 31 |
| | | | | 1 | | | 445D | 143 | 3.2 | 4567 | | 405E | 142 | 3.2 | 4497 | | 415E | 141 | 3.2 | 4658 | | 435E | 140 | 3.1 | 4865 | 2077 | |
| | | 3#14 | 2#14 | 1 | 7#14 | 12.85 | 155MfR | 36 | - | 3693 | 11.76 | 155NeR | 35 | - | 3833 | 10.80 | 155OdR | 35 | - | 3973 | 9.95 | 155OdR | 35 | - | 4113 | 1772 | 28 |
| | | | | 2 | | | 445D | 143 | 3.2 | 5135 | | 465D | 142 | 3.2 | 5368 | | 485D | 141 | 3.2 | 5600 | | 435E | 140 | 3.1 | 5510 | 2261 | |
| | 30 | 2#11 | 2#11 | 1 | 4#14 | 8.40 | 114R | 51 | - | 2009 | 7.69 | 114R | 51 | - | 2087 | 7.06 | 124R | 50 | - | 2191 | 6.51 | 124R | 50 | - | 2269 | 1051 | 33 |
| | | | | 1 | | | 335F | 205 | 3.9 | 3327 | | 355F | 203 | 3.9 | 3502 | | 325G | 202 | 3.9 | 3434 | | 345G | 201 | 3.9 | 3609 | 1478 | |
| | | 2#11 | 2#11 | 1 | 5#14 | 8.69 | 114R | 51 | - | 2233 | 7.95 | 114R | 51 | - | 2322 | 7.30 | 124R | 50 | - | 2435 | 6.73 | 124R | 50 | - | 2524 | 1051 | 31 |
| | | | | 1 | | | 335F | 205 | 3.9 | 3551 | | 355F | 203 | 3.9 | 3737 | | 365F | 202 | 3.9 | 3873 | | 345G | 201 | 3.9 | 3864 | 1814 | |
| | | 3#14 | 2#14 | 1 | 7#14 | 13.90 | 145MeR | 51 | - | 3673 | 12.72 | 145NeR | 51 | - | 3813 | 11.68 | 145OdR | 50 | - | 3954 | 10.77 | 145OcR | 50 | - | 4094 | 1814 | 25 |
| | | | | 1 | | | 445D | 205 | 3.9 | 5242 | | 465D | 203 | 3.9 | 5480 | | 485D | 202 | 3.9 | 5717 | | 505D | 200 | 3.9 | 5954 | 2446 | |
| | | 3#14 | 3#14 | 1 | 9#14 | 16.41 | 175IiR | 51 | - | 4495 | 15.01 | 175IiR | 51 | - | 4667 | 13.79 | 175JhR | 50 | - | 4840 | 12.71 | 175KgR | 50 | - | 5012 | 2137 | 23 |
| | | | | 2 | | | 535C | 205 | 3.9 | 6380 | | 555C | 203 | 3.9 | 6649 | | 585C | 202 | 3.9 | 6967 | | 605C | 200 | 3.9 | 7236 | 2888 | |
| | 36 | 2#11 | 2#11 | 1 | 5#14 | 8.76 | 104R | 68 | - | 2217 | 8.02 | 114R | 68 | - | 2332 | 7.36 | 114R | 67 | - | 2420 | 6.79 | 114R | 67 | - | 2508 | 1060 | 25 |
| | | | | 1 | | | 385E | 272 | 4.7 | 3886 | | 405E | 270 | 4.7 | 4076 | | 415E | 268 | 4.6 | 4215 | | 435E | 267 | 4.6 | 4406 | 1842 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 10.47 | 114R | 68 | - | 2608 | 9.58 | 124R | 68 | - | 2739 | 8.80 | 124R | 67 | - | 2844 | 8.11 | 124R | 67 | - | 2948 | 1496 | 26 |
| | | | | 1 | | | 385E | 272 | 4.7 | 4251 | | 405E | 270 | 4.7 | 4457 | | 415E | 268 | 4.6 | 4613 | | 435E | 266 | 4.6 | 4819 | 1842 | |
| | | 3#14 | 3#14 | 1 | 8#14 | 15.99 | 155KfR | 68 | - | 4211 | 14.63 | 145MeR | 68 | - | 4331 | 13.44 | 145NeR | 67 | - | 4493 | 12.38 | 145OdR | 67 | - | 4655 | 2177 | 21 |
| | | | | 1 | | | 535C | 272 | 4.7 | 6285 | | 555C | 270 | 4.7 | 6549 | | 585C | 268 | 4.6 | 6863 | | 505D | 266 | 4.6 | 6618 | 2814 | |
| | | 4#14 | 3#14 | 1 | 10#14 | 18.38 | 185HjR | 68 | - | 5129 | 16.81 | 175IiR | 68 | - | 5285 | 15.44 | 185IiR | 67 | - | 5525 | 14.23 | 175JhR | 67 | - | 5680 | 2501 | 20 |
| | | | | 2 | | | 535C | 272 | 4.7 | 7078 | | 555C | 270 | 4.7 | 7377 | | 585C | 268 | 4.6 | 7728 | | 605C | 266 | 4.6 | 8027 | 3234 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b - 2''$).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

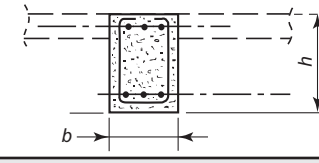
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

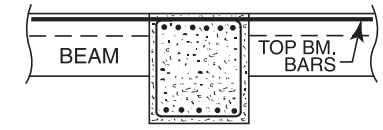
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w/1.4$.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 40 ft | | | | | SPAN, $\ell_n$ = 42 ft. | | | | | SPAN, $\ell_n$ = 44 ft. | | | | | SPAN, $\ell_n$ = 46 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 48 | 24 | 2#11 | 1#11 | 1 | 4#14 | 9.18 | 094U | 45 | - | 1659 | 8.32 | 094U | 44 | - | 1729 | 7.58 | 104U | 44 | - | 1826 | 6.94 | 104U | 44 | - | 1896 | 917 | 25 |
| | | | | 1 | | | 275G | 180 | 3.8 | 2767 | | 285G | 178 | 3.8 | 2888 | | 305G | 176 | 3.8 | 3058 | | 315G | 174 | 3.7 | 3178 | 1694 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 11.65 | 105U | 45 | - | 2104 | 10.57 | 105U | 44 | - | 2187 | 9.63 | 104U | 44 | - | 2114 | 8.81 | 114U | 44 | - | 2224 | 1296 | 26 |
| | | | | 1 | | | 345E | 179 | 3.8 | 3381 | | 325F | 178 | 3.8 | 3363 | | 335F | 176 | 3.8 | 3496 | | 355F | 174 | 3.7 | 3680 | 1694 | |
| | | 3#14 | 2#14 | 1 | 7#14 | 18.47 | 155JiU | 45 | - | 3475 | 16.76 | 145KhU | 44 | - | 3572 | 15.27 | 145MgU | 44 | - | 3712 | 13.97 | 145NfU | 44 | - | 3852 | 2076 | 20 |
| | | | | 2 | | | 485C | 179 | 3.8 | 5239 | | 425D | 178 | 3.8 | 5078 | | 445D | 176 | 3.8 | 5319 | | 465D | 174 | 3.7 | 5560 | 2687 | |
| | | 3#14 | 2#14 | 1 | 8#14 | 20.52 | 225Ffl | 45 | - | 3980 | 18.61 | 215l | 44 | - | 4088 | 16.96 | 225l | 44 | - | 4281 | 15.51 | 165JiU | 44 | - | 4173 | 2076 | 19 |
| | | | | 2 | | | 485C | 179 | 3.8 | 5443 | | 505C | 178 | 3.8 | 5694 | | 535C | 176 | 3.8 | 5995 | | 555C | 174 | 3.7 | 6246 | 2984 | |
| | 30 | 2#11 | 2#11 | 1 | 4#14 | 11.84 | 094U | 65 | - | 1826 | 10.74 | 104U | 64 | - | 1933 | 9.78 | 104U | 63 | - | 2011 | 8.95 | 104U | 63 | - | 2089 | 1220 | 21 |
| | | | | 1 | | | 345E | 259 | 4.7 | 3361 | | 365E | 256 | 4.7 | 3545 | | 335F | 254 | 4.6 | 3465 | | 355F | 251 | 4.6 | 3648 | 1721 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 14.56 | 105U | 65 | - | 2551 | 13.21 | 105U | 64 | - | 2656 | 12.04 | 105U | 63 | - | 2760 | 11.01 | 115U | 63 | - | 2909 | 1721 | 20 |
| | | | | 1 | | | 405D | 259 | 4.7 | 4213 | | 365E | 256 | 4.7 | 4107 | | 385E | 254 | 4.6 | 4317 | | 405E | 251 | 4.6 | 4527 | 2118 | |
| | | 3#14 | 3#14 | 1 | 8#14 | 22.20 | 175HkU | 65 | - | 4018 | 20.13 | 165ljU | 64 | - | 4135 | 18.34 | 165JiU | 63 | - | 4297 | 16.78 | 165JiU | 63 | - | 4459 | 2501 | 16 |
| | | | | 1 | | | 485C | 259 | 4.7 | 5790 | | 505C | 256 | 4.7 | 6057 | | 535C | 254 | 4.6 | 6377 | | 555C | 251 | 4.6 | 6644 | 3228 | |
| | | 4#14 | 3#14 | 1 | 10#14 | 25.65 | 235Fil | 65 | - | 5007 | 23.26 | 245Fil | 64 | - | 5249 | 21.20 | 245Fhl | 63 | - | 5446 | 19.39 | 195HmU | 63 | - | 5422 | 2871 | 15 |
| | | | | 2 | | | 605B | 259 | 4.7 | 7143 | | 635B | 256 | 4.7 | 7499 | | 665B | 254 | 4.6 | 7855 | | 555C | 251 | 4.6 | 7473 | 3730 | |
| | 36 | 2#14 | 2#14 | 1 | 5#14 | 14.76 | 095U | 87 | - | 2519 | 13.38 | 105U | 86 | - | 2670 | 12.19 | 104U | 85 | - | 2609 | 11.16 | 104U | 84 | - | 2713 | 1739 | 17 |
| | | | | 1 | | | 405D | 346 | 5.6 | 4311 | | 425D | 342 | 5.5 | 4525 | | 385E | 339 | 5.5 | 4409 | | 405E | 336 | 5.4 | 4624 | 2146 | |
| | | 2#14 | 2#14 | 1 | 6#14 | 17.39 | 105RcU | 87 | - | 2769 | 15.78 | 115RcU | 86 | - | 2930 | 14.38 | 105U | 85 | - | 2999 | 13.15 | 115U | 84 | - | 3159 | 1739 | 18 |
| | | | | 1 | | | 405D | 346 | 5.6 | 4515 | | 425D | 342 | 5.5 | 4739 | | 445D | 339 | 5.5 | 4964 | | 465D | 336 | 5.4 | 5189 | 2542 | |
| | | 4#14 | 3#14 | 1 | 10#14 | 26.41 | 185GmU | 87 | - | 4809 | 23.96 | 195GmU | 86 | - | 5053 | 21.83 | 185HlU | 85 | - | 5204 | 19.97 | 185HlU | 84 | - | 5402 | 2926 | 14 |
| | | | | 2 | | | 605B | 346 | 5.6 | 7289 | | 635B | 342 | 5.5 | 7652 | | 665B | 339 | 5.5 | 8015 | | 695B | 336 | 5.4 | 8378 | 3842 | |
| | | 4#14 | 4#14 | 1 | 12#14 | 30.78 | 255Eml | 87 | - | 5768 | 27.91 | 265Eml | 86 | - | 6043 | 25.43 | 255Fkl | 85 | - | 6227 | 23.27 | 235FqU | 84 | - | 6365 | 3300 | 12 |
| | | | | 2 | | | 805A | 346 | 5.6 | 9029 | | 635B | 342 | 5.5 | 8322 | | 665B | 339 | 5.5 | 8717 | | 695B | 336 | 5.4 | 9111 | 4476 | |
| | 42 | 3#11 | 2#11 | 1 | 5#14 | 14.89 | 094U | 110 | - | 2265 | 13.51 | 094U | 109 | - | 2364 | 12.31 | 094U | 108 | - | 2462 | 11.26 | 104U | 107 | - | 2591 | 1532 | 14 |
| | | | | 1 | | | 485C | 440 | 6.5 | 4754 | | 505C | 435 | 6.4 | 4968 | | 535C | 431 | 6.4 | 5239 | | 555C | 427 | 6.3 | 5453 | 2166 | |
| | | 3#14 | 2#14 | 1 | 7#14 | 20.39 | 115OeU | 110 | - | 3348 | 18.49 | 115QdU | 109 | - | 3488 | 16.85 | 115RcU | 108 | - | 3629 | 15.42 | 115RcU | 107 | - | 3769 | 2166 | 15 |
| | | | | 1 | | | 485C | 440 | 6.5 | 5590 | | 505C | 435 | 6.4 | 5845 | | 535C | 431 | 6.4 | 6158 | | 555C | 427 | 6.3 | 6413 | 2965 | |
| | | 4#14 | 4#14 | 1 | 11#14 | 30.59 | 235ErU | 110 | - | 5504 | 27.75 | 215FpU | 109 | - | 5629 | 25.28 | 225FpU | 108 | - | 5895 | 23.13 | 205GnU | 107 | - | 6020 | 3351 | 12 |
| | | | | 1 | | | 605B | 440 | 6.5 | 7869 | | 635B | 435 | 6.4 | 8261 | | 665B | 431 | 6.4 | 8653 | | 695B | 427 | 6.3 | 9045 | 4449 | |
| | | 5#14 | 4#14 | 1 | 14#14 | 35.90 | 285Dql | 110 | - | 6666 | 32.57 | 295Dql | 109 | - | 6979 | 29.67 | 305Dql | 108 | - | 7291 | 27.15 | 265EuU | 107 | - | 7367 | 3726 | 11 |
| | | | | 2 | | | 805A | 440 | 6.5 | 9945 | | 845A | 435 | 6.4 | 10441 | | 885A | 431 | 6.4 | 10936 | | 925A | 427 | 6.3 | 11431 | 5222 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

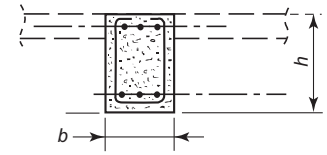
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

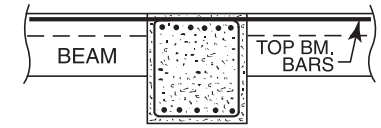
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# RECTANGULAR BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 48 ft | | | | | SPAN, $\ell_n$ = 50 ft. | | | | | SPAN, $\ell_n$ = 52 ft. | | | | | SPAN, $\ell_n$ = 54 ft. | | | | | | |
| $h$ | $b$ | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 48 | 24 | 2#11 | 1#11 | 1 | 4#14 | 6.37 | 104U | 43 | - | 1966 | 5.87 | 104U | 43 | - | 2036 | 5.43 | 104U | 43 | - | 2106 | 5.04 | 114U | 42 | - | 2204 | 917 | 25 |
| | | | | 1 | | | 325G | 173 | 3.7 | 3299 | | 345G | 172 | 3.7 | 3469 | | 355G | 170 | 3.6 | 3590 | | 365G | 169 | 3.6 | 3710 | 1694 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 8.09 | 114U | 43 | - | 2307 | 7.46 | 114U | 43 | - | 2390 | 6.89 | 124U | 43 | - | 2500 | 6.39 | 124U | 42 | - | 2583 | 1296 | 26 |
| | | | | 1 | | | 365F | 173 | 3.7 | 3813 | | 345G | 172 | 3.7 | 3795 | | 355G | 170 | 3.6 | 3928 | | 365G | 169 | 3.6 | 4061 | 1694 | |
| | | 3#14 | 2#14 | 1 | 7#14 | 12.83 | 145OfU | 43 | - | 3992 | 11.82 | 145OeU | 43 | - | 4133 | 10.93 | 145PeU | 43 | - | 4273 | 10.14 | 145QdU | 42 | - | 4413 | 2076 | 20 |
| | | | | 2 | | | 485D | 173 | 3.7 | 5800 | | 505D | 172 | 3.7 | 6041 | | 525D | 170 | 3.6 | 6282 | | 465E | 169 | 3.6 | 6121 | 2687 | |
| | | 3#14 | 2#14 | 1 | 8#14 | 14.25 | 165KhU | 43 | - | 4324 | 13.13 | 165MhU | 43 | - | 4474 | 12.14 | 165NgU | 43 | - | 4624 | 11.26 | 165NgU | 42 | - | 4775 | 2076 | 19 |
| | | | | 2 | | | 485D | 173 | 3.7 | 6045 | | 505D | 172 | 3.7 | 6296 | | 525D | 170 | 3.6 | 6547 | | 545D | 169 | 3.6 | 6798 | 2984 | |
| | 30 | 2#11 | 2#11 | 1 | 4#14 | 8.22 | 104U | 62 | - | 2167 | 7.57 | 104U | 62 | - | 2245 | 7.00 | 114U | 61 | - | 2351 | 6.49 | 114U | 61 | - | 2429 | 1220 | 21 |
| | | | | 1 | | | 365F | 249 | 4.5 | 3779 | | 385F | 248 | 4.5 | 3962 | | 355G | 246 | 4.5 | 3882 | | 365G | 244 | 4.5 | 4013 | 1721 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 10.11 | 115U | 62 | - | 3014 | 9.32 | 114U | 62 | - | 2942 | 8.62 | 124U | 61 | - | 3075 | 7.99 | 124U | 61 | - | 3179 | 1721 | 20 |
| | | | | 1 | | | 415E | 249 | 4.5 | 4684 | | 435E | 247 | 4.5 | 4894 | | 395F | 246 | 4.5 | 4788 | | 415F | 244 | 4.5 | 4998 | 2118 | |
| | | 3#14 | 3#14 | 1 | 8#14 | 15.41 | 155KhU | 62 | - | 4577 | 14.21 | 155MgU | 62 | - | 4739 | 13.13 | 155NfU | 61 | - | 4901 | 12.18 | 155OfU | 61 | - | 5062 | 2501 | 16 |
| | | | | 1 | | | 585C | 249 | 4.5 | 6964 | | 605C | 247 | 4.5 | 7231 | | 525D | 246 | 4.5 | 6972 | | 545D | 244 | 4.5 | 7239 | 3228 | |
| | | 4#14 | 3#14 | 1 | 10#14 | 17.81 | 205HmU | 62 | - | 5664 | 16.41 | 185lkU | 62 | - | 5772 | 15.18 | 185JjU | 61 | - | 5970 | 14.07 | 185JjU | 61 | - | 6167 | 2871 | 15 |
| | | | | 2 | | | 585C | 249 | 4.5 | 7829 | | 605C | 247 | 4.5 | 8132 | | 625C | 246 | 4.5 | 8434 | | 655C | 244 | 4.5 | 8790 | 3730 | |
| | 36 | 2#14 | 2#14 | 1 | 5#14 | 10.25 | 104U | 83 | - | 2818 | 9.44 | 114U | 83 | - | 2952 | 8.73 | 114U | 82 | - | 3057 | 8.10 | 114U | 82 | - | 3161 | 1739 | 17 |
| | | | | 1 | | | 415E | 333 | 5.4 | 4784 | | 435E | 331 | 5.4 | 4999 | | 455E | 329 | 5.3 | 5213 | | 465E | 327 | 5.3 | 5373 | 2146 | |
| | | 2#14 | 2#14 | 1 | 6#14 | 12.08 | 115U | 83 | - | 3274 | 11.13 | 115U | 83 | - | 3389 | 10.29 | 125U | 82 | - | 3550 | 9.54 | 124U | 82 | - | 3466 | 1739 | 18 |
| | | | | 1 | | | 485D | 333 | 5.4 | 5414 | | 435E | 331 | 5.4 | 5254 | | 455E | 329 | 5.3 | 5479 | | 465E | 327 | 5.3 | 5648 | 2542 | |
| | | 4#14 | 3#14 | 1 | 10#14 | 18.34 | 185lkU | 83 | - | 5600 | 16.90 | 175JiU | 83 | - | 5751 | 15.63 | 165KhU | 82 | - | 5903 | 14.49 | 175KhU | 82 | - | 6147 | 2926 | 14 |
| | | | | 2 | | | 585C | 333 | 5.4 | 7970 | | 605C | 331 | 5.4 | 8278 | | 625C | 329 | 5.3 | 8585 | | 655C | 327 | 5.3 | 8948 | 3842 | |
| | | 4#14 | 4#14 | 1 | 12#14 | 21.37 | 225GpU | 83 | - | 6548 | 19.70 | 225GoU | 83 | - | 6778 | 18.21 | 215HnU | 82 | - | 6961 | 16.89 | 215HnU | 82 | - | 7191 | 3300 | 12 |
| | | | | 2 | | | 725B | 333 | 5.4 | 9506 | | 755B | 331 | 5.4 | 9901 | | 785B | 329 | 5.3 | 10296 | | 815B | 327 | 5.3 | 10691 | 4476 | |
| | 42 | 3#11 | 2#11 | 1 | 5#14 | 10.34 | 104U | 106 | - | 2690 | 9.53 | 104U | 105 | - | 2789 | 8.81 | 104U | 104 | - | 2888 | 8.17 | 104U | 104 | - | 2987 | 1532 | 14 |
| | | | | 1 | | | 585C | 424 | 6.3 | 5725 | | 605C | 420 | 6.2 | 5939 | | 395F | 418 | 6.2 | 4829 | | 415F | 415 | 6.1 | 5043 | 2166 | |
| | | 3#14 | 2#14 | 1 | 7#14 | 14.16 | 115U | 106 | - | 3909 | 13.05 | 115U | 105 | - | 4049 | 12.06 | 125U | 104 | - | 4237 | 11.19 | 125U | 104 | - | 4377 | 2166 | 15 |
| | | | | 1 | | | 585C | 423 | 6.3 | 6726 | | 605C | 420 | 6.2 | 6982 | | 625C | 417 | 6.2 | 7237 | | 655C | 415 | 6.1 | 7550 | 2965 | |
| | | 4#14 | 4#14 | 1 | 11#14 | 21.25 | 195HlU | 106 | - | 6192 | 19.58 | 195HlU | 105 | - | 6411 | 18.10 | 185lkU | 104 | - | 6583 | 16.79 | 195lkU | 104 | - | 6850 | 3351 | 12 |
| | | | | 1 | | | 725B | 423 | 6.3 | 9437 | | 755B | 420 | 6.2 | 9829 | | 785B | 417 | 6.2 | 10220 | | 655C | 415 | 6.1 | 9692 | 4449 | |
| | | 5#14 | 4#14 | 1 | 14#14 | 24.93 | 275EuU | 106 | - | 7680 | 22.98 | 255FsU | 105 | - | 7850 | 21.25 | 255FrU | 104 | - | 8116 | 19.70 | 235GpU | 104 | - | 8286 | 3726 | 11 |
| | | | | 2 | | | 725B | 423 | 6.3 | 10546 | | 755B | 420 | 6.2 | 10984 | | 785B | 417 | 6.2 | 11421 | | 815B | 415 | 6.1 | 11859 | 5222 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b - 2''$).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

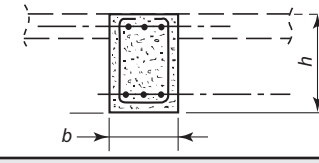
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

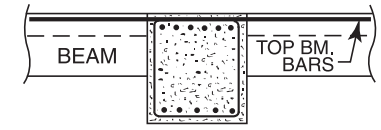
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w/1.4$.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 12 ft | | | | | SPAN, $\ell_n$ = 14 ft. | | | | | SPAN, $\ell_n$ = 16 ft. | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ | $b$ | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 12.5 | 24 | 2# 6 | 1# 6 | 1 | 4# 5 | 3.77 | 103C | 6 | - | 149 | 2.77 | 103C | 5 | - | 162 | 2.12 | 103C | 5 | - | 176 | 1.68 | 093C | 5 | - | 184 | 57 | 2230 |
| | | | | 1 | | | 143C | 22 | 1.0 | 200 | | 173C | 22 | 1.0 | 237 | | 193C | 21 | 1.0 | 266 | | 223C | 21 | 1.0 | 303 | 54 | |
| | | 2# 6 | 2# 6 | 1 | 4# 7 | 5.73 | 133C | 6 | - | 220 | 4.21 | 143C | 5 | - | 247 | 3.23 | 153C | 5 | - | 273 | 2.55 | 153C | 5 | - | 294 | 75 | 3056 |
| | | | | 1 | | | 144C | 22 | 1.0 | 364 | | 173C | 22 | 1.0 | 299 | | 193C | 21 | 1.0 | 335 | | 223C | 21 | 1.0 | 379 | 99 | |
| | | 3# 6 | 3# 6 | 1 | 4# 8 | 8.31 | 143C | 6 | - | 287 | 6.10* | 163C | 5 | - | 327 | 4.67* | 173C | 5 | - | 362 | 3.69* | 183C | 5 | - | 397 | 108 | 2853 |
| | | | | 1 | | | 144C | 22 | 1.0 | 425 | | 174C | 22 | 1.0 | 500 | | 194C | 21 | 1.0 | 561 | | 224C | 21 | 1.0 | 636 | 125 | |
| | | 4# 6 | 4# 6 | 1 | 4# 9 | 10.58 | 144C | 6 | - | 431 | 7.77* | 173C | 5 | - | 408 | 5.95* | 193C | 5 | - | 457 | 4.70* | 203C | 5 | - | 501 | 139 | 2476 |
| | | | | 1 | | | 144C | 22 | 1.0 | 490 | | 174C | 22 | 1.0 | 575 | | 194C | 21 | 1.0 | 644 | | 224C | 21 | 1.0 | 729 | 152 | |
| | 36 | 2# 6 | 2# 6 | 1 | 5# 6 | 5.86 | 113C | 9 | - | 213 | 4.31 | N/A | 9 | - | 160 | 3.30 | N/A | 9 | - | 180 | 2.61 | N/A | 9 | - | 200 | 76 | 1576 |
| | | | | 1 | | | 243A | 38 | 1.5 | 367 | | 283A | 37 | 1.5 | 425 | | 323A | 36 | 1.5 | 483 | | 363A | 36 | 1.5 | 540 | 94 | |
| | | 3# 6 | 2# 6 | 1 | 5# 7 | 7.25 | 123C | 9 | - | 265 | 5.33 | 133C | 9 | - | 298 | 4.08 | N/A | 9 | - | 238 | 3.22 | N/A | 9 | - | 264 | 94 | 1933 |
| | | | | 1 | | | 243A | 38 | 1.5 | 412 | | 283A | 37 | 1.5 | 476 | | 323A | 36 | 1.5 | 540 | | 363A | 36 | 1.5 | 605 | 125 | |
| | | 5# 6 | 4# 6 | 1 | 5# 9 | 12.46 | 144C | 9 | - | 508 | 9.16* | 163C | 9 | - | 477 | 7.01* | 173C | 9 | - | 529 | 5.54* | 183C | 9 | - | 581 | 163 | 1880 |
| | | | | 1 | | | 244A | 38 | 1.5 | 774 | | 174C | 37 | 1.5 | 688 | | 323A | 36 | 1.5 | 719 | | 363A | 36 | 1.5 | 802 | 195 | |
| | | 6# 6 | 5# 6 | 1 | 5#10 | 14.87 | 144C | 9 | - | 591 | 10.93* | 174C | 9 | - | 687 | 8.37* | 183C | 9 | - | 640 | 6.61* | 203C | 9 | - | 710 | 194 | 1671 |
| | | | | 1 | | | 244A | 38 | 1.5 | 857 | | 284A | 37 | 1.5 | 988 | | 194C | 36 | 1.5 | 876 | | 363A | 36 | 1.5 | 918 | 237 | |
| | 48 | 3# 6 | 3# 6 | 1 | 6# 6 | 7.95 | 113C | 13 | - | 273 | 5.84 | N/A | 13 | - | 217 | 4.47 | N/A | 13 | - | 244 | 3.53 | N/A | 13 | - | 271 | 114 | 1216 |
| | | | | 1 | | | ** | 54 | 5.4 | 189 | | ** | 53 | 5.4 | 217 | | ** | 52 | 5.3 | 244 | | ** | 51 | 5.3 | 271 | 114 | |
| | | 4# 6 | 3# 6 | 1 | 6# 8 | 10.12 | 123C | 13 | - | 369 | 7.44 | 133C | 13 | - | 415 | 5.69 | 133C | 13 | - | 454 | 4.50 | N/A | 13 | - | 393 | 132 | 1445 |
| | | | | 1 | | | ** | 54 | 5.4 | 277 | | ** | 53 | 5.4 | 316 | | ** | 52 | 5.3 | 354 | | ** | 51 | 5.3 | 393 | 194 | |
| | | 6# 6 | 6# 6 | 1 | 6# 9 | 16.56 | 144C | 13 | - | 619 | 12.17* | 164C | 13 | - | 706 | 9.32* | 173C | 13 | - | 655 | 7.36* | 183C | 13 | - | 721 | 217 | 1461 |
| | | | | 1 | | | 244A | 54 | 2.1 | 936 | | 284A | 53 | 2.0 | 1081 | | 194C | 52 | 2.0 | 941 | | ** | 51 | 5.3 | 583 | 238 | |
| | | 8# 6 | 7# 6 | 1 | 6#10 | 20.16 | 164AdC | 13 | - | 761 | 14.81* | 174C | 13 | - | 848 | 11.34* | 184C | 13 | - | 936 | 8.96* | 203C | 13 | - | 893 | 264 | 1292 |
| | | | | 1 | | | 244A | 54 | 2.1 | 1048 | | 284A | 53 | 2.0 | 1208 | | 324A | 52 | 2.0 | 1368 | | 224C | 51 | 2.0 | 1222 | 290 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

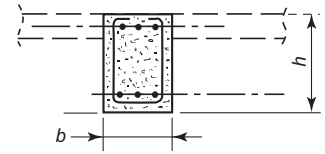
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

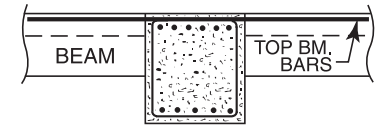
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 12.5 | 24 | 2# 6 | 1# 6 | 1 | 4# 5 | 1.36 | 083C | 5 | - | 192 | 1.12 | 073C | 5 | - | 199 | 0.94 | 053C | 5 | - | 202 | 0.80 | N/A | 5 | - | 187 | 57 | 2230 |
| | | | | 1 | | | 243C | 21 | 1.0 | 331 | | 263C | 21 | 1.0 | 360 | | 293C | 21 | 1.0 | 397 | | 313C | 21 | 1.0 | 426 | 54 | |
| | | 2# 7 | 1# 7 | 1 | 4# 7 | 2.09* | 163C | 5 | - | 326 | 1.73* | 163C | 5 | - | 347 | 1.45* | 153C | 5 | - | 363 | 1.24* | 153C | 5 | - | 384 | 76 | 3079 |
| | | | | 1 | | | 243C | 21 | 1.0 | 421 | | 263C | 21 | 1.0 | 457 | | 293C | 21 | 1.0 | 502 | | 313C | 21 | 1.0 | 539 | 99 | |
| | | 2# 9 | 1# 9 | 1 | 4# 8 | 3.14X | 253B | 5 | - | 495 | 2.60X | 263B | 5 | - | 532 | 2.18X | 273B | 5 | - | 570 | 1.86X | 283B | 5 | - | 607 | 119 | 2811 |
| | | | | 1 | | | 303B | 21 | 1.0 | 585 | | 333B | 21 | 1.0 | 640 | | 363B | 21 | 1.0 | 695 | | 393B | 21 | 1.0 | 750 | 125 | |
| | | 2#10 | 1#10 | 1 | 4# 9 | 3.81X | 273B | 5 | - | 603 | 3.15X | 283B | 5 | - | 649 | 2.65X | 303B | 5 | - | 701 | 2.25Y | 313B | 5 | - | 748 | 145 | 2480 |
| | | | | 1 | | | 303B | 21 | 1.0 | 682 | | 333B | 21 | 1.0 | 746 | | 363B | 21 | 1.0 | 810 | | 393B | 21 | 1.0 | 873 | 152 | |
| | 36 | 2# 6 | 2# 6 | 1 | 5# 6 | 2.11 | N/A | 9 | - | 220 | 1.74 | N/A | 9 | - | 240 | 1.47 | N/A | 9 | - | 260 | 1.25 | N/A | 9 | - | 280 | 76 | 1576 |
| | | | | 1 | | | 403A | 36 | 1.5 | 598 | | 443A | 35 | 1.5 | 656 | | ** | 35 | 0.0 | 260 | | ** | 35 | 0.0 | 280 | 94 | |
| | | 2# 8 | 2# 8 | 1 | 5# 7 | 3.15* | N/A | 9 | - | 350 | 2.60* | N/A | 9 | - | 382 | 2.19* | N/A | 9 | - | 414 | 1.86* | N/A | 9 | - | 445 | 131 | 2088 |
| | | | | 1 | | | 403A | 36 | 1.5 | 728 | | 443A | 35 | 1.5 | 798 | | 483A | 35 | 1.4 | 868 | | 523A | 35 | 1.4 | 938 | 125 | |
| | | 2# 9 | 2# 9 | 1 | 5# 9 | 4.43* | 243B | 9 | - | 666 | 3.66X | 253B | 9 | - | 718 | 3.08X | 263B | 9 | - | 769 | 2.62X | 263B | 9 | - | 815 | 161 | 1904 |
| | | | | 1 | | | 403A | 36 | 1.5 | 885 | | 443A | 35 | 1.5 | 968 | | 483A | 35 | 1.4 | 1051 | | 523A | 35 | 1.4 | 1134 | 195 | |
| | | 2#10 | 2#10 | 1 | 5#10 | 5.42X | 263B | 9 | - | 817 | 4.48X | 283B | 9 | - | 888 | 3.76X | 293B | 9 | - | 952 | 3.21Y | 303B | 9 | - | 1016 | 197 | 1691 |
| | | | | 1 | | | 403A | 36 | 1.5 | 1023 | | 443A | 35 | 1.5 | 1118 | | 483A | 35 | 1.4 | 1214 | | 523A | 35 | 1.4 | 1309 | 237 | |
| | 48 | 3# 6 | 3# 6 | 1 | 6# 6 | 2.86 | N/A | 13 | - | 299 | 2.37 | N/A | 13 | - | 326 | 1.99 | N/A | 13 | - | 354 | 1.69 | N/A | 12 | - | 381 | 114 | 1216 |
| | | | | 1 | | | ** | 51 | 5.4 | 299 | | ** | 50 | 0.0 | 326 | | ** | 50 | 0.0 | 354 | | ** | 50 | 0.0 | 381 | 114 | |
| | | 3# 7 | 3# 7 | 1 | 6# 8 | 4.19* | N/A | 13 | - | 463 | 3.46* | N/A | 13 | - | 505 | 2.91* | N/A | 13 | - | 547 | 2.48* | N/A | 12 | - | 588 | 152 | 1554 |
| | | | | 1 | | | ** | 51 | 5.4 | 463 | | ** | 50 | 5.4 | 505 | | ** | 50 | 5.3 | 547 | | ** | 50 | 5.3 | 588 | 194 | |
| | | 3# 9 | 3# 9 | 1 | 6# 9 | 5.96* | 243B | 13 | - | 870 | 4.93X | 253B | 13 | - | 940 | 4.14X | 263B | 13 | - | 1010 | 3.53X | 273B | 12 | - | 1079 | 238 | 1428 |
| | | | | 1 | | | ** | 51 | 2.1 | 687 | | ** | 50 | 2.0 | 749 | | ** | 50 | 2.0 | 811 | | ** | 50 | 5.3 | 873 | 238 | |
| | | 3#10 | 3#10 | 1 | 6#10 | 7.26X | 263B | 13 | - | 1073 | 6.00X | 283B | 13 | - | 1167 | 5.04X | 293B | 13 | - | 1253 | 4.29Y | 303B | 12 | - | 1339 | 290 | 1266 |
| | | | | 1 | | | ** | 51 | 2.1 | 874 | | ** | 50 | 2.0 | 953 | | ** | 50 | 2.0 | 1031 | | ** | 50 | 2.0 | 1110 | 290 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

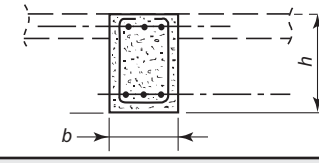
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

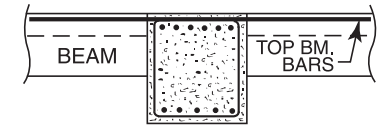
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 12 ft | | | | | SPAN, $\ell_n$ = 14 ft. | | | | | SPAN, $\ell_n$ = 16 ft. | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 14.5 | 24 | 2# 6 | 1# 6 | 1 | 4# 6 | 5.28 | 103D | 7 | - | 171 | 3.88 | 103D | 7 | - | 187 | 2.97 | 103D | 7 | - | 202 | 2.35 | 103D | 7 | - | 218 | 69 | 1491 |
| | | | | 1 | | | 143C | 29 | 1.2 | 225 | | 173C | 28 | 1.2 | 265 | | 193C | 28 | 1.1 | 297 | | 223C | 28 | 1.1 | 337 | 90 | |
| | | 2# 6 | 2# 6 | 1 | 4# 7 | 6.94 | 113D | 7 | - | 215 | 5.10 | 123D | 7 | - | 242 | 3.91 | 123D | 7 | - | 262 | 3.09 | 133D | 7 | - | 289 | 90 | 1866 |
| | | | | 1 | | | 144C | 29 | 1.2 | 377 | | 173C | 28 | 1.2 | 307 | | 193C | 28 | 1.1 | 345 | | 223C | 28 | 1.1 | 390 | 120 | |
| | | 4# 6 | 3# 6 | 1 | 4# 9 | 11.64 | 124D | 7 | - | 403 | 8.55 | 143D | 7 | - | 379 | 6.55 | 153D | 7 | - | 421 | 5.17* | 173D | 7 | - | 469 | 152 | 1672 |
| | | | | 1 | | | 125D | 29 | 1.2 | 580 | | 144D | 28 | 1.2 | 522 | | 164D | 28 | 1.1 | 591 | | 224C | 28 | 1.1 | 725 | 188 | |
| | | 10# 4 | 9# 4 | 2 | 4#10 | 13.25 | 144C | 7 | - | 495 | 9.73 | 173C | 7 | - | 473 | 7.45* | 193C | 7 | - | 530 | 5.89* | 213C | 7 | - | 587 | 173 | 1537 |
| | | | | 1 | | | 145C | 29 | 1.2 | 702 | | 174C | 28 | 1.2 | 648 | | 194C | 28 | 1.1 | 725 | | 224C | 27 | 1.1 | 819 | 228 | |
| | 36 | 2# 6 | 2# 6 | 1 | 5# 7 | 7.07 | 093D | 12 | - | 230 | 5.20 | N/A | 12 | - | 189 | 3.98 | N/A | 12 | - | 212 | 3.14 | N/A | 12 | - | 235 | 92 | 812 |
| | | | | 1 | | | 243A | 50 | 1.8 | 405 | | 283A | 49 | 1.7 | 468 | | 323A | 48 | 1.7 | 531 | | 363A | 47 | 1.7 | 594 | 152 | |
| | | 3# 6 | 3# 6 | 1 | 5# 8 | 10.42 | 113D | 12 | - | 311 | 7.65 | 123D | 12 | - | 351 | 5.86 | 123D | 12 | - | 383 | 4.63 | 133D | 12 | - | 423 | 136 | 1218 |
| | | | | 1 | | | 124D | 50 | 1.8 | 468 | | 283A | 49 | 1.7 | 544 | | 323A | 48 | 1.7 | 617 | | 363A | 47 | 1.7 | 689 | 196 | |
| | | 6# 6 | 5# 6 | 1 | 5#10 | 18.20 | 124D | 12 | - | 576 | 13.37 | 144D | 12 | - | 660 | 10.24 | 164D | 12 | - | 745 | 8.09* | 173D | 12 | - | 699 | 238 | 1089 |
| | | | | 1 | | | 125D | 50 | 1.8 | 790 | | 145D | 49 | 1.7 | 910 | | 165D | 48 | 1.7 | 1030 | | 185D | 47 | 1.7 | 1150 | 294 | |
| | | 7# 6 | 6# 6 | 1 | 5#11 | 21.08 | 125D | 12 | - | 769 | 15.49 | 144D | 12 | - | 762 | 11.86* | 164D | 12 | - | 858 | 9.37* | 174D | 12 | - | 939 | 276 | 978 |
| | | | | 1 | | | 245A | 50 | 1.8 | 1262 | | 145D | 49 | 1.7 | 1011 | | 165D | 48 | 1.7 | 1143 | | 185D | 47 | 1.7 | 1274 | 342 | |
| | 48 | 3# 6 | 3# 6 | 1 | 6# 7 | 10.56 | 103D | 18 | - | 302 | 7.76 | N/A | 18 | - | 252 | 5.94 | N/A | 17 | - | 283 | 4.69 | N/A | 17 | - | 314 | 138 | 744 |
| | | | | 1 | | | ** | 72 | 5.4 | 221 | | ** | 70 | 0.0 | 252 | | ** | 69 | 0.0 | 283 | | ** | 68 | 0.0 | 314 | 184 | |
| | | 4# 6 | 4# 6 | 1 | 6# 8 | 13.89 | 113D | 18 | - | 383 | 10.20 | 123D | 18 | - | 433 | 7.81 | 123D | 17 | - | 474 | 6.17 | 133D | 17 | - | 523 | 181 | 940 |
| | | | | 1 | | | ** | 72 | 5.4 | 294 | | ** | 70 | 5.4 | 335 | | ** | 69 | 5.3 | 376 | | ** | 68 | 5.3 | 417 | 237 | |
| | | 7# 6 | 7# 6 | 1 | 6#10 | 23.28 | 125D | 18 | - | 807 | 17.10 | 144D | 18 | - | 794 | 13.09 | 154D | 17 | - | 879 | 10.35* | 174D | 17 | - | 980 | 304 | 856 |
| | | | | 1 | | | 245A | 72 | 2.4 | 1383 | | 145D | 70 | 2.3 | 1086 | | 195C | 69 | 2.3 | 1339 | | 224C | 68 | 2.2 | 1213 | 358 | |
| | | 9# 6 | 9# 6 | 1 | 6#11 | 29.05 | 244A | 18 | - | 1019 | 21.34 | 145D | 18 | - | 1083 | 16.34* | 165D | 17 | - | 1221 | 12.91* | 184D | 17 | - | 1188 | 380 | 753 |
| | | | | 1 | | | 245A | 72 | 2.4 | 1520 | | 285A | 70 | 2.3 | 1754 | | 325A | 69 | 2.3 | 1989 | | 185D | 68 | 2.2 | 1563 | 424 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

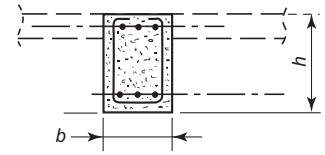
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

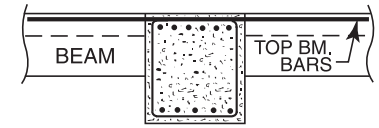
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 14.5 | 24 | 2# 7 | 1# 7 | 1 | 4# 6 | 2.27 | 123D | 7 | - | 278 | 1.88 | 123D | 7 | - | 297 | 1.58 | 113D | 7 | - | 310 | 1.34 | 113D | 7 | - | 329 | 92 | 1819 |
| | | | | 1 | | | 243C | 27 | 1.1 | 402 | | 263C | 27 | 1.1 | 437 | | 293C | 27 | 1.1 | 480 | | 313C | 27 | 1.1 | 516 | 90 | |
| | | 2# 8 | 1# 8 | 1 | 4# 7 | 3.02* | 153D | 7 | - | 365 | 2.49* | 163D | 7 | - | 396 | 2.10* | 163D | 7 | - | 421 | 1.79* | 163D | 7 | - | 446 | 118 | 1967 |
| | | | | 1 | | | 243C | 27 | 1.1 | 470 | | 263C | 27 | 1.1 | 512 | | 293C | 27 | 1.1 | 561 | | 313C | 27 | 1.1 | 602 | 120 | |
| | | 2#10 | 1#10 | 1 | 4# 9 | 4.71* | 223C | 7 | - | 586 | 3.89* | 233C | 7 | - | 633 | 3.27X | 243C | 7 | - | 680 | 2.79X | 253C | 7 | - | 726 | 179 | 1614 |
| | | | | 1 | | | 244C | 27 | 1.1 | 844 | | 264C | 27 | 1.1 | 918 | | 294C | 27 | 1.1 | 1008 | | 314C | 27 | 1.1 | 1081 | 188 | |
| | | 2#10 | 1#10 | 1 | 4#10 | 4.93* | 223C | 7 | - | 640 | 4.08* | 243C | 7 | - | 698 | 3.43X | 253C | 7 | - | 749 | 2.92X | 263C | 7 | - | 799 | 179 | 1498 |
| | | | | 1 | | | 244C | 27 | 1.1 | 899 | | 264C | 27 | 1.1 | 976 | | 294C | 27 | 1.1 | 1071 | | 314C | 27 | 1.1 | 1148 | 228 | |
| | 36 | 2# 7 | 2# 7 | 1 | 5# 7 | 3.41 | N/A | 12 | - | 301 | 2.82 | N/A | 12 | - | 328 | 2.37 | N/A | 12 | - | 355 | 2.02 | N/A | 11 | - | 383 | 123 | 1211 |
| | | | | 1 | | | 403A | 47 | 1.7 | 699 | | 443A | 46 | 1.7 | 766 | | 483A | 46 | 1.6 | 834 | | 523A | 46 | 1.6 | 901 | 152 | |
| | | 2# 9 | 2# 9 | 1 | 5# 8 | 4.90* | 193C | 12 | - | 588 | 4.05* | 193C | 12 | - | 629 | 3.40* | 203C | 11 | - | 677 | 2.90* | N/A | 11 | - | 575 | 197 | 1282 |
| | | | | 1 | | | 403A | 47 | 1.7 | 851 | | 443A | 46 | 1.7 | 932 | | 483A | 46 | 1.6 | 1013 | | 523A | 46 | 1.6 | 1093 | 196 | |
| | | 2#10 | 2#10 | 1 | 5#10 | 6.68* | 213C | 12 | - | 795 | 5.52* | 233C | 12 | - | 866 | 4.64X | 243C | 11 | - | 931 | 3.95X | 253C | 11 | - | 995 | 242 | 1097 |
| | | | | 1 | | | 403A | 47 | 1.7 | 1043 | | 443A | 46 | 1.7 | 1140 | | 483A | 46 | 1.6 | 1238 | | 523A | 46 | 1.6 | 1335 | 294 | |
| | | 3#10 | 2#10 | 1 | 5#11 | 8.10* | 233C | 12 | - | 977 | 6.69* | 243C | 12 | - | 1056 | 5.63X | 263C | 11 | - | 1142 | 4.79X | 273C | 11 | - | 1221 | 294 | 970 |
| | | | | 1 | | | 244C | 47 | 1.7 | 1283 | | 264C | 46 | 1.6 | 1394 | | 483A | 46 | 1.6 | 1434 | | 523A | 46 | 1.6 | 1546 | 342 | |
| | 48 | 3# 7 | 3# 7 | 1 | 6# 7 | 4.62 | N/A | 17 | - | 409 | 3.82 | N/A | 17 | - | 446 | 3.21 | N/A | 17 | - | 483 | 2.73 | N/A | 16 | - | 521 | 184 | 924 |
| | | | | 1 | | | ** | 67 | 5.4 | 409 | | ** | 67 | 0.0 | 446 | | ** | 66 | 0.0 | 483 | | ** | 66 | 0.0 | 521 | 184 | |
| | | 3# 8 | 3# 8 | 1 | 6# 8 | 5.93* | 153D | 17 | - | 659 | 4.90* | 153D | 17 | - | 708 | 4.12* | N/A | 17 | - | 634 | 3.51* | N/A | 16 | - | 683 | 237 | 983 |
| | | | | 1 | | | ** | 67 | 5.4 | 537 | | ** | 67 | 5.4 | 585 | | ** | 66 | 5.3 | 634 | | ** | 66 | 5.3 | 683 | 237 | |
| | | 3#10 | 3#10 | 1 | 6#10 | 8.97* | 213C | 17 | - | 1045 | 7.41* | 233C | 17 | - | 1140 | 6.23X | 243C | 17 | - | 1227 | 5.31X | 253C | 16 | - | 1313 | 358 | 822 |
| | | | | 1 | | | 244C | 67 | 2.2 | 1422 | | 264C | 66 | 2.2 | 1546 | | ** | 66 | 2.3 | 1031 | | ** | 66 | 2.2 | 1110 | 358 | |
| | | 3#10 | 3#10 | 1 | 6#11 | 9.87* | 224C | 17 | - | 1315 | 8.15* | 243C | 17 | - | 1248 | 6.85X | 253C | 17 | - | 1342 | 5.84X | 263C | 16 | - | 1436 | 358 | 777 |
| | | | | 1 | | | 245C | 67 | 2.2 | 1847 | | 264C | 66 | 2.2 | 1646 | | 294C | 66 | 2.2 | 1800 | | ** | 66 | 2.2 | 1224 | 424 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

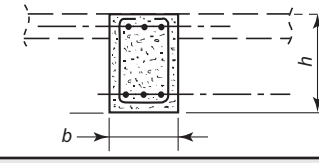
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

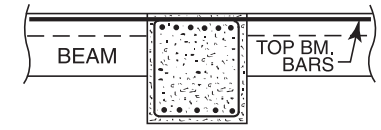
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 16 ft | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | SPAN, $\ell_n$ = 20 ft. | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 16.5 | 24 | 2# 7 | 1# 7 | 1 | 4# 7 | 4.66 | 113E | 9 | - | 266 | 3.69 | 123E | 9 | - | 294 | 2.99 | 123E | 9 | - | 315 | 2.47 | 123E | 8 | - | 337 | 108 | 1206 |
| | | | | 1 | | | 193C | 35 | 1.3 | 359 | | 223C | 35 | 1.3 | 406 | | 243C | 34 | 1.3 | 445 | | 263C | 34 | 1.3 | 484 | 142 | |
| | | 2# 8 | 1# 8 | 1 | 4# 8 | 6.02 | 123E | 9 | - | 334 | 4.75 | 133E | 9 | - | 368 | 3.85 | 143E | 9 | - | 403 | 3.18 | 143E | 8 | - | 431 | 140 | 1263 |
| | | | | 1 | | | 194C | 35 | 1.3 | 583 | | 224C | 34 | 1.3 | 663 | | 243C | 34 | 1.3 | 519 | | 263C | 34 | 1.3 | 564 | 182 | |
| | | 3# 8 | 2# 8 | 1 | 4#10 | 9.58 | 144E | 9 | - | 604 | 7.57 | 153E | 9 | - | 566 | 6.13* | 163E | 9 | - | 618 | 5.07* | 183E | 8 | - | 677 | 223 | 1022 |
| | | | | 1 | | | 145E | 35 | 1.3 | 817 | | 165E | 34 | 1.3 | 919 | | 175E | 34 | 1.3 | 993 | | 194E | 34 | 1.2 | 886 | 274 | |
| | | 8# 5 | 7# 5 | 2 | 4#10 | 10.54 | 164D | 9 | - | 664 | 8.33* | 184D | 9 | - | 740 | 6.74* | 203D | 8 | - | 687 | 5.57* | 213D | 8 | - | 743 | 245 | 1018 |
| | | | | 1 | | | 165D | 35 | 1.3 | 908 | | 185D | 34 | 1.3 | 1014 | | 205D | 34 | 1.3 | 1121 | | 224D | 34 | 1.2 | 984 | 274 | |
| | 36 | 2# 8 | 2# 8 | 1 | 5# 7 | 7.03 | 113E | 15 | - | 370 | 5.55 | 123E | 15 | - | 409 | 4.50 | N/A | 15 | - | 350 | 3.72 | N/A | 15 | - | 382 | 188 | 817 |
| | | | | 1 | | | 323A | 61 | 1.9 | 621 | | 363A | 60 | 1.9 | 694 | | 403A | 59 | 1.9 | 768 | | 443A | 59 | 1.9 | 842 | 179 | |
| | | 2# 8 | 2# 8 | 1 | 5# 9 | 8.08 | 123E | 15 | - | 461 | 6.38 | 133E | 15 | - | 509 | 5.17 | 133E | 15 | - | 549 | 4.27 | 133E | 15 | - | 588 | 188 | 807 |
| | | | | 1 | | | 323A | 61 | 1.9 | 704 | | 363A | 60 | 1.9 | 786 | | 403A | 59 | 1.9 | 868 | | 443A | 59 | 1.9 | 949 | 285 | |
| | | 4# 8 | 3# 8 | 1 | 5#10 | 13.52 | 144E | 15 | - | 765 | 10.68 | 154E | 15 | - | 841 | 8.65* | 164E | 15 | - | 916 | 7.15* | 173E | 15 | - | 868 | 314 | 740 |
| | | | | 1 | | | 145E | 61 | 1.9 | 1021 | | 165E | 60 | 1.9 | 1148 | | 205D | 59 | 1.9 | 1341 | | 224D | 59 | 1.9 | 1189 | 351 | |
| | | 5# 8 | 4# 8 | 1 | 5#11 | 16.29 | 145E | 15 | - | 1042 | 12.87* | 164E | 15 | - | 1021 | 10.43* | 174E | 15 | - | 1112 | 8.62* | 184E | 15 | - | 1204 | 392 | 645 |
| | | | | 1 | | | 245B | 61 | 1.9 | 1503 | | 275B | 60 | 1.9 | 1679 | | 175E | 59 | 1.9 | 1423 | | 195E | 59 | 1.8 | 1566 | 417 | |
| | 48 | 3# 7 | 3# 7 | 1 | 6# 8 | 9.33 | 113E | 22 | - | 475 | 7.37 | 123E | 22 | - | 526 | 5.97 | N/A | 21 | - | 463 | 4.93 | N/A | 21 | - | 505 | 217 | 606 |
| | | | | 1 | | | ** | 88 | 5.4 | 380 | | ** | 87 | 0.0 | 422 | | ** | 86 | 0.0 | 463 | | ** | 85 | 0.0 | 505 | 280 | |
| | | 3# 8 | 3# 8 | 1 | 6# 9 | 12.03 | 123E | 22 | - | 598 | 9.51 | 133E | 22 | - | 660 | 7.70 | 143E | 21 | - | 723 | 6.36 | 143E | 21 | - | 776 | 280 | 645 |
| | | | | 1 | | | 194C | 88 | 2.6 | 945 | | ** | 87 | 5.4 | 548 | | ** | 86 | 5.3 | 601 | | ** | 85 | 5.3 | 655 | 346 | |
| | | 5# 8 | 4# 8 | 1 | 6#11 | 17.45 | 145E | 22 | - | 1146 | 13.79 | 154E | 22 | - | 1105 | 11.17* | 164E | 21 | - | 1204 | 9.23* | 174E | 21 | - | 1303 | 406 | 543 |
| | | | | 1 | | | 245B | 88 | 2.6 | 1685 | | 275B | 87 | 2.5 | 1882 | | 175E | 86 | 2.5 | 1583 | | 264C | 85 | 2.5 | 1636 | 508 | |
| | | 6# 8 | 6# 8 | 1 | 7#11 | 22.47 | 165BdE | 22 | - | 1387 | 17.75* | 165E | 22 | - | 1491 | 14.38* | 175E | 21 | - | 1621 | 11.88* | 185E | 21 | - | 1751 | 522 | 476 |
| | | | | 1 | | | 245B | 88 | 2.6 | 1873 | | 275B | 87 | 2.5 | 2090 | | 305B | 86 | 2.5 | 2308 | | 335B | 85 | 2.5 | 2526 | 579 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

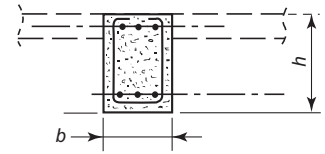
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

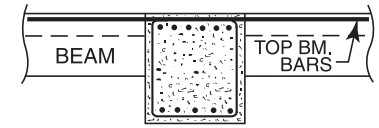
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 24 ft | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 16.5 | 24 | 2# 7 | 1# 7 | 1 | 4# 7 | 2.07 | 123E | 8 | - | 358 | 1.77 | 113E | 8 | - | 373 | 1.52 | 113E | 8 | - | 394 | 1.33 | 103E | 8 | - | 409 | 108 | 1206 |
| | | | | 1 | | | 293C | 33 | 1.2 | 531 | | 313C | 33 | 1.2 | 570 | | 343C | 33 | 1.2 | 617 | | 363C | 33 | 1.2 | 656 | 142 | |
| | | 2# 9 | 1# 9 | 1 | 4# 8 | 3.17* | 193D | 8 | - | 544 | 2.70* | 193D | 8 | - | 576 | 2.33* | 203D | 8 | - | 614 | 2.03* | 203D | 8 | - | 646 | 173 | 1257 |
| | | | | 1 | | | 293C | 33 | 1.2 | 670 | | 313C | 33 | 1.2 | 720 | | 343C | 33 | 1.2 | 778 | | 363C | 33 | 1.2 | 827 | 182 | |
| | | 2#10 | 1#10 | 1 | 4#10 | 4.08* | 213D | 8 | - | 734 | 3.48* | 223D | 8 | - | 786 | 3.00* | 233D | 8 | - | 837 | 2.61X | 243D | 8 | - | 889 | 213 | 1040 |
| | | | | 1 | | | 294C | 33 | 1.2 | 1097 | | 314C | 33 | 1.2 | 1177 | | 344C | 33 | 1.2 | 1273 | | 363C | 33 | 1.2 | 1043 | 274 | |
| | | 2#11 | 1#11 | 1 | 4#10 | 4.76* | 223D | 8 | - | 813 | 4.06X | 233D | 8 | - | 871 | 3.50X | 243D | 8 | - | 928 | 3.05X | 253D | 8 | - | 985 | 254 | 989 |
| | | | | 1 | | | 244D | 33 | 1.2 | 1083 | | 314C | 33 | 1.2 | 1255 | | 344C | 33 | 1.2 | 1357 | | 364C | 33 | 1.2 | 1442 | 274 | |
| | 36 | 2# 8 | 2# 8 | 1 | 5# 7 | 3.12 | N/A | 15 | - | 414 | 2.66 | N/A | 14 | - | 445 | 2.29 | N/A | 14 | - | 477 | 2.00 | N/A | 14 | - | 509 | 188 | 817 |
| | | | | 1 | | | 483A | 58 | 1.9 | 916 | | 523A | 58 | 1.8 | 990 | | 563A | 57 | 1.8 | 1063 | | 603A | 57 | 1.8 | 1137 | 179 | |
| | | 2# 9 | 2# 9 | 1 | 5# 9 | 4.45* | 183D | 15 | - | 734 | 3.79* | 193D | 14 | - | 787 | 3.27* | 193D | 14 | - | 833 | 2.85* | N/A | 14 | - | 733 | 233 | 841 |
| | | | | 1 | | | 483A | 58 | 1.9 | 1099 | | 523A | 58 | 1.8 | 1186 | | 563A | 57 | 1.8 | 1273 | | 603A | 57 | 1.8 | 1361 | 285 | |
| | | 2#11 | 2#11 | 1 | 5#10 | 6.11* | 213D | 14 | - | 1014 | 5.20* | 223D | 14 | - | 1086 | 4.49X | 233D | 14 | - | 1159 | 3.91X | 243D | 14 | - | 1232 | 344 | 723 |
| | | | | 1 | | | 244D | 58 | 1.8 | 1346 | | 264D | 58 | 1.8 | 1452 | | 563A | 57 | 1.8 | 1569 | | 603A | 57 | 1.8 | 1676 | 351 | |
| | | 3#11 | 2#11 | 1 | 5#11 | 7.24* | 223D | 14 | - | 1244 | 6.17* | 233D | 14 | - | 1333 | 5.32X | 253D | 14 | - | 1429 | 4.63X | 263D | 14 | - | 1519 | 417 | 635 |
| | | | | 1 | | | 245D | 58 | 1.8 | 1872 | | 265D | 58 | 1.8 | 2020 | | 284D | 57 | 1.8 | 1813 | | 304D | 57 | 1.8 | 1936 | 417 | |
| | 48 | 3# 7 | 3# 7 | 1 | 6# 8 | 4.15 | N/A | 21 | - | 547 | 3.53 | N/A | 21 | - | 588 | 3.05 | N/A | 21 | - | 630 | 2.65 | N/A | 21 | - | 672 | 217 | 606 |
| | | | | 1 | | | ** | 84 | 5.4 | 547 | | ** | 83 | 0.0 | 588 | | ** | 83 | 0.0 | 630 | | ** | 82 | 0.0 | 672 | 280 | |
| | | 3# 9 | 3# 9 | 1 | 6# 9 | 6.02* | 183D | 21 | - | 967 | 5.13* | 193D | 21 | - | 1037 | 4.42* | 193D | 21 | - | 1099 | 3.85* | N/A | 21 | - | 997 | 346 | 632 |
| | | | | 1 | | | ** | 84 | 2.6 | 811 | | ** | 83 | 5.4 | 873 | | ** | 83 | 5.3 | 935 | | ** | 82 | 5.3 | 997 | 346 | |
| | | 3#10 | 3#10 | 1 | 6#11 | 8.16* | 213D | 21 | - | 1320 | 6.95* | 223D | 21 | - | 1414 | 6.00X | 233D | 21 | - | 1508 | 5.22X | 243D | 21 | - | 1603 | 427 | 539 |
| | | | | 1 | | | 294C | 84 | 2.5 | 1827 | | 314C | 83 | 2.4 | 1960 | | ** | 83 | 2.5 | 1310 | | ** | 82 | 2.5 | 1395 | 508 | |
| | | 3#11 | 3#11 | 1 | 7#11 | 9.71* | 224D | 21 | - | 1737 | 8.28X | 234D | 21 | - | 1857 | 7.14X | 253D | 21 | - | 1791 | 6.22X | 263D | 21 | - | 1903 | 508 | 485 |
| | | | | 1 | | | 245D | 84 | 2.4 | 2283 | | 315C | 83 | 2.4 | 2652 | | 344C | 83 | 2.4 | 2382 | | 364C | 82 | 2.4 | 2533 | 579 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

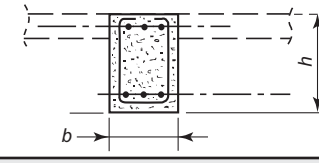
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

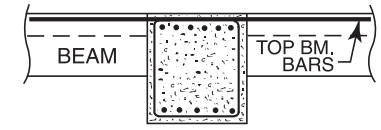
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 16 ft | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | SPAN, $\ell_n$ = 20 ft. | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 18.5 | 24 | 2# 8 | 1# 8 | 1 | 4# 7 | 6.40 | 113F | 11 | - | 302 | 5.06 | 113F | 11 | - | 327 | 4.10 | 123F | 10 | - | 359 | 3.39 | 123F | 10 | - | 384 | 161 | 902 |
| | | | | 1 | | | 124F | 43 | 1.5 | 442 | | 144F | 42 | 1.4 | 504 | | 243C | 41 | 1.4 | 494 | | 263C | 41 | 1.4 | 538 | 163 | |
| | | 2# 8 | 1# 8 | 1 | 4# 8 | 6.93 | 113F | 11 | - | 333 | 5.48 | 123F | 11 | - | 368 | 4.44 | 123F | 10 | - | 395 | 3.67 | 133F | 10 | - | 430 | 161 | 886 |
| | | | | 1 | | | 125F | 43 | 1.5 | 611 | | 144F | 42 | 1.4 | 537 | | 244C | 41 | 1.4 | 747 | | 263C | 41 | 1.4 | 577 | 210 | |
| | | 7# 5 | 6# 5 | 2 | 4#10 | 10.87 | 144E | 11 | - | 618 | 8.59 | 153E | 10 | - | 575 | 6.96 | 173E | 10 | - | 635 | 5.75* | 183E | 10 | - | 687 | 253 | 766 |
| | | | | 1 | | | 145E | 43 | 1.5 | 838 | | 165E | 42 | 1.4 | 943 | | 175E | 41 | 1.4 | 1018 | | 195E | 41 | 1.4 | 1124 | 319 | |
| | | 9# 5 | 8# 5 | 2 | 4#11 | 13.74 | 323A | 11 | - | 769 | 10.86 | 164E | 10 | - | 822 | 8.79* | 174E | 10 | - | 894 | 7.27* | 194E | 10 | - | 980 | 319 | 668 |
| | | | | 1 | | | 324A | 43 | 1.5 | 1124 | | 165E | 42 | 1.4 | 1074 | | 175E | 41 | 1.4 | 1162 | | 195E | 41 | 1.4 | 1279 | 379 | |
| | 36 | 2# 8 | 2# 8 | 1 | 5# 8 | 9.30 | 113F | 19 | - | 414 | 7.35 | 113F | 18 | - | 449 | 5.95 | 123F | 18 | - | 493 | 4.92 | 123F | 18 | - | 529 | 216 | 589 |
| | | | | 1 | | | 323A | 75 | 2.2 | 675 | | 363A | 74 | 2.2 | 754 | | 403A | 73 | 2.1 | 834 | | 443A | 72 | 2.1 | 913 | 267 | |
| | | 3# 8 | 2# 8 | 1 | 5# 9 | 11.48 | 113F | 19 | - | 504 | 9.07 | 123F | 18 | - | 558 | 7.35 | 133F | 18 | - | 611 | 6.07 | 133F | 18 | - | 656 | 267 | 597 |
| | | | | 1 | | | 165D | 75 | 2.2 | 968 | | 184D | 74 | 2.1 | 846 | | 403A | 73 | 2.1 | 944 | | 443A | 72 | 2.1 | 1033 | 330 | |
| | | 4# 8 | 4# 8 | 1 | 5#11 | 17.66 | 125F | 19 | - | 965 | 13.95 | 144F | 18 | - | 953 | 11.30 | 154F | 18 | - | 1040 | 9.34* | 164F | 18 | - | 1127 | 410 | 488 |
| | | | | 1 | | | 195C | 75 | 2.2 | 1318 | | 225C | 74 | 2.1 | 1493 | | 245C | 73 | 2.1 | 1633 | | 175F | 72 | 2.1 | 1462 | 487 | |
| | | 13# 5 | 12# 5 | 2 | 6#11 | 20.24 | 324A | 19 | - | 1308 | 15.99 | 165E | 18 | - | 1294 | 12.96 | 175E | 18 | - | 1405 | 10.71* | 194E | 18 | - | 1361 | 471 | 448 |
| | | | | 1 | | | 324A | 75 | 2.2 | 1487 | | 275B | 73 | 2.1 | 1822 | | 305B | 72 | 2.1 | 2012 | | 335B | 72 | 2.1 | 2202 | 568 | |
| | 48 | 3# 8 | 3# 8 | 1 | 6# 8 | 12.61 | 113F | 27 | - | 540 | 9.96 | 113F | 27 | - | 589 | 8.07 | 123F | 27 | - | 646 | 6.67 | 123F | 26 | - | 695 | 322 | 447 |
| | | | | 1 | | | ** | 110 | 5.4 | 439 | | ** | 108 | 0.0 | 488 | | ** | 106 | 0.0 | 537 | | ** | 105 | 0.0 | 585 | 322 | |
| | | 3# 8 | 3# 8 | 1 | 6#10 | 13.87 | 113F | 27 | - | 663 | 10.96 | 123F | 27 | - | 733 | 8.87 | 123F | 27 | - | 793 | 7.33 | 133F | 26 | - | 862 | 322 | 421 |
| | | | | 1 | | | 194C | 110 | 2.9 | 1031 | | ** | 108 | 5.4 | 623 | | ** | 106 | 5.3 | 683 | | ** | 105 | 5.3 | 743 | 495 | |
| | | 6# 8 | 5# 8 | 1 | 6#11 | 23.16 | 125F | 27 | - | 1193 | 18.30 | 145F | 27 | - | 1342 | 14.82 | 155F | 27 | - | 1463 | 12.25* | 164F | 26 | - | 1416 | 563 | 375 |
| | | | | 1 | | | 245B | 110 | 2.9 | 1802 | | 275B | 108 | 2.8 | 2013 | | 305B | 106 | 2.8 | 2224 | | 335B | 105 | 2.8 | 2435 | 592 | |
| | | 17# 5 | 16# 5 | 2 | 6#14 | 26.74 | 324A | 27 | - | 1686 | 21.13 | 165E | 27 | - | 1690 | 17.11 | 175E | 26 | - | 1836 | 14.14* | 195E | 26 | - | 2011 | 622 | 331 |
| | | | | 1 | | | 325A | 109 | 2.9 | 2384 | | 275B | 107 | 2.8 | 2305 | | 305B | 106 | 2.8 | 2542 | | 335B | 104 | 2.7 | 2778 | 800 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

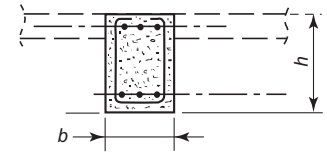
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

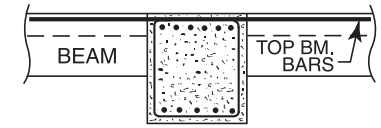
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 24 ft | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) $\times 10^{-9}$ |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft.-kips | sq. in. | lb. | ft.-kip | in. |
| 18.5 | 24 | 2# 8 | 1# 8 | 1 | 4# 7 | 2.85 | 123F | 10 | - | 409 | 2.43 | 123F | 10 | - | 434 | 2.09 | 123F | 10 | - | 459 | 1.82 | 123F | 10 | - | 483 | 161 | 902 |
| | | | | 1 | | | 293C | 41 | 1.4 | 590 | | 313C | 40 | 1.4 | 634 | | 343C | 40 | 1.4 | 686 | | 363C | 40 | 1.4 | 729 | 163 | |
| | | 2# 9 | 1# 9 | 1 | 4# 8 | 3.66 | 163E | 10 | - | 532 | 3.12* | 173E | 10 | - | 571 | 2.69* | 173E | 10 | - | 603 | 2.34* | 183E | 10 | - | 642 | 200 | 902 |
| | | | | 1 | | | 294C | 41 | 1.4 | 946 | | 313C | 40 | 1.4 | 735 | | 343C | 40 | 1.4 | 795 | | 363C | 40 | 1.4 | 845 | 210 | |
| | | 2#11 | 1#11 | 1 | 4#10 | 5.56* | 193E | 10 | - | 803 | 4.73* | 203E | 10 | - | 861 | 4.08* | 213E | 10 | - | 918 | 3.56* | 223E | 10 | - | 976 | 296 | 722 |
| | | | | 1 | | | 215E | 41 | 1.4 | 1291 | | 224E | 40 | 1.4 | 1119 | | 244E | 40 | 1.4 | 1206 | | 264E | 40 | 1.4 | 1293 | 319 | |
| | | 2#11 | 2#11 | 1 | 4#11 | 6.58* | 204E | 10 | - | 1133 | 5.61* | 213E | 10 | - | 1068 | 4.84* | 223E | 10 | - | 1139 | 4.21X | 233E | 10 | - | 1211 | 379 | 617 |
| | | | | 1 | | | 215E | 41 | 1.4 | 1477 | | 225E | 40 | 1.4 | 1571 | | 245E | 40 | 1.4 | 1696 | | 265E | 40 | 1.4 | 1820 | 379 | |
| | 36 | 2# 8 | 2# 8 | 1 | 5# 8 | 4.13 | 123F | 18 | - | 564 | 3.52 | 123F | 18 | - | 600 | 3.04 | 123F | 18 | - | 635 | 2.65 | 123F | 17 | - | 671 | 216 | 589 |
| | | | | 1 | | | 483A | 71 | 2.1 | 993 | | 523A | 71 | 2.1 | 1072 | | 563A | 70 | 2.0 | 1152 | | 603A | 70 | 2.0 | 1231 | 267 | |
| | | 2#10 | 2#10 | 1 | 5# 9 | 5.75 | 173E | 18 | - | 819 | 4.90* | 173E | 18 | - | 871 | 4.22* | 183E | 18 | - | 932 | 3.68* | 183E | 17 | - | 984 | 334 | 581 |
| | | | | 1 | | | 483A | 71 | 2.1 | 1207 | | 523A | 71 | 2.1 | 1303 | | 563A | 70 | 2.0 | 1399 | | 603A | 70 | 2.0 | 1495 | 330 | |
| | | 2#11 | 2#11 | 1 | 5#11 | 7.65* | 193E | 18 | - | 1097 | 6.52* | 203E | 18 | - | 1176 | 5.62* | 213E | 18 | - | 1255 | 4.90* | 213E | 17 | - | 1326 | 400 | 495 |
| | | | | 1 | | | 245D | 71 | 2.1 | 1773 | | 264D | 71 | 2.0 | 1571 | | 284D | 70 | 2.0 | 1685 | | 304D | 70 | 2.0 | 1798 | 487 | |
| | | 3#11 | 2#11 | 1 | 6#11 | 9.31* | 204E | 18 | - | 1482 | 7.93* | 214E | 18 | - | 1585 | 6.84* | 224E | 18 | - | 1688 | 5.96X | 233E | 17 | - | 1615 | 487 | 436 |
| | | | | 1 | | | 215E | 71 | 2.0 | 1891 | | 225E | 71 | 2.0 | 2014 | | 285D | 70 | 2.0 | 2309 | | 305D | 70 | 2.0 | 2466 | 568 | |
| | 48 | 3# 8 | 3# 8 | 1 | 6# 8 | 5.60 | N/A | 26 | - | 634 | 4.77 | N/A | 26 | - | 683 | 4.12 | N/A | 26 | - | 732 | 3.59 | N/A | 25 | - | 780 | 322 | 447 |
| | | | | 1 | | | ** | 104 | 5.4 | 634 | | ** | 103 | 0.0 | 683 | | ** | 102 | 0.0 | 732 | | ** | 102 | 0.0 | 780 | 322 | |
| | | 3# 9 | 3# 9 | 1 | 6#10 | 7.65 | 173E | 26 | - | 1061 | 6.52* | 173E | 26 | - | 1129 | 5.62* | 183E | 26 | - | 1207 | 4.89* | 183E | 25 | - | 1275 | 400 | 433 |
| | | | | 1 | | | ** | 104 | 2.9 | 905 | | ** | 103 | 5.4 | 974 | | ** | 102 | 5.3 | 1042 | | ** | 102 | 5.3 | 1110 | 495 | |
| | | 3#11 | 3#11 | 1 | 6#11 | 10.29* | 194E | 26 | - | 1615 | 8.77* | 204E | 26 | - | 1729 | 7.56* | 213E | 26 | - | 1665 | 6.59* | 213E | 25 | - | 1762 | 592 | 371 |
| | | | | 1 | | | 215E | 104 | 2.7 | 2108 | | 314C | 103 | 2.7 | 2140 | | 344C | 102 | 2.7 | 2311 | | 364C | 101 | 2.7 | 2458 | 592 | |
| | | 4#11 | 3#11 | 1 | 6#14 | 12.94* | 205E | 26 | - | 2229 | 11.02* | 214E | 26 | - | 2161 | 9.51* | 224E | 26 | - | 2302 | 8.28X | 234E | 25 | - | 2444 | 677 | 317 |
| | | | | 1 | | | 365B | 104 | 2.7 | 3087 | | 395B | 103 | 2.7 | 3329 | | 425B | 102 | 2.7 | 3571 | | 265E | 101 | 2.7 | 3064 | 800 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

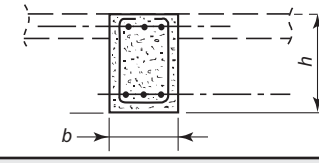
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

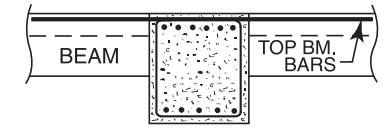
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 20.5 | 24 | 2# 8 | 1# 8 | 1 | 4# 7 | 4.64 | 113G | 12 | - | 357 | 3.83 | 113G | 12 | - | 382 | 3.22 | 113G | 12 | - | 407 | 2.74 | 113G | 12 | - | 432 | 182 | 633 |
| | | | | 1 | | | 144G | 49 | 1.6 | 541 | | 154G | 49 | 1.6 | 585 | | 293C | 48 | 1.6 | 605 | | 313C | 48 | 1.5 | 649 | 185 | |
| | | 2#10 | 1#10 | 1 | 4# 9 | 7.41 | 143F | 12 | - | 558 | 6.12 | 153F | 12 | - | 606 | 5.15 | 163F | 12 | - | 654 | 4.38* | 173F | 12 | - | 703 | 282 | 615 |
| | | | | 1 | | | 155F | 49 | 1.6 | 918 | | 175F | 49 | 1.6 | 1020 | | 185F | 48 | 1.5 | 1092 | | 205F | 48 | 1.5 | 1195 | 296 | |
| | | 2#10 | 2#10 | 1 | 4#11 | 10.06 | 154F | 12 | - | 868 | 8.31 | 174F | 12 | - | 955 | 6.98* | 184F | 12 | - | 1027 | 5.95* | 193F | 12 | - | 961 | 365 | 498 |
| | | | | 1 | | | 155F | 49 | 1.6 | 1112 | | 175F | 49 | 1.6 | 1231 | | 185F | 48 | 1.5 | 1319 | | 205F | 48 | 1.5 | 1438 | 435 | |
| | | 3#10 | 2#10 | 1 | 5#11 | 12.20 | 303B | 12 | - | 1042 | 10.09 | 174F | 12 | - | 1138 | 8.48* | 184F | 12 | - | 1224 | 7.22* | 194F | 12 | - | 1311 | 443 | 430 |
| | | | | 1 | | | 304B | 49 | 1.6 | 1387 | | 265C | 49 | 1.6 | 1693 | | 295C | 48 | 1.5 | 1859 | | 205F | 48 | 1.5 | 1650 | 519 | |
| | 36 | 2# 9 | 2# 9 | 1 | 5# 8 | 7.57 | 123F | 22 | - | 556 | 6.25 | 133F | 22 | - | 606 | 5.26 | 133F | 21 | - | 647 | 4.48 | 133F | 21 | - | 688 | 305 | 435 |
| | | | | 1 | | | 403A | 88 | 2.4 | 911 | | 443A | 86 | 2.3 | 998 | | 483A | 85 | 2.3 | 1085 | | 523A | 85 | 2.3 | 1172 | 302 | |
| | | 2#10 | 2#10 | 1 | 5#10 | 10.45 | 143F | 22 | - | 766 | 8.63 | 153F | 22 | - | 832 | 7.26 | 163F | 21 | - | 898 | 6.18 | 163F | 21 | - | 955 | 379 | 413 |
| | | | | 1 | | | 155F | 88 | 2.3 | 1184 | | 225D | 86 | 2.3 | 1494 | | 244D | 85 | 2.3 | 1296 | | 264D | 85 | 2.3 | 1398 | 466 | |
| | | 3#10 | 3#10 | 1 | 5#11 | 13.94 | 154F | 22 | - | 1141 | 11.52 | 164F | 22 | - | 1237 | 9.68* | 174F | 21 | - | 1333 | 8.25* | 184F | 21 | - | 1429 | 548 | 352 |
| | | | | 1 | | | 245C | 88 | 2.3 | 1753 | | 265C | 86 | 2.3 | 1905 | | 295C | 85 | 2.3 | 2092 | | 205F | 85 | 2.3 | 1848 | 557 | |
| | | 4#10 | 3#10 | 1 | 5#14 | 17.26 | 155F | 22 | - | 1566 | 14.26 | 175F | 22 | - | 1721 | 11.98* | 185F | 21 | - | 1850 | 10.21* | 194F | 21 | - | 1788 | 627 | 299 |
| | | | | 1 | | | 245C | 88 | 2.3 | 2028 | | 265C | 86 | 2.3 | 2202 | | 295C | 85 | 2.3 | 2411 | | 315C | 85 | 2.3 | 2585 | 754 | |
| | 48 | 3# 8 | 3# 8 | 1 | 6# 9 | 10.05 | 113G | 32 | - | 708 | 8.30 | 123G | 32 | - | 771 | 6.98 | 123G | 31 | - | 825 | 5.95 | N/A | 31 | - | 763 | 365 | 323 |
| | | | | 1 | | | ** | 129 | 5.4 | 601 | | ** | 127 | 0.0 | 655 | | ** | 125 | 0.0 | 709 | | ** | 124 | 0.0 | 763 | 454 | |
| | | 3#10 | 3#10 | 1 | 6#10 | 14.11 | 144F | 32 | - | 1134 | 11.66 | 154F | 32 | - | 1231 | 9.80 | 163F | 31 | - | 1186 | 8.35 | 163F | 31 | - | 1264 | 564 | 310 |
| | | | | 1 | | | 175E | 128 | 3.1 | 1569 | | 195E | 127 | 3.1 | 1729 | | 294C | 125 | 3.0 | 1773 | | 314C | 124 | 3.0 | 1902 | 564 | |
| | | 4#10 | 4#10 | 1 | 7#11 | 19.40 | 155F | 32 | - | 1656 | 16.03 | 165F | 32 | - | 1793 | 13.47* | 175F | 31 | - | 1931 | 11.48* | 184F | 31 | - | 1870 | 731 | 260 |
| | | | | 1 | | | 305B | 128 | 3.1 | 2438 | | 335B | 127 | 3.1 | 2668 | | 365B | 125 | 3.0 | 2899 | | 395B | 124 | 3.0 | 3129 | 775 | |
| | | 5#10 | 4#10 | 1 | 6#14 | 22.30 | 175CfF | 32 | - | 1949 | 18.43 | 175F | 32 | - | 2076 | 15.48* | 185F | 31 | - | 2232 | 13.19* | 195F | 31 | - | 2388 | 810 | 236 |
| | | | | 1 | | | 305B | 128 | 3.1 | 2672 | | 335B | 127 | 3.1 | 2921 | | 365B | 125 | 3.0 | 3171 | | 395B | 124 | 3.0 | 3420 | 921 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

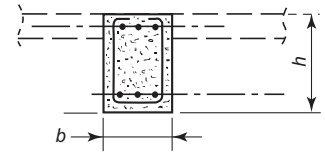
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

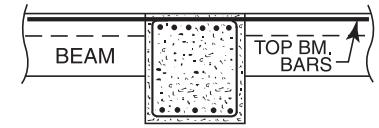
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 28 ft | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 20.5 | 24 | 2# 8 | 1# 8 | 1 | 4# 7 | 2.37 | 113G | 12 | - | 457 | 2.06 | 113G | 12 | - | 482 | 1.81 | 113G | 12 | - | 507 | 1.61 | 103G | 12 | - | 524 | 182 | 633 |
| | | | | 1 | | | 343C | 47 | 1.5 | 703 | | 363C | 47 | 1.5 | 747 | | 383C | 47 | 1.5 | 792 | | 413C | 47 | 1.5 | 846 | 185 | |
| | | 2#10 | 1#10 | 1 | 4# 9 | 3.78* | 173F | 12 | - | 743 | 3.29* | 183F | 12 | - | 792 | 2.89* | 183F | 12 | - | 832 | 2.56* | 193F | 12 | - | 880 | 282 | 615 |
| | | | | 1 | | | 214F | 47 | 1.5 | 1015 | | 234F | 47 | 1.5 | 1094 | | 383C | 47 | 1.5 | 1064 | | 413C | 47 | 1.5 | 1133 | 296 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 4.75* | 193F | 12 | - | 995 | 4.14* | 203F | 12 | - | 1058 | 3.64* | 203F | 12 | - | 1113 | 3.22* | 213F | 12 | - | 1176 | 338 | 510 |
| | | | | 1 | | | 215F | 47 | 1.5 | 1503 | | 235F | 47 | 1.5 | 1620 | | 245F | 47 | 1.5 | 1707 | | 264F | 47 | 1.5 | 1513 | 435 | |
| | | 2#14 | 1#14 | 1 | 5#11 | 6.47* | 214F | 12 | - | 1458 | 5.63* | 224F | 12 | - | 1548 | 4.95* | 233F | 12 | - | 1471 | 4.39X | 243F | 12 | - | 1554 | 460 | 427 |
| | | | | 1 | | | 215F | 47 | 1.5 | 1799 | | 235F | 47 | 1.5 | 1936 | | 245F | 47 | 1.5 | 2042 | | 265F | 47 | 1.5 | 2179 | 519 | |
| | 36 | 2# 9 | 2# 9 | 1 | 5# 8 | 3.86 | 143F | 21 | - | 737 | 3.36 | 133F | 21 | - | 770 | 2.96 | 133F | 21 | - | 811 | 2.62 | 133F | 21 | - | 852 | 305 | 435 |
| | | | | 1 | | | 563A | 84 | 2.3 | 1259 | | 603A | 83 | 2.2 | 1346 | | 643A | 83 | 2.2 | 1433 | | 683A | 83 | 2.2 | 1519 | 302 | |
| | | 2#10 | 2#10 | 1 | 5#10 | 5.33* | 173F | 21 | - | 1021 | 4.64* | 173F | 21 | - | 1078 | 4.08* | 183F | 21 | - | 1144 | 3.62* | 183F | 21 | - | 1202 | 379 | 413 |
| | | | | 1 | | | 563A | 84 | 2.3 | 1516 | | 603A | 83 | 2.2 | 1620 | | 643A | 83 | 2.2 | 1723 | | 683A | 82 | 2.2 | 1826 | 466 | |
| | | 3#11 | 2#11 | 1 | 5#11 | 7.11* | 193F | 21 | - | 1403 | 6.19* | 203F | 21 | - | 1493 | 5.44* | 203F | 21 | - | 1574 | 4.82* | 213F | 21 | - | 1664 | 557 | 351 |
| | | | | 1 | | | 215F | 84 | 2.2 | 1994 | | 304D | 83 | 2.2 | 1991 | | 324D | 83 | 2.2 | 2117 | | 344D | 82 | 2.2 | 2243 | 557 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 8.78* | 204F | 21 | - | 1910 | 7.65* | 214F | 21 | - | 2029 | 6.72* | 224F | 21 | - | 2148 | 5.95X | 234F | 21 | - | 2267 | 625 | 302 |
| | | | | 1 | | | 345C | 84 | 2.2 | 2799 | | 365C | 83 | 2.2 | 2973 | | 245F | 83 | 2.2 | 2643 | | 265F | 82 | 2.2 | 2817 | 754 | |
| | 48 | 3# 8 | 3# 8 | 1 | 6# 9 | 5.13 | N/A | 31 | - | 817 | 4.47 | N/A | 31 | - | 871 | 3.92 | N/A | 30 | - | 924 | 3.48 | N/A | 30 | - | 978 | 365 | 323 |
| | | | | 1 | | | ** | 123 | 5.4 | 817 | | ** | 122 | 0.0 | 871 | | ** | 122 | 0.0 | 924 | | ** | 121 | 0.0 | 978 | 454 | |
| | | 3#10 | 3#10 | 1 | 6#10 | 7.20* | 173F | 31 | - | 1352 | 6.27* | 173F | 31 | - | 1431 | 5.51* | 183F | 30 | - | 1519 | 4.88* | 183F | 30 | - | 1598 | 564 | 310 |
| | | | | 1 | | | ** | 123 | 3.1 | 1188 | | ** | 122 | 3.1 | 1267 | | ** | 122 | 3.0 | 1345 | | ** | 121 | 3.0 | 1424 | 564 | |
| | | 3#11 | 3#11 | 1 | 7#11 | 9.50* | 194F | 31 | - | 1928 | 8.28* | 204F | 31 | - | 2050 | 7.27* | 203F | 30 | - | 1975 | 6.44* | 213F | 30 | - | 2087 | 677 | 268 |
| | | | | 1 | | | 245E | 123 | 3.0 | 2556 | | 364C | 122 | 3.0 | 2599 | | 384C | 122 | 3.0 | 2753 | | 414C | 121 | 2.9 | 2933 | 775 | |
| | | 3#14 | 3#14 | 1 | 6#14 | 11.76* | 205F | 31 | - | 2730 | 10.24* | 215F | 31 | - | 2899 | 9.00* | 224F | 30 | - | 2826 | 7.97X | 234F | 30 | - | 2985 | 921 | 226 |
| | | | | 1 | | | 425B | 123 | 3.0 | 3854 | | 455B | 122 | 3.0 | 4116 | | 485B | 121 | 2.9 | 4379 | | 295E | 121 | 2.9 | 3742 | 921 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

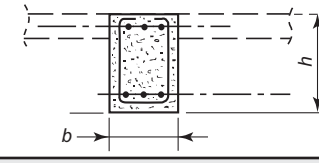
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

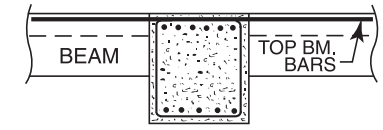
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 24.5 | 24 | 2# 9 | 1# 9 | 1 | 4# 8 | 7.41 | 113H | 17 | - | 449 | 6.12 | 123H | 16 | - | 489 | 5.14 | 123H | 16 | - | 521 | 4.38 | 123H | 16 | - | 553 | 281 | 383 |
| | | | | 1 | | | 125H | 67 | 1.9 | 760 | | 135H | 66 | 1.9 | 826 | | 155H | 65 | 1.9 | 926 | | 165H | 64 | 1.9 | 992 | 296 | |
| | | 2#10 | 1#10 | 1 | 4#10 | 9.65 | 124H | 17 | - | 706 | 7.97 | 133H | 16 | - | 663 | 6.70 | 133H | 16 | - | 707 | 5.71 | 143H | 16 | - | 761 | 350 | 350 |
| | | | | 1 | | | 175E | 67 | 1.9 | 1082 | | 135H | 66 | 1.9 | 991 | | 155H | 65 | 1.9 | 1103 | | 165H | 64 | 1.9 | 1182 | 457 | |
| | | 3#10 | 2#10 | 1 | 4#11 | 13.69 | 125H | 17 | - | 1056 | 11.31 | 134H | 16 | - | 1018 | 9.51 | 154H | 16 | - | 1118 | 8.10 | 164H | 16 | - | 1200 | 558 | 289 |
| | | | | 1 | | | 175E | 67 | 1.9 | 1311 | | 195E | 66 | 1.9 | 1445 | | 215E | 65 | 1.9 | 1578 | | 225E | 64 | 1.8 | 1678 | 547 | |
| | | 8# 6 | 8# 6 | 2 | 4#14 | 16.26 | 244C | 17 | - | 1327 | 13.44 | 264C | 16 | - | 1441 | 11.29 | 155H | 16 | - | 1488 | 9.62 | 165H | 16 | - | 1596 | 591 | 256 |
| | | | | 1 | | | 245C | 67 | 1.9 | 1739 | | 265C | 66 | 1.9 | 1887 | | 215E | 65 | 1.9 | 1799 | | 225E | 64 | 1.8 | 1913 | 742 | |
| | 36 | 2#10 | 2#10 | 1 | 5# 9 | 11.65 | 113H | 30 | - | 683 | 9.63 | 123H | 30 | - | 744 | 8.09 | 123H | 29 | - | 797 | 6.89 | 133H | 29 | - | 858 | 471 | 252 |
| | | | | 1 | | | 175E | 121 | 2.8 | 1236 | | 195E | 119 | 2.8 | 1365 | | 155H | 117 | 2.8 | 1262 | | 165H | 116 | 2.7 | 1353 | 465 | |
| | | 2#10 | 2#10 | 1 | 5#11 | 12.96 | 124H | 30 | - | 945 | 10.71 | 123H | 30 | - | 901 | 9.00 | 133H | 29 | - | 974 | 7.67 | 133H | 29 | - | 1037 | 471 | 232 |
| | | | | 1 | | | 175E | 121 | 2.8 | 1381 | | 195E | 119 | 2.8 | 1522 | | 215E | 117 | 2.8 | 1663 | | 225E | 116 | 2.7 | 1765 | 697 | |
| | | 4#10 | 3#10 | 1 | 5#14 | 21.66 | 135EdH | 30 | - | 1549 | 17.90 | 135H | 30 | - | 1650 | 15.04 | 155H | 29 | - | 1811 | 12.82 | 165H | 29 | - | 1942 | 787 | 187 |
| | | | | 1 | | | 245C | 121 | 2.8 | 2095 | | 265C | 119 | 2.8 | 2274 | | 245D | 117 | 2.8 | 2298 | | 265D | 116 | 2.7 | 2477 | 956 | |
| | | 5#10 | 4#10 | 1 | 6#14 | 26.96 | 245C | 30 | - | 2156 | 22.28 | 265C | 30 | - | 2342 | 18.73 | 294C | 29 | - | 2239 | 15.96 | 175EeH | 29 | - | 2329 | 980 | 162 |
| | | | | 1 | | | 405A | 121 | 2.8 | 2997 | | 445A | 119 | 2.8 | 3279 | | 485A | 117 | 2.8 | 3561 | | 315C | 116 | 2.7 | 3028 | 1114 | |
| | 48 | 3# 9 | 3# 9 | 1 | 6#10 | 15.47 | 114H | 45 | - | 993 | 12.78 | 123H | 44 | - | 965 | 10.74 | 123H | 43 | - | 1033 | 9.15 | 133H | 43 | - | 1112 | 562 | 187 |
| | | | | 1 | | | 175E | 179 | 3.8 | 1510 | | 264C | 176 | 3.7 | 1549 | | 294C | 174 | 3.7 | 1700 | | ** | 172 | 0.0 | 974 | 701 | |
| | | 3#10 | 3#10 | 1 | 6#11 | 19.30 | 125H | 45 | - | 1355 | 15.95 | 134H | 44 | - | 1318 | 13.40 | 134H | 43 | - | 1404 | 11.42 | 144H | 43 | - | 1510 | 701 | 181 |
| | | | | 1 | | | 305B | 179 | 3.8 | 2276 | | 335B | 176 | 3.7 | 2493 | | 215E | 174 | 3.7 | 2055 | | 225E | 172 | 3.6 | 2184 | 845 | |
| | | 5#10 | 4#10 | 1 | 6#14 | 27.96 | 145EfH | 45 | - | 1899 | 23.10 | 155EeH | 44 | - | 2058 | 19.41 | 165EdH | 43 | - | 2217 | 16.54 | 165H | 43 | - | 2344 | 1016 | 147 |
| | | | | 1 | | | 305B | 179 | 3.8 | 2756 | | 335B | 176 | 3.7 | 3013 | | 365B | 174 | 3.7 | 3271 | | 395B | 172 | 3.6 | 3528 | 1164 | |
| | | 6#10 | 5#10 | 1 | 7#14 | 33.24 | 245C | 45 | - | 2505 | 27.47 | 175DiH | 44 | - | 2430 | 23.08 | 185DiH | 43 | - | 2614 | 19.67 | 185EgH | 43 | - | 2766 | 1213 | 131 |
| | | | | 1 | | | 405A | 179 | 3.8 | 3474 | | 445A | 176 | 3.7 | 3800 | | 365B | 174 | 3.7 | 3603 | | 395B | 172 | 3.6 | 3886 | 1329 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

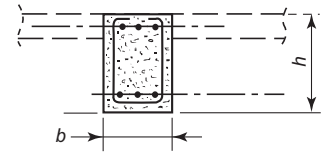
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

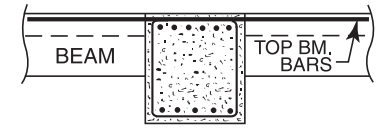
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 28 ft | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 24.5 | 24 | 2# 9 | 1# 9 | 1 | 4# 8 | 3.78 | 133H | 16 | - | 594 | 3.29 | 133H | 16 | - | 626 | 2.89 | 133H | 16 | - | 658 | 2.56 | 133H | 16 | - | 690 | 281 | 383 |
| | | | | 1 | | | 175H | 64 | 1.8 | 1058 | | 185H | 63 | 1.8 | 1124 | | 195H | 63 | 1.8 | 1190 | | 214H | 62 | 1.8 | 1018 | 296 | |
| | | 2#11 | 1#11 | 1 | 4#10 | 5.83 | 163H | 16 | - | 907 | 5.08* | 163H | 16 | - | 957 | 4.46* | 173H | 16 | - | 1017 | 3.95* | 173H | 16 | - | 1067 | 422 | 340 |
| | | | | 1 | | | 175H | 64 | 1.8 | 1345 | | 185H | 63 | 1.8 | 1429 | | 195H | 63 | 1.8 | 1514 | | 215H | 62 | 1.8 | 1632 | 457 | |
| | | 2#14 | 1#14 | 1 | 4#11 | 6.98 | 164H | 16 | - | 1311 | 6.08* | 174H | 16 | - | 1397 | 5.35* | 183H | 16 | - | 1336 | 4.74* | 193H | 16 | - | 1414 | 582 | 286 |
| | | | | 1 | | | 245E | 63 | 1.8 | 1857 | | 265E | 63 | 1.8 | 1993 | | 195H | 62 | 1.8 | 1825 | | 215H | 62 | 1.8 | 1961 | 547 | |
| | | 3#11 | 2#11 | 1 | 4#14 | 9.32* | 175H | 16 | - | 1782 | 8.12* | 184H | 16 | - | 1715 | 7.14* | 194H | 16 | - | 1818 | 6.32* | 204H | 16 | - | 1921 | 664 | 242 |
| | | | | 1 | | | 245E | 64 | 1.8 | 2141 | | 265E | 63 | 1.8 | 2295 | | 285E | 63 | 1.8 | 2449 | | 295E | 62 | 1.8 | 2569 | 742 | |
| | 36 | 2#10 | 2#10 | 1 | 5# 9 | 5.94 | 133H | 29 | - | 910 | 5.18 | 133H | 28 | - | 963 | 4.55 | 143H | 28 | - | 1024 | 4.03 | 143H | 28 | - | 1076 | 471 | 252 |
| | | | | 1 | | | 563A | 115 | 2.7 | 1483 | | 603A | 114 | 2.7 | 1585 | | 643A | 113 | 2.7 | 1687 | | 683A | 112 | 2.7 | 1789 | 465 | |
| | | 2#11 | 2#11 | 1 | 5#11 | 7.98 | 153H | 29 | - | 1229 | 6.96 | 163H | 28 | - | 1309 | 6.11 | 163H | 28 | - | 1380 | 5.41* | 173H | 28 | - | 1461 | 569 | 230 |
| | | | | 1 | | | 245E | 115 | 2.7 | 2015 | | 265E | 114 | 2.7 | 2163 | | 195H | 113 | 2.7 | 1962 | | 215H | 112 | 2.6 | 2111 | 697 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 11.05 | 175H | 29 | - | 2078 | 9.63* | 174H | 28 | - | 1993 | 8.46* | 184H | 28 | - | 2114 | 7.49* | 194H | 28 | - | 2234 | 787 | 188 |
| | | | | 1 | | | 285D | 114 | 2.7 | 2661 | | 265E | 114 | 2.7 | 2685 | | 285E | 113 | 2.6 | 2865 | | 295E | 112 | 2.6 | 3006 | 956 | |
| | | 3#14 | 2#14 | 1 | 6#14 | 13.42* | 175H | 29 | - | 2450 | 11.69* | 185H | 28 | - | 2605 | 10.28* | 195H | 28 | - | 2761 | 9.10* | 205H | 28 | - | 2917 | 956 | 164 |
| | | | | 1 | | | 345C | 114 | 2.7 | 3265 | | 305D | 114 | 2.7 | 3236 | | 325D | 113 | 2.6 | 3440 | | 345D | 112 | 2.6 | 3644 | 1114 | |
| | 48 | 3# 9 | 3# 9 | 1 | 6#10 | 7.89 | 133H | 43 | - | 1181 | 6.87 | 133H | 42 | - | 1249 | 6.04 | 133H | 42 | - | 1317 | 5.35 | 143H | 42 | - | 1396 | 562 | 187 |
| | | | | 1 | | | ** | 170 | 3.8 | 1042 | | ** | 169 | 3.7 | 1110 | | ** | 167 | 3.7 | 1179 | | ** | 166 | 0.0 | 1247 | 701 | |
| | | 3#11 | 3#11 | 1 | 6#11 | 10.78 | 154H | 42 | - | 1779 | 9.39 | 164H | 42 | - | 1897 | 8.26* | 163H | 42 | - | 1838 | 7.31* | 173H | 42 | - | 1945 | 845 | 173 |
| | | | | 1 | | | 245E | 170 | 3.6 | 2520 | | 364C | 169 | 3.6 | 2557 | | 384C | 167 | 3.5 | 2709 | | 414C | 166 | 3.5 | 2888 | 845 | |
| | | 3#14 | 3#14 | 1 | 6#14 | 14.86 | 175H | 42 | - | 2688 | 12.94* | 175H | 42 | - | 2828 | 11.37* | 185H | 42 | - | 3000 | 10.08* | 195H | 42 | - | 3172 | 1164 | 140 |
| | | | | 1 | | | 425B | 170 | 3.6 | 3971 | | 455B | 168 | 3.5 | 4242 | | 485B | 167 | 3.5 | 4512 | | 515B | 166 | 3.5 | 4783 | 1164 | |
| | | 4#14 | 3#14 | 1 | 7#14 | 16.96* | 195EfH | 42 | - | 3125 | 14.77* | 195EdH | 42 | - | 3288 | 12.98* | 195H | 42 | - | 3452 | 11.50* | 205H | 42 | - | 3648 | 1329 | 127 |
| | | | | 1 | | | 425B | 170 | 3.6 | 4343 | | 455B | 168 | 3.5 | 4638 | | 485B | 167 | 3.5 | 4932 | | 515B | 166 | 3.5 | 5227 | 1329 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

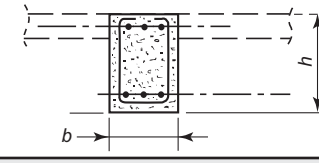
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

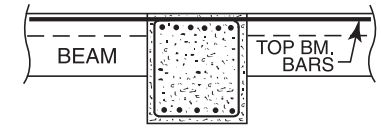
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 22 ft | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 28.5 | 24 | 2#10 | 1#10 | 1 | 4# 9 | 9.10 | 113J | 21 | - | 598 | 7.65 | 113J | 21 | - | 638 | 6.51 | 123J | 21 | - | 689 | 5.62 | 123J | 20 | - | 729 | 419 | 240 |
| | | | | 1 | | | 175F | 85 | 2.3 | 1115 | | 185F | 83 | 2.2 | 1192 | | 145I | 82 | 2.2 | 1086 | | 165I | 81 | 2.2 | 1200 | 440 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 11.52 | 114J | 21 | - | 888 | 9.68 | 124J | 21 | - | 962 | 8.25 | 134J | 21 | - | 1035 | 7.11 | 133J | 20 | - | 975 | 507 | 211 |
| | | | | 1 | | | 175F | 85 | 2.3 | 1307 | | 185F | 83 | 2.2 | 1399 | | 205F | 82 | 2.2 | 1528 | | 215F | 81 | 2.2 | 1620 | 659 | |
| | | 3#11 | 2#11 | 1 | 4#14 | 18.29 | 224D | 21 | - | 1478 | 15.37 | 244D | 21 | - | 1601 | 13.10 | 135J | 21 | - | 1625 | 11.29 | 145J | 20 | - | 1741 | 804 | 163 |
| | | | | 1 | | | 445A | 85 | 2.3 | 2683 | | 245D | 83 | 2.2 | 2035 | | 265D | 82 | 2.2 | 2195 | | 245E | 81 | 2.2 | 2208 | 904 | |
| | | 10# 6 | 9# 6 | 2 | 5#14 | 19.00 | 224D | 21 | - | 1637 | 15.97 | 244D | 21 | - | 1772 | 13.60 | 264D | 21 | - | 1908 | 11.73 | 145J | 20 | - | 1937 | 836 | 150 |
| | | | | 1 | | | 445A | 85 | 2.2 | 2842 | | 245D | 83 | 2.2 | 2207 | | 265D | 82 | 2.2 | 2378 | | 285D | 81 | 2.1 | 2550 | 1079 | |
| | 36 | 2#10 | 2#10 | 1 | 5#10 | 12.79 | 114J | 39 | - | 926 | 10.75 | 113J | 38 | - | 877 | 9.16 | 113J | 38 | - | 934 | 7.90 | 123J | 37 | - | 1002 | 562 | 157 |
| | | | | 1 | | | 195E | 156 | 3.3 | 1491 | | 215E | 153 | 3.3 | 1632 | | 225E | 151 | 3.2 | 1731 | | 245E | 149 | 3.2 | 1871 | 694 | |
| | | 2#11 | 2#11 | 1 | 5#11 | 15.49 | 114J | 39 | - | 1096 | 13.01 | 124J | 38 | - | 1187 | 11.09 | 124J | 38 | - | 1258 | 9.56 | 134J | 37 | - | 1350 | 681 | 152 |
| | | | | 1 | | | 195E | 155 | 3.3 | 1661 | | 215E | 153 | 3.3 | 1815 | | 225E | 151 | 3.2 | 1927 | | 245E | 149 | 3.2 | 2081 | 838 | |
| | | 4#11 | 3#11 | 1 | 5#14 | 23.95 | 135FfJ | 39 | - | 1839 | 20.12 | 145GeJ | 38 | - | 1987 | 17.15 | 145GdJ | 38 | - | 2102 | 14.78 | 145J | 37 | - | 2217 | 1136 | 118 |
| | | | | 1 | | | 335B | 155 | 3.3 | 2790 | | 295C | 153 | 3.3 | 2739 | | 315C | 151 | 3.2 | 2937 | | 345C | 149 | 3.2 | 3177 | 1159 | |
| | | 4#11 | 4#11 | 1 | 7#14 | 29.02 | 225D | 39 | - | 2482 | 24.38 | 245D | 38 | - | 2688 | 20.78 | 265D | 38 | - | 2895 | 17.92 | 175FgJ | 37 | - | 2746 | 1276 | 101 |
| | | | | 1 | | | 445A | 155 | 3.3 | 3598 | | 485A | 153 | 3.3 | 3907 | | 525A | 151 | 3.2 | 4215 | | 345C | 149 | 3.2 | 3609 | 1544 | |
| | 48 | 3#10 | 3#10 | 1 | 6#10 | 17.33 | 114J | 58 | - | 1197 | 14.56 | 114J | 57 | - | 1276 | 12.41 | 124J | 56 | - | 1377 | 10.70 | 124J | 56 | - | 1455 | 838 | 119 |
| | | | | 1 | | | 335B | 233 | 4.4 | 2484 | | 215E | 229 | 4.3 | 2006 | | 314C | 226 | 4.3 | 2016 | | 344C | 223 | 4.2 | 2182 | 838 | |
| | | 3#11 | 3#11 | 1 | 6#11 | 20.95 | 115J | 58 | - | 1569 | 17.60 | 125J | 57 | - | 1701 | 15.00 | 124J | 56 | - | 1643 | 12.93 | 134J | 56 | - | 1762 | 1014 | 114 |
| | | | | 1 | | | 335B | 233 | 4.4 | 2714 | | 365B | 229 | 4.3 | 2950 | | 395B | 226 | 4.3 | 3186 | | 245E | 223 | 4.2 | 2587 | 1014 | |
| | | 5#11 | 4#11 | 1 | 7#14 | 33.33 | 175DkJ | 58 | - | 2489 | 28.00 | 185DkJ | 57 | - | 2677 | 23.86 | 175EiJ | 56 | - | 2795 | 20.57 | 175FgJ | 56 | - | 2948 | 1466 | 88 |
| | | | | 1 | | | 445A | 233 | 4.4 | 3935 | | 365B | 229 | 4.3 | 3716 | | 395B | 226 | 4.3 | 4008 | | 425B | 223 | 4.2 | 4300 | 1612 | |
| | | 6#11 | 5#11 | 1 | 9#14 | 39.73 | 295AnD | 58 | - | 3384 | 33.39 | 305AlD | 57 | - | 3610 | 28.45 | 315AiD | 56 | - | 3835 | 24.53 | 215DmJ | 56 | - | 3675 | 1748 | 76 |
| | | | | 1 | | | 445A | 233 | 4.4 | 4408 | | 485A | 229 | 4.3 | 4784 | | 525A | 226 | 4.3 | 5160 | | 565A | 223 | 4.2 | 5537 | 1998 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

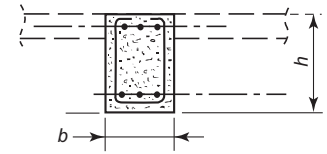
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

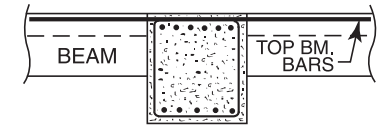
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, END SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 30 ft | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES (5) | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) $\times 10^{-9}$ |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft-kips | sq. in. | lb. | k/ft | | ft.-kips | sq. in. | lb. | ft.-kip | in. |
| 28.5 | 24 | 2#10 | 1#10 | 1 | 4# 9 | 4.89 | 133J | 20 | - | 779 | 4.30 | 133J | 20 | - | 820 | 3.81 | 133J | 20 | - | 861 | 3.40 | 133J | 20 | - | 901 | 419 | 240 |
| | | | | 1 | | | 185H | 81 | 2.1 | 1314 | | 195H | 80 | 2.1 | 1391 | | 215H | 79 | 2.1 | 1505 | | 225H | 79 | 2.1 | 1583 | 440 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 6.20 | 143J | 20 | - | 1040 | 5.45 | 143J | 20 | - | 1095 | 4.82 | 153J | 20 | - | 1160 | 4.30 | 153J | 20 | - | 1215 | 507 | 211 |
| | | | | 1 | | | 235F | 80 | 2.1 | 1748 | | 245F | 80 | 2.1 | 1840 | | 195I | 79 | 2.1 | 1712 | | 205I | 79 | 2.1 | 1804 | 659 | |
| | | 2#14 | 1#14 | 1 | 4#14 | 8.60 | 154J | 20 | - | 1593 | 7.56 | 164J | 20 | - | 1691 | 6.70 | 174J | 20 | - | 1789 | 5.97* | 174J | 20 | - | 1869 | 703 | 171 |
| | | | | 1 | | | 235F | 80 | 2.1 | 2158 | | 245F | 80 | 2.1 | 2274 | | 265F | 79 | 2.1 | 2427 | | 275F | 79 | 2.1 | 2544 | 904 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 11.06 | 155J | 20 | - | 2121 | 9.72 | 165J | 20 | - | 2252 | 8.61* | 175J | 20 | - | 2384 | 7.68* | 185J | 20 | - | 2515 | 904 | 145 |
| | | | | 1 | | | 305D | 80 | 2.1 | 2778 | | 285E | 80 | 2.1 | 2807 | | 295E | 79 | 2.1 | 2945 | | 315E | 79 | 2.1 | 3121 | 1079 | |
| | 26 | 2#10 | 1#10 | 1 | 4# 9 | 4.92 | 123J | 23 | - | 772 | 4.32 | 123J | 23 | - | 812 | 3.83 | 133J | 22 | - | 863 | 3.41 | 133J | 22 | - | 903 | 421 | 222 |
| | | | | 1 | | | 155J | 91 | 2.3 | 1216 | | 165J | 90 | 2.3 | 1294 | | 235G | 90 | 2.3 | 1597 | | 245G | 89 | 2.3 | 1676 | 442 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 6.23 | 133J | 23 | - | 1032 | 5.48 | 143J | 23 | - | 1097 | 4.85 | 143J | 22 | - | 1153 | 4.33 | 153J | 22 | - | 1218 | 509 | 202 |
| | | | | 1 | | | 205G | 91 | 2.3 | 1654 | | 225G | 90 | 2.3 | 1785 | | 235G | 89 | 2.3 | 1878 | | 245G | 89 | 2.2 | 1970 | 664 | |
| | | 2#14 | 2#14 | 1 | 4#14 | 10.17 | 155J | 23 | - | 1969 | 8.94 | 165J | 23 | - | 2092 | 7.92* | 174J | 22 | - | 2026 | 7.06* | 184J | 22 | - | 2138 | 915 | 152 |
| | | | | 1 | | | 265E | 91 | 2.3 | 2493 | | 285E | 90 | 2.3 | 2662 | | 295E | 89 | 2.3 | 2792 | | 275F | 89 | 2.2 | 2810 | 915 | |
| | | 2#14 | 2#14 | 1 | 5#14 | 11.19 | 155J | 23 | - | 2128 | 9.83 | 165J | 23 | - | 2260 | 8.71* | 175J | 22 | - | 2392 | 7.77* | 185J | 22 | - | 2524 | 915 | 141 |
| | | | | 1 | | | 305D | 91 | 2.3 | 2802 | | 285E | 90 | 2.3 | 2829 | | 295E | 89 | 2.3 | 2969 | | 315E | 89 | 2.2 | 3146 | 1105 | |
| | 48 | 3#10 | 3#10 | 1 | 6#10 | 9.32 | 124J | 55 | - | 1534 | 8.19 | 134J | 55 | - | 1635 | 7.26 | 134J | 54 | - | 1713 | 6.47 | 134J | 54 | - | 1792 | 838 | 119 |
| | | | | 1 | | | 364C | 221 | 4.2 | 2319 | | ** | 219 | 4.3 | 1345 | | ** | 217 | 4.3 | 1424 | | ** | 216 | 4.2 | 1502 | 838 | |
| | | 3#11 | 3#11 | 1 | 6#11 | 11.27 | 134J | 55 | - | 1859 | 9.90 | 144J | 55 | - | 1979 | 8.77 | 144J | 54 | - | 2076 | 7.82 | 154J | 54 | - | 2195 | 1014 | 114 |
| | | | | 1 | | | 265E | 221 | 4.2 | 2777 | | 384C | 219 | 4.2 | 2778 | | 414C | 217 | 4.1 | 2963 | | 434C | 216 | 4.1 | 3118 | 1014 | |
| | | 3#14 | 3#14 | 1 | 7#14 | 17.21 | 165GeJ | 55 | - | 2999 | 15.12 | 175GdJ | 55 | - | 3182 | 13.39* | 175J | 54 | - | 3331 | 11.95* | 175J | 54 | - | 3479 | 1407 | 90 |
| | | | | 1 | | | 455B | 221 | 4.2 | 4526 | | 485B | 219 | 4.1 | 4813 | | 515B | 217 | 4.1 | 5101 | | 545B | 216 | 4.1 | 5389 | 1612 | |
| | | 4#14 | 4#14 | 1 | 9#14 | 22.12 | 225DmJ | 55 | - | 3969 | 19.44* | 215EkJ | 55 | - | 4129 | 17.22* | 215EjJ | 54 | - | 4324 | 15.36* | 215FhJ | 54 | - | 4519 | 1809 | 75 |
| | | | | 1 | | | 455B | 221 | 4.2 | 5285 | | 485B | 219 | 4.1 | 5619 | | 515B | 217 | 4.1 | 5954 | | 545B | 216 | 4.1 | 6288 | 1998 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

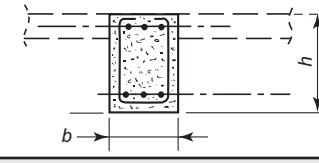
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

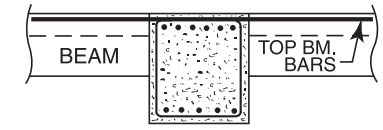
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 12 ft | | | | | SPAN, $\ell_n$ = 14 ft. | | | | | SPAN, $\ell_n$ = 16 ft. | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 12.5 | 24 | 2# 6 | 1# 6 | 1 | 4# 6 | 5.73 | 113C | 6 | - | 163 | 4.21 | 113C | 6 | - | 179 | 3.23 | 123C | 5 | - | 201 | 2.55 | 123C | 5 | - | 217 | 57 | 1419 |
| | | | | 1 | | | 143C | 23 | 1.1 | 209 | | 173C | 22 | 1.0 | 248 | | 193C | 22 | 1.0 | 280 | | 223C | 22 | 1.0 | 319 | 75 | |
| | | 2# 6 | 1# 6 | 1 | 4# 7 | 6.36 | 113C | 6 | - | 180 | 4.67 | 123C | 6 | - | 205 | 3.58 | 133C | 5 | - | 230 | 2.83 | 133C | 5 | - | 249 | 57 | 1557 |
| | | | | 1 | | | 144C | 23 | 1.1 | 335 | | 173C | 22 | 1.0 | 268 | | 193C | 22 | 1.0 | 303 | | 223C | 22 | 1.0 | 345 | 99 | |
| | | 3# 6 | 2# 6 | 1 | 4# 8 | 9.60 | 133C | 6 | - | 244 | 7.05 | 143C | 6 | - | 278 | 5.40 | 153C | 5 | - | 311 | 4.27 | 163C | 5 | - | 345 | 92 | 1749 |
| | | | | 1 | | | 144C | 23 | 1.1 | 388 | | 174C | 22 | 1.0 | 462 | | 194C | 22 | 1.0 | 521 | | 224C | 22 | 1.0 | 595 | 125 | |
| | | 3# 6 | 3# 6 | 1 | 4# 9 | 11.64 | 133C | 6 | - | 281 | 8.55 | 153C | 6 | - | 326 | 6.55 | 163C | 5 | - | 366 | 5.17* | 173C | 5 | - | 406 | 108 | 1618 |
| | | | | 1 | | | 144C | 23 | 1.0 | 425 | | 174C | 22 | 1.0 | 505 | | 194C | 22 | 1.0 | 570 | | 224C | 22 | 1.0 | 650 | 152 | |
| | 36 | 2# 6 | 2# 6 | 1 | 5# 7 | 8.53 | 113C | 10 | - | 221 | 6.27 | 113C | 9 | - | 245 | 4.80 | N/A | 9 | - | 196 | 3.79 | N/A | 9 | - | 220 | 76 | 930 |
| | | | | 1 | | | 243A | 38 | 1.6 | 375 | | 283A | 38 | 1.5 | 437 | | 323A | 37 | 1.5 | 499 | | 363A | 36 | 1.5 | 561 | 125 | |
| | | 3# 6 | 2# 6 | 1 | 5# 8 | 10.54 | 123C | 10 | - | 272 | 7.75 | 133C | 9 | - | 310 | 5.93 | 133C | 9 | - | 341 | 4.69 | 143C | 9 | - | 379 | 94 | 1116 |
| | | | | 1 | | | 243A | 38 | 1.6 | 420 | | 283A | 38 | 1.5 | 489 | | 323A | 37 | 1.5 | 558 | | 363A | 36 | 1.5 | 627 | 160 | |
| | | 4# 6 | 3# 6 | 1 | 5# 9 | 14.43 | 133C | 10 | - | 341 | 10.60 | 143C | 9 | - | 389 | 8.12 | 153C | 9 | - | 437 | 6.41 | 163C | 9 | - | 485 | 129 | 1176 |
| | | | | 1 | | | 144C | 38 | 1.6 | 516 | | 174C | 38 | 1.5 | 614 | | 323A | 37 | 1.5 | 640 | | 363A | 36 | 1.5 | 720 | 195 | |
| | | 5# 6 | 4# 6 | 1 | 5#10 | 18.13 | 134C | 10 | - | 494 | 13.32 | 154C | 9 | - | 573 | 10.20 | 163C | 9 | - | 536 | 8.06* | 183C | 9 | - | 602 | 163 | 1072 |
| | | | | 1 | | | 244A | 38 | 1.6 | 772 | | 284A | 38 | 1.5 | 900 | | 194C | 37 | 1.5 | 784 | | 224C | 36 | 1.5 | 893 | 237 | |
| | 48 | 3# 6 | 3# 6 | 1 | 6# 7 | 11.63 | 113C | 14 | - | 281 | 8.55 | 113C | 13 | - | 313 | 6.54 | 123C | 13 | - | 353 | 5.17 | N/A | 13 | - | 294 | 114 | 725 |
| | | | | 1 | | | ** | 55 | 4.2 | 197 | | ** | 53 | 4.3 | 229 | | ** | 53 | 4.3 | 261 | | ** | 52 | 4.2 | 294 | 152 | |
| | | 3# 6 | 3# 6 | 1 | 6# 8 | 12.72 | 113C | 14 | - | 311 | 9.35 | 123C | 13 | - | 356 | 7.16 | 133C | 13 | - | 401 | 5.66 | 133C | 13 | - | 438 | 114 | 783 |
| | | | | 1 | | | ** | 55 | 4.2 | 227 | | ** | 53 | 4.2 | 264 | | ** | 53 | 4.1 | 302 | | ** | 52 | 4.1 | 339 | 194 | |
| | | 5# 6 | 5# 6 | 1 | 6#10 | 20.50 | 134C | 14 | - | 566 | 15.06 | 144C | 13 | - | 641 | 11.53 | 163C | 13 | - | 616 | 9.11 | 173C | 13 | - | 684 | 184 | 850 |
| | | | | 1 | | | 244A | 55 | 2.1 | 897 | | 284A | 53 | 2.0 | 1046 | | 194C | 53 | 2.0 | 909 | | 224C | 52 | 2.0 | 1036 | 290 | |
| | | 6# 6 | 6# 6 | 1 | 6#10 | 22.17 | 134C | 14 | - | 599 | 16.29 | 154C | 13 | - | 694 | 12.47 | 164C | 13 | - | 775 | 9.85* | 173C | 13 | - | 733 | 217 | 822 |
| | | | | 1 | | | 244A | 55 | 2.1 | 930 | | 284A | 53 | 2.0 | 1084 | | 324A | 53 | 2.0 | 1238 | | 224C | 52 | 2.0 | 1085 | 290 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

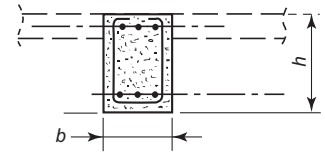
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

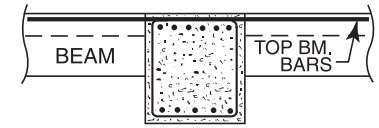
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 12.5 | 24 | 2# 6 | 1# 6 | 1 | 4# 6 | 2.06 | 123C | 5 | - | 233 | 1.71 | 113C | 5 | - | 244 | 1.43 | 113C | 5 | - | 260 | 1.22 | 103C | 5 | - | 271 | 57 | 1419 |
| | | | | 1 | | | 243C | 21 | 1.0 | 351 | | 263C | 21 | 1.0 | 382 | | 293C | 21 | 1.0 | 422 | | 313C | 21 | 1.0 | 453 | 75 | |
| | | 2# 6 | 1# 6 | 1 | 4# 7 | 2.29 | 133C | 5 | - | 268 | 1.89 | 133C | 5 | - | 287 | 1.59 | 133C | 5 | - | 306 | 1.36 | 123C | 5 | - | 320 | 57 | 1557 |
| | | | | 1 | | | 243C | 21 | 1.0 | 380 | | 263C | 21 | 1.0 | 414 | | 293C | 21 | 1.0 | 456 | | 313C | 21 | 1.0 | 491 | 99 | |
| | | 2# 8 | 1# 8 | 1 | 4# 8 | 3.46* | 173C | 5 | - | 390 | 2.86* | 183C | 5 | - | 425 | 2.40* | 193C | 5 | - | 460 | 2.05* | 193C | 5 | - | 489 | 97 | 1730 |
| | | | | 1 | | | 243C | 21 | 1.0 | 480 | | 263C | 21 | 1.0 | 524 | | 293C | 21 | 1.0 | 576 | | 313C | 21 | 1.0 | 620 | 125 | |
| | | 3# 6 | 3# 6 | 1 | 4# 9 | 4.19* | 183C | 5 | - | 445 | 3.46* | 203C | 5 | - | 490 | 2.91* | 203C | 5 | - | 524 | 2.48X | 213C | 5 | - | 564 | 108 | 1618 |
| | | | | 1 | | | 244C | 21 | 1.0 | 715 | | 264C | 21 | 1.0 | 780 | | 293C | 21 | 1.0 | 635 | | 313C | 21 | 1.0 | 684 | 152 | |
| | 36 | 2# 6 | 2# 6 | 1 | 5# 7 | 3.07 | N/A | 9 | - | 244 | 2.54 | N/A | 9 | - | 269 | 2.13 | N/A | 9 | - | 293 | 1.82 | N/A | 9 | - | 317 | 76 | 930 |
| | | | | 1 | | | 403A | 36 | 1.5 | 623 | | 443A | 36 | 1.5 | 685 | | 483A | 36 | 1.5 | 747 | | 523A | 35 | 1.5 | 809 | 125 | |
| | | 2# 7 | 2# 7 | 1 | 5# 8 | 4.09 | 153C | 9 | - | 425 | 3.38 | 153C | 9 | - | 457 | 2.84 | N/A | 9 | - | 389 | 2.42* | N/A | 9 | - | 421 | 102 | 1176 |
| | | | | 1 | | | 403A | 36 | 1.5 | 704 | | 443A | 36 | 1.5 | 774 | | 483A | 35 | 1.5 | 844 | | 523A | 35 | 1.5 | 914 | 160 | |
| | | 2# 8 | 2# 8 | 1 | 5# 9 | 5.25* | 173C | 9 | - | 532 | 4.34* | 183C | 9 | - | 580 | 3.64* | 193C | 9 | - | 628 | 3.11* | 193C | 9 | - | 669 | 131 | 1183 |
| | | | | 1 | | | 403A | 36 | 1.5 | 797 | | 443A | 36 | 1.5 | 877 | | 483A | 35 | 1.5 | 956 | | 523A | 35 | 1.5 | 1035 | 195 | |
| | | 2# 9 | 2# 9 | 1 | 5#10 | 6.45* | 233B | 9 | - | 684 | 5.33* | 243B | 9 | - | 744 | 4.48* | 263B | 9 | - | 809 | 3.82X | 273B | 9 | - | 868 | 161 | 1085 |
| | | | | 1 | | | 403A | 36 | 1.5 | 910 | | 443A | 36 | 1.5 | 1001 | | 483A | 35 | 1.5 | 1091 | | 523A | 35 | 1.5 | 1181 | 237 | |
| | 48 | 3# 6 | 3# 6 | 1 | 6# 7 | 4.19 | N/A | 13 | - | 326 | 3.46 | N/A | 13 | - | 358 | 2.91 | N/A | 13 | - | 390 | 2.48 | N/A | 13 | - | 422 | 114 | 725 |
| | | | | 1 | | | ** | 51 | 4.2 | 326 | | ** | 51 | 4.3 | 358 | | ** | 51 | 4.3 | 390 | | ** | 50 | 0.0 | 422 | 152 | |
| | | 3# 6 | 3# 6 | 1 | 6# 8 | 4.58 | N/A | 13 | - | 376 | 3.79 | N/A | 13 | - | 413 | 3.18 | N/A | 13 | - | 450 | 2.71 | N/A | 13 | - | 487 | 114 | 783 |
| | | | | 1 | | | ** | 51 | 4.2 | 376 | | ** | 51 | 4.2 | 413 | | ** | 51 | 4.1 | 450 | | ** | 50 | 4.1 | 487 | 194 | |
| | | 3# 8 | 3# 8 | 1 | 6#10 | 7.79* | 183C | 13 | - | 770 | 6.44* | 193C | 13 | - | 840 | 5.41* | 203C | 13 | - | 910 | 4.61* | 203C | 13 | - | 973 | 194 | 852 |
| | | | | 1 | | | ** | 51 | 2.1 | 633 | | ** | 51 | 2.0 | 695 | | ** | 51 | 2.0 | 758 | | ** | 50 | 2.0 | 820 | 290 | |
| | | 4# 8 | 3# 8 | 1 | 6#10 | 7.98* | 183C | 13 | - | 826 | 6.60* | 193C | 13 | - | 902 | 5.54* | 203C | 13 | - | 977 | 4.72* | 213C | 13 | - | 1053 | 223 | 820 |
| | | | | 1 | | | ** | 51 | 2.1 | 689 | | ** | 51 | 2.0 | 756 | | ** | 51 | 2.0 | 824 | | ** | 50 | 2.0 | 892 | 290 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

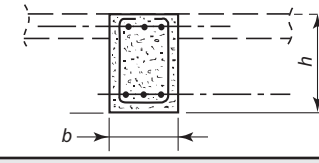
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

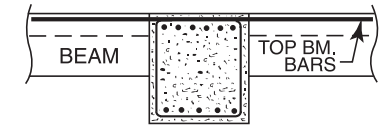
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 12 ft | | | | | SPAN, $\ell_n$ = 14 ft. | | | | | SPAN, $\ell_n$ = 16 ft. | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 14.5 | 24 | 2# 6 | 1# 6 | 1 | 4# 7 | 7.68 | 103D | 7 | - | 179 | 5.64 | 103D | 7 | - | 199 | 4.32 | 113D | 7 | - | 224 | 3.41 | 113D | 7 | - | 243 | 69 | 876 |
| | | | | 1 | | | 144C | 30 | 1.2 | 348 | | 173C | 29 | 1.2 | 277 | | 193C | 28 | 1.2 | 312 | | 223C | 28 | 1.2 | 356 | 120 | |
| | | 2# 6 | 2# 6 | 1 | 4# 8 | 10.10 | 103D | 7 | - | 213 | 7.42 | 113D | 7 | - | 244 | 5.68 | 123D | 7 | - | 275 | 4.49 | 133D | 7 | - | 306 | 90 | 1067 |
| | | | | 1 | | | 124D | 30 | 1.2 | 348 | | 174C | 29 | 1.2 | 455 | | 194C | 28 | 1.2 | 513 | | 223C | 28 | 1.2 | 406 | 154 | |
| | | 3# 6 | 3# 6 | 1 | 4# 9 | 14.39 | 114D | 7 | - | 342 | 10.57 | 133D | 7 | - | 322 | 8.09 | 143D | 7 | - | 362 | 6.40 | 153D | 7 | - | 402 | 132 | 1048 |
| | | | | 1 | | | 125D | 30 | 1.2 | 531 | | 145D | 29 | 1.2 | 619 | | 164D | 28 | 1.2 | 538 | | 224C | 28 | 1.2 | 670 | 188 | |
| | | 4# 6 | 3# 6 | 1 | 4#10 | 16.93 | 223A | 7 | - | 391 | 12.44 | 134D | 7 | - | 456 | 9.52 | 143D | 7 | - | 426 | 7.52 | 153D | 7 | - | 474 | 152 | 950 |
| | | | | 1 | | | 244A | 30 | 1.2 | 650 | | 145D | 29 | 1.2 | 675 | | 165D | 28 | 1.2 | 771 | | 184D | 28 | 1.1 | 677 | 228 | |
| | 36 | 2# 6 | 2# 6 | 1 | 5# 7 | 10.29 | 093D | 13 | - | 212 | 7.56 | 103D | 12 | - | 243 | 5.79 | N/A | 12 | - | 196 | 4.57 | N/A | 12 | - | 220 | 92 | 500 |
| | | | | 1 | | | 243A | 51 | 1.8 | 387 | | 283A | 50 | 1.8 | 451 | | 323A | 49 | 1.7 | 515 | | 363A | 48 | 1.7 | 579 | 152 | |
| | | 3# 6 | 3# 6 | 1 | 5# 8 | 14.98 | 103D | 13 | - | 277 | 11.01 | 113D | 12 | - | 318 | 8.43 | 123D | 12 | - | 359 | 6.66 | 133D | 12 | - | 400 | 136 | 742 |
| | | | | 1 | | | 125D | 51 | 1.8 | 588 | | 144D | 50 | 1.8 | 514 | | 323A | 49 | 1.7 | 592 | | 363A | 48 | 1.7 | 665 | 196 | |
| | | 5# 6 | 4# 6 | 1 | 5#10 | 22.09 | 114D | 13 | - | 478 | 16.23 | 134D | 12 | - | 558 | 12.42 | 144D | 12 | - | 625 | 9.82 | 153D | 12 | - | 589 | 198 | 693 |
| | | | | 1 | | | 125D | 51 | 1.8 | 706 | | 145D | 50 | 1.8 | 822 | | 165D | 49 | 1.7 | 938 | | 185D | 48 | 1.7 | 1055 | 294 | |
| | | 5# 6 | 5# 6 | 1 | 5#11 | 24.30 | 115D | 13 | - | 626 | 17.85 | 134D | 12 | - | 621 | 13.67 | 144D | 12 | - | 697 | 10.80 | 154D | 12 | - | 773 | 218 | 638 |
| | | | | 1 | | | 245A | 51 | 1.8 | 1141 | | 145D | 50 | 1.8 | 885 | | 165D | 49 | 1.7 | 1010 | | 185D | 48 | 1.7 | 1135 | 342 | |
| | 48 | 3# 6 | 3# 6 | 1 | 6# 8 | 15.36 | 103D | 18 | - | 309 | 11.29 | 103D | 18 | - | 346 | 8.64 | 113D | 18 | - | 391 | 6.83 | N/A | 17 | - | 339 | 138 | 440 |
| | | | | 1 | | | ** | 74 | 4.2 | 227 | | ** | 72 | 4.3 | 264 | | ** | 70 | 4.3 | 302 | | ** | 69 | 0.0 | 339 | 237 | |
| | | 4# 6 | 3# 6 | 1 | 6# 9 | 17.80 | 103D | 18 | - | 363 | 13.08 | 113D | 18 | - | 417 | 10.01 | 123D | 18 | - | 472 | 7.91 | 123D | 17 | - | 518 | 160 | 497 |
| | | | | 1 | | | 144C | 74 | 2.4 | 601 | | ** | 72 | 4.2 | 328 | | ** | 70 | 4.1 | 374 | | ** | 69 | 4.1 | 420 | 292 | |
| | | 6# 6 | 5# 6 | 1 | 6#10 | 27.19 | 115D | 18 | - | 670 | 19.98 | 124D | 18 | - | 645 | 15.29 | 144D | 18 | - | 740 | 12.08 | 154D | 17 | - | 820 | 244 | 542 |
| | | | | 1 | | | 245A | 74 | 2.4 | 1272 | | 145D | 72 | 2.3 | 969 | | 195C | 70 | 2.3 | 1216 | | 224C | 69 | 2.3 | 1084 | 358 | |
| | | 7# 6 | 7# 6 | 1 | 6#11 | 32.41 | 115D | 18 | - | 766 | 23.81 | 135D | 18 | - | 896 | 18.23 | 144D | 18 | - | 866 | 14.41 | 154D | 17 | - | 962 | 304 | 490 |
| | | | | 1 | | | 245A | 74 | 2.4 | 1367 | | 285A | 72 | 2.3 | 1593 | | 325A | 70 | 2.3 | 1819 | | 185D | 69 | 2.3 | 1384 | 424 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

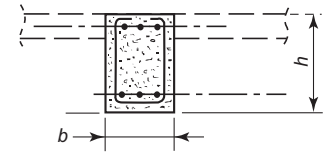
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

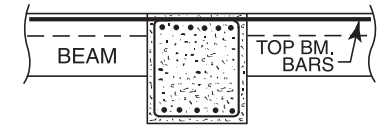
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 14.5 | 24 | 2# 6 | 1# 6 | 1 | 4# 7 | 2.77 | 113D | 7 | - | 262 | 2.29 | 113D | 7 | - | 281 | 1.92 | 113D | 7 | - | 301 | 1.64 | 103D | 7 | - | 314 | 69 | 876 |
| | | | | 1 | | | 243C | 28 | 1.1 | 392 | | 263C | 27 | 1.1 | 427 | | 293C | 27 | 1.1 | 471 | | 313C | 27 | 1.1 | 507 | 120 | |
| | | 2# 7 | 1# 7 | 1 | 4# 8 | 3.69 | 143D | 7 | - | 345 | 3.05 | 143D | 7 | - | 370 | 2.57 | 143D | 7 | - | 396 | 2.19 | 153D | 7 | - | 427 | 92 | 1077 |
| | | | | 1 | | | 243C | 28 | 1.1 | 456 | | 263C | 27 | 1.1 | 498 | | 293C | 27 | 1.1 | 548 | | 313C | 27 | 1.1 | 590 | 154 | |
| | | 2# 9 | 1# 9 | 1 | 4# 9 | 5.18 | 193C | 7 | - | 492 | 4.28 | 203C | 7 | - | 535 | 3.60* | 213C | 7 | - | 578 | 3.07* | 223C | 7 | - | 621 | 146 | 1023 |
| | | | | 1 | | | 244C | 28 | 1.1 | 769 | | 264C | 27 | 1.1 | 838 | | 294C | 27 | 1.1 | 924 | | 313C | 27 | 1.1 | 740 | 188 | |
| | | 2# 9 | 1# 9 | 1 | 4#10 | 5.85 | 203C | 7 | - | 546 | 4.83* | 213C | 7 | - | 594 | 4.06* | 223C | 7 | - | 642 | 3.46* | 233C | 7 | - | 689 | 146 | 965 |
| | | | | 1 | | | 244C | 28 | 1.1 | 817 | | 264C | 27 | 1.1 | 891 | | 294C | 27 | 1.1 | 982 | | 314C | 27 | 1.1 | 1057 | 228 | |
| | 36 | 2# 7 | 2# 7 | 1 | 5# 7 | 4.21 | N/A | 12 | - | 283 | 3.48 | N/A | 12 | - | 311 | 2.92 | N/A | 12 | - | 339 | 2.49 | N/A | 12 | - | 367 | 123 | 601 |
| | | | | 1 | | | 403A | 47 | 1.7 | 682 | | 443A | 47 | 1.7 | 750 | | 483A | 47 | 1.7 | 818 | | 523A | 46 | 1.7 | 885 | 152 | |
| | | 2# 8 | 2# 8 | 1 | 5# 8 | 5.39 | 143D | 12 | - | 470 | 4.46 | 143D | 12 | - | 507 | 3.74 | 143D | 12 | - | 543 | 3.19 | N/A | 12 | - | 480 | 159 | 718 |
| | | | | 1 | | | 403A | 47 | 1.7 | 769 | | 443A | 47 | 1.7 | 845 | | 483A | 47 | 1.7 | 921 | | 523A | 46 | 1.7 | 998 | 196 | |
| | | 2# 9 | 2# 9 | 1 | 5#10 | 7.89 | 193C | 12 | - | 667 | 6.52* | 203C | 12 | - | 727 | 5.48* | 213C | 12 | - | 787 | 4.67* | 223C | 12 | - | 846 | 197 | 699 |
| | | | | 1 | | | 403A | 47 | 1.7 | 930 | | 443A | 47 | 1.7 | 1023 | | 483A | 47 | 1.7 | 1115 | | 523A | 46 | 1.7 | 1207 | 294 | |
| | | 2#10 | 2#10 | 1 | 5#11 | 9.42* | 203C | 12 | - | 807 | 7.78* | 213C | 12 | - | 880 | 6.54* | 223C | 12 | - | 952 | 5.57* | 243C | 12 | - | 1032 | 242 | 629 |
| | | | | 1 | | | 244C | 47 | 1.7 | 1135 | | 264C | 47 | 1.7 | 1239 | | 483A | 46 | 1.7 | 1273 | | 523A | 46 | 1.7 | 1379 | 342 | |
| | 48 | 3# 6 | 3# 6 | 1 | 6# 8 | 5.53 | N/A | 17 | - | 376 | 4.57 | N/A | 17 | - | 413 | 3.84 | N/A | 17 | - | 450 | 3.27 | N/A | 17 | - | 487 | 138 | 440 |
| | | | | 1 | | | ** | 68 | 4.2 | 376 | | ** | 67 | 4.3 | 413 | | ** | 67 | 4.3 | 450 | | ** | 66 | 0.0 | 487 | 237 | |
| | | 3# 7 | 3# 7 | 1 | 6# 9 | 7.39 | 143D | 17 | - | 607 | 6.11 | 143D | 17 | - | 655 | 5.13 | 143D | 17 | - | 704 | 4.37 | N/A | 17 | - | 639 | 184 | 549 |
| | | | | 1 | | | ** | 68 | 2.4 | 493 | | ** | 67 | 4.2 | 541 | | ** | 67 | 4.1 | 590 | | ** | 66 | 4.1 | 639 | 292 | |
| | | 3# 9 | 3# 9 | 1 | 6#10 | 9.87 | 183C | 17 | - | 858 | 8.15 | 203C | 17 | - | 944 | 6.85* | 203C | 17 | - | 1015 | 5.84* | 213C | 17 | - | 1093 | 292 | 517 |
| | | | | 1 | | | 244C | 68 | 2.2 | 1259 | | ** | 67 | 2.3 | 782 | | ** | 67 | 2.3 | 852 | | ** | 66 | 2.3 | 922 | 358 | |
| | | 3# 9 | 3# 9 | 1 | 6#11 | 11.67* | 204C | 17 | - | 1109 | 9.64* | 213C | 17 | - | 1042 | 8.10* | 223C | 17 | - | 1128 | 6.90* | 233C | 17 | - | 1214 | 292 | 501 |
| | | | | 1 | | | 245C | 68 | 2.2 | 1673 | | 264C | 67 | 2.2 | 1464 | | 294C | 67 | 2.2 | 1610 | | ** | 66 | 2.3 | 1027 | 424 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

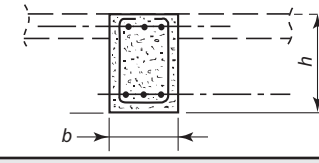
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

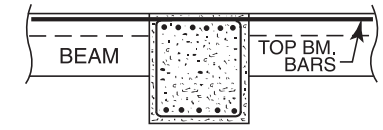
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 16 ft | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | SPAN, $\ell_n$ = 20 ft. | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 16.5 | 24 | 2# 7 | 1# 7 | 1 | 4# 7 | 6.12 | 103E | 9 | - | 248 | 4.83 | 113E | 9 | - | 276 | 3.91 | 113E | 9 | - | 299 | 3.24 | 123E | 9 | - | 327 | 108 | 659 |
| | | | | 1 | | | 194C | 36 | 1.3 | 510 | | 223C | 35 | 1.3 | 395 | | 243C | 35 | 1.3 | 435 | | 263C | 34 | 1.3 | 474 | 142 | |
| | | 2# 8 | 1# 8 | 1 | 4# 8 | 7.84 | 113E | 9 | - | 310 | 6.20 | 123E | 9 | - | 345 | 5.02 | 133E | 9 | - | 381 | 4.15 | 133E | 9 | - | 410 | 140 | 733 |
| | | | | 1 | | | 144E | 36 | 1.3 | 479 | | 224C | 35 | 1.3 | 647 | | 244C | 35 | 1.3 | 710 | | 263C | 34 | 1.3 | 550 | 182 | |
| | | 2# 9 | 1# 9 | 1 | 4#10 | 10.83 | 143D | 9 | - | 433 | 8.56 | 153D | 9 | - | 481 | 6.93 | 173D | 9 | - | 536 | 5.73 | 183D | 9 | - | 585 | 173 | 666 |
| | | | | 1 | | | 165D | 36 | 1.3 | 793 | | 184D | 35 | 1.3 | 693 | | 204D | 35 | 1.3 | 770 | | 264C | 34 | 1.3 | 915 | 274 | |
| | | 2# 9 | 2# 9 | 1 | 4#11 | 13.44 | 154D | 9 | - | 620 | 10.62 | 164D | 9 | - | 685 | 8.60 | 173D | 9 | - | 641 | 7.11 | 193D | 9 | - | 707 | 224 | 586 |
| | | | | 1 | | | 165D | 36 | 1.3 | 877 | | 185D | 35 | 1.3 | 986 | | 205D | 35 | 1.3 | 1095 | | 224D | 34 | 1.3 | 961 | 312 | |
| | 36 | 2# 7 | 2# 7 | 1 | 5# 8 | 9.10 | 103E | 16 | - | 337 | 7.19 | 113E | 15 | - | 377 | 5.82 | 113E | 15 | - | 409 | 4.81 | N/A | 15 | - | 357 | 145 | 435 |
| | | | | 1 | | | 323A | 62 | 2.0 | 596 | | 363A | 61 | 2.0 | 670 | | 403A | 60 | 1.9 | 744 | | 443A | 59 | 1.9 | 818 | 231 | |
| | | 2# 8 | 2# 8 | 1 | 5# 9 | 11.75 | 113E | 16 | - | 420 | 9.29 | 123E | 15 | - | 469 | 7.52 | 133E | 15 | - | 518 | 6.22 | 133E | 15 | - | 560 | 188 | 496 |
| | | | | 1 | | | 165D | 62 | 2.0 | 867 | | 184D | 61 | 1.9 | 747 | | 403A | 60 | 1.9 | 838 | | 443A | 59 | 1.9 | 921 | 285 | |
| | | 3# 9 | 2# 9 | 1 | 5#11 | 17.87 | 154D | 16 | - | 762 | 14.12 | 164D | 15 | - | 843 | 11.44 | 174D | 15 | - | 924 | 9.45 | 183D | 15 | - | 874 | 285 | 436 |
| | | | | 1 | | | 165D | 62 | 2.0 | 1070 | | 185D | 61 | 1.9 | 1202 | | 205D | 60 | 1.9 | 1334 | | 225D | 59 | 1.9 | 1467 | 417 | |
| | | 3# 9 | 3# 9 | 1 | 6#11 | 20.16 | 155D | 16 | - | 996 | 15.93 | 164D | 15 | - | 953 | 12.90 | 174D | 15 | - | 1046 | 10.66 | 194D | 15 | - | 1154 | 336 | 390 |
| | | | | 1 | | | 325A | 62 | 2.0 | 1698 | | 185D | 61 | 1.9 | 1312 | | 205D | 60 | 1.9 | 1456 | | 225D | 59 | 1.9 | 1601 | 469 | |
| | 48 | 3# 7 | 3# 7 | 1 | 6# 8 | 12.03 | 103E | 23 | - | 435 | 9.51 | 113E | 22 | - | 487 | 7.70 | 113E | 22 | - | 529 | 6.36 | N/A | 22 | - | 477 | 217 | 324 |
| | | | | 1 | | | ** | 90 | 4.2 | 349 | | ** | 88 | 4.3 | 392 | | ** | 87 | 4.3 | 434 | | ** | 86 | 0.0 | 477 | 280 | |
| | | 3# 8 | 3# 8 | 1 | 6# 9 | 14.89 | 113E | 23 | - | 545 | 11.76 | 123E | 22 | - | 609 | 9.53 | 133E | 22 | - | 673 | 7.87 | 133E | 22 | - | 728 | 280 | 360 |
| | | | | 1 | | | 194C | 90 | 2.6 | 901 | | ** | 88 | 4.2 | 505 | | ** | 87 | 4.1 | 560 | | ** | 86 | 4.1 | 616 | 346 | |
| | | 3# 9 | 3# 9 | 1 | 6#11 | 21.66 | 145D | 22 | - | 1011 | 17.11 | 154D | 22 | - | 965 | 13.86 | 174D | 22 | - | 1077 | 11.45 | 184D | 21 | - | 1172 | 346 | 345 |
| | | | | 1 | | | 325A | 90 | 2.6 | 1854 | | 185D | 88 | 2.6 | 1399 | | 205D | 87 | 2.5 | 1554 | | 265C | 86 | 2.5 | 1860 | 508 | |
| | | 4# 9 | 3# 9 | 1 | 7#11 | 24.89 | 155D | 22 | - | 1152 | 19.67 | 165D | 22 | - | 1271 | 15.93 | 174D | 22 | - | 1219 | 13.16 | 184D | 21 | - | 1328 | 398 | 318 |
| | | | | 1 | | | 325A | 90 | 2.6 | 1969 | | 365A | 88 | 2.6 | 2213 | | 405A | 87 | 2.5 | 2457 | | 225D | 86 | 2.5 | 1864 | 579 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

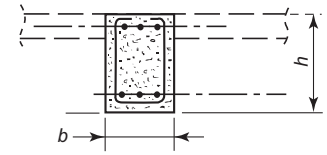
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

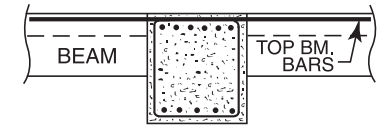
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 24 ft | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 16.5 | 24 | 2# 7 | 1# 7 | 1 | 4# 7 | 2.72 | 123E | 8 | - | 350 | 2.32 | 123E | 8 | - | 372 | 2.00 | 113E | 8 | - | 387 | 1.74 | 113E | 8 | - | 409 | 108 | 659 |
| | | | | 1 | | | 293C | 34 | 1.3 | 522 | | 313C | 34 | 1.3 | 562 | | 343C | 33 | 1.2 | 610 | | 363C | 33 | 1.2 | 650 | 142 | |
| | | 2# 8 | 1# 8 | 1 | 4# 8 | 3.49 | 143E | 8 | - | 445 | 2.97 | 143E | 8 | - | 474 | 2.56 | 153E | 8 | - | 510 | 2.23 | 153E | 8 | - | 539 | 140 | 733 |
| | | | | 1 | | | 293C | 34 | 1.3 | 605 | | 313C | 34 | 1.3 | 651 | | 343C | 33 | 1.2 | 706 | | 363C | 33 | 1.2 | 753 | 182 | |
| | | 2# 9 | 1# 9 | 1 | 4#10 | 4.81 | 193D | 8 | - | 633 | 4.10* | 193D | 8 | - | 674 | 3.54* | 203D | 8 | - | 723 | 3.08* | 213D | 8 | - | 771 | 173 | 666 |
| | | | | 1 | | | 294C | 34 | 1.3 | 1009 | | 314C | 34 | 1.3 | 1085 | | 344C | 33 | 1.2 | 1179 | | 363C | 33 | 1.2 | 945 | 274 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 5.94* | 203D | 8 | - | 765 | 5.06* | 213D | 8 | - | 824 | 4.36* | 223D | 8 | - | 883 | 3.80* | 233D | 8 | - | 941 | 213 | 597 |
| | | | | 1 | | | 244D | 34 | 1.3 | 1048 | | 264D | 34 | 1.2 | 1135 | | 344C | 33 | 1.2 | 1325 | | 364C | 33 | 1.2 | 1412 | 312 | |
| | 36 | 2# 7 | 2# 7 | 1 | 5# 8 | 4.04 | N/A | 15 | - | 389 | 3.44 | N/A | 15 | - | 421 | 2.97 | N/A | 14 | - | 454 | 2.59 | N/A | 14 | - | 486 | 145 | 435 |
| | | | | 1 | | | 483A | 59 | 1.9 | 892 | | 523A | 58 | 1.9 | 966 | | 563A | 58 | 1.9 | 1040 | | 603A | 58 | 1.8 | 1114 | 231 | |
| | | 2# 8 | 2# 8 | 1 | 5# 9 | 5.22 | 143E | 15 | - | 609 | 4.45 | 143E | 15 | - | 650 | 3.84 | 153E | 14 | - | 699 | 3.34 | N/A | 14 | - | 626 | 188 | 496 |
| | | | | 1 | | | 483A | 59 | 1.9 | 1004 | | 523A | 58 | 1.9 | 1087 | | 563A | 58 | 1.9 | 1170 | | 603A | 58 | 1.8 | 1254 | 285 | |
| | | 2#10 | 2#10 | 1 | 5#11 | 7.97* | 193D | 15 | - | 940 | 6.79* | 203D | 15 | - | 1014 | 5.85* | 213D | 14 | - | 1087 | 5.10* | 223D | 14 | - | 1160 | 288 | 436 |
| | | | | 1 | | | 245D | 59 | 1.9 | 1592 | | 264D | 58 | 1.9 | 1394 | | 284D | 58 | 1.8 | 1501 | | 603A | 58 | 1.8 | 1620 | 417 | |
| | | 2#11 | 2#11 | 1 | 6#11 | 8.96* | 204D | 15 | - | 1265 | 7.63* | 213D | 15 | - | 1207 | 6.58* | 223D | 14 | - | 1295 | 5.73* | 233D | 14 | - | 1382 | 344 | 389 |
| | | | | 1 | | | 245D | 59 | 1.9 | 1764 | | 265D | 58 | 1.9 | 1910 | | 285D | 58 | 1.8 | 2056 | | 304D | 58 | 1.8 | 1822 | 469 | |
| | 48 | 3# 7 | 3# 7 | 1 | 6# 8 | 5.35 | N/A | 21 | - | 520 | 4.56 | N/A | 21 | - | 563 | 3.93 | N/A | 21 | - | 606 | 3.42 | N/A | 21 | - | 648 | 217 | 324 |
| | | | | 1 | | | ** | 85 | 4.2 | 520 | | ** | 85 | 4.3 | 563 | | ** | 84 | 4.3 | 606 | | ** | 83 | 0.0 | 648 | 280 | |
| | | 3# 8 | 3# 8 | 1 | 6# 9 | 6.62 | 143E | 21 | - | 792 | 5.64 | 143E | 21 | - | 847 | 4.86 | N/A | 21 | - | 781 | 4.23 | N/A | 21 | - | 837 | 280 | 360 |
| | | | | 1 | | | ** | 85 | 2.6 | 671 | | ** | 84 | 4.2 | 726 | | ** | 84 | 4.1 | 781 | | ** | 83 | 4.1 | 837 | 346 | |
| | | 3# 9 | 3# 9 | 1 | 6#11 | 9.62 | 193D | 21 | - | 1113 | 8.20* | 193D | 21 | - | 1191 | 7.07* | 203D | 21 | - | 1278 | 6.16* | 213D | 21 | - | 1365 | 346 | 345 |
| | | | | 1 | | | 294C | 85 | 2.5 | 1637 | | 314C | 84 | 2.5 | 1763 | | ** | 84 | 2.5 | 1105 | | ** | 83 | 2.5 | 1183 | 508 | |
| | | 3#10 | 3#10 | 1 | 7#11 | 11.06* | 194D | 21 | - | 1468 | 9.43* | 204D | 21 | - | 1580 | 8.13* | 213D | 21 | - | 1521 | 7.08* | 223D | 21 | - | 1625 | 427 | 311 |
| | | | | 1 | | | 295C | 85 | 2.5 | 2254 | | 315C | 84 | 2.5 | 2425 | | 344C | 84 | 2.5 | 2147 | | 364C | 83 | 2.4 | 2289 | 579 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

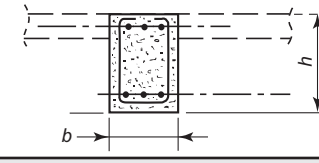
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

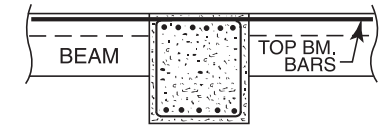
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 16 ft | | | | | SPAN, $\ell_n$ = 18 ft. | | | | | SPAN, $\ell_n$ = 20 ft. | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 18.5 | 24 | 2# 7 | 1# 7 | 1 | 4# 8 | 7.80 | 103F | 11 | - | 279 | 6.16 | 103F | 11 | - | 305 | 4.99 | 113F | 11 | - | 337 | 4.12 | 113F | 10 | - | 363 | 124 | 460 |
| | | | | 1 | | | 125F | 44 | 1.5 | 565 | | 144F | 43 | 1.5 | 489 | | 243C | 42 | 1.5 | 480 | | 263C | 42 | 1.4 | 524 | 210 | |
| | | 2# 8 | 1# 8 | 1 | 4# 9 | 10.08 | 113F | 11 | - | 346 | 7.97 | 113F | 11 | - | 379 | 6.45 | 123F | 11 | - | 419 | 5.33 | 133F | 10 | - | 459 | 161 | 507 |
| | | | | 1 | | | 125F | 44 | 1.5 | 625 | | 145F | 43 | 1.5 | 717 | | 155F | 42 | 1.4 | 779 | | 174F | 42 | 1.4 | 676 | 260 | |
| | | 2# 9 | 2# 9 | 1 | 4#10 | 13.75 | 134E | 11 | - | 563 | 10.86 | 144E | 11 | - | 623 | 8.80 | 153E | 11 | - | 581 | 7.27 | 163E | 10 | - | 635 | 260 | 450 |
| | | | | 1 | | | 145E | 44 | 1.5 | 797 | | 165E | 43 | 1.5 | 903 | | 175E | 42 | 1.4 | 980 | | 195E | 42 | 1.4 | 1086 | 319 | |
| | | 2# 9 | 2# 9 | 1 | 4#11 | 16.27 | 134E | 11 | - | 606 | 12.86 | 144E | 11 | - | 672 | 10.42 | 154E | 11 | - | 738 | 8.61 | 164E | 10 | - | 804 | 260 | 428 |
| | | | | 1 | | | 245B | 44 | 1.5 | 1137 | | 165E | 43 | 1.5 | 952 | | 175E | 42 | 1.4 | 1033 | | 195E | 42 | 1.4 | 1145 | 379 | |
| | 36 | 2# 8 | 2# 8 | 1 | 5# 8 | 11.48 | 103F | 19 | - | 379 | 9.07 | 103F | 19 | - | 415 | 7.35 | 113F | 19 | - | 460 | 6.07 | 113F | 18 | - | 496 | 216 | 304 |
| | | | | 1 | | | 164D | 77 | 2.2 | 640 | | 363A | 76 | 2.2 | 729 | | 403A | 74 | 2.2 | 809 | | 443A | 73 | 2.1 | 889 | 267 | |
| | | 2# 9 | 2# 9 | 1 | 5#10 | 16.83 | 124E | 19 | - | 617 | 13.29 | 134E | 19 | - | 685 | 10.77 | 143E | 19 | - | 646 | 8.90 | 153E | 18 | - | 706 | 269 | 341 |
| | | | | 1 | | | 145E | 77 | 2.2 | 911 | | 185D | 75 | 2.2 | 1102 | | 205D | 74 | 2.1 | 1224 | | 224D | 73 | 2.1 | 1056 | 408 | |
| | | 3# 9 | 2# 9 | 1 | 5#11 | 20.69 | 135E | 19 | - | 868 | 16.35 | 144E | 19 | - | 826 | 13.24 | 154E | 19 | - | 908 | 10.94 | 164E | 18 | - | 990 | 330 | 316 |
| | | | | 1 | | | 245B | 77 | 2.2 | 1369 | | 275B | 75 | 2.2 | 1538 | | 175E | 74 | 2.1 | 1258 | | 195E | 73 | 2.1 | 1394 | 487 | |
| | | 3# 9 | 3# 9 | 1 | 6#11 | 24.41 | 135E | 19 | - | 966 | 19.29 | 145E | 19 | - | 1069 | 15.62 | 154E | 19 | - | 1030 | 12.91 | 164E | 18 | - | 1124 | 390 | 285 |
| | | | | 1 | | | 245B | 77 | 2.2 | 1466 | | 275B | 75 | 2.2 | 1648 | | 305B | 74 | 2.1 | 1830 | | 335B | 73 | 2.1 | 2012 | 568 | |
| | 48 | 3# 7 | 3# 7 | 1 | 6# 9 | 15.59 | 103F | 28 | - | 487 | 12.32 | 103F | 28 | - | 536 | 9.98 | 113F | 27 | - | 593 | 8.25 | 113F | 27 | - | 642 | 249 | 233 |
| | | | | 1 | | | 194C | 113 | 3.0 | 864 | | ** | 110 | 4.3 | 444 | | ** | 108 | 4.3 | 493 | | ** | 107 | 0.0 | 541 | 400 | |
| | | 3# 8 | 3# 8 | 1 | 6#10 | 20.17 | 114F | 28 | - | 702 | 15.94 | 114F | 28 | - | 764 | 12.91 | 123F | 27 | - | 742 | 10.67 | 133F | 27 | - | 814 | 322 | 259 |
| | | | | 1 | | | 245B | 112 | 3.0 | 1455 | | 165E | 110 | 2.9 | 1202 | | 244C | 108 | 2.9 | 1224 | | 264C | 107 | 2.8 | 1336 | 495 | |
| | | 4# 9 | 3# 9 | 1 | 7#11 | 28.84 | 135E | 28 | - | 1116 | 22.79 | 145E | 27 | - | 1237 | 18.46 | 155E | 27 | - | 1357 | 15.25 | 164E | 27 | - | 1309 | 461 | 231 |
| | | | | 1 | | | 245B | 112 | 3.0 | 1697 | | 275B | 110 | 2.9 | 1908 | | 305B | 108 | 2.8 | 2118 | | 335B | 107 | 2.8 | 2329 | 677 | |
| | | 4# 9 | 4# 9 | 1 | 6#14 | 32.55 | 165BfE | 28 | - | 1335 | 25.72 | 145E | 27 | - | 1387 | 20.83 | 155E | 27 | - | 1524 | 17.22 | 165E | 27 | - | 1661 | 520 | 210 |
| | | | | 1 | | | 245B | 112 | 3.0 | 1831 | | 275B | 110 | 2.9 | 2058 | | 305B | 108 | 2.8 | 2285 | | 335B | 107 | 2.8 | 2513 | 800 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

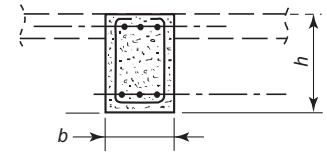
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

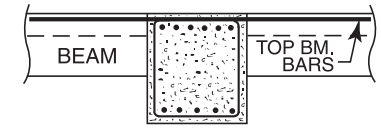
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 24 ft | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 18.5 | 24 | 2# 7 | 1# 7 | 1 | 4# 8 | 3.47 | 113F | 10 | - | 388 | 2.95 | 113F | 10 | - | 414 | 2.55 | 113F | 10 | - | 439 | 2.22 | 113F | 10 | - | 465 | 124 | 460 |
| | | | | 1 | | | 293C | 41 | 1.4 | 577 | | 313C | 41 | 1.4 | 621 | | 343C | 41 | 1.4 | 674 | | 363C | 40 | 1.4 | 718 | 210 | |
| | | 2# 8 | 1# 8 | 1 | 4# 9 | 4.48 | 133F | 10 | - | 492 | 3.82 | 143F | 10 | - | 532 | 3.29 | 143F | 10 | - | 565 | 2.87 | 143F | 10 | - | 598 | 161 | 507 |
| | | | | 1 | | | 184F | 41 | 1.4 | 727 | | 313C | 41 | 1.4 | 718 | | 343C | 41 | 1.4 | 778 | | 363C | 40 | 1.4 | 829 | 260 | |
| | | 2#10 | 1#10 | 1 | 4#10 | 6.11 | 173E | 10 | - | 689 | 5.21 | 183E | 10 | - | 743 | 4.49 | 183E | 10 | - | 790 | 3.91* | 193E | 10 | - | 844 | 247 | 458 |
| | | | | 1 | | | 215E | 41 | 1.4 | 1192 | | 224E | 41 | 1.4 | 1016 | | 244E | 40 | 1.4 | 1099 | | 364C | 40 | 1.4 | 1364 | 319 | |
| | | 2#11 | 1#11 | 1 | 4#11 | 7.24 | 183E | 10 | - | 830 | 6.17 | 193E | 10 | - | 895 | 5.32* | 193E | 10 | - | 952 | 4.63* | 203E | 10 | - | 1017 | 296 | 411 |
| | | | | 1 | | | 215E | 41 | 1.4 | 1326 | | 225E | 41 | 1.4 | 1413 | | 245E | 40 | 1.4 | 1530 | | 264E | 40 | 1.4 | 1348 | 379 | |
| | 36 | 2# 8 | 2# 8 | 1 | 5# 8 | 5.10 | 113F | 18 | - | 533 | 4.35 | 113F | 18 | - | 569 | 3.75 | 113F | 18 | - | 606 | 3.27 | 113F | 18 | - | 642 | 216 | 304 |
| | | | | 1 | | | 483A | 72 | 2.1 | 970 | | 523A | 72 | 2.1 | 1050 | | 563A | 71 | 2.1 | 1130 | | 603A | 71 | 2.1 | 1211 | 267 | |
| | | 2# 9 | 2# 9 | 1 | 5#10 | 7.48 | 163E | 18 | - | 767 | 6.37 | 163E | 18 | - | 819 | 5.49 | 173E | 18 | - | 880 | 4.79 | 173E | 18 | - | 933 | 269 | 341 |
| | | | | 1 | | | 244D | 72 | 2.1 | 1151 | | 523A | 72 | 2.1 | 1259 | | 563A | 71 | 2.1 | 1356 | | 603A | 71 | 2.1 | 1452 | 408 | |
| | | 2#10 | 2#10 | 1 | 5#11 | 9.28 | 174E | 18 | - | 1064 | 7.91 | 183E | 18 | - | 1007 | 6.82* | 183E | 18 | - | 1073 | 5.94* | 193E | 18 | - | 1147 | 334 | 316 |
| | | | | 1 | | | 245D | 72 | 2.1 | 1625 | | 265D | 72 | 2.1 | 1760 | | 284D | 71 | 2.1 | 1527 | | 304D | 71 | 2.0 | 1635 | 487 | |
| | | 2#11 | 2#11 | 1 | 6#11 | 10.86 | 184E | 18 | - | 1252 | 9.25 | 194E | 18 | - | 1347 | 7.98* | 194E | 18 | - | 1427 | 6.95* | 203E | 18 | - | 1369 | 400 | 284 |
| | | | | 1 | | | 215E | 72 | 2.1 | 1693 | | 225E | 72 | 2.1 | 1808 | | 285D | 71 | 2.1 | 2095 | | 305D | 71 | 2.0 | 2244 | 568 | |
| | 48 | 3# 7 | 3# 7 | 1 | 6# 9 | 6.93 | 113F | 26 | - | 691 | 5.91 | N/A | 26 | - | 639 | 5.09 | N/A | 26 | - | 687 | 4.44 | N/A | 26 | - | 736 | 249 | 233 |
| | | | | 1 | | | ** | 106 | 3.0 | 590 | | ** | 105 | 4.3 | 639 | | ** | 104 | 4.3 | 687 | | ** | 103 | 0.0 | 736 | 400 | |
| | | 3# 8 | 3# 8 | 1 | 6#10 | 8.96 | 133F | 26 | - | 876 | 7.64 | 143F | 26 | - | 948 | 6.59 | 143F | 26 | - | 1011 | 5.74 | 143F | 26 | - | 1073 | 322 | 259 |
| | | | | 1 | | | ** | 105 | 3.0 | 758 | | ** | 104 | 2.9 | 820 | | ** | 104 | 2.9 | 882 | | ** | 103 | 2.8 | 945 | 495 | |
| | | 3#10 | 3#10 | 1 | 7#11 | 12.94 | 174E | 26 | - | 1450 | 11.02 | 184E | 26 | - | 1563 | 9.51* | 194E | 26 | - | 1675 | 8.28* | 193E | 26 | - | 1608 | 495 | 226 |
| | | | | 1 | | | 365B | 105 | 2.8 | 2571 | | 225E | 104 | 2.7 | 2113 | | 245E | 104 | 2.7 | 2287 | | 364C | 103 | 2.7 | 2322 | 677 | |
| | | 3#11 | 3#11 | 1 | 6#14 | 15.28 | 185E | 26 | - | 1927 | 13.02 | 194E | 26 | - | 1872 | 11.23* | 204E | 26 | - | 2007 | 9.78* | 214E | 26 | - | 2142 | 592 | 203 |
| | | | | 1 | | | 365B | 105 | 2.8 | 2840 | | 395B | 104 | 2.7 | 3076 | | 425B | 103 | 2.7 | 3311 | | 265E | 103 | 2.7 | 2797 | 800 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

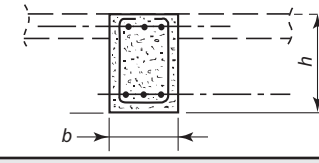
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

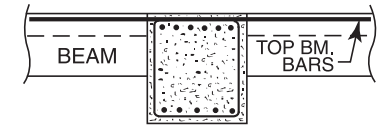
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 20.5 | 24 | 2# 8 | 1# 8 | 1 | 4# 8 | 6.58 | 103G | 13 | - | 371 | 5.44 | 113G | 12 | - | 408 | 4.57 | 113G | 12 | - | 437 | 3.90 | 123G | 12 | - | 473 | 182 | 357 |
| | | | | 1 | | | 145G | 51 | 1.6 | 730 | | 155G | 50 | 1.6 | 790 | | 164G | 49 | 1.6 | 659 | | 184G | 49 | 1.6 | 726 | 239 | |
| | | 2# 9 | 1# 9 | 1 | 4# 9 | 8.15 | 123F | 13 | - | 467 | 6.74 | 133F | 12 | - | 511 | 5.66 | 143F | 12 | - | 556 | 4.82 | 143F | 12 | - | 593 | 227 | 370 |
| | | | | 1 | | | 155F | 51 | 1.6 | 842 | | 175F | 50 | 1.6 | 941 | | 185F | 49 | 1.6 | 1009 | | 204F | 49 | 1.6 | 869 | 296 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 11.29 | 144F | 13 | - | 737 | 9.33 | 144F | 12 | - | 789 | 7.84 | 153F | 12 | - | 747 | 6.68 | 163F | 12 | - | 807 | 282 | 327 |
| | | | | 1 | | | 155F | 51 | 1.6 | 995 | | 175F | 50 | 1.6 | 1110 | | 185F | 49 | 1.6 | 1193 | | 205F | 49 | 1.6 | 1307 | 435 | |
| | | 2#11 | 1#11 | 1 | 5#11 | 13.54 | 144F | 13 | - | 866 | 11.19 | 154F | 12 | - | 945 | 9.40 | 164F | 12 | - | 1025 | 8.01 | 174F | 12 | - | 1104 | 338 | 288 |
| | | | | 1 | | | 245C | 50 | 1.6 | 1404 | | 265C | 50 | 1.6 | 1531 | | 185F | 49 | 1.6 | 1346 | | 205F | 49 | 1.5 | 1473 | 519 | |
| | 36 | 2# 8 | 2# 8 | 1 | 5# 9 | 9.80 | 103G | 22 | - | 505 | 8.10 | 113G | 22 | - | 555 | 6.80 | 113G | 22 | - | 597 | 5.80 | 123G | 22 | - | 647 | 244 | 239 |
| | | | | 1 | | | 204D | 90 | 2.4 | 866 | | 443A | 88 | 2.4 | 965 | | 483A | 87 | 2.3 | 1052 | | 523A | 86 | 2.3 | 1139 | 375 | |
| | | 2# 9 | 2# 9 | 1 | 5#10 | 12.21 | 123F | 22 | - | 635 | 10.09 | 133F | 22 | - | 697 | 8.48 | 143F | 22 | - | 758 | 7.22 | 143F | 22 | - | 810 | 305 | 250 |
| | | | | 1 | | | 155F | 90 | 2.4 | 1071 | | 225D | 88 | 2.4 | 1376 | | 244D | 87 | 2.3 | 1173 | | 264D | 86 | 2.3 | 1270 | 466 | |
| | | 2#11 | 2#11 | 1 | 6#11 | 17.95 | 145F | 22 | - | 1182 | 14.84 | 155F | 22 | - | 1289 | 12.47 | 164F | 22 | - | 1235 | 10.62 | 164F | 22 | - | 1315 | 456 | 214 |
| | | | | 1 | | | 245C | 89 | 2.4 | 1671 | | 265C | 88 | 2.3 | 1823 | | 295C | 87 | 2.3 | 2010 | | 315C | 86 | 2.3 | 2162 | 652 | |
| | | 3#11 | 2#11 | 1 | 5#14 | 20.74 | 145F | 22 | - | 1379 | 17.14 | 155F | 22 | - | 1504 | 14.40 | 165F | 22 | - | 1630 | 12.27 | 175F | 22 | - | 1756 | 557 | 191 |
| | | | | 1 | | | 245C | 89 | 2.4 | 1868 | | 265C | 88 | 2.3 | 2038 | | 295C | 87 | 2.3 | 2245 | | 315C | 86 | 2.3 | 2416 | 754 | |
| | 48 | 3# 8 | 3# 8 | 1 | 6# 9 | 12.50 | 103G | 33 | - | 657 | 10.33 | 113G | 32 | - | 722 | 8.68 | 113G | 32 | - | 777 | 7.40 | 113G | 32 | - | 832 | 365 | 171 |
| | | | | 1 | | | ** | 131 | 3.0 | 560 | | ** | 129 | 4.3 | 616 | | ** | 128 | 4.3 | 671 | | ** | 126 | 0.0 | 726 | 454 | |
| | | 3# 9 | 3# 9 | 1 | 6#11 | 18.18 | 134F | 33 | - | 1034 | 15.02 | 144F | 32 | - | 1131 | 12.62 | 144F | 32 | - | 1209 | 10.76 | 153F | 32 | - | 1172 | 454 | 184 |
| | | | | 1 | | | 305B | 131 | 3.2 | 2018 | | 195E | 129 | 3.1 | 1647 | | 215E | 128 | 3.1 | 1807 | | 314C | 126 | 3.1 | 1820 | 677 | |
| | | 3#10 | 3#10 | 1 | 6#14 | 22.58 | 145F | 33 | - | 1490 | 18.66 | 145F | 32 | - | 1597 | 15.68 | 155F | 32 | - | 1733 | 13.36 | 164F | 32 | - | 1693 | 564 | 160 |
| | | | | 1 | | | 305B | 131 | 3.2 | 2302 | | 335B | 129 | 3.1 | 2531 | | 365B | 128 | 3.1 | 2760 | | 395B | 126 | 3.1 | 2989 | 921 | |
| | | 3#11 | 3#11 | 1 | 6#14 | 25.35 | 165CeF | 33 | - | 1659 | 20.95 | 155F | 32 | - | 1746 | 17.60 | 165F | 32 | - | 1893 | 15.00 | 175F | 32 | - | 2039 | 677 | 153 |
| | | | | 1 | | | 305B | 131 | 3.2 | 2411 | | 335B | 129 | 3.1 | 2651 | | 365B | 128 | 3.1 | 2890 | | 395B | 126 | 3.1 | 3130 | 921 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

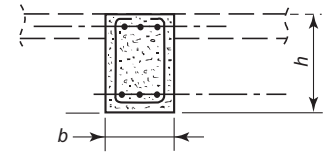
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

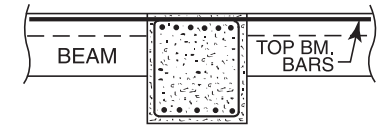
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS(1) | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$(3) | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 28 ft | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 20.5 | 24 | 2# 8 | 1# 8 | 1 | 4# 8 | 3.36 | 123G | 12 | - | 502 | 2.93 | 123G | 12 | - | 531 | 2.57 | 123G | 12 | - | 560 | 2.28 | 123G | 12 | - | 589 | 182 | 357 |
| | | | | 1 | | | 343C | 48 | 1.6 | 741 | | 363C | 48 | 1.5 | 789 | | 383C | 47 | 1.5 | 837 | | 413C | 47 | 1.5 | 895 | 239 | |
| | | 2# 9 | 1# 9 | 1 | 4# 9 | 4.16 | 153F | 12 | - | 637 | 3.62 | 153F | 12 | - | 674 | 3.18 | 163F | 12 | - | 718 | 2.82 | 163F | 12 | - | 755 | 227 | 370 |
| | | | | 1 | | | 214F | 48 | 1.5 | 925 | | 364C | 48 | 1.5 | 1249 | | 383C | 47 | 1.5 | 965 | | 413C | 47 | 1.5 | 1031 | 296 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 5.76 | 173F | 12 | - | 867 | 5.02 | 183F | 12 | - | 926 | 4.41* | 183F | 12 | - | 978 | 3.91* | 193F | 12 | - | 1038 | 282 | 327 |
| | | | | 1 | | | 215F | 48 | 1.5 | 1390 | | 235F | 48 | 1.5 | 1504 | | 245F | 47 | 1.5 | 1587 | | 265F | 47 | 1.5 | 1702 | 435 | |
| | | 2#11 | 1#11 | 1 | 5#11 | 6.91 | 184F | 12 | - | 1184 | 6.02* | 193F | 12 | - | 1126 | 5.29* | 203F | 12 | - | 1198 | 4.69* | 203F | 12 | - | 1262 | 338 | 288 |
| | | | | 1 | | | 215F | 48 | 1.5 | 1569 | | 235F | 48 | 1.5 | 1696 | | 245F | 47 | 1.5 | 1792 | | 265F | 47 | 1.5 | 1919 | 519 | |
| | 36 | 2# 8 | 2# 8 | 1 | 5# 9 | 5.00 | 123G | 21 | - | 688 | 4.35 | 123G | 21 | - | 729 | 3.83 | 123G | 21 | - | 771 | 3.39 | 123G | 21 | - | 812 | 244 | 239 |
| | | | | 1 | | | 563A | 85 | 2.3 | 1227 | | 603A | 85 | 2.3 | 1314 | | 643A | 84 | 2.3 | 1401 | | 683A | 84 | 2.3 | 1488 | 375 | |
| | | 2# 9 | 2# 9 | 1 | 5#10 | 6.23 | 153F | 21 | - | 871 | 5.43 | 153F | 21 | - | 924 | 4.77 | 163F | 21 | - | 985 | 4.22 | 163F | 21 | - | 1037 | 305 | 250 |
| | | | | 1 | | | 563A | 85 | 2.3 | 1384 | | 603A | 85 | 2.3 | 1482 | | 643A | 84 | 2.3 | 1581 | | 683A | 84 | 2.3 | 1679 | 466 | |
| | | 2#11 | 2#11 | 1 | 6#11 | 9.16 | 174F | 21 | - | 1411 | 7.98 | 184F | 21 | - | 1507 | 7.01* | 193F | 21 | - | 1450 | 6.21* | 193F | 21 | - | 1530 | 456 | 214 |
| | | | | 1 | | | 345C | 85 | 2.3 | 2350 | | 235F | 85 | 2.3 | 2034 | | 325D | 84 | 2.3 | 2437 | | 344D | 83 | 2.2 | 2126 | 652 | |
| | | 3#11 | 2#11 | 1 | 5#14 | 10.58 | 184F | 21 | - | 1701 | 9.22* | 194F | 21 | - | 1816 | 8.10* | 204F | 21 | - | 1932 | 7.18* | 204F | 21 | - | 2031 | 557 | 191 |
| | | | | 1 | | | 345C | 85 | 2.3 | 2623 | | 365C | 85 | 2.3 | 2794 | | 385C | 84 | 2.2 | 2964 | | 265F | 83 | 2.2 | 2631 | 754 | |
| | 48 | 3# 8 | 3# 8 | 1 | 6# 9 | 6.38 | N/A | 31 | - | 781 | 5.55 | N/A | 31 | - | 837 | 4.88 | N/A | 31 | - | 892 | 4.32 | N/A | 31 | - | 947 | 365 | 171 |
| | | | | 1 | | | ** | 125 | 3.0 | 781 | | ** | 124 | 4.3 | 837 | | ** | 123 | 4.3 | 892 | | ** | 123 | 0.0 | 947 | 454 | |
| | | 3# 9 | 3# 9 | 1 | 6#11 | 9.28 | 163F | 31 | - | 1259 | 8.08 | 163F | 31 | - | 1338 | 7.10 | 173F | 31 | - | 1426 | 6.29 | 173F | 31 | - | 1504 | 454 | 184 |
| | | | | 1 | | | 344C | 125 | 3.0 | 1974 | | ** | 124 | 3.1 | 1183 | | ** | 123 | 3.1 | 1261 | | ** | 123 | 3.1 | 1340 | 677 | |
| | | 3#10 | 3#10 | 1 | 6#14 | 11.52 | 174F | 31 | - | 1818 | 10.04 | 184F | 31 | - | 1943 | 8.82 | 184F | 31 | - | 2049 | 7.81* | 193F | 31 | - | 2005 | 564 | 160 |
| | | | | 1 | | | 245E | 125 | 3.0 | 2483 | | 265E | 124 | 3.0 | 2671 | | 384C | 123 | 3.0 | 2687 | | 414C | 122 | 3.0 | 2870 | 921 | |
| | | 3#11 | 3#11 | 1 | 6#14 | 12.93 | 185F | 31 | - | 2186 | 11.27 | 184F | 31 | - | 2105 | 9.90* | 194F | 31 | - | 2241 | 8.77* | 204F | 31 | - | 2376 | 677 | 153 |
| | | | | 1 | | | 425B | 125 | 3.0 | 3369 | | 455B | 124 | 3.0 | 3609 | | 285E | 123 | 3.0 | 3032 | | 295E | 122 | 3.0 | 3189 | 921 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

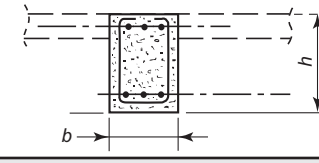
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

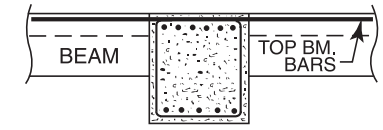
Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 20 ft | | | | | SPAN, $\ell_n$ = 22 ft. | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 24.5 | 24 | 2# 8 | 1# 8 | 1 | 4# 9 | 9.01 | 093I | 17 | - | 411 | 7.45 | 103I | 17 | - | 453 | 6.26 | 103I | 17 | - | 486 | 5.33 | 103I | 16 | - | 518 | 225 | 199 |
| | | | | 1 | | | 125H | 69 | 2.0 | 740 | | 135H | 68 | 2.0 | 807 | | 155H | 67 | 1.9 | 908 | | 165H | 66 | 1.9 | 974 | 368 | |
| | | 2#10 | 1#10 | 1 | 4#10 | 12.57 | 114H | 17 | - | 659 | 10.39 | 124H | 17 | - | 722 | 8.73 | 123H | 17 | - | 672 | 7.44 | 133H | 16 | - | 727 | 350 | 208 |
| | | | | 1 | | | 175E | 69 | 2.0 | 1051 | | 195E | 68 | 1.9 | 1165 | | 215E | 66 | 1.9 | 1280 | | 165H | 66 | 1.9 | 1157 | 457 | |
| | | 2#11 | 1#11 | 1 | 5#11 | 16.91 | 125H | 17 | - | 978 | 13.98 | 125H | 17 | - | 1043 | 11.74 | 134H | 17 | - | 1004 | 10.01 | 144H | 16 | - | 1085 | 422 | 179 |
| | | | | 1 | | | 205D | 69 | 2.0 | 1335 | | 195E | 68 | 1.9 | 1366 | | 215E | 66 | 1.9 | 1498 | | 225E | 66 | 1.9 | 1597 | 664 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 20.43 | 224C | 17 | - | 1159 | 16.89 | 244C | 17 | - | 1270 | 14.19 | 145H | 17 | - | 1321 | 12.09 | 145H | 16 | - | 1399 | 547 | 158 |
| | | | | 1 | | | 245C | 69 | 2.0 | 1604 | | 265C | 68 | 1.9 | 1750 | | 245D | 66 | 1.9 | 1760 | | 225E | 66 | 1.9 | 1770 | 742 | |
| | 36 | 2# 9 | 2# 9 | 1 | 5#10 | 15.09 | 104H | 31 | - | 717 | 12.47 | 113H | 30 | - | 690 | 10.48 | 113H | 30 | - | 743 | 8.93 | 123H | 30 | - | 805 | 377 | 142 |
| | | | | 1 | | | 175E | 124 | 2.9 | 1191 | | 195E | 122 | 2.9 | 1321 | | 215E | 120 | 2.8 | 1451 | | 225E | 118 | 2.8 | 1542 | 580 | |
| | | 2#10 | 2#10 | 1 | 5#11 | 18.85 | 115H | 31 | - | 989 | 15.58 | 124H | 30 | - | 952 | 13.09 | 124H | 30 | - | 1018 | 11.16 | 134H | 30 | - | 1102 | 471 | 142 |
| | | | | 1 | | | 205D | 124 | 2.9 | 1439 | | 195E | 122 | 2.9 | 1466 | | 215E | 120 | 2.8 | 1609 | | 225E | 118 | 2.8 | 1713 | 697 | |
| | | 3#11 | 2#11 | 1 | 5#14 | 26.31 | 135EeH | 31 | - | 1388 | 21.74 | 145EdH | 30 | - | 1517 | 18.27 | 135H | 30 | - | 1586 | 15.57 | 145H | 30 | - | 1714 | 697 | 118 |
| | | | | 1 | | | 305B | 124 | 2.9 | 2167 | | 265C | 122 | 2.9 | 2111 | | 295C | 120 | 2.8 | 2326 | | 265D | 118 | 2.8 | 2308 | 956 | |
| | | 3#11 | 3#11 | 1 | 6#14 | 30.65 | 225C | 31 | - | 1836 | 25.33 | 245C | 30 | - | 2012 | 21.28 | 155EeH | 30 | - | 1863 | 18.13 | 165EdH | 30 | - | 2010 | 821 | 105 |
| | | | | 1 | | | 405A | 124 | 2.9 | 2736 | | 445A | 122 | 2.9 | 3008 | | 295C | 120 | 2.8 | 2544 | | 315C | 118 | 2.8 | 2738 | 1114 | |
| | 48 | 3# 8 | 3# 8 | 1 | 6#10 | 18.03 | 094I | 46 | - | 816 | 14.90 | 104I | 45 | - | 899 | 12.52 | 104I | 44 | - | 962 | 10.67 | 104I | 44 | - | 1024 | 450 | 101 |
| | | | | 1 | | | 175E | 185 | 3.9 | 1374 | | 264C | 181 | 3.8 | 1408 | | 294C | 178 | 3.8 | 1552 | | ** | 176 | 0.0 | 820 | 701 | |
| | | 3#10 | 3#10 | 1 | 6#11 | 23.25 | 115H | 46 | - | 1245 | 19.22 | 114H | 45 | - | 1202 | 16.15 | 124H | 44 | - | 1310 | 13.76 | 134H | 44 | - | 1418 | 701 | 104 |
| | | | | 1 | | | 305B | 184 | 3.9 | 2199 | | 335B | 181 | 3.8 | 2417 | | 215E | 178 | 3.7 | 1981 | | 225E | 175 | 3.7 | 2113 | 845 | |
| | | 3#11 | 3#11 | 1 | 6#14 | 32.03 | 135EfH | 46 | - | 1606 | 26.47 | 145EeH | 45 | - | 1755 | 22.24 | 145EdH | 44 | - | 1872 | 18.95 | 145H | 44 | - | 1989 | 845 | 94 |
| | | | | 1 | | | 305B | 184 | 3.9 | 2495 | | 335B | 181 | 3.8 | 2743 | | 365B | 178 | 3.7 | 2991 | | 395B | 175 | 3.7 | 3238 | 1164 | |
| | | 4#11 | 3#11 | 1 | 8#14 | 38.89 | 225C | 46 | - | 2213 | 32.14 | 165DhH | 45 | - | 2167 | 27.01 | 175DhH | 44 | - | 2347 | 23.01 | 165EfH | 44 | - | 2463 | 972 | 82 |
| | | | | 1 | | | 405A | 184 | 3.9 | 3247 | | 445A | 181 | 3.8 | 3569 | | 365B | 178 | 3.7 | 3368 | | 395B | 175 | 3.7 | 3647 | 1485 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

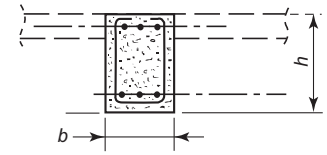
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

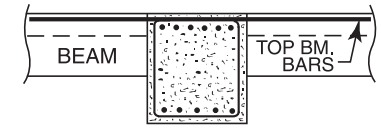
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 28 ft | | | | | SPAN, $\ell_n$ = 30 ft. | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 24.5 | 24 | 2# 8 | 1# 8 | 1 | 4# 9 | 4.60 | 113I | 16 | - | 560 | 4.01 | 113I | 16 | - | 593 | 3.52 | 113I | 16 | - | 626 | 3.12 | 113I | 16 | - | 658 | 225 | 199 |
| | | | | 1 | | | 175H | 65 | 1.9 | 1041 | | 185H | 64 | 1.9 | 1108 | | 195H | 64 | 1.8 | 1174 | | 215H | 63 | 1.8 | 1275 | 368 | |
| | | 2#10 | 1#10 | 1 | 4#10 | 6.41 | 133H | 16 | - | 774 | 5.59 | 143H | 16 | - | 829 | 4.91 | 143H | 16 | - | 876 | 4.35 | 153H | 16 | - | 931 | 350 | 208 |
| | | | | 1 | | | 175H | 65 | 1.9 | 1237 | | 185H | 64 | 1.9 | 1318 | | 195H | 64 | 1.8 | 1399 | | 215H | 63 | 1.8 | 1513 | 457 | |
| | | 2#11 | 1#11 | 1 | 5#11 | 8.63 | 154H | 16 | - | 1167 | 7.52 | 154H | 16 | - | 1231 | 6.61 | 164H | 16 | - | 1313 | 5.85 | 173H | 16 | - | 1257 | 422 | 179 |
| | | | | 1 | | | 245E | 65 | 1.9 | 1729 | | 265E | 64 | 1.8 | 1862 | | 285E | 64 | 1.8 | 1994 | | 215H | 63 | 1.8 | 1821 | 664 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 10.42 | 154H | 16 | - | 1354 | 9.08 | 164H | 16 | - | 1448 | 7.98 | 174H | 16 | - | 1543 | 7.07 | 174H | 16 | - | 1621 | 547 | 158 |
| | | | | 1 | | | 245E | 65 | 1.9 | 1916 | | 265E | 64 | 1.8 | 2062 | | 285E | 64 | 1.8 | 2208 | | 295E | 63 | 1.8 | 2320 | 742 | |
| | 36 | 2# 9 | 2# 9 | 1 | 5#10 | 7.70 | 123H | 29 | - | 857 | 6.71 | 133H | 29 | - | 920 | 5.89 | 133H | 29 | - | 972 | 5.22 | 133H | 28 | - | 1025 | 377 | 142 |
| | | | | 1 | | | 175H | 117 | 2.7 | 1401 | | 603A | 116 | 2.7 | 1542 | | 643A | 115 | 2.7 | 1645 | | 683A | 114 | 2.7 | 1747 | 580 | |
| | | 2#10 | 2#10 | 1 | 5#11 | 9.62 | 133H | 29 | - | 1052 | 8.38 | 143H | 29 | - | 1127 | 7.37 | 143H | 29 | - | 1192 | 6.52 | 153H | 28 | - | 1268 | 471 | 142 |
| | | | | 1 | | | 245E | 117 | 2.7 | 1857 | | 265E | 116 | 2.7 | 2000 | | 285E | 115 | 2.7 | 2143 | | 215H | 114 | 2.7 | 1937 | 697 | |
| | | 3#11 | 2#11 | 1 | 5#14 | 13.42 | 155H | 29 | - | 1843 | 11.69 | 155H | 29 | - | 1941 | 10.28 | 164H | 29 | - | 1894 | 9.10 | 174H | 28 | - | 2012 | 697 | 118 |
| | | | | 1 | | | 285D | 117 | 2.7 | 2485 | | 305D | 116 | 2.7 | 2661 | | 285E | 115 | 2.7 | 2682 | | 295E | 114 | 2.7 | 2820 | 956 | |
| | | 2#14 | 2#14 | 1 | 6#14 | 15.64 | 155H | 29 | - | 2065 | 13.62 | 165H | 29 | - | 2209 | 11.97 | 175H | 29 | - | 2354 | 10.60 | 185H | 28 | - | 2498 | 787 | 107 |
| | | | | 1 | | | 345C | 117 | 2.7 | 2940 | | 305D | 116 | 2.7 | 2899 | | 325D | 115 | 2.7 | 3092 | | 345D | 114 | 2.7 | 3284 | 1114 | |
| | 48 | 3# 8 | 3# 8 | 1 | 6#10 | 9.20 | 114I | 43 | - | 1107 | 8.01 | 114I | 43 | - | 1169 | 7.04 | 114I | 43 | - | 1232 | 6.24 | 114I | 42 | - | 1294 | 450 | 101 |
| | | | | 1 | | | ** | 174 | 3.9 | 882 | | ** | 172 | 3.8 | 945 | | ** | 170 | 3.8 | 1007 | | ** | 169 | 0.0 | 1070 | 701 | |
| | | 3#10 | 3#10 | 1 | 6#11 | 11.86 | 134H | 43 | - | 1506 | 10.33 | 143H | 43 | - | 1477 | 9.08 | 143H | 43 | - | 1565 | 8.05 | 143H | 42 | - | 1653 | 701 | 104 |
| | | | | 1 | | | 344C | 173 | 3.7 | 2172 | | 364C | 172 | 3.6 | 2315 | | 384C | 170 | 3.6 | 2457 | | ** | 169 | 3.7 | 1504 | 845 | |
| | | 3#11 | 3#11 | 1 | 6#14 | 16.34 | 145H | 43 | - | 2106 | 14.24 | 155H | 43 | - | 2256 | 12.51 | 164H | 43 | - | 2214 | 11.08 | 164H | 42 | - | 2331 | 845 | 94 |
| | | | | 1 | | | 425B | 173 | 3.6 | 3486 | | 455B | 172 | 3.6 | 3734 | | 485B | 170 | 3.6 | 3982 | | 295E | 169 | 3.6 | 3270 | 1164 | |
| | | 4#11 | 3#11 | 1 | 8#14 | 19.84 | 175EeH | 43 | - | 2643 | 17.29 | 175EdH | 43 | - | 2791 | 15.19 | 175H | 43 | - | 2939 | 13.46 | 175H | 42 | - | 3087 | 972 | 82 |
| | | | | 1 | | | 425B | 173 | 3.6 | 3926 | | 455B | 172 | 3.6 | 4205 | | 485B | 170 | 3.6 | 4484 | | 515B | 169 | 3.6 | 4763 | 1485 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

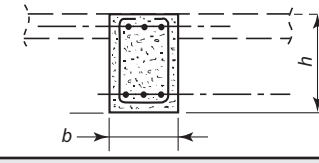
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

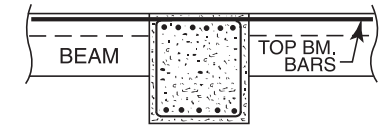
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f'_c$ = 4,000 psi
$f_y$ = 60,000 psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | BOTTOM | | Layers | TOP | SPAN, $\ell_n$ = 22 ft | | | | | SPAN, $\ell_n$ = 24 ft. | | | | | SPAN, $\ell_n$ = 26 ft. | | | | | SPAN, $\ell_n$ = 28 ft. | | | | | | |
| $h$ in. | $b$ in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft-kips | $A\ell$ sq. in. | STEEL WGT lb. | LOAD (4) k/ft | STIR. TIES (5) | $\phi T_n$ ft.-kips | $A\ell$ sq. in. | STEEL WGT lb. | (6) ft.-kip | (7) $\times 10^{-9}$ in. |
| 28.5 | 24 | 2# 9 | 1# 9 | 1 | 4#10 | 11.08 | 103J | 22 | - | 561 | 9.31 | 103J | 21 | - | 603 | 7.93 | 113J | 21 | - | 654 | 6.84 | 113J | 21 | - | 696 | 335 | 130 |
| | | | | 1 | | | 175F | 88 | 2.3 | 1088 | | 185F | 86 | 2.3 | 1167 | | 205F | 85 | 2.2 | 1282 | | 165l | 83 | 2.2 | 1177 | 548 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 13.87 | 104J | 22 | - | 766 | 11.65 | 114J | 21 | - | 837 | 9.93 | 114J | 21 | - | 889 | 8.56 | 123J | 21 | - | 852 | 419 | 131 |
| | | | | 1 | | | 175F | 88 | 2.3 | 1204 | | 185F | 86 | 2.3 | 1293 | | 205F | 84 | 2.2 | 1418 | | 215F | 83 | 2.2 | 1507 | 659 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 20.57 | 204D | 22 | - | 1240 | 17.28 | 125J | 21 | - | 1301 | 14.73 | 125J | 21 | - | 1379 | 12.70 | 135J | 21 | - | 1487 | 659 | 107 |
| | | | | 1 | | | 225D | 88 | 2.3 | 1675 | | 245D | 86 | 2.3 | 1827 | | 265D | 84 | 2.2 | 1978 | | 245E | 83 | 2.2 | 1983 | 904 | |
| | | 3#10 | 2#10 | 1 | 5#14 | 22.23 | 214D | 22 | - | 1390 | 18.68 | 224D | 21 | - | 1498 | 15.91 | 125J | 21 | - | 1534 | 13.72 | 135J | 21 | - | 1653 | 672 | 97 |
| | | | | 1 | | | 445A | 88 | 2.3 | 2614 | | 245D | 86 | 2.3 | 1970 | | 265D | 84 | 2.2 | 2133 | | 285D | 83 | 2.2 | 2296 | 1079 | |
| | 36 | 2#10 | 2#10 | 1 | 5#11 | 18.61 | 104J | 40 | - | 934 | 15.63 | 114J | 39 | - | 1020 | 13.32 | 114J | 39 | - | 1085 | 11.49 | 114J | 38 | - | 1151 | 562 | 91 |
| | | | | 1 | | | 225D | 160 | 3.4 | 1644 | | 215E | 157 | 3.4 | 1668 | | 225E | 155 | 3.3 | 1775 | | 245E | 153 | 3.3 | 1923 | 838 | |
| | | 2#11 | 2#11 | 1 | 5#11 | 19.05 | 105J | 40 | - | 1133 | 16.01 | 114J | 39 | - | 1106 | 13.64 | 114J | 39 | - | 1179 | 11.76 | 124J | 38 | - | 1272 | 681 | 87 |
| | | | | 1 | | | 225D | 160 | 3.4 | 1723 | | 215E | 157 | 3.4 | 1754 | | 225E | 155 | 3.3 | 1869 | | 245E | 152 | 3.3 | 2024 | 838 | |
| | | 3#11 | 2#11 | 1 | 6#14 | 27.71 | 125GeJ | 40 | - | 1603 | 23.29 | 125GdJ | 39 | - | 1712 | 19.84 | 135GdJ | 39 | - | 1853 | 17.11 | 135J | 38 | - | 1963 | 838 | 74 |
| | | | | 1 | | | 335B | 160 | 3.4 | 2586 | | 295C | 157 | 3.4 | 2529 | | 315C | 155 | 3.3 | 2721 | | 345C | 152 | 3.3 | 2955 | 1357 | |
| | | 4#11 | 3#11 | 1 | 7#14 | 35.10 | 215D | 40 | - | 2216 | 29.50 | 225D | 39 | - | 2386 | 25.13 | 245D | 39 | - | 2589 | 21.67 | 165FgJ | 38 | - | 2468 | 1136 | 64 |
| | | | | 1 | | | 445A | 160 | 3.4 | 3365 | | 485A | 157 | 3.4 | 3669 | | 525A | 155 | 3.3 | 3973 | | 425B | 152 | 3.3 | 3696 | 1544 | |
| | 48 | 3# 9 | 3# 9 | 1 | 6#11 | 22.17 | 104J | 60 | - | 1093 | 18.62 | 104J | 59 | - | 1171 | 15.87 | 114J | 58 | - | 1272 | 13.68 | 114J | 57 | - | 1350 | 670 | 67 |
| | | | | 1 | | | 335B | 241 | 4.5 | 2402 | | 365B | 236 | 4.5 | 2620 | | 225E | 232 | 4.4 | 2048 | | 245E | 229 | 4.3 | 2219 | 1014 | |
| | | 3#10 | 3#10 | 1 | 6#14 | 27.73 | 115GcJ | 60 | - | 1569 | 23.30 | 115J | 59 | - | 1676 | 19.86 | 115J | 58 | - | 1782 | 17.12 | 125J | 57 | - | 1924 | 838 | 64 |
| | | | | 1 | | | 335B | 241 | 4.5 | 2715 | | 365B | 236 | 4.5 | 2960 | | 395B | 232 | 4.4 | 3206 | | 425B | 229 | 4.3 | 3452 | 1407 | |
| | | 4#11 | 3#11 | 1 | 7#14 | 36.66 | 155DiJ | 60 | - | 2064 | 30.80 | 155EhJ | 59 | - | 2202 | 26.25 | 145FfJ | 58 | - | 2304 | 22.63 | 145GeJ | 57 | - | 2442 | 1168 | 58 |
| | | | | 1 | | | 335B | 240 | 4.5 | 3069 | | 365B | 236 | 4.4 | 3346 | | 395B | 232 | 4.4 | 3623 | | 425B | 228 | 4.3 | 3900 | 1612 | |
| | | 5#11 | 4#11 | 1 | 9#14 | 45.42 | 275AlD | 60 | - | 2920 | 38.17 | 275AjD | 59 | - | 3096 | 32.52 | 245D | 58 | - | 3168 | 28.04 | 195DkJ | 57 | - | 3169 | 1466 | 49 |
| | | | | 1 | | | 445A | 240 | 4.5 | 4014 | | 485A | 236 | 4.4 | 4376 | | 525A | 232 | 4.4 | 4739 | | 425B | 228 | 4.3 | 4451 | 1998 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

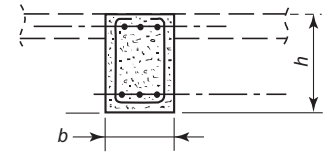
(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

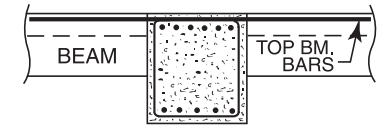
Other notation: N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f'_c}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

$f_c' = 4{,}000$ psi
$f_y = 60{,}000$ psi

# JOIST-BAND BEAMS, INTERIOR SPANS




| STEM | | BARS[1] | | | | TOTAL CAPACITY $U = 1.2D + 1.6L$[3] | | | | | | | | | | | | | | | | | $+\phi M_n$ $-\phi M_n$ | DEFL (C) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | SPAN, $\ell_n$ = 30 ft | | | | | SPAN, $\ell_n$ = 32 ft. | | | | | SPAN, $\ell_n$ = 34 ft. | | | | | SPAN, $\ell_n$ = 36 ft. | | | | | | |
| $h$ | $b$ | BOTTOM | | Layers | TOP | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | LOAD (4) | STIR. TIES | $\phi T_n$ | $A\ell$ | STEEL WGT | (6) | (7) |
| in. | in. | $\ell_n$ + 12 in. | 0.875 $\ell_n$ | (2) | | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft-kips | sq. in. | lb. | k/ft | (5) | ft.-kips | sq. in. | lb. | ft.-kip | $\times 10^{-9}$ in. |
| 28.5 | 24 | 2# 9 | 1# 9 | 1 | 4#10 | 5.96 | 113J | 21 | - | 738 | 5.24 | 123J | 20 | - | 789 | 4.64 | 123J | 20 | - | 831 | 4.14 | 123J | 20 | - | 872 | 335 | 130 |
| | | | | 1 | | | 175I | 82 | 2.2 | 1255 | | 195H | 81 | 2.2 | 1370 | | 215H | 81 | 2.2 | 1485 | | 225H | 80 | 2.1 | 1563 | 548 | |
| | | 2#10 | 1#10 | 1 | 4#11 | 7.46 | 123J | 21 | - | 904 | 6.55 | 133J | 20 | - | 966 | 5.81 | 133J | 20 | - | 1018 | 5.18 | 143J | 20 | - | 1080 | 419 | 131 |
| | | | | 1 | | | 235F | 82 | 2.2 | 1632 | | 245F | 81 | 2.2 | 1721 | | 265F | 81 | 2.1 | 1846 | | 205I | 80 | 2.1 | 1678 | 659 | |
| | | 2#11 | 2#11 | 1 | 4#14 | 11.06 | 145J | 21 | - | 1594 | 9.72 | 144J | 20 | - | 1519 | 8.61 | 154J | 20 | - | 1615 | 7.68 | 164J | 20 | - | 1712 | 659 | 107 |
| | | | | 1 | | | 265E | 82 | 2.2 | 2134 | | 285E | 81 | 2.2 | 2285 | | 265F | 81 | 2.1 | 2290 | | 275F | 80 | 2.1 | 2405 | 904 | |
| | | 2#14 | 1#14 | 1 | 5#14 | 12.51 | 145J | 21 | - | 1825 | 11.00 | 155J | 20 | - | 1948 | 9.74 | 155J | 20 | - | 2041 | 8.69 | 165J | 20 | - | 2163 | 703 | 97 |
| | | | | 1 | | | 305D | 82 | 2.2 | 2512 | | 285E | 81 | 2.2 | 2532 | | 295E | 81 | 2.1 | 2661 | | 315E | 80 | 2.1 | 2828 | 1079 | |
| | 36 | 2#10 | 2#10 | 1 | 5#11 | 10.01 | 123J | 38 | - | 1120 | 8.79 | 123J | 37 | - | 1185 | 7.79 | 133J | 37 | - | 1261 | 6.95 | 133J | 37 | - | 1327 | 562 | 91 |
| | | | | 1 | | | 265E | 151 | 3.2 | 2072 | | 285E | 149 | 3.2 | 2221 | | 295E | 148 | 3.2 | 2328 | | 225H | 147 | 3.1 | 2102 | 838 | |
| | | 2#11 | 2#11 | 1 | 5#11 | 10.25 | 124J | 38 | - | 1345 | 9.01 | 123J | 37 | - | 1300 | 7.98 | 133J | 37 | - | 1384 | 7.12 | 133J | 37 | - | 1456 | 681 | 87 |
| | | | | 1 | | | 265E | 151 | 3.2 | 2180 | | 285E | 149 | 3.2 | 2336 | | 295E | 148 | 3.2 | 2450 | | 315E | 147 | 3.1 | 2606 | 838 | |
| | | 2#14 | 2#14 | 1 | 6#14 | 16.59 | 155GdJ | 38 | - | 2222 | 14.58 | 145J | 37 | - | 2304 | 12.92 | 155J | 37 | - | 2451 | 11.52 | 165J | 37 | - | 2598 | 949 | 72 |
| | | | | 1 | | | 365C | 150 | 3.2 | 3232 | | 325D | 149 | 3.2 | 3181 | | 345D | 148 | 3.1 | 3379 | | 365D | 146 | 3.1 | 3576 | 1357 | |
| | | 3#14 | 2#14 | 1 | 7#14 | 18.88 | 165GfJ | 38 | - | 2644 | 16.59 | 165GeJ | 37 | - | 2784 | 14.70 | 165GdJ | 37 | - | 2925 | 13.11 | 175GcJ | 37 | - | 3097 | 1159 | 64 |
| | | | | 1 | | | 365C | 150 | 3.2 | 3622 | | 385C | 149 | 3.2 | 3846 | | 415C | 148 | 3.1 | 4111 | | 435C | 146 | 3.1 | 4334 | 1544 | |
| | 48 | 3# 9 | 3# 9 | 1 | 6#11 | 11.92 | 114J | 56 | - | 1428 | 10.48 | 124J | 56 | - | 1528 | 9.28 | 124J | 55 | - | 1607 | 8.28 | 124J | 55 | - | 1685 | 670 | 67 |
| | | | | 1 | | | 364C | 226 | 4.3 | 2236 | | 384C | 224 | 4.2 | 2373 | | 414C | 222 | 4.2 | 2539 | | ** | 220 | 4.3 | 1418 | 1014 | |
| | | 3#10 | 3#10 | 1 | 6#14 | 14.91 | 124J | 56 | - | 1876 | 13.11 | 134J | 56 | - | 2004 | 11.61 | 134J | 55 | - | 2111 | 10.36 | 144J | 55 | - | 2239 | 838 | 64 |
| | | | | 1 | | | 455B | 226 | 4.3 | 3697 | | 285E | 224 | 4.2 | 3015 | | 295E | 221 | 4.2 | 3167 | | 315E | 220 | 4.1 | 3367 | 1407 | |
| | | 4#11 | 3#11 | 1 | 7#14 | 19.71 | 145GdJ | 56 | - | 2580 | 17.33 | 155GcJ | 56 | - | 2753 | 15.35 | 155J | 55 | - | 2891 | 13.69 | 155J | 55 | - | 3029 | 1168 | 58 |
| | | | | 1 | | | 455B | 226 | 4.3 | 4177 | | 485B | 223 | 4.2 | 4454 | | 515B | 221 | 4.2 | 4731 | | 545B | 220 | 4.1 | 5008 | 1612 | |
| | | 3#14 | 3#14 | 1 | 9#14 | 24.43 | 185EiJ | 56 | - | 3237 | 21.47 | 185EiJ | 56 | - | 3409 | 19.02 | 185FgJ | 55 | - | 3581 | 16.96 | 175GfJ | 55 | - | 3718 | 1407 | 50 |
| | | | | 1 | | | 455B | 226 | 4.3 | 4693 | | 485B | 223 | 4.2 | 5005 | | 515B | 221 | 4.2 | 5316 | | 545B | 219 | 4.1 | 5628 | 1998 | |

(1) See "Recommended Bar Details", Fig. 12-1. For girders, use tabulated beam depth – 2 inches ($b$ – 2″).
(2) In "Layers" column, first line is number of layers for bottom bars, second line is for number of layers for top bars.
(3) For superimposed factored load capacity, deduct 1.2 × stem weight.
(4) Total capacities tabulated causing deflection in excess of $\ell_n/360$ are designated thus: * – $\ell_n/360$ < deflection < $\ell_n/240$
X – $\ell_n/240$ < deflection < $\ell_n/180$
Y – deflection > $\ell_n/180$

(5) For each beam design, first line is for open stirrups, second line is for closed ties. See Fig. 12-4. At free ends, use stirrups tabulated for "Interior Spans". For $b$ > 24 in., provide 4 legs (two stirrups) of size and spacing tabulated. For stirrup nomenclature, see page 12-14.

Other notation:
N/A – STIRRUPS ARE NOT REQUIRED
** – MAXIMUM SPACING IS LESS THAN 3 INCHES. NOT RECOMMENDED
*** – SHEAR STRESS IS GREATER THAN $10\sqrt{f_c'}$
**** – TORSION STRESS EXCEEDS ALLOWABLE

(6) $+\phi M_n$ and $-\phi M_n$ are design moment strength capacities for rectangular section $b \times h$
(7) Midspan elastic deflection (in.) = $C \times (w/1.4) \times \ell_n^4$, where $w$ = tabulated load (k/ft.), $\ell_n$ in ft.
"Average service load" is taken as $w$/1.4.

# CHAPTER 13 – SQUARE SPREAD FOOTINGS, PILE CAPS AND DRILLED PIERS

This Chapter covers square spread footings for individual columns, pile caps for individual columns, and drilled pier (caisson) foundations.

## SQUARE SPREAD FOOTINGS FOR INDIVIDUAL COLUMNS

The function of a spread footing is to distribute the total downward load of a column, pier or wall (including the weight of the footing itself) over a sufficient area of soil to keep the bearing pressure within that allowable for the soil encountered. Also, the centroid of the downward load should coincide with that of the soil pressure prism to avoid eccentricities and overturning.

Net factored axial load capacities for columns bearing on individual square spread footings are included in the tabulated designs in this Chapter. The footing designs are based on concrete with a compressive strength $f'_c$ = 3,000 psi and reinforcing bars with $f_y$ = 60,000 psi. In the tabulated designs, 1.2 times the weight of the footing has been deducted from the total factored load on the footing.

Allowable soil pressures are usually recommended by a geotechnical engineer, or set by the statutory building code as safe bearing capacities per square foot, where "safe" means for "service loads." The service load from column to footing is the computed dead load plus live load. For strength design, the total factored load becomes 1.2 × dead load plus 1.6 × live load (or other combinations as in ACI 9.2). A load factor of 1.4 times the "safe soil bearing capacity" will provide about the same "safety factor" on soil for 1.2 dead plus 1.6 live load from the column. Therefore, the tabulated designs are arranged for factored capacities of 1,400, 2,800, 4,200... psf, corresponding to the safe bearing capacities of 1,000, 2,000, 3,000... psf.

Usually, in design practice, and invariably throughout these tabulated designs, soil pressures are assumed uniformly distributed across the bottom of the footing. If the distribution pressure is high directly underneath the column and decreasing toward the edges of the footing, the footing bending moment would be reduced. If the distribution pressure is high around the edges of the footing and low in the center, the footing bending moment would be increased.

To meet the first functional requirement of a footing, all downward loads in the column from the floors above are accumulated. All dead loads will be multiplied by a factor of 1.2, as required by ACI 9.2.l. Included under this load factor are all floor finishes, ceilings, piping, ducts, partitions, cases, storage racks, fixed mechanical equipment, or any similar permanent, known, unvarying loads. Similarly, all live loads are augmented by a factor of 1.6 as required by ACI 9.2.l. Live loads are only the specified superimposed live loads, suitable values for which are specified in all statutory building codes with allowable reductions for column design. The effects of all wind, earthquake and other loads that should be used in the design of the column are similarly computed and properly augmented.

The effects of these various loadings will be combined into a required column strength, *U,* which is the largest from the equations in ACI 9.2:

$U = 1.4D$
$U = 1.2D + 1.6L$
$U = 1.2D + 1.0L + 1.6W$ (whichever is larger)

This maximum column required strength is the one to be used in entering the tabulated designs in this Chapter.

The strength-reduction factors, $\phi$ (ACI 9.3) have already been incorporated into the tabulated designs.

A footing can usually be made square, centered under the column it supports, and of size such as those tabulated. Rectangular footings can be substituted when space is restricted in one direction and not in the other. Round, octagonal, and other footing shapes can be used. Approximations are possible for such shapes from tabulated designs.

A word of caution: No tables or methods of computation can replace sound engineering judgment, especially in dealing with soil conditions. Selection of the footing design for an appropriate soil bearing capacity must be based on knowledge of the soil's characteristics.

### Design Considerations

The general design considerations leading to the footing tabulated designs involve both code requirements and normal design and construction practices. Some of these considerations are listed below:

(1) Choice of materials. Normal-weight concrete with a specified compressive strength of 3,000 psi is usually the most economical choice. Higher strength concrete can be used where the depth or the weight of the footing is very critical and must be minimized, but usually savings in concrete volume do not offset

higher unit price. Lower strength concretes will reduce shear and increase development lengths. Grade 60 reinforcing bars ($f_y$ = 60,000 psi) are the standard grade recommended for overall economy.

(2) Design for concentric load. Only special designs consider moment transfer from column to footing, which are outside the scope of the tabulated designs.

(3) Size of column. Again, conservatively, the smallest practicable reinforced concrete square tied column was assumed for design of the footings. Normally, for the loads shown, a larger column will be used with consequent reduction of factored shears and moments. For much larger columns on small footings with high soil bearing capacity, it may be worthwhile to reduce the reinforcement in proportion to the square of the ratio of reduced cantilever span to the tabulated dimension (except when minimum reinforcement controls).

(4) Effective depth. Average effective depth was used to compute both design shear strength and the required flexural reinforcement. For square footings, it is normal to require equal flexural reinforcement each way.

(5), Shear. Both two-way and one-way shear have been considered.

(6) Length of reinforcing bars. As is common practice, all reinforcing bars are shown as equal length. For each tabulated design, the bar size is the maximum for the available development length and minimum spacing. For very large footings, alternate length bars may be used, but an additional step in design is required to satisfy the stringent code requirements for bars cut off in tension zones (ACI 12.10.5).

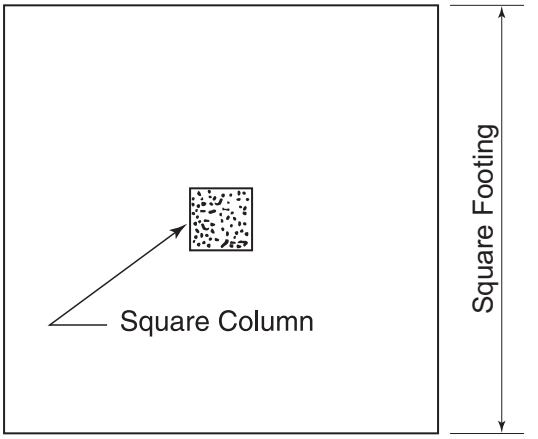
(7) Minimum area of shrinkage and temperature reinforcement, $A_s$ = 0.0018$bh$ (ACI 10.5.4 and ACI 7.12)

## Scope of Load Tables

The scope of the tabulated designs provide a range of safe bearing capacity from 1,000 psf to 15,500 psf in increments of 500 psf, which was considered adequate to include the poorest soil normally encountered to high quality bearing clays. Footing sizes offered cover the range 4′-0″ to 20′-0″ square, considered adequate for most structures using individual footings.

## Basis of Tabulated Designs

See Fig. 13-1 for the material strengths, concrete cover, effective depth $d$, arrangement of reinforcing bars, and design shear strengths used in the preparation of the tabulated designs.




$f_y$ = 60,000 psi
$f_c'$ = 3,000 psi (footing)
= 5,000 psi (column)

Two-way shear*
$\phi V_c = \phi 4\sqrt{f_c'}\, b_o d$

One-way shear
$\phi V_c = \phi 2\sqrt{f_c'}\, b_w d$

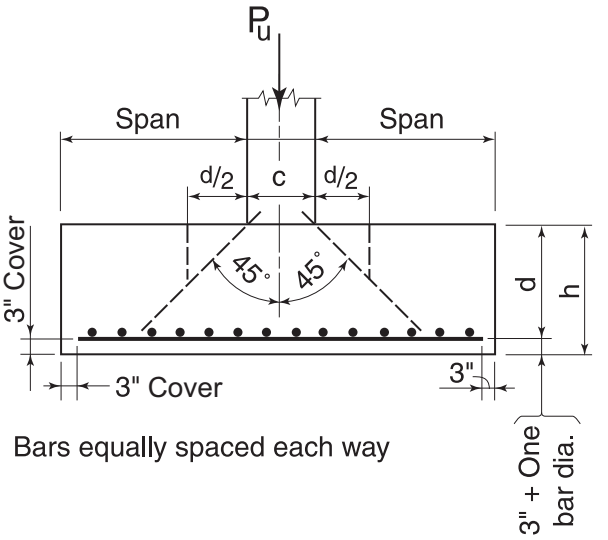



**Figure 13-1 Footing Dimensions**

*ACI Eq. 11-31 is not applicable for square columns. For the column sizes and footing thicknesses in the tabulated designs, ACI Eq. 11-32 does not control design shear strength.

### Use of Tabulated Designs

The tabulated designs plus details of Fig. 13-1 are arranged to provide a complete design for square spread footings. Select the table for the appropriate safe soil bearing capacity and enter the table with the maximum column factored load, $P_u = 1.2D + 1.6L$, proceed down the last column of the table, and select the first design with a column design capacity larger than the factored load. For quick estimates, the volume of concrete, the size and the number of bars, and the total weight of reinforcing bars are included in the tabulated designs.

The Manual Example on Page 13-4 illustrates the computations of the computer program used to prepare the tabulated designs. It will be noted that the process of preparing tabulated designs reverses the normal design procedure. Beginning with a selected increment of footing size and safe soil bearing capacity, the minimum column size, depth, and required reinforcement are determined. Since the weight of the footing must be deducted from the total load on the soil, the computer program uses a convergent system of trial depths to select the tabulated depth which is determined by shear for the net load.

## DEVELOPMENT OF DOWELS IN FOOTINGS

Table 13-1 gives the minimum compression development lengths, $\ell_d$, for Grade 60 ($f_y$ = 60,000 psi) reinforcing bars in concrete with $f'_c \geq$ 3,000 psi. For minimum footing thickness, add 3 inches of bottom concrete cover.

**Table 13-1 Compression $\ell_d$ for Grade 60 Reinforcing Bars with $f'_c \geq$ 3,000 psi**

| Compression $\ell_d$ (inches) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| #5 | #6 | #7 | #8 | #9 | #10 | #11 | #14 | #18 |
| 14 | 17 | 19 | 22 | 25 | 28 | 31 | 38 | 50 |

When the dowel compression development length exceeds the available length for a given footing thickness, three possibilities are:

(1) Add a monolithic concrete cap suffciently thick to provide the required embedment length.

(2) Use a greater number of smaller diameter dowels to provide the required area of dowels and embedment length within the thickness selected.

(3) Thicken the footing to provide necessary embedment length.

This discussion considers dowels in compression only. Dowels in tension are excluded here.

Dowels are required to transfer only the *excess* compression above bearing allowed on the footing or on the gross area of column (ACI 15.8.1.2). The column dowels must provide a minimum area of 0.5 percent times the gross area of the column. (ACI 15.8.2.1).

The strength-reduction factor, $\phi = 0.65$, is identical to that for compression in tied columns (ACI 9.3.2.2-b). Design bearing strength on full sections (as on the base of the column) is $\phi(0.85 f'_c A_1)$ (ACI 10.14.1). If the load bearing, $A_1$, is one half or less than the area resisting the bearing load, $A_2$, the design bearing strength is $2\phi(0.85 f'_c A_1)$.

### Example 1. Dowels for Minimum Size Columns

From the Manual Example of a footing design on Page 13-4, take an 18 in. × 18 in. column with $P_u$ = 1,345 kips on a footing 38-in. deep. Column concrete $f'_c$ = 5,000 psi; longitudinal column bars are 8 percent of gross area of column; $f_y$ = 60,000 psi. Footing concrete $f'_c$ = 3,000 psi.

Design bearing strength of column concrete
$= 0.85\phi f'_c = (0.85)(0.65)(5{,}000) = 2{,}763$ psi

Design bearing strength of footing concrete
$= 2(0.85)\phi f'_c = 2(0.85)(0.65)(3{,}000) = 3{,}315$ psi

Note that the design bearing strength is always critical on the column until the compressive strength of the column concrete is twice that of the footing.

Column compression is transferred by a combination of concrete bearing and steel bearing. The design bearing strength of the column is then (2,763)(18 × 18) = 895 kips

Excess compression to be transferred by dowels,
$P_u - 895 = 1{,}345 - 895 = 450$ kips

Area of dowels required = 450/60 = 7.50 in.$^2$, which is greater than the minimum area of dowels = $0.005A_g$ = 0.005(18)(18) = 1.62 in.$^2$

Embedment depth available = 38 – 3 = 35 in.
Maximum size bar (see Table 13-1):

For #11 bar, compression $\ell_d$ = 31 in. < 35 in.

Area of #11 bar = 1.56 in.$^2$

Number of bars required: 7.50/1.56 = 5 – #11 bars

Total length of dowel = embedment (compression $\ell_d$) in footing plus compression lap splice in column. Compression lap splice in column with $f'_c$ = 5,000 psi; see Table 5-1; for a #11 bar, the lap length = 0.83(43) = 36 in. if column tie area ≥ 0.0015*hs* or 43 in. with lesser ties. With vertical bars equal to 8 percent of the column area, ties will usually satisfy these requirements (ACI 12.17.2.4). Dowel length is 31 + 36 = 67 in.

## Example 2. Dowels for Columns with Minimum Longitudinal Reinforcement

Select dowels for a 26 in. × 26 in. column with 8-#9 longitudinal bars (1.18 percent); $f_y$ = 60,000 psi; column concrete $f'_c$ = 5,000 psi. Same factored load as in Example 1, $P_u$ = 1,345 kips. Footing concrete $f'_c$ = 3,000 psi.

Design concrete bearing strength of footing
= $2(0.85)\phi f'_c = 2(0.85)(0.65)(3{,}000) = 3{,}315$ psi

Design concrete bearing strength of column
= $0.85\phi f'_c = 0.85(0.65)(5{,}000) = 2{,}763$ psi (controls)

Total compression = 1,345(1,000)/(26 × 26)

= 1,990 psi < 2,763 psi

There is no excess compression since the total compression load is less than the controlling design bearing strength. The Code nevertheless requires dowels with a total minimum area = 0.005(26)(26) = 3.38 in.$^2$ (ACI 15.8.2.1).

Try: 4 – #9 dowels ($A_s$ = 4.00 in.$^2$).

From Table 13-1, for a #9 bar, compression $\ell_d$ = 25 in.

From Table 5-1, the compression lap length of the #9 dowels = 34 in. (the required length would be less than 34 in. if the reduction for column ties was considered (ACI 12.17.2.4).) Dowel length is 34 + 25 = 59 in.

Use: 4 – #9 × 4′-11″ dowels

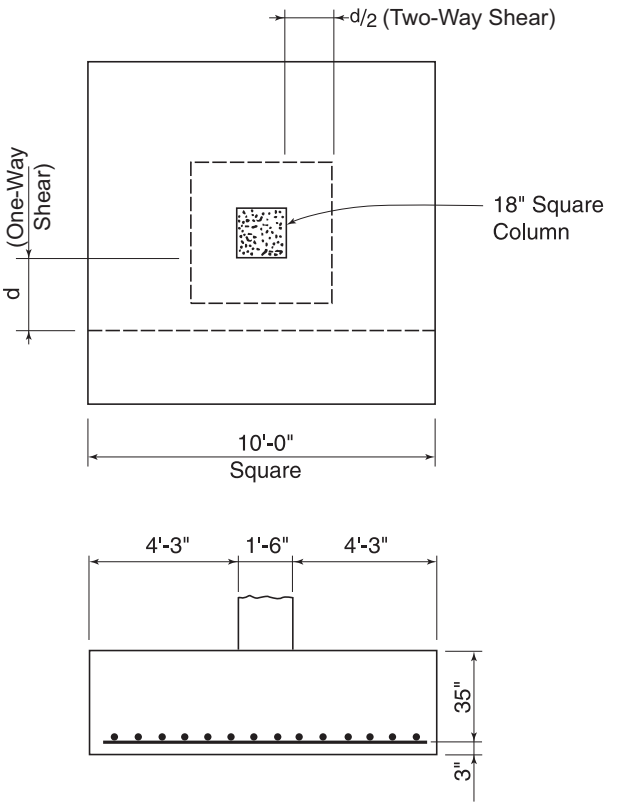
## Manual Example

For a safe allowable soil bearing capacity of 10,000 psf, determine the maximum column capacity, and the minimum depth and required reinforcement for a 10′-0″ square footing. Use $f'_c$ = 3,000 psi and $f_y$ = 60,000 psi for the footing. The design should be adequate for any square column *larger* than that required for a tied column with $f'_c$ = 5,000 psi, and 8 percent Grade 60 vertical reinforcement. See Fig. 13-1, and the following plan view and elevation of the footing. Compare results to tabulated designs on Page 13-15.

*Soil Calculations:*

Safe allowable bearing capacity, $q_a$ = 10,000 psf (given)
Total factored bearing capacity, $q_t$ = 14,000 psf
For first trial, assume footing thickness 3′-2″ (38”)
Net factored soil pressure = $q_s$

$q_s = q_t = 14{,}000 - 1.2(38/12)(150) = 13{,}430$ psf




*Factored column load, $P_u$:*

$$P_u = \frac{(10 \times 10)(13{,}430)}{1000} = 1{,}343 \text{ kips}$$

*Minimum size square tied column:*

$f'_c$ = 5,000 psi; $f_y$ = 60,000 psi; $\rho$ = 0.08;

Maximum axial design strength (ACI Eq. 10-2):
$\phi P_{n(max)} = 0.80\phi\,[0.85 f'_c\,(A_g - A_{st}) + f_y\,A_{st}]$

Substituting $A_{st} = \rho A_g$ and $\phi$ = 0.65 and solving for:
$\phi P_{n(max)}/A_g = 0.442 f'_c(1 - \rho) + 0.520 f_y \rho = 4.53$ ksi

Min. size of square column, $c = \sqrt{\frac{P_u}{4.53}} = \sqrt{\frac{1{,}343}{4.53}}$
= 17.22 = 18 in.
Min. size of square column = 18 in. × 18 in.

*Two-way shear*

Design shear strength, $\phi V_c = \phi 4\sqrt{f'_c} b_o d$ on a critical section located at a distance $d/2$ from the face of the column (ACI 11.11.2). See plan view of the footing.

Compute the minimum effective depth for the maximum size bar that can be developed in the span length. Embedment length available for tension development = 51 – 3 = 48 in. Assume #9 bars per tabulated design. See Chapter 5 for required tension $\ell_d$. From Table 5-2(a), Case 1, $\ell_d$ = 62 in.; from Table 5-3(a), $\ell_d$ = 41 in.

for 2 in. or 3 in. of concrete cover, provided the c.-c. spacing of the bars > twice the concrete cover plus one bar diameter (Note 3 under Table 5-3(a)). If the applicable $\ell_d$ is 41 in., the available embedment length of 48 in. > 41 in. From the tabulated design on Page 13-15, the c.-c. spacing of #9 bars = $(12 \times 10 - 3 - 3 - 1.128)/(9 - 1) = 14.11$ in. which is greater than 2(3) + 1 = 7 in.; hence, $\ell_d$ = 41 in.

$d = 38 - 3 - 1.128 = 33.87$ in.

For two-way shear, $b_o = 4(18 + 33.87) = 207.5$ in.

Total factored shear $V_u$

$$V_u = \frac{(13{,}430)}{1000}\left(10 \times 10 - \frac{51.87}{12} \times \frac{51.87}{12}\right)$$
$$= 1{,}092 \text{ kips}$$

$\phi V_c = 0.75(4)\sqrt{3{,}000}(207.5)(33.87)/1{,}000$
$\phi V_c = 1{,}154$ kips > $V_u$, okay

*One-way (beam) shear*

Design shear strength, $\phi V_c = \phi 2\sqrt{f'_c} b_w d$ on a critical section located at a distance $d$ from the face of the column. See plan view of the footing.

$$V_u = \frac{(51 - 33.87)}{12}(10)(13{,}430)/1{,}000 = 192 \text{ kips}$$

$\phi V_c = 0.75(2)\sqrt{3{,}000}(120)(33.87)/1{,}000$
$\phi V_c = 334$ kips > $V_u$, okay

*Selection of bar size* – The bar size and number of bars are selected by the following process:

1. Compute the required number of each bar size that would satisfy the total required $A_s$.
2. Reject bar sizes that are too large to be fully developed by anchorage (as straight bars).
3. Reject bar sizes for which the required number results in $A_s$ more than 10 percent higher than $A_s$ required (to save tonnage).
4. Reject bar sizes that require spacing at more than 18 in.
5. Reject bar sizes that require a total number of bars 25 percent more than the minimum number for bar sizes passing criteria 1 through 4 (to avoid high placing cost).
6. If more than one choice remains, select from the remaining choices the same bar size used for the preceding smaller footing if this bar size is one of those remaining. If not, select the bar size remaining that gives the least weight of reinforcing bars.

*Required flexural reinforcement*

Factored moment is computed at the face of the column at the critical section prescribed (ACI 15.4.2.-a).

$$M_u = \frac{1}{2}(13{,}430)(10)(4.25)^2/1{,}000$$
$$= 1{,}213 \text{ ft.-kips}$$
$$= 1{,}213(12/10) = 1{,}455 \text{ in.-kips/ft.}$$

From Chapter 5 with $f'_c$ = 3,000 psi and $b$ = 12 in.:

$$A_s = 0.510(d) - \sqrt{0.260d^2 - 0.0189M_u}$$
$$= 0.510(33.87) - \sqrt{0.260(33.87)^2 - 0.0189(1{,}455)}$$
$$= 0.815 \text{ in.}^2/\text{ft.} = 8.15 \text{ in.}^2$$

∴Use 9-#9 bars (#9 bars used in 9'-6" footing)

Need to check that $\varepsilon_t \geq 0.005$, which is required in the ACI Building Code for $\phi$ =0.90.

From Chapter 5, $\rho_{max} = 0.01355$

$$\rho = \frac{A_s}{bd} = \frac{9.00}{12(10)33.87} = 0.01329 < 0.01355, \text{ OK}$$

*Quantities of materials*

Weight of reinforcing bars:

Weight = (2)(9)(3.40)(9.5) = 581 pounds

$$\text{Volume of Concrete} = \frac{(10 \times 10)(38/12)}{27}$$
$$= 11.7 \text{ cubic yards}$$

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 1,400 psf (SAFE BEARING CAPACITY 1,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 12 | 10 | 4-#4 * | 0.73 | 19 | 0.6 | 20 |
| 4'-6" | 12 | 10 | 5-#4 | 0.83 | 27 | 0.8 | 25 |
| 5'-0" | 12 | 10 | 4-#5 | 0.90 | 38 | 0.9 | 31 |
| 5'-6" | 12 | 10 | 5-#5 | 0.99 | 52 | 1.1 | 37 |
| 6'-0" | 12 | 10 | 5-#5 | 1.09 | 57 | 1.3 | 44 |
| 6'-6" | 12 | 10 | 6-#5 | 1.18 | 75 | 1.6 | 52 |
| 7'-0" | 12 | 10 | 6-#5 | 1.27 | 81 | 1.8 | 60 |
| 7'-6" | 12 | 10 | 6-#5 | 1.38 | 88 | 2.1 | 69 |
| 8'-0" | 12 | 10 | 6-#5 | 1.71 | 94 | 2.4 | 78 |
| 8'-6" | 12 | 10 | 7-#5 | 2.08 | 117 | 2.7 | 88 |
| 9'-0" | 13 | 10 | 8-#5 | 2.20 | 142 | 3.3 | 98 |
| 9'-6" | 14 | 10 | 8-#5 | 2.33 | 150 | 3.9 | 107 |
| 10'-0" | 14 | 10 | 9-#5 | 2.75 | 178 | 4.3 | 119 |
| 10'-6" | 15 | 10 | 10-#5 | 2.88 | 209 | 5.1 | 130 |
| 11'-0" | 15 | 10 | 11-#5 | 3.35 | 241 | 5.6 | 142 |
| 11'-6" | 16 | 10 | 12-#5 | 3.49 | 275 | 6.5 | 153 |
| 12'-0" | 16 | 10 | 13-#5 | 4.00 | 312 | 7.1 | 167 |
| 12'-6" | 17 | 10 | 14-#5 | 4.15 | 350 | 8.2 | 179 |
| 13'-0" | 18 | 10 | 14-#5 | 4.30 | 365 | 9.4 | 191 |
| 13'-6" | 18 | 10 | 16-#5 | 4.85 | 434 | 10.1 | 206 |
| 14'-0" | 19 | 10 | 17-#5 | 5.00 | 479 | 11.5 | 219 |
| 14'-6" | 19 | 10 | 13-#6 | 5.64 | 547 | 12.3 | 234 |
| 15'-0" | 20 | 10 | 14-#6 | 5.80 | 610 | 13.9 | 248 |
| 15'-6" | 20 | 10 | 15-#6 | 6.43 | 676 | 14.8 | 264 |
| 16'-0" | 21 | 10 | 15-#6 | 6.58 | 698 | 16.6 | 278 |
| 16'-6" | 22 | 10 | 16-#6 | 6.74 | 769 | 18.5 | 291 |
| 17'-0" | 22 | 10 | 17-#6 | 7.41 | 843 | 19.6 | 309 |
| 17'-6" | 23 | 10 | 13-#7 | 7.62 | 903 | 21.7 | 323 |
| 18'-0" | 23 | 10 | 14-#7 | 8.33 | 1002 | 23.0 | 342 |
| 18'-6" | 24 | 10 | 15-#7 | 8.48 | 1104 | 25.4 | 356 |
| 19'-0" | 24 | 10 | 16-#7 | 9.22 | 1210 | 26.7 | 375 |
| 19'-6" | 25 | 10 | 16-#7 | 9.37 | 1243 | 29.3 | 390 |
| 20'-0" | 25 | 10 | 17-#7 | 10.14 | 1355 | 30.9 | 410 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 2,100 psf (SAFE BEARING CAPACITY 1,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 12 | 10 | 4-#4 * | 0.73 | 19 | 0.6 | 31 |
| 4'-6" | 12 | 10 | 5-#4 | 0.83 | 27 | 0.8 | 39 |
| 5'-0" | 12 | 10 | 4-#5 | 0.90 | 38 | 0.9 | 48 |
| 5'-6" | 12 | 10 | 5-#5 | 0.99 | 52 | 1.1 | 58 |
| 6'-0" | 12 | 10 | 5-#5 | 1.09 | 57 | 1.3 | 69 |
| 6'-6" | 12 | 10 | 6-#5 | 1.36 | 75 | 1.6 | 81 |
| 7'-0" | 13 | 10 | 6-#5 | 1.54 | 81 | 2.0 | 93 |
| 7'-6" | 13 | 10 | 7-#5 | 1.93 | 102 | 2.3 | 107 |
| 8'-0" | 14 | 10 | 7-#5 | 2.13 | 110 | 2.8 | 121 |
| 8'-6" | 15 | 10 | 8-#5 | 2.34 | 134 | 3.3 | 135 |
| 9'-0" | 16 | 10 | 9-#5 | 2.56 | 160 | 4.0 | 151 |
| 9'-6" | 16 | 10 | 10-#5 | 3.06 | 188 | 4.5 | 168 |
| 10'-0" | 17 | 10 | 11-#5 | 3.30 | 218 | 5.2 | 185 |
| 10'-6" | 18 | 10 | 12-#5 | 3.55 | 250 | 6.1 | 202 |
| 11'-0" | 19 | 10 | 9-#6 | 3.85 | 284 | 7.1 | 220 |
| 11'-6" | 19 | 10 | 11-#6 | 4.44 | 363 | 7.8 | 240 |
| 12'-0" | 20 | 10 | 11-#6 | 4.72 | 380 | 8.9 | 259 |
| 12'-6" | 21 | 10 | 12-#6 | 5.00 | 433 | 10.1 | 279 |
| 13'-0" | 22 | 10 | 13-#6 | 5.30 | 488 | 11.5 | 299 |
| 13'-6" | 22 | 10 | 14-#6 | 5.98 | 547 | 12.4 | 323 |
| 14'-0" | 23 | 10 | 15-#6 | 6.29 | 608 | 13.9 | 344 |
| 14'-6" | 24 | 10 | 16-#6 | 6.61 | 673 | 15.6 | 366 |
| 15'-0" | 24 | 10 | 17-#6 | 7.36 | 740 | 16.7 | 392 |
| 15'-6" | 25 | 10 | 13-#7 | 7.74 | 797 | 18.5 | 414 |
| 16'-0" | 26 | 10 | 14-#7 | 8.08 | 887 | 20.5 | 438 |
| 16'-6" | 26 | 11 | 15-#7 | 8.81 | 981 | 21.8 | 466 |
| 17'-0" | 27 | 11 | 12-#8 | 9.21 | 1057 | 24.1 | 490 |
| 17'-6" | 28 | 11 | 13-#8 | 9.57 | 1180 | 26.5 | 515 |
| 18'-0" | 28 | 11 | 14-#8 | 10.46 | 1308 | 28.0 | 544 |
| 18'-6" | 29 | 12 | 14-#8 | 10.73 | 1346 | 30.6 | 570 |
| 19'-0" | 29 | 12 | 15-#8 | 11.67 | 1482 | 32.3 | 601 |
| 19'-6" | 30 | 12 | 16-#8 | 12.05 | 1623 | 35.2 | 627 |
| 20'-0" | 30 | 13 | 17-#8 | 12.93 | 1770 | 37.0 | 660 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 2,800 psf (SAFE BEARING CAPACITY 2,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 12 | 10 | 4-#4 * | 0.73 | 19 | 0.6 | 42 |
| 4'-6" | 12 | 10 | 5-#4 | 0.83 | 27 | 0.8 | 53 |
| 5'-0" | 12 | 10 | 4-#5 | 0.90 | 38 | 0.9 | 66 |
| 5'-6" | 12 | 10 | 5-#5 | 1.06 | 52 | 1.1 | 79 |
| 6'-0" | 13 | 10 | 5-#5 | 1.26 | 57 | 1.4 | 94 |
| 6'-6" | 13 | 10 | 6-#5 | 1.66 | 75 | 1.7 | 110 |
| 7'-0" | 14 | 10 | 7-#5 | 1.89 | 95 | 2.1 | 127 |
| 7'-6" | 15 | 10 | 7-#5 | 2.15 | 102 | 2.6 | 145 |
| 8'-0" | 16 | 10 | 8-#5 | 2.42 | 125 | 3.2 | 164 |
| 8'-6" | 17 | 10 | 9-#5 | 2.70 | 150 | 3.8 | 184 |
| 9'-0" | 18 | 10 | 7-#6 | 3.03 | 179 | 4.5 | 205 |
| 9'-6" | 19 | 10 | 8-#6 | 3.34 | 216 | 5.3 | 227 |
| 10'-0" | 20 | 10 | 9-#6 | 3.67 | 257 | 6.2 | 250 |
| 10'-6" | 21 | 10 | 10-#6 | 4.01 | 300 | 7.1 | 274 |
| 11'-0" | 21 | 10 | 8-#7 | 4.70 | 343 | 7.8 | 301 |
| 11'-6" | 22 | 10 | 9-#7 | 5.07 | 405 | 9.0 | 327 |
| 12'-0" | 23 | 10 | 10-#7 | 5.46 | 470 | 10.2 | 354 |
| 12'-6" | 24 | 10 | 10-#7 | 5.86 | 491 | 11.6 | 381 |
| 13'-0" | 25 | 10 | 11-#7 | 6.28 | 562 | 13.0 | 410 |
| 13'-6" | 26 | 10 | 12-#7 | 6.70 | 638 | 14.6 | 439 |
| 14'-0" | 26 | 11 | 13-#7 | 7.43 | 717 | 15.7 | 472 |
| 14'-6" | 27 | 11 | 14-#7 | 7.88 | 801 | 17.5 | 504 |
| 15'-0" | 28 | 11 | 14-#7 | 8.34 | 830 | 19.4 | 536 |
| 15'-6" | 28 | 12 | 12-#8 | 9.20 | 961 | 20.8 | 572 |
| 16'-0" | 29 | 12 | 13-#8 | 9.69 | 1076 | 22.9 | 605 |
| 16'-6" | 30 | 12 | 13-#8 | 10.19 | 1111 | 25.2 | 640 |
| 17'-0" | 31 | 13 | 14-#8 | 10.59 | 1234 | 27.7 | 675 |
| 17'-6" | 31 | 13 | 15-#8 | 11.61 | 1362 | 29.3 | 715 |
| 18'-0" | 32 | 13 | 16-#8 | 12.14 | 1495 | 32.0 | 752 |
| 18'-6" | 33 | 14 | 16-#8 | 12.56 | 1538 | 34.9 | 789 |
| 19'-0" | 34 | 14 | 17-#8 | 13.11 | 1679 | 37.9 | 827 |
| 19'-6" | 34 | 14 | 15-#9 | 14.30 | 1938 | 39.9 | 871 |
| 20'-0" | 35 | 15 | 15-#9 | 14.74 | 1989 | 43.2 | 910 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 3,500 psf (SAFE BEARING CAPACITY 2,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 12 | 10 | 4-#4 * | 0.73 | 19 | 0.6 | 53 |
| 4'-6" | 12 | 10 | 5-#4 | 0.83 | 27 | 0.8 | 67 |
| 5'-0" | 12 | 10 | 4-#5 | 0.98 | 38 | 0.9 | 83 |
| 5'-6" | 13 | 10 | 5-#5 | 1.20 | 52 | 1.2 | 100 |
| 6'-0" | 14 | 10 | 5-#5 | 1.44 | 57 | 1.6 | 118 |
| 6'-6" | 15 | 10 | 6-#5 | 1.71 | 75 | 2.0 | 138 |
| 7'-0" | 16 | 10 | 7-#5 | 1.99 | 95 | 2.4 | 160 |
| 7'-6" | 17 | 10 | 8-#5 | 2.30 | 117 | 3.0 | 183 |
| 8'-0" | 18 | 10 | 9-#5 | 2.62 | 141 | 3.6 | 207 |
| 8'-6" | 19 | 10 | 7-#6 | 2.99 | 168 | 4.2 | 232 |
| 9'-0" | 20 | 10 | 8-#6 | 3.36 | 204 | 5.0 | 259 |
| 9'-6" | 21 | 10 | 9-#6 | 3.74 | 243 | 5.8 | 287 |
| 10'-0" | 22 | 10 | 10-#6 | 4.15 | 285 | 6.8 | 317 |
| 10'-6" | 23 | 10 | 8-#7 | 4.60 | 327 | 7.8 | 348 |
| 11'-0" | 24 | 10 | 9-#7 | 5.04 | 386 | 9.0 | 380 |
| 11'-6" | 25 | 10 | 10-#7 | 5.50 | 450 | 10.2 | 413 |
| 12'-0" | 26 | 10 | 10-#7 | 5.97 | 470 | 11.6 | 448 |
| 12'-6" | 27 | 11 | 11-#7 | 6.37 | 540 | 13.0 | 484 |
| 13'-0" | 28 | 11 | 12-#7 | 6.88 | 613 | 14.6 | 521 |
| 13'-6" | 28 | 12 | 13-#7 | 7.66 | 691 | 15.8 | 561 |
| 14'-0" | 29 | 12 | 14-#7 | 8.21 | 773 | 17.5 | 601 |
| 14'-6" | 30 | 12 | 15-#7 | 8.77 | 858 | 19.5 | 641 |
| 15'-0" | 31 | 13 | 12-#8 | 9.28 | 929 | 21.5 | 683 |
| 15'-6" | 32 | 13 | 13-#8 | 9.87 | 1041 | 23.7 | 726 |
| 16'-0" | 32 | 14 | 14-#8 | 10.80 | 1159 | 25.3 | 773 |
| 16'-6" | 33 | 14 | 15-#8 | 11.43 | 1282 | 27.7 | 818 |
| 17'-0" | 34 | 14 | 16-#8 | 12.08 | 1410 | 30.3 | 864 |
| 17'-6" | 35 | 15 | 16-#8 | 12.61 | 1452 | 33.1 | 911 |
| 18'-0" | 36 | 15 | 17-#8 | 13.28 | 1589 | 36.0 | 959 |
| 18'-6" | 37 | 15 | 18-#8 | 13.96 | 1730 | 39.1 | 1008 |
| 19'-0" | 37 | 16 | 20-#8 | 15.05 | 1976 | 41.2 | 1063 |
| 19'-6" | 38 | 16 | 20-#8 | 15.77 | 2029 | 44.6 | 1114 |
| 20'-0" | 39 | 17 | 21-#8 | 16.35 | 2187 | 48.1 | 1166 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 4,200 psf (SAFE BEARING CAPACITY 3,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 12 | 10 | 4-#4 * | 0.73 | 19 | 0.6 | 64 |
| 4'-6" | 12 | 10 | 5-#4 | 0.83 | 27 | 0.8 | 81 |
| 5'-0" | 13 | 10 | 4-#5 | 1.05 | 38 | 1.0 | 100 |
| 5'-6" | 14 | 10 | 5-#5 | 1.31 | 52 | 1.3 | 121 |
| 6'-0" | 15 | 10 | 6-#5 | 1.59 | 69 | 1.7 | 143 |
| 6'-6" | 16 | 10 | 7-#5 | 1.90 | 88 | 2.1 | 167 |
| 7'-0" | 17 | 10 | 8-#5 | 2.23 | 108 | 2.6 | 193 |
| 7'-6" | 18 | 10 | 6-#6 | 2.62 | 126 | 3.1 | 221 |
| 8'-0" | 19 | 10 | 7-#6 | 3.00 | 158 | 3.8 | 251 |
| 8'-6" | 21 | 10 | 8-#6 | 3.19 | 192 | 4.7 | 281 |
| 9'-0" | 22 | 10 | 9-#6 | 3.61 | 230 | 5.5 | 313 |
| 9'-6" | 23 | 10 | 10-#6 | 4.06 | 270 | 6.4 | 348 |
| 10'-0" | 24 | 10 | 8-#7 | 4.55 | 311 | 7.4 | 384 |
| 10'-6" | 25 | 10 | 9-#7 | 5.05 | 368 | 8.5 | 422 |
| 11'-0" | 26 | 11 | 10-#7 | 5.47 | 429 | 9.7 | 461 |
| 11'-6" | 27 | 11 | 11-#7 | 6.00 | 495 | 11.0 | 502 |
| 12'-0" | 28 | 11 | 11-#7 | 6.56 | 517 | 12.4 | 544 |
| 12'-6" | 29 | 12 | 12-#7 | 7.04 | 589 | 14.0 | 588 |
| 13'-0" | 30 | 12 | 13-#7 | 7.63 | 664 | 15.6 | 634 |
| 13'-6" | 30 | 13 | 11-#8 | 8.54 | 764 | 16.9 | 683 |
| 14'-0" | 31 | 13 | 12-#8 | 9.19 | 865 | 18.8 | 732 |
| 14'-6" | 32 | 14 | 13-#8 | 9.74 | 972 | 20.8 | 782 |
| 15'-0" | 33 | 14 | 11-#9 | 10.48 | 1085 | 22.9 | 834 |
| 15'-6" | 34 | 14 | 12-#9 | 11.19 | 1224 | 25.2 | 887 |
| 16'-0" | 35 | 15 | 12-#9 | 11.79 | 1265 | 27.7 | 941 |
| 16'-6" | 36 | 15 | 13-#9 | 12.53 | 1414 | 30.3 | 996 |
| 17'-0" | 37 | 16 | 14-#9 | 13.16 | 1571 | 33.0 | 1053 |
| 17'-6" | 38 | 16 | 14-#9 | 13.94 | 1618 | 35.9 | 1112 |
| 18'-0" | 38 | 17 | 16-#9 | 15.10 | 1904 | 38.0 | 1176 |
| 18'-6" | 39 | 17 | 16-#9 | 15.93 | 1958 | 41.2 | 1237 |
| 19'-0" | 41 | 17 | 17-#9 | 16.23 | 2139 | 45.7 | 1294 |
| 19'-6" | 41 | 18 | 14-#10 | 17.55 | 2289 | 48.1 | 1363 |
| 20'-0" | 42 | 18 | 15-#10 | 18.43 | 2517 | 51.9 | 1428 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 4,900 psf (SAFE BEARING CAPACITY 3,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 12 | 10 | 4-#4 * | 0.73 | 19 | 0.6 | 76 |
| 4'-6" | 12 | 10 | 5-#4 | 0.96 | 27 | 0.8 | 96 |
| 5'-0" | 14 | 10 | 4-#5 | 1.12 | 38 | 1.1 | 117 |
| 5'-6" | 15 | 10 | 5-#5 | 1.40 | 52 | 1.4 | 141 |
| 6'-0" | 16 | 10 | 6-#5 | 1.71 | 69 | 1.8 | 168 |
| 6'-6" | 17 | 10 | 7-#5 | 2.06 | 88 | 2.2 | 196 |
| 7'-0" | 18 | 10 | 8-#5 | 2.44 | 108 | 2.7 | 227 |
| 7'-6" | 20 | 10 | 9-#5 | 2.66 | 131 | 3.5 | 259 |
| 8'-0" | 21 | 10 | 10-#5 | 3.08 | 156 | 4.1 | 293 |
| 8'-6" | 22 | 10 | 12-#5 | 3.53 | 200 | 4.9 | 330 |
| 9'-0" | 23 | 10 | 13-#5 | 4.01 | 231 | 5.8 | 369 |
| 9'-6" | 25 | 10 | 10-#6 | 4.36 | 270 | 7.0 | 408 |
| 10'-0" | 26 | 10 | 11-#6 | 4.83 | 314 | 8.0 | 451 |
| 10'-6" | 27 | 11 | 9-#7 | 5.32 | 368 | 9.2 | 496 |
| 11'-0" | 28 | 11 | 10-#7 | 5.90 | 429 | 10.5 | 542 |
| 11'-6" | 29 | 12 | 11-#7 | 6.40 | 495 | 11.8 | 590 |
| 12'-0" | 30 | 12 | 9-#8 | 7.06 | 553 | 13.3 | 641 |
| 12'-6" | 31 | 13 | 10-#8 | 7.60 | 641 | 14.9 | 693 |
| 13'-0" | 32 | 13 | 11-#8 | 8.28 | 734 | 16.7 | 747 |
| 13'-6" | 32 | 14 | 12-#8 | 9.23 | 833 | 18.0 | 806 |
| 14'-0" | 34 | 14 | 10-#9 | 9.63 | 918 | 20.6 | 860 |
| 14'-6" | 34 | 15 | 11-#9 | 10.65 | 1047 | 22.1 | 923 |
| 15'-0" | 36 | 15 | 12-#9 | 11.03 | 1183 | 25.0 | 981 |
| 15'-6" | 36 | 16 | 13-#9 | 12.11 | 1326 | 26.7 | 1047 |
| 16'-0" | 38 | 16 | 13-#9 | 12.50 | 1370 | 30.0 | 1108 |
| 16'-6" | 38 | 17 | 14-#9 | 13.66 | 1523 | 31.9 | 1179 |
| 17'-0" | 39 | 17 | 15-#9 | 14.54 | 1683 | 34.8 | 1247 |
| 17'-6" | 40 | 18 | 16-#9 | 15.28 | 1850 | 37.8 | 1317 |
| 18'-0" | 41 | 18 | 13-#10 | 16.27 | 1958 | 41.0 | 1388 |
| 18'-6" | 42 | 18 | 14-#10 | 17.22 | 2169 | 44.4 | 1461 |
| 19'-0" | 43 | 19 | 15-#10 | 18.02 | 2388 | 47.9 | 1536 |
| 19'-6" | 44 | 19 | 15-#10 | 19.01 | 2453 | 51.6 | 1612 |
| 20'-0" | 45 | 20 | 16-#10 | 19.84 | 2685 | 55.6 | 1690 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 5,600 psf (SAFE BEARING CAPACITY 4,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 12 | 10 | 4-#4 * | 0.73 | 19 | 0.6 | 87 |
| 4'-6" | 13 | 10 | 5-#4 | 0.98 | 27 | 0.8 | 109 |
| 5'-0" | 14 | 10 | 5-#5 | 1.28 | 47 | 1.1 | 135 |
| 5'-6" | 16 | 10 | 5-#5 | 1.47 | 52 | 1.5 | 162 |
| 6'-0" | 17 | 10 | 6-#5 | 1.82 | 69 | 1.9 | 192 |
| 6'-6" | 18 | 10 | 8-#5 | 2.20 | 100 | 2.3 | 225 |
| 7'-0" | 20 | 10 | 8-#5 | 2.48 | 108 | 3.0 | 260 |
| 7'-6" | 21 | 10 | 7-#6 | 2.90 | 147 | 3.6 | 297 |
| 8'-0" | 22 | 10 | 8-#6 | 3.37 | 180 | 4.3 | 337 |
| 8'-6" | 24 | 10 | 9-#6 | 3.72 | 216 | 5.4 | 379 |
| 9'-0" | 25 | 10 | 10-#6 | 4.19 | 255 | 6.3 | 423 |
| 9'-6" | 26 | 11 | 8-#7 | 4.68 | 294 | 7.2 | 470 |
| 10'-0" | 27 | 11 | 9-#7 | 5.27 | 350 | 8.3 | 520 |
| 10'-6" | 28 | 12 | 10-#7 | 5.78 | 409 | 9.5 | 571 |
| 11'-0" | 29 | 12 | 11-#7 | 6.43 | 472 | 10.8 | 625 |
| 11'-6" | 30 | 13 | 9-#8 | 7.03 | 529 | 12.2 | 681 |
| 12'-0" | 31 | 13 | 10-#8 | 7.74 | 614 | 13.8 | 739 |
| 12'-6" | 32 | 14 | 11-#8 | 8.35 | 705 | 15.4 | 800 |
| 13'-0" | 33 | 14 | 12-#8 | 9.12 | 801 | 17.2 | 863 |
| 13'-6" | 34 | 15 | 10-#9 | 9.82 | 884 | 19.1 | 928 |
| 14'-0" | 36 | 15 | 11-#9 | 10.27 | 1010 | 21.8 | 992 |
| 14'-6" | 36 | 16 | 12-#9 | 11.36 | 1142 | 23.4 | 1064 |
| 15'-0" | 38 | 16 | 12-#9 | 11.83 | 1183 | 26.4 | 1132 |
| 15'-6" | 39 | 17 | 13-#9 | 12.57 | 1326 | 28.9 | 1205 |
| 16'-0" | 40 | 17 | 14-#9 | 13.49 | 1476 | 31.6 | 1280 |
| 16'-6" | 41 | 18 | 15-#9 | 14.27 | 1632 | 34.5 | 1357 |
| 17'-0" | 42 | 18 | 16-#9 | 15.24 | 1795 | 37.5 | 1436 |
| 17'-6" | 43 | 19 | 13-#10 | 16.13 | 1902 | 40.6 | 1517 |
| 18'-0" | 44 | 19 | 14-#10 | 17.16 | 2108 | 44.0 | 1601 |
| 18'-6" | 45 | 20 | 15-#10 | 18.03 | 2324 | 47.5 | 1686 |
| 19'-0" | 46 | 20 | 16-#10 | 19.11 | 2547 | 51.3 | 1773 |
| 19'-6" | 47 | 21 | 16-#10 | 20.02 | 2616 | 55.2 | 1861 |
| 20'-0" | 48 | 21 | 17-#10 | 21.15 | 2853 | 59.3 | 1952 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 6,300 psf (SAFE BEARING CAPACITY 4,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 12 | 10 | 5-#4 * | 0.82 | 23 | 0.6 | 98 |
| 4'-6" | 14 | 10 | 6-#4 | 1.02 | 32 | 0.9 | 123 |
| 5'-0" | 15 | 10 | 5-#5 | 1.32 | 47 | 1.2 | 152 |
| 5'-6" | 16 | 10 | 6-#5 | 1.67 | 63 | 1.5 | 183 |
| 6'-0" | 18 | 10 | 7-#5 | 1.91 | 80 | 2.0 | 217 |
| 6'-6" | 19 | 10 | 8-#5 | 2.32 | 100 | 2.5 | 254 |
| 7'-0" | 21 | 10 | 6-#6 | 2.62 | 117 | 3.2 | 293 |
| 7'-6" | 22 | 10 | 8-#6 | 3.10 | 168 | 3.8 | 336 |
| 8'-0" | 23 | 10 | 9-#6 | 3.61 | 203 | 4.5 | 381 |
| 8'-6" | 25 | 10 | 9-#6 | 3.95 | 216 | 5.6 | 428 |
| 9'-0" | 26 | 11 | 8-#7 | 4.46 | 278 | 6.5 | 479 |
| 9'-6" | 27 | 11 | 9-#7 | 5.07 | 331 | 7.5 | 532 |
| 10'-0" | 28 | 12 | 10-#7 | 5.61 | 388 | 8.6 | 588 |
| 10'-6" | 30 | 12 | 8-#8 | 6.05 | 427 | 10.2 | 645 |
| 11'-0" | 30 | 13 | 9-#8 | 6.93 | 505 | 11.2 | 708 |
| 11'-6" | 31 | 14 | 10-#8 | 7.55 | 587 | 12.7 | 772 |
| 12'-0" | 33 | 14 | 11-#8 | 8.01 | 676 | 14.7 | 836 |
| 12'-6" | 34 | 15 | 11-#8 | 8.68 | 705 | 16.4 | 905 |
| 13'-0" | 35 | 15 | 10-#9 | 9.55 | 850 | 18.3 | 976 |
| 13'-6" | 36 | 16 | 11-#9 | 10.27 | 972 | 20.3 | 1050 |
| 14'-0" | 37 | 16 | 12-#9 | 11.17 | 1102 | 22.4 | 1126 |
| 14'-6" | 38 | 17 | 12-#9 | 11.95 | 1142 | 24.7 | 1205 |
| 15'-0" | 40 | 17 | 13-#9 | 12.50 | 1282 | 27.8 | 1283 |
| 15'-6" | 41 | 18 | 14-#9 | 13.32 | 1428 | 30.4 | 1366 |
| 16'-0" | 42 | 18 | 15-#9 | 14.32 | 1581 | 33.2 | 1452 |
| 16'-6" | 43 | 19 | 16-#9 | 15.19 | 1741 | 36.1 | 1540 |
| 17'-0" | 44 | 19 | 13-#10 | 16.32 | 1846 | 39.2 | 1630 |
| 17'-6" | 45 | 20 | 14-#10 | 17.24 | 2048 | 42.5 | 1723 |
| 18'-0" | 46 | 21 | 15-#10 | 18.18 | 2259 | 46.0 | 1818 |
| 18'-6" | 47 | 21 | 16-#10 | 19.34 | 2479 | 49.6 | 1915 |
| 19'-0" | 48 | 22 | 17-#10 | 20.33 | 2707 | 53.5 | 2014 |
| 19'-6" | 49 | 22 | 17-#10 | 21.56 | 2780 | 57.5 | 2116 |
| 20'-0" | 50 | 23 | 18-#10 | 22.60 | 3021 | 61.7 | 2220 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 7,000 psf (SAFE BEARING CAPACITY 5,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 13 | 10 | 5-#4 * | 0.82 | 23 | 0.6 | 109 |
| 4'-6" | 14 | 10 | 6-#4 | 1.11 | 32 | 0.9 | 137 |
| 5'-0" | 16 | 10 | 5-#5 | 1.35 | 47 | 1.2 | 169 |
| 5'-6" | 17 | 10 | 6-#5 | 1.72 | 63 | 1.6 | 204 |
| 6'-0" | 19 | 10 | 7-#5 | 1.99 | 80 | 2.1 | 242 |
| 6'-6" | 20 | 10 | 8-#5 | 2.43 | 100 | 2.6 | 283 |
| 7'-0" | 22 | 10 | 9-#5 | 2.78 | 122 | 3.3 | 327 |
| 7'-6" | 23 | 10 | 11-#5 | 3.25 | 161 | 4.0 | 374 |
| 8'-0" | 25 | 10 | 12-#5 | 3.69 | 188 | 4.9 | 424 |
| 8'-6" | 26 | 11 | 7-#7 | 4.15 | 229 | 5.8 | 478 |
| 9'-0" | 27 | 11 | 8-#7 | 4.77 | 278 | 6.8 | 534 |
| 9'-6" | 28 | 12 | 9-#7 | 5.32 | 331 | 7.8 | 594 |
| 10'-0" | 29 | 13 | 10-#7 | 5.91 | 388 | 9.0 | 657 |
| 10'-6" | 31 | 13 | 11-#7 | 6.37 | 450 | 10.5 | 720 |
| 11'-0" | 32 | 14 | 9-#8 | 7.04 | 505 | 12.0 | 789 |
| 11'-6" | 33 | 14 | 10-#8 | 7.83 | 587 | 13.5 | 860 |
| 12'-0" | 34 | 15 | 11-#8 | 8.53 | 676 | 15.1 | 935 |
| 12'-6" | 36 | 15 | 12-#8 | 9.07 | 769 | 17.4 | 1009 |
| 13'-0" | 37 | 16 | 10-#9 | 9.86 | 850 | 19.3 | 1089 |
| 13'-6" | 38 | 17 | 11-#9 | 10.64 | 972 | 21.4 | 1172 |
| 14'-0" | 39 | 17 | 12-#9 | 11.60 | 1102 | 23.6 | 1257 |
| 14'-6" | 40 | 18 | 13-#9 | 12.44 | 1238 | 26.0 | 1346 |
| 15'-0" | 41 | 18 | 11-#10 | 13.53 | 1373 | 28.5 | 1437 |
| 15'-6" | 42 | 19 | 12-#10 | 14.43 | 1549 | 31.1 | 1530 |
| 16'-0" | 44 | 19 | 12-#10 | 15.09 | 1601 | 34.8 | 1623 |
| 16'-6" | 45 | 20 | 13-#10 | 16.04 | 1790 | 37.8 | 1722 |
| 17'-0" | 46 | 21 | 14-#10 | 17.01 | 1988 | 41.0 | 1824 |
| 17'-6" | 47 | 21 | 15-#10 | 18.20 | 2195 | 44.4 | 1928 |
| 18'-0" | 48 | 22 | 13-#11 | 19.29 | 2417 | 48.0 | 2035 |
| 18'-6" | 49 | 22 | 14-#11 | 20.56 | 2678 | 51.8 | 2144 |
| 19'-0" | 50 | 23 | 14-#11 | 21.65 | 2752 | 55.7 | 2256 |
| 19'-6" | 52 | 23 | 15-#11 | 22.42 | 3028 | 61.0 | 2365 |
| 20'-0" | 53 | 24 | 16-#11 | 23.55 | 3315 | 65.4 | 2482 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 7,700 psf (SAFE BEARING CAPACITY 5,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 13 | 10 | 5-#4 * | 0.90 | 23 | 0.6 | 120 |
| 4'-6" | 15 | 10 | 6-#4 | 1.12 | 32 | 0.9 | 151 |
| 5'-0" | 16 | 10 | 5-#5 | 1.49 | 47 | 1.2 | 187 |
| 5'-6" | 18 | 10 | 6-#5 | 1.76 | 63 | 1.7 | 225 |
| 6'-0" | 19 | 10 | 8-#5 | 2.20 | 92 | 2.1 | 267 |
| 6'-6" | 21 | 10 | 6-#6 | 2.54 | 108 | 2.7 | 312 |
| 7'-0" | 23 | 10 | 7-#6 | 2.91 | 137 | 3.5 | 360 |
| 7'-6" | 24 | 10 | 8-#6 | 3.43 | 168 | 4.2 | 413 |
| 8'-0" | 25 | 11 | 9-#6 | 3.93 | 203 | 4.9 | 469 |
| 8'-6" | 27 | 11 | 10-#6 | 4.35 | 240 | 6.0 | 527 |
| 9'-0" | 28 | 12 | 12-#6 | 4.91 | 306 | 7.0 | 590 |
| 9'-6" | 29 | 13 | 13-#6 | 5.50 | 351 | 8.1 | 656 |
| 10'-0" | 31 | 13 | 14-#6 | 5.99 | 400 | 9.6 | 724 |
| 10'-6" | 32 | 14 | 16-#6 | 6.64 | 481 | 10.9 | 796 |
| 11'-0" | 33 | 14 | 17-#6 | 7.45 | 536 | 12.3 | 872 |
| 11'-6" | 34 | 15 | 19-#6 | 8.17 | 628 | 13.9 | 951 |
| 12'-0" | 35 | 16 | 15-#7 | 8.95 | 705 | 15.6 | 1033 |
| 12'-6" | 37 | 16 | 16-#7 | 9.56 | 785 | 17.8 | 1116 |
| 13'-0" | 38 | 17 | 18-#7 | 10.36 | 920 | 19.8 | 1205 |
| 13'-6" | 39 | 17 | 19-#7 | 11.36 | 1010 | 21.9 | 1297 |
| 14'-0" | 40 | 18 | 21-#7 | 12.23 | 1159 | 24.2 | 1392 |
| 14'-6" | 42 | 19 | 13-#9 | 12.84 | 1238 | 27.3 | 1486 |
| 15'-0" | 43 | 19 | 14-#9 | 13.94 | 1380 | 29.9 | 1587 |
| 15'-6" | 44 | 20 | 15-#9 | 14.90 | 1530 | 32.6 | 1691 |
| 16'-0" | 46 | 20 | 16-#9 | 15.64 | 1686 | 36.3 | 1795 |
| 16'-6" | 47 | 21 | 17-#9 | 16.65 | 1850 | 39.5 | 1904 |
| 17'-0" | 48 | 22 | 14-#10 | 17.75 | 1988 | 42.8 | 2017 |
| 17'-6" | 49 | 22 | 15-#10 | 19.03 | 2195 | 46.3 | 2133 |
| 18'-0" | 50 | 23 | 13-#11 | 20.20 | 2417 | 50.0 | 2252 |
| 18'-6" | 52 | 23 | 14-#11 | 21.04 | 2678 | 54.9 | 2368 |
| 19'-0" | 53 | 24 | 15-#11 | 22.20 | 2949 | 59.1 | 2493 |
| 19'-6" | 54 | 25 | 15-#11 | 23.38 | 3028 | 63.4 | 2620 |
| 20'-0" | 55 | 25 | 16-#11 | 24.83 | 3315 | 67.9 | 2750 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\qquad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 8,400 psf (SAFE BEARING CAPACITY 6,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 14 | 10 | 5-#4 * | 0.91 | 23 | 0.7 | 131 |
| 4'-6" | 15 | 10 | 4-#5 * | 1.24 | 33 | 0.9 | 166 |
| 5'-0" | 17 | 10 | 5-#5 | 1.50 | 47 | 1.3 | 204 |
| 5'-6" | 19 | 10 | 6-#5 | 1.83 | 63 | 1.8 | 245 |
| 6'-0" | 20 | 10 | 8-#5 | 2.25 | 92 | 2.2 | 292 |
| 6'-6" | 22 | 10 | 6-#6 | 2.62 | 108 | 2.9 | 341 |
| 7'-0" | 23 | 10 | 8-#6 | 3.17 | 156 | 3.5 | 395 |
| 7'-6" | 25 | 10 | 6-#7 | 3.60 | 172 | 4.3 | 451 |
| 8'-0" | 26 | 11 | 7-#7 | 4.13 | 215 | 5.1 | 513 |
| 8'-6" | 27 | 12 | 8-#7 | 4.70 | 262 | 6.0 | 578 |
| 9'-0" | 29 | 12 | 9-#7 | 5.19 | 313 | 7.3 | 645 |
| 9'-6" | 30 | 13 | 10-#7 | 5.82 | 368 | 8.4 | 717 |
| 10'-0" | 31 | 14 | 11-#7 | 6.49 | 427 | 9.6 | 794 |
| 10'-6" | 33 | 14 | 9-#8 | 7.09 | 481 | 11.2 | 872 |
| 11'-0" | 34 | 15 | 10-#8 | 7.82 | 561 | 12.7 | 955 |
| 11'-6" | 35 | 16 | 11-#8 | 8.59 | 646 | 14.3 | 1041 |
| 12'-0" | 37 | 16 | 12-#8 | 9.23 | 737 | 16.4 | 1130 |
| 12'-6" | 38 | 17 | 13-#8 | 10.06 | 833 | 18.3 | 1223 |
| 13'-0" | 39 | 18 | 11-#9 | 10.96 | 935 | 20.3 | 1321 |
| 13'-6" | 41 | 18 | 12-#9 | 11.67 | 1061 | 23.1 | 1419 |
| 14'-0" | 42 | 19 | 10-#10 | 12.64 | 1162 | 25.4 | 1523 |
| 14'-6" | 43 | 19 | 11-#10 | 13.79 | 1325 | 27.9 | 1630 |
| 15'-0" | 45 | 20 | 12-#10 | 14.38 | 1497 | 31.3 | 1738 |
| 15'-6" | 46 | 21 | 13-#10 | 15.40 | 1678 | 34.1 | 1852 |
| 16'-0" | 47 | 21 | 14-#10 | 16.65 | 1868 | 37.1 | 1970 |
| 16'-6" | 48 | 22 | 14-#10 | 17.74 | 1928 | 40.3 | 2091 |
| 17'-0" | 49 | 23 | 15-#10 | 18.87 | 2130 | 43.7 | 2215 |
| 17'-6" | 51 | 23 | 13-#11 | 19.82 | 2348 | 48.2 | 2338 |
| 18'-0" | 52 | 24 | 14-#11 | 21.00 | 2603 | 52.0 | 2469 |
| 18'-6" | 54 | 24 | 15-#11 | 21.93 | 2869 | 57.0 | 2598 |
| 19'-0" | 55 | 25 | 15-#11 | 23.16 | 2949 | 61.3 | 2735 |
| 19'-6" | 56 | 26 | 16-#11 | 24.43 | 3230 | 65.7 | 2875 |
| 20'-0" | 57 | 26 | 17-#11 | 25.98 | 3523 | 70.4 | 3018 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\qquad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 9,100 psf (SAFE BEARING CAPACITY 6,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 14 | 10 | 5-#4 * | 0.97 | 23 | 0.7 | 142 |
| 4'-6" | 16 | 10 | 4-#5 * | 1.23 | 33 | 1.0 | 179 |
| 5'-0" | 18 | 10 | 4-#6 * | 1.54 | 54 | 1.4 | 221 |
| 5'-6" | 19 | 10 | 5-#6 * | 1.97 | 75 | 1.8 | 267 |
| 6'-0" | 21 | 10 | 6-#6 | 2.32 | 99 | 2.3 | 316 |
| 6'-6" | 23 | 10 | 7-#6 | 2.70 | 126 | 3.0 | 370 |
| 7'-0" | 24 | 10 | 8-#6 | 3.27 | 156 | 3.6 | 428 |
| 7'-6" | 26 | 11 | 9-#6 | 3.61 | 189 | 4.5 | 490 |
| 8'-0" | 27 | 12 | 7-#7 | 4.19 | 215 | 5.3 | 556 |
| 8'-6" | 28 | 12 | 9-#7 | 4.89 | 294 | 6.2 | 627 |
| 9'-0" | 30 | 13 | 9-#7 | 5.31 | 313 | 7.5 | 701 |
| 9'-6" | 31 | 14 | 10-#7 | 5.97 | 368 | 8.6 | 779 |
| 10'-0" | 33 | 14 | 11-#7 | 6.55 | 427 | 10.2 | 861 |
| 10'-6" | 34 | 15 | 13-#7 | 7.28 | 531 | 11.6 | 947 |
| 11'-0" | 35 | 16 | 14-#7 | 8.05 | 601 | 13.1 | 1038 |
| 11'-6" | 37 | 16 | 9-#9 | 8.78 | 673 | 15.1 | 1130 |
| 12'-0" | 38 | 17 | 10-#9 | 9.63 | 782 | 16.9 | 1228 |
| 12'-6" | 39 | 18 | 11-#9 | 10.51 | 898 | 18.8 | 1330 |
| 13'-0" | 41 | 18 | 12-#9 | 11.25 | 1020 | 21.4 | 1434 |
| 13'-6" | 42 | 19 | 10-#10 | 12.24 | 1119 | 23.6 | 1544 |
| 14'-0" | 43 | 20 | 11-#10 | 13.23 | 1278 | 26.0 | 1657 |
| 14'-6" | 45 | 20 | 12-#10 | 14.05 | 1446 | 29.2 | 1771 |
| 15'-0" | 46 | 21 | 12-#10 | 15.10 | 1497 | 31.9 | 1892 |
| 15'-6" | 47 | 22 | 13-#10 | 16.19 | 1678 | 34.9 | 2017 |
| 16'-0" | 49 | 22 | 14-#10 | 17.08 | 1868 | 38.7 | 2141 |
| 16'-6" | 50 | 23 | 12-#11 | 18.29 | 2040 | 42.0 | 2273 |
| 17'-0" | 51 | 24 | 13-#11 | 19.48 | 2279 | 45.5 | 2409 |
| 17'-6" | 53 | 24 | 14-#11 | 20.44 | 2529 | 50.1 | 2543 |
| 18'-0" | 54 | 25 | 14-#11 | 21.69 | 2603 | 54.0 | 2686 |
| 18'-6" | 55 | 26 | 15-#11 | 22.98 | 2869 | 58.1 | 2832 |
| 19'-0" | 57 | 26 | 16-#11 | 24.01 | 3145 | 63.5 | 2976 |
| 19'-6" | 58 | 27 | 17-#11 | 25.36 | 3432 | 68.1 | 3129 |
| 20'-0" | 59 | 27 | 18-#11 | 26.99 | 3730 | 72.8 | 3286 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 9,800 psf (SAFE BEARING CAPACITY 7,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 15 | 10 | 5-#4 * | 0.99 | 23 | 0.7 | 153 |
| 4'-6" | 16 | 10 | 7-#4 | 1.32 | 37 | 1.0 | 194 |
| 5'-0" | 18 | 10 | 4-#6 * | 1.65 | 54 | 1.4 | 238 |
| 5'-6" | 20 | 10 | 5-#6 * | 1.99 | 75 | 1.9 | 287 |
| 6'-0" | 22 | 10 | 6-#6 | 2.37 | 99 | 2.4 | 341 |
| 6'-6" | 23 | 10 | 7-#6 | 2.91 | 126 | 3.0 | 399 |
| 7'-0" | 25 | 11 | 8-#6 | 3.26 | 156 | 3.8 | 462 |
| 7'-6" | 26 | 11 | 9-#6 | 3.91 | 189 | 4.5 | 529 |
| 8'-0" | 28 | 12 | 10-#6 | 4.31 | 225 | 5.5 | 600 |
| 8'-6" | 29 | 13 | 12-#6 | 4.93 | 288 | 6.5 | 677 |
| 9'-0" | 31 | 13 | 13-#6 | 5.49 | 332 | 7.8 | 756 |
| 9'-6" | 32 | 14 | 8-#8 | 6.24 | 384 | 8.9 | 841 |
| 10'-0" | 33 | 15 | 9-#8 | 6.99 | 457 | 10.2 | 931 |
| 10'-6" | 35 | 16 | 10-#8 | 7.50 | 534 | 11.9 | 1023 |
| 11'-0" | 36 | 16 | 11-#8 | 8.46 | 617 | 13.4 | 1120 |
| 11'-6" | 38 | 17 | 12-#8 | 9.02 | 705 | 15.5 | 1221 |
| 12'-0" | 39 | 18 | 10-#9 | 9.94 | 782 | 17.3 | 1327 |
| 12'-6" | 41 | 18 | 11-#9 | 10.71 | 898 | 19.8 | 1435 |
| 13'-0" | 42 | 19 | 12-#9 | 11.67 | 1020 | 21.9 | 1550 |
| 13'-6" | 43 | 20 | 13-#9 | 12.67 | 1149 | 24.2 | 1668 |
| 14'-0" | 45 | 20 | 11-#10 | 13.57 | 1278 | 27.2 | 1789 |
| 14'-6" | 46 | 21 | 12-#10 | 14.64 | 1446 | 29.9 | 1915 |
| 15'-0" | 47 | 22 | 13-#10 | 15.75 | 1622 | 32.6 | 2046 |
| 15'-6" | 49 | 22 | 14-#10 | 16.69 | 1807 | 36.3 | 2178 |
| 16'-0" | 50 | 23 | 12-#11 | 17.93 | 1976 | 39.5 | 2317 |
| 16'-6" | 51 | 24 | 13-#11 | 19.16 | 2210 | 42.9 | 2460 |
| 17'-0" | 53 | 24 | 13-#11 | 20.17 | 2279 | 47.3 | 2602 |
| 17'-6" | 54 | 25 | 14-#11 | 21.47 | 2529 | 51.0 | 2753 |
| 18'-0" | 55 | 26 | 15-#11 | 22.80 | 2789 | 55.0 | 2908 |
| 18'-6" | 57 | 26 | 16-#11 | 23.89 | 3060 | 60.2 | 3061 |
| 19'-0" | 58 | 27 | 17-#11 | 25.29 | 3342 | 64.6 | 3224 |
| 19'-6" | 60 | 28 | 17-#11 | 26.18 | 3432 | 70.4 | 3384 |
| 20'-0" | 61 | 29 | 18-#11 | 27.63 | 3730 | 75.3 | 3554 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 10,500 psf (SAFE BEARING CAPACITY 7,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 15 | 10 | 6-#4 * | 1.02 | 28 | 0.7 | 164 |
| 4'-6" | 17 | 10 | 7-#4 | 1.31 | 37 | 1.1 | 207 |
| 5'-0" | 19 | 10 | 4-#6 * | 1.65 | 54 | 1.5 | 255 |
| 5'-6" | 20 | 10 | 5-#6 * | 2.14 | 75 | 1.9 | 309 |
| 6'-0" | 22 | 10 | 6-#6 | 2.54 | 99 | 2.4 | 366 |
| 6'-6" | 24 | 10 | 7-#6 | 2.97 | 126 | 3.1 | 428 |
| 7'-0" | 25 | 11 | 8-#6 | 3.51 | 156 | 3.8 | 496 |
| 7'-6" | 27 | 12 | 9-#6 | 3.91 | 189 | 4.7 | 568 |
| 8'-0" | 29 | 12 | 6-#8 * | 4.48 | 240 | 5.7 | 644 |
| 8'-6" | 30 | 13 | 7-#8 | 5.14 | 299 | 6.7 | 726 |
| 9'-0" | 31 | 14 | 8-#8 | 5.84 | 363 | 7.8 | 813 |
| 9'-6" | 33 | 15 | 9-#8 | 6.34 | 433 | 9.2 | 903 |
| 10'-0" | 34 | 15 | 10-#8 | 7.25 | 507 | 10.5 | 999 |
| 10'-6" | 36 | 16 | 10-#8 | 7.81 | 534 | 12.3 | 1098 |
| 11'-0" | 37 | 17 | 11-#8 | 8.66 | 617 | 13.8 | 1203 |
| 11'-6" | 38 | 18 | 10-#9 | 9.60 | 748 | 15.5 | 1313 |
| 12'-0" | 40 | 18 | 11-#9 | 10.39 | 860 | 17.8 | 1426 |
| 12'-6" | 41 | 19 | 12-#9 | 11.37 | 979 | 19.8 | 1545 |
| 13'-0" | 43 | 20 | 10-#10 | 12.09 | 1076 | 22.4 | 1665 |
| 13'-6" | 45 | 20 | 11-#10 | 12.97 | 1231 | 25.3 | 1791 |
| 14'-0" | 46 | 21 | 12-#10 | 14.05 | 1394 | 27.8 | 1923 |
| 14'-6" | 47 | 22 | 12-#10 | 15.18 | 1446 | 30.5 | 2059 |
| 15'-0" | 48 | 23 | 13-#10 | 16.35 | 1622 | 33.3 | 2201 |
| 15'-6" | 50 | 23 | 14-#10 | 17.35 | 1807 | 37.1 | 2342 |
| 16'-0" | 51 | 24 | 12-#11 | 18.66 | 1976 | 40.3 | 2492 |
| 16'-6" | 53 | 25 | 13-#11 | 19.49 | 2210 | 44.5 | 2642 |
| 17'-0" | 54 | 25 | 14-#11 | 21.05 | 2455 | 48.2 | 2800 |
| 17'-6" | 56 | 26 | 15-#11 | 21.92 | 2710 | 52.9 | 2958 |
| 18'-0" | 57 | 27 | 15-#11 | 23.31 | 2789 | 57.0 | 3125 |
| 18'-6" | 59 | 27 | 16-#11 | 24.48 | 3060 | 62.3 | 3291 |
| 19'-0" | 60 | 28 | 17-#11 | 25.94 | 3342 | 66.9 | 3466 |
| 19'-6" | 61 | 29 | 18-#11 | 27.44 | 3634 | 71.6 | 3645 |
| 20'-0" | 63 | 30 | 19-#11 | 28.42 | 3937 | 77.8 | 3822 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 11,200 psf (SAFE BEARING CAPACITY 8,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 15 | 10 | 6-#4 * | 1.09 | 28 | 0.7 | 176 |
| 4'-6" | 17 | 10 | 7-#4 | 1.39 | 37 | 1.1 | 222 |
| 5'-0" | 19 | 10 | 6-#5 | 1.75 | 56 | 1.5 | 273 |
| 5'-6" | 21 | 10 | 7-#5 | 2.13 | 73 | 2.0 | 329 |
| 6'-0" | 23 | 10 | 6-#6 | 2.56 | 99 | 2.6 | 391 |
| 6'-6" | 24 | 11 | 8-#6 | 3.08 | 144 | 3.1 | 458 |
| 7'-0" | 26 | 11 | 6-#7 * | 3.60 | 159 | 3.9 | 530 |
| 7'-6" | 28 | 12 | 7-#7 | 4.02 | 200 | 4.9 | 606 |
| 8'-0" | 29 | 13 | 6-#8 * | 4.69 | 240 | 5.7 | 689 |
| 8'-6" | 30 | 14 | 7-#8 | 5.38 | 299 | 6.7 | 777 |
| 9'-0" | 32 | 14 | 8-#8 | 6.01 | 363 | 8.0 | 868 |
| 9'-6" | 34 | 15 | 9-#8 | 6.55 | 433 | 9.5 | 965 |
| 10'-0" | 35 | 16 | 10-#8 | 7.36 | 507 | 10.8 | 1068 |
| 10'-6" | 36 | 17 | 11-#8 | 8.21 | 587 | 12.3 | 1175 |
| 11'-0" | 38 | 17 | 12-#8 | 8.99 | 673 | 14.2 | 1286 |
| 11'-6" | 40 | 18 | 10-#9 | 9.66 | 748 | 16.3 | 1402 |
| 12'-0" | 41 | 19 | 11-#9 | 10.63 | 860 | 18.2 | 1524 |
| 12'-6" | 42 | 20 | 12-#9 | 11.65 | 979 | 20.3 | 1652 |
| 13'-0" | 44 | 20 | 10-#10 | 12.61 | 1076 | 23.0 | 1781 |
| 13'-6" | 45 | 21 | 11-#10 | 13.71 | 1231 | 25.3 | 1918 |
| 14'-0" | 47 | 22 | 12-#10 | 14.48 | 1394 | 28.4 | 2057 |
| 14'-6" | 48 | 23 | 13-#10 | 15.66 | 1566 | 31.1 | 2203 |
| 15'-0" | 50 | 23 | 11-#11 | 16.75 | 1695 | 34.7 | 2351 |
| 15'-6" | 51 | 24 | 12-#11 | 18.02 | 1913 | 37.8 | 2507 |
| 16'-0" | 53 | 25 | 13-#11 | 18.88 | 2141 | 41.9 | 2664 |
| 16'-6" | 54 | 25 | 14-#11 | 20.46 | 2380 | 45.4 | 2829 |
| 17'-0" | 56 | 26 | 14-#11 | 21.38 | 2455 | 50.0 | 2994 |
| 17'-6" | 57 | 27 | 15-#11 | 22.79 | 2710 | 53.9 | 3168 |
| 18'-0" | 58 | 28 | 16-#11 | 24.25 | 2975 | 58.0 | 3347 |
| 18'-6" | 60 | 28 | 17-#11 | 25.51 | 3252 | 63.4 | 3525 |
| 19'-0" | 62 | 29 | 17-#11 | 26.51 | 3342 | 69.1 | 3707 |
| 19'-6" | 63 | 30 | 18-#11 | 28.08 | 3634 | 73.9 | 3899 |
| 20'-0" | 64 | 31 | 20-#11 | 29.68 | 4144 | 79.0 | 4096 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 11,900 psf (SAFE BEARING CAPACITY 8,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 16 | 10 | 6-#4 * | 1.08 | 28 | 0.8 | 187 |
| 4'-6" | 18 | 10 | 5-#5 * | 1.40 | 42 | 1.1 | 236 |
| 5'-0" | 20 | 10 | 4-#6 * | 1.76 | 54 | 1.5 | 290 |
| 5'-6" | 22 | 10 | 5-#6 * | 2.17 | 75 | 2.1 | 350 |
| 6'-0" | 24 | 10 | 6-#6 | 2.62 | 99 | 2.7 | 415 |
| 6'-6" | 25 | 11 | 8-#6 | 3.12 | 144 | 3.3 | 487 |
| 7'-0" | 26 | 12 | 9-#6 | 3.71 | 176 | 3.9 | 564 |
| 7'-6" | 28 | 12 | 10-#6 | 4.26 | 210 | 4.9 | 646 |
| 8'-0" | 30 | 13 | 8-#7 | 4.77 | 245 | 5.9 | 733 |
| 8'-6" | 31 | 14 | 7-#8 | 5.51 | 299 | 6.9 | 826 |
| 9'-0" | 33 | 15 | 8-#8 | 6.04 | 363 | 8.3 | 924 |
| 9'-6" | 34 | 16 | 9-#8 | 6.84 | 433 | 9.5 | 1028 |
| 10'-0" | 36 | 16 | 10-#8 | 7.58 | 507 | 11.1 | 1136 |
| 10'-6" | 37 | 17 | 11-#8 | 8.48 | 587 | 12.6 | 1251 |
| 11'-0" | 39 | 18 | 12-#8 | 9.13 | 673 | 14.6 | 1369 |
| 11'-6" | 40 | 19 | 13-#8 | 10.10 | 764 | 16.3 | 1494 |
| 12'-0" | 42 | 19 | 14-#8 | 10.99 | 860 | 18.7 | 1623 |
| 12'-6" | 44 | 20 | 15-#8 | 11.72 | 961 | 21.2 | 1756 |
| 13'-0" | 45 | 21 | 13-#9 | 12.86 | 1105 | 23.5 | 1897 |
| 13'-6" | 46 | 22 | 15-#9 | 14.01 | 1326 | 25.9 | 2043 |
| 14'-0" | 48 | 22 | 12-#10 | 15.08 | 1394 | 29.0 | 2191 |
| 14'-6" | 50 | 23 | 13-#10 | 15.92 | 1566 | 32.4 | 2344 |
| 15'-0" | 51 | 24 | 14-#10 | 17.19 | 1747 | 35.4 | 2505 |
| 15'-6" | 52 | 25 | 12-#11 | 18.57 | 1913 | 38.6 | 2672 |
| 16'-0" | 54 | 26 | 13-#11 | 19.49 | 2141 | 42.7 | 2839 |
| 16'-6" | 56 | 26 | 14-#11 | 20.68 | 2380 | 47.1 | 3011 |
| 17'-0" | 57 | 27 | 15-#11 | 22.11 | 2630 | 50.8 | 3192 |
| 17'-6" | 58 | 28 | 16-#11 | 23.60 | 2890 | 54.8 | 3378 |
| 18'-0" | 60 | 29 | 16-#11 | 24.62 | 2975 | 60.0 | 3564 |
| 18'-6" | 62 | 29 | 17-#11 | 25.94 | 3252 | 65.5 | 3754 |
| 19'-0" | 63 | 30 | 18-#11 | 27.53 | 3538 | 70.2 | 3955 |
| 19'-6" | 64 | 31 | 19-#11 | 29.18 | 3836 | 75.1 | 4160 |
| 20'-0" | 66 | 32 | 20-#11 | 30.30 | 4144 | 81.5 | 4364 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 12,600 psf (SAFE BEARING CAPACITY 9,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 16 | 10 | 6-#4 * | 1.13 | 28 | 0.8 | 198 |
| 4'-6" | 18 | 10 | 5-#5 * | 1.47 | 42 | 1.1 | 250 |
| 5'-0" | 20 | 10 | 6-#5 | 1.85 | 56 | 1.5 | 308 |
| 5'-6" | 22 | 10 | 8-#5 | 2.27 | 83 | 2.1 | 371 |
| 6'-0" | 24 | 10 | 9-#5 | 2.73 | 103 | 2.7 | 441 |
| 6'-6" | 26 | 11 | 11-#5 | 3.14 | 138 | 3.4 | 516 |
| 7'-0" | 27 | 12 | 9-#6 | 3.76 | 176 | 4.1 | 598 |
| 7'-6" | 29 | 13 | 10-#6 | 4.23 | 210 | 5.0 | 684 |
| 8'-0" | 30 | 14 | 12-#6 | 4.92 | 270 | 5.9 | 778 |
| 8'-6" | 32 | 14 | 13-#6 | 5.57 | 312 | 7.1 | 876 |
| 9'-0" | 34 | 15 | 14-#6 | 6.14 | 357 | 8.5 | 979 |
| 9'-6" | 35 | 16 | 16-#6 | 6.96 | 433 | 9.7 | 1090 |
| 10'-0" | 36 | 17 | 18-#6 | 7.84 | 514 | 11.1 | 1206 |
| 10'-6" | 38 | 18 | 11-#8 | 8.56 | 587 | 12.9 | 1326 |
| 11'-0" | 40 | 18 | 12-#8 | 9.41 | 673 | 14.9 | 1452 |
| 11'-6" | 41 | 19 | 11-#9 * | 10.46 | 823 | 16.7 | 1585 |
| 12'-0" | 43 | 20 | 9-#10 * | 11.25 | 891 | 19.1 | 1722 |
| 12'-6" | 44 | 21 | 10-#10 * | 12.36 | 1033 | 21.2 | 1866 |
| 13'-0" | 46 | 22 | 11-#10 * | 13.16 | 1183 | 24.0 | 2013 |
| 13'-6" | 48 | 22 | 12-#10 | 14.20 | 1343 | 27.0 | 2165 |
| 14'-0" | 49 | 23 | 10-#11 * | 15.49 | 1435 | 29.6 | 2326 |
| 14'-6" | 51 | 24 | 11-#11 | 16.38 | 1636 | 33.1 | 2488 |
| 15'-0" | 52 | 25 | 12-#11 | 17.70 | 1849 | 36.1 | 2660 |
| 15'-6" | 53 | 26 | 13-#11 | 19.07 | 2072 | 39.3 | 2836 |
| 16'-0" | 55 | 26 | 14-#11 | 20.29 | 2306 | 43.5 | 3014 |
| 16'-6" | 57 | 27 | 14-#11 | 21.30 | 2380 | 47.9 | 3198 |
| 17'-0" | 58 | 28 | 15-#11 | 22.79 | 2630 | 51.7 | 3390 |
| 17'-6" | 60 | 29 | 16-#11 | 23.85 | 2890 | 56.7 | 3583 |
| 18'-0" | 62 | 29 | 17-#11 | 25.21 | 3161 | 62.0 | 3781 |
| 18'-6" | 63 | 30 | 18-#11 | 26.82 | 3443 | 66.5 | 3989 |
| 19'-0" | 64 | 31 | 19-#11 | 28.49 | 3735 | 71.3 | 4202 |
| 19'-6" | 66 | 32 | 20-#11 | 29.65 | 4038 | 77.5 | 4415 |
| 20'-0" | 67 | 33 | 21-#11 | 31.40 | 4351 | 82.7 | 4638 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 13,300 psf (SAFE BEARING CAPACITY 9,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 17 | 10 | 6-#4 * | 1.17 | 28 | 0.8 | 209 |
| 4'-6" | 19 | 10 | 5-#5 * | 1.49 | 42 | 1.2 | 264 |
| 5'-0" | 21 | 10 | 7-#5 | 1.88 | 66 | 1.6 | 325 |
| 5'-6" | 23 | 10 | 8-#5 | 2.30 | 83 | 2.1 | 392 |
| 6'-0" | 24 | 11 | 7-#6 | 2.82 | 116 | 2.7 | 466 |
| 6'-6" | 26 | 11 | 8-#6 | 3.34 | 144 | 3.4 | 545 |
| 7'-0" | 28 | 12 | 9-#6 | 3.80 | 176 | 4.2 | 631 |
| 7'-6" | 29 | 13 | 6-#8 * | 4.52 | 224 | 5.0 | 724 |
| 8'-0" | 31 | 14 | 7-#8 * | 5.05 | 280 | 6.1 | 821 |
| 8'-6" | 32 | 15 | 8-#8 * | 5.82 | 342 | 7.1 | 926 |
| 9'-0" | 34 | 16 | 7-#9 * | 6.44 | 405 | 8.5 | 1036 |
| 9'-6" | 36 | 16 | 8-#9 * | 7.21 | 490 | 10.0 | 1152 |
| 10'-0" | 37 | 17 | 9-#9 * | 8.13 | 581 | 11.4 | 1275 |
| 10'-6" | 39 | 18 | 9-#9 * | 8.82 | 612 | 13.3 | 1402 |
| 11'-0" | 40 | 19 | 10-#9 * | 9.83 | 714 | 14.9 | 1537 |
| 11'-6" | 42 | 20 | 11-#9 * | 10.59 | 823 | 17.1 | 1676 |
| 12'-0" | 43 | 21 | 12-#9 | 11.69 | 938 | 19.1 | 1822 |
| 12'-6" | 45 | 21 | 13-#9 | 12.70 | 1061 | 21.7 | 1973 |
| 13'-0" | 47 | 22 | 11-#10 * | 13.60 | 1183 | 24.5 | 2129 |
| 13'-6" | 48 | 23 | 12-#10 | 14.84 | 1343 | 27.0 | 2293 |
| 14'-0" | 50 | 24 | 13-#10 | 15.75 | 1510 | 30.2 | 2460 |
| 14'-6" | 51 | 25 | 11-#11 | 17.13 | 1636 | 33.1 | 2635 |
| 15'-0" | 53 | 25 | 12-#11 | 18.34 | 1849 | 36.8 | 2814 |
| 15'-6" | 55 | 26 | 13-#11 | 19.34 | 2072 | 40.8 | 2997 |
| 16'-0" | 56 | 27 | 14-#11 | 20.81 | 2306 | 44.2 | 3190 |
| 16'-6" | 58 | 28 | 15-#11 | 21.87 | 2550 | 48.7 | 3384 |
| 17'-0" | 59 | 29 | 16-#11 | 23.42 | 2805 | 52.6 | 3588 |
| 17'-6" | 61 | 29 | 16-#11 | 24.81 | 2890 | 57.7 | 3793 |
| 18'-0" | 63 | 30 | 17-#11 | 25.96 | 3161 | 63.0 | 4003 |
| 18'-6" | 64 | 31 | 18-#11 | 27.64 | 3443 | 67.6 | 4223 |
| 19'-0" | 66 | 32 | 19-#11 | 28.84 | 3735 | 73.5 | 4444 |
| 19'-6" | 67 | 33 | 20-#11 | 30.61 | 4038 | 78.6 | 4675 |
| 20'-0" | 69 | 33 | 21-#11 | 32.18 | 4351 | 85.2 | 4906 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 14,000 psf (SAFE BEARING CAPACITY 10,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 17 | 10 | 6-#4 * | 1.17 | 28 | 0.8 | 220 |
| 4'-6" | 19 | 10 | 5-#5 * | 1.53 | 42 | 1.2 | 278 |
| 5'-0" | 21 | 10 | 7-#5 | 1.94 | 66 | 1.6 | 342 |
| 5'-6" | 23 | 10 | 8-#5 | 2.40 | 83 | 2.1 | 413 |
| 6'-0" | 25 | 11 | 7-#6 | 2.82 | 116 | 2.8 | 491 |
| 6'-6" | 26 | 12 | 8-#6 | 3.42 | 144 | 3.4 | 575 |
| 7'-0" | 28 | 13 | 9-#6 | 3.90 | 176 | 4.2 | 665 |
| 7'-6" | 30 | 13 | 6-#8 * | 4.58 | 224 | 5.2 | 762 |
| 8'-0" | 32 | 14 | 7-#8 * | 5.13 | 280 | 6.3 | 865 |
| 8'-6" | 33 | 15 | 8-#8 * | 5.92 | 342 | 7.4 | 976 |
| 9'-0" | 35 | 16 | 7-#9 * | 6.57 | 405 | 8.8 | 1091 |
| 9'-6" | 36 | 17 | 8-#9 * | 7.46 | 490 | 10.0 | 1215 |
| 10'-0" | 38 | 18 | 9-#9 * | 8.15 | 581 | 11.7 | 1343 |
| 10'-6" | 39 | 19 | 10-#9 * | 9.14 | 680 | 13.3 | 1479 |
| 11'-0" | 41 | 19 | 8-#10 * | 10.12 | 723 | 15.3 | 1620 |
| 11'-6" | 43 | 20 | 9-#10 * | 10.91 | 852 | 17.6 | 1766 |
| 12'-0" | 45 | 21 | 10-#10 * | 11.73 | 990 | 20.0 | 1919 |
| 12'-6" | 46 | 22 | 11-#10 * | 12.91 | 1136 | 22.2 | 2080 |
| 13'-0" | 48 | 23 | 11-#10 * | 13.80 | 1183 | 25.0 | 2244 |
| 13'-6" | 49 | 24 | 12-#10 | 15.08 | 1343 | 27.6 | 2418 |
| 14'-0" | 51 | 24 | 13-#10 | 16.26 | 1510 | 30.9 | 2594 |
| 14'-6" | 53 | 25 | 14-#10 | 17.24 | 1687 | 34.4 | 2776 |
| 15'-0" | 54 | 26 | 12-#11 | 18.71 | 1849 | 37.5 | 2968 |
| 15'-6" | 56 | 27 | 13-#11 | 19.76 | 2072 | 41.5 | 3162 |
| 16'-0" | 57 | 28 | 14-#11 | 21.28 | 2306 | 45.0 | 3365 |
| 16'-6" | 59 | 29 | 15-#11 | 22.39 | 2550 | 49.6 | 3571 |
| 17'-0" | 61 | 29 | 16-#11 | 23.80 | 2805 | 54.4 | 3782 |
| 17'-6" | 62 | 30 | 17-#11 | 25.45 | 3071 | 58.6 | 4003 |
| 18'-0" | 64 | 31 | 18-#11 | 26.65 | 3347 | 64.0 | 4225 |
| 18'-6" | 65 | 32 | 19-#11 | 28.40 | 3634 | 68.7 | 4458 |
| 19'-0" | 67 | 33 | 20-#11 | 29.66 | 3932 | 74.7 | 4691 |
| 19'-6" | 68 | 34 | 21-#11 | 31.50 | 4240 | 79.8 | 4936 |
| 20'-0" | 70 | 34 | 22-#11 | 33.15 | 4559 | 86.4 | 5180 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $\quad f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 14,700 psf (SAFE BEARING CAPACITY 10,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-0" | 17 | 10 | 7-#4 * | 1.22 | 33 | 0.8 | 231 |
| 4'-6" | 19 | 10 | 6-#5 * | 1.61 | 50 | 1.2 | 292 |
| 5'-0" | 21 | 10 | 7-#5 | 2.04 | 66 | 1.6 | 360 |
| 5'-6" | 24 | 10 | 8-#5 | 2.42 | 83 | 2.2 | 434 |
| 6'-0" | 25 | 11 | 7-#6 | 2.97 | 116 | 2.8 | 516 |
| 6'-6" | 27 | 12 | 8-#6 | 3.43 | 144 | 3.5 | 604 |
| 7'-0" | 28 | 13 | 7-#7 * | 4.13 | 186 | 4.2 | 700 |
| 7'-6" | 30 | 14 | 6-#8 * | 4.69 | 224 | 5.2 | 802 |
| 8'-0" | 32 | 15 | 7-#8 * | 5.26 | 280 | 6.3 | 910 |
| 8'-6" | 33 | 16 | 8-#8 * | 6.09 | 342 | 7.4 | 1026 |
| 9'-0" | 35 | 16 | 7-#9 * | 6.92 | 405 | 8.8 | 1148 |
| 9'-6" | 37 | 17 | 8-#9 * | 7.60 | 490 | 10.3 | 1277 |
| 10'-0" | 39 | 18 | 9-#9 * | 8.32 | 581 | 12.0 | 1412 |
| 10'-6" | 40 | 19 | 10-#9 * | 9.34 | 680 | 13.6 | 1555 |
| 11'-0" | 42 | 20 | 11-#9 * | 10.13 | 785 | 15.7 | 1702 |
| 11'-6" | 44 | 21 | 11-#9 * | 10.95 | 823 | 18.0 | 1857 |
| 12'-0" | 45 | 22 | 10-#10 * | 12.16 | 990 | 20.0 | 2020 |
| 12'-6" | 47 | 22 | 11-#10 * | 13.26 | 1136 | 22.7 | 2187 |
| 13'-0" | 49 | 23 | 12-#10 * | 14.19 | 1291 | 25.6 | 2360 |
| 13'-6" | 50 | 24 | 10-#11 * | 15.56 | 1381 | 28.1 | 2542 |
| 14'-0" | 52 | 25 | 11-#11 * | 16.56 | 1578 | 31.5 | 2728 |
| 14'-6" | 54 | 26 | 12-#11 | 17.58 | 1785 | 35.0 | 2920 |
| 15'-0" | 55 | 27 | 13-#11 | 19.05 | 2003 | 38.2 | 3122 |
| 15'-6" | 57 | 28 | 13-#11 | 20.14 | 2072 | 42.3 | 3326 |
| 16'-0" | 59 | 28 | 14-#11 | 21.53 | 2306 | 46.6 | 3537 |
| 16'-6" | 60 | 29 | 15-#11 | 23.14 | 2550 | 50.4 | 3757 |
| 17'-0" | 62 | 30 | 16-#11 | 24.33 | 2805 | 55.3 | 3980 |
| 17'-6" | 63 | 31 | 17-#11 | 26.04 | 3071 | 59.5 | 4212 |
| 18'-0" | 65 | 32 | 18-#11 | 27.30 | 3347 | 65.0 | 4447 |
| 18'-6" | 67 | 33 | 19-#11 | 28.58 | 3634 | 70.8 | 4687 |
| 19'-0" | 68 | 34 | 20-#11 | 30.43 | 3932 | 75.8 | 4938 |
| 19'-6" | 70 | 34 | 21-#11 | 32.10 | 4240 | 82.2 | 5190 |
| 20'-0" | 72 | 35 | 22-#11 | 33.48 | 4559 | 88.9 | 5448 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 15,400 psf (SAFE BEARING CAPACITY 11,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-6" | 20 | 10 | 6-#5 * | 1.59 | 50 | 1.3 | 306 |
| 5'-0" | 22 | 10 | 7-#5 | 2.02 | 66 | 1.7 | 377 |
| 5'-6" | 24 | 11 | 8-#5 | 2.42 | 83 | 2.2 | 455 |
| 6'-0" | 26 | 11 | 7-#6 | 2.97 | 116 | 2.9 | 540 |
| 6'-6" | 27 | 12 | 9-#6 | 3.61 | 162 | 3.5 | 634 |
| 7'-0" | 29 | 13 | 7-#7 * | 4.15 | 186 | 4.4 | 733 |
| 7'-6" | 31 | 14 | 6-#8 * | 4.73 | 224 | 5.4 | 840 |
| 8'-0" | 32 | 15 | 7-#8 * | 5.53 | 280 | 6.3 | 955 |
| 8'-6" | 34 | 16 | 8-#8 * | 6.17 | 342 | 7.6 | 1076 |
| 9'-0" | 36 | 17 | 7-#9 * | 6.86 | 405 | 9.0 | 1204 |
| 9'-6" | 37 | 18 | 8-#9 * | 7.82 | 490 | 10.3 | 1340 |
| 10'-0" | 39 | 19 | 9-#9 * | 8.57 | 581 | 12.0 | 1482 |
| 10'-6" | 41 | 19 | 10-#9 * | 9.53 | 680 | 14.0 | 1630 |
| 11'-0" | 43 | 20 | 11-#9 * | 10.35 | 785 | 16.1 | 1785 |
| 11'-6" | 44 | 21 | 12-#9 * | 11.51 | 898 | 18.0 | 1949 |
| 12'-0" | 46 | 22 | 10-#10 * | 12.45 | 990 | 20.4 | 2118 |
| 12'-6" | 48 | 23 | 11-#10 * | 13.38 | 1136 | 23.1 | 2294 |
| 13'-0" | 49 | 24 | 12-#10 * | 14.69 | 1291 | 25.6 | 2478 |
| 13'-6" | 51 | 25 | 13-#10 | 15.69 | 1454 | 28.7 | 2667 |
| 14'-0" | 53 | 26 | 11-#11 * | 16.77 | 1578 | 32.1 | 2863 |
| 14'-6" | 54 | 27 | 12-#11 | 18.24 | 1785 | 35.0 | 3068 |
| 15'-0" | 56 | 27 | 13-#11 | 19.60 | 2003 | 38.9 | 3276 |
| 15'-6" | 58 | 28 | 14-#11 | 20.75 | 2231 | 43.0 | 3491 |
| 16'-0" | 60 | 29 | 15-#11 | 21.92 | 2471 | 47.4 | 3712 |
| 16'-6" | 61 | 30 | 16-#11 | 23.58 | 2720 | 51.3 | 3944 |
| 17'-0" | 63 | 31 | 16-#11 | 24.82 | 2805 | 56.2 | 4177 |
| 17'-6" | 64 | 32 | 18-#11 | 26.58 | 3252 | 60.5 | 4422 |
| 18'-0" | 66 | 33 | 18-#11 | 27.89 | 3347 | 66.0 | 4669 |
| 18'-6" | 68 | 33 | 19-#11 | 29.56 | 3634 | 71.8 | 4922 |
| 19'-0" | 70 | 34 | 20-#11 | 30.93 | 3932 | 78.0 | 5180 |
| 19'-6" | 71 | 35 | 22-#11 | 32.88 | 4442 | 83.3 | 5451 |
| 20'-0" | 73 | 36 | 23-#11 | 34.33 | 4766 | 90.1 | 5722 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 16,100 psf (SAFE BEARING CAPACITY 11,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-6" | 20 | 10 | 6-#5 * | 1.66 | 50 | 1.3 | 320 |
| 5'-0" | 22 | 10 | 7-#5 | 2.12 | 66 | 1.7 | 394 |
| 5'-6" | 24 | 11 | 6-#6 * | 2.55 | 90 | 2.2 | 476 |
| 6'-0" | 26 | 12 | 7-#6 | 3.01 | 116 | 2.9 | 566 |
| 6'-6" | 27 | 13 | 9-#6 | 3.66 | 162 | 3.5 | 663 |
| 7'-0" | 29 | 14 | 10-#6 | 4.20 | 195 | 4.4 | 768 |
| 7'-6" | 31 | 14 | 12-#6 | 4.91 | 252 | 5.4 | 879 |
| 8'-0" | 33 | 15 | 13-#6 | 5.53 | 293 | 6.5 | 999 |
| 8'-6" | 35 | 16 | 8-#8 * | 6.24 | 342 | 7.8 | 1125 |
| 9'-0" | 36 | 17 | 10-#8 | 7.17 | 454 | 9.0 | 1260 |
| 9'-6" | 38 | 18 | 8-#9 * | 7.94 | 490 | 10.6 | 1402 |
| 10'-0" | 40 | 19 | 9-#9 * | 8.71 | 581 | 12.3 | 1550 |
| 10'-6" | 42 | 20 | 10-#9 * | 9.52 | 680 | 14.3 | 1706 |
| 11'-0" | 43 | 21 | 11-#9 * | 10.65 | 785 | 16.1 | 1870 |
| 11'-6" | 45 | 22 | 12-#9 * | 11.54 | 898 | 18.4 | 2040 |
| 12'-0" | 47 | 23 | 10-#10 * | 12.51 | 990 | 20.9 | 2217 |
| 12'-6" | 48 | 24 | 11-#10 * | 13.81 | 1136 | 23.1 | 2403 |
| 13'-0" | 50 | 24 | 12-#10 * | 15.04 | 1291 | 26.1 | 2594 |
| 13'-6" | 52 | 25 | 13-#10 | 16.08 | 1454 | 29.3 | 2792 |
| 14'-0" | 54 | 26 | 14-#10 | 17.16 | 1627 | 32.7 | 2997 |
| 14'-6" | 55 | 27 | 12-#11 | 18.72 | 1785 | 35.7 | 3212 |
| 15'-0" | 57 | 28 | 13-#11 | 19.87 | 2003 | 39.6 | 3430 |
| 15'-6" | 59 | 29 | 14-#11 | 21.05 | 2231 | 43.7 | 3655 |
| 16'-0" | 60 | 30 | 15-#11 | 22.72 | 2471 | 47.4 | 3891 |
| 16'-6" | 62 | 31 | 16-#11 | 23.98 | 2720 | 52.1 | 4130 |
| 17'-0" | 64 | 32 | 17-#11 | 25.27 | 2981 | 57.1 | 4375 |
| 17'-6" | 66 | 32 | 18-#11 | 26.90 | 3252 | 62.4 | 4627 |
| 18'-0" | 68 | 33 | 19-#11 | 28.26 | 3533 | 68.0 | 4886 |
| 18'-6" | 69 | 34 | 20-#11 | 30.17 | 3825 | 72.9 | 5156 |
| 19'-0" | 71 | 35 | 21-#11 | 31.60 | 4128 | 79.1 | 5428 |
| 19'-6" | 72 | 36 | 22-#11 | 33.61 | 4442 | 84.5 | 5711 |
| 20'-0" | 74 | 37 | 23-#11 | 35.11 | 4766 | 91.4 | 5996 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 16,800 psf (SAFE BEARING CAPACITY 12,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-6" | 20 | 10 | 6-#5 * | 1.73 | 50 | 1.3 | 334 |
| 5'-0" | 23 | 10 | 7-#5 | 2.09 | 66 | 1.8 | 411 |
| 5'-6" | 24 | 11 | 9-#5 | 2.65 | 94 | 2.2 | 497 |
| 6'-0" | 26 | 12 | 11-#5 | 3.13 | 126 | 2.9 | 591 |
| 6'-6" | 28 | 13 | 12-#5 | 3.64 | 150 | 3.7 | 692 |
| 7'-0" | 30 | 14 | 14-#5 | 4.20 | 190 | 4.5 | 801 |
| 7'-6" | 31 | 15 | 12-#6 | 5.00 | 252 | 5.4 | 919 |
| 8'-0" | 33 | 16 | 13-#6 | 5.64 | 293 | 6.5 | 1044 |
| 8'-6" | 35 | 17 | 15-#6 | 6.32 | 360 | 7.8 | 1176 |
| 9'-0" | 37 | 18 | 16-#6 | 7.03 | 409 | 9.3 | 1316 |
| 9'-6" | 39 | 18 | 19-#6 | 7.95 | 514 | 10.9 | 1463 |
| 10'-0" | 41 | 19 | 20-#6 | 8.75 | 571 | 12.7 | 1619 |
| 10'-6" | 42 | 20 | 10-#9 * | 9.96 | 680 | 14.3 | 1783 |
| 11'-0" | 44 | 21 | 11-#9 * | 10.85 | 785 | 16.4 | 1953 |
| 11'-6" | 46 | 22 | 12-#9 * | 11.77 | 898 | 18.8 | 2131 |
| 12'-0" | 48 | 23 | 13-#9 | 12.72 | 1017 | 21.3 | 2316 |
| 12'-6" | 49 | 24 | 15-#9 | 14.05 | 1224 | 23.6 | 2510 |
| 13'-0" | 51 | 25 | 12-#10 * | 15.14 | 1291 | 26.6 | 2710 |
| 13'-6" | 53 | 26 | 13-#10 | 16.21 | 1454 | 29.8 | 2917 |
| 14'-0" | 54 | 27 | 14-#10 | 17.71 | 1627 | 32.7 | 3134 |
| 14'-6" | 56 | 28 | 15-#10 | 18.86 | 1807 | 36.3 | 3356 |
| 15'-0" | 58 | 29 | 13-#11 | 20.10 | 2003 | 40.3 | 3584 |
| 15'-6" | 59 | 30 | 14-#11 | 21.76 | 2231 | 43.7 | 3824 |
| 16'-0" | 62 | 30 | 15-#11 | 22.88 | 2471 | 49.0 | 4063 |
| 16'-6" | 63 | 31 | 16-#11 | 24.64 | 2720 | 52.9 | 4317 |
| 17'-0" | 65 | 32 | 17-#11 | 25.98 | 2981 | 58.0 | 4573 |
| 17'-6" | 67 | 33 | 18-#11 | 27.36 | 3252 | 63.3 | 4837 |
| 18'-0" | 68 | 34 | 19-#11 | 29.28 | 3533 | 68.0 | 5113 |
| 18'-6" | 70 | 35 | 20-#11 | 30.73 | 3825 | 73.9 | 5390 |
| 19'-0" | 72 | 36 | 21-#11 | 32.22 | 4128 | 80.2 | 5675 |
| 19'-6" | 73 | 37 | 22-#11 | 34.29 | 4442 | 85.7 | 5972 |
| 20'-0" | 75 | 38 | 23-#11 | 35.85 | 4766 | 92.6 | 6270 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 17,500 psf (SAFE BEARING CAPACITY 12,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-6" | 21 | 10 | 6-#5 * | 1.70 | 50 | 1.3 | 348 |
| 5'-0" | 23 | 10 | 5-#6 * | 2.20 | 68 | 1.8 | 429 |
| 5'-6" | 25 | 11 | 7-#6 * | 2.65 | 105 | 2.3 | 518 |
| 6'-0" | 27 | 12 | 8-#6 | 3.13 | 132 | 3.0 | 615 |
| 6'-6" | 28 | 13 | 9-#6 | 3.82 | 162 | 3.7 | 722 |
| 7'-0" | 30 | 14 | 8-#7 * | 4.42 | 213 | 4.5 | 835 |
| 7'-6" | 32 | 15 | 9-#7 * | 5.04 | 258 | 5.6 | 957 |
| 8'-0" | 34 | 16 | 10-#7 | 5.70 | 307 | 6.7 | 1087 |
| 8'-6" | 36 | 17 | 11-#7 | 6.40 | 360 | 8.0 | 1225 |
| 9'-0" | 37 | 18 | 13-#7 | 7.37 | 452 | 9.3 | 1373 |
| 9'-6" | 39 | 19 | 14-#7 | 8.16 | 515 | 10.9 | 1527 |
| 10'-0" | 41 | 20 | 15-#7 | 8.99 | 583 | 12.7 | 1689 |
| 10'-6" | 43 | 21 | 10-#9 * | 9.92 | 680 | 14.6 | 1858 |
| 11'-0" | 44 | 22 | 9-#10 * | 11.16 | 813 | 16.4 | 2038 |
| 11'-6" | 46 | 23 | 10-#10 * | 12.12 | 947 | 18.8 | 2223 |
| 12'-0" | 48 | 24 | 11-#10 * | 13.11 | 1089 | 21.3 | 2416 |
| 12'-6" | 50 | 25 | 12-#10 * | 14.14 | 1239 | 24.1 | 2617 |
| 13'-0" | 52 | 25 | 10-#11 * | 15.50 | 1328 | 27.1 | 2826 |
| 13'-6" | 54 | 26 | 11-#11 * | 16.62 | 1520 | 30.4 | 3042 |
| 14'-0" | 55 | 27 | 12-#11 * | 18.15 | 1721 | 33.3 | 3268 |
| 14'-6" | 57 | 28 | 13-#11 * | 19.35 | 1934 | 37.0 | 3500 |
| 15'-0" | 59 | 29 | 14-#11 | 20.59 | 2157 | 41.0 | 3738 |
| 15'-6" | 61 | 30 | 15-#11 | 21.86 | 2391 | 45.2 | 3985 |
| 16'-0" | 62 | 31 | 16-#11 | 23.61 | 2635 | 49.0 | 4242 |
| 16'-6" | 64 | 32 | 17-#11 | 24.97 | 2890 | 53.8 | 4503 |
| 17'-0" | 66 | 33 | 17-#11 | 26.36 | 2981 | 58.9 | 4771 |
| 17'-6" | 68 | 34 | 18-#11 | 27.78 | 3252 | 64.3 | 5047 |
| 18'-0" | 69 | 35 | 20-#11 | 29.74 | 3719 | 69.0 | 5335 |
| 18'-6" | 71 | 36 | 21-#11 | 31.25 | 4017 | 75.0 | 5625 |
| 19'-0" | 73 | 37 | 22-#11 | 32.79 | 4325 | 81.3 | 5922 |
| 19'-6" | 74 | 38 | 23-#11 | 34.91 | 4644 | 86.8 | 6232 |
| 20'-0" | 76 | 39 | 24-#11 | 36.53 | 4973 | 93.8 | 6544 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCRETE REINFORCING STEEL INSTITUTE

### CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 18,200 psf (SAFE BEARING CAPACITY 13,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-6" | 21 | 10 | 6-#5 * | 1.77 | 50 | 1.3 | 362 |
| 5'-0" | 23 | 10 | 8-#5 | 2.27 | 75 | 1.8 | 446 |
| 5'-6" | 25 | 11 | 9-#5 | 2.74 | 94 | 2.3 | 539 |
| 6'-0" | 27 | 12 | 11-#5 | 3.25 | 126 | 3.0 | 641 |
| 6'-6" | 29 | 13 | 9-#6 | 3.81 | 162 | 3.8 | 751 |
| 7'-0" | 31 | 14 | 8-#7 * | 4.43 | 213 | 4.7 | 869 |
| 7'-6" | 33 | 15 | 9-#7 * | 5.06 | 258 | 5.7 | 996 |
| 8'-0" | 34 | 16 | 10-#7 | 5.94 | 307 | 6.7 | 1132 |
| 8'-6" | 36 | 17 | 7-#9 * | 6.73 | 381 | 8.0 | 1276 |
| 9'-0" | 38 | 18 | 8-#9 * | 7.50 | 462 | 9.5 | 1428 |
| 9'-6" | 40 | 19 | 9-#9 * | 8.31 | 551 | 11.1 | 1588 |
| 10'-0" | 42 | 20 | 10-#9 * | 9.17 | 646 | 13.0 | 1757 |
| 10'-6" | 43 | 21 | 11-#9 * | 10.34 | 748 | 14.6 | 1935 |
| 11'-0" | 45 | 22 | 9-#10 * | 11.33 | 813 | 16.8 | 2121 |
| 11'-6" | 47 | 23 | 10-#10 * | 12.31 | 947 | 19.2 | 2314 |
| 12'-0" | 49 | 24 | 11-#10 * | 13.34 | 1089 | 21.8 | 2515 |
| 12'-6" | 51 | 25 | 12-#10 * | 14.41 | 1239 | 24.6 | 2724 |
| 13'-0" | 52 | 26 | 13-#10 * | 15.87 | 1398 | 27.1 | 2944 |
| 13'-6" | 54 | 27 | 11-#11 * | 17.07 | 1520 | 30.4 | 3169 |
| 14'-0" | 56 | 28 | 12-#11 * | 18.26 | 1721 | 33.9 | 3403 |
| 14'-6" | 58 | 29 | 13-#11 * | 19.50 | 1934 | 37.6 | 3644 |
| 15'-0" | 60 | 30 | 14-#11 | 20.77 | 2157 | 41.7 | 3893 |
| 15'-6" | 61 | 31 | 15-#11 | 22.51 | 2391 | 45.2 | 4153 |
| 16'-0" | 63 | 32 | 16-#11 | 23.87 | 2635 | 49.8 | 4417 |
| 16'-6" | 65 | 33 | 17-#11 | 25.26 | 2890 | 54.6 | 4690 |
| 17'-0" | 67 | 34 | 18-#11 | 26.69 | 3156 | 59.8 | 4969 |
| 17'-6" | 68 | 35 | 19-#11 | 28.65 | 3432 | 64.3 | 5261 |
| 18'-0" | 70 | 36 | 20-#11 | 30.17 | 3719 | 70.0 | 5557 |
| 18'-6" | 72 | 36 | 21-#11 | 32.08 | 4017 | 76.1 | 5859 |
| 19'-0" | 74 | 37 | 22-#11 | 33.68 | 4325 | 82.5 | 6169 |
| 19'-6" | 76 | 38 | 23-#11 | 35.31 | 4644 | 89.2 | 6487 |
| 20'-0" | 78 | 39 | 24-#11 | 36.98 | 4973 | 96.3 | 6812 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

### CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f_c' = 3{,}000$ psi $f_y = 60{,}000$ psi

FACTORED SOIL BEARING CAPACITY 18,900 psf (SAFE BEARING CAPACITY 13,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-6" | 21 | 10 | 6-#5 * | 1.84 | 50 | 1.3 | 376 |
| 5'-0" | 23 | 11 | 8-#5 | 2.27 | 75 | 1.8 | 464 |
| 5'-6" | 25 | 12 | 9-#5 | 2.74 | 94 | 2.3 | 560 |
| 6'-0" | 27 | 13 | 11-#5 | 3.26 | 126 | 3.0 | 666 |
| 6'-6" | 29 | 14 | 9-#6 | 3.84 | 162 | 3.8 | 780 |
| 7'-0" | 31 | 15 | 8-#7 * | 4.47 | 213 | 4.7 | 903 |
| 7'-6" | 33 | 16 | 9-#7 * | 5.12 | 258 | 5.7 | 1035 |
| 8'-0" | 34 | 17 | 8-#8 * | 6.05 | 320 | 6.7 | 1177 |
| 8'-6" | 36 | 18 | 7-#9 * | 6.83 | 381 | 8.0 | 1327 |
| 9'-0" | 38 | 19 | 8-#9 * | 7.63 | 462 | 9.5 | 1485 |
| 9'-6" | 40 | 20 | 9-#9 * | 8.47 | 551 | 11.1 | 1652 |
| 10'-0" | 42 | 21 | 10-#9 * | 9.35 | 646 | 13.0 | 1827 |
| 10'-6" | 44 | 22 | 11-#9 * | 10.27 | 748 | 15.0 | 2011 |
| 11'-0" | 45 | 23 | 12-#9 * | 11.53 | 857 | 16.8 | 2205 |
| 11'-6" | 47 | 24 | 10-#10 * | 12.59 | 947 | 19.2 | 2406 |
| 12'-0" | 49 | 25 | 11-#10 * | 13.65 | 1089 | 21.8 | 2616 |
| 12'-6" | 51 | 26 | 12-#10 * | 14.75 | 1239 | 24.6 | 2834 |
| 13'-0" | 53 | 26 | 13-#10 * | 16.15 | 1398 | 27.6 | 3060 |
| 13'-6" | 55 | 27 | 14-#10 | 17.34 | 1566 | 30.9 | 3294 |
| 14'-0" | 57 | 28 | 12-#11 * | 18.62 | 1721 | 34.5 | 3537 |
| 14'-6" | 59 | 29 | 13-#11 * | 19.90 | 1934 | 38.3 | 3788 |
| 15'-0" | 61 | 30 | 14-#11 | 21.21 | 2157 | 42.4 | 4047 |
| 15'-6" | 62 | 31 | 15-#11 | 23.00 | 2391 | 46.0 | 4317 |
| 16'-0" | 64 | 32 | 16-#11 | 24.40 | 2635 | 50.6 | 4593 |
| 16'-6" | 66 | 33 | 17-#11 | 25.84 | 2890 | 55.5 | 4876 |
| 17'-0" | 68 | 34 | 18-#11 | 27.32 | 3156 | 60.7 | 5167 |
| 17'-6" | 70 | 35 | 19-#11 | 28.85 | 3432 | 66.2 | 5467 |
| 18'-0" | 71 | 36 | 20-#11 | 30.91 | 3719 | 71.0 | 5779 |
| 18'-6" | 73 | 37 | 21-#11 | 32.52 | 4017 | 77.1 | 6094 |
| 19'-0" | 75 | 38 | 22-#11 | 34.17 | 4325 | 83.6 | 6417 |
| 19'-6" | 77 | 39 | 23-#11 | 35.86 | 4644 | 90.4 | 6748 |
| 20'-0" | 79 | 40 | 25-#11 | 37.58 | 5180 | 97.5 | 7086 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f_c'$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 19,600 psf (SAFE BEARING CAPACITY 14,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-6" | 22 | 10 | 6-#5 * | 1.80 | 50 | 1.4 | 390 |
| 5'-0" | 24 | 11 | 8-#5 | 2.23 | 75 | 1.9 | 481 |
| 5'-6" | 25 | 12 | 7-#6 * | 2.87 | 105 | 2.3 | 582 |
| 6'-0" | 27 | 13 | 8-#6 | 3.41 | 132 | 3.0 | 691 |
| 6'-6" | 29 | 14 | 10-#6 | 3.99 | 180 | 3.8 | 810 |
| 7'-0" | 31 | 15 | 8-#7 * | 4.65 | 213 | 4.7 | 938 |
| 7'-6" | 33 | 16 | 9-#7 * | 5.32 | 258 | 5.7 | 1075 |
| 8'-0" | 35 | 17 | 8-#8 * | 6.07 | 320 | 6.9 | 1221 |
| 8'-6" | 37 | 18 | 7-#9 * | 6.87 | 381 | 8.3 | 1376 |
| 9'-0" | 39 | 19 | 8-#9 * | 7.68 | 462 | 9.8 | 1540 |
| 9'-6" | 41 | 20 | 9-#9 * | 8.54 | 551 | 11.4 | 1713 |
| 10'-0" | 42 | 21 | 10-#9 * | 9.71 | 646 | 13.0 | 1897 |
| 10'-6" | 44 | 22 | 11-#9 * | 10.67 | 748 | 15.0 | 2088 |
| 11'-0" | 46 | 23 | 12-#9 * | 11.68 | 857 | 17.2 | 2288 |
| 11'-6" | 48 | 24 | 13-#9 * | 12.72 | 972 | 19.6 | 2497 |
| 12'-0" | 50 | 25 | 11-#10 * | 13.85 | 1089 | 22.2 | 2714 |
| 12'-6" | 52 | 26 | 12-#10 * | 14.99 | 1239 | 25.1 | 2941 |
| 13'-0" | 54 | 27 | 13-#10 * | 16.16 | 1398 | 28.2 | 3176 |
| 13'-6" | 56 | 28 | 14-#10 * | 17.38 | 1566 | 31.5 | 3419 |
| 14'-0" | 57 | 29 | 15-#10 | 19.03 | 1743 | 34.5 | 3674 |
| 14'-6" | 59 | 30 | 17-#10 | 20.34 | 2048 | 38.3 | 3935 |
| 15'-0" | 61 | 31 | 14-#11 | 21.76 | 2157 | 42.4 | 4204 |
| 15'-6" | 63 | 32 | 15-#11 | 23.16 | 2391 | 46.7 | 4482 |
| 16'-0" | 65 | 33 | 16-#11 | 24.60 | 2635 | 51.4 | 4768 |
| 16'-6" | 67 | 34 | 17-#11 | 26.08 | 2890 | 56.3 | 5062 |
| 17'-0" | 68 | 35 | 19-#11 | 28.08 | 3331 | 60.7 | 5370 |
| 17'-6" | 70 | 36 | 20-#11 | 29.66 | 3613 | 66.2 | 5681 |
| 18'-0" | 72 | 37 | 21-#11 | 31.27 | 3905 | 72.0 | 6000 |
| 18'-6" | 74 | 38 | 22-#11 | 32.93 | 4208 | 78.2 | 6328 |
| 19'-0" | 76 | 39 | 23-#11 | 34.62 | 4521 | 84.7 | 6664 |
| 19'-6" | 78 | 40 | 24-#11 | 36.36 | 4845 | 91.5 | 7008 |
| 20'-0" | 79 | 41 | 25-#11 | 38.70 | 5180 | 97.5 | 7366 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 20,300 psf (SAFE BEARING CAPACITY 14,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-6" | 22 | 10 | 7-#5 * | 1.87 | 58 | 1.4 | 404 |
| 5'-0" | 24 | 11 | 8-#5 | 2.32 | 75 | 1.9 | 499 |
| 5'-6" | 26 | 12 | 7-#6 * | 2.83 | 105 | 2.4 | 602 |
| 6'-0" | 28 | 13 | 8-#6 | 3.38 | 132 | 3.1 | 716 |
| 6'-6" | 30 | 14 | 10-#6 | 3.97 | 180 | 3.9 | 839 |
| 7'-0" | 32 | 15 | 8-#7 * | 4.64 | 213 | 4.8 | 971 |
| 7'-6" | 34 | 16 | 9-#7 * | 5.33 | 258 | 5.9 | 1113 |
| 8'-0" | 35 | 17 | 8-#8 * | 6.30 | 320 | 6.9 | 1266 |
| 8'-6" | 37 | 18 | 9-#8 * | 7.10 | 384 | 8.3 | 1427 |
| 9'-0" | 39 | 19 | 8-#9 * | 7.97 | 462 | 9.8 | 1597 |
| 9'-6" | 41 | 20 | 9-#9 * | 8.86 | 551 | 11.4 | 1777 |
| 10'-0" | 43 | 21 | 10-#9 * | 9.80 | 646 | 13.3 | 1966 |
| 10'-6" | 45 | 22 | 11-#9 * | 10.78 | 748 | 15.3 | 2164 |
| 11'-0" | 47 | 23 | 12-#9 * | 11.81 | 857 | 17.6 | 2371 |
| 11'-6" | 49 | 24 | 13-#9 * | 12.89 | 972 | 20.0 | 2587 |
| 12'-0" | 51 | 25 | 15-#9 * | 14.00 | 1173 | 22.7 | 2813 |
| 12'-6" | 53 | 26 | 12-#10 * | 15.21 | 1239 | 25.6 | 3048 |
| 13'-0" | 55 | 27 | 13-#10 * | 16.42 | 1398 | 28.7 | 3291 |
| 13'-6" | 56 | 28 | 12-#11 * | 18.10 | 1658 | 31.5 | 3547 |
| 14'-0" | 58 | 29 | 13-#11 * | 19.41 | 1865 | 35.1 | 3808 |
| 14'-6" | 60 | 31 | 14-#11 * | 20.47 | 2083 | 38.9 | 4079 |
| 15'-0" | 62 | 32 | 15-#11 | 21.86 | 2311 | 43.1 | 4358 |
| 15'-6" | 63 | 33 | 16-#11 | 23.73 | 2550 | 46.7 | 4650 |
| 16'-0" | 65 | 34 | 17-#11 | 25.22 | 2800 | 51.4 | 4947 |
| 16'-6" | 67 | 35 | 18-#11 | 26.75 | 3060 | 56.3 | 5253 |
| 17'-0" | 69 | 36 | 19-#11 | 28.32 | 3331 | 61.5 | 5568 |
| 17'-6" | 71 | 37 | 20-#11 | 29.94 | 3613 | 67.1 | 5891 |
| 18'-0" | 73 | 38 | 21-#11 | 31.60 | 3905 | 73.0 | 6222 |
| 18'-6" | 75 | 39 | 22-#11 | 33.30 | 4208 | 79.2 | 6563 |
| 19'-0" | 77 | 40 | 23-#11 | 35.04 | 4521 | 85.8 | 6911 |
| 19'-6" | 78 | 41 | 24-#11 | 37.38 | 4845 | 91.5 | 7274 |
| 20'-0" | 80 | 42 | 26-#11 | 39.21 | 5387 | 98.8 | 7640 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## CONCRETE REINFORCING STEEL INSTITUTE

### CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 21,000 psf (SAFE BEARING CAPACITY 15,000 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-6" | 22 | 10 | 7-#5 * | 1.93 | 58 | 1.4 | 419 |
| 5'-0" | 24 | 11 | 8-#5 | 2.40 | 75 | 1.9 | 516 |
| 5'-6" | 26 | 12 | 7-#6 * | 2.93 | 105 | 2.4 | 623 |
| 6'-0" | 28 | 13 | 8-#6 | 3.50 | 132 | 3.1 | 741 |
| 6'-6" | 30 | 14 | 10-#6 | 4.12 | 180 | 3.9 | 868 |
| 7'-0" | 32 | 15 | 11-#6 | 4.78 | 215 | 4.8 | 1005 |
| 7'-6" | 34 | 16 | 13-#6 | 5.50 | 273 | 5.9 | 1153 |
| 8'-0" | 35 | 18 | 15-#6 | 6.31 | 338 | 6.9 | 1310 |
| 8'-6" | 37 | 19 | 12-#7 | 7.15 | 392 | 8.3 | 1477 |
| 9'-0" | 39 | 20 | 14-#7 | 8.01 | 486 | 9.8 | 1654 |
| 9'-6" | 41 | 21 | 9-#9 * | 8.99 | 551 | 11.4 | 1840 |
| 10'-0" | 43 | 22 | 10-#9 * | 9.95 | 646 | 13.3 | 2036 |
| 10'-6" | 45 | 23 | 11-#9 * | 10.96 | 748 | 15.3 | 2241 |
| 11'-0" | 47 | 24 | 8-#11 * | 12.10 | 893 | 17.6 | 2456 |
| 11'-6" | 49 | 25 | 9-#11 * | 13.21 | 1052 | 20.0 | 2680 |
| 12'-0" | 51 | 26 | 10-#11 * | 14.36 | 1222 | 22.7 | 2914 |
| 12'-6" | 53 | 27 | 10-#11 * | 15.56 | 1275 | 25.6 | 3157 |
| 13'-0" | 55 | 28 | 11-#11 * | 16.81 | 1461 | 28.7 | 3410 |
| 13'-6" | 57 | 29 | 12-#11 * | 18.10 | 1658 | 32.1 | 3671 |
| 14'-0" | 59 | 30 | 13-#11 * | 19.44 | 1865 | 35.7 | 3943 |
| 14'-6" | 61 | 31 | 14-#11 * | 20.82 | 2083 | 39.6 | 4223 |
| 15'-0" | 63 | 32 | 15-#11 | 22.25 | 2311 | 43.8 | 4512 |
| 15'-6" | 64 | 33 | 16-#11 | 24.16 | 2550 | 47.5 | 4815 |
| 16'-0" | 66 | 34 | 17-#11 | 25.69 | 2800 | 52.1 | 5123 |
| 16'-6" | 68 | 35 | 18-#11 | 27.27 | 3060 | 57.1 | 5440 |
| 17'-0" | 70 | 36 | 19-#11 | 28.89 | 3331 | 62.4 | 5766 |
| 17'-6" | 72 | 37 | 20-#11 | 30.55 | 3613 | 68.1 | 6101 |
| 18'-0" | 74 | 38 | 21-#11 | 32.26 | 3905 | 74.0 | 6444 |
| 18'-6" | 76 | 39 | 22-#11 | 34.01 | 4208 | 80.3 | 6797 |
| 19'-0" | 78 | 40 | 23-#11 | 35.81 | 4521 | 86.9 | 7159 |
| 19'-6" | 80 | 41 | 25-#11 | 37.64 | 5047 | 93.9 | 7529 |
| 20'-0" | 82 | 42 | 26-#11 | 39.53 | 5387 | 101.2 | 7908 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

### CONCENTRICALLY LOADED SQUARE SPREAD FOOTINGS

$f'_c$ = 3,000 psi $f_y$ = 60,000 psi

FACTORED SOIL BEARING CAPACITY 21,700 psf (SAFE BEARING CAPACITY 15,500 psf)

| Size B | Thick-ness (in.) | Min. Col. Size (in.) | Bars Each Way (No.-Size) | Required Steel Area (sq.-in.) | Weight of Bars (pounds) | Volume of Concrete (cu. yd.) | Factored Column Capacity (kips) |
|---|---|---|---|---|---|---|---|
| 4'-6" | 23 | 10 | 7-#5 * | 1.89 | 58 | 1.4 | 432 |
| 5'-0" | 25 | 11 | 8-#5 | 2.36 | 75 | 1.9 | 533 |
| 5'-6" | 27 | 12 | 7-#6 * | 2.90 | 105 | 2.5 | 644 |
| 6'-0" | 28 | 14 | 8-#6 | 3.50 | 132 | 3.1 | 766 |
| 6'-6" | 30 | 15 | 10-#6 | 4.13 | 180 | 3.9 | 898 |
| 7'-0" | 32 | 16 | 11-#6 | 4.80 | 215 | 4.8 | 1040 |
| 7'-6" | 34 | 17 | 13-#6 | 5.53 | 273 | 5.9 | 1192 |
| 8'-0" | 36 | 18 | 15-#6 | 6.31 | 338 | 7.1 | 1354 |
| 8'-6" | 38 | 19 | 12-#7 | 7.17 | 392 | 8.5 | 1527 |
| 9'-0" | 40 | 20 | 14-#7 | 8.05 | 486 | 10.0 | 1709 |
| 9'-6" | 42 | 21 | 15-#7 | 8.98 | 552 | 11.7 | 1902 |
| 10'-0" | 44 | 22 | 8-#10 * | 10.06 | 654 | 13.6 | 2104 |
| 10'-6" | 46 | 23 | 9-#10 * | 11.09 | 775 | 15.7 | 2316 |
| 11'-0" | 48 | 24 | 8-#11 * | 12.22 | 893 | 17.9 | 2539 |
| 11'-6" | 50 | 25 | 9-#11 * | 13.35 | 1052 | 20.4 | 2771 |
| 12'-0" | 52 | 26 | 10-#11 * | 14.53 | 1222 | 23.1 | 3012 |
| 12'-6" | 54 | 27 | 11-#11 * | 15.76 | 1403 | 26.0 | 3264 |
| 13'-0" | 56 | 28 | 11-#11 * | 17.04 | 1461 | 29.2 | 3525 |
| 13'-6" | 58 | 29 | 12-#11 * | 18.36 | 1658 | 32.6 | 3796 |
| 14'-0" | 59 | 31 | 13-#11 * | 19.83 | 1865 | 35.7 | 4080 |
| 14'-6" | 61 | 32 | 14-#11 * | 21.26 | 2083 | 39.6 | 4370 |
| 15'-0" | 63 | 33 | 15-#11 | 22.73 | 2311 | 43.8 | 4670 |
| 15'-6" | 65 | 34 | 16-#11 | 24.24 | 2550 | 48.2 | 4979 |
| 16'-0" | 67 | 35 | 17-#11 | 25.81 | 2800 | 52.9 | 5298 |
| 16'-6" | 69 | 36 | 18-#11 | 27.42 | 3060 | 58.0 | 5626 |
| 17'-0" | 71 | 37 | 19-#11 | 29.07 | 3331 | 63.3 | 5964 |
| 17'-6" | 73 | 38 | 20-#11 | 30.77 | 3613 | 69.0 | 6310 |
| 18'-0" | 75 | 39 | 21-#11 | 32.52 | 3905 | 75.0 | 6666 |
| 18'-6" | 77 | 40 | 22-#11 | 34.32 | 4208 | 81.3 | 7032 |
| 19'-0" | 78 | 41 | 24-#11 | 36.70 | 4718 | 86.9 | 7411 |
| 19'-6" | 80 | 42 | 25-#11 | 38.60 | 5047 | 93.9 | 7795 |
| 20'-0" | 82 | 43 | 26-#11 | 40.54 | 5387 | 101.2 | 8188 |

Notes: 1. Epoxy-coated bars of the same size and number may be used except where an "*" is printed. In which case, use: smaller bars (with increased number of bars); hooked or headed bars; increased $f'_c$, or larger footing.
2. Reinforcing steel quantities do not include footing dowels.

## PILE CAPS FOR INDIVIDUAL COLUMNS

### General

In this Chapter, a pile cap is considered to be a reinforced concrete structural slab which distributes a column load to a group of individual piles. The tabulated designs are based upon use of a square reinforced concrete column of at least the minimum size indicated or a structural steel column on a square steel base plate such that the section half-way between the column face and the edge of the base plate is equivalent to the size of the column. The tabulated designs are adequate (and conservative) for rectangular columns or steel base plates if the short side or section is equal to the minimum tabulated column size. Columns are located at the centroid of the pile groups.

Pile caps are an important structure, however, somewhat neglected in handbooks on structural steel because they are reinforced concrete or in handbooks on reinforced concrete in the range where steel piles are used. Since pile caps are basic to safety of the structure and usually not open to visual inspection under service, a conservative design is justified. Complete analyses are complex, usually involving strut and tie design models and allowable values for use in design are not available for certain modes of failure. As a result, most pile caps are designed in practice by various short-cut rule-of-thumb procedures using what are hoped to be conservative allowable stresses. Since practical limits on pile capacity and pile spacing exist, a set of tabulated designs can be offered for the usual range of column loads in which the complex analyses are performed by computer.

### Basis of Tabulated Designs

(See also Figs. 13-2 and 13-3)

a. *ACI 318 Building Code*. The tabulated designs for pile caps in this Chapter are based on the ACI 318-99 Code. However, headed bars, which first appeared in the ACI 318-08 Code, are recognized as a viable alternative to hooked bars and are referenced in the tabulated designs.

b. *Concrete strengths.* Due to space limitations, tabulated designs are shown for only the two most commonly used concrete compressive strengths, $f'_c$ = 3,000 psi and $f'_c$ = 4,000 psi. Since shear strength controls depth, and $v_c = k\sqrt{f'_c}$, the saving in concrete and formwork for higher values of $f'_c$ would not ordinarily offset the higher concrete cost and added reinforcing steel required for lesser depth. If minimum depth is itself an important cost consideration, then higher strength concrete, or specifying $f'_c$ at periods later than 28 days, or both may be desirable. Such designs could not be adapted from tabulated design. (See "Manual Example.")

c. *Pile embedment*. A minimum embedment of 6 inches has been established as good practice with structural steel shapes to avoid use of cover plates for bearing.

If precast concrete piles are to be used in the tabulated designs, a minimum embedment of 4 inches is usually sufficient. Design depth is unaffected so only 4 inches of embedment needs to be shown, deduct 2 inches from tabulated thickness, and reduce tabulated concrete volume appropriately.

d. *Concrete cover.* The tabulated designs are based on a concrete cover (between the top of a steel pile and the reinforcing bars) of 3 inches.

e. *Pile spacing.* A minimum pile spacing of 3′-0″ c.-c. and a minimum clear distance of 2′-0″ between piles were established as generally conservative for piles up to 12 inches in diameter. For larger piles, the minimum clear distance controls, and larger spacings are required, as shown in the tabulated designs. See Fig. 13-3. If a closer spacing is used, the tabulated designs for thickness and reinforcing bars are generally conservative. The condition of overlapping critical shear sections for a pair of piles should be investigated, but should not be critical as the allowable $v_c$ will increase if the angle of the potential crack to the vertical, $a < 45°$ . . . (ACI Commentary R11.8.7).

f. *Patterns.* Patterns for 2-pile to 30-pile pile cap layouts are included. To prevent vertical edge splitting, the minimum edge distance, $E$, to the center of piles is 15 inches for pile capacity $P \le 60$ tons, 21 inches for $60 < P \le 120$, 27 inches for $120 < P \le 200$, and 30 inches for $P > 200$ tons. A minimum clear edge distance, $E' = E - 3$ inches $\ge 9$ inches, is required for (hooked or headed) end anchorage. Where the pile diameter, $d_p$, exceeds 12 inches, the edge distance, $E$, should be increased to maintain the minimum clear edge distance. See Fig. 13-3.

Note that some tabulated designs show dimensions on the line below. These dimensions are for use with "clipped corners" to save concrete as an option. For example, the 3-pile cap shown in Fig. 13-2 would be dimensioned in the tabulated designs as:

| *Long A* | *Short B* | |
|---|---|---|
| 5'-6" | 5'-2" | (first line) |
| 1'-6" | 1'-7" | (second line) |

In other words, the "clipped corner" dimensions are the truncated dimensions of the pile cap with the corners removed.

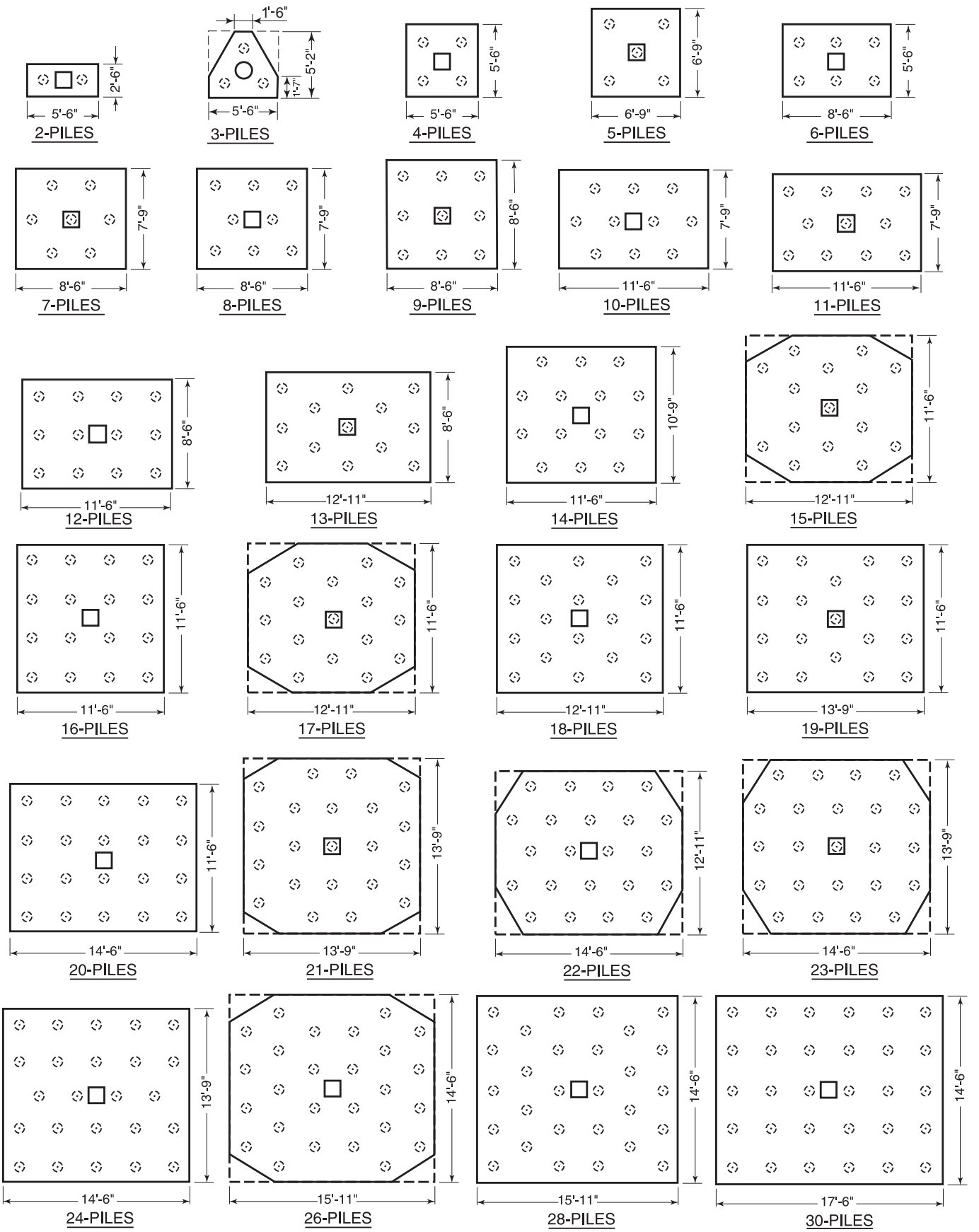



**Figure 13-2 Arrangements of Piles and Plan Dimensions* of Pile Caps**

*Minimum dimensions shown. See tabulated designs for dimensions used.

g. *Pile capacity.* Pile capacity is tabulated in tons, ($D + L$), as is usually done in accepted practice. The range shown, 40 tons to 200 tons, covers the usual range for precast concrete or structural steel piles. *Net* column loads, $P_u$, are shown (weight of pile cap has been deducted). Column load is shown in kips for strength design as $P_u = 1.6(D + L)$ where the average load factor is assumed to be 1.6.

h. *Flexural reinforcement*. All tabulated designs are based on the use of Grade 60 ($f_y$ = 60,000 psi) reinforcing bars. Areas of required flexural reinforcement are conservatively based on an average effective depth, $d = D - d_c$, where $D$ = total depth, and $d_c$ = 10 inches for structural steel piles, or $d_c$ = 8 inches for concrete piles. The requirements for minimum areas of flexural reinforcement (ACI 10.5 and 7.12) are satisfied by the following conservative interpretation, where $A_s$ is the calculated area of reinforcement required for flexure (ACI 7.12 and 10.5):

(1) if $A_s > 0.0033bd$, use $A_s$ (where $200/f_y = 0.0033$)
(2) if $A_s < 0.0033bd < 4/3A_s$, use $0.0033bd$
(3) if $0.0018bD < 4/3A_s < 0.0033bd$, use $4/3A_s$
(4) if $4/3A_s < 0.0018bD < 0.0033bd$, use $0.0018bD$

For 2-pile pile caps only, use (1), (2), or (3) for the required flexural (long) bars. Flexural reinforcement areas in the short direction for rectangular pile caps have been increased to permit use of uniform bar spacings to avoid errors in field placing and still conform to ACI 15.4.4.2.

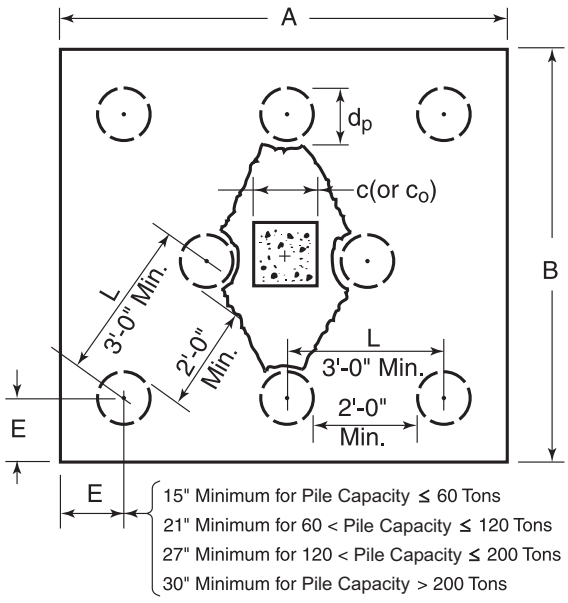
i. *Anchorage.* For pile caps with 2, 3, 4, 5, 6, 7, or 9 piles, all reinforcing bars must be provided with standard end hooks. For pile caps with 8, 10, 11, or 12 piles, only the short reinforcing bars must be provided with end hooks, and should be placed as the lower layer. As an alternative to hooked bars, the bar ends can instead be headed. See Figs. 13-12 and 13-13.

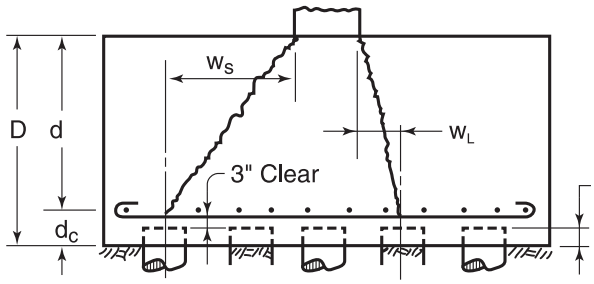
j. *Column size.* The column sizes shown are derived from square column sizes for a bearing stress of 4,000 psi on the gross column area. Tabulated designs are conservative if the column is larger than the minimum column size tabulated.

## Design Procedure

*a. Flexure.* The design strength of the critical section for flexure and the required area of flexural reinforcement at $f_y$ = 60,000 psi is determined by the ACI strength design method for factored pile loads equal to $1.6(D + L)$. Since the depth of the pile cap required is usually established by shear, the flexural reinforcement ratio is usually near or controlled by the minimum ratios required by ACI 10.5 and ACI 7.12.

*b. Shear.* Due to the variety of conditions resulting from the 26 pile cap patterns, a variable number of critical sections for shear must be investigated. See Fig. 13-4. The possibilities of shear failures at $d/2$ about a single pile or at an "overlapping" section $d/2$ about a pair of piles are most conveniently related to the footing depth using $f'_c$ = 3,000 psi with solutions for the full range of pile loads (12-inch pile diameter and 36-inch pile spacing). See Fig. 13-5. Fig. 13-5 also includes solutions for a "corner" failure at 45° as a beam, in one-way shear with $v_c = 2\sqrt{f'_c}$. This latter condition with one (or three) pile loads on the critical section is generally precluded by the dimensions of pile diameter, pile spacing, and pile cap depths.




**NOTATION**

D = total depth = d + $d_c$
d = effective depth
$d_c$ = average to ctr. of bars
c (or $c_o$) = col. side (dia.)
$d_p$ = diameter of pile
E = edge to ℄ piles
L = spacing, c-c. piles
A = long side
B = short side
P = pile capacity (D + L) in tons
w = horizontal component col. face-to-bot. crack (sub "S" short side "L" long side)

**Figure 13-3 Pile Cap Nomenclature, Dimensions, and Plan and Section Details**

In addition to these possible critical sections, shear is investigated as prescribed in the Code for a "punching" failure about the column at a section located at a distance $d/2$ from the column face ($v_c = 4\sqrt{f'_c}$), and for a "beam" failure straight across the width of the pile cap in either direction at a section located at a distance $d$ from the column face ($v_c = 2\sqrt{f'_c}$) . . . (ACI 11.12). See Fig. 13-4. Both of these Code-required investigations become inappropriate as the depth of the footing increases so that the sections at distance $d$ (or $d/2$) exclude all or part of the pile loads causing shear or even fall outside the footing.

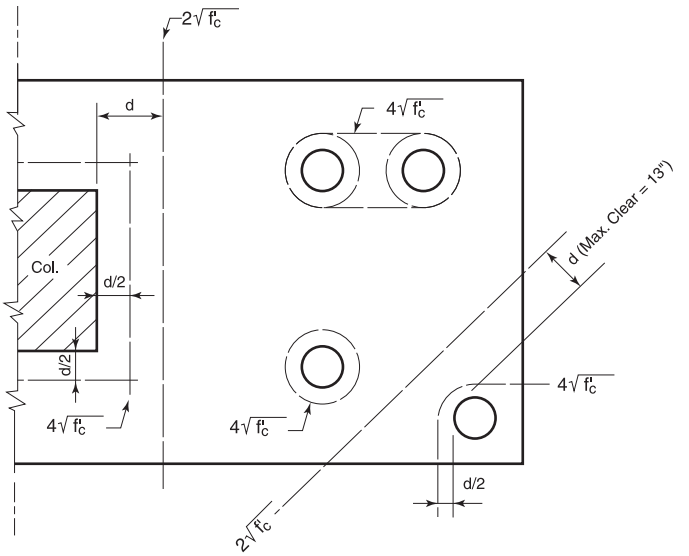



**Figure 13-4 Plan of Critical Shear Sections for Code-Prescribed Allowable Shear on Concrete (One-Way, $v_c = 2\sqrt{f'_c}$; Two-Way, $v_c = 4\sqrt{f'_c}$)**

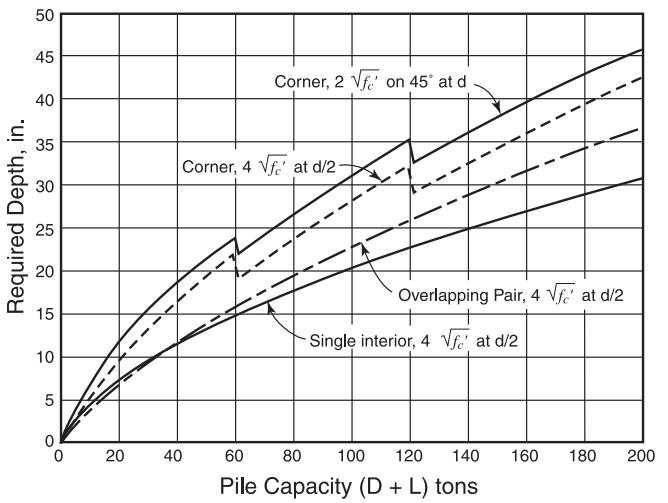



**Figure 13-5 Solutions for Design Depth Required at Code-Prescribed Allowable Shear on Concrete at Critical Sections Around Piles versus Pile Capacity, Tons ($D + L$)**

## SPECIAL INVESTIGATIONS

As the previous Code-prescribed assumptions are not satisfied, two special investigations for possible shear failure are necessary. The investigation of a beam shear failure, cracking across the width of a footing, when footing depth creates "deep beam" shear, and a column punching failure when the nearest piles cause such failure to occur in a manner approaching "pure shear" will establish two additional rational basis for selecting the depth when "normal" shear investigations do not apply. See Figs. 13-6 and 13-7. Limiting values for $v_c$ under these special conditions, based on research, become very high.*

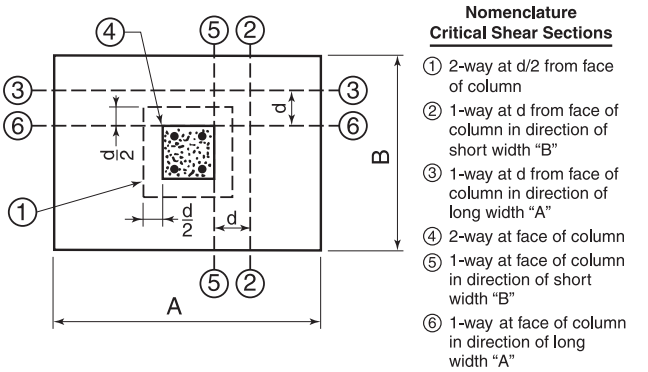



**Figure 13-6 Critical Sections and Notation for Special Investigations of Deep Beam (One-Way) Shear**

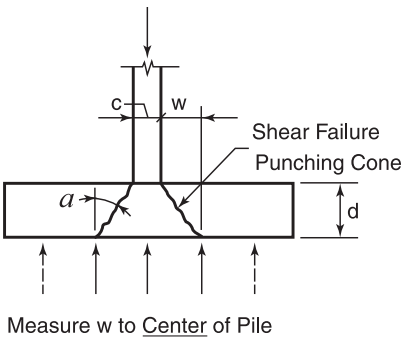



**Figure 13-7 Two-Way Shear at Columns; Code-Prescribed Investigation, $v_c = 4\sqrt{f'_c}$ for $a = 45^o$; Special Deep Two-Way Corbel Investigation for $a < 45^o$****

*Joint ASCE-ACI Committee 426, "The Shear Strength of Reinforced Concrete," Journal of the Structural Division, ASCE, Part I — Beams and Special Members, June 1973 and Part II — Slabs, Aug. 1974.

**Tabulated designs reflect $w' = w + 3$ in. in all calculations for shear and flexure to include adverse tolerance effects.

## SPECIAL INVESTIGATION – Two-Way Deep Corbel

**For square (or equivalent round) columns.** The shear failure section is a pyramidal frustrum with slope angle to the vertical, $\alpha \approx 45^o$, and $w \approx d$. This condition is part of the explicitly Code-prescribed investigation. The allowable shear stress on concrete is: $v_c = 4\sqrt{f'_c}$, at a section, which is located at a distance of $d/2$ from the perimeter of the column for all piles outside this section. The shear section perimeter is: $b_o = 4(c + d)$.

When $w < d$, and $45^o > \alpha \geq 0$, the explicit Code provisions do not apply. The condition is an inverted "deep" two-way cantilever slab with concentrated loads (pile loads, $1.6P$). Providing horizontal shear-friction reinforcement distributed through 2/3 of the depth as for small one-way corbels is impracticable (ACI 11.9.4, 11.9.5). Failure when $\alpha < 45^o$ can occur, but only at increasingly higher values of $v_c$, approaching a theoretical strength $v_c = 0.5f'_c \approx 32\sqrt{f'_c}$ at $\alpha = 0$ ("pure" shear). The "deep" beam formulas of the Code for one-way shear omit limits for cantilever spans and are not applicable for this condition (ACI 11.8). See Figures 5.1 and 5.9 in the reference noted on Page 13-24.

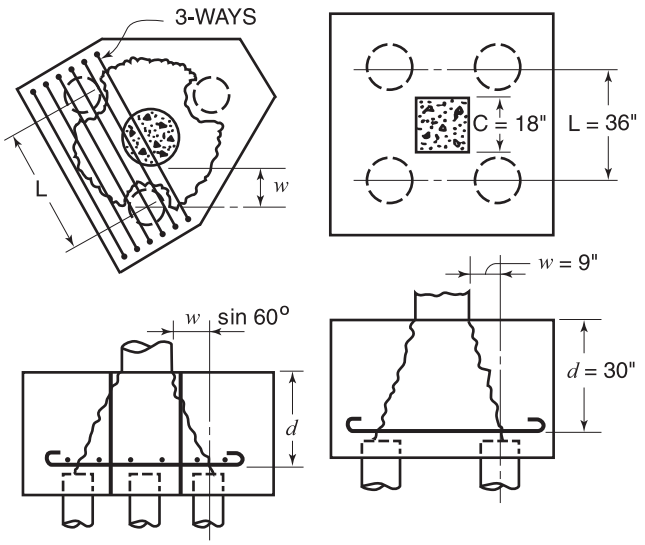



**Figure 13-8 Deep Two-Way Pile Cap Slabs**

Since the various pile arrangements in Fig. 13-2 include all variations of distance $w$ from face of column to centers of first piles and $w$ can approach zero, it is most convenient to make this special investigation on the perimeter at the **face** of the column with the special critical section $b_s = 4c$. This special investigation will be made only when $w < d/2$ since the ACI-prescribed procedure can be applied when $w \geq d/2$. Converting the ACI-prescribed $v_c$ from $v_c = 4\sqrt{f'_c}$, at the section perimeter at $d/2$, $b_o = 4(c + d)$ to the perimeter at the column ($b_s$), $v_c$ becomes

$$v_c\,(4\sqrt{f'_c}) = b_o/b_s = (1 + d/c)$$

For the special investigation then, on a section at the face of the column, when $w = d/2$ the allowable shear stress, $v_c = (1 + d/c)(4\sqrt{f'_c})$ with $b_s = 4c$. A simple conservative linear variation for $v_c$ between the value $v_c = (1 + d/c)4\sqrt{f'_c}$ at $w = d/2$ and $v_c = 32\sqrt{f'_c}$ at $w = 0$ is used. See Fig. 13-9.

$$v_c = (d/w)(1 + d/c)(2\sqrt{f'_c}) \quad \text{(ACI Eq. 13-1)}$$

For the determination of the shear strength for design, Eq. 13-1 becomes

$$\phi V_c = 0.85\left(\frac{d}{w}\right)\left(1 + \frac{d}{c}\right)(2\sqrt{f'_c})(b_s d)$$

## SPECIAL INVESTIGATION – One-Way Deep Beam

A similar special investigation is required for possible failure in one-way shear as a deep beam. See Fig. 13-6. Possible failure sections (cracks) in both directions are shown in Fig. 13-10 for a 6-pile cap arrangement. Under Code prescribed procedures, shear is investigated at a distance $d$ from the face of the column with an allowable value, $v_c = 2\sqrt{f'_c}$, for shear on concrete. Note that for a value of $d \geq 7.25$ inches, Section S2 is outside all piles. Similarly, for $d \geq 26.5$ inches, Section S1 is outside all piles.

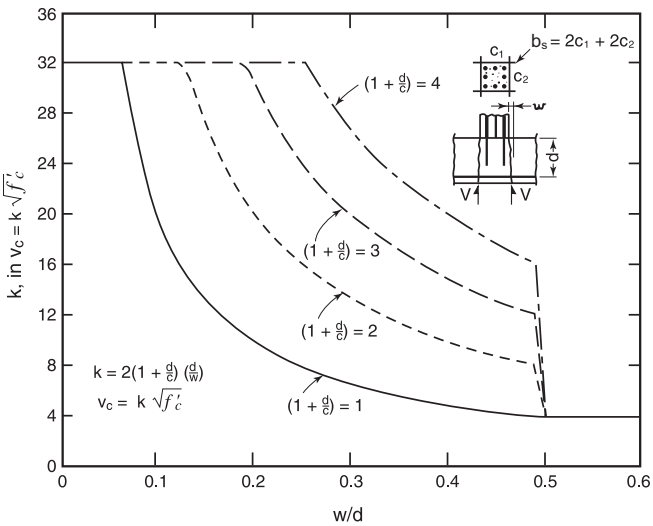



**Figure 13-9 Derivation of Allowable Shear, $v_c$, for Two-Way Deep Corbels, $w/d < 0.5$**

As for the two-way deep corbels, a one-way shear section is investigated at the *face* of the column. In this case, the width of the critical section is unchanged. No correction factor, based upon column size or ratio ($d/c$),

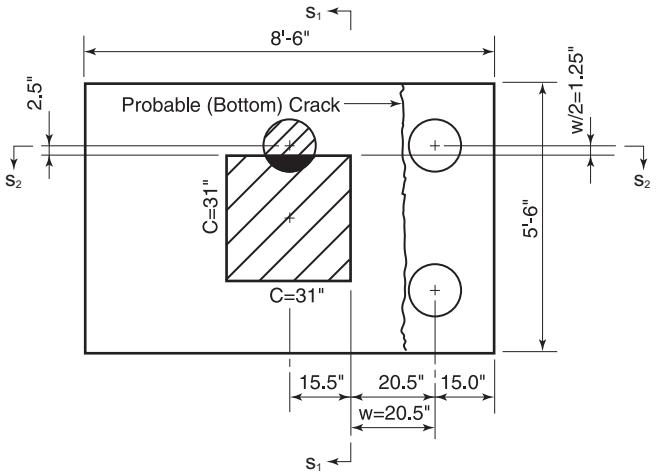



**Figure 13-10 Critical Sections through 6-Pile Cap with 200-Ton Piles for One-Way Deep Beam Shear**

is required. Research reports, including tests for shear with ($w/d$) as low as 0.5, show shear strengths of approximately 1,200 to 1,300 psi and show an exponential increase in shear strength as ($w/d$) decreases. These very favorable strengths develop in confined situations (at the face of a support), and the support here (upside down) is the column, the width of which involves a variable ($c/A$) or ($c/B$). No test results are available to evaluate the precise effect of the (column width/footing width) ratios nor to evaluate the precise upper value for $v_c$ at $w = 0$, at the column. Under these conditions, no further refinement than an average value for $v_c$ applied across the full footing width is justifiable. A conservative upper limit for the value, $v_c$, as $w$ approaches zero is $10\sqrt{f'_c}$.* In order to include the effect ($M_u/V_ud$) for several lines of piles at varying spans, the initial value beginning at ($w/d$) = 1.0 will be that from ACI Eq. 11-5, and a simple linear function for the effect of $(d/w)$ will be used for the transition.

For ($w/d$) ≥ 1.0, a one-way (normal) shear investigation with loads outside the critical section (located at a distance $d$ from the face of the column, $b$ = footing width) and

$$v_c = 1.9\sqrt{f'_c} + 2500\rho_w\left(\frac{V_ud}{M_u}\right) \geq 2\sqrt{f'_c} \quad \text{(ACI Eq. 11-5)}$$

which reduces for $\rho_w \approx 0.002$ and 3,000 psi ≤ $f'_c$ ≤ 4,000 psi to $v_c = 1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\,(V_ud/M_u) \geq 2\sqrt{f'_c}$.

For ($w/d$) < 1.0, $1.0 > M_u/V_ud > 0$; $\infty > V_ud/M_u \geq 1.0$ (no limits on $M_u$, $V_ud$, other than above)

*Reference: footnote, Page 13-24. Also Rogowsky and MacGregor, "Shear Strength of Deep Reinforced Concrete Continuous Beams," Struct. Eng. Report No. 110, Univ. of Alberta, Nov. 1983.

$$v_c = \left(\frac{d}{w}\right)\left[3.5 - 2.5\left(\frac{M_u}{V_ud}\right)\right]\left[1.9\sqrt{f'_c} + 2500\rho_w\left(\frac{V_ud}{M_u}\right)\right] \leq 10\sqrt{f'_c}$$

$$v_c = \left(\frac{d}{w}\right)\left[3.5 - 2.5\left(\frac{M_u}{V_ud}\right)\right]\left[1.9\sqrt{f'_c} + 0.1\sqrt{f'_c}\left(\frac{V_ud}{M_u}\right)\right] \leq 10\sqrt{f'_c} \quad \text{(ACI Eq. 13-2)}$$

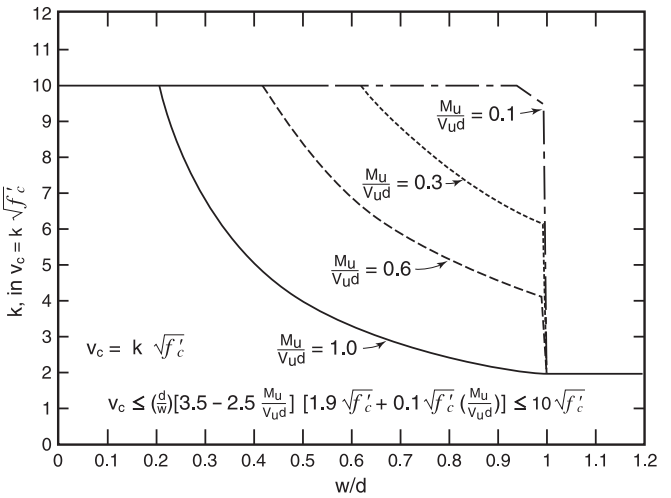



**Figure 13-11 Derivation of Allowable Shear, $v_c$, for One-Way Deep Beam Sections, $w/d < 1.0$**

For visual representation of Eq. 11-5, see Fig. 13-11. Note again that the equation permits reaching the maximum shear value in a short finite length of $w$, the distance from the column face to the center of the pile, which allows for the finite size of piles.

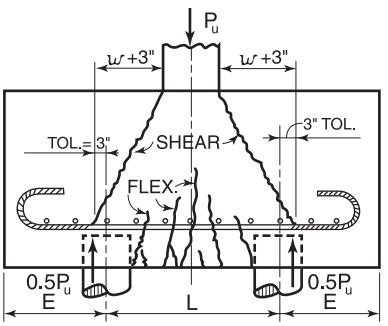



**Figure 13-12 Shear Failure Model**

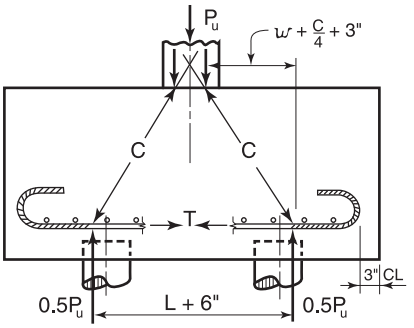



**Figure 13-13 Tied-Arch Model**

**"Tied-Arch" Behavior**

The provision to include a 180º end hooks or heads on all reinforcing bars in pile caps with single lines of piles around the column is a prudent precaution against a premature "tied-arch" shear failure mode. See Fig. 13-13. In addition, however, the maximum bar size should be related to the embedment length available. The ACI Code establishes required development lengths required for full development of hooks and headed bars. The Code permits a 30 percent reduction in hook development where confining reinforcement and at least 2½ inches of concrete cover are present. Crossing bars provide a degree of confinement and the compressive reactions of the piles contribute also to confinement. See Chapter 5 for hook and headed bar development lengths.

**Special Anchorage Requirements**

High-capacity piles, up to the limits set by supporting soil strata, minimize the number of piles required as well as the area of the pile cap for a given column load. An obvious potential economy results in more "deep beam" or "deep slab" pile caps. Theoretical analyses indicating a "tied-arch" mode of failure as depth/span ratios become larger have been confirmed to some extent by model tests and reports of field behavior. See Fig. 13-13. When $w << d$ in one-way shear or flexure, and $w << 0.5d$ in two-way shear or flexure, the ordinary requirement for tension development length at simple supports is:

$$\ell_d \le (M_n/V_u) + \ell_a \quad \text{(ACI Eq. 12-2)}$$

and may not be adequate, even with the increase of 30 percent allowed in $M_n/V_u$.

Ordinarily, with all tension reinforcement extended to the support, the requirement can be expressed as

$$\left[\frac{M_n}{V_u}\right] = \left[\frac{(P_u L/4)}{\phi P_u/2}\right] = \frac{L}{2\phi}$$

where $P_u$ = factored column load

$\ell_a = E - 3$ inches

$\ell_d \le (L/2\phi) + E - 3$ inches

The "tied-arch" model at failure (Fig. 13-13) indicates that full development of the bars at the **center** of the support is desirable, particularly with an adverse 3-inch tolerance.

**Shear at Critical Sections Around Piles** (Fig. 13-4)

Compare the graphic solutions (Fig. 13-5) for the four conditions of Fig. 13-4 to the thicknesses of pile caps tabulated. Read from Fig. 13-5 the following minimum thicknesses for 3,000 psi concrete:

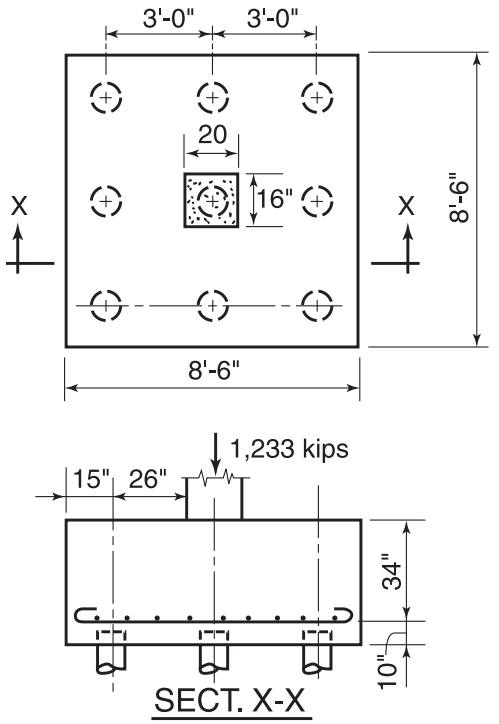
| Pile Capacity (Tons) | Corner $d$ at 45º (in.) | Corner $d/2$ Circle (in.) | Overlapping Pair (in.) | Single Interior (in.) |
|---|---|---|---|---|
| 40 | 19 | 17 | 12 | 12 |
| 50 | 22 | 20 | 14 | 14 |
| 60 | 25 | 23 | 16 | 15 |
| 70 | 25 | 22 | 18 | 17 |
| 80 | 27 | 24 | 20 | 18 |
| 90 | 30 | 27 | 22 | 20 |
| 100 | 32 | 29 | 23 | 21 |
| 110 | 34 | 31 | 25 | 22 |
| 120 | 36 | 33 | 27 | 23 |
| 130 | 35 | 31 | 28 | 24 |
| 140 | 37 | 33 | 30 | 26 |
| 150 | 39 | 35 | 31 | 27 |
| 160 | 40 | 37 | 32 | 28 |
| 170 | 42 | 39 | 34 | 29 |
| 180 | 44 | 40 | 35 | 30 |
| 190 | 45 | 42 | 36 | 31 |
| 200 | 47 | 43 | 37 | 31 |

In order to check conformance with the above analyses, it is necessary to study the pile arrangement and various sections at $d/2$ and $d$. Take $d = (D - 10$ inches) for this purpose. See tabulated designs, Pages 13-31 to 13-37.

It will be noted that the "single interior pile punching failure" never controlled the arrangements used. The 3-pile corner failure at 45º in beam (one-way) shear cannot occur with the CRSI arrangements. Where "overlaps" exist for pairs of piles, the perimeter is usually incomplete and would not control. The single pile corner "beam" or "punching" shear failure alone of the criteria in Figs. 13-4 and 13-5 approaches critical shear for some combinations. These criteria and solutions (Figs. 13-4 and 13-5) are presented, however, for specifying piles at larger spacings than assumed for the tabulated designs (3′-0″). Smaller spacings will require even less than the thicknesses shown in Fig. 13-5 and will often make these possible failure sections inapplicable, or applicable at higher allowable stresses ($v_c$). Consideration of these cases is advised where pile arrangement is based on larger spacings.

## USE OF TABLES

**Example 1.** Select a pile cap, using piles with a 50-ton capacity for the multi-story column of Example 1, Chapter 3. $P_u$ = 1,036 kips. $M_u$ = 0 ft-kips (calculated). Column size is 16 in. × 20 in.; $f'_c$ = 3,000 psi.




**9-Pile Pile Cap Design (Example 1)**

Enter pile cap table, Page 13-31, for 50-ton piles. Try 9-pile pile cap. From the tabulated designs, $P_u$ = 1,376 kips. Note that minimum column size tabulated is 19 in. In the 16-in. direction of the column, the pile loads will have an additional 1.5 in. moment arm distance. This effect should be negligible, but will be checked here for illustrative purposes. See Figs. 13-2 and 13-3. Note that the reaction of these 50-ton piles is located 3′-0″ from the column center. Cantilever span for the tabulated design, $\ell_c = 36 - 0.5 \times 19 = 26.5$ in. The column size of Example 1 will increase the footing moment (1.5/26.5 = 5.6 percent. The ratio of tabulated to required capacity is (1,376/1,036) = 1.33, approximately 33 percent above that required, and the listed capacity includes adverse 3 in. tolerances. No change in tabulated reinforcement nor thickness is required. Use tabulated design.

*Shear*. Again for illustrative purposes, note slab shear on section ① controlled. See Fig. 13-6. For this condition, the allowable shear is $v_c$ = 219 psi. The ratios of computed/allowable shears are: 0.919 controlling slab shear on (ACI) section ①; and 0.911 controlling beam shear on both (CRSI) sections ⑤ and ⑥ due to two-way symmetry.

*"Tied Arch."* Note also that the tabulated design requires the same number and size of reinforcing bars in each direction, all with hooked or headed bar ends. Bar size for hooked bars is limited to #6 for which $\ell_{dh}$ = 0.7 (17) = 12 in. See Table 5-5(a) in Chapter 5. The edge distance, $E$ = 15 in., provides a net hook embedment of 15 – 3 (end concrete cover) = 12 in. (For this purpose, the 3-in. tolerance was not considered.) Also note that the average effective depth, $d$ = 44 – 10 = 34 in., and that $w$ = 26.5 in., which definitely is within the range of proportions where tied-arch behavior should be considered in the design.

## MANUAL EXAMPLE

To illustrate the design assumptions, applicable Code requirements and procedures used in the preparation of the pile cap tabulated designs, one of the designs will be reviewed with all calculations performed longhand. This review will also assist or guide anyone wishing to extend the scope of the tabulated designs to longer spans or heavier loads; to use other concrete compressive strengths or yield strengths of reinforcing bars; conditions of concrete cover other than those used (shown in Fig. 13-3); or columns smaller than the tabulated sizes.

From the table on Page 13-31, review the 12-pile pile cap with 50-ton piles.

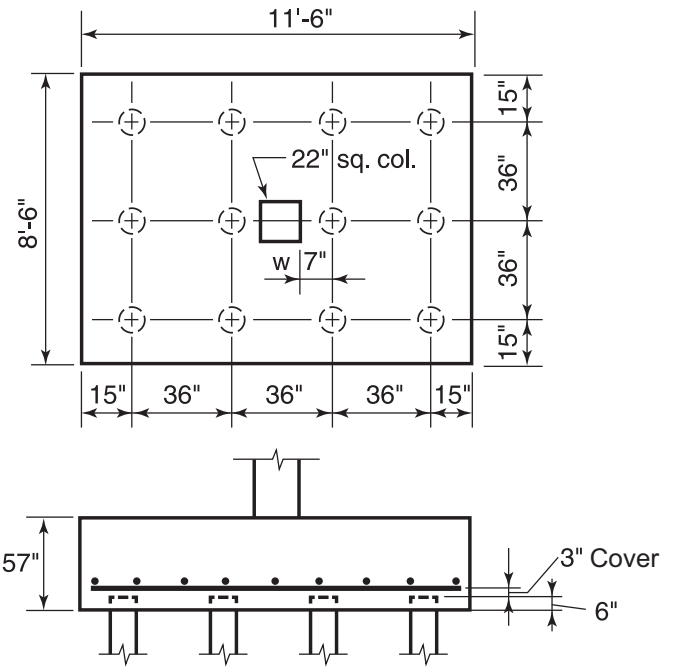



**Fig. 13-14 Manual Example**

*12-Pile Pile Cap*

Piles : Service load = 50 tons
Pile Cap: $f'_c$ = 3,000 psi
$f_y$ = 60,000 psi

Column : $P_u/A_g$ = 4,000 psi

with a 1.6 load factor; a 36-in. pile spacing; and a 15-in. edge distance

**1. Minimum Square Column Size**

$$h = \sqrt{\frac{[12 \times 100 - 11.5 \times 8.5 \times (57/12) \times 0.15]\ 1.6}{4}}$$

= 21.26, use 22 in.

**2. Required Flexural Reinforcement—Short Bars**

The moment arm of $M_u$ is taken from a point, which is located between the column center and the column face $c/4$, and includes the placing tolerance of 3 inches but neglects the pile cap dead load.

$M_u = 4 \times 1.6 \times 100\ (36 + 3 - 22/4) = 21{,}440$ in.-kips

$M_u = 21{,}440/11.5 = 1{,}864$ in.-kips/ft

$d = 57 - 9 - 1.128 - 0.375 = 46.497$ in.

For $f'_c$ = 3,000 psi and $f_y$ = 60,000 psi, the required area of flexural reinforcement,

$A_s = 0.51d - \sqrt{0.26d^2 - 0.0189M_u}$ (See Chapter 5)

$= 0.51(46.5) - \sqrt{0.26(46.5)^2 - 0.0189(1{,}864)}$

$= 0.759$ in.$^2$/ft

Calculated total required $A_s = 0.759 \times 11.5 = 8.73$ in.$^2$

(4/3) $A_s$ = (4/3)(8.73) = 11.64 in.$^2$

$(200/f_y) \times 11.5 \times 12 \times 46.497 = 21.39$ in.$^2$

$0.0018 \times 11.5 \times 12 \times 57 = 14.16$ in.$^2$

Increase the calculated area in order to maintain uniform spacing of the short bars (ACI 15.4.4).

$\beta = 11.5/8.5 = 1.353$, ratio of long-to-short sides

$A_s = 8.73(2\beta)/(1 + \beta) = 10.04$ in.$^2$

Thus, use $A_s$ = 14.16 in.$^2$ (14.16 in.$^2$ tabulated)

$E' = E - 3$ in. (concrete cover)
$E = 15 - 3 = 12$ in. for hook embedment

Maximum bar size is #6 ($\ell_{dh}$ = 0.7 (17) = 12 in., see Table 5-5(a) in Chapter 5)

Thus, use 32 – #6 bars with standard hooks at ends; $A_s$ provided is 14.08 in.$^2$

**3. Required Flexural Reinforcement – Long Bars**

3 piles at 18 in.; 3 piles at 54 in., plus a 3-in. tolerance

$M_u = 1.6 \times 100[3 \times (18 + 3) + 3 \times (54 + 3) - 6 \times 22/4]$
$= 32{,}160$ in.-kips

$M_u = 32{,}160/8.5 = 3{,}784$ in.-kips/ft

$d = 57 - 9 - 1.128/2 = 47.44$ in.

$A_s = 0.51(47.44) - \sqrt{0.26(47.44)^2 - 0.0189(3{,}784)}$
$= 1.53$ in.$^2$/ft

Calculated total required $A_s = 1.53 \times 8.5 = 13.01$ in.$^2$

(4/3) $A_s$ = (4/3)(13.01) = 17.34 in.$^2$

$(200/f_y)\ 8.5 \times 12 \times 47.44 = 16.13$ in.$^2$

$0.0018 \times 8.5 \times 12 \times 57 = 10.46$ in.$^2$

Thus, use $A_s$ = 16.13 in.$^2$ (16.13 tabulated)

Embedment length available for tension development
$= (11.5 \times 12)/2 - 3 - 11 = 55$ in.

13 – #10 bars; $A_s$ = 16.51 in.$^2$
16 – #9 bars; $A_s$ = 16.00 in.$^2$
Hence, use 16 - #9 bars

Check tension development length of #9 bars vs. available embedment length; c.-c. spacing of #9 bars = ((8.5 × 12) – (4.31 × 2))/15 = 6.23 in. or 6.23/1.128 = 5.5$d_b$; concrete cover = 3.75 in. or 3.75/1.128 = 3.3$d_b$; from Table 5-3(a) for "Other Bars", $\ell_d$ = 41 in. < 55 in., okay.

**4. Check Shear at a distance *d*/2 from Column: Case ①**

Centers of 10 piles lie outside section at $d/2$ from face of column

$V_u = 10 \times 1.6 \times 100 = 1{,}600$ kips

$d = 57 - 9 - 1 = 47$ in.

$b_o = 4\ (22 + 47) = 276$ in.

$\phi V_c = 0.85 \times 4 \times \sqrt{3000} \times 276 \times 47/1000$
$= 2{,}416$ kips > 1,600 kips

$V_u/\phi V_c = 0.662$ (0.632 tabulated, using long formula for shear strength)

**5. Check One-Way Beam Shear at a distance *d* from Column: Case ② (Short Direction)**

No check is necessary, because all piles are within this section.

**6. Check Deep Beam (One-Way) Shear at Face of Column (When $w/d < 1.0$): Case ⑤**

$w' = 7 + 3 = 10$ in.

$V_u = 6 \times 1.6 \times 100 = 960$ kips

$M_u = 1.6 \times 100\ [3 \times 10 + 3 \times 46] = 26{,}880$ in.-kips

$V_u d/M_u = 1.679$

$M_u/V_u d = 0.596$

$k = [3.5 - 2.5\ (0.596)][1.9 + 0.1\ (1.679)] \times 47/11$
$= 17.76 > 10$, use 10

$\phi V_c = 0.85 \times 10 \times \sqrt{3000} \times 8.5 \times 12 \times 47/1000$
$= 2{,}232$ kips $> V_u$

$V_u/\phi V_c = 0.430$ (0.409 tabulated, due to round-off)

**7. Quantities of Concrete and Reinforcing Bars**

Concrete:

8.5(11.5)(57/12)/27 = 17.197 cubic yards
(17.2 cubic yards tabulated)

Reinforcing bars:

| | |
|---|---|
| 16 – #9 bars × 11′-0″; 16(3.400)(11) = | 598 pounds |
| 32 – #6 bars × 8′-0″; 32 (1.502)(8) = | 385 pounds |
| 32 – #6 bars with standard end hooks at each end; 64 hooks at 8″; 64(64(1.502)(0.67) = | 64 pounds |
| Total weight = | 1,047 pounds |

Total weight = 1,047/2,000 = 0.524 tons
(0.523 tons tabulated)

**8. Compute Net Design Capacity of Pile Cap**

Total design capacity = $12 \times 1.6 \times 100 = 1{,}920$ kips

Pile cap weight = $17.197 \times 27 \times 0.15 = 69.6$ kips

Factored pile cap weight = $1.4 \times 69.6 = 97.4$ kips

Net design capacity = 1,920 – 97.4 = 1,823 kips

(1,808 kips tabulated. Computer program conservatively uses the combined load factor 1.6 for the dead load of the pile cap.)

$f_c'$ = 3,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 8 in.
spaced at 3′-0″

## 40-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 15″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Concrete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 246 | 10 | 5- 6 | 2- 6 | 34 | 1.4 | 8 H# 5 | 2.37 | 5 H# 4 | N/A | 0.031 | 0.956 | N/A |
| 3 | 370 | 11 | 5- 6 | 5- 2 | 31 | 2.0 | 4 H# 6 | 1.78 | 3-WAYS | | 0.057 | 0.775 | 0.952 |
| | | | 1- 6 | 1- 7 | | | | | | | | | |
| 4 | 493 | 12 | 5- 6 | 5- 6 | 31 | 2.9 | 11 H# 6 | 4.76 | 11 H# 6 | 4.76 | 0.105 | 0.762 | 0.965 |
| 5 | 608 | 13 | 6- 9 | 6- 9 | 35 | 4.9 | 14 H# 6 | 6.31 | 14 H# 6 | 6.31 | 0.159 | 0.859 | 0.688 |
| 6 | 726 | 14 | 8- 6 | 5- 6 | 44 | 6.3 | 14 H# 6 | 6.31 | 18 H# 6 | 8.08 | 0.184 | 0.968 | 0.399 |
| 7 | 845 | 17 | 8- 6 | 7- 9 | 38 | 7.7 | 16 H# 6 | 7.25 | 16 H# 6 | 6.98 | 0.215 | 0.707 | 0.985 |
| 8 | 972 | 16 | 8- 6 | 7- 9 | 39 | 7.9 | 21 H# 6 | 9.08 | 22 H# 6 | 9.77 | 0.289 | 0.967 | 0.748 |
| 9 | 1089 | 17 | 8- 6 | 8- 6 | 43 | 9.6 | 22 H# 6 | 9.77 | 22 H# 6 | 9.77 | 0.308 | 0.909 | 0.795 |
| 10 | 1206 | 18 | 11- 6 | 7- 9 | 41 | 11.3 | 8 #10 | 10.20 | 23 H# 6 | 10.18 | 0.338 | 0.621 | 0.852 |
| 11 | 1331 | 19 | 11- 6 | 7- 9 | 43 | 11.8 | 12 # 9 | 12.06 | 25 H# 6 | 11.15 | 0.386 | 0.813 | 0.954 |
| 12 | 1442 | 19 | 11- 6 | 8- 6 | 48 | 14.5 | 10 #10 | 13.04 | 27 H# 6 | 11.92 | 0.426 | 0.997 | 0.881 |
| 13 | 1549 | 20 | 12- 11 | 8- 6 | 52 | 17.6 | 14 # 9 | 14.43 | 18 # 8 | 14.51 | 0.488 | 0.923 | 0.747 |
| 14 | 1690 | 21 | 11- 6 | 10- 9 | 41 | 15.6 | 12 #10 | 15.08 | 16 # 9 | 16.41 | 0.563 | 0.883 | 0.994 |
| 15 | 1790 | 22 | 12- 11 | 11- 6 | 48 | 19.9 | 14 #10 | 17.65 | 19 # 9 | 19.20 | 0.729 | 0.673 | 0.993 |
| | | | 5- 11 | 7- 6 | | | | | | | | | |
| 16 | 1921 | 22 | 11- 6 | 11- 6 | 48 | 19.6 | 18 # 9 | 17.68 | 18 # 9 | 17.68 | 0.673 | 0.985 | 0.844 |
| 17 | 2038 | 23 | 12- 11 | 11- 6 | 51 | 21.2 | 15 #10 | 19.03 | 18 # 9 | 17.65 | 0.737 | 0.787 | 0.992 |
| | | | 5- 11 | 7- 6 | | | | | | | | | |
| 18 | 2152 | 24 | 12- 11 | 11- 6 | 51 | 23.4 | 15 #10 | 19.03 | 20 # 9 | 20.00 | 0.775 | 0.903 | 0.970 |
| 19 | 2261 | 24 | 13- 9 | 11- 6 | 54 | 26.4 | 16 #10 | 20.41 | 21 # 9 | 20.88 | 0.849 | 0.835 | 0.973 |
| 20 | 2376 | 25 | 14- 6 | 11- 6 | 55 | 28.3 | 13 #11 | 20.84 | 22 # 9 | 22.63 | 0.895 | 0.944 | 0.920 |
| 21 | 2492 | 25 | 13- 9 | 13- 9 | 56 | 30.2 | 19 #10 | 24.80 | 19 #10 | 24.80 | 1.083 | 0.764 | 0.988 |
| | | | 11- 0 | 3- 5 | | | | | | | | | |
| 22 | 2632 | 26 | 14- 6 | 12- 11 | 53 | 28.3 | 14 #11 | 22.37 | 19 #10 | 24.33 | 1.028 | 0.961 | 0.975 |
| | | | 10- 6 | 5- 11 | | | | | | | | | |
| 23 | 2728 | 27 | 14- 6 | 13- 9 | 58 | 33.2 | 17 #11 | 26.56 | 21 #10 | 26.86 | 1.231 | 0.711 | 0.987 |
| | | | 10- 6 | 6- 9 | | | | | | | | | |
| 24 | 2852 | 27 | 14- 6 | 13- 9 | 55 | 33.8 | 16 #11 | 24.91 | 20 #10 | 25.49 | 1.165 | 0.813 | 0.986 |
| 26 | 3080 | 28 | 15- 11 | 14- 6 | 57 | 38.1 | 18 #11 | 28.74 | 19 #11 | 29.21 | 1.444 | 0.633 | 0.995 |
| | | | 8- 11 | 10- 6 | | | | | | | | | |
| 28 | 3307 | 29 | 15- 11 | 14- 6 | 60 | 42.7 | 19 #11 | 29.17 | 20 #11 | 31.12 | 1.522 | 0.716 | 0.881 |
| 30 | 3540 | 30 | 17- 6 | 14- 6 | 59 | 46.2 | 22 #11 | 34.82 | 21 #11 | 33.52 | 1.775 | 0.741 | 0.979 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 3,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 8 in.
spaced at 3′-0″

## 50-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 15″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Concrete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 309 | 10 | 5- 6 | 2- 6 | 39 | 1.7 | 8 H# 5 | 2.46 | 5 H# 4 | N/A | 0.031 | 0.853 | N/A |
| 3 | 466 | 13 | 5- 6 | 5- 2 | 33 | 2.2 | 7 H# 5 | 1.99 | 3-WAYS | | 0.068 | 0.627 | 0.972 |
| | | | 1- 6 | 1- 7 | | | | | | | | | |
| 4 | 619 | 13 | 5- 6 | 5- 6 | 34 | 3.2 | 12 H# 6 | 5.42 | 12 H# 6 | 5.42 | 0.114 | 0.598 | 0.946 |
| 5 | 767 | 14 | 6- 9 | 6- 9 | 36 | 5.1 | 16 H# 6 | 7.19 | 16 H# 6 | 7.19 | 0.182 | 0.874 | 0.794 |
| 6 | 917 | 16 | 8- 6 | 5- 6 | 45 | 6.5 | 17 H# 6 | 7.67 | 19 H# 6 | 8.26 | 0.210 | 0.968 | 0.462 |
| 7 | 1064 | 19 | 8- 6 | 7- 9 | 42 | 8.5 | 18 H# 6 | 7.82 | 17 H# 6 | 7.71 | 0.236 | 0.491 | 0.960 |
| 8 | 1225 | 18 | 8- 6 | 7- 9 | 41 | 8.3 | 22 H# 6 | 9.80 | 24 H# 6 | 10.50 | 0.309 | 0.839 | 0.813 |
| 9 | 1376 | 19 | 8- 6 | 8- 6 | 44 | 9.8 | 26 H# 6 | 11.58 | 26 H# 6 | 11.58 | 0.364 | 0.911 | 0.919 |
| 10 | 1525 | 20 | 11- 6 | 7- 9 | 42 | 11.6 | 10 #10 | 12.42 | 24 H# 6 | 10.72 | 0.391 | 0.579 | 0.985 |
| 11 | 1676 | 21 | 11- 6 | 7- 9 | 47 | 12.9 | 13 # 9 | 13.35 | 28 H# 6 | 12.27 | 0.424 | 0.923 | 0.962 |
| 12 | 1808 | 22 | 11- 6 | 8- 6 | 57 | 17.2 | 16 # 9 | 16.13 | 32 H# 6 | 14.16 | 0.523 | 0.409 | 0.632 |
| 13 | 1952 | 23 | 12- 11 | 8- 6 | 58 | 19.7 | 13 #10 | 16.44 | 20 # 8 | 16.18 | 0.561 | 0.995 | 0.474 |
| 14 | 2128 | 24 | 11- 6 | 10- 9 | 45 | 17.2 | 16 # 9 | 16.41 | 18 # 9 | 17.65 | 0.613 | 0.999 | 0.982 |
| 15 | 2257 | 24 | 12- 11 | 11- 6 | 53 | 22.0 | 16 #10 | 19.95 | 21 # 9 | 21.16 | 0.820 | 0.637 | 0.993 |
| | | | 5- 11 | 7- 6 | | | | | | | | | |
| 16 | 2414 | 25 | 11- 6 | 11- 6 | 55 | 22.4 | 21 # 9 | 20.90 | 21 # 9 | 20.90 | 0.785 | 0.422 | 0.772 |
| 17 | 2577 | 26 | 12- 11 | 11- 6 | 53 | 22.0 | 16 #10 | 19.95 | 21 # 9 | 20.83 | 0.820 | 0.985 | 0.820 |
| | | | 5- 11 | 7- 6 | | | | | | | | | |
| 18 | 2707 | 27 | 12- 11 | 11- 6 | 58 | 26.6 | 17 #10 | 22.25 | 21 # 9 | 20.87 | 0.847 | 0.983 | 0.788 |
| 19 | 2859 | 27 | 13- 9 | 11- 6 | 57 | 27.8 | 18 #10 | 22.41 | 24 # 9 | 24.16 | 0.962 | 0.992 | 0.812 |
| 20 | 3003 | 28 | 14- 6 | 11- 6 | 59 | 30.4 | 15 #11 | 23.65 | 25 # 9 | 25.61 | 1.025 | 0.946 | 0.972 |
| 21 | 3150 | 29 | 13- 9 | 13- 9 | 60 | 32.4 | 21 #10 | 27.00 | 21 #10 | 27.00 | 1.197 | 0.916 | 0.599 |
| | | | 11- 0 | 3- 5 | | | | | | | | | |
| 22 | 3318 | 29 | 14- 6 | 12- 11 | 58 | 31.0 | 16 #11 | 24.95 | 21 #10 | 27.23 | 1.156 | 0.950 | 0.990 |
| | | | 10- 6 | 5- 11 | | | | | | | | | |
| 23 | 3450 | 30 | 14- 6 | 13- 9 | 62 | 35.5 | 18 #11 | 28.76 | 23 #10 | 29.55 | 1.325 | 0.871 | 0.958 |
| | | | 10- 6 | 6- 9 | | | | | | | | | |
| 24 | 3608 | 31 | 14- 6 | 13- 9 | 58 | 35.7 | 18 #11 | 27.52 | 22 #10 | 28.32 | 1.297 | 0.966 | 0.842 |
| 26 | 3886 | 32 | 15- 11 | 14- 6 | 63 | 42.2 | 20 #11 | 31.38 | 21 #11 | 32.57 | 1.600 | 0.767 | 0.986 |
| | | | 8- 11 | 10- 6 | | | | | | | | | |
| 28 | 4189 | 33 | 15- 11 | 14- 6 | 63 | 44.9 | 21 #11 | 33.61 | 26 #10 | 33.08 | 1.643 | 0.858 | 0.970 |
| 30 | 4470 | 34 | 17- 6 | 14- 6 | 65 | 50.9 | 24 #11 | 38.33 | 29 #10 | 37.77 | 1.957 | 0.844 | 0.982 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 3,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 8 in.
spaced at 3′-0″

## 60-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 15″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Concrete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 372 | 10 | 5- 6 | 2- 6 | 43 | 1.8 | 6 H# 6 | 2.61 | 5 H# 4 | N/A | 0.034 | 0.829 | N/A |
| 3 | 561 | 14 | 5- 6<br>1- 6 | 5- 2<br>1- 7 | 35 | 2.3 | 5 H# 6 | 2.18 | 3-WAYS | | 0.071 | 0.549 | 0.994 |
| 4 | 746 | 14 | 5- 6 | 5- 6 | 36 | 3.4 | 13 H# 6 | 5.86 | 13 H# 6 | 5.86 | 0.124 | 0.539 | 0.974 |
| 5 | 927 | 16 | 6- 9 | 6- 9 | 36 | 5.1 | 16 H# 6 | 7.19 | 16 H# 6 | 7.19 | 0.182 | 0.937 | 0.915 |
| 6 | 1109 | 17 | 8- 6 | 5- 6 | 46 | 6.6 | 18 H# 6 | 8.06 | 19 H# 6 | 8.45 | 0.217 | 1.000 | 0.523 |
| 7 | 1284 | 21 | 8- 6 | 7- 9 | 45 | 9.1 | 19 H# 6 | 8.45 | 19 H# 6 | 8.26 | 0.256 | 0.408 | 0.966 |
| 8 | 1481 | 20 | 8- 6 | 7- 9 | 41 | 8.3 | 22 H# 6 | 9.80 | 24 H# 6 | 10.64 | 0.309 | 0.915 | 0.945 |
| 9 | 1661 | 21 | 8- 6 | 8- 6 | 46 | 10.3 | 28 H# 6 | 12.45 | 28 H# 6 | 12.45 | 0.393 | 0.816 | 0.975 |
| 10 | 1834 | 22 | 11- 6 | 7- 9 | 48 | 13.2 | 12 # 9 | 12.29 | 27 H# 6 | 11.92 | 0.398 | 0.531 | 0.945 |
| 11 | 2019 | 23 | 11- 6 | 7- 9 | 52 | 14.3 | 14 # 9 | 13.92 | 29 H# 6 | 12.92 | 0.449 | 0.997 | 0.914 |
| 12 | 2194 | 24 | 11- 6 | 8- 6 | 56 | 16.9 | 16 # 9 | 15.79 | 31 H# 6 | 13.91 | 0.516 | 0.507 | 0.771 |
| 13 | 2357 | 25 | 12-11 | 8- 6 | 63 | 21.3 | 14 #10 | 18.14 | 22 # 8 | 17.58 | 0.609 | 0.445 | 0.471 |
| 14 | 2564 | 26 | 11- 6 | 10- 9 | 50 | 19.1 | 17 # 9 | 17.39 | 18 # 9 | 18.14 | 0.632 | 0.750 | 0.929 |
| 15 | 2740 | 27 | 12-11<br>5-11 | 11- 6<br>7- 6 | 52 | 21.6 | 15 #10 | 19.49 | 21 # 9 | 21.27 | 0.793 | 0.796 | 0.841 |
| 16 | 2929 | 28 | 11- 6 | 11- 6 | 54 | 22.0 | 21 # 9 | 21.04 | 21 # 9 | 21.04 | 0.785 | 0.523 | 0.932 |
| 17 | 3097 | 28 | 12-11<br>5-11 | 11- 6<br>7- 6 | 62 | 25.7 | 19 #10 | 24.09 | 20 # 9 | 20.20 | 0.882 | 0.382 | 0.584 |
| 18 | 3274 | 29 | 12-11 | 11- 6 | 61 | 28.0 | 19 #10 | 23.63 | 23 # 9 | 23.39 | 0.938 | 0.432 | 0.590 |
| 19 | 3439 | 30 | 13- 9 | 11- 6 | 66 | 32.2 | 20 #10 | 25.93 | 23 # 9 | 23.62 | 1.000 | 0.403 | 0.603 |
| 20 | 3616 | 31 | 14- 6 | 11- 6 | 67 | 34.5 | 17 #11 | 26.36 | 25 # 9 | 25.70 | 1.100 | 0.997 | 0.679 |
| 21 | 3804 | 31 | 13- 9<br>11- 0 | 13- 9<br>3- 5 | 65 | 35.1 | 23 #10 | 29.75 | 23 #10 | 29.75 | 1.311 | 0.388 | 0.608 |
| 22 | 4016 | 32 | 14- 6<br>10- 6 | 12-11<br>5-11 | 60 | 32.1 | 17 #11 | 26.83 | 22 #10 | 28.39 | 1.220 | 0.528 | 0.830 |
| 23 | 4178 | 33 | 14- 6<br>10- 6 | 13- 9<br>6- 9 | 64 | 36.6 | 23 #10 | 29.90 | 24 #10 | 30.80 | 1.377 | 0.782 | 0.952 |
| 24 | 4352 | 33 | 14- 6 | 13- 9 | 64 | 39.4 | 23 #10 | 29.90 | 24 #10 | 30.80 | 1.377 | 0.874 | 0.824 |
| 26 | 4697 | 35 | 15-11<br>8-11 | 14- 6<br>10- 6 | 68 | 45.5 | 22 #11 | 34.03 | 27 #10 | 35.10 | 1.714 | 0.899 | 0.998 |
| 28 | 5062 | 36 | 15-11 | 14- 6 | 68 | 48.4 | 23 #11 | 36.46 | 28 #10 | 36.26 | 1.785 | 0.957 | 0.983 |
| 30 | 5399 | 37 | 17- 6 | 14- 6 | 71 | 55.6 | 26 #11 | 41.03 | 33 #10 | 41.97 | 2.168 | 0.893 | 0.975 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.

** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.

(1) "H"—Use hooked or headed bars.

(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.

(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 3,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 10 in.
spaced at 3′-0″

## 80-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 21″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Concrete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 494 | 12 | 6- 6 | 3- 6 | 38 | 2.7 | 4 H# 9 | 3.98 | 5 H# 4 | N/A | 0.064 | 0.960 | N/A |
| 3 | 743 | 16 | 6- 6<br>2- 1 | 6- 2<br>2- 3 | 39 | 3.8 | 3 H# 9 | 2.41 | 3-WAYS | | 0.130 | 0.477 | 0.985 |
| 4 | 991 | 16 | 6- 6 | 6- 6 | 39 | 5.1 | 10 H# 8 | 7.41 | 10 H# 8 | 7.41 | 0.209 | 0.474 | 0.915 |
| 5 | 1233 | 18 | 7- 9 | 7- 9 | 39 | 7.2 | 9 H# 9 | 9.13 | 9 H# 9 | 9.13 | 0.298 | 0.681 | 0.974 |
| 6 | 1479 | 20 | 9- 6 | 6- 6 | 46 | 8.8 | 12 H# 8 | 9.49 | 12 H# 8 | 9.44 | 0.299 | 0.983 | 0.657 |
| 7 | 1708 | 24 | 9- 6 | 8- 9 | 50 | 12.8 | 12 H# 8 | 9.45 | 10 H# 9 | 10.26 | 0.356 | 0.376 | 0.985 |
| 8 | 1968 | 23 | 9- 6 | 8- 9 | 48 | 12.3 | 13 H# 9 | 13.24 | 14 H# 9 | 14.18 | 0.510 | 0.506 | 0.967 |
| 9 | 2210 | 24 | 9- 6 | 9- 6 | 52 | 14.5 | 15 H# 9 | 14.88 | 15 H# 9 | 14.88 | 0.586 | 0.529 | 0.962 |
| 10 | 2448 | 25 | 12- 6 | 8- 9 | 51 | 17.2 | 12 #10 | 14.82 | 14 H# 9 | 13.77 | 0.566 | 0.583 | 0.976 |
| 11 | 2695 | 26 | 12- 6 | 8- 9 | 55 | 18.6 | 13 #10 | 16.92 | 19 H# 8 | 15.46 | 0.591 | 0.559 | 0.666 |
| 12 | 2939 | 28 | 12- 6 | 9- 6 | 56 | 20.5 | 20 # 9 | 19.64 | 17 H# 9 | 17.46 | 0.740 | 0.607 | 0.974 |
| 13 | 3166 | 29 | 13-11 | 9- 6 | 61 | 24.9 | 16 #10 | 20.93 | 23 # 8 | 18.34 | 0.738 | 0.508 | 0.493 |
| 14 | 3422 | 30 | 12- 6 | 11- 9 | 55 | 24.9 | 17 #10 | 21.32 | 22 # 9 | 22.08 | 0.860 | 0.550 | 0.971 |
| 15 | 3670 | 31 | 13-11<br>6- 2 | 12- 6<br>8- 1 | 54 | 26.1 | 18 #10 | 23.47 | 20 #10 | 25.31 | 1.036 | 0.937 | 0.990 |
| 16 | 3911 | 32 | 12- 6 | 12- 6 | 59 | 28.5 | 19 #10 | 24.68 | 19 #10 | 24.68 | 0.981 | 0.577 | 0.995 |
| 17 | 4166 | 33 | 13-11<br>6- 2 | 12- 6<br>8- 1 | 59 | 28.6 | 21 #10 | 26.44 | 21 #10 | 26.77 | 1.148 | 0.503 | 0.812 |
| 18 | 4402 | 34 | 13-11 | 12- 6 | 59 | 31.7 | 23 #10 | 29.30 | 27 # 9 | 26.81 | 1.215 | 0.517 | 0.796 |
| 19 | 4631 | 35 | 14- 9 | 12- 6 | 63 | 35.9 | 20 #11 | 30.85 | 30 # 9 | 30.70 | 1.369 | 0.528 | 0.837 |
| 20 | 4856 | 35 | 15- 6 | 12- 6 | 68 | 40.7 | 20 #11 | 31.09 | 32 # 9 | 32.75 | 1.450 | 0.490 | 0.847 |
| 21 | 5122 | 36 | 14- 9<br>11- 9 | 14- 9<br>3- 7 | 63 | 39.0 | 25 #10 | 32.46 | 25 #10 | 32.46 | 1.533 | 0.505 | 0.822 |
| 22 | 5385 | 37 | 15- 6<br>11- 1 | 13-11<br>6- 2 | 62 | 38.0 | 21 #11 | 33.50 | 27 #10 | 34.14 | 1.616 | 0.638 | 0.988 |
| 23 | 5608 | 38 | 15- 6<br>11- 1 | 14- 9<br>7- 0 | 66 | 43.1 | 21 #11 | 33.69 | 27 #10 | 34.22 | 1.665 | 0.950 | 0.977 |
| 24 | 5842 | 39 | 15- 6 | 14- 9 | 66 | 46.6 | 23 #11 | 36.48 | 29 #10 | 37.24 | 1.806 | 0.529 | 0.978 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.

** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.

(1) "H"—Use hooked or headed bars.

(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.

(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 3,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 10 in.
spaced at 3′-0″

## 100-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 21″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Con-crete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 621 | 13 | 6- 6 | 3- 6 | 41 | 2.9 | 6 H# 8 | 4.41 | 5 H# 4 | N/A | 0.069 | 0.991 | N/A |
| 3 | 933 | 18 | 6- 6<br>2- 1 | 6- 2<br>2- 3 | 42 | 4.1 | 6 H# 9 | 2.67 | 3-WAYS | | 0.130 | 0.542 | 0.923 |
| 4 | 1246 | 18 | 6- 6 | 6- 6 | 40 | 5.2 | 8 H# 9 | 7.91 | 8 H# 9 | 7.91 | 0.231 | 0.576 | 0.931 |
| 5 | 1548 | 20 | 7- 9 | 7- 9 | 43 | 8.0 | 13 H# 8 | 10.39 | 13 H# 8 | 10.39 | 0.315 | 0.532 | 0.956 |
| 6 | 1860 | 22 | 9- 6 | 6- 6 | 48 | 9.1 | 13 H# 8 | 10.41 | 10 H# 9 | 9.85 | 0.333 | 0.946 | 0.994 |
| 7 | 2148 | 27 | 9- 6 | 8- 9 | 55 | 14.1 | 13 H# 8 | 10.39 | 11 H# 9 | 11.29 | 0.389 | 0.421 | 0.981 |
| 8 | 2476 | 25 | 9- 6 | 8- 9 | 50 | 12.8 | 14 H# 9 | 14.15 | 15 H# 9 | 14.94 | 0.548 | 0.508 | 0.967 |
| 9 | 2778 | 27 | 9- 6 | 9- 6 | 56 | 15.6 | 17 H# 9 | 16.74 | 17 H# 9 | 16.74 | 0.665 | 0.459 | 1.000 |
| 10 | 3088 | 28 | 12- 6 | 8- 9 | 51 | 17.2 | 18 # 9 | 18.46 | 16 H# 9 | 15.67 | 0.660 | 0.727 | 0.973 |
| 11 | 3404 | 30 | 12- 6 | 8- 9 | 53 | 17.9 | 17 #10 | 22.02 | 20 H# 9 | 19.89 | 0.804 | 0.739 | 0.788 |
| 12 | 3702 | 31 | 12- 6 | 9- 6 | 58 | 21.3 | 18 #10 | 23.34 | 21 H# 9 | 20.71 | 0.875 | 0.732 | 0.695 |
| 13 | 4001 | 32 | 13-11 | 9- 6 | 60 | 24.5 | 21 #10 | 26.89 | 23 # 8 | 18.63 | 0.883 | 0.583 | 0.595 |
| 14 | 4303 | 33 | 12- 6 | 11- 9 | 60 | 27.2 | 19 #10 | 23.67 | 24 # 9 | 24.58 | 0.950 | 0.622 | 0.997 |
| 15 | 4614 | 34 | 13-11<br>6- 2 | 12- 6<br>8- 1 | 59 | 28.6 | 20 #10 | 25.98 | 27 # 9 | 27.76 | 1.128 | 0.570 | 0.803 |
| 16 | 4916 | 36 | 12- 6 | 12- 6 | 65 | 31.3 | 27 # 9 | 27.72 | 27 # 9 | 27.72 | 1.102 | 0.646 | 0.996 |
| 17 | 5254 | 37 | 13-11<br>6- 2 | 12- 6<br>8- 1 | 59 | 28.6 | 26 #10 | 32.84 | 27 # 9 | 27.05 | 1.301 | 0.634 | 0.980 |
| 18 | 5558 | 38 | 13-11 | 12- 6 | 58 | 31.1 | 29 #10 | 37.45 | 31 # 9 | 31.45 | 1.470 | 0.666 | 0.994 |
| 19 | 5844 | 39 | 14- 9 | 12- 6 | 64 | 36.4 | 29 #10 | 37.63 | 31 # 9 | 31.66 | 1.522 | 0.654 | 0.984 |
| 20 | 6132 | 40 | 15- 6 | 12- 6 | 69 | 41.3 | 24 #11 | 37.93 | 35 # 9 | 35.98 | 1.670 | 0.607 | 0.990 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 3,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 12 in.
spaced at 3′-1″

## 120-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 21″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Con-crete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 747 | 14 | 6- 7 | 3- 6 | 45 | 3.2 | 6 H# 8 | 4.83 | 5 H# 4 | N/A | 0.070 | 0.985 | N/A |
| 3 | 1123 | 19 | 6- 7<br>2- 1 | 6- 3<br>2- 2 | 44 | 4.3 | 3 H# 9 | 3.07 | 3-WAYS | | 0.131 | 0.606 | 0.933 |
| 4 | 1500 | 20 | 6- 7 | 6- 7 | 41 | 5.5 | 11 H# 8 | 8.30 | 11 H# 8 | 8.30 | 0.233 | 0.662 | 0.947 |
| 5 | 1862 | 22 | 7-11 | 7-11 | 46 | 8.9 | 15 H# 8 | 11.56 | 15 H# 8 | 11.56 | 0.370 | 0.479 | 0.964 |
| 6 | 2240 | 24 | 9- 8 | 6- 7 | 50 | 9.8 | 12 H# 9 | 12.16 | 11 H# 9 | 11.17 | 0.399 | 0.946 | 0.995 |
| 7 | 2584 | 29 | 9- 8 | 8-11 | 60 | 16.0 | 15 H# 8 | 11.56 | 16 H# 8 | 12.53 | 0.439 | 0.447 | 0.970 |
| 8 | 2980 | 28 | 9- 8 | 8-11 | 53 | 14.1 | 20 H# 8 | 15.52 | 16 H# 9 | 16.41 | 0.591 | 0.522 | 0.872 |
| 9 | 3342 | 29 | 9- 8 | 9- 8 | 61 | 17.6 | 18 H# 9 | 18.41 | 18 H# 9 | 18.41 | 0.714 | 0.411 | 0.991 |
| 10 | 3721 | 31 | 12- 9 | 8-11 | 52 | 18.2 | 17 #10 | 22.13 | 19 H# 9 | 18.65 | 0.801 | 0.832 | 0.993 |
| 11 | 4103 | 33 | 12- 9 | 8-11 | 53 | 18.6 | 21 #10 | 27.11 | 21 H# 9 | 21.50 | 0.943 | 0.874 | 0.914 |
| 12 | 4467 | 34 | 12- 9 | 9- 8 | 57 | 21.7 | 23 #10 | 29.40 | 23 H# 9 | 23.54 | 1.062 | 0.886 | 0.799 |
| 13 | 4826 | 35 | 14- 3 | 9- 8 | 60 | 25.5 | 26 #10 | 33.32 | 28 # 8 | 22.64 | 1.112 | 0.687 | 0.695 |
| 14 | 5177 | 36 | 12- 9 | 12- 0 | 65 | 30.7 | 21 #10 | 26.58 | 27 # 9 | 27.62 | 1.081 | 0.667 | 0.997 |
| 15 | 5566 | 38 | 14- 3<br>6- 5 | 12- 9<br>8- 3 | 59 | 29.9 | 25 #10 | 31.76 | 33 # 9 | 33.78 | 1.427 | 0.671 | 0.926 |
| 16 | 5913 | 39 | 12- 9 | 12- 9 | 71 | 35.6 | 31 # 9 | 31.33 | 31 # 9 | 31.33 | 1.291 | 0.687 | 0.985 |

Minimum Pile Diameter = 12 in.
spaced at 3′-1″

## 140-TON STEEL PILES

Edge $E$ = 27″

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 867 | 15 | 7- 7 | 4- 6 | 42 | 4.4 | 4 H#11 | 5.83 | 6 H# 4 | N/A | 0.119 | 0.996 | N/A |
| 3 | 1304 | 21 | 7- 7<br>2- 7 | 7- 2<br>2-11 | 44 | 6.0 | 3 H#10 | 3.45 | 3-WAYS | | 0.192 | 0.612 | 0.974 |
| 4 | 1743 | 21 | 7- 7 | 7- 7 | 42 | 7.5 | 8 H#10 | 9.82 | 8 H#10 | 9.82 | 0.341 | 0.647 | 0.950 |
| 5 | 2165 | 24 | 8-11 | 8-11 | 47 | 11.5 | 11 H#10 | 13.33 | 11 H#10 | 13.33 | 0.532 | 0.470 | 0.950 |
| 6 | 2605 | 26 | 10- 8 | 7- 7 | 51 | 12.7 | 11 H#10 | 13.53 | 8 H#11 | 12.27 | 0.525 | 0.823 | 0.989 |
| 7 | 3009 | 31 | 10- 8 | 9-11 | 60 | 19.6 | 8 H#11 | 12.85 | 9 H#11 | 13.82 | 0.584 | 0.468 | 0.554 |
| 8 | 3474 | 30 | 10- 8 | 9-11 | 52 | 17.0 | 11 H#11 | 16.78 | 11 H#11 | 17.45 | 0.757 | 0.559 | 0.976 |
| 9 | 3890 | 32 | 10- 8 | 10- 8 | 62 | 21.8 | 13 H#11 | 20.61 | 13 H#11 | 20.61 | 0.921 | 0.417 | 0.979 |
| 10 | 4330 | 33 | 13- 9 | 9-11 | 55 | 23.1 | 18 #10 | 23.40 | 13 H#11 | 19.74 | 0.948 | 0.695 | 0.988 |
| 11 | 4780 | 35 | 13- 9 | 9-11 | 54 | 22.7 | 24 #10 | 30.24 | 15 H#11 | 23.66 | 1.186 | 0.895 | 0.999 |
| 12 | 5214 | 37 | 13- 9 | 10- 8 | 55 | 24.9 | 27 #10 | 35.18 | 17 H#11 | 26.20 | 1.372 | 0.979 | 0.938 |
| 13 | 5632 | 38 | 15- 3 | 10- 8 | 59 | 29.6 | 25 #11 | 39.22 | 33 # 8 | 26.11 | 1.427 | 0.741 | 0.806 |
| 14 | 6021 | 39 | 13- 9 | 13- 0 | 70 | 38.6 | 24 #10 | 31.39 | 25 #10 | 32.50 | 1.357 | 0.660 | 0.977 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 3,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 15 in.
spaced at 3′-3″

## 160-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 27″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Concrete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 991 | 16 | 7- 9 | 4- 6 | 46 | 5.0 | 4 H#11 | 6.42 | 6 H# 4 | N/A | 0.121 | 0.969 | N/A |
| 3 | 1493 | 22 | 7- 9 | 7- 4 | 46 | 6.5 | 3 H#11 | 3.91 | 3-WAYS | | 0.249 | 0.647 | 0.988 |
| | | | 2- 7 | 2-11 | | | | | | | | | |
| 4 | 1996 | 23 | 7- 9 | 7- 9 | 43 | 8.0 | 8 H#10 | 10.34 | 8 H#10 | 10.34 | 0.347 | 0.703 | 0.968 |
| 5 | 2477 | 25 | 9- 2 | 9- 2 | 49 | 12.7 | 9 H#11 | 14.41 | 9 H#11 | 14.41 | 0.566 | 0.497 | 0.982 |
| 6 | 2981 | 28 | 11- 0 | 7- 9 | 53 | 13.9 | 10 H#11 | 15.52 | 9 H#11 | 13.90 | 0.612 | 0.853 | 0.996 |
| 7 | 3447 | 34 | 11- 0 | 10- 2 | 61 | 21.1 | 12 H#10 | 14.62 | 12 H#10 | 14.49 | 0.667 | 0.513 | 0.575 |
| 8 | 3975 | 32 | 11- 0 | 10- 2 | 54 | 18.6 | 14 H#10 | 18.04 | 13 H#11 | 19.94 | 0.845 | 0.596 | 0.991 |
| 9 | 4450 | 34 | 11- 0 | 11- 0 | 65 | 24.3 | 15 H#11 | 23.35 | 15 H#11 | 23.35 | 1.089 | 0.437 | 0.985 |
| 10 | 4951 | 36 | 14- 3 | 10- 2 | 58 | 25.9 | 20 #10 | 26.14 | 14 H#11 | 21.95 | 1.069 | 0.727 | 0.986 |
| 11 | 5463 | 37 | 14- 3 | 10- 2 | 58 | 25.9 | 26 #10 | 33.21 | 17 H#11 | 26.80 | 1.349 | 0.915 | 0.758 |
| 12 | 5959 | 39 | 14- 3 | 11- 0 | 59 | 28.5 | 30 #10 | 38.71 | 18 H#11 | 28.84 | 1.541 | 0.996 | 0.919 |

Minimum Pile Diameter = 15 in.
spaced at 3′-3″

## 180-TON STEEL PILES

Edge $E$ = 27″

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1117 | 17 | 7- 9 | 4- 6 | 49 | 5.3 | 6 H#10 | 6.57 | 6 H# 4 | N/A | 0.140 | 0.999 | N/A |
| 3 | 1684 | 24 | 7- 9 | 7- 4 | 47 | 6.6 | 3 H#11 | 4.18 | 3-WAYS | | 0.249 | 0.710 | 0.934 |
| | | | 2- 7 | 2-11 | | | | | | | | | |
| 4 | 2251 | 24 | 7- 9 | 7- 9 | 44 | 8.2 | 7 H#11 | 10.90 | 7 H#11 | 10.90 | 0.387 | 0.769 | 0.948 |
| 5 | 2795 | 27 | 9- 2 | 9- 2 | 50 | 13.0 | 12 H#10 | 14.80 | 12 H#10 | 14.80 | 0.594 | 0.547 | 0.952 |
| 6 | 3362 | 29 | 11- 0 | 7- 9 | 55 | 14.5 | 13 H#10 | 16.61 | 12 H#10 | 14.65 | 0.633 | 0.810 | 0.954 |
| 7 | 3900 | 36 | 11- 0 | 10- 2 | 59 | 20.4 | 11 H#11 | 16.92 | 13 H#10 | 16.08 | 0.749 | 0.604 | 0.650 |
| 8 | 4484 | 34 | 11- 0 | 10- 2 | 55 | 19.0 | 12 H#11 | 19.23 | 14 H#11 | 21.74 | 0.913 | 0.658 | 0.953 |
| 9 | 5024 | 36 | 11- 0 | 11- 0 | 66 | 24.6 | 16 H#11 | 24.77 | 16 H#11 | 24.77 | 1.162 | 0.485 | 0.996 |
| 10 | 5594 | 38 | 14- 3 | 10- 2 | 57 | 25.5 | 23 #10 | 30.02 | 16 H#11 | 25.02 | 1.226 | 0.839 | 0.853 |
| 11 | 6162 | 40 | 14- 3 | 10- 2 | 60 | 26.8 | 27 #10 | 35.19 | 18 H#11 | 27.94 | 1.412 | 0.991 | 0.656 |

Minimum Pile Diameter = 15 in.
spaced at 3′-3″

## 200-TON STEEL PILES

Edge $E$ = 27″

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1242 | 18 | 7- 9 | 4- 6 | 54 | 5.8 | 4 H#11 | 6.37 | 6 H# 4 | N/A | 0.121 | 0.982 | N/A |
| 3 | 1876 | 25 | 7- 9 | 7- 4 | 47 | 6.6 | 3 H#11 | 4.61 | 3-WAYS | | 0.249 | 0.790 | 0.986 |
| | | | 2- 7 | 2-11 | | | | | | | | | |
| 4 | 2508 | 26 | 7- 9 | 7- 9 | 43 | 8.0 | 8 H#11 | 12.17 | 8 H#11 | 12.17 | 0.443 | 0.883 | 0.997 |
| 5 | 3114 | 28 | 9- 2 | 9- 2 | 51 | 13.2 | 12 H#10 | 15.17 | 12 H#10 | 15.17 | 0.594 | 0.594 | 0.952 |
| 6 | 3746 | 31 | 11- 0 | 7- 9 | 55 | 14.5 | 12 H#11 | 18.37 | 10 H#11 | 15.89 | 0.712 | 0.830 | 0.985 |
| 7 | 4352 | 38 | 11- 0 | 10- 2 | 57 | 19.7 | 12 H#11 | 19.23 | 12 H#11 | 18.54 | 0.845 | 0.702 | 0.721 |
| 8 | 4996 | 36 | 11- 0 | 10- 2 | 55 | 19.0 | 17 H#10 | 21.10 | 15 H#11 | 23.82 | 0.999 | 0.734 | 0.954 |
| 9 | 5597 | 38 | 11- 0 | 11- 0 | 67 | 25.0 | 16 H#11 | 25.21 | 16 H#11 | 25.21 | 1.162 | 0.532 | 0.995 |
| 10 | 6240 | 40 | 14- 3 | 10- 2 | 55 | 24.6 | 27 #10 | 34.95 | 16 H#11 | 25.26 | 1.344 | 0.978 | 0.940 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.

** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.

(1) "H"—Use hooked or headed bars.

(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.

(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 4,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 8 in.
spaced at 3′-0″

## 40-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 15″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Concrete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 246 | 10 | 5- 6 | 2- 6 | 33 | 1.4 | 4 H# 7 | 2.36 | 5 H# 4 | N/A | 0.032 | 0.914 | N/A |
| 3 | 371 | 11 | 5- 6 | 5- 2 | 30 | 2.0 | 3 H# 7 | 1.75 | 3-WAYS | | 0.061 | 0.817 | 0.894 |
| | | | 1- 6 | 1- 7 | | | | | | | | | |
| 4 | 494 | 12 | 5- 6 | 5- 6 | 29 | 2.7 | 8 H# 7 | 4.55 | 8 H# 7 | 4.55 | 0.109 | 0.920 | 0.984 |
| 5 | 609 | 13 | 6- 9 | 6- 9 | 34 | 4.8 | 11 H# 7 | 6.43 | 11 H# 7 | 6.43 | 0.178 | 0.879 | 0.638 |
| 6 | 727 | 14 | 8- 6 | 5- 6 | 43 | 6.2 | 11 H# 7 | 6.48 | 13 H# 7 | 7.89 | 0.197 | 0.960 | 0.364 |
| 7 | 848 | 17 | 8- 6 | 7- 9 | 36 | 7.3 | 13 H# 7 | 7.81 | 12 H# 7 | 7.05 | 0.238 | 0.830 | 0.964 |
| 8 | 973 | 16 | 8- 6 | 7- 9 | 38 | 7.7 | 15 H# 7 | 8.85 | 16 H# 7 | 9.41 | 0.294 | 0.962 | 0.687 |
| 9 | 1091 | 17 | 8- 6 | 8- 6 | 42 | 9.4 | 17 H# 7 | 10.10 | 17 H# 7 | 10.10 | 0.336 | 0.902 | 0.725 |
| 10 | 1206 | 18 | 11- 6 | 7- 9 | 41 | 11.3 | 8 #10 | 10.09 | 17 H# 7 | 10.18 | 0.344 | 0.544 | 0.738 |
| 11 | 1336 | 19 | 11- 6 | 7- 9 | 40 | 11.0 | 13 # 9 | 13.23 | 20 H# 7 | 12.33 | 0.425 | 0.770 | 0.966 |
| 12 | 1451 | 20 | 11- 6 | 8- 6 | 43 | 13.0 | 11 #10 | 14.33 | 21 H# 7 | 12.89 | 0.468 | 0.985 | 0.806 |
| 13 | 1552 | 20 | 12-11 | 8- 6 | 51 | 17.3 | 9 #11 | 14.04 | 14 # 9 | 14.23 | 0.487 | 0.913 | 0.674 |
| 14 | 1695 | 21 | 11- 6 | 10- 9 | 39 | 14.9 | 13 #10 | 16.05 | 14 #10 | 17.56 | 0.616 | 0.817 | 0.986 |
| 15 | 1798 | 22 | 12-11 | 11- 6 | 45 | 18.7 | 13 #10 | 16.27 | 14 #10 | 17.62 | 0.679 | 0.825 | 0.986 |
| | | | 5-11 | 7- 6 | | | | | | | | | |
| 16 | 1936 | 23 | 11- 6 | 11- 6 | 42 | 17.1 | 16 #10 | 20.15 | 16 #10 | 20.15 | 0.757 | 0.993 | 0.953 |
| 17 | 2046 | 23 | 12-11 | 11- 6 | 48 | 19.9 | 11 #11 | 17.67 | 15 #10 | 19.09 | 0.718 | 0.791 | 0.975 |
| | | | 5-11 | 7- 6 | | | | | | | | | |
| 18 | 2158 | 24 | 12-11 | 11- 6 | 49 | 22.5 | 12 #11 | 18.87 | 15 #10 | 19.61 | 0.751 | 0.894 | 0.913 |
| 19 | 2273 | 24 | 13- 9 | 11- 6 | 50 | 24.4 | 17 #10 | 21.11 | 17 #10 | 21.50 | 0.887 | 0.902 | 0.987 |
| 20 | 2379 | 25 | 14- 6 | 11- 6 | 54 | 27.8 | 16 #10 | 20.91 | 18 #10 | 23.01 | 0.908 | 0.917 | 0.827 |
| 21 | 2506 | 26 | 13- 9 | 13- 9 | 52 | 28.1 | 15 #11 | 23.26 | 15 #11 | 23.26 | 1.056 | 0.720 | 0.982 |
| | | | 11- 0 | 3- 5 | | | | | | | | | |
| 22 | 2635 | 26 | 14- 6 | 12-11 | 52 | 27.8 | 14 #11 | 21.85 | 15 #11 | 23.71 | 1.015 | 0.860 | 0.982 |
| | | | 10- 6 | 5-11 | | | | | | | | | |
| 23 | 2743 | 27 | 14- 6 | 13- 9 | 54 | 30.9 | 16 #11 | 24.36 | 16 #11 | 24.87 | 1.158 | 0.654 | 0.988 |
| | | | 10- 6 | 6- 9 | | | | | | | | | |
| 24 | 2864 | 27 | 14- 6 | 13- 9 | 52 | 32.0 | 16 #11 | 25.27 | 17 #11 | 26.19 | 1.193 | 0.791 | 0.958 |
| 26 | 3098 | 28 | 15-11 | 14- 6 | 53 | 35.5 | 20 #11 | 31.40 | 17 #11 | 26.67 | 1.451 | 0.817 | 0.999 |
| | | | 8-11 | 10- 6 | | | | | | | | | |
| 28 | 3316 | 29 | 15-11 | 14- 6 | 58 | 41.3 | 19 #11 | 29.70 | 19 #11 | 29.85 | 1.485 | 0.648 | 0.978 |
| 30 | 3540 | 30 | 17- 6 | 14- 6 | 59 | 46.2 | 15 #14 | 34.48 | 21 #11 | 33.32 | 1.756 | 0.648 | 0.848 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.

** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.

(1) "H"—Use hooked or headed bars.

(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.

(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 4,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 8 in.
spaced at 3′-0″

## 50-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 15″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Con-crete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.$^2$) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.$^2$) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 310 | 10 | 5- 6 | 2- 6 | 35 | 1.5 | 6 H# 6 | 2.56 | 5 H# 4 | N/A | 0.034 | 0.969 | N/A |
| 3 | 466 | 13 | 5- 6 | 5- 2 | 31 | 2.0 | 3 H# 7 | 1.83 | 3-WAYS | | 0.061 | 0.747 | 0.976 |
| | | | 1- 6 | 1- 7 | | | | | | | | | |
| 4 | 620 | 13 | 5- 6 | 5- 6 | 32 | 3.0 | 11 H# 6 | 4.98 | 11 H# 6 | 4.98 | 0.105 | 0.679 | 0.945 |
| 5 | 768 | 14 | 6- 9 | 6- 9 | 35 | 4.9 | 16 H# 6 | 6.92 | 16 H# 6 | 6.92 | 0.182 | 0.883 | 0.734 |
| 6 | 918 | 16 | 8- 6 | 5- 6 | 44 | 6.3 | 13 H# 7 | 7.60 | 18 H# 6 | 8.08 | 0.214 | 0.949 | 0.420 |
| 7 | 1068 | 19 | 8- 6 | 7- 9 | 39 | 7.9 | 14 H# 7 | 8.65 | 13 H# 7 | 7.83 | 0.257 | 0.593 | 0.977 |
| 8 | 1225 | 18 | 8- 6 | 7- 9 | 41 | 8.3 | 16 H# 7 | 9.78 | 17 H# 7 | 10.43 | 0.313 | 0.735 | 0.704 |
| 9 | 1377 | 19 | 8- 6 | 8- 6 | 43 | 9.6 | 19 H# 7 | 11.41 | 19 H# 7 | 11.41 | 0.375 | 0.894 | 0.836 |
| 10 | 1528 | 20 | 11- 6 | 7- 9 | 40 | 11.0 | 13 # 9 | 13.13 | 19 H# 7 | 11.41 | 0.416 | 0.657 | 0.948 |
| 11 | 1681 | 21 | 11- 6 | 7- 9 | 44 | 12.1 | 15 # 9 | 14.48 | 22 H# 7 | 13.40 | 0.481 | 0.866 | 0.957 |
| 12 | 1816 | 22 | 11- 6 | 8- 6 | 53 | 16.0 | 15 # 9 | 14.77 | 22 H# 7 | 13.17 | 0.498 | 0.978 | 0.635 |
| 13 | 1968 | 23 | 12- 11 | 8- 6 | 51 | 17.3 | 13 #10 | 16.63 | 18 # 8 | 14.23 | 0.540 | 0.999 | 0.814 |
| 14 | 2136 | 24 | 11- 6 | 10- 9 | 42 | 16.0 | 14 #10 | 17.95 | 15 #10 | 19.46 | 0.662 | 0.939 | 0.983 |
| 15 | 2265 | 24 | 12- 11 | 11- 6 | 50 | 20.8 | 12 #11 | 18.54 | 16 #10 | 20.13 | 0.774 | 0.579 | 0.969 |
| | | | 5- 11 | 7- 6 | | | | | | | | | |
| 16 | 2422 | 25 | 11- 6 | 11- 6 | 52 | 21.2 | 15 #10 | 19.49 | 15 #10 | 19.49 | 0.710 | 0.988 | 0.750 |
| 17 | 2580 | 26 | 12- 11 | 11- 6 | 52 | 21.6 | 13 #11 | 19.80 | 17 #10 | 21.16 | 0.831 | 0.872 | 0.999 |
| | | | 5- 11 | 7- 6 | | | | | | | | | |
| 18 | 2725 | 27 | 12- 11 | 11- 6 | 52 | 23.8 | 14 #11 | 21.81 | 17 #10 | 21.16 | 0.864 | 0.969 | 0.850 |
| 19 | 2875 | 27 | 13- 9 | 11- 6 | 52 | 25.4 | 16 #11 | 25.16 | 18 #10 | 22.53 | 0.989 | 0.950 | 0.846 |
| 20 | 3016 | 28 | 14- 6 | 11- 6 | 55 | 28.3 | 16 #11 | 25.72 | 20 #10 | 25.49 | 1.068 | 0.890 | 0.969 |
| 21 | 3160 | 29 | 13- 9 | 13- 9 | 57 | 30.8 | 17 #11 | 26.01 | 17 #11 | 26.01 | 1.197 | 0.840 | 0.992 |
| | | | 11- 0 | 3- 5 | | | | | | | | | |
| 22 | 3332 | 29 | 14- 6 | 12- 11 | 54 | 28.9 | 16 #11 | 25.58 | 17 #11 | 26.32 | 1.156 | 0.871 | 0.989 |
| | | | 10- 6 | 5- 11 | | | | | | | | | |
| 23 | 3461 | 30 | 14- 6 | 13- 9 | 59 | 33.8 | 17 #11 | 27.11 | 18 #11 | 27.77 | 1.266 | 0.786 | 0.973 |
| | | | 10- 6 | 6- 9 | | | | | | | | | |
| 24 | 3616 | 31 | 14- 6 | 13- 9 | 56 | 34.5 | 18 #11 | 28.55 | 19 #11 | 29.46 | 1.338 | 0.875 | 0.992 |
| 26 | 3904 | 32 | 15- 11 | 14- 6 | 59 | 39.5 | 22 #11 | 33.88 | 19 #11 | 30.49 | 1.608 | 0.693 | 0.972 |
| | | | 8- 11 | 10- 6 | | | | | | | | | |
| 28 | 4212 | 33 | 15- 11 | 14- 6 | 58 | 41.3 | 24 #11 | 37.13 | 21 #11 | 32.98 | 1.764 | 0.812 | 0.988 |
| 30 | 4495 | 34 | 17- 6 | 14- 6 | 60 | 47.0 | 19 #14 | 42.30 | 24 #11 | 37.68 | 2.128 | 0.801 | 0.995 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 4,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 8 in.
spaced at 3′-0″

## 60-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 15″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Con-crete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.$^2$) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.$^2$) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 373 | 10 | 5- 6 | 2- 6 | 40 | 1.7 | 5 H# 7 | 2.86 | 5 H# 4 | N/A | 0.039 | 0.841 | N/A |
| 3 | 562 | 14 | 5- 6 | 5- 2 | 33 | 2.2 | 5 H# 6 | 2.01 | 3-WAYS | | 0.071 | 0.625 | 0.986 |
| | | | 1- 6 | 1- 7 | | | | | | | | | |
| 4 | 747 | 14 | 5- 6 | 5- 6 | 34 | 3.2 | 9 H# 7 | 5.40 | 9 H# 7 | 5.40 | 0.123 | 0.594 | 0.962 |
| 5 | 928 | 16 | 6- 9 | 6- 9 | 35 | 4.9 | 12 H# 7 | 7.03 | 12 H# 7 | 7.03 | 0.194 | 0.937 | 0.844 |
| 6 | 1109 | 17 | 8- 6 | 5- 6 | 45 | 6.5 | 13 H# 7 | 7.82 | 14 H# 7 | 8.26 | 0.224 | 0.973 | 0.475 |
| 7 | 1288 | 21 | 8- 6 | 7- 9 | 42 | 8.5 | 15 H# 7 | 9.26 | 14 H# 7 | 8.41 | 0.276 | 0.462 | 0.968 |
| 8 | 1483 | 20 | 8- 6 | 7- 9 | 40 | 8.1 | 16 H# 7 | 9.74 | 18 H# 7 | 10.98 | 0.322 | 0.893 | 0.863 |
| 9 | 1665 | 21 | 8- 6 | 8- 6 | 43 | 9.6 | 19 H# 7 | 11.41 | 19 H# 7 | 11.41 | 0.375 | 0.977 | 0.973 |
| 10 | 1845 | 22 | 11- 6 | 7- 9 | 42 | 11.6 | 15 # 9 | 14.70 | 21 H# 7 | 12.69 | 0.472 | 0.531 | 0.994 |
| 11 | 2028 | 23 | 11- 6 | 7- 9 | 47 | 12.9 | 16 # 9 | 15.82 | 24 H# 7 | 14.57 | 0.518 | 0.966 | 0.974 |
| 12 | 2194 | 24 | 11- 6 | 8- 6 | 56 | 16.9 | 16 # 9 | 15.79 | 23 H# 7 | 13.91 | 0.526 | 0.439 | 0.667 |
| 13 | 2362 | 25 | 12- 11 | 8- 6 | 61 | 20.7 | 11 #11 | 17.44 | 21 # 8 | 17.02 | 0.587 | 0.992 | 0.435 |
| 14 | 2571 | 26 | 11- 6 | 10- 9 | 47 | 17.9 | 18 # 9 | 18.32 | 20 # 9 | 19.60 | 0.685 | 0.998 | 0.913 |
| 15 | 2740 | 27 | 12- 11 | 11- 6 | 52 | 21.6 | 15 #10 | 19.49 | 17 #10 | 21.23 | 0.803 | 0.696 | 0.728 |
| | | | 5- 11 | 7- 6 | | | | | | | | | |
| 16 | 2929 | 28 | 11- 6 | 11- 6 | 54 | 22.0 | 16 #10 | 20.92 | 16 #10 | 20.92 | 0.757 | 0.453 | 0.807 |
| 17 | 3107 | 28 | 12- 11 | 11- 6 | 58 | 24.1 | 14 #11 | 22.22 | 17 #10 | 22.03 | 0.864 | 0.998 | 0.699 |
| | | | 5- 11 | 7- 6 | | | | | | | | | |
| 18 | 3277 | 29 | 12- 11 | 11- 6 | 60 | 27.5 | 15 #11 | 23.14 | 19 #10 | 23.85 | 0.944 | 0.999 | 0.528 |
| 19 | 3458 | 30 | 13- 9 | 11- 6 | 60 | 29.3 | 16 #11 | 24.86 | 21 #10 | 26.73 | 1.060 | 0.988 | 0.630 |
| 20 | 3643 | 31 | 14- 6 | 11- 6 | 59 | 30.4 | 18 #11 | 28.11 | 22 #10 | 27.81 | 1.190 | 0.990 | 0.754 |
| 21 | 3829 | 31 | 13- 9 | 13- 9 | 58 | 31.3 | 18 #11 | 27.64 | 18 #11 | 27.64 | 1.267 | 0.998 | 0.660 |
| | | | 11- 0 | 3- 5 | | | | | | | | | |
| 22 | 4016 | 32 | 14- 6 | 12- 11 | 60 | 32.1 | 17 #11 | 26.54 | 22 #10 | 28.39 | 1.220 | 0.462 | 0.719 |
| | | | 10- 6 | 5- 11 | | | | | | | | | |
| 23 | 4189 | 33 | 14- 6 | 13- 9 | 61 | 34.9 | 18 #11 | 28.29 | 18 #11 | 28.93 | 1.303 | 0.942 | 0.960 |
| | | | 10- 6 | 6- 9 | | | | | | | | | |
| 24 | 4372 | 34 | 14- 6 | 13- 9 | 59 | 36.3 | 20 #11 | 31.93 | 21 #11 | 32.86 | 1.483 | 0.994 | 0.827 |
| 26 | 4714 | 35 | 15- 11 | 14- 6 | 64 | 42.8 | 23 #11 | 36.45 | 21 #11 | 33.67 | 1.723 | 0.807 | 0.972 |
| | | | 8- 11 | 10- 6 | | | | | | | | | |
| 28 | 5085 | 36 | 15- 11 | 14- 6 | 63 | 44.9 | 25 #11 | 39.86 | 22 #11 | 35.31 | 1.842 | 0.899 | 0.987 |
| 30 | 5425 | 37 | 17- 6 | 14- 6 | 66 | 51.7 | 20 #14 | 44.75 | 25 #11 | 39.76 | 2.230 | 0.876 | 0.972 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 4,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 10 in.
spaced at 3′-0″

## 80-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 21″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Concrete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 495 | 12 | 6- 6 | 3- 6 | 36 | 2.5 | 3 H#10 | 3.70 | 5 H# 4 | N/A | 0.064 | 0.967 | N/A |
| 3 | 744 | 16 | 6- 6 | 6- 2 | 37 | 3.6 | 3 H# 9 | 2.58 | 3-WAYS | | 0.130 | 0.444 | 0.959 |
| | | | 2- 1 | 2- 3 | | | | | | | | | |
| 4 | 992 | 16 | 6- 6 | 6- 6 | 37 | 4.8 | 7 H# 9 | 7.13 | 7 H# 9 | 7.13 | 0.202 | 0.441 | 0.959 |
| 5 | 1235 | 18 | 7- 9 | 7- 9 | 37 | 6.9 | 7 H#10 | 8.68 | 7 H#10 | 8.68 | 0.304 | 0.742 | 0.947 |
| 6 | 1480 | 20 | 9- 6 | 6- 6 | 45 | 8.6 | 9 H# 9 | 9.21 | 9 H# 9 | 9.23 | 0.306 | 0.952 | 0.596 |
| 7 | 1713 | 24 | 9- 6 | 8- 9 | 47 | 12.1 | 8 H#10 | 10.25 | 10 H# 9 | 9.64 | 0.386 | 0.353 | 0.969 |
| 8 | 1978 | 23 | 9- 6 | 8- 9 | 42 | 10.8 | 12 H# 9 | 11.85 | 11 H#10 | 13.42 | 0.497 | 0.737 | 0.980 |
| 9 | 2217 | 24 | 9- 6 | 9- 6 | 48 | 13.4 | 15 H# 9 | 14.61 | 15 H# 9 | 14.61 | 0.586 | 0.628 | 0.981 |
| 10 | 2455 | 25 | 12- 6 | 8- 9 | 48 | 16.2 | 10 #11 | 15.98 | 11 H#10 | 13.84 | 0.581 | 0.541 | 0.956 |
| 11 | 2700 | 26 | 12- 6 | 8- 9 | 53 | 17.9 | 11 #11 | 17.62 | 13 H#10 | 16.27 | 0.661 | 0.998 | 0.651 |
| 12 | 2943 | 28 | 12- 6 | 9- 6 | 54 | 19.8 | 16 #10 | 20.42 | 14 H#10 | 18.31 | 0.770 | 0.550 | 0.907 |
| 13 | 3166 | 29 | 13-11 | 9- 6 | 61 | 24.9 | 13 #11 | 20.72 | 18 # 9 | 18.34 | 0.739 | 0.447 | 0.427 |
| 14 | 3434 | 30 | 12- 6 | 11- 9 | 51 | 23.1 | 17 #10 | 21.33 | 18 #10 | 22.65 | 0.875 | 0.776 | 0.977 |
| 15 | 3683 | 31 | 13-11 | 12- 6 | 50 | 24.2 | 17 #11 | 25.83 | 22 #10 | 27.99 | 1.174 | 0.854 | 0.998 |
| | | | 6- 2 | 8- 1 | | | | | | | | | |
| 16 | 3924 | 32 | 12- 6 | 12- 6 | 55 | 26.5 | 21 #10 | 26.52 | 21 #10 | 26.52 | 1.084 | 0.546 | 0.988 |
| 17 | 4166 | 33 | 13-11 | 12- 6 | 59 | 28.6 | 17 #11 | 26.19 | 21 #10 | 26.69 | 1.148 | 0.435 | 0.703 |
| | | | 6- 2 | 8- 1 | | | | | | | | | |
| 18 | 4402 | 34 | 13-11 | 12- 6 | 59 | 31.7 | 19 #11 | 28.98 | 21 #10 | 26.69 | 1.219 | 0.448 | 0.689 |
| 19 | 4631 | 35 | 14- 9 | 12- 6 | 63 | 35.9 | 19 #11 | 30.48 | 24 #10 | 30.65 | 1.339 | 0.457 | 0.725 |
| 20 | 4856 | 35 | 15- 6 | 12- 6 | 68 | 40.7 | 20 #11 | 30.75 | 25 #10 | 32.56 | 1.442 | 0.424 | 0.733 |
| 21 | 5122 | 36 | 14- 9 | 14- 9 | 63 | 39.0 | 21 #11 | 32.24 | 21 #11 | 32.24 | 1.590 | 0.437 | 0.712 |
| | | | 11- 9 | 3- 7 | | | | | | | | | |
| 22 | 5401 | 37 | 15- 6 | 13-11 | 58 | 35.6 | 23 #11 | 36.18 | 24 #11 | 37.03 | 1.772 | 0.573 | 0.972 |
| | | | 11- 1 | 6- 2 | | | | | | | | | |
| 23 | 5621 | 38 | 15- 6 | 14- 9 | 63 | 41.1 | 23 #11 | 35.43 | 23 #11 | 36.09 | 1.787 | 0.810 | 0.978 |
| | | | 11- 1 | 7- 0 | | | | | | | | | |
| 24 | 5865 | 39 | 15- 6 | 14- 9 | 61 | 43.0 | 25 #11 | 40.02 | 26 #11 | 41.02 | 1.980 | 0.984 | 0.984 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.

** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.

(1) "H"—Use hooked or headed bars.

(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.

(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 4,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 10 in.
spaced at 3′-0″

## 100-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 21″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Concrete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 622 | 13 | 6- 6 | 3- 6 | 39 | 2.7 | 4 H# 9 | 4.12 | 5 H# 4 | N/A | 0.064 | 0.979 | N/A |
| 3 | 934 | 18 | 6- 6 | 6- 2 | 40 | 3.9 | 3 H# 9 | 2.84 | 3-WAYS | | 0.130 | 0.501 | 0.949 |
| | | | 2- 1 | 2- 3 | | | | | | | | | |
| 4 | 1247 | 18 | 6- 6 | 6- 6 | 38 | 5.0 | 6 H#10 | 7.39 | 6 H#10 | 7.39 | 0.228 | 0.535 | 0.967 |
| 5 | 1551 | 20 | 7- 9 | 7- 9 | 40 | 7.4 | 10 H# 9 | 9.50 | 10 H# 9 | 9.50 | 0.331 | 0.612 | 0.966 |
| 6 | 1863 | 22 | 9- 6 | 6- 6 | 46 | 8.8 | 11 H# 9 | 10.93 | 8 H#10 | 10.32 | 0.367 | 0.984 | 0.993 |
| 7 | 2155 | 27 | 9- 6 | 8- 9 | 51 | 13.1 | 9 H#10 | 11.24 | 8 H#10 | 10.47 | 0.420 | 0.401 | 0.988 |
| 8 | 2480 | 25 | 9- 6 | 8- 9 | 48 | 12.3 | 11 H#10 | 13.45 | 11 H#10 | 14.10 | 0.542 | 0.516 | 0.958 |
| 9 | 2784 | 27 | 9- 6 | 9- 6 | 53 | 14.8 | 13 H#10 | 16.48 | 13 H#10 | 16.48 | 0.662 | 0.488 | 0.966 |
| 10 | 3088 | 28 | 12- 6 | 8- 9 | 51 | 17.2 | 14 #10 | 18.24 | 12 H#10 | 15.66 | 0.648 | 0.638 | 0.843 |
| 11 | 3404 | 30 | 12- 6 | 8- 9 | 53 | 17.9 | 17 #10 | 21.68 | 16 H#10 | 19.78 | 0.820 | 0.640 | 0.683 |
| 12 | 3704 | 31 | 12- 6 | 9- 6 | 57 | 20.9 | 19 #10 | 23.57 | 17 H#10 | 21.08 | 0.923 | 0.648 | 0.987 |
| 13 | 4001 | 32 | 13-11 | 9- 6 | 60 | 24.5 | 17 #11 | 26.53 | 19 # 9 | 18.62 | 0.897 | 0.515 | 0.515 |
| 14 | 4315 | 33 | 12- 6 | 11- 9 | 56 | 25.4 | 18 #10 | 23.34 | 19 #10 | 24.57 | 0.925 | 0.587 | 0.987 |
| 15 | 4614 | 34 | 13-11 | 12- 6 | 59 | 28.6 | 20 #10 | 25.69 | 22 #10 | 27.51 | 1.145 | 0.493 | 0.695 |
| | | | 6- 2 | 8- 1 | | | | | | | | | |
| 16 | 4929 | 36 | 12- 6 | 12- 6 | 61 | 29.4 | 22 #10 | 28.31 | 22 #10 | 28.31 | 1.136 | 0.605 | 0.973 |
| 17 | 5261 | 37 | 13-11 | 12- 6 | 57 | 27.6 | 22 #11 | 33.96 | 22 #10 | 28.18 | 1.352 | 0.575 | 0.906 |
| | | | 6- 2 | 8- 1 | | | | | | | | | |
| 18 | 5561 | 38 | 13-11 | 12- 6 | 57 | 30.6 | 24 #11 | 37.77 | 25 #10 | 31.98 | 1.501 | 0.589 | 0.890 |
| 19 | 5855 | 39 | 14- 9 | 12- 6 | 61 | 34.7 | 25 #11 | 39.59 | 26 #10 | 33.56 | 1.618 | 0.601 | 0.933 |
| 20 | 6144 | 40 | 15- 6 | 12- 6 | 66 | 39.5 | 25 #11 | 39.67 | 27 #10 | 34.19 | 1.693 | 0.555 | 0.932 |

Minimum Pile Diameter = 12 in.
spaced at 3′-1″

## 120-TON STEEL PILES

Edge $E$ = 21″

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 748 | 14 | 6- 7 | 3- 6 | 43 | 3.1 | 5 H# 9 | 4.68 | 5 H# 4 | N/A | 0.080 | 0.953 | N/A |
| 3 | 1125 | 19 | 6- 7 | 6- 3 | 42 | 4.1 | 3 H#10 | 3.25 | 3-WAYS | | 0.173 | 0.558 | 0.949 |
| | | | 2- 1 | 2- 2 | | | | | | | | | |
| 4 | 1502 | 20 | 6- 7 | 6- 7 | 39 | 5.2 | 7 H#10 | 8.40 | 7 H#10 | 8.40 | 0.269 | 0.613 | 0.976 |
| 5 | 1866 | 22 | 7-11 | 7-11 | 43 | 8.3 | 11 H# 9 | 10.59 | 11 H# 9 | 10.59 | 0.371 | 0.537 | 0.961 |
| 6 | 2242 | 24 | 9- 8 | 6- 7 | 48 | 9.4 | 10 H#10 | 12.73 | 12 H# 9 | 11.79 | 0.433 | 0.971 | 0.986 |
| 7 | 2593 | 29 | 9- 8 | 8-11 | 55 | 14.6 | 10 H#10 | 12.44 | 9 H#10 | 11.60 | 0.476 | 0.431 | 0.997 |
| 8 | 2985 | 28 | 9- 8 | 8-11 | 50 | 13.3 | 11 H#10 | 14.40 | 16 H# 9 | 15.94 | 0.581 | 0.500 | 0.962 |
| 9 | 3349 | 29 | 9- 8 | 9- 8 | 57 | 16.4 | 14 H#10 | 18.31 | 14 H#10 | 18.31 | 0.723 | 0.450 | 0.980 |
| 10 | 3726 | 31 | 12- 9 | 8-11 | 50 | 17.5 | 18 #10 | 23.00 | 15 H#10 | 19.58 | 0.837 | 0.759 | 0.976 |
| 11 | 4103 | 33 | 12- 9 | 8-11 | 53 | 18.6 | 21 #10 | 26.59 | 17 H#10 | 21.47 | 0.965 | 0.757 | 0.792 |
| 12 | 4467 | 34 | 12- 9 | 9- 8 | 57 | 21.7 | 23 #10 | 28.89 | 18 H#10 | 23.51 | 1.071 | 0.767 | 0.692 |
| 13 | 4826 | 35 | 14- 3 | 9- 8 | 60 | 25.5 | 21 #11 | 32.75 | 28 # 8 | 22.56 | 1.110 | 0.595 | 0.602 |
| 14 | 5192 | 37 | 12- 9 | 12- 0 | 60 | 28.3 | 20 #10 | 25.87 | 21 #10 | 27.00 | 1.047 | 0.637 | 0.994 |
| 15 | 5566 | 38 | 14- 3 | 12- 9 | 59 | 29.9 | 20 #11 | 31.38 | 26 #10 | 33.53 | 1.416 | 0.581 | 0.802 |
| | | | 6- 5 | 8- 3 | | | | | | | | | |
| 16 | 5929 | 39 | 12- 9 | 12- 9 | 66 | 33.1 | 24 #10 | 31.20 | 24 #10 | 31.20 | 1.265 | 0.650 | 0.978 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.

** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.

(1) "H"—Use hooked or headed bars.

(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.

(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 4,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 12 in.
spaced at 3′-1″

## 140-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 27″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Con-crete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 868 | 15 | 7- 7 | 4- 6 | 40 | 4.2 | 4 H#11 | 5.47 | 6 H# 4 | N/A | 0.119 | 0.979 | N/A |
| 3 | 1306 | 21 | 7- 7<br>2- 7 | 7- 2<br>2-11 | 42 | 5.7 | 3 H#10 | 3.65 | 3-WAYS | | 0.192 | 0.564 | 0.990 |
| 4 | 1746 | 21 | 7- 7 | 7- 7 | 40 | 7.1 | 6 H#11 | 9.37 | 6 H#11 | 9.37 | 0.327 | 0.598 | 0.974 |
| 5 | 2168 | 24 | 8-11 | 8-11 | 45 | 11.0 | 8 H#11 | 12.59 | 8 H#11 | 12.59 | 0.492 | 0.431 | 0.952 |
| 6 | 2608 | 26 | 10- 8 | 7- 7 | 49 | 12.2 | 9 H#11 | 14.16 | 10 H#10 | 12.91 | 0.532 | 0.836 | 0.977 |
| 7 | 3011 | 31 | 10- 8 | 9-11 | 59 | 19.3 | 8 H#11 | 12.82 | 11 H#10 | 13.59 | 0.573 | 0.414 | 0.983 |
| 8 | 3476 | 30 | 10- 8 | 9-11 | 51 | 16.7 | 11 H#11 | 16.38 | 8 H#14 | 17.82 | 0.678 | 0.497 | 0.900 |
| 9 | 3897 | 32 | 10- 8 | 10- 8 | 59 | 20.7 | 14 H#11 | 21.03 | 14 H#11 | 21.03 | 0.992 | 0.384 | 0.992 |
| 10 | 4340 | 33 | 13- 9 | 9-11 | 51 | 21.5 | 16 #11 | 25.65 | 10 H#14 | 21.86 | 0.923 | 0.773 | 0.992 |
| 11 | 4786 | 35 | 13- 9 | 9-11 | 52 | 21.9 | 20 #11 | 31.35 | 11 H#14 | 24.77 | 1.100 | 0.813 | 0.931 |
| 12 | 5217 | 37 | 13- 9 | 10- 8 | 54 | 24.4 | 23 #11 | 35.43 | 12 H#14 | 26.78 | 1.276 | 0.868 | 0.841 |
| 13 | 5632 | 38 | 15- 3 | 10- 8 | 59 | 29.6 | 24 #11 | 38.41 | 26 # 9 | 25.97 | 1.390 | 0.642 | 0.698 |
| 14 | 6039 | 39 | 13- 9 | 13- 0 | 65 | 35.9 | 18 #11 | 28.75 | 23 #10 | 29.68 | 1.252 | 0.625 | 0.973 |

Minimum Pile Diameter = 15 in.
spaced at 3′-3″

## 160-TON STEEL PILES

Edge $E$ = 27″

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 994 | 16 | 7- 9 | 4- 6 | 43 | 4.6 | 4 H#11 | 6.01 | 6 H# 4 | N/A | 0.121 | 0.982 | N/A |
| 3 | 1495 | 22 | 7- 9<br>2- 7 | 7- 4<br>2-11 | 44 | 6.2 | 3 H#11 | 4.13 | 3-WAYS | | 0.249 | 0.594 | 0.994 |
| 4 | 1998 | 23 | 7- 9 | 7- 9 | 41 | 7.6 | 7 H#11 | 10.67 | 7 H#11 | 10.67 | 0.387 | 0.649 | 0.987 |
| 5 | 2481 | 25 | 9- 2 | 9- 2 | 47 | 12.2 | 9 H#11 | 13.67 | 9 H#11 | 13.67 | 0.566 | 0.454 | 0.977 |
| 6 | 2985 | 28 | 11- 0 | 7- 9 | 51 | 13.4 | 7 H#14 | 16.22 | 12 H#10 | 14.63 | 0.541 | 0.860 | 0.977 |
| 7 | 3447 | 34 | 11- 0 | 10- 2 | 61 | 21.1 | 12 H#10 | 14.54 | 12 H#10 | 14.49 | 0.667 | 0.444 | 0.498 |
| 8 | 3979 | 32 | 11- 0 | 10- 2 | 52 | 17.9 | 8 H#14 | 18.49 | 14 H#11 | 21.02 | 0.799 | 0.542 | 0.969 |
| 9 | 4457 | 34 | 11- 0 | 11- 0 | 62 | 23.2 | 10 H#14 | 22.95 | 10 H#14 | 22.95 | 0.803 | 0.401 | 0.989 |
| 10 | 4963 | 36 | 14- 3 | 10- 2 | 54 | 24.1 | 18 #11 | 28.46 | 11 H#14 | 24.17 | 1.064 | 0.688 | 0.979 |
| 11 | 5478 | 38 | 14- 3 | 10- 2 | 53 | 23.7 | 23 #11 | 36.73 | 13 H#14 | 28.95 | 1.321 | 0.887 | 0.990 |
| 12 | 5968 | 39 | 14- 3 | 11- 0 | 56 | 27.1 | 26 #11 | 40.86 | 14 H#14 | 30.84 | 1.512 | 0.920 | 0.878 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

$f_c'$ = 4,000 psi; $w$ = 150 pcf
$f_y$ = 60 ksi
Minimum Pile Diameter = 15 in.
spaced at 3′-3″

## 180-TON STEEL PILES

capacity for unfactored, service ($D + L$)

Min. cover = 3″
$d_c$ = 10″
Edge $E$ = 27″
See Fig. 13-3

| PILES | COLUMN | | PILE CAP | | | | REINFORCING BARS | | | | | SHEAR | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | $V_u/\phi V_n$ | |
| No. of Piles per cap | Max. Load $P_u$ (net) (kips) | Min. Size * (in.) | Long A ** (ft-in.) | Short B ** (ft-in.) | D (in.) | Con-crete ** (c.y.) | Long A-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Short B-Bars (1) No.-Size | Min. $A_s$ (2) (in.²) | Steel Wt. (3) (tons) | Beam One-Way Ratio | Slab Two-Way Ratio |
| 2 | 1120 | 17 | 7- 9 | 4- 6 | 45 | 4.8 | 4 H#11 | 6.35 | 6 H# 4 | N/A | 0.121 | 0.993 | N/A |
| 3 | 1686 | 24 | 7- 9<br>2- 7 | 7- 4<br>2-11 | 45 | 6.3 | 3 H#11 | 4.40 | 3-WAYS | | 0.249 | 0.650 | 0.935 |
| 4 | 2253 | 24 | 7- 9 | 7- 9 | 42 | 7.8 | 9 H#10 | 11.51 | 9 H#10 | 11.51 | 0.390 | 0.708 | 0.961 |
| 5 | 2799 | 27 | 9- 2 | 9- 2 | 48 | 12.4 | 9 H#11 | 14.04 | 9 H#11 | 14.04 | 0.566 | 0.499 | 0.943 |
| 6 | 3367 | 30 | 11- 0 | 7- 9 | 52 | 13.7 | 8 H#14 | 17.66 | 10 H#11 | 15.62 | 0.598 | 0.832 | 0.945 |
| 7 | 3900 | 36 | 11- 0 | 10- 2 | 59 | 20.4 | 11 H#11 | 16.81 | 10 H#11 | 16.01 | 0.740 | 0.523 | 0.563 |
| 8 | 4491 | 34 | 11- 0 | 10- 2 | 52 | 17.9 | 9 H#14 | 20.58 | 15 H#11 | 23.41 | 0.873 | 0.612 | 0.986 |
| 9 | 5031 | 36 | 11- 0 | 11- 0 | 63 | 23.5 | 15 H#11 | 23.45 | 15 H#11 | 23.45 | 1.089 | 0.445 | 0.997 |
| 10 | 5594 | 38 | 14- 3 | 10- 2 | 57 | 25.5 | 19 #11 | 29.56 | 11 H#14 | 25.00 | 1.101 | 0.727 | 0.739 |
| 11 | 6176 | 40 | 14- 3 | 10- 2 | 55 | 24.6 | 25 #11 | 39.02 | 14 H#14 | 30.59 | 1.431 | 0.955 | 0.731 |

Minimum Pile Diameter = 15 in.
spaced at 3′-3″

## 200-TON STEEL PILES

Edge $E$ = 27″

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1246 | 18 | 7- 9 | 4- 6 | 48 | 5.2 | 6 H#10 | 6.91 | 6 H# 4 | N/A | 0.140 | 0.999 | N/A |
| 3 | 1878 | 25 | 7- 9<br>2- 7 | 7- 4<br>2-11 | 45 | 6.3 | 3 H#11 | 4.54 | 3-WAYS | | 0.249 | 0.723 | 0.987 |
| 4 | 2509 | 26 | 7- 9 | 7- 9 | 42 | 7.8 | 8 H#11 | 12.50 | 8 H#11 | 12.50 | 0.443 | 0.789 | 0.935 |
| 5 | 3117 | 28 | 9- 2 | 9- 2 | 49 | 12.7 | 10 H#11 | 14.79 | 10 H#11 | 14.79 | 0.629 | 0.542 | 0.939 |
| 6 | 3749 | 31 | 11- 0 | 7- 9 | 53 | 13.9 | 12 H#11 | 19.05 | 11 H#11 | 16.59 | 0.740 | 0.828 | 0.945 |
| 7 | 4352 | 38 | 11- 0 | 10- 2 | 57 | 19.7 | 12 H#11 | 19.16 | 8 H#14 | 18.47 | 0.731 | 0.608 | 0.624 |
| 8 | 5003 | 36 | 11- 0 | 10- 2 | 52 | 17.9 | 10 H#14 | 22.60 | 16 H#11 | 25.72 | 0.947 | 0.682 | 0.986 |
| 9 | 5605 | 38 | 11- 0 | 11- 0 | 64 | 23.9 | 15 H#11 | 23.89 | 15 H#11 | 23.89 | 1.089 | 0.487 | 0.992 |
| 10 | 6240 | 40 | 14- 3 | 10- 2 | 55 | 24.6 | 22 #11 | 34.28 | 11 H#14 | 25.21 | 1.210 | 0.847 | 0.814 |

* Concrete columns—side dimension of square column. Structural steel columns, $b$ or $t$ + 0.5 × sum of overhangs to edges of base plate. For 3-Pile and 7-Pile caps only, diameter of round column.
** See detail layouts for clipped corner pile cap arrangements. Concrete quantities based on clipped corners.
(1) "H"—Use hooked or headed bars.
(2) Based on calculation of $A_s$; (4/3)$A_s$; 0.0033 $bd$; 0.0018 $bh$.
(3) Total reinforcing steel weight—long plus short bars. For 3-Pile cap, total of 3 bands.

## SUMMARY OF DERIVATIONS AND DESIGN PROCEDURES FOR DRILLED PIER (CAISSON) LOAD TABLES

### ACI 318-08

Section 22.8.3 Maximum stress (due to factored axial load) on unreinforced pedestals ≤ permissible bearing stress (design bearing strength of ACI 22.5.5).

Section 15.8.1.1 Bearing stress ≤ permissible bearing stress (design bearing strength of ACI 10.14).

Section 9.3.2.2 Strength-reduction factor, $\phi = 0.65$

Section 10.14.1 Permissible (design) bearing stress ≤ $0.85\phi f'_c A_1\sqrt{A_2/A_1} \le (2)(0.85\phi f'_c)$ where $\sqrt{A_2/A_1} \le 2$, $A_1$ = loaded area, and supporting surface area, $A_2 \ge 4$ times (concentric) $A_1$.

Section 15.8.1.1 Permissible (design) bearing stress on pedestal = $0.85\phi f'_c = (0.85)(0.65)f'_c = 0.553f'_c$ assuming column or effective size of structural steel base plate is the same as shaft size.

**International Building Code (Section 1810.1.2)**

1. Minimum longitudinal reinforcement for axial loads: 0.0025 (Seismic Design Category C); 0.0050 (SDC D, E, or F).

2. Maximum allowable axial stress in concrete, $f_c$: $0.25f'_c$ for enlarged base piles and driven uncased piles; $0.33f'_c$ for drilled or augered uncased piles, caisson piles and micropiles. Both maximum limits are presented so that either may be selected ($0.33f'_c$ was conservatively rounded down to $0.30f'_c$).

3. Minimum of four longitudinal bars.

4. Maximum tie spacing: 16 longitudinal bar diameters (SDC C), 12 longitudinal bar diameters or one-half pile diameter or 12 inches, whichever is smallest (SDC D, E, or F).

**Dimensional Proportions Recommended**

1. Extend longitudinal reinforcement at minimum $10'\text{-}0'' \ge 3d$,* to provide for disturbed soil causing reduced lateral resistance at top.

2. Minimum edge of bell thickness = 12 in.

3. Minimum angle for slope of bell to horizontal = 60º.

4. Specified concrete cover to lateral ties = 3 in. (ACI 7.7.1-a).

*$d$ is the diameter of the shaft (see Fig. 13-16).

## USE OF DRILLED PIER (CAISSON) TABLES

**Example 1**

An interior column resists a factored load, $P_u$, of 2,000 kips. A rock stratum approximately 75 feet below the surface has been permitted a service load bearing value of 20,000 psf under the local building code (which has been verified by load tests). Test borings indicate feasibility of belled bottom, unlined holes, and the presence of lateral support for the full depth. Select from the tabulated designs and provide a quantity estimate of materials. Assume that $f_c = 0.30f'_c$.

*Solution.*

Service load, $P = \dfrac{P_u}{1.6} = \dfrac{2{,}000}{1.6} = 1{,}250$ kips

Enter "Shaft Maximum Allowable Axial Load" table with 1,250 kips and read under "$f_c = 0.30f'_c$:"

for $f'_c$ = 3000 psi, the diameter required = 3′-6″
for $f'_c$ = 4000 psi, the diameter required = 3′-6″
for $f'_c$ = 5000 psi, the diameter required = 3′-0″
for $f'_c$ = 6000 psi, the diameter required = 2′-6″

Enter "Bell Safe Bearing Load" table with $P$ = 1,250 kips and $p$ = 20,000 psf and read; bell diameter required = 9′-0″.

In the tabulated designs, note that the minimum shaft size recommended with a 9′-0″ bell is 3′-0″ diameter. Compare quantities for concrete with $f'_c$ = 3,000 psi and $f'_c$ = 5,000 psi. See table of Concrete Quantities. Read:

9′-0″ Bell + 3′-0″ Shaft: 179 + (7.07 × 75) = 709 cubic feet

9′-0″ Bell + 3′-6″ Shaft: 164 + (9.62 × 75) = 886 cubic feet

See table of minimum reinforcement:

Shaft dia. = 3′-0″: 215 pounds

Shaft dia. = 3′-6″: 278 pounds

**Example 2**

Same as Example 1, but assume that an intermediate stratum of soil does not provide lateral support. This stratum begins approximately 20 feet below the surface and extends 10 feet deeper (total depth to bottom = 30 feet). This soil stratum will also require a casing (which will not be considered in design calculations) (Section 3.7.3, Reference 2). The shaft must be designed for an unbraced length of 10 feet plus 2$d$ (Section 3.7.5, Reference 2). Since this length will exceed 3$d$ (plain concrete pedestals), the shaft will be designed as a rein-

forced concrete column with minimum longitudinal reinforcement (percentage of reinforcement ≥ 0.01). Use $f'_c$ = 5,000 psi. See round-tied column tabulated designs, Page 4-24. Select a column at least 3 inches less in diameter than the drilled shaft (even multiples of 6 inches) to allow for 3 inches of concrete cover instead of 1½ inches in portion below casing. For $P_u$ = 2,000 kips, read for a 32-inch diameter column, with 6-#11 bars; maximum design axial strength is 2,049 kips (percentage of reinforcement = 1.16). Check for slenderness effects. See Fig. 13-15.

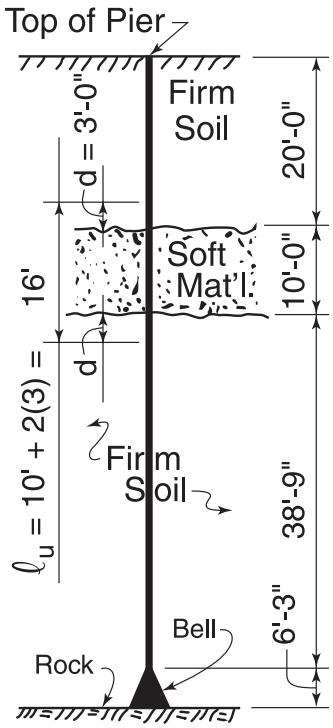



**Figure 13-15 Example 3**

For a 32-inch shaft diameter, slenderness effects will have to be considered. Thus, try a 36-inch shaft diameter:

Unbraced length, $\ell_u = (10 \times 12) + 2(36) = 192$ in.

For columns braced against sidesway, take $k$ = 1.0 (ACI 10.10.6.3).

Compute $\frac{k\ell_u}{r} = \frac{1.0(192)}{0.25(36)} = 21.3$

Compare $\frac{k\ell_u}{r}$ vs. $34 - 12\, M_1/M_2$ (ACI 10.10.1)

$34 - 12\, M_1/M_2 = 34 - 12\,(0)/(0) = 22$

$\frac{k\ell_u}{r} = 21.3 < 22$, neglect slenderness

Use a shaft diameter of 3′-0″ with a bell diameter of 9′-0″; 6-#11 bars × 36′-0″ and #4 ties spaced at 18 in.; with $f'_c$ = 5,000 psi specified.

Quantities: See tabulated designs.

5,000 psi concrete: [(7.07)(75) + 179]/27 = 26 cubic yards

Reinforcing steel:

Longitudinal bars: (6)(5.313)(36) = 1,148 pounds
Ties: (24)(0.668)($\pi$ 32 + 24)/12 = 166 pounds
Total = 1,314 pounds

**References**

(1) 2006 International Building Code, International Code Council, Washington, D.C.
(2) "Design and Construction of Drilled Piers (ACI 336.3R-93, Reapproved 2006)" American Concrete Institute, Farmington Hills, Michigan.

| Shaft Diameter (ft-in.) | Shaft Area (in.²) | SHAFT MAXIMUM ALLOWABLE AXIAL LOAD—KIPS* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | $f_c = 0.25f'_c$ | | | | $f_c = 0.30f'_c$ | | | |
| | | $f'_c$ = 3,000 psi | $f'_c$ = 4,000 psi | $f'_c$ = 5,000 psi | $f'_c$ = 6,000 psi | $f'_c$ = 3,000 psi | $f'_c$ = 4,000 psi | $f'_c$ = 5,000 psi | $f'_c$ = 6,000 psi |
| 1-6 | 254 | 191 | 254 | 318 | 382 | 229 | 305 | 382 | 458 |
| 2-0 | 452 | 339 | 452 | 565 | 679 | 407 | 543 | 679 | 814 |
| 2-6 | 707 | 530 | 707 | 884 | 1060 | 636 | 848 | 1060 | 1272 |
| 3-0 | 1018 | 763 | 1018 | 1272 | 1527 | 916 | 1221 | 1527 | 1832 |
| 3-6 | 1385 | 1039 | 1385 | 1732 | 2078 | 1247 | 1663 | 2078 | 2494 |
| 4-0 | 1810 | 1357 | 1810 | 2262 | 2714 | 1629 | 2171 | 2714 | 3257 |
| 4-6 | 2290 | 1718 | 2290 | 2863 | 3435 | 2061 | 2748 | 3435 | 4122 |
| 5-0 | 2827 | 2121 | 2827 | 3534 | 4241 | 2545 | 3393 | 4241 | 5089 |
| 5-6 | 3421 | 2566 | 3421 | 4276 | 5132 | 3079 | 4105 | 5132 | 6158 |
| 6-0 | 4072 | 3054 | 4072 | 5089 | 6107 | 3664 | 4886 | 6107 | 7329 |
| 6-6 | 4778 | 3584 | 4778 | 5973 | 7168 | 4301 | 5734 | 7168 | 8601 |
| 7-0 | 5542 | 4156 | 5542 | 6927 | 8313 | 4988 | 6650 | 8313 | 9975 |

* For shafts designed as plain concrete piers, laterally braced by soil.

| Bell Diameter (ft-in) | Bearing Area (ft²) | BELL SAFE BEARING LOAD—KIPS** | | | | | |
|---|---|---|---|---|---|---|---|
| | | 10,000 psf** | 12,000 psf** | 15,000 psf** | 20,000 psf** | 25,000 psf** | 30,000 psf** |
| 1-6 | 1.77 | 18 | 21 | 27 | 35 | 44 | 53 |
| 2-0 | 3.14 | 31 | 38 | 47 | 63 | 79 | 94 |
| 2-6 | 4.91 | 49 | 59 | 74 | 98 | 123 | 147 |
| 3-0 | 7.07 | 71 | 85 | 106 | 141 | 177 | 212 |
| 3-6 | 9.62 | 96 | 115 | 144 | 192 | 241 | 289 |
| 4-0 | 12.57 | 126 | 151 | 188 | 251 | 314 | 377 |
| 4-6 | 15.90 | 159 | 191 | 239 | 318 | 398 | 477 |
| 5-0 | 19.63 | 196 | 236 | 295 | 393 | 491 | 589 |
| 5-6 | 23.76 | 238 | 285 | 356 | 475 | 594 | 713 |
| 6-0 | 28.27 | 283 | 339 | 424 | 565 | 707 | 848 |
| 6-6 | 33.18 | 332 | 398 | 498 | 664 | 830 | 995 |
| 7-0 | 38.48 | 385 | 462 | 557 | 770 | 962 | 1155 |
| 7-6 | 44.18 | 442 | 530 | 663 | 884 | 1104 | 1325 |
| 8-0 | 50.27 | 503 | 603 | 754 | 1005 | 1257 | 1508 |
| 8-6 | 56.75 | 567 | 681 | 851 | 1135 | 1419 | 1702 |
| 9-0 | 63.62 | 636 | 763 | 954 | 1272 | 1590 | 1909 |
| 9-6 | 70.88 | 709 | 851 | 1063 | 1418 | 1772 | 2126 |
| 10-0 | 78.54 | 785 | 942 | 1178 | 1571 | 1963 | 2356 |
| 10-6 | 86.59 | 866 | 1039 | 1299 | 1732 | 2165 | 2598 |
| 11-0 | 95.03 | 950 | 1140 | 1425 | 1901 | 2376 | 2851 |
| 11-6 | 103.87 | 1039 | 1246 | 1558 | 2077 | 2597 | 3116 |
| 12-0 | 113.10 | 1131 | 1357 | 1696 | 2262 | 2827 | 3393 |
| 12-6 | 122.72 | 1227 | 1473 | 1841 | 2454 | 3068 | 3682 |
| 13-0 | 132.73 | 1327 | 1593 | 1991 | 2655 | 3318 | 3982 |
| 13-6 | 143.14 | 1431 | 1718 | 2147 | 2863 | 3578 | 4294 |
| 14-0 | 153.94 | 1539 | 1847 | 2309 | 3079 | 3848 | 4618 |
| 14-6 | 165.13 | 1651 | 1982 | 2477 | 3303 | 4128 | 4954 |
| 15-0 | 176.71 | 1767 | 2121 | 2651 | 3534 | 4418 | 5301 |
| 15-6 | 188.69 | 1887 | 2264 | 2830 | 3774 | 4717 | 5661 |
| 16-0 | 201.06 | 2011 | 2413 | 3016 | 4021 | 5027 | 6032 |
| 16-6 | 213.82 | 2138 | 2566 | 3207 | 4276 | 5346 | 6415 |
| 17-0 | 226.98 | 2270 | 2724 | 3405 | 4540 | 5675 | 6809 |
| 17-6 | 240.53 | 2405 | 2886 | 3608 | 4811 | 6013 | 7216 |
| 18-0 | 254.47 | 2545 | 3054 | 3817 | 5089 | 6362 | 7634 |
| 18-6 | 268.80 | 2688 | 3226 | 4032 | 5376 | 6720 | 8064 |
| 19-0 | 283.53 | 2835 | 3402 | 4253 | 5671 | 7088 | 8506 |
| 19-6 | 298.65 | 2986 | 3584 | 4480 | 5973 | 7466 | 8959 |
| 20-0 | 314.16 | 3142 | 3770 | 4712 | 6283 | 7854 | 9425 |
| 20-6 | 330.06 | 3301 | 3961 | 4951 | 6601 | 8252 | 9902 |
| 21-0 | 346.36 | 3464 | 4156 | 5195 | 6927 | 8659 | 10391 |

** As permitted by statutory building code or established by accepted tests.

# DRILLED PIER—SHAFT & BELL—CONCRETE QUANTITIES

| Bell | | | Bell | | | Bell | | |
|---|---|---|---|---|---|---|---|---|
| Diameter (ft-in.) | Volume (c.f.) | Height (ft) | Diameter (ft-in.) | Volume (c.f.) | Height (ft) | Diameter (ft-in.) | Volume (c.f.) | Height (ft) |
| Shaft | Diameter $d$ = 1′-6″ Volume = 1.77 cf/ft | | Shaft | Diameter $d$ = 4′-0″ Volume = 12.57 cf/ft | | Shaft | Diameter $d$ = 5′-6″ Volume = 23.76 cf/ft | |
| 2-0 | 2 | 1.43 | 4-6 | 4 | 1.43 | 6-0 | 5 | 1.43 |
| 2-6 | 4 | 1.87 | 5-0 | 10 | 1.87 | 6-6 | 13 | 1.87 |
| 3-0 | 8 | 2.30 | 5-6 | 18 | 2.30 | 7-0 | 24 | 2.30 |
| 3-6 | 14 | 2.73 | 6-0 | 28 | 2.73 | 7-6 | 37 | 2.73 |
| 4-0 | 21 | 3.17 | 6-6 | 41 | 3.17 | 8-0 | 53 | 3.17 |
| 4-6 | 29 | 3.60 | 7-0 | 57 | 3.60 | 8-6 | 73 | 3.60 |
| Shaft | Diameter $d$ = 2′-0″ Volume = 3.14 cf/ft | | 7-6 | 75 | 4.03 | 9-0 | 95 | 4.03 |
| 2-6 | 2 | 1.43 | 8-0 | 96 | 4.46 | 9-6 | 121 | 4.46 |
| 3-0 | 6 | 1.87 | 8-6 | 120 | 4.90 | 10-0 | 151 | 4.90 |
| 3-6 | 10 | 2.30 | 9-0 | 147 | 5.33 | 10-6 | 185 | 5.33 |
| 4-0 | 17 | 2.73 | 9-6 | 178 | 5.76 | 11-0 | 222 | 5.76 |
| 4-6 | 25 | 3.17 | 10-0 | 213 | 6.20 | 11-6 | 264 | 6.20 |
| 5-0 | 35 | 3.60 | 10-6 | 251 | 6.63 | 12-0 | 310 | 6.63 |
| 5-6 | 47 | 4.03 | 11-0 | 294 | 7.06 | 12-6 | 360 | 7.06 |
| 6-0 | 61 | 4.46 | 11-6 | 340 | 7.50 | 13-0 | 415 | 7.50 |
| Shaft | Diameter $d$ = 2′-6″ Volume = 4.91 cf/ft | | 12-0 | 391 | 7.93 | 13-6 | 475 | 7.93 |
| 3-0 | 3 | 1.43 | Shaft | Diameter $d$ = 4′-6″ Volume = 15.90 cf/ft | | 14-0 | 540 | 8.36 |
| 3-6 | 7 | 1.87 | 5-0 | 5 | 1.43 | 14-6 | 610 | 8.79 |
| 4-0 | 12 | 2.30 | 5-6 | 11 | 1.87 | 15-0 | 685 | 9.23 |
| 4-6 | 20 | 2.73 | 6-0 | 20 | 2.30 | 15-6 | 766 | 9.66 |
| 5-0 | 29 | 3.17 | 6-6 | 31 | 2.73 | 16-0 | 852 | 10.09 |
| 5-6 | 40 | 3.60 | 7-0 | 45 | 3.17 | 16-6 | 944 | 10.53 |
| 6-0 | 54 | 4.03 | 7-6 | 62 | 3.60 | Shaft | Diameter $d$ = 6′-0″ Volume = 28.27 cf/ft | |
| 6-6 | 70 | 4.46 | 8-0 | 82 | 4.03 | 6-5 | 6 | 1.43 |
| 7-0 | 89 | 4.90 | 8-6 | 104 | 4.46 | 7-0 | 15 | 1.87 |
| 7-6 | 110 | 5.33 | 9-0 | 130 | 4.90 | 7-6 | 26 | 2.30 |
| Shaft | Diameter $d$ = 3′-0″ Volume = 7.07 cf/ft | | 9-6 | 160 | 5.33 | 8-0 | 40 | 2.73 |
| 4-0 | 8 | 1.87 | 10-0 | 193 | 5.76 | 8-6 | 58 | 3.17 |
| 4-6 | 14 | 2.30 | 10-6 | 230 | 6.20 | 9-0 | 78 | 3.60 |
| 5-0 | 23 | 2.73 | 11-0 | 271 | 6.63 | 9-6 | 102 | 4.03 |
| 5-6 | 33 | 3.17 | 11-6 | 316 | 7.06 | 10-0 | 130 | 4.46 |
| 6-0 | 46 | 3.60 | 12-0 | 365 | 7.50 | 10-6 | 162 | 4.90 |
| 6-6 | 61 | 4.03 | 12-6 | 419 | 7.93 | 11-0 | 197 | 5.33 |
| 7-0 | 79 | 4.46 | 13-0 | 477 | 8.36 | 11-6 | 237 | 5.76 |
| 7-6 | 99 | 4.90 | 13-6 | 540 | 8.79 | 12-0 | 281 | 6.20 |
| 8-0 | 123 | 5.33 | Shaft | Diameter $d$ = 5′-0″ Volume = 19.63 cf/ft | | 12-6 | 329 | 6.63 |
| 8-6 | 149 | 5.76 | 5-5 | 5 | 1.43 | 13-0 | 382 | 7.06 |
| 9-0 | 179 | 6.20 | 6-0 | 12 | 1.87 | 13-6 | 440 | 7.50 |
| Shaft | Diameter $d$ = 3′-6″ Volume = 9.62 cf/ft | | 6-6 | 22 | 2.30 | 14-0 | 503 | 7.93 |
| 4-6 | 9 | 1.87 | 7-0 | 34 | 2.73 | 14-6 | 571 | 8.36 |
| 5-0 | 16 | 2.30 | 7-6 | 49 | 3.17 | 15-0 | 644 | 8.79 |
| 5-6 | 25 | 2.73 | 8-0 | 67 | 3.60 | 15-6 | 723 | 9.23 |
| 6-0 | 37 | 3.17 | 8-6 | 88 | 4.03 | 16-0 | 808 | 9.66 |
| 6-6 | 51 | 3.60 | 9-0 | 113 | 4.46 | 16-6 | 898 | 10.09 |
| 7-0 | 68 | 4.03 | 9-6 | 141 | 4.90 | 17-0 | 994 | 10.53 |
| 7-6 | 87 | 4.46 | 10-0 | 172 | 5.33 | 17-6 | 1097 | 10.96 |
| 8-0 | 110 | 4.90 | 10-6 | 208 | 5.76 | 18-0 | 1206 | 11.39 |
| 8-6 | 135 | 5.33 | 11-0 | 247 | 6.20 | | | |
| 9-0 | 164 | 5.76 | 11-6 | 290 | 6.63 | | | |
| 9-6 | 196 | 6.20 | 12-0 | 338 | 7.06 | | | |
| 10-0 | 232 | 6.63 | 12-6 | 390 | 7.50 | | | |
| 10-6 | 271 | 7.06 | 13-0 | 447 | 7.93 | | | |
| | | | 13-6 | 508 | 8.36 | | | |
| | | | 14-0 | 575 | 8.79 | | | |
| | | | 14-6 | 647 | 9.23 | | | |
| | | | 15-0 | 724 | 9.66 | | | |

## DRILLED PIER—SHAFT & BELL—CONCRETE QUANTITIES . . . (CONT.)

| Bell | | |
|---|---|---|
| Diameter (ft-in.) | Volume (c.f.) | Height (ft) |
| Shaft | Diameter $d$ = 6′-6″ Volume = 33.18 cf/ft | |
| 7-0 | 6 | 1.43 |
| 7-6 | 16 | 1.87 |
| 8-0 | 28 | 2.30 |
| 8-6 | 43 | 2.73 |
| 9-0 | 62 | 3.17 |
| 9-6 | 84 | 3.60 |
| 10-0 | 109 | 4.03 |
| 10-6 | 139 | 4.46 |
| 11-0 | 172 | 4.90 |
| 11-6 | 210 | 5.33 |
| 12-0 | 251 | 5.76 |
| 12-6 | 298 | 6.20 |
| 13-0 | 349 | 6.63 |
| 13-6 | 404 | 7.06 |
| 14-0 | 465 | 7.50 |
| 14-6 | 531 | 7.93 |
| 15-0 | 602 | 8.36 |
| 15-6 | 679 | 8.79 |
| 16-0 | 761 | 9.23 |
| 16-6 | 849 | 9.66 |
| 17-0 | 944 | 10.09 |
| 17-6 | 1044 | 10.53 |
| 18-0 | 1151 | 10.96 |
| 18-6 | 1264 | 11.39 |
| 19-0 | 1384 | 11.83 |
| 19-6 | 1511 | 12.26 |
| Shaft | Diameter $d$ = 7′-0″ Volume = 38.48 cf/ft | |
| 7-6 | 7 | 1.43 |
| 8-0 | 17 | 1.87 |
| 8-6 | 30 | 2.30 |
| 9-0 | 46 | 2.73 |
| 9-6 | 66 | 3.17 |
| 10-0 | 89 | 3.60 |
| 10-6 | 116 | 4.03 |
| 11-0 | 147 | 4.46 |
| 11-6 | 182 | 4.90 |
| 12-0 | 222 | 5.33 |
| 12-6 | 266 | 5.76 |
| 13-0 | 315 | 6.20 |
| 13-6 | 368 | 6.63 |
| 14-0 | 427 | 7.06 |
| 14-6 | 490 | 7.50 |
| 15-0 | 559 | 7.93 |
| 15-6 | 633 | 8.36 |
| 16-0 | 714 | 8.79 |
| 16-6 | 799 | 9.23 |
| 17-0 | 891 | 9.66 |
| 17-6 | 989 | 10.09 |
| 18-0 | 1094 | 10.53 |
| 18-6 | 1205 | 10.96 |
| 19-0 | 1322 | 11.39 |
| 19-6 | 1447 | 11.83 |
| 20-0 | 1578 | 12.26 |
| 20-6 | 1717 | 12.69 |
| 21-0 | 1863 | 13.12 |

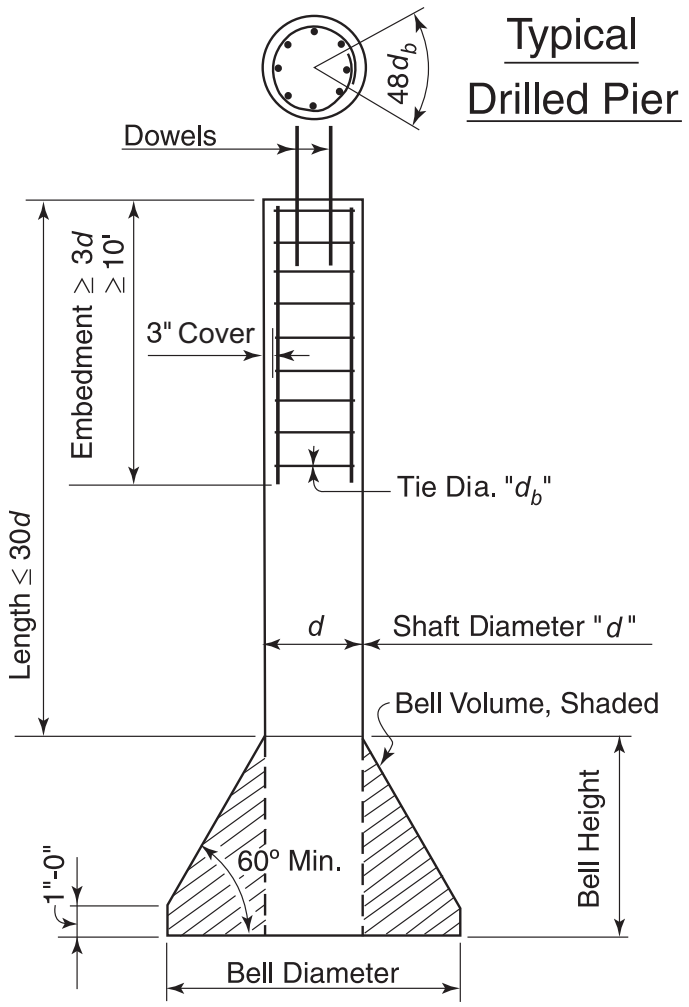



**Figure 13-16 Recommended Minimum Proportions and Reinforcement Details (Percentage of Reinforcement ≈ 0.005) for Unlined Drilled Piers Designed as Plain Concrete**

## DRILLED PIER—REINFORCEMENT

| Shaft Diameter (ft-in.) | Number, Sizes, Spacing | | Total Weight (lbs) per Pier* | | |
|---|---|---|---|---|---|
| $d$ | Vertical | Ties** | Vertical | Ties** | Total |
| 1′-6″ | 6-#5 | #3 @ 10″ | 63 | 20 | 83 |
| 2′-0″ | 6-#6 | #3 @ 12″ | 90 | 23 | 113 |
| 2′-6″ | 6-#7 | #3 @ 14″ | 123 | 26 | 149 |
| 3′-0″ | 7-#8 | #3 @ 16″ | 187 | 28 | 215 |
| 3′-6″ | 7-#9 | #3 @ 18″ | 250 | 28 | 278 |
| 4′-0″ | 7-#10 | #4 @ 18″ | 361 | 69 | 430 |
| 4′-6″ | 9-#10 | #4 @ 18″ | 523 | 87 | 610 |
| 5′-0″ | 9-#11 | #4 @ 18″ | 717 | 107 | 824 |
| 5′-6″ | 11-#11 | #4 @ 18″ | 964 | 129 | 1093 |
| 6′-0″ | 13-#11 | #4 @ 18″ | 1243 | 153 | 1397 |
| 6′-6″ | 16-#11 | #4 @ 18″ | 1658 | 180 | 1838 |
| 7′-0″ | 18-#11 | #4 @ 18″ | 2008 | 208 | 2217 |

* Total weights for minimum embedment. See Fig. 13-16.
** Begin first tie 2 inches below top.

# CHAPTER 14 – CANTILEVERED RETAINING WALLS

## INTRODUCTION

**General.** The tabulated designs in this Chapter give complete dimensions and reinforcement details for cantilevered retaining walls varying from 3 to 22 feet in height above the top of footing, for two backfill conditions: level backfill and no surcharge,† and backfill sloping upward. The tabulated designs show base pressures on the earth at the heel and toe, factors of safety against sliding and overturning and calculated deflection at the top. Various soil properties and backfill conditions considered are listed in Table 14-1.

† Instead of a fixed surcharge, AASHTO recommends 2 feet of added depth of fill for walls as the equivalent loading for a normal highway surcharge. It should usually be satisfactory to select a design tabulated for 2 feet added to actual height, and to reduce reinforcement and concrete quantities for the amounts that would have been required in the top 2 feet.

The backfill material actually used in retaining wall construction will often differ from that assumed for purposes of design. The resulting differences in forces can be considerable and as a result the retaining wall could be under-designed. The determination of pressures for the actual soil conditions, allowable soil pressures, influence of foundation on under lying strata, and similar matters of judgement require consideration by an engineer familiar with soil mechanics.

### TABLE 14-1 SOIL PROPERTIES AND BACKFILL CONDITIONS USED IN TABULATED DESIGNS

| Backfill Condition | Internal Friction Angle, $\phi$ | Backfill Density, $\gamma$ | Sliding Friction Coefficient, $\mu$ |
|---|---|---|---|
| Level | 30°, 35°, 40° | 115, 130 pcf | 0.45, 0.55 |
| Sloping* | 30°, 35°, 40°, | 115, 130 pcf | 0.45, 0.55 |

*Backfill slope, $\beta$, set equal to soil angle of internal friction, $\phi$

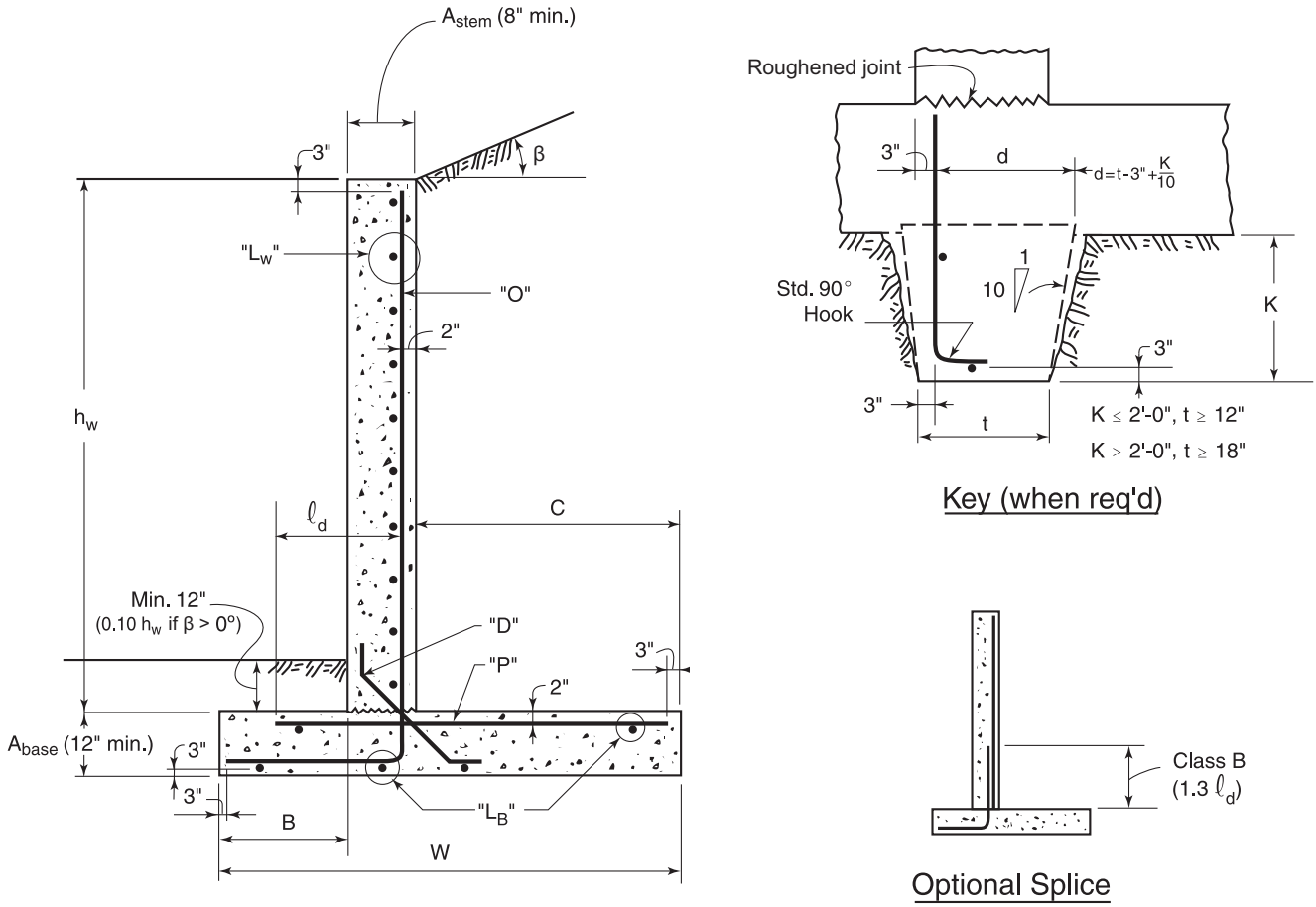



**Figure 14-1 Notation for Dimensions and Reinforcement for Wall Heights ≤ 10′**

The importance of drainage behind a wall cannot be overemphasized. Weep holes through the vertical stem at intervals of about 10 feet, located near the base of the wall at the exterior grade level, and a French drain of gravel, crushed stone, or equivalent, a foot or so thick, for most of the height at the back of the wall are desirable. It is also usually desirable to provide weakened plane contraction joints at intervals of about 25 feet and keyed expansion joints about every fourth contraction joint. The exact spacing will depend upon the climate, exposure, and similar factors. Weakened plane joints are made either with suitable rubber strips placed vertically full height in each face of the wall and left there or with wood strips similarly placed but eventually removed and the resulting slot filled with mastic caulking. Alternate longitudinal bars, at least, should be cut exactly opposite such weakened plane joints.

The tabulated designs in this Chapter provide for stability under service loads against overturning about a point at the toe of the footing. The minimum factor of safety against overturning under service loads is 2.0. The minimum factor of safety against horizontal sliding is 1.5. See Figs. 14-1, 14-2 and 14-3. For tall walls, it is recommended that the user provide for stability against a sliding circle failure based upon properties of the underlying soil and the actual backfill material. When keys are not feasible or where the sliding circle analysis requires additional precautions for soil-loading combinations outside the scope of the tabulated designs, some alternate wall geometries are suggested. See Fig. 14-4.

The use of a key usually adds costs for separate excavation, formwork, or concreting operations—sometimes all three. Some engineers question the effectiveness of keys unless they are cast against near-vertical undisturbed soil.

The tabulated designs were proportioned to obtain the most economical design. Three different wall configurations were investigated:

1. Length of base was varied from 0.40 $h_w$ to 1.0 $h_w$ while the stem and base thicknesses were varied up to 24 inches with no key.

2. Length of base was varied from 0.67 $h_w$ to 1.0 $h_w$ while key depth was varied from 16 to 60 inches and the stem and base thicknesses were varied up to 50 inches.

3. Key depth was varied from 16 to 60 inches while the base length was varied from 1.0 $h_w$ to 1.5 $h_w$ and the base and stem thicknesses were varied up to 60 inches.

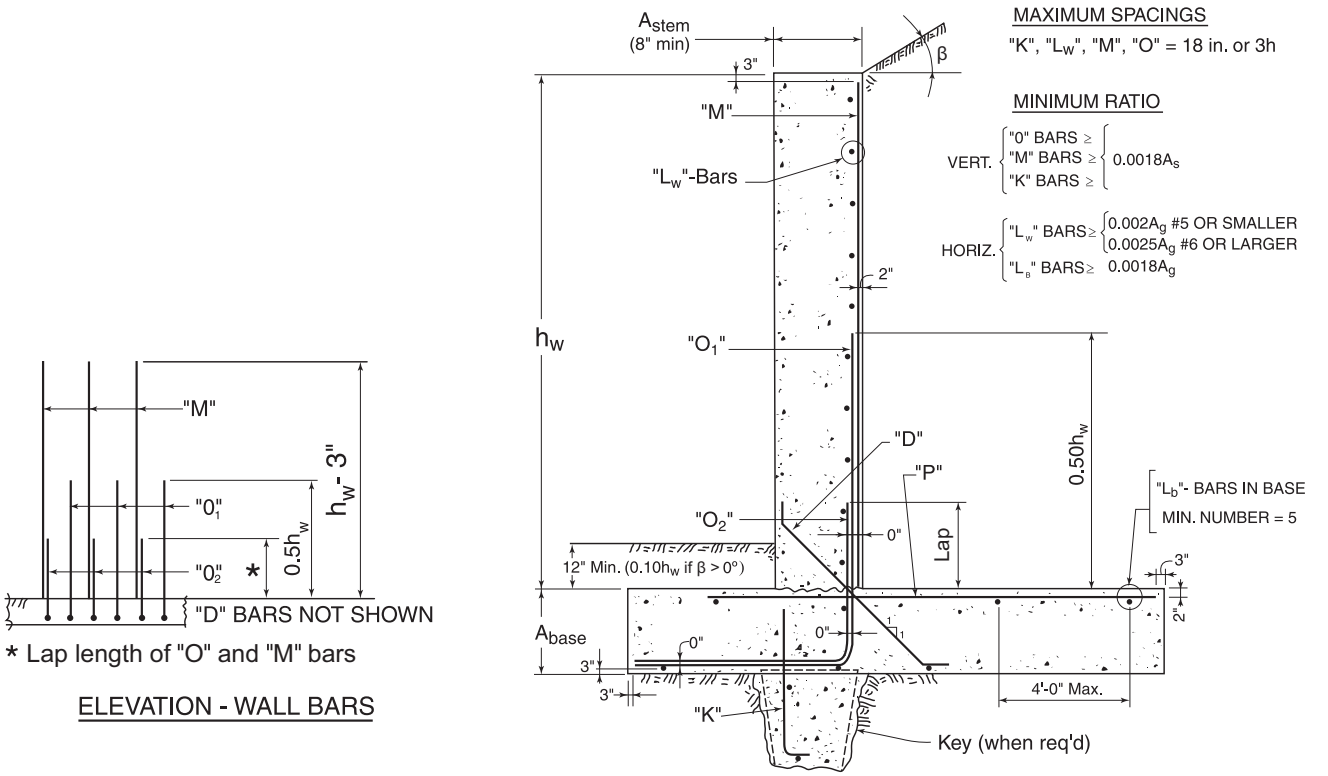



**Figure 14-2 Notation for Dimensions and Reinforcement for Wall Heights > 10'**

In the case where, for a specific wall height, any of the design requirements (i.e., factor of safety against sliding or overturning, deflection at the top of the wall) could not be met regardless what dimensions were tried, the computer program used to develop the tabulated designs skipped this wall height and stops. For example, on Page 14-35 for a sloping backfill with $\gamma$ = 115 pcf, $\phi$ = 30º, and $\mu$ = 0.45, the tabulated designs stop at 18 feet. This stoppage occurs because, for any wall height greater than 18 feet with these soil properties, no dimensions for wall, base, and key could be found to satisfy all design requirements.

When the subsoil conditions are too unstable to permit trenching to the tabulated depths for keys with near-vertical sides which would serve as forms, the sides should be formed or the retaining wall should be redesigned. It may also be necessary to redesign when the actual soil can not be relied upon to develop the coefficient of friction used. Conversely, local conditions may require additional depth of front fill to protect the base against frost.

Based on local conditions, there are at least three options:

1. When frost protection is not required, the base slab and heel may be widened (to increase weight above and friction resistance). A key may be added or deepened. See Fig. 14-4 (a).

2. When the base is to be located below a frost line, the key may be eliminated or a shallower key may suffice because of the passive resistance of the soil at the toe. See Fig. 14-4 (b) and (c).

3. When the soil has a very low friction coefficient, or for some clay subsoils where cohesion is low or unreliable, and the required depth of key is impracticable, the base may be supported on battered piles.

**Soil Data and Assumed Properties.** Three different soil internal friction angles, two soil densities, and two sliding friction coefficients were used in the tabulated designs. See Table 14-1.

Rankine formulas were used to determine the soil pressures on the retaining wall. At a depth $h$, the active and passive earth pressures are, respectively:

$$P_a = K_a\,(h)\,\gamma$$
$$P_p = K_p\,(h)\,\gamma$$

where $K_a = \cos\beta\left[\dfrac{\cos\beta - \sqrt{\cos^2\beta - \cos^2\phi}}{\cos\beta + \sqrt{\cos^2\beta - \cos^2\phi}}\right] (\beta \neq 0^\circ)$

$= \tan^2(45^\circ - \phi/2)\ (\beta = 0^\circ)$

$K_p = \tan^2(45^\circ + \phi/2)$

To facilitate manual calculations, Table 14-2a lists various active and passive pressure coefficients, based on the Rankine formulas. Note that frontfill is conservatively assumed to be level.

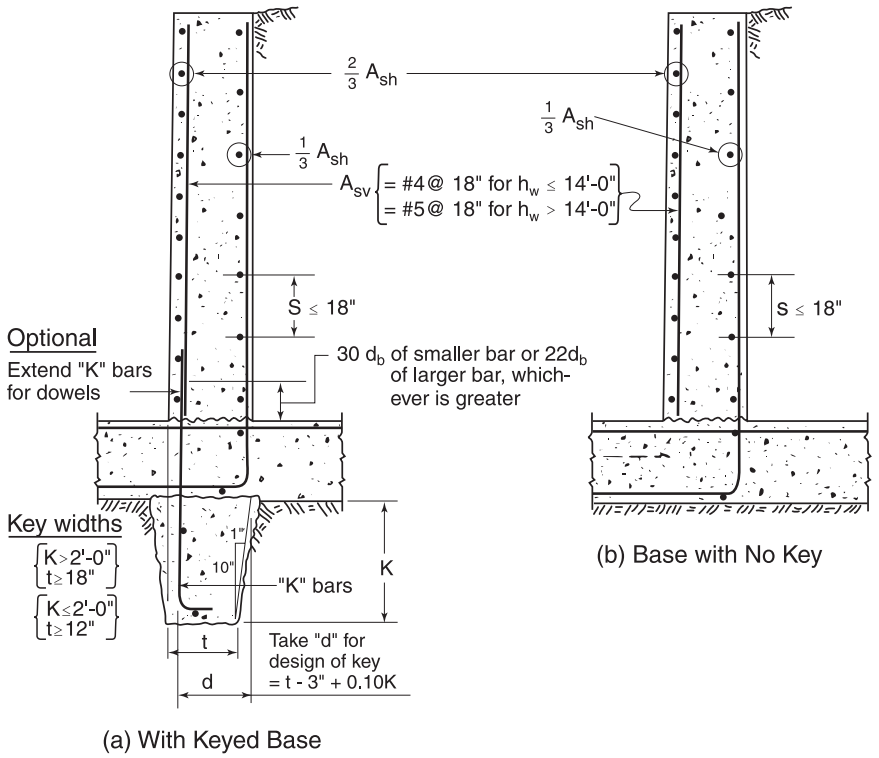



**Figure 14-3 Shrinkage and Temperature Bars in Exposed Face (When Used)**

TABLE 14-2a ACTIVE AND PASSIVE PRESSURE COEFFICIENTS (RANKINE)

| Internal Friction Angle, $\phi$ (deg) | Active pressure Coefficient, $K_a$, for Various Backfill Angles (deg) | | | | | | | | | | Passive Pressure Coefficient, $K_p$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 5 | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | |
| 5 | 0.8397 | 0.9962 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1.1910 |
| 10 | 0.7041 | 0.7352 | 0.9848 | N/A | N/A | N/A | N/A | N/A | N/A | N/A | 1.4203 |
| 15 | 0.5888 | 0.6046 | 0.6636 | 0.9659 | N/A | N/A | N/A | N/A | N/A | N/A | 1.6984 |
| 20 | 0.4903 | 0.4996 | 0.5312 | 0.6028 | 0.9397 | N/A | N/A | N/A | N/A | N/A | 2.0396 |
| 25 | 0.4059 | 0.4117 | 0.4309 | 0.4695 | 0.5469 | 0.9063 | N/A | N/A | N/A | N/A | 2.4639 |
| 30 | 0.3333 | 0.3372 | 0.3495 | 0.3729 | 0.4142 | 0.4936 | 0.8660 | N/A | N/A | N/A | 3.0000 |
| 35 | 0.2710 | 0.2736 | 0.2818 | 0.2968 | 0.3216 | 0.3631 | 0.4416 | 0.8192 | N/A | N/A | 3.6902 |
| 40 | 0.2174 | 0.2192 | 0.2247 | 0.2346 | 0.2504 | 0.2750 | 0.3151 | 0.3906 | 0.7660 | N/A | 4.5989 |
| 45 | 0.1716 | 0.1716 | 0.1765 | 0.1831 | 0.1934 | 0.2088 | 0.2321 | 0.2695 | 0.3404 | 0.7071 | 5.8284 |

TABLE 14-2b EQUIVALENT ACTIVE AND PASSIVE FLUID PRESSURES FOR SOILS IN THE TABULATED DESIGNS

| Unit Density, $\gamma$ (pcf) | Internal Friction Angle, $\phi$ | Active Fluid Pressure, $\gamma_a$ (pcf) | | | | Passive Fluid Pressure $\gamma_p$ (pcf) |
|---|---|---|---|---|---|---|
| | | $\beta = 0°$ | $\beta = \phi$ | | | |
| | | | $\gamma_a$ | $\gamma_a \cos\phi$ | $\gamma_a \sin\phi$ | |
| 115 | 30° | 38 | 100 | 87 | 50 | 345 |
| 115 | 35° | 31 | 94 | 77 | 54 | 424 |
| 115 | 40° | 25 | 88 | 67 | 57 | 529 |
| 130 | 30° | 43 | 113 | 98 | 56 | 390 |
| 130 | 35° | 35 | 106 | 87 | 61 | 480 |
| 130 | 40° | 28 | 100 | 77 | 64 | 598 |

In some cases, the equivalent fluid pressure of the soil can be determined, but the soil's internal angle of friction, $\phi$, and its unit density, $\gamma$, will be unknown. The equivalent soil fluid pressures are defined as:

$\gamma_a$ = Active fluid pressure = $K_a\,\gamma$
$\gamma_p$ = Passive fluid pressure = $K_p\,\gamma$

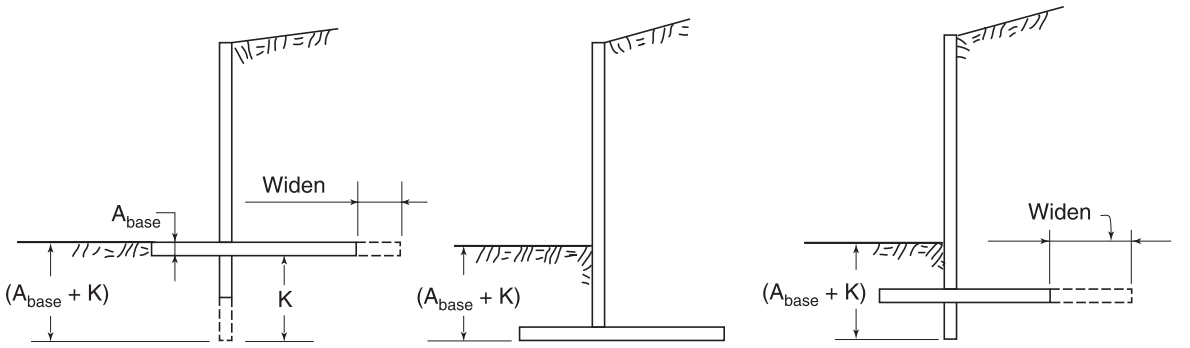
Table 14-2b shows the equivalent active and passive fluid pressures for the soil properties assumed in the tabulated designs.

Note, for the case of a sloping backfill with $\beta = \phi$, the horizontal and vertical component of the active equivalent soil pressure ($\gamma_a$ cos ($\phi$) and $\gamma_a$ sin ($\phi$), respectively) are also listed in Table 14-2b.

To use the tabulated designs in this Chapter, the angle of internal friction ($\phi$) and unit soil density ($\gamma$) must be known. If these factors are not known, but the active and passive fluid pressures ($\gamma_a$ and $\gamma_p$, respectively) are known, then for the case of a level backfill, it is possible to solve for $\phi$ and $\gamma$, given $\gamma_a$ and $\gamma_p$:

$$\phi = 2\,\tan^{-1}\left[\frac{1-\sqrt[4]{\gamma_a/\gamma_p}}{1+\sqrt[4]{\gamma_a/\gamma_p}}\right]$$

$$\gamma = \gamma_a / \tan^2(45° - \phi/2)$$




(a) No Frost (b) Frost depth ≈ $(A_{base} + K)$ (c) Intermediate

**Figure 14-4 Alternative Designs to Resist Horizontal Sliding**

## COST CONSIDERATIONS IN DESIGN

**Less Thickness – More Flexural Reinforcement.** Use of the minimum thickness possible for walls, principally reinforced for bending in one direction, seldom achieves overall economy. The cost of reinforcing steel is a major item in the total cost. When larger concrete cover is required and even with single curtains of reinforcing steel in both directions, wall thicknesses less than 8 inches are likely to make concrete placing and consolidation difficult. Tabulated designs in this Chapter are, therefore, based on an 8 in. minimum wall thickness. As walls become taller or more heavily loaded, greater thickness becomes economical. Reduction in weight of flexural reinforcement is directly proportional to an increase in effective depth, *d*, approximately 15 percent for the first added inch of thickness. Note, however, that horizontal (shrinkage and temperature) reinforcing steel weight *increases* approximately 15 percent for the same added inch.

**More Thickness – More Horizontal Reinforcement.** For taller walls, for doubly reinforced walls where lateral force may be applied from either side, or where two curtains of horizontal shrinkage and temperature bars are desired, a minimum wall thickness of 12 inches is required to provide adequate clearance for concreting.

In general, wall and base thicknesses in the tabulated designs provide a reasonably effective balance between flexural and horizontal reinforcing steel areas for overall economy. Some savings in concrete (and lesser amounts in horizontal reinforcement) may be achieved by use of tapered walls for heights above 10 feet. Since the tapered walls complicate concrete placing slightly and form construction considerably, use of tapered walls will seldom achieve overall economy without several form reuses, as on long walls.

**Crack Control.** Wide vertical cracks are objectionable, but the width of vertical cracks can be controlled by more horizontal reinforcing steel (increasing reinforcing steel cost) or closer spacing of control or construction joints (increasing construction time). With such joints at very close spacing (10 to 15 feet) that may happen to match the natural shrinkage crack interval, theoretically, horizontal reinforcing steel for crack control would not be necessary. Unfortunately, this "natural crack interval" is a function of the unpredictable concrete tensile strength during early curing. Cracks often occur during the first night after casting, particularly, if a large temperature drop occurs at this most crucial period. Figure 14-5 shows a general relationship developed in ACI Committee 350, Environmental Engineering Concrete Structures, between joint spacing and horizontal reinforcement for walls intended to be watertight.

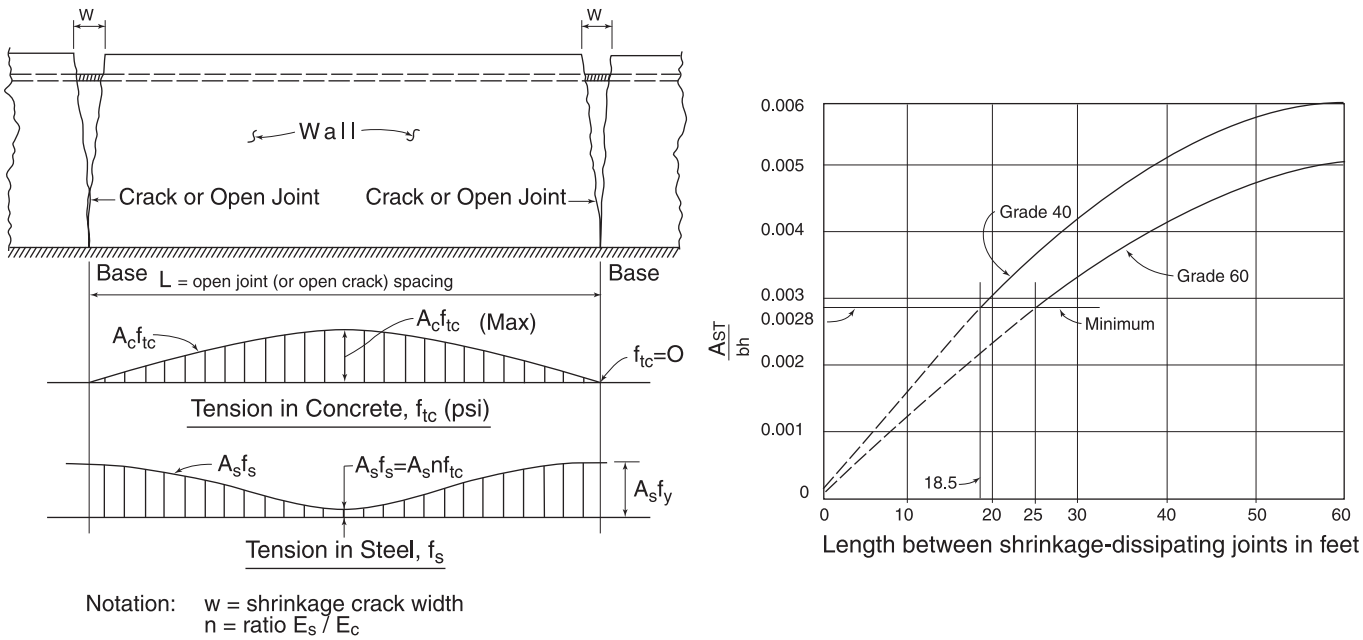



**Figure 14-5 Joint Spacing Related to Reinforcing Steel for Shrinkage and Temperature**

Project requirements affecting acceptable width of vertical cracks vary considerably. ACI Building Code requirements for horizontal reinforcing steel are minimum values. These minimal quantities of crack control steel are still required even with such close joints as to theoretically remove any need of reinforcing steel. The use of such minimal steel ratios could reasonably be extended also to building walls with longer joint spacings or even with no joints. Vertical cracks may not be objectionable for covered walls, retaining walls in well-drained locations well above the water table, and some interior walls.

**Horizontal (Longitudinal) Reinforcement.** Cantilevered retaining walls will usually require some horizontal steel. The amount required for serviceability can vary from a minimum for walls under 10 feet in length to 0.005 (for Grade 60) times the gross area for walls without contraction joints (or construction joints serving to accommodate some contraction) (see Fig. 14-5). Exposure conditions and appearance requirements for "no cracks" or minimum crack widths will also add to horizontal reinforcing steel requirements and may require both horizontal crack control steel and vertical bars for its support in the exposed face.

Horizontal reinforcement in cantilevered retaining wall designs conforming to the ACI Building Code must meet the following requirements for minimum ratios of Grade 60 reinforcing bars to gross area:

horizontally (ACI 14.3.3)
#3, #4, and #5 bars . . . . . 0.0020
other bars . . . . . 0.0025

For the base, temperature and shrinkage exposure is ordinarily less severe than for walls. Appearance and watertightness are ordinarily not design requirements. Longitudinal bars spaced no greater than approximately 4 feet are recommended, top and bottom, as practical support bars and spacers to hold the flexural and diagonal corner bars in place during construction. As shown in Figs. 14-1, 14-2, and 14-3, the tabulated designs provide for a minimum of five longitudinal bars. The longitudinal bars in the stem will provide a minimum steel ratio of 0.002, with spacing, *s,* equal to about one average wall thickness but not to exceed 18 inches in one layer as shown, which will also serve to hold the vertical flexural bars in proper position.

It would be impossible to tabulate longitudinal bars designed for each special service condition encountered. The longitudinal reinforcement in the tabulated designs is the minimum to satisfy the various Code requirements, as well as practical placing requirements. The tabulated designs are suitable for moderate exposures, with provision for shrinkage control (contraction joints) at short intervals, and where adequate drainage is provided. More longitudinal reinforcement may be needed for any special condition. For extreme exposure or watertight cracks, both vertical and horizontal crack control reinforcement near the exposed face will be desirable.

## CRACK CONTROL IN CANTILEVERED WALLS

**General.** Observations of retaining walls in service generally show that objectionable horizontal cracks are rare and usually associated with a structural deficiency, while vertical cracks are common. As noted previously, vertical cracking is related to joint interval, for relief of tension stresses due to shrinkage, and total longitudinal reinforcing steel capacity ($A_s f_y$). See Fig. 14-5. The tension in the concrete has been relieved (to zero) at each crack. Between cracks, tensile stress in the concrete increases as shrinkage, temperature drop, or both occur. The tensile stress increases from zero at each vertical crack to a maximum at the midpoint between the vertical cracks. If tensile stresses in the concrete exceed the concrete tensile strength, a new vertical crack occurs. If this process is repeated often enough, the result will be closely spaced, *tight* vertical cracks. When the maximum force in the horizontal reinforcing steel ($A_s f_y$) is *less* than the tensile force carried by the concrete, the process of forming new cracks at closer spacings stops. Instead, the reinforcing steel yields at existing cracks which *widen* to provide needed strain relief in the concrete between them. This process provides the relationship between (relief) joint spacing and ratio of shrinkage and temperature reinforcing steel to crack width. Precise predictions of crack widths are not feasible, because early curing conditions control the tensile strength of the concrete. These same conditions vary the tensile force caused by drying and possible sudden temperature drops even during the first 24 hours. The curves in Fig. 14-5 should, therefore, be regarded merely as a guide, effective for usual applications.

**Vertical Reinforcement (Flexure).** Note that walls have been classified as "low" ($h_w \leq 10$ ft) and "high" ($h_w > 10$ ft) with different arrangements of vertical reinforcing steel. In low walls, lap splices of vertical reinforcement can be avoided entirely. The vertical bars are L-shaped and serve as vertical, dowel, and footing reinforcement. Temporary bracing must be provided for all dowels to ensure proper position (plumb) and location. For high walls, only 50 percent of the main flexural reinforcing steel is lap spliced at the base, using Class "B" lap splices to the short dowels.

Dimensions of the wall, base, and key (if required), as shown in Figs. 14-1, 14-2 and 14-3, are included in the tabulated designs. Note that the minimum wall thickness, 8 inches, is shown in Fig. 14-2. Sometimes, the front (exposed) face of the wall is cambered for expected lateral deflection-plus-tilt at the top. A variable thickness wall may be used, tapered from the top (8 inches) to the base, with the slope located on either face. Camber on the front face is desirable, even if a sloping back face is used.

**Vertical Reinforcement (Front Face).** When horizontal bars for shrinkage and temperature are used in both faces, the vertical reinforcement in the front face serves the practical purpose of spacing and supporting the longitudinal bars.*

**Code Requirements for Crack Control.** The Code requirements for "Distribution of Flexural Reinforcement" (ACI 10.6) provide crack control for the tensile zone in one-way beams or slabs under ordinary exposure. If desired, these provisions may be applied to cantilevered walls (designed as one-way slabs) at points of maximum flexural stress for the vertical bars in the back face. Since the tensile zone is in the back face where the horizontal flexural cracks are not objectionable for appearance, special crack control requirements on the spacing of the bars are not necessary. Tests have shown a 76 percent reduction of the crack width at the base of the cantilever stem when diagonal bars were present.**

All arbitrary maximum bar spacing requirements applicable to walls were observed in developing the tabulated designs. These include: for temperature and shrinkage (longitudinal) bars five times wall thickness, 5*h*, or 18 in. (ACI 7.12.2.2); for main bars, 3*h* or 18 in. (ACI 10.5.4 and ACI 14.3.5).

*The back face is somewhat protected from the direct effect of temperature changes, which cause warping stresses. To allow for this effect, two-thirds of the total horizontal reinforcing steel in the walls may be located in the front face.

**"Reinforced Corners and Joints Subjected to Bending Moment," I. Nilson and A. Losberg, ASCE ST 6, June, 1976.

## TABULATED DESIGNS FOR RETAINING WALLS

Complete designs are presented for walls ranging from = 3 to 22 feet high, for the various soil conditions; under two backfill conditions, Level Backfill, No Surcharge; and Sloping Backfill (backfill angle $\beta = \phi$). The tabulated designs show; "Low" walls $h_w \leq 10$ feet, and "High" walls $h_w > 10$ feet. Fig 14-2 shows two bar arrangements for walls: (a) where dowels are at full height to serve as both footing and wall reinforcement, and (b) with dowels and straight bars. With the second arrangement, the full-height vertical bars are lap spliced, (Class B) to the dowels. Figures 14-2 and 14-3 show bar designations as tabulated for high walls.

The tabulated designs present the following data:

- Concrete Dimensions & Volume. Dimensions of the stem, base and key (if needed), and concrete quantity.
- Service Load Analysis. Base soil pressures at the toe and heel, safety factors against sliding and overturning, and calculated deflection at the top of the wall.
- Stem Reinforcement. Bar size and spacing for the "O", "M", "D" and "$L_w$" bars.
- Base Reinforcement. Bar size and spacing for the "P", "$L_b$" and "K" (if needed) bars.
- Total steel weight.

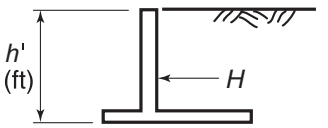
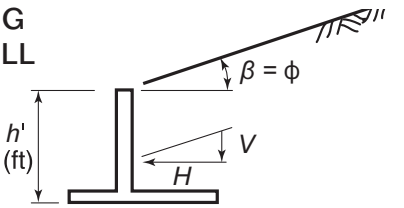
An analysis of on site soil conditions must be made in order to design against an overturning shear failure (sliding on a circular arc), as well as determine the actual coefficient of friction between concrete and soil.

The critical starting dimension is the height of the wall from the top to the base ($h_w$). The tabulated designs were prepared for a 12 in. minimum depth of soil above the base at the toe (frontfill). Note that for Sloping Backfill, the tabulated designs are based upon a minimum frontfill of $0.10h_w \geq 12$ in. Frost conditions may require greater frontfill in some areas. Consideration should be given whether to use a small camber to offset tilt and deflection or to use a tapered wall to save concrete or both.

## ANALYSIS AND DESIGN PROCEDURES

**Analysis.** Service load analyses were used to establish concrete dimensions that control deflection at the top of the cantilever wall, limit soil stresses and tilting of the base, and provide the minimum safety factors of 1.5 against (horizontal) sliding and 2.0 against overturning about the toe.

TABLE 14-3 SERVICE LOAD BACKFILL PRESSURES, LOADS AND MOMENTS

| | LEVEL BACKFILL   | SLOPING BACKFILL   |
|---|---|---|
| Soil Properties<br>$\gamma$(pcf) / $\phi$ | $H = (½)\ K_a\ \gamma(h')^2$<br>$M = H(h'/3) = (1/6)\ K_a\ \gamma(h')^3$ | $H = (½)\ K_a\ \gamma \cos(\beta)\ (h')^2$<br>$V = (½)\ K_a\ \gamma \sin(\beta)\ (h')^2$<br>$M = H\ (h'/3) = (1/6)\ K_a\ \gamma \cos(\beta)\ (h')^3$ |
| 115 / 30° | $H = 19.2\ (h')^2$ (lbs)<br>$M = 6.39\ (h')^3$ (ft-lbs) | $H = 43.1\ (h')^2$ (lbs)<br>$V = 24.9\ (h')^2$ (lbs)<br>$M = 14.4\ (h')^3$ (ft-lbs) |
| 115 / 35° | $H = 15.6\ (h')^2$ (lbs)<br>$M = 5.19\ (h')^3$ (ft-lbs) | $H = 38.6\ (h')^2$ (lbs)<br>$V = 27.0\ (h')^2$ (lbs)<br>$M = 12.9\ (h')^3$ (ft-lbs) |
| 115 / 40° | $H = 12.5\ (h')^2$ (lbs)<br>$M = 4.17\ (h')^3$ (ft-lbs) | $H = 33.7\ (h')^2$ (lbs)<br>$V = 28.3\ (h')^2$ (lbs)<br>$M = 11.2\ (h')^3$ (ft-lbs) |
| 130 / 30° | $H = 21.7\ (h')^2$ (lbs)<br>$M = 7.22\ (h')^3$ (ft-lbs) | $H = 48.8\ (h')^2$ (lbs)<br>$V = 28.1\ (h')^2$ (lbs)<br>$M = 16.3\ (h')^3$ (ft-lbs) |
| 130 / 35° | $H = 17.6\ (h')^2$ (lbs)<br>$M = 5.87\ (h')^3$ (ft-lbs) | $H = 43.6\ (h')^2$ (lbs)<br>$V = 30.5\ (h')^2$ (lbs)<br>$M = 14.5\ (h')^3$ (ft-lbs) |
| 130 / 40° | $H = 14.1\ (h')^2$ (lbs)<br>$M = 4.71\ (h')^3$ (ft-lbs) | $H = 38.1\ (h')^2$ (lbs)<br>$V = 32.0\ (h')^2$ (lbs)<br>$M = 12.7\ (h')^3$ (ft-lbs) |

**1. Service Load Shear and Moment** (See Table 14-3)

**2. Service Load Analyses for Stem Deflection Control**

Determination of $E_cI_e$:

$f'_c$ = 3,000 psi

$E_c$= 57,000 $\sqrt{f'_c}$ = 3,122,000 psi

No creep factors used. Elastic deflection under full load, considering loss of stiffness in cracked section, neglecting effects of batter, and tilt:

$t$ = Average wall thickness (in.)

$\Delta$ = Maximum lateral deflection at top of wall (in.)

$H$ = Total lateral force (pounds)

$$I_e = \left(\frac{M_{cr}}{M_a}\right)^3 I_g + \left[1 - \left(\frac{M_{cr}}{M_a}\right)^3\right] I_{cr}$$

$I_{cr}/I_g$, ratio is between 0.28 and 0.38

$$\frac{M_a}{M_{cr}} = (0.266)\left(\frac{t}{t - 3''}\right)^2$$

Within limits
$\rho \cong 0.008$
10 ft < $h$ < 22 ft

$I_e \cong 0.32t^3$

$E_cI_e \cong 1{,}000{,}000t^3$

$\Delta = W\ (h_w)^4/30EI$

$H = K_a\ (h_w)\ \gamma \cos\beta$

substituting:

$$\Delta = \frac{K_a\ (h_w)^5\ \gamma \cos\beta}{30 \times 10^6 t^3}$$

A minimum uniform wall thickness of 8 inches is used. This arbitrary minimum allows for 2 inches specified concrete cover plus two layers of reinforcing steel in the back face, say 3.5 inches, which provides a 4.5 inch space for placing and vibrating concrete to avoid honeycomb areas.

One of the criteria used in the tabulated designs to determine the stem thickness is to limit cantilever deflection of non-tapered walls (neglecting rotation) to $h_w$/240. Deflection was calculated for service load, cracked section, effective $I_e$, per ACI 318, with no creep (load reduces from passive to active as wall deflects) and calculated for non-tapered wall. For

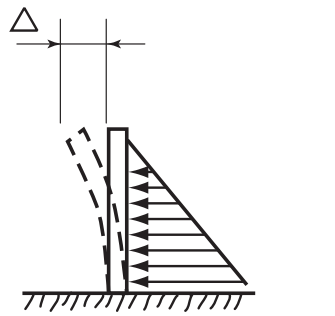
Computed deflections of the stem have been tabulated. Total lateral displacement will be the sum of deflection plus tilt. See Fig. 14-6. Differential settlement of the base, $\Delta_s = \Delta_{toe} - \Delta_{heel}$. Settlement must be calculated, since it will be a function of the soil properties. Consolidation of the soil below the base slab is a function of loading on the soil or the soil pressure. For estimates, it may usually be assumed that $\Delta_s$ per 1,000 psf differential pressure ($P_{toe} - P_{heel}$) is approximately $^1/_{16}$ inch for compaction equivalent to good highway practice or $^1/_8$ inch for ordinary building construction practice. Tilt will equal $h_w$ sin θ where tan θ = $\Delta_s/W$. If such displacement is considered unsightly, some camber of the exposed face formwork is suggested where the exposed face is intended to appear vertical. Where the sloping face is the exposed face, no further precaution is required, since this slope is much larger than the small camber to offset $h_w/240$ plus tilt.

**3. Service Load Analyses for Proportions of Base**

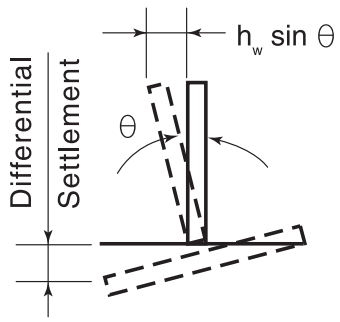
The depth of the base, $A_b$, can vary from 12 inches to the thickness of the stem, which provides a practical, efficient connection. For large projects where potential savings in concrete quantity justify refinements in design and construction, the base may be tapered in the outer two-thirds of the heel portion to a (recommended) minimum of 12 in. See Fig. 14-7. This refinement will require complete investigation of development for top bars in the base ("P" bars), and may necessitate adjusting the size and spacing. Alternatively, with a full depth base, alternate top bars ("P" bars) may be cut-off at 0.5$C$ (half-span) plus 12$d_b$ or $C$/16, whichever is greater, from the back face of the wall.

## SERVICE LOAD ANALYSES FOR SLIDING AND OVERTURNING

Resistance against sliding and overturning is investigated by analyzing a particular retaining wall configuration (stem thickness, base thickness, base width, and no key or with key). To investigate overturning, forces and resulting moments (about the toe) are determined, due to the soil pushing against the retaining wall and due to the stabilizing effect of the retaining wall itself and the soil backfill, and are compared. To investigate sliding, the static frictional force due to the weight of the soil above the base and the weight of the wall itself is calculated and added to the passive resisting force from the soil at the front face. This is compared to the horizontal force from the soil acting on the back face. A factor of safety of at least 2.0 against overturning and at least 1.5 against sliding is sought. If necessary, the retaining wall configuration is adjusted until both safety factors are satisfied.



a) Lateral Deflection




b) Lateral Tilt

**Figure 14-6 Deflection and Tilt**

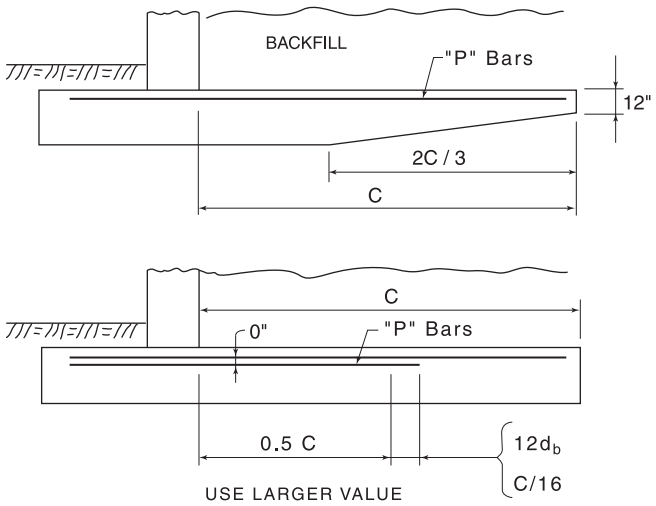



**Figure 14-7 Modifications for Base Slab (Heel)**

Centerline moments under elastic loads are used to calculate soil pressures for use in estimating settlement and angle of rotation ("tilt"). See Fig. 14-9.

**General Notes and Assumptions on Service Load Analyses**

1. Determine the safe service load bearing pressure for the in-place subbase system, $q_a$, and compare it to the tabulated maximum for the soil, loading condition, and wall height of design. It will be noted that the range of tabulated wall heights should be acceptable for most soils. If the bearing pressure is too large, the design of the base must be modified or the subbase improved. Battered pile supports may be required. The stem design can be utilized without redesign if the redesigned base provides the proper shear and moment resistance.

2. Sliding resistance calculations were based upon coefficients of friction, $\mu$, concrete-to-soil in Table 14-1. Some soils with properties other than those assumed in Table 14-1 may not develop the assumed coefficient of friction. Where such soils consist of cohesive soils, calculate sliding based on tests or assume some conservative (1000 lbs/SF max) cohesion resistance. If more exact values of $\mu$ are available, and those used here are not conservative with any particular soil used, the tabulated designs must be modified to maintain the factor of safety against sliding $\geq 1.5$.

3. A minimum depth of fill of 12 inches is assumed above the top of the toe. For sloping backfill designs, a depth of fill of $0.10h_w$ (minimum 12 inches) above the top of the toe was included in calculating passive pressures on toe and heel. The local Code requirement for depth below the frost line will determine whether the elevation at the bottom of the base requires more than these minimum depths above the top of the base.

4. Length of base, W, is selected such that positive pressure is provided in both the toe and the heel.

5. Length of the toe was assumed equal to $0.20h_w$ (minimum 12 inches).

6. Maximum key depth was set to $0.25h_w$ or 60 in.

## FACTORED LOAD DESIGN PROCEDURES

The retaining wall tabulated designs in Chapter 14 differ from other tabulated designs in this book in one important aspect. All other design tabulations are for single *structural elements* while retaining walls are complete *structures*. Even the two-way slab *systems* tabulated in Chapter 9, 10, and 11 are not complete as structures — only the slab element is designed. The cantilevered retaining wall is actually a structure comprising three distinct connected structural elements, four if a key is required. Under ACI 318, several loading conditions must be considered, but the controling combination is assumed to be $1.2D + 1.6H$. For the tabulations herein, each element has been designed conservatively for the load condition critical for that element. Under any given load condition, static equilibrium must be satisfied for all moments of all loads taken about a common point.

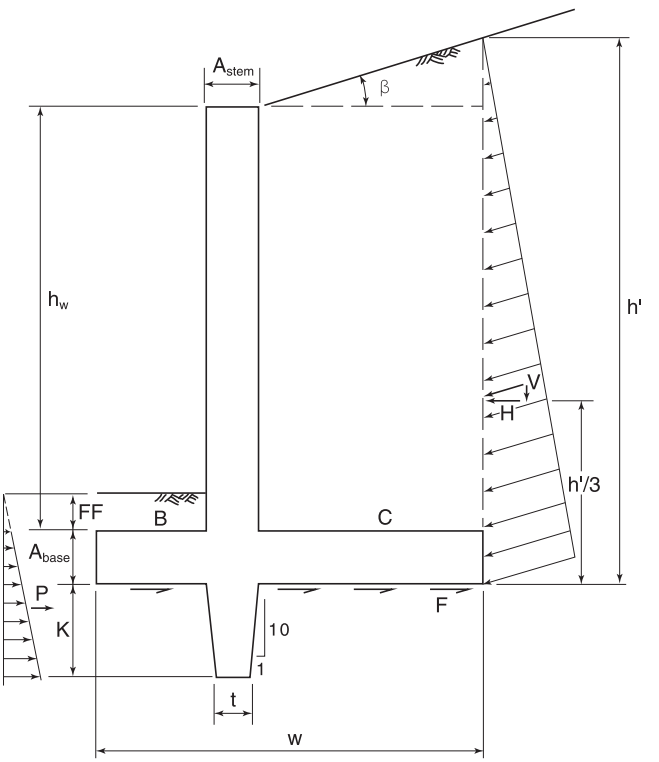



**Figure 14-8 Proportioning Base Dimensions for Service Load Conditions**

There is the requirement that the moments $M_{us}$, $M_{ut}$, $M_{uh}$, and $M_{uk}$, (about stem, toe, heel, and key, respectively) must be in equilibrium, that is, $M_{us}+M_{ut}+M_{uh}+M_{uk}=0$.The stem factored moment, $M_{us}$, is a direct function of load with a simple (1.6) load factor. The stem is the primary element directly resisting the external load. Its reaction to this load indirectly creates the moments in the other elements. The toe factored moment, $M_{ut}$, is based upon a loading of 1.6 times the soil service load reaction under the toe. The heel factored moment, $M_{uh}$, is calculated from the weight of the backfill above (with a 1.6 load factor), plus the dead load of the heel itself, minus 1.6 times the force of the soil service pressure underneath, which is also conservatively reduced by 25 percent (i.e. soil reaction is 0.75). This factored heel moment is then compared to the "global" $M_{uh}$ of $M_{us} + M_{uk} - M_{ut}$ and the larger value is used for determining the required reinforcement in the heel. Finally, an upper limit of $M_{uh} \le M_{us}$ is enforced. The objective is to ensure against premature failure of toe, heel, or key before the stem develops its full factored load at $1.6H$, so that the prescribed overload ($1.6/\phi$) is satisfied for the structure as a whole.

"D" bars in the stem/base were designed for shear at the base of the stem and at the face of the heel.

**Stem.** Stem design is straightforward with a factor of 1.6 for moment at critical section located at the top of the base. See Fig. 14-10a. Reinforcement ratio of the "O" bars must be limited to $\le 0.0135$ for 3,000 psi concrete (see Chapter 5).

**Toe.** Soil pressures calculated during the service load analysis are used to determine the upward soil pressures beneath the toe. Downward force of the frontfill and the dead load of the toe itself is conservatively ignored. The soil reaction is multiplied by a 1.6 load factor. See Fig. 14-10d.

The adequacy of the "O" bars in the toe must also be investigated. If the "O" bars, as detailed in Figs. 14-1 or 14-2, do not have enough available embedment length for the tension development of the bar (i.e., available length $< \ell_d$), then the bars must be hooked or headed. Where the tension development length of the "O" bars is longer than the available embedment length, an "H" flag is printed prior to the size and spacing of the "O" bars in the tabulated designs.

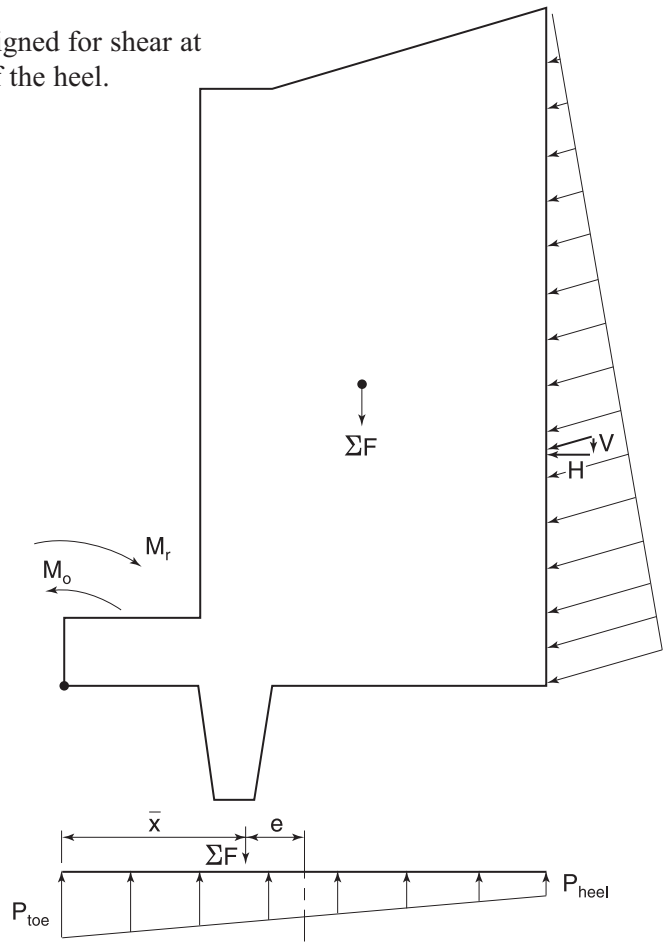



**Fig. 14-9 Determination of Base Service Load Pressures**

**Key.** The key is designed to resist the passive force of the soil at the frontface, utilizing a conservative 1.6 load factor. See Fig. 14-10e.

**Heel.** The heel is designed for the downward load of the soil above, plus the dead load of the heel itself, minus the upward force of the soil reaction underneath. As a conservative measure, the upward soil reaction is reduced 25 percent and a 1.6 load factor is used. The resulting factored moment is then compared to the "global" moment of $M_{us} + M_{uk} - M_{ut}$ and the larger value is selected for designing the heel. Finally, the maximum limit of $M_{us}$ is applied. See Figs. 14-10f and 14-10g.

An "H" flag is printed prior to (indicating that a hook or headed bar is necessary in the toe) or after (hook or headed bar needed in heel) the "P" bars when the tension development length is greater than the available embedment length.

## DESIGN

With all dimensions established to provide proper stiffnesses required to control deflection and to provide stability under service load without exceeding soil properties available, the strength design method is used to select Grade 60 reinforcement required under factored loads. See Figs. 14-10 and 14-11.

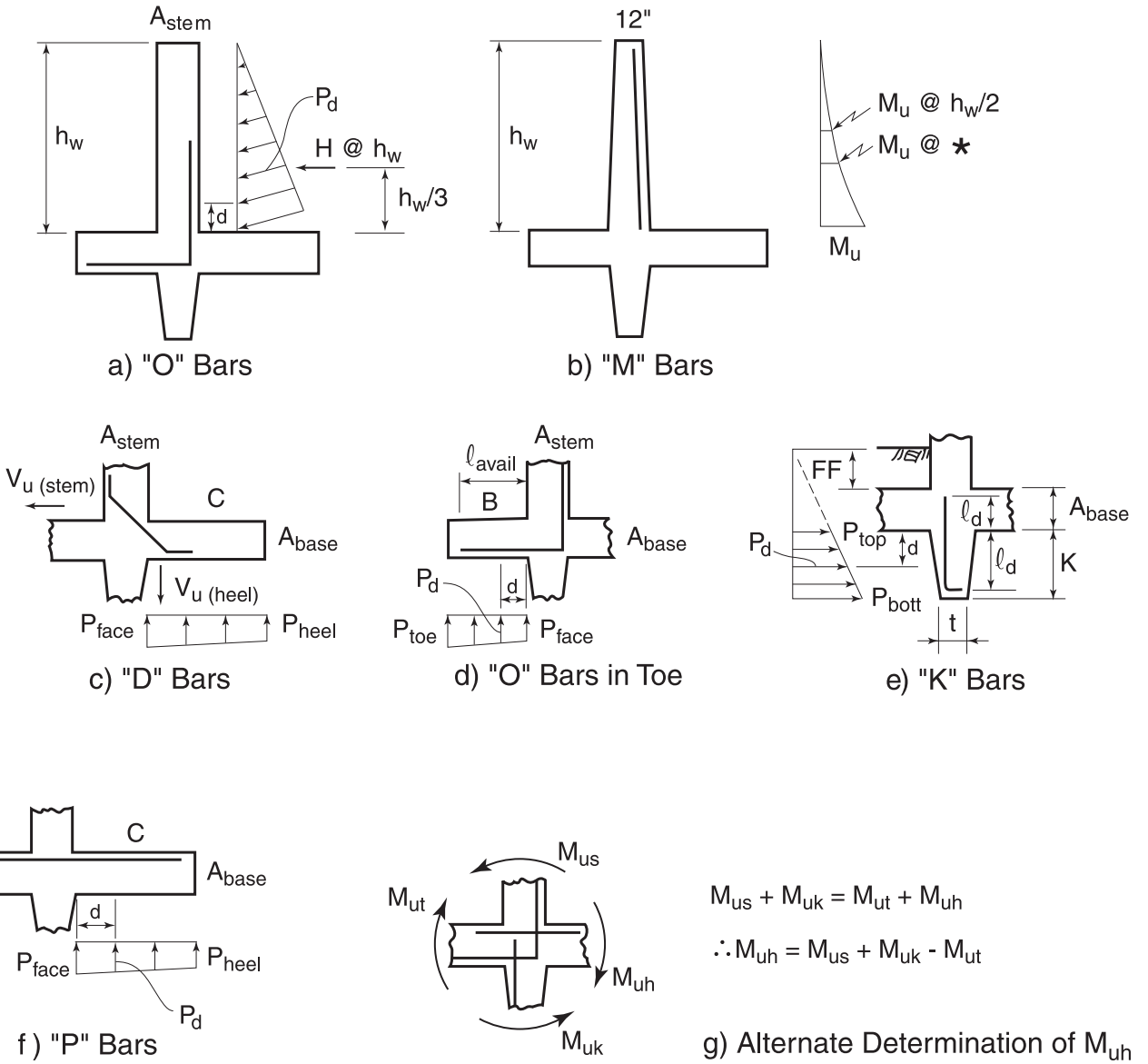



**Figure 14-10 Design Loads**

## I. Strength Design – for Stem (See Fig. 14-10a)

$V_{us}$ at "$d$" from base = $1.6H\,(h_w - \mathrm{d})^2/h_w{}^2$
$M_{us} = 1.6H\,(h_w/3)$

The quadratic equation for required area of tensile steel in strength design is $M_u = \phi M_n = \phi f_y\, A_s\,(d - a/2)$ where $a = A_s f_y\,/0.85 f_c'\, b$. The general solution is,

$$A_s = \frac{1.7 f_c' bd}{2 f_y} - \frac{1}{2}\sqrt{\frac{2.89\,(f_c' bd)^2}{f_y{}^2} - \frac{6.8 f_c' b M_u}{\phi f_y{}^2}}$$

For $f_c' = 3$ ksi, $f_y = 60$ ksi, $b = 12''$ width, and $M_u$, in kip-in., the solution becomes

$A_s = 0.51\,d - \sqrt{0.26\,d^2 - 0.0189\,M_u}$ in.$^2$/ft.

The "O" bar size is based on a spacing of 15, 12, 9, or 6 inches for walls not over 10 feet high. When the wall height is over 10 feet, the spacing is 9 or 6 inches. For walls not over 10 feet high, the "O" bars extend to the height of the wall less 3 inches. Cut-off locations of the "O" bars for walls over 10 feet high alternates between 0.5 $h_w$ and *, where * is the lap splice length of the "O" and "M" bars, which is the larger of the development length of the larger bar and the lap splice length of the smaller bar.

For walls over 10 feet in height, selection of the "M" bar size is based on the larger amount of required flexural reinforcement at two critical sections: at a distance "*" from the base where half of the "O" bars are assumed effective in flexure (along with all the "M" bars), and at a distance of 0.5 $h_w$, where only the "M" bars are assumed effective. Factored moments in the wall are based on a function of the cube of the depth below the top of the wall. See Fig. 14-10b. Moments at these two critical sections are calculated as:

$M_u$ at $0.50\,h_w = 0.125\,M_{us}$
$M_u$ at $* = M_{us}\,((h_w - *)/h_w)^3$

Spacing of the "M" bars is set equal to twice the spacing of the "O" bars for walls over 10 feet high.

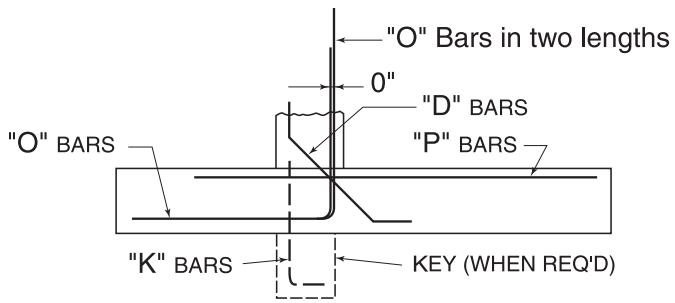



**Figure 14-11 Flexural Bar Designations**

## II. Strength Design for Toe (See Fig. 14-10d)

$V_{ut}$ at "$d$" from face = $1.6\,[P_d + P_{toe}]\,((B - d)/2)$
$M_{ut} = 1.6\,[P_{face} + 2P_{toe}]\,(B^2/6)$

Calculate $M_{ut}$ of factored loads on critical section at face of stem and provide $A_s$ required in bottom of toe. Check that "O" bars in toe will be properly developed in the length between the critical section and a point 3 inches from the front of the toe.

## III. Strength Design for Heel (See Figs. 14-10f and 14-10g)

$V_{uh}$ at "$d$" from face
$= [1.2A_{base}(C - d)150 + 1.6(w_3 + w_4)](C - d)/C$
$- 0.75(1.6)[P_d + P_{heel}]((C - d)/2)$
$M_{uh} = [1.2A_{base}(C)150(C/2) + 1.6(w_3(C/2) + w_4(2C/3)]$
$- 0.75(1.6)[P_{face} + 2P_{heel}](C^2/6)$

Standard specifications (AREMA, etc.) require that the heel be designed to meet either of two criteria:

(1) The heel must be capable of resisting *all* vertical loads above it (as a cantilever) minus the upward soil pressure below it. Or,

(2) "More exact analyses" may be applied.

Note that criterion (1) is generally conservative, except for the reduction for upward soil pressure from below. To allow for a partial reduction of soil support under the heel, the upward soil pressure is reduced by 25 percent. Factored load moment for heel *need not be larger* than factored moment for stem: $M_{uh} \le M_{us}$. Factored load moment for the heel *must be equal or*

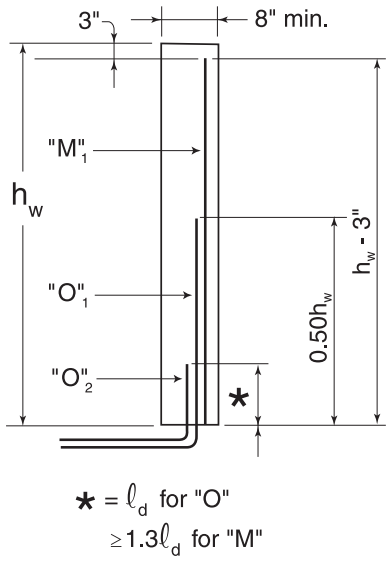



**Figure 14-12 Stem Bar Designations and Cut-off Points for $h_w > 10'$**

*larger* than the difference between factored load moments of stem, key, and toe: $M_{uh} \geq M_{us} + M_{uk} - M_{ut}$.

Development of "P" bars on both sides of the stem must be checked.

## IV. Strength Design for Key (See Fig. 14-10e)

Passive soil pressures:

$P_{top} = K_p\,(FF + A_{base})\,\gamma$

$P_d = K_p\,(FF + A_{base} + d)\,\gamma$

$P_{bott} = K_p\,(FF + A_{base} + K)\,\gamma$

Factored moment:

$M_{uk} = 1.6\,[P_{top} + 2P_{bott}](K^2/6)$

Factored shear at d from face:

$V_{uk} = 1.6\,[P_d + 2P_{bott}]((K - d)/2)$

Development of "K" bars is determined and checked against the depth of the key.

## Selected References


(1) Vetter, C. P., Assoc. M. AM. Soc. C. E., "Stresses in Reinforced Concrete Due to Volume Changes." In Transactions of the American Society of Civil Engineers, Volume 98. New York, 1933.

(2) "Application of Strength Design Methods to Sanitary Structures," Klein, Hoffman, and Rice, *Concrete International,* April, 1981, pp. 35-40.

(3) "Control of Cracking in Concrete Structures," ACI Committee 224, *Concrete International,* October, 1980, pp. 35-76.

**Example 1**

This example shows how a surcharge load can be accommodated using the tabulated designs.

*Given conditions:*

1. $f'_c$ = 3,000 psi; $f_y$ = 60,000 psi
2. 11-ft wall, level backfill, 2-ft surcharge
3. Soil properties: $\gamma$ = 115 pcf, $\phi$ = 30°, $\mu$ = 0.45

*Solution:*

From Page 14-23, for a 13′ (i.e., 11′ + 2′) wall, see Fig. 14-13. Calculated deflection (0.616 in.) must be adjusted for an 11-ft wall:

$\Delta \approx 0.616\ (11/13) = 0.521$ in.

Concrete quantity (0.78 cy/lf) must also be adjusted:

0.78 – 2 * 11/12 * 1/27 = 0.78 – 0.07 = 0.71 cy/lf

Total weight of reinforcing steel (70.09 lbs/lf) must be adjusted:

"M" Bars: #5 @ 12 × 2′-0″ = 1.043 (2) 12/12 = 2.09 lbs/lf
"$L_w$" Bars: 2 - #5 = 2 (1.043) 1 = 2.09 lbs/lf
4.18 lbs/lf

Total weight of reinforcing steel
= 70.09 – 4.18 = 65.91 lbs/lf

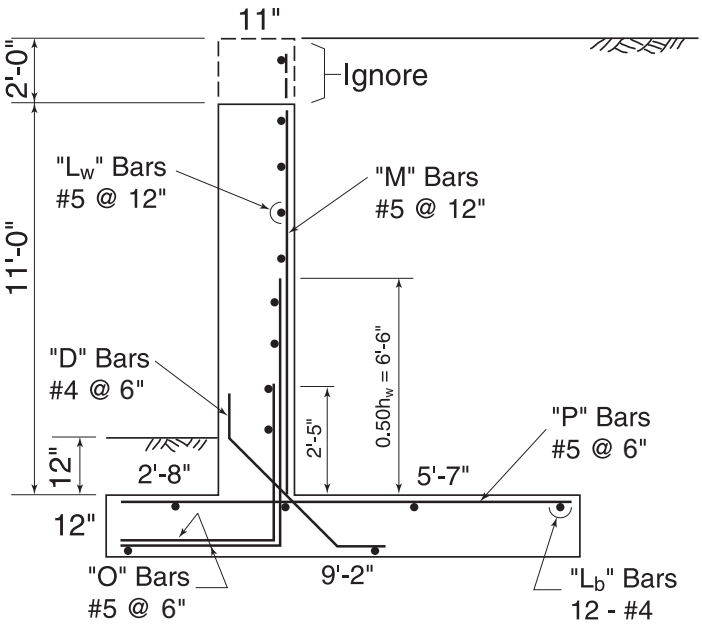



**Figure 14-13 Example 1**

**Example 2**

This example shows how a tabulated design is adjusted for contraction joints.

*Given conditions:*

1. $f'_c$ = 3,000 psi; $f_y$ = 60,000 psi
2. 18-ft wall, sloping backfill ($\beta = \phi$)
3. Soil properties: $\gamma$ = 130 pcf, $\phi$ = 35°, $\mu$ = 0.55
4. Assume vertical shrinkage-dissipating joints in the wall at 40-ft spacing

*Solution:*

From Page 14-44:

Deflection = 0.892 in., Concrete quantity = 2.52 cy/lf

See Fig. 14-14. For joints spaced at 40 ft, steel ratio of 0.0041 is suggested, of which two-thirds will be placed in the front face. Resulting areas of shrinkage and temperature bars:

Front face = 0.0027 (12) 22 = 0.71 in.$^2$/ft = #8 @ 12″
Back face = 0.0014 (12) 22 = 0.37 in.$^2$/ft = #6 @ 12″

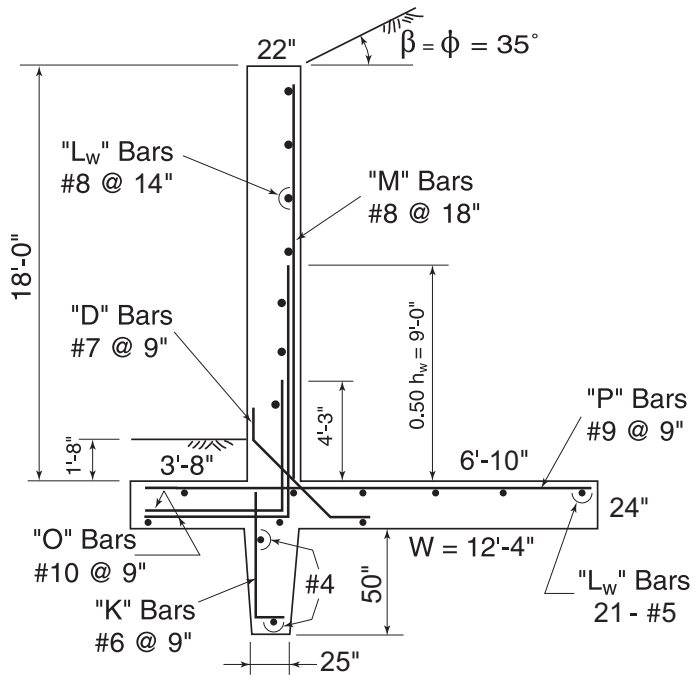



**Figure 14-14 Example 2**

Note that this reinforcement will replace the tabulated "$L_w$" bars (#8 @ 14″). Details for this reinforcement is shown in Figure 14-15.

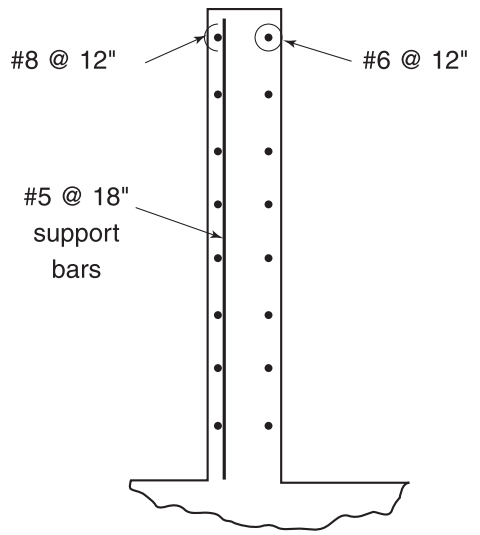



**Figure 14-15 Shrinkage & Temperature Steel in Stem of Example 2**

Reinforcement quantity (251.16 lbs/lf) must be adjusted:

Original "$L_w$" Bars: #8 @ 14″ = 1′ × 2.67 × $\frac{(18 \times 12)}{14}$
= 41.19 lbs/lf

#8 Front Face: #8 @ 12″ = 1′ × 2.67(18)
= 48.06 lbs/lf
#6 Back Face: #6 @ 12″ = 1′ × 1.502(18)
= 27.04 lbs/lf
#5 Support bars: #5 @ 18″ = 18′ × 1.043 (12/18)
= 12.52 lbs/lf
Total weight of reinforcing steel
= 251.16 – 41.19 + 48.06 + 27.04 + 12.52
= 297.59 lbs/lf

# MANUAL REVIEWS

## MANUAL EXAMPLE 1—LEVEL BACKFILL

$f'_c$ = 3,000 psi; $f_y$ = 60,000 psi, 9-ft wall
Soil: $\gamma$ = 115 pcf; $\phi$ = 35º; $\mu$ = 0.45
Minimum safety factors:
1.50 (sliding), 2.0 (overturning)
SR = Soil Reaction = 0.75

From tabulated design on Page 14-25:

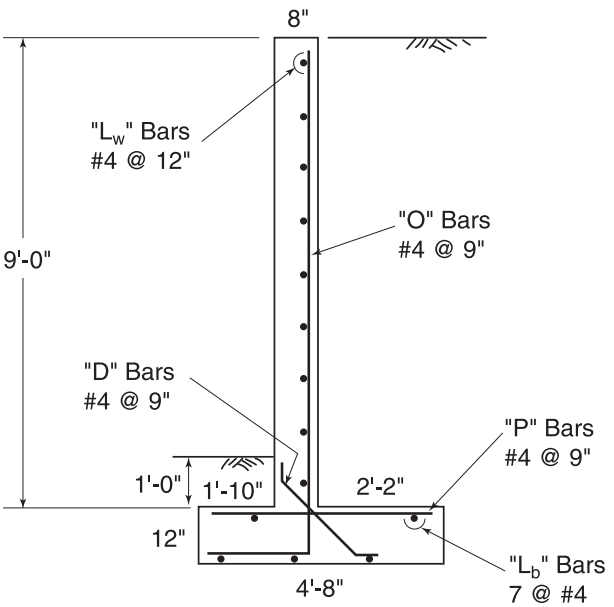



**Figure 14-16 Manual Example 1**

*Stability* (See Figure 14-8)
Weights:

| | | |
|---|---|---|
| Wall = $A_{stem}\ h_w\ \gamma_c$ = (8/12) 9 (150) | = | 900 lbs |
| Base = $A_{base}\ W\ \gamma_c$ = (12/12)4.667(150) | = | 700 lbs |
| Backfill = $C\ (h_w)\ \gamma_s$ = 2.167 (9) 115 | = | 2,243 lbs |
| $W_T$ | = | 3,843 lbs |

$K_a = \tan^2 (45º - \phi/2) = \tan^2 (45 - 35/2) = 0.271$
$h' = h_w + A_{base} = 9 + (12/12) = 10$ ft
$H = (1/2)\ Ka\ (h')^2\ \gamma_s = 0.5\ (0.271)\ 10^2\ (115) = 1{,}558$ lbs
$K_p = \tan^2 (45º + \phi/2) = \tan^2 (45 + 35/2) = 3.690$
$P = (1/2)\ Kp\ [(FF + A_{base})^2 - FF^2]\ \gamma_s$
$= 0.5\ (3.690)\ [(1 + 12/12)^2 - 1^2]\ 115 = 637$ lbs
$F = \mu W_T = 0.45\ (3{,}843) = 1{,}729$ lbs
Safety Factor (sliding)
$= (F + P)/H$
$= (1{,}729 + 637)/1{,}558$
= 1.519 > 1.50, Okay (1.52 printed)

*Moments about Toe:*

Wall = $W_w(B + A_{stem}/2)$
= 900 (1.833 + 8/24) = 1,950 ft-lbs

Base = $W_B\,(W)/2$ = 700 (4.667)/2 = 1,633 ft-lbs

Backfill = $W_{BA}\,(W - C/2)$
= 2,243(4.667 – 2.167/2) = 8,038 ft-lbs

$M_T$ = 11,621 ft-lbs

$M_o = H\,(h')/3$ = 1,558 (10) /3 = 5,193 ft-lbs

Safety Factor (overturning) = $M_T/M_o$ = 11,621/5,193
= 2.238 > 2.0, Okay (2.24 printed)

*Deflection*

$\Delta = K_a\,(h_w)^5\gamma_c \cos\beta/(30 \times 10^6\, t^3)$
$= 0.271(9)^5\,115(1)/(30 \times 10^6 8^3)\,1728$
= 0.207 in. (0.207 printed)

$\Delta_{max} = h_w/240$ = 12(9) / 240 = 0.450 in. > 0.207, Okay

*Soil Service Pressures* (See Figure 14-9)

$\Sigma F = W_T$ = 3,843 lbs, $\Sigma M_r = M_t$ = 11,621 ft-lbs

$M_o$ = 5,193 ft-lbs

$\bar{x} = (M_r - M_o)/\Sigma F$ = (11,621 – 5,193)/3,843
= 1.673 ft

$e = W/2 - \bar{x}$ = 4.667/2 – 1.673 = 0.661 ft

$e_{max} = W/6$ = 4.667/6 = 0.778 > $e$, Okay

$P_{toe} = (\Sigma F/W)\,[1 + 6e/W]$
= (3,843/4.667) [1 + 6(0.661)/4.667]
= 823 + 700 = 1,523 psf (1,523 printed)

$P_{heel} = (\Sigma F/W)\,[1 - 6e/W]$
= 823 – 700 = 123 psf (123 printed)

*Reinforcement in Stem, "O" Bars* (See Figure 14-10a)

$H\,@\,h_w = (1/2)\,K_a\,(h_w)^2\,\gamma_s$
$= 0.5\,(0.271)\,9^2\,(115)$ = 1,262 lbs

$V_u = 1.6\,(H\,@\,h_w) = 1.6\,(1{,}262)$ = 2,019 lbs

$M_u = V_u(h_w)\,/\,3 = 2{,}019\,(9)/3$
= 6,057 ft-lbs = 72.68 in.-k

$d = A_{stem} - 2'' - 0.25''$ = 8-2.25 = 5.75 in.

$C_1 = 1.7 f_c'\,bd/(2\,f_y) = 1.7(3)12(5.75)\,/\,(2(60))$
= 2.933 in.$^2$

$C_2 = 6.8\,f_c'\,b\,M_u\,/(4(0.9)\,f_y{}^2)$
$= 6.8\,(3)12\,(72.68)\,/(4(0.9)60^2) = 1.373$ in.$^4$

$A_s = C_1 - \sqrt{C_1{}^2 - C_2} = 2.933 - \sqrt{2.933^2 - 1.373}$
= 0.244 in.$^2$/ft

S & T: 0.0018$bt$ = 0.0018 (12) 8 = 0.173 in.$^2$/ft

Required $A_s$ in toe = 0.259 in.$^2$/ft (see calculations for toe reinforcement)

$\therefore A_s$ = 0.259 in.$^2$/ft

"*O*" Bars: #4 @ 9″ = 0.20 (12/9)
= 0.267 in.$^2$/ft > 0.259, Okay

Confirm section is tension-controlled, so $\phi = 0.90$

$$\rho = \frac{A_s}{bd} = \frac{0.267}{8(12)} = 0.00278$$

From Chapter 5 for $f_c'$ = 3,000 psi and $f_y$ = 60,000 psi:

Max $\rho$ = 0.0135 > 0.00278

Hence, $\phi = 0.90$

*Shear check:*

$H\,@\,(h_w - d) = H\,@\,h_w\,(h_w - d)^2/h_w{}^2$
$= 1{,}262\,(9 - 5.75/12)^2/9^2$
= 1,131 lbs

$V_u = 1.6H\,@\,(h_w - d) = 1.6\,(1{,}131)$
= 1,810 lbs

$\phi V_c = \phi\,2\sqrt{f_c'}\,12(d)$
$= 0.75\,(2)\sqrt{3{,}000}\,12(5.75)$
= 5,669 lbs > 1,810 lbs, Okay

*Reinforcement in Stem & Base, "D" Bars* (See Figure 14-10c)

$V_{u\,(stem)}$ = 2,019 lbs

$V_{u\,(heel)}$: Backfill = $1.6W_{BA} = 1.6(2{,}243)$ = 3,589 lbs

Heel = $1.2A_{base}\,(C)\,\gamma_c$
$= 1.2(12/12)(2.167)(150)$ = 390 lbs

$V_{u\,(down)}$ = 3,979 lbs

$P_{face} = P_{heel} + (P_{toe} - P_{heel})\,C/W$
$= 123 + (1{,}523 - 123)\,2.167/4.667$
= 773 psf

$V_{u\,(up)} = SR\,(1.6)\,[P_{face} + P_{heel}]\,C/2$
$= 0.75\,(1.6)\,[773 + 123]\,2.167/2$ = 1,165 lbs

$\therefore V_{u\,(heel)} = V_{u\,(down)} - V_{u\,(up)} = 3{,}979 - 1{,}165$
= 2,814 lbs

$V_u$ = maximum of $V_{u\,(stem)}$ and $V_{u\,(heel)}$
= 2,814 lbs

$A_s = V_u\,/\,(0.75\,(0.707)\,f_y)$
$= 2{,}814\,/\,(0.75\,(0.707)\,60{,}000)$
= 0.088 in.$^2$/ft

"*D*" Bars: #4 @ 9″ = 0.20 (12/9)
= 0.267 in.$^2$/ft > 0.088, Okay

*Reinforcement in Stem, "$L_w$" Bars*

For #4 bars, $A_s = 0.002bt$ = 0.002 (12) 8 = 0.192 in.$^2$/ft

"$L_w$" Bars: #4 @ 12″ = 0.20 in.$^2$/ft > 0.192, Okay

*Reinforcement in Base (Toe), "O" Bars* (See Figure 14-10d)

$P_{face} = P_{toe} - (P_{toe} - P_{heel})\,B/W$
$= 1{,}523 - (1{,}523 - 123)\,1.833/4.667$
= 973 psf

$M_u = 1.6\,[P_{face} + 2P_{toe}]B^2/6$
$= 1.6\,[973 + 2\,(1{,}523)]\,(1.833)^2/6$
= 3,601 ft-lbs = 43.21 in.-k

$d = A_{base} - 3'' - 0.5'' - 0.25''$ = 12 – 3.75 = 8.25 in.

$C_1 = 1.7\,(3)\,12\,(8.25)\,/\,(2(60))$ = 4.208 in.$^2$

$C_2 = 6.8\,(3)\,12\,(43.21)\,/\,(4(0.9)\,60^2) = 0.816$ in.$^4$

$A_s = 4.208 - \sqrt{4.208^2 - 0.816}$ = 0.098 in.$^2$/ft

*S & T*: 0.0018$bt$ = 0.0018 (12) 12
= 0.259 in.$^2$/ft

$\therefore A_s = 0.259$ in.$^2$/ft

$\rho = \dfrac{0.259}{12(12)} = 0.00180 < 0.0135$

Hence, $\phi = 0.90$

"*O*" Bars: #4 @ 9″ = 0.20 (12/9)
= 0.267 in.$^2$/ft > 0.259, Okay

Check development of "*O*" bars in toe:
$\ell_{avail}$ = B – 3″ = 22 – 3 = 19 in.
$\ell_d$ for #4 @ 9″ with 3″ cover = 13 in. (Table 5-3(a))
$\ell_{avail} > \ell_d$, Okay

*Shear check:*

*P* at "*d*" from face
$= P_{toe} - (P_{toe} - P_{heel})(B - d)/W$
$= 1{,}523 - (1{,}523 - 123)(22 - 8.25)/56$
= 1,180 psf

$V = (P_{toe} + P_d)(B - d)/2$
$= (1{,}523 + 1{,}180)(22 - 8.25)/12/2$
= 1,549 lbs

$V_u = 1.6V = 1.6(1{,}549) = 2{,}478$ lbs

$\phi V_c = \phi\, 2\sqrt{f'_c}\,(12)d$
$= 0.75\ (2)\ \sqrt{3{,}000}\ (12)8.25$
= 8,134 lbs > 2,478 lbs, Okay

*Reinforcement in Base (Heel), "P" Bars* (See Figures 14-10f and 14-10g)

$V_u$ = 2,814 lbs (from "*D*" Bar calcs)

Downward Moment (from "*D*" Bar calcs):
Backfill = $W_{BA}\,(C)/2 = 3{,}589\,(2.167/2) = 3{,}888$ ft-lbs
Heel = $W_{UH}\,(C)/2 = 390\ (2.167/2) =$ 423 ft-lbs
$M_{u\ (down)} = 4{,}311$ ft-lbs

Upward Moment (from "*D*" Bar calcs):
$M_{u\ (up)} = \text{SR}\ (1.6)\ [P_{face} + 2\ P_{heel}]\ C^2/6$
$= 0.75\ (1.6)\ [773 + 2(123)]\ 2.167^2/6$
= 957 ft-lbs

$\therefore M_u = M_{u\,(down)} - M_{u\,(up)} = 4{,}311 - 957 = 3{,}354$ ft-lbs

$M_{u\ (global)} = M_{u\ (stem)} - M_{u\ (toe)} = 6{,}057 - 3{,}601$
= 2,456 ft-lbs

$\therefore M_u = 3{,}354$ ft-lbs < $M_{u\ (stem)}$, Okay

$M_u = 3{,}354$ ft-lbs = 40.25 in.-k

$d = A_{base} - 2'' - 0.25'' = 12 - 2.25 = 9.75$ in.

$C_1 = 1.7\ (3)\ 12\ (9.75)\ /\ (2(60)) = 4.973$ in.$^2$

$C_2 = 6.8\ (3)\ 12\ (40.25)\ /\ (4(0.9)\ 60^2) = 0.760$ in.$^4$

$A_S = 4.973 - \sqrt{4.973^2 - 0.760} = 0.077$ in.$^2$/ft

*S* & *T*: 0.0018*bt* = 0.0018 (12) 12 = 0.259 in.$^2$/ft

$\therefore A_S = 0.259$ in.$^2$/ft

"*P*" Bars: #4 @ 9″ = 0.20 (12/9)
= 0.267 in.$^2$/ft > 0.259, Okay

$\rho_{act} = A_S/\,(bd) = 0.267/(12(9.75))$
= 0.00228 < 0.0135, $\phi = 0.90$

Check development of "*P*" Bars at critical section:
$\ell_d$ for #4 @ 9″ with 2″ cover = 13 in. (Table 5-3(a)).
$\ell_{avail\ (toward\ toe)} = B + A_{stem} - 3'' = 22 + 8 - 3$
= 27 in. > 13, Okay
$\ell_{avail\ (toward\ heel)} = C - 3'' = 26 - 3$
= 23 in. > 13, Okay

*Shear check:*

$V_{u\ (down)} = 3{,}979$ lbs (from "*D*" Bar calcs)

$V_u$ @ *d* from face = $V_{u\ (down)}\ (C - d)/C$
$= 3{,}979$ lbs $(26 - 9.75)/26$
= 2,487 lbs

*P* at "*d*" from face = $P_{heel} + (P_{toe} - P_{heel})(C - d)/W$
$= 123 + (1{,}523 - 123)(26 - 9.75)/56$
= 529 psf

$V_{u\ (up)} = SR(1.6)(P_d + P_{heel})(C - d)/2$
$= 0.75(1.6)(529 + 123)(26 - 9.75)/12/2$
= 530 lbs

$V_u = V_{u\ (down)} - V_{u\ (up)}$
$= 2{,}487 - 530 = 1{,}957$ lbs

$\phi V_c = \phi 2\sqrt{f'_c}\ (12)d$
$= 0.75\ (2)\ \sqrt{3{,}000}\ (12)\ 9.75$
= 9,613 lbs > 1,957 lbs, Okay

*Reinforcement in Base, "$L_b$" Bars*

*S* & *T*: 0.0018*bt* = 0.0018 (12) 4.667 (12)
= 1.210 in.$^2$/ft

"$L_b$"Bars: 7 - #4 = 7 (0.20) = 1.40 in.$^2$ > 1.210, Okay

*Concrete Volume*

Stem = $A_{stem}\ (h_w)$ = (8/12) 9/27 = 0.222 cy/ft
Base = $A_{base}\ (W)$ = (12/12) 4.667/27 = 0.173 cy/ft
0.395 cy/ft
(0.40 printed)

*Weight of Reinforcing Steel*

Lengths:

"*O*" Bars $= B + A_{stem} - 3'' - 2'' + A_{base} + h_w - 3'' - 3''$
$= 1.833 + 8/12 - 5/12 + 12/12 + 9 - 6/12$
= 11.583 ft

"*D*" Bars $= \sqrt{2}\,[A_{stem} + 2'' + A_{base} - 4'' - 5''] + 6'' + 6''$
$= \sqrt{2}\,[8 + 2 + 12 - 9]\ /\ 12 + 1$
= 2.532 ft

"*P*" Bars $= C - 3'' + 2'' + \ell_d$
$= 2.167 - 3/12 + 2/12 + 13/12$
= 3.167 ft

Number "$L_w$" Bars = $h_w$/spacing = 9(12) / 12 = 9

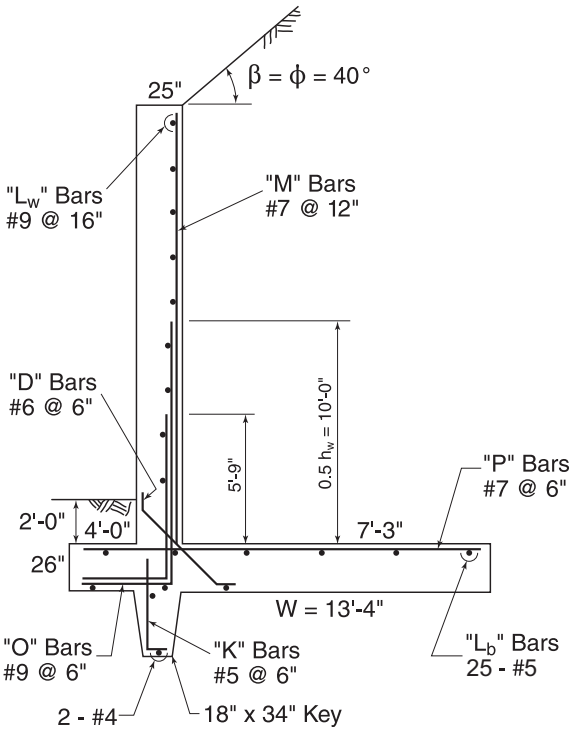
Weights:

| | | |
|---|---|---|
| "*O*" Bars | = 11.583(0.668)(12/9) | = 10.32 lbs/ft |
| "*D*" Bars | = 2.532 (0.668)(12/9) | = 2.26 lbs/ft |
| "*P*" Bars | = 3.167(0.668)(12/9) | = 2.82 lbs/ft |
| "$L_w$" Bars | = 9(1)(0.668) | = 6.01 lbs/ft |
| "$L_b$" Bars | = 7 (1) (0.668) | = 4.68 lbs/ft |
| | | 26.09 lbs/ft |
| | | (26.08 printed) |

## MANUAL EXAMPLE 2—SLOPED BACKFILL

$f'_c$ = 3,000 psi; $f_y$ = 60,000 psi; 20-ft wall
Soil: $\gamma$ = 130 pcf; $\phi$ = 40º; $\mu$ = 0.55
Minimum safety factors:
1.50 (sliding); 2.0 (overturning)
SR = Soil Reaction = 0.75

From tabulated design on Page 14-46:




*Stability* (See Figure 14-8)

Weights:

Wall = $A_{stem}\ h_w \gamma_c$ = (25/12) 20 (150) = 6,250 lbs
Base = $A_{base}\ W \gamma_c$ = (26/12) 13.333 (150)
= 4,333 lbs
Key = $K\ (t + K/10)\ \gamma_c$
= 34 (18 + 34/10) 150/144 = 758 lbs
Backfill-A = $C\ (h_w)\ \gamma_s$ = 7.25 (20) 130 = 18,850 lbs
Backfill-B = $C^2$ (0.5) tan ($\beta$) $\gamma_s$
= $7.25^2$ (0.5) tan 40 (130) = 2,867 lbs
$W_T$ = 33,058 lbs

$K_a$ = cos ($\phi$) (for $\beta = \phi$)
= cos (40) = 0.766

$h'$ = $h_w + A_{base} + C$ tan ($\beta$)
= 20 + 26/12 + 7.25 tan (40) = 28.25 ft
$H_T$ = (1/2) $K_a\ (h')^2\ \gamma_s$ = 0.5 (0.766) $28.25^2$ (130)
= 39,736 lbs
$H$ = $H_T$ cos ($\beta$) = 39,736 cos (40) = 30,440 lbs
$V$ = $H_T$ sin ($\beta$) = 39,736 sin (40) = 25,542 lbs
$K_p$ = $\tan^2 (45 + \phi/2) = \tan^2 (45 + 40/2) = 4.599$
$P$ = (1/2) $K_p\ [(FF + A_{base} + K)^2 - FF^2]\ \gamma_s$
= 0.5 (4.599) $[(2 + 26/12 + 34/12)^2 - 2^2]$ 130
= 13,452 lbs
$F$ = $\mu\ (W_T + V)$ = 0.55 (33,058 + 25,542)
= 32,230 lbs
Safety Factor (sliding) = $(F + P)/H$
= (32,320 + 13,452) / 30,440
= 1.501 > 1.5, Okay (1.50 printed)

*Moments about Toe:*

Wall = $W_w\ (B + A_{stem}/2)$
= 6,250 (4 + 25/24) = 31,510 ft-lbs
Base = $W_B\ (W)/2$
= 4,333 (13,333)/2 = 28,886 ft-lbs
Key = $W_K\ (B + A_{stem}/2)$
= 758 (4 + 25/24) = 3,822 ft-lbs
Backfill-A = $W_{BA}\ (W - C/2)$
= 18,850 (13,333 – 7.25/2) = 182,996 ft-lbs
Backfill-B $\ell_d$ = $W_{BB}\ (W - C/3)$
= 2,867 (13,333 – 7.25/3) = 31,297 ft-lbs
$M_t$ = 278,511 ft-lbs

$M_o = H(h')/3$ = 30,440(28.25)/3 = 286,643 ft/lbs
Safety Factor (overturning) = $[M_t + V(W)] / M_o$
= [278,511 + 25,542 (13.333)] / 286,643
= 2.160 > 2.0, Okay (2.16 printed)

*Deflection*

$\Delta$ = $K_a (h_w)^5\ \gamma_c \cos \beta / (30 \times 10^6\ t^3)$
= 0.766 $(20)^5$ 130 cos (40) / ($30 \times 10^6\ 25^3$) 1728
= 0.900 in. (0.900 printed)
$\Delta_{max}$ = $h_w/240$ = 12 (20) / 240 = 1.0 in. > 0.900, Okay

*Soil Service Pressures* (See Figure 14-9)

$\Sigma F$ = $W_T + V$ = 33,058 + 25,542 = 58,600 lbs
$M_r$ = $M_t + V\ (W)$ = 278,511 + 25,542 (13.333)
= 619,062 ft-lbs
$M_o$ = $H(h')/3$
= 30,440 (28.25)/3 = 286,643 ft-lbs
$\bar{x}$ = $[M_r - M_o] / \Sigma F$
= [619,062 – 286,643] / 58,600 = 5.673 ft
$e$ = $W/2 - \bar{x}$ = 13.333/2 – 5.673 = 0.994 ft
$e_{max}$ = $W/6$ = 13.333/6 = 2.222 > $e$, Okay
$P_{toe}$ = $(\Sigma F/W)\ [1 + 6e/W]$
= 58,600/13.333 [1 + 6(0.994)/13.333]
= 4,395 + 1,966 = 6,361 psf (6,361 printed)
$P_{heel}$ = $(\Sigma F/W)[1 - 6e/W]$ = 4,395 – 1,966
= 2,429 psf (2,430 printed)

*Reinforcement in Stem, "O" Bars* (See Figure 14-10a)

$H_T @ h_w = (1/2)\, K_a\, (h_w)^2\, \gamma_s$
$= 0.5\ (0.766)\ 20^2\ (130) = 19{,}916$ lbs

$H @ h_w = H_T @ h_w \cos \beta = 19{,}916 \cos (40)$
$= 15{,}257$ lbs

$V @ h_w = H_T @ h_w \sin \beta = 19{,}916 \sin (40)$
$= 12{,}802$ lbs

$V_u = 1.6H @ h_w = 1.6(15{,}257) = 24{,}411$ lbs

$M_u = V_u\,(h_w)/3 = 24{,}411(20)/3$
$= 162{,}740$ ft-lbs $= 1{,}953$ in.-k

$d = A_{stem} - 2'' - 0.25'' = 25 - 2.25 = 22.75$ in.

$C_1 = 1.7 f'_c\, bd/\,(2\, f_y) = 1.7(3)12(22.75)/(2\ (60))$
$= 11.603$ in.$^2$

$C_2 = 6.8\, f'_c\, bM_u/(4(0.9)\, f_y^2)$
$= 6.8\ (3)\ 12\ (1{,}953)/\ (4\ (0.9)\ 60^2)$
$= 36.890$ in.$^4$

$A_s = C_1 - \sqrt{C_1^2 - C_2} = 11.603 - \sqrt{11.603^2 - 36.890}$
$= 1.717$ in.$^2$/ft

$S\ \&\ T$: $0.0018bt = 0.0018\ (12)\ 25 = 0.540$ in.$^2$/ft

$\therefore A_s = 1.717$ in.$^2$/ft

"$O$" Bars: #9 @ 6 $= 1.00\ (12/6)$
$= 2.00$ in.$^2$/ft $> 1.717$, Okay

$$\rho = \frac{2.00}{25(12)} = 0.0067 < 0.0135,\ \phi = 0.90$$

*Shear check:*

$H @ (h_w - d) = H @ h_w\, (h_w - d)^2/h_w^2$
$= 15{,}257\ (20 - 22.75/12)^2/20^2$
$= 12{,}502$ lbs

$V_u = 1.6H @ (h_w - d) = 1.6(12{,}502)$
$= 20{,}003$ lbs

$\phi V_c = \phi\ 2\ \sqrt{f'_c}\ (12)d$
$= 0.75\ (2)\ \sqrt{3{,}000}\ (12)\ 22.75$
$= 22{,}429$ lbs $> 20{,}003$ lbs, Okay

*Reinforcement in Stem, "M" Bars* (See Figure 14-10b)

$M_{u\,(base)} = 1{,}953$ in.-k (from "$O$" Bars calcs)

$d = A_{stem} - 2'' - 0.25'' = 25 - 2.25 = 22.75$ in.

At $hw/2$: $M_u = M_{u\,(base)}/8 = 1{,}953/8 = 244.1$ in.-k

$C_1 = 1.7 f'_c\, bd/(2 f_y) = 1.7(3)12(22.75)/2(60)$
$= 11.603$ in.$^2$

$C_2 = 6.8\, f'_c\, b\, M_u/4(0.9) f_y^2$
$= 6.8(3)12(244.1)/4(0.9)60^2 = 4.611$ in.$^4$

$A_s = C_1 - \sqrt{C_1^2 - C_2}$
$= 11.603 - \sqrt{11.603^2 - 4.611}$
$= 0.200$ in.$^2$/ft

$S\&T$: $0.0018bt = 0.0018(12)25 = 0.540$ in.$^2$/ft

$\therefore A_s = 0.540$ in.$^2$/ft

"$M$" Bars: #7 @ 12″
$= 0.600$ in.$^2$/ft $> 0.540$, Okay

At *: $\ell_d$ of "$O$" Bars $= 41$ in. (Table 5-3(a))
$1.3\ell_d$ of "$M$" Bars $= 1.3 \times 29 = 38$ in. (Table 5-3(a))

$\therefore$ * $= 41$ in.

$M_u = M_{u\,(base)}\,(h_w - *)^3/h_w^3$
$= 1{,}953\ (20 - 41/12)^3/20^3 = 1{,}113$ in.-k

$C_1 = 11.603$ in.$^2$

$C_2 = 6.8(3)12(1{,}113)/4(0.9)60^2 = 21.023$ in.$^4$

$A_s = 11.603 - \sqrt{11.603^2 - 21.023}$
$= 0.994$ in.$^2$/ft

$S\&T = 0.540$ in.$^2$/ft

$\therefore A_s = 0.994$ in.$^2$/ft

(½) "$O$" Bars = (½) #9 @ 6″ $= 1.000$ in.$^2$/ft

"$M$" Bars $= 0.600$ in.$^2$/ft

Total $A_s = 1.000 + 0.600 = 1.600 > 0.994$, Okay

*Reinforcement in Stem & Base, "D" Bars* (See Figure 14-10c)

$V_u$ (*stem*) $= 24{,}411$ lbs

$V_u$ (*heel*):

Backfill-A $= 1.6\ W_{BA} = 1.6\ (18{,}850) = 30{,}160$ lbs

Backfill-B $= 1.6\ W_{BB} = 1.6\ \ (2{,}867) = \ \ 4{,}587$ lbs

Heel $= 1.2\ A_{base}\,(C)\,\gamma_c$
$= 1.2\ (26/12)\ 7.25\ (150) = \underline{\ 2{,}828\ \text{lbs}}$

$V_{u\,(down)} = 37{,}575$ lbs

$P_{face} = P_{heel} + (P_{toe} - P_{heel})\ C/W$
$= 2{,}429 + (6{,}361 - 2{,}429)\ 7.25/13.333$
$= 4{,}567$ psf

$V_{u\,(up)} = SR(1.6)\ [P_{face} + P_{heel}]\ C/2$
$= 0.75\ (1.6)\ [4{,}567 + 2{,}429]\ (7.25/2)$
$= 30{,}433$ lbs

$\therefore V_u = V_{u\,(down)} - V_{u\,(up)} = 37{,}575 - 30{,}433$
$= 7{,}142$ lbs

$\therefore V_u = 24{,}411$ lbs

$A_s = V_u\ /\ (0.75\ (0.707)\ f_y)$
$= 24{,}411/(0.75\ (0.707)\ 60{,}000) = 0.767$ in.$^2$/ft

"$D$" Bars: #6 @ 6″ $= 0.44\ (12/6)$
$= 0.88$ in.$^2$/ft $> 0.767$, Okay

*Reinforcement in Stem, "$L_w$" Bars*

For #9 bars, $A_s = 0.0025bt = 0.0025\ (12)\ 25$
$= 0.75$ in.$^2$/ft

"$L_w$" Bars: #9 @ 16″ $= 1.00\ (12/16) = 0.75$ in.$^2$/ft, Okay

*Reinforcement in Base (Toe), "O" Bars* (See Figure 14-10d)

$P_{face} = P_{toe} - (P_{toe} - P_{heel})\ B/W$
$= 6{,}361 - (6{,}361 - 2{,}429)\ 4/13.333$
$= 5{,}181$ psf

$M_u = 1.6\ [P_{face} + 2P_{toe}]\ B^2/6$
$= 1.6\ [5{,}181 + 2(6{,}361)]\ 4^2/6$
$= 76{,}386$ ft-lbs $= 916.6$ in.-k

$d = A_{base} - 3'' - 0.5'' - 0.25'' = 26 - 3.75 = 22.25$ in.

$C_1 = 1.7(3)12(22.25)/(2(60)) = 11.348$ in.$^2$

$C_2 = 6.8(3)12(916.6)/(4(0.9)\ 60^2) = 17.314$ in.$^4$

$A_s = 11.348 - \sqrt{11.348^2 - 17.314} = 0.790$ in.$^2$/ft

$S\ \&\ T = 0.0018bt = 0.0018(12)26$
$= 0.562$ in.$^2$/ft
$\therefore A_s = 0.790$ in.$^2$/ft
"$O$" Bars: #9 @ 6″ = 1.00 (12/6) = 2.00 in.$^2$/ft

$$\rho = \frac{2.00}{26(12)} = 0.0064 < 0.0135,\ \phi = 0.90$$

Check development of "$O$" bars in toe:
$\ell_{avail}$ = B – 3″ = 48 – 3 = 45 in.
$\ell_d$ for #9 @ 6″ with 3″ cover = 41 in. (Table 5-3(a))
$\ell_{avail} > \ell_d$, okay
$A_s = 2.00$ in.$^2$/ft > 0.790, Okay

*Shear check:*
$P$ at "$d$" from face
$= P_{toe} - (P_{toe} - P_{heel})(B - d)/W$
$= 6{,}361 - (6{,}361 - 2{,}430)(48 - 22.25)/12/13.333$
$= 5{,}728$ psf
$V = (P_{toe} + P_d)(B - d)/2$
$= (6{,}361 + 5{,}728)(48 - 22.25)/12/2$
$= 12{,}970$ lbs
$V_u = 1.6V = 1.6(12{,}970) = 20{,}752$ lbs
$\phi V_c = \phi\, 2\sqrt{f'_c}\ bd$
$= 0.75(2)\sqrt{3{,}000}\ (12)22.25$
$= 21{,}936$ lbs > 20,752 lbs, Okay

*Reinforcement in Key, "K" Bars* (See Figure14-10e)
$d$ of Key at $d$ from bottom of base:

$$d = \frac{(t - 3.25)10}{11} + \frac{K}{11} = \frac{(18 - 3.25)10}{11} + \frac{34}{11}$$

$= 16.50$ in.
$P_{top} = K_p\,(FF + A_{base})\ \gamma_s\ 4.599\ (2 + 26/12)\ 130$
$= 2{,}491$ psf
$P_{bott} = K_p\,(FF + A_{base} + K)\ \gamma_s$
$= 4.599\ (2 + 26/12 + 34/12)\ 130 = 4{,}185$ psf
$P$ at "$d$" from face
$= P_{top} + (P_{bott} - P_{top})d/K$
$= 2{,}491 + (4{,}185 - 2{,}491)16.50/34$
$= 3{,}313$ psf
$V_{u(d)} = 1.6[P_d + P_{bott}](K - d)/2/12$
$= 1.6[3{,}313 + 4{,}185](34 - 16.50)/2/12$
$= 8{,}748$ lbs
$\phi V_c = 0.75\ (2)\sqrt{f'_c}\ bd = 0.75(2)\sqrt{3{,}000}\ (12)16.50$
$= 16{,}267$ lbs > 8,748, Okay
$M_u = 1.6\ [P_{top} + 2P_{bott}]\ K^2/6$
$= 1.6\ [2{,}491 + 2\ (4{,}185)]\ (34/12)^2/6$
$= 23{,}250$ ft-lbs = 279.0 in.-k
$C_1 = 1.7(3)12(16.50)/(2(60)) = 8.415$ in.$^2$
$C_2 = 6.8(3)12(279.0)/(4(0.9)60^2) = 5.270$ in.$^4$
$A_s = 8.415 - \sqrt{8.415^2 - 5.270} = 0.319$ in.$^2$/ft
$S\ \&\ T$: $0.0018b\,(t + 2K/10)$
$= 0.0018\ (12)\ (18 + 2\ (34)/10) = 0.536$ in.$^2$/ft
$\therefore A_s = 0.536$ in.$^2$/ft
"$K$" Bars: #5 @ 6″
$= 0.31\ (12/6) = 0.62$ in.$^2$/ft > 0.536, Okay

$$\rho = \frac{0.62}{16.50(12)} = 0.00313 < 0.0135,\ \phi = 0.90$$

*Reinforcement in Base (Heel), "P" Bars*
(See Figures 14-10f and 14-10g)
$V_u = 7{,}142$ lbs (from "$D$" Bar calcs)
Downward Moment (from "$D$" Bar calcs):

Backfill-A = $W_{u(BA)}\ (C/2)$
$= 30{,}160\ (7.25)/2 = 109{,}330$ ft-lbs

Backfill-B = $W_{u(BB)}\ (2C/3)$
$= 4{,}587(2)7.25/3 = 22{,}170$ ft-lbs
Heel = $W_{u(H)}(C/2) = 2{,}828(7.25)/2 = 10{,}252$ ft-lbs
$M_{u\ (down)} = 141{,}752$ ft-lbs

Upward Moment (from "$D$" Bar calcs):
$M_{u\ (up)} = SR\ (1.6)\ [P_{face} + 2P_{heel}]\ C^2/6$
$= 0.75\ (1.6)\ [4{,}567 + 2(2{,}429)]\ 7.25^2/6$
$= 99{,}080$ ft-lbs
$\therefore M_u = M_{u\ (down)} - M_{u\ (up)} = 141{,}752 - 99{,}080$
$= 42{,}672$ ft-lbs
$M_{u(global)} = M_{u\ (stem)} + M_{u\ (key)} - M_{u\ (toe)}$
$= 162{,}740 + 23{,}250 - 76{,}386 = 109{,}604$ ft-lbs
$\therefore M_u = 109{,}604$ ft-lbs < $M_{u\ (stem)}$, Okay
$M_u = 1{,}315.2$ in.-k
$d = A_{base} - 2'' - 0.25'' = 26 - 2.25 = 23.75$ in.
$C_1 = 1.7\ (3)\ 12\ (23.75)\ /\ (2(60)) = 12.113$ in.$^2$
$C_2 = 6.8\ (3)\ 12\ (1{,}315.2)\ /\ (4(0.9)\ 60^2) = 24.846$ in.$^4$
$A_s = 12.113 - \sqrt{12.113^2 - 24.846} = 1.073$ in.$^2$/ft
$S\ \&\ T$: $0.0018bt = 0.0018(12)26 = 0.562$ in.$^2$/ft
$\therefore A_s = 1.073$ in.$^2$/ft
"$P$" Bars: #7 @ 6″ = 0.60 (12/6)
$= 1.20$ in.$^2$/ft > 1.073, Okay
$\rho_{act} = A_s/(bd) = 1.20\ /\ (12(23.75))$
$= 0.00421 < 0.0135,\ \phi = 0.90$
Check development of "$P$" Bars at critical section:
$\ell_d$ for #7 @ 6″ with 2″ cover = 38 in. (Table 5-3(a))
$\ell_{avail\ (toward\ toe)} = B + A_{stem} - 3''$
$= 48 + 25 - 3 = 70$ in. > 38, Okay
$\ell_{avail\ (toward\ heel)} = C - 3'' = 87 - 3$
$= 84$ in. > 38, Okay

*Shear check:*

$V_{u\ (down)}$ = 37,575 lbs (from "*D*" Bar calcs)

$V_u$ @ "*d*" from face (down)

$= V_u\ (C - d)/C$

$= 37{,}575\ (87 - 23.75)/87$

$= 27{,}317$ lbs

$P$ @ "*d*" from face

$= P_{heel} + (P_{toe} - P_{heel})(C - d)/W$

$= 2{,}430 + (6{,}361 - 2{,}430)(87 - 23.75)/160$

$= 3{,}984$ psf

$V_u$ @ "*d*" from face (up)

$= SR(1.6)(P_d + P_{heel})(C - d)/2$

$= 0.75(1.6)(3{,}984 + 2{,}430)(87 - 23.75)/12/2$

$= 20{,}284$ lbs

$V_u$ @ "*d*" = $V_u$ @ "*d*" (down) – $V_u$ @ "*d*" (up)

$= 27{,}317 - 20{,}284 = 7{,}033$ lbs

$\phi V_c = \phi\ (2)\ \sqrt{f'_c}\ (12)\ d$

$= 0.75(2)\sqrt{3{,}000}\ (12)23.75$

$= 23{,}415$ lbs > 7,033 lbs, Okay

*Reinforcement in Base, "$L_b$" Bars*

*S* & *T*: $0.0018bt = 0.0018\ (12)\ 13.333\ (26)$

$= 7.488$ in.$^2$/ft

"$L_b$" Bars: 25 - #5 = 25(0.31)

= 7.75 in.$^2$/ft > 7.488, Okay

*Concrete Volume*

| | | |
|---|---|---|
| Stem = $A_{stem}\ h_w$ | = (25/12) 20/27 | = 1.543 cy/ft |
| Base = $A_{base}\ W$ | = (26/12) 13.333/27 | = 1.070 cy/ft |
| Key = $K\ (t + K/10)$ | | |
| | = 34(18 + 34/10) / 144/27 | = 0.187 cy/ft |
| | | 2.800 cy/ft |
| | | (2.80 printed) |

*Weight of Reinforcing Steel*

Lengths:

"*O*" Bars: $= B + A_{stem} - 3'' - 2'' + A_{base} + 0.5\,h_w - 3''$

(long) $= 4 + 25/12 - 5/12 + 26/12 + 0.5\ (20) - 3/12$

$= 17.583$ ft

"*O*" Bars: $x$ = max ($\ell_d$ for "*O*", 1.3 $\ell_d$ for "*M*")

(short) = max ($\ell_d$ for #9, 1.3 $\ell_d$ for #7)

= max (41″, 38″)

= 41 in. = 3.417 ft

$L = B + A_{stem} - 3'' - 2'' + A_{base} + x - 3''$

$= 4 + (25/12) - 5/12 + (26/12) + 3.417 - 3/12$

$= 11.000$ ft

"*M*" Bar: $= h_w - 3'' = 20 - 3/12 = 19.75$ ft

"*D*" Bar: $= \sqrt{2}\ [A_{stem} + 2'' + A_{base} - 4'' - 5''] + 6'' + 6''$

$= \sqrt{2}\ [25 + 2 + 26 - 9]/12 + 1 = 6.185$ ft

"*P*" Bars: $x$ = min ($\ell_d$ for "*P*", $B + A_{stem} - 2'' - 3''$)

= min (38″, 48″ + 25″ – 5″)

= min (38″, 68″) = 38 in.

$L = x + C + 2'' - 3''$

$= 38'' + 87'' - 1''$

= 124 in. = 10.333 ft

"*K*" Bars: $= K - 3'' + \ell_d + 16d_b$

$= 34/12 - 3/12 + 17/12 + 16\ (5/8)\ /\ 12$

= 4.833 ft

Number "$L_w$" Bars = $h_w$ /spacing = 20 (12) / 16 = 15

Weights:

| | | |
|---|---|---|
| "*O*" Bars(long) | = 17.583 (3.400) (12/12) | = 59.78 lbs |
| "*O*" Bars(short) | = 11.000 (3.400) (12/12) | = 37.40 lbs |
| "*M*" Bars | = 19.75 (2.044) (12/12) | = 40.37 lbs |
| "*D*" Bars | = 6.185 (1.502) (12/6) | = 18.58 lbs |
| "*P*" Bars | = 10.333 (2.044) (12/6) | = 42.24 lbs |
| "*K*" Bars | = 4.833 (1.043) (12/6) | = 10.08 lbs |
| "$L_w$" Bars | = 15 (1) (3.400) | = 51.00 lbs |
| "$L_b$" Bars | = 25 (1) (1.043) | = 26.08 lbs |
| 2 - #4 in key | = 2 (1) (0.668) | = 1.34 lbs |
| | | 286.87 lbs |
| | | (286.87 printed) |

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 115 pcf, $\phi$ = 30°, $\mu$ = 0.45

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "O" Bars | Dowels into Stem | (3) "M" Bars | "D" Bars | (5) "$L_w$" Bars | (2) "P" Bars | "$L_b$" Bars | (6) "K" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 494 | 289 | 3.22 | 4.11 | 0.001 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 823 | 122 | 2.26 | 2.58 | 0.004 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 6 | 3 - 2 | 12 | None | 0.24 | 1051 | 110 | 1.95 | 2.54 | 0.013 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 17.17 |
| 6 | 8 | 1 - 8 | 3 - 7 | 12 | None | 0.28 | 1206 | 71 | 1.65 | 2.32 | 0.034 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 19.10 |
| 7 | 8 | 2 - 2 | 4 - 3 | 12 | None | 0.33 | 1295 | 155 | 1.55 | 2.48 | 0.072 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 21.92 |
| 8 | 8 | 2 -10 | 5 - 2 | 12 | None | 0.39 | 1278 | 341 | 1.55 | 2.87 | 0.141 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 7 # 4 | None | 24.97 |
| 9 | 8 | 3 - 6 | 6 - 0 | 12 | None | 0.44 | 1339 | 469 | 1.54 | 3.14 | 0.255 | # 5@12 | None | None | # 4@12 | # 4@12 | # 5@12 | 8 # 4 | None | 30.17 |
| 10 | 8 | 4 - 0 | 6 - 8 | 12 | None | 0.49 | 1445 | 535 | 1.50 | 3.19 | 0.431 | # 6@12 | None | None | # 4@12 | # 4@12 | # 5@12 | 9 # 4 | None | 39.10 |
| 11 | 9 | 4 - 7 | 7 - 7 | 12 | None | 0.59 | 1476 | 678 | 1.52 | 3.45 | 0.488 | # 6@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 10 # 4 | None | 50.21 |
| 12 | 10 | 5 - 1 | 8 - 4 | 12 | None | 0.68 | 1579 | 762 | 1.51 | 3.54 | 0.549 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 7 # 5 | None | 58.28 |
| 13 | 11 | 5 - 7 | 9 - 2 | 12 | None | 0.78 | 1620 | 894 | 1.52 | 3.74 | 0.616 | # 5@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 5@12 | # 5@ 6 | 12 # 4 | None | 70.09 |
| 14 | 12 | 6 - 1 | 9 -11 | 12 | None | 0.89 | 1725 | 975 | 1.52 | 3.80 | 0.687 | # 7@ 9 | 2 - 5 | # 6@18 | # 4@ 9 | # 5@12 | # 7@ 9 | 13 # 4 | None | 86.90 |
| 15 | 14 | 6 - 4 | 10 - 6 | 14 | None | 1.10 | 1934 | 997 | 1.51 | 3.67 | 0.611 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@12 | # 7@ 9 | 16 # 4 | None | 109.02 |
| 16 | 15 | 6 - 9 | 11 - 3 | 16 | None | 1.30 | 2075 | 1065 | 1.51 | 3.66 | 0.686 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@11 | # 7@ 9 | 5 # 8 | None | 121.72 |
| 17 | 16 | 7 - 3 | 12 - 0 | 16 | None | 1.43 | 2179 | 1147 | 1.51 | 3.71 | 0.765 | # 6@ 6 | 2 - 2 | # 6@12 | # 4@ 6 | # 7@15 | # 6@ 6 | 7 # 7 | None | 133.58 |
| 18 | 17 | 7 - 7 | 12 - 8 | 18 | None | 1.65 | 2320 | 1215 | 1.51 | 3.70 | 0.849 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@14 | # 8@ 9 | 16 # 5 | None | 159.81 |
| 19 | 18 | 8 - 1 | 13 - 5 | 18 | None | 1.80 | 2425 | 1297 | 1.51 | 3.74 | 0.937 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@17 | # 7@ 6 | 17 # 5 | None | 185.10 |
| 20 | 20 | 8 - 4 | 14 - 0 | 20 | None | 2.10 | 2635 | 1318 | 1.50 | 3.65 | 0.883 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@15 | # 7@ 6 | 14 # 6 | None | 202.92 |
| 21 | 21 | 8 - 9 | 14 - 9 | 22 | None | 2.36 | 2776 | 1386 | 1.50 | 3.64 | 0.974 | # 7@ 6 | 3 - 2 | # 7@12 | # 5@ 6 | # 8@15 | # 7@ 6 | 16 # 6 | None | 228.31 |
| 22 | 22 | 7 - 7 | 13 -10 | 22 | 12x20 | 2.50 | 3276 | 961 | 1.51 | 2.91 | 1.069 | # 9@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 8@14 | # 8@ 9 | 15 # 6 | # 4@ 9 | 232.88 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 115 pcf, $\phi$ = 30°, $\mu$ = 0.55

BACKFILL SLOPE: LEVEL

$f'_c$ = 3,000 psi
$f_y$ = 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 494 | 289 | 3.56 | 4.11 | 0.001 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 823 | 122 | 2.53 | 2.58 | 0.004 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 6 | 3 - 2 | 12 | None | 0.24 | 1051 | 110 | 2.21 | 2.54 | 0.013 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 17.17 |
| 6 | 8 | 1 - 8 | 3 - 7 | 12 | None | 0.28 | 1206 | 71 | 1.89 | 2.32 | 0.034 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 19.10 |
| 7 | 8 | 2 - 0 | 4 - 1 | 12 | None | 0.32 | 1363 | 69 | 1.73 | 2.27 | 0.072 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 21.78 |
| 8 | 8 | 2 - 2 | 4 - 6 | 12 | None | 0.36 | 1521 | 21 | 1.56 | 2.13 | 0.141 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 23.71 |
| 9 | 8 | 2 - 8 | 5 - 2 | 12 | None | 0.41 | 1603 | 114 | 1.54 | 2.27 | 0.255 | # 5@12 | None | None | # 4@12 | # 4@12 | # 5@12 | 7 # 4 | None | 28.63 |
| 10 | 8 | 3 - 2 | 5 -10 | 12 | None | 0.46 | 1692 | 200 | 1.53 | 2.39 | 0.431 | # 6@12 | None | None | # 4@12 | # 4@12 | # 5@12 | 5 # 5 | None | 37.43 |
| 11 | 9 | 3 - 7 | 6 - 7 | 12 | None | 0.55 | 1733 | 318 | 1.53 | 2.54 | 0.488 | # 6@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 45.41 |
| 12 | 10 | 3 -11 | 7 - 2 | 12 | None | 0.63 | 1869 | 354 | 1.51 | 2.56 | 0.549 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 6 # 5 | None | 55.61 |
| 13 | 11 | 4 - 3 | 7 -10 | 12 | None | 0.73 | 1919 | 464 | 1.51 | 2.67 | 0.616 | # 5@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 5@12 | # 4@ 6 | 7 # 5 | None | 61.93 |
| 14 | 12 | 4 - 9 | 8 - 7 | 12 | None | 0.84 | 2007 | 566 | 1.53 | 2.79 | 0.687 | # 7@ 9 | 2 - 5 | # 6@18 | # 4@ 9 | # 5@12 | # 6@ 9 | 12 # 4 | None | 75.97 |
| 15 | 14 | 4 -10 | 9 - 0 | 14 | None | 1.04 | 2284 | 502 | 1.50 | 2.64 | 0.611 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@12 | # 6@ 9 | 9 # 5 | None | 96.95 |
| 16 | 15 | 5 - 3 | 9 - 9 | 16 | None | 1.22 | 2421 | 574 | 1.53 | 2.69 | 0.686 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@11 | # 6@ 9 | 17 # 4 | None | 107.63 |
| 17 | 16 | 5 - 7 | 10 - 4 | 16 | None | 1.35 | 2558 | 609 | 1.51 | 2.70 | 0.765 | # 6@ 6 | 2 - 2 | # 6@12 | # 4@ 6 | # 7@15 | # 5@ 6 | 6 # 7 | None | 118.83 |
| 18 | 17 | 5 - 9 | 10 -10 | 18 | None | 1.55 | 2745 | 612 | 1.50 | 2.65 | 0.849 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@14 | # 6@ 9 | 14 # 5 | None | 133.90 |
| 19 | 18 | 6 - 3 | 11 - 7 | 18 | None | 1.70 | 2832 | 716 | 1.52 | 2.74 | 0.937 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@17 | # 6@ 6 | 23 # 4 | None | 162.10 |
| 20 | 20 | 6 - 6 | 12 - 2 | 20 | None | 1.99 | 3060 | 719 | 1.52 | 2.71 | 0.883 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@15 | # 6@ 6 | 17 # 5 | None | 178.73 |
| 21 | 21 | 6 - 9 | 12 - 9 | 22 | None | 2.23 | 3248 | 722 | 1.51 | 2.67 | 0.974 | # 7@ 6 | 3 - 2 | # 7@12 | # 5@ 6 | # 8@15 | # 6@ 6 | 14 # 6 | None | 203.48 |
| 22 | 22 | 7 - 1 | 13 - 4 | 22 | None | 2.40 | 3384 | 758 | 1.50 | 2.67 | 1.069 | # 9@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 8@14 | # 8@ 9 | 21 # 5 | None | 226.32 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \leq$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 115 pcf, $\phi$ = 35°, $\mu$ = 0.45

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "O" Bars | Dowels into Stem | (3) "M" Bars | "D" Bars | (5) "$L_w$" Bars | (2) "P" Bars | "$L_b$" Bars | (6) "K" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 430 | 354 | 4.44 | 5.06 | 0.001 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 697 | 248 | 3.09 | 3.18 | 0.004 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.22 | 1095 | 11 | 2.32 | 2.18 | 0.011 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 16.73 |
| 6 | 8 | 1 - 6 | 3 - 5 | 12 | None | 0.27 | 1073 | 184 | 2.10 | 2.57 | 0.027 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 18.96 |
| 7 | 8 | 1 - 6 | 3 - 7 | 12 | None | 0.31 | 1351 | 14 | 1.74 | 2.11 | 0.059 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 20.66 |
| 8 | 8 | 1 -10 | 4 - 2 | 12 | None | 0.35 | 1398 | 95 | 1.61 | 2.21 | 0.115 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 23.41 |
| 9 | 8 | 2 - 2 | 4 - 8 | 12 | None | 0.40 | 1523 | 123 | 1.52 | 2.24 | 0.207 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 7 # 4 | None | 26.08 |
| 10 | 8 | 2 -10 | 5 - 6 | 12 | None | 0.45 | 1516 | 332 | 1.55 | 2.59 | 0.351 | # 6@15 | None | None | # 4@15 | # 4@12 | # 6@15 | 5 # 5 | None | 33.88 |
| 11 | 9 | 3 - 3 | 6 - 3 | 12 | None | 0.54 | 1537 | 472 | 1.54 | 2.79 | 0.397 | # 5@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 40.83 |
| 12 | 10 | 3 - 7 | 6 -10 | 12 | None | 0.62 | 1649 | 533 | 1.51 | 2.83 | 0.447 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 52.17 |
| 13 | 11 | 3 -11 | 7 - 6 | 12 | None | 0.72 | 1681 | 662 | 1.51 | 2.99 | 0.501 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 10 # 4 | None | 59.45 |
| 14 | 12 | 4 - 5 | 8 - 3 | 12 | None | 0.82 | 1753 | 782 | 1.53 | 3.16 | 0.559 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 7 # 5 | None | 63.89 |
| 15 | 13 | 4 - 7 | 8 - 8 | 14 | None | 0.98 | 1986 | 751 | 1.50 | 2.99 | 0.620 | # 5@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 6@12 | # 4@ 6 | 6 # 6 | None | 78.17 |
| 16 | 14 | 5 - 0 | 9 - 5 | 14 | None | 1.10 | 2022 | 874 | 1.50 | 3.11 | 0.686 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@12 | # 6@ 9 | 5 # 7 | None | 102.31 |
| 17 | 15 | 5 - 4 | 10 - 0 | 16 | None | 1.28 | 2214 | 905 | 1.52 | 3.08 | 0.755 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@11 | # 6@ 9 | 8 # 6 | None | 113.92 |
| 18 | 16 | 5 - 8 | 10 - 8 | 16 | None | 1.42 | 2252 | 1026 | 1.52 | 3.19 | 0.828 | # 6@ 6 | 2 - 2 | # 6@12 | # 4@ 6 | # 7@15 | # 5@ 6 | 12 # 5 | None | 122.40 |
| 19 | 17 | 6 - 0 | 11 - 3 | 18 | None | 1.62 | 2442 | 1058 | 1.53 | 3.16 | 0.905 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@14 | # 6@ 9 | 10 # 6 | None | 139.68 |
| 20 | 18 | 6 - 4 | 11 -10 | 18 | None | 1.77 | 2557 | 1116 | 1.51 | 3.16 | 0.985 | # 8@ 9 | 3 - 2 | # 7@18 | # 6@ 9 | # 8@17 | # 7@ 9 | 15 # 5 | None | 160.43 |
| 21 | 20 | 6 - 6 | 12 - 5 | 20 | None | 2.06 | 2718 | 1154 | 1.51 | 3.13 | 0.916 | # 8@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 8@15 | # 7@ 9 | 9 # 7 | None | 186.28 |
| 22 | 21 | 6 -10 | 13 - 0 | 22 | None | 2.31 | 2909 | 1185 | 1.52 | 3.10 | 0.999 | # 7@ 6 | 3 - 2 | # 7@12 | # 5@ 6 | # 8@15 | # 6@ 6 | 20 # 5 | None | 209.93 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 115 pcf, $\phi$ = 35°, $\mu$ = 0.55

BACKFILL SLOPE: LEVEL

$f'_c$ = 3,000 psi

$f_y$ = 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 430 | 354 | 4.86 | 5.06 | 0.001 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 697 | 248 | 3.41 | 3.18 | 0.004 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.22 | 1095 | 11 | 2.58 | 2.18 | 0.011 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 16.73 |
| 6 | 8 | 1 - 6 | 3 - 5 | 12 | None | 0.27 | 1073 | 184 | 2.38 | 2.57 | 0.027 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 18.96 |
| 7 | 8 | 1 - 6 | 3 - 7 | 12 | None | 0.31 | 1351 | 14 | 1.99 | 2.11 | 0.059 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 20.66 |
| 8 | 8 | 1 -10 | 4 - 2 | 12 | None | 0.35 | 1398 | 95 | 1.86 | 2.21 | 0.115 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 23.41 |
| 9 | 8 | 2 - 0 | 4 - 6 | 12 | None | 0.39 | 1605 | 15 | 1.70 | 2.06 | 0.207 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 25.26 |
| 10 | 8 | 2 - 4 | 5 - 0 | 12 | None | 0.43 | 1727 | 46 | 1.63 | 2.10 | 0.351 | # 6@15 | None | None | # 4@15 | # 4@12 | # 6@15 | 7 # 4 | None | 32.74 |
| 11 | 9 | 2 - 5 | 5 - 5 | 12 | None | 0.51 | 1870 | 13 | 1.53 | 2.03 | 0.397 | # 5@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 7 # 4 | None | 38.75 |
| 12 | 10 | 2 - 9 | 6 - 0 | 12 | None | 0.59 | 1964 | 95 | 1.52 | 2.12 | 0.447 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 5 # 5 | None | 50.63 |
| 13 | 11 | 2 -11 | 6 - 6 | 12 | None | 0.68 | 2027 | 170 | 1.50 | 2.18 | 0.501 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 54.95 |
| 14 | 12 | 3 - 3 | 7 - 1 | 12 | None | 0.78 | 2127 | 246 | 1.50 | 2.26 | 0.559 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 6 # 5 | None | 58.63 |
| 15 | 13 | 3 - 7 | 7 - 8 | 14 | None | 0.93 | 2324 | 275 | 1.54 | 2.28 | 0.620 | # 5@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 6@12 | # 4@ 6 | 12 # 4 | None | 75.83 |
| 16 | 14 | 3 -10 | 8 - 3 | 14 | None | 1.05 | 2391 | 345 | 1.52 | 2.32 | 0.686 | # 7@ 9 | 3 - 2 | # 7@18 | # 4@ 9 | # 6@12 | # 5@ 9 | 13 # 4 | None | 93.05 |
| 17 | 15 | 4 - 0 | 8 - 8 | 16 | None | 1.21 | 2658 | 277 | 1.51 | 2.25 | 0.755 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@11 | # 5@ 9 | 5 # 7 | None | 105.29 |
| 18 | 16 | 4 - 4 | 9 - 4 | 16 | None | 1.35 | 2657 | 442 | 1.53 | 2.38 | 0.828 | # 6@ 6 | 2 - 2 | # 6@12 | # 4@ 6 | # 7@15 | # 5@ 6 | 17 # 4 | None | 118.46 |
| 19 | 17 | 4 - 6 | 9 - 9 | 18 | None | 1.54 | 2921 | 377 | 1.52 | 2.31 | 0.905 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@14 | # 6@ 9 | 19 # 4 | None | 134.35 |
| 20 | 18 | 4 -10 | 10 - 4 | 18 | None | 1.69 | 3024 | 448 | 1.52 | 2.35 | 0.985 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 8@17 | # 6@ 9 | 13 # 5 | None | 143.83 |
| 21 | 20 | 4 -10 | 10 - 9 | 20 | None | 1.96 | 3258 | 387 | 1.51 | 2.28 | 0.916 | # 8@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 8@15 | # 6@ 9 | 15 # 5 | None | 171.27 |
| 22 | 21 | 5 - 2 | 11 - 4 | 22 | None | 2.19 | 3455 | 416 | 1.53 | 2.30 | 0.999 | # 7@ 6 | 3 - 2 | # 7@12 | # 5@ 6 | # 8@15 | # 5@ 6 | 9 # 7 | None | 195.14 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \leq$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 115 pcf, $\phi$ = 40°, $\mu$ = 0.45

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "O" Bars | Dowels into Stem | (3) "M" Bars | "D" Bars | (5) "$L_w$" Bars | (2) "P" Bars | "$L_b$" Bars | (6) "K" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 374 | 409 | 6.32 | 6.30 | 0.001 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 589 | 356 | 4.35 | 3.96 | 0.003 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.22 | 908 | 198 | 3.24 | 2.72 | 0.009 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 16.73 |
| 6 | 8 | 1 - 0 | 2 -11 | 12 | None | 0.26 | 1081 | 103 | 2.56 | 2.28 | 0.022 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 18.51 |
| 7 | 8 | 1 - 6 | 3 - 7 | 12 | None | 0.31 | 1105 | 259 | 2.37 | 2.63 | 0.047 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 20.66 |
| 8 | 8 | 1 - 6 | 3 -10 | 12 | None | 0.34 | 1275 | 163 | 2.01 | 2.29 | 0.092 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 22.44 |
| 9 | 8 | 1 - 8 | 4 - 2 | 12 | None | 0.38 | 1449 | 111 | 1.80 | 2.16 | 0.166 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 24.97 |
| 10 | 8 | 1 -10 | 4 - 6 | 12 | None | 0.41 | 1627 | 55 | 1.65 | 2.06 | 0.281 | # 6@18 | None | None | # 4@18 | # 4@12 | # 6@18 | 6 # 4 | None | 28.00 |
| 11 | 8 | 2 - 0 | 4 -11 | 12 | None | 0.45 | 1735 | 38 | 1.53 | 2.01 | 0.453 | # 5@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 4@12 | # 4@ 9 | 7 # 4 | None | 34.03 |
| 12 | 9 | 2 - 4 | 5 - 6 | 12 | None | 0.54 | 1791 | 164 | 1.51 | 2.15 | 0.492 | # 5@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 5 # 5 | None | 41.51 |
| 13 | 10 | 2 - 8 | 6 - 2 | 12 | None | 0.63 | 1750 | 376 | 1.53 | 2.40 | 0.535 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 54.45 |
| 14 | 11 | 3 - 0 | 6 - 9 | 12 | None | 0.73 | 1825 | 479 | 1.53 | 2.51 | 0.582 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 57.89 |
| 15 | 12 | 3 - 4 | 7 - 4 | 12 | None | 0.83 | 1904 | 578 | 1.53 | 2.61 | 0.633 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 10 # 4 | None | 61.99 |
| 16 | 13 | 3 - 5 | 7 - 9 | 14 | None | 0.98 | 2095 | 545 | 1.51 | 2.51 | 0.687 | # 5@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 6@12 | # 4@ 6 | 12 # 4 | None | 79.18 |
| 17 | 14 | 3 - 9 | 8 - 4 | 14 | None | 1.09 | 2174 | 644 | 1.51 | 2.59 | 0.745 | # 7@ 9 | 3 - 2 | # 7@18 | # 4@ 9 | # 6@12 | # 5@ 9 | 13 # 4 | None | 96.91 |
| 18 | 15 | 3 -11 | 8 -10 | 16 | None | 1.27 | 2304 | 702 | 1.53 | 2.61 | 0.806 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@11 | # 5@ 9 | 7 # 6 | None | 109.79 |
| 19 | 16 | 4 - 3 | 9 - 5 | 16 | None | 1.40 | 2385 | 797 | 1.53 | 2.68 | 0.871 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@15 | # 5@ 9 | 17 # 4 | None | 114.58 |
| 20 | 17 | 4 - 3 | 9 - 8 | 18 | None | 1.59 | 2670 | 682 | 1.50 | 2.52 | 0.938 | # 6@ 6 | 2 - 2 | # 6@12 | # 4@ 6 | # 7@14 | # 4@ 6 | 19 # 4 | None | 127.36 |
| 21 | 18 | 4 - 8 | 10 - 5 | 18 | None | 1.74 | 2654 | 864 | 1.52 | 2.66 | 1.009 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 8@17 | # 6@ 9 | 7 # 7 | None | 150.02 |
| 22 | 19 | 4 -10 | 10 -10 | 20 | None | 1.96 | 2878 | 839 | 1.52 | 2.60 | 1.082 | # 8@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 8@16 | # 6@ 9 | 6 # 8 | None | 174.34 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 115 pcf, $\phi$ = 40°, $\mu$ = 0.55

BACKFILL SLOPE: LEVEL

$f'_c$ = 3,000 psi
$f_y$ = 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 374 | 409 | 6.84 | 6.30 | 0.001 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 589 | 356 | 4.76 | 3.96 | 0.003 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.22 | 908 | 198 | 3.56 | 2.72 | 0.009 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 16.73 |
| 6 | 8 | 1 - 0 | 2 -11 | 12 | None | 0.26 | 1081 | 103 | 2.85 | 2.28 | 0.022 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 18.51 |
| 7 | 8 | 1 - 6 | 3 - 7 | 12 | None | 0.31 | 1105 | 259 | 2.67 | 2.63 | 0.047 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 20.66 |
| 8 | 8 | 1 - 6 | 3 -10 | 12 | None | 0.34 | 1275 | 163 | 2.28 | 2.29 | 0.092 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 22.44 |
| 9 | 8 | 1 - 8 | 4 - 2 | 12 | None | 0.38 | 1449 | 111 | 2.06 | 2.16 | 0.166 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 24.97 |
| 10 | 8 | 1 -10 | 4 - 6 | 12 | None | 0.41 | 1627 | 55 | 1.90 | 2.06 | 0.281 | # 6@18 | None | None | # 4@18 | # 4@12 | # 6@18 | 6 # 4 | None | 28.00 |
| 11 | 8 | 2 - 0 | 4 -11 | 12 | None | 0.45 | 1735 | 38 | 1.77 | 2.01 | 0.453 | # 5@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 4@12 | # 4@ 9 | 7 # 4 | None | 34.03 |
| 12 | 9 | 2 - 2 | 5 - 4 | 12 | None | 0.53 | 1879 | 41 | 1.70 | 2.00 | 0.492 | # 5@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 7 # 4 | None | 40.83 |
| 13 | 10 | 2 - 4 | 5 -10 | 12 | None | 0.62 | 1902 | 158 | 1.68 | 2.11 | 0.535 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 5 # 5 | None | 53.36 |
| 14 | 11 | 2 - 6 | 6 - 3 | 12 | None | 0.71 | 2045 | 162 | 1.63 | 2.10 | 0.582 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 57.44 |
| 15 | 12 | 2 - 8 | 6 - 8 | 12 | None | 0.80 | 2189 | 166 | 1.60 | 2.09 | 0.633 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 60.73 |
| 16 | 13 | 2 - 9 | 7 - 1 | 14 | None | 0.95 | 2398 | 111 | 1.59 | 2.03 | 0.687 | # 5@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 6@12 | # 4@ 6 | 7 # 5 | None | 77.57 |
| 17 | 14 | 2 -11 | 7 - 6 | 14 | None | 1.06 | 2542 | 115 | 1.56 | 2.03 | 0.745 | # 7@ 9 | 3 - 2 | # 7@18 | # 4@ 9 | # 6@12 | # 5@ 9 | 12 # 4 | None | 95.09 |
| 18 | 15 | 3 - 1 | 8 - 0 | 16 | None | 1.23 | 2662 | 184 | 1.60 | 2.08 | 0.806 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@11 | # 5@ 9 | 9 # 5 | None | 107.50 |
| 19 | 16 | 3 - 3 | 8 - 5 | 16 | None | 1.35 | 2806 | 188 | 1.57 | 2.08 | 0.871 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@15 | # 5@ 9 | 5 # 7 | None | 112.05 |
| 20 | 17 | 3 - 5 | 8 -10 | 18 | None | 1.54 | 3049 | 143 | 1.58 | 2.05 | 0.938 | # 6@ 6 | 2 - 2 | # 6@12 | # 4@ 6 | # 7@14 | # 4@ 6 | 8 # 6 | None | 125.57 |
| 21 | 18 | 3 - 6 | 9 - 3 | 18 | None | 1.68 | 3159 | 136 | 1.54 | 2.03 | 1.009 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 8@17 | # 5@ 9 | 6 # 7 | None | 141.77 |
| 22 | 19 | 3 - 8 | 9 - 8 | 20 | None | 1.88 | 3403 | 90 | 1.55 | 2.00 | 1.082 | # 8@ 9 | 3 - 7 | # 8@18 | # 5@ 9 | # 8@16 | # 6@ 9 | 7 # 7 | None | 167.38 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \leq$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 130 pcf, $\phi$ = 30°, $\mu$ = 0.45

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "O" Bars | Dowels into Stem | (3) "M" Bars | "D" Bars | (5) "$L_w$" Bars | (2) "P" Bars | "$L_b$" Bars | (6) "K" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 525 | 293 | 3.10 | 3.85 | 0.001 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 891 | 99 | 2.18 | 2.43 | 0.005 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 6 | 3 - 2 | 12 | None | 0.24 | 1138 | 94 | 1.88 | 2.42 | 0.015 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 17.17 |
| 6 | 8 | 1 - 8 | 3 - 7 | 12 | None | 0.28 | 1314 | 46 | 1.58 | 2.22 | 0.038 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 19.10 |
| 7 | 8 | 2 - 4 | 4 - 5 | 12 | None | 0.34 | 1345 | 234 | 1.55 | 2.59 | 0.082 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 22.07 |
| 8 | 8 | 3 - 0 | 5 - 4 | 12 | None | 0.40 | 1340 | 430 | 1.54 | 2.98 | 0.160 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 7 # 4 | None | 25.12 |
| 9 | 8 | 3 - 8 | 6 - 2 | 12 | None | 0.45 | 1415 | 568 | 1.54 | 3.24 | 0.288 | # 6@15 | None | None | # 4@15 | # 4@12 | # 6@15 | 8 # 4 | None | 32.94 |
| 10 | 8 | 4 - 2 | 6 -10 | 12 | None | 0.50 | 1535 | 643 | 1.50 | 3.28 | 0.488 | # 8@18 | None | None | # 5@18 | # 4@12 | # 6@18 | 9 # 4 | None | 42.91 |
| 11 | 10 | 4 - 8 | 7 - 9 | 12 | None | 0.63 | 1577 | 799 | 1.51 | 3.53 | 0.402 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 7 # 5 | None | 54.84 |
| 12 | 11 | 5 - 2 | 8 - 6 | 12 | None | 0.72 | 1689 | 892 | 1.50 | 3.62 | 0.467 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 6@ 9 | 5 # 6 | None | 63.33 |
| 13 | 12 | 5 - 8 | 9 - 4 | 12 | None | 0.83 | 1736 | 1037 | 1.51 | 3.81 | 0.536 | # 5@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 5@12 | # 5@ 6 | 8 # 5 | None | 70.92 |
| 14 | 13 | 6 - 2 | 10 - 1 | 14 | None | 1.00 | 1924 | 1105 | 1.53 | 3.79 | 0.611 | # 7@ 9 | 2 - 5 | # 6@18 | # 5@ 9 | # 6@12 | # 7@ 9 | 7 # 6 | None | 98.06 |
| 15 | 14 | 6 - 8 | 10 -10 | 14 | None | 1.12 | 2039 | 1196 | 1.52 | 3.84 | 0.691 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@12 | # 7@ 9 | 17 # 4 | None | 110.60 |
| 16 | 15 | 7 - 1 | 11 - 7 | 16 | None | 1.31 | 2190 | 1270 | 1.52 | 3.80 | 0.775 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@11 | # 7@ 9 | 20 # 4 | None | 131.61 |
| 17 | 17 | 7 - 4 | 12 - 2 | 18 | None | 1.57 | 2413 | 1292 | 1.50 | 3.68 | 0.721 | # 8@ 9 | 3 - 2 | # 7@18 | # 6@ 9 | # 7@14 | # 7@ 9 | 6 # 8 | None | 147.35 |
| 18 | 18 | 7 -10 | 13 - 0 | 18 | None | 1.72 | 2460 | 1436 | 1.51 | 3.82 | 0.809 | # 8@ 9 | 3 - 2 | # 7@18 | # 6@ 9 | # 8@17 | # 8@ 9 | 26 # 4 | None | 168.59 |
| 19 | 19 | 8 - 4 | 13 - 9 | 20 | None | 1.96 | 2648 | 1503 | 1.52 | 3.80 | 0.901 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@16 | # 7@ 6 | 10 # 7 | None | 193.26 |
| 20 | 20 | 7 - 2 | 12 -10 | 20 | 12x18 | 2.09 | 3168 | 1056 | 1.51 | 2.97 | 0.998 | # 9@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 8@15 | # 8@ 9 | 18 # 5 | # 4@ 9 | 209.43 |
| 21 | 22 | 7 - 6 | 13 - 7 | 22 | 12x18 | 2.41 | 3321 | 1131 | 1.51 | 2.99 | 0.957 | # 9@ 9 | 3 - 7 | # 8@18 | # 7@ 9 | # 8@14 | # 8@ 9 | 21 # 5 | # 4@ 9 | 229.40 |
| 22 | 23 | 7 - 8 | 14 - 0 | 24 | 12x20 | 2.67 | 3609 | 1065 | 1.50 | 2.87 | 1.057 | # 8@ 6 | 3 - 2 | # 7@12 | # 6@ 6 | # 9@17 | # 7@ 6 | 24 # 5 | # 4@ 6 | 269.20 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 130 pcf, $\phi$ = 30°, $\mu$ = 0.55

BACKFILL SLOPE: LEVEL

$f'_c$ = 3,000 psi
$f_y$ = 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 525 | 293 | 3.42 | 3.85 | 0.001 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 891 | 99 | 2.42 | 2.43 | 0.005 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 6 | 3 - 2 | 12 | None | 0.24 | 1138 | 94 | 2.13 | 2.42 | 0.015 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 17.17 |
| 6 | 8 | 1 - 8 | 3 - 7 | 12 | None | 0.28 | 1314 | 46 | 1.81 | 2.22 | 0.038 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 19.10 |
| 7 | 8 | 2 - 0 | 4 - 1 | 12 | None | 0.32 | 1489 | 45 | 1.66 | 2.19 | 0.082 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 21.78 |
| 8 | 8 | 2 - 4 | 4 - 8 | 12 | None | 0.37 | 1585 | 97 | 1.56 | 2.23 | 0.160 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 7 # 4 | None | 24.52 |
| 9 | 8 | 2 -10 | 5 - 4 | 12 | None | 0.42 | 1685 | 196 | 1.54 | 2.36 | 0.288 | # 6@15 | None | None | # 4@15 | # 4@12 | # 6@15 | 7 # 4 | None | 31.27 |
| 10 | 8 | 3 - 4 | 6 - 0 | 12 | None | 0.47 | 1789 | 289 | 1.53 | 2.48 | 0.488 | # 8@18 | None | None | # 5@18 | # 4@12 | # 6@18 | 8 # 4 | None | 41.40 |
| 11 | 10 | 3 - 8 | 6 - 9 | 12 | None | 0.59 | 1843 | 415 | 1.53 | 2.62 | 0.402 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 49.38 |
| 12 | 11 | 4 - 0 | 7 - 4 | 12 | None | 0.68 | 1993 | 454 | 1.50 | 2.62 | 0.467 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 10 # 4 | None | 56.42 |
| 13 | 12 | 4 - 4 | 8 - 0 | 12 | None | 0.78 | 2050 | 573 | 1.50 | 2.73 | 0.536 | # 5@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 5@12 | # 5@ 6 | 7 # 5 | None | 67.10 |
| 14 | 13 | 4 - 8 | 8 - 7 | 14 | None | 0.93 | 2291 | 570 | 1.50 | 2.68 | 0.611 | # 7@ 9 | 2 - 5 | # 6@18 | # 5@ 9 | # 6@12 | # 6@ 9 | 6 # 6 | None | 85.90 |
| 15 | 14 | 5 - 2 | 9 - 4 | 14 | None | 1.05 | 2388 | 684 | 1.52 | 2.79 | 0.691 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@12 | # 6@ 9 | 5 # 7 | None | 98.45 |
| 16 | 15 | 5 - 5 | 9 -11 | 16 | None | 1.23 | 2590 | 685 | 1.50 | 2.72 | 0.775 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@11 | # 6@ 9 | 8 # 6 | None | 117.59 |
| 17 | 17 | 5 - 8 | 10 - 6 | 18 | None | 1.47 | 2836 | 684 | 1.50 | 2.68 | 0.721 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@14 | # 6@ 9 | 7 # 7 | None | 130.17 |
| 18 | 18 | 6 - 0 | 11 - 2 | 18 | None | 1.62 | 2893 | 801 | 1.51 | 2.75 | 0.809 | # 8@ 9 | 3 - 2 | # 7@18 | # 6@ 9 | # 8@17 | # 7@ 9 | 10 # 6 | None | 150.63 |
| 19 | 19 | 6 - 4 | 11 - 9 | 20 | None | 1.84 | 3134 | 799 | 1.50 | 2.71 | 0.901 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@16 | # 6@ 6 | 17 # 5 | None | 169.15 |
| 20 | 20 | 6 -10 | 12 - 6 | 20 | None | 2.01 | 3231 | 912 | 1.52 | 2.79 | 0.998 | # 9@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 8@15 | # 8@ 9 | 7 # 8 | None | 204.15 |
| 21 | 22 | 7 - 0 | 13 - 1 | 22 | None | 2.31 | 3437 | 915 | 1.51 | 2.74 | 0.957 | # 9@ 9 | 3 - 7 | # 8@18 | # 7@ 9 | # 8@14 | # 8@ 9 | 8 # 8 | None | 223.07 |
| 22 | 23 | 7 - 4 | 13 - 8 | 24 | None | 2.57 | 3678 | 912 | 1.50 | 2.71 | 1.057 | # 8@ 6 | 3 - 2 | # 7@12 | # 6@ 6 | # 9@17 | # 7@ 6 | 9 # 8 | None | 261.26 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 130 pcf, $\phi$ = 35°, $\mu$ = 0.45

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "O" Bars | Dowels into Stem | (3) "M" Bars | "D" Bars | (5) "$L_w$" Bars | (2) "P" Bars | "$L_b$" Bars | (6) "K" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 452 | 366 | 4.29 | 4.73 | 0.001 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 749 | 241 | 2.98 | 2.99 | 0.004 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 6 | 3 - 2 | 12 | None | 0.24 | 963 | 268 | 2.52 | 2.98 | 0.012 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 17.17 |
| 6 | 8 | 1 - 6 | 3 - 5 | 12 | None | 0.27 | 1165 | 171 | 2.02 | 2.46 | 0.031 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 18.96 |
| 7 | 8 | 1 - 8 | 3 - 9 | 12 | None | 0.31 | 1387 | 95 | 1.75 | 2.23 | 0.067 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 20.81 |
| 8 | 8 | 1 -10 | 4 - 2 | 12 | None | 0.35 | 1533 | 66 | 1.56 | 2.13 | 0.130 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 23.41 |
| 9 | 8 | 2 - 4 | 4 -10 | 12 | None | 0.40 | 1590 | 212 | 1.52 | 2.34 | 0.234 | # 6@18 | None | None | # 4@18 | # 4@12 | # 6@18 | 7 # 4 | None | 27.34 |
| 10 | 8 | 2 -10 | 5 - 6 | 12 | None | 0.45 | 1660 | 343 | 1.50 | 2.51 | 0.396 | # 7@18 | None | None | # 4@18 | # 4@12 | # 6@18 | 5 # 5 | None | 34.82 |
| 11 | 9 | 3 - 5 | 6 - 5 | 12 | None | 0.54 | 1625 | 581 | 1.54 | 2.88 | 0.448 | # 6@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 45.26 |
| 12 | 10 | 3 - 9 | 7 - 0 | 12 | None | 0.63 | 1748 | 647 | 1.50 | 2.91 | 0.505 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 6 # 5 | None | 55.38 |
| 13 | 11 | 4 - 3 | 7 -10 | 12 | None | 0.73 | 1742 | 853 | 1.54 | 3.21 | 0.566 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 7 # 5 | None | 60.53 |
| 14 | 12 | 4 - 7 | 8 - 5 | 12 | None | 0.83 | 1866 | 917 | 1.51 | 3.21 | 0.632 | # 7@ 9 | 2 - 5 | # 6@18 | # 4@ 9 | # 5@12 | # 6@ 9 | 5 # 6 | None | 75.13 |
| 15 | 13 | 4 -11 | 9 - 0 | 14 | None | 0.99 | 2072 | 950 | 1.52 | 3.16 | 0.701 | # 7@ 9 | 2 - 5 | # 6@18 | # 5@ 9 | # 6@12 | # 6@ 9 | 9 # 5 | None | 90.38 |
| 16 | 14 | 5 - 4 | 9 - 9 | 14 | None | 1.11 | 2117 | 1081 | 1.52 | 3.27 | 0.775 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@12 | # 6@ 9 | 5 # 7 | None | 102.98 |
| 17 | 16 | 5 - 7 | 10 - 4 | 16 | None | 1.35 | 2325 | 1117 | 1.53 | 3.23 | 0.703 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@15 | # 6@ 9 | 6 # 7 | None | 115.14 |
| 18 | 17 | 5 - 9 | 10 -10 | 18 | None | 1.55 | 2492 | 1152 | 1.52 | 3.17 | 0.780 | # 6@ 6 | 2 - 2 | # 6@12 | # 5@ 6 | # 7@14 | # 5@ 6 | 14 # 5 | None | 131.15 |
| 19 | 18 | 6 - 1 | 11 - 5 | 18 | None | 1.69 | 2617 | 1217 | 1.50 | 3.18 | 0.862 | # 8@ 9 | 3 - 2 | # 7@18 | # 6@ 9 | # 8@17 | # 7@ 9 | 15 # 5 | None | 154.28 |
| 20 | 19 | 6 - 5 | 12 - 0 | 20 | None | 1.91 | 2823 | 1249 | 1.51 | 3.14 | 0.947 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@16 | # 6@ 6 | 17 # 5 | None | 175.22 |
| 21 | 20 | 6 -10 | 12 - 9 | 20 | None | 2.08 | 2866 | 1381 | 1.51 | 3.22 | 1.036 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@15 | # 6@ 6 | 7 # 8 | None | 186.86 |
| 22 | 22 | 7 - 1 | 13 - 4 | 22 | None | 2.40 | 3075 | 1417 | 1.51 | 3.19 | 0.982 | # 7@ 6 | 3 - 2 | # 7@12 | # 5@ 6 | # 8@14 | # 6@ 6 | 21 # 5 | None | 214.98 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 130 pcf, $\phi$ = 35°, $\mu$ = 0.55

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 452 | 366 | 4.68 | 4.73 | 0.001 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 749 | 241 | 3.28 | 2.99 | 0.004 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 6 | 3 - 2 | 12 | None | 0.24 | 963 | 268 | 2.83 | 2.98 | 0.012 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 17.17 |
| 6 | 8 | 1 - 6 | 3 - 5 | 12 | None | 0.27 | 1165 | 171 | 2.29 | 2.46 | 0.031 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 18.96 |
| 7 | 8 | 1 - 8 | 3 - 9 | 12 | None | 0.31 | 1387 | 95 | 1.99 | 2.23 | 0.067 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 20.81 |
| 8 | 8 | 1 -10 | 4 - 2 | 12 | None | 0.35 | 1533 | 66 | 1.79 | 2.13 | 0.130 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 23.41 |
| 9 | 8 | 2 - 2 | 4 - 8 | 12 | None | 0.40 | 1672 | 100 | 1.70 | 2.16 | 0.234 | # 6@18 | None | None | # 4@18 | # 4@12 | # 6@18 | 7 # 4 | None | 27.17 |
| 10 | 8 | 2 - 4 | 5 - 0 | 12 | None | 0.43 | 1902 | 12 | 1.57 | 2.03 | 0.396 | # 7@18 | None | None | # 4@18 | # 4@12 | # 6@18 | 7 # 4 | None | 33.78 |
| 11 | 9 | 2 - 7 | 5 - 7 | 12 | None | 0.51 | 1968 | 95 | 1.53 | 2.10 | 0.448 | # 6@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 5 # 5 | None | 43.72 |
| 12 | 10 | 2 -11 | 6 - 2 | 12 | None | 0.60 | 2075 | 180 | 1.52 | 2.18 | 0.505 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 8 # 4 | None | 50.90 |
| 13 | 11 | 3 - 3 | 6 -10 | 12 | None | 0.70 | 2074 | 363 | 1.54 | 2.37 | 0.566 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 9 # 4 | None | 57.85 |
| 14 | 12 | 3 - 7 | 7 - 5 | 12 | None | 0.79 | 2190 | 438 | 1.54 | 2.42 | 0.632 | # 7@ 9 | 2 - 5 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 10 # 4 | None | 68.77 |
| 15 | 13 | 3 - 9 | 7 -10 | 14 | None | 0.94 | 2475 | 364 | 1.52 | 2.32 | 0.701 | # 7@ 9 | 2 - 5 | # 6@18 | # 5@ 9 | # 6@12 | # 5@ 9 | 12 # 4 | None | 83.06 |
| 16 | 14 | 4 - 0 | 8 - 5 | 14 | None | 1.05 | 2552 | 437 | 1.50 | 2.36 | 0.775 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@12 | # 5@ 9 | 13 # 4 | None | 95.02 |
| 17 | 16 | 4 - 3 | 9 - 0 | 16 | None | 1.28 | 2768 | 469 | 1.53 | 2.37 | 0.703 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@15 | # 5@ 9 | 10 # 5 | None | 106.32 |
| 18 | 17 | 4 - 5 | 9 - 6 | 18 | None | 1.47 | 2944 | 493 | 1.53 | 2.37 | 0.780 | # 6@ 6 | 2 - 2 | # 6@12 | # 4@ 6 | # 7@14 | # 5@ 6 | 12 # 5 | None | 123.06 |
| 19 | 18 | 4 - 9 | 10 - 1 | 18 | None | 1.62 | 3060 | 568 | 1.53 | 2.41 | 0.862 | # 8@ 9 | 3 - 2 | # 7@18 | # 6@ 9 | # 8@17 | # 6@ 9 | 5 # 8 | None | 140.68 |
| 20 | 19 | 4 -11 | 10 - 6 | 20 | None | 1.82 | 3346 | 493 | 1.52 | 2.33 | 0.947 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@16 | # 5@ 6 | 15 # 5 | None | 161.51 |
| 21 | 20 | 5 - 2 | 11 - 1 | 20 | None | 1.98 | 3423 | 567 | 1.50 | 2.36 | 1.036 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@15 | # 5@ 6 | 8 # 7 | None | 172.18 |
| 22 | 22 | 5 - 5 | 11 - 8 | 22 | None | 2.28 | 3639 | 598 | 1.52 | 2.37 | 0.982 | # 7@ 6 | 3 - 2 | # 7@12 | # 5@ 6 | # 8@14 | # 5@ 6 | 7 # 8 | None | 199.22 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \leq$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 130 pcf, $\phi$ = 40°, $\mu$ = 0.45

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "O" Bars | Dowels into Stem | (3) "M" Bars | "D" Bars | (5) "$L_w$" Bars | (2) "P" Bars | "$L_b$" Bars | (6) "K" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 389 | 429 | 6.13 | 5.90 | 0.001 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 626 | 364 | 4.22 | 3.72 | 0.003 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.22 | 983 | 180 | 3.13 | 2.56 | 0.010 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 16.73 |
| 6 | 8 | 1 - 0 | 2 -11 | 12 | None | 0.26 | 1183 | 64 | 2.48 | 2.15 | 0.025 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 18.51 |
| 7 | 8 | 1 - 6 | 3 - 7 | 12 | None | 0.31 | 1203 | 250 | 2.29 | 2.51 | 0.053 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 20.66 |
| 8 | 8 | 1 - 6 | 3 -10 | 12 | None | 0.34 | 1398 | 134 | 1.94 | 2.19 | 0.104 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 22.44 |
| 9 | 8 | 1 - 8 | 4 - 2 | 12 | None | 0.38 | 1594 | 74 | 1.74 | 2.07 | 0.188 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 24.97 |
| 10 | 8 | 2 - 0 | 4 - 8 | 12 | None | 0.42 | 1694 | 149 | 1.66 | 2.15 | 0.318 | # 5@12 | None | None | # 4@12 | # 4@12 | # 5@12 | 7 # 4 | None | 29.82 |
| 11 | 8 | 2 - 2 | 5 - 1 | 12 | None | 0.46 | 1816 | 132 | 1.53 | 2.09 | 0.512 | # 6@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 4@12 | # 4@ 9 | 7 # 4 | None | 38.41 |
| 12 | 9 | 2 - 6 | 5 - 8 | 12 | None | 0.54 | 1884 | 261 | 1.51 | 2.23 | 0.556 | # 6@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 5 # 5 | None | 46.20 |
| 13 | 10 | 2 -10 | 6 - 4 | 12 | None | 0.64 | 1849 | 483 | 1.53 | 2.47 | 0.605 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 54.60 |
| 14 | 11 | 3 - 2 | 6 -11 | 12 | None | 0.73 | 1934 | 592 | 1.52 | 2.57 | 0.658 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 58.03 |
| 15 | 12 | 3 - 6 | 7 - 6 | 12 | None | 0.83 | 2022 | 698 | 1.52 | 2.66 | 0.716 | # 5@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 5@12 | # 4@ 6 | 10 # 4 | None | 66.51 |
| 16 | 13 | 3 - 9 | 8 - 1 | 14 | None | 0.99 | 2164 | 756 | 1.54 | 2.67 | 0.777 | # 7@ 9 | 2 - 5 | # 6@18 | # 4@ 9 | # 6@12 | # 5@ 9 | 8 # 5 | None | 85.55 |
| 17 | 14 | 4 - 1 | 8 - 8 | 14 | None | 1.11 | 2255 | 858 | 1.53 | 2.75 | 0.843 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@12 | # 5@ 9 | 6 # 6 | None | 99.44 |
| 18 | 16 | 4 - 0 | 9 - 0 | 16 | None | 1.33 | 2460 | 826 | 1.52 | 2.64 | 0.751 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@15 | # 5@ 9 | 16 # 4 | None | 109.04 |
| 19 | 17 | 4 - 2 | 9 - 5 | 18 | None | 1.52 | 2704 | 793 | 1.51 | 2.57 | 0.821 | # 6@ 6 | 2 - 2 | # 6@12 | # 4@ 6 | # 7@14 | # 4@ 6 | 12 # 5 | None | 122.30 |
| 20 | 18 | 4 - 6 | 10 - 0 | 18 | None | 1.67 | 2791 | 899 | 1.51 | 2.63 | 0.893 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 8@17 | # 6@ 9 | 5 # 8 | None | 142.95 |
| 21 | 19 | 4 - 9 | 10 - 7 | 20 | None | 1.88 | 2933 | 957 | 1.53 | 2.64 | 0.969 | # 8@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 8@16 | # 6@ 9 | 15 # 5 | None | 167.90 |
| 22 | 20 | 5 - 1 | 11 - 2 | 20 | None | 2.05 | 3022 | 1060 | 1.52 | 2.70 | 1.049 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@15 | # 5@ 6 | 11 # 6 | None | 178.01 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 130 pcf, $\phi$ = 40°, $\mu$ = 0.55

BACKFILL SLOPE: LEVEL

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 389 | 429 | 6.62 | 5.90 | 0.001 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 626 | 364 | 4.59 | 3.72 | 0.003 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.22 | 983 | 180 | 3.44 | 2.56 | 0.010 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 16.73 |
| 6 | 8 | 1 - 0 | 2 -11 | 12 | None | 0.26 | 1183 | 64 | 2.74 | 2.15 | 0.025 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 18.51 |
| 7 | 8 | 1 - 6 | 3 - 7 | 12 | None | 0.31 | 1203 | 250 | 2.57 | 2.51 | 0.053 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 20.66 |
| 8 | 8 | 1 - 6 | 3 -10 | 12 | None | 0.34 | 1398 | 134 | 2.19 | 2.19 | 0.104 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 22.44 |
| 9 | 8 | 1 - 8 | 4 - 2 | 12 | None | 0.38 | 1594 | 74 | 1.99 | 2.07 | 0.188 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | None | 24.97 |
| 10 | 8 | 2 - 0 | 4 - 8 | 12 | None | 0.42 | 1694 | 149 | 1.91 | 2.15 | 0.318 | # 5@12 | None | None | # 4@12 | # 4@12 | # 5@12 | 7 # 4 | None | 29.82 |
| 11 | 8 | 2 - 2 | 5 - 1 | 12 | None | 0.46 | 1816 | 132 | 1.77 | 2.09 | 0.512 | # 6@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 4@12 | # 4@ 9 | 7 # 4 | None | 38.41 |
| 12 | 9 | 2 - 4 | 5 - 6 | 12 | None | 0.54 | 1975 | 132 | 1.70 | 2.08 | 0.556 | # 6@ 9 | 1 -10 | # 5@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 5 # 5 | None | 46.05 |
| 13 | 10 | 2 - 4 | 5 -10 | 12 | None | 0.62 | 2100 | 118 | 1.62 | 2.04 | 0.605 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 5 # 5 | None | 53.36 |
| 14 | 11 | 2 - 6 | 6 - 3 | 12 | None | 0.71 | 2259 | 117 | 1.57 | 2.03 | 0.658 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 4@ 9 | 9 # 4 | None | 57.44 |
| 15 | 12 | 2 - 8 | 6 - 8 | 12 | None | 0.80 | 2418 | 117 | 1.53 | 2.02 | 0.716 | # 5@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 5@12 | # 4@ 6 | 9 # 4 | None | 64.73 |
| 16 | 13 | 2 -11 | 7 - 3 | 14 | None | 0.95 | 2551 | 186 | 1.57 | 2.07 | 0.777 | # 7@ 9 | 2 - 5 | # 6@18 | # 4@ 9 | # 6@12 | # 5@ 9 | 5 # 6 | None | 83.56 |
| 17 | 14 | 3 - 1 | 7 - 8 | 14 | None | 1.06 | 2710 | 186 | 1.54 | 2.06 | 0.843 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@12 | # 5@ 9 | 12 # 4 | None | 97.05 |
| 18 | 16 | 3 - 0 | 8 - 0 | 16 | None | 1.29 | 2941 | 122 | 1.53 | 2.01 | 0.751 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@15 | # 5@ 9 | 9 # 5 | None | 106.35 |
| 19 | 17 | 3 - 4 | 8 - 7 | 18 | None | 1.47 | 3108 | 205 | 1.58 | 2.07 | 0.821 | # 6@ 6 | 2 - 2 | # 6@12 | # 4@ 6 | # 7@14 | # 4@ 6 | 17 # 4 | None | 120.02 |
| 20 | 18 | 3 - 6 | 9 - 0 | 18 | None | 1.61 | 3267 | 205 | 1.56 | 2.06 | 0.893 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 8@17 | # 5@ 9 | 8 # 6 | None | 135.74 |
| 21 | 19 | 3 - 7 | 9 - 5 | 20 | None | 1.81 | 3498 | 135 | 1.54 | 2.01 | 0.969 | # 8@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 8@16 | # 6@ 9 | 7 # 7 | None | 164.23 |
| 22 | 20 | 3 - 9 | 9 -10 | 20 | None | 1.96 | 3657 | 134 | 1.52 | 2.01 | 1.049 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@15 | # 5@ 6 | 14 # 5 | None | 173.31 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \leq$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 115 pcf, $\phi$ = 30°, $\mu$ = 0.45

BACKFILL SLOPE: 30°

$f_c' =$ 3,000 psi

$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "O" Bars | Dowels into Stem | (3) "M" Bars | "D" Bars | (5) "$L_w$" Bars | (2) "P" Bars | "$L_b$" Bars | (6) "K" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | 12x18 | 0.24 | 1003 | 391 | 3.07 | 2.53 | 0.002 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | # 4@ 9 | 17.62 |
| 4 | 8 | 1 - 6 | 3 - 2 | 12 | 12x18 | 0.28 | 1501 | 240 | 2.14 | 2.14 | 0.010 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | # 4@ 9 | 19.62 |
| 5 | 8 | 2 - 2 | 3 -10 | 12 | 12x18 | 0.33 | 1949 | 161 | 1.66 | 2.02 | 0.030 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | # 4@ 9 | 21.78 |
| 6 | 8 | 2 - 8 | 4 - 7 | 12 | 12x22 | 0.40 | 2158 | 244 | 1.54 | 2.03 | 0.075 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | # 5@ 9 | 27.33 |
| 7 | 10 | 3 - 4 | 5 - 7 | 18 | 12x24 | 0.62 | 2685 | 270 | 1.50 | 2.03 | 0.083 | H# 7@18 | None | None | # 4@18 | # 5@12 | H# 7@18 | 5 # 6 | # 6@18 | 44.26 |
| 8 | 11 | 3 - 3 | 5 -10 | 14 | 18x32 | 0.70 | 2888 | 268 | 1.52 | 2.00 | 0.122 | # 5@12 | None | None | # 4@12 | # 5@12 | # 5@12 | 9 # 4 | # 6@12 | 41.49 |
| 9 | 19 | 3 - 3 | 6 - 8 | 20 | 18x32 | 1.11 | 3278 | 365 | 1.50 | 2.05 | 0.043 | H# 6@12 | None | None | # 4@12 | # 8@16 | # 6@12 | 5 # 7 | # 6@12 | 68.86 |
| 10 | 29 | 2 -11 | 7 - 4 | 30 | 18x30 | 1.74 | 3973 | 303 | 1.51 | 2.00 | 0.020 | H# 9@18 | None | None | # 6@18 | # 9@13 | H# 9@18H | 8 # 7 | # 7@18 | 116.07 |
| 11 | 33 | 3 - 2 | 8 - 2 | 34 | 18x32 | 2.15 | 4295 | 397 | 1.51 | 2.02 | 0.022 | H# 7@ 9 | 5 - 6 | #10@18 | # 4@ 9 | # 9@12 | # 7@ 9 | 10 # 7 | # 5@ 9 | 155.25 |
| 12 | 35 | 3 - 6 | 8 -10 | 36 | 18x36 | 2.48 | 4707 | 384 | 1.51 | 2.00 | 0.029 | H# 7@ 9 | 5 - 6 | #10@18 | # 5@ 9 | # 9@11 | # 7@ 9 | 16 # 6 | # 5@ 9 | 176.61 |
| 13 | 39 | 3 - 9 | 9 - 8 | 40 | 19x38 | 2.98 | 5037 | 481 | 1.50 | 2.03 | 0.031 | # 6@ 6 | 4 - 5 | # 9@12 | # 4@ 6 | # 9@10 | # 6@ 6 | 19 # 6 | # 5@ 6 | 210.78 |
| 14 | 40 | 4 - 2 | 10 - 4 | 42 | 21x42 | 3.34 | 5495 | 443 | 1.50 | 2.00 | 0.042 | # 8@ 9 | 6 - 7 | #11@18 | # 6@ 9 | # 9@10 | # 8@ 9 | 12 # 8 | # 6@ 9 | 254.94 |
| 15 | 43 | 4 - 9 | 11 - 4 | 48 | 22x44 | 3.97 | 6008 | 483 | 1.50 | 2.01 | 0.047 | # 8@ 9 | 6 - 7 | #11@18 | # 6@ 9 | # 9@ 9 | # 8@ 9 | 15 # 8 | # 6@ 9 | 285.38 |
| 16 | 46 | 4 - 9 | 11 -10 | 48 | 24x48 | 4.38 | 6246 | 532 | 1.50 | 2.01 | 0.054 | # 8@ 9 | 6 - 7 | #11@18 | # 6@ 9 | # 9@ 8 | # 8@ 9 | 21 # 7 | # 6@ 9 | 309.44 |
| 17 | 54 | 9 - 1 | 17 - 0 | 54 | 25x50 | 6.05 | 5258 | 2133 | 1.50 | 2.67 | 0.045 | # 7@ 6 | 5 - 6 | #10@12 | # 6@ 6 | # 9@ 7 | # 7@ 6 | 34 # 7 | # 5@ 6 | 419.52 |
| 18 | 56 | 9 - 8 | 18 - 0 | 56 | 27x54 | 6.67 | 5503 | 2275 | 1.50 | 2.68 | 0.053 | # 9@ 9 | 5 - 6 | #10@18 | # 7@ 9 | # 9@ 7 | # 9@ 9 | 28 # 8 | # 7@ 9 | 442.46 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 115 pcf, $\phi$ = 30°, $\mu$ = 0.55

BACKFILL SLOPE: 30°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 906 | 294 | 1.55 | 2.28 | 0.002 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 9 | 2 - 2 | 3 -11 | 12 | 12x16 | 0.31 | 1808 | 221 | 1.73 | 2.05 | 0.007 | H# 4@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 22.42 |
| 5 | 8 | 2 - 2 | 3 -10 | 12 | 12x16 | 0.32 | 1933 | 160 | 1.74 | 2.01 | 0.030 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | # 4@ 9 | 21.63 |
| 6 | 8 | 2 - 9 | 4 - 8 | 12 | 12x16 | 0.38 | 2081 | 281 | 1.50 | 2.05 | 0.075 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 7 # 4 | # 4@ 9 | 25.26 |
| 7 | 10 | 3 - 1 | 5 - 4 | 14 | 12x20 | 0.52 | 2486 | 275 | 1.50 | 2.02 | 0.083 | H# 5@12 | None | None | # 4@12 | # 5@12 | # 5@12 | 9 # 4 | # 5@12 | 34.99 |
| 8 | 12 | 3 - 6 | 6 - 2 | 16 | 12x24 | 0.69 | 2745 | 378 | 1.50 | 2.05 | 0.094 | H# 6@15 | None | None | # 4@15 | # 5@12 | # 6@15 | 7 # 5 | # 6@15 | 44.17 |
| 9 | 15 | 3 - 9 | 6 -10 | 20 | 18x26 | 0.98 | 3295 | 334 | 1.50 | 2.02 | 0.087 | H# 6@12 | None | None | # 4@12 | # 6@11 | # 6@12 | 5 # 7 | # 6@12 | 64.37 |
| 10 | 19 | 4 - 1 | 7 - 8 | 20 | 18x30 | 1.22 | 3424 | 514 | 1.50 | 2.10 | 0.072 | # 6@12 | None | None | # 5@12 | # 8@16 | # 6@12 | 11 # 5 | # 6@12 | 77.32 |
| 11 | 21 | 4 - 6 | 8 - 6 | 24 | 18x32 | 1.52 | 3813 | 555 | 1.50 | 2.09 | 0.086 | # 6@ 9 | 3 - 7 | # 8@18 | # 4@ 9 | # 8@15 | # 6@ 9 | 15 # 5 | # 5@ 9 | 104.48 |
| 12 | 21 | 5 - 2 | 9 - 4 | 26 | 18x36 | 1.73 | 4205 | 580 | 1.50 | 2.07 | 0.133 | # 6@ 9 | 3 - 7 | # 8@18 | # 5@ 9 | # 8@15 | # 6@ 9 | 17 # 5 | # 5@ 9 | 117.05 |
| 13 | 26 | 4 -10 | 9 - 8 | 28 | 19x38 | 2.10 | 4586 | 522 | 1.50 | 2.02 | 0.105 | # 5@ 6 | 3 - 2 | # 7@12 | # 4@ 6 | # 9@15 | # 5@ 6 | 19 # 5 | # 5@ 6 | 138.10 |
| 14 | 28 | 5 - 2 | 10 - 4 | 28 | 21x42 | 2.38 | 4860 | 582 | 1.50 | 2.03 | 0.122 | # 5@ 6 | 3 - 7 | # 8@12 | # 5@ 6 | # 9@14 | # 5@ 6 | 8 # 8 | # 5@ 6 | 165.53 |
| 15 | 28 | 6 - 0 | 11 - 4 | 34 | 22x44 | 2.78 | 5466 | 554 | 1.50 | 2.01 | 0.172 | # 7@ 9 | 4 - 5 | # 9@18 | # 6@ 9 | # 9@14 | # 7@ 9 | 19 # 6 | # 6@ 9 | 196.11 |
| 16 | 30 | 6 - 1 | 11 -10 | 34 | 24x48 | 3.08 | 5743 | 565 | 1.50 | 2.00 | 0.193 | # 7@ 9 | 4 - 5 | # 9@18 | # 6@ 9 | # 9@13 | # 7@ 9 | 20 # 6 | # 6@ 9 | 209.86 |
| 17 | 32 | 6 - 9 | 12 -10 | 38 | 25x50 | 3.57 | 6139 | 653 | 1.50 | 2.02 | 0.215 | # 6@ 6 | 3 - 7 | # 8@12 | # 6@ 6 | # 9@12 | # 6@ 6 | 24 # 6 | # 5@ 6 | 248.55 |
| 18 | 36 | 6 - 6 | 13 - 2 | 36 | 27x54 | 3.91 | 6280 | 701 | 1.50 | 2.02 | 0.201 | # 8@ 9 | 5 - 6 | #10@18 | # 7@ 9 | # 9@11 | # 7@ 9 | 13 # 8 | # 7@ 9 | 283.88 |
| 19 | 38 | 7 - 0 | 14 - 0 | 40 | 28x56 | 4.44 | 6754 | 707 | 1.50 | 2.01 | 0.224 | # 8@ 9 | 5 - 6 | #10@18 | # 7@ 9 | # 9@10 | # 8@ 9 | 21 # 7 | # 7@ 9 | 322.07 |
| 20 | 40 | 7 - 4 | 14 - 8 | 40 | 30x60 | 4.84 | 7028 | 766 | 1.50 | 2.02 | 0.248 | # 7@ 6 | 4 - 5 | # 9@12 | # 6@ 6 | # 9@10 | # 7@ 6 | 29 # 6 | # 6@ 6 | 357.70 |
| 21 | 42 | 7 -11 | 15 - 8 | 48 | 30x60 | 5.60 | 7627 | 753 | 1.50 | 2.01 | 0.274 | # 9@ 9 | 6 - 7 | #11@18 | # 8@ 9 | # 9@ 9 | # 8@ 9 | 21 # 8 | # 7@ 9 | 416.81 |
| 22 | 50 | 8 - 5 | 17 - 0 | 50 | 30x60 | 6.57 | 7540 | 1194 | 1.50 | 2.11 | 0.205 | # 7@ 6 | 5 - 6 | #10@12 | # 7@ 6 | # 9@ 8 | # 7@ 6 | 31 # 7 | # 6@ 6 | 471.80 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 115 pcf, $\phi$ = 35°, $\mu$ = 0.45

BACKFILL SLOPE: 35°

$f_c' =$ 3,000 psi

$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "O" Bars | Dowels into Stem | (3) "M" Bars | "D" Bars | (5) "$L_w$" Bars | (2) "P" Bars | "$L_b$" Bars | (6) "K" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 810 | 452 | 1.63 | 2.52 | 0.002 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 2 - 0 | 3 - 8 | 12 | 12x16 | 0.29 | 1826 | 338 | 1.86 | 2.08 | 0.009 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | # 4@ 9 | 19.92 |
| 5 | 8 | 1 -10 | 3 - 6 | 12 | 12x16 | 0.31 | 1955 | 259 | 1.90 | 2.02 | 0.027 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | # 4@ 9 | 21.33 |
| 6 | 8 | 2 - 3 | 4 - 2 | 12 | 12x16 | 0.36 | 2154 | 339 | 1.58 | 2.01 | 0.068 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 24.15 |
| 7 | 9 | 2 - 8 | 4 -10 | 12 | 12x20 | 0.45 | 2425 | 417 | 1.53 | 2.03 | 0.102 | # 4@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9 | 7 # 4 | # 4@ 9 | 30.00 |
| 8 | 12 | 2 - 8 | 5 - 4 | 12 | 12x24 | 0.58 | 2609 | 500 | 1.52 | 2.04 | 0.084 | # 4@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9 | 7 # 4 | # 5@ 9 | 35.43 |
| 9 | 14 | 3 - 4 | 6 - 4 | 20 | 12x24 | 0.87 | 3262 | 522 | 1.50 | 2.02 | 0.096 | H# 6@12 | None | None | # 4@12 | # 6@12 | # 6@12 | 9 # 5 | # 5@12 | 58.49 |
| 10 | 15 | 3 - 7 | 6 -10 | 18 | 18x30 | 1.00 | 3515 | 585 | 1.51 | 2.03 | 0.132 | H# 7@18 | None | None | # 5@18 | # 6@11 | H# 7@18 | 9 # 5 | # 7@18 | 65.95 |
| 11 | 16 | 4 - 1 | 7 - 8 | 22 | 18x32 | 1.24 | 3911 | 655 | 1.50 | 2.03 | 0.175 | # 6@ 9 | 3 - 2 | # 7@18 | # 4@ 9 | # 7@15 | # 6@ 9 | 12 # 5 | # 5@ 9 | 88.07 |
| 12 | 18 | 4 - 3 | 8 - 2 | 22 | 18x36 | 1.42 | 4220 | 674 | 1.51 | 2.01 | 0.190 | # 6@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 8@17 | # 6@ 9 | 5 # 8 | # 5@ 9 | 97.85 |
| 13 | 21 | 4 - 5 | 8 -10 | 24 | 19x38 | 1.72 | 4471 | 781 | 1.50 | 2.03 | 0.178 | # 6@ 9 | 3 - 7 | # 8@18 | # 5@ 9 | # 8@15 | # 6@ 9 | 15 # 5 | # 6@ 9 | 119.81 |
| 14 | 21 | 4 -11 | 9 - 6 | 26 | 21x42 | 1.94 | 4947 | 767 | 1.51 | 2.01 | 0.258 | # 7@ 9 | 3 - 7 | # 8@18 | # 5@ 9 | # 8@15 | # 6@ 9 | 9 # 7 | # 6@ 9 | 138.39 |
| 15 | 24 | 5 - 2 | 10 - 2 | 28 | 22x44 | 2.29 | 5283 | 838 | 1.50 | 2.01 | 0.244 | # 7@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 9@16 | # 7@ 9 | 14 # 6 | # 6@ 9 | 166.58 |
| 16 | 25 | 5 - 4 | 10 - 8 | 28 | 24x48 | 2.51 | 5562 | 867 | 1.50 | 2.00 | 0.298 | # 6@ 6 | 3 - 2 | # 7@12 | # 5@ 6 | # 9@16 | # 6@ 6 | 21 # 5 | # 5@ 6 | 182.22 |
| 17 | 27 | 5 -10 | 11 - 6 | 32 | 25x50 | 2.94 | 6011 | 931 | 1.51 | 2.01 | 0.321 | # 8@ 9 | 4 - 5 | # 9@18 | # 6@ 9 | # 9@14 | # 7@ 9 | 19 # 6 | # 6@ 9 | 220.89 |
| 18 | 28 | 6 - 2 | 12 - 2 | 32 | 27x54 | 3.21 | 6210 | 1047 | 1.50 | 2.02 | 0.383 | # 7@ 6 | 3 - 7 | # 8@12 | # 6@ 6 | # 9@14 | # 6@ 6 | 11 # 8 | # 5@ 6 | 247.63 |
| 19 | 30 | 6 - 6 | 12 -10 | 36 | 28x56 | 3.67 | 6739 | 1024 | 1.51 | 2.00 | 0.408 | # 7@ 6 | 3 - 7 | # 8@12 | # 6@ 6 | # 9@13 | # 6@ 6 | 23 # 6 | # 6@ 6 | 280.27 |
| 20 | 30 | 7 - 0 | 13 - 6 | 36 | 30x60 | 3.91 | 7064 | 1074 | 1.50 | 2.00 | 0.527 | # 8@ 6 | 3 - 7 | # 8@12 | # 6@ 6 | # 9@13 | # 7@ 6 | 24 # 6 | # 6@ 6 | 322.15 |
| 21 | 36 | 6 -11 | 14 - 2 | 40 | 30x60 | 4.64 | 7325 | 1204 | 1.50 | 2.02 | 0.389 | # 9@ 9 | 5 - 6 | #10@18 | # 8@ 9 | # 9@11 | # 8@ 9 | 28 # 6 | # 7@ 9 | 354.64 |
| 22 | 42 | 6 - 9 | 14 - 8 | 44 | 30x60 | 5.40 | 7752 | 1212 | 1.50 | 2.01 | 0.309 | # 9@ 9 | 6 - 7 | #11@18 | # 8@ 9 | # 9@ 9 | # 8@ 9 | 18 # 8 | # 7@ 9 | 410.28 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 115 pcf, $\phi$ = 35°, $\mu$ = 0.55

BACKFILL SLOPE: 35°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 810 | 452 | 1.83 | 2.52 | 0.002 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 10 | 1 - 0 | 2 -10 | 12 | None | 0.23 | 1316 | 310 | 1.52 | 2.09 | 0.005 | H# 4@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9H | 5 # 4 | None | 17.03 |
| 5 | 8 | 2 - 8 | 4 - 4 | 12 | 12x16 | 0.34 | 2280 | 317 | 1.73 | 2.02 | 0.027 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 22.74 |
| 6 | 8 | 2 - 3 | 4 - 2 | 12 | 12x16 | 0.36 | 2154 | 339 | 1.76 | 2.01 | 0.068 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 24.15 |
| 7 | 9 | 2 - 8 | 4 -10 | 12 | 12x16 | 0.43 | 2401 | 414 | 1.57 | 2.02 | 0.102 | # 4@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9 | 7 # 4 | # 4@ 9 | 29.70 |
| 8 | 8 | 3 - 2 | 5 - 6 | 12 | 12x20 | 0.47 | 2669 | 471 | 1.52 | 2.00 | 0.284 | # 7@15 | None | None | # 4@15 | # 4@12 | # 6@15 | 5 # 5 | # 6@15 | 40.90 |
| 9 | 9 | 3 - 7 | 6 - 2 | 12 | 12x24 | 0.57 | 2938 | 548 | 1.51 | 2.02 | 0.360 | # 6@ 9 | None | None | # 4@ 9 | # 5@12 | # 5@ 9 | 8 # 4 | # 5@ 9 | 54.19 |
| 10 | 12 | 4 - 0 | 7 - 0 | 18 | 12x24 | 0.85 | 3479 | 579 | 1.51 | 2.01 | 0.257 | H# 8@18 | None | None | # 5@18 | # 5@12 | H# 7@18 | 9 # 5 | # 6@18 | 61.99 |
| 11 | 11 | 4 - 2 | 7 - 4 | 12 | 18x32 | 0.82 | 3519 | 654 | 1.51 | 2.01 | 0.538 | # 7@ 9 | 2 - 5 | # 6@18 | # 4@ 9 | # 5@12 | # 6@ 9 | 10 # 4 | # 5@ 9 | 71.15 |
| 12 | 13 | 4 - 6 | 8 - 0 | 14 | 18x34 | 1.01 | 3886 | 695 | 1.51 | 2.01 | 0.503 | # 7@ 9 | 2 - 5 | # 6@18 | # 5@ 9 | # 6@12 | # 7@ 9 | 8 # 5 | # 5@ 9 | 91.85 |
| 13 | 14 | 5 - 0 | 8 -10 | 16 | 18x36 | 1.20 | 4136 | 828 | 1.50 | 2.03 | 0.601 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@12 | # 7@ 9 | 7 # 6 | # 5@ 9 | 116.12 |
| 14 | 16 | 5 - 4 | 9 - 6 | 18 | 19x38 | 1.44 | 4511 | 871 | 1.50 | 2.03 | 0.584 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@15 | # 7@ 9 | 12 # 5 | # 6@ 9 | 130.90 |
| 15 | 18 | 5 - 8 | 10 - 2 | 20 | 20x40 | 1.71 | 4888 | 913 | 1.50 | 2.02 | 0.579 | # 8@ 9 | 3 - 2 | # 7@18 | # 6@ 9 | # 8@17 | # 7@ 9 | 10 # 6 | # 6@ 9 | 149.07 |
| 16 | 18 | 6 - 1 | 10 -10 | 20 | 22x44 | 1.86 | 5129 | 998 | 1.50 | 2.03 | 0.799 | # 9@ 9 | 3 - 5 | # 7@18 | # 6@ 9 | # 8@17 | # 8@ 9 | 6 # 8 | # 6@ 9 | 175.75 |
| 17 | 20 | 6 - 5 | 11 - 6 | 22 | 23x46 | 2.16 | 5505 | 1041 | 1.51 | 2.02 | 0.789 | # 8@ 6 | 2 - 9 | # 6@12 | # 5@ 6 | # 8@15 | # 7@ 6 | 7 # 8 | # 5@ 6 | 207.67 |
| 18 | 22 | 6 - 6 | 12 - 0 | 24 | 24x48 | 2.47 | 5876 | 1030 | 1.51 | 2.00 | 0.789 | # 8@ 6 | 3 - 2 | # 7@12 | # 6@ 6 | # 8@14 | # 7@ 6 | 8 # 8 | # 5@ 6 | 236.51 |
| 19 | 23 | 6 -11 | 12 - 8 | 24 | 26x52 | 2.70 | 6159 | 1109 | 1.51 | 2.01 | 0.905 | #10@ 9 | 4 - 3 | # 8@18 | # 7@ 9 | # 9@17 | # 9@ 9 | 15 # 6 | # 6@ 9 | 261.61 |
| 20 | 25 | 7 - 3 | 13 - 4 | 26 | 27x54 | 3.06 | 6536 | 1151 | 1.51 | 2.01 | 0.910 | # 9@ 6 | 3 - 5 | # 7@12 | # 6@ 6 | # 9@16 | # 8@ 6 | 25 # 5 | # 5@ 6 | 305.51 |
| 21 | 26 | 7 - 7 | 14 - 0 | 28 | 28x56 | 3.38 | 6869 | 1199 | 1.51 | 2.00 | 1.033 | # 9@ 6 | 3 - 5 | # 7@12 | # 6@ 6 | # 9@15 | # 8@ 6 | 11 # 8 | # 6@ 6 | 333.31 |
| 22 | 28 | 7 -11 | 14 - 8 | 30 | 29x58 | 3.78 | 7246 | 1241 | 1.51 | 2.00 | 1.043 | #11@ 9 | 5 - 1 | # 9@18 | # 8@ 9 | # 9@14 | #10@ 9 | 16 # 7 | # 7@ 9 | 389.42 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 115 pcf, $\phi$ = 40°, $\mu$ = 0.45

BACKFILL SLOPE: 40°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "O" Bars | Dowels into Stem | (3) "M" Bars | "D" Bars | (5) "$L_w$" Bars | (2) "P" Bars | "$L_b$" Bars | (6) "K" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 705 | 612 | 2.00 | 2.79 | 0.002 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 1292 | 413 | 1.58 | 2.12 | 0.008 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 10 | 1 - 7 | 3 - 5 | 16 | None | 0.32 | 1903 | 439 | 1.50 | 2.07 | 0.012 | H# 6@15 | None | None | # 4@15 | # 5@12 | H# 6@15H | 6 # 4 | None | 24.07 |
| 6 | 8 | 1 -10 | 3 - 9 | 12 | 12x18 | 0.35 | 2148 | 472 | 2.11 | 2.04 | 0.059 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | # 4@ 9 | 23.26 |
| 7 | 8 | 2 - 4 | 4 - 5 | 12 | 12x18 | 0.40 | 2414 | 561 | 1.77 | 2.04 | 0.128 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 26.08 |
| 8 | 9 | 2 - 7 | 5 - 0 | 12 | 12x18 | 0.47 | 2580 | 675 | 1.58 | 2.05 | 0.175 | # 6@15 | None | None | # 4@15 | # 5@12 | # 6@15 | 7 # 4 | # 6@15 | 38.10 |
| 9 | 8 | 3 - 2 | 5 - 8 | 12 | 12x22 | 0.51 | 2917 | 744 | 1.53 | 2.03 | 0.448 | # 6@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 5 | # 5@ 9 | 47.06 |
| 10 | 12 | 3 - 0 | 6 - 0 | 12 | 12x24 | 0.68 | 3161 | 779 | 1.51 | 2.02 | 0.225 | # 6@12 | None | None | # 4@12 | # 5@12 | # 6@12 | 8 # 4 | # 5@12 | 49.82 |
| 11 | 12 | 3 - 8 | 6 -11 | 18 | 12x24 | 0.88 | 3676 | 870 | 1.51 | 2.02 | 0.362 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 9 # 5 | # 5@ 9 | 65.22 |
| 12 | 12 | 3 -11 | 7 - 4 | 14 | 18x30 | 0.92 | 3843 | 940 | 1.51 | 2.02 | 0.560 | # 7@ 9 | 2 - 5 | # 6@18 | # 4@ 9 | # 5@12 | # 6@ 9 | 12 # 4 | # 5@ 9 | 75.87 |
| 13 | 14 | 4 - 0 | 7 -10 | 16 | 18x32 | 1.12 | 4131 | 1019 | 1.52 | 2.02 | 0.526 | # 6@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 6@12 | # 5@ 6 | 9 # 5 | # 5@ 6 | 96.34 |
| 14 | 15 | 4 - 6 | 8 - 7 | 20 | 18x32 | 1.35 | 4625 | 1062 | 1.50 | 2.00 | 0.619 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@11 | # 6@ 9 | 12 # 5 | # 5@ 9 | 117.00 |
| 15 | 18 | 4 -10 | 9 - 4 | 24 | 18x32 | 1.70 | 5022 | 1171 | 1.50 | 2.02 | 0.506 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 8@17 | # 6@ 9 | 11 # 6 | # 5@ 9 | 134.55 |
| 16 | 18 | 5 -11 | 10 - 8 | 20 | 20x40 | 1.79 | 4677 | 1763 | 1.52 | 2.19 | 0.699 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@17 | # 6@ 6 | 15 # 5 | # 5@ 6 | 159.67 |
| 17 | 20 | 6 - 3 | 11 - 4 | 20 | 21x42 | 2.02 | 4881 | 1909 | 1.50 | 2.21 | 0.690 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@15 | # 7@ 6 | 16 # 5 | # 5@ 6 | 187.57 |
| 18 | 22 | 6 - 6 | 12 - 0 | 22 | 22x44 | 2.34 | 5136 | 2040 | 1.51 | 2.22 | 0.690 | # 9@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 8@14 | # 8@ 9 | 13 # 6 | # 6@ 9 | 209.77 |
| 19 | 22 | 7 - 0 | 12 - 8 | 24 | 23x46 | 2.55 | 5559 | 2091 | 1.50 | 2.19 | 0.904 | # 8@ 6 | 3 - 2 | # 7@12 | # 5@ 6 | # 8@14 | # 7@ 6 | 15 # 6 | # 5@ 6 | 241.17 |
| 20 | 24 | 7 - 4 | 13 - 4 | 26 | 24x48 | 2.91 | 5900 | 2192 | 1.51 | 2.19 | 0.900 | #10@ 9 | 4 - 3 | # 8@18 | # 7@ 9 | # 9@16 | # 9@ 9 | 25 # 5 | # 6@ 9 | 279.75 |
| 21 | 25 | 7 - 8 | 14 - 0 | 30 | 24x48 | 3.27 | 6320 | 2248 | 1.50 | 2.17 | 1.016 | # 9@ 6 | 3 - 5 | # 7@12 | # 6@ 6 | # 9@16 | # 7@ 6 | 21 # 6 | # 5@ 6 | 309.00 |
| 22 | 27 | 8 - 0 | 14 - 8 | 32 | 25x50 | 3.67 | 6661 | 2348 | 1.51 | 2.17 | 1.018 | # 9@ 6 | 3 - 5 | # 7@12 | # 6@ 6 | # 9@14 | # 7@ 6 | 17 # 7 | # 5@ 6 | 332.68 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 115 pcf, $\phi$ = 40°, $\mu$ = 0.55

BACKFILL SLOPE: 40°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 705 | 612 | 2.23 | 2.79 | 0.002 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 1292 | 413 | 1.78 | 2.12 | 0.008 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 8 | 1 - 8 | 3 - 4 | 12 | None | 0.25 | 1736 | 449 | 1.51 | 2.07 | 0.024 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | None | 17.32 |
| 6 | 8 | 2 - 8 | 4 - 7 | 16 | None | 0.37 | 1972 | 774 | 1.50 | 2.25 | 0.059 | H# 6@15 | None | None | # 4@15 | # 4@12 | H# 6@15 | 8 # 4 | None | 26.68 |
| 7 | 8 | 2 - 4 | 4 - 5 | 12 | 12x18 | 0.40 | 2414 | 561 | 1.97 | 2.04 | 0.128 | # 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 26.08 |
| 8 | 9 | 2 - 7 | 5 - 0 | 12 | 12x18 | 0.47 | 2580 | 675 | 1.77 | 2.05 | 0.175 | # 6@15 | None | None | # 4@15 | # 5@12 | # 6@15 | 7 # 4 | # 6@15 | 38.10 |
| 9 | 8 | 3 - 2 | 5 - 8 | 12 | 12x18 | 0.50 | 2897 | 740 | 1.60 | 2.03 | 0.448 | # 6@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 5 | # 4@ 9 | 44.40 |
| 10 | 10 | 3 - 4 | 6 - 2 | 12 | 12x18 | 0.60 | 3151 | 803 | 1.51 | 2.02 | 0.389 | # 6@ 9 | None | None | # 4@ 9 | # 5@12 | # 5@ 9 | 8 # 4 | # 4@ 9 | 54.60 |
| 11 | 12 | 3 - 8 | 6 -11 | 12 | 12x20 | 0.73 | 3221 | 1029 | 1.50 | 2.09 | 0.362 | # 6@ 9 | 2 - 2 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 9 # 4 | # 4@ 9 | 56.86 |
| 12 | 12 | 3 -11 | 7 - 4 | 14 | 12x22 | 0.84 | 3771 | 922 | 1.51 | 2.00 | 0.560 | # 7@ 9 | 2 - 5 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 12 # 4 | # 5@ 9 | 71.25 |
| 13 | 14 | 4 - 6 | 8 - 4 | 14 | 12x24 | 1.01 | 3698 | 1325 | 1.50 | 2.13 | 0.526 | # 6@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 6@12 | # 5@ 6 | 13 # 4 | # 4@ 6 | 89.93 |
| 14 | 15 | 4 - 6 | 8 - 7 | 18 | 12x24 | 1.21 | 4408 | 1107 | 1.50 | 2.01 | 0.619 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@11 | # 6@ 9 | 17 # 4 | # 5@ 9 | 113.99 |
| 15 | 16 | 5 - 0 | 9 - 4 | 22 | 12x24 | 1.46 | 4904 | 1155 | 1.51 | 2.00 | 0.721 | # 7@ 6 | 2 - 5 | # 6@12 | # 4@ 6 | # 7@15 | # 5@ 6 | 15 # 5 | # 4@ 6 | 131.39 |
| 16 | 18 | 5 - 0 | 9 - 9 | 20 | 18x28 | 1.64 | 5008 | 1264 | 1.52 | 2.01 | 0.699 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@17 | # 5@ 6 | 14 # 5 | # 4@ 6 | 142.64 |
| 17 | 20 | 5 - 3 | 10 - 4 | 20 | 18x30 | 1.85 | 5239 | 1368 | 1.51 | 2.02 | 0.690 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@15 | # 6@ 6 | 15 # 5 | # 4@ 6 | 164.17 |
| 18 | 22 | 5 - 4 | 10 -10 | 22 | 18x32 | 2.13 | 5531 | 1446 | 1.53 | 2.02 | 0.690 | # 9@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 8@14 | # 7@ 9 | 17 # 5 | # 5@ 9 | 189.71 |
| 19 | 22 | 5 -11 | 11 - 7 | 24 | 18x32 | 2.32 | 5924 | 1521 | 1.50 | 2.02 | 0.904 | # 8@ 6 | 3 - 2 | # 7@12 | # 5@ 6 | # 8@14 | # 6@ 6 | 14 # 6 | # 5@ 6 | 220.10 |
| 20 | 24 | 10 - 4 | 16 - 4 | 24 | 18x32 | 2.87 | 4845 | 3378 | 1.50 | 2.59 | 0.900 | #10@ 9 | 4 - 3 | # 8@18 | # 7@ 9 | # 9@16 | # 9@ 9 | 28 # 5 | # 5@ 9 | 288.52 |
| 21 | 25 | 7 - 8 | 14 - 0 | 26 | 18x36 | 2.94 | 5967 | 2330 | 1.51 | 2.19 | 1.016 | # 9@ 6 | 3 - 5 | # 7@12 | # 6@ 6 | # 9@16 | # 7@ 6 | 10 # 8 | # 5@ 6 | 298.39 |
| 22 | 27 | 8 - 0 | 14 - 8 | 28 | 18x36 | 3.30 | 6296 | 2429 | 1.50 | 2.19 | 1.018 | # 9@ 6 | 3 - 5 | # 7@12 | # 6@ 6 | # 9@14 | # 7@ 6 | 29 # 5 | # 5@ 6 | 322.06 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 130 pcf, $\phi$ = 30°, $\mu$ = 0.45

BACKFILL SLOPE: 30°

$f_c' =$ 3,000 psi

$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "O" Bars | Dowels into Stem | (3) "M" Bars | "D" Bars | (5) "$L_w$" Bars | (2) "P" Bars | "$L_b$" Bars | (6) "K" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | 12x18 | 0.24 | 1087 | 395 | 3.02 | 2.43 | 0.003 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | # 4@ 9 | 17.62 |
| 4 | 8 | 1 - 6 | 3 - 2 | 12 | 12x18 | 0.28 | 1637 | 237 | 2.10 | 2.08 | 0.011 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | # 4@ 9 | 19.62 |
| 5 | 8 | 2 - 4 | 4 - 0 | 12 | 12x18 | 0.34 | 2049 | 250 | 1.62 | 2.06 | 0.034 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 22.59 |
| 6 | 8 | 2 -10 | 4 - 9 | 12 | 12x22 | 0.40 | 2290 | 341 | 1.51 | 2.07 | 0.085 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 7 # 4 | # 5@ 9 | 28.15 |
| 7 | 9 | 3 - 1 | 5 - 3 | 12 | 18x28 | 0.54 | 2769 | 293 | 1.52 | 2.01 | 0.129 | H# 5@12 | None | None | # 4@12 | # 5@12 | # 5@12 | 7 # 4 | # 6@12 | 36.47 |
| 8 | 12 | 3 - 4 | 6 - 0 | 14 | 18x32 | 0.73 | 3044 | 390 | 1.50 | 2.03 | 0.106 | H# 6@15 | None | None | # 4@15 | # 5@12 | # 6@15 | 6 # 5 | # 7@15 | 46.51 |
| 9 | 21 | 3 - 3 | 6 -10 | 22 | 18x32 | 1.22 | 3580 | 428 | 1.51 | 2.03 | 0.036 | H# 7@15 | None | None | # 5@15 | # 8@15 | # 7@15H | 11 # 5 | # 7@15 | 78.12 |
| 10 | 32 | 3 - 0 | 7 - 8 | 32 | 18x30 | 1.91 | 4201 | 442 | 1.51 | 2.03 | 0.017 | H# 8@12 | None | None | # 5@12 | # 9@12 | # 8@12H | 9 # 7 | # 6@12 | 130.35 |
| 11 | 36 | 3 - 1 | 8 - 4 | 36 | 18x32 | 2.32 | 4643 | 441 | 1.50 | 2.00 | 0.019 | H# 7@ 9 | 5 - 6 | #10@18 | # 5@ 9 | # 9@11 | # 7@ 9H | 15 # 6 | # 5@ 9 | 166.50 |
| 12 | 37 | 3 -10 | 9 - 4 | 40 | 18x36 | 2.72 | 5120 | 500 | 1.50 | 2.01 | 0.028 | # 6@ 6 | 4 - 5 | # 9@12 | # 4@ 6 | # 9@10 | # 6@ 6 | 14 # 7 | # 5@ 6 | 198.24 |
| 13 | 42 | 3 -10 | 10 - 0 | 44 | 19x38 | 3.27 | 5530 | 528 | 1.51 | 2.00 | 0.028 | H# 8@ 9 | 6 - 7 | #11@18 | # 6@ 9 | # 9@ 9 | # 8@ 9 | 16 # 7 | # 6@ 9 | 250.86 |
| 14 | 43 | 4 - 5 | 10 -10 | 46 | 21x42 | 3.67 | 5941 | 580 | 1.50 | 2.01 | 0.038 | H# 8@ 9 | 6 - 7 | #11@18 | # 6@ 9 | # 9@ 9 | # 8@ 9 | 18 # 7 | # 6@ 9 | 271.11 |
| 15 | 49 | 4 - 5 | 11 - 6 | 50 | 22x44 | 4.34 | 6392 | 600 | 1.51 | 2.01 | 0.036 | # 7@ 6 | 5 - 6 | #10@12 | # 5@ 6 | # 9@ 8 | # 7@ 6 | 21 # 7 | # 5@ 6 | 322.95 |
| 16 | 54 | 8 - 3 | 16 - 0 | 54 | 24x48 | 5.69 | 5412 | 2178 | 1.50 | 2.59 | 0.037 | # 7@ 6 | 5 - 6 | #10@12 | # 6@ 6 | # 9@ 7 | # 7@ 6 | 24 # 8 | # 5@ 6 | 397.54 |
| 17 | 59 | 8 - 8 | 17 - 0 | 59 | 25x50 | 6.58 | 5825 | 2294 | 1.50 | 2.58 | 0.039 | H# 9@ 9 | 5 - 6 | #10@18 | # 7@ 9 | # 9@ 6 | # 9@ 9 | 28 # 8 | # 6@ 9 | 439.02 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 130 pcf, $\phi$ = 30°, $\mu$ = 0.55

BACKFILL SLOPE: 30°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 9 | 1 - 0 | 2 - 9 | 12 | None | 0.19 | 934 | 351 | 1.52 | 2.32 | 0.002 | H# 4@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9H | 5 # 4 | None | 14.92 |
| 4 | 8 | 1 - 6 | 3 - 2 | 12 | 12x18 | 0.28 | 1637 | 237 | 2.28 | 2.08 | 0.011 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | # 4@ 9 | 19.62 |
| 5 | 8 | 2 - 4 | 4 - 0 | 12 | 12x18 | 0.34 | 2049 | 250 | 1.79 | 2.06 | 0.034 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 22.59 |
| 6 | 8 | 2 -10 | 4 - 9 | 12 | 12x18 | 0.39 | 2262 | 341 | 1.54 | 2.06 | 0.085 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 7 # 4 | # 4@ 9 | 25.49 |
| 7 | 10 | 3 - 2 | 5 - 5 | 12 | 12x22 | 0.50 | 2549 | 401 | 1.50 | 2.06 | 0.094 | # 4@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9 | 5 # 5 | # 5@ 9 | 33.67 |
| 8 | 8 | 4 - 0 | 6 - 4 | 12 | 18x28 | 0.58 | 2858 | 526 | 1.50 | 2.11 | 0.359 | # 6@ 9 | None | None | # 4@ 9 | # 4@12 | # 5@ 9 | 9 # 4 | # 5@ 9 | 49.25 |
| 9 | 11 | 4 - 1 | 6 -10 | 14 | 18x32 | 0.78 | 3332 | 461 | 1.50 | 2.04 | 0.249 | # 8@18 | None | None | # 5@18 | # 5@12 | # 7@18 | 7 # 5 | # 8@18 | 61.87 |
| 10 | 13 | 5 - 1 | 8 - 2 | 24 | 18x32 | 1.18 | 4044 | 520 | 1.50 | 2.04 | 0.256 | # 6@ 9 | None | None | # 4@ 9 | # 6@12 | # 6@ 9 | 14 # 5 | # 5@ 9 | 84.21 |
| 11 | 24 | 6 - 4 | 10 - 7 | 24 | 18x32 | 1.77 | 3374 | 1454 | 1.50 | 2.56 | 0.065 | # 6@ 9 | 3 - 7 | # 8@18 | # 5@ 9 | # 9@16 | # 6@ 9 | 7 # 8 | # 5@ 9 | 118.09 |
| 12 | 25 | 4 - 8 | 9 - 2 | 28 | 18x36 | 1.92 | 4699 | 543 | 1.50 | 2.01 | 0.089 | # 5@ 6 | 3 - 2 | # 7@12 | # 4@ 6 | # 9@16 | # 5@ 6 | 18 # 5 | # 5@ 6 | 129.55 |
| 13 | 27 | 5 - 1 | 10 - 0 | 32 | 19x38 | 2.29 | 5137 | 581 | 1.50 | 2.00 | 0.106 | # 7@ 9 | 4 - 5 | # 9@18 | # 6@ 9 | # 9@14 | # 7@ 9 | 16 # 6 | # 6@ 9 | 173.11 |
| 14 | 29 | 5 - 9 | 11 - 0 | 32 | 21x42 | 2.61 | 5279 | 817 | 1.50 | 2.07 | 0.124 | # 7@ 9 | 4 - 5 | # 9@18 | # 6@ 9 | # 9@13 | # 7@ 9 | 13 # 7 | # 6@ 9 | 189.26 |
| 15 | 32 | 5 -10 | 11 - 6 | 36 | 22x44 | 3.06 | 5916 | 674 | 1.50 | 2.01 | 0.130 | # 7@ 9 | 5 - 6 | #10@18 | # 6@ 9 | # 9@12 | # 7@ 9 | 15 # 7 | # 6@ 9 | 217.71 |
| 16 | 32 | 6 - 5 | 12 - 4 | 38 | 24x48 | 3.38 | 6286 | 738 | 1.50 | 2.01 | 0.180 | # 6@ 6 | 3 - 7 | # 8@12 | # 6@ 6 | # 9@12 | # 6@ 6 | 17 # 7 | # 5@ 6 | 238.58 |
| 17 | 36 | 7 - 3 | 13 - 8 | 40 | 25x50 | 3.96 | 6345 | 1112 | 1.50 | 2.11 | 0.171 | # 6@ 6 | 3 - 7 | # 8@12 | # 6@ 6 | # 9@11 | # 6@ 6 | 15 # 8 | # 5@ 6 | 264.48 |
| 18 | 36 | 7 - 8 | 14 - 4 | 42 | 27x54 | 4.31 | 6790 | 1096 | 1.50 | 2.09 | 0.227 | # 8@ 9 | 5 - 6 | #10@18 | # 7@ 9 | # 9@11 | # 8@ 9 | 22 # 7 | # 7@ 9 | 311.48 |
| 19 | 42 | 7 - 0 | 14 - 4 | 44 | 28x56 | 4.89 | 7398 | 838 | 1.50 | 2.00 | 0.188 | # 8@ 9 | 6 - 7 | #11@18 | # 8@ 9 | # 9@ 9 | # 8@ 9 | 23 # 7 | # 7@ 9 | 361.06 |
| 20 | 42 | 7 - 8 | 15 - 2 | 46 | 30x60 | 5.30 | 7848 | 867 | 1.50 | 2.00 | 0.243 | # 7@ 6 | 4 - 5 | # 9@12 | # 7@ 6 | # 9@ 9 | # 7@ 6 | 26 # 7 | # 6@ 6 | 395.84 |
| 21 | 50 | 7 - 5 | 15 -10 | 50 | 30x60 | 6.24 | 8129 | 965 | 1.50 | 2.01 | 0.183 | # 7@ 6 | 5 - 6 | #10@12 | # 7@ 6 | # 9@ 8 | # 7@ 6 | 22 # 8 | # 6@ 6 | 453.68 |
| 22 | 52 | 13 -11 | 22 - 8 | 52 | 30x60 | 7.72 | 6543 | 3304 | 1.50 | 2.71 | 0.206 | # 9@ 9 | 5 - 6 | #10@18 | # 9@ 9 | # 9@ 7 | # 9@ 9 | 43 # 7 | # 7@ 9 | 536.31 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 130 pcf, $\phi$ = 35°, $\mu$ = 0.45

BACKFILL SLOPE: 35°

$f_c' =$ 3,000 psi

$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 881 | 477 | 1.59 | 2.44 | 0.002 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 2 - 0 | 3 - 8 | 12 | 12x16 | 0.29 | 2004 | 358 | 1.83 | 2.03 | 0.010 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | # 4@ 9 | 19.92 |
| 5 | 8 | 2 - 0 | 3 - 8 | 12 | 12x16 | 0.32 | 2054 | 363 | 1.85 | 2.06 | 0.031 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | # 4@ 9 | 21.48 |
| 6 | 8 | 2 - 5 | 4 - 4 | 12 | 12x16 | 0.36 | 2284 | 455 | 1.55 | 2.05 | 0.076 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 24.30 |
| 7 | 10 | 2 - 7 | 4 -10 | 12 | 12x20 | 0.47 | 2623 | 474 | 1.51 | 2.01 | 0.084 | # 4@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9 | 7 # 4 | # 4@ 9 | 30.10 |
| 8 | 11 | 3 - 1 | 5 - 8 | 14 | 12x24 | 0.61 | 2912 | 620 | 1.51 | 2.05 | 0.124 | H# 6@15 | None | None | # 4@15 | # 5@12 | # 6@15 | 9 # 4 | # 6@15 | 41.29 |
| 9 | 17 | 3 - 1 | 6 - 4 | 20 | 12x24 | 0.95 | 3446 | 634 | 1.50 | 2.03 | 0.060 | H# 6@12 | None | None | # 4@12 | # 7@14 | # 6@12 | 9 # 5 | # 5@12 | 61.56 |
| 10 | 15 | 3 - 9 | 7 - 0 | 20 | 18x30 | 1.06 | 3939 | 642 | 1.50 | 2.00 | 0.149 | # 6@12 | None | None | # 5@12 | # 6@11 | # 6@12 | 7 # 6 | # 6@12 | 70.03 |
| 11 | 18 | 4 - 1 | 7 -10 | 24 | 18x32 | 1.37 | 4283 | 775 | 1.51 | 2.03 | 0.139 | # 6@ 9 | 3 - 2 | # 7@18 | # 4@ 9 | # 8@17 | # 6@ 9 | 7 # 7 | # 5@ 9 | 93.91 |
| 12 | 21 | 4 - 0 | 8 - 2 | 22 | 18x36 | 1.53 | 4496 | 800 | 1.50 | 2.01 | 0.135 | # 6@ 9 | 3 - 7 | # 8@18 | # 5@ 9 | # 8@15 | # 6@ 9 | 5 # 8 | # 5@ 9 | 109.00 |
| 13 | 23 | 4 - 5 | 9 - 0 | 26 | 19x38 | 1.87 | 4896 | 903 | 1.51 | 2.02 | 0.153 | # 6@ 9 | 3 - 7 | # 8@18 | # 5@ 9 | # 9@17 | # 6@ 9 | 17 # 5 | # 6@ 9 | 127.11 |
| 14 | 22 | 5 - 2 | 9 -10 | 28 | 21x42 | 2.07 | 5382 | 958 | 1.50 | 2.02 | 0.254 | # 7@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 8@14 | # 7@ 9 | 10 # 7 | # 6@ 9 | 156.46 |
| 15 | 26 | 5 - 2 | 10 - 4 | 30 | 22x44 | 2.46 | 5787 | 962 | 1.50 | 2.00 | 0.217 | # 7@ 9 | 4 - 5 | # 9@18 | # 6@ 9 | # 9@15 | # 7@ 9 | 16 # 6 | # 6@ 9 | 183.15 |
| 16 | 27 | 5 - 6 | 11 - 0 | 30 | 24x48 | 2.71 | 6009 | 1089 | 1.50 | 2.02 | 0.268 | # 8@ 9 | 4 - 5 | # 9@18 | # 6@ 9 | # 9@14 | # 7@ 9 | 12 # 7 | # 6@ 9 | 207.42 |
| 17 | 29 | 6 - 0 | 11 -10 | 34 | 25x50 | 3.15 | 6500 | 1156 | 1.50 | 2.02 | 0.293 | # 8@ 9 | 4 - 5 | # 9@18 | # 7@ 9 | # 9@13 | # 7@ 9 | 20 # 6 | # 6@ 9 | 233.86 |
| 18 | 30 | 6 - 2 | 12 - 4 | 34 | 27x54 | 3.41 | 6809 | 1185 | 1.50 | 2.01 | 0.352 | # 7@ 6 | 3 - 7 | # 8@12 | # 6@ 6 | # 9@13 | # 7@ 6 | 21 # 6 | # 5@ 6 | 272.41 |
| 19 | 32 | 6 - 8 | 13 - 2 | 38 | 28x56 | 3.90 | 7299 | 1252 | 1.50 | 2.01 | 0.380 | # 9@ 9 | 5 - 6 | #10@18 | # 7@ 9 | # 9@12 | # 8@ 9 | 25 # 6 | # 7@ 9 | 313.03 |
| 20 | 34 | 6 -10 | 13 - 8 | 38 | 30x60 | 4.26 | 7653 | 1273 | 1.50 | 2.00 | 0.409 | # 8@ 6 | 3 - 7 | # 8@12 | # 6@ 6 | # 9@11 | # 7@ 6 | 19 # 7 | # 6@ 6 | 342.65 |
| 21 | 40 | 6 - 9 | 14 - 4 | 42 | 30x60 | 5.01 | 7932 | 1398 | 1.50 | 2.01 | 0.321 | # 9@ 9 | 6 - 7 | #11@18 | # 8@ 9 | # 9@10 | # 9@ 9 | 22 # 7 | # 7@ 9 | 398.73 |
| 22 | 44 | 7 - 1 | 15 - 2 | 48 | 31x60 | 5.81 | 8478 | 1447 | 1.50 | 2.01 | 0.304 | # 8@ 6 | 4 - 5 | # 9@12 | # 7@ 6 | # 9@ 9 | # 7@ 6 | 20 # 8 | # 6@ 6 | 438.29 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 130 pcf, $\phi$ = 35°, $\mu$ = 0.55

BACKFILL SLOPE: 35°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 881 | 477 | 1.78 | 2.44 | 0.002 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 8 | 3 - 4 | 14 | None | 0.24 | 1459 | 462 | 1.51 | 2.19 | 0.010 | H# 5@12 | None | None | # 4@12 | # 4@12 | H# 5@12 | 6 # 4 | None | 17.83 |
| 5 | 8 | 2 - 0 | 3 - 8 | 12 | 12x18 | 0.32 | 2070 | 365 | 2.16 | 2.06 | 0.031 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 5 # 4 | # 4@ 9 | 21.63 |
| 6 | 8 | 2 - 4 | 4 - 3 | 12 | 12x18 | 0.37 | 2340 | 409 | 1.82 | 2.02 | 0.076 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 24.37 |
| 7 | 10 | 2 - 8 | 4 -11 | 12 | 12x18 | 0.46 | 2569 | 520 | 1.62 | 2.04 | 0.084 | # 4@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9 | 7 # 4 | # 4@ 9 | 30.03 |
| 8 | 8 | 3 - 8 | 6 - 0 | 12 | 12x20 | 0.49 | 2717 | 784 | 1.50 | 2.14 | 0.322 | # 8@18 | None | None | # 5@18 | # 4@12 | # 6@18 | 8 # 4 | # 6@18 | 41.67 |
| 9 | 11 | 3 - 5 | 6 - 2 | 12 | 12x24 | 0.62 | 3157 | 651 | 1.50 | 2.02 | 0.223 | # 7@15 | None | None | # 5@15 | # 5@12 | # 6@15 | 8 # 4 | # 6@15 | 49.14 |
| 10 | 12 | 4 - 2 | 7 - 2 | 12 | 18x28 | 0.79 | 3353 | 918 | 1.50 | 2.13 | 0.291 | # 6@ 9 | None | None | # 4@ 9 | # 5@12 | # 6@ 9 | 6 # 5 | # 5@ 9 | 64.44 |
| 11 | 12 | 4 - 4 | 7 - 7 | 14 | 18x32 | 0.91 | 3879 | 814 | 1.52 | 2.03 | 0.468 | # 7@ 9 | 2 - 5 | # 6@18 | # 4@ 9 | # 5@12 | # 6@ 9 | 12 # 4 | # 5@ 9 | 73.82 |
| 12 | 14 | 4 -10 | 8 - 5 | 18 | 18x32 | 1.16 | 4348 | 882 | 1.50 | 2.03 | 0.456 | # 6@ 6 | 1 -10 | # 5@12 | # 4@ 6 | # 6@12 | # 5@ 6 | 11 # 5 | # 5@ 6 | 96.86 |
| 13 | 15 | 5 - 7 | 9 - 6 | 24 | 18x32 | 1.48 | 4814 | 1032 | 1.50 | 2.05 | 0.553 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@11 | # 6@ 9 | 16 # 5 | # 5@ 9 | 120.80 |
| 14 | 24 | 7 - 2 | 12 - 0 | 24 | 18x32 | 2.10 | 4145 | 2085 | 1.50 | 2.48 | 0.195 | # 7@ 9 | 3 - 7 | # 8@18 | # 6@ 9 | # 9@16 | # 6@ 9 | 8 # 8 | # 5@ 9 | 152.49 |
| 15 | 19 | 6 - 9 | 11 - 4 | 22 | 20x40 | 1.90 | 4982 | 1567 | 1.51 | 2.19 | 0.556 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 8@16 | # 6@ 6 | 9 # 7 | # 5@ 6 | 163.14 |
| 16 | 19 | 6 - 0 | 10 -10 | 20 | 23x46 | 1.93 | 5635 | 1114 | 1.51 | 2.01 | 0.768 | # 8@ 6 | 2 - 9 | # 6@12 | # 5@ 6 | # 8@16 | # 7@ 6 | 6 # 8 | # 5@ 6 | 192.16 |
| 17 | 21 | 6 - 6 | 11 - 8 | 24 | 23x46 | 2.29 | 6107 | 1181 | 1.50 | 2.01 | 0.770 | # 8@ 6 | 3 - 2 | # 7@12 | # 6@ 6 | # 8@15 | # 7@ 6 | 14 # 6 | # 5@ 6 | 227.64 |
| 18 | 22 | 6 -10 | 12 - 4 | 24 | 25x50 | 2.52 | 6332 | 1304 | 1.51 | 2.02 | 0.892 | #10@ 9 | 4 - 3 | # 8@18 | # 7@ 9 | # 8@14 | # 9@ 9 | 21 # 5 | # 6@ 9 | 251.16 |
| 19 | 24 | 7 - 2 | 13 - 0 | 26 | 26x52 | 2.87 | 6744 | 1348 | 1.50 | 2.02 | 0.900 | # 9@ 6 | 3 - 5 | # 7@12 | # 6@ 6 | # 9@16 | # 8@ 6 | 24 # 5 | # 5@ 6 | 294.47 |
| 20 | 26 | 7 - 6 | 13 - 8 | 28 | 27x54 | 3.24 | 7155 | 1392 | 1.50 | 2.01 | 0.915 | # 9@ 6 | 3 - 5 | # 7@12 | # 6@ 6 | # 9@15 | # 8@ 6 | 19 # 6 | # 5@ 6 | 315.47 |
| 21 | 28 | 7 - 9 | 14 - 4 | 30 | 28x56 | 3.63 | 7479 | 1470 | 1.50 | 2.01 | 0.935 | #11@ 9 | 5 - 1 | # 9@18 | # 8@ 9 | # 9@14 | #10@ 9 | 12 # 8 | # 7@ 9 | 378.73 |
| 22 | 32 | 8 - 1 | 15 - 2 | 34 | 28x56 | 4.25 | 7862 | 1592 | 1.50 | 2.03 | 0.790 | # 9@ 6 | 3 - 7 | # 8@12 | # 7@ 6 | # 9@12 | # 8@ 6 | 19 # 7 | # 6@ 6 | 401.17 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 130 pcf, $\phi$ = 40°, $\mu$ = 0.45

BACKFILL SLOPE: 40°

$f_c' =$ 3,000 psi

$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "O" Bars | Dowels into Stem | (3) "M" Bars | "D" Bars | (5) "$L_w$" Bars | (2) "P" Bars | "$L_b$" Bars | (6) "K" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 762 | 658 | 1.96 | 2.71 | 0.002 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 1421 | 428 | 1.54 | 2.07 | 0.009 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 12 | 1 - 5 | 3 - 5 | 16 | None | 0.35 | 1980 | 522 | 1.51 | 2.09 | 0.008 | H# 6@15 | None | None | # 4@15 | # 5@12 | H# 6@15H | 6 # 4 | None | 24.20 |
| 6 | 8 | 2 - 0 | 3 -11 | 12 | 12x18 | 0.36 | 2274 | 604 | 2.05 | 2.07 | 0.067 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 24.08 |
| 7 | 9 | 2 - 3 | 4 - 5 | 12 | 12x18 | 0.42 | 2605 | 638 | 1.77 | 2.03 | 0.101 | # 4@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 28.81 |
| 8 | 8 | 2 -10 | 5 - 2 | 12 | 12x18 | 0.45 | 2820 | 804 | 1.53 | 2.05 | 0.281 | # 6@12 | None | None | # 4@12 | # 4@12 | # 5@12 | 7 # 4 | # 5@12 | 36.69 |
| 9 | 9 | 3 - 1 | 5 - 8 | 12 | 12x22 | 0.54 | 3173 | 845 | 1.53 | 2.03 | 0.356 | # 6@ 9 | None | None | # 4@ 9 | # 5@12 | # 5@ 9 | 5 # 5 | # 5@ 9 | 53.14 |
| 10 | 11 | 3 - 5 | 6 - 4 | 14 | 12x24 | 0.70 | 3538 | 954 | 1.50 | 2.04 | 0.330 | # 6@ 9 | None | None | # 4@ 9 | # 5@12 | # 5@ 9 | 10 # 4 | # 5@ 9 | 59.76 |
| 11 | 11 | 4 - 1 | 7 - 3 | 20 | 12x24 | 0.91 | 4107 | 1058 | 1.50 | 2.03 | 0.532 | # 7@ 9 | 2 - 5 | # 6@18 | # 4@ 9 | # 5@12 | # 6@ 9 | 11 # 5 | # 5@ 9 | 78.51 |
| 12 | 14 | 3 - 9 | 7 - 4 | 14 | 18x30 | 1.00 | 4135 | 1091 | 1.51 | 2.02 | 0.398 | # 7@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@12 | # 6@ 9 | 12 # 4 | # 5@ 9 | 88.71 |
| 13 | 15 | 3 -11 | 7 -10 | 16 | 18x32 | 1.16 | 4510 | 1137 | 1.51 | 2.00 | 0.483 | # 6@ 6 | 2 - 2 | # 6@12 | # 4@ 6 | # 6@11 | # 5@ 6 | 9 # 5 | # 5@ 6 | 104.43 |
| 14 | 16 | 4 - 8 | 8 -10 | 22 | 18x32 | 1.47 | 5098 | 1265 | 1.51 | 2.01 | 0.577 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@15 | # 6@ 9 | 7 # 7 | # 5@ 9 | 120.43 |
| 15 | 22 | 4 - 4 | 9 - 2 | 24 | 18x32 | 1.87 | 5407 | 1288 | 1.51 | 2.00 | 0.313 | # 6@ 6 | 3 - 2 | # 7@12 | # 5@ 6 | # 8@14 | # 5@ 6 | 8 # 7 | # 5@ 6 | 151.19 |
| 16 | 18 | 5 -11 | 10 - 8 | 24 | 19x38 | 1.90 | 5447 | 1827 | 1.51 | 2.12 | 0.790 | # 9@ 9 | 3 - 5 | # 7@18 | # 6@ 9 | # 8@17 | # 7@ 9 | 7 # 8 | # 6@ 9 | 170.29 |
| 17 | 20 | 6 - 3 | 11 - 4 | 22 | 21x42 | 2.09 | 5528 | 2055 | 1.50 | 2.16 | 0.780 | # 8@ 6 | 2 - 9 | # 6@12 | # 5@ 6 | # 8@15 | # 7@ 6 | 9 # 7 | # 5@ 6 | 206.00 |
| 18 | 21 | 6 - 7 | 12 - 0 | 24 | 22x44 | 2.35 | 5857 | 2169 | 1.50 | 2.16 | 0.897 | # 8@ 6 | 3 - 2 | # 7@12 | # 6@ 6 | # 8@15 | # 7@ 6 | 8 # 8 | # 5@ 6 | 232.68 |
| 19 | 23 | 6 -11 | 12 - 8 | 24 | 24x48 | 2.64 | 6093 | 2337 | 1.52 | 2.18 | 0.894 | #10@ 9 | 4 - 3 | # 8@18 | # 7@ 9 | # 9@17 | # 9@ 9 | 15 # 6 | # 6@ 9 | 260.95 |
| 20 | 25 | 7 - 3 | 13 - 4 | 30 | 23x46 | 3.10 | 6740 | 2326 | 1.50 | 2.14 | 0.900 | # 9@ 6 | 3 - 5 | # 7@12 | # 6@ 6 | # 9@16 | # 7@ 6 | 11 # 8 | # 5@ 6 | 295.93 |
| 21 | 26 | 7 - 7 | 14 - 0 | 32 | 25x48 | 3.44 | 7069 | 2440 | 1.50 | 2.13 | 1.021 | # 9@ 6 | 3 - 5 | # 7@12 | # 6@ 6 | # 9@15 | # 7@ 6 | 22 # 6 | # 5@ 6 | 316.32 |
| 22 | 29 | 7 -10 | 14 - 8 | 30 | 27x52 | 3.76 | 7100 | 2693 | 1.50 | 2.17 | 0.929 | # 9@ 6 | 3 - 7 | # 8@12 | # 7@ 6 | # 9@13 | # 8@ 6 | 16 # 7 | # 5@ 6 | 371.50 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# CANTILEVERED RETAINING WALLS

SOIL PROPERTIES: $\gamma$ = 130 pcf, $\phi$ = 40°, $\mu$ = 0.55

BACKFILL SLOPE: 40°

$f_c' =$ 3,000 psi
$f_y =$ 60,000 psi

| CONCRETE DIMENSIONS & VOLUME | | | | | | | SERVICE LOAD ANALYSES | | | | | STEM REINFORCEMENT (4) | | | | | BASE REINFORCEMENT | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Height Above Base ($h_w$) | Stem Thick-ness ($A_{stem}$) | Heel ($C$) | Width of Base ($W$) | Base Depth ($A_{base}$) | Key ($t \times k$) | (1) Concrete Quantity | Base Soil Pressure | | Safety Factors | | Deflection at Top | (2) "$O$" Bars | Dowels into Stem | (3) "$M$" Bars | "$D$" Bars | (5) "$L_w$" Bars | (2) "$P$" Bars | "$L_b$" Bars | (6) "$K$" Bars | (7) Total Steel Weight |
| | | | | | | | Toe | Heel | Sliding | Overturning | | | | | | | | | | |
| ft | in. | ft-in. | ft-in. | in. | in. × in. | cy / lf | psf | psf | | | in. | Size @ in. | ft-in. | Size @ in. | Size @ in. | Size @ in. | Size @ in. | No. Size | Size @ in. | lb / lf |
| 3 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.17 | 762 | 658 | 2.17 | 2.71 | 0.002 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 13.61 |
| 4 | 8 | 1 - 0 | 2 - 8 | 12 | None | 0.20 | 1421 | 428 | 1.73 | 2.07 | 0.009 | H# 4@ 9 | None | None | # 4@ 9 | # 4@12 | # 4@ 9H | 5 # 4 | None | 15.17 |
| 5 | 9 | 1 - 9 | 3 - 6 | 12 | None | 0.27 | 1778 | 609 | 1.50 | 2.15 | 0.019 | H# 4@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9 | 5 # 4 | None | 19.45 |
| 6 | 8 | 2 - 4 | 4 - 3 | 18 | None | 0.38 | 2486 | 590 | 1.51 | 2.03 | 0.067 | H# 7@18 | None | None | # 4@18 | # 4@12 | H# 7@18H | 6 # 5 | None | 30.67 |
| 7 | 9 | 2 - 3 | 4 - 5 | 12 | 12x18 | 0.42 | 2605 | 638 | 1.96 | 2.03 | 0.101 | # 4@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9 | 6 # 4 | # 4@ 9 | 28.81 |
| 8 | 8 | 2 -10 | 5 - 2 | 12 | 12x18 | 0.45 | 2820 | 804 | 1.72 | 2.05 | 0.281 | # 6@12 | None | None | # 4@12 | # 4@12 | # 5@12 | 7 # 4 | # 5@12 | 36.69 |
| 9 | 9 | 3 - 1 | 5 - 8 | 12 | 12x18 | 0.52 | 3153 | 841 | 1.59 | 2.02 | 0.356 | # 6@ 9 | None | None | # 4@ 9 | # 5@12 | # 4@ 9 | 5 # 5 | # 4@ 9 | 47.97 |
| 10 | 11 | 3 - 3 | 6 - 2 | 12 | 12x20 | 0.64 | 3442 | 911 | 1.54 | 2.01 | 0.330 | # 6@ 9 | None | None | # 4@ 9 | # 5@12 | # 5@ 9 | 8 # 4 | # 4@ 9 | 54.91 |
| 11 | 11 | 3 - 9 | 6 -11 | 14 | 12x20 | 0.74 | 3770 | 1044 | 1.50 | 2.02 | 0.532 | # 7@ 9 | 2 - 5 | # 6@18 | # 4@ 9 | # 5@12 | # 5@ 9 | 7 # 5 | # 4@ 9 | 64.32 |
| 12 | 13 | 4 - 0 | 7 - 6 | 14 | 12x24 | 0.89 | 4041 | 1147 | 1.53 | 2.03 | 0.498 | # 7@ 9 | 2 - 5 | # 6@18 | # 5@ 9 | # 6@12 | # 6@ 9 | 12 # 4 | # 5@ 9 | 82.86 |
| 13 | 14 | 4 - 2 | 8 - 0 | 16 | 12x24 | 1.05 | 4411 | 1193 | 1.50 | 2.01 | 0.595 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 6@12 | # 6@ 9 | 9 # 5 | # 5@ 9 | 104.16 |
| 14 | 16 | 4 - 7 | 8 - 9 | 20 | 12x24 | 1.32 | 4903 | 1276 | 1.51 | 2.01 | 0.577 | # 8@ 9 | 3 - 2 | # 7@18 | # 5@ 9 | # 7@15 | # 6@ 9 | 5 # 8 | # 5@ 9 | 117.49 |
| 15 | 17 | 4 - 9 | 9 - 2 | 18 | 18x28 | 1.45 | 5171 | 1327 | 1.51 | 2.00 | 0.679 | # 7@ 6 | 2 - 5 | # 6@12 | # 5@ 6 | # 7@14 | # 6@ 6 | 6 # 7 | # 4@ 6 | 138.68 |
| 16 | 18 | 5 - 2 | 9 -11 | 20 | 18x30 | 1.66 | 5460 | 1482 | 1.52 | 2.02 | 0.790 | # 9@ 9 | 3 - 5 | # 7@18 | # 6@ 9 | # 8@17 | # 7@ 9 | 14 # 5 | # 5@ 9 | 156.73 |
| 17 | 20 | 5 - 5 | 10 - 6 | 22 | 18x30 | 1.92 | 5873 | 1524 | 1.51 | 2.01 | 0.780 | # 8@ 6 | 2 - 9 | # 6@12 | # 5@ 6 | # 8@15 | # 6@ 6 | 17 # 5 | # 4@ 6 | 183.48 |
| 18 | 21 | 5 - 9 | 11 - 2 | 24 | 18x32 | 2.17 | 6163 | 1680 | 1.51 | 2.02 | 0.897 | # 8@ 6 | 3 - 2 | # 7@12 | # 6@ 6 | # 8@15 | # 6@ 6 | 19 # 5 | # 5@ 6 | 213.17 |
| 19 | 24 | 8 - 3 | 14 - 1 | 24 | 18x32 | 2.63 | 5438 | 3039 | 1.50 | 2.38 | 0.787 | # 8@ 6 | 3 - 2 | # 7@12 | # 6@ 6 | # 9@16 | # 7@ 6 | 24 # 5 | # 5@ 6 | 258.04 |
| 20 | 25 | 7 - 3 | 13 - 4 | 26 | 18x34 | 2.80 | 6361 | 2430 | 1.50 | 2.16 | 0.900 | # 9@ 6 | 3 - 5 | # 7@12 | # 6@ 6 | # 9@16 | # 7@ 6 | 25 # 5 | # 5@ 6 | 286.87 |
| 21 | 26 | 7 - 7 | 14 - 0 | 28 | 18x36 | 3.10 | 6686 | 2542 | 1.51 | 2.15 | 1.021 | # 9@ 6 | 3 - 5 | # 7@12 | # 6@ 6 | # 9@15 | # 7@ 6 | 11 # 8 | # 5@ 6 | 306.88 |
| 22 | 29 | 7 -10 | 14 - 8 | 30 | 18x36 | 3.53 | 6998 | 2675 | 1.50 | 2.16 | 0.929 | # 9@ 6 | 3 - 7 | # 8@12 | # 7@ 6 | # 9@13 | # 7@ 6 | 16 # 7 | # 5@ 6 | 352.83 |

(1) Calculated for uniform thickness base and stem. Deduct for tapered stem or base. Nominal dimensions used for calculations. Actual quantities for concrete cast against earth, especially for keys, are larger. User should allow additional amounts based upon job conditions.

(2) 'H' designates a standard hook or headed bar. If an 'H' flag appears before 'O' or 'P' bar callout, then use hook or headed bar in toe of base. If 'H' appears after 'P' bar callout, then use hook or headed bar in heel of base. Alternatively, designer to resize bar.

(3) If optional splice is used (Fig. 14-1) for $h_w \le$ 10'-0", provide 'M' bars at same size and spacing as 'O' bars with length = $h_w$ – 3". See Fig. 14-1 to establish cut-off height for 'O' bars.

(4) Lengths alternate for 'O' bars. See Fig. 14-2.

(5) 'Lw' bars are 0.0025 $A_g$ (0.002 $A_g$ for sizes #5 and smaller).

(6) 'K' bars are to have 90° hook in bottom of key. Where 'H' by 'K' bar is shown use 180° hook. Add longitudinal bars in key: 2-#4 where 'K' bars are shown.

(7) Does not include lap allowance for horizontal bars, which varies with joint spacing, stagger, etc.

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

Click On The Column Criteria You Need

## SQUARE TIED COLUMNS

$f_c' = 5{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 6{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 8{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 6{,}000$ psi, $f_y = 75{,}000$ psi

$f_c' = 8{,}000$ psi, $f_y = 75{,}000$ psi

$f_c' = 10{,}000$ psi, $f_y = 75{,}000$ psi

## RECTANGULAR TIED COLUMNS

$f_c' = 5{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 6{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 8{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 6{,}000$ psi, $f_y = 75{,}000$ psi

$f_c' = 8{,}000$ psi, $f_y = 75{,}000$ psi

$f_c' = 10{,}000$ psi, $f_y = 75{,}000$ psi

# DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

## ROUND SPIRAL COLUMNS

$f_c' = 4{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 5{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 6{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 8{,}000$ psi, $f_y = 60{,}000$ psi

$f_c' = 6{,}000$ psi, $f_y = 75{,}000$ psi

$f_c' = 8{,}000$ psi, $f_y = 75{,}000$ psi

$f_c' = 10{,}000$ psi, $f_y = 75{,}000$ psi

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

## SQUARE TIED COLUMNS

## $f'_c = 5{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below

| | | | | |
|---|---|---|---|---|
| 10″ × 10″ | 12″ × 12″ | 14″ × 14″ | 16″ × 16″ | 18″ × 18″ |
| 20″ × 20″ | 22″ × 22″ | 24″ × 24″ | 26″ × 26″ | 28″ × 28″ |
| 30″ × 30″ | 32″ × 32″ | 34″ × 34″ | 36″ × 36″ | 38″ × 38″ |
| 40″ × 40″ | 42″ × 42″ | 44″ × 44″ | 46″ × 46″ | 48″ × 48″ |

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

## SQUARE TIED COLUMNS

## $f'_c = 6{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below

| | | | | |
|---|---|---|---|---|
| 10″ × 10″ | 12″ × 12″ | 14″ × 14″ | 16″ × 16″ | 18″ × 18″ |
| 20″ × 20″ | 22″ × 22″ | 24″ × 24″ | 26″ × 26″ | 28″ × 28″ |
| 30″ × 30″ | 32″ × 32″ | 34″ × 34″ | 36″ × 36″ | 38″ × 38″ |
| 40″ × 40″ | 42″ × 42″ | 44″ × 44″ | 46″ × 46″ | 48″ × 48″ |

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

## SQUARE TIED COLUMNS

## $f'_c = 8{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below

| | | | | |
|---|---|---|---|---|
| 10″ × 10″ | 12″ × 12″ | 14″ × 14″ | 16″ × 16″ | 18″ × 18″ |
| 20″ × 20″ | 22″ × 22″ | 24″ × 24″ | 26″ × 26″ | 28″ × 28″ |
| 30″ × 30″ | 32″ × 32″ | 34″ × 34″ | 36″ × 36″ | 38″ × 38″ |
| 40″ × 40″ | 42″ × 42″ | 44″ × 44″ | 46″ × 46″ | 48″ × 48″ |

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

## SQUARE TIED COLUMNS

## $f'_c = 6{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

| | | | | |
|---|---|---|---|---|
| 24″ × 24″ | 26″ × 26″ | 28″ × 28″ | 30″ × 30″ | 32″ × 32″ |
| 34″ × 34″ | 36″ × 36″ | 38″ × 38″ | 40″ × 40″ | 42″ × 42″ |
| | 44″ × 44″ | 46″ × 46″ | 48″ × 48″ | |

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

## SQUARE TIED COLUMNS

## $f'_c = 8{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

| | | | | |
|---|---|---|---|---|
| 24″ × 24″ | 26″ × 26″ | 28″ × 28″ | 30″ × 30″ | 32″ × 32″ |
| 34″ × 34″ | 36″ × 36″ | 38″ × 38″ | 40″ × 40″ | 42″ × 42″ |
| | 44″ × 44″ | 46″ × 46″ | 48″ × 48″ | |

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

## SQUARE TIED COLUMNS

## $f'_c = 10{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

| | | | | |
|---|---|---|---|---|
| 24″ × 24″ | 26″ × 26″ | 28″ × 28″ | 30″ × 30″ | 32″ × 32″ |
| 34″ × 34″ | 36″ × 36″ | 38″ × 38″ | 40″ × 40″ | 42″ × 42″ |
| | 44″ × 44″ | 46″ × 46″ | 48″ × 48″ | |

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

## RECTANGULAR TIED COLUMNS

## $f'_c = 5{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below


10″ × 10″
10″ × 12″
10″ × 14″
10″ × 16″
10″ × 18″
10″ × 20″

12″ × 12″
12″ × 14″
12″ × 16″
12″ × 18″
12″ × 20″
12″ × 22″
12″ × 24″

14″ × 14″
14″ × 16″
14″ × 18″
14″ × 20″
14″ × 22″
14″ × 24″
14″ × 26″
14″ × 28″

16″ × 16″
16″ × 18″
16″ × 20″
16″ × 22″
16″ × 24″
16″ × 26″
16″ × 28″
16″ × 30″
16″ × 32″

18″ × 18″
18″ × 20″
18″ × 22″
18″ × 24″
18″ × 26″
18″ × 28″
18″ × 30″
18″ × 32″
18″ × 34″
18″ × 36″

20″ × 20″
20″ × 22″
20″ × 24″
20″ × 26″
20″ × 28″
20″ × 30″
20″ × 32″
20″ × 34″
20″ × 36″
20″ × 38″
20″ × 40″

22″ × 22″
22″ × 24″
22″ × 26″
22″ × 28″
22″ × 30″
22″ × 32″
22″ × 34″
22″ × 36″
22″ × 38″
22″ × 40″
22″ × 42″
22″ × 44″

24″ × 24″
24″ × 26″
24″ × 28″
24″ × 30″
24″ × 32″
24″ × 34″
24″ × 36″
24″ × 38″
24″ × 40″
24″ × 42″
24″ × 44″
24″ × 46″
24″ × 48″


Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

## RECTANGULAR TIED COLUMNS

## $f'_c = 6{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below


10″ × 10″
10″ × 12″
10″ × 14″
10″ × 16″
10″ × 18″
10″ × 20″

12″ × 12″
12″ × 14″
12″ × 16″
12″ × 18″
12″ × 20″
12″ × 22″
12″ × 24″

14″ × 14″
14″ × 16″
14″ × 18″
14″ × 20″
14″ × 22″
14″ × 24″
14″ × 26″
14″ × 28″

16″ × 16″
16″ × 18″
16″ × 20″
16″ × 22″
16″ × 24″
16″ × 26″
16″ × 28″
16″ × 30″
16″ × 32″

18″ × 18″
18″ × 20″
18″ × 22″
18″ × 24″
18″ × 26″
18″ × 28″
18″ × 30″
18″ × 32″
18″ × 34″
18″ × 36″

20″ × 20″
20″ × 22″
20″ × 24″
20″ × 26″
20″ × 28″
20″ × 30″
20″ × 32″
20″ × 34″
20″ × 36″
20″ × 38″
20″ × 40″

22″ × 22″
22″ × 24″
22″ × 26″
22″ × 28″
22″ × 30″
22″ × 32″
22″ × 34″
22″ × 36″
22″ × 38″
22″ × 40″
22″ × 42″
22″ × 44″

24″ × 24″
24″ × 26″
24″ × 28″
24″ × 30″
24″ × 32″
24″ × 34″
24″ × 36″
24″ × 38″
24″ × 40″
24″ × 42″
24″ × 44″
24″ × 46″
24″ × 48″


Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

## RECTANGULAR TIED COLUMNS

## $f'_c = 8{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below


10″ × 10″
10″ × 12″
10″ × 14″
10″ × 16″
10″ × 18″
10″ × 20″

12″ × 12″
12″ × 14″
12″ × 16″
12″ × 18″
12″ × 20″
12″ × 22″
12″ × 24″

14″ × 14″
14″ × 16″
14″ × 18″
14″ × 20″
14″ × 22″
14″ × 24″
14″ × 26″
14″ × 28″

16″ × 16″
16″ × 18″
16″ × 20″
16″ × 22″
16″ × 24″
16″ × 26″
16″ × 28″
16″ × 30″
16″ × 32″

18″ × 18″
18″ × 20″
18″ × 22″
18″ × 24″
18″ × 26″
18″ × 28″
18″ × 30″
18″ × 32″
18″ × 34″
18″ × 36″

20″ × 20″
20″ × 22″
20″ × 24″
20″ × 26″
20″ × 28″
20″ × 30″
20″ × 32″
20″ × 34″
20″ × 36″
20″ × 38″
20″ × 40″

22″ × 22″
22″ × 24″
22″ × 26″
22″ × 28″
22″ × 30″
22″ × 32″
22″ × 34″
22″ × 36″
22″ × 38″
22″ × 40″
22″ × 42″
22″ × 44″

24″ × 24″
24″ × 26″
24″ × 28″
24″ × 30″
24″ × 32″
24″ × 34″
24″ × 36″
24″ × 38″
24″ × 40″
24″ × 42″
24″ × 44″
24″ × 46″
24″ × 48″


Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

## RECTANGULAR TIED COLUMNS

## $f'_c = 6{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 24″ × 24″ | 26″ × 26″ | 28″ × 28″ | 30″ × 30″ | 32″ × 32″ | 34″ × 34″ | 36″ × 36″ | 38″ × 38″ |
| 24″ × 26″ | 26″ × 28″ | 28″ × 30″ | 30″ × 32″ | 32″ × 34″ | 34″ × 36″ | 36″ × 38″ | 38″ × 40″ |
| 24″ × 28″ | 26″ × 30″ | 28″ × 32″ | 30″ × 34″ | 32″ × 36″ | 34″ × 38″ | 36″ × 40″ | 38″ × 42″ |
| 24″ × 30″ | 26″ × 32″ | 28″ × 34″ | 30″ × 36″ | 32″ × 38″ | 34″ × 40″ | 36″ × 42″ | 38″ × 44″ |
| 24″ × 32″ | 26″ × 34″ | 28″ × 36″ | 30″ × 38″ | 32″ × 40″ | 34″ × 42″ | 36″ × 44″ | 38″ × 46″ |
| 24″ × 34″ | 26″ × 36″ | 28″ × 38″ | 30″ × 40″ | 32″ × 42″ | 34″ × 44″ | 36″ × 46″ | 38″ × 48″ |
| 24″ × 36″ | 26″ × 38″ | 28″ × 40″ | 30″ × 42″ | 32″ × 44″ | 34″ × 46″ | 36″ × 48″ | |
| 24″ × 38″ | 26″ × 40″ | 28″ × 42″ | 30″ × 44″ | 32″ × 46″ | 34″ × 48″ | | |
| 24″ × 40″ | 26″ × 42″ | 28″ × 44″ | 30″ × 46″ | 32″ × 48″ | | | 40″ × 40″ |
| 24″ × 42″ | 26″ × 44″ | 28″ × 46″ | 30″ × 48″ | | | 42″ × 42″ | 40″ × 42″ |
| 24″ × 44″ | 26″ × 46″ | 28″ × 48″ | | | 44″ × 44″ | 42″ × 44″ | 40″ × 44″ |
| 24″ × 46″ | 26″ × 48″ | | | 46″ × 46″ | 44″ × 46″ | 42″ × 46″ | 40″ × 46″ |
| 24″ × 48″ | | | 48″ × 48″ | 46″ × 48″ | 44″ × 48″ | 42″ × 48″ | 40″ × 48″ |

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

## RECTANGULAR TIED COLUMNS

## $f'_c = 8{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 24″ × 24″ | 26″ × 26″ | 28″ × 28″ | 30″ × 30″ | 32″ × 32″ | 34″ × 34″ | 36″ × 36″ | 38″ × 38″ |
| 24″ × 26″ | 26″ × 28″ | 28″ × 30″ | 30″ × 32″ | 32″ × 34″ | 34″ × 36″ | 36″ × 38″ | 38″ × 40″ |
| 24″ × 28″ | 26″ × 30″ | 28″ × 32″ | 30″ × 34″ | 32″ × 36″ | 34″ × 38″ | 36″ × 40″ | 38″ × 42″ |
| 24″ × 30″ | 26″ × 32″ | 28″ × 34″ | 30″ × 36″ | 32″ × 38″ | 34″ × 40″ | 36″ × 42″ | 38″ × 44″ |
| 24″ × 32″ | 26″ × 34″ | 28″ × 36″ | 30″ × 38″ | 32″ × 40″ | 34″ × 42″ | 36″ × 44″ | 38″ × 46″ |
| 24″ × 34″ | 26″ × 36″ | 28″ × 38″ | 30″ × 40″ | 32″ × 42″ | 34″ × 44″ | 36″ × 46″ | 38″ × 48″ |
| 24″ × 36″ | 26″ × 38″ | 28″ × 40″ | 30″ × 42″ | 32″ × 44″ | 34″ × 46″ | 36″ × 48″ | |
| 24″ × 38″ | 26″ × 40″ | 28″ × 42″ | 30″ × 44″ | 32″ × 46″ | 34″ × 48″ | | |
| 24″ × 40″ | 26″ × 42″ | 28″ × 44″ | 30″ × 46″ | 32″ × 48″ | | | 40″ × 40″ |
| 24″ × 42″ | 26″ × 44″ | 28″ × 46″ | 30″ × 48″ | | | 42″ × 42″ | 40″ × 42″ |
| 24″ × 44″ | 26″ × 46″ | 28″ × 48″ | | | 44″ × 44″ | 42″ × 44″ | 40″ × 44″ |
| 24″ × 46″ | 26″ × 48″ | | | 46″ × 46″ | 44″ × 46″ | 42″ × 46″ | 40″ × 46″ |
| 24″ × 48″ | | | 48″ × 48″ | 46″ × 48″ | 44″ × 48″ | 42″ × 48″ | 40″ × 48″ |

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 3 COLUMN TABLES

## RECTANGULAR TIED COLUMNS

## $f'_c = 10{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 24″ × 24″ | 26″ × 26″ | 28″ × 28″ | 30″ × 30″ | 32″ × 32″ | 34″ × 34″ | 36″ × 36″ | 38″ × 38″ |
| 24″ × 26″ | 26″ × 28″ | 28″ × 30″ | 30″ × 32″ | 32″ × 34″ | 34″ × 36″ | 36″ × 38″ | 38″ × 40″ |
| 24″ × 28″ | 26″ × 30″ | 28″ × 32″ | 30″ × 34″ | 32″ × 36″ | 34″ × 38″ | 36″ × 40″ | 38″ × 42″ |
| 24″ × 30″ | 26″ × 32″ | 28″ × 34″ | 30″ × 36″ | 32″ × 38″ | 34″ × 40″ | 36″ × 42″ | 38″ × 44″ |
| 24″ × 32″ | 26″ × 34″ | 28″ × 36″ | 30″ × 38″ | 32″ × 40″ | 34″ × 42″ | 36″ × 44″ | 38″ × 46″ |
| 24″ × 34″ | 26″ × 36″ | 28″ × 38″ | 30″ × 40″ | 32″ × 42″ | 34″ × 44″ | 36″ × 46″ | 38″ × 48″ |
| 24″ × 36″ | 26″ × 38″ | 28″ × 40″ | 30″ × 42″ | 32″ × 44″ | 34″ × 46″ | 36″ × 48″ | |
| 24″ × 38″ | 26″ × 40″ | 28″ × 42″ | 30″ × 44″ | 32″ × 46″ | 34″ × 48″ | | |
| 24″ × 40″ | 26″ × 42″ | 28″ × 44″ | 30″ × 46″ | 32″ × 48″ | | | 40″ × 40″ |
| 24″ × 42″ | 26″ × 44″ | 28″ × 46″ | 30″ × 48″ | | | 42″ × 42″ | 40″ × 42″ |
| 24″ × 44″ | 26″ × 46″ | 28″ × 48″ | | | 44″ × 44″ | 42″ × 44″ | 40″ × 44″ |
| 24″ × 46″ | 26″ × 48″ | | | 46″ × 46″ | 44″ × 46″ | 42″ × 46″ | 40″ × 46″ |
| 24″ × 48″ | | | 48″ × 48″ | 46″ × 48″ | 44″ × 48″ | 42″ × 48″ | 40″ × 48″ |

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

## ROUND SPIRAL COLUMNS

$f'_c = 4{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below


12″ DIA. 14″ DIA. 16″ DIA. 18″ DIA. 20″ DIA.

22″ DIA. 24″ DIA. 26″ DIA. 28″ DIA. 30″ DIA.

32″ DIA. 34″ DIA. 36″ DIA.

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

## ROUND SPIRAL COLUMNS

$f'_c = 5{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below


12″ DIA. 14″ DIA. 16″ DIA. 18″ DIA. 20″ DIA.

22″ DIA. 24″ DIA. 26″ DIA. 28″ DIA. 30″ DIA.

32″ DIA. 34″ DIA. 36″ DIA.

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

## ROUND SPIRAL COLUMNS

$f'_c = 6{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below


12″ DIA. 14″ DIA. 16″ DIA. 18″ DIA. 20″ DIA.

22″ DIA. 24″ DIA. 26″ DIA. 28″ DIA. 30″ DIA.

32″ DIA. 34″ DIA. 36″ DIA.

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

## ROUND SPIRAL COLUMNS

$f'_c = 8{,}000$ psi, $f_y = 60{,}000$ psi

Click On The Column Size Below


12″ DIA. 14″ DIA. 16″ DIA. 18″ DIA. 20″ DIA.

22″ DIA. 24″ DIA. 26″ DIA. 28″ DIA. 30″ DIA.

32″ DIA. 34″ DIA. 36″ DIA.

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

## ROUND SPIRAL COLUMNS

## $f'_c = 6{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below


24″ DIA. 26″ DIA. 28″ DIA. 30″ DIA. 32″ DIA.

34″ DIA. 36″ DIA. 38″ DIA. 40″ DIA. 42″ DIA.

44″ DIA. 46″ DIA. 48″ DIA.

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

## ROUND SPIRAL COLUMNS

## $f'_c$ = 8,000 psi, $f_y$ = 75,000 psi

Click On The Column Size Below

| | | | | |
|---|---|---|---|---|
| 24″ DIA. | 26″ DIA. | 28″ DIA. | 30″ DIA. | 32″ DIA. |
| 34″ DIA. | 36″ DIA. | 38″ DIA. | 40″ DIA. | 42″ DIA. |
| | 44″ DIA. | 46″ DIA. | 48″ DIA. | |

Return To Column Criteria

# DESIGN HANDBOOK – CHAPTER 4 COLUMN TABLES

## ROUND SPIRAL COLUMNS

$f'_c = 10{,}000$ psi, $f_y = 75{,}000$ psi

Click On The Column Size Below

| | | | | |
|---|---|---|---|---|
| 24″ DIA. | 26″ DIA. | 28″ DIA. | 30″ DIA. | 32″ DIA. |
| 34″ DIA. | 36″ DIA. | 38″ DIA. | 40″ DIA. | 42″ DIA. |
| | 44″ DIA. | 46″ DIA. | 48″ DIA. | |

Return To Column Criteria

## SQUARE TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#5 | 1.24 | 244 | 257 | 387 | 195 | 422 | 163 | 434 | 136 | 437 | 95 | 465 | 66 | 265 |
| 4-#6 | 1.76 | 252 | 272 | 413 | 203 | 451 | 168 | 467 | 138 | 478 | 90 | 505 | 54 | 349 |
| 4-#7 | 2.40 | 262 | 291 | 444 | 213 | 485 | 174 | 505 | 140 | 526 | 84 | 563 | 42 | 445 |
| 4-#8 | 3.16 | 273 | 313 | 479 | 226 | 523 | 181 | 548 | 142 | 580 | 76 | 616 | 23 | 553 |
| 4-#9 | 4.00 | 284 | 337 | 512 | 238 | 561 | 188 | 592 | 144 | 635 | 67 | 668 | 1 | 666 |
| 4-#10 | 5.08 | 298 | 368 | 552 | 254 | 606 | 197 | 644 | 145 | 700 | 54 | 727 | -30 | 716 |
| 4-#11 | 6.24 | 305 | 402 | 571 | 264 | 624 | 198 | 662 | 139 | 723 | 31 | 720 | -82 | 729 |
| 8-#5 | 2.48 | 251 | 293 | 419 | 217 | 461 | 178 | 480 | 145 | 495 | 88 | 526 | 21 | 467 |
| 8-#6 | 3.52 | 262 | 323 | 457 | 234 | 505 | 189 | 529 | 150 | 557 | 80 | 588 | -12 | 588 |
| 8-#7 | 4.80 | 276 | 360 | 502 | 256 | 555 | 201 | 587 | 155 | 630 | 69 | 676 | -46 | 657 |

## SQUARE TIED COLUMNS 12" x 12"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.22 | 430 | 369 | 663 | 290 | 741 | 244 | 780 | 207 | 798 | 147 | 874 | 110 | 457 |
| 4-#7 | 1.67 | 444 | 388 | 706 | 300 | 794 | 251 | 840 | 210 | 873 | 142 | 954 | 98 | 591 |
| 4-#8 | 2.19 | 461 | 410 | 756 | 313 | 855 | 260 | 908 | 214 | 959 | 137 | 1045 | 83 | 742 |
| 4-#9 | 2.78 | 478 | 434 | 810 | 326 | 920 | 269 | 979 | 218 | 1048 | 131 | 1137 | 66 | 903 |
| 4-#10 | 3.53 | 499 | 466 | 876 | 344 | 1001 | 282 | 1066 | 223 | 1158 | 122 | 1247 | 42 | 1101 |
| 4-#11 | 4.33 | 512 | 499 | 935 | 360 | 1050 | 287 | 1119 | 221 | 1222 | 105 | 1286 | 2 | 1278 |
| 4-#14 | 6.25 | 558 | 579 | 1081 | 406 | 1205 | 312 | 1296 | 228 | 1446 | 77 | 1539 | -57 | 1497 |
| 8-#5 | 1.72 | 428 | 390 | 668 | 306 | 752 | 255 | 794 | 215 | 820 | 147 | 902 | 80 | 617 |
| 8-#6 | 2.44 | 445 | 420 | 722 | 323 | 817 | 267 | 872 | 223 | 915 | 141 | 1007 | 54 | 829 |
| 8-#7 | 3.33 | 466 | 457 | 786 | 345 | 896 | 282 | 962 | 231 | 1028 | 134 | 1128 | 19 | 1075 |
| 8-#8 | 4.39 | 489 | 501 | 860 | 370 | 986 | 300 | 1064 | 241 | 1157 | 125 | 1265 | -23 | 1259 |
| 8-#9 | 5.56 | 515 | 550 | 939 | 399 | 1083 | 320 | 1171 | 251 | 1292 | 114 | 1405 | -72 | 1385 |
| 8-#10 | 7.06 | 547 | 613 | 1037 | 436 | 1204 | 346 | 1302 | 263 | 1457 | 99 | 1572 | -138 | 1537 |

## SQUARE TIED COLUMNS 14" x 14"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.22 | 692 | 503 | 1045 | 405 | 1188 | 340 | 1261 | 289 | 1322 | 209 | 1475 | 163 | 735 |
| 4-#8 | 1.61 | 716 | 525 | 1110 | 417 | 1267 | 349 | 1355 | 294 | 1440 | 205 | 1609 | 152 | 930 |
| 4-#9 | 2.04 | 740 | 549 | 1180 | 430 | 1352 | 358 | 1456 | 299 | 1565 | 201 | 1748 | 139 | 1139 |
| 4-#10 | 2.59 | 769 | 580 | 1268 | 448 | 1458 | 370 | 1583 | 307 | 1721 | 195 | 1919 | 121 | 1398 |
| 4-#11 | 3.18 | 790 | 614 | 1353 | 463 | 1554 | 381 | 1684 | 310 | 1832 | 182 | 2014 | 89 | 1642 |
| 4-#14 | 4.59 | 854 | 694 | 1553 | 508 | 1800 | 414 | 1952 | 324 | 2169 | 161 | 2360 | 32 | 2234 |
| 8-#5 | 1.27 | 669 | 505 | 994 | 412 | 1132 | 345 | 1197 | 293 | 1245 | 214 | 1394 | 145 | 765 |
| 8-#6 | 1.80 | 693 | 535 | 1063 | 429 | 1216 | 358 | 1297 | 302 | 1375 | 210 | 1543 | 122 | 1037 |
| 8-#7 | 2.45 | 722 | 572 | 1147 | 451 | 1317 | 373 | 1418 | 312 | 1529 | 206 | 1721 | 94 | 1357 |
| 8-#8 | 3.22 | 754 | 616 | 1242 | 477 | 1435 | 391 | 1558 | 324 | 1707 | 200 | 1922 | 59 | 1721 |
| 8-#9 | 4.08 | 789 | 665 | 1346 | 506 | 1562 | 412 | 1710 | 337 | 1896 | 193 | 2133 | 19 | 2092 |
| 8-#10 | 5.18 | 833 | 728 | 1475 | 543 | 1721 | 438 | 1901 | 354 | 2131 | 183 | 2391 | -35 | 2370 |
| 8-#11 | 6.37 | 865 | 795 | 1596 | 578 | 1862 | 462 | 2053 | 364 | 2300 | 161 | 2540 | -116 | 2486 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.23 | 1045 | 657 | 1551 | 539 | 1786 | 453 | 1910 | 385 | 2030 | 281 | 2308 | 225 | 1117 |
| 4-#9 | 1.56 | 1078 | 682 | 1638 | 552 | 1891 | 462 | 2034 | 390 | 2196 | 278 | 2497 | 215 | 1373 |
| 4-#10 | 1.98 | 1118 | 713 | 1747 | 569 | 2024 | 474 | 2192 | 397 | 2403 | 275 | 2730 | 201 | 1694 |
| 4-#11 | 2.44 | 1147 | 747 | 1859 | 583 | 2149 | 484 | 2335 | 402 | 2562 | 264 | 2887 | 175 | 2005 |
| 4-#14 | 3.52 | 1232 | 827 | 2114 | 628 | 2460 | 516 | 2706 | 421 | 3017 | 249 | 3387 | 130 | 2752 |
| 4-#18 | 6.25 | 1422 | 1030 | 2710 | 745 | 3193 | 600 | 3548 | 465 | 4045 | 202 | 4463 | -6 | 4459 |
| 8-#6 | 1.38 | 1016 | 668 | 1491 | 552 | 1721 | 463 | 1837 | 392 | 1936 | 285 | 2215 | 196 | 1244 |
| 8-#7 | 1.88 | 1052 | 705 | 1593 | 574 | 1846 | 479 | 1985 | 401 | 2134 | 282 | 2449 | 172 | 1638 |
| 8-#8 | 2.47 | 1094 | 749 | 1712 | 600 | 1990 | 497 | 2157 | 412 | 2364 | 279 | 2718 | 142 | 2089 |
| 8-#9 | 3.13 | 1142 | 798 | 1840 | 629 | 2147 | 518 | 2344 | 425 | 2614 | 276 | 3002 | 108 | 2569 |
| 8-#10 | 3.97 | 1198 | 860 | 2000 | 667 | 2344 | 545 | 2580 | 441 | 2926 | 271 | 3355 | 62 | 3165 |
| 8-#11 | 4.88 | 1241 | 928 | 2159 | 701 | 2529 | 568 | 2795 | 462 | 3168 | 254 | 3597 | -7 | 3591 |
| 8-#14 | 7.03 | 1371 | 1088 | 2534 | 797 | 2993 | 636 | 3353 | 505 | 3853 | 228 | 4353 | -144 | 4236 |
| 12-#10 | 5.95 | 1343 | 1008 | 2324 | 764 | 2736 | 622 | 3052 | 491 | 3557 | 260 | 4151 | -27 | 4124 |

## SQUARE TIED COLUMNS 18" x 18"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.23 | 1502 | 832 | 2194 | 691 | 2552 | 581 | 2744 | 494 | 2935 | 361 | 3399 | 297 | 1607 |
| 4-#10 | 1.57 | 1552 | 863 | 2325 | 708 | 2711 | 593 | 2932 | 501 | 3185 | 358 | 3696 | 286 | 1988 |
| 4-#11 | 1.93 | 1592 | 897 | 2465 | 721 | 2866 | 602 | 3108 | 505 | 3415 | 351 | 3917 | 265 | 2367 |
| 4-#14 | 2.78 | 1701 | 977 | 2775 | 766 | 3243 | 633 | 3557 | 524 | 4003 | 343 | 4577 | 229 | 3269 |
| 4-#18 | 4.94 | 1943 | 1180 | 3507 | 881 | 4141 | 716 | 4631 | 574 | 5333 | 308 | 6051 | 120 | 5398 |
| 8-#6 | 1.09 | 1425 | 818 | 2015 | 693 | 2348 | 583 | 2507 | 497 | 2625 | 369 | 3038 | 277 | 1449 |
| 8-#7 | 1.48 | 1470 | 855 | 2137 | 715 | 2495 | 599 | 2682 | 506 | 2858 | 366 | 3330 | 256 | 1916 |
| 8-#8 | 1.95 | 1522 | 899 | 2278 | 741 | 2667 | 618 | 2887 | 518 | 3131 | 364 | 3667 | 230 | 2454 |
| 8-#9 | 2.47 | 1577 | 948 | 2431 | 770 | 2854 | 638 | 3109 | 530 | 3429 | 361 | 4027 | 200 | 3030 |
| 8-#10 | 3.14 | 1647 | 1011 | 2624 | 807 | 3090 | 665 | 3391 | 546 | 3805 | 357 | 4476 | 160 | 3750 |
| 8-#11 | 3.85 | 1708 | 1078 | 2821 | 842 | 3317 | 689 | 3656 | 559 | 4154 | 348 | 4816 | 100 | 4440 |
| 8-#14 | 5.56 | 1869 | 1238 | 3277 | 938 | 3879 | 758 | 4329 | 600 | 5040 | 335 | 5813 | -19 | 5789 |
| 12-#10 | 4.70 | 1829 | 1158 | 3009 | 907 | 3555 | 745 | 3952 | 599 | 4557 | 349 | 5477 | 80 | 5139 |
| 12-#11 | 5.78 | 1916 | 1259 | 3279 | 963 | 3870 | 785 | 4322 | 622 | 5046 | 336 | 5964 | -5 | 5958 |

## SQUARE TIED COLUMNS 20" x 20"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.00 | 2023 | 1000 | 2858 | 849 | 3349 | 715 | 3600 | 611 | 3822 | 454 | 4473 | 386 | 1840 |
| 4-#10 | 1.27 | 2083 | 1031 | 3012 | 865 | 3534 | 727 | 3818 | 617 | 4112 | 451 | 4835 | 377 | 2282 |
| 4-#11 | 1.56 | 2134 | 1065 | 3181 | 877 | 3720 | 735 | 4029 | 621 | 4384 | 444 | 5120 | 359 | 2727 |
| 4-#14 | 2.25 | 2270 | 1145 | 3546 | 921 | 4163 | 766 | 4556 | 639 | 5087 | 436 | 5944 | 330 | 3784 |
| 4-#18 | 4.00 | 2570 | 1348 | 4417 | 1036 | 5227 | 848 | 5826 | 688 | 6777 | 418 | 7826 | 241 | 6304 |
| 8-#7 | 1.20 | 1984 | 1023 | 2788 | 873 | 3281 | 734 | 3526 | 624 | 3731 | 461 | 4382 | 346 | 2193 |
| 8-#8 | 1.58 | 2047 | 1067 | 2953 | 899 | 3480 | 753 | 3763 | 636 | 4046 | 458 | 4789 | 323 | 2818 |
| 8-#9 | 2.00 | 2113 | 1116 | 3132 | 928 | 3697 | 774 | 4021 | 648 | 4391 | 455 | 5225 | 296 | 3490 |
| 8-#10 | 2.54 | 2197 | 1179 | 3356 | 966 | 3971 | 801 | 4349 | 665 | 4828 | 452 | 5772 | 261 | 4331 |
| 8-#11 | 3.12 | 2268 | 1246 | 3593 | 1000 | 4243 | 824 | 4663 | 677 | 5241 | 444 | 6211 | 208 | 5156 |
| 8-#14 | 4.50 | 2469 | 1406 | 4129 | 1096 | 4903 | 894 | 5453 | 719 | 6298 | 434 | 7454 | 103 | 7130 |
| 8-#18 | 8.00 | 2932 | 1812 | 5413 | 1343 | 6491 | 1070 | 7358 | 825 | 8841 | 406 | 10293 | -195 | 9981 |
| 12-#10 | 3.81 | 2403 | 1326 | 3803 | 1066 | 4511 | 882 | 4999 | 719 | 5699 | 446 | 6980 | 187 | 6068 |
| 12-#11 | 4.68 | 2522 | 1427 | 4126 | 1122 | 4887 | 922 | 5439 | 743 | 6280 | 435 | 7612 | 112 | 7083 |
| 12-#14 | 6.75 | 2822 | 1667 | 4881 | 1272 | 5811 | 1034 | 6547 | 812 | 7764 | 419 | 9389 | -42 | 9313 |
| 16-#10 | 5.08 | 2610 | 1473 | 4276 | 1167 | 5090 | 956 | 5692 | 767 | 6622 | 448 | 8194 | 109 | 7783 |

## SQUARE TIED COLUMNS 22" x 22"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.05 | 2722 | 1217 | 3818 | 1040 | 4508 | 876 | 4868 | 747 | 5204 | 554 | 6164 | 476 | 2575 |
| 4-#11 | 1.29 | 2783 | 1251 | 4017 | 1051 | 4724 | 883 | 5112 | 750 | 5518 | 547 | 6516 | 460 | 3087 |
| 4-#14 | 1.86 | 2945 | 1331 | 4439 | 1094 | 5234 | 913 | 5717 | 768 | 6324 | 539 | 7505 | 436 | 4299 |
| 4-#18 | 3.31 | 3311 | 1533 | 5449 | 1207 | 6466 | 995 | 7185 | 816 | 8285 | 521 | 9803 | 363 | 7208 |
| 8-#8 | 1.31 | 2679 | 1253 | 3746 | 1075 | 4443 | 903 | 4802 | 767 | 5126 | 563 | 6101 | 423 | 3180 |
| 8-#9 | 1.65 | 2757 | 1302 | 3951 | 1104 | 4691 | 924 | 5096 | 779 | 5517 | 560 | 6614 | 399 | 3947 |
| 8-#10 | 2.10 | 2855 | 1364 | 4208 | 1141 | 5004 | 951 | 5469 | 796 | 6015 | 557 | 7260 | 367 | 4911 |
| 8-#11 | 2.58 | 2940 | 1431 | 4486 | 1175 | 5320 | 974 | 5834 | 808 | 6492 | 549 | 7799 | 319 | 5869 |
| 8-#14 | 3.72 | 3168 | 1591 | 5103 | 1272 | 6078 | 1044 | 6740 | 851 | 7704 | 540 | 9293 | 225 | 8157 |
| 8-#18 | 6.61 | 3725 | 1997 | 6590 | 1519 | 7914 | 1222 | 8940 | 959 | 10654 | 517 | 12758 | -41 | 12673 |
| 12-#10 | 3.15 | 3095 | 1511 | 4717 | 1243 | 5618 | 1033 | 6209 | 852 | 7006 | 553 | 8677 | 299 | 7035 |
| 12-#11 | 3.87 | 3223 | 1612 | 5094 | 1299 | 6055 | 1074 | 6719 | 876 | 7678 | 542 | 9456 | 230 | 8224 |
| 12-#14 | 5.58 | 3590 | 1852 | 5964 | 1449 | 7118 | 1187 | 7992 | 947 | 9382 | 529 | 11594 | 92 | 11123 |
| 16-#10 | 4.20 | 3319 | 1659 | 5255 | 1344 | 6277 | 1108 | 6998 | 901 | 8057 | 556 | 10097 | 229 | 8943 |
| 16-#11 | 5.16 | 3504 | 1793 | 5738 | 1422 | 6843 | 1165 | 7664 | 934 | 8935 | 544 | 11119 | 136 | 10556 |

## SQUARE TIED COLUMNS 24" x 24"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.08 | 3551 | 1454 | 4984 | 1243 | 5895 | 1046 | 6375 | 892 | 6834 | 660 | 8121 | 568 | 3446 |
| 4-#14 | 1.56 | 3740 | 1534 | 5463 | 1285 | 6471 | 1076 | 7058 | 910 | 7742 | 652 | 9277 | 548 | 4812 |
| 4-#18 | 2.78 | 4173 | 1737 | 6614 | 1397 | 7871 | 1156 | 8724 | 957 | 9965 | 633 | 11995 | 488 | 8112 |
| 8-#8 | 1.10 | 3428 | 1456 | 4669 | 1268 | 5571 | 1068 | 6020 | 911 | 6387 | 678 | 7591 | 527 | 3541 |
| 8-#9 | 1.39 | 3519 | 1505 | 4900 | 1297 | 5849 | 1089 | 6350 | 924 | 6825 | 675 | 8193 | 506 | 4403 |
| 8-#10 | 1.76 | 3632 | 1567 | 5190 | 1334 | 6201 | 1116 | 6769 | 940 | 7384 | 672 | 8958 | 480 | 5489 |
| 8-#11 | 2.17 | 3732 | 1635 | 5509 | 1367 | 6562 | 1139 | 7183 | 952 | 7925 | 664 | 9599 | 435 | 6580 |
| 8-#14 | 3.13 | 3995 | 1795 | 6209 | 1464 | 7419 | 1209 | 8206 | 995 | 9292 | 656 | 11344 | 350 | 9180 |
| 8-#18 | 5.56 | 4643 | 2201 | 7900 | 1712 | 9503 | 1387 | 10702 | 1105 | 12635 | 635 | 15443 | 111 | 15057 |
| 12-#10 | 2.65 | 3906 | 1715 | 5761 | 1437 | 6890 | 1199 | 7598 | 997 | 8494 | 670 | 10585 | 416 | 7994 |
| 12-#11 | 3.25 | 4055 | 1816 | 6194 | 1492 | 7388 | 1240 | 8179 | 1021 | 9258 | 660 | 11513 | 352 | 9407 |
| 12-#14 | 4.69 | 4454 | 2056 | 7180 | 1643 | 8590 | 1353 | 9617 | 1093 | 11182 | 648 | 14015 | 226 | 12717 |
| 16-#10 | 3.53 | 4159 | 1862 | 6365 | 1539 | 7629 | 1275 | 8484 | 1047 | 9672 | 674 | 12212 | 352 | 10119 |
| 16-#11 | 4.33 | 4356 | 1997 | 6918 | 1617 | 8275 | 1332 | 9241 | 1081 | 10671 | 664 | 13429 | 267 | 11978 |
| 16-#14 | 6.25 | 4893 | 2317 | 8206 | 1823 | 9847 | 1486 | 11123 | 1179 | 13185 | 652 | 16695 | 96 | 16273 |
| 20-#10 | 4.41 | 4396 | 2009 | 6928 | 1646 | 8389 | 1351 | 9378 | 1104 | 10864 | 672 | 13858 | 271 | 12313 |
| 20-#11 | 5.42 | 4638 | 2177 | 7602 | 1749 | 9186 | 1425 | 10314 | 1150 | 12117 | 668 | 15431 | 175 | 14458 |

## SQUARE TIED COLUMNS 26" x 26"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.33 | 4664 | 1755 | 6630 | 1493 | 7889 | 1254 | 8594 | 1065 | 9358 | 775 | 11278 | 667 | 5325 |
| 4-#18 | 2.37 | 5163 | 1958 | 7923 | 1604 | 9457 | 1333 | 10458 | 1111 | 11842 | 756 | 14420 | 618 | 9016 |
| 8-#9 | 1.18 | 4409 | 1726 | 5989 | 1508 | 7186 | 1269 | 7798 | 1081 | 8331 | 801 | 9955 | 618 | 4858 |
| 8-#10 | 1.50 | 4538 | 1788 | 6313 | 1545 | 7578 | 1296 | 8263 | 1097 | 8950 | 798 | 10805 | 592 | 6065 |
| 8-#11 | 1.85 | 4653 | 1856 | 6674 | 1577 | 7984 | 1318 | 8728 | 1109 | 9555 | 789 | 11626 | 558 | 7289 |
| 8-#14 | 2.66 | 4954 | 2016 | 7457 | 1674 | 8940 | 1388 | 9868 | 1152 | 11077 | 782 | 13627 | 481 | 10201 |
| 8-#18 | 4.73 | 5668 | 2422 | 9354 | 1922 | 11273 | 1568 | 12659 | 1263 | 14812 | 763 | 18365 | 262 | 17166 |
| 12-#10 | 2.25 | 4847 | 1936 | 6945 | 1648 | 8341 | 1380 | 9182 | 1155 | 10180 | 796 | 12618 | 529 | 8861 |
| 12-#11 | 2.77 | 5019 | 2037 | 7435 | 1703 | 8902 | 1420 | 9834 | 1179 | 11035 | 786 | 13797 | 479 | 10615 |
| 12-#14 | 3.99 | 5471 | 2277 | 8537 | 1855 | 10243 | 1535 | 11438 | 1252 | 13179 | 776 | 16670 | 363 | 14362 |
| 12-#18 | 7.10 | 6612 | 2885 | 11213 | 2240 | 13518 | 1824 | 15363 | 1436 | 18434 | 747 | 23460 | 38 | 23231 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 3.01 | 5129 | 2083 | 7615 | 1751 | 9161 | 1457 | 10164 | 1206 | 11486 | 802 | 14425 | 469 | 11317 |
| 16-#11 | 3.69 | 5354 | 2218 | 8240 | 1829 | 9887 | 1514 | 11014 | 1241 | 12605 | 792 | 15966 | 402 | 13415 |
| 16-#14 | 5.33 | 5936 | 2538 | 9680 | 2036 | 11642 | 1669 | 13113 | 1340 | 15408 | 783 | 19714 | 245 | 18476 |
| 20-#10 | 3.76 | 5396 | 2230 | 8233 | 1858 | 10003 | 1534 | 11156 | 1264 | 12807 | 801 | 16258 | 388 | 13850 |
| 20-#11 | 4.62 | 5671 | 2398 | 8990 | 1961 | 10899 | 1608 | 12206 | 1311 | 14194 | 789 | 18162 | 302 | 16306 |

## SQUARE TIED COLUMNS 28" x 28"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.15 | 5728 | 1994 | 7949 | 1720 | 9501 | 1447 | 10342 | 1233 | 11187 | 909 | 13494 | 791 | 5837 |
| 4-#18 | 2.04 | 6296 | 2196 | 9387 | 1829 | 11239 | 1525 | 12403 | 1278 | 13933 | 889 | 17096 | 753 | 9917 |
| 8-#9 | 1.02 | 5438 | 1965 | 7229 | 1736 | 8717 | 1464 | 9457 | 1251 | 10050 | 936 | 11962 | 738 | 5311 |
| 8-#10 | 1.30 | 5582 | 2027 | 7586 | 1773 | 9148 | 1490 | 9968 | 1267 | 10730 | 933 | 12895 | 712 | 6640 |
| 8-#11 | 1.59 | 5714 | 2094 | 7992 | 1805 | 9600 | 1512 | 10484 | 1279 | 11399 | 925 | 13801 | 679 | 7996 |
| 8-#14 | 2.30 | 6053 | 2254 | 8859 | 1902 | 10655 | 1582 | 11741 | 1322 | 13076 | 918 | 16108 | 612 | 11218 |
| 8-#18 | 4.08 | 6857 | 2660 | 10963 | 2150 | 13238 | 1762 | 14827 | 1433 | 17204 | 900 | 21541 | 416 | 18973 |
| 12-#10 | 1.94 | 5927 | 2174 | 8281 | 1877 | 9986 | 1575 | 10977 | 1326 | 12080 | 933 | 14892 | 650 | 9725 |
| 12-#11 | 2.39 | 6123 | 2275 | 8828 | 1932 | 10610 | 1616 | 11700 | 1350 | 13026 | 923 | 16199 | 601 | 11679 |
| 12-#14 | 3.44 | 6630 | 2515 | 10048 | 2083 | 12091 | 1730 | 13469 | 1424 | 15390 | 914 | 19508 | 499 | 16057 |
| 12-#18 | 6.12 | 7913 | 3124 | 13016 | 2470 | 15718 | 2022 | 17813 | 1610 | 21203 | 889 | 27295 | 204 | 25955 |
| 16-#10 | 2.59 | 6240 | 2322 | 9016 | 1981 | 10886 | 1653 | 12055 | 1378 | 13514 | 940 | 16879 | 592 | 12539 |
| 16-#11 | 3.18 | 6494 | 2456 | 9714 | 2058 | 11694 | 1710 | 12998 | 1413 | 14754 | 931 | 18589 | 527 | 14878 |
| 16-#14 | 4.59 | 7144 | 2776 | 11307 | 2265 | 13632 | 1866 | 15315 | 1513 | 17846 | 923 | 22902 | 389 | 20499 |
| 20-#10 | 3.24 | 6537 | 2469 | 9688 | 2087 | 11811 | 1731 | 13144 | 1437 | 14964 | 940 | 18899 | 512 | 15291 |
| 20-#11 | 3.98 | 6847 | 2637 | 10531 | 2189 | 12807 | 1805 | 14310 | 1484 | 16501 | 929 | 21013 | 428 | 18211 |
| 20-#14 | 5.74 | 7647 | 3037 | 12477 | 2455 | 15215 | 2002 | 17180 | 1614 | 20330 | 920 | 26341 | 245 | 24793 |
| 24-#10 | 3.89 | 6869 | 2616 | 10407 | 2186 | 12700 | 1813 | 14252 | 1488 | 16437 | 947 | 20941 | 463 | 17956 |
| 24-#11 | 4.78 | 7243 | 2818 | 11397 | 2311 | 13889 | 1906 | 15645 | 1546 | 18275 | 936 | 23469 | 364 | 21276 |

## SQUARE TIED COLUMNS 30" x 30"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.00 | 6942 | 2250 | 9432 | 1963 | 11323 | 1655 | 12317 | 1414 | 13248 | 1053 | 15911 | 918 | 6348 |
| 4-#18 | 1.78 | 7581 | 2453 | 11016 | 2071 | 13230 | 1731 | 14577 | 1459 | 16254 | 1032 | 20040 | 894 | 10817 |
| 8-#10 | 1.13 | 6777 | 2284 | 9022 | 2019 | 10927 | 1700 | 11900 | 1450 | 12741 | 1079 | 15250 | 841 | 7214 |
| 8-#11 | 1.39 | 6925 | 2351 | 9472 | 2050 | 11425 | 1722 | 12467 | 1461 | 13474 | 1071 | 16242 | 808 | 8702 |
| 8-#14 | 2.00 | 7303 | 2511 | 10423 | 2146 | 12580 | 1792 | 13841 | 1505 | 15305 | 1064 | 18760 | 742 | 12234 |
| 8-#18 | 3.56 | 8200 | 2917 | 12737 | 2394 | 15414 | 1972 | 17223 | 1616 | 19827 | 1047 | 24986 | 573 | 20777 |
| 12-#10 | 1.69 | 7158 | 2431 | 9778 | 2123 | 11839 | 1786 | 12998 | 1510 | 14211 | 1080 | 17431 | 780 | 10586 |
| 12-#11 | 2.08 | 7378 | 2532 | 10384 | 2177 | 12526 | 1826 | 13793 | 1534 | 15249 | 1070 | 18865 | 731 | 12740 |
| 12-#14 | 3.00 | 7941 | 2772 | 11722 | 2329 | 14148 | 1941 | 15728 | 1608 | 17832 | 1062 | 22486 | 631 | 17803 |
| 12-#18 | 5.33 | 9302 | 3381 | 14985 | 2717 | 18128 | 2234 | 20492 | 1796 | 24203 | 1040 | 31405 | 372 | 28747 |
| 16-#10 | 2.26 | 7502 | 2578 | 10579 | 2227 | 12820 | 1864 | 14172 | 1562 | 15772 | 1088 | 19599 | 724 | 13785 |
| 16-#11 | 2.77 | 7786 | 2713 | 11351 | 2305 | 13709 | 1921 | 15209 | 1597 | 17133 | 1079 | 21477 | 661 | 16367 |
| 16-#14 | 4.00 | 8506 | 3033 | 13097 | 2512 | 15831 | 2078 | 17744 | 1698 | 20514 | 1073 | 26199 | 526 | 22553 |
| 16-#18 | 7.11 | 10298 | 3844 | 17364 | 3040 | 21041 | 2474 | 23981 | 1954 | 28846 | 1054 | 37817 | 173 | 36884 |
| 20-#10 | 2.82 | 7830 | 2725 | 11306 | 2333 | 13827 | 1942 | 15359 | 1622 | 17353 | 1088 | 21805 | 645 | 16746 |
| 20-#11 | 3.47 | 8176 | 2893 | 12235 | 2435 | 14924 | 2017 | 16641 | 1669 | 19039 | 1078 | 24130 | 562 | 19995 |
| 20-#14 | 5.00 | 9059 | 3294 | 14364 | 2701 | 17561 | 2214 | 19782 | 1801 | 23228 | 1071 | 29967 | 383 | 27432 |
| 24-#10 | 3.39 | 8195 | 2873 | 12088 | 2433 | 14788 | 2024 | 16567 | 1674 | 18957 | 1096 | 24034 | 598 | 19770 |
| 24-#11 | 4.16 | 8612 | 3074 | 13179 | 2557 | 16094 | 2118 | 18098 | 1733 | 20975 | 1087 | 26814 | 501 | 23437 |

## SQUARE TIED COLUMNS 32" x 32"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.56 | 9027 | 2727 | 12820 | 2332 | 15445 | 1953 | 16994 | 1652 | 18823 | 1186 | 23098 | 1030 | 11716 |
| 8-#11 | 1.22 | 8296 | 2625 | 11126 | 2313 | 13473 | 1946 | 14693 | 1657 | 15796 | 1227 | 18966 | 946 | 9406 |
| 8-#14 | 1.76 | 8714 | 2785 | 12162 | 2409 | 14728 | 2016 | 16184 | 1700 | 17782 | 1220 | 21696 | 881 | 13247 |
| 8-#18 | 3.13 | 9707 | 3191 | 14686 | 2656 | 17813 | 2196 | 19863 | 1812 | 22696 | 1204 | 28462 | 715 | 22576 |
| 12-#10 | 1.49 | 8550 | 2705 | 11448 | 2387 | 13915 | 2011 | 15263 | 1706 | 16589 | 1237 | 20256 | 918 | 11445 |
| 12-#11 | 1.83 | 8793 | 2806 | 12114 | 2441 | 14666 | 2051 | 16129 | 1730 | 17718 | 1228 | 21816 | 870 | 13798 |
| 12-#14 | 2.64 | 9415 | 3046 | 13570 | 2593 | 16428 | 2166 | 18231 | 1805 | 20521 | 1220 | 25748 | 771 | 19375 |
| 12-#18 | 4.69 | 10914 | 3655 | 17129 | 2981 | 20762 | 2460 | 23414 | 1994 | 27450 | 1200 | 35460 | 516 | 31606 |
| 16-#10 | 1.98 | 8926 | 2852 | 12315 | 2492 | 14976 | 2090 | 16533 | 1760 | 18278 | 1246 | 22604 | 865 | 15007 |
| 16-#11 | 2.44 | 9240 | 2987 | 13161 | 2569 | 15947 | 2147 | 17664 | 1794 | 19759 | 1237 | 24649 | 802 | 17881 |
| 16-#14 | 3.52 | 10032 | 3307 | 15062 | 2777 | 18254 | 2304 | 20417 | 1896 | 23429 | 1232 | 29780 | 670 | 24638 |
| 16-#18 | 6.25 | 11937 | 4118 | 19715 | 3305 | 23928 | 2702 | 27206 | 2155 | 32495 | 1217 | 42439 | 325 | 40778 |
| 20-#10 | 2.48 | 9285 | 2999 | 13096 | 2597 | 16066 | 2169 | 17817 | 1820 | 19988 | 1247 | 24996 | 786 | 18216 |
| 20-#11 | 3.05 | 9668 | 3168 | 14112 | 2699 | 17264 | 2243 | 19215 | 1867 | 21825 | 1237 | 27531 | 705 | 21771 |
| 20-#14 | 4.39 | 10636 | 3568 | 16425 | 2965 | 20130 | 2442 | 22627 | 2001 | 26373 | 1232 | 33879 | 528 | 30139 |
| 24-#10 | 2.98 | 9685 | 3147 | 13941 | 2698 | 17098 | 2250 | 19124 | 1873 | 21724 | 1256 | 27412 | 741 | 21564 |
| 24-#11 | 3.66 | 10145 | 3348 | 15134 | 2822 | 18522 | 2343 | 20793 | 1932 | 23922 | 1247 | 30444 | 646 | 25641 |
| 24-#14 | 5.27 | 11315 | 3829 | 17882 | 3141 | 21933 | 2587 | 24876 | 2093 | 29360 | 1244 | 38024 | 441 | 35320 |

## SQUARE TIED COLUMNS 34" x 34"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.38 | 10646 | 3019 | 14811 | 2610 | 17899 | 2190 | 19670 | 1859 | 21655 | 1351 | 26459 | 1174 | 12615 |
| 8-#11 | 1.08 | 9837 | 2917 | 12964 | 2593 | 15758 | 2185 | 17178 | 1866 | 18382 | 1393 | 21994 | 1093 | 10109 |
| 8-#14 | 1.56 | 10297 | 3077 | 14086 | 2689 | 17114 | 2255 | 18787 | 1909 | 20522 | 1387 | 24935 | 1029 | 14259 |
| 8-#18 | 2.77 | 11388 | 3482 | 16822 | 2936 | 20451 | 2435 | 22763 | 2021 | 25829 | 1371 | 32239 | 865 | 24372 |
| 12-#10 | 1.32 | 10112 | 2997 | 13301 | 2668 | 16227 | 2251 | 17786 | 1916 | 19231 | 1405 | 23384 | 1066 | 12302 |
| 12-#11 | 1.62 | 10381 | 3097 | 14028 | 2722 | 17043 | 2290 | 18725 | 1939 | 20451 | 1395 | 25071 | 1018 | 14853 |
| 12-#14 | 2.34 | 11062 | 3337 | 15604 | 2873 | 18946 | 2406 | 20992 | 2014 | 23474 | 1388 | 29314 | 920 | 20899 |
| 12-#18 | 4.15 | 12701 | 3946 | 19459 | 3262 | 23635 | 2701 | 26596 | 2205 | 30960 | 1370 | 39817 | 668 | 34533 |
| 16-#10 | 1.76 | 10520 | 3144 | 14233 | 2773 | 17368 | 2331 | 19153 | 1970 | 21048 | 1414 | 25912 | 1014 | 16154 |
| 16-#11 | 2.16 | 10866 | 3278 | 15156 | 2850 | 18423 | 2387 | 20377 | 2005 | 22649 | 1405 | 28125 | 952 | 19422 |
| 16-#14 | 3.11 | 11731 | 3598 | 17212 | 3058 | 20915 | 2545 | 23349 | 2107 | 26609 | 1401 | 33665 | 822 | 26755 |
| 16-#18 | 5.54 | 13810 | 4410 | 22253 | 3588 | 27054 | 2945 | 30691 | 2368 | 36407 | 1390 | 47363 | 484 | 44458 |
| 20-#10 | 2.20 | 10912 | 3291 | 15069 | 2879 | 18540 | 2410 | 20534 | 2030 | 22887 | 1416 | 28489 | 937 | 19702 |
| 20-#11 | 2.70 | 11332 | 3459 | 16173 | 2980 | 19842 | 2484 | 22048 | 2078 | 24874 | 1407 | 31236 | 855 | 23565 |
| 20-#14 | 3.89 | 12389 | 3859 | 18671 | 3246 | 22937 | 2684 | 25731 | 2213 | 29781 | 1403 | 38094 | 681 | 32789 |
| 24-#10 | 2.64 | 11347 | 3438 | 15978 | 2980 | 19645 | 2491 | 21940 | 2084 | 24755 | 1425 | 31093 | 892 | 23287 |
| 24-#11 | 3.24 | 11851 | 3640 | 17274 | 3103 | 21187 | 2584 | 23748 | 2143 | 27133 | 1417 | 34378 | 799 | 27887 |
| 24-#14 | 4.67 | 13126 | 4120 | 20241 | 3423 | 24866 | 2828 | 28156 | 2306 | 33002 | 1416 | 42569 | 598 | 38392 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 36" x 36"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.23 | 12447 | 3328 | 16999 | 2905 | 20606 | 2443 | 22622 | 2079 | 24767 | 1526 | 30141 | 1327 | 13513 |
| 8-#14 | 1.39 | 12061 | 3386 | 16206 | 2986 | 19752 | 2509 | 21665 | 2131 | 23543 | 1563 | 28497 | 1186 | 15269 |
| 8-#18 | 2.47 | 13252 | 3792 | 19155 | 3233 | 23342 | 2688 | 25938 | 2243 | 29242 | 1548 | 36338 | 1024 | 26164 |
| 12-#10 | 1.18 | 11855 | 3306 | 15347 | 2967 | 18791 | 2506 | 20584 | 2139 | 22153 | 1582 | 26836 | 1222 | 13157 |
| 12-#11 | 1.44 | 12149 | 3407 | 16136 | 3020 | 19672 | 2545 | 21595 | 2162 | 23465 | 1572 | 28648 | 1175 | 15906 |
| 12-#14 | 2.08 | 12891 | 3647 | 17833 | 3172 | 21717 | 2661 | 24029 | 2237 | 26707 | 1566 | 33202 | 1078 | 22420 |
| 12-#18 | 3.70 | 14674 | 4256 | 21987 | 3560 | 26761 | 2956 | 30053 | 2429 | 34751 | 1549 | 44496 | 828 | 37527 |
| 16-#10 | 1.57 | 12297 | 3453 | 16342 | 3072 | 20013 | 2586 | 22047 | 2193 | 24098 | 1592 | 29544 | 1172 | 17297 |
| 16-#11 | 1.93 | 12675 | 3588 | 17345 | 3149 | 21151 | 2643 | 23366 | 2228 | 25820 | 1583 | 31924 | 1111 | 20872 |
| 16-#14 | 2.78 | 13615 | 3908 | 19558 | 3357 | 23827 | 2800 | 26556 | 2331 | 30068 | 1581 | 37873 | 983 | 28903 |
| 16-#18 | 4.94 | 15871 | 4720 | 24988 | 3888 | 30433 | 3202 | 34451 | 2593 | 40601 | 1572 | 52610 | 651 | 48029 |
| 20-#10 | 1.96 | 12722 | 3601 | 17235 | 3178 | 21261 | 2665 | 23526 | 2254 | 26067 | 1595 | 32304 | 1096 | 21203 |
| 20-#11 | 2.41 | 13180 | 3769 | 18429 | 3278 | 22671 | 2740 | 25156 | 2302 | 28204 | 1586 | 35263 | 1015 | 25376 |
| 20-#14 | 3.47 | 14327 | 4169 | 21113 | 3544 | 25996 | 2940 | 29111 | 2437 | 33470 | 1583 | 42632 | 843 | 35323 |
| 20-#18 | 6.17 | 17106 | 5183 | 27721 | 4222 | 34206 | 3448 | 38896 | 2779 | 46521 | 1573 | 60861 | 400 | 58125 |
| 24-#10 | 2.35 | 13192 | 3748 | 18208 | 3279 | 22443 | 2747 | 25028 | 2308 | 28066 | 1604 | 35099 | 1052 | 25021 |
| 24-#11 | 2.89 | 13741 | 3950 | 19608 | 3402 | 24104 | 2840 | 26979 | 2367 | 30624 | 1597 | 38636 | 960 | 30032 |
| 24-#14 | 4.17 | 15122 | 4430 | 22795 | 3722 | 28052 | 3084 | 31711 | 2531 | 36925 | 1598 | 47437 | 762 | 41516 |

## SQUARE TIED COLUMNS 38" x 38"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.11 | 14440 | 3655 | 19394 | 3218 | 23580 | 2710 | 25865 | 2312 | 28176 | 1711 | 34164 | 1490 | 14410 |
| 8-#14 | 1.25 | 14017 | 3713 | 18531 | 3301 | 22657 | 2778 | 24834 | 2365 | 26860 | 1751 | 32400 | 1352 | 16278 |
| 8-#18 | 2.22 | 15311 | 4119 | 21695 | 3547 | 26500 | 2957 | 29404 | 2477 | 32952 | 1736 | 40778 | 1191 | 27955 |
| 12-#10 | 1.06 | 13790 | 3633 | 17598 | 3284 | 21620 | 2777 | 23673 | 2375 | 25372 | 1770 | 30630 | 1388 | 14011 |
| 12-#11 | 1.30 | 14110 | 3734 | 18450 | 3336 | 22567 | 2815 | 24756 | 2397 | 26775 | 1760 | 32568 | 1341 | 16957 |
| 12-#14 | 1.87 | 14912 | 3974 | 20268 | 3487 | 24753 | 2930 | 27357 | 2472 | 30237 | 1754 | 37433 | 1244 | 23937 |
| 12-#18 | 3.32 | 16843 | 4583 | 24722 | 3876 | 30154 | 3226 | 33802 | 2665 | 38839 | 1739 | 49517 | 997 | 40588 |
| 16-#10 | 1.41 | 14265 | 3780 | 18654 | 3389 | 22922 | 2857 | 25232 | 2429 | 27445 | 1781 | 33519 | 1339 | 18438 |
| 16-#11 | 1.73 | 14676 | 3915 | 19736 | 3465 | 24144 | 2913 | 26645 | 2463 | 29287 | 1772 | 36065 | 1278 | 22278 |
| 16-#14 | 2.49 | 15693 | 4235 | 22109 | 3673 | 27007 | 3071 | 30055 | 2567 | 33825 | 1770 | 42423 | 1152 | 31083 |
| 16-#18 | 4.43 | 18131 | 5047 | 27930 | 4205 | 34080 | 3474 | 38503 | 2831 | 45091 | 1764 | 58199 | 825 | 51643 |
| 20-#10 | 1.76 | 14724 | 3928 | 19606 | 3495 | 24247 | 2935 | 26809 | 2491 | 29544 | 1784 | 36462 | 1264 | 22720 |
| 20-#11 | 2.16 | 15221 | 4096 | 20891 | 3595 | 25759 | 3010 | 28556 | 2538 | 31830 | 1775 | 39629 | 1184 | 27203 |
| 20-#14 | 3.12 | 16460 | 4496 | 23760 | 3860 | 29322 | 3211 | 32782 | 2674 | 37457 | 1773 | 47509 | 1014 | 37877 |
| 20-#18 | 5.54 | 19456 | 5510 | 30834 | 4538 | 38113 | 3721 | 43255 | 3019 | 51419 | 1766 | 67037 | 575 | 62744 |
| 24-#10 | 2.11 | 15230 | 4075 | 20642 | 3596 | 25507 | 3017 | 28403 | 2544 | 31675 | 1794 | 39447 | 1221 | 26764 |
| 24-#11 | 2.59 | 15826 | 4277 | 22147 | 3719 | 27286 | 3110 | 30499 | 2604 | 34412 | 1787 | 43235 | 1130 | 32150 |
| 24-#14 | 3.74 | 17315 | 4757 | 25555 | 4038 | 31504 | 3355 | 35558 | 2769 | 41144 | 1789 | 52648 | 935 | 44690 |

## SQUARE TIED COLUMNS 40" x 40"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.00 | 16636 | 4000 | 22008 | 3549 | 26836 | 2992 | 29416 | 2558 | 31898 | 1907 | 38549 | 1662 | 15307 |
| 8-#14 | 1.13 | 16176 | 4058 | 21073 | 3634 | 25842 | 3062 | 28310 | 2613 | 30491 | 1948 | 36665 | 1526 | 17285 |
| 8-#18 | 2.00 | 17574 | 4464 | 24453 | 3879 | 29940 | 3241 | 33178 | 2725 | 36975 | 1934 | 45579 | 1367 | 29742 |
| 12-#11 | 1.17 | 16274 | 4079 | 20980 | 3669 | 25742 | 3100 | 28224 | 2646 | 30398 | 1958 | 36849 | 1515 | 18006 |
| 12-#14 | 1.69 | 17138 | 4319 | 22919 | 3821 | 28071 | 3215 | 30992 | 2721 | 34080 | 1953 | 42025 | 1419 | 25452 |
| 12-#18 | 3.00 | 19218 | 4928 | 27675 | 4209 | 33829 | 3511 | 37859 | 2914 | 43240 | 1938 | 54899 | 1174 | 43554 |
| 16-#10 | 1.27 | 16436 | 4125 | 21182 | 3723 | 26112 | 3142 | 28724 | 2678 | 31105 | 1979 | 37855 | 1515 | 19577 |
| 16-#11 | 1.56 | 16880 | 4260 | 22342 | 3798 | 27419 | 3198 | 30232 | 2712 | 33068 | 1971 | 40568 | 1454 | 23681 |
| 16-#14 | 2.25 | 17975 | 4580 | 24871 | 4006 | 30467 | 3356 | 33861 | 2816 | 37894 | 1969 | 47335 | 1329 | 33294 |
| 16-#18 | 4.00 | 20598 | 5391 | 31091 | 4539 | 38008 | 3760 | 42863 | 3081 | 49894 | 1965 | 64149 | 1007 | 55298 |
| 20-#10 | 1.59 | 16928 | 4272 | 22192 | 3829 | 27514 | 3221 | 30398 | 2740 | 33334 | 1983 | 40982 | 1441 | 24209 |
| 20-#11 | 1.95 | 17466 | 4440 | 23568 | 3928 | 29128 | 3295 | 32262 | 2788 | 35770 | 1974 | 44358 | 1362 | 29048 |
| 20-#14 | 2.81 | 18799 | 4841 | 26625 | 4194 | 32919 | 3496 | 36761 | 2924 | 41756 | 1974 | 52746 | 1193 | 40451 |
| 20-#18 | 5.00 | 22016 | 5855 | 34166 | 4872 | 42302 | 4008 | 47922 | 3271 | 56630 | 1970 | 73574 | 758 | 67453 |
| 24-#10 | 1.90 | 17471 | 4420 | 23291 | 3931 | 28850 | 3303 | 32084 | 2793 | 35596 | 1994 | 44156 | 1398 | 28518 |
| 24-#11 | 2.34 | 18114 | 4621 | 24902 | 4053 | 30750 | 3395 | 34318 | 2854 | 38514 | 1987 | 48197 | 1308 | 34279 |
| 24-#14 | 3.38 | 19715 | 5101 | 28532 | 4373 | 35237 | 3640 | 39712 | 3020 | 45676 | 1991 | 58221 | 1115 | 47916 |

## SQUARE TIED COLUMNS 42" x 42"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.02 | 18548 | 4420 | 23842 | 3984 | 29323 | 3361 | 32109 | 2874 | 34451 | 2156 | 41310 | 1710 | 18292 |
| 8-#18 | 1.81 | 20051 | 4826 | 27440 | 4229 | 33676 | 3539 | 37275 | 2985 | 41328 | 2142 | 50759 | 1551 | 31528 |
| 12-#11 | 1.06 | 18650 | 4441 | 23736 | 4021 | 29212 | 3399 | 32016 | 2907 | 34352 | 2167 | 41511 | 1699 | 19054 |
| 12-#14 | 1.53 | 19577 | 4681 | 25798 | 4171 | 31684 | 3515 | 34950 | 2982 | 38253 | 2161 | 46997 | 1603 | 26964 |
| 12-#18 | 2.72 | 21809 | 5290 | 30857 | 4560 | 37800 | 3811 | 42239 | 3176 | 47970 | 2148 | 60661 | 1360 | 46253 |
| 16-#10 | 1.15 | 18820 | 4488 | 23935 | 4074 | 29596 | 3443 | 32539 | 2941 | 35095 | 2189 | 42483 | 1690 | 20713 |
| 16-#11 | 1.41 | 19297 | 4622 | 25174 | 4149 | 30988 | 3498 | 34142 | 2974 | 37178 | 2180 | 45452 | 1639 | 25081 |
| 16-#14 | 2.04 | 20472 | 4942 | 27860 | 4357 | 34222 | 3656 | 37989 | 3079 | 42294 | 2179 | 52627 | 1516 | 35413 |
| 16-#18 | 3.63 | 23284 | 5754 | 34480 | 4890 | 42232 | 4061 | 47546 | 3345 | 55028 | 2176 | 70479 | 1197 | 58996 |
| 20-#10 | 1.44 | 19346 | 4635 | 25003 | 4181 | 31074 | 3521 | 34311 | 3003 | 37454 | 2193 | 45883 | 1627 | 25634 |
| 20-#11 | 1.77 | 19925 | 4803 | 26471 | 4280 | 32791 | 3595 | 36291 | 3050 | 40040 | 2184 | 49467 | 1548 | 30911 |
| 20-#14 | 2.55 | 21353 | 5203 | 29716 | 4545 | 36810 | 3796 | 41062 | 3187 | 46385 | 2184 | 58363 | 1382 | 43046 |
| 20-#18 | 4.54 | 24795 | 6218 | 37726 | 5223 | 46786 | 4310 | 52912 | 3535 | 62172 | 2183 | 80484 | 952 | 72252 |
| 24-#10 | 1.73 | 19926 | 4782 | 26166 | 4283 | 32488 | 3604 | 36087 | 3056 | 39848 | 2204 | 49248 | 1584 | 30283 |
| 24-#11 | 2.12 | 20617 | 4984 | 27884 | 4404 | 34508 | 3695 | 38460 | 3116 | 42946 | 2197 | 53539 | 1495 | 36419 |
| 24-#14 | 3.06 | 22330 | 5464 | 31736 | 4724 | 39266 | 3941 | 44176 | 3282 | 50539 | 2202 | 64175 | 1304 | 51007 |
| 24-#18 | 5.44 | 26488 | 6681 | 41256 | 5540 | 51077 | 4566 | 58373 | 3704 | 69425 | 2211 | 90596 | 812 | 84315 |

## SQUARE TIED COLUMNS 44" x 44"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.65 | 22753 | 5206 | 30667 | 4596 | 37722 | 3853 | 41712 | 3259 | 46027 | 2360 | 56339 | 1745 | 33312 |
| 12-#14 | 1.39 | 22239 | 5061 | 28915 | 4540 | 35607 | 3829 | 39248 | 3257 | 42773 | 2380 | 52369 | 1796 | 28473 |
| 12-#18 | 2.48 | 24626 | 5670 | 34278 | 4928 | 42081 | 4125 | 46959 | 3451 | 53047 | 2368 | 66822 | 1555 | 48947 |
| 16-#10 | 1.05 | 21427 | 4868 | 26924 | 4444 | 33389 | 3758 | 36692 | 3216 | 39432 | 2408 | 47595 | 1884 | 21848 |
| 16-#11 | 1.29 | 21938 | 5002 | 28243 | 4518 | 34866 | 3813 | 38390 | 3249 | 41635 | 2399 | 50620 | 1821 | 26479 |
| 16-#14 | 1.86 | 23193 | 5322 | 31086 | 4725 | 38288 | 3971 | 42457 | 3354 | 47040 | 2399 | 58318 | 1711 | 37435 |
| 16-#18 | 3.31 | 26198 | 6134 | 38096 | 5258 | 46767 | 4376 | 52569 | 3621 | 60507 | 2398 | 77208 | 1395 | 62736 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 1.31 | 21988 | 5015 | 28050 | 4551 | 34944 | 3837 | 38561 | 3278 | 41920 | 2412 | 51184 | 1821 | 27056 |
| 20-#11 | 1.61 | 22608 | 5183 | 29612 | 4648 | 36764 | 3909 | 40660 | 3325 | 44656 | 2404 | 54976 | 1743 | 32747 |
| 20-#14 | 2.32 | 24132 | 5583 | 33045 | 4913 | 41011 | 4111 | 45703 | 3463 | 51361 | 2405 | 64380 | 1579 | 45663 |
| 20-#18 | 4.13 | 27804 | 6598 | 41525 | 5591 | 51562 | 4625 | 58242 | 3812 | 68060 | 2405 | 87792 | 1154 | 76920 |
| 24-#10 | 1.57 | 22605 | 5162 | 29277 | 4653 | 36435 | 3919 | 40430 | 3331 | 44446 | 2424 | 54739 | 1779 | 32059 |
| 24-#11 | 1.93 | 23345 | 5364 | 31103 | 4773 | 38575 | 4011 | 42941 | 3391 | 47724 | 2417 | 59282 | 1690 | 38571 |
| 24-#14 | 2.79 | 25172 | 5844 | 35178 | 5093 | 43604 | 4256 | 48979 | 3557 | 55748 | 2423 | 70528 | 1502 | 54043 |
| 24-#18 | 4.96 | 29601 | 7062 | 45256 | 5909 | 56097 | 4882 | 64013 | 3982 | 75728 | 2435 | 98501 | 1015 | 89805 |

## SQUARE TIED COLUMNS 46" x 46"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.51 | 25690 | 5604 | 34143 | 4981 | 42093 | 4181 | 46504 | 3546 | 51089 | 2589 | 62337 | 1947 | 35094 |
| 12-#14 | 1.28 | 25137 | 5459 | 32280 | 4926 | 39853 | 4159 | 43900 | 3544 | 47655 | 2610 | 58159 | 1998 | 29980 |
| 12-#18 | 2.27 | 27679 | 6068 | 37950 | 5313 | 46687 | 4455 | 52034 | 3739 | 58487 | 2598 | 73402 | 1758 | 51636 |
| 16-#11 | 1.18 | 24813 | 5400 | 31560 | 4904 | 39068 | 4143 | 42994 | 3537 | 46455 | 2629 | 56317 | 2024 | 27874 |
| 16-#14 | 1.70 | 26149 | 5720 | 34561 | 5111 | 42677 | 4301 | 47281 | 3642 | 52149 | 2629 | 64256 | 1897 | 39453 |
| 16-#18 | 3.02 | 29349 | 6532 | 41962 | 5643 | 51627 | 4706 | 57947 | 3909 | 66350 | 2629 | 84357 | 1602 | 66519 |
| 20-#10 | 1.20 | 24864 | 5413 | 31344 | 4938 | 39136 | 4167 | 43167 | 3567 | 46749 | 2643 | 56905 | 2025 | 28475 |
| 20-#11 | 1.47 | 25525 | 5581 | 33000 | 5035 | 41060 | 4239 | 45383 | 3614 | 49635 | 2634 | 60904 | 1947 | 34497 |
| 20-#14 | 2.13 | 27147 | 5981 | 36623 | 5300 | 45536 | 4440 | 50699 | 3752 | 56699 | 2635 | 70816 | 1784 | 48300 |
| 20-#18 | 3.78 | 31053 | 6996 | 45574 | 5977 | 56664 | 4955 | 63927 | 4102 | 74311 | 2638 | 95518 | 1364 | 81438 |
| 24-#10 | 1.44 | 25519 | 5560 | 32635 | 5040 | 40705 | 4250 | 45127 | 3620 | 49407 | 2654 | 60650 | 1983 | 33846 |
| 24-#11 | 1.77 | 26308 | 5762 | 34569 | 5160 | 42966 | 4341 | 47776 | 3679 | 52864 | 2648 | 65444 | 1895 | 40735 |
| 24-#14 | 2.55 | 28251 | 6242 | 38869 | 5480 | 48266 | 4586 | 54137 | 3846 | 61320 | 2655 | 77301 | 1708 | 57092 |
| 24-#18 | 4.54 | 32955 | 7459 | 49505 | 6296 | 61442 | 5212 | 69986 | 4271 | 82394 | 2669 | 106825 | 1226 | 95309 |

## SQUARE TIED COLUMNS 48" x 48"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.39 | 28872 | 6020 | 37880 | 5383 | 46803 | 4524 | 51668 | 3845 | 56530 | 2828 | 68773 | 2159 | 36874 |
| 12-#14 | 1.17 | 28279 | 5875 | 35905 | 5330 | 44438 | 4503 | 48924 | 3845 | 52916 | 2849 | 64388 | 2209 | 31486 |
| 12-#18 | 2.08 | 30979 | 6483 | 41882 | 5716 | 51633 | 4799 | 57480 | 4039 | 64306 | 2838 | 80420 | 1970 | 54321 |
| 16-#11 | 1.08 | 27934 | 5815 | 35135 | 5308 | 43608 | 4488 | 47968 | 3838 | 51654 | 2869 | 62453 | 2236 | 29267 |
| 16-#14 | 1.56 | 29351 | 6135 | 38295 | 5515 | 47404 | 4646 | 52475 | 3943 | 57637 | 2869 | 70796 | 2110 | 41467 |
| 16-#18 | 2.78 | 32749 | 6947 | 46089 | 6046 | 56825 | 5052 | 63697 | 4211 | 72572 | 2870 | 91943 | 1817 | 70345 |
| 20-#10 | 1.10 | 27985 | 5828 | 34895 | 5343 | 43666 | 4512 | 48143 | 3869 | 51958 | 2883 | 63065 | 2237 | 29892 |
| 20-#11 | 1.35 | 28687 | 5996 | 36647 | 5439 | 45694 | 4584 | 50477 | 3915 | 54994 | 2875 | 67271 | 2160 | 36243 |
| 20-#14 | 1.95 | 30408 | 6396 | 40460 | 5703 | 50400 | 4785 | 56066 | 4053 | 62417 | 2876 | 77690 | 1998 | 50959 |
| 20-#18 | 3.47 | 34552 | 7411 | 49884 | 6380 | 62104 | 5299 | 69984 | 4405 | 80941 | 2881 | 103682 | 1582 | 85974 |
| 24-#10 | 1.32 | 28677 | 5975 | 36249 | 5445 | 45312 | 4596 | 50194 | 3921 | 54748 | 2895 | 67000 | 2195 | 35602 |
| 24-#11 | 1.63 | 29516 | 6177 | 38294 | 5564 | 47695 | 4686 | 52983 | 3980 | 58385 | 2889 | 72044 | 2108 | 42911 |
| 24-#14 | 2.34 | 31576 | 6657 | 42818 | 5884 | 53266 | 4931 | 59666 | 4147 | 67272 | 2896 | 84512 | 1923 | 60155 |
| 24-#18 | 4.17 | 36560 | 7875 | 54016 | 6700 | 67125 | 5558 | 76332 | 4573 | 89439 | 2913 | 115588 | 1446 | 100881 |

## SQUARE TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#5 | 1.24 | 289 | 301 | 464 | 216 | 492 | 181 | 497 | 152 | 490 | 107 | 514 | 77 | 274 |
| 4-#6 | 1.76 | 297 | 315 | 490 | 224 | 520 | 186 | 529 | 154 | 530 | 102 | 565 | 68 | 360 |
| 4-#7 | 2.40 | 307 | 334 | 520 | 234 | 553 | 191 | 567 | 155 | 577 | 96 | 613 | 53 | 459 |
| 4-#8 | 3.16 | 318 | 355 | 554 | 246 | 590 | 198 | 609 | 157 | 630 | 88 | 666 | 34 | 570 |
| 4-#9 | 4.00 | 330 | 379 | 586 | 258 | 627 | 205 | 651 | 158 | 684 | 78 | 717 | 11 | 686 |
| 4-#10 | 5.08 | 345 | 410 | 625 | 273 | 671 | 213 | 702 | 159 | 749 | 65 | 776 | -19 | 783 |
| 4-#11 | 6.24 | 354 | 443 | 642 | 282 | 687 | 214 | 719 | 152 | 770 | 41 | 767 | -72 | 799 |
| 8-#5 | 2.48 | 298 | 336 | 495 | 238 | 531 | 198 | 542 | 161 | 547 | 100 | 575 | 31 | 482 |
| 8-#6 | 3.52 | 311 | 366 | 533 | 255 | 573 | 208 | 591 | 165 | 608 | 92 | 651 | 5 | 639 |
| 8-#7 | 4.80 | 326 | 402 | 577 | 275 | 622 | 222 | 647 | 170 | 680 | 80 | 725 | -35 | 705 |

## SQUARE TIED COLUMNS 12" x 12"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.22 | 506 | 432 | 800 | 322 | 865 | 271 | 892 | 231 | 892 | 165 | 962 | 126 | 469 |
| 4-#7 | 1.67 | 521 | 450 | 842 | 332 | 916 | 278 | 950 | 234 | 966 | 161 | 1041 | 114 | 606 |
| 4-#8 | 2.19 | 538 | 472 | 891 | 344 | 976 | 286 | 1017 | 237 | 1050 | 155 | 1129 | 99 | 761 |
| 4-#9 | 2.78 | 556 | 496 | 943 | 357 | 1039 | 295 | 1087 | 241 | 1138 | 149 | 1220 | 81 | 924 |
| 4-#10 | 3.53 | 577 | 527 | 1008 | 374 | 1119 | 307 | 1173 | 245 | 1246 | 140 | 1328 | 57 | 1126 |
| 4-#11 | 4.33 | 592 | 560 | 1064 | 389 | 1165 | 312 | 1223 | 242 | 1309 | 122 | 1411 | 30 | 1309 |
| 4-#14 | 6.25 | 640 | 639 | 1207 | 434 | 1317 | 336 | 1397 | 248 | 1529 | 92 | 1624 | -41 | 1575 |
| 8-#5 | 1.72 | 507 | 453 | 806 | 338 | 876 | 282 | 906 | 239 | 914 | 166 | 990 | 96 | 632 |
| 8-#6 | 2.44 | 526 | 482 | 858 | 354 | 940 | 293 | 983 | 246 | 1008 | 160 | 1093 | 69 | 849 |
| 8-#7 | 3.33 | 548 | 519 | 921 | 375 | 1017 | 308 | 1071 | 254 | 1119 | 152 | 1213 | 35 | 1103 |
| 8-#8 | 4.39 | 573 | 562 | 993 | 400 | 1106 | 325 | 1172 | 263 | 1247 | 143 | 1347 | -8 | 1346 |
| 8-#9 | 5.56 | 601 | 610 | 1070 | 428 | 1201 | 344 | 1277 | 273 | 1380 | 132 | 1485 | -58 | 1473 |
| 8-#10 | 7.06 | 635 | 672 | 1166 | 463 | 1320 | 369 | 1406 | 284 | 1543 | 116 | 1650 | -125 | 1625 |

## SQUARE TIED COLUMNS 14" x 14"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.22 | 812 | 588 | 1265 | 450 | 1387 | 378 | 1442 | 322 | 1473 | 235 | 1617 | 185 | 751 |
| 4-#8 | 1.61 | 836 | 610 | 1329 | 461 | 1465 | 386 | 1534 | 326 | 1590 | 231 | 1749 | 174 | 950 |
| 4-#9 | 2.04 | 861 | 634 | 1398 | 474 | 1548 | 395 | 1633 | 332 | 1714 | 226 | 1886 | 160 | 1162 |
| 4-#10 | 2.59 | 891 | 665 | 1483 | 491 | 1652 | 407 | 1758 | 338 | 1867 | 220 | 2054 | 142 | 1425 |
| 4-#11 | 3.18 | 913 | 698 | 1565 | 504 | 1745 | 416 | 1856 | 341 | 1975 | 206 | 2146 | 110 | 1676 |
| 4-#14 | 4.59 | 980 | 777 | 1761 | 549 | 1986 | 448 | 2120 | 353 | 2308 | 184 | 2486 | 50 | 2278 |
| 8-#5 | 1.27 | 792 | 591 | 1217 | 457 | 1333 | 383 | 1380 | 328 | 1399 | 240 | 1538 | 168 | 781 |
| 8-#6 | 1.80 | 817 | 620 | 1285 | 473 | 1416 | 395 | 1478 | 335 | 1527 | 236 | 1686 | 145 | 1058 |
| 8-#7 | 2.45 | 847 | 657 | 1366 | 494 | 1515 | 410 | 1597 | 345 | 1680 | 232 | 1860 | 116 | 1386 |
| 8-#8 | 3.22 | 884 | 700 | 1460 | 520 | 1631 | 428 | 1736 | 356 | 1856 | 225 | 2060 | 81 | 1758 |
| 8-#9 | 4.08 | 921 | 748 | 1561 | 547 | 1755 | 447 | 1885 | 369 | 2042 | 218 | 2268 | 40 | 2152 |
| 8-#10 | 5.18 | 967 | 810 | 1687 | 584 | 1911 | 473 | 2073 | 385 | 2274 | 207 | 2523 | -15 | 2515 |
| 8-#11 | 6.37 | 1003 | 876 | 1804 | 617 | 2049 | 495 | 2222 | 394 | 2440 | 184 | 2667 | -97 | 2629 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.23 | 1223 | 769 | 1884 | 598 | 2087 | 503 | 2183 | 429 | 2260 | 316 | 2524 | 255 | 1138 |
| 4-#9 | 1.56 | 1255 | 793 | 1969 | 611 | 2191 | 512 | 2306 | 434 | 2424 | 313 | 2709 | 244 | 1398 |
| 4-#10 | 1.98 | 1296 | 824 | 2076 | 627 | 2320 | 524 | 2461 | 440 | 2628 | 309 | 2940 | 230 | 1723 |
| 4-#11 | 2.44 | 1328 | 857 | 2184 | 640 | 2441 | 532 | 2600 | 444 | 2783 | 297 | 3091 | 204 | 2041 |
| 4-#14 | 3.52 | 1416 | 936 | 2433 | 684 | 2746 | 563 | 2965 | 462 | 3233 | 281 | 3585 | 157 | 2799 |
| 4-#18 | 6.25 | 1614 | 1136 | 3015 | 798 | 3467 | 644 | 3794 | 503 | 4248 | 231 | 4645 | 18 | 4563 |
| 8-#6 | 1.38 | 1199 | 779 | 1826 | 612 | 2025 | 514 | 2113 | 439 | 2169 | 320 | 2433 | 227 | 1266 |
| 8-#7 | 1.88 | 1237 | 816 | 1926 | 633 | 2147 | 528 | 2259 | 449 | 2364 | 317 | 2664 | 202 | 1666 |
| 8-#8 | 2.47 | 1281 | 859 | 2042 | 658 | 2289 | 546 | 2429 | 460 | 2592 | 314 | 2930 | 172 | 2127 |
| 8-#9 | 3.13 | 1328 | 907 | 2168 | 686 | 2443 | 566 | 2613 | 473 | 2839 | 310 | 3211 | 137 | 2617 |
| 8-#10 | 3.97 | 1393 | 969 | 2325 | 723 | 2637 | 592 | 2846 | 490 | 3147 | 304 | 3559 | 90 | 3225 |
| 8-#11 | 4.88 | 1440 | 1035 | 2479 | 756 | 2816 | 614 | 3056 | 503 | 3384 | 286 | 3795 | 20 | 3743 |
| 8-#14 | 7.03 | 1578 | 1193 | 2846 | 849 | 3273 | 679 | 3605 | 545 | 4063 | 259 | 4542 | -119 | 4456 |
| 12-#10 | 5.95 | 1548 | 1114 | 2645 | 818 | 3022 | 669 | 3311 | 531 | 3787 | 299 | 4350 | 1 | 4348 |

## SQUARE TIED COLUMNS 18" x 18"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.23 | 1753 | 973 | 2672 | 768 | 2986 | 646 | 3138 | 550 | 3266 | 406 | 3709 | 336 | 1633 |
| 4-#10 | 1.57 | 1803 | 1004 | 2800 | 784 | 3141 | 657 | 3322 | 557 | 3513 | 402 | 4003 | 324 | 2019 |
| 4-#11 | 1.93 | 1845 | 1037 | 2935 | 796 | 3291 | 665 | 3494 | 559 | 3738 | 395 | 4217 | 302 | 2405 |
| 4-#14 | 2.78 | 1958 | 1116 | 3238 | 839 | 3660 | 695 | 3936 | 577 | 4319 | 385 | 4869 | 264 | 3318 |
| 4-#18 | 4.94 | 2209 | 1316 | 3954 | 951 | 4543 | 775 | 4994 | 624 | 5633 | 347 | 6323 | 152 | 5475 |
| 8-#6 | 1.09 | 1684 | 960 | 2499 | 770 | 2787 | 649 | 2907 | 557 | 2962 | 414 | 3355 | 317 | 1472 |
| 8-#7 | 1.48 | 1731 | 996 | 2618 | 791 | 2932 | 664 | 3079 | 567 | 3192 | 412 | 3643 | 295 | 1946 |
| 8-#8 | 1.95 | 1784 | 1040 | 2756 | 816 | 3100 | 682 | 3281 | 578 | 3462 | 408 | 3977 | 268 | 2492 |
| 8-#9 | 2.47 | 1842 | 1088 | 2906 | 845 | 3284 | 702 | 3500 | 592 | 3756 | 405 | 4333 | 238 | 3079 |
| 8-#10 | 3.14 | 1915 | 1149 | 3095 | 881 | 3515 | 727 | 3777 | 609 | 4129 | 400 | 4777 | 197 | 3811 |
| 8-#11 | 3.85 | 1976 | 1216 | 3286 | 914 | 3737 | 750 | 4036 | 622 | 4471 | 391 | 5109 | 136 | 4519 |
| 8-#14 | 5.56 | 2154 | 1373 | 3732 | 1007 | 4289 | 816 | 4700 | 665 | 5348 | 375 | 6094 | 15 | 6053 |
| 12-#10 | 4.70 | 2099 | 1294 | 3476 | 978 | 3973 | 806 | 4331 | 652 | 4873 | 390 | 5771 | 116 | 5261 |
| 12-#11 | 5.78 | 2206 | 1394 | 3738 | 1032 | 4280 | 845 | 4693 | 673 | 5376 | 386 | 6250 | 30 | 6122 |

## SQUARE TIED COLUMNS 20" x 20"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.00 | 2367 | 1175 | 3521 | 945 | 3952 | 797 | 4148 | 682 | 4283 | 510 | 4907 | 435 | 1868 |
| 4-#10 | 1.27 | 2426 | 1206 | 3672 | 960 | 4133 | 808 | 4363 | 688 | 4570 | 506 | 5265 | 426 | 2315 |
| 4-#11 | 1.56 | 2478 | 1239 | 3835 | 971 | 4312 | 814 | 4567 | 690 | 4836 | 499 | 5543 | 406 | 2768 |
| 4-#14 | 2.25 | 2615 | 1318 | 4192 | 1014 | 4746 | 844 | 5085 | 707 | 5530 | 490 | 6356 | 376 | 3836 |
| 4-#18 | 4.00 | 2928 | 1518 | 5043 | 1124 | 5792 | 923 | 6337 | 753 | 7202 | 469 | 8215 | 284 | 6386 |
| 8-#7 | 1.20 | 2339 | 1198 | 3455 | 969 | 3886 | 816 | 4078 | 699 | 4195 | 518 | 4820 | 395 | 2224 |
| 8-#8 | 1.58 | 2403 | 1241 | 3616 | 994 | 4082 | 834 | 4311 | 711 | 4508 | 515 | 5222 | 372 | 2856 |
| 8-#9 | 2.00 | 2472 | 1289 | 3791 | 1022 | 4295 | 854 | 4565 | 724 | 4848 | 511 | 5653 | 344 | 3539 |
| 8-#10 | 2.54 | 2559 | 1351 | 4011 | 1059 | 4565 | 880 | 4888 | 742 | 5280 | 507 | 6194 | 308 | 4394 |
| 8-#11 | 3.12 | 2634 | 1417 | 4241 | 1091 | 4829 | 901 | 5195 | 754 | 5686 | 498 | 6624 | 254 | 5236 |
| 8-#14 | 4.50 | 2836 | 1575 | 4766 | 1185 | 5477 | 968 | 5973 | 798 | 6733 | 486 | 7854 | 147 | 7246 |
| 8-#18 | 8.00 | 3337 | 1974 | 6024 | 1425 | 7041 | 1138 | 7854 | 910 | 9250 | 454 | 10661 | -156 | 10431 |
| 12-#10 | 3.81 | 2776 | 1496 | 4453 | 1157 | 5096 | 960 | 5529 | 787 | 6143 | 499 | 7395 | 234 | 6213 |
| 12-#11 | 4.68 | 2890 | 1595 | 4767 | 1211 | 5462 | 999 | 5960 | 809 | 6715 | 486 | 8017 | 156 | 7247 |
| 12-#14 | 6.75 | 3224 | 1832 | 5509 | 1357 | 6371 | 1107 | 7053 | 875 | 8220 | 483 | 9777 | 1 | 9774 |
| 16-#10 | 5.08 | 2969 | 1641 | 4889 | 1264 | 5668 | 1032 | 6216 | 841 | 7059 | 500 | 8602 | 154 | 7933 |

## SQUARE TIED COLUMNS 22" x 22"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.05 | 3179 | 1429 | 4705 | 1157 | 5313 | 975 | 5602 | 834 | 5822 | 623 | 6746 | 535 | 2609 |
| 4-#11 | 1.29 | 3240 | 1462 | 4896 | 1167 | 5522 | 981 | 5838 | 835 | 6129 | 614 | 7089 | 518 | 3129 |
| 4-#14 | 1.86 | 3402 | 1540 | 5309 | 1208 | 6022 | 1010 | 6433 | 852 | 6925 | 605 | 8066 | 493 | 4353 |
| 4-#18 | 3.31 | 3776 | 1740 | 6297 | 1318 | 7231 | 1088 | 7879 | 897 | 8864 | 584 | 10336 | 417 | 7294 |
| 8-#8 | 1.31 | 3151 | 1464 | 4637 | 1192 | 5253 | 1002 | 5540 | 859 | 5748 | 632 | 6687 | 483 | 3219 |
| 8-#9 | 1.65 | 3231 | 1512 | 4837 | 1220 | 5496 | 1022 | 5829 | 872 | 6135 | 629 | 7194 | 458 | 3997 |
| 8-#10 | 2.10 | 3332 | 1574 | 5089 | 1256 | 5803 | 1048 | 6197 | 889 | 6627 | 625 | 7833 | 426 | 4974 |
| 8-#11 | 2.58 | 3421 | 1640 | 5358 | 1288 | 6110 | 1070 | 6552 | 902 | 7095 | 616 | 8362 | 376 | 5951 |
| 8-#14 | 3.72 | 3658 | 1797 | 5963 | 1382 | 6856 | 1137 | 7446 | 946 | 8295 | 605 | 9839 | 280 | 8275 |
| 8-#18 | 6.61 | 4251 | 2197 | 7420 | 1623 | 8662 | 1308 | 9617 | 1060 | 11216 | 578 | 13267 | 10 | 13235 |
| 12-#10 | 3.15 | 3584 | 1719 | 5592 | 1356 | 6408 | 1130 | 6927 | 936 | 7608 | 619 | 9242 | 356 | 7205 |
| 12-#11 | 3.87 | 3719 | 1818 | 5960 | 1409 | 6834 | 1169 | 7426 | 958 | 8269 | 607 | 10009 | 286 | 8417 |
| 12-#14 | 5.58 | 4080 | 2054 | 6814 | 1556 | 7879 | 1278 | 8682 | 1026 | 9956 | 590 | 12127 | 145 | 11352 |
| 16-#10 | 4.20 | 3802 | 1864 | 6089 | 1464 | 7059 | 1203 | 7708 | 991 | 8651 | 621 | 10653 | 285 | 9103 |
| 16-#11 | 5.16 | 3980 | 1996 | 6553 | 1541 | 7612 | 1257 | 8361 | 1024 | 9517 | 608 | 11662 | 191 | 10755 |

## SQUARE TIED COLUMNS 24" x 24"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.08 | 4144 | 1706 | 6136 | 1382 | 6941 | 1165 | 7328 | 995 | 7636 | 742 | 8876 | 639 | 3490 |
| 4-#14 | 1.56 | 4331 | 1784 | 6604 | 1423 | 7506 | 1193 | 8000 | 1011 | 8534 | 732 | 10018 | 618 | 4869 |
| 4-#18 | 2.78 | 4766 | 1984 | 7730 | 1531 | 8880 | 1270 | 9640 | 1056 | 10731 | 711 | 12704 | 554 | 8201 |
| 8-#8 | 1.10 | 4039 | 1708 | 5834 | 1409 | 6631 | 1188 | 6987 | 1015 | 7203 | 761 | 8361 | 600 | 3581 |
| 8-#9 | 1.39 | 4130 | 1756 | 6060 | 1437 | 6904 | 1208 | 7311 | 1027 | 7636 | 758 | 8957 | 578 | 4453 |
| 8-#10 | 1.76 | 4246 | 1818 | 6344 | 1473 | 7250 | 1234 | 7724 | 1051 | 8188 | 754 | 9713 | 551 | 5554 |
| 8-#11 | 2.17 | 4351 | 1884 | 6653 | 1504 | 7600 | 1255 | 8128 | 1063 | 8719 | 745 | 10343 | 505 | 6663 |
| 8-#14 | 3.13 | 4623 | 2041 | 7339 | 1598 | 8442 | 1322 | 9136 | 1108 | 10072 | 735 | 12070 | 418 | 9300 |
| 8-#18 | 5.56 | 5275 | 2441 | 8996 | 1839 | 10493 | 1494 | 11598 | 1223 | 13381 | 710 | 16126 | 174 | 15486 |
| 12-#10 | 2.65 | 4533 | 1963 | 6908 | 1574 | 7927 | 1316 | 8542 | 1099 | 9287 | 750 | 11332 | 486 | 8101 |
| 12-#11 | 3.25 | 4691 | 2062 | 7330 | 1627 | 8413 | 1355 | 9110 | 1121 | 10039 | 738 | 12246 | 421 | 9630 |
| 12-#14 | 4.69 | 5105 | 2298 | 8298 | 1774 | 9595 | 1466 | 10529 | 1190 | 11943 | 723 | 14725 | 292 | 12984 |
| 16-#10 | 3.53 | 4778 | 2108 | 7465 | 1682 | 8658 | 1390 | 9419 | 1155 | 10457 | 754 | 12949 | 422 | 10298 |
| 16-#11 | 4.33 | 4984 | 2240 | 7998 | 1759 | 9289 | 1445 | 10162 | 1189 | 11442 | 741 | 14151 | 335 | 12188 |
| 16-#14 | 6.25 | 5514 | 2555 | 9244 | 1964 | 10836 | 1594 | 12019 | 1287 | 13931 | 726 | 17389 | 160 | 16653 |
| 20-#10 | 4.41 | 5030 | 2253 | 8054 | 1780 | 9393 | 1473 | 10303 | 1203 | 11654 | 758 | 14641 | 349 | 12573 |
| 20-#11 | 5.42 | 5283 | 2418 | 8712 | 1880 | 10171 | 1545 | 11222 | 1247 | 12878 | 744 | 16142 | 241 | 14749 |

## SQUARE TIED COLUMNS 26" x 26"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.33 | 5414 | 2050 | 8092 | 1657 | 9218 | 1393 | 9804 | 1186 | 10376 | 871 | 12235 | 750 | 5384 |
| 4-#18 | 2.37 | 5913 | 2250 | 9358 | 1764 | 10757 | 1469 | 11639 | 1229 | 12832 | 848 | 15341 | 697 | 9106 |
| 8-#9 | 1.18 | 5184 | 2021 | 7474 | 1674 | 8538 | 1410 | 9031 | 1204 | 9371 | 899 | 10937 | 703 | 4908 |
| 8-#10 | 1.50 | 5314 | 2083 | 7790 | 1710 | 8922 | 1436 | 9488 | 1219 | 9983 | 895 | 11778 | 676 | 6130 |
| 8-#11 | 1.85 | 5434 | 2149 | 8141 | 1740 | 9316 | 1456 | 9942 | 1239 | 10577 | 886 | 12585 | 641 | 7374 |
| 8-#14 | 2.66 | 5744 | 2307 | 8908 | 1834 | 10256 | 1524 | 11065 | 1285 | 12082 | 876 | 14566 | 562 | 10321 |
| 8-#18 | 4.73 | 6484 | 2706 | 10767 | 2075 | 12551 | 1697 | 13818 | 1400 | 15781 | 853 | 19256 | 338 | 17387 |
| 12-#10 | 2.25 | 5638 | 2228 | 8415 | 1811 | 9673 | 1519 | 10395 | 1276 | 11201 | 892 | 13581 | 612 | 8968 |
| 12-#11 | 2.77 | 5818 | 2327 | 8892 | 1864 | 10220 | 1558 | 11033 | 1298 | 12042 | 880 | 14745 | 561 | 10756 |
| 12-#14 | 3.99 | 6286 | 2564 | 9975 | 2011 | 11538 | 1669 | 12614 | 1368 | 14163 | 867 | 17591 | 443 | 14669 |
| 12-#18 | 7.10 | 7418 | 3163 | 12604 | 2387 | 14760 | 1951 | 16485 | 1545 | 19366 | 831 | 24320 | 111 | 23629 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 3.01 | 5910 | 2373 | 9034 | 1921 | 10483 | 1594 | 11367 | 1325 | 12497 | 897 | 15378 | 551 | 11517 |
| 16-#11 | 3.69 | 6143 | 2505 | 9635 | 1997 | 11193 | 1649 | 12201 | 1368 | 13600 | 885 | 16901 | 483 | 13648 |
| 16-#14 | 5.33 | 6741 | 2820 | 11029 | 2203 | 12920 | 1799 | 14273 | 1467 | 16376 | 873 | 20618 | 323 | 18770 |
| 20-#10 | 3.76 | 6193 | 2518 | 9679 | 2018 | 11298 | 1678 | 12347 | 1383 | 13824 | 902 | 17262 | 479 | 14056 |
| 20-#11 | 4.62 | 6479 | 2683 | 10419 | 2118 | 12173 | 1750 | 13379 | 1427 | 15196 | 890 | 19159 | 394 | 16642 |

## SQUARE TIED COLUMNS 28" x 28"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.15 | 6665 | 2336 | 9789 | 1912 | 11174 | 1610 | 11866 | 1375 | 12472 | 1021 | 14703 | 889 | 5899 |
| 4-#18 | 2.04 | 7229 | 2536 | 11195 | 2017 | 12879 | 1684 | 13895 | 1417 | 15185 | 998 | 18265 | 847 | 10011 |
| 8-#9 | 1.02 | 6403 | 2308 | 9093 | 1931 | 10416 | 1629 | 11007 | 1395 | 11360 | 1052 | 13201 | 838 | 5362 |
| 8-#10 | 1.30 | 6549 | 2369 | 9443 | 1967 | 10839 | 1655 | 11510 | 1410 | 12031 | 1048 | 14123 | 811 | 6705 |
| 8-#11 | 1.59 | 6685 | 2435 | 9836 | 1996 | 11277 | 1675 | 12013 | 1420 | 12688 | 1038 | 15014 | 777 | 8082 |
| 8-#14 | 2.30 | 7032 | 2593 | 10684 | 2090 | 12314 | 1742 | 13251 | 1460 | 14346 | 1029 | 17298 | 708 | 11341 |
| 8-#18 | 4.08 | 7863 | 2993 | 12747 | 2331 | 14854 | 1915 | 16295 | 1592 | 18433 | 1007 | 22676 | 507 | 19197 |
| 12-#10 | 1.94 | 6909 | 2514 | 10129 | 2068 | 11663 | 1739 | 12505 | 1468 | 13368 | 1046 | 16109 | 748 | 9831 |
| 12-#11 | 2.39 | 7112 | 2614 | 10662 | 2120 | 12271 | 1777 | 13212 | 1490 | 14299 | 1034 | 17398 | 698 | 11820 |
| 12-#14 | 3.44 | 7636 | 2850 | 11860 | 2268 | 13727 | 1889 | 14957 | 1561 | 16637 | 1022 | 20679 | 593 | 16407 |
| 12-#18 | 6.12 | 8903 | 3449 | 14776 | 2645 | 17294 | 2173 | 19241 | 1740 | 22392 | 989 | 28398 | 292 | 26411 |
| 16-#10 | 2.59 | 7210 | 2659 | 10808 | 2178 | 12552 | 1815 | 13572 | 1518 | 14791 | 1052 | 18085 | 690 | 12760 |
| 16-#11 | 3.18 | 7472 | 2792 | 11480 | 2255 | 13342 | 1869 | 14498 | 1550 | 16013 | 1040 | 19775 | 623 | 15136 |
| 16-#14 | 4.59 | 8137 | 3107 | 13022 | 2461 | 15249 | 2021 | 16784 | 1646 | 19075 | 1030 | 24054 | 482 | 20823 |
| 20-#10 | 3.24 | 7523 | 2804 | 11511 | 2276 | 13467 | 1890 | 14649 | 1576 | 16248 | 1058 | 20080 | 607 | 15512 |
| 20-#11 | 3.98 | 7845 | 2970 | 12334 | 2375 | 14420 | 1972 | 15794 | 1621 | 17768 | 1047 | 22267 | 535 | 18501 |
| 20-#14 | 5.74 | 8668 | 3364 | 14244 | 2634 | 16782 | 2168 | 18627 | 1747 | 21570 | 1037 | 27588 | 353 | 25246 |
| 24-#10 | 3.89 | 7870 | 2949 | 12220 | 2373 | 14342 | 1972 | 15746 | 1626 | 17690 | 1056 | 22110 | 556 | 18269 |
| 24-#11 | 4.78 | 8259 | 3148 | 13189 | 2494 | 15508 | 2062 | 17115 | 1681 | 19505 | 1042 | 24610 | 455 | 21633 |

## SQUARE TIED COLUMNS 30" x 30"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.00 | 8094 | 2644 | 11708 | 2186 | 13394 | 1844 | 14205 | 1579 | 14841 | 1184 | 17414 | 1031 | 6412 |
| 4-#18 | 1.78 | 8725 | 2844 | 13257 | 2290 | 15265 | 1917 | 16429 | 1620 | 17812 | 1160 | 21498 | 1004 | 10914 |
| 8-#10 | 1.13 | 7963 | 2677 | 11317 | 2243 | 13018 | 1891 | 13809 | 1616 | 14353 | 1212 | 16775 | 957 | 7279 |
| 8-#11 | 1.39 | 8115 | 2743 | 11753 | 2272 | 13501 | 1910 | 14361 | 1625 | 15072 | 1202 | 17749 | 922 | 8788 |
| 8-#14 | 2.00 | 8500 | 2901 | 12684 | 2365 | 14636 | 1977 | 15714 | 1666 | 16883 | 1193 | 20242 | 854 | 12358 |
| 8-#18 | 3.56 | 9424 | 3300 | 14951 | 2606 | 17422 | 2151 | 19050 | 1797 | 21358 | 1172 | 26408 | 679 | 21001 |
| 12-#10 | 1.69 | 8359 | 2822 | 12064 | 2345 | 13916 | 1976 | 14893 | 1675 | 15809 | 1211 | 18944 | 894 | 10693 |
| 12-#11 | 2.08 | 8587 | 2921 | 12655 | 2397 | 14585 | 2013 | 15669 | 1697 | 16829 | 1199 | 20358 | 844 | 12881 |
| 12-#14 | 3.00 | 9167 | 3158 | 13968 | 2544 | 16179 | 2125 | 17577 | 1768 | 19385 | 1188 | 23947 | 741 | 18063 |
| 12-#18 | 5.33 | 10572 | 3757 | 17173 | 2922 | 20093 | 2411 | 22274 | 1948 | 25691 | 1158 | 32790 | 475 | 29265 |
| 16-#10 | 2.26 | 8689 | 2967 | 12804 | 2456 | 14884 | 2052 | 16055 | 1725 | 17358 | 1218 | 21099 | 838 | 14016 |
| 16-#11 | 2.77 | 8981 | 3099 | 13547 | 2532 | 15754 | 2106 | 17071 | 1758 | 18699 | 1207 | 22955 | 772 | 16650 |
| 16-#14 | 4.00 | 9716 | 3415 | 15237 | 2739 | 17842 | 2258 | 19573 | 1855 | 22046 | 1197 | 27639 | 634 | 22909 |
| 16-#18 | 7.11 | 11497 | 4214 | 19369 | 3265 | 22971 | 2644 | 25729 | 2126 | 30298 | 1170 | 39166 | 274 | 37627 |
| 20-#10 | 2.82 | 9035 | 3112 | 13564 | 2553 | 15881 | 2128 | 17228 | 1784 | 18946 | 1225 | 23278 | 755 | 16984 |
| 20-#11 | 3.47 | 9393 | 3277 | 14471 | 2651 | 16956 | 2199 | 18486 | 1829 | 20614 | 1214 | 25576 | 670 | 20280 |
| 20-#14 | 5.00 | 10300 | 3671 | 16561 | 2911 | 19517 | 2406 | 21586 | 1956 | 24772 | 1207 | 31512 | 507 | 27948 |
| 24-#10 | 3.39 | 9416 | 3257 | 14336 | 2651 | 16827 | 2209 | 18423 | 1834 | 20517 | 1223 | 25494 | 707 | 20107 |
| 24-#11 | 4.16 | 9848 | 3456 | 15403 | 2771 | 18107 | 2299 | 19928 | 1890 | 22509 | 1211 | 28243 | 608 | 23836 |

## SQUARE TIED COLUMNS 32" x 32"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.56 | 10415 | 3172 | 15557 | 2582 | 17933 | 2167 | 19260 | 1838 | 20731 | 1333 | 24889 | 1156 | 11817 |
| 8-#11 | 1.22 | 9736 | 3072 | 13907 | 2567 | 16007 | 2162 | 17006 | 1845 | 17749 | 1378 | 20812 | 1077 | 9492 |
| 8-#14 | 1.76 | 10161 | 3230 | 14922 | 2660 | 17240 | 2229 | 18474 | 1886 | 19713 | 1369 | 23513 | 1010 | 13373 |
| 8-#18 | 3.13 | 11180 | 3629 | 17395 | 2900 | 20273 | 2402 | 22101 | 1991 | 24576 | 1348 | 30213 | 838 | 22803 |
| 12-#10 | 1.49 | 10002 | 3151 | 14236 | 2642 | 16450 | 2229 | 17576 | 1896 | 18542 | 1387 | 22107 | 1050 | 11552 |
| 12-#11 | 1.83 | 10254 | 3250 | 14884 | 2693 | 17181 | 2266 | 18423 | 1917 | 19652 | 1376 | 23646 | 1000 | 13939 |
| 12-#14 | 2.64 | 10892 | 3486 | 16314 | 2840 | 18913 | 2378 | 20493 | 1989 | 22425 | 1365 | 27543 | 898 | 19591 |
| 12-#18 | 4.69 | 12437 | 4086 | 19809 | 3218 | 23174 | 2665 | 25605 | 2171 | 29282 | 1337 | 37172 | 636 | 32190 |
| 16-#10 | 1.98 | 10361 | 3296 | 15037 | 2753 | 17498 | 2306 | 18834 | 1947 | 20219 | 1395 | 24442 | 996 | 15164 |
| 16-#11 | 2.44 | 10683 | 3428 | 15851 | 2829 | 18447 | 2360 | 19942 | 1979 | 21677 | 1384 | 26462 | 931 | 18192 |
| 16-#14 | 3.52 | 11490 | 3743 | 17691 | 3036 | 20716 | 2512 | 22658 | 2077 | 25311 | 1376 | 31552 | 795 | 25028 |
| 16-#18 | 6.25 | 13442 | 4543 | 22197 | 3563 | 26302 | 2900 | 29359 | 2324 | 34289 | 1353 | 44112 | 443 | 41488 |
| 20-#10 | 2.48 | 10739 | 3441 | 15853 | 2850 | 18577 | 2383 | 20103 | 2006 | 21936 | 1403 | 26806 | 914 | 18471 |
| 20-#11 | 3.05 | 11133 | 3606 | 16846 | 2948 | 19750 | 2454 | 21475 | 2051 | 23752 | 1392 | 29310 | 829 | 22077 |
| 20-#14 | 4.39 | 12128 | 4000 | 19116 | 3208 | 22573 | 2647 | 24842 | 2180 | 28267 | 1387 | 35601 | 648 | 30681 |
| 24-#10 | 2.98 | 11155 | 3586 | 16688 | 2948 | 19592 | 2463 | 21397 | 2057 | 23636 | 1402 | 29206 | 867 | 21833 |
| 24-#11 | 3.66 | 11631 | 3784 | 17855 | 3068 | 20987 | 2553 | 23037 | 2113 | 25806 | 1391 | 32205 | 770 | 26083 |
| 24-#14 | 5.27 | 12834 | 4257 | 20555 | 3380 | 24346 | 2791 | 27068 | 2268 | 31193 | 1383 | 39720 | 559 | 35859 |

## SQUARE TIED COLUMNS 34" x 34"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.38 | 12310 | 3522 | 18113 | 2895 | 20903 | 2433 | 22408 | 2070 | 23962 | 1518 | 28628 | 1318 | 12719 |
| 8-#11 | 1.08 | 11563 | 3422 | 16314 | 2883 | 18812 | 2432 | 19967 | 2080 | 20738 | 1565 | 24224 | 1243 | 10196 |
| 8-#14 | 1.56 | 12027 | 3580 | 17413 | 2975 | 20144 | 2498 | 21551 | 2120 | 22855 | 1556 | 27134 | 1176 | 14386 |
| 8-#18 | 2.77 | 13142 | 3979 | 20093 | 3215 | 23424 | 2671 | 25470 | 2226 | 28106 | 1536 | 34366 | 1006 | 24600 |
| 12-#10 | 1.32 | 11849 | 3501 | 16658 | 2959 | 19283 | 2499 | 20576 | 2132 | 21588 | 1575 | 25621 | 1216 | 12409 |
| 12-#11 | 1.62 | 12125 | 3600 | 17366 | 3009 | 20076 | 2536 | 21493 | 2153 | 22787 | 1564 | 27284 | 1166 | 14994 |
| 12-#14 | 2.34 | 12822 | 3837 | 18913 | 3156 | 21947 | 2648 | 23727 | 2224 | 25777 | 1554 | 31489 | 1065 | 21115 |
| 12-#18 | 4.15 | 14510 | 4436 | 22699 | 3534 | 26557 | 2935 | 29252 | 2408 | 33186 | 1528 | 41901 | 806 | 35186 |
| 16-#10 | 1.76 | 12237 | 3646 | 17519 | 3070 | 20410 | 2576 | 21929 | 2183 | 23392 | 1584 | 28135 | 1163 | 16310 |
| 16-#11 | 2.16 | 12590 | 3778 | 18408 | 3145 | 21440 | 2630 | 23129 | 2215 | 24969 | 1573 | 30321 | 1099 | 19673 |
| 16-#14 | 3.11 | 13470 | 4093 | 20398 | 3352 | 23891 | 2783 | 26060 | 2314 | 28888 | 1566 | 35816 | 965 | 27179 |
| 16-#18 | 5.54 | 15597 | 4893 | 25279 | 3880 | 29935 | 3173 | 33306 | 2563 | 38592 | 1546 | 49406 | 620 | 45066 |
| 20-#10 | 2.20 | 12648 | 3791 | 18394 | 3166 | 21570 | 2654 | 23295 | 2243 | 25239 | 1592 | 30681 | 1082 | 19976 |
| 20-#11 | 2.70 | 13080 | 3956 | 19472 | 3264 | 22844 | 2724 | 24780 | 2288 | 27203 | 1582 | 33395 | 998 | 23891 |
| 20-#14 | 3.89 | 14163 | 4350 | 21924 | 3523 | 25893 | 2918 | 28415 | 2418 | 32075 | 1578 | 40191 | 820 | 33220 |
| 24-#10 | 2.64 | 13100 | 3936 | 19291 | 3265 | 22656 | 2734 | 24687 | 2295 | 27068 | 1592 | 33269 | 1037 | 23570 |
| 24-#11 | 3.24 | 13621 | 4135 | 20558 | 3384 | 24167 | 2824 | 26463 | 2351 | 29415 | 1581 | 36517 | 941 | 28274 |
| 24-#14 | 4.67 | 14930 | 4607 | 23473 | 3697 | 27790 | 3062 | 30814 | 2507 | 35229 | 1576 | 44638 | 734 | 38988 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 36" x 36"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.23 | 14423 | 3894 | 20937 | 3228 | 24191 | 2717 | 25892 | 2317 | 27525 | 1715 | 32739 | 1491 | 13620 |
| 8-#14 | 1.39 | 14110 | 3951 | 20171 | 3310 | 23366 | 2784 | 24963 | 2370 | 26329 | 1755 | 31128 | 1352 | 15397 |
| 8-#18 | 2.47 | 15324 | 4351 | 23060 | 3549 | 26894 | 2956 | 29175 | 2475 | 31968 | 1735 | 38891 | 1184 | 26395 |
| 12-#10 | 1.18 | 13913 | 3872 | 19347 | 3295 | 22434 | 2786 | 23912 | 2382 | 24967 | 1775 | 29508 | 1392 | 13265 |
| 12-#11 | 1.44 | 14214 | 3971 | 20115 | 3344 | 23290 | 2823 | 24898 | 2403 | 26255 | 1763 | 31294 | 1342 | 16047 |
| 12-#14 | 2.08 | 14970 | 4208 | 21779 | 3491 | 25299 | 2935 | 27296 | 2475 | 29462 | 1754 | 35807 | 1242 | 22635 |
| 12-#18 | 3.70 | 16803 | 4807 | 25859 | 3869 | 30258 | 3222 | 33236 | 2659 | 37422 | 1729 | 47003 | 986 | 38254 |
| 16-#10 | 1.57 | 14331 | 4017 | 20265 | 3406 | 23641 | 2864 | 25361 | 2434 | 26897 | 1784 | 32202 | 1340 | 17452 |
| 16-#11 | 1.93 | 14715 | 4150 | 21231 | 3481 | 24752 | 2917 | 26652 | 2466 | 28592 | 1773 | 34552 | 1277 | 21081 |
| 16-#14 | 2.78 | 15669 | 4465 | 23373 | 3688 | 27385 | 3070 | 29799 | 2565 | 32798 | 1767 | 40452 | 1145 | 29365 |
| 16-#18 | 4.94 | 17974 | 5264 | 28630 | 4217 | 33887 | 3461 | 37590 | 2816 | 43227 | 1750 | 55072 | 805 | 48688 |
| 20-#10 | 1.96 | 14776 | 4162 | 21200 | 3503 | 24876 | 2941 | 26822 | 2495 | 28875 | 1793 | 34929 | 1261 | 21496 |
| 20-#11 | 2.41 | 15246 | 4328 | 22365 | 3599 | 26256 | 3012 | 28421 | 2539 | 30987 | 1783 | 37850 | 1177 | 25723 |
| 20-#14 | 3.47 | 16418 | 4722 | 24999 | 3859 | 29531 | 3206 | 32324 | 2670 | 36215 | 1781 | 45154 | 1000 | 35780 |
| 20-#18 | 6.17 | 19269 | 5721 | 31488 | 4522 | 37621 | 3700 | 41982 | 3000 | 49174 | 1770 | 63222 | 545 | 59187 |
| 24-#10 | 2.35 | 15263 | 4307 | 22160 | 3602 | 26039 | 3022 | 28309 | 2546 | 30833 | 1794 | 37706 | 1216 | 25317 |
| 24-#11 | 2.89 | 15829 | 4506 | 23529 | 3720 | 27665 | 3111 | 30225 | 2602 | 33357 | 1783 | 41203 | 1122 | 30397 |
| 24-#14 | 4.17 | 17246 | 4979 | 26660 | 4033 | 31553 | 3349 | 34897 | 2760 | 39597 | 1779 | 49929 | 918 | 42171 |

## SQUARE TIED COLUMNS 38" x 38"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.11 | 16766 | 4286 | 24045 | 3580 | 27818 | 3018 | 29732 | 2579 | 31439 | 1923 | 37244 | 1674 | 14520 |
| 8-#14 | 1.25 | 16423 | 4343 | 23212 | 3664 | 26925 | 3086 | 28732 | 2633 | 30154 | 1965 | 35516 | 1538 | 16407 |
| 8-#18 | 2.22 | 17736 | 4743 | 26311 | 3902 | 30702 | 3258 | 33235 | 2738 | 36181 | 1946 | 43809 | 1372 | 28187 |
| 12-#10 | 1.06 | 16207 | 4265 | 22317 | 3651 | 25920 | 3090 | 27603 | 2648 | 28697 | 1987 | 33790 | 1578 | 14119 |
| 12-#11 | 1.30 | 16533 | 4364 | 23145 | 3699 | 26841 | 3126 | 28660 | 2668 | 30074 | 1974 | 35700 | 1528 | 17098 |
| 12-#14 | 1.87 | 17349 | 4600 | 24929 | 3846 | 28989 | 3238 | 31222 | 2739 | 33498 | 1965 | 40520 | 1429 | 24152 |
| 12-#18 | 3.32 | 19329 | 5200 | 29303 | 4224 | 34298 | 3525 | 37575 | 2924 | 42009 | 1942 | 52499 | 1175 | 41289 |
| 16-#10 | 1.41 | 16655 | 4410 | 23292 | 3762 | 27207 | 3168 | 29147 | 2700 | 30754 | 1996 | 36664 | 1528 | 18592 |
| 16-#11 | 1.73 | 17071 | 4542 | 24333 | 3836 | 28400 | 3221 | 30530 | 2731 | 32567 | 1985 | 39178 | 1465 | 22485 |
| 16-#14 | 2.49 | 18099 | 4857 | 26630 | 4044 | 31215 | 3374 | 33893 | 2830 | 37059 | 1980 | 45483 | 1335 | 31583 |
| 16-#18 | 4.43 | 20586 | 5657 | 32265 | 4573 | 38176 | 3766 | 42229 | 3083 | 48214 | 1965 | 61132 | 1000 | 52355 |
| 20-#10 | 1.76 | 17133 | 4555 | 24287 | 3859 | 28518 | 3245 | 30705 | 2761 | 32835 | 1997 | 39572 | 1450 | 22992 |
| 20-#11 | 2.16 | 17642 | 4720 | 25541 | 3955 | 29998 | 3316 | 32418 | 2805 | 35122 | 1996 | 42699 | 1367 | 27574 |
| 20-#14 | 3.12 | 18906 | 5114 | 28357 | 4214 | 33507 | 3511 | 36588 | 2936 | 40707 | 1994 | 50508 | 1191 | 38362 |
| 20-#18 | 5.54 | 21977 | 6113 | 35303 | 4878 | 42168 | 4007 | 46925 | 3269 | 54570 | 1987 | 69864 | 741 | 63931 |
| 24-#10 | 2.11 | 17657 | 4700 | 25311 | 3958 | 29757 | 3326 | 32283 | 2812 | 34949 | 2007 | 42538 | 1405 | 27076 |
| 24-#11 | 2.59 | 18269 | 4898 | 26781 | 4076 | 31500 | 3415 | 34342 | 2869 | 37651 | 1996 | 46283 | 1312 | 32531 |
| 24-#14 | 3.74 | 19795 | 5371 | 30129 | 4389 | 35652 | 3654 | 39336 | 3027 | 44318 | 1994 | 55615 | 1111 | 45408 |

## SQUARE TIED COLUMNS 40" x 40"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.00 | 19352 | 4700 | 27453 | 3952 | 31799 | 3335 | 33947 | 2856 | 35725 | 2144 | 42164 | 1867 | 15420 |
| 8-#14 | 1.13 | 18979 | 4757 | 26551 | 4038 | 30840 | 3406 | 32875 | 2912 | 34351 | 2187 | 40320 | 1734 | 17415 |
| 8-#18 | 2.00 | 20393 | 5157 | 29861 | 4276 | 34866 | 3577 | 37672 | 3017 | 40765 | 2168 | 49143 | 1569 | 29976 |
| 12-#11 | 1.17 | 19095 | 4778 | 26473 | 4075 | 30746 | 3446 | 32797 | 2947 | 34265 | 2197 | 40522 | 1724 | 18148 |
| 12-#14 | 1.69 | 19971 | 5014 | 28376 | 4221 | 33033 | 3558 | 35522 | 3019 | 37905 | 2188 | 45650 | 1625 | 25666 |
| 12-#18 | 3.00 | 22100 | 5614 | 33045 | 4599 | 38693 | 3845 | 42290 | 3204 | 46968 | 2166 | 58411 | 1374 | 43991 |
| 16-#10 | 1.27 | 19222 | 4823 | 26614 | 4138 | 31128 | 3489 | 33309 | 2980 | 34983 | 2220 | 41543 | 1725 | 19730 |
| 16-#11 | 1.56 | 19669 | 4956 | 27730 | 4211 | 32403 | 3542 | 34784 | 3011 | 36914 | 2209 | 44221 | 1662 | 23887 |
| 16-#14 | 2.25 | 20773 | 5271 | 30178 | 4418 | 35400 | 3695 | 38362 | 3111 | 41691 | 2204 | 50931 | 1534 | 33715 |
| 16-#18 | 4.00 | 23444 | 6070 | 36200 | 4949 | 42822 | 4087 | 47245 | 3364 | 53572 | 2191 | 67610 | 1203 | 56066 |
| 20-#10 | 1.59 | 19733 | 4968 | 27671 | 4235 | 32515 | 3566 | 34963 | 3041 | 37192 | 2221 | 44633 | 1648 | 24418 |
| 20-#11 | 1.95 | 20281 | 5134 | 29013 | 4330 | 34094 | 3636 | 36790 | 3086 | 39593 | 2210 | 47965 | 1566 | 29443 |
| 20-#14 | 2.81 | 21638 | 5528 | 32013 | 4589 | 37827 | 3831 | 41228 | 3217 | 45570 | 2219 | 56277 | 1393 | 40966 |
| 20-#18 | 5.00 | 24932 | 6527 | 39417 | 5253 | 47072 | 4329 | 52244 | 3552 | 60338 | 2215 | 76922 | 945 | 68771 |
| 24-#10 | 1.90 | 20294 | 5113 | 28757 | 4334 | 33829 | 3647 | 36631 | 3092 | 39437 | 2231 | 47788 | 1604 | 28845 |
| 24-#11 | 2.34 | 20953 | 5312 | 30330 | 4452 | 35689 | 3735 | 38826 | 3149 | 42316 | 2221 | 51781 | 1511 | 34677 |
| 24-#14 | 3.38 | 22589 | 5785 | 33896 | 4764 | 40107 | 3974 | 44149 | 3309 | 49409 | 2220 | 61719 | 1313 | 48533 |

## SQUARE TIED COLUMNS 42" x 42"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#14 | 1.02 | 21790 | 5192 | 30202 | 4432 | 35128 | 3742 | 37414 | 3205 | 38939 | 2421 | 45563 | 1940 | 18422 |
| 8-#18 | 1.81 | 23306 | 5592 | 33725 | 4669 | 39403 | 3913 | 42503 | 3310 | 45740 | 2402 | 54916 | 1776 | 31764 |
| 12-#11 | 1.06 | 21911 | 5213 | 30112 | 4470 | 35024 | 3783 | 37328 | 3241 | 38846 | 2432 | 45784 | 1931 | 19196 |
| 12-#14 | 1.53 | 22849 | 5449 | 32135 | 4616 | 37451 | 3895 | 40218 | 3313 | 42704 | 2423 | 51219 | 1832 | 27178 |
| 12-#18 | 2.72 | 25128 | 6048 | 37102 | 4993 | 43462 | 4182 | 47401 | 3498 | 52317 | 2402 | 64762 | 1582 | 46687 |
| 16-#10 | 1.15 | 22043 | 5258 | 30247 | 4533 | 35421 | 3827 | 37865 | 3275 | 39603 | 2455 | 46862 | 1933 | 20866 |
| 16-#11 | 1.41 | 22523 | 5391 | 31440 | 4606 | 36779 | 3879 | 39433 | 3306 | 41652 | 2444 | 49704 | 1870 | 25286 |
| 16-#14 | 2.04 | 23704 | 5706 | 34039 | 4813 | 39959 | 4033 | 43227 | 3405 | 46714 | 2439 | 56818 | 1743 | 35739 |
| 16-#18 | 3.63 | 26561 | 6505 | 40449 | 5344 | 47841 | 4425 | 52655 | 3660 | 59321 | 2428 | 74526 | 1416 | 59822 |
| 20-#10 | 1.44 | 22589 | 5403 | 31365 | 4631 | 36884 | 3904 | 39616 | 3336 | 41940 | 2457 | 50133 | 1857 | 25841 |
| 20-#11 | 1.77 | 23176 | 5569 | 32797 | 4725 | 38563 | 3973 | 41557 | 3380 | 44488 | 2445 | 53670 | 1775 | 31276 |
| 20-#14 | 2.55 | 24626 | 5963 | 35981 | 4984 | 42520 | 4168 | 46264 | 3513 | 50769 | 2441 | 62485 | 1604 | 43591 |
| 20-#18 | 4.54 | 28148 | 6962 | 43844 | 5647 | 52348 | 4668 | 57958 | 3849 | 66497 | 2454 | 84411 | 1161 | 73414 |
| 24-#10 | 1.73 | 23186 | 5548 | 32514 | 4730 | 38275 | 3985 | 41374 | 3387 | 44317 | 2467 | 53477 | 1813 | 30627 |
| 24-#11 | 2.12 | 23893 | 5747 | 34192 | 4847 | 40252 | 4073 | 43704 | 3443 | 47372 | 2457 | 57718 | 1721 | 36835 |
| 24-#14 | 3.06 | 25641 | 6220 | 37975 | 5160 | 44935 | 4312 | 49345 | 3604 | 54892 | 2457 | 68261 | 1525 | 51577 |
| 24-#18 | 5.44 | 29903 | 7419 | 47330 | 5957 | 56568 | 4922 | 63363 | 4010 | 73601 | 2454 | 94460 | 1018 | 85757 |

## SQUARE TIED COLUMNS 44" x 44"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#18 | 1.65 | 26487 | 6048 | 37918 | 5082 | 44334 | 4265 | 47749 | 3617 | 51126 | 2647 | 61149 | 1994 | 33550 |
| 12-#14 | 1.39 | 25995 | 5905 | 36222 | 5030 | 42261 | 4248 | 45328 | 3621 | 47913 | 2669 | 57249 | 2049 | 28687 |
| 12-#18 | 2.48 | 28426 | 6505 | 41488 | 5407 | 48624 | 4536 | 52926 | 3807 | 58077 | 2649 | 71574 | 1800 | 49379 |
| 16-#10 | 1.05 | 25133 | 5714 | 34206 | 4949 | 40106 | 4182 | 42836 | 3585 | 44634 | 2702 | 52643 | 2150 | 22000 |
| 16-#11 | 1.29 | 25645 | 5847 | 35476 | 5020 | 41546 | 4233 | 44496 | 3615 | 46800 | 2690 | 55648 | 2088 | 26682 |
| 16-#14 | 1.86 | 26903 | 6162 | 38227 | 5227 | 44910 | 4387 | 48506 | 3714 | 52148 | 2686 | 63166 | 1962 | 37758 |
| 16-#18 | 3.31 | 29949 | 6961 | 45014 | 5757 | 53254 | 4780 | 58481 | 3970 | 65481 | 2676 | 81903 | 1638 | 63623 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 1.31 | 25713 | 5859 | 35385 | 5046 | 41645 | 4258 | 44683 | 3646 | 47100 | 2704 | 56096 | 2075 | 27261 |
| 20-#11 | 1.61 | 26340 | 6025 | 36908 | 5140 | 43424 | 4327 | 46739 | 3690 | 49794 | 2692 | 59837 | 1994 | 33026 |
| 20-#14 | 2.32 | 27884 | 6419 | 40276 | 5399 | 47606 | 4522 | 51713 | 3822 | 56431 | 2688 | 69155 | 1824 | 46239 |
| 20-#18 | 4.13 | 31635 | 7418 | 48601 | 6061 | 57999 | 5022 | 64087 | 4160 | 73067 | 2704 | 92359 | 1387 | 77898 |
| 24-#10 | 1.57 | 26347 | 6004 | 36596 | 5146 | 43111 | 4340 | 46532 | 3697 | 49607 | 2715 | 59629 | 2032 | 32420 |
| 24-#11 | 1.93 | 27101 | 6203 | 38380 | 5262 | 45206 | 4427 | 48997 | 3753 | 52839 | 2705 | 64117 | 1940 | 39007 |
| 24-#14 | 2.79 | 28962 | 6676 | 42382 | 5575 | 50155 | 4667 | 54955 | 3913 | 60785 | 2705 | 75266 | 1746 | 54636 |
| 24-#18 | 4.96 | 33498 | 7875 | 52284 | 6373 | 62459 | 5277 | 69799 | 4323 | 80576 | 2705 | 103003 | 1245 | 91298 |

## SQUARE TIED COLUMNS 46" x 46"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#18 | 1.51 | 29950 | 6525 | 42455 | 5514 | 49675 | 4635 | 53430 | 3940 | 56941 | 2904 | 67865 | 2221 | 35333 |
| 12-#14 | 1.28 | 29422 | 6382 | 40651 | 5464 | 47481 | 4619 | 50872 | 3945 | 53552 | 2927 | 63763 | 2276 | 30194 |
| 12-#18 | 2.27 | 32005 | 6982 | 46217 | 5840 | 54196 | 4906 | 58886 | 4130 | 64266 | 2907 | 78869 | 2029 | 52065 |
| 16-#11 | 1.18 | 29047 | 6324 | 39853 | 5455 | 46724 | 4605 | 49993 | 3939 | 52379 | 2948 | 62076 | 2316 | 28077 |
| 16-#14 | 1.70 | 30383 | 6639 | 42757 | 5661 | 50271 | 4758 | 54219 | 4038 | 58013 | 2945 | 69998 | 2190 | 39773 |
| 16-#18 | 3.02 | 33620 | 7439 | 49922 | 6190 | 59077 | 5151 | 64741 | 4295 | 72071 | 2936 | 89763 | 1870 | 67469 |
| 20-#10 | 1.20 | 29117 | 6337 | 39745 | 5482 | 46814 | 4630 | 50184 | 3971 | 52689 | 2963 | 62543 | 2304 | 28679 |
| 20-#11 | 1.47 | 29784 | 6502 | 41360 | 5575 | 48694 | 4698 | 52355 | 4014 | 55531 | 2951 | 66488 | 2223 | 34773 |
| 20-#14 | 2.13 | 31424 | 6896 | 44914 | 5833 | 53101 | 4893 | 57598 | 4147 | 62523 | 2948 | 76308 | 2055 | 48910 |
| 20-#18 | 3.78 | 35407 | 7895 | 53701 | 6495 | 64061 | 5393 | 70651 | 4485 | 79961 | 2938 | 100790 | 1622 | 82412 |
| 24-#10 | 1.44 | 29789 | 6482 | 41020 | 5582 | 48357 | 4712 | 52123 | 4021 | 55327 | 2974 | 66265 | 2261 | 34162 |
| 24-#11 | 1.77 | 30591 | 6680 | 42909 | 5697 | 50570 | 4799 | 54723 | 4077 | 58736 | 2964 | 71001 | 2170 | 41191 |
| 24-#14 | 2.55 | 32566 | 7153 | 47131 | 6009 | 55785 | 5038 | 61000 | 4237 | 67109 | 2965 | 82754 | 1977 | 57709 |
| 24-#18 | 4.54 | 37379 | 8352 | 57582 | 6807 | 68760 | 5648 | 76649 | 4648 | 87983 | 2968 | 112029 | 1482 | 96913 |

## SQUARE TIED COLUMNS 48" x 48"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#18 | 1.39 | 33706 | 7024 | 47350 | 5967 | 55445 | 5021 | 59565 | 4277 | 63206 | 3173 | 75086 | 2458 | 37116 |
| 12-#14 | 1.17 | 33142 | 6881 | 45438 | 5918 | 53130 | 5006 | 56870 | 4283 | 59641 | 3196 | 70783 | 2513 | 31700 |
| 12-#18 | 2.08 | 35880 | 7481 | 51305 | 6294 | 60198 | 5293 | 65300 | 4468 | 70906 | 3177 | 86669 | 2267 | 54747 |
| 16-#11 | 1.08 | 32743 | 6823 | 44587 | 5909 | 52329 | 4993 | 55944 | 4277 | 58407 | 3218 | 69010 | 2554 | 29469 |
| 16-#14 | 1.56 | 34157 | 7138 | 47644 | 6115 | 56061 | 5146 | 60386 | 4377 | 64327 | 3215 | 77336 | 2429 | 41785 |
| 16-#18 | 2.78 | 37587 | 7937 | 55189 | 6643 | 65329 | 5539 | 71455 | 4634 | 79110 | 3207 | 98128 | 2111 | 71361 |
| 20-#10 | 1.10 | 32815 | 6835 | 44461 | 5937 | 52412 | 5018 | 56138 | 4310 | 58729 | 3233 | 69497 | 2543 | 30094 |
| 20-#11 | 1.35 | 33522 | 7001 | 46169 | 6029 | 54393 | 5086 | 58424 | 4353 | 61718 | 3221 | 73646 | 2462 | 36517 |
| 20-#14 | 1.95 | 35257 | 7395 | 49909 | 6287 | 59025 | 5281 | 63935 | 4486 | 69065 | 3218 | 83968 | 2295 | 51603 |
| 20-#18 | 3.47 | 39476 | 8394 | 59160 | 6949 | 70553 | 5780 | 77668 | 4825 | 87405 | 3211 | 109727 | 1867 | 86955 |
| 24-#10 | 1.32 | 33524 | 6980 | 45799 | 6038 | 54030 | 5101 | 58168 | 4361 | 61498 | 3245 | 73408 | 2500 | 35864 |
| 24-#11 | 1.63 | 34374 | 7179 | 47795 | 6152 | 56362 | 5187 | 60904 | 4415 | 65083 | 3235 | 78390 | 2409 | 43388 |
| 24-#14 | 2.34 | 36464 | 7652 | 52237 | 6464 | 61844 | 5426 | 67498 | 4576 | 73882 | 3237 | 90748 | 2218 | 60797 |
| 24-#18 | 4.17 | 41558 | 8851 | 63239 | 7261 | 75491 | 6036 | 83952 | 4987 | 95839 | 3241 | 121561 | 1727 | 102600 |

## SQUARE TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#5 | 1.24 | 377 | 388 | 613 | 246 | 618 | 206 | 607 | 174 | 577 | 124 | 601 | 95 | 288 |
| 4-#6 | 1.76 | 386 | 402 | 636 | 253 | 645 | 210 | 638 | 175 | 616 | 119 | 642 | 84 | 377 |
| 4-#7 | 2.40 | 397 | 420 | 664 | 262 | 676 | 215 | 673 | 176 | 661 | 112 | 690 | 68 | 481 |
| 4-#8 | 3.16 | 409 | 441 | 696 | 274 | 710 | 221 | 713 | 177 | 713 | 103 | 742 | 49 | 596 |
| 4-#9 | 4.00 | 422 | 464 | 726 | 285 | 745 | 227 | 754 | 178 | 765 | 93 | 793 | 27 | 716 |
| 4-#10 | 5.08 | 437 | 494 | 762 | 299 | 787 | 235 | 802 | 178 | 827 | 79 | 851 | -4 | 853 |
| 4-#11 | 6.24 | 449 | 526 | 774 | 307 | 799 | 234 | 815 | 170 | 845 | 54 | 840 | -57 | 871 |
| 8-#5 | 2.48 | 392 | 422 | 643 | 266 | 656 | 222 | 651 | 182 | 633 | 117 | 665 | 51 | 504 |
| 8-#6 | 3.52 | 407 | 451 | 678 | 282 | 696 | 233 | 698 | 186 | 693 | 108 | 729 | 20 | 668 |
| 8-#7 | 4.80 | 425 | 486 | 720 | 307 | 743 | 245 | 752 | 190 | 762 | 96 | 802 | -19 | 804 |

## SQUARE TIED COLUMNS 12" x 12"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.22 | 657 | 558 | 1066 | 367 | 1092 | 309 | 1089 | 263 | 1049 | 191 | 1097 | 148 | 488 |
| 4-#7 | 1.67 | 672 | 576 | 1105 | 375 | 1140 | 315 | 1145 | 266 | 1120 | 186 | 1174 | 135 | 629 |
| 4-#8 | 2.19 | 690 | 597 | 1151 | 386 | 1197 | 322 | 1209 | 269 | 1202 | 180 | 1294 | 129 | 789 |
| 4-#9 | 2.78 | 708 | 620 | 1200 | 399 | 1257 | 331 | 1276 | 272 | 1287 | 173 | 1390 | 113 | 958 |
| 4-#10 | 3.53 | 731 | 650 | 1261 | 415 | 1333 | 342 | 1358 | 275 | 1392 | 163 | 1506 | 91 | 1166 |
| 4-#11 | 4.33 | 749 | 682 | 1310 | 428 | 1374 | 345 | 1403 | 271 | 1450 | 144 | 1545 | 53 | 1358 |
| 4-#14 | 6.25 | 800 | 758 | 1445 | 471 | 1518 | 367 | 1570 | 275 | 1663 | 112 | 1756 | -19 | 1764 |
| 8-#5 | 1.72 | 664 | 578 | 1074 | 381 | 1104 | 322 | 1105 | 272 | 1071 | 191 | 1126 | 119 | 655 |
| 8-#6 | 2.44 | 685 | 607 | 1123 | 397 | 1165 | 333 | 1178 | 278 | 1162 | 185 | 1226 | 91 | 880 |
| 8-#7 | 3.33 | 710 | 642 | 1182 | 417 | 1238 | 348 | 1264 | 286 | 1271 | 177 | 1342 | 55 | 1144 |
| 8-#8 | 4.39 | 740 | 684 | 1250 | 440 | 1324 | 366 | 1361 | 294 | 1395 | 167 | 1526 | 26 | 1443 |
| 8-#9 | 5.56 | 771 | 730 | 1323 | 467 | 1415 | 386 | 1462 | 302 | 1525 | 155 | 1672 | -21 | 1603 |
| 8-#10 | 7.06 | 810 | 790 | 1414 | 501 | 1530 | 411 | 1587 | 312 | 1684 | 138 | 1848 | -84 | 1756 |

## SQUARE TIED COLUMNS 14" x 14"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.22 | 1049 | 759 | 1700 | 512 | 1757 | 431 | 1764 | 368 | 1728 | 271 | 1838 | 216 | 776 |
| 4-#8 | 1.61 | 1073 | 780 | 1759 | 522 | 1830 | 438 | 1852 | 372 | 1842 | 267 | 1966 | 204 | 980 |
| 4-#9 | 2.04 | 1098 | 804 | 1823 | 534 | 1910 | 446 | 1948 | 376 | 1962 | 261 | 2099 | 190 | 1197 |
| 4-#10 | 2.59 | 1129 | 834 | 1904 | 550 | 2009 | 457 | 2068 | 382 | 2111 | 254 | 2263 | 170 | 1468 |
| 4-#11 | 3.18 | 1155 | 866 | 1976 | 562 | 2093 | 465 | 2158 | 383 | 2213 | 238 | 2347 | 137 | 1729 |
| 4-#14 | 4.59 | 1225 | 942 | 2160 | 604 | 2324 | 494 | 2412 | 393 | 2536 | 215 | 2791 | 102 | 2347 |
| 8-#5 | 1.27 | 1038 | 762 | 1657 | 519 | 1708 | 439 | 1707 | 374 | 1658 | 277 | 1763 | 199 | 805 |
| 8-#6 | 1.80 | 1065 | 790 | 1720 | 534 | 1787 | 451 | 1801 | 381 | 1782 | 273 | 1907 | 176 | 1090 |
| 8-#7 | 2.45 | 1097 | 826 | 1797 | 554 | 1882 | 466 | 1916 | 390 | 1931 | 267 | 2077 | 146 | 1428 |
| 8-#8 | 3.22 | 1135 | 868 | 1886 | 578 | 1992 | 484 | 2050 | 400 | 2103 | 260 | 2271 | 110 | 1814 |
| 8-#9 | 4.08 | 1175 | 914 | 1981 | 605 | 2112 | 504 | 2194 | 412 | 2286 | 252 | 2474 | 68 | 2224 |
| 8-#10 | 5.18 | 1226 | 974 | 2101 | 639 | 2262 | 530 | 2376 | 427 | 2512 | 240 | 2722 | 11 | 2695 |
| 8-#11 | 6.37 | 1275 | 1038 | 2208 | 669 | 2390 | 552 | 2516 | 435 | 2670 | 215 | 2858 | -72 | 2839 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.23 | 1575 | 993 | 2544 | 681 | 2650 | 573 | 2673 | 490 | 2648 | 364 | 2860 | 296 | 1170 |
| 4-#9 | 1.56 | 1606 | 1016 | 2624 | 693 | 2748 | 581 | 2791 | 494 | 2807 | 360 | 3040 | 285 | 1436 |
| 4-#10 | 1.98 | 1646 | 1046 | 2724 | 708 | 2872 | 592 | 2940 | 499 | 3007 | 355 | 3264 | 269 | 1768 |
| 4-#11 | 2.44 | 1680 | 1078 | 2820 | 719 | 2981 | 599 | 3069 | 501 | 3153 | 342 | 3407 | 242 | 2097 |
| 4-#14 | 3.52 | 1771 | 1154 | 3054 | 760 | 3273 | 627 | 3422 | 517 | 3591 | 324 | 3887 | 192 | 2873 |
| 4-#18 | 6.25 | 1982 | 1348 | 3606 | 868 | 3964 | 703 | 4222 | 553 | 4581 | 269 | 4915 | 47 | 4681 |
| 8-#6 | 1.38 | 1564 | 1003 | 2494 | 695 | 2594 | 588 | 2609 | 501 | 2562 | 369 | 2774 | 269 | 1299 |
| 8-#7 | 1.88 | 1604 | 1038 | 2589 | 714 | 2711 | 603 | 2749 | 510 | 2752 | 365 | 2999 | 243 | 1710 |
| 8-#8 | 2.47 | 1651 | 1080 | 2698 | 738 | 2847 | 621 | 2913 | 520 | 2975 | 361 | 3259 | 212 | 2183 |
| 8-#9 | 3.13 | 1701 | 1127 | 2816 | 765 | 2994 | 641 | 3091 | 532 | 3217 | 356 | 3533 | 176 | 2689 |
| 8-#10 | 3.97 | 1765 | 1186 | 2965 | 799 | 3181 | 667 | 3317 | 548 | 3518 | 349 | 3873 | 128 | 3320 |
| 8-#11 | 4.88 | 1820 | 1250 | 3105 | 829 | 3348 | 689 | 3516 | 559 | 3745 | 329 | 4099 | 56 | 3922 |
| 8-#14 | 7.03 | 1968 | 1403 | 3455 | 918 | 3787 | 756 | 4049 | 598 | 4408 | 300 | 4826 | -87 | 4777 |
| 12-#10 | 5.95 | 1932 | 1327 | 3257 | 901 | 3553 | 731 | 3769 | 585 | 4150 | 343 | 4653 | 36 | 4508 |

## SQUARE TIED COLUMNS 18" x 18"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.23 | 2252 | 1256 | 3627 | 874 | 3798 | 736 | 3845 | 629 | 3826 | 467 | 4194 | 389 | 1673 |
| 4-#10 | 1.57 | 2299 | 1286 | 3747 | 889 | 3946 | 746 | 4023 | 634 | 4067 | 463 | 4480 | 376 | 2066 |
| 4-#11 | 1.93 | 2342 | 1318 | 3866 | 899 | 4082 | 752 | 4182 | 635 | 4281 | 454 | 4684 | 352 | 2464 |
| 4-#14 | 2.78 | 2453 | 1395 | 4151 | 939 | 4435 | 780 | 4608 | 651 | 4849 | 442 | 5319 | 312 | 3396 |
| 4-#18 | 4.94 | 2717 | 1588 | 4829 | 1046 | 5282 | 855 | 5632 | 693 | 6131 | 399 | 6734 | 193 | 5598 |
| 8-#6 | 1.09 | 2200 | 1243 | 3469 | 878 | 3614 | 744 | 3627 | 637 | 3534 | 478 | 3853 | 371 | 1506 |
| 8-#7 | 1.48 | 2248 | 1278 | 3581 | 897 | 3752 | 759 | 3793 | 646 | 3758 | 474 | 4134 | 349 | 1990 |
| 8-#8 | 1.95 | 2304 | 1321 | 3712 | 921 | 3914 | 777 | 3988 | 657 | 4022 | 470 | 4460 | 321 | 2550 |
| 8-#9 | 2.47 | 2365 | 1367 | 3853 | 947 | 4089 | 797 | 4200 | 669 | 4309 | 466 | 4808 | 289 | 3152 |
| 8-#10 | 3.14 | 2441 | 1427 | 4032 | 982 | 4312 | 824 | 4468 | 685 | 4674 | 460 | 5242 | 247 | 3906 |
| 8-#11 | 3.85 | 2510 | 1491 | 4206 | 1012 | 4517 | 846 | 4713 | 696 | 5004 | 448 | 5560 | 184 | 4645 |
| 8-#14 | 5.56 | 2690 | 1644 | 4630 | 1101 | 5049 | 913 | 5357 | 736 | 5862 | 430 | 6522 | 59 | 6341 |
| 12-#10 | 4.70 | 2638 | 1567 | 4379 | 1086 | 4754 | 890 | 5007 | 724 | 5427 | 457 | 6223 | 164 | 5450 |
| 12-#11 | 5.78 | 2746 | 1664 | 4618 | 1138 | 5043 | 925 | 5351 | 742 | 5898 | 443 | 6686 | 76 | 6341 |

## SQUARE TIED COLUMNS 20" x 20"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.00 | 3051 | 1525 | 4854 | 1078 | 5087 | 910 | 5137 | 780 | 5067 | 588 | 5588 | 502 | 1909 |
| 4-#10 | 1.27 | 3107 | 1555 | 4995 | 1093 | 5259 | 920 | 5343 | 786 | 5347 | 584 | 5936 | 492 | 2364 |
| 4-#11 | 1.56 | 3158 | 1587 | 5139 | 1102 | 5421 | 925 | 5532 | 786 | 5600 | 574 | 6201 | 471 | 2830 |
| 4-#14 | 2.25 | 3290 | 1663 | 5475 | 1141 | 5836 | 952 | 6032 | 801 | 6277 | 563 | 6994 | 438 | 3918 |
| 4-#18 | 4.00 | 3604 | 1857 | 6280 | 1246 | 6838 | 1026 | 7242 | 842 | 7911 | 537 | 8807 | 339 | 6514 |
| 8-#7 | 1.20 | 3046 | 1547 | 4799 | 1103 | 5032 | 934 | 5075 | 799 | 4987 | 597 | 5508 | 464 | 2269 |
| 8-#8 | 1.58 | 3111 | 1589 | 4951 | 1126 | 5219 | 953 | 5300 | 810 | 5291 | 593 | 5901 | 439 | 2915 |
| 8-#9 | 2.00 | 3182 | 1636 | 5116 | 1153 | 5422 | 973 | 5546 | 822 | 5624 | 588 | 6322 | 410 | 3612 |
| 8-#10 | 2.54 | 3271 | 1695 | 5324 | 1187 | 5681 | 999 | 5858 | 838 | 6047 | 583 | 6852 | 373 | 4488 |
| 8-#11 | 3.12 | 3354 | 1760 | 5532 | 1216 | 5926 | 1021 | 6147 | 849 | 6437 | 572 | 7265 | 316 | 5362 |
| 8-#14 | 4.50 | 3567 | 1912 | 6031 | 1305 | 6550 | 1089 | 6902 | 890 | 7462 | 557 | 8468 | 205 | 7433 |
| 8-#18 | 8.00 | 4078 | 2300 | 7230 | 1533 | 8057 | 1263 | 8729 | 994 | 9929 | 518 | 11211 | -107 | 11077 |
| 12-#10 | 3.81 | 3498 | 1836 | 5727 | 1292 | 6195 | 1067 | 6482 | 879 | 6920 | 582 | 8038 | 296 | 6435 |
| 12-#11 | 4.68 | 3626 | 1932 | 6013 | 1345 | 6538 | 1102 | 6891 | 898 | 7478 | 569 | 8640 | 216 | 7503 |
| 12-#14 | 6.75 | 3952 | 2161 | 6709 | 1489 | 7414 | 1205 | 7952 | 959 | 8931 | 551 | 10366 | 56 | 10086 |
| 16-#10 | 5.08 | 3681 | 1977 | 6170 | 1387 | 6752 | 1146 | 7154 | 931 | 7794 | 570 | 9230 | 215 | 8159 |

## SQUARE TIED COLUMNS 22" x 22"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.05 | 4085 | 1852 | 6493 | 1320 | 6837 | 1114 | 6928 | 954 | 6873 | 718 | 7658 | 618 | 2661 |
| 4-#11 | 1.29 | 4144 | 1884 | 6662 | 1327 | 7026 | 1118 | 7146 | 954 | 7165 | 708 | 7984 | 599 | 3194 |
| 4-#14 | 1.86 | 4298 | 1960 | 7050 | 1366 | 7502 | 1144 | 7720 | 968 | 7941 | 697 | 8938 | 571 | 4439 |
| 4-#18 | 3.31 | 4664 | 2154 | 7983 | 1469 | 8661 | 1216 | 9117 | 1008 | 9836 | 671 | 11154 | 488 | 7428 |
| 8-#8 | 1.31 | 4088 | 1886 | 6440 | 1355 | 6788 | 1147 | 6877 | 980 | 6808 | 728 | 7607 | 566 | 3279 |
| 8-#9 | 1.65 | 4170 | 1933 | 6628 | 1381 | 7020 | 1168 | 7156 | 992 | 7186 | 724 | 8103 | 540 | 4071 |
| 8-#10 | 2.10 | 4273 | 1992 | 6866 | 1415 | 7315 | 1194 | 7511 | 1008 | 7667 | 719 | 8728 | 506 | 5069 |
| 8-#11 | 2.58 | 4369 | 2057 | 7110 | 1443 | 7599 | 1215 | 7846 | 1019 | 8117 | 708 | 9238 | 454 | 6077 |
| 8-#14 | 3.72 | 4616 | 2209 | 7684 | 1532 | 8316 | 1283 | 8712 | 1060 | 9291 | 694 | 10684 | 355 | 8463 |
| 8-#18 | 6.61 | 5211 | 2597 | 9071 | 1761 | 10056 | 1459 | 10820 | 1166 | 12153 | 660 | 14037 | 75 | 13768 |
| 12-#10 | 3.15 | 4530 | 2133 | 7325 | 1521 | 7900 | 1263 | 8221 | 1051 | 8660 | 720 | 10121 | 435 | 7397 |
| 12-#11 | 3.87 | 4677 | 2229 | 7659 | 1573 | 8299 | 1298 | 8696 | 1069 | 9306 | 707 | 10865 | 362 | 8711 |
| 12-#14 | 5.58 | 5053 | 2458 | 8461 | 1719 | 9305 | 1402 | 9914 | 1132 | 10973 | 692 | 12943 | 216 | 11712 |
| 16-#10 | 4.20 | 4739 | 2274 | 7830 | 1617 | 8535 | 1343 | 8987 | 1104 | 9655 | 710 | 11516 | 362 | 9354 |
| 16-#11 | 5.16 | 4927 | 2402 | 8262 | 1689 | 9058 | 1396 | 9612 | 1134 | 10496 | 693 | 12499 | 264 | 11055 |

## SQUARE TIED COLUMNS 24" x 24"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.08 | 5319 | 2209 | 8461 | 1576 | 8921 | 1330 | 9051 | 1139 | 9003 | 855 | 10060 | 736 | 3558 |
| 4-#14 | 1.56 | 5494 | 2286 | 8900 | 1614 | 9460 | 1356 | 9698 | 1152 | 9877 | 843 | 11176 | 713 | 4958 |
| 4-#18 | 2.78 | 5914 | 2479 | 9962 | 1716 | 10774 | 1426 | 11282 | 1191 | 12024 | 816 | 13800 | 642 | 8340 |
| 8-#8 | 1.10 | 5252 | 2212 | 8202 | 1606 | 8649 | 1362 | 8744 | 1167 | 8598 | 878 | 9574 | 700 | 3642 |
| 8-#9 | 1.39 | 5345 | 2258 | 8414 | 1632 | 8909 | 1382 | 9057 | 1179 | 9020 | 873 | 10157 | 678 | 4529 |
| 8-#10 | 1.76 | 5462 | 2318 | 8683 | 1666 | 9240 | 1408 | 9455 | 1195 | 9559 | 868 | 10898 | 648 | 5649 |
| 8-#11 | 2.17 | 5572 | 2382 | 8962 | 1693 | 9564 | 1428 | 9836 | 1205 | 10069 | 857 | 11505 | 601 | 6789 |
| 8-#14 | 3.13 | 5853 | 2535 | 9612 | 1782 | 10373 | 1497 | 10812 | 1247 | 11393 | 844 | 13196 | 510 | 9490 |
| 8-#18 | 5.56 | 6533 | 2922 | 11189 | 2011 | 12347 | 1673 | 13201 | 1354 | 14635 | 812 | 17167 | 256 | 15929 |
| 12-#10 | 2.65 | 5749 | 2458 | 9198 | 1773 | 9896 | 1478 | 10251 | 1239 | 10672 | 871 | 12498 | 581 | 8266 |
| 12-#11 | 3.25 | 5917 | 2555 | 9580 | 1824 | 10351 | 1513 | 10791 | 1258 | 11405 | 858 | 13386 | 514 | 9908 |
| 12-#14 | 4.69 | 6343 | 2784 | 10487 | 1970 | 11488 | 1618 | 12166 | 1321 | 13287 | 845 | 15820 | 380 | 13396 |
| 16-#10 | 3.53 | 5986 | 2599 | 9764 | 1869 | 10608 | 1559 | 11110 | 1294 | 11788 | 862 | 14097 | 515 | 10575 |
| 16-#11 | 4.33 | 6200 | 2727 | 10259 | 1942 | 11205 | 1612 | 11821 | 1324 | 12744 | 846 | 15268 | 425 | 12518 |
| 16-#14 | 6.25 | 6743 | 3033 | 11449 | 2138 | 12699 | 1759 | 13626 | 1415 | 15184 | 825 | 18452 | 245 | 17177 |
| 20-#10 | 4.41 | 6260 | 2739 | 10337 | 1963 | 11322 | 1629 | 11973 | 1337 | 12969 | 865 | 15770 | 441 | 12915 |
| 20-#11 | 5.42 | 6527 | 2900 | 10928 | 2071 | 12061 | 1697 | 12856 | 1376 | 14161 | 848 | 17237 | 329 | 15200 |

## SQUARE TIED COLUMNS 26" x 26"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.33 | 6895 | 2639 | 11049 | 1885 | 11735 | 1587 | 11994 | 1354 | 12110 | 1004 | 13733 | 864 | 5476 |
| 4-#18 | 2.37 | 7370 | 2833 | 12241 | 1985 | 13206 | 1656 | 13764 | 1391 | 14507 | 976 | 16769 | 804 | 9251 |
| 8-#9 | 1.18 | 6724 | 2612 | 10498 | 1906 | 11115 | 1607 | 11275 | 1383 | 11152 | 1036 | 12484 | 822 | 4985 |
| 8-#10 | 1.50 | 6855 | 2671 | 10797 | 1939 | 11482 | 1630 | 11716 | 1399 | 11749 | 1031 | 13308 | 793 | 6226 |
| 8-#11 | 1.85 | 6979 | 2736 | 11113 | 1966 | 11846 | 1661 | 12142 | 1409 | 12319 | 1019 | 14089 | 756 | 7499 |
| 8-#14 | 2.66 | 7296 | 2888 | 11839 | 2055 | 12747 | 1730 | 13229 | 1450 | 13791 | 1007 | 16029 | 672 | 10514 |
| 8-#18 | 4.73 | 8062 | 3276 | 13607 | 2283 | 14956 | 1906 | 15899 | 1558 | 17413 | 976 | 20623 | 439 | 17745 |
| 12-#10 | 2.25 | 7173 | 2812 | 11368 | 2047 | 12209 | 1712 | 12599 | 1444 | 12982 | 1035 | 15090 | 727 | 9132 |
| 12-#11 | 2.77 | 7362 | 2908 | 11800 | 2098 | 12720 | 1747 | 13203 | 1462 | 13802 | 1022 | 16224 | 674 | 10975 |
| 12-#14 | 3.99 | 7839 | 3137 | 12814 | 2244 | 13988 | 1853 | 14736 | 1527 | 15897 | 1010 | 19019 | 550 | 15136 |
| 12-#18 | 7.10 | 8999 | 3718 | 15284 | 2617 | 17092 | 2121 | 18495 | 1689 | 21042 | 976 | 25627 | 206 | 24263 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 3.01 | 7438 | 2952 | 11996 | 2144 | 12999 | 1783 | 13551 | 1499 | 14219 | 1027 | 16866 | 664 | 11822 |
| 16-#11 | 3.69 | 7678 | 3081 | 12554 | 2216 | 13670 | 1847 | 14348 | 1530 | 15289 | 1012 | 18356 | 593 | 14010 |
| 16-#14 | 5.33 | 8286 | 3386 | 13885 | 2414 | 15336 | 1996 | 16361 | 1623 | 18009 | 993 | 22011 | 426 | 19237 |
| 20-#10 | 3.76 | 7744 | 3093 | 12624 | 2237 | 13791 | 1865 | 14507 | 1544 | 15528 | 1031 | 18730 | 590 | 14376 |
| 20-#11 | 4.62 | 8044 | 3253 | 13317 | 2331 | 14621 | 1933 | 15498 | 1584 | 16864 | 1015 | 20589 | 501 | 17133 |

## SQUARE TIED COLUMNS 28" x 28"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.15 | 8518 | 3021 | 13522 | 2179 | 14353 | 1838 | 14633 | 1572 | 14665 | 1178 | 16602 | 1023 | 5994 |
| 4-#18 | 2.04 | 9049 | 3215 | 14846 | 2277 | 15981 | 1905 | 16590 | 1608 | 17312 | 1149 | 20085 | 974 | 10160 |
| 8-#9 | 1.02 | 8324 | 2994 | 12905 | 2202 | 13664 | 1860 | 13837 | 1604 | 13606 | 1212 | 15155 | 977 | 5441 |
| 8-#10 | 1.30 | 8469 | 3053 | 13234 | 2236 | 14068 | 1883 | 14321 | 1620 | 14261 | 1207 | 16058 | 949 | 6803 |
| 8-#11 | 1.59 | 8608 | 3117 | 13587 | 2262 | 14472 | 1900 | 14792 | 1629 | 14890 | 1195 | 16920 | 912 | 8208 |
| 8-#14 | 2.30 | 8960 | 3270 | 14390 | 2350 | 15466 | 1982 | 15990 | 1670 | 16511 | 1183 | 19158 | 839 | 11531 |
| 8-#18 | 4.08 | 9814 | 3657 | 16349 | 2578 | 17909 | 2158 | 18941 | 1779 | 20512 | 1153 | 24430 | 628 | 19556 |
| 12-#10 | 1.94 | 8819 | 3194 | 13861 | 2344 | 14866 | 1966 | 15290 | 1665 | 15614 | 1212 | 18021 | 884 | 9995 |
| 12-#11 | 2.39 | 9029 | 3290 | 14343 | 2394 | 15433 | 2001 | 15959 | 1684 | 16521 | 1200 | 19277 | 831 | 12038 |
| 12-#14 | 3.44 | 9557 | 3519 | 15464 | 2540 | 16832 | 2106 | 17649 | 1748 | 18830 | 1188 | 22500 | 721 | 16869 |
| 12-#18 | 6.12 | 10845 | 4100 | 18203 | 2914 | 20269 | 2376 | 21807 | 1914 | 24519 | 1158 | 30085 | 407 | 27127 |
| 16-#10 | 2.59 | 9111 | 3334 | 14551 | 2442 | 15733 | 2038 | 16335 | 1722 | 16972 | 1205 | 19975 | 823 | 13095 |
| 16-#11 | 3.18 | 9379 | 3463 | 15173 | 2513 | 16478 | 2088 | 17219 | 1752 | 18157 | 1190 | 21627 | 753 | 15530 |
| 16-#14 | 4.59 | 10053 | 3768 | 16644 | 2711 | 18318 | 2251 | 19440 | 1846 | 21157 | 1173 | 25837 | 606 | 21332 |
| 20-#10 | 3.24 | 9449 | 3475 | 15234 | 2535 | 16603 | 2120 | 17386 | 1767 | 18410 | 1210 | 22028 | 750 | 15854 |
| 20-#11 | 3.98 | 9784 | 3635 | 16004 | 2628 | 17525 | 2188 | 18484 | 1807 | 19889 | 1195 | 24091 | 662 | 18919 |
| 20-#14 | 5.74 | 10627 | 4017 | 17834 | 2877 | 19806 | 2375 | 21238 | 1924 | 23619 | 1179 | 29333 | 474 | 25950 |
| 24-#10 | 3.89 | 9781 | 3615 | 15882 | 2639 | 17475 | 2189 | 18461 | 1824 | 19867 | 1215 | 24045 | 698 | 18748 |
| 24-#11 | 4.78 | 10183 | 3808 | 16785 | 2755 | 18586 | 2273 | 19778 | 1876 | 21643 | 1199 | 26516 | 595 | 22189 |

## SQUARE TIED COLUMNS 30" x 30"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.00 | 10379 | 3431 | 16343 | 2496 | 17342 | 2108 | 17642 | 1808 | 17567 | 1365 | 19778 | 1188 | 6510 |
| 4-#18 | 1.78 | 10967 | 3625 | 17798 | 2593 | 19127 | 2174 | 19785 | 1843 | 20464 | 1335 | 23775 | 1154 | 11069 |
| 8-#10 | 1.13 | 10322 | 3463 | 16018 | 2555 | 17023 | 2156 | 17296 | 1858 | 17121 | 1397 | 19180 | 1116 | 7378 |
| 8-#11 | 1.39 | 10476 | 3528 | 16409 | 2580 | 17467 | 2172 | 17813 | 1866 | 17809 | 1384 | 20122 | 1079 | 8916 |
| 8-#14 | 2.00 | 10863 | 3680 | 17289 | 2668 | 18554 | 2234 | 19121 | 1907 | 19579 | 1372 | 22564 | 1007 | 12548 |
| 8-#18 | 3.56 | 11806 | 4068 | 19440 | 2896 | 21232 | 2430 | 22353 | 2016 | 23958 | 1343 | 28612 | 823 | 21363 |
| 12-#10 | 1.69 | 10703 | 3604 | 16700 | 2664 | 17892 | 2239 | 18351 | 1904 | 18594 | 1402 | 21325 | 1052 | 10854 |
| 12-#11 | 2.08 | 10935 | 3700 | 17233 | 2713 | 18515 | 2273 | 19085 | 1922 | 19587 | 1390 | 22701 | 999 | 13098 |
| 12-#14 | 3.00 | 11515 | 3929 | 18461 | 2859 | 20046 | 2379 | 20933 | 1987 | 22110 | 1379 | 26227 | 891 | 18399 |
| 12-#18 | 5.33 | 12931 | 4510 | 21470 | 3234 | 23815 | 2650 | 25490 | 2154 | 28343 | 1351 | 34922 | 612 | 30067 |
| 16-#10 | 2.26 | 11023 | 3745 | 17452 | 2762 | 18837 | 2311 | 19490 | 1961 | 20074 | 1397 | 23456 | 994 | 14256 |
| 16-#11 | 2.77 | 11319 | 3873 | 18139 | 2833 | 19656 | 2361 | 20460 | 1991 | 21372 | 1382 | 25268 | 925 | 17080 |
| 16-#14 | 4.00 | 12059 | 4178 | 19751 | 3031 | 21669 | 2505 | 22888 | 2086 | 24651 | 1366 | 29878 | 780 | 23461 |
| 16-#18 | 7.11 | 13868 | 4953 | 23701 | 3537 | 26623 | 2906 | 28875 | 2327 | 32741 | 1324 | 41225 | 405 | 38765 |
| 20-#10 | 2.82 | 11393 | 3885 | 18191 | 2855 | 19785 | 2395 | 20635 | 2007 | 21640 | 1402 | 25698 | 921 | 17348 |
| 20-#11 | 3.47 | 11763 | 4046 | 19038 | 2947 | 20799 | 2462 | 21840 | 2047 | 23262 | 1388 | 27966 | 835 | 20724 |
| 20-#14 | 5.00 | 12689 | 4427 | 21039 | 3196 | 23296 | 2650 | 24853 | 2166 | 27341 | 1373 | 33708 | 650 | 28740 |
| 24-#10 | 3.39 | 11754 | 4026 | 18896 | 2960 | 20727 | 2463 | 21806 | 2065 | 23226 | 1408 | 27770 | 855 | 20504 |
| 24-#11 | 4.16 | 12198 | 4218 | 19890 | 3075 | 21945 | 2547 | 23252 | 2117 | 25175 | 1393 | 30616 | 770 | 24449 |

## SQUARE TIED COLUMNS 32" x 32"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.56 | 13141 | 4063 | 21124 | 2931 | 22669 | 2463 | 23377 | 2094 | 23988 | 1536 | 27693 | 1329 | 11976 |
| 8-#11 | 1.22 | 12598 | 3966 | 19602 | 2921 | 20858 | 2463 | 21230 | 2120 | 21100 | 1587 | 23721 | 1258 | 9622 |
| 8-#14 | 1.76 | 13021 | 4119 | 20559 | 3009 | 22038 | 2525 | 22648 | 2161 | 23018 | 1575 | 26368 | 1187 | 13563 |
| 8-#18 | 3.13 | 14054 | 4506 | 22904 | 3236 | 24951 | 2685 | 26162 | 2270 | 27776 | 1547 | 32938 | 1005 | 23166 |
| 12-#10 | 1.49 | 12842 | 4042 | 19911 | 3007 | 21314 | 2532 | 21809 | 2159 | 21947 | 1606 | 25027 | 1231 | 11712 |
| 12-#11 | 1.83 | 13096 | 4139 | 20494 | 3055 | 21994 | 2565 | 22608 | 2177 | 23026 | 1594 | 26523 | 1179 | 14155 |
| 12-#14 | 2.64 | 13728 | 4368 | 21831 | 3201 | 23657 | 2671 | 24613 | 2242 | 25763 | 1583 | 30352 | 1072 | 19925 |
| 12-#18 | 4.69 | 15275 | 4949 | 25110 | 3576 | 27758 | 2943 | 29570 | 2410 | 32539 | 1558 | 39818 | 797 | 33084 |
| 16-#10 | 1.98 | 13190 | 4183 | 20724 | 3105 | 22337 | 2605 | 23041 | 2217 | 23548 | 1601 | 27335 | 1175 | 15402 |
| 16-#11 | 2.44 | 13514 | 4311 | 21477 | 3176 | 23230 | 2654 | 24097 | 2247 | 24960 | 1587 | 29308 | 1107 | 18582 |
| 16-#14 | 3.52 | 14321 | 4617 | 23230 | 3374 | 25417 | 2798 | 26734 | 2343 | 28518 | 1572 | 34316 | 965 | 25626 |
| 16-#18 | 6.25 | 16297 | 5391 | 27535 | 3880 | 30810 | 3165 | 33248 | 2586 | 37318 | 1534 | 46679 | 598 | 42381 |
| 20-#10 | 2.48 | 13593 | 4324 | 21518 | 3198 | 23363 | 2688 | 24280 | 2264 | 25242 | 1608 | 29767 | 1103 | 18860 |
| 20-#11 | 3.05 | 13998 | 4484 | 22443 | 3289 | 24468 | 2756 | 25593 | 2304 | 27007 | 1593 | 32238 | 1018 | 22547 |
| 20-#14 | 4.39 | 15008 | 4866 | 24616 | 3538 | 27181 | 2944 | 28865 | 2423 | 31435 | 1581 | 38482 | 836 | 31318 |
| 24-#10 | 2.98 | 13984 | 4464 | 22281 | 3303 | 24374 | 2756 | 25547 | 2322 | 26959 | 1614 | 32012 | 1039 | 22248 |
| 24-#11 | 3.66 | 14469 | 4657 | 23366 | 3418 | 25701 | 2840 | 27123 | 2374 | 29081 | 1600 | 34945 | 937 | 26682 |
| 24-#14 | 5.27 | 15677 | 5115 | 25930 | 3723 | 28948 | 3066 | 31045 | 2524 | 34389 | 1589 | 42574 | 743 | 36700 |

## SQUARE TIED COLUMNS 34" x 34"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.38 | 15587 | 4530 | 24846 | 3292 | 26634 | 2771 | 27392 | 2363 | 27908 | 1749 | 32033 | 1517 | 12882 |
| 8-#11 | 1.08 | 14993 | 4433 | 23190 | 3286 | 24672 | 2774 | 25070 | 2391 | 24789 | 1803 | 27745 | 1449 | 10327 |
| 8-#14 | 1.56 | 15452 | 4586 | 24226 | 3372 | 25945 | 2835 | 26599 | 2432 | 26855 | 1791 | 30595 | 1378 | 14576 |
| 8-#18 | 2.77 | 16575 | 4973 | 26765 | 3598 | 29094 | 2995 | 30393 | 2541 | 31991 | 1763 | 37686 | 1199 | 24966 |
| 12-#10 | 1.32 | 15253 | 4509 | 23515 | 3373 | 25158 | 2844 | 25690 | 2431 | 25697 | 1823 | 29154 | 1423 | 12568 |
| 12-#11 | 1.62 | 15529 | 4605 | 24151 | 3420 | 25895 | 2877 | 26554 | 2449 | 26862 | 1811 | 30771 | 1370 | 15208 |
| 12-#14 | 2.34 | 16214 | 4835 | 25597 | 3566 | 27689 | 2983 | 28716 | 2514 | 29812 | 1801 | 34901 | 1264 | 21447 |
| 12-#18 | 4.15 | 17892 | 5415 | 29147 | 3940 | 32124 | 3255 | 34073 | 2683 | 37132 | 1777 | 45136 | 993 | 36178 |
| 16-#10 | 1.76 | 15629 | 4650 | 24390 | 3471 | 26259 | 2917 | 27016 | 2490 | 27420 | 1819 | 31640 | 1368 | 16546 |
| 16-#11 | 2.16 | 15982 | 4778 | 25210 | 3541 | 27226 | 2966 | 28158 | 2520 | 28945 | 1804 | 33774 | 1301 | 19991 |
| 16-#14 | 3.11 | 16856 | 5084 | 27105 | 3739 | 29587 | 3110 | 31002 | 2616 | 32783 | 1791 | 39179 | 1161 | 27826 |
| 16-#18 | 5.54 | 19001 | 5858 | 31767 | 4246 | 35421 | 3479 | 38045 | 2861 | 42293 | 1755 | 52556 | 800 | 46027 |
| 20-#10 | 2.20 | 16065 | 4790 | 25240 | 3564 | 27361 | 3001 | 28349 | 2537 | 29243 | 1826 | 34259 | 1297 | 20389 |
| 20-#11 | 2.70 | 16505 | 4951 | 26244 | 3654 | 28561 | 3069 | 29769 | 2577 | 31150 | 1812 | 36936 | 1212 | 24390 |
| 20-#14 | 3.89 | 17601 | 5332 | 28589 | 3903 | 31490 | 3258 | 33300 | 2698 | 35927 | 1801 | 43681 | 1032 | 33892 |
| 24-#10 | 2.64 | 16486 | 4931 | 26060 | 3669 | 28444 | 3069 | 29712 | 2596 | 31089 | 1833 | 36681 | 1235 | 24003 |
| 24-#11 | 3.24 | 17014 | 5123 | 27237 | 3784 | 29879 | 3152 | 31418 | 2648 | 33384 | 1820 | 39856 | 1133 | 28813 |
| 24-#14 | 4.67 | 18322 | 5581 | 30005 | 4089 | 33380 | 3379 | 35651 | 2799 | 39112 | 1811 | 47839 | 916 | 39908 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 36" x 36"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.23 | 18323 | 5025 | 28990 | 3676 | 31047 | 3098 | 31857 | 2649 | 32250 | 1977 | 36824 | 1716 | 13788 |
| 8-#14 | 1.39 | 18172 | 5081 | 28312 | 3759 | 30300 | 3165 | 30998 | 2720 | 31114 | 2021 | 35275 | 1581 | 15588 |
| 8-#18 | 2.47 | 19386 | 5468 | 31047 | 3984 | 33684 | 3324 | 35074 | 2828 | 36627 | 1993 | 42885 | 1404 | 26763 |
| 12-#10 | 1.18 | 17952 | 5004 | 27539 | 3761 | 29450 | 3176 | 30021 | 2721 | 29813 | 2043 | 33735 | 1626 | 13422 |
| 12-#11 | 1.44 | 18251 | 5101 | 28228 | 3808 | 30244 | 3208 | 30950 | 2737 | 31121 | 2041 | 35470 | 1573 | 16260 |
| 12-#14 | 2.08 | 18989 | 5330 | 29782 | 3953 | 32170 | 3313 | 33269 | 2803 | 34285 | 2032 | 39902 | 1468 | 22966 |
| 12-#18 | 3.70 | 20801 | 5911 | 33605 | 4327 | 36939 | 3586 | 39025 | 2972 | 42147 | 2009 | 50906 | 1199 | 39263 |
| 16-#10 | 1.57 | 18358 | 5145 | 28472 | 3860 | 30629 | 3249 | 31440 | 2780 | 31714 | 2050 | 36398 | 1573 | 17687 |
| 16-#11 | 1.93 | 18739 | 5273 | 29362 | 3929 | 31671 | 3297 | 32668 | 2809 | 33353 | 2036 | 38691 | 1506 | 21396 |
| 16-#14 | 2.78 | 19682 | 5579 | 31401 | 4127 | 34206 | 3442 | 35721 | 2906 | 37470 | 2023 | 44495 | 1368 | 30062 |
| 16-#18 | 4.94 | 21996 | 6353 | 36420 | 4635 | 40480 | 3812 | 43291 | 3152 | 47690 | 1990 | 58884 | 1012 | 49721 |
| 20-#10 | 1.96 | 18826 | 5285 | 29381 | 3952 | 31803 | 3333 | 32867 | 2827 | 33666 | 2058 | 39204 | 1503 | 21883 |
| 20-#11 | 2.41 | 19302 | 5446 | 30465 | 4042 | 33101 | 3400 | 34395 | 2867 | 35716 | 2044 | 42084 | 1418 | 26252 |
| 20-#14 | 3.47 | 20483 | 5828 | 32982 | 4291 | 36247 | 3590 | 38185 | 2988 | 40842 | 2034 | 49332 | 1240 | 36489 |
| 20-#18 | 6.17 | 23384 | 6796 | 39199 | 4927 | 44030 | 4073 | 47579 | 3296 | 53557 | 2006 | 67271 | 782 | 60637 |
| 24-#10 | 2.35 | 19278 | 5426 | 30258 | 4058 | 32961 | 3401 | 34324 | 2886 | 35585 | 2054 | 41802 | 1441 | 25769 |
| 24-#11 | 2.89 | 19848 | 5618 | 31528 | 4172 | 34505 | 3484 | 36162 | 2939 | 38109 | 2052 | 45220 | 1341 | 30957 |
| 24-#14 | 4.17 | 21257 | 6077 | 34500 | 4477 | 38261 | 3711 | 40706 | 3091 | 44257 | 2045 | 53798 | 1127 | 43174 |

## SQUARE TIED COLUMNS 38" x 38"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.11 | 21366 | 5549 | 33579 | 4084 | 35936 | 3446 | 36797 | 2952 | 37040 | 2218 | 42093 | 1928 | 14692 |
| 8-#14 | 1.25 | 21197 | 5604 | 32843 | 4168 | 35130 | 3514 | 35874 | 3025 | 35821 | 2264 | 40433 | 1796 | 16599 |
| 8-#18 | 2.22 | 22503 | 5991 | 35774 | 4393 | 38750 | 3673 | 40230 | 3133 | 41711 | 2236 | 48561 | 1620 | 28558 |
| 12-#10 | 1.06 | 20958 | 5528 | 32006 | 4173 | 34217 | 3527 | 34828 | 3027 | 34431 | 2287 | 38795 | 1841 | 14276 |
| 12-#11 | 1.30 | 21279 | 5624 | 32748 | 4218 | 35068 | 3558 | 35821 | 3043 | 35753 | 2271 | 40649 | 1788 | 17309 |
| 12-#14 | 1.87 | 22071 | 5853 | 34412 | 4363 | 37126 | 3663 | 38297 | 3109 | 39204 | 2276 | 45382 | 1683 | 24483 |
| 12-#18 | 3.32 | 24016 | 6434 | 38508 | 4737 | 42229 | 3936 | 44453 | 3279 | 47609 | 2254 | 57154 | 1417 | 41966 |
| 16-#10 | 1.41 | 21392 | 5668 | 32997 | 4271 | 35473 | 3600 | 36341 | 3086 | 36457 | 2295 | 41636 | 1789 | 18826 |
| 16-#11 | 1.73 | 21802 | 5796 | 33954 | 4339 | 36590 | 3648 | 37654 | 3115 | 38209 | 2280 | 44088 | 1722 | 22799 |
| 16-#14 | 2.49 | 22813 | 6102 | 36140 | 4538 | 39299 | 3793 | 40915 | 3212 | 42605 | 2268 | 50289 | 1586 | 32189 |
| 16-#18 | 4.43 | 25299 | 6876 | 41518 | 5046 | 46014 | 4163 | 49014 | 3460 | 53534 | 2237 | 65690 | 1235 | 53462 |
| 20-#10 | 1.76 | 21894 | 5809 | 33965 | 4364 | 36719 | 3684 | 37862 | 3134 | 38538 | 2303 | 44628 | 1721 | 23308 |
| 20-#11 | 2.16 | 22406 | 5969 | 35129 | 4453 | 38109 | 3751 | 39497 | 3174 | 40730 | 2289 | 47710 | 1636 | 28133 |
| 20-#14 | 3.12 | 23672 | 6351 | 37819 | 4701 | 41478 | 3942 | 43546 | 3296 | 46204 | 2280 | 55458 | 1460 | 39108 |
| 20-#18 | 5.54 | 26788 | 7319 | 44471 | 5337 | 49810 | 4426 | 53597 | 3606 | 59806 | 2255 | 74674 | 1007 | 65531 |
| 24-#10 | 2.11 | 22376 | 5949 | 34900 | 4470 | 37953 | 3753 | 39407 | 3193 | 40583 | 2300 | 47404 | 1659 | 27548 |
| 24-#11 | 2.59 | 22988 | 6142 | 36262 | 4583 | 39605 | 3835 | 41382 | 3246 | 43208 | 2284 | 51064 | 1559 | 33113 |
| 24-#14 | 3.74 | 24499 | 6600 | 39439 | 4888 | 43616 | 4062 | 46238 | 3399 | 49850 | 2292 | 60236 | 1348 | 46322 |

## SQUARE TIED COLUMNS 40" x 40"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.00 | 24731 | 6100 | 38637 | 4514 | 41326 | 3813 | 42240 | 3271 | 42301 | 2472 | 47867 | 2151 | 15596 |
| 8-#14 | 1.13 | 24546 | 6156 | 37842 | 4601 | 40461 | 3883 | 41253 | 3347 | 41000 | 2520 | 46097 | 2022 | 17608 |
| 8-#18 | 2.00 | 25944 | 6543 | 40970 | 4824 | 44318 | 4041 | 45889 | 3454 | 47267 | 2493 | 54742 | 1847 | 30350 |
| 12-#11 | 1.17 | 24630 | 6175 | 37736 | 4652 | 40393 | 3928 | 41195 | 3366 | 40928 | 2528 | 46334 | 2014 | 18358 |
| 12-#14 | 1.69 | 25476 | 6405 | 39510 | 4796 | 42583 | 4033 | 43829 | 3431 | 44483 | 2513 | 51368 | 1910 | 25996 |
| 12-#18 | 3.00 | 27556 | 6985 | 43881 | 5169 | 48020 | 4305 | 50384 | 3601 | 53544 | 2513 | 63907 | 1645 | 44663 |
| 16-#10 | 1.27 | 24750 | 6220 | 37989 | 4705 | 40818 | 3971 | 41744 | 3410 | 41674 | 2553 | 47381 | 2017 | 19962 |
| 16-#11 | 1.56 | 25188 | 6348 | 39014 | 4772 | 42010 | 4018 | 43143 | 3438 | 43537 | 2538 | 49991 | 1950 | 24198 |
| 16-#14 | 2.25 | 26269 | 6654 | 41342 | 4971 | 44894 | 4163 | 46612 | 3535 | 48212 | 2526 | 56589 | 1815 | 34211 |
| 16-#18 | 4.00 | 28927 | 7428 | 47086 | 5479 | 52050 | 4534 | 55239 | 3784 | 59850 | 2497 | 73002 | 1469 | 57250 |
| 20-#10 | 1.59 | 25284 | 6360 | 39016 | 4798 | 42136 | 4055 | 43359 | 3458 | 43882 | 2562 | 50559 | 1950 | 24731 |
| 20-#11 | 1.95 | 25832 | 6521 | 40260 | 4886 | 43618 | 4121 | 45102 | 3497 | 46216 | 2548 | 53842 | 1866 | 29948 |
| 20-#14 | 2.81 | 27185 | 6902 | 43125 | 5134 | 47201 | 4312 | 49410 | 3620 | 52039 | 2539 | 62089 | 1691 | 41752 |
| 20-#18 | 5.00 | 30517 | 7871 | 50213 | 5770 | 56091 | 4798 | 60118 | 3932 | 66527 | 2517 | 82583 | 1241 | 70226 |
| 24-#10 | 1.90 | 25797 | 6501 | 40008 | 4905 | 43446 | 4124 | 44993 | 3517 | 46054 | 2559 | 53512 | 1888 | 29339 |
| 24-#11 | 2.34 | 26452 | 6693 | 41465 | 5017 | 45207 | 4205 | 47095 | 3569 | 48850 | 2544 | 57413 | 1789 | 35283 |
| 24-#14 | 3.38 | 28066 | 7151 | 44846 | 5322 | 49472 | 4432 | 52271 | 3724 | 55802 | 2533 | 67180 | 1580 | 49381 |

## SQUARE TIED COLUMNS 42" x 42"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.02 | 28235 | 6735 | 43333 | 5056 | 46319 | 4272 | 47160 | 3686 | 46677 | 2790 | 52293 | 2260 | 18617 |
| 8-#18 | 1.81 | 29726 | 7123 | 46660 | 5278 | 50412 | 4429 | 52077 | 3792 | 53320 | 2762 | 61455 | 2086 | 32140 |
| 12-#11 | 1.06 | 28321 | 6755 | 43217 | 5108 | 46245 | 4317 | 47098 | 3705 | 46601 | 2799 | 52552 | 2253 | 19405 |
| 12-#14 | 1.53 | 29221 | 6984 | 45101 | 5252 | 48568 | 4422 | 49889 | 3771 | 50366 | 2784 | 57886 | 2149 | 27507 |
| 12-#18 | 2.72 | 31436 | 7565 | 49747 | 5624 | 54339 | 4694 | 56844 | 3941 | 59976 | 2784 | 71193 | 1885 | 47355 |
| 16-#10 | 1.15 | 28447 | 6800 | 43472 | 5162 | 46690 | 4362 | 47676 | 3751 | 47388 | 2825 | 53659 | 2256 | 21095 |
| 16-#11 | 1.41 | 28914 | 6928 | 44565 | 5229 | 47957 | 4408 | 49161 | 3779 | 49364 | 2809 | 56428 | 2190 | 25596 |
| 16-#14 | 2.04 | 30064 | 7233 | 47035 | 5426 | 51016 | 4553 | 52838 | 3876 | 54317 | 2798 | 63423 | 2056 | 36230 |
| 16-#18 | 3.63 | 32895 | 8008 | 53147 | 5935 | 58613 | 4924 | 61993 | 4125 | 66664 | 2771 | 80846 | 1713 | 61087 |
| 20-#10 | 1.44 | 29014 | 6940 | 44558 | 5255 | 48080 | 4445 | 49385 | 3799 | 49725 | 2834 | 57024 | 2190 | 26151 |
| 20-#11 | 1.77 | 29599 | 7101 | 45884 | 5343 | 49653 | 4511 | 51235 | 3838 | 52201 | 2820 | 60508 | 2107 | 31697 |
| 20-#14 | 2.55 | 31039 | 7482 | 48923 | 5590 | 53450 | 4701 | 55803 | 3961 | 58372 | 2812 | 69253 | 1934 | 44419 |
| 20-#18 | 4.54 | 34587 | 8451 | 56448 | 6225 | 62898 | 5189 | 67169 | 4274 | 73745 | 2792 | 91016 | 1489 | 74739 |
| 24-#10 | 1.73 | 29558 | 7081 | 45608 | 5362 | 49465 | 4514 | 51107 | 3857 | 52024 | 2831 | 60155 | 2129 | 31142 |
| 24-#11 | 2.12 | 30257 | 7273 | 47159 | 5473 | 51335 | 4595 | 53338 | 3909 | 54990 | 2816 | 64297 | 2031 | 37466 |
| 24-#14 | 3.06 | 31973 | 7731 | 50746 | 5778 | 55856 | 4822 | 58821 | 4064 | 62359 | 2806 | 74658 | 1824 | 52454 |
| 24-#18 | 5.44 | 36199 | 8893 | 59633 | 6558 | 67103 | 5403 | 72464 | 4458 | 80917 | 2814 | 100417 | 1291 | 87793 |

## SQUARE TIED COLUMNS 44" x 44"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.65 | 33864 | 7731 | 52867 | 5755 | 57061 | 4836 | 58821 | 4148 | 59896 | 3046 | 68728 | 2337 | 33923 |
| 12-#14 | 1.39 | 33323 | 7593 | 51208 | 5730 | 55105 | 4831 | 56505 | 4127 | 56773 | 3068 | 64965 | 2399 | 29017 |
| 12-#18 | 2.48 | 35674 | 8174 | 56131 | 6102 | 61212 | 5103 | 63859 | 4298 | 66708 | 3034 | 79037 | 2137 | 50042 |
| 16-#10 | 1.05 | 32501 | 7408 | 49471 | 5642 | 53114 | 4772 | 54164 | 4108 | 53626 | 3110 | 60499 | 2507 | 22227 |
| 16-#11 | 1.29 | 32997 | 7536 | 50632 | 5708 | 54457 | 4817 | 55735 | 4136 | 55714 | 3094 | 63424 | 2441 | 26992 |
| 16-#14 | 1.86 | 34217 | 7842 | 53245 | 5905 | 57691 | 4962 | 59619 | 4233 | 60945 | 3083 | 70816 | 2308 | 38245 |
| 16-#18 | 3.31 | 37222 | 8616 | 59713 | 6413 | 65730 | 5333 | 69302 | 4483 | 74001 | 3057 | 89250 | 1968 | 64971 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 1.31 | 33101 | 7548 | 50616 | 5736 | 54576 | 4855 | 55967 | 4157 | 56092 | 3119 | 64050 | 2442 | 27569 |
| 20-#11 | 1.61 | 33722 | 7709 | 52024 | 5822 | 56242 | 4920 | 57925 | 4195 | 58708 | 3105 | 67734 | 2359 | 33443 |
| 20-#14 | 2.32 | 35250 | 8091 | 55237 | 6069 | 60253 | 5110 | 62751 | 4318 | 65228 | 3098 | 76976 | 2188 | 47110 |
| 20-#18 | 4.13 | 39016 | 9059 | 63200 | 6704 | 70242 | 5598 | 74775 | 4633 | 81487 | 3080 | 100007 | 1748 | 79283 |
| 24-#10 | 1.57 | 33676 | 7689 | 51724 | 5843 | 56037 | 4924 | 57778 | 4215 | 58517 | 3117 | 67358 | 2381 | 32854 |
| 24-#11 | 1.93 | 34418 | 7881 | 53370 | 5953 | 58017 | 5004 | 60136 | 4267 | 61653 | 3102 | 71741 | 2284 | 39664 |
| 24-#14 | 2.79 | 36238 | 8340 | 57162 | 6258 | 62793 | 5232 | 65926 | 4422 | 69439 | 3093 | 82696 | 2079 | 55544 |
| 24-#18 | 4.96 | 40722 | 9501 | 66567 | 7037 | 74685 | 5812 | 80370 | 4818 | 88846 | 3068 | 109965 | 1551 | 93482 |

## SQUARE TIED COLUMNS 46" x 46"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.51 | 38377 | 8367 | 59616 | 6255 | 64289 | 5263 | 66146 | 4520 | 67019 | 3343 | 76586 | 2599 | 35706 |
| 12-#14 | 1.28 | 37798 | 8229 | 57857 | 6232 | 62222 | 5259 | 63703 | 4501 | 63727 | 3366 | 72631 | 2661 | 30520 |
| 12-#18 | 2.27 | 40286 | 8810 | 63057 | 6603 | 68664 | 5530 | 71456 | 4671 | 74198 | 3332 | 87468 | 2400 | 52725 |
| 16-#11 | 1.18 | 37454 | 8173 | 57240 | 6210 | 61537 | 5246 | 62890 | 4510 | 62612 | 3392 | 71009 | 2704 | 28383 |
| 16-#14 | 1.70 | 38743 | 8478 | 59995 | 6406 | 64946 | 5390 | 66983 | 4607 | 68121 | 3382 | 78797 | 2572 | 40257 |
| 16-#18 | 3.02 | 41924 | 9253 | 66821 | 6913 | 73428 | 5762 | 77194 | 4857 | 81885 | 3356 | 98240 | 2235 | 68904 |
| 20-#10 | 1.20 | 37562 | 8185 | 57213 | 6239 | 61652 | 5284 | 63131 | 4532 | 63007 | 3418 | 71664 | 2706 | 28984 |
| 20-#11 | 1.47 | 38220 | 8345 | 58705 | 6324 | 63410 | 5348 | 65196 | 4570 | 65764 | 3403 | 75547 | 2623 | 35187 |
| 20-#14 | 2.13 | 39835 | 8727 | 62092 | 6571 | 67635 | 5538 | 70281 | 4693 | 72631 | 3397 | 85287 | 2454 | 49825 |
| 20-#18 | 3.78 | 43821 | 9695 | 70494 | 7205 | 78166 | 6026 | 82963 | 5008 | 89775 | 3381 | 109584 | 2018 | 83859 |
| 24-#10 | 1.44 | 38168 | 8325 | 58378 | 6346 | 63189 | 5354 | 65030 | 4590 | 65558 | 3416 | 75150 | 2645 | 34555 |
| 24-#11 | 1.77 | 38953 | 8518 | 60121 | 6455 | 65278 | 5433 | 67516 | 4641 | 68864 | 3401 | 79772 | 2548 | 41875 |
| 24-#14 | 2.55 | 40877 | 8976 | 64119 | 6760 | 70309 | 5660 | 73614 | 4796 | 77067 | 3392 | 91321 | 2345 | 58649 |
| 24-#18 | 4.54 | 45621 | 10138 | 74042 | 7539 | 82847 | 6241 | 88838 | 5193 | 97533 | 3370 | 120101 | 1823 | 99241 |

## SQUARE TIED COLUMNS 48" x 48"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.39 | 43280 | 9032 | 66931 | 6778 | 72123 | 5709 | 74080 | 4909 | 74714 | 3653 | 85057 | 2873 | 37488 |
| 12-#14 | 1.17 | 42665 | 8894 | 65070 | 6757 | 69945 | 5707 | 71509 | 4891 | 71254 | 3677 | 80911 | 2935 | 32024 |
| 12-#18 | 2.08 | 45290 | 9475 | 70548 | 7127 | 76722 | 5977 | 79661 | 5061 | 82260 | 3643 | 96512 | 2675 | 55404 |
| 16-#11 | 1.08 | 42301 | 8837 | 64412 | 6735 | 69223 | 5694 | 70655 | 4901 | 70083 | 3704 | 79208 | 2978 | 29772 |
| 16-#14 | 1.56 | 43661 | 9143 | 67311 | 6930 | 72806 | 5838 | 74955 | 4998 | 75870 | 3693 | 87391 | 2847 | 42266 |
| 16-#18 | 2.78 | 47017 | 9917 | 74494 | 7436 | 81731 | 6210 | 85694 | 5249 | 90342 | 3669 | 107844 | 2513 | 72884 |
| 20-#10 | 1.10 | 42413 | 8850 | 64375 | 6765 | 69333 | 5733 | 70904 | 4924 | 70495 | 3730 | 79893 | 2981 | 30398 |
| 20-#11 | 1.35 | 43108 | 9010 | 65949 | 6849 | 71184 | 5796 | 73076 | 4961 | 73393 | 3716 | 83975 | 2899 | 36927 |
| 20-#14 | 1.95 | 44811 | 9392 | 69513 | 7096 | 75623 | 5986 | 78420 | 5084 | 80608 | 3709 | 94212 | 2730 | 52363 |
| 20-#18 | 3.47 | 49017 | 10360 | 78354 | 7729 | 86696 | 6473 | 91759 | 5400 | 98637 | 3695 | 119775 | 2299 | 88466 |
| 24-#10 | 1.32 | 43050 | 8990 | 65597 | 6872 | 70946 | 5803 | 72891 | 4981 | 73173 | 3729 | 83557 | 2921 | 36253 |
| 24-#11 | 1.63 | 43879 | 9183 | 67436 | 6981 | 73145 | 5882 | 75504 | 5032 | 76649 | 3713 | 88418 | 2824 | 44008 |
| 24-#14 | 2.34 | 45907 | 9641 | 71641 | 7285 | 78431 | 6108 | 81909 | 5187 | 85268 | 3706 | 100561 | 2622 | 61771 |
| 24-#18 | 4.17 | 50912 | 10803 | 82082 | 8064 | 91616 | 6689 | 97913 | 5584 | 106793 | 3686 | 130851 | 2105 | 104995 |

## SQUARE TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.08 | 4283 | 1754 | 6419 | 1412 | 7321 | 1146 | 7653 | 946 | 7832 | 655 | 9267 | 596 | 4289 |
| 4-#14 | 1.56 | 4520 | 1855 | 7006 | 1467 | 7998 | 1182 | 8443 | 963 | 8864 | 634 | 10574 | 557 | 5996 |
| 4-#18 | 2.78 | 5064 | 2109 | 8374 | 1603 | 9610 | 1271 | 10331 | 1004 | 11333 | 578 | 13663 | 446 | 10115 |
| 8-#11 | 2.17 | 4365 | 1981 | 7077 | 1550 | 8143 | 1242 | 8629 | 1009 | 9117 | 632 | 10930 | 442 | 8194 |
| 8-#14 | 3.13 | 4624 | 2182 | 7941 | 1664 | 9155 | 1317 | 9818 | 1051 | 10672 | 598 | 12904 | 327 | 11398 |
| 8-#18 | 5.56 | 5218 | 2691 | 9962 | 1948 | 11566 | 1503 | 12654 | 1151 | 14391 | 501 | 17563 | 12 | 17520 |
| 12-#11 | 3.25 | 4576 | 2208 | 7895 | 1688 | 9126 | 1348 | 9801 | 1062 | 10698 | 610 | 13159 | 294 | 11355 |
| 12-#14 | 4.69 | 4925 | 2509 | 9101 | 1862 | 10539 | 1468 | 11467 | 1125 | 12898 | 562 | 16023 | 110 | 15383 |
| 16-#11 | 4.33 | 4836 | 2435 | 8705 | 1835 | 10174 | 1444 | 11046 | 1125 | 12305 | 577 | 15325 | 187 | 14420 |
| 16-#14 | 6.25 | 5261 | 2836 | 10248 | 2074 | 12013 | 1603 | 13219 | 1213 | 15160 | 511 | 19057 | -53 | 18792 |
| 20-#11 | 5.42 | 5092 | 2662 | 9569 | 1973 | 11228 | 1550 | 12301 | 1178 | 13980 | 554 | 17572 | 61 | 17333 |

## SQUARE TIED COLUMNS 26" x 26"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.33 | 5632 | 2120 | 8538 | 1701 | 9815 | 1378 | 10342 | 1131 | 10770 | 766 | 12852 | 690 | 6635 |
| 4-#18 | 2.37 | 6259 | 2374 | 10128 | 1842 | 11654 | 1469 | 12494 | 1175 | 13581 | 715 | 16407 | 589 | 11243 |
| 8-#11 | 1.85 | 5463 | 2246 | 8611 | 1786 | 9969 | 1440 | 10543 | 1179 | 11044 | 766 | 13239 | 578 | 9083 |
| 8-#14 | 2.66 | 5762 | 2447 | 9576 | 1900 | 11116 | 1517 | 11888 | 1224 | 12804 | 735 | 15491 | 471 | 12683 |
| 8-#18 | 4.73 | 6463 | 2956 | 11922 | 2192 | 13866 | 1709 | 15121 | 1331 | 17039 | 649 | 20855 | 176 | 20131 |
| 12-#11 | 2.77 | 5709 | 2473 | 9519 | 1925 | 11073 | 1548 | 11858 | 1234 | 12817 | 747 | 15760 | 435 | 12804 |
| 12-#14 | 3.99 | 6098 | 2774 | 10866 | 2099 | 12674 | 1671 | 13744 | 1301 | 15307 | 704 | 19031 | 260 | 17342 |
| 12-#18 | 7.10 | 7015 | 3537 | 14144 | 2543 | 16511 | 1976 | 18274 | 1460 | 21295 | 582 | 26808 | -213 | 25614 |
| 16-#11 | 3.69 | 5989 | 2700 | 10418 | 2073 | 12249 | 1646 | 13255 | 1300 | 14621 | 717 | 18207 | 336 | 16400 |
| 16-#14 | 5.33 | 6509 | 3101 | 12143 | 2313 | 14332 | 1811 | 15715 | 1394 | 17851 | 659 | 22469 | 110 | 21912 |
| 20-#11 | 4.62 | 6311 | 2927 | 11378 | 2212 | 13432 | 1755 | 14663 | 1356 | 16500 | 698 | 20742 | 217 | 19661 |

## SQUARE TIED COLUMNS 28" x 28"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.15 | 6910 | 2406 | 10278 | 1956 | 11881 | 1590 | 12501 | 1312 | 12922 | 907 | 15414 | 831 | 7273 |
| 4-#18 | 2.04 | 7623 | 2661 | 12043 | 2095 | 13950 | 1684 | 14918 | 1359 | 16078 | 860 | 19439 | 739 | 12370 |
| 8-#11 | 1.59 | 6728 | 2533 | 10351 | 2042 | 12022 | 1652 | 12716 | 1362 | 13218 | 909 | 15832 | 723 | 9969 |
| 8-#14 | 2.30 | 7070 | 2733 | 11418 | 2156 | 13327 | 1732 | 14219 | 1408 | 15183 | 881 | 18365 | 621 | 13963 |
| 8-#18 | 4.08 | 7883 | 3242 | 14019 | 2448 | 16419 | 1930 | 17850 | 1522 | 19937 | 803 | 24437 | 345 | 22871 |
| 12-#11 | 2.39 | 7011 | 2760 | 11349 | 2181 | 13239 | 1761 | 14175 | 1420 | 15185 | 893 | 18647 | 584 | 14295 |
| 12-#14 | 3.44 | 7455 | 3061 | 12838 | 2356 | 15058 | 1890 | 16281 | 1490 | 17964 | 855 | 22327 | 417 | 19354 |
| 12-#18 | 6.12 | 8513 | 3824 | 16472 | 2801 | 19373 | 2202 | 21370 | 1658 | 24686 | 746 | 31137 | -32 | 30896 |
| 16-#11 | 3.18 | 7331 | 2986 | 12339 | 2331 | 14535 | 1861 | 15724 | 1488 | 17185 | 866 | 21376 | 491 | 18213 |
| 16-#14 | 4.59 | 7933 | 3388 | 14245 | 2571 | 16901 | 2032 | 18472 | 1586 | 20792 | 814 | 26171 | 277 | 24629 |
| 20-#11 | 3.98 | 7665 | 3213 | 13395 | 2470 | 15840 | 1970 | 17286 | 1546 | 19269 | 850 | 24201 | 379 | 21923 |
| 20-#14 | 5.74 | 8398 | 3715 | 15746 | 2771 | 18756 | 2189 | 20680 | 1667 | 23739 | 788 | 30153 | 108 | 29670 |
| 24-#11 | 4.78 | 8007 | 3440 | 14464 | 2610 | 17169 | 2069 | 18874 | 1614 | 21375 | 834 | 26994 | 245 | 25567 |

## SQUARE TIED COLUMNS 30" x 30"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.00 | 8368 | 2714 | 12242 | 2230 | 14187 | 1816 | 14939 | 1507 | 15341 | 1058 | 18284 | 981 | 7909 |
| 4-#18 | 1.78 | 9169 | 2968 | 14182 | 2368 | 16517 | 1913 | 17622 | 1556 | 18842 | 1014 | 22780 | 896 | 13493 |
| 8-#11 | 1.39 | 8172 | 2840 | 12314 | 2318 | 14335 | 1879 | 15168 | 1558 | 15658 | 1061 | 18733 | 876 | 10852 |
| 8-#14 | 2.00 | 8558 | 3041 | 13484 | 2431 | 15762 | 1959 | 16830 | 1606 | 17828 | 1036 | 21547 | 779 | 15238 |
| 8-#18 | 3.56 | 9448 | 3550 | 16340 | 2723 | 19244 | 2164 | 20860 | 1725 | 23103 | 965 | 28331 | 517 | 25735 |
| 12-#11 | 2.08 | 8494 | 3067 | 13403 | 2458 | 15662 | 1989 | 16771 | 1618 | 17776 | 1038 | 21843 | 740 | 15831 |
| 12-#14 | 3.00 | 8996 | 3368 | 15034 | 2632 | 17651 | 2118 | 19100 | 1690 | 20888 | 1014 | 25933 | 580 | 21418 |
| 12-#18 | 5.33 | 10202 | 4132 | 19025 | 3078 | 22506 | 2442 | 24748 | 1867 | 28345 | 916 | 35782 | 151 | 34688 |
| 16-#11 | 2.77 | 8855 | 3294 | 14482 | 2608 | 17076 | 2089 | 18473 | 1688 | 20016 | 1024 | 24854 | 653 | 20019 |
| 16-#14 | 4.00 | 9492 | 3695 | 16570 | 2848 | 19664 | 2261 | 21510 | 1790 | 24000 | 977 | 30184 | 448 | 27446 |
| 16-#18 | 7.11 | 11032 | 4713 | 21684 | 3460 | 25982 | 2693 | 28877 | 2036 | 33676 | 841 | 43012 | -104 | 42223 |
| 20-#11 | 3.47 | 9231 | 3521 | 15634 | 2748 | 18499 | 2200 | 20190 | 1748 | 22305 | 1011 | 27865 | 532 | 24244 |
| 20-#14 | 5.00 | 10013 | 4022 | 18210 | 3050 | 21690 | 2420 | 23940 | 1874 | 27242 | 955 | 34584 | 288 | 33023 |
| 24-#11 | 4.16 | 9614 | 3748 | 16801 | 2888 | 19949 | 2300 | 21934 | 1818 | 24576 | 987 | 31058 | 416 | 28390 |

## SQUARE TIED COLUMNS 32" x 32"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.56 | 10909 | 3297 | 16561 | 2660 | 19337 | 2156 | 20627 | 1766 | 21891 | 1178 | 26451 | 1061 | 14616 |
| 8-#11 | 1.22 | 9809 | 3169 | 14514 | 2613 | 16935 | 2122 | 17900 | 1766 | 18383 | 1224 | 21964 | 1038 | 11733 |
| 8-#14 | 1.76 | 10239 | 3370 | 15788 | 2726 | 18485 | 2202 | 19740 | 1817 | 20759 | 1201 | 25059 | 945 | 16509 |
| 8-#18 | 3.13 | 11235 | 3879 | 18901 | 3017 | 22304 | 2410 | 24171 | 1940 | 26555 | 1136 | 32557 | 696 | 28009 |
| 12-#11 | 1.83 | 10170 | 3396 | 15693 | 2754 | 18372 | 2233 | 19640 | 1827 | 20691 | 1203 | 25366 | 906 | 17171 |
| 12-#14 | 2.64 | 10731 | 3697 | 17468 | 2928 | 20533 | 2362 | 22218 | 1904 | 24032 | 1167 | 29870 | 751 | 23535 |
| 12-#18 | 4.69 | 12093 | 4460 | 21817 | 3374 | 25858 | 2690 | 28427 | 2087 | 32292 | 1094 | 40760 | 339 | 38095 |
| 16-#11 | 2.44 | 10573 | 3623 | 16862 | 2905 | 19903 | 2334 | 21488 | 1898 | 23132 | 1191 | 28663 | 822 | 21850 |
| 16-#14 | 3.52 | 11285 | 4024 | 19134 | 3145 | 22715 | 2507 | 24848 | 2006 | 27495 | 1149 | 34529 | 626 | 30130 |
| 16-#18 | 6.25 | 13014 | 5042 | 24707 | 3758 | 29644 | 2945 | 32947 | 2261 | 38128 | 1025 | 48713 | 98 | 48121 |
| 20-#11 | 3.05 | 10992 | 3850 | 18110 | 3045 | 21446 | 2445 | 23352 | 1959 | 25627 | 1180 | 31956 | 706 | 26625 |
| 20-#14 | 4.39 | 11864 | 4351 | 20912 | 3347 | 24912 | 2666 | 27501 | 2092 | 31033 | 1130 | 39186 | 453 | 36238 |
| 24-#11 | 3.66 | 11417 | 4077 | 19375 | 3186 | 23016 | 2546 | 25246 | 2031 | 28102 | 1159 | 35451 | 594 | 31167 |
| 24-#14 | 5.27 | 12524 | 4678 | 22714 | 3549 | 27149 | 2811 | 30197 | 2194 | 34543 | 1097 | 44126 | 287 | 42219 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 34" x 34"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.38 | 12854 | 3647 | 19195 | 2973 | 22445 | 2413 | 23951 | 1989 | 25245 | 1352 | 30475 | 1235 | 15737 |
| 8-#11 | 1.08 | 11650 | 3519 | 16966 | 2928 | 19841 | 2382 | 20937 | 1986 | 21412 | 1397 | 25546 | 1209 | 12612 |
| 8-#14 | 1.56 | 12126 | 3720 | 18344 | 3041 | 21513 | 2462 | 22930 | 2038 | 23994 | 1376 | 28923 | 1120 | 17778 |
| 8-#18 | 2.77 | 13231 | 4229 | 21716 | 3332 | 25642 | 2669 | 27802 | 2167 | 30312 | 1316 | 37136 | 882 | 30274 |
| 12-#11 | 1.62 | 12051 | 3746 | 18235 | 3069 | 21388 | 2493 | 22811 | 2048 | 23911 | 1377 | 29238 | 1081 | 18498 |
| 12-#14 | 2.34 | 12673 | 4047 | 20155 | 3244 | 23720 | 2622 | 25604 | 2126 | 27542 | 1345 | 34155 | 931 | 25705 |
| 12-#18 | 4.15 | 14119 | 4810 | 24863 | 3690 | 29478 | 2952 | 32428 | 2319 | 36423 | 1253 | 46094 | 533 | 41573 |
| 16-#11 | 2.16 | 12498 | 3973 | 19495 | 3221 | 23037 | 2595 | 24801 | 2120 | 26553 | 1368 | 32824 | 1000 | 23707 |
| 16-#14 | 3.11 | 13287 | 4374 | 21950 | 3462 | 26072 | 2768 | 28442 | 2230 | 31294 | 1329 | 39227 | 812 | 32701 |
| 16-#18 | 5.54 | 15213 | 5392 | 27984 | 4075 | 33566 | 3208 | 37338 | 2498 | 42886 | 1217 | 54771 | 304 | 52783 |
| 20-#11 | 2.70 | 12961 | 4200 | 20839 | 3362 | 24698 | 2707 | 26808 | 2182 | 29253 | 1359 | 36401 | 888 | 29007 |
| 20-#14 | 3.89 | 13925 | 4701 | 23867 | 3665 | 28441 | 2928 | 31304 | 2318 | 35129 | 1314 | 44292 | 644 | 39524 |
| 24-#11 | 3.24 | 13430 | 4427 | 22201 | 3503 | 26389 | 2808 | 28848 | 2254 | 31933 | 1339 | 40194 | 779 | 33868 |
| 24-#14 | 4.67 | 14576 | 5029 | 25809 | 3867 | 30852 | 3074 | 34214 | 2421 | 38933 | 1283 | 49666 | 483 | 46245 |

## SQUARE TIED COLUMNS 36" x 36"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.23 | 15017 | 4019 | 22097 | 3306 | 25878 | 2686 | 27603 | 2224 | 28922 | 1536 | 34872 | 1418 | 16857 |
| 8-#14 | 1.39 | 14231 | 4091 | 21168 | 3375 | 24867 | 2737 | 26450 | 2273 | 27552 | 1560 | 33161 | 1304 | 19043 |
| 8-#18 | 2.47 | 15448 | 4600 | 24800 | 3666 | 29305 | 2944 | 31756 | 2407 | 34393 | 1505 | 42090 | 1075 | 32533 |
| 12-#11 | 1.44 | 14150 | 4117 | 21045 | 3405 | 24729 | 2770 | 26319 | 2283 | 27453 | 1562 | 33483 | 1264 | 19820 |
| 12-#14 | 2.08 | 14835 | 4418 | 23109 | 3579 | 27232 | 2899 | 29316 | 2362 | 31375 | 1532 | 38810 | 1120 | 27861 |
| 12-#18 | 3.70 | 16427 | 5182 | 28179 | 4025 | 33424 | 3229 | 36745 | 2562 | 40991 | 1447 | 51804 | 733 | 45121 |
| 16-#11 | 1.93 | 14641 | 4344 | 22394 | 3557 | 26496 | 2872 | 28451 | 2356 | 30298 | 1555 | 37360 | 1187 | 25591 |
| 16-#14 | 2.78 | 15509 | 4746 | 25035 | 3798 | 29755 | 3045 | 32359 | 2466 | 35418 | 1519 | 44300 | 1004 | 35303 |
| 16-#18 | 4.94 | 17539 | 5763 | 31530 | 4412 | 37814 | 3486 | 42042 | 2744 | 47970 | 1416 | 61207 | 516 | 57578 |
| 20-#11 | 2.41 | 15149 | 4571 | 23835 | 3699 | 28275 | 2984 | 30602 | 2419 | 33204 | 1547 | 41220 | 1078 | 31230 |
| 20-#14 | 3.47 | 16209 | 5073 | 27090 | 4001 | 32294 | 3206 | 35428 | 2555 | 39549 | 1506 | 49773 | 843 | 42882 |
| 20-#18 | 6.17 | 18813 | 6345 | 35106 | 4772 | 42233 | 3771 | 47383 | 2900 | 55102 | 1385 | 70607 | 212 | 69560 |
| 24-#11 | 2.89 | 15663 | 4798 | 25294 | 3840 | 30087 | 3086 | 32788 | 2491 | 36088 | 1529 | 45312 | 973 | 36612 |
| 24-#14 | 4.17 | 16920 | 5400 | 29172 | 4205 | 34880 | 3353 | 38548 | 2659 | 43648 | 1478 | 55579 | 687 | 50339 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 38" x 38"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.11 | 17411 | 4411 | 25283 | 3658 | 29655 | 2976 | 31568 | 2471 | 32941 | 1730 | 39665 | 1610 | 17976 |
| 8-#14 | 1.25 | 16566 | 4484 | 24275 | 3730 | 28565 | 3029 | 30328 | 2521 | 31452 | 1755 | 37794 | 1497 | 20306 |
| 8-#18 | 2.22 | 17897 | 4993 | 28168 | 4019 | 33313 | 3236 | 36000 | 2655 | 38816 | 1703 | 47440 | 1277 | 34786 |
| 12-#11 | 1.30 | 16479 | 4510 | 24137 | 3760 | 28413 | 3062 | 30186 | 2532 | 31338 | 1757 | 38124 | 1458 | 21139 |
| 12-#14 | 1.87 | 17227 | 4811 | 26346 | 3934 | 31089 | 3191 | 33386 | 2611 | 35550 | 1729 | 43861 | 1317 | 29773 |
| 12-#18 | 3.32 | 18970 | 5574 | 31779 | 4380 | 37714 | 3521 | 41331 | 2812 | 45903 | 1650 | 57897 | 943 | 48739 |
| 16-#11 | 1.73 | 17015 | 4737 | 25576 | 3913 | 30298 | 3165 | 32460 | 2606 | 34384 | 1751 | 42292 | 1382 | 27501 |
| 16-#14 | 2.49 | 17964 | 5138 | 28402 | 4153 | 33781 | 3338 | 36634 | 2716 | 39884 | 1718 | 49770 | 1205 | 37936 |
| 16-#18 | 4.43 | 20182 | 6156 | 35360 | 4768 | 42406 | 3781 | 46992 | 2996 | 53398 | 1624 | 68042 | 733 | 62507 |
| 20-#11 | 2.16 | 17569 | 4964 | 27112 | 4055 | 32196 | 3278 | 34754 | 2669 | 37496 | 1745 | 46435 | 1276 | 33469 |
| 20-#14 | 3.12 | 18727 | 5465 | 30596 | 4358 | 36492 | 3501 | 39910 | 2806 | 44311 | 1708 | 55653 | 1048 | 46311 |
| 20-#18 | 5.54 | 21451 | 6737 | 39183 | 5129 | 47129 | 4066 | 52701 | 3153 | 61056 | 1597 | 78167 | 438 | 75512 |
| 24-#11 | 2.59 | 18129 | 5190 | 28669 | 4197 | 34129 | 3380 | 37086 | 2742 | 40585 | 1729 | 50827 | 1174 | 39399 |
| 24-#14 | 3.74 | 19500 | 5792 | 32819 | 4562 | 39252 | 3648 | 43240 | 2911 | 48706 | 1682 | 61889 | 897 | 54238 |

## SQUARE TIED COLUMNS 40" x 40"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.00 | 20048 | 4825 | 28769 | 4030 | 33796 | 3283 | 35912 | 2731 | 37321 | 1934 | 44875 | 1812 | 19094 |
| 8-#14 | 1.13 | 19143 | 4897 | 27679 | 4104 | 32625 | 3337 | 34585 | 2783 | 35713 | 1960 | 42845 | 1699 | 21567 |
| 8-#18 | 2.00 | 20590 | 5406 | 31835 | 4393 | 37685 | 3543 | 40623 | 2916 | 43601 | 1911 | 53209 | 1486 | 37034 |
| 12-#11 | 1.17 | 19051 | 4924 | 27525 | 4135 | 32460 | 3371 | 34431 | 2795 | 35567 | 1961 | 43182 | 1660 | 22454 |
| 12-#14 | 1.69 | 19864 | 5225 | 29881 | 4309 | 35308 | 3500 | 37834 | 2873 | 40087 | 1936 | 49331 | 1524 | 31679 |
| 12-#18 | 3.00 | 21760 | 5988 | 35677 | 4755 | 42368 | 3830 | 46296 | 3075 | 51177 | 1862 | 64409 | 1161 | 52428 |
| 16-#11 | 1.56 | 19633 | 5150 | 29055 | 4288 | 34463 | 3474 | 36847 | 2869 | 38810 | 1956 | 47642 | 1586 | 29438 |
| 16-#14 | 2.25 | 20664 | 5552 | 32066 | 4529 | 38170 | 3648 | 41287 | 2979 | 44711 | 1927 | 55659 | 1415 | 40601 |
| 16-#18 | 4.00 | 23075 | 6569 | 39490 | 5144 | 47361 | 4091 | 52321 | 3261 | 59188 | 1840 | 75297 | 957 | 67499 |
| 20-#11 | 1.95 | 20233 | 5377 | 30687 | 4431 | 36480 | 3588 | 39284 | 2932 | 42124 | 1952 | 52069 | 1483 | 35723 |
| 20-#14 | 2.81 | 21491 | 5879 | 34399 | 4733 | 41052 | 3811 | 44770 | 3070 | 49436 | 1919 | 61951 | 1262 | 49742 |
| 20-#18 | 5.00 | 24447 | 7151 | 43559 | 5506 | 52389 | 4378 | 58397 | 3420 | 67374 | 1818 | 86149 | 671 | 81126 |
| 24-#11 | 2.34 | 20839 | 5604 | 32341 | 4573 | 38534 | 3691 | 41762 | 3006 | 45414 | 1936 | 56760 | 1385 | 42231 |
| 24-#14 | 3.38 | 22328 | 6206 | 36762 | 4938 | 43987 | 3959 | 48311 | 3176 | 54126 | 1895 | 68619 | 1115 | 58114 |

## SQUARE TIED COLUMNS 42" x 42"

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.02 | 21976 | 5332 | 31396 | 4498 | 37067 | 3662 | 39238 | 3058 | 40337 | 2174 | 48335 | 1911 | 22826 |
| 8-#18 | 1.81 | 23541 | 5841 | 35816 | 4786 | 42438 | 3867 | 45644 | 3192 | 48767 | 2129 | 59418 | 1704 | 39277 |
| 12-#11 | 1.06 | 21878 | 5359 | 31225 | 4530 | 36888 | 3697 | 39073 | 3071 | 40148 | 2174 | 48681 | 1872 | 23767 |
| 12-#14 | 1.53 | 22756 | 5660 | 33728 | 4704 | 39908 | 3825 | 42681 | 3150 | 44980 | 2152 | 55240 | 1739 | 33580 |
| 12-#18 | 2.72 | 24809 | 6423 | 39890 | 5149 | 47403 | 4155 | 51659 | 3352 | 56831 | 2084 | 71362 | 1386 | 56188 |
| 16-#11 | 1.41 | 22506 | 5585 | 32845 | 4683 | 39008 | 3800 | 41631 | 3146 | 43582 | 2170 | 53432 | 1800 | 31230 |
| 16-#14 | 2.04 | 23621 | 5987 | 36043 | 4924 | 42940 | 3974 | 46338 | 3257 | 49890 | 2144 | 61989 | 1633 | 43298 |
| 16-#18 | 3.63 | 26230 | 7004 | 43934 | 5539 | 52698 | 4417 | 58048 | 3539 | 65360 | 2065 | 82995 | 1188 | 71998 |
| 20-#11 | 1.77 | 23154 | 5812 | 34574 | 4826 | 41144 | 3914 | 44212 | 3210 | 47091 | 2166 | 58144 | 1700 | 37994 |
| 20-#14 | 2.55 | 24513 | 6314 | 38515 | 5129 | 45994 | 4137 | 50028 | 3348 | 54906 | 2137 | 68690 | 1484 | 52930 |
| 20-#18 | 4.54 | 27707 | 7586 | 48249 | 5902 | 58031 | 4706 | 64492 | 3699 | 74073 | 2047 | 94574 | 909 | 86837 |
| 24-#11 | 2.12 | 23807 | 6039 | 36325 | 4969 | 43319 | 4017 | 46836 | 3284 | 50574 | 2151 | 63135 | 1603 | 44971 |
| 24-#14 | 3.06 | 25415 | 6641 | 41019 | 5334 | 49103 | 4285 | 53779 | 3455 | 59886 | 2115 | 75790 | 1341 | 62043 |
| 24-#18 | 5.44 | 29213 | 8168 | 52622 | 6265 | 63461 | 4967 | 71042 | 3886 | 82722 | 2002 | 106849 | 642 | 101416 |

## SQUARE TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 6,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.65 | 26760 | 6297 | 40126 | 5199 | 47592 | 4207 | 51083 | 3481 | 54332 | 2357 | 66090 | 1932 | 41517 |
| 12-#14 | 1.39 | 25917 | 6116 | 37903 | 5118 | 44909 | 4166 | 47945 | 3440 | 50232 | 2375 | 61612 | 1964 | 35476 |
| 12-#18 | 2.48 | 28130 | 6879 | 44432 | 5563 | 52839 | 4497 | 57439 | 3643 | 62886 | 2315 | 78777 | 1620 | 60019 |
| 16-#11 | 1.29 | 25648 | 6042 | 36962 | 5098 | 43954 | 4142 | 46834 | 3436 | 48753 | 2394 | 59685 | 2023 | 32986 |
| 16-#14 | 1.86 | 26847 | 6443 | 40348 | 5339 | 48111 | 4315 | 51807 | 3547 | 55416 | 2369 | 68781 | 1860 | 46027 |
| 16-#18 | 3.31 | 29658 | 7461 | 48706 | 5953 | 58437 | 4760 | 64192 | 3831 | 71931 | 2300 | 91156 | 1426 | 76537 |
| 20-#11 | 1.61 | 26343 | 6268 | 38787 | 5241 | 46209 | 4256 | 49558 | 3501 | 52457 | 2390 | 64682 | 1925 | 40283 |
| 20-#14 | 2.32 | 27806 | 6770 | 42958 | 5544 | 51336 | 4479 | 55704 | 3640 | 60714 | 2363 | 75893 | 1715 | 56137 |
| 20-#18 | 4.13 | 31243 | 8042 | 53268 | 6318 | 64074 | 5049 | 71004 | 3992 | 81173 | 2285 | 103463 | 1155 | 92642 |
| 24-#11 | 1.93 | 27045 | 6495 | 40636 | 5384 | 48505 | 4359 | 52328 | 3576 | 56134 | 2376 | 69972 | 1831 | 47628 |
| 24-#14 | 2.79 | 28774 | 7097 | 45603 | 5750 | 54620 | 4628 | 59665 | 3747 | 65973 | 2341 | 83424 | 1575 | 66024 |
| 24-#18 | 4.96 | 32856 | 8624 | 57891 | 6682 | 69814 | 5312 | 77929 | 4181 | 90347 | 2243 | 116505 | 894 | 108456 |

## SQUARE TIED COLUMNS 46" x 46"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#18 | 1.51 | 30262 | 6775 | 44779 | 5631 | 53165 | 4564 | 56959 | 3784 | 60287 | 2594 | 73245 | 2168 | 43752 |
| 12-#14 | 1.28 | 29359 | 6593 | 42420 | 5552 | 50329 | 4524 | 53646 | 3744 | 55901 | 2610 | 68469 | 2198 | 37369 |
| 12-#18 | 2.27 | 31734 | 7356 | 49317 | 5996 | 58695 | 4854 | 63657 | 3947 | 69322 | 2555 | 86677 | 1862 | 63921 |
| 16-#11 | 1.18 | 29071 | 6519 | 41421 | 5533 | 49319 | 4500 | 52473 | 3741 | 54343 | 2629 | 66422 | 2256 | 34739 |
| 16-#14 | 1.70 | 30355 | 6920 | 44995 | 5773 | 53701 | 4673 | 57714 | 3852 | 61360 | 2604 | 76058 | 2096 | 48788 |
| 16-#18 | 3.02 | 33371 | 7938 | 53822 | 6388 | 64595 | 5118 | 70775 | 4136 | 78876 | 2542 | 99803 | 1673 | 81119 |
| 20-#11 | 1.47 | 29814 | 6746 | 43342 | 5677 | 51692 | 4614 | 55341 | 3806 | 58241 | 2625 | 71704 | 2160 | 42588 |
| 20-#14 | 2.13 | 31381 | 7247 | 47744 | 5979 | 57097 | 4838 | 61817 | 3945 | 66939 | 2598 | 83580 | 1954 | 59363 |
| 20-#18 | 3.78 | 35067 | 8519 | 58631 | 6753 | 70536 | 5408 | 77954 | 4299 | 88638 | 2529 | 112839 | 1408 | 98544 |
| 24-#11 | 1.77 | 30564 | 6973 | 45289 | 5820 | 54109 | 4718 | 58257 | 3881 | 62111 | 2612 | 77294 | 2068 | 50294 |
| 24-#14 | 2.55 | 32417 | 7574 | 50529 | 6186 | 60555 | 4987 | 65989 | 4053 | 72477 | 2578 | 91544 | 1818 | 70058 |
| 24-#18 | 4.54 | 36788 | 9101 | 63504 | 7118 | 76587 | 5672 | 85253 | 4488 | 98327 | 2490 | 126648 | 1154 | 115762 |

## SQUARE TIED COLUMNS 48" x 48"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#18 | 1.39 | 34057 | 7273 | 49792 | 6084 | 59177 | 4936 | 63292 | 4101 | 66621 | 2838 | 80907 | 2413 | 45985 |
| 12-#14 | 1.17 | 33095 | 7092 | 47294 | 6006 | 56187 | 4898 | 59805 | 4062 | 62007 | 2854 | 75831 | 2441 | 39258 |
| 12-#18 | 2.08 | 35633 | 7855 | 54561 | 6450 | 64990 | 5228 | 70333 | 4265 | 76117 | 2800 | 95085 | 2113 | 67448 |
| 16-#11 | 1.08 | 32787 | 7017 | 46236 | 5988 | 55121 | 4874 | 58570 | 4059 | 60369 | 2874 | 73666 | 2499 | 36488 |
| 16-#14 | 1.56 | 34158 | 7419 | 49999 | 6228 | 59728 | 5048 | 64077 | 4170 | 67742 | 2850 | 83842 | 2342 | 51577 |
| 16-#18 | 2.78 | 37382 | 8436 | 59297 | 6842 | 71191 | 5492 | 77815 | 4455 | 86160 | 2788 | 108957 | 1928 | 85743 |
| 20-#11 | 1.35 | 33578 | 7244 | 48253 | 6132 | 57613 | 4989 | 61582 | 4124 | 64463 | 2871 | 79233 | 2404 | 44911 |
| 20-#14 | 1.95 | 35252 | 7746 | 52887 | 6434 | 63296 | 5212 | 68388 | 4264 | 73602 | 2845 | 91775 | 2203 | 62609 |
| 20-#18 | 3.47 | 39190 | 9018 | 64353 | 7208 | 77437 | 5784 | 85362 | 4619 | 96421 | 2777 | 122722 | 1668 | 104541 |
| 24-#11 | 1.63 | 34377 | 7471 | 50298 | 6275 | 60152 | 5093 | 64643 | 4200 | 68527 | 2858 | 85123 | 2314 | 52972 |
| 24-#14 | 2.34 | 36356 | 8073 | 55813 | 6641 | 66929 | 5362 | 72770 | 4372 | 79419 | 2825 | 100171 | 2069 | 74146 |
| 24-#18 | 4.17 | 41023 | 9600 | 69475 | 7573 | 83798 | 6048 | 93035 | 4809 | 106607 | 2739 | 137300 | 1420 | 122825 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.08 | 5464 | 2258 | 8743 | 1607 | 9230 | 1305 | 9271 | 1081 | 9069 | 757 | 10452 | 694 | 4363 |
| 4-#14 | 1.56 | 5695 | 2356 | 9301 | 1658 | 9881 | 1338 | 10037 | 1095 | 10079 | 735 | 11732 | 652 | 6096 |
| 4-#18 | 2.78 | 6240 | 2604 | 10606 | 1788 | 11434 | 1421 | 11870 | 1131 | 12498 | 674 | 14758 | 534 | 10284 |
| 8-#11 | 2.17 | 5609 | 2479 | 9386 | 1739 | 10036 | 1410 | 10231 | 1142 | 10338 | 733 | 12093 | 537 | 8366 |
| 8-#14 | 3.13 | 5893 | 2675 | 10214 | 1848 | 11015 | 1486 | 11388 | 1181 | 11865 | 696 | 14030 | 419 | 11667 |
| 8-#18 | 5.56 | 6564 | 3172 | 12155 | 2120 | 13351 | 1676 | 14154 | 1273 | 15518 | 592 | 18604 | 94 | 18222 |
| 12-#11 | 3.25 | 5867 | 2701 | 10145 | 1885 | 10993 | 1500 | 11376 | 1190 | 11903 | 709 | 14299 | 387 | 11739 |
| 12-#14 | 4.69 | 6253 | 2994 | 11291 | 2058 | 12361 | 1614 | 13000 | 1247 | 14068 | 658 | 17117 | 198 | 15870 |
| 16-#11 | 4.33 | 6155 | 2922 | 10966 | 2018 | 12019 | 1604 | 12600 | 1251 | 13478 | 671 | 16443 | 278 | 14976 |
| 16-#14 | 6.25 | 6654 | 3313 | 12453 | 2248 | 13805 | 1762 | 14721 | 1333 | 16375 | 619 | 20120 | 32 | 19961 |
| 20-#11 | 5.42 | 6454 | 3143 | 11785 | 2164 | 13047 | 1695 | 13855 | 1312 | 15134 | 646 | 18668 | 150 | 18000 |

## SQUARE TIED COLUMNS 26" x 26"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.33 | 7124 | 2710 | 11495 | 1929 | 12241 | 1565 | 12397 | 1289 | 12339 | 886 | 14349 | 804 | 6738 |
| 4-#18 | 2.37 | 7745 | 2958 | 13011 | 2063 | 14013 | 1650 | 14486 | 1327 | 15094 | 829 | 17835 | 696 | 11415 |
| 8-#11 | 1.85 | 7030 | 2833 | 11583 | 2012 | 12408 | 1638 | 12608 | 1337 | 12620 | 886 | 14742 | 693 | 9253 |
| 8-#14 | 2.66 | 7354 | 3029 | 12508 | 2120 | 13518 | 1716 | 13918 | 1379 | 14348 | 853 | 16954 | 581 | 12949 |
| 8-#18 | 4.73 | 8121 | 3525 | 14762 | 2400 | 16182 | 1912 | 17070 | 1479 | 18509 | 759 | 22222 | 277 | 20958 |
| 12-#11 | 2.77 | 7326 | 3054 | 12426 | 2159 | 13482 | 1731 | 13894 | 1388 | 14376 | 865 | 17239 | 548 | 13233 |
| 12-#14 | 3.99 | 7766 | 3348 | 13705 | 2332 | 15033 | 1848 | 15731 | 1449 | 16826 | 820 | 20459 | 368 | 17886 |
| 12-#18 | 7.10 | 8811 | 4093 | 16824 | 2773 | 18755 | 2139 | 20151 | 1594 | 22721 | 688 | 28115 | -118 | 27476 |
| 16-#11 | 3.69 | 7653 | 3276 | 13337 | 2292 | 14635 | 1837 | 15267 | 1452 | 16144 | 831 | 19661 | 446 | 16885 |
| 16-#14 | 5.33 | 8223 | 3667 | 14999 | 2523 | 16658 | 2000 | 17669 | 1539 | 19320 | 767 | 23862 | 214 | 22682 |
| 20-#11 | 4.62 | 7993 | 3497 | 14276 | 2426 | 15789 | 1930 | 16675 | 1516 | 18002 | 810 | 22172 | 325 | 20269 |

## SQUARE TIED COLUMNS 28" x 28"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.15 | 8775 | 3091 | 14012 | 2223 | 14946 | 1809 | 15098 | 1498 | 14908 | 1048 | 17313 | 965 | 7379 |
| 4-#18 | 2.04 | 9473 | 3340 | 15694 | 2355 | 16940 | 1896 | 17445 | 1539 | 18000 | 996 | 21259 | 866 | 12544 |
| 8-#11 | 1.59 | 8673 | 3215 | 14103 | 2307 | 15102 | 1882 | 15325 | 1548 | 15212 | 1050 | 17738 | 858 | 10137 |
| 8-#14 | 2.30 | 9038 | 3411 | 15124 | 2416 | 16365 | 1964 | 16789 | 1591 | 17140 | 1020 | 20225 | 752 | 14227 |
| 8-#18 | 4.08 | 9903 | 3907 | 17621 | 2695 | 19361 | 2164 | 20329 | 1697 | 21811 | 934 | 26191 | 466 | 23836 |
| 12-#11 | 2.39 | 9007 | 3436 | 15030 | 2455 | 16286 | 1976 | 16752 | 1601 | 17159 | 1033 | 20526 | 717 | 14774 |
| 12-#14 | 3.44 | 9503 | 3730 | 16442 | 2628 | 18049 | 2099 | 18805 | 1665 | 19894 | 991 | 24149 | 545 | 19959 |
| 12-#18 | 6.12 | 10682 | 4474 | 19899 | 3070 | 22234 | 2397 | 23769 | 1820 | 26512 | 873 | 32824 | 83 | 32230 |
| 16-#11 | 3.18 | 9376 | 3657 | 16032 | 2589 | 17557 | 2084 | 18275 | 1667 | 19121 | 1001 | 23227 | 621 | 18697 |
| 16-#14 | 4.59 | 10017 | 4049 | 17868 | 2821 | 19855 | 2253 | 20958 | 1759 | 22666 | 943 | 27954 | 401 | 25512 |
| 20-#11 | 3.98 | 9758 | 3879 | 17065 | 2724 | 18830 | 2178 | 19837 | 1734 | 21181 | 984 | 26026 | 506 | 22601 |
| 20-#14 | 5.74 | 10553 | 4368 | 19335 | 3014 | 21666 | 2388 | 23167 | 1852 | 25580 | 914 | 31898 | 229 | 30733 |
| 24-#11 | 4.78 | 10147 | 4100 | 18060 | 2871 | 20132 | 2286 | 21366 | 1786 | 23265 | 966 | 28900 | 385 | 26418 |

## SQUARE TIED COLUMNS 30" x 30"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.00 | 10664 | 3502 | 16876 | 2540 | 17993 | 2070 | 18166 | 1722 | 17810 | 1222 | 20648 | 1138 | 8018 |
| 4-#18 | 1.78 | 11440 | 3750 | 18724 | 2671 | 20239 | 2161 | 20771 | 1765 | 21240 | 1173 | 25057 | 1046 | 13672 |
| 8-#11 | 1.39 | 10555 | 3625 | 16970 | 2626 | 18159 | 2144 | 18409 | 1774 | 18137 | 1226 | 21106 | 1033 | 11018 |
| 8-#14 | 2.00 | 10961 | 3821 | 18089 | 2734 | 19539 | 2226 | 20026 | 1819 | 20267 | 1198 | 23870 | 932 | 15501 |
| 8-#18 | 3.56 | 11927 | 4317 | 20829 | 3013 | 22914 | 2434 | 23956 | 1929 | 25448 | 1119 | 30536 | 661 | 26284 |
| 12-#11 | 2.08 | 10928 | 3846 | 17981 | 2774 | 19450 | 2239 | 19977 | 1829 | 20276 | 1211 | 24186 | 895 | 16153 |
| 12-#14 | 3.00 | 11480 | 4140 | 19528 | 2947 | 21378 | 2362 | 22246 | 1896 | 23296 | 1173 | 28214 | 730 | 22087 |
| 12-#18 | 5.33 | 12796 | 4885 | 23322 | 3390 | 26089 | 2672 | 27756 | 2058 | 30638 | 1066 | 37913 | 288 | 35657 |
| 16-#11 | 2.77 | 11338 | 4068 | 19074 | 2909 | 20836 | 2348 | 21651 | 1897 | 22431 | 1182 | 27168 | 805 | 20537 |
| 16-#14 | 4.00 | 12053 | 4459 | 21084 | 3141 | 23350 | 2518 | 24616 | 1992 | 26348 | 1129 | 32422 | 595 | 28296 |
| 16-#18 | 7.11 | 13765 | 5452 | 26016 | 3732 | 29494 | 2945 | 31815 | 2223 | 35864 | 977 | 45071 | 27 | 44909 |
| 20-#11 | 3.47 | 11763 | 4289 | 20201 | 3044 | 22225 | 2443 | 23367 | 1966 | 24695 | 1167 | 30255 | 696 | 24996 |
| 20-#14 | 5.00 | 12648 | 4778 | 22688 | 3335 | 25328 | 2654 | 27046 | 2089 | 29554 | 1104 | 36781 | 431 | 33968 |
| 24-#11 | 4.16 | 12195 | 4510 | 21287 | 3193 | 23645 | 2552 | 25048 | 2020 | 26984 | 1152 | 33430 | 578 | 29269 |

## SQUARE TIED COLUMNS 32" x 32"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.56 | 13664 | 4188 | 22128 | 3009 | 23902 | 2441 | 24490 | 2007 | 24837 | 1361 | 29255 | 1235 | 14799 |
| 8-#11 | 1.22 | 12692 | 4063 | 20208 | 2967 | 21613 | 2425 | 21866 | 2014 | 21419 | 1414 | 24873 | 1219 | 11897 |
| 8-#14 | 1.76 | 13140 | 4259 | 21425 | 3074 | 23110 | 2507 | 23657 | 2062 | 23750 | 1387 | 27914 | 1122 | 16771 |
| 8-#18 | 3.13 | 14208 | 4756 | 24410 | 3353 | 26812 | 2717 | 27978 | 2176 | 29444 | 1315 | 35282 | 864 | 28550 |
| 12-#11 | 1.83 | 13104 | 4285 | 21303 | 3116 | 23012 | 2521 | 23568 | 2070 | 23750 | 1401 | 28244 | 1084 | 17479 |
| 12-#14 | 2.64 | 13714 | 4578 | 22985 | 3289 | 25104 | 2644 | 26081 | 2141 | 27056 | 1366 | 32679 | 925 | 24272 |
| 12-#18 | 4.69 | 15171 | 5323 | 27118 | 3732 | 30271 | 2958 | 32139 | 2310 | 35124 | 1268 | 43406 | 500 | 39159 |
| 16-#11 | 2.44 | 13556 | 4506 | 22488 | 3252 | 24513 | 2631 | 25386 | 2140 | 26099 | 1374 | 31509 | 999 | 22404 |
| 16-#14 | 3.52 | 14347 | 4898 | 24673 | 3484 | 27243 | 2801 | 28668 | 2240 | 30388 | 1325 | 37292 | 797 | 30880 |
| 16-#18 | 6.25 | 16239 | 5891 | 30045 | 4075 | 33982 | 3234 | 36582 | 2480 | 40846 | 1186 | 51281 | 253 | 49612 |
| 20-#11 | 3.05 | 14025 | 4727 | 23708 | 3387 | 26018 | 2726 | 27250 | 2209 | 28566 | 1361 | 34885 | 894 | 27418 |
| 20-#14 | 4.39 | 15003 | 5217 | 26412 | 3678 | 29388 | 2938 | 31320 | 2340 | 33887 | 1304 | 42067 | 640 | 37280 |
| 24-#11 | 3.66 | 14501 | 4949 | 24885 | 3536 | 27556 | 2836 | 29075 | 2265 | 31061 | 1348 | 38191 | 760 | 31986 |
| 24-#14 | 5.27 | 15670 | 5536 | 28089 | 3893 | 31579 | 3095 | 33919 | 2419 | 37425 | 1283 | 46981 | 471 | 43565 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 34" x 34"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.38 | 16160 | 4655 | 25928 | 3370 | 27969 | 2738 | 28629 | 2264 | 28816 | 1561 | 33880 | 1434 | 15924 |
| 8-#11 | 1.08 | 15101 | 4530 | 23842 | 3331 | 25491 | 2725 | 25729 | 2269 | 25082 | 1613 | 29067 | 1415 | 12775 |
| 8-#14 | 1.56 | 15591 | 4726 | 25157 | 3438 | 27106 | 2806 | 27669 | 2317 | 27615 | 1588 | 32384 | 1323 | 18039 |
| 8-#18 | 2.77 | 16764 | 5222 | 28388 | 3715 | 31105 | 3016 | 32419 | 2438 | 33821 | 1521 | 40456 | 1075 | 30810 |
| 12-#11 | 1.62 | 15552 | 4752 | 25021 | 3481 | 26997 | 2822 | 27562 | 2325 | 27605 | 1602 | 32725 | 1285 | 18801 |
| 12-#14 | 2.34 | 16221 | 5045 | 26839 | 3653 | 29254 | 2944 | 30284 | 2398 | 31198 | 1570 | 37567 | 1130 | 26445 |
| 12-#18 | 4.15 | 17822 | 5790 | 31311 | 4096 | 34839 | 3259 | 36942 | 2577 | 39993 | 1480 | 49329 | 719 | 42736 |
| 16-#11 | 2.16 | 16048 | 4973 | 26297 | 3617 | 28614 | 2932 | 29519 | 2396 | 30149 | 1577 | 36277 | 1202 | 24299 |
| 16-#14 | 3.11 | 16915 | 5364 | 28658 | 3849 | 31560 | 3102 | 33075 | 2498 | 34810 | 1532 | 42590 | 1007 | 33497 |
| 16-#18 | 5.54 | 18992 | 6357 | 34472 | 4441 | 38845 | 3537 | 41771 | 2751 | 46212 | 1404 | 57921 | 485 | 54459 |
| 20-#11 | 2.70 | 16561 | 5194 | 27611 | 3753 | 30235 | 3028 | 31487 | 2453 | 32820 | 1566 | 39942 | 1101 | 29650 |
| 20-#14 | 3.89 | 17633 | 5683 | 30532 | 4044 | 33872 | 3240 | 35937 | 2599 | 38602 | 1514 | 47782 | 857 | 40668 |
| 24-#11 | 3.24 | 17081 | 5415 | 28879 | 3903 | 31891 | 3138 | 33492 | 2523 | 35521 | 1555 | 43533 | 972 | 34750 |
| 24-#14 | 4.67 | 18363 | 6003 | 32340 | 4260 | 36234 | 3398 | 38741 | 2680 | 42437 | 1496 | 52867 | 665 | 47702 |

## SQUARE TIED COLUMNS 36" x 36"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.23 | 18947 | 5150 | 30150 | 3754 | 32487 | 3054 | 33202 | 2535 | 33199 | 1773 | 38957 | 1644 | 17048 |
| 8-#14 | 1.39 | 18332 | 5221 | 29309 | 3825 | 31553 | 3125 | 32117 | 2588 | 31885 | 1800 | 37308 | 1533 | 19302 |
| 8-#18 | 2.47 | 19610 | 5718 | 32787 | 4101 | 35849 | 3334 | 37289 | 2713 | 38604 | 1737 | 46084 | 1295 | 33064 |
| 12-#11 | 1.44 | 18290 | 5247 | 29158 | 3869 | 31433 | 3141 | 32000 | 2597 | 31866 | 1815 | 37658 | 1496 | 20119 |
| 12-#14 | 2.08 | 19019 | 5540 | 31112 | 4041 | 33855 | 3263 | 34919 | 2669 | 35746 | 1785 | 42905 | 1346 | 28355 |
| 12-#18 | 3.70 | 20765 | 6285 | 35925 | 4483 | 39858 | 3579 | 42169 | 2855 | 45268 | 1702 | 55707 | 946 | 46388 |
| 16-#11 | 1.93 | 18830 | 5468 | 30525 | 4005 | 33165 | 3251 | 34097 | 2668 | 34605 | 1792 | 41499 | 1415 | 26222 |
| 16-#14 | 2.78 | 19774 | 5859 | 33063 | 4237 | 36327 | 3422 | 37912 | 2771 | 39638 | 1750 | 48343 | 1227 | 36148 |
| 16-#18 | 4.94 | 22039 | 6852 | 39320 | 4830 | 44160 | 3858 | 47378 | 3033 | 51985 | 1631 | 65019 | 723 | 59449 |
| 20-#11 | 2.41 | 19387 | 5689 | 31934 | 4141 | 34902 | 3348 | 36205 | 2725 | 37479 | 1782 | 45454 | 1318 | 31898 |
| 20-#14 | 3.47 | 20555 | 6179 | 35073 | 4433 | 38806 | 3561 | 40921 | 2853 | 43724 | 1734 | 53952 | 1082 | 44133 |
| 20-#18 | 6.17 | 23362 | 7420 | 42817 | 5176 | 48474 | 4103 | 52719 | 3211 | 59037 | 1596 | 74655 | 449 | 71779 |
| 24-#11 | 2.89 | 19952 | 5910 | 33293 | 4292 | 36677 | 3459 | 38354 | 2796 | 40386 | 1773 | 49329 | 1192 | 37561 |
| 24-#14 | 4.17 | 21348 | 6498 | 37012 | 4649 | 41340 | 3720 | 43988 | 2954 | 47856 | 1718 | 59447 | 896 | 51661 |

## SQUARE TIED COLUMNS 38" x 38"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.11 | 22039 | 5673 | 34817 | 4162 | 37482 | 3389 | 38201 | 2820 | 38012 | 1996 | 44514 | 1864 | 18171 |
| 8-#14 | 1.25 | 21379 | 5744 | 33906 | 4234 | 36476 | 3462 | 37036 | 2874 | 36584 | 2025 | 42711 | 1755 | 20562 |
| 8-#18 | 2.22 | 22764 | 6241 | 37631 | 4510 | 41071 | 3671 | 42563 | 2999 | 43816 | 1965 | 52192 | 1524 | 35313 |
| 12-#11 | 1.30 | 21334 | 5770 | 33740 | 4279 | 36346 | 3479 | 36910 | 2884 | 36556 | 2039 | 43073 | 1717 | 21435 |
| 12-#14 | 1.87 | 22123 | 6064 | 35830 | 4451 | 38933 | 3601 | 40026 | 2957 | 40723 | 2011 | 48723 | 1572 | 30258 |
| 12-#18 | 3.32 | 24017 | 6808 | 40984 | 4893 | 45354 | 3917 | 47777 | 3144 | 50973 | 1934 | 62552 | 1184 | 50116 |
| 16-#11 | 1.73 | 21918 | 5991 | 35198 | 4416 | 38193 | 3590 | 39147 | 2956 | 39490 | 2018 | 47202 | 1639 | 28170 |
| 16-#14 | 2.49 | 22941 | 6383 | 37912 | 4648 | 41571 | 3761 | 43221 | 3059 | 44896 | 1978 | 54576 | 1456 | 38832 |
| 16-#18 | 4.43 | 25397 | 7376 | 44613 | 5241 | 49952 | 4198 | 53345 | 3323 | 58188 | 1868 | 72600 | 968 | 64501 |
| 20-#11 | 2.16 | 22520 | 6212 | 36700 | 4553 | 40047 | 3687 | 41396 | 3014 | 42568 | 2010 | 51447 | 1545 | 34164 |
| 20-#14 | 3.12 | 23785 | 6702 | 40058 | 4844 | 44218 | 3901 | 46432 | 3142 | 49275 | 1965 | 60603 | 1316 | 47571 |
| 20-#18 | 5.54 | 26827 | 7943 | 48352 | 5589 | 54564 | 4444 | 58941 | 3467 | 65762 | 1837 | 82978 | 704 | 77455 |
| 24-#11 | 2.59 | 23131 | 6434 | 38150 | 4703 | 41940 | 3798 | 43688 | 3086 | 45681 | 2002 | 55607 | 1422 | 40418 |
| 24-#14 | 3.74 | 24642 | 7021 | 42128 | 5061 | 46922 | 4060 | 49706 | 3245 | 53705 | 1952 | 66510 | 1135 | 55571 |

## SQUARE TIED COLUMNS 40" x 40"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.00 | 25455 | 6225 | 39953 | 4592 | 42981 | 3743 | 43698 | 3121 | 43277 | 2231 | 50577 | 2096 | 19293 |
| 8-#14 | 1.13 | 24749 | 6296 | 38970 | 4667 | 41902 | 3818 | 42452 | 3177 | 41737 | 2261 | 48621 | 1987 | 21821 |
| 8-#18 | 2.00 | 26242 | 6792 | 42944 | 4941 | 46795 | 4026 | 48335 | 3302 | 49482 | 2204 | 58808 | 1764 | 37558 |
| 12-#11 | 1.17 | 24702 | 6321 | 38789 | 4712 | 41762 | 3836 | 42317 | 3188 | 41682 | 2275 | 48994 | 1950 | 22747 |
| 12-#14 | 1.69 | 25551 | 6615 | 41016 | 4884 | 44514 | 3958 | 45631 | 3260 | 46153 | 2250 | 55048 | 1808 | 32157 |
| 12-#18 | 3.00 | 27594 | 7360 | 46513 | 5325 | 51354 | 4273 | 53883 | 3447 | 57132 | 2178 | 69905 | 1432 | 53920 |
| 16-#11 | 1.56 | 25329 | 6543 | 40338 | 4850 | 43725 | 3947 | 44694 | 3260 | 44806 | 2254 | 53412 | 1874 | 29928 |
| 16-#14 | 2.25 | 26431 | 6934 | 43229 | 5081 | 47319 | 4118 | 49027 | 3364 | 50607 | 2219 | 61318 | 1696 | 41551 |
| 16-#18 | 4.00 | 29081 | 7927 | 50375 | 5674 | 56248 | 4556 | 59809 | 3628 | 64846 | 2116 | 80690 | 1222 | 69032 |
| 20-#11 | 1.95 | 25977 | 6764 | 41935 | 4987 | 45694 | 4045 | 47084 | 3318 | 48084 | 2248 | 57947 | 1783 | 36448 |
| 20-#14 | 2.81 | 27340 | 7253 | 45511 | 5278 | 50133 | 4259 | 52442 | 3447 | 55281 | 2207 | 67763 | 1560 | 50774 |
| 20-#18 | 5.00 | 30621 | 8495 | 54355 | 6023 | 61157 | 4803 | 65766 | 3774 | 72942 | 2089 | 91810 | 967 | 83233 |
| 24-#11 | 2.34 | 26633 | 6985 | 43475 | 5138 | 47706 | 4157 | 49519 | 3391 | 51399 | 2241 | 62393 | 1663 | 43138 |
| 24-#14 | 3.38 | 28261 | 7573 | 47712 | 5496 | 53008 | 4419 | 55922 | 3550 | 60008 | 2196 | 74080 | 1383 | 59538 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 42" x 42"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.02 | 28459 | 6876 | 44528 | 5122 | 47859 | 4192 | 48393 | 3495 | 47349 | 2508 | 55065 | 2231 | 23078 |
| 8-#18 | 1.81 | 30060 | 7372 | 48751 | 5395 | 53050 | 4400 | 54630 | 3620 | 55625 | 2455 | 65958 | 2014 | 39798 |
| 12-#11 | 1.06 | 28409 | 6901 | 44330 | 5169 | 47708 | 4211 | 48249 | 3507 | 47258 | 2521 | 55449 | 2194 | 24057 |
| 12-#14 | 1.53 | 29319 | 7195 | 46694 | 5340 | 50625 | 4333 | 51760 | 3579 | 52037 | 2498 | 61908 | 2055 | 34052 |
| 12-#18 | 2.72 | 31513 | 7940 | 52535 | 5780 | 57884 | 4648 | 60513 | 3767 | 63769 | 2432 | 77792 | 1689 | 57800 |
| 16-#11 | 1.41 | 29081 | 7123 | 45970 | 5306 | 49786 | 4309 | 50765 | 3580 | 50566 | 2501 | 60156 | 2120 | 31681 |
| 16-#14 | 2.04 | 30262 | 7514 | 49040 | 5537 | 53597 | 4494 | 55357 | 3684 | 56766 | 2469 | 68594 | 1946 | 44304 |
| 16-#18 | 3.63 | 33108 | 8507 | 56632 | 6130 | 63074 | 4932 | 66797 | 3949 | 71981 | 2374 | 89316 | 1485 | 73607 |
| 20-#11 | 1.77 | 29774 | 7344 | 47661 | 5444 | 51871 | 4421 | 53295 | 3639 | 54037 | 2495 | 64982 | 2031 | 38750 |
| 20-#14 | 2.55 | 31236 | 7833 | 51457 | 5735 | 56578 | 4635 | 58975 | 3768 | 61728 | 2459 | 75458 | 1814 | 53997 |
| 20-#18 | 4.54 | 34758 | 9075 | 60852 | 6480 | 68280 | 5181 | 73114 | 4096 | 80600 | 2351 | 101179 | 1237 | 89113 |
| 24-#11 | 2.12 | 30477 | 7565 | 49293 | 5595 | 54002 | 4520 | 55875 | 3711 | 57547 | 2489 | 69713 | 1913 | 45804 |
| 24-#14 | 3.06 | 32223 | 8153 | 53789 | 5953 | 59624 | 4796 | 62662 | 3872 | 66747 | 2449 | 82186 | 1640 | 63560 |
| 24-#18 | 5.44 | 36435 | 9642 | 64925 | 6866 | 73599 | 5465 | 79554 | 4279 | 89317 | 2327 | 112805 | 915 | 104407 |

## SQUARE TIED COLUMNS 44" x 44"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#18 | 1.65 | 34236 | 7981 | 55075 | 5872 | 59861 | 4793 | 61475 | 3954 | 62269 | 2717 | 73668 | 2274 | 42035 |
| 12-#14 | 1.39 | 33444 | 7803 | 52889 | 5818 | 57292 | 4728 | 58438 | 3915 | 58381 | 2756 | 69328 | 2313 | 35943 |
| 12-#18 | 2.48 | 35790 | 8548 | 59075 | 6258 | 64970 | 5042 | 67693 | 4102 | 70907 | 2698 | 86240 | 1956 | 61727 |
| 16-#11 | 1.29 | 33189 | 7731 | 52119 | 5786 | 56403 | 4704 | 57387 | 3915 | 56826 | 2759 | 67461 | 2376 | 33431 |
| 16-#14 | 1.86 | 34451 | 8122 | 55366 | 6017 | 60431 | 4869 | 62237 | 4019 | 63375 | 2728 | 76431 | 2206 | 47092 |
| 16-#18 | 3.31 | 37495 | 9115 | 63405 | 6609 | 70456 | 5327 | 74335 | 4286 | 79619 | 2643 | 98504 | 1757 | 78226 |
| 20-#11 | 1.61 | 33928 | 7952 | 53904 | 5923 | 58605 | 4817 | 60058 | 3975 | 60490 | 2754 | 72578 | 2290 | 41071 |
| 20-#14 | 2.32 | 35490 | 8442 | 57919 | 6215 | 63579 | 5031 | 66058 | 4104 | 68615 | 2719 | 83714 | 2078 | 57241 |
| 20-#18 | 4.13 | 39257 | 9683 | 67867 | 6960 | 75959 | 5577 | 81013 | 4434 | 88761 | 2623 | 111111 | 1516 | 95096 |
| 24-#11 | 1.93 | 34678 | 8173 | 55626 | 6075 | 60854 | 4915 | 62781 | 4048 | 64195 | 2748 | 77595 | 2174 | 48480 |
| 24-#14 | 2.79 | 36543 | 8761 | 60383 | 6433 | 66796 | 5172 | 69953 | 4209 | 73915 | 2710 | 90855 | 1908 | 67639 |
| 24-#18 | 4.96 | 41046 | 10250 | 72173 | 7346 | 81583 | 5862 | 87821 | 4618 | 98007 | 2603 | 123468 | 1201 | 111716 |

## SQUARE TIED COLUMNS 46" x 46"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 8,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.51 | 38787 | 8617 | 61941 | 6372 | 67255 | 5204 | 68897 | 4304 | 69411 | 2990 | 81966 | 2545 | 44269 |
| 12-#14 | 1.28 | 37943 | 8440 | 59625 | 6320 | 64542 | 5141 | 65694 | 4266 | 65249 | 3027 | 77336 | 2583 | 37830 |
| 12-#18 | 2.27 | 40442 | 9184 | 66157 | 6759 | 72638 | 5455 | 75449 | 4453 | 78534 | 2973 | 95277 | 2233 | 65108 |
| 16-#11 | 1.18 | 37672 | 8367 | 58807 | 6288 | 63603 | 5118 | 64585 | 4267 | 63612 | 3030 | 75355 | 2644 | 35177 |
| 16-#14 | 1.70 | 39014 | 8759 | 62234 | 6519 | 67847 | 5283 | 69694 | 4371 | 70508 | 2999 | 84856 | 2478 | 49785 |
| 16-#18 | 3.02 | 42258 | 9752 | 70721 | 7111 | 78420 | 5741 | 82449 | 4638 | 87736 | 2920 | 108281 | 2038 | 82892 |
| 20-#11 | 1.47 | 38457 | 8589 | 60686 | 6426 | 65920 | 5231 | 67397 | 4327 | 67469 | 3025 | 80763 | 2560 | 43411 |
| 20-#14 | 2.13 | 40119 | 9078 | 64922 | 6717 | 71163 | 5444 | 73718 | 4456 | 76027 | 2991 | 92559 | 2353 | 60507 |
| 20-#18 | 3.78 | 44133 | 10319 | 75424 | 7462 | 84222 | 5991 | 89488 | 4788 | 97392 | 2903 | 121632 | 1804 | 101182 |
| 24-#11 | 1.77 | 39253 | 8810 | 62500 | 6578 | 68288 | 5329 | 70263 | 4400 | 71369 | 3020 | 86066 | 2446 | 51169 |
| 24-#14 | 2.55 | 41238 | 9397 | 67517 | 6936 | 74551 | 5587 | 77819 | 4562 | 81609 | 2983 | 100111 | 2185 | 71720 |
| 24-#18 | 4.54 | 46035 | 10887 | 79963 | 7849 | 90149 | 6277 | 96664 | 4973 | 107158 | 2886 | 134721 | 1494 | 118738 |

## SQUARE TIED COLUMNS 48" x 48"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#18 | 1.39 | 43728 | 9282 | 69373 | 6895 | 75257 | 5635 | 76921 | 4670 | 77042 | 3272 | 90878 | 2827 | 46499 |
| 12-#14 | 1.17 | 42833 | 9104 | 66926 | 6844 | 72401 | 5572 | 73552 | 4633 | 72667 | 3309 | 85959 | 2863 | 39715 |
| 12-#18 | 2.08 | 45487 | 9849 | 73804 | 7283 | 80916 | 5886 | 83807 | 4820 | 86631 | 3256 | 104928 | 2521 | 68481 |
| 16-#11 | 1.08 | 42545 | 9032 | 66060 | 6813 | 71411 | 5550 | 72386 | 4635 | 70947 | 3313 | 83864 | 2923 | 36920 |
| 16-#14 | 1.56 | 43969 | 9424 | 69666 | 7043 | 75872 | 5715 | 77754 | 4739 | 78191 | 3282 | 93897 | 2760 | 52311 |
| 16-#18 | 2.78 | 47414 | 10417 | 78602 | 7635 | 86994 | 6173 | 91166 | 5006 | 96304 | 3205 | 118673 | 2330 | 87602 |
| 20-#11 | 1.35 | 43377 | 9253 | 68034 | 6952 | 73845 | 5663 | 75338 | 4695 | 74997 | 3309 | 89563 | 2841 | 45727 |
| 20-#14 | 1.95 | 45139 | 9743 | 72491 | 7242 | 79355 | 5877 | 81980 | 4825 | 83988 | 3275 | 102019 | 2638 | 63795 |
| 20-#18 | 3.47 | 49403 | 10984 | 83547 | 7988 | 93093 | 6425 | 98566 | 5157 | 106455 | 3189 | 132770 | 2101 | 107370 |
| 24-#11 | 1.63 | 44220 | 9475 | 69938 | 7104 | 76332 | 5762 | 78349 | 4769 | 79093 | 3304 | 95152 | 2729 | 53869 |
| 24-#14 | 2.34 | 46326 | 10062 | 75217 | 7461 | 82915 | 6020 | 86289 | 4930 | 89851 | 3268 | 109984 | 2473 | 75540 |
| 24-#18 | 4.17 | 51420 | 11551 | 88319 | 8375 | 99325 | 6711 | 106110 | 5343 | 116721 | 3173 | 146590 | 1797 | 125597 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.08 | 6671 | 2762 | 10576 | 1970 | 11102 | 1604 | 11077 | 1334 | 10670 | 951 | 12200 | 880 | 4440 |
| 4-#14 | 1.56 | 6897 | 2857 | 11125 | 2018 | 11739 | 1633 | 11825 | 1345 | 11661 | 926 | 13453 | 834 | 6196 |
| 4-#18 | 2.78 | 7432 | 3099 | 12404 | 2139 | 13256 | 1708 | 13617 | 1373 | 14035 | 858 | 16416 | 709 | 10432 |
| 8-#11 | 2.17 | 6804 | 2977 | 11203 | 2097 | 11892 | 1706 | 12021 | 1393 | 11923 | 925 | 13819 | 721 | 8491 |
| 8-#14 | 3.13 | 7077 | 3168 | 12015 | 2200 | 12850 | 1779 | 13154 | 1428 | 13424 | 885 | 15719 | 598 | 11854 |
| 8-#18 | 5.56 | 7722 | 3652 | 13914 | 2458 | 15133 | 1959 | 15862 | 1511 | 17015 | 772 | 20208 | 262 | 19081 |
| 12-#11 | 3.25 | 7049 | 3193 | 11935 | 2242 | 12822 | 1792 | 13139 | 1436 | 13472 | 899 | 16003 | 569 | 12151 |
| 12-#14 | 4.69 | 7418 | 3480 | 13053 | 2408 | 14158 | 1899 | 14727 | 1487 | 15604 | 843 | 18775 | 373 | 16359 |
| 16-#11 | 4.33 | 7324 | 3409 | 12734 | 2369 | 13827 | 1894 | 14341 | 1496 | 15015 | 856 | 18125 | 457 | 15459 |
| 16-#14 | 6.25 | 7800 | 3791 | 14186 | 2590 | 15572 | 2045 | 16418 | 1570 | 17888 | 802 | 21746 | 204 | 20695 |
| 20-#11 | 5.42 | 7609 | 3625 | 13527 | 2514 | 14830 | 1980 | 15577 | 1555 | 16652 | 830 | 20327 | 326 | 18534 |

## SQUARE TIED COLUMNS 26" x 26"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.33 | 8655 | 3299 | 13812 | 2356 | 14613 | 1915 | 14686 | 1586 | 14369 | 1113 | 16565 | 1021 | 6842 |
| 4-#18 | 2.37 | 9263 | 3541 | 15302 | 2481 | 16345 | 1992 | 16729 | 1617 | 17073 | 1050 | 19979 | 906 | 11570 |
| 8-#11 | 1.85 | 8553 | 3419 | 13892 | 2438 | 14778 | 1991 | 14898 | 1636 | 14654 | 1115 | 16964 | 911 | 9379 |
| 8-#14 | 2.66 | 8866 | 3610 | 14799 | 2540 | 15864 | 2064 | 16181 | 1673 | 16352 | 1077 | 19134 | 795 | 13139 |
| 8-#18 | 4.73 | 9604 | 4094 | 17009 | 2805 | 18470 | 2250 | 19269 | 1764 | 20444 | 975 | 24306 | 481 | 21992 |
| 12-#11 | 2.77 | 8835 | 3635 | 14705 | 2584 | 15823 | 2078 | 16154 | 1681 | 16392 | 1092 | 19436 | 764 | 13699 |
| 12-#14 | 3.99 | 9257 | 3922 | 15954 | 2749 | 17337 | 2189 | 17953 | 1736 | 18805 | 1042 | 22604 | 578 | 18453 |
| 12-#18 | 7.10 | 10255 | 4648 | 18998 | 3173 | 20970 | 2463 | 22277 | 1866 | 24613 | 900 | 30138 | 80 | 29608 |
| 16-#11 | 3.69 | 9149 | 3851 | 15593 | 2712 | 16951 | 2183 | 17504 | 1744 | 18125 | 1053 | 21833 | 660 | 17288 |
| 16-#14 | 5.33 | 9693 | 4233 | 17214 | 2933 | 18929 | 2338 | 19856 | 1824 | 21248 | 981 | 25972 | 421 | 23558 |
| 20-#11 | 4.62 | 9475 | 4067 | 16510 | 2840 | 18078 | 2271 | 18891 | 1806 | 19962 | 1030 | 24320 | 536 | 20890 |

## SQUARE TIED COLUMNS 28" x 28"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.15 | 10689 | 3777 | 16903 | 2724 | 17918 | 2221 | 17973 | 1846 | 17463 | 1315 | 20108 | 1221 | 7486 |
| 4-#18 | 2.04 | 11373 | 4019 | 18557 | 2847 | 19868 | 2299 | 20268 | 1879 | 20499 | 1255 | 23975 | 1114 | 12706 |
| 8-#11 | 1.59 | 10580 | 3897 | 16984 | 2807 | 18072 | 2296 | 18201 | 1898 | 17772 | 1319 | 20541 | 1115 | 10265 |
| 8-#14 | 2.30 | 10931 | 4088 | 17988 | 2909 | 19309 | 2373 | 19635 | 1937 | 19668 | 1284 | 22982 | 1004 | 14419 |
| 8-#18 | 4.08 | 11766 | 4572 | 20437 | 3173 | 22241 | 2563 | 23104 | 2033 | 24262 | 1190 | 28840 | 707 | 24363 |
| 12-#11 | 2.39 | 10899 | 4113 | 17879 | 2954 | 19224 | 2384 | 19595 | 1946 | 19700 | 1299 | 23302 | 971 | 15035 |
| 12-#14 | 3.44 | 11375 | 4399 | 19260 | 3119 | 20947 | 2500 | 21605 | 2004 | 22393 | 1253 | 26867 | 793 | 20609 |
| 12-#18 | 6.12 | 12503 | 5125 | 22634 | 3544 | 25035 | 2782 | 26464 | 2143 | 28914 | 1124 | 35407 | 318 | 33071 |
| 16-#11 | 3.18 | 11252 | 4328 | 18855 | 3083 | 20469 | 2491 | 21093 | 2011 | 21622 | 1262 | 25976 | 873 | 19146 |
| 16-#14 | 4.59 | 11867 | 4710 | 20648 | 3304 | 22717 | 2652 | 23721 | 2095 | 25111 | 1197 | 30634 | 646 | 26303 |
| 20-#11 | 3.98 | 11619 | 4544 | 19864 | 3212 | 21711 | 2580 | 22631 | 2075 | 23660 | 1243 | 28748 | 756 | 23317 |
| 20-#14 | 5.74 | 12380 | 5021 | 22082 | 3490 | 24483 | 2779 | 25896 | 2186 | 27991 | 1166 | 34539 | 471 | 31572 |
| 24-#11 | 4.78 | 11993 | 4760 | 20825 | 3358 | 22985 | 2686 | 24126 | 2123 | 25722 | 1224 | 31595 | 632 | 27230 |

## SQUARE TIED COLUMNS 30" x 30"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.00 | 13022 | 4289 | 20429 | 3120 | 21658 | 2546 | 21717 | 2126 | 20973 | 1532 | 24116 | 1435 | 8130 |
| 4-#18 | 1.78 | 13782 | 4531 | 22248 | 3241 | 23857 | 2628 | 24266 | 2161 | 24341 | 1475 | 28437 | 1334 | 13840 |
| 8-#11 | 1.39 | 12904 | 4410 | 20511 | 3205 | 21822 | 2623 | 21963 | 2180 | 21306 | 1537 | 24583 | 1331 | 11149 |
| 8-#14 | 2.00 | 13296 | 4600 | 21611 | 3306 | 23174 | 2700 | 23547 | 2220 | 23400 | 1505 | 27296 | 1226 | 15691 |
| 8-#18 | 3.56 | 14228 | 5085 | 24300 | 3569 | 26479 | 2897 | 27399 | 2321 | 28497 | 1417 | 33843 | 943 | 26639 |
| 12-#11 | 2.08 | 13261 | 4625 | 21487 | 3352 | 23078 | 2713 | 23495 | 2229 | 23424 | 1520 | 27634 | 1191 | 16366 |
| 12-#14 | 3.00 | 13792 | 4912 | 23000 | 3517 | 24962 | 2828 | 25717 | 2290 | 26399 | 1478 | 31598 | 1020 | 22828 |
| 12-#18 | 5.33 | 15055 | 5638 | 26705 | 3942 | 29567 | 3122 | 31111 | 2437 | 33634 | 1359 | 41148 | 565 | 36617 |
| 16-#11 | 2.77 | 13655 | 4841 | 22552 | 3482 | 24435 | 2820 | 25141 | 2296 | 25537 | 1486 | 30586 | 1099 | 21035 |
| 16-#14 | 4.00 | 14342 | 5223 | 24516 | 3704 | 26894 | 2982 | 28046 | 2384 | 29391 | 1426 | 35765 | 881 | 28914 |
| 16-#18 | 7.11 | 15978 | 6191 | 29330 | 4271 | 32902 | 3391 | 35100 | 2596 | 38755 | 1257 | 48233 | 297 | 46366 |
| 20-#11 | 3.47 | 14064 | 5057 | 23653 | 3611 | 25791 | 2910 | 26831 | 2363 | 27775 | 1469 | 33644 | 987 | 25676 |
| 20-#14 | 5.00 | 14913 | 5534 | 26083 | 3890 | 28824 | 3110 | 30440 | 2478 | 32560 | 1399 | 40082 | 714 | 34929 |
| 24-#11 | 4.16 | 14479 | 5273 | 24701 | 3758 | 27181 | 3017 | 28474 | 2412 | 30041 | 1452 | 36790 | 866 | 29981 |

## SQUARE TIED COLUMNS 32" x 32"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.56 | 16510 | 5079 | 26405 | 3664 | 28309 | 2978 | 28755 | 2462 | 28630 | 1709 | 33398 | 1567 | 14973 |
| 8-#11 | 1.22 | 15547 | 4958 | 24502 | 3632 | 26068 | 2974 | 26195 | 2479 | 25286 | 1770 | 29124 | 1561 | 12031 |
| 8-#14 | 1.76 | 15979 | 5149 | 25699 | 3732 | 27535 | 3051 | 27951 | 2522 | 27579 | 1740 | 32108 | 1460 | 16961 |
| 8-#18 | 3.13 | 17011 | 5633 | 28630 | 3994 | 31161 | 3250 | 32186 | 2627 | 33179 | 1658 | 39346 | 1190 | 28907 |
| 12-#11 | 1.83 | 15942 | 5173 | 25559 | 3779 | 27429 | 3065 | 27859 | 2530 | 27595 | 1756 | 32463 | 1424 | 17692 |
| 12-#14 | 2.64 | 16529 | 5460 | 27205 | 3944 | 29474 | 3180 | 30320 | 2594 | 30852 | 1716 | 36829 | 1259 | 24858 |
| 12-#18 | 4.69 | 17929 | 6186 | 31243 | 4369 | 34526 | 3477 | 36252 | 2748 | 38803 | 1607 | 47392 | 820 | 40247 |
| 16-#11 | 2.44 | 16378 | 5389 | 26713 | 3909 | 28899 | 3172 | 29646 | 2598 | 29898 | 1724 | 35696 | 1336 | 22956 |
| 16-#14 | 3.52 | 17138 | 5771 | 28849 | 4131 | 31570 | 3335 | 32863 | 2691 | 34118 | 1668 | 41396 | 1127 | 31561 |
| 16-#18 | 6.25 | 18951 | 6739 | 34095 | 4699 | 38161 | 3749 | 40620 | 2913 | 44411 | 1512 | 55187 | 567 | 51301 |
| 20-#11 | 3.05 | 16829 | 5605 | 27906 | 4040 | 30368 | 3263 | 31482 | 2666 | 32338 | 1709 | 39040 | 1229 | 27928 |
| 20-#14 | 4.39 | 17768 | 6082 | 30549 | 4319 | 33662 | 3464 | 35477 | 2788 | 37578 | 1644 | 46126 | 968 | 38372 |
| 24-#11 | 3.66 | 17287 | 5821 | 29042 | 4187 | 31874 | 3371 | 33267 | 2717 | 34807 | 1694 | 42272 | 1088 | 32782 |
| 24-#14 | 5.27 | 18410 | 6393 | 32167 | 4531 | 35808 | 3619 | 38016 | 2860 | 41079 | 1620 | 50994 | 795 | 44969 |

## SQUARE TIED COLUMNS 34" x 34"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.38 | 19579 | 5663 | 31058 | 4115 | 33271 | 3349 | 33769 | 2782 | 33394 | 1957 | 38892 | 1813 | 16104 |
| 8-#11 | 1.08 | 18530 | 5541 | 28987 | 4087 | 30845 | 3349 | 30938 | 2798 | 29743 | 2018 | 34197 | 1805 | 12912 |
| 8-#14 | 1.56 | 19003 | 5732 | 30282 | 4186 | 32427 | 3425 | 32840 | 2841 | 32233 | 1989 | 37453 | 1707 | 18228 |
| 8-#18 | 2.77 | 20136 | 6216 | 33456 | 4447 | 36345 | 3623 | 37497 | 2951 | 38338 | 1912 | 45383 | 1448 | 31169 |
| 12-#11 | 1.62 | 18963 | 5757 | 30125 | 4235 | 32310 | 3440 | 32730 | 2849 | 32242 | 2005 | 37820 | 1672 | 19014 |
| 12-#14 | 2.34 | 19608 | 6043 | 31905 | 4399 | 34517 | 3555 | 35396 | 2914 | 35782 | 1969 | 42588 | 1511 | 26772 |
| 12-#18 | 4.15 | 21147 | 6769 | 36277 | 4823 | 39977 | 3853 | 41918 | 3077 | 44449 | 1867 | 54171 | 1086 | 43960 |
| 16-#11 | 2.16 | 19441 | 5973 | 31368 | 4366 | 33893 | 3548 | 34654 | 2918 | 34737 | 1976 | 41339 | 1587 | 24907 |
| 16-#14 | 3.11 | 20275 | 6354 | 33677 | 4587 | 36775 | 3711 | 38140 | 3013 | 39323 | 1923 | 47562 | 1385 | 34246 |
| 16-#18 | 5.54 | 22269 | 7323 | 39356 | 5155 | 43902 | 4126 | 46666 | 3247 | 50545 | 1778 | 62679 | 845 | 56397 |
| 20-#11 | 2.70 | 19935 | 6188 | 32653 | 4496 | 35475 | 3639 | 36582 | 2969 | 37378 | 1963 | 44970 | 1484 | 30199 |
| 20-#14 | 3.89 | 20967 | 6666 | 35509 | 4775 | 39031 | 3841 | 40960 | 3111 | 43073 | 1902 | 52705 | 1231 | 41900 |
| 24-#11 | 3.24 | 20437 | 6404 | 33877 | 4644 | 37097 | 3748 | 38554 | 3038 | 40051 | 1950 | 48481 | 1347 | 35636 |
| 24-#14 | 4.67 | 21670 | 6977 | 37254 | 4988 | 41344 | 3997 | 43701 | 3184 | 46868 | 1882 | 57677 | 1029 | 48875 |

## SQUARE TIED COLUMNS 36" x 36"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.23 | 23010 | 6282 | 36237 | 4596 | 38797 | 3745 | 39327 | 3121 | 38665 | 2220 | 44951 | 2073 | 17233 |
| 8-#14 | 1.39 | 22389 | 6351 | 35390 | 4669 | 37882 | 3822 | 38276 | 3179 | 37395 | 2253 | 43365 | 1968 | 19493 |
| 8-#18 | 2.47 | 23624 | 6835 | 38809 | 4929 | 42093 | 4020 | 43349 | 3294 | 44004 | 2180 | 51987 | 1718 | 33425 |
| 12-#11 | 1.44 | 22346 | 6376 | 35216 | 4719 | 37754 | 3839 | 38157 | 3188 | 37396 | 2270 | 43745 | 1933 | 20330 |
| 12-#14 | 2.08 | 23048 | 6662 | 37130 | 4883 | 40122 | 3954 | 41016 | 3254 | 41218 | 2235 | 48910 | 1777 | 28680 |
| 12-#18 | 3.70 | 24729 | 7388 | 41837 | 5307 | 45992 | 4251 | 48119 | 3423 | 50603 | 2141 | 61519 | 1363 | 47758 |
| 16-#11 | 1.93 | 22866 | 6591 | 36548 | 4850 | 39450 | 3948 | 40219 | 3258 | 40082 | 2242 | 47549 | 1851 | 26717 |
| 16-#14 | 2.78 | 23776 | 6973 | 39030 | 5072 | 42544 | 4110 | 43959 | 3353 | 45035 | 2193 | 54296 | 1655 | 36968 |
| 16-#18 | 4.94 | 25953 | 7941 | 45144 | 5640 | 50207 | 4527 | 53240 | 3596 | 57188 | 2056 | 70740 | 1133 | 61164 |
| 20-#11 | 2.41 | 23404 | 6807 | 37925 | 4982 | 41145 | 4039 | 42285 | 3310 | 42924 | 2231 | 51467 | 1751 | 32489 |
| 20-#14 | 3.47 | 24529 | 7284 | 40995 | 5260 | 44963 | 4242 | 46907 | 3427 | 49075 | 2175 | 59852 | 1507 | 45153 |
| 20-#18 | 6.17 | 27224 | 8495 | 48563 | 5973 | 54416 | 4758 | 58503 | 3770 | 64161 | 2017 | 80285 | 854 | 73539 |
| 24-#11 | 2.89 | 23950 | 7023 | 39236 | 5130 | 42884 | 4148 | 44397 | 3379 | 45802 | 2220 | 55258 | 1618 | 38429 |
| 24-#14 | 4.17 | 25293 | 7596 | 42867 | 5474 | 47443 | 4398 | 49921 | 3526 | 53165 | 2156 | 65226 | 1310 | 52843 |

## SQUARE TIED COLUMNS 38" x 38"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.11 | 26823 | 6936 | 41973 | 5105 | 44919 | 4163 | 45431 | 3476 | 44472 | 2498 | 51609 | 2346 | 18362 |
| 8-#14 | 1.25 | 26157 | 7005 | 41053 | 5181 | 43934 | 4244 | 44301 | 3537 | 43092 | 2533 | 49875 | 2243 | 20757 |
| 8-#18 | 2.22 | 27495 | 7489 | 44717 | 5439 | 48437 | 4440 | 49722 | 3651 | 50207 | 2463 | 59190 | 2000 | 35677 |
| 12-#11 | 1.30 | 26112 | 7030 | 40861 | 5232 | 43794 | 4261 | 44173 | 3547 | 43086 | 2550 | 50269 | 2208 | 21643 |
| 12-#14 | 1.87 | 26872 | 7316 | 42910 | 5395 | 46324 | 4376 | 47225 | 3612 | 47190 | 2517 | 55832 | 2056 | 30583 |
| 12-#18 | 3.32 | 28696 | 8042 | 47954 | 5818 | 52604 | 4673 | 54819 | 3782 | 57293 | 2428 | 69453 | 1654 | 51640 |
| 16-#11 | 1.73 | 26674 | 7246 | 42282 | 5364 | 45604 | 4370 | 46372 | 3617 | 45964 | 2523 | 54359 | 2128 | 28477 |
| 16-#14 | 2.49 | 27660 | 7627 | 44939 | 5585 | 48909 | 4533 | 50366 | 3712 | 51283 | 2476 | 61630 | 1937 | 39728 |
| 16-#18 | 4.43 | 30024 | 8596 | 51489 | 6153 | 57108 | 4950 | 60293 | 3957 | 64368 | 2348 | 79403 | 1432 | 65750 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 38" x 38"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.16 | 27256 | 7461 | 43751 | 5495 | 47412 | 4463 | 48576 | 3670 | 49008 | 2514 | 58565 | 2031 | 34798 |
| 20-#14 | 3.12 | 28475 | 7939 | 47036 | 5774 | 51491 | 4665 | 53513 | 3788 | 55615 | 2461 | 67601 | 1794 | 48387 |
| 20-#18 | 5.54 | 31400 | 9149 | 55143 | 6487 | 61607 | 5183 | 65777 | 4088 | 71858 | 2313 | 89684 | 1162 | 79422 |
| 24-#11 | 2.59 | 27846 | 7677 | 45150 | 5644 | 49266 | 4572 | 50829 | 3740 | 52090 | 2504 | 62635 | 1901 | 41104 |
| 24-#14 | 3.74 | 29302 | 8250 | 49035 | 5988 | 54139 | 4822 | 56731 | 3888 | 59999 | 2445 | 73377 | 1602 | 56873 |

## SQUARE TIED COLUMNS 40" x 40"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.00 | 31040 | 7625 | 48296 | 5642 | 51670 | 4606 | 52155 | 3852 | 50845 | 2791 | 58900 | 2634 | 19489 |
| 8-#14 | 1.13 | 30328 | 7694 | 47302 | 5721 | 50614 | 4688 | 50949 | 3915 | 49356 | 2827 | 57019 | 2531 | 22018 |
| 8-#18 | 2.00 | 31771 | 8179 | 51213 | 5978 | 55410 | 4884 | 56717 | 4029 | 56975 | 2760 | 67027 | 2296 | 37924 |
| 12-#11 | 1.17 | 30281 | 7719 | 47092 | 5774 | 50463 | 4707 | 50811 | 3926 | 49326 | 2843 | 57427 | 2497 | 22954 |
| 12-#14 | 1.69 | 31099 | 8006 | 49276 | 5936 | 53155 | 4821 | 54056 | 3991 | 53730 | 2813 | 63387 | 2349 | 32481 |
| 12-#18 | 3.00 | 33069 | 8732 | 54657 | 6358 | 59844 | 5118 | 62141 | 4161 | 64551 | 2729 | 78021 | 1958 | 55607 |
| 16-#11 | 1.56 | 30886 | 7935 | 48601 | 5906 | 52386 | 4817 | 53148 | 3997 | 52390 | 2818 | 61803 | 2419 | 30233 |
| 16-#14 | 2.25 | 31948 | 8317 | 51433 | 6126 | 55903 | 4979 | 57395 | 4092 | 58098 | 2774 | 69598 | 2233 | 42526 |
| 16-#18 | 4.00 | 34501 | 9285 | 58420 | 6694 | 64639 | 5396 | 67968 | 4338 | 72115 | 2653 | 88703 | 1742 | 70385 |
| 20-#11 | 1.95 | 31512 | 8151 | 50162 | 6038 | 54307 | 4909 | 55490 | 4050 | 55633 | 2809 | 66297 | 2325 | 37129 |
| 20-#14 | 2.81 | 32826 | 8628 | 53663 | 6316 | 58649 | 5112 | 60742 | 4168 | 62721 | 2761 | 75984 | 2094 | 51644 |
| 20-#18 | 5.00 | 35984 | 9838 | 62311 | 7029 | 69428 | 5630 | 73805 | 4470 | 80122 | 2622 | 99719 | 1480 | 85419 |
| 24-#11 | 2.34 | 32147 | 8367 | 51650 | 6187 | 56278 | 5019 | 57884 | 4120 | 58914 | 2801 | 70647 | 2197 | 43791 |
| 24-#14 | 3.38 | 33717 | 8939 | 55788 | 6531 | 61464 | 5270 | 64163 | 4269 | 67400 | 2747 | 82163 | 1906 | 60966 |

## SQUARE TIED COLUMNS 42" x 42"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#14 | 1.02 | 34925 | 8419 | 54166 | 6291 | 57957 | 5157 | 58251 | 4313 | 56199 | 3135 | 64830 | 2834 | 23278 |
| 8-#18 | 1.81 | 36472 | 8903 | 58325 | 6546 | 63045 | 5351 | 64367 | 4426 | 64340 | 3072 | 75531 | 2604 | 40167 |
| 12-#11 | 1.06 | 34874 | 8444 | 53937 | 6344 | 57794 | 5176 | 58105 | 4325 | 56134 | 3150 | 65252 | 2800 | 24263 |
| 12-#14 | 1.53 | 35752 | 8731 | 56257 | 6506 | 60648 | 5290 | 61542 | 4390 | 60842 | 3122 | 71610 | 2655 | 34375 |
| 12-#18 | 2.72 | 37867 | 9457 | 61978 | 6926 | 67747 | 5587 | 70118 | 4560 | 72405 | 3044 | 87256 | 2274 | 59004 |
| 16-#11 | 1.41 | 35523 | 8660 | 55536 | 6476 | 59830 | 5269 | 60579 | 4396 | 59379 | 3125 | 69915 | 2723 | 31985 |
| 16-#14 | 2.04 | 36662 | 9042 | 58543 | 6696 | 63559 | 5449 | 65080 | 4491 | 65481 | 3085 | 78234 | 2542 | 45203 |
| 16-#18 | 3.63 | 39406 | 10010 | 65969 | 7263 | 72832 | 5866 | 76297 | 4738 | 80459 | 2972 | 98670 | 2063 | 75070 |
| 20-#11 | 1.77 | 36193 | 8876 | 57189 | 6608 | 61865 | 5379 | 63059 | 4450 | 62812 | 3117 | 74697 | 2632 | 39479 |
| 20-#14 | 2.55 | 37603 | 9353 | 60906 | 6887 | 66468 | 5582 | 68625 | 4568 | 70389 | 3073 | 85035 | 2407 | 54925 |
| 20-#18 | 4.54 | 40997 | 10563 | 70095 | 7600 | 77912 | 6101 | 82488 | 4872 | 88984 | 2945 | 110424 | 1809 | 91530 |
| 24-#11 | 2.12 | 36873 | 9092 | 58764 | 6758 | 63952 | 5472 | 65594 | 4521 | 66287 | 3110 | 79327 | 2507 | 46491 |
| 24-#14 | 3.06 | 38558 | 9664 | 63157 | 7102 | 69451 | 5740 | 72250 | 4670 | 75357 | 3061 | 91618 | 2223 | 65050 |
| 24-#18 | 5.44 | 42614 | 11117 | 74025 | 7981 | 83121 | 6381 | 88817 | 5050 | 97611 | 2917 | 121795 | 1469 | 107333 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## SQUARE TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bars symmetrical in 4 faces

$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.65 | 41620 | 9664 | 66084 | 7142 | 71376 | 5842 | 72704 | 4843 | 72331 | 3398 | 84736 | 2927 | 42407 |
| 12-#14 | 1.39 | 40850 | 9491 | 63885 | 7104 | 68836 | 5783 | 69716 | 4809 | 68539 | 3445 | 80534 | 2975 | 36267 |
| 12-#18 | 2.48 | 43113 | 10217 | 69945 | 7523 | 76346 | 6078 | 78783 | 4978 | 80886 | 3374 | 97192 | 2603 | 62387 |
| 16-#11 | 1.29 | 40605 | 9420 | 63115 | 7075 | 67969 | 5762 | 68697 | 4815 | 66994 | 3448 | 78728 | 3042 | 33733 |
| 16-#14 | 1.86 | 41822 | 9802 | 66298 | 7295 | 71911 | 5917 | 73452 | 4911 | 73438 | 3409 | 87571 | 2864 | 47735 |
| 16-#18 | 3.31 | 44759 | 10770 | 74164 | 7861 | 81721 | 6359 | 85313 | 5158 | 89431 | 3305 | 109340 | 2397 | 79806 |
| 20-#11 | 1.61 | 41320 | 9636 | 64860 | 7208 | 70118 | 5873 | 71315 | 4869 | 70618 | 3441 | 83799 | 2953 | 41759 |
| 20-#14 | 2.32 | 42827 | 10113 | 68794 | 7486 | 74983 | 6076 | 77196 | 4988 | 78622 | 3397 | 94788 | 2733 | 58230 |
| 20-#18 | 4.13 | 46460 | 11324 | 78526 | 8199 | 87091 | 6595 | 91858 | 5293 | 98473 | 3281 | 121832 | 2150 | 97756 |
| 24-#11 | 1.93 | 42045 | 9852 | 66523 | 7358 | 72321 | 5966 | 73992 | 4941 | 74286 | 3434 | 88709 | 2831 | 49204 |
| 24-#14 | 2.79 | 43846 | 10424 | 71172 | 7701 | 78134 | 6210 | 81024 | 5090 | 83868 | 3386 | 101775 | 2552 | 68886 |
| 24-#18 | 4.96 | 48187 | 11877 | 82682 | 8580 | 92598 | 6876 | 98549 | 5472 | 107624 | 3257 | 133919 | 1816 | 114227 |

## SQUARE TIED COLUMNS 46" x 46"

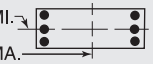
| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#18 | 1.51 | 47235 | 10459 | 74521 | 7766 | 80436 | 6356 | 81762 | 5280 | 80951 | 3738 | 94674 | 3263 | 44641 |
| 12-#14 | 1.28 | 46416 | 10286 | 72188 | 7731 | 77753 | 6299 | 78611 | 5247 | 76893 | 3783 | 90192 | 3309 | 38155 |
| 12-#18 | 2.27 | 48828 | 11013 | 78590 | 8149 | 85673 | 6594 | 88167 | 5417 | 89986 | 3716 | 107863 | 2944 | 65762 |
| 16-#11 | 1.18 | 46155 | 10216 | 71370 | 7703 | 76837 | 6279 | 77537 | 5255 | 75266 | 3786 | 88276 | 3375 | 35480 |
| 16-#14 | 1.70 | 47450 | 10598 | 74730 | 7922 | 80991 | 6433 | 82545 | 5350 | 82052 | 3747 | 97643 | 3201 | 50261 |
| 16-#18 | 3.02 | 50581 | 11566 | 83036 | 8487 | 91338 | 6875 | 95050 | 5597 | 99013 | 3650 | 120746 | 2743 | 84592 |
| 20-#11 | 1.47 | 46915 | 10432 | 73207 | 7836 | 79098 | 6390 | 80293 | 5309 | 79081 | 3780 | 93636 | 3288 | 43946 |
| 20-#14 | 2.13 | 48519 | 10909 | 77358 | 8113 | 84226 | 6593 | 86488 | 5428 | 87510 | 3737 | 105276 | 3072 | 61559 |
| 20-#18 | 3.78 | 52393 | 12119 | 87634 | 8826 | 96998 | 7113 | 101949 | 5733 | 108564 | 3628 | 133976 | 2503 | 103593 |
| 24-#11 | 1.77 | 47686 | 10647 | 74958 | 7986 | 81417 | 6484 | 83110 | 5381 | 82942 | 3773 | 98826 | 3168 | 51931 |
| 24-#14 | 2.55 | 49603 | 11220 | 79863 | 8329 | 87545 | 6727 | 90519 | 5531 | 93035 | 3726 | 112667 | 2895 | 72735 |
| 24-#18 | 4.54 | 54231 | 12672 | 92015 | 9208 | 102803 | 7394 | 109002 | 5914 | 118230 | 3607 | 146780 | 2175 | 121205 |

## SQUARE TIED COLUMNS 48" x 48"

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 8-#18 | 1.39 | 53339 | 11290 | 83664 | 8420 | 90256 | 6894 | 91572 | 5737 | 90198 | 4089 | 105380 | 3612 | 46870 |
| 12-#14 | 1.17 | 52471 | 11117 | 81197 | 8386 | 87430 | 6838 | 88258 | 5706 | 85932 | 4136 | 100619 | 3657 | 40036 |
| 12-#18 | 2.08 | 55031 | 11844 | 87941 | 8803 | 95761 | 7132 | 98305 | 5875 | 99694 | 4069 | 119302 | 3300 | 69130 |
| 16-#11 | 1.08 | 52194 | 11047 | 80330 | 8359 | 86465 | 6820 | 87130 | 5714 | 84224 | 4140 | 98593 | 3722 | 37220 |
| 16-#14 | 1.56 | 53567 | 11429 | 83867 | 8578 | 90831 | 6973 | 92391 | 5809 | 91351 | 4101 | 108484 | 3551 | 52783 |
| 16-#18 | 2.78 | 56893 | 12397 | 92616 | 9142 | 101716 | 7415 | 105541 | 6056 | 109183 | 4005 | 132920 | 3102 | 89430 |
| 20-#11 | 1.35 | 52998 | 11263 | 82260 | 8493 | 88840 | 6931 | 90024 | 5769 | 88230 | 4134 | 104241 | 3637 | 46129 |
| 20-#14 | 1.95 | 54700 | 11740 | 86628 | 8769 | 94231 | 7133 | 96533 | 5888 | 97085 | 4091 | 116533 | 3425 | 64913 |
| 20-#18 | 3.47 | 58816 | 12950 | 97450 | 9481 | 107667 | 7653 | 112793 | 6194 | 119223 | 3984 | 146889 | 2868 | 109284 |
| 24-#11 | 1.63 | 53814 | 11478 | 84098 | 8643 | 91275 | 7025 | 92982 | 5841 | 92284 | 4127 | 109712 | 3519 | 54672 |
| 24-#14 | 2.34 | 55849 | 12051 | 89260 | 8986 | 97716 | 7268 | 100768 | 5991 | 102889 | 4081 | 124328 | 3251 | 76600 |
| 24-#18 | 4.17 | 60767 | 13503 | 102056 | 9865 | 113770 | 7936 | 120208 | 6375 | 129384 | 3964 | 160411 | 2545 | 128267 |

## RECTANGULAR TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.86 | MA | 255 | 275 | 419 | 206 | 461 | 171 | 480 | 140 | 495 | 91 | 526 | 54 | 366 |
| 2L-3S | | MI | 239 | 275 | 387 | 206 | 422 | 170 | 434 | 141 | 437 | 92 | 465 | 33 | 370 |
| 6-#6 | 2.64 | MA | 268 | 298 | 457 | 219 | 505 | 179 | 529 | 143 | 557 | 84 | 588 | 36 | 485 |
| 2L-3S | | MI | 246 | 298 | 413 | 218 | 451 | 178 | 467 | 145 | 478 | 85 | 505 | 6 | 489 |
| 6-#7 | 3.60 | MA | 282 | 325 | 502 | 235 | 555 | 188 | 587 | 147 | 630 | 75 | 676 | 19 | 624 |
| 2L-3S | | MI | 254 | 325 | 444 | 234 | 485 | 187 | 505 | 149 | 526 | 77 | 563 | -23 | 551 |

## RECTANGULAR TIED COLUMNS 10" x 12"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#5 | 1.03 | MA | 353 | 301 | 536 | 239 | 599 | 201 | 629 | 172 | 641 | 124 | 704 | 96 | 332 |
| 2E | | MI | 288 | 301 | 452 | 230 | 491 | 193 | 503 | 162 | 501 | 115 | 534 | 84 | 276 |
| 4-#6 | 1.47 | MA | 366 | 316 | 572 | 247 | 643 | 207 | 681 | 175 | 704 | 121 | 773 | 87 | 444 |
| 2E | | MI | 297 | 316 | 478 | 237 | 520 | 197 | 536 | 164 | 542 | 110 | 574 | 71 | 362 |
| 4-#7 | 2.00 | MA | 380 | 335 | 615 | 258 | 696 | 214 | 740 | 179 | 779 | 117 | 853 | 76 | 575 |
| 2E | | MI | 306 | 335 | 509 | 247 | 554 | 203 | 574 | 165 | 590 | 104 | 631 | 60 | 461 |
| 4-#8 | 2.63 | MA | 397 | 357 | 665 | 270 | 756 | 223 | 808 | 183 | 865 | 112 | 944 | 61 | 724 |
| 2E | | MI | 317 | 357 | 544 | 259 | 592 | 209 | 617 | 167 | 644 | 96 | 684 | 41 | 572 |
| 4-#9 | 3.33 | MA | 414 | 381 | 718 | 284 | 821 | 233 | 880 | 187 | 955 | 106 | 1037 | 44 | 882 |
| 2E | | MI | 328 | 381 | 578 | 272 | 630 | 216 | 660 | 169 | 698 | 87 | 735 | 18 | 687 |
| 4-#10 | 4.23 | MA | 435 | 412 | 783 | 302 | 902 | 246 | 967 | 192 | 1064 | 97 | 1148 | 21 | 1078 |
| 2E | | MI | 342 | 412 | 618 | 287 | 676 | 225 | 712 | 170 | 764 | 74 | 794 | -13 | 799 |
| 4-#11 | 5.20 | MA | 448 | 446 | 841 | 318 | 950 | 252 | 1020 | 191 | 1130 | 81 | 1187 | -19 | 1189 |
| 2E | | MI | 349 | 446 | 638 | 296 | 693 | 226 | 730 | 163 | 785 | 50 | 785 | -65 | 792 |
| 6-#5 | 1.55 | MA | 370 | 319 | 578 | 251 | 654 | 210 | 695 | 177 | 725 | 122 | 800 | 88 | 467 |
| 2L-3S | | MI | 283 | 319 | 452 | 241 | 491 | 200 | 503 | 167 | 501 | 112 | 534 | 51 | 384 |
| 6-#5 | 1.55 | MA | 347 | 319 | 536 | 251 | 599 | 210 | 629 | 178 | 641 | 123 | 704 | 66 | 471 |
| 3L-2S | | MI | 300 | 319 | 483 | 241 | 530 | 200 | 548 | 166 | 559 | 111 | 595 | 72 | 379 |
| 6-#6 | 2.20 | MA | 388 | 342 | 632 | 263 | 719 | 219 | 773 | 182 | 821 | 118 | 905 | 75 | 628 |
| 2L-3S | | MI | 290 | 342 | 478 | 253 | 520 | 207 | 536 | 170 | 542 | 106 | 574 | 24 | 506 |
| 6-#6 | 2.20 | MA | 358 | 342 | 572 | 264 | 643 | 219 | 681 | 184 | 704 | 119 | 773 | 43 | 631 |
| 3L-2S | | MI | 312 | 342 | 522 | 253 | 574 | 208 | 598 | 169 | 621 | 105 | 656 | 54 | 501 |
| 6-#7 | 3.00 | MA | 410 | 370 | 695 | 279 | 797 | 230 | 862 | 188 | 934 | 112 | 1027 | 58 | 818 |
| 2L-3S | | MI | 298 | 370 | 509 | 268 | 554 | 216 | 574 | 174 | 590 | 97 | 631 | -5 | 619 |
| 6-#7 | 3.00 | MA | 371 | 370 | 615 | 280 | 696 | 230 | 740 | 190 | 779 | 114 | 853 | 15 | 816 |
| 3L-2S | | MI | 326 | 370 | 568 | 269 | 624 | 217 | 655 | 172 | 694 | 96 | 743 | 37 | 642 |
| 6-#8 | 3.95 | MA | 386 | 403 | 665 | 299 | 756 | 243 | 808 | 197 | 865 | 107 | 944 | -21 | 939 |
| 3L-2S | | MI | 343 | 403 | 619 | 288 | 681 | 228 | 719 | 175 | 774 | 84 | 823 | 8 | 801 |
| 6-#9 | 5.00 | MA | 403 | 439 | 718 | 320 | 821 | 258 | 880 | 205 | 955 | 99 | 1037 | -61 | 1023 |
| 3L-2S | | MI | 359 | 439 | 669 | 307 | 738 | 239 | 785 | 178 | 857 | 71 | 901 | -25 | 882 |
| 6-#10 | 6.35 | MA | 423 | 486 | 783 | 348 | 902 | 276 | 967 | 213 | 1064 | 88 | 1148 | -116 | 1124 |
| 3L-2S | | MI | 380 | 486 | 729 | 331 | 806 | 253 | 863 | 181 | 956 | 52 | 991 | -71 | 976 |

## RECTANGULAR TIED COLUMNS 10" x 14"

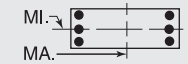
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.26 | MA | 497 | 360 | 749 | 292 | 855 | 245 | 910 | 208 | 960 | 151 | 1076 | 118 | 539 |
| 2E | | MI | 341 | 360 | 543 | 272 | 589 | 226 | 604 | 189 | 607 | 131 | 642 | 89 | 375 |
| 4-#7 | 1.71 | MA | 518 | 379 | 804 | 302 | 922 | 252 | 990 | 212 | 1063 | 148 | 1194 | 109 | 704 |
| 2E | | MI | 351 | 379 | 575 | 281 | 623 | 232 | 642 | 191 | 654 | 124 | 699 | 77 | 476 |
| 4-#8 | 2.26 | MA | 541 | 401 | 869 | 314 | 1001 | 261 | 1084 | 217 | 1181 | 145 | 1328 | 98 | 895 |
| 2E | | MI | 361 | 401 | 610 | 293 | 661 | 238 | 685 | 192 | 707 | 116 | 751 | 58 | 589 |
| 4-#9 | 2.86 | MA | 564 | 425 | 938 | 328 | 1085 | 271 | 1185 | 223 | 1307 | 140 | 1469 | 86 | 1098 |
| 2E | | MI | 372 | 425 | 644 | 305 | 699 | 245 | 728 | 193 | 762 | 106 | 802 | 35 | 707 |
| 4-#10 | 3.63 | MA | 593 | 457 | 1024 | 346 | 1192 | 284 | 1312 | 231 | 1463 | 135 | 1641 | 68 | 1352 |
| 2E | | MI | 386 | 457 | 685 | 320 | 745 | 253 | 780 | 195 | 827 | 93 | 861 | 4 | 849 |
| 4-#11 | 4.46 | MA | 614 | 490 | 1105 | 363 | 1286 | 296 | 1414 | 236 | 1576 | 122 | 1739 | 37 | 1586 |
| 2E | | MI | 393 | 490 | 705 | 328 | 762 | 253 | 798 | 187 | 848 | 69 | 851 | -49 | 873 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 10" x 14"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

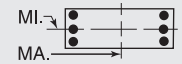
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.33 | MA | 502 | 363 | 756 | 295 | 867 | 247 | 926 | 210 | 986 | 152 | 1111 | 119 | 567 |
| 2L-3S | | MI | 327 | 363 | 516 | 275 | 560 | 229 | 572 | 193 | 566 | 133 | 603 | 68 | 396 |
| 6-#5 | 1.33 | MA | 472 | 363 | 702 | 296 | 798 | 248 | 843 | 210 | 874 | 153 | 977 | 96 | 571 |
| 3L-2S | | MI | 344 | 363 | 548 | 275 | 599 | 230 | 617 | 192 | 623 | 132 | 664 | 90 | 392 |
| 6-#6 | 1.89 | MA | 528 | 386 | 824 | 308 | 951 | 256 | 1026 | 215 | 1115 | 149 | 1261 | 109 | 771 |
| 2L-3S | | MI | 334 | 386 | 543 | 287 | 589 | 236 | 604 | 196 | 607 | 126 | 642 | 42 | 522 |
| 6-#6 | 1.89 | MA | 488 | 386 | 749 | 309 | 855 | 257 | 910 | 218 | 960 | 150 | 1076 | 77 | 774 |
| 3L-2S | | MI | 356 | 386 | 587 | 288 | 643 | 237 | 666 | 194 | 685 | 125 | 724 | 72 | 516 |
| 6-#7 | 2.57 | MA | 558 | 414 | 906 | 324 | 1052 | 268 | 1147 | 222 | 1270 | 145 | 1439 | 97 | 1013 |
| 2L-3S | | MI | 342 | 414 | 575 | 302 | 623 | 245 | 642 | 199 | 654 | 117 | 699 | 12 | 665 |
| 6-#7 | 2.57 | MA | 507 | 414 | 804 | 326 | 922 | 269 | 990 | 225 | 1063 | 147 | 1194 | 53 | 1010 |
| 3L-2S | | MI | 371 | 414 | 633 | 303 | 693 | 246 | 724 | 197 | 757 | 116 | 811 | 54 | 660 |
| 6-#8 | 3.39 | MA | 528 | 447 | 869 | 345 | 1001 | 283 | 1084 | 234 | 1181 | 143 | 1328 | 23 | 1277 |
| 3L-2S | | MI | 387 | 447 | 685 | 322 | 749 | 257 | 788 | 201 | 838 | 104 | 891 | 26 | 821 |
| 6-#9 | 4.29 | MA | 551 | 483 | 938 | 367 | 1085 | 298 | 1185 | 244 | 1307 | 138 | 1469 | -11 | 1463 |
| 3L-2S | | MI | 404 | 483 | 735 | 341 | 807 | 267 | 853 | 203 | 921 | 90 | 969 | -8 | 971 |
| 6-#10 | 5.44 | MA | 580 | 530 | 1024 | 395 | 1192 | 318 | 1312 | 257 | 1463 | 131 | 1641 | -56 | 1611 |
| 3L-2S | | MI | 424 | 530 | 795 | 364 | 875 | 281 | 931 | 206 | 1019 | 71 | 1058 | -54 | 1042 |
| 6-#11 | 6.69 | MA | 601 | 581 | 1105 | 421 | 1286 | 335 | 1414 | 265 | 1576 | 114 | 1739 | -122 | 1690 |
| 3L-2S | | MI | 436 | 581 | 822 | 379 | 902 | 284 | 959 | 196 | 1053 | 37 | 1047 | -131 | 1061 |
| 8-#5 | 1.77 | MA | 495 | 381 | 756 | 307 | 867 | 256 | 926 | 215 | 986 | 152 | 1111 | 90 | 735 |
| 3E | | MI | 339 | 381 | 548 | 286 | 599 | 237 | 617 | 197 | 623 | 129 | 664 | 57 | 497 |
| 8-#5 | 1.77 | MA | 478 | 381 | 717 | 309 | 814 | 259 | 861 | 217 | 897 | 151 | 1013 | 80 | 735 |
| 4L-2S | | MI | 355 | 381 | 580 | 287 | 638 | 238 | 662 | 196 | 681 | 128 | 725 | 78 | 493 |
| 8-#6 | 2.51 | MA | 520 | 411 | 824 | 325 | 951 | 269 | 1026 | 225 | 1115 | 149 | 1261 | 69 | 999 |
| 3E | | MI | 350 | 411 | 587 | 303 | 643 | 247 | 666 | 201 | 685 | 120 | 724 | 24 | 657 |
| 8-#6 | 2.51 | MA | 496 | 411 | 770 | 327 | 876 | 272 | 935 | 225 | 992 | 148 | 1126 | 54 | 956 |
| 4L-2S | | MI | 372 | 411 | 631 | 304 | 696 | 248 | 728 | 200 | 764 | 119 | 806 | 54 | 653 |
| 8-#7 | 3.43 | MA | 549 | 449 | 906 | 347 | 1052 | 285 | 1147 | 235 | 1270 | 145 | 1439 | 40 | 1308 |
| 3E | | MI | 363 | 449 | 633 | 323 | 693 | 259 | 724 | 206 | 757 | 109 | 811 | -11 | 794 |
| 8-#7 | 3.43 | MA | 519 | 449 | 833 | 350 | 950 | 289 | 1023 | 235 | 1105 | 143 | 1260 | 22 | 1195 |
| 4L-2S | | MI | 391 | 449 | 692 | 325 | 763 | 261 | 805 | 204 | 861 | 107 | 923 | 31 | 838 |
| 8-#8 | 4.51 | MA | 545 | 493 | 905 | 377 | 1037 | 309 | 1126 | 247 | 1236 | 137 | 1412 | -18 | 1408 |
| 4L-2S | | MI | 412 | 493 | 760 | 350 | 838 | 275 | 891 | 209 | 969 | 92 | 1030 | -6 | 1032 |
| 8-#9 | 5.71 | MA | 574 | 541 | 983 | 406 | 1130 | 331 | 1237 | 260 | 1384 | 135 | 1570 | -64 | 1552 |
| 4L-2S | | MI | 435 | 541 | 826 | 376 | 915 | 290 | 978 | 213 | 1079 | 74 | 1135 | -51 | 1111 |

## RECTANGULAR TIED COLUMNS 10" x 16"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.10 | MA | 647 | 405 | 943 | 336 | 1090 | 282 | 1166 | 241 | 1234 | 177 | 1414 | 146 | 634 |
| 2E | | MI | 385 | 405 | 608 | 306 | 658 | 256 | 673 | 215 | 671 | 151 | 710 | 107 | 386 |
| 4-#7 | 1.50 | MA | 674 | 423 | 1011 | 346 | 1173 | 290 | 1264 | 245 | 1366 | 176 | 1570 | 139 | 834 |
| 2E | | MI | 395 | 423 | 640 | 315 | 692 | 261 | 711 | 216 | 718 | 144 | 767 | 95 | 490 |
| 4-#8 | 1.98 | MA | 703 | 445 | 1090 | 358 | 1269 | 299 | 1379 | 250 | 1520 | 174 | 1750 | 131 | 1065 |
| 2E | | MI | 406 | 445 | 676 | 327 | 729 | 267 | 753 | 217 | 771 | 136 | 819 | 76 | 605 |
| 4-#9 | 2.50 | MA | 735 | 470 | 1175 | 372 | 1374 | 309 | 1504 | 256 | 1686 | 172 | 1940 | 121 | 1314 |
| 2E | | MI | 417 | 470 | 710 | 338 | 768 | 273 | 797 | 218 | 825 | 126 | 869 | 53 | 725 |
| 4-#10 | 3.17 | MA | 772 | 501 | 1282 | 390 | 1505 | 322 | 1661 | 264 | 1894 | 169 | 2175 | 108 | 1626 |
| 2E | | MI | 430 | 501 | 751 | 353 | 814 | 281 | 848 | 219 | 890 | 113 | 927 | 22 | 871 |
| 4-#11 | 3.90 | MA | 801 | 534 | 1387 | 407 | 1628 | 333 | 1805 | 271 | 2056 | 159 | 2337 | 84 | 1923 |
| 2E | | MI | 437 | 534 | 772 | 360 | 831 | 281 | 866 | 211 | 910 | 88 | 916 | -32 | 932 |
| 6-#5 | 1.16 | MA | 653 | 408 | 951 | 339 | 1105 | 285 | 1185 | 243 | 1261 | 178 | 1455 | 147 | 668 |
| 2L-3S | | MI | 372 | 408 | 581 | 310 | 629 | 258 | 640 | 218 | 630 | 153 | 671 | 86 | 407 |
| 6-#5 | 1.16 | MA | 616 | 408 | 886 | 341 | 1022 | 286 | 1084 | 243 | 1126 | 180 | 1283 | 124 | 672 |
| 3L-2S | | MI | 388 | 408 | 613 | 310 | 668 | 259 | 686 | 218 | 688 | 152 | 732 | 108 | 403 |
| 6-#6 | 1.65 | MA | 686 | 430 | 1035 | 352 | 1207 | 294 | 1307 | 248 | 1424 | 176 | 1653 | 140 | 913 |
| 2L-3S | | MI | 378 | 430 | 608 | 321 | 658 | 265 | 673 | 221 | 671 | 146 | 710 | 59 | 536 |
| 6-#6 | 1.65 | MA | 636 | 430 | 943 | 354 | 1090 | 296 | 1166 | 249 | 1234 | 178 | 1414 | 108 | 916 |
| 3L-2S | | MI | 401 | 430 | 652 | 322 | 711 | 266 | 735 | 220 | 749 | 145 | 792 | 89 | 530 |

## RECTANGULAR TIED COLUMNS 10" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

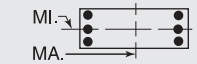
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 2.25 | MA | 725 | 458 | 1135 | 368 | 1330 | 306 | 1454 | 255 | 1622 | 174 | 1888 | 130 | 1207 |
| 2L-3S | | MI | 386 | 458 | 640 | 336 | 692 | 274 | 711 | 224 | 718 | 137 | 767 | 30 | 683 |
| 6-#7 | 2.25 | MA | 659 | 458 | 1011 | 371 | 1173 | 308 | 1264 | 256 | 1366 | 177 | 1570 | 87 | 1205 |
| 3L-2S | | MI | 415 | 458 | 699 | 337 | 762 | 275 | 792 | 223 | 821 | 136 | 879 | 72 | 676 |
| 6-#8 | 2.96 | MA | 686 | 491 | 1090 | 391 | 1269 | 322 | 1379 | 265 | 1520 | 175 | 1750 | 61 | 1532 |
| 3L-2S | | MI | 431 | 491 | 751 | 355 | 818 | 285 | 856 | 226 | 902 | 124 | 958 | 43 | 840 |
| 6-#9 | 3.75 | MA | 718 | 528 | 1175 | 413 | 1374 | 338 | 1504 | 274 | 1686 | 172 | 1940 | 32 | 1871 |
| 3L-2S | | MI | 448 | 528 | 801 | 374 | 876 | 296 | 922 | 228 | 984 | 110 | 1036 | 10 | 1010 |
| 6-#10 | 4.76 | MA | 756 | 575 | 1282 | 442 | 1505 | 358 | 1661 | 286 | 1894 | 169 | 2175 | -8 | 2168 |
| 3L-2S | | MI | 468 | 575 | 861 | 398 | 944 | 309 | 999 | 230 | 1082 | 91 | 1124 | -36 | 1106 |
| 6-#11 | 5.85 | MA | 785 | 625 | 1387 | 469 | 1628 | 377 | 1805 | 304 | 2056 | 156 | 2337 | -64 | 2289 |
| 3L-2S | | MI | 480 | 625 | 890 | 412 | 971 | 311 | 1027 | 220 | 1116 | 56 | 1113 | -115 | 1125 |
| 8-#5 | 1.55 | MA | 645 | 425 | 951 | 352 | 1105 | 295 | 1185 | 249 | 1261 | 179 | 1455 | 120 | 869 |
| 3E | | MI | 383 | 425 | 613 | 321 | 668 | 266 | 686 | 222 | 688 | 150 | 732 | 75 | 510 |
| 8-#5 | 1.55 | MA | 624 | 425 | 905 | 354 | 1041 | 298 | 1107 | 251 | 1155 | 179 | 1332 | 109 | 869 |
| 4L-2S | | MI | 400 | 425 | 644 | 321 | 707 | 267 | 731 | 222 | 745 | 149 | 793 | 96 | 506 |
| 8-#6 | 2.20 | MA | 676 | 456 | 1035 | 370 | 1207 | 308 | 1307 | 256 | 1424 | 177 | 1653 | 102 | 1189 |
| 3E | | MI | 394 | 456 | 652 | 337 | 711 | 276 | 735 | 226 | 749 | 141 | 792 | 42 | 673 |
| 8-#6 | 2.20 | MA | 647 | 456 | 970 | 373 | 1117 | 312 | 1197 | 260 | 1274 | 177 | 1481 | 86 | 1163 |
| 4L-2S | | MI | 416 | 456 | 696 | 338 | 765 | 277 | 797 | 225 | 828 | 139 | 874 | 72 | 668 |
| 8-#7 | 3.00 | MA | 712 | 493 | 1135 | 393 | 1330 | 324 | 1454 | 266 | 1622 | 175 | 1888 | 78 | 1567 |
| 3E | | MI | 407 | 493 | 699 | 357 | 762 | 288 | 792 | 231 | 821 | 129 | 879 | 7 | 860 |
| 8-#7 | 3.00 | MA | 675 | 493 | 1047 | 396 | 1209 | 329 | 1306 | 271 | 1420 | 174 | 1659 | 57 | 1459 |
| 4L-2S | | MI | 435 | 493 | 757 | 359 | 832 | 290 | 874 | 230 | 925 | 127 | 991 | 49 | 856 |
| 8-#8 | 3.95 | MA | 712 | 537 | 1136 | 423 | 1315 | 350 | 1433 | 284 | 1589 | 171 | 1863 | 21 | 1791 |
| 4L-2S | | MI | 457 | 537 | 826 | 384 | 907 | 304 | 959 | 234 | 1033 | 112 | 1098 | 11 | 1068 |
| 8-#9 | 5.00 | MA | 750 | 586 | 1232 | 454 | 1431 | 373 | 1571 | 298 | 1773 | 167 | 2079 | -19 | 2069 |
| 4L-2S | | MI | 479 | 586 | 892 | 410 | 984 | 319 | 1046 | 238 | 1143 | 94 | 1202 | -33 | 1176 |
| 8-#10 | 6.35 | MA | 798 | 648 | 1353 | 493 | 1576 | 402 | 1744 | 315 | 2002 | 161 | 2346 | -73 | 2300 |
| 4L-2S | | MI | 507 | 648 | 971 | 442 | 1075 | 337 | 1151 | 242 | 1274 | 69 | 1321 | -94 | 1302 |

## RECTANGULAR TIED COLUMNS 10" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.33 | MA | 848 | 467 | 1236 | 390 | 1448 | 327 | 1565 | 278 | 1688 | 202 | 1981 | 168 | 964 |
| 2E | | MI | 439 | 467 | 706 | 349 | 761 | 290 | 780 | 241 | 782 | 164 | 835 | 113 | 503 |
| 4-#8 | 1.76 | MA | 885 | 489 | 1329 | 403 | 1562 | 336 | 1701 | 283 | 1871 | 200 | 2206 | 162 | 1236 |
| 2E | | MI | 450 | 489 | 742 | 360 | 798 | 296 | 822 | 242 | 835 | 156 | 886 | 93 | 621 |
| 4-#9 | 2.22 | MA | 923 | 514 | 1430 | 416 | 1686 | 346 | 1849 | 289 | 2069 | 198 | 2447 | 154 | 1530 |
| 2E | | MI | 461 | 514 | 776 | 372 | 837 | 302 | 865 | 243 | 889 | 146 | 936 | 70 | 743 |
| 4-#10 | 2.82 | MA | 971 | 545 | 1557 | 434 | 1843 | 359 | 2037 | 297 | 2321 | 196 | 2747 | 144 | 1901 |
| 2E | | MI | 474 | 545 | 817 | 386 | 883 | 310 | 917 | 244 | 953 | 133 | 994 | 39 | 891 |
| 4-#11 | 3.47 | MA | 1009 | 579 | 1686 | 451 | 1994 | 371 | 2213 | 304 | 2554 | 191 | 2975 | 124 | 2260 |
| 2E | | MI | 481 | 579 | 839 | 393 | 900 | 308 | 934 | 235 | 973 | 107 | 981 | -15 | 990 |
| 6-#5 | 1.03 | MA | 823 | 452 | 1164 | 383 | 1366 | 323 | 1470 | 275 | 1564 | 204 | 1834 | 174 | 768 |
| 2L-3S | | MI | 416 | 452 | 646 | 344 | 697 | 288 | 709 | 244 | 695 | 174 | 740 | 104 | 417 |
| 6-#5 | 1.03 | MA | 778 | 452 | 1088 | 385 | 1269 | 324 | 1352 | 277 | 1405 | 206 | 1623 | 151 | 772 |
| 3L-2S | | MI | 433 | 452 | 677 | 344 | 736 | 289 | 754 | 243 | 752 | 173 | 801 | 126 | 414 |
| 6-#6 | 1.47 | MA | 863 | 474 | 1263 | 396 | 1486 | 332 | 1614 | 281 | 1756 | 202 | 2079 | 168 | 1056 |
| 2L-3S | | MI | 422 | 474 | 673 | 355 | 727 | 294 | 742 | 247 | 735 | 167 | 779 | 77 | 549 |
| 6-#6 | 1.47 | MA | 802 | 474 | 1155 | 399 | 1350 | 334 | 1448 | 283 | 1533 | 205 | 1786 | 136 | 1059 |
| 3L-2S | | MI | 445 | 474 | 717 | 356 | 780 | 296 | 804 | 245 | 814 | 165 | 861 | 107 | 543 |
| 6-#7 | 2.00 | MA | 910 | 502 | 1381 | 412 | 1632 | 343 | 1788 | 288 | 1990 | 200 | 2373 | 161 | 1401 |
| 2L-3S | | MI | 430 | 502 | 706 | 370 | 761 | 303 | 780 | 250 | 782 | 158 | 835 | 48 | 700 |
| 6-#7 | 2.00 | MA | 831 | 502 | 1236 | 416 | 1448 | 346 | 1565 | 290 | 1688 | 204 | 1981 | 118 | 1399 |
| 3L-2S | | MI | 459 | 502 | 764 | 371 | 831 | 304 | 861 | 248 | 885 | 156 | 947 | 89 | 692 |
| 6-#8 | 2.63 | MA | 865 | 535 | 1329 | 436 | 1562 | 361 | 1701 | 299 | 1871 | 202 | 2206 | 95 | 1788 |
| 3L-2S | | MI | 476 | 535 | 817 | 389 | 887 | 314 | 925 | 251 | 966 | 144 | 1026 | 61 | 858 |
| 6-#9 | 3.33 | MA | 901 | 572 | 1430 | 459 | 1686 | 377 | 1849 | 309 | 2069 | 201 | 2447 | 69 | 2202 |
| 3L-2S | | MI | 492 | 572 | 867 | 407 | 945 | 324 | 990 | 253 | 1048 | 130 | 1103 | 27 | 1031 |

## RECTANGULAR TIED COLUMNS 10" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 4.23 | MA | 951 | 619 | 1557 | 488 | 1843 | 398 | 2037 | 321 | 2321 | 198 | 2747 | 35 | 2666 |
| 3L-2S | | MI | 513 | 619 | 928 | 431 | 1013 | 337 | 1068 | 255 | 1146 | 111 | 1191 | -19 | 1198 |
| 6-#11 | 5.20 | MA | 990 | 669 | 1686 | 515 | 1994 | 417 | 2213 | 332 | 2554 | 192 | 2975 | -15 | 2958 |
| 3L-2S | | MI | 524 | 669 | 957 | 444 | 1040 | 339 | 1095 | 244 | 1178 | 75 | 1178 | -98 | 1188 |
| 8-#5 | 1.38 | MA | 813 | 470 | 1164 | 397 | 1366 | 333 | 1470 | 282 | 1564 | 206 | 1834 | 148 | 1003 |
| 3E | | MI | 427 | 470 | 677 | 355 | 736 | 296 | 754 | 248 | 752 | 170 | 801 | 93 | 522 |
| 8-#5 | 1.38 | MA | 788 | 470 | 1111 | 399 | 1292 | 336 | 1379 | 285 | 1440 | 206 | 1684 | 136 | 1003 |
| 4L-2S | | MI | 444 | 470 | 709 | 356 | 776 | 297 | 800 | 247 | 810 | 169 | 862 | 114 | 518 |
| 8-#6 | 1.96 | MA | 851 | 500 | 1263 | 415 | 1486 | 346 | 1614 | 290 | 1756 | 204 | 2079 | 132 | 1379 |
| 3E | | MI | 438 | 500 | 717 | 371 | 780 | 305 | 804 | 252 | 814 | 161 | 861 | 60 | 689 |
| 8-#6 | 1.96 | MA | 817 | 500 | 1187 | 418 | 1382 | 351 | 1486 | 294 | 1581 | 205 | 1870 | 115 | 1367 |
| 4L-2S | | MI | 461 | 500 | 761 | 372 | 834 | 307 | 866 | 251 | 892 | 160 | 943 | 89 | 683 |
| 8-#7 | 2.67 | MA | 895 | 537 | 1381 | 438 | 1632 | 362 | 1788 | 300 | 1990 | 202 | 2373 | 112 | 1827 |
| 3E | | MI | 451 | 537 | 764 | 391 | 831 | 317 | 861 | 256 | 885 | 149 | 947 | 25 | 879 |
| 8-#7 | 2.67 | MA | 852 | 537 | 1279 | 441 | 1491 | 369 | 1615 | 306 | 1754 | 203 | 2093 | 89 | 1731 |
| 4L-2S | | MI | 480 | 537 | 822 | 393 | 901 | 319 | 942 | 255 | 989 | 147 | 1059 | 66 | 874 |
| 8-#8 | 3.51 | MA | 893 | 581 | 1385 | 470 | 1618 | 390 | 1766 | 319 | 1956 | 200 | 2351 | 56 | 2129 |
| 4L-2S | | MI | 501 | 581 | 892 | 418 | 976 | 333 | 1028 | 259 | 1096 | 132 | 1165 | 29 | 1088 |
| 8-#9 | 4.44 | MA | 938 | 630 | 1500 | 501 | 1756 | 414 | 1931 | 334 | 2175 | 198 | 2625 | 20 | 2550 |
| 4L-2S | | MI | 523 | 630 | 958 | 443 | 1053 | 347 | 1115 | 263 | 1206 | 114 | 1269 | -16 | 1240 |
| 8-#10 | 5.64 | MA | 1004 | 692 | 1644 | 541 | 1929 | 444 | 2139 | 353 | 2452 | 194 | 2967 | -29 | 2941 |
| 4L-2S | | MI | 551 | 692 | 1038 | 475 | 1144 | 365 | 1219 | 266 | 1338 | 89 | 1388 | -77 | 1368 |
| 8-#11 | 6.93 | MA | 1053 | 760 | 1787 | 579 | 2095 | 472 | 2332 | 369 | 2707 | 185 | 3224 | -94 | 3139 |
| 4L-2S | | MI | 567 | 760 | 1074 | 495 | 1179 | 369 | 1256 | 254 | 1384 | 43 | 1374 | -181 | 1394 |
| 10-#10 | 7.06 | MA | 1051 | 766 | 1753 | 594 | 2049 | 483 | 2277 | 377 | 2628 | 196 | 3198 | -101 | 3121 |
| 5L-2S | | MI | 590 | 766 | 1148 | 519 | 1275 | 393 | 1370 | 277 | 1530 | 67 | 1585 | -135 | 1560 |

## RECTANGULAR TIED COLUMNS 10" x 20"

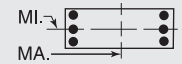
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.20 | MA | 1040 | 512 | 1478 | 434 | 1746 | 365 | 1892 | 311 | 2039 | 228 | 2425 | 195 | 1093 |
| 2E | | MI | 484 | 512 | 771 | 383 | 830 | 319 | 848 | 266 | 846 | 184 | 903 | 130 | 516 |
| 4-#8 | 1.58 | MA | 1084 | 534 | 1586 | 447 | 1879 | 374 | 2050 | 316 | 2250 | 226 | 2697 | 190 | 1407 |
| 2E | | MI | 494 | 534 | 807 | 394 | 867 | 324 | 890 | 267 | 899 | 176 | 954 | 111 | 636 |
| 4-#9 | 2.00 | MA | 1131 | 558 | 1703 | 461 | 2022 | 384 | 2221 | 322 | 2480 | 224 | 2989 | 184 | 1746 |
| 2E | | MI | 505 | 558 | 842 | 405 | 906 | 330 | 933 | 268 | 952 | 166 | 1003 | 87 | 760 |
| 4-#10 | 2.54 | MA | 1188 | 589 | 1851 | 479 | 2204 | 397 | 2439 | 330 | 2772 | 222 | 3355 | 177 | 2175 |
| 2E | | MI | 519 | 589 | 884 | 420 | 952 | 338 | 985 | 269 | 1017 | 152 | 1061 | 56 | 911 |
| 4-#11 | 3.12 | MA | 1237 | 623 | 2003 | 495 | 2383 | 409 | 2649 | 336 | 3048 | 218 | 3651 | 160 | 2597 |
| 2E | | MI | 525 | 623 | 906 | 425 | 970 | 336 | 1001 | 259 | 1035 | 126 | 1047 | 2 | 1043 |
| 6-#6 | 1.32 | MA | 1058 | 519 | 1508 | 440 | 1790 | 370 | 1947 | 314 | 2116 | 229 | 2538 | 196 | 1198 |
| 2L-3S | | MI | 466 | 519 | 739 | 390 | 796 | 324 | 810 | 272 | 799 | 187 | 847 | 95 | 562 |
| 6-#6 | 1.32 | MA | 987 | 519 | 1385 | 443 | 1633 | 372 | 1757 | 316 | 1859 | 232 | 2190 | 164 | 1202 |
| 3L-2S | | MI | 489 | 519 | 782 | 390 | 849 | 325 | 872 | 271 | 878 | 186 | 929 | 125 | 556 |
| 6-#7 | 1.80 | MA | 1114 | 546 | 1645 | 456 | 1958 | 381 | 2149 | 321 | 2386 | 226 | 2891 | 191 | 1596 |
| 2L-3S | | MI | 474 | 546 | 771 | 404 | 830 | 332 | 848 | 275 | 846 | 178 | 903 | 65 | 715 |
| 6-#7 | 1.80 | MA | 1021 | 546 | 1478 | 461 | 1746 | 385 | 1892 | 324 | 2039 | 231 | 2425 | 147 | 1594 |
| 3L-2S | | MI | 504 | 546 | 829 | 405 | 900 | 333 | 929 | 273 | 949 | 176 | 1015 | 107 | 707 |
| 6-#8 | 2.37 | MA | 1062 | 579 | 1586 | 481 | 1879 | 400 | 2050 | 333 | 2250 | 230 | 2697 | 127 | 2044 |
| 3L-2S | | MI | 520 | 579 | 882 | 423 | 956 | 343 | 993 | 276 | 1029 | 164 | 1093 | 78 | 875 |
| 6-#9 | 3.00 | MA | 1105 | 616 | 1703 | 504 | 2022 | 416 | 2221 | 343 | 2480 | 228 | 2989 | 103 | 2526 |
| 3L-2S | | MI | 537 | 616 | 933 | 441 | 1014 | 353 | 1058 | 278 | 1111 | 150 | 1170 | 44 | 1050 |
| 6-#10 | 3.81 | MA | 1160 | 663 | 1851 | 533 | 2204 | 437 | 2439 | 356 | 2772 | 227 | 3355 | 72 | 3124 |
| 3L-2S | | MI | 557 | 663 | 994 | 464 | 1082 | 366 | 1136 | 280 | 1209 | 130 | 1258 | -2 | 1259 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 10" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 4.68 | MA | 1213 | 713 | 2003 | 561 | 2383 | 457 | 2649 | 367 | 3048 | 222 | 3651 | 28 | 3580 |
| 3L-2S | | MI | 568 | 713 | 1024 | 476 | 1109 | 366 | 1163 | 268 | 1241 | 94 | 1243 | -81 | 1280 |
| 8-#5 | 1.24 | MA | 999 | 514 | 1395 | 441 | 1651 | 371 | 1781 | 315 | 1894 | 232 | 2245 | 175 | 1137 |
| 3E | | MI | 472 | 514 | 742 | 390 | 805 | 325 | 823 | 274 | 817 | 190 | 869 | 110 | 534 |
| 8-#5 | 1.24 | MA | 970 | 514 | 1334 | 443 | 1567 | 374 | 1678 | 319 | 1752 | 233 | 2070 | 163 | 1137 |
| 4L-2S | | MI | 488 | 514 | 774 | 390 | 844 | 326 | 869 | 273 | 874 | 190 | 931 | 132 | 530 |
| 8-#6 | 1.76 | MA | 1044 | 544 | 1508 | 459 | 1790 | 384 | 1947 | 323 | 2116 | 231 | 2538 | 161 | 1569 |
| 3E | | MI | 482 | 544 | 782 | 406 | 849 | 335 | 872 | 277 | 878 | 181 | 929 | 77 | 703 |
| 8-#6 | 1.76 | MA | 1005 | 544 | 1422 | 463 | 1671 | 389 | 1801 | 328 | 1916 | 232 | 2293 | 143 | 1557 |
| 4L-2S | | MI | 505 | 544 | 826 | 406 | 903 | 336 | 934 | 276 | 957 | 180 | 1011 | 107 | 697 |
| 8-#7 | 2.40 | MA | 1097 | 581 | 1645 | 482 | 1958 | 401 | 2149 | 334 | 2386 | 229 | 2891 | 143 | 2086 |
| 3E | | MI | 495 | 581 | 829 | 425 | 900 | 346 | 929 | 282 | 949 | 169 | 1015 | 42 | 897 |
| 8-#7 | 2.40 | MA | 1047 | 581 | 1528 | 487 | 1797 | 408 | 1951 | 340 | 2115 | 231 | 2561 | 119 | 2011 |
| 4L-2S | | MI | 524 | 581 | 888 | 427 | 970 | 348 | 1011 | 280 | 1053 | 168 | 1127 | 84 | 890 |
| 8-#8 | 3.16 | MA | 1096 | 625 | 1651 | 515 | 1944 | 430 | 2126 | 354 | 2349 | 229 | 2873 | 89 | 2476 |
| 4L-2S | | MI | 545 | 625 | 957 | 451 | 1045 | 361 | 1096 | 284 | 1160 | 152 | 1233 | 46 | 1107 |
| 8-#9 | 4.00 | MA | 1150 | 674 | 1785 | 547 | 2104 | 454 | 2317 | 370 | 2604 | 227 | 3207 | 55 | 2969 |
| 4L-2S | | MI | 568 | 674 | 1024 | 476 | 1122 | 376 | 1183 | 288 | 1270 | 134 | 1336 | 1 | 1333 |
| 8-#10 | 5.08 | MA | 1219 | 737 | 1953 | 588 | 2307 | 485 | 2560 | 389 | 2927 | 224 | 3625 | 11 | 3581 |
| 4L-2S | | MI | 595 | 737 | 1104 | 508 | 1213 | 393 | 1287 | 291 | 1401 | 108 | 1455 | -60 | 1432 |
| 8-#11 | 6.24 | MA | 1290 | 804 | 2123 | 627 | 2504 | 514 | 2790 | 406 | 3231 | 217 | 3961 | -49 | 3902 |
| 4L-2S | | MI | 611 | 804 | 1141 | 527 | 1248 | 396 | 1324 | 278 | 1446 | 62 | 1440 | -164 | 1458 |
| 10-#10 | 6.35 | MA | 1279 | 810 | 2081 | 642 | 2448 | 525 | 2723 | 415 | 3135 | 229 | 3903 | -56 | 3845 |
| 5L-2S | | MI | 634 | 810 | 1214 | 552 | 1344 | 421 | 1438 | 302 | 1593 | 87 | 1652 | -118 | 1627 |

## RECTANGULAR TIED COLUMNS 12" x 12"

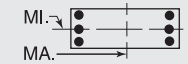
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.29 | MA | 434 | 372 | 668 | 294 | 752 | 247 | 794 | 209 | 820 | 148 | 902 | 111 | 480 |
| 2L-3S | | MI | 411 | 372 | 626 | 295 | 697 | 247 | 728 | 210 | 735 | 149 | 805 | 88 | 484 |
| 6-#6 | 1.83 | MA | 452 | 395 | 722 | 306 | 817 | 256 | 872 | 214 | 915 | 143 | 1007 | 98 | 644 |
| 2L-3S | | MI | 421 | 395 | 663 | 307 | 741 | 255 | 780 | 216 | 798 | 145 | 874 | 66 | 649 |
| 6-#7 | 2.50 | MA | 474 | 423 | 786 | 322 | 896 | 267 | 962 | 220 | 1028 | 138 | 1128 | 81 | 837 |
| 2L-3S | | MI | 434 | 423 | 706 | 323 | 794 | 266 | 840 | 222 | 873 | 139 | 954 | 37 | 839 |
| 6-#8 | 3.29 | MA | 498 | 456 | 860 | 341 | 986 | 280 | 1064 | 227 | 1157 | 130 | 1265 | 59 | 1057 |
| 2L-3S | | MI | 449 | 456 | 756 | 342 | 855 | 279 | 908 | 229 | 959 | 132 | 1045 | 2 | 1042 |
| 6-#9 | 4.17 | MA | 524 | 492 | 939 | 362 | 1083 | 296 | 1171 | 233 | 1292 | 121 | 1405 | 33 | 1290 |
| 2L-3S | | MI | 465 | 492 | 810 | 363 | 920 | 294 | 979 | 236 | 1048 | 124 | 1137 | -39 | 1129 |
| 6-#10 | 5.29 | MA | 555 | 539 | 1037 | 390 | 1204 | 316 | 1302 | 241 | 1457 | 109 | 1572 | -2 | 1572 |
| 2L-3S | | MI | 485 | 539 | 876 | 390 | 1001 | 312 | 1066 | 245 | 1158 | 113 | 1247 | -94 | 1230 |

## RECTANGULAR TIED COLUMNS 12" x 14"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.05 | MA | 584 | 422 | 868 | 343 | 987 | 289 | 1045 | 246 | 1089 | 181 | 1217 | 145 | 552 |
| 2E | | MI | 493 | 422 | 753 | 334 | 840 | 281 | 879 | 239 | 893 | 172 | 976 | 132 | 470 |
| 4-#7 | 1.43 | MA | 605 | 441 | 924 | 353 | 1055 | 296 | 1126 | 251 | 1192 | 178 | 1335 | 136 | 720 |
| 2E | | MI | 508 | 441 | 797 | 343 | 892 | 287 | 939 | 242 | 967 | 168 | 1056 | 120 | 606 |
| 4-#8 | 1.88 | MA | 628 | 463 | 989 | 366 | 1134 | 305 | 1219 | 256 | 1310 | 175 | 1469 | 125 | 913 |
| 2E | | MI | 525 | 463 | 848 | 355 | 953 | 296 | 1007 | 246 | 1052 | 162 | 1145 | 106 | 760 |
| 4-#9 | 2.38 | MA | 652 | 487 | 1059 | 379 | 1219 | 314 | 1320 | 261 | 1436 | 171 | 1608 | 112 | 1119 |
| 2E | | MI | 542 | 487 | 902 | 368 | 1018 | 305 | 1078 | 250 | 1141 | 156 | 1237 | 88 | 923 |
| 4-#10 | 3.02 | MA | 681 | 519 | 1146 | 397 | 1325 | 327 | 1447 | 269 | 1592 | 165 | 1780 | 94 | 1376 |
| 2E | | MI | 563 | 519 | 968 | 386 | 1099 | 318 | 1165 | 254 | 1251 | 147 | 1347 | 64 | 1124 |
| 4-#11 | 3.71 | MA | 702 | 552 | 1229 | 413 | 1420 | 338 | 1549 | 273 | 1704 | 152 | 1877 | 63 | 1615 |
| 2E | | MI | 577 | 552 | 1029 | 401 | 1149 | 322 | 1218 | 252 | 1315 | 130 | 1384 | 24 | 1305 |
| 4-#14 | 5.36 | MA | 766 | 632 | 1428 | 459 | 1666 | 371 | 1817 | 287 | 2042 | 132 | 2223 | 6 | 2200 |
| 2E | | MI | 621 | 632 | 1176 | 446 | 1304 | 347 | 1395 | 258 | 1538 | 100 | 1636 | -36 | 1595 |
| 6-#5 | 1.11 | MA | 590 | 425 | 875 | 347 | 999 | 292 | 1062 | 249 | 1115 | 183 | 1252 | 146 | 580 |
| 2L-3S | | MI | 474 | 425 | 716 | 338 | 795 | 284 | 827 | 242 | 830 | 174 | 907 | 111 | 496 |

## RECTANGULAR TIED COLUMNS 12" x 14"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

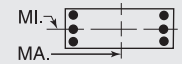
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.11 | MA | 559 | 425 | 821 | 348 | 931 | 293 | 978 | 249 | 1003 | 184 | 1118 | 123 | 585 |
| 3L-2S | | MI | 498 | 425 | 758 | 337 | 850 | 284 | 893 | 241 | 914 | 174 | 1004 | 133 | 492 |
| 6-#6 | 1.57 | MA | 615 | 448 | 944 | 359 | 1083 | 301 | 1162 | 254 | 1245 | 180 | 1402 | 136 | 786 |
| 2L-3S | | MI | 485 | 448 | 753 | 350 | 840 | 292 | 879 | 248 | 893 | 170 | 976 | 88 | 664 |
| 6-#6 | 1.57 | MA | 574 | 448 | 868 | 361 | 987 | 302 | 1045 | 256 | 1089 | 181 | 1217 | 104 | 791 |
| 3L-2S | | MI | 516 | 448 | 813 | 349 | 916 | 292 | 971 | 246 | 1009 | 169 | 1108 | 120 | 658 |
| 6-#7 | 2.14 | MA | 645 | 476 | 1026 | 375 | 1184 | 312 | 1282 | 261 | 1400 | 176 | 1580 | 123 | 1031 |
| 2L-3S | | MI | 498 | 476 | 797 | 366 | 892 | 303 | 939 | 254 | 967 | 165 | 1056 | 59 | 859 |
| 6-#7 | 2.14 | MA | 593 | 476 | 924 | 377 | 1055 | 313 | 1126 | 264 | 1192 | 178 | 1335 | 80 | 1034 |
| 3L-2S | | MI | 538 | 476 | 877 | 365 | 994 | 303 | 1061 | 252 | 1122 | 163 | 1230 | 103 | 854 |
| 6-#8 | 2.82 | MA | 679 | 509 | 1122 | 394 | 1302 | 326 | 1423 | 269 | 1578 | 171 | 1782 | 108 | 1313 |
| 2L-3S | | MI | 512 | 509 | 848 | 384 | 953 | 316 | 1007 | 260 | 1052 | 158 | 1145 | 24 | 1077 |
| 6-#8 | 2.82 | MA | 614 | 509 | 989 | 397 | 1134 | 327 | 1219 | 273 | 1310 | 173 | 1469 | 50 | 1307 |
| 3L-2S | | MI | 563 | 509 | 952 | 384 | 1085 | 317 | 1163 | 258 | 1250 | 155 | 1366 | 81 | 1077 |
| 6-#9 | 3.57 | MA | 714 | 545 | 1224 | 415 | 1428 | 341 | 1575 | 278 | 1767 | 165 | 1993 | 88 | 1614 |
| 2L-3S | | MI | 528 | 545 | 902 | 405 | 1018 | 330 | 1078 | 267 | 1141 | 149 | 1237 | -17 | 1234 |
| 6-#9 | 3.57 | MA | 636 | 545 | 1059 | 418 | 1219 | 342 | 1320 | 282 | 1436 | 168 | 1608 | 16 | 1578 |
| 3L-2S | | MI | 588 | 545 | 1031 | 405 | 1182 | 332 | 1270 | 265 | 1385 | 146 | 1505 | 55 | 1313 |
| 6-#10 | 4.54 | MA | 757 | 592 | 1352 | 443 | 1587 | 361 | 1765 | 290 | 2002 | 157 | 2252 | 62 | 1989 |
| 2L-3S | | MI | 548 | 592 | 968 | 431 | 1099 | 348 | 1165 | 276 | 1251 | 137 | 1347 | -72 | 1335 |
| 6-#10 | 4.54 | MA | 665 | 592 | 1146 | 446 | 1325 | 361 | 1447 | 295 | 1592 | 161 | 1780 | -30 | 1765 |
| 3L-2S | | MI | 620 | 592 | 1129 | 432 | 1303 | 351 | 1401 | 272 | 1550 | 134 | 1672 | 20 | 1604 |
| 6-#11 | 5.57 | MA | 685 | 643 | 1229 | 471 | 1420 | 378 | 1549 | 302 | 1704 | 144 | 1877 | -96 | 1841 |
| 3L-2S | | MI | 641 | 643 | 1215 | 457 | 1376 | 361 | 1481 | 271 | 1649 | 109 | 1732 | -39 | 1735 |
| 8-#5 | 1.48 | MA | 612 | 443 | 929 | 358 | 1068 | 300 | 1145 | 254 | 1227 | 182 | 1386 | 140 | 747 |
| 2L-4S | | MI | 477 | 443 | 727 | 350 | 807 | 294 | 841 | 247 | 849 | 173 | 932 | 94 | 635 |
| 8-#5 | 1.48 | MA | 582 | 443 | 875 | 360 | 999 | 301 | 1062 | 254 | 1115 | 183 | 1252 | 118 | 751 |
| 3E | | MI | 492 | 443 | 758 | 349 | 850 | 292 | 893 | 248 | 914 | 172 | 1004 | 103 | 631 |
| 8-#5 | 1.48 | MA | 564 | 443 | 836 | 361 | 946 | 303 | 996 | 256 | 1026 | 182 | 1155 | 107 | 754 |
| 4L-2S | | MI | 514 | 443 | 801 | 349 | 904 | 292 | 959 | 247 | 999 | 172 | 1101 | 125 | 627 |
| 8-#6 | 2.10 | MA | 646 | 473 | 1020 | 375 | 1179 | 312 | 1278 | 261 | 1401 | 178 | 1587 | 127 | 1016 |
| 2L-4S | | MI | 489 | 473 | 769 | 367 | 855 | 306 | 898 | 254 | 920 | 168 | 1009 | 64 | 837 |
| 8-#6 | 2.10 | MA | 606 | 473 | 944 | 377 | 1083 | 313 | 1162 | 264 | 1245 | 179 | 1402 | 95 | 1019 |
| 3E | | MI | 509 | 473 | 813 | 366 | 916 | 304 | 971 | 255 | 1009 | 167 | 1108 | 76 | 847 |
| 8-#6 | 2.10 | MA | 582 | 473 | 889 | 379 | 1008 | 317 | 1070 | 264 | 1121 | 178 | 1268 | 81 | 1006 |
| 4L-2S | | MI | 539 | 473 | 873 | 365 | 991 | 304 | 1063 | 254 | 1126 | 166 | 1241 | 108 | 843 |
| 8-#7 | 2.86 | MA | 635 | 510 | 1026 | 399 | 1184 | 329 | 1282 | 274 | 1400 | 175 | 1580 | 67 | 1334 |
| 3E | | MI | 529 | 510 | 877 | 387 | 994 | 319 | 1061 | 263 | 1122 | 160 | 1230 | 42 | 1098 |
| 8-#7 | 2.86 | MA | 605 | 510 | 953 | 401 | 1083 | 333 | 1159 | 274 | 1235 | 174 | 1401 | 49 | 1252 |
| 4L-2S | | MI | 568 | 510 | 958 | 387 | 1096 | 319 | 1183 | 262 | 1277 | 158 | 1404 | 85 | 1097 |
| 8-#8 | 3.76 | MA | 668 | 554 | 1122 | 425 | 1302 | 348 | 1423 | 286 | 1578 | 170 | 1782 | 33 | 1692 |
| 3E | | MI | 552 | 554 | 952 | 413 | 1085 | 336 | 1163 | 273 | 1250 | 151 | 1366 | -1 | 1365 |
| 8-#8 | 3.76 | MA | 630 | 554 | 1026 | 428 | 1170 | 353 | 1262 | 285 | 1365 | 168 | 1552 | 9 | 1527 |
| 4L-2S | | MI | 600 | 554 | 1055 | 412 | 1217 | 338 | 1319 | 270 | 1449 | 148 | 1586 | 57 | 1388 |
| 8-#9 | 4.76 | MA | 703 | 603 | 1224 | 454 | 1428 | 368 | 1575 | 299 | 1767 | 163 | 1993 | -8 | 1988 |
| 3E | | MI | 577 | 603 | 1031 | 441 | 1182 | 356 | 1270 | 282 | 1385 | 139 | 1505 | -50 | 1493 |
| 8-#9 | 4.76 | MA | 658 | 603 | 1104 | 457 | 1263 | 375 | 1373 | 298 | 1513 | 165 | 1710 | -37 | 1703 |
| 4L-2S | | MI | 634 | 603 | 1160 | 441 | 1346 | 358 | 1462 | 280 | 1629 | 137 | 1773 | 22 | 1696 |
| 8-#10 | 6.05 | MA | 747 | 666 | 1352 | 492 | 1587 | 395 | 1765 | 316 | 2002 | 153 | 2252 | -62 | 2212 |
| 3E | | MI | 609 | 666 | 1129 | 477 | 1303 | 382 | 1401 | 294 | 1550 | 124 | 1672 | -116 | 1646 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

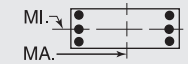
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.25 | MA | 787 | 494 | 1164 | 406 | 1345 | 341 | 1441 | 290 | 1536 | 212 | 1757 | 171 | 850 |
| 2E | | MI | 572 | 494 | 888 | 386 | 991 | 324 | 1038 | 274 | 1061 | 193 | 1157 | 143 | 620 |
| 4-#8 | 1.65 | MA | 818 | 516 | 1243 | 419 | 1442 | 350 | 1556 | 295 | 1690 | 209 | 1936 | 162 | 1084 |
| 2E | | MI | 589 | 516 | 939 | 398 | 1052 | 332 | 1106 | 278 | 1146 | 188 | 1246 | 128 | 776 |
| 4-#9 | 2.08 | MA | 850 | 540 | 1329 | 432 | 1546 | 360 | 1681 | 301 | 1856 | 207 | 2125 | 153 | 1335 |
| 2E | | MI | 606 | 540 | 994 | 411 | 1117 | 341 | 1177 | 281 | 1235 | 181 | 1337 | 110 | 941 |
| 4-#10 | 2.65 | MA | 888 | 572 | 1437 | 450 | 1678 | 372 | 1838 | 309 | 2064 | 204 | 2360 | 139 | 1650 |
| 2E | | MI | 627 | 572 | 1061 | 428 | 1198 | 353 | 1264 | 286 | 1344 | 172 | 1447 | 86 | 1145 |
| 4-#11 | 3.25 | MA | 917 | 605 | 1544 | 466 | 1801 | 383 | 1981 | 314 | 2224 | 194 | 2520 | 114 | 1952 |
| 2E | | MI | 641 | 605 | 1123 | 442 | 1248 | 358 | 1317 | 282 | 1407 | 154 | 1482 | 45 | 1331 |
| 4-#14 | 4.69 | MA | 1000 | 685 | 1796 | 512 | 2112 | 417 | 2353 | 335 | 2681 | 180 | 3023 | 70 | 2686 |
| 2E | | MI | 685 | 685 | 1271 | 487 | 1403 | 381 | 1493 | 289 | 1629 | 124 | 1734 | -15 | 1689 |
| 6-#6 | 1.38 | MA | 800 | 501 | 1187 | 412 | 1378 | 346 | 1483 | 293 | 1595 | 212 | 1840 | 171 | 929 |
| 2L-3S | | MI | 548 | 501 | 844 | 393 | 938 | 329 | 979 | 280 | 987 | 196 | 1077 | 110 | 679 |
| 6-#6 | 1.38 | MA | 749 | 501 | 1095 | 415 | 1262 | 348 | 1342 | 294 | 1405 | 214 | 1601 | 139 | 934 |
| 3L-2S | | MI | 580 | 501 | 903 | 393 | 1014 | 329 | 1071 | 278 | 1103 | 194 | 1210 | 142 | 672 |
| 6-#7 | 1.88 | MA | 839 | 529 | 1288 | 428 | 1502 | 357 | 1631 | 300 | 1793 | 210 | 2075 | 162 | 1225 |
| 2L-3S | | MI | 561 | 529 | 888 | 409 | 991 | 339 | 1038 | 285 | 1061 | 190 | 1157 | 81 | 878 |
| 6-#7 | 1.88 | MA | 772 | 529 | 1164 | 431 | 1345 | 359 | 1441 | 301 | 1536 | 212 | 1757 | 118 | 1228 |
| 3L-2S | | MI | 602 | 529 | 968 | 408 | 1093 | 340 | 1160 | 284 | 1216 | 188 | 1331 | 125 | 870 |
| 6-#8 | 2.47 | MA | 883 | 562 | 1404 | 447 | 1646 | 371 | 1804 | 308 | 2024 | 207 | 2345 | 150 | 1569 |
| 2L-3S | | MI | 575 | 562 | 939 | 427 | 1052 | 352 | 1106 | 292 | 1146 | 183 | 1246 | 46 | 1100 |
| 6-#8 | 2.47 | MA | 799 | 562 | 1243 | 451 | 1442 | 374 | 1556 | 310 | 1690 | 210 | 1936 | 92 | 1563 |
| 3L-2S | | MI | 627 | 562 | 1043 | 426 | 1184 | 353 | 1262 | 290 | 1344 | 181 | 1466 | 103 | 1096 |
| 6-#9 | 3.13 | MA | 928 | 598 | 1531 | 468 | 1802 | 386 | 1991 | 318 | 2275 | 205 | 2631 | 135 | 1938 |
| 2L-3S | | MI | 591 | 598 | 994 | 447 | 1117 | 366 | 1177 | 299 | 1235 | 174 | 1337 | 4 | 1329 |
| 6-#9 | 3.13 | MA | 831 | 598 | 1329 | 473 | 1546 | 389 | 1681 | 319 | 1856 | 208 | 2125 | 63 | 1917 |
| 3L-2S | | MI | 653 | 598 | 1123 | 447 | 1281 | 368 | 1369 | 296 | 1478 | 171 | 1605 | 77 | 1334 |
| 6-#10 | 3.97 | MA | 984 | 645 | 1690 | 496 | 1999 | 406 | 2227 | 330 | 2587 | 200 | 2985 | 116 | 2401 |
| 2L-3S | | MI | 610 | 645 | 1061 | 473 | 1198 | 384 | 1264 | 307 | 1344 | 162 | 1447 | -50 | 1439 |
| 6-#10 | 3.97 | MA | 868 | 645 | 1437 | 501 | 1678 | 409 | 1838 | 331 | 2064 | 204 | 2360 | 23 | 2310 |
| 3L-2S | | MI | 684 | 645 | 1221 | 474 | 1402 | 387 | 1500 | 304 | 1643 | 159 | 1771 | 42 | 1629 |
| 6-#11 | 4.88 | MA | 896 | 696 | 1544 | 527 | 1801 | 427 | 1981 | 348 | 2224 | 191 | 2520 | -33 | 2496 |
| 3L-2S | | MI | 705 | 696 | 1309 | 498 | 1475 | 396 | 1580 | 301 | 1741 | 134 | 1830 | -18 | 1833 |
| 6-#14 | 7.03 | MA | 983 | 816 | 1796 | 599 | 2112 | 477 | 2353 | 381 | 2681 | 173 | 3023 | -149 | 2923 |
| 3L-2S | | MI | 773 | 816 | 1528 | 568 | 1708 | 434 | 1845 | 312 | 2077 | 91 | 2212 | -106 | 2145 |
| 8-#5 | 1.29 | MA | 795 | 496 | 1168 | 411 | 1359 | 345 | 1462 | 293 | 1568 | 213 | 1815 | 175 | 881 |
| 2L-4S | | MI | 541 | 496 | 817 | 393 | 905 | 331 | 940 | 279 | 944 | 199 | 1034 | 117 | 649 |
| 8-#5 | 1.29 | MA | 759 | 496 | 1102 | 413 | 1276 | 347 | 1361 | 294 | 1432 | 215 | 1643 | 152 | 885 |
| 3E | | MI | 555 | 496 | 848 | 393 | 948 | 329 | 993 | 280 | 1009 | 198 | 1106 | 125 | 644 |
| 8-#5 | 1.29 | MA | 737 | 496 | 1056 | 415 | 1212 | 350 | 1283 | 297 | 1325 | 215 | 1520 | 141 | 888 |
| 4L-2S | | MI | 578 | 496 | 891 | 392 | 1002 | 329 | 1059 | 279 | 1093 | 197 | 1203 | 148 | 640 |
| 8-#6 | 1.83 | MA | 839 | 526 | 1278 | 428 | 1495 | 358 | 1624 | 301 | 1785 | 211 | 2079 | 165 | 1206 |
| 2L-4S | | MI | 553 | 526 | 860 | 410 | 954 | 343 | 997 | 286 | 1014 | 194 | 1111 | 86 | 867 |
| 8-#6 | 1.83 | MA | 789 | 526 | 1187 | 431 | 1378 | 359 | 1483 | 302 | 1595 | 213 | 1840 | 133 | 1209 |
| 3E | | MI | 572 | 526 | 903 | 409 | 1014 | 340 | 1071 | 287 | 1103 | 192 | 1210 | 98 | 863 |
| 8-#6 | 1.83 | MA | 760 | 526 | 1122 | 433 | 1288 | 364 | 1373 | 305 | 1445 | 213 | 1669 | 117 | 1205 |
| 4L-2S | | MI | 603 | 526 | 963 | 409 | 1090 | 341 | 1163 | 286 | 1220 | 191 | 1342 | 130 | 858 |
| 8-#7 | 2.50 | MA | 826 | 563 | 1288 | 453 | 1502 | 375 | 1631 | 311 | 1793 | 211 | 2075 | 109 | 1593 |
| 3E | | MI | 593 | 563 | 968 | 430 | 1093 | 355 | 1160 | 295 | 1216 | 185 | 1331 | 64 | 1119 |
| 8-#7 | 2.50 | MA | 788 | 563 | 1200 | 456 | 1380 | 381 | 1483 | 316 | 1590 | 210 | 1846 | 88 | 1526 |
| 4L-2S | | MI | 632 | 563 | 1049 | 430 | 1194 | 356 | 1282 | 293 | 1371 | 183 | 1505 | 107 | 1116 |
| 8-#8 | 3.29 | MA | 870 | 608 | 1404 | 480 | 1646 | 394 | 1804 | 323 | 2024 | 208 | 2345 | 80 | 2033 |
| 3E | | MI | 616 | 608 | 1043 | 456 | 1184 | 373 | 1262 | 304 | 1344 | 176 | 1466 | 21 | 1406 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

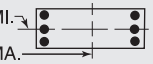
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#8 | 3.29 | MA | 820 | 608 | 1290 | 484 | 1488 | 401 | 1610 | 328 | 1759 | 207 | 2050 | 53 | 1867 |
| 4L-2S | | MI | 664 | 608 | 1147 | 455 | 1315 | 374 | 1418 | 302 | 1542 | 174 | 1687 | 79 | 1409 |
| 8-#9 | 4.17 | MA | 915 | 656 | 1531 | 509 | 1802 | 416 | 1991 | 335 | 2275 | 205 | 2631 | 46 | 2502 |
| 3E | | MI | 640 | 656 | 1123 | 483 | 1281 | 392 | 1369 | 314 | 1478 | 165 | 1605 | -28 | 1599 |
| 8-#9 | 4.17 | MA | 860 | 656 | 1387 | 514 | 1603 | 424 | 1747 | 342 | 1943 | 203 | 2265 | 12 | 2225 |
| 4L-2S | | MI | 698 | 656 | 1252 | 483 | 1445 | 394 | 1561 | 311 | 1722 | 162 | 1873 | 44 | 1720 |
| 8-#10 | 5.29 | MA | 972 | 719 | 1690 | 547 | 1999 | 443 | 2227 | 352 | 2587 | 200 | 2985 | 0 | 2985 |
| 3E | | MI | 671 | 719 | 1221 | 519 | 1402 | 417 | 1500 | 325 | 1643 | 149 | 1771 | -95 | 1753 |
| 8-#10 | 5.29 | MA | 907 | 719 | 1508 | 553 | 1749 | 453 | 1921 | 360 | 2171 | 197 | 2531 | -42 | 2510 |
| 4L-2S | | MI | 740 | 719 | 1382 | 520 | 1606 | 421 | 1736 | 322 | 1942 | 145 | 2096 | -2 | 2096 |
| 10-#10 | 6.61 | MA | 1016 | 792 | 1761 | 599 | 2069 | 487 | 2310 | 381 | 2694 | 193 | 3156 | -65 | 3098 |
| 4L-3S | | MI | 732 | 792 | 1382 | 565 | 1606 | 451 | 1736 | 343 | 1942 | 136 | 2096 | -139 | 2061 |

## RECTANGULAR TIED COLUMNS 12" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.11 | MA | 992 | 547 | 1424 | 460 | 1663 | 387 | 1788 | 329 | 1905 | 243 | 2220 | 204 | 979 |
| 2E | | MI | 636 | 547 | 979 | 429 | 1089 | 360 | 1138 | 306 | 1155 | 218 | 1258 | 165 | 633 |
| 4-#8 | 1.46 | MA | 1029 | 569 | 1519 | 472 | 1778 | 395 | 1925 | 335 | 2088 | 241 | 2445 | 197 | 1254 |
| 2E | | MI | 653 | 569 | 1031 | 440 | 1150 | 368 | 1205 | 309 | 1240 | 213 | 1347 | 150 | 792 |
| 4-#9 | 1.85 | MA | 1068 | 593 | 1621 | 485 | 1903 | 405 | 2073 | 340 | 2286 | 239 | 2685 | 190 | 1551 |
| 2E | | MI | 670 | 593 | 1086 | 453 | 1216 | 377 | 1276 | 313 | 1328 | 206 | 1437 | 132 | 959 |
| 4-#10 | 2.35 | MA | 1117 | 625 | 1749 | 503 | 2060 | 418 | 2261 | 348 | 2537 | 236 | 2984 | 179 | 1924 |
| 2E | | MI | 691 | 625 | 1153 | 470 | 1297 | 389 | 1363 | 317 | 1437 | 197 | 1546 | 108 | 1165 |
| 4-#11 | 2.89 | MA | 1156 | 658 | 1881 | 519 | 2212 | 429 | 2437 | 354 | 2769 | 231 | 3210 | 159 | 2289 |
| 2E | | MI | 705 | 658 | 1216 | 483 | 1347 | 393 | 1415 | 313 | 1500 | 178 | 1580 | 66 | 1356 |
| 4-#14 | 4.17 | MA | 1261 | 738 | 2184 | 565 | 2586 | 462 | 2886 | 374 | 3360 | 224 | 3875 | 124 | 3172 |
| 2E | | MI | 749 | 738 | 1365 | 527 | 1503 | 416 | 1592 | 319 | 1721 | 148 | 1831 | 6 | 1811 |
| 4-#18 | 7.41 | MA | 1500 | 941 | 2906 | 684 | 3481 | 548 | 3960 | 427 | 4693 | 191 | 5358 | 17 | 5265 |
| 2E | | MI | 848 | 941 | 1643 | 624 | 1817 | 466 | 1950 | 322 | 2172 | 58 | 2203 | -211 | 2197 |
| 6-#6 | 1.22 | MA | 1007 | 554 | 1451 | 466 | 1702 | 391 | 1837 | 333 | 1973 | 244 | 2318 | 205 | 1071 |
| 2L-3S | | MI | 612 | 554 | 934 | 436 | 1036 | 366 | 1078 | 312 | 1081 | 221 | 1179 | 133 | 692 |
| 6-#6 | 1.22 | MA | 945 | 554 | 1343 | 468 | 1565 | 394 | 1671 | 334 | 1750 | 246 | 2025 | 173 | 1076 |
| 3L-2S | | MI | 644 | 554 | 994 | 436 | 1112 | 366 | 1170 | 310 | 1198 | 220 | 1311 | 165 | 686 |
| 6-#7 | 1.67 | MA | 1055 | 582 | 1570 | 481 | 1848 | 403 | 2012 | 339 | 2207 | 241 | 2612 | 197 | 1420 |
| 2L-3S | | MI | 624 | 582 | 979 | 451 | 1089 | 376 | 1138 | 317 | 1155 | 215 | 1258 | 104 | 894 |
| 6-#7 | 1.67 | MA | 974 | 582 | 1424 | 485 | 1663 | 406 | 1788 | 342 | 1905 | 245 | 2220 | 154 | 1422 |
| 3L-2S | | MI | 666 | 582 | 1059 | 451 | 1191 | 376 | 1260 | 316 | 1310 | 214 | 1432 | 147 | 886 |
| 6-#8 | 2.19 | MA | 1109 | 615 | 1709 | 500 | 2019 | 416 | 2216 | 348 | 2481 | 239 | 2951 | 188 | 1825 |
| 2L-3S | | MI | 639 | 615 | 1031 | 469 | 1150 | 388 | 1205 | 324 | 1240 | 208 | 1347 | 68 | 1121 |
| 6-#8 | 2.19 | MA | 1008 | 615 | 1519 | 505 | 1778 | 420 | 1925 | 350 | 2088 | 243 | 2445 | 131 | 1819 |
| 3L-2S | | MI | 691 | 615 | 1135 | 469 | 1282 | 389 | 1362 | 321 | 1438 | 206 | 1567 | 125 | 1114 |
| 6-#9 | 2.78 | MA | 1166 | 651 | 1859 | 521 | 2204 | 431 | 2439 | 357 | 2779 | 236 | 3313 | 178 | 2262 |
| 2L-3S | | MI | 654 | 651 | 1086 | 489 | 1216 | 402 | 1276 | 330 | 1328 | 199 | 1437 | 26 | 1357 |
| 6-#9 | 2.78 | MA | 1044 | 651 | 1621 | 527 | 1903 | 436 | 2073 | 360 | 2286 | 241 | 2685 | 105 | 2241 |
| 3L-2S | | MI | 717 | 651 | 1215 | 489 | 1380 | 404 | 1468 | 327 | 1572 | 196 | 1705 | 99 | 1355 |
| 6-#10 | 3.53 | MA | 1236 | 698 | 2048 | 549 | 2439 | 451 | 2720 | 369 | 3157 | 233 | 3764 | 162 | 2812 |
| 2L-3S | | MI | 673 | 698 | 1153 | 515 | 1297 | 419 | 1363 | 338 | 1437 | 187 | 1546 | -29 | 1543 |
| 6-#10 | 3.53 | MA | 1089 | 698 | 1749 | 556 | 2060 | 456 | 2261 | 372 | 2537 | 239 | 2984 | 70 | 2763 |
| 3L-2S | | MI | 748 | 698 | 1314 | 516 | 1501 | 423 | 1599 | 335 | 1736 | 183 | 1871 | 64 | 1652 |
| 6-#11 | 4.33 | MA | 1131 | 749 | 1881 | 583 | 2212 | 475 | 2437 | 382 | 2769 | 232 | 3210 | 20 | 3163 |
| 3L-2S | | MI | 769 | 749 | 1403 | 539 | 1574 | 431 | 1678 | 332 | 1834 | 158 | 1928 | 3 | 1917 |
| 6-#14 | 6.25 | MA | 1240 | 869 | 2184 | 656 | 2586 | 527 | 2886 | 413 | 3360 | 223 | 3875 | -81 | 3789 |
| 3L-2S | | MI | 837 | 869 | 1622 | 608 | 1807 | 469 | 1944 | 343 | 2169 | 115 | 2309 | -85 | 2246 |
| 8-#5 | 1.15 | MA | 1001 | 549 | 1428 | 464 | 1678 | 391 | 1811 | 333 | 1940 | 245 | 2284 | 207 | 1015 |
| 2L-4S | | MI | 604 | 549 | 907 | 437 | 1003 | 367 | 1039 | 311 | 1038 | 225 | 1136 | 139 | 661 |
| 8-#5 | 1.15 | MA | 957 | 549 | 1351 | 466 | 1581 | 392 | 1693 | 334 | 1781 | 247 | 2074 | 185 | 1019 |
| 3E | | MI | 619 | 549 | 938 | 436 | 1046 | 366 | 1092 | 312 | 1103 | 224 | 1208 | 148 | 656 |

## RECTANGULAR TIED COLUMNS 12" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#5 | 1.15 | MA | 931 | 549 | 1298 | 469 | 1507 | 396 | 1602 | 337 | 1657 | 247 | 1925 | 172 | 1022 |
| 4L-2S | | MI | 642 | 549 | 981 | 435 | 1100 | 366 | 1158 | 311 | 1187 | 223 | 1305 | 170 | 652 |
| 8-#6 | 1.63 | MA | 1054 | 579 | 1558 | 481 | 1838 | 403 | 2002 | 340 | 2197 | 242 | 2611 | 200 | 1396 |
| 2L-4S | | MI | 616 | 579 | 950 | 453 | 1052 | 379 | 1096 | 318 | 1108 | 219 | 1212 | 109 | 885 |
| 8-#6 | 1.63 | MA | 994 | 579 | 1451 | 484 | 1702 | 405 | 1837 | 342 | 1973 | 245 | 2318 | 168 | 1399 |
| 3E | | MI | 636 | 579 | 994 | 452 | 1112 | 377 | 1170 | 319 | 1198 | 218 | 1311 | 121 | 879 |
| 8-#6 | 1.63 | MA | 960 | 579 | 1375 | 487 | 1597 | 410 | 1709 | 346 | 1799 | 246 | 2110 | 151 | 1395 |
| 4L-2S | | MI | 667 | 579 | 1054 | 452 | 1188 | 377 | 1262 | 318 | 1314 | 217 | 1444 | 153 | 873 |
| 8-#7 | 2.22 | MA | 1039 | 617 | 1570 | 507 | 1848 | 421 | 2012 | 352 | 2207 | 243 | 2612 | 148 | 1853 |
| 3E | | MI | 656 | 617 | 1059 | 473 | 1191 | 392 | 1260 | 327 | 1310 | 210 | 1432 | 86 | 1138 |
| 8-#7 | 2.22 | MA | 994 | 617 | 1467 | 511 | 1706 | 428 | 1838 | 357 | 1971 | 244 | 2333 | 125 | 1810 |
| 4L-2S | | MI | 696 | 617 | 1140 | 472 | 1293 | 392 | 1382 | 325 | 1465 | 209 | 1606 | 130 | 1133 |
| 8-#8 | 2.93 | MA | 1091 | 661 | 1709 | 534 | 2019 | 441 | 2216 | 364 | 2481 | 241 | 2951 | 122 | 2375 |
| 3E | | MI | 679 | 661 | 1135 | 498 | 1282 | 409 | 1362 | 336 | 1438 | 201 | 1567 | 43 | 1430 |
| 8-#8 | 2.93 | MA | 1035 | 661 | 1575 | 539 | 1834 | 449 | 1990 | 370 | 2172 | 241 | 2590 | 92 | 2218 |
| 4L-2S | | MI | 729 | 661 | 1238 | 497 | 1414 | 410 | 1518 | 334 | 1636 | 199 | 1787 | 101 | 1429 |
| 8-#9 | 3.70 | MA | 1151 | 709 | 1859 | 564 | 2204 | 462 | 2439 | 377 | 2779 | 239 | 3313 | 93 | 2934 |
| 3E | | MI | 704 | 709 | 1215 | 526 | 1380 | 428 | 1468 | 345 | 1572 | 190 | 1705 | -6 | 1704 |
| 8-#9 | 3.70 | MA | 1079 | 709 | 1690 | 569 | 1972 | 472 | 2154 | 385 | 2391 | 238 | 2864 | 56 | 2648 |
| 4L-2S | | MI | 763 | 709 | 1344 | 525 | 1543 | 430 | 1660 | 342 | 1816 | 187 | 1973 | 66 | 1743 |
| 8-#10 | 4.70 | MA | 1221 | 772 | 2048 | 602 | 2439 | 490 | 2720 | 394 | 3157 | 235 | 3764 | 53 | 3619 |
| 3E | | MI | 734 | 772 | 1314 | 561 | 1501 | 453 | 1599 | 356 | 1736 | 174 | 1871 | -73 | 1858 |
| 8-#10 | 4.70 | MA | 1143 | 772 | 1836 | 609 | 2146 | 502 | 2362 | 404 | 2668 | 234 | 3205 | 7 | 3179 |
| 4L-2S | | MI | 805 | 772 | 1474 | 562 | 1705 | 457 | 1835 | 353 | 2036 | 170 | 2196 | 19 | 2130 |
| 8-#11 | 5.78 | MA | 1190 | 839 | 1982 | 647 | 2313 | 529 | 2556 | 419 | 2923 | 225 | 3460 | -59 | 3416 |
| 4L-2S | | MI | 833 | 839 | 1589 | 596 | 1802 | 470 | 1941 | 351 | 2168 | 138 | 2276 | -59 | 2280 |
| 10-#10 | 5.88 | MA | 1276 | 846 | 2135 | 655 | 2525 | 536 | 2822 | 425 | 3288 | 231 | 3985 | -10 | 3972 |
| 4L-3S | | MI | 794 | 846 | 1474 | 607 | 1705 | 487 | 1835 | 374 | 2036 | 160 | 2196 | -117 | 2169 |
| 10-#10 | 5.88 | MA | 1191 | 846 | 1945 | 662 | 2266 | 541 | 2500 | 428 | 2844 | 237 | 3435 | -65 | 3390 |
| 5L-2S | | MI | 861 | 846 | 1635 | 608 | 1909 | 490 | 2070 | 371 | 2335 | 157 | 2520 | -25 | 2515 |
| 12-#10 | 7.06 | MA | 1321 | 919 | 2243 | 708 | 2645 | 575 | 2960 | 449 | 3464 | 233 | 4215 | -82 | 4128 |
| 5L-3S | | MI | 854 | 919 | 1635 | 653 | 1909 | 520 | 2070 | 392 | 2335 | 147 | 2520 | -161 | 2475 |

## RECTANGULAR TIED COLUMNS 12" x 20"

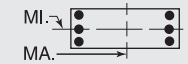
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.00 | MA | 1218 | 600 | 1706 | 513 | 2011 | 432 | 2167 | 369 | 2308 | 274 | 2723 | 235 | 1109 |
| 2E | | MI | 700 | 600 | 1070 | 472 | 1188 | 397 | 1237 | 338 | 1249 | 244 | 1359 | 187 | 645 |
| 4-#8 | 1.32 | MA | 1263 | 622 | 1815 | 525 | 2143 | 441 | 2325 | 374 | 2519 | 272 | 2994 | 231 | 1425 |
| 2E | | MI | 717 | 622 | 1122 | 483 | 1249 | 405 | 1305 | 341 | 1333 | 238 | 1447 | 172 | 806 |
| 4-#9 | 1.67 | MA | 1310 | 646 | 1934 | 538 | 2288 | 450 | 2497 | 380 | 2748 | 270 | 3285 | 225 | 1767 |
| 2E | | MI | 734 | 646 | 1177 | 495 | 1314 | 413 | 1376 | 344 | 1422 | 231 | 1538 | 154 | 976 |
| 4-#10 | 2.12 | MA | 1368 | 678 | 2083 | 556 | 2470 | 463 | 2715 | 387 | 3040 | 267 | 3651 | 217 | 2199 |
| 2E | | MI | 756 | 678 | 1246 | 512 | 1396 | 425 | 1462 | 348 | 1530 | 222 | 1646 | 130 | 1185 |
| 4-#11 | 2.60 | MA | 1417 | 711 | 2238 | 572 | 2650 | 474 | 2925 | 393 | 3316 | 263 | 3945 | 200 | 2626 |
| 2E | | MI | 769 | 711 | 1310 | 524 | 1446 | 428 | 1514 | 343 | 1592 | 203 | 1679 | 88 | 1380 |
| 4-#14 | 3.75 | MA | 1546 | 791 | 2594 | 618 | 3090 | 507 | 3451 | 414 | 4021 | 257 | 4775 | 172 | 3658 |
| 2E | | MI | 813 | 791 | 1460 | 567 | 1602 | 450 | 1690 | 349 | 1813 | 172 | 1928 | 27 | 1840 |
| 4-#18 | 6.67 | MA | 1835 | 994 | 3447 | 737 | 4148 | 594 | 4721 | 467 | 5717 | 241 | 6669 | 86 | 6129 |
| 2E | | MI | 911 | 994 | 1739 | 663 | 1917 | 500 | 2048 | 351 | 2262 | 81 | 2298 | -191 | 2293 |
| 6-#6 | 1.10 | MA | 1236 | 607 | 1736 | 519 | 2054 | 436 | 2223 | 372 | 2385 | 275 | 2837 | 237 | 1214 |
| 2L-3S | | MI | 676 | 607 | 1025 | 480 | 1134 | 402 | 1177 | 344 | 1175 | 247 | 1280 | 155 | 704 |
| 6-#6 | 1.10 | MA | 1164 | 607 | 1612 | 522 | 1897 | 439 | 2032 | 374 | 2128 | 279 | 2489 | 205 | 1219 |
| 3L-2S | | MI | 708 | 607 | 1084 | 479 | 1210 | 403 | 1269 | 343 | 1292 | 245 | 1413 | 187 | 698 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 20"

Short columns – no sidesway
Bending on major or minor axis

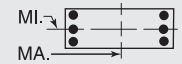



$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 1.50 | MA | 1293 | 635 | 1873 | 534 | 2223 | 448 | 2424 | 379 | 2655 | 273 | 3189 | 231 | 1614 |
| 2L-3S | | MI | 688 | 635 | 1070 | 494 | 1188 | 412 | 1237 | 349 | 1249 | 241 | 1359 | 126 | 910 |
| 6-#7 | 1.50 | MA | 1198 | 635 | 1706 | 539 | 2011 | 451 | 2167 | 382 | 2308 | 277 | 2723 | 188 | 1617 |
| 3L-2S | | MI | 730 | 635 | 1150 | 493 | 1289 | 413 | 1359 | 347 | 1404 | 239 | 1533 | 169 | 901 |
| 6-#8 | 1.98 | MA | 1357 | 668 | 2034 | 553 | 2420 | 461 | 2661 | 387 | 2972 | 270 | 3599 | 225 | 2081 |
| 2L-3S | | MI | 702 | 668 | 1122 | 512 | 1249 | 424 | 1305 | 355 | 1333 | 233 | 1447 | 90 | 1140 |
| 6-#8 | 1.98 | MA | 1238 | 668 | 1815 | 559 | 2143 | 466 | 2325 | 391 | 2519 | 276 | 2994 | 167 | 2075 |
| 3L-2S | | MI | 755 | 668 | 1226 | 511 | 1381 | 426 | 1461 | 353 | 1532 | 231 | 1668 | 147 | 1131 |
| 6-#9 | 2.50 | MA | 1426 | 704 | 2208 | 574 | 2635 | 477 | 2918 | 397 | 3317 | 267 | 4038 | 216 | 2586 |
| 2L-3S | | MI | 717 | 704 | 1177 | 532 | 1314 | 438 | 1376 | 362 | 1422 | 224 | 1538 | 48 | 1381 |
| 6-#9 | 2.50 | MA | 1282 | 704 | 1934 | 581 | 2288 | 482 | 2497 | 401 | 2748 | 274 | 3285 | 144 | 2565 |
| 3L-2S | | MI | 781 | 704 | 1307 | 531 | 1478 | 440 | 1567 | 359 | 1665 | 221 | 1805 | 121 | 1374 |
| 6-#10 | 3.17 | MA | 1510 | 751 | 2427 | 602 | 2908 | 497 | 3245 | 409 | 3756 | 264 | 4588 | 205 | 3224 |
| 2L-3S | | MI | 736 | 751 | 1246 | 557 | 1396 | 455 | 1462 | 369 | 1530 | 212 | 1646 | -7 | 1645 |
| 6-#10 | 3.17 | MA | 1336 | 751 | 2083 | 610 | 2470 | 503 | 2715 | 414 | 3040 | 272 | 3651 | 112 | 3174 |
| 3L-2S | | MI | 813 | 751 | 1406 | 558 | 1600 | 459 | 1698 | 366 | 1830 | 208 | 1971 | 85 | 1675 |
| 6-#11 | 3.90 | MA | 1383 | 802 | 2238 | 638 | 2650 | 522 | 2925 | 424 | 3316 | 267 | 3945 | 68 | 3762 |
| 3L-2S | | MI | 833 | 802 | 1496 | 580 | 1674 | 466 | 1777 | 362 | 1926 | 182 | 2027 | 25 | 1945 |
| 6-#14 | 5.63 | MA | 1520 | 922 | 2594 | 712 | 3090 | 575 | 3451 | 456 | 4021 | 261 | 4775 | -23 | 4741 |
| 3L-2S | | MI | 900 | 922 | 1717 | 649 | 1906 | 503 | 2043 | 373 | 2260 | 139 | 2406 | -64 | 2344 |
| 8-#5 | 1.03 | MA | 1228 | 602 | 1709 | 517 | 2026 | 436 | 2192 | 372 | 2346 | 276 | 2794 | 239 | 1149 |
| 2L-4S | | MI | 667 | 602 | 997 | 480 | 1101 | 404 | 1139 | 344 | 1132 | 250 | 1238 | 162 | 673 |
| 8-#5 | 1.03 | MA | 1177 | 602 | 1621 | 520 | 1915 | 438 | 2057 | 374 | 2163 | 279 | 2545 | 216 | 1152 |
| 3E | | MI | 683 | 602 | 1028 | 479 | 1144 | 403 | 1191 | 344 | 1197 | 249 | 1310 | 170 | 668 |
| 8-#5 | 1.03 | MA | 1147 | 602 | 1560 | 522 | 1830 | 442 | 1953 | 377 | 2022 | 280 | 2369 | 203 | 1156 |
| 4L-2S | | MI | 706 | 602 | 1071 | 479 | 1199 | 403 | 1257 | 343 | 1282 | 249 | 1407 | 193 | 664 |
| 8-#6 | 1.47 | MA | 1291 | 632 | 1859 | 535 | 2211 | 448 | 2413 | 379 | 2642 | 274 | 3185 | 234 | 1587 |
| 2L-4S | | MI | 679 | 632 | 1041 | 496 | 1150 | 416 | 1196 | 350 | 1202 | 245 | 1314 | 131 | 900 |
| 8-#6 | 1.47 | MA | 1221 | 632 | 1736 | 538 | 2054 | 451 | 2223 | 382 | 2385 | 277 | 2837 | 202 | 1589 |
| 3E | | MI | 700 | 632 | 1084 | 495 | 1210 | 414 | 1269 | 351 | 1292 | 243 | 1413 | 143 | 893 |
| 8-#6 | 1.47 | MA | 1181 | 632 | 1650 | 541 | 1935 | 456 | 2076 | 386 | 2185 | 279 | 2592 | 184 | 1585 |
| 4L-2S | | MI | 731 | 632 | 1144 | 495 | 1286 | 414 | 1361 | 350 | 1408 | 242 | 1545 | 175 | 887 |
| 8-#7 | 2.00 | MA | 1275 | 670 | 1873 | 560 | 2223 | 467 | 2424 | 392 | 2655 | 276 | 3189 | 184 | 2112 |
| 3E | | MI | 720 | 670 | 1150 | 516 | 1289 | 428 | 1359 | 359 | 1404 | 236 | 1533 | 108 | 1156 |
| 8-#7 | 2.00 | MA | 1223 | 670 | 1757 | 565 | 2061 | 474 | 2226 | 398 | 2384 | 277 | 2860 | 159 | 2088 |
| 4L-2S | | MI | 760 | 670 | 1231 | 515 | 1391 | 429 | 1481 | 357 | 1559 | 234 | 1707 | 152 | 1150 |
| 8-#8 | 2.63 | MA | 1337 | 714 | 2034 | 588 | 2420 | 487 | 2661 | 404 | 2972 | 274 | 3599 | 161 | 2716 |
| 3E | | MI | 743 | 714 | 1226 | 541 | 1381 | 445 | 1461 | 368 | 1532 | 226 | 1668 | 65 | 1453 |
| 8-#8 | 2.63 | MA | 1272 | 714 | 1881 | 593 | 2209 | 496 | 2402 | 412 | 2618 | 275 | 3171 | 129 | 2578 |
| 4L-2S | | MI | 793 | 714 | 1330 | 540 | 1512 | 447 | 1617 | 365 | 1730 | 224 | 1888 | 123 | 1448 |
| 8-#9 | 3.33 | MA | 1403 | 762 | 2208 | 618 | 2635 | 509 | 2918 | 417 | 3317 | 272 | 4038 | 135 | 3366 |
| 3E | | MI | 767 | 762 | 1307 | 568 | 1478 | 464 | 1567 | 377 | 1665 | 215 | 1805 | 16 | 1762 |
| 8-#9 | 3.33 | MA | 1325 | 762 | 2016 | 625 | 2370 | 520 | 2593 | 427 | 2872 | 273 | 3504 | 95 | 3082 |
| 4L-2S | | MI | 827 | 762 | 1436 | 568 | 1642 | 466 | 1759 | 374 | 1909 | 212 | 2073 | 88 | 1765 |
| 8-#10 | 4.23 | MA | 1486 | 825 | 2427 | 656 | 2908 | 537 | 3245 | 435 | 3756 | 269 | 4588 | 100 | 4179 |
| 3E | | MI | 797 | 825 | 1406 | 603 | 1600 | 489 | 1698 | 387 | 1830 | 198 | 1971 | -51 | 1963 |
| 8-#10 | 4.23 | MA | 1393 | 825 | 2185 | 665 | 2573 | 551 | 2835 | 447 | 3195 | 270 | 3922 | 51 | 3704 |
| 4L-2S | | MI | 869 | 825 | 1567 | 604 | 1804 | 492 | 1934 | 384 | 2129 | 195 | 2295 | 41 | 2155 |
| 8-#11 | 5.20 | MA | 1461 | 892 | 2359 | 703 | 2771 | 579 | 3066 | 463 | 3498 | 262 | 4255 | -9 | 4245 |
| 4L-2S | | MI | 897 | 892 | 1683 | 637 | 1901 | 505 | 2040 | 381 | 2260 | 162 | 2375 | -38 | 2379 |
| 8-#14 | 7.50 | MA | 1630 | 1052 | 2763 | 805 | 3258 | 656 | 3648 | 511 | 4276 | 252 | 5200 | -135 | 5031 |
| 4L-2S | | MI | 988 | 1052 | 1974 | 730 | 2211 | 556 | 2395 | 397 | 2708 | 105 | 2884 | -156 | 2791 |
| 10-#10 | 5.29 | MA | 1559 | 899 | 2530 | 711 | 3010 | 584 | 3366 | 468 | 3911 | 267 | 4859 | 39 | 4685 |
| 4L-3S | | MI | 857 | 899 | 1567 | 649 | 1804 | 522 | 1934 | 405 | 2129 | 185 | 2295 | -95 | 2276 |
| 10-#10 | 5.29 | MA | 1446 | 899 | 2313 | 719 | 2714 | 591 | 2999 | 473 | 3403 | 275 | 4199 | -16 | 4184 |
| 5L-2S | | MI | 925 | 899 | 1728 | 650 | 2007 | 526 | 2169 | 402 | 2428 | 182 | 2620 | -3 | 2620 |
| 12-#10 | 6.35 | MA | 1606 | 972 | 2658 | 765 | 3152 | 625 | 3529 | 494 | 4119 | 272 | 5136 | -28 | 5096 |
| 5L-3S | | MI | 917 | 972 | 1728 | 695 | 2007 | 556 | 2169 | 423 | 2428 | 172 | 2620 | -139 | 2585 |

## RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

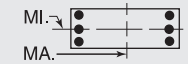
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.20 | MA | 1518 | 675 | 2133 | 578 | 2537 | 486 | 2758 | 413 | 2983 | 304 | 3584 | 263 | 1596 |
| 2E | | MI | 781 | 675 | 1214 | 525 | 1348 | 441 | 1404 | 373 | 1427 | 263 | 1548 | 194 | 821 |
| 4-#9 | 1.52 | MA | 1573 | 699 | 2268 | 591 | 2702 | 495 | 2953 | 419 | 3244 | 301 | 3927 | 258 | 1983 |
| 2E | | MI | 798 | 699 | 1269 | 537 | 1413 | 449 | 1475 | 375 | 1515 | 256 | 1638 | 176 | 993 |
| 4-#10 | 1.92 | MA | 1641 | 731 | 2438 | 609 | 2910 | 508 | 3202 | 427 | 3576 | 299 | 4358 | 252 | 2473 |
| 2E | | MI | 820 | 731 | 1338 | 553 | 1495 | 461 | 1561 | 379 | 1623 | 246 | 1746 | 151 | 1204 |
| 4-#11 | 2.36 | MA | 1701 | 764 | 2617 | 625 | 3118 | 519 | 3444 | 433 | 3895 | 294 | 4721 | 238 | 2963 |
| 2E | | MI | 833 | 764 | 1404 | 565 | 1545 | 463 | 1613 | 374 | 1684 | 227 | 1777 | 109 | 1403 |
| 4-#14 | 3.41 | MA | 1855 | 844 | 3025 | 671 | 3622 | 552 | 4048 | 453 | 4704 | 288 | 5719 | 216 | 4144 |
| 2E | | MI | 877 | 844 | 1555 | 608 | 1701 | 485 | 1789 | 379 | 1905 | 196 | 2025 | 48 | 1869 |
| 4-#18 | 6.06 | MA | 2198 | 1047 | 4009 | 790 | 4843 | 639 | 5515 | 506 | 6673 | 274 | 8033 | 147 | 6993 |
| 2E | | MI | 974 | 1047 | 1835 | 702 | 2016 | 533 | 2146 | 380 | 2353 | 104 | 2393 | -171 | 2387 |
| 6-#6 | 1.00 | MA | 1486 | 660 | 2042 | 572 | 2435 | 482 | 2640 | 412 | 2829 | 306 | 3389 | 267 | 1356 |
| 2L-3S | | MI | 739 | 660 | 1115 | 523 | 1233 | 439 | 1277 | 376 | 1269 | 272 | 1382 | 178 | 716 |
| 6-#6 | 1.00 | MA | 1403 | 660 | 1903 | 575 | 2258 | 485 | 2425 | 414 | 2540 | 310 | 2988 | 235 | 1362 |
| 3L-2S | | MI | 772 | 660 | 1175 | 522 | 1309 | 439 | 1369 | 375 | 1386 | 271 | 1514 | 210 | 710 |
| 6-#7 | 1.36 | MA | 1553 | 688 | 2198 | 587 | 2627 | 493 | 2869 | 418 | 3135 | 304 | 3807 | 264 | 1809 |
| 2L-3S | | MI | 752 | 688 | 1161 | 537 | 1286 | 449 | 1336 | 381 | 1343 | 266 | 1460 | 148 | 924 |
| 6-#7 | 1.36 | MA | 1444 | 688 | 2009 | 592 | 2387 | 497 | 2578 | 422 | 2743 | 309 | 3265 | 220 | 1811 |
| 3L-2S | | MI | 794 | 688 | 1241 | 536 | 1388 | 449 | 1458 | 379 | 1498 | 264 | 1634 | 192 | 915 |
| 6-#8 | 1.80 | MA | 1628 | 721 | 2380 | 606 | 2851 | 507 | 3137 | 427 | 3495 | 301 | 4287 | 259 | 2337 |
| 2L-3S | | MI | 766 | 721 | 1214 | 555 | 1348 | 461 | 1404 | 387 | 1427 | 258 | 1548 | 112 | 1158 |
| 6-#8 | 1.80 | MA | 1491 | 721 | 2133 | 613 | 2537 | 512 | 2758 | 431 | 2983 | 308 | 3584 | 201 | 2330 |
| 3L-2S | | MI | 819 | 721 | 1317 | 554 | 1479 | 462 | 1560 | 385 | 1625 | 256 | 1768 | 169 | 1148 |
| 6-#9 | 2.27 | MA | 1708 | 757 | 2578 | 627 | 3095 | 522 | 3430 | 436 | 3888 | 299 | 4804 | 253 | 2910 |
| 2L-3S | | MI | 781 | 757 | 1269 | 574 | 1413 | 474 | 1475 | 393 | 1515 | 249 | 1638 | 70 | 1403 |
| 6-#9 | 2.27 | MA | 1541 | 757 | 2268 | 635 | 2702 | 528 | 2953 | 441 | 3244 | 307 | 3927 | 180 | 2889 |
| 3L-2S | | MI | 845 | 757 | 1398 | 574 | 1577 | 476 | 1667 | 390 | 1759 | 246 | 1906 | 143 | 1394 |
| 6-#10 | 2.89 | MA | 1807 | 804 | 2828 | 655 | 3406 | 542 | 3803 | 448 | 4387 | 295 | 5454 | 244 | 3635 |
| 2L-3S | | MI | 799 | 804 | 1338 | 599 | 1495 | 491 | 1561 | 401 | 1623 | 237 | 1746 | 15 | 1699 |
| 6-#10 | 2.89 | MA | 1605 | 804 | 2438 | 664 | 2910 | 550 | 3202 | 454 | 3576 | 306 | 4358 | 152 | 3586 |
| 3L-2S | | MI | 877 | 804 | 1499 | 599 | 1699 | 494 | 1797 | 397 | 1923 | 233 | 2070 | 107 | 1696 |
| 6-#11 | 3.55 | MA | 1661 | 855 | 2617 | 692 | 3118 | 569 | 3444 | 465 | 3895 | 301 | 4721 | 111 | 4267 |
| 3L-2S | | MI | 897 | 855 | 1590 | 622 | 1773 | 501 | 1876 | 393 | 2018 | 207 | 2125 | 46 | 1971 |
| 6-#14 | 5.11 | MA | 1824 | 975 | 3025 | 767 | 3622 | 623 | 4048 | 499 | 4704 | 296 | 5719 | 29 | 5641 |
| 3L-2S | | MI | 964 | 975 | 1811 | 689 | 2006 | 538 | 2141 | 403 | 2352 | 163 | 2503 | -43 | 2439 |
| 8-#6 | 1.33 | MA | 1550 | 685 | 2182 | 588 | 2612 | 493 | 2855 | 419 | 3119 | 305 | 3790 | 265 | 1777 |
| 2L-4S | | MI | 743 | 685 | 1131 | 539 | 1248 | 453 | 1295 | 382 | 1296 | 270 | 1415 | 154 | 914 |
| 8-#6 | 1.33 | MA | 1470 | 685 | 2042 | 591 | 2435 | 497 | 2640 | 422 | 2829 | 309 | 3389 | 233 | 1779 |
| 3E | | MI | 763 | 685 | 1175 | 539 | 1309 | 451 | 1369 | 383 | 1386 | 269 | 1514 | 165 | 907 |
| 8-#6 | 1.33 | MA | 1425 | 685 | 1946 | 595 | 2301 | 502 | 2476 | 427 | 2605 | 311 | 3108 | 215 | 1775 |
| 4L-2S | | MI | 795 | 685 | 1235 | 538 | 1385 | 451 | 1461 | 382 | 1503 | 268 | 1647 | 197 | 901 |
| 8-#7 | 1.82 | MA | 1533 | 723 | 2198 | 614 | 2627 | 513 | 2869 | 432 | 3135 | 308 | 3807 | 218 | 2371 |
| 3E | | MI | 783 | 723 | 1241 | 559 | 1388 | 465 | 1458 | 391 | 1498 | 261 | 1634 | 130 | 1173 |
| 8-#7 | 1.82 | MA | 1473 | 723 | 2067 | 619 | 2445 | 521 | 2646 | 439 | 2831 | 310 | 3426 | 192 | 2347 |
| 4L-2S | | MI | 825 | 723 | 1322 | 558 | 1490 | 465 | 1580 | 389 | 1653 | 260 | 1808 | 174 | 1166 |
| 8-#8 | 2.39 | MA | 1604 | 767 | 2380 | 641 | 2851 | 533 | 3137 | 444 | 3495 | 306 | 4287 | 198 | 3057 |
| 3E | | MI | 806 | 767 | 1317 | 583 | 1479 | 482 | 1560 | 399 | 1625 | 251 | 1768 | 87 | 1473 |
| 8-#8 | 2.39 | MA | 1530 | 767 | 2209 | 648 | 2613 | 543 | 2846 | 453 | 3097 | 309 | 3792 | 164 | 2948 |
| 4L-2S | | MI | 857 | 767 | 1421 | 582 | 1611 | 483 | 1716 | 397 | 1823 | 249 | 1989 | 145 | 1467 |
| 8-#9 | 3.03 | MA | 1682 | 815 | 2578 | 671 | 3095 | 555 | 3430 | 458 | 3888 | 304 | 4804 | 174 | 3798 |
| 3E | | MI | 830 | 815 | 1398 | 610 | 1577 | 500 | 1667 | 408 | 1759 | 240 | 1906 | 38 | 1787 |
| 8-#9 | 3.03 | MA | 1593 | 815 | 2362 | 679 | 2796 | 567 | 3064 | 469 | 3387 | 307 | 4185 | 133 | 3526 |
| 4L-2S | | MI | 892 | 815 | 1528 | 610 | 1741 | 502 | 1859 | 405 | 2002 | 237 | 2173 | 110 | 1786 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

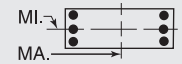
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 3.85 | MA | 1779 | 878 | 2828 | 710 | 3406 | 583 | 3803 | 476 | 4387 | 302 | 5454 | 143 | 4728 |
| 3E | | MI | 860 | 878 | 1499 | 645 | 1699 | 525 | 1797 | 419 | 1923 | 223 | 2070 | -29 | 2066 |
| 8-#10 | 3.85 | MA | 1672 | 878 | 2556 | 720 | 3028 | 598 | 3341 | 489 | 3756 | 305 | 4680 | 91 | 4242 |
| 4L-2S | | MI | 933 | 878 | 1659 | 645 | 1902 | 528 | 2033 | 415 | 2222 | 220 | 2395 | 63 | 2180 |
| 8-#11 | 4.73 | MA | 1742 | 945 | 2757 | 759 | 3258 | 627 | 3608 | 506 | 4108 | 299 | 5094 | 36 | 4927 |
| 4L-2S | | MI | 961 | 945 | 1776 | 678 | 2000 | 540 | 2139 | 412 | 2352 | 186 | 2473 | -17 | 2476 |
| 8-#14 | 6.82 | MA | 1954 | 1105 | 3222 | 863 | 3818 | 706 | 4278 | 556 | 5002 | 291 | 6233 | -81 | 6107 |
| 4L-2S | | MI | 1052 | 1105 | 2068 | 771 | 2310 | 590 | 2493 | 427 | 2800 | 129 | 2981 | -135 | 2894 |
| 10-#10 | 4.81 | MA | 1851 | 952 | 2946 | 766 | 3524 | 632 | 3942 | 510 | 4567 | 302 | 5775 | 83 | 5359 |
| 4L-3S | | MI | 920 | 952 | 1659 | 691 | 1902 | 558 | 2033 | 437 | 2222 | 210 | 2395 | -73 | 2382 |
| 10-#10 | 4.81 | MA | 1728 | 952 | 2703 | 776 | 3191 | 640 | 3529 | 517 | 3995 | 312 | 5004 | 30 | 4905 |
| 5L-2S | | MI | 990 | 952 | 1820 | 692 | 2106 | 562 | 2269 | 433 | 2521 | 206 | 2720 | 19 | 2656 |
| 10-#11 | 5.91 | MA | 1811 | 1036 | 2932 | 826 | 3451 | 677 | 3832 | 539 | 4391 | 305 | 5473 | -44 | 5422 |
| 5L-2S | | MI | 1025 | 1036 | 1963 | 735 | 2227 | 578 | 2402 | 431 | 2686 | 166 | 2821 | -80 | 2824 |
| 12-#10 | 5.77 | MA | 1903 | 1025 | 3094 | 822 | 3687 | 674 | 4130 | 538 | 4806 | 308 | 6100 | 21 | 6024 |
| 5L-3S | | MI | 980 | 1025 | 1820 | 737 | 2106 | 592 | 2269 | 455 | 2521 | 197 | 2720 | -118 | 2693 |
| 12-#10 | 5.77 | MA | 1770 | 1025 | 2821 | 837 | 3372 | 681 | 3726 | 551 | 4258 | 319 | 5392 | -38 | 5280 |
| 6L-2S | | MI | 1046 | 1025 | 1981 | 738 | 2310 | 595 | 2504 | 451 | 2820 | 193 | 3044 | -25 | 3039 |
| 14-#10 | 6.73 | MA | 1962 | 1099 | 3212 | 883 | 3868 | 715 | 4327 | 573 | 5070 | 315 | 6487 | -46 | 6335 |
| 6L-3S | | MI | 1038 | 1099 | 1981 | 783 | 2310 | 626 | 2504 | 473 | 2820 | 183 | 3044 | -162 | 2999 |

## RECTANGULAR TIED COLUMNS 12" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.10 | MA | 1795 | 728 | 2472 | 631 | 2960 | 531 | 3222 | 453 | 3480 | 335 | 4192 | 292 | 1766 |
| 2E | | MI | 845 | 728 | 1305 | 568 | 1446 | 477 | 1503 | 404 | 1521 | 288 | 1648 | 216 | 834 |
| 4-#9 | 1.39 | MA | 1859 | 752 | 2623 | 644 | 3144 | 541 | 3441 | 459 | 3772 | 333 | 4595 | 289 | 2199 |
| 2E | | MI | 862 | 752 | 1361 | 580 | 1512 | 486 | 1574 | 407 | 1609 | 281 | 1738 | 198 | 1008 |
| 4-#10 | 1.76 | MA | 1937 | 784 | 2813 | 662 | 3378 | 553 | 3720 | 466 | 4145 | 330 | 5106 | 286 | 2747 |
| 2E | | MI | 884 | 784 | 1431 | 595 | 1594 | 497 | 1661 | 410 | 1717 | 271 | 1845 | 173 | 1222 |
| 4-#11 | 2.17 | MA | 2007 | 817 | 3017 | 678 | 3614 | 564 | 3996 | 472 | 4508 | 326 | 5539 | 274 | 3300 |
| 2E | | MI | 897 | 817 | 1498 | 606 | 1644 | 498 | 1712 | 405 | 1777 | 251 | 1875 | 130 | 1425 |
| 4-#14 | 3.13 | MA | 2185 | 897 | 3478 | 724 | 4183 | 598 | 4677 | 492 | 5421 | 320 | 6706 | 257 | 4630 |
| 2E | | MI | 941 | 897 | 1649 | 648 | 1800 | 519 | 1888 | 409 | 1996 | 220 | 2122 | 69 | 1896 |
| 4-#18 | 5.56 | MA | 2586 | 1100 | 4593 | 843 | 5567 | 684 | 6340 | 545 | 7652 | 305 | 9446 | 201 | 7857 |
| 2E | | MI | 1038 | 1100 | 1931 | 741 | 2116 | 567 | 2244 | 410 | 2444 | 127 | 2489 | -150 | 2480 |
| 6-#7 | 1.25 | MA | 1834 | 741 | 2544 | 640 | 3059 | 538 | 3345 | 458 | 3649 | 335 | 4429 | 292 | 2003 |
| 2L-3S | | MI | 815 | 741 | 1252 | 580 | 1385 | 485 | 1436 | 413 | 1437 | 291 | 1561 | 170 | 938 |
| 6-#7 | 1.25 | MA | 1711 | 741 | 2334 | 646 | 2792 | 543 | 3021 | 462 | 3212 | 341 | 3823 | 249 | 2006 |
| 3L-2S | | MI | 858 | 741 | 1332 | 579 | 1486 | 486 | 1557 | 411 | 1592 | 290 | 1735 | 214 | 929 |
| 6-#8 | 1.65 | MA | 1921 | 774 | 2748 | 659 | 3310 | 552 | 3646 | 466 | 4052 | 333 | 4984 | 289 | 2592 |
| 2L-3S | | MI | 829 | 774 | 1305 | 597 | 1446 | 497 | 1503 | 419 | 1521 | 283 | 1648 | 134 | 1175 |
| 6-#8 | 1.65 | MA | 1765 | 774 | 2472 | 666 | 2960 | 558 | 3222 | 471 | 3480 | 341 | 4192 | 232 | 2586 |
| 3L-2S | | MI | 883 | 774 | 1409 | 596 | 1578 | 498 | 1659 | 416 | 1719 | 281 | 1869 | 191 | 1164 |
| 6-#9 | 2.08 | MA | 2013 | 810 | 2970 | 681 | 3584 | 567 | 3974 | 475 | 4492 | 330 | 5591 | 285 | 3234 |
| 2L-3S | | MI | 844 | 810 | 1361 | 616 | 1512 | 510 | 1574 | 425 | 1609 | 274 | 1738 | 92 | 1424 |
| 6-#9 | 2.08 | MA | 1823 | 810 | 2623 | 689 | 3144 | 574 | 3441 | 482 | 3772 | 340 | 4595 | 213 | 3213 |
| 3L-2S | | MI | 909 | 810 | 1490 | 616 | 1676 | 512 | 1766 | 422 | 1852 | 271 | 2006 | 165 | 1412 |
| 6-#10 | 2.65 | MA | 2126 | 857 | 3250 | 708 | 3932 | 587 | 4392 | 488 | 5052 | 327 | 6361 | 281 | 4047 |
| 2L-3S | | MI | 862 | 857 | 1431 | 641 | 1594 | 527 | 1661 | 432 | 1717 | 261 | 1845 | 37 | 1725 |
| 6-#10 | 2.65 | MA | 1896 | 857 | 2813 | 718 | 3378 | 596 | 3720 | 495 | 4145 | 338 | 5106 | 189 | 3997 |
| 3L-2S | | MI | 941 | 857 | 1591 | 641 | 1797 | 530 | 1896 | 428 | 2016 | 258 | 2170 | 129 | 1718 |
| 6-#11 | 3.25 | MA | 1962 | 908 | 3017 | 746 | 3614 | 616 | 3996 | 506 | 4508 | 334 | 5539 | 152 | 4773 |
| 3L-2S | | MI | 961 | 908 | 1684 | 663 | 1872 | 536 | 1975 | 423 | 2111 | 231 | 2223 | 67 | 1997 |
| 6-#14 | 4.69 | MA | 2136 | 1028 | 3478 | 822 | 4183 | 670 | 4677 | 540 | 5421 | 330 | 6706 | 76 | 6480 |
| 3L-2S | | MI | 1028 | 1028 | 1906 | 730 | 2105 | 572 | 2240 | 433 | 2444 | 187 | 2600 | -22 | 2533 |

## RECTANGULAR TIED COLUMNS 12" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#6 | 1.22 | MA | 1831 | 739 | 2525 | 641 | 3042 | 539 | 3329 | 458 | 3630 | 337 | 4405 | 293 | 1967 |
| 2L-4S | | MI | 806 | 739 | 1222 | 582 | 1347 | 490 | 1394 | 414 | 1390 | 296 | 1517 | 176 | 928 |
| 8-#6 | 1.22 | MA | 1741 | 739 | 2370 | 645 | 2845 | 542 | 3090 | 461 | 3307 | 341 | 3958 | 262 | 1969 |
| 3E | | MI | 827 | 739 | 1265 | 582 | 1407 | 487 | 1468 | 415 | 1480 | 294 | 1616 | 188 | 920 |
| 8-#6 | 1.22 | MA | 1689 | 739 | 2263 | 648 | 2696 | 548 | 2908 | 467 | 3058 | 343 | 3649 | 244 | 1965 |
| 4L-2S | | MI | 859 | 739 | 1325 | 581 | 1483 | 488 | 1560 | 414 | 1597 | 293 | 1748 | 220 | 914 |
| 8-#7 | 1.67 | MA | 1812 | 776 | 2544 | 667 | 3059 | 559 | 3345 | 472 | 3649 | 340 | 4429 | 247 | 2630 |
| 3E | | MI | 847 | 776 | 1332 | 602 | 1486 | 501 | 1557 | 422 | 1592 | 287 | 1735 | 153 | 1189 |
| 8-#7 | 1.67 | MA | 1745 | 776 | 2399 | 673 | 2857 | 567 | 3098 | 479 | 3311 | 343 | 4009 | 222 | 2607 |
| 4L-2S | | MI | 889 | 776 | 1413 | 601 | 1588 | 502 | 1679 | 421 | 1747 | 285 | 1909 | 196 | 1181 |
| 8-#8 | 2.19 | MA | 1894 | 820 | 2748 | 695 | 3310 | 579 | 3646 | 484 | 4052 | 338 | 4984 | 229 | 3399 |
| 3E | | MI | 870 | 820 | 1409 | 626 | 1578 | 518 | 1659 | 431 | 1719 | 277 | 1869 | 110 | 1493 |
| 8-#8 | 2.19 | MA | 1811 | 820 | 2557 | 702 | 3046 | 589 | 3322 | 494 | 3609 | 342 | 4432 | 196 | 3327 |
| 4L-2S | | MI | 922 | 820 | 1513 | 625 | 1710 | 519 | 1815 | 429 | 1917 | 274 | 2089 | 167 | 1485 |
| 8-#9 | 2.78 | MA | 1983 | 868 | 2970 | 725 | 3584 | 601 | 3974 | 498 | 4492 | 337 | 5591 | 210 | 4230 |
| 3E | | MI | 894 | 868 | 1490 | 652 | 1676 | 536 | 1766 | 439 | 1852 | 265 | 2006 | 59 | 1811 |
| 8-#9 | 2.78 | MA | 1882 | 868 | 2730 | 734 | 3252 | 614 | 3567 | 510 | 3935 | 341 | 4894 | 167 | 3981 |
| 4L-2S | | MI | 956 | 868 | 1619 | 652 | 1839 | 538 | 1958 | 437 | 2096 | 262 | 2274 | 132 | 1806 |
| 8-#10 | 3.53 | MA | 2094 | 931 | 3250 | 764 | 3932 | 630 | 4392 | 516 | 5052 | 335 | 6361 | 184 | 5277 |
| 3E | | MI | 923 | 931 | 1591 | 687 | 1797 | 560 | 1896 | 450 | 2016 | 248 | 2170 | -7 | 2169 |
| 8-#10 | 3.53 | MA | 1974 | 931 | 2947 | 775 | 3512 | 646 | 3878 | 531 | 4349 | 339 | 5479 | 130 | 4791 |
| 4L-2S | | MI | 998 | 931 | 1752 | 687 | 2001 | 564 | 2132 | 446 | 2315 | 245 | 2495 | 85 | 2203 |
| 8-#11 | 4.33 | MA | 2055 | 998 | 3176 | 815 | 3774 | 675 | 4183 | 549 | 4750 | 334 | 5974 | 78 | 5573 |
| 4L-2S | | MI | 1025 | 998 | 1870 | 719 | 2099 | 575 | 2238 | 442 | 2445 | 211 | 2571 | 5 | 2556 |
| 8-#14 | 6.25 | MA | 2278 | 1158 | 3702 | 919 | 4408 | 756 | 4940 | 601 | 5761 | 328 | 7310 | -31 | 7249 |
| 4L-2S | | MI | 1115 | 1158 | 2163 | 811 | 2410 | 625 | 2592 | 457 | 2892 | 153 | 3078 | -114 | 2994 |
| 10-#10 | 4.41 | MA | 2177 | 1005 | 3384 | 821 | 4067 | 679 | 4550 | 552 | 5256 | 336 | 6734 | 125 | 6044 |
| 4L-3S | | MI | 983 | 1005 | 1752 | 733 | 2001 | 594 | 2132 | 468 | 2315 | 235 | 2495 | -52 | 2487 |
| 10-#10 | 4.41 | MA | 2033 | 1005 | 3114 | 831 | 3697 | 688 | 4092 | 560 | 4620 | 348 | 5851 | 71 | 5585 |
| 5L-2S | | MI | 1054 | 1005 | 1912 | 733 | 2205 | 598 | 2368 | 464 | 2614 | 231 | 2819 | 41 | 2682 |
| 10-#11 | 5.42 | MA | 2129 | 1089 | 3375 | 883 | 3994 | 727 | 4437 | 583 | 5072 | 342 | 6412 | 2 | 6403 |
| 5L-2S | | MI | 1089 | 1089 | 2056 | 776 | 2327 | 614 | 2501 | 461 | 2779 | 190 | 2919 | -58 | 2924 |
| 10-#14 | 7.81 | MA | 2400 | 1289 | 3982 | 1017 | 4717 | 829 | 5298 | 649 | 6215 | 339 | 7921 | -144 | 7705 |
| 5L-2S | | MI | 1203 | 1289 | 2420 | 893 | 2714 | 678 | 2944 | 481 | 3339 | 119 | 3556 | -205 | 3437 |
| 12-#10 | 5.29 | MA | 2231 | 1078 | 3551 | 877 | 4252 | 722 | 4763 | 581 | 5527 | 344 | 7106 | 66 | 6844 |
| 5L-3S | | MI | 1043 | 1078 | 1912 | 779 | 2205 | 628 | 2368 | 486 | 2614 | 222 | 2819 | -96 | 2800 |
| 12-#10 | 5.29 | MA | 2081 | 1078 | 3241 | 892 | 3902 | 731 | 4314 | 595 | 4906 | 349 | 6243 | -5 | 6232 |
| 6L-2S | | MI | 1110 | 1078 | 2073 | 779 | 2409 | 631 | 2603 | 482 | 2914 | 218 | 3144 | -3 | 3144 |
| 12-#11 | 6.50 | MA | 2188 | 1179 | 3533 | 958 | 4238 | 778 | 4702 | 626 | 5427 | 351 | 6936 | -81 | 6728 |
| 6L-2S | | MI | 1153 | 1179 | 2243 | 832 | 2554 | 652 | 2764 | 480 | 3113 | 170 | 3267 | -121 | 3266 |
| 14-#10 | 6.17 | MA | 2283 | 1152 | 3678 | 938 | 4457 | 764 | 4986 | 617 | 5812 | 345 | 7497 | -10 | 7463 |
| 6L-3S | | MI | 1102 | 1152 | 2073 | 825 | 2409 | 661 | 2603 | 504 | 2914 | 208 | 3144 | -140 | 3109 |

## RECTANGULAR TIED COLUMNS 14" x 14"

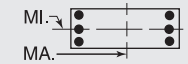
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#6 | 1.35 | MA | 703 | 510 | 1063 | 411 | 1216 | 345 | 1297 | 292 | 1375 | 211 | 1543 | 163 | 801 |
| 2L-3S | | MI | 661 | 510 | 988 | 413 | 1120 | 346 | 1181 | 295 | 1219 | 212 | 1359 | 131 | 807 |
| 6-#7 | 1.84 | MA | 733 | 538 | 1147 | 427 | 1317 | 356 | 1418 | 299 | 1529 | 207 | 1721 | 150 | 1048 |
| 2L-3S | | MI | 678 | 538 | 1045 | 429 | 1188 | 357 | 1261 | 302 | 1322 | 208 | 1475 | 107 | 1054 |
| 6-#8 | 2.42 | MA | 767 | 571 | 1242 | 446 | 1435 | 370 | 1558 | 307 | 1707 | 202 | 1922 | 134 | 1333 |
| 2L-3S | | MI | 700 | 571 | 1110 | 448 | 1267 | 371 | 1355 | 311 | 1440 | 204 | 1609 | 77 | 1333 |
| 6-#9 | 3.06 | MA | 802 | 607 | 1346 | 466 | 1562 | 385 | 1710 | 316 | 1896 | 196 | 2133 | 115 | 1637 |
| 2L-3S | | MI | 722 | 607 | 1180 | 469 | 1352 | 385 | 1456 | 320 | 1565 | 198 | 1748 | 42 | 1626 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 14"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 3.89 | MA | 845 | 654 | 1475 | 494 | 1721 | 404 | 1901 | 328 | 2131 | 187 | 2391 | 89 | 2015 |
| 2L-3S | | MI | 750 | 654 | 1268 | 497 | 1458 | 405 | 1583 | 333 | 1721 | 191 | 1919 | -3 | 1917 |
| 6-#11 | 4.78 | MA | 877 | 705 | 1596 | 519 | 1862 | 422 | 2053 | 335 | 2300 | 169 | 2540 | 43 | 2363 |
| 2L-3S | | MI | 770 | 705 | 1353 | 521 | 1554 | 420 | 1684 | 339 | 1832 | 173 | 2014 | -70 | 1990 |
| 8-#6 | 1.80 | MA | 733 | 535 | 1139 | 427 | 1312 | 357 | 1414 | 300 | 1530 | 209 | 1728 | 154 | 1033 |
| 2L-4S | | MI | 668 | 535 | 1009 | 431 | 1141 | 361 | 1205 | 302 | 1251 | 209 | 1409 | 108 | 1038 |
| 8-#7 | 2.45 | MA | 773 | 572 | 1248 | 449 | 1447 | 372 | 1575 | 309 | 1737 | 204 | 1966 | 138 | 1356 |
| 2L-4S | | MI | 691 | 572 | 1073 | 453 | 1216 | 377 | 1294 | 312 | 1364 | 204 | 1541 | 75 | 1305 |
| 8-#8 | 3.22 | MA | 817 | 616 | 1375 | 474 | 1603 | 390 | 1762 | 320 | 1975 | 198 | 2236 | 117 | 1729 |
| 2L-4S | | MI | 716 | 616 | 1147 | 479 | 1303 | 397 | 1397 | 324 | 1495 | 198 | 1692 | 35 | 1587 |
| 8-#9 | 4.08 | MA | 863 | 665 | 1511 | 503 | 1771 | 411 | 1964 | 333 | 2228 | 190 | 2518 | 91 | 2128 |
| 2L-4S | | MI | 743 | 665 | 1226 | 508 | 1396 | 418 | 1508 | 336 | 1641 | 196 | 1849 | -11 | 1848 |

## RECTANGULAR TIED COLUMNS 14" x 16"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.07 | MA | 901 | 565 | 1317 | 467 | 1517 | 393 | 1618 | 335 | 1706 | 247 | 1944 | 202 | 865 |
| 2E | | MI | 779 | 565 | 1165 | 457 | 1321 | 384 | 1396 | 327 | 1451 | 240 | 1616 | 190 | 749 |
| 4-#8 | 1.41 | MA | 932 | 587 | 1397 | 479 | 1614 | 401 | 1733 | 340 | 1860 | 245 | 2122 | 194 | 1101 |
| 2E | | MI | 803 | 587 | 1231 | 468 | 1400 | 392 | 1490 | 332 | 1569 | 236 | 1749 | 178 | 947 |
| 4-#9 | 1.79 | MA | 964 | 611 | 1484 | 492 | 1719 | 411 | 1857 | 345 | 2026 | 243 | 2311 | 184 | 1355 |
| 2E | | MI | 827 | 611 | 1302 | 481 | 1485 | 402 | 1591 | 337 | 1694 | 231 | 1888 | 165 | 1157 |
| 4-#10 | 2.27 | MA | 1003 | 642 | 1592 | 509 | 1851 | 423 | 2015 | 353 | 2233 | 239 | 2545 | 170 | 1672 |
| 2E | | MI | 857 | 642 | 1390 | 498 | 1592 | 414 | 1718 | 345 | 1849 | 225 | 2058 | 147 | 1419 |
| 4-#11 | 2.79 | MA | 1032 | 676 | 1702 | 524 | 1975 | 433 | 2158 | 358 | 2393 | 229 | 2703 | 145 | 1979 |
| 2E | | MI | 878 | 676 | 1477 | 512 | 1688 | 423 | 1819 | 347 | 1959 | 211 | 2152 | 115 | 1668 |
| 4-#14 | 4.02 | MA | 1116 | 756 | 1955 | 570 | 2286 | 466 | 2530 | 378 | 2849 | 214 | 3205 | 100 | 2720 |
| 2E | | MI | 942 | 756 | 1678 | 557 | 1934 | 456 | 2087 | 360 | 2296 | 190 | 2496 | 57 | 2266 |
| 4-#18 | 7.14 | MA | 1307 | 959 | 2548 | 688 | 3018 | 552 | 3371 | 423 | 3878 | 168 | 4284 | -35 | 4255 |
| 2E | | MI | 1085 | 959 | 2142 | 674 | 2456 | 528 | 2669 | 385 | 3029 | 126 | 3190 | -117 | 3178 |
| 6-#6 | 1.18 | MA | 914 | 572 | 1339 | 473 | 1550 | 398 | 1660 | 338 | 1766 | 248 | 2027 | 203 | 944 |
| 2L-3S | | MI | 747 | 572 | 1107 | 465 | 1252 | 390 | 1316 | 334 | 1349 | 242 | 1500 | 158 | 821 |
| 6-#6 | 1.18 | MA | 862 | 572 | 1247 | 476 | 1433 | 400 | 1519 | 339 | 1575 | 250 | 1789 | 171 | 949 |
| 3L-2S | | MI | 790 | 572 | 1183 | 463 | 1348 | 389 | 1432 | 331 | 1504 | 241 | 1685 | 190 | 815 |
| 6-#7 | 1.61 | MA | 953 | 599 | 1440 | 489 | 1674 | 409 | 1808 | 345 | 1963 | 246 | 2262 | 193 | 1243 |
| 2L-3S | | MI | 765 | 599 | 1165 | 481 | 1321 | 401 | 1396 | 341 | 1451 | 239 | 1616 | 133 | 1072 |
| 6-#7 | 1.61 | MA | 885 | 599 | 1317 | 492 | 1517 | 411 | 1618 | 346 | 1706 | 248 | 1944 | 150 | 1248 |
| 3L-2S | | MI | 821 | 599 | 1267 | 478 | 1450 | 400 | 1553 | 337 | 1659 | 237 | 1861 | 177 | 1065 |
| 6-#8 | 2.12 | MA | 998 | 632 | 1558 | 507 | 1818 | 422 | 1980 | 353 | 2194 | 243 | 2531 | 181 | 1589 |
| 2L-3S | | MI | 787 | 632 | 1231 | 499 | 1400 | 414 | 1490 | 349 | 1569 | 234 | 1749 | 103 | 1356 |
| 6-#8 | 2.12 | MA | 912 | 632 | 1397 | 511 | 1614 | 425 | 1733 | 354 | 1860 | 246 | 2122 | 124 | 1589 |
| 3L-2S | | MI | 855 | 632 | 1363 | 497 | 1568 | 413 | 1694 | 345 | 1837 | 232 | 2063 | 161 | 1352 |
| 6-#9 | 2.68 | MA | 1044 | 669 | 1685 | 528 | 1974 | 437 | 2167 | 362 | 2445 | 240 | 2817 | 167 | 1961 |
| 2L-3S | | MI | 809 | 669 | 1302 | 520 | 1485 | 429 | 1591 | 358 | 1694 | 229 | 1888 | 69 | 1655 |
| 6-#9 | 2.68 | MA | 941 | 669 | 1484 | 533 | 1719 | 440 | 1857 | 363 | 2026 | 243 | 2311 | 94 | 1950 |
| 3L-2S | | MI | 890 | 669 | 1467 | 518 | 1695 | 428 | 1845 | 354 | 2025 | 226 | 2273 | 142 | 1658 |
| 6-#10 | 3.40 | MA | 1100 | 716 | 1845 | 555 | 2171 | 457 | 2403 | 374 | 2756 | 236 | 3170 | 147 | 2427 |
| 2L-3S | | MI | 836 | 716 | 1390 | 547 | 1592 | 448 | 1718 | 371 | 1849 | 221 | 2058 | 23 | 2013 |
| 6-#10 | 3.40 | MA | 980 | 716 | 1592 | 561 | 1851 | 460 | 2015 | 375 | 2233 | 239 | 2545 | 54 | 2394 |
| 3L-2S | | MI | 934 | 716 | 1597 | 544 | 1854 | 447 | 2036 | 366 | 2259 | 217 | 2531 | 115 | 2040 |
| 6-#11 | 4.18 | MA | 1144 | 766 | 2001 | 581 | 2355 | 475 | 2619 | 384 | 2999 | 222 | 3414 | 111 | 2869 |
| 2L-3S | | MI | 855 | 766 | 1477 | 571 | 1688 | 463 | 1819 | 377 | 1959 | 203 | 2152 | -44 | 2138 |
| 6-#11 | 4.18 | MA | 1008 | 766 | 1702 | 586 | 1975 | 477 | 2158 | 392 | 2393 | 226 | 2703 | -3 | 2702 |
| 3L-2S | | MI | 965 | 766 | 1720 | 569 | 1996 | 465 | 2188 | 372 | 2428 | 198 | 2678 | 69 | 2394 |
| 6-#14 | 6.03 | MA | 1093 | 886 | 1955 | 657 | 2286 | 527 | 2530 | 424 | 2849 | 207 | 3205 | -119 | 3129 |
| 3L-2S | | MI | 1061 | 886 | 2017 | 639 | 2364 | 515 | 2591 | 394 | 2935 | 169 | 3199 | -17 | 3192 |
| 8-#6 | 1.57 | MA | 953 | 597 | 1430 | 489 | 1666 | 409 | 1801 | 346 | 1956 | 247 | 2266 | 197 | 1223 |
| 2L-4S | | MI | 754 | 597 | 1128 | 483 | 1273 | 405 | 1341 | 341 | 1381 | 240 | 1550 | 135 | 1057 |

## RECTANGULAR TIED COLUMNS 14" x 16"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#6 | 1.57 | MA | 903 | 597 | 1339 | 492 | 1550 | 411 | 1660 | 347 | 1766 | 249 | 2027 | 165 | 1227 |
| 3E | | MI | 779 | 597 | 1183 | 481 | 1348 | 402 | 1432 | 341 | 1504 | 241 | 1685 | 149 | 1053 |
| 8-#6 | 1.57 | MA | 873 | 597 | 1274 | 494 | 1460 | 415 | 1550 | 350 | 1616 | 249 | 1856 | 149 | 1228 |
| 4L-2S | | MI | 821 | 597 | 1259 | 479 | 1444 | 401 | 1549 | 338 | 1660 | 240 | 1870 | 181 | 1048 |
| 8-#7 | 2.14 | MA | 1004 | 634 | 1564 | 510 | 1831 | 425 | 1998 | 355 | 2220 | 244 | 2580 | 184 | 1616 |
| 2L-4S | | MI | 775 | 634 | 1193 | 505 | 1349 | 421 | 1429 | 350 | 1494 | 235 | 1682 | 102 | 1356 |
| 8-#7 | 2.14 | MA | 939 | 634 | 1440 | 514 | 1674 | 427 | 1808 | 356 | 1963 | 247 | 2262 | 141 | 1617 |
| 3E | | MI | 809 | 634 | 1267 | 502 | 1450 | 417 | 1553 | 351 | 1659 | 236 | 1861 | 121 | 1378 |
| 8-#7 | 2.14 | MA | 900 | 634 | 1352 | 517 | 1552 | 432 | 1659 | 361 | 1760 | 246 | 2033 | 120 | 1589 |
| 4L-2S | | MI | 861 | 634 | 1369 | 500 | 1579 | 416 | 1710 | 347 | 1867 | 235 | 2106 | 165 | 1375 |
| 8-#8 | 2.82 | MA | 1062 | 678 | 1719 | 536 | 2022 | 443 | 2228 | 366 | 2529 | 241 | 2940 | 169 | 2071 |
| 2L-4S | | MI | 801 | 678 | 1267 | 531 | 1436 | 441 | 1532 | 362 | 1624 | 228 | 1832 | 62 | 1644 |
| 8-#8 | 2.82 | MA | 981 | 678 | 1558 | 540 | 1818 | 446 | 1980 | 368 | 2194 | 244 | 2531 | 111 | 2062 |
| 3E | | MI | 841 | 678 | 1363 | 528 | 1568 | 435 | 1694 | 362 | 1837 | 231 | 2063 | 86 | 1747 |
| 8-#8 | 2.82 | MA | 932 | 678 | 1443 | 544 | 1660 | 453 | 1787 | 373 | 1930 | 242 | 2236 | 84 | 1938 |
| 4L-2S | | MI | 905 | 678 | 1496 | 526 | 1736 | 434 | 1897 | 359 | 2104 | 228 | 2376 | 143 | 1750 |
| 8-#9 | 3.57 | MA | 1122 | 727 | 1887 | 565 | 2230 | 464 | 2477 | 379 | 2863 | 237 | 3322 | 150 | 2560 |
| 2L-4S | | MI | 828 | 727 | 1347 | 559 | 1530 | 462 | 1643 | 374 | 1770 | 226 | 1989 | 16 | 1943 |
| 8-#9 | 3.57 | MA | 1028 | 727 | 1685 | 569 | 1974 | 467 | 2167 | 380 | 2445 | 240 | 2817 | 77 | 2537 |
| 3E | | MI | 875 | 727 | 1467 | 557 | 1695 | 455 | 1845 | 375 | 2025 | 223 | 2273 | 45 | 2137 |
| 8-#9 | 3.57 | MA | 972 | 727 | 1541 | 574 | 1776 | 475 | 1924 | 387 | 2113 | 238 | 2451 | 43 | 2303 |
| 4L-2S | | MI | 952 | 727 | 1632 | 554 | 1904 | 455 | 2099 | 371 | 2356 | 220 | 2658 | 118 | 2152 |
| 8-#10 | 4.54 | MA | 1085 | 790 | 1845 | 607 | 2171 | 494 | 2403 | 396 | 2756 | 235 | 3170 | 31 | 3093 |
| 3E | | MI | 919 | 790 | 1597 | 593 | 1854 | 481 | 2036 | 392 | 2259 | 213 | 2531 | -9 | 2526 |
| 8-#10 | 4.54 | MA | 1017 | 790 | 1663 | 612 | 1922 | 504 | 2098 | 404 | 2341 | 232 | 2716 | -11 | 2712 |
| 4L-2S | | MI | 1009 | 790 | 1803 | 590 | 2116 | 481 | 2354 | 387 | 2669 | 210 | 3003 | 83 | 2652 |
| 8-#11 | 5.57 | MA | 1129 | 857 | 2001 | 643 | 2355 | 518 | 2619 | 418 | 2999 | 219 | 3414 | -37 | 3381 |
| 3E | | MI | 950 | 857 | 1720 | 627 | 1996 | 504 | 2188 | 402 | 2428 | 190 | 2678 | -90 | 2639 |
| 10-#10 | 5.67 | MA | 1126 | 863 | 1916 | 658 | 2242 | 537 | 2487 | 425 | 2864 | 228 | 3341 | -34 | 3314 |
| 4L-3S | | MI | 999 | 863 | 1803 | 639 | 2116 | 515 | 2354 | 413 | 2669 | 205 | 3003 | -41 | 2975 |

## RECTANGULAR TIED COLUMNS 14" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.25 | MA | 1173 | 649 | 1709 | 541 | 1994 | 454 | 2148 | 386 | 2304 | 282 | 2683 | 233 | 1272 |
| 2E | | MI | 890 | 649 | 1352 | 520 | 1533 | 436 | 1625 | 370 | 1698 | 266 | 1889 | 205 | 962 |
| 4-#9 | 1.59 | MA | 1213 | 673 | 1812 | 554 | 2119 | 464 | 2296 | 391 | 2502 | 279 | 2923 | 225 | 1571 |
| 2E | | MI | 915 | 673 | 1423 | 532 | 1618 | 445 | 1726 | 375 | 1823 | 261 | 2028 | 192 | 1175 |
| 4-#10 | 2.02 | MA | 1262 | 704 | 1941 | 571 | 2277 | 476 | 2484 | 399 | 2753 | 277 | 3222 | 215 | 1947 |
| 2E | | MI | 945 | 704 | 1512 | 549 | 1725 | 457 | 1853 | 382 | 1978 | 255 | 2197 | 173 | 1440 |
| 4-#11 | 2.48 | MA | 1302 | 738 | 2076 | 586 | 2430 | 486 | 2661 | 404 | 2984 | 271 | 3446 | 194 | 2316 |
| 2E | | MI | 965 | 738 | 1601 | 562 | 1822 | 466 | 1954 | 384 | 2087 | 241 | 2289 | 141 | 1693 |
| 4-#14 | 3.57 | MA | 1408 | 818 | 2381 | 632 | 2805 | 519 | 3110 | 424 | 3574 | 263 | 4109 | 159 | 3206 |
| 2E | | MI | 1029 | 818 | 1804 | 607 | 2069 | 498 | 2222 | 397 | 2423 | 219 | 2633 | 83 | 2297 |
| 4-#18 | 6.35 | MA | 1648 | 1021 | 3106 | 750 | 3701 | 604 | 4184 | 476 | 4906 | 230 | 5589 | 51 | 5310 |
| 2E | | MI | 1172 | 1021 | 2269 | 722 | 2591 | 569 | 2803 | 421 | 3155 | 154 | 3324 | -92 | 3321 |
| 6-#6 | 1.05 | MA | 1151 | 633 | 1639 | 535 | 1917 | 451 | 2060 | 384 | 2191 | 285 | 2558 | 241 | 1086 |
| 2L-3S | | MI | 834 | 633 | 1227 | 517 | 1385 | 435 | 1451 | 372 | 1478 | 273 | 1641 | 185 | 834 |
| 6-#6 | 1.05 | MA | 1089 | 633 | 1531 | 538 | 1780 | 453 | 1895 | 386 | 1967 | 288 | 2265 | 209 | 1092 |
| 3L-2S | | MI | 877 | 633 | 1302 | 515 | 1481 | 434 | 1568 | 370 | 1634 | 272 | 1826 | 217 | 828 |
| 6-#7 | 1.43 | MA | 1199 | 661 | 1759 | 551 | 2064 | 462 | 2235 | 391 | 2424 | 282 | 2851 | 233 | 1437 |
| 2L-3S | | MI | 852 | 661 | 1285 | 532 | 1453 | 445 | 1532 | 379 | 1580 | 269 | 1757 | 160 | 1089 |
| 6-#7 | 1.43 | MA | 1118 | 661 | 1613 | 554 | 1879 | 465 | 2011 | 393 | 2122 | 286 | 2459 | 190 | 1443 |
| 3L-2S | | MI | 908 | 661 | 1387 | 530 | 1583 | 444 | 1688 | 376 | 1788 | 268 | 2002 | 204 | 1080 |
| 6-#8 | 1.88 | MA | 1254 | 694 | 1898 | 569 | 2235 | 475 | 2440 | 399 | 2698 | 280 | 3190 | 224 | 1844 |
| 2L-3S | | MI | 872 | 694 | 1352 | 551 | 1533 | 458 | 1625 | 387 | 1698 | 265 | 1889 | 130 | 1377 |
| 6-#8 | 1.88 | MA | 1151 | 694 | 1709 | 574 | 1994 | 479 | 2148 | 402 | 2304 | 284 | 2683 | 167 | 1845 |
| 3L-2S | | MI | 942 | 694 | 1484 | 548 | 1701 | 457 | 1829 | 384 | 1966 | 262 | 2203 | 188 | 1370 |
| 6-#9 | 2.38 | MA | 1312 | 731 | 2050 | 590 | 2421 | 490 | 2662 | 408 | 2996 | 277 | 3551 | 213 | 2285 |
| 2L-3S | | MI | 895 | 731 | 1423 | 571 | 1618 | 473 | 1726 | 396 | 1823 | 259 | 2028 | 95 | 1681 |

## RECTANGULAR TIED COLUMNS 14" x 18"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

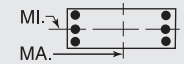
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#9 | 2.38 | MA | 1187 | 731 | 1812 | 596 | 2119 | 495 | 2296 | 411 | 2502 | 282 | 2923 | 141 | 2274 |
| 3L-2S | | MI | 978 | 731 | 1588 | 569 | 1828 | 472 | 1981 | 392 | 2154 | 256 | 2413 | 168 | 1679 |
| 6-#10 | 3.02 | MA | 1383 | 778 | 2240 | 617 | 2656 | 510 | 2944 | 420 | 3373 | 273 | 4002 | 198 | 2838 |
| 2L-3S | | MI | 922 | 778 | 1512 | 598 | 1725 | 491 | 1853 | 408 | 1978 | 251 | 2197 | 49 | 2052 |
| 6-#10 | 3.02 | MA | 1232 | 778 | 1941 | 624 | 2277 | 515 | 2484 | 423 | 2753 | 279 | 3222 | 106 | 2805 |
| 3L-2S | | MI | 1022 | 778 | 1719 | 595 | 1987 | 491 | 2171 | 404 | 2388 | 247 | 2670 | 142 | 2064 |
| 6-#11 | 3.71 | MA | 1440 | 828 | 2431 | 643 | 2881 | 528 | 3208 | 430 | 3723 | 267 | 4345 | 169 | 3374 |
| 2L-3S | | MI | 941 | 828 | 1601 | 621 | 1822 | 505 | 1954 | 414 | 2087 | 232 | 2289 | -18 | 2284 |
| 6-#11 | 3.71 | MA | 1274 | 828 | 2076 | 650 | 2430 | 532 | 2661 | 432 | 2984 | 272 | 3446 | 55 | 3311 |
| 3L-2S | | MI | 1053 | 828 | 1844 | 619 | 2130 | 507 | 2323 | 409 | 2556 | 228 | 2815 | 95 | 2423 |
| 6-#14 | 5.36 | MA | 1380 | 948 | 2381 | 723 | 2805 | 584 | 3110 | 463 | 3574 | 262 | 4109 | -47 | 4062 |
| 3L-2S | | MI | 1149 | 948 | 2142 | 688 | 2498 | 557 | 2725 | 430 | 3063 | 198 | 3335 | 9 | 3300 |
| 8-#6 | 1.40 | MA | 1198 | 659 | 1746 | 551 | 2054 | 462 | 2226 | 392 | 2414 | 284 | 2851 | 237 | 1413 |
| 2L-4S | | MI | 841 | 659 | 1248 | 535 | 1406 | 450 | 1476 | 380 | 1510 | 270 | 1691 | 162 | 1075 |
| 8-#6 | 1.40 | MA | 1138 | 659 | 1639 | 554 | 1917 | 465 | 2060 | 394 | 2191 | 286 | 2558 | 205 | 1417 |
| 3E | | MI | 866 | 659 | 1302 | 533 | 1481 | 446 | 1568 | 380 | 1634 | 272 | 1826 | 176 | 1069 |
| 8-#6 | 1.40 | MA | 1103 | 659 | 1563 | 557 | 1813 | 469 | 1932 | 398 | 2016 | 287 | 2350 | 187 | 1418 |
| 4L-2S | | MI | 908 | 659 | 1378 | 531 | 1577 | 445 | 1684 | 377 | 1790 | 270 | 2011 | 208 | 1063 |
| 8-#7 | 1.90 | MA | 1262 | 696 | 1904 | 572 | 2248 | 478 | 2459 | 401 | 2726 | 281 | 3243 | 227 | 1875 |
| 2L-4S | | MI | 861 | 696 | 1313 | 556 | 1481 | 465 | 1565 | 389 | 1623 | 265 | 1823 | 129 | 1398 |
| 8-#7 | 1.90 | MA | 1183 | 696 | 1759 | 576 | 2064 | 481 | 2235 | 403 | 2424 | 284 | 2851 | 184 | 1876 |
| 3E | | MI | 895 | 696 | 1387 | 554 | 1583 | 461 | 1688 | 389 | 1788 | 267 | 2002 | 148 | 1398 |
| 8-#7 | 1.90 | MA | 1137 | 696 | 1656 | 580 | 1922 | 487 | 2062 | 409 | 2188 | 285 | 2572 | 161 | 1863 |
| 4L-2S | | MI | 948 | 696 | 1489 | 552 | 1712 | 460 | 1845 | 386 | 1996 | 265 | 2247 | 191 | 1392 |
| 8-#8 | 2.51 | MA | 1333 | 740 | 2088 | 598 | 2476 | 496 | 2732 | 412 | 3092 | 277 | 3696 | 215 | 2412 |
| 2L-4S | | MI | 887 | 740 | 1388 | 582 | 1569 | 484 | 1668 | 400 | 1753 | 259 | 1973 | 89 | 1697 |
| 8-#8 | 2.51 | MA | 1235 | 740 | 1898 | 603 | 2235 | 500 | 2440 | 415 | 2698 | 282 | 3190 | 158 | 2404 |
| 3E | | MI | 928 | 740 | 1484 | 580 | 1701 | 479 | 1829 | 401 | 1966 | 261 | 2203 | 113 | 1772 |
| 8-#8 | 2.51 | MA | 1177 | 740 | 1765 | 608 | 2050 | 508 | 2213 | 422 | 2389 | 282 | 2828 | 128 | 2301 |
| 4L-2S | | MI | 993 | 740 | 1616 | 577 | 1869 | 478 | 2033 | 397 | 2233 | 259 | 2516 | 170 | 1770 |
| 8-#9 | 3.17 | MA | 1408 | 789 | 2287 | 626 | 2723 | 517 | 3028 | 425 | 3489 | 274 | 4179 | 201 | 2992 |
| 2L-4S | | MI | 913 | 789 | 1468 | 611 | 1663 | 505 | 1779 | 412 | 1899 | 256 | 2129 | 42 | 2003 |
| 8-#9 | 3.17 | MA | 1290 | 789 | 2050 | 632 | 2421 | 521 | 2662 | 428 | 2996 | 279 | 3551 | 128 | 2969 |
| 3E | | MI | 962 | 789 | 1588 | 608 | 1828 | 499 | 1981 | 413 | 2154 | 253 | 2413 | 72 | 2166 |
| 8-#9 | 3.17 | MA | 1221 | 789 | 1881 | 638 | 2189 | 531 | 2378 | 436 | 2607 | 279 | 3102 | 91 | 2739 |
| 4L-2S | | MI | 1040 | 789 | 1754 | 605 | 2038 | 498 | 2235 | 409 | 2485 | 251 | 2798 | 144 | 2175 |
| 8-#10 | 4.03 | MA | 1364 | 851 | 2240 | 670 | 2656 | 548 | 2944 | 445 | 3373 | 276 | 4002 | 89 | 3674 |
| 3E | | MI | 1005 | 851 | 1719 | 644 | 1987 | 525 | 2171 | 430 | 2388 | 243 | 2670 | 17 | 2631 |
| 8-#10 | 4.03 | MA | 1277 | 851 | 2028 | 678 | 2363 | 561 | 2586 | 455 | 2884 | 275 | 3442 | 43 | 3279 |
| 4L-2S | | MI | 1098 | 851 | 1925 | 641 | 2250 | 524 | 2489 | 425 | 2798 | 240 | 3142 | 110 | 2679 |
| 8-#11 | 4.95 | MA | 1422 | 919 | 2431 | 707 | 2881 | 574 | 3208 | 458 | 3723 | 268 | 4345 | 30 | 4264 |
| 3E | | MI | 1035 | 919 | 1844 | 677 | 2130 | 547 | 2323 | 439 | 2556 | 220 | 2815 | -64 | 2789 |
| 8-#11 | 4.95 | MA | 1329 | 919 | 2177 | 714 | 2531 | 587 | 2779 | 469 | 3138 | 265 | 3695 | -24 | 3680 |
| 4L-2S | | MI | 1140 | 919 | 2086 | 675 | 2438 | 549 | 2692 | 434 | 3024 | 215 | 3341 | 49 | 3141 |
| 10-#10 | 5.04 | MA | 1416 | 925 | 2327 | 724 | 2742 | 594 | 3045 | 476 | 3505 | 271 | 4222 | 26 | 4120 |
| 4L-3S | | MI | 1085 | 925 | 1925 | 690 | 2250 | 558 | 2489 | 451 | 2798 | 235 | 3142 | -15 | 3133 |
| 10-#10 | 5.04 | MA | 1332 | 925 | 2136 | 731 | 2483 | 599 | 2724 | 479 | 3060 | 277 | 3673 | -30 | 3653 |
| 5L-2S | | MI | 1172 | 925 | 2132 | 687 | 2512 | 558 | 2807 | 446 | 3208 | 232 | 3615 | 78 | 3289 |
| 10-#11 | 6.19 | MA | 1485 | 1009 | 2533 | 771 | 2982 | 628 | 3327 | 495 | 3877 | 261 | 4594 | -49 | 4540 |
| 4L-3S | | MI | 1128 | 1009 | 2086 | 734 | 2438 | 588 | 2692 | 464 | 3024 | 207 | 3341 | -110 | 3286 |
| 12-#10 | 6.05 | MA | 1462 | 999 | 2435 | 777 | 2862 | 633 | 3184 | 500 | 3680 | 274 | 4453 | -47 | 4406 |
| 5L-3S | | MI | 1164 | 999 | 2132 | 736 | 2512 | 592 | 2807 | 472 | 3208 | 228 | 3615 | -47 | 3579 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

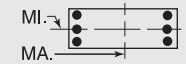
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.13 | MA | 1441 | 710 | 2045 | 603 | 2408 | 507 | 2601 | 432 | 2787 | 318 | 3292 | 271 | 1442 |
| 2E | | MI | 977 | 710 | 1472 | 571 | 1666 | 480 | 1761 | 409 | 1827 | 297 | 2029 | 232 | 977 |
| 4-#9 | 1.43 | MA | 1488 | 735 | 2165 | 616 | 2553 | 516 | 2773 | 437 | 3017 | 316 | 3582 | 265 | 1787 |
| 2E | | MI | 1002 | 735 | 1544 | 583 | 1751 | 489 | 1862 | 413 | 1952 | 292 | 2167 | 218 | 1192 |
| 4-#10 | 1.81 | MA | 1547 | 766 | 2315 | 633 | 2736 | 529 | 2991 | 445 | 3308 | 313 | 3947 | 257 | 2221 |
| 2E | | MI | 1032 | 766 | 1634 | 600 | 1859 | 500 | 1989 | 420 | 2107 | 285 | 2336 | 200 | 1459 |
| 4-#11 | 2.23 | MA | 1597 | 800 | 2474 | 648 | 2918 | 539 | 3201 | 450 | 3583 | 308 | 4238 | 240 | 2653 |
| 2E | | MI | 1053 | 800 | 1725 | 612 | 1956 | 508 | 2089 | 421 | 2215 | 270 | 2427 | 167 | 1717 |
| 4-#14 | 3.21 | MA | 1728 | 880 | 2832 | 694 | 3358 | 572 | 3727 | 470 | 4287 | 302 | 5067 | 212 | 3692 |
| 2E | | MI | 1117 | 880 | 1929 | 656 | 2203 | 540 | 2357 | 434 | 2550 | 249 | 2769 | 108 | 2326 |
| 4-#18 | 5.71 | MA | 2020 | 1083 | 3689 | 812 | 4418 | 657 | 4998 | 522 | 5982 | 285 | 6959 | 125 | 6174 |
| 2E | | MI | 1259 | 1083 | 2396 | 770 | 2726 | 610 | 2938 | 457 | 3281 | 183 | 3458 | -67 | 3460 |
| 6-#7 | 1.29 | MA | 1471 | 723 | 2102 | 612 | 2487 | 514 | 2700 | 437 | 2924 | 319 | 3488 | 272 | 1632 |
| 2L-3S | | MI | 938 | 723 | 1405 | 584 | 1586 | 489 | 1667 | 417 | 1710 | 300 | 1898 | 187 | 1104 |
| 6-#7 | 1.29 | MA | 1375 | 723 | 1935 | 617 | 2275 | 518 | 2443 | 440 | 2577 | 324 | 3021 | 228 | 1637 |
| 3L-2S | | MI | 995 | 723 | 1507 | 582 | 1715 | 488 | 1824 | 414 | 1918 | 298 | 2143 | 231 | 1095 |
| 6-#8 | 1.69 | MA | 1537 | 756 | 2264 | 631 | 2685 | 528 | 2936 | 445 | 3240 | 316 | 3896 | 265 | 2100 |
| 2L-3S | | MI | 958 | 756 | 1472 | 602 | 1666 | 502 | 1761 | 426 | 1827 | 295 | 2029 | 157 | 1396 |
| 6-#8 | 1.69 | MA | 1415 | 756 | 2045 | 637 | 2408 | 533 | 2601 | 449 | 2787 | 322 | 3292 | 208 | 2101 |
| 3L-2S | | MI | 1030 | 756 | 1605 | 600 | 1834 | 501 | 1964 | 422 | 2095 | 293 | 2343 | 214 | 1387 |
| 6-#9 | 2.14 | MA | 1606 | 793 | 2439 | 652 | 2901 | 543 | 3194 | 454 | 3585 | 313 | 4334 | 257 | 2609 |
| 2L-3S | | MI | 981 | 793 | 1544 | 623 | 1751 | 516 | 1862 | 434 | 1952 | 289 | 2167 | 122 | 1705 |
| 6-#9 | 2.14 | MA | 1459 | 793 | 2165 | 659 | 2553 | 548 | 2773 | 458 | 3017 | 320 | 3582 | 184 | 2598 |
| 3L-2S | | MI | 1066 | 793 | 1710 | 620 | 1961 | 515 | 2116 | 430 | 2283 | 286 | 2552 | 195 | 1699 |
| 6-#10 | 2.72 | MA | 1692 | 840 | 2660 | 679 | 3174 | 562 | 3521 | 466 | 4024 | 310 | 4884 | 245 | 3250 |
| 2L-3S | | MI | 1008 | 840 | 1634 | 649 | 1859 | 534 | 1989 | 446 | 2107 | 281 | 2336 | 76 | 2082 |
| 6-#10 | 2.72 | MA | 1513 | 840 | 2315 | 688 | 2736 | 569 | 2991 | 471 | 3308 | 318 | 3947 | 153 | 3217 |
| 3L-2S | | MI | 1110 | 840 | 1841 | 646 | 2121 | 534 | 2306 | 441 | 2517 | 277 | 2809 | 168 | 2086 |
| 6-#11 | 3.34 | MA | 1764 | 890 | 2886 | 705 | 3441 | 580 | 3835 | 476 | 4439 | 304 | 5329 | 221 | 3880 |
| 2L-3S | | MI | 1026 | 890 | 1725 | 671 | 1956 | 548 | 2089 | 451 | 2215 | 262 | 2427 | 8 | 2412 |
| 6-#11 | 3.34 | MA | 1559 | 890 | 2474 | 714 | 2918 | 587 | 3201 | 481 | 3583 | 312 | 4238 | 107 | 3818 |
| 3L-2S | | MI | 1141 | 890 | 1968 | 669 | 2264 | 550 | 2458 | 446 | 2683 | 258 | 2953 | 121 | 2450 |
| 6-#14 | 4.82 | MA | 1695 | 1010 | 2832 | 787 | 3358 | 640 | 3727 | 512 | 4287 | 305 | 5067 | 16 | 5026 |
| 3L-2S | | MI | 1237 | 1010 | 2267 | 738 | 2633 | 599 | 2860 | 467 | 3190 | 227 | 3472 | 34 | 3334 |
| 8-#6 | 1.26 | MA | 1470 | 721 | 2087 | 613 | 2475 | 515 | 2688 | 438 | 2911 | 320 | 3484 | 275 | 1603 |
| 2L-4S | | MI | 927 | 721 | 1367 | 587 | 1538 | 494 | 1611 | 418 | 1640 | 301 | 1832 | 189 | 1090 |
| 8-#6 | 1.26 | MA | 1399 | 721 | 1963 | 616 | 2318 | 518 | 2498 | 440 | 2654 | 324 | 3136 | 243 | 1607 |
| 3E | | MI | 953 | 721 | 1422 | 585 | 1613 | 491 | 1703 | 418 | 1764 | 302 | 1967 | 203 | 1083 |
| 8-#6 | 1.26 | MA | 1358 | 721 | 1877 | 620 | 2199 | 523 | 2352 | 445 | 2455 | 325 | 2890 | 224 | 1608 |
| 4L-2S | | MI | 995 | 721 | 1497 | 583 | 1709 | 490 | 1820 | 416 | 1919 | 301 | 2152 | 235 | 1077 |
| 8-#7 | 1.71 | MA | 1545 | 758 | 2269 | 634 | 2699 | 530 | 2957 | 447 | 3271 | 317 | 3954 | 268 | 2134 |
| 2L-4S | | MI | 947 | 758 | 1433 | 608 | 1614 | 510 | 1700 | 427 | 1753 | 296 | 1964 | 156 | 1420 |
| 8-#7 | 1.71 | MA | 1452 | 758 | 2102 | 639 | 2487 | 534 | 2700 | 450 | 2924 | 322 | 3488 | 224 | 2135 |
| 3E | | MI | 981 | 758 | 1507 | 606 | 1715 | 505 | 1824 | 427 | 1918 | 298 | 2143 | 175 | 1416 |
| 8-#7 | 1.71 | MA | 1399 | 758 | 1985 | 643 | 2326 | 541 | 2502 | 456 | 2653 | 323 | 3158 | 200 | 2122 |
| 4L-2S | | MI | 1036 | 758 | 1609 | 604 | 1845 | 504 | 1981 | 424 | 2125 | 296 | 2388 | 218 | 1409 |
| 8-#8 | 2.26 | MA | 1630 | 802 | 2482 | 660 | 2962 | 549 | 3272 | 458 | 3694 | 314 | 4501 | 259 | 2753 |
| 2L-4S | | MI | 973 | 802 | 1509 | 633 | 1702 | 528 | 1803 | 438 | 1882 | 289 | 2113 | 115 | 1749 |
| 8-#8 | 2.26 | MA | 1514 | 802 | 2264 | 665 | 2685 | 553 | 2936 | 462 | 3240 | 320 | 3896 | 202 | 2745 |
| 3E | | MI | 1014 | 802 | 1605 | 631 | 1834 | 523 | 1964 | 439 | 2095 | 291 | 2343 | 139 | 1794 |
| 8-#8 | 2.26 | MA | 1448 | 802 | 2111 | 671 | 2474 | 562 | 2678 | 470 | 2887 | 321 | 3468 | 170 | 2674 |
| 4L-2S | | MI | 1081 | 802 | 1737 | 628 | 2002 | 522 | 2168 | 435 | 2363 | 289 | 2657 | 197 | 1790 |
| 8-#9 | 2.86 | MA | 1720 | 851 | 2713 | 688 | 3249 | 569 | 3616 | 471 | 4154 | 311 | 5087 | 248 | 3424 |
| 2L-4S | | MI | 999 | 851 | 1590 | 662 | 1796 | 549 | 1914 | 450 | 2028 | 286 | 2269 | 69 | 2060 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

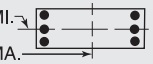
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 2.86 | MA | 1581 | 851 | 2439 | 695 | 2901 | 575 | 3194 | 475 | 3585 | 318 | 4334 | 175 | 3401 |
| 3E | | MI | 1049 | 851 | 1710 | 659 | 1961 | 543 | 2116 | 451 | 2283 | 284 | 2552 | 98 | 2194 |
| 8-#9 | 2.86 | MA | 1500 | 851 | 2247 | 702 | 2635 | 586 | 2869 | 485 | 3141 | 319 | 3801 | 136 | 3188 |
| 4L-2S | | MI | 1128 | 851 | 1875 | 656 | 2171 | 542 | 2370 | 447 | 2614 | 281 | 2937 | 171 | 2197 |
| 8-#10 | 3.63 | MA | 1664 | 913 | 2660 | 734 | 3174 | 603 | 3521 | 492 | 4024 | 315 | 4884 | 140 | 4223 |
| 3E | | MI | 1091 | 913 | 1841 | 695 | 2121 | 568 | 2306 | 467 | 2517 | 273 | 2809 | 44 | 2686 |
| 8-#10 | 3.63 | MA | 1567 | 913 | 2417 | 742 | 2839 | 617 | 3111 | 504 | 3463 | 316 | 4218 | 91 | 3821 |
| 4L-2S | | MI | 1186 | 913 | 2047 | 692 | 2383 | 568 | 2624 | 463 | 2927 | 270 | 3281 | 136 | 2704 |
| 8-#11 | 4.46 | MA | 1742 | 981 | 2886 | 771 | 3441 | 629 | 3835 | 507 | 4439 | 308 | 5329 | 88 | 5017 |
| 3E | | MI | 1121 | 981 | 1968 | 727 | 2264 | 589 | 2458 | 476 | 2683 | 249 | 2953 | -38 | 2938 |
| 8-#11 | 4.46 | MA | 1624 | 981 | 2595 | 780 | 3038 | 644 | 3342 | 520 | 3766 | 308 | 4549 | 31 | 4420 |
| 4L-2S | | MI | 1228 | 981 | 2210 | 725 | 2572 | 591 | 2827 | 472 | 3152 | 245 | 3478 | 75 | 3172 |
| 8-#14 | 6.43 | MA | 1800 | 1141 | 3001 | 881 | 3526 | 721 | 3924 | 567 | 4543 | 297 | 5492 | -96 | 5390 |
| 4L-2S | | MI | 1355 | 1141 | 2606 | 819 | 3062 | 659 | 3364 | 500 | 3829 | 205 | 4174 | -39 | 4157 |
| 10-#10 | 4.54 | MA | 1723 | 987 | 2762 | 788 | 3276 | 650 | 3641 | 526 | 4179 | 312 | 5155 | 79 | 4796 |
| 4L-3S | | MI | 1172 | 987 | 2047 | 741 | 2383 | 602 | 2624 | 489 | 2927 | 265 | 3281 | 12 | 3253 |
| 10-#10 | 4.54 | MA | 1621 | 987 | 2545 | 797 | 2980 | 657 | 3274 | 530 | 3671 | 321 | 4495 | 25 | 4419 |
| 5L-2S | | MI | 1261 | 987 | 2254 | 738 | 2645 | 601 | 2942 | 484 | 3337 | 262 | 3754 | 104 | 3315 |
| 10-#11 | 5.57 | MA | 1818 | 1071 | 3007 | 836 | 3562 | 685 | 3976 | 546 | 4622 | 303 | 5639 | 12 | 5588 |
| 4L-3S | | MI | 1214 | 1071 | 2210 | 784 | 2572 | 631 | 2827 | 501 | 3152 | 237 | 3478 | -84 | 3439 |
| 12-#10 | 5.44 | MA | 1773 | 1061 | 2890 | 843 | 3418 | 691 | 3805 | 552 | 4387 | 317 | 5432 | 13 | 5391 |
| 5L-3S | | MI | 1251 | 1061 | 2254 | 787 | 2645 | 635 | 2942 | 510 | 3337 | 258 | 3754 | -20 | 3739 |

## RECTANGULAR TIED COLUMNS 14" x 22"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.03 | MA | 1734 | 772 | 2406 | 664 | 2856 | 560 | 3091 | 478 | 3309 | 355 | 3946 | 308 | 1613 |
| 2E | | MI | 1064 | 772 | 1593 | 622 | 1799 | 524 | 1896 | 447 | 1956 | 327 | 2170 | 258 | 991 |
| 4-#9 | 1.30 | MA | 1789 | 797 | 2542 | 678 | 3021 | 569 | 3286 | 484 | 3570 | 353 | 4289 | 303 | 2003 |
| 2E | | MI | 1089 | 797 | 1666 | 635 | 1884 | 532 | 1997 | 451 | 2081 | 322 | 2307 | 245 | 1209 |
| 4-#10 | 1.65 | MA | 1858 | 828 | 2714 | 695 | 3229 | 582 | 3535 | 491 | 3902 | 350 | 4719 | 297 | 2495 |
| 2E | | MI | 1119 | 828 | 1756 | 651 | 1992 | 544 | 2124 | 458 | 2235 | 315 | 2476 | 226 | 1478 |
| 4-#11 | 2.03 | MA | 1918 | 862 | 2897 | 710 | 3439 | 592 | 3778 | 496 | 4220 | 345 | 5080 | 283 | 2990 |
| 2E | | MI | 1140 | 862 | 1849 | 662 | 2090 | 551 | 2225 | 459 | 2343 | 300 | 2564 | 193 | 1740 |
| 4-#14 | 2.92 | MA | 2075 | 942 | 3308 | 756 | 3944 | 625 | 4382 | 516 | 5028 | 338 | 6076 | 260 | 4178 |
| 2E | | MI | 1205 | 942 | 2054 | 705 | 2337 | 582 | 2492 | 470 | 2678 | 278 | 2905 | 134 | 2355 |
| 4-#18 | 5.19 | MA | 2423 | 1145 | 4297 | 874 | 5168 | 710 | 5849 | 568 | 6995 | 323 | 8387 | 190 | 7038 |
| 2E | | MI | 1346 | 1145 | 2524 | 818 | 2861 | 651 | 3072 | 492 | 3407 | 211 | 3592 | -42 | 3596 |
| 6-#7 | 1.17 | MA | 1769 | 785 | 2470 | 674 | 2944 | 567 | 3202 | 483 | 3462 | 356 | 4171 | 309 | 1826 |
| 2L-3S | | MI | 1025 | 785 | 1525 | 636 | 1719 | 533 | 1802 | 456 | 1839 | 331 | 2038 | 214 | 1119 |
| 6-#7 | 1.17 | MA | 1658 | 785 | 2281 | 679 | 2705 | 571 | 2911 | 487 | 3070 | 361 | 3629 | 265 | 1831 |
| 3L-2S | | MI | 1082 | 785 | 1627 | 633 | 1848 | 532 | 1959 | 453 | 2047 | 329 | 2284 | 258 | 1110 |
| 6-#8 | 1.54 | MA | 1845 | 818 | 2653 | 693 | 3169 | 581 | 3470 | 491 | 3821 | 353 | 4650 | 304 | 2356 |
| 2L-3S | | MI | 1045 | 818 | 1593 | 654 | 1799 | 546 | 1896 | 464 | 1956 | 325 | 2170 | 183 | 1414 |
| 6-#8 | 1.54 | MA | 1705 | 818 | 2406 | 699 | 2856 | 586 | 3091 | 496 | 3309 | 360 | 3946 | 247 | 2357 |
| 3L-2S | | MI | 1117 | 818 | 1725 | 651 | 1967 | 545 | 2100 | 460 | 2224 | 323 | 2483 | 241 | 1404 |
| 6-#9 | 1.95 | MA | 1926 | 855 | 2853 | 714 | 3414 | 596 | 3764 | 500 | 4214 | 350 | 5166 | 298 | 2933 |
| 2L-3S | | MI | 1068 | 855 | 1666 | 674 | 1884 | 560 | 1997 | 472 | 2081 | 319 | 2307 | 148 | 1727 |
| 6-#9 | 1.95 | MA | 1756 | 855 | 2542 | 722 | 3021 | 602 | 3286 | 506 | 3570 | 358 | 4289 | 225 | 2922 |
| 3L-2S | | MI | 1153 | 855 | 1831 | 671 | 2094 | 559 | 2251 | 468 | 2412 | 317 | 2692 | 221 | 1718 |
| 6-#10 | 2.47 | MA | 2026 | 902 | 3104 | 741 | 3725 | 615 | 4136 | 512 | 4713 | 346 | 5815 | 289 | 3661 |
| 2L-3S | | MI | 1095 | 902 | 1756 | 700 | 1992 | 578 | 2124 | 484 | 2235 | 311 | 2476 | 102 | 2110 |
| 6-#10 | 2.47 | MA | 1819 | 902 | 2714 | 751 | 3229 | 623 | 3535 | 519 | 3902 | 357 | 4719 | 196 | 3628 |
| 3L-2S | | MI | 1198 | 902 | 1963 | 697 | 2254 | 577 | 2442 | 479 | 2645 | 307 | 2948 | 194 | 2108 |
| 6-#11 | 3.04 | MA | 2114 | 952 | 3366 | 767 | 4034 | 633 | 4499 | 522 | 5193 | 340 | 6364 | 269 | 4385 |
| 2L-3S | | MI | 1112 | 952 | 1849 | 721 | 2090 | 591 | 2225 | 488 | 2343 | 291 | 2564 | 34 | 2468 |
| 6-#11 | 3.04 | MA | 1875 | 952 | 2897 | 777 | 3439 | 642 | 3778 | 529 | 4220 | 351 | 5080 | 155 | 4323 |
| 3L-2S | | MI | 1229 | 952 | 2091 | 719 | 2398 | 592 | 2594 | 484 | 2811 | 287 | 3090 | 147 | 2476 |

## RECTANGULAR TIED COLUMNS 14" x 22"

Short columns – no sidesway
Bending on major or minor axis

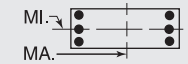



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 4.38 | MA | 2025 | 1072 | 3308 | 852 | 3944 | 695 | 4382 | 561 | 5028 | 346 | 6076 | 73 | 5872 |
| 3L-2S | | MI | 1325 | 1072 | 2393 | 787 | 2767 | 641 | 2995 | 504 | 3317 | 256 | 3608 | 60 | 3367 |
| 6-#18 | 7.79 | MA | 2408 | 1376 | 4297 | 1040 | 5168 | 831 | 5849 | 644 | 6995 | 330 | 8387 | -157 | 8112 |
| 3L-2S | | MI | 1540 | 1376 | 3085 | 963 | 3549 | 750 | 3868 | 542 | 4418 | 160 | 4651 | -201 | 4620 |
| 8-#6 | 1.14 | MA | 1766 | 783 | 2452 | 675 | 2929 | 568 | 3187 | 484 | 3446 | 357 | 4154 | 311 | 1793 |
| 2L-4S | | MI | 1014 | 783 | 1487 | 639 | 1671 | 538 | 1747 | 457 | 1770 | 332 | 1974 | 216 | 1104 |
| 8-#6 | 1.14 | MA | 1685 | 783 | 2313 | 679 | 2752 | 571 | 2973 | 487 | 3156 | 361 | 3753 | 279 | 1797 |
| 3E | | MI | 1039 | 783 | 1541 | 637 | 1746 | 535 | 1838 | 457 | 1893 | 333 | 2108 | 230 | 1097 |
| 8-#6 | 1.14 | MA | 1638 | 783 | 2216 | 682 | 2619 | 577 | 2809 | 492 | 2932 | 363 | 3473 | 260 | 1798 |
| 4L-2S | | MI | 1082 | 783 | 1617 | 635 | 1842 | 534 | 1955 | 454 | 2049 | 332 | 2293 | 262 | 1091 |
| 8-#7 | 1.56 | MA | 1854 | 820 | 2659 | 696 | 3184 | 583 | 3492 | 493 | 3854 | 354 | 4712 | 307 | 2393 |
| 2L-4S | | MI | 1034 | 820 | 1553 | 660 | 1747 | 554 | 1835 | 466 | 1882 | 326 | 2104 | 183 | 1439 |
| 8-#7 | 1.56 | MA | 1747 | 820 | 2470 | 701 | 2944 | 587 | 3202 | 497 | 3462 | 359 | 4171 | 263 | 2394 |
| 3E | | MI | 1068 | 820 | 1627 | 657 | 1848 | 549 | 1959 | 466 | 2047 | 328 | 2284 | 201 | 1432 |
| 8-#7 | 1.56 | MA | 1687 | 820 | 2339 | 706 | 2763 | 595 | 2979 | 503 | 3158 | 361 | 3790 | 237 | 2381 |
| 4L-2S | | MI | 1123 | 820 | 1729 | 655 | 1977 | 548 | 2116 | 463 | 2255 | 326 | 2529 | 245 | 1425 |
| 8-#8 | 2.05 | MA | 1953 | 864 | 2900 | 722 | 3483 | 602 | 3850 | 504 | 4334 | 351 | 5353 | 300 | 3095 |
| 2L-4S | | MI | 1057 | 864 | 1630 | 685 | 1835 | 572 | 1938 | 476 | 2011 | 320 | 2253 | 142 | 1798 |
| 8-#8 | 2.05 | MA | 1820 | 864 | 2653 | 728 | 3169 | 607 | 3470 | 509 | 3821 | 358 | 4650 | 243 | 3086 |
| 3E | | MI | 1101 | 864 | 1725 | 682 | 1967 | 567 | 2100 | 477 | 2224 | 322 | 2483 | 166 | 1815 |
| 8-#8 | 2.05 | MA | 1744 | 864 | 2482 | 734 | 2932 | 617 | 3179 | 518 | 3423 | 360 | 4155 | 210 | 3044 |
| 4L-2S | | MI | 1169 | 864 | 1858 | 680 | 2135 | 566 | 2303 | 473 | 2492 | 320 | 2797 | 223 | 1808 |
| 8-#9 | 2.60 | MA | 2059 | 913 | 3163 | 750 | 3808 | 622 | 4241 | 517 | 4858 | 347 | 6043 | 292 | 3856 |
| 2L-4S | | MI | 1084 | 913 | 1711 | 713 | 1929 | 593 | 2049 | 488 | 2157 | 317 | 2408 | 95 | 2115 |
| 8-#9 | 2.60 | MA | 1897 | 913 | 2853 | 758 | 3414 | 629 | 3764 | 522 | 4214 | 356 | 5166 | 219 | 3833 |
| 3E | | MI | 1135 | 913 | 1831 | 710 | 2094 | 586 | 2251 | 489 | 2412 | 314 | 2692 | 125 | 2219 |
| 8-#9 | 2.60 | MA | 1805 | 913 | 2637 | 766 | 3115 | 641 | 3397 | 533 | 3713 | 358 | 4547 | 178 | 3647 |
| 4L-2S | | MI | 1216 | 913 | 1996 | 707 | 2304 | 585 | 2505 | 485 | 2743 | 311 | 3077 | 198 | 2218 |
| 8-#10 | 3.30 | MA | 1994 | 975 | 3104 | 797 | 3725 | 657 | 4136 | 540 | 4713 | 353 | 5815 | 188 | 4772 |
| 3E | | MI | 1178 | 975 | 1963 | 746 | 2254 | 611 | 2442 | 505 | 2645 | 303 | 2948 | 70 | 2717 |
| 8-#10 | 3.30 | MA | 1884 | 975 | 2832 | 806 | 3348 | 672 | 3674 | 553 | 4081 | 356 | 5041 | 136 | 4375 |
| 4L-2S | | MI | 1274 | 975 | 2170 | 743 | 2516 | 611 | 2759 | 500 | 3055 | 300 | 3421 | 162 | 2728 |
| 8-#11 | 4.05 | MA | 2080 | 1042 | 3366 | 834 | 4034 | 683 | 4499 | 555 | 5193 | 347 | 6364 | 142 | 5691 |
| 3E | | MI | 1207 | 1042 | 2091 | 777 | 2398 | 632 | 2594 | 513 | 2811 | 279 | 3090 | -12 | 3086 |
| 8-#11 | 4.05 | MA | 1952 | 1042 | 3037 | 845 | 3579 | 700 | 3942 | 570 | 4432 | 349 | 5453 | 80 | 5073 |
| 4L-2S | | MI | 1316 | 1042 | 2334 | 775 | 2706 | 634 | 2963 | 509 | 3280 | 274 | 3616 | 101 | 3201 |
| 8-#14 | 5.84 | MA | 2142 | 1202 | 3504 | 947 | 4141 | 778 | 4612 | 619 | 5326 | 341 | 6590 | -37 | 6538 |
| 4L-2S | | MI | 1443 | 1202 | 2731 | 868 | 3197 | 701 | 3499 | 537 | 3956 | 235 | 4311 | -14 | 4306 |
| 10-#10 | 4.12 | MA | 2064 | 1049 | 3222 | 852 | 3844 | 705 | 4275 | 574 | 4892 | 353 | 6137 | 128 | 5485 |
| 4L-3S | | MI | 1258 | 1049 | 2170 | 792 | 2516 | 645 | 2759 | 526 | 3055 | 295 | 3421 | 38 | 3319 |
| 10-#10 | 4.12 | MA | 1941 | 1049 | 2979 | 862 | 3511 | 713 | 3862 | 581 | 4321 | 363 | 5366 | 74 | 5108 |
| 5L-2S | | MI | 1350 | 1049 | 2376 | 789 | 2779 | 645 | 3077 | 522 | 3465 | 292 | 3893 | 130 | 3342 |
| 10-#11 | 5.06 | MA | 2164 | 1133 | 3506 | 901 | 4174 | 742 | 4663 | 596 | 5406 | 345 | 6736 | 67 | 6407 |
| 4L-3S | | MI | 1300 | 1133 | 2334 | 834 | 2706 | 673 | 2963 | 538 | 3280 | 266 | 3616 | -59 | 3590 |
| 10-#11 | 5.06 | MA | 2023 | 1133 | 3212 | 912 | 3772 | 750 | 4165 | 602 | 4716 | 356 | 5832 | 0 | 5832 |
| 5L-2S | | MI | 1403 | 1133 | 2577 | 832 | 3014 | 675 | 3332 | 534 | 3748 | 262 | 4142 | 55 | 3919 |
| 12-#10 | 4.95 | MA | 2116 | 1122 | 3370 | 908 | 4007 | 747 | 4463 | 602 | 5132 | 359 | 6461 | 66 | 6219 |
| 5L-3S | | MI | 1338 | 1122 | 2376 | 838 | 2779 | 679 | 3077 | 548 | 3465 | 288 | 3893 | 6 | 3877 |
| 12-#10 | 4.95 | MA | 1980 | 1122 | 3097 | 923 | 3692 | 755 | 4059 | 615 | 4584 | 369 | 5753 | 6 | 5726 |
| 6L-2S | | MI | 1425 | 1122 | 2583 | 835 | 3041 | 678 | 3395 | 543 | 3876 | 284 | 4366 | 99 | 3952 |
| 12-#11 | 6.08 | MA | 2242 | 1223 | 3681 | 968 | 4367 | 791 | 4887 | 629 | 5689 | 351 | 7116 | -14 | 7094 |
| 5L-3S | | MI | 1391 | 1223 | 2577 | 890 | 3014 | 715 | 3332 | 563 | 3748 | 254 | 4142 | -105 | 4087 |
| 14-#10 | 5.77 | MA | 2158 | 1196 | 3488 | 969 | 4188 | 789 | 4660 | 637 | 5395 | 366 | 6849 | -2 | 6846 |
| 6L-3S | | MI | 1416 | 1196 | 2583 | 884 | 3041 | 712 | 3395 | 569 | 3876 | 280 | 4366 | -26 | 4345 |

## RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

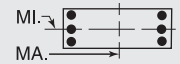
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.19 | MA | 2116 | 859 | 2945 | 740 | 3522 | 622 | 3837 | 530 | 4161 | 389 | 5028 | 339 | 2219 |
| 2E | | MI | 1176 | 859 | 1787 | 686 | 2018 | 576 | 2132 | 489 | 2210 | 352 | 2447 | 271 | 1224 |
| 4-#10 | 1.51 | MA | 2195 | 890 | 3137 | 757 | 3756 | 634 | 4116 | 537 | 4534 | 386 | 5539 | 335 | 2770 |
| 2E | | MI | 1207 | 890 | 1878 | 701 | 2125 | 587 | 2259 | 496 | 2364 | 345 | 2615 | 253 | 1496 |
| 4-#11 | 1.86 | MA | 2266 | 923 | 3345 | 772 | 3994 | 645 | 4392 | 542 | 4895 | 381 | 5969 | 323 | 3327 |
| 2E | | MI | 1228 | 923 | 1973 | 712 | 2224 | 594 | 2360 | 496 | 2471 | 329 | 2702 | 219 | 1762 |
| 4-#14 | 2.68 | MA | 2446 | 1003 | 3809 | 818 | 4564 | 677 | 5074 | 562 | 5808 | 375 | 7134 | 306 | 4664 |
| 2E | | MI | 1292 | 1003 | 2179 | 755 | 2472 | 624 | 2627 | 507 | 2805 | 307 | 3042 | 160 | 2382 |
| 4-#18 | 4.76 | MA | 2854 | 1206 | 4930 | 936 | 5951 | 763 | 6737 | 614 | 8038 | 360 | 9871 | 249 | 7902 |
| 2E | | MI | 1434 | 1206 | 2651 | 867 | 2996 | 691 | 3207 | 528 | 3533 | 240 | 3726 | -17 | 3728 |
| 6-#7 | 1.07 | MA | 2091 | 847 | 2863 | 736 | 3435 | 620 | 3741 | 529 | 4039 | 392 | 4864 | 342 | 2020 |
| 2L-3S | | MI | 1111 | 847 | 1645 | 687 | 1852 | 577 | 1938 | 494 | 1969 | 361 | 2179 | 241 | 1132 |
| 6-#7 | 1.07 | MA | 1966 | 847 | 2652 | 741 | 3168 | 625 | 3417 | 533 | 3601 | 398 | 4259 | 299 | 2026 |
| 3L-2S | | MI | 1169 | 847 | 1747 | 685 | 1981 | 576 | 2095 | 491 | 2176 | 359 | 2424 | 284 | 1124 |
| 6-#8 | 1.41 | MA | 2179 | 880 | 3068 | 755 | 3687 | 633 | 4042 | 537 | 4441 | 389 | 5418 | 338 | 2612 |
| 2L-3S | | MI | 1132 | 880 | 1714 | 705 | 1932 | 590 | 2031 | 502 | 2086 | 356 | 2310 | 210 | 1431 |
| 6-#8 | 1.41 | MA | 2020 | 880 | 2792 | 762 | 3337 | 639 | 3618 | 542 | 3869 | 397 | 4626 | 282 | 2613 |
| 3L-2S | | MI | 1204 | 880 | 1846 | 702 | 2100 | 589 | 2235 | 498 | 2353 | 354 | 2623 | 268 | 1420 |
| 6-#9 | 1.79 | MA | 2272 | 917 | 3291 | 776 | 3961 | 648 | 4370 | 546 | 4881 | 387 | 6024 | 335 | 3257 |
| 2L-3S | | MI | 1154 | 916 | 1787 | 725 | 2018 | 603 | 2132 | 510 | 2210 | 350 | 2447 | 175 | 1748 |
| 6-#9 | 1.79 | MA | 2078 | 916 | 2945 | 784 | 3522 | 656 | 3837 | 552 | 4161 | 396 | 5028 | 263 | 3246 |
| 3L-2S | | MI | 1241 | 917 | 1953 | 722 | 2227 | 602 | 2387 | 506 | 2541 | 347 | 2832 | 248 | 1736 |
| 6-#10 | 2.27 | MA | 2387 | 963 | 3574 | 803 | 4310 | 668 | 4788 | 558 | 5441 | 383 | 6793 | 330 | 4073 |
| 2L-3S | | MI | 1181 | 963 | 1878 | 751 | 2125 | 621 | 2259 | 522 | 2364 | 341 | 2615 | 128 | 2136 |
| 6-#10 | 2.27 | MA | 2151 | 963 | 3137 | 813 | 3756 | 677 | 4116 | 566 | 4534 | 395 | 5539 | 238 | 4039 |
| 3L-2S | | MI | 1285 | 963 | 2085 | 747 | 2388 | 621 | 2577 | 517 | 2774 | 337 | 3087 | 221 | 2129 |
| 6-#11 | 2.79 | MA | 2489 | 1014 | 3871 | 828 | 4661 | 686 | 5201 | 568 | 5986 | 377 | 7447 | 314 | 4891 |
| 2L-3S | | MI | 1198 | 1014 | 1973 | 771 | 2224 | 633 | 2360 | 525 | 2471 | 321 | 2702 | 59 | 2502 |
| 6-#11 | 2.79 | MA | 2216 | 1014 | 3345 | 840 | 3994 | 696 | 4392 | 576 | 4895 | 390 | 5969 | 200 | 4829 |
| 3L-2S | | MI | 1317 | 1014 | 2215 | 769 | 2532 | 635 | 2729 | 521 | 2939 | 317 | 3228 | 173 | 2502 |
| 6-#14 | 4.02 | MA | 2390 | 1134 | 3809 | 915 | 4564 | 750 | 5074 | 610 | 5808 | 385 | 7134 | 125 | 6697 |
| 3L-2S | | MI | 1412 | 1134 | 2518 | 836 | 2901 | 683 | 3130 | 540 | 3444 | 285 | 3744 | 86 | 3399 |
| 6-#18 | 7.14 | MA | 2833 | 1438 | 4930 | 1106 | 5951 | 888 | 6737 | 695 | 8038 | 373 | 9871 | -85 | 9682 |
| 3L-2S | | MI | 1627 | 1438 | 3212 | 1011 | 3684 | 791 | 4003 | 578 | 4544 | 189 | 4785 | -176 | 4767 |
| 8-#6 | 1.05 | MA | 2088 | 845 | 2843 | 737 | 3418 | 621 | 3724 | 530 | 4020 | 393 | 4841 | 343 | 1983 |
| 2L-4S | | MI | 1100 | 845 | 1606 | 690 | 1803 | 582 | 1882 | 496 | 1899 | 363 | 2115 | 243 | 1118 |
| 8-#6 | 1.05 | MA | 1996 | 845 | 2687 | 741 | 3220 | 624 | 3485 | 533 | 3697 | 398 | 4394 | 312 | 1987 |
| 3E | | MI | 1126 | 845 | 1661 | 689 | 1878 | 579 | 1974 | 495 | 2023 | 364 | 2250 | 257 | 1110 |
| 8-#6 | 1.05 | MA | 1944 | 845 | 2580 | 745 | 3072 | 630 | 3303 | 538 | 3448 | 400 | 4085 | 294 | 1988 |
| 4L-2S | | MI | 1169 | 845 | 1736 | 687 | 1974 | 578 | 2090 | 493 | 2179 | 363 | 2435 | 289 | 1104 |
| 8-#7 | 1.43 | MA | 2188 | 882 | 3074 | 758 | 3702 | 636 | 4065 | 539 | 4476 | 390 | 5470 | 339 | 2652 |
| 2L-4S | | MI | 1120 | 882 | 1673 | 711 | 1880 | 598 | 1971 | 504 | 2011 | 357 | 2245 | 209 | 1457 |
| 8-#7 | 1.43 | MA | 2068 | 882 | 2863 | 763 | 3435 | 641 | 3741 | 543 | 4039 | 397 | 4864 | 297 | 2653 |
| 3E | | MI | 1154 | 882 | 1747 | 709 | 1981 | 593 | 2095 | 504 | 2176 | 359 | 2424 | 228 | 1449 |
| 8-#7 | 1.43 | MA | 1999 | 882 | 2718 | 768 | 3234 | 648 | 3494 | 550 | 3701 | 399 | 4444 | 272 | 2640 |
| 4L-2S | | MI | 1210 | 882 | 1849 | 707 | 2110 | 592 | 2251 | 501 | 2384 | 357 | 2669 | 272 | 1441 |
| 8-#8 | 1.88 | MA | 2303 | 926 | 3344 | 784 | 4036 | 654 | 4465 | 550 | 5013 | 387 | 6210 | 335 | 3436 |
| 2L-4S | | MI | 1143 | 926 | 1750 | 736 | 1968 | 616 | 2074 | 515 | 2141 | 350 | 2393 | 169 | 1836 |
| 8-#8 | 1.88 | MA | 2151 | 926 | 3068 | 790 | 3687 | 660 | 4042 | 555 | 4441 | 395 | 5418 | 279 | 3428 |
| 3E | | MI | 1188 | 926 | 1846 | 734 | 2100 | 611 | 2235 | 515 | 2353 | 352 | 2623 | 193 | 1834 |
| 8-#8 | 1.88 | MA | 2065 | 926 | 2878 | 797 | 3423 | 671 | 3718 | 565 | 3999 | 398 | 4867 | 246 | 3385 |
| 4L-2S | | MI | 1256 | 926 | 1979 | 731 | 2268 | 610 | 2439 | 511 | 2621 | 350 | 2937 | 250 | 1826 |
| 8-#9 | 2.38 | MA | 2423 | 974 | 3638 | 812 | 4401 | 675 | 4903 | 563 | 5600 | 384 | 7020 | 331 | 4288 |
| 2L-4S | | MI | 1170 | 974 | 1832 | 764 | 2062 | 636 | 2185 | 526 | 2286 | 347 | 2548 | 122 | 2168 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 2.38 | MA | 2239 | 974 | 3291 | 820 | 3961 | 682 | 4370 | 569 | 4881 | 393 | 6024 | 259 | 4265 |
| 3E | | MI | 1222 | 974 | 1953 | 761 | 2227 | 630 | 2387 | 527 | 2541 | 344 | 2832 | 151 | 2243 |
| 8-#9 | 2.38 | MA | 2136 | 974 | 3051 | 829 | 3629 | 695 | 3963 | 581 | 4324 | 397 | 5328 | 217 | 4117 |
| 4L-2S | | MI | 1304 | 974 | 2118 | 758 | 2437 | 629 | 2641 | 523 | 2872 | 341 | 3217 | 224 | 2238 |
| 8-#10 | 3.02 | MA | 2351 | 1037 | 3574 | 859 | 4310 | 711 | 4788 | 587 | 5441 | 391 | 6793 | 233 | 5320 |
| 3E | | MI | 1264 | 1037 | 2085 | 797 | 2388 | 655 | 2577 | 543 | 2774 | 333 | 3087 | 96 | 2746 |
| 8-#10 | 3.02 | MA | 2226 | 1037 | 3271 | 870 | 3891 | 727 | 4274 | 601 | 4738 | 396 | 5912 | 179 | 4941 |
| 4L-2S | | MI | 1363 | 1037 | 2292 | 794 | 2650 | 654 | 2895 | 538 | 3184 | 330 | 3560 | 189 | 2751 |
| 8-#11 | 3.71 | MA | 2451 | 1104 | 3871 | 897 | 4661 | 737 | 5201 | 602 | 5986 | 385 | 7447 | 191 | 6365 |
| 3E | | MI | 1293 | 1104 | 2215 | 827 | 2532 | 675 | 2729 | 550 | 2939 | 308 | 3228 | 13 | 3198 |
| 8-#11 | 3.71 | MA | 2306 | 1104 | 3504 | 909 | 4154 | 756 | 4580 | 619 | 5137 | 390 | 6404 | 127 | 5738 |
| 4L-2S | | MI | 1404 | 1104 | 2458 | 825 | 2840 | 676 | 3098 | 546 | 3407 | 304 | 3753 | 127 | 3230 |
| 8-#14 | 5.36 | MA | 2526 | 1264 | 4033 | 1013 | 4789 | 835 | 5337 | 670 | 6148 | 384 | 7738 | 17 | 7651 |
| 4L-2S | | MI | 1531 | 1264 | 2856 | 918 | 3331 | 743 | 3634 | 574 | 4083 | 264 | 4447 | 12 | 4400 |
| 10-#10 | 3.78 | MA | 2431 | 1111 | 3707 | 916 | 4445 | 760 | 4946 | 623 | 5644 | 392 | 7167 | 174 | 6188 |
| 4L-3S | | MI | 1345 | 1111 | 2292 | 843 | 2650 | 688 | 2895 | 564 | 3184 | 326 | 3560 | 65 | 3350 |
| 10-#10 | 3.78 | MA | 2286 | 1111 | 3438 | 926 | 4075 | 769 | 4488 | 630 | 5009 | 404 | 6284 | 121 | 5802 |
| 5L-2S | | MI | 1439 | 1111 | 2498 | 840 | 2912 | 688 | 3213 | 559 | 3594 | 322 | 4032 | 157 | 3367 |
| 10-#11 | 4.64 | MA | 2548 | 1195 | 4030 | 965 | 4821 | 797 | 5388 | 645 | 6228 | 385 | 7883 | 117 | 7240 |
| 4L-3S | | MI | 1386 | 1195 | 2458 | 884 | 2840 | 716 | 3098 | 575 | 3407 | 296 | 3753 | -33 | 3740 |
| 10-#11 | 4.64 | MA | 2381 | 1195 | 3703 | 977 | 4374 | 807 | 4834 | 653 | 5460 | 398 | 6842 | 51 | 6653 |
| 5L-2S | | MI | 1491 | 1195 | 2701 | 882 | 3148 | 718 | 3467 | 571 | 3876 | 291 | 4279 | 81 | 3949 |
| 10-#14 | 6.70 | MA | 2632 | 1395 | 4313 | 1111 | 5098 | 908 | 5695 | 718 | 6602 | 394 | 8350 | -96 | 8214 |
| 5L-2S | | MI | 1650 | 1395 | 3195 | 999 | 3761 | 803 | 4138 | 607 | 4723 | 242 | 5150 | -62 | 5120 |
| 12-#10 | 4.54 | MA | 2486 | 1184 | 3875 | 972 | 4630 | 803 | 5159 | 651 | 5916 | 400 | 7538 | 116 | 7069 |
| 5L-3S | | MI | 1425 | 1184 | 2498 | 889 | 2912 | 722 | 3213 | 585 | 3594 | 318 | 4032 | 33 | 3947 |
| 12-#10 | 4.54 | MA | 2332 | 1184 | 3565 | 987 | 4281 | 812 | 4711 | 666 | 5294 | 405 | 6676 | 44 | 6471 |
| 6L-2S | | MI | 1514 | 1184 | 2705 | 886 | 3174 | 722 | 3530 | 581 | 4004 | 314 | 4505 | 125 | 3979 |
| 12-#11 | 5.57 | MA | 2617 | 1285 | 4228 | 1034 | 5041 | 848 | 5642 | 679 | 6551 | 394 | 8320 | 42 | 8157 |
| 5L-3S | | MI | 1478 | 1285 | 2701 | 940 | 3148 | 757 | 3467 | 600 | 3876 | 283 | 4279 | -79 | 4241 |
| 12-#11 | 5.57 | MA | 2437 | 1285 | 3861 | 1053 | 4618 | 858 | 5098 | 696 | 5815 | 406 | 7366 | -32 | 7238 |
| 6L-2S | | MI | 1577 | 1285 | 2944 | 938 | 3457 | 759 | 3836 | 596 | 4344 | 279 | 4805 | 35 | 4664 |
| 14-#10 | 5.29 | MA | 2534 | 1258 | 4001 | 1033 | 4835 | 845 | 5382 | 687 | 6201 | 401 | 7930 | 39 | 7742 |
| 6L-3S | | MI | 1503 | 1258 | 2705 | 935 | 3174 | 756 | 3530 | 607 | 4004 | 310 | 4505 | 1 | 4503 |
| 14-#11 | 6.50 | MA | 2677 | 1376 | 4387 | 1109 | 5285 | 900 | 5907 | 722 | 6906 | 402 | 8844 | -41 | 8670 |
| 6L-3S | | MI | 1568 | 1376 | 2944 | 997 | 3457 | 799 | 3836 | 625 | 4344 | 270 | 4805 | -125 | 4734 |

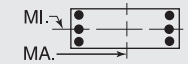
## RECTANGULAR TIED COLUMNS 14" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.10 | MA | 2467 | 920 | 3372 | 801 | 4056 | 675 | 4425 | 576 | 4791 | 426 | 5783 | 371 | 2435 |
| 2E | | MI | 1263 | 920 | 1909 | 737 | 2151 | 620 | 2268 | 527 | 2339 | 382 | 2586 | 298 | 1239 |
| 4-#10 | 1.40 | MA | 2558 | 952 | 3585 | 819 | 4316 | 687 | 4735 | 583 | 5204 | 423 | 6352 | 368 | 3044 |
| 2E | | MI | 1294 | 952 | 2000 | 752 | 2259 | 630 | 2394 | 533 | 2492 | 375 | 2754 | 279 | 1514 |
| 4-#11 | 1.71 | MA | 2639 | 985 | 3818 | 834 | 4583 | 697 | 5044 | 588 | 5610 | 418 | 6904 | 362 | 3664 |
| 2E | | MI | 1315 | 985 | 2096 | 762 | 2358 | 636 | 2495 | 533 | 2598 | 359 | 2839 | 245 | 1783 |
| 4-#14 | 2.47 | MA | 2845 | 1065 | 4334 | 879 | 5218 | 730 | 5803 | 608 | 6625 | 412 | 8241 | 349 | 5150 |
| 2E | | MI | 1379 | 1065 | 2304 | 804 | 2606 | 666 | 2762 | 544 | 2932 | 336 | 3178 | 185 | 2409 |
| 4-#18 | 4.40 | MA | 3315 | 1268 | 5587 | 998 | 6768 | 815 | 7663 | 660 | 9119 | 397 | 11406 | 303 | 8766 |
| 2E | | MI | 1521 | 1268 | 2779 | 915 | 3130 | 732 | 3342 | 564 | 3659 | 268 | 3860 | 7 | 3832 |
| 6-#8 | 1.30 | MA | 2538 | 942 | 3507 | 817 | 4238 | 686 | 4650 | 583 | 5099 | 426 | 6212 | 370 | 2868 |
| 2L-3S | | MI | 1218 | 942 | 1835 | 756 | 2065 | 633 | 2167 | 540 | 2215 | 386 | 2450 | 237 | 1447 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis

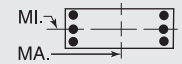



$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.30 | MA | 2360 | 942 | 3203 | 824 | 3852 | 693 | 4182 | 589 | 4467 | 435 | 5338 | 316 | 2869 |
| 3L-2S | | MI | 1291 | 942 | 1967 | 754 | 2233 | 633 | 2370 | 536 | 2482 | 384 | 2764 | 294 | 1436 |
| 6-#9 | 1.65 | MA | 2643 | 978 | 3755 | 838 | 4542 | 701 | 5014 | 592 | 5586 | 423 | 6883 | 367 | 3581 |
| 2L-3S | | MI | 1241 | 978 | 1909 | 776 | 2151 | 647 | 2268 | 548 | 2339 | 380 | 2586 | 202 | 1767 |
| 6-#9 | 1.65 | MA | 2426 | 978 | 3372 | 847 | 4056 | 709 | 4425 | 599 | 4791 | 434 | 5783 | 297 | 3570 |
| 3L-2S | | MI | 1328 | 978 | 2074 | 773 | 2361 | 646 | 2522 | 544 | 2670 | 377 | 2971 | 274 | 1754 |
| 6-#10 | 2.09 | MA | 2774 | 1025 | 4068 | 865 | 4929 | 721 | 5477 | 604 | 6207 | 420 | 7740 | 363 | 4484 |
| 2L-3S | | MI | 1267 | 1025 | 2000 | 801 | 2259 | 664 | 2394 | 559 | 2492 | 371 | 2754 | 155 | 2160 |
| 6-#10 | 2.09 | MA | 2509 | 1025 | 3585 | 876 | 4316 | 731 | 4735 | 613 | 5204 | 432 | 6352 | 273 | 4451 |
| 3L-2S | | MI | 1373 | 1025 | 2207 | 798 | 2521 | 664 | 2712 | 555 | 2903 | 368 | 3226 | 247 | 2149 |
| 6-#11 | 2.57 | MA | 2891 | 1076 | 4400 | 890 | 5322 | 739 | 5939 | 614 | 6818 | 414 | 8577 | 356 | 5396 |
| 2L-3S | | MI | 1284 | 1076 | 2096 | 821 | 2358 | 676 | 2495 | 562 | 2598 | 351 | 2839 | 85 | 2533 |
| 6-#11 | 2.57 | MA | 2584 | 1076 | 3818 | 903 | 4583 | 750 | 5044 | 624 | 5610 | 428 | 6904 | 243 | 5334 |
| 3L-2S | | MI | 1404 | 1076 | 2339 | 819 | 2666 | 678 | 2864 | 558 | 3067 | 346 | 3365 | 199 | 2527 |
| 6-#14 | 3.71 | MA | 2781 | 1196 | 4334 | 979 | 5218 | 805 | 5803 | 658 | 6625 | 425 | 8241 | 173 | 7426 |
| 3L-2S | | MI | 1500 | 1196 | 2643 | 885 | 3036 | 725 | 3265 | 577 | 3571 | 315 | 3881 | 111 | 3430 |
| 6-#18 | 6.59 | MA | 3287 | 1500 | 5587 | 1171 | 6768 | 944 | 7663 | 745 | 9119 | 415 | 11406 | -20 | 11352 |
| 3L-2S | | MI | 1714 | 1500 | 3340 | 1060 | 3819 | 832 | 4138 | 613 | 4670 | 217 | 4919 | -151 | 4911 |
| 8-#7 | 1.32 | MA | 2548 | 944 | 3513 | 820 | 4254 | 689 | 4675 | 585 | 5136 | 427 | 6267 | 371 | 2912 |
| 2L-4S | | MI | 1207 | 944 | 1794 | 763 | 2012 | 642 | 2106 | 543 | 2141 | 388 | 2386 | 236 | 1473 |
| 8-#7 | 1.32 | MA | 2413 | 944 | 3281 | 825 | 3959 | 694 | 4317 | 590 | 4654 | 434 | 5599 | 330 | 2913 |
| 3E | | MI | 1241 | 944 | 1867 | 761 | 2114 | 637 | 2230 | 543 | 2306 | 389 | 2565 | 255 | 1464 |
| 8-#7 | 1.32 | MA | 2337 | 944 | 3121 | 831 | 3738 | 702 | 4046 | 597 | 4282 | 437 | 5141 | 305 | 2900 |
| 4L-2S | | MI | 1297 | 944 | 1969 | 759 | 2243 | 636 | 2387 | 540 | 2514 | 388 | 2810 | 299 | 1456 |
| 8-#8 | 1.74 | MA | 2677 | 988 | 3812 | 845 | 4624 | 707 | 5118 | 596 | 5730 | 424 | 7087 | 367 | 3777 |
| 2L-4S | | MI | 1230 | 988 | 1871 | 788 | 2101 | 660 | 2209 | 553 | 2270 | 380 | 2534 | 195 | 1859 |
| 8-#8 | 1.74 | MA | 2507 | 988 | 3507 | 853 | 4238 | 714 | 4650 | 602 | 5099 | 432 | 6212 | 313 | 3769 |
| 3E | | MI | 1273 | 988 | 1967 | 785 | 2233 | 654 | 2370 | 553 | 2482 | 383 | 2764 | 219 | 1853 |
| 8-#8 | 1.74 | MA | 2411 | 988 | 3298 | 860 | 3948 | 724 | 4294 | 612 | 4612 | 436 | 5610 | 280 | 3726 |
| 4L-2S | | MI | 1344 | 988 | 2099 | 782 | 2401 | 653 | 2574 | 550 | 2750 | 380 | 3077 | 277 | 1844 |
| 8-#9 | 2.20 | MA | 2814 | 1036 | 4137 | 874 | 5028 | 728 | 5603 | 609 | 6381 | 420 | 7984 | 363 | 4720 |
| 2L-4S | | MI | 1256 | 1036 | 1954 | 815 | 2195 | 680 | 2320 | 564 | 2415 | 377 | 2688 | 148 | 2219 |
| 8-#9 | 2.20 | MA | 2607 | 1036 | 3755 | 883 | 4542 | 736 | 5014 | 616 | 5586 | 431 | 6883 | 293 | 4697 |
| 3E | | MI | 1308 | 1036 | 2074 | 812 | 2361 | 673 | 2522 | 565 | 2670 | 374 | 2971 | 178 | 2266 |
| 8-#9 | 2.20 | MA | 2492 | 1036 | 3491 | 892 | 4176 | 749 | 4566 | 628 | 4973 | 436 | 6123 | 251 | 4598 |
| 4L-2S | | MI | 1392 | 1036 | 2239 | 809 | 2570 | 673 | 2776 | 561 | 3001 | 372 | 3357 | 251 | 2258 |
| 8-#10 | 2.79 | MA | 2733 | 1099 | 4068 | 922 | 4929 | 764 | 5477 | 634 | 6207 | 429 | 7740 | 268 | 5869 |
| 3E | | MI | 1351 | 1099 | 2207 | 847 | 2521 | 698 | 2712 | 581 | 2903 | 363 | 3226 | 123 | 2773 |
| 8-#10 | 2.79 | MA | 2594 | 1099 | 3734 | 933 | 4467 | 781 | 4911 | 649 | 5433 | 435 | 6777 | 215 | 5519 |
| 4L-2S | | MI | 1451 | 1099 | 2414 | 844 | 2783 | 698 | 3030 | 576 | 3313 | 360 | 3699 | 215 | 2774 |
| 8-#11 | 3.43 | MA | 2848 | 1166 | 4400 | 960 | 5322 | 791 | 5939 | 650 | 6818 | 424 | 8577 | 237 | 7039 |
| 3E | | MI | 1379 | 1166 | 2339 | 877 | 2666 | 717 | 2864 | 587 | 3067 | 338 | 3365 | 39 | 3246 |
| 8-#11 | 3.43 | MA | 2686 | 1166 | 3996 | 973 | 4763 | 811 | 5254 | 668 | 5881 | 429 | 7402 | 171 | 6417 |
| 4L-2S | | MI | 1492 | 1166 | 2582 | 875 | 2974 | 719 | 3233 | 583 | 3535 | 334 | 3891 | 153 | 3258 |
| 8-#14 | 4.95 | MA | 2936 | 1326 | 4586 | 1078 | 5471 | 892 | 6100 | 720 | 7009 | 425 | 8935 | 68 | 8563 |
| 4L-2S | | MI | 1619 | 1326 | 2982 | 967 | 3465 | 785 | 3769 | 610 | 4211 | 293 | 4583 | 37 | 4434 |
| 10-#10 | 3.49 | MA | 2823 | 1173 | 4217 | 979 | 5079 | 815 | 5654 | 671 | 6435 | 431 | 8164 | 210 | 6902 |
| 4L-3S | | MI | 1432 | 1173 | 2414 | 893 | 2783 | 732 | 3030 | 602 | 3313 | 356 | 3699 | 91 | 3380 |
| 10-#10 | 3.49 | MA | 2658 | 1173 | 3921 | 990 | 4674 | 824 | 5150 | 679 | 5736 | 444 | 7196 | 160 | 6446 |
| 5L-2S | | MI | 1527 | 1173 | 2620 | 890 | 3046 | 731 | 3348 | 597 | 3723 | 352 | 4171 | 183 | 3392 |
| 10-#11 | 4.29 | MA | 2958 | 1257 | 4578 | 1029 | 5501 | 852 | 6150 | 694 | 7090 | 425 | 9075 | 165 | 8087 |
| 4L-3S | | MI | 1472 | 1257 | 2582 | 934 | 2974 | 758 | 3233 | 612 | 3535 | 325 | 3891 | -7 | 3888 |
| 10-#11 | 4.29 | MA | 2765 | 1257 | 4219 | 1042 | 5009 | 863 | 5540 | 703 | 6243 | 440 | 7898 | 99 | 7495 |
| 5L-2S | | MI | 1579 | 1257 | 2825 | 932 | 3282 | 760 | 3602 | 608 | 4004 | 321 | 4417 | 107 | 3979 |
| 10-#14 | 6.18 | MA | 3047 | 1457 | 4900 | 1177 | 5819 | 966 | 6502 | 770 | 7520 | 438 | 9631 | -39 | 9564 |
| 5L-2S | | MI | 1738 | 1457 | 3320 | 1049 | 3895 | 845 | 4273 | 644 | 4850 | 271 | 5286 | -36 | 5271 |
| 12-#10 | 4.19 | MA | 2882 | 1246 | 4404 | 1036 | 5286 | 858 | 5893 | 700 | 6738 | 441 | 8584 | 155 | 7855 |
| 5L-3S | | MI | 1512 | 1246 | 2620 | 939 | 3046 | 765 | 3348 | 623 | 3723 | 348 | 4171 | 59 | 3984 |

## RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

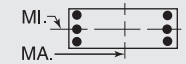
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 4.19 | MA | 2709 | 1246 | 4057 | 1051 | 4903 | 868 | 5400 | 716 | 6055 | 446 | 7641 | 84 | 7232 |
| 6L-2S | | MI | 1602 | 1246 | 2827 | 936 | 3308 | 765 | 3666 | 618 | 4133 | 344 | 4644 | 151 | 4005 |
| 12-#11 | 5.14 | MA | 3030 | 1347 | 4801 | 1098 | 5748 | 904 | 6435 | 729 | 7452 | 435 | 9571 | 93 | 9172 |
| 5L-3S | | MI | 1564 | 1347 | 2825 | 990 | 3282 | 800 | 3602 | 637 | 4004 | 313 | 4417 | -53 | 4392 |
| 12-#11 | 5.14 | MA | 2829 | 1347 | 4388 | 1117 | 5283 | 916 | 5837 | 747 | 6624 | 441 | 8421 | 5 | 8395 |
| 6L-2S | | MI | 1666 | 1347 | 3068 | 988 | 3591 | 801 | 3971 | 633 | 4472 | 308 | 4943 | 61 | 4696 |
| 14-#10 | 4.88 | MA | 2936 | 1320 | 4539 | 1097 | 5516 | 902 | 6142 | 737 | 7057 | 443 | 9029 | 79 | 8642 |
| 6L-3S | | MI | 1590 | 1320 | 2827 | 985 | 3308 | 799 | 3666 | 644 | 4133 | 340 | 4644 | 27 | 4570 |
| 14-#10 | 4.88 | MA | 2793 | 1320 | 4229 | 1104 | 5108 | 917 | 5667 | 746 | 6394 | 456 | 8110 | 37 | 7968 |
| 7L-2S | | MI | 1677 | 1320 | 3034 | 982 | 3570 | 799 | 3984 | 640 | 4543 | 337 | 5116 | 119 | 4615 |
| 14-#11 | 6.00 | MA | 3098 | 1438 | 4970 | 1173 | 6021 | 957 | 6732 | 773 | 7832 | 437 | 10094 | -1 | 10091 |
| 6L-3S | | MI | 1655 | 1438 | 3068 | 1047 | 3591 | 841 | 3971 | 662 | 4472 | 300 | 4943 | -99 | 4889 |
| 16-#10 | 5.58 | MA | 3023 | 1394 | 4711 | 1150 | 5721 | 950 | 6409 | 767 | 7396 | 452 | 9498 | 32 | 9375 |
| 7L-3S | | MI | 1668 | 1394 | 3034 | 1031 | 3570 | 833 | 3984 | 666 | 4543 | 332 | 5116 | -5 | 5112 |

## RECTANGULAR TIED COLUMNS 14" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.02 | MA | 2844 | 982 | 3824 | 863 | 4624 | 728 | 5051 | 622 | 5460 | 463 | 6583 | 403 | 2651 |
| 2E | | MI | 1350 | 982 | 2030 | 788 | 2284 | 663 | 2403 | 565 | 2468 | 413 | 2726 | 324 | 1254 |
| 4-#10 | 1.30 | MA | 2945 | 1014 | 4058 | 881 | 4910 | 740 | 5391 | 629 | 5914 | 460 | 7208 | 400 | 3318 |
| 2E | | MI | 1381 | 1014 | 2123 | 803 | 2392 | 674 | 2530 | 571 | 2621 | 405 | 2893 | 305 | 1531 |
| 4-#11 | 1.59 | MA | 3037 | 1047 | 4315 | 896 | 5205 | 750 | 5733 | 634 | 6362 | 455 | 7818 | 394 | 4001 |
| 2E | | MI | 1402 | 1047 | 2220 | 812 | 2492 | 679 | 2630 | 570 | 2726 | 388 | 2977 | 271 | 1804 |
| 4-#14 | 2.30 | MA | 3269 | 1127 | 4884 | 941 | 5905 | 783 | 6570 | 654 | 7482 | 448 | 9361 | 387 | 5636 |
| 2E | | MI | 1467 | 1127 | 2429 | 853 | 2740 | 708 | 2897 | 580 | 3059 | 365 | 3314 | 211 | 2435 |
| 4-#18 | 4.08 | MA | 3804 | 1330 | 6269 | 1059 | 7619 | 868 | 8626 | 706 | 10238 | 433 | 12993 | 353 | 9630 |
| 2E | | MI | 1608 | 1330 | 2906 | 963 | 3265 | 773 | 3476 | 599 | 3785 | 296 | 3994 | 32 | 3869 |
| 6-#8 | 1.21 | MA | 2923 | 1004 | 3972 | 879 | 4822 | 739 | 5296 | 629 | 5796 | 463 | 7051 | 403 | 3124 |
| 2L-3S | | MI | 1305 | 1004 | 1955 | 808 | 2198 | 677 | 2302 | 578 | 2344 | 417 | 2590 | 264 | 1463 |
| 6-#8 | 1.21 | MA | 2725 | 1004 | 3639 | 886 | 4400 | 746 | 4784 | 635 | 5105 | 472 | 6094 | 349 | 3125 |
| 3L-2S | | MI | 1378 | 1004 | 2088 | 805 | 2366 | 676 | 2506 | 575 | 2612 | 415 | 2904 | 321 | 1451 |
| 6-#9 | 1.53 | MA | 3041 | 1040 | 4243 | 900 | 5156 | 754 | 5695 | 638 | 6330 | 460 | 7788 | 399 | 3905 |
| 2L-3S | | MI | 1327 | 1040 | 2030 | 827 | 2284 | 690 | 2403 | 586 | 2468 | 410 | 2726 | 228 | 1785 |
| 6-#9 | 1.53 | MA | 2799 | 1040 | 3824 | 909 | 4624 | 762 | 5051 | 646 | 5460 | 471 | 6583 | 331 | 3894 |
| 3L-2S | | MI | 1416 | 1040 | 2195 | 824 | 2494 | 690 | 2657 | 582 | 2799 | 407 | 3111 | 301 | 1771 |
| 6-#10 | 1.94 | MA | 3187 | 1087 | 4586 | 927 | 5581 | 774 | 6204 | 650 | 7012 | 456 | 8728 | 395 | 4896 |
| 2L-3S | | MI | 1354 | 1087 | 2123 | 852 | 2392 | 708 | 2530 | 597 | 2621 | 401 | 2893 | 181 | 2183 |
| 6-#10 | 1.94 | MA | 2892 | 1087 | 4058 | 938 | 4910 | 784 | 5391 | 659 | 5914 | 470 | 7208 | 307 | 4862 |
| 3L-2S | | MI | 1461 | 1087 | 2329 | 849 | 2654 | 707 | 2848 | 592 | 3031 | 398 | 3365 | 273 | 2169 |
| 6-#11 | 2.39 | MA | 3320 | 1138 | 4954 | 952 | 6016 | 791 | 6715 | 660 | 7688 | 450 | 9654 | 388 | 5902 |
| 2L-3S | | MI | 1371 | 1138 | 2220 | 870 | 2492 | 718 | 2630 | 599 | 2726 | 380 | 2977 | 111 | 2563 |
| 6-#11 | 2.39 | MA | 2977 | 1138 | 4315 | 966 | 5205 | 804 | 5733 | 671 | 6362 | 466 | 7818 | 278 | 5840 |
| 3L-2S | | MI | 1492 | 1138 | 2463 | 869 | 2800 | 720 | 2999 | 595 | 3195 | 376 | 3503 | 225 | 2551 |
| 6-#14 | 3.44 | MA | 3198 | 1258 | 4884 | 1042 | 5905 | 859 | 6570 | 706 | 7482 | 463 | 9361 | 216 | 8155 |
| 3L-2S | | MI | 1588 | 1258 | 2768 | 935 | 3170 | 767 | 3400 | 614 | 3698 | 344 | 4017 | 137 | 3460 |
| 6-#18 | 6.12 | MA | 3767 | 1562 | 6269 | 1235 | 7619 | 1000 | 8626 | 794 | 10238 | 455 | 12993 | 39 | 12868 |
| 3L-2S | | MI | 1801 | 1562 | 3467 | 1108 | 3954 | 873 | 4272 | 649 | 4796 | 246 | 5053 | -126 | 5052 |
| 8-#7 | 1.22 | MA | 2934 | 1005 | 3977 | 882 | 4839 | 741 | 5322 | 631 | 5835 | 464 | 7109 | 403 | 3171 |
| 2L-4S | | MI | 1293 | 1005 | 1914 | 815 | 2145 | 686 | 2241 | 581 | 2270 | 418 | 2527 | 263 | 1489 |
| 8-#7 | 1.22 | MA | 2784 | 1005 | 3723 | 888 | 4517 | 747 | 4931 | 636 | 5308 | 471 | 6379 | 363 | 3172 |
| 3E | | MI | 1328 | 1005 | 1987 | 812 | 2246 | 681 | 2365 | 581 | 2435 | 420 | 2706 | 282 | 1479 |
| 8-#7 | 1.22 | MA | 2700 | 1005 | 3549 | 893 | 4276 | 755 | 4635 | 644 | 4903 | 474 | 5883 | 339 | 3159 |
| 4L-2S | | MI | 1384 | 1005 | 2089 | 810 | 2376 | 680 | 2522 | 578 | 2643 | 418 | 2951 | 326 | 1470 |
| 8-#8 | 1.61 | MA | 3078 | 1050 | 4304 | 907 | 5245 | 760 | 5808 | 642 | 6487 | 461 | 8008 | 400 | 4118 |
| 2L-4S | | MI | 1316 | 1050 | 1992 | 839 | 2234 | 704 | 2345 | 591 | 2399 | 411 | 2674 | 222 | 1879 |
| 8-#8 | 1.61 | MA | 2888 | 1050 | 3972 | 915 | 4822 | 767 | 5296 | 649 | 5796 | 470 | 7051 | 346 | 4110 |
| 3E | | MI | 1360 | 1050 | 2088 | 836 | 2366 | 698 | 2506 | 592 | 2612 | 413 | 2904 | 246 | 1871 |

## RECTANGULAR TIED COLUMNS 14" x 28"

Short columns – no sidesway
Bending on major or minor axis

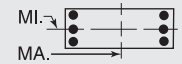



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#8 | 1.61 | MA | 2783 | 1050 | 3743 | 922 | 4506 | 778 | 4908 | 659 | 5265 | 474 | 6399 | 314 | 4068 |
| 4L-2S | | MI | 1431 | 1050 | 2220 | 834 | 2534 | 697 | 2709 | 588 | 2879 | 411 | 3217 | 303 | 1861 |
| 8-#9 | 2.04 | MA | 3231 | 1098 | 4662 | 936 | 5688 | 781 | 6340 | 655 | 7200 | 457 | 8992 | 395 | 5152 |
| 2L-4S | | MI | 1342 | 1098 | 2075 | 866 | 2329 | 723 | 2455 | 602 | 2544 | 407 | 2828 | 175 | 2268 |
| 8-#9 | 2.04 | MA | 3001 | 1098 | 4243 | 945 | 5156 | 789 | 5695 | 663 | 6330 | 468 | 7788 | 327 | 5129 |
| 3E | | MI | 1395 | 1098 | 2195 | 863 | 2494 | 717 | 2657 | 603 | 2799 | 405 | 3111 | 204 | 2287 |
| 8-#9 | 2.04 | MA | 2873 | 1098 | 3955 | 955 | 4757 | 803 | 5206 | 676 | 5661 | 474 | 6964 | 286 | 5037 |
| 4L-2S | | MI | 1480 | 1098 | 2361 | 860 | 2704 | 716 | 2911 | 599 | 3130 | 402 | 3496 | 277 | 2278 |
| 8-#10 | 2.59 | MA | 3142 | 1161 | 4586 | 984 | 5581 | 818 | 6204 | 681 | 7012 | 467 | 8728 | 303 | 6418 |
| 3E | | MI | 1437 | 1161 | 2329 | 898 | 2654 | 741 | 2848 | 618 | 3031 | 393 | 3365 | 149 | 2800 |
| 8-#10 | 2.59 | MA | 2987 | 1161 | 4223 | 996 | 5077 | 835 | 5586 | 697 | 6166 | 473 | 7684 | 250 | 6108 |
| 4L-2S | | MI | 1538 | 1161 | 2536 | 895 | 2917 | 741 | 3165 | 614 | 3441 | 390 | 3838 | 241 | 2796 |
| 8-#11 | 3.18 | MA | 3271 | 1228 | 4954 | 1022 | 6016 | 845 | 6715 | 697 | 7688 | 462 | 9654 | 272 | 7713 |
| 3E | | MI | 1466 | 1228 | 2463 | 927 | 2800 | 760 | 2999 | 624 | 3195 | 367 | 3503 | 65 | 3279 |
| 8-#11 | 3.18 | MA | 3092 | 1228 | 4513 | 1036 | 5405 | 865 | 5967 | 716 | 6664 | 469 | 8380 | 207 | 7108 |
| 4L-2S | | MI | 1580 | 1228 | 2706 | 925 | 3108 | 761 | 3368 | 620 | 3663 | 363 | 4029 | 179 | 3284 |
| 8-#14 | 4.59 | MA | 3371 | 1388 | 5164 | 1142 | 6186 | 947 | 6900 | 770 | 7908 | 466 | 10147 | 112 | 9490 |
| 4L-2S | | MI | 1707 | 1388 | 3107 | 1016 | 3600 | 827 | 3904 | 647 | 4338 | 322 | 4720 | 63 | 4468 |
| 10-#10 | 3.24 | MA | 3242 | 1234 | 4752 | 1042 | 5748 | 869 | 6399 | 718 | 7264 | 470 | 9204 | 245 | 7628 |
| 4L-3S | | MI | 1519 | 1234 | 2536 | 944 | 2917 | 775 | 3165 | 640 | 3441 | 386 | 3838 | 117 | 3409 |
| 10-#10 | 3.24 | MA | 3054 | 1234 | 4430 | 1054 | 5305 | 879 | 5851 | 728 | 6502 | 484 | 8151 | 197 | 7098 |
| 5L-2S | | MI | 1615 | 1234 | 2742 | 941 | 3179 | 775 | 3483 | 635 | 3851 | 382 | 4310 | 210 | 3416 |
| 10-#11 | 3.98 | MA | 3394 | 1319 | 5151 | 1093 | 6215 | 907 | 6949 | 742 | 7990 | 465 | 10216 | 201 | 8946 |
| 4L-3S | | MI | 1559 | 1319 | 2706 | 984 | 3108 | 801 | 3368 | 649 | 3663 | 355 | 4029 | 19 | 3981 |
| 10-#11 | 3.98 | MA | 3175 | 1319 | 4760 | 1106 | 5678 | 919 | 6283 | 752 | 7065 | 480 | 8935 | 139 | 8359 |
| 5L-2S | | MI | 1668 | 1319 | 2949 | 982 | 3416 | 803 | 3737 | 645 | 4131 | 351 | 4554 | 133 | 4009 |
| 10-#14 | 5.74 | MA | 3488 | 1519 | 5513 | 1243 | 6573 | 1023 | 7347 | 821 | 8476 | 481 | 10927 | 11 | 10888 |
| 5L-2S | | MI | 1826 | 1519 | 3445 | 1098 | 4030 | 887 | 4408 | 681 | 4977 | 300 | 5422 | -11 | 5418 |
| 12-#10 | 3.89 | MA | 3303 | 1308 | 4958 | 1100 | 5976 | 913 | 6664 | 749 | 7600 | 480 | 9672 | 192 | 8644 |
| 5L-3S | | MI | 1599 | 1308 | 2742 | 990 | 3179 | 809 | 3483 | 661 | 3851 | 378 | 4310 | 85 | 4015 |
| 12-#10 | 3.89 | MA | 3112 | 1308 | 4573 | 1114 | 5559 | 923 | 6127 | 765 | 6855 | 487 | 8651 | 122 | 8006 |
| 6L-2S | | MI | 1691 | 1308 | 2949 | 987 | 3441 | 808 | 3801 | 656 | 4261 | 374 | 4783 | 178 | 4031 |
| 12-#11 | 4.78 | MA | 3470 | 1409 | 5399 | 1163 | 6489 | 960 | 7265 | 778 | 8391 | 476 | 10770 | 133 | 10210 |
| 5L-3S | | MI | 1650 | 1409 | 2949 | 1040 | 3416 | 842 | 3737 | 674 | 4131 | 342 | 4554 | -27 | 4543 |
| 12-#11 | 4.78 | MA | 3247 | 1409 | 4939 | 1181 | 5981 | 972 | 6613 | 797 | 7487 | 483 | 9524 | 46 | 9308 |
| 6L-2S | | MI | 1754 | 1409 | 3192 | 1038 | 3724 | 844 | 4106 | 670 | 4600 | 338 | 5080 | 87 | 4727 |
| 12-#14 | 6.89 | MA | 3602 | 1649 | 5774 | 1350 | 7002 | 1099 | 7813 | 885 | 9072 | 484 | 11751 | -124 | 11388 |
| 6L-2S | | MI | 1945 | 1649 | 3784 | 1179 | 4459 | 946 | 4911 | 714 | 5616 | 279 | 6125 | -85 | 6083 |
| 14-#10 | 4.54 | MA | 3364 | 1382 | 5102 | 1160 | 6230 | 957 | 6940 | 786 | 7953 | 484 | 10171 | 117 | 9553 |
| 6L-3S | | MI | 1677 | 1382 | 2949 | 1036 | 3441 | 842 | 3801 | 682 | 4261 | 370 | 4783 | 53 | 4618 |
| 14-#10 | 4.54 | MA | 3206 | 1382 | 4763 | 1168 | 5778 | 972 | 6422 | 796 | 7230 | 497 | 9173 | 78 | 8842 |
| 7L-2S | | MI | 1766 | 1382 | 3156 | 1033 | 3703 | 842 | 4119 | 677 | 4672 | 367 | 5255 | 146 | 4642 |
| 14-#11 | 5.57 | MA | 3545 | 1499 | 5578 | 1237 | 6792 | 1013 | 7595 | 823 | 8813 | 479 | 11359 | 40 | 11155 |
| 6L-3S | | MI | 1741 | 1499 | 3192 | 1097 | 3724 | 884 | 4106 | 700 | 4600 | 330 | 5080 | -73 | 5043 |
| 14-#11 | 5.57 | MA | 3361 | 1499 | 5167 | 1246 | 6253 | 1032 | 6965 | 834 | 7936 | 495 | 10144 | -12 | 10114 |
| 7L-2S | | MI | 1840 | 1499 | 3434 | 1095 | 4033 | 885 | 4475 | 695 | 5068 | 325 | 5606 | 40 | 5442 |
| 16-#10 | 5.18 | MA | 3460 | 1455 | 5291 | 1214 | 6449 | 1006 | 7235 | 817 | 8328 | 494 | 10694 | 73 | 10383 |
| 7L-3S | | MI | 1755 | 1455 | 3156 | 1082 | 3703 | 876 | 4119 | 703 | 4672 | 362 | 5255 | 21 | 5194 |
| 16-#10 | 5.18 | MA | 3302 | 1455 | 4965 | 1222 | 6012 | 1012 | 6711 | 832 | 7617 | 508 | 9734 | 19 | 9668 |
| 8L-2S | | MI | 1840 | 1455 | 3362 | 1079 | 3966 | 876 | 4437 | 699 | 5082 | 359 | 5728 | 114 | 5251 |
| 16-#11 | 6.37 | MA | 3664 | 1590 | 5805 | 1302 | 7064 | 1074 | 7948 | 860 | 9261 | 490 | 11979 | -18 | 11914 |
| 7L-3S | | MI | 1831 | 1590 | 3434 | 1153 | 4033 | 925 | 4475 | 725 | 5068 | 317 | 5606 | -119 | 5537 |
| 18-#10 | 5.83 | MA | 3552 | 1529 | 5494 | 1268 | 6683 | 1046 | 7524 | 854 | 8715 | 504 | 11254 | 14 | 11205 |
| 8L-3S | | MI | 1833 | 1529 | 3362 | 1128 | 3966 | 910 | 4437 | 725 | 5082 | 355 | 5728 | -10 | 5719 |

## RECTANGULAR TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

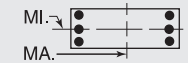
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 1.41 | MA | 1067 | 670 | 1593 | 549 | 1846 | 460 | 1985 | 390 | 2134 | 281 | 2449 | 225 | 1259 |
| 2L-3S | | MI | 998 | 670 | 1469 | 552 | 1689 | 463 | 1794 | 391 | 1877 | 284 | 2131 | 181 | 1266 |
| 6-#8 | 1.85 | MA | 1112 | 703 | 1712 | 568 | 1990 | 474 | 2157 | 398 | 2364 | 279 | 2718 | 212 | 1607 |
| 2L-3S | | MI | 1025 | 703 | 1551 | 572 | 1786 | 476 | 1910 | 399 | 2030 | 281 | 2308 | 155 | 1612 |
| 6-#9 | 2.34 | MA | 1160 | 740 | 1840 | 588 | 2147 | 488 | 2344 | 407 | 2614 | 276 | 3002 | 198 | 1982 |
| 2L-3S | | MI | 1054 | 740 | 1638 | 593 | 1891 | 491 | 2034 | 408 | 2196 | 279 | 2497 | 125 | 1979 |
| 6-#10 | 2.98 | MA | 1216 | 787 | 2000 | 615 | 2344 | 508 | 2580 | 418 | 2926 | 271 | 3355 | 178 | 2452 |
| 2L-3S | | MI | 1093 | 787 | 1747 | 620 | 2024 | 511 | 2192 | 419 | 2403 | 274 | 2730 | 85 | 2431 |
| 6-#11 | 3.66 | MA | 1260 | 837 | 2159 | 640 | 2529 | 525 | 2795 | 428 | 3168 | 256 | 3597 | 141 | 2899 |
| 2L-3S | | MI | 1120 | 837 | 1859 | 645 | 2149 | 527 | 2335 | 435 | 2562 | 261 | 2887 | 28 | 2826 |
| 6-#14 | 5.27 | MA | 1384 | 957 | 2534 | 710 | 2993 | 576 | 3353 | 459 | 3853 | 236 | 4353 | 75 | 3994 |
| 2L-3S | | MI | 1204 | 957 | 2114 | 715 | 2460 | 576 | 2706 | 468 | 3017 | 242 | 3387 | -89 | 3333 |
| 8-#7 | 1.88 | MA | 1119 | 705 | 1717 | 571 | 2002 | 476 | 2175 | 400 | 2390 | 280 | 2767 | 216 | 1634 |
| 2L-4S | | MI | 1013 | 705 | 1505 | 577 | 1724 | 484 | 1836 | 406 | 1931 | 282 | 2220 | 151 | 1632 |
| 8-#8 | 2.47 | MA | 1178 | 749 | 1873 | 596 | 2195 | 495 | 2405 | 411 | 2699 | 276 | 3127 | 200 | 2092 |
| 2L-4S | | MI | 1045 | 749 | 1597 | 604 | 1832 | 504 | 1963 | 418 | 2100 | 278 | 2422 | 115 | 2005 |
| 8-#9 | 3.13 | MA | 1238 | 798 | 2041 | 624 | 2403 | 515 | 2654 | 424 | 3033 | 273 | 3508 | 181 | 2584 |
| 2L-4S | | MI | 1079 | 798 | 1695 | 634 | 1948 | 526 | 2101 | 431 | 2283 | 273 | 2636 | 74 | 2377 |
| 8-#10 | 3.97 | MA | 1312 | 860 | 2253 | 661 | 2665 | 541 | 2969 | 440 | 3449 | 267 | 3980 | 154 | 3201 |
| 2L-4S | | MI | 1128 | 860 | 1819 | 672 | 2094 | 555 | 2275 | 448 | 2511 | 267 | 2901 | 20 | 2833 |

## RECTANGULAR TIED COLUMNS 16" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.10 | MA | 1318 | 728 | 1899 | 610 | 2210 | 513 | 2372 | 437 | 2521 | 323 | 2922 | 269 | 1288 |
| 2E | | MI | 1159 | 728 | 1704 | 599 | 1958 | 504 | 2086 | 429 | 2200 | 316 | 2495 | 256 | 1133 |
| 4-#9 | 1.39 | MA | 1358 | 752 | 2003 | 623 | 2336 | 522 | 2520 | 443 | 2718 | 320 | 3161 | 261 | 1589 |
| 2E | | MI | 1192 | 752 | 1792 | 612 | 2064 | 513 | 2211 | 435 | 2366 | 314 | 2682 | 246 | 1391 |
| 4-#10 | 1.76 | MA | 1407 | 784 | 2133 | 640 | 2494 | 534 | 2708 | 450 | 2969 | 317 | 3459 | 250 | 1968 |
| 2E | | MI | 1232 | 784 | 1903 | 629 | 2196 | 525 | 2368 | 442 | 2572 | 310 | 2915 | 232 | 1714 |
| 4-#11 | 2.17 | MA | 1448 | 817 | 2270 | 654 | 2648 | 544 | 2885 | 454 | 3199 | 311 | 3681 | 229 | 2342 |
| 2E | | MI | 1262 | 817 | 2017 | 642 | 2322 | 534 | 2512 | 445 | 2731 | 298 | 3070 | 206 | 2030 |
| 4-#14 | 3.13 | MA | 1555 | 897 | 2578 | 699 | 3024 | 576 | 3334 | 474 | 3789 | 303 | 4343 | 194 | 3238 |
| 2E | | MI | 1347 | 897 | 2273 | 686 | 2634 | 565 | 2883 | 464 | 3185 | 283 | 3569 | 160 | 2783 |
| 4-#18 | 5.56 | MA | 1796 | 1100 | 3307 | 816 | 3921 | 660 | 4408 | 525 | 5120 | 269 | 5820 | 85 | 5354 |
| 2E | | MI | 1538 | 1100 | 2872 | 802 | 3368 | 649 | 3724 | 507 | 4212 | 236 | 4643 | 24 | 4534 |
| 6-#7 | 1.25 | MA | 1344 | 741 | 1948 | 620 | 2279 | 521 | 2459 | 443 | 2641 | 323 | 3090 | 269 | 1454 |
| 2L-3S | | MI | 1112 | 741 | 1622 | 613 | 1860 | 514 | 1971 | 436 | 2047 | 320 | 2317 | 212 | 1283 |
| 6-#7 | 1.25 | MA | 1261 | 741 | 1802 | 624 | 2095 | 524 | 2235 | 445 | 2339 | 327 | 2698 | 226 | 1461 |
| 3L-2S | | MI | 1181 | 741 | 1746 | 610 | 2017 | 512 | 2161 | 435 | 2304 | 317 | 2635 | 256 | 1275 |
| 6-#8 | 1.65 | MA | 1399 | 774 | 2088 | 638 | 2451 | 534 | 2663 | 451 | 2915 | 320 | 3428 | 260 | 1863 |
| 2L-3S | | MI | 1138 | 774 | 1704 | 632 | 1958 | 528 | 2086 | 444 | 2200 | 317 | 2495 | 186 | 1633 |
| 6-#8 | 1.65 | MA | 1294 | 774 | 1899 | 643 | 2210 | 538 | 2372 | 453 | 2521 | 325 | 2922 | 203 | 1868 |
| 3L-2S | | MI | 1227 | 774 | 1865 | 628 | 2162 | 525 | 2334 | 443 | 2535 | 314 | 2904 | 244 | 1626 |
| 6-#9 | 2.08 | MA | 1458 | 810 | 2241 | 659 | 2637 | 549 | 2886 | 459 | 3212 | 317 | 3789 | 249 | 2306 |
| 2L-3S | | MI | 1167 | 810 | 1792 | 653 | 2064 | 542 | 2211 | 452 | 2366 | 314 | 2682 | 156 | 2005 |
| 6-#9 | 2.08 | MA | 1330 | 810 | 2003 | 665 | 2336 | 553 | 2520 | 462 | 2718 | 323 | 3161 | 176 | 2303 |
| 3L-2S | | MI | 1274 | 810 | 1994 | 648 | 2319 | 540 | 2521 | 451 | 2784 | 311 | 3188 | 229 | 2003 |
| 6-#10 | 2.65 | MA | 1530 | 857 | 2432 | 686 | 2873 | 568 | 3167 | 471 | 3589 | 314 | 4239 | 233 | 2863 |
| 2L-3S | | MI | 1203 | 857 | 1903 | 680 | 2196 | 562 | 2368 | 464 | 2572 | 310 | 2915 | 116 | 2464 |
| 6-#10 | 2.65 | MA | 1375 | 857 | 2133 | 693 | 2494 | 573 | 2708 | 474 | 2969 | 320 | 3459 | 141 | 2842 |
| 3L-2S | | MI | 1332 | 857 | 2155 | 675 | 2517 | 559 | 2757 | 463 | 3095 | 306 | 3540 | 209 | 2475 |
| 6-#11 | 3.25 | MA | 1587 | 908 | 2626 | 710 | 3099 | 585 | 3432 | 480 | 3938 | 307 | 4580 | 204 | 3404 |
| 2L-3S | | MI | 1233 | 908 | 2017 | 704 | 2322 | 577 | 2512 | 479 | 2731 | 296 | 3070 | 58 | 2899 |
| 6-#11 | 3.25 | MA | 1416 | 908 | 2270 | 718 | 2648 | 590 | 2885 | 483 | 3199 | 312 | 3681 | 90 | 3361 |
| 3L-2S | | MI | 1376 | 908 | 2316 | 698 | 2702 | 575 | 2972 | 472 | 3336 | 291 | 3780 | 172 | 2928 |
| 6-#14 | 4.69 | MA | 1743 | 1028 | 3080 | 780 | 3661 | 636 | 4105 | 511 | 4825 | 296 | 5579 | 152 | 4723 |
| 2L-3S | | MI | 1315 | 1028 | 2273 | 774 | 2634 | 626 | 2883 | 511 | 3185 | 276 | 3569 | -59 | 3535 |
| 6-#14 | 4.69 | MA | 1522 | 1028 | 2578 | 790 | 3024 | 641 | 3334 | 513 | 3789 | 302 | 4343 | -12 | 4332 |
| 3L-2S | | MI | 1501 | 1028 | 2694 | 768 | 3167 | 625 | 3529 | 502 | 4022 | 270 | 4535 | 105 | 4029 |

## RECTANGULAR TIED COLUMNS 16" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#7 | 1.67 | MA | 1406 | 776 | 2093 | 642 | 2464 | 537 | 2682 | 453 | 2943 | 322 | 3482 | 263 | 1893 |
| 2L-4S | | MI | 1126 | 776 | 1658 | 638 | 1896 | 536 | 2013 | 451 | 2101 | 317 | 2406 | 182 | 1657 |
| 8-#7 | 1.67 | MA | 1326 | 776 | 1948 | 646 | 2279 | 540 | 2459 | 455 | 2641 | 325 | 3090 | 220 | 1897 |
| 3E | | MI | 1166 | 776 | 1746 | 635 | 2017 | 530 | 2161 | 446 | 2304 | 318 | 2635 | 204 | 1657 |
| 8-#7 | 1.67 | MA | 1280 | 776 | 1845 | 649 | 2138 | 546 | 2285 | 460 | 2404 | 326 | 2811 | 197 | 1891 |
| 4L-2S | | MI | 1233 | 776 | 1869 | 631 | 2174 | 528 | 2352 | 445 | 2561 | 316 | 2953 | 247 | 1651 |
| 8-#8 | 2.19 | MA | 1479 | 820 | 2278 | 667 | 2692 | 555 | 2955 | 464 | 3308 | 318 | 3935 | 251 | 2433 |
| 2L-4S | | MI | 1157 | 820 | 1750 | 664 | 2004 | 555 | 2140 | 463 | 2270 | 313 | 2608 | 146 | 2069 |
| 8-#8 | 2.19 | MA | 1378 | 820 | 2088 | 672 | 2451 | 559 | 2663 | 466 | 2915 | 323 | 3428 | 194 | 2430 |
| 3E | | MI | 1208 | 820 | 1865 | 660 | 2162 | 549 | 2334 | 457 | 2535 | 315 | 2904 | 174 | 2113 |
| 8-#8 | 2.19 | MA | 1320 | 820 | 1954 | 677 | 2266 | 567 | 2437 | 473 | 2606 | 323 | 3067 | 164 | 2379 |
| 4L-2S | | MI | 1292 | 820 | 2026 | 657 | 2367 | 546 | 2582 | 456 | 2869 | 312 | 3313 | 231 | 2112 |
| 8-#9 | 2.78 | MA | 1555 | 868 | 2478 | 695 | 2939 | 575 | 3251 | 476 | 3706 | 315 | 4417 | 237 | 3016 |
| 2L-4S | | MI | 1191 | 868 | 1850 | 694 | 2121 | 577 | 2278 | 476 | 2453 | 309 | 2822 | 105 | 2448 |
| 8-#9 | 2.78 | MA | 1434 | 868 | 2241 | 701 | 2637 | 580 | 2886 | 479 | 3212 | 320 | 3789 | 164 | 3001 |
| 3E | | MI | 1255 | 868 | 1994 | 689 | 2319 | 569 | 2521 | 469 | 2784 | 311 | 3188 | 139 | 2598 |
| 8-#9 | 2.78 | MA | 1363 | 868 | 2072 | 707 | 2405 | 590 | 2601 | 487 | 2824 | 320 | 3340 | 127 | 2826 |
| 4L-2S | | MI | 1354 | 868 | 2195 | 684 | 2575 | 566 | 2831 | 468 | 3203 | 308 | 3694 | 212 | 2607 |
| 8-#10 | 3.53 | MA | 1648 | 931 | 2731 | 732 | 3252 | 602 | 3627 | 492 | 4209 | 310 | 5019 | 217 | 3750 |
| 2L-4S | | MI | 1239 | 931 | 1974 | 732 | 2267 | 606 | 2451 | 493 | 2680 | 302 | 3086 | 51 | 2912 |
| 8-#10 | 3.53 | MA | 1503 | 931 | 2432 | 739 | 2873 | 607 | 3167 | 495 | 3589 | 316 | 4239 | 124 | 3714 |
| 3E | | MI | 1311 | 931 | 2155 | 726 | 2517 | 595 | 2757 | 485 | 3095 | 306 | 3540 | 93 | 3201 |
| 8-#10 | 3.53 | MA | 1418 | 931 | 2220 | 746 | 2580 | 619 | 2809 | 506 | 3100 | 315 | 3679 | 78 | 3375 |
| 4L-2S | | MI | 1428 | 931 | 2408 | 721 | 2838 | 592 | 3146 | 484 | 3618 | 302 | 4165 | 185 | 3227 |
| 8-#11 | 4.33 | MA | 1565 | 998 | 2626 | 774 | 3099 | 631 | 3432 | 509 | 3938 | 308 | 4580 | 65 | 4394 |
| 3E | | MI | 1354 | 998 | 2316 | 760 | 2702 | 618 | 2972 | 505 | 3336 | 288 | 3780 | 24 | 3721 |
| 8-#11 | 4.33 | MA | 1469 | 998 | 2372 | 782 | 2749 | 645 | 3003 | 519 | 3353 | 305 | 3930 | 11 | 3888 |
| 4L-2S | | MI | 1486 | 998 | 2616 | 755 | 3082 | 616 | 3433 | 498 | 3942 | 284 | 4490 | 137 | 3815 |
| 8-#14 | 6.25 | MA | 1727 | 1158 | 3080 | 871 | 3661 | 701 | 4105 | 550 | 4825 | 295 | 5579 | -54 | 5509 |
| 3E | | MI | 1482 | 1158 | 2694 | 855 | 3167 | 686 | 3529 | 548 | 4022 | 263 | 4535 | -114 | 4446 |
| 10-#10 | 4.41 | MA | 1632 | 1005 | 2731 | 785 | 3252 | 641 | 3627 | 517 | 4209 | 313 | 5019 | 107 | 4585 |
| 3L-4S | | MI | 1349 | 1005 | 2227 | 778 | 2588 | 639 | 2840 | 514 | 3203 | 299 | 3711 | 28 | 3612 |
| 10-#10 | 4.41 | MA | 1558 | 1005 | 2519 | 792 | 2959 | 653 | 3269 | 527 | 3721 | 312 | 4460 | 61 | 4211 |
| 4L-3S | | MI | 1413 | 1005 | 2408 | 772 | 2838 | 629 | 3146 | 506 | 3618 | 302 | 4165 | 70 | 3937 |
| 10-#10 | 4.41 | MA | 1468 | 1005 | 2328 | 799 | 2700 | 658 | 2948 | 530 | 3276 | 318 | 3910 | 6 | 3894 |
| 5L-2S | | MI | 1523 | 1005 | 2661 | 767 | 3158 | 626 | 3534 | 505 | 4141 | 299 | 4790 | 162 | 3974 |
| 10-#11 | 5.42 | MA | 1625 | 1089 | 2728 | 838 | 3200 | 686 | 3550 | 546 | 4092 | 301 | 4829 | -14 | 4815 |
| 4L-3S | | MI | 1472 | 1089 | 2616 | 817 | 3082 | 660 | 3433 | 531 | 3942 | 281 | 4490 | -10 | 4480 |
| 12-#10 | 5.29 | MA | 1687 | 1078 | 2817 | 838 | 3338 | 686 | 3728 | 548 | 4341 | 308 | 5240 | 44 | 5054 |
| 4E | | MI | 1455 | 1078 | 2479 | 824 | 2908 | 673 | 3229 | 535 | 3726 | 295 | 4336 | 4 | 4320 |
| 12-#10 | 5.29 | MA | 1604 | 1078 | 2627 | 845 | 3079 | 691 | 3407 | 551 | 3896 | 314 | 4690 | -11 | 4680 |
| 5L-3S | | MI | 1513 | 1078 | 2661 | 818 | 3158 | 663 | 3534 | 527 | 4141 | 298 | 4790 | 46 | 4654 |

## RECTANGULAR TIED COLUMNS 16" x 20"

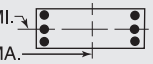
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.25 | MA | 1667 | 823 | 2396 | 693 | 2819 | 583 | 3048 | 495 | 3285 | 362 | 3879 | 305 | 1805 |
| 2E | | MI | 1306 | 823 | 1947 | 672 | 2236 | 564 | 2388 | 479 | 2536 | 349 | 2868 | 277 | 1408 |
| 4-#10 | 1.59 | MA | 1726 | 854 | 2547 | 710 | 3002 | 595 | 3267 | 502 | 3576 | 359 | 4243 | 297 | 2242 |
| 2E | | MI | 1346 | 854 | 2058 | 688 | 2369 | 576 | 2545 | 486 | 2742 | 345 | 3100 | 263 | 1734 |
| 4-#11 | 1.95 | MA | 1777 | 888 | 2710 | 725 | 3185 | 604 | 3477 | 507 | 3850 | 353 | 4532 | 280 | 2679 |
| 2E | | MI | 1377 | 888 | 2175 | 701 | 2496 | 584 | 2689 | 489 | 2899 | 333 | 3253 | 236 | 2054 |
| 4-#14 | 2.81 | MA | 1910 | 968 | 3070 | 770 | 3626 | 637 | 4003 | 526 | 4554 | 347 | 5359 | 251 | 3724 |
| 2E | | MI | 1462 | 968 | 2433 | 744 | 2808 | 615 | 3060 | 508 | 3354 | 318 | 3751 | 191 | 2812 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

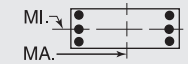
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 5.00 | MA | 2204 | 1171 | 3932 | 886 | 4687 | 721 | 5274 | 578 | 6247 | 330 | 7248 | 164 | 6218 |
| 2E | | MI | 1653 | 1171 | 3034 | 859 | 3543 | 697 | 3901 | 549 | 4379 | 269 | 4822 | 53 | 4576 |
| 6-#7 | 1.13 | MA | 1649 | 812 | 2331 | 691 | 2752 | 581 | 2975 | 495 | 3193 | 365 | 3786 | 312 | 1648 |
| 2L-3S | | MI | 1225 | 812 | 1775 | 673 | 2032 | 566 | 2148 | 481 | 2218 | 356 | 2504 | 244 | 1298 |
| 6-#7 | 1.13 | MA | 1552 | 812 | 2164 | 695 | 2540 | 585 | 2718 | 498 | 2846 | 370 | 3319 | 269 | 1655 |
| 3L-2S | | MI | 1295 | 812 | 1899 | 670 | 2189 | 564 | 2338 | 480 | 2474 | 353 | 2822 | 287 | 1290 |
| 6-#8 | 1.48 | MA | 1716 | 845 | 2493 | 709 | 2950 | 594 | 3212 | 503 | 3509 | 362 | 4194 | 305 | 2119 |
| 2L-3S | | MI | 1251 | 845 | 1858 | 692 | 2130 | 579 | 2263 | 489 | 2370 | 353 | 2681 | 218 | 1652 |
| 6-#8 | 1.48 | MA | 1592 | 845 | 2275 | 715 | 2673 | 599 | 2876 | 507 | 3056 | 368 | 3589 | 248 | 2124 |
| 3L-2S | | MI | 1341 | 845 | 2019 | 688 | 2335 | 576 | 2511 | 487 | 2705 | 350 | 3090 | 275 | 1643 |
| 6-#9 | 1.88 | MA | 1786 | 881 | 2670 | 730 | 3166 | 609 | 3470 | 512 | 3854 | 359 | 4631 | 297 | 2630 |
| 2L-3S | | MI | 1280 | 881 | 1947 | 713 | 2236 | 594 | 2388 | 497 | 2536 | 350 | 2868 | 187 | 2029 |
| 6-#9 | 1.88 | MA | 1635 | 881 | 2396 | 737 | 2819 | 615 | 3048 | 516 | 3285 | 366 | 3879 | 224 | 2627 |
| 3L-2S | | MI | 1389 | 881 | 2148 | 708 | 2492 | 591 | 2698 | 496 | 2954 | 346 | 3374 | 260 | 2023 |
| 6-#10 | 2.38 | MA | 1872 | 928 | 2892 | 757 | 3440 | 628 | 3797 | 524 | 4292 | 355 | 5180 | 285 | 3275 |
| 2L-3S | | MI | 1316 | 928 | 2058 | 740 | 2369 | 613 | 2545 | 508 | 2742 | 345 | 3100 | 147 | 2494 |
| 6-#10 | 2.38 | MA | 1690 | 928 | 2547 | 765 | 3002 | 635 | 3267 | 529 | 3576 | 364 | 4243 | 193 | 3254 |
| 3L-2S | | MI | 1447 | 928 | 2311 | 734 | 2690 | 609 | 2934 | 507 | 3265 | 341 | 3725 | 240 | 2498 |
| 6-#11 | 2.92 | MA | 1946 | 979 | 3122 | 781 | 3708 | 646 | 4111 | 533 | 4706 | 349 | 5623 | 261 | 3910 |
| 2L-3S | | MI | 1345 | 979 | 2175 | 762 | 2496 | 627 | 2689 | 523 | 2899 | 330 | 3253 | 89 | 2938 |
| 6-#11 | 2.92 | MA | 1735 | 979 | 2710 | 790 | 3185 | 652 | 3477 | 538 | 3850 | 357 | 4532 | 147 | 3866 |
| 3L-2S | | MI | 1491 | 979 | 2474 | 757 | 2876 | 625 | 3149 | 515 | 3505 | 326 | 3963 | 202 | 2955 |
| 6-#14 | 4.22 | MA | 2135 | 1099 | 3653 | 851 | 4366 | 696 | 4900 | 564 | 5765 | 340 | 6870 | 219 | 5452 |
| 2L-3S | | MI | 1427 | 1099 | 2433 | 832 | 2808 | 676 | 3060 | 554 | 3354 | 311 | 3751 | -28 | 3735 |
| 6-#14 | 4.22 | MA | 1870 | 1099 | 3070 | 863 | 3626 | 705 | 4003 | 569 | 4554 | 350 | 5359 | 56 | 5215 |
| 3L-2S | | MI | 1617 | 1099 | 2853 | 826 | 3341 | 675 | 3706 | 545 | 4190 | 304 | 4717 | 135 | 4063 |
| 6-#18 | 7.50 | MA | 2180 | 1403 | 3932 | 1049 | 4687 | 837 | 5274 | 647 | 6247 | 329 | 7248 | -200 | 6995 |
| 3L-2S | | MI | 1902 | 1403 | 3741 | 1004 | 4439 | 803 | 4968 | 613 | 5734 | 235 | 6337 | -68 | 6278 |
| 8-#7 | 1.50 | MA | 1724 | 846 | 2498 | 712 | 2964 | 597 | 3232 | 505 | 3540 | 364 | 4253 | 308 | 2152 |
| 2L-4S | | MI | 1238 | 846 | 1811 | 698 | 2068 | 587 | 2189 | 496 | 2272 | 353 | 2593 | 214 | 1679 |
| 8-#7 | 1.50 | MA | 1630 | 846 | 2331 | 717 | 2752 | 601 | 2975 | 508 | 3193 | 368 | 3786 | 265 | 2156 |
| 3E | | MI | 1279 | 846 | 1899 | 695 | 2189 | 582 | 2338 | 491 | 2474 | 354 | 2822 | 235 | 1675 |
| 8-#7 | 1.50 | MA | 1576 | 846 | 2214 | 721 | 2590 | 608 | 2777 | 514 | 2922 | 370 | 3456 | 240 | 2150 |
| 4L-2S | | MI | 1347 | 846 | 2022 | 692 | 2346 | 580 | 2528 | 490 | 2731 | 351 | 3140 | 279 | 1668 |
| 8-#8 | 1.98 | MA | 1810 | 890 | 2712 | 738 | 3227 | 615 | 3548 | 516 | 3962 | 360 | 4798 | 299 | 2774 |
| 2L-4S | | MI | 1270 | 890 | 1904 | 725 | 2176 | 607 | 2317 | 507 | 2440 | 349 | 2795 | 178 | 2126 |
| 8-#8 | 1.98 | MA | 1692 | 890 | 2493 | 743 | 2950 | 620 | 3212 | 520 | 3509 | 366 | 4194 | 242 | 2771 |
| 3E | | MI | 1321 | 890 | 2019 | 721 | 2335 | 600 | 2511 | 502 | 2705 | 351 | 3090 | 205 | 2135 |
| 8-#8 | 1.98 | MA | 1624 | 890 | 2341 | 749 | 2739 | 629 | 2953 | 528 | 3155 | 368 | 3766 | 210 | 2743 |
| 4L-2S | | MI | 1407 | 890 | 2180 | 717 | 2539 | 597 | 2758 | 501 | 3039 | 348 | 3499 | 262 | 2131 |
| 8-#9 | 2.50 | MA | 1901 | 939 | 2944 | 766 | 3514 | 636 | 3891 | 529 | 4423 | 356 | 5383 | 288 | 3448 |
| 2L-4S | | MI | 1304 | 939 | 2004 | 754 | 2293 | 628 | 2455 | 520 | 2622 | 344 | 3008 | 136 | 2516 |
| 8-#9 | 2.50 | MA | 1758 | 939 | 2670 | 773 | 3166 | 641 | 3470 | 533 | 3854 | 363 | 4631 | 216 | 3433 |
| 3E | | MI | 1366 | 939 | 2148 | 749 | 2492 | 620 | 2698 | 514 | 2954 | 347 | 3374 | 170 | 2626 |
| 8-#9 | 2.50 | MA | 1676 | 939 | 2478 | 780 | 2901 | 652 | 3145 | 543 | 3409 | 365 | 4098 | 176 | 3287 |
| 4L-2S | | MI | 1469 | 939 | 2350 | 744 | 2748 | 617 | 3008 | 513 | 3373 | 344 | 3879 | 243 | 2629 |
| 8-#10 | 3.17 | MA | 2014 | 1002 | 3237 | 803 | 3877 | 662 | 4327 | 545 | 5007 | 352 | 6117 | 273 | 4298 |
| 2L-4S | | MI | 1346 | 1002 | 2129 | 791 | 2440 | 656 | 2628 | 537 | 2850 | 338 | 3271 | 82 | 2987 |
| 8-#10 | 3.17 | MA | 1842 | 1002 | 2892 | 811 | 3440 | 669 | 3797 | 550 | 4292 | 360 | 5180 | 181 | 4262 |
| 3E | | MI | 1424 | 1002 | 2311 | 786 | 2690 | 646 | 2934 | 529 | 3265 | 341 | 3725 | 124 | 3234 |
| 8-#10 | 3.17 | MA | 1742 | 1002 | 2650 | 819 | 3105 | 682 | 3387 | 562 | 3732 | 362 | 4514 | 131 | 3931 |
| 4L-2S | | MI | 1544 | 1002 | 2563 | 780 | 3010 | 643 | 3322 | 528 | 3788 | 338 | 4350 | 216 | 3253 |
| 8-#11 | 3.90 | MA | 1920 | 1069 | 3122 | 847 | 3708 | 694 | 4111 | 564 | 4706 | 353 | 5623 | 128 | 5068 |
| 3E | | MI | 1467 | 1069 | 2474 | 819 | 2876 | 669 | 3149 | 549 | 3505 | 323 | 3963 | 54 | 3808 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

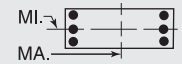
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 3.90 | MA | 1798 | 1069 | 2830 | 856 | 3305 | 709 | 3618 | 577 | 4033 | 353 | 4843 | 70 | 4542 |
| 4L-2S | | MI | 1603 | 1069 | 2773 | 814 | 3256 | 667 | 3609 | 541 | 4111 | 319 | 4674 | 168 | 3845 |
| 8-#14 | 5.63 | MA | 2115 | 1229 | 3653 | 945 | 4366 | 764 | 4900 | 607 | 5765 | 344 | 6870 | 24 | 6800 |
| 3E | | MI | 1594 | 1229 | 2853 | 913 | 3341 | 735 | 3706 | 592 | 4190 | 297 | 4717 | -84 | 4655 |
| 8-#14 | 5.63 | MA | 1971 | 1229 | 3239 | 957 | 3794 | 785 | 4201 | 624 | 4809 | 342 | 5784 | -57 | 5730 |
| 4L-2S | | MI | 1768 | 1229 | 3273 | 908 | 3875 | 734 | 4352 | 583 | 5026 | 291 | 5682 | 79 | 5301 |
| 10-#10 | 3.97 | MA | 1989 | 1075 | 3237 | 857 | 3877 | 702 | 4327 | 571 | 5007 | 357 | 6117 | 169 | 5271 |
| 3L-4S | | MI | 1460 | 1075 | 2382 | 837 | 2761 | 690 | 3017 | 558 | 3373 | 334 | 3896 | 59 | 3685 |
| 10-#10 | 3.97 | MA | 1898 | 1075 | 2994 | 866 | 3542 | 716 | 3917 | 583 | 4447 | 358 | 5451 | 119 | 4901 |
| 4L-3S | | MI | 1527 | 1075 | 2563 | 832 | 3010 | 680 | 3322 | 550 | 3788 | 337 | 4350 | 101 | 3972 |
| 10-#10 | 3.97 | MA | 1796 | 1075 | 2778 | 874 | 3246 | 723 | 3550 | 588 | 3939 | 367 | 4791 | 65 | 4586 |
| 5L-2S | | MI | 1640 | 1075 | 2816 | 826 | 3331 | 677 | 3711 | 550 | 4311 | 334 | 4975 | 193 | 4001 |
| 10-#11 | 4.88 | MA | 1992 | 1159 | 3243 | 913 | 3829 | 751 | 4252 | 603 | 4889 | 349 | 5933 | 51 | 5704 |
| 4L-3S | | MI | 1585 | 1159 | 2773 | 875 | 3256 | 710 | 3609 | 575 | 4111 | 316 | 4674 | 20 | 4619 |
| 10-#14 | 7.03 | MA | 2228 | 1359 | 3822 | 1039 | 4534 | 845 | 5098 | 662 | 6020 | 336 | 7294 | -89 | 7156 |
| 4L-3S | | MI | 1758 | 1359 | 3273 | 995 | 3875 | 795 | 4352 | 629 | 5026 | 284 | 5682 | -140 | 5556 |
| 12-#10 | 4.76 | MA | 2061 | 1149 | 3339 | 912 | 3980 | 750 | 4447 | 604 | 5163 | 355 | 6388 | 107 | 5878 |
| 4E | | MI | 1567 | 1149 | 2635 | 883 | 3081 | 724 | 3406 | 580 | 3896 | 330 | 4521 | 35 | 4390 |
| 12-#10 | 4.76 | MA | 1949 | 1149 | 3122 | 920 | 3683 | 756 | 4080 | 609 | 4655 | 363 | 5728 | 53 | 5552 |
| 5L-3S | | MI | 1627 | 1149 | 2816 | 878 | 3331 | 714 | 3711 | 572 | 4311 | 334 | 4975 | 77 | 4708 |
| 14-#10 | 5.56 | MA | 2107 | 1223 | 3467 | 966 | 4121 | 790 | 4611 | 630 | 5370 | 360 | 6665 | 41 | 6522 |
| 5L-4S | | MI | 1671 | 1223 | 2887 | 929 | 3402 | 757 | 3794 | 601 | 4419 | 326 | 5146 | 12 | 5100 |

## RECTANGULAR TIED COLUMNS 16" x 22"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.14 | MA | 2005 | 894 | 2817 | 764 | 3340 | 643 | 3619 | 548 | 3896 | 404 | 4651 | 348 | 2021 |
| 2E | | MI | 1419 | 894 | 2101 | 732 | 2409 | 615 | 2565 | 524 | 2706 | 385 | 3054 | 308 | 1425 |
| 4-#10 | 1.44 | MA | 2075 | 925 | 2990 | 781 | 3549 | 655 | 3868 | 555 | 4227 | 401 | 5081 | 342 | 2517 |
| 2E | | MI | 1460 | 925 | 2213 | 748 | 2542 | 627 | 2722 | 530 | 2912 | 381 | 3285 | 294 | 1752 |
| 4-#11 | 1.77 | MA | 2135 | 959 | 3177 | 795 | 3761 | 665 | 4112 | 560 | 4544 | 395 | 5439 | 327 | 3016 |
| 2E | | MI | 1491 | 959 | 2332 | 759 | 2670 | 634 | 2865 | 533 | 3068 | 368 | 3436 | 267 | 2076 |
| 4-#14 | 2.56 | MA | 2293 | 1039 | 3591 | 840 | 4267 | 697 | 4716 | 579 | 5352 | 388 | 6433 | 304 | 4210 |
| 2E | | MI | 1577 | 1039 | 2592 | 803 | 2982 | 665 | 3236 | 551 | 3522 | 352 | 3933 | 221 | 2841 |
| 4-#18 | 4.55 | MA | 2646 | 1242 | 4585 | 957 | 5492 | 781 | 6183 | 630 | 7318 | 373 | 8741 | 233 | 7082 |
| 2E | | MI | 1768 | 1242 | 3197 | 916 | 3718 | 746 | 4077 | 592 | 4545 | 303 | 5001 | 83 | 4616 |
| 6-#7 | 1.02 | MA | 1984 | 882 | 2742 | 761 | 3262 | 641 | 3535 | 548 | 3788 | 407 | 4534 | 354 | 1842 |
| 2L-3S | | MI | 1338 | 882 | 1928 | 734 | 2204 | 617 | 2325 | 526 | 2388 | 391 | 2691 | 275 | 1313 |
| 6-#7 | 1.02 | MA | 1872 | 882 | 2553 | 766 | 3023 | 646 | 3244 | 551 | 3396 | 412 | 3992 | 311 | 1850 |
| 3L-2S | | MI | 1409 | 882 | 2051 | 731 | 2361 | 615 | 2515 | 525 | 2645 | 389 | 3009 | 319 | 1304 |
| 6-#8 | 1.35 | MA | 2061 | 915 | 2927 | 780 | 3488 | 655 | 3803 | 556 | 4148 | 404 | 5012 | 349 | 2375 |
| 2L-3S | | MI | 1365 | 915 | 2011 | 752 | 2302 | 630 | 2440 | 533 | 2541 | 388 | 2867 | 249 | 1670 |
| 6-#8 | 1.35 | MA | 1919 | 915 | 2680 | 786 | 3174 | 660 | 3424 | 560 | 3635 | 411 | 4309 | 292 | 2380 |
| 3L-2S | | MI | 1454 | 915 | 2172 | 748 | 2507 | 628 | 2688 | 532 | 2875 | 386 | 3276 | 306 | 1660 |
| 6-#9 | 1.70 | MA | 2143 | 952 | 3127 | 800 | 3733 | 669 | 4097 | 565 | 4540 | 401 | 5528 | 342 | 2954 |
| 2L-3S | | MI | 1393 | 952 | 2101 | 773 | 2409 | 645 | 2565 | 542 | 2706 | 385 | 3054 | 218 | 2051 |
| 6-#9 | 1.70 | MA | 1970 | 952 | 2817 | 808 | 3340 | 676 | 3619 | 570 | 3896 | 409 | 4651 | 270 | 2951 |
| 3L-2S | | MI | 1503 | 952 | 2303 | 768 | 2664 | 642 | 2875 | 540 | 3124 | 382 | 3559 | 291 | 2042 |
| 6-#10 | 2.16 | MA | 2244 | 999 | 3380 | 827 | 4045 | 689 | 4469 | 576 | 5038 | 397 | 6176 | 333 | 3686 |
| 2L-3S | | MI | 1429 | 999 | 2213 | 799 | 2542 | 663 | 2722 | 552 | 2912 | 380 | 3285 | 178 | 2522 |
| 6-#10 | 2.16 | MA | 2033 | 999 | 2990 | 837 | 3549 | 697 | 3868 | 583 | 4227 | 408 | 5081 | 241 | 3665 |
| 3L-2S | | MI | 1562 | 999 | 2466 | 794 | 2863 | 660 | 3111 | 551 | 3435 | 377 | 3910 | 271 | 2519 |
| 6-#11 | 2.66 | MA | 2333 | 1049 | 3646 | 852 | 4356 | 706 | 4833 | 586 | 5518 | 391 | 6723 | 313 | 4415 |
| 2L-3S | | MI | 1458 | 1049 | 2332 | 821 | 2670 | 677 | 2865 | 567 | 3068 | 365 | 3436 | 119 | 2974 |
| 6-#11 | 2.66 | MA | 2088 | 1049 | 3177 | 863 | 3761 | 714 | 4112 | 592 | 4544 | 402 | 5439 | 200 | 4372 |
| 3L-2S | | MI | 1606 | 1049 | 2632 | 816 | 3049 | 675 | 3326 | 559 | 3674 | 361 | 4147 | 233 | 2982 |
| 6-#14 | 3.84 | MA | 2560 | 1169 | 4255 | 922 | 5110 | 756 | 5738 | 617 | 6732 | 382 | 8221 | 280 | 6181 |
| 2L-3S | | MI | 1538 | 1169 | 2592 | 890 | 2982 | 725 | 3236 | 597 | 3522 | 345 | 3933 | 2 | 3929 |

## RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

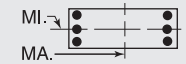
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 3.84 | MA | 2238 | 1169 | 3591 | 936 | 4267 | 768 | 4716 | 624 | 5352 | 396 | 6433 | 117 | 6042 |
| 3L-2S | | MI | 1732 | 1169 | 3012 | 884 | 3516 | 724 | 3883 | 589 | 4358 | 339 | 4899 | 165 | 4096 |
| 6-#18 | 6.82 | MA | 2616 | 1474 | 4585 | 1124 | 5492 | 902 | 6183 | 706 | 7318 | 380 | 8741 | -114 | 8548 |
| 3L-2S | | MI | 2018 | 1474 | 3903 | 1061 | 4615 | 852 | 5145 | 655 | 5901 | 269 | 6516 | -38 | 6486 |
| 8-#7 | 1.36 | MA | 2070 | 917 | 2931 | 783 | 3502 | 657 | 3825 | 558 | 4181 | 405 | 5076 | 352 | 2412 |
| 2L-4S | | MI | 1351 | 917 | 1963 | 759 | 2240 | 639 | 2366 | 541 | 2442 | 389 | 2780 | 245 | 1698 |
| 8-#7 | 1.36 | MA | 1962 | 917 | 2742 | 788 | 3262 | 662 | 3535 | 561 | 3788 | 411 | 4534 | 308 | 2415 |
| 3E | | MI | 1392 | 917 | 2051 | 756 | 2361 | 633 | 2515 | 536 | 2645 | 390 | 3009 | 266 | 1692 |
| 8-#7 | 1.36 | MA | 1900 | 917 | 2611 | 793 | 3081 | 669 | 3312 | 568 | 3484 | 413 | 4153 | 283 | 2410 |
| 4L-2S | | MI | 1461 | 917 | 2175 | 752 | 2518 | 631 | 2705 | 535 | 2902 | 387 | 3327 | 310 | 1684 |
| 8-#8 | 1.80 | MA | 2171 | 961 | 3174 | 808 | 3801 | 676 | 4183 | 569 | 4660 | 402 | 5716 | 345 | 3115 |
| 2L-4S | | MI | 1382 | 961 | 2057 | 785 | 2348 | 658 | 2494 | 552 | 2610 | 385 | 2981 | 209 | 2153 |
| 8-#8 | 1.80 | MA | 2035 | 961 | 2927 | 815 | 3488 | 681 | 3803 | 573 | 4148 | 409 | 5012 | 288 | 3113 |
| 3E | | MI | 1434 | 961 | 2172 | 781 | 2507 | 651 | 2688 | 547 | 2875 | 386 | 3276 | 236 | 2156 |
| 8-#8 | 1.80 | MA | 1957 | 961 | 2755 | 821 | 3250 | 691 | 3512 | 582 | 3750 | 411 | 4518 | 255 | 3085 |
| 4L-2S | | MI | 1521 | 961 | 2333 | 777 | 2711 | 649 | 2935 | 545 | 3209 | 383 | 3685 | 294 | 2149 |
| 8-#9 | 2.27 | MA | 2277 | 1010 | 3437 | 837 | 4127 | 696 | 4574 | 581 | 5184 | 398 | 6405 | 337 | 3880 |
| 2L-4S | | MI | 1416 | 1010 | 2159 | 814 | 2465 | 680 | 2631 | 565 | 2792 | 380 | 3193 | 168 | 2580 |
| 8-#9 | 2.27 | MA | 2112 | 1010 | 3127 | 844 | 3733 | 702 | 4097 | 587 | 4540 | 407 | 5528 | 264 | 3865 |
| 3E | | MI | 1479 | 1010 | 2303 | 809 | 2664 | 671 | 2875 | 558 | 3124 | 382 | 3559 | 201 | 2651 |
| 8-#9 | 2.27 | MA | 2018 | 1010 | 2911 | 852 | 3434 | 714 | 3730 | 597 | 4039 | 410 | 4910 | 223 | 3761 |
| 4L-2S | | MI | 1584 | 1010 | 2504 | 804 | 2920 | 668 | 3184 | 557 | 3543 | 379 | 4065 | 274 | 2650 |
| 8-#10 | 2.89 | MA | 2409 | 1072 | 3771 | 873 | 4541 | 722 | 5070 | 597 | 5850 | 394 | 7271 | 325 | 4847 |
| 2L-4S | | MI | 1458 | 1072 | 2285 | 851 | 2613 | 707 | 2805 | 581 | 3019 | 373 | 3456 | 113 | 3059 |
| 8-#10 | 2.89 | MA | 2210 | 1072 | 3380 | 883 | 4045 | 730 | 4469 | 604 | 5038 | 404 | 6176 | 233 | 4811 |
| 3E | | MI | 1538 | 1072 | 2466 | 845 | 2863 | 697 | 3111 | 574 | 3435 | 376 | 3910 | 155 | 3265 |
| 8-#10 | 2.89 | MA | 2096 | 1072 | 3108 | 892 | 3668 | 745 | 4007 | 617 | 4407 | 407 | 5403 | 181 | 4501 |
| 4L-2S | | MI | 1660 | 1072 | 2719 | 840 | 3183 | 694 | 3499 | 573 | 3958 | 373 | 4535 | 247 | 3277 |
| 8-#11 | 3.55 | MA | 2295 | 1140 | 3646 | 919 | 4356 | 756 | 4833 | 618 | 5518 | 397 | 6723 | 186 | 5742 |
| 3E | | MI | 1580 | 1140 | 2632 | 878 | 3049 | 719 | 3326 | 593 | 3674 | 358 | 4147 | 85 | 3848 |
| 8-#11 | 3.55 | MA | 2163 | 1140 | 3317 | 930 | 3901 | 773 | 4276 | 633 | 4757 | 400 | 5811 | 125 | 5211 |
| 4L-2S | | MI | 1718 | 1140 | 2931 | 873 | 3429 | 717 | 3786 | 585 | 4280 | 354 | 4857 | 198 | 3875 |
| 8-#14 | 5.11 | MA | 2535 | 1300 | 4255 | 1018 | 5110 | 827 | 5738 | 662 | 6732 | 390 | 8221 | 93 | 7919 |
| 3E | | MI | 1706 | 1300 | 3012 | 971 | 3516 | 785 | 3883 | 635 | 4358 | 332 | 4899 | -54 | 4861 |
| 8-#14 | 5.11 | MA | 2351 | 1300 | 3787 | 1032 | 4463 | 851 | 4946 | 682 | 5650 | 391 | 6947 | 7 | 6914 |
| 4L-2S | | MI | 1885 | 1300 | 3432 | 966 | 4049 | 784 | 4529 | 626 | 5194 | 325 | 5864 | 110 | 5337 |
| 10-#10 | 3.61 | MA | 2381 | 1146 | 3771 | 929 | 4541 | 764 | 5070 | 625 | 5850 | 401 | 7271 | 225 | 5957 |
| 3L-4S | | MI | 1572 | 1146 | 2537 | 897 | 2933 | 741 | 3194 | 603 | 3542 | 369 | 4081 | 90 | 3755 |
| 10-#10 | 3.61 | MA | 2277 | 1146 | 3498 | 938 | 4163 | 779 | 4608 | 638 | 5218 | 404 | 6498 | 173 | 5606 |
| 4L-3S | | MI | 1641 | 1146 | 2719 | 891 | 3183 | 731 | 3499 | 595 | 3958 | 373 | 4535 | 132 | 4005 |
| 10-#10 | 3.61 | MA | 2154 | 1146 | 3255 | 948 | 3831 | 787 | 4196 | 645 | 4646 | 414 | 5727 | 119 | 5277 |
| 5L-2S | | MI | 1756 | 1146 | 2971 | 886 | 3504 | 728 | 3888 | 594 | 4481 | 369 | 5160 | 224 | 4028 |
| 10-#11 | 4.43 | MA | 2376 | 1230 | 3786 | 986 | 4496 | 814 | 4997 | 659 | 5730 | 395 | 7095 | 111 | 6539 |
| 4L-3S | | MI | 1699 | 1230 | 2931 | 934 | 3429 | 760 | 3786 | 619 | 4280 | 351 | 4857 | 51 | 4716 |
| 10-#11 | 4.43 | MA | 2235 | 1230 | 3492 | 997 | 4094 | 823 | 4499 | 666 | 5040 | 406 | 6191 | 44 | 6041 |
| 5L-2S | | MI | 1829 | 1230 | 3230 | 929 | 3809 | 758 | 4247 | 611 | 4886 | 346 | 5567 | 164 | 4761 |
| 10-#14 | 6.39 | MA | 2667 | 1430 | 4452 | 1114 | 5307 | 910 | 5968 | 720 | 7030 | 385 | 8735 | -17 | 8701 |
| 4L-3S | | MI | 1870 | 1430 | 3432 | 1053 | 4049 | 844 | 4529 | 673 | 5194 | 318 | 5864 | -109 | 5769 |
| 12-#10 | 4.33 | MA | 2452 | 1220 | 3889 | 984 | 4659 | 813 | 5209 | 660 | 6029 | 400 | 7593 | 165 | 6717 |
| 4E | | MI | 1679 | 1220 | 2790 | 943 | 3254 | 775 | 3582 | 624 | 4065 | 365 | 4706 | 66 | 4458 |
| 12-#10 | 4.33 | MA | 2330 | 1220 | 3646 | 994 | 4326 | 820 | 4797 | 666 | 5457 | 410 | 6822 | 111 | 6406 |
| 5L-3S | | MI | 1742 | 1220 | 2971 | 937 | 3504 | 764 | 3888 | 616 | 4481 | 369 | 5160 | 108 | 4743 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

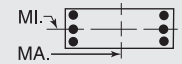
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 4.33 | MA | 2191 | 1220 | 3373 | 1009 | 4011 | 828 | 4392 | 679 | 4909 | 420 | 6115 | 51 | 5888 |
| 6L-2S | | MI | 1851 | 1220 | 3224 | 932 | 3825 | 761 | 4276 | 615 | 5004 | 365 | 5785 | 201 | 4775 |
| 12-#11 | 5.32 | MA | 2443 | 1321 | 3961 | 1054 | 4689 | 864 | 5220 | 692 | 6014 | 402 | 7475 | 30 | 7365 |
| 5L-3S | | MI | 1815 | 1321 | 3230 | 991 | 3809 | 801 | 4247 | 645 | 4886 | 343 | 5567 | 16 | 5520 |
| 14-#10 | 5.05 | MA | 2502 | 1293 | 4037 | 1040 | 4822 | 854 | 5398 | 687 | 6269 | 407 | 7918 | 103 | 7515 |
| 5L-4S | | MI | 1783 | 1293 | 3043 | 989 | 3575 | 808 | 3971 | 645 | 4588 | 362 | 5331 | 43 | 5166 |
| 14-#10 | 5.05 | MA | 2370 | 1293 | 3764 | 1055 | 4507 | 862 | 4993 | 701 | 5721 | 417 | 7210 | 43 | 7013 |
| 6L-3S | | MI | 1841 | 1293 | 3224 | 983 | 3825 | 798 | 4276 | 637 | 5004 | 365 | 5785 | 85 | 5480 |
| 16-#10 | 5.77 | MA | 2545 | 1367 | 4155 | 1101 | 5003 | 896 | 5594 | 722 | 6532 | 413 | 8305 | 35 | 8141 |
| 6L-4S | | MI | 1885 | 1367 | 3295 | 1035 | 3895 | 842 | 4360 | 666 | 5111 | 358 | 5956 | 20 | 5879 |

## RECTANGULAR TIED COLUMNS 16" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.04 | MA | 2372 | 965 | 3266 | 835 | 3899 | 703 | 4233 | 600 | 4550 | 446 | 5462 | 388 | 2237 |
| 2E | | MI | 1533 | 965 | 2256 | 792 | 2581 | 666 | 2741 | 568 | 2876 | 420 | 3239 | 339 | 1440 |
| 4-#10 | 1.32 | MA | 2453 | 996 | 3460 | 852 | 4134 | 715 | 4512 | 608 | 4922 | 443 | 5972 | 385 | 2791 |
| 2E | | MI | 1574 | 996 | 2369 | 808 | 2715 | 678 | 2899 | 575 | 3081 | 416 | 3470 | 325 | 1770 |
| 4-#11 | 1.63 | MA | 2524 | 1030 | 3673 | 866 | 4375 | 725 | 4789 | 612 | 5283 | 437 | 6399 | 372 | 3353 |
| 2E | | MI | 1605 | 1030 | 2490 | 818 | 2843 | 684 | 3042 | 577 | 3237 | 403 | 3620 | 297 | 2099 |
| 4-#14 | 2.34 | MA | 2706 | 1110 | 4139 | 911 | 4946 | 757 | 5471 | 632 | 6194 | 430 | 7563 | 354 | 4696 |
| 2E | | MI | 1692 | 1110 | 2751 | 861 | 3157 | 714 | 3413 | 594 | 3690 | 386 | 4115 | 251 | 2868 |
| 4-#18 | 4.17 | MA | 3121 | 1312 | 5267 | 1028 | 6335 | 841 | 7134 | 683 | 8423 | 415 | 10296 | 297 | 7946 |
| 2E | | MI | 1883 | 1312 | 3359 | 973 | 3894 | 794 | 4253 | 634 | 4712 | 337 | 5181 | 112 | 4656 |
| 6-#8 | 1.23 | MA | 2436 | 986 | 3388 | 851 | 4064 | 715 | 4437 | 608 | 4830 | 446 | 5853 | 388 | 2631 |
| 2L-3S | | MI | 1478 | 986 | 2165 | 812 | 2475 | 682 | 2617 | 578 | 2711 | 424 | 3053 | 280 | 1687 |
| 6-#8 | 1.23 | MA | 2275 | 986 | 3113 | 857 | 3714 | 721 | 4014 | 613 | 4258 | 454 | 5061 | 332 | 2636 |
| 3L-2S | | MI | 1568 | 986 | 2326 | 809 | 2679 | 679 | 2864 | 577 | 3045 | 421 | 3463 | 337 | 1676 |
| 6-#9 | 1.56 | MA | 2530 | 1023 | 3613 | 871 | 4339 | 730 | 4766 | 617 | 5270 | 443 | 6458 | 384 | 3278 |
| 2L-3S | | MI | 1506 | 1023 | 2256 | 833 | 2581 | 696 | 2741 | 586 | 2876 | 421 | 3239 | 250 | 2072 |
| 6-#9 | 1.56 | MA | 2333 | 1023 | 3266 | 879 | 3899 | 737 | 4233 | 623 | 4550 | 452 | 5462 | 312 | 3275 |
| 3L-2S | | MI | 1617 | 1023 | 2457 | 828 | 2837 | 693 | 3051 | 585 | 3294 | 417 | 3745 | 322 | 2060 |
| 6-#10 | 1.98 | MA | 2647 | 1070 | 3897 | 898 | 4688 | 749 | 5184 | 629 | 5829 | 439 | 7226 | 380 | 4098 |
| 2L-3S | | MI | 1541 | 1070 | 2369 | 859 | 2715 | 714 | 2899 | 597 | 3081 | 416 | 3470 | 209 | 2548 |
| 6-#10 | 1.98 | MA | 2407 | 1070 | 3460 | 908 | 4134 | 758 | 4512 | 636 | 4922 | 451 | 5972 | 287 | 4076 |
| 3L-2S | | MI | 1677 | 1070 | 2621 | 854 | 3035 | 711 | 3287 | 596 | 3604 | 412 | 4095 | 302 | 2540 |
| 6-#11 | 2.44 | MA | 2750 | 1120 | 4198 | 923 | 5041 | 766 | 5597 | 638 | 6374 | 433 | 7878 | 363 | 4921 |
| 2L-3S | | MI | 1571 | 1120 | 2490 | 880 | 2843 | 727 | 3042 | 610 | 3237 | 400 | 3620 | 150 | 3007 |
| 6-#11 | 2.44 | MA | 2471 | 1120 | 3673 | 934 | 4375 | 776 | 4789 | 646 | 5283 | 445 | 6399 | 249 | 4877 |
| 3L-2S | | MI | 1721 | 1120 | 2789 | 875 | 3223 | 725 | 3503 | 603 | 3843 | 396 | 4330 | 263 | 3007 |
| 6-#14 | 3.52 | MA | 3015 | 1240 | 4886 | 993 | 5893 | 817 | 6619 | 669 | 7744 | 424 | 9630 | 337 | 6910 |
| 2L-3S | | MI | 1651 | 1240 | 2751 | 948 | 3157 | 775 | 3413 | 640 | 3690 | 379 | 4115 | 32 | 4044 |
| 6-#14 | 3.52 | MA | 2644 | 1240 | 4139 | 1009 | 4946 | 830 | 5471 | 679 | 6194 | 441 | 7563 | 173 | 6771 |
| 3L-2S | | MI | 1848 | 1240 | 3171 | 942 | 3690 | 774 | 4059 | 632 | 4526 | 373 | 5081 | 195 | 4128 |
| 6-#18 | 6.25 | MA | 3084 | 1544 | 5267 | 1198 | 6335 | 967 | 7134 | 763 | 8423 | 428 | 10296 | -37 | 10215 |
| 3L-2S | | MI | 2133 | 1544 | 4065 | 1118 | 4790 | 900 | 5321 | 697 | 6068 | 303 | 6695 | -9 | 6689 |
| 8-#7 | 1.25 | MA | 2446 | 988 | 3392 | 854 | 4079 | 718 | 4460 | 610 | 4865 | 447 | 5905 | 389 | 2671 |
| 2L-4S | | MI | 1464 | 988 | 2116 | 819 | 2411 | 690 | 2543 | 586 | 2613 | 425 | 2967 | 277 | 1716 |
| 8-#7 | 1.25 | MA | 2323 | 988 | 3182 | 859 | 3811 | 722 | 4136 | 614 | 4428 | 453 | 5299 | 347 | 2674 |
| 3E | | MI | 1506 | 988 | 2204 | 816 | 2533 | 685 | 2692 | 581 | 2815 | 426 | 3196 | 298 | 1708 |
| 8-#7 | 1.25 | MA | 2254 | 988 | 3036 | 864 | 3610 | 730 | 3889 | 622 | 4090 | 456 | 4879 | 321 | 2669 |
| 4L-2S | | MI | 1575 | 988 | 2328 | 813 | 2690 | 683 | 2882 | 580 | 3072 | 423 | 3514 | 341 | 1700 |
| 8-#8 | 1.65 | MA | 2561 | 1032 | 3664 | 879 | 4413 | 736 | 4861 | 621 | 5402 | 444 | 6645 | 385 | 3457 |
| 2L-4S | | MI | 1495 | 1032 | 2211 | 845 | 2520 | 710 | 2670 | 597 | 2780 | 420 | 3167 | 240 | 2178 |
| 8-#8 | 1.65 | MA | 2406 | 1032 | 3388 | 886 | 4064 | 742 | 4437 | 627 | 4830 | 452 | 5853 | 329 | 3454 |
| 3E | | MI | 1548 | 1032 | 2326 | 841 | 2679 | 703 | 2864 | 591 | 3045 | 422 | 3463 | 268 | 2176 |
| 8-#8 | 1.65 | MA | 2319 | 1032 | 3198 | 893 | 3800 | 752 | 4114 | 636 | 4388 | 455 | 5301 | 295 | 3426 |
| 4L-2S | | MI | 1635 | 1032 | 2487 | 837 | 2883 | 700 | 3112 | 590 | 3379 | 419 | 3872 | 325 | 2167 |

## RECTANGULAR TIED COLUMNS 16" x 24"

Short columns – no sidesway
Bending on major or minor axis

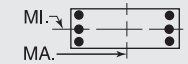



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 2.08 | MA | 2684 | 1081 | 3959 | 907 | 4779 | 756 | 5299 | 634 | 5989 | 440 | 7454 | 381 | 4312 |
| 2L-4S | | MI | 1528 | 1081 | 2313 | 873 | 2638 | 731 | 2808 | 610 | 2962 | 415 | 3379 | 199 | 2643 |
| 8-#9 | 2.08 | MA | 2496 | 1081 | 3613 | 916 | 4339 | 764 | 4766 | 640 | 5270 | 450 | 6458 | 309 | 4297 |
| 3E | | MI | 1592 | 1081 | 2457 | 869 | 2837 | 722 | 3051 | 603 | 3294 | 418 | 3745 | 232 | 2675 |
| 8-#9 | 2.08 | MA | 2390 | 1081 | 3373 | 924 | 4007 | 776 | 4359 | 652 | 4713 | 454 | 5761 | 266 | 4230 |
| 4L-2S | | MI | 1699 | 1081 | 2659 | 864 | 3092 | 719 | 3361 | 602 | 3713 | 415 | 4251 | 305 | 2670 |
| 8-#10 | 2.65 | MA | 2835 | 1143 | 4334 | 944 | 5243 | 783 | 5856 | 650 | 6736 | 436 | 8481 | 375 | 5396 |
| 2L-4S | | MI | 1570 | 1143 | 2440 | 910 | 2786 | 758 | 2982 | 626 | 3189 | 408 | 3641 | 144 | 3128 |
| 8-#10 | 2.65 | MA | 2607 | 1143 | 3897 | 954 | 4688 | 792 | 5184 | 658 | 5829 | 447 | 7226 | 282 | 5360 |
| 3E | | MI | 1651 | 1143 | 2621 | 905 | 3035 | 748 | 3287 | 618 | 3604 | 412 | 4095 | 186 | 3294 |
| 8-#10 | 2.65 | MA | 2479 | 1143 | 3594 | 965 | 4269 | 808 | 4670 | 672 | 5126 | 452 | 6345 | 228 | 5084 |
| 4L-2S | | MI | 1776 | 1143 | 2874 | 900 | 3356 | 745 | 3676 | 617 | 4127 | 408 | 4720 | 278 | 3300 |
| 8-#11 | 3.25 | MA | 2707 | 1210 | 4198 | 991 | 5041 | 817 | 5597 | 672 | 6374 | 441 | 7878 | 240 | 6416 |
| 3E | | MI | 1693 | 1210 | 2789 | 936 | 3223 | 769 | 3503 | 636 | 3843 | 393 | 4330 | 115 | 3884 |
| 8-#11 | 3.25 | MA | 2559 | 1210 | 3832 | 1003 | 4534 | 836 | 4976 | 689 | 5525 | 445 | 6835 | 176 | 5895 |
| 4L-2S | | MI | 1834 | 1210 | 3089 | 931 | 3603 | 767 | 3963 | 629 | 4449 | 388 | 5040 | 229 | 3904 |
| 8-#14 | 4.69 | MA | 2971 | 1370 | 4886 | 1090 | 5893 | 890 | 6619 | 717 | 7744 | 435 | 9630 | 156 | 8950 |
| 3E | | MI | 1819 | 1370 | 3171 | 1030 | 3690 | 834 | 4059 | 678 | 4526 | 366 | 5081 | -24 | 5065 |
| 8-#14 | 4.69 | MA | 2775 | 1370 | 4363 | 1106 | 5170 | 915 | 5734 | 740 | 6535 | 439 | 8167 | 66 | 7832 |
| 4L-2S | | MI | 2001 | 1370 | 3591 | 1024 | 4223 | 833 | 4706 | 669 | 5362 | 360 | 6046 | 140 | 5372 |
| 10-#10 | 3.31 | MA | 2802 | 1217 | 4334 | 1000 | 5243 | 825 | 5856 | 679 | 6736 | 444 | 8481 | 277 | 6642 |
| 3L-4S | | MI | 1685 | 1217 | 2692 | 956 | 3106 | 792 | 3371 | 647 | 3712 | 404 | 4266 | 121 | 3822 |
| 10-#10 | 3.31 | MA | 2685 | 1217 | 4031 | 1011 | 4823 | 841 | 5342 | 693 | 6033 | 448 | 7599 | 223 | 6324 |
| 4L-3S | | MI | 1755 | 1217 | 2874 | 951 | 3356 | 782 | 3676 | 639 | 4127 | 408 | 4720 | 163 | 4036 |
| 10-#10 | 3.31 | MA | 2540 | 1217 | 3761 | 1021 | 4454 | 850 | 4884 | 701 | 5398 | 460 | 6717 | 170 | 5926 |
| 5L-2S | | MI | 1873 | 1217 | 3126 | 946 | 3677 | 778 | 4065 | 638 | 4650 | 404 | 5345 | 255 | 4053 |
| 10-#11 | 4.06 | MA | 2801 | 1301 | 4357 | 1059 | 5201 | 877 | 5784 | 715 | 6616 | 441 | 8313 | 166 | 7389 |
| 4L-3S | | MI | 1812 | 1301 | 3089 | 993 | 3603 | 810 | 3963 | 662 | 4449 | 385 | 5040 | 81 | 4758 |
| 10-#11 | 4.06 | MA | 2634 | 1301 | 4031 | 1071 | 4754 | 887 | 5230 | 723 | 5848 | 454 | 7273 | 100 | 6892 |
| 5L-2S | | MI | 1945 | 1301 | 3388 | 988 | 3983 | 808 | 4423 | 655 | 5055 | 381 | 5751 | 194 | 4792 |
| 10-#14 | 5.86 | MA | 3113 | 1501 | 5110 | 1188 | 6118 | 975 | 6882 | 777 | 8085 | 433 | 10234 | 49 | 9974 |
| 4L-3S | | MI | 1982 | 1501 | 3591 | 1111 | 4223 | 894 | 4706 | 716 | 5362 | 353 | 6046 | -79 | 5980 |
| 10-#14 | 5.86 | MA | 2883 | 1501 | 4643 | 1204 | 5480 | 988 | 6092 | 788 | 6989 | 449 | 8779 | -47 | 8715 |
| 5L-2S | | MI | 2152 | 1501 | 4012 | 1105 | 4756 | 893 | 5352 | 707 | 6198 | 347 | 7012 | 84 | 6608 |
| 12-#10 | 3.97 | MA | 2884 | 1290 | 4467 | 1057 | 5377 | 875 | 6014 | 715 | 6940 | 445 | 8854 | 218 | 7570 |
| 4E | | MI | 1791 | 1290 | 2945 | 1002 | 3427 | 825 | 3759 | 668 | 4235 | 401 | 4891 | 97 | 4524 |
| 12-#10 | 3.97 | MA | 2741 | 1290 | 4198 | 1067 | 5008 | 884 | 5556 | 722 | 6304 | 457 | 7971 | 165 | 7192 |
| 5L-3S | | MI | 1856 | 1290 | 3126 | 997 | 3677 | 815 | 4065 | 660 | 4650 | 404 | 5345 | 139 | 4776 |
| 12-#10 | 3.97 | MA | 2584 | 1290 | 3888 | 1082 | 4659 | 893 | 5107 | 737 | 5683 | 461 | 7108 | 93 | 6657 |
| 6L-2S | | MI | 1968 | 1290 | 3379 | 992 | 3997 | 812 | 4453 | 660 | 5173 | 401 | 5970 | 231 | 4802 |
| 12-#11 | 4.88 | MA | 2871 | 1391 | 4556 | 1128 | 5421 | 929 | 6038 | 749 | 6939 | 449 | 8751 | 91 | 8387 |
| 5L-3S | | MI | 1929 | 1391 | 3388 | 1049 | 3983 | 851 | 4423 | 689 | 5055 | 378 | 5751 | 47 | 5612 |
| 12-#11 | 4.88 | MA | 2687 | 1391 | 4189 | 1147 | 4998 | 939 | 5495 | 766 | 6203 | 462 | 7796 | 17 | 7716 |
| 6L-2S | | MI | 2055 | 1391 | 3687 | 1044 | 4363 | 849 | 4884 | 681 | 5660 | 374 | 6461 | 160 | 5675 |
| 12-#14 | 7.03 | MA | 3233 | 1631 | 5390 | 1286 | 6427 | 1048 | 7240 | 825 | 8539 | 443 | 10846 | -64 | 10717 |
| 5L-3S | | MI | 2143 | 1631 | 4012 | 1193 | 4756 | 954 | 5352 | 753 | 6198 | 340 | 7012 | -135 | 6880 |
| 14-#10 | 4.63 | MA | 2937 | 1364 | 4635 | 1113 | 5562 | 917 | 6227 | 743 | 7211 | 453 | 9226 | 160 | 8461 |
| 5L-4S | | MI | 1896 | 1364 | 3198 | 1048 | 3747 | 859 | 4148 | 689 | 4758 | 397 | 5516 | 74 | 5230 |
| 14-#10 | 4.63 | MA | 2787 | 1364 | 4325 | 1128 | 5213 | 926 | 5778 | 758 | 6590 | 458 | 8363 | 88 | 7920 |
| 6L-3S | | MI | 1955 | 1364 | 3379 | 1043 | 3997 | 849 | 4453 | 682 | 5173 | 400 | 5970 | 116 | 5514 |
| 14-#11 | 5.69 | MA | 2928 | 1482 | 4714 | 1203 | 5665 | 980 | 6303 | 792 | 7294 | 458 | 9275 | 8 | 9237 |
| 6L-3S | | MI | 2044 | 1482 | 3687 | 1106 | 4363 | 893 | 4884 | 715 | 5660 | 371 | 6461 | 12 | 6422 |
| 16-#10 | 5.29 | MA | 2985 | 1438 | 4761 | 1174 | 5767 | 960 | 6450 | 779 | 7496 | 454 | 9617 | 83 | 9186 |
| 6L-4S | | MI | 1998 | 1438 | 3450 | 1095 | 4068 | 893 | 4536 | 711 | 5281 | 393 | 6141 | 51 | 5942 |

## RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

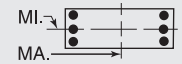
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.22 | MA | 2860 | 1067 | 3959 | 923 | 4758 | 776 | 5199 | 660 | 5662 | 485 | 6863 | 422 | 3065 |
| 2E | | MI | 1687 | 1067 | 2524 | 867 | 2888 | 728 | 3076 | 619 | 3251 | 451 | 3655 | 356 | 1788 |
| 4-#11 | 1.50 | MA | 2942 | 1100 | 4197 | 937 | 5027 | 785 | 5509 | 665 | 6066 | 479 | 7412 | 416 | 3690 |
| 2E | | MI | 1719 | 1100 | 2648 | 877 | 3017 | 734 | 3219 | 620 | 3406 | 438 | 3803 | 328 | 2120 |
| 4-#14 | 2.16 | MA | 3150 | 1180 | 4717 | 982 | 5663 | 818 | 6268 | 684 | 7081 | 472 | 8747 | 402 | 5182 |
| 2E | | MI | 1806 | 1180 | 2910 | 919 | 3331 | 764 | 3590 | 637 | 3858 | 421 | 4297 | 281 | 2895 |
| 4-#18 | 3.85 | MA | 3629 | 1383 | 5977 | 1099 | 7216 | 902 | 8128 | 735 | 9572 | 457 | 11909 | 355 | 8810 |
| 2E | | MI | 1998 | 1383 | 3521 | 1029 | 4069 | 843 | 4430 | 676 | 4879 | 370 | 5360 | 142 | 4696 |
| 6-#8 | 1.14 | MA | 2840 | 1057 | 3878 | 921 | 4678 | 775 | 5114 | 661 | 5557 | 488 | 6725 | 425 | 2887 |
| 2L-3S | | MI | 1591 | 1057 | 2318 | 873 | 2647 | 733 | 2793 | 623 | 2881 | 460 | 3240 | 311 | 1703 |
| 6-#8 | 1.14 | MA | 2659 | 1057 | 3574 | 928 | 4292 | 782 | 4646 | 666 | 4925 | 496 | 5851 | 370 | 2892 |
| 3L-2S | | MI | 1682 | 1057 | 2479 | 869 | 2851 | 731 | 3041 | 622 | 3215 | 457 | 3649 | 369 | 1692 |
| 6-#9 | 1.44 | MA | 2947 | 1093 | 4127 | 942 | 4983 | 790 | 5478 | 670 | 6043 | 485 | 7395 | 421 | 3602 |
| 2L-3S | | MI | 1619 | 1093 | 2410 | 893 | 2753 | 747 | 2918 | 631 | 3046 | 456 | 3425 | 281 | 2091 |
| 6-#9 | 1.44 | MA | 2725 | 1093 | 3744 | 951 | 4497 | 798 | 4889 | 677 | 5249 | 495 | 6295 | 351 | 3599 |
| 3L-2S | | MI | 1731 | 1093 | 2611 | 888 | 3009 | 744 | 3228 | 630 | 3464 | 453 | 3931 | 353 | 2078 |
| 6-#10 | 1.83 | MA | 3078 | 1140 | 4442 | 969 | 5370 | 809 | 5942 | 681 | 6664 | 481 | 8251 | 417 | 4509 |
| 2L-3S | | MI | 1654 | 1140 | 2524 | 919 | 2888 | 765 | 3076 | 641 | 3251 | 451 | 3655 | 240 | 2572 |
| 6-#10 | 1.83 | MA | 2809 | 1140 | 3959 | 980 | 4758 | 819 | 5199 | 690 | 5662 | 494 | 6863 | 327 | 4488 |
| 3L-2S | | MI | 1791 | 1140 | 2776 | 913 | 3208 | 762 | 3464 | 640 | 3774 | 447 | 4280 | 332 | 2561 |
| 6-#11 | 2.25 | MA | 3197 | 1191 | 4779 | 993 | 5765 | 827 | 6404 | 691 | 7274 | 475 | 9085 | 410 | 5426 |
| 2L-3S | | MI | 1683 | 1191 | 2648 | 939 | 3017 | 778 | 3219 | 654 | 3406 | 435 | 3803 | 180 | 3038 |
| 6-#11 | 2.25 | MA | 2883 | 1191 | 4197 | 1006 | 5027 | 838 | 5509 | 700 | 6066 | 489 | 7412 | 297 | 5383 |
| 3L-2S | | MI | 1836 | 1191 | 2947 | 934 | 3397 | 776 | 3679 | 646 | 4012 | 430 | 4513 | 294 | 3032 |
| 6-#14 | 3.25 | MA | 3499 | 1311 | 5544 | 1063 | 6714 | 877 | 7542 | 722 | 8800 | 466 | 11096 | 390 | 7639 |
| 2L-3S | | MI | 1763 | 1311 | 2910 | 1006 | 3331 | 824 | 3590 | 684 | 3858 | 414 | 4297 | 62 | 4124 |
| 6-#14 | 3.25 | MA | 3080 | 1311 | 4717 | 1081 | 5663 | 892 | 6268 | 734 | 7081 | 485 | 8747 | 227 | 7500 |
| 3L-2S | | MI | 1963 | 1311 | 3330 | 1000 | 3864 | 823 | 4236 | 675 | 4694 | 408 | 5263 | 226 | 4159 |
| 6-#18 | 5.77 | MA | 3583 | 1615 | 5977 | 1272 | 7216 | 1031 | 8128 | 820 | 9572 | 474 | 11909 | 32 | 11811 |
| 3L-2S | | MI | 2249 | 1615 | 4227 | 1174 | 4965 | 949 | 5498 | 740 | 6235 | 336 | 6874 | 21 | 6779 |
| 8-#7 | 1.15 | MA | 2850 | 1059 | 3882 | 925 | 4693 | 778 | 5138 | 663 | 5594 | 489 | 6781 | 426 | 2930 |
| 2L-4S | | MI | 1577 | 1059 | 2269 | 880 | 2583 | 742 | 2720 | 631 | 2783 | 461 | 3154 | 308 | 1732 |
| 8-#7 | 1.15 | MA | 2713 | 1059 | 3650 | 930 | 4398 | 783 | 4781 | 667 | 5112 | 496 | 6113 | 384 | 2934 |
| 3E | | MI | 1619 | 1059 | 2357 | 877 | 2705 | 737 | 2868 | 626 | 2986 | 461 | 3383 | 329 | 1723 |
| 8-#7 | 1.15 | MA | 2636 | 1059 | 3490 | 936 | 4177 | 791 | 4509 | 675 | 4740 | 499 | 5654 | 360 | 2928 |
| 4L-2S | | MI | 1689 | 1059 | 2481 | 873 | 2862 | 734 | 3058 | 625 | 3242 | 459 | 3701 | 373 | 1715 |
| 8-#8 | 1.52 | MA | 2981 | 1103 | 4182 | 950 | 5064 | 796 | 5582 | 674 | 6188 | 486 | 7599 | 422 | 3798 |
| 2L-4S | | MI | 1608 | 1103 | 2365 | 905 | 2693 | 761 | 2847 | 642 | 2951 | 456 | 3353 | 271 | 2200 |
| 8-#8 | 1.52 | MA | 2807 | 1103 | 3878 | 957 | 4678 | 803 | 5114 | 680 | 5557 | 494 | 6725 | 367 | 3795 |
| 3E | | MI | 1661 | 1103 | 2479 | 901 | 2851 | 754 | 3041 | 636 | 3215 | 458 | 3649 | 299 | 2194 |
| 8-#8 | 1.52 | MA | 2710 | 1103 | 3669 | 964 | 4387 | 813 | 4758 | 690 | 5070 | 498 | 6123 | 334 | 3767 |
| 4L-2S | | MI | 1749 | 1103 | 2640 | 897 | 3055 | 751 | 3289 | 635 | 3550 | 455 | 4058 | 356 | 2185 |
| 8-#9 | 1.92 | MA | 3119 | 1151 | 4510 | 978 | 5468 | 817 | 6067 | 686 | 6838 | 482 | 8496 | 417 | 4744 |
| 2L-4S | | MI | 1641 | 1151 | 2467 | 933 | 2810 | 782 | 2985 | 654 | 3132 | 451 | 3565 | 230 | 2690 |
| 8-#9 | 1.92 | MA | 2908 | 1151 | 4127 | 987 | 4983 | 824 | 5478 | 693 | 6043 | 492 | 7395 | 347 | 4729 |
| 3E | | MI | 1706 | 1151 | 2611 | 929 | 3009 | 773 | 3228 | 647 | 3464 | 453 | 3931 | 264 | 2698 |
| 8-#9 | 1.92 | MA | 2790 | 1151 | 3863 | 996 | 4617 | 838 | 5030 | 706 | 5430 | 497 | 6635 | 306 | 4662 |
| 4L-2S | | MI | 1813 | 1151 | 2813 | 924 | 3265 | 771 | 3538 | 646 | 3882 | 450 | 4436 | 336 | 2690 |
| 8-#10 | 2.44 | MA | 3290 | 1214 | 4925 | 1015 | 5983 | 843 | 6684 | 703 | 7666 | 478 | 9638 | 412 | 5944 |
| 2L-4S | | MI | 1683 | 1214 | 2595 | 970 | 2958 | 809 | 3159 | 670 | 3359 | 444 | 3826 | 175 | 3195 |
| 8-#10 | 2.44 | MA | 3035 | 1214 | 4442 | 1026 | 5370 | 853 | 5942 | 711 | 6664 | 490 | 8251 | 322 | 5908 |
| 3E | | MI | 1761 | 1214 | 2776 | 965 | 3208 | 799 | 3464 | 662 | 3774 | 447 | 4280 | 217 | 3322 |
| 8-#10 | 2.44 | MA | 2891 | 1214 | 4109 | 1037 | 4908 | 870 | 5376 | 727 | 5890 | 496 | 7287 | 269 | 5679 |
| 4L-2S | | MI | 1891 | 1214 | 3029 | 959 | 3529 | 796 | 3853 | 661 | 4297 | 444 | 4905 | 309 | 3323 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

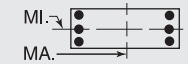
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 3.00 | MA | 3149 | 1281 | 4779 | 1063 | 5765 | 879 | 6404 | 726 | 7274 | 485 | 9085 | 291 | 7090 |
| 3E | | MI | 1806 | 1281 | 2947 | 995 | 3397 | 819 | 3679 | 680 | 4012 | 427 | 4513 | 146 | 3919 |
| 8-#11 | 3.00 | MA | 2983 | 1281 | 4375 | 1075 | 5206 | 899 | 5719 | 744 | 6338 | 490 | 7910 | 224 | 6593 |
| 4L-2S | | MI | 1949 | 1281 | 3246 | 990 | 3777 | 817 | 4140 | 672 | 4617 | 423 | 5223 | 259 | 3932 |
| 8-#14 | 4.33 | MA | 3448 | 1441 | 5544 | 1162 | 6714 | 952 | 7542 | 772 | 8800 | 479 | 11096 | 215 | 9922 |
| 3E | | MI | 1931 | 1441 | 3330 | 1088 | 3864 | 884 | 4236 | 721 | 4694 | 401 | 5263 | 7 | 5246 |
| 8-#14 | 4.33 | MA | 3230 | 1441 | 4968 | 1180 | 5916 | 979 | 6565 | 796 | 7464 | 486 | 9441 | 121 | 8766 |
| 4L-2S | | MI | 2117 | 1441 | 3751 | 1082 | 4397 | 883 | 4882 | 713 | 5530 | 394 | 6228 | 170 | 5406 |
| 8-#18 | 7.69 | MA | 3884 | 1847 | 6405 | 1445 | 7646 | 1181 | 8632 | 926 | 10223 | 470 | 13058 | -159 | 12691 |
| 4L-2S | | MI | 2498 | 1847 | 4933 | 1319 | 5861 | 1055 | 6566 | 803 | 7590 | 303 | 8389 | -100 | 8300 |
| 10-#10 | 3.05 | MA | 3254 | 1288 | 4925 | 1072 | 5983 | 886 | 6684 | 732 | 7666 | 487 | 9638 | 317 | 7328 |
| 3L-4S | | MI | 1797 | 1288 | 2848 | 1016 | 3279 | 843 | 3547 | 691 | 3882 | 440 | 4451 | 152 | 3888 |
| 10-#10 | 3.05 | MA | 3122 | 1288 | 4591 | 1083 | 5521 | 903 | 6118 | 748 | 6892 | 493 | 8675 | 264 | 7054 |
| 4L-3S | | MI | 1868 | 1288 | 3029 | 1011 | 3529 | 832 | 3853 | 683 | 4297 | 443 | 4905 | 193 | 4066 |
| 10-#10 | 3.05 | MA | 2956 | 1288 | 4295 | 1094 | 5115 | 913 | 5615 | 756 | 6193 | 506 | 7707 | 214 | 6583 |
| 5L-2S | | MI | 1988 | 1288 | 3282 | 1005 | 3849 | 829 | 4241 | 683 | 4820 | 440 | 5530 | 286 | 4078 |
| 10-#11 | 3.75 | MA | 3256 | 1372 | 4957 | 1132 | 5945 | 940 | 6614 | 770 | 7546 | 486 | 9583 | 218 | 8253 |
| 4L-3S | | MI | 1926 | 1372 | 3246 | 1052 | 3777 | 860 | 4140 | 706 | 4617 | 420 | 5223 | 112 | 4795 |
| 10-#11 | 3.75 | MA | 3063 | 1372 | 4598 | 1145 | 5453 | 951 | 6004 | 780 | 6700 | 500 | 8406 | 153 | 7737 |
| 5L-2S | | MI | 2061 | 1372 | 3546 | 1047 | 4156 | 858 | 4600 | 699 | 5223 | 416 | 5934 | 225 | 4822 |
| 10-#14 | 5.41 | MA | 3610 | 1572 | 5796 | 1262 | 6967 | 1039 | 7838 | 834 | 9183 | 480 | 11790 | 109 | 11152 |
| 4L-3S | | MI | 2095 | 1572 | 3751 | 1169 | 4397 | 944 | 4882 | 759 | 5530 | 387 | 6228 | -49 | 6189 |
| 10-#14 | 5.41 | MA | 3343 | 1572 | 5283 | 1279 | 6264 | 1054 | 6967 | 846 | 7975 | 499 | 10137 | 14 | 10082 |
| 5L-2S | | MI | 2269 | 1572 | 4171 | 1163 | 4930 | 943 | 5529 | 750 | 6366 | 381 | 7194 | 114 | 6644 |
| 12-#10 | 3.66 | MA | 3346 | 1361 | 5074 | 1129 | 6134 | 937 | 6861 | 769 | 7894 | 489 | 10063 | 259 | 8437 |
| 4E | | MI | 1904 | 1361 | 3100 | 1062 | 3600 | 876 | 3936 | 713 | 4405 | 436 | 5076 | 128 | 4587 |
| 12-#10 | 3.66 | MA | 3182 | 1361 | 4778 | 1140 | 5728 | 947 | 6357 | 778 | 7196 | 502 | 9095 | 209 | 7985 |
| 5L-3S | | MI | 1970 | 1361 | 3282 | 1057 | 3849 | 866 | 4241 | 705 | 4820 | 439 | 5530 | 170 | 4807 |
| 12-#10 | 3.66 | MA | 3005 | 1361 | 4431 | 1155 | 5344 | 956 | 5864 | 793 | 6512 | 508 | 8152 | 138 | 7440 |
| 6L-2S | | MI | 2084 | 1361 | 3534 | 1051 | 4170 | 863 | 4630 | 704 | 5343 | 436 | 6155 | 262 | 4828 |
| 12-#11 | 4.50 | MA | 3329 | 1462 | 5180 | 1201 | 6192 | 992 | 6900 | 806 | 7908 | 496 | 10079 | 147 | 9431 |
| 5L-3S | | MI | 2043 | 1462 | 3546 | 1108 | 4156 | 902 | 4600 | 732 | 5223 | 413 | 5934 | 77 | 5668 |
| 12-#11 | 4.50 | MA | 3124 | 1462 | 4767 | 1220 | 5726 | 1003 | 6302 | 824 | 7080 | 502 | 8929 | 59 | 8634 |
| 6L-2S | | MI | 2171 | 1462 | 3845 | 1103 | 4536 | 900 | 5061 | 725 | 5829 | 409 | 6644 | 191 | 5707 |
| 12-#14 | 6.49 | MA | 3714 | 1702 | 6111 | 1361 | 7315 | 1113 | 8241 | 884 | 9694 | 493 | 12486 | 3 | 12475 |
| 5L-3S | | MI | 2256 | 1702 | 4171 | 1251 | 4930 | 1003 | 5529 | 797 | 6366 | 374 | 7194 | -105 | 7096 |
| 14-#10 | 4.27 | MA | 3401 | 1435 | 5261 | 1186 | 6340 | 980 | 7100 | 799 | 8198 | 498 | 10483 | 204 | 9391 |
| 5L-4S | | MI | 2009 | 1435 | 3353 | 1108 | 3920 | 910 | 4325 | 734 | 4928 | 432 | 5701 | 105 | 5293 |
| 14-#10 | 4.27 | MA | 3234 | 1435 | 4913 | 1201 | 5957 | 990 | 6607 | 814 | 7515 | 504 | 9540 | 133 | 8843 |
| 6L-3S | | MI | 2070 | 1435 | 3534 | 1103 | 4170 | 900 | 4630 | 726 | 5343 | 436 | 6155 | 147 | 5547 |
| 14-#10 | 4.27 | MA | 3087 | 1435 | 4603 | 1207 | 5550 | 1005 | 6131 | 823 | 6851 | 517 | 8621 | 90 | 8258 |
| 7L-2S | | MI | 2179 | 1435 | 3787 | 1097 | 4491 | 897 | 5019 | 725 | 5866 | 432 | 6780 | 239 | 5575 |
| 14-#11 | 5.25 | MA | 3394 | 1553 | 5349 | 1276 | 6465 | 1045 | 7197 | 850 | 8288 | 498 | 10602 | 53 | 10327 |
| 6L-3S | | MI | 2158 | 1553 | 3845 | 1165 | 4536 | 943 | 5061 | 758 | 5829 | 406 | 6644 | 43 | 6510 |
| 16-#10 | 4.88 | MA | 3456 | 1508 | 5396 | 1247 | 6570 | 1024 | 7349 | 836 | 8517 | 501 | 10928 | 128 | 10248 |
| 6L-4S | | MI | 2111 | 1508 | 3606 | 1154 | 4241 | 944 | 4713 | 755 | 5451 | 428 | 6326 | 82 | 6003 |
| 16-#10 | 4.88 | MA | 3318 | 1508 | 5085 | 1253 | 6163 | 1039 | 6873 | 844 | 7854 | 514 | 10009 | 86 | 9666 |
| 7L-3S | | MI | 2168 | 1508 | 3787 | 1149 | 4491 | 933 | 5019 | 747 | 5866 | 432 | 6780 | 123 | 6286 |
| 18-#10 | 5.50 | MA | 3543 | 1582 | 5568 | 1300 | 6775 | 1073 | 7616 | 865 | 8856 | 510 | 11397 | 81 | 11073 |
| 7L-4S | | MI | 2212 | 1582 | 3858 | 1200 | 4562 | 977 | 5102 | 776 | 5974 | 425 | 6951 | 58 | 6717 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis

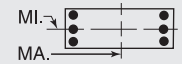



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.13 | MA | 3295 | 1137 | 4486 | 993 | 5419 | 836 | 5928 | 713 | 6445 | 526 | 7803 | 458 | 3340 |
| 2E | | MI | 1801 | 1137 | 2679 | 927 | 3060 | 779 | 3252 | 663 | 3421 | 486 | 3840 | 387 | 1805 |
| 4-#11 | 1.39 | MA | 3389 | 1171 | 4749 | 1007 | 5717 | 846 | 6272 | 717 | 6893 | 521 | 8411 | 452 | 4027 |
| 2E | | MI | 1833 | 1171 | 2805 | 936 | 3190 | 784 | 3396 | 664 | 3574 | 472 | 3986 | 359 | 2141 |
| 4-#14 | 2.01 | MA | 3623 | 1251 | 5322 | 1052 | 6419 | 878 | 7109 | 737 | 8011 | 514 | 9952 | 445 | 5668 |
| 2E | | MI | 1920 | 1251 | 3069 | 977 | 3505 | 813 | 3767 | 681 | 4026 | 455 | 4479 | 311 | 2921 |
| 4-#18 | 3.57 | MA | 4164 | 1454 | 6715 | 1169 | 8136 | 962 | 9165 | 788 | 10766 | 498 | 13579 | 410 | 9674 |
| 2E | | MI | 2113 | 1454 | 3683 | 1086 | 4244 | 891 | 4606 | 719 | 5046 | 404 | 5539 | 171 | 4733 |
| 6-#8 | 1.06 | MA | 3273 | 1127 | 4396 | 992 | 5330 | 836 | 5833 | 713 | 6327 | 530 | 7648 | 461 | 3143 |
| 2L-3S | | MI | 1704 | 1127 | 2472 | 933 | 2819 | 784 | 2970 | 668 | 3051 | 495 | 3426 | 343 | 1719 |
| 6-#8 | 1.06 | MA | 3072 | 1127 | 4063 | 1000 | 4908 | 842 | 5321 | 720 | 5636 | 539 | 6692 | 408 | 3148 |
| 3L-2S | | MI | 1796 | 1127 | 2633 | 929 | 3023 | 782 | 3218 | 667 | 3385 | 492 | 3835 | 400 | 1707 |
| 6-#9 | 1.34 | MA | 3392 | 1164 | 4669 | 1013 | 5665 | 850 | 6233 | 722 | 6861 | 527 | 8384 | 458 | 3926 |
| 2L-3S | | MI | 1732 | 1164 | 2564 | 952 | 2926 | 798 | 3095 | 675 | 3216 | 491 | 3611 | 312 | 2109 |
| 6-#9 | 1.34 | MA | 3146 | 1164 | 4250 | 1022 | 5133 | 859 | 5588 | 730 | 5992 | 538 | 7180 | 390 | 3923 |
| 3L-2S | | MI | 1845 | 1164 | 2766 | 948 | 3182 | 795 | 3405 | 674 | 3634 | 488 | 4116 | 384 | 2095 |
| 6-#10 | 1.70 | MA | 3540 | 1211 | 5015 | 1039 | 6090 | 870 | 6742 | 734 | 7543 | 523 | 9323 | 453 | 4921 |
| 2L-3S | | MI | 1767 | 1211 | 2679 | 978 | 3060 | 816 | 3252 | 685 | 3421 | 486 | 3840 | 271 | 2594 |
| 6-#10 | 1.70 | MA | 3239 | 1211 | 4486 | 1051 | 5419 | 880 | 5928 | 743 | 6445 | 537 | 7803 | 366 | 4899 |
| 3L-2S | | MI | 1905 | 1211 | 2932 | 973 | 3381 | 813 | 3641 | 684 | 3944 | 483 | 4465 | 363 | 2581 |
| 6-#11 | 2.09 | MA | 3675 | 1261 | 5388 | 1064 | 6528 | 887 | 7254 | 743 | 8218 | 516 | 10246 | 447 | 5932 |
| 2L-3S | | MI | 1796 | 1261 | 2805 | 997 | 3190 | 828 | 3396 | 698 | 3574 | 469 | 3986 | 211 | 3068 |
| 6-#11 | 2.09 | MA | 3324 | 1261 | 4749 | 1078 | 5717 | 899 | 6272 | 754 | 6893 | 532 | 8411 | 336 | 5888 |
| 3L-2S | | MI | 1950 | 1261 | 3104 | 992 | 3570 | 826 | 3856 | 690 | 4180 | 465 | 4696 | 324 | 3057 |
| 6-#14 | 3.01 | MA | 4013 | 1381 | 6231 | 1134 | 7573 | 937 | 8507 | 774 | 9899 | 508 | 12566 | 436 | 8368 |
| 2L-3S | | MI | 1875 | 1381 | 3069 | 1064 | 3505 | 874 | 3767 | 727 | 4026 | 448 | 4479 | 92 | 4166 |
| 6-#14 | 3.01 | MA | 3545 | 1381 | 5322 | 1153 | 6419 | 954 | 7109 | 788 | 8011 | 529 | 9952 | 274 | 8229 |
| 3L-2S | | MI | 2078 | 1381 | 3490 | 1059 | 4038 | 873 | 4413 | 718 | 4862 | 442 | 5444 | 256 | 4189 |
| 6-#18 | 5.36 | MA | 4080 | 1686 | 6715 | 1345 | 8136 | 1094 | 9165 | 876 | 10766 | 521 | 13579 | 96 | 13262 |
| 3L-2S | | MI | 2364 | 1686 | 4389 | 1231 | 5140 | 997 | 5674 | 782 | 6401 | 370 | 7054 | 50 | 6821 |
| 8-#7 | 1.07 | MA | 3284 | 1129 | 4400 | 995 | 5346 | 838 | 5859 | 716 | 6367 | 531 | 7708 | 462 | 3189 |
| 2L-4S | | MI | 1690 | 1129 | 2422 | 940 | 2755 | 794 | 2896 | 676 | 2953 | 496 | 3341 | 339 | 1748 |
| 8-#7 | 1.07 | MA | 3132 | 1129 | 4146 | 1001 | 5024 | 844 | 5468 | 720 | 5840 | 538 | 6977 | 422 | 3193 |
| 3E | | MI | 1732 | 1129 | 2510 | 937 | 2877 | 788 | 3045 | 671 | 3156 | 497 | 3569 | 361 | 1738 |
| 8-#7 | 1.07 | MA | 3046 | 1129 | 3972 | 1007 | 4783 | 852 | 5172 | 728 | 5435 | 542 | 6481 | 398 | 3187 |
| 4L-2S | | MI | 1802 | 1129 | 2633 | 934 | 3034 | 786 | 3235 | 670 | 3413 | 495 | 3887 | 404 | 1729 |
| 8-#8 | 1.41 | MA | 3430 | 1173 | 4729 | 1021 | 5752 | 857 | 6345 | 727 | 7018 | 528 | 8605 | 458 | 4139 |
| 2L-4S | | MI | 1721 | 1173 | 2518 | 965 | 2865 | 812 | 3024 | 687 | 3121 | 492 | 3540 | 303 | 2221 |
| 8-#8 | 1.41 | MA | 3237 | 1173 | 4396 | 1028 | 5330 | 863 | 5833 | 733 | 6327 | 537 | 7648 | 405 | 4136 |
| 3E | | MI | 1774 | 1173 | 2633 | 962 | 3023 | 805 | 3218 | 681 | 3385 | 493 | 3835 | 330 | 2212 |
| 8-#8 | 1.41 | MA | 3129 | 1173 | 4168 | 1036 | 5014 | 875 | 5445 | 743 | 5796 | 541 | 6997 | 372 | 4108 |
| 4L-2S | | MI | 1863 | 1173 | 2794 | 958 | 3228 | 803 | 3466 | 680 | 3720 | 490 | 4244 | 387 | 2202 |
| 8-#9 | 1.79 | MA | 3584 | 1222 | 5088 | 1049 | 6196 | 877 | 6877 | 739 | 7731 | 524 | 9588 | 454 | 5176 |
| 2L-4S | | MI | 1754 | 1222 | 2622 | 993 | 2983 | 833 | 3162 | 699 | 3302 | 486 | 3750 | 261 | 2717 |
| 8-#9 | 1.79 | MA | 3350 | 1222 | 4669 | 1058 | 5665 | 885 | 6233 | 747 | 6861 | 535 | 8384 | 386 | 5161 |
| 3E | | MI | 1819 | 1222 | 2766 | 989 | 3182 | 825 | 3405 | 692 | 3634 | 489 | 4116 | 295 | 2719 |
| 8-#9 | 1.79 | MA | 3219 | 1222 | 4382 | 1068 | 5266 | 899 | 5744 | 760 | 6192 | 541 | 7560 | 344 | 5094 |
| 4L-2S | | MI | 1928 | 1222 | 2967 | 984 | 3437 | 822 | 3715 | 691 | 4052 | 486 | 4622 | 367 | 2710 |
| 8-#10 | 2.27 | MA | 3776 | 1285 | 5544 | 1085 | 6761 | 903 | 7555 | 755 | 8641 | 519 | 10843 | 449 | 6493 |
| 2L-4S | | MI | 1795 | 1285 | 2750 | 1030 | 3131 | 860 | 3335 | 714 | 3528 | 479 | 4011 | 206 | 3260 |
| 8-#10 | 2.27 | MA | 3491 | 1285 | 5015 | 1097 | 6090 | 914 | 6742 | 765 | 7543 | 533 | 9323 | 361 | 6457 |
| 3E | | MI | 1875 | 1285 | 2932 | 1024 | 3381 | 850 | 3641 | 707 | 3944 | 482 | 4465 | 248 | 3348 |
| 8-#10 | 2.27 | MA | 3333 | 1285 | 4652 | 1109 | 5586 | 931 | 6124 | 781 | 6697 | 540 | 8279 | 308 | 6286 |
| 4L-2S | | MI | 2006 | 1285 | 3184 | 1019 | 3702 | 847 | 4030 | 706 | 4467 | 479 | 5090 | 340 | 3345 |
| 8-#11 | 2.79 | MA | 3621 | 1352 | 5388 | 1134 | 6528 | 940 | 7254 | 780 | 8218 | 528 | 10246 | 330 | 7764 |
| 3E | | MI | 1919 | 1352 | 3104 | 1054 | 3570 | 869 | 3856 | 724 | 4180 | 462 | 4696 | 176 | 3953 |
| 8-#11 | 2.79 | MA | 3437 | 1352 | 4947 | 1148 | 5917 | 961 | 6505 | 799 | 7194 | 535 | 8973 | 265 | 7303 |
| 4L-2S | | MI | 2065 | 1352 | 3404 | 1049 | 3950 | 867 | 4316 | 716 | 4786 | 458 | 5407 | 290 | 3958 |

## RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

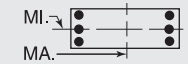
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 4.02 | MA | 3956 | 1512 | 6231 | 1234 | 7573 | 1013 | 8507 | 826 | 9899 | 523 | 12566 | 265 | 10894 |
| 3E | | MI | 2044 | 1512 | 3490 | 1146 | 4038 | 934 | 4413 | 765 | 4862 | 435 | 5444 | 37 | 5351 |
| 8-#14 | 4.02 | MA | 3713 | 1512 | 5602 | 1253 | 6700 | 1042 | 7439 | 852 | 8438 | 532 | 10737 | 170 | 9716 |
| 4L-2S | | MI | 2233 | 1512 | 3910 | 1140 | 4571 | 933 | 5059 | 756 | 5698 | 429 | 6410 | 200 | 5440 |
| 8-#18 | 7.14 | MA | 4400 | 1918 | 7192 | 1521 | 8616 | 1248 | 9728 | 986 | 11493 | 521 | 14889 | -92 | 14638 |
| 4L-2S | | MI | 2613 | 1918 | 5096 | 1376 | 6036 | 1103 | 6742 | 845 | 7757 | 336 | 8568 | -71 | 8510 |
| 10-#10 | 2.83 | MA | 3735 | 1358 | 5544 | 1143 | 6761 | 947 | 7555 | 786 | 8641 | 530 | 10843 | 356 | 8014 |
| 3L-4S | | MI | 1904 | 1358 | 3003 | 1076 | 3452 | 893 | 3724 | 736 | 4051 | 475 | 4636 | 183 | 3951 |
| 10-#10 | 2.83 | MA | 3589 | 1358 | 5180 | 1155 | 6257 | 965 | 6937 | 802 | 7795 | 537 | 9800 | 304 | 7798 |
| 4L-3S | | MI | 1982 | 1358 | 3184 | 1070 | 3702 | 883 | 4030 | 728 | 4467 | 479 | 5090 | 224 | 4095 |
| 10-#10 | 2.83 | MA | 3401 | 1358 | 4858 | 1167 | 5815 | 975 | 6388 | 811 | 7033 | 550 | 8747 | 256 | 7247 |
| 5L-2S | | MI | 2104 | 1358 | 3437 | 1065 | 4022 | 880 | 4418 | 727 | 4990 | 475 | 5715 | 317 | 4102 |
| 10-#11 | 3.48 | MA | 3740 | 1442 | 5585 | 1204 | 6727 | 1002 | 7487 | 825 | 8520 | 531 | 10808 | 259 | 9132 |
| 4L-3S | | MI | 2039 | 1442 | 3404 | 1110 | 3950 | 910 | 4316 | 750 | 4786 | 455 | 5407 | 142 | 4831 |
| 10-#11 | 3.48 | MA | 3521 | 1442 | 5194 | 1218 | 6190 | 1014 | 6821 | 835 | 7596 | 546 | 9527 | 197 | 8529 |
| 5L-2S | | MI | 2177 | 1442 | 3703 | 1105 | 4330 | 908 | 4777 | 742 | 5392 | 451 | 6117 | 256 | 4851 |
| 10-#14 | 5.02 | MA | 4136 | 1642 | 6511 | 1335 | 7854 | 1102 | 8837 | 890 | 10326 | 526 | 13351 | 161 | 12346 |
| 4L-3S | | MI | 2208 | 1642 | 3910 | 1227 | 4571 | 993 | 5059 | 802 | 5698 | 422 | 6410 | -19 | 6396 |
| 10-#14 | 5.02 | MA | 3832 | 1642 | 5951 | 1354 | 7087 | 1118 | 7886 | 904 | 9005 | 547 | 11517 | 69 | 11247 |
| 5L-2S | | MI | 2385 | 1642 | 4330 | 1222 | 5105 | 992 | 5705 | 794 | 6534 | 415 | 7376 | 145 | 6680 |
| 12-#10 | 3.40 | MA | 3837 | 1432 | 5709 | 1201 | 6928 | 999 | 7750 | 823 | 8893 | 533 | 11320 | 299 | 9316 |
| 4E | | MI | 2017 | 1432 | 3256 | 1122 | 3772 | 927 | 4113 | 757 | 4574 | 471 | 5261 | 159 | 4650 |
| 12-#10 | 3.40 | MA | 3652 | 1432 | 5387 | 1213 | 6486 | 1009 | 7202 | 833 | 8131 | 547 | 10267 | 251 | 8787 |
| 5L-3S | | MI | 2084 | 1432 | 3437 | 1116 | 4022 | 917 | 4418 | 749 | 4990 | 475 | 5715 | 201 | 4838 |
| 12-#10 | 3.40 | MA | 3456 | 1432 | 5002 | 1227 | 6069 | 1020 | 6664 | 849 | 7386 | 554 | 9246 | 181 | 8239 |
| 6L-2S | | MI | 2201 | 1432 | 3690 | 1111 | 4343 | 914 | 4807 | 748 | 5513 | 471 | 6340 | 293 | 4854 |
| 12-#11 | 4.18 | MA | 3817 | 1533 | 5833 | 1275 | 7001 | 1055 | 7803 | 862 | 8921 | 542 | 11363 | 191 | 10392 |
| 5L-3S | | MI | 2157 | 1533 | 3703 | 1167 | 4330 | 952 | 4777 | 776 | 5392 | 448 | 6117 | 108 | 5706 |
| 12-#11 | 4.18 | MA | 3589 | 1533 | 5373 | 1292 | 6494 | 1067 | 7151 | 881 | 8017 | 549 | 10116 | 104 | 9570 |
| 6L-2S | | MI | 2288 | 1533 | 4002 | 1162 | 4710 | 950 | 5237 | 768 | 5998 | 443 | 6827 | 221 | 5738 |
| 12-#14 | 6.03 | MA | 4245 | 1773 | 6861 | 1435 | 8241 | 1178 | 9284 | 941 | 10893 | 541 | 14131 | 60 | 13892 |
| 5L-3S | | MI | 2369 | 1773 | 4330 | 1309 | 5105 | 1053 | 5705 | 840 | 6534 | 408 | 7376 | -74 | 7309 |
| 12-#14 | 6.03 | MA | 3940 | 1773 | 6212 | 1462 | 7516 | 1194 | 8352 | 968 | 9602 | 550 | 12341 | -67 | 12149 |
| 6L-2S | | MI | 2536 | 1773 | 4750 | 1303 | 5638 | 1052 | 6352 | 831 | 7371 | 402 | 8342 | 89 | 7915 |
| 14-#10 | 3.97 | MA | 3896 | 1506 | 5916 | 1259 | 7157 | 1043 | 8015 | 854 | 9229 | 543 | 11787 | 246 | 10330 |
| 5L-4S | | MI | 2122 | 1506 | 3508 | 1168 | 4093 | 961 | 4501 | 778 | 5097 | 467 | 5886 | 136 | 5354 |
| 14-#10 | 3.97 | MA | 3710 | 1506 | 5531 | 1273 | 6740 | 1053 | 7478 | 870 | 8484 | 550 | 10766 | 176 | 9781 |
| 6L-3S | | MI | 2184 | 1506 | 3690 | 1162 | 4343 | 951 | 4807 | 770 | 5513 | 471 | 6340 | 178 | 5578 |
| 14-#10 | 3.97 | MA | 3547 | 1506 | 5191 | 1280 | 6287 | 1068 | 6959 | 879 | 7761 | 564 | 9769 | 136 | 9167 |
| 7L-2S | | MI | 2296 | 1506 | 3942 | 1157 | 4664 | 947 | 5196 | 770 | 6035 | 467 | 6965 | 270 | 5602 |
| 14-#11 | 4.88 | MA | 3889 | 1623 | 6012 | 1349 | 7304 | 1109 | 8133 | 907 | 9343 | 545 | 11952 | 98 | 11434 |
| 6L-3S | | MI | 2272 | 1623 | 4002 | 1224 | 4710 | 993 | 5237 | 802 | 5998 | 440 | 6827 | 73 | 6579 |
| 14-#11 | 4.88 | MA | 3700 | 1623 | 5601 | 1357 | 6765 | 1128 | 7504 | 917 | 8466 | 561 | 10736 | 46 | 10545 |
| 7L-2S | | MI | 2397 | 1623 | 4302 | 1218 | 5090 | 991 | 5698 | 795 | 6604 | 436 | 7538 | 187 | 6621 |
| 14-#14 | 7.03 | MA | 4360 | 1903 | 7121 | 1543 | 8670 | 1254 | 9750 | 1005 | 11490 | 544 | 14955 | -75 | 14645 |
| 6L-3S | | MI | 2528 | 1903 | 4750 | 1390 | 5638 | 1112 | 6352 | 878 | 7371 | 395 | 8342 | -130 | 8207 |
| 16-#10 | 4.54 | MA | 3956 | 1579 | 6059 | 1319 | 7411 | 1087 | 8291 | 891 | 9582 | 547 | 12286 | 171 | 11326 |
| 6L-4S | | MI | 2224 | 1579 | 3761 | 1214 | 4414 | 994 | 4890 | 799 | 5620 | 464 | 6511 | 113 | 6063 |
| 16-#10 | 4.54 | MA | 3803 | 1579 | 5720 | 1326 | 6958 | 1102 | 7773 | 901 | 8859 | 561 | 11289 | 131 | 10709 |
| 7L-3S | | MI | 2283 | 1579 | 3942 | 1208 | 4664 | 984 | 5196 | 792 | 6035 | 467 | 6965 | 154 | 6318 |
| 16-#10 | 4.54 | MA | 3645 | 1579 | 5393 | 1335 | 6521 | 1109 | 7248 | 916 | 8149 | 574 | 10329 | 78 | 9996 |
| 8L-2S | | MI | 2390 | 1579 | 4195 | 1203 | 4984 | 981 | 5584 | 791 | 6558 | 464 | 7590 | 247 | 6348 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

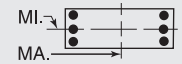
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 5.57 | MA | 4004 | 1714 | 6239 | 1414 | 7576 | 1169 | 8486 | 943 | 9791 | 556 | 12572 | 40 | 12406 |
| 7L-3S | | MI | 2386 | 1714 | 4302 | 1280 | 5090 | 1034 | 5698 | 828 | 6604 | 433 | 7538 | 39 | 7410 |
| 18-#10 | 5.10 | MA | 4052 | 1653 | 6249 | 1372 | 7629 | 1135 | 8586 | 922 | 9957 | 557 | 12809 | 126 | 12251 |
| 7L-4S | | MI | 2326 | 1653 | 4014 | 1260 | 4734 | 1028 | 5279 | 821 | 6143 | 460 | 7136 | 89 | 6775 |
| 18-#10 | 5.10 | MA | 3896 | 1653 | 5922 | 1381 | 7192 | 1142 | 8062 | 938 | 9246 | 571 | 11849 | 73 | 11542 |
| 8L-3S | | MI | 2381 | 1653 | 4195 | 1254 | 4984 | 1018 | 5584 | 813 | 6558 | 463 | 7590 | 131 | 7057 |
| 20-#10 | 5.67 | MA | 4142 | 1726 | 6451 | 1427 | 7864 | 1176 | 8875 | 959 | 10344 | 567 | 13369 | 68 | 13088 |
| 8L-4S | | MI | 2426 | 1726 | 4266 | 1306 | 5055 | 1062 | 5667 | 842 | 6666 | 456 | 7761 | 66 | 7491 |

## RECTANGULAR TIED COLUMNS 16" x 30"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#10 | 1.06 | MA | 3760 | 1208 | 5042 | 1064 | 6119 | 896 | 6700 | 765 | 7272 | 568 | 8794 | 495 | 3614 |
| 2E | | MI | 1914 | 1208 | 2834 | 986 | 3233 | 830 | 3429 | 708 | 3590 | 522 | 4025 | 418 | 1822 |
| 4-#11 | 1.30 | MA | 3865 | 1242 | 5330 | 1078 | 6446 | 906 | 7077 | 770 | 7763 | 563 | 9461 | 489 | 4364 |
| 2E | | MI | 1947 | 1242 | 2963 | 995 | 3364 | 834 | 3572 | 708 | 3743 | 507 | 4169 | 389 | 2161 |
| 4-#14 | 1.88 | MA | 4126 | 1322 | 5956 | 1123 | 7212 | 938 | 7991 | 789 | 8986 | 556 | 11145 | 481 | 6154 |
| 2E | | MI | 2035 | 1322 | 3229 | 1035 | 3679 | 863 | 3943 | 724 | 4194 | 490 | 4661 | 342 | 2946 |
| 4-#18 | 3.33 | MA | 4729 | 1525 | 7481 | 1240 | 9094 | 1022 | 10245 | 840 | 12003 | 540 | 15305 | 463 | 10538 |
| 2E | | MI | 2228 | 1525 | 3846 | 1143 | 4419 | 940 | 4783 | 761 | 5213 | 438 | 5718 | 201 | 4769 |
| 6-#9 | 1.25 | MA | 3866 | 1235 | 5240 | 1083 | 6385 | 911 | 7030 | 775 | 7724 | 568 | 9424 | 495 | 4250 |
| 2L-3S | | MI | 1845 | 1235 | 2719 | 1012 | 3098 | 849 | 3272 | 720 | 3385 | 527 | 3796 | 343 | 2127 |
| 6-#9 | 1.25 | MA | 3596 | 1235 | 4785 | 1093 | 5808 | 920 | 6330 | 783 | 6779 | 580 | 8115 | 428 | 4247 |
| 3L-2S | | MI | 1958 | 1235 | 2920 | 1008 | 3354 | 846 | 3582 | 719 | 3804 | 524 | 4302 | 416 | 2112 |
| 6-#10 | 1.59 | MA | 4030 | 1282 | 5617 | 1110 | 6849 | 930 | 7584 | 787 | 8466 | 565 | 10447 | 490 | 5332 |
| 2L-3S | | MI | 1880 | 1282 | 2834 | 1038 | 3233 | 867 | 3429 | 730 | 3590 | 521 | 4025 | 302 | 2616 |
| 6-#10 | 1.59 | MA | 3699 | 1282 | 5042 | 1122 | 6119 | 941 | 6700 | 797 | 7272 | 579 | 8794 | 404 | 5311 |
| 3L-2S | | MI | 2019 | 1282 | 3087 | 1032 | 3554 | 864 | 3818 | 729 | 4113 | 518 | 4650 | 394 | 2600 |
| 6-#11 | 1.95 | MA | 4181 | 1332 | 6025 | 1135 | 7328 | 947 | 8146 | 796 | 9206 | 558 | 11460 | 483 | 6437 |
| 2L-3S | | MI | 1909 | 1332 | 2963 | 1056 | 3364 | 878 | 3572 | 741 | 3743 | 504 | 4169 | 241 | 3095 |
| 6-#11 | 1.95 | MA | 3794 | 1332 | 5330 | 1149 | 6446 | 960 | 7077 | 807 | 7763 | 575 | 9461 | 375 | 6393 |
| 3L-2S | | MI | 2065 | 1332 | 3262 | 1051 | 3744 | 876 | 4033 | 734 | 4349 | 500 | 4880 | 355 | 3080 |
| 6-#14 | 2.81 | MA | 4558 | 1452 | 6946 | 1205 | 8470 | 998 | 9516 | 827 | 11043 | 550 | 13994 | 473 | 9097 |
| 2L-3S | | MI | 1988 | 1452 | 3229 | 1122 | 3679 | 924 | 3943 | 770 | 4194 | 483 | 4661 | 122 | 4205 |
| 6-#14 | 2.81 | MA | 4040 | 1452 | 5956 | 1225 | 7212 | 1015 | 7991 | 842 | 8986 | 573 | 11145 | 315 | 8958 |
| 3L-2S | | MI | 2193 | 1452 | 3649 | 1117 | 4212 | 923 | 4590 | 761 | 5030 | 476 | 5626 | 286 | 4218 |
| 6-#18 | 5.00 | MA | 4634 | 1757 | 7481 | 1418 | 9094 | 1157 | 10245 | 931 | 12003 | 566 | 15305 | 157 | 14749 |
| 3L-2S | | MI | 2479 | 1757 | 4552 | 1288 | 5315 | 1046 | 5851 | 824 | 6568 | 404 | 7233 | 80 | 6863 |
| 8-#7 | 1.00 | MA | 3746 | 1200 | 4946 | 1066 | 6038 | 899 | 6622 | 768 | 7184 | 573 | 8686 | 499 | 3448 |
| 2L-4S | | MI | 1803 | 1200 | 2574 | 1001 | 2927 | 845 | 3073 | 721 | 3124 | 532 | 3527 | 371 | 1762 |
| 8-#7 | 1.00 | MA | 3579 | 1200 | 4670 | 1072 | 5688 | 904 | 6198 | 773 | 6612 | 580 | 7893 | 460 | 3452 |
| 3E | | MI | 1845 | 1200 | 2662 | 998 | 3048 | 840 | 3222 | 716 | 3327 | 533 | 3756 | 392 | 1752 |
| 8-#7 | 1.00 | MA | 3485 | 1200 | 4482 | 1078 | 5427 | 913 | 5877 | 782 | 6173 | 584 | 7359 | 435 | 3446 |
| 4L-2S | | MI | 1916 | 1200 | 2786 | 994 | 3205 | 838 | 3412 | 715 | 3583 | 530 | 4074 | 436 | 1744 |
| 8-#8 | 1.32 | MA | 3907 | 1244 | 5304 | 1091 | 6480 | 917 | 7151 | 779 | 7893 | 569 | 9662 | 495 | 4480 |
| 2L-4S | | MI | 1834 | 1244 | 2672 | 1026 | 3037 | 864 | 3201 | 731 | 3291 | 527 | 3726 | 334 | 2240 |
| 8-#8 | 1.32 | MA | 3695 | 1244 | 4943 | 1099 | 6021 | 924 | 6595 | 786 | 7142 | 579 | 8623 | 443 | 4478 |
| 3E | | MI | 1887 | 1244 | 2787 | 1022 | 3195 | 857 | 3395 | 726 | 3556 | 529 | 4021 | 361 | 2229 |
| 8-#8 | 1.32 | MA | 3577 | 1244 | 4696 | 1107 | 5678 | 936 | 6175 | 797 | 6567 | 584 | 7922 | 411 | 4450 |
| 4L-2S | | MI | 1977 | 1244 | 2948 | 1018 | 3400 | 854 | 3642 | 725 | 3890 | 526 | 4430 | 419 | 2218 |
| 8-#9 | 1.67 | MA | 4079 | 1293 | 5695 | 1120 | 6963 | 937 | 7730 | 792 | 8669 | 566 | 10733 | 491 | 5608 |
| 2L-4S | | MI | 1866 | 1293 | 2776 | 1053 | 3155 | 884 | 3339 | 743 | 3472 | 522 | 3936 | 292 | 2743 |
| 8-#9 | 1.67 | MA | 3820 | 1293 | 5240 | 1129 | 6385 | 946 | 7030 | 800 | 7724 | 578 | 9424 | 424 | 5593 |
| 3E | | MI | 1932 | 1293 | 2920 | 1049 | 3354 | 876 | 3582 | 737 | 3804 | 524 | 4302 | 326 | 2739 |
| 8-#9 | 1.67 | MA | 3676 | 1293 | 4929 | 1139 | 5953 | 961 | 6500 | 813 | 6998 | 584 | 8537 | 383 | 5526 |
| 4L-2S | | MI | 2042 | 1293 | 3122 | 1044 | 3610 | 873 | 3892 | 736 | 4222 | 521 | 4808 | 399 | 2728 |
| 8-#10 | 2.12 | MA | 4291 | 1355 | 6191 | 1156 | 7578 | 964 | 8469 | 808 | 9659 | 561 | 12099 | 485 | 7042 |
| 2L-4S | | MI | 1907 | 1355 | 2906 | 1089 | 3304 | 911 | 3512 | 759 | 3698 | 514 | 4196 | 237 | 3323 |

## RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

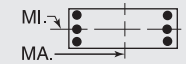
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 2.12 | MA | 3977 | 1355 | 5617 | 1168 | 6849 | 975 | 7584 | 818 | 8466 | 576 | 10447 | 400 | 7006 |
| 3E | | MI | 1988 | 1355 | 3087 | 1084 | 3554 | 901 | 3818 | 751 | 4113 | 518 | 4650 | 279 | 3373 |
| 8-#10 | 2.12 | MA | 3802 | 1355 | 5223 | 1181 | 6302 | 993 | 6915 | 835 | 7549 | 584 | 9323 | 348 | 6863 |
| 4L-2S | | MI | 2121 | 1355 | 3340 | 1078 | 3874 | 897 | 4206 | 750 | 4636 | 514 | 5275 | 371 | 3366 |
| 8-#11 | 2.60 | MA | 4122 | 1423 | 6025 | 1206 | 7328 | 1001 | 8146 | 833 | 9206 | 571 | 11460 | 370 | 8437 |
| 3E | | MI | 2032 | 1423 | 3262 | 1113 | 3744 | 919 | 4033 | 767 | 4349 | 497 | 4880 | 207 | 3984 |
| 8-#11 | 2.60 | MA | 3919 | 1423 | 5547 | 1220 | 6665 | 1023 | 7333 | 853 | 8095 | 579 | 10087 | 305 | 8026 |
| 4L-2S | | MI | 2180 | 1423 | 3561 | 1108 | 4124 | 917 | 4493 | 760 | 4955 | 493 | 5590 | 320 | 3984 |
| 8-#14 | 3.75 | MA | 4493 | 1583 | 6946 | 1306 | 8470 | 1075 | 9516 | 880 | 11043 | 567 | 13994 | 306 | 11866 |
| 3E | | MI | 2156 | 1583 | 3649 | 1204 | 4212 | 983 | 4590 | 808 | 5030 | 469 | 5626 | 67 | 5430 |
| 8-#14 | 3.75 | MA | 4226 | 1583 | 6263 | 1326 | 7523 | 1105 | 8355 | 908 | 9455 | 577 | 12022 | 212 | 10682 |
| 4L-2S | | MI | 2348 | 1583 | 4069 | 1198 | 4746 | 982 | 5236 | 799 | 5866 | 463 | 6592 | 230 | 5472 |
| 8-#18 | 6.67 | MA | 4989 | 1988 | 8008 | 1596 | 9625 | 1313 | 10866 | 1044 | 12807 | 570 | 16776 | -29 | 16614 |
| 4L-2S | | MI | 2729 | 1988 | 5258 | 1433 | 6211 | 1152 | 6919 | 887 | 7924 | 370 | 8747 | -41 | 8716 |
| 10-#10 | 2.65 | MA | 4245 | 1429 | 6191 | 1214 | 7578 | 1008 | 8469 | 839 | 9659 | 572 | 12099 | 395 | 8700 |
| 3L-4S | | MI | 2017 | 1429 | 3158 | 1135 | 3625 | 944 | 3901 | 780 | 4221 | 510 | 4821 | 214 | 4013 |
| 10-#10 | 2.65 | MA | 4085 | 1429 | 5798 | 1227 | 7032 | 1026 | 7799 | 856 | 8743 | 580 | 10976 | 343 | 8550 |
| 4L-3S | | MI | 2096 | 1429 | 3340 | 1130 | 3874 | 934 | 4206 | 772 | 4636 | 514 | 5275 | 255 | 4122 |
| 10-#10 | 2.65 | MA | 3875 | 1429 | 5449 | 1239 | 6553 | 1038 | 7205 | 866 | 7917 | 595 | 9838 | 297 | 7918 |
| 5L-2S | | MI | 2220 | 1429 | 3592 | 1124 | 4195 | 931 | 4595 | 771 | 5159 | 510 | 5900 | 348 | 4125 |
| 10-#11 | 3.25 | MA | 4254 | 1513 | 6242 | 1276 | 7548 | 1064 | 8403 | 879 | 9538 | 575 | 12085 | 299 | 10023 |
| 4L-3S | | MI | 2153 | 1513 | 3561 | 1169 | 4124 | 960 | 4493 | 794 | 4955 | 490 | 5590 | 173 | 4865 |
| 10-#11 | 3.25 | MA | 4008 | 1513 | 5818 | 1291 | 6966 | 1077 | 7681 | 891 | 8536 | 592 | 10700 | 240 | 9329 |
| 5L-2S | | MI | 2293 | 1513 | 3861 | 1164 | 4504 | 958 | 4954 | 786 | 5561 | 485 | 6300 | 286 | 4880 |
| 10-#14 | 4.69 | MA | 4693 | 1713 | 7254 | 1408 | 8780 | 1165 | 9879 | 945 | 11513 | 571 | 14871 | 203 | 13556 |
| 4L-3S | | MI | 2321 | 1713 | 4069 | 1285 | 4746 | 1043 | 5236 | 845 | 5866 | 456 | 6592 | 11 | 6561 |
| 10-#14 | 4.69 | MA | 4351 | 1713 | 6648 | 1428 | 7948 | 1182 | 8847 | 961 | 10080 | 594 | 12886 | 115 | 12423 |
| 5L-2S | | MI | 2501 | 1713 | 4489 | 1280 | 5279 | 1042 | 5882 | 837 | 6703 | 450 | 7558 | 175 | 6715 |
| 12-#10 | 3.17 | MA | 4358 | 1503 | 6372 | 1273 | 7761 | 1060 | 8683 | 877 | 9936 | 577 | 12628 | 338 | 10208 |
| 4E | | MI | 2130 | 1503 | 3411 | 1181 | 3945 | 978 | 4290 | 801 | 4744 | 507 | 5446 | 190 | 4710 |
| 12-#10 | 3.17 | MA | 4151 | 1503 | 6024 | 1285 | 7283 | 1071 | 8089 | 887 | 9111 | 591 | 11491 | 292 | 9595 |
| 5L-3S | | MI | 2198 | 1503 | 3592 | 1176 | 4195 | 968 | 4595 | 793 | 5159 | 510 | 5900 | 232 | 4867 |
| 12-#10 | 3.17 | MA | 3936 | 1503 | 5601 | 1299 | 6831 | 1082 | 7507 | 904 | 8304 | 599 | 10392 | 223 | 9053 |
| 6L-2S | | MI | 2317 | 1503 | 3845 | 1171 | 4516 | 965 | 4984 | 793 | 5682 | 507 | 6525 | 324 | 4879 |
| 12-#11 | 3.90 | MA | 4335 | 1603 | 6513 | 1347 | 7848 | 1118 | 8750 | 917 | 9979 | 587 | 12698 | 234 | 11362 |
| 5L-3S | | MI | 2270 | 1603 | 3861 | 1226 | 4504 | 1002 | 4954 | 820 | 5561 | 482 | 6300 | 138 | 5742 |
| 12-#11 | 3.90 | MA | 4084 | 1603 | 6008 | 1365 | 7299 | 1131 | 8043 | 937 | 8999 | 596 | 11355 | 148 | 10521 |
| 6L-2S | | MI | 2404 | 1603 | 4160 | 1221 | 4884 | 1000 | 5414 | 812 | 6167 | 478 | 7011 | 252 | 5768 |
| 12-#14 | 5.63 | MA | 4806 | 1844 | 7639 | 1509 | 9206 | 1242 | 10371 | 998 | 12137 | 588 | 15735 | 107 | 15307 |
| 5L-3S | | MI | 2482 | 1844 | 4489 | 1367 | 5279 | 1102 | 5882 | 883 | 6703 | 443 | 7558 | -44 | 7519 |
| 12-#14 | 5.63 | MA | 4470 | 1844 | 6923 | 1535 | 8420 | 1259 | 9360 | 1026 | 10736 | 599 | 13806 | -19 | 13743 |
| 6L-2S | | MI | 2653 | 1844 | 4909 | 1361 | 5812 | 1101 | 6529 | 874 | 7539 | 437 | 8524 | 119 | 7952 |
| 14-#10 | 3.70 | MA | 4420 | 1576 | 6599 | 1331 | 8012 | 1105 | 8973 | 909 | 10304 | 588 | 13143 | 288 | 11275 |
| 5L-4S | | MI | 2235 | 1576 | 3664 | 1227 | 4266 | 1012 | 4678 | 822 | 5267 | 503 | 6071 | 167 | 5413 |
| 14-#10 | 3.70 | MA | 4215 | 1576 | 6176 | 1345 | 7561 | 1116 | 8391 | 925 | 9497 | 596 | 12044 | 218 | 10735 |
| 6L-3S | | MI | 2299 | 1576 | 3845 | 1222 | 4516 | 1001 | 4984 | 815 | 5682 | 506 | 6525 | 209 | 5609 |
| 14-#10 | 3.70 | MA | 4037 | 1576 | 5808 | 1353 | 7063 | 1130 | 7831 | 935 | 8715 | 610 | 10968 | 180 | 10078 |
| 7L-2S | | MI | 2412 | 1576 | 4098 | 1217 | 4836 | 998 | 5372 | 814 | 6205 | 503 | 7150 | 301 | 5628 |
| 14-#11 | 4.55 | MA | 4414 | 1694 | 6703 | 1421 | 8181 | 1172 | 9112 | 963 | 10442 | 591 | 13353 | 142 | 12555 |
| 6L-3S | | MI | 2386 | 1694 | 4160 | 1282 | 4884 | 1043 | 5414 | 846 | 6167 | 475 | 7011 | 104 | 6617 |
| 14-#11 | 4.55 | MA | 4207 | 1694 | 6257 | 1430 | 7587 | 1191 | 8431 | 974 | 9492 | 608 | 12041 | 93 | 11618 |
| 7L-2S | | MI | 2514 | 1694 | 4459 | 1277 | 5263 | 1041 | 5874 | 838 | 6773 | 471 | 7721 | 217 | 6653 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

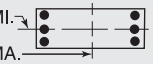
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 6.56 | MA | 4932 | 1974 | 7914 | 1616 | 9678 | 1319 | 10884 | 1064 | 12793 | 593 | 16654 | -27 | 16523 |
| 6L-3S | | MI | 2641 | 1974 | 4909 | 1449 | 5812 | 1162 | 6529 | 921 | 7539 | 430 | 8524 | -100 | 8424 |
| 16-#10 | 4.23 | MA | 4486 | 1650 | 6751 | 1391 | 8290 | 1150 | 9275 | 947 | 10691 | 592 | 13697 | 213 | 12419 |
| 6L-4S | | MI | 2338 | 1650 | 3916 | 1273 | 4586 | 1045 | 5067 | 844 | 5790 | 499 | 6696 | 144 | 6121 |
| 16-#10 | 4.23 | MA | 4318 | 1650 | 6383 | 1399 | 7792 | 1164 | 8715 | 957 | 9908 | 607 | 12621 | 176 | 11764 |
| 7L-3S | | MI | 2398 | 1650 | 4098 | 1268 | 4836 | 1035 | 5372 | 836 | 6205 | 502 | 7150 | 185 | 6350 |
| 16-#10 | 4.23 | MA | 4141 | 1650 | 6029 | 1408 | 7319 | 1171 | 8137 | 972 | 9140 | 621 | 11585 | 124 | 10970 |
| 8L-2S | | MI | 2507 | 1650 | 4350 | 1263 | 5157 | 1032 | 5761 | 835 | 6728 | 499 | 7775 | 278 | 6375 |
| 16-#11 | 5.20 | MA | 4541 | 1784 | 6952 | 1487 | 8469 | 1232 | 9500 | 1000 | 10935 | 604 | 14040 | 87 | 13643 |
| 7L-3S | | MI | 2501 | 1784 | 4459 | 1339 | 5263 | 1084 | 5874 | 872 | 6773 | 468 | 7721 | 70 | 7490 |
| 18-#10 | 4.76 | MA | 4592 | 1724 | 6958 | 1445 | 8522 | 1198 | 9599 | 978 | 11102 | 603 | 14273 | 171 | 13449 |
| 7L-4S | | MI | 2439 | 1724 | 4169 | 1319 | 4907 | 1079 | 5455 | 865 | 6313 | 495 | 7321 | 120 | 6833 |
| 18-#10 | 4.76 | MA | 4417 | 1724 | 6604 | 1454 | 8048 | 1205 | 9021 | 993 | 10333 | 618 | 13237 | 119 | 12651 |
| 8L-3S | | MI | 2496 | 1724 | 4350 | 1314 | 5157 | 1069 | 5761 | 857 | 6728 | 499 | 7775 | 162 | 7089 |
| 20-#10 | 5.29 | MA | 4687 | 1797 | 7179 | 1500 | 8778 | 1239 | 9905 | 1014 | 11527 | 614 | 14890 | 115 | 14331 |
| 8L-4S | | MI | 2540 | 1797 | 4422 | 1365 | 5228 | 1112 | 5844 | 886 | 6836 | 491 | 7946 | 97 | 7548 |

## RECTANGULAR TIED COLUMNS 16" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.22 | MA | 4370 | 1312 | 5939 | 1149 | 7213 | 966 | 7925 | 822 | 8678 | 604 | 10563 | 526 | 4701 |
| 2E | | MI | 2060 | 1312 | 3120 | 1053 | 3538 | 885 | 3749 | 751 | 3912 | 542 | 4353 | 420 | 2181 |
| 4-#14 | 1.76 | MA | 4658 | 1392 | 6617 | 1194 | 8045 | 998 | 8917 | 842 | 10004 | 598 | 12390 | 518 | 6640 |
| 2E | | MI | 2149 | 1392 | 3388 | 1093 | 3853 | 913 | 4120 | 767 | 4362 | 524 | 4843 | 372 | 2971 |
| 4-#18 | 3.13 | MA | 5325 | 1595 | 8276 | 1311 | 10090 | 1083 | 11366 | 893 | 13285 | 582 | 16913 | 499 | 11402 |
| 2E | | MI | 2342 | 1595 | 4008 | 1200 | 4594 | 988 | 4959 | 803 | 5379 | 471 | 5898 | 230 | 4804 |
| 6-#9 | 1.17 | MA | 4369 | 1305 | 5839 | 1154 | 7144 | 971 | 7870 | 827 | 8630 | 610 | 10515 | 531 | 4574 |
| 2L-3S | | MI | 1958 | 1305 | 2873 | 1072 | 3271 | 900 | 3449 | 764 | 3555 | 562 | 3982 | 374 | 2144 |
| 6-#9 | 1.17 | MA | 4074 | 1305 | 5347 | 1164 | 6520 | 980 | 7114 | 836 | 7609 | 623 | 9103 | 466 | 4571 |
| 3L-2S | | MI | 2072 | 1305 | 3075 | 1068 | 3527 | 897 | 3758 | 763 | 3974 | 559 | 4488 | 447 | 2129 |
| 6-#10 | 1.49 | MA | 4550 | 1352 | 6246 | 1181 | 7646 | 990 | 8470 | 839 | 9433 | 607 | 11622 | 527 | 5744 |
| 2L-3S | | MI | 1994 | 1352 | 2990 | 1097 | 3406 | 918 | 3606 | 774 | 3760 | 557 | 4210 | 333 | 2636 |
| 6-#10 | 1.49 | MA | 4188 | 1352 | 5625 | 1193 | 6858 | 1002 | 7515 | 850 | 8144 | 622 | 9837 | 443 | 5722 |
| 3L-2S | | MI | 2133 | 1352 | 3242 | 1092 | 3727 | 915 | 3995 | 773 | 4283 | 553 | 4835 | 425 | 2619 |
| 6-#11 | 1.83 | MA | 4717 | 1403 | 6690 | 1205 | 8167 | 1007 | 9081 | 849 | 10239 | 600 | 12724 | 520 | 6943 |
| 2L-3S | | MI | 2019 | 1403 | 3120 | 1115 | 3538 | 928 | 3749 | 785 | 3912 | 539 | 4353 | 272 | 3121 |
| 6-#11 | 1.83 | MA | 4293 | 1403 | 5939 | 1220 | 7213 | 1021 | 7925 | 861 | 8678 | 618 | 10563 | 414 | 6899 |
| 3L-2S | | MI | 2179 | 1403 | 3420 | 1110 | 3918 | 926 | 4210 | 777 | 4518 | 535 | 5063 | 385 | 3103 |
| 6-#14 | 2.64 | MA | 5133 | 1523 | 7690 | 1275 | 9406 | 1058 | 10566 | 880 | 12231 | 591 | 15473 | 509 | 9826 |
| 2L-3S | | MI | 2100 | 1523 | 3388 | 1181 | 3853 | 973 | 4120 | 813 | 4362 | 517 | 4843 | 153 | 4243 |
| 6-#14 | 2.64 | MA | 4564 | 1523 | 6617 | 1296 | 8045 | 1077 | 8917 | 896 | 10004 | 616 | 12390 | 355 | 9687 |
| 3L-2S | | MI | 2308 | 1523 | 3808 | 1175 | 4386 | 972 | 4766 | 805 | 5198 | 511 | 5808 | 316 | 4247 |
| 6-#18 | 4.69 | MA | 5219 | 1827 | 8276 | 1490 | 10090 | 1219 | 11366 | 986 | 13285 | 611 | 16913 | 200 | 16271 |
| 3L-2S | | MI | 2595 | 1827 | 4714 | 1345 | 5490 | 1094 | 6027 | 867 | 6735 | 437 | 7412 | 109 | 6904 |
| 8-#8 | 1.23 | MA | 4414 | 1315 | 5907 | 1162 | 7245 | 977 | 7999 | 832 | 8811 | 611 | 10771 | 532 | 4822 |
| 2L-4S | | MI | 1947 | 1315 | 2825 | 1086 | 3209 | 915 | 3378 | 776 | 3461 | 563 | 3912 | 365 | 2258 |
| 8-#8 | 1.23 | MA | 4182 | 1315 | 5517 | 1170 | 6750 | 985 | 7399 | 839 | 8001 | 621 | 9650 | 480 | 4819 |
| 3E | | MI | 2001 | 1315 | 2940 | 1082 | 3368 | 908 | 3571 | 771 | 3726 | 564 | 4207 | 393 | 2246 |
| 8-#8 | 1.23 | MA | 4053 | 1315 | 5252 | 1178 | 6381 | 997 | 6947 | 850 | 7382 | 627 | 8898 | 449 | 4791 |
| 4L-2S | | MI | 2091 | 1315 | 3101 | 1078 | 3572 | 906 | 3819 | 769 | 4060 | 562 | 4617 | 450 | 2235 |
| 8-#9 | 1.56 | MA | 4602 | 1363 | 6330 | 1190 | 7768 | 998 | 8626 | 844 | 9650 | 608 | 11928 | 527 | 6040 |
| 2L-4S | | MI | 1979 | 1363 | 2930 | 1113 | 3328 | 935 | 3515 | 788 | 3642 | 557 | 4122 | 323 | 2766 |
| 8-#9 | 1.56 | MA | 4319 | 1363 | 5839 | 1200 | 7144 | 1007 | 7870 | 853 | 8630 | 620 | 10515 | 462 | 6025 |
| 3E | | MI | 2045 | 1363 | 3075 | 1109 | 3527 | 927 | 3758 | 781 | 3974 | 560 | 4488 | 357 | 2759 |
| 8-#9 | 1.56 | MA | 4162 | 1363 | 5504 | 1210 | 6679 | 1022 | 7299 | 867 | 7849 | 627 | 9566 | 422 | 5958 |
| 4L-2S | | MI | 2156 | 1363 | 3276 | 1104 | 3782 | 924 | 4068 | 780 | 4392 | 557 | 4993 | 430 | 2747 |

## RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis

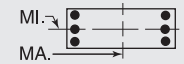



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.98 | MA | 4836 | 1426 | 6867 | 1227 | 8433 | 1024 | 9425 | 860 | 10722 | 603 | 13407 | 522 | 7590 |
| 2L-4S | | MI | 2020 | 1426 | 3061 | 1149 | 3477 | 962 | 3689 | 803 | 3867 | 549 | 4381 | 268 | 3385 |
| 8-#10 | 1.98 | MA | 4491 | 1426 | 6246 | 1240 | 7646 | 1036 | 8470 | 871 | 9433 | 619 | 11622 | 438 | 7554 |
| 3E | | MI | 2101 | 1426 | 3242 | 1144 | 3727 | 951 | 3995 | 795 | 4283 | 553 | 4835 | 310 | 3397 |
| 8-#10 | 1.98 | MA | 4301 | 1426 | 5822 | 1252 | 7057 | 1054 | 7748 | 889 | 8445 | 627 | 10418 | 387 | 7412 |
| 4L-2S | | MI | 2235 | 1426 | 3495 | 1138 | 4047 | 948 | 4383 | 794 | 4806 | 549 | 5460 | 402 | 3387 |
| 8-#11 | 2.44 | MA | 4652 | 1493 | 6690 | 1277 | 8167 | 1062 | 9081 | 887 | 10239 | 614 | 12724 | 408 | 9111 |
| 3E | | MI | 2146 | 1493 | 3420 | 1171 | 3918 | 969 | 4210 | 811 | 4518 | 532 | 5063 | 237 | 4015 |
| 8-#11 | 2.44 | MA | 4431 | 1493 | 6175 | 1292 | 7453 | 1084 | 8205 | 908 | 9040 | 623 | 11253 | 344 | 8762 |
| 4L-2S | | MI | 2295 | 1493 | 3719 | 1166 | 4297 | 967 | 4670 | 804 | 5124 | 527 | 5773 | 351 | 4010 |
| 8-#14 | 3.52 | MA | 5060 | 1653 | 7690 | 1378 | 9406 | 1136 | 10566 | 934 | 12231 | 610 | 15473 | 346 | 12838 |
| 3E | | MI | 2269 | 1653 | 3808 | 1262 | 4386 | 1033 | 4766 | 851 | 5198 | 504 | 5808 | 97 | 5471 |
| 8-#14 | 3.52 | MA | 4769 | 1653 | 6953 | 1399 | 8384 | 1168 | 9314 | 963 | 10517 | 622 | 13359 | 253 | 11661 |
| 4L-2S | | MI | 2464 | 1653 | 4228 | 1256 | 4920 | 1032 | 5413 | 842 | 6035 | 498 | 6774 | 261 | 5504 |
| 8-#18 | 6.25 | MA | 5608 | 2059 | 8853 | 1670 | 10672 | 1377 | 12048 | 1101 | 14165 | 618 | 18547 | 16 | 18455 |
| 4L-2S | | MI | 2844 | 2059 | 5420 | 1490 | 6386 | 1200 | 7095 | 930 | 8090 | 404 | 8927 | -12 | 8919 |
| 10-#10 | 2.48 | MA | 4785 | 1500 | 6867 | 1286 | 8433 | 1069 | 9425 | 892 | 10722 | 615 | 13407 | 433 | 9386 |
| 3L-4S | | MI | 2130 | 1500 | 3314 | 1195 | 3797 | 995 | 4078 | 824 | 4390 | 546 | 5006 | 244 | 4073 |
| 10-#10 | 2.48 | MA | 4610 | 1500 | 6443 | 1298 | 7845 | 1088 | 8703 | 910 | 9734 | 624 | 12203 | 382 | 9236 |
| 4L-3S | | MI | 2207 | 1500 | 3495 | 1190 | 4047 | 985 | 4383 | 816 | 4806 | 549 | 5460 | 286 | 4149 |
| 10-#10 | 2.48 | MA | 4377 | 1500 | 6069 | 1311 | 7330 | 1099 | 8064 | 920 | 8845 | 639 | 10981 | 338 | 8596 |
| 5L-2S | | MI | 2335 | 1500 | 3748 | 1184 | 4368 | 982 | 4772 | 816 | 5329 | 546 | 6085 | 379 | 4148 |
| 10-#11 | 3.05 | MA | 4797 | 1584 | 6927 | 1348 | 8406 | 1126 | 9361 | 934 | 10600 | 619 | 13413 | 339 | 10927 |
| 4L-3S | | MI | 2266 | 1584 | 3719 | 1228 | 4297 | 1011 | 4670 | 837 | 5124 | 524 | 5773 | 203 | 4898 |
| 10-#11 | 3.05 | MA | 4524 | 1584 | 6471 | 1363 | 7780 | 1139 | 8583 | 946 | 9520 | 637 | 11925 | 282 | 10137 |
| 5L-2S | | MI | 2408 | 1584 | 4018 | 1223 | 4677 | 1009 | 5130 | 830 | 5730 | 520 | 6484 | 317 | 4908 |
| 10-#14 | 4.39 | MA | 5279 | 1784 | 8026 | 1480 | 9745 | 1227 | 10963 | 1000 | 12744 | 616 | 16442 | 244 | 14781 |
| 4L-3S | | MI | 2434 | 1784 | 4228 | 1344 | 4920 | 1092 | 5413 | 889 | 6035 | 490 | 6774 | 41 | 6659 |
| 10-#14 | 4.39 | MA | 4899 | 1784 | 7373 | 1501 | 8848 | 1246 | 9851 | 1017 | 11198 | 641 | 14308 | 160 | 13604 |
| 5L-2S | | MI | 2617 | 1784 | 4648 | 1338 | 5453 | 1091 | 6059 | 880 | 6871 | 484 | 7740 | 205 | 6749 |
| 10-#18 | 7.81 | MA | 5832 | 2291 | 9574 | 1850 | 11470 | 1514 | 12970 | 1195 | 15336 | 646 | 20163 | -159 | 19532 |
| 5L-2S | | MI | 3093 | 2291 | 6126 | 1635 | 7282 | 1306 | 8163 | 993 | 9446 | 370 | 10441 | -133 | 10321 |
| 12-#10 | 2.98 | MA | 4909 | 1573 | 7064 | 1344 | 8633 | 1121 | 9658 | 931 | 11023 | 620 | 13988 | 377 | 11063 |
| 4E | | MI | 2242 | 1573 | 3566 | 1241 | 4118 | 1029 | 4466 | 846 | 4913 | 542 | 5631 | 221 | 4769 |
| 12-#10 | 2.98 | MA | 4679 | 1573 | 6689 | 1357 | 8118 | 1133 | 9018 | 942 | 10134 | 635 | 12766 | 333 | 10411 |
| 5L-3S | | MI | 2312 | 1573 | 3748 | 1236 | 4368 | 1019 | 4772 | 838 | 5329 | 545 | 6085 | 263 | 4895 |
| 12-#10 | 2.98 | MA | 4445 | 1573 | 6229 | 1371 | 7632 | 1145 | 8393 | 959 | 9266 | 644 | 11589 | 264 | 9875 |
| 6L-2S | | MI | 2432 | 1573 | 4000 | 1230 | 4688 | 1016 | 5160 | 837 | 5852 | 542 | 6710 | 355 | 4903 |
| 12-#11 | 3.66 | MA | 4882 | 1674 | 7223 | 1420 | 8734 | 1181 | 9739 | 972 | 11081 | 632 | 14085 | 276 | 12339 |
| 5L-3S | | MI | 2384 | 1674 | 4018 | 1285 | 4677 | 1052 | 5130 | 863 | 5730 | 517 | 6484 | 169 | 5777 |
| 12-#11 | 3.66 | MA | 4607 | 1674 | 6670 | 1437 | 8143 | 1194 | 8978 | 993 | 10026 | 642 | 12646 | 191 | 11473 |
| 6L-2S | | MI | 2520 | 1674 | 4318 | 1279 | 5057 | 1050 | 5591 | 856 | 6335 | 513 | 7194 | 282 | 5798 |
| 12-#14 | 5.27 | MA | 5396 | 1914 | 8445 | 1583 | 10209 | 1305 | 11500 | 1055 | 13425 | 635 | 17391 | 152 | 16725 |
| 5L-3S | | MI | 2595 | 1914 | 4648 | 1425 | 5453 | 1152 | 6059 | 926 | 6871 | 477 | 7740 | -14 | 7728 |
| 12-#14 | 5.27 | MA | 5030 | 1914 | 7663 | 1608 | 9363 | 1324 | 10411 | 1084 | 11915 | 647 | 15323 | 27 | 15164 |
| 6L-2S | | MI | 2769 | 1914 | 5069 | 1419 | 5986 | 1151 | 6705 | 918 | 7707 | 471 | 8706 | 149 | 7988 |
| 14-#10 | 3.47 | MA | 4973 | 1647 | 7310 | 1403 | 8906 | 1167 | 9973 | 963 | 11423 | 632 | 14551 | 328 | 12228 |
| 5L-4S | | MI | 2348 | 1647 | 3819 | 1287 | 4439 | 1062 | 4855 | 867 | 5436 | 538 | 6256 | 198 | 5471 |
| 14-#10 | 3.47 | MA | 4749 | 1647 | 6849 | 1417 | 8420 | 1178 | 9348 | 980 | 10555 | 640 | 13374 | 259 | 11692 |
| 6L-3S | | MI | 2413 | 1647 | 4000 | 1282 | 4688 | 1052 | 5160 | 859 | 5852 | 542 | 6710 | 240 | 5639 |
| 14-#10 | 3.47 | MA | 4555 | 1647 | 6453 | 1425 | 7877 | 1192 | 8745 | 991 | 9713 | 656 | 12220 | 224 | 10955 |
| 7L-2S | | MI | 2529 | 1647 | 4253 | 1276 | 5009 | 1049 | 5549 | 858 | 6375 | 538 | 7335 | 332 | 5654 |
| 14-#11 | 4.27 | MA | 4969 | 1765 | 7422 | 1493 | 9097 | 1235 | 10134 | 1019 | 11586 | 637 | 14807 | 185 | 13672 |
| 6L-3S | | MI | 2500 | 1765 | 4318 | 1341 | 5057 | 1093 | 5591 | 889 | 6335 | 510 | 7194 | 134 | 6653 |
| 14-#11 | 4.27 | MA | 4742 | 1765 | 6941 | 1503 | 8447 | 1253 | 9401 | 1031 | 10562 | 655 | 13399 | 138 | 12711 |
| 7L-2S | | MI | 2630 | 1765 | 4617 | 1336 | 5437 | 1091 | 6051 | 882 | 6941 | 506 | 7904 | 248 | 6684 |
| 14-#14 | 6.15 | MA | 5535 | 2045 | 8735 | 1689 | 10724 | 1384 | 12060 | 1121 | 14142 | 641 | 18406 | 19 | 18297 |
| 6L-3S | | MI | 2755 | 2045 | 5069 | 1507 | 5986 | 1212 | 6705 | 964 | 7707 | 464 | 8706 | -70 | 8639 |

## RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 6.15 | MA | 5233 | 2045 | 8047 | 1702 | 9805 | 1410 | 11010 | 1138 | 12676 | 665 | 16385 | -51 | 16232 |
| 7L-2S | | MI | 2920 | 2045 | 5489 | 1501 | 6519 | 1211 | 7352 | 955 | 8543 | 458 | 9671 | 94 | 9222 |
| 16-#10 | 3.97 | MA | 5046 | 1721 | 7470 | 1463 | 9208 | 1212 | 10303 | 1002 | 11844 | 637 | 15159 | 254 | 13510 |
| 6L-4S | | MI | 2451 | 1721 | 4072 | 1333 | 4759 | 1096 | 5244 | 888 | 5959 | 534 | 6881 | 174 | 6178 |
| 16-#10 | 3.97 | MA | 4862 | 1721 | 7074 | 1471 | 8665 | 1226 | 9700 | 1012 | 11002 | 652 | 14005 | 219 | 12777 |
| 7L-3S | | MI | 2513 | 1721 | 4253 | 1328 | 5009 | 1086 | 5549 | 880 | 6375 | 538 | 7335 | 216 | 6380 |
| 16-#10 | 3.97 | MA | 4666 | 1721 | 6693 | 1480 | 8155 | 1234 | 9068 | 1027 | 10175 | 668 | 12893 | 169 | 11959 |
| 8L-2S | | MI | 2624 | 1721 | 4506 | 1322 | 5330 | 1083 | 5938 | 879 | 6898 | 534 | 7960 | 309 | 6402 |
| 16-#11 | 4.88 | MA | 5107 | 1855 | 7692 | 1560 | 9401 | 1295 | 10557 | 1057 | 12123 | 651 | 15559 | 132 | 14902 |
| 7L-3S | | MI | 2615 | 1855 | 4617 | 1398 | 5437 | 1135 | 6051 | 916 | 6941 | 503 | 7904 | 100 | 7528 |
| 16-#11 | 4.88 | MA | 4877 | 1855 | 7230 | 1571 | 8782 | 1304 | 9803 | 1076 | 11117 | 669 | 14204 | 69 | 13913 |
| 8L-2S | | MI | 2740 | 1855 | 4916 | 1392 | 5817 | 1133 | 6512 | 908 | 7547 | 498 | 8614 | 214 | 7567 |
| 16-#14 | 7.03 | MA | 5746 | 2175 | 9120 | 1784 | 11166 | 1469 | 12660 | 1176 | 14903 | 659 | 19468 | -60 | 19206 |
| 7L-3S | | MI | 2913 | 2175 | 5489 | 1588 | 6519 | 1271 | 7352 | 1002 | 8543 | 451 | 9671 | -125 | 9537 |
| 18-#10 | 4.46 | MA | 5161 | 1794 | 7695 | 1517 | 9452 | 1260 | 10654 | 1034 | 12291 | 649 | 15789 | 214 | 14598 |
| 7L-4S | | MI | 2553 | 1794 | 4324 | 1379 | 5080 | 1130 | 5632 | 909 | 6482 | 530 | 7506 | 151 | 6889 |
| 18-#10 | 4.46 | MA | 4968 | 1794 | 7314 | 1526 | 8943 | 1268 | 10023 | 1048 | 11464 | 664 | 14678 | 165 | 13775 |
| 8L-3S | | MI | 2611 | 1794 | 4506 | 1374 | 5330 | 1120 | 5938 | 902 | 6898 | 534 | 7960 | 193 | 7121 |
| 18-#10 | 4.46 | MA | 4751 | 1794 | 6944 | 1537 | 8447 | 1277 | 9398 | 1056 | 10623 | 673 | 13580 | 119 | 12960 |
| 9L-2S | | MI | 2718 | 1794 | 4758 | 1368 | 5650 | 1116 | 6326 | 901 | 7421 | 530 | 8585 | 285 | 7148 |
| 18-#11 | 5.48 | MA | 5236 | 1946 | 7981 | 1627 | 9735 | 1345 | 10959 | 1102 | 12677 | 665 | 16364 | 63 | 16109 |
| 8L-3S | | MI | 2729 | 1946 | 4916 | 1454 | 5817 | 1176 | 6512 | 942 | 7547 | 495 | 8614 | 66 | 8391 |
| 20-#10 | 4.96 | MA | 5262 | 1868 | 7935 | 1572 | 9731 | 1301 | 10978 | 1069 | 12753 | 661 | 16462 | 160 | 15590 |
| 8L-4S | | MI | 2654 | 1868 | 4577 | 1425 | 5401 | 1163 | 6021 | 931 | 7005 | 527 | 8131 | 128 | 7603 |
| 20-#10 | 4.96 | MA | 5055 | 1868 | 7565 | 1583 | 9235 | 1310 | 10353 | 1077 | 11912 | 669 | 15365 | 114 | 14770 |
| 9L-3S | | MI | 2708 | 1868 | 4758 | 1420 | 5650 | 1153 | 6326 | 923 | 7421 | 530 | 8585 | 170 | 7861 |
| 22-#10 | 5.46 | MA | 5352 | 1942 | 8186 | 1629 | 10023 | 1344 | 11308 | 1098 | 13201 | 666 | 17150 | 109 | 16580 |
| 9L-4S | | MI | 2753 | 1942 | 4829 | 1471 | 5721 | 1197 | 6409 | 952 | 7528 | 523 | 8756 | 104 | 8320 |

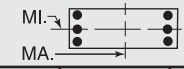
## RECTANGULAR TIED COLUMNS 18" x 18"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#8 | 1.46 | MA | 1544 | 853 | 2278 | 707 | 2667 | 593 | 2887 | 502 | 3131 | 361 | 3667 | 296 | 1882 |
| 2L-3S | | MI | 1437 | 853 | 2089 | 712 | 2427 | 597 | 2595 | 504 | 2738 | 366 | 3161 | 239 | 1889 |
| 6-#9 | 1.85 | MA | 1603 | 890 | 2431 | 728 | 2854 | 607 | 3109 | 511 | 3429 | 358 | 4027 | 285 | 2327 |
| 2L-3S | | MI | 1473 | 890 | 2194 | 734 | 2552 | 612 | 2744 | 513 | 2935 | 363 | 3399 | 212 | 2329 |
| 6-#10 | 2.35 | MA | 1675 | 937 | 2624 | 754 | 3090 | 626 | 3391 | 522 | 3805 | 354 | 4476 | 269 | 2887 |
| 2L-3S | | MI | 1518 | 937 | 2325 | 761 | 2711 | 632 | 2932 | 525 | 3185 | 360 | 3696 | 177 | 2875 |
| 6-#11 | 2.89 | MA | 1734 | 987 | 2821 | 778 | 3317 | 643 | 3656 | 531 | 4154 | 347 | 4816 | 239 | 3433 |
| 2L-3S | | MI | 1554 | 987 | 2465 | 785 | 2866 | 648 | 3108 | 533 | 3415 | 352 | 3917 | 126 | 3404 |
| 6-#14 | 4.17 | MA | 1891 | 1107 | 3277 | 847 | 3879 | 693 | 4329 | 561 | 5040 | 335 | 5813 | 186 | 4758 |
| 2L-3S | | MI | 1663 | 1107 | 2775 | 857 | 3243 | 698 | 3557 | 562 | 4003 | 342 | 4577 | 23 | 4523 |
| 6-#18 | 7.41 | MA | 2249 | 1412 | 4358 | 1026 | 5221 | 822 | 5940 | 641 | 7040 | 286 | 8037 | 26 | 7897 |
| 2L-3S | | MI | 1914 | 1412 | 3507 | 1038 | 4141 | 826 | 4631 | 658 | 5333 | 297 | 6051 | -265 | 5830 |
| 8-#8 | 1.95 | MA | 1624 | 899 | 2468 | 736 | 2908 | 614 | 3179 | 515 | 3525 | 359 | 4173 | 287 | 2453 |
| 2L-4S | | MI | 1462 | 899 | 2144 | 746 | 2482 | 626 | 2661 | 525 | 2822 | 364 | 3306 | 200 | 2437 |
| 8-#9 | 2.47 | MA | 1701 | 948 | 2669 | 764 | 3156 | 634 | 3475 | 527 | 3922 | 355 | 4655 | 272 | 3039 |
| 2L-4S | | MI | 1505 | 948 | 2263 | 776 | 2622 | 648 | 2825 | 539 | 3040 | 360 | 3578 | 163 | 2908 |
| 8-#10 | 3.14 | MA | 1795 | 1011 | 2923 | 800 | 3469 | 660 | 3850 | 543 | 4425 | 351 | 5256 | 252 | 3776 |
| 2L-4S | | MI | 1559 | 1011 | 2412 | 815 | 2797 | 677 | 3033 | 556 | 3317 | 356 | 3917 | 114 | 3466 |
| 8-#11 | 3.85 | MA | 1870 | 1078 | 3177 | 835 | 3769 | 684 | 4203 | 557 | 4892 | 343 | 5715 | 213 | 4489 |
| 2L-4S | | MI | 1610 | 1078 | 2567 | 849 | 2967 | 702 | 3227 | 570 | 3568 | 345 | 4166 | 46 | 3989 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 3.92 | MA | 1911 | 1084 | 3221 | 846 | 3848 | 694 | 4310 | 564 | 5046 | 347 | 6036 | 235 | 4660 |
| 2L-5S | | MI | 1610 | 1084 | 2520 | 868 | 2917 | 716 | 3171 | 581 | 3492 | 359 | 4147 | 41 | 4029 |
| 10-#10 | 3.92 | MA | 1777 | 1084 | 2923 | 853 | 3469 | 699 | 3850 | 568 | 4425 | 353 | 5256 | 143 | 4623 |
| 3L-4S | | MI | 1692 | 1084 | 2711 | 861 | 3176 | 711 | 3492 | 578 | 3937 | 352 | 4697 | 97 | 4299 |
| 10-#11 | 4.81 | MA | 1853 | 1168 | 3177 | 899 | 3769 | 730 | 4203 | 585 | 4892 | 344 | 5715 | 74 | 5475 |
| 3L-4S | | MI | 1766 | 1168 | 2923 | 906 | 3418 | 744 | 3774 | 596 | 4307 | 341 | 5065 | 21 | 4982 |
| **RECTANGULAR TIED COLUMNS 18" x 20"** | | | | | | | | | | | | | | | |
| 4-#9 | 1.11 | MA | 1845 | 912 | 2627 | 771 | 3084 | 649 | 3324 | 553 | 3553 | 408 | 4176 | 346 | 1823 |
| 2E | | MI | 1646 | 912 | 2385 | 760 | 2769 | 640 | 2967 | 545 | 3151 | 402 | 3637 | 333 | 1624 |
| 4-#10 | 1.41 | MA | 1905 | 943 | 2779 | 788 | 3268 | 661 | 3543 | 560 | 3844 | 405 | 4539 | 337 | 2263 |
| 2E | | MI | 1696 | 943 | 2517 | 777 | 2928 | 651 | 3155 | 552 | 3401 | 398 | 3934 | 322 | 2008 |
| 4-#11 | 1.73 | MA | 1955 | 976 | 2945 | 801 | 3452 | 669 | 3753 | 564 | 4117 | 399 | 4826 | 319 | 2704 |
| 2E | | MI | 1737 | 976 | 2660 | 789 | 3084 | 659 | 3332 | 555 | 3630 | 391 | 4152 | 300 | 2390 |
| 4-#14 | 2.50 | MA | 2090 | 1057 | 3308 | 845 | 3894 | 701 | 4279 | 583 | 4820 | 391 | 5652 | 291 | 3755 |
| 2E | | MI | 1847 | 1057 | 2972 | 833 | 3461 | 690 | 3781 | 573 | 4218 | 382 | 4811 | 263 | 3298 |
| 4-#18 | 4.44 | MA | 2387 | 1259 | 4174 | 961 | 4957 | 784 | 5550 | 633 | 6512 | 374 | 7537 | 203 | 6262 |
| 2E | | MI | 2090 | 1259 | 3708 | 947 | 4361 | 773 | 4855 | 623 | 5546 | 347 | 6282 | 154 | 5440 |
| 6-#8 | 1.32 | MA | 1894 | 933 | 2723 | 787 | 3215 | 661 | 3488 | 561 | 3778 | 408 | 4491 | 346 | 2138 |
| 2L-3S | | MI | 1581 | 933 | 2279 | 781 | 2643 | 656 | 2819 | 556 | 2954 | 407 | 3399 | 274 | 1908 |
| 6-#8 | 1.32 | MA | 1769 | 933 | 2505 | 793 | 2938 | 665 | 3152 | 565 | 3325 | 414 | 3887 | 288 | 2145 |
| 3L-2S | | MI | 1688 | 933 | 2468 | 777 | 2883 | 652 | 3110 | 553 | 3348 | 402 | 3906 | 332 | 1899 |
| 6-#9 | 1.67 | MA | 1965 | 970 | 2901 | 807 | 3432 | 675 | 3746 | 570 | 4122 | 405 | 4928 | 337 | 2651 |
| 2L-3S | | MI | 1616 | 970 | 2385 | 802 | 2769 | 671 | 2967 | 565 | 3151 | 404 | 3637 | 248 | 2353 |
| 6-#9 | 1.67 | MA | 1812 | 970 | 2627 | 814 | 3084 | 681 | 3324 | 574 | 3553 | 412 | 4176 | 264 | 2653 |
| 3L-2S | | MI | 1747 | 970 | 2622 | 797 | 3070 | 666 | 3333 | 562 | 3645 | 399 | 4265 | 320 | 2347 |
| 6-#10 | 2.12 | MA | 2052 | 1017 | 3124 | 834 | 3706 | 694 | 4073 | 581 | 4560 | 401 | 5476 | 325 | 3298 |
| 2L-3S | | MI | 1661 | 1017 | 2517 | 830 | 2928 | 690 | 3155 | 576 | 3401 | 401 | 3934 | 212 | 2905 |
| 6-#10 | 2.12 | MA | 1866 | 1017 | 2779 | 842 | 3268 | 701 | 3543 | 586 | 3844 | 410 | 4539 | 233 | 3287 |
| 3L-2S | | MI | 1821 | 1017 | 2816 | 823 | 3307 | 685 | 3615 | 573 | 4021 | 395 | 4714 | 305 | 2909 |
| 6-#11 | 2.60 | MA | 2126 | 1067 | 3358 | 858 | 3976 | 711 | 4387 | 590 | 4973 | 394 | 5917 | 300 | 3939 |
| 2L-3S | | MI | 1697 | 1067 | 2660 | 853 | 3084 | 705 | 3332 | 583 | 3630 | 393 | 4152 | 161 | 3443 |
| 6-#11 | 2.60 | MA | 1912 | 1067 | 2945 | 867 | 3452 | 718 | 3753 | 594 | 4117 | 403 | 4826 | 187 | 3909 |
| 3L-2S | | MI | 1880 | 1067 | 3016 | 846 | 3535 | 701 | 3879 | 581 | 4369 | 387 | 5051 | 274 | 3461 |
| 6-#14 | 3.75 | MA | 2319 | 1187 | 3891 | 927 | 4635 | 761 | 5177 | 620 | 6031 | 385 | 7162 | 259 | 5487 |
| 2L-3S | | MI | 1805 | 1187 | 2972 | 924 | 3461 | 755 | 3781 | 612 | 4218 | 381 | 4811 | 58 | 4670 |
| 6-#14 | 3.75 | MA | 2046 | 1187 | 3308 | 939 | 3894 | 769 | 4279 | 625 | 4820 | 395 | 5652 | 95 | 5378 |
| 3L-2S | | MI | 2039 | 1187 | 3473 | 914 | 4098 | 750 | 4553 | 611 | 5254 | 375 | 6047 | 221 | 4792 |
| 6-#18 | 6.67 | MA | 2753 | 1491 | 5170 | 1106 | 6221 | 890 | 7082 | 700 | 8576 | 362 | 10004 | 130 | 9193 |
| 2L-3S | | MI | 2053 | 1491 | 3708 | 1104 | 4361 | 882 | 4855 | 707 | 5546 | 336 | 6282 | -231 | 6095 |
| 6-#18 | 6.67 | MA | 2352 | 1491 | 4174 | 1123 | 4957 | 900 | 5550 | 703 | 6512 | 373 | 7537 | -161 | 7339 |
| 3L-2S | | MI | 2398 | 1491 | 4559 | 1092 | 5441 | 879 | 6164 | 690 | 7253 | 325 | 8268 | 60 | 7943 |
| 8-#8 | 1.76 | MA | 1989 | 979 | 2941 | 816 | 3492 | 682 | 3823 | 574 | 4231 | 406 | 5096 | 340 | 2794 |
| 2L-4S | | MI | 1605 | 979 | 2334 | 815 | 2698 | 685 | 2884 | 576 | 3039 | 405 | 3544 | 236 | 2467 |
| 8-#8 | 1.76 | MA | 1869 | 979 | 2723 | 821 | 3215 | 686 | 3488 | 578 | 3778 | 412 | 4491 | 282 | 2795 |
| 3E | | MI | 1666 | 979 | 2468 | 810 | 2883 | 676 | 3110 | 569 | 3348 | 405 | 3906 | 266 | 2477 |
| 8-#8 | 1.76 | MA | 1800 | 979 | 2570 | 827 | 3004 | 695 | 3229 | 586 | 3424 | 414 | 4063 | 251 | 2778 |
| 4L-2S | | MI | 1769 | 979 | 2658 | 805 | 3124 | 673 | 3402 | 566 | 3742 | 400 | 4412 | 323 | 2472 |
| 8-#9 | 2.22 | MA | 2081 | 1028 | 3175 | 844 | 3779 | 702 | 4167 | 586 | 4691 | 402 | 5680 | 329 | 3471 |
| 2L-4S | | MI | 1647 | 1028 | 2454 | 845 | 2838 | 707 | 3049 | 590 | 3257 | 401 | 3816 | 198 | 2987 |
| 8-#9 | 2.22 | MA | 1936 | 1028 | 2901 | 850 | 3432 | 707 | 3746 | 591 | 4122 | 409 | 4928 | 256 | 3462 |
| 3E | | MI | 1721 | 1028 | 2622 | 839 | 3070 | 697 | 3333 | 581 | 3645 | 401 | 4265 | 235 | 3058 |
| 8-#9 | 2.22 | MA | 1852 | 1028 | 2708 | 857 | 3166 | 718 | 3420 | 600 | 3678 | 411 | 4395 | 216 | 3382 |
| 4L-2S | | MI | 1847 | 1028 | 2860 | 833 | 3372 | 693 | 3699 | 578 | 4139 | 396 | 4893 | 308 | 3061 |
| 8-#10 | 2.82 | MA | 2195 | 1090 | 3469 | 880 | 4143 | 728 | 4603 | 602 | 5276 | 398 | 6413 | 313 | 4324 |
| 2L-4S | | MI | 1701 | 1090 | 2604 | 883 | 3014 | 736 | 3257 | 607 | 3533 | 396 | 4154 | 149 | 3553 |
| 8-#10 | 2.82 | MA | 2019 | 1090 | 3124 | 888 | 3706 | 735 | 4073 | 607 | 4560 | 406 | 5476 | 221 | 4298 |
| 3E | | MI | 1791 | 1090 | 2816 | 876 | 3307 | 724 | 3615 | 597 | 4021 | 397 | 4714 | 195 | 3783 |

## RECTANGULAR TIED COLUMNS 18" x 20"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

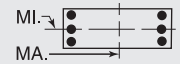
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 2.82 | MA | 1918 | 1090 | 2882 | 897 | 3371 | 748 | 3663 | 619 | 4000 | 407 | 4810 | 171 | 4036 |
| 4L-2S | | MI | 1943 | 1090 | 3115 | 869 | 3686 | 719 | 4074 | 594 | 4641 | 391 | 5494 | 288 | 3801 |
| 8-#11 | 3.47 | MA | 2291 | 1157 | 3770 | 914 | 4499 | 752 | 5021 | 616 | 5830 | 390 | 7007 | 281 | 5163 |
| 2L-4S | | MI | 1744 | 1157 | 2762 | 917 | 3185 | 760 | 3451 | 620 | 3783 | 385 | 4401 | 82 | 4085 |
| 8-#11 | 3.47 | MA | 2090 | 1157 | 3358 | 923 | 3976 | 759 | 4387 | 621 | 4973 | 398 | 5917 | 168 | 5114 |
| 3E | | MI | 1852 | 1157 | 3016 | 910 | 3535 | 747 | 3879 | 609 | 4369 | 388 | 5051 | 135 | 4482 |
| 8-#11 | 3.47 | MA | 1972 | 1157 | 3066 | 933 | 3573 | 775 | 3894 | 634 | 4300 | 398 | 5137 | 110 | 4658 |
| 4L-2S | | MI | 2018 | 1157 | 3372 | 902 | 3987 | 742 | 4427 | 607 | 5108 | 383 | 5950 | 248 | 4519 |
| 8-#14 | 5.00 | MA | 2292 | 1317 | 3891 | 1021 | 4635 | 829 | 5177 | 663 | 6031 | 389 | 7162 | 63 | 6972 |
| 3E | | MI | 2012 | 1317 | 3473 | 1005 | 4098 | 815 | 4553 | 650 | 5254 | 374 | 6047 | 16 | 6004 |
| 8-#14 | 5.00 | MA | 2143 | 1317 | 3477 | 1033 | 4063 | 850 | 4477 | 680 | 5076 | 387 | 6077 | -17 | 6062 |
| 4L-2S | | MI | 2225 | 1317 | 3975 | 996 | 4735 | 810 | 5324 | 649 | 6290 | 368 | 7282 | 179 | 6273 |
| 10-#10 | 3.53 | MA | 2335 | 1164 | 3814 | 926 | 4580 | 762 | 5133 | 624 | 5991 | 394 | 7350 | 301 | 5346 |
| 2L-5S | | MI | 1753 | 1164 | 2712 | 936 | 3134 | 775 | 3395 | 632 | 3708 | 399 | 4385 | 77 | 4160 |
| 10-#10 | 3.53 | MA | 2168 | 1164 | 3469 | 934 | 4143 | 768 | 4603 | 629 | 5276 | 403 | 6413 | 209 | 5308 |
| 3L-4S | | MI | 1834 | 1164 | 2903 | 929 | 3393 | 769 | 3716 | 629 | 4153 | 393 | 4934 | 132 | 4383 |
| 10-#10 | 3.53 | MA | 2074 | 1164 | 3227 | 943 | 3808 | 782 | 4193 | 640 | 4715 | 404 | 5747 | 159 | 5002 |
| 4L-3S | | MI | 1922 | 1164 | 3115 | 922 | 3686 | 757 | 4074 | 619 | 4641 | 394 | 5494 | 178 | 4658 |
| 10-#10 | 3.53 | MA | 1972 | 1164 | 3010 | 951 | 3512 | 789 | 3826 | 645 | 4207 | 412 | 5087 | 105 | 4731 |
| 5L-2S | | MI | 2059 | 1164 | 3413 | 915 | 4065 | 752 | 4533 | 615 | 5262 | 388 | 6274 | 271 | 4687 |
| 10-#11 | 4.33 | MA | 2270 | 1248 | 3770 | 980 | 4499 | 800 | 5021 | 647 | 5830 | 394 | 7007 | 149 | 6318 |
| 3L-4S | | MI | 1907 | 1248 | 3118 | 974 | 3636 | 801 | 3998 | 646 | 4522 | 381 | 5300 | 56 | 5075 |
| 10-#11 | 4.33 | MA | 2156 | 1248 | 3478 | 989 | 4096 | 816 | 4528 | 660 | 5156 | 394 | 6227 | 91 | 5815 |
| 4L-3S | | MI | 1997 | 1248 | 3372 | 966 | 3987 | 788 | 4427 | 635 | 5108 | 384 | 5950 | 109 | 5519 |
| 10-#14 | 6.25 | MA | 2400 | 1448 | 4060 | 1114 | 4803 | 909 | 5374 | 718 | 6287 | 380 | 7587 | -49 | 7515 |
| 4L-3S | | MI | 2212 | 1448 | 3975 | 1087 | 4735 | 875 | 5324 | 687 | 6290 | 367 | 7282 | -27 | 7244 |
| 12-#10 | 4.23 | MA | 2320 | 1237 | 3814 | 980 | 4580 | 802 | 5133 | 650 | 5991 | 399 | 7350 | 197 | 6318 |
| 3L-5S | | MI | 1883 | 1237 | 3011 | 982 | 3513 | 808 | 3854 | 653 | 4329 | 396 | 5165 | 60 | 4980 |
| 12-#10 | 4.23 | MA | 2226 | 1237 | 3571 | 989 | 4246 | 816 | 4723 | 662 | 5431 | 400 | 6684 | 147 | 5975 |
| 4E | | MI | 1972 | 1237 | 3201 | 975 | 3772 | 803 | 4176 | 650 | 4773 | 389 | 5714 | 115 | 5220 |
| 12-#10 | 4.23 | MA | 2126 | 1237 | 3355 | 997 | 3949 | 822 | 4356 | 667 | 4923 | 409 | 6024 | 93 | 5706 |
| 5L-3S | | MI | 2044 | 1237 | 3413 | 968 | 4065 | 791 | 4533 | 640 | 5262 | 390 | 6274 | 161 | 5531 |
| 12-#11 | 5.20 | MA | 2346 | 1338 | 3891 | 1046 | 4619 | 857 | 5163 | 686 | 6012 | 389 | 7318 | 72 | 6981 |
| 4E | | MI | 2058 | 1338 | 3473 | 1030 | 4088 | 843 | 4545 | 672 | 5261 | 376 | 6199 | 30 | 6074 |
| 14-#10 | 4.94 | MA | 2387 | 1311 | 3916 | 1035 | 4683 | 849 | 5253 | 683 | 6147 | 397 | 7621 | 135 | 6953 |
| 4L-5S | | MI | 2017 | 1311 | 3310 | 1028 | 3892 | 842 | 4314 | 674 | 4949 | 392 | 5945 | 43 | 5806 |
| 14-#10 | 4.94 | MA | 2275 | 1311 | 3699 | 1043 | 4387 | 856 | 4886 | 688 | 5638 | 405 | 6961 | 81 | 6672 |
| 5L-4S | | MI | 2098 | 1311 | 3500 | 1021 | 4151 | 837 | 4635 | 671 | 5393 | 386 | 6494 | 98 | 6063 |
| **RECTANGULAR TIED COLUMNS 18" x 22"** | | | | | | | | | | | | | | | |
| 4-#9 | 1.01 | MA | 2220 | 991 | 3092 | 851 | 3659 | 717 | 3953 | 612 | 4221 | 455 | 5013 | 393 | 2039 |
| 2E | | MI | 1790 | 991 | 2575 | 829 | 2985 | 698 | 3191 | 596 | 3368 | 442 | 3875 | 368 | 1641 |
| 4-#10 | 1.28 | MA | 2291 | 1022 | 3266 | 867 | 3869 | 729 | 4202 | 619 | 4553 | 452 | 5442 | 386 | 2537 |
| 2E | | MI | 1840 | 1022 | 2709 | 845 | 3145 | 710 | 3379 | 603 | 3617 | 439 | 4171 | 357 | 2027 |
| 4-#11 | 1.58 | MA | 2352 | 1056 | 3457 | 881 | 4082 | 737 | 4445 | 623 | 4869 | 446 | 5798 | 371 | 3041 |
| 2E | | MI | 1881 | 1056 | 2855 | 857 | 3302 | 717 | 3556 | 605 | 3845 | 431 | 4387 | 335 | 2413 |
| 4-#14 | 2.27 | MA | 2511 | 1136 | 3873 | 925 | 4589 | 769 | 5050 | 642 | 5676 | 439 | 6790 | 348 | 4241 |
| 2E | | MI | 1993 | 1136 | 3168 | 900 | 3680 | 748 | 4005 | 623 | 4432 | 422 | 5045 | 298 | 3327 |
| 4-#18 | 4.04 | MA | 2869 | 1339 | 4873 | 1041 | 5817 | 852 | 6517 | 692 | 7640 | 422 | 9095 | 277 | 7126 |
| 2E | | MI | 2237 | 1339 | 3908 | 1013 | 4581 | 829 | 5079 | 672 | 5759 | 385 | 6513 | 188 | 5480 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis



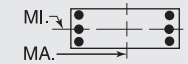

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.20 | MA | 2277 | 1013 | 3200 | 867 | 3806 | 729 | 4136 | 620 | 4474 | 455 | 5375 | 394 | 2393 |
| 2L-3S | | MI | 1724 | 1013 | 2468 | 850 | 2859 | 714 | 3042 | 607 | 3171 | 448 | 3638 | 310 | 1926 |
| 6-#8 | 1.20 | MA | 2133 | 1013 | 2953 | 873 | 3493 | 734 | 3757 | 625 | 3961 | 462 | 4672 | 337 | 2401 |
| 3L-2S | | MI | 1832 | 1013 | 2658 | 846 | 3100 | 711 | 3334 | 605 | 3565 | 443 | 4144 | 368 | 1916 |
| 6-#9 | 1.52 | MA | 2360 | 1049 | 3402 | 887 | 4052 | 743 | 4430 | 629 | 4866 | 452 | 5890 | 387 | 2975 |
| 2L-3S | | MI | 1760 | 1049 | 2575 | 871 | 2985 | 729 | 3191 | 616 | 3368 | 445 | 3875 | 283 | 2375 |
| 6-#9 | 1.52 | MA | 2184 | 1049 | 3092 | 895 | 3659 | 750 | 3953 | 634 | 4221 | 461 | 5013 | 315 | 2977 |
| 3L-2S | | MI | 1892 | 1049 | 2813 | 865 | 3287 | 725 | 3556 | 613 | 3861 | 439 | 4503 | 356 | 2366 |
| 6-#10 | 1.92 | MA | 2462 | 1096 | 3656 | 913 | 4365 | 762 | 4803 | 640 | 5364 | 448 | 6537 | 378 | 3709 |
| 2L-3S | | MI | 1804 | 1096 | 2709 | 898 | 3145 | 748 | 3379 | 627 | 3617 | 441 | 4171 | 248 | 2933 |
| 6-#10 | 1.92 | MA | 2248 | 1096 | 3266 | 923 | 3869 | 770 | 4202 | 647 | 4553 | 459 | 5442 | 286 | 3698 |
| 3L-2S | | MI | 1966 | 1096 | 3008 | 891 | 3524 | 743 | 3838 | 624 | 4237 | 435 | 4951 | 340 | 2931 |
| 6-#11 | 2.36 | MA | 2551 | 1147 | 3926 | 937 | 4677 | 779 | 5166 | 649 | 5843 | 441 | 7082 | 357 | 4444 |
| 2L-3S | | MI | 1840 | 1147 | 2855 | 921 | 3302 | 763 | 3556 | 633 | 3845 | 433 | 4387 | 196 | 3479 |
| 6-#11 | 2.36 | MA | 2302 | 1147 | 3457 | 948 | 4082 | 787 | 4445 | 656 | 4869 | 452 | 5798 | 244 | 4415 |
| 3L-2S | | MI | 2026 | 1147 | 3211 | 913 | 3753 | 758 | 4103 | 631 | 4584 | 427 | 5286 | 309 | 3487 |
| 6-#14 | 3.41 | MA | 2783 | 1267 | 4538 | 1007 | 5433 | 829 | 6072 | 680 | 7056 | 432 | 8578 | 324 | 6216 |
| 2L-3S | | MI | 1948 | 1267 | 3168 | 991 | 3680 | 812 | 4005 | 662 | 4432 | 421 | 5045 | 92 | 4759 |
| 6-#14 | 3.41 | MA | 2451 | 1267 | 3873 | 1021 | 4589 | 840 | 5050 | 687 | 5676 | 446 | 6790 | 161 | 6107 |
| 3L-2S | | MI | 2186 | 1267 | 3670 | 981 | 4317 | 807 | 4777 | 661 | 5469 | 415 | 6281 | 256 | 4825 |
| 6-#18 | 6.06 | MA | 3297 | 1571 | 6014 | 1186 | 7265 | 958 | 8272 | 759 | 10009 | 411 | 12050 | 220 | 10489 |
| 2L-3S | | MI | 2192 | 1571 | 3908 | 1169 | 4581 | 938 | 5079 | 756 | 5759 | 375 | 6513 | -197 | 6359 |
| 6-#18 | 6.06 | MA | 2826 | 1571 | 4873 | 1207 | 5817 | 973 | 6517 | 768 | 7640 | 429 | 9095 | -71 | 8979 |
| 3L-2S | | MI | 2546 | 1571 | 4760 | 1158 | 5662 | 935 | 6388 | 739 | 7466 | 364 | 8499 | 94 | 7988 |
| 8-#8 | 1.60 | MA | 2388 | 1058 | 3447 | 895 | 4120 | 750 | 4516 | 633 | 4986 | 453 | 6079 | 390 | 3135 |
| 2L-4S | | MI | 1748 | 1058 | 2524 | 884 | 2915 | 743 | 3108 | 627 | 3256 | 446 | 3783 | 272 | 2494 |
| 8-#8 | 1.60 | MA | 2249 | 1058 | 3200 | 901 | 3806 | 755 | 4136 | 638 | 4474 | 460 | 5375 | 333 | 3137 |
| 3E | | MI | 1809 | 1058 | 2658 | 879 | 3100 | 735 | 3334 | 620 | 3565 | 445 | 4144 | 301 | 2497 |
| 8-#8 | 1.60 | MA | 2170 | 1058 | 3028 | 908 | 3569 | 765 | 3845 | 647 | 4076 | 463 | 4880 | 300 | 3119 |
| 4L-2S | | MI | 1914 | 1058 | 2848 | 874 | 3340 | 732 | 3626 | 618 | 3958 | 441 | 4651 | 359 | 2491 |
| 8-#9 | 2.02 | MA | 2495 | 1107 | 3712 | 923 | 4446 | 770 | 4907 | 646 | 5510 | 449 | 6767 | 382 | 3903 |
| 2L-4S | | MI | 1790 | 1107 | 2645 | 913 | 3055 | 766 | 3272 | 641 | 3473 | 442 | 4054 | 234 | 3060 |
| 8-#9 | 2.02 | MA | 2327 | 1107 | 3402 | 931 | 4052 | 776 | 4430 | 651 | 4866 | 458 | 5890 | 309 | 3894 |
| 3E | | MI | 1865 | 1107 | 2813 | 907 | 3287 | 756 | 3556 | 632 | 3861 | 442 | 4503 | 271 | 3083 |
| 8-#9 | 2.02 | MA | 2231 | 1107 | 3186 | 939 | 3753 | 788 | 4064 | 662 | 4365 | 461 | 5272 | 268 | 3846 |
| 4L-2S | | MI | 1992 | 1107 | 3051 | 902 | 3589 | 751 | 3922 | 630 | 4355 | 437 | 5131 | 344 | 3082 |
| 8-#10 | 2.57 | MA | 2628 | 1170 | 4047 | 959 | 4860 | 796 | 5404 | 662 | 6175 | 445 | 7633 | 370 | 4873 |
| 2L-4S | | MI | 1843 | 1170 | 2796 | 951 | 3231 | 794 | 3480 | 658 | 3749 | 437 | 4392 | 185 | 3637 |
| 8-#10 | 2.57 | MA | 2425 | 1170 | 3656 | 969 | 4365 | 804 | 4803 | 668 | 5364 | 455 | 6537 | 278 | 4847 |
| 3E | | MI | 1934 | 1170 | 3008 | 944 | 3524 | 782 | 3838 | 648 | 4237 | 438 | 4951 | 231 | 3814 |
| 8-#10 | 2.57 | MA | 2309 | 1170 | 3384 | 978 | 3987 | 819 | 4340 | 681 | 4732 | 458 | 5764 | 226 | 4621 |
| 4L-2S | | MI | 2088 | 1170 | 3306 | 937 | 3903 | 777 | 4298 | 645 | 4858 | 432 | 5731 | 323 | 3826 |
| 8-#11 | 3.15 | MA | 2745 | 1237 | 4395 | 994 | 5272 | 820 | 5888 | 675 | 6816 | 437 | 8365 | 344 | 5837 |
| 2L-4S | | MI | 1885 | 1237 | 2956 | 985 | 3403 | 818 | 3674 | 670 | 3999 | 425 | 4637 | 117 | 4178 |
| 8-#11 | 3.15 | MA | 2510 | 1237 | 3926 | 1004 | 4677 | 829 | 5166 | 682 | 5843 | 448 | 7082 | 230 | 5788 |
| 3E | | MI | 1996 | 1237 | 3211 | 977 | 3753 | 804 | 4103 | 659 | 4584 | 428 | 5286 | 170 | 4521 |
| 8-#11 | 3.15 | MA | 2375 | 1237 | 3597 | 1015 | 4222 | 846 | 4609 | 697 | 5082 | 450 | 6170 | 169 | 5343 |
| 4L-2S | | MI | 2165 | 1237 | 3567 | 970 | 4205 | 800 | 4651 | 657 | 5323 | 423 | 6185 | 283 | 4549 |
| 8-#14 | 4.55 | MA | 2739 | 1397 | 4538 | 1102 | 5433 | 899 | 6072 | 725 | 7056 | 440 | 8578 | 137 | 8043 |
| 3E | | MI | 2155 | 1397 | 3670 | 1072 | 4317 | 872 | 4777 | 700 | 5469 | 414 | 6281 | 50 | 6141 |
| 8-#14 | 4.55 | MA | 2561 | 1397 | 4070 | 1117 | 4786 | 923 | 5280 | 745 | 5974 | 441 | 7304 | 51 | 7067 |
| 4L-2S | | MI | 2374 | 1397 | 4172 | 1063 | 4954 | 867 | 5548 | 698 | 6505 | 408 | 7516 | 214 | 6309 |
| 10-#10 | 3.21 | MA | 2791 | 1243 | 4438 | 1005 | 5356 | 829 | 6004 | 683 | 6986 | 441 | 8728 | 362 | 6032 |
| 2L-5S | | MI | 1895 | 1243 | 2904 | 1005 | 3351 | 833 | 3619 | 683 | 3925 | 440 | 4622 | 113 | 4245 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

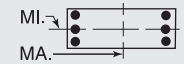
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 3.21 | MA | 2597 | 1243 | 4047 | 1015 | 4860 | 837 | 5404 | 689 | 6175 | 451 | 7633 | 270 | 5994 |
| 3L-4S | | MI | 1976 | 1243 | 3095 | 998 | 3610 | 828 | 3940 | 680 | 4369 | 433 | 5172 | 168 | 4464 |
| 10-#10 | 3.21 | MA | 2490 | 1243 | 3774 | 1024 | 4483 | 852 | 4941 | 702 | 5544 | 455 | 6859 | 218 | 5720 |
| 4L-3S | | MI | 2061 | 1243 | 3306 | 990 | 3903 | 816 | 4298 | 669 | 4858 | 434 | 5731 | 214 | 4691 |
| 10-#10 | 3.21 | MA | 2367 | 1243 | 3531 | 1034 | 4150 | 860 | 4529 | 709 | 4972 | 465 | 6088 | 164 | 5383 |
| 5L-2S | | MI | 2207 | 1243 | 3605 | 983 | 4282 | 811 | 4757 | 666 | 5478 | 428 | 6511 | 306 | 4713 |
| 10-#11 | 3.94 | MA | 2712 | 1327 | 4395 | 1061 | 5272 | 870 | 5888 | 708 | 6816 | 444 | 8365 | 217 | 7160 |
| 3L-4S | | MI | 2049 | 1327 | 3312 | 1041 | 3855 | 859 | 4222 | 696 | 4738 | 421 | 5536 | 91 | 5165 |
| 10-#11 | 3.94 | MA | 2588 | 1327 | 4066 | 1072 | 4817 | 887 | 5331 | 723 | 6055 | 446 | 7454 | 155 | 6665 |
| 4L-3S | | MI | 2142 | 1327 | 3567 | 1034 | 4205 | 846 | 4651 | 686 | 5323 | 424 | 6185 | 144 | 5561 |
| 10-#11 | 3.94 | MA | 2447 | 1327 | 3772 | 1082 | 4415 | 896 | 4833 | 729 | 5365 | 456 | 6550 | 88 | 6241 |
| 5L-2S | | MI | 2301 | 1327 | 3922 | 1026 | 4657 | 841 | 5198 | 684 | 6062 | 419 | 7084 | 258 | 5603 |
| 10-#14 | 5.68 | MA | 2877 | 1527 | 4734 | 1198 | 5629 | 982 | 6302 | 783 | 7354 | 435 | 9092 | 27 | 8959 |
| 4L-3S | | MI | 2355 | 1527 | 4172 | 1154 | 4954 | 932 | 5548 | 737 | 6505 | 407 | 7516 | 8 | 7492 |
| 12-#10 | 3.85 | MA | 2765 | 1317 | 4438 | 1061 | 5356 | 871 | 6004 | 710 | 6986 | 448 | 8728 | 261 | 7141 |
| 3L-5S | | MI | 2026 | 1317 | 3203 | 1051 | 3730 | 867 | 4078 | 704 | 4545 | 436 | 5402 | 96 | 5094 |
| 12-#10 | 3.85 | MA | 2666 | 1317 | 4165 | 1071 | 4979 | 886 | 5542 | 724 | 6355 | 451 | 7954 | 209 | 6827 |
| 4E | | MI | 2106 | 1317 | 3393 | 1044 | 3989 | 861 | 4399 | 701 | 4989 | 430 | 5952 | 151 | 5298 |
| 12-#10 | 3.85 | MA | 2544 | 1317 | 3922 | 1080 | 4646 | 894 | 5130 | 730 | 5783 | 461 | 7183 | 156 | 6508 |
| 5L-3S | | MI | 2189 | 1317 | 3605 | 1036 | 4282 | 849 | 4757 | 691 | 5478 | 431 | 6511 | 197 | 5566 |
| 12-#10 | 3.85 | MA | 2402 | 1317 | 3649 | 1096 | 4331 | 902 | 4725 | 743 | 5235 | 471 | 6476 | 96 | 6044 |
| 6L-2S | | MI | 2323 | 1317 | 3904 | 1029 | 4661 | 844 | 5216 | 688 | 6098 | 425 | 7291 | 289 | 5598 |
| 12-#11 | 4.73 | MA | 2795 | 1418 | 4535 | 1128 | 5412 | 928 | 6052 | 749 | 7029 | 441 | 8738 | 141 | 7995 |
| 4E | | MI | 2200 | 1418 | 3668 | 1098 | 4306 | 900 | 4769 | 722 | 5476 | 416 | 6435 | 65 | 6160 |
| 12-#11 | 4.73 | MA | 2656 | 1418 | 4240 | 1139 | 5010 | 937 | 5554 | 755 | 6339 | 452 | 7834 | 75 | 7558 |
| 5L-3S | | MI | 2284 | 1418 | 3922 | 1090 | 4657 | 887 | 5198 | 712 | 6062 | 420 | 7084 | 119 | 6599 |
| 14-#10 | 4.49 | MA | 2838 | 1391 | 4556 | 1117 | 5475 | 920 | 6143 | 745 | 7166 | 448 | 9050 | 201 | 7940 |
| 4L-5S | | MI | 2160 | 1391 | 3502 | 1097 | 4109 | 900 | 4537 | 725 | 5165 | 433 | 6182 | 79 | 5926 |
| 14-#10 | 4.49 | MA | 2718 | 1391 | 4313 | 1126 | 5142 | 928 | 5731 | 751 | 6594 | 458 | 8279 | 147 | 7636 |
| 5L-4S | | MI | 2241 | 1391 | 3692 | 1090 | 4368 | 895 | 4859 | 722 | 5609 | 426 | 6732 | 134 | 6139 |
| 14-#10 | 4.49 | MA | 2582 | 1391 | 4040 | 1142 | 4827 | 936 | 5326 | 765 | 6046 | 468 | 7571 | 88 | 7163 |
| 6L-3S | | MI | 2310 | 1391 | 3904 | 1082 | 4661 | 883 | 5216 | 712 | 6098 | 427 | 7291 | 180 | 6440 |
| 14-#11 | 5.52 | MA | 2873 | 1508 | 4709 | 1195 | 5605 | 978 | 6275 | 781 | 7312 | 448 | 9118 | 61 | 8882 |
| 5L-4S | | MI | 2347 | 1508 | 4024 | 1154 | 4758 | 942 | 5316 | 749 | 6215 | 412 | 7334 | 40 | 7163 |
| 16-#10 | 5.13 | MA | 2887 | 1464 | 4703 | 1172 | 5638 | 961 | 6332 | 773 | 7405 | 454 | 9374 | 139 | 8768 |
| 5E | | MI | 2285 | 1464 | 3800 | 1143 | 4488 | 934 | 4997 | 746 | 5785 | 429 | 6962 | 62 | 6753 |
| 16-#10 | 5.13 | MA | 2757 | 1464 | 4431 | 1188 | 5323 | 969 | 5927 | 786 | 6858 | 464 | 8667 | 80 | 8286 |
| 6L-4S | | MI | 2365 | 1464 | 3991 | 1136 | 4747 | 929 | 5318 | 743 | 6229 | 423 | 7512 | 117 | 6984 |

## RECTANGULAR TIED COLUMNS 18" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.18 | MA | 2709 | 1102 | 3783 | 947 | 4512 | 796 | 4908 | 678 | 5311 | 499 | 6405 | 434 | 2811 |
| 2E | | MI | 1984 | 1102 | 2901 | 914 | 3362 | 768 | 3602 | 653 | 3833 | 479 | 4408 | 393 | 2045 |
| 4-#11 | 1.44 | MA | 2781 | 1136 | 4001 | 960 | 4755 | 805 | 5186 | 682 | 5671 | 493 | 6830 | 421 | 3378 |
| 2E | | MI | 2026 | 1136 | 3050 | 924 | 3520 | 775 | 3780 | 655 | 4060 | 472 | 4623 | 370 | 2436 |
| 4-#14 | 2.08 | MA | 2966 | 1216 | 4470 | 1005 | 5327 | 837 | 5868 | 701 | 6581 | 486 | 7991 | 403 | 4727 |
| 2E | | MI | 2138 | 1216 | 3365 | 967 | 3899 | 805 | 4229 | 673 | 4647 | 461 | 5279 | 333 | 3354 |
| 4-#18 | 3.70 | MA | 3387 | 1419 | 5603 | 1120 | 6719 | 920 | 7532 | 751 | 8808 | 469 | 10720 | 345 | 7990 |
| 2E | | MI | 2384 | 1419 | 4109 | 1079 | 4802 | 885 | 5302 | 720 | 5972 | 424 | 6744 | 222 | 5520 |
| 6-#8 | 1.10 | MA | 2693 | 1092 | 3708 | 946 | 4440 | 797 | 4833 | 679 | 5219 | 503 | 6287 | 438 | 2649 |
| 2L-3S | | MI | 1867 | 1092 | 2658 | 920 | 3075 | 773 | 3266 | 658 | 3388 | 489 | 3877 | 346 | 1943 |
| 6-#8 | 1.10 | MA | 2530 | 1092 | 3433 | 953 | 4091 | 802 | 4409 | 684 | 4647 | 510 | 5495 | 381 | 2657 |
| 3L-2S | | MI | 1976 | 1092 | 2848 | 915 | 3316 | 770 | 3557 | 656 | 3781 | 484 | 4383 | 404 | 1932 |
| 6-#9 | 1.39 | MA | 2788 | 1129 | 3935 | 966 | 4716 | 811 | 5162 | 688 | 5658 | 499 | 6892 | 434 | 3299 |
| 2L-3S | | MI | 1903 | 1129 | 2766 | 940 | 3202 | 788 | 3414 | 667 | 3584 | 486 | 4113 | 319 | 2396 |
| 6-#9 | 1.39 | MA | 2588 | 1129 | 3588 | 975 | 4277 | 818 | 4629 | 694 | 4939 | 509 | 5896 | 362 | 3301 |
| 3L-2S | | MI | 2036 | 1129 | 3004 | 934 | 3504 | 783 | 3780 | 664 | 4078 | 480 | 4741 | 392 | 2384 |

## RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis



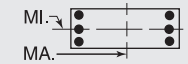

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 1.76 | MA | 2906 | 1176 | 4220 | 993 | 5067 | 830 | 5580 | 699 | 6218 | 495 | 7659 | 429 | 4121 |
| 2L-3S | | MI | 1947 | 1176 | 2901 | 967 | 3362 | 807 | 3602 | 678 | 3833 | 482 | 4408 | 283 | 2959 |
| 6-#10 | 1.76 | MA | 2662 | 1176 | 3783 | 1003 | 4512 | 839 | 4908 | 707 | 5311 | 507 | 6405 | 337 | 4110 |
| 3L-2S | | MI | 2111 | 1176 | 3200 | 960 | 3741 | 802 | 4062 | 675 | 4454 | 476 | 5188 | 376 | 2952 |
| 6-#11 | 2.17 | MA | 3010 | 1226 | 4526 | 1017 | 5421 | 847 | 5994 | 708 | 6762 | 488 | 8308 | 412 | 4950 |
| 2L-3S | | MI | 1983 | 1226 | 3050 | 988 | 3520 | 821 | 3780 | 684 | 4060 | 473 | 4623 | 231 | 3513 |
| 6-#11 | 2.17 | MA | 2726 | 1226 | 4001 | 1029 | 4755 | 856 | 5186 | 716 | 5671 | 501 | 6830 | 298 | 4920 |
| 3L-2S | | MI | 2172 | 1226 | 3406 | 981 | 3972 | 816 | 4327 | 682 | 4799 | 467 | 5522 | 344 | 3513 |
| 6-#14 | 3.13 | MA | 3278 | 1346 | 5217 | 1086 | 6274 | 897 | 7016 | 739 | 8131 | 479 | 10059 | 385 | 6945 |
| 2L-3S | | MI | 2090 | 1346 | 3365 | 1058 | 3899 | 870 | 4229 | 712 | 4647 | 461 | 5279 | 127 | 4808 |
| 6-#14 | 3.13 | MA | 2898 | 1346 | 4470 | 1102 | 5327 | 910 | 5868 | 749 | 6581 | 496 | 7991 | 222 | 6836 |
| 3L-2S | | MI | 2333 | 1346 | 3867 | 1048 | 4536 | 864 | 5000 | 711 | 5683 | 454 | 6515 | 291 | 4857 |
| 6-#18 | 5.56 | MA | 3879 | 1650 | 6889 | 1265 | 8351 | 1026 | 9510 | 818 | 11478 | 458 | 14169 | 301 | 11785 |
| 2L-3S | | MI | 2332 | 1650 | 4109 | 1235 | 4802 | 994 | 5302 | 805 | 5972 | 414 | 6744 | -163 | 6620 |
| 6-#18 | 5.56 | MA | 3335 | 1650 | 5603 | 1290 | 6719 | 1045 | 7532 | 832 | 8808 | 482 | 10720 | 11 | 10690 |
| 3L-2S | | MI | 2694 | 1650 | 4960 | 1224 | 5882 | 991 | 6612 | 787 | 7679 | 403 | 8730 | 128 | 8032 |
| 8-#8 | 1.46 | MA | 2819 | 1138 | 3984 | 975 | 4790 | 817 | 5257 | 693 | 5791 | 500 | 7080 | 435 | 3477 |
| 2L-4S | | MI | 1891 | 1138 | 2714 | 953 | 3131 | 802 | 3331 | 679 | 3472 | 487 | 4022 | 308 | 2519 |
| 8-#8 | 1.46 | MA | 2662 | 1138 | 3708 | 982 | 4440 | 823 | 4833 | 698 | 5219 | 508 | 6287 | 378 | 3478 |
| 3E | | MI | 1953 | 1138 | 2848 | 948 | 3316 | 794 | 3557 | 672 | 3781 | 486 | 4383 | 337 | 2517 |
| 8-#8 | 1.46 | MA | 2573 | 1138 | 3518 | 988 | 4176 | 834 | 4510 | 707 | 4777 | 512 | 5736 | 345 | 3461 |
| 4L-2S | | MI | 2058 | 1138 | 3038 | 943 | 3556 | 791 | 3849 | 669 | 4175 | 482 | 4889 | 395 | 2509 |
| 8-#9 | 1.85 | MA | 2943 | 1187 | 4281 | 1003 | 5156 | 838 | 5695 | 705 | 6378 | 497 | 7888 | 430 | 4335 |
| 2L-4S | | MI | 1933 | 1187 | 2836 | 982 | 3271 | 824 | 3496 | 692 | 3689 | 483 | 4292 | 270 | 3092 |
| 8-#9 | 1.85 | MA | 2752 | 1187 | 3935 | 1011 | 4716 | 845 | 5162 | 711 | 5658 | 506 | 6892 | 358 | 4326 |
| 3E | | MI | 2008 | 1187 | 3004 | 976 | 3504 | 814 | 3780 | 684 | 4078 | 483 | 4741 | 307 | 3107 |
| 8-#9 | 1.85 | MA | 2643 | 1187 | 3695 | 1019 | 4384 | 858 | 4755 | 723 | 5102 | 510 | 6195 | 316 | 4278 |
| 4L-2S | | MI | 2137 | 1187 | 3242 | 970 | 3805 | 810 | 4146 | 681 | 4571 | 477 | 5369 | 380 | 3102 |
| 8-#10 | 2.35 | MA | 3096 | 1249 | 4657 | 1039 | 5621 | 864 | 6252 | 721 | 7125 | 492 | 8914 | 424 | 5422 |
| 2L-4S | | MI | 1986 | 1249 | 2988 | 1020 | 3448 | 853 | 3704 | 709 | 3965 | 477 | 4629 | 220 | 3718 |
| 8-#10 | 2.35 | MA | 2864 | 1249 | 4220 | 1049 | 5067 | 873 | 5580 | 728 | 6218 | 504 | 7659 | 332 | 5396 |
| 3E | | MI | 2078 | 1249 | 3200 | 1013 | 3741 | 840 | 4062 | 699 | 4454 | 478 | 5188 | 266 | 3843 |
| 8-#10 | 2.35 | MA | 2733 | 1249 | 3917 | 1060 | 4647 | 889 | 5066 | 743 | 5515 | 508 | 6778 | 278 | 5219 |
| 4L-2S | | MI | 2234 | 1249 | 3498 | 1006 | 4120 | 835 | 4521 | 696 | 5074 | 472 | 5968 | 359 | 3849 |
| 8-#11 | 2.89 | MA | 3232 | 1317 | 5051 | 1073 | 6088 | 888 | 6802 | 734 | 7853 | 484 | 9787 | 402 | 6511 |
| 2L-4S | | MI | 2027 | 1317 | 3151 | 1052 | 3621 | 875 | 3898 | 720 | 4214 | 465 | 4872 | 152 | 4268 |
| 8-#11 | 2.89 | MA | 2964 | 1317 | 4526 | 1085 | 5421 | 898 | 5994 | 742 | 6762 | 497 | 8308 | 289 | 6462 |
| 3E | | MI | 2139 | 1317 | 3406 | 1045 | 3972 | 862 | 4327 | 710 | 4799 | 468 | 5522 | 205 | 4558 |
| 8-#11 | 2.89 | MA | 2811 | 1317 | 4160 | 1097 | 4914 | 916 | 5373 | 759 | 5913 | 501 | 7265 | 224 | 6044 |
| 4L-2S | | MI | 2312 | 1317 | 3761 | 1037 | 4423 | 857 | 4874 | 708 | 5538 | 463 | 6421 | 319 | 4578 |
| 8-#14 | 4.17 | MA | 3227 | 1477 | 5217 | 1184 | 6274 | 969 | 7016 | 787 | 8131 | 490 | 10059 | 205 | 9015 |
| 3E | | MI | 2298 | 1477 | 3867 | 1139 | 4536 | 929 | 5000 | 749 | 5683 | 453 | 6515 | 85 | 6264 |
| 8-#14 | 4.17 | MA | 3026 | 1477 | 4694 | 1200 | 5552 | 995 | 6131 | 809 | 6922 | 494 | 8595 | 114 | 8005 |
| 4L-2S | | MI | 2521 | 1477 | 4369 | 1130 | 5172 | 924 | 5772 | 748 | 6719 | 447 | 7750 | 249 | 6344 |
| 8-#18 | 7.41 | MA | 3878 | 1882 | 6889 | 1435 | 8351 | 1151 | 9510 | 899 | 11478 | 471 | 14169 | -33 | 14077 |
| 3E | | MI | 2673 | 1882 | 4960 | 1380 | 5882 | 1100 | 6612 | 872 | 7679 | 393 | 8730 | -256 | 8470 |
| 8-#18 | 7.41 | MA | 3592 | 1882 | 5983 | 1461 | 7098 | 1193 | 7976 | 934 | 9384 | 473 | 11710 | -185 | 11381 |
| 4L-2S | | MI | 2999 | 1882 | 5811 | 1369 | 6962 | 1097 | 7921 | 854 | 9386 | 382 | 10715 | 34 | 10529 |
| 10-#10 | 2.94 | MA | 3281 | 1323 | 5094 | 1085 | 6175 | 897 | 6924 | 742 | 8031 | 488 | 10168 | 419 | 6718 |
| 2L-5S | | MI | 2038 | 1323 | 3096 | 1073 | 3568 | 891 | 3842 | 734 | 4141 | 480 | 4859 | 148 | 4318 |
| 10-#10 | 2.94 | MA | 3060 | 1323 | 4657 | 1095 | 5621 | 906 | 6252 | 749 | 7125 | 500 | 8914 | 327 | 6680 |
| 3L-4S | | MI | 2119 | 1323 | 3287 | 1066 | 3827 | 886 | 4163 | 730 | 4585 | 474 | 5409 | 203 | 4542 |
| 10-#10 | 2.94 | MA | 2939 | 1323 | 4354 | 1106 | 5201 | 922 | 5738 | 764 | 6422 | 505 | 8032 | 273 | 6453 |
| 4L-3S | | MI | 2205 | 1323 | 3498 | 1059 | 4120 | 874 | 4521 | 720 | 5074 | 475 | 5968 | 249 | 4722 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

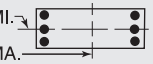
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.94 | MA | 2795 | 1323 | 4084 | 1116 | 4832 | 931 | 5280 | 771 | 5786 | 516 | 7150 | 219 | 6043 |
| 5L-2S | | MI | 2355 | 1323 | 3797 | 1052 | 4499 | 869 | 4981 | 717 | 5694 | 469 | 6748 | 342 | 4739 |
| 10-#11 | 3.61 | MA | 3194 | 1407 | 5051 | 1142 | 6088 | 939 | 6802 | 768 | 7853 | 493 | 9787 | 279 | 8002 |
| 3L-4S | | MI | 2190 | 1407 | 3507 | 1109 | 4073 | 917 | 4445 | 747 | 4953 | 461 | 5771 | 126 | 5252 |
| 10-#11 | 3.61 | MA | 3054 | 1407 | 4685 | 1153 | 5581 | 958 | 6181 | 785 | 7004 | 497 | 8743 | 215 | 7531 |
| 4L-3S | | MI | 2286 | 1407 | 3761 | 1101 | 4423 | 903 | 4874 | 736 | 5538 | 464 | 6421 | 180 | 5600 |
| 10-#11 | 3.61 | MA | 2888 | 1407 | 4358 | 1165 | 5134 | 968 | 5627 | 793 | 6235 | 509 | 7703 | 149 | 7086 |
| 5L-2S | | MI | 2449 | 1407 | 4117 | 1094 | 4875 | 899 | 5422 | 734 | 6277 | 459 | 7320 | 293 | 5634 |
| 10-#14 | 5.21 | MA | 3365 | 1607 | 5441 | 1281 | 6499 | 1055 | 7279 | 847 | 8471 | 488 | 10662 | 97 | 10138 |
| 4L-3S | | MI | 2499 | 1607 | 4369 | 1221 | 5172 | 989 | 5772 | 787 | 6719 | 446 | 7750 | 43 | 7620 |
| 10-#14 | 5.21 | MA | 3135 | 1607 | 4974 | 1298 | 5861 | 1068 | 6488 | 857 | 7376 | 505 | 9207 | 2 | 9201 |
| 5L-2S | | MI | 2707 | 1607 | 4870 | 1211 | 5809 | 984 | 6544 | 786 | 7756 | 440 | 8986 | 206 | 7823 |
| 12-#10 | 3.53 | MA | 3252 | 1397 | 5094 | 1141 | 6175 | 940 | 6924 | 771 | 8031 | 497 | 10168 | 322 | 7964 |
| 3L-5S | | MI | 2169 | 1397 | 3395 | 1119 | 3947 | 925 | 4302 | 755 | 4761 | 477 | 5639 | 131 | 5165 |
| 12-#10 | 3.53 | MA | 3139 | 1397 | 4791 | 1152 | 5755 | 956 | 6410 | 785 | 7328 | 501 | 9287 | 268 | 7694 |
| 4E | | MI | 2249 | 1397 | 3585 | 1112 | 4206 | 920 | 4623 | 752 | 5205 | 470 | 6189 | 186 | 5374 |
| 12-#10 | 3.53 | MA | 2997 | 1397 | 4521 | 1162 | 5386 | 965 | 5952 | 793 | 6693 | 513 | 8404 | 214 | 7303 |
| 5L-3S | | MI | 2334 | 1397 | 3797 | 1105 | 4499 | 908 | 4981 | 742 | 5694 | 471 | 6748 | 233 | 5599 |
| 12-#10 | 3.53 | MA | 2836 | 1397 | 4211 | 1177 | 5037 | 974 | 5503 | 807 | 6071 | 517 | 7541 | 143 | 6833 |
| 6L-2S | | MI | 2471 | 1397 | 4096 | 1098 | 4878 | 903 | 5440 | 738 | 6314 | 465 | 7529 | 325 | 5625 |
| 12-#11 | 4.33 | MA | 3290 | 1497 | 5211 | 1210 | 6248 | 999 | 6989 | 811 | 8095 | 492 | 10222 | 206 | 9027 |
| 4E | | MI | 2342 | 1497 | 3863 | 1165 | 4524 | 958 | 4993 | 773 | 5692 | 456 | 6670 | 100 | 6245 |
| 12-#11 | 4.33 | MA | 3126 | 1497 | 4884 | 1222 | 5801 | 1009 | 6435 | 819 | 7326 | 505 | 9181 | 140 | 8606 |
| 5L-3S | | MI | 2429 | 1497 | 4117 | 1158 | 4875 | 945 | 5422 | 762 | 6277 | 460 | 7320 | 154 | 6640 |
| 12-#11 | 4.33 | MA | 2938 | 1497 | 4517 | 1241 | 5378 | 1019 | 5892 | 836 | 6590 | 518 | 8227 | 66 | 7909 |
| 6L-2S | | MI | 2583 | 1497 | 4473 | 1150 | 5326 | 940 | 5969 | 760 | 7016 | 454 | 8219 | 267 | 6686 |
| 12-#14 | 6.25 | MA | 3466 | 1737 | 5721 | 1379 | 6808 | 1127 | 7636 | 895 | 8926 | 499 | 11274 | -16 | 11245 |
| 5L-3S | | MI | 2696 | 1737 | 4870 | 1302 | 5809 | 1048 | 6544 | 825 | 7756 | 439 | 8986 | 1 | 8984 |
| 14-#10 | 4.12 | MA | 3335 | 1470 | 5227 | 1198 | 6310 | 990 | 7081 | 806 | 8235 | 498 | 10541 | 263 | 8942 |
| 4L-5S | | MI | 2297 | 1470 | 3694 | 1165 | 4326 | 959 | 4761 | 776 | 5381 | 473 | 6419 | 114 | 6016 |
| 14-#10 | 4.12 | MA | 3193 | 1470 | 4958 | 1208 | 5940 | 998 | 6623 | 814 | 7600 | 509 | 9659 | 209 | 8568 |
| 5L-4S | | MI | 2385 | 1470 | 3884 | 1158 | 4585 | 954 | 5082 | 773 | 5825 | 467 | 6969 | 169 | 6213 |
| 14-#10 | 4.12 | MA | 3040 | 1470 | 4648 | 1223 | 5591 | 1007 | 6175 | 829 | 6978 | 514 | 8796 | 138 | 8090 |
| 6L-3S | | MI | 2456 | 1470 | 4096 | 1151 | 4878 | 941 | 5440 | 763 | 6314 | 468 | 7529 | 216 | 6474 |
| 14-#11 | 5.06 | MA | 3358 | 1588 | 5409 | 1278 | 6468 | 1050 | 7243 | 845 | 8417 | 501 | 10660 | 130 | 10103 |
| 5L-4S | | MI | 2490 | 1588 | 4219 | 1222 | 4976 | 999 | 5540 | 799 | 6430 | 452 | 7569 | 75 | 7245 |
| 14-#11 | 5.06 | MA | 3179 | 1588 | 5042 | 1297 | 6045 | 1060 | 6700 | 862 | 7681 | 514 | 9705 | 56 | 9423 |
| 6L-3S | | MI | 2570 | 1588 | 4473 | 1214 | 5326 | 986 | 5969 | 788 | 7016 | 455 | 8219 | 128 | 7679 |
| 16-#10 | 4.70 | MA | 3386 | 1544 | 5395 | 1254 | 6495 | 1032 | 7295 | 835 | 8507 | 506 | 10913 | 204 | 9836 |
| 5E | | MI | 2429 | 1544 | 3992 | 1211 | 4705 | 992 | 5221 | 797 | 6001 | 470 | 7200 | 97 | 6866 |
| 16-#10 | 4.70 | MA | 3239 | 1544 | 5085 | 1269 | 6145 | 1041 | 6846 | 850 | 7885 | 510 | 10050 | 133 | 9351 |
| 6L-4S | | MI | 2509 | 1544 | 4183 | 1204 | 4964 | 987 | 5542 | 794 | 6445 | 463 | 7749 | 152 | 7056 |
| 16-#11 | 5.78 | MA | 3415 | 1678 | 5567 | 1354 | 6712 | 1101 | 7508 | 888 | 8772 | 509 | 11183 | 47 | 10941 |
| 6L-4S | | MI | 2635 | 1678 | 4575 | 1278 | 5427 | 1041 | 6087 | 825 | 7169 | 448 | 8468 | 49 | 8251 |
| 18-#10 | 5.29 | MA | 3434 | 1617 | 5521 | 1315 | 6700 | 1075 | 7518 | 871 | 8792 | 507 | 11305 | 128 | 10614 |
| 6L-5S | | MI | 2552 | 1617 | 4291 | 1257 | 5084 | 1026 | 5680 | 819 | 6621 | 466 | 7980 | 80 | 7696 |

## RECTANGULAR TIED COLUMNS 18" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.09 | MA | 3161 | 1182 | 4333 | 1026 | 5199 | 864 | 5663 | 737 | 6119 | 546 | 7374 | 475 | 3086 |
| 2E | | MI | 2128 | 1182 | 3093 | 982 | 3579 | 826 | 3826 | 704 | 4050 | 520 | 4646 | 428 | 2062 |
| 4-#11 | 1.33 | MA | 3244 | 1215 | 4576 | 1040 | 5470 | 873 | 5974 | 741 | 6522 | 540 | 7920 | 469 | 3715 |
| 2E | | MI | 2170 | 1215 | 3245 | 992 | 3738 | 832 | 4003 | 706 | 4276 | 512 | 4858 | 405 | 2457 |
| 4-#14 | 1.92 | MA | 3454 | 1295 | 5099 | 1084 | 6108 | 905 | 6734 | 760 | 7536 | 533 | 9253 | 455 | 5213 |
| 2E | | MI | 2283 | 1295 | 3562 | 1034 | 4118 | 862 | 4452 | 723 | 4862 | 501 | 5513 | 368 | 3381 |
| 4-#18 | 3.42 | MA | 3938 | 1498 | 6366 | 1200 | 7665 | 988 | 8594 | 810 | 10026 | 516 | 12411 | 408 | 8854 |
| 2E | | MI | 2530 | 1498 | 4310 | 1144 | 5022 | 941 | 5526 | 769 | 6185 | 463 | 6975 | 256 | 5560 |

## RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

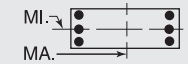
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.01 | MA | 3141 | 1172 | 4249 | 1026 | 5118 | 864 | 5578 | 738 | 6014 | 550 | 7238 | 479 | 2905 |
| 2L-3S | | MI | 2010 | 1172 | 2848 | 989 | 3291 | 832 | 3489 | 710 | 3604 | 529 | 4116 | 382 | 1959 |
| 6-#8 | 1.01 | MA | 2959 | 1172 | 3945 | 1033 | 4732 | 871 | 5110 | 744 | 5383 | 558 | 6363 | 424 | 2913 |
| 3L-2S | | MI | 2120 | 1172 | 3038 | 984 | 3532 | 829 | 3781 | 707 | 3998 | 525 | 4622 | 439 | 1948 |
| 6-#9 | 1.28 | MA | 3249 | 1208 | 4499 | 1046 | 5423 | 879 | 5942 | 747 | 6501 | 546 | 7907 | 475 | 3623 |
| 2L-3S | | MI | 2046 | 1208 | 2957 | 1009 | 3418 | 847 | 3638 | 718 | 3800 | 526 | 4351 | 355 | 2415 |
| 6-#9 | 1.28 | MA | 3025 | 1208 | 4117 | 1055 | 4938 | 887 | 5353 | 754 | 5706 | 557 | 6807 | 405 | 3625 |
| 3L-2S | | MI | 2181 | 1208 | 3195 | 1003 | 3720 | 842 | 4004 | 715 | 4294 | 521 | 4979 | 428 | 2402 |
| 6-#10 | 1.63 | MA | 3382 | 1255 | 4816 | 1072 | 5812 | 898 | 6406 | 759 | 7121 | 543 | 8761 | 471 | 4532 |
| 2L-3S | | MI | 2090 | 1255 | 3093 | 1035 | 3579 | 865 | 3826 | 729 | 4050 | 522 | 4646 | 319 | 2983 |
| 6-#10 | 1.63 | MA | 3108 | 1255 | 4333 | 1084 | 5199 | 908 | 5663 | 767 | 6119 | 555 | 7374 | 381 | 4521 |
| 3L-2S | | MI | 2255 | 1255 | 3392 | 1028 | 3958 | 860 | 4285 | 726 | 4670 | 516 | 5426 | 411 | 2972 |
| 6-#11 | 2.00 | MA | 3502 | 1306 | 5158 | 1096 | 6209 | 914 | 6869 | 767 | 7730 | 536 | 9593 | 463 | 5455 |
| 2L-3S | | MI | 2126 | 1306 | 3245 | 1056 | 3738 | 878 | 4003 | 734 | 4276 | 513 | 4858 | 266 | 3544 |
| 6-#11 | 2.00 | MA | 3183 | 1306 | 4576 | 1109 | 5470 | 925 | 5974 | 777 | 6522 | 550 | 7920 | 350 | 5426 |
| 3L-2S | | MI | 2316 | 1306 | 3600 | 1048 | 4190 | 874 | 4551 | 732 | 5014 | 507 | 5757 | 379 | 3538 |
| 6-#14 | 2.88 | MA | 3807 | 1426 | 5927 | 1166 | 7159 | 964 | 8007 | 798 | 9255 | 526 | 11602 | 443 | 7674 |
| 2L-3S | | MI | 2233 | 1426 | 3562 | 1125 | 4118 | 927 | 4452 | 762 | 4862 | 500 | 5513 | 162 | 4853 |
| 6-#14 | 2.88 | MA | 3379 | 1426 | 5099 | 1183 | 6108 | 979 | 6734 | 810 | 7536 | 546 | 9253 | 280 | 7565 |
| 3L-2S | | MI | 2479 | 1426 | 4064 | 1115 | 4755 | 921 | 5224 | 760 | 5898 | 494 | 6749 | 326 | 4888 |
| 6-#18 | 5.13 | MA | 4498 | 1730 | 7797 | 1345 | 9480 | 1094 | 10795 | 877 | 12997 | 505 | 16356 | 375 | 13081 |
| 2L-3S | | MI | 2473 | 1730 | 4310 | 1301 | 5022 | 1050 | 5526 | 854 | 6185 | 453 | 6975 | -128 | 6880 |
| 6-#18 | 5.13 | MA | 3853 | 1730 | 6366 | 1373 | 7665 | 1117 | 8594 | 895 | 10026 | 534 | 12411 | 85 | 12146 |
| 3L-2S | | MI | 2841 | 1730 | 5161 | 1289 | 6102 | 1047 | 6835 | 836 | 7892 | 442 | 8961 | 162 | 8075 |
| 8-#8 | 1.35 | MA | 3284 | 1217 | 4553 | 1054 | 5504 | 885 | 6046 | 752 | 6646 | 547 | 8112 | 476 | 3818 |
| 2L-4S | | MI | 2034 | 1217 | 2904 | 1022 | 3347 | 861 | 3555 | 730 | 3689 | 527 | 4261 | 343 | 2541 |
| 8-#8 | 1.35 | MA | 3107 | 1217 | 4249 | 1062 | 5118 | 892 | 5578 | 757 | 6014 | 556 | 7238 | 421 | 3819 |
| 3E | | MI | 2096 | 1217 | 3038 | 1017 | 3532 | 853 | 3781 | 723 | 3998 | 527 | 4622 | 373 | 2535 |
| 8-#8 | 1.35 | MA | 3008 | 1217 | 4040 | 1069 | 4827 | 902 | 5222 | 767 | 5528 | 560 | 6636 | 388 | 3802 |
| 4L-2S | | MI | 2203 | 1217 | 3228 | 1012 | 3772 | 849 | 4073 | 720 | 4392 | 523 | 5128 | 431 | 2526 |
| 8-#9 | 1.71 | MA | 3423 | 1266 | 4882 | 1082 | 5909 | 905 | 6531 | 764 | 7296 | 544 | 9007 | 471 | 4767 |
| 2L-4S | | MI | 2075 | 1266 | 3027 | 1051 | 3488 | 883 | 3719 | 743 | 3906 | 523 | 4530 | 306 | 3122 |
| 8-#9 | 1.71 | MA | 3209 | 1266 | 4499 | 1091 | 5423 | 913 | 5942 | 771 | 6501 | 554 | 7907 | 401 | 4758 |
| 3E | | MI | 2152 | 1266 | 3195 | 1045 | 3720 | 873 | 4004 | 735 | 4294 | 523 | 4979 | 343 | 3130 |
| 8-#9 | 1.71 | MA | 3088 | 1266 | 4236 | 1100 | 5058 | 927 | 5494 | 783 | 5888 | 559 | 7147 | 360 | 4710 |
| 4L-2S | | MI | 2282 | 1266 | 3433 | 1039 | 4022 | 869 | 4369 | 732 | 4788 | 518 | 5608 | 415 | 3122 |
| 8-#10 | 2.17 | MA | 3597 | 1329 | 5299 | 1119 | 6424 | 932 | 7148 | 780 | 8123 | 539 | 10149 | 466 | 5970 |
| 2L-4S | | MI | 2128 | 1329 | 3180 | 1088 | 3665 | 911 | 3928 | 760 | 4181 | 518 | 4866 | 256 | 3796 |
| 8-#10 | 2.17 | MA | 3336 | 1329 | 4816 | 1130 | 5812 | 941 | 6406 | 788 | 7121 | 552 | 8761 | 376 | 5944 |
| 3E | | MI | 2221 | 1329 | 3392 | 1081 | 3958 | 899 | 4285 | 750 | 4670 | 519 | 5426 | 302 | 3871 |
| 8-#10 | 2.17 | MA | 3189 | 1329 | 4483 | 1141 | 5350 | 958 | 5840 | 804 | 6347 | 558 | 7798 | 323 | 5831 |
| 4L-2S | | MI | 2379 | 1329 | 3690 | 1074 | 4337 | 894 | 4745 | 747 | 5290 | 513 | 6206 | 394 | 3871 |
| 8-#11 | 2.67 | MA | 3753 | 1396 | 5740 | 1153 | 6948 | 956 | 7764 | 794 | 8939 | 531 | 11266 | 457 | 7185 |
| 2L-4S | | MI | 2169 | 1396 | 3346 | 1120 | 3839 | 933 | 4122 | 771 | 4429 | 505 | 5107 | 187 | 4355 |
| 8-#11 | 2.67 | MA | 3450 | 1396 | 5158 | 1166 | 6209 | 967 | 6869 | 803 | 7730 | 546 | 9593 | 344 | 7135 |
| 3E | | MI | 2278 | 1396 | 3600 | 1112 | 4190 | 920 | 4551 | 760 | 5014 | 508 | 5757 | 240 | 4593 |
| 8-#11 | 2.67 | MA | 3280 | 1396 | 4754 | 1178 | 5650 | 986 | 6184 | 821 | 6794 | 551 | 8418 | 277 | 6760 |
| 4L-2S | | MI | 2458 | 1396 | 3956 | 1105 | 4641 | 915 | 5098 | 758 | 5753 | 503 | 6656 | 354 | 4605 |
| 8-#14 | 3.85 | MA | 3749 | 1556 | 5927 | 1265 | 7159 | 1039 | 8007 | 848 | 9255 | 540 | 11602 | 268 | 9987 |
| 3E | | MI | 2441 | 1556 | 4064 | 1206 | 4755 | 986 | 5224 | 799 | 5898 | 493 | 6749 | 120 | 6313 |
| 8-#14 | 3.85 | MA | 3525 | 1556 | 5351 | 1282 | 6361 | 1066 | 7030 | 872 | 7920 | 546 | 9948 | 174 | 8960 |
| 4L-2S | | MI | 2669 | 1556 | 4566 | 1197 | 5391 | 981 | 5996 | 798 | 6934 | 487 | 7984 | 283 | 6378 |
| 8-#18 | 6.84 | MA | 4492 | 1962 | 7797 | 1518 | 9480 | 1223 | 10795 | 962 | 12997 | 523 | 16356 | 52 | 16170 |
| 3E | | MI | 2814 | 1962 | 5161 | 1446 | 6102 | 1156 | 6835 | 920 | 7892 | 432 | 8961 | -222 | 8742 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis

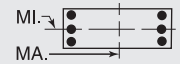



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 6.84 | MA | 4171 | 1962 | 6794 | 1546 | 8094 | 1268 | 9098 | 1002 | 10677 | 530 | 13560 | -107 | 13329 |
| 4L-2S | | MI | 3148 | 1962 | 6012 | 1434 | 7182 | 1153 | 8144 | 903 | 9600 | 421 | 10946 | 68 | 10575 |
| 10-#10 | 2.71 | MA | 3806 | 1402 | 5782 | 1165 | 7037 | 965 | 7891 | 801 | 9126 | 535 | 11537 | 461 | 7403 |
| 2L-5S | | MI | 2180 | 1402 | 3288 | 1142 | 3785 | 950 | 4066 | 785 | 4357 | 521 | 5097 | 184 | 4388 |
| 10-#10 | 2.71 | MA | 3557 | 1402 | 5299 | 1176 | 6424 | 975 | 7148 | 810 | 8123 | 548 | 10149 | 371 | 7366 |
| 3L-4S | | MI | 2261 | 1402 | 3479 | 1134 | 4044 | 945 | 4387 | 781 | 4801 | 514 | 5646 | 239 | 4618 |
| 10-#10 | 2.71 | MA | 3421 | 1402 | 4966 | 1187 | 5962 | 992 | 6582 | 825 | 7349 | 554 | 9186 | 318 | 7200 |
| 4L-3S | | MI | 2349 | 1402 | 3690 | 1127 | 4337 | 932 | 4745 | 771 | 5290 | 515 | 6206 | 285 | 4752 |
| 10-#10 | 2.71 | MA | 3255 | 1402 | 4670 | 1198 | 5557 | 1002 | 6079 | 834 | 6650 | 567 | 8218 | 267 | 6711 |
| 5L-2S | | MI | 2501 | 1402 | 3989 | 1120 | 4716 | 927 | 5204 | 768 | 5910 | 509 | 6986 | 377 | 4764 |
| 10-#11 | 3.33 | MA | 3710 | 1487 | 5740 | 1222 | 6948 | 1008 | 7764 | 829 | 8939 | 541 | 11266 | 338 | 8845 |
| 3L-4S | | MI | 2333 | 1487 | 3702 | 1176 | 4291 | 974 | 4669 | 797 | 5168 | 501 | 6006 | 161 | 5336 |
| 10-#11 | 3.33 | MA | 3554 | 1487 | 5336 | 1235 | 6389 | 1028 | 7079 | 847 | 8002 | 547 | 10091 | 271 | 8413 |
| 4L-3S | | MI | 2430 | 1487 | 3956 | 1169 | 4641 | 961 | 5098 | 786 | 5753 | 504 | 6656 | 215 | 5638 |
| 10-#11 | 3.33 | MA | 3361 | 1487 | 4977 | 1248 | 5897 | 1039 | 6469 | 856 | 7156 | 561 | 8914 | 206 | 7882 |
| 5L-2S | | MI | 2596 | 1487 | 4312 | 1162 | 5093 | 956 | 5645 | 784 | 6492 | 499 | 7555 | 328 | 5664 |
| 10-#14 | 4.81 | MA | 3906 | 1687 | 6179 | 1364 | 7412 | 1126 | 8303 | 910 | 9638 | 540 | 12296 | 162 | 11335 |
| 4L-3S | | MI | 2643 | 1687 | 4566 | 1288 | 5391 | 1046 | 5996 | 837 | 6934 | 486 | 7984 | 78 | 7745 |
| 10-#14 | 4.81 | MA | 3639 | 1687 | 5666 | 1382 | 6709 | 1141 | 7432 | 922 | 8430 | 559 | 10643 | 67 | 10376 |
| 5L-2S | | MI | 2856 | 1687 | 5067 | 1278 | 6028 | 1041 | 6767 | 836 | 7970 | 480 | 9220 | 241 | 7859 |
| 12-#10 | 3.26 | MA | 3772 | 1476 | 5782 | 1222 | 7037 | 1009 | 7891 | 831 | 9126 | 545 | 11537 | 366 | 8787 |
| 3L-5S | | MI | 2312 | 1476 | 3587 | 1188 | 4164 | 983 | 4525 | 806 | 4977 | 517 | 5877 | 167 | 5233 |
| 12-#10 | 3.26 | MA | 3646 | 1476 | 5448 | 1233 | 6575 | 1025 | 7325 | 846 | 8352 | 551 | 10574 | 313 | 8576 |
| 4E | | MI | 2392 | 1476 | 3777 | 1180 | 4423 | 978 | 4846 | 803 | 5421 | 511 | 6426 | 222 | 5448 |
| 12-#10 | 3.26 | MA | 3482 | 1476 | 5152 | 1244 | 6169 | 1035 | 6822 | 855 | 7653 | 563 | 9606 | 263 | 8108 |
| 5L-3S | | MI | 2474 | 1476 | 3989 | 1173 | 4716 | 966 | 5204 | 793 | 5910 | 512 | 6986 | 268 | 5630 |
| 12-#10 | 3.26 | MA | 3302 | 1476 | 4805 | 1258 | 5786 | 1045 | 6328 | 870 | 6969 | 569 | 8663 | 192 | 7639 |
| 6L-2S | | MI | 2619 | 1476 | 4288 | 1166 | 5095 | 961 | 5664 | 789 | 6530 | 506 | 7766 | 360 | 5651 |
| 12-#11 | 4.00 | MA | 3819 | 1577 | 5918 | 1292 | 7127 | 1069 | 7974 | 873 | 9210 | 543 | 11764 | 266 | 10075 |
| 4E | | MI | 2485 | 1577 | 4058 | 1233 | 4742 | 1016 | 5217 | 823 | 5907 | 496 | 6905 | 136 | 6327 |
| 12-#11 | 4.00 | MA | 3629 | 1577 | 5559 | 1304 | 6635 | 1080 | 7364 | 882 | 8364 | 557 | 10587 | 200 | 9570 |
| 5L-3S | | MI | 2574 | 1577 | 4312 | 1226 | 5093 | 1002 | 5645 | 812 | 6492 | 500 | 7555 | 189 | 6679 |
| 12-#11 | 4.00 | MA | 3419 | 1577 | 5146 | 1323 | 6170 | 1091 | 6766 | 900 | 7536 | 563 | 9437 | 112 | 8851 |
| 6L-2S | | MI | 2732 | 1577 | 4668 | 1218 | 5544 | 998 | 6193 | 810 | 7231 | 494 | 8454 | 302 | 6718 |
| 12-#14 | 5.77 | MA | 4012 | 1817 | 6494 | 1463 | 7760 | 1200 | 8706 | 960 | 10149 | 553 | 12992 | 56 | 12757 |
| 5L-3S | | MI | 2840 | 1817 | 5067 | 1369 | 6028 | 1106 | 6767 | 875 | 7970 | 479 | 9220 | 36 | 9104 |
| 14-#10 | 3.80 | MA | 3865 | 1550 | 5931 | 1279 | 7188 | 1059 | 8068 | 868 | 9354 | 547 | 11962 | 308 | 9958 |
| 4L-5S | | MI | 2440 | 1550 | 3886 | 1234 | 4543 | 1017 | 4985 | 827 | 5597 | 514 | 6657 | 150 | 6083 |
| 14-#10 | 3.80 | MA | 3703 | 1550 | 5635 | 1290 | 6782 | 1069 | 7564 | 876 | 8655 | 560 | 10993 | 258 | 9509 |
| 5L-4S | | MI | 2528 | 1550 | 4076 | 1226 | 4802 | 1012 | 5306 | 824 | 6041 | 507 | 7206 | 205 | 6285 |
| 14-#10 | 3.80 | MA | 3531 | 1550 | 5288 | 1304 | 6399 | 1079 | 7071 | 892 | 7972 | 566 | 10051 | 187 | 9035 |
| 6L-3S | | MI | 2601 | 1550 | 4288 | 1219 | 5095 | 1000 | 5664 | 814 | 6530 | 508 | 7766 | 251 | 6507 |
| 14-#10 | 3.80 | MA | 3382 | 1550 | 4977 | 1311 | 5991 | 1094 | 6595 | 900 | 7308 | 579 | 9132 | 144 | 8520 |
| 7L-2S | | MI | 2735 | 1550 | 4586 | 1212 | 5474 | 995 | 6123 | 811 | 7150 | 502 | 8546 | 343 | 6535 |
| 14-#11 | 4.67 | MA | 3890 | 1667 | 6141 | 1361 | 7374 | 1121 | 8260 | 908 | 9572 | 553 | 12260 | 194 | 11262 |
| 5L-4S | | MI | 2633 | 1667 | 4414 | 1289 | 5194 | 1057 | 5764 | 849 | 6646 | 492 | 7804 | 110 | 7325 |
| 14-#11 | 4.67 | MA | 3690 | 1667 | 5728 | 1379 | 6909 | 1132 | 7662 | 926 | 8744 | 559 | 11110 | 106 | 10536 |
| 6L-3S | | MI | 2715 | 1667 | 4668 | 1282 | 5544 | 1044 | 6193 | 838 | 7231 | 495 | 8454 | 163 | 7719 |
| 16-#10 | 4.34 | MA | 3919 | 1623 | 6118 | 1336 | 7395 | 1102 | 8307 | 897 | 9657 | 556 | 12381 | 253 | 10913 |
| 5E | | MI | 2573 | 1623 | 4184 | 1280 | 4922 | 1051 | 5444 | 848 | 6217 | 510 | 7437 | 133 | 6936 |
| 16-#10 | 4.34 | MA | 3755 | 1623 | 5770 | 1350 | 7011 | 1112 | 7813 | 913 | 8974 | 562 | 11439 | 182 | 10434 |
| 6L-4S | | MI | 2653 | 1623 | 4375 | 1273 | 5181 | 1046 | 5765 | 845 | 6661 | 504 | 7986 | 188 | 7126 |
| 16-#10 | 4.34 | MA | 3613 | 1623 | 5460 | 1357 | 6604 | 1128 | 7338 | 921 | 8311 | 575 | 10520 | 140 | 9924 |
| 7L-3S | | MI | 2721 | 1623 | 4586 | 1265 | 5474 | 1033 | 6123 | 835 | 7150 | 505 | 8546 | 234 | 7383 |
| 16-#11 | 5.33 | MA | 3954 | 1758 | 6310 | 1436 | 7647 | 1174 | 8557 | 952 | 9953 | 554 | 12783 | 100 | 12224 |
| 6L-4S | | MI | 2778 | 1758 | 4770 | 1346 | 5645 | 1098 | 6311 | 875 | 7385 | 488 | 8703 | 84 | 8329 |

## RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 4.88 | MA | 3974 | 1697 | 6253 | 1396 | 7624 | 1146 | 8556 | 934 | 9976 | 559 | 12827 | 177 | 11835 |
| 6L-5S | | MI | 2697 | 1697 | 4483 | 1326 | 5301 | 1084 | 5904 | 870 | 6837 | 507 | 8217 | 116 | 7792 |
| 18-#10 | 4.88 | MA | 3839 | 1697 | 5942 | 1403 | 7217 | 1161 | 8080 | 942 | 9313 | 572 | 11908 | 135 | 11329 |
| 7L-4S | | MI | 2776 | 1697 | 4673 | 1319 | 5560 | 1079 | 6225 | 866 | 7282 | 500 | 8767 | 171 | 7972 |
| 20-#10 | 5.43 | MA | 4060 | 1771 | 6425 | 1449 | 7829 | 1195 | 8823 | 964 | 10315 | 568 | 13296 | 130 | 12735 |
| 7L-5S | | MI | 2819 | 1771 | 4782 | 1372 | 5680 | 1118 | 6363 | 891 | 7457 | 503 | 8997 | 99 | 8634 |

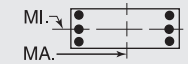
## RECTANGULAR TIED COLUMNS 18" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.01 | MA | 3645 | 1261 | 4915 | 1106 | 5929 | 932 | 6466 | 797 | 6976 | 593 | 8398 | 517 | 3360 |
| 2E | | MI | 2272 | 1261 | 3285 | 1051 | 3795 | 885 | 4050 | 755 | 4266 | 560 | 4883 | 464 | 2079 |
| 4-#11 | 1.24 | MA | 3739 | 1295 | 5183 | 1119 | 6229 | 941 | 6810 | 800 | 7423 | 587 | 9003 | 511 | 4051 |
| 2E | | MI | 2314 | 1295 | 3439 | 1060 | 3956 | 890 | 4227 | 756 | 4491 | 552 | 5093 | 440 | 2478 |
| 4-#14 | 1.79 | MA | 3976 | 1375 | 5760 | 1164 | 6932 | 973 | 7647 | 819 | 8541 | 580 | 10542 | 502 | 5699 |
| 2E | | MI | 2428 | 1375 | 3759 | 1101 | 4337 | 919 | 4676 | 773 | 5076 | 541 | 5747 | 403 | 3407 |
| 4-#18 | 3.17 | MA | 4522 | 1578 | 7160 | 1279 | 8653 | 1056 | 9705 | 870 | 11294 | 563 | 14165 | 467 | 9718 |
| 2E | | MI | 2676 | 1578 | 4510 | 1210 | 5242 | 997 | 5750 | 818 | 6399 | 502 | 7206 | 290 | 5597 |
| 6-#9 | 1.19 | MA | 3742 | 1288 | 5096 | 1126 | 6174 | 947 | 6770 | 806 | 7393 | 594 | 8980 | 516 | 3947 |
| 2L-3S | | MI | 2189 | 1288 | 3148 | 1078 | 3635 | 905 | 3862 | 769 | 4017 | 567 | 4589 | 391 | 2433 |
| 6-#9 | 1.19 | MA | 3494 | 1288 | 4677 | 1135 | 5642 | 955 | 6126 | 814 | 6523 | 605 | 7776 | 448 | 3949 |
| 3L-2S | | MI | 2325 | 1288 | 3386 | 1072 | 3937 | 901 | 4227 | 766 | 4511 | 562 | 5217 | 463 | 2419 |
| 6-#10 | 1.51 | MA | 3892 | 1335 | 5444 | 1152 | 6600 | 966 | 7279 | 818 | 8074 | 590 | 9918 | 512 | 4944 |
| 2L-3S | | MI | 2234 | 1335 | 3285 | 1104 | 3795 | 924 | 4050 | 780 | 4266 | 563 | 4883 | 354 | 3006 |
| 6-#10 | 1.51 | MA | 3587 | 1335 | 4915 | 1164 | 5929 | 976 | 6466 | 827 | 6976 | 603 | 8398 | 424 | 4933 |
| 3L-2S | | MI | 2400 | 1335 | 3584 | 1097 | 4175 | 918 | 4509 | 777 | 4886 | 557 | 5663 | 447 | 2992 |
| 6-#11 | 1.86 | MA | 4028 | 1385 | 5822 | 1176 | 7040 | 982 | 7792 | 827 | 8748 | 583 | 10839 | 505 | 5961 |
| 2L-3S | | MI | 2269 | 1385 | 3439 | 1124 | 3956 | 936 | 4227 | 784 | 4491 | 553 | 5093 | 301 | 3573 |
| 6-#11 | 1.86 | MA | 3672 | 1385 | 5183 | 1189 | 6229 | 994 | 6810 | 837 | 7423 | 598 | 9003 | 394 | 5931 |
| 3L-2S | | MI | 2461 | 1385 | 3795 | 1116 | 4408 | 931 | 4774 | 782 | 5230 | 547 | 5992 | 414 | 3562 |
| 6-#14 | 2.68 | MA | 4370 | 1505 | 6669 | 1245 | 8086 | 1032 | 9046 | 857 | 10429 | 574 | 13156 | 494 | 8403 |
| 2L-3S | | MI | 2376 | 1505 | 3759 | 1192 | 4337 | 984 | 4676 | 811 | 5076 | 540 | 5747 | 197 | 4895 |
| 6-#14 | 2.68 | MA | 3892 | 1505 | 5760 | 1264 | 6932 | 1049 | 7647 | 871 | 8541 | 595 | 10542 | 332 | 8294 |
| 3L-2S | | MI | 2625 | 1505 | 4261 | 1182 | 4973 | 979 | 5448 | 810 | 6112 | 534 | 6982 | 360 | 4918 |
| 6-#18 | 4.76 | MA | 5155 | 1810 | 8736 | 1424 | 10653 | 1162 | 12129 | 937 | 14565 | 552 | 18610 | 444 | 14377 |
| 2L-3S | | MI | 2614 | 1810 | 4510 | 1367 | 5242 | 1106 | 5750 | 902 | 6399 | 492 | 7206 | -94 | 7138 |
| 6-#18 | 4.76 | MA | 4425 | 1810 | 7160 | 1455 | 8653 | 1188 | 9705 | 957 | 11294 | 586 | 14165 | 154 | 13643 |
| 3L-2S | | MI | 2988 | 1810 | 5361 | 1355 | 6322 | 1103 | 7059 | 885 | 8106 | 481 | 9192 | 196 | 8117 |
| 8-#8 | 1.25 | MA | 3780 | 1297 | 5154 | 1134 | 6260 | 953 | 6882 | 811 | 7550 | 595 | 9202 | 517 | 4159 |
| 2L-4S | | MI | 2176 | 1297 | 3094 | 1091 | 3563 | 920 | 3778 | 781 | 3906 | 568 | 4499 | 379 | 2562 |
| 8-#8 | 1.25 | MA | 3585 | 1297 | 4821 | 1141 | 5838 | 960 | 6370 | 817 | 6859 | 604 | 8246 | 464 | 4161 |
| 3E | | MI | 2240 | 1297 | 3228 | 1086 | 3748 | 912 | 4004 | 774 | 4215 | 568 | 4861 | 409 | 2553 |
| 8-#8 | 1.25 | MA | 3475 | 1297 | 4593 | 1149 | 5522 | 971 | 5982 | 827 | 6328 | 608 | 7594 | 431 | 4143 |
| 4L-2S | | MI | 2347 | 1297 | 3418 | 1081 | 3989 | 908 | 4296 | 772 | 4609 | 564 | 5367 | 466 | 2543 |
| 8-#9 | 1.59 | MA | 3937 | 1346 | 5515 | 1162 | 6705 | 973 | 7414 | 823 | 8263 | 591 | 10185 | 513 | 5199 |
| 2L-4S | | MI | 2218 | 1346 | 3218 | 1120 | 3704 | 942 | 3943 | 794 | 4122 | 564 | 4768 | 341 | 3149 |
| 8-#9 | 1.59 | MA | 3698 | 1346 | 5096 | 1171 | 6174 | 982 | 6770 | 831 | 7393 | 602 | 8980 | 444 | 5190 |
| 3E | | MI | 2295 | 1346 | 3386 | 1114 | 3937 | 932 | 4227 | 786 | 4511 | 564 | 5217 | 378 | 3151 |
| 8-#9 | 1.59 | MA | 3565 | 1346 | 4808 | 1181 | 5775 | 996 | 6281 | 844 | 6724 | 608 | 8157 | 403 | 5142 |
| 4L-2S | | MI | 2426 | 1346 | 3624 | 1108 | 4238 | 927 | 4593 | 783 | 5004 | 559 | 5846 | 451 | 3142 |
| 8-#10 | 2.02 | MA | 4131 | 1408 | 5972 | 1198 | 7271 | 999 | 8093 | 839 | 9172 | 586 | 11438 | 507 | 6519 |
| 2L-4S | | MI | 2271 | 1408 | 3372 | 1157 | 3882 | 969 | 4151 | 811 | 4397 | 559 | 5104 | 291 | 3870 |
| 8-#10 | 2.02 | MA | 3840 | 1408 | 5444 | 1210 | 6600 | 1010 | 7279 | 848 | 8074 | 600 | 9918 | 420 | 6493 |
| 3E | | MI | 2365 | 1408 | 3584 | 1150 | 4175 | 957 | 4509 | 801 | 4886 | 559 | 5663 | 338 | 3897 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis

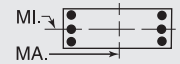



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 2.02 | MA | 3678 | 1408 | 5080 | 1221 | 6096 | 1027 | 6662 | 865 | 7229 | 607 | 8875 | 367 | 6383 |
| 4L-2S | | MI | 2524 | 1408 | 3882 | 1143 | 4554 | 952 | 4969 | 798 | 5506 | 553 | 6443 | 430 | 3893 |
| 8-#11 | 2.48 | MA | 4308 | 1476 | 6460 | 1232 | 7850 | 1024 | 8774 | 853 | 10074 | 578 | 12675 | 499 | 7858 |
| 2L-4S | | MI | 2311 | 1476 | 3541 | 1188 | 4057 | 991 | 4346 | 821 | 4644 | 545 | 5343 | 222 | 4439 |
| 8-#11 | 2.48 | MA | 3970 | 1476 | 5822 | 1246 | 7040 | 1036 | 7792 | 863 | 8748 | 594 | 10839 | 388 | 7809 |
| 3E | | MI | 2421 | 1476 | 3795 | 1180 | 4408 | 977 | 4774 | 810 | 5230 | 548 | 5992 | 275 | 4627 |
| 8-#11 | 2.48 | MA | 3782 | 1476 | 5381 | 1260 | 6429 | 1056 | 7043 | 882 | 7724 | 601 | 9565 | 323 | 7489 |
| 4L-2S | | MI | 2605 | 1476 | 4151 | 1173 | 4859 | 973 | 5322 | 808 | 5968 | 543 | 6891 | 389 | 4632 |
| 8-#14 | 3.57 | MA | 4306 | 1636 | 6669 | 1346 | 8086 | 1108 | 9046 | 909 | 10429 | 589 | 13156 | 323 | 10959 |
| 3E | | MI | 2584 | 1636 | 4261 | 1273 | 4973 | 1043 | 5448 | 849 | 6112 | 533 | 6982 | 155 | 6358 |
| 8-#14 | 3.57 | MA | 4056 | 1636 | 6039 | 1364 | 7214 | 1137 | 7977 | 935 | 8967 | 598 | 11327 | 228 | 9932 |
| 4L-2S | | MI | 2816 | 1636 | 4762 | 1264 | 5610 | 1038 | 6219 | 848 | 7149 | 527 | 8218 | 318 | 6412 |
| 8-#18 | 6.35 | MA | 5142 | 2042 | 8736 | 1600 | 10653 | 1293 | 12129 | 1024 | 14565 | 575 | 18610 | 130 | 18108 |
| 3E | | MI | 2955 | 2042 | 5361 | 1512 | 6322 | 1212 | 7059 | 969 | 8106 | 471 | 9192 | -188 | 9012 |
| 8-#18 | 6.35 | MA | 4736 | 2042 | 7638 | 1631 | 9133 | 1341 | 10267 | 1067 | 12021 | 586 | 15475 | -35 | 15385 |
| 4L-2S | | MI | 3296 | 2042 | 6212 | 1500 | 7402 | 1209 | 8368 | 952 | 9813 | 460 | 11177 | 103 | 10620 |
| 10-#10 | 2.52 | MA | 4364 | 1482 | 6501 | 1244 | 7942 | 1033 | 8906 | 860 | 10270 | 583 | 12959 | 502 | 8089 |
| 2L-5S | | MI | 2323 | 1482 | 3480 | 1210 | 4002 | 1008 | 4290 | 835 | 4573 | 561 | 5334 | 219 | 4454 |
| 10-#10 | 2.52 | MA | 4086 | 1482 | 5972 | 1256 | 7271 | 1044 | 8093 | 870 | 9172 | 596 | 11438 | 415 | 8052 |
| 3L-4S | | MI | 2404 | 1482 | 3671 | 1203 | 4261 | 1003 | 4611 | 832 | 5017 | 555 | 5884 | 274 | 4691 |
| 10-#10 | 2.52 | MA | 3936 | 1482 | 5609 | 1268 | 6767 | 1061 | 7475 | 886 | 8326 | 603 | 10395 | 362 | 7931 |
| 4L-3S | | MI | 2493 | 1482 | 3882 | 1196 | 4554 | 991 | 4969 | 822 | 5506 | 556 | 6443 | 321 | 4780 |
| 10-#10 | 2.52 | MA | 3748 | 1482 | 5287 | 1279 | 6325 | 1072 | 6926 | 895 | 7564 | 617 | 9342 | 314 | 7386 |
| 5L-2S | | MI | 2647 | 1482 | 4181 | 1189 | 4933 | 986 | 5428 | 819 | 6126 | 550 | 7223 | 413 | 4788 |
| 10-#11 | 3.10 | MA | 4260 | 1566 | 6460 | 1303 | 7850 | 1077 | 8774 | 889 | 10074 | 590 | 12675 | 382 | 9687 |
| 3L-4S | | MI | 2467 | 1566 | 3897 | 1244 | 4509 | 1032 | 4893 | 847 | 5383 | 541 | 6242 | 196 | 5418 |
| 10-#11 | 3.10 | MA | 4086 | 1566 | 6019 | 1316 | 7239 | 1097 | 8026 | 908 | 9050 | 597 | 11401 | 317 | 9309 |
| 4L-3S | | MI | 2574 | 1566 | 4151 | 1237 | 4859 | 1019 | 5322 | 836 | 5968 | 544 | 6891 | 250 | 5673 |
| 10-#11 | 3.10 | MA | 3867 | 1566 | 5628 | 1330 | 6702 | 1110 | 7360 | 919 | 8126 | 613 | 10120 | 255 | 8688 |
| 5L-2S | | MI | 2743 | 1566 | 4507 | 1229 | 5311 | 1014 | 5869 | 834 | 6707 | 539 | 7790 | 363 | 5694 |
| 10-#14 | 4.46 | MA | 4481 | 1766 | 6949 | 1446 | 8368 | 1197 | 9376 | 973 | 10855 | 591 | 13942 | 219 | 12550 |
| 4L-3S | | MI | 2787 | 1766 | 4762 | 1355 | 5610 | 1103 | 6219 | 887 | 7149 | 526 | 8218 | 112 | 7819 |
| 10-#14 | 4.46 | MA | 4177 | 1766 | 6389 | 1465 | 7601 | 1213 | 8424 | 986 | 9535 | 613 | 12107 | 126 | 11579 |
| 5L-2S | | MI | 3004 | 1766 | 5264 | 1345 | 6247 | 1098 | 6991 | 886 | 8185 | 519 | 9454 | 276 | 7895 |
| 10-#18 | 7.94 | MA | 5505 | 2273 | 9214 | 1776 | 11133 | 1447 | 12691 | 1134 | 15293 | 575 | 19920 | -58 | 19694 |
| 4L-3S | | MI | 3287 | 2273 | 6212 | 1657 | 7402 | 1318 | 8368 | 1036 | 9813 | 449 | 11177 | -282 | 10847 |
| 12-#10 | 3.02 | MA | 4326 | 1556 | 6501 | 1302 | 7942 | 1077 | 8906 | 891 | 10270 | 593 | 12959 | 410 | 9610 |
| 3L-5S | | MI | 2455 | 1556 | 3779 | 1256 | 4381 | 1042 | 4749 | 857 | 5193 | 558 | 6114 | 202 | 5298 |
| 12-#10 | 3.02 | MA | 4186 | 1556 | 6138 | 1314 | 7438 | 1095 | 8288 | 907 | 9424 | 600 | 11915 | 357 | 9471 |
| 4E | | MI | 2535 | 1556 | 3969 | 1249 | 4640 | 1037 | 5070 | 854 | 5637 | 551 | 6664 | 257 | 5520 |
| 12-#10 | 3.02 | MA | 4000 | 1556 | 5816 | 1325 | 6996 | 1105 | 7739 | 916 | 8662 | 614 | 10862 | 309 | 8920 |
| 5L-3S | | MI | 2619 | 1556 | 4181 | 1242 | 4933 | 1025 | 5428 | 843 | 6126 | 552 | 7223 | 304 | 5661 |
| 12-#10 | 3.02 | MA | 3801 | 1556 | 5430 | 1339 | 6578 | 1116 | 7202 | 933 | 7917 | 620 | 9841 | 239 | 8461 |
| 6L-2S | | MI | 2767 | 1556 | 4480 | 1235 | 5312 | 1019 | 5887 | 840 | 6746 | 546 | 8003 | 396 | 5677 |
| 12-#11 | 3.71 | MA | 4382 | 1657 | 6658 | 1373 | 8049 | 1139 | 9008 | 934 | 10376 | 593 | 13236 | 311 | 11138 |
| 4E | | MI | 2627 | 1657 | 4253 | 1301 | 4960 | 1073 | 5440 | 873 | 6122 | 536 | 7141 | 171 | 6406 |
| 12-#11 | 3.71 | MA | 4165 | 1657 | 6267 | 1386 | 7513 | 1151 | 8342 | 945 | 9451 | 608 | 11955 | 249 | 10544 |
| 5L-3S | | MI | 2719 | 1657 | 4507 | 1293 | 5311 | 1060 | 5869 | 863 | 6707 | 540 | 7790 | 224 | 6717 |
| 12-#11 | 3.71 | MA | 3933 | 1657 | 5807 | 1404 | 7006 | 1163 | 7689 | 964 | 8548 | 615 | 10709 | 162 | 9812 |
| 6L-2S | | MI | 2879 | 1657 | 4863 | 1286 | 5762 | 1055 | 6416 | 860 | 7446 | 534 | 8689 | 337 | 6749 |
| 12-#14 | 5.36 | MA | 4591 | 1897 | 7298 | 1546 | 8755 | 1273 | 9823 | 1024 | 11423 | 607 | 14722 | 118 | 14212 |
| 5L-3S | | MI | 2984 | 1897 | 5264 | 1436 | 6247 | 1163 | 6991 | 924 | 8185 | 519 | 9454 | 70 | 9222 |
| 12-#14 | 5.36 | MA | 4280 | 1897 | 6650 | 1573 | 8030 | 1289 | 8891 | 1050 | 10131 | 616 | 12931 | -9 | 12905 |
| 6L-2S | | MI | 3189 | 1897 | 5766 | 1427 | 6884 | 1157 | 7763 | 923 | 9221 | 512 | 10690 | 234 | 9373 |
| 14-#10 | 3.53 | MA | 4430 | 1629 | 6666 | 1360 | 8109 | 1128 | 9102 | 928 | 10522 | 596 | 13435 | 352 | 10989 |
| 4L-5S | | MI | 2583 | 1629 | 4078 | 1302 | 4760 | 1075 | 5208 | 878 | 5813 | 554 | 6894 | 185 | 6147 |
| 14-#10 | 3.53 | MA | 4246 | 1629 | 6344 | 1371 | 7667 | 1139 | 8553 | 938 | 9760 | 610 | 12382 | 305 | 10458 |
| 5L-4S | | MI | 2663 | 1629 | 4268 | 1295 | 5019 | 1070 | 5529 | 875 | 6257 | 548 | 7444 | 241 | 6354 |

## RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 3.53 | MA | 4056 | 1629 | 5959 | 1385 | 7249 | 1149 | 8015 | 954 | 9015 | 617 | 11361 | 234 | 9996 |
| 6L-3S | | MI | 2747 | 1629 | 4480 | 1288 | 5312 | 1058 | 5887 | 865 | 6746 | 549 | 8003 | 287 | 6539 |
| 14-#10 | 3.53 | MA | 3890 | 1629 | 5620 | 1393 | 6797 | 1164 | 7497 | 963 | 8292 | 631 | 10364 | 195 | 9427 |
| 7L-2S | | MI | 2883 | 1629 | 4778 | 1281 | 5691 | 1053 | 6347 | 862 | 7366 | 543 | 8783 | 379 | 6562 |
| 14-#11 | 4.33 | MA | 4455 | 1747 | 6905 | 1443 | 8323 | 1192 | 9324 | 971 | 10777 | 604 | 13791 | 243 | 12404 |
| 5L-4S | | MI | 2776 | 1747 | 4609 | 1357 | 5412 | 1115 | 5988 | 899 | 6861 | 532 | 8040 | 145 | 7402 |
| 14-#11 | 4.33 | MA | 4234 | 1747 | 6446 | 1461 | 7816 | 1204 | 8672 | 990 | 9873 | 611 | 12544 | 156 | 11668 |
| 6L-3S | | MI | 2861 | 1747 | 4863 | 1350 | 5762 | 1101 | 6416 | 889 | 7446 | 535 | 8689 | 198 | 7758 |
| 14-#11 | 4.33 | MA | 4041 | 1747 | 6035 | 1469 | 7277 | 1223 | 8042 | 1000 | 8996 | 627 | 11329 | 104 | 10882 |
| 7L-2S | | MI | 3014 | 1747 | 5219 | 1342 | 6214 | 1097 | 6964 | 887 | 8185 | 530 | 9589 | 312 | 7800 |
| 14-#14 | 6.25 | MA | 4701 | 2027 | 7559 | 1654 | 9184 | 1349 | 10289 | 1088 | 12019 | 609 | 15546 | -17 | 15466 |
| 6L-3S | | MI | 3179 | 2027 | 5766 | 1518 | 6884 | 1222 | 7763 | 962 | 9221 | 511 | 10690 | 28 | 10593 |
| 16-#10 | 4.03 | MA | 4486 | 1703 | 6873 | 1417 | 8338 | 1172 | 9366 | 959 | 10858 | 607 | 13902 | 300 | 11998 |
| 5E | | MI | 2718 | 1703 | 4376 | 1348 | 5139 | 1109 | 5668 | 899 | 6433 | 551 | 7674 | 168 | 6999 |
| 16-#10 | 4.03 | MA | 4304 | 1703 | 6488 | 1431 | 7920 | 1183 | 8829 | 975 | 10113 | 613 | 12882 | 229 | 11533 |
| 6L-4S | | MI | 2797 | 1703 | 4567 | 1341 | 5398 | 1104 | 5989 | 896 | 6878 | 544 | 8224 | 224 | 7194 |
| 16-#10 | 4.03 | MA | 4147 | 1703 | 6149 | 1439 | 7468 | 1198 | 8310 | 984 | 9390 | 627 | 11884 | 190 | 10980 |
| 7L-3S | | MI | 2867 | 1703 | 4778 | 1334 | 5691 | 1092 | 6347 | 886 | 7366 | 545 | 8783 | 270 | 7415 |
| 16-#10 | 4.03 | MA | 3988 | 1703 | 5822 | 1447 | 7031 | 1205 | 7786 | 1000 | 8680 | 641 | 10924 | 136 | 10272 |
| 8L-2S | | MI | 2998 | 1703 | 5077 | 1327 | 6070 | 1087 | 6806 | 883 | 7986 | 539 | 9563 | 362 | 7445 |
| 16-#11 | 4.95 | MA | 4528 | 1837 | 7084 | 1517 | 8626 | 1245 | 9654 | 1016 | 11199 | 607 | 14380 | 150 | 13527 |
| 6L-4S | | MI | 2922 | 1837 | 4964 | 1414 | 5864 | 1156 | 6535 | 925 | 7600 | 528 | 8939 | 119 | 8405 |
| 16-#11 | 4.95 | MA | 4345 | 1837 | 6673 | 1526 | 8088 | 1264 | 9024 | 1026 | 10322 | 623 | 13164 | 98 | 12744 |
| 7L-3S | | MI | 3000 | 1837 | 5219 | 1406 | 6214 | 1143 | 6964 | 915 | 8185 | 531 | 9589 | 173 | 8799 |
| 18-#10 | 4.54 | MA | 4547 | 1777 | 7017 | 1478 | 8591 | 1217 | 9642 | 996 | 11211 | 610 | 14402 | 225 | 13073 |
| 6L-5S | | MI | 2842 | 1777 | 4675 | 1394 | 5518 | 1143 | 6127 | 920 | 7053 | 547 | 8454 | 151 | 7854 |
| 18-#10 | 4.54 | MA | 4397 | 1777 | 6677 | 1485 | 8139 | 1231 | 9124 | 1006 | 10488 | 624 | 13404 | 185 | 12533 |
| 7L-4S | | MI | 2921 | 1777 | 4865 | 1387 | 5777 | 1138 | 6448 | 917 | 7498 | 541 | 9004 | 207 | 8039 |
| 18-#10 | 4.54 | MA | 4241 | 1777 | 6351 | 1494 | 7702 | 1238 | 8599 | 1021 | 9778 | 638 | 12444 | 131 | 11818 |
| 8L-3S | | MI | 2986 | 1777 | 5077 | 1380 | 6070 | 1125 | 6806 | 907 | 7986 | 542 | 9563 | 253 | 8291 |
| 18-#11 | 5.57 | MA | 4643 | 1928 | 7312 | 1582 | 8898 | 1306 | 10007 | 1052 | 11647 | 618 | 15000 | 92 | 14605 |
| 7L-4S | | MI | 3065 | 1928 | 5320 | 1470 | 6315 | 1197 | 7082 | 952 | 8339 | 523 | 9838 | 94 | 9412 |
| 20-#10 | 5.04 | MA | 4643 | 1850 | 7206 | 1531 | 8810 | 1265 | 9937 | 1027 | 11586 | 620 | 14924 | 180 | 14084 |
| 7L-5S | | MI | 2964 | 1850 | 4974 | 1440 | 5897 | 1176 | 6587 | 942 | 7673 | 544 | 9234 | 134 | 8711 |
| 20-#10 | 5.04 | MA | 4488 | 1850 | 6880 | 1540 | 8373 | 1272 | 9413 | 1043 | 10875 | 634 | 13965 | 127 | 13365 |
| 8L-4S | | MI | 3042 | 1850 | 5164 | 1433 | 6156 | 1171 | 6908 | 939 | 8118 | 537 | 9784 | 190 | 8887 |
| 22-#10 | 5.54 | MA | 4731 | 1924 | 7408 | 1586 | 9044 | 1306 | 10226 | 1064 | 11973 | 631 | 15485 | 122 | 14911 |
| 8L-5S | | MI | 3084 | 1924 | 5272 | 1486 | 6276 | 1210 | 7046 | 963 | 8294 | 540 | 10014 | 117 | 9570 |

## RECTANGULAR TIED COLUMNS 18" x 30"

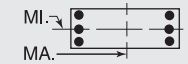
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.16 | MA | 4266 | 1374 | 5822 | 1199 | 7031 | 1009 | 7694 | 860 | 8373 | 634 | 10145 | 552 | 4388 |
| 2E | | MI | 2458 | 1374 | 3634 | 1127 | 4174 | 948 | 4451 | 806 | 4706 | 592 | 5329 | 475 | 2498 |
| 4-#14 | 1.67 | MA | 4530 | 1454 | 6452 | 1243 | 7800 | 1041 | 8609 | 879 | 9595 | 627 | 11826 | 544 | 6185 |
| 2E | | MI | 2572 | 1454 | 3956 | 1168 | 4555 | 976 | 4900 | 822 | 5291 | 580 | 5981 | 437 | 3432 |
| 4-#18 | 2.96 | MA | 5140 | 1657 | 7986 | 1359 | 9685 | 1124 | 10863 | 929 | 12611 | 611 | 15981 | 524 | 10582 |
| 2E | | MI | 2822 | 1657 | 4711 | 1276 | 5462 | 1053 | 5974 | 867 | 6612 | 541 | 7437 | 324 | 5633 |
| 6-#9 | 1.11 | MA | 4268 | 1367 | 5724 | 1205 | 6967 | 1015 | 7646 | 865 | 8335 | 641 | 10111 | 558 | 4271 |
| 2L-3S | | MI | 2332 | 1367 | 3339 | 1146 | 3851 | 964 | 4085 | 820 | 4233 | 608 | 4827 | 426 | 2451 |
| 6-#9 | 1.11 | MA | 3995 | 1367 | 5269 | 1215 | 6389 | 1024 | 6946 | 874 | 7390 | 652 | 8803 | 491 | 4273 |
| 3L-2S | | MI | 2469 | 1367 | 3577 | 1140 | 4153 | 959 | 4451 | 817 | 4727 | 602 | 5455 | 499 | 2436 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis

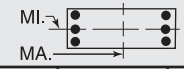



$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 1.41 | MA | 4434 | 1414 | 6103 | 1232 | 7431 | 1034 | 8201 | 877 | 9076 | 637 | 11133 | 553 | 5355 |
| 2L-3S | | MI | 2377 | 1414 | 3477 | 1172 | 4012 | 982 | 4273 | 831 | 4482 | 603 | 5120 | 390 | 3027 |
| 6-#10 | 1.41 | MA | 4098 | 1414 | 5528 | 1244 | 6702 | 1045 | 7317 | 887 | 7883 | 651 | 9481 | 468 | 5344 |
| 3L-2S | | MI | 2544 | 1414 | 3776 | 1165 | 4391 | 977 | 4733 | 827 | 5102 | 597 | 5900 | 482 | 3012 |
| 6-#11 | 1.73 | MA | 4587 | 1465 | 6517 | 1255 | 7914 | 1050 | 8763 | 886 | 9816 | 630 | 12143 | 546 | 6466 |
| 2L-3S | | MI | 2412 | 1465 | 3634 | 1191 | 4174 | 994 | 4451 | 834 | 4706 | 593 | 5329 | 336 | 3601 |
| 6-#11 | 1.73 | MA | 4193 | 1465 | 5822 | 1270 | 7031 | 1063 | 7694 | 897 | 8373 | 647 | 10145 | 438 | 6437 |
| 3L-2S | | MI | 2606 | 1465 | 3990 | 1184 | 4626 | 989 | 4998 | 832 | 5445 | 587 | 6228 | 450 | 3586 |
| 6-#14 | 2.50 | MA | 4968 | 1585 | 7443 | 1325 | 9057 | 1100 | 10134 | 916 | 11652 | 621 | 14675 | 535 | 9132 |
| 2L-3S | | MI | 2513 | 1585 | 3956 | 1259 | 4555 | 1041 | 4900 | 861 | 5291 | 579 | 5981 | 232 | 4934 |
| 6-#14 | 2.50 | MA | 4439 | 1585 | 6452 | 1345 | 7800 | 1118 | 8609 | 932 | 9595 | 644 | 11826 | 377 | 9023 |
| 3L-2S | | MI | 2771 | 1585 | 4458 | 1249 | 5192 | 1036 | 5672 | 860 | 6327 | 573 | 7216 | 395 | 4947 |
| 6-#18 | 4.44 | MA | 5849 | 1889 | 9707 | 1504 | 11869 | 1230 | 13510 | 996 | 16183 | 599 | 20928 | 509 | 15673 |
| 2L-3S | | MI | 2755 | 1889 | 4711 | 1432 | 5462 | 1162 | 5974 | 951 | 6612 | 531 | 7437 | -60 | 7395 |
| 6-#18 | 4.44 | MA | 5032 | 1889 | 7986 | 1537 | 9685 | 1258 | 10863 | 1019 | 12611 | 636 | 15981 | 218 | 15179 |
| 3L-2S | | MI | 3136 | 1889 | 5562 | 1421 | 6542 | 1159 | 7283 | 934 | 8319 | 520 | 9423 | 231 | 8159 |
| 8-#8 | 1.17 | MA | 4310 | 1377 | 5786 | 1213 | 7060 | 1021 | 7767 | 870 | 8504 | 642 | 10351 | 559 | 4501 |
| 2L-4S | | MI | 2319 | 1377 | 3284 | 1160 | 3779 | 979 | 4002 | 833 | 4122 | 609 | 4738 | 415 | 2581 |
| 8-#8 | 1.17 | MA | 4095 | 1377 | 5425 | 1221 | 6602 | 1028 | 7211 | 877 | 7754 | 651 | 9312 | 506 | 4502 |
| 3E | | MI | 2383 | 1377 | 3418 | 1155 | 3964 | 971 | 4228 | 826 | 4431 | 609 | 5099 | 445 | 2570 |
| 8-#8 | 1.17 | MA | 3974 | 1377 | 5178 | 1229 | 6259 | 1040 | 6791 | 887 | 7178 | 656 | 8610 | 474 | 4484 |
| 4L-2S | | MI | 2491 | 1377 | 3607 | 1150 | 4205 | 967 | 4520 | 823 | 4825 | 604 | 5606 | 502 | 2560 |
| 8-#9 | 1.48 | MA | 4483 | 1425 | 6179 | 1241 | 7544 | 1041 | 8346 | 882 | 9280 | 638 | 11420 | 554 | 5631 |
| 2L-4S | | MI | 2361 | 1425 | 3409 | 1188 | 3921 | 1000 | 4167 | 845 | 4339 | 605 | 5006 | 377 | 3175 |
| 8-#9 | 1.48 | MA | 4220 | 1425 | 5724 | 1251 | 6967 | 1050 | 7646 | 890 | 8335 | 650 | 10111 | 487 | 5622 |
| 3E | | MI | 2439 | 1425 | 3577 | 1183 | 4153 | 990 | 4451 | 837 | 4727 | 605 | 5455 | 414 | 3171 |
| 8-#9 | 1.48 | MA | 4074 | 1425 | 5413 | 1261 | 6535 | 1064 | 7116 | 904 | 7610 | 656 | 9225 | 446 | 5574 |
| 4L-2S | | MI | 2571 | 1425 | 3815 | 1177 | 4455 | 986 | 4816 | 834 | 5221 | 600 | 6084 | 487 | 3160 |
| 8-#10 | 1.88 | MA | 4698 | 1488 | 6678 | 1278 | 8161 | 1067 | 9085 | 898 | 10270 | 633 | 12786 | 548 | 7068 |
| 2L-4S | | MI | 2413 | 1488 | 3564 | 1225 | 4099 | 1028 | 4375 | 862 | 4613 | 599 | 5341 | 327 | 3904 |
| 8-#10 | 1.88 | MA | 4378 | 1488 | 6103 | 1290 | 7431 | 1078 | 8201 | 908 | 9076 | 648 | 11133 | 463 | 7041 |
| 3E | | MI | 2508 | 1488 | 3776 | 1218 | 4391 | 1016 | 4733 | 852 | 5102 | 600 | 5900 | 373 | 3922 |
| 8-#10 | 1.88 | MA | 4200 | 1488 | 5709 | 1302 | 6885 | 1096 | 7531 | 925 | 8160 | 656 | 10009 | 411 | 6931 |
| 4L-2S | | MI | 2669 | 1488 | 4074 | 1211 | 4771 | 1011 | 5192 | 849 | 5722 | 594 | 6680 | 465 | 3915 |
| 8-#11 | 2.31 | MA | 4896 | 1555 | 7212 | 1312 | 8796 | 1091 | 9832 | 912 | 11259 | 625 | 14141 | 540 | 8532 |
| 2L-4S | | MI | 2453 | 1555 | 3736 | 1255 | 4275 | 1048 | 4569 | 871 | 4860 | 585 | 5578 | 257 | 4521 |
| 8-#11 | 2.31 | MA | 4523 | 1555 | 6517 | 1326 | 7914 | 1104 | 8763 | 923 | 9816 | 642 | 12143 | 432 | 8483 |
| 3E | | MI | 2564 | 1555 | 3990 | 1248 | 4626 | 1035 | 4998 | 861 | 5445 | 588 | 6228 | 310 | 4658 |
| 8-#11 | 2.31 | MA | 4316 | 1555 | 6039 | 1341 | 7251 | 1126 | 7951 | 943 | 8705 | 651 | 10770 | 367 | 8232 |
| 4L-2S | | MI | 2750 | 1555 | 4346 | 1240 | 5077 | 1030 | 5545 | 858 | 6184 | 583 | 7127 | 424 | 4658 |
| 8-#14 | 3.33 | MA | 4895 | 1715 | 7443 | 1426 | 9057 | 1177 | 10134 | 969 | 11652 | 638 | 14675 | 368 | 11931 |
| 3E | | MI | 2728 | 1715 | 4458 | 1340 | 5192 | 1101 | 5672 | 899 | 6327 | 572 | 7216 | 189 | 6402 |
| 8-#14 | 3.33 | MA | 4621 | 1715 | 6760 | 1446 | 8110 | 1207 | 8973 | 997 | 10064 | 648 | 12703 | 274 | 10920 |
| 4L-2S | | MI | 2963 | 1715 | 4959 | 1331 | 5829 | 1095 | 6443 | 898 | 7363 | 566 | 8452 | 353 | 6444 |
| 8-#18 | 5.93 | MA | 5827 | 2121 | 9707 | 1682 | 11869 | 1364 | 13510 | 1086 | 16183 | 625 | 20928 | 203 | 20088 |
| 3E | | MI | 3096 | 2121 | 5562 | 1577 | 6542 | 1268 | 7283 | 1018 | 8319 | 510 | 9423 | -154 | 9279 |
| 8-#18 | 5.93 | MA | 5376 | 2121 | 8513 | 1714 | 10216 | 1414 | 11485 | 1132 | 13414 | 640 | 17453 | 32 | 17252 |
| 4L-2S | | MI | 3444 | 2121 | 6413 | 1566 | 7622 | 1265 | 8592 | 1001 | 10026 | 499 | 11409 | 137 | 10665 |
| 10-#10 | 2.35 | MA | 4955 | 1562 | 7253 | 1324 | 8890 | 1101 | 9969 | 919 | 11463 | 630 | 14438 | 544 | 8775 |
| 2L-5S | | MI | 2466 | 1562 | 3672 | 1279 | 4219 | 1067 | 4513 | 886 | 4789 | 602 | 5571 | 255 | 4519 |
| 10-#10 | 2.35 | MA | 4649 | 1562 | 6678 | 1336 | 8161 | 1112 | 9085 | 929 | 10270 | 644 | 12786 | 458 | 8737 |
| 3L-4S | | MI | 2547 | 1562 | 3863 | 1271 | 4478 | 1061 | 4834 | 883 | 5233 | 596 | 6121 | 310 | 4763 |
| 10-#10 | 2.35 | MA | 4483 | 1562 | 6284 | 1348 | 7615 | 1130 | 8415 | 946 | 9353 | 652 | 11662 | 406 | 8617 |
| 4L-3S | | MI | 2637 | 1562 | 4074 | 1264 | 4771 | 1049 | 5192 | 873 | 5722 | 596 | 6680 | 356 | 4808 |
| 10-#10 | 2.35 | MA | 4273 | 1562 | 5936 | 1360 | 7136 | 1141 | 7821 | 956 | 8528 | 667 | 10524 | 360 | 8070 |
| 5L-2S | | MI | 2792 | 1562 | 4373 | 1257 | 5150 | 1044 | 5652 | 870 | 6342 | 590 | 7460 | 448 | 4811 |
| 10-#11 | 2.89 | MA | 4843 | 1646 | 7212 | 1383 | 8796 | 1146 | 9832 | 949 | 11259 | 638 | 14141 | 426 | 10530 |
| 3L-4S | | MI | 2609 | 1646 | 4092 | 1312 | 4727 | 1090 | 5117 | 897 | 5598 | 581 | 6477 | 231 | 5497 |

## RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.89 | MA | 4652 | 1646 | 6734 | 1397 | 8133 | 1167 | 9020 | 969 | 10148 | 646 | 12768 | 362 | 10219 |
| 4L-3S | | MI | 2719 | 1646 | 4346 | 1304 | 5077 | 1076 | 5545 | 887 | 6184 | 584 | 7127 | 285 | 5708 |
| 10-#11 | 2.89 | MA | 4406 | 1646 | 6311 | 1411 | 7551 | 1180 | 8298 | 980 | 9146 | 663 | 11383 | 303 | 9502 |
| 5L-2S | | MI | 2890 | 1646 | 4702 | 1297 | 5529 | 1072 | 6093 | 885 | 6923 | 579 | 8026 | 398 | 5722 |
| 10-#14 | 4.17 | MA | 5090 | 1846 | 7751 | 1528 | 9367 | 1267 | 10497 | 1035 | 12121 | 642 | 15552 | 266 | 13782 |
| 4L-3S | | MI | 2931 | 1846 | 4959 | 1422 | 5829 | 1160 | 6443 | 936 | 7363 | 565 | 8452 | 147 | 7864 |
| 10-#14 | 4.17 | MA | 4747 | 1846 | 7144 | 1548 | 8536 | 1285 | 9465 | 1050 | 10689 | 665 | 13567 | 178 | 12811 |
| 5L-2S | | MI | 3152 | 1846 | 5461 | 1412 | 6466 | 1155 | 7215 | 935 | 8399 | 559 | 9688 | 311 | 7930 |
| 10-#18 | 7.41 | MA | 6227 | 2353 | 10234 | 1859 | 12399 | 1520 | 14132 | 1199 | 16987 | 629 | 22399 | 17 | 22288 |
| 4L-3S | | MI | 3429 | 2353 | 6413 | 1722 | 7622 | 1374 | 8592 | 1085 | 10026 | 488 | 11409 | -248 | 11126 |
| 10-#18 | 7.41 | MA | 5595 | 2353 | 9172 | 1892 | 10945 | 1548 | 12328 | 1223 | 14484 | 666 | 18919 | -151 | 18385 |
| 5L-2S | | MI | 3749 | 2353 | 7264 | 1711 | 8702 | 1371 | 9901 | 1068 | 11733 | 477 | 13394 | 43 | 13162 |
| 12-#10 | 2.82 | MA | 4913 | 1635 | 7253 | 1382 | 8890 | 1146 | 9969 | 951 | 11463 | 641 | 14438 | 453 | 10433 |
| 3L-5S | | MI | 2598 | 1635 | 3971 | 1325 | 4598 | 1100 | 4973 | 908 | 5409 | 598 | 6351 | 238 | 5361 |
| 12-#10 | 2.82 | MA | 4759 | 1635 | 6859 | 1394 | 8344 | 1164 | 9299 | 968 | 10547 | 649 | 13314 | 401 | 10305 |
| 4E | | MI | 2678 | 1635 | 4161 | 1317 | 4857 | 1095 | 5294 | 904 | 5853 | 592 | 6901 | 293 | 5589 |
| 12-#10 | 2.82 | MA | 4551 | 1635 | 6511 | 1406 | 7865 | 1175 | 8705 | 978 | 9721 | 663 | 12177 | 356 | 9740 |
| 5L-3S | | MI | 2763 | 1635 | 4373 | 1310 | 5150 | 1083 | 5652 | 894 | 6342 | 593 | 7460 | 339 | 5690 |
| 12-#10 | 2.82 | MA | 4333 | 1635 | 6088 | 1420 | 7414 | 1186 | 8124 | 995 | 8915 | 671 | 11078 | 286 | 9298 |
| 6L-2S | | MI | 2914 | 1635 | 4672 | 1303 | 5529 | 1078 | 6111 | 891 | 6962 | 587 | 8241 | 431 | 5702 |
| 12-#11 | 3.47 | MA | 4978 | 1736 | 7430 | 1454 | 9015 | 1208 | 10089 | 995 | 11591 | 642 | 14766 | 356 | 12215 |
| 4E | | MI | 2770 | 1736 | 4448 | 1368 | 5178 | 1131 | 5664 | 923 | 6337 | 576 | 7376 | 206 | 6484 |
| 12-#11 | 3.47 | MA | 4735 | 1736 | 7006 | 1468 | 8433 | 1221 | 9367 | 1007 | 10589 | 659 | 13381 | 297 | 11526 |
| 5L-3S | | MI | 2864 | 1736 | 4702 | 1361 | 5529 | 1118 | 6093 | 913 | 6923 | 580 | 8026 | 259 | 6753 |
| 12-#11 | 3.47 | MA | 4479 | 1736 | 6500 | 1485 | 7884 | 1234 | 8661 | 1027 | 9609 | 667 | 12038 | 210 | 10789 |
| 6L-2S | | MI | 3027 | 1736 | 5058 | 1353 | 5981 | 1113 | 6640 | 911 | 7661 | 574 | 8925 | 373 | 6779 |
| 12-#14 | 5.00 | MA | 5205 | 1976 | 8135 | 1629 | 9793 | 1344 | 10989 | 1088 | 12746 | 659 | 16416 | 169 | 15695 |
| 5L-3S | | MI | 3129 | 1976 | 5461 | 1503 | 6466 | 1220 | 7215 | 974 | 8399 | 558 | 9688 | 105 | 9326 |
| 12-#14 | 5.00 | MA | 4862 | 1976 | 7420 | 1655 | 9007 | 1362 | 9978 | 1115 | 11345 | 670 | 14487 | 43 | 14249 |
| 6L-2S | | MI | 3338 | 1976 | 5963 | 1494 | 7102 | 1215 | 7987 | 973 | 9435 | 552 | 10924 | 269 | 9410 |
| 14-#10 | 3.29 | MA | 5027 | 1709 | 7434 | 1440 | 9073 | 1197 | 10184 | 989 | 11740 | 645 | 14967 | 396 | 11996 |
| 4L-5S | | MI | 2727 | 1709 | 4270 | 1371 | 4977 | 1134 | 5432 | 929 | 6029 | 595 | 7131 | 221 | 6209 |
| 14-#10 | 3.29 | MA | 4822 | 1709 | 7085 | 1452 | 8595 | 1209 | 9589 | 999 | 10915 | 660 | 13829 | 351 | 11415 |
| 5L-4S | | MI | 2806 | 1709 | 4460 | 1363 | 5236 | 1129 | 5753 | 926 | 6474 | 589 | 7681 | 276 | 6422 |
| 14-#10 | 3.29 | MA | 4613 | 1709 | 6662 | 1466 | 8143 | 1220 | 9008 | 1016 | 10108 | 667 | 12730 | 281 | 10972 |
| 6L-3S | | MI | 2888 | 1709 | 4672 | 1356 | 5529 | 1117 | 6111 | 916 | 6962 | 589 | 8241 | 322 | 6569 |
| 14-#10 | 3.29 | MA | 4431 | 1709 | 6295 | 1474 | 7645 | 1234 | 8447 | 1026 | 9326 | 682 | 11654 | 244 | 10328 |
| 7L-2S | | MI | 3031 | 1709 | 4970 | 1349 | 5908 | 1111 | 6570 | 912 | 7582 | 583 | 9021 | 414 | 6588 |
| 14-#11 | 4.04 | MA | 5055 | 1827 | 7701 | 1524 | 9315 | 1262 | 10436 | 1033 | 12032 | 655 | 15379 | 291 | 13555 |
| 5L-4S | | MI | 2919 | 1827 | 4803 | 1425 | 5630 | 1172 | 6211 | 950 | 7076 | 572 | 8275 | 180 | 7478 |
| 14-#11 | 4.04 | MA | 4811 | 1827 | 7195 | 1542 | 8766 | 1275 | 9730 | 1053 | 11052 | 663 | 14037 | 204 | 12817 |
| 6L-3S | | MI | 3006 | 1827 | 5058 | 1417 | 5981 | 1159 | 6640 | 939 | 7661 | 575 | 8925 | 233 | 7796 |
| 14-#11 | 4.04 | MA | 4598 | 1827 | 6749 | 1551 | 8172 | 1293 | 9048 | 1064 | 10102 | 680 | 12725 | 155 | 11993 |
| 7L-2S | | MI | 3162 | 1827 | 5414 | 1410 | 6432 | 1154 | 7188 | 937 | 8400 | 570 | 9824 | 347 | 7832 |
| 14-#14 | 5.83 | MA | 5326 | 2107 | 8411 | 1736 | 10265 | 1421 | 11502 | 1153 | 13402 | 664 | 17335 | 35 | 17145 |
| 6L-3S | | MI | 3324 | 2107 | 5963 | 1585 | 7102 | 1279 | 7987 | 1012 | 9435 | 551 | 10924 | 63 | 10705 |
| 16-#10 | 3.76 | MA | 5086 | 1782 | 7660 | 1498 | 9324 | 1242 | 10473 | 1020 | 12108 | 656 | 15482 | 346 | 13092 |
| 5E | | MI | 2854 | 1782 | 4568 | 1417 | 5356 | 1167 | 5891 | 950 | 6649 | 591 | 7912 | 204 | 7060 |
| 16-#10 | 3.76 | MA | 4886 | 1782 | 7237 | 1512 | 8873 | 1253 | 9892 | 1037 | 11302 | 664 | 14383 | 276 | 12649 |
| 6L-4S | | MI | 2942 | 1782 | 4759 | 1409 | 5615 | 1162 | 6213 | 947 | 7094 | 585 | 8461 | 259 | 7261 |
| 16-#10 | 3.76 | MA | 4713 | 1782 | 6869 | 1520 | 8375 | 1268 | 9331 | 1047 | 10519 | 679 | 13307 | 239 | 12015 |
| 7L-3S | | MI | 3014 | 1782 | 4970 | 1402 | 5908 | 1150 | 6570 | 937 | 7582 | 586 | 9021 | 305 | 7447 |
| 16-#10 | 3.76 | MA | 4536 | 1782 | 6516 | 1529 | 7901 | 1275 | 8753 | 1062 | 9750 | 693 | 12271 | 187 | 11275 |
| 8L-2S | | MI | 3147 | 1782 | 5269 | 1395 | 6287 | 1145 | 7030 | 934 | 8202 | 580 | 9801 | 398 | 7473 |
| 16-#11 | 4.62 | MA | 5135 | 1917 | 7890 | 1598 | 9648 | 1317 | 10799 | 1079 | 12495 | 659 | 16035 | 198 | 14847 |
| 6L-4S | | MI | 3065 | 1917 | 5159 | 1481 | 6082 | 1214 | 6759 | 976 | 7815 | 568 | 9174 | 154 | 8479 |
| 16-#11 | 4.62 | MA | 4934 | 1917 | 7444 | 1608 | 9054 | 1335 | 10117 | 1090 | 11545 | 675 | 14723 | 149 | 14020 |
| 7L-3S | | MI | 3146 | 1917 | 5414 | 1474 | 6432 | 1200 | 7188 | 965 | 8400 | 571 | 9824 | 208 | 8838 |

## RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 4.23 | MA | 5153 | 1856 | 7812 | 1558 | 9602 | 1287 | 10776 | 1058 | 12495 | 660 | 16035 | 271 | 14328 |
| 6L-5S | | MI | 2986 | 1856 | 4867 | 1463 | 5735 | 1201 | 6351 | 971 | 7269 | 588 | 8692 | 187 | 7914 |
| 18-#10 | 4.23 | MA | 4989 | 1856 | 7444 | 1566 | 9104 | 1301 | 10215 | 1068 | 11713 | 675 | 14959 | 234 | 13702 |
| 7L-4S | | MI | 3065 | 1856 | 5057 | 1455 | 5994 | 1196 | 6672 | 968 | 7714 | 581 | 9241 | 242 | 8104 |
| 18-#10 | 4.23 | MA | 4814 | 1856 | 7091 | 1575 | 8631 | 1309 | 9638 | 1083 | 10944 | 690 | 13924 | 183 | 12956 |
| 8L-3S | | MI | 3133 | 1856 | 5269 | 1448 | 6287 | 1184 | 7030 | 958 | 8202 | 582 | 9801 | 288 | 8324 |
| 18-#11 | 5.20 | MA | 5261 | 2007 | 8139 | 1664 | 9936 | 1376 | 11186 | 1116 | 12988 | 671 | 16721 | 143 | 16046 |
| 7L-4S | | MI | 3209 | 2007 | 5515 | 1538 | 6533 | 1255 | 7306 | 1002 | 8554 | 563 | 10073 | 129 | 9485 |
| 20-#10 | 4.70 | MA | 5259 | 1930 | 8019 | 1612 | 9834 | 1335 | 11100 | 1090 | 12906 | 672 | 16612 | 229 | 15378 |
| 7L-5S | | MI | 3109 | 1930 | 5166 | 1509 | 6114 | 1235 | 6810 | 993 | 7890 | 584 | 9472 | 170 | 8770 |
| 20-#10 | 4.70 | MA | 5086 | 1930 | 7665 | 1621 | 9360 | 1342 | 10522 | 1105 | 12137 | 686 | 15576 | 178 | 14638 |
| 8L-4S | | MI | 3187 | 1930 | 5356 | 1501 | 6373 | 1230 | 7131 | 989 | 8334 | 578 | 10021 | 225 | 8951 |
| 22-#10 | 5.17 | MA | 5352 | 2003 | 8240 | 1667 | 10090 | 1376 | 11406 | 1126 | 13331 | 683 | 17228 | 173 | 16319 |
| 8L-5S | | MI | 3230 | 2003 | 5464 | 1555 | 6493 | 1268 | 7270 | 1014 | 8510 | 581 | 10252 | 153 | 9629 |

## RECTANGULAR TIED COLUMNS 18" x 32"

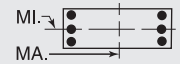
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.08 | MA | 4827 | 1454 | 6493 | 1278 | 7877 | 1077 | 8626 | 919 | 9373 | 681 | 11344 | 593 | 4725 |
| 2E | | MI | 2601 | 1454 | 3829 | 1195 | 4392 | 1005 | 4674 | 857 | 4921 | 632 | 5564 | 510 | 2518 |
| 4-#14 | 1.56 | MA | 5118 | 1534 | 7177 | 1323 | 8710 | 1108 | 9619 | 938 | 10698 | 674 | 13168 | 585 | 6671 |
| 2E | | MI | 2716 | 1534 | 4153 | 1235 | 4774 | 1033 | 5124 | 872 | 5505 | 620 | 6215 | 472 | 3457 |
| 4-#18 | 2.78 | MA | 5793 | 1737 | 8844 | 1438 | 10760 | 1192 | 12070 | 988 | 13977 | 658 | 17686 | 566 | 11446 |
| 2E | | MI | 2968 | 1737 | 4911 | 1342 | 5682 | 1109 | 6197 | 916 | 6825 | 580 | 7668 | 358 | 5668 |
| 6-#9 | 1.04 | MA | 4826 | 1447 | 6384 | 1285 | 7803 | 1082 | 8570 | 925 | 9326 | 688 | 11300 | 599 | 4595 |
| 2L-3S | | MI | 2476 | 1447 | 3530 | 1215 | 4068 | 1022 | 4309 | 871 | 4450 | 648 | 5065 | 462 | 2468 |
| 6-#9 | 1.04 | MA | 4528 | 1447 | 5893 | 1295 | 7180 | 1092 | 7814 | 933 | 8306 | 700 | 9887 | 534 | 4597 |
| 3L-2S | | MI | 2613 | 1447 | 3768 | 1209 | 4370 | 1018 | 4674 | 869 | 4943 | 643 | 5693 | 535 | 2453 |
| 6-#10 | 1.32 | MA | 5009 | 1494 | 6794 | 1311 | 8306 | 1102 | 9170 | 936 | 10129 | 684 | 12406 | 595 | 5767 |
| 2L-3S | | MI | 2520 | 1494 | 3669 | 1241 | 4229 | 1040 | 4497 | 881 | 4698 | 644 | 5358 | 426 | 3048 |
| 6-#10 | 1.32 | MA | 4641 | 1494 | 6173 | 1324 | 7518 | 1113 | 8215 | 947 | 8840 | 699 | 10621 | 511 | 5756 |
| 3L-2S | | MI | 2688 | 1494 | 3968 | 1234 | 4608 | 1035 | 4956 | 878 | 5318 | 638 | 6138 | 518 | 3031 |
| 6-#11 | 1.63 | MA | 5178 | 1544 | 7245 | 1335 | 8830 | 1118 | 9782 | 945 | 10933 | 677 | 13504 | 587 | 6972 |
| 2L-3S | | MI | 2555 | 1544 | 3829 | 1259 | 4392 | 1051 | 4674 | 885 | 4921 | 633 | 5564 | 371 | 3627 |
| 6-#11 | 1.63 | MA | 4747 | 1544 | 6493 | 1350 | 7877 | 1131 | 8626 | 957 | 9373 | 695 | 11344 | 482 | 6942 |
| 3L-2S | | MI | 2750 | 1544 | 4185 | 1251 | 4844 | 1047 | 5222 | 883 | 5660 | 627 | 6463 | 485 | 3609 |
| 6-#14 | 2.34 | MA | 5599 | 1664 | 8249 | 1404 | 10071 | 1168 | 11269 | 975 | 12925 | 668 | 16251 | 576 | 9861 |
| 2L-3S | | MI | 2655 | 1664 | 4153 | 1326 | 4774 | 1098 | 5124 | 911 | 5505 | 619 | 6215 | 266 | 4972 |
| 6-#14 | 2.34 | MA | 5018 | 1664 | 7177 | 1425 | 8710 | 1187 | 9619 | 992 | 10698 | 692 | 13168 | 422 | 9752 |
| 3L-2S | | MI | 2917 | 1664 | 4654 | 1316 | 5411 | 1093 | 5895 | 910 | 6541 | 613 | 7450 | 430 | 4976 |
| 6-#18 | 4.17 | MA | 6571 | 1969 | 10710 | 1583 | 13127 | 1297 | 14940 | 1055 | 17851 | 647 | 23050 | 550 | 16969 |
| 2L-3S | | MI | 2896 | 1969 | 4911 | 1498 | 5682 | 1218 | 6197 | 1000 | 6825 | 570 | 7668 | -26 | 7650 |
| 6-#18 | 4.17 | MA | 5672 | 1969 | 8844 | 1618 | 10760 | 1328 | 12070 | 1081 | 13977 | 686 | 17686 | 266 | 16475 |
| 3L-2S | | MI | 3282 | 1969 | 5762 | 1487 | 6762 | 1215 | 7506 | 983 | 8532 | 559 | 9654 | 265 | 8200 |
| 8-#8 | 1.10 | MA | 4871 | 1456 | 6451 | 1293 | 7903 | 1089 | 8699 | 929 | 9507 | 689 | 11557 | 600 | 4842 |
| 2L-4S | | MI | 2463 | 1456 | 3474 | 1229 | 3995 | 1038 | 4225 | 884 | 4339 | 650 | 4977 | 451 | 2599 |
| 8-#8 | 1.10 | MA | 4636 | 1456 | 6061 | 1301 | 7408 | 1096 | 8099 | 936 | 8697 | 699 | 10435 | 548 | 4843 |
| 3E | | MI | 2526 | 1456 | 3608 | 1224 | 4180 | 1030 | 4452 | 877 | 4648 | 650 | 5338 | 481 | 2587 |
| 8-#8 | 1.10 | MA | 4506 | 1456 | 5795 | 1309 | 7039 | 1108 | 7647 | 947 | 8078 | 704 | 9684 | 517 | 4826 |
| 4L-2S | | MI | 2635 | 1456 | 3797 | 1220 | 4421 | 1026 | 4743 | 875 | 5042 | 645 | 5844 | 538 | 2576 |
| 8-#9 | 1.39 | MA | 5062 | 1505 | 6876 | 1321 | 8427 | 1109 | 9326 | 941 | 10346 | 685 | 12713 | 595 | 6063 |
| 2L-4S | | MI | 2504 | 1505 | 3600 | 1257 | 4137 | 1059 | 4390 | 897 | 4555 | 645 | 5244 | 413 | 3198 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

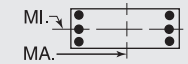
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.39 | MA | 4774 | 1505 | 6384 | 1331 | 7803 | 1118 | 8570 | 950 | 9326 | 697 | 11300 | 530 | 6054 |
| 3E | | MI | 2582 | 1505 | 3768 | 1251 | 4370 | 1049 | 4674 | 888 | 4943 | 646 | 5693 | 450 | 3191 |
| 8-#9 | 1.39 | MA | 4615 | 1505 | 6049 | 1341 | 7338 | 1133 | 7999 | 964 | 8545 | 704 | 10350 | 489 | 6006 |
| 4L-2S | | MI | 2715 | 1505 | 4005 | 1245 | 4671 | 1045 | 5040 | 885 | 5437 | 640 | 6322 | 522 | 3179 |
| 8-#10 | 1.76 | MA | 5298 | 1567 | 7415 | 1357 | 9094 | 1135 | 10125 | 957 | 11418 | 680 | 14190 | 590 | 7616 |
| 2L-4S | | MI | 2556 | 1567 | 3756 | 1294 | 4316 | 1086 | 4599 | 913 | 4829 | 640 | 5578 | 363 | 3935 |
| 8-#10 | 1.76 | MA | 4947 | 1567 | 6794 | 1370 | 8306 | 1147 | 9170 | 968 | 10129 | 696 | 12406 | 506 | 7590 |
| 3E | | MI | 2652 | 1567 | 3968 | 1287 | 4608 | 1074 | 4956 | 903 | 5318 | 640 | 6138 | 409 | 3946 |
| 8-#10 | 1.76 | MA | 4753 | 1567 | 6370 | 1383 | 7717 | 1165 | 8449 | 985 | 9141 | 704 | 11202 | 454 | 7480 |
| 4L-2S | | MI | 2814 | 1567 | 4266 | 1280 | 4987 | 1069 | 5416 | 900 | 5938 | 634 | 6918 | 501 | 3936 |
| 8-#11 | 2.17 | MA | 5518 | 1635 | 7996 | 1391 | 9784 | 1159 | 10938 | 971 | 12494 | 672 | 15665 | 581 | 9206 |
| 2L-4S | | MI | 2596 | 1635 | 3931 | 1323 | 4493 | 1106 | 4793 | 922 | 5075 | 625 | 5814 | 292 | 4601 |
| 8-#11 | 2.17 | MA | 5109 | 1635 | 7245 | 1406 | 8830 | 1173 | 9782 | 983 | 10933 | 690 | 13504 | 476 | 9157 |
| 3E | | MI | 2708 | 1635 | 4185 | 1315 | 4844 | 1093 | 5222 | 911 | 5660 | 628 | 6463 | 346 | 4689 |
| 8-#11 | 2.17 | MA | 4882 | 1635 | 6730 | 1421 | 8116 | 1195 | 8906 | 1004 | 9734 | 700 | 12033 | 412 | 8963 |
| 4L-2S | | MI | 2895 | 1635 | 4541 | 1308 | 5295 | 1088 | 5769 | 909 | 6399 | 623 | 7362 | 459 | 4684 |
| 8-#14 | 3.13 | MA | 5519 | 1795 | 8249 | 1507 | 10071 | 1246 | 11269 | 1030 | 12925 | 686 | 16251 | 413 | 12903 |
| 3E | | MI | 2871 | 1795 | 4654 | 1407 | 5411 | 1158 | 5895 | 949 | 6541 | 612 | 7450 | 224 | 6443 |
| 8-#14 | 3.13 | MA | 5218 | 1795 | 7512 | 1528 | 9049 | 1277 | 10016 | 1059 | 11211 | 698 | 14136 | 320 | 11924 |
| 4L-2S | | MI | 3110 | 1795 | 5156 | 1398 | 6048 | 1152 | 6667 | 948 | 7578 | 606 | 8686 | 388 | 6476 |
| 8-#18 | 5.56 | MA | 6503 | 2201 | 10710 | 1763 | 13127 | 1434 | 14940 | 1148 | 17851 | 675 | 23050 | 251 | 21965 |
| 3E | | MI | 3238 | 2201 | 5762 | 1643 | 6762 | 1324 | 7506 | 1067 | 8532 | 548 | 9654 | -120 | 9545 |
| 8-#18 | 5.56 | MA | 6050 | 2201 | 9421 | 1798 | 11341 | 1486 | 12751 | 1196 | 14857 | 693 | 19320 | 83 | 18842 |
| 4L-2S | | MI | 3591 | 2201 | 6613 | 1632 | 7842 | 1321 | 8815 | 1050 | 10239 | 537 | 11640 | 171 | 10709 |
| 10-#10 | 2.20 | MA | 5580 | 1641 | 8036 | 1403 | 9882 | 1169 | 11080 | 979 | 12707 | 677 | 15975 | 585 | 9461 |
| 2L-5S | | MI | 2609 | 1641 | 3864 | 1347 | 4436 | 1125 | 4737 | 937 | 5005 | 642 | 5809 | 290 | 4581 |
| 10-#10 | 2.20 | MA | 5244 | 1641 | 7415 | 1416 | 9094 | 1180 | 10125 | 989 | 11418 | 692 | 14190 | 501 | 9423 |
| 3L-4S | | MI | 2690 | 1641 | 4054 | 1340 | 4695 | 1120 | 5058 | 934 | 5449 | 636 | 6358 | 346 | 4811 |
| 10-#10 | 2.20 | MA | 5063 | 1641 | 6991 | 1429 | 8505 | 1199 | 9404 | 1007 | 10430 | 701 | 12987 | 449 | 9303 |
| 4L-3S | | MI | 2781 | 1641 | 4266 | 1333 | 4987 | 1108 | 5416 | 924 | 5938 | 637 | 6918 | 392 | 4834 |
| 10-#10 | 2.20 | MA | 4831 | 1641 | 6617 | 1441 | 7990 | 1211 | 8764 | 1017 | 9541 | 716 | 11765 | 406 | 8760 |
| 5L-2S | | MI | 2938 | 1641 | 4565 | 1326 | 5367 | 1103 | 5875 | 921 | 6558 | 631 | 7698 | 484 | 4834 |
| 10-#11 | 2.71 | MA | 5459 | 1725 | 7996 | 1463 | 9784 | 1214 | 10938 | 1009 | 12494 | 686 | 15665 | 470 | 11372 |
| 3L-4S | | MI | 2752 | 1725 | 4287 | 1379 | 4945 | 1147 | 5340 | 948 | 5814 | 621 | 6713 | 266 | 5575 |
| 10-#11 | 2.71 | MA | 5250 | 1725 | 7481 | 1478 | 9070 | 1236 | 10062 | 1030 | 11295 | 695 | 14194 | 406 | 11143 |
| 4L-3S | | MI | 2858 | 1725 | 4541 | 1372 | 5295 | 1134 | 5769 | 937 | 6399 | 624 | 7362 | 320 | 5741 |
| 10-#11 | 2.71 | MA | 4977 | 1725 | 7025 | 1493 | 8443 | 1250 | 9285 | 1042 | 10215 | 713 | 12705 | 349 | 10323 |
| 5L-2S | | MI | 3036 | 1725 | 4897 | 1364 | 5747 | 1129 | 6317 | 935 | 7138 | 619 | 8261 | 433 | 5750 |
| 10-#14 | 3.91 | MA | 5731 | 1925 | 8585 | 1609 | 10410 | 1337 | 11666 | 1096 | 13437 | 692 | 17220 | 311 | 15030 |
| 4L-3S | | MI | 3075 | 1925 | 5156 | 1489 | 6048 | 1217 | 6667 | 986 | 7578 | 605 | 8686 | 182 | 7908 |
| 10-#14 | 3.91 | MA | 5351 | 1925 | 7932 | 1630 | 9514 | 1356 | 10553 | 1113 | 11892 | 717 | 15086 | 227 | 13990 |
| 5L-2S | | MI | 3300 | 1925 | 5658 | 1479 | 6684 | 1212 | 7439 | 985 | 8614 | 599 | 9922 | 346 | 7964 |
| 10-#18 | 6.94 | MA | 6914 | 2433 | 11287 | 1943 | 13709 | 1592 | 15621 | 1263 | 18731 | 682 | 24684 | 67 | 24295 |
| 4L-3S | | MI | 3571 | 2433 | 6613 | 1788 | 7842 | 1430 | 8815 | 1134 | 10239 | 527 | 11640 | -214 | 11402 |
| 10-#18 | 6.94 | MA | 6278 | 2433 | 10142 | 1977 | 12139 | 1623 | 13673 | 1289 | 16028 | 722 | 20936 | -93 | 20579 |
| 5L-2S | | MI | 3897 | 2433 | 7465 | 1776 | 8922 | 1427 | 10124 | 1117 | 11946 | 516 | 13625 | 77 | 13207 |
| 12-#10 | 2.65 | MA | 5533 | 1715 | 8036 | 1462 | 9882 | 1214 | 11080 | 1010 | 12707 | 689 | 15975 | 496 | 11256 |
| 3L-5S | | MI | 2741 | 1715 | 4163 | 1393 | 4815 | 1159 | 5196 | 959 | 5625 | 639 | 6589 | 273 | 5422 |
| 12-#10 | 2.65 | MA | 5365 | 1715 | 7612 | 1475 | 9293 | 1233 | 10359 | 1028 | 11719 | 697 | 14771 | 445 | 11128 |
| 4E | | MI | 2821 | 1715 | 4353 | 1386 | 5074 | 1153 | 5517 | 955 | 6070 | 633 | 7138 | 329 | 5657 |
| 12-#10 | 2.65 | MA | 5135 | 1715 | 7237 | 1487 | 8778 | 1244 | 9719 | 1039 | 10830 | 713 | 13550 | 401 | 10568 |
| 5L-3S | | MI | 2908 | 1715 | 4565 | 1379 | 5367 | 1141 | 5875 | 945 | 6558 | 633 | 7698 | 375 | 5718 |
| 12-#10 | 2.65 | MA | 4896 | 1715 | 6777 | 1501 | 8293 | 1256 | 9093 | 1056 | 9962 | 721 | 12373 | 332 | 10127 |
| 6L-2S | | MI | 3060 | 1715 | 4864 | 1372 | 5746 | 1136 | 6335 | 942 | 7178 | 627 | 8478 | 467 | 5726 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis

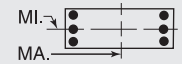


$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 3.25 | MA | 5607 | 1816 | 8233 | 1534 | 10023 | 1278 | 11218 | 1056 | 12855 | 691 | 16354 | 400 | 13307 |
| 4E | | MI | 2913 | 1816 | 4642 | 1436 | 5396 | 1189 | 5888 | 974 | 6552 | 616 | 7612 | 241 | 6559 |
| 12-#11 | 3.25 | MA | 5337 | 1816 | 7777 | 1549 | 9397 | 1291 | 10441 | 1068 | 11775 | 709 | 14866 | 344 | 12517 |
| 5L-3S | | MI | 3008 | 1816 | 4897 | 1428 | 5747 | 1175 | 6317 | 963 | 7138 | 620 | 8261 | 294 | 6788 |
| 12-#11 | 3.25 | MA | 5058 | 1816 | 7225 | 1566 | 8806 | 1305 | 9680 | 1089 | 10720 | 718 | 13427 | 258 | 11783 |
| 6L-2S | | MI | 3174 | 1816 | 5253 | 1421 | 6199 | 1171 | 6864 | 961 | 7877 | 614 | 9160 | 408 | 6809 |
| 12-#14 | 4.69 | MA | 5851 | 2056 | 9004 | 1711 | 10875 | 1415 | 12202 | 1150 | 14119 | 711 | 18169 | 219 | 17140 |
| 5L-3S | | MI | 3273 | 2056 | 5658 | 1570 | 6684 | 1277 | 7439 | 1024 | 8614 | 598 | 9922 | 140 | 9371 |
| 12-#14 | 4.69 | MA | 5476 | 2056 | 8222 | 1737 | 10028 | 1434 | 11113 | 1179 | 12609 | 723 | 16101 | 94 | 15574 |
| 6L-2S | | MI | 3486 | 2056 | 6159 | 1561 | 7321 | 1272 | 8210 | 1023 | 9650 | 592 | 11158 | 303 | 9446 |
| 14-#10 | 3.09 | MA | 5658 | 1788 | 8233 | 1521 | 10081 | 1266 | 11314 | 1049 | 13008 | 694 | 16556 | 440 | 12956 |
| 4L-5S | | MI | 2870 | 1788 | 4462 | 1439 | 5194 | 1192 | 5656 | 980 | 6245 | 635 | 7369 | 256 | 6269 |
| 14-#10 | 3.09 | MA | 5431 | 1788 | 7858 | 1533 | 9566 | 1278 | 10674 | 1060 | 12119 | 709 | 15334 | 396 | 12379 |
| 5L-4S | | MI | 2950 | 1788 | 4652 | 1432 | 5453 | 1187 | 5977 | 977 | 6690 | 629 | 7918 | 312 | 6489 |
| 14-#10 | 3.09 | MA | 5202 | 1788 | 7397 | 1547 | 9080 | 1290 | 10048 | 1077 | 11251 | 718 | 14157 | 327 | 11955 |
| 6L-3S | | MI | 3032 | 1788 | 4864 | 1425 | 5746 | 1175 | 6335 | 966 | 7178 | 630 | 8478 | 358 | 6599 |
| 14-#10 | 3.09 | MA | 5004 | 1788 | 7001 | 1555 | 8537 | 1304 | 9445 | 1088 | 10409 | 733 | 13003 | 291 | 11227 |
| 7L-2S | | MI | 3179 | 1788 | 5162 | 1418 | 6125 | 1170 | 6794 | 963 | 7798 | 624 | 9258 | 450 | 6614 |
| 14-#11 | 3.79 | MA | 5687 | 1906 | 8529 | 1606 | 10351 | 1332 | 11597 | 1094 | 13336 | 705 | 17026 | 338 | 14714 |
| 5L-4S | | MI | 3062 | 1906 | 4998 | 1492 | 5848 | 1230 | 6435 | 1000 | 7291 | 612 | 8511 | 215 | 7552 |
| 14-#11 | 3.79 | MA | 5421 | 1906 | 7976 | 1623 | 9760 | 1346 | 10836 | 1115 | 12281 | 714 | 15587 | 252 | 13983 |
| 6L-3S | | MI | 3151 | 1906 | 5253 | 1485 | 6199 | 1217 | 6864 | 989 | 7877 | 615 | 9160 | 269 | 7833 |
| 14-#11 | 3.79 | MA | 5189 | 1906 | 7495 | 1633 | 9110 | 1364 | 10102 | 1127 | 11257 | 732 | 14179 | 205 | 13127 |
| 7L-2S | | MI | 3310 | 1906 | 5608 | 1477 | 6650 | 1212 | 7411 | 987 | 8615 | 610 | 10059 | 382 | 7863 |
| 14-#14 | 5.47 | MA | 5984 | 2186 | 9294 | 1818 | 11389 | 1494 | 12763 | 1217 | 14835 | 717 | 19184 | 86 | 18709 |
| 6L-3S | | MI | 3469 | 2186 | 6159 | 1652 | 7321 | 1336 | 8210 | 1062 | 9650 | 591 | 11158 | 98 | 10815 |
| 14-#14 | 5.47 | MA | 5675 | 2186 | 8606 | 1831 | 10470 | 1520 | 11712 | 1234 | 13370 | 742 | 17163 | 16 | 17089 |
| 7L-2S | | MI | 3671 | 2186 | 6661 | 1642 | 7958 | 1331 | 8982 | 1060 | 10686 | 584 | 12393 | 261 | 10923 |
| 16-#10 | 3.53 | MA | 5720 | 1862 | 8479 | 1579 | 10354 | 1312 | 11629 | 1081 | 13408 | 706 | 17119 | 391 | 14194 |
| 5E | | MI | 2998 | 1862 | 4760 | 1485 | 5573 | 1226 | 6115 | 1001 | 6865 | 632 | 8149 | 239 | 7119 |
| 16-#10 | 3.53 | MA | 5501 | 1862 | 8018 | 1593 | 9868 | 1323 | 11003 | 1099 | 12540 | 714 | 15942 | 322 | 13781 |
| 6L-4S | | MI | 3077 | 1862 | 4951 | 1478 | 5832 | 1221 | 6436 | 998 | 7310 | 626 | 8698 | 295 | 7326 |
| 16-#10 | 3.53 | MA | 5312 | 1862 | 7622 | 1601 | 9325 | 1337 | 10400 | 1109 | 11698 | 730 | 14788 | 287 | 13049 |
| 7L-3S | | MI | 3159 | 1862 | 5162 | 1471 | 6125 | 1209 | 6794 | 988 | 7798 | 626 | 9258 | 341 | 7478 |
| 16-#10 | 3.53 | MA | 5116 | 1862 | 7241 | 1611 | 8815 | 1345 | 9769 | 1124 | 10871 | 745 | 13676 | 237 | 12295 |
| 8L-2S | | MI | 3295 | 1862 | 5461 | 1464 | 6504 | 1203 | 7253 | 985 | 8419 | 620 | 10038 | 433 | 7499 |
| 16-#11 | 4.33 | MA | 5775 | 1997 | 8728 | 1679 | 10714 | 1387 | 11992 | 1141 | 13841 | 710 | 17748 | 246 | 16185 |
| 6L-4S | | MI | 3209 | 1997 | 5354 | 1549 | 6300 | 1271 | 6982 | 1026 | 8030 | 608 | 9410 | 189 | 8552 |
| 16-#11 | 4.33 | MA | 5556 | 1997 | 8247 | 1689 | 10064 | 1405 | 11258 | 1153 | 12817 | 728 | 16340 | 199 | 15319 |
| 7L-3S | | MI | 3292 | 1997 | 5608 | 1541 | 6650 | 1258 | 7411 | 1015 | 8615 | 611 | 10059 | 243 | 8876 |
| 16-#11 | 4.33 | MA | 5325 | 1997 | 7784 | 1700 | 9445 | 1414 | 10504 | 1172 | 11812 | 746 | 14984 | 136 | 14280 |
| 8L-2S | | MI | 3444 | 1997 | 5964 | 1534 | 7102 | 1253 | 7959 | 1013 | 9354 | 606 | 10958 | 356 | 8915 |
| 16-#14 | 6.25 | MA | 6189 | 2317 | 9679 | 1913 | 11831 | 1579 | 13362 | 1271 | 15597 | 735 | 20246 | 7 | 20212 |
| 7L-3S | | MI | 3662 | 2317 | 6661 | 1733 | 7958 | 1396 | 8982 | 1099 | 10686 | 584 | 12393 | 55 | 12191 |
| 18-#10 | 3.97 | MA | 5793 | 1936 | 8639 | 1639 | 10656 | 1357 | 11958 | 1120 | 13829 | 711 | 17727 | 317 | 15599 |
| 6L-5S | | MI | 3131 | 1936 | 5059 | 1531 | 5952 | 1260 | 6574 | 1022 | 7486 | 628 | 8929 | 222 | 7972 |
| 18-#10 | 3.97 | MA | 5613 | 1936 | 8243 | 1647 | 10113 | 1371 | 11355 | 1130 | 12987 | 726 | 16573 | 282 | 14872 |
| 7L-4S | | MI | 3210 | 1936 | 5249 | 1524 | 6211 | 1254 | 6896 | 1019 | 7930 | 622 | 9479 | 278 | 8168 |
| 18-#10 | 3.97 | MA | 5420 | 1936 | 7862 | 1657 | 9603 | 1379 | 10724 | 1145 | 12160 | 741 | 15461 | 232 | 14111 |
| 8L-3S | | MI | 3279 | 1936 | 5461 | 1517 | 6504 | 1242 | 7253 | 1009 | 8419 | 623 | 10038 | 324 | 8355 |
| 18-#10 | 3.97 | MA | 5199 | 1936 | 7492 | 1667 | 9107 | 1388 | 10098 | 1153 | 11319 | 750 | 14364 | 187 | 13365 |
| 9L-2S | | MI | 3410 | 1936 | 5760 | 1510 | 6883 | 1237 | 7713 | 1006 | 9039 | 617 | 10818 | 416 | 8383 |
| 18-#11 | 4.88 | MA | 5913 | 2087 | 8998 | 1746 | 11018 | 1446 | 12414 | 1179 | 14378 | 723 | 18500 | 193 | 17510 |
| 7L-4S | | MI | 3353 | 2087 | 5710 | 1605 | 6751 | 1313 | 7530 | 1052 | 8769 | 603 | 10309 | 164 | 9556 |
| 18-#11 | 4.88 | MA | 5686 | 2087 | 8536 | 1757 | 10399 | 1455 | 11660 | 1198 | 13372 | 741 | 17144 | 130 | 16477 |
| 8L-3S | | MI | 3431 | 2087 | 5964 | 1598 | 7102 | 1299 | 7959 | 1041 | 9354 | 607 | 10958 | 217 | 9917 |

## RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

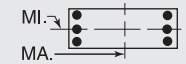
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 4.41 | MA | 5908 | 2009 | 8864 | 1693 | 10901 | 1405 | 12310 | 1152 | 14276 | 723 | 18358 | 277 | 16694 |
| 7L-5S | | MI | 3254 | 2009 | 5358 | 1577 | 6331 | 1293 | 7034 | 1044 | 8106 | 625 | 9709 | 205 | 8828 |
| 20-#10 | 4.41 | MA | 5716 | 2009 | 8483 | 1703 | 10391 | 1412 | 11679 | 1166 | 13449 | 738 | 17246 | 227 | 15927 |
| 8L-4S | | MI | 3332 | 2009 | 5548 | 1570 | 6590 | 1288 | 7355 | 1040 | 8550 | 618 | 10259 | 261 | 9014 |
| 20-#10 | 4.41 | MA | 5504 | 2009 | 8113 | 1713 | 9895 | 1421 | 11053 | 1174 | 12607 | 746 | 16148 | 182 | 15176 |
| 9L-3S | | MI | 3398 | 2009 | 5760 | 1563 | 6883 | 1276 | 7713 | 1030 | 9039 | 619 | 10818 | 307 | 9232 |
| 20-#11 | 5.42 | MA | 6038 | 2177 | 9287 | 1813 | 11352 | 1497 | 12816 | 1224 | 14932 | 737 | 19305 | 124 | 18674 |
| 8L-4S | | MI | 3496 | 2177 | 6066 | 1662 | 7203 | 1354 | 8077 | 1078 | 9508 | 599 | 11208 | 138 | 10565 |
| 22-#10 | 4.85 | MA | 6007 | 2083 | 9104 | 1749 | 11179 | 1446 | 12634 | 1188 | 14738 | 734 | 19031 | 223 | 17744 |
| 8L-5S | | MI | 3375 | 2083 | 5656 | 1623 | 6710 | 1327 | 7493 | 1065 | 8726 | 621 | 10489 | 188 | 9686 |
| 22-#10 | 4.85 | MA | 5803 | 2083 | 8734 | 1759 | 10683 | 1455 | 12008 | 1195 | 13896 | 743 | 17933 | 177 | 16987 |
| 9L-4S | | MI | 3453 | 2083 | 5847 | 1616 | 6969 | 1322 | 7814 | 1062 | 9170 | 615 | 11039 | 244 | 9863 |
| 24-#10 | 5.29 | MA | 6096 | 2157 | 9355 | 1805 | 11471 | 1489 | 12963 | 1216 | 15185 | 739 | 19718 | 172 | 18798 |
| 9L-5S | | MI | 3495 | 2157 | 5955 | 1669 | 7089 | 1360 | 7953 | 1086 | 9346 | 618 | 11269 | 172 | 10546 |

## RECTANGULAR TIED COLUMNS 18" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.02 | MA | 5419 | 1533 | 7196 | 1358 | 8765 | 1144 | 9606 | 978 | 10422 | 728 | 12601 | 634 | 5062 |
| 2E | | MI | 2745 | 1533 | 4024 | 1262 | 4610 | 1063 | 4898 | 907 | 5136 | 672 | 5800 | 545 | 2537 |
| 4-#14 | 1.47 | MA | 5738 | 1613 | 7933 | 1402 | 9664 | 1176 | 10677 | 997 | 11851 | 721 | 14567 | 626 | 7157 |
| 2E | | MI | 2860 | 1613 | 4349 | 1302 | 4993 | 1090 | 5347 | 922 | 5720 | 660 | 6449 | 507 | 3481 |
| 4-#18 | 2.61 | MA | 6479 | 1816 | 9734 | 1518 | 11878 | 1259 | 13324 | 1047 | 15393 | 705 | 19448 | 607 | 12310 |
| 2E | | MI | 3113 | 1816 | 5112 | 1407 | 5902 | 1165 | 6421 | 965 | 7038 | 619 | 7899 | 393 | 5703 |
| 6-#10 | 1.25 | MA | 5616 | 1573 | 7517 | 1391 | 9223 | 1169 | 10188 | 995 | 11230 | 731 | 13736 | 636 | 6178 |
| 2L-3S | | MI | 2663 | 1573 | 3861 | 1309 | 4446 | 1099 | 4721 | 932 | 4914 | 684 | 5595 | 461 | 3067 |
| 6-#10 | 1.25 | MA | 5217 | 1573 | 6850 | 1404 | 8377 | 1181 | 9162 | 1006 | 9846 | 747 | 11819 | 553 | 6167 |
| 3L-2S | | MI | 2832 | 1573 | 4160 | 1302 | 4825 | 1094 | 5180 | 929 | 5534 | 678 | 6375 | 553 | 3049 |
| 6-#11 | 1.53 | MA | 5803 | 1624 | 8004 | 1415 | 9790 | 1186 | 10849 | 1004 | 12100 | 724 | 14924 | 628 | 7477 |
| 2L-3S | | MI | 2698 | 1624 | 4024 | 1326 | 4610 | 1109 | 4898 | 935 | 5136 | 673 | 5800 | 406 | 3652 |
| 6-#11 | 1.53 | MA | 5334 | 1624 | 7196 | 1430 | 8765 | 1200 | 9606 | 1017 | 10422 | 743 | 12601 | 525 | 7448 |
| 3L-2S | | MI | 2894 | 1624 | 4380 | 1319 | 5062 | 1104 | 5446 | 933 | 5875 | 667 | 6699 | 520 | 3631 |
| 6-#14 | 2.21 | MA | 6263 | 1744 | 9087 | 1484 | 11128 | 1236 | 12452 | 1034 | 14247 | 715 | 17885 | 618 | 10590 |
| 2L-3S | | MI | 2798 | 1744 | 4349 | 1393 | 4993 | 1155 | 5347 | 961 | 5720 | 659 | 6449 | 301 | 5008 |
| 6-#14 | 2.21 | MA | 5630 | 1744 | 7933 | 1506 | 9664 | 1255 | 10677 | 1052 | 11851 | 741 | 14567 | 466 | 10481 |
| 3L-2S | | MI | 3062 | 1744 | 4851 | 1383 | 5630 | 1150 | 6119 | 960 | 6756 | 653 | 7684 | 465 | 5004 |
| 6-#18 | 3.92 | MA | 7329 | 2048 | 11744 | 1663 | 14429 | 1365 | 16417 | 1114 | 19568 | 694 | 25228 | 592 | 18265 |
| 2L-3S | | MI | 3038 | 2048 | 5112 | 1564 | 5902 | 1274 | 6421 | 1049 | 7038 | 609 | 7899 | 8 | 7879 |
| 6-#18 | 3.92 | MA | 6345 | 2048 | 9734 | 1699 | 11878 | 1398 | 13324 | 1142 | 15393 | 736 | 19448 | 314 | 17771 |
| 3L-2S | | MI | 3429 | 2048 | 5963 | 1552 | 6982 | 1271 | 7730 | 1032 | 8745 | 598 | 9885 | 299 | 8241 |
| 8-#8 | 1.03 | MA | 5465 | 1536 | 7147 | 1373 | 8789 | 1157 | 9679 | 988 | 10560 | 736 | 12820 | 641 | 5183 |
| 2L-4S | | MI | 2606 | 1536 | 3664 | 1298 | 4211 | 1097 | 4449 | 935 | 4556 | 691 | 5215 | 487 | 2616 |
| 8-#8 | 1.03 | MA | 5210 | 1536 | 6729 | 1381 | 8258 | 1164 | 9035 | 996 | 9691 | 746 | 11617 | 591 | 5184 |
| 3E | | MI | 2670 | 1536 | 3798 | 1293 | 4396 | 1089 | 4675 | 928 | 4865 | 691 | 5577 | 517 | 2603 |
| 8-#8 | 1.03 | MA | 5069 | 1536 | 6444 | 1389 | 7863 | 1177 | 8551 | 1007 | 9027 | 752 | 10816 | 559 | 5167 |
| 4L-2S | | MI | 2779 | 1536 | 3987 | 1289 | 4637 | 1085 | 4967 | 926 | 5259 | 686 | 6083 | 574 | 2592 |
| 8-#9 | 1.31 | MA | 5673 | 1584 | 7604 | 1400 | 9352 | 1177 | 10353 | 1001 | 11462 | 732 | 14064 | 637 | 6495 |
| 2L-4S | | MI | 2647 | 1584 | 3790 | 1326 | 4354 | 1118 | 4614 | 948 | 4771 | 686 | 5482 | 448 | 3220 |
| 8-#9 | 1.31 | MA | 5361 | 1584 | 7077 | 1411 | 8683 | 1186 | 9542 | 1009 | 10367 | 745 | 12547 | 572 | 6486 |
| 3E | | MI | 2726 | 1584 | 3959 | 1320 | 4586 | 1108 | 4898 | 939 | 5160 | 686 | 5932 | 485 | 3210 |
| 8-#9 | 1.31 | MA | 5188 | 1584 | 6718 | 1421 | 8184 | 1202 | 8930 | 1024 | 9530 | 752 | 11534 | 532 | 6438 |
| 4L-2S | | MI | 2859 | 1584 | 4196 | 1314 | 4888 | 1103 | 5264 | 936 | 5653 | 681 | 6560 | 558 | 3197 |
| 8-#10 | 1.66 | MA | 5931 | 1647 | 8184 | 1437 | 10070 | 1203 | 11213 | 1017 | 12615 | 727 | 15653 | 631 | 8165 |
| 2L-4S | | MI | 2699 | 1647 | 3948 | 1362 | 4533 | 1145 | 4822 | 964 | 5045 | 680 | 5816 | 398 | 3965 |
| 8-#10 | 1.66 | MA | 5550 | 1647 | 7517 | 1450 | 9223 | 1215 | 10188 | 1028 | 11230 | 743 | 13736 | 548 | 8139 |
| 3E | | MI | 2795 | 1647 | 4160 | 1355 | 4825 | 1132 | 5180 | 954 | 5534 | 681 | 6375 | 444 | 3968 |
| 8-#10 | 1.66 | MA | 5339 | 1647 | 7063 | 1463 | 8593 | 1234 | 9414 | 1046 | 10171 | 753 | 12452 | 497 | 8028 |
| 4L-2S | | MI | 2959 | 1647 | 4458 | 1348 | 5204 | 1127 | 5639 | 951 | 6154 | 675 | 7155 | 536 | 3956 |

## RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

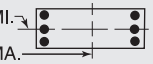
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 2.04 | MA | 6174 | 1714 | 8812 | 1471 | 10816 | 1227 | 12092 | 1030 | 13778 | 720 | 17247 | 623 | 9880 |
| 2L-4S | | MI | 2738 | 1714 | 4125 | 1390 | 4711 | 1164 | 5017 | 972 | 5290 | 665 | 6049 | 327 | 4678 |
| 8-#11 | 2.04 | MA | 5728 | 1714 | 8004 | 1486 | 9790 | 1241 | 10849 | 1043 | 12100 | 738 | 14924 | 519 | 9831 |
| 3E | | MI | 2851 | 1714 | 4380 | 1383 | 5062 | 1150 | 5446 | 961 | 5875 | 668 | 6699 | 381 | 4718 |
| 8-#11 | 2.04 | MA | 5481 | 1714 | 7452 | 1502 | 9024 | 1264 | 9909 | 1064 | 10814 | 749 | 13354 | 456 | 9637 |
| 4L-2S | | MI | 3040 | 1714 | 4736 | 1375 | 5513 | 1146 | 5993 | 959 | 6614 | 663 | 7598 | 494 | 4709 |
| 8-#14 | 2.94 | MA | 6175 | 1874 | 9087 | 1587 | 11128 | 1315 | 12452 | 1090 | 14247 | 735 | 17885 | 457 | 13875 |
| 3E | | MI | 3014 | 1874 | 4851 | 1474 | 5630 | 1215 | 6119 | 998 | 6756 | 652 | 7684 | 259 | 6483 |
| 8-#14 | 2.94 | MA | 5848 | 1874 | 8296 | 1609 | 10031 | 1347 | 11107 | 1120 | 12407 | 748 | 15628 | 365 | 12942 |
| 4L-2S | | MI | 3256 | 1874 | 5353 | 1465 | 6266 | 1210 | 6891 | 997 | 7792 | 645 | 8920 | 422 | 6508 |
| 8-#18 | 5.23 | MA | 7250 | 2280 | 11744 | 1844 | 14429 | 1504 | 16417 | 1209 | 19568 | 725 | 25228 | 298 | 23693 |
| 3E | | MI | 3380 | 2280 | 5963 | 1709 | 6982 | 1380 | 7730 | 1116 | 8745 | 587 | 9885 | -86 | 9809 |
| 8-#18 | 5.23 | MA | 6758 | 2280 | 10360 | 1880 | 12510 | 1558 | 14065 | 1260 | 16350 | 746 | 21245 | 132 | 20419 |
| 4L-2S | | MI | 3739 | 2280 | 6814 | 1697 | 8062 | 1377 | 9039 | 1099 | 10452 | 576 | 11871 | 205 | 10752 |
| 10-#10 | 2.08 | MA | 6239 | 1721 | 8851 | 1483 | 10916 | 1237 | 12239 | 1038 | 13999 | 724 | 17570 | 626 | 10147 |
| 2L-5S | | MI | 2752 | 1721 | 4056 | 1415 | 4653 | 1183 | 4960 | 988 | 5221 | 683 | 6046 | 326 | 4641 |
| 10-#10 | 2.08 | MA | 5872 | 1721 | 8184 | 1496 | 10070 | 1249 | 11213 | 1049 | 12615 | 740 | 15653 | 544 | 10109 |
| 3L-4S | | MI | 2833 | 1721 | 4246 | 1408 | 4912 | 1178 | 5282 | 985 | 5665 | 677 | 6596 | 381 | 4843 |
| 10-#10 | 2.08 | MA | 5676 | 1721 | 7730 | 1509 | 9439 | 1268 | 10440 | 1067 | 11556 | 749 | 14369 | 493 | 9989 |
| 4L-3S | | MI | 2925 | 1721 | 4458 | 1401 | 5204 | 1166 | 5639 | 975 | 6154 | 677 | 7155 | 427 | 4860 |
| 10-#10 | 2.08 | MA | 5420 | 1721 | 7329 | 1522 | 8888 | 1280 | 9755 | 1078 | 10604 | 765 | 13063 | 451 | 9458 |
| 5L-2S | | MI | 3083 | 1721 | 4757 | 1394 | 5583 | 1161 | 6099 | 972 | 6774 | 671 | 7935 | 520 | 4856 |
| 10-#11 | 2.55 | MA | 6109 | 1805 | 8812 | 1543 | 10816 | 1283 | 12092 | 1069 | 13778 | 734 | 17247 | 513 | 12214 |
| 3L-4S | | MI | 2894 | 1805 | 4481 | 1447 | 5163 | 1205 | 5564 | 998 | 6029 | 661 | 6948 | 302 | 5650 |
| 10-#11 | 2.55 | MA | 5881 | 1805 | 8260 | 1558 | 10050 | 1305 | 11152 | 1091 | 12492 | 744 | 15677 | 450 | 12011 |
| 4L-3S | | MI | 3001 | 1805 | 4736 | 1439 | 5513 | 1192 | 5993 | 987 | 6614 | 664 | 7598 | 355 | 5773 |
| 10-#11 | 2.55 | MA | 5581 | 1805 | 7772 | 1574 | 9379 | 1319 | 10319 | 1103 | 11334 | 763 | 14085 | 396 | 11153 |
| 5L-2S | | MI | 3183 | 1805 | 5091 | 1432 | 5965 | 1187 | 6540 | 985 | 7353 | 659 | 8497 | 468 | 5777 |
| 10-#14 | 3.68 | MA | 6406 | 2005 | 9450 | 1690 | 11496 | 1407 | 12882 | 1158 | 14803 | 742 | 18946 | 357 | 16294 |
| 4L-3S | | MI | 3219 | 2005 | 5353 | 1556 | 6266 | 1274 | 6891 | 1036 | 7792 | 645 | 8920 | 217 | 7951 |
| 10-#14 | 3.68 | MA | 5987 | 2005 | 8751 | 1712 | 10535 | 1426 | 11689 | 1175 | 13146 | 768 | 16662 | 276 | 15114 |
| 5L-2S | | MI | 3447 | 2005 | 5855 | 1546 | 6903 | 1269 | 7662 | 1035 | 8828 | 638 | 10156 | 380 | 7998 |
| 10-#18 | 6.54 | MA | 7696 | 2512 | 12371 | 2025 | 15062 | 1664 | 17157 | 1327 | 20524 | 735 | 27026 | 116 | 26297 |
| 4L-3S | | MI | 3713 | 2512 | 6814 | 1854 | 8062 | 1486 | 9039 | 1183 | 10452 | 566 | 11871 | -179 | 11676 |
| 10-#18 | 6.54 | MA | 6994 | 2512 | 11143 | 2061 | 13377 | 1696 | 15067 | 1355 | 17622 | 777 | 23012 | -37 | 22859 |
| 5L-2S | | MI | 4045 | 2512 | 7665 | 1842 | 9142 | 1483 | 10348 | 1166 | 12159 | 555 | 13856 | 111 | 13253 |
| 12-#10 | 2.49 | MA | 6187 | 1794 | 8851 | 1542 | 10916 | 1282 | 12239 | 1070 | 13999 | 736 | 17570 | 539 | 12079 |
| 3L-5S | | MI | 2884 | 1794 | 4355 | 1461 | 5032 | 1217 | 5420 | 1009 | 5841 | 679 | 6826 | 309 | 5482 |
| 12-#10 | 2.49 | MA | 6003 | 1794 | 8397 | 1555 | 10285 | 1301 | 11466 | 1088 | 12940 | 746 | 16286 | 488 | 11951 |
| 4E | | MI | 2964 | 1794 | 4545 | 1454 | 5291 | 1212 | 5741 | 1006 | 6286 | 673 | 7376 | 364 | 5718 |
| 12-#10 | 2.49 | MA | 5751 | 1794 | 7996 | 1568 | 9734 | 1314 | 10781 | 1099 | 11988 | 762 | 14980 | 446 | 11403 |
| 5L-3S | | MI | 3052 | 1794 | 4757 | 1447 | 5583 | 1200 | 6099 | 996 | 6774 | 674 | 7935 | 410 | 5745 |
| 12-#10 | 2.49 | MA | 5492 | 1794 | 7497 | 1581 | 9213 | 1325 | 10111 | 1117 | 11059 | 771 | 13723 | 378 | 10915 |
| 6L-2S | | MI | 3205 | 1794 | 5056 | 1440 | 5963 | 1195 | 6558 | 993 | 7394 | 668 | 8715 | 503 | 5750 |
| 12-#11 | 3.06 | MA | 6269 | 1895 | 9068 | 1615 | 11075 | 1347 | 12395 | 1117 | 14170 | 740 | 18000 | 444 | 14389 |
| 4E | | MI | 3047 | 1895 | 4837 | 1503 | 5614 | 1246 | 6111 | 1024 | 6768 | 656 | 7847 | 276 | 6633 |
| 12-#11 | 3.06 | MA | 5972 | 1895 | 8580 | 1630 | 10404 | 1361 | 11562 | 1129 | 13012 | 759 | 16408 | 390 | 13515 |
| 5L-3S | | MI | 3153 | 1895 | 5091 | 1496 | 5965 | 1233 | 6540 | 1013 | 7353 | 660 | 8497 | 329 | 6822 |
| 12-#11 | 3.06 | MA | 5669 | 1895 | 7981 | 1647 | 9772 | 1375 | 10747 | 1151 | 11881 | 769 | 14873 | 304 | 12787 |
| 6L-2S | | MI | 3321 | 1895 | 5447 | 1488 | 6417 | 1228 | 7088 | 1011 | 8092 | 654 | 9396 | 443 | 6838 |
| 12-#14 | 4.41 | MA | 6531 | 2135 | 9905 | 1793 | 11999 | 1486 | 13464 | 1213 | 15542 | 762 | 19980 | 267 | 18504 |
| 5L-3S | | MI | 3418 | 2135 | 5855 | 1637 | 6903 | 1334 | 7662 | 1074 | 8828 | 637 | 10156 | 175 | 9416 |
| 12-#14 | 4.41 | MA | 6124 | 2135 | 9056 | 1818 | 11093 | 1506 | 12297 | 1243 | 13922 | 776 | 17773 | 144 | 16885 |
| 6L-2S | | MI | 3634 | 2135 | 6356 | 1628 | 7540 | 1329 | 8434 | 1073 | 9865 | 631 | 11392 | 338 | 9481 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

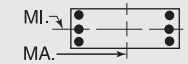
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 7.84 | MA | 7906 | 2744 | 13154 | 2206 | 15929 | 1802 | 18160 | 1422 | 21797 | 766 | 28792 | -52 | 28468 |
| 5L-3S | | MI | 4040 | 2744 | 7665 | 1999 | 9142 | 1592 | 10348 | 1250 | 12159 | 545 | 13856 | -273 | 13510 |
| 14-#10 | 2.91 | MA | 6322 | 1868 | 9064 | 1601 | 11132 | 1335 | 12491 | 1109 | 14325 | 742 | 18203 | 483 | 13916 |
| 4L-5S | | MI | 3014 | 1868 | 4654 | 1507 | 5411 | 1251 | 5879 | 1031 | 6461 | 676 | 7606 | 292 | 6327 |
| 14-#10 | 2.91 | MA | 6072 | 1868 | 8662 | 1614 | 10580 | 1347 | 11807 | 1121 | 13373 | 758 | 16898 | 441 | 13351 |
| 5L-4S | | MI | 3093 | 1868 | 4844 | 1500 | 5670 | 1246 | 6200 | 1028 | 6906 | 670 | 8156 | 347 | 6554 |
| 14-#10 | 2.91 | MA | 5825 | 1868 | 8164 | 1627 | 10059 | 1359 | 11137 | 1139 | 12443 | 767 | 15640 | 373 | 12881 |
| 6L-3S | | MI | 3177 | 1868 | 5056 | 1493 | 5963 | 1233 | 6558 | 1017 | 7394 | 670 | 8715 | 393 | 6627 |
| 14-#10 | 2.91 | MA | 5610 | 1868 | 7740 | 1636 | 9472 | 1373 | 10491 | 1150 | 11542 | 783 | 14410 | 338 | 12135 |
| 7L-2S | | MI | 3326 | 1868 | 5354 | 1486 | 6342 | 1228 | 7018 | 1014 | 8015 | 664 | 9495 | 486 | 6640 |
| 14-#11 | 3.57 | MA | 6353 | 1986 | 9388 | 1687 | 11430 | 1402 | 12805 | 1156 | 14690 | 754 | 18731 | 384 | 15881 |
| 5L-4S | | MI | 3206 | 1986 | 5193 | 1560 | 6066 | 1288 | 6659 | 1050 | 7507 | 652 | 8746 | 250 | 7625 |
| 14-#11 | 3.57 | MA | 6064 | 1986 | 8789 | 1704 | 10797 | 1416 | 11990 | 1177 | 13559 | 765 | 17196 | 298 | 15153 |
| 6L-3S | | MI | 3296 | 1986 | 5447 | 1552 | 6417 | 1274 | 7088 | 1039 | 8092 | 655 | 9396 | 304 | 7868 |
| 14-#11 | 3.57 | MA | 5812 | 1986 | 8273 | 1714 | 10091 | 1434 | 11204 | 1190 | 12462 | 783 | 15692 | 254 | 14203 |
| 7L-2S | | MI | 3458 | 1986 | 5803 | 1545 | 6868 | 1270 | 7635 | 1037 | 8831 | 650 | 10295 | 417 | 7894 |
| 14-#14 | 5.15 | MA | 6675 | 2266 | 10210 | 1900 | 12557 | 1565 | 14072 | 1281 | 16318 | 769 | 21091 | 135 | 20259 |
| 6L-3S | | MI | 3614 | 2266 | 6356 | 1719 | 7540 | 1394 | 8434 | 1111 | 9865 | 630 | 11392 | 132 | 10879 |
| 14-#14 | 5.15 | MA | 6339 | 2266 | 9471 | 1914 | 11558 | 1591 | 12946 | 1298 | 14747 | 795 | 18931 | 69 | 18583 |
| 7L-2S | | MI | 3820 | 2266 | 6858 | 1709 | 8177 | 1388 | 9206 | 1110 | 10901 | 624 | 12627 | 296 | 10960 |
| 16-#10 | 3.32 | MA | 6386 | 1942 | 9329 | 1660 | 11427 | 1381 | 12832 | 1142 | 14758 | 755 | 18815 | 436 | 15303 |
| 5E | | MI | 3142 | 1942 | 4952 | 1554 | 5790 | 1284 | 6339 | 1052 | 7081 | 672 | 8386 | 275 | 7177 |
| 16-#10 | 3.32 | MA | 6149 | 1942 | 8831 | 1673 | 10906 | 1393 | 12162 | 1160 | 13828 | 764 | 17557 | 368 | 14848 |
| 6L-4S | | MI | 3220 | 1942 | 5143 | 1546 | 6049 | 1279 | 6660 | 1049 | 7526 | 666 | 8936 | 330 | 7390 |
| 16-#10 | 3.32 | MA | 5944 | 1942 | 8406 | 1682 | 10318 | 1407 | 11517 | 1171 | 12927 | 780 | 16327 | 334 | 14093 |
| 7L-3S | | MI | 3305 | 1942 | 5354 | 1539 | 6342 | 1267 | 7018 | 1039 | 8015 | 667 | 9495 | 376 | 7508 |
| 16-#10 | 3.32 | MA | 5729 | 1942 | 7999 | 1692 | 9772 | 1415 | 10832 | 1185 | 12041 | 796 | 15140 | 286 | 13331 |
| 8L-2S | | MI | 3443 | 1942 | 5653 | 1532 | 6721 | 1262 | 7477 | 1036 | 8635 | 661 | 10275 | 469 | 7526 |
| 16-#11 | 4.08 | MA | 6448 | 2076 | 9598 | 1760 | 11823 | 1458 | 13233 | 1203 | 15237 | 760 | 19520 | 293 | 17519 |
| 6L-4S | | MI | 3353 | 2076 | 5549 | 1616 | 6518 | 1329 | 7206 | 1076 | 8245 | 648 | 9645 | 225 | 8623 |
| 16-#11 | 4.08 | MA | 6210 | 2076 | 9081 | 1770 | 11117 | 1475 | 12447 | 1216 | 14140 | 779 | 18015 | 248 | 16574 |
| 7L-3S | | MI | 3438 | 2076 | 5803 | 1609 | 6868 | 1316 | 7635 | 1066 | 8831 | 651 | 10295 | 278 | 8912 |
| 16-#11 | 4.08 | MA | 5956 | 2076 | 8585 | 1782 | 10453 | 1485 | 11628 | 1234 | 13062 | 798 | 16566 | 187 | 15488 |
| 8L-2S | | MI | 3593 | 2076 | 6159 | 1602 | 7320 | 1311 | 8182 | 1063 | 9570 | 646 | 11194 | 391 | 8947 |
| 16-#14 | 5.88 | MA | 6897 | 2396 | 10625 | 1995 | 13022 | 1650 | 14721 | 1336 | 17143 | 789 | 22248 | 60 | 21944 |
| 7L-3S | | MI | 3807 | 2396 | 6858 | 1800 | 8177 | 1453 | 9206 | 1149 | 10901 | 623 | 12627 | 90 | 12297 |
| 18-#10 | 3.74 | MA | 6465 | 2015 | 9498 | 1719 | 11752 | 1426 | 13188 | 1181 | 15213 | 760 | 19474 | 363 | 16816 |
| 6L-5S | | MI | 3268 | 2015 | 5251 | 1600 | 6169 | 1318 | 6798 | 1073 | 7702 | 669 | 9166 | 258 | 8029 |
| 18-#10 | 3.74 | MA | 6270 | 2015 | 9073 | 1728 | 11164 | 1440 | 12543 | 1192 | 14311 | 776 | 18244 | 329 | 16051 |
| 7L-4S | | MI | 3354 | 2015 | 5441 | 1592 | 6428 | 1313 | 7119 | 1070 | 8146 | 663 | 9716 | 313 | 8231 |
| 18-#10 | 3.74 | MA | 6058 | 2015 | 8665 | 1738 | 10618 | 1449 | 11858 | 1207 | 13426 | 793 | 17057 | 281 | 15282 |
| 8L-3S | | MI | 3426 | 2015 | 5653 | 1585 | 6721 | 1301 | 7477 | 1060 | 8635 | 663 | 10275 | 359 | 8386 |
| 18-#10 | 3.74 | MA | 5819 | 2015 | 8269 | 1749 | 10087 | 1458 | 11188 | 1214 | 12525 | 802 | 15888 | 236 | 14518 |
| 9L-2S | | MI | 3559 | 2015 | 5952 | 1578 | 7100 | 1296 | 7936 | 1057 | 9255 | 657 | 11055 | 452 | 8410 |
| 18-#11 | 4.59 | MA | 6598 | 2167 | 9890 | 1827 | 12142 | 1516 | 13690 | 1242 | 15818 | 775 | 20338 | 242 | 18944 |
| 7L-4S | | MI | 3497 | 2167 | 5905 | 1673 | 6969 | 1370 | 7754 | 1102 | 8984 | 643 | 10544 | 199 | 9626 |
| 18-#11 | 4.59 | MA | 6348 | 2167 | 9394 | 1838 | 11478 | 1526 | 12871 | 1260 | 14740 | 794 | 18889 | 181 | 17851 |
| 8L-3S | | MI | 3577 | 2167 | 6159 | 1666 | 7320 | 1357 | 8182 | 1092 | 9570 | 647 | 11194 | 252 | 9955 |
| 20-#10 | 4.15 | MA | 6590 | 2089 | 9740 | 1774 | 12010 | 1474 | 13569 | 1213 | 15696 | 773 | 20161 | 324 | 18009 |
| 7L-5S | | MI | 3399 | 2089 | 5550 | 1646 | 6548 | 1352 | 7257 | 1094 | 8322 | 665 | 9946 | 241 | 8884 |
| 20-#10 | 4.15 | MA | 6380 | 2089 | 9332 | 1784 | 11464 | 1482 | 12883 | 1228 | 14810 | 789 | 18974 | 276 | 17233 |
| 8L-4S | | MI | 3477 | 2089 | 5740 | 1638 | 6807 | 1346 | 7579 | 1091 | 8766 | 659 | 10496 | 296 | 9076 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

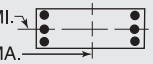
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 4.15 | MA | 6149 | 2089 | 8936 | 1795 | 10933 | 1492 | 12213 | 1236 | 13910 | 798 | 17806 | 231 | 16471 |
| 9L-3S | | MI | 3544 | 2089 | 5952 | 1631 | 7100 | 1334 | 7936 | 1081 | 9255 | 660 | 11055 | 342 | 9264 |
| 20-#10 | 4.15 | MA | 5936 | 2089 | 8520 | 1802 | 10380 | 1509 | 11558 | 1244 | 13028 | 814 | 16543 | 179 | 15575 |
| 10L-2S | | MI | 3673 | 2089 | 6250 | 1624 | 7479 | 1329 | 8396 | 1078 | 9875 | 654 | 11835 | 435 | 9293 |
| 20-#11 | 5.10 | MA | 6731 | 2257 | 10202 | 1895 | 12504 | 1567 | 14114 | 1286 | 16418 | 789 | 21212 | 175 | 20213 |
| 8L-4S | | MI | 3640 | 2257 | 6261 | 1730 | 7421 | 1412 | 8301 | 1128 | 9723 | 639 | 11443 | 173 | 10634 |
| 22-#10 | 4.57 | MA | 6695 | 2163 | 9999 | 1830 | 12311 | 1516 | 13909 | 1249 | 16195 | 785 | 20891 | 271 | 19184 |
| 8L-5S | | MI | 3521 | 2163 | 5848 | 1692 | 6927 | 1385 | 7717 | 1116 | 8942 | 662 | 10726 | 224 | 9741 |
| 22-#10 | 4.57 | MA | 6473 | 2163 | 9603 | 1841 | 11780 | 1525 | 13239 | 1257 | 15294 | 795 | 19723 | 226 | 18417 |
| 9L-4S | | MI | 3599 | 2163 | 6039 | 1684 | 7186 | 1380 | 8038 | 1113 | 9386 | 656 | 11276 | 279 | 9923 |
| 22-#10 | 4.57 | MA | 6269 | 2163 | 9187 | 1848 | 11226 | 1542 | 12583 | 1266 | 14412 | 810 | 18460 | 175 | 17525 |
| 10L-3S | | MI | 3662 | 2163 | 6250 | 1677 | 7479 | 1368 | 8396 | 1102 | 9875 | 656 | 11835 | 325 | 10141 |
| 24-#10 | 4.98 | MA | 6791 | 2236 | 10270 | 1887 | 12626 | 1559 | 14265 | 1278 | 16679 | 791 | 21640 | 221 | 20362 |
| 9L-5S | | MI | 3641 | 2236 | 6147 | 1738 | 7306 | 1419 | 8176 | 1137 | 9562 | 658 | 11506 | 207 | 10600 |
| 24-#10 | 4.98 | MA | 6594 | 2236 | 9853 | 1894 | 12072 | 1576 | 13609 | 1287 | 15797 | 807 | 20377 | 170 | 19474 |
| 10L-4S | | MI | 3719 | 2236 | 6337 | 1730 | 7565 | 1414 | 8497 | 1134 | 10006 | 652 | 12056 | 262 | 10774 |

## RECTANGULAR TIED COLUMNS 18" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.39 | MA | 6391 | 1693 | 8721 | 1482 | 10660 | 1244 | 11783 | 1056 | 13054 | 768 | 16024 | 668 | 7643 |
| 2E | | MI | 3004 | 1693 | 4546 | 1369 | 5212 | 1148 | 5571 | 972 | 5934 | 699 | 6683 | 542 | 3505 |
| 4-#18 | 2.47 | MA | 7199 | 1896 | 10655 | 1598 | 13039 | 1327 | 14627 | 1106 | 16859 | 752 | 21267 | 648 | 13174 |
| 2E | | MI | 3258 | 1896 | 5312 | 1473 | 6122 | 1221 | 6645 | 1014 | 7251 | 658 | 8130 | 427 | 5737 |
| 6-#10 | 1.18 | MA | 6255 | 1653 | 8272 | 1470 | 10184 | 1237 | 11253 | 1054 | 12381 | 778 | 15124 | 677 | 6590 |
| 2L-3S | | MI | 2806 | 1653 | 4053 | 1378 | 4663 | 1157 | 4944 | 983 | 5130 | 725 | 5832 | 497 | 3086 |
| 6-#10 | 1.18 | MA | 5825 | 1653 | 7559 | 1484 | 9279 | 1250 | 10157 | 1066 | 10901 | 795 | 13075 | 596 | 6579 |
| 3L-2S | | MI | 2976 | 1653 | 4352 | 1370 | 5042 | 1152 | 5404 | 980 | 5750 | 719 | 6612 | 589 | 3067 |
| 6-#11 | 1.44 | MA | 6460 | 1703 | 8795 | 1494 | 10794 | 1254 | 11964 | 1063 | 13317 | 771 | 16401 | 670 | 7982 |
| 2L-3S | | MI | 2841 | 1703 | 4219 | 1394 | 4828 | 1167 | 5122 | 985 | 5352 | 713 | 6035 | 441 | 3676 |
| 6-#11 | 1.44 | MA | 5952 | 1703 | 7930 | 1510 | 9696 | 1268 | 10634 | 1077 | 11522 | 791 | 13915 | 568 | 7953 |
| 3L-2S | | MI | 3038 | 1703 | 4575 | 1386 | 5280 | 1162 | 5669 | 983 | 6091 | 707 | 6934 | 555 | 3653 |
| 6-#14 | 2.08 | MA | 6960 | 1823 | 9956 | 1563 | 12228 | 1304 | 13683 | 1094 | 15619 | 762 | 19576 | 659 | 11319 |
| 2L-3S | | MI | 2941 | 1823 | 4546 | 1460 | 5212 | 1212 | 5571 | 1011 | 5934 | 698 | 6683 | 336 | 5042 |
| 6-#14 | 2.08 | MA | 6274 | 1823 | 8721 | 1586 | 10660 | 1324 | 11783 | 1112 | 13054 | 789 | 16024 | 510 | 11210 |
| 3L-2S | | MI | 3207 | 1823 | 5048 | 1450 | 5849 | 1207 | 6343 | 1009 | 6971 | 692 | 7918 | 499 | 5031 |
| 6-#18 | 3.70 | MA | 8121 | 2128 | 12811 | 1742 | 15774 | 1433 | 17942 | 1173 | 21335 | 741 | 27464 | 633 | 19561 |
| 2L-3S | | MI | 3180 | 2128 | 5312 | 1630 | 6122 | 1330 | 6645 | 1098 | 7251 | 648 | 8130 | 42 | 8026 |
| 6-#18 | 3.70 | MA | 7051 | 2128 | 10655 | 1780 | 13039 | 1467 | 14627 | 1203 | 16859 | 786 | 21267 | 360 | 19067 |
| 3L-2S | | MI | 3576 | 2128 | 6164 | 1618 | 7202 | 1327 | 7954 | 1081 | 8958 | 636 | 10116 | 333 | 8280 |
| 8-#9 | 1.23 | MA | 6317 | 1664 | 8364 | 1480 | 10321 | 1245 | 11429 | 1060 | 12628 | 779 | 15472 | 678 | 6927 |
| 2L-4S | | MI | 2790 | 1664 | 3981 | 1395 | 4570 | 1176 | 4837 | 999 | 4988 | 727 | 5720 | 484 | 3241 |
| 8-#9 | 1.23 | MA | 5980 | 1664 | 7800 | 1491 | 9605 | 1255 | 10561 | 1069 | 11457 | 792 | 13851 | 614 | 6918 |
| 3E | | MI | 2869 | 1664 | 4150 | 1389 | 4803 | 1166 | 5122 | 990 | 5376 | 727 | 6170 | 521 | 3228 |
| 8-#9 | 1.23 | MA | 5793 | 1664 | 7418 | 1501 | 9074 | 1270 | 9909 | 1084 | 10564 | 800 | 12776 | 575 | 6870 |
| 4L-2S | | MI | 3003 | 1664 | 4387 | 1383 | 5104 | 1162 | 5487 | 988 | 5870 | 722 | 6798 | 594 | 3214 |
| 8-#10 | 1.57 | MA | 6597 | 1727 | 8985 | 1516 | 11089 | 1271 | 12350 | 1076 | 13862 | 774 | 17174 | 672 | 8714 |
| 2L-4S | | MI | 2841 | 1727 | 4140 | 1431 | 4750 | 1203 | 5046 | 1015 | 5261 | 721 | 6053 | 434 | 3992 |
| 8-#10 | 1.57 | MA | 6184 | 1727 | 8272 | 1530 | 10184 | 1283 | 11253 | 1087 | 12381 | 791 | 15124 | 591 | 8687 |
| 3E | | MI | 2939 | 1727 | 4352 | 1424 | 5042 | 1191 | 5404 | 1005 | 5750 | 721 | 6612 | 480 | 3990 |
| 8-#10 | 1.57 | MA | 5957 | 1727 | 7788 | 1543 | 9511 | 1303 | 10428 | 1106 | 11252 | 801 | 13761 | 540 | 8577 |
| 4L-2S | | MI | 3103 | 1727 | 4650 | 1416 | 5421 | 1186 | 5863 | 1001 | 6370 | 715 | 7392 | 572 | 3977 |
| 8-#11 | 1.93 | MA | 6862 | 1794 | 9660 | 1551 | 11891 | 1295 | 13294 | 1089 | 15112 | 767 | 18887 | 664 | 10554 |
| 2L-4S | | MI | 2881 | 1794 | 4320 | 1458 | 4929 | 1221 | 5240 | 1022 | 5505 | 705 | 6284 | 362 | 4730 |
| 8-#11 | 1.93 | MA | 6378 | 1794 | 8795 | 1566 | 10794 | 1310 | 11964 | 1103 | 13317 | 786 | 16401 | 562 | 10505 |
| 3E | | MI | 2995 | 1794 | 4575 | 1450 | 5280 | 1208 | 5669 | 1011 | 6091 | 708 | 6934 | 416 | 4745 |
| 8-#11 | 1.93 | MA | 6112 | 1794 | 8206 | 1582 | 9975 | 1333 | 10961 | 1125 | 11943 | 797 | 14733 | 499 | 10311 |
| 4L-2S | | MI | 3185 | 1794 | 4930 | 1443 | 5732 | 1203 | 6217 | 1009 | 6829 | 703 | 7833 | 529 | 4733 |

## RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis



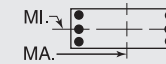

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.78 | MA | 6864 | 1954 | 9956 | 1667 | 12228 | 1384 | 13683 | 1150 | 15619 | 783 | 19576 | 501 | 14847 |
| 3E | | MI | 3158 | 1954 | 5048 | 1541 | 5849 | 1272 | 6343 | 1048 | 6971 | 691 | 7918 | 294 | 6521 |
| 8-#14 | 2.78 | MA | 6511 | 1954 | 9112 | 1690 | 11057 | 1417 | 12246 | 1181 | 13653 | 798 | 17178 | 410 | 13975 |
| 4L-2S | | MI | 3403 | 1954 | 5550 | 1532 | 6485 | 1267 | 7115 | 1047 | 8007 | 685 | 9154 | 457 | 6538 |
| 8-#18 | 4.94 | MA | 8031 | 2360 | 12811 | 1925 | 15774 | 1573 | 17942 | 1270 | 21335 | 775 | 27464 | 345 | 25421 |
| 3E | | MI | 3522 | 2360 | 6164 | 1775 | 7202 | 1436 | 7954 | 1165 | 8958 | 626 | 10116 | -52 | 10072 |
| 8-#18 | 4.94 | MA | 7498 | 2360 | 11331 | 1963 | 13722 | 1629 | 15427 | 1323 | 17892 | 797 | 23229 | 180 | 22013 |
| 4L-2S | | MI | 3886 | 2360 | 7015 | 1763 | 8282 | 1433 | 9263 | 1148 | 10665 | 615 | 12102 | 239 | 10795 |
| 10-#10 | 1.96 | MA | 6930 | 1800 | 9698 | 1562 | 11994 | 1305 | 13446 | 1097 | 15342 | 771 | 19223 | 667 | 10832 |
| 2L-5S | | MI | 2895 | 1800 | 4248 | 1484 | 4869 | 1242 | 5184 | 1039 | 5437 | 723 | 6283 | 361 | 4699 |
| 10-#10 | 1.96 | MA | 6533 | 1800 | 8985 | 1576 | 11089 | 1317 | 12350 | 1108 | 13862 | 788 | 17174 | 586 | 10795 |
| 3L-4S | | MI | 2976 | 1800 | 4438 | 1477 | 5129 | 1237 | 5505 | 1036 | 5882 | 717 | 6833 | 417 | 4873 |
| 10-#10 | 1.96 | MA | 6321 | 1800 | 8501 | 1589 | 10416 | 1336 | 11524 | 1127 | 12732 | 797 | 15810 | 536 | 10675 |
| 4L-3S | | MI | 3068 | 1800 | 4650 | 1470 | 5421 | 1224 | 5863 | 1026 | 6370 | 718 | 7392 | 463 | 4884 |
| 10-#10 | 1.96 | MA | 6043 | 1800 | 8069 | 1602 | 9828 | 1349 | 10794 | 1139 | 11716 | 814 | 14420 | 495 | 10163 |
| 5L-2S | | MI | 3228 | 1800 | 4949 | 1462 | 5800 | 1219 | 6322 | 1023 | 6990 | 712 | 8173 | 555 | 4878 |
| 10-#11 | 2.41 | MA | 6791 | 1884 | 9660 | 1623 | 11891 | 1351 | 13294 | 1129 | 15112 | 782 | 18887 | 556 | 13057 |
| 3L-4S | | MI | 3037 | 1884 | 4676 | 1514 | 5381 | 1263 | 5788 | 1048 | 6244 | 701 | 7183 | 337 | 5724 |
| 10-#11 | 2.41 | MA | 6545 | 1884 | 9071 | 1639 | 11073 | 1374 | 12291 | 1151 | 13738 | 793 | 17219 | 493 | 12854 |
| 4L-3S | | MI | 3145 | 1884 | 4930 | 1507 | 5732 | 1249 | 6217 | 1037 | 6829 | 704 | 7833 | 390 | 5803 |
| 10-#11 | 2.41 | MA | 6217 | 1884 | 8550 | 1655 | 10357 | 1389 | 11402 | 1164 | 12503 | 812 | 15523 | 441 | 11990 |
| 5L-2S | | MI | 3329 | 1884 | 5286 | 1500 | 6183 | 1245 | 6764 | 1035 | 7568 | 699 | 8732 | 504 | 5803 |
| 10-#14 | 3.47 | MA | 7114 | 2084 | 10348 | 1771 | 12625 | 1476 | 14147 | 1219 | 16218 | 792 | 20730 | 401 | 17573 |
| 4L-3S | | MI | 3363 | 2084 | 5550 | 1623 | 6485 | 1332 | 7115 | 1086 | 8007 | 684 | 9154 | 252 | 7992 |
| 10-#14 | 3.47 | MA | 6656 | 2084 | 9602 | 1794 | 11599 | 1497 | 12873 | 1237 | 14449 | 819 | 18297 | 324 | 16246 |
| 5L-2S | | MI | 3594 | 2084 | 6051 | 1613 | 7122 | 1326 | 7886 | 1085 | 9043 | 678 | 10390 | 415 | 8031 |
| 10-#18 | 6.17 | MA | 8513 | 2592 | 13487 | 2108 | 16458 | 1735 | 18742 | 1390 | 22368 | 786 | 29426 | 165 | 28316 |
| 4L-3S | | MI | 3855 | 2592 | 7015 | 1919 | 8282 | 1542 | 9263 | 1232 | 10665 | 605 | 12102 | -145 | 11948 |
| 10-#18 | 6.17 | MA | 7743 | 2592 | 12177 | 2145 | 14659 | 1769 | 16509 | 1420 | 19266 | 831 | 25146 | 18 | 25067 |
| 5L-2S | | MI | 4194 | 2592 | 7866 | 1908 | 9363 | 1539 | 10572 | 1215 | 12373 | 594 | 14087 | 145 | 13298 |
| 12-#10 | 2.35 | MA | 6873 | 1874 | 9698 | 1622 | 11994 | 1351 | 13446 | 1130 | 15342 | 784 | 19223 | 581 | 12902 |
| 3L-5S | | MI | 3027 | 1874 | 4547 | 1530 | 5249 | 1275 | 5644 | 1060 | 6057 | 720 | 7063 | 344 | 5539 |
| 12-#10 | 2.35 | MA | 6674 | 1874 | 9214 | 1635 | 11321 | 1370 | 12621 | 1148 | 14212 | 794 | 17859 | 531 | 12774 |
| 4E | | MI | 3107 | 1874 | 4737 | 1523 | 5508 | 1270 | 5965 | 1057 | 6502 | 714 | 7613 | 400 | 5750 |
| 12-#10 | 2.35 | MA | 6399 | 1874 | 8782 | 1648 | 10733 | 1383 | 11891 | 1160 | 13197 | 811 | 16469 | 490 | 12245 |
| 5L-3S | | MI | 3196 | 1874 | 4949 | 1516 | 5800 | 1258 | 6322 | 1047 | 6990 | 714 | 8173 | 446 | 5772 |
| 12-#10 | 2.35 | MA | 6121 | 1874 | 8250 | 1662 | 10172 | 1394 | 11177 | 1178 | 12206 | 820 | 15131 | 424 | 11708 |
| 6L-2S | | MI | 3351 | 1874 | 5248 | 1509 | 6179 | 1253 | 6782 | 1044 | 7610 | 708 | 8953 | 538 | 5773 |
| 12-#11 | 2.89 | MA | 6964 | 1975 | 9935 | 1695 | 12170 | 1416 | 13621 | 1177 | 15533 | 789 | 19704 | 487 | 15400 |
| 4E | | MI | 3190 | 1975 | 5032 | 1571 | 5833 | 1304 | 6335 | 1074 | 6983 | 696 | 8082 | 311 | 6705 |
| 12-#11 | 2.89 | MA | 6640 | 1975 | 9415 | 1711 | 11454 | 1430 | 12732 | 1190 | 14298 | 808 | 18009 | 435 | 14521 |
| 5L-3S | | MI | 3298 | 1975 | 5286 | 1564 | 6183 | 1291 | 6764 | 1064 | 7568 | 700 | 8732 | 364 | 6855 |
| 12-#11 | 2.89 | MA | 6312 | 1975 | 8770 | 1728 | 10780 | 1445 | 11862 | 1212 | 13092 | 819 | 16376 | 351 | 13796 |
| 6L-2S | | MI | 3468 | 1975 | 5642 | 1556 | 6635 | 1286 | 7311 | 1062 | 8307 | 694 | 9631 | 478 | 6867 |
| 12-#14 | 4.17 | MA | 7244 | 2215 | 10837 | 1875 | 13167 | 1556 | 14774 | 1275 | 17014 | 813 | 21849 | 315 | 19877 |
| 5L-3S | | MI | 3563 | 2215 | 6051 | 1704 | 7122 | 1391 | 7886 | 1124 | 9043 | 677 | 10390 | 209 | 9459 |
| 12-#14 | 4.17 | MA | 6804 | 2215 | 9921 | 1899 | 12200 | 1577 | 13528 | 1306 | 15286 | 827 | 19504 | 192 | 18214 |
| 6L-2S | | MI | 3782 | 2215 | 6553 | 1695 | 7759 | 1386 | 8658 | 1122 | 10079 | 671 | 11625 | 373 | 9516 |
| 12-#18 | 7.41 | MA | 8729 | 2824 | 14333 | 2290 | 17394 | 1875 | 19825 | 1487 | 23742 | 820 | 31343 | 2 | 31332 |
| 5L-3S | | MI | 4182 | 2824 | 7866 | 2064 | 9363 | 1648 | 10572 | 1299 | 12373 | 584 | 14087 | -239 | 13792 |
| 12-#18 | 7.41 | MA | 8042 | 2824 | 12755 | 2334 | 15696 | 1909 | 17638 | 1539 | 20710 | 843 | 27200 | -218 | 26308 |
| 6L-2S | | MI | 4499 | 2824 | 8717 | 2053 | 10443 | 1645 | 11881 | 1281 | 14080 | 573 | 16073 | 52 | 15794 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis

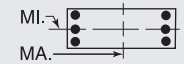



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.74 | MA | 7019 | 1948 | 9927 | 1681 | 12225 | 1404 | 13717 | 1170 | 15692 | 790 | 19909 | 526 | 14876 |
| 4L-5S | | MI | 3157 | 1948 | 4846 | 1576 | 5628 | 1309 | 6103 | 1082 | 6677 | 716 | 7844 | 327 | 6384 |
| 14-#10 | 2.74 | MA | 6747 | 1948 | 9495 | 1694 | 11638 | 1416 | 12987 | 1181 | 14677 | 807 | 18519 | 485 | 14330 |
| 5L-4S | | MI | 3237 | 1948 | 5036 | 1569 | 5887 | 1304 | 6424 | 1078 | 7122 | 710 | 8393 | 383 | 6617 |
| 14-#10 | 2.74 | MA | 6479 | 1948 | 8963 | 1708 | 11077 | 1428 | 12273 | 1200 | 13686 | 817 | 17180 | 419 | 13811 |
| 6L-3S | | MI | 3322 | 1948 | 5248 | 1562 | 6179 | 1292 | 6782 | 1068 | 7610 | 711 | 8953 | 429 | 6655 |
| 14-#10 | 2.74 | MA | 6247 | 1948 | 8510 | 1717 | 10450 | 1442 | 11582 | 1211 | 12725 | 833 | 15876 | 385 | 13054 |
| 7L-2S | | MI | 3472 | 1948 | 5546 | 1555 | 6559 | 1287 | 7241 | 1065 | 8231 | 705 | 9733 | 521 | 6664 |
| 14-#11 | 3.37 | MA | 7052 | 2065 | 10280 | 1768 | 12552 | 1472 | 14062 | 1217 | 16093 | 804 | 20494 | 429 | 17057 |
| 5L-4S | | MI | 3349 | 2065 | 5388 | 1628 | 6284 | 1345 | 6883 | 1100 | 7722 | 692 | 8981 | 285 | 7696 |
| 14-#11 | 3.37 | MA | 6739 | 2065 | 9634 | 1784 | 11877 | 1486 | 13192 | 1239 | 14887 | 815 | 18862 | 345 | 16328 |
| 6L-3S | | MI | 3441 | 2065 | 5642 | 1620 | 6635 | 1332 | 7311 | 1090 | 8307 | 695 | 9631 | 339 | 7903 |
| 14-#11 | 3.37 | MA | 6467 | 2065 | 9083 | 1795 | 11115 | 1503 | 12355 | 1252 | 13717 | 834 | 17263 | 302 | 15287 |
| 7L-2S | | MI | 3605 | 2065 | 5998 | 1613 | 7086 | 1327 | 7859 | 1088 | 9046 | 690 | 10530 | 452 | 7924 |
| 14-#14 | 4.86 | MA | 7399 | 2345 | 11157 | 1981 | 13768 | 1636 | 15428 | 1343 | 17851 | 821 | 23056 | 184 | 21826 |
| 6L-3S | | MI | 3759 | 2345 | 6553 | 1786 | 7759 | 1451 | 8658 | 1161 | 10079 | 670 | 11625 | 167 | 10923 |
| 14-#14 | 4.86 | MA | 7037 | 2345 | 10368 | 1995 | 12688 | 1661 | 14228 | 1362 | 16175 | 848 | 20757 | 120 | 20102 |
| 7L-2S | | MI | 3968 | 2345 | 7055 | 1776 | 8395 | 1445 | 9430 | 1160 | 11115 | 664 | 12861 | 331 | 10996 |
| 16-#10 | 3.14 | MA | 7086 | 2021 | 10208 | 1740 | 12542 | 1450 | 14084 | 1202 | 16157 | 803 | 20568 | 481 | 16419 |
| 5E | | MI | 3285 | 2021 | 5144 | 1622 | 6007 | 1343 | 6562 | 1103 | 7298 | 713 | 8624 | 310 | 7233 |
| 16-#10 | 3.14 | MA | 6829 | 2021 | 9676 | 1754 | 11981 | 1462 | 13370 | 1221 | 15166 | 813 | 19229 | 414 | 15915 |
| 6L-4S | | MI | 3364 | 2021 | 5334 | 1615 | 6266 | 1338 | 6883 | 1100 | 7742 | 707 | 9173 | 366 | 7452 |
| 16-#10 | 3.14 | MA | 6608 | 2021 | 9223 | 1763 | 11354 | 1476 | 12679 | 1232 | 14205 | 830 | 17925 | 380 | 15148 |
| 7L-3S | | MI | 3446 | 2021 | 5546 | 1608 | 6559 | 1325 | 7241 | 1090 | 8231 | 707 | 9733 | 412 | 7537 |
| 16-#10 | 3.14 | MA | 6374 | 2021 | 8788 | 1773 | 10772 | 1485 | 11943 | 1246 | 13246 | 840 | 16662 | 334 | 14383 |
| 8L-2S | | MI | 3591 | 2021 | 5845 | 1601 | 6938 | 1320 | 7701 | 1086 | 8851 | 701 | 10513 | 504 | 7552 |
| 16-#11 | 3.85 | MA | 7154 | 2156 | 10499 | 1841 | 12975 | 1528 | 14522 | 1265 | 16682 | 810 | 21347 | 339 | 18859 |
| 6L-4S | | MI | 3496 | 2156 | 5744 | 1684 | 6736 | 1387 | 7430 | 1127 | 8461 | 688 | 9880 | 260 | 8692 |
| 16-#11 | 3.85 | MA | 6897 | 2156 | 9948 | 1851 | 12213 | 1545 | 13685 | 1278 | 15512 | 830 | 19749 | 296 | 17824 |
| 7L-3S | | MI | 3583 | 2156 | 5998 | 1677 | 7086 | 1373 | 7859 | 1116 | 9046 | 691 | 10530 | 313 | 8948 |
| 16-#11 | 3.85 | MA | 6620 | 2156 | 9419 | 1863 | 11504 | 1555 | 12799 | 1296 | 14363 | 850 | 18207 | 237 | 16713 |
| 8L-2S | | MI | 3741 | 2156 | 6354 | 1669 | 7538 | 1368 | 8406 | 1114 | 9785 | 686 | 11429 | 427 | 8978 |
| 16-#14 | 5.56 | MA | 7639 | 2476 | 11603 | 2077 | 14256 | 1721 | 16128 | 1400 | 18740 | 842 | 24309 | 112 | 23701 |
| 7L-3S | | MI | 3953 | 2476 | 7055 | 1867 | 8395 | 1510 | 9430 | 1199 | 11115 | 663 | 12861 | 125 | 12387 |
| 16-#14 | 5.56 | MA | 7250 | 2476 | 10845 | 2094 | 13241 | 1735 | 14873 | 1426 | 17093 | 869 | 22095 | 24 | 21992 |
| 8L-2S | | MI | 4153 | 2476 | 7557 | 1858 | 9032 | 1505 | 10201 | 1198 | 12151 | 657 | 14097 | 289 | 12473 |
| 18-#10 | 3.53 | MA | 7171 | 2095 | 10389 | 1800 | 12886 | 1495 | 14466 | 1242 | 16646 | 810 | 21279 | 409 | 18017 |
| 6L-5S | | MI | 3412 | 2095 | 5443 | 1668 | 6386 | 1376 | 7022 | 1124 | 7918 | 709 | 9404 | 294 | 8085 |
| 18-#10 | 3.53 | MA | 6960 | 2095 | 9936 | 1809 | 12259 | 1509 | 13775 | 1253 | 15685 | 826 | 19974 | 375 | 17241 |
| 7L-4S | | MI | 3490 | 2095 | 5633 | 1661 | 6645 | 1371 | 7343 | 1121 | 8362 | 703 | 9953 | 349 | 8292 |
| 18-#10 | 3.53 | MA | 6729 | 2095 | 9501 | 1819 | 11676 | 1518 | 13040 | 1268 | 14726 | 836 | 18711 | 329 | 16469 |
| 8L-3S | | MI | 3572 | 2095 | 5845 | 1654 | 6938 | 1359 | 7701 | 1111 | 8851 | 704 | 10513 | 395 | 8416 |
| 18-#10 | 3.53 | MA | 6471 | 2095 | 9074 | 1829 | 11110 | 1528 | 12325 | 1276 | 13781 | 853 | 17472 | 284 | 15631 |
| 9L-2S | | MI | 3707 | 2095 | 6144 | 1647 | 7317 | 1354 | 8160 | 1108 | 9471 | 698 | 11293 | 487 | 8437 |
| 18-#11 | 4.33 | MA | 7316 | 2246 | 10813 | 1908 | 13310 | 1586 | 15015 | 1304 | 17307 | 826 | 22235 | 291 | 20360 |
| 7L-4S | | MI | 3641 | 2246 | 6100 | 1741 | 7187 | 1428 | 7977 | 1153 | 9199 | 683 | 10779 | 234 | 9695 |
| 18-#11 | 4.33 | MA | 7043 | 2246 | 10283 | 1920 | 12601 | 1596 | 14129 | 1322 | 16158 | 845 | 20693 | 231 | 19241 |
| 8L-3S | | MI | 3723 | 2246 | 6354 | 1733 | 7538 | 1415 | 8406 | 1142 | 9785 | 687 | 11429 | 287 | 9992 |
| 18-#11 | 4.33 | MA | 6740 | 2246 | 9770 | 1933 | 11912 | 1607 | 13260 | 1331 | 14989 | 856 | 19174 | 176 | 18134 |
| 9L-2S | | MI | 3875 | 2246 | 6710 | 1726 | 7990 | 1410 | 8953 | 1140 | 10524 | 681 | 12328 | 401 | 10029 |
| 18-#14 | 6.25 | MA | 7842 | 2606 | 12081 | 2175 | 14809 | 1795 | 16774 | 1463 | 19659 | 863 | 25647 | 15 | 25581 |
| 8L-3S | | MI | 4145 | 2606 | 7557 | 1949 | 9032 | 1570 | 10201 | 1237 | 12151 | 656 | 14097 | 83 | 13783 |
| 20-#10 | 3.92 | MA | 7305 | 2168 | 10648 | 1855 | 13164 | 1543 | 14872 | 1275 | 17165 | 823 | 22024 | 370 | 19334 |
| 7L-5S | | MI | 3544 | 2168 | 5742 | 1714 | 6765 | 1410 | 7481 | 1145 | 8538 | 706 | 10184 | 277 | 8939 |
| 20-#10 | 3.92 | MA | 7076 | 2168 | 10214 | 1865 | 12581 | 1552 | 14136 | 1289 | 16206 | 833 | 20761 | 324 | 18555 |
| 8L-4S | | MI | 3622 | 2168 | 5932 | 1707 | 7024 | 1405 | 7802 | 1142 | 8982 | 700 | 10733 | 332 | 9136 |
| 20-#10 | 3.92 | MA | 6827 | 2168 | 9787 | 1875 | 12015 | 1562 | 13422 | 1297 | 15261 | 849 | 19521 | 279 | 17721 |
| 9L-3S | | MI | 3691 | 2168 | 6144 | 1700 | 7317 | 1393 | 8160 | 1132 | 9471 | 700 | 11293 | 378 | 9295 |

## RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 3.92 | MA | 6597 | 2168 | 9343 | 1883 | 11424 | 1579 | 12722 | 1306 | 14309 | 865 | 18178 | 229 | 16802 |
| 10L-2S | | MI | 3822 | 2168 | 6442 | 1693 | 7696 | 1388 | 8619 | 1129 | 10091 | 694 | 12073 | 470 | 9320 |
| 20-#11 | 4.81 | MA | 7456 | 2337 | 11148 | 1977 | 13699 | 1637 | 15459 | 1348 | 17954 | 841 | 23178 | 225 | 21770 |
| 8L-4S | | MI | 3784 | 2337 | 6455 | 1797 | 7639 | 1469 | 8525 | 1179 | 9938 | 679 | 11678 | 208 | 10701 |
| 20-#11 | 4.81 | MA | 7166 | 2337 | 10634 | 1990 | 13009 | 1649 | 14589 | 1358 | 16785 | 852 | 21659 | 170 | 20655 |
| 9L-3S | | MI | 3861 | 2337 | 6710 | 1790 | 7990 | 1456 | 8953 | 1168 | 10524 | 682 | 12328 | 262 | 11035 |
| 22-#10 | 4.31 | MA | 7416 | 2242 | 10926 | 1911 | 13486 | 1585 | 15233 | 1310 | 17686 | 829 | 22810 | 319 | 20641 |
| 8L-5S | | MI | 3666 | 2242 | 6040 | 1760 | 7144 | 1444 | 7941 | 1167 | 9158 | 702 | 10964 | 260 | 9796 |
| 22-#10 | 4.31 | MA | 7176 | 2242 | 10500 | 1921 | 12919 | 1595 | 14518 | 1319 | 16741 | 846 | 21570 | 274 | 19810 |
| 9L-4S | | MI | 3744 | 2242 | 6231 | 1753 | 7403 | 1438 | 8262 | 1163 | 9602 | 696 | 11513 | 315 | 9983 |
| 22-#10 | 4.31 | MA | 6956 | 2242 | 10056 | 1929 | 12329 | 1613 | 13819 | 1328 | 15789 | 861 | 20228 | 224 | 18886 |
| 10L-3S | | MI | 3809 | 2242 | 6442 | 1746 | 7696 | 1426 | 8619 | 1153 | 10091 | 697 | 12073 | 361 | 10173 |
| 22-#11 | 5.30 | MA | 7581 | 2427 | 11499 | 2046 | 14107 | 1690 | 15919 | 1384 | 18580 | 848 | 24145 | 164 | 23177 |
| 9L-4S | | MI | 3926 | 2427 | 6811 | 1854 | 8091 | 1511 | 9072 | 1205 | 10677 | 675 | 12577 | 183 | 11712 |
| 24-#10 | 4.70 | MA | 7519 | 2316 | 11213 | 1967 | 13824 | 1629 | 15615 | 1340 | 18222 | 842 | 23620 | 270 | 21899 |
| 9L-5S | | MI | 3787 | 2316 | 6339 | 1806 | 7523 | 1477 | 8400 | 1188 | 9778 | 699 | 11744 | 243 | 10654 |
| 24-#10 | 4.70 | MA | 7307 | 2316 | 10769 | 1975 | 13234 | 1646 | 14915 | 1349 | 17269 | 857 | 22277 | 219 | 20970 |
| 10L-4S | | MI | 3864 | 2316 | 6529 | 1799 | 7782 | 1472 | 8721 | 1185 | 10222 | 693 | 12293 | 298 | 10833 |

## RECTANGULAR TIED COLUMNS 20" x 20"

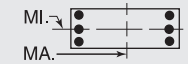
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.19 | MA | 2072 | 1021 | 2953 | 865 | 3480 | 727 | 3763 | 619 | 4046 | 455 | 4789 | 386 | 2155 |
| 2L-3S | | MI | 1946 | 1021 | 2735 | 871 | 3203 | 732 | 3428 | 623 | 3593 | 460 | 4184 | 329 | 2164 |
| 6-#9 | 1.50 | MA | 2143 | 1058 | 3132 | 885 | 3697 | 742 | 4021 | 627 | 4391 | 451 | 5225 | 377 | 2671 |
| 2L-3S | | MI | 1989 | 1058 | 2858 | 892 | 3349 | 747 | 3600 | 632 | 3822 | 458 | 4473 | 305 | 2677 |
| 6-#10 | 1.90 | MA | 2231 | 1105 | 3356 | 911 | 3971 | 760 | 4349 | 639 | 4828 | 447 | 5772 | 365 | 3321 |
| 2L-3S | | MI | 2043 | 1105 | 3012 | 920 | 3534 | 767 | 3818 | 644 | 4112 | 455 | 4835 | 273 | 3317 |
| 6-#11 | 2.34 | MA | 2306 | 1155 | 3593 | 934 | 4243 | 776 | 4663 | 647 | 5241 | 439 | 6211 | 340 | 3966 |
| 2L-3S | | MI | 2088 | 1155 | 3181 | 943 | 3720 | 783 | 4029 | 651 | 4384 | 448 | 5120 | 227 | 3949 |
| 6-#14 | 3.38 | MA | 2501 | 1275 | 4129 | 1003 | 4903 | 825 | 5453 | 677 | 6298 | 430 | 7454 | 298 | 5521 |
| 2L-3S | | MI | 2222 | 1275 | 3546 | 1015 | 4163 | 834 | 4556 | 682 | 5087 | 440 | 5944 | 134 | 5436 |
| 6-#18 | 6.00 | MA | 2938 | 1580 | 5413 | 1181 | 6491 | 954 | 7358 | 755 | 8841 | 406 | 10293 | 168 | 9239 |
| 2L-3S | | MI | 2525 | 1580 | 4417 | 1198 | 5227 | 964 | 5826 | 758 | 6777 | 417 | 7826 | -122 | 7680 |
| 8-#8 | 1.58 | MA | 2168 | 1067 | 3171 | 894 | 3757 | 748 | 4099 | 632 | 4500 | 452 | 5393 | 380 | 2813 |
| 2L-4S | | MI | 1976 | 1067 | 2800 | 905 | 3269 | 762 | 3504 | 644 | 3693 | 460 | 4361 | 291 | 2808 |
| 8-#9 | 2.00 | MA | 2261 | 1116 | 3406 | 921 | 4045 | 768 | 4443 | 644 | 4960 | 448 | 5977 | 369 | 3493 |
| 2L-4S | | MI | 2028 | 1116 | 2939 | 935 | 3431 | 785 | 3696 | 658 | 3946 | 457 | 4691 | 257 | 3455 |
| 8-#10 | 2.54 | MA | 2376 | 1179 | 3701 | 957 | 4409 | 794 | 4879 | 660 | 5544 | 443 | 6709 | 353 | 4350 |
| 2L-4S | | MI | 2093 | 1179 | 3114 | 974 | 3637 | 814 | 3939 | 677 | 4268 | 453 | 5106 | 211 | 4137 |
| 8-#11 | 3.12 | MA | 2474 | 1246 | 4006 | 991 | 4766 | 817 | 5297 | 673 | 6097 | 435 | 7301 | 321 | 5193 |
| 2L-4S | | MI | 2147 | 1246 | 3301 | 1009 | 3840 | 840 | 4170 | 691 | 4567 | 443 | 5431 | 150 | 4769 |
| 8-#14 | 4.50 | MA | 2724 | 1406 | 4713 | 1084 | 5643 | 885 | 6350 | 714 | 7509 | 424 | 8964 | 266 | 7245 |
| 2L-4S | | MI | 2315 | 1406 | 3715 | 1109 | 4331 | 915 | 4753 | 737 | 5342 | 431 | 6369 | 22 | 6277 |
| 10-#10 | 3.17 | MA | 2517 | 1252 | 4046 | 1003 | 4846 | 828 | 5409 | 681 | 6259 | 440 | 7646 | 341 | 5373 |
| 2L-5S | | MI | 2148 | 1252 | 3242 | 1029 | 3778 | 855 | 4102 | 703 | 4475 | 458 | 5383 | 145 | 4821 |
| 10-#10 | 3.17 | MA | 2346 | 1252 | 3701 | 1012 | 4409 | 834 | 4879 | 686 | 5544 | 448 | 6709 | 249 | 5343 |
| 3L-4S | | MI | 2250 | 1252 | 3459 | 1020 | 4074 | 848 | 4469 | 698 | 4983 | 450 | 6043 | 199 | 5099 |
| 10-#11 | 3.90 | MA | 2449 | 1336 | 4006 | 1056 | 4766 | 866 | 5297 | 703 | 6097 | 439 | 7301 | 189 | 6362 |
| 3L-4S | | MI | 2331 | 1336 | 3714 | 1066 | 4363 | 881 | 4804 | 717 | 5423 | 439 | 6521 | 131 | 5922 |
| 10-#14 | 5.63 | MA | 2707 | 1536 | 4713 | 1178 | 5643 | 953 | 6350 | 757 | 7509 | 428 | 8964 | 71 | 8730 |
| 3L-4S | | MI | 2573 | 1536 | 4298 | 1190 | 5071 | 974 | 5650 | 774 | 6553 | 425 | 7879 | -10 | 7866 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis

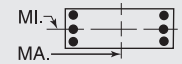



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.15 | MA | 2506 | 1120 | 3542 | 954 | 4188 | 802 | 4535 | 683 | 4878 | 503 | 5803 | 431 | 2556 |
| 2E | | MI | 2261 | 1120 | 3244 | 942 | 3800 | 793 | 4094 | 675 | 4380 | 496 | 5131 | 417 | 2301 |
| 4-#11 | 1.42 | MA | 2568 | 1153 | 3737 | 966 | 4403 | 810 | 4779 | 686 | 5194 | 496 | 6157 | 415 | 3064 |
| 2E | | MI | 2312 | 1153 | 3416 | 954 | 3987 | 800 | 4305 | 677 | 4651 | 489 | 5414 | 399 | 2750 |
| 4-#14 | 2.05 | MA | 2728 | 1233 | 4156 | 1010 | 4912 | 841 | 5383 | 705 | 6000 | 489 | 7148 | 392 | 4270 |
| 2E | | MI | 2449 | 1233 | 3784 | 997 | 4431 | 831 | 4832 | 695 | 5353 | 481 | 6237 | 369 | 3813 |
| 4-#18 | 3.64 | MA | 3090 | 1436 | 5161 | 1124 | 6141 | 923 | 6851 | 754 | 7963 | 472 | 9449 | 320 | 7168 |
| 2E | | MI | 2752 | 1436 | 4659 | 1110 | 5497 | 912 | 6103 | 744 | 7042 | 462 | 8115 | 280 | 6344 |
| 6-#8 | 1.08 | MA | 2493 | 1110 | 3473 | 953 | 4125 | 803 | 4469 | 685 | 4800 | 507 | 5738 | 439 | 2411 |
| 2L-3S | | MI | 2123 | 1110 | 2965 | 948 | 3468 | 798 | 3703 | 680 | 3862 | 506 | 4482 | 369 | 2182 |
| 6-#8 | 1.08 | MA | 2348 | 1110 | 3226 | 960 | 3811 | 808 | 4090 | 689 | 4287 | 514 | 5035 | 382 | 2420 |
| 3L-2S | | MI | 2250 | 1110 | 3183 | 943 | 3745 | 794 | 4039 | 677 | 4315 | 501 | 5086 | 427 | 2172 |
| 6-#9 | 1.36 | MA | 2576 | 1146 | 3676 | 973 | 4371 | 817 | 4763 | 693 | 5191 | 503 | 6252 | 432 | 2995 |
| 2L-3S | | MI | 2166 | 1146 | 3089 | 969 | 3615 | 813 | 3876 | 689 | 4090 | 504 | 4770 | 345 | 2699 |
| 6-#9 | 1.36 | MA | 2398 | 1146 | 3366 | 981 | 3978 | 823 | 4286 | 698 | 4547 | 512 | 5375 | 360 | 3001 |
| 3L-2S | | MI | 2322 | 1146 | 3363 | 963 | 3962 | 808 | 4297 | 685 | 4659 | 497 | 5522 | 418 | 2690 |
| 6-#10 | 1.73 | MA | 2679 | 1193 | 3932 | 1000 | 4684 | 836 | 5136 | 704 | 5690 | 499 | 6899 | 423 | 3732 |
| 2L-3S | | MI | 2220 | 1193 | 3244 | 997 | 3800 | 833 | 4094 | 701 | 4380 | 501 | 5131 | 313 | 3345 |
| 6-#10 | 1.73 | MA | 2462 | 1193 | 3542 | 1009 | 4188 | 844 | 4535 | 711 | 4878 | 509 | 5803 | 331 | 3728 |
| 3L-2S | | MI | 2410 | 1193 | 3589 | 988 | 4237 | 826 | 4624 | 696 | 5096 | 493 | 6068 | 405 | 3342 |
| 6-#11 | 2.13 | MA | 2769 | 1244 | 4206 | 1022 | 4998 | 851 | 5500 | 712 | 6167 | 492 | 7441 | 402 | 4472 |
| 2L-3S | | MI | 2265 | 1244 | 3416 | 1020 | 3987 | 848 | 4305 | 708 | 4651 | 493 | 5414 | 266 | 3985 |
| 6-#11 | 2.13 | MA | 2516 | 1244 | 3737 | 1033 | 4403 | 860 | 4779 | 719 | 5194 | 503 | 6157 | 288 | 4454 |
| 3L-2S | | MI | 2486 | 1244 | 3829 | 1010 | 4510 | 841 | 4939 | 704 | 5508 | 485 | 6505 | 380 | 3993 |
| 6-#14 | 3.07 | MA | 3002 | 1364 | 4821 | 1091 | 5755 | 901 | 6406 | 742 | 7380 | 482 | 8935 | 368 | 6250 |
| 2L-3S | | MI | 2390 | 1364 | 3784 | 1091 | 4431 | 899 | 4832 | 738 | 5353 | 485 | 6237 | 174 | 5488 |
| 6-#14 | 3.07 | MA | 2665 | 1364 | 4156 | 1106 | 4912 | 912 | 5383 | 750 | 6000 | 496 | 7148 | 205 | 6165 |
| 3L-2S | | MI | 2683 | 1364 | 4367 | 1079 | 5171 | 890 | 5729 | 733 | 6564 | 475 | 7747 | 337 | 5554 |
| 6-#18 | 5.45 | MA | 3522 | 1668 | 6302 | 1269 | 7589 | 1029 | 8606 | 821 | 10332 | 461 | 12404 | 263 | 10535 |
| 2L-3S | | MI | 2699 | 1668 | 4659 | 1272 | 5497 | 1027 | 6103 | 814 | 7042 | 461 | 8115 | -84 | 8018 |
| 6-#18 | 5.45 | MA | 3037 | 1668 | 5161 | 1291 | 6141 | 1044 | 6851 | 830 | 7963 | 478 | 9449 | -27 | 9405 |
| 3L-2S | | MI | 3122 | 1668 | 5655 | 1255 | 6761 | 1018 | 7635 | 811 | 9106 | 450 | 10583 | 207 | 9284 |
| 8-#8 | 1.44 | MA | 2604 | 1156 | 3720 | 982 | 4438 | 824 | 4849 | 698 | 5313 | 505 | 6441 | 435 | 3155 |
| 2L-4S | | MI | 2153 | 1156 | 3030 | 983 | 3534 | 828 | 3780 | 702 | 3962 | 506 | 4658 | 332 | 2836 |
| 8-#8 | 1.44 | MA | 2464 | 1156 | 3473 | 988 | 4125 | 829 | 4469 | 702 | 4800 | 512 | 5738 | 378 | 3159 |
| 3E | | MI | 2224 | 1156 | 3183 | 977 | 3745 | 819 | 4039 | 694 | 4315 | 504 | 5086 | 363 | 2839 |
| 8-#8 | 1.44 | MA | 2384 | 1156 | 3301 | 994 | 3887 | 839 | 4178 | 711 | 4402 | 514 | 5243 | 345 | 3150 |
| 4L-2S | | MI | 2347 | 1156 | 3401 | 971 | 4022 | 815 | 4375 | 690 | 4768 | 498 | 5691 | 421 | 2832 |
| 8-#9 | 1.82 | MA | 2713 | 1204 | 3987 | 1010 | 4765 | 843 | 5240 | 710 | 5836 | 501 | 7129 | 427 | 3925 |
| 2L-4S | | MI | 2204 | 1204 | 3170 | 1013 | 3697 | 851 | 3972 | 716 | 4214 | 503 | 4988 | 297 | 3492 |
| 8-#9 | 1.82 | MA | 2542 | 1204 | 3676 | 1017 | 4371 | 850 | 4763 | 715 | 5191 | 509 | 6252 | 354 | 3922 |
| 3E | | MI | 2291 | 1204 | 3363 | 1006 | 3962 | 840 | 4297 | 706 | 4659 | 501 | 5522 | 337 | 3515 |
| 8-#9 | 1.82 | MA | 2445 | 1204 | 3460 | 1025 | 4072 | 862 | 4397 | 726 | 4691 | 512 | 5634 | 312 | 3887 |
| 4L-2S | | MI | 2440 | 1204 | 3637 | 999 | 4310 | 834 | 4718 | 702 | 5228 | 494 | 6274 | 409 | 3514 |
| 8-#10 | 2.31 | MA | 2847 | 1267 | 4323 | 1046 | 5180 | 869 | 5737 | 726 | 6501 | 496 | 7994 | 415 | 4898 |
| 2L-4S | | MI | 2269 | 1267 | 3346 | 1051 | 3902 | 880 | 4214 | 734 | 4536 | 499 | 5402 | 252 | 4233 |
| 8-#10 | 2.31 | MA | 2640 | 1267 | 3932 | 1055 | 4684 | 877 | 5136 | 732 | 5690 | 506 | 6899 | 322 | 4880 |
| 3E | | MI | 2374 | 1267 | 3589 | 1043 | 4237 | 867 | 4624 | 722 | 5096 | 498 | 6068 | 301 | 4362 |
| 8-#10 | 2.31 | MA | 2522 | 1267 | 3660 | 1065 | 4307 | 892 | 4674 | 745 | 5058 | 509 | 6125 | 270 | 4735 |
| 4L-2S | | MI | 2556 | 1267 | 3933 | 1034 | 4675 | 860 | 5155 | 717 | 5812 | 489 | 7005 | 393 | 4374 |
| 8-#11 | 2.84 | MA | 2964 | 1334 | 4675 | 1079 | 5593 | 893 | 6221 | 739 | 7141 | 488 | 8724 | 388 | 5867 |
| 2L-4S | | MI | 2322 | 1334 | 3537 | 1086 | 4107 | 905 | 4446 | 747 | 4834 | 489 | 5725 | 189 | 4876 |
| 8-#11 | 2.84 | MA | 2725 | 1334 | 4206 | 1090 | 4998 | 901 | 5500 | 745 | 6167 | 498 | 7441 | 275 | 5830 |
| 3E | | MI | 2445 | 1334 | 3829 | 1076 | 4510 | 889 | 4939 | 734 | 5508 | 489 | 6505 | 247 | 5195 |
| 8-#11 | 2.84 | MA | 2587 | 1334 | 3877 | 1100 | 4543 | 918 | 4943 | 760 | 5406 | 500 | 6529 | 213 | 5470 |
| 4L-2S | | MI | 2655 | 1334 | 4241 | 1067 | 5034 | 883 | 5573 | 730 | 6364 | 480 | 7595 | 361 | 5223 |
| 8-#14 | 4.09 | MA | 3264 | 1494 | 5486 | 1173 | 6599 | 960 | 7428 | 780 | 8761 | 476 | 10723 | 345 | 8217 |
| 2L-4S | | MI | 2489 | 1494 | 3953 | 1184 | 4599 | 979 | 5029 | 793 | 5609 | 476 | 6661 | 61 | 6401 |

## RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

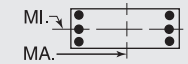
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 4.09 | MA | 2953 | 1494 | 4821 | 1187 | 5755 | 972 | 6406 | 788 | 7380 | 490 | 8935 | 181 | 8102 |
| 3E | | MI | 2646 | 1494 | 4367 | 1172 | 5171 | 958 | 5729 | 776 | 6564 | 479 | 7747 | 142 | 7185 |
| 8-#14 | 4.09 | MA | 2771 | 1494 | 4352 | 1201 | 5108 | 995 | 5614 | 808 | 6298 | 491 | 7662 | 95 | 7214 |
| 4L-2S | | MI | 2908 | 1494 | 4951 | 1160 | 5911 | 950 | 6626 | 771 | 7775 | 469 | 9257 | 305 | 7281 |
| 8-#18 | 7.27 | MA | 3512 | 1900 | 6302 | 1436 | 7589 | 1150 | 8606 | 897 | 10332 | 467 | 12404 | -84 | 12223 |
| 3E | | MI | 3106 | 1900 | 5655 | 1417 | 6761 | 1133 | 7635 | 881 | 9106 | 450 | 10583 | -157 | 10339 |
| 10-#10 | 2.89 | MA | 3011 | 1341 | 4714 | 1092 | 5676 | 903 | 6338 | 747 | 7312 | 492 | 9089 | 407 | 6059 |
| 2L-5S | | MI | 2324 | 1341 | 3474 | 1106 | 4044 | 921 | 4378 | 760 | 4743 | 504 | 5679 | 185 | 4906 |
| 10-#10 | 2.89 | MA | 2813 | 1341 | 4323 | 1101 | 5180 | 911 | 5737 | 753 | 6501 | 502 | 7994 | 314 | 6029 |
| 3L-4S | | MI | 2426 | 1341 | 3691 | 1097 | 4340 | 914 | 4745 | 755 | 5251 | 495 | 6339 | 240 | 5192 |
| 10-#10 | 2.89 | MA | 2703 | 1341 | 4050 | 1111 | 4803 | 926 | 5275 | 767 | 5869 | 506 | 7220 | 262 | 5830 |
| 4L-3S | | MI | 2525 | 1341 | 3933 | 1089 | 4675 | 900 | 5155 | 744 | 5812 | 494 | 7005 | 289 | 5377 |
| 10-#10 | 2.89 | MA | 2580 | 1341 | 3807 | 1120 | 4470 | 934 | 4862 | 773 | 5297 | 516 | 6449 | 208 | 5482 |
| 5L-2S | | MI | 2699 | 1341 | 4278 | 1080 | 5112 | 894 | 5685 | 739 | 6527 | 486 | 7942 | 381 | 5399 |
| 10-#11 | 3.55 | MA | 2928 | 1425 | 4675 | 1146 | 5593 | 943 | 6221 | 771 | 7141 | 494 | 8724 | 261 | 7204 |
| 3L-4S | | MI | 2507 | 1425 | 3949 | 1142 | 4631 | 946 | 5080 | 773 | 5691 | 484 | 6815 | 170 | 6024 |
| 10-#11 | 3.55 | MA | 2801 | 1425 | 4346 | 1157 | 5138 | 960 | 5664 | 786 | 6380 | 496 | 7813 | 199 | 6786 |
| 4L-3S | | MI | 2620 | 1425 | 4241 | 1133 | 5034 | 931 | 5573 | 760 | 6364 | 484 | 7595 | 228 | 6403 |
| 10-#11 | 3.55 | MA | 2660 | 1425 | 4051 | 1168 | 4736 | 968 | 5166 | 793 | 5690 | 507 | 6909 | 133 | 6412 |
| 5L-2S | | MI | 2818 | 1425 | 4654 | 1124 | 5557 | 924 | 6208 | 756 | 7220 | 476 | 8686 | 342 | 6446 |
| 10-#14 | 5.11 | MA | 3243 | 1625 | 5486 | 1269 | 6599 | 1031 | 7428 | 826 | 8761 | 484 | 10723 | 157 | 10042 |
| 3L-4S | | MI | 2747 | 1625 | 4536 | 1266 | 5339 | 1039 | 5926 | 831 | 6820 | 470 | 8172 | 30 | 8041 |
| 10-#14 | 5.11 | MA | 3069 | 1625 | 5017 | 1283 | 5952 | 1055 | 6636 | 846 | 7678 | 485 | 9449 | 71 | 9098 |
| 4L-3S | | MI | 2886 | 1625 | 4951 | 1254 | 5911 | 1018 | 6626 | 813 | 7775 | 473 | 9257 | 110 | 8883 |
| 12-#10 | 3.46 | MA | 2983 | 1414 | 4714 | 1147 | 5676 | 945 | 6338 | 774 | 7312 | 499 | 9089 | 306 | 7177 |
| 3L-5S | | MI | 2479 | 1414 | 3819 | 1152 | 4481 | 954 | 4908 | 782 | 5459 | 500 | 6616 | 173 | 5889 |
| 12-#10 | 3.46 | MA | 2880 | 1414 | 4441 | 1157 | 5299 | 959 | 5876 | 788 | 6680 | 502 | 8316 | 254 | 6933 |
| 4E | | MI | 2580 | 1414 | 4036 | 1143 | 4777 | 948 | 5275 | 777 | 5967 | 492 | 7276 | 228 | 6158 |
| 12-#10 | 3.46 | MA | 2759 | 1414 | 4198 | 1166 | 4966 | 967 | 5463 | 794 | 6109 | 512 | 7545 | 200 | 6603 |
| 5L-3S | | MI | 2672 | 1414 | 4278 | 1135 | 5112 | 934 | 5685 | 765 | 6527 | 491 | 7942 | 277 | 6389 |
| 12-#10 | 3.46 | MA | 2614 | 1414 | 3925 | 1182 | 4651 | 975 | 5059 | 808 | 5561 | 522 | 6837 | 141 | 6194 |
| 6L-2S | | MI | 2839 | 1414 | 4623 | 1126 | 5550 | 927 | 6215 | 760 | 7243 | 482 | 8879 | 369 | 6421 |
| 12-#11 | 4.25 | MA | 3009 | 1515 | 4815 | 1213 | 5733 | 1001 | 6386 | 812 | 7353 | 492 | 9097 | 186 | 8112 |
| 4E | | MI | 2698 | 1515 | 4362 | 1199 | 5154 | 988 | 5715 | 800 | 6547 | 480 | 7906 | 151 | 7182 |
| 12-#11 | 4.25 | MA | 2870 | 1515 | 4520 | 1224 | 5331 | 1010 | 5887 | 819 | 6663 | 503 | 8193 | 119 | 7745 |
| 5L-3S | | MI | 2797 | 1515 | 4654 | 1189 | 5557 | 972 | 6208 | 786 | 7220 | 480 | 8686 | 209 | 7610 |
| 12-#14 | 6.14 | MA | 3377 | 1755 | 5682 | 1365 | 6795 | 1114 | 7659 | 884 | 9058 | 479 | 11237 | 48 | 10994 |
| 4E | | MI | 2996 | 1755 | 5119 | 1348 | 6079 | 1098 | 6823 | 868 | 8031 | 464 | 9682 | -2 | 9678 |
| 14-#10 | 4.04 | MA | 3053 | 1488 | 4832 | 1203 | 5794 | 993 | 6477 | 809 | 7492 | 499 | 9411 | 246 | 8042 |
| 4L-5S | | MI | 2630 | 1488 | 4164 | 1198 | 4919 | 988 | 5438 | 803 | 6175 | 497 | 7553 | 161 | 6877 |
| 14-#10 | 4.04 | MA | 2933 | 1488 | 4589 | 1212 | 5462 | 1001 | 6064 | 815 | 6920 | 509 | 8640 | 192 | 7729 |
| 5L-4S | | MI | 2730 | 1488 | 4380 | 1189 | 5215 | 981 | 5805 | 798 | 6683 | 488 | 8213 | 215 | 7131 |
| 14-#10 | 4.04 | MA | 2794 | 1488 | 4316 | 1228 | 5147 | 1009 | 5660 | 829 | 6372 | 519 | 7932 | 132 | 7308 |
| 6L-3S | | MI | 2823 | 1488 | 4623 | 1181 | 5550 | 967 | 6215 | 786 | 7243 | 487 | 8879 | 265 | 7400 |
| 14-#11 | 4.96 | MA | 3074 | 1606 | 4989 | 1281 | 5926 | 1051 | 6609 | 845 | 7637 | 498 | 9477 | 105 | 9062 |
| 5L-4S | | MI | 2874 | 1606 | 4774 | 1255 | 5677 | 1029 | 6349 | 826 | 7403 | 476 | 8996 | 132 | 8348 |
| 16-#10 | 4.62 | MA | 3103 | 1561 | 4979 | 1258 | 5957 | 1035 | 6665 | 837 | 7731 | 505 | 9735 | 184 | 8857 |
| 5E | | MI | 2778 | 1561 | 4508 | 1244 | 5356 | 1022 | 5968 | 824 | 6890 | 493 | 8490 | 149 | 7868 |
| 16-#10 | 4.62 | MA | 2970 | 1561 | 4707 | 1274 | 5643 | 1043 | 6261 | 850 | 7183 | 515 | 9028 | 124 | 8426 |
| 6L-4S | | MI | 2889 | 1561 | 4725 | 1235 | 5652 | 1015 | 6335 | 819 | 7399 | 485 | 9150 | 203 | 8109 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis

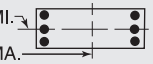



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.06 | MA | 2966 | 1208 | 4107 | 1042 | 4890 | 877 | 5305 | 749 | 5700 | 555 | 6838 | 483 | 2831 |
| 2E | | MI | 2439 | 1208 | 3476 | 1020 | 4066 | 859 | 4370 | 732 | 4648 | 542 | 5427 | 458 | 2319 |
| 4-#11 | 1.30 | MA | 3038 | 1242 | 4328 | 1054 | 5135 | 885 | 5582 | 752 | 6058 | 548 | 7260 | 470 | 3401 |
| 2E | | MI | 2490 | 1242 | 3652 | 1030 | 4254 | 865 | 4581 | 734 | 4919 | 534 | 5708 | 438 | 2773 |
| 4-#14 | 1.88 | MA | 3224 | 1322 | 4801 | 1098 | 5709 | 917 | 6264 | 771 | 6968 | 541 | 8420 | 451 | 4756 |
| 2E | | MI | 2628 | 1322 | 4022 | 1073 | 4699 | 895 | 5108 | 752 | 5620 | 526 | 6529 | 409 | 3840 |
| 4-#18 | 3.33 | MA | 3651 | 1525 | 5940 | 1212 | 7103 | 999 | 7929 | 820 | 9194 | 524 | 11145 | 392 | 8032 |
| 2E | | MI | 2934 | 1525 | 4902 | 1185 | 5767 | 975 | 6379 | 799 | 7308 | 506 | 8405 | 319 | 6384 |
| 6-#9 | 1.25 | MA | 3045 | 1235 | 4256 | 1062 | 5094 | 892 | 5558 | 759 | 6047 | 556 | 7326 | 483 | 3319 |
| 2L-3S | | MI | 2343 | 1235 | 3320 | 1047 | 3880 | 880 | 4151 | 747 | 4359 | 550 | 5067 | 385 | 2720 |
| 6-#9 | 1.25 | MA | 2843 | 1235 | 3910 | 1070 | 4654 | 900 | 5025 | 765 | 5328 | 565 | 6330 | 411 | 3325 |
| 3L-2S | | MI | 2500 | 1235 | 3594 | 1040 | 4228 | 874 | 4573 | 743 | 4927 | 543 | 5819 | 458 | 2708 |
| 6-#10 | 1.59 | MA | 3164 | 1282 | 4544 | 1088 | 5445 | 911 | 5976 | 770 | 6606 | 552 | 8092 | 478 | 4144 |
| 2L-3S | | MI | 2397 | 1282 | 3476 | 1074 | 4066 | 899 | 4370 | 758 | 4648 | 547 | 5427 | 353 | 3371 |
| 6-#10 | 1.59 | MA | 2917 | 1282 | 4107 | 1098 | 4890 | 920 | 5305 | 778 | 5700 | 563 | 6838 | 386 | 4140 |
| 3L-2S | | MI | 2589 | 1282 | 3821 | 1066 | 4503 | 892 | 4900 | 754 | 5364 | 539 | 6364 | 446 | 3363 |
| 6-#11 | 1.95 | MA | 3269 | 1332 | 4854 | 1111 | 5802 | 927 | 6390 | 778 | 7149 | 544 | 8739 | 460 | 4977 |
| 2L-3S | | MI | 2442 | 1332 | 3652 | 1096 | 4254 | 913 | 4581 | 765 | 4919 | 538 | 5708 | 306 | 4018 |
| 6-#11 | 1.95 | MA | 2981 | 1332 | 4328 | 1123 | 5135 | 937 | 5582 | 786 | 6058 | 557 | 7260 | 347 | 4959 |
| 3L-2S | | MI | 2665 | 1332 | 4064 | 1087 | 4777 | 906 | 5215 | 760 | 5775 | 530 | 6799 | 419 | 4018 |
| 6-#14 | 2.81 | MA | 3539 | 1452 | 5548 | 1180 | 6656 | 976 | 7412 | 808 | 8518 | 535 | 10487 | 434 | 6979 |
| 2L-3S | | MI | 2566 | 1452 | 4022 | 1167 | 4699 | 963 | 5108 | 794 | 5620 | 530 | 6529 | 213 | 5537 |
| 6-#14 | 2.81 | MA | 3153 | 1452 | 4801 | 1196 | 5709 | 989 | 6264 | 818 | 6968 | 551 | 8420 | 271 | 6894 |
| 3L-2S | | MI | 2865 | 1452 | 4605 | 1154 | 5439 | 955 | 6005 | 790 | 6831 | 520 | 8039 | 377 | 5586 |
| 6-#18 | 5.00 | MA | 4148 | 1757 | 7226 | 1357 | 8735 | 1105 | 9907 | 887 | 11864 | 513 | 14594 | 349 | 11831 |
| 2L-3S | | MI | 2873 | 1757 | 4902 | 1347 | 5767 | 1091 | 6379 | 869 | 7308 | 505 | 8405 | -45 | 8354 |
| 6-#18 | 5.00 | MA | 3588 | 1757 | 5940 | 1383 | 7103 | 1124 | 7929 | 900 | 9194 | 537 | 11145 | 58 | 10973 |
| 3L-2S | | MI | 3306 | 1757 | 5898 | 1330 | 7031 | 1081 | 7911 | 866 | 9371 | 494 | 10872 | 246 | 9328 |
| 8-#8 | 1.32 | MA | 3077 | 1244 | 4304 | 1070 | 5167 | 899 | 5653 | 764 | 6181 | 557 | 7514 | 484 | 3496 |
| 2L-4S | | MI | 2329 | 1244 | 3260 | 1061 | 3799 | 895 | 4056 | 760 | 4230 | 552 | 4956 | 372 | 2860 |
| 8-#8 | 1.32 | MA | 2918 | 1244 | 4029 | 1077 | 4817 | 905 | 5229 | 769 | 5609 | 565 | 6722 | 428 | 3501 |
| 3E | | MI | 2401 | 1244 | 3413 | 1055 | 4010 | 886 | 4314 | 752 | 4584 | 550 | 5384 | 404 | 2858 |
| 8-#8 | 1.32 | MA | 2827 | 1244 | 3838 | 1084 | 4553 | 915 | 4905 | 778 | 5166 | 568 | 6170 | 395 | 3491 |
| 4L-2S | | MI | 2525 | 1244 | 3631 | 1049 | 4287 | 881 | 4650 | 748 | 5037 | 545 | 5988 | 461 | 2850 |
| 8-#9 | 1.67 | MA | 3202 | 1293 | 4603 | 1098 | 5534 | 919 | 6091 | 776 | 6767 | 553 | 8322 | 480 | 4357 |
| 2L-4S | | MI | 2380 | 1293 | 3401 | 1090 | 3962 | 917 | 4247 | 774 | 4483 | 549 | 5285 | 337 | 3524 |
| 8-#9 | 1.67 | MA | 3008 | 1293 | 4256 | 1106 | 5094 | 926 | 5558 | 782 | 6047 | 562 | 7326 | 408 | 4354 |
| 3E | | MI | 2468 | 1293 | 3594 | 1083 | 4228 | 906 | 4573 | 764 | 4927 | 547 | 5819 | 377 | 3539 |
| 8-#9 | 1.67 | MA | 2898 | 1293 | 4016 | 1115 | 4761 | 939 | 5151 | 793 | 5490 | 566 | 6629 | 365 | 4319 |
| 4L-2S | | MI | 2619 | 1293 | 3868 | 1076 | 4576 | 900 | 4994 | 760 | 5496 | 540 | 6571 | 450 | 3534 |
| 8-#10 | 2.12 | MA | 3356 | 1355 | 4980 | 1134 | 5999 | 945 | 6648 | 791 | 7513 | 548 | 9347 | 473 | 5447 |
| 2L-4S | | MI | 2445 | 1355 | 3579 | 1129 | 4168 | 946 | 4490 | 792 | 4804 | 545 | 5698 | 292 | 4326 |
| 8-#10 | 2.12 | MA | 3120 | 1355 | 4544 | 1144 | 5445 | 954 | 5976 | 799 | 6606 | 560 | 8092 | 381 | 5429 |
| 3E | | MI | 2552 | 1355 | 3821 | 1120 | 4503 | 933 | 4900 | 780 | 5364 | 543 | 6364 | 341 | 4392 |
| 8-#10 | 2.12 | MA | 2986 | 1355 | 4241 | 1155 | 5025 | 970 | 5462 | 813 | 5903 | 564 | 7211 | 327 | 5343 |
| 4L-2S | | MI | 2736 | 1355 | 4166 | 1112 | 4941 | 926 | 5430 | 775 | 6080 | 535 | 7301 | 433 | 4397 |
| 8-#11 | 2.60 | MA | 3493 | 1423 | 5379 | 1167 | 6468 | 968 | 7199 | 804 | 8240 | 540 | 10217 | 451 | 6541 |
| 2L-4S | | MI | 2498 | 1423 | 3773 | 1162 | 4375 | 970 | 4722 | 804 | 5102 | 534 | 6019 | 229 | 4979 |
| 8-#11 | 2.60 | MA | 3220 | 1423 | 4854 | 1179 | 5802 | 978 | 6390 | 812 | 7149 | 553 | 8739 | 338 | 6504 |
| 3E | | MI | 2622 | 1423 | 4064 | 1153 | 4777 | 955 | 5215 | 791 | 5775 | 534 | 6799 | 287 | 5232 |
| 8-#11 | 2.60 | MA | 3064 | 1423 | 4487 | 1191 | 5295 | 997 | 5769 | 829 | 6300 | 557 | 7695 | 273 | 6187 |
| 4L-2S | | MI | 2835 | 1423 | 4477 | 1143 | 5301 | 948 | 5849 | 787 | 6631 | 526 | 7889 | 400 | 5252 |
| 8-#14 | 3.75 | MA | 3844 | 1583 | 6294 | 1261 | 7603 | 1036 | 8560 | 846 | 10067 | 528 | 12555 | 417 | 9189 |
| 2L-4S | | MI | 2650 | 1583 | 4191 | 1260 | 4867 | 1044 | 5305 | 849 | 5875 | 521 | 6954 | 101 | 6522 |
| 8-#14 | 3.75 | MA | 3483 | 1583 | 5548 | 1277 | 6656 | 1049 | 7412 | 856 | 8518 | 545 | 10487 | 253 | 9074 |
| 3E | | MI | 2824 | 1583 | 4605 | 1248 | 5439 | 1023 | 6005 | 832 | 6831 | 524 | 8039 | 181 | 7236 |
| 8-#14 | 3.75 | MA | 3277 | 1583 | 5025 | 1293 | 5933 | 1075 | 6528 | 879 | 7309 | 550 | 9024 | 163 | 8171 |
| 4L-2S | | MI | 3092 | 1583 | 5189 | 1236 | 6179 | 1014 | 6902 | 827 | 8042 | 514 | 9549 | 345 | 7316 |

## RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis



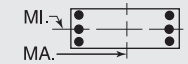

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 6.67 | MA | 4132 | 1988 | 7226 | 1528 | 8735 | 1230 | 9907 | 967 | 11864 | 526 | 14594 | 15 | 14543 |
| 3E | | MI | 3281 | 1988 | 5898 | 1492 | 7031 | 1197 | 7911 | 936 | 9371 | 494 | 10872 | -118 | 10694 |
| 8-#18 | 6.67 | MA | 3836 | 1988 | 6319 | 1553 | 7482 | 1272 | 8373 | 1003 | 9769 | 528 | 12135 | -137 | 11909 |
| 4L-2S | | MI | 3671 | 1988 | 6894 | 1475 | 8295 | 1187 | 9443 | 933 | 11434 | 483 | 13339 | 173 | 12257 |
| 10-#10 | 2.65 | MA | 3543 | 1429 | 5417 | 1180 | 6553 | 978 | 7320 | 813 | 8420 | 545 | 10601 | 468 | 6744 |
| 2L-5S | | MI | 2501 | 1429 | 3706 | 1183 | 4310 | 987 | 4653 | 818 | 5011 | 550 | 5975 | 225 | 4987 |
| 10-#10 | 2.65 | MA | 3318 | 1429 | 4980 | 1190 | 5999 | 987 | 6648 | 820 | 7513 | 556 | 9347 | 376 | 6715 |
| 3L-4S | | MI | 2603 | 1429 | 3923 | 1175 | 4606 | 980 | 5020 | 813 | 5520 | 541 | 6635 | 280 | 5281 |
| 10-#10 | 2.65 | MA | 3193 | 1429 | 4677 | 1201 | 5579 | 1003 | 6134 | 835 | 6810 | 561 | 8465 | 322 | 6577 |
| 4L-3S | | MI | 2703 | 1429 | 4166 | 1166 | 4941 | 966 | 5430 | 801 | 6080 | 540 | 7301 | 329 | 5408 |
| 10-#10 | 2.65 | MA | 3049 | 1429 | 4408 | 1211 | 5210 | 1012 | 5676 | 842 | 6175 | 572 | 7582 | 269 | 6152 |
| 5L-2S | | MI | 2880 | 1429 | 4510 | 1158 | 5378 | 959 | 5961 | 796 | 6795 | 531 | 8238 | 421 | 5425 |
| 10-#11 | 3.25 | MA | 3452 | 1513 | 5379 | 1236 | 6468 | 1019 | 7199 | 838 | 8240 | 548 | 10217 | 328 | 8047 |
| 3L-4S | | MI | 2682 | 1513 | 4185 | 1219 | 4898 | 1011 | 5356 | 830 | 5958 | 529 | 7109 | 210 | 6124 |
| 10-#11 | 3.25 | MA | 3308 | 1513 | 5013 | 1248 | 5961 | 1038 | 6578 | 855 | 7391 | 552 | 9174 | 264 | 7668 |
| 4L-3S | | MI | 2798 | 1513 | 4477 | 1209 | 5301 | 996 | 5849 | 817 | 6631 | 530 | 7889 | 268 | 6442 |
| 10-#11 | 3.25 | MA | 3142 | 1513 | 4686 | 1259 | 5514 | 1048 | 6023 | 863 | 6623 | 565 | 8133 | 198 | 7211 |
| 5L-2S | | MI | 3001 | 1513 | 4889 | 1200 | 5824 | 989 | 6484 | 813 | 7487 | 521 | 8980 | 381 | 6477 |
| 10-#14 | 4.69 | MA | 3803 | 1713 | 6294 | 1359 | 7603 | 1109 | 8560 | 894 | 10067 | 539 | 12555 | 236 | 11257 |
| 3L-4S | | MI | 2921 | 1713 | 4774 | 1342 | 5607 | 1103 | 6202 | 887 | 7086 | 515 | 8464 | 69 | 8156 |
| 10-#14 | 4.69 | MA | 3617 | 1713 | 5771 | 1375 | 6880 | 1134 | 7676 | 916 | 8858 | 543 | 11091 | 146 | 10295 |
| 4L-3S | | MI | 3064 | 1713 | 5189 | 1330 | 6179 | 1083 | 6902 | 870 | 8042 | 517 | 9549 | 149 | 8936 |
| 10-#14 | 4.69 | MA | 3387 | 1713 | 5305 | 1391 | 6243 | 1147 | 6885 | 927 | 7763 | 560 | 9636 | 50 | 9451 |
| 5L-2S | | MI | 3313 | 1713 | 5772 | 1317 | 6920 | 1074 | 7799 | 865 | 9253 | 507 | 11059 | 313 | 9038 |
| 12-#10 | 3.17 | MA | 3511 | 1503 | 5417 | 1236 | 6553 | 1021 | 7320 | 841 | 8420 | 553 | 10601 | 371 | 8000 |
| 3L-5S | | MI | 2656 | 1503 | 4051 | 1229 | 4747 | 1020 | 5184 | 839 | 5727 | 546 | 6912 | 213 | 5968 |
| 12-#10 | 3.17 | MA | 3395 | 1503 | 5114 | 1247 | 6134 | 1037 | 6806 | 856 | 7717 | 557 | 9720 | 317 | 7814 |
| 4E | | MI | 2756 | 1503 | 4268 | 1221 | 5043 | 1013 | 5551 | 834 | 6235 | 538 | 7572 | 268 | 6245 |
| 12-#10 | 3.17 | MA | 3252 | 1503 | 4845 | 1257 | 5764 | 1046 | 6348 | 863 | 7082 | 569 | 8837 | 264 | 7409 |
| 5L-3S | | MI | 2851 | 1503 | 4510 | 1212 | 5378 | 1000 | 5961 | 822 | 6795 | 536 | 8238 | 317 | 6422 |
| 12-#10 | 3.17 | MA | 3089 | 1503 | 4535 | 1272 | 5415 | 1055 | 5899 | 878 | 6460 | 574 | 7974 | 192 | 7003 |
| 6L-2S | | MI | 3021 | 1503 | 4855 | 1204 | 5816 | 993 | 6491 | 817 | 7511 | 528 | 9175 | 409 | 6447 |
| 12-#11 | 3.90 | MA | 3545 | 1603 | 5538 | 1304 | 6628 | 1079 | 7386 | 881 | 8482 | 548 | 10652 | 254 | 9158 |
| 4E | | MI | 2863 | 1603 | 4597 | 1275 | 5421 | 1053 | 5991 | 856 | 6814 | 525 | 8200 | 191 | 7279 |
| 12-#11 | 3.90 | MA | 3381 | 1603 | 5212 | 1316 | 6181 | 1089 | 6832 | 889 | 7714 | 561 | 9612 | 188 | 8726 |
| 5L-3S | | MI | 2977 | 1603 | 4889 | 1266 | 5824 | 1037 | 6484 | 843 | 7487 | 525 | 8980 | 249 | 7651 |
| 12-#11 | 3.90 | MA | 3190 | 1603 | 4844 | 1335 | 5758 | 1099 | 6288 | 906 | 6978 | 574 | 8657 | 115 | 8094 |
| 6L-2S | | MI | 3161 | 1603 | 5302 | 1257 | 6348 | 1030 | 7118 | 839 | 8344 | 517 | 10070 | 362 | 7697 |
| 12-#14 | 5.63 | MA | 3946 | 1844 | 6518 | 1456 | 7828 | 1194 | 8824 | 954 | 10408 | 537 | 13158 | 129 | 12431 |
| 4E | | MI | 3171 | 1844 | 5357 | 1423 | 6348 | 1163 | 7099 | 925 | 8297 | 509 | 9974 | 37 | 9803 |
| 12-#14 | 5.63 | MA | 3719 | 1844 | 6051 | 1473 | 7190 | 1207 | 8033 | 964 | 9312 | 554 | 11703 | 33 | 11574 |
| 5L-3S | | MI | 3298 | 1844 | 5772 | 1411 | 6920 | 1142 | 7799 | 907 | 9253 | 511 | 11059 | 118 | 10632 |
| 14-#10 | 3.70 | MA | 3591 | 1576 | 5551 | 1293 | 6688 | 1071 | 7478 | 877 | 8624 | 554 | 10974 | 312 | 9057 |
| 4L-5S | | MI | 2807 | 1576 | 4396 | 1275 | 5185 | 1054 | 5714 | 860 | 6443 | 543 | 7849 | 201 | 6954 |
| 14-#10 | 3.70 | MA | 3450 | 1576 | 5281 | 1303 | 6319 | 1080 | 7020 | 885 | 7988 | 565 | 10091 | 259 | 8670 |
| 5L-4S | | MI | 2907 | 1576 | 4613 | 1267 | 5481 | 1047 | 6081 | 855 | 6951 | 534 | 8509 | 256 | 7215 |
| 14-#10 | 3.70 | MA | 3294 | 1576 | 4971 | 1318 | 5969 | 1088 | 6571 | 899 | 7367 | 570 | 9229 | 187 | 8254 |
| 6L-3S | | MI | 2996 | 1576 | 4855 | 1258 | 5816 | 1033 | 6491 | 844 | 7511 | 533 | 9175 | 305 | 7434 |
| 14-#11 | 4.55 | MA | 3614 | 1694 | 5737 | 1373 | 6848 | 1130 | 7640 | 915 | 8805 | 557 | 11090 | 179 | 10245 |
| 5L-4S | | MI | 3051 | 1694 | 5010 | 1332 | 5945 | 1094 | 6625 | 883 | 7670 | 521 | 9290 | 172 | 8441 |
| 14-#11 | 4.55 | MA | 3432 | 1694 | 5370 | 1391 | 6425 | 1140 | 7096 | 932 | 8069 | 569 | 10135 | 105 | 9602 |
| 6L-3S | | MI | 3144 | 1694 | 5302 | 1322 | 6348 | 1079 | 7118 | 869 | 8344 | 521 | 10070 | 230 | 8858 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

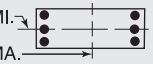
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 6.56 | MA | 4064 | 1974 | 6798 | 1554 | 8137 | 1267 | 9181 | 1002 | 10862 | 548 | 13770 | 16 | 13705 |
| 5L-4S | | MI | 3414 | 1974 | 5941 | 1505 | 7088 | 1223 | 7996 | 962 | 9508 | 503 | 11484 | 5 | 11460 |
| 16-#10 | 4.23 | MA | 3644 | 1650 | 5718 | 1349 | 6873 | 1113 | 7691 | 906 | 8895 | 562 | 11346 | 254 | 9934 |
| 5E | | MI | 2956 | 1650 | 4741 | 1321 | 5622 | 1087 | 6244 | 882 | 7158 | 539 | 8787 | 189 | 7943 |
| 16-#10 | 4.23 | MA | 3494 | 1650 | 5408 | 1364 | 6524 | 1122 | 7242 | 920 | 8274 | 567 | 10483 | 182 | 9509 |
| 6L-4S | | MI | 3055 | 1650 | 4957 | 1313 | 5918 | 1081 | 6611 | 877 | 7667 | 531 | 9446 | 244 | 8191 |
| 16-#11 | 5.20 | MA | 3668 | 1784 | 5895 | 1448 | 7092 | 1182 | 7905 | 958 | 9160 | 565 | 11614 | 96 | 11114 |
| 6L-4S | | MI | 3223 | 1784 | 5422 | 1388 | 6468 | 1135 | 7259 | 909 | 8526 | 517 | 10380 | 153 | 9610 |
| 18-#10 | 4.76 | MA | 3690 | 1724 | 5845 | 1410 | 7078 | 1156 | 7914 | 942 | 9180 | 563 | 11738 | 177 | 10768 |
| 6L-5S | | MI | 3113 | 1724 | 5085 | 1367 | 6059 | 1121 | 6774 | 903 | 7874 | 536 | 9724 | 177 | 8935 |

## RECTANGULAR TIED COLUMNS 20" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.20 | MA | 3545 | 1330 | 4955 | 1143 | 5914 | 961 | 6439 | 818 | 6978 | 601 | 8428 | 523 | 3738 |
| 2E | | MI | 2668 | 1330 | 3888 | 1107 | 4521 | 930 | 4857 | 791 | 5186 | 580 | 6002 | 478 | 2794 |
| 4-#14 | 1.73 | MA | 3757 | 1410 | 5482 | 1186 | 6553 | 992 | 7199 | 836 | 7992 | 593 | 9760 | 508 | 5242 |
| 2E | | MI | 2806 | 1410 | 4260 | 1149 | 4967 | 960 | 5384 | 808 | 5886 | 571 | 6821 | 448 | 3867 |
| 4-#18 | 3.08 | MA | 4246 | 1613 | 6755 | 1301 | 8113 | 1074 | 9060 | 886 | 10480 | 576 | 12913 | 460 | 8896 |
| 2E | | MI | 3115 | 1613 | 5144 | 1259 | 6037 | 1039 | 6655 | 855 | 7573 | 550 | 8694 | 357 | 6424 |
| 6-#9 | 1.15 | MA | 3551 | 1323 | 4872 | 1150 | 5864 | 968 | 6406 | 825 | 6958 | 608 | 8419 | 529 | 3643 |
| 2L-3S | | MI | 2520 | 1323 | 3551 | 1125 | 4145 | 946 | 4427 | 805 | 4627 | 596 | 5363 | 426 | 2739 |
| 6-#9 | 1.15 | MA | 3324 | 1323 | 4489 | 1159 | 5378 | 976 | 5817 | 831 | 6164 | 618 | 7319 | 459 | 3649 |
| 3L-2S | | MI | 2678 | 1323 | 3825 | 1118 | 4493 | 940 | 4848 | 801 | 5196 | 589 | 6116 | 498 | 2726 |
| 6-#10 | 1.47 | MA | 3685 | 1370 | 5190 | 1176 | 6253 | 986 | 6870 | 836 | 7578 | 604 | 9272 | 525 | 4555 |
| 2L-3S | | MI | 2574 | 1370 | 3708 | 1152 | 4332 | 965 | 4646 | 816 | 4916 | 593 | 5723 | 393 | 3395 |
| 6-#10 | 1.47 | MA | 3407 | 1370 | 4707 | 1187 | 5641 | 996 | 6128 | 844 | 6576 | 617 | 7884 | 435 | 4551 |
| 3L-2S | | MI | 2768 | 1370 | 4053 | 1143 | 4769 | 958 | 5176 | 811 | 5632 | 584 | 6660 | 486 | 3384 |
| 6-#11 | 1.80 | MA | 3806 | 1421 | 5537 | 1199 | 6653 | 1002 | 7334 | 844 | 8186 | 596 | 10101 | 517 | 5483 |
| 2L-3S | | MI | 2618 | 1421 | 3888 | 1173 | 4521 | 978 | 4857 | 822 | 5186 | 584 | 6002 | 346 | 4049 |
| 6-#11 | 1.80 | MA | 3482 | 1421 | 4955 | 1212 | 5914 | 1013 | 6439 | 853 | 6978 | 611 | 8428 | 403 | 5465 |
| 3L-2S | | MI | 2844 | 1421 | 4300 | 1163 | 5045 | 972 | 5491 | 817 | 6042 | 575 | 7093 | 459 | 4043 |
| 6-#14 | 2.60 | MA | 4114 | 1541 | 6310 | 1268 | 7604 | 1052 | 8472 | 874 | 9710 | 587 | 12108 | 496 | 7708 |
| 2L-3S | | MI | 2742 | 1541 | 4260 | 1242 | 4967 | 1028 | 5384 | 851 | 5886 | 575 | 6821 | 253 | 5582 |
| 6-#14 | 2.60 | MA | 3678 | 1541 | 5482 | 1286 | 6553 | 1067 | 7199 | 886 | 7992 | 606 | 9760 | 333 | 7623 |
| 3L-2S | | MI | 3046 | 1541 | 4843 | 1230 | 5707 | 1019 | 6281 | 846 | 7097 | 565 | 8331 | 416 | 5617 |
| 6-#18 | 4.62 | MA | 4815 | 1845 | 8186 | 1446 | 9929 | 1180 | 11261 | 953 | 13451 | 565 | 16859 | 428 | 13127 |
| 2L-3S | | MI | 3048 | 1845 | 5144 | 1421 | 6037 | 1155 | 6655 | 924 | 7573 | 550 | 8694 | -6 | 8687 |
| 6-#18 | 4.62 | MA | 4150 | 1845 | 6755 | 1474 | 8113 | 1203 | 9060 | 970 | 10480 | 594 | 12913 | 137 | 12471 |
| 3L-2S | | MI | 3489 | 1845 | 6140 | 1404 | 7301 | 1145 | 8187 | 922 | 9636 | 539 | 11161 | 284 | 9371 |
| 8-#8 | 1.22 | MA | 3586 | 1332 | 4924 | 1159 | 5944 | 974 | 6509 | 829 | 7104 | 609 | 8625 | 530 | 3837 |
| 2L-4S | | MI | 2506 | 1332 | 3490 | 1139 | 4064 | 961 | 4331 | 817 | 4499 | 598 | 5254 | 413 | 2883 |
| 8-#8 | 1.22 | MA | 3407 | 1332 | 4620 | 1166 | 5558 | 981 | 6041 | 835 | 6472 | 618 | 7750 | 475 | 3842 |
| 3E | | MI | 2578 | 1332 | 3642 | 1133 | 4275 | 952 | 4590 | 810 | 4853 | 597 | 5681 | 444 | 2877 |
| 8-#8 | 1.22 | MA | 3307 | 1332 | 4410 | 1173 | 5267 | 992 | 5686 | 845 | 5986 | 622 | 7149 | 442 | 3832 |
| 4L-2S | | MI | 2704 | 1332 | 3861 | 1127 | 4552 | 948 | 4926 | 806 | 5306 | 591 | 6286 | 502 | 2868 |
| 8-#9 | 1.54 | MA | 3727 | 1381 | 5254 | 1186 | 6350 | 994 | 6995 | 841 | 7753 | 605 | 9519 | 525 | 4789 |
| 2L-4S | | MI | 2557 | 1381 | 3632 | 1168 | 4227 | 983 | 4523 | 831 | 4751 | 595 | 5582 | 378 | 3554 |
| 8-#9 | 1.54 | MA | 3509 | 1381 | 4872 | 1195 | 5864 | 1002 | 6406 | 848 | 6958 | 616 | 8419 | 455 | 4786 |
| 3E | | MI | 2645 | 1381 | 3825 | 1161 | 4493 | 972 | 4848 | 821 | 5196 | 593 | 6116 | 417 | 3562 |
| 8-#9 | 1.54 | MA | 3386 | 1381 | 4608 | 1204 | 5498 | 1016 | 5958 | 861 | 6345 | 621 | 7659 | 414 | 4751 |
| 4L-2S | | MI | 2798 | 1381 | 4099 | 1154 | 4841 | 967 | 5270 | 817 | 5765 | 586 | 6868 | 490 | 3554 |
| 8-#10 | 1.95 | MA | 3902 | 1444 | 5673 | 1222 | 6866 | 1020 | 7613 | 857 | 8581 | 600 | 10660 | 520 | 5996 |
| 2L-4S | | MI | 2621 | 1444 | 3811 | 1206 | 4434 | 1012 | 4766 | 849 | 5072 | 590 | 5994 | 332 | 4382 |
| 8-#10 | 1.95 | MA | 3636 | 1444 | 5190 | 1233 | 6253 | 1030 | 6870 | 866 | 7578 | 613 | 9272 | 430 | 5977 |
| 3E | | MI | 2729 | 1444 | 4053 | 1198 | 4769 | 998 | 5176 | 837 | 5632 | 589 | 6660 | 381 | 4419 |
| 8-#10 | 1.95 | MA | 3487 | 1444 | 4857 | 1245 | 5791 | 1047 | 6304 | 881 | 6804 | 619 | 8309 | 377 | 5892 |
| 4L-2S | | MI | 2915 | 1444 | 4398 | 1189 | 5207 | 992 | 5706 | 832 | 6348 | 581 | 7597 | 474 | 4420 |

## RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

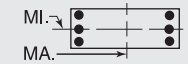
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 2.40 | MA | 4059 | 1511 | 6119 | 1256 | 7391 | 1044 | 8229 | 870 | 9395 | 592 | 11774 | 511 | 7215 |
| 2L-4S | | MI | 2673 | 1511 | 4008 | 1238 | 4642 | 1035 | 4998 | 861 | 5369 | 579 | 6313 | 269 | 5079 |
| 8-#11 | 2.40 | MA | 3751 | 1511 | 5537 | 1269 | 6653 | 1055 | 7334 | 879 | 8186 | 607 | 10101 | 397 | 7178 |
| 3E | | MI | 2800 | 1511 | 4300 | 1229 | 5045 | 1020 | 5491 | 848 | 6042 | 579 | 7093 | 327 | 5267 |
| 8-#11 | 2.40 | MA | 3577 | 1511 | 5133 | 1281 | 6094 | 1074 | 6649 | 897 | 7250 | 612 | 8926 | 331 | 6919 |
| 4L-2S | | MI | 3015 | 1511 | 4712 | 1220 | 5568 | 1013 | 6125 | 843 | 6898 | 571 | 8183 | 440 | 5279 |
| 8-#14 | 3.46 | MA | 4459 | 1671 | 7137 | 1350 | 8655 | 1111 | 9745 | 912 | 11429 | 581 | 14457 | 485 | 10161 |
| 2L-4S | | MI | 2824 | 1671 | 4429 | 1336 | 5135 | 1109 | 5581 | 906 | 6142 | 566 | 7246 | 140 | 6639 |
| 8-#14 | 3.46 | MA | 4051 | 1671 | 6310 | 1367 | 7604 | 1126 | 8472 | 924 | 9710 | 600 | 12108 | 321 | 10046 |
| 3E | | MI | 3001 | 1671 | 4843 | 1324 | 5707 | 1088 | 6281 | 888 | 7097 | 569 | 8331 | 221 | 7285 |
| 8-#14 | 3.46 | MA | 3820 | 1671 | 5734 | 1385 | 6807 | 1154 | 7495 | 949 | 8375 | 607 | 10454 | 227 | 9146 |
| 4L-2S | | MI | 3274 | 1671 | 5427 | 1312 | 6448 | 1079 | 7178 | 884 | 8308 | 558 | 9842 | 384 | 7350 |
| 8-#18 | 6.15 | MA | 4792 | 2077 | 8186 | 1619 | 9929 | 1309 | 11261 | 1037 | 13451 | 583 | 16859 | 105 | 16476 |
| 3E | | MI | 3456 | 2077 | 6140 | 1566 | 7301 | 1261 | 8187 | 991 | 9636 | 538 | 11161 | -79 | 11044 |
| 8-#18 | 6.15 | MA | 4418 | 2077 | 7184 | 1647 | 8542 | 1354 | 9564 | 1077 | 11131 | 590 | 14063 | -55 | 13952 |
| 4L-2S | | MI | 3856 | 2077 | 7136 | 1549 | 8565 | 1251 | 9719 | 989 | 11699 | 527 | 13628 | 211 | 12303 |
| 10-#10 | 2.44 | MA | 4113 | 1517 | 6156 | 1268 | 7479 | 1054 | 8355 | 878 | 9583 | 597 | 12048 | 515 | 7430 |
| 2L-5S | | MI | 2677 | 1517 | 3939 | 1261 | 4576 | 1052 | 4929 | 875 | 5279 | 595 | 6271 | 265 | 5065 |
| 10-#10 | 2.44 | MA | 3859 | 1517 | 5673 | 1279 | 6866 | 1064 | 7613 | 887 | 8581 | 610 | 10660 | 425 | 7401 |
| 3L-4S | | MI | 2779 | 1517 | 4155 | 1252 | 4872 | 1046 | 5296 | 870 | 5788 | 587 | 6931 | 320 | 5368 |
| 10-#10 | 2.44 | MA | 3720 | 1517 | 5340 | 1291 | 6404 | 1080 | 7047 | 902 | 7806 | 616 | 9697 | 372 | 7304 |
| 4L-3S | | MI | 2881 | 1517 | 4398 | 1244 | 5207 | 1032 | 5706 | 858 | 6348 | 586 | 7597 | 369 | 5438 |
| 10-#10 | 2.44 | MA | 3554 | 1517 | 5044 | 1302 | 5998 | 1090 | 6543 | 911 | 7108 | 628 | 8729 | 321 | 6831 |
| 5L-2S | | MI | 3060 | 1517 | 4742 | 1235 | 5644 | 1025 | 6236 | 854 | 7064 | 577 | 8534 | 462 | 5450 |
| 10-#11 | 3.00 | MA | 4013 | 1601 | 6119 | 1325 | 7391 | 1096 | 8229 | 905 | 9395 | 602 | 11774 | 391 | 8889 |
| 3L-4S | | MI | 2858 | 1601 | 4421 | 1295 | 5165 | 1077 | 5632 | 887 | 6225 | 575 | 7403 | 250 | 6220 |
| 10-#11 | 3.00 | MA | 3852 | 1601 | 5715 | 1338 | 6832 | 1116 | 7544 | 923 | 8458 | 608 | 10599 | 325 | 8566 |
| 4L-3S | | MI | 2976 | 1601 | 4712 | 1286 | 5568 | 1061 | 6125 | 874 | 6898 | 575 | 8183 | 308 | 6480 |
| 10-#11 | 3.00 | MA | 3659 | 1601 | 5356 | 1351 | 6340 | 1127 | 6934 | 933 | 7612 | 622 | 9422 | 260 | 8020 |
| 5L-2S | | MI | 3183 | 1601 | 5125 | 1276 | 6091 | 1054 | 6760 | 870 | 7755 | 567 | 9273 | 421 | 6507 |
| 10-#14 | 4.33 | MA | 4411 | 1801 | 7137 | 1449 | 8655 | 1186 | 9745 | 962 | 11429 | 594 | 14457 | 309 | 12472 |
| 3L-4S | | MI | 3096 | 1801 | 5012 | 1418 | 5876 | 1168 | 6478 | 943 | 7353 | 560 | 8756 | 108 | 8268 |
| 10-#14 | 4.33 | MA | 4203 | 1801 | 6561 | 1466 | 7857 | 1213 | 8769 | 986 | 10094 | 601 | 12803 | 215 | 11512 |
| 4L-3S | | MI | 3243 | 1801 | 5427 | 1405 | 6448 | 1147 | 7178 | 926 | 8308 | 562 | 9842 | 189 | 8986 |
| 10-#14 | 4.33 | MA | 3936 | 1801 | 6048 | 1484 | 7155 | 1228 | 7898 | 998 | 8886 | 620 | 11150 | 121 | 10660 |
| 5L-2S | | MI | 3497 | 1801 | 6010 | 1393 | 7188 | 1139 | 8075 | 921 | 9519 | 552 | 11352 | 352 | 9074 |
| 10-#18 | 7.69 | MA | 5108 | 2309 | 8614 | 1792 | 10358 | 1460 | 11764 | 1144 | 14102 | 579 | 18008 | -87 | 17737 |
| 4L-3S | | MI | 3853 | 2309 | 7136 | 1711 | 8565 | 1367 | 9719 | 1058 | 11699 | 526 | 13628 | -152 | 13354 |
| 12-#10 | 2.93 | MA | 4076 | 1591 | 6156 | 1325 | 7479 | 1097 | 8355 | 908 | 9583 | 606 | 12048 | 420 | 8823 |
| 3L-5S | | MI | 2833 | 1591 | 4283 | 1307 | 5013 | 1086 | 5459 | 897 | 5995 | 592 | 7208 | 253 | 6044 |
| 12-#10 | 2.93 | MA | 3946 | 1591 | 5822 | 1337 | 7017 | 1114 | 7789 | 924 | 8809 | 612 | 11085 | 367 | 8710 |
| 4E | | MI | 2933 | 1591 | 4500 | 1298 | 5309 | 1079 | 5826 | 892 | 6503 | 583 | 7868 | 308 | 6329 |
| 12-#10 | 2.93 | MA | 3782 | 1591 | 5527 | 1348 | 6611 | 1124 | 7286 | 932 | 8110 | 625 | 10116 | 317 | 8223 |
| 5L-3S | | MI | 3029 | 1591 | 4742 | 1290 | 5644 | 1066 | 6236 | 880 | 7064 | 582 | 8534 | 357 | 6453 |
| 12-#10 | 2.93 | MA | 3599 | 1591 | 5179 | 1362 | 6228 | 1134 | 6793 | 947 | 7427 | 631 | 9174 | 246 | 7829 |
| 6L-2S | | MI | 3202 | 1591 | 5087 | 1281 | 6082 | 1059 | 6767 | 875 | 7779 | 574 | 9472 | 450 | 6474 |
| 12-#11 | 3.60 | MA | 4119 | 1692 | 6297 | 1394 | 7571 | 1157 | 8439 | 949 | 9667 | 604 | 12273 | 319 | 10221 |
| 4E | | MI | 3039 | 1692 | 4833 | 1351 | 5689 | 1118 | 6267 | 913 | 7081 | 570 | 8494 | 231 | 7372 |
| 12-#11 | 3.60 | MA | 3929 | 1692 | 5938 | 1407 | 7079 | 1168 | 7829 | 959 | 8820 | 618 | 11096 | 254 | 9702 |
| 5L-3S | | MI | 3157 | 1692 | 5125 | 1342 | 6091 | 1102 | 6760 | 900 | 7755 | 571 | 9273 | 289 | 7690 |
| 12-#11 | 3.60 | MA | 3715 | 1692 | 5525 | 1426 | 6614 | 1179 | 7231 | 977 | 7992 | 624 | 9945 | 166 | 9060 |
| 6L-2S | | MI | 3345 | 1692 | 5537 | 1333 | 6615 | 1096 | 7394 | 896 | 8611 | 562 | 10364 | 402 | 7729 |
| 12-#14 | 5.19 | MA | 4574 | 1932 | 7389 | 1548 | 8908 | 1273 | 10042 | 1024 | 11813 | 594 | 15151 | 204 | 13888 |
| 4E | | MI | 3346 | 1932 | 5595 | 1499 | 6616 | 1228 | 7375 | 981 | 8564 | 554 | 10267 | 76 | 9911 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

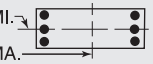
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 5.19 | MA | 4310 | 1932 | 6876 | 1565 | 8205 | 1288 | 9171 | 1036 | 10605 | 614 | 13498 | 109 | 13031 |
| 5L-3S | | MI | 3478 | 1932 | 6010 | 1487 | 7188 | 1207 | 8075 | 964 | 9519 | 556 | 11352 | 157 | 10688 |
| 14-#10 | 3.42 | MA | 4167 | 1665 | 6305 | 1383 | 7629 | 1148 | 8532 | 945 | 9811 | 609 | 12473 | 362 | 10087 |
| 4L-5S | | MI | 2985 | 1665 | 4628 | 1353 | 5450 | 1120 | 5990 | 918 | 6711 | 588 | 8146 | 241 | 7027 |
| 14-#10 | 3.42 | MA | 4004 | 1665 | 6009 | 1394 | 7224 | 1157 | 8028 | 953 | 9112 | 621 | 11504 | 312 | 9620 |
| 5L-4S | | MI | 3085 | 1665 | 4845 | 1344 | 5747 | 1113 | 6357 | 913 | 7219 | 580 | 8805 | 296 | 7297 |
| 14-#10 | 3.42 | MA | 3830 | 1665 | 5662 | 1408 | 6840 | 1167 | 7535 | 969 | 8429 | 627 | 10562 | 241 | 9219 |
| 6L-3S | | MI | 3175 | 1665 | 5087 | 1336 | 6082 | 1099 | 6767 | 901 | 7779 | 579 | 9472 | 345 | 7467 |
| 14-#10 | 3.42 | MA | 3677 | 1665 | 5351 | 1415 | 6433 | 1182 | 7059 | 977 | 7765 | 640 | 9643 | 198 | 8722 |
| 7L-2S | | MI | 3343 | 1665 | 5432 | 1327 | 6519 | 1093 | 7297 | 896 | 8495 | 570 | 10409 | 437 | 7495 |
| 14-#11 | 4.20 | MA | 4191 | 1782 | 6520 | 1464 | 7818 | 1209 | 8724 | 985 | 10028 | 614 | 12769 | 248 | 11389 |
| 5L-4S | | MI | 3228 | 1782 | 5245 | 1408 | 6212 | 1159 | 6901 | 939 | 7937 | 566 | 9584 | 212 | 8532 |
| 14-#11 | 4.20 | MA | 3987 | 1782 | 6107 | 1482 | 7352 | 1220 | 8126 | 1003 | 9200 | 619 | 11618 | 160 | 10737 |
| 6L-3S | | MI | 3325 | 1782 | 5537 | 1399 | 6615 | 1144 | 7394 | 926 | 8611 | 566 | 10364 | 270 | 8899 |
| 14-#14 | 6.06 | MA | 4674 | 2062 | 7704 | 1647 | 9256 | 1347 | 10444 | 1074 | 12323 | 608 | 15847 | 97 | 15410 |
| 5L-4S | | MI | 3590 | 2062 | 6179 | 1581 | 7356 | 1287 | 8273 | 1019 | 9775 | 547 | 11777 | 45 | 11564 |
| 16-#10 | 3.91 | MA | 4222 | 1738 | 6492 | 1440 | 7836 | 1191 | 8771 | 974 | 10115 | 618 | 12892 | 307 | 11021 |
| 5E | | MI | 3134 | 1738 | 4973 | 1399 | 5888 | 1153 | 6520 | 939 | 7426 | 585 | 9083 | 229 | 8015 |
| 16-#10 | 3.91 | MA | 4054 | 1738 | 6145 | 1454 | 7453 | 1201 | 8278 | 990 | 9431 | 624 | 11950 | 236 | 10612 |
| 6L-4S | | MI | 3233 | 1738 | 5190 | 1390 | 6184 | 1147 | 6887 | 934 | 7935 | 576 | 9742 | 284 | 8270 |
| 16-#10 | 3.91 | MA | 3909 | 1738 | 5834 | 1461 | 7046 | 1216 | 7802 | 998 | 8768 | 637 | 11031 | 193 | 10129 |
| 7L-3S | | MI | 3326 | 1738 | 5432 | 1382 | 6519 | 1133 | 7297 | 922 | 8495 | 575 | 10409 | 333 | 8480 |
| 16-#11 | 4.80 | MA | 4253 | 1873 | 6689 | 1539 | 8091 | 1262 | 9022 | 1029 | 10409 | 615 | 13292 | 154 | 12419 |
| 6L-4S | | MI | 3401 | 1873 | 5658 | 1465 | 6735 | 1201 | 7535 | 965 | 8794 | 562 | 10674 | 193 | 9699 |
| 18-#10 | 4.40 | MA | 4274 | 1812 | 6627 | 1500 | 8066 | 1234 | 9020 | 1011 | 10434 | 620 | 13338 | 231 | 12008 |
| 6L-5S | | MI | 3281 | 1812 | 5318 | 1445 | 6325 | 1187 | 7050 | 960 | 8142 | 581 | 10020 | 217 | 9005 |
| 18-#10 | 4.40 | MA | 4136 | 1812 | 6317 | 1507 | 7658 | 1250 | 8544 | 1020 | 9770 | 633 | 12419 | 189 | 11538 |
| 7L-4S | | MI | 3392 | 1812 | 5534 | 1436 | 6622 | 1180 | 7417 | 955 | 8650 | 573 | 10679 | 272 | 9248 |
| 20-#10 | 4.88 | MA | 4358 | 1886 | 6799 | 1553 | 8271 | 1283 | 9287 | 1041 | 10773 | 630 | 13806 | 184 | 12945 |
| 7L-5S | | MI | 3436 | 1886 | 5662 | 1491 | 6763 | 1221 | 7580 | 982 | 8858 | 578 | 10957 | 205 | 9998 |

## RECTANGULAR TIED COLUMNS 20" x 28"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#11 | 1.11 | MA | 4088 | 1418 | 5617 | 1231 | 6742 | 1036 | 7348 | 884 | 7953 | 653 | 9596 | 569 | 4075 |
| 2E | | MI | 2846 | 1418 | 4123 | 1183 | 4789 | 995 | 5133 | 848 | 5453 | 625 | 6296 | 518 | 2815 |
| 4-#14 | 1.61 | MA | 4327 | 1499 | 6198 | 1275 | 7446 | 1067 | 8186 | 902 | 9070 | 646 | 11132 | 560 | 5728 |
| 2E | | MI | 2985 | 1499 | 4498 | 1225 | 5235 | 1025 | 5660 | 865 | 6153 | 616 | 7114 | 487 | 3893 |
| 4-#18 | 2.86 | MA | 4879 | 1701 | 7605 | 1389 | 9170 | 1150 | 10245 | 951 | 11821 | 629 | 14751 | 524 | 9760 |
| 2E | | MI | 3296 | 1701 | 5387 | 1334 | 6307 | 1102 | 6931 | 910 | 7838 | 594 | 8983 | 396 | 6461 |
| 6-#9 | 1.07 | MA | 4092 | 1412 | 5522 | 1239 | 6682 | 1043 | 7307 | 890 | 7924 | 660 | 9577 | 575 | 3967 |
| 2L-3S | | MI | 2697 | 1412 | 3781 | 1202 | 4411 | 1012 | 4703 | 862 | 4895 | 642 | 5660 | 466 | 2757 |
| 6-#9 | 1.07 | MA | 3841 | 1412 | 5104 | 1248 | 6151 | 1052 | 6663 | 898 | 7055 | 672 | 8372 | 507 | 3973 |
| 3L-2S | | MI | 2856 | 1412 | 4055 | 1195 | 4759 | 1006 | 5124 | 858 | 5464 | 635 | 6412 | 539 | 2743 |
| 6-#10 | 1.36 | MA | 4243 | 1459 | 5872 | 1265 | 7110 | 1062 | 7817 | 902 | 8605 | 656 | 10514 | 570 | 4966 |
| 2L-3S | | MI | 2751 | 1459 | 3941 | 1229 | 4598 | 1031 | 4922 | 873 | 5185 | 638 | 6019 | 433 | 3417 |
| 6-#10 | 1.36 | MA | 3934 | 1459 | 5343 | 1276 | 6439 | 1072 | 7004 | 911 | 7507 | 670 | 8994 | 483 | 4963 |
| 3L-2S | | MI | 2946 | 1459 | 4285 | 1220 | 5035 | 1024 | 5452 | 869 | 5900 | 630 | 6956 | 526 | 3404 |
| 6-#11 | 1.67 | MA | 4380 | 1509 | 6256 | 1288 | 7552 | 1078 | 8331 | 910 | 9278 | 649 | 11431 | 563 | 5988 |
| 2L-3S | | MI | 2795 | 1509 | 4123 | 1249 | 4789 | 1044 | 5133 | 879 | 5453 | 629 | 6296 | 385 | 4079 |
| 6-#11 | 1.67 | MA | 4019 | 1509 | 5617 | 1301 | 6742 | 1090 | 7348 | 920 | 7953 | 665 | 9596 | 452 | 5970 |
| 3L-2S | | MI | 3022 | 1509 | 4536 | 1240 | 5312 | 1037 | 5767 | 874 | 6309 | 620 | 7387 | 499 | 4068 |
| 6-#14 | 2.41 | MA | 4726 | 1629 | 7107 | 1356 | 8600 | 1127 | 9585 | 940 | 10958 | 639 | 13747 | 551 | 8437 |
| 2L-3S | | MI | 2919 | 1629 | 4498 | 1318 | 5235 | 1093 | 5660 | 907 | 6153 | 620 | 7114 | 292 | 5624 |
| 6-#14 | 2.41 | MA | 4240 | 1629 | 6198 | 1375 | 7446 | 1143 | 8186 | 954 | 9070 | 661 | 11132 | 389 | 8352 |
| 3L-2S | | MI | 3225 | 1629 | 5081 | 1306 | 5976 | 1084 | 6557 | 902 | 7364 | 610 | 8624 | 455 | 5647 |

## RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis



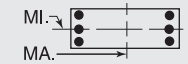

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 4.29 | MA | 5523 | 1933 | 9181 | 1534 | 11170 | 1256 | 12668 | 1018 | 15093 | 617 | 19196 | 501 | 14423 |
| 2L-3S | | MI | 3223 | 1933 | 5387 | 1496 | 6307 | 1218 | 6931 | 980 | 7838 | 594 | 8983 | 32 | 8898 |
| 6-#18 | 4.29 | MA | 4771 | 1933 | 7605 | 1565 | 9170 | 1281 | 10245 | 1039 | 11821 | 651 | 14751 | 211 | 14001 |
| 3L-2S | | MI | 3672 | 1933 | 6383 | 1479 | 7571 | 1208 | 8463 | 977 | 9901 | 583 | 11450 | 323 | 9413 |
| 8-#8 | 1.13 | MA | 4131 | 1421 | 5579 | 1247 | 6768 | 1050 | 7419 | 895 | 8082 | 662 | 9800 | 576 | 4179 |
| 2L-4S | | MI | 2683 | 1421 | 3719 | 1216 | 4328 | 1028 | 4607 | 875 | 4768 | 644 | 5551 | 453 | 2903 |
| 8-#8 | 1.13 | MA | 3933 | 1421 | 5246 | 1255 | 6346 | 1057 | 6907 | 901 | 7391 | 671 | 8843 | 523 | 4183 |
| 3E | | MI | 2756 | 1421 | 3872 | 1211 | 4540 | 1019 | 4866 | 867 | 5121 | 643 | 5979 | 485 | 2895 |
| 8-#8 | 1.13 | MA | 3822 | 1421 | 5018 | 1262 | 6029 | 1068 | 6519 | 912 | 6860 | 675 | 8191 | 490 | 4174 |
| 4L-2S | | MI | 2882 | 1421 | 4091 | 1205 | 4817 | 1014 | 5201 | 864 | 5574 | 637 | 6583 | 542 | 2885 |
| 8-#9 | 1.43 | MA | 4289 | 1470 | 5941 | 1275 | 7214 | 1070 | 7952 | 907 | 8794 | 658 | 10781 | 571 | 5221 |
| 2L-4S | | MI | 2733 | 1470 | 3863 | 1245 | 4493 | 1050 | 4799 | 889 | 5020 | 641 | 5879 | 418 | 3581 |
| 8-#9 | 1.43 | MA | 4047 | 1470 | 5522 | 1284 | 6682 | 1078 | 7307 | 915 | 7924 | 669 | 9577 | 503 | 5218 |
| 3E | | MI | 2823 | 1470 | 4055 | 1239 | 4759 | 1038 | 5124 | 879 | 5464 | 639 | 6412 | 457 | 3583 |
| 8-#9 | 1.43 | MA | 3911 | 1470 | 5235 | 1294 | 6283 | 1092 | 6819 | 928 | 7255 | 674 | 8753 | 462 | 5183 |
| 4L-2S | | MI | 2977 | 1470 | 4329 | 1232 | 5106 | 1033 | 5546 | 875 | 6033 | 632 | 7165 | 530 | 3574 |
| 8-#10 | 1.81 | MA | 4484 | 1532 | 6401 | 1311 | 7781 | 1096 | 8630 | 923 | 9703 | 653 | 12034 | 566 | 6544 |
| 2L-4S | | MI | 2797 | 1532 | 4043 | 1283 | 4700 | 1078 | 5042 | 907 | 5340 | 636 | 6290 | 372 | 4419 |
| 8-#10 | 1.81 | MA | 4189 | 1532 | 5872 | 1322 | 7110 | 1106 | 7817 | 932 | 8605 | 667 | 10514 | 478 | 6526 |
| 3E | | MI | 2907 | 1532 | 4285 | 1275 | 5035 | 1064 | 5452 | 895 | 5900 | 635 | 6956 | 421 | 4446 |
| 8-#10 | 1.81 | MA | 4024 | 1532 | 5509 | 1334 | 6606 | 1124 | 7199 | 948 | 7760 | 673 | 9470 | 425 | 6441 |
| 4L-2S | | MI | 3094 | 1532 | 4630 | 1266 | 5473 | 1058 | 5982 | 890 | 6616 | 627 | 7893 | 514 | 4442 |
| 8-#11 | 2.23 | MA | 4663 | 1599 | 6894 | 1344 | 8362 | 1119 | 9313 | 936 | 10604 | 644 | 13267 | 557 | 7889 |
| 2L-4S | | MI | 2849 | 1599 | 4244 | 1315 | 4909 | 1101 | 5274 | 918 | 5636 | 624 | 6607 | 308 | 5175 |
| 8-#11 | 2.23 | MA | 4320 | 1599 | 6256 | 1358 | 7552 | 1131 | 8331 | 946 | 9278 | 660 | 11431 | 446 | 7852 |
| 3E | | MI | 2977 | 1599 | 4536 | 1306 | 5312 | 1085 | 5767 | 905 | 6309 | 625 | 7387 | 366 | 5300 |
| 8-#11 | 2.23 | MA | 4127 | 1599 | 5815 | 1371 | 6941 | 1152 | 7582 | 965 | 8254 | 667 | 10157 | 381 | 7666 |
| 4L-2S | | MI | 3195 | 1599 | 4948 | 1296 | 5835 | 1078 | 6402 | 900 | 7165 | 616 | 8477 | 480 | 5306 |
| 8-#14 | 3.21 | MA | 5112 | 1759 | 8016 | 1438 | 9754 | 1187 | 10984 | 977 | 12846 | 633 | 16361 | 543 | 11133 |
| 2L-4S | | MI | 2999 | 1759 | 4667 | 1412 | 5404 | 1173 | 5857 | 962 | 6408 | 611 | 7539 | 180 | 6752 |
| 8-#14 | 3.21 | MA | 4655 | 1759 | 7107 | 1457 | 8600 | 1203 | 9585 | 991 | 10958 | 655 | 13747 | 381 | 11018 |
| 3E | | MI | 3179 | 1759 | 5081 | 1400 | 5976 | 1152 | 6557 | 945 | 7364 | 613 | 8624 | 260 | 7330 |
| 8-#14 | 3.21 | MA | 4400 | 1759 | 6477 | 1476 | 7728 | 1232 | 8516 | 1018 | 9496 | 663 | 11918 | 285 | 10139 |
| 4L-2S | | MI | 3457 | 1759 | 5665 | 1388 | 6716 | 1144 | 7454 | 940 | 8575 | 603 | 10134 | 424 | 7384 |
| 8-#18 | 5.71 | MA | 5492 | 2165 | 9181 | 1710 | 11170 | 1387 | 12668 | 1106 | 15093 | 640 | 19196 | 187 | 18457 |
| 3E | | MI | 3632 | 2165 | 6383 | 1641 | 7571 | 1324 | 8463 | 1047 | 9901 | 582 | 11450 | -41 | 11392 |
| 8-#18 | 5.71 | MA | 5073 | 2165 | 8083 | 1741 | 9650 | 1435 | 10807 | 1149 | 12549 | 651 | 16061 | 22 | 15934 |
| 4L-2S | | MI | 4040 | 2165 | 7379 | 1624 | 8835 | 1314 | 9995 | 1044 | 11964 | 571 | 13917 | 250 | 12348 |
| 10-#10 | 2.27 | MA | 4720 | 1606 | 6930 | 1357 | 8452 | 1129 | 9444 | 944 | 10801 | 649 | 13554 | 561 | 8116 |
| 2L-5S | | MI | 2854 | 1606 | 4171 | 1338 | 4841 | 1118 | 5205 | 933 | 5548 | 641 | 6568 | 306 | 5139 |
| 10-#10 | 2.27 | MA | 4437 | 1606 | 6401 | 1368 | 7781 | 1140 | 8630 | 953 | 9703 | 663 | 12034 | 473 | 8087 |
| 3L-4S | | MI | 2956 | 1606 | 4388 | 1329 | 5138 | 1112 | 5572 | 928 | 6056 | 633 | 7227 | 360 | 5426 |
| 10-#10 | 2.27 | MA | 4283 | 1606 | 6037 | 1380 | 7277 | 1157 | 8013 | 970 | 8858 | 670 | 10990 | 421 | 7990 |
| 4L-3S | | MI | 3059 | 1606 | 4630 | 1321 | 5473 | 1098 | 5982 | 916 | 6616 | 631 | 7893 | 409 | 5466 |
| 10-#10 | 2.27 | MA | 4094 | 1606 | 5715 | 1392 | 6834 | 1168 | 7464 | 979 | 8095 | 684 | 9937 | 373 | 7518 |
| 5L-2S | | MI | 3240 | 1606 | 4975 | 1312 | 5910 | 1091 | 6512 | 911 | 7332 | 623 | 8831 | 502 | 5474 |
| 10-#11 | 2.79 | MA | 4611 | 1690 | 6894 | 1414 | 8362 | 1172 | 9313 | 972 | 10604 | 656 | 13267 | 440 | 9731 |
| 3L-4S | | MI | 3034 | 1690 | 4656 | 1371 | 5433 | 1142 | 5908 | 944 | 6492 | 620 | 7697 | 289 | 6313 |
| 10-#11 | 2.79 | MA | 4433 | 1690 | 6454 | 1428 | 7751 | 1193 | 8564 | 991 | 9580 | 663 | 11993 | 375 | 9479 |
| 4L-3S | | MI | 3154 | 1690 | 4948 | 1362 | 5835 | 1126 | 6402 | 931 | 7165 | 620 | 8477 | 347 | 6516 |
| 10-#11 | 2.79 | MA | 4213 | 1690 | 6062 | 1442 | 7214 | 1205 | 7898 | 1002 | 8656 | 679 | 10712 | 313 | 8838 |
| 5L-2S | | MI | 3363 | 1690 | 5360 | 1353 | 6359 | 1119 | 7036 | 926 | 8022 | 612 | 9567 | 461 | 6536 |
| 10-#14 | 4.02 | MA | 5057 | 1890 | 8016 | 1538 | 9754 | 1263 | 10984 | 1029 | 12846 | 648 | 16361 | 372 | 13687 |
| 3L-4S | | MI | 3271 | 1890 | 5250 | 1493 | 6144 | 1233 | 6754 | 1000 | 7619 | 605 | 9049 | 148 | 8377 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis

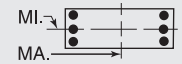



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 4.02 | MA | 4826 | 1890 | 7387 | 1557 | 8882 | 1291 | 9915 | 1055 | 11384 | 657 | 14532 | 277 | 12747 |
| 4L-3S | | MI | 3421 | 1890 | 5665 | 1481 | 6716 | 1212 | 7454 | 982 | 8575 | 607 | 10134 | 228 | 9034 |
| 10-#14 | 4.02 | MA | 4522 | 1890 | 6827 | 1576 | 8115 | 1308 | 8963 | 1069 | 10064 | 679 | 12698 | 184 | 11900 |
| 5L-2S | | MI | 3681 | 1890 | 6248 | 1469 | 7456 | 1203 | 8351 | 978 | 9786 | 597 | 11644 | 392 | 9110 |
| 10-#18 | 7.14 | MA | 5844 | 2397 | 9659 | 1885 | 11650 | 1541 | 13231 | 1216 | 15820 | 640 | 20506 | -1 | 20502 |
| 4L-3S | | MI | 4029 | 2397 | 7379 | 1786 | 8835 | 1430 | 9995 | 1114 | 11964 | 570 | 13917 | -113 | 13718 |
| 12-#10 | 2.72 | MA | 4678 | 1679 | 6930 | 1414 | 8452 | 1173 | 9444 | 975 | 10801 | 660 | 13554 | 468 | 9646 |
| 3L-5S | | MI | 3010 | 1679 | 4516 | 1384 | 5279 | 1152 | 5735 | 954 | 6263 | 638 | 7505 | 293 | 6116 |
| 12-#10 | 2.72 | MA | 4534 | 1679 | 6566 | 1426 | 7948 | 1191 | 8826 | 991 | 9955 | 666 | 12510 | 416 | 9541 |
| 4E | | MI | 3110 | 1679 | 4732 | 1375 | 5575 | 1145 | 6102 | 949 | 6771 | 629 | 8164 | 348 | 6411 |
| 12-#10 | 2.72 | MA | 4348 | 1679 | 6244 | 1438 | 7505 | 1201 | 8277 | 1000 | 9193 | 680 | 11457 | 368 | 9046 |
| 5L-3S | | MI | 3208 | 1679 | 4975 | 1367 | 5910 | 1132 | 6512 | 937 | 7332 | 628 | 8831 | 397 | 6484 |
| 12-#10 | 2.72 | MA | 4146 | 1679 | 5859 | 1452 | 7088 | 1212 | 7740 | 1016 | 8448 | 687 | 10437 | 298 | 8673 |
| 6L-2S | | MI | 3383 | 1679 | 5319 | 1358 | 6347 | 1125 | 7042 | 932 | 8047 | 619 | 9768 | 490 | 6500 |
| 12-#11 | 3.34 | MA | 4730 | 1780 | 7092 | 1484 | 8562 | 1234 | 9546 | 1017 | 10906 | 659 | 13829 | 369 | 11301 |
| 4E | | MI | 3215 | 1780 | 5069 | 1428 | 5956 | 1183 | 6543 | 970 | 7348 | 616 | 8788 | 270 | 7463 |
| 12-#11 | 3.34 | MA | 4513 | 1780 | 6701 | 1498 | 8025 | 1246 | 8880 | 1028 | 9982 | 674 | 12548 | 307 | 10687 |
| 5L-3S | | MI | 3328 | 1780 | 5360 | 1419 | 6359 | 1168 | 7036 | 957 | 8022 | 616 | 9567 | 328 | 7728 |
| 12-#11 | 3.34 | MA | 4277 | 1780 | 6241 | 1516 | 7518 | 1258 | 8228 | 1047 | 9078 | 682 | 11301 | 220 | 10044 |
| 6L-2S | | MI | 3528 | 1780 | 5773 | 1409 | 6882 | 1161 | 7670 | 952 | 8878 | 608 | 10658 | 442 | 7760 |
| 12-#14 | 4.82 | MA | 5239 | 2020 | 8296 | 1639 | 10036 | 1351 | 11314 | 1093 | 13273 | 651 | 17146 | 268 | 15365 |
| 4E | | MI | 3522 | 2020 | 5833 | 1575 | 6884 | 1292 | 7652 | 1037 | 8830 | 599 | 10559 | 116 | 10016 |
| 12-#14 | 4.82 | MA | 4938 | 2020 | 7736 | 1658 | 9269 | 1367 | 10362 | 1107 | 11952 | 672 | 15312 | 176 | 14521 |
| 5L-3S | | MI | 3657 | 2020 | 6248 | 1563 | 7456 | 1271 | 8351 | 1020 | 9786 | 601 | 11644 | 196 | 10737 |
| 12-#14 | 4.82 | MA | 4621 | 2020 | 7088 | 1684 | 8543 | 1384 | 9429 | 1133 | 10660 | 681 | 13522 | 49 | 13285 |
| 6L-2S | | MI | 3902 | 2020 | 6831 | 1551 | 8196 | 1263 | 9249 | 1015 | 10997 | 591 | 13154 | 360 | 10831 |
| 14-#10 | 3.17 | MA | 4780 | 1753 | 7095 | 1472 | 8619 | 1224 | 9639 | 1012 | 11053 | 663 | 14031 | 411 | 11093 |
| 4L-5S | | MI | 3162 | 1753 | 4860 | 1430 | 5716 | 1186 | 6265 | 975 | 6979 | 634 | 8442 | 281 | 7098 |
| 14-#10 | 3.17 | MA | 4596 | 1753 | 6773 | 1484 | 8176 | 1235 | 9090 | 1021 | 10291 | 677 | 12978 | 363 | 10579 |
| 5L-4S | | MI | 3262 | 1753 | 5077 | 1421 | 6013 | 1179 | 6632 | 970 | 7487 | 626 | 9101 | 336 | 7377 |
| 14-#10 | 3.17 | MA | 4402 | 1753 | 6388 | 1498 | 7759 | 1245 | 8553 | 1038 | 9546 | 684 | 11957 | 293 | 10201 |
| 6L-3S | | MI | 3355 | 1753 | 5319 | 1413 | 6347 | 1165 | 7042 | 958 | 8047 | 624 | 9768 | 385 | 7499 |
| 14-#10 | 3.17 | MA | 4233 | 1753 | 6048 | 1506 | 7306 | 1260 | 8035 | 1047 | 8823 | 697 | 10959 | 253 | 9624 |
| 7L-2S | | MI | 3524 | 1753 | 5664 | 1404 | 6785 | 1159 | 7573 | 954 | 8763 | 616 | 10705 | 478 | 7522 |
| 14-#11 | 3.90 | MA | 4805 | 1871 | 7339 | 1555 | 8835 | 1288 | 9862 | 1054 | 11307 | 670 | 14383 | 301 | 12542 |
| 5L-4S | | MI | 3406 | 1871 | 5481 | 1484 | 6479 | 1224 | 7177 | 996 | 8205 | 611 | 9878 | 251 | 8620 |
| 14-#11 | 3.90 | MA | 4579 | 1871 | 6880 | 1573 | 8328 | 1300 | 9210 | 1073 | 10403 | 677 | 13137 | 214 | 11892 |
| 6L-3S | | MI | 3505 | 1871 | 5773 | 1475 | 6882 | 1209 | 7670 | 983 | 8878 | 612 | 10658 | 309 | 8938 |
| 14-#11 | 3.90 | MA | 4382 | 1871 | 6469 | 1581 | 7789 | 1318 | 8581 | 1083 | 9526 | 693 | 11921 | 162 | 11190 |
| 7L-2S | | MI | 3688 | 1871 | 6185 | 1466 | 7405 | 1202 | 8304 | 979 | 9734 | 603 | 11748 | 423 | 8980 |
| 14-#14 | 5.63 | MA | 5343 | 2151 | 8646 | 1739 | 10423 | 1427 | 11761 | 1144 | 13840 | 666 | 17926 | 167 | 17148 |
| 5L-4S | | MI | 3766 | 2151 | 6416 | 1657 | 7624 | 1352 | 8549 | 1075 | 10041 | 592 | 12069 | 84 | 11665 |
| 14-#14 | 5.63 | MA | 5043 | 2151 | 7997 | 1765 | 9697 | 1443 | 10828 | 1171 | 12548 | 675 | 16136 | 40 | 15943 |
| 6L-3S | | MI | 3889 | 2151 | 6831 | 1644 | 8196 | 1331 | 9249 | 1058 | 10997 | 595 | 13154 | 164 | 12440 |
| 16-#10 | 3.63 | MA | 4838 | 1827 | 7302 | 1530 | 8848 | 1269 | 9904 | 1043 | 11389 | 673 | 14498 | 358 | 12116 |
| 5E | | MI | 3312 | 1827 | 5205 | 1476 | 6154 | 1219 | 6796 | 997 | 7695 | 631 | 9379 | 269 | 8084 |
| 16-#10 | 3.63 | MA | 4652 | 1827 | 6916 | 1544 | 8430 | 1279 | 9366 | 1059 | 10644 | 680 | 13477 | 288 | 11732 |
| 6L-4S | | MI | 3411 | 1827 | 5422 | 1467 | 6450 | 1213 | 7162 | 992 | 8203 | 622 | 10039 | 324 | 8348 |
| 16-#10 | 3.63 | MA | 4491 | 1827 | 6577 | 1552 | 7978 | 1294 | 8848 | 1068 | 9921 | 694 | 12479 | 248 | 11169 |
| 7L-3S | | MI | 3499 | 1827 | 5664 | 1459 | 6785 | 1199 | 7573 | 980 | 8763 | 621 | 10705 | 373 | 8513 |
| 16-#10 | 3.63 | MA | 4333 | 1827 | 6251 | 1560 | 7541 | 1301 | 8324 | 1084 | 9211 | 708 | 11520 | 195 | 10535 |
| 8L-2S | | MI | 3663 | 1827 | 6009 | 1450 | 7222 | 1192 | 8103 | 975 | 9479 | 612 | 11642 | 466 | 8543 |
| 16-#11 | 4.46 | MA | 4875 | 1961 | 7518 | 1629 | 9138 | 1341 | 10192 | 1099 | 11729 | 673 | 14972 | 208 | 13744 |
| 6L-4S | | MI | 3579 | 1961 | 5893 | 1541 | 7003 | 1266 | 7811 | 1022 | 9061 | 607 | 10968 | 232 | 9785 |
| 16-#11 | 4.46 | MA | 4688 | 1961 | 7107 | 1637 | 8600 | 1360 | 9563 | 1109 | 10852 | 689 | 13757 | 156 | 13048 |
| 7L-3S | | MI | 3671 | 1961 | 6185 | 1532 | 7405 | 1250 | 8304 | 1009 | 9734 | 607 | 11748 | 290 | 10147 |
| 16-#14 | 6.43 | MA | 5455 | 2281 | 8906 | 1847 | 10852 | 1503 | 12227 | 1208 | 14437 | 669 | 18750 | 32 | 18589 |
| 6L-4S | | MI | 4005 | 2281 | 7000 | 1738 | 8364 | 1412 | 9446 | 1113 | 11252 | 586 | 13579 | 52 | 13323 |

## RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

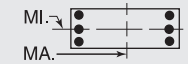
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 4.08 | MA | 4896 | 1900 | 7445 | 1590 | 9101 | 1313 | 10180 | 1080 | 11742 | 677 | 14997 | 283 | 13266 |
| 6L-5S | | MI | 3460 | 1900 | 5550 | 1522 | 6591 | 1253 | 7326 | 1018 | 8410 | 627 | 10316 | 257 | 9073 |
| 18-#10 | 4.08 | MA | 4743 | 1900 | 7106 | 1598 | 8649 | 1328 | 9661 | 1089 | 11019 | 690 | 14000 | 243 | 12716 |
| 7L-4S | | MI | 3558 | 1900 | 5766 | 1513 | 6887 | 1246 | 7693 | 1013 | 8918 | 619 | 10976 | 312 | 9324 |
| 18-#10 | 4.08 | MA | 4586 | 1900 | 6779 | 1606 | 8212 | 1334 | 9137 | 1105 | 10309 | 704 | 13040 | 190 | 12083 |
| 8L-3S | | MI | 3648 | 1900 | 6009 | 1505 | 7222 | 1233 | 8103 | 1001 | 9479 | 617 | 11642 | 361 | 9526 |
| 18-#11 | 5.01 | MA | 4987 | 2052 | 7746 | 1694 | 9410 | 1401 | 10545 | 1136 | 12177 | 684 | 15592 | 150 | 14909 |
| 7L-4S | | MI | 3749 | 2052 | 6306 | 1598 | 7526 | 1307 | 8446 | 1048 | 9917 | 603 | 12059 | 213 | 10954 |
| 20-#10 | 4.54 | MA | 4989 | 1974 | 7635 | 1644 | 9320 | 1361 | 10475 | 1111 | 12117 | 687 | 15520 | 239 | 14265 |
| 7L-5S | | MI | 3616 | 1974 | 5894 | 1568 | 7029 | 1287 | 7856 | 1039 | 9126 | 624 | 11253 | 245 | 10065 |
| 20-#10 | 4.54 | MA | 4835 | 1974 | 7308 | 1652 | 8883 | 1368 | 9950 | 1126 | 11407 | 701 | 14560 | 185 | 13630 |
| 8L-4S | | MI | 3715 | 1974 | 6111 | 1559 | 7325 | 1280 | 8223 | 1034 | 9634 | 615 | 11913 | 300 | 10305 |
| 22-#10 | 4.99 | MA | 5079 | 2048 | 7837 | 1698 | 9554 | 1402 | 10764 | 1148 | 12504 | 697 | 16080 | 180 | 15177 |
| 8L-5S | | MI | 3758 | 2048 | 6239 | 1614 | 7466 | 1320 | 8386 | 1060 | 9842 | 620 | 12190 | 233 | 11059 |

## RECTANGULAR TIED COLUMNS 20" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.04 | MA | 4668 | 1507 | 6315 | 1319 | 7617 | 1112 | 8311 | 949 | 8983 | 705 | 10828 | 614 | 4412 |
| 2E | | MI | 3024 | 1507 | 4359 | 1260 | 5056 | 1061 | 5409 | 905 | 5720 | 670 | 6590 | 557 | 2835 |
| 4-#14 | 1.50 | MA | 4934 | 1587 | 6949 | 1363 | 8387 | 1143 | 9227 | 968 | 10203 | 698 | 12507 | 606 | 6214 |
| 2E | | MI | 3163 | 1587 | 4736 | 1300 | 5504 | 1089 | 5936 | 921 | 6420 | 661 | 7406 | 527 | 3918 |
| 4-#18 | 2.67 | MA | 5550 | 1790 | 8491 | 1478 | 10276 | 1225 | 11482 | 1017 | 13218 | 681 | 16658 | 586 | 10624 |
| 2E | | MI | 3476 | 1790 | 5629 | 1408 | 6577 | 1166 | 7208 | 966 | 8103 | 639 | 9272 | 435 | 6497 |
| 6-#9 | 1.00 | MA | 4669 | 1500 | 6209 | 1327 | 7548 | 1119 | 8262 | 956 | 8946 | 713 | 10799 | 621 | 4291 |
| 2L-3S | | MI | 2874 | 1500 | 4012 | 1280 | 4676 | 1078 | 4978 | 920 | 5164 | 688 | 5957 | 506 | 2775 |
| 6-#9 | 1.00 | MA | 4393 | 1500 | 5753 | 1337 | 6971 | 1127 | 7562 | 964 | 8001 | 725 | 9490 | 554 | 4297 |
| 3L-2S | | MI | 3034 | 1500 | 4286 | 1273 | 5024 | 1073 | 5400 | 916 | 5733 | 681 | 6709 | 579 | 2760 |
| 6-#10 | 1.27 | MA | 4837 | 1547 | 6590 | 1353 | 8014 | 1137 | 8817 | 967 | 9687 | 709 | 11819 | 616 | 5378 |
| 2L-3S | | MI | 2928 | 1547 | 4173 | 1306 | 4864 | 1097 | 5197 | 931 | 5453 | 684 | 6315 | 474 | 3439 |
| 6-#10 | 1.27 | MA | 4497 | 1547 | 6015 | 1365 | 7284 | 1148 | 7933 | 977 | 8494 | 723 | 10167 | 531 | 5374 |
| 3L-2S | | MI | 3124 | 1547 | 4518 | 1298 | 5301 | 1090 | 5728 | 926 | 6168 | 676 | 7253 | 566 | 3423 |
| 6-#11 | 1.56 | MA | 4991 | 1597 | 7010 | 1376 | 8499 | 1153 | 9381 | 975 | 10426 | 701 | 12826 | 609 | 6493 |
| 2L-3S | | MI | 2972 | 1597 | 4359 | 1326 | 5056 | 1109 | 5409 | 935 | 5720 | 674 | 6590 | 425 | 4106 |
| 6-#11 | 1.56 | MA | 4592 | 1597 | 6315 | 1390 | 7617 | 1166 | 8311 | 987 | 8983 | 718 | 10828 | 501 | 6476 |
| 3L-2S | | MI | 3201 | 1597 | 4771 | 1316 | 5579 | 1102 | 6043 | 931 | 6576 | 666 | 7681 | 538 | 4091 |
| 6-#14 | 2.25 | MA | 5376 | 1717 | 7940 | 1445 | 9644 | 1202 | 10751 | 1005 | 12261 | 692 | 15356 | 597 | 9166 |
| 2L-3S | | MI | 3096 | 1717 | 4736 | 1394 | 5504 | 1157 | 5936 | 964 | 6420 | 664 | 7406 | 331 | 5663 |
| 6-#14 | 2.25 | MA | 4838 | 1717 | 6949 | 1465 | 8387 | 1220 | 9227 | 1021 | 10203 | 715 | 12507 | 439 | 9081 |
| 3L-2S | | MI | 3404 | 1717 | 5319 | 1382 | 6244 | 1149 | 6833 | 959 | 7630 | 654 | 8916 | 495 | 5676 |
| 6-#18 | 4.00 | MA | 6265 | 2022 | 10212 | 1623 | 12460 | 1331 | 14129 | 1084 | 16791 | 670 | 21604 | 571 | 15719 |
| 2L-3S | | MI | 3398 | 2022 | 5629 | 1571 | 6577 | 1282 | 7208 | 1035 | 8103 | 638 | 9272 | 71 | 9083 |
| 6-#18 | 4.00 | MA | 5429 | 2022 | 8491 | 1655 | 10276 | 1359 | 11482 | 1108 | 13218 | 707 | 16658 | 280 | 15297 |
| 3L-2S | | MI | 3855 | 2022 | 6625 | 1553 | 7841 | 1272 | 8740 | 1033 | 10166 | 627 | 11739 | 362 | 9455 |
| 8-#8 | 1.05 | MA | 4711 | 1509 | 6269 | 1336 | 7641 | 1125 | 8383 | 961 | 9115 | 714 | 11039 | 622 | 4520 |
| 2L-4S | | MI | 2859 | 1509 | 3949 | 1294 | 4593 | 1094 | 4883 | 933 | 5036 | 690 | 5849 | 493 | 2922 |
| 8-#8 | 1.05 | MA | 4494 | 1509 | 5907 | 1343 | 7182 | 1132 | 7827 | 967 | 8365 | 723 | 10000 | 570 | 4524 |
| 3E | | MI | 2933 | 1509 | 4102 | 1289 | 4805 | 1085 | 5141 | 925 | 5390 | 689 | 6277 | 525 | 2912 |
| 8-#8 | 1.05 | MA | 4372 | 1509 | 5660 | 1351 | 6839 | 1144 | 7406 | 978 | 7790 | 729 | 9298 | 537 | 4515 |
| 4L-2S | | MI | 3060 | 1509 | 4320 | 1283 | 5082 | 1080 | 5477 | 922 | 5843 | 683 | 6881 | 583 | 2901 |
| 8-#9 | 1.33 | MA | 4886 | 1558 | 6664 | 1363 | 8126 | 1145 | 8962 | 973 | 9891 | 710 | 12107 | 617 | 5653 |
| 2L-4S | | MI | 2910 | 1558 | 4094 | 1323 | 4758 | 1116 | 5074 | 947 | 5288 | 687 | 6176 | 458 | 3607 |
| 8-#9 | 1.33 | MA | 4620 | 1558 | 6209 | 1373 | 7548 | 1154 | 8262 | 981 | 8946 | 722 | 10799 | 550 | 5650 |
| 3E | | MI | 3000 | 1558 | 4286 | 1316 | 5024 | 1105 | 5400 | 937 | 5733 | 685 | 6709 | 498 | 3603 |
| 8-#9 | 1.33 | MA | 4471 | 1558 | 5897 | 1383 | 7116 | 1168 | 7732 | 994 | 8221 | 728 | 9912 | 510 | 5615 |
| 4L-2S | | MI | 3155 | 1558 | 4560 | 1309 | 5372 | 1099 | 5821 | 933 | 6302 | 678 | 7461 | 570 | 3592 |
| 8-#10 | 1.69 | MA | 5104 | 1621 | 7164 | 1399 | 8743 | 1171 | 9702 | 989 | 10881 | 705 | 13472 | 611 | 7093 |
| 2L-4S | | MI | 2974 | 1621 | 4275 | 1361 | 4966 | 1144 | 5318 | 964 | 5608 | 682 | 6586 | 412 | 4453 |

## RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

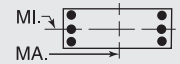
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.69 | MA | 4778 | 1621 | 6590 | 1411 | 8014 | 1182 | 8817 | 998 | 9687 | 720 | 11819 | 526 | 7075 |
| 3E | | MI | 3084 | 1621 | 4518 | 1352 | 5301 | 1130 | 5728 | 952 | 6168 | 681 | 7253 | 462 | 4471 |
| 8-#10 | 1.69 | MA | 4597 | 1621 | 6196 | 1424 | 7468 | 1200 | 8148 | 1015 | 8771 | 727 | 10695 | 474 | 6989 |
| 4L-2S | | MI | 3273 | 1621 | 4862 | 1344 | 5738 | 1124 | 6258 | 947 | 6884 | 672 | 8190 | 554 | 4464 |
| 8-#11 | 2.08 | MA | 5304 | 1688 | 7705 | 1433 | 9381 | 1194 | 10450 | 1002 | 11869 | 697 | 14824 | 603 | 8563 |
| 2L-4S | | MI | 3025 | 1688 | 4479 | 1391 | 5176 | 1166 | 5550 | 975 | 5903 | 670 | 6901 | 348 | 5269 |
| 8-#11 | 2.08 | MA | 4924 | 1688 | 7010 | 1447 | 8499 | 1207 | 9381 | 1013 | 10426 | 714 | 12826 | 495 | 8526 |
| 3E | | MI | 3154 | 1688 | 4771 | 1382 | 5579 | 1150 | 6043 | 962 | 6576 | 670 | 7681 | 406 | 5332 |
| 8-#11 | 2.08 | MA | 4712 | 1688 | 6532 | 1461 | 7836 | 1229 | 8568 | 1033 | 9314 | 722 | 11453 | 430 | 8371 |
| 4L-2S | | MI | 3374 | 1688 | 5184 | 1373 | 6103 | 1143 | 6678 | 957 | 7433 | 661 | 8771 | 519 | 5332 |
| 8-#14 | 3.00 | MA | 5803 | 1848 | 8931 | 1526 | 10902 | 1262 | 12276 | 1043 | 14318 | 685 | 18204 | 589 | 12105 |
| 2L-4S | | MI | 3174 | 1848 | 4905 | 1488 | 5672 | 1238 | 6133 | 1018 | 6675 | 656 | 7831 | 219 | 6862 |
| 8-#14 | 3.00 | MA | 5297 | 1848 | 7940 | 1546 | 9644 | 1280 | 10751 | 1058 | 12261 | 709 | 15356 | 431 | 11990 |
| 3E | | MI | 3347 | 1848 | 5319 | 1476 | 6244 | 1217 | 6833 | 1001 | 7630 | 658 | 8916 | 299 | 7374 |
| 8-#14 | 3.00 | MA | 5016 | 1848 | 7257 | 1566 | 8697 | 1310 | 9591 | 1086 | 10673 | 719 | 13384 | 336 | 11149 |
| 4L-2S | | MI | 3638 | 1848 | 5902 | 1463 | 6984 | 1208 | 7730 | 996 | 8841 | 648 | 10426 | 463 | 7416 |
| 8-#18 | 5.33 | MA | 6192 | 2254 | 10212 | 1800 | 12460 | 1465 | 14129 | 1175 | 16791 | 695 | 21604 | 265 | 20346 |
| 3E | | MI | 3808 | 2254 | 6625 | 1716 | 7841 | 1388 | 8740 | 1102 | 10166 | 626 | 11739 | -2 | 11737 |
| 8-#18 | 5.33 | MA | 5765 | 2254 | 9018 | 1833 | 10806 | 1516 | 12104 | 1221 | 14021 | 710 | 18129 | 94 | 17538 |
| 4L-2S | | MI | 4224 | 2254 | 7621 | 1698 | 9105 | 1378 | 10272 | 1100 | 12229 | 615 | 14206 | 289 | 12393 |
| 10-#10 | 2.12 | MA | 5364 | 1694 | 7739 | 1445 | 9473 | 1205 | 10586 | 1010 | 12074 | 702 | 15124 | 607 | 8802 |
| 2L-5S | | MI | 3030 | 1694 | 4403 | 1415 | 5107 | 1184 | 5481 | 990 | 5816 | 687 | 6864 | 346 | 5211 |
| 10-#10 | 2.12 | MA | 5051 | 1694 | 7164 | 1457 | 8743 | 1216 | 9702 | 1020 | 10881 | 716 | 13472 | 521 | 8772 |
| 3L-4S | | MI | 3132 | 1694 | 4620 | 1407 | 5404 | 1178 | 5848 | 985 | 6324 | 678 | 7523 | 400 | 5463 |
| 10-#10 | 2.12 | MA | 4882 | 1694 | 6771 | 1470 | 8197 | 1234 | 9032 | 1037 | 9964 | 724 | 12348 | 469 | 8676 |
| 4L-3S | | MI | 3237 | 1694 | 4862 | 1398 | 5738 | 1164 | 6258 | 973 | 6884 | 677 | 8190 | 450 | 5494 |
| 10-#10 | 2.12 | MA | 4671 | 1694 | 6422 | 1482 | 7718 | 1245 | 8438 | 1047 | 9139 | 739 | 11211 | 423 | 8213 |
| 5L-2S | | MI | 3420 | 1694 | 5207 | 1390 | 6176 | 1157 | 6788 | 969 | 7600 | 669 | 9127 | 542 | 5497 |
| 10-#11 | 2.60 | MA | 5246 | 1778 | 7705 | 1503 | 9381 | 1248 | 10450 | 1039 | 11869 | 709 | 14824 | 489 | 10574 |
| 3L-4S | | MI | 3211 | 1778 | 4892 | 1448 | 5700 | 1207 | 6185 | 1001 | 6759 | 665 | 7991 | 329 | 6404 |
| 10-#11 | 2.60 | MA | 5050 | 1778 | 7227 | 1518 | 8718 | 1270 | 9637 | 1059 | 10757 | 718 | 13451 | 424 | 10407 |
| 4L-3S | | MI | 3332 | 1778 | 5184 | 1439 | 6103 | 1192 | 6678 | 988 | 7433 | 665 | 8771 | 387 | 6550 |
| 10-#11 | 2.60 | MA | 4804 | 1778 | 6803 | 1532 | 8137 | 1283 | 8916 | 1070 | 9755 | 735 | 12066 | 365 | 9664 |
| 5L-2S | | MI | 3544 | 1778 | 5596 | 1429 | 6626 | 1185 | 7312 | 983 | 8289 | 657 | 9861 | 500 | 6565 |
| 10-#14 | 3.75 | MA | 5741 | 1978 | 8931 | 1628 | 10902 | 1339 | 12276 | 1096 | 14318 | 702 | 18204 | 422 | 14902 |
| 3L-4S | | MI | 3446 | 1978 | 5488 | 1569 | 6412 | 1297 | 7031 | 1056 | 7886 | 650 | 9341 | 187 | 8483 |
| 10-#14 | 3.75 | MA | 5487 | 1978 | 8247 | 1648 | 9955 | 1369 | 11115 | 1124 | 12730 | 713 | 16233 | 328 | 14000 |
| 4L-3S | | MI | 3600 | 1978 | 5902 | 1557 | 6984 | 1277 | 7730 | 1039 | 8841 | 652 | 10426 | 268 | 9079 |
| 10-#14 | 3.75 | MA | 5144 | 1978 | 7641 | 1668 | 9123 | 1387 | 10082 | 1139 | 11297 | 736 | 14248 | 240 | 13069 |
| 5L-2S | | MI | 3864 | 1978 | 6486 | 1545 | 7724 | 1268 | 8628 | 1034 | 10052 | 642 | 11937 | 431 | 9145 |
| 10-#18 | 6.67 | MA | 6556 | 2486 | 10739 | 1978 | 12990 | 1621 | 14751 | 1287 | 17594 | 699 | 23076 | 79 | 22555 |
| 4L-3S | | MI | 4206 | 2486 | 7621 | 1861 | 9105 | 1494 | 10272 | 1169 | 12229 | 614 | 14206 | -75 | 14078 |
| 10-#18 | 6.67 | MA | 5986 | 2486 | 9677 | 2011 | 11535 | 1650 | 12947 | 1311 | 15091 | 736 | 19595 | -89 | 19288 |
| 5L-2S | | MI | 4588 | 2486 | 8617 | 1843 | 10369 | 1484 | 11804 | 1167 | 14293 | 603 | 16673 | 216 | 15322 |
| 12-#10 | 2.54 | MA | 5318 | 1768 | 7739 | 1503 | 9473 | 1249 | 10586 | 1041 | 12074 | 713 | 15124 | 516 | 10469 |
| 3L-5S | | MI | 3186 | 1768 | 4748 | 1461 | 5545 | 1218 | 6011 | 1012 | 6531 | 683 | 7801 | 334 | 6186 |
| 12-#10 | 2.54 | MA | 5159 | 1768 | 7345 | 1516 | 8927 | 1267 | 9916 | 1058 | 11157 | 720 | 14000 | 464 | 10364 |
| 4E | | MI | 3287 | 1768 | 4965 | 1453 | 5841 | 1211 | 6378 | 1007 | 7040 | 675 | 8460 | 388 | 6471 |
| 12-#10 | 2.54 | MA | 4951 | 1768 | 6997 | 1528 | 8448 | 1279 | 9322 | 1068 | 10332 | 735 | 12863 | 419 | 9878 |
| 5L-3S | | MI | 3386 | 1768 | 5207 | 1444 | 6176 | 1198 | 6788 | 995 | 7600 | 674 | 9127 | 437 | 6513 |
| 12-#10 | 2.54 | MA | 4729 | 1768 | 6574 | 1542 | 7996 | 1290 | 8740 | 1085 | 9525 | 743 | 11764 | 349 | 9484 |
| 6L-2S | | MI | 3564 | 1768 | 5552 | 1436 | 6613 | 1191 | 7318 | 990 | 8315 | 665 | 10064 | 530 | 6525 |
| 12-#11 | 3.12 | MA | 5378 | 1869 | 7922 | 1574 | 9600 | 1311 | 10706 | 1085 | 12200 | 713 | 15449 | 418 | 12395 |
| 4E | | MI | 3392 | 1869 | 5304 | 1504 | 6223 | 1248 | 6819 | 1027 | 7616 | 661 | 9081 | 310 | 7551 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

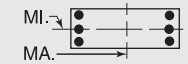
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 3.12 | MA | 5135 | 1869 | 7498 | 1589 | 9019 | 1324 | 9985 | 1096 | 11198 | 730 | 14065 | 359 | 11682 |
| 5L-3S | | MI | 3507 | 1869 | 5596 | 1495 | 6626 | 1233 | 7312 | 1014 | 8289 | 661 | 9861 | 368 | 7764 |
| 12-#11 | 3.12 | MA | 4874 | 1869 | 6992 | 1606 | 8470 | 1337 | 9278 | 1116 | 10219 | 739 | 12722 | 273 | 11046 |
| 6L-2S | | MI | 3710 | 1869 | 6008 | 1486 | 7149 | 1226 | 7946 | 1009 | 9145 | 653 | 10952 | 481 | 7790 |
| 12-#14 | 4.50 | MA | 5942 | 2109 | 9238 | 1729 | 11212 | 1429 | 12639 | 1162 | 14788 | 707 | 19081 | 319 | 16861 |
| 4E | | MI | 3698 | 2109 | 6071 | 1651 | 7152 | 1357 | 7928 | 1094 | 9097 | 643 | 10851 | 155 | 10119 |
| 12-#14 | 4.50 | MA | 5604 | 2109 | 8632 | 1749 | 10380 | 1447 | 11607 | 1177 | 13355 | 730 | 17097 | 231 | 15972 |
| 5L-3S | | MI | 3837 | 2109 | 6486 | 1639 | 7724 | 1336 | 8628 | 1077 | 10052 | 646 | 11937 | 236 | 10784 |
| 12-#14 | 4.50 | MA | 5254 | 2109 | 7917 | 1775 | 9595 | 1464 | 10596 | 1205 | 11954 | 741 | 15168 | 106 | 14605 |
| 6L-2S | | MI | 4086 | 2109 | 7069 | 1626 | 8464 | 1328 | 9525 | 1072 | 11263 | 636 | 13447 | 399 | 10868 |
| 12-#18 | 8.00 | MA | 6808 | 2718 | 11398 | 2156 | 13719 | 1756 | 15593 | 1378 | 18664 | 725 | 24542 | -104 | 23999 |
| 5L-3S | | MI | 4594 | 2718 | 8617 | 2005 | 10369 | 1600 | 11804 | 1236 | 14293 | 603 | 16673 | -148 | 16379 |
| 14-#10 | 2.96 | MA | 5430 | 1841 | 7920 | 1562 | 9656 | 1301 | 10800 | 1079 | 12351 | 717 | 15653 | 459 | 12053 |
| 4L-5S | | MI | 3340 | 1841 | 5093 | 1507 | 5982 | 1252 | 6541 | 1033 | 7247 | 680 | 8738 | 322 | 7167 |
| 14-#10 | 2.96 | MA | 5224 | 1841 | 7572 | 1574 | 9177 | 1312 | 10206 | 1089 | 11525 | 732 | 14516 | 414 | 11547 |
| 5L-4S | | MI | 3439 | 1841 | 5309 | 1499 | 6278 | 1245 | 6908 | 1028 | 7755 | 671 | 9398 | 376 | 7454 |
| 14-#10 | 2.96 | MA | 5011 | 1841 | 7149 | 1588 | 8726 | 1323 | 9624 | 1106 | 10719 | 739 | 13417 | 344 | 11168 |
| 6L-3S | | MI | 3534 | 1841 | 5552 | 1490 | 6613 | 1231 | 7318 | 1016 | 8315 | 670 | 10064 | 425 | 7529 |
| 14-#10 | 2.96 | MA | 4826 | 1841 | 6781 | 1596 | 8228 | 1338 | 9064 | 1116 | 9936 | 754 | 12341 | 307 | 10538 |
| 7L-2S | | MI | 3706 | 1841 | 5896 | 1482 | 7051 | 1225 | 7848 | 1011 | 9031 | 662 | 11001 | 518 | 7548 |
| 14-#11 | 3.64 | MA | 5457 | 1959 | 8193 | 1645 | 9901 | 1365 | 11054 | 1122 | 12641 | 726 | 16063 | 353 | 13704 |
| 5L-4S | | MI | 3570 | 1959 | 5717 | 1561 | 6747 | 1290 | 7453 | 1053 | 8472 | 657 | 10172 | 291 | 8706 |
| 14-#11 | 3.64 | MA | 5208 | 1959 | 7688 | 1663 | 9352 | 1378 | 10347 | 1142 | 11662 | 734 | 14720 | 267 | 13065 |
| 6L-3S | | MI | 3685 | 1959 | 6008 | 1552 | 7149 | 1274 | 7946 | 1040 | 9145 | 657 | 10952 | 349 | 8975 |
| 14-#11 | 3.64 | MA | 4992 | 1959 | 7241 | 1672 | 8757 | 1396 | 9666 | 1154 | 10711 | 751 | 13408 | 218 | 12324 |
| 7L-2S | | MI | 3872 | 1959 | 6421 | 1542 | 7673 | 1267 | 8580 | 1035 | 10001 | 648 | 12042 | 462 | 9011 |
| 14-#14 | 5.25 | MA | 6050 | 2239 | 9623 | 1831 | 11638 | 1506 | 13131 | 1214 | 15412 | 724 | 19946 | 223 | 18879 |
| 5L-4S | | MI | 3943 | 2239 | 6654 | 1732 | 7892 | 1417 | 8825 | 1131 | 10308 | 637 | 12361 | 123 | 11765 |
| 14-#14 | 5.25 | MA | 5720 | 2239 | 8907 | 1856 | 10852 | 1524 | 12120 | 1242 | 14011 | 735 | 18016 | 97 | 17503 |
| 6L-3S | | MI | 4069 | 2239 | 7069 | 1720 | 8464 | 1396 | 9525 | 1114 | 11263 | 640 | 13447 | 204 | 12488 |
| 16-#10 | 3.39 | MA | 5490 | 1915 | 8147 | 1620 | 9907 | 1346 | 11090 | 1110 | 12719 | 728 | 16168 | 409 | 13219 |
| 5E | | MI | 3490 | 1915 | 5437 | 1553 | 6420 | 1285 | 7071 | 1054 | 7963 | 676 | 9675 | 310 | 8151 |
| 16-#10 | 3.39 | MA | 5285 | 1915 | 7724 | 1634 | 9455 | 1357 | 10508 | 1127 | 11912 | 736 | 15069 | 339 | 12855 |
| 6L-4S | | MI | 3589 | 1915 | 5654 | 1545 | 6716 | 1279 | 7438 | 1049 | 8471 | 668 | 10335 | 364 | 8424 |
| 16-#10 | 3.39 | MA | 5109 | 1915 | 7356 | 1642 | 8957 | 1371 | 9948 | 1137 | 11130 | 751 | 13993 | 302 | 12222 |
| 7L-3S | | MI | 3679 | 1915 | 5896 | 1536 | 7051 | 1265 | 7848 | 1037 | 9031 | 667 | 11001 | 413 | 8544 |
| 16-#10 | 3.39 | MA | 4932 | 1915 | 7002 | 1651 | 8484 | 1379 | 9370 | 1153 | 10361 | 765 | 12957 | 251 | 11567 |
| 8L-2S | | MI | 3847 | 1915 | 6241 | 1528 | 7488 | 1258 | 8379 | 1032 | 9747 | 658 | 11938 | 506 | 8570 |
| 16-#11 | 4.16 | MA | 5534 | 2050 | 8383 | 1719 | 10234 | 1419 | 11416 | 1168 | 13105 | 730 | 16718 | 261 | 15088 |
| 6L-4S | | MI | 3757 | 2050 | 6129 | 1617 | 7270 | 1331 | 8087 | 1079 | 9328 | 652 | 11262 | 272 | 9869 |
| 16-#11 | 4.16 | MA | 5328 | 2050 | 7937 | 1728 | 9640 | 1438 | 10735 | 1180 | 12154 | 747 | 15406 | 212 | 14363 |
| 7L-3S | | MI | 3852 | 2050 | 6421 | 1608 | 7673 | 1315 | 8580 | 1066 | 10001 | 653 | 12042 | 330 | 10186 |
| 16-#14 | 6.00 | MA | 6173 | 2370 | 9898 | 1938 | 12110 | 1583 | 13644 | 1280 | 16069 | 728 | 20865 | 89 | 20400 |
| 6L-4S | | MI | 4182 | 2370 | 7238 | 1814 | 8633 | 1476 | 9722 | 1169 | 11519 | 631 | 13872 | 91 | 13420 |
| 18-#10 | 3.81 | MA | 5554 | 1989 | 8298 | 1680 | 10185 | 1391 | 11393 | 1149 | 13106 | 732 | 16721 | 334 | 14543 |
| 6L-5S | | MI | 3638 | 1989 | 5782 | 1599 | 6857 | 1319 | 7602 | 1075 | 8678 | 673 | 10612 | 297 | 9139 |
| 18-#10 | 3.81 | MA | 5386 | 1989 | 7931 | 1688 | 9687 | 1405 | 10832 | 1159 | 12323 | 747 | 15646 | 297 | 13908 |
| 7L-4S | | MI | 3737 | 1989 | 5999 | 1591 | 7153 | 1312 | 7968 | 1070 | 9187 | 664 | 11272 | 352 | 9399 |
| 18-#10 | 3.81 | MA | 5211 | 1989 | 7577 | 1697 | 9213 | 1412 | 10254 | 1174 | 11555 | 762 | 14610 | 246 | 13249 |
| 8L-3S | | MI | 3829 | 1989 | 6241 | 1582 | 7488 | 1299 | 8379 | 1058 | 9747 | 663 | 11938 | 401 | 9558 |
| 18-#11 | 4.68 | MA | 5657 | 2140 | 8632 | 1785 | 10522 | 1479 | 11804 | 1206 | 13597 | 743 | 17404 | 206 | 16402 |
| 7L-4S | | MI | 3928 | 2140 | 6541 | 1674 | 7793 | 1372 | 8722 | 1105 | 10184 | 648 | 12353 | 253 | 11037 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

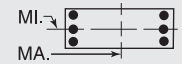
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 4.23 | MA | 5657 | 2062 | 8506 | 1734 | 10416 | 1439 | 11716 | 1180 | 13517 | 744 | 17298 | 292 | 15595 |
| 7L-5S | | MI | 3784 | 2062 | 6127 | 1645 | 7295 | 1353 | 8132 | 1097 | 9394 | 669 | 11549 | 285 | 10130 |
| 20-#10 | 4.23 | MA | 5484 | 2062 | 8152 | 1743 | 9943 | 1446 | 11138 | 1195 | 12748 | 758 | 16262 | 241 | 14931 |
| 8L-4S | | MI | 3895 | 2062 | 6343 | 1637 | 7591 | 1346 | 8499 | 1092 | 9902 | 661 | 12209 | 340 | 10377 |
| 22-#10 | 4.66 | MA | 5752 | 2136 | 8727 | 1789 | 10672 | 1480 | 12022 | 1216 | 13941 | 755 | 17915 | 236 | 16613 |
| 8L-5S | | MI | 3939 | 2136 | 6471 | 1691 | 7732 | 1386 | 8662 | 1118 | 10110 | 666 | 12486 | 273 | 11123 |

## RECTANGULAR TIED COLUMNS 20" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.41 | MA | 5577 | 1675 | 7736 | 1452 | 9375 | 1218 | 10321 | 1033 | 11392 | 750 | 13945 | 652 | 6700 |
| 2E | | MI | 3341 | 1675 | 4974 | 1376 | 5772 | 1154 | 6212 | 977 | 6686 | 706 | 7698 | 566 | 3943 |
| 4-#18 | 2.50 | MA | 6258 | 1878 | 9412 | 1566 | 11429 | 1300 | 12773 | 1083 | 14669 | 733 | 18459 | 632 | 11488 |
| 2E | | MI | 3656 | 1878 | 5871 | 1483 | 6847 | 1230 | 7484 | 1021 | 8368 | 683 | 9561 | 474 | 6532 |
| 6-#10 | 1.19 | MA | 5467 | 1635 | 7342 | 1442 | 8966 | 1213 | 9871 | 1033 | 10824 | 761 | 13189 | 662 | 5789 |
| 2L-3S | | MI | 3104 | 1635 | 4405 | 1383 | 5130 | 1163 | 5473 | 988 | 5721 | 730 | 6612 | 514 | 3459 |
| 6-#10 | 1.19 | MA | 5095 | 1635 | 6721 | 1454 | 8178 | 1224 | 8916 | 1044 | 9535 | 776 | 11404 | 578 | 5786 |
| 3L-2S | | MI | 3302 | 1635 | 4750 | 1375 | 5567 | 1156 | 6003 | 984 | 6436 | 722 | 7549 | 606 | 3442 |
| 6-#11 | 1.46 | MA | 5638 | 1686 | 7799 | 1464 | 9494 | 1228 | 10484 | 1041 | 11628 | 753 | 14285 | 654 | 6999 |
| 2L-3S | | MI | 3149 | 1686 | 4594 | 1402 | 5323 | 1174 | 5685 | 992 | 5987 | 719 | 6884 | 465 | 4132 |
| 6-#11 | 1.46 | MA | 5201 | 1686 | 7048 | 1479 | 8540 | 1242 | 9328 | 1053 | 10068 | 771 | 12124 | 549 | 6981 |
| 3L-2S | | MI | 3379 | 1686 | 5007 | 1393 | 5847 | 1167 | 6319 | 988 | 6844 | 711 | 7974 | 578 | 4114 |
| 6-#14 | 2.11 | MA | 6063 | 1806 | 8808 | 1533 | 10736 | 1278 | 11971 | 1071 | 13619 | 744 | 17029 | 643 | 9895 |
| 2L-3S | | MI | 3272 | 1806 | 4974 | 1470 | 5772 | 1222 | 6212 | 1020 | 6686 | 709 | 7698 | 371 | 5701 |
| 6-#14 | 2.11 | MA | 5472 | 1806 | 7736 | 1554 | 9375 | 1297 | 10321 | 1088 | 11392 | 769 | 13945 | 489 | 9810 |
| 3L-2S | | MI | 3584 | 1806 | 5557 | 1458 | 6512 | 1213 | 7110 | 1015 | 7897 | 699 | 9209 | 534 | 5705 |
| 6-#18 | 3.75 | MA | 7045 | 2110 | 11278 | 1711 | 13797 | 1406 | 15643 | 1150 | 18543 | 722 | 23823 | 617 | 17015 |
| 2L-3S | | MI | 3574 | 2110 | 5871 | 1645 | 6847 | 1346 | 7484 | 1091 | 8368 | 682 | 9561 | 110 | 9264 |
| 6-#18 | 3.75 | MA | 6125 | 2110 | 9412 | 1746 | 11429 | 1437 | 12773 | 1176 | 14669 | 762 | 18459 | 333 | 16593 |
| 3L-2S | | MI | 4037 | 2110 | 6867 | 1628 | 8111 | 1336 | 9016 | 1088 | 10431 | 671 | 12029 | 401 | 9496 |
| 8-#9 | 1.25 | MA | 5521 | 1646 | 7421 | 1452 | 9086 | 1220 | 10026 | 1039 | 11042 | 762 | 13497 | 663 | 6085 |
| 2L-4S | | MI | 3086 | 1646 | 4325 | 1401 | 5024 | 1182 | 5350 | 1004 | 5557 | 733 | 6473 | 499 | 3630 |
| 8-#9 | 1.25 | MA | 5229 | 1646 | 6930 | 1462 | 8462 | 1230 | 9270 | 1047 | 10022 | 775 | 12085 | 598 | 6082 |
| 3E | | MI | 3177 | 1646 | 4517 | 1394 | 5289 | 1171 | 5675 | 995 | 6001 | 731 | 7006 | 538 | 3623 |
| 8-#9 | 1.25 | MA | 5067 | 1646 | 6595 | 1472 | 7997 | 1245 | 8700 | 1061 | 9241 | 782 | 11135 | 557 | 6047 |
| 4L-2S | | MI | 3333 | 1646 | 4791 | 1387 | 5637 | 1165 | 6097 | 990 | 6570 | 724 | 7758 | 611 | 3611 |
| 8-#10 | 1.59 | MA | 5759 | 1709 | 7963 | 1488 | 9754 | 1246 | 10826 | 1054 | 12113 | 757 | 14974 | 657 | 7642 |
| 2L-4S | | MI | 3150 | 1709 | 4507 | 1438 | 5232 | 1210 | 5593 | 1022 | 5876 | 728 | 6882 | 452 | 4484 |
| 8-#10 | 1.59 | MA | 5403 | 1709 | 7342 | 1500 | 8966 | 1258 | 9871 | 1065 | 10824 | 773 | 13189 | 573 | 7623 |
| 3E | | MI | 3261 | 1709 | 4750 | 1429 | 5567 | 1196 | 6003 | 1010 | 6436 | 726 | 7549 | 502 | 4494 |
| 8-#10 | 1.59 | MA | 5205 | 1709 | 6918 | 1513 | 8378 | 1277 | 9149 | 1082 | 9837 | 781 | 11985 | 522 | 7538 |
| 4L-2S | | MI | 3452 | 1709 | 5094 | 1421 | 6004 | 1190 | 6534 | 1005 | 7152 | 718 | 8486 | 594 | 4485 |
| 8-#11 | 1.95 | MA | 5982 | 1776 | 8551 | 1521 | 10447 | 1270 | 11640 | 1067 | 13188 | 749 | 16445 | 648 | 9237 |
| 2L-4S | | MI | 3201 | 1776 | 4715 | 1468 | 5444 | 1231 | 5826 | 1032 | 6170 | 715 | 7195 | 388 | 5328 |
| 8-#11 | 1.95 | MA | 5565 | 1776 | 7799 | 1536 | 9494 | 1283 | 10484 | 1079 | 11628 | 767 | 14285 | 543 | 9200 |
| 3E | | MI | 3331 | 1776 | 5007 | 1458 | 5847 | 1215 | 6319 | 1018 | 6844 | 715 | 7974 | 446 | 5363 |
| 8-#11 | 1.95 | MA | 5334 | 1776 | 7284 | 1551 | 8779 | 1305 | 9608 | 1100 | 10429 | 776 | 12813 | 479 | 9045 |
| 4L-2S | | MI | 3553 | 1776 | 5419 | 1449 | 6370 | 1209 | 6954 | 1014 | 7700 | 707 | 9065 | 559 | 5358 |
| 8-#14 | 2.81 | MA | 6532 | 1936 | 9881 | 1615 | 12097 | 1337 | 13620 | 1109 | 15845 | 738 | 20112 | 635 | 13077 |
| 2L-4S | | MI | 3349 | 1936 | 5143 | 1564 | 5940 | 1303 | 6410 | 1075 | 6941 | 701 | 8123 | 258 | 6970 |
| 8-#14 | 2.81 | MA | 5976 | 1936 | 8808 | 1636 | 10736 | 1356 | 11971 | 1125 | 13619 | 762 | 17029 | 480 | 12962 |
| 3E | | MI | 3524 | 1936 | 5557 | 1551 | 6512 | 1282 | 7110 | 1058 | 7897 | 703 | 9209 | 339 | 7415 |
| 8-#14 | 2.81 | MA | 5669 | 1936 | 8071 | 1656 | 9714 | 1387 | 10718 | 1154 | 11905 | 775 | 14914 | 387 | 12176 |
| 4L-2S | | MI | 3820 | 1936 | 6140 | 1539 | 7252 | 1273 | 8007 | 1053 | 9108 | 693 | 10719 | 502 | 7448 |
| 8-#18 | 5.00 | MA | 6961 | 2342 | 11278 | 1891 | 13797 | 1543 | 15643 | 1243 | 18543 | 751 | 23823 | 317 | 22074 |
| 3E | | MI | 3984 | 2342 | 6867 | 1790 | 8111 | 1451 | 9016 | 1158 | 10431 | 670 | 12029 | 37 | 11917 |
| 8-#18 | 5.00 | MA | 6494 | 2342 | 9989 | 1925 | 12011 | 1595 | 13454 | 1291 | 15549 | 769 | 20094 | 149 | 19165 |
| 4L-2S | | MI | 4408 | 2342 | 7864 | 1773 | 9375 | 1441 | 10548 | 1155 | 12495 | 659 | 14496 | 328 | 12437 |

## RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis

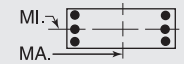



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.98 | MA | 6045 | 1783 | 8584 | 1534 | 10542 | 1280 | 11781 | 1076 | 13402 | 754 | 16759 | 653 | 9488 |
| 2L-5S | | MI | 3207 | 1783 | 4635 | 1492 | 5373 | 1250 | 5757 | 1048 | 6084 | 733 | 7160 | 386 | 5280 |
| 10-#10 | 1.98 | MA | 5702 | 1783 | 7963 | 1546 | 9754 | 1292 | 10826 | 1086 | 12113 | 769 | 14974 | 569 | 9458 |
| 3L-4S | | MI | 3309 | 1783 | 4852 | 1484 | 5669 | 1244 | 6124 | 1043 | 6592 | 724 | 7820 | 440 | 5497 |
| 10-#10 | 1.98 | MA | 5517 | 1783 | 7539 | 1559 | 9165 | 1310 | 10104 | 1104 | 11126 | 778 | 13770 | 517 | 9361 |
| 4L-3S | | MI | 3414 | 1783 | 5094 | 1475 | 6004 | 1230 | 6534 | 1031 | 7152 | 723 | 8486 | 490 | 5520 |
| 10-#10 | 1.98 | MA | 5284 | 1783 | 7165 | 1572 | 8651 | 1322 | 9465 | 1114 | 10237 | 793 | 12548 | 473 | 8915 |
| 5L-2S | | MI | 3599 | 1783 | 5439 | 1467 | 6442 | 1223 | 7064 | 1026 | 7868 | 714 | 9423 | 582 | 5519 |
| 10-#11 | 2.44 | MA | 5918 | 1867 | 8551 | 1592 | 10447 | 1325 | 11640 | 1105 | 13188 | 763 | 16445 | 537 | 11416 |
| 3L-4S | | MI | 3387 | 1867 | 5127 | 1524 | 5967 | 1272 | 6461 | 1058 | 7027 | 710 | 8285 | 369 | 6493 |
| 10-#11 | 2.44 | MA | 5704 | 1867 | 8036 | 1607 | 9733 | 1347 | 10764 | 1126 | 11990 | 772 | 14974 | 473 | 11249 |
| 4L-3S | | MI | 3510 | 1867 | 5419 | 1515 | 6370 | 1257 | 6954 | 1045 | 7700 | 711 | 9065 | 427 | 6583 |
| 10-#11 | 2.44 | MA | 5430 | 1867 | 7580 | 1622 | 9107 | 1360 | 9986 | 1138 | 10910 | 790 | 13485 | 417 | 10499 |
| 5L-2S | | MI | 3724 | 1867 | 5832 | 1506 | 6893 | 1250 | 7588 | 1040 | 8556 | 702 | 10155 | 540 | 6592 |
| 10-#14 | 3.52 | MA | 6463 | 2067 | 9881 | 1717 | 12097 | 1416 | 13620 | 1163 | 15845 | 756 | 20112 | 471 | 16117 |
| 3L-4S | | MI | 3607 | 2067 | 5726 | 1645 | 6680 | 1362 | 7307 | 1113 | 8152 | 695 | 9634 | 226 | 8587 |
| 10-#14 | 3.52 | MA | 6184 | 2067 | 9144 | 1738 | 11075 | 1447 | 12368 | 1192 | 14131 | 769 | 17998 | 378 | 15270 |
| 4L-3S | | MI | 3778 | 2067 | 6140 | 1633 | 7252 | 1341 | 8007 | 1095 | 9108 | 697 | 10719 | 307 | 9123 |
| 10-#14 | 3.52 | MA | 5803 | 2067 | 8491 | 1759 | 10179 | 1466 | 11255 | 1209 | 12586 | 793 | 15864 | 294 | 14211 |
| 5L-2S | | MI | 4047 | 2067 | 6724 | 1621 | 7992 | 1333 | 8904 | 1090 | 10319 | 687 | 12229 | 470 | 9179 |
| 10-#18 | 6.25 | MA | 7361 | 2574 | 11855 | 2070 | 14378 | 1701 | 16324 | 1358 | 19423 | 758 | 25457 | 134 | 24620 |
| 4L-3S | | MI | 4382 | 2574 | 7864 | 1935 | 9375 | 1557 | 10548 | 1225 | 12495 | 659 | 14496 | -36 | 14435 |
| 10-#18 | 6.25 | MA | 6725 | 2574 | 10710 | 2105 | 12809 | 1732 | 14377 | 1384 | 16720 | 797 | 21710 | -26 | 21611 |
| 5L-2S | | MI | 4773 | 2574 | 8860 | 1918 | 10639 | 1547 | 12080 | 1222 | 14558 | 648 | 16963 | 255 | 15367 |
| 12-#10 | 2.38 | MA | 5994 | 1856 | 8584 | 1592 | 10542 | 1325 | 11781 | 1107 | 13402 | 766 | 16759 | 564 | 11292 |
| 3L-5S | | MI | 3363 | 1856 | 4980 | 1538 | 5811 | 1284 | 6287 | 1069 | 6799 | 729 | 8097 | 374 | 6254 |
| 12-#10 | 2.38 | MA | 5820 | 1856 | 8160 | 1605 | 9953 | 1344 | 11059 | 1125 | 12415 | 774 | 15555 | 512 | 11187 |
| 4E | | MI | 3464 | 1856 | 5197 | 1530 | 6107 | 1277 | 6654 | 1064 | 7308 | 721 | 8757 | 428 | 6507 |
| 12-#10 | 2.38 | MA | 5590 | 1856 | 7785 | 1618 | 9438 | 1355 | 10420 | 1135 | 11526 | 790 | 14333 | 469 | 10717 |
| 5L-3S | | MI | 3565 | 1856 | 5439 | 1521 | 6442 | 1264 | 7064 | 1052 | 7868 | 719 | 9423 | 478 | 6541 |
| 12-#10 | 2.38 | MA | 5348 | 1856 | 7325 | 1631 | 8953 | 1367 | 9794 | 1153 | 10658 | 798 | 13156 | 399 | 10276 |
| 6L-2S | | MI | 3744 | 1856 | 5784 | 1513 | 6879 | 1257 | 7594 | 1047 | 8583 | 711 | 10360 | 570 | 6549 |
| 12-#11 | 2.92 | MA | 6063 | 1957 | 8787 | 1664 | 10687 | 1388 | 11920 | 1152 | 13550 | 768 | 17134 | 467 | 13456 |
| 4E | | MI | 3569 | 1957 | 5540 | 1581 | 6490 | 1314 | 7095 | 1084 | 7883 | 706 | 9375 | 350 | 7637 |
| 12-#11 | 2.92 | MA | 5792 | 1957 | 8332 | 1679 | 10060 | 1402 | 11142 | 1164 | 12470 | 786 | 15646 | 411 | 12685 |
| 5L-3S | | MI | 3685 | 1957 | 5832 | 1572 | 6893 | 1298 | 7588 | 1071 | 8556 | 706 | 10155 | 408 | 7799 |
| 12-#11 | 2.92 | MA | 5508 | 1957 | 7779 | 1696 | 9470 | 1415 | 10381 | 1185 | 11415 | 795 | 14207 | 325 | 12066 |
| 6L-2S | | MI | 3892 | 1957 | 6244 | 1562 | 7417 | 1291 | 8222 | 1066 | 9412 | 698 | 11246 | 521 | 7820 |
| 12-#14 | 4.22 | MA | 6682 | 2197 | 10216 | 1819 | 12436 | 1507 | 14017 | 1230 | 16358 | 762 | 21081 | 370 | 18374 |
| 4E | | MI | 3874 | 2197 | 6309 | 1727 | 7420 | 1422 | 8204 | 1150 | 9363 | 688 | 11144 | 195 | 10219 |
| 12-#14 | 4.22 | MA | 6306 | 2197 | 9563 | 1840 | 11540 | 1525 | 12905 | 1246 | 14813 | 787 | 18947 | 286 | 17359 |
| 5L-3S | | MI | 4016 | 2197 | 6724 | 1714 | 7992 | 1401 | 8904 | 1133 | 10319 | 691 | 12229 | 275 | 10829 |
| 12-#14 | 4.22 | MA | 5924 | 2197 | 8781 | 1865 | 10694 | 1544 | 11815 | 1275 | 13303 | 799 | 16879 | 161 | 15931 |
| 6L-2S | | MI | 4270 | 2197 | 7307 | 1702 | 8733 | 1392 | 9801 | 1128 | 11530 | 681 | 13739 | 439 | 10904 |
| 12-#18 | 7.50 | MA | 7626 | 2806 | 12576 | 2250 | 15176 | 1837 | 17246 | 1451 | 20594 | 786 | 27073 | -42 | 26838 |
| 5L-3S | | MI | 4772 | 2806 | 8860 | 2080 | 10639 | 1663 | 12080 | 1292 | 14558 | 647 | 16963 | -109 | 16750 |
| 14-#10 | 2.78 | MA | 6116 | 1930 | 8781 | 1651 | 10741 | 1377 | 12014 | 1146 | 13704 | 771 | 17340 | 507 | 13013 |
| 4L-5S | | MI | 3517 | 1930 | 5325 | 1584 | 6248 | 1318 | 6817 | 1090 | 7515 | 726 | 9034 | 362 | 7233 |
| 14-#10 | 2.78 | MA | 5888 | 1930 | 8406 | 1664 | 10226 | 1389 | 11375 | 1157 | 12815 | 786 | 16118 | 464 | 12522 |
| 5L-4S | | MI | 3617 | 1930 | 5542 | 1576 | 6544 | 1311 | 7184 | 1085 | 8023 | 717 | 9694 | 416 | 7516 |
| 14-#10 | 2.78 | MA | 5656 | 1930 | 7945 | 1677 | 9741 | 1401 | 10749 | 1174 | 11947 | 795 | 14941 | 395 | 12098 |
| 6L-3S | | MI | 3713 | 1930 | 5784 | 1568 | 6879 | 1297 | 7594 | 1073 | 8583 | 716 | 10360 | 466 | 7559 |
| 14-#10 | 2.78 | MA | 5454 | 1930 | 7549 | 1686 | 9197 | 1415 | 10146 | 1185 | 11105 | 810 | 13787 | 359 | 11464 |
| 7L-2S | | MI | 3887 | 1930 | 6129 | 1559 | 7317 | 1290 | 8124 | 1069 | 9299 | 707 | 11297 | 558 | 7574 |
| 14-#11 | 3.41 | MA | 6145 | 2048 | 9083 | 1735 | 11014 | 1443 | 12298 | 1191 | 14031 | 781 | 17807 | 405 | 14875 |
| 5L-4S | | MI | 3747 | 2048 | 5952 | 1637 | 7014 | 1355 | 7729 | 1110 | 8739 | 702 | 10466 | 331 | 8790 |
| 14-#11 | 3.41 | MA | 5873 | 2048 | 8531 | 1752 | 10423 | 1456 | 11537 | 1211 | 12975 | 791 | 16368 | 319 | 14256 |
| 6L-3S | | MI | 3865 | 2048 | 6244 | 1628 | 7417 | 1339 | 8222 | 1097 | 9412 | 702 | 11246 | 389 | 9012 |


## RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis

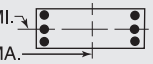



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 3.41 | MA | 5637 | 2048 | 8050 | 1762 | 9773 | 1474 | 10804 | 1223 | 11952 | 809 | 14959 | 273 | 13423 |
| 7L-2S | | MI | 4055 | 2048 | 6656 | 1619 | 7940 | 1332 | 8856 | 1092 | 10269 | 694 | 12336 | 502 | 9043 |
| 14-#14 | 4.92 | MA | 6795 | 2328 | 10636 | 1922 | 12901 | 1585 | 14554 | 1284 | 17040 | 781 | 22030 | 277 | 20510 |
| 5L-4S | | MI | 4119 | 2328 | 6892 | 1808 | 8161 | 1481 | 9101 | 1188 | 10574 | 682 | 12654 | 163 | 11862 |
| 14-#14 | 4.92 | MA | 6434 | 2328 | 9853 | 1947 | 12055 | 1604 | 13465 | 1313 | 15529 | 793 | 19962 | 153 | 19068 |
| 6L-3S | | MI | 4249 | 2328 | 7307 | 1796 | 8733 | 1460 | 9801 | 1171 | 11530 | 684 | 13739 | 243 | 12535 |
| 14-#14 | 4.92 | MA | 6118 | 2328 | 9166 | 1960 | 11136 | 1630 | 12414 | 1329 | 14064 | 818 | 17940 | 83 | 17544 |
| 7L-2S | | MI | 4491 | 2328 | 7890 | 1784 | 9473 | 1452 | 10698 | 1166 | 12741 | 674 | 15249 | 407 | 12624 |
| 16-#10 | 3.17 | MA | 6179 | 2003 | 9027 | 1710 | 11014 | 1423 | 12329 | 1178 | 14104 | 783 | 17903 | 459 | 14332 |
| 5E | | MI | 3668 | 2003 | 5669 | 1630 | 6686 | 1351 | 7347 | 1112 | 8231 | 722 | 9971 | 350 | 8217 |
| 16-#10 | 3.17 | MA | 5956 | 2003 | 8566 | 1723 | 10529 | 1434 | 11704 | 1196 | 13236 | 791 | 16726 | 390 | 13921 |
| 6L-4S | | MI | 3767 | 2003 | 5886 | 1622 | 6982 | 1345 | 7714 | 1107 | 8739 | 714 | 10631 | 404 | 8498 |
| 16-#10 | 3.17 | MA | 5763 | 2003 | 8170 | 1732 | 9985 | 1448 | 11101 | 1206 | 12394 | 807 | 15572 | 354 | 13287 |
| 7L-3S | | MI | 3858 | 2003 | 6129 | 1614 | 7317 | 1331 | 8124 | 1095 | 9299 | 712 | 11297 | 454 | 8575 |
| 16-#10 | 3.17 | MA | 5567 | 2003 | 7789 | 1741 | 9475 | 1456 | 10469 | 1221 | 11567 | 822 | 14460 | 305 | 12615 |
| 8L-2S | | MI | 4028 | 2003 | 6473 | 1605 | 7754 | 1324 | 8654 | 1090 | 10015 | 704 | 12234 | 546 | 8597 |
| 16-#11 | 3.90 | MA | 6229 | 2138 | 9282 | 1809 | 11377 | 1498 | 12693 | 1237 | 14536 | 786 | 18528 | 313 | 16450 |
| 6L-4S | | MI | 3935 | 2138 | 6365 | 1694 | 7537 | 1396 | 8363 | 1136 | 9595 | 698 | 11556 | 312 | 9951 |
| 16-#11 | 3.90 | MA | 6005 | 2138 | 8801 | 1819 | 10727 | 1515 | 11960 | 1250 | 13512 | 804 | 17120 | 267 | 15612 |
| 7L-3S | | MI | 4033 | 2138 | 6656 | 1685 | 7940 | 1381 | 8856 | 1123 | 10269 | 698 | 12336 | 370 | 10223 |
| 16-#11 | 3.90 | MA | 5774 | 2138 | 8339 | 1830 | 10108 | 1524 | 11206 | 1268 | 12506 | 822 | 15764 | 203 | 14632 |
| 8L-2S | | MI | 4215 | 2138 | 7069 | 1675 | 8463 | 1374 | 9491 | 1118 | 11125 | 689 | 13427 | 483 | 10263 |
| 16-#14 | 5.63 | MA | 6929 | 2458 | 10926 | 2028 | 13416 | 1663 | 15114 | 1351 | 17756 | 787 | 23045 | 144 | 22204 |
| 6L-4S | | MI | 4360 | 2458 | 7476 | 1890 | 8901 | 1541 | 9998 | 1226 | 11785 | 676 | 14164 | 131 | 13514 |
| 16-#14 | 5.63 | MA | 6634 | 2458 | 10238 | 2042 | 12497 | 1689 | 14064 | 1367 | 16290 | 812 | 21024 | 74 | 20669 |
| 7L-3S | | MI | 4478 | 2458 | 7890 | 1878 | 9473 | 1520 | 10698 | 1208 | 12741 | 678 | 15249 | 211 | 14240 |
| 18-#10 | 3.57 | MA | 6250 | 2077 | 9187 | 1769 | 11316 | 1468 | 12659 | 1217 | 14525 | 788 | 18510 | 385 | 15747 |
| 6L-5S | | MI | 3816 | 2077 | 6014 | 1677 | 7123 | 1385 | 7877 | 1133 | 8946 | 719 | 10908 | 338 | 9204 |
| 18-#10 | 3.57 | MA | 6066 | 2077 | 8791 | 1778 | 10773 | 1482 | 12056 | 1227 | 13683 | 803 | 17356 | 349 | 15112 |
| 7L-4S | | MI | 3915 | 2077 | 6231 | 1668 | 7419 | 1378 | 8244 | 1128 | 9455 | 710 | 11568 | 392 | 9471 |
| 18-#10 | 3.57 | MA | 5872 | 2077 | 8410 | 1787 | 10263 | 1490 | 11424 | 1242 | 12856 | 819 | 16245 | 300 | 14432 |
| 8L-3S | | MI | 4002 | 2077 | 6473 | 1660 | 7754 | 1364 | 8654 | 1116 | 10015 | 709 | 12234 | 441 | 9590 |
| 18-#10 | 3.57 | MA | 5648 | 2077 | 8040 | 1797 | 9767 | 1499 | 10799 | 1249 | 12014 | 827 | 15147 | 254 | 13713 |
| 9L-2S | | MI | 4167 | 2077 | 6818 | 1651 | 8192 | 1358 | 9185 | 1111 | 10731 | 700 | 13171 | 534 | 9617 |
| 18-#11 | 4.39 | MA | 6364 | 2228 | 9553 | 1875 | 11681 | 1557 | 13116 | 1276 | 15072 | 800 | 19281 | 261 | 17818 |
| 7L-4S | | MI | 4107 | 2228 | 6777 | 1750 | 8061 | 1438 | 8998 | 1162 | 10451 | 693 | 12647 | 293 | 11117 |
| 18-#11 | 4.39 | MA | 6137 | 2228 | 9090 | 1886 | 11062 | 1566 | 12362 | 1294 | 14067 | 818 | 17925 | 197 | 16830 |
| 8L-3S | | MI | 4198 | 2228 | 7069 | 1741 | 8463 | 1422 | 9491 | 1149 | 11125 | 693 | 13427 | 351 | 11434 |
| 18-#14 | 6.33 | MA | 7136 | 2588 | 11310 | 2123 | 13858 | 1749 | 15714 | 1405 | 18517 | 805 | 24107 | 65 | 23794 |
| 7L-4S | | MI | 4596 | 2588 | 8059 | 1971 | 9641 | 1601 | 10895 | 1263 | 12996 | 670 | 15674 | 99 | 15174 |
| 20-#10 | 3.97 | MA | 6362 | 2151 | 9412 | 1824 | 11561 | 1516 | 13011 | 1249 | 14972 | 800 | 19141 | 344 | 16938 |
| 7L-5S | | MI | 3963 | 2151 | 6359 | 1723 | 7561 | 1418 | 8408 | 1154 | 9662 | 715 | 11845 | 326 | 10193 |
| 20-#10 | 3.97 | MA | 6170 | 2151 | 9031 | 1833 | 11051 | 1524 | 12379 | 1263 | 14145 | 815 | 18029 | 295 | 16249 |
| 8L-4S | | MI | 4061 | 2151 | 6576 | 1714 | 7857 | 1412 | 8774 | 1149 | 10170 | 707 | 12505 | 380 | 10448 |
| 20-#10 | 3.97 | MA | 5954 | 2151 | 8661 | 1843 | 10555 | 1533 | 11754 | 1271 | 13303 | 824 | 16932 | 249 | 15533 |
| 9L-3S | | MI | 4151 | 2151 | 6818 | 1706 | 8192 | 1398 | 9185 | 1137 | 10731 | 705 | 13171 | 429 | 10604 |
| 20-#11 | 4.88 | MA | 6491 | 2319 | 9842 | 1943 | 12016 | 1607 | 13518 | 1320 | 15627 | 814 | 20085 | 191 | 19028 |
| 8L-4S | | MI | 4276 | 2319 | 7189 | 1807 | 8584 | 1479 | 9632 | 1188 | 11308 | 689 | 13737 | 274 | 12288 |
| 22-#10 | 4.37 | MA | 6463 | 2224 | 9652 | 1879 | 11839 | 1557 | 13334 | 1285 | 15434 | 812 | 19814 | 290 | 18066 |
| 8L-5S | | MI | 4119 | 2224 | 6704 | 1769 | 7998 | 1452 | 8938 | 1175 | 10378 | 712 | 12782 | 314 | 11185 |
| 22-#10 | 4.37 | MA | 6254 | 2224 | 9282 | 1889 | 11343 | 1566 | 12709 | 1292 | 14592 | 820 | 18717 | 245 | 17353 |
| 9L-4S | | MI | 4217 | 2224 | 6920 | 1760 | 8294 | 1445 | 9305 | 1170 | 10886 | 703 | 13442 | 368 | 11429 |
| 24-#10 | 4.76 | MA | 6549 | 2298 | 9903 | 1935 | 12131 | 1600 | 13664 | 1313 | 15881 | 817 | 20501 | 240 | 19172 |
| 9L-5S | | MI | 4261 | 2298 | 7048 | 1815 | 8435 | 1486 | 9468 | 1197 | 11093 | 708 | 13719 | 301 | 12179 |

## RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis

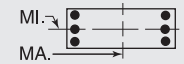



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.32 | MA | 6256 | 1764 | 8558 | 1540 | 10412 | 1294 | 11469 | 1099 | 12636 | 803 | 15448 | 698 | 7186 |
| 2E | | MI | 3519 | 1764 | 5212 | 1452 | 6040 | 1219 | 6489 | 1034 | 6953 | 750 | 7991 | 605 | 3967 |
| 4-#18 | 2.35 | MA | 7004 | 1967 | 10368 | 1654 | 12630 | 1376 | 14117 | 1149 | 16176 | 785 | 20324 | 678 | 12352 |
| 2E | | MI | 3836 | 1967 | 6114 | 1558 | 7117 | 1293 | 7760 | 1077 | 8633 | 727 | 9851 | 512 | 6567 |
| 6-#10 | 1.12 | MA | 6132 | 1724 | 8130 | 1530 | 9966 | 1288 | 10978 | 1099 | 12017 | 813 | 14623 | 708 | 6201 |
| 2L-3S | | MI | 3281 | 1724 | 4637 | 1461 | 5395 | 1229 | 5749 | 1046 | 5989 | 776 | 6908 | 554 | 3479 |
| 6-#10 | 1.12 | MA | 5729 | 1724 | 7463 | 1543 | 9120 | 1300 | 9952 | 1110 | 10632 | 829 | 12706 | 626 | 6197 |
| 3L-2S | | MI | 3480 | 1724 | 4982 | 1452 | 5833 | 1222 | 6279 | 1041 | 6705 | 767 | 7845 | 646 | 3461 |
| 6-#11 | 1.38 | MA | 6321 | 1774 | 8624 | 1553 | 10536 | 1304 | 11640 | 1107 | 12885 | 806 | 15808 | 700 | 7504 |
| 2L-3S | | MI | 3326 | 1774 | 4830 | 1478 | 5591 | 1239 | 5961 | 1049 | 6255 | 765 | 7178 | 504 | 4157 |
| 6-#11 | 1.38 | MA | 5846 | 1774 | 7816 | 1568 | 9511 | 1318 | 10397 | 1120 | 11208 | 825 | 13484 | 597 | 7487 |
| 3L-2S | | MI | 3557 | 1774 | 5242 | 1469 | 6114 | 1232 | 6595 | 1045 | 7111 | 756 | 8268 | 618 | 4137 |
| 6-#14 | 1.99 | MA | 6786 | 1894 | 9712 | 1622 | 11876 | 1353 | 13244 | 1137 | 15032 | 796 | 18766 | 689 | 10624 |
| 2L-3S | | MI | 3449 | 1894 | 5212 | 1546 | 6040 | 1287 | 6489 | 1076 | 6953 | 754 | 7991 | 410 | 5737 |
| 6-#14 | 1.99 | MA | 6143 | 1894 | 8558 | 1643 | 10412 | 1373 | 11469 | 1155 | 12636 | 822 | 15448 | 537 | 10539 |
| 3L-2S | | MI | 3763 | 1894 | 5795 | 1534 | 6780 | 1278 | 7386 | 1071 | 8163 | 744 | 9501 | 574 | 5733 |
| 6-#18 | 3.53 | MA | 7864 | 2199 | 12379 | 1799 | 15182 | 1482 | 17210 | 1215 | 20351 | 774 | 26104 | 663 | 18311 |
| 2L-3S | | MI | 3749 | 2199 | 6114 | 1720 | 7117 | 1409 | 7760 | 1146 | 8633 | 726 | 9851 | 149 | 9391 |
| 6-#18 | 3.53 | MA | 6857 | 2199 | 10368 | 1836 | 12630 | 1514 | 14117 | 1244 | 16176 | 817 | 20324 | 384 | 17889 |
| 3L-2S | | MI | 4219 | 2199 | 7110 | 1703 | 8381 | 1399 | 9292 | 1144 | 10696 | 715 | 12318 | 439 | 9537 |
| 8-#9 | 1.18 | MA | 6191 | 1735 | 8215 | 1540 | 10094 | 1296 | 11143 | 1104 | 12249 | 815 | 14952 | 709 | 6517 |
| 2L-4S | | MI | 3263 | 1735 | 4556 | 1478 | 5289 | 1248 | 5626 | 1062 | 5825 | 778 | 6770 | 539 | 3652 |
| 8-#9 | 1.18 | MA | 5874 | 1735 | 7687 | 1550 | 9424 | 1305 | 10331 | 1113 | 11153 | 827 | 13435 | 645 | 6514 |
| 3E | | MI | 3354 | 1735 | 4748 | 1471 | 5555 | 1237 | 5951 | 1052 | 6269 | 777 | 7303 | 578 | 3642 |
| 8-#9 | 1.18 | MA | 5699 | 1735 | 7328 | 1561 | 8926 | 1321 | 9720 | 1128 | 10316 | 835 | 12422 | 605 | 6479 |
| 4L-2S | | MI | 3511 | 1735 | 5022 | 1464 | 5902 | 1231 | 6373 | 1048 | 6838 | 770 | 8055 | 651 | 3629 |
| 8-#10 | 1.49 | MA | 6451 | 1797 | 8797 | 1576 | 10812 | 1322 | 12003 | 1120 | 13401 | 810 | 16540 | 703 | 8190 |
| 2L-4S | | MI | 3326 | 1797 | 4740 | 1515 | 5498 | 1276 | 5869 | 1079 | 6144 | 774 | 7179 | 492 | 4513 |
| 8-#10 | 1.49 | MA | 6064 | 1797 | 8130 | 1589 | 9966 | 1334 | 10978 | 1131 | 12017 | 826 | 14623 | 621 | 8172 |
| 3E | | MI | 3438 | 1797 | 4982 | 1507 | 5833 | 1262 | 6279 | 1067 | 6705 | 772 | 7845 | 542 | 4517 |
| 8-#10 | 1.49 | MA | 5850 | 1797 | 7676 | 1602 | 9336 | 1353 | 10204 | 1149 | 10958 | 835 | 13339 | 570 | 8087 |
| 4L-2S | | MI | 3631 | 1797 | 5327 | 1498 | 6270 | 1255 | 6809 | 1062 | 7420 | 764 | 8782 | 634 | 4505 |
| 8-#11 | 1.84 | MA | 6696 | 1865 | 9432 | 1609 | 11562 | 1345 | 12883 | 1133 | 14563 | 801 | 18131 | 694 | 9911 |
| 2L-4S | | MI | 3377 | 1865 | 4951 | 1544 | 5711 | 1296 | 6102 | 1088 | 6437 | 760 | 7489 | 427 | 5367 |
| 8-#11 | 1.84 | MA | 6243 | 1865 | 8624 | 1625 | 10536 | 1359 | 11640 | 1146 | 12885 | 820 | 15808 | 591 | 9873 |
| 3E | | MI | 3509 | 1865 | 5242 | 1535 | 6114 | 1281 | 6595 | 1075 | 7111 | 760 | 8268 | 485 | 5392 |
| 8-#11 | 1.84 | MA | 5991 | 1865 | 8072 | 1640 | 9770 | 1382 | 10701 | 1167 | 11599 | 830 | 14238 | 527 | 9719 |
| 4L-2S | | MI | 3732 | 1865 | 5655 | 1526 | 6637 | 1274 | 7230 | 1071 | 7967 | 752 | 9359 | 599 | 5383 |
| 8-#14 | 2.65 | MA | 7298 | 2025 | 10866 | 1703 | 13341 | 1413 | 15019 | 1175 | 17428 | 790 | 22083 | 681 | 14049 |
| 2L-4S | | MI | 3524 | 2025 | 5381 | 1639 | 6208 | 1367 | 6686 | 1131 | 7208 | 746 | 8416 | 298 | 7075 |
| 8-#14 | 2.65 | MA | 6692 | 2025 | 9712 | 1725 | 11876 | 1433 | 13244 | 1192 | 15032 | 816 | 18766 | 529 | 13934 |
| 3E | | MI | 3701 | 2025 | 5795 | 1627 | 6780 | 1346 | 7386 | 1114 | 8163 | 748 | 9501 | 378 | 7455 |
| 8-#14 | 2.65 | MA | 6357 | 2025 | 8921 | 1746 | 10779 | 1465 | 11899 | 1222 | 13191 | 830 | 16510 | 437 | 13217 |
| 4L-2S | | MI | 4001 | 2025 | 6378 | 1615 | 7521 | 1338 | 8283 | 1109 | 9374 | 738 | 11011 | 542 | 7480 |
| 8-#18 | 4.71 | MA | 7768 | 2430 | 12379 | 1981 | 15182 | 1620 | 17210 | 1311 | 20351 | 806 | 26104 | 369 | 23802 |
| 3E | | MI | 4161 | 2430 | 7110 | 1865 | 8381 | 1515 | 9292 | 1213 | 10696 | 714 | 12318 | 76 | 12087 |
| 8-#18 | 4.71 | MA | 7261 | 2430 | 10995 | 2017 | 13263 | 1674 | 14858 | 1361 | 17133 | 826 | 22122 | 203 | 20812 |
| 4L-2S | | MI | 4592 | 2430 | 8106 | 1848 | 9645 | 1505 | 10824 | 1210 | 12760 | 703 | 14785 | 366 | 12480 |
| 10-#10 | 1.87 | MA | 6762 | 1871 | 9464 | 1622 | 11659 | 1355 | 13029 | 1141 | 14786 | 806 | 18457 | 698 | 10173 |
| 2L-5S | | MI | 3383 | 1871 | 4868 | 1570 | 5639 | 1316 | 6032 | 1105 | 6352 | 778 | 7456 | 426 | 5347 |
| 10-#10 | 1.87 | MA | 6389 | 1871 | 8797 | 1635 | 10812 | 1367 | 12003 | 1152 | 13401 | 822 | 16540 | 616 | 10144 |
| 3L-4S | | MI | 3485 | 1871 | 5084 | 1561 | 5935 | 1310 | 6399 | 1100 | 6860 | 770 | 8116 | 480 | 5529 |
| 10-#10 | 1.87 | MA | 6188 | 1871 | 8343 | 1648 | 10182 | 1387 | 11230 | 1170 | 12342 | 831 | 15256 | 565 | 10047 |
| 4L-3S | | MI | 3592 | 1871 | 5327 | 1553 | 6270 | 1296 | 6809 | 1088 | 7420 | 769 | 8782 | 530 | 5546 |
| 10-#10 | 1.87 | MA | 5932 | 1871 | 7942 | 1661 | 9631 | 1399 | 10545 | 1182 | 11390 | 848 | 13951 | 523 | 9625 |
| 5L-2S | | MI | 3779 | 1871 | 5671 | 1544 | 6708 | 1289 | 7340 | 1084 | 8136 | 760 | 9719 | 622 | 5542 |
| 10-#11 | 2.29 | MA | 6627 | 1955 | 9432 | 1681 | 11562 | 1401 | 12883 | 1172 | 14563 | 816 | 18131 | 585 | 12259 |
| 3L-4S | | MI | 3563 | 1955 | 5363 | 1601 | 6234 | 1337 | 6737 | 1115 | 7294 | 756 | 8579 | 408 | 6573 |

## RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis



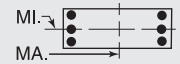

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.29 | MA | 6394 | 1955 | 8880 | 1697 | 10796 | 1423 | 11944 | 1193 | 13277 | 826 | 16561 | 521 | 12091 |
| 4L-3S | | MI | 3688 | 1955 | 5655 | 1591 | 6637 | 1322 | 7230 | 1101 | 7967 | 756 | 9359 | 466 | 6615 |
| 10-#11 | 2.29 | MA | 6092 | 1955 | 8392 | 1712 | 10125 | 1437 | 11110 | 1206 | 12119 | 845 | 14969 | 467 | 11343 |
| 5L-2S | | MI | 3903 | 1955 | 6067 | 1582 | 7161 | 1315 | 7864 | 1097 | 8823 | 748 | 10449 | 580 | 6619 |
| 10-#14 | 3.31 | MA | 7222 | 2155 | 10866 | 1806 | 13341 | 1492 | 15019 | 1230 | 17428 | 810 | 22083 | 520 | 17332 |
| 3L-4S | | MI | 3782 | 2155 | 5964 | 1721 | 6948 | 1427 | 7583 | 1169 | 8419 | 739 | 9926 | 266 | 8688 |
| 10-#14 | 3.31 | MA | 6918 | 2155 | 10075 | 1828 | 12244 | 1524 | 13674 | 1260 | 15587 | 824 | 19827 | 428 | 16556 |
| 4L-3S | | MI | 3957 | 2155 | 6378 | 1709 | 7521 | 1406 | 8283 | 1152 | 9374 | 742 | 11011 | 346 | 9166 |
| 10-#14 | 3.31 | MA | 6498 | 2155 | 9376 | 1850 | 11283 | 1544 | 12481 | 1278 | 13930 | 850 | 17544 | 347 | 15363 |
| 5L-2S | | MI | 4230 | 2155 | 6962 | 1697 | 8261 | 1397 | 9180 | 1147 | 10585 | 732 | 12521 | 510 | 9213 |
| 10-#18 | 5.88 | MA | 8203 | 2662 | 13006 | 2162 | 15815 | 1780 | 17951 | 1428 | 21307 | 815 | 27902 | 187 | 26703 |
| 4L-3S | | MI | 4560 | 2662 | 8106 | 2010 | 9645 | 1621 | 10824 | 1280 | 12760 | 703 | 14785 | 3 | 14776 |
| 10-#18 | 5.88 | MA | 7500 | 2662 | 11778 | 2198 | 14130 | 1813 | 15860 | 1456 | 18405 | 858 | 23888 | 34 | 23742 |
| 5L-2S | | MI | 4958 | 2662 | 9102 | 1992 | 10909 | 1611 | 12356 | 1277 | 14823 | 692 | 17252 | 293 | 15413 |
| 12-#10 | 2.24 | MA | 6706 | 1945 | 9464 | 1681 | 11659 | 1401 | 13029 | 1174 | 14786 | 819 | 18457 | 611 | 12115 |
| 3L-5S | | MI | 3540 | 1945 | 5212 | 1616 | 6077 | 1350 | 6563 | 1127 | 7067 | 775 | 8393 | 414 | 6320 |
| 12-#10 | 2.24 | MA | 6518 | 1945 | 9010 | 1694 | 11028 | 1420 | 12256 | 1192 | 13727 | 828 | 17174 | 560 | 12009 |
| 4E | | MI | 3641 | 1945 | 5429 | 1607 | 6373 | 1343 | 6930 | 1122 | 7576 | 766 | 9053 | 468 | 6541 |
| 12-#10 | 2.24 | MA | 6265 | 1945 | 8609 | 1707 | 10477 | 1432 | 11571 | 1203 | 12775 | 844 | 15868 | 518 | 11564 |
| 5L-3S | | MI | 3743 | 1945 | 5671 | 1599 | 6708 | 1329 | 7340 | 1110 | 8136 | 765 | 9719 | 518 | 6568 |
| 12-#10 | 2.24 | MA | 6003 | 1945 | 8110 | 1721 | 9956 | 1444 | 10901 | 1221 | 11845 | 853 | 14610 | 450 | 11073 |
| 6L-2S | | MI | 3924 | 1945 | 6016 | 1590 | 7145 | 1323 | 7870 | 1105 | 8852 | 757 | 10656 | 610 | 6573 |
| 12-#11 | 2.75 | MA | 6784 | 2045 | 9688 | 1753 | 11821 | 1465 | 13186 | 1219 | 14955 | 822 | 18884 | 515 | 14467 |
| 4E | | MI | 3745 | 2045 | 5775 | 1657 | 6758 | 1379 | 7371 | 1141 | 8150 | 751 | 9669 | 389 | 7721 |
| 12-#11 | 2.75 | MA | 6487 | 2045 | 9200 | 1769 | 11150 | 1479 | 12353 | 1232 | 13797 | 841 | 17292 | 461 | 13696 |
| 5L-3S | | MI | 3863 | 2045 | 6067 | 1648 | 7161 | 1363 | 7864 | 1128 | 8823 | 752 | 10449 | 447 | 7833 |
| 12-#11 | 2.75 | MA | 6178 | 2045 | 8601 | 1786 | 10518 | 1493 | 11538 | 1254 | 12666 | 851 | 15757 | 376 | 13102 |
| 6L-2S | | MI | 4072 | 2045 | 6480 | 1639 | 7684 | 1356 | 8498 | 1123 | 9679 | 743 | 11540 | 561 | 7849 |
| 12-#14 | 3.97 | MA | 7460 | 2286 | 11229 | 1909 | 13708 | 1584 | 15449 | 1298 | 17983 | 817 | 23145 | 419 | 19904 |
| 4E | | MI | 4050 | 2286 | 6547 | 1802 | 7689 | 1486 | 8480 | 1207 | 9630 | 733 | 11436 | 234 | 10317 |
| 12-#14 | 3.97 | MA | 7046 | 2286 | 10530 | 1931 | 12748 | 1603 | 14256 | 1315 | 16326 | 843 | 20861 | 339 | 18756 |
| 5L-3S | | MI | 4195 | 2286 | 6962 | 1790 | 8261 | 1465 | 9180 | 1189 | 10585 | 736 | 12521 | 314 | 10874 |
| 12-#14 | 3.97 | MA | 6630 | 2286 | 9681 | 1956 | 11841 | 1623 | 13088 | 1345 | 14707 | 857 | 18655 | 215 | 17276 |
| 6L-2S | | MI | 4454 | 2286 | 7545 | 1778 | 9001 | 1457 | 10077 | 1184 | 11796 | 726 | 14031 | 478 | 10939 |
| 12-#18 | 7.06 | MA | 8417 | 2894 | 13789 | 2343 | 16682 | 1918 | 18953 | 1523 | 22580 | 847 | 29668 | 19 | 29587 |
| 5L-3S | | MI | 4950 | 2894 | 9102 | 2155 | 10909 | 1727 | 12356 | 1347 | 14823 | 691 | 17252 | -70 | 17118 |
| 14-#10 | 2.61 | MA | 6839 | 2018 | 9677 | 1740 | 11874 | 1454 | 13282 | 1213 | 15111 | 824 | 19091 | 555 | 13974 |
| 4L-5S | | MI | 3694 | 2018 | 5557 | 1662 | 6514 | 1384 | 7093 | 1148 | 7783 | 771 | 9330 | 402 | 7298 |
| 14-#10 | 2.61 | MA | 6589 | 2018 | 9275 | 1753 | 11323 | 1466 | 12597 | 1224 | 14159 | 841 | 17785 | 513 | 13506 |
| 5L-4S | | MI | 3794 | 2018 | 5774 | 1653 | 6810 | 1377 | 7460 | 1143 | 8291 | 763 | 9990 | 456 | 7552 |
| 14-#10 | 2.61 | MA | 6337 | 2018 | 8777 | 1767 | 10802 | 1478 | 11927 | 1242 | 13230 | 850 | 16527 | 445 | 13032 |
| 6L-3S | | MI | 3891 | 2018 | 6016 | 1645 | 7145 | 1363 | 7870 | 1131 | 8852 | 762 | 10656 | 506 | 7588 |
| 14-#10 | 2.61 | MA | 6118 | 2018 | 8353 | 1775 | 10214 | 1492 | 11281 | 1253 | 12328 | 866 | 15298 | 411 | 12398 |
| 7L-2S | | MI | 4067 | 2018 | 6361 | 1636 | 7583 | 1356 | 8400 | 1126 | 9567 | 753 | 11593 | 598 | 7600 |
| 14-#11 | 3.21 | MA | 6870 | 2136 | 10008 | 1825 | 12176 | 1520 | 13596 | 1258 | 15475 | 836 | 19615 | 455 | 16055 |
| 5L-4S | | MI | 3924 | 2136 | 6188 | 1714 | 7281 | 1420 | 8005 | 1167 | 9006 | 747 | 10760 | 370 | 8872 |
| 14-#11 | 3.21 | MA | 6575 | 2136 | 9409 | 1842 | 11543 | 1534 | 12781 | 1280 | 14344 | 846 | 18080 | 370 | 15465 |
| 6L-3S | | MI | 4036 | 2136 | 6480 | 1705 | 7684 | 1405 | 8498 | 1154 | 9679 | 747 | 11540 | 428 | 9047 |
| 14-#11 | 3.21 | MA | 6318 | 2136 | 8893 | 1852 | 10837 | 1552 | 11996 | 1293 | 13247 | 865 | 16576 | 326 | 14518 |
| 7L-2S | | MI | 4237 | 2136 | 6892 | 1695 | 8207 | 1398 | 9132 | 1149 | 10536 | 739 | 12630 | 542 | 9073 |
| 14-#14 | 4.63 | MA | 7577 | 2416 | 11684 | 2013 | 14212 | 1663 | 16031 | 1353 | 18722 | 837 | 24179 | 330 | 22152 |
| 5L-4S | | MI | 4296 | 2416 | 7130 | 1884 | 8429 | 1546 | 9377 | 1244 | 10841 | 727 | 12946 | 202 | 11958 |
| 14-#14 | 4.63 | MA | 7184 | 2416 | 10835 | 2037 | 13305 | 1683 | 14863 | 1383 | 17103 | 851 | 21972 | 207 | 20651 |
| 6L-3S | | MI | 4429 | 2416 | 7545 | 1872 | 9001 | 1525 | 10077 | 1227 | 11796 | 729 | 14031 | 282 | 12580 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis

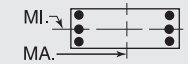



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 4.63 | MA | 6841 | 2416 | 10096 | 2051 | 12306 | 1708 | 13738 | 1401 | 15532 | 877 | 19812 | 140 | 19084 |
| 7L-2S | | MI | 4675 | 2416 | 8128 | 1860 | 9741 | 1517 | 10974 | 1222 | 13007 | 719 | 15542 | 446 | 12661 |
| 16-#10 | 2.99 | MA | 6905 | 2092 | 9942 | 1799 | 12169 | 1500 | 13622 | 1245 | 15544 | 837 | 19702 | 508 | 15452 |
| 5E | | MI | 3846 | 2092 | 5902 | 1708 | 6952 | 1417 | 7623 | 1169 | 8499 | 768 | 10267 | 390 | 8280 |
| 16-#10 | 2.99 | MA | 6663 | 2092 | 9444 | 1813 | 11648 | 1511 | 12953 | 1263 | 14614 | 846 | 18444 | 441 | 14993 |
| 6L-4S | | MI | 3945 | 2092 | 6118 | 1699 | 7248 | 1410 | 7990 | 1164 | 9007 | 759 | 10927 | 444 | 8561 |
| 16-#10 | 2.99 | MA | 6454 | 2092 | 9019 | 1821 | 11061 | 1525 | 12307 | 1274 | 13713 | 862 | 17215 | 406 | 14357 |
| 7L-3S | | MI | 4038 | 2092 | 6361 | 1691 | 7583 | 1397 | 8400 | 1152 | 9567 | 758 | 11593 | 494 | 8605 |
| 16-#10 | 2.99 | MA | 6238 | 2092 | 8612 | 1831 | 10514 | 1534 | 11622 | 1289 | 12827 | 878 | 16027 | 358 | 13681 |
| 8L-2S | | MI | 4209 | 2092 | 6705 | 1682 | 8020 | 1390 | 8930 | 1147 | 10283 | 750 | 12530 | 586 | 8623 |
| 16-#11 | 3.67 | MA | 6962 | 2226 | 10217 | 1899 | 12569 | 1576 | 14024 | 1306 | 16022 | 842 | 20403 | 364 | 17830 |
| 6L-4S | | MI | 4100 | 2226 | 6600 | 1770 | 7804 | 1461 | 8639 | 1193 | 9862 | 743 | 11850 | 351 | 10031 |
| 16-#11 | 3.67 | MA | 6718 | 2226 | 9701 | 1909 | 11863 | 1593 | 13239 | 1319 | 14925 | 861 | 18899 | 320 | 16890 |
| 7L-3S | | MI | 4213 | 2226 | 6892 | 1761 | 8207 | 1446 | 9132 | 1180 | 10536 | 743 | 12630 | 409 | 10260 |
| 16-#11 | 3.67 | MA | 6464 | 2226 | 9205 | 1920 | 11199 | 1603 | 12419 | 1337 | 13848 | 880 | 17450 | 259 | 15873 |
| 8L-2S | | MI | 4399 | 2226 | 7304 | 1752 | 8731 | 1439 | 9767 | 1175 | 11392 | 735 | 13721 | 523 | 10294 |
| 16-#14 | 5.29 | MA | 7722 | 2546 | 11989 | 2119 | 14770 | 1742 | 16638 | 1421 | 19499 | 845 | 25289 | 198 | 24027 |
| 6L-4S | | MI | 4537 | 2546 | 7714 | 1966 | 9169 | 1606 | 10274 | 1282 | 12052 | 721 | 14456 | 170 | 13607 |
| 16-#14 | 5.29 | MA | 7401 | 2546 | 11250 | 2133 | 13770 | 1768 | 15513 | 1438 | 17928 | 871 | 23129 | 132 | 22447 |
| 7L-3S | | MI | 4659 | 2546 | 8128 | 1953 | 9741 | 1585 | 10974 | 1265 | 13007 | 723 | 15542 | 251 | 14286 |
| 18-#10 | 3.36 | MA | 6982 | 2166 | 10111 | 1859 | 12495 | 1545 | 13978 | 1285 | 15999 | 843 | 20361 | 436 | 16956 |
| 6L-5S | | MI | 3995 | 2166 | 6246 | 1754 | 7389 | 1451 | 8153 | 1190 | 9215 | 764 | 11204 | 378 | 9266 |
| 18-#10 | 3.36 | MA | 6782 | 2166 | 9686 | 1867 | 11907 | 1559 | 13333 | 1296 | 15097 | 859 | 19132 | 401 | 16316 |
| 7L-4S | | MI | 4093 | 2166 | 6463 | 1745 | 7685 | 1444 | 8520 | 1185 | 9723 | 756 | 11864 | 432 | 9542 |
| 18-#10 | 3.36 | MA | 6569 | 2166 | 9278 | 1877 | 11361 | 1567 | 12648 | 1310 | 14212 | 875 | 17944 | 353 | 15633 |
| 8L-3S | | MI | 4182 | 2166 | 6705 | 1737 | 8020 | 1430 | 8930 | 1173 | 10283 | 755 | 12530 | 482 | 9621 |
| 18-#10 | 3.36 | MA | 6326 | 2166 | 8882 | 1888 | 10830 | 1577 | 11978 | 1318 | 13311 | 884 | 16776 | 308 | 14839 |
| 9L-2S | | MI | 4349 | 2166 | 7050 | 1728 | 8458 | 1424 | 9460 | 1169 | 10999 | 746 | 13467 | 574 | 9644 |
| 18-#11 | 4.13 | MA | 7108 | 2317 | 10510 | 1965 | 12888 | 1634 | 14482 | 1345 | 16603 | 857 | 21222 | 314 | 19262 |
| 7L-4S | | MI | 4286 | 2317 | 7013 | 1827 | 8328 | 1503 | 9274 | 1219 | 10719 | 738 | 12941 | 332 | 11196 |
| 18-#11 | 4.13 | MA | 6858 | 2317 | 10014 | 1977 | 12224 | 1644 | 13662 | 1363 | 15525 | 875 | 19773 | 253 | 18236 |
| 8L-3S | | MI | 4379 | 2317 | 7304 | 1818 | 8731 | 1487 | 9767 | 1206 | 11392 | 739 | 13721 | 390 | 11471 |
| 18-#14 | 5.96 | MA | 7946 | 2677 | 12404 | 2214 | 15235 | 1827 | 17288 | 1476 | 20324 | 864 | 26447 | 123 | 25809 |
| 7L-4S | | MI | 4774 | 2677 | 8297 | 2047 | 9909 | 1665 | 11171 | 1320 | 13263 | 715 | 15967 | 138 | 15265 |
| 20-#10 | 3.74 | MA | 7103 | 2239 | 10353 | 1913 | 12753 | 1593 | 14359 | 1317 | 16482 | 855 | 21049 | 396 | 18275 |
| 7L-5S | | MI | 4142 | 2239 | 6591 | 1800 | 7826 | 1484 | 8683 | 1212 | 9930 | 761 | 12141 | 366 | 10255 |
| 20-#10 | 3.74 | MA | 6893 | 2239 | 9945 | 1923 | 12207 | 1601 | 13674 | 1331 | 15597 | 871 | 19861 | 348 | 17585 |
| 8L-4S | | MI | 4240 | 2239 | 6808 | 1791 | 8123 | 1478 | 9050 | 1207 | 10438 | 752 | 12801 | 420 | 10518 |
| 20-#10 | 3.74 | MA | 6658 | 2239 | 9549 | 1934 | 11676 | 1610 | 13004 | 1339 | 14696 | 880 | 18693 | 303 | 16794 |
| 9L-3S | | MI | 4333 | 2239 | 7050 | 1783 | 8458 | 1464 | 9460 | 1195 | 10999 | 751 | 13467 | 470 | 10636 |
| 20-#10 | 3.74 | MA | 6441 | 2239 | 9133 | 1941 | 11122 | 1627 | 12348 | 1348 | 13814 | 896 | 17430 | 252 | 15962 |
| 10L-2S | | MI | 4486 | 2239 | 7395 | 1774 | 8895 | 1457 | 9990 | 1190 | 11714 | 743 | 14404 | 562 | 10664 |
| 20-#11 | 4.59 | MA | 7243 | 2407 | 10822 | 2033 | 13250 | 1685 | 14905 | 1389 | 17203 | 871 | 22096 | 247 | 20600 |
| 8L-4S | | MI | 4455 | 2407 | 7425 | 1883 | 8851 | 1544 | 9908 | 1245 | 11575 | 734 | 14031 | 313 | 12366 |
| 22-#10 | 4.11 | MA | 7211 | 2313 | 10612 | 1969 | 13053 | 1635 | 14699 | 1353 | 16981 | 868 | 21778 | 344 | 19537 |
| 8L-5S | | MI | 4287 | 2313 | 6936 | 1846 | 8264 | 1518 | 9214 | 1233 | 10646 | 757 | 13078 | 354 | 11246 |
| 22-#10 | 4.11 | MA | 6984 | 2313 | 10216 | 1980 | 12522 | 1644 | 14029 | 1360 | 16080 | 877 | 20610 | 298 | 18749 |
| 9L-4S | | MI | 4398 | 2313 | 7153 | 1837 | 8560 | 1511 | 9580 | 1228 | 11154 | 749 | 13738 | 408 | 11498 |
| 22-#10 | 4.11 | MA | 6775 | 2313 | 9800 | 1987 | 11969 | 1661 | 13373 | 1369 | 15199 | 893 | 19347 | 247 | 17912 |
| 10L-3S | | MI | 4472 | 2313 | 7395 | 1829 | 8895 | 1498 | 9990 | 1216 | 11714 | 748 | 14404 | 457 | 11650 |
| 24-#10 | 4.48 | MA | 7303 | 2386 | 10883 | 2026 | 13369 | 1678 | 15055 | 1382 | 17465 | 873 | 22527 | 294 | 20704 |
| 9L-5S | | MI | 4442 | 2386 | 7281 | 1892 | 8701 | 1552 | 9744 | 1254 | 11362 | 754 | 14015 | 342 | 12239 |
| 24-#10 | 4.48 | MA | 7102 | 2386 | 10466 | 2033 | 12815 | 1695 | 14399 | 1390 | 16583 | 889 | 21264 | 242 | 19862 |
| 10L-4S | | MI | 4540 | 2386 | 7497 | 1883 | 8998 | 1545 | 10111 | 1249 | 11870 | 745 | 14675 | 396 | 12481 |

## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

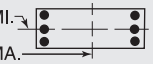
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.25 | MA | 6971 | 1852 | 9415 | 1628 | 11496 | 1369 | 12669 | 1165 | 13935 | 855 | 17016 | 744 | 7672 |
| 2E | | MI | 3697 | 1852 | 5450 | 1528 | 6308 | 1283 | 6765 | 1090 | 7219 | 795 | 8283 | 645 | 3991 |
| 4-#18 | 2.22 | MA | 7788 | 2055 | 11360 | 1743 | 13880 | 1451 | 15515 | 1214 | 17738 | 838 | 22253 | 724 | 13216 |
| 2E | | MI | 4016 | 2055 | 6356 | 1632 | 7387 | 1357 | 8036 | 1132 | 8898 | 771 | 10140 | 551 | 6601 |
| 6-#10 | 1.06 | MA | 6834 | 1812 | 8954 | 1618 | 11014 | 1363 | 12138 | 1164 | 13264 | 866 | 16122 | 754 | 6612 |
| 2L-3S | | MI | 3458 | 1812 | 4869 | 1538 | 5661 | 1294 | 6025 | 1103 | 6257 | 821 | 7204 | 594 | 3498 |
| 6-#10 | 1.06 | MA | 6399 | 1812 | 8241 | 1632 | 10110 | 1376 | 11041 | 1176 | 11784 | 882 | 14072 | 673 | 6609 |
| 3L-2S | | MI | 3658 | 1812 | 5214 | 1530 | 6099 | 1288 | 6555 | 1098 | 6973 | 813 | 8141 | 686 | 3479 |
| 6-#11 | 1.30 | MA | 7041 | 1863 | 9484 | 1641 | 11627 | 1379 | 12850 | 1173 | 14198 | 858 | 17395 | 746 | 8010 |
| 2L-3S | | MI | 3502 | 1863 | 5066 | 1555 | 5858 | 1304 | 6237 | 1106 | 6522 | 810 | 7472 | 544 | 4181 |
| 6-#11 | 1.30 | MA | 6527 | 1863 | 8619 | 1657 | 10530 | 1394 | 11520 | 1186 | 12403 | 878 | 14909 | 644 | 7992 |
| 3L-2S | | MI | 3735 | 1863 | 5478 | 1546 | 6381 | 1298 | 6871 | 1102 | 7378 | 801 | 8562 | 657 | 4159 |
| 6-#14 | 1.88 | MA | 7547 | 1983 | 10650 | 1710 | 13064 | 1429 | 14570 | 1203 | 16500 | 849 | 20568 | 735 | 11353 |
| 2L-3S | | MI | 3625 | 1983 | 5450 | 1621 | 6308 | 1351 | 6765 | 1133 | 7219 | 799 | 8283 | 449 | 5771 |
| 6-#14 | 1.88 | MA | 6849 | 1983 | 9415 | 1732 | 11496 | 1449 | 12669 | 1221 | 13935 | 876 | 17016 | 586 | 11268 |
| 3L-2S | | MI | 3941 | 1983 | 6033 | 1609 | 7049 | 1343 | 7662 | 1128 | 8430 | 789 | 9793 | 613 | 5760 |
| 6-#18 | 3.33 | MA | 8721 | 2287 | 13516 | 1888 | 16615 | 1557 | 18831 | 1281 | 22213 | 827 | 28450 | 709 | 19607 |
| 2L-3S | | MI | 3925 | 2287 | 6356 | 1794 | 7387 | 1473 | 8036 | 1202 | 8898 | 770 | 10140 | 187 | 9453 |
| 6-#18 | 3.33 | MA | 7627 | 2287 | 11360 | 1925 | 13880 | 1591 | 15515 | 1311 | 17738 | 872 | 22253 | 436 | 19185 |
| 3L-2S | | MI | 4400 | 2287 | 7352 | 1777 | 8651 | 1463 | 9568 | 1199 | 10961 | 759 | 12607 | 478 | 9576 |
| 8-#9 | 1.11 | MA | 6897 | 1823 | 9043 | 1628 | 11150 | 1371 | 12313 | 1170 | 13511 | 867 | 16471 | 755 | 6949 |
| 2L-4S | | MI | 3440 | 1823 | 4787 | 1556 | 5554 | 1314 | 5902 | 1120 | 6093 | 824 | 7066 | 579 | 3673 |
| 8-#9 | 1.11 | MA | 6555 | 1823 | 8479 | 1639 | 10434 | 1381 | 11446 | 1179 | 12340 | 880 | 14850 | 691 | 6946 |
| 3E | | MI | 3531 | 1823 | 4979 | 1549 | 5820 | 1303 | 6227 | 1110 | 6538 | 823 | 7600 | 619 | 3660 |
| 8-#9 | 1.11 | MA | 6366 | 1823 | 8097 | 1650 | 9902 | 1397 | 10794 | 1194 | 11447 | 888 | 13774 | 652 | 6911 |
| 4L-2S | | MI | 3689 | 1823 | 5253 | 1542 | 6168 | 1298 | 6648 | 1106 | 7107 | 816 | 8352 | 691 | 3646 |
| 8-#10 | 1.41 | MA | 7179 | 1886 | 9667 | 1664 | 11919 | 1397 | 13234 | 1186 | 14744 | 862 | 18171 | 749 | 8739 |
| 2L-4S | | MI | 3503 | 1886 | 4972 | 1593 | 5764 | 1342 | 6145 | 1137 | 6412 | 819 | 7475 | 533 | 4541 |
| 8-#10 | 1.41 | MA | 6761 | 1886 | 8954 | 1678 | 11014 | 1410 | 12138 | 1197 | 13264 | 879 | 16122 | 668 | 8721 |
| 3E | | MI | 3616 | 1886 | 5214 | 1584 | 6099 | 1328 | 6555 | 1125 | 6973 | 818 | 8141 | 582 | 4539 |
| 8-#10 | 1.41 | MA | 6530 | 1886 | 8470 | 1691 | 10341 | 1429 | 11313 | 1216 | 12134 | 888 | 14758 | 617 | 8635 |
| 4L-2S | | MI | 3809 | 1886 | 5559 | 1576 | 6536 | 1321 | 7085 | 1120 | 7688 | 810 | 9078 | 674 | 4525 |
| 8-#11 | 1.73 | MA | 7447 | 1953 | 10349 | 1698 | 12724 | 1421 | 14180 | 1199 | 15993 | 854 | 19881 | 740 | 10585 |
| 2L-4S | | MI | 3553 | 1953 | 5186 | 1621 | 5978 | 1361 | 6378 | 1145 | 6705 | 805 | 7782 | 467 | 5404 |
| 8-#11 | 1.73 | MA | 6956 | 1953 | 9484 | 1714 | 11627 | 1435 | 12850 | 1212 | 14198 | 873 | 17395 | 638 | 10547 |
| 3E | | MI | 3686 | 1953 | 5478 | 1611 | 6381 | 1346 | 6871 | 1132 | 7378 | 805 | 8562 | 525 | 5419 |
| 8-#11 | 1.73 | MA | 6685 | 1953 | 8895 | 1730 | 10809 | 1458 | 11847 | 1234 | 12824 | 884 | 15727 | 576 | 10393 |
| 4L-2S | | MI | 3911 | 1953 | 5890 | 1602 | 6905 | 1339 | 7506 | 1128 | 8234 | 797 | 9653 | 638 | 5407 |
| 8-#14 | 2.50 | MA | 8102 | 2113 | 11886 | 1792 | 14632 | 1488 | 16470 | 1240 | 19065 | 842 | 24119 | 726 | 15021 |
| 2L-4S | | MI | 3700 | 2113 | 5619 | 1715 | 6477 | 1432 | 6962 | 1188 | 7474 | 790 | 8708 | 337 | 7177 |
| 8-#14 | 2.50 | MA | 7444 | 2113 | 10650 | 1814 | 13064 | 1509 | 14570 | 1259 | 16500 | 870 | 20568 | 577 | 14906 |
| 3E | | MI | 3878 | 2113 | 6033 | 1703 | 7049 | 1411 | 7662 | 1170 | 8430 | 793 | 9793 | 418 | 7493 |
| 8-#14 | 2.50 | MA | 7082 | 2113 | 9807 | 1836 | 11893 | 1542 | 13133 | 1290 | 14534 | 884 | 18169 | 486 | 14274 |
| 4L-2S | | MI | 4180 | 2113 | 6616 | 1691 | 7789 | 1402 | 8559 | 1165 | 9641 | 783 | 11304 | 581 | 7510 |
| 8-#18 | 4.44 | MA | 8613 | 2519 | 13516 | 2070 | 16615 | 1697 | 18831 | 1378 | 22213 | 861 | 28450 | 420 | 25530 |
| 3E | | MI | 4338 | 2519 | 7352 | 1939 | 8651 | 1579 | 9568 | 1269 | 10961 | 759 | 12607 | 114 | 12253 |
| 8-#18 | 4.44 | MA | 8063 | 2519 | 12036 | 2108 | 14563 | 1753 | 16315 | 1431 | 18771 | 883 | 24215 | 255 | 22451 |
| 4L-2S | | MI | 4775 | 2519 | 8348 | 1922 | 9915 | 1569 | 11100 | 1266 | 13025 | 748 | 15074 | 405 | 12523 |
| 10-#10 | 1.76 | MA | 7516 | 1959 | 10379 | 1710 | 12824 | 1431 | 14331 | 1207 | 16224 | 859 | 20220 | 744 | 10859 |
| 2L-5S | | MI | 3560 | 1959 | 5100 | 1647 | 5905 | 1382 | 6308 | 1163 | 6620 | 824 | 7752 | 466 | 5413 |
| 10-#10 | 1.76 | MA | 7112 | 1959 | 9667 | 1724 | 11919 | 1443 | 13234 | 1219 | 14744 | 875 | 18171 | 663 | 10830 |
| 3L-4S | | MI | 3662 | 1959 | 5317 | 1639 | 6201 | 1375 | 6675 | 1158 | 7128 | 816 | 8412 | 521 | 5559 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

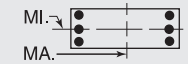
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.76 | MA | 6895 | 1959 | 9182 | 1737 | 11246 | 1463 | 12409 | 1237 | 13614 | 885 | 16807 | 612 | 10733 |
| 4L-3S | | MI | 3770 | 1959 | 5559 | 1630 | 6536 | 1362 | 7085 | 1146 | 7688 | 814 | 9078 | 570 | 5570 |
| 10-#10 | 1.76 | MA | 6616 | 1959 | 8751 | 1750 | 10658 | 1475 | 11679 | 1249 | 12599 | 902 | 15417 | 572 | 10343 |
| 5L-2S | | MI | 3958 | 1959 | 5904 | 1622 | 6974 | 1355 | 7615 | 1141 | 8404 | 806 | 10015 | 662 | 5563 |
| 10-#11 | 2.17 | MA | 7372 | 2043 | 10349 | 1770 | 12724 | 1476 | 14180 | 1238 | 15993 | 869 | 19881 | 632 | 13101 |
| 3L-4S | | MI | 3740 | 2043 | 5599 | 1677 | 6502 | 1403 | 7013 | 1171 | 7561 | 801 | 8873 | 448 | 6613 |
| 10-#11 | 2.17 | MA | 7120 | 2043 | 9760 | 1786 | 11906 | 1500 | 13177 | 1260 | 14619 | 880 | 18212 | 570 | 12934 |
| 4L-3S | | MI | 3865 | 2043 | 5890 | 1668 | 6905 | 1387 | 7506 | 1158 | 8234 | 801 | 9653 | 506 | 6646 |
| 10-#11 | 2.17 | MA | 6790 | 2043 | 9239 | 1802 | 11191 | 1514 | 12288 | 1274 | 13384 | 900 | 16517 | 518 | 12194 |
| 5L-2S | | MI | 4083 | 2043 | 6303 | 1659 | 7428 | 1380 | 8140 | 1154 | 9090 | 793 | 10743 | 619 | 6646 |
| 10-#14 | 3.13 | MA | 8018 | 2243 | 11886 | 1895 | 14632 | 1568 | 16470 | 1297 | 19065 | 863 | 24119 | 569 | 18547 |
| 3L-4S | | MI | 3958 | 2243 | 6202 | 1797 | 7217 | 1491 | 7859 | 1225 | 8685 | 784 | 10218 | 305 | 8787 |
| 10-#14 | 3.13 | MA | 7689 | 2243 | 11042 | 1918 | 13461 | 1601 | 15034 | 1328 | 17099 | 878 | 21721 | 477 | 17858 |
| 4L-3S | | MI | 4135 | 2243 | 6616 | 1785 | 7789 | 1471 | 8559 | 1208 | 9641 | 787 | 11304 | 386 | 9207 |
| 10-#14 | 3.13 | MA | 7229 | 2243 | 10296 | 1940 | 12435 | 1622 | 13760 | 1346 | 15329 | 905 | 19288 | 400 | 16525 |
| 5L-2S | | MI | 4412 | 2243 | 7200 | 1772 | 8529 | 1462 | 9456 | 1203 | 10852 | 777 | 12814 | 549 | 9246 |
| 10-#18 | 5.56 | MA | 9082 | 2751 | 14192 | 2253 | 17299 | 1859 | 19631 | 1498 | 23247 | 872 | 30411 | 240 | 28756 |
| 4L-3S | | MI | 4737 | 2751 | 8348 | 2084 | 9915 | 1685 | 11100 | 1336 | 13025 | 747 | 15074 | 41 | 14936 |
| 10-#18 | 5.56 | MA | 8312 | 2751 | 12882 | 2291 | 15500 | 1893 | 17397 | 1528 | 20145 | 917 | 26132 | 93 | 25703 |
| 5L-2S | | MI | 5142 | 2751 | 9344 | 2067 | 11179 | 1675 | 12632 | 1333 | 15088 | 736 | 17541 | 332 | 15458 |
| 12-#10 | 2.12 | MA | 7455 | 2033 | 10379 | 1770 | 12824 | 1477 | 14331 | 1240 | 16224 | 872 | 20220 | 658 | 12938 |
| 3L-5S | | MI | 3717 | 2033 | 5445 | 1693 | 6343 | 1416 | 6838 | 1184 | 7336 | 821 | 8689 | 454 | 6384 |
| 12-#10 | 2.12 | MA | 7251 | 2033 | 9895 | 1783 | 12151 | 1496 | 13506 | 1258 | 15094 | 881 | 18857 | 608 | 12832 |
| 4E | | MI | 3818 | 2033 | 5661 | 1685 | 6639 | 1409 | 7205 | 1179 | 7844 | 812 | 9349 | 508 | 6573 |
| 12-#10 | 2.12 | MA | 6976 | 2033 | 9464 | 1796 | 11563 | 1509 | 12776 | 1270 | 14079 | 898 | 17467 | 567 | 12418 |
| 5L-3S | | MI | 3921 | 2033 | 5904 | 1676 | 6974 | 1395 | 7615 | 1167 | 8404 | 811 | 10015 | 558 | 6595 |
| 12-#10 | 2.12 | MA | 6693 | 2033 | 8932 | 1810 | 11002 | 1521 | 12062 | 1288 | 13088 | 908 | 16128 | 501 | 11875 |
| 6L-2S | | MI | 4104 | 2033 | 6248 | 1668 | 7411 | 1389 | 8146 | 1162 | 9120 | 802 | 10952 | 650 | 6596 |
| 12-#11 | 2.60 | MA | 7542 | 2134 | 10624 | 1843 | 13003 | 1541 | 14507 | 1286 | 16415 | 876 | 20698 | 564 | 15478 |
| 4E | | MI | 3922 | 2134 | 6011 | 1734 | 7025 | 1444 | 7647 | 1197 | 8417 | 797 | 9963 | 429 | 7803 |
| 12-#11 | 2.60 | MA | 7217 | 2134 | 10104 | 1859 | 12288 | 1556 | 13618 | 1300 | 15179 | 895 | 19003 | 512 | 14716 |
| 5L-3S | | MI | 4042 | 2134 | 6303 | 1724 | 7428 | 1428 | 8140 | 1184 | 9090 | 797 | 10743 | 487 | 7866 |
| 12-#11 | 2.60 | MA | 6884 | 2134 | 9459 | 1875 | 11614 | 1570 | 12748 | 1322 | 13973 | 906 | 17370 | 428 | 14089 |
| 6L-2S | | MI | 4252 | 2134 | 6715 | 1715 | 7951 | 1422 | 8774 | 1180 | 9947 | 789 | 11834 | 600 | 7878 |
| 12-#14 | 3.75 | MA | 8275 | 2374 | 12278 | 1999 | 15029 | 1661 | 16934 | 1365 | 19664 | 872 | 25273 | 469 | 21451 |
| 4E | | MI | 4226 | 2374 | 6785 | 1878 | 7957 | 1551 | 8756 | 1263 | 9896 | 778 | 11728 | 273 | 10413 |
| 12-#14 | 3.75 | MA | 7822 | 2374 | 11532 | 2022 | 14003 | 1681 | 15661 | 1384 | 17895 | 899 | 22840 | 391 | 20162 |
| 5L-3S | | MI | 4374 | 2374 | 7200 | 1866 | 8529 | 1530 | 9456 | 1246 | 10852 | 780 | 12814 | 354 | 10917 |
| 12-#14 | 3.75 | MA | 7373 | 2374 | 10616 | 2046 | 13036 | 1702 | 14415 | 1415 | 16166 | 914 | 20495 | 268 | 18639 |
| 6L-2S | | MI | 4637 | 2374 | 7783 | 1854 | 9269 | 1522 | 10353 | 1241 | 12063 | 770 | 14324 | 517 | 10974 |
| 12-#18 | 6.67 | MA | 9303 | 2983 | 15037 | 2435 | 18235 | 1999 | 20713 | 1595 | 24620 | 906 | 32329 | 78 | 31970 |
| 5L-3S | | MI | 5128 | 2983 | 9344 | 2229 | 11179 | 1791 | 12632 | 1403 | 15088 | 735 | 17541 | -32 | 17482 |
| 12-#18 | 6.67 | MA | 8601 | 2983 | 13460 | 2480 | 16537 | 2033 | 18527 | 1647 | 21589 | 929 | 28186 | -143 | 27610 |
| 6L-2S | | MI | 5506 | 2983 | 10340 | 2212 | 12443 | 1781 | 14164 | 1400 | 17151 | 724 | 20008 | 259 | 18386 |
| 14-#10 | 2.47 | MA | 7598 | 2107 | 10608 | 1829 | 13055 | 1530 | 14602 | 1280 | 16574 | 878 | 20906 | 603 | 14934 |
| 4L-5S | | MI | 3872 | 2107 | 5789 | 1739 | 6780 | 1449 | 7369 | 1205 | 8051 | 817 | 9626 | 442 | 7361 |
| 14-#10 | 2.47 | MA | 7326 | 2107 | 10177 | 1842 | 12468 | 1542 | 13872 | 1291 | 15559 | 895 | 19516 | 562 | 14497 |
| 5L-4S | | MI | 3972 | 2107 | 6006 | 1731 | 7076 | 1443 | 7735 | 1200 | 8559 | 809 | 10286 | 496 | 7586 |
| 14-#10 | 2.47 | MA | 7054 | 2107 | 9645 | 1856 | 11907 | 1554 | 13158 | 1310 | 14568 | 904 | 18177 | 496 | 13971 |
| 6L-3S | | MI | 4070 | 2107 | 6248 | 1722 | 7411 | 1429 | 8146 | 1188 | 9120 | 807 | 10952 | 546 | 7616 |
| 14-#10 | 2.47 | MA | 6818 | 2107 | 9191 | 1865 | 11280 | 1568 | 12467 | 1321 | 13607 | 921 | 16873 | 462 | 13338 |
| 7L-2S | | MI | 4248 | 2107 | 6593 | 1714 | 7849 | 1422 | 8676 | 1184 | 9835 | 799 | 11889 | 638 | 7625 |
| 14-#11 | 3.03 | MA | 7632 | 2224 | 10969 | 1915 | 13385 | 1597 | 14948 | 1326 | 16975 | 891 | 21488 | 506 | 17243 |
| 5L-4S | | MI | 4101 | 2224 | 6423 | 1790 | 7548 | 1485 | 8281 | 1224 | 9273 | 792 | 11054 | 410 | 8953 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis

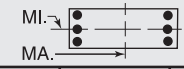



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 3.03 | MA | 7313 | 2224 | 10323 | 1932 | 12711 | 1612 | 14078 | 1348 | 15768 | 902 | 19855 | 422 | 16639 |
| 6L-3S | | MI | 4215 | 2224 | 6715 | 1781 | 7951 | 1470 | 8774 | 1210 | 9947 | 793 | 11834 | 468 | 9082 |
| 14-#11 | 3.03 | MA | 7036 | 2224 | 9772 | 1942 | 11949 | 1629 | 13241 | 1361 | 14598 | 921 | 18257 | 379 | 15625 |
| 7L-2S | | MI | 4420 | 2224 | 7128 | 1772 | 8475 | 1463 | 9408 | 1206 | 10803 | 784 | 12924 | 581 | 9103 |
| 14-#14 | 4.38 | MA | 8396 | 2504 | 12767 | 2103 | 15571 | 1741 | 17561 | 1421 | 20460 | 893 | 26392 | 383 | 23796 |
| 5L-4S | | MI | 4473 | 2504 | 7368 | 1960 | 8697 | 1611 | 9653 | 1301 | 11107 | 772 | 13239 | 241 | 12051 |
| 14-#14 | 4.38 | MA | 7971 | 2504 | 11851 | 2127 | 14604 | 1761 | 16315 | 1452 | 18732 | 908 | 24047 | 260 | 22253 |
| 6L-3S | | MI | 4609 | 2504 | 7783 | 1948 | 9269 | 1590 | 10353 | 1283 | 12063 | 774 | 14324 | 322 | 12624 |
| 14-#14 | 4.38 | MA | 7601 | 2504 | 11062 | 2142 | 13524 | 1786 | 15115 | 1471 | 17055 | 935 | 21749 | 197 | 20651 |
| 7L-2S | | MI | 4860 | 2504 | 8366 | 1935 | 10009 | 1581 | 11250 | 1278 | 13274 | 764 | 15834 | 485 | 12697 |
| 14-#18 | 7.78 | MA | 9610 | 3215 | 15615 | 2625 | 19273 | 2139 | 21842 | 1714 | 26065 | 918 | 34382 | -158 | 33494 |
| 6L-3S | | MI | 5512 | 3215 | 10340 | 2374 | 12443 | 1897 | 14164 | 1470 | 17151 | 723 | 20008 | -105 | 19788 |
| 16-#10 | 2.82 | MA | 7668 | 2180 | 10889 | 1888 | 13372 | 1576 | 14968 | 1312 | 17039 | 891 | 21565 | 557 | 16580 |
| 5E | | MI | 4023 | 2180 | 6134 | 1785 | 7217 | 1483 | 7899 | 1227 | 8767 | 814 | 10563 | 430 | 8342 |
| 16-#10 | 2.82 | MA | 7406 | 2180 | 10357 | 1902 | 12811 | 1588 | 14255 | 1331 | 16048 | 901 | 20227 | 491 | 16070 |
| 6L-4S | | MI | 4123 | 2180 | 6351 | 1777 | 7514 | 1476 | 8266 | 1222 | 9275 | 805 | 11223 | 484 | 8597 |
| 16-#10 | 2.82 | MA | 7180 | 2180 | 9904 | 1911 | 12184 | 1602 | 13564 | 1342 | 15087 | 917 | 18922 | 457 | 15432 |
| 7L-3S | | MI | 4217 | 2180 | 6593 | 1768 | 7849 | 1463 | 8676 | 1210 | 9835 | 804 | 11889 | 534 | 8634 |
| 16-#10 | 2.82 | MA | 6945 | 2180 | 9469 | 1921 | 11602 | 1611 | 12828 | 1356 | 14128 | 927 | 17659 | 411 | 14741 |
| 8L-2S | | MI | 4390 | 2180 | 6938 | 1760 | 8286 | 1456 | 9206 | 1205 | 10551 | 795 | 12826 | 626 | 8649 |
| 16-#11 | 3.47 | MA | 7731 | 2315 | 11188 | 1988 | 13808 | 1653 | 15408 | 1374 | 17563 | 898 | 22341 | 416 | 19190 |
| 6L-4S | | MI | 4278 | 2315 | 6836 | 1847 | 8072 | 1527 | 8915 | 1250 | 10130 | 788 | 12144 | 391 | 10110 |
| 16-#11 | 3.47 | MA | 7468 | 2315 | 10637 | 1999 | 13046 | 1670 | 14571 | 1388 | 16393 | 917 | 20743 | 373 | 18164 |
| 7L-3S | | MI | 4393 | 2315 | 7128 | 1838 | 8475 | 1511 | 9408 | 1237 | 10803 | 788 | 12924 | 449 | 10296 |
| 16-#11 | 3.47 | MA | 7190 | 2315 | 10108 | 2011 | 12338 | 1680 | 13685 | 1405 | 15244 | 937 | 19201 | 314 | 17132 |
| 8L-2S | | MI | 4582 | 2315 | 7540 | 1828 | 8998 | 1504 | 10043 | 1232 | 11659 | 780 | 14015 | 562 | 10326 |
| 16-#14 | 5.00 | MA | 8552 | 2635 | 13087 | 2209 | 16172 | 1821 | 18216 | 1490 | 21297 | 902 | 27599 | 251 | 25867 |
| 6L-4S | | MI | 4715 | 2635 | 7952 | 2041 | 9437 | 1670 | 10550 | 1338 | 12318 | 766 | 14749 | 209 | 13699 |
| 16-#14 | 5.00 | MA | 8205 | 2635 | 12298 | 2223 | 15092 | 1846 | 17015 | 1509 | 19620 | 929 | 25300 | 188 | 24252 |
| 7L-3S | | MI | 4840 | 2635 | 8366 | 2029 | 10009 | 1649 | 11250 | 1321 | 13274 | 768 | 15834 | 290 | 14331 |
| 16-#14 | 5.00 | MA | 7817 | 2635 | 11540 | 2240 | 14077 | 1860 | 15760 | 1535 | 17974 | 956 | 23086 | 100 | 22633 |
| 8L-2S | | MI | 5079 | 2635 | 8949 | 2017 | 10749 | 1641 | 12147 | 1316 | 14485 | 758 | 17344 | 453 | 14417 |
| 18-#10 | 3.17 | MA | 7750 | 2254 | 11070 | 1948 | 13716 | 1621 | 15351 | 1352 | 17528 | 897 | 22276 | 486 | 18170 |
| 6L-5S | | MI | 4173 | 2254 | 6479 | 1831 | 7655 | 1517 | 8429 | 1248 | 9483 | 810 | 11500 | 418 | 9327 |
| 18-#10 | 3.17 | MA | 7534 | 2254 | 10617 | 1957 | 13089 | 1636 | 14660 | 1363 | 16567 | 914 | 20972 | 452 | 17527 |
| 7L-4S | | MI | 4272 | 2254 | 6695 | 1823 | 7951 | 1510 | 8796 | 1243 | 9991 | 802 | 12160 | 472 | 9607 |
| 18-#10 | 3.17 | MA | 7302 | 2254 | 10182 | 1967 | 12506 | 1644 | 13925 | 1378 | 15608 | 924 | 19709 | 406 | 16837 |
| 8L-3S | | MI | 4362 | 2254 | 6938 | 1814 | 8286 | 1496 | 9206 | 1231 | 10551 | 800 | 12826 | 522 | 9651 |
| 18-#10 | 3.17 | MA | 7040 | 2254 | 9756 | 1977 | 11940 | 1654 | 13210 | 1386 | 14664 | 940 | 18469 | 361 | 15978 |
| 9L-2S | | MI | 4531 | 2254 | 7282 | 1806 | 8723 | 1490 | 9736 | 1226 | 11267 | 792 | 13763 | 614 | 9671 |
| 18-#11 | 3.90 | MA | 7889 | 2405 | 11502 | 2055 | 14144 | 1711 | 15901 | 1414 | 18189 | 913 | 23228 | 367 | 20702 |
| 7L-4S | | MI | 4464 | 2405 | 7248 | 1903 | 8595 | 1568 | 9550 | 1276 | 10986 | 784 | 13235 | 372 | 11273 |
| 18-#11 | 3.90 | MA | 7615 | 2405 | 10972 | 2067 | 13435 | 1722 | 15015 | 1431 | 17040 | 932 | 21686 | 308 | 19661 |
| 8L-3S | | MI | 4560 | 2405 | 7540 | 1894 | 8998 | 1552 | 10043 | 1263 | 11659 | 784 | 14015 | 430 | 11508 |
| 18-#11 | 3.90 | MA | 7307 | 2405 | 10459 | 2080 | 12746 | 1733 | 14146 | 1441 | 15871 | 943 | 20167 | 252 | 18641 |
| 9L-2S | | MI | 4742 | 2405 | 7952 | 1885 | 9521 | 1546 | 10677 | 1258 | 12515 | 776 | 15105 | 543 | 11545 |
| 18-#14 | 5.63 | MA | 8794 | 2765 | 13533 | 2305 | 16660 | 1906 | 18915 | 1546 | 22186 | 923 | 28852 | 179 | 27852 |
| 7L-4S | | MI | 4952 | 2765 | 8535 | 2123 | 10177 | 1730 | 11447 | 1376 | 13529 | 759 | 16259 | 178 | 15354 |
| 18-#14 | 5.63 | MA | 8411 | 2765 | 12775 | 2322 | 15645 | 1920 | 17661 | 1572 | 20539 | 950 | 26638 | 92 | 26234 |
| 8L-3S | | MI | 5068 | 2765 | 8949 | 2111 | 10749 | 1709 | 12147 | 1359 | 14485 | 762 | 17344 | 258 | 16038 |
| 20-#10 | 3.53 | MA | 7881 | 2328 | 11330 | 2003 | 13994 | 1669 | 15757 | 1385 | 18047 | 910 | 23021 | 447 | 19621 |
| 7L-5S | | MI | 4321 | 2328 | 6823 | 1877 | 8092 | 1550 | 8959 | 1269 | 10198 | 807 | 12437 | 406 | 10315 |
| 20-#10 | 3.53 | MA | 7652 | 2328 | 10895 | 2013 | 13411 | 1678 | 15021 | 1399 | 17088 | 920 | 21758 | 401 | 18933 |
| 8L-4S | | MI | 4419 | 2328 | 7040 | 1869 | 8389 | 1544 | 9326 | 1264 | 10706 | 798 | 13097 | 460 | 10586 |
| 20-#10 | 3.53 | MA | 7398 | 2328 | 10469 | 2023 | 12845 | 1688 | 14307 | 1407 | 16144 | 937 | 20518 | 356 | 18068 |
| 9L-3S | | MI | 4506 | 2328 | 7282 | 1860 | 8723 | 1530 | 9736 | 1252 | 11267 | 797 | 13763 | 510 | 10666 |
| 20-#10 | 3.53 | MA | 7164 | 2328 | 10024 | 2031 | 12254 | 1705 | 13607 | 1416 | 15192 | 952 | 19176 | 306 | 17224 |
| 10L-2S | | MI | 4671 | 2328 | 7627 | 1852 | 9161 | 1523 | 10266 | 1247 | 11982 | 788 | 14700 | 602 | 10692 |

## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 4.33 | MA | 8031 | 2496 | 11837 | 2124 | 14532 | 1763 | 16345 | 1458 | 18835 | 928 | 24172 | 302 | 22191 |
| 8L-4S | | MI | 4635 | 2496 | 7661 | 1960 | 9118 | 1609 | 10184 | 1302 | 11842 | 779 | 14325 | 353 | 12441 |
| 20-#11 | 4.33 | MA | 7735 | 2496 | 11323 | 2137 | 13843 | 1774 | 15475 | 1467 | 17666 | 939 | 22653 | 246 | 21163 |
| 9L-3S | | MI | 4725 | 2496 | 7952 | 1951 | 9521 | 1594 | 10677 | 1289 | 12515 | 780 | 15105 | 411 | 12720 |
| 20-#14 | 6.25 | MA | 8990 | 2896 | 14011 | 2403 | 17213 | 1979 | 19561 | 1610 | 23104 | 944 | 30190 | 83 | 29824 |
| 8L-4S | | MI | 5186 | 2896 | 9118 | 2204 | 10918 | 1789 | 12345 | 1414 | 14740 | 753 | 17769 | 146 | 17016 |
| 22-#10 | 3.88 | MA | 7995 | 2401 | 11608 | 2059 | 14316 | 1712 | 16118 | 1420 | 18568 | 917 | 23807 | 396 | 21024 |
| 8L-5S | | MI | 4467 | 2401 | 7168 | 1923 | 8530 | 1584 | 9489 | 1290 | 10914 | 803 | 13374 | 394 | 11305 |
| 22-#10 | 3.88 | MA | 7750 | 2401 | 11182 | 2069 | 13749 | 1721 | 15403 | 1429 | 17624 | 933 | 22568 | 351 | 20158 |
| 9L-4S | | MI | 4565 | 2401 | 7385 | 1915 | 8826 | 1577 | 9856 | 1285 | 11422 | 795 | 14034 | 448 | 11565 |
| 22-#10 | 3.88 | MA | 7524 | 2401 | 10737 | 2077 | 13159 | 1739 | 14704 | 1438 | 16672 | 949 | 21225 | 301 | 19309 |
| 10L-3S | | MI | 4654 | 2401 | 7627 | 1906 | 9161 | 1564 | 10266 | 1273 | 11982 | 793 | 14700 | 498 | 11681 |
| 22-#11 | 4.77 | MA | 8153 | 2586 | 12188 | 2193 | 14940 | 1815 | 16805 | 1493 | 19461 | 935 | 25139 | 240 | 23685 |
| 9L-4S | | MI | 4803 | 2586 | 8073 | 2016 | 9642 | 1651 | 10818 | 1328 | 12698 | 775 | 15415 | 334 | 13614 |
| 24-#10 | 4.23 | MA | 8094 | 2475 | 11894 | 2116 | 14654 | 1755 | 16500 | 1450 | 19104 | 930 | 24617 | 346 | 22249 |
| 9L-5S | | MI | 4622 | 2475 | 7513 | 1969 | 8967 | 1618 | 10020 | 1312 | 11630 | 800 | 14311 | 382 | 12298 |
| 24-#10 | 4.23 | MA | 7877 | 2475 | 11450 | 2123 | 14064 | 1772 | 15800 | 1459 | 18152 | 945 | 23274 | 296 | 21394 |
| 10L-4S | | MI | 4720 | 2475 | 7729 | 1961 | 9263 | 1611 | 10386 | 1307 | 12138 | 791 | 14971 | 436 | 12547 |

## RECTANGULAR TIED COLUMNS 20" x 38"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.18 | MA | 7723 | 1941 | 10308 | 1717 | 12628 | 1444 | 13923 | 1231 | 15288 | 907 | 18647 | 790 | 8158 |
| 2E | | MI | 3875 | 1941 | 5688 | 1604 | 6577 | 1348 | 7041 | 1146 | 7486 | 840 | 8576 | 684 | 4014 |
| 4-#18 | 2.11 | MA | 8608 | 2143 | 12387 | 1831 | 15177 | 1527 | 16966 | 1280 | 19354 | 890 | 24247 | 770 | 14080 |
| 2E | | MI | 4195 | 2143 | 6599 | 1707 | 7657 | 1420 | 8313 | 1187 | 9163 | 815 | 10429 | 590 | 6634 |
| 6-#10 | 1.00 | MA | 7572 | 1901 | 9813 | 1707 | 12110 | 1439 | 13351 | 1230 | 14566 | 918 | 17684 | 800 | 7024 |
| 2L-3S | | MI | 3635 | 1901 | 5102 | 1615 | 5927 | 1360 | 6301 | 1161 | 6525 | 867 | 7500 | 634 | 3516 |
| 6-#10 | 1.00 | MA | 7104 | 1901 | 9054 | 1720 | 11147 | 1452 | 12184 | 1242 | 12991 | 935 | 15503 | 720 | 7020 |
| 3L-2S | | MI | 3836 | 1901 | 5446 | 1607 | 6365 | 1354 | 6831 | 1156 | 7241 | 859 | 8437 | 726 | 3496 |
| 6-#11 | 1.23 | MA | 7796 | 1951 | 10380 | 1730 | 12766 | 1455 | 14113 | 1238 | 15566 | 910 | 19046 | 792 | 8515 |
| 2L-3S | | MI | 3679 | 1951 | 5301 | 1631 | 6125 | 1370 | 6513 | 1163 | 6789 | 855 | 7766 | 584 | 4204 |
| 6-#11 | 1.23 | MA | 7243 | 1951 | 9458 | 1746 | 11597 | 1470 | 12696 | 1252 | 13653 | 931 | 16398 | 692 | 8498 |
| 3L-2S | | MI | 3913 | 1951 | 5714 | 1622 | 6648 | 1363 | 7147 | 1158 | 7645 | 847 | 8856 | 697 | 4180 |
| 6-#14 | 1.78 | MA | 8344 | 2071 | 11625 | 1798 | 14300 | 1504 | 15949 | 1268 | 18023 | 901 | 22433 | 781 | 12082 |
| 2L-3S | | MI | 3802 | 2071 | 5688 | 1697 | 6577 | 1416 | 7041 | 1189 | 7486 | 844 | 8576 | 489 | 5803 |
| 6-#14 | 1.78 | MA | 7592 | 2071 | 10308 | 1821 | 12628 | 1525 | 13923 | 1288 | 15288 | 929 | 18647 | 634 | 11997 |
| 3L-2S | | MI | 4120 | 2071 | 6271 | 1685 | 7317 | 1407 | 7938 | 1184 | 8696 | 834 | 10086 | 652 | 5787 |
| 6-#18 | 3.16 | MA | 9616 | 2375 | 14688 | 1976 | 18096 | 1633 | 20504 | 1347 | 24131 | 879 | 30861 | 754 | 20903 |
| 2L-3S | | MI | 4101 | 2375 | 6599 | 1869 | 7657 | 1536 | 8313 | 1257 | 9163 | 814 | 10429 | 226 | 9511 |
| 6-#18 | 3.16 | MA | 8433 | 2375 | 12387 | 2015 | 15177 | 1668 | 16966 | 1379 | 19354 | 926 | 24247 | 486 | 20481 |
| 3L-2S | | MI | 4582 | 2375 | 7595 | 1852 | 8921 | 1526 | 9845 | 1254 | 11226 | 803 | 12896 | 517 | 9615 |
| 8-#9 | 1.05 | MA | 7638 | 1912 | 9907 | 1717 | 12253 | 1447 | 13537 | 1236 | 14827 | 919 | 18054 | 801 | 7381 |
| 2L-4S | | MI | 3616 | 1912 | 5018 | 1634 | 5820 | 1381 | 6177 | 1178 | 6362 | 870 | 7363 | 619 | 3692 |
| 8-#9 | 1.05 | MA | 7271 | 1912 | 9307 | 1728 | 11492 | 1457 | 12614 | 1245 | 13581 | 933 | 16329 | 738 | 7378 |
| 3E | | MI | 3709 | 1912 | 5210 | 1627 | 6086 | 1369 | 6503 | 1168 | 6806 | 869 | 7897 | 659 | 3678 |
| 8-#9 | 1.05 | MA | 7069 | 1912 | 8900 | 1739 | 10927 | 1473 | 11921 | 1260 | 12632 | 941 | 15190 | 699 | 7343 |
| 4L-2S | | MI | 3867 | 1912 | 5484 | 1620 | 6433 | 1364 | 6924 | 1164 | 7375 | 862 | 8649 | 732 | 3663 |
| 8-#10 | 1.34 | MA | 7944 | 1974 | 10571 | 1753 | 13073 | 1473 | 14518 | 1251 | 16142 | 914 | 19866 | 795 | 9288 |
| 2L-4S | | MI | 3679 | 1974 | 5204 | 1670 | 6030 | 1408 | 6421 | 1194 | 6680 | 865 | 7771 | 573 | 4567 |
| 8-#10 | 1.34 | MA | 7493 | 1974 | 9813 | 1766 | 12110 | 1485 | 13351 | 1263 | 14566 | 932 | 17684 | 715 | 9269 |
| 3E | | MI | 3793 | 1974 | 5446 | 1661 | 6365 | 1394 | 6831 | 1182 | 7241 | 864 | 8437 | 622 | 4560 |
| 8-#10 | 1.34 | MA | 7245 | 1974 | 9298 | 1780 | 11395 | 1505 | 12474 | 1282 | 13365 | 942 | 16241 | 665 | 9184 |
| 4L-2S | | MI | 3987 | 1974 | 5791 | 1653 | 6802 | 1387 | 7361 | 1177 | 7956 | 855 | 9374 | 714 | 4545 |
| 8-#11 | 1.64 | MA | 8234 | 2041 | 11301 | 1786 | 13935 | 1496 | 15530 | 1264 | 17478 | 906 | 21695 | 786 | 11259 |
| 2L-4S | | MI | 3730 | 2041 | 5422 | 1697 | 6246 | 1427 | 6654 | 1202 | 6972 | 850 | 8076 | 507 | 5439 |
| 8-#11 | 1.64 | MA | 7705 | 2041 | 10380 | 1802 | 12766 | 1511 | 14113 | 1278 | 15566 | 926 | 19046 | 686 | 11221 |
| 3E | | MI | 3863 | 2041 | 5714 | 1688 | 6648 | 1411 | 7147 | 1189 | 7645 | 851 | 8856 | 565 | 5446 |

## RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

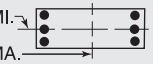
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.64 | MA | 7414 | 2041 | 9753 | 1819 | 11896 | 1535 | 13046 | 1301 | 14105 | 938 | 17280 | 623 | 11067 |
| 4L-2S | | MI | 4089 | 2041 | 6126 | 1679 | 7172 | 1404 | 7782 | 1184 | 8501 | 842 | 9947 | 678 | 5431 |
| 8-#14 | 2.37 | MA | 8942 | 2201 | 12942 | 1880 | 15971 | 1564 | 17975 | 1306 | 20757 | 895 | 26220 | 772 | 15993 |
| 2L-4S | | MI | 3875 | 2201 | 5857 | 1791 | 6745 | 1497 | 7238 | 1244 | 7741 | 835 | 9000 | 376 | 7277 |
| 8-#14 | 2.37 | MA | 8232 | 2201 | 11625 | 1903 | 14300 | 1585 | 15949 | 1325 | 18023 | 923 | 22433 | 625 | 15878 |
| 3E | | MI | 4055 | 2201 | 6271 | 1779 | 7317 | 1476 | 7938 | 1227 | 8696 | 838 | 10086 | 457 | 7530 |
| 8-#14 | 2.37 | MA | 7843 | 2201 | 10727 | 1926 | 13054 | 1618 | 14421 | 1357 | 15931 | 939 | 19893 | 535 | 15346 |
| 4L-2S | | MI | 4360 | 2201 | 6854 | 1767 | 8057 | 1467 | 8835 | 1222 | 9907 | 828 | 11596 | 620 | 7539 |
| 8-#18 | 4.21 | MA | 9495 | 2607 | 14688 | 2160 | 18096 | 1774 | 20504 | 1446 | 24131 | 915 | 30861 | 471 | 27258 |
| 3E | | MI | 4514 | 2607 | 7595 | 2014 | 8921 | 1642 | 9845 | 1324 | 11226 | 803 | 12896 | 153 | 12403 |
| 8-#18 | 4.21 | MA | 8903 | 2607 | 13113 | 2199 | 15911 | 1831 | 17825 | 1500 | 20465 | 940 | 26372 | 307 | 24098 |
| 4L-2S | | MI | 4957 | 2607 | 8591 | 1997 | 10185 | 1632 | 11377 | 1321 | 13290 | 792 | 15363 | 444 | 12565 |
| 10-#10 | 1.67 | MA | 8306 | 2048 | 11330 | 1799 | 14036 | 1506 | 15686 | 1273 | 17718 | 911 | 22048 | 790 | 11545 |
| 2L-5S | | MI | 3737 | 2048 | 5332 | 1724 | 6171 | 1448 | 6584 | 1220 | 6888 | 870 | 8048 | 506 | 5476 |
| 10-#10 | 1.67 | MA | 7872 | 2048 | 10571 | 1812 | 13073 | 1519 | 14518 | 1285 | 16142 | 928 | 19866 | 710 | 11516 |
| 3L-4S | | MI | 3839 | 2048 | 5549 | 1716 | 6467 | 1441 | 6951 | 1215 | 7396 | 862 | 8708 | 561 | 5588 |
| 10-#10 | 1.67 | MA | 7638 | 2048 | 10057 | 1826 | 12358 | 1539 | 13642 | 1304 | 14941 | 938 | 18422 | 660 | 11419 |
| 4L-3S | | MI | 3947 | 2048 | 5791 | 1707 | 6802 | 1428 | 7361 | 1203 | 7956 | 860 | 9374 | 610 | 5593 |
| 10-#10 | 1.67 | MA | 7336 | 2048 | 9595 | 1839 | 11734 | 1552 | 12866 | 1316 | 13863 | 955 | 16948 | 621 | 11067 |
| 5L-2S | | MI | 4137 | 2048 | 6136 | 1699 | 7240 | 1421 | 7891 | 1198 | 8672 | 852 | 10311 | 702 | 5585 |
| 10-#11 | 2.05 | MA | 8153 | 2132 | 11301 | 1859 | 13935 | 1552 | 15530 | 1305 | 17478 | 922 | 21695 | 680 | 13943 |
| 3L-4S | | MI | 3916 | 2132 | 5834 | 1754 | 6769 | 1468 | 7289 | 1228 | 7828 | 846 | 9167 | 488 | 6651 |
| 10-#11 | 2.05 | MA | 7881 | 2132 | 10675 | 1875 | 13065 | 1576 | 14463 | 1327 | 16017 | 934 | 19928 | 617 | 13776 |
| 4L-3S | | MI | 4043 | 2132 | 6126 | 1744 | 7172 | 1452 | 7782 | 1215 | 8501 | 846 | 9947 | 546 | 6676 |
| 10-#11 | 2.05 | MA | 7524 | 2132 | 10118 | 1891 | 12305 | 1591 | 13519 | 1341 | 14704 | 954 | 18129 | 567 | 13053 |
| 5L-2S | | MI | 4262 | 2132 | 6538 | 1735 | 7695 | 1445 | 8416 | 1211 | 9358 | 838 | 11037 | 659 | 6672 |
| 10-#14 | 2.96 | MA | 8850 | 2332 | 12942 | 1984 | 15971 | 1644 | 17975 | 1363 | 20757 | 917 | 26220 | 617 | 19762 |
| 3L-4S | | MI | 4134 | 2332 | 6440 | 1873 | 7485 | 1556 | 8135 | 1282 | 8952 | 829 | 10511 | 345 | 8884 |
| 10-#14 | 2.96 | MA | 8495 | 2332 | 12044 | 2007 | 14725 | 1678 | 16447 | 1395 | 18665 | 933 | 23680 | 526 | 19175 |
| 4L-3S | | MI | 4313 | 2332 | 6854 | 1860 | 8057 | 1535 | 8835 | 1264 | 9907 | 832 | 11596 | 425 | 9246 |
| 10-#14 | 2.96 | MA | 7997 | 2332 | 11252 | 2030 | 13635 | 1699 | 15093 | 1414 | 16784 | 961 | 21097 | 451 | 17690 |
| 5L-2S | | MI | 4593 | 2332 | 7438 | 1848 | 8797 | 1527 | 9732 | 1259 | 11118 | 821 | 13106 | 589 | 9279 |
| 10-#18 | 5.26 | MA | 9999 | 2839 | 15414 | 2344 | 18831 | 1937 | 21364 | 1567 | 25241 | 929 | 32986 | 292 | 30828 |
| 4L-3S | | MI | 4914 | 2839 | 8591 | 2159 | 10185 | 1748 | 11377 | 1391 | 13290 | 791 | 15363 | 80 | 15093 |
| 10-#18 | 5.26 | MA | 9161 | 2839 | 14021 | 2383 | 16917 | 1973 | 18988 | 1599 | 21940 | 976 | 28440 | 150 | 27695 |
| 5L-2S | | MI | 5326 | 2839 | 9587 | 2142 | 11449 | 1738 | 12909 | 1388 | 15353 | 780 | 17830 | 371 | 15502 |
| 12-#10 | 2.01 | MA | 8241 | 2121 | 11330 | 1858 | 14036 | 1553 | 15686 | 1306 | 17718 | 925 | 22048 | 705 | 13761 |
| 3L-5S | | MI | 3894 | 2121 | 5677 | 1770 | 6608 | 1482 | 7114 | 1242 | 7604 | 866 | 8985 | 494 | 6446 |
| 12-#10 | 2.01 | MA | 8021 | 2121 | 10816 | 1872 | 13321 | 1572 | 14809 | 1325 | 16517 | 935 | 20604 | 655 | 13655 |
| 4E | | MI | 3995 | 2121 | 5893 | 1762 | 6905 | 1475 | 7481 | 1237 | 8112 | 858 | 9645 | 549 | 6604 |
| 12-#10 | 2.01 | MA | 7722 | 2121 | 10354 | 1885 | 12697 | 1585 | 14033 | 1337 | 15438 | 952 | 19130 | 616 | 13279 |
| 5L-3S | | MI | 4099 | 2121 | 6136 | 1753 | 7240 | 1461 | 7891 | 1225 | 8672 | 857 | 10311 | 598 | 6620 |
| 12-#10 | 2.01 | MA | 7419 | 2121 | 9788 | 1899 | 12096 | 1597 | 13275 | 1356 | 14386 | 962 | 17710 | 551 | 12682 |
| 6L-2S | | MI | 4283 | 2121 | 6481 | 1745 | 7677 | 1455 | 8421 | 1220 | 9388 | 848 | 11248 | 690 | 6619 |
| 12-#11 | 2.46 | MA | 8336 | 2222 | 11596 | 1932 | 14234 | 1617 | 15880 | 1353 | 17930 | 929 | 22576 | 612 | 16489 |
| 4E | | MI | 4099 | 2222 | 6247 | 1810 | 7292 | 1509 | 7923 | 1254 | 8684 | 842 | 10257 | 469 | 7859 |
| 12-#11 | 2.46 | MA | 7983 | 2222 | 11039 | 1948 | 13474 | 1633 | 14935 | 1367 | 16617 | 950 | 20777 | 561 | 15744 |
| 5L-3S | | MI | 4220 | 2222 | 6538 | 1801 | 7695 | 1494 | 8416 | 1241 | 9358 | 842 | 11037 | 527 | 7898 |
| 12-#11 | 2.46 | MA | 7625 | 2222 | 10351 | 1964 | 12751 | 1647 | 14012 | 1390 | 15335 | 961 | 19045 | 479 | 15058 |
| 6L-2S | | MI | 4432 | 2222 | 6951 | 1792 | 8219 | 1487 | 9050 | 1237 | 10214 | 834 | 12128 | 640 | 7906 |
| 12-#14 | 3.55 | MA | 9126 | 2462 | 13362 | 2089 | 16396 | 1738 | 18472 | 1433 | 21400 | 926 | 27466 | 518 | 23013 |
| 4E | | MI | 4403 | 2462 | 7023 | 1954 | 8225 | 1616 | 9032 | 1319 | 10163 | 823 | 12021 | 313 | 10507 |
| 12-#14 | 3.55 | MA | 8634 | 2462 | 12569 | 2112 | 15307 | 1759 | 17119 | 1452 | 19518 | 955 | 24884 | 443 | 21563 |
| 5L-3S | | MI | 4554 | 2462 | 7438 | 1942 | 8797 | 1595 | 9732 | 1302 | 11118 | 825 | 13106 | 393 | 10958 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

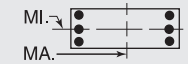
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 3.55 | MA | 8151 | 2462 | 11586 | 2136 | 14280 | 1780 | 15795 | 1484 | 17681 | 971 | 22397 | 322 | 20020 |
| 6L-2S | | MI | 4820 | 2462 | 8021 | 1930 | 9537 | 1586 | 10629 | 1297 | 12329 | 815 | 14616 | 557 | 11008 |
| 12-#18 | 6.32 | MA | 10227 | 3071 | 16322 | 2528 | 19837 | 2079 | 22526 | 1665 | 26717 | 965 | 35054 | 135 | 34384 |
| 5L-3S | | MI | 5306 | 3071 | 9587 | 2304 | 11449 | 1854 | 12909 | 1458 | 15353 | 779 | 17830 | 7 | 17805 |
| 12-#18 | 6.32 | MA | 9470 | 3071 | 14625 | 2571 | 18031 | 2114 | 20201 | 1719 | 23491 | 990 | 30665 | -84 | 30302 |
| 6L-2S | | MI | 5691 | 3071 | 10583 | 2287 | 12713 | 1844 | 14441 | 1455 | 17416 | 768 | 20297 | 298 | 18432 |
| 14-#10 | 2.34 | MA | 8394 | 2195 | 11575 | 1918 | 14284 | 1606 | 15976 | 1346 | 18092 | 931 | 22786 | 650 | 15894 |
| 4L-5S | | MI | 4049 | 2195 | 6021 | 1816 | 7046 | 1515 | 7644 | 1263 | 8319 | 863 | 9922 | 482 | 7422 |
| 14-#10 | 2.34 | MA | 8099 | 2195 | 11113 | 1931 | 13660 | 1619 | 15201 | 1358 | 17014 | 948 | 21312 | 611 | 15495 |
| 5L-4S | | MI | 4149 | 2195 | 6238 | 1808 | 7342 | 1509 | 8011 | 1258 | 8828 | 854 | 10582 | 537 | 7618 |
| 14-#10 | 2.34 | MA | 7807 | 2195 | 10547 | 1945 | 13059 | 1630 | 14443 | 1377 | 15961 | 959 | 19892 | 546 | 14916 |
| 6L-3S | | MI | 4249 | 2195 | 6481 | 1799 | 7677 | 1495 | 8421 | 1246 | 9388 | 853 | 11248 | 586 | 7643 |
| 14-#10 | 2.34 | MA | 7553 | 2195 | 10065 | 1954 | 12393 | 1645 | 13702 | 1388 | 14941 | 976 | 18513 | 512 | 14288 |
| 7L-2S | | MI | 4428 | 2195 | 6825 | 1791 | 8114 | 1488 | 8952 | 1241 | 10103 | 845 | 12185 | 678 | 7649 |
| 14-#11 | 2.87 | MA | 8430 | 2313 | 11960 | 2004 | 14643 | 1674 | 16352 | 1393 | 18529 | 945 | 23426 | 555 | 18440 |
| 5L-4S | | MI | 4279 | 2313 | 6659 | 1867 | 7816 | 1550 | 8557 | 1280 | 9541 | 838 | 11348 | 450 | 9031 |
| 14-#11 | 2.87 | MA | 8087 | 2313 | 11273 | 2021 | 13920 | 1688 | 15429 | 1416 | 17247 | 957 | 21693 | 473 | 17775 |
| 6L-3S | | MI | 4394 | 2313 | 6951 | 1857 | 8219 | 1535 | 9050 | 1267 | 10214 | 838 | 12128 | 508 | 9116 |
| 14-#11 | 2.87 | MA | 7789 | 2313 | 10687 | 2032 | 13109 | 1706 | 14539 | 1430 | 16004 | 977 | 20003 | 431 | 16744 |
| 7L-2S | | MI | 4600 | 2313 | 7363 | 1848 | 8742 | 1528 | 9685 | 1263 | 11070 | 829 | 13218 | 621 | 9133 |
| 14-#14 | 4.14 | MA | 9252 | 2593 | 13886 | 2193 | 16978 | 1818 | 19145 | 1490 | 22253 | 949 | 28670 | 434 | 25436 |
| 5L-4S | | MI | 4650 | 2593 | 7606 | 2036 | 8965 | 1675 | 9929 | 1357 | 11374 | 817 | 13531 | 281 | 12143 |
| 14-#14 | 4.14 | MA | 8794 | 2593 | 12903 | 2217 | 15951 | 1840 | 17821 | 1522 | 20416 | 964 | 26183 | 313 | 23873 |
| 6L-3S | | MI | 4789 | 2593 | 8021 | 2023 | 9537 | 1654 | 10629 | 1340 | 12329 | 819 | 14616 | 361 | 12667 |
| 14-#14 | 4.14 | MA | 8396 | 2593 | 12064 | 2232 | 14790 | 1864 | 16545 | 1541 | 18634 | 993 | 23750 | 252 | 22244 |
| 7L-2S | | MI | 5043 | 2593 | 8604 | 2011 | 10278 | 1646 | 11526 | 1335 | 13540 | 809 | 16126 | 525 | 12733 |
| 14-#18 | 7.37 | MA | 10555 | 3303 | 16925 | 2716 | 20951 | 2220 | 23740 | 1786 | 28268 | 979 | 37278 | -99 | 36683 |
| 6L-3S | | MI | 5691 | 3303 | 10583 | 2449 | 12713 | 1960 | 14441 | 1525 | 17416 | 768 | 20297 | -66 | 20162 |
| 16-#10 | 2.67 | MA | 8467 | 2269 | 11872 | 1977 | 14624 | 1653 | 16368 | 1379 | 18589 | 945 | 23493 | 606 | 17715 |
| 5E | | MI | 4201 | 2269 | 6366 | 1862 | 7483 | 1549 | 8175 | 1284 | 9035 | 859 | 10859 | 470 | 8402 |
| 16-#10 | 2.67 | MA | 8185 | 2269 | 11306 | 1991 | 14022 | 1664 | 15610 | 1398 | 17537 | 955 | 22074 | 541 | 17152 |
| 6L-4S | | MI | 4301 | 2269 | 6583 | 1854 | 7780 | 1542 | 8541 | 1279 | 9543 | 851 | 11519 | 525 | 8630 |
| 16-#10 | 2.67 | MA | 7943 | 2269 | 10824 | 2000 | 13356 | 1679 | 14869 | 1409 | 16517 | 972 | 20694 | 507 | 16518 |
| 7L-3S | | MI | 4396 | 2269 | 6825 | 1845 | 8114 | 1529 | 8952 | 1267 | 10103 | 850 | 12185 | 574 | 8662 |
| 16-#10 | 2.67 | MA | 7688 | 2269 | 10362 | 2011 | 12737 | 1688 | 14087 | 1424 | 15498 | 983 | 19356 | 462 | 15768 |
| 8L-2S | | MI | 4571 | 2269 | 7170 | 1837 | 8552 | 1522 | 9482 | 1262 | 10819 | 841 | 13122 | 666 | 8674 |
| 16-#11 | 3.28 | MA | 8536 | 2403 | 12194 | 2077 | 15089 | 1730 | 16846 | 1442 | 19160 | 953 | 24341 | 467 | 20490 |
| 6L-4S | | MI | 4455 | 2403 | 7071 | 1923 | 8339 | 1592 | 9191 | 1307 | 10397 | 833 | 12438 | 431 | 10187 |
| 16-#11 | 3.28 | MA | 8253 | 2403 | 11608 | 2088 | 14278 | 1747 | 15955 | 1456 | 17917 | 973 | 22651 | 425 | 19449 |
| 7L-3S | | MI | 4566 | 2403 | 7363 | 1914 | 8742 | 1576 | 9685 | 1293 | 11070 | 834 | 13218 | 489 | 10331 |
| 16-#11 | 3.28 | MA | 7952 | 2403 | 11045 | 2101 | 13524 | 1758 | 15004 | 1473 | 16676 | 985 | 21016 | 367 | 18408 |
| 8L-2S | | MI | 4765 | 2403 | 7776 | 1905 | 9265 | 1569 | 10319 | 1289 | 11926 | 825 | 14308 | 602 | 10356 |
| 16-#14 | 4.74 | MA | 9419 | 2723 | 14220 | 2299 | 17622 | 1899 | 19846 | 1559 | 23150 | 958 | 29970 | 305 | 27726 |
| 6L-4S | | MI | 4892 | 2723 | 8190 | 2117 | 9705 | 1735 | 10826 | 1395 | 12585 | 810 | 15041 | 249 | 13788 |
| 16-#14 | 4.74 | MA | 9046 | 2723 | 13381 | 2314 | 16462 | 1924 | 18571 | 1579 | 21368 | 986 | 27536 | 243 | 26082 |
| 7L-3S | | MI | 5021 | 2723 | 8604 | 2105 | 10278 | 1714 | 11526 | 1377 | 13540 | 813 | 16126 | 329 | 14375 |
| 16-#14 | 4.74 | MA | 8624 | 2723 | 12575 | 2331 | 15382 | 1938 | 17221 | 1604 | 19618 | 1015 | 25188 | 158 | 24312 |
| 8L-2S | | MI | 5264 | 2723 | 9187 | 2093 | 11018 | 1705 | 12423 | 1372 | 14751 | 803 | 17637 | 493 | 14454 |
| 18-#10 | 3.01 | MA | 8555 | 2342 | 12065 | 2037 | 14986 | 1698 | 16777 | 1420 | 19113 | 952 | 24255 | 536 | 19390 |
| 6L-5S | | MI | 4351 | 2342 | 6711 | 1908 | 7921 | 1583 | 8705 | 1305 | 9751 | 856 | 11796 | 458 | 9387 |
| 18-#10 | 3.01 | MA | 8323 | 2342 | 11583 | 2046 | 14319 | 1712 | 16036 | 1431 | 18092 | 969 | 22876 | 502 | 18748 |
| 7L-4S | | MI | 4450 | 2342 | 6928 | 1900 | 8217 | 1576 | 9072 | 1300 | 10259 | 847 | 12456 | 512 | 9642 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

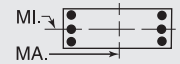


$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 3.01 | MA | 8072 | 2342 | 11121 | 2057 | 13700 | 1721 | 15255 | 1445 | 17074 | 979 | 21538 | 457 | 18000 |
| 8L-3S | | MI | 4542 | 2342 | 7170 | 1891 | 8552 | 1562 | 9482 | 1288 | 10819 | 846 | 13122 | 562 | 9680 |
| 18-#10 | 3.01 | MA | 7790 | 2342 | 10665 | 2067 | 13098 | 1731 | 14496 | 1454 | 16071 | 996 | 20227 | 413 | 17131 |
| 9L-2S | | MI | 4713 | 2342 | 7515 | 1883 | 8989 | 1556 | 10012 | 1284 | 11535 | 838 | 14059 | 654 | 9698 |
| 18-#11 | 3.69 | MA | 8706 | 2494 | 12529 | 2145 | 15447 | 1788 | 17372 | 1482 | 19830 | 969 | 25299 | 419 | 22153 |
| 7L-4S | | MI | 4643 | 2494 | 7484 | 1980 | 8862 | 1633 | 9826 | 1333 | 11253 | 829 | 13529 | 412 | 11349 |
| 18-#11 | 3.69 | MA | 8409 | 2494 | 11966 | 2157 | 14693 | 1799 | 16421 | 1499 | 18589 | 980 | 23664 | 361 | 21104 |
| 8L-3S | | MI | 4741 | 2494 | 7776 | 1970 | 9265 | 1618 | 10319 | 1320 | 11926 | 829 | 14308 | 470 | 11544 |
| 18-#11 | 3.69 | MA | 8078 | 2494 | 11417 | 2170 | 13961 | 1811 | 15497 | 1510 | 17367 | 1000 | 22058 | 306 | 20041 |
| 9L-2S | | MI | 4925 | 2494 | 8188 | 1961 | 9789 | 1611 | 10953 | 1315 | 12782 | 821 | 15399 | 583 | 11577 |
| 18-#14 | 5.33 | MA | 9678 | 2854 | 14698 | 2395 | 18133 | 1983 | 20597 | 1616 | 24103 | 980 | 31323 | 234 | 29921 |
| 7L-4S | | MI | 5130 | 2854 | 8773 | 2199 | 10446 | 1795 | 11724 | 1432 | 13796 | 804 | 16551 | 217 | 15441 |
| 18-#14 | 5.33 | MA | 9262 | 2854 | 13892 | 2413 | 17054 | 1998 | 19247 | 1642 | 22353 | 1009 | 28974 | 149 | 28160 |
| 8L-3S | | MI | 5249 | 2854 | 9187 | 2187 | 11018 | 1774 | 12423 | 1415 | 14751 | 807 | 17637 | 297 | 16083 |
| 20-#10 | 3.34 | MA | 8696 | 2416 | 12342 | 2092 | 15282 | 1746 | 17204 | 1452 | 19668 | 965 | 25058 | 497 | 20977 |
| 7L-5S | | MI | 4499 | 2416 | 7056 | 1954 | 8358 | 1616 | 9235 | 1327 | 10466 | 852 | 12733 | 446 | 10374 |
| 20-#10 | 3.34 | MA | 8447 | 2416 | 11880 | 2103 | 14663 | 1755 | 16422 | 1466 | 18650 | 976 | 23719 | 452 | 20232 |
| 8L-4S | | MI | 4598 | 2416 | 7272 | 1946 | 8654 | 1610 | 9602 | 1322 | 10975 | 844 | 13393 | 500 | 10652 |
| 20-#10 | 3.34 | MA | 8175 | 2416 | 11424 | 2113 | 14061 | 1765 | 15663 | 1475 | 17647 | 993 | 22409 | 408 | 19356 |
| 9L-3S | | MI | 4686 | 2416 | 7515 | 1937 | 8989 | 1596 | 10012 | 1310 | 11535 | 843 | 14059 | 550 | 10697 |
| 20-#10 | 3.34 | MA | 7923 | 2416 | 10951 | 2121 | 13434 | 1783 | 14920 | 1485 | 16624 | 1008 | 20986 | 359 | 18503 |
| 10L-2S | | MI | 4853 | 2416 | 7859 | 1929 | 9427 | 1589 | 10542 | 1305 | 12250 | 834 | 14996 | 642 | 10719 |
| 20-#11 | 4.11 | MA | 8856 | 2584 | 12888 | 2214 | 15862 | 1840 | 17838 | 1526 | 20501 | 976 | 26313 | 355 | 23799 |
| 8L-4S | | MI | 4814 | 2584 | 7896 | 2036 | 9386 | 1674 | 10460 | 1359 | 12109 | 825 | 14619 | 393 | 12516 |
| 20-#11 | 4.11 | MA | 8537 | 2584 | 12338 | 2227 | 15130 | 1852 | 16914 | 1536 | 19280 | 996 | 24706 | 300 | 22741 |
| 9L-3S | | MI | 4906 | 2584 | 8188 | 2027 | 9789 | 1659 | 10953 | 1346 | 12782 | 825 | 15399 | 451 | 12757 |
| 20-#11 | 4.11 | MA | 8242 | 2584 | 11763 | 2236 | 14366 | 1873 | 16010 | 1547 | 18054 | 1015 | 22968 | 238 | 21513 |
| 10L-2S | | MI | 5085 | 2584 | 8600 | 2018 | 10312 | 1652 | 11587 | 1341 | 13639 | 817 | 16489 | 564 | 12796 |
| 20-#14 | 5.92 | MA | 9884 | 2984 | 15209 | 2494 | 18725 | 2058 | 21273 | 1679 | 25087 | 1002 | 32761 | 141 | 32008 |
| 8L-4S | | MI | 5365 | 2984 | 9356 | 2280 | 11186 | 1854 | 12621 | 1470 | 15007 | 798 | 18061 | 185 | 17101 |
| 22-#10 | 3.68 | MA | 8815 | 2490 | 12639 | 2149 | 15626 | 1789 | 17589 | 1488 | 20225 | 972 | 25901 | 448 | 22464 |
| 8L-5S | | MI | 4646 | 2490 | 7400 | 2000 | 8796 | 1650 | 9765 | 1348 | 11182 | 849 | 13670 | 434 | 11363 |
| 22-#10 | 3.68 | MA | 8552 | 2490 | 12183 | 2159 | 15024 | 1799 | 16830 | 1496 | 19223 | 989 | 24590 | 403 | 21582 |
| 9L-4S | | MI | 4744 | 2490 | 7617 | 1992 | 9092 | 1643 | 10132 | 1343 | 11690 | 840 | 14330 | 488 | 11631 |
| 22-#10 | 3.68 | MA | 8309 | 2490 | 11710 | 2167 | 14397 | 1816 | 16087 | 1506 | 18200 | 1004 | 23167 | 354 | 20723 |
| 10L-3S | | MI | 4836 | 2490 | 7859 | 1984 | 9427 | 1630 | 10542 | 1331 | 12250 | 839 | 14996 | 538 | 11712 |
| 22-#10 | 3.68 | MA | 8069 | 2490 | 11179 | 2183 | 13797 | 1826 | 15334 | 1523 | 17158 | 1012 | 21864 | 307 | 19838 |
| 11L-2S | | MI | 4990 | 2490 | 8204 | 1975 | 9864 | 1623 | 11072 | 1326 | 12966 | 831 | 15933 | 630 | 11739 |
| 22-#11 | 4.52 | MA | 8986 | 2675 | 13259 | 2283 | 16299 | 1893 | 18331 | 1562 | 21192 | 992 | 27355 | 294 | 25440 |
| 9L-4S | | MI | 4982 | 2675 | 8309 | 2093 | 9909 | 1716 | 11094 | 1385 | 12965 | 820 | 15709 | 374 | 13688 |
| 22-#11 | 4.52 | MA | 8703 | 2675 | 12685 | 2293 | 15535 | 1914 | 17426 | 1573 | 19966 | 1011 | 25616 | 232 | 24206 |
| 10L-3S | | MI | 5069 | 2675 | 8600 | 2084 | 10312 | 1700 | 11587 | 1372 | 13639 | 821 | 16489 | 432 | 13968 |
| 24-#10 | 4.01 | MA | 8922 | 2563 | 12941 | 2205 | 15988 | 1832 | 17997 | 1518 | 20798 | 986 | 26772 | 398 | 23807 |
| 9L-5S | | MI | 4791 | 2563 | 7745 | 2046 | 9233 | 1684 | 10295 | 1369 | 11898 | 845 | 14607 | 422 | 12355 |
| 24-#10 | 4.01 | MA | 8688 | 2563 | 12469 | 2213 | 15360 | 1850 | 17255 | 1527 | 19776 | 1001 | 25349 | 350 | 22943 |
| 10L-4S | | MI | 4901 | 2563 | 7962 | 2038 | 9529 | 1677 | 10662 | 1364 | 12406 | 837 | 15267 | 476 | 12612 |
| 24-#10 | 4.01 | MA | 8450 | 2563 | 11937 | 2229 | 14760 | 1860 | 16501 | 1544 | 18734 | 1008 | 24046 | 302 | 22061 |
| 11L-3S | | MI | 4976 | 2563 | 8204 | 2030 | 9864 | 1663 | 11072 | 1352 | 12966 | 836 | 15933 | 526 | 12727 |
| 24-#11 | 4.93 | MA | 9155 | 2765 | 13606 | 2349 | 16704 | 1956 | 18843 | 1599 | 21879 | 1007 | 28264 | 226 | 26899 |
| 10L-4S | | MI | 5149 | 2765 | 8721 | 2149 | 10432 | 1757 | 11729 | 1411 | 13822 | 816 | 16800 | 355 | 14863 |

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis

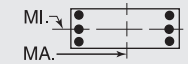



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.13 | MA | 8510 | 2029 | 11236 | 1805 | 13809 | 1520 | 15230 | 1296 | 16697 | 959 | 20343 | 835 | 8644 |
| 2E | | MI | 4052 | 2029 | 5926 | 1679 | 6845 | 1413 | 7317 | 1203 | 7752 | 885 | 8868 | 724 | 4036 |
| 4-#18 | 2.00 | MA | 9465 | 2232 | 13449 | 1920 | 16522 | 1602 | 18470 | 1346 | 21026 | 942 | 26305 | 816 | 14944 |
| 2E | | MI | 4374 | 2232 | 6841 | 1781 | 7927 | 1484 | 8589 | 1243 | 9428 | 859 | 10718 | 628 | 6667 |
| 6-#11 | 1.17 | MA | 8587 | 2039 | 11310 | 1818 | 13952 | 1530 | 15429 | 1304 | 16988 | 963 | 20762 | 838 | 9021 |
| 2L-3S | | MI | 3856 | 2039 | 5537 | 1708 | 6392 | 1435 | 6789 | 1220 | 7056 | 900 | 8060 | 623 | 4226 |
| 6-#11 | 1.17 | MA | 7995 | 2039 | 10333 | 1835 | 12711 | 1546 | 13926 | 1319 | 14958 | 984 | 17951 | 739 | 9003 |
| 3L-2S | | MI | 4091 | 2039 | 5949 | 1698 | 6916 | 1428 | 7423 | 1215 | 7912 | 892 | 9150 | 737 | 4202 |
| 6-#14 | 1.69 | MA | 9177 | 2159 | 12634 | 1887 | 15583 | 1579 | 17382 | 1334 | 19601 | 953 | 24364 | 827 | 12811 |
| 2L-3S | | MI | 3979 | 2159 | 5926 | 1773 | 6845 | 1481 | 7317 | 1245 | 7752 | 889 | 8868 | 528 | 5834 |
| 6-#14 | 1.69 | MA | 8370 | 2159 | 11236 | 1910 | 13809 | 1601 | 15230 | 1354 | 16697 | 982 | 20343 | 682 | 12726 |
| 3L-2S | | MI | 4299 | 2159 | 6509 | 1761 | 7585 | 1472 | 8214 | 1241 | 8963 | 879 | 10378 | 692 | 5813 |
| 6-#18 | 3.00 | MA | 10548 | 2464 | 15895 | 2065 | 19625 | 1708 | 22231 | 1413 | 26104 | 931 | 33335 | 800 | 22199 |
| 2L-3S | | MI | 4277 | 2464 | 6841 | 1943 | 7927 | 1600 | 8589 | 1313 | 9428 | 859 | 10718 | 265 | 9567 |
| 6-#18 | 3.00 | MA | 9275 | 2464 | 13449 | 2105 | 16522 | 1745 | 18470 | 1446 | 21026 | 980 | 26305 | 536 | 21777 |
| 3L-2S | | MI | 4763 | 2464 | 7837 | 1926 | 9191 | 1590 | 10121 | 1310 | 11491 | 848 | 13185 | 555 | 9654 |
| 8-#9 | 1.00 | MA | 8416 | 2000 | 10806 | 1805 | 13405 | 1522 | 14813 | 1301 | 16199 | 972 | 19701 | 847 | 7813 |
| 2L-4S | | MI | 3793 | 2000 | 5249 | 1711 | 6085 | 1447 | 6453 | 1235 | 6630 | 916 | 7660 | 660 | 3711 |
| 8-#9 | 1.00 | MA | 8023 | 2000 | 10170 | 1816 | 12597 | 1532 | 13835 | 1311 | 14878 | 986 | 17872 | 785 | 7810 |
| 3E | | MI | 3886 | 2000 | 5441 | 1704 | 6351 | 1436 | 6778 | 1226 | 7075 | 915 | 8194 | 699 | 3695 |
| 8-#9 | 1.00 | MA | 7807 | 2000 | 9740 | 1827 | 11999 | 1548 | 13101 | 1327 | 13873 | 994 | 16671 | 746 | 7775 |
| 4L-2S | | MI | 4045 | 2000 | 5715 | 1697 | 6699 | 1430 | 7200 | 1221 | 7644 | 908 | 8946 | 772 | 3680 |
| 8-#10 | 1.27 | MA | 8744 | 2063 | 11512 | 1841 | 14275 | 1548 | 15856 | 1317 | 17595 | 967 | 21625 | 841 | 9836 |
| 2L-4S | | MI | 3856 | 2063 | 5436 | 1747 | 6296 | 1474 | 6697 | 1252 | 6949 | 911 | 8067 | 613 | 4591 |
| 8-#10 | 1.27 | MA | 8261 | 2063 | 10707 | 1855 | 13254 | 1561 | 14618 | 1330 | 15924 | 984 | 19311 | 762 | 9818 |
| 3E | | MI | 3970 | 2063 | 5679 | 1739 | 6631 | 1460 | 7107 | 1240 | 7509 | 909 | 8733 | 662 | 4580 |
| 8-#10 | 1.27 | MA | 7996 | 2063 | 10162 | 1869 | 12497 | 1581 | 13689 | 1349 | 14652 | 995 | 17788 | 712 | 9732 |
| 4L-2S | | MI | 4166 | 2063 | 6023 | 1730 | 7068 | 1453 | 7637 | 1235 | 8224 | 901 | 9670 | 755 | 4564 |
| 8-#11 | 1.56 | MA | 9058 | 2130 | 12288 | 1875 | 15193 | 1571 | 16933 | 1330 | 19018 | 958 | 23573 | 832 | 11933 |
| 2L-4S | | MI | 3906 | 2130 | 5657 | 1774 | 6513 | 1492 | 6930 | 1259 | 7239 | 896 | 8370 | 547 | 5471 |
| 8-#11 | 1.56 | MA | 8490 | 2130 | 11310 | 1891 | 13952 | 1587 | 15429 | 1345 | 16988 | 979 | 20762 | 733 | 11895 |
| 3E | | MI | 4040 | 2130 | 5949 | 1764 | 6916 | 1476 | 7423 | 1246 | 7912 | 896 | 9150 | 604 | 5472 |
| 8-#11 | 1.56 | MA | 8178 | 2130 | 10647 | 1908 | 13030 | 1611 | 14299 | 1368 | 15440 | 992 | 18898 | 671 | 11740 |
| 4L-2S | | MI | 4268 | 2130 | 6362 | 1755 | 7439 | 1469 | 8058 | 1241 | 8769 | 888 | 10241 | 718 | 5455 |
| 8-#14 | 2.25 | MA | 9820 | 2290 | 14033 | 1968 | 17358 | 1639 | 19533 | 1372 | 22505 | 947 | 28384 | 818 | 16965 |
| 2L-4S | | MI | 4051 | 2290 | 6094 | 1867 | 7013 | 1561 | 7514 | 1300 | 8007 | 880 | 9293 | 416 | 7375 |
| 8-#14 | 2.25 | MA | 9057 | 2290 | 12634 | 1992 | 15583 | 1661 | 17382 | 1392 | 19601 | 976 | 24364 | 673 | 16850 |
| 3E | | MI | 4233 | 2290 | 6509 | 1855 | 7585 | 1540 | 8214 | 1283 | 8963 | 883 | 10378 | 496 | 7565 |
| 8-#14 | 2.25 | MA | 8640 | 2290 | 11684 | 2015 | 14263 | 1695 | 15762 | 1425 | 17383 | 993 | 21682 | 584 | 16412 |
| 4L-2S | | MI | 4539 | 2290 | 7092 | 1843 | 8325 | 1532 | 9111 | 1278 | 10174 | 873 | 11888 | 660 | 7568 |
| 8-#18 | 4.00 | MA | 10415 | 2696 | 15895 | 2249 | 19625 | 1851 | 22231 | 1513 | 26104 | 969 | 33335 | 521 | 28986 |
| 3E | | MI | 4691 | 2696 | 7837 | 2088 | 9191 | 1706 | 10121 | 1380 | 11491 | 847 | 13185 | 192 | 12462 |
| 8-#18 | 4.00 | MA | 9778 | 2696 | 14225 | 2289 | 17307 | 1909 | 19389 | 1568 | 22213 | 996 | 28594 | 359 | 25761 |
| 4L-2S | | MI | 5140 | 2696 | 8833 | 2071 | 10455 | 1696 | 11653 | 1377 | 13555 | 836 | 15652 | 483 | 12607 |
| 10-#10 | 1.59 | MA | 9132 | 2136 | 12317 | 1887 | 15297 | 1582 | 17094 | 1338 | 19266 | 963 | 23939 | 836 | 12231 |
| 2L-5S | | MI | 3914 | 2136 | 5564 | 1802 | 6437 | 1514 | 6860 | 1278 | 7156 | 916 | 8344 | 546 | 5537 |
| 10-#10 | 1.59 | MA | 8667 | 2136 | 11512 | 1901 | 14275 | 1595 | 15856 | 1351 | 17595 | 981 | 21625 | 757 | 12201 |
| 3L-4S | | MI | 4016 | 2136 | 5781 | 1793 | 6733 | 1507 | 7227 | 1273 | 7664 | 907 | 9004 | 601 | 5615 |
| 10-#10 | 1.59 | MA | 8417 | 2136 | 10967 | 1915 | 13518 | 1615 | 14927 | 1370 | 16323 | 991 | 20102 | 707 | 12105 |
| 4L-3S | | MI | 4125 | 2136 | 6023 | 1785 | 7068 | 1494 | 7637 | 1261 | 8224 | 906 | 9670 | 650 | 5616 |
| 10-#10 | 1.59 | MA | 8092 | 2136 | 10475 | 1928 | 12858 | 1628 | 14106 | 1382 | 15181 | 1009 | 18544 | 669 | 11798 |
| 5L-2S | | MI | 4315 | 2136 | 6368 | 1776 | 7506 | 1487 | 8167 | 1256 | 8940 | 898 | 10607 | 743 | 5606 |
| 10-#11 | 1.95 | MA | 8970 | 2220 | 12288 | 1948 | 15193 | 1628 | 16933 | 1371 | 19018 | 975 | 23573 | 727 | 14786 |
| 3L-4S | | MI | 4093 | 2220 | 6070 | 1830 | 7036 | 1533 | 7565 | 1285 | 8095 | 891 | 9461 | 528 | 6687 |
| 10-#11 | 1.95 | MA | 8679 | 2220 | 11625 | 1964 | 14271 | 1652 | 15803 | 1394 | 17470 | 987 | 21708 | 665 | 14619 |
| 4L-3S | | MI | 4220 | 2220 | 6362 | 1821 | 7439 | 1518 | 8058 | 1272 | 8769 | 892 | 10241 | 585 | 6705 |
| 10-#11 | 1.95 | MA | 8294 | 2220 | 11031 | 1980 | 13466 | 1668 | 14803 | 1408 | 16079 | 1008 | 19806 | 616 | 13919 |
| 5L-2S | | MI | 4441 | 2220 | 6774 | 1812 | 7962 | 1511 | 8692 | 1267 | 9625 | 883 | 11331 | 699 | 6697 |


## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

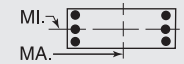

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.81 | MA | 9720 | 2420 | 14033 | 2073 | 17358 | 1721 | 19533 | 1430 | 22505 | 970 | 28384 | 665 | 20977 |
| 3L-4S | | MI | 4310 | 2420 | 6678 | 1948 | 7753 | 1621 | 8411 | 1338 | 9218 | 874 | 10803 | 384 | 8979 |
| 10-#14 | 2.81 | MA | 9339 | 2420 | 13082 | 2097 | 16037 | 1755 | 17913 | 1462 | 20287 | 987 | 25702 | 575 | 20507 |
| 4L-3S | | MI | 4481 | 2420 | 7092 | 1936 | 8325 | 1600 | 9111 | 1321 | 10174 | 876 | 11888 | 464 | 9285 |
| 10-#14 | 2.81 | MA | 8800 | 2420 | 12237 | 2120 | 14883 | 1777 | 16479 | 1482 | 18293 | 1016 | 22971 | 502 | 18858 |
| 5L-2S | | MI | 4775 | 2420 | 7676 | 1924 | 9065 | 1591 | 10008 | 1316 | 11385 | 866 | 13398 | 628 | 9311 |
| 10-#18 | 5.00 | MA | 10953 | 2928 | 16671 | 2434 | 20411 | 2015 | 23151 | 1635 | 27291 | 985 | 35625 | 343 | 32916 |
| 4L-3S | | MI | 5092 | 2928 | 8833 | 2233 | 10455 | 1812 | 11653 | 1447 | 13555 | 835 | 15652 | 119 | 15248 |
| 10-#18 | 5.00 | MA | 10047 | 2928 | 15196 | 2474 | 18383 | 2052 | 20632 | 1669 | 23791 | 1034 | 30814 | 206 | 29717 |
| 5L-2S | | MI | 5510 | 2928 | 9829 | 2216 | 11719 | 1802 | 13185 | 1444 | 15618 | 824 | 18120 | 410 | 15546 |
| 12-#10 | 1.90 | MA | 9062 | 2210 | 12317 | 1947 | 15297 | 1628 | 17094 | 1372 | 19266 | 977 | 23939 | 752 | 14584 |
| 3L-5S | | MI | 4071 | 2210 | 5909 | 1848 | 6874 | 1548 | 7390 | 1299 | 7872 | 912 | 9281 | 534 | 6507 |
| 12-#10 | 1.90 | MA | 8826 | 2210 | 11772 | 1961 | 14540 | 1649 | 16165 | 1391 | 17994 | 988 | 22416 | 702 | 14478 |
| 4E | | MI | 4172 | 2210 | 6126 | 1839 | 7171 | 1541 | 7757 | 1294 | 8380 | 904 | 9941 | 589 | 6634 |
| 12-#10 | 1.90 | MA | 8505 | 2210 | 11280 | 1974 | 13880 | 1662 | 15345 | 1404 | 16853 | 1006 | 20858 | 664 | 14147 |
| 5L-3S | | MI | 4277 | 2210 | 6368 | 1831 | 7506 | 1527 | 8167 | 1282 | 8940 | 902 | 10607 | 638 | 6646 |
| 12-#10 | 1.90 | MA | 8181 | 2210 | 10680 | 1988 | 13238 | 1673 | 14542 | 1423 | 15739 | 1016 | 19357 | 600 | 13493 |
| 6L-2S | | MI | 4463 | 2210 | 6713 | 1822 | 7943 | 1521 | 8697 | 1277 | 9656 | 894 | 11544 | 730 | 6641 |
| 12-#11 | 2.34 | MA | 9166 | 2311 | 12603 | 2021 | 15512 | 1694 | 17306 | 1420 | 19500 | 983 | 24519 | 659 | 17500 |
| 4E | | MI | 4276 | 2311 | 6482 | 1887 | 7560 | 1574 | 8199 | 1311 | 8951 | 887 | 10551 | 509 | 7897 |
| 12-#11 | 2.34 | MA | 8786 | 2311 | 12009 | 2037 | 14707 | 1709 | 16306 | 1434 | 18109 | 1004 | 22617 | 610 | 16780 |
| 5L-3S | | MI | 4398 | 2311 | 6774 | 1877 | 7962 | 1559 | 8692 | 1298 | 9625 | 887 | 11331 | 566 | 7929 |
| 12-#11 | 2.34 | MA | 8403 | 2311 | 11280 | 2054 | 13935 | 1723 | 15329 | 1458 | 16752 | 1016 | 20785 | 530 | 16028 |
| 6L-2S | | MI | 4612 | 2311 | 7186 | 1868 | 8486 | 1552 | 9326 | 1294 | 10481 | 879 | 12422 | 680 | 7933 |
| 12-#14 | 3.38 | MA | 10014 | 2551 | 14481 | 2178 | 17812 | 1814 | 20064 | 1500 | 23191 | 981 | 29723 | 566 | 24591 |
| 4E | | MI | 4579 | 2551 | 7261 | 2030 | 8493 | 1680 | 9308 | 1376 | 10429 | 868 | 12313 | 352 | 10600 |
| 12-#14 | 3.38 | MA | 9483 | 2551 | 13636 | 2201 | 16658 | 1836 | 18630 | 1520 | 21197 | 1010 | 26992 | 494 | 22972 |
| 5L-3S | | MI | 4733 | 2551 | 7676 | 2018 | 9065 | 1659 | 10008 | 1358 | 11385 | 870 | 13398 | 432 | 10999 |
| 12-#14 | 3.38 | MA | 8966 | 2551 | 12592 | 2225 | 15560 | 1857 | 17228 | 1553 | 19251 | 1027 | 24362 | 375 | 21418 |
| 6L-2S | | MI | 5003 | 2551 | 8259 | 2006 | 9806 | 1651 | 10905 | 1354 | 12596 | 860 | 14909 | 596 | 11042 |
| 12-#18 | 6.00 | MA | 11189 | 3160 | 17641 | 2619 | 21486 | 2158 | 24393 | 1736 | 28868 | 1023 | 37844 | 191 | 36829 |
| 5L-3S | | MI | 5484 | 3160 | 9829 | 2378 | 11719 | 1918 | 13185 | 1513 | 15618 | 823 | 18120 | 46 | 17954 |
| 12-#18 | 6.00 | MA | 10377 | 3160 | 15825 | 2662 | 19574 | 2194 | 21929 | 1791 | 25449 | 1049 | 33209 | -27 | 33086 |
| 6L-2S | | MI | 5876 | 3160 | 10825 | 2361 | 12983 | 1908 | 14717 | 1511 | 17682 | 812 | 20587 | 337 | 18477 |
| 14-#10 | 2.22 | MA | 9226 | 2283 | 12577 | 2007 | 15561 | 1682 | 17403 | 1413 | 19665 | 984 | 24730 | 697 | 16854 |
| 4L-5S | | MI | 4226 | 2283 | 6254 | 1894 | 7312 | 1581 | 7920 | 1320 | 8587 | 909 | 10218 | 522 | 7482 |
| 14-#10 | 2.22 | MA | 8908 | 2283 | 12085 | 2020 | 14901 | 1695 | 16583 | 1425 | 18524 | 1002 | 23172 | 659 | 16501 |
| 5L-4S | | MI | 4326 | 2283 | 6470 | 1885 | 7608 | 1575 | 8287 | 1315 | 9096 | 900 | 10878 | 577 | 7649 |
| 14-#10 | 2.22 | MA | 8595 | 2283 | 11485 | 2034 | 14260 | 1707 | 15781 | 1444 | 17410 | 1013 | 21671 | 595 | 15865 |
| 6L-3S | | MI | 4427 | 2283 | 6713 | 1877 | 7943 | 1561 | 8697 | 1303 | 9656 | 899 | 11544 | 626 | 7669 |
| 14-#10 | 2.22 | MA | 8325 | 2283 | 10975 | 2043 | 13553 | 1721 | 14990 | 1455 | 16330 | 1030 | 20217 | 562 | 15249 |
| 7L-2S | | MI | 4608 | 2283 | 7057 | 1868 | 8380 | 1554 | 9227 | 1298 | 10372 | 890 | 12481 | 718 | 7672 |
| 14-#11 | 2.73 | MA | 9264 | 2401 | 12987 | 2093 | 15948 | 1751 | 17810 | 1461 | 20139 | 999 | 25427 | 605 | 19644 |
| 5L-4S | | MI | 4456 | 2401 | 6895 | 1943 | 8083 | 1616 | 8833 | 1337 | 9808 | 883 | 11642 | 490 | 9105 |
| 14-#11 | 2.73 | MA | 8897 | 2401 | 12257 | 2110 | 15176 | 1765 | 16833 | 1484 | 18782 | 1012 | 23595 | 524 | 18911 |
| 6L-3S | | MI | 4572 | 2401 | 7186 | 1934 | 8486 | 1600 | 9326 | 1324 | 10481 | 883 | 12422 | 547 | 9148 |
| 14-#11 | 2.73 | MA | 8578 | 2401 | 11636 | 2121 | 14316 | 1783 | 15881 | 1497 | 17466 | 1033 | 21814 | 482 | 17874 |
| 7L-2S | | MI | 4781 | 2401 | 7599 | 1925 | 9009 | 1593 | 9961 | 1320 | 11337 | 875 | 13512 | 661 | 9162 |
| 14-#14 | 3.94 | MA | 10145 | 2681 | 15034 | 2283 | 18433 | 1896 | 20781 | 1558 | 24101 | 1004 | 31013 | 485 | 27085 |
| 5L-4S | | MI | 4827 | 2681 | 7844 | 2111 | 9234 | 1740 | 10206 | 1413 | 11640 | 862 | 13823 | 320 | 12233 |
| 14-#14 | 3.94 | MA | 9654 | 2681 | 13990 | 2307 | 17335 | 1917 | 19379 | 1590 | 22155 | 1020 | 28382 | 367 | 25510 |
| 6L-3S | | MI | 4969 | 2681 | 8259 | 2099 | 9806 | 1719 | 10905 | 1396 | 12596 | 864 | 14909 | 401 | 12710 |
| 14-#14 | 3.94 | MA | 9228 | 2681 | 13101 | 2323 | 16104 | 1942 | 18028 | 1610 | 20268 | 1050 | 25816 | 306 | 23862 |
| 7L-2S | | MI | 5227 | 2681 | 8842 | 2087 | 10546 | 1711 | 11803 | 1391 | 13807 | 854 | 16419 | 564 | 12768 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis

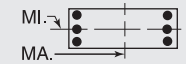



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 7.00 | MA | 11538 | 3391 | 18271 | 2807 | 22677 | 2300 | 25690 | 1858 | 30526 | 1038 | 40239 | -42 | 39974 |
| 6L-3S | | MI | 5870 | 3391 | 10825 | 2523 | 12983 | 2024 | 14717 | 1580 | 17682 | 812 | 20587 | -27 | 20532 |
| 16-#10 | 2.54 | MA | 9302 | 2357 | 12890 | 2066 | 15923 | 1729 | 17821 | 1446 | 20195 | 999 | 25486 | 655 | 18858 |
| 5E | | MI | 4379 | 2357 | 6598 | 1940 | 7749 | 1615 | 8450 | 1342 | 9303 | 905 | 11155 | 510 | 8461 |
| 16-#10 | 2.54 | MA | 9000 | 2357 | 12290 | 2080 | 15281 | 1740 | 17019 | 1466 | 19081 | 1009 | 23985 | 590 | 18238 |
| 6L-4S | | MI | 4478 | 2357 | 6815 | 1931 | 8045 | 1608 | 8817 | 1337 | 9811 | 897 | 11815 | 565 | 8663 |
| 16-#10 | 2.54 | MA | 8741 | 2357 | 11780 | 2089 | 14575 | 1755 | 16228 | 1476 | 18001 | 1027 | 22531 | 557 | 17614 |
| 7L-3S | | MI | 4575 | 2357 | 7057 | 1923 | 8380 | 1595 | 9227 | 1325 | 10372 | 895 | 12481 | 614 | 8690 |
| 16-#10 | 2.54 | MA | 8467 | 2357 | 11291 | 2100 | 13919 | 1765 | 15400 | 1491 | 16924 | 1038 | 21117 | 513 | 16804 |
| 8L-2S | | MI | 4752 | 2357 | 7402 | 1914 | 8818 | 1588 | 9758 | 1320 | 11087 | 887 | 13418 | 706 | 8700 |
| 16-#11 | 3.12 | MA | 9378 | 2492 | 13235 | 2167 | 16416 | 1806 | 18336 | 1510 | 20812 | 1007 | 26406 | 518 | 21793 |
| 6L-4S | | MI | 4633 | 2492 | 7307 | 2000 | 8606 | 1657 | 9468 | 1363 | 10664 | 878 | 12732 | 471 | 10262 |
| 16-#11 | 3.12 | MA | 9075 | 2492 | 12614 | 2178 | 15557 | 1824 | 17385 | 1523 | 19496 | 1028 | 24624 | 476 | 20745 |
| 7L-3S | | MI | 4745 | 2492 | 7599 | 1990 | 9009 | 1641 | 9961 | 1350 | 11337 | 879 | 13512 | 528 | 10365 |
| 16-#11 | 3.12 | MA | 8750 | 2492 | 12018 | 2191 | 14759 | 1835 | 16377 | 1541 | 18182 | 1041 | 22896 | 420 | 19703 |
| 8L-2S | | MI | 4947 | 2492 | 8011 | 1981 | 9533 | 1635 | 10595 | 1346 | 12193 | 870 | 14602 | 642 | 10387 |
| 16-#14 | 4.50 | MA | 10323 | 2812 | 15389 | 2389 | 19110 | 1976 | 21530 | 1628 | 25059 | 1014 | 32403 | 358 | 29602 |
| 6L-4S | | MI | 5070 | 2812 | 8428 | 2193 | 9974 | 1800 | 11103 | 1451 | 12851 | 855 | 15334 | 288 | 13876 |
| 16-#14 | 4.50 | MA | 9923 | 2812 | 14499 | 2404 | 17879 | 2001 | 20179 | 1648 | 23172 | 1043 | 29837 | 297 | 27939 |
| 7L-3S | | MI | 5201 | 2812 | 8842 | 2181 | 10546 | 1779 | 11803 | 1434 | 13807 | 858 | 16419 | 369 | 14419 |
| 16-#14 | 4.50 | MA | 9467 | 2812 | 13645 | 2422 | 16735 | 2017 | 18735 | 1673 | 21288 | 1060 | 27355 | 214 | 26011 |
| 8L-2S | | MI | 5448 | 2812 | 9425 | 2169 | 11286 | 1770 | 12700 | 1429 | 15018 | 848 | 17929 | 532 | 14490 |
| 18-#10 | 2.86 | MA | 9396 | 2431 | 13095 | 2126 | 16303 | 1774 | 18257 | 1487 | 20752 | 1006 | 26299 | 586 | 20614 |
| 6L-5S | | MI | 4529 | 2431 | 6943 | 1986 | 8187 | 1649 | 8981 | 1363 | 10019 | 902 | 12092 | 498 | 9445 |
| 18-#10 | 2.86 | MA | 9148 | 2431 | 12585 | 2136 | 15596 | 1789 | 17466 | 1497 | 19673 | 1023 | 24845 | 552 | 19979 |
| 7L-4S | | MI | 4628 | 2431 | 7160 | 1977 | 8483 | 1642 | 9347 | 1358 | 10527 | 893 | 12752 | 553 | 9675 |
| 18-#10 | 2.86 | MA | 8877 | 2431 | 12096 | 2146 | 14941 | 1798 | 16638 | 1513 | 18595 | 1034 | 23431 | 508 | 19172 |
| 8L-3S | | MI | 4721 | 2431 | 7402 | 1969 | 8818 | 1628 | 9758 | 1346 | 11087 | 892 | 13418 | 602 | 9709 |
| 18-#10 | 2.86 | MA | 8576 | 2431 | 11609 | 2156 | 14304 | 1808 | 15834 | 1522 | 17534 | 1052 | 22050 | 464 | 18296 |
| 9L-2S | | MI | 4894 | 2431 | 7747 | 1960 | 9255 | 1621 | 10288 | 1341 | 11803 | 883 | 14355 | 694 | 9724 |
| 18-#11 | 3.51 | MA | 9559 | 2582 | 13592 | 2234 | 16798 | 1865 | 18889 | 1549 | 21526 | 1024 | 27435 | 470 | 23616 |
| 7L-4S | | MI | 4808 | 2582 | 7719 | 2056 | 9130 | 1698 | 10102 | 1389 | 11520 | 874 | 13822 | 452 | 11423 |
| 18-#11 | 3.51 | MA | 9239 | 2582 | 12996 | 2247 | 15999 | 1876 | 17881 | 1567 | 20212 | 1036 | 25707 | 414 | 22564 |
| 8L-3S | | MI | 4922 | 2582 | 8011 | 2047 | 9533 | 1683 | 10595 | 1376 | 12193 | 874 | 14602 | 509 | 11580 |
| 18-#11 | 3.51 | MA | 8885 | 2582 | 12409 | 2260 | 15224 | 1888 | 16902 | 1578 | 18919 | 1057 | 24014 | 360 | 21410 |
| 9L-2S | | MI | 5109 | 2582 | 8424 | 2038 | 10056 | 1676 | 11229 | 1372 | 13050 | 866 | 15693 | 623 | 11609 |
| 18-#14 | 5.06 | MA | 10599 | 2942 | 15898 | 2486 | 19654 | 2061 | 22330 | 1686 | 26075 | 1037 | 33858 | 289 | 32015 |
| 7L-4S | | MI | 5309 | 2942 | 9011 | 2274 | 10714 | 1859 | 12000 | 1489 | 14062 | 849 | 16844 | 256 | 15528 |
| 18-#14 | 5.06 | MA | 10150 | 2942 | 15044 | 2504 | 18510 | 2076 | 20886 | 1711 | 24192 | 1054 | 31375 | 206 | 30098 |
| 8L-3S | | MI | 5431 | 2942 | 9425 | 2262 | 11286 | 1838 | 12700 | 1471 | 15018 | 852 | 17929 | 337 | 16127 |
| 18-#14 | 5.06 | MA | 9674 | 2942 | 14209 | 2522 | 17398 | 2093 | 19483 | 1725 | 22337 | 1083 | 28937 | 126 | 28133 |
| 9L-2S | | MI | 5668 | 2942 | 10009 | 2250 | 12026 | 1830 | 13597 | 1466 | 16229 | 842 | 19439 | 500 | 16210 |
| 20-#10 | 3.17 | MA | 9546 | 2504 | 13390 | 2182 | 16618 | 1822 | 18704 | 1519 | 21344 | 1020 | 27159 | 547 | 22344 |
| 7L-5S | | MI | 4678 | 2504 | 7288 | 2032 | 8624 | 1682 | 9511 | 1384 | 10734 | 898 | 13029 | 486 | 10431 |
| 20-#10 | 3.17 | MA | 9278 | 2504 | 12901 | 2192 | 15962 | 1832 | 17876 | 1534 | 20266 | 1031 | 25745 | 504 | 21540 |
| 8L-4S | | MI | 4776 | 2504 | 7505 | 2023 | 8920 | 1676 | 9878 | 1379 | 11243 | 890 | 13689 | 541 | 10687 |
| 20-#10 | 3.17 | MA | 8987 | 2504 | 12414 | 2202 | 15326 | 1842 | 17072 | 1543 | 19205 | 1048 | 24364 | 460 | 20657 |
| 9L-3S | | MI | 4866 | 2504 | 7747 | 2015 | 9255 | 1662 | 10288 | 1367 | 11803 | 888 | 14355 | 590 | 10726 |
| 20-#10 | 3.17 | MA | 8718 | 2504 | 11914 | 2211 | 14662 | 1860 | 16286 | 1553 | 18112 | 1063 | 22860 | 412 | 19801 |
| 10L-2S | | MI | 5035 | 2504 | 8092 | 2006 | 9693 | 1655 | 10818 | 1362 | 12519 | 880 | 15292 | 682 | 10746 |
| 20-#11 | 3.90 | MA | 9717 | 2672 | 13974 | 2304 | 17240 | 1918 | 19385 | 1593 | 22242 | 1032 | 28518 | 408 | 25424 |
| 8L-4S | | MI | 4993 | 2672 | 8132 | 2113 | 9653 | 1740 | 10736 | 1416 | 12376 | 870 | 14913 | 433 | 12589 |
| 20-#11 | 3.90 | MA | 9375 | 2672 | 13387 | 2316 | 16465 | 1930 | 18406 | 1604 | 20949 | 1053 | 26824 | 354 | 24276 |
| 9L-3S | | MI | 5087 | 2672 | 8424 | 2103 | 10056 | 1724 | 11229 | 1402 | 13050 | 870 | 15693 | 490 | 12793 |
| 20-#11 | 3.90 | MA | 9060 | 2672 | 12778 | 2326 | 15656 | 1951 | 17448 | 1615 | 19637 | 1071 | 24987 | 293 | 23023 |
| 10L-2S | | MI | 5269 | 2672 | 8836 | 2094 | 10579 | 1717 | 11863 | 1398 | 13906 | 862 | 16783 | 604 | 12828 |
| 20-#14 | 5.63 | MA | 10816 | 3073 | 16442 | 2585 | 20285 | 2136 | 23037 | 1748 | 27095 | 1048 | 35396 | 197 | 34185 |
| 8L-4S | | MI | 5544 | 3073 | 9594 | 2356 | 11454 | 1919 | 12897 | 1526 | 15273 | 843 | 18354 | 224 | 17186 |

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

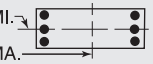
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 5.63 | MA | 10361 | 3073 | 15608 | 2604 | 19173 | 2153 | 21634 | 1763 | 25240 | 1077 | 32958 | 118 | 32209 |
| 9L-3S | | MI | 5657 | 3073 | 10009 | 2344 | 12026 | 1898 | 13597 | 1509 | 16229 | 845 | 19439 | 305 | 17835 |
| 22-#10 | 3.49 | MA | 9672 | 2578 | 13706 | 2238 | 16984 | 1865 | 19114 | 1555 | 21937 | 1027 | 28059 | 499 | 23907 |
| 8L-5S | | MI | 4825 | 2578 | 7633 | 2078 | 9062 | 1716 | 10041 | 1405 | 11450 | 895 | 13966 | 474 | 11420 |
| 22-#10 | 3.49 | MA | 9390 | 2578 | 13219 | 2248 | 16347 | 1876 | 18310 | 1564 | 20876 | 1045 | 26678 | 455 | 23018 |
| 9L-4S | | MI | 4923 | 2578 | 7849 | 2069 | 9358 | 1709 | 10408 | 1400 | 11958 | 886 | 14626 | 529 | 11695 |
| 22-#10 | 3.49 | MA | 9131 | 2578 | 12719 | 2257 | 15684 | 1894 | 17524 | 1574 | 19783 | 1059 | 25174 | 407 | 22156 |
| 10L-3S | | MI | 5009 | 2578 | 8092 | 2061 | 9693 | 1695 | 10818 | 1388 | 12519 | 885 | 15292 | 578 | 11743 |
| 22-#10 | 3.49 | MA | 8872 | 2578 | 12156 | 2273 | 15043 | 1903 | 16726 | 1591 | 18680 | 1067 | 23798 | 361 | 21195 |
| 11L-2S | | MI | 5174 | 2578 | 8436 | 2052 | 10130 | 1689 | 11348 | 1383 | 13234 | 876 | 16229 | 670 | 11767 |
| 22-#11 | 4.29 | MA | 9856 | 2763 | 14365 | 2373 | 17705 | 1971 | 19910 | 1630 | 22979 | 1048 | 29635 | 348 | 27141 |
| 9L-4S | | MI | 5162 | 2763 | 8544 | 2169 | 10176 | 1781 | 11370 | 1442 | 13233 | 866 | 16003 | 414 | 13760 |
| 22-#11 | 4.29 | MA | 9553 | 2763 | 13756 | 2383 | 16897 | 1993 | 18952 | 1641 | 21666 | 1067 | 27798 | 287 | 25881 |
| 10L-3S | | MI | 5251 | 2763 | 8836 | 2160 | 10579 | 1765 | 11863 | 1429 | 13906 | 866 | 16783 | 471 | 14005 |
| 22-#14 | 6.19 | MA | 11033 | 3203 | 17006 | 2685 | 20948 | 2212 | 23785 | 1801 | 28144 | 1071 | 36978 | 109 | 36284 |
| 9L-4S | | MI | 5776 | 3203 | 10177 | 2438 | 12194 | 1978 | 13794 | 1564 | 16484 | 837 | 19864 | 193 | 18850 |
| 24-#10 | 3.81 | MA | 9786 | 2652 | 14024 | 2294 | 17369 | 1909 | 19549 | 1585 | 22547 | 1041 | 28992 | 450 | 25379 |
| 9L-5S | | MI | 4970 | 2652 | 7977 | 2124 | 9499 | 1750 | 10571 | 1427 | 12166 | 891 | 14903 | 462 | 12412 |
| 24-#10 | 3.81 | MA | 9535 | 2652 | 13524 | 2303 | 16705 | 1927 | 18762 | 1595 | 21455 | 1056 | 27488 | 402 | 24510 |
| 10L-4S | | MI | 5068 | 2652 | 8194 | 2115 | 9795 | 1743 | 10938 | 1422 | 12674 | 883 | 15563 | 516 | 12675 |
| 24-#10 | 3.81 | MA | 9279 | 2652 | 12960 | 2319 | 16065 | 1937 | 17965 | 1613 | 20352 | 1064 | 26112 | 356 | 23552 |
| 11L-3S | | MI | 5158 | 2652 | 8436 | 2107 | 10130 | 1729 | 11348 | 1410 | 13234 | 881 | 16229 | 566 | 12758 |
| 24-#11 | 4.68 | MA | 10036 | 2853 | 14734 | 2439 | 18138 | 2034 | 20456 | 1668 | 23696 | 1063 | 30609 | 281 | 28739 |
| 10L-4S | | MI | 5329 | 2853 | 8957 | 2226 | 10700 | 1822 | 12005 | 1468 | 14089 | 861 | 17094 | 395 | 14934 |

## RECTANGULAR TIED COLUMNS 22" x 22"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#9 | 1.24 | MA | 2792 | 1244 | 3951 | 1060 | 4691 | 891 | 5096 | 757 | 5517 | 555 | 6614 | 477 | 3014 |
| 2L-3S | | MI | 2612 | 1244 | 3641 | 1068 | 4297 | 897 | 4619 | 763 | 4873 | 563 | 5737 | 404 | 3023 |
| 6-#10 | 1.57 | MA | 2896 | 1291 | 4208 | 1086 | 5004 | 909 | 5469 | 768 | 6015 | 550 | 7260 | 468 | 3754 |
| 2L-3S | | MI | 2676 | 1291 | 3818 | 1095 | 4508 | 917 | 4868 | 775 | 5204 | 560 | 6164 | 375 | 3756 |
| 6-#11 | 1.93 | MA | 2986 | 1341 | 4486 | 1108 | 5320 | 924 | 5834 | 776 | 6492 | 542 | 7799 | 446 | 4498 |
| 2L-3S | | MI | 2730 | 1341 | 4017 | 1118 | 4724 | 933 | 5112 | 782 | 5518 | 553 | 6516 | 333 | 4490 |
| 6-#14 | 2.79 | MA | 3221 | 1461 | 5103 | 1176 | 6078 | 973 | 6740 | 805 | 7704 | 532 | 9293 | 412 | 6283 |
| 2L-3S | | MI | 2878 | 1461 | 4439 | 1190 | 5234 | 984 | 5717 | 813 | 6324 | 546 | 7505 | 249 | 6217 |
| 6-#18 | 4.96 | MA | 3746 | 1765 | 6590 | 1352 | 7914 | 1100 | 8940 | 883 | 10654 | 510 | 12758 | 307 | 10580 |
| 2L-3S | | MI | 3249 | 1765 | 5449 | 1374 | 6466 | 1116 | 7185 | 892 | 8285 | 528 | 9803 | 16 | 9759 |
| 8-#8 | 1.31 | MA | 2820 | 1253 | 3993 | 1069 | 4757 | 898 | 5182 | 762 | 5639 | 556 | 6804 | 480 | 3173 |
| 2L-4S | | MI | 2598 | 1253 | 3575 | 1081 | 4206 | 913 | 4511 | 776 | 4728 | 565 | 5606 | 390 | 3177 |
| 8-#9 | 1.65 | MA | 2930 | 1302 | 4261 | 1096 | 5084 | 917 | 5573 | 774 | 6161 | 552 | 7491 | 472 | 3946 |
| 2L-4S | | MI | 2658 | 1302 | 3735 | 1111 | 4391 | 936 | 4730 | 790 | 5017 | 563 | 5996 | 357 | 3924 |
| 8-#10 | 2.10 | MA | 3065 | 1364 | 4599 | 1132 | 5500 | 943 | 6070 | 790 | 6826 | 547 | 8355 | 459 | 4923 |
| 2L-4S | | MI | 2735 | 1364 | 3936 | 1151 | 4627 | 966 | 5007 | 809 | 5384 | 560 | 6486 | 315 | 4845 |
| 8-#11 | 2.58 | MA | 3183 | 1431 | 4955 | 1164 | 5915 | 965 | 6555 | 802 | 7466 | 538 | 9083 | 432 | 5897 |
| 2L-4S | | MI | 2800 | 1431 | 4157 | 1186 | 4865 | 991 | 5277 | 824 | 5731 | 551 | 6888 | 257 | 5591 |
| 8-#14 | 3.72 | MA | 3488 | 1591 | 5768 | 1257 | 6921 | 1033 | 7762 | 843 | 9085 | 526 | 11080 | 389 | 8253 |
| 2L-4S | | MI | 2982 | 1591 | 4635 | 1286 | 5430 | 1067 | 5947 | 871 | 6622 | 541 | 8019 | 139 | 7356 |
| 10-#10 | 2.62 | MA | 3231 | 1438 | 4990 | 1178 | 5996 | 976 | 6671 | 811 | 7638 | 543 | 9450 | 451 | 6085 |
| 2L-5S | | MI | 2794 | 1438 | 4083 | 1206 | 4790 | 1007 | 5196 | 837 | 5623 | 567 | 6811 | 253 | 5577 |
| 10-#10 | 2.62 | MA | 3029 | 1438 | 4599 | 1187 | 5500 | 984 | 6070 | 817 | 6826 | 553 | 8355 | 359 | 6062 |
| 3L-4S | | MI | 2917 | 1438 | 4326 | 1197 | 5122 | 999 | 5608 | 831 | 6195 | 557 | 7582 | 307 | 5936 |
| 10-#11 | 3.22 | MA | 3376 | 1522 | 5424 | 1221 | 6510 | 1007 | 7276 | 828 | 8439 | 534 | 10367 | 418 | 7288 |
| 2L-5S | | MI | 2873 | 1522 | 4331 | 1253 | 5058 | 1041 | 5500 | 856 | 6014 | 557 | 7268 | 177 | 6520 |
| 10-#11 | 3.22 | MA | 3144 | 1522 | 4955 | 1231 | 5915 | 1015 | 6555 | 835 | 7466 | 544 | 9083 | 305 | 7246 |
| 3L-4S | | MI | 3014 | 1522 | 4625 | 1242 | 5460 | 1033 | 5998 | 850 | 6704 | 547 | 8172 | 244 | 6903 |
| 10-#14 | 4.65 | MA | 3460 | 1722 | 5768 | 1353 | 6921 | 1103 | 7762 | 889 | 9085 | 534 | 11080 | 201 | 10098 |
| 3L-4S | | MI | 3280 | 1722 | 5300 | 1368 | 6274 | 1127 | 6970 | 909 | 8002 | 535 | 9806 | 115 | 9233 |

## RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis



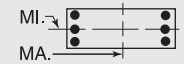

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.18 | MA | 3295 | 1348 | 4656 | 1148 | 5515 | 966 | 5979 | 822 | 6446 | 604 | 7691 | 519 | 3424 |
| 2E | | MI | 2999 | 1348 | 4297 | 1136 | 5046 | 956 | 5446 | 813 | 5843 | 597 | 6875 | 504 | 3110 |
| 4-#14 | 1.70 | MA | 3482 | 1428 | 5132 | 1192 | 6090 | 996 | 6661 | 840 | 7355 | 596 | 8848 | 500 | 4785 |
| 2E | | MI | 3162 | 1428 | 4721 | 1179 | 5556 | 986 | 6051 | 831 | 6648 | 589 | 7862 | 480 | 4326 |
| 4-#18 | 3.03 | MA | 3913 | 1631 | 6277 | 1305 | 7487 | 1077 | 8326 | 888 | 9579 | 578 | 11570 | 440 | 8072 |
| 2E | | MI | 3531 | 1631 | 5737 | 1291 | 6790 | 1066 | 7519 | 878 | 8608 | 570 | 10156 | 407 | 7248 |
| 6-#9 | 1.14 | MA | 3302 | 1341 | 4578 | 1157 | 5471 | 974 | 5954 | 830 | 6436 | 612 | 7759 | 533 | 3338 |
| 2L-3S | | MI | 2827 | 1341 | 3915 | 1154 | 4616 | 971 | 4952 | 827 | 5199 | 614 | 6099 | 449 | 3044 |
| 6-#9 | 1.14 | MA | 3098 | 1341 | 4232 | 1165 | 5032 | 981 | 5421 | 836 | 5717 | 622 | 6763 | 461 | 3347 |
| 3L-2S | | MI | 3007 | 1341 | 4225 | 1146 | 5010 | 964 | 5429 | 822 | 5843 | 606 | 6976 | 522 | 3032 |
| 6-#10 | 1.44 | MA | 3422 | 1388 | 4867 | 1183 | 5823 | 992 | 6372 | 841 | 6995 | 608 | 8525 | 528 | 4165 |
| 2L-3S | | MI | 2890 | 1388 | 4094 | 1181 | 4828 | 991 | 5201 | 839 | 5530 | 611 | 6526 | 420 | 3782 |
| 6-#10 | 1.44 | MA | 3172 | 1388 | 4430 | 1193 | 5269 | 1001 | 5701 | 848 | 6088 | 619 | 7270 | 435 | 4168 |
| 3L-2S | | MI | 3112 | 1388 | 4484 | 1172 | 5323 | 983 | 5802 | 832 | 6341 | 601 | 7621 | 512 | 3775 |
| 6-#11 | 1.77 | MA | 3528 | 1438 | 5181 | 1205 | 6182 | 1007 | 6787 | 848 | 7537 | 600 | 9169 | 509 | 5004 |
| 2L-3S | | MI | 2944 | 1438 | 4297 | 1204 | 5046 | 1005 | 5446 | 846 | 5843 | 604 | 6875 | 377 | 4523 |
| 6-#11 | 1.77 | MA | 3236 | 1438 | 4656 | 1217 | 5515 | 1017 | 5979 | 856 | 6446 | 613 | 7691 | 396 | 4995 |
| 3L-2S | | MI | 3203 | 1438 | 4766 | 1193 | 5641 | 997 | 6167 | 839 | 6817 | 593 | 8158 | 490 | 4524 |
| 6-#14 | 2.56 | MA | 3800 | 1558 | 5878 | 1273 | 7037 | 1056 | 7809 | 878 | 8905 | 590 | 10916 | 483 | 7012 |
| 2L-3S | | MI | 3092 | 1558 | 4721 | 1275 | 5556 | 1056 | 6051 | 876 | 6648 | 596 | 7862 | 293 | 6266 |
| 6-#14 | 2.56 | MA | 3408 | 1558 | 5132 | 1289 | 6090 | 1069 | 6661 | 888 | 7355 | 607 | 8848 | 319 | 6946 |
| 3L-2S | | MI | 3440 | 1558 | 5386 | 1261 | 6400 | 1045 | 7074 | 868 | 8028 | 583 | 9650 | 456 | 6315 |
| 6-#18 | 4.55 | MA | 4415 | 1863 | 7563 | 1450 | 9119 | 1183 | 10304 | 955 | 12249 | 567 | 15019 | 397 | 11876 |
| 2L-3S | | MI | 3461 | 1863 | 5737 | 1457 | 6790 | 1187 | 7519 | 954 | 8608 | 577 | 10156 | 59 | 9990 |
| 6-#18 | 4.55 | MA | 3841 | 1863 | 6277 | 1475 | 7487 | 1203 | 8326 | 969 | 9579 | 591 | 11570 | 106 | 11249 |
| 3L-2S | | MI | 3969 | 1863 | 6878 | 1436 | 8238 | 1172 | 9274 | 945 | 10977 | 559 | 13112 | 350 | 10624 |
| 8-#8 | 1.20 | MA | 3334 | 1350 | 4624 | 1166 | 5544 | 980 | 6048 | 835 | 6570 | 614 | 7949 | 534 | 3515 |
| 2L-4S | | MI | 2811 | 1350 | 3848 | 1168 | 4524 | 987 | 4844 | 840 | 5054 | 617 | 5969 | 435 | 3201 |
| 8-#8 | 1.20 | MA | 3173 | 1350 | 4349 | 1173 | 5194 | 986 | 5625 | 840 | 5998 | 621 | 7157 | 478 | 3521 |
| 3E | | MI | 2893 | 1350 | 4020 | 1162 | 4762 | 977 | 5135 | 831 | 5452 | 614 | 6464 | 468 | 3199 |
| 8-#8 | 1.20 | MA | 3082 | 1350 | 4158 | 1179 | 4930 | 997 | 5301 | 849 | 5555 | 625 | 6605 | 444 | 3518 |
| 4L-2S | | MI | 3036 | 1350 | 4267 | 1155 | 5075 | 972 | 5515 | 827 | 5965 | 607 | 7167 | 525 | 3191 |
| 8-#9 | 1.52 | MA | 3460 | 1399 | 4924 | 1193 | 5911 | 1000 | 6487 | 846 | 7156 | 609 | 8755 | 529 | 4378 |
| 2L-4S | | MI | 2872 | 1399 | 4009 | 1198 | 4711 | 1009 | 5063 | 855 | 5343 | 614 | 6358 | 402 | 3956 |
| 8-#9 | 1.52 | MA | 3263 | 1399 | 4578 | 1202 | 5471 | 1007 | 5954 | 853 | 6436 | 619 | 7759 | 457 | 4379 |
| 3E | | MI | 2972 | 1399 | 4225 | 1190 | 5010 | 997 | 5429 | 844 | 5843 | 611 | 6976 | 444 | 3971 |
| 8-#9 | 1.52 | MA | 3152 | 1399 | 4338 | 1210 | 5139 | 1020 | 5547 | 864 | 5879 | 623 | 7063 | 415 | 4356 |
| 4L-2S | | MI | 3146 | 1399 | 4536 | 1182 | 5403 | 991 | 5906 | 838 | 6487 | 603 | 7853 | 516 | 3966 |
| 8-#10 | 1.92 | MA | 3615 | 1461 | 5304 | 1229 | 6377 | 1026 | 7044 | 862 | 7902 | 604 | 9779 | 523 | 5471 |
| 2L-4S | | MI | 2948 | 1461 | 4212 | 1237 | 4946 | 1039 | 5340 | 873 | 5709 | 611 | 6848 | 360 | 4890 |
| 8-#10 | 1.92 | MA | 3376 | 1461 | 4867 | 1239 | 5823 | 1035 | 6372 | 869 | 6995 | 616 | 8525 | 430 | 5460 |
| 3E | | MI | 3070 | 1461 | 4484 | 1227 | 5323 | 1024 | 5802 | 860 | 6341 | 608 | 7621 | 412 | 4940 |
| 8-#10 | 1.92 | MA | 3240 | 1461 | 4564 | 1250 | 5403 | 1051 | 5858 | 884 | 6292 | 621 | 7644 | 376 | 5394 |
| 4L-2S | | MI | 3283 | 1461 | 4875 | 1218 | 5819 | 1016 | 6403 | 854 | 7152 | 598 | 8716 | 504 | 4946 |
| 8-#11 | 2.36 | MA | 3753 | 1529 | 5707 | 1261 | 6848 | 1048 | 7595 | 874 | 8628 | 596 | 10647 | 500 | 6571 |
| 2L-4S | | MI | 3013 | 1529 | 4436 | 1271 | 5186 | 1064 | 5610 | 887 | 6056 | 601 | 7247 | 302 | 5709 |
| 8-#11 | 2.36 | MA | 3476 | 1529 | 5181 | 1273 | 6182 | 1058 | 6787 | 882 | 7537 | 608 | 9169 | 386 | 6543 |
| 3E | | MI | 3155 | 1529 | 4766 | 1260 | 5641 | 1047 | 6167 | 872 | 6817 | 599 | 8158 | 363 | 5906 |
| 8-#11 | 2.36 | MA | 3317 | 1529 | 4815 | 1285 | 5675 | 1077 | 6166 | 899 | 6688 | 612 | 8126 | 322 | 6324 |
| 4L-2S | | MI | 3401 | 1529 | 5235 | 1250 | 6236 | 1038 | 6889 | 865 | 7790 | 588 | 9442 | 476 | 5926 |
| 8-#14 | 3.41 | MA | 4108 | 1689 | 6625 | 1355 | 7984 | 1116 | 8957 | 915 | 10454 | 584 | 12983 | 465 | 9225 |
| 2L-4S | | MI | 3193 | 1689 | 4918 | 1371 | 5753 | 1140 | 6281 | 934 | 6946 | 591 | 8376 | 183 | 7493 |
| 8-#14 | 3.41 | MA | 3739 | 1689 | 5878 | 1371 | 7037 | 1129 | 7809 | 926 | 8905 | 601 | 10916 | 302 | 9129 |
| 3E | | MI | 3383 | 1689 | 5386 | 1356 | 6400 | 1116 | 7074 | 914 | 8028 | 590 | 9650 | 269 | 8208 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis

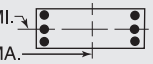


$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 3.41 | MA | 3529 | 1689 | 5356 | 1387 | 6315 | 1154 | 6925 | 948 | 7696 | 605 | 9452 | 212 | 8331 |
| 4L-2S | | MI | 3710 | 1689 | 6051 | 1342 | 7244 | 1105 | 8096 | 906 | 9409 | 576 | 11437 | 432 | 8288 |
| 8-#18 | 6.06 | MA | 4387 | 2095 | 7563 | 1620 | 9119 | 1309 | 10304 | 1036 | 12249 | 580 | 15019 | 63 | 14803 |
| 3E | | MI | 3938 | 2095 | 6878 | 1602 | 8238 | 1293 | 9274 | 1021 | 10977 | 566 | 13112 | 3 | 13103 |
| 8-#18 | 6.06 | MA | 4082 | 2095 | 6656 | 1645 | 7866 | 1350 | 8771 | 1072 | 10154 | 582 | 12560 | -89 | 12421 |
| 4L-2S | | MI | 4395 | 2095 | 8019 | 1581 | 9686 | 1278 | 11029 | 1012 | 13346 | 548 | 16067 | 293 | 13985 |
| 10-#10 | 2.41 | MA | 3804 | 1535 | 5740 | 1275 | 6931 | 1059 | 7716 | 883 | 8808 | 601 | 11034 | 518 | 6771 |
| 2L-5S | | MI | 3008 | 1535 | 4359 | 1292 | 5109 | 1081 | 5529 | 901 | 5949 | 618 | 7172 | 298 | 5666 |
| 10-#10 | 2.41 | MA | 3575 | 1535 | 5304 | 1285 | 6377 | 1068 | 7044 | 891 | 7902 | 612 | 9779 | 425 | 6748 |
| 3L-4S | | MI | 3131 | 1535 | 4602 | 1283 | 5442 | 1073 | 5941 | 895 | 6520 | 608 | 7943 | 352 | 6031 |
| 10-#10 | 2.41 | MA | 3448 | 1535 | 5001 | 1296 | 5958 | 1084 | 6530 | 905 | 7199 | 617 | 8898 | 371 | 6670 |
| 4L-3S | | MI | 3245 | 1535 | 4875 | 1273 | 5819 | 1058 | 6403 | 881 | 7152 | 604 | 8716 | 404 | 6094 |
| 10-#10 | 2.41 | MA | 3303 | 1535 | 4731 | 1306 | 5588 | 1093 | 6072 | 913 | 6563 | 629 | 8015 | 318 | 6256 |
| 5L-2S | | MI | 3450 | 1535 | 5266 | 1264 | 6315 | 1050 | 7004 | 875 | 7963 | 594 | 9812 | 496 | 6111 |
| 10-#11 | 2.95 | MA | 3974 | 1619 | 6232 | 1318 | 7515 | 1090 | 8403 | 900 | 9719 | 591 | 12126 | 490 | 8131 |
| 2L-5S | | MI | 3087 | 1619 | 4611 | 1338 | 5379 | 1114 | 5833 | 919 | 6339 | 608 | 7627 | 221 | 6624 |
| 10-#11 | 2.95 | MA | 3709 | 1619 | 5707 | 1330 | 6848 | 1100 | 7595 | 908 | 8628 | 604 | 10647 | 377 | 8088 |
| 3L-4S | | MI | 3227 | 1619 | 4905 | 1327 | 5781 | 1105 | 6332 | 913 | 7029 | 597 | 8531 | 288 | 7016 |
| 10-#11 | 2.95 | MA | 3562 | 1619 | 5341 | 1342 | 6341 | 1118 | 6974 | 925 | 7779 | 608 | 9604 | 313 | 7799 |
| 4L-3S | | MI | 3360 | 1619 | 5235 | 1317 | 6236 | 1088 | 6889 | 898 | 7790 | 595 | 9442 | 349 | 7285 |
| 10-#11 | 2.95 | MA | 3396 | 1619 | 5014 | 1354 | 5894 | 1128 | 6420 | 933 | 7011 | 621 | 8564 | 247 | 7330 |
| 5L-2S | | MI | 3596 | 1619 | 5703 | 1306 | 6831 | 1080 | 7610 | 892 | 8764 | 584 | 10726 | 463 | 7319 |
| 10-#14 | 4.26 | MA | 4061 | 1819 | 6625 | 1452 | 7984 | 1188 | 8957 | 963 | 10454 | 594 | 12983 | 285 | 11313 |
| 3L-4S | | MI | 3492 | 1819 | 5582 | 1452 | 6596 | 1199 | 7304 | 972 | 8326 | 585 | 10164 | 159 | 9364 |
| 10-#14 | 4.26 | MA | 3870 | 1819 | 6102 | 1468 | 7262 | 1214 | 8073 | 986 | 9245 | 599 | 11519 | 194 | 10447 |
| 4L-3S | | MI | 3665 | 1819 | 6051 | 1438 | 7244 | 1176 | 8096 | 952 | 9409 | 584 | 11437 | 245 | 10151 |
| 10-#14 | 4.26 | MA | 3640 | 1819 | 5636 | 1485 | 6624 | 1227 | 7282 | 996 | 8150 | 616 | 10064 | 99 | 9693 |
| 5L-2S | | MI | 3969 | 1819 | 6716 | 1424 | 8087 | 1164 | 9119 | 944 | 10789 | 570 | 13225 | 409 | 10253 |
| 10-#18 | 7.58 | MA | 4657 | 2326 | 7942 | 1790 | 9498 | 1456 | 10749 | 1139 | 12824 | 571 | 16008 | -132 | 15688 |
| 4L-3S | | MI | 4399 | 2326 | 8019 | 1747 | 9686 | 1399 | 11029 | 1088 | 13346 | 555 | 16067 | -54 | 15932 |
| 12-#10 | 2.89 | MA | 3990 | 1609 | 6177 | 1321 | 7486 | 1093 | 8388 | 904 | 9715 | 597 | 12288 | 513 | 8067 |
| 2L-6S | | MI | 3039 | 1609 | 4477 | 1354 | 5290 | 1122 | 5725 | 936 | 6212 | 624 | 7560 | 230 | 6476 |
| 12-#10 | 2.89 | MA | 3769 | 1609 | 5740 | 1331 | 6931 | 1102 | 7716 | 912 | 8808 | 609 | 11034 | 420 | 8035 |
| 3L-5S | | MI | 3187 | 1609 | 4750 | 1338 | 5605 | 1114 | 6130 | 922 | 6760 | 614 | 8267 | 290 | 6782 |
| 12-#10 | 2.89 | MA | 3650 | 1609 | 5437 | 1342 | 6512 | 1118 | 7202 | 926 | 8106 | 614 | 10153 | 366 | 7929 |
| 4E | | MI | 3309 | 1609 | 4993 | 1329 | 5938 | 1106 | 6542 | 916 | 7332 | 604 | 9038 | 344 | 7134 |
| 12-#10 | 2.89 | MA | 3507 | 1609 | 5168 | 1352 | 6143 | 1127 | 6744 | 934 | 7470 | 625 | 9270 | 313 | 7509 |
| 5L-3S | | MI | 3416 | 1609 | 5266 | 1319 | 6315 | 1091 | 7004 | 903 | 7963 | 601 | 9812 | 396 | 7245 |
| 12-#10 | 2.89 | MA | 3342 | 1609 | 4858 | 1367 | 5793 | 1136 | 6295 | 949 | 6849 | 630 | 8407 | 241 | 7165 |
| 6L-2S | | MI | 3614 | 1609 | 5656 | 1310 | 6811 | 1084 | 7605 | 896 | 8774 | 591 | 10907 | 488 | 7270 |
| 12-#11 | 3.55 | MA | 3937 | 1710 | 6232 | 1386 | 7515 | 1141 | 8403 | 935 | 9719 | 600 | 12126 | 368 | 9632 |
| 3L-5S | | MI | 3297 | 1710 | 5080 | 1395 | 5974 | 1155 | 6555 | 946 | 7312 | 604 | 8911 | 208 | 7964 |
| 12-#11 | 3.55 | MA | 3800 | 1710 | 5866 | 1398 | 7008 | 1160 | 7782 | 951 | 8870 | 604 | 11082 | 303 | 9285 |
| 4E | | MI | 3436 | 1710 | 5374 | 1384 | 6376 | 1147 | 7053 | 939 | 8003 | 593 | 9815 | 274 | 8333 |
| 12-#11 | 3.55 | MA | 3636 | 1710 | 5539 | 1410 | 6561 | 1169 | 7228 | 959 | 8102 | 617 | 10042 | 237 | 8840 |
| 5L-3S | | MI | 3560 | 1710 | 5703 | 1373 | 6831 | 1129 | 7610 | 924 | 8764 | 591 | 10726 | 336 | 8662 |
| 12-#11 | 3.55 | MA | 3442 | 1710 | 5172 | 1429 | 6138 | 1179 | 6685 | 976 | 7366 | 629 | 9087 | 164 | 8273 |
| 6L-2S | | MI | 3787 | 1710 | 6172 | 1363 | 7426 | 1121 | 8331 | 918 | 9737 | 580 | 12010 | 449 | 8708 |
| 12-#14 | 5.11 | MA | 4200 | 1950 | 6849 | 1550 | 8209 | 1274 | 9220 | 1024 | 10795 | 593 | 13587 | 177 | 12576 |
| 4E | | MI | 3803 | 1950 | 6247 | 1534 | 7440 | 1259 | 8326 | 1009 | 9706 | 579 | 11951 | 136 | 11248 |
| 12-#14 | 5.11 | MA | 3973 | 1950 | 6382 | 1566 | 7571 | 1287 | 8430 | 1034 | 9699 | 609 | 12131 | 82 | 11808 |
| 5L-3S | | MI | 3949 | 1950 | 6716 | 1519 | 8087 | 1235 | 9119 | 989 | 10789 | 578 | 13225 | 221 | 12094 |
| 14-#10 | 3.37 | MA | 3959 | 1682 | 6177 | 1377 | 7486 | 1136 | 8388 | 933 | 9715 | 605 | 12288 | 415 | 9321 |
| 3L-6S | | MI | 3220 | 1682 | 4868 | 1400 | 5786 | 1156 | 6326 | 957 | 7023 | 621 | 8655 | 222 | 7582 |
| 14-#10 | 3.37 | MA | 3848 | 1682 | 5874 | 1388 | 7066 | 1152 | 7874 | 948 | 9012 | 610 | 11407 | 361 | 9168 |
| 4L-5S | | MI | 3363 | 1682 | 5141 | 1384 | 6101 | 1148 | 6731 | 944 | 7571 | 611 | 9363 | 282 | 7902 |
| 14-#10 | 3.37 | MA | 3706 | 1682 | 5605 | 1398 | 6697 | 1161 | 7416 | 955 | 8377 | 622 | 10524 | 308 | 8767 |
| 5L-4S | | MI | 3483 | 1682 | 5384 | 1375 | 6434 | 1140 | 7143 | 937 | 8143 | 601 | 10134 | 335 | 8236 |

## RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 3.37 | MA | 3547 | 1682 | 5295 | 1413 | 6348 | 1169 | 6967 | 970 | 7755 | 626 | 9661 | 236 | 8412 |
| 6L-3S | | MI | 3585 | 1682 | 5656 | 1365 | 6811 | 1125 | 7605 | 924 | 8774 | 597 | 10907 | 387 | 8395 |
| 14-#11 | 4.14 | MA | 4033 | 1800 | 6391 | 1455 | 7675 | 1201 | 8590 | 977 | 9961 | 599 | 12561 | 294 | 10778 |
| 4L-5S | | MI | 3503 | 1800 | 5549 | 1451 | 6569 | 1196 | 7276 | 972 | 8286 | 599 | 10195 | 194 | 9310 |
| 14-#11 | 4.14 | MA | 3870 | 1800 | 6065 | 1467 | 7228 | 1211 | 8036 | 985 | 9193 | 612 | 11520 | 228 | 10356 |
| 5L-4S | | MI | 3641 | 1800 | 5843 | 1441 | 6971 | 1188 | 7774 | 965 | 8976 | 588 | 11098 | 261 | 9659 |
| 14-#11 | 4.14 | MA | 3685 | 1800 | 5697 | 1486 | 6805 | 1221 | 7493 | 1002 | 8456 | 625 | 10566 | 154 | 9774 |
| 6L-3S | | MI | 3767 | 1800 | 6172 | 1430 | 7426 | 1171 | 8331 | 950 | 9737 | 586 | 12010 | 322 | 10038 |
| 14-#14 | 5.97 | MA | 4298 | 2080 | 7129 | 1648 | 8518 | 1346 | 9578 | 1072 | 11249 | 603 | 14199 | 64 | 13930 |
| 5L-4S | | MI | 4085 | 2080 | 6912 | 1615 | 8284 | 1318 | 9349 | 1047 | 11087 | 573 | 13739 | 112 | 13143 |
| 16-#10 | 3.85 | MA | 4042 | 1756 | 6311 | 1434 | 7620 | 1185 | 8545 | 969 | 9919 | 607 | 12661 | 356 | 10413 |
| 4L-6S | | MI | 3398 | 1756 | 5259 | 1446 | 6282 | 1190 | 6927 | 978 | 7834 | 617 | 9750 | 214 | 8692 |
| 16-#10 | 3.85 | MA | 3901 | 1756 | 6041 | 1444 | 7251 | 1194 | 8087 | 977 | 9284 | 618 | 11779 | 303 | 10028 |
| 5E | | MI | 3535 | 1756 | 5531 | 1431 | 6597 | 1182 | 7332 | 965 | 8382 | 607 | 10458 | 273 | 9025 |
| 16-#10 | 3.85 | MA | 3748 | 1756 | 5731 | 1459 | 6902 | 1203 | 7639 | 991 | 8662 | 623 | 10916 | 231 | 9663 |
| 6L-4S | | MI | 3655 | 1756 | 5775 | 1421 | 6930 | 1174 | 7744 | 958 | 8954 | 597 | 11229 | 327 | 9345 |
| 16-#11 | 4.73 | MA | 4099 | 1890 | 6590 | 1523 | 7895 | 1252 | 8845 | 1011 | 10284 | 608 | 12999 | 219 | 11876 |
| 5E | | MI | 3705 | 1890 | 6018 | 1508 | 7164 | 1238 | 7997 | 998 | 9260 | 595 | 11478 | 180 | 10660 |
| 16-#11 | 4.73 | MA | 3922 | 1890 | 6223 | 1542 | 7472 | 1262 | 8301 | 1028 | 9547 | 621 | 12044 | 145 | 11281 |
| 6L-4S | | MI | 3858 | 1890 | 6312 | 1497 | 7566 | 1229 | 8495 | 991 | 9950 | 584 | 12382 | 247 | 10991 |
| 18-#10 | 4.33 | MA | 4093 | 1830 | 6478 | 1490 | 7805 | 1228 | 8759 | 998 | 10191 | 615 | 13033 | 298 | 11293 |
| 5L-6S | | MI | 3572 | 1830 | 5650 | 1492 | 6778 | 1223 | 7528 | 999 | 8646 | 614 | 10846 | 206 | 9805 |
| 18-#10 | 4.33 | MA | 3946 | 1830 | 6168 | 1505 | 7456 | 1237 | 8310 | 1012 | 9569 | 619 | 12170 | 226 | 10916 |
| 6L-5S | | MI | 3704 | 1830 | 5922 | 1477 | 7093 | 1215 | 7933 | 986 | 9193 | 604 | 11553 | 265 | 10152 |
| 18-#11 | 5.32 | MA | 4154 | 1981 | 6748 | 1599 | 8139 | 1303 | 9109 | 1054 | 10638 | 616 | 13522 | 135 | 12792 |
| 6L-5S | | MI | 3917 | 1981 | 6487 | 1564 | 7759 | 1279 | 8718 | 1024 | 10233 | 591 | 12762 | 166 | 12014 |

## RECTANGULAR TIED COLUMNS 22" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.09 | MA | 3846 | 1445 | 5334 | 1246 | 6358 | 1049 | 6903 | 894 | 7434 | 662 | 8936 | 576 | 3761 |
| 2E | | MI | 3214 | 1445 | 4577 | 1222 | 5367 | 1028 | 5780 | 877 | 6168 | 648 | 7234 | 548 | 3131 |
| 4-#14 | 1.57 | MA | 4060 | 1525 | 5864 | 1289 | 6999 | 1079 | 7664 | 912 | 8447 | 654 | 10266 | 561 | 5271 |
| 2E | | MI | 3378 | 1525 | 5004 | 1264 | 5879 | 1058 | 6385 | 894 | 6972 | 639 | 8219 | 524 | 4353 |
| 4-#18 | 2.80 | MA | 4553 | 1728 | 7145 | 1402 | 8561 | 1160 | 9526 | 961 | 10934 | 636 | 13416 | 513 | 8936 |
| 2E | | MI | 3751 | 1728 | 6024 | 1374 | 7115 | 1137 | 7853 | 940 | 8930 | 620 | 10510 | 450 | 7288 |
| 6-#9 | 1.05 | MA | 3852 | 1438 | 5244 | 1254 | 6305 | 1057 | 6870 | 902 | 7416 | 670 | 8931 | 583 | 3662 |
| 2L-3S | | MI | 3041 | 1438 | 4190 | 1240 | 4935 | 1045 | 5285 | 891 | 5525 | 665 | 6461 | 494 | 3063 |
| 6-#9 | 1.05 | MA | 3623 | 1438 | 4861 | 1263 | 5819 | 1064 | 6281 | 909 | 6621 | 680 | 7831 | 513 | 3671 |
| 3L-2S | | MI | 3223 | 1438 | 4500 | 1233 | 5329 | 1038 | 5762 | 886 | 6169 | 657 | 7338 | 567 | 3050 |
| 6-#10 | 1.33 | MA | 3987 | 1485 | 5564 | 1280 | 6695 | 1075 | 7334 | 913 | 8035 | 665 | 9783 | 578 | 4577 |
| 2L-3S | | MI | 3104 | 1485 | 4370 | 1267 | 5147 | 1064 | 5535 | 903 | 5855 | 662 | 6887 | 465 | 3806 |
| 6-#10 | 1.33 | MA | 3707 | 1485 | 5082 | 1291 | 6082 | 1085 | 6592 | 921 | 7033 | 678 | 8395 | 489 | 4579 |
| 3L-2S | | MI | 3328 | 1485 | 4760 | 1258 | 5643 | 1056 | 6136 | 897 | 6666 | 652 | 7982 | 557 | 3795 |
| 6-#11 | 1.64 | MA | 4110 | 1535 | 5916 | 1302 | 7096 | 1090 | 7799 | 921 | 8642 | 657 | 10609 | 570 | 5509 |
| 2L-3S | | MI | 3158 | 1535 | 4577 | 1289 | 5367 | 1078 | 5780 | 909 | 6168 | 654 | 7234 | 421 | 4555 |
| 6-#11 | 1.64 | MA | 3781 | 1535 | 5334 | 1315 | 6358 | 1101 | 6903 | 930 | 7434 | 672 | 8936 | 457 | 5501 |
| 3L-2S | | MI | 3419 | 1535 | 5045 | 1278 | 5962 | 1070 | 6501 | 903 | 7141 | 643 | 8517 | 534 | 4549 |
| 6-#14 | 2.36 | MA | 4420 | 1655 | 6692 | 1370 | 8049 | 1139 | 8937 | 950 | 10166 | 648 | 12614 | 549 | 7741 |
| 2L-3S | | MI | 3306 | 1655 | 5004 | 1360 | 5879 | 1129 | 6385 | 939 | 6972 | 646 | 8219 | 337 | 6311 |
| 6-#14 | 2.36 | MA | 3977 | 1655 | 5864 | 1388 | 6999 | 1154 | 7664 | 962 | 8447 | 667 | 10266 | 386 | 7675 |
| 3L-2S | | MI | 3658 | 1655 | 5669 | 1345 | 6723 | 1118 | 7407 | 931 | 8352 | 633 | 10007 | 500 | 6346 |
| 6-#18 | 4.20 | MA | 5130 | 1960 | 8575 | 1547 | 10377 | 1266 | 11727 | 1028 | 13905 | 625 | 17361 | 480 | 13172 |
| 2L-3S | | MI | 3673 | 1960 | 6024 | 1541 | 7115 | 1258 | 7853 | 1016 | 8930 | 627 | 10510 | 103 | 10216 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 26"

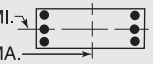
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 4.20 | MA | 4447 | 1960 | 7145 | 1575 | 8561 | 1289 | 9526 | 1045 | 10934 | 654 | 13416 | 190 | 12787 |
| 3L-2S | | MI | 4192 | 1960 | 7165 | 1519 | 8563 | 1243 | 9608 | 1007 | 11299 | 609 | 13465 | 393 | 10667 |
| 8-#8 | 1.10 | MA | 3887 | 1447 | 5294 | 1263 | 6384 | 1063 | 6973 | 907 | 7562 | 671 | 9138 | 584 | 3856 |
| 2L-4S | | MI | 3025 | 1447 | 4121 | 1255 | 4842 | 1061 | 5177 | 905 | 5381 | 668 | 6332 | 480 | 3224 |
| 8-#8 | 1.10 | MA | 3707 | 1447 | 4990 | 1270 | 5998 | 1070 | 6505 | 913 | 6930 | 680 | 8263 | 530 | 3862 |
| 3E | | MI | 3108 | 1447 | 4293 | 1248 | 5080 | 1051 | 5468 | 896 | 5779 | 666 | 6827 | 513 | 3218 |
| 8-#8 | 1.10 | MA | 3605 | 1447 | 4781 | 1278 | 5707 | 1081 | 6150 | 923 | 6443 | 684 | 7661 | 497 | 3859 |
| 4L-2S | | MI | 3252 | 1447 | 4540 | 1242 | 5393 | 1046 | 5848 | 891 | 6291 | 659 | 7530 | 570 | 3209 |
| 8-#9 | 1.40 | MA | 4030 | 1496 | 5627 | 1290 | 6790 | 1083 | 7459 | 919 | 8210 | 667 | 10031 | 579 | 4810 |
| 2L-4S | | MI | 3085 | 1496 | 4284 | 1284 | 5030 | 1083 | 5396 | 919 | 5668 | 665 | 6720 | 447 | 3986 |
| 8-#9 | 1.40 | MA | 3809 | 1496 | 5244 | 1299 | 6305 | 1091 | 6870 | 926 | 7416 | 677 | 8931 | 510 | 4811 |
| 3E | | MI | 3186 | 1496 | 4500 | 1277 | 5329 | 1071 | 5762 | 908 | 6169 | 663 | 7338 | 489 | 3994 |
| 8-#9 | 1.40 | MA | 3685 | 1496 | 4980 | 1308 | 5939 | 1104 | 6422 | 938 | 6803 | 682 | 8171 | 468 | 4788 |
| 4L-2S | | MI | 3363 | 1496 | 4810 | 1269 | 5722 | 1065 | 6240 | 903 | 6813 | 654 | 8215 | 561 | 3986 |
| 8-#10 | 1.78 | MA | 4206 | 1559 | 6047 | 1326 | 7307 | 1109 | 8077 | 934 | 9038 | 662 | 11171 | 574 | 6020 |
| 2L-4S | | MI | 3161 | 1559 | 4488 | 1323 | 5266 | 1113 | 5674 | 937 | 6035 | 662 | 7209 | 405 | 4931 |
| 8-#10 | 1.78 | MA | 3937 | 1559 | 5564 | 1337 | 6695 | 1118 | 7334 | 943 | 8035 | 675 | 9783 | 484 | 6008 |
| 3E | | MI | 3285 | 1559 | 4760 | 1314 | 5643 | 1098 | 6136 | 924 | 6666 | 659 | 7982 | 457 | 4968 |
| 8-#10 | 1.78 | MA | 3786 | 1559 | 5231 | 1348 | 6233 | 1135 | 6768 | 958 | 7261 | 681 | 8820 | 430 | 5943 |
| 4L-2S | | MI | 3500 | 1559 | 5151 | 1304 | 6139 | 1090 | 6737 | 918 | 7478 | 649 | 9078 | 549 | 4969 |
| 8-#11 | 2.18 | MA | 4365 | 1626 | 6498 | 1359 | 7835 | 1131 | 8694 | 947 | 9851 | 653 | 12282 | 564 | 7245 |
| 2L-4S | | MI | 3225 | 1626 | 4716 | 1356 | 5507 | 1137 | 5944 | 950 | 6380 | 652 | 7606 | 346 | 5822 |
| 8-#11 | 2.18 | MA | 4052 | 1626 | 5916 | 1372 | 7096 | 1142 | 7799 | 956 | 8642 | 667 | 10609 | 451 | 7217 |
| 3E | | MI | 3370 | 1626 | 5045 | 1346 | 5962 | 1119 | 6501 | 935 | 7141 | 650 | 8517 | 407 | 5941 |
| 8-#11 | 2.18 | MA | 3875 | 1626 | 5513 | 1384 | 6537 | 1162 | 7114 | 974 | 7706 | 673 | 9435 | 384 | 7073 |
| 4L-2S | | MI | 3619 | 1626 | 5514 | 1335 | 6557 | 1111 | 7222 | 929 | 8115 | 639 | 9801 | 521 | 5953 |
| 8-#14 | 3.15 | MA | 4768 | 1786 | 7520 | 1452 | 9100 | 1199 | 10211 | 988 | 11885 | 641 | 14963 | 538 | 10197 |
| 2L-4S | | MI | 3405 | 1786 | 5200 | 1455 | 6075 | 1212 | 6615 | 997 | 7270 | 642 | 8733 | 227 | 7626 |
| 8-#14 | 3.15 | MA | 4352 | 1786 | 6692 | 1469 | 8049 | 1213 | 8937 | 1000 | 10166 | 661 | 12614 | 374 | 10101 |
| 3E | | MI | 3598 | 1786 | 5669 | 1441 | 6723 | 1188 | 7407 | 977 | 8352 | 640 | 10007 | 313 | 8257 |
| 8-#14 | 3.15 | MA | 4116 | 1786 | 6116 | 1487 | 7252 | 1241 | 7961 | 1025 | 8830 | 667 | 10960 | 280 | 9326 |
| 4L-2S | | MI | 3930 | 1786 | 6333 | 1427 | 7566 | 1177 | 8430 | 969 | 9732 | 626 | 11795 | 476 | 8322 |
| 8-#18 | 5.59 | MA | 5094 | 2192 | 8575 | 1720 | 10377 | 1395 | 11727 | 1112 | 13905 | 643 | 17361 | 157 | 16775 |
| 3E | | MI | 4152 | 2192 | 7165 | 1686 | 8563 | 1364 | 9608 | 1083 | 11299 | 615 | 13465 | 46 | 13317 |
| 8-#18 | 5.59 | MA | 4709 | 2192 | 7573 | 1748 | 8990 | 1440 | 10029 | 1152 | 11585 | 650 | 14565 | -2 | 14561 |
| 4L-2S | | MI | 4621 | 2192 | 8306 | 1664 | 10011 | 1349 | 11363 | 1074 | 13668 | 598 | 16421 | 337 | 14031 |
| 10-#10 | 2.22 | MA | 4419 | 1632 | 6530 | 1372 | 7920 | 1142 | 8819 | 956 | 10040 | 658 | 12559 | 569 | 7457 |
| 2L-5S | | MI | 3221 | 1632 | 4635 | 1379 | 5429 | 1154 | 5862 | 965 | 6274 | 669 | 7533 | 343 | 5753 |
| 10-#10 | 2.22 | MA | 4161 | 1632 | 6047 | 1383 | 7307 | 1152 | 8077 | 964 | 9038 | 671 | 11171 | 479 | 7434 |
| 3L-4S | | MI | 3345 | 1632 | 4878 | 1369 | 5762 | 1146 | 6275 | 959 | 6846 | 659 | 8304 | 396 | 6073 |
| 10-#10 | 2.22 | MA | 4019 | 1632 | 5714 | 1394 | 6846 | 1169 | 7511 | 979 | 8263 | 677 | 10208 | 426 | 7356 |
| 4L-3S | | MI | 3461 | 1632 | 5151 | 1360 | 6139 | 1131 | 6737 | 945 | 7478 | 655 | 9078 | 448 | 6124 |
| 10-#10 | 2.22 | MA | 3853 | 1632 | 5418 | 1406 | 6440 | 1179 | 7007 | 988 | 7565 | 690 | 9240 | 375 | 6945 |
| 5L-2S | | MI | 3668 | 1632 | 5542 | 1350 | 6635 | 1123 | 7338 | 939 | 8289 | 645 | 10173 | 541 | 6135 |
| 10-#11 | 2.73 | MA | 4614 | 1716 | 7080 | 1415 | 8574 | 1173 | 9589 | 973 | 11059 | 649 | 13956 | 558 | 8973 |
| 2L-5S | | MI | 3300 | 1716 | 4891 | 1423 | 5700 | 1187 | 6167 | 983 | 6664 | 658 | 7986 | 266 | 6722 |
| 10-#11 | 2.73 | MA | 4315 | 1716 | 6498 | 1428 | 7835 | 1184 | 8694 | 982 | 9851 | 663 | 12282 | 445 | 8930 |
| 3L-4S | | MI | 3441 | 1716 | 5185 | 1413 | 6102 | 1178 | 6665 | 976 | 7354 | 648 | 8890 | 332 | 7125 |
| 10-#11 | 2.73 | MA | 4151 | 1716 | 6095 | 1441 | 7276 | 1203 | 8009 | 1000 | 8914 | 669 | 11108 | 378 | 8713 |
| 4L-3S | | MI | 3575 | 1716 | 5514 | 1402 | 6557 | 1161 | 7222 | 961 | 8115 | 645 | 9801 | 394 | 7322 |
| 10-#11 | 2.73 | MA | 3958 | 1716 | 5736 | 1454 | 6784 | 1214 | 7399 | 1009 | 8068 | 683 | 9931 | 313 | 8150 |
| 5L-2S | | MI | 3815 | 1716 | 5983 | 1391 | 7152 | 1152 | 7943 | 955 | 9089 | 635 | 11085 | 507 | 7349 |
| 10-#14 | 3.93 | MA | 4714 | 1916 | 7520 | 1551 | 9100 | 1273 | 10211 | 1038 | 11885 | 654 | 14963 | 363 | 12528 |
| 3L-4S | | MI | 3704 | 1916 | 5865 | 1537 | 6919 | 1271 | 7638 | 1035 | 8650 | 635 | 10521 | 203 | 9491 |
| 10-#14 | 3.93 | MA | 4500 | 1916 | 6944 | 1569 | 8302 | 1300 | 9234 | 1062 | 10549 | 661 | 13309 | 269 | 11682 |
| 4L-3S | | MI | 3881 | 1916 | 6333 | 1523 | 7566 | 1248 | 8430 | 1015 | 9732 | 634 | 11795 | 289 | 10201 |
| 10-#14 | 3.93 | MA | 4234 | 1916 | 6431 | 1586 | 7600 | 1315 | 8363 | 1075 | 9341 | 681 | 11656 | 174 | 10936 |
| 5L-2S | | MI | 4192 | 1916 | 6998 | 1508 | 8410 | 1237 | 9452 | 1007 | 11113 | 620 | 13582 | 453 | 10289 |

## RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

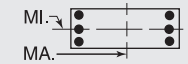
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 6.99 | MA | 5399 | 2424 | 9004 | 1893 | 10806 | 1546 | 12230 | 1219 | 14556 | 639 | 18510 | -34 | 18408 |
| 4L-3S | | MI | 4614 | 2424 | 8306 | 1831 | 10011 | 1470 | 11363 | 1150 | 13668 | 604 | 16421 | -10 | 16395 |
| 12-#10 | 2.66 | MA | 4628 | 1706 | 7013 | 1418 | 8533 | 1176 | 9562 | 977 | 11042 | 655 | 13947 | 564 | 8889 |
| 2L-6S | | MI | 3252 | 1706 | 4753 | 1440 | 5610 | 1196 | 6059 | 1000 | 6537 | 675 | 7921 | 275 | 6610 |
| 12-#10 | 2.66 | MA | 4379 | 1706 | 6530 | 1429 | 7920 | 1186 | 8819 | 985 | 10040 | 668 | 12559 | 474 | 8858 |
| 3L-5S | | MI | 3402 | 1706 | 5026 | 1425 | 5925 | 1188 | 6463 | 986 | 7085 | 665 | 8629 | 335 | 6865 |
| 12-#10 | 2.66 | MA | 4246 | 1706 | 6197 | 1440 | 7458 | 1203 | 8253 | 1001 | 9266 | 674 | 11596 | 421 | 8770 |
| 4E | | MI | 3523 | 1706 | 5269 | 1415 | 6258 | 1180 | 6876 | 980 | 7657 | 655 | 9399 | 388 | 7215 |
| 12-#10 | 2.66 | MA | 4082 | 1706 | 5901 | 1452 | 7052 | 1212 | 7750 | 1009 | 8567 | 686 | 10627 | 370 | 8334 |
| 5L-3S | | MI | 3633 | 1706 | 5542 | 1406 | 6635 | 1165 | 7338 | 967 | 8289 | 652 | 10173 | 440 | 7276 |
| 12-#10 | 2.66 | MA | 3897 | 1706 | 5553 | 1466 | 6669 | 1222 | 7257 | 1025 | 7884 | 692 | 9685 | 299 | 8012 |
| 6L-2S | | MI | 3833 | 1706 | 5932 | 1396 | 7131 | 1157 | 7939 | 960 | 9100 | 642 | 11268 | 533 | 7297 |
| 12-#11 | 3.27 | MA | 4572 | 1807 | 7080 | 1485 | 8574 | 1225 | 9589 | 1008 | 11059 | 659 | 13956 | 439 | 10643 |
| 3L-5S | | MI | 3511 | 1807 | 5360 | 1480 | 6295 | 1228 | 6888 | 1009 | 7637 | 654 | 9270 | 252 | 8060 |
| 12-#11 | 3.27 | MA | 4419 | 1807 | 6677 | 1497 | 8015 | 1245 | 8904 | 1026 | 10123 | 665 | 12781 | 372 | 10363 |
| 4E | | MI | 3650 | 1807 | 5654 | 1469 | 6697 | 1219 | 7386 | 1003 | 8327 | 643 | 10174 | 319 | 8439 |
| 12-#11 | 3.27 | MA | 4228 | 1807 | 6318 | 1510 | 7523 | 1256 | 8294 | 1035 | 9276 | 679 | 11604 | 307 | 9827 |
| 5L-3S | | MI | 3777 | 1807 | 5983 | 1459 | 7152 | 1202 | 7943 | 988 | 9089 | 641 | 11085 | 380 | 8701 |
| 12-#11 | 3.27 | MA | 4012 | 1807 | 5904 | 1529 | 7058 | 1267 | 7696 | 1053 | 8448 | 685 | 10454 | 219 | 9260 |
| 6L-2S | | MI | 4007 | 1807 | 6452 | 1448 | 7747 | 1194 | 8665 | 981 | 10062 | 630 | 12368 | 493 | 8739 |
| 12-#14 | 4.72 | MA | 4873 | 2047 | 7772 | 1650 | 9353 | 1360 | 10507 | 1100 | 12268 | 655 | 15657 | 257 | 14051 |
| 4E | | MI | 3995 | 2047 | 6530 | 1618 | 7763 | 1331 | 8660 | 1072 | 10030 | 629 | 12309 | 179 | 11370 |
| 12-#14 | 4.72 | MA | 4609 | 2047 | 7259 | 1668 | 8650 | 1375 | 9636 | 1112 | 11060 | 674 | 14005 | 162 | 13298 |
| 5L-3S | | MI | 4168 | 2047 | 6998 | 1604 | 8410 | 1307 | 9452 | 1052 | 11113 | 628 | 13582 | 265 | 12146 |
| 14-#10 | 3.11 | MA | 4594 | 1780 | 7013 | 1475 | 8533 | 1219 | 9562 | 1006 | 11042 | 664 | 13947 | 469 | 10281 |
| 3L-6S | | MI | 3433 | 1780 | 5144 | 1486 | 6106 | 1229 | 6660 | 1021 | 7349 | 672 | 9016 | 267 | 7712 |
| 14-#10 | 3.11 | MA | 4469 | 1780 | 6679 | 1486 | 8071 | 1236 | 8996 | 1022 | 10268 | 670 | 12984 | 416 | 10185 |
| 4L-5S | | MI | 3578 | 1780 | 5417 | 1471 | 6421 | 1222 | 7064 | 1008 | 7897 | 662 | 9724 | 326 | 7983 |
| 14-#10 | 3.11 | MA | 4306 | 1780 | 6384 | 1498 | 7665 | 1246 | 8493 | 1030 | 9569 | 683 | 12015 | 366 | 9727 |
| 5L-4S | | MI | 3698 | 1780 | 5660 | 1461 | 6753 | 1214 | 7477 | 1001 | 8468 | 652 | 10495 | 380 | 8329 |
| 14-#10 | 3.11 | MA | 4128 | 1780 | 6036 | 1512 | 7282 | 1256 | 7999 | 1046 | 8886 | 689 | 11073 | 295 | 9396 |
| 6L-3S | | MI | 3802 | 1780 | 5932 | 1452 | 7131 | 1199 | 7939 | 988 | 9100 | 648 | 11268 | 432 | 8427 |
| 14-#10 | 3.11 | MA | 3973 | 1780 | 5725 | 1519 | 6874 | 1271 | 7524 | 1054 | 8223 | 701 | 10154 | 252 | 8885 |
| 7L-2S | | MI | 3996 | 1780 | 6323 | 1442 | 7627 | 1191 | 8540 | 982 | 9911 | 638 | 12364 | 524 | 8455 |
| 14-#11 | 3.82 | MA | 4681 | 1897 | 7259 | 1554 | 8753 | 1286 | 9799 | 1052 | 11331 | 660 | 14454 | 366 | 12021 |
| 4L-5S | | MI | 3718 | 1897 | 5829 | 1537 | 6890 | 1269 | 7610 | 1035 | 8611 | 650 | 10553 | 238 | 9402 |
| 14-#11 | 3.82 | MA | 4492 | 1897 | 6900 | 1567 | 8261 | 1297 | 9189 | 1061 | 10485 | 675 | 13277 | 301 | 11509 |
| 5L-4S | | MI | 3856 | 1897 | 6123 | 1526 | 7292 | 1261 | 8108 | 1029 | 9301 | 639 | 11457 | 305 | 9761 |
| 14-#11 | 3.82 | MA | 4285 | 1897 | 6486 | 1585 | 7796 | 1308 | 8591 | 1079 | 9657 | 680 | 12127 | 213 | 10931 |
| 6L-3S | | MI | 3975 | 1897 | 6452 | 1515 | 7747 | 1243 | 8665 | 1014 | 10062 | 637 | 12368 | 366 | 10078 |
| 14-#14 | 5.51 | MA | 4974 | 2177 | 8087 | 1749 | 9701 | 1435 | 10909 | 1150 | 12779 | 668 | 16353 | 150 | 15667 |
| 5L-4S | | MI | 4299 | 2177 | 7195 | 1700 | 8606 | 1391 | 9683 | 1110 | 11411 | 623 | 14096 | 156 | 13260 |
| 16-#10 | 3.55 | MA | 4686 | 1853 | 7162 | 1532 | 8684 | 1270 | 9739 | 1043 | 11270 | 667 | 14371 | 411 | 11590 |
| 4L-6S | | MI | 3611 | 1853 | 5535 | 1532 | 6601 | 1263 | 7261 | 1042 | 8160 | 668 | 10112 | 259 | 8818 |
| 16-#10 | 3.55 | MA | 4525 | 1853 | 6866 | 1544 | 8278 | 1280 | 9235 | 1052 | 10572 | 679 | 13403 | 361 | 11123 |
| 5E | | MI | 3751 | 1853 | 5807 | 1517 | 6916 | 1255 | 7665 | 1029 | 8708 | 658 | 10819 | 318 | 9105 |
| 16-#10 | 3.55 | MA | 4354 | 1853 | 6519 | 1558 | 7894 | 1289 | 8742 | 1067 | 9888 | 685 | 12461 | 290 | 10784 |
| 6L-4S | | MI | 3870 | 1853 | 6051 | 1507 | 7249 | 1247 | 8078 | 1022 | 9280 | 648 | 11590 | 372 | 9435 |
| 16-#10 | 3.55 | MA | 4206 | 1853 | 6208 | 1565 | 7487 | 1305 | 8266 | 1076 | 9225 | 698 | 11542 | 247 | 10287 |
| 7L-3S | | MI | 3969 | 1853 | 6323 | 1498 | 7627 | 1232 | 8540 | 1009 | 9911 | 645 | 12364 | 424 | 9577 |
| 16-#11 | 4.36 | MA | 4750 | 1988 | 7482 | 1623 | 9000 | 1338 | 10084 | 1088 | 11693 | 670 | 14950 | 295 | 13196 |
| 5E | | MI | 3921 | 1988 | 6298 | 1593 | 7485 | 1311 | 8331 | 1061 | 9584 | 645 | 11837 | 224 | 10750 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

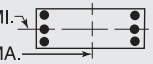
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 4.36 | MA | 4551 | 1988 | 7068 | 1642 | 8535 | 1349 | 9486 | 1105 | 10865 | 676 | 13800 | 207 | 12606 |
| 6L-4S | | MI | 4058 | 1988 | 6592 | 1582 | 7888 | 1302 | 8829 | 1055 | 10275 | 635 | 12741 | 291 | 11091 |
| 18-#10 | 4.00 | MA | 4740 | 1927 | 7349 | 1590 | 8890 | 1313 | 9978 | 1073 | 11574 | 676 | 14791 | 356 | 12524 |
| 5L-6S | | MI | 3786 | 1927 | 5926 | 1578 | 7097 | 1297 | 7861 | 1063 | 8971 | 665 | 11207 | 250 | 9929 |
| 18-#10 | 4.00 | MA | 4575 | 1927 | 7002 | 1604 | 8507 | 1323 | 9484 | 1088 | 10891 | 682 | 13848 | 285 | 12175 |
| 6L-5S | | MI | 3921 | 1927 | 6198 | 1563 | 7412 | 1289 | 8266 | 1050 | 9519 | 655 | 11914 | 310 | 10230 |
| 18-#10 | 4.00 | MA | 4434 | 1927 | 6691 | 1611 | 8100 | 1338 | 9009 | 1097 | 10227 | 694 | 12929 | 242 | 11691 |
| 7L-4S | | MI | 4040 | 1927 | 6441 | 1553 | 7745 | 1281 | 8678 | 1044 | 10091 | 645 | 12685 | 364 | 10546 |
| 18-#11 | 4.91 | MA | 4812 | 2078 | 7650 | 1698 | 9273 | 1391 | 10382 | 1132 | 12073 | 672 | 15473 | 201 | 14286 |
| 6L-5S | | MI | 4135 | 2078 | 6767 | 1650 | 8081 | 1352 | 9052 | 1087 | 10558 | 641 | 13121 | 211 | 12102 |
| 20-#10 | 4.44 | MA | 4792 | 2000 | 7484 | 1650 | 9120 | 1357 | 10227 | 1110 | 11893 | 678 | 15236 | 280 | 13569 |
| 6E | | MI | 3958 | 2000 | 6316 | 1624 | 7593 | 1330 | 8462 | 1085 | 9782 | 661 | 12302 | 242 | 11043 |
| 20-#10 | 4.44 | MA | 4657 | 2000 | 7174 | 1657 | 8712 | 1372 | 9751 | 1118 | 11230 | 691 | 14317 | 238 | 13097 |
| 7L-5S | | MI | 4088 | 2000 | 6589 | 1609 | 7908 | 1322 | 8867 | 1071 | 10330 | 651 | 13010 | 302 | 11357 |

## RECTANGULAR TIED COLUMNS 22" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.01 | MA | 4438 | 1542 | 6051 | 1343 | 7254 | 1132 | 7887 | 967 | 8483 | 719 | 10188 | 627 | 4098 |
| 2E | | MI | 3429 | 1542 | 4856 | 1307 | 5688 | 1101 | 6113 | 940 | 6492 | 698 | 7593 | 593 | 3152 |
| 4-#14 | 1.46 | MA | 4678 | 1622 | 6636 | 1386 | 7960 | 1162 | 8725 | 985 | 9599 | 711 | 11723 | 618 | 5757 |
| 2E | | MI | 3594 | 1622 | 5287 | 1348 | 6201 | 1130 | 6719 | 957 | 7296 | 689 | 8577 | 568 | 4379 |
| 4-#18 | 2.60 | MA | 5235 | 1825 | 8051 | 1499 | 9687 | 1243 | 10784 | 1033 | 12349 | 694 | 15337 | 582 | 9800 |
| 2E | | MI | 3969 | 1825 | 6312 | 1458 | 7439 | 1208 | 8188 | 1002 | 9253 | 669 | 10864 | 493 | 7325 |
| 6-#10 | 1.24 | MA | 4593 | 1582 | 6301 | 1377 | 7619 | 1158 | 8355 | 985 | 9136 | 723 | 11109 | 629 | 4988 |
| 2L-3S | | MI | 3318 | 1582 | 4646 | 1354 | 5467 | 1138 | 5868 | 967 | 6181 | 713 | 7248 | 509 | 3829 |
| 6-#10 | 1.24 | MA | 4281 | 1582 | 5772 | 1389 | 6948 | 1168 | 7542 | 995 | 8038 | 737 | 9589 | 541 | 4991 |
| 3L-2S | | MI | 3544 | 1582 | 5036 | 1344 | 5963 | 1130 | 6469 | 961 | 6992 | 703 | 8344 | 602 | 3815 |
| 6-#11 | 1.52 | MA | 4732 | 1633 | 6690 | 1399 | 8064 | 1173 | 8869 | 993 | 9809 | 715 | 12024 | 621 | 6014 |
| 2L-3S | | MI | 3372 | 1633 | 4856 | 1374 | 5688 | 1151 | 6113 | 973 | 6492 | 705 | 7593 | 465 | 4584 |
| 6-#11 | 1.52 | MA | 4366 | 1633 | 6051 | 1413 | 7254 | 1185 | 7887 | 1003 | 8483 | 731 | 10188 | 510 | 6006 |
| 3L-2S | | MI | 3636 | 1633 | 5325 | 1364 | 6283 | 1142 | 6835 | 966 | 7466 | 694 | 8876 | 579 | 4573 |
| 6-#14 | 2.19 | MA | 5081 | 1753 | 7545 | 1468 | 9114 | 1222 | 10124 | 1022 | 11487 | 705 | 14337 | 609 | 8470 |
| 2L-3S | | MI | 3520 | 1753 | 5287 | 1444 | 6201 | 1201 | 6719 | 1002 | 7296 | 697 | 8577 | 381 | 6353 |
| 6-#14 | 2.19 | MA | 4587 | 1753 | 6636 | 1486 | 7960 | 1238 | 8725 | 1036 | 9599 | 727 | 11723 | 447 | 8404 |
| 3L-2S | | MI | 3875 | 1753 | 5951 | 1430 | 7045 | 1190 | 7741 | 994 | 8676 | 683 | 10364 | 544 | 6376 |
| 6-#18 | 3.90 | MA | 5886 | 2057 | 9627 | 1644 | 11687 | 1349 | 13208 | 1100 | 15621 | 683 | 19782 | 558 | 14468 |
| 2L-3S | | MI | 3886 | 2057 | 6312 | 1624 | 7439 | 1329 | 8188 | 1078 | 9253 | 676 | 10864 | 146 | 10437 |
| 6-#18 | 3.90 | MA | 5117 | 2057 | 8051 | 1675 | 9687 | 1375 | 10784 | 1121 | 12349 | 716 | 15337 | 268 | 14106 |
| 3L-2S | | MI | 4414 | 2057 | 7453 | 1603 | 8887 | 1314 | 9943 | 1069 | 11622 | 658 | 13819 | 437 | 10709 |
| 8-#8 | 1.03 | MA | 4480 | 1545 | 6003 | 1360 | 7276 | 1146 | 7956 | 979 | 8614 | 729 | 10397 | 635 | 4197 |
| 2L-4S | | MI | 3239 | 1545 | 4394 | 1341 | 5161 | 1135 | 5510 | 969 | 5707 | 719 | 6695 | 525 | 3244 |
| 8-#8 | 1.03 | MA | 4280 | 1545 | 5670 | 1368 | 6854 | 1153 | 7445 | 985 | 7923 | 738 | 9440 | 581 | 4204 |
| 3E | | MI | 3322 | 1545 | 4566 | 1335 | 5399 | 1125 | 5801 | 960 | 6105 | 717 | 7190 | 558 | 3236 |
| 8-#8 | 1.03 | MA | 4168 | 1545 | 5442 | 1375 | 6537 | 1164 | 7057 | 996 | 7392 | 742 | 8788 | 549 | 4201 |
| 4L-2S | | MI | 3467 | 1545 | 4813 | 1329 | 5712 | 1120 | 6181 | 956 | 6617 | 710 | 7893 | 615 | 3226 |
| 8-#9 | 1.30 | MA | 4639 | 1593 | 6368 | 1388 | 7723 | 1166 | 8489 | 991 | 9326 | 724 | 11377 | 630 | 5242 |
| 2L-4S | | MI | 3299 | 1593 | 4558 | 1371 | 5349 | 1157 | 5729 | 983 | 5994 | 717 | 7082 | 492 | 4013 |
| 8-#9 | 1.30 | MA | 4395 | 1593 | 5949 | 1397 | 7191 | 1174 | 7845 | 999 | 8456 | 736 | 10173 | 562 | 5243 |
| 3E | | MI | 3401 | 1593 | 4775 | 1363 | 5648 | 1145 | 6096 | 972 | 6495 | 714 | 7700 | 534 | 4015 |
| 8-#9 | 1.30 | MA | 4257 | 1593 | 5662 | 1407 | 6792 | 1188 | 7356 | 1012 | 7787 | 741 | 9350 | 520 | 5220 |
| 4L-2S | | MI | 3579 | 1593 | 5085 | 1355 | 6041 | 1138 | 6573 | 967 | 7139 | 705 | 8577 | 606 | 4006 |
| 8-#10 | 1.65 | MA | 4837 | 1656 | 6830 | 1423 | 8290 | 1192 | 9168 | 1007 | 10234 | 719 | 12629 | 624 | 6569 |
| 2L-4S | | MI | 3375 | 1656 | 4764 | 1409 | 5585 | 1186 | 6007 | 1002 | 6360 | 713 | 7570 | 449 | 4968 |
| 8-#10 | 1.65 | MA | 4538 | 1656 | 6301 | 1435 | 7619 | 1202 | 8355 | 1016 | 9136 | 733 | 11109 | 537 | 6557 |
| 3E | | MI | 3499 | 1656 | 5036 | 1400 | 5963 | 1171 | 6469 | 988 | 6992 | 710 | 8344 | 501 | 4994 |
| 8-#10 | 1.65 | MA | 4370 | 1656 | 5937 | 1447 | 7115 | 1220 | 7737 | 1032 | 8291 | 740 | 10065 | 484 | 6491 |
| 4L-2S | | MI | 3717 | 1656 | 5427 | 1390 | 6459 | 1163 | 7070 | 982 | 7803 | 700 | 9439 | 594 | 4991 |

## RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis



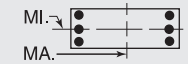

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 2.03 | MA | 5017 | 1723 | 7328 | 1456 | 8874 | 1214 | 9851 | 1019 | 11134 | 711 | 13859 | 615 | 7919 |
| 2L-4S | | MI | 3438 | 1723 | 4996 | 1441 | 5828 | 1209 | 6278 | 1014 | 6705 | 702 | 7965 | 390 | 5913 |
| 8-#11 | 2.03 | MA | 4669 | 1723 | 6690 | 1470 | 8064 | 1226 | 8869 | 1029 | 9809 | 726 | 12024 | 504 | 7891 |
| 3E | | MI | 3584 | 1723 | 5325 | 1431 | 6283 | 1192 | 6835 | 999 | 7466 | 700 | 8876 | 452 | 5974 |
| 8-#11 | 2.03 | MA | 4473 | 1723 | 6249 | 1483 | 7453 | 1247 | 8120 | 1048 | 8785 | 734 | 10750 | 439 | 7767 |
| 4L-2S | | MI | 3837 | 1723 | 5794 | 1420 | 6879 | 1184 | 7556 | 992 | 8440 | 689 | 10160 | 565 | 5980 |
| 8-#14 | 2.92 | MA | 5470 | 1883 | 8454 | 1549 | 10268 | 1282 | 11523 | 1060 | 13376 | 699 | 16951 | 601 | 11169 |
| 2L-4S | | MI | 3617 | 1883 | 5483 | 1540 | 6398 | 1284 | 6949 | 1060 | 7594 | 692 | 9090 | 271 | 7755 |
| 8-#14 | 2.92 | MA | 5005 | 1883 | 7545 | 1568 | 9114 | 1298 | 10124 | 1074 | 11487 | 720 | 14337 | 439 | 11073 |
| 3E | | MI | 3812 | 1883 | 5951 | 1526 | 7045 | 1260 | 7741 | 1040 | 8676 | 690 | 10364 | 357 | 8302 |
| 8-#14 | 2.92 | MA | 4744 | 1883 | 6915 | 1587 | 8242 | 1327 | 9055 | 1100 | 10026 | 729 | 12508 | 343 | 10339 |
| 4L-2S | | MI | 4149 | 1883 | 6616 | 1511 | 7889 | 1249 | 8764 | 1032 | 10056 | 677 | 12152 | 520 | 8356 |
| 8-#18 | 5.19 | MA | 5843 | 2289 | 9627 | 1820 | 11687 | 1481 | 13208 | 1188 | 15621 | 705 | 19782 | 245 | 18717 |
| 3E | | MI | 4366 | 2289 | 7453 | 1769 | 8887 | 1435 | 9943 | 1145 | 11622 | 665 | 13819 | 89 | 13527 |
| 8-#18 | 5.19 | MA | 5412 | 2289 | 8529 | 1850 | 10167 | 1529 | 11347 | 1231 | 13076 | 716 | 16647 | 79 | 16183 |
| 4L-2S | | MI | 4845 | 2289 | 8594 | 1748 | 10335 | 1420 | 11698 | 1136 | 13990 | 647 | 16775 | 380 | 14076 |
| 10-#10 | 2.06 | MA | 5075 | 1730 | 7358 | 1469 | 8961 | 1225 | 9982 | 1028 | 11332 | 716 | 14149 | 619 | 8142 |
| 2L-5S | | MI | 3435 | 1730 | 4911 | 1465 | 5749 | 1228 | 6195 | 1029 | 6600 | 720 | 7894 | 387 | 5835 |
| 10-#10 | 2.06 | MA | 4787 | 1730 | 6830 | 1481 | 8290 | 1236 | 9168 | 1037 | 10234 | 730 | 12629 | 532 | 8120 |
| 3L-4S | | MI | 3558 | 1730 | 5154 | 1455 | 6081 | 1220 | 6608 | 1023 | 7172 | 710 | 8665 | 441 | 6112 |
| 10-#10 | 2.06 | MA | 4630 | 1730 | 6466 | 1493 | 7786 | 1253 | 8550 | 1053 | 9389 | 737 | 11586 | 479 | 8041 |
| 4L-3S | | MI | 3676 | 1730 | 5427 | 1446 | 6459 | 1205 | 7070 | 1009 | 7803 | 706 | 9439 | 493 | 6152 |
| 10-#10 | 2.06 | MA | 4441 | 1730 | 6144 | 1505 | 7344 | 1264 | 8001 | 1063 | 8627 | 750 | 10533 | 431 | 7643 |
| 5L-2S | | MI | 3886 | 1730 | 5818 | 1436 | 6955 | 1197 | 7671 | 1003 | 8614 | 696 | 10534 | 585 | 6159 |
| 10-#11 | 2.53 | MA | 5296 | 1814 | 7967 | 1512 | 9685 | 1256 | 10833 | 1045 | 12460 | 706 | 15695 | 609 | 9815 |
| 2L-5S | | MI | 3513 | 1814 | 5171 | 1509 | 6021 | 1259 | 6501 | 1046 | 6988 | 709 | 8345 | 310 | 6817 |
| 10-#11 | 2.53 | MA | 4962 | 1814 | 7328 | 1526 | 8874 | 1268 | 9851 | 1055 | 11134 | 722 | 13859 | 498 | 9773 |
| 3L-4S | | MI | 3654 | 1814 | 5465 | 1498 | 6424 | 1251 | 6999 | 1040 | 7678 | 698 | 9249 | 377 | 7231 |
| 10-#11 | 2.53 | MA | 4780 | 1814 | 6888 | 1540 | 8263 | 1288 | 9102 | 1074 | 10110 | 729 | 12586 | 433 | 9634 |
| 4L-3S | | MI | 3791 | 1814 | 5794 | 1487 | 6879 | 1234 | 7556 | 1025 | 8440 | 696 | 10160 | 438 | 7358 |
| 10-#11 | 2.53 | MA | 4560 | 1814 | 6496 | 1553 | 7727 | 1300 | 8437 | 1085 | 9186 | 745 | 11305 | 371 | 8980 |
| 5L-2S | | MI | 4034 | 1814 | 6263 | 1477 | 7474 | 1225 | 8277 | 1018 | 9413 | 685 | 11444 | 551 | 7378 |
| 10-#14 | 3.65 | MA | 5409 | 2014 | 8454 | 1650 | 10268 | 1357 | 11523 | 1112 | 13376 | 714 | 16951 | 430 | 13743 |
| 3L-4S | | MI | 3917 | 2014 | 6148 | 1622 | 7241 | 1344 | 7971 | 1098 | 8974 | 685 | 10878 | 247 | 9615 |
| 10-#14 | 3.65 | MA | 5172 | 2014 | 7825 | 1668 | 9396 | 1386 | 10454 | 1138 | 11914 | 723 | 15123 | 334 | 12936 |
| 4L-3S | | MI | 4097 | 2014 | 6616 | 1607 | 7889 | 1320 | 8764 | 1077 | 10056 | 684 | 12152 | 333 | 10249 |
| 10-#14 | 3.65 | MA | 4867 | 2014 | 7265 | 1687 | 8628 | 1403 | 9502 | 1152 | 10593 | 744 | 13288 | 242 | 12113 |
| 5L-2S | | MI | 4418 | 2014 | 7281 | 1593 | 8732 | 1309 | 9786 | 1070 | 11437 | 670 | 13940 | 497 | 10325 |
| 10-#18 | 6.49 | MA | 6184 | 2521 | 10104 | 1995 | 12167 | 1635 | 13771 | 1298 | 16348 | 705 | 21092 | 56 | 20747 |
| 4L-3S | | MI | 4829 | 2521 | 8594 | 1914 | 10335 | 1541 | 11698 | 1212 | 13990 | 654 | 16775 | 33 | 16657 |
| 12-#10 | 2.47 | MA | 5308 | 1803 | 7887 | 1515 | 9632 | 1259 | 10795 | 1049 | 12430 | 712 | 15669 | 614 | 9712 |
| 2L-6S | | MI | 3465 | 1803 | 5029 | 1526 | 5929 | 1269 | 6392 | 1064 | 6863 | 726 | 8282 | 320 | 6730 |
| 12-#10 | 2.47 | MA | 5030 | 1803 | 7358 | 1527 | 8961 | 1269 | 9982 | 1058 | 11332 | 726 | 14149 | 527 | 9681 |
| 3L-5S | | MI | 3616 | 1803 | 5302 | 1511 | 6244 | 1261 | 6796 | 1050 | 7411 | 716 | 8990 | 379 | 6946 |
| 12-#10 | 2.47 | MA | 4883 | 1803 | 6995 | 1539 | 8457 | 1287 | 9364 | 1075 | 10487 | 733 | 13106 | 474 | 9593 |
| 4E | | MI | 3738 | 1803 | 5545 | 1501 | 6577 | 1253 | 7209 | 1044 | 7983 | 706 | 9761 | 433 | 7256 |
| 12-#10 | 2.47 | MA | 4696 | 1803 | 6673 | 1551 | 8015 | 1297 | 8815 | 1084 | 9724 | 747 | 12053 | 426 | 9167 |
| 5L-3S | | MI | 3849 | 1803 | 5818 | 1492 | 6955 | 1238 | 7671 | 1031 | 8614 | 703 | 10534 | 485 | 7306 |
| 12-#10 | 2.47 | MA | 4492 | 1803 | 6287 | 1565 | 7598 | 1308 | 8277 | 1100 | 8979 | 754 | 11032 | 356 | 8819 |
| 6L-2S | | MI | 4052 | 1803 | 6208 | 1482 | 7450 | 1231 | 8272 | 1024 | 9426 | 693 | 11630 | 577 | 7322 |
| 12-#11 | 3.04 | MA | 5248 | 1904 | 7967 | 1583 | 9685 | 1309 | 10833 | 1082 | 12460 | 718 | 15695 | 492 | 11653 |
| 3L-5S | | MI | 3725 | 1904 | 5640 | 1565 | 6617 | 1301 | 7222 | 1072 | 7962 | 705 | 9629 | 296 | 8152 |
| 12-#11 | 3.04 | MA | 5078 | 1904 | 7526 | 1596 | 9074 | 1330 | 10085 | 1101 | 11436 | 725 | 14421 | 427 | 11458 |
| 4E | | MI | 3865 | 1904 | 5934 | 1555 | 7019 | 1292 | 7720 | 1066 | 8652 | 694 | 10533 | 363 | 8541 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis

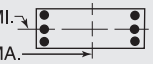



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 3.04 | MA | 4861 | 1904 | 7135 | 1610 | 8537 | 1342 | 9419 | 1111 | 10512 | 741 | 13140 | 365 | 10823 |
| 5L-3S | | MI | 3993 | 1904 | 6263 | 1544 | 7474 | 1275 | 8277 | 1051 | 9413 | 692 | 11444 | 424 | 8738 |
| 12-#11 | 3.04 | MA | 4621 | 1904 | 6675 | 1628 | 8030 | 1354 | 8766 | 1130 | 9608 | 748 | 11893 | 278 | 10267 |
| 6L-2S | | MI | 4227 | 1904 | 6732 | 1533 | 8069 | 1266 | 8998 | 1044 | 10387 | 681 | 12727 | 538 | 8770 |
| 12-#14 | 4.38 | MA | 5587 | 2144 | 8734 | 1750 | 10550 | 1446 | 11853 | 1176 | 13802 | 717 | 17737 | 326 | 15546 |
| 4E | | MI | 4208 | 2144 | 6812 | 1703 | 8085 | 1403 | 8994 | 1135 | 10354 | 679 | 12666 | 223 | 11489 |
| 12-#14 | 4.38 | MA | 5286 | 2144 | 8174 | 1769 | 9782 | 1462 | 10901 | 1189 | 12481 | 738 | 15902 | 233 | 14762 |
| 5L-3S | | MI | 4386 | 2144 | 7281 | 1689 | 8732 | 1380 | 9786 | 1115 | 11437 | 678 | 13940 | 309 | 12195 |
| 12-#14 | 4.38 | MA | 4963 | 2144 | 7525 | 1795 | 9057 | 1479 | 9968 | 1216 | 11190 | 747 | 14112 | 107 | 13543 |
| 6L-2S | | MI | 4673 | 2144 | 7946 | 1674 | 9576 | 1369 | 10809 | 1107 | 12817 | 664 | 15727 | 473 | 12289 |
| 14-#10 | 2.89 | MA | 5269 | 1877 | 7887 | 1573 | 9632 | 1303 | 10795 | 1080 | 12430 | 723 | 15669 | 522 | 11241 |
| 3L-6S | | MI | 3647 | 1877 | 5420 | 1572 | 6425 | 1303 | 6993 | 1085 | 7674 | 723 | 9378 | 311 | 7839 |
| 14-#10 | 2.89 | MA | 5130 | 1877 | 7524 | 1585 | 9128 | 1321 | 10177 | 1096 | 11585 | 730 | 14626 | 469 | 11145 |
| 4L-5S | | MI | 3793 | 1877 | 5693 | 1557 | 6740 | 1295 | 7397 | 1072 | 8222 | 713 | 10085 | 371 | 8061 |
| 14-#10 | 2.89 | MA | 4945 | 1877 | 7202 | 1597 | 8686 | 1331 | 9628 | 1105 | 10822 | 743 | 13573 | 422 | 10695 |
| 5L-4S | | MI | 3914 | 1877 | 5936 | 1547 | 7073 | 1287 | 7810 | 1065 | 8794 | 703 | 10856 | 425 | 8400 |
| 14-#10 | 2.89 | MA | 4749 | 1877 | 6816 | 1611 | 8269 | 1342 | 9091 | 1121 | 10077 | 750 | 12552 | 351 | 10362 |
| 6L-3S | | MI | 4019 | 1877 | 6208 | 1538 | 7450 | 1272 | 8272 | 1052 | 9426 | 699 | 11630 | 477 | 8459 |
| 14-#10 | 2.89 | MA | 4577 | 1877 | 6477 | 1618 | 7816 | 1356 | 8573 | 1131 | 9354 | 764 | 11555 | 312 | 9804 |
| 7L-2S | | MI | 4216 | 1877 | 6599 | 1528 | 7946 | 1264 | 8873 | 1046 | 10237 | 689 | 12725 | 569 | 8482 |
| 14-#11 | 3.55 | MA | 5370 | 1995 | 8165 | 1653 | 9884 | 1371 | 11067 | 1127 | 12762 | 721 | 16257 | 421 | 13282 |
| 4L-5S | | MI | 3933 | 1995 | 6109 | 1622 | 7212 | 1342 | 7943 | 1099 | 8935 | 700 | 10912 | 282 | 9492 |
| 14-#11 | 3.55 | MA | 5155 | 1995 | 7773 | 1666 | 9347 | 1383 | 10401 | 1137 | 11837 | 736 | 14976 | 359 | 12673 |
| 5L-4S | | MI | 4071 | 1995 | 6403 | 1611 | 7614 | 1333 | 8441 | 1092 | 9626 | 689 | 11816 | 349 | 9861 |
| 14-#11 | 3.55 | MA | 4925 | 1995 | 7314 | 1684 | 8840 | 1395 | 9748 | 1156 | 10934 | 743 | 13729 | 272 | 12108 |
| 6L-3S | | MI | 4192 | 1995 | 6732 | 1600 | 8069 | 1316 | 8998 | 1077 | 10387 | 687 | 12727 | 411 | 10117 |
| 14-#11 | 3.55 | MA | 4725 | 1995 | 6903 | 1693 | 8302 | 1414 | 9119 | 1166 | 10056 | 759 | 12514 | 220 | 11457 |
| 7L-2S | | MI | 4418 | 1995 | 7201 | 1590 | 8664 | 1308 | 9720 | 1071 | 11360 | 676 | 14011 | 524 | 10159 |
| 14-#14 | 5.11 | MA | 5693 | 2275 | 9084 | 1850 | 10937 | 1522 | 12300 | 1227 | 14370 | 732 | 18517 | 225 | 17417 |
| 5L-4S | | MI | 4514 | 2275 | 7477 | 1785 | 8929 | 1463 | 10016 | 1173 | 11735 | 673 | 14453 | 200 | 13375 |
| 14-#14 | 5.11 | MA | 5387 | 2275 | 8435 | 1877 | 10211 | 1538 | 11367 | 1253 | 13078 | 741 | 16727 | 98 | 16191 |
| 6L-3S | | MI | 4655 | 2275 | 7946 | 1770 | 9576 | 1439 | 10809 | 1153 | 12817 | 672 | 15727 | 286 | 14141 |
| 16-#10 | 3.30 | MA | 5372 | 1950 | 8052 | 1631 | 9799 | 1354 | 10990 | 1117 | 12682 | 726 | 16146 | 464 | 12699 |
| 4L-6S | | MI | 3825 | 1950 | 5811 | 1618 | 6921 | 1337 | 7594 | 1106 | 8485 | 719 | 10473 | 303 | 8942 |
| 16-#10 | 3.30 | MA | 5189 | 1950 | 7730 | 1643 | 9357 | 1365 | 10441 | 1126 | 11920 | 740 | 15093 | 417 | 12228 |
| 5E | | MI | 3966 | 1950 | 6083 | 1603 | 7236 | 1329 | 7998 | 1093 | 9033 | 709 | 11180 | 363 | 9181 |
| 16-#10 | 3.30 | MA | 4999 | 1950 | 7345 | 1657 | 8940 | 1375 | 9904 | 1143 | 11175 | 747 | 14072 | 346 | 11907 |
| 6L-4S | | MI | 4086 | 1950 | 6327 | 1593 | 7569 | 1321 | 8411 | 1087 | 9605 | 699 | 11951 | 417 | 9522 |
| 16-#10 | 3.30 | MA | 4836 | 1950 | 7006 | 1664 | 8487 | 1390 | 9386 | 1152 | 10452 | 761 | 13075 | 307 | 11343 |
| 7L-3S | | MI | 4187 | 1950 | 6599 | 1584 | 7946 | 1306 | 8873 | 1073 | 10237 | 696 | 12725 | 469 | 9610 |
| 16-#10 | 3.30 | MA | 4677 | 1950 | 6679 | 1673 | 8050 | 1397 | 8862 | 1168 | 9742 | 774 | 12115 | 253 | 10777 |
| 8L-2S | | MI | 4377 | 1950 | 6990 | 1574 | 8442 | 1298 | 9474 | 1067 | 11048 | 686 | 13820 | 561 | 9640 |
| 16-#11 | 4.05 | MA | 5442 | 2085 | 8412 | 1723 | 10157 | 1424 | 11383 | 1163 | 13163 | 732 | 16811 | 353 | 14527 |
| 5E | | MI | 4136 | 2085 | 6578 | 1678 | 7807 | 1383 | 8664 | 1125 | 9909 | 696 | 12196 | 269 | 10838 |
| 16-#11 | 4.05 | MA | 5222 | 2085 | 7952 | 1741 | 9650 | 1436 | 10731 | 1182 | 12259 | 739 | 15565 | 266 | 13953 |
| 6L-4S | | MI | 4273 | 2085 | 6872 | 1668 | 8209 | 1375 | 9163 | 1118 | 10599 | 685 | 13100 | 335 | 11188 |
| 16-#11 | 4.05 | MA | 5031 | 2085 | 7541 | 1749 | 9112 | 1455 | 10101 | 1193 | 11382 | 755 | 14349 | 214 | 13313 |
| 7L-3S | | MI | 4398 | 2085 | 7201 | 1657 | 8664 | 1358 | 9720 | 1103 | 11360 | 683 | 14011 | 397 | 11495 |
| 16-#14 | 5.84 | MA | 5800 | 2405 | 9344 | 1958 | 11365 | 1598 | 12766 | 1291 | 14966 | 735 | 19341 | 89 | 18843 |
| 6L-4S | | MI | 4792 | 2405 | 8142 | 1866 | 9772 | 1522 | 11039 | 1211 | 13115 | 667 | 16241 | 176 | 15270 |
| 18-#10 | 3.71 | MA | 5428 | 2024 | 8259 | 1689 | 10028 | 1398 | 11255 | 1148 | 13018 | 736 | 16613 | 412 | 13764 |
| 5L-6S | | MI | 4000 | 2024 | 6202 | 1664 | 7417 | 1370 | 8195 | 1128 | 9297 | 716 | 11568 | 295 | 10049 |
| 18-#10 | 3.71 | MA | 5245 | 2024 | 7874 | 1703 | 9611 | 1409 | 10717 | 1164 | 12273 | 743 | 15592 | 342 | 13453 |
| 6L-5S | | MI | 4137 | 2024 | 6474 | 1649 | 7732 | 1362 | 8599 | 1114 | 9845 | 706 | 12276 | 355 | 10304 |
| 18-#10 | 3.71 | MA | 5089 | 2024 | 7535 | 1710 | 9158 | 1424 | 10199 | 1173 | 11550 | 757 | 14595 | 302 | 12885 |
| 7L-4S | | MI | 4256 | 2024 | 6717 | 1639 | 8065 | 1354 | 9012 | 1108 | 10416 | 696 | 13047 | 409 | 10631 |
| 18-#10 | 3.71 | MA | 4932 | 2024 | 7208 | 1719 | 8721 | 1430 | 9675 | 1189 | 10840 | 771 | 13635 | 248 | 12321 |
| 8L-3S | | MI | 4352 | 2024 | 6990 | 1630 | 8442 | 1339 | 9474 | 1094 | 11048 | 692 | 13820 | 461 | 10760 |

## RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

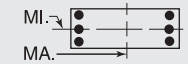
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 4.56 | MA | 5512 | 2175 | 8591 | 1797 | 10461 | 1478 | 11713 | 1208 | 13585 | 735 | 17400 | 260 | 15801 |
| 6L-5S | | MI | 4337 | 2175 | 7047 | 1735 | 8402 | 1425 | 9386 | 1151 | 10883 | 692 | 13480 | 255 | 12187 |
| 18-#11 | 4.56 | MA | 5331 | 2175 | 8180 | 1806 | 9922 | 1496 | 11083 | 1219 | 12708 | 751 | 16185 | 208 | 15180 |
| 7L-4S | | MI | 4489 | 2175 | 7341 | 1724 | 8804 | 1416 | 9884 | 1144 | 11573 | 681 | 14384 | 322 | 12521 |
| 20-#10 | 4.12 | MA | 5486 | 2098 | 8403 | 1749 | 10282 | 1442 | 11531 | 1185 | 13371 | 740 | 17113 | 337 | 14984 |
| 6E | | MI | 4173 | 2098 | 6592 | 1710 | 7913 | 1404 | 8796 | 1149 | 10108 | 712 | 12663 | 287 | 11160 |
| 20-#10 | 4.12 | MA | 5336 | 2098 | 8063 | 1756 | 9829 | 1457 | 11013 | 1194 | 12648 | 754 | 16115 | 297 | 14429 |
| 7L-5S | | MI | 4305 | 2098 | 6865 | 1695 | 8228 | 1396 | 9200 | 1135 | 10656 | 702 | 13371 | 347 | 11431 |
| 20-#10 | 4.12 | MA | 5182 | 2098 | 7737 | 1765 | 9392 | 1464 | 10488 | 1210 | 11938 | 767 | 15155 | 244 | 13867 |
| 8L-4S | | MI | 4424 | 2098 | 7108 | 1685 | 8561 | 1388 | 9613 | 1129 | 11228 | 692 | 14142 | 400 | 11744 |
| 20-#11 | 5.06 | MA | 5625 | 2266 | 8818 | 1862 | 10732 | 1538 | 12065 | 1245 | 14033 | 746 | 18020 | 202 | 17044 |
| 7L-5S | | MI | 4548 | 2266 | 7516 | 1791 | 8997 | 1466 | 10107 | 1177 | 11856 | 687 | 14764 | 241 | 13540 |
| 22-#10 | 4.54 | MA | 5580 | 2171 | 8592 | 1802 | 10500 | 1491 | 11826 | 1216 | 13746 | 750 | 17635 | 292 | 15975 |
| 7L-6S | | MI | 4343 | 2171 | 6983 | 1756 | 8409 | 1437 | 9397 | 1170 | 10919 | 709 | 13759 | 279 | 12274 |
| 22-#10 | 4.54 | MA | 5427 | 2171 | 8266 | 1811 | 10064 | 1498 | 11302 | 1231 | 13036 | 764 | 16675 | 239 | 15414 |
| 8L-5S | | MI | 4472 | 2171 | 7256 | 1741 | 8724 | 1430 | 9801 | 1157 | 11467 | 699 | 14466 | 339 | 12560 |

## RECTANGULAR TIED COLUMNS 22" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.36 | MA | 5337 | 1720 | 7446 | 1483 | 8974 | 1245 | 9845 | 1057 | 10812 | 769 | 13188 | 668 | 6243 |
| 2E | | MI | 3809 | 1720 | 5569 | 1433 | 6524 | 1202 | 7053 | 1020 | 7620 | 739 | 8934 | 612 | 4404 |
| 4-#18 | 2.42 | MA | 5958 | 1922 | 8996 | 1596 | 10867 | 1326 | 12101 | 1105 | 13825 | 751 | 17334 | 648 | 10664 |
| 2E | | MI | 4187 | 1922 | 6600 | 1541 | 7764 | 1279 | 8522 | 1064 | 9575 | 718 | 11218 | 537 | 7361 |
| 6-#10 | 1.15 | MA | 5239 | 1680 | 7076 | 1475 | 8596 | 1241 | 9434 | 1058 | 10298 | 781 | 12505 | 679 | 5400 |
| 2L-3S | | MI | 3532 | 1680 | 4922 | 1440 | 5787 | 1211 | 6201 | 1031 | 6506 | 764 | 7610 | 554 | 3850 |
| 6-#10 | 1.15 | MA | 4895 | 1680 | 6501 | 1487 | 7867 | 1252 | 8550 | 1068 | 9104 | 795 | 10853 | 594 | 5402 |
| 3L-2S | | MI | 3759 | 1680 | 5312 | 1430 | 6282 | 1203 | 6802 | 1025 | 7318 | 754 | 8705 | 647 | 3835 |
| 6-#11 | 1.42 | MA | 5394 | 1730 | 7502 | 1497 | 9084 | 1256 | 9998 | 1065 | 11035 | 772 | 13509 | 671 | 6520 |
| 2L-3S | | MI | 3587 | 1730 | 5136 | 1460 | 6010 | 1224 | 6447 | 1036 | 6817 | 755 | 7951 | 510 | 4612 |
| 6-#11 | 1.42 | MA | 4991 | 1730 | 6807 | 1511 | 8202 | 1269 | 8929 | 1076 | 9592 | 789 | 11511 | 563 | 6512 |
| 3L-2S | | MI | 3852 | 1730 | 5605 | 1449 | 6605 | 1215 | 7168 | 1030 | 7791 | 744 | 9235 | 623 | 4597 |
| 6-#14 | 2.05 | MA | 5783 | 1850 | 8437 | 1565 | 10232 | 1305 | 11369 | 1095 | 12870 | 763 | 16036 | 660 | 9199 |
| 2L-3S | | MI | 3734 | 1850 | 5569 | 1529 | 6524 | 1273 | 7053 | 1065 | 7620 | 747 | 8934 | 425 | 6392 |
| 6-#14 | 2.05 | MA | 5237 | 1850 | 7446 | 1585 | 8974 | 1322 | 9845 | 1110 | 10812 | 786 | 13188 | 502 | 9133 |
| 3L-2S | | MI | 4092 | 1850 | 6234 | 1514 | 7367 | 1262 | 8075 | 1057 | 9000 | 733 | 10722 | 588 | 6405 |
| 6-#18 | 3.64 | MA | 6680 | 2154 | 10717 | 1741 | 13050 | 1432 | 14748 | 1172 | 17398 | 740 | 22280 | 632 | 15764 |
| 2L-3S | | MI | 4099 | 2154 | 6600 | 1708 | 7764 | 1400 | 8522 | 1140 | 9575 | 725 | 11218 | 189 | 10552 |
| 6-#18 | 3.64 | MA | 5827 | 2154 | 8996 | 1774 | 10867 | 1460 | 12101 | 1196 | 13825 | 777 | 17334 | 342 | 15402 |
| 3L-2S | | MI | 4636 | 2154 | 7741 | 1686 | 9212 | 1385 | 10277 | 1131 | 11944 | 707 | 14173 | 480 | 10751 |
| 8-#9 | 1.21 | MA | 5289 | 1691 | 7148 | 1485 | 8708 | 1249 | 9579 | 1063 | 10502 | 782 | 12794 | 680 | 5674 |
| 2L-4S | | MI | 3513 | 1691 | 4833 | 1457 | 5668 | 1231 | 6062 | 1047 | 6320 | 768 | 7444 | 537 | 4039 |
| 8-#9 | 1.21 | MA | 5019 | 1691 | 6693 | 1495 | 8130 | 1258 | 8878 | 1071 | 9557 | 794 | 11486 | 614 | 5675 |
| 3E | | MI | 3615 | 1691 | 5049 | 1450 | 5967 | 1219 | 6429 | 1037 | 6821 | 765 | 8062 | 578 | 4035 |
| 8-#9 | 1.21 | MA | 4869 | 1691 | 6382 | 1505 | 7698 | 1272 | 8349 | 1085 | 8832 | 800 | 10599 | 573 | 5652 |
| 4L-2S | | MI | 3794 | 1691 | 5359 | 1442 | 6360 | 1212 | 6906 | 1031 | 7465 | 756 | 8939 | 651 | 4024 |
| 8-#10 | 1.54 | MA | 5508 | 1753 | 7651 | 1521 | 9326 | 1275 | 10318 | 1079 | 11491 | 777 | 14158 | 675 | 7117 |
| 2L-4S | | MI | 3588 | 1753 | 5040 | 1495 | 5905 | 1260 | 6340 | 1066 | 6686 | 764 | 7931 | 494 | 5001 |
| 8-#10 | 1.54 | MA | 5178 | 1753 | 7076 | 1533 | 8596 | 1286 | 9434 | 1089 | 10298 | 792 | 12505 | 589 | 7106 |
| 3E | | MI | 3714 | 1753 | 5312 | 1486 | 6282 | 1245 | 6802 | 1052 | 7318 | 761 | 8705 | 546 | 5019 |
| 8-#10 | 1.54 | MA | 4994 | 1753 | 6682 | 1545 | 8050 | 1304 | 8764 | 1106 | 9381 | 799 | 11382 | 537 | 7040 |
| 4L-2S | | MI | 3933 | 1753 | 5703 | 1476 | 6778 | 1237 | 7403 | 1046 | 8129 | 751 | 9800 | 638 | 5012 |
| 8-#11 | 1.89 | MA | 5710 | 1820 | 8197 | 1553 | 9966 | 1297 | 11067 | 1091 | 12478 | 768 | 15507 | 665 | 8593 |
| 2L-4S | | MI | 3652 | 1820 | 5276 | 1527 | 6150 | 1282 | 6611 | 1077 | 7029 | 753 | 8324 | 435 | 5959 |
| 8-#11 | 1.89 | MA | 5325 | 1820 | 7502 | 1568 | 9084 | 1310 | 9998 | 1103 | 11035 | 785 | 13509 | 557 | 8565 |
| 3E | | MI | 3799 | 1820 | 5605 | 1516 | 6605 | 1265 | 7168 | 1062 | 7791 | 751 | 9235 | 496 | 6006 |
| 8-#11 | 1.89 | MA | 5110 | 1820 | 7024 | 1582 | 8421 | 1331 | 9185 | 1122 | 9924 | 793 | 12136 | 493 | 8441 |
| 4L-2S | | MI | 4054 | 1820 | 6074 | 1505 | 7200 | 1256 | 7889 | 1056 | 8764 | 740 | 10519 | 609 | 6006 |

## RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

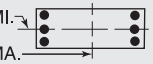
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.73 | MA | 6214 | 1980 | 9428 | 1646 | 11489 | 1364 | 12893 | 1132 | 14927 | 756 | 18885 | 651 | 12141 |
| 2L-4S | | MI | 3829 | 1980 | 5765 | 1625 | 6720 | 1356 | 7283 | 1123 | 7918 | 742 | 9448 | 315 | 7880 |
| 8-#14 | 2.73 | MA | 5699 | 1980 | 8437 | 1666 | 10232 | 1382 | 11369 | 1148 | 12870 | 780 | 16036 | 493 | 12045 |
| 3E | | MI | 4027 | 1980 | 6234 | 1610 | 7367 | 1333 | 8075 | 1103 | 9000 | 740 | 10722 | 401 | 8346 |
| 8-#14 | 2.73 | MA | 5412 | 1980 | 7753 | 1686 | 9284 | 1412 | 10208 | 1175 | 11282 | 790 | 14065 | 399 | 11369 |
| 4L-2S | | MI | 4368 | 1980 | 6899 | 1596 | 8211 | 1322 | 9098 | 1095 | 10380 | 727 | 12509 | 564 | 8388 |
| 8-#18 | 4.85 | MA | 6593 | 2386 | 10717 | 1919 | 13050 | 1566 | 14748 | 1263 | 17398 | 766 | 22280 | 326 | 20445 |
| 3E | | MI | 4580 | 2386 | 7741 | 1853 | 9212 | 1506 | 10277 | 1207 | 11944 | 714 | 14173 | 133 | 13733 |
| 8-#18 | 4.85 | MA | 6156 | 2386 | 9523 | 1952 | 11397 | 1617 | 12723 | 1309 | 14629 | 780 | 18806 | 156 | 17815 |
| 4L-2S | | MI | 5069 | 2386 | 8882 | 1831 | 10660 | 1491 | 12032 | 1198 | 14313 | 696 | 17128 | 423 | 14121 |
| 10-#10 | 1.92 | MA | 5771 | 1827 | 8226 | 1567 | 10055 | 1308 | 11202 | 1100 | 12685 | 773 | 15810 | 670 | 8828 |
| 2L-5S | | MI | 3649 | 1827 | 5187 | 1551 | 6068 | 1301 | 6529 | 1093 | 6925 | 771 | 8256 | 432 | 5915 |
| 10-#10 | 1.92 | MA | 5453 | 1827 | 7651 | 1579 | 9326 | 1319 | 10318 | 1110 | 11491 | 788 | 14158 | 584 | 8806 |
| 3L-4S | | MI | 3772 | 1827 | 5430 | 1541 | 6401 | 1293 | 6941 | 1087 | 7497 | 761 | 9027 | 486 | 6149 |
| 10-#10 | 1.92 | MA | 5281 | 1827 | 7257 | 1591 | 8780 | 1337 | 9648 | 1127 | 10575 | 796 | 13034 | 532 | 8727 |
| 4L-3S | | MI | 3892 | 1827 | 5703 | 1532 | 6778 | 1278 | 7403 | 1073 | 8129 | 757 | 9800 | 538 | 6180 |
| 10-#10 | 1.92 | MA | 5070 | 1827 | 6909 | 1603 | 8301 | 1348 | 9054 | 1137 | 9749 | 811 | 11897 | 487 | 8349 |
| 5L-2S | | MI | 4103 | 1827 | 6094 | 1522 | 7274 | 1270 | 8004 | 1067 | 8940 | 747 | 10895 | 630 | 6182 |
| 10-#11 | 2.36 | MA | 6018 | 1911 | 8892 | 1610 | 10848 | 1339 | 12136 | 1117 | 13921 | 764 | 17505 | 659 | 10658 |
| 2L-5S | | MI | 3727 | 1911 | 5451 | 1594 | 6343 | 1332 | 6834 | 1110 | 7313 | 759 | 8704 | 354 | 6908 |
| 10-#11 | 2.36 | MA | 5649 | 1911 | 8197 | 1624 | 9966 | 1351 | 11067 | 1129 | 12478 | 781 | 15507 | 551 | 10615 |
| 3L-4S | | MI | 3868 | 1911 | 5745 | 1583 | 6745 | 1323 | 7332 | 1103 | 8003 | 749 | 9608 | 421 | 7328 |
| 10-#11 | 2.36 | MA | 5449 | 1911 | 7719 | 1638 | 9303 | 1373 | 10255 | 1149 | 11367 | 789 | 14134 | 487 | 10477 |
| 4L-3S | | MI | 4007 | 1911 | 6074 | 1573 | 7200 | 1306 | 7889 | 1088 | 8764 | 746 | 10519 | 482 | 7392 |
| 10-#11 | 2.36 | MA | 5202 | 1911 | 7296 | 1653 | 8722 | 1386 | 9533 | 1160 | 10365 | 806 | 12750 | 428 | 9818 |
| 5L-2S | | MI | 4252 | 1911 | 6543 | 1562 | 7795 | 1298 | 8611 | 1082 | 9738 | 736 | 11803 | 596 | 7407 |
| 10-#14 | 3.41 | MA | 6146 | 2111 | 9428 | 1748 | 11489 | 1442 | 12893 | 1185 | 14927 | 773 | 18885 | 484 | 14958 |
| 3L-4S | | MI | 4129 | 2111 | 6430 | 1706 | 7564 | 1416 | 8305 | 1161 | 9298 | 736 | 11235 | 291 | 9735 |
| 10-#14 | 3.41 | MA | 5884 | 2111 | 8744 | 1768 | 10542 | 1472 | 11733 | 1213 | 13339 | 784 | 16913 | 390 | 14209 |
| 4L-3S | | MI | 4313 | 2111 | 6899 | 1692 | 8211 | 1392 | 9098 | 1140 | 10380 | 734 | 12509 | 377 | 10294 |
| 10-#14 | 3.41 | MA | 5542 | 2111 | 8138 | 1788 | 9710 | 1489 | 10700 | 1228 | 11906 | 807 | 14929 | 302 | 13259 |
| 5L-2S | | MI | 4638 | 2111 | 7564 | 1678 | 9055 | 1381 | 10120 | 1133 | 11761 | 720 | 14297 | 541 | 10360 |
| 10-#18 | 6.06 | MA | 6949 | 2618 | 11244 | 2097 | 13581 | 1723 | 15370 | 1376 | 18201 | 769 | 23752 | 140 | 22814 |
| 4L-3S | | MI | 5045 | 2618 | 8882 | 1998 | 10660 | 1612 | 12032 | 1274 | 14313 | 703 | 17128 | 76 | 16854 |
| 10-#18 | 6.06 | MA | 6379 | 2618 | 10182 | 2130 | 12126 | 1751 | 13565 | 1400 | 15698 | 806 | 20272 | -27 | 20181 |
| 5L-2S | | MI | 5494 | 2618 | 10023 | 1976 | 12108 | 1597 | 13787 | 1265 | 16682 | 685 | 20084 | 367 | 17482 |
| 12-#10 | 2.31 | MA | 6028 | 1900 | 8800 | 1613 | 10785 | 1342 | 12086 | 1121 | 13878 | 770 | 17463 | 665 | 10535 |
| 2L-6S | | MI | 3678 | 1900 | 5305 | 1612 | 6249 | 1343 | 6725 | 1128 | 7189 | 777 | 8643 | 364 | 6808 |
| 12-#10 | 2.31 | MA | 5722 | 1900 | 8226 | 1625 | 10055 | 1353 | 11202 | 1131 | 12685 | 785 | 15810 | 579 | 10504 |
| 3L-5S | | MI | 3830 | 1900 | 5578 | 1597 | 6564 | 1335 | 7130 | 1114 | 7737 | 767 | 9351 | 424 | 7023 |
| 12-#10 | 2.31 | MA | 5559 | 1900 | 7832 | 1637 | 9509 | 1371 | 10532 | 1148 | 11768 | 792 | 14687 | 527 | 10416 |
| 4E | | MI | 3952 | 1900 | 5821 | 1587 | 6897 | 1327 | 7542 | 1108 | 8308 | 757 | 10122 | 478 | 7294 |
| 12-#10 | 2.31 | MA | 5351 | 1900 | 7484 | 1649 | 9030 | 1382 | 9938 | 1158 | 10943 | 807 | 13549 | 482 | 10008 |
| 5L-3S | | MI | 4065 | 1900 | 6094 | 1578 | 7274 | 1312 | 8004 | 1095 | 8940 | 754 | 10895 | 530 | 7336 |
| 12-#10 | 2.31 | MA | 5126 | 1900 | 7061 | 1663 | 8579 | 1393 | 9357 | 1175 | 10136 | 815 | 12450 | 412 | 9614 |
| 6L-2S | | MI | 4271 | 1900 | 6485 | 1568 | 7770 | 1304 | 8605 | 1088 | 9751 | 744 | 11991 | 622 | 7348 |
| 12-#11 | 2.84 | MA | 5965 | 2001 | 8892 | 1681 | 10848 | 1393 | 12136 | 1155 | 13921 | 776 | 17505 | 546 | 12664 |
| 3L-5S | | MI | 3940 | 2001 | 5920 | 1651 | 6938 | 1373 | 7556 | 1136 | 8286 | 755 | 9988 | 340 | 8240 |
| 12-#11 | 2.84 | MA | 5778 | 2001 | 8414 | 1695 | 10185 | 1414 | 11324 | 1175 | 12810 | 785 | 16132 | 481 | 12515 |
| 4E | | MI | 4079 | 2001 | 6214 | 1640 | 7340 | 1365 | 8054 | 1129 | 8977 | 744 | 10891 | 407 | 8641 |
| 12-#11 | 2.84 | MA | 5534 | 2001 | 7991 | 1709 | 9604 | 1427 | 10602 | 1186 | 11808 | 802 | 14748 | 422 | 11829 |
| 5L-3S | | MI | 4210 | 2001 | 6543 | 1629 | 7795 | 1348 | 8611 | 1114 | 9738 | 742 | 11803 | 469 | 8775 |
| 12-#11 | 2.84 | MA | 5270 | 2001 | 7485 | 1727 | 9055 | 1440 | 9895 | 1206 | 10828 | 810 | 13405 | 336 | 11293 |
| 6L-2S | | MI | 4447 | 2001 | 7012 | 1618 | 8390 | 1339 | 9332 | 1108 | 10711 | 731 | 13086 | 582 | 8801 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis

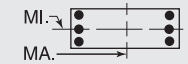



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 4.09 | MA | 6342 | 2241 | 9735 | 1849 | 11799 | 1531 | 13257 | 1251 | 15397 | 778 | 19762 | 382 | 17061 |
| 4E | | MI | 4422 | 2241 | 7095 | 1788 | 8407 | 1475 | 9328 | 1198 | 10678 | 729 | 13023 | 267 | 11605 |
| 12-#14 | 4.09 | MA | 6003 | 2241 | 9129 | 1869 | 10967 | 1549 | 12225 | 1266 | 13964 | 801 | 17778 | 294 | 16152 |
| 5L-3S | | MI | 4592 | 2241 | 7564 | 1773 | 9055 | 1452 | 10120 | 1178 | 11761 | 728 | 14297 | 353 | 12242 |
| 12-#14 | 4.09 | MA | 5648 | 2241 | 8413 | 1895 | 10182 | 1567 | 11214 | 1294 | 12563 | 812 | 15849 | 168 | 14899 |
| 6L-2S | | MI | 4897 | 2241 | 8228 | 1759 | 9898 | 1441 | 11143 | 1170 | 13141 | 714 | 16084 | 517 | 12326 |
| 12-#18 | 7.27 | MA | 7204 | 2850 | 11903 | 2275 | 14310 | 1857 | 16212 | 1466 | 19271 | 795 | 25218 | -43 | 25002 |
| 5L-3S | | MI | 5498 | 2850 | 10023 | 2143 | 12108 | 1718 | 13787 | 1341 | 16682 | 692 | 20084 | 20 | 20008 |
| 14-#10 | 2.69 | MA | 5985 | 1974 | 8800 | 1671 | 10785 | 1387 | 12086 | 1153 | 13878 | 781 | 17463 | 574 | 12201 |
| 3L-6S | | MI | 3860 | 1974 | 5696 | 1658 | 6745 | 1376 | 7326 | 1149 | 8000 | 774 | 9739 | 356 | 7932 |
| 14-#10 | 2.69 | MA | 5832 | 1974 | 8407 | 1683 | 10239 | 1405 | 11417 | 1170 | 12962 | 789 | 16339 | 522 | 12106 |
| 4L-5S | | MI | 4008 | 1974 | 5969 | 1643 | 7060 | 1368 | 7731 | 1136 | 8548 | 764 | 10446 | 416 | 8137 |
| 14-#10 | 2.69 | MA | 5625 | 1974 | 8058 | 1695 | 9760 | 1416 | 10822 | 1180 | 12136 | 804 | 15202 | 477 | 11673 |
| 5L-4S | | MI | 4129 | 1974 | 6212 | 1633 | 7393 | 1361 | 8143 | 1129 | 9120 | 754 | 11217 | 470 | 8439 |
| 14-#10 | 2.69 | MA | 5409 | 1974 | 7635 | 1709 | 9308 | 1427 | 10241 | 1197 | 11330 | 811 | 14103 | 407 | 11294 |
| 6L-3S | | MI | 4236 | 1974 | 6485 | 1624 | 7770 | 1346 | 8605 | 1116 | 9751 | 750 | 11991 | 522 | 8489 |
| 14-#10 | 2.69 | MA | 5221 | 1974 | 7268 | 1717 | 8810 | 1441 | 9680 | 1206 | 10547 | 826 | 13027 | 370 | 10735 |
| 7L-2S | | MI | 4435 | 1974 | 6875 | 1614 | 8266 | 1338 | 9206 | 1110 | 10562 | 740 | 13086 | 614 | 8509 |
| 14-#11 | 3.31 | MA | 6100 | 2092 | 9110 | 1751 | 11067 | 1455 | 12393 | 1201 | 14253 | 780 | 18131 | 475 | 14556 |
| 4L-5S | | MI | 4148 | 2092 | 6389 | 1707 | 7533 | 1415 | 8277 | 1162 | 9260 | 751 | 11271 | 327 | 9579 |
| 14-#11 | 3.31 | MA | 5858 | 2092 | 8686 | 1766 | 10486 | 1468 | 11671 | 1212 | 13251 | 797 | 16746 | 416 | 13846 |
| 5L-4S | | MI | 4285 | 2092 | 6683 | 1696 | 7935 | 1406 | 8775 | 1156 | 9950 | 740 | 12175 | 393 | 9958 |
| 14-#11 | 3.31 | MA | 5606 | 2092 | 8180 | 1783 | 9937 | 1481 | 10964 | 1232 | 12271 | 806 | 15403 | 330 | 13305 |
| 6L-3S | | MI | 4409 | 2092 | 7012 | 1686 | 8390 | 1389 | 9332 | 1140 | 10711 | 738 | 13086 | 455 | 10155 |
| 14-#11 | 3.31 | MA | 5385 | 2092 | 7734 | 1792 | 9343 | 1499 | 10283 | 1243 | 11321 | 823 | 14091 | 281 | 12557 |
| 7L-2S | | MI | 4638 | 2092 | 7481 | 1675 | 8985 | 1380 | 10053 | 1134 | 11685 | 727 | 14370 | 568 | 10191 |
| 14-#14 | 4.77 | MA | 6452 | 2372 | 10120 | 1951 | 12225 | 1609 | 13749 | 1304 | 16021 | 795 | 20627 | 285 | 19051 |
| 5L-4S | | MI | 4729 | 2372 | 7760 | 1869 | 9251 | 1535 | 10350 | 1236 | 12059 | 723 | 14811 | 244 | 13487 |
| 14-#14 | 4.77 | MA | 6115 | 2372 | 9404 | 1976 | 11439 | 1626 | 12738 | 1332 | 14620 | 806 | 18697 | 160 | 17795 |
| 6L-3S | | MI | 4875 | 2372 | 8228 | 1855 | 9898 | 1511 | 11143 | 1216 | 13141 | 722 | 16084 | 330 | 14189 |
| 16-#10 | 3.08 | MA | 6098 | 2048 | 8982 | 1729 | 10968 | 1438 | 12301 | 1191 | 14155 | 785 | 17991 | 517 | 13797 |
| 4L-6S | | MI | 4039 | 2048 | 6087 | 1704 | 7241 | 1410 | 7927 | 1170 | 8811 | 770 | 10834 | 348 | 9059 |
| 16-#10 | 3.08 | MA | 5893 | 2048 | 8633 | 1741 | 10489 | 1449 | 11706 | 1201 | 13330 | 800 | 16854 | 472 | 13341 |
| 5E | | MI | 4182 | 2048 | 6359 | 1689 | 7556 | 1402 | 8332 | 1157 | 9359 | 760 | 11542 | 408 | 9255 |
| 16-#10 | 3.08 | MA | 5685 | 2048 | 8210 | 1755 | 10038 | 1461 | 11125 | 1218 | 12523 | 808 | 15755 | 402 | 12975 |
| 6L-4S | | MI | 4302 | 2048 | 6603 | 1679 | 7889 | 1394 | 8744 | 1151 | 9931 | 750 | 12313 | 461 | 9584 |
| 16-#10 | 3.08 | MA | 5506 | 2048 | 7842 | 1763 | 9540 | 1475 | 10564 | 1228 | 11740 | 823 | 14679 | 365 | 12413 |
| 7L-3S | | MI | 4405 | 2048 | 6875 | 1670 | 8266 | 1379 | 9206 | 1137 | 10562 | 747 | 13086 | 513 | 9642 |
| 16-#10 | 3.08 | MA | 5328 | 2048 | 7489 | 1772 | 9067 | 1482 | 9986 | 1243 | 10972 | 837 | 13643 | 314 | 11846 |
| 8L-2S | | MI | 4598 | 2048 | 7266 | 1660 | 8762 | 1371 | 9807 | 1131 | 11374 | 737 | 14181 | 606 | 9667 |
| 16-#11 | 3.78 | MA | 6175 | 2182 | 9381 | 1822 | 11368 | 1510 | 12740 | 1238 | 14694 | 793 | 18744 | 410 | 15867 |
| 5E | | MI | 4352 | 2182 | 6858 | 1764 | 8128 | 1456 | 8998 | 1188 | 10234 | 746 | 12555 | 313 | 10922 |
| 16-#11 | 3.78 | MA | 5933 | 2182 | 8875 | 1840 | 10819 | 1522 | 12033 | 1258 | 13714 | 801 | 17401 | 324 | 15320 |
| 6L-4S | | MI | 4489 | 2182 | 7152 | 1753 | 8530 | 1447 | 9496 | 1182 | 10924 | 736 | 13459 | 380 | 11282 |
| 16-#11 | 3.78 | MA | 5723 | 2182 | 8429 | 1849 | 10225 | 1541 | 11352 | 1269 | 12764 | 818 | 16089 | 275 | 14590 |
| 7L-3S | | MI | 4606 | 2182 | 7481 | 1742 | 8985 | 1430 | 10053 | 1167 | 11685 | 733 | 14370 | 441 | 11534 |
| 16-#14 | 5.45 | MA | 6570 | 2502 | 10395 | 2058 | 12697 | 1686 | 14262 | 1369 | 16677 | 799 | 21546 | 151 | 20695 |
| 6L-4S | | MI | 5008 | 2502 | 8425 | 1951 | 10095 | 1595 | 11373 | 1274 | 13439 | 717 | 16598 | 220 | 15379 |
| 18-#10 | 3.46 | MA | 6157 | 2121 | 9208 | 1787 | 11219 | 1483 | 12591 | 1222 | 14523 | 797 | 18507 | 467 | 15013 |
| 5L-6S | | MI | 4215 | 2121 | 6478 | 1750 | 7737 | 1444 | 8528 | 1192 | 9622 | 767 | 11929 | 340 | 10166 |
| 18-#10 | 3.46 | MA | 5956 | 2121 | 8785 | 1801 | 10767 | 1494 | 12009 | 1239 | 13716 | 804 | 17408 | 397 | 14660 |
| 6L-5S | | MI | 4353 | 2121 | 6750 | 1735 | 8052 | 1436 | 8933 | 1178 | 10170 | 757 | 12637 | 400 | 10377 |
| 18-#10 | 3.46 | MA | 5784 | 2121 | 8417 | 1809 | 10269 | 1509 | 11448 | 1249 | 12934 | 819 | 16332 | 360 | 14093 |
| 7L-4S | | MI | 4473 | 2121 | 6993 | 1725 | 8384 | 1428 | 9345 | 1172 | 10742 | 747 | 13408 | 453 | 10715 |
| 18-#10 | 3.46 | MA | 5609 | 2121 | 8064 | 1818 | 9796 | 1516 | 10871 | 1264 | 12165 | 834 | 15296 | 309 | 13529 |
| 8L-3S | | MI | 4571 | 2121 | 7266 | 1716 | 8762 | 1413 | 9807 | 1159 | 11374 | 743 | 14181 | 505 | 10793 |
| 18-#11 | 4.25 | MA | 6253 | 2273 | 9570 | 1896 | 11701 | 1564 | 13102 | 1284 | 15158 | 797 | 19399 | 318 | 17338 |
| 6L-5S | | MI | 4553 | 2273 | 7327 | 1820 | 8723 | 1497 | 9719 | 1214 | 11207 | 742 | 13839 | 299 | 12270 |

## RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 4.25 | MA | 6053 | 2273 | 9124 | 1905 | 11107 | 1582 | 12421 | 1296 | 14207 | 814 | 18087 | 269 | 16626 |
| 7L-4S | | MI | 4689 | 2273 | 7621 | 1809 | 9125 | 1489 | 10217 | 1208 | 11897 | 731 | 14743 | 366 | 12613 |
| 20-#10 | 3.85 | MA | 6221 | 2195 | 9360 | 1847 | 11497 | 1528 | 12893 | 1260 | 14910 | 801 | 19060 | 393 | 16346 |
| 6E | | MI | 4388 | 2195 | 6868 | 1796 | 8233 | 1477 | 9129 | 1213 | 10434 | 763 | 13025 | 332 | 11274 |
| 20-#10 | 3.85 | MA | 6056 | 2195 | 8992 | 1855 | 10999 | 1542 | 12333 | 1270 | 14127 | 815 | 17984 | 355 | 15775 |
| 7L-5S | | MI | 4523 | 2195 | 7141 | 1781 | 8547 | 1469 | 9534 | 1199 | 10981 | 753 | 13732 | 391 | 11502 |
| 20-#10 | 3.85 | MA | 5883 | 2195 | 8638 | 1864 | 10526 | 1550 | 11755 | 1285 | 13359 | 830 | 16948 | 304 | 15212 |
| 8L-4S | | MI | 4641 | 2195 | 7384 | 1771 | 8880 | 1461 | 9946 | 1193 | 11553 | 743 | 14503 | 445 | 11826 |
| 20-#11 | 4.73 | MA | 6377 | 2363 | 9819 | 1962 | 11989 | 1623 | 13490 | 1322 | 15650 | 810 | 20085 | 263 | 18664 |
| 7L-5S | | MI | 4766 | 2363 | 7796 | 1877 | 9318 | 1539 | 10441 | 1240 | 12181 | 738 | 15122 | 286 | 13621 |
| 22-#10 | 4.23 | MA | 6324 | 2269 | 9567 | 1901 | 11728 | 1576 | 13217 | 1292 | 15321 | 812 | 19637 | 350 | 17459 |
| 7L-6S | | MI | 4559 | 2269 | 7259 | 1843 | 8728 | 1511 | 9730 | 1234 | 11245 | 760 | 14120 | 324 | 12386 |
| 22-#10 | 4.23 | MA | 6153 | 2269 | 9213 | 1910 | 11255 | 1583 | 12639 | 1307 | 14552 | 827 | 18601 | 299 | 16894 |
| 8L-5S | | MI | 4690 | 2269 | 7532 | 1827 | 9043 | 1503 | 10135 | 1221 | 11793 | 750 | 14828 | 383 | 12629 |
| 24-#10 | 4.62 | MA | 6418 | 2342 | 9788 | 1956 | 11984 | 1617 | 13523 | 1328 | 15746 | 823 | 20253 | 294 | 18577 |
| 8L-6S | | MI | 4728 | 2342 | 7650 | 1889 | 9224 | 1545 | 10331 | 1255 | 12056 | 756 | 15215 | 315 | 13500 |

## RECTANGULAR TIED COLUMNS 22" x 32"

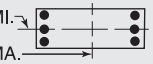
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.28 | MA | 6035 | 1817 | 8295 | 1581 | 10041 | 1328 | 11024 | 1129 | 12086 | 826 | 14723 | 719 | 6729 |
| 2E | | MI | 4025 | 1817 | 5852 | 1518 | 6846 | 1275 | 7386 | 1083 | 7944 | 789 | 9291 | 656 | 4429 |
| 4-#18 | 2.27 | MA | 6723 | 2020 | 9980 | 1694 | 12098 | 1409 | 13477 | 1178 | 15362 | 809 | 19232 | 698 | 11528 |
| 2E | | MI | 4404 | 2020 | 6888 | 1624 | 8088 | 1350 | 8856 | 1126 | 9898 | 768 | 11572 | 580 | 7396 |
| 6-#10 | 1.08 | MA | 5924 | 1777 | 7890 | 1572 | 9626 | 1324 | 10572 | 1130 | 11520 | 838 | 13973 | 730 | 5811 |
| 2L-3S | | MI | 3747 | 1777 | 5198 | 1526 | 6106 | 1284 | 6535 | 1095 | 6832 | 815 | 7971 | 599 | 3871 |
| 6-#10 | 1.08 | MA | 5549 | 1777 | 7269 | 1585 | 8838 | 1335 | 9617 | 1140 | 10231 | 854 | 12188 | 646 | 5814 |
| 3L-2S | | MI | 3975 | 1777 | 5588 | 1516 | 6602 | 1277 | 7136 | 1089 | 7643 | 805 | 9066 | 691 | 3854 |
| 6-#11 | 1.33 | MA | 6097 | 1827 | 8354 | 1594 | 10157 | 1339 | 11185 | 1137 | 12323 | 830 | 15065 | 722 | 7025 |
| 2L-3S | | MI | 3801 | 1827 | 5416 | 1545 | 6331 | 1296 | 6781 | 1099 | 7142 | 805 | 8310 | 554 | 4638 |
| 6-#11 | 1.33 | MA | 5655 | 1827 | 7602 | 1609 | 9203 | 1352 | 10029 | 1150 | 10762 | 848 | 12904 | 616 | 7017 |
| 3L-2S | | MI | 4067 | 1827 | 5885 | 1534 | 6926 | 1288 | 7502 | 1093 | 8115 | 795 | 9594 | 667 | 4620 |
| 6-#14 | 1.92 | MA | 6525 | 1947 | 9367 | 1662 | 11402 | 1388 | 12673 | 1167 | 14313 | 820 | 17807 | 710 | 9928 |
| 2L-3S | | MI | 3948 | 1947 | 5852 | 1614 | 6846 | 1345 | 7386 | 1128 | 7944 | 797 | 9291 | 469 | 6430 |
| 6-#14 | 1.92 | MA | 5926 | 1947 | 8295 | 1683 | 10041 | 1406 | 11024 | 1184 | 12086 | 845 | 14723 | 555 | 9862 |
| 3L-2S | | MI | 4309 | 1947 | 6517 | 1599 | 7690 | 1334 | 8409 | 1120 | 9324 | 783 | 11079 | 632 | 6434 |
| 6-#18 | 3.41 | MA | 7517 | 2252 | 11846 | 1839 | 14466 | 1515 | 16346 | 1245 | 19235 | 798 | 24596 | 683 | 17060 |
| 2L-3S | | MI | 4295 | 2252 | 6888 | 1791 | 8088 | 1471 | 8856 | 1202 | 9898 | 775 | 11572 | 233 | 10622 |
| 6-#18 | 3.41 | MA | 6578 | 2252 | 9980 | 1873 | 12098 | 1546 | 13477 | 1271 | 15362 | 837 | 19232 | 399 | 16698 |
| 3L-2S | | MI | 4857 | 2252 | 8029 | 1769 | 9536 | 1456 | 10611 | 1193 | 12267 | 757 | 14527 | 523 | 10792 |
| 8-#9 | 1.14 | MA | 5978 | 1788 | 7967 | 1582 | 9745 | 1332 | 10726 | 1136 | 11738 | 840 | 14282 | 731 | 6106 |
| 2L-4S | | MI | 3726 | 1788 | 5108 | 1544 | 5987 | 1304 | 6396 | 1112 | 6646 | 819 | 7806 | 582 | 4062 |
| 8-#9 | 1.14 | MA | 5684 | 1788 | 7476 | 1592 | 9121 | 1341 | 9970 | 1144 | 10718 | 852 | 12869 | 665 | 6107 |
| 3E | | MI | 3830 | 1788 | 5324 | 1536 | 6286 | 1292 | 6762 | 1101 | 7147 | 816 | 8425 | 623 | 4055 |
| 8-#9 | 1.14 | MA | 5520 | 1788 | 7141 | 1602 | 8656 | 1356 | 9400 | 1158 | 9937 | 859 | 11920 | 625 | 6084 |
| 4L-2S | | MI | 4010 | 1788 | 5634 | 1528 | 6679 | 1286 | 7239 | 1096 | 7791 | 808 | 9302 | 696 | 4043 |
| 8-#10 | 1.44 | MA | 6219 | 1850 | 8511 | 1618 | 10414 | 1358 | 11527 | 1151 | 12809 | 835 | 15757 | 725 | 7666 |
| 2L-4S | | MI | 3802 | 1850 | 5316 | 1581 | 6225 | 1333 | 6673 | 1130 | 7011 | 815 | 8293 | 539 | 5033 |
| 8-#10 | 1.44 | MA | 5858 | 1850 | 7890 | 1631 | 9626 | 1369 | 10572 | 1162 | 11520 | 850 | 13973 | 641 | 7654 |
| 3E | | MI | 3929 | 1850 | 5588 | 1572 | 6602 | 1318 | 7136 | 1116 | 7643 | 812 | 9066 | 591 | 5043 |
| 8-#10 | 1.44 | MA | 5658 | 1850 | 7466 | 1643 | 9038 | 1388 | 9850 | 1179 | 10532 | 858 | 12769 | 590 | 7589 |
| 4L-2S | | MI | 4149 | 1850 | 5979 | 1562 | 7098 | 1310 | 7737 | 1110 | 8454 | 802 | 10161 | 683 | 5033 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

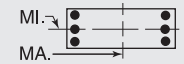
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.77 | MA | 6444 | 1918 | 9105 | 1650 | 11111 | 1380 | 12341 | 1164 | 13883 | 826 | 17226 | 716 | 9267 |
| 2L-4S | | MI | 3865 | 1918 | 5556 | 1612 | 6471 | 1355 | 6945 | 1141 | 7354 | 803 | 8683 | 479 | 6002 |
| 8-#11 | 1.77 | MA | 6021 | 1918 | 8354 | 1665 | 10157 | 1394 | 11185 | 1176 | 12323 | 844 | 15065 | 610 | 9239 |
| 3E | | MI | 4014 | 1918 | 5885 | 1601 | 6926 | 1338 | 7502 | 1126 | 8115 | 801 | 9594 | 540 | 6037 |
| 8-#11 | 1.77 | MA | 5786 | 1918 | 7839 | 1680 | 9442 | 1416 | 10309 | 1196 | 11124 | 853 | 13594 | 546 | 9115 |
| 4L-2S | | MI | 4271 | 1918 | 6354 | 1591 | 7521 | 1329 | 8223 | 1119 | 9089 | 790 | 10878 | 654 | 6032 |
| 8-#14 | 2.56 | MA | 6999 | 2078 | 10440 | 1744 | 12763 | 1447 | 14323 | 1205 | 16539 | 814 | 20890 | 702 | 13113 |
| 2L-4S | | MI | 4042 | 2078 | 6048 | 1709 | 7043 | 1428 | 7617 | 1186 | 8242 | 792 | 9805 | 359 | 8002 |
| 8-#14 | 2.56 | MA | 6433 | 2078 | 9367 | 1764 | 11402 | 1466 | 12673 | 1221 | 14313 | 839 | 17807 | 547 | 13017 |
| 3E | | MI | 4242 | 2078 | 6517 | 1695 | 7690 | 1405 | 8409 | 1166 | 9324 | 791 | 11079 | 445 | 8387 |
| 8-#14 | 2.56 | MA | 6120 | 2078 | 8630 | 1785 | 10380 | 1497 | 11420 | 1250 | 12598 | 851 | 15692 | 454 | 12417 |
| 4L-2S | | MI | 4586 | 2078 | 7181 | 1681 | 8534 | 1394 | 9431 | 1158 | 10704 | 777 | 12866 | 608 | 8420 |
| 8-#18 | 4.55 | MA | 7419 | 2484 | 11846 | 2018 | 14466 | 1652 | 16346 | 1338 | 19235 | 826 | 24596 | 384 | 22173 |
| 3E | | MI | 4795 | 2484 | 8029 | 1936 | 9536 | 1577 | 10611 | 1269 | 12267 | 764 | 14527 | 176 | 13935 |
| 8-#18 | 4.55 | MA | 6940 | 2484 | 10557 | 2053 | 12680 | 1704 | 14158 | 1386 | 16241 | 844 | 20867 | 215 | 19469 |
| 4L-2S | | MI | 5292 | 2484 | 9170 | 1914 | 10984 | 1562 | 12366 | 1260 | 14635 | 746 | 17482 | 467 | 14165 |
| 10-#10 | 1.80 | MA | 6507 | 1924 | 9132 | 1664 | 11202 | 1391 | 12481 | 1172 | 14098 | 831 | 17542 | 720 | 9514 |
| 2L-5S | | MI | 3863 | 1924 | 5463 | 1637 | 6388 | 1375 | 6862 | 1157 | 7251 | 822 | 8617 | 477 | 5992 |
| 10-#10 | 1.80 | MA | 6160 | 1924 | 8511 | 1677 | 10414 | 1403 | 11527 | 1183 | 12809 | 847 | 15757 | 636 | 9491 |
| 3L-4S | | MI | 3986 | 1924 | 5706 | 1628 | 6721 | 1367 | 7274 | 1151 | 7823 | 812 | 9388 | 531 | 6183 |
| 10-#10 | 1.80 | MA | 5971 | 1924 | 8087 | 1689 | 9826 | 1421 | 10805 | 1201 | 11821 | 855 | 14553 | 585 | 9413 |
| 4L-3S | | MI | 4107 | 1924 | 5979 | 1618 | 7098 | 1352 | 7737 | 1138 | 8454 | 808 | 10161 | 583 | 6206 |
| 10-#10 | 1.80 | MA | 5737 | 1924 | 7713 | 1702 | 9311 | 1433 | 10165 | 1211 | 10933 | 870 | 13332 | 541 | 9063 |
| 5L-2S | | MI | 4321 | 1924 | 6370 | 1608 | 7594 | 1344 | 8337 | 1131 | 9266 | 798 | 11257 | 675 | 6205 |
| 10-#11 | 2.22 | MA | 6782 | 2008 | 9857 | 1707 | 12064 | 1421 | 13497 | 1190 | 15444 | 821 | 19386 | 710 | 11500 |
| 2L-5S | | MI | 3941 | 2008 | 5731 | 1679 | 6664 | 1405 | 7168 | 1173 | 7638 | 810 | 9063 | 398 | 6996 |
| 10-#11 | 2.22 | MA | 6377 | 2008 | 9105 | 1722 | 11111 | 1435 | 12341 | 1202 | 13883 | 839 | 17226 | 604 | 11458 |
| 3L-4S | | MI | 4081 | 2008 | 6025 | 1669 | 7066 | 1396 | 7666 | 1167 | 8328 | 799 | 9967 | 465 | 7373 |
| 10-#11 | 2.22 | MA | 6157 | 2008 | 8590 | 1737 | 10396 | 1457 | 11465 | 1223 | 12684 | 849 | 15754 | 540 | 11319 |
| 4L-3S | | MI | 4222 | 2008 | 6354 | 1658 | 7521 | 1379 | 8223 | 1152 | 9089 | 797 | 10878 | 527 | 7425 |
| 10-#11 | 2.22 | MA | 5883 | 2008 | 8134 | 1752 | 9770 | 1471 | 10688 | 1235 | 11604 | 867 | 14266 | 484 | 10666 |
| 5L-2S | | MI | 4470 | 2008 | 6823 | 1647 | 8116 | 1370 | 8944 | 1145 | 10063 | 786 | 12162 | 640 | 7435 |
| 10-#14 | 3.20 | MA | 6924 | 2208 | 10440 | 1846 | 12763 | 1526 | 14323 | 1259 | 16539 | 833 | 20890 | 538 | 16173 |
| 3L-4S | | MI | 4342 | 2208 | 6713 | 1791 | 7886 | 1488 | 8639 | 1224 | 9622 | 786 | 11593 | 335 | 9853 |
| 10-#14 | 3.20 | MA | 6637 | 2208 | 9703 | 1867 | 11741 | 1557 | 13070 | 1288 | 14825 | 845 | 18775 | 445 | 15500 |
| 4L-3S | | MI | 4528 | 2208 | 7181 | 1777 | 8534 | 1464 | 9431 | 1203 | 10704 | 784 | 12866 | 421 | 10338 |
| 10-#14 | 3.20 | MA | 6256 | 2208 | 9050 | 1888 | 10844 | 1576 | 11957 | 1304 | 13280 | 870 | 16641 | 361 | 14416 |
| 5L-2S | | MI | 4858 | 2208 | 7846 | 1762 | 9377 | 1453 | 10454 | 1196 | 12085 | 771 | 14654 | 585 | 10394 |
| 10-#18 | 5.68 | MA | 7809 | 2715 | 12423 | 2198 | 15048 | 1810 | 17027 | 1453 | 20115 | 833 | 26230 | 200 | 24906 |
| 4L-3S | | MI | 5260 | 2715 | 9170 | 2081 | 10984 | 1683 | 12366 | 1336 | 14635 | 753 | 17482 | 119 | 17047 |
| 10-#18 | 5.68 | MA | 7173 | 2715 | 11278 | 2232 | 13478 | 1840 | 15080 | 1479 | 17413 | 873 | 22483 | 40 | 22321 |
| 5L-2S | | MI | 5719 | 2715 | 10311 | 2059 | 12432 | 1668 | 14121 | 1327 | 17004 | 735 | 20437 | 410 | 17527 |
| 12-#10 | 2.16 | MA | 6790 | 1998 | 9753 | 1710 | 11990 | 1425 | 13436 | 1194 | 15387 | 828 | 19327 | 715 | 11358 |
| 2L-6S | | MI | 3891 | 1998 | 5581 | 1699 | 6569 | 1416 | 7058 | 1192 | 7514 | 828 | 9005 | 409 | 6883 |
| 12-#10 | 2.16 | MA | 6454 | 1998 | 9132 | 1723 | 11202 | 1436 | 12481 | 1204 | 14098 | 843 | 17542 | 631 | 11327 |
| 3L-5S | | MI | 4045 | 1998 | 5854 | 1683 | 6884 | 1408 | 7463 | 1178 | 8062 | 818 | 9712 | 469 | 7098 |
| 12-#10 | 2.16 | MA | 6276 | 1998 | 8708 | 1735 | 10614 | 1455 | 11760 | 1222 | 13110 | 851 | 16338 | 580 | 11239 |
| 4E | | MI | 4167 | 1998 | 6097 | 1674 | 7217 | 1400 | 7875 | 1172 | 8634 | 808 | 10483 | 522 | 7330 |
| 12-#10 | 2.16 | MA | 6045 | 1998 | 8333 | 1748 | 10099 | 1467 | 11120 | 1232 | 12222 | 867 | 15117 | 536 | 10858 |
| 5L-3S | | MI | 4281 | 1998 | 6370 | 1664 | 7594 | 1385 | 8337 | 1159 | 9266 | 805 | 11257 | 574 | 7364 |
| 12-#10 | 2.16 | MA | 5800 | 1998 | 7873 | 1762 | 9613 | 1478 | 10495 | 1250 | 11353 | 875 | 13940 | 467 | 10415 |
| 6L-2S | | MI | 4489 | 1998 | 6761 | 1654 | 8090 | 1377 | 8938 | 1152 | 10077 | 795 | 12352 | 667 | 7372 |
| 12-#11 | 2.66 | MA | 6723 | 2099 | 9857 | 1778 | 12064 | 1476 | 13497 | 1228 | 15444 | 835 | 19386 | 598 | 13675 |
| 3L-5S | | MI | 4154 | 2099 | 6200 | 1736 | 7259 | 1446 | 7889 | 1199 | 8611 | 805 | 10347 | 385 | 8326 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

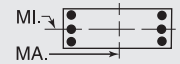



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.66 | MA | 6518 | 2099 | 9342 | 1793 | 11350 | 1498 | 12621 | 1249 | 14245 | 844 | 17915 | 534 | 13526 |
| 4E | | MI | 4293 | 2099 | 6494 | 1725 | 7661 | 1438 | 8387 | 1193 | 9301 | 795 | 11250 | 451 | 8738 |
| 12-#11 | 2.66 | MA | 6248 | 2099 | 8886 | 1808 | 10724 | 1512 | 11844 | 1261 | 13165 | 862 | 16426 | 478 | 12845 |
| 5L-3S | | MI | 4426 | 2099 | 6823 | 1714 | 8116 | 1420 | 8944 | 1178 | 10063 | 793 | 12162 | 513 | 8810 |
| 12-#11 | 2.66 | MA | 5959 | 2099 | 8334 | 1825 | 10133 | 1525 | 11083 | 1281 | 12110 | 872 | 14987 | 392 | 12332 |
| 6L-2S | | MI | 4665 | 2099 | 7292 | 1704 | 8711 | 1412 | 9666 | 1171 | 11036 | 782 | 13445 | 626 | 8831 |
| 12-#14 | 3.84 | MA | 7138 | 2339 | 10775 | 1948 | 13102 | 1616 | 14720 | 1326 | 17052 | 839 | 21859 | 437 | 18594 |
| 4E | | MI | 4635 | 2339 | 7378 | 1872 | 8730 | 1548 | 9662 | 1261 | 11002 | 779 | 13380 | 311 | 11719 |
| 12-#14 | 3.84 | MA | 6762 | 2339 | 10122 | 1969 | 12205 | 1635 | 13607 | 1342 | 15507 | 863 | 19725 | 352 | 17553 |
| 5L-3S | | MI | 4809 | 2339 | 7846 | 1858 | 9377 | 1524 | 10454 | 1241 | 12085 | 778 | 14654 | 397 | 12287 |
| 12-#14 | 3.84 | MA | 6373 | 2339 | 9340 | 1994 | 11359 | 1654 | 12518 | 1371 | 13997 | 876 | 17656 | 228 | 16275 |
| 6L-2S | | MI | 5120 | 2339 | 8511 | 1844 | 10221 | 1513 | 11476 | 1233 | 13465 | 764 | 16442 | 561 | 12362 |
| 12-#18 | 6.82 | MA | 8019 | 2947 | 13144 | 2377 | 15846 | 1946 | 17950 | 1546 | 21286 | 862 | 27846 | 25 | 27747 |
| 5L-3S | | MI | 5714 | 2947 | 10311 | 2226 | 12432 | 1789 | 14121 | 1403 | 17004 | 741 | 20437 | 63 | 20193 |
| 14-#10 | 2.53 | MA | 6741 | 2071 | 9753 | 1769 | 11990 | 1470 | 13436 | 1226 | 15387 | 839 | 19327 | 626 | 13161 |
| 3L-6S | | MI | 4074 | 2071 | 5972 | 1745 | 7065 | 1450 | 7659 | 1213 | 8325 | 825 | 10100 | 401 | 8005 |
| 14-#10 | 2.53 | MA | 6574 | 2071 | 9329 | 1781 | 11401 | 1489 | 12715 | 1243 | 14399 | 848 | 18123 | 575 | 13066 |
| 4L-5S | | MI | 4223 | 2071 | 6245 | 1729 | 7380 | 1442 | 8064 | 1200 | 8873 | 815 | 10808 | 461 | 8211 |
| 14-#10 | 2.53 | MA | 6345 | 2071 | 8954 | 1794 | 10886 | 1500 | 12075 | 1254 | 13511 | 863 | 16901 | 531 | 12659 |
| 5L-4S | | MI | 4344 | 2071 | 6488 | 1720 | 7712 | 1434 | 8476 | 1193 | 9445 | 805 | 11579 | 514 | 8476 |
| 14-#10 | 2.53 | MA | 6109 | 2071 | 8493 | 1808 | 10401 | 1512 | 11449 | 1271 | 12642 | 872 | 15724 | 462 | 12231 |
| 6L-3S | | MI | 4453 | 2071 | 6761 | 1710 | 8090 | 1419 | 8938 | 1180 | 10077 | 801 | 12352 | 566 | 8519 |
| 14-#10 | 2.53 | MA | 5904 | 2071 | 8097 | 1816 | 9857 | 1526 | 10847 | 1282 | 11800 | 887 | 14570 | 427 | 11679 |
| 7L-2S | | MI | 4654 | 2071 | 7151 | 1700 | 8586 | 1411 | 9539 | 1174 | 10888 | 791 | 13447 | 659 | 8534 |
| 14-#11 | 3.10 | MA | 6870 | 2189 | 10093 | 1850 | 12304 | 1540 | 13777 | 1275 | 15805 | 840 | 20075 | 528 | 15735 |
| 4L-5S | | MI | 4362 | 2189 | 6669 | 1792 | 7854 | 1487 | 8610 | 1225 | 9585 | 801 | 11630 | 371 | 9663 |
| 14-#11 | 3.10 | MA | 6602 | 2189 | 9638 | 1865 | 11677 | 1553 | 13000 | 1287 | 14725 | 858 | 18587 | 472 | 15029 |
| 5L-4S | | MI | 4500 | 2189 | 6963 | 1782 | 8256 | 1479 | 9109 | 1219 | 10275 | 790 | 12534 | 438 | 10052 |
| 14-#11 | 3.10 | MA | 6326 | 2189 | 9085 | 1882 | 11087 | 1567 | 12239 | 1308 | 13670 | 867 | 17148 | 386 | 14520 |
| 6L-3S | | MI | 4626 | 2189 | 7292 | 1771 | 8711 | 1462 | 9666 | 1204 | 11036 | 788 | 13445 | 499 | 10191 |
| 14-#11 | 3.10 | MA | 6086 | 2189 | 8604 | 1891 | 10437 | 1585 | 11505 | 1320 | 12646 | 885 | 15740 | 340 | 13670 |
| 7L-2S | | MI | 4858 | 2189 | 7761 | 1760 | 9306 | 1453 | 10387 | 1197 | 12010 | 777 | 14729 | 612 | 10222 |
| 14-#14 | 4.47 | MA | 7253 | 2469 | 11195 | 2051 | 13566 | 1695 | 15256 | 1380 | 17733 | 857 | 22808 | 344 | 20696 |
| 5L-4S | | MI | 4922 | 2469 | 8042 | 1954 | 9574 | 1607 | 10684 | 1299 | 12382 | 773 | 15168 | 288 | 13597 |
| 14-#14 | 4.47 | MA | 6884 | 2469 | 10412 | 2076 | 12720 | 1713 | 14167 | 1409 | 16223 | 869 | 20740 | 219 | 19412 |
| 6L-3S | | MI | 5094 | 2469 | 8511 | 1940 | 10221 | 1584 | 11476 | 1279 | 13465 | 772 | 16442 | 374 | 14236 |
| 14-#14 | 4.47 | MA | 6563 | 2469 | 9725 | 2089 | 11801 | 1740 | 13117 | 1425 | 14758 | 894 | 18718 | 150 | 17985 |
| 7L-2S | | MI | 5377 | 2469 | 9176 | 1925 | 11065 | 1573 | 12499 | 1271 | 14845 | 758 | 18229 | 537 | 14325 |
| 16-#10 | 2.89 | MA | 6865 | 2145 | 9950 | 1827 | 12189 | 1522 | 13670 | 1264 | 15688 | 844 | 19908 | 570 | 14894 |
| 4L-6S | | MI | 4253 | 2145 | 6363 | 1791 | 7560 | 1484 | 8260 | 1234 | 9137 | 821 | 11195 | 393 | 9130 |
| 16-#10 | 2.89 | MA | 6638 | 2145 | 9575 | 1840 | 11674 | 1534 | 13030 | 1275 | 14800 | 860 | 18686 | 527 | 14464 |
| 5E | | MI | 4397 | 2145 | 6635 | 1775 | 7875 | 1476 | 8665 | 1221 | 9685 | 811 | 11903 | 452 | 9327 |
| 16-#10 | 2.89 | MA | 6411 | 2145 | 9114 | 1854 | 11189 | 1546 | 12404 | 1292 | 13931 | 868 | 17509 | 457 | 14050 |
| 6L-4S | | MI | 4518 | 2145 | 6879 | 1766 | 8208 | 1468 | 9077 | 1215 | 10256 | 801 | 12674 | 506 | 9622 |
| 16-#10 | 2.89 | MA | 6215 | 2145 | 8718 | 1862 | 10645 | 1560 | 11801 | 1303 | 13089 | 884 | 16355 | 422 | 13495 |
| 7L-3S | | MI | 4622 | 2145 | 7151 | 1756 | 8586 | 1453 | 9539 | 1201 | 10888 | 798 | 13447 | 558 | 9672 |
| 16-#10 | 2.89 | MA | 6018 | 2145 | 8337 | 1871 | 10136 | 1568 | 11170 | 1318 | 12262 | 899 | 15243 | 373 | 12923 |
| 8L-2S | | MI | 4818 | 2145 | 7542 | 1747 | 9081 | 1445 | 10140 | 1195 | 11699 | 788 | 14543 | 650 | 9694 |
| 16-#11 | 3.55 | MA | 6949 | 2279 | 10389 | 1921 | 12631 | 1595 | 14156 | 1313 | 16286 | 854 | 20747 | 466 | 17217 |
| 5E | | MI | 4567 | 2279 | 7138 | 1849 | 8449 | 1529 | 9332 | 1251 | 10558 | 797 | 12914 | 357 | 11004 |
| 16-#11 | 3.55 | MA | 6684 | 2279 | 9837 | 1938 | 12040 | 1608 | 13395 | 1334 | 15230 | 863 | 19309 | 380 | 16705 |
| 6L-4S | | MI | 4704 | 2279 | 7432 | 1838 | 8851 | 1520 | 9830 | 1245 | 11249 | 786 | 13818 | 424 | 11375 |
| 16-#11 | 3.55 | MA | 6455 | 2279 | 9356 | 1948 | 11390 | 1626 | 12661 | 1346 | 14207 | 881 | 17900 | 334 | 15875 |
| 7L-3S | | MI | 4824 | 2279 | 7761 | 1827 | 9306 | 1503 | 10387 | 1230 | 12010 | 784 | 14729 | 485 | 11571 |
| 16-#11 | 3.55 | MA | 6225 | 2279 | 8893 | 1959 | 10771 | 1635 | 11907 | 1364 | 13201 | 899 | 16544 | 271 | 14970 |
| 8L-2S | | MI | 5049 | 2279 | 8230 | 1817 | 9902 | 1494 | 11108 | 1224 | 12983 | 773 | 16013 | 599 | 11611 |
| 16-#14 | 5.11 | MA | 7382 | 2599 | 11485 | 2157 | 14081 | 1773 | 15817 | 1446 | 18450 | 863 | 23823 | 211 | 22550 |
| 6L-4S | | MI | 5223 | 2599 | 8707 | 2036 | 10417 | 1667 | 11707 | 1337 | 13763 | 767 | 16956 | 264 | 15485 |

## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

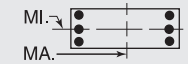
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 5.11 | MA | 7080 | 2599 | 10797 | 2171 | 13162 | 1799 | 14766 | 1463 | 16984 | 888 | 21802 | 141 | 21111 |
| 7L-3S | | MI | 5361 | 2599 | 9176 | 2021 | 11065 | 1643 | 12499 | 1316 | 14845 | 766 | 18229 | 350 | 16184 |
| 18-#10 | 3.25 | MA | 6926 | 2219 | 10196 | 1886 | 12462 | 1568 | 13985 | 1296 | 16089 | 856 | 20471 | 522 | 16272 |
| 5L-6S | | MI | 4430 | 2219 | 6754 | 1837 | 8056 | 1517 | 8861 | 1256 | 9948 | 818 | 12291 | 385 | 10259 |
| 18-#10 | 3.25 | MA | 6707 | 2219 | 9735 | 1900 | 11977 | 1579 | 13359 | 1314 | 15220 | 865 | 19294 | 453 | 15871 |
| 6L-5S | | MI | 4570 | 2219 | 7026 | 1821 | 8371 | 1509 | 9266 | 1242 | 10496 | 808 | 12998 | 444 | 10448 |
| 18-#10 | 3.25 | MA | 6519 | 2219 | 9339 | 1908 | 11433 | 1593 | 12756 | 1324 | 14378 | 880 | 18140 | 417 | 15314 |
| 7L-4S | | MI | 4689 | 2219 | 7269 | 1812 | 8704 | 1501 | 9678 | 1236 | 11068 | 797 | 13769 | 498 | 10768 |
| 18-#10 | 3.25 | MA | 6325 | 2219 | 8958 | 1917 | 10923 | 1601 | 12125 | 1339 | 13551 | 896 | 17028 | 368 | 14740 |
| 8L-3S | | MI | 4789 | 2219 | 7542 | 1802 | 9081 | 1486 | 10140 | 1223 | 11699 | 794 | 14543 | 550 | 10824 |
| 18-#10 | 3.25 | MA | 6097 | 2219 | 8588 | 1928 | 10428 | 1610 | 11500 | 1346 | 12710 | 904 | 15931 | 322 | 13994 |
| 9L-2S | | MI | 4980 | 2219 | 7933 | 1793 | 9577 | 1478 | 10741 | 1216 | 12510 | 784 | 15638 | 642 | 10852 |
| 18-#11 | 3.99 | MA | 7034 | 2370 | 10588 | 1995 | 12994 | 1649 | 14551 | 1360 | 16791 | 859 | 21469 | 374 | 18894 |
| 6L-5S | | MI | 4769 | 2370 | 7607 | 1905 | 9044 | 1570 | 10053 | 1278 | 11532 | 793 | 14198 | 344 | 12350 |
| 18-#11 | 3.99 | MA | 6816 | 2370 | 10107 | 2005 | 12344 | 1667 | 13818 | 1372 | 15767 | 877 | 20061 | 328 | 18081 |
| 7L-4S | | MI | 4905 | 2370 | 7901 | 1895 | 9447 | 1562 | 10551 | 1271 | 12222 | 782 | 15102 | 410 | 12703 |
| 18-#11 | 3.99 | MA | 6589 | 2370 | 9645 | 2016 | 11725 | 1676 | 13063 | 1391 | 14761 | 894 | 18705 | 265 | 17169 |
| 8L-3S | | MI | 5029 | 2370 | 8230 | 1884 | 9902 | 1544 | 11108 | 1256 | 12983 | 780 | 16013 | 472 | 12950 |
| 18-#14 | 5.75 | MA | 7584 | 2730 | 11870 | 2252 | 14523 | 1859 | 16416 | 1501 | 19211 | 882 | 24885 | 132 | 24236 |
| 7L-4S | | MI | 5498 | 2730 | 9372 | 2117 | 11261 | 1726 | 12729 | 1374 | 15143 | 761 | 18743 | 240 | 17381 |
| 20-#10 | 3.61 | MA | 6997 | 2292 | 10356 | 1946 | 12765 | 1613 | 14314 | 1335 | 16509 | 861 | 21079 | 448 | 17694 |
| 6E | | MI | 4603 | 2292 | 7144 | 1883 | 8552 | 1551 | 9462 | 1277 | 10759 | 814 | 13386 | 376 | 11386 |
| 20-#10 | 3.61 | MA | 6817 | 2292 | 9960 | 1954 | 12221 | 1627 | 13711 | 1346 | 15667 | 877 | 19925 | 412 | 17135 |
| 7L-5S | | MI | 4739 | 2292 | 7417 | 1867 | 8867 | 1543 | 9867 | 1264 | 11307 | 804 | 14094 | 436 | 11571 |
| 20-#10 | 3.61 | MA | 6625 | 2292 | 9579 | 1963 | 11711 | 1635 | 13080 | 1360 | 14840 | 892 | 18813 | 363 | 16558 |
| 8L-4S | | MI | 4858 | 2292 | 7660 | 1858 | 9200 | 1535 | 10279 | 1257 | 11879 | 794 | 14865 | 490 | 11906 |
| 20-#10 | 3.61 | MA | 6405 | 2292 | 9209 | 1974 | 11215 | 1644 | 12454 | 1368 | 13999 | 901 | 17715 | 317 | 15815 |
| 9L-3S | | MI | 4954 | 2292 | 7933 | 1848 | 9577 | 1520 | 10741 | 1244 | 12510 | 791 | 15638 | 542 | 11976 |
| 20-#11 | 4.43 | MA | 7170 | 2460 | 10859 | 2061 | 13298 | 1709 | 14974 | 1398 | 17328 | 872 | 22221 | 322 | 20289 |
| 7L-5S | | MI | 4968 | 2460 | 8075 | 1962 | 9640 | 1611 | 10774 | 1304 | 12505 | 788 | 15481 | 330 | 13700 |
| 20-#11 | 4.43 | MA | 6945 | 2460 | 10396 | 2072 | 12679 | 1718 | 14219 | 1417 | 16322 | 890 | 20866 | 259 | 19368 |
| 8L-4S | | MI | 5120 | 2460 | 8370 | 1951 | 10042 | 1603 | 11272 | 1297 | 13196 | 777 | 16385 | 397 | 14037 |
| 22-#10 | 3.97 | MA | 7109 | 2366 | 10580 | 2000 | 13009 | 1661 | 14666 | 1367 | 16956 | 873 | 21709 | 407 | 18956 |
| 7L-6S | | MI | 4775 | 2366 | 7535 | 1929 | 9048 | 1584 | 10063 | 1298 | 11570 | 811 | 14481 | 368 | 12495 |
| 22-#10 | 3.97 | MA | 6919 | 2366 | 10200 | 2009 | 12499 | 1668 | 14035 | 1382 | 16129 | 889 | 20598 | 358 | 18376 |
| 8L-5S | | MI | 4907 | 2366 | 7808 | 1913 | 9363 | 1576 | 10468 | 1285 | 12118 | 801 | 15189 | 428 | 12698 |
| 22-#10 | 3.97 | MA | 6706 | 2366 | 9830 | 2020 | 12003 | 1677 | 13409 | 1389 | 15288 | 897 | 19500 | 312 | 17635 |
| 9L-4S | | MI | 5025 | 2366 | 8051 | 1904 | 9696 | 1569 | 10880 | 1278 | 12690 | 790 | 15960 | 482 | 13019 |
| 22-#11 | 4.88 | MA | 7294 | 2551 | 11148 | 2129 | 13633 | 1759 | 15376 | 1443 | 17882 | 886 | 23026 | 253 | 21567 |
| 8L-5S | | MI | 5178 | 2551 | 8544 | 2018 | 10235 | 1653 | 11495 | 1330 | 13479 | 784 | 16765 | 316 | 15053 |
| 24-#10 | 4.33 | MA | 7209 | 2439 | 10820 | 2056 | 13287 | 1702 | 14990 | 1403 | 17418 | 885 | 22382 | 353 | 20193 |
| 8L-6S | | MI | 4944 | 2439 | 7926 | 1975 | 9544 | 1618 | 10664 | 1319 | 12382 | 807 | 15577 | 360 | 13607 |
| 24-#10 | 4.33 | MA | 7002 | 2439 | 10451 | 2066 | 12791 | 1711 | 14364 | 1410 | 16577 | 894 | 21285 | 307 | 19456 |
| 9L-5S | | MI | 5073 | 2439 | 8198 | 1959 | 9859 | 1610 | 11069 | 1306 | 12929 | 797 | 16284 | 420 | 13826 |

## RECTANGULAR TIED COLUMNS 22" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.20 | MA | 6773 | 1914 | 9183 | 1678 | 11160 | 1411 | 12261 | 1202 | 13420 | 884 | 16330 | 769 | 7215 |
| 2E | | MI | 4240 | 1914 | 6134 | 1602 | 7169 | 1347 | 7720 | 1145 | 8268 | 839 | 9648 | 700 | 4453 |
| 4-#18 | 2.14 | MA | 7528 | 2117 | 11003 | 1791 | 13383 | 1492 | 14911 | 1250 | 16959 | 866 | 21201 | 749 | 12392 |
| 2E | | MI | 4621 | 2117 | 7176 | 1708 | 8413 | 1421 | 9190 | 1188 | 10220 | 817 | 11925 | 623 | 7431 |
| 6-#10 | 1.02 | MA | 6648 | 1874 | 8743 | 1669 | 10709 | 1407 | 11768 | 1202 | 12803 | 896 | 15511 | 780 | 6223 |
| 2L-3S | | MI | 3961 | 1874 | 5474 | 1612 | 6426 | 1358 | 6868 | 1159 | 7157 | 866 | 8332 | 644 | 3890 |
| 6-#10 | 1.02 | MA | 6241 | 1874 | 8076 | 1682 | 9863 | 1419 | 10742 | 1213 | 11418 | 912 | 13594 | 698 | 6225 |
| 3L-2S | | MI | 4190 | 1874 | 5864 | 1603 | 6922 | 1350 | 7469 | 1153 | 7969 | 856 | 9427 | 736 | 3872 |

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

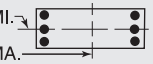
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.25 | MA | 6839 | 1924 | 9244 | 1691 | 11282 | 1422 | 12431 | 1210 | 13671 | 888 | 16691 | 772 | 7531 |
| 2L-3S | | MI | 4015 | 1924 | 5696 | 1630 | 6652 | 1369 | 7114 | 1163 | 7466 | 856 | 8669 | 598 | 4663 |
| 6-#11 | 1.25 | MA | 6358 | 1924 | 8436 | 1707 | 10257 | 1436 | 11188 | 1223 | 11993 | 906 | 14368 | 669 | 7523 |
| 3L-2S | | MI | 4283 | 1924 | 6165 | 1619 | 7247 | 1361 | 7835 | 1156 | 8440 | 845 | 9953 | 712 | 4642 |
| 6-#14 | 1.80 | MA | 7308 | 2044 | 10337 | 1759 | 12625 | 1471 | 14036 | 1239 | 15816 | 878 | 19647 | 761 | 10657 |
| 2L-3S | | MI | 4162 | 2044 | 6134 | 1698 | 7169 | 1417 | 7720 | 1191 | 8268 | 847 | 9648 | 513 | 6466 |
| 6-#14 | 1.80 | MA | 6655 | 2044 | 9183 | 1781 | 11160 | 1490 | 12261 | 1257 | 13420 | 904 | 16330 | 609 | 10591 |
| 3L-2S | | MI | 4526 | 2044 | 6799 | 1684 | 8012 | 1406 | 8743 | 1183 | 9648 | 833 | 11436 | 676 | 6462 |
| 6-#18 | 3.21 | MA | 8396 | 2349 | 13014 | 1936 | 15935 | 1598 | 18003 | 1317 | 21133 | 855 | 26981 | 733 | 18356 |
| 2L-3S | | MI | 4508 | 2349 | 7176 | 1875 | 8413 | 1543 | 9190 | 1264 | 10220 | 824 | 11925 | 276 | 10687 |
| 6-#18 | 3.21 | MA | 7370 | 2349 | 11003 | 1972 | 13383 | 1630 | 14911 | 1345 | 16959 | 898 | 21201 | 455 | 17994 |
| 3L-2S | | MI | 5077 | 2349 | 8317 | 1853 | 9861 | 1527 | 10945 | 1255 | 12589 | 806 | 14881 | 567 | 10833 |
| 8-#9 | 1.07 | MA | 6707 | 1885 | 8825 | 1679 | 10835 | 1415 | 11933 | 1208 | 13036 | 897 | 15840 | 781 | 6538 |
| 2L-4S | | MI | 3940 | 1885 | 5382 | 1630 | 6306 | 1378 | 6729 | 1176 | 6972 | 870 | 8168 | 627 | 4084 |
| 8-#9 | 1.07 | MA | 6387 | 1885 | 8297 | 1690 | 10166 | 1424 | 11121 | 1217 | 11940 | 910 | 14324 | 717 | 6539 |
| 3E | | MI | 4044 | 1885 | 5598 | 1623 | 6605 | 1366 | 7095 | 1165 | 7473 | 867 | 8787 | 668 | 4074 |
| 8-#9 | 1.07 | MA | 6210 | 1885 | 7938 | 1700 | 9667 | 1440 | 10510 | 1231 | 11103 | 917 | 13311 | 677 | 6516 |
| 4L-2S | | MI | 4225 | 1885 | 5908 | 1615 | 6998 | 1360 | 7572 | 1160 | 8117 | 859 | 9664 | 741 | 4061 |
| 8-#10 | 1.36 | MA | 6970 | 1948 | 9410 | 1715 | 11555 | 1440 | 12794 | 1223 | 14187 | 892 | 17428 | 776 | 8215 |
| 2L-4S | | MI | 4015 | 1948 | 5592 | 1668 | 6544 | 1407 | 7007 | 1194 | 7337 | 866 | 8654 | 584 | 5062 |
| 8-#10 | 1.36 | MA | 6578 | 1948 | 8743 | 1728 | 10709 | 1453 | 11768 | 1235 | 12803 | 908 | 15511 | 693 | 8203 |
| 3E | | MI | 4143 | 1948 | 5864 | 1658 | 6922 | 1392 | 7469 | 1180 | 7969 | 863 | 9427 | 636 | 5065 |
| 8-#10 | 1.36 | MA | 6361 | 1948 | 8289 | 1741 | 10078 | 1472 | 10994 | 1253 | 11744 | 917 | 14227 | 642 | 8137 |
| 4L-2S | | MI | 4365 | 1948 | 6255 | 1649 | 7418 | 1384 | 8070 | 1174 | 8780 | 853 | 10523 | 728 | 5054 |
| 8-#11 | 1.67 | MA | 7217 | 2015 | 10052 | 1748 | 12308 | 1463 | 13674 | 1236 | 15348 | 883 | 19015 | 766 | 9940 |
| 2L-4S | | MI | 4078 | 2015 | 5836 | 1697 | 6792 | 1428 | 7278 | 1204 | 7679 | 854 | 9042 | 523 | 6041 |
| 8-#11 | 1.67 | MA | 6757 | 2015 | 9244 | 1763 | 11282 | 1477 | 12431 | 1249 | 13671 | 902 | 16691 | 663 | 9913 |
| 3E | | MI | 4228 | 2015 | 6165 | 1687 | 7247 | 1410 | 7835 | 1189 | 8440 | 852 | 9953 | 585 | 6066 |
| 8-#11 | 1.67 | MA | 6502 | 2015 | 8692 | 1779 | 10516 | 1500 | 11492 | 1270 | 12384 | 912 | 15122 | 599 | 9789 |
| 4L-2S | | MI | 4487 | 2015 | 6634 | 1676 | 7842 | 1402 | 8557 | 1183 | 9414 | 841 | 11237 | 698 | 6057 |
| 8-#14 | 2.41 | MA | 7825 | 2175 | 11491 | 1841 | 14089 | 1530 | 15811 | 1277 | 18212 | 872 | 22965 | 752 | 14085 |
| 2L-4S | | MI | 4254 | 2175 | 6331 | 1794 | 7365 | 1501 | 7950 | 1249 | 8566 | 842 | 10162 | 403 | 8121 |
| 8-#14 | 2.41 | MA | 7208 | 2175 | 10337 | 1862 | 12625 | 1550 | 14036 | 1295 | 15816 | 898 | 19647 | 600 | 13989 |
| 3E | | MI | 4457 | 2175 | 6799 | 1780 | 8012 | 1477 | 8743 | 1229 | 9648 | 841 | 11436 | 489 | 8427 |
| 8-#14 | 2.41 | MA | 6867 | 2175 | 9546 | 1884 | 11528 | 1582 | 12691 | 1325 | 13976 | 911 | 17391 | 508 | 13481 |
| 4L-2S | | MI | 4804 | 2175 | 7464 | 1765 | 8856 | 1466 | 9765 | 1221 | 11028 | 827 | 13224 | 652 | 8452 |
| 8-#18 | 4.28 | MA | 8286 | 2581 | 13014 | 2117 | 15935 | 1736 | 18003 | 1412 | 21133 | 887 | 26981 | 440 | 23901 |
| 3E | | MI | 5009 | 2581 | 8317 | 2019 | 9861 | 1648 | 10945 | 1331 | 12589 | 813 | 14881 | 219 | 14004 |
| 8-#18 | 4.28 | MA | 7765 | 2581 | 11630 | 2153 | 14016 | 1791 | 15651 | 1463 | 17915 | 907 | 22998 | 273 | 21145 |
| 4L-2S | | MI | 5515 | 2581 | 9458 | 1998 | 11309 | 1633 | 12700 | 1322 | 14958 | 795 | 17836 | 510 | 14208 |
| 10-#10 | 1.70 | MA | 7284 | 2021 | 10077 | 1761 | 12401 | 1474 | 13819 | 1245 | 15572 | 889 | 19345 | 771 | 10200 |
| 2L-5S | | MI | 4077 | 2021 | 5739 | 1723 | 6708 | 1448 | 7195 | 1221 | 7576 | 873 | 8978 | 522 | 6067 |
| 10-#10 | 1.70 | MA | 6905 | 2021 | 9410 | 1774 | 11555 | 1486 | 12794 | 1256 | 14187 | 905 | 17428 | 688 | 10177 |
| 3L-4S | | MI | 4200 | 2021 | 5982 | 1714 | 7040 | 1440 | 7608 | 1215 | 8148 | 863 | 9749 | 575 | 6215 |
| 10-#10 | 1.70 | MA | 6701 | 2021 | 8956 | 1787 | 10925 | 1505 | 12020 | 1274 | 13129 | 914 | 16144 | 637 | 10099 |
| 4L-3S | | MI | 4322 | 2021 | 6255 | 1704 | 7418 | 1425 | 8070 | 1202 | 8780 | 859 | 10523 | 627 | 6231 |
| 10-#10 | 1.70 | MA | 6444 | 2021 | 8555 | 1800 | 10373 | 1517 | 11335 | 1285 | 12177 | 930 | 14838 | 595 | 9784 |
| 5L-2S | | MI | 4537 | 2021 | 6646 | 1695 | 7913 | 1417 | 8671 | 1195 | 9591 | 849 | 11618 | 720 | 6227 |
| 10-#11 | 2.09 | MA | 7586 | 2105 | 10860 | 1804 | 13334 | 1504 | 14917 | 1262 | 17026 | 879 | 21338 | 760 | 12343 |
| 2L-5S | | MI | 4154 | 2105 | 6011 | 1765 | 6985 | 1478 | 7502 | 1237 | 7962 | 860 | 9422 | 443 | 7082 |
| 10-#11 | 2.09 | MA | 7144 | 2105 | 10052 | 1820 | 12308 | 1519 | 13674 | 1275 | 15348 | 898 | 19015 | 657 | 12300 |
| 3L-4S | | MI | 4295 | 2105 | 6305 | 1754 | 7387 | 1469 | 8000 | 1230 | 8652 | 849 | 10326 | 509 | 7415 |
| 10-#11 | 2.09 | MA | 6906 | 2105 | 9500 | 1835 | 11542 | 1541 | 12735 | 1296 | 14062 | 908 | 17445 | 593 | 12162 |
| 4L-3S | | MI | 4437 | 2105 | 6634 | 1743 | 7842 | 1452 | 8557 | 1215 | 9414 | 847 | 11237 | 571 | 7457 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

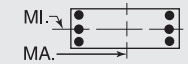
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.09 | MA | 6604 | 2105 | 9012 | 1851 | 10871 | 1555 | 11902 | 1309 | 12905 | 927 | 15853 | 539 | 11522 |
| 5L-2S | | MI | 4687 | 2105 | 7103 | 1732 | 8438 | 1443 | 9278 | 1209 | 10387 | 837 | 12520 | 684 | 7462 |
| 10-#14 | 3.01 | MA | 7742 | 2305 | 11491 | 1944 | 14089 | 1610 | 15811 | 1332 | 18212 | 891 | 22965 | 592 | 17388 |
| 3L-4S | | MI | 4555 | 2305 | 6996 | 1876 | 8209 | 1560 | 8973 | 1287 | 9946 | 836 | 11950 | 379 | 9967 |
| 10-#14 | 3.01 | MA | 7430 | 2305 | 10700 | 1966 | 12992 | 1642 | 14466 | 1362 | 16372 | 905 | 20708 | 500 | 16808 |
| 4L-3S | | MI | 4744 | 2305 | 7464 | 1861 | 8856 | 1537 | 9765 | 1266 | 11028 | 834 | 13224 | 465 | 10381 |
| 10-#14 | 3.01 | MA | 7009 | 2305 | 10001 | 1987 | 12031 | 1661 | 13273 | 1380 | 14715 | 931 | 18425 | 419 | 15584 |
| 5L-2S | | MI | 5077 | 2305 | 8129 | 1847 | 9700 | 1526 | 10788 | 1258 | 12409 | 821 | 15011 | 629 | 10428 |
| 10-#18 | 5.35 | MA | 8710 | 2813 | 13640 | 2298 | 16567 | 1897 | 18744 | 1530 | 22090 | 896 | 28778 | 258 | 27020 |
| 4L-3S | | MI | 5476 | 2813 | 9458 | 2164 | 11309 | 1754 | 12700 | 1398 | 14958 | 802 | 17836 | 163 | 17236 |
| 10-#18 | 5.35 | MA | 8008 | 2813 | 12413 | 2334 | 14883 | 1929 | 16653 | 1558 | 19188 | 939 | 24764 | 105 | 24303 |
| 5L-2S | | MI | 5944 | 2813 | 10599 | 2143 | 12757 | 1739 | 14455 | 1389 | 17327 | 784 | 20791 | 453 | 17573 |
| 12-#10 | 2.04 | MA | 7591 | 2095 | 10744 | 1807 | 13248 | 1508 | 14845 | 1266 | 16956 | 885 | 21262 | 766 | 12181 |
| 2L-6S | | MI | 4104 | 2095 | 5858 | 1785 | 6888 | 1490 | 7392 | 1256 | 7840 | 879 | 9366 | 454 | 6954 |
| 12-#10 | 2.04 | MA | 7225 | 2095 | 10077 | 1820 | 12401 | 1520 | 13819 | 1277 | 15572 | 901 | 19345 | 683 | 12150 |
| 3L-5S | | MI | 4259 | 2095 | 6130 | 1769 | 7203 | 1482 | 7796 | 1243 | 8388 | 869 | 10074 | 513 | 7171 |
| 12-#10 | 2.04 | MA | 7032 | 2095 | 9623 | 1833 | 11771 | 1539 | 13046 | 1295 | 14513 | 910 | 18061 | 632 | 12062 |
| 4E | | MI | 4381 | 2095 | 6373 | 1760 | 7536 | 1474 | 8209 | 1236 | 8960 | 859 | 10845 | 567 | 7364 |
| 12-#10 | 2.04 | MA | 6778 | 2095 | 9222 | 1846 | 11220 | 1551 | 12361 | 1306 | 13561 | 926 | 16755 | 590 | 11716 |
| 5L-3S | | MI | 4497 | 2095 | 6646 | 1750 | 7913 | 1459 | 8671 | 1223 | 9591 | 856 | 11618 | 619 | 7391 |
| 12-#10 | 2.04 | MA | 6513 | 2095 | 8723 | 1860 | 10699 | 1563 | 11691 | 1324 | 12631 | 936 | 15497 | 523 | 11220 |
| 6L-2S | | MI | 4707 | 2095 | 7037 | 1741 | 8409 | 1451 | 9272 | 1217 | 10402 | 846 | 12713 | 712 | 7396 |
| 12-#11 | 2.50 | MA | 7522 | 2196 | 10860 | 1876 | 13334 | 1560 | 14917 | 1301 | 17026 | 893 | 21338 | 651 | 14686 |
| 3L-5S | | MI | 4368 | 2196 | 6480 | 1821 | 7580 | 1519 | 8223 | 1263 | 8936 | 856 | 10706 | 429 | 8410 |
| 12-#11 | 2.50 | MA | 7299 | 2196 | 10308 | 1892 | 12567 | 1583 | 13978 | 1322 | 15740 | 904 | 19768 | 587 | 14537 |
| 4E | | MI | 4507 | 2196 | 6774 | 1810 | 7983 | 1510 | 8721 | 1256 | 9626 | 845 | 11609 | 496 | 8788 |
| 12-#11 | 2.50 | MA | 7000 | 2196 | 9820 | 1907 | 11896 | 1597 | 13145 | 1335 | 14582 | 922 | 18176 | 533 | 13869 |
| 5L-3S | | MI | 4642 | 2196 | 7103 | 1800 | 8438 | 1493 | 9278 | 1241 | 10387 | 843 | 12520 | 557 | 8844 |
| 12-#11 | 2.50 | MA | 6688 | 2196 | 9221 | 1924 | 11264 | 1611 | 12329 | 1357 | 13452 | 933 | 16641 | 448 | 13300 |
| 6L-2S | | MI | 4884 | 2196 | 7572 | 1789 | 9033 | 1485 | 9999 | 1235 | 11361 | 832 | 13804 | 670 | 8860 |
| 12-#14 | 3.61 | MA | 7975 | 2436 | 11854 | 2047 | 14457 | 1701 | 16241 | 1400 | 18768 | 899 | 24026 | 491 | 20145 |
| 4E | | MI | 4849 | 2436 | 7660 | 1957 | 9052 | 1620 | 9995 | 1324 | 11326 | 830 | 13737 | 355 | 11830 |
| 12-#14 | 3.61 | MA | 7560 | 2436 | 11155 | 2069 | 13496 | 1721 | 15048 | 1418 | 17111 | 925 | 21742 | 410 | 18965 |
| 5L-3S | | MI | 5025 | 2436 | 8129 | 1943 | 9700 | 1596 | 10788 | 1304 | 12409 | 828 | 15011 | 441 | 12332 |
| 12-#14 | 3.61 | MA | 7138 | 2436 | 10306 | 2093 | 12589 | 1741 | 13880 | 1448 | 15491 | 939 | 19536 | 287 | 17651 |
| 6L-2S | | MI | 5346 | 2436 | 8794 | 1928 | 10543 | 1585 | 11810 | 1296 | 13789 | 814 | 16799 | 605 | 12397 |
| 12-#18 | 6.42 | MA | 8928 | 3045 | 14424 | 2479 | 17434 | 2035 | 19746 | 1625 | 23362 | 927 | 30545 | 90 | 30151 |
| 5L-3S | | MI | 5931 | 3045 | 10599 | 2309 | 12757 | 1860 | 14455 | 1465 | 17327 | 791 | 20791 | 106 | 20375 |
| 14-#10 | 2.38 | MA | 7538 | 2169 | 10744 | 1866 | 13248 | 1553 | 14845 | 1298 | 16956 | 898 | 21262 | 678 | 14121 |
| 3L-6S | | MI | 4288 | 2169 | 6248 | 1831 | 7384 | 1523 | 7993 | 1277 | 8651 | 876 | 10461 | 446 | 8075 |
| 14-#10 | 2.38 | MA | 7355 | 2169 | 10290 | 1879 | 12617 | 1573 | 14072 | 1316 | 15898 | 907 | 19978 | 627 | 14026 |
| 4L-5S | | MI | 4437 | 2169 | 6521 | 1815 | 7699 | 1515 | 8397 | 1264 | 9199 | 866 | 11169 | 505 | 8282 |
| 14-#10 | 2.38 | MA | 7105 | 2169 | 9888 | 1892 | 12066 | 1585 | 13387 | 1328 | 14946 | 923 | 18672 | 586 | 13653 |
| 5L-4S | | MI | 4558 | 2169 | 6764 | 1806 | 8032 | 1507 | 8810 | 1257 | 9771 | 855 | 11940 | 559 | 8512 |
| 14-#10 | 2.38 | MA | 6849 | 2169 | 9390 | 1906 | 11545 | 1596 | 12717 | 1346 | 14016 | 932 | 17414 | 518 | 13174 |
| 6L-3S | | MI | 4670 | 2169 | 7037 | 1796 | 8409 | 1493 | 9272 | 1244 | 10402 | 852 | 12713 | 611 | 8548 |
| 14-#10 | 2.38 | MA | 6627 | 2169 | 8966 | 1914 | 10957 | 1610 | 12072 | 1357 | 13115 | 948 | 16185 | 483 | 12634 |
| 7L-2S | | MI | 4873 | 2169 | 7427 | 1787 | 8905 | 1485 | 9873 | 1238 | 11214 | 842 | 13809 | 703 | 8560 |
| 14-#11 | 2.92 | MA | 7682 | 2286 | 11116 | 1948 | 13593 | 1624 | 15221 | 1348 | 17418 | 899 | 22091 | 581 | 16914 |
| 4L-5S | | MI | 4577 | 2286 | 6949 | 1878 | 8176 | 1560 | 8944 | 1289 | 9909 | 852 | 11989 | 415 | 9744 |
| 14-#11 | 2.92 | MA | 7387 | 2286 | 10628 | 1964 | 12922 | 1638 | 14387 | 1361 | 16260 | 918 | 20499 | 527 | 16221 |
| 5L-4S | | MI | 4715 | 2286 | 7243 | 1867 | 8578 | 1552 | 9442 | 1282 | 10600 | 841 | 12893 | 482 | 10145 |
| 14-#11 | 2.92 | MA | 7087 | 2286 | 10029 | 1980 | 12289 | 1652 | 13572 | 1383 | 15129 | 928 | 18964 | 442 | 15673 |
| 6L-3S | | MI | 4843 | 2286 | 7572 | 1856 | 9033 | 1534 | 9999 | 1267 | 11361 | 839 | 13804 | 543 | 10227 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis

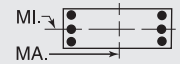


$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.92 | MA | 6826 | 2286 | 9513 | 1990 | 11583 | 1670 | 12787 | 1395 | 14033 | 947 | 17460 | 398 | 14797 |
| 7L-2S | | MI | 5078 | 2286 | 8041 | 1846 | 9628 | 1526 | 10721 | 1261 | 12334 | 828 | 15088 | 657 | 10253 |
| 14-#14 | 4.21 | MA | 8095 | 2566 | 12309 | 2150 | 14960 | 1780 | 16823 | 1455 | 19506 | 919 | 25060 | 402 | 22352 |
| 5L-4S | | MI | 5137 | 2566 | 8325 | 2039 | 9896 | 1679 | 11018 | 1362 | 12706 | 823 | 15525 | 332 | 13705 |
| 14-#14 | 4.21 | MA | 7694 | 2566 | 11460 | 2175 | 14054 | 1800 | 15655 | 1485 | 17887 | 932 | 22853 | 278 | 21028 |
| 6L-3S | | MI | 5312 | 2566 | 8794 | 2024 | 10543 | 1656 | 11810 | 1342 | 13789 | 822 | 16799 | 418 | 14281 |
| 14-#14 | 4.21 | MA | 7345 | 2566 | 10721 | 2189 | 13054 | 1826 | 14530 | 1503 | 16316 | 958 | 20693 | 212 | 19569 |
| 7L-2S | | MI | 5601 | 2566 | 9458 | 2010 | 11387 | 1645 | 12833 | 1334 | 15169 | 808 | 18587 | 581 | 14362 |
| 16-#10 | 2.72 | MA | 7672 | 2242 | 10957 | 1925 | 13463 | 1606 | 15097 | 1338 | 17282 | 903 | 21895 | 623 | 15991 |
| 4L-6S | | MI | 4467 | 2242 | 6639 | 1877 | 7880 | 1557 | 8594 | 1298 | 9462 | 872 | 11557 | 437 | 9199 |
| 16-#10 | 2.72 | MA | 7424 | 2242 | 10555 | 1938 | 12912 | 1618 | 14412 | 1349 | 16330 | 919 | 20589 | 581 | 15594 |
| 5E | | MI | 4613 | 2242 | 6911 | 1861 | 8195 | 1549 | 8998 | 1285 | 10010 | 862 | 12264 | 497 | 9397 |
| 16-#10 | 2.72 | MA | 7177 | 2242 | 10057 | 1952 | 12391 | 1630 | 13743 | 1367 | 15401 | 929 | 19331 | 513 | 15130 |
| 6L-4S | | MI | 4733 | 2242 | 7155 | 1852 | 8528 | 1541 | 9411 | 1279 | 10582 | 852 | 13035 | 551 | 9659 |
| 16-#10 | 2.72 | MA | 6964 | 2242 | 9632 | 1960 | 11803 | 1644 | 13097 | 1378 | 14499 | 945 | 18102 | 478 | 14590 |
| 7L-3S | | MI | 4839 | 2242 | 7427 | 1842 | 8905 | 1526 | 9873 | 1265 | 11214 | 849 | 13809 | 603 | 9702 |
| 16-#10 | 2.72 | MA | 6748 | 2242 | 9225 | 1970 | 11257 | 1652 | 12412 | 1392 | 13614 | 961 | 16914 | 430 | 13959 |
| 8L-2S | | MI | 5038 | 2242 | 7818 | 1833 | 9401 | 1518 | 10474 | 1259 | 12025 | 839 | 14904 | 695 | 9720 |
| 16-#11 | 3.34 | MA | 7764 | 2377 | 11436 | 2020 | 13947 | 1679 | 15630 | 1387 | 17938 | 914 | 22822 | 521 | 18577 |
| 5E | | MI | 4783 | 2377 | 7418 | 1934 | 8771 | 1602 | 9665 | 1315 | 10883 | 847 | 13273 | 402 | 11084 |
| 16-#11 | 3.34 | MA | 7476 | 2377 | 10837 | 2037 | 13315 | 1694 | 14815 | 1409 | 16807 | 924 | 21287 | 436 | 18049 |
| 6L-4S | | MI | 4920 | 2377 | 7712 | 1923 | 9173 | 1593 | 10163 | 1308 | 11573 | 837 | 14177 | 468 | 11465 |
| 16-#11 | 3.34 | MA | 7227 | 2377 | 10321 | 2047 | 12609 | 1711 | 14030 | 1422 | 15710 | 943 | 19783 | 392 | 17172 |
| 7L-3S | | MI | 5042 | 2377 | 8041 | 1913 | 9628 | 1576 | 10721 | 1293 | 12334 | 834 | 15088 | 530 | 11608 |
| 16-#11 | 3.34 | MA | 6973 | 2377 | 9825 | 2059 | 11945 | 1720 | 13210 | 1440 | 14633 | 962 | 18334 | 331 | 16242 |
| 8L-2S | | MI | 5270 | 2377 | 8510 | 1902 | 10223 | 1567 | 11442 | 1287 | 13308 | 824 | 16372 | 643 | 11642 |
| 16-#14 | 4.81 | MA | 8235 | 2697 | 12614 | 2256 | 15518 | 1860 | 17430 | 1523 | 20283 | 926 | 26171 | 270 | 24404 |
| 6L-4S | | MI | 5439 | 2697 | 8990 | 2120 | 10740 | 1739 | 12041 | 1400 | 14087 | 817 | 17313 | 308 | 15590 |
| 16-#14 | 4.81 | MA | 7906 | 2697 | 11875 | 2270 | 14519 | 1885 | 16305 | 1541 | 18712 | 952 | 24011 | 203 | 22933 |
| 7L-3S | | MI | 5581 | 2697 | 9458 | 2106 | 11387 | 1715 | 12833 | 1379 | 15169 | 816 | 18587 | 394 | 16230 |
| 18-#10 | 3.06 | MA | 7736 | 2316 | 11222 | 1984 | 13758 | 1652 | 15438 | 1370 | 17715 | 916 | 22506 | 576 | 17538 |
| 5L-6S | | MI | 4644 | 2316 | 7030 | 1923 | 8376 | 1591 | 9195 | 1320 | 10273 | 869 | 12652 | 429 | 10327 |
| 18-#10 | 3.06 | MA | 7498 | 2316 | 10724 | 1998 | 13237 | 1664 | 14768 | 1388 | 16785 | 925 | 21248 | 508 | 17088 |
| 6L-5S | | MI | 4786 | 2316 | 7302 | 1907 | 8691 | 1583 | 9599 | 1306 | 10821 | 859 | 13360 | 489 | 10516 |
| 18-#10 | 3.06 | MA | 7294 | 2316 | 10299 | 2006 | 12650 | 1678 | 14123 | 1399 | 15884 | 941 | 20019 | 473 | 16548 |
| 7L-4S | | MI | 4905 | 2316 | 7545 | 1898 | 9024 | 1575 | 10012 | 1300 | 11393 | 848 | 14130 | 543 | 10805 |
| 18-#10 | 3.06 | MA | 7081 | 2316 | 9891 | 2016 | 12103 | 1686 | 13438 | 1414 | 14998 | 957 | 18832 | 426 | 15920 |
| 8L-3S | | MI | 5007 | 2316 | 7818 | 1888 | 9401 | 1560 | 10474 | 1287 | 12025 | 845 | 14904 | 595 | 10855 |
| 18-#10 | 3.06 | MA | 6834 | 2316 | 9495 | 2027 | 11572 | 1695 | 12768 | 1421 | 14098 | 966 | 17663 | 380 | 15144 |
| 9L-2S | | MI | 5200 | 2316 | 8209 | 1879 | 9897 | 1552 | 11075 | 1280 | 12836 | 835 | 15999 | 687 | 10879 |
| 18-#11 | 3.75 | MA | 7856 | 2467 | 11646 | 2093 | 14340 | 1735 | 16058 | 1435 | 18485 | 920 | 23610 | 430 | 20427 |
| 6L-5S | | MI | 4985 | 2467 | 7886 | 1991 | 9366 | 1643 | 10387 | 1341 | 11857 | 843 | 14557 | 388 | 12429 |
| 18-#11 | 3.75 | MA | 7619 | 2467 | 11130 | 2104 | 13634 | 1752 | 15273 | 1448 | 17388 | 939 | 22106 | 386 | 19545 |
| 7L-4S | | MI | 5121 | 2467 | 8181 | 1980 | 9768 | 1634 | 10885 | 1335 | 12547 | 832 | 15460 | 455 | 12791 |
| 18-#11 | 3.75 | MA | 7369 | 2467 | 10634 | 2115 | 12970 | 1762 | 14453 | 1466 | 16311 | 957 | 20657 | 325 | 18607 |
| 8L-3S | | MI | 5238 | 2467 | 8510 | 1969 | 10223 | 1617 | 11442 | 1320 | 13308 | 830 | 16372 | 516 | 12988 |
| 18-#14 | 5.41 | MA | 8454 | 2827 | 13029 | 2352 | 15983 | 1945 | 18080 | 1578 | 21108 | 946 | 27328 | 195 | 26297 |
| 7L-4S | | MI | 5715 | 2827 | 9655 | 2202 | 11583 | 1799 | 13063 | 1437 | 15467 | 811 | 19100 | 284 | 17483 |
| 20-#10 | 3.40 | MA | 7813 | 2389 | 11391 | 2044 | 14084 | 1697 | 15794 | 1409 | 18170 | 922 | 23166 | 503 | 19048 |
| 6E | | MI | 4818 | 2389 | 7420 | 1969 | 8872 | 1624 | 9796 | 1341 | 11085 | 865 | 13747 | 421 | 11456 |
| 20-#10 | 3.40 | MA | 7617 | 2389 | 10966 | 2052 | 13496 | 1711 | 15149 | 1420 | 17268 | 938 | 21936 | 468 | 18507 |
| 7L-5S | | MI | 4956 | 2389 | 7693 | 1953 | 9187 | 1616 | 10200 | 1328 | 11633 | 855 | 14455 | 481 | 11639 |
| 20-#10 | 3.40 | MA | 7406 | 2389 | 10558 | 2062 | 12950 | 1720 | 14464 | 1435 | 16383 | 954 | 20749 | 421 | 17882 |
| 8L-4S | | MI | 5075 | 2389 | 7936 | 1944 | 9520 | 1608 | 10613 | 1321 | 12204 | 845 | 15226 | 535 | 11951 |
| 20-#10 | 3.40 | MA | 7168 | 2389 | 10162 | 2073 | 12419 | 1729 | 13794 | 1443 | 15482 | 963 | 19580 | 376 | 17100 |
| 9L-3S | | MI | 5173 | 2389 | 8209 | 1934 | 9897 | 1593 | 11075 | 1308 | 12836 | 842 | 15999 | 587 | 12007 |
| 20-#10 | 3.40 | MA | 6947 | 2389 | 9746 | 2081 | 11865 | 1746 | 13138 | 1451 | 14600 | 979 | 18318 | 324 | 16334 |
| 10L-2S | | MI | 5361 | 2389 | 8599 | 1925 | 10393 | 1586 | 11676 | 1302 | 13647 | 832 | 17095 | 679 | 12036 |

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

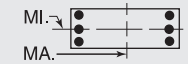
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 4.17 | MA | 8003 | 2558 | 11938 | 2160 | 14660 | 1794 | 16516 | 1474 | 19066 | 934 | 24429 | 380 | 21918 |
| 7L-5S | | MI | 5185 | 2558 | 8355 | 2047 | 9961 | 1684 | 11108 | 1367 | 12830 | 839 | 15840 | 374 | 13777 |
| 20-#11 | 4.17 | MA | 7755 | 2558 | 11442 | 2172 | 13996 | 1803 | 15696 | 1492 | 17989 | 953 | 22980 | 319 | 20971 |
| 8L-4S | | MI | 5320 | 2558 | 8650 | 2037 | 10363 | 1676 | 11606 | 1361 | 13520 | 828 | 16744 | 441 | 14124 |
| 22-#10 | 3.74 | MA | 7935 | 2463 | 11633 | 2098 | 14342 | 1745 | 16174 | 1442 | 18653 | 934 | 23853 | 464 | 20467 |
| 7L-6S | | MI | 4990 | 2463 | 7811 | 2015 | 9368 | 1658 | 10397 | 1362 | 11896 | 862 | 14843 | 413 | 12588 |
| 22-#10 | 3.74 | MA | 7726 | 2463 | 11225 | 2108 | 13796 | 1753 | 15489 | 1456 | 17767 | 950 | 22666 | 416 | 19843 |
| 8L-5S | | MI | 5124 | 2463 | 8084 | 1999 | 9683 | 1650 | 10801 | 1349 | 12444 | 852 | 15550 | 473 | 12764 |
| 22-#10 | 3.74 | MA | 7495 | 2463 | 10829 | 2119 | 13265 | 1763 | 14819 | 1464 | 16867 | 959 | 21497 | 371 | 19056 |
| 9L-4S | | MI | 5243 | 2463 | 8327 | 1990 | 10015 | 1642 | 11214 | 1342 | 13016 | 841 | 16321 | 526 | 13096 |
| 22-#10 | 3.74 | MA | 7282 | 2463 | 10413 | 2127 | 12711 | 1780 | 14163 | 1473 | 15985 | 975 | 20235 | 319 | 18285 |
| 10L-3S | | MI | 5336 | 2463 | 8599 | 1980 | 10393 | 1627 | 11676 | 1329 | 13647 | 838 | 17095 | 578 | 13159 |
| 22-#11 | 4.59 | MA | 8134 | 2648 | 12250 | 2228 | 15021 | 1844 | 16939 | 1518 | 19666 | 949 | 25303 | 313 | 23336 |
| 8L-5S | | MI | 5397 | 2648 | 8824 | 2104 | 10556 | 1725 | 11829 | 1393 | 13804 | 834 | 17124 | 360 | 15128 |
| 24-#10 | 4.07 | MA | 8040 | 2537 | 11892 | 2154 | 14642 | 1787 | 16515 | 1477 | 19152 | 947 | 24583 | 411 | 21805 |
| 8L-6S | | MI | 5160 | 2537 | 8202 | 2061 | 9864 | 1692 | 10998 | 1383 | 12707 | 858 | 15938 | 405 | 13712 |
| 24-#10 | 4.07 | MA | 7816 | 2537 | 11496 | 2165 | 14111 | 1796 | 15845 | 1485 | 18251 | 956 | 23414 | 366 | 21012 |
| 9L-5S | | MI | 5291 | 2537 | 8474 | 2045 | 10179 | 1684 | 11402 | 1370 | 13255 | 848 | 16645 | 465 | 13892 |
| 24-#10 | 4.07 | MA | 7611 | 2537 | 11079 | 2173 | 13558 | 1813 | 15189 | 1494 | 17369 | 972 | 22152 | 314 | 20236 |
| 10L-4S | | MI | 5409 | 2537 | 8717 | 2036 | 10511 | 1676 | 11815 | 1364 | 13827 | 838 | 17416 | 518 | 14211 |

## RECTANGULAR TIED COLUMNS 22" x 36"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.14 | MA | 7550 | 2011 | 10109 | 1775 | 12332 | 1494 | 13556 | 1274 | 14815 | 942 | 18007 | 820 | 7701 |
| 2E | | MI | 4456 | 2011 | 6417 | 1687 | 7491 | 1419 | 8054 | 1208 | 8592 | 889 | 10006 | 744 | 4477 |
| 4-#18 | 2.02 | MA | 8374 | 2214 | 12065 | 1888 | 14720 | 1575 | 16403 | 1322 | 18616 | 924 | 23239 | 799 | 13256 |
| 2E | | MI | 4837 | 2214 | 7464 | 1791 | 8737 | 1493 | 9524 | 1250 | 10543 | 866 | 12279 | 666 | 7465 |
| 6-#11 | 1.18 | MA | 7620 | 2022 | 10173 | 1788 | 12461 | 1505 | 13736 | 1282 | 15079 | 945 | 18389 | 823 | 8036 |
| 2L-3S | | MI | 4229 | 2022 | 5976 | 1715 | 6974 | 1442 | 7448 | 1226 | 7791 | 906 | 9028 | 643 | 4686 |
| 6-#11 | 1.18 | MA | 7101 | 2022 | 9309 | 1804 | 11363 | 1519 | 12406 | 1295 | 13284 | 965 | 15903 | 721 | 8028 |
| 3L-2S | | MI | 4498 | 2022 | 6445 | 1705 | 7569 | 1433 | 8169 | 1220 | 8765 | 896 | 10312 | 756 | 4664 |
| 6-#14 | 1.70 | MA | 8131 | 2142 | 11345 | 1857 | 13900 | 1554 | 15457 | 1312 | 17380 | 935 | 21559 | 811 | 11386 |
| 2L-3S | | MI | 4376 | 2142 | 6417 | 1783 | 7491 | 1490 | 8054 | 1254 | 8592 | 897 | 10006 | 556 | 6500 |
| 6-#14 | 1.70 | MA | 7424 | 2142 | 10109 | 1879 | 12332 | 1574 | 13556 | 1330 | 14815 | 963 | 18007 | 662 | 11320 |
| 3L-2S | | MI | 4742 | 2142 | 7082 | 1768 | 8335 | 1479 | 9077 | 1246 | 9972 | 883 | 11793 | 720 | 6489 |
| 6-#18 | 3.03 | MA | 9317 | 2446 | 14220 | 2033 | 17456 | 1681 | 19719 | 1389 | 23092 | 913 | 29436 | 784 | 19652 |
| 2L-3S | | MI | 4721 | 2446 | 7464 | 1958 | 8737 | 1614 | 9524 | 1326 | 10543 | 873 | 12279 | 319 | 10749 |
| 6-#18 | 3.03 | MA | 8202 | 2446 | 12065 | 2071 | 14720 | 1715 | 16403 | 1419 | 18616 | 958 | 23239 | 511 | 19290 |
| 3L-2S | | MI | 5297 | 2446 | 8605 | 1936 | 10185 | 1598 | 11279 | 1317 | 12911 | 855 | 15234 | 610 | 10872 |
| 8-#9 | 1.01 | MA | 7475 | 1982 | 9722 | 1777 | 11978 | 1498 | 13198 | 1280 | 14393 | 955 | 17470 | 832 | 6970 |
| 2L-4S | | MI | 4154 | 1982 | 5657 | 1717 | 6625 | 1452 | 7062 | 1240 | 7298 | 921 | 8531 | 672 | 4105 |
| 8-#9 | 1.01 | MA | 7130 | 1982 | 9158 | 1787 | 11263 | 1508 | 12330 | 1290 | 13223 | 968 | 15848 | 768 | 6971 |
| 3E | | MI | 4259 | 1982 | 5873 | 1709 | 6924 | 1440 | 7428 | 1229 | 7799 | 918 | 9149 | 713 | 4092 |
| 8-#9 | 1.01 | MA | 6939 | 1982 | 8775 | 1798 | 10731 | 1523 | 11678 | 1304 | 12330 | 976 | 14773 | 729 | 6948 |
| 4L-2S | | MI | 4441 | 1982 | 6183 | 1701 | 7317 | 1433 | 7905 | 1224 | 8443 | 910 | 10026 | 786 | 4078 |
| 8-#10 | 1.28 | MA | 7761 | 2045 | 10348 | 1812 | 12749 | 1523 | 14119 | 1296 | 15626 | 950 | 19168 | 826 | 8763 |
| 2L-4S | | MI | 4229 | 2045 | 5868 | 1754 | 6864 | 1480 | 7340 | 1258 | 7663 | 917 | 9015 | 628 | 5089 |
| 8-#10 | 1.28 | MA | 7337 | 2045 | 9635 | 1826 | 11844 | 1536 | 13023 | 1307 | 14146 | 966 | 17119 | 745 | 8752 |
| 3E | | MI | 4358 | 2045 | 6140 | 1744 | 7241 | 1465 | 7802 | 1244 | 8294 | 914 | 9789 | 680 | 5087 |
| 8-#10 | 1.28 | MA | 7102 | 2045 | 9151 | 1839 | 11171 | 1555 | 12198 | 1326 | 13016 | 976 | 15755 | 694 | 8686 |
| 4L-2S | | MI | 4581 | 2045 | 6531 | 1735 | 7737 | 1457 | 8403 | 1238 | 9106 | 904 | 10884 | 773 | 5074 |
| 8-#11 | 1.58 | MA | 8031 | 2112 | 11038 | 1845 | 13558 | 1546 | 15066 | 1308 | 16874 | 941 | 20874 | 817 | 10614 |
| 2L-4S | | MI | 4292 | 2112 | 6116 | 1783 | 7114 | 1500 | 7612 | 1267 | 8003 | 904 | 9401 | 567 | 6078 |
| 8-#11 | 1.58 | MA | 7533 | 2112 | 10173 | 1861 | 12461 | 1561 | 13736 | 1322 | 15079 | 960 | 18389 | 715 | 10587 |
| 3E | | MI | 4443 | 2112 | 6445 | 1772 | 7569 | 1483 | 8169 | 1252 | 8765 | 902 | 10312 | 629 | 6093 |
| 8-#11 | 1.58 | MA | 7257 | 2112 | 9584 | 1877 | 11642 | 1584 | 12733 | 1344 | 13706 | 971 | 16720 | 652 | 10463 |
| 4L-2S | | MI | 4703 | 2112 | 6914 | 1761 | 8164 | 1475 | 8890 | 1246 | 9738 | 891 | 11596 | 742 | 6081 |

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

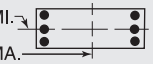
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.27 | MA | 8692 | 2272 | 12580 | 1938 | 15468 | 1613 | 17357 | 1349 | 19945 | 929 | 25111 | 803 | 15057 |
| 2L-4S | | MI | 4467 | 2272 | 6613 | 1879 | 7687 | 1573 | 8284 | 1312 | 8890 | 892 | 10519 | 447 | 8237 |
| 8-#14 | 2.27 | MA | 8023 | 2272 | 11345 | 1960 | 13900 | 1634 | 15457 | 1368 | 17380 | 956 | 21559 | 653 | 14961 |
| 3E | | MI | 4671 | 2272 | 7082 | 1864 | 8335 | 1549 | 9077 | 1292 | 9972 | 891 | 11793 | 533 | 8465 |
| 8-#14 | 2.27 | MA | 7654 | 2272 | 10501 | 1983 | 12729 | 1667 | 14020 | 1399 | 15414 | 971 | 19160 | 562 | 14561 |
| 4L-2S | | MI | 5022 | 2272 | 7747 | 1850 | 9178 | 1538 | 10099 | 1284 | 11352 | 877 | 13581 | 696 | 8482 |
| 8-#18 | 4.04 | MA | 9194 | 2678 | 14220 | 2216 | 17456 | 1821 | 19719 | 1486 | 23092 | 947 | 29436 | 496 | 25629 |
| 3E | | MI | 5224 | 2678 | 8605 | 2103 | 10185 | 1720 | 11279 | 1393 | 12911 | 862 | 15234 | 263 | 14068 |
| 8-#18 | 4.04 | MA | 8630 | 2678 | 12741 | 2253 | 15404 | 1877 | 17203 | 1539 | 19650 | 969 | 25200 | 331 | 22842 |
| 4L-2S | | MI | 5738 | 2678 | 9746 | 2081 | 11633 | 1704 | 13034 | 1384 | 15280 | 844 | 18190 | 553 | 14251 |
| 10-#10 | 1.60 | MA | 8100 | 2118 | 11061 | 1858 | 13654 | 1557 | 15216 | 1317 | 17106 | 946 | 21218 | 821 | 10886 |
| 2L-5S | | MI | 4291 | 2118 | 6015 | 1809 | 7027 | 1522 | 7529 | 1285 | 7902 | 924 | 9339 | 566 | 6139 |
| 10-#10 | 1.60 | MA | 7691 | 2118 | 10348 | 1872 | 12749 | 1569 | 14119 | 1329 | 15626 | 963 | 19168 | 740 | 10863 |
| 3L-4S | | MI | 4414 | 2118 | 6258 | 1800 | 7360 | 1514 | 7941 | 1279 | 8474 | 913 | 10110 | 620 | 6245 |
| 10-#10 | 1.60 | MA | 7470 | 2118 | 9864 | 1885 | 12076 | 1589 | 13294 | 1347 | 14496 | 973 | 17805 | 689 | 10785 |
| 4L-3S | | MI | 4537 | 2118 | 6531 | 1790 | 7737 | 1499 | 8403 | 1266 | 9106 | 910 | 10884 | 672 | 6256 |
| 10-#10 | 1.60 | MA | 7190 | 2118 | 9432 | 1898 | 11488 | 1601 | 12564 | 1359 | 13481 | 989 | 16415 | 649 | 10514 |
| 5L-2S | | MI | 4754 | 2118 | 6922 | 1781 | 8233 | 1491 | 9004 | 1259 | 9917 | 900 | 11979 | 764 | 6249 |
| 10-#11 | 1.97 | MA | 8430 | 2203 | 11902 | 1901 | 14655 | 1587 | 16396 | 1334 | 18670 | 937 | 23360 | 811 | 13185 |
| 2L-5S | | MI | 4368 | 2203 | 6291 | 1850 | 7307 | 1550 | 7835 | 1300 | 8287 | 911 | 9781 | 487 | 7165 |
| 10-#11 | 1.97 | MA | 7952 | 2203 | 11038 | 1917 | 13558 | 1602 | 15066 | 1348 | 16874 | 956 | 20874 | 709 | 13142 |
| 3L-4S | | MI | 4509 | 2203 | 6585 | 1839 | 7709 | 1542 | 8333 | 1294 | 8977 | 900 | 10685 | 554 | 7455 |
| 10-#11 | 1.97 | MA | 7694 | 2203 | 10449 | 1933 | 12740 | 1625 | 14063 | 1370 | 15501 | 967 | 19206 | 646 | 13004 |
| 4L-3S | | MI | 4652 | 2203 | 6914 | 1828 | 8164 | 1525 | 8890 | 1278 | 9738 | 898 | 11596 | 615 | 7488 |
| 10-#11 | 1.97 | MA | 7364 | 2203 | 9928 | 1949 | 12024 | 1640 | 13174 | 1383 | 14265 | 987 | 17511 | 594 | 12387 |
| 5L-2S | | MI | 4904 | 2203 | 7383 | 1818 | 8759 | 1516 | 9612 | 1272 | 10712 | 887 | 12879 | 728 | 7488 |
| 10-#14 | 2.84 | MA | 8601 | 2403 | 12580 | 2042 | 15468 | 1693 | 17357 | 1405 | 19945 | 950 | 25111 | 645 | 18603 |
| 3L-4S | | MI | 4769 | 2403 | 7278 | 1960 | 8531 | 1632 | 9307 | 1350 | 10270 | 886 | 12307 | 423 | 10079 |
| 10-#14 | 2.84 | MA | 8263 | 2403 | 11737 | 2064 | 14297 | 1726 | 15921 | 1436 | 17979 | 965 | 22712 | 554 | 18132 |
| 4L-3S | | MI | 4959 | 2403 | 7747 | 1946 | 9178 | 1609 | 10099 | 1329 | 11352 | 885 | 13581 | 509 | 10422 |
| 10-#14 | 2.84 | MA | 7803 | 2403 | 10991 | 2087 | 13271 | 1747 | 14647 | 1455 | 16210 | 992 | 20279 | 476 | 16762 |
| 5L-2S | | MI | 5296 | 2403 | 8411 | 1932 | 10022 | 1598 | 11122 | 1321 | 12733 | 871 | 15369 | 672 | 10461 |
| 10-#18 | 5.05 | MA | 9653 | 2910 | 14897 | 2398 | 18140 | 1983 | 20519 | 1606 | 24125 | 958 | 31397 | 316 | 29157 |
| 4L-3S | | MI | 5692 | 2910 | 9746 | 2248 | 11633 | 1826 | 13034 | 1460 | 15280 | 851 | 18190 | 206 | 17390 |
| 10-#18 | 5.05 | MA | 8882 | 2910 | 13587 | 2436 | 16340 | 2017 | 18286 | 1636 | 21023 | 1003 | 27118 | 169 | 26319 |
| 5L-2S | | MI | 6168 | 2910 | 10887 | 2226 | 13081 | 1810 | 14789 | 1451 | 17649 | 833 | 21145 | 497 | 17618 |
| 12-#10 | 1.92 | MA | 8433 | 2192 | 11774 | 1904 | 14558 | 1591 | 16312 | 1338 | 18586 | 943 | 23267 | 816 | 13004 |
| 2L-6S | | MI | 4318 | 2192 | 6134 | 1871 | 7208 | 1563 | 7725 | 1320 | 8165 | 930 | 9727 | 498 | 7022 |
| 12-#10 | 1.92 | MA | 8037 | 2192 | 11061 | 1918 | 13654 | 1603 | 15216 | 1350 | 17106 | 959 | 21218 | 735 | 12973 |
| 3L-5S | | MI | 4473 | 2192 | 6406 | 1855 | 7523 | 1555 | 8130 | 1307 | 8713 | 920 | 10435 | 558 | 7242 |
| 12-#10 | 1.92 | MA | 7828 | 2192 | 10577 | 1931 | 12981 | 1623 | 14391 | 1368 | 15976 | 969 | 19854 | 684 | 12885 |
| 4E | | MI | 4595 | 2192 | 6649 | 1846 | 7856 | 1547 | 8542 | 1300 | 9285 | 910 | 11206 | 612 | 7396 |
| 12-#10 | 1.92 | MA | 7551 | 2192 | 10145 | 1944 | 12393 | 1635 | 13660 | 1380 | 14961 | 986 | 18464 | 644 | 12582 |
| 5L-3S | | MI | 4713 | 2192 | 6922 | 1836 | 8233 | 1532 | 9004 | 1287 | 9917 | 907 | 11979 | 664 | 7418 |
| 12-#10 | 1.92 | MA | 7266 | 2192 | 9613 | 1958 | 11832 | 1647 | 12946 | 1399 | 13970 | 995 | 17125 | 578 | 12031 |
| 6L-2S | | MI | 4924 | 2192 | 7313 | 1827 | 8729 | 1524 | 9605 | 1281 | 10728 | 897 | 13075 | 756 | 7419 |
| 12-#11 | 2.36 | MA | 8360 | 2293 | 11902 | 1974 | 14655 | 1643 | 16396 | 1374 | 18670 | 952 | 23360 | 703 | 15697 |
| 3L-5S | | MI | 4582 | 2293 | 6760 | 1906 | 7902 | 1592 | 8556 | 1326 | 9260 | 906 | 11064 | 473 | 8490 |
| 12-#11 | 2.36 | MA | 8119 | 2293 | 11313 | 1990 | 13837 | 1667 | 15393 | 1396 | 17296 | 963 | 21692 | 640 | 15548 |
| 4E | | MI | 4721 | 2293 | 7054 | 1896 | 8304 | 1583 | 9055 | 1320 | 9951 | 896 | 11968 | 540 | 8830 |
| 12-#11 | 2.36 | MA | 7793 | 2293 | 10793 | 2006 | 13121 | 1681 | 14504 | 1409 | 16061 | 982 | 19996 | 588 | 14902 |
| 5L-3S | | MI | 4858 | 2293 | 7383 | 1885 | 8759 | 1566 | 9612 | 1305 | 10712 | 893 | 12879 | 601 | 8877 |
| 12-#11 | 2.36 | MA | 7456 | 2293 | 10148 | 2022 | 12447 | 1696 | 13634 | 1431 | 14854 | 993 | 18363 | 504 | 14274 |
| 6L-2S | | MI | 5102 | 2293 | 7852 | 1874 | 9354 | 1557 | 10333 | 1298 | 11685 | 883 | 14163 | 715 | 8889 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

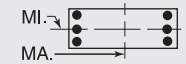
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 3.41 | MA | 8852 | 2533 | 12972 | 2146 | 15865 | 1786 | 17821 | 1474 | 20544 | 959 | 26264 | 545 | 21713 |
| 4E | | MI | 5063 | 2533 | 7943 | 2042 | 9375 | 1692 | 10329 | 1387 | 11650 | 880 | 14095 | 399 | 11938 |
| 12-#14 | 3.41 | MA | 8399 | 2533 | 12226 | 2168 | 14839 | 1806 | 16548 | 1493 | 18775 | 986 | 23831 | 467 | 20387 |
| 5L-3S | | MI | 5242 | 2533 | 8411 | 2027 | 10022 | 1668 | 11122 | 1367 | 12733 | 878 | 15369 | 485 | 12375 |
| 12-#14 | 3.41 | MA | 7942 | 2533 | 11310 | 2192 | 13872 | 1827 | 15302 | 1524 | 17047 | 1001 | 21487 | 345 | 19047 |
| 6L-2S | | MI | 5566 | 2533 | 9076 | 2013 | 10866 | 1657 | 12144 | 1359 | 14113 | 865 | 17156 | 649 | 12432 |
| 12-#18 | 6.06 | MA | 9878 | 3142 | 15742 | 2581 | 19076 | 2123 | 21601 | 1703 | 25499 | 992 | 33315 | 153 | 32588 |
| 5L-3S | | MI | 6149 | 3142 | 10887 | 2393 | 13081 | 1932 | 14789 | 1527 | 17649 | 840 | 21145 | 150 | 20554 |
| 12-#18 | 6.06 | MA | 9161 | 3142 | 14165 | 2625 | 17378 | 2157 | 19415 | 1755 | 22468 | 1015 | 29171 | -67 | 28901 |
| 6L-2S | | MI | 6593 | 3142 | 12028 | 2371 | 14529 | 1916 | 16544 | 1518 | 20018 | 822 | 24100 | 440 | 20978 |
| 14-#10 | 2.24 | MA | 8375 | 2266 | 11774 | 1964 | 14558 | 1637 | 16312 | 1371 | 18586 | 956 | 23267 | 730 | 15081 |
| 3L-6S | | MI | 4501 | 2266 | 6524 | 1917 | 7704 | 1597 | 8326 | 1341 | 8977 | 927 | 10823 | 490 | 8142 |
| 14-#10 | 2.24 | MA | 8177 | 2266 | 11290 | 1977 | 13885 | 1656 | 15487 | 1390 | 17457 | 966 | 21903 | 680 | 14986 |
| 4L-5S | | MI | 4652 | 2266 | 6797 | 1901 | 8019 | 1589 | 8731 | 1328 | 9525 | 917 | 11530 | 550 | 8351 |
| 14-#10 | 2.24 | MA | 7904 | 2266 | 10858 | 1990 | 13298 | 1669 | 14757 | 1401 | 16441 | 982 | 20513 | 639 | 14656 |
| 5L-4S | | MI | 4773 | 2266 | 7040 | 1892 | 8352 | 1581 | 9143 | 1322 | 10096 | 906 | 12301 | 604 | 8546 |
| 14-#10 | 2.24 | MA | 7628 | 2266 | 10326 | 2004 | 12737 | 1680 | 14043 | 1420 | 15450 | 992 | 19175 | 573 | 14122 |
| 6L-3S | | MI | 4886 | 2266 | 7313 | 1882 | 8729 | 1566 | 9605 | 1308 | 10728 | 903 | 13075 | 656 | 8576 |
| 14-#10 | 2.24 | MA | 7389 | 2266 | 9873 | 2013 | 12110 | 1695 | 13352 | 1431 | 14489 | 1009 | 17870 | 539 | 13602 |
| 7L-2S | | MI | 5092 | 2266 | 7703 | 1873 | 9225 | 1558 | 10206 | 1302 | 11539 | 893 | 14170 | 748 | 8585 |
| 14-#11 | 2.76 | MA | 8533 | 2383 | 12178 | 2046 | 14934 | 1708 | 16722 | 1422 | 19091 | 958 | 24177 | 634 | 18094 |
| 4L-5S | | MI | 4792 | 2383 | 7229 | 1963 | 8497 | 1633 | 9278 | 1352 | 10234 | 902 | 12348 | 460 | 9823 |
| 14-#11 | 2.76 | MA | 8211 | 2383 | 11658 | 2062 | 14219 | 1723 | 15834 | 1435 | 17856 | 978 | 22482 | 582 | 17421 |
| 5L-4S | | MI | 4930 | 2383 | 7523 | 1952 | 8899 | 1624 | 9776 | 1346 | 10924 | 891 | 13252 | 526 | 10203 |
| 14-#11 | 2.76 | MA | 7887 | 2383 | 11012 | 2079 | 13544 | 1737 | 14964 | 1457 | 16649 | 989 | 20849 | 498 | 16816 |
| 6L-3S | | MI | 5060 | 2383 | 7852 | 1942 | 9354 | 1607 | 10333 | 1331 | 11685 | 889 | 14163 | 588 | 10261 |
| 14-#11 | 2.76 | MA | 7605 | 2383 | 10461 | 2089 | 12782 | 1754 | 14127 | 1471 | 15480 | 1009 | 19251 | 455 | 15928 |
| 7L-2S | | MI | 5297 | 2383 | 8321 | 1931 | 9949 | 1599 | 11054 | 1324 | 12659 | 878 | 15447 | 701 | 10283 |
| 14-#14 | 3.98 | MA | 8977 | 2664 | 13462 | 2250 | 16407 | 1866 | 18448 | 1530 | 21340 | 980 | 27383 | 459 | 24018 |
| 5L-4S | | MI | 5351 | 2664 | 8608 | 2123 | 10218 | 1752 | 11352 | 1425 | 13030 | 873 | 15882 | 376 | 13810 |
| 14-#14 | 3.98 | MA | 8543 | 2664 | 12545 | 2274 | 15440 | 1886 | 17202 | 1561 | 19612 | 995 | 25038 | 336 | 22662 |
| 6L-3S | | MI | 5520 | 2664 | 9076 | 2109 | 10866 | 1728 | 12144 | 1405 | 14113 | 872 | 17156 | 461 | 14325 |
| 14-#14 | 3.98 | MA | 8166 | 2664 | 11757 | 2288 | 14360 | 1911 | 16002 | 1580 | 17936 | 1022 | 22740 | 273 | 21182 |
| 7L-2S | | MI | 5824 | 2664 | 9741 | 2095 | 11709 | 1717 | 13167 | 1397 | 15493 | 858 | 18944 | 625 | 14398 |
| 14-#18 | 7.07 | MA | 10174 | 3374 | 16320 | 2770 | 20114 | 2263 | 22731 | 1822 | 26943 | 1004 | 35368 | -83 | 34903 |
| 6L-3S | | MI | 6596 | 3374 | 12028 | 2538 | 14529 | 2037 | 16544 | 1594 | 20018 | 829 | 24100 | 93 | 23714 |
| 16-#10 | 2.57 | MA | 8520 | 2339 | 12003 | 2023 | 14790 | 1690 | 16583 | 1411 | 18937 | 962 | 23953 | 675 | 17088 |
| 4L-6S | | MI | 4681 | 2339 | 6915 | 1963 | 8200 | 1630 | 8927 | 1362 | 9788 | 923 | 11918 | 482 | 9266 |
| 16-#10 | 2.57 | MA | 8249 | 2339 | 11571 | 2036 | 14202 | 1702 | 15853 | 1422 | 17921 | 979 | 22563 | 634 | 16733 |
| 5E | | MI | 4828 | 2339 | 7187 | 1947 | 8515 | 1623 | 9331 | 1349 | 10336 | 913 | 12625 | 542 | 9465 |
| 16-#10 | 2.57 | MA | 7982 | 2339 | 11039 | 2050 | 13641 | 1714 | 15139 | 1441 | 16930 | 988 | 21224 | 568 | 16215 |
| 6L-4S | | MI | 4949 | 2339 | 7431 | 1938 | 8848 | 1615 | 9744 | 1343 | 10908 | 903 | 13396 | 596 | 9694 |
| 16-#10 | 2.57 | MA | 7753 | 2339 | 10586 | 2059 | 13014 | 1728 | 14448 | 1452 | 15970 | 1005 | 19920 | 534 | 15697 |
| 7L-3S | | MI | 5056 | 2339 | 7703 | 1928 | 9225 | 1600 | 10206 | 1329 | 11539 | 900 | 14170 | 648 | 9731 |
| 16-#10 | 2.57 | MA | 7517 | 2339 | 10151 | 2069 | 12432 | 1737 | 13713 | 1467 | 15010 | 1015 | 18657 | 487 | 15006 |
| 8L-2S | | MI | 5257 | 2339 | 8094 | 1919 | 9721 | 1592 | 10807 | 1323 | 12350 | 890 | 15265 | 740 | 9746 |
| 16-#11 | 3.15 | MA | 8619 | 2474 | 12522 | 2119 | 15316 | 1764 | 17164 | 1462 | 19651 | 974 | 24968 | 576 | 19946 |
| 5E | | MI | 4998 | 2474 | 7697 | 2019 | 9092 | 1674 | 9999 | 1378 | 11208 | 898 | 13632 | 446 | 11162 |
| 16-#11 | 3.15 | MA | 8307 | 2474 | 11877 | 2135 | 14642 | 1779 | 16294 | 1484 | 18445 | 985 | 23335 | 492 | 19360 |
| 6L-4S | | MI | 5135 | 2474 | 7992 | 2009 | 9494 | 1666 | 10497 | 1372 | 11898 | 887 | 14536 | 513 | 11553 |
| 16-#11 | 3.15 | MA | 8039 | 2474 | 11326 | 2146 | 13880 | 1796 | 15457 | 1497 | 17275 | 1004 | 21737 | 449 | 18468 |
| 7L-3S | | MI | 5259 | 2474 | 8321 | 1998 | 9949 | 1648 | 11054 | 1357 | 12659 | 885 | 15447 | 574 | 11644 |
| 16-#11 | 3.15 | MA | 7761 | 2474 | 10797 | 2158 | 13171 | 1806 | 14571 | 1515 | 16126 | 1024 | 20195 | 390 | 17533 |
| 8L-2S | | MI | 5490 | 2474 | 8790 | 1987 | 10544 | 1640 | 11775 | 1350 | 13633 | 874 | 16731 | 687 | 11673 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis

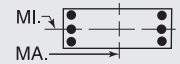


$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 4.55 | MA | 9128 | 2794 | 13781 | 2355 | 17008 | 1946 | 19103 | 1599 | 22177 | 988 | 28590 | 327 | 26278 |
| 6L-4S | | MI | 5634 | 2794 | 9273 | 2205 | 11062 | 1811 | 12374 | 1463 | 14411 | 867 | 17670 | 352 | 15692 |
| 16-#14 | 4.55 | MA | 8773 | 2794 | 12992 | 2370 | 15928 | 1971 | 17902 | 1618 | 20501 | 1016 | 26292 | 264 | 24784 |
| 7L-3S | | MI | 5800 | 2794 | 9741 | 2190 | 11709 | 1788 | 13167 | 1442 | 15493 | 866 | 18944 | 438 | 16275 |
| 16-#14 | 4.55 | MA | 8384 | 2794 | 12234 | 2387 | 14913 | 1985 | 16647 | 1644 | 18854 | 1043 | 24078 | 176 | 23101 |
| 8L-2S | | MI | 6081 | 2794 | 10406 | 2176 | 12553 | 1777 | 14189 | 1434 | 16873 | 852 | 20732 | 601 | 16361 |
| 18-#10 | 2.89 | MA | 8587 | 2413 | 12284 | 2082 | 15107 | 1736 | 16950 | 1444 | 19402 | 975 | 24612 | 629 | 18814 |
| 5L-6S | | MI | 4859 | 2413 | 7306 | 2009 | 8696 | 1664 | 9528 | 1384 | 10599 | 920 | 13013 | 474 | 10392 |
| 18-#10 | 2.89 | MA | 8329 | 2413 | 11752 | 2096 | 14546 | 1748 | 16236 | 1462 | 18411 | 985 | 23273 | 563 | 18310 |
| 6L-5S | | MI | 5002 | 2413 | 7578 | 1993 | 9011 | 1656 | 9932 | 1370 | 11147 | 910 | 13721 | 534 | 10583 |
| 18-#10 | 2.89 | MA | 8109 | 2413 | 11299 | 2105 | 13919 | 1762 | 15545 | 1474 | 17450 | 1002 | 21969 | 529 | 17793 |
| 7L-4S | | MI | 5121 | 2413 | 7821 | 1984 | 9343 | 1648 | 10345 | 1364 | 11719 | 899 | 14492 | 588 | 10841 |
| 18-#10 | 2.89 | MA | 7876 | 2413 | 10864 | 2115 | 13336 | 1771 | 14809 | 1488 | 16490 | 1011 | 20706 | 483 | 17092 |
| 8L-3S | | MI | 5225 | 2413 | 8094 | 1974 | 9721 | 1633 | 10807 | 1351 | 12350 | 896 | 15265 | 640 | 10885 |
| 18-#10 | 2.89 | MA | 7610 | 2413 | 10437 | 2125 | 12770 | 1780 | 14095 | 1496 | 15546 | 1028 | 19466 | 438 | 16308 |
| 9L-2S | | MI | 5420 | 2413 | 8485 | 1965 | 10217 | 1625 | 11408 | 1344 | 13162 | 886 | 16361 | 732 | 10906 |
| 18-#11 | 3.55 | MA | 8718 | 2564 | 12742 | 2192 | 15739 | 1820 | 17624 | 1510 | 20240 | 980 | 25820 | 486 | 21907 |
| 6L-5S | | MI | 5201 | 2564 | 8166 | 2076 | 9687 | 1716 | 10720 | 1404 | 12181 | 894 | 14916 | 432 | 12505 |
| 18-#11 | 3.55 | MA | 8462 | 2564 | 12191 | 2202 | 14977 | 1837 | 16787 | 1523 | 19070 | 1000 | 24222 | 443 | 21007 |
| 7L-4S | | MI | 5337 | 2564 | 8460 | 2065 | 10089 | 1707 | 11218 | 1398 | 12871 | 883 | 15819 | 499 | 12878 |
| 18-#11 | 3.55 | MA | 8188 | 2564 | 11661 | 2214 | 14268 | 1847 | 15901 | 1541 | 17921 | 1020 | 22680 | 384 | 20064 |
| 8L-3S | | MI | 5456 | 2564 | 8790 | 2055 | 10544 | 1690 | 11775 | 1383 | 13633 | 881 | 16731 | 560 | 13025 |
| 18-#11 | 3.55 | MA | 7876 | 2564 | 11148 | 2227 | 13579 | 1858 | 15032 | 1550 | 16752 | 1030 | 21161 | 329 | 19056 |
| 9L-2S | | MI | 5680 | 2564 | 9259 | 2044 | 11139 | 1681 | 12497 | 1376 | 14606 | 870 | 18014 | 674 | 13062 |
| 18-#14 | 5.11 | MA | 9364 | 2924 | 14228 | 2452 | 17496 | 2031 | 19802 | 1655 | 23066 | 1009 | 29843 | 255 | 28385 |
| 7L-4S | | MI | 5932 | 2924 | 9937 | 2286 | 11906 | 1871 | 13397 | 1500 | 15791 | 861 | 19458 | 328 | 17583 |
| 18-#14 | 5.11 | MA | 8981 | 2924 | 13470 | 2468 | 16481 | 2044 | 18548 | 1681 | 21419 | 1037 | 27629 | 168 | 26712 |
| 8L-3S | | MI | 6066 | 2924 | 10406 | 2272 | 12553 | 1847 | 14189 | 1480 | 16873 | 860 | 20732 | 414 | 18225 |
| 20-#10 | 3.21 | MA | 8669 | 2487 | 12465 | 2142 | 15451 | 1781 | 17332 | 1484 | 19891 | 981 | 25323 | 558 | 20407 |
| 6E | | MI | 5033 | 2487 | 7696 | 2055 | 9192 | 1698 | 10129 | 1405 | 11410 | 916 | 14108 | 466 | 11521 |
| 20-#10 | 3.21 | MA | 8458 | 2487 | 12011 | 2151 | 14824 | 1796 | 16641 | 1495 | 18930 | 998 | 24018 | 524 | 19891 |
| 7L-5S | | MI | 5173 | 2487 | 7969 | 2039 | 9506 | 1690 | 10533 | 1392 | 11958 | 906 | 14816 | 526 | 11705 |
| 20-#10 | 3.21 | MA | 8228 | 2487 | 11577 | 2161 | 14241 | 1804 | 15906 | 1509 | 17971 | 1008 | 22755 | 478 | 19189 |
| 8L-4S | | MI | 5292 | 2487 | 8212 | 2030 | 9839 | 1682 | 10946 | 1385 | 12530 | 896 | 15587 | 579 | 11988 |
| 20-#10 | 3.21 | MA | 7970 | 2487 | 11150 | 2172 | 13675 | 1814 | 15191 | 1517 | 17026 | 1024 | 21516 | 433 | 18399 |
| 9L-3S | | MI | 5391 | 2487 | 8485 | 2020 | 10217 | 1667 | 11408 | 1372 | 13162 | 893 | 16361 | 631 | 12038 |
| 20-#10 | 3.21 | MA | 7732 | 2487 | 10706 | 2179 | 13084 | 1831 | 14492 | 1526 | 16074 | 1040 | 20173 | 383 | 17628 |
| 10L-2S | | MI | 5582 | 2487 | 8875 | 2011 | 10712 | 1659 | 12009 | 1366 | 13973 | 883 | 17456 | 724 | 12063 |
| 20-#11 | 3.94 | MA | 8877 | 2655 | 13055 | 2259 | 16074 | 1878 | 18117 | 1549 | 20865 | 996 | 26708 | 437 | 23546 |
| 7L-5S | | MI | 5401 | 2655 | 8635 | 2133 | 10282 | 1757 | 11441 | 1431 | 13155 | 889 | 16199 | 418 | 13852 |
| 20-#11 | 3.94 | MA | 8606 | 2655 | 12526 | 2271 | 15366 | 1888 | 17231 | 1567 | 19716 | 1015 | 25166 | 378 | 22594 |
| 8L-4S | | MI | 5537 | 2655 | 8929 | 2122 | 10684 | 1748 | 11940 | 1424 | 13845 | 878 | 17103 | 485 | 14208 |
| 20-#11 | 3.94 | MA | 8305 | 2655 | 12012 | 2284 | 14677 | 1900 | 16362 | 1576 | 18547 | 1026 | 23647 | 323 | 21590 |
| 9L-3S | | MI | 5660 | 2655 | 9259 | 2111 | 11139 | 1731 | 12497 | 1409 | 14606 | 876 | 18014 | 546 | 14404 |
| 20-#14 | 5.68 | MA | 9563 | 3055 | 14705 | 2550 | 18049 | 2104 | 20448 | 1719 | 23985 | 1030 | 31181 | 159 | 30323 |
| 8L-4S | | MI | 6204 | 3055 | 10602 | 2368 | 12749 | 1930 | 14419 | 1538 | 17171 | 855 | 21245 | 304 | 19481 |
| 22-#10 | 3.53 | MA | 8800 | 2560 | 12724 | 2197 | 15728 | 1829 | 17738 | 1516 | 20410 | 995 | 26068 | 519 | 21988 |
| 7L-6S | | MI | 5206 | 2560 | 8087 | 2101 | 9687 | 1731 | 10730 | 1426 | 12222 | 913 | 15204 | 458 | 12652 |
| 22-#10 | 3.53 | MA | 8573 | 2560 | 12289 | 2207 | 15146 | 1838 | 17002 | 1530 | 19451 | 1004 | 24805 | 473 | 21287 |
| 8L-5S | | MI | 5342 | 2560 | 8360 | 2085 | 10002 | 1723 | 11134 | 1413 | 12769 | 903 | 15911 | 517 | 12829 |
| 22-#10 | 3.53 | MA | 8323 | 2560 | 11863 | 2218 | 14579 | 1848 | 16288 | 1539 | 18506 | 1021 | 23565 | 428 | 20490 |
| 9L-4S | | MI | 5460 | 2560 | 8603 | 2076 | 10335 | 1716 | 11547 | 1407 | 13341 | 892 | 16682 | 571 | 13135 |
| 22-#10 | 3.53 | MA | 8094 | 2560 | 11419 | 2225 | 13989 | 1865 | 15589 | 1548 | 17554 | 1036 | 22222 | 378 | 19714 |
| 10L-3S | | MI | 5556 | 2560 | 8875 | 2066 | 10712 | 1701 | 12009 | 1393 | 13973 | 889 | 17456 | 623 | 13190 |
| 22-#11 | 4.33 | MA | 9016 | 2745 | 13391 | 2327 | 16463 | 1930 | 18561 | 1593 | 21511 | 1011 | 27651 | 372 | 25124 |
| 8L-5S | | MI | 5599 | 2745 | 9104 | 2189 | 10877 | 1798 | 12163 | 1457 | 14128 | 885 | 17483 | 405 | 15202 |
| 22-#11 | 4.33 | MA | 8725 | 2745 | 12877 | 2340 | 15774 | 1941 | 17691 | 1603 | 20342 | 1022 | 26132 | 317 | 24124 |
| 9L-4S | | MI | 5751 | 2745 | 9398 | 2178 | 11279 | 1790 | 12661 | 1450 | 14819 | 874 | 18387 | 471 | 15544 |

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#10 | 3.85 | MA | 8912 | 2634 | 13002 | 2253 | 16050 | 1872 | 18099 | 1552 | 20931 | 1001 | 26854 | 468 | 23384 |
| 8L-6S | | MI | 5376 | 2634 | 8478 | 2147 | 10183 | 1765 | 11331 | 1448 | 13033 | 909 | 16299 | 450 | 13784 |
| 24-#10 | 3.85 | MA | 8670 | 2634 | 12576 | 2264 | 15484 | 1881 | 17384 | 1560 | 19986 | 1017 | 25615 | 423 | 22582 |
| 9L-5S | | MI | 5509 | 2634 | 8750 | 2131 | 10498 | 1757 | 11735 | 1434 | 13581 | 899 | 17007 | 509 | 13956 |
| 24-#10 | 3.85 | MA | 8448 | 2634 | 12132 | 2271 | 14894 | 1899 | 16685 | 1569 | 19034 | 1033 | 24272 | 373 | 21800 |
| 10L-4S | | MI | 5627 | 2634 | 8993 | 2122 | 10831 | 1749 | 12148 | 1428 | 14153 | 889 | 17778 | 563 | 14282 |
| 24-#11 | 4.73 | MA | 9137 | 2836 | 13742 | 2397 | 16871 | 1982 | 19021 | 1629 | 22137 | 1018 | 28618 | 311 | 26658 |
| 9L-5S | | MI | 5809 | 2836 | 9573 | 2246 | 11472 | 1840 | 12884 | 1483 | 15102 | 881 | 18767 | 391 | 16556 |

## RECTANGULAR TIED COLUMNS 22" x 38"

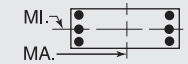
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.08 | MA | 8367 | 2108 | 11075 | 1872 | 13557 | 1577 | 14910 | 1346 | 16270 | 999 | 19755 | 870 | 8187 |
| 2E | | MI | 4671 | 2108 | 6700 | 1772 | 7814 | 1491 | 8388 | 1271 | 8916 | 940 | 10363 | 788 | 4500 |
| 4-#18 | 1.91 | MA | 9261 | 2311 | 13166 | 1985 | 16110 | 1658 | 17955 | 1395 | 20335 | 981 | 25349 | 850 | 14120 |
| 2E | | MI | 5054 | 2311 | 7752 | 1875 | 9062 | 1564 | 9858 | 1312 | 10865 | 916 | 12633 | 710 | 7498 |
| 6-#11 | 1.12 | MA | 8441 | 2119 | 11141 | 1886 | 13692 | 1588 | 15099 | 1354 | 16548 | 1003 | 20157 | 873 | 8542 |
| 2L-3S | | MI | 4443 | 2119 | 6256 | 1801 | 7295 | 1515 | 7782 | 1290 | 8116 | 957 | 9387 | 687 | 4709 |
| 6-#11 | 1.12 | MA | 7883 | 2119 | 10220 | 1902 | 12523 | 1603 | 13683 | 1368 | 14636 | 1023 | 17508 | 773 | 8534 |
| 3L-2S | | MI | 4714 | 2119 | 6725 | 1790 | 7890 | 1506 | 8503 | 1283 | 9089 | 946 | 10671 | 800 | 4686 |
| 6-#14 | 1.61 | MA | 8994 | 2239 | 12392 | 1954 | 15228 | 1637 | 16936 | 1384 | 19005 | 993 | 23541 | 862 | 12115 |
| 2L-3S | | MI | 4590 | 2239 | 6700 | 1867 | 7814 | 1562 | 8388 | 1317 | 8916 | 947 | 10363 | 600 | 6532 |
| 6-#14 | 1.61 | MA | 8232 | 2239 | 11075 | 1977 | 13557 | 1658 | 14910 | 1403 | 16270 | 1021 | 19755 | 715 | 12049 |
| 3L-2S | | MI | 4959 | 2239 | 7365 | 1853 | 8657 | 1551 | 9410 | 1309 | 10296 | 933 | 12151 | 764 | 6516 |
| 6-#18 | 2.87 | MA | 10280 | 2543 | 15466 | 2130 | 19030 | 1764 | 21493 | 1462 | 25111 | 970 | 31962 | 834 | 20948 |
| 2L-3S | | MI | 4935 | 2543 | 7752 | 2041 | 9062 | 1685 | 9858 | 1388 | 10865 | 923 | 12633 | 363 | 10807 |
| 6-#18 | 2.87 | MA | 9074 | 2543 | 13166 | 2169 | 16110 | 1799 | 17955 | 1493 | 20335 | 1017 | 25349 | 566 | 20586 |
| 3L-2S | | MI | 5517 | 2543 | 8893 | 2020 | 10510 | 1670 | 11613 | 1379 | 13234 | 905 | 15588 | 653 | 10911 |
| 8-#10 | 1.22 | MA | 8591 | 2142 | 11325 | 1910 | 13995 | 1606 | 15503 | 1368 | 17126 | 1007 | 20980 | 877 | 9312 |
| 2L-4S | | MI | 4443 | 2142 | 6144 | 1840 | 7184 | 1554 | 7673 | 1322 | 7988 | 968 | 9376 | 673 | 5115 |
| 8-#10 | 1.22 | MA | 8135 | 2142 | 10566 | 1923 | 13032 | 1619 | 14336 | 1380 | 15550 | 1024 | 18798 | 796 | 9300 |
| 3E | | MI | 4572 | 2142 | 6416 | 1830 | 7561 | 1539 | 8135 | 1308 | 8620 | 965 | 10150 | 725 | 5108 |
| 8-#10 | 1.22 | MA | 7884 | 2142 | 10052 | 1937 | 12317 | 1639 | 13459 | 1399 | 14349 | 1035 | 17355 | 746 | 9234 |
| 4L-2S | | MI | 4797 | 2142 | 6807 | 1821 | 8057 | 1531 | 8736 | 1302 | 9431 | 955 | 11245 | 817 | 5094 |
| 8-#11 | 1.49 | MA | 8884 | 2209 | 12062 | 1942 | 14861 | 1629 | 16516 | 1380 | 18461 | 998 | 22805 | 867 | 11288 |
| 2L-4S | | MI | 4505 | 2209 | 6396 | 1868 | 7435 | 1573 | 7946 | 1331 | 8328 | 955 | 9760 | 612 | 6112 |
| 8-#11 | 1.49 | MA | 8348 | 2209 | 11141 | 1958 | 13692 | 1644 | 15099 | 1394 | 16548 | 1019 | 20157 | 767 | 11261 |
| 3E | | MI | 4657 | 2209 | 6725 | 1857 | 7890 | 1556 | 8503 | 1316 | 9089 | 953 | 10671 | 673 | 6120 |
| 8-#11 | 1.49 | MA | 8052 | 2209 | 10515 | 1975 | 12822 | 1668 | 14032 | 1417 | 15087 | 1030 | 18390 | 704 | 11137 |
| 4L-2S | | MI | 4920 | 2209 | 7194 | 1847 | 8485 | 1547 | 9224 | 1309 | 10063 | 942 | 11955 | 786 | 6105 |
| 8-#14 | 2.15 | MA | 9600 | 2369 | 13709 | 2035 | 16900 | 1696 | 18962 | 1422 | 21739 | 987 | 27327 | 853 | 16029 |
| 2L-4S | | MI | 4680 | 2369 | 6896 | 1963 | 8010 | 1645 | 8618 | 1375 | 9214 | 942 | 10877 | 491 | 8350 |
| 8-#14 | 2.15 | MA | 8877 | 2369 | 12392 | 2058 | 15228 | 1717 | 16936 | 1441 | 19005 | 1015 | 23541 | 706 | 15933 |
| 3E | | MI | 4886 | 2369 | 7365 | 1949 | 8657 | 1621 | 9410 | 1355 | 10296 | 941 | 12151 | 577 | 8502 |
| 8-#14 | 2.15 | MA | 8480 | 2369 | 11495 | 2081 | 13982 | 1751 | 15408 | 1473 | 16913 | 1031 | 21001 | 616 | 15565 |
| 4L-2S | | MI | 5239 | 2369 | 8029 | 1935 | 9501 | 1610 | 10433 | 1347 | 11676 | 927 | 13938 | 740 | 8511 |
| 8-#18 | 3.83 | MA | 10144 | 2775 | 15466 | 2314 | 19030 | 1905 | 21493 | 1560 | 25111 | 1006 | 31962 | 551 | 27357 |
| 3E | | MI | 5439 | 2775 | 8893 | 2186 | 10510 | 1791 | 11613 | 1455 | 13234 | 912 | 15588 | 306 | 14131 |
| 8-#18 | 3.83 | MA | 9535 | 2775 | 13892 | 2353 | 16845 | 1963 | 18814 | 1614 | 21445 | 1031 | 27474 | 387 | 24551 |
| 4L-2S | | MI | 5959 | 2775 | 10034 | 2165 | 11958 | 1776 | 13368 | 1446 | 15603 | 894 | 18544 | 597 | 14293 |
| 10-#10 | 1.52 | MA | 8957 | 2216 | 12084 | 1956 | 14958 | 1640 | 16671 | 1389 | 18702 | 1004 | 23162 | 872 | 11571 |
| 2L-5S | | MI | 4504 | 2216 | 6291 | 1895 | 7347 | 1595 | 7862 | 1349 | 8228 | 975 | 9701 | 611 | 6209 |
| 10-#10 | 1.52 | MA | 8516 | 2216 | 11325 | 1969 | 13995 | 1653 | 15503 | 1401 | 17126 | 1021 | 20980 | 791 | 11549 |
| 3L-4S | | MI | 4628 | 2216 | 6534 | 1886 | 7680 | 1587 | 8274 | 1343 | 8799 | 964 | 10472 | 665 | 6274 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

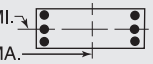



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.52 | MA | 8278 | 2216 | 10811 | 1983 | 13280 | 1673 | 14626 | 1420 | 15925 | 1031 | 19536 | 741 | 11470 |
| 4L-3S | | MI | 4752 | 2216 | 6807 | 1876 | 8057 | 1572 | 8736 | 1330 | 9431 | 961 | 11245 | 717 | 6279 |
| 10-#10 | 1.52 | MA | 7976 | 2216 | 10349 | 1996 | 12656 | 1685 | 13851 | 1432 | 14846 | 1048 | 18062 | 702 | 11250 |
| 5L-2S | | MI | 4971 | 2216 | 7198 | 1867 | 8553 | 1564 | 9337 | 1323 | 10242 | 951 | 12341 | 809 | 6271 |
| 10-#11 | 1.87 | MA | 9315 | 2300 | 12984 | 1999 | 16030 | 1670 | 17933 | 1407 | 20373 | 994 | 25453 | 861 | 14027 |
| 2L-5S | | MI | 4582 | 2300 | 6571 | 1935 | 7628 | 1623 | 8169 | 1363 | 8612 | 961 | 10140 | 531 | 7245 |
| 10-#11 | 1.87 | MA | 8799 | 2300 | 12062 | 2015 | 14861 | 1685 | 16516 | 1421 | 18461 | 1014 | 22805 | 761 | 13985 |
| 3L-4S | | MI | 4723 | 2300 | 6865 | 1924 | 8030 | 1614 | 8667 | 1357 | 9302 | 950 | 11044 | 598 | 7493 |
| 10-#11 | 1.87 | MA | 8522 | 2300 | 11436 | 2031 | 13991 | 1709 | 15449 | 1443 | 17000 | 1026 | 21038 | 699 | 13846 |
| 4L-3S | | MI | 4867 | 2300 | 7194 | 1914 | 8485 | 1597 | 9224 | 1342 | 10063 | 948 | 11955 | 659 | 7518 |
| 10-#11 | 1.87 | MA | 8164 | 2300 | 10880 | 2047 | 13230 | 1724 | 14505 | 1457 | 15687 | 1046 | 19239 | 648 | 13260 |
| 5L-2S | | MI | 5121 | 2300 | 7663 | 1903 | 9080 | 1589 | 9945 | 1335 | 11036 | 937 | 13238 | 773 | 7514 |
| 10-#14 | 2.69 | MA | 9500 | 2500 | 13709 | 2140 | 16900 | 1777 | 18962 | 1479 | 21739 | 1009 | 27327 | 698 | 19818 |
| 3L-4S | | MI | 4982 | 2500 | 7561 | 2045 | 8854 | 1705 | 9641 | 1412 | 10594 | 936 | 12664 | 467 | 10189 |
| 10-#14 | 2.69 | MA | 9136 | 2500 | 12812 | 2163 | 15654 | 1811 | 17434 | 1510 | 19647 | 1025 | 24787 | 607 | 19443 |
| 4L-3S | | MI | 5175 | 2500 | 8029 | 2031 | 9501 | 1681 | 10433 | 1392 | 11676 | 935 | 13938 | 553 | 10461 |
| 10-#14 | 2.69 | MA | 8636 | 2500 | 12019 | 2186 | 14564 | 1832 | 16080 | 1530 | 17766 | 1053 | 22205 | 532 | 17949 |
| 5L-2S | | MI | 5515 | 2500 | 8694 | 2016 | 10344 | 1670 | 11455 | 1384 | 13056 | 921 | 15726 | 716 | 10494 |
| 10-#18 | 4.78 | MA | 10636 | 3007 | 16192 | 2498 | 19765 | 2069 | 22353 | 1681 | 26221 | 1020 | 34088 | 372 | 31284 |
| 4L-3S | | MI | 5908 | 3007 | 10034 | 2331 | 11958 | 1897 | 13368 | 1522 | 15603 | 901 | 18544 | 249 | 17454 |
| 10-#18 | 4.78 | MA | 9798 | 3007 | 14800 | 2537 | 17851 | 2104 | 19977 | 1713 | 22920 | 1067 | 29542 | 230 | 28368 |
| 5L-2S | | MI | 6392 | 3007 | 11175 | 2310 | 13406 | 1882 | 15123 | 1513 | 17972 | 883 | 21499 | 540 | 17662 |
| 12-#10 | 1.82 | MA | 9315 | 2289 | 12843 | 2002 | 15921 | 1674 | 17838 | 1411 | 20277 | 1000 | 25343 | 867 | 13827 |
| 2L-6S | | MI | 4531 | 2289 | 6410 | 1957 | 7528 | 1637 | 8058 | 1384 | 8491 | 981 | 10088 | 543 | 7088 |
| 12-#10 | 1.82 | MA | 8888 | 2289 | 12084 | 2015 | 14958 | 1686 | 16671 | 1423 | 18702 | 1017 | 23162 | 787 | 13796 |
| 3L-5S | | MI | 4687 | 2289 | 6682 | 1941 | 7843 | 1629 | 8463 | 1371 | 9039 | 971 | 10796 | 603 | 7311 |
| 12-#10 | 1.82 | MA | 8663 | 2289 | 11570 | 2029 | 14243 | 1706 | 15794 | 1442 | 17501 | 1028 | 21718 | 736 | 13708 |
| 4E | | MI | 4810 | 2289 | 6925 | 1932 | 8176 | 1621 | 8875 | 1364 | 9611 | 961 | 11567 | 657 | 7427 |
| 12-#10 | 1.82 | MA | 8364 | 2289 | 11108 | 2042 | 13619 | 1719 | 15018 | 1453 | 16422 | 1045 | 20244 | 697 | 13456 |
| 5L-3S | | MI | 4928 | 2289 | 7198 | 1922 | 8553 | 1606 | 9337 | 1351 | 10242 | 958 | 12341 | 709 | 7443 |
| 12-#10 | 1.82 | MA | 8057 | 2289 | 10542 | 2056 | 13018 | 1731 | 14260 | 1472 | 15370 | 1055 | 18824 | 632 | 12847 |
| 6L-2S | | MI | 5141 | 2289 | 7589 | 1913 | 9049 | 1598 | 9938 | 1345 | 11054 | 948 | 13436 | 801 | 7442 |
| 12-#11 | 2.24 | MA | 9239 | 2390 | 12984 | 2072 | 16030 | 1727 | 17933 | 1447 | 20373 | 1010 | 25453 | 755 | 16708 |
| 3L-5S | | MI | 4796 | 2390 | 7039 | 1992 | 8223 | 1664 | 8890 | 1389 | 9585 | 957 | 11423 | 518 | 8569 |
| 12-#11 | 2.24 | MA | 8979 | 2390 | 12357 | 2088 | 15160 | 1751 | 16866 | 1469 | 18912 | 1022 | 23686 | 693 | 16559 |
| 4E | | MI | 4935 | 2390 | 7334 | 1981 | 8625 | 1656 | 9388 | 1383 | 10275 | 946 | 12327 | 584 | 8870 |
| 12-#11 | 2.24 | MA | 8625 | 2390 | 11801 | 2104 | 14399 | 1766 | 15922 | 1483 | 17599 | 1042 | 21888 | 642 | 15943 |
| 5L-3S | | MI | 5074 | 2390 | 7663 | 1970 | 9080 | 1639 | 9945 | 1368 | 11036 | 944 | 13238 | 646 | 8909 |
| 12-#11 | 2.24 | MA | 8263 | 2390 | 11113 | 2120 | 13676 | 1780 | 14998 | 1506 | 16318 | 1054 | 20155 | 560 | 15253 |
| 6L-2S | | MI | 5320 | 2390 | 8132 | 1960 | 9675 | 1630 | 10667 | 1362 | 12010 | 933 | 14522 | 759 | 8916 |
| 12-#14 | 3.23 | MA | 9770 | 2630 | 14129 | 2244 | 17325 | 1870 | 19460 | 1548 | 22382 | 1018 | 28573 | 598 | 23298 |
| 4E | | MI | 5277 | 2630 | 8226 | 2126 | 9697 | 1764 | 10663 | 1450 | 11974 | 930 | 14452 | 443 | 12044 |
| 12-#14 | 3.23 | MA | 9277 | 2630 | 13337 | 2267 | 16235 | 1891 | 18106 | 1568 | 20500 | 1047 | 25991 | 524 | 21820 |
| 5L-3S | | MI | 5458 | 2630 | 8694 | 2112 | 10344 | 1741 | 11455 | 1430 | 13056 | 928 | 15726 | 529 | 12416 |
| 12-#14 | 3.23 | MA | 8787 | 2630 | 12353 | 2291 | 15208 | 1913 | 16782 | 1599 | 18663 | 1063 | 23505 | 403 | 20461 |
| 6L-2S | | MI | 5785 | 2630 | 9359 | 2098 | 11188 | 1730 | 12478 | 1422 | 14437 | 915 | 17513 | 693 | 12466 |
| 12-#18 | 5.74 | MA | 10869 | 3239 | 17100 | 2682 | 20770 | 2210 | 23515 | 1780 | 27697 | 1056 | 36156 | 215 | 35060 |
| 5L-3S | | MI | 6366 | 3239 | 11175 | 2476 | 13406 | 2003 | 15123 | 1589 | 17972 | 890 | 21499 | 193 | 20730 |
| 12-#18 | 5.74 | MA | 10097 | 3239 | 15403 | 2725 | 18965 | 2245 | 21190 | 1834 | 24472 | 1081 | 31767 | -4 | 31747 |
| 6L-2S | | MI | 6818 | 3239 | 12316 | 2455 | 14854 | 1987 | 16878 | 1580 | 20341 | 872 | 24454 | 484 | 21024 |
| 14-#10 | 2.13 | MA | 9252 | 2363 | 12843 | 2061 | 15921 | 1720 | 17838 | 1444 | 20277 | 1014 | 25343 | 782 | 16042 |
| 3L-6S | | MI | 4715 | 2363 | 6800 | 2003 | 8024 | 1670 | 8659 | 1405 | 9302 | 978 | 11184 | 535 | 8208 |
| 14-#10 | 2.13 | MA | 9039 | 2363 | 12328 | 2075 | 15207 | 1740 | 16961 | 1463 | 19076 | 1024 | 23900 | 732 | 15946 |
| 4L-5S | | MI | 4867 | 2363 | 7073 | 1988 | 8339 | 1662 | 9064 | 1392 | 9850 | 968 | 11891 | 595 | 8419 |
| 14-#10 | 2.13 | MA | 8743 | 2363 | 11867 | 2088 | 14583 | 1753 | 16186 | 1475 | 17998 | 1041 | 22426 | 692 | 15666 |
| 5L-4S | | MI | 4988 | 2363 | 7316 | 1978 | 8671 | 1654 | 9476 | 1386 | 10422 | 957 | 12662 | 649 | 8578 |
| 14-#10 | 2.13 | MA | 8447 | 2363 | 11301 | 2102 | 13981 | 1764 | 15428 | 1494 | 16945 | 1051 | 21006 | 627 | 15075 |
| 6L-3S | | MI | 5102 | 2363 | 7589 | 1968 | 9049 | 1639 | 9938 | 1372 | 11054 | 954 | 13436 | 701 | 8603 |

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

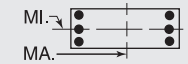
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.13 | MA | 8190 | 2363 | 10819 | 2111 | 13315 | 1779 | 14687 | 1505 | 15925 | 1069 | 19627 | 593 | 14578 |
| 7L-2S | | MI | 5310 | 2363 | 7979 | 1959 | 9545 | 1632 | 10539 | 1366 | 11865 | 944 | 14531 | 793 | 8609 |
| 14-#11 | 2.61 | MA | 9424 | 2481 | 13279 | 2144 | 16329 | 1792 | 18283 | 1495 | 20825 | 1017 | 26335 | 687 | 19273 |
| 4L-5S | | MI | 5006 | 2481 | 7508 | 2048 | 8818 | 1706 | 9611 | 1416 | 10559 | 953 | 12707 | 504 | 9901 |
| 14-#11 | 2.61 | MA | 9075 | 2481 | 12722 | 2160 | 15568 | 1807 | 17339 | 1509 | 19512 | 1038 | 24536 | 636 | 18631 |
| 5L-4S | | MI | 5145 | 2481 | 7803 | 2038 | 9220 | 1697 | 10109 | 1409 | 11249 | 942 | 13611 | 571 | 10245 |
| 14-#11 | 2.61 | MA | 8726 | 2481 | 12034 | 2177 | 14845 | 1821 | 16415 | 1532 | 18230 | 1049 | 22803 | 554 | 17964 |
| 6L-3S | | MI | 5276 | 2481 | 8132 | 2027 | 9675 | 1680 | 10667 | 1394 | 12010 | 940 | 14522 | 632 | 10295 |
| 14-#11 | 2.61 | MA | 8424 | 2481 | 11448 | 2188 | 14034 | 1839 | 15525 | 1546 | 16987 | 1070 | 21113 | 512 | 17070 |
| 7L-2S | | MI | 5516 | 2481 | 8601 | 2016 | 10270 | 1671 | 11388 | 1388 | 12984 | 929 | 15806 | 745 | 10312 |
| 14-#14 | 3.77 | MA | 9900 | 2761 | 14654 | 2349 | 17907 | 1951 | 20132 | 1605 | 23235 | 1040 | 29778 | 515 | 25695 |
| 5L-4S | | MI | 5565 | 2761 | 8890 | 2208 | 10541 | 1824 | 11686 | 1488 | 13354 | 924 | 16240 | 419 | 13913 |
| 14-#14 | 3.77 | MA | 9433 | 2761 | 13670 | 2373 | 16880 | 1972 | 18808 | 1637 | 21397 | 1056 | 27291 | 394 | 24316 |
| 6L-3S | | MI | 5737 | 2761 | 9359 | 2194 | 11188 | 1800 | 12478 | 1468 | 14437 | 922 | 17513 | 505 | 14368 |
| 14-#14 | 3.77 | MA | 9027 | 2761 | 12831 | 2388 | 15719 | 1997 | 17532 | 1656 | 19616 | 1085 | 24857 | 332 | 22787 |
| 7L-2S | | MI | 6047 | 2761 | 10024 | 2179 | 12032 | 1789 | 13501 | 1460 | 15817 | 908 | 19301 | 669 | 14434 |
| 14-#18 | 6.70 | MA | 11186 | 3471 | 17704 | 2870 | 21885 | 2351 | 24728 | 1901 | 29248 | 1070 | 38380 | -19 | 38258 |
| 6L-3S | | MI | 6815 | 3471 | 12316 | 2621 | 14854 | 2109 | 16878 | 1656 | 20341 | 878 | 24454 | 136 | 23884 |
| 16-#10 | 2.43 | MA | 9407 | 2437 | 13087 | 2121 | 16170 | 1774 | 18128 | 1484 | 20652 | 1021 | 26081 | 727 | 18186 |
| 4L-6S | | MI | 4896 | 2437 | 7191 | 2049 | 8519 | 1704 | 9260 | 1427 | 10113 | 974 | 12279 | 527 | 9330 |
| 16-#10 | 2.43 | MA | 9114 | 2437 | 12626 | 2134 | 15546 | 1786 | 17353 | 1496 | 19573 | 1038 | 24607 | 688 | 17879 |
| 5E | | MI | 5044 | 2437 | 7463 | 2034 | 8834 | 1696 | 9665 | 1413 | 10661 | 964 | 12987 | 587 | 9532 |
| 16-#10 | 2.43 | MA | 8827 | 2437 | 12060 | 2148 | 14945 | 1798 | 16595 | 1515 | 18521 | 1048 | 23187 | 622 | 17305 |
| 6L-4S | | MI | 5164 | 2437 | 7707 | 2024 | 9167 | 1688 | 10077 | 1407 | 11233 | 954 | 13758 | 640 | 9728 |
| 16-#10 | 2.43 | MA | 8581 | 2437 | 11578 | 2157 | 14278 | 1812 | 15854 | 1526 | 17501 | 1065 | 21808 | 589 | 16809 |
| 7L-3S | | MI | 5273 | 2437 | 7979 | 2014 | 9545 | 1673 | 10539 | 1393 | 11865 | 951 | 14531 | 692 | 9760 |
| 16-#10 | 2.43 | MA | 8326 | 2437 | 11116 | 2168 | 13659 | 1822 | 15072 | 1541 | 16482 | 1075 | 20470 | 544 | 16050 |
| 8L-2S | | MI | 5476 | 2437 | 8370 | 2005 | 10040 | 1665 | 11140 | 1387 | 12676 | 941 | 15626 | 785 | 9772 |
| 16-#11 | 2.99 | MA | 9514 | 2571 | 13643 | 2217 | 16738 | 1848 | 18755 | 1535 | 21425 | 1033 | 27184 | 630 | 21323 |
| 5E | | MI | 5213 | 2571 | 7977 | 2105 | 9413 | 1747 | 10333 | 1442 | 11532 | 948 | 13991 | 490 | 11238 |
| 16-#11 | 2.99 | MA | 9179 | 2571 | 12955 | 2233 | 16014 | 1863 | 17832 | 1558 | 20143 | 1045 | 25451 | 548 | 20677 |
| 6L-4S | | MI | 5350 | 2571 | 8271 | 2094 | 9815 | 1738 | 10831 | 1435 | 12222 | 937 | 14895 | 557 | 11618 |
| 16-#11 | 2.99 | MA | 8890 | 2571 | 12369 | 2244 | 15203 | 1880 | 16942 | 1572 | 18900 | 1065 | 23761 | 506 | 19775 |
| 7L-3S | | MI | 5476 | 2571 | 8601 | 2083 | 10270 | 1721 | 11388 | 1420 | 12984 | 935 | 15806 | 618 | 11679 |
| 16-#11 | 2.99 | MA | 8589 | 2571 | 11807 | 2257 | 14450 | 1891 | 15991 | 1589 | 17659 | 1077 | 22126 | 448 | 18843 |
| 8L-2S | | MI | 5709 | 2571 | 9069 | 2073 | 10865 | 1713 | 12109 | 1414 | 13957 | 925 | 17089 | 732 | 11704 |
| 16-#14 | 4.31 | MA | 10062 | 2891 | 14987 | 2454 | 18551 | 2032 | 20834 | 1675 | 24132 | 1050 | 31077 | 385 | 28170 |
| 6L-4S | | MI | 5849 | 2891 | 9555 | 2290 | 11384 | 1883 | 12708 | 1525 | 14735 | 917 | 18027 | 396 | 15793 |
| 16-#14 | 4.31 | MA | 9679 | 2891 | 14148 | 2469 | 17390 | 2056 | 19558 | 1694 | 22350 | 1078 | 28644 | 324 | 26649 |
| 7L-3S | | MI | 6020 | 2891 | 10024 | 2275 | 12032 | 1860 | 13501 | 1505 | 15817 | 916 | 19301 | 482 | 16319 |
| 16-#14 | 4.31 | MA | 9257 | 2891 | 13342 | 2487 | 16311 | 2071 | 18208 | 1720 | 20600 | 1107 | 26296 | 238 | 24820 |
| 8L-2S | | MI | 6305 | 2891 | 10688 | 2261 | 12875 | 1849 | 14523 | 1497 | 17197 | 902 | 21089 | 645 | 16398 |
| 18-#10 | 2.73 | MA | 9477 | 2510 | 13384 | 2180 | 16509 | 1820 | 18520 | 1517 | 21149 | 1034 | 26789 | 683 | 20097 |
| 5L-6S | | MI | 5073 | 2510 | 7582 | 2095 | 9015 | 1738 | 9861 | 1448 | 10925 | 971 | 13374 | 519 | 10456 |
| 18-#10 | 2.73 | MA | 9200 | 2510 | 12818 | 2194 | 15908 | 1831 | 17762 | 1536 | 20097 | 1044 | 25369 | 617 | 19537 |
| 6L-5S | | MI | 5217 | 2510 | 7854 | 2080 | 9330 | 1730 | 10266 | 1434 | 11473 | 961 | 14082 | 578 | 10649 |
| 18-#10 | 2.73 | MA | 8963 | 2510 | 12337 | 2203 | 15241 | 1846 | 17021 | 1547 | 19076 | 1062 | 23990 | 584 | 19039 |
| 7L-4S | | MI | 5337 | 2510 | 8097 | 2070 | 9663 | 1722 | 10678 | 1428 | 12044 | 950 | 14853 | 632 | 10876 |
| 18-#10 | 2.73 | MA | 8711 | 2510 | 11875 | 2214 | 14622 | 1855 | 16240 | 1562 | 18058 | 1072 | 22651 | 539 | 18283 |
| 8L-3S | | MI | 5442 | 2510 | 8370 | 2060 | 10040 | 1707 | 11140 | 1415 | 12676 | 947 | 15626 | 684 | 10915 |
| 18-#10 | 2.73 | MA | 8426 | 2510 | 11418 | 2224 | 14020 | 1865 | 15481 | 1571 | 17055 | 1089 | 21341 | 494 | 17486 |
| 9L-2S | | MI | 5640 | 2510 | 8761 | 2051 | 10536 | 1699 | 11741 | 1408 | 13487 | 937 | 16722 | 777 | 10932 |
| 18-#11 | 3.36 | MA | 9621 | 2662 | 13877 | 2290 | 17183 | 1904 | 19249 | 1584 | 22055 | 1041 | 28100 | 542 | 23393 |
| 6L-5S | | MI | 5417 | 2662 | 8446 | 2161 | 10008 | 1788 | 11054 | 1468 | 12506 | 944 | 15274 | 476 | 12580 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

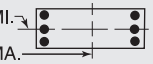



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 3.36 | MA | 9346 | 2662 | 13291 | 2301 | 16372 | 1921 | 18359 | 1598 | 20812 | 1061 | 26409 | 500 | 22481 |
| 7L-4S | | MI | 5553 | 2662 | 8740 | 2151 | 10410 | 1780 | 11552 | 1461 | 13196 | 933 | 16178 | 543 | 12963 |
| 18-#11 | 3.36 | MA | 9048 | 2662 | 12728 | 2313 | 15619 | 1932 | 17408 | 1615 | 19572 | 1073 | 24775 | 442 | 21540 |
| 8L-3S | | MI | 5674 | 2662 | 9069 | 2140 | 10865 | 1763 | 12109 | 1446 | 13957 | 931 | 17089 | 604 | 13061 |
| 18-#11 | 3.36 | MA | 8712 | 2662 | 12178 | 2326 | 14887 | 1944 | 16483 | 1626 | 18350 | 1093 | 23168 | 387 | 20438 |
| 9L-2S | | MI | 5901 | 2662 | 9538 | 2129 | 11461 | 1754 | 12830 | 1440 | 14931 | 920 | 18373 | 718 | 13094 |
| 18-#14 | 4.84 | MA | 10315 | 3022 | 15465 | 2551 | 19061 | 2116 | 21584 | 1732 | 25085 | 1072 | 32430 | 315 | 30502 |
| 7L-4S | | MI | 6148 | 3022 | 10220 | 2371 | 12228 | 1943 | 13731 | 1563 | 16115 | 911 | 19815 | 372 | 17681 |
| 18-#14 | 4.84 | MA | 9898 | 3022 | 14659 | 2568 | 17982 | 2131 | 20234 | 1757 | 23335 | 1101 | 30082 | 230 | 28669 |
| 8L-3S | | MI | 6286 | 3022 | 10688 | 2357 | 12875 | 1919 | 14523 | 1543 | 17197 | 910 | 21089 | 458 | 18270 |
| 20-#10 | 3.04 | MA | 9566 | 2584 | 13577 | 2240 | 16871 | 1865 | 18929 | 1557 | 21672 | 1041 | 27551 | 613 | 21772 |
| 6E | | MI | 5249 | 2584 | 7972 | 2141 | 9511 | 1771 | 10462 | 1469 | 11736 | 967 | 14470 | 511 | 11584 |
| 20-#10 | 3.04 | MA | 9338 | 2584 | 13096 | 2249 | 16204 | 1880 | 18188 | 1568 | 20652 | 1058 | 26172 | 579 | 21270 |
| 7L-5S | | MI | 5389 | 2584 | 8245 | 2126 | 9826 | 1763 | 10867 | 1456 | 12284 | 957 | 15177 | 570 | 11769 |
| 20-#10 | 3.04 | MA | 9089 | 2584 | 12634 | 2260 | 15585 | 1889 | 17407 | 1583 | 19634 | 1068 | 24833 | 534 | 20517 |
| 8L-4S | | MI | 5508 | 2584 | 8488 | 2116 | 10159 | 1755 | 11279 | 1449 | 12856 | 947 | 15948 | 624 | 12024 |
| 20-#10 | 3.04 | MA | 8812 | 2584 | 12177 | 2270 | 14983 | 1899 | 16648 | 1592 | 18631 | 1086 | 23523 | 490 | 19713 |
| 9L-3S | | MI | 5609 | 2584 | 8761 | 2107 | 10536 | 1740 | 11741 | 1436 | 13487 | 944 | 16722 | 676 | 12068 |
| 20-#10 | 3.04 | MA | 8557 | 2584 | 11705 | 2278 | 14356 | 1917 | 15905 | 1601 | 17608 | 1100 | 22099 | 441 | 18942 |
| 10L-2S | | MI | 5803 | 2584 | 9151 | 2097 | 11032 | 1732 | 12342 | 1430 | 14298 | 934 | 17817 | 768 | 12091 |
| 20-#11 | 3.73 | MA | 9791 | 2752 | 14212 | 2357 | 17541 | 1963 | 19775 | 1624 | 22725 | 1057 | 29058 | 494 | 25187 |
| 7L-5S | | MI | 5618 | 2752 | 8915 | 2218 | 10603 | 1830 | 11775 | 1494 | 13479 | 940 | 16558 | 463 | 13926 |
| 20-#11 | 3.73 | MA | 9497 | 2752 | 13649 | 2370 | 16788 | 1973 | 18824 | 1642 | 21484 | 1068 | 27423 | 436 | 24236 |
| 8L-4S | | MI | 5753 | 2752 | 9209 | 2207 | 11006 | 1821 | 12273 | 1488 | 14170 | 929 | 17462 | 529 | 14292 |
| 20-#11 | 3.73 | MA | 9173 | 2752 | 13100 | 2383 | 16056 | 1985 | 17900 | 1652 | 20262 | 1089 | 25817 | 381 | 23139 |
| 9L-3S | | MI | 5869 | 2752 | 9538 | 2196 | 11461 | 1804 | 12830 | 1472 | 14931 | 927 | 18373 | 591 | 14441 |
| 20-#11 | 3.73 | MA | 8873 | 2752 | 12525 | 2392 | 15292 | 2006 | 16996 | 1663 | 19037 | 1107 | 24078 | 319 | 21994 |
| 10L-2S | | MI | 6089 | 2752 | 10007 | 2186 | 12056 | 1795 | 13552 | 1466 | 15904 | 916 | 19657 | 704 | 14481 |
| 20-#14 | 5.38 | MA | 10524 | 3152 | 15976 | 2650 | 19654 | 2190 | 22260 | 1795 | 26069 | 1094 | 33868 | 221 | 32519 |
| 8L-4S | | MI | 6421 | 3152 | 10885 | 2453 | 13072 | 2003 | 14753 | 1601 | 17495 | 905 | 21603 | 348 | 19576 |
| 22-#10 | 3.34 | MA | 9706 | 2658 | 13855 | 2295 | 17167 | 1913 | 19356 | 1590 | 22228 | 1055 | 28353 | 574 | 23500 |
| 7L-6S | | MI | 5422 | 2658 | 8363 | 2187 | 10007 | 1805 | 11063 | 1490 | 12547 | 964 | 15565 | 502 | 12714 |
| 22-#10 | 3.34 | MA | 9460 | 2658 | 13393 | 2306 | 16548 | 1922 | 18574 | 1604 | 21209 | 1065 | 27015 | 529 | 22750 |
| 8L-5S | | MI | 5559 | 2658 | 8636 | 2172 | 10322 | 1797 | 11468 | 1477 | 13095 | 954 | 16273 | 562 | 12892 |
| 22-#10 | 3.34 | MA | 9191 | 2658 | 12936 | 2316 | 15947 | 1933 | 17815 | 1613 | 20206 | 1082 | 25704 | 485 | 21939 |
| 9L-4S | | MI | 5677 | 2658 | 8879 | 2162 | 10655 | 1789 | 11880 | 1471 | 13667 | 943 | 17044 | 616 | 13172 |
| 22-#10 | 3.34 | MA | 8945 | 2658 | 12464 | 2324 | 15319 | 1950 | 17072 | 1623 | 19184 | 1097 | 24281 | 436 | 21163 |
| 10L-3S | | MI | 5775 | 2658 | 9151 | 2153 | 11032 | 1774 | 12342 | 1457 | 14298 | 940 | 17817 | 668 | 13221 |
| 22-#10 | 3.34 | MA | 8704 | 2658 | 11932 | 2340 | 14719 | 1960 | 16318 | 1640 | 18142 | 1105 | 22978 | 389 | 20244 |
| 11L-2S | | MI | 5964 | 2658 | 9542 | 2143 | 11528 | 1766 | 12943 | 1451 | 15110 | 930 | 18912 | 760 | 13248 |
| 22-#11 | 4.11 | MA | 9937 | 2842 | 14570 | 2426 | 17957 | 2015 | 20241 | 1668 | 23397 | 1064 | 30071 | 430 | 26932 |
| 8L-5S | | MI | 5816 | 2842 | 9384 | 2274 | 11199 | 1871 | 12496 | 1520 | 14453 | 935 | 17842 | 449 | 15275 |
| 22-#11 | 4.11 | MA | 9624 | 2842 | 14021 | 2439 | 17225 | 2026 | 19317 | 1678 | 22175 | 1084 | 28465 | 375 | 25839 |
| 9L-4S | | MI | 5951 | 2842 | 9678 | 2264 | 11601 | 1862 | 12994 | 1514 | 15143 | 925 | 18746 | 516 | 15625 |
| 22-#11 | 4.11 | MA | 9336 | 2842 | 13446 | 2449 | 16461 | 2048 | 18413 | 1689 | 20949 | 1103 | 26726 | 313 | 24687 |
| 10L-3S | | MI | 6070 | 2842 | 10007 | 2253 | 12056 | 1845 | 13552 | 1499 | 15904 | 922 | 19657 | 577 | 15821 |
| 24-#10 | 3.65 | MA | 9824 | 2731 | 14152 | 2352 | 17511 | 1956 | 19741 | 1626 | 22785 | 1061 | 29196 | 524 | 24971 |
| 8L-6S | | MI | 5592 | 2731 | 8754 | 2233 | 10503 | 1839 | 11664 | 1512 | 13358 | 960 | 16660 | 494 | 13845 |
| 24-#10 | 3.65 | MA | 9564 | 2731 | 13695 | 2362 | 16910 | 1966 | 18982 | 1634 | 21782 | 1079 | 27886 | 480 | 24166 |
| 9L-5S | | MI | 5726 | 2731 | 9026 | 2218 | 10818 | 1831 | 12069 | 1498 | 13906 | 950 | 17368 | 554 | 14018 |
| 24-#10 | 3.65 | MA | 9325 | 2731 | 13223 | 2370 | 16283 | 1984 | 18240 | 1644 | 20760 | 1093 | 26463 | 431 | 23383 |
| 10L-4S | | MI | 5845 | 2731 | 9269 | 2208 | 11151 | 1823 | 12481 | 1492 | 14478 | 940 | 18139 | 608 | 14319 |
| 24-#10 | 3.65 | MA | 9087 | 2731 | 12691 | 2386 | 15683 | 1994 | 17486 | 1661 | 19718 | 1101 | 25160 | 384 | 22468 |
| 11L-3S | | MI | 5938 | 2731 | 9542 | 2199 | 11528 | 1808 | 12943 | 1479 | 15110 | 937 | 18912 | 660 | 14373 |
| 24-#11 | 4.48 | MA | 10067 | 2933 | 14942 | 2496 | 18394 | 2068 | 20734 | 1704 | 24088 | 1080 | 31113 | 369 | 28540 |
| 9L-5S | | MI | 6028 | 2933 | 9853 | 2331 | 11794 | 1912 | 13218 | 1546 | 15427 | 931 | 19126 | 435 | 16627 |
| 24-#11 | 4.48 | MA | 9790 | 2933 | 14367 | 2505 | 17630 | 2089 | 19830 | 1715 | 22862 | 1099 | 29375 | 307 | 27381 |
| 10L-4S | | MI | 6163 | 2933 | 10147 | 2320 | 12196 | 1904 | 13716 | 1540 | 16117 | 920 | 20029 | 502 | 16963 |

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis

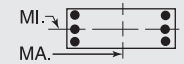



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.02 | MA | 9224 | 2206 | 12080 | 1969 | 14834 | 1660 | 16323 | 1419 | 17786 | 1057 | 21573 | 921 | 8673 |
| 2E | | MI | 4886 | 2206 | 6982 | 1856 | 8136 | 1563 | 8722 | 1334 | 9240 | 990 | 10720 | 832 | 4522 |
| 4-#18 | 1.82 | MA | 10188 | 2409 | 14305 | 2083 | 17553 | 1741 | 19564 | 1467 | 22114 | 1039 | 27529 | 900 | 14984 |
| 2E | | MI | 5270 | 2409 | 8040 | 1958 | 9387 | 1635 | 10192 | 1374 | 11188 | 965 | 12987 | 753 | 7531 |
| 6-#11 | 1.06 | MA | 9302 | 2216 | 12148 | 1983 | 14975 | 1671 | 16521 | 1427 | 18078 | 1060 | 21995 | 924 | 9047 |
| 2L-3S | | MI | 4657 | 2216 | 6536 | 1886 | 7616 | 1587 | 8115 | 1353 | 8440 | 1007 | 9746 | 731 | 4732 |
| 6-#11 | 1.06 | MA | 8704 | 2216 | 11170 | 2000 | 13734 | 1686 | 15017 | 1441 | 16048 | 1081 | 19185 | 825 | 9039 |
| 3L-2S | | MI | 4929 | 2216 | 7005 | 1875 | 8211 | 1579 | 8836 | 1347 | 9414 | 997 | 11030 | 844 | 4707 |
| 6-#14 | 1.53 | MA | 9897 | 2336 | 13478 | 2051 | 16609 | 1720 | 18474 | 1456 | 20690 | 1050 | 25594 | 912 | 12844 |
| 2L-3S | | MI | 4804 | 2336 | 6982 | 1952 | 8136 | 1634 | 8722 | 1380 | 9240 | 997 | 10720 | 644 | 6563 |
| 6-#14 | 1.53 | MA | 9080 | 2336 | 12080 | 2075 | 14834 | 1741 | 16323 | 1476 | 17786 | 1080 | 21573 | 767 | 12778 |
| 3L-2S | | MI | 5175 | 2336 | 7647 | 1938 | 8980 | 1623 | 9744 | 1372 | 10620 | 983 | 12508 | 808 | 6542 |
| 6-#18 | 2.73 | MA | 11283 | 2641 | 16751 | 2228 | 20657 | 1847 | 23326 | 1534 | 27191 | 1028 | 34559 | 885 | 22244 |
| 2L-3S | | MI | 5148 | 2641 | 8040 | 2125 | 9387 | 1756 | 10192 | 1450 | 11188 | 972 | 12987 | 406 | 10863 |
| 6-#18 | 2.73 | MA | 9986 | 2641 | 14305 | 2267 | 17553 | 1884 | 19564 | 1567 | 22114 | 1077 | 27529 | 621 | 21882 |
| 3L-2S | | MI | 5736 | 2641 | 9181 | 2103 | 10834 | 1741 | 11947 | 1441 | 13556 | 954 | 15942 | 697 | 10950 |
| 8-#10 | 1.15 | MA | 9460 | 2239 | 12341 | 2007 | 15294 | 1689 | 16946 | 1440 | 18686 | 1065 | 22862 | 927 | 9861 |
| 2L-4S | | MI | 4656 | 2239 | 6420 | 1926 | 7503 | 1627 | 8007 | 1386 | 8314 | 1019 | 9738 | 718 | 5140 |
| 8-#10 | 1.15 | MA | 8972 | 2239 | 11536 | 2021 | 14273 | 1702 | 15708 | 1453 | 17015 | 1082 | 20548 | 848 | 9849 |
| 3E | | MI | 4787 | 2239 | 6692 | 1917 | 7881 | 1612 | 8469 | 1373 | 8945 | 1016 | 10511 | 770 | 5129 |
| 8-#10 | 1.15 | MA | 8704 | 2239 | 10991 | 2035 | 13516 | 1723 | 14779 | 1472 | 15743 | 1093 | 19025 | 798 | 9783 |
| 4L-2S | | MI | 5013 | 2239 | 7083 | 1907 | 8377 | 1604 | 9070 | 1366 | 9757 | 1006 | 11606 | 862 | 5113 |
| 8-#11 | 1.42 | MA | 9777 | 2307 | 13126 | 2039 | 16216 | 1712 | 18025 | 1453 | 20108 | 1056 | 24806 | 918 | 11962 |
| 2L-4S | | MI | 4719 | 2307 | 6676 | 1953 | 7756 | 1646 | 8279 | 1394 | 8653 | 1005 | 10119 | 656 | 6145 |
| 8-#11 | 1.42 | MA | 9202 | 2307 | 12148 | 2056 | 14975 | 1727 | 16521 | 1467 | 18078 | 1077 | 21995 | 819 | 11935 |
| 3E | | MI | 4872 | 2307 | 7005 | 1943 | 8211 | 1629 | 8836 | 1379 | 9414 | 1003 | 11030 | 717 | 6145 |
| 8-#11 | 1.42 | MA | 8885 | 2307 | 11485 | 2073 | 14053 | 1752 | 15391 | 1490 | 16530 | 1089 | 20131 | 757 | 11811 |
| 4L-2S | | MI | 5136 | 2307 | 7474 | 1932 | 8806 | 1620 | 9558 | 1373 | 10388 | 992 | 12314 | 831 | 6129 |
| 8-#14 | 2.05 | MA | 10547 | 2467 | 14877 | 2133 | 18384 | 1779 | 20626 | 1494 | 23594 | 1044 | 29614 | 904 | 17001 |
| 2L-4S | | MI | 4893 | 2467 | 7179 | 2048 | 8332 | 1717 | 8952 | 1438 | 9538 | 992 | 11234 | 535 | 8458 |
| 8-#14 | 2.05 | MA | 9771 | 2467 | 13478 | 2156 | 16609 | 1801 | 18474 | 1514 | 20690 | 1073 | 25594 | 759 | 16905 |
| 3E | | MI | 5100 | 2467 | 7647 | 2034 | 8980 | 1694 | 9744 | 1418 | 10620 | 991 | 12508 | 621 | 8537 |
| 8-#14 | 2.05 | MA | 9346 | 2467 | 12527 | 2180 | 15288 | 1835 | 16854 | 1547 | 18472 | 1090 | 22912 | 669 | 16537 |
| 4L-2S | | MI | 5457 | 2467 | 8312 | 2019 | 9823 | 1683 | 10767 | 1410 | 12000 | 977 | 14295 | 784 | 8540 |
| 8-#18 | 3.64 | MA | 11134 | 2872 | 16751 | 2412 | 20657 | 1990 | 23326 | 1634 | 27191 | 1066 | 34559 | 605 | 29085 |
| 3E | | MI | 5653 | 2872 | 9181 | 2270 | 10834 | 1862 | 11947 | 1517 | 13556 | 961 | 15942 | 349 | 14190 |
| 8-#18 | 3.64 | MA | 10480 | 2872 | 15081 | 2452 | 18339 | 2048 | 20484 | 1690 | 23301 | 1092 | 29819 | 443 | 26250 |
| 4L-2S | | MI | 6181 | 2872 | 10322 | 2248 | 12282 | 1847 | 13702 | 1508 | 15925 | 943 | 18897 | 640 | 14335 |
| 10-#10 | 1.44 | MA | 9853 | 2313 | 13146 | 2053 | 16316 | 1723 | 18184 | 1462 | 20357 | 1061 | 25176 | 922 | 12257 |
| 2L-5S | | MI | 4718 | 2313 | 6567 | 1982 | 7667 | 1669 | 8195 | 1413 | 8553 | 1026 | 10062 | 656 | 6271 |
| 10-#10 | 1.44 | MA | 9380 | 2313 | 12341 | 2067 | 15294 | 1736 | 16946 | 1474 | 18686 | 1079 | 22862 | 843 | 12235 |
| 3L-4S | | MI | 4842 | 2313 | 6810 | 1972 | 7999 | 1661 | 8608 | 1407 | 9125 | 1015 | 10833 | 710 | 6301 |
| 10-#10 | 1.44 | MA | 9126 | 2313 | 11796 | 2081 | 14537 | 1756 | 16018 | 1493 | 17414 | 1090 | 21339 | 793 | 12156 |
| 4L-3S | | MI | 4967 | 2313 | 7083 | 1963 | 8377 | 1646 | 9070 | 1394 | 9757 | 1012 | 11606 | 762 | 6302 |
| 10-#10 | 1.44 | MA | 8800 | 2313 | 11304 | 2093 | 13877 | 1769 | 15197 | 1506 | 16272 | 1107 | 19781 | 755 | 11958 |
| 5L-2S | | MI | 5187 | 2313 | 7474 | 1953 | 8872 | 1638 | 9671 | 1387 | 10568 | 1002 | 12702 | 854 | 6292 |
| 10-#11 | 1.77 | MA | 10240 | 2397 | 14104 | 2096 | 17457 | 1753 | 19529 | 1479 | 22138 | 1052 | 27617 | 912 | 14870 |
| 2L-5S | | MI | 4796 | 2397 | 6850 | 2020 | 7949 | 1696 | 8502 | 1427 | 8936 | 1012 | 10499 | 576 | 7323 |
| 10-#11 | 1.77 | MA | 9686 | 2397 | 13126 | 2113 | 16216 | 1769 | 18025 | 1493 | 20108 | 1072 | 24806 | 813 | 14827 |
| 3L-4S | | MI | 4936 | 2397 | 7145 | 2010 | 8351 | 1687 | 9001 | 1420 | 9626 | 1001 | 11402 | 642 | 7529 |
| 10-#11 | 1.77 | MA | 9389 | 2397 | 12463 | 2129 | 15294 | 1793 | 16894 | 1516 | 18560 | 1085 | 22941 | 751 | 14689 |
| 4L-3S | | MI | 5082 | 2397 | 7474 | 1999 | 8806 | 1670 | 9558 | 1405 | 10388 | 999 | 12314 | 704 | 7547 |
| 10-#11 | 1.77 | MA | 9003 | 2397 | 11869 | 2145 | 14489 | 1809 | 15894 | 1531 | 17169 | 1106 | 21039 | 702 | 14140 |
| 5L-2S | | MI | 5338 | 2397 | 7943 | 1988 | 9401 | 1661 | 10279 | 1399 | 11361 | 988 | 13597 | 817 | 7540 |
| 10-#14 | 2.56 | MA | 10440 | 2597 | 14877 | 2238 | 18384 | 1861 | 20626 | 1552 | 23594 | 1067 | 29614 | 750 | 21033 |
| 3L-4S | | MI | 5195 | 2597 | 7843 | 2130 | 9176 | 1777 | 9974 | 1475 | 10918 | 986 | 13022 | 511 | 10296 |
| 10-#14 | 2.56 | MA | 10048 | 2597 | 13926 | 2261 | 17063 | 1895 | 19006 | 1584 | 21376 | 1084 | 26933 | 660 | 20658 |
| 4L-3S | | MI | 5390 | 2597 | 8312 | 2115 | 9823 | 1753 | 10767 | 1455 | 12000 | 985 | 14295 | 597 | 10500 |


## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

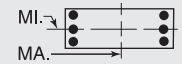

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.56 | MA | 9509 | 2597 | 13081 | 2284 | 15909 | 1917 | 17572 | 1604 | 19382 | 1113 | 24201 | 588 | 19146 |
| 5L-2S | | MI | 5733 | 2597 | 8977 | 2101 | 10667 | 1742 | 11789 | 1447 | 13380 | 971 | 16083 | 760 | 10526 |
| 10-#18 | 4.55 | MA | 11660 | 3104 | 17527 | 2597 | 21442 | 2154 | 24245 | 1757 | 28378 | 1081 | 36849 | 428 | 33407 |
| 4L-3S | | MI | 6124 | 3104 | 10322 | 2415 | 12282 | 1968 | 13702 | 1584 | 15925 | 950 | 18897 | 293 | 17516 |
| 10-#18 | 4.55 | MA | 10753 | 3104 | 16051 | 2637 | 19414 | 2191 | 21726 | 1790 | 24878 | 1130 | 32038 | 291 | 30449 |
| 5L-2S | | MI | 6615 | 3104 | 11463 | 2393 | 13730 | 1953 | 15457 | 1575 | 18294 | 932 | 21853 | 583 | 17706 |
| 12-#10 | 1.73 | MA | 10237 | 2387 | 13951 | 2099 | 17337 | 1757 | 19422 | 1483 | 22028 | 1058 | 27490 | 917 | 14650 |
| 2L-6S | | MI | 4745 | 2387 | 6686 | 2043 | 7847 | 1710 | 8392 | 1448 | 8817 | 1032 | 10450 | 588 | 7152 |
| 12-#10 | 1.73 | MA | 9779 | 2387 | 13146 | 2113 | 16316 | 1770 | 18184 | 1495 | 20357 | 1075 | 25176 | 838 | 14618 |
| 3L-5S | | MI | 4902 | 2387 | 6958 | 2028 | 8162 | 1702 | 8796 | 1435 | 9364 | 1022 | 11157 | 648 | 7378 |
| 12-#10 | 1.73 | MA | 9538 | 2387 | 12601 | 2127 | 15559 | 1790 | 17256 | 1515 | 19085 | 1086 | 23653 | 788 | 14531 |
| 4E | | MI | 5024 | 2387 | 7201 | 2018 | 8495 | 1694 | 9209 | 1428 | 9936 | 1012 | 11928 | 701 | 7457 |
| 12-#10 | 1.73 | MA | 9216 | 2387 | 12109 | 2139 | 14899 | 1803 | 16435 | 1527 | 17944 | 1104 | 22095 | 750 | 14330 |
| 5L-3S | | MI | 5144 | 2387 | 7474 | 2009 | 8872 | 1679 | 9671 | 1415 | 10568 | 1009 | 12702 | 753 | 7469 |
| 12-#10 | 1.73 | MA | 8888 | 2387 | 11509 | 2154 | 14257 | 1814 | 15633 | 1546 | 16830 | 1114 | 20594 | 686 | 13668 |
| 6L-2S | | MI | 5358 | 2387 | 7865 | 1999 | 9368 | 1671 | 10272 | 1409 | 11379 | 999 | 13797 | 846 | 7464 |
| 12-#11 | 2.13 | MA | 10158 | 2487 | 14104 | 2169 | 17457 | 1810 | 19529 | 1519 | 22138 | 1068 | 27617 | 807 | 17719 |
| 3L-5S | | MI | 5010 | 2487 | 7319 | 2077 | 8544 | 1737 | 9224 | 1453 | 9910 | 1007 | 11782 | 562 | 8646 |
| 12-#11 | 2.13 | MA | 9878 | 2487 | 13440 | 2186 | 16535 | 1834 | 18398 | 1543 | 20590 | 1080 | 25752 | 745 | 17570 |
| 4E | | MI | 5150 | 2487 | 7614 | 2066 | 8946 | 1729 | 9722 | 1446 | 10600 | 997 | 12686 | 629 | 8908 |
| 12-#11 | 2.13 | MA | 9497 | 2487 | 12847 | 2201 | 15730 | 1850 | 17398 | 1557 | 19199 | 1101 | 23850 | 696 | 16992 |
| 5L-3S | | MI | 5289 | 2487 | 7943 | 2056 | 9401 | 1711 | 10279 | 1431 | 11361 | 994 | 13597 | 690 | 8940 |
| 12-#11 | 2.13 | MA | 9110 | 2487 | 12117 | 2219 | 14958 | 1864 | 16421 | 1580 | 17842 | 1114 | 22018 | 615 | 16237 |
| 6L-2S | | MI | 5538 | 2487 | 8412 | 2045 | 9997 | 1703 | 11000 | 1425 | 12335 | 984 | 14881 | 803 | 8943 |
| 12-#14 | 3.07 | MA | 10728 | 2728 | 15325 | 2343 | 18838 | 1954 | 21157 | 1622 | 24280 | 1078 | 30953 | 652 | 24785 |
| 4E | | MI | 5490 | 2728 | 8508 | 2211 | 10020 | 1836 | 10997 | 1513 | 12298 | 980 | 14809 | 487 | 12149 |
| 12-#14 | 3.07 | MA | 10196 | 2728 | 14480 | 2365 | 17684 | 1976 | 19723 | 1642 | 22286 | 1107 | 28222 | 579 | 23262 |
| 5L-3S | | MI | 5674 | 2728 | 8977 | 2197 | 10667 | 1813 | 11789 | 1493 | 13380 | 979 | 16083 | 573 | 12457 |
| 12-#14 | 3.07 | MA | 9670 | 2728 | 13435 | 2390 | 16586 | 1997 | 18321 | 1675 | 20340 | 1124 | 25592 | 460 | 21894 |
| 6L-2S | | MI | 6005 | 2728 | 9642 | 2182 | 11511 | 1802 | 12812 | 1485 | 14761 | 965 | 17871 | 737 | 12500 |
| 12-#18 | 5.45 | MA | 11901 | 3336 | 18497 | 2782 | 22518 | 2297 | 25488 | 1857 | 29955 | 1119 | 39068 | 276 | 37563 |
| 5L-3S | | MI | 6583 | 3336 | 11463 | 2560 | 13730 | 2074 | 15457 | 1651 | 18294 | 939 | 21853 | 236 | 20844 |
| 12-#18 | 5.45 | MA | 11073 | 3336 | 16681 | 2825 | 20605 | 2333 | 23024 | 1912 | 26536 | 1146 | 34434 | 58 | 34014 |
| 6L-2S | | MI | 7043 | 3336 | 12604 | 2538 | 15178 | 2059 | 17212 | 1642 | 20663 | 921 | 24808 | 527 | 21069 |
| 14-#10 | 2.02 | MA | 10169 | 2460 | 13951 | 2159 | 17337 | 1803 | 19422 | 1516 | 22028 | 1072 | 27490 | 833 | 17002 |
| 3L-6S | | MI | 4929 | 2460 | 7076 | 2089 | 8343 | 1744 | 8993 | 1469 | 9628 | 1029 | 11545 | 580 | 8271 |
| 14-#10 | 2.02 | MA | 9940 | 2460 | 13406 | 2173 | 16580 | 1823 | 18494 | 1536 | 20756 | 1083 | 25967 | 783 | 16906 |
| 4L-5S | | MI | 5082 | 2460 | 7349 | 2074 | 8658 | 1736 | 9397 | 1456 | 10176 | 1019 | 12253 | 639 | 8484 |
| 14-#10 | 2.02 | MA | 9621 | 2460 | 12914 | 2185 | 15920 | 1837 | 17673 | 1548 | 19615 | 1100 | 24409 | 745 | 16683 |
| 5L-4S | | MI | 5203 | 2460 | 7592 | 2064 | 8991 | 1728 | 9810 | 1450 | 10748 | 1008 | 13024 | 693 | 8609 |
| 14-#10 | 2.02 | MA | 9305 | 2460 | 12314 | 2200 | 15279 | 1848 | 16871 | 1567 | 18501 | 1111 | 22908 | 681 | 16033 |
| 6L-3S | | MI | 5318 | 2460 | 7865 | 2055 | 9368 | 1713 | 10272 | 1436 | 11379 | 1005 | 13797 | 745 | 8629 |
| 14-#10 | 2.02 | MA | 9030 | 2460 | 11804 | 2209 | 14572 | 1863 | 16080 | 1578 | 17421 | 1129 | 21454 | 648 | 15543 |
| 7L-2S | | MI | 5527 | 2460 | 8255 | 2045 | 9864 | 1705 | 10873 | 1430 | 12190 | 995 | 14892 | 838 | 8632 |
| 14-#11 | 2.48 | MA | 10356 | 2578 | 14418 | 2242 | 17776 | 1876 | 19902 | 1569 | 22620 | 1076 | 28563 | 739 | 20453 |
| 4L-5S | | MI | 5221 | 2578 | 7788 | 2133 | 9139 | 1778 | 9945 | 1479 | 10883 | 1003 | 13066 | 548 | 9976 |
| 14-#11 | 2.48 | MA | 9979 | 2578 | 13824 | 2258 | 16971 | 1891 | 18902 | 1583 | 21229 | 1097 | 26661 | 690 | 19849 |
| 5L-4S | | MI | 5359 | 2578 | 8082 | 2123 | 9542 | 1770 | 10443 | 1473 | 11574 | 992 | 13970 | 615 | 10285 |
| 14-#11 | 2.48 | MA | 9606 | 2578 | 13095 | 2275 | 16199 | 1905 | 17924 | 1606 | 19872 | 1109 | 24828 | 609 | 19117 |
| 6L-3S | | MI | 5493 | 2578 | 8412 | 2112 | 9997 | 1753 | 11000 | 1458 | 12335 | 990 | 14881 | 676 | 10328 |
| 14-#11 | 2.48 | MA | 9282 | 2578 | 12474 | 2286 | 15339 | 1923 | 16973 | 1620 | 18556 | 1130 | 23047 | 568 | 18223 |
| 7L-2S | | MI | 5734 | 2578 | 8880 | 2101 | 10592 | 1744 | 11721 | 1451 | 13308 | 979 | 16165 | 790 | 10341 |
| 14-#14 | 3.58 | MA | 10863 | 2858 | 15878 | 2447 | 19459 | 2036 | 21874 | 1680 | 25190 | 1101 | 32243 | 571 | 27382 |
| 5L-4S | | MI | 5780 | 2858 | 9173 | 2293 | 10863 | 1896 | 12019 | 1551 | 13678 | 974 | 16597 | 463 | 14015 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

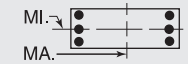
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 3.58 | MA | 10363 | 2858 | 14834 | 2471 | 18361 | 2057 | 20472 | 1712 | 23244 | 1118 | 29612 | 452 | 25988 |
| 6L-3S | | MI | 5954 | 2858 | 9642 | 2278 | 11511 | 1872 | 12812 | 1530 | 14761 | 972 | 17871 | 549 | 14411 |
| 14-#14 | 3.58 | MA | 9928 | 2858 | 13944 | 2487 | 17130 | 2082 | 19120 | 1732 | 21357 | 1147 | 27046 | 391 | 24331 |
| 7L-2S | | MI | 6273 | 2858 | 10306 | 2264 | 12354 | 1861 | 13834 | 1523 | 16141 | 959 | 19658 | 713 | 14469 |
| 14-#18 | 6.36 | MA | 12239 | 3568 | 19127 | 2970 | 23709 | 2439 | 26785 | 1979 | 31614 | 1135 | 41464 | 42 | 41156 |
| 6L-3S | | MI | 7033 | 3568 | 12604 | 2705 | 15178 | 2180 | 17212 | 1718 | 20663 | 928 | 24808 | 180 | 24052 |
| 16-#10 | 2.31 | MA | 10334 | 2534 | 14211 | 2219 | 17602 | 1857 | 19732 | 1557 | 22428 | 1079 | 28281 | 779 | 19283 |
| 4L-6S | | MI | 5110 | 2534 | 7467 | 2135 | 8839 | 1777 | 9594 | 1491 | 10439 | 1025 | 12640 | 572 | 9392 |
| 16-#10 | 2.31 | MA | 10018 | 2534 | 13719 | 2231 | 16941 | 1870 | 18911 | 1569 | 21286 | 1097 | 26723 | 741 | 19034 |
| 5E | | MI | 5259 | 2534 | 7739 | 2120 | 9154 | 1769 | 9998 | 1477 | 10987 | 1015 | 13348 | 631 | 9596 |
| 16-#10 | 2.31 | MA | 9712 | 2534 | 13119 | 2246 | 16300 | 1882 | 18109 | 1589 | 20172 | 1107 | 25222 | 676 | 18400 |
| 6L-4S | | MI | 5379 | 2534 | 7983 | 2110 | 9487 | 1762 | 10411 | 1471 | 11559 | 1005 | 14119 | 685 | 9760 |
| 16-#10 | 2.31 | MA | 9448 | 2534 | 12609 | 2255 | 15594 | 1896 | 17318 | 1599 | 19092 | 1125 | 23768 | 643 | 17920 |
| 7L-3S | | MI | 5490 | 2534 | 8255 | 2101 | 9864 | 1747 | 10873 | 1458 | 12190 | 1002 | 14892 | 737 | 9787 |
| 16-#10 | 2.31 | MA | 9174 | 2534 | 12120 | 2266 | 14938 | 1906 | 16490 | 1614 | 18015 | 1136 | 22354 | 599 | 17103 |
| 8L-2S | | MI | 5694 | 2534 | 8646 | 2091 | 10360 | 1739 | 11474 | 1451 | 13002 | 992 | 15988 | 829 | 9797 |
| 16-#11 | 2.84 | MA | 10449 | 2668 | 14802 | 2314 | 18212 | 1933 | 20406 | 1609 | 23259 | 1093 | 29471 | 684 | 22709 |
| 5E | | MI | 5428 | 2668 | 8257 | 2190 | 9735 | 1820 | 10666 | 1505 | 11857 | 999 | 14350 | 534 | 11312 |
| 16-#11 | 2.84 | MA | 10090 | 2668 | 14073 | 2332 | 17439 | 1947 | 19428 | 1632 | 21902 | 1105 | 27639 | 603 | 22000 |
| 6L-4S | | MI | 5565 | 2668 | 8551 | 2179 | 10137 | 1811 | 11164 | 1499 | 12547 | 988 | 15254 | 601 | 11660 |
| 16-#11 | 2.84 | MA | 9781 | 2668 | 13452 | 2343 | 16580 | 1964 | 18477 | 1646 | 20586 | 1126 | 25857 | 562 | 21095 |
| 7L-3S | | MI | 5693 | 2668 | 8880 | 2169 | 10592 | 1794 | 11721 | 1484 | 13308 | 986 | 16165 | 662 | 11713 |
| 16-#11 | 2.84 | MA | 9456 | 2668 | 12856 | 2356 | 15782 | 1975 | 17469 | 1664 | 19272 | 1138 | 24129 | 506 | 20144 |
| 8L-2S | | MI | 5929 | 2668 | 9349 | 2158 | 11187 | 1785 | 12443 | 1477 | 14282 | 975 | 17448 | 776 | 11735 |
| 16-#14 | 4.09 | MA | 11036 | 2988 | 16233 | 2553 | 20136 | 2116 | 22623 | 1750 | 26148 | 1111 | 33633 | 443 | 30081 |
| 6L-4S | | MI | 6065 | 2988 | 9838 | 2374 | 11707 | 1956 | 13042 | 1588 | 15059 | 967 | 18385 | 440 | 15892 |
| 16-#14 | 4.09 | MA | 10626 | 2988 | 15343 | 2568 | 18905 | 2141 | 21272 | 1770 | 24260 | 1141 | 31067 | 382 | 28433 |
| 7L-3S | | MI | 6229 | 2988 | 10306 | 2360 | 12354 | 1932 | 13834 | 1568 | 16141 | 966 | 19658 | 526 | 16363 |
| 16-#14 | 4.09 | MA | 10170 | 2988 | 14489 | 2586 | 17761 | 2157 | 19828 | 1795 | 22377 | 1157 | 28585 | 300 | 26560 |
| 8L-2S | | MI | 6529 | 2988 | 10971 | 2345 | 13198 | 1921 | 14857 | 1560 | 17521 | 952 | 21446 | 689 | 16434 |
| 18-#10 | 2.60 | MA | 10408 | 2608 | 14524 | 2277 | 17963 | 1904 | 20149 | 1591 | 22957 | 1093 | 29037 | 736 | 21388 |
| 5L-6S | | MI | 5288 | 2608 | 7858 | 2181 | 9335 | 1811 | 10195 | 1512 | 11250 | 1022 | 13736 | 563 | 10517 |
| 18-#10 | 2.60 | MA | 10111 | 2608 | 13924 | 2292 | 17322 | 1915 | 19347 | 1610 | 21843 | 1104 | 27536 | 672 | 20770 |
| 6L-5S | | MI | 5433 | 2608 | 8130 | 2166 | 9650 | 1803 | 10599 | 1498 | 11798 | 1012 | 14443 | 623 | 10712 |
| 18-#10 | 2.60 | MA | 9857 | 2608 | 13414 | 2301 | 16615 | 1930 | 18556 | 1621 | 20764 | 1122 | 26082 | 638 | 20291 |
| 7L-4S | | MI | 5553 | 2608 | 8373 | 2156 | 9983 | 1795 | 11011 | 1492 | 12370 | 1001 | 15214 | 677 | 10910 |
| 18-#10 | 2.60 | MA | 9586 | 2608 | 12925 | 2312 | 15960 | 1939 | 17728 | 1636 | 19686 | 1132 | 24668 | 594 | 19472 |
| 8L-3S | | MI | 5660 | 2608 | 8646 | 2147 | 10360 | 1780 | 11474 | 1479 | 13002 | 998 | 15988 | 729 | 10943 |
| 18-#10 | 2.60 | MA | 9281 | 2608 | 12438 | 2322 | 15323 | 1950 | 16925 | 1645 | 18625 | 1150 | 23287 | 550 | 18678 |
| 9L-2S | | MI | 5859 | 2608 | 9037 | 2137 | 10856 | 1772 | 12075 | 1472 | 13813 | 988 | 17083 | 821 | 10958 |
| 18-#11 | 3.19 | MA | 10564 | 2759 | 15050 | 2388 | 18680 | 1988 | 20932 | 1658 | 23931 | 1101 | 30450 | 597 | 24884 |
| 6L-5S | | MI | 5632 | 2759 | 8726 | 2247 | 10330 | 1861 | 11387 | 1531 | 12831 | 994 | 15633 | 521 | 12653 |
| 18-#11 | 3.19 | MA | 10268 | 2759 | 14429 | 2399 | 17821 | 2006 | 19980 | 1672 | 22616 | 1122 | 28668 | 556 | 23967 |
| 7L-4S | | MI | 5769 | 2759 | 9020 | 2236 | 10732 | 1852 | 11886 | 1525 | 13521 | 984 | 16537 | 587 | 13034 |
| 18-#11 | 3.19 | MA | 9947 | 2759 | 13834 | 2412 | 17022 | 2017 | 18973 | 1690 | 21302 | 1134 | 26940 | 500 | 23019 |
| 8L-3S | | MI | 5891 | 2759 | 9349 | 2225 | 11187 | 1835 | 12443 | 1510 | 14282 | 981 | 17448 | 649 | 13096 |
| 18-#11 | 3.19 | MA | 9588 | 2759 | 13247 | 2425 | 16247 | 2029 | 17994 | 1700 | 20009 | 1155 | 25247 | 445 | 21836 |
| 9L-2S | | MI | 6121 | 2759 | 9818 | 2214 | 11782 | 1827 | 13164 | 1503 | 15255 | 971 | 18732 | 762 | 13125 |
| 18-#14 | 4.60 | MA | 11306 | 3119 | 16742 | 2650 | 20680 | 2201 | 23423 | 1808 | 27164 | 1134 | 35088 | 374 | 32534 |
| 7L-4S | | MI | 6365 | 3119 | 10503 | 2456 | 12551 | 2015 | 14065 | 1626 | 16439 | 961 | 20172 | 416 | 17777 |
| 18-#14 | 4.60 | MA | 10856 | 3119 | 15887 | 2668 | 19536 | 2216 | 21979 | 1833 | 25281 | 1151 | 32606 | 291 | 30648 |
| 8L-3S | | MI | 6506 | 3119 | 10971 | 2441 | 13198 | 1992 | 14857 | 1606 | 17521 | 960 | 21446 | 502 | 18314 |
| 18-#14 | 4.60 | MA | 10372 | 3119 | 15053 | 2686 | 18424 | 2233 | 20576 | 1847 | 23426 | 1180 | 30167 | 211 | 28791 |
| 9L-2S | | MI | 6785 | 3119 | 11636 | 2427 | 14042 | 1981 | 15879 | 1598 | 18901 | 946 | 23234 | 665 | 18397 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis

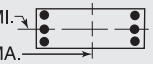



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 2.89 | MA | 10502 | 2681 | 14729 | 2338 | 18343 | 1949 | 20585 | 1631 | 23514 | 1100 | 29850 | 667 | 23142 |
| 6E | | MI | 5464 | 2681 | 8248 | 2227 | 9831 | 1845 | 10795 | 1533 | 12061 | 1018 | 14831 | 555 | 11644 |
| 20-#10 | 2.89 | MA | 10258 | 2681 | 14219 | 2347 | 17637 | 1964 | 19794 | 1642 | 22435 | 1118 | 28396 | 633 | 22657 |
| 7L-5S | | MI | 5605 | 2681 | 8521 | 2212 | 10146 | 1837 | 11200 | 1520 | 12609 | 1008 | 15539 | 615 | 11832 |
| 20-#10 | 2.89 | MA | 9990 | 2681 | 13730 | 2358 | 16981 | 1973 | 18966 | 1657 | 21357 | 1129 | 26982 | 590 | 21841 |
| 8L-4S | | MI | 5725 | 2681 | 8764 | 2202 | 10479 | 1829 | 11612 | 1513 | 13181 | 998 | 16310 | 669 | 12059 |
| 20-#10 | 2.89 | MA | 9694 | 2681 | 13243 | 2368 | 16345 | 1983 | 18163 | 1666 | 20296 | 1146 | 25601 | 546 | 21040 |
| 9L-3S | | MI | 5827 | 2681 | 9037 | 2193 | 10856 | 1814 | 12075 | 1500 | 13813 | 995 | 17083 | 721 | 12098 |
| 20-#10 | 2.89 | MA | 9421 | 2681 | 12743 | 2377 | 15681 | 2001 | 17377 | 1676 | 19203 | 1161 | 24097 | 498 | 20210 |
| 10L-2S | | MI | 6023 | 2681 | 9427 | 2183 | 11352 | 1806 | 12676 | 1494 | 14624 | 985 | 18178 | 813 | 12117 |
| 20-#11 | 3.55 | MA | 10746 | 2849 | 15407 | 2456 | 19061 | 2047 | 21484 | 1698 | 24646 | 1117 | 31479 | 550 | 26839 |
| 7L-5S | | MI | 5834 | 2849 | 9195 | 2303 | 10925 | 1902 | 12109 | 1557 | 13804 | 990 | 16917 | 507 | 13998 |
| 20-#11 | 3.55 | MA | 10428 | 2849 | 14811 | 2469 | 18263 | 2058 | 20477 | 1716 | 23332 | 1129 | 29751 | 494 | 25894 |
| 8L-4S | | MI | 5970 | 2849 | 9489 | 2292 | 11327 | 1894 | 12607 | 1551 | 14494 | 979 | 17821 | 574 | 14373 |
| 20-#11 | 3.55 | MA | 10081 | 2849 | 14225 | 2481 | 17488 | 2070 | 19498 | 1727 | 22039 | 1150 | 28057 | 439 | 24703 |
| 9L-3S | | MI | 6087 | 2849 | 9818 | 2282 | 11782 | 1877 | 13164 | 1536 | 15255 | 977 | 18732 | 635 | 14477 |
| 20-#11 | 3.55 | MA | 9760 | 2849 | 13616 | 2491 | 16679 | 2092 | 18540 | 1738 | 20726 | 1169 | 26220 | 378 | 23542 |
| 10L-2S | | MI | 6311 | 2849 | 10287 | 2271 | 12377 | 1868 | 13885 | 1529 | 16229 | 966 | 20016 | 748 | 14513 |
| 20-#14 | 5.11 | MA | 11526 | 3249 | 17286 | 2749 | 21311 | 2276 | 24130 | 1870 | 28184 | 1145 | 36626 | 282 | 34737 |
| 8L-4S | | MI | 6639 | 3249 | 11167 | 2537 | 13394 | 2075 | 15087 | 1664 | 17819 | 955 | 21960 | 392 | 19671 |
| 20-#14 | 5.11 | MA | 11062 | 3249 | 16452 | 2768 | 20199 | 2293 | 22727 | 1885 | 26329 | 1174 | 34188 | 203 | 32869 |
| 9L-3S | | MI | 6770 | 3249 | 11636 | 2523 | 14042 | 2051 | 15879 | 1643 | 18901 | 954 | 23234 | 478 | 20265 |
| 22-#10 | 3.17 | MA | 10652 | 2755 | 15024 | 2393 | 18658 | 1997 | 21032 | 1663 | 24106 | 1115 | 30710 | 629 | 25023 |
| 7L-6S | | MI | 5637 | 2755 | 8639 | 2273 | 10327 | 1878 | 11396 | 1554 | 12873 | 1015 | 15926 | 547 | 12774 |
| 22-#10 | 3.17 | MA | 10386 | 2755 | 14535 | 2404 | 18003 | 2007 | 20204 | 1678 | 23028 | 1125 | 29296 | 585 | 24210 |
| 8L-5S | | MI | 5776 | 2755 | 8912 | 2258 | 10642 | 1870 | 11801 | 1541 | 13421 | 1005 | 16634 | 607 | 12954 |
| 22-#10 | 3.17 | MA | 10099 | 2755 | 14048 | 2414 | 17366 | 2017 | 19401 | 1687 | 21967 | 1143 | 27915 | 541 | 23402 |
| 9L-4S | | MI | 5894 | 2755 | 9155 | 2248 | 10974 | 1862 | 12213 | 1535 | 13992 | 994 | 17405 | 661 | 13207 |
| 22-#10 | 3.17 | MA | 9835 | 2755 | 13548 | 2423 | 16703 | 2035 | 18615 | 1697 | 20874 | 1157 | 26411 | 493 | 22575 |
| 10L-3S | | MI | 5993 | 2755 | 9427 | 2239 | 11352 | 1848 | 12676 | 1521 | 14624 | 991 | 18178 | 713 | 13251 |
| 22-#10 | 3.17 | MA | 9567 | 2755 | 12985 | 2439 | 16062 | 2045 | 17817 | 1714 | 19771 | 1165 | 25035 | 447 | 21632 |
| 11L-2S | | MI | 6184 | 2755 | 9818 | 2229 | 11848 | 1840 | 13277 | 1515 | 15435 | 981 | 19274 | 805 | 13275 |
| 22-#11 | 3.90 | MA | 10899 | 2940 | 15789 | 2525 | 19504 | 2099 | 21980 | 1742 | 25362 | 1125 | 32561 | 488 | 28757 |
| 8L-5S | | MI | 6033 | 2940 | 9664 | 2360 | 11520 | 1944 | 12830 | 1583 | 14778 | 986 | 18201 | 493 | 15346 |
| 22-#11 | 3.90 | MA | 10564 | 2940 | 15202 | 2538 | 18728 | 2112 | 21002 | 1753 | 24069 | 1146 | 30868 | 433 | 27570 |
| 9L-4S | | MI | 6168 | 2940 | 9958 | 2349 | 11922 | 1935 | 13328 | 1577 | 15468 | 975 | 19105 | 560 | 15706 |
| 22-#11 | 3.90 | MA | 10255 | 2940 | 14594 | 2548 | 17920 | 2133 | 20044 | 1764 | 22756 | 1165 | 29031 | 373 | 26401 |
| 10L-3S | | MI | 6291 | 2940 | 10287 | 2338 | 12377 | 1918 | 13885 | 1562 | 16229 | 973 | 20016 | 621 | 15858 |
| 22-#14 | 5.63 | MA | 11736 | 3380 | 17850 | 2850 | 21974 | 2352 | 24878 | 1923 | 29233 | 1168 | 38208 | 194 | 36946 |
| 9L-4S | | MI | 6909 | 3380 | 11832 | 2619 | 14238 | 2134 | 16110 | 1701 | 19199 | 949 | 23747 | 368 | 21571 |
| 24-#10 | 3.46 | MA | 10776 | 2828 | 15340 | 2450 | 19024 | 2040 | 21443 | 1700 | 24700 | 1122 | 31610 | 580 | 26579 |
| 8L-6S | | MI | 5809 | 2828 | 9030 | 2319 | 10823 | 1912 | 11997 | 1576 | 13684 | 1011 | 17022 | 539 | 13905 |
| 24-#10 | 3.46 | MA | 10497 | 2828 | 14853 | 2460 | 18388 | 2051 | 20639 | 1709 | 23638 | 1139 | 30229 | 536 | 25764 |
| 9L-5S | | MI | 5944 | 2828 | 9302 | 2304 | 11137 | 1904 | 12402 | 1562 | 14232 | 1001 | 17729 | 599 | 14079 |
| 24-#10 | 3.46 | MA | 10242 | 2828 | 14353 | 2469 | 17724 | 2069 | 19853 | 1718 | 22546 | 1154 | 28725 | 488 | 24939 |
| 10L-4S | | MI | 6062 | 2828 | 9546 | 2294 | 11470 | 1896 | 12814 | 1556 | 14804 | 991 | 18500 | 653 | 14355 |
| 24-#10 | 3.46 | MA | 9986 | 2828 | 13790 | 2485 | 17084 | 2078 | 19055 | 1736 | 21443 | 1162 | 27348 | 442 | 23990 |
| 11L-3S | | MI | 6158 | 2828 | 9818 | 2285 | 11848 | 1881 | 13277 | 1543 | 15435 | 988 | 19274 | 705 | 14404 |
| 24-#11 | 4.25 | MA | 11038 | 3030 | 16180 | 2594 | 19969 | 2153 | 22505 | 1779 | 26099 | 1142 | 33679 | 427 | 30436 |
| 9L-5S | | MI | 6230 | 3030 | 10133 | 2416 | 12115 | 1985 | 13551 | 1610 | 15751 | 982 | 19485 | 479 | 16697 |
| 24-#11 | 4.25 | MA | 10740 | 3030 | 15571 | 2604 | 19161 | 2174 | 21547 | 1790 | 24786 | 1160 | 31842 | 367 | 29260 |
| 10L-4S | | MI | 6382 | 3030 | 10427 | 2405 | 12517 | 1976 | 14049 | 1603 | 16441 | 971 | 20388 | 546 | 17042 |

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

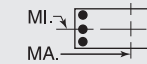



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.73 | MA | 11155 | 2506 | 15484 | 2180 | 19049 | 1824 | 21233 | 1539 | 23953 | 1096 | 29780 | 951 | 15848 |
| 2E | | MI | 5486 | 2506 | 8328 | 2042 | 9711 | 1706 | 10526 | 1436 | 11510 | 1015 | 13341 | 796 | 7563 |
| 6-#11 | 1.01 | MA | 10202 | 2313 | 13194 | 2080 | 16312 | 1754 | 18002 | 1499 | 19668 | 1118 | 23904 | 974 | 9553 |
| 2L-3S | | MI | 4871 | 2313 | 6816 | 1971 | 7938 | 1660 | 8449 | 1417 | 8765 | 1058 | 10105 | 775 | 4753 |
| 6-#11 | 1.01 | MA | 9564 | 2313 | 12160 | 2097 | 14999 | 1769 | 16411 | 1514 | 17521 | 1139 | 20931 | 876 | 9544 |
| 3L-2S | | MI | 5144 | 2313 | 7285 | 1961 | 8533 | 1652 | 9170 | 1410 | 9739 | 1047 | 11389 | 889 | 4728 |
| 6-#14 | 1.46 | MA | 10840 | 2433 | 14603 | 2148 | 18043 | 1802 | 20071 | 1529 | 22436 | 1108 | 27717 | 963 | 13573 |
| 2L-3S | | MI | 5018 | 2433 | 7265 | 2037 | 8458 | 1706 | 9056 | 1443 | 9564 | 1047 | 11077 | 688 | 6593 |
| 6-#14 | 1.46 | MA | 9967 | 2433 | 13123 | 2172 | 16165 | 1825 | 17795 | 1549 | 19363 | 1138 | 23462 | 820 | 13507 |
| 3L-2S | | MI | 5390 | 2433 | 7930 | 2022 | 9302 | 1695 | 10078 | 1435 | 10944 | 1034 | 12865 | 852 | 6568 |
| 6-#18 | 2.60 | MA | 12328 | 2738 | 18074 | 2325 | 22336 | 1930 | 25217 | 1606 | 29331 | 1085 | 37227 | 935 | 23540 |
| 2L-3S | | MI | 5362 | 2738 | 8328 | 2208 | 9711 | 1827 | 10526 | 1512 | 11510 | 1021 | 13341 | 449 | 10917 |
| 6-#18 | 2.60 | MA | 10938 | 2738 | 15484 | 2366 | 19049 | 1968 | 21233 | 1641 | 23953 | 1136 | 29780 | 675 | 23178 |
| 3L-2S | | MI | 5954 | 2738 | 9469 | 2187 | 11159 | 1812 | 12281 | 1503 | 13879 | 1004 | 16296 | 740 | 10987 |
| 8-#10 | 1.10 | MA | 10369 | 2337 | 13395 | 2104 | 16646 | 1772 | 18448 | 1513 | 20307 | 1122 | 24815 | 977 | 10409 |
| 2L-4S | | MI | 4870 | 2337 | 6696 | 2012 | 7823 | 1700 | 8340 | 1450 | 8639 | 1070 | 10099 | 762 | 5162 |
| 8-#10 | 1.10 | MA | 9849 | 2337 | 12545 | 2118 | 15566 | 1786 | 17139 | 1525 | 18540 | 1140 | 22369 | 899 | 10398 |
| 3E | | MI | 5001 | 2337 | 6968 | 2003 | 8200 | 1686 | 8802 | 1437 | 9271 | 1067 | 10872 | 814 | 5149 |
| 8-#10 | 1.10 | MA | 9563 | 2337 | 11970 | 2133 | 14767 | 1806 | 16158 | 1545 | 17197 | 1151 | 20766 | 850 | 10332 |
| 4L-2S | | MI | 5228 | 2337 | 7359 | 1993 | 8696 | 1678 | 9403 | 1430 | 10082 | 1057 | 11968 | 907 | 5132 |
| 8-#11 | 1.35 | MA | 10710 | 2404 | 14228 | 2137 | 17624 | 1795 | 19592 | 1525 | 21816 | 1113 | 26878 | 968 | 12636 |
| 2L-4S | | MI | 4932 | 2404 | 6956 | 2038 | 8078 | 1719 | 8613 | 1458 | 8977 | 1056 | 10478 | 700 | 6176 |
| 8-#11 | 1.35 | MA | 10096 | 2404 | 13194 | 2154 | 16312 | 1811 | 18002 | 1540 | 19668 | 1135 | 23904 | 870 | 12608 |
| 3E | | MI | 5086 | 2404 | 7285 | 2028 | 8533 | 1701 | 9170 | 1443 | 9739 | 1054 | 11389 | 762 | 6170 |
| 8-#11 | 1.35 | MA | 9758 | 2404 | 12494 | 2171 | 15338 | 1835 | 16807 | 1564 | 18033 | 1148 | 21942 | 809 | 12485 |
| 4L-2S | | MI | 5351 | 2404 | 7754 | 2017 | 9128 | 1693 | 9891 | 1436 | 10712 | 1043 | 12673 | 875 | 6152 |
| 8-#14 | 1.95 | MA | 11536 | 2564 | 16083 | 2230 | 19921 | 1862 | 22348 | 1566 | 25509 | 1102 | 31972 | 954 | 17973 |
| 2L-4S | | MI | 5106 | 2564 | 7461 | 2133 | 8655 | 1789 | 9286 | 1501 | 9861 | 1042 | 11591 | 579 | 8507 |
| 8-#14 | 1.95 | MA | 10705 | 2564 | 14603 | 2254 | 18043 | 1885 | 20071 | 1587 | 22436 | 1132 | 27717 | 811 | 17877 |
| 3E | | MI | 5315 | 2564 | 7930 | 2118 | 9302 | 1766 | 10078 | 1480 | 10944 | 1041 | 12865 | 665 | 8572 |
| 8-#14 | 1.95 | MA | 10251 | 2564 | 13599 | 2278 | 16647 | 1919 | 18359 | 1620 | 20092 | 1149 | 24894 | 722 | 17509 |
| 4L-2S | | MI | 5673 | 2564 | 8595 | 2104 | 10146 | 1755 | 11101 | 1473 | 12324 | 1027 | 14653 | 828 | 8569 |
| 8-#18 | 3.46 | MA | 12165 | 2970 | 18074 | 2511 | 22336 | 2074 | 25217 | 1708 | 29331 | 1125 | 37227 | 659 | 30813 |
| 3E | | MI | 5868 | 2970 | 9469 | 2353 | 11159 | 1933 | 12281 | 1579 | 13879 | 1010 | 16296 | 393 | 14248 |
| 8-#18 | 3.46 | MA | 11465 | 2970 | 16310 | 2552 | 19885 | 2134 | 22212 | 1765 | 25217 | 1153 | 32234 | 499 | 27966 |
| 4L-2S | | MI | 6402 | 2970 | 10610 | 2331 | 12607 | 1918 | 14036 | 1570 | 16248 | 992 | 19251 | 683 | 14376 |
| 10-#10 | 1.37 | MA | 10788 | 2410 | 14246 | 2150 | 17726 | 1806 | 19756 | 1534 | 22074 | 1119 | 27261 | 973 | 12943 |
| 2L-5S | | MI | 4932 | 2410 | 6843 | 2068 | 7986 | 1742 | 8528 | 1478 | 8879 | 1077 | 10423 | 700 | 6305 |
| 10-#10 | 1.37 | MA | 10284 | 2410 | 13395 | 2164 | 16646 | 1819 | 18448 | 1547 | 20307 | 1137 | 24815 | 894 | 12920 |
| 3L-4S | | MI | 5056 | 2410 | 7086 | 2058 | 8319 | 1734 | 8941 | 1471 | 9451 | 1066 | 11194 | 754 | 6327 |
| 10-#10 | 1.37 | MA | 10013 | 2410 | 12821 | 2179 | 15847 | 1840 | 17467 | 1566 | 18964 | 1148 | 23212 | 845 | 12842 |
| 4L-3S | | MI | 5182 | 2410 | 7359 | 2049 | 8696 | 1719 | 9403 | 1458 | 10082 | 1063 | 11968 | 806 | 6324 |
| 10-#10 | 1.37 | MA | 9664 | 2410 | 12299 | 2191 | 15150 | 1853 | 16601 | 1579 | 17759 | 1166 | 21480 | 798 | 12644 |
| 5L-2S | | MI | 5403 | 2410 | 7750 | 2039 | 9192 | 1711 | 10004 | 1451 | 10894 | 1053 | 13063 | 899 | 6312 |
| 10-#11 | 1.69 | MA | 11204 | 2494 | 15263 | 2193 | 18937 | 1836 | 21183 | 1551 | 23963 | 1109 | 29851 | 962 | 15712 |
| 2L-5S | | MI | 5009 | 2494 | 7130 | 2106 | 8271 | 1769 | 8836 | 1490 | 9261 | 1062 | 10858 | 620 | 7399 |
| 10-#11 | 1.69 | MA | 10612 | 2494 | 14228 | 2210 | 17624 | 1852 | 19592 | 1566 | 21816 | 1131 | 26878 | 864 | 15670 |
| 3L-4S | | MI | 5150 | 2494 | 7425 | 2095 | 8673 | 1760 | 9334 | 1484 | 9951 | 1051 | 11761 | 687 | 7563 |
| 10-#11 | 1.69 | MA | 10295 | 2494 | 13528 | 2227 | 16651 | 1877 | 18398 | 1590 | 20180 | 1143 | 24915 | 803 | 15531 |
| 4L-3S | | MI | 5297 | 2494 | 7754 | 2084 | 9128 | 1743 | 9891 | 1469 | 10712 | 1049 | 12673 | 748 | 7575 |
| 10-#11 | 1.69 | MA | 9881 | 2494 | 12897 | 2243 | 15801 | 1893 | 17343 | 1605 | 18712 | 1165 | 22910 | 756 | 15029 |
| 5L-2S | | MI | 5555 | 2494 | 8223 | 2074 | 9723 | 1734 | 10613 | 1462 | 11686 | 1038 | 13956 | 861 | 7565 |
| 10-#14 | 2.44 | MA | 11419 | 2694 | 16083 | 2335 | 19921 | 1944 | 22348 | 1625 | 25509 | 1126 | 31972 | 802 | 22248 |
| 3L-4S | | MI | 5409 | 2694 | 8126 | 2214 | 9498 | 1849 | 10308 | 1538 | 11242 | 1036 | 13379 | 555 | 10401 |
| 10-#14 | 2.44 | MA | 11001 | 2694 | 15079 | 2359 | 18526 | 1979 | 20636 | 1658 | 23165 | 1143 | 29149 | 713 | 21873 |
| 4L-3S | | MI | 5606 | 2694 | 8595 | 2200 | 10146 | 1825 | 11101 | 1518 | 12324 | 1035 | 14653 | 641 | 10537 |
| 10-#14 | 2.44 | MA | 10421 | 2694 | 14181 | 2382 | 17307 | 2001 | 19122 | 1679 | 21060 | 1173 | 26269 | 643 | 20352 |
| 5L-2S | | MI | 5951 | 2694 | 9259 | 2185 | 10989 | 1814 | 12123 | 1510 | 13704 | 1021 | 16440 | 804 | 10557 |


## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

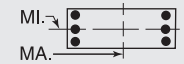

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 4.33 | MA | 12725 | 3202 | 18900 | 2697 | 23173 | 2239 | 26196 | 1832 | 30596 | 1142 | 39681 | 483 | 35549 |
| 4L-3S | | MI | 6340 | 3202 | 10610 | 2498 | 12607 | 2039 | 14036 | 1646 | 16248 | 999 | 19251 | 336 | 17576 |
| 10-#18 | 4.33 | MA | 11748 | 3202 | 17342 | 2738 | 21030 | 2277 | 23535 | 1866 | 26896 | 1193 | 34605 | 351 | 32561 |
| 5L-2S | | MI | 6838 | 3202 | 11751 | 2476 | 14055 | 2024 | 15791 | 1637 | 18617 | 981 | 22206 | 627 | 17749 |
| 12-#10 | 1.65 | MA | 11199 | 2484 | 15097 | 2196 | 18806 | 1839 | 21065 | 1555 | 23840 | 1115 | 29708 | 968 | 15473 |
| 2L-6S | | MI | 4958 | 2484 | 6962 | 2129 | 8167 | 1784 | 8725 | 1512 | 9142 | 1083 | 10811 | 633 | 7214 |
| 12-#10 | 1.65 | MA | 10709 | 2484 | 14246 | 2210 | 17726 | 1853 | 19756 | 1568 | 22074 | 1133 | 27261 | 889 | 15441 |
| 3L-5S | | MI | 5116 | 2484 | 7234 | 2114 | 8482 | 1776 | 9129 | 1499 | 9690 | 1073 | 11519 | 692 | 7443 |
| 12-#10 | 1.65 | MA | 10452 | 2484 | 13672 | 2225 | 16927 | 1873 | 18776 | 1588 | 20730 | 1144 | 25658 | 840 | 15354 |
| 4E | | MI | 5238 | 2484 | 7477 | 2104 | 8815 | 1768 | 9542 | 1492 | 10262 | 1063 | 12290 | 746 | 7485 |
| 12-#10 | 1.65 | MA | 10107 | 2484 | 13149 | 2237 | 16230 | 1887 | 17910 | 1600 | 19526 | 1163 | 23926 | 793 | 15153 |
| 5L-3S | | MI | 5359 | 2484 | 7750 | 2095 | 9192 | 1753 | 10004 | 1479 | 10894 | 1060 | 13063 | 798 | 7493 |
| 12-#10 | 1.65 | MA | 9758 | 2484 | 12516 | 2251 | 15549 | 1898 | 17064 | 1620 | 18350 | 1174 | 22434 | 740 | 14493 |
| 6L-2S | | MI | 5575 | 2484 | 8141 | 2085 | 9688 | 1745 | 10605 | 1473 | 11705 | 1050 | 14158 | 890 | 7486 |
| 12-#11 | 2.03 | MA | 11116 | 2585 | 15263 | 2267 | 18937 | 1893 | 21183 | 1592 | 23963 | 1126 | 29851 | 858 | 18730 |
| 3L-5S | | MI | 5225 | 2585 | 7599 | 2162 | 8866 | 1810 | 9557 | 1516 | 10234 | 1058 | 12141 | 606 | 8721 |
| 12-#11 | 2.03 | MA | 10817 | 2585 | 14562 | 2284 | 17963 | 1918 | 19989 | 1616 | 22327 | 1139 | 27888 | 797 | 18580 |
| 4E | | MI | 5364 | 2585 | 7893 | 2152 | 9268 | 1801 | 10055 | 1510 | 10925 | 1047 | 13045 | 673 | 8945 |
| 12-#11 | 2.03 | MA | 10408 | 2585 | 13931 | 2299 | 17114 | 1934 | 18933 | 1631 | 20859 | 1161 | 25883 | 750 | 18049 |
| 5L-3S | | MI | 5505 | 2585 | 8223 | 2141 | 9723 | 1784 | 10613 | 1495 | 11686 | 1045 | 13956 | 734 | 8970 |
| 12-#11 | 2.03 | MA | 9996 | 2585 | 13160 | 2317 | 16292 | 1948 | 17902 | 1654 | 19426 | 1173 | 23951 | 670 | 17227 |
| 6L-2S | | MI | 5755 | 2585 | 8691 | 2130 | 10318 | 1776 | 11334 | 1488 | 12659 | 1034 | 15240 | 848 | 8970 |
| 12-#14 | 2.92 | MA | 11726 | 2825 | 16559 | 2441 | 20404 | 2039 | 22913 | 1696 | 26238 | 1137 | 33404 | 705 | 26243 |
| 4E | | MI | 5704 | 2825 | 8791 | 2296 | 10342 | 1909 | 11331 | 1576 | 12622 | 1030 | 15166 | 531 | 12251 |
| 12-#14 | 2.92 | MA | 11154 | 2825 | 15661 | 2463 | 19186 | 2061 | 21399 | 1716 | 24133 | 1167 | 30524 | 634 | 24713 |
| 5L-3S | | MI | 5890 | 2825 | 9259 | 2281 | 10989 | 1885 | 12123 | 1556 | 13704 | 1029 | 16440 | 617 | 12496 |
| 12-#14 | 2.92 | MA | 10594 | 2825 | 14557 | 2488 | 18017 | 2081 | 19918 | 1750 | 22078 | 1185 | 27750 | 518 | 23345 |
| 6L-2S | | MI | 6224 | 2825 | 9924 | 2267 | 11833 | 1874 | 13146 | 1548 | 15085 | 1015 | 18228 | 781 | 12533 |
| 12-#18 | 5.19 | MA | 12974 | 3434 | 19933 | 2882 | 24318 | 2383 | 27519 | 1933 | 32274 | 1182 | 42052 | 335 | 40098 |
| 5L-3S | | MI | 6800 | 3434 | 11751 | 2643 | 14055 | 2145 | 15791 | 1713 | 18617 | 988 | 22206 | 279 | 20905 |
| 12-#18 | 5.19 | MA | 12089 | 3434 | 17998 | 2925 | 22296 | 2421 | 24916 | 1990 | 28662 | 1210 | 37163 | 121 | 36257 |
| 6L-2S | | MI | 7268 | 3434 | 12891 | 2621 | 15503 | 2130 | 17546 | 1704 | 20986 | 970 | 25162 | 570 | 21114 |
| 14-#10 | 1.92 | MA | 11126 | 2557 | 15097 | 2256 | 18806 | 1887 | 21065 | 1589 | 23840 | 1130 | 29708 | 885 | 17962 |
| 3L-6S | | MI | 5143 | 2557 | 7352 | 2175 | 8663 | 1817 | 9326 | 1533 | 9953 | 1080 | 11906 | 624 | 8332 |
| 14-#10 | 1.92 | MA | 10881 | 2557 | 14523 | 2271 | 18007 | 1907 | 20085 | 1609 | 22497 | 1141 | 28105 | 835 | 17866 |
| 4L-5S | | MI | 5296 | 2557 | 7625 | 2160 | 8978 | 1809 | 9730 | 1520 | 10501 | 1070 | 12614 | 684 | 8549 |
| 14-#10 | 1.92 | MA | 10539 | 2557 | 14000 | 2283 | 17310 | 1920 | 19219 | 1621 | 21292 | 1159 | 26373 | 788 | 17664 |
| 5L-4S | | MI | 5418 | 2557 | 7868 | 2150 | 9311 | 1801 | 10143 | 1514 | 11073 | 1059 | 13385 | 738 | 8640 |
| 14-#10 | 1.92 | MA | 10202 | 2557 | 13367 | 2297 | 16629 | 1932 | 18373 | 1641 | 20117 | 1170 | 24881 | 735 | 16996 |
| 6L-3S | | MI | 5534 | 2557 | 8141 | 2141 | 9688 | 1786 | 10605 | 1500 | 11705 | 1056 | 14158 | 790 | 8655 |
| 14-#10 | 1.92 | MA | 9910 | 2557 | 12828 | 2307 | 15883 | 1947 | 17532 | 1652 | 18978 | 1188 | 23352 | 702 | 16470 |
| 7L-2S | | MI | 5745 | 2557 | 8531 | 2131 | 10184 | 1778 | 11206 | 1494 | 12516 | 1046 | 15254 | 882 | 8655 |
| 14-#11 | 2.36 | MA | 11327 | 2675 | 15596 | 2340 | 19275 | 1959 | 21580 | 1642 | 24475 | 1135 | 30861 | 791 | 21632 |
| 4L-5S | | MI | 5436 | 2675 | 8068 | 2219 | 9461 | 1851 | 10279 | 1542 | 11208 | 1054 | 13425 | 592 | 10049 |
| 14-#11 | 2.36 | MA | 10922 | 2675 | 14966 | 2356 | 18426 | 1975 | 20524 | 1657 | 23007 | 1156 | 28856 | 744 | 21074 |
| 5L-4S | | MI | 5574 | 2675 | 8362 | 2208 | 9863 | 1843 | 10777 | 1536 | 11898 | 1043 | 14329 | 659 | 10323 |
| 14-#11 | 2.36 | MA | 10525 | 2675 | 14195 | 2373 | 17605 | 1989 | 19492 | 1680 | 21574 | 1169 | 26924 | 664 | 20276 |
| 6L-3S | | MI | 5709 | 2675 | 8691 | 2197 | 10318 | 1825 | 11334 | 1521 | 12659 | 1041 | 15240 | 720 | 10360 |
| 14-#11 | 2.36 | MA | 10180 | 2675 | 13539 | 2385 | 16696 | 2007 | 18479 | 1694 | 20185 | 1190 | 25051 | 623 | 19387 |
| 7L-2S | | MI | 5953 | 2675 | 9160 | 2187 | 10913 | 1817 | 12055 | 1515 | 13633 | 1030 | 16524 | 834 | 10370 |
| 14-#14 | 3.41 | MA | 11866 | 2955 | 17141 | 2545 | 21064 | 2121 | 23675 | 1754 | 27206 | 1161 | 34779 | 626 | 29069 |
| 5L-4S | | MI | 5994 | 2955 | 9456 | 2377 | 11186 | 1968 | 12353 | 1614 | 14002 | 1024 | 16954 | 507 | 14114 |
| 14-#14 | 3.41 | MA | 11332 | 2955 | 16037 | 2570 | 19895 | 2141 | 22195 | 1787 | 25151 | 1179 | 32005 | 509 | 27677 |
| 6L-3S | | MI | 6171 | 2955 | 9924 | 2363 | 11833 | 1945 | 13146 | 1593 | 15085 | 1022 | 18228 | 593 | 14452 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

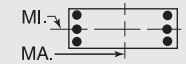



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 3.41 | MA | 10868 | 2955 | 15097 | 2586 | 18594 | 2167 | 20755 | 1807 | 23158 | 1209 | 29307 | 449 | 25888 |
| 7L-2S | | MI | 6493 | 2955 | 10589 | 2349 | 12677 | 1934 | 14168 | 1586 | 16465 | 1009 | 20016 | 757 | 14504 |
| 14-#18 | 6.06 | MA | 13332 | 3665 | 20588 | 3070 | 25584 | 2527 | 28900 | 2057 | 34040 | 1199 | 44610 | 106 | 43823 |
| 6L-3S | | MI | 7251 | 3665 | 12891 | 2788 | 15503 | 2251 | 17546 | 1780 | 20986 | 977 | 25162 | 223 | 24217 |
| 14-#18 | 6.06 | MA | 12610 | 3665 | 18938 | 3097 | 23300 | 2570 | 26392 | 2092 | 30537 | 1249 | 39828 | -4 | 39811 |
| 7L-2S | | MI | 7692 | 3665 | 14032 | 2766 | 16951 | 2236 | 19301 | 1771 | 23355 | 959 | 28117 | 514 | 24474 |
| 16-#10 | 2.20 | MA | 11302 | 2631 | 15374 | 2317 | 19087 | 1941 | 21394 | 1630 | 24264 | 1137 | 30551 | 830 | 20380 |
| 4L-6S | | MI | 5324 | 2631 | 7743 | 2221 | 9159 | 1851 | 9927 | 1555 | 10765 | 1076 | 13002 | 616 | 9453 |
| 16-#10 | 2.20 | MA | 10963 | 2631 | 14851 | 2329 | 18390 | 1954 | 20528 | 1643 | 23059 | 1155 | 28819 | 784 | 20177 |
| 5E | | MI | 5474 | 2631 | 8015 | 2206 | 9474 | 1843 | 10331 | 1541 | 11313 | 1066 | 13709 | 676 | 9660 |
| 16-#10 | 2.20 | MA | 10636 | 2631 | 14218 | 2344 | 17709 | 1965 | 19682 | 1662 | 21884 | 1167 | 27327 | 730 | 19501 |
| 6L-4S | | MI | 5594 | 2631 | 8259 | 2196 | 9807 | 1835 | 10744 | 1535 | 11884 | 1056 | 14480 | 730 | 9792 |
| 16-#10 | 2.20 | MA | 10355 | 2631 | 13679 | 2353 | 16963 | 1980 | 18841 | 1673 | 20745 | 1185 | 25799 | 697 | 18983 |
| 7L-3S | | MI | 5706 | 2631 | 8531 | 2187 | 10184 | 1820 | 11206 | 1522 | 12516 | 1053 | 15254 | 782 | 9815 |
| 16-#10 | 2.20 | MA | 10061 | 2631 | 13163 | 2364 | 16271 | 1990 | 17967 | 1688 | 19608 | 1196 | 24309 | 654 | 18164 |
| 8L-2S | | MI | 5912 | 2631 | 8922 | 2177 | 10680 | 1812 | 11807 | 1515 | 13327 | 1043 | 16349 | 874 | 9822 |
| 16-#11 | 2.70 | MA | 11425 | 2766 | 16000 | 2412 | 19739 | 2017 | 22115 | 1683 | 25154 | 1152 | 31829 | 738 | 24104 |
| 5E | | MI | 5643 | 2766 | 8537 | 2275 | 10056 | 1892 | 11000 | 1569 | 12182 | 1049 | 14709 | 579 | 11384 |
| 16-#11 | 2.70 | MA | 11041 | 2766 | 15229 | 2430 | 18917 | 2031 | 21083 | 1706 | 23721 | 1165 | 29898 | 658 | 23328 |
| 6L-4S | | MI | 5781 | 2766 | 8831 | 2265 | 10458 | 1884 | 11498 | 1562 | 12872 | 1038 | 15613 | 645 | 11700 |
| 16-#11 | 2.70 | MA | 10712 | 2766 | 14573 | 2441 | 18009 | 2049 | 20070 | 1720 | 22332 | 1186 | 28024 | 617 | 22426 |
| 7L-3S | | MI | 5910 | 2766 | 9160 | 2254 | 10913 | 1867 | 12055 | 1547 | 13633 | 1036 | 16524 | 707 | 11746 |
| 16-#11 | 2.70 | MA | 10362 | 2766 | 13944 | 2454 | 17166 | 2060 | 19006 | 1738 | 20946 | 1199 | 26203 | 562 | 21404 |
| 8L-2S | | MI | 6148 | 2766 | 9629 | 2243 | 11508 | 1858 | 12776 | 1541 | 14607 | 1025 | 17807 | 820 | 11764 |
| 16-#14 | 3.90 | MA | 12050 | 3086 | 17517 | 2651 | 21774 | 2201 | 24472 | 1825 | 28224 | 1172 | 36260 | 500 | 32010 |
| 6L-4S | | MI | 6280 | 3086 | 10120 | 2459 | 12029 | 2028 | 13376 | 1651 | 15383 | 1018 | 18742 | 484 | 15989 |
| 16-#14 | 3.90 | MA | 11612 | 3086 | 16577 | 2667 | 20472 | 2226 | 23031 | 1845 | 26231 | 1202 | 33562 | 440 | 30230 |
| 7L-3S | | MI | 6447 | 3086 | 10589 | 2444 | 12677 | 2004 | 14168 | 1631 | 16465 | 1016 | 20016 | 570 | 16405 |
| 16-#14 | 3.90 | MA | 11123 | 3086 | 15675 | 2686 | 19264 | 2242 | 21506 | 1870 | 24243 | 1220 | 30945 | 359 | 28321 |
| 8L-2S | | MI | 6752 | 3086 | 11254 | 2430 | 13520 | 1993 | 15191 | 1623 | 17845 | 1002 | 21803 | 733 | 16470 |
| 16-#18 | 6.93 | MA | 13871 | 3897 | 21528 | 3242 | 26588 | 2676 | 30377 | 2158 | 35915 | 1238 | 47275 | -19 | 47155 |
| 7L-3S | | MI | 7695 | 3897 | 14032 | 2933 | 16951 | 2357 | 19301 | 1847 | 23355 | 966 | 28117 | 166 | 27384 |
| 18-#10 | 2.47 | MA | 11378 | 2705 | 15702 | 2375 | 19470 | 1988 | 21837 | 1664 | 24826 | 1152 | 31265 | 779 | 22686 |
| 5L-6S | | MI | 5502 | 2705 | 8134 | 2267 | 9655 | 1885 | 10528 | 1576 | 11576 | 1073 | 14097 | 608 | 10577 |
| 18-#10 | 2.47 | MA | 11061 | 2705 | 15069 | 2390 | 18789 | 1999 | 20991 | 1684 | 23651 | 1163 | 29773 | 725 | 22008 |
| 6L-5S | | MI | 5649 | 2705 | 8406 | 2252 | 9970 | 1877 | 10932 | 1563 | 12124 | 1063 | 14805 | 668 | 10775 |
| 18-#10 | 2.47 | MA | 10791 | 2705 | 14530 | 2399 | 18043 | 2014 | 20150 | 1694 | 22512 | 1181 | 28245 | 692 | 21496 |
| 7L-4S | | MI | 5769 | 2705 | 8649 | 2242 | 10302 | 1869 | 11345 | 1556 | 12696 | 1052 | 15575 | 722 | 10942 |
| 18-#10 | 2.47 | MA | 10500 | 2705 | 14014 | 2410 | 17351 | 2024 | 19276 | 1709 | 21375 | 1192 | 26755 | 650 | 20669 |
| 8L-3S | | MI | 5877 | 2705 | 8922 | 2233 | 10680 | 1854 | 11807 | 1543 | 13327 | 1049 | 16349 | 774 | 10972 |
| 18-#10 | 2.47 | MA | 10175 | 2705 | 13497 | 2420 | 16679 | 2034 | 18428 | 1719 | 20245 | 1210 | 25214 | 596 | 19884 |
| 9L-2S | | MI | 6078 | 2705 | 9313 | 2223 | 11176 | 1846 | 12408 | 1537 | 14138 | 1039 | 17444 | 866 | 10984 |
| 18-#11 | 3.04 | MA | 11547 | 2856 | 16263 | 2486 | 20230 | 2072 | 22674 | 1732 | 25868 | 1160 | 32871 | 652 | 26381 |
| 6L-5S | | MI | 5848 | 2856 | 9006 | 2332 | 10651 | 1934 | 11721 | 1595 | 13155 | 1045 | 15992 | 565 | 12724 |
| 18-#11 | 3.04 | MA | 11231 | 2856 | 15607 | 2498 | 19321 | 2090 | 21661 | 1746 | 24480 | 1182 | 30997 | 611 | 25464 |
| 7L-4S | | MI | 5985 | 2856 | 9300 | 2321 | 11053 | 1925 | 12219 | 1588 | 13845 | 1034 | 16896 | 632 | 13075 |
| 18-#11 | 3.04 | MA | 10886 | 2856 | 14978 | 2511 | 18479 | 2101 | 20597 | 1764 | 23093 | 1195 | 29177 | 556 | 24446 |
| 8L-3S | | MI | 6109 | 2856 | 9629 | 2310 | 11508 | 1908 | 12776 | 1573 | 14607 | 1032 | 17807 | 693 | 13130 |
| 18-#11 | 3.04 | MA | 10503 | 2856 | 14355 | 2523 | 17660 | 2114 | 19563 | 1775 | 21728 | 1216 | 27396 | 502 | 23249 |
| 9L-2S | | MI | 6341 | 2856 | 10098 | 2300 | 12103 | 1899 | 13498 | 1567 | 15580 | 1021 | 19091 | 806 | 13156 |
| 18-#14 | 4.38 | MA | 12337 | 3216 | 18057 | 2749 | 22351 | 2286 | 25308 | 1882 | 29305 | 1196 | 37817 | 432 | 34572 |
| 7L-4S | | MI | 6561 | 3216 | 10785 | 2540 | 12873 | 2087 | 14398 | 1689 | 16763 | 1011 | 20529 | 460 | 17872 |
| 18-#14 | 4.38 | MA | 11854 | 3216 | 17155 | 2767 | 21142 | 2302 | 23782 | 1908 | 27316 | 1214 | 35200 | 351 | 32649 |
| 8L-3S | | MI | 6727 | 3216 | 11254 | 2526 | 13520 | 2064 | 15191 | 1669 | 17845 | 1010 | 21803 | 546 | 18357 |
| 18-#14 | 4.38 | MA | 11337 | 3216 | 16267 | 2786 | 19968 | 2319 | 22300 | 1923 | 25358 | 1244 | 32636 | 272 | 30755 |
| 9L-2S | | MI | 7009 | 3216 | 11919 | 2512 | 14364 | 2053 | 16213 | 1661 | 19225 | 996 | 23591 | 709 | 18434 |
| 20-#10 | 2.75 | MA | 11479 | 2778 | 15920 | 2436 | 19868 | 2032 | 22299 | 1705 | 25417 | 1160 | 32219 | 720 | 24517 |
| 6E | | MI | 5679 | 2778 | 8524 | 2313 | 10150 | 1918 | 11129 | 1597 | 12387 | 1069 | 15192 | 600 | 11704 |

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

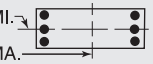



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 2.75 | MA | 11218 | 2778 | 15381 | 2445 | 19123 | 2048 | 21458 | 1715 | 24278 | 1178 | 30691 | 687 | 24008 |
| 7L-5S | | MI | 5822 | 2778 | 8797 | 2298 | 10465 | 1910 | 11533 | 1584 | 12935 | 1059 | 15900 | 660 | 11894 |
| 20-#10 | 2.75 | MA | 10930 | 2778 | 14865 | 2456 | 18431 | 2057 | 20585 | 1731 | 23142 | 1189 | 29202 | 645 | 23174 |
| 8L-4S | | MI | 5941 | 2778 | 9040 | 2288 | 10798 | 1902 | 11946 | 1577 | 13507 | 1049 | 16671 | 714 | 12092 |
| 20-#10 | 2.75 | MA | 10615 | 2778 | 14348 | 2466 | 17759 | 2068 | 19736 | 1740 | 22012 | 1206 | 27660 | 591 | 22381 |
| 9L-3S | | MI | 6045 | 2778 | 9313 | 2279 | 11176 | 1887 | 12408 | 1564 | 14138 | 1046 | 17444 | 766 | 12127 |
| 20-#10 | 2.75 | MA | 10324 | 2778 | 13820 | 2475 | 17059 | 2086 | 18907 | 1750 | 20859 | 1221 | 26166 | 554 | 21486 |
| 10L-2S | | MI | 6242 | 2778 | 9703 | 2269 | 11671 | 1879 | 13009 | 1558 | 14950 | 1036 | 18540 | 858 | 12144 |
| 20-#11 | 3.38 | MA | 11740 | 2947 | 16641 | 2554 | 20634 | 2131 | 23252 | 1772 | 26627 | 1178 | 33970 | 605 | 28503 |
| 7L-5S | | MI | 6050 | 2947 | 9475 | 2388 | 11246 | 1975 | 12442 | 1621 | 14129 | 1041 | 17276 | 551 | 14068 |
| 20-#11 | 3.38 | MA | 11399 | 2947 | 16012 | 2567 | 19791 | 2143 | 22187 | 1790 | 25241 | 1190 | 32150 | 550 | 27487 |
| 8L-4S | | MI | 6186 | 2947 | 9769 | 2378 | 11648 | 1967 | 12940 | 1614 | 14819 | 1030 | 18180 | 618 | 14450 |
| 20-#11 | 3.38 | MA | 11028 | 2947 | 15389 | 2580 | 18972 | 2155 | 21154 | 1801 | 23876 | 1212 | 30370 | 496 | 26282 |
| 9L-3S | | MI | 6305 | 2947 | 10098 | 2367 | 12103 | 1949 | 13498 | 1599 | 15580 | 1028 | 19091 | 679 | 14513 |
| 20-#11 | 3.38 | MA | 10686 | 2947 | 14746 | 2590 | 18119 | 2177 | 20143 | 1813 | 22477 | 1230 | 28434 | 437 | 25110 |
| 10L-2S | | MI | 6532 | 2947 | 10567 | 2356 | 12698 | 1941 | 14219 | 1593 | 16554 | 1017 | 20375 | 793 | 14545 |
| 20-#14 | 4.87 | MA | 12568 | 3347 | 18635 | 2849 | 23021 | 2361 | 26059 | 1946 | 30389 | 1208 | 39456 | 342 | 36976 |
| 8L-4S | | MI | 6856 | 3347 | 11450 | 2622 | 13717 | 2147 | 15421 | 1727 | 18143 | 1005 | 22317 | 436 | 19764 |
| 20-#14 | 4.87 | MA | 12072 | 3347 | 17747 | 2867 | 21846 | 2379 | 24577 | 1961 | 28431 | 1238 | 36891 | 263 | 35070 |
| 9L-3S | | MI | 6991 | 3347 | 11919 | 2608 | 14364 | 2123 | 16213 | 1706 | 19225 | 1004 | 23591 | 522 | 20309 |
| 22-#10 | 3.02 | MA | 11638 | 2852 | 16232 | 2491 | 20202 | 2081 | 22767 | 1737 | 26045 | 1174 | 33137 | 683 | 26521 |
| 7L-6S | | MI | 5853 | 2852 | 8915 | 2359 | 10646 | 1952 | 11730 | 1618 | 13198 | 1066 | 16288 | 592 | 12833 |
| 22-#10 | 3.02 | MA | 11353 | 2852 | 15716 | 2502 | 19511 | 2091 | 21893 | 1752 | 24908 | 1185 | 31648 | 640 | 25678 |
| 8L-5S | | MI | 5992 | 2852 | 9188 | 2344 | 10961 | 1944 | 12134 | 1605 | 13746 | 1056 | 16995 | 652 | 13015 |
| 22-#10 | 3.02 | MA | 11047 | 2852 | 15199 | 2512 | 18839 | 2102 | 21045 | 1761 | 23779 | 1203 | 30106 | 586 | 24878 |
| 9L-4S | | MI | 6111 | 2852 | 9431 | 2334 | 11294 | 1936 | 12547 | 1599 | 14318 | 1045 | 17766 | 705 | 13241 |
| 22-#10 | 3.02 | MA | 10765 | 2852 | 14671 | 2521 | 18139 | 2120 | 20216 | 1771 | 22626 | 1217 | 28612 | 550 | 23986 |
| 10L-3S | | MI | 6212 | 2852 | 9703 | 2325 | 11671 | 1921 | 13009 | 1585 | 14950 | 1042 | 18540 | 757 | 13281 |
| 22-#10 | 3.02 | MA | 10477 | 2852 | 14076 | 2538 | 17458 | 2129 | 19374 | 1789 | 21461 | 1226 | 27162 | 504 | 23035 |
| 11L-2S | | MI | 6405 | 2852 | 10094 | 2315 | 12167 | 1913 | 13610 | 1579 | 15761 | 1032 | 19635 | 850 | 13302 |
| 22-#11 | 3.71 | MA | 11901 | 3037 | 17047 | 2624 | 21103 | 2184 | 23778 | 1816 | 27388 | 1186 | 35123 | 544 | 30529 |
| 8L-5S | | MI | 6250 | 3037 | 9944 | 2445 | 11841 | 2016 | 13164 | 1647 | 15102 | 1036 | 18560 | 537 | 15415 |
| 22-#11 | 3.71 | MA | 11543 | 3037 | 16423 | 2636 | 20285 | 2197 | 22745 | 1827 | 26023 | 1207 | 33343 | 490 | 29315 |
| 9L-4S | | MI | 6385 | 3037 | 10238 | 2434 | 12243 | 2008 | 13662 | 1640 | 15793 | 1026 | 19464 | 604 | 15785 |
| 22-#11 | 3.71 | MA | 11214 | 3037 | 15780 | 2646 | 19431 | 2218 | 21733 | 1839 | 24624 | 1225 | 31407 | 431 | 28135 |
| 10L-3S | | MI | 6500 | 3037 | 10567 | 2423 | 12698 | 1991 | 14219 | 1625 | 16554 | 1023 | 20375 | 666 | 15894 |
| 22-#11 | 3.71 | MA | 10883 | 3037 | 15056 | 2667 | 18611 | 2230 | 20707 | 1860 | 23205 | 1235 | 29635 | 374 | 26931 |
| 11L-2S | | MI | 6720 | 3037 | 11036 | 2413 | 13293 | 1982 | 14940 | 1619 | 17527 | 1013 | 21658 | 779 | 15932 |
| 22-#14 | 5.36 | MA | 12791 | 3477 | 19227 | 2949 | 23725 | 2438 | 26854 | 1998 | 31504 | 1231 | 41147 | 255 | 39385 |
| 9L-4S | | MI | 7127 | 3477 | 12115 | 2703 | 14560 | 2207 | 16443 | 1764 | 19523 | 999 | 24105 | 412 | 21662 |
| 24-#10 | 3.30 | MA | 11768 | 2926 | 16567 | 2548 | 20590 | 2125 | 23202 | 1773 | 26675 | 1182 | 34094 | 635 | 28183 |
| 8L-6S | | MI | 6024 | 2926 | 9306 | 2405 | 11142 | 1985 | 12331 | 1640 | 14010 | 1062 | 17383 | 584 | 13963 |
| 24-#10 | 3.30 | MA | 11471 | 2926 | 16050 | 2558 | 19919 | 2135 | 22354 | 1783 | 25546 | 1199 | 32552 | 582 | 27375 |
| 9L-5S | | MI | 6161 | 2926 | 9578 | 2390 | 11457 | 1978 | 12735 | 1626 | 14557 | 1052 | 18091 | 643 | 14140 |
| 24-#10 | 3.30 | MA | 11198 | 2926 | 15522 | 2567 | 19219 | 2153 | 21524 | 1793 | 24392 | 1214 | 31058 | 545 | 26486 |
| 10L-4S | | MI | 6279 | 2926 | 9822 | 2380 | 11790 | 1970 | 13148 | 1620 | 15129 | 1042 | 18861 | 697 | 14390 |
| 24-#10 | 3.30 | MA | 10916 | 2926 | 14927 | 2584 | 18538 | 2163 | 20683 | 1810 | 23228 | 1222 | 29608 | 500 | 25529 |
| 11L-3S | | MI | 6377 | 2926 | 10094 | 2371 | 12167 | 1955 | 13610 | 1607 | 15761 | 1039 | 19635 | 749 | 14434 |
| 24-#10 | 3.30 | MA | 10599 | 2926 | 14416 | 2594 | 17858 | 2172 | 19868 | 1821 | 22092 | 1239 | 28139 | 462 | 24561 |
| 12L-2S | | MI | 6566 | 2926 | 10485 | 2361 | 12663 | 1947 | 14211 | 1600 | 16572 | 1029 | 20730 | 842 | 14460 |
| 24-#11 | 4.05 | MA | 12048 | 3127 | 17457 | 2693 | 21597 | 2238 | 24335 | 1853 | 28170 | 1203 | 36316 | 484 | 32347 |
| 9L-5S | | MI | 6448 | 3127 | 10413 | 2501 | 12436 | 2058 | 13885 | 1673 | 16076 | 1032 | 19843 | 524 | 16766 |
| 24-#11 | 4.05 | MA | 11731 | 3127 | 16814 | 2703 | 20744 | 2260 | 23324 | 1865 | 26771 | 1221 | 34380 | 425 | 31160 |
| 10L-4S | | MI | 6583 | 3127 | 10707 | 2491 | 12838 | 2049 | 14383 | 1667 | 16766 | 1021 | 20747 | 590 | 17120 |
| 24-#11 | 4.05 | MA | 11405 | 3127 | 16090 | 2723 | 19923 | 2272 | 22298 | 1886 | 25353 | 1231 | 32608 | 368 | 29960 |
| 11L-3S | | MI | 6701 | 3127 | 11036 | 2480 | 13293 | 2032 | 14940 | 1652 | 17527 | 1019 | 21658 | 652 | 17275 |

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

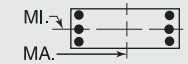



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.65 | MA | 12162 | 2603 | 16701 | 2277 | 20597 | 1907 | 22960 | 1612 | 25853 | 1154 | 32101 | 1001 | 16712 |
| 2E | | MI | 5702 | 2603 | 8615 | 2125 | 10036 | 1777 | 10861 | 1498 | 11832 | 1064 | 13694 | 840 | 7594 |
| 6-#14 | 1.39 | MA | 11823 | 2531 | 15767 | 2245 | 19529 | 1885 | 21727 | 1601 | 24242 | 1166 | 29911 | 1013 | 14302 |
| 2L-3S | | MI | 5232 | 2531 | 7548 | 2121 | 8781 | 1778 | 9389 | 1506 | 9888 | 1097 | 11435 | 732 | 6621 |
| 6-#14 | 1.39 | MA | 10893 | 2531 | 14205 | 2270 | 17547 | 1908 | 19325 | 1622 | 21000 | 1196 | 25422 | 872 | 14236 |
| 3L-2S | | MI | 5606 | 2531 | 8212 | 2107 | 9624 | 1767 | 10412 | 1498 | 11268 | 1084 | 13222 | 896 | 6594 |
| 6-#18 | 2.48 | MA | 13413 | 2835 | 19437 | 2422 | 24068 | 2013 | 27167 | 1678 | 31533 | 1143 | 39965 | 986 | 24836 |
| 2L-3S | | MI | 5575 | 2835 | 8615 | 2292 | 10036 | 1898 | 10861 | 1574 | 11832 | 1071 | 13694 | 492 | 10968 |
| 6-#18 | 2.48 | MA | 11930 | 2835 | 16701 | 2464 | 20597 | 2052 | 22960 | 1714 | 25853 | 1195 | 32101 | 728 | 24474 |
| 3L-2S | | MI | 6172 | 2835 | 9756 | 2270 | 11484 | 1883 | 12616 | 1565 | 14201 | 1053 | 16650 | 783 | 11023 |
| 8-#10 | 1.05 | MA | 11318 | 2434 | 14489 | 2201 | 18051 | 1855 | 20008 | 1585 | 21988 | 1180 | 26839 | 1028 | 10958 |
| 2L-4S | | MI | 5084 | 2434 | 6972 | 2098 | 8143 | 1774 | 8673 | 1514 | 8965 | 1121 | 10460 | 807 | 5184 |
| 8-#10 | 1.05 | MA | 10765 | 2434 | 13592 | 2216 | 16912 | 1869 | 18628 | 1598 | 20126 | 1198 | 24260 | 951 | 10946 |
| 3E | | MI | 5215 | 2434 | 7244 | 2089 | 8520 | 1759 | 9135 | 1501 | 9597 | 1118 | 11234 | 859 | 5168 |
| 8-#10 | 1.05 | MA | 10462 | 2434 | 12987 | 2230 | 16071 | 1890 | 17596 | 1618 | 18712 | 1210 | 22577 | 901 | 10880 |
| 4L-2S | | MI | 5443 | 2434 | 7635 | 2079 | 9016 | 1751 | 9736 | 1494 | 10408 | 1108 | 12329 | 951 | 5151 |
| 8-#11 | 1.29 | MA | 11682 | 2501 | 15370 | 2234 | 19085 | 1878 | 21218 | 1597 | 23584 | 1171 | 29020 | 1019 | 13310 |
| 2L-4S | | MI | 5146 | 2501 | 7235 | 2124 | 8399 | 1791 | 8947 | 1521 | 9302 | 1106 | 10837 | 745 | 6206 |
| 8-#11 | 1.29 | MA | 11029 | 2501 | 14279 | 2251 | 17701 | 1894 | 19541 | 1613 | 21319 | 1193 | 25884 | 922 | 13282 |
| 3E | | MI | 5301 | 2501 | 7565 | 2113 | 8854 | 1774 | 9504 | 1506 | 10063 | 1104 | 11748 | 806 | 6195 |
| 8-#11 | 1.29 | MA | 10670 | 2501 | 13542 | 2268 | 16675 | 1919 | 18283 | 1637 | 19597 | 1206 | 23824 | 861 | 13159 |
| 4L-2S | | MI | 5567 | 2501 | 8034 | 2102 | 9449 | 1766 | 10225 | 1500 | 11037 | 1093 | 13031 | 919 | 6175 |
| 8-#14 | 1.86 | MA | 12564 | 2661 | 17329 | 2327 | 21511 | 1945 | 24129 | 1638 | 27485 | 1159 | 34401 | 1004 | 18945 |
| 2L-4S | | MI | 5319 | 2661 | 7744 | 2217 | 8977 | 1862 | 9620 | 1564 | 10185 | 1092 | 11948 | 623 | 8553 |
| 8-#14 | 1.86 | MA | 11679 | 2661 | 15767 | 2351 | 19529 | 1968 | 21727 | 1660 | 24242 | 1190 | 29911 | 863 | 18849 |
| 3E | | MI | 5530 | 2661 | 8212 | 2203 | 9624 | 1838 | 10412 | 1543 | 11268 | 1091 | 13222 | 709 | 8605 |
| 8-#14 | 1.86 | MA | 11196 | 2661 | 14710 | 2376 | 18059 | 2003 | 19923 | 1694 | 21773 | 1209 | 26947 | 775 | 18481 |
| 4L-2S | | MI | 5890 | 2661 | 8877 | 2189 | 10468 | 1827 | 11434 | 1536 | 12648 | 1077 | 15010 | 872 | 8597 |
| 8-#18 | 3.31 | MA | 13236 | 3067 | 19437 | 2609 | 24068 | 2158 | 27167 | 1781 | 31533 | 1184 | 39965 | 713 | 32541 |
| 3E | | MI | 6083 | 3067 | 9756 | 2437 | 11484 | 2004 | 12616 | 1641 | 14201 | 1060 | 16650 | 436 | 14304 |
| 8-#18 | 3.31 | MA | 12490 | 3067 | 17577 | 2651 | 21485 | 2219 | 23999 | 1839 | 27194 | 1214 | 34721 | 554 | 29699 |
| 4L-2S | | MI | 6623 | 3067 | 10897 | 2415 | 12932 | 1989 | 14370 | 1632 | 16570 | 1042 | 19605 | 727 | 14417 |
| 10-#10 | 1.31 | MA | 11763 | 2507 | 15386 | 2247 | 19189 | 1889 | 21387 | 1606 | 23850 | 1176 | 29417 | 1023 | 13629 |
| 2L-5S | | MI | 5146 | 2507 | 7119 | 2154 | 8306 | 1816 | 8862 | 1542 | 9204 | 1128 | 10785 | 745 | 6337 |
| 10-#10 | 1.31 | MA | 11227 | 2507 | 14489 | 2262 | 18051 | 1902 | 20008 | 1619 | 21988 | 1195 | 26839 | 946 | 13606 |
| 3L-4S | | MI | 5270 | 2507 | 7362 | 2144 | 8639 | 1808 | 9274 | 1535 | 9776 | 1117 | 11555 | 799 | 6352 |
| 10-#10 | 1.31 | MA | 10939 | 2507 | 13884 | 2276 | 17209 | 1923 | 18975 | 1639 | 20574 | 1206 | 25156 | 896 | 13528 |
| 4L-3S | | MI | 5396 | 2507 | 7635 | 2135 | 9016 | 1793 | 9736 | 1522 | 10408 | 1114 | 12329 | 851 | 6346 |
| 10-#10 | 1.31 | MA | 10567 | 2507 | 13332 | 2289 | 16476 | 1937 | 18064 | 1652 | 19306 | 1225 | 23335 | 851 | 13330 |
| 5L-2S | | MI | 5619 | 2507 | 8026 | 2125 | 9512 | 1785 | 10337 | 1516 | 11219 | 1104 | 13424 | 943 | 6332 |
| 10-#11 | 1.61 | MA | 12209 | 2592 | 16460 | 2290 | 20469 | 1919 | 22896 | 1624 | 25849 | 1167 | 32156 | 1013 | 16555 |
| 2L-5S | | MI | 5223 | 2592 | 7410 | 2191 | 8592 | 1841 | 9170 | 1554 | 9585 | 1113 | 11216 | 664 | 7474 |
| 10-#11 | 1.61 | MA | 11578 | 2592 | 15370 | 2308 | 19085 | 1935 | 21218 | 1639 | 23584 | 1189 | 29020 | 916 | 16512 |
| 3L-4S | | MI | 5364 | 2592 | 7704 | 2180 | 8994 | 1833 | 9668 | 1547 | 10276 | 1102 | 12120 | 731 | 7596 |
| 10-#11 | 1.61 | MA | 11241 | 2592 | 14632 | 2325 | 18060 | 1960 | 19961 | 1663 | 21861 | 1202 | 26960 | 855 | 16374 |
| 4L-3S | | MI | 5512 | 2592 | 8034 | 2170 | 9449 | 1815 | 10225 | 1532 | 11037 | 1100 | 13031 | 792 | 7602 |
| 10-#11 | 1.61 | MA | 10798 | 2592 | 13964 | 2340 | 17166 | 1977 | 18849 | 1678 | 20315 | 1224 | 24736 | 797 | 15925 |
| 5L-2S | | MI | 5771 | 2592 | 8502 | 2159 | 10044 | 1807 | 10946 | 1526 | 12010 | 1089 | 14315 | 906 | 7589 |
| 10-#14 | 2.32 | MA | 12439 | 2792 | 17329 | 2433 | 21511 | 2028 | 24129 | 1698 | 27485 | 1184 | 34401 | 855 | 23463 |
| 3L-4S | | MI | 5622 | 2792 | 8409 | 2299 | 9821 | 1921 | 10642 | 1601 | 11566 | 1086 | 13736 | 599 | 10495 |
| 10-#14 | 2.32 | MA | 11993 | 2792 | 16271 | 2457 | 20041 | 2063 | 22325 | 1731 | 25015 | 1202 | 31436 | 766 | 23088 |
| 4L-3S | | MI | 5821 | 2792 | 8877 | 2285 | 10468 | 1898 | 11434 | 1581 | 12648 | 1085 | 15010 | 685 | 10573 |
| 10-#14 | 2.32 | MA | 11373 | 2792 | 15319 | 2480 | 18758 | 2086 | 20731 | 1753 | 22798 | 1233 | 28407 | 697 | 21561 |
| 5L-2S | | MI | 6169 | 2792 | 9542 | 2270 | 11312 | 1887 | 12457 | 1573 | 14028 | 1071 | 16798 | 848 | 10587 |
| 10-#18 | 4.13 | MA | 13830 | 3299 | 20313 | 2796 | 24956 | 2324 | 28206 | 1906 | 32874 | 1203 | 42584 | 538 | 37707 |
| 4L-3S | | MI | 6556 | 3299 | 10897 | 2581 | 12932 | 2110 | 14370 | 1708 | 16570 | 1049 | 19605 | 379 | 17634 |
| 10-#18 | 4.13 | MA | 12784 | 3299 | 18660 | 2836 | 22699 | 2363 | 25402 | 1942 | 28975 | 1255 | 37243 | 409 | 34688 |
| 5L-2S | | MI | 7061 | 3299 | 12038 | 2560 | 14379 | 2095 | 16125 | 1699 | 18939 | 1031 | 22560 | 670 | 17792 |

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.57 | MA | 12200 | 2581 | 16283 | 2293 | 20327 | 1922 | 22767 | 1628 | 25713 | 1173 | 31996 | 1018 | 16296 |
| 2L-6S | | MI | 5172 | 2581 | 7238 | 2215 | 8487 | 1857 | 9058 | 1576 | 9468 | 1134 | 11172 | 677 | 7274 |
| 12-#10 | 1.57 | MA | 11680 | 2581 | 15386 | 2308 | 19189 | 1936 | 21387 | 1640 | 23850 | 1191 | 29417 | 941 | 16264 |
| 3L-5S | | MI | 5330 | 2581 | 7510 | 2200 | 8802 | 1849 | 9463 | 1563 | 10016 | 1124 | 11880 | 737 | 7486 |
| 12-#10 | 1.57 | MA | 11405 | 2581 | 14781 | 2322 | 18348 | 1957 | 20355 | 1660 | 22436 | 1203 | 27735 | 892 | 16176 |
| 4E | | MI | 5453 | 2581 | 7753 | 2190 | 9134 | 1841 | 9875 | 1556 | 10587 | 1114 | 12651 | 791 | 7513 |
| 12-#10 | 1.57 | MA | 11037 | 2581 | 14229 | 2335 | 17615 | 1971 | 19444 | 1673 | 21168 | 1221 | 25914 | 846 | 15976 |
| 5L-3S | | MI | 5574 | 2581 | 8026 | 2181 | 9512 | 1826 | 10337 | 1543 | 11219 | 1111 | 13424 | 843 | 7516 |
| 12-#10 | 1.57 | MA | 10668 | 2581 | 13561 | 2349 | 16893 | 1981 | 18554 | 1693 | 19932 | 1233 | 24346 | 793 | 15323 |
| 6L-2S | | MI | 5792 | 2581 | 8417 | 2171 | 10008 | 1818 | 10938 | 1537 | 12030 | 1101 | 14520 | 935 | 7508 |
| 12-#11 | 1.93 | MA | 12115 | 2682 | 16460 | 2364 | 20469 | 1977 | 22896 | 1665 | 25849 | 1184 | 32156 | 910 | 19741 |
| 3L-5S | | MI | 5439 | 2682 | 7879 | 2248 | 9187 | 1883 | 9891 | 1580 | 10559 | 1108 | 12500 | 650 | 8794 |
| 12-#11 | 1.93 | MA | 11796 | 2682 | 15723 | 2382 | 19444 | 2002 | 21638 | 1689 | 24126 | 1198 | 30095 | 849 | 19591 |
| 4E | | MI | 5578 | 2682 | 8173 | 2237 | 9589 | 1874 | 10389 | 1573 | 11249 | 1098 | 13404 | 717 | 8980 |
| 12-#11 | 1.93 | MA | 11359 | 2682 | 15055 | 2397 | 18550 | 2018 | 20527 | 1704 | 22580 | 1220 | 27872 | 791 | 19114 |
| 5L-3S | | MI | 5720 | 2682 | 8502 | 2226 | 10044 | 1857 | 10946 | 1558 | 12010 | 1095 | 14315 | 778 | 9000 |
| 12-#11 | 1.93 | MA | 10921 | 2682 | 14242 | 2415 | 17679 | 2032 | 19441 | 1728 | 21072 | 1233 | 25956 | 724 | 18222 |
| 6L-2S | | MI | 5972 | 2682 | 8971 | 2215 | 10639 | 1848 | 11667 | 1552 | 12984 | 1085 | 15599 | 892 | 8996 |
| 12-#14 | 2.79 | MA | 12764 | 2922 | 17833 | 2539 | 22023 | 2123 | 24727 | 1769 | 28257 | 1196 | 35926 | 757 | 27701 |
| 4E | | MI | 5918 | 2922 | 9074 | 2380 | 10664 | 1981 | 11665 | 1639 | 12946 | 1080 | 15524 | 575 | 12351 |
| 12-#14 | 2.79 | MA | 12153 | 2922 | 16881 | 2561 | 20740 | 2146 | 23133 | 1791 | 26040 | 1227 | 32896 | 689 | 26158 |
| 5L-3S | | MI | 6106 | 2922 | 9542 | 2366 | 11312 | 1957 | 12457 | 1619 | 14028 | 1079 | 16798 | 661 | 12535 |
| 12-#14 | 2.79 | MA | 11557 | 2922 | 15716 | 2586 | 19500 | 2166 | 21575 | 1824 | 23876 | 1245 | 29979 | 574 | 24813 |
| 6L-2S | | MI | 6443 | 2922 | 10207 | 2352 | 12155 | 1946 | 13479 | 1611 | 15409 | 1065 | 18585 | 825 | 12566 |
| 12-#18 | 4.96 | MA | 14088 | 3531 | 21395 | 2981 | 26170 | 2469 | 29609 | 2009 | 34654 | 1244 | 45107 | 394 | 42665 |
| 5L-3S | | MI | 7017 | 3531 | 12038 | 2726 | 14379 | 2216 | 16125 | 1775 | 18939 | 1038 | 22560 | 323 | 20965 |
| 12-#18 | 4.96 | MA | 13145 | 3531 | 19353 | 3024 | 24023 | 2506 | 26867 | 2067 | 30848 | 1274 | 39963 | 183 | 38522 |
| 6L-2S | | MI | 7492 | 3531 | 13179 | 2705 | 15827 | 2201 | 17880 | 1766 | 21308 | 1020 | 25516 | 613 | 21159 |
| 14-#10 | 1.84 | MA | 12122 | 2655 | 16283 | 2354 | 20327 | 1970 | 22767 | 1662 | 25713 | 1188 | 31996 | 936 | 18922 |
| 3L-6S | | MI | 5356 | 2655 | 7628 | 2261 | 8983 | 1891 | 9659 | 1597 | 10279 | 1131 | 12268 | 669 | 8391 |
| 14-#10 | 1.84 | MA | 11861 | 2655 | 15678 | 2368 | 19486 | 1990 | 21735 | 1682 | 24299 | 1199 | 30313 | 887 | 18826 |
| 4L-5S | | MI | 5511 | 2655 | 7901 | 2246 | 9298 | 1883 | 10064 | 1584 | 10827 | 1121 | 12975 | 729 | 8611 |
| 14-#10 | 1.84 | MA | 11497 | 2655 | 15126 | 2381 | 18753 | 2004 | 20824 | 1695 | 23031 | 1218 | 28492 | 841 | 18624 |
| 5L-4S | | MI | 5632 | 2655 | 8144 | 2236 | 9630 | 1875 | 10476 | 1578 | 11399 | 1110 | 13746 | 783 | 8669 |
| 14-#10 | 1.84 | MA | 11139 | 2655 | 14458 | 2395 | 18031 | 2015 | 19933 | 1715 | 21794 | 1229 | 26924 | 788 | 17964 |
| 6L-3S | | MI | 5750 | 2655 | 8417 | 2227 | 10008 | 1860 | 10938 | 1564 | 12030 | 1107 | 14520 | 835 | 8681 |
| 14-#10 | 1.84 | MA | 10829 | 2655 | 13891 | 2405 | 17246 | 2031 | 19042 | 1725 | 20596 | 1248 | 25322 | 756 | 17399 |
| 7L-2S | | MI | 5962 | 2655 | 8807 | 2217 | 10503 | 1852 | 11539 | 1558 | 12842 | 1097 | 15615 | 927 | 8678 |
| 14-#11 | 2.26 | MA | 12338 | 2772 | 16814 | 2438 | 20828 | 2043 | 23316 | 1715 | 26391 | 1193 | 33231 | 843 | 22811 |
| 4L-5S | | MI | 5650 | 2772 | 8348 | 2304 | 9782 | 1924 | 10612 | 1606 | 11533 | 1104 | 13784 | 637 | 10121 |
| 14-#11 | 2.26 | MA | 11905 | 2772 | 16146 | 2453 | 19934 | 2059 | 22205 | 1730 | 24845 | 1215 | 31007 | 785 | 22308 |
| 5L-4S | | MI | 5789 | 2772 | 8642 | 2293 | 10184 | 1915 | 11110 | 1599 | 12223 | 1093 | 14688 | 703 | 10360 |
| 14-#11 | 2.26 | MA | 11483 | 2772 | 15333 | 2471 | 19063 | 2073 | 21119 | 1754 | 23337 | 1229 | 29091 | 719 | 21440 |
| 6L-3S | | MI | 5925 | 2772 | 8971 | 2283 | 10639 | 1898 | 11667 | 1584 | 12984 | 1091 | 15599 | 765 | 10391 |
| 14-#11 | 2.26 | MA | 11117 | 2772 | 14642 | 2483 | 18106 | 2091 | 20045 | 1767 | 21875 | 1250 | 27126 | 678 | 20563 |
| 7L-2S | | MI | 6170 | 2772 | 9440 | 2272 | 11234 | 1890 | 12389 | 1578 | 13958 | 1080 | 16883 | 878 | 10398 |
| 14-#14 | 3.25 | MA | 12910 | 3052 | 18442 | 2643 | 22722 | 2205 | 25535 | 1828 | 29282 | 1221 | 37386 | 680 | 30754 |
| 5L-4S | | MI | 6209 | 3052 | 9738 | 2462 | 11508 | 2040 | 12687 | 1677 | 14326 | 1074 | 17311 | 551 | 14212 |
| 14-#14 | 3.25 | MA | 12341 | 3052 | 17278 | 2668 | 21482 | 2225 | 23977 | 1862 | 27118 | 1239 | 34468 | 565 | 29385 |
| 6L-3S | | MI | 6387 | 3052 | 10207 | 2448 | 12155 | 2017 | 13479 | 1656 | 15409 | 1073 | 18585 | 637 | 14492 |
| 14-#14 | 3.25 | MA | 11848 | 3052 | 16288 | 2685 | 20111 | 2251 | 22448 | 1881 | 25021 | 1270 | 31638 | 506 | 27460 |
| 7L-2S | | MI | 6713 | 3052 | 10872 | 2433 | 12999 | 2006 | 14502 | 1649 | 16789 | 1059 | 20373 | 801 | 14538 |
| 14-#18 | 5.79 | MA | 14466 | 3763 | 22088 | 3169 | 27494 | 2612 | 31075 | 2134 | 36527 | 1263 | 47826 | 168 | 46513 |
| 6L-3S | | MI | 7469 | 3763 | 13179 | 2871 | 15827 | 2322 | 17880 | 1842 | 21308 | 1027 | 25516 | 266 | 24296 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

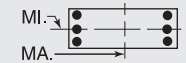
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 5.79 | MA | 13697 | 3763 | 20348 | 3197 | 25086 | 2657 | 28431 | 2170 | 32837 | 1315 | 42808 | 60 | 42425 |
| 7L-2S | | MI | 7917 | 3763 | 14320 | 2850 | 17275 | 2307 | 19635 | 1833 | 23677 | 1009 | 28471 | 557 | 24520 |
| 16-#10 | 2.10 | MA | 12308 | 2728 | 16575 | 2414 | 20624 | 2024 | 23114 | 1703 | 26161 | 1196 | 32892 | 882 | 21477 |
| 4L-6S | | MI | 5538 | 2728 | 8019 | 2307 | 9478 | 1924 | 10260 | 1619 | 11090 | 1127 | 13363 | 661 | 9512 |
| 16-#10 | 2.10 | MA | 11947 | 2728 | 16023 | 2427 | 19891 | 2038 | 22203 | 1716 | 24893 | 1214 | 31071 | 836 | 21275 |
| 5E | | MI | 5689 | 2728 | 8291 | 2292 | 9793 | 1916 | 10665 | 1605 | 11638 | 1117 | 14070 | 721 | 9721 |
| 16-#10 | 2.10 | MA | 11600 | 2728 | 15355 | 2441 | 19170 | 2049 | 21313 | 1736 | 23656 | 1226 | 29503 | 784 | 20606 |
| 6L-4S | | MI | 5810 | 2728 | 8535 | 2282 | 10126 | 1909 | 11077 | 1599 | 12210 | 1107 | 14841 | 775 | 9822 |
| 16-#10 | 2.10 | MA | 11301 | 2728 | 14788 | 2451 | 18384 | 2064 | 20422 | 1746 | 22458 | 1244 | 27900 | 751 | 20049 |
| 7L-3S | | MI | 5923 | 2728 | 8807 | 2273 | 10503 | 1894 | 11539 | 1586 | 12842 | 1104 | 15615 | 827 | 9841 |
| 16-#10 | 2.10 | MA | 10987 | 2728 | 14245 | 2462 | 17656 | 2074 | 19502 | 1762 | 21262 | 1255 | 26335 | 709 | 19233 |
| 8L-2S | | MI | 6130 | 2728 | 9198 | 2263 | 10999 | 1886 | 12140 | 1579 | 13653 | 1094 | 16710 | 919 | 9846 |
| 16-#11 | 2.58 | MA | 12440 | 2863 | 17237 | 2510 | 21318 | 2101 | 23883 | 1756 | 27109 | 1211 | 34143 | 779 | 25506 |
| 5E | | MI | 5859 | 2863 | 8817 | 2361 | 10377 | 1965 | 11333 | 1632 | 12506 | 1100 | 15068 | 623 | 11455 |
| 16-#11 | 2.58 | MA | 12032 | 2863 | 16424 | 2528 | 20447 | 2114 | 22797 | 1780 | 25601 | 1224 | 32227 | 713 | 24661 |
| 6L-4S | | MI | 5996 | 2863 | 9111 | 2350 | 10779 | 1957 | 11832 | 1626 | 13196 | 1089 | 15971 | 690 | 11739 |
| 16-#11 | 2.58 | MA | 11682 | 2863 | 15733 | 2539 | 19491 | 2133 | 21722 | 1793 | 24139 | 1246 | 30262 | 672 | 23768 |
| 7L-3S | | MI | 6127 | 2863 | 9440 | 2339 | 11234 | 1939 | 12389 | 1610 | 13958 | 1087 | 16883 | 751 | 11779 |
| 16-#11 | 2.58 | MA | 11308 | 2863 | 15071 | 2553 | 18603 | 2144 | 20601 | 1812 | 22680 | 1259 | 28348 | 618 | 22673 |
| 8L-2S | | MI | 6366 | 2863 | 9909 | 2328 | 11829 | 1931 | 13110 | 1604 | 14931 | 1076 | 18166 | 864 | 11794 |
| 16-#14 | 3.72 | MA | 13105 | 3183 | 18840 | 2749 | 23464 | 2285 | 26379 | 1900 | 30361 | 1233 | 38958 | 557 | 33956 |
| 6L-4S | | MI | 6495 | 3183 | 10403 | 2543 | 12352 | 2100 | 13710 | 1714 | 15706 | 1068 | 19099 | 528 | 16084 |
| 16-#14 | 3.72 | MA | 12638 | 3183 | 17849 | 2766 | 22092 | 2311 | 24850 | 1919 | 28263 | 1264 | 36127 | 497 | 32041 |
| 7L-3S | | MI | 6664 | 3183 | 10872 | 2529 | 12999 | 2076 | 14502 | 1694 | 16789 | 1066 | 20373 | 614 | 16447 |
| 16-#14 | 3.72 | MA | 12115 | 3183 | 16899 | 2785 | 20819 | 2327 | 23243 | 1945 | 26170 | 1282 | 33377 | 418 | 30103 |
| 8L-2S | | MI | 6975 | 3183 | 11536 | 2515 | 13843 | 2065 | 15525 | 1686 | 18169 | 1053 | 22160 | 777 | 16506 |
| 16-#18 | 6.61 | MA | 15036 | 3995 | 23084 | 3342 | 28558 | 2763 | 32638 | 2237 | 38516 | 1303 | 50672 | 44 | 50387 |
| 7L-3S | | MI | 7914 | 3995 | 14320 | 3016 | 17275 | 2428 | 19635 | 1909 | 23677 | 1016 | 28471 | 210 | 27542 |
| 18-#10 | 2.36 | MA | 12388 | 2802 | 16920 | 2473 | 21030 | 2071 | 23583 | 1737 | 26755 | 1211 | 33649 | 831 | 23926 |
| 5L-6S | | MI | 5717 | 2802 | 8410 | 2353 | 9974 | 1958 | 10861 | 1640 | 11901 | 1124 | 14458 | 653 | 10635 |
| 18-#10 | 2.36 | MA | 12051 | 2802 | 16252 | 2487 | 20308 | 2082 | 22693 | 1757 | 25519 | 1222 | 32081 | 779 | 23251 |
| 6L-5S | | MI | 5864 | 2802 | 8682 | 2338 | 10289 | 1950 | 11266 | 1627 | 12449 | 1114 | 15166 | 713 | 10836 |
| 18-#10 | 2.36 | MA | 11764 | 2802 | 15685 | 2497 | 19523 | 2098 | 21802 | 1767 | 24320 | 1241 | 30479 | 746 | 22698 |
| 7L-4S | | MI | 5984 | 2802 | 8925 | 2328 | 10622 | 1942 | 11678 | 1620 | 13021 | 1103 | 15937 | 766 | 10974 |
| 18-#10 | 2.36 | MA | 11453 | 2802 | 15142 | 2508 | 18794 | 2108 | 20882 | 1783 | 23124 | 1252 | 28914 | 704 | 21874 |
| 8L-3S | | MI | 6094 | 2802 | 9198 | 2319 | 10999 | 1927 | 12140 | 1607 | 13653 | 1100 | 16710 | 818 | 10999 |
| 18-#10 | 2.36 | MA | 11108 | 2802 | 14595 | 2518 | 18088 | 2119 | 19989 | 1793 | 21927 | 1269 | 27296 | 651 | 21102 |
| 9L-2S | | MI | 6297 | 2802 | 9589 | 2309 | 11495 | 1919 | 12741 | 1601 | 14464 | 1090 | 17806 | 911 | 11009 |
| 18-#11 | 2.90 | MA | 12569 | 2953 | 17515 | 2584 | 21832 | 2156 | 24474 | 1806 | 27866 | 1220 | 35363 | 707 | 27884 |
| 6L-5S | | MI | 6064 | 2953 | 9286 | 2417 | 10972 | 2007 | 12055 | 1658 | 13480 | 1095 | 16351 | 609 | 12794 |
| 18-#11 | 2.90 | MA | 12233 | 2953 | 16824 | 2596 | 20875 | 2174 | 23400 | 1819 | 26404 | 1242 | 33397 | 666 | 26973 |
| 7L-4S | | MI | 6200 | 2953 | 9580 | 2406 | 11374 | 1998 | 12553 | 1652 | 14170 | 1085 | 17255 | 676 | 13115 |
| 18-#11 | 2.90 | MA | 11865 | 2953 | 16162 | 2609 | 19987 | 2186 | 22279 | 1838 | 24945 | 1255 | 31484 | 612 | 25882 |
| 8L-3S | | MI | 6326 | 2953 | 9909 | 2396 | 11829 | 1981 | 13110 | 1637 | 14931 | 1082 | 18166 | 737 | 13164 |
| 18-#11 | 2.90 | MA | 11457 | 2953 | 15501 | 2622 | 19125 | 2199 | 21191 | 1849 | 23503 | 1277 | 29502 | 547 | 24676 |
| 9L-2S | | MI | 6560 | 2953 | 10378 | 2385 | 12424 | 1972 | 13831 | 1630 | 15905 | 1072 | 19450 | 851 | 13186 |
| 18-#14 | 4.18 | MA | 13408 | 3313 | 19411 | 2848 | 24074 | 2371 | 27252 | 1957 | 31506 | 1258 | 40617 | 489 | 36623 |
| 7L-4S | | MI | 6777 | 3313 | 11068 | 2625 | 13195 | 2160 | 14732 | 1752 | 17087 | 1061 | 20887 | 504 | 17966 |
| 18-#14 | 4.18 | MA | 12892 | 3313 | 18461 | 2866 | 22801 | 2387 | 25645 | 1983 | 29412 | 1276 | 37867 | 410 | 34670 |
| 8L-3S | | MI | 6946 | 3313 | 11536 | 2611 | 13843 | 2136 | 15525 | 1732 | 18169 | 1060 | 22160 | 590 | 18400 |
| 18-#14 | 4.18 | MA | 12342 | 3313 | 17520 | 2885 | 21565 | 2405 | 24084 | 1999 | 27351 | 1307 | 35177 | 332 | 32745 |
| 9L-2S | | MI | 7233 | 3313 | 12201 | 2596 | 14686 | 2125 | 16547 | 1724 | 19549 | 1046 | 23948 | 753 | 18471 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

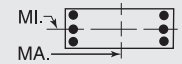



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 2.62 | MA | 12495 | 2876 | 17149 | 2533 | 21446 | 2116 | 24072 | 1778 | 27381 | 1219 | 34660 | 774 | 25897 |
| 6E | | MI | 5894 | 2876 | 8800 | 2400 | 10470 | 1992 | 11462 | 1661 | 12713 | 1120 | 15554 | 645 | 11762 |
| 20-#10 | 2.62 | MA | 12218 | 2876 | 16582 | 2543 | 20661 | 2131 | 23181 | 1789 | 26183 | 1237 | 33057 | 741 | 25347 |
| 7L-5S | | MI | 6038 | 2876 | 9073 | 2384 | 10785 | 1984 | 11867 | 1648 | 13261 | 1110 | 16261 | 704 | 11954 |
| 20-#10 | 2.62 | MA | 11910 | 2876 | 16039 | 2554 | 19933 | 2141 | 22261 | 1804 | 24987 | 1248 | 31492 | 699 | 24514 |
| 8L-4S | | MI | 6157 | 2876 | 9316 | 2374 | 11118 | 1976 | 12279 | 1642 | 13832 | 1100 | 17032 | 758 | 12125 |
| 20-#10 | 2.62 | MA | 11575 | 2876 | 15492 | 2564 | 19226 | 2152 | 21369 | 1814 | 23789 | 1266 | 29875 | 646 | 23735 |
| 9L-3S | | MI | 6263 | 2876 | 9589 | 2365 | 11495 | 1961 | 12741 | 1628 | 14464 | 1097 | 17806 | 810 | 12155 |
| 20-#10 | 2.62 | MA | 11257 | 2876 | 14936 | 2573 | 18489 | 2171 | 20496 | 1824 | 22575 | 1281 | 28305 | 610 | 22773 |
| 10L-2S | | MI | 6462 | 2876 | 9979 | 2355 | 11991 | 1953 | 13342 | 1622 | 15275 | 1087 | 18901 | 903 | 12170 |
| 20-#11 | 3.22 | MA | 12774 | 3044 | 17915 | 2652 | 22259 | 2215 | 25078 | 1846 | 28669 | 1238 | 36533 | 660 | 30178 |
| 7L-5S | | MI | 6266 | 3044 | 9755 | 2474 | 11567 | 2048 | 12776 | 1684 | 14453 | 1091 | 17635 | 596 | 14137 |
| 20-#11 | 3.22 | MA | 12409 | 3044 | 17252 | 2666 | 21372 | 2227 | 23957 | 1864 | 27210 | 1251 | 34620 | 607 | 29090 |
| 8L-4S | | MI | 6402 | 3044 | 10049 | 2463 | 11969 | 2039 | 13274 | 1678 | 15144 | 1080 | 18539 | 662 | 14491 |
| 20-#11 | 3.22 | MA | 12016 | 3044 | 16592 | 2678 | 20510 | 2240 | 22868 | 1875 | 25768 | 1272 | 32638 | 541 | 27875 |
| 9L-3S | | MI | 6523 | 3044 | 10378 | 2452 | 12424 | 2022 | 13831 | 1663 | 15905 | 1078 | 19450 | 724 | 14548 |
| 20-#11 | 3.22 | MA | 11652 | 3044 | 15914 | 2689 | 19611 | 2262 | 21804 | 1888 | 24288 | 1290 | 30718 | 495 | 26698 |
| 10L-2S | | MI | 6752 | 3044 | 10847 | 2442 | 13020 | 2014 | 14552 | 1656 | 16878 | 1067 | 20734 | 837 | 14576 |
| 20-#14 | 4.65 | MA | 13650 | 3444 | 20023 | 2948 | 24783 | 2447 | 28047 | 2021 | 32654 | 1270 | 42356 | 401 | 39236 |
| 8L-4S | | MI | 7074 | 3444 | 11733 | 2707 | 14039 | 2219 | 15755 | 1790 | 18467 | 1055 | 22674 | 480 | 19855 |
| 20-#14 | 4.65 | MA | 13123 | 3444 | 19081 | 2966 | 23547 | 2465 | 26486 | 2036 | 30593 | 1301 | 39667 | 323 | 37299 |
| 9L-3S | | MI | 7212 | 3444 | 12201 | 2692 | 14686 | 2196 | 16547 | 1769 | 19549 | 1054 | 23948 | 566 | 20352 |
| 22-#10 | 2.89 | MA | 12663 | 2949 | 17479 | 2589 | 21799 | 2165 | 24561 | 1810 | 28045 | 1234 | 35636 | 736 | 27996 |
| 7L-6S | | MI | 6068 | 2949 | 9191 | 2446 | 10966 | 2025 | 12063 | 1682 | 13524 | 1117 | 16649 | 637 | 12890 |
| 22-#10 | 2.89 | MA | 12359 | 2949 | 16936 | 2601 | 21071 | 2175 | 23641 | 1826 | 26849 | 1245 | 34071 | 694 | 27155 |
| 8L-5S | | MI | 6209 | 2949 | 9464 | 2430 | 11281 | 2017 | 12468 | 1669 | 14072 | 1107 | 17356 | 696 | 13075 |
| 22-#10 | 2.89 | MA | 12034 | 2949 | 16389 | 2610 | 20364 | 2186 | 22748 | 1835 | 25651 | 1262 | 32454 | 641 | 26367 |
| 9L-4S | | MI | 6328 | 2949 | 9707 | 2421 | 11614 | 2009 | 12880 | 1663 | 14644 | 1096 | 18127 | 750 | 13274 |
| 22-#10 | 2.89 | MA | 11735 | 2949 | 15833 | 2619 | 19627 | 2204 | 21875 | 1846 | 24437 | 1277 | 30884 | 605 | 25408 |
| 10L-3S | | MI | 6430 | 2949 | 9979 | 2411 | 11991 | 1994 | 13342 | 1649 | 15275 | 1093 | 18901 | 802 | 13310 |
| 22-#10 | 2.89 | MA | 11427 | 2949 | 15207 | 2636 | 18906 | 2214 | 20989 | 1864 | 23212 | 1286 | 29361 | 561 | 24454 |
| 11L-2S | | MI | 6625 | 2949 | 10370 | 2401 | 12487 | 1987 | 13943 | 1643 | 16086 | 1083 | 19996 | 894 | 13329 |
| 22-#11 | 3.55 | MA | 12943 | 3134 | 18343 | 2722 | 22756 | 2268 | 25634 | 1890 | 29474 | 1247 | 37755 | 601 | 32298 |
| 8L-5S | | MI | 6467 | 3134 | 10224 | 2530 | 12162 | 2089 | 13497 | 1710 | 15427 | 1087 | 18919 | 582 | 15483 |
| 22-#11 | 3.55 | MA | 12562 | 3134 | 17683 | 2735 | 21894 | 2281 | 24546 | 1902 | 28032 | 1268 | 35773 | 535 | 31074 |
| 9L-4S | | MI | 6602 | 3134 | 10518 | 2519 | 12565 | 2081 | 13995 | 1704 | 16117 | 1076 | 19823 | 648 | 15862 |
| 22-#11 | 3.55 | MA | 12212 | 3134 | 17005 | 2745 | 20995 | 2304 | 23482 | 1914 | 26553 | 1286 | 33854 | 489 | 29888 |
| 10L-3S | | MI | 6719 | 3134 | 10847 | 2509 | 13020 | 2063 | 14552 | 1689 | 16878 | 1074 | 20734 | 710 | 15930 |
| 22-#11 | 3.55 | MA | 11859 | 3134 | 16242 | 2766 | 20126 | 2315 | 22401 | 1935 | 25059 | 1296 | 31991 | 433 | 28592 |
| 11L-2S | | MI | 6943 | 3134 | 11316 | 2498 | 13615 | 2055 | 15274 | 1682 | 17852 | 1063 | 22017 | 823 | 15964 |
| 22-#14 | 5.11 | MA | 13886 | 3574 | 20643 | 3048 | 25528 | 2524 | 28888 | 2074 | 33835 | 1294 | 44156 | 314 | 41852 |
| 9L-4S | | MI | 7346 | 3574 | 12397 | 2788 | 14883 | 2279 | 16777 | 1827 | 19847 | 1049 | 24462 | 456 | 21751 |
| 24-#10 | 3.15 | MA | 12800 | 3023 | 17833 | 2647 | 22209 | 2209 | 25021 | 1847 | 28711 | 1241 | 36649 | 690 | 29795 |
| 8L-6S | | MI | 6240 | 3023 | 9582 | 2492 | 11462 | 2059 | 12664 | 1704 | 14335 | 1113 | 17744 | 628 | 14020 |
| 24-#10 | 3.15 | MA | 12484 | 3023 | 17286 | 2656 | 21502 | 2219 | 24128 | 1856 | 27513 | 1259 | 35032 | 637 | 29000 |
| 9L-5S | | MI | 6378 | 3023 | 9854 | 2476 | 11777 | 2051 | 13069 | 1690 | 14883 | 1103 | 18452 | 688 | 14199 |
| 24-#10 | 3.15 | MA | 12194 | 3023 | 16730 | 2665 | 20766 | 2238 | 23255 | 1867 | 26300 | 1274 | 33463 | 601 | 28044 |
| 10L-4S | | MI | 6497 | 3023 | 10098 | 2467 | 12110 | 2043 | 13481 | 1684 | 15455 | 1093 | 19223 | 742 | 14424 |
| 24-#10 | 3.15 | MA | 11892 | 3023 | 16104 | 2682 | 20045 | 2247 | 22369 | 1885 | 25075 | 1283 | 31939 | 556 | 27083 |
| 11L-3S | | MI | 6595 | 3023 | 10370 | 2457 | 12487 | 2028 | 13943 | 1671 | 16086 | 1090 | 19996 | 794 | 14464 |
| 24-#10 | 3.15 | MA | 11556 | 3023 | 15565 | 2693 | 19329 | 2257 | 21512 | 1896 | 23879 | 1299 | 30399 | 519 | 26136 |
| 12L-2S | | MI | 6787 | 3023 | 10761 | 2447 | 12983 | 2020 | 14544 | 1664 | 16898 | 1080 | 21092 | 886 | 14487 |
| 24-#11 | 3.87 | MA | 13099 | 3225 | 18773 | 2791 | 23278 | 2323 | 26224 | 1928 | 30297 | 1264 | 38909 | 529 | 34273 |
| 9L-5S | | MI | 6665 | 3225 | 10693 | 2587 | 12758 | 2130 | 14218 | 1736 | 16401 | 1082 | 20202 | 568 | 16833 |
| 24-#11 | 3.87 | MA | 12761 | 3225 | 18096 | 2802 | 22380 | 2345 | 25159 | 1940 | 28817 | 1282 | 36990 | 483 | 33079 |
| 10L-4S | | MI | 6800 | 3225 | 10987 | 2576 | 13160 | 2122 | 14717 | 1730 | 17091 | 1072 | 21106 | 635 | 17197 |
| 24-#11 | 3.87 | MA | 12412 | 3225 | 17333 | 2822 | 21510 | 2356 | 24079 | 1961 | 27323 | 1292 | 35127 | 427 | 31787 |
| 11L-3S | | MI | 6922 | 3225 | 11316 | 2565 | 13615 | 2105 | 15274 | 1715 | 17852 | 1070 | 22017 | 696 | 17311 |

## RECTANGULAR TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#9 | 1.04 | MA | 3558 | 1447 | 4900 | 1252 | 5849 | 1055 | 6350 | 901 | 6825 | 669 | 8193 | 582 | 3356 |
| 2L-3S | | MI | 3353 | 1447 | 4553 | 1261 | 5409 | 1062 | 5817 | 907 | 6106 | 678 | 7197 | 510 | 3368 |
| 6-#10 | 1.32 | MA | 3679 | 1494 | 5190 | 1278 | 6201 | 1073 | 6769 | 911 | 7384 | 664 | 8958 | 577 | 4186 |
| 2L-3S | | MI | 3427 | 1494 | 4753 | 1288 | 5647 | 1082 | 6097 | 919 | 6477 | 676 | 7703 | 485 | 4194 |
| 6-#11 | 1.63 | MA | 3786 | 1544 | 5509 | 1299 | 6562 | 1087 | 7183 | 918 | 7925 | 656 | 9599 | 558 | 5029 |
| 2L-3S | | MI | 3491 | 1544 | 4984 | 1311 | 5895 | 1097 | 6375 | 926 | 6834 | 668 | 8121 | 445 | 5029 |
| 6-#14 | 2.34 | MA | 4060 | 1664 | 6209 | 1367 | 7419 | 1136 | 8206 | 947 | 9292 | 645 | 11344 | 531 | 7044 |
| 2L-3S | | MI | 3662 | 1664 | 5463 | 1383 | 6471 | 1149 | 7058 | 958 | 7742 | 662 | 9277 | 368 | 6995 |
| 6-#18 | 4.17 | MA | 4682 | 1969 | 7900 | 1542 | 9503 | 1262 | 10702 | 1024 | 12635 | 622 | 15443 | 445 | 11920 |
| 2L-3S | | MI | 4072 | 1969 | 6614 | 1567 | 7871 | 1281 | 8724 | 1038 | 9965 | 646 | 11995 | 154 | 11517 |
| 8-#8 | 1.10 | MA | 3591 | 1456 | 4945 | 1262 | 5921 | 1062 | 6444 | 906 | 6959 | 670 | 8383 | 583 | 3533 |
| 2L-4S | | MI | 3336 | 1456 | 4479 | 1275 | 5307 | 1078 | 5697 | 920 | 5945 | 681 | 7039 | 494 | 3543 |
| 8-#9 | 1.39 | MA | 3717 | 1505 | 5246 | 1289 | 6288 | 1081 | 6883 | 917 | 7545 | 666 | 9189 | 578 | 4398 |
| 2L-4S | | MI | 3406 | 1505 | 4660 | 1305 | 5516 | 1101 | 5942 | 935 | 6268 | 679 | 7496 | 464 | 4388 |
| 8-#10 | 1.76 | MA | 3874 | 1567 | 5627 | 1324 | 6755 | 1107 | 7440 | 933 | 8290 | 661 | 10212 | 572 | 5495 |
| 2L-4S | | MI | 3494 | 1567 | 4887 | 1345 | 5782 | 1132 | 6254 | 955 | 6681 | 677 | 8076 | 426 | 5439 |
| 8-#11 | 2.17 | MA | 4013 | 1635 | 6035 | 1356 | 7229 | 1129 | 7992 | 944 | 9016 | 651 | 11078 | 549 | 6600 |
| 2L-4S | | MI | 3571 | 1635 | 5143 | 1379 | 6055 | 1157 | 6562 | 969 | 7076 | 668 | 8556 | 371 | 6456 |
| 8-#14 | 3.13 | MA | 4370 | 1795 | 6956 | 1448 | 8366 | 1195 | 9354 | 985 | 10841 | 639 | 13412 | 514 | 9260 |
| 2L-4S | | MI | 3781 | 1795 | 5687 | 1480 | 6696 | 1234 | 7321 | 1018 | 8083 | 660 | 9881 | 260 | 8486 |
| 8-#18 | 5.56 | MA | 5171 | 2201 | 9186 | 1687 | 11135 | 1368 | 12679 | 1091 | 15304 | 611 | 18892 | 402 | 15713 |
| 2L-4S | | MI | 4329 | 2201 | 6993 | 1737 | 8250 | 1429 | 9168 | 1140 | 10540 | 637 | 12985 | -41 | 12924 |
| 10-#10 | 2.20 | MA | 4065 | 1641 | 6064 | 1370 | 7310 | 1140 | 8112 | 954 | 9197 | 657 | 11467 | 567 | 6796 |
| 2L-5S | | MI | 3558 | 1641 | 5054 | 1401 | 5966 | 1174 | 6468 | 983 | 6952 | 685 | 8448 | 367 | 6356 |
| 10-#10 | 2.20 | MA | 3832 | 1641 | 5627 | 1380 | 6755 | 1149 | 7440 | 961 | 8290 | 669 | 10212 | 475 | 6779 |
| 3L-4S | | MI | 3703 | 1641 | 5324 | 1391 | 6336 | 1165 | 6926 | 976 | 7587 | 673 | 9331 | 421 | 6716 |
| 10-#11 | 2.71 | MA | 4236 | 1725 | 6560 | 1412 | 7895 | 1170 | 8800 | 970 | 10107 | 647 | 12556 | 539 | 8161 |
| 2L-5S | | MI | 3650 | 1725 | 5342 | 1448 | 6275 | 1208 | 6817 | 1003 | 7398 | 677 | 8994 | 296 | 7444 |
| 10-#11 | 2.71 | MA | 3966 | 1725 | 6035 | 1424 | 7229 | 1180 | 7992 | 978 | 9016 | 660 | 11078 | 426 | 8127 |
| 3L-4S | | MI | 3816 | 1725 | 5668 | 1436 | 6722 | 1198 | 7371 | 995 | 8167 | 664 | 10034 | 362 | 7926 |
| 10-#14 | 3.91 | MA | 4674 | 1925 | 7702 | 1530 | 9313 | 1255 | 10502 | 1023 | 12391 | 633 | 15479 | 497 | 11468 |
| 2L-5S | | MI | 3893 | 1925 | 5967 | 1578 | 7005 | 1307 | 7679 | 1066 | 8537 | 671 | 10493 | 147 | 9929 |
| 10-#14 | 3.91 | MA | 4318 | 1925 | 6956 | 1546 | 8366 | 1268 | 9354 | 1033 | 10841 | 650 | 13412 | 333 | 11366 |
| 3L-4S | | MI | 4123 | 1925 | 6433 | 1562 | 7643 | 1294 | 8469 | 1056 | 9632 | 654 | 11948 | 243 | 10595 |
| 10-#18 | 6.94 | MA | 5170 | 2433 | 9186 | 1857 | 11135 | 1493 | 12679 | 1171 | 15304 | 624 | 18892 | 68 | 18634 |
| 3L-4S | | MI | 4905 | 2433 | 8279 | 1882 | 9882 | 1535 | 11146 | 1207 | 13210 | 626 | 16433 | -84 | 16238 |

## RECTANGULAR TIED COLUMNS 24" x 26"

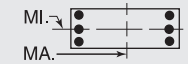
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.00 | MA | 4147 | 1560 | 5713 | 1349 | 6802 | 1137 | 7368 | 971 | 7890 | 723 | 9445 | 630 | 3783 |
| 2E | | MI | 3808 | 1560 | 5312 | 1337 | 6275 | 1126 | 6772 | 962 | 7221 | 716 | 8551 | 616 | 3468 |
| 4-#14 | 1.44 | MA | 4363 | 1640 | 6247 | 1391 | 7444 | 1167 | 8129 | 988 | 8902 | 714 | 10772 | 614 | 5298 |
| 2E | | MI | 3997 | 1640 | 5794 | 1379 | 6853 | 1156 | 7455 | 979 | 8129 | 707 | 9705 | 597 | 4839 |
| 4-#18 | 2.56 | MA | 4858 | 1843 | 7534 | 1503 | 9009 | 1247 | 9992 | 1036 | 11388 | 696 | 13918 | 565 | 8976 |
| 2E | | MI | 4433 | 1843 | 6951 | 1489 | 8255 | 1235 | 9121 | 1026 | 10350 | 688 | 12420 | 536 | 8152 |
| 6-#10 | 1.22 | MA | 4289 | 1600 | 5939 | 1384 | 7136 | 1164 | 7799 | 990 | 8492 | 727 | 10294 | 632 | 4598 |
| 2L-3S | | MI | 3681 | 1600 | 5077 | 1383 | 6025 | 1163 | 6493 | 989 | 6865 | 732 | 8136 | 534 | 4218 |
| 6-#10 | 1.22 | MA | 4006 | 1600 | 5456 | 1395 | 6524 | 1173 | 7056 | 999 | 7490 | 740 | 8906 | 543 | 4605 |
| 3L-2S | | MI | 3936 | 1600 | 5514 | 1373 | 6579 | 1154 | 7165 | 982 | 7772 | 720 | 9391 | 626 | 4207 |
| 6-#11 | 1.50 | MA | 4412 | 1650 | 6295 | 1405 | 7540 | 1178 | 8263 | 997 | 9099 | 718 | 11118 | 624 | 5535 |
| 2L-3S | | MI | 3746 | 1650 | 5312 | 1405 | 6275 | 1178 | 6772 | 996 | 7221 | 724 | 8551 | 494 | 5060 |
| 6-#11 | 1.50 | MA | 4081 | 1650 | 5713 | 1418 | 6802 | 1189 | 7368 | 1006 | 7890 | 733 | 9445 | 510 | 5534 |
| 3L-2S | | MI | 4043 | 1650 | 5837 | 1393 | 6942 | 1168 | 7580 | 988 | 8312 | 711 | 10030 | 607 | 5054 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

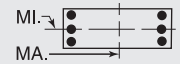



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 2.16 | MA | 4725 | 1770 | 7075 | 1473 | 8494 | 1226 | 9403 | 1026 | 10621 | 708 | 13121 | 603 | 7773 |
| 2L-3S | | MI | 3917 | 1770 | 5794 | 1476 | 6853 | 1229 | 7455 | 1027 | 8129 | 717 | 9705 | 416 | 7040 |
| 6-#14 | 2.16 | MA | 4277 | 1770 | 6247 | 1490 | 7444 | 1241 | 8129 | 1038 | 8902 | 727 | 10772 | 439 | 7724 |
| 3L-2S | | MI | 4319 | 1770 | 6540 | 1460 | 7800 | 1216 | 8603 | 1017 | 9679 | 701 | 11773 | 580 | 7075 |
| 6-#18 | 3.85 | MA | 5443 | 2075 | 8965 | 1648 | 10825 | 1353 | 12193 | 1103 | 14359 | 685 | 17863 | 533 | 13216 |
| 2L-3S | | MI | 4326 | 2075 | 6951 | 1659 | 8255 | 1360 | 9121 | 1106 | 10350 | 701 | 12420 | 202 | 11695 |
| 6-#18 | 3.85 | MA | 4745 | 2075 | 7534 | 1676 | 9009 | 1375 | 9992 | 1120 | 11388 | 714 | 13918 | 242 | 12904 |
| 3L-2S | | MI | 4948 | 2075 | 8237 | 1634 | 9887 | 1341 | 11099 | 1093 | 13020 | 677 | 15868 | 493 | 11963 |
| 8-#8 | 1.01 | MA | 4188 | 1562 | 5665 | 1368 | 6824 | 1152 | 7437 | 985 | 8019 | 733 | 9650 | 639 | 3874 |
| 2L-4S | | MI | 3591 | 1562 | 4799 | 1371 | 5684 | 1160 | 6093 | 991 | 6334 | 738 | 7474 | 543 | 3565 |
| 8-#8 | 1.01 | MA | 4007 | 1562 | 5361 | 1375 | 6438 | 1159 | 6969 | 990 | 7388 | 741 | 8776 | 584 | 3882 |
| 3E | | MI | 3684 | 1562 | 4989 | 1364 | 5948 | 1149 | 6416 | 982 | 6776 | 734 | 8026 | 577 | 3559 |
| 8-#8 | 1.01 | MA | 3904 | 1562 | 5152 | 1382 | 6147 | 1170 | 6613 | 1000 | 6901 | 745 | 8174 | 551 | 3884 |
| 4L-2S | | MI | 3847 | 1562 | 5265 | 1357 | 6297 | 1144 | 6840 | 977 | 7348 | 727 | 8818 | 633 | 3550 |
| 8-#9 | 1.28 | MA | 4332 | 1611 | 5999 | 1395 | 7231 | 1172 | 7923 | 996 | 8668 | 729 | 10543 | 634 | 4830 |
| 2L-4S | | MI | 3660 | 1611 | 4982 | 1401 | 5894 | 1183 | 6338 | 1006 | 6657 | 736 | 7930 | 514 | 4418 |
| 8-#9 | 1.28 | MA | 4109 | 1611 | 5616 | 1404 | 6746 | 1180 | 7334 | 1003 | 7873 | 739 | 9443 | 564 | 4835 |
| 3E | | MI | 3774 | 1611 | 5221 | 1392 | 6226 | 1170 | 6746 | 994 | 7214 | 732 | 8627 | 556 | 4426 |
| 8-#9 | 1.28 | MA | 3983 | 1611 | 5353 | 1412 | 6380 | 1193 | 6886 | 1016 | 7260 | 744 | 8682 | 522 | 4820 |
| 4L-2S | | MI | 3975 | 1611 | 5568 | 1384 | 6666 | 1163 | 7279 | 988 | 7934 | 722 | 9623 | 628 | 4418 |
| 8-#10 | 1.63 | MA | 4510 | 1674 | 6421 | 1430 | 7749 | 1197 | 8541 | 1011 | 9495 | 723 | 11682 | 627 | 6043 |
| 2L-4S | | MI | 3748 | 1674 | 5211 | 1440 | 6160 | 1213 | 6651 | 1025 | 7069 | 733 | 8509 | 475 | 5479 |
| 8-#10 | 1.63 | MA | 4237 | 1674 | 5939 | 1441 | 7136 | 1207 | 7799 | 1020 | 8492 | 736 | 10294 | 538 | 6038 |
| 3E | | MI | 3888 | 1674 | 5514 | 1429 | 6579 | 1197 | 7165 | 1011 | 7772 | 728 | 9391 | 529 | 5517 |
| 8-#10 | 1.63 | MA | 4084 | 1674 | 5605 | 1452 | 6674 | 1224 | 7233 | 1035 | 7718 | 742 | 9331 | 484 | 5988 |
| 4L-2S | | MI | 4132 | 1674 | 5950 | 1419 | 7134 | 1188 | 7836 | 1003 | 8679 | 717 | 10645 | 621 | 5517 |
| 8-#11 | 2.00 | MA | 4670 | 1741 | 6877 | 1462 | 8279 | 1219 | 9159 | 1023 | 10307 | 714 | 12791 | 618 | 7274 |
| 2L-4S | | MI | 3825 | 1741 | 5471 | 1473 | 6435 | 1237 | 6959 | 1039 | 7463 | 724 | 8986 | 420 | 6537 |
| 8-#11 | 2.00 | MA | 4353 | 1741 | 6295 | 1475 | 7540 | 1230 | 8263 | 1032 | 9099 | 728 | 11118 | 504 | 7254 |
| 3E | | MI | 3988 | 1741 | 5837 | 1462 | 6942 | 1219 | 7580 | 1022 | 8312 | 720 | 10030 | 484 | 6615 |
| 8-#11 | 2.00 | MA | 4173 | 1741 | 5892 | 1487 | 6981 | 1250 | 7579 | 1050 | 8162 | 734 | 9943 | 438 | 7156 |
| 4L-2S | | MI | 4272 | 1741 | 6362 | 1450 | 7609 | 1209 | 8388 | 1014 | 9403 | 707 | 11508 | 598 | 6627 |
| 8-#14 | 2.88 | MA | 5076 | 1901 | 7903 | 1554 | 9545 | 1286 | 10676 | 1064 | 12340 | 702 | 15469 | 591 | 10232 |
| 2L-4S | | MI | 4034 | 1901 | 6018 | 1574 | 7078 | 1314 | 7718 | 1087 | 8470 | 716 | 10309 | 309 | 8635 |
| 8-#14 | 2.88 | MA | 4653 | 1901 | 7075 | 1572 | 8494 | 1301 | 9403 | 1076 | 10621 | 721 | 13121 | 427 | 10152 |
| 3E | | MI | 4251 | 1901 | 6540 | 1558 | 7800 | 1288 | 8603 | 1065 | 9679 | 711 | 11773 | 399 | 9229 |
| 8-#14 | 2.88 | MA | 4413 | 1901 | 6499 | 1589 | 7697 | 1328 | 8426 | 1101 | 9286 | 728 | 11466 | 333 | 9499 |
| 4L-2S | | MI | 4632 | 1901 | 7286 | 1542 | 8747 | 1275 | 9751 | 1054 | 11228 | 695 | 13840 | 563 | 9294 |
| 8-#18 | 5.13 | MA | 5998 | 2307 | 10396 | 1793 | 12641 | 1459 | 14394 | 1170 | 17329 | 674 | 21808 | 501 | 17441 |
| 2L-4S | | MI | 4577 | 2307 | 7330 | 1830 | 8634 | 1508 | 9565 | 1209 | 10925 | 691 | 13409 | 7 | 13376 |
| 8-#18 | 5.13 | MA | 5395 | 2307 | 8965 | 1821 | 10825 | 1481 | 12193 | 1187 | 14359 | 703 | 17863 | 210 | 17067 |
| 3E | | MI | 4899 | 2307 | 8237 | 1804 | 9887 | 1466 | 11099 | 1173 | 13020 | 690 | 15868 | 159 | 15306 |
| 8-#18 | 5.13 | MA | 5001 | 2307 | 7962 | 1849 | 9438 | 1526 | 10495 | 1227 | 12039 | 710 | 15067 | 50 | 14793 |
| 4L-2S | | MI | 5441 | 2307 | 9523 | 1779 | 11519 | 1447 | 13077 | 1160 | 15690 | 666 | 19317 | 450 | 15759 |
| 10-#10 | 2.04 | MA | 4725 | 1747 | 6904 | 1476 | 8362 | 1231 | 9284 | 1033 | 10497 | 720 | 13070 | 623 | 7482 |
| 2L-5S | | MI | 3812 | 1747 | 5378 | 1496 | 6345 | 1255 | 6864 | 1054 | 7341 | 741 | 8881 | 417 | 6451 |
| 10-#10 | 2.04 | MA | 4463 | 1747 | 6421 | 1487 | 7749 | 1241 | 8541 | 1041 | 9495 | 733 | 11682 | 533 | 7465 |
| 3L-4S | | MI | 3957 | 1747 | 5647 | 1486 | 6714 | 1246 | 7322 | 1046 | 7976 | 729 | 9764 | 470 | 6759 |
| 10-#10 | 2.04 | MA | 4318 | 1747 | 6088 | 1498 | 7287 | 1257 | 7975 | 1057 | 8721 | 738 | 10719 | 479 | 7402 |
| 4L-3S | | MI | 4089 | 1747 | 5950 | 1475 | 7134 | 1230 | 7836 | 1032 | 8679 | 725 | 10645 | 524 | 6809 |
| 10-#10 | 2.04 | MA | 4151 | 1747 | 5792 | 1509 | 6881 | 1267 | 7472 | 1065 | 8022 | 751 | 9750 | 429 | 7054 |
| 5L-2S | | MI | 4325 | 1747 | 6387 | 1465 | 7688 | 1221 | 8508 | 1024 | 9586 | 713 | 11900 | 616 | 6821 |
| 10-#11 | 2.50 | MA | 4921 | 1831 | 7459 | 1518 | 9017 | 1260 | 10054 | 1049 | 11515 | 710 | 14464 | 612 | 9004 |
| 2L-5S | | MI | 3904 | 1831 | 5669 | 1542 | 6655 | 1289 | 7213 | 1073 | 7786 | 732 | 9424 | 345 | 7552 |
| 10-#11 | 2.50 | MA | 4617 | 1831 | 6877 | 1531 | 8279 | 1272 | 9159 | 1059 | 10307 | 724 | 12791 | 498 | 8970 |
| 3L-4S | | MI | 4071 | 1831 | 5996 | 1530 | 7102 | 1279 | 7767 | 1065 | 8554 | 720 | 10465 | 411 | 8049 |
| 10-#11 | 2.50 | MA | 4450 | 1831 | 6474 | 1544 | 7720 | 1291 | 8474 | 1077 | 9370 | 730 | 11616 | 432 | 8854 |
| 4L-3S | | MI | 4223 | 1831 | 6362 | 1518 | 7609 | 1260 | 8388 | 1048 | 9403 | 715 | 11508 | 475 | 8165 |

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

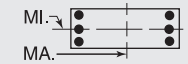
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.50 | MA | 4256 | 1831 | 6115 | 1557 | 7228 | 1302 | 7864 | 1086 | 8524 | 744 | 10439 | 367 | 8274 |
| 5L-2S | | MI | 4497 | 1831 | 6888 | 1506 | 8276 | 1250 | 9196 | 1040 | 10494 | 703 | 12986 | 588 | 8191 |
| 10-#14 | 3.61 | MA | 5419 | 2031 | 8731 | 1636 | 10596 | 1345 | 11949 | 1101 | 14059 | 696 | 17818 | 579 | 12683 |
| 2L-5S | | MI | 4147 | 2031 | 6298 | 1672 | 7387 | 1387 | 8076 | 1135 | 8924 | 726 | 10921 | 196 | 10128 |
| 10-#14 | 3.61 | MA | 5017 | 2031 | 7903 | 1653 | 9545 | 1360 | 10676 | 1114 | 12340 | 715 | 15469 | 416 | 12581 |
| 3L-4S | | MI | 4376 | 2031 | 6764 | 1655 | 8025 | 1374 | 8866 | 1125 | 10019 | 709 | 12377 | 292 | 10738 |
| 10-#14 | 3.61 | MA | 4798 | 2031 | 7327 | 1671 | 8748 | 1388 | 9699 | 1138 | 11005 | 722 | 13815 | 322 | 11847 |
| 4L-3S | | MI | 4576 | 2031 | 7286 | 1639 | 8747 | 1348 | 9751 | 1102 | 11228 | 705 | 13840 | 382 | 11416 |
| 10-#14 | 3.61 | MA | 4531 | 2031 | 6813 | 1689 | 8045 | 1403 | 8828 | 1151 | 9797 | 741 | 12162 | 227 | 11131 |
| 5L-2S | | MI | 4937 | 2031 | 8033 | 1623 | 9694 | 1335 | 10899 | 1092 | 12778 | 688 | 15907 | 545 | 11504 |
| 10-#18 | 6.41 | MA | 5991 | 2539 | 10396 | 1966 | 12641 | 1587 | 14394 | 1254 | 17329 | 692 | 21808 | 177 | 21073 |
| 3L-4S | | MI | 5154 | 2539 | 8616 | 1975 | 10266 | 1614 | 11543 | 1276 | 13595 | 680 | 16858 | -36 | 16777 |
| 10-#18 | 6.41 | MA | 5692 | 2539 | 9393 | 1994 | 11254 | 1632 | 12696 | 1294 | 15010 | 699 | 19012 | 18 | 18909 |
| 4L-3S | | MI | 5428 | 2539 | 9523 | 1949 | 11519 | 1572 | 13077 | 1240 | 15690 | 678 | 19317 | 116 | 18870 |
| 12-#10 | 2.44 | MA | 4936 | 1821 | 7387 | 1522 | 8974 | 1265 | 10026 | 1054 | 11499 | 716 | 14458 | 618 | 8916 |
| 2L-6S | | MI | 3849 | 1821 | 5505 | 1557 | 6550 | 1298 | 7087 | 1090 | 7626 | 742 | 9273 | 340 | 7439 |
| 12-#10 | 2.44 | MA | 4683 | 1821 | 6904 | 1533 | 8362 | 1274 | 9284 | 1062 | 10497 | 729 | 13070 | 528 | 8891 |
| 3L-5S | | MI | 4018 | 1821 | 5815 | 1542 | 6899 | 1289 | 7536 | 1075 | 8247 | 738 | 10136 | 412 | 7697 |
| 12-#10 | 2.44 | MA | 4547 | 1821 | 6571 | 1544 | 7900 | 1291 | 8718 | 1078 | 9723 | 735 | 12107 | 475 | 8817 |
| 4E | | MI | 4161 | 1821 | 6084 | 1532 | 7268 | 1280 | 7994 | 1068 | 8883 | 726 | 11018 | 465 | 8038 |
| 12-#10 | 2.44 | MA | 4382 | 1821 | 6275 | 1555 | 7494 | 1301 | 8214 | 1086 | 9024 | 748 | 11138 | 424 | 8439 |
| 5L-3S | | MI | 4285 | 1821 | 6387 | 1521 | 7688 | 1264 | 8508 | 1053 | 9586 | 721 | 11900 | 519 | 8099 |
| 12-#10 | 2.44 | MA | 4195 | 1821 | 5927 | 1570 | 7111 | 1311 | 7721 | 1102 | 8341 | 754 | 10196 | 353 | 8137 |
| 6L-2S | | MI | 4513 | 1821 | 6824 | 1511 | 8242 | 1255 | 9180 | 1046 | 10492 | 710 | 13154 | 611 | 8120 |
| 12-#11 | 3.00 | MA | 5168 | 1922 | 8041 | 1575 | 9756 | 1302 | 10949 | 1075 | 12724 | 705 | 16137 | 606 | 10730 |
| 2L-6S | | MI | 3947 | 1922 | 5828 | 1617 | 6898 | 1340 | 7478 | 1116 | 8141 | 741 | 9948 | 261 | 8612 |
| 12-#11 | 3.00 | MA | 4875 | 1922 | 7459 | 1588 | 9017 | 1313 | 10054 | 1085 | 11515 | 720 | 14464 | 492 | 10683 |
| 3L-5S | | MI | 4146 | 1922 | 6195 | 1598 | 7321 | 1330 | 8021 | 1099 | 8877 | 728 | 10903 | 335 | 9055 |
| 12-#11 | 3.00 | MA | 4719 | 1922 | 7056 | 1600 | 8458 | 1333 | 9369 | 1103 | 10579 | 726 | 13289 | 426 | 10499 |
| 4E | | MI | 4311 | 1922 | 6521 | 1587 | 7769 | 1320 | 8575 | 1091 | 9645 | 715 | 11943 | 401 | 9526 |
| 12-#11 | 3.00 | MA | 4528 | 1922 | 6697 | 1613 | 7966 | 1344 | 8759 | 1112 | 9732 | 740 | 12112 | 361 | 9947 |
| 5L-3S | | MI | 4453 | 1922 | 6888 | 1575 | 8276 | 1302 | 9196 | 1075 | 10494 | 711 | 12986 | 465 | 9712 |
| 12-#11 | 3.00 | MA | 4309 | 1922 | 6283 | 1632 | 7501 | 1355 | 8161 | 1130 | 8904 | 746 | 10962 | 273 | 9454 |
| 6L-2S | | MI | 4717 | 1922 | 7413 | 1563 | 8942 | 1292 | 10005 | 1067 | 11585 | 698 | 14465 | 579 | 9750 |
| 12-#14 | 4.33 | MA | 5373 | 2162 | 8731 | 1735 | 10596 | 1420 | 11949 | 1151 | 14059 | 709 | 17818 | 404 | 15010 |
| 3L-5S | | MI | 4482 | 2162 | 7044 | 1753 | 8334 | 1446 | 9224 | 1173 | 10473 | 720 | 12988 | 179 | 12257 |
| 12-#14 | 4.33 | MA | 5172 | 2162 | 8154 | 1753 | 9798 | 1447 | 10972 | 1176 | 12723 | 716 | 16164 | 310 | 14209 |
| 4E | | MI | 4709 | 2162 | 7510 | 1737 | 8972 | 1433 | 10014 | 1163 | 11569 | 703 | 14444 | 274 | 12855 |
| 12-#14 | 4.33 | MA | 4908 | 2162 | 7641 | 1770 | 9096 | 1462 | 10101 | 1188 | 11515 | 735 | 14511 | 215 | 13530 |
| 5L-3S | | MI | 4893 | 2162 | 8033 | 1721 | 9694 | 1408 | 10899 | 1140 | 12778 | 699 | 15907 | 365 | 13604 |
| 12-#18 | 7.69 | MA | 6317 | 2771 | 10824 | 2139 | 13070 | 1738 | 14897 | 1361 | 17980 | 688 | 22958 | -14 | 22904 |
| 4E | | MI | 5709 | 2771 | 9902 | 2119 | 11898 | 1720 | 13521 | 1343 | 16265 | 669 | 20306 | -80 | 20072 |
| 14-#10 | 2.85 | MA | 4898 | 1894 | 7387 | 1579 | 8974 | 1308 | 10026 | 1084 | 11499 | 726 | 14458 | 523 | 10315 |
| 3L-6S | | MI | 4056 | 1894 | 5941 | 1603 | 7104 | 1331 | 7759 | 1111 | 8533 | 739 | 10527 | 335 | 8703 |
| 14-#10 | 2.85 | MA | 4770 | 1894 | 7054 | 1590 | 8512 | 1325 | 9460 | 1099 | 10725 | 731 | 13495 | 470 | 10233 |
| 4L-5S | | MI | 4219 | 1894 | 6251 | 1588 | 7453 | 1323 | 8208 | 1097 | 9154 | 734 | 11390 | 407 | 8949 |
| 14-#10 | 2.85 | MA | 4607 | 1894 | 6758 | 1601 | 8107 | 1335 | 8957 | 1108 | 10026 | 744 | 12526 | 419 | 9828 |
| 5L-4S | | MI | 4361 | 1894 | 6521 | 1578 | 7822 | 1314 | 8666 | 1089 | 9790 | 722 | 12273 | 460 | 9318 |
| 14-#10 | 2.85 | MA | 4427 | 1894 | 6410 | 1616 | 7723 | 1344 | 8464 | 1123 | 9343 | 750 | 11584 | 349 | 9539 |
| 6L-3S | | MI | 4478 | 1894 | 6824 | 1567 | 8242 | 1298 | 9180 | 1074 | 10492 | 718 | 13154 | 514 | 9387 |
| 14-#10 | 2.85 | MA | 4270 | 1894 | 6099 | 1623 | 7316 | 1360 | 7988 | 1132 | 8680 | 763 | 10665 | 306 | 9041 |
| 7L-2S | | MI | 4699 | 1894 | 7261 | 1557 | 8796 | 1289 | 9852 | 1067 | 11399 | 706 | 14409 | 606 | 9415 |
| 14-#11 | 3.50 | MA | 5129 | 2012 | 8041 | 1644 | 9756 | 1354 | 10949 | 1111 | 12724 | 715 | 16137 | 486 | 12397 |
| 3L-6S | | MI | 4191 | 2012 | 6353 | 1674 | 7565 | 1381 | 8286 | 1142 | 9232 | 736 | 11426 | 252 | 10103 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

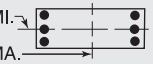
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 3.50 | MA | 4982 | 2012 | 7638 | 1657 | 9197 | 1374 | 10264 | 1129 | 11787 | 721 | 14962 | 420 | 12153 |
| 4L-5S | | MI | 4382 | 2012 | 6720 | 1655 | 7988 | 1371 | 8829 | 1125 | 9968 | 724 | 12381 | 326 | 10563 |
| 14-#11 | 3.50 | MA | 4793 | 2012 | 7279 | 1670 | 8705 | 1385 | 9654 | 1138 | 10941 | 736 | 13785 | 355 | 11625 |
| 5L-4S | | MI | 4545 | 2012 | 7047 | 1643 | 8435 | 1361 | 9384 | 1117 | 10736 | 711 | 13421 | 392 | 11011 |
| 14-#11 | 3.50 | MA | 4583 | 2012 | 6865 | 1688 | 8240 | 1396 | 9056 | 1156 | 10113 | 741 | 12635 | 267 | 11119 |
| 6L-3S | | MI | 4679 | 2012 | 7413 | 1631 | 8942 | 1343 | 10005 | 1101 | 11585 | 707 | 14465 | 456 | 11257 |
| 14-#14 | 5.05 | MA | 5536 | 2292 | 8982 | 1834 | 10849 | 1507 | 12246 | 1214 | 14442 | 709 | 18512 | 298 | 16581 |
| 4L-5S | | MI | 4809 | 2292 | 7790 | 1835 | 9281 | 1506 | 10372 | 1211 | 12023 | 714 | 15056 | 161 | 14365 |
| 14-#14 | 5.05 | MA | 5275 | 2292 | 8469 | 1852 | 10146 | 1522 | 11375 | 1226 | 13234 | 729 | 16859 | 203 | 15917 |
| 5L-4S | | MI | 5033 | 2292 | 8257 | 1819 | 9919 | 1493 | 11162 | 1200 | 13118 | 697 | 16511 | 257 | 14982 |
| 16-#10 | 3.26 | MA | 4989 | 1968 | 7536 | 1636 | 9125 | 1358 | 10203 | 1120 | 11728 | 728 | 14882 | 465 | 11650 |
| 4L-6S | | MI | 4258 | 1968 | 6378 | 1649 | 7658 | 1365 | 8431 | 1132 | 9439 | 735 | 11782 | 330 | 9954 |
| 16-#10 | 3.26 | MA | 4827 | 1968 | 7241 | 1647 | 8719 | 1368 | 9699 | 1129 | 11029 | 741 | 13914 | 415 | 11222 |
| 5E | | MI | 4416 | 1968 | 6688 | 1634 | 8007 | 1356 | 8880 | 1118 | 10061 | 731 | 12645 | 402 | 10206 |
| 16-#10 | 3.26 | MA | 4653 | 1968 | 6893 | 1662 | 8336 | 1378 | 9206 | 1144 | 10345 | 747 | 12971 | 344 | 10944 |
| 6L-4S | | MI | 4557 | 1968 | 6958 | 1624 | 8377 | 1347 | 9338 | 1110 | 10696 | 719 | 13527 | 455 | 10598 |
| 16-#10 | 3.26 | MA | 4503 | 1968 | 6582 | 1669 | 7929 | 1393 | 8730 | 1153 | 9682 | 759 | 12052 | 301 | 10438 |
| 7L-3S | | MI | 4668 | 1968 | 7261 | 1613 | 8796 | 1331 | 9852 | 1096 | 11399 | 714 | 14409 | 509 | 10675 |
| 16-#11 | 4.00 | MA | 5240 | 2103 | 8220 | 1713 | 9935 | 1415 | 11159 | 1155 | 12995 | 717 | 16635 | 414 | 13814 |
| 4L-6S | | MI | 4430 | 2103 | 6878 | 1730 | 8232 | 1423 | 9094 | 1168 | 10323 | 732 | 12905 | 243 | 11600 |
| 16-#11 | 4.00 | MA | 5052 | 2103 | 7861 | 1726 | 9443 | 1426 | 10549 | 1164 | 12149 | 731 | 15458 | 349 | 13308 |
| 5E | | MI | 4613 | 2103 | 7246 | 1711 | 8655 | 1413 | 9638 | 1151 | 11059 | 719 | 13859 | 316 | 12077 |
| 16-#11 | 4.00 | MA | 4850 | 2103 | 7447 | 1745 | 8978 | 1437 | 9951 | 1182 | 11321 | 737 | 14308 | 261 | 12788 |
| 6L-4S | | MI | 4775 | 2103 | 7572 | 1700 | 9102 | 1403 | 10192 | 1143 | 11827 | 707 | 14900 | 382 | 12505 |
| 16-#14 | 5.77 | MA | 5634 | 2423 | 9297 | 1933 | 11197 | 1581 | 12648 | 1264 | 14953 | 722 | 19208 | 192 | 18285 |
| 5E | | MI | 5151 | 2423 | 8537 | 1916 | 10228 | 1566 | 11520 | 1248 | 13572 | 708 | 17123 | 144 | 16481 |
| 18-#10 | 3.66 | MA | 5043 | 2042 | 7723 | 1693 | 9332 | 1402 | 10442 | 1150 | 12031 | 737 | 15302 | 410 | 12619 |
| 5L-6S | | MI | 4457 | 2042 | 6815 | 1695 | 8212 | 1399 | 9103 | 1154 | 10346 | 732 | 13036 | 325 | 11200 |
| 18-#10 | 3.66 | MA | 4876 | 2042 | 7376 | 1708 | 8949 | 1412 | 9949 | 1166 | 11348 | 743 | 14359 | 339 | 12337 |
| 6L-5S | | MI | 4609 | 2042 | 7125 | 1680 | 8562 | 1390 | 9551 | 1139 | 10968 | 727 | 13899 | 397 | 11465 |
| 18-#10 | 3.66 | MA | 4732 | 2042 | 7065 | 1715 | 8541 | 1427 | 9473 | 1174 | 10684 | 756 | 13440 | 296 | 11838 |
| 7L-4S | | MI | 4749 | 2042 | 7394 | 1670 | 8931 | 1381 | 10009 | 1132 | 11603 | 715 | 14782 | 450 | 11862 |
| 18-#11 | 4.50 | MA | 5307 | 2193 | 8443 | 1783 | 10182 | 1468 | 11444 | 1190 | 13357 | 727 | 17131 | 343 | 14995 |
| 5L-6S | | MI | 4664 | 2193 | 7404 | 1787 | 8899 | 1464 | 9902 | 1194 | 11414 | 728 | 14383 | 233 | 13101 |
| 18-#11 | 4.50 | MA | 5112 | 2193 | 8029 | 1801 | 9717 | 1479 | 10846 | 1208 | 12529 | 733 | 15981 | 255 | 14462 |
| 6L-5S | | MI | 4841 | 2193 | 7771 | 1768 | 9322 | 1454 | 10446 | 1177 | 12150 | 715 | 15338 | 307 | 13595 |
| 20-#10 | 4.07 | MA | 5094 | 2115 | 7859 | 1754 | 9561 | 1445 | 10691 | 1187 | 12350 | 740 | 15747 | 334 | 13726 |
| 6E | | MI | 4652 | 2115 | 7252 | 1741 | 8767 | 1432 | 9774 | 1175 | 11253 | 728 | 14291 | 320 | 12450 |
| 20-#10 | 4.07 | MA | 4956 | 2115 | 7548 | 1761 | 9154 | 1461 | 10216 | 1195 | 11687 | 752 | 14828 | 292 | 13240 |
| 7L-5S | | MI | 4800 | 2115 | 7562 | 1726 | 9116 | 1423 | 10223 | 1160 | 11875 | 724 | 15153 | 392 | 12728 |
| 20-#11 | 5.00 | MA | 5370 | 2284 | 8611 | 1858 | 10456 | 1520 | 11742 | 1234 | 13738 | 728 | 17654 | 249 | 16140 |
| 6E | | MI | 4894 | 2284 | 7929 | 1843 | 9566 | 1505 | 10711 | 1220 | 12505 | 723 | 15861 | 224 | 14607 |

## RECTANGULAR TIED COLUMNS 24" x 28"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.34 | MA | 5029 | 1746 | 7073 | 1497 | 8474 | 1257 | 9264 | 1067 | 10129 | 777 | 12313 | 676 | 5784 |
| 2E | | MI | 4254 | 1746 | 6125 | 1472 | 7234 | 1236 | 7852 | 1049 | 8516 | 762 | 10134 | 645 | 4865 |
| 4-#18 | 2.38 | MA | 5589 | 1949 | 8496 | 1609 | 10204 | 1337 | 11324 | 1115 | 12877 | 759 | 15924 | 639 | 9840 |
| 2E | | MI | 4692 | 1949 | 7288 | 1581 | 8639 | 1313 | 9518 | 1094 | 10735 | 742 | 12845 | 584 | 8189 |
| 6-#10 | 1.13 | MA | 4943 | 1706 | 6729 | 1490 | 8129 | 1254 | 8893 | 1069 | 9667 | 790 | 11704 | 687 | 5009 |
| 2L-3S | | MI | 3936 | 1706 | 5400 | 1478 | 6403 | 1244 | 6889 | 1060 | 7254 | 788 | 8569 | 583 | 4240 |
| 6-#10 | 1.13 | MA | 4629 | 1706 | 6201 | 1502 | 7458 | 1265 | 8079 | 1078 | 8570 | 803 | 10184 | 600 | 5017 |
| 3L-2S | | MI | 4193 | 1706 | 5837 | 1468 | 6958 | 1235 | 7561 | 1053 | 8161 | 777 | 9823 | 676 | 4227 |
| 6-#11 | 1.39 | MA | 5083 | 1756 | 7124 | 1511 | 8576 | 1268 | 9407 | 1076 | 10339 | 781 | 12616 | 679 | 6040 |
| 2L-3S | | MI | 4001 | 1756 | 5639 | 1499 | 6655 | 1258 | 7168 | 1066 | 7609 | 780 | 8982 | 543 | 5090 |
| 6-#11 | 1.39 | MA | 4713 | 1756 | 6485 | 1525 | 7766 | 1280 | 8425 | 1086 | 9013 | 797 | 10781 | 568 | 6040 |
| 3L-2S | | MI | 4300 | 1756 | 6165 | 1487 | 7322 | 1248 | 7977 | 1058 | 8700 | 767 | 10460 | 656 | 5078 |

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

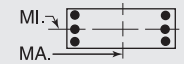
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 2.01 | MA | 5434 | 1876 | 7983 | 1579 | 9628 | 1317 | 10663 | 1105 | 12017 | 771 | 14927 | 667 | 8502 |
| 2L-3S | | MI | 4172 | 1876 | 6125 | 1570 | 7234 | 1308 | 7852 | 1097 | 8516 | 773 | 10134 | 465 | 7082 |
| 6-#14 | 2.01 | MA | 4934 | 1876 | 7073 | 1598 | 8474 | 1333 | 9264 | 1119 | 10129 | 792 | 12313 | 505 | 8453 |
| 3L-2S | | MI | 4578 | 1876 | 6871 | 1554 | 8181 | 1295 | 9000 | 1086 | 10066 | 756 | 12201 | 628 | 7105 |
| 6-#18 | 3.57 | MA | 6245 | 2181 | 10072 | 1754 | 12204 | 1443 | 13748 | 1182 | 16149 | 748 | 20368 | 615 | 14512 |
| 2L-3S | | MI | 4580 | 2181 | 7288 | 1752 | 8639 | 1439 | 9518 | 1175 | 10735 | 755 | 12845 | 250 | 11774 |
| 6-#18 | 3.57 | MA | 5463 | 2181 | 8496 | 1785 | 10204 | 1469 | 11324 | 1203 | 12877 | 781 | 15924 | 325 | 14200 |
| 3L-2S | | MI | 5212 | 2181 | 8574 | 1726 | 10271 | 1419 | 11496 | 1161 | 13405 | 731 | 16293 | 541 | 12005 |
| 8-#9 | 1.19 | MA | 4990 | 1717 | 6795 | 1501 | 8231 | 1262 | 9027 | 1075 | 9857 | 791 | 11974 | 689 | 5262 |
| 2L-4S | | MI | 3915 | 1717 | 5303 | 1496 | 6271 | 1264 | 6734 | 1077 | 7046 | 792 | 8364 | 563 | 4445 |
| 8-#9 | 1.19 | MA | 4742 | 1717 | 6376 | 1510 | 7700 | 1271 | 8382 | 1083 | 8987 | 803 | 10769 | 620 | 5267 |
| 3E | | MI | 4030 | 1717 | 5543 | 1488 | 6604 | 1251 | 7142 | 1065 | 7603 | 788 | 9061 | 605 | 4447 |
| 8-#9 | 1.19 | MA | 4604 | 1717 | 6088 | 1519 | 7301 | 1285 | 7893 | 1096 | 8318 | 808 | 9946 | 579 | 5252 |
| 4L-2S | | MI | 4231 | 1717 | 5890 | 1479 | 7043 | 1244 | 7674 | 1059 | 8322 | 779 | 10057 | 677 | 4438 |
| 8-#10 | 1.51 | MA | 5189 | 1780 | 7258 | 1536 | 8800 | 1288 | 9706 | 1090 | 10765 | 786 | 13224 | 683 | 6592 |
| 2L-4S | | MI | 4003 | 1780 | 5534 | 1535 | 6538 | 1294 | 7047 | 1096 | 7458 | 789 | 8942 | 524 | 5516 |
| 8-#10 | 1.51 | MA | 4886 | 1780 | 6729 | 1548 | 8129 | 1298 | 8893 | 1100 | 9667 | 800 | 11704 | 595 | 6586 |
| 3E | | MI | 4143 | 1780 | 5837 | 1524 | 6958 | 1278 | 7561 | 1081 | 8161 | 785 | 9823 | 578 | 5543 |
| 8-#10 | 1.51 | MA | 4716 | 1780 | 6366 | 1559 | 7625 | 1316 | 8275 | 1116 | 8822 | 807 | 10661 | 542 | 6536 |
| 4L-2S | | MI | 4390 | 1780 | 6274 | 1514 | 7512 | 1269 | 8233 | 1074 | 9068 | 773 | 11078 | 671 | 5539 |
| 8-#11 | 1.86 | MA | 5371 | 1847 | 7762 | 1568 | 9386 | 1310 | 10389 | 1102 | 11664 | 777 | 14452 | 673 | 7948 |
| 2L-4S | | MI | 4079 | 1847 | 5798 | 1568 | 6815 | 1318 | 7356 | 1109 | 7851 | 780 | 9417 | 469 | 6587 |
| 8-#11 | 1.86 | MA | 5017 | 1847 | 7124 | 1581 | 8576 | 1322 | 9407 | 1112 | 10339 | 793 | 12616 | 562 | 7928 |
| 3E | | MI | 4243 | 1847 | 6165 | 1556 | 7322 | 1299 | 7977 | 1092 | 8700 | 775 | 10460 | 533 | 6648 |
| 8-#11 | 1.86 | MA | 4818 | 1847 | 6683 | 1595 | 7965 | 1342 | 8659 | 1131 | 9315 | 800 | 11342 | 497 | 7829 |
| 4L-2S | | MI | 4531 | 1847 | 6690 | 1544 | 7989 | 1289 | 8785 | 1084 | 9791 | 763 | 11938 | 646 | 6654 |
| 8-#14 | 2.68 | MA | 5827 | 2007 | 8892 | 1660 | 10782 | 1376 | 12062 | 1143 | 13905 | 765 | 17542 | 658 | 11204 |
| 2L-4S | | MI | 4287 | 2007 | 6349 | 1667 | 7459 | 1394 | 8115 | 1157 | 8857 | 771 | 10738 | 357 | 8780 |
| 8-#14 | 2.68 | MA | 5354 | 2007 | 7983 | 1679 | 9628 | 1393 | 10663 | 1157 | 12017 | 786 | 14927 | 496 | 11124 |
| 3E | | MI | 4507 | 2007 | 6871 | 1651 | 8181 | 1368 | 9000 | 1134 | 10066 | 767 | 12201 | 448 | 9274 |
| 8-#14 | 2.68 | MA | 5089 | 2007 | 7353 | 1698 | 8755 | 1422 | 9594 | 1183 | 10555 | 795 | 13099 | 401 | 10531 |
| 4L-2S | | MI | 4893 | 2007 | 7617 | 1635 | 9129 | 1355 | 10148 | 1124 | 11615 | 750 | 14269 | 611 | 9328 |
| 8-#18 | 4.76 | MA | 6874 | 2413 | 11648 | 1899 | 14204 | 1549 | 16172 | 1249 | 19421 | 737 | 24813 | 592 | 19169 |
| 2L-4S | | MI | 4792 | 2413 | 7667 | 1922 | 9018 | 1586 | 9963 | 1277 | 11311 | 746 | 13834 | 55 | 13560 |
| 8-#18 | 4.76 | MA | 6159 | 2413 | 10072 | 1930 | 12204 | 1575 | 13748 | 1270 | 16149 | 770 | 20368 | 302 | 18809 |
| 3E | | MI | 5155 | 2413 | 8574 | 1897 | 10271 | 1545 | 11496 | 1242 | 13405 | 744 | 16293 | 207 | 15517 |
| 8-#18 | 4.76 | MA | 5752 | 2413 | 8974 | 1960 | 10684 | 1623 | 11886 | 1313 | 13604 | 781 | 17234 | 136 | 16426 |
| 4L-2S | | MI | 5709 | 2413 | 9860 | 1871 | 11902 | 1525 | 13474 | 1228 | 16075 | 720 | 19741 | 497 | 15804 |
| 10-#10 | 1.89 | MA | 5429 | 1853 | 7787 | 1582 | 9471 | 1321 | 10519 | 1112 | 11863 | 783 | 14745 | 678 | 8168 |
| 2L-5S | | MI | 4067 | 1853 | 5701 | 1591 | 6723 | 1336 | 7260 | 1125 | 7729 | 797 | 9314 | 466 | 6542 |
| 10-#10 | 1.89 | MA | 5137 | 1853 | 7258 | 1594 | 8800 | 1332 | 9706 | 1121 | 10765 | 796 | 13224 | 590 | 8151 |
| 3L-4S | | MI | 4212 | 1853 | 5971 | 1581 | 7092 | 1327 | 7718 | 1117 | 8365 | 786 | 10197 | 519 | 6798 |
| 10-#10 | 1.89 | MA | 4977 | 1853 | 6895 | 1606 | 8296 | 1349 | 9088 | 1137 | 9920 | 803 | 12181 | 538 | 8088 |
| 4L-3S | | MI | 4345 | 1853 | 6274 | 1570 | 7512 | 1311 | 8233 | 1103 | 9068 | 781 | 11078 | 573 | 6838 |
| 10-#10 | 1.89 | MA | 4788 | 1853 | 6573 | 1617 | 7854 | 1360 | 8539 | 1146 | 9158 | 817 | 11128 | 490 | 7762 |
| 5L-2S | | MI | 4584 | 1853 | 6710 | 1560 | 8066 | 1302 | 8904 | 1095 | 9974 | 769 | 12332 | 666 | 6845 |
| 10-#11 | 2.32 | MA | 5651 | 1937 | 8401 | 1624 | 10197 | 1351 | 11372 | 1128 | 12990 | 772 | 16287 | 667 | 9846 |
| 2L-5S | | MI | 4158 | 1937 | 5997 | 1636 | 7035 | 1369 | 7610 | 1143 | 8174 | 788 | 9855 | 393 | 7657 |
| 10-#11 | 2.32 | MA | 5312 | 1937 | 7762 | 1638 | 9386 | 1363 | 10389 | 1139 | 11664 | 788 | 14452 | 556 | 9812 |
| 3L-4S | | MI | 4325 | 1937 | 6324 | 1624 | 7482 | 1359 | 8164 | 1135 | 8942 | 775 | 10895 | 459 | 8122 |
| 10-#11 | 2.32 | MA | 5127 | 1937 | 7322 | 1652 | 8775 | 1384 | 9641 | 1158 | 10640 | 795 | 13178 | 491 | 9697 |
| 4L-3S | | MI | 4480 | 1937 | 6690 | 1612 | 7989 | 1340 | 8785 | 1118 | 9791 | 771 | 11938 | 524 | 8200 |
| 10-#11 | 2.32 | MA | 4907 | 1937 | 6930 | 1665 | 8239 | 1396 | 8975 | 1168 | 9716 | 811 | 11897 | 429 | 9115 |
| 5L-2S | | MI | 4757 | 1937 | 7216 | 1600 | 8656 | 1331 | 9593 | 1110 | 10882 | 758 | 13417 | 637 | 8221 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

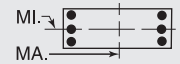



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 3.35 | MA | 6210 | 2137 | 9802 | 1742 | 11936 | 1436 | 13460 | 1180 | 15793 | 759 | 20156 | 650 | 13898 |
| 2L-5S | | MI | 4400 | 2137 | 6629 | 1765 | 7768 | 1466 | 8473 | 1205 | 9311 | 782 | 11350 | 244 | 10257 |
| 10-#14 | 3.35 | MA | 5761 | 2137 | 8892 | 1761 | 10782 | 1452 | 12062 | 1194 | 13905 | 780 | 17542 | 488 | 13796 |
| 3L-4S | | MI | 4630 | 2137 | 7095 | 1749 | 8406 | 1453 | 9263 | 1195 | 10406 | 765 | 12805 | 340 | 10877 |
| 10-#14 | 3.35 | MA | 5518 | 2137 | 8263 | 1780 | 9910 | 1481 | 10993 | 1221 | 12443 | 789 | 15713 | 392 | 13120 |
| 4L-3S | | MI | 4833 | 2137 | 7617 | 1733 | 9129 | 1428 | 10148 | 1172 | 11615 | 760 | 14269 | 430 | 11464 |
| 10-#14 | 3.35 | MA | 5213 | 2137 | 7703 | 1798 | 9142 | 1498 | 10041 | 1235 | 11123 | 810 | 13879 | 300 | 12280 |
| 5L-2S | | MI | 5200 | 2137 | 8364 | 1717 | 10076 | 1414 | 11296 | 1162 | 13165 | 744 | 16336 | 594 | 11540 |
| 10-#18 | 5.95 | MA | 6860 | 2645 | 11648 | 2075 | 14204 | 1681 | 16172 | 1337 | 19421 | 759 | 24813 | 278 | 23428 |
| 3L-4S | | MI | 5404 | 2645 | 8953 | 2067 | 10650 | 1692 | 11941 | 1344 | 13981 | 735 | 17283 | 11 | 17223 |
| 10-#18 | 5.95 | MA | 6472 | 2645 | 10550 | 2105 | 12684 | 1729 | 14310 | 1380 | 16876 | 770 | 21678 | 113 | 20974 |
| 4L-3S | | MI | 5686 | 2645 | 9860 | 2042 | 11902 | 1651 | 13474 | 1309 | 16075 | 733 | 19741 | 163 | 19102 |
| 12-#10 | 2.27 | MA | 5664 | 1927 | 8316 | 1628 | 10142 | 1355 | 11333 | 1133 | 12961 | 779 | 16265 | 673 | 9739 |
| 2L-6S | | MI | 4103 | 1927 | 5828 | 1652 | 6928 | 1379 | 7483 | 1160 | 8014 | 798 | 9706 | 389 | 7528 |
| 12-#10 | 2.27 | MA | 5382 | 1927 | 7787 | 1640 | 9471 | 1365 | 10519 | 1142 | 11863 | 793 | 14745 | 585 | 9714 |
| 3L-5S | | MI | 4273 | 1927 | 6138 | 1637 | 7277 | 1370 | 7932 | 1146 | 8636 | 794 | 10568 | 461 | 7786 |
| 12-#10 | 2.27 | MA | 5231 | 1927 | 7423 | 1652 | 8967 | 1383 | 9901 | 1158 | 11018 | 800 | 13701 | 533 | 9640 |
| 4E | | MI | 4417 | 1927 | 6407 | 1627 | 7646 | 1361 | 8390 | 1138 | 9271 | 782 | 11451 | 514 | 8079 |
| 12-#10 | 2.27 | MA | 5044 | 1927 | 7101 | 1663 | 8525 | 1393 | 9352 | 1168 | 10256 | 814 | 12648 | 485 | 9282 |
| 5L-3S | | MI | 4543 | 1927 | 6710 | 1616 | 8066 | 1345 | 8904 | 1124 | 9974 | 778 | 12332 | 568 | 8129 |
| 12-#10 | 2.27 | MA | 4838 | 1927 | 6716 | 1677 | 8107 | 1404 | 8815 | 1184 | 9511 | 820 | 11627 | 415 | 8933 |
| 6L-2S | | MI | 4774 | 1927 | 7147 | 1606 | 8620 | 1336 | 9576 | 1116 | 10881 | 766 | 13587 | 661 | 8145 |
| 12-#11 | 2.79 | MA | 5927 | 2028 | 9039 | 1681 | 11007 | 1392 | 12354 | 1154 | 14316 | 768 | 18123 | 661 | 11741 |
| 2L-6S | | MI | 4201 | 2028 | 6155 | 1711 | 7278 | 1420 | 7874 | 1186 | 8528 | 796 | 10378 | 310 | 8774 |
| 12-#11 | 2.79 | MA | 5600 | 2028 | 8401 | 1694 | 10197 | 1404 | 11372 | 1165 | 12990 | 784 | 16287 | 551 | 11694 |
| 3L-5S | | MI | 4401 | 2028 | 6523 | 1693 | 7702 | 1410 | 8418 | 1169 | 9265 | 784 | 11333 | 384 | 9156 |
| 12-#11 | 2.79 | MA | 5427 | 2028 | 7960 | 1708 | 9586 | 1425 | 10623 | 1184 | 11966 | 791 | 15014 | 485 | 11568 |
| 4E | | MI | 4566 | 2028 | 6849 | 1681 | 8149 | 1400 | 8972 | 1161 | 10033 | 771 | 12373 | 450 | 9641 |
| 12-#11 | 2.79 | MA | 5209 | 2028 | 7569 | 1722 | 9049 | 1437 | 9957 | 1194 | 11042 | 807 | 13733 | 423 | 10954 |
| 5L-3S | | MI | 4711 | 2028 | 7216 | 1669 | 8656 | 1382 | 9593 | 1145 | 10882 | 767 | 13417 | 514 | 9749 |
| 12-#11 | 2.79 | MA | 4966 | 2028 | 7109 | 1740 | 8542 | 1449 | 9305 | 1213 | 10138 | 814 | 12486 | 336 | 10483 |
| 6L-2S | | MI | 4978 | 2028 | 7741 | 1657 | 9322 | 1372 | 10401 | 1137 | 11973 | 754 | 14895 | 628 | 9781 |
| 12-#14 | 4.02 | MA | 6158 | 2268 | 9802 | 1842 | 11936 | 1512 | 13460 | 1232 | 15793 | 774 | 20156 | 479 | 16468 |
| 3L-5S | | MI | 4736 | 2268 | 7375 | 1847 | 8715 | 1526 | 9621 | 1242 | 10860 | 775 | 13417 | 227 | 12403 |
| 12-#14 | 4.02 | MA | 5934 | 2268 | 9172 | 1861 | 11064 | 1541 | 12392 | 1258 | 14331 | 783 | 18327 | 384 | 15722 |
| 4E | | MI | 4963 | 2268 | 7841 | 1830 | 9353 | 1513 | 10411 | 1232 | 11956 | 759 | 14872 | 323 | 12988 |
| 12-#14 | 4.02 | MA | 5633 | 2268 | 8612 | 1880 | 10296 | 1557 | 11440 | 1272 | 13011 | 804 | 16493 | 291 | 14921 |
| 5L-3S | | MI | 5152 | 2268 | 8364 | 1814 | 10076 | 1487 | 11296 | 1210 | 13165 | 754 | 16336 | 413 | 13653 |
| 12-#14 | 4.02 | MA | 5306 | 2268 | 7963 | 1906 | 9571 | 1574 | 10507 | 1299 | 11719 | 813 | 14703 | 164 | 13792 |
| 6L-2S | | MI | 5503 | 2268 | 9110 | 1798 | 11023 | 1474 | 12444 | 1199 | 14714 | 737 | 18403 | 577 | 13747 |
| 12-#18 | 7.14 | MA | 7222 | 2877 | 12126 | 2250 | 14684 | 1835 | 16734 | 1447 | 20148 | 759 | 26123 | 90 | 25540 |
| 4E | | MI | 5959 | 2877 | 10239 | 2212 | 12282 | 1798 | 13919 | 1411 | 16650 | 724 | 20731 | -32 | 20641 |
| 14-#10 | 2.65 | MA | 5622 | 2001 | 8316 | 1686 | 10142 | 1399 | 11333 | 1163 | 12961 | 789 | 16265 | 580 | 11275 |
| 3L-6S | | MI | 4310 | 2001 | 6265 | 1698 | 7482 | 1413 | 8155 | 1182 | 8921 | 795 | 10960 | 384 | 8789 |
| 14-#10 | 2.65 | MA | 5480 | 2001 | 7952 | 1698 | 9638 | 1417 | 10715 | 1180 | 12116 | 796 | 15221 | 528 | 11194 |
| 4L-5S | | MI | 4475 | 2001 | 6575 | 1683 | 7831 | 1404 | 8604 | 1167 | 9543 | 790 | 11823 | 456 | 9036 |
| 14-#10 | 2.65 | MA | 5295 | 2001 | 7630 | 1709 | 9196 | 1427 | 10166 | 1189 | 11353 | 810 | 14168 | 480 | 10806 |
| 5L-4S | | MI | 4617 | 2001 | 6844 | 1673 | 8201 | 1395 | 9062 | 1160 | 10178 | 779 | 12706 | 509 | 9360 |
| 14-#10 | 2.65 | MA | 5095 | 2001 | 7245 | 1723 | 8778 | 1438 | 9628 | 1205 | 10609 | 817 | 13147 | 410 | 10472 |
| 6L-3S | | MI | 4737 | 2001 | 7147 | 1662 | 8620 | 1379 | 9576 | 1145 | 10881 | 774 | 13587 | 563 | 9419 |
| 14-#10 | 2.65 | MA | 4922 | 2001 | 6906 | 1731 | 8326 | 1452 | 9110 | 1215 | 9886 | 831 | 12150 | 370 | 9976 |
| 7L-2S | | MI | 4961 | 2001 | 7584 | 1652 | 9175 | 1370 | 10248 | 1138 | 11788 | 762 | 14841 | 656 | 9442 |
| 14-#11 | 3.25 | MA | 5883 | 2118 | 9039 | 1751 | 11007 | 1446 | 12354 | 1191 | 14316 | 780 | 18123 | 545 | 13576 |
| 3L-6S | | MI | 4445 | 2118 | 6681 | 1768 | 7945 | 1462 | 8683 | 1212 | 9619 | 792 | 11857 | 301 | 10261 |
| 14-#11 | 3.25 | MA | 5720 | 2118 | 8599 | 1765 | 10396 | 1466 | 11605 | 1210 | 13292 | 787 | 16849 | 479 | 13428 |
| 4L-5S | | MI | 4638 | 2118 | 7048 | 1749 | 8368 | 1452 | 9226 | 1195 | 10356 | 779 | 12811 | 375 | 10662 |
| 14-#11 | 3.25 | MA | 5504 | 2118 | 8207 | 1778 | 9859 | 1478 | 10939 | 1220 | 12368 | 802 | 15568 | 417 | 12798 |
| 5L-4S | | MI | 4801 | 2118 | 7375 | 1737 | 8815 | 1442 | 9780 | 1187 | 11124 | 767 | 13852 | 441 | 11123 |

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

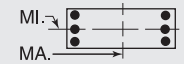



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 3.25 | MA | 5271 | 2118 | 7748 | 1796 | 9352 | 1490 | 10287 | 1239 | 11464 | 810 | 14322 | 330 | 12317 |
| 6L-3S | | MI | 4939 | 2118 | 7741 | 1725 | 9322 | 1423 | 10401 | 1171 | 11973 | 762 | 14895 | 505 | 11296 |
| 14-#11 | 3.25 | MA | 5068 | 2118 | 7337 | 1805 | 8814 | 1509 | 9658 | 1250 | 10586 | 825 | 13106 | 278 | 11650 |
| 7L-2S | | MI | 5197 | 2118 | 8267 | 1713 | 9989 | 1413 | 11209 | 1163 | 13064 | 750 | 16373 | 618 | 11339 |
| 14-#14 | 4.69 | MA | 6340 | 2398 | 10081 | 1943 | 12218 | 1600 | 13790 | 1296 | 16219 | 776 | 20942 | 375 | 18334 |
| 4L-5S | | MI | 5064 | 2398 | 8121 | 1928 | 9663 | 1586 | 10769 | 1280 | 12410 | 769 | 15484 | 210 | 14557 |
| 14-#14 | 4.69 | MA | 6042 | 2398 | 9521 | 1962 | 11450 | 1617 | 12839 | 1310 | 14899 | 798 | 19107 | 282 | 17569 |
| 5L-4S | | MI | 5289 | 2398 | 8588 | 1912 | 10300 | 1572 | 11559 | 1270 | 13505 | 752 | 16940 | 306 | 15111 |
| 14-#14 | 4.69 | MA | 5731 | 2398 | 8873 | 1988 | 10725 | 1633 | 11906 | 1336 | 13607 | 807 | 17317 | 156 | 16431 |
| 6L-3S | | MI | 5478 | 2398 | 9110 | 1896 | 11023 | 1547 | 12444 | 1247 | 14714 | 748 | 18403 | 396 | 15842 |
| 16-#10 | 3.02 | MA | 5723 | 2074 | 8481 | 1744 | 10309 | 1450 | 11528 | 1201 | 13214 | 793 | 16741 | 523 | 12748 |
| 4L-6S | | MI | 4513 | 2074 | 6701 | 1744 | 8036 | 1446 | 8827 | 1203 | 9828 | 791 | 12215 | 379 | 10053 |
| 16-#10 | 3.02 | MA | 5540 | 2074 | 8159 | 1755 | 9867 | 1461 | 10979 | 1210 | 12451 | 807 | 15688 | 475 | 12336 |
| 5E | | MI | 4673 | 2074 | 7011 | 1729 | 8386 | 1437 | 9276 | 1188 | 10450 | 787 | 13077 | 451 | 10290 |
| 16-#10 | 3.02 | MA | 5347 | 2074 | 7774 | 1769 | 9449 | 1471 | 10442 | 1226 | 11706 | 813 | 14668 | 405 | 12014 |
| 6L-4S | | MI | 4814 | 2074 | 7281 | 1719 | 8755 | 1428 | 9734 | 1181 | 11085 | 775 | 13960 | 504 | 10641 |
| 16-#10 | 3.02 | MA | 5181 | 2074 | 7434 | 1777 | 8997 | 1486 | 9924 | 1236 | 10983 | 827 | 13670 | 365 | 11510 |
| 7L-3S | | MI | 4927 | 2074 | 7584 | 1708 | 9175 | 1412 | 10248 | 1166 | 11788 | 771 | 14841 | 558 | 10707 |
| 16-#10 | 3.02 | MA | 5022 | 2074 | 7108 | 1785 | 8560 | 1493 | 9399 | 1251 | 10273 | 841 | 12710 | 312 | 11007 |
| 8L-2S | | MI | 5145 | 2074 | 8021 | 1698 | 9729 | 1403 | 10920 | 1159 | 12695 | 759 | 16096 | 651 | 10737 |
| 16-#11 | 3.71 | MA | 6007 | 2209 | 9237 | 1821 | 11206 | 1508 | 12587 | 1236 | 14618 | 782 | 18685 | 473 | 15254 |
| 4L-6S | | MI | 4684 | 2209 | 7206 | 1825 | 8612 | 1503 | 9491 | 1238 | 10710 | 788 | 13335 | 291 | 11753 |
| 16-#11 | 3.71 | MA | 5793 | 2209 | 8846 | 1835 | 10670 | 1520 | 11921 | 1246 | 13693 | 798 | 17404 | 411 | 14648 |
| 5E | | MI | 4870 | 2209 | 7574 | 1806 | 9035 | 1493 | 10034 | 1221 | 11446 | 775 | 14290 | 365 | 12172 |
| 16-#11 | 3.71 | MA | 5569 | 2209 | 8386 | 1853 | 10163 | 1532 | 11269 | 1265 | 12789 | 805 | 16157 | 324 | 14155 |
| 6L-4S | | MI | 5032 | 2209 | 7900 | 1794 | 9482 | 1483 | 10588 | 1213 | 12215 | 762 | 15330 | 431 | 12613 |
| 16-#11 | 3.71 | MA | 5375 | 2209 | 7975 | 1861 | 9624 | 1550 | 10640 | 1276 | 11912 | 821 | 14942 | 272 | 13507 |
| 7L-3S | | MI | 5162 | 2209 | 8267 | 1782 | 9989 | 1464 | 11209 | 1197 | 13064 | 758 | 16373 | 495 | 12843 |
| 16-#14 | 5.36 | MA | 6441 | 2529 | 10431 | 2043 | 12604 | 1676 | 14237 | 1347 | 16787 | 792 | 21721 | 274 | 20223 |
| 5E | | MI | 5386 | 2529 | 8868 | 2010 | 10610 | 1645 | 11917 | 1318 | 13959 | 763 | 17552 | 193 | 16684 |
| 16-#14 | 5.36 | MA | 6145 | 2529 | 9782 | 2069 | 11879 | 1693 | 13305 | 1374 | 15495 | 801 | 19931 | 147 | 19075 |
| 6L-4S | | MI | 5634 | 2529 | 9334 | 1994 | 11248 | 1632 | 12707 | 1308 | 15055 | 746 | 19007 | 289 | 17244 |
| 18-#10 | 3.40 | MA | 5780 | 2148 | 8688 | 1801 | 10538 | 1494 | 11792 | 1231 | 13549 | 803 | 17209 | 470 | 13868 |
| 5L-6S | | MI | 4713 | 2148 | 7138 | 1790 | 8591 | 1480 | 9499 | 1224 | 10735 | 788 | 13469 | 374 | 11320 |
| 18-#10 | 3.40 | MA | 5594 | 2148 | 8302 | 1815 | 10120 | 1505 | 11255 | 1248 | 12804 | 810 | 16188 | 400 | 13558 |
| 6L-5S | | MI | 4867 | 2148 | 7448 | 1775 | 8940 | 1471 | 9947 | 1210 | 11356 | 783 | 14332 | 446 | 11547 |
| 18-#10 | 3.40 | MA | 5435 | 2148 | 7963 | 1823 | 9668 | 1520 | 10737 | 1257 | 12081 | 824 | 15190 | 360 | 13047 |
| 7L-4S | | MI | 5007 | 2148 | 7718 | 1765 | 9309 | 1462 | 10405 | 1202 | 11992 | 772 | 15215 | 499 | 11922 |
| 18-#10 | 3.40 | MA | 5278 | 2148 | 7637 | 1832 | 9231 | 1527 | 10213 | 1273 | 11371 | 838 | 14230 | 307 | 12546 |
| 8L-3S | | MI | 5116 | 2148 | 8021 | 1754 | 9729 | 1446 | 10920 | 1188 | 12695 | 767 | 16096 | 553 | 11995 |
| 18-#11 | 4.18 | MA | 6076 | 2299 | 9484 | 1891 | 11480 | 1561 | 12903 | 1272 | 15019 | 794 | 19239 | 405 | 16502 |
| 5L-6S | | MI | 4919 | 2299 | 7732 | 1881 | 9279 | 1544 | 10299 | 1264 | 11801 | 783 | 14813 | 282 | 13250 |
| 18-#11 | 4.18 | MA | 5861 | 2299 | 9025 | 1909 | 10973 | 1573 | 12251 | 1291 | 14115 | 801 | 17993 | 318 | 15998 |
| 6L-5S | | MI | 5099 | 2299 | 8099 | 1862 | 9702 | 1534 | 10842 | 1247 | 12537 | 771 | 15768 | 356 | 13688 |
| 18-#11 | 4.18 | MA | 5676 | 2299 | 8614 | 1918 | 10434 | 1592 | 11622 | 1302 | 13238 | 817 | 16777 | 266 | 15367 |
| 7L-4S | | MI | 5260 | 2299 | 8426 | 1850 | 10149 | 1524 | 11397 | 1239 | 13306 | 758 | 16808 | 422 | 14109 |
| 18-#14 | 6.03 | MA | 6550 | 2659 | 10692 | 2151 | 13033 | 1752 | 14704 | 1411 | 17383 | 794 | 22546 | 139 | 21724 |
| 6L-5S | | MI | 5722 | 2659 | 9614 | 2091 | 11557 | 1705 | 13064 | 1355 | 15509 | 757 | 19619 | 176 | 18802 |
| 20-#10 | 3.78 | MA | 5837 | 2221 | 8831 | 1862 | 10791 | 1539 | 12068 | 1269 | 13902 | 806 | 17708 | 395 | 15104 |
| 6E | | MI | 4909 | 2221 | 7575 | 1836 | 9145 | 1513 | 10170 | 1245 | 11641 | 784 | 14723 | 369 | 12582 |
| 20-#10 | 3.78 | MA | 5684 | 2221 | 8492 | 1869 | 10339 | 1553 | 11550 | 1278 | 13179 | 820 | 16710 | 356 | 14587 |
| 7L-5S | | MI | 5059 | 2221 | 7885 | 1821 | 9494 | 1504 | 10619 | 1231 | 12263 | 780 | 15586 | 441 | 12808 |
| 20-#10 | 3.78 | MA | 5529 | 2221 | 8165 | 1878 | 9902 | 1560 | 11026 | 1294 | 12469 | 834 | 15750 | 302 | 14086 |
| 8L-4S | | MI | 5198 | 2221 | 8154 | 1811 | 9863 | 1496 | 11077 | 1223 | 12898 | 768 | 16469 | 494 | 13204 |
| 20-#11 | 4.64 | MA | 6147 | 2390 | 9663 | 1966 | 11783 | 1614 | 13233 | 1318 | 15441 | 797 | 19828 | 312 | 17844 |
| 6E | | MI | 5150 | 2390 | 8257 | 1938 | 9946 | 1585 | 11107 | 1290 | 12892 | 779 | 16292 | 273 | 14752 |
| 20-#11 | 4.64 | MA | 5971 | 2390 | 9252 | 1974 | 11245 | 1633 | 12604 | 1328 | 14563 | 812 | 18613 | 260 | 17229 |
| 7L-5S | | MI | 5324 | 2390 | 8624 | 1919 | 10369 | 1576 | 11651 | 1274 | 13628 | 766 | 17246 | 346 | 15206 |

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

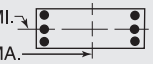
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 4.16 | MA | 5928 | 2295 | 9021 | 1915 | 11010 | 1587 | 12364 | 1300 | 14277 | 817 | 18231 | 351 | 16128 |
| 7L-6S | | MI | 5102 | 2295 | 8012 | 1882 | 9699 | 1547 | 10842 | 1267 | 12548 | 781 | 15978 | 364 | 13831 |
| 22-#10 | 4.16 | MA | 5775 | 2295 | 8694 | 1924 | 10573 | 1594 | 11839 | 1315 | 13567 | 831 | 17271 | 297 | 15629 |
| 8L-5S | | MI | 5248 | 2295 | 8322 | 1867 | 10048 | 1538 | 11291 | 1252 | 13170 | 776 | 16841 | 436 | 14072 |
| 22-#11 | 5.11 | MA | 6260 | 2480 | 9891 | 2031 | 12055 | 1674 | 13586 | 1354 | 15889 | 808 | 20448 | 254 | 19094 |
| 7L-6S | | MI | 5378 | 2480 | 8783 | 1994 | 10613 | 1627 | 11915 | 1316 | 13983 | 775 | 17770 | 263 | 16257 |
| **RECTANGULAR TIED COLUMNS 24" x 30"** | | | | | | | | | | | | | | | |
| 4-#14 | 1.25 | MA | 5739 | 1852 | 7942 | 1603 | 9561 | 1348 | 10463 | 1146 | 11421 | 840 | 13869 | 731 | 6270 |
| 2E | | MI | 4511 | 1852 | 6455 | 1566 | 7616 | 1315 | 8249 | 1118 | 8903 | 818 | 10563 | 694 | 4890 |
| 4-#18 | 2.22 | MA | 6365 | 2055 | 9501 | 1715 | 11457 | 1428 | 12720 | 1194 | 14432 | 821 | 18011 | 709 | 10704 |
| 2E | | MI | 4951 | 2055 | 7625 | 1674 | 9023 | 1392 | 9916 | 1163 | 11121 | 797 | 13269 | 632 | 8225 |
| 6-#10 | 1.06 | MA | 5640 | 1812 | 7563 | 1596 | 9179 | 1345 | 10050 | 1148 | 10909 | 852 | 13192 | 743 | 5421 |
| 2L-3S | | MI | 4191 | 1812 | 5723 | 1573 | 6781 | 1325 | 7285 | 1131 | 7643 | 844 | 9002 | 633 | 4262 |
| 6-#10 | 1.06 | MA | 5294 | 1812 | 6988 | 1608 | 8450 | 1356 | 9166 | 1158 | 9715 | 867 | 11539 | 657 | 5428 |
| 3L-2S | | MI | 4449 | 1812 | 6160 | 1563 | 7336 | 1316 | 7957 | 1123 | 8549 | 833 | 10256 | 725 | 4246 |
| 6-#11 | 1.30 | MA | 5797 | 1863 | 7995 | 1617 | 9669 | 1359 | 10615 | 1155 | 11645 | 844 | 14192 | 734 | 6546 |
| 2L-3S | | MI | 4255 | 1863 | 5967 | 1593 | 7035 | 1338 | 7565 | 1136 | 7997 | 835 | 9412 | 591 | 5117 |
| 6-#11 | 1.30 | MA | 5389 | 1863 | 7300 | 1632 | 8787 | 1372 | 9546 | 1166 | 10202 | 861 | 12194 | 626 | 6545 |
| 3L-2S | | MI | 4557 | 1863 | 6492 | 1581 | 7702 | 1328 | 8373 | 1128 | 9088 | 823 | 10890 | 705 | 5102 |
| 6-#14 | 1.88 | MA | 6189 | 1983 | 8933 | 1685 | 10819 | 1407 | 11987 | 1184 | 13479 | 834 | 16717 | 722 | 9231 |
| 2L-3S | | MI | 4427 | 1983 | 6455 | 1663 | 7616 | 1388 | 8249 | 1166 | 8903 | 828 | 10563 | 513 | 7121 |
| 6-#14 | 1.88 | MA | 5636 | 1983 | 7942 | 1705 | 9561 | 1425 | 10463 | 1199 | 11421 | 857 | 13869 | 564 | 9182 |
| 3L-2S | | MI | 4836 | 1983 | 7202 | 1647 | 8563 | 1375 | 9397 | 1156 | 10452 | 811 | 12630 | 677 | 7134 |
| 6-#18 | 3.33 | MA | 7093 | 2287 | 11222 | 1860 | 13641 | 1534 | 15367 | 1261 | 18005 | 810 | 22957 | 694 | 15808 |
| 2L-3S | | MI | 4833 | 2287 | 7625 | 1844 | 9023 | 1518 | 9916 | 1243 | 11121 | 810 | 13269 | 298 | 11848 |
| 6-#18 | 3.33 | MA | 6226 | 2287 | 9501 | 1893 | 11457 | 1562 | 12720 | 1284 | 14432 | 847 | 18011 | 403 | 15496 |
| 3L-2S | | MI | 5476 | 2287 | 8911 | 1819 | 10654 | 1498 | 11894 | 1230 | 13791 | 786 | 16718 | 589 | 12047 |
| 8-#9 | 1.11 | MA | 5691 | 1823 | 7632 | 1607 | 9289 | 1353 | 10195 | 1154 | 11113 | 854 | 13482 | 744 | 5694 |
| 2L-4S | | MI | 4169 | 1823 | 5625 | 1591 | 6649 | 1345 | 7130 | 1148 | 7435 | 848 | 8798 | 612 | 4471 |
| 8-#9 | 1.11 | MA | 5419 | 1823 | 7177 | 1617 | 8711 | 1362 | 9495 | 1162 | 10168 | 866 | 12173 | 677 | 5699 |
| 3E | | MI | 4285 | 1823 | 5865 | 1583 | 6981 | 1333 | 7537 | 1136 | 7992 | 844 | 9494 | 655 | 4467 |
| 8-#9 | 1.11 | MA | 5267 | 1823 | 6866 | 1626 | 8279 | 1376 | 8965 | 1176 | 9443 | 872 | 11286 | 636 | 5684 |
| 4L-2S | | MI | 4488 | 1823 | 6211 | 1574 | 7421 | 1325 | 8070 | 1130 | 8711 | 835 | 10490 | 727 | 4456 |
| 8-#10 | 1.41 | MA | 5912 | 1886 | 8137 | 1642 | 9908 | 1378 | 10935 | 1169 | 12102 | 849 | 14844 | 738 | 7141 |
| 2L-4S | | MI | 4257 | 1886 | 5857 | 1630 | 6916 | 1375 | 7443 | 1166 | 7846 | 845 | 9375 | 573 | 5550 |
| 8-#10 | 1.41 | MA | 5578 | 1886 | 7563 | 1654 | 9179 | 1389 | 10050 | 1179 | 10909 | 864 | 13192 | 652 | 7135 |
| 3E | | MI | 4399 | 1886 | 6160 | 1619 | 7336 | 1359 | 7957 | 1152 | 8549 | 841 | 10256 | 628 | 5568 |
| 8-#10 | 1.41 | MA | 5392 | 1886 | 7169 | 1667 | 8633 | 1407 | 9381 | 1196 | 9992 | 871 | 12068 | 600 | 7085 |
| 4L-2S | | MI | 4648 | 1886 | 6597 | 1609 | 7890 | 1350 | 8629 | 1144 | 9456 | 829 | 11511 | 720 | 5561 |
| 8-#11 | 1.73 | MA | 6116 | 1953 | 8690 | 1674 | 10551 | 1400 | 11684 | 1181 | 13088 | 840 | 16190 | 728 | 8622 |
| 2L-4S | | MI | 4332 | 1953 | 6126 | 1662 | 7195 | 1398 | 7752 | 1179 | 8239 | 835 | 9847 | 518 | 6633 |
| 8-#11 | 1.73 | MA | 5725 | 1953 | 7995 | 1688 | 9669 | 1413 | 10615 | 1192 | 11645 | 856 | 14192 | 620 | 8602 |
| 3E | | MI | 4499 | 1953 | 6492 | 1650 | 7702 | 1379 | 8373 | 1162 | 9088 | 831 | 10890 | 582 | 6680 |
| 8-#11 | 1.73 | MA | 5507 | 1953 | 7517 | 1703 | 9007 | 1434 | 9803 | 1212 | 10534 | 865 | 12819 | 555 | 8503 |
| 4L-2S | | MI | 4789 | 1953 | 7018 | 1638 | 8369 | 1370 | 9181 | 1154 | 10178 | 818 | 12369 | 695 | 6680 |
| 8-#14 | 2.50 | MA | 6624 | 2113 | 9924 | 1766 | 12076 | 1467 | 13511 | 1222 | 15536 | 828 | 19566 | 713 | 12176 |
| 2L-4S | | MI | 4540 | 2113 | 6679 | 1761 | 7840 | 1473 | 8512 | 1226 | 9243 | 826 | 11166 | 406 | 8921 |
| 8-#14 | 2.50 | MA | 6100 | 2113 | 8933 | 1786 | 10819 | 1484 | 11987 | 1237 | 13479 | 851 | 16717 | 555 | 12096 |
| 3E | | MI | 4763 | 2113 | 7202 | 1745 | 8563 | 1448 | 9397 | 1204 | 10452 | 822 | 12630 | 496 | 9318 |
| 8-#14 | 2.50 | MA | 5808 | 2113 | 8250 | 1806 | 9871 | 1515 | 10826 | 1265 | 11891 | 861 | 14746 | 461 | 11582 |
| 4L-2S | | MI | 5153 | 2113 | 7948 | 1729 | 9510 | 1435 | 10545 | 1194 | 12002 | 805 | 14697 | 660 | 9360 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis



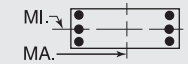

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 4.44 | MA | 7799 | 2519 | 12942 | 2005 | 15825 | 1639 | 18014 | 1328 | 21578 | 799 | 27903 | 679 | 20897 |
| 2L-4S | | MI | 5042 | 2519 | 8004 | 2014 | 9402 | 1665 | 10360 | 1346 | 11696 | 801 | 14259 | 103 | 13739 |
| 8-#18 | 4.44 | MA | 6995 | 2519 | 11222 | 2038 | 13641 | 1668 | 15367 | 1351 | 18005 | 836 | 22957 | 388 | 20537 |
| 3E | | MI | 5411 | 2519 | 8911 | 1989 | 10654 | 1623 | 11894 | 1310 | 13791 | 799 | 16718 | 255 | 15593 |
| 8-#18 | 4.44 | MA | 6547 | 2519 | 10028 | 2071 | 11988 | 1718 | 13342 | 1397 | 15236 | 851 | 19482 | 217 | 18083 |
| 4L-2S | | MI | 5976 | 2519 | 10196 | 1964 | 12286 | 1604 | 13871 | 1297 | 16461 | 775 | 20166 | 545 | 15849 |
| 10-#10 | 1.76 | MA | 6177 | 1959 | 8712 | 1688 | 10638 | 1412 | 11819 | 1190 | 13295 | 845 | 16497 | 733 | 8854 |
| 2L-5S | | MI | 4322 | 1959 | 6024 | 1686 | 7101 | 1417 | 7657 | 1195 | 8118 | 854 | 9747 | 515 | 6630 |
| 10-#10 | 1.76 | MA | 5855 | 1959 | 8137 | 1700 | 9908 | 1423 | 10935 | 1200 | 12102 | 860 | 14844 | 647 | 8837 |
| 3L-4S | | MI | 4467 | 1959 | 6294 | 1676 | 7470 | 1408 | 8115 | 1188 | 8753 | 842 | 10629 | 569 | 6834 |
| 10-#10 | 1.76 | MA | 5679 | 1959 | 7744 | 1713 | 9362 | 1441 | 10265 | 1217 | 11185 | 868 | 13720 | 595 | 8774 |
| 4L-3S | | MI | 4601 | 1959 | 6597 | 1665 | 7890 | 1392 | 8629 | 1173 | 9456 | 837 | 11511 | 623 | 6865 |
| 10-#10 | 1.76 | MA | 5468 | 1959 | 7395 | 1725 | 8884 | 1452 | 9671 | 1227 | 10360 | 883 | 12583 | 550 | 8478 |
| 5L-2S | | MI | 4843 | 1959 | 7034 | 1655 | 8444 | 1383 | 9300 | 1166 | 10363 | 826 | 12765 | 715 | 6868 |
| 10-#11 | 2.17 | MA | 6426 | 2043 | 9385 | 1730 | 11433 | 1441 | 12753 | 1207 | 14531 | 835 | 18188 | 722 | 10689 |
| 2L-5S | | MI | 4413 | 2043 | 6325 | 1730 | 7415 | 1449 | 8006 | 1213 | 8561 | 844 | 10285 | 442 | 7757 |
| 10-#11 | 2.17 | MA | 6052 | 2043 | 8690 | 1745 | 10551 | 1454 | 11684 | 1218 | 13088 | 852 | 16190 | 614 | 10654 |
| 3L-4S | | MI | 4580 | 2043 | 6652 | 1718 | 7862 | 1439 | 8560 | 1205 | 9330 | 831 | 11325 | 508 | 8170 |
| 10-#11 | 2.17 | MA | 5847 | 2043 | 8212 | 1759 | 9889 | 1476 | 10872 | 1238 | 11977 | 860 | 14818 | 549 | 10540 |
| 4L-3S | | MI | 4737 | 2043 | 7018 | 1706 | 8369 | 1421 | 9181 | 1188 | 10178 | 827 | 12369 | 573 | 8235 |
| 10-#11 | 2.17 | MA | 5600 | 2043 | 7788 | 1773 | 9307 | 1489 | 10150 | 1250 | 10974 | 877 | 13433 | 491 | 9965 |
| 5L-2S | | MI | 5017 | 2043 | 7543 | 1695 | 9036 | 1411 | 9990 | 1180 | 11269 | 814 | 13847 | 686 | 8250 |
| 10-#14 | 3.13 | MA | 7047 | 2243 | 10915 | 1848 | 13334 | 1526 | 15036 | 1259 | 17593 | 821 | 22415 | 705 | 15113 |
| 2L-5S | | MI | 4654 | 2243 | 6959 | 1859 | 8150 | 1546 | 8870 | 1274 | 9698 | 837 | 11778 | 293 | 10381 |
| 10-#14 | 3.13 | MA | 6550 | 2243 | 9924 | 1868 | 12076 | 1544 | 13511 | 1275 | 15536 | 844 | 19566 | 547 | 15011 |
| 3L-4S | | MI | 4883 | 2243 | 7426 | 1842 | 8788 | 1533 | 9660 | 1264 | 10793 | 820 | 13234 | 389 | 11012 |
| 10-#14 | 3.13 | MA | 6282 | 2243 | 9241 | 1888 | 11129 | 1574 | 12351 | 1302 | 13948 | 855 | 17594 | 452 | 14412 |
| 4L-3S | | MI | 5091 | 2243 | 7948 | 1826 | 9510 | 1507 | 10545 | 1241 | 12002 | 816 | 14697 | 479 | 11509 |
| 10-#14 | 3.13 | MA | 5939 | 2243 | 8634 | 1908 | 10297 | 1592 | 11318 | 1318 | 12515 | 878 | 15610 | 364 | 13440 |
| 5L-2S | | MI | 5463 | 2243 | 8694 | 1810 | 10457 | 1494 | 11693 | 1231 | 13552 | 799 | 16765 | 642 | 11575 |
| 10-#18 | 5.56 | MA | 7776 | 2751 | 12942 | 2183 | 15825 | 1774 | 18014 | 1418 | 21578 | 825 | 27903 | 373 | 25588 |
| 3L-4S | | MI | 5654 | 2751 | 9290 | 2159 | 11034 | 1771 | 12338 | 1413 | 14366 | 790 | 17708 | 59 | 17393 |
| 10-#18 | 5.56 | MA | 7342 | 2751 | 11749 | 2216 | 14172 | 1824 | 15988 | 1464 | 18808 | 840 | 24429 | 202 | 23066 |
| 4L-3S | | MI | 5944 | 2751 | 10196 | 2134 | 12286 | 1729 | 13871 | 1377 | 16461 | 788 | 20166 | 211 | 19329 |
| 10-#18 | 5.56 | MA | 6773 | 2751 | 10687 | 2248 | 12717 | 1852 | 14184 | 1488 | 16306 | 876 | 20948 | 34 | 20796 |
| 5L-2S | | MI | 6464 | 2751 | 11482 | 2109 | 13918 | 1710 | 15849 | 1364 | 19131 | 764 | 23615 | 502 | 19642 |
| 12-#10 | 2.12 | MA | 6437 | 2033 | 9287 | 1734 | 11367 | 1445 | 12703 | 1212 | 14489 | 842 | 18149 | 728 | 10562 |
| 2L-6S | | MI | 4356 | 2033 | 6151 | 1747 | 7306 | 1460 | 7879 | 1231 | 8403 | 855 | 10138 | 439 | 7612 |
| 12-#10 | 2.12 | MA | 6125 | 2033 | 8712 | 1746 | 10638 | 1457 | 11819 | 1222 | 13295 | 857 | 16497 | 642 | 10537 |
| 3L-5S | | MI | 4529 | 2033 | 6461 | 1732 | 7655 | 1451 | 8328 | 1217 | 9025 | 850 | 11001 | 510 | 7872 |
| 12-#10 | 2.12 | MA | 5959 | 2033 | 8318 | 1759 | 10092 | 1475 | 11149 | 1239 | 12379 | 864 | 15373 | 590 | 10463 |
| 4E | | MI | 4672 | 2033 | 6731 | 1722 | 8025 | 1442 | 8786 | 1209 | 9660 | 838 | 11884 | 564 | 8117 |
| 12-#10 | 2.12 | MA | 5750 | 2033 | 7970 | 1771 | 9613 | 1486 | 10555 | 1249 | 11553 | 879 | 14235 | 545 | 10133 |
| 5L-3S | | MI | 4800 | 2033 | 7034 | 1711 | 8444 | 1426 | 9300 | 1194 | 10363 | 834 | 12765 | 618 | 8159 |
| 12-#10 | 2.12 | MA | 5523 | 2033 | 7547 | 1785 | 9161 | 1497 | 9973 | 1266 | 10747 | 887 | 13136 | 475 | 9736 |
| 6L-2S | | MI | 5034 | 2033 | 7470 | 1701 | 8999 | 1417 | 9972 | 1187 | 11270 | 822 | 14020 | 710 | 8171 |
| 12-#11 | 2.60 | MA | 6731 | 2134 | 10080 | 1787 | 12315 | 1483 | 13822 | 1233 | 15974 | 831 | 20186 | 716 | 12751 |
| 2L-6S | | MI | 4454 | 2134 | 6483 | 1806 | 7659 | 1500 | 8271 | 1256 | 8916 | 852 | 10809 | 359 | 8932 |
| 12-#11 | 2.60 | MA | 6370 | 2134 | 9385 | 1801 | 11433 | 1496 | 12753 | 1244 | 14531 | 848 | 18188 | 608 | 12705 |
| 3L-5S | | MI | 4656 | 2134 | 6850 | 1787 | 8082 | 1491 | 8814 | 1239 | 9652 | 839 | 11763 | 433 | 9253 |
| 12-#11 | 2.60 | MA | 6178 | 2134 | 8907 | 1816 | 10771 | 1517 | 11941 | 1264 | 13420 | 856 | 16816 | 543 | 12578 |
| 4E | | MI | 4821 | 2134 | 7177 | 1775 | 8529 | 1481 | 9369 | 1231 | 10421 | 827 | 12804 | 499 | 9707 |
| 12-#11 | 2.60 | MA | 5934 | 2134 | 8483 | 1830 | 10189 | 1530 | 11219 | 1276 | 12418 | 873 | 15431 | 485 | 11971 |
| 5L-3S | | MI | 4969 | 2134 | 7543 | 1763 | 9036 | 1462 | 9990 | 1215 | 11269 | 822 | 13847 | 563 | 9786 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

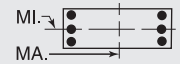



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.60 | MA | 5667 | 2134 | 7977 | 1847 | 9640 | 1543 | 10513 | 1296 | 11438 | 881 | 14088 | 398 | 11515 |
| 6L-2S | | MI | 5239 | 2134 | 8069 | 1751 | 9703 | 1452 | 10798 | 1207 | 12360 | 810 | 15325 | 676 | 9812 |
| 12-#14 | 3.75 | MA | 6988 | 2374 | 10915 | 1949 | 13334 | 1604 | 15036 | 1312 | 17593 | 838 | 22415 | 538 | 17926 |
| 3L-5S | | MI | 4991 | 2374 | 7706 | 1940 | 9097 | 1606 | 10018 | 1312 | 11247 | 831 | 13846 | 276 | 12523 |
| 12-#14 | 3.75 | MA | 6742 | 2374 | 10232 | 1969 | 12387 | 1634 | 13875 | 1340 | 16005 | 849 | 20443 | 444 | 17255 |
| 4E | | MI | 5218 | 2374 | 8172 | 1924 | 9735 | 1593 | 10808 | 1302 | 12343 | 814 | 15301 | 371 | 13119 |
| 12-#14 | 3.75 | MA | 6403 | 2374 | 9625 | 1989 | 11555 | 1651 | 12842 | 1355 | 14573 | 872 | 18459 | 356 | 16325 |
| 5L-3S | | MI | 5410 | 2374 | 8694 | 1908 | 10457 | 1567 | 11693 | 1279 | 13552 | 810 | 16765 | 462 | 13700 |
| 12-#14 | 3.75 | MA | 6042 | 2374 | 8910 | 2015 | 10769 | 1669 | 11831 | 1383 | 13172 | 883 | 16529 | 230 | 15176 |
| 6L-2S | | MI | 5767 | 2374 | 9441 | 1892 | 11404 | 1554 | 12840 | 1269 | 15101 | 793 | 18832 | 625 | 13784 |
| 12-#18 | 6.67 | MA | 8175 | 2983 | 13470 | 2361 | 16356 | 1930 | 18635 | 1531 | 22381 | 829 | 29375 | 187 | 28066 |
| 4E | | MI | 6211 | 2983 | 10576 | 2304 | 12666 | 1877 | 14316 | 1480 | 17036 | 778 | 21156 | 16 | 21068 |
| 12-#18 | 6.67 | MA | 7548 | 2983 | 12408 | 2393 | 14901 | 1958 | 16831 | 1555 | 19878 | 865 | 25895 | 19 | 25805 |
| 5L-3S | | MI | 6463 | 2983 | 11482 | 2279 | 13918 | 1835 | 15849 | 1444 | 19131 | 777 | 23615 | 168 | 22904 |
| 14-#10 | 2.47 | MA | 6390 | 2107 | 9287 | 1792 | 11367 | 1490 | 12703 | 1243 | 14489 | 853 | 18149 | 637 | 12235 |
| 3L-6S | | MI | 4564 | 2107 | 6588 | 1793 | 7860 | 1494 | 8551 | 1252 | 9310 | 851 | 11393 | 434 | 8871 |
| 14-#10 | 2.47 | MA | 6233 | 2107 | 8893 | 1805 | 10821 | 1508 | 12033 | 1260 | 13572 | 861 | 17025 | 585 | 12154 |
| 4L-5S | | MI | 4731 | 2107 | 6898 | 1778 | 8210 | 1485 | 9000 | 1238 | 9931 | 847 | 12256 | 505 | 9119 |
| 14-#10 | 2.47 | MA | 6026 | 2107 | 8545 | 1817 | 10342 | 1519 | 11439 | 1270 | 12747 | 876 | 15888 | 540 | 11794 |
| 5L-4S | | MI | 4873 | 2107 | 7167 | 1768 | 8579 | 1476 | 9458 | 1230 | 10567 | 835 | 13138 | 559 | 9399 |
| 14-#10 | 2.47 | MA | 5807 | 2107 | 8122 | 1831 | 9891 | 1531 | 10857 | 1287 | 11940 | 883 | 14789 | 470 | 11411 |
| 6L-3S | | MI | 4995 | 2107 | 7470 | 1757 | 8999 | 1460 | 9972 | 1216 | 11270 | 830 | 14020 | 613 | 9449 |
| 14-#10 | 2.47 | MA | 5617 | 2107 | 7754 | 1839 | 9393 | 1545 | 10297 | 1297 | 11158 | 898 | 13713 | 433 | 10924 |
| 7L-2S | | MI | 5222 | 2107 | 7907 | 1747 | 9553 | 1451 | 10644 | 1208 | 12176 | 819 | 15274 | 705 | 9469 |
| 14-#11 | 3.03 | MA | 6682 | 2224 | 10080 | 1858 | 12315 | 1537 | 13822 | 1271 | 15974 | 844 | 20186 | 602 | 14755 |
| 3L-6S | | MI | 4699 | 2224 | 7008 | 1862 | 8325 | 1542 | 9079 | 1282 | 10007 | 848 | 12287 | 350 | 10414 |
| 14-#11 | 3.03 | MA | 6502 | 2224 | 9602 | 1872 | 11653 | 1558 | 13010 | 1291 | 14863 | 852 | 18814 | 537 | 14619 |
| 4L-5S | | MI | 4894 | 2224 | 7376 | 1843 | 8748 | 1532 | 9623 | 1265 | 10743 | 835 | 13242 | 423 | 10756 |
| 14-#11 | 3.03 | MA | 6260 | 2224 | 9178 | 1886 | 11071 | 1571 | 12288 | 1302 | 13861 | 869 | 17429 | 479 | 13982 |
| 5L-4S | | MI | 5057 | 2224 | 7702 | 1831 | 9196 | 1522 | 10177 | 1257 | 11512 | 822 | 14282 | 489 | 11232 |
| 14-#11 | 3.03 | MA | 6003 | 2224 | 8672 | 1904 | 10522 | 1584 | 11582 | 1322 | 12881 | 877 | 16086 | 392 | 13536 |
| 6L-3S | | MI | 5197 | 2224 | 8069 | 1819 | 9703 | 1503 | 10798 | 1241 | 12360 | 818 | 15325 | 554 | 11334 |
| 14-#11 | 3.03 | MA | 5780 | 2224 | 8226 | 1913 | 9928 | 1602 | 10900 | 1333 | 11930 | 894 | 14774 | 343 | 12768 |
| 7L-2S | | MI | 5459 | 2224 | 8594 | 1808 | 10369 | 1493 | 11606 | 1233 | 13451 | 805 | 16804 | 667 | 11370 |
| 14-#14 | 4.38 | MA | 7189 | 2504 | 11223 | 2051 | 13644 | 1693 | 15399 | 1378 | 18063 | 843 | 23292 | 435 | 20108 |
| 4L-5S | | MI | 5320 | 2504 | 8452 | 2022 | 10044 | 1665 | 11165 | 1350 | 12797 | 824 | 15913 | 259 | 14672 |
| 14-#14 | 4.38 | MA | 6854 | 2504 | 10616 | 2071 | 12812 | 1711 | 14367 | 1393 | 16630 | 866 | 21308 | 347 | 19215 |
| 5L-4S | | MI | 5545 | 2504 | 8918 | 2006 | 10682 | 1652 | 11956 | 1339 | 13892 | 808 | 17368 | 354 | 15237 |
| 14-#14 | 4.38 | MA | 6511 | 2504 | 9901 | 2096 | 12026 | 1729 | 13356 | 1421 | 15229 | 877 | 19378 | 222 | 18062 |
| 6L-3S | | MI | 5724 | 2504 | 9441 | 1989 | 11404 | 1627 | 12840 | 1317 | 15101 | 803 | 18832 | 445 | 15890 |
| 14-#18 | 7.78 | MA | 8354 | 3215 | 14129 | 2538 | 17085 | 2064 | 19478 | 1622 | 23451 | 854 | 30841 | 4 | 30823 |
| 5L-4S | | MI | 6752 | 3215 | 11861 | 2449 | 14297 | 1983 | 16294 | 1547 | 19706 | 767 | 24604 | -27 | 24513 |
| 16-#10 | 2.82 | MA | 6502 | 2180 | 9468 | 1851 | 11551 | 1542 | 12917 | 1281 | 14766 | 857 | 18678 | 581 | 13845 |
| 4L-6S | | MI | 4768 | 2180 | 7025 | 1839 | 8415 | 1527 | 9223 | 1274 | 10217 | 848 | 12647 | 429 | 10133 |
| 16-#10 | 2.82 | MA | 6296 | 2180 | 9120 | 1863 | 11072 | 1553 | 12323 | 1291 | 13940 | 872 | 17540 | 535 | 13458 |
| 5E | | MI | 4930 | 2180 | 7335 | 1824 | 8764 | 1518 | 9672 | 1259 | 10838 | 843 | 13510 | 500 | 10371 |
| 16-#10 | 2.82 | MA | 6085 | 2180 | 8697 | 1877 | 10620 | 1564 | 11741 | 1308 | 13134 | 880 | 16441 | 465 | 13089 |
| 6L-4S | | MI | 5071 | 2180 | 7604 | 1814 | 9133 | 1509 | 10130 | 1252 | 11473 | 831 | 14393 | 554 | 10681 |
| 16-#10 | 2.82 | MA | 5902 | 2180 | 8329 | 1885 | 10122 | 1579 | 11181 | 1318 | 12351 | 894 | 15366 | 428 | 12596 |
| 7L-3S | | MI | 5187 | 2180 | 7907 | 1803 | 9553 | 1493 | 10644 | 1237 | 12176 | 827 | 15274 | 608 | 10739 |
| 16-#10 | 2.82 | MA | 5725 | 2180 | 7975 | 1894 | 9649 | 1586 | 10603 | 1333 | 11582 | 909 | 14330 | 377 | 12098 |
| 8L-2S | | MI | 5407 | 2180 | 8344 | 1793 | 10107 | 1484 | 11316 | 1230 | 13083 | 815 | 16529 | 700 | 10764 |
| 16-#11 | 3.47 | MA | 6818 | 2315 | 10297 | 1929 | 12535 | 1600 | 14079 | 1317 | 16306 | 848 | 20812 | 532 | 16661 |
| 4L-6S | | MI | 4939 | 2315 | 7534 | 1919 | 8992 | 1583 | 9887 | 1308 | 11098 | 844 | 13765 | 340 | 11902 |
| 16-#11 | 3.47 | MA | 6579 | 2315 | 9873 | 1943 | 11953 | 1612 | 13357 | 1328 | 15304 | 864 | 19427 | 473 | 15999 |
| 5E | | MI | 5127 | 2315 | 7901 | 1900 | 9415 | 1573 | 10431 | 1291 | 11834 | 831 | 14720 | 414 | 12265 |
| 16-#11 | 3.47 | MA | 6332 | 2315 | 9367 | 1960 | 11404 | 1625 | 12651 | 1348 | 14324 | 873 | 18084 | 386 | 15544 |
| 6L-4S | | MI | 5289 | 2315 | 8228 | 1888 | 9862 | 1563 | 10985 | 1283 | 12602 | 818 | 15760 | 480 | 12719 |

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 3.47 | MA | 6119 | 2315 | 8921 | 1969 | 10810 | 1644 | 11969 | 1359 | 13374 | 890 | 16772 | 337 | 14795 |
| 7L-3S | | MI | 5422 | 2315 | 8594 | 1876 | 10369 | 1545 | 11606 | 1267 | 13451 | 814 | 16804 | 544 | 12881 |
| 16-#14 | 5.00 | MA | 7295 | 2635 | 11607 | 2152 | 14070 | 1771 | 15891 | 1431 | 18687 | 860 | 24156 | 339 | 22112 |
| 5E | | MI | 5643 | 2635 | 9198 | 2103 | 10991 | 1725 | 12313 | 1387 | 14346 | 818 | 17980 | 241 | 16828 |
| 16-#14 | 5.00 | MA | 6968 | 2635 | 10892 | 2178 | 13284 | 1788 | 14880 | 1458 | 17286 | 870 | 22227 | 213 | 20953 |
| 6L-4S | | MI | 5866 | 2635 | 9665 | 2087 | 11629 | 1712 | 13104 | 1377 | 15442 | 801 | 19436 | 337 | 17365 |
| 18-#10 | 3.17 | MA | 6561 | 2254 | 9695 | 1909 | 11801 | 1587 | 13207 | 1312 | 15134 | 868 | 19193 | 530 | 15127 |
| 5L-6S | | MI | 4968 | 2254 | 7461 | 1885 | 8969 | 1561 | 9895 | 1295 | 11123 | 844 | 13902 | 424 | 11398 |
| 18-#10 | 3.17 | MA | 6357 | 2254 | 9272 | 1923 | 11350 | 1598 | 12626 | 1329 | 14327 | 876 | 18094 | 461 | 14770 |
| 6L-5S | | MI | 5125 | 2254 | 7771 | 1870 | 9318 | 1552 | 10344 | 1280 | 11745 | 840 | 14765 | 495 | 11627 |
| 18-#10 | 3.17 | MA | 6182 | 2254 | 8904 | 1931 | 10852 | 1612 | 12065 | 1339 | 13545 | 891 | 17018 | 423 | 14271 |
| 7L-4S | | MI | 5265 | 2254 | 8041 | 1860 | 9687 | 1543 | 10802 | 1273 | 12380 | 828 | 15647 | 549 | 11963 |
| 18-#10 | 3.17 | MA | 6006 | 2254 | 8550 | 1940 | 10379 | 1620 | 11487 | 1354 | 12776 | 906 | 15982 | 372 | 13781 |
| 8L-3S | | MI | 5376 | 2254 | 8344 | 1849 | 10107 | 1527 | 11316 | 1258 | 13083 | 823 | 16529 | 603 | 12027 |
| 18-#11 | 3.90 | MA | 6891 | 2405 | 10568 | 1999 | 12835 | 1654 | 14426 | 1354 | 16747 | 860 | 21425 | 467 | 18020 |
| 5L-6S | | MI | 5175 | 2405 | 8059 | 1975 | 9659 | 1624 | 10696 | 1334 | 12189 | 839 | 15244 | 331 | 13395 |
| 18-#11 | 3.90 | MA | 6653 | 2405 | 10063 | 2017 | 12286 | 1667 | 13720 | 1374 | 15767 | 868 | 20082 | 380 | 17556 |
| 6L-5S | | MI | 5356 | 2405 | 8427 | 1956 | 10082 | 1615 | 11239 | 1317 | 12925 | 826 | 16198 | 405 | 13778 |
| 18-#11 | 3.90 | MA | 6450 | 2405 | 9617 | 2026 | 11692 | 1685 | 13038 | 1385 | 14817 | 885 | 18770 | 331 | 16824 |
| 7L-4S | | MI | 5518 | 2405 | 8753 | 1944 | 10529 | 1605 | 11793 | 1309 | 13693 | 814 | 17239 | 471 | 14212 |
| 18-#14 | 5.63 | MA | 7415 | 2765 | 11883 | 2259 | 14542 | 1848 | 16404 | 1496 | 19344 | 864 | 25076 | 205 | 23847 |
| 6L-5S | | MI | 5981 | 2765 | 9945 | 2185 | 11938 | 1785 | 13461 | 1425 | 15896 | 812 | 20048 | 224 | 18990 |
| 20-#10 | 3.53 | MA | 6624 | 2328 | 9846 | 1969 | 12079 | 1631 | 13510 | 1351 | 15521 | 873 | 19746 | 456 | 16453 |
| 6E | | MI | 5165 | 2328 | 7898 | 1931 | 9523 | 1594 | 10566 | 1316 | 12030 | 841 | 15156 | 419 | 12666 |
| 20-#10 | 3.53 | MA | 6456 | 2328 | 9479 | 1977 | 11581 | 1646 | 12949 | 1361 | 14738 | 887 | 18670 | 418 | 15948 |
| 7L-5S | | MI | 5318 | 2328 | 8208 | 1916 | 9872 | 1586 | 11015 | 1302 | 12652 | 836 | 16019 | 490 | 12886 |
| 20-#10 | 3.53 | MA | 6282 | 2328 | 9125 | 1986 | 11108 | 1653 | 12371 | 1376 | 13969 | 902 | 17635 | 367 | 15461 |
| 8L-4S | | MI | 5457 | 2328 | 8478 | 1906 | 10242 | 1577 | 11473 | 1294 | 13287 | 824 | 16902 | 544 | 13245 |
| 20-#11 | 4.33 | MA | 6969 | 2496 | 10758 | 2073 | 13168 | 1708 | 14789 | 1400 | 17210 | 864 | 22080 | 374 | 19571 |
| 6E | | MI | 5406 | 2496 | 8585 | 2032 | 10326 | 1666 | 11504 | 1360 | 13280 | 835 | 16722 | 321 | 14893 |
| 20-#11 | 4.33 | MA | 6775 | 2496 | 10312 | 2083 | 12574 | 1726 | 14107 | 1411 | 16260 | 881 | 20768 | 325 | 18856 |
| 7L-5S | | MI | 5583 | 2496 | 8952 | 2013 | 10749 | 1656 | 12047 | 1344 | 14016 | 822 | 17677 | 395 | 15295 |
| 22-#10 | 3.88 | MA | 6725 | 2401 | 10053 | 2023 | 12311 | 1679 | 13833 | 1382 | 15932 | 884 | 20323 | 413 | 17627 |
| 7L-6S | | MI | 5360 | 2401 | 8335 | 1977 | 10077 | 1628 | 11238 | 1337 | 12937 | 837 | 16411 | 414 | 13935 |
| 22-#10 | 3.88 | MA | 6553 | 2401 | 9700 | 2032 | 11838 | 1687 | 13255 | 1397 | 15163 | 899 | 19287 | 362 | 17143 |
| 8L-5S | | MI | 5508 | 2401 | 8645 | 1962 | 10427 | 1619 | 11687 | 1323 | 13558 | 833 | 17274 | 485 | 14148 |
| 22-#11 | 4.77 | MA | 7094 | 2586 | 11007 | 2139 | 13456 | 1767 | 15177 | 1438 | 17703 | 877 | 22766 | 319 | 20890 |
| 7L-6S | | MI | 5635 | 2586 | 9110 | 2088 | 10993 | 1707 | 12312 | 1386 | 14371 | 831 | 18200 | 312 | 16395 |
| 24-#10 | 4.23 | MA | 6820 | 2475 | 10274 | 2078 | 12567 | 1721 | 14139 | 1418 | 16356 | 895 | 20939 | 357 | 18826 |
| 8L-6S | | MI | 5551 | 2475 | 8772 | 2023 | 10632 | 1662 | 11910 | 1359 | 13844 | 834 | 17665 | 409 | 15206 |

## RECTANGULAR TIED COLUMNS 24" x 32"

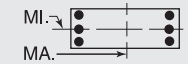
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.17 | MA | 6492 | 1958 | 8854 | 1709 | 10706 | 1438 | 11726 | 1225 | 12780 | 903 | 15501 | 786 | 6756 |
| 2E | | MI | 4767 | 1958 | 6786 | 1659 | 7997 | 1395 | 8646 | 1188 | 9290 | 873 | 10991 | 742 | 4915 |
| 4-#18 | 2.08 | MA | 7186 | 2161 | 10548 | 1821 | 12768 | 1518 | 14180 | 1273 | 16054 | 884 | 20006 | 765 | 11568 |
| 2E | | MI | 5210 | 2161 | 7961 | 1766 | 9407 | 1471 | 10313 | 1231 | 11506 | 851 | 13694 | 680 | 8260 |
| 6-#11 | 1.22 | MA | 6554 | 1969 | 8908 | 1723 | 10820 | 1449 | 11887 | 1234 | 13017 | 907 | 15845 | 789 | 7051 |
| 2L-3S | | MI | 4510 | 1969 | 6295 | 1687 | 7415 | 1418 | 7961 | 1206 | 8384 | 891 | 9842 | 640 | 5143 |
| 6-#11 | 1.22 | MA | 6108 | 1969 | 8157 | 1738 | 9866 | 1463 | 10731 | 1246 | 11457 | 925 | 13685 | 683 | 7051 |
| 3L-2S | | MI | 4814 | 1969 | 6820 | 1676 | 8082 | 1408 | 8770 | 1198 | 9475 | 878 | 11321 | 754 | 5125 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

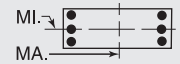



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.76 | MA | 6987 | 2089 | 9926 | 1791 | 12067 | 1498 | 13375 | 1263 | 15006 | 897 | 18584 | 777 | 9960 |
| 2L-3S | | MI | 4682 | 2089 | 6786 | 1757 | 7997 | 1468 | 8646 | 1236 | 9290 | 883 | 10991 | 562 | 7159 |
| 6-#14 | 1.76 | MA | 6380 | 2089 | 8854 | 1812 | 10706 | 1516 | 11726 | 1279 | 12780 | 921 | 15501 | 622 | 9911 |
| 3L-2S | | MI | 5095 | 2089 | 7533 | 1741 | 8944 | 1455 | 9794 | 1225 | 10839 | 867 | 13058 | 725 | 7163 |
| 6-#18 | 3.13 | MA | 7987 | 2393 | 12414 | 1966 | 15136 | 1624 | 17050 | 1340 | 19927 | 873 | 25369 | 749 | 17104 |
| 2L-3S | | MI | 5087 | 2393 | 7961 | 1936 | 9407 | 1596 | 10313 | 1312 | 11506 | 864 | 13694 | 346 | 11918 |
| 6-#18 | 3.13 | MA | 7032 | 2393 | 10548 | 2001 | 12768 | 1654 | 14180 | 1366 | 16054 | 913 | 20006 | 465 | 16792 |
| 3L-2S | | MI | 5738 | 2393 | 9247 | 1911 | 11038 | 1577 | 12291 | 1298 | 14176 | 840 | 17143 | 637 | 12088 |
| 8-#9 | 1.04 | MA | 6435 | 1929 | 8513 | 1713 | 10404 | 1443 | 11427 | 1233 | 12434 | 917 | 15067 | 799 | 6126 |
| 2L-4S | | MI | 4424 | 1929 | 5947 | 1687 | 7026 | 1427 | 7526 | 1219 | 7824 | 905 | 9231 | 662 | 4494 |
| 8-#9 | 1.04 | MA | 6138 | 1929 | 8021 | 1723 | 9781 | 1453 | 10671 | 1241 | 11414 | 929 | 13654 | 733 | 6131 |
| 3E | | MI | 4540 | 1929 | 6186 | 1678 | 7359 | 1414 | 7933 | 1207 | 8381 | 901 | 9928 | 704 | 4487 |
| 8-#9 | 1.04 | MA | 5972 | 1929 | 7686 | 1733 | 9315 | 1467 | 10100 | 1255 | 10633 | 936 | 12704 | 693 | 6116 |
| 4L-2S | | MI | 4745 | 1929 | 6533 | 1670 | 7798 | 1407 | 8466 | 1201 | 9100 | 891 | 10924 | 776 | 4475 |
| 8-#10 | 1.32 | MA | 6678 | 1992 | 9059 | 1748 | 11074 | 1469 | 12227 | 1248 | 13505 | 912 | 16541 | 793 | 7689 |
| 2L-4S | | MI | 4511 | 1992 | 6181 | 1725 | 7294 | 1456 | 7839 | 1237 | 8235 | 902 | 9808 | 623 | 5581 |
| 8-#10 | 1.32 | MA | 6313 | 1992 | 8438 | 1761 | 10287 | 1480 | 11272 | 1259 | 12216 | 927 | 14756 | 709 | 7683 |
| 3E | | MI | 4654 | 1992 | 6484 | 1714 | 7714 | 1440 | 8353 | 1223 | 8938 | 897 | 10689 | 677 | 5591 |
| 8-#10 | 1.32 | MA | 6110 | 1992 | 8014 | 1774 | 9698 | 1499 | 10551 | 1276 | 11228 | 936 | 13552 | 657 | 7634 |
| 4L-2S | | MI | 4905 | 1992 | 6920 | 1704 | 8268 | 1431 | 9025 | 1215 | 9845 | 885 | 11944 | 769 | 5582 |
| 8-#11 | 1.63 | MA | 6904 | 2059 | 9660 | 1780 | 11774 | 1491 | 13043 | 1260 | 14578 | 902 | 18006 | 783 | 9295 |
| 2L-4S | | MI | 4587 | 2059 | 6454 | 1756 | 7575 | 1478 | 8149 | 1249 | 8626 | 891 | 10278 | 567 | 6676 |
| 8-#11 | 1.63 | MA | 6477 | 2059 | 8908 | 1795 | 10820 | 1504 | 11887 | 1272 | 13017 | 920 | 15845 | 677 | 9276 |
| 3E | | MI | 4755 | 2059 | 6820 | 1744 | 8082 | 1460 | 8770 | 1232 | 9475 | 887 | 11321 | 631 | 6710 |
| 8-#11 | 1.63 | MA | 6238 | 2059 | 8393 | 1810 | 10106 | 1526 | 11011 | 1293 | 11818 | 930 | 14374 | 613 | 9177 |
| 4L-2S | | MI | 5047 | 2059 | 7346 | 1732 | 8749 | 1450 | 9578 | 1224 | 10566 | 874 | 12799 | 744 | 6706 |
| 8-#14 | 2.34 | MA | 7465 | 2219 | 10999 | 1872 | 13428 | 1557 | 15025 | 1300 | 17233 | 890 | 21668 | 768 | 13148 |
| 2L-4S | | MI | 4793 | 2219 | 7010 | 1854 | 8222 | 1553 | 8909 | 1296 | 9630 | 882 | 11595 | 454 | 9058 |
| 8-#14 | 2.34 | MA | 6890 | 2219 | 9926 | 1893 | 12067 | 1576 | 13375 | 1317 | 15006 | 915 | 18584 | 614 | 13068 |
| 3E | | MI | 5019 | 2219 | 7533 | 1838 | 8944 | 1528 | 9794 | 1273 | 10839 | 877 | 13058 | 545 | 9359 |
| 8-#14 | 2.34 | MA | 6571 | 2219 | 9189 | 1914 | 11045 | 1607 | 12123 | 1346 | 13292 | 927 | 16470 | 521 | 12650 |
| 4L-2S | | MI | 5413 | 2219 | 8279 | 1822 | 9891 | 1514 | 10941 | 1263 | 12389 | 861 | 15126 | 708 | 9392 |
| 8-#18 | 4.17 | MA | 8761 | 2625 | 14280 | 2111 | 17503 | 1730 | 19919 | 1406 | 23801 | 862 | 30733 | 734 | 22625 |
| 2L-4S | | MI | 5293 | 2625 | 8341 | 2106 | 9786 | 1744 | 10757 | 1415 | 12081 | 855 | 14684 | 150 | 13914 |
| 8-#18 | 4.17 | MA | 7877 | 2625 | 12414 | 2146 | 15136 | 1760 | 17050 | 1433 | 19927 | 902 | 25369 | 450 | 22265 |
| 3E | | MI | 5667 | 2625 | 9247 | 2081 | 11038 | 1702 | 12291 | 1379 | 14176 | 853 | 17143 | 303 | 15664 |
| 8-#18 | 4.17 | MA | 7387 | 2625 | 11125 | 2180 | 13349 | 1813 | 14861 | 1481 | 16934 | 920 | 21640 | 281 | 19764 |
| 4L-2S | | MI | 6243 | 2625 | 10533 | 2056 | 12670 | 1683 | 14269 | 1365 | 16846 | 829 | 20591 | 593 | 15893 |
| 10-#10 | 1.65 | MA | 6969 | 2065 | 9680 | 1794 | 11862 | 1502 | 13182 | 1269 | 14794 | 908 | 18326 | 788 | 9540 |
| 2L-5S | | MI | 4576 | 2065 | 6348 | 1781 | 7479 | 1498 | 8053 | 1266 | 8506 | 910 | 10180 | 565 | 6715 |
| 10-#10 | 1.65 | MA | 6616 | 2065 | 9059 | 1807 | 11074 | 1514 | 12227 | 1280 | 13505 | 924 | 16541 | 704 | 9523 |
| 3L-4S | | MI | 4722 | 2065 | 6617 | 1771 | 7849 | 1489 | 8511 | 1258 | 9142 | 898 | 11062 | 618 | 6868 |
| 10-#10 | 1.65 | MA | 6425 | 2065 | 8635 | 1820 | 10486 | 1533 | 11506 | 1298 | 12517 | 932 | 15337 | 652 | 9460 |
| 4L-3S | | MI | 4858 | 2065 | 6920 | 1760 | 8268 | 1473 | 9025 | 1244 | 9845 | 894 | 11944 | 672 | 6892 |
| 10-#10 | 1.65 | MA | 6190 | 2065 | 8261 | 1832 | 9971 | 1544 | 10866 | 1308 | 11628 | 948 | 14115 | 609 | 9203 |
| 5L-2S | | MI | 5101 | 2065 | 7357 | 1750 | 8822 | 1464 | 9696 | 1236 | 10751 | 882 | 13198 | 764 | 6891 |
| 10-#11 | 2.03 | MA | 7246 | 2150 | 10411 | 1836 | 12728 | 1532 | 14199 | 1286 | 16138 | 898 | 20166 | 777 | 11531 |
| 2L-5S | | MI | 4667 | 2150 | 6653 | 1824 | 7795 | 1530 | 8403 | 1283 | 8949 | 899 | 10715 | 491 | 7854 |
| 10-#11 | 2.03 | MA | 6834 | 2150 | 9660 | 1851 | 11774 | 1545 | 13043 | 1298 | 14578 | 916 | 18006 | 671 | 11497 |
| 3L-4S | | MI | 4834 | 2150 | 6979 | 1812 | 8242 | 1520 | 8957 | 1275 | 9717 | 887 | 11756 | 557 | 8216 |
| 10-#11 | 2.03 | MA | 6611 | 2150 | 9145 | 1866 | 11059 | 1568 | 12167 | 1319 | 13379 | 925 | 16534 | 607 | 11382 |
| 4L-3S | | MI | 4993 | 2150 | 7346 | 1800 | 8749 | 1501 | 9578 | 1258 | 10566 | 883 | 12799 | 621 | 8268 |
| 10-#11 | 2.03 | MA | 6336 | 2150 | 8689 | 1881 | 10433 | 1581 | 11389 | 1331 | 12299 | 943 | 15046 | 551 | 10825 |
| 5L-2S | | MI | 5276 | 2150 | 7871 | 1789 | 9416 | 1491 | 10386 | 1250 | 11657 | 870 | 14277 | 735 | 8277 |
| 10-#14 | 2.93 | MA | 7930 | 2350 | 12071 | 1954 | 14789 | 1617 | 16675 | 1338 | 19460 | 884 | 24751 | 760 | 16328 |
| 2L-5S | | MI | 4908 | 2350 | 7290 | 1952 | 8531 | 1626 | 9266 | 1344 | 10084 | 892 | 12207 | 341 | 10501 |
| 10-#14 | 2.93 | MA | 7384 | 2350 | 10999 | 1975 | 13428 | 1636 | 15025 | 1355 | 17233 | 909 | 21668 | 605 | 16226 |
| 3L-4S | | MI | 5137 | 2350 | 7757 | 1936 | 9169 | 1613 | 10057 | 1334 | 11180 | 875 | 13662 | 437 | 11144 |

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

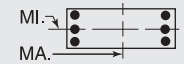
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.93 | MA | 7090 | 2350 | 10262 | 1996 | 12406 | 1667 | 13772 | 1384 | 15519 | 921 | 19553 | 512 | 15722 |
| 4L-3S | | MI | 5348 | 2350 | 8279 | 1920 | 9891 | 1587 | 10941 | 1311 | 12389 | 871 | 15126 | 527 | 11553 |
| 10-#14 | 2.93 | MA | 6708 | 2350 | 9609 | 2017 | 11510 | 1685 | 12660 | 1400 | 13974 | 946 | 17419 | 428 | 14612 |
| 5L-2S | | MI | 5724 | 2350 | 9025 | 1904 | 10839 | 1574 | 12089 | 1301 | 13938 | 854 | 17193 | 691 | 11609 |
| 10-#18 | 5.21 | MA | 8691 | 2857 | 14280 | 2291 | 17503 | 1866 | 19919 | 1500 | 23801 | 891 | 30733 | 435 | 27748 |
| 3L-4S | | MI | 5905 | 2857 | 9626 | 2251 | 11418 | 1850 | 12735 | 1482 | 14751 | 844 | 18132 | 107 | 17559 |
| 10-#18 | 5.21 | MA | 8258 | 2857 | 12991 | 2325 | 15717 | 1919 | 17731 | 1548 | 20807 | 909 | 27004 | 266 | 25183 |
| 4L-3S | | MI | 6203 | 2857 | 10533 | 2226 | 12670 | 1808 | 14269 | 1446 | 16846 | 842 | 20591 | 259 | 19416 |
| 10-#18 | 5.21 | MA | 7623 | 2857 | 11846 | 2360 | 14147 | 1949 | 15783 | 1574 | 18105 | 948 | 23256 | 106 | 22815 |
| 5L-2S | | MI | 6734 | 2857 | 11819 | 2201 | 14302 | 1789 | 16247 | 1432 | 19516 | 818 | 24040 | 550 | 19687 |
| 12-#10 | 1.98 | MA | 7254 | 2139 | 10301 | 1840 | 12650 | 1536 | 14137 | 1291 | 16083 | 905 | 20110 | 783 | 11385 |
| 2L-6S | | MI | 4610 | 2139 | 6475 | 1842 | 7684 | 1541 | 8276 | 1302 | 8792 | 911 | 10571 | 488 | 7692 |
| 12-#10 | 1.98 | MA | 6912 | 2139 | 9680 | 1853 | 11862 | 1548 | 13182 | 1301 | 14794 | 920 | 18326 | 699 | 11360 |
| 3L-5S | | MI | 4784 | 2139 | 6785 | 1827 | 8034 | 1532 | 8724 | 1287 | 9413 | 906 | 11434 | 560 | 7954 |
| 12-#10 | 1.98 | MA | 6731 | 2139 | 9256 | 1866 | 11274 | 1566 | 12460 | 1319 | 13806 | 929 | 17122 | 648 | 11286 |
| 4E | | MI | 4927 | 2139 | 7054 | 1817 | 8403 | 1523 | 9182 | 1280 | 10049 | 895 | 12317 | 613 | 8153 |
| 12-#10 | 1.98 | MA | 6500 | 2139 | 8881 | 1878 | 10759 | 1578 | 11821 | 1329 | 12917 | 944 | 15900 | 604 | 10994 |
| 5L-3S | | MI | 5057 | 2139 | 7357 | 1806 | 8822 | 1507 | 9696 | 1265 | 10751 | 890 | 13198 | 667 | 8187 |
| 12-#10 | 1.98 | MA | 6252 | 2139 | 8421 | 1892 | 10273 | 1589 | 11195 | 1347 | 12049 | 953 | 14723 | 535 | 10545 |
| 6L-2S | | MI | 5293 | 2139 | 7794 | 1796 | 9377 | 1498 | 10368 | 1258 | 11658 | 878 | 14453 | 759 | 8195 |
| 12-#11 | 2.44 | MA | 7580 | 2240 | 11163 | 1893 | 13682 | 1573 | 15355 | 1312 | 17699 | 894 | 22327 | 771 | 13762 |
| 2L-6S | | MI | 4707 | 2240 | 6811 | 1900 | 8039 | 1581 | 8668 | 1326 | 9304 | 908 | 11239 | 408 | 9055 |
| 12-#11 | 2.44 | MA | 7183 | 2240 | 10411 | 1908 | 12728 | 1587 | 14199 | 1324 | 16138 | 912 | 20166 | 665 | 13716 |
| 3L-5S | | MI | 4911 | 2240 | 7178 | 1881 | 8462 | 1571 | 9211 | 1309 | 10040 | 895 | 12194 | 482 | 9348 |
| 12-#11 | 2.44 | MA | 6974 | 2240 | 9896 | 1923 | 12013 | 1609 | 13323 | 1345 | 14939 | 921 | 18695 | 601 | 13589 |
| 4E | | MI | 5076 | 2240 | 7505 | 1869 | 8909 | 1561 | 9765 | 1301 | 10808 | 882 | 13234 | 548 | 9754 |
| 12-#11 | 2.44 | MA | 6702 | 2240 | 9440 | 1938 | 11387 | 1622 | 12545 | 1357 | 13859 | 939 | 17207 | 545 | 12998 |
| 5L-3S | | MI | 5227 | 2240 | 7871 | 1857 | 9416 | 1542 | 10386 | 1284 | 11657 | 878 | 14277 | 612 | 9821 |
| 12-#11 | 2.44 | MA | 6411 | 2240 | 8888 | 1955 | 10796 | 1636 | 11785 | 1378 | 12804 | 948 | 15768 | 459 | 12486 |
| 6L-2S | | MI | 5500 | 2240 | 8397 | 1845 | 10083 | 1532 | 11194 | 1276 | 12748 | 865 | 15756 | 725 | 9842 |
| 12-#14 | 3.52 | MA | 7864 | 2480 | 12071 | 2056 | 14789 | 1695 | 16675 | 1392 | 19460 | 903 | 24751 | 597 | 19384 |
| 3L-5S | | MI | 5246 | 2480 | 8037 | 2034 | 9478 | 1686 | 10414 | 1382 | 11634 | 886 | 14274 | 324 | 12638 |
| 12-#14 | 3.52 | MA | 7594 | 2480 | 11334 | 2077 | 13767 | 1726 | 15422 | 1421 | 17746 | 915 | 22636 | 503 | 18807 |
| 4E | | MI | 5473 | 2480 | 8503 | 2017 | 10116 | 1672 | 11205 | 1371 | 12729 | 869 | 15729 | 420 | 13246 |
| 12-#14 | 3.52 | MA | 7217 | 2480 | 10681 | 2098 | 12871 | 1745 | 14309 | 1438 | 16201 | 940 | 20503 | 419 | 17740 |
| 5L-3S | | MI | 5669 | 2480 | 9025 | 2001 | 10839 | 1647 | 12089 | 1349 | 13938 | 865 | 17193 | 510 | 13745 |
| 12-#14 | 3.52 | MA | 6822 | 2480 | 9899 | 2123 | 12024 | 1764 | 13220 | 1467 | 14690 | 952 | 18434 | 295 | 16582 |
| 6L-2S | | MI | 6030 | 2480 | 9772 | 1985 | 11786 | 1634 | 13237 | 1338 | 15488 | 848 | 19260 | 674 | 13820 |
| 12-#18 | 6.25 | MA | 9099 | 3089 | 14856 | 2470 | 18085 | 2025 | 20600 | 1615 | 24681 | 898 | 32367 | 251 | 30618 |
| 4E | | MI | 6463 | 3089 | 10912 | 2396 | 13049 | 1956 | 14713 | 1548 | 17421 | 833 | 21581 | 64 | 21226 |
| 12-#18 | 6.25 | MA | 8472 | 3089 | 13712 | 2505 | 16515 | 2055 | 18653 | 1641 | 21978 | 937 | 28620 | 91 | 28242 |
| 5L-3S | | MI | 6723 | 3089 | 11819 | 2371 | 14302 | 1914 | 16247 | 1513 | 19516 | 831 | 24040 | 216 | 23118 |
| 14-#10 | 2.32 | MA | 7203 | 2213 | 10301 | 1899 | 12650 | 1581 | 14137 | 1322 | 16083 | 917 | 20110 | 694 | 13195 |
| 3L-6S | | MI | 4819 | 2213 | 6911 | 1888 | 8239 | 1575 | 8947 | 1323 | 9698 | 907 | 11826 | 483 | 8950 |
| 14-#10 | 2.32 | MA | 7031 | 2213 | 9877 | 1912 | 12062 | 1600 | 13415 | 1340 | 15095 | 925 | 18907 | 643 | 13114 |
| 4L-5S | | MI | 4987 | 2213 | 7221 | 1873 | 8588 | 1566 | 9396 | 1308 | 10320 | 903 | 12689 | 555 | 9200 |
| 14-#10 | 2.32 | MA | 6801 | 2213 | 9502 | 1924 | 11547 | 1611 | 12776 | 1351 | 14206 | 941 | 17685 | 599 | 12790 |
| 5L-4S | | MI | 5129 | 2213 | 7491 | 1863 | 8957 | 1557 | 9854 | 1301 | 10955 | 891 | 13571 | 608 | 9436 |
| 14-#10 | 2.32 | MA | 6562 | 2213 | 9041 | 1938 | 11061 | 1623 | 12150 | 1368 | 13338 | 949 | 16508 | 530 | 12356 |
| 6L-3S | | MI | 5253 | 2213 | 7794 | 1852 | 9377 | 1541 | 10368 | 1286 | 11658 | 887 | 14453 | 662 | 9479 |
| 14-#10 | 2.32 | MA | 6355 | 2213 | 8645 | 1946 | 10518 | 1637 | 11547 | 1379 | 12496 | 964 | 15354 | 494 | 11884 |
| 7L-2S | | MI | 5483 | 2213 | 8231 | 1842 | 9931 | 1532 | 11040 | 1279 | 12565 | 875 | 15707 | 754 | 9494 |
| 14-#11 | 2.84 | MA | 7525 | 2330 | 11163 | 1964 | 13682 | 1628 | 15355 | 1350 | 17699 | 907 | 22327 | 659 | 15935 |
| 3L-6S | | MI | 4953 | 2330 | 7336 | 1956 | 8706 | 1622 | 9476 | 1352 | 10395 | 904 | 12717 | 399 | 10563 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

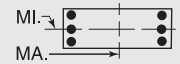



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.84 | MA | 7328 | 2330 | 10648 | 1979 | 12967 | 1650 | 14479 | 1371 | 16500 | 917 | 20856 | 596 | 15798 |
| 4L-5S | | MI | 5150 | 2330 | 7704 | 1937 | 9129 | 1612 | 10019 | 1335 | 11131 | 891 | 13672 | 472 | 10848 |
| 14-#11 | 2.84 | MA | 7059 | 2330 | 10192 | 1994 | 12341 | 1664 | 13701 | 1383 | 15420 | 935 | 19367 | 539 | 15176 |
| 5L-4S | | MI | 5313 | 2330 | 8030 | 1925 | 9576 | 1602 | 10573 | 1327 | 11899 | 878 | 14712 | 538 | 11293 |
| 14-#11 | 2.84 | MA | 6779 | 2330 | 9640 | 2011 | 11750 | 1677 | 12941 | 1404 | 14365 | 944 | 17928 | 453 | 14684 |
| 6L-3S | | MI | 5456 | 2330 | 8397 | 1914 | 10083 | 1584 | 11194 | 1311 | 12748 | 874 | 15756 | 603 | 11371 |
| 14-#11 | 2.84 | MA | 6535 | 2330 | 9159 | 2021 | 11100 | 1695 | 12207 | 1416 | 13341 | 962 | 16520 | 407 | 13900 |
| 7L-2S | | MI | 5721 | 2330 | 8922 | 1902 | 10750 | 1574 | 12003 | 1303 | 13839 | 861 | 17234 | 716 | 11401 |
| 14-#14 | 4.10 | MA | 8084 | 2610 | 12407 | 2159 | 15128 | 1786 | 17071 | 1459 | 19972 | 909 | 25720 | 495 | 21902 |
| 4L-5S | | MI | 5576 | 2610 | 8783 | 2115 | 10425 | 1745 | 11562 | 1419 | 13184 | 880 | 16341 | 307 | 14784 |
| 14-#14 | 4.10 | MA | 7711 | 2610 | 11754 | 2180 | 14232 | 1805 | 15959 | 1476 | 18427 | 933 | 23586 | 411 | 20873 |
| 5L-4S | | MI | 5800 | 2610 | 9249 | 2099 | 11063 | 1732 | 12353 | 1409 | 14279 | 863 | 17797 | 403 | 15360 |
| 14-#14 | 4.10 | MA | 7336 | 2610 | 10971 | 2205 | 13385 | 1823 | 14869 | 1505 | 16917 | 946 | 21518 | 286 | 19716 |
| 6L-3S | | MI | 5984 | 2610 | 9772 | 2083 | 11786 | 1706 | 13237 | 1386 | 15488 | 859 | 19260 | 493 | 15937 |
| 14-#14 | 4.10 | MA | 7009 | 2610 | 10284 | 2218 | 12466 | 1850 | 13819 | 1521 | 15452 | 970 | 19496 | 216 | 18412 |
| 7L-2S | | MI | 6332 | 2610 | 10518 | 2067 | 12733 | 1693 | 14385 | 1376 | 17038 | 842 | 21328 | 657 | 16026 |
| 14-#18 | 7.29 | MA | 9358 | 3321 | 15578 | 2650 | 18883 | 2161 | 21523 | 1708 | 25852 | 926 | 33983 | 76 | 33670 |
| 5L-4S | | MI | 7005 | 3321 | 12198 | 2541 | 14681 | 2062 | 16691 | 1615 | 20091 | 822 | 25029 | 21 | 24911 |
| 16-#10 | 2.65 | MA | 7324 | 2286 | 10498 | 1958 | 12850 | 1633 | 14370 | 1361 | 16384 | 922 | 20691 | 638 | 14942 |
| 4L-6S | | MI | 5023 | 2286 | 7348 | 1934 | 8793 | 1608 | 9619 | 1344 | 10605 | 904 | 13080 | 478 | 10210 |
| 16-#10 | 2.65 | MA | 7097 | 2286 | 10123 | 1970 | 12335 | 1645 | 13731 | 1372 | 15495 | 937 | 19470 | 594 | 14590 |
| 5E | | MI | 5186 | 2286 | 7658 | 1919 | 9142 | 1599 | 10068 | 1330 | 11227 | 899 | 13943 | 550 | 10450 |
| 16-#10 | 2.65 | MA | 6866 | 2286 | 9662 | 1984 | 11849 | 1657 | 13105 | 1389 | 14627 | 945 | 18293 | 525 | 14171 |
| 6L-4S | | MI | 5328 | 2286 | 7928 | 1909 | 9511 | 1590 | 10526 | 1322 | 11862 | 888 | 14826 | 603 | 10719 |
| 16-#10 | 2.65 | MA | 6667 | 2286 | 9266 | 1992 | 11306 | 1671 | 12502 | 1400 | 13785 | 961 | 17139 | 490 | 13695 |
| 7L-3S | | MI | 5446 | 2286 | 8231 | 1898 | 9931 | 1574 | 11040 | 1308 | 12565 | 883 | 15707 | 657 | 10770 |
| 16-#10 | 2.65 | MA | 6470 | 2286 | 8885 | 2002 | 10796 | 1679 | 11871 | 1415 | 12958 | 976 | 16027 | 440 | 13143 |
| 8L-2S | | MI | 5669 | 2286 | 8667 | 1888 | 10485 | 1565 | 11712 | 1300 | 13472 | 871 | 16962 | 749 | 10791 |
| 16-#11 | 3.25 | MA | 7675 | 2421 | 11399 | 2036 | 13921 | 1692 | 15635 | 1397 | 18060 | 912 | 23016 | 590 | 18009 |
| 4L-6S | | MI | 5194 | 2421 | 7862 | 2013 | 9372 | 1663 | 10284 | 1378 | 11486 | 899 | 14196 | 389 | 12047 |
| 16-#11 | 3.25 | MA | 7408 | 2421 | 10944 | 2051 | 13294 | 1705 | 14857 | 1409 | 16980 | 930 | 21528 | 533 | 17360 |
| 5E | | MI | 5384 | 2421 | 8229 | 1994 | 9795 | 1653 | 10827 | 1361 | 12222 | 886 | 15150 | 463 | 12355 |
| 16-#11 | 3.25 | MA | 7139 | 2421 | 10391 | 2068 | 12704 | 1719 | 14097 | 1430 | 15925 | 940 | 20089 | 448 | 16886 |
| 6L-4S | | MI | 5546 | 2421 | 8556 | 1982 | 10242 | 1644 | 11382 | 1353 | 12990 | 874 | 16191 | 529 | 12822 |
| 16-#11 | 3.25 | MA | 6906 | 2421 | 9910 | 2078 | 12054 | 1736 | 13363 | 1442 | 14901 | 958 | 18681 | 401 | 16097 |
| 7L-3S | | MI | 5682 | 2421 | 8922 | 1970 | 10750 | 1625 | 12003 | 1337 | 13839 | 870 | 17234 | 593 | 12919 |
| 16-#11 | 3.25 | MA | 6675 | 2421 | 9447 | 2089 | 11435 | 1745 | 12609 | 1461 | 13896 | 975 | 17325 | 338 | 15295 |
| 8L-2S | | MI | 5939 | 2421 | 9447 | 1958 | 11416 | 1615 | 12811 | 1329 | 14930 | 857 | 18712 | 706 | 12958 |
| 16-#14 | 4.69 | MA | 8193 | 2741 | 12826 | 2261 | 15593 | 1864 | 17608 | 1513 | 20654 | 927 | 26669 | 402 | 24013 |
| 5E | | MI | 5899 | 2741 | 9529 | 2197 | 11373 | 1805 | 12710 | 1457 | 14733 | 874 | 18409 | 290 | 16937 |
| 16-#14 | 4.69 | MA | 7836 | 2741 | 12044 | 2286 | 14746 | 1883 | 16519 | 1542 | 19144 | 939 | 24601 | 278 | 22854 |
| 6L-4S | | MI | 6122 | 2741 | 9996 | 2181 | 12010 | 1792 | 13501 | 1447 | 15829 | 857 | 19864 | 386 | 17485 |
| 16-#14 | 4.69 | MA | 7527 | 2741 | 11356 | 2299 | 13827 | 1909 | 15468 | 1559 | 17678 | 964 | 22579 | 208 | 21539 |
| 7L-3S | | MI | 6307 | 2741 | 10518 | 2164 | 12733 | 1766 | 14385 | 1424 | 17038 | 852 | 21328 | 476 | 18128 |
| 18-#10 | 2.98 | MA | 7387 | 2360 | 10744 | 2016 | 13122 | 1679 | 14686 | 1393 | 16784 | 934 | 21254 | 589 | 16394 |
| 5L-6S | | MI | 5224 | 2360 | 7785 | 1980 | 9347 | 1642 | 10291 | 1365 | 11512 | 900 | 14335 | 473 | 11474 |
| 18-#10 | 2.98 | MA | 7163 | 2360 | 10283 | 2030 | 12637 | 1690 | 14060 | 1411 | 15916 | 942 | 20077 | 520 | 15988 |
| 6L-5S | | MI | 5383 | 2360 | 8095 | 1965 | 9696 | 1633 | 10740 | 1351 | 12134 | 896 | 15198 | 545 | 11704 |
| 18-#10 | 2.98 | MA | 6972 | 2360 | 9887 | 2038 | 12093 | 1704 | 13457 | 1421 | 15074 | 957 | 18923 | 485 | 15508 |
| 7L-4S | | MI | 5523 | 2360 | 8364 | 1955 | 10066 | 1624 | 11198 | 1343 | 12769 | 884 | 16080 | 598 | 12002 |
| 18-#10 | 2.98 | MA | 6778 | 2360 | 9506 | 2048 | 11584 | 1712 | 12826 | 1436 | 14247 | 973 | 17812 | 435 | 14963 |
| 8L-3S | | MI | 5636 | 2360 | 8667 | 1944 | 10485 | 1608 | 11712 | 1329 | 13472 | 880 | 16962 | 652 | 12059 |
| 18-#10 | 2.98 | MA | 6547 | 2360 | 9136 | 2058 | 11088 | 1721 | 12200 | 1443 | 13406 | 981 | 16714 | 390 | 14263 |
| 9L-2S | | MI | 5854 | 2360 | 9104 | 1934 | 11039 | 1599 | 12384 | 1321 | 14379 | 868 | 18216 | 744 | 12086 |
| 18-#11 | 3.66 | MA | 7751 | 2511 | 11695 | 2107 | 14248 | 1746 | 16013 | 1435 | 18541 | 926 | 23688 | 527 | 19548 |
| 5L-6S | | MI | 5430 | 2511 | 8387 | 2069 | 10039 | 1705 | 11092 | 1404 | 12577 | 895 | 15674 | 380 | 13537 |
| 18-#11 | 3.66 | MA | 7491 | 2511 | 11143 | 2124 | 13657 | 1760 | 15253 | 1456 | 17486 | 935 | 22249 | 442 | 19090 |
| 6L-5S | | MI | 5614 | 2511 | 8754 | 2050 | 10462 | 1695 | 11636 | 1387 | 13313 | 882 | 16629 | 453 | 13866 |

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

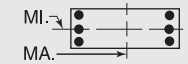
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 3.66 | MA | 7268 | 2511 | 10662 | 2134 | 13007 | 1778 | 14519 | 1468 | 16462 | 953 | 20841 | 395 | 18297 |
| 7L-4S | | MI | 5775 | 2511 | 9081 | 2038 | 10909 | 1685 | 12190 | 1379 | 14081 | 869 | 17669 | 519 | 14313 |
| 18-#11 | 3.66 | MA | 7041 | 2511 | 10199 | 2145 | 12388 | 1787 | 13765 | 1487 | 15456 | 971 | 19485 | 332 | 17495 |
| 8L-3S | | MI | 5904 | 2511 | 9447 | 2027 | 11416 | 1666 | 12811 | 1363 | 14930 | 865 | 18712 | 584 | 14466 |
| 18-#14 | 5.27 | MA | 8324 | 2871 | 13116 | 2368 | 16107 | 1943 | 18168 | 1580 | 21370 | 933 | 27684 | 269 | 25996 |
| 6L-5S | | MI | 6217 | 2871 | 10276 | 2278 | 12320 | 1864 | 13858 | 1494 | 16283 | 867 | 20476 | 273 | 19095 |
| 18-#14 | 5.27 | MA | 8033 | 2871 | 12429 | 2381 | 15188 | 1969 | 17118 | 1596 | 19905 | 958 | 25663 | 199 | 24665 |
| 7L-4S | | MI | 6464 | 2871 | 10742 | 2262 | 12957 | 1851 | 14649 | 1484 | 17378 | 851 | 21931 | 369 | 19618 |
| 20-#10 | 3.31 | MA | 7455 | 2434 | 10904 | 2076 | 13425 | 1724 | 15015 | 1432 | 17205 | 938 | 21862 | 515 | 17808 |
| 6E | | MI | 5422 | 2434 | 8222 | 2026 | 9901 | 1675 | 10963 | 1387 | 12419 | 897 | 15589 | 468 | 12740 |
| 20-#10 | 3.31 | MA | 7271 | 2434 | 10508 | 2084 | 12881 | 1738 | 14412 | 1442 | 16363 | 954 | 20708 | 480 | 17323 |
| 7L-5S | | MI | 5576 | 2434 | 8532 | 2011 | 10251 | 1667 | 11411 | 1372 | 13040 | 892 | 16452 | 540 | 12962 |
| 20-#10 | 3.31 | MA | 7079 | 2434 | 10127 | 2094 | 12372 | 1746 | 13780 | 1457 | 15536 | 969 | 19596 | 430 | 16791 |
| 8L-4S | | MI | 5716 | 2434 | 8801 | 2001 | 10620 | 1658 | 11869 | 1365 | 13676 | 881 | 17335 | 593 | 13285 |
| 20-#10 | 3.31 | MA | 6856 | 2434 | 9757 | 2104 | 11876 | 1755 | 13155 | 1465 | 14695 | 978 | 18499 | 385 | 16084 |
| 9L-3S | | MI | 5824 | 2434 | 9104 | 1990 | 11039 | 1642 | 12384 | 1350 | 14379 | 876 | 18216 | 647 | 13347 |
| 20-#11 | 4.06 | MA | 7836 | 2602 | 11894 | 2181 | 14611 | 1801 | 16409 | 1482 | 19046 | 931 | 24410 | 436 | 21296 |
| 6E | | MI | 5662 | 2602 | 8913 | 2126 | 10706 | 1746 | 11900 | 1430 | 13668 | 891 | 17152 | 370 | 15031 |
| 20-#11 | 4.06 | MA | 7624 | 2602 | 11413 | 2191 | 13961 | 1819 | 15675 | 1494 | 18022 | 949 | 23002 | 389 | 20499 |
| 7L-5S | | MI | 5841 | 2602 | 9280 | 2107 | 11129 | 1736 | 12444 | 1414 | 14404 | 878 | 18107 | 444 | 15381 |
| 20-#11 | 4.06 | MA | 7398 | 2602 | 10951 | 2202 | 13342 | 1828 | 14921 | 1513 | 17016 | 967 | 21646 | 326 | 19695 |
| 8L-4S | | MI | 6002 | 2602 | 9607 | 2095 | 11576 | 1726 | 12998 | 1406 | 15172 | 865 | 19147 | 510 | 15810 |
| 20-#14 | 5.86 | MA | 8528 | 3002 | 13501 | 2462 | 16549 | 2028 | 18768 | 1634 | 22132 | 952 | 28746 | 191 | 27792 |
| 7L-5S | | MI | 6551 | 3002 | 11022 | 2360 | 13267 | 1924 | 15006 | 1532 | 17832 | 861 | 22543 | 256 | 21258 |
| 22-#10 | 3.64 | MA | 7566 | 2507 | 11128 | 2130 | 13669 | 1772 | 15367 | 1464 | 17652 | 950 | 22493 | 475 | 19140 |
| 7L-6S | | MI | 5617 | 2507 | 8658 | 2072 | 10456 | 1709 | 11634 | 1408 | 13325 | 893 | 16844 | 463 | 14008 |
| 22-#10 | 3.64 | MA | 7375 | 2507 | 10748 | 2140 | 13159 | 1780 | 14735 | 1478 | 16825 | 966 | 21381 | 426 | 18620 |
| 8L-5S | | MI | 5767 | 2507 | 8968 | 2057 | 10805 | 1700 | 12083 | 1393 | 13947 | 889 | 17707 | 535 | 14223 |
| 22-#10 | 3.64 | MA | 7159 | 2507 | 10378 | 2150 | 12664 | 1789 | 14110 | 1486 | 15984 | 974 | 20284 | 380 | 17906 |
| 9L-4S | | MI | 5906 | 2507 | 9238 | 2047 | 11174 | 1691 | 12541 | 1386 | 14582 | 877 | 18589 | 588 | 14568 |
| 22-#11 | 4.47 | MA | 7972 | 2692 | 12165 | 2247 | 14915 | 1860 | 16831 | 1520 | 19583 | 945 | 25162 | 383 | 22703 |
| 7L-6S | | MI | 5892 | 2692 | 9438 | 2182 | 11373 | 1787 | 12709 | 1456 | 14759 | 886 | 18631 | 361 | 16530 |
| 22-#11 | 4.47 | MA | 7749 | 2692 | 11702 | 2258 | 14296 | 1869 | 16077 | 1539 | 18577 | 963 | 23807 | 320 | 21894 |
| 8L-5S | | MI | 6065 | 2692 | 9805 | 2163 | 11796 | 1777 | 13252 | 1440 | 15495 | 874 | 19585 | 435 | 16899 |
| 24-#10 | 3.97 | MA | 7666 | 2581 | 11368 | 2186 | 13947 | 1813 | 15690 | 1500 | 18114 | 962 | 23166 | 421 | 20447 |
| 8L-6S | | MI | 5809 | 2581 | 9095 | 2118 | 11010 | 1743 | 12306 | 1429 | 14232 | 890 | 18098 | 458 | 15278 |
| 24-#10 | 3.97 | MA | 7456 | 2581 | 10999 | 2196 | 13451 | 1822 | 15065 | 1507 | 17273 | 971 | 22068 | 375 | 19727 |
| 9L-5S | | MI | 5955 | 2581 | 9405 | 2103 | 11359 | 1734 | 12755 | 1415 | 14854 | 885 | 18961 | 530 | 15486 |
| 24-#11 | 4.88 | MA | 8094 | 2783 | 12454 | 2315 | 15250 | 1911 | 17233 | 1565 | 20137 | 958 | 25967 | 314 | 24094 |
| 8L-6S | | MI | 6118 | 2783 | 9963 | 2239 | 12040 | 1829 | 13517 | 1482 | 15849 | 882 | 20109 | 351 | 18033 |

## RECTANGULAR TIED COLUMNS 24" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.10 | MA | 7289 | 2064 | 9807 | 1815 | 11908 | 1529 | 13052 | 1304 | 14204 | 966 | 17211 | 841 | 7242 |
| 2E | | MI | 5024 | 2064 | 7117 | 1753 | 8379 | 1475 | 9042 | 1257 | 9677 | 928 | 11420 | 791 | 4939 |
| 4-#18 | 1.96 | MA | 8050 | 2267 | 11638 | 1927 | 14136 | 1609 | 15704 | 1351 | 17741 | 947 | 22077 | 820 | 12432 |
| 2E | | MI | 5468 | 2267 | 8298 | 1858 | 9790 | 1550 | 10710 | 1300 | 11892 | 906 | 14119 | 728 | 8295 |
| 6-#11 | 1.15 | MA | 7355 | 2075 | 9864 | 1829 | 12028 | 1540 | 13223 | 1313 | 14456 | 969 | 17575 | 844 | 7556 |
| 2L-3S | | MI | 4765 | 2075 | 6622 | 1782 | 7795 | 1499 | 8358 | 1276 | 8772 | 947 | 10273 | 689 | 5168 |
| 6-#11 | 1.15 | MA | 6870 | 2075 | 9056 | 1845 | 11003 | 1554 | 11980 | 1325 | 12778 | 988 | 15252 | 740 | 7556 |
| 3L-2S | | MI | 5071 | 2075 | 7148 | 1770 | 8462 | 1489 | 9166 | 1268 | 9863 | 934 | 11751 | 803 | 5148 |
| 6-#14 | 1.65 | MA | 7829 | 2195 | 10961 | 1897 | 13373 | 1588 | 14827 | 1342 | 16600 | 959 | 20529 | 832 | 10689 |
| 2L-3S | | MI | 4936 | 2195 | 7117 | 1850 | 8379 | 1548 | 9042 | 1305 | 9677 | 939 | 11420 | 610 | 7195 |
| 6-#14 | 1.65 | MA | 7168 | 2195 | 9807 | 1919 | 11908 | 1608 | 13052 | 1359 | 14204 | 985 | 17211 | 680 | 10640 |
| 3L-2S | | MI | 5352 | 2195 | 7863 | 1834 | 9326 | 1535 | 10190 | 1295 | 11226 | 922 | 13487 | 774 | 7191 |
| 6-#18 | 2.94 | MA | 8927 | 2499 | 13648 | 2072 | 16687 | 1714 | 18797 | 1418 | 21916 | 936 | 27857 | 804 | 18400 |
| 2L-3S | | MI | 5342 | 2499 | 8298 | 2028 | 9790 | 1675 | 10710 | 1381 | 11892 | 919 | 14119 | 394 | 11983 |

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

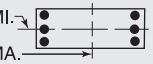
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 2.94 | MA | 7883 | 2499 | 11638 | 2109 | 14136 | 1747 | 15704 | 1447 | 17741 | 978 | 22077 | 526 | 18088 |
| 3L-2S | | MI | 5999 | 2499 | 9584 | 2003 | 11422 | 1656 | 12688 | 1367 | 14562 | 895 | 17568 | 684 | 12129 |
| 8-#10 | 1.25 | MA | 7488 | 2098 | 10023 | 1854 | 12298 | 1559 | 13584 | 1327 | 14974 | 974 | 18315 | 848 | 8238 |
| 2L-4S | | MI | 4765 | 2098 | 6504 | 1820 | 7673 | 1537 | 8235 | 1308 | 8624 | 958 | 10241 | 672 | 5611 |
| 8-#10 | 1.25 | MA | 7091 | 2098 | 9356 | 1867 | 11452 | 1571 | 12558 | 1338 | 13589 | 991 | 16398 | 765 | 8232 |
| 3E | | MI | 4910 | 2098 | 6807 | 1809 | 8092 | 1521 | 8749 | 1293 | 9327 | 953 | 11122 | 726 | 5614 |
| 8-#10 | 1.25 | MA | 6871 | 2098 | 8902 | 1880 | 10821 | 1590 | 11785 | 1356 | 12530 | 1000 | 15114 | 714 | 8182 |
| 4L-2S | | MI | 5162 | 2098 | 7244 | 1799 | 8646 | 1512 | 9421 | 1286 | 10233 | 942 | 12376 | 819 | 5602 |
| 8-#11 | 1.53 | MA | 7737 | 2165 | 10672 | 1886 | 13054 | 1581 | 14466 | 1339 | 16134 | 965 | 19898 | 838 | 9969 |
| 2L-4S | | MI | 4841 | 2165 | 6782 | 1850 | 7955 | 1559 | 8545 | 1319 | 9014 | 947 | 10708 | 615 | 6715 |
| 8-#11 | 1.53 | MA | 7271 | 2165 | 9864 | 1901 | 12028 | 1595 | 13223 | 1352 | 14456 | 984 | 17575 | 734 | 9950 |
| 3E | | MI | 5010 | 2165 | 7148 | 1838 | 8462 | 1540 | 9166 | 1302 | 9863 | 943 | 11751 | 680 | 6740 |
| 8-#11 | 1.53 | MA | 7013 | 2165 | 9312 | 1917 | 11262 | 1618 | 12283 | 1373 | 13170 | 994 | 16005 | 671 | 9851 |
| 4L-2S | | MI | 5305 | 2165 | 7673 | 1826 | 9129 | 1530 | 9974 | 1294 | 10954 | 930 | 13229 | 793 | 6731 |
| 8-#14 | 2.21 | MA | 8351 | 2325 | 12115 | 1979 | 14837 | 1648 | 16602 | 1379 | 18996 | 953 | 23846 | 824 | 14120 |
| 2L-4S | | MI | 5046 | 2325 | 7341 | 1948 | 8603 | 1633 | 9306 | 1365 | 10017 | 937 | 12023 | 503 | 9192 |
| 8-#14 | 2.21 | MA | 7724 | 2325 | 10961 | 2000 | 13373 | 1667 | 14827 | 1397 | 16600 | 979 | 20529 | 672 | 14040 |
| 3E | | MI | 5275 | 2325 | 7863 | 1932 | 9326 | 1607 | 10190 | 1343 | 11226 | 933 | 13487 | 593 | 9399 |
| 8-#14 | 2.21 | MA | 7377 | 2325 | 10171 | 2022 | 12276 | 1699 | 13483 | 1427 | 14760 | 993 | 18272 | 580 | 13729 |
| 4L-2S | | MI | 5672 | 2325 | 8610 | 1916 | 10273 | 1594 | 11338 | 1333 | 12776 | 916 | 15554 | 757 | 9424 |
| 8-#18 | 3.92 | MA | 9772 | 2731 | 15659 | 2217 | 19239 | 1820 | 21889 | 1485 | 26091 | 925 | 33637 | 789 | 24353 |
| 2L-4S | | MI | 5543 | 2731 | 8677 | 2199 | 10170 | 1822 | 11155 | 1483 | 12467 | 910 | 15109 | 198 | 14086 |
| 8-#18 | 3.92 | MA | 8804 | 2731 | 13648 | 2253 | 16687 | 1853 | 18797 | 1514 | 21916 | 967 | 27857 | 511 | 23993 |
| 3E | | MI | 5900 | 2731 | 9584 | 2173 | 11422 | 1781 | 12688 | 1448 | 14562 | 908 | 17568 | 350 | 15732 |
| 8-#18 | 3.92 | MA | 8270 | 2731 | 12264 | 2290 | 14768 | 1907 | 16444 | 1564 | 18698 | 988 | 23874 | 344 | 21468 |
| 4L-2S | | MI | 6508 | 2731 | 10870 | 2148 | 13054 | 1761 | 14666 | 1434 | 17231 | 884 | 21016 | 641 | 15936 |
| 10-#10 | 1.56 | MA | 7804 | 2172 | 10690 | 1900 | 13144 | 1593 | 14609 | 1348 | 16358 | 971 | 20232 | 843 | 10225 |
| 2L-5S | | MI | 4831 | 2172 | 6671 | 1876 | 7857 | 1579 | 8449 | 1337 | 8895 | 966 | 10612 | 614 | 6797 |
| 10-#10 | 1.56 | MA | 7421 | 2172 | 10023 | 1913 | 12298 | 1605 | 13584 | 1359 | 14974 | 987 | 18315 | 760 | 10208 |
| 3L-4S | | MI | 4976 | 2172 | 6941 | 1866 | 8227 | 1570 | 8907 | 1329 | 9530 | 954 | 11495 | 667 | 6900 |
| 10-#10 | 1.56 | MA | 7213 | 2172 | 9569 | 1926 | 11667 | 1624 | 12810 | 1377 | 13915 | 996 | 17031 | 709 | 10145 |
| 4L-3S | | MI | 5114 | 2172 | 7244 | 1855 | 8646 | 1554 | 9421 | 1315 | 10233 | 950 | 12376 | 721 | 6917 |
| 10-#10 | 1.56 | MA | 6956 | 2172 | 9168 | 1939 | 11116 | 1636 | 12125 | 1389 | 12963 | 1012 | 15725 | 668 | 9936 |
| 5L-2S | | MI | 5359 | 2172 | 7680 | 1845 | 9201 | 1545 | 10093 | 1307 | 11140 | 938 | 13631 | 814 | 6913 |
| 10-#11 | 1.91 | MA | 8109 | 2256 | 11480 | 1943 | 14079 | 1622 | 15709 | 1365 | 17811 | 961 | 22222 | 832 | 12373 |
| 2L-5S | | MI | 4922 | 2256 | 6980 | 1918 | 8175 | 1610 | 8799 | 1353 | 9337 | 955 | 11146 | 540 | 7948 |
| 10-#11 | 1.91 | MA | 7661 | 2256 | 10672 | 1958 | 13054 | 1637 | 14466 | 1378 | 16134 | 980 | 19898 | 728 | 12339 |
| 3L-4S | | MI | 5089 | 2256 | 7307 | 1906 | 8622 | 1600 | 9353 | 1345 | 10105 | 942 | 12186 | 606 | 8258 |
| 10-#11 | 1.91 | MA | 7418 | 2256 | 10120 | 1973 | 12288 | 1659 | 13526 | 1399 | 14847 | 990 | 18329 | 665 | 12225 |
| 4L-3S | | MI | 5249 | 2256 | 7673 | 1895 | 9129 | 1581 | 9974 | 1328 | 10954 | 938 | 13229 | 670 | 8300 |
| 10-#11 | 1.91 | MA | 7116 | 2256 | 9632 | 1989 | 11617 | 1673 | 12693 | 1412 | 13690 | 1009 | 16737 | 611 | 11694 |
| 5L-2S | | MI | 5535 | 2256 | 8199 | 1883 | 9796 | 1571 | 10783 | 1320 | 12045 | 925 | 14708 | 784 | 8304 |
| 10-#14 | 2.76 | MA | 8858 | 2456 | 13269 | 2060 | 16302 | 1707 | 18377 | 1417 | 21392 | 947 | 27164 | 815 | 17543 |
| 2L-5S | | MI | 5162 | 2456 | 7621 | 2046 | 8913 | 1706 | 9663 | 1413 | 10471 | 948 | 12635 | 390 | 10617 |
| 10-#14 | 2.76 | MA | 8261 | 2456 | 12115 | 2082 | 14837 | 1727 | 16602 | 1435 | 18996 | 973 | 23846 | 663 | 17441 |
| 3L-4S | | MI | 5391 | 2456 | 8087 | 2029 | 9550 | 1693 | 10454 | 1403 | 11567 | 931 | 14091 | 486 | 11273 |
| 10-#14 | 2.76 | MA | 7942 | 2456 | 11325 | 2103 | 13741 | 1759 | 15258 | 1465 | 17156 | 987 | 21590 | 571 | 17051 |
| 4L-3S | | MI | 5604 | 2456 | 8610 | 2013 | 10273 | 1667 | 11338 | 1380 | 12776 | 926 | 15554 | 576 | 11596 |
| 10-#14 | 2.76 | MA | 7521 | 2456 | 10626 | 2125 | 12780 | 1779 | 14065 | 1482 | 15499 | 1013 | 19306 | 490 | 15794 |
| 5L-2S | | MI | 5985 | 2456 | 9356 | 1997 | 11220 | 1654 | 12486 | 1370 | 14325 | 910 | 17622 | 740 | 11643 |
| 10-#18 | 4.90 | MA | 9691 | 2963 | 15659 | 2398 | 19239 | 1959 | 21889 | 1581 | 26091 | 956 | 33637 | 496 | 29908 |
| 3L-4S | | MI | 6156 | 2963 | 9963 | 2344 | 11801 | 1928 | 13133 | 1550 | 15137 | 899 | 18557 | 155 | 17722 |
| 10-#18 | 4.90 | MA | 9219 | 2963 | 14275 | 2435 | 17320 | 2013 | 19537 | 1631 | 22873 | 977 | 29655 | 329 | 27325 |
| 4L-3S | | MI | 6461 | 2963 | 10870 | 2318 | 13054 | 1887 | 14666 | 1514 | 17231 | 897 | 21016 | 307 | 19484 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

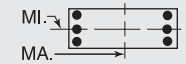
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 4.90 | MA | 8516 | 2963 | 13048 | 2471 | 15636 | 2045 | 17447 | 1659 | 19970 | 1019 | 25641 | 176 | 24848 |
| 5L-2S | | MI | 7002 | 2963 | 12156 | 2293 | 14686 | 1867 | 16644 | 1501 | 19901 | 873 | 24464 | 598 | 19733 |
| 12-#10 | 1.87 | MA | 8115 | 2245 | 11357 | 1946 | 13991 | 1626 | 15635 | 1370 | 17743 | 967 | 22149 | 838 | 12208 |
| 2L-6S | | MI | 4865 | 2245 | 6798 | 1937 | 8063 | 1622 | 8672 | 1372 | 9180 | 967 | 11004 | 537 | 7769 |
| 12-#10 | 1.87 | MA | 7743 | 2245 | 10690 | 1959 | 13144 | 1639 | 14609 | 1381 | 16358 | 984 | 20232 | 756 | 12182 |
| 3L-5S | | MI | 5039 | 2245 | 7108 | 1922 | 8412 | 1613 | 9121 | 1358 | 9802 | 962 | 11867 | 609 | 8034 |
| 12-#10 | 1.87 | MA | 7546 | 2245 | 10236 | 1972 | 12514 | 1658 | 13836 | 1399 | 15299 | 993 | 18948 | 705 | 12109 |
| 4E | | MI | 5183 | 2245 | 7377 | 1912 | 8781 | 1604 | 9579 | 1350 | 10437 | 951 | 12750 | 662 | 8187 |
| 12-#10 | 1.87 | MA | 7292 | 2245 | 9835 | 1985 | 11962 | 1670 | 13151 | 1410 | 14347 | 1009 | 17642 | 663 | 11863 |
| 5L-3S | | MI | 5314 | 2245 | 7680 | 1901 | 9201 | 1588 | 10093 | 1336 | 11140 | 946 | 13631 | 716 | 8214 |
| 12-#10 | 1.87 | MA | 7024 | 2245 | 9336 | 1999 | 11441 | 1682 | 12481 | 1428 | 13418 | 1018 | 16385 | 595 | 11358 |
| 6L-2S | | MI | 5552 | 2245 | 8117 | 1891 | 9755 | 1579 | 10764 | 1328 | 12047 | 935 | 14885 | 809 | 8219 |
| 12-#11 | 2.29 | MA | 8473 | 2346 | 12288 | 1999 | 15105 | 1664 | 16951 | 1391 | 19489 | 957 | 24545 | 826 | 14773 |
| 2L-6S | | MI | 4961 | 2346 | 7138 | 1994 | 8419 | 1661 | 9064 | 1396 | 9691 | 964 | 11670 | 457 | 9147 |
| 12-#11 | 2.29 | MA | 8041 | 2346 | 11480 | 2015 | 14079 | 1678 | 15709 | 1404 | 17811 | 975 | 22222 | 722 | 14727 |
| 3L-5S | | MI | 5166 | 2346 | 7506 | 1975 | 8842 | 1651 | 9608 | 1379 | 10428 | 951 | 12624 | 531 | 9439 |
| 12-#11 | 2.29 | MA | 7813 | 2346 | 10928 | 2030 | 13313 | 1701 | 14769 | 1425 | 16525 | 986 | 20652 | 659 | 14600 |
| 4E | | MI | 5331 | 2346 | 7832 | 1963 | 9289 | 1641 | 10162 | 1371 | 11196 | 938 | 13665 | 597 | 9799 |
| 12-#11 | 2.29 | MA | 7514 | 2346 | 10440 | 2045 | 12642 | 1715 | 13936 | 1438 | 15368 | 1004 | 19060 | 605 | 14034 |
| 5L-3S | | MI | 5484 | 2346 | 8199 | 1951 | 9796 | 1623 | 10783 | 1354 | 12045 | 934 | 14708 | 661 | 9855 |
| 12-#11 | 2.29 | MA | 7198 | 2346 | 9841 | 2062 | 12010 | 1729 | 13121 | 1459 | 14237 | 1015 | 17525 | 520 | 13463 |
| 6L-2S | | MI | 5760 | 2346 | 8724 | 1939 | 10463 | 1613 | 11591 | 1346 | 13136 | 921 | 16186 | 774 | 9871 |
| 12-#14 | 3.31 | MA | 8784 | 2586 | 13269 | 2163 | 16302 | 1787 | 18377 | 1472 | 21392 | 967 | 27164 | 655 | 20842 |
| 3L-5S | | MI | 5501 | 2586 | 8367 | 2127 | 9860 | 1765 | 10811 | 1451 | 12021 | 941 | 14703 | 373 | 12751 |
| 12-#14 | 3.31 | MA | 8490 | 2586 | 12479 | 2185 | 15205 | 1819 | 17033 | 1502 | 19552 | 980 | 24907 | 562 | 20378 |
| 4E | | MI | 5727 | 2586 | 8834 | 2111 | 10498 | 1752 | 11602 | 1441 | 13116 | 925 | 16158 | 469 | 13370 |
| 12-#14 | 3.31 | MA | 8074 | 2586 | 11780 | 2207 | 14244 | 1838 | 15840 | 1520 | 17895 | 1006 | 22624 | 482 | 19166 |
| 5L-3S | | MI | 5927 | 2586 | 9356 | 2095 | 11220 | 1727 | 12486 | 1418 | 14325 | 920 | 17622 | 559 | 13790 |
| 12-#14 | 3.31 | MA | 7646 | 2586 | 10930 | 2231 | 13338 | 1858 | 14672 | 1550 | 16276 | 1020 | 20417 | 358 | 18010 |
| 6L-2S | | MI | 6293 | 2586 | 10102 | 2079 | 12167 | 1713 | 13634 | 1408 | 15875 | 903 | 19689 | 722 | 13855 |
| 12-#18 | 5.88 | MA | 10134 | 3195 | 16286 | 2580 | 19872 | 2119 | 22630 | 1698 | 27047 | 966 | 35435 | 314 | 33196 |
| 4E | | MI | 6715 | 3195 | 11249 | 2488 | 13433 | 2034 | 15111 | 1617 | 17807 | 888 | 22006 | 112 | 21382 |
| 12-#18 | 5.88 | MA | 9440 | 3195 | 15058 | 2616 | 18187 | 2151 | 20539 | 1726 | 24145 | 1008 | 31421 | 161 | 30698 |
| 5L-3S | | MI | 6983 | 3195 | 12156 | 2463 | 14686 | 1993 | 16644 | 1581 | 19901 | 886 | 24464 | 264 | 23242 |
| 14-#10 | 2.18 | MA | 8059 | 2319 | 11357 | 2005 | 13991 | 1672 | 15635 | 1402 | 17743 | 980 | 22149 | 751 | 14155 |
| 3L-6S | | MI | 5073 | 2319 | 7235 | 1983 | 8617 | 1656 | 9343 | 1394 | 10087 | 964 | 12259 | 532 | 9025 |
| 14-#10 | 2.18 | MA | 7871 | 2319 | 10903 | 2018 | 13360 | 1691 | 14862 | 1420 | 16684 | 989 | 20865 | 700 | 14074 |
| 4L-5S | | MI | 5243 | 2319 | 7545 | 1968 | 8966 | 1647 | 9792 | 1379 | 10709 | 959 | 13121 | 604 | 9278 |
| 14-#10 | 2.18 | MA | 7620 | 2319 | 10501 | 2031 | 12809 | 1703 | 14177 | 1431 | 15732 | 1005 | 19559 | 658 | 13794 |
| 5L-4S | | MI | 5385 | 2319 | 7814 | 1958 | 9335 | 1638 | 10250 | 1372 | 11344 | 947 | 14004 | 657 | 9472 |
| 14-#10 | 2.18 | MA | 7361 | 2319 | 10003 | 2045 | 12288 | 1715 | 13507 | 1449 | 14802 | 1014 | 18302 | 590 | 13307 |
| 6L-3S | | MI | 5511 | 2319 | 8117 | 1947 | 9755 | 1622 | 10764 | 1357 | 12047 | 943 | 14885 | 711 | 9508 |
| 14-#10 | 2.18 | MA | 7136 | 2319 | 9579 | 2054 | 11700 | 1729 | 12862 | 1460 | 13901 | 1031 | 17072 | 555 | 12858 |
| 7L-2S | | MI | 5743 | 2319 | 8554 | 1937 | 10309 | 1613 | 11436 | 1350 | 12954 | 931 | 16140 | 804 | 9520 |
| 14-#11 | 2.68 | MA | 8413 | 2437 | 12288 | 2071 | 15105 | 1719 | 16951 | 1430 | 19489 | 971 | 24545 | 716 | 17114 |
| 3L-6S | | MI | 5207 | 2437 | 7664 | 2050 | 9086 | 1702 | 9872 | 1422 | 10782 | 959 | 13148 | 447 | 10659 |
| 14-#11 | 2.68 | MA | 8198 | 2437 | 11736 | 2086 | 14339 | 1742 | 16012 | 1451 | 18203 | 981 | 22975 | 653 | 16978 |
| 4L-5S | | MI | 5405 | 2437 | 8031 | 2031 | 9509 | 1692 | 10416 | 1405 | 11518 | 946 | 14102 | 521 | 10938 |
| 14-#11 | 2.68 | MA | 7902 | 2437 | 11248 | 2102 | 13668 | 1756 | 15179 | 1464 | 17045 | 1000 | 21383 | 599 | 16380 |
| 5L-4S | | MI | 5569 | 2437 | 8358 | 2020 | 9956 | 1683 | 10970 | 1397 | 12287 | 934 | 15143 | 587 | 11339 |
| 14-#11 | 2.68 | MA | 7598 | 2437 | 10649 | 2119 | 13035 | 1770 | 14364 | 1486 | 15915 | 1010 | 19848 | 514 | 15830 |
| 6L-3S | | MI | 5714 | 2437 | 8724 | 2008 | 10463 | 1664 | 11591 | 1381 | 13136 | 930 | 16186 | 651 | 11406 |
| 14-#11 | 2.68 | MA | 7334 | 2437 | 10133 | 2129 | 12329 | 1788 | 13578 | 1498 | 14818 | 1029 | 18344 | 470 | 15047 |
| 7L-2S | | MI | 5982 | 2437 | 9250 | 1996 | 11130 | 1654 | 12399 | 1373 | 14227 | 917 | 17664 | 765 | 11432 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

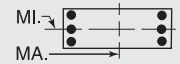



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 3.86 | MA | 9023 | 2717 | 13633 | 2266 | 16670 | 1878 | 18808 | 1540 | 21948 | 974 | 28225 | 554 | 23715 |
| 4L-5S | | MI | 5832 | 2717 | 9114 | 2209 | 10807 | 1825 | 11959 | 1489 | 13570 | 935 | 16770 | 356 | 14893 |
| 14-#14 | 3.86 | MA | 8612 | 2717 | 12934 | 2288 | 15709 | 1898 | 17615 | 1558 | 20291 | 1000 | 25941 | 473 | 22543 |
| 5L-4S | | MI | 6056 | 2717 | 9580 | 2193 | 11445 | 1812 | 12750 | 1478 | 14666 | 918 | 18225 | 451 | 15480 |
| 14-#14 | 3.86 | MA | 8204 | 2717 | 12084 | 2313 | 14802 | 1918 | 16447 | 1588 | 18672 | 1014 | 23735 | 350 | 21390 |
| 6L-3S | | MI | 6243 | 2717 | 10102 | 2176 | 12167 | 1786 | 13634 | 1456 | 15875 | 914 | 19689 | 542 | 15982 |
| 14-#14 | 3.86 | MA | 7849 | 2717 | 11346 | 2327 | 13802 | 1943 | 15322 | 1605 | 17101 | 1040 | 21575 | 283 | 20039 |
| 7L-2S | | MI | 6596 | 2717 | 10849 | 2160 | 13114 | 1773 | 14782 | 1446 | 17424 | 897 | 21756 | 705 | 16063 |
| 14-#18 | 6.86 | MA | 10336 | 3427 | 17069 | 2761 | 20739 | 2257 | 23632 | 1793 | 28319 | 997 | 37201 | 145 | 36547 |
| 5L-4S | | MI | 7258 | 3427 | 12535 | 2633 | 15065 | 2140 | 17088 | 1684 | 20477 | 877 | 25454 | 69 | 25060 |
| 16-#10 | 2.49 | MA | 8190 | 2392 | 11570 | 2065 | 14206 | 1725 | 15887 | 1441 | 18068 | 986 | 22782 | 695 | 16039 |
| 4L-6S | | MI | 5278 | 2392 | 7671 | 2029 | 9171 | 1689 | 10015 | 1415 | 10994 | 960 | 13513 | 527 | 10284 |
| 16-#10 | 2.49 | MA | 7941 | 2392 | 11168 | 2077 | 13655 | 1737 | 15202 | 1452 | 17116 | 1002 | 21476 | 653 | 15731 |
| 5E | | MI | 5443 | 2392 | 7981 | 2014 | 9520 | 1680 | 10464 | 1400 | 11615 | 955 | 14376 | 599 | 10527 |
| 16-#10 | 2.49 | MA | 7690 | 2392 | 10670 | 2091 | 13134 | 1749 | 14533 | 1470 | 16187 | 1011 | 20219 | 585 | 15258 |
| 6L-4S | | MI | 5584 | 2392 | 8251 | 2004 | 9890 | 1671 | 10922 | 1393 | 12251 | 944 | 15259 | 652 | 10756 |
| 16-#10 | 2.49 | MA | 7474 | 2392 | 10245 | 2100 | 12546 | 1763 | 13887 | 1481 | 15285 | 1027 | 18989 | 550 | 14807 |
| 7L-3S | | MI | 5705 | 2392 | 8554 | 1993 | 10309 | 1655 | 11436 | 1378 | 12954 | 939 | 16140 | 706 | 10799 |
| 16-#10 | 2.49 | MA | 7258 | 2392 | 9837 | 2110 | 12000 | 1771 | 13202 | 1496 | 14400 | 1043 | 17802 | 503 | 14191 |
| 8L-2S | | MI | 5931 | 2392 | 8991 | 1983 | 10863 | 1646 | 12108 | 1371 | 13860 | 928 | 17394 | 799 | 10818 |
| 16-#11 | 3.06 | MA | 8575 | 2527 | 12544 | 2143 | 15364 | 1783 | 17255 | 1477 | 19881 | 977 | 25298 | 647 | 19357 |
| 4L-6S | | MI | 5448 | 2527 | 8189 | 2107 | 9752 | 1744 | 10681 | 1448 | 11873 | 955 | 14626 | 438 | 12175 |
| 16-#11 | 3.06 | MA | 8282 | 2527 | 12056 | 2158 | 14693 | 1797 | 16422 | 1490 | 18723 | 996 | 23706 | 593 | 18730 |
| 5E | | MI | 5640 | 2527 | 8557 | 2088 | 10176 | 1734 | 11224 | 1431 | 12609 | 942 | 15581 | 512 | 12442 |
| 16-#11 | 3.06 | MA | 7989 | 2527 | 11457 | 2175 | 14061 | 1811 | 15606 | 1512 | 17592 | 1006 | 22171 | 508 | 18200 |
| 6L-4S | | MI | 5803 | 2527 | 8883 | 2076 | 10623 | 1724 | 11778 | 1423 | 13378 | 929 | 16621 | 578 | 12878 |
| 16-#11 | 3.06 | MA | 7737 | 2527 | 10941 | 2185 | 13355 | 1829 | 14821 | 1524 | 16496 | 1025 | 20667 | 464 | 17414 |
| 7L-3S | | MI | 5941 | 2527 | 9250 | 2064 | 11130 | 1705 | 12399 | 1407 | 14227 | 925 | 17664 | 642 | 12956 |
| 16-#11 | 3.06 | MA | 7482 | 2527 | 10445 | 2197 | 12691 | 1838 | 14001 | 1543 | 15418 | 1043 | 19218 | 403 | 16597 |
| 8L-2S | | MI | 6201 | 2527 | 9775 | 2052 | 11796 | 1695 | 13207 | 1399 | 15318 | 913 | 19143 | 755 | 12990 |
| 16-#14 | 4.41 | MA | 9136 | 2847 | 14088 | 2370 | 17173 | 1958 | 19390 | 1595 | 22687 | 994 | 29259 | 465 | 25926 |
| 5E | | MI | 6156 | 2847 | 9860 | 2290 | 11754 | 1885 | 13107 | 1526 | 15120 | 929 | 18837 | 339 | 17042 |
| 16-#14 | 4.41 | MA | 8748 | 2847 | 13238 | 2394 | 16267 | 1977 | 18222 | 1625 | 21068 | 1008 | 27052 | 341 | 24768 |
| 6L-4S | | MI | 6379 | 2847 | 10326 | 2274 | 12392 | 1871 | 13898 | 1516 | 16215 | 912 | 20293 | 434 | 17601 |
| 16-#14 | 4.41 | MA | 8413 | 2847 | 12500 | 2408 | 15267 | 2003 | 17097 | 1643 | 19497 | 1034 | 24892 | 275 | 23404 |
| 7L-3S | | MI | 6555 | 2847 | 10849 | 2258 | 13114 | 1846 | 14782 | 1493 | 17424 | 908 | 21756 | 525 | 18174 |
| 18-#10 | 2.80 | MA | 8256 | 2466 | 11835 | 2124 | 14501 | 1771 | 16228 | 1474 | 18501 | 998 | 23393 | 648 | 17671 |
| 5L-6S | | MI | 5480 | 2466 | 8108 | 2075 | 9725 | 1723 | 10687 | 1436 | 11900 | 957 | 14768 | 522 | 11547 |
| 18-#10 | 2.80 | MA | 8013 | 2466 | 11337 | 2137 | 13980 | 1782 | 15558 | 1492 | 17571 | 1007 | 22136 | 580 | 17212 |
| 6L-5S | | MI | 5640 | 2466 | 8418 | 2060 | 10074 | 1714 | 11136 | 1422 | 12522 | 952 | 15630 | 594 | 11779 |
| 18-#10 | 2.80 | MA | 7806 | 2466 | 10912 | 2146 | 13392 | 1796 | 14913 | 1503 | 16670 | 1024 | 20906 | 546 | 16759 |
| 7L-4S | | MI | 5780 | 2466 | 8688 | 2050 | 10444 | 1705 | 11594 | 1414 | 13157 | 940 | 16513 | 647 | 12040 |
| 18-#10 | 2.80 | MA | 7592 | 2466 | 10504 | 2156 | 12846 | 1805 | 14228 | 1517 | 15785 | 1040 | 19719 | 498 | 16155 |
| 8L-3S | | MI | 5896 | 2466 | 8991 | 2039 | 10863 | 1689 | 12108 | 1400 | 13860 | 936 | 17394 | 701 | 12090 |
| 18-#10 | 2.80 | MA | 7343 | 2466 | 10108 | 2166 | 12315 | 1814 | 13558 | 1525 | 14884 | 1049 | 18550 | 453 | 15436 |
| 9L-2S | | MI | 6116 | 2466 | 9427 | 2029 | 11418 | 1680 | 12780 | 1392 | 14767 | 924 | 18649 | 794 | 12113 |
| 18-#11 | 3.44 | MA | 8655 | 2617 | 12864 | 2215 | 15719 | 1839 | 17665 | 1516 | 20401 | 991 | 26029 | 587 | 21086 |
| 5L-6S | | MI | 5685 | 2617 | 8715 | 2163 | 10419 | 1785 | 11489 | 1474 | 12964 | 951 | 16105 | 429 | 13675 |
| 18-#11 | 3.44 | MA | 8372 | 2617 | 12266 | 2232 | 15086 | 1853 | 16849 | 1538 | 19270 | 1002 | 24494 | 502 | 20572 |
| 6L-5S | | MI | 5872 | 2617 | 9082 | 2144 | 10842 | 1775 | 12032 | 1457 | 13700 | 938 | 17059 | 502 | 13951 |
| 18-#11 | 3.44 | MA | 8130 | 2617 | 11749 | 2242 | 14380 | 1870 | 16064 | 1551 | 18173 | 1020 | 22990 | 458 | 19784 |
| 7L-4S | | MI | 6033 | 2617 | 9409 | 2133 | 11289 | 1765 | 12586 | 1449 | 14469 | 925 | 18099 | 568 | 14411 |
| 18-#11 | 3.44 | MA | 7879 | 2617 | 11253 | 2253 | 13716 | 1880 | 15244 | 1569 | 17096 | 1039 | 21541 | 397 | 18963 |
| 8L-3S | | MI | 6165 | 2617 | 9775 | 2121 | 11796 | 1747 | 13207 | 1433 | 15318 | 921 | 19143 | 633 | 14504 |
| 18-#14 | 4.96 | MA | 9279 | 2977 | 14392 | 2476 | 17731 | 2037 | 19997 | 1663 | 23463 | 1001 | 30370 | 332 | 28145 |
| 6L-5S | | MI | 6475 | 2977 | 10606 | 2372 | 12701 | 1944 | 14255 | 1564 | 16670 | 923 | 20905 | 321 | 19198 |
| 18-#14 | 4.96 | MA | 8962 | 2977 | 13654 | 2490 | 16731 | 2062 | 18872 | 1681 | 21892 | 1027 | 28210 | 266 | 26769 |
| 7L-4S | | MI | 6697 | 2977 | 11073 | 2356 | 13339 | 1931 | 15045 | 1554 | 17765 | 906 | 22360 | 417 | 19731 |

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 3.11 | MA | 8331 | 2540 | 12004 | 2183 | 14826 | 1816 | 16584 | 1513 | 18956 | 1004 | 24053 | 575 | 19169 |
| 6E | | MI | 5678 | 2540 | 8545 | 2121 | 10280 | 1756 | 11359 | 1457 | 12807 | 953 | 16022 | 517 | 12811 |
| 20-#10 | 3.11 | MA | 8131 | 2540 | 11579 | 2192 | 14239 | 1830 | 15939 | 1524 | 18055 | 1020 | 22823 | 541 | 18712 |
| 7L-5S | | MI | 5834 | 2540 | 8855 | 2106 | 10629 | 1748 | 11808 | 1443 | 13429 | 948 | 16885 | 589 | 13036 |
| 20-#10 | 3.11 | MA | 7920 | 2540 | 11171 | 2202 | 13692 | 1838 | 15254 | 1538 | 17169 | 1036 | 21636 | 493 | 18117 |
| 8L-4S | | MI | 5974 | 2540 | 9124 | 2096 | 10998 | 1739 | 12266 | 1435 | 14064 | 937 | 17768 | 642 | 13323 |
| 20-#10 | 3.11 | MA | 7678 | 2540 | 10775 | 2212 | 13161 | 1848 | 14584 | 1546 | 16268 | 1045 | 20467 | 448 | 17393 |
| 9L-3S | | MI | 6084 | 2540 | 9427 | 2085 | 11418 | 1723 | 12780 | 1421 | 14767 | 932 | 18649 | 696 | 13379 |
| 20-#10 | 3.11 | MA | 7454 | 2540 | 10359 | 2220 | 12608 | 1865 | 13928 | 1555 | 15387 | 1061 | 19205 | 396 | 16692 |
| 10L-2S | | MI | 6300 | 2540 | 9864 | 2075 | 11972 | 1714 | 13451 | 1413 | 15674 | 921 | 19903 | 789 | 13408 |
| 20-#11 | 3.82 | MA | 8747 | 2708 | 13074 | 2288 | 16112 | 1894 | 18092 | 1564 | 20948 | 997 | 26817 | 496 | 22947 |
| 6E | | MI | 5919 | 2708 | 9240 | 2220 | 11086 | 1826 | 12297 | 1500 | 14055 | 946 | 17583 | 419 | 15166 |
| 20-#11 | 3.82 | MA | 8516 | 2708 | 12558 | 2298 | 15406 | 1911 | 17307 | 1577 | 19851 | 1016 | 25313 | 452 | 22156 |
| 7L-5S | | MI | 6099 | 2708 | 9608 | 2201 | 11509 | 1816 | 12840 | 1484 | 14791 | 934 | 18537 | 493 | 15464 |
| 20-#11 | 3.82 | MA | 8268 | 2708 | 12062 | 2310 | 14742 | 1921 | 16487 | 1595 | 18774 | 1035 | 23864 | 391 | 21328 |
| 8L-4S | | MI | 6260 | 2708 | 9934 | 2189 | 11956 | 1806 | 13395 | 1476 | 15560 | 921 | 19578 | 559 | 15906 |
| 20-#14 | 5.51 | MA | 9499 | 3108 | 14808 | 2571 | 18196 | 2122 | 20647 | 1718 | 24288 | 1021 | 31527 | 257 | 30133 |
| 7L-5S | | MI | 6811 | 3108 | 11353 | 2453 | 13648 | 2004 | 15403 | 1602 | 18219 | 916 | 22972 | 304 | 21358 |
| 22-#10 | 3.42 | MA | 8450 | 2613 | 12246 | 2238 | 15085 | 1864 | 16964 | 1545 | 19439 | 1016 | 24740 | 536 | 20667 |
| 7L-6S | | MI | 5874 | 2613 | 8982 | 2167 | 10834 | 1790 | 12030 | 1479 | 13714 | 950 | 17277 | 512 | 14078 |
| 22-#10 | 3.42 | MA | 8241 | 2613 | 11838 | 2248 | 14539 | 1872 | 16279 | 1560 | 18554 | 1033 | 23553 | 488 | 20080 |
| 8L-5S | | MI | 6026 | 2613 | 9292 | 2152 | 11183 | 1781 | 12479 | 1464 | 14336 | 945 | 18139 | 584 | 14295 |
| 22-#10 | 3.42 | MA | 8006 | 2613 | 11442 | 2258 | 14008 | 1881 | 15609 | 1567 | 17653 | 1042 | 22384 | 443 | 19349 |
| 9L-4S | | MI | 6165 | 2613 | 9561 | 2142 | 11552 | 1772 | 12937 | 1457 | 14971 | 933 | 19022 | 637 | 14607 |
| 22-#10 | 3.42 | MA | 7790 | 2613 | 11025 | 2266 | 13454 | 1898 | 14954 | 1576 | 16771 | 1057 | 21122 | 391 | 18643 |
| 10L-3S | | MI | 6271 | 2613 | 9864 | 2131 | 11972 | 1756 | 13451 | 1442 | 15674 | 929 | 19903 | 691 | 14667 |
| 22-#11 | 4.21 | MA | 8895 | 2798 | 13366 | 2355 | 16431 | 1953 | 18550 | 1603 | 21529 | 1012 | 27636 | 446 | 24530 |
| 7L-6S | | MI | 6149 | 2798 | 9766 | 2276 | 11753 | 1868 | 13105 | 1526 | 15146 | 942 | 19061 | 410 | 16662 |
| 22-#11 | 4.21 | MA | 8649 | 2798 | 12870 | 2367 | 15767 | 1962 | 17730 | 1621 | 20452 | 1031 | 26187 | 385 | 23694 |
| 8L-5S | | MI | 6324 | 2798 | 10133 | 2258 | 12176 | 1858 | 13649 | 1510 | 15882 | 929 | 20016 | 483 | 16981 |
| 24-#10 | 3.74 | MA | 8557 | 2687 | 12505 | 2294 | 15385 | 1906 | 17305 | 1581 | 19938 | 1029 | 25470 | 483 | 22043 |
| 8L-6S | | MI | 6067 | 2687 | 9418 | 2213 | 11388 | 1824 | 12702 | 1500 | 14621 | 946 | 18531 | 507 | 15347 |
| 24-#10 | 3.74 | MA | 8329 | 2687 | 12109 | 2304 | 14854 | 1915 | 16635 | 1589 | 19038 | 1038 | 24301 | 438 | 21306 |
| 9L-5S | | MI | 6215 | 2687 | 9728 | 2198 | 11737 | 1815 | 13151 | 1485 | 15242 | 941 | 19394 | 579 | 15557 |
| 24-#10 | 3.74 | MA | 8120 | 2687 | 11692 | 2312 | 14300 | 1932 | 15979 | 1597 | 18156 | 1054 | 23039 | 386 | 20595 |
| 10L-4S | | MI | 6354 | 2687 | 9998 | 2188 | 12107 | 1806 | 13609 | 1478 | 15878 | 930 | 20277 | 632 | 15890 |
| 24-#11 | 4.59 | MA | 9024 | 2889 | 13678 | 2423 | 16793 | 2004 | 18973 | 1647 | 22129 | 1026 | 28510 | 379 | 26059 |
| 8L-6S | | MI | 6376 | 2889 | 10291 | 2333 | 12420 | 1909 | 13913 | 1552 | 16237 | 938 | 20539 | 400 | 18162 |

## RECTANGULAR TIED COLUMNS 24" x 36"

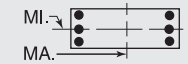
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.04 | MA | 8129 | 2170 | 10804 | 1922 | 13168 | 1619 | 14443 | 1383 | 15695 | 1028 | 18998 | 896 | 7728 |
| 2E | | MI | 5280 | 2170 | 7448 | 1846 | 8760 | 1555 | 9439 | 1327 | 10064 | 984 | 11848 | 840 | 4963 |
| 4-#18 | 1.85 | MA | 8959 | 2373 | 12770 | 2033 | 15561 | 1699 | 17292 | 1430 | 19495 | 1010 | 24225 | 875 | 13296 |
| 2E | | MI | 5726 | 2373 | 8635 | 1950 | 10174 | 1628 | 11108 | 1369 | 12277 | 961 | 14544 | 776 | 8329 |
| 6-#11 | 1.08 | MA | 8199 | 2181 | 10862 | 1936 | 13294 | 1630 | 14622 | 1391 | 15960 | 1032 | 19382 | 899 | 8062 |
| 2L-3S | | MI | 5020 | 2181 | 6950 | 1876 | 8176 | 1579 | 8755 | 1346 | 9159 | 1003 | 10703 | 738 | 5192 |
| 6-#11 | 1.08 | MA | 7675 | 2181 | 9998 | 1951 | 12197 | 1645 | 13292 | 1405 | 14165 | 1052 | 16897 | 797 | 8062 |
| 3L-2S | | MI | 5327 | 2181 | 7476 | 1864 | 8842 | 1569 | 9563 | 1338 | 10250 | 990 | 12181 | 851 | 5170 |
| 6-#14 | 1.56 | MA | 8714 | 2301 | 12039 | 2003 | 14736 | 1679 | 16343 | 1421 | 18261 | 1022 | 22550 | 887 | 11418 |
| 2L-3S | | MI | 5191 | 2301 | 7448 | 1944 | 8760 | 1627 | 9439 | 1375 | 10064 | 994 | 11848 | 659 | 7229 |
| 6-#14 | 1.56 | MA | 7999 | 2301 | 10804 | 2025 | 13168 | 1699 | 14443 | 1439 | 15695 | 1049 | 18998 | 738 | 11369 |
| 3L-2S | | MI | 5610 | 2301 | 8194 | 1928 | 9707 | 1614 | 10587 | 1364 | 11613 | 977 | 13915 | 822 | 7218 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

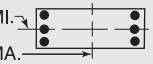



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 2.78 | MA | 9911 | 2605 | 14925 | 2178 | 18297 | 1805 | 20607 | 1497 | 23971 | 999 | 30422 | 859 | 19696 |
| 2L-3S | | MI | 5596 | 2605 | 8635 | 2121 | 10174 | 1754 | 11108 | 1449 | 12277 | 974 | 14544 | 442 | 12045 |
| 6-#18 | 2.78 | MA | 8777 | 2605 | 12770 | 2216 | 15561 | 1839 | 17292 | 1528 | 19495 | 1044 | 24225 | 586 | 19384 |
| 3L-2S | | MI | 6259 | 2605 | 9921 | 2095 | 11806 | 1734 | 13086 | 1436 | 14947 | 950 | 17992 | 732 | 12168 |
| 8-#10 | 1.18 | MA | 8341 | 2204 | 11030 | 1960 | 13579 | 1650 | 15004 | 1406 | 16509 | 1037 | 20166 | 903 | 8786 |
| 2L-4S | | MI | 5020 | 2204 | 6827 | 1915 | 8051 | 1618 | 8631 | 1378 | 9012 | 1014 | 10673 | 721 | 5638 |
| 8-#10 | 1.18 | MA | 7912 | 2204 | 10317 | 1974 | 12674 | 1662 | 13908 | 1417 | 15029 | 1054 | 18117 | 822 | 8781 |
| 3E | | MI | 5165 | 2204 | 7130 | 1904 | 8470 | 1602 | 9145 | 1364 | 9715 | 1009 | 11555 | 776 | 5636 |
| 8-#10 | 1.18 | MA | 7675 | 2204 | 9833 | 1987 | 12001 | 1682 | 13082 | 1436 | 13899 | 1064 | 16753 | 771 | 8731 |
| 4L-2S | | MI | 5419 | 2204 | 7567 | 1894 | 9025 | 1593 | 9817 | 1356 | 10622 | 998 | 12809 | 868 | 5623 |
| 8-#11 | 1.44 | MA | 8613 | 2271 | 11727 | 1992 | 14391 | 1672 | 15952 | 1418 | 17756 | 1028 | 21868 | 893 | 10643 |
| 2L-4S | | MI | 5095 | 2271 | 7109 | 1944 | 8335 | 1639 | 8942 | 1389 | 9402 | 1002 | 11138 | 664 | 6752 |
| 8-#11 | 1.44 | MA | 8109 | 2271 | 10862 | 2008 | 13294 | 1686 | 14622 | 1431 | 15960 | 1048 | 19382 | 791 | 10624 |
| 3E | | MI | 5265 | 2271 | 7476 | 1932 | 8842 | 1620 | 9563 | 1372 | 10250 | 998 | 12181 | 729 | 6767 |
| 8-#11 | 1.44 | MA | 7830 | 2271 | 10273 | 2024 | 12476 | 1709 | 13619 | 1453 | 14587 | 1058 | 17714 | 728 | 10525 |
| 4L-2S | | MI | 5562 | 2271 | 8001 | 1920 | 9509 | 1610 | 10371 | 1364 | 11341 | 985 | 13660 | 842 | 6755 |
| 8-#14 | 2.08 | MA | 9280 | 2431 | 13275 | 2085 | 16304 | 1738 | 18244 | 1458 | 20826 | 1016 | 26102 | 879 | 15092 |
| 2L-4S | | MI | 5300 | 2431 | 7672 | 2041 | 8985 | 1713 | 9703 | 1435 | 10404 | 992 | 12452 | 551 | 9322 |
| 8-#14 | 2.08 | MA | 8601 | 2431 | 12039 | 2107 | 14736 | 1759 | 16343 | 1477 | 18261 | 1043 | 22550 | 729 | 15012 |
| 3E | | MI | 5531 | 2431 | 8194 | 2025 | 9707 | 1687 | 10587 | 1412 | 11613 | 988 | 13915 | 642 | 9437 |
| 8-#14 | 2.08 | MA | 8226 | 2431 | 11195 | 2129 | 13565 | 1792 | 14907 | 1508 | 16294 | 1058 | 20152 | 638 | 14701 |
| 4L-2S | | MI | 5931 | 2431 | 8941 | 2009 | 10654 | 1674 | 11735 | 1402 | 13163 | 971 | 15983 | 805 | 9454 |
| 8-#18 | 3.70 | MA | 10828 | 2837 | 17081 | 2323 | 21032 | 1911 | 23923 | 1564 | 28446 | 988 | 36619 | 844 | 26081 |
| 2L-4S | | MI | 5794 | 2837 | 9014 | 2291 | 10553 | 1901 | 11552 | 1552 | 12852 | 964 | 15534 | 246 | 14253 |
| 8-#18 | 3.70 | MA | 9775 | 2837 | 14925 | 2361 | 18297 | 1945 | 20607 | 1594 | 23971 | 1033 | 30422 | 571 | 25721 |
| 3E | | MI | 6155 | 2837 | 9921 | 2266 | 11806 | 1860 | 13086 | 1516 | 14947 | 963 | 17992 | 398 | 15796 |
| 8-#18 | 3.70 | MA | 9198 | 2837 | 13446 | 2399 | 16245 | 2001 | 18092 | 1647 | 20528 | 1055 | 26186 | 406 | 23194 |
| 4L-2S | | MI | 6773 | 2837 | 11207 | 2240 | 13438 | 1840 | 15063 | 1503 | 17617 | 939 | 21441 | 689 | 15979 |
| 10-#10 | 1.47 | MA | 8683 | 2278 | 11743 | 2006 | 14484 | 1683 | 16101 | 1427 | 17989 | 1034 | 22215 | 898 | 10911 |
| 2L-5S | | MI | 5086 | 2278 | 6994 | 1971 | 8236 | 1660 | 8845 | 1407 | 9284 | 1022 | 11045 | 663 | 6877 |
| 10-#10 | 1.47 | MA | 8269 | 2278 | 11030 | 2020 | 13579 | 1696 | 15004 | 1439 | 16509 | 1050 | 20166 | 817 | 10894 |
| 3L-4S | | MI | 5231 | 2278 | 7264 | 1961 | 8605 | 1651 | 9303 | 1400 | 9919 | 1011 | 11928 | 716 | 6931 |
| 10-#10 | 1.47 | MA | 8044 | 2278 | 10545 | 2033 | 12906 | 1715 | 14179 | 1457 | 15379 | 1060 | 18802 | 766 | 10831 |
| 4L-3S | | MI | 5370 | 2278 | 7567 | 1950 | 9025 | 1635 | 9817 | 1385 | 10622 | 1006 | 12809 | 771 | 6942 |
| 10-#10 | 1.47 | MA | 7764 | 2278 | 10114 | 2046 | 12318 | 1728 | 13449 | 1469 | 14364 | 1077 | 17412 | 726 | 10668 |
| 5L-2S | | MI | 5617 | 2278 | 8004 | 1940 | 9579 | 1627 | 10489 | 1378 | 11529 | 994 | 14064 | 863 | 6935 |
| 10-#11 | 1.81 | MA | 9016 | 2362 | 12591 | 2049 | 15489 | 1713 | 17282 | 1444 | 19551 | 1024 | 24354 | 887 | 13216 |
| 2L-5S | | MI | 5176 | 2362 | 7308 | 2012 | 8555 | 1690 | 9196 | 1423 | 9724 | 1011 | 11576 | 589 | 8039 |
| 10-#11 | 1.81 | MA | 8531 | 2362 | 11727 | 2065 | 14391 | 1728 | 15952 | 1457 | 17756 | 1043 | 21868 | 785 | 13182 |
| 3L-4S | | MI | 5343 | 2362 | 7635 | 2001 | 9002 | 1680 | 9750 | 1415 | 10493 | 998 | 12617 | 655 | 8298 |
| 10-#11 | 1.81 | MA | 8268 | 2362 | 11138 | 2080 | 13573 | 1751 | 14949 | 1479 | 16382 | 1054 | 20200 | 722 | 13067 |
| 4L-3S | | MI | 5506 | 2362 | 8001 | 1989 | 9509 | 1662 | 10371 | 1398 | 11341 | 994 | 13660 | 719 | 8331 |
| 10-#11 | 1.81 | MA | 7938 | 2362 | 10617 | 2096 | 12858 | 1765 | 14060 | 1493 | 15147 | 1074 | 18504 | 670 | 12571 |
| 5L-2S | | MI | 5793 | 2362 | 8527 | 1977 | 10176 | 1652 | 11179 | 1390 | 12432 | 981 | 15138 | 833 | 8331 |
| 10-#14 | 2.60 | MA | 9831 | 2562 | 14510 | 2166 | 17872 | 1798 | 20144 | 1496 | 23391 | 1010 | 29654 | 870 | 18758 |
| 2L-5S | | MI | 5416 | 2562 | 7952 | 2139 | 9294 | 1785 | 10060 | 1483 | 10858 | 1003 | 13064 | 439 | 10729 |
| 10-#14 | 2.60 | MA | 9183 | 2562 | 13275 | 2188 | 16304 | 1818 | 18244 | 1514 | 20826 | 1037 | 26102 | 721 | 18656 |
| 3L-4S | | MI | 5645 | 2562 | 8418 | 2123 | 9932 | 1772 | 10851 | 1473 | 11954 | 986 | 14519 | 534 | 11399 |
| 10-#14 | 2.60 | MA | 8837 | 2562 | 12431 | 2211 | 15133 | 1851 | 16807 | 1545 | 18860 | 1052 | 23703 | 630 | 18333 |
| 4L-3S | | MI | 5861 | 2562 | 8941 | 2107 | 10654 | 1747 | 11735 | 1450 | 13163 | 982 | 15983 | 625 | 11637 |
| 10-#14 | 2.60 | MA | 8377 | 2562 | 11685 | 2233 | 14107 | 1872 | 15534 | 1564 | 17090 | 1079 | 21271 | 552 | 16987 |
| 5L-2S | | MI | 6246 | 2562 | 9687 | 2091 | 11601 | 1733 | 12883 | 1440 | 14712 | 965 | 18050 | 788 | 11676 |
| 10-#18 | 4.63 | MA | 10736 | 3069 | 17081 | 2506 | 21032 | 2051 | 23923 | 1661 | 28446 | 1021 | 36619 | 556 | 32068 |
| 3L-4S | | MI | 6408 | 3069 | 10300 | 2436 | 12185 | 2007 | 13530 | 1619 | 15522 | 953 | 18982 | 203 | 17882 |
| 10-#18 | 4.63 | MA | 10224 | 3069 | 15602 | 2543 | 18980 | 2107 | 21407 | 1714 | 25004 | 1044 | 32383 | 391 | 29489 |
| 4L-3S | | MI | 6719 | 3069 | 11207 | 2411 | 13438 | 1965 | 15063 | 1583 | 17617 | 951 | 21441 | 355 | 19550 |
| 10-#18 | 4.63 | MA | 9454 | 3069 | 14292 | 2581 | 17181 | 2141 | 19174 | 1744 | 21902 | 1089 | 28104 | 244 | 26917 |
| 5L-2S | | MI | 7270 | 3069 | 12493 | 2385 | 15070 | 1946 | 17041 | 1570 | 20287 | 928 | 24889 | 646 | 19778 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

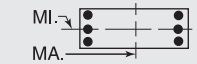



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.76 | MA | 9019 | 2351 | 12455 | 2052 | 15388 | 1717 | 17197 | 1448 | 19469 | 1030 | 24265 | 893 | 13031 |
| 2L-6S | | MI | 5119 | 2351 | 7121 | 2032 | 8441 | 1703 | 9068 | 1443 | 9569 | 1023 | 11437 | 587 | 7844 |
| 12-#10 | 1.76 | MA | 8617 | 2351 | 11743 | 2066 | 14484 | 1729 | 16101 | 1460 | 17989 | 1047 | 22215 | 812 | 13005 |
| 3L-5S | | MI | 5294 | 2351 | 7431 | 2017 | 8790 | 1694 | 9517 | 1428 | 10190 | 1019 | 12300 | 658 | 8112 |
| 12-#10 | 1.76 | MA | 8404 | 2351 | 11258 | 2079 | 13811 | 1749 | 15275 | 1478 | 16859 | 1057 | 20851 | 761 | 12932 |
| 4E | | MI | 5438 | 2351 | 7701 | 2007 | 9159 | 1685 | 9975 | 1421 | 10826 | 1007 | 13182 | 712 | 8219 |
| 12-#10 | 1.76 | MA | 8127 | 2351 | 10827 | 2092 | 13223 | 1761 | 14545 | 1490 | 15844 | 1073 | 19461 | 721 | 12739 |
| 5L-3S | | MI | 5571 | 2351 | 8004 | 1996 | 9579 | 1669 | 10489 | 1406 | 11529 | 1002 | 14064 | 766 | 8241 |
| 12-#10 | 1.76 | MA | 7838 | 2351 | 10295 | 2106 | 12662 | 1773 | 13831 | 1509 | 14853 | 1083 | 18123 | 654 | 12178 |
| 6L-2S | | MI | 5811 | 2351 | 8440 | 1986 | 10133 | 1660 | 11160 | 1399 | 12435 | 991 | 15318 | 858 | 8242 |
| 12-#11 | 2.17 | MA | 9411 | 2452 | 13456 | 2105 | 16586 | 1754 | 18612 | 1470 | 21346 | 1019 | 26839 | 881 | 15784 |
| 2L-6S | | MI | 5215 | 2452 | 7466 | 2088 | 8799 | 1741 | 9461 | 1466 | 10079 | 1019 | 12100 | 506 | 9235 |
| 12-#11 | 2.17 | MA | 8942 | 2452 | 12591 | 2121 | 15489 | 1769 | 17282 | 1483 | 19551 | 1039 | 24354 | 779 | 15738 |
| 3L-5S | | MI | 5421 | 2452 | 7834 | 2069 | 9222 | 1731 | 10004 | 1449 | 10815 | 1006 | 13054 | 579 | 9528 |
| 12-#11 | 2.17 | MA | 8695 | 2452 | 12002 | 2137 | 14671 | 1792 | 16279 | 1505 | 18177 | 1050 | 22686 | 716 | 15611 |
| 4E | | MI | 5587 | 2452 | 8160 | 2057 | 9669 | 1721 | 10558 | 1441 | 11583 | 994 | 14095 | 645 | 9841 |
| 12-#11 | 2.17 | MA | 8369 | 2452 | 11482 | 2153 | 13955 | 1807 | 15390 | 1519 | 16942 | 1069 | 20990 | 664 | 15079 |
| 5L-3S | | MI | 5741 | 2452 | 8527 | 2045 | 10176 | 1703 | 11179 | 1424 | 12432 | 990 | 15138 | 710 | 9887 |
| 12-#11 | 2.17 | MA | 8028 | 2452 | 10837 | 2169 | 13281 | 1821 | 14521 | 1541 | 15735 | 1080 | 19357 | 580 | 14446 |
| 6L-2S | | MI | 6020 | 2452 | 9052 | 2033 | 10843 | 1693 | 11987 | 1416 | 13523 | 977 | 16616 | 823 | 9900 |
| 12-#14 | 3.13 | MA | 9749 | 2692 | 14510 | 2270 | 17872 | 1878 | 20144 | 1552 | 23391 | 1031 | 29654 | 712 | 22300 |
| 3L-5S | | MI | 5756 | 2692 | 8698 | 2221 | 10241 | 1845 | 11208 | 1521 | 12408 | 997 | 15131 | 421 | 12859 |
| 12-#14 | 3.13 | MA | 9430 | 2692 | 13666 | 2292 | 16701 | 1911 | 18708 | 1583 | 21425 | 1045 | 27255 | 621 | 21967 |
| 4E | | MI | 5982 | 2692 | 9165 | 2204 | 10879 | 1832 | 11998 | 1510 | 13503 | 980 | 16586 | 517 | 13492 |
| 12-#14 | 3.13 | MA | 8975 | 2692 | 12921 | 2315 | 15675 | 1931 | 17434 | 1602 | 19655 | 1073 | 24823 | 543 | 20603 |
| 5L-3S | | MI | 6185 | 2692 | 9687 | 2188 | 11601 | 1806 | 12883 | 1488 | 14712 | 976 | 18050 | 607 | 13833 |
| 12-#14 | 3.13 | MA | 8513 | 2692 | 12004 | 2339 | 14708 | 1952 | 16189 | 1633 | 17927 | 1088 | 22478 | 421 | 19439 |
| 6L-2S | | MI | 6555 | 2692 | 10433 | 2172 | 12549 | 1793 | 14031 | 1477 | 16262 | 959 | 20117 | 771 | 13890 |
| 12-#18 | 5.56 | MA | 11214 | 3301 | 17757 | 2688 | 21716 | 2213 | 24723 | 1781 | 29479 | 1033 | 38580 | 376 | 35798 |
| 4E | | MI | 6968 | 3301 | 11586 | 2581 | 13817 | 2113 | 15508 | 1686 | 18192 | 942 | 22431 | 160 | 21535 |
| 12-#18 | 5.56 | MA | 10454 | 3301 | 16447 | 2726 | 19917 | 2247 | 22490 | 1811 | 26378 | 1078 | 34300 | 229 | 33189 |
| 5L-3S | | MI | 7243 | 3301 | 12493 | 2555 | 15070 | 2071 | 17041 | 1650 | 20287 | 940 | 24889 | 312 | 23308 |
| 12-#18 | 5.56 | MA | 9724 | 3301 | 14869 | 2770 | 18219 | 2281 | 20303 | 1863 | 23346 | 1101 | 30157 | 8 | 30105 |
| 6L-2S | | MI | 7757 | 3301 | 13779 | 2530 | 16702 | 2052 | 19019 | 1636 | 22957 | 916 | 28338 | 602 | 23570 |
| 14-#10 | 2.06 | MA | 8958 | 2425 | 12455 | 2112 | 15388 | 1763 | 17197 | 1481 | 19469 | 1043 | 24265 | 807 | 15115 |
| 3L-6S | | MI | 5328 | 2425 | 7558 | 2078 | 8995 | 1737 | 9739 | 1464 | 10476 | 1020 | 12691 | 582 | 9098 |
| 14-#10 | 2.06 | MA | 8756 | 2425 | 11971 | 2125 | 14715 | 1783 | 16372 | 1500 | 18339 | 1053 | 22901 | 756 | 15034 |
| 4L-5S | | MI | 5498 | 2425 | 7868 | 2063 | 9344 | 1728 | 10188 | 1450 | 11097 | 1015 | 13554 | 653 | 9354 |
| 14-#10 | 2.06 | MA | 8482 | 2425 | 11540 | 2138 | 14128 | 1795 | 15642 | 1511 | 17324 | 1070 | 21511 | 716 | 14807 |
| 5L-4S | | MI | 5641 | 2425 | 8137 | 2053 | 9713 | 1719 | 10646 | 1442 | 11733 | 1004 | 14437 | 707 | 9506 |
| 14-#10 | 2.06 | MA | 8202 | 2425 | 11008 | 2152 | 13567 | 1807 | 14928 | 1530 | 16333 | 1080 | 20172 | 650 | 14263 |
| 6L-3S | | MI | 5768 | 2425 | 8440 | 2042 | 10133 | 1703 | 11160 | 1428 | 12435 | 999 | 15318 | 761 | 9536 |
| 14-#10 | 2.06 | MA | 7960 | 2425 | 10554 | 2161 | 12940 | 1821 | 14237 | 1541 | 15372 | 1096 | 18868 | 615 | 13843 |
| 7L-2S | | MI | 6003 | 2425 | 8877 | 2032 | 10687 | 1694 | 11832 | 1420 | 13342 | 987 | 16573 | 853 | 9545 |
| 14-#11 | 2.53 | MA | 9345 | 2543 | 13456 | 2178 | 16586 | 1810 | 18612 | 1509 | 21346 | 1035 | 26839 | 773 | 18293 |
| 3L-6S | | MI | 5461 | 2543 | 7992 | 2144 | 9466 | 1783 | 10269 | 1492 | 11170 | 1015 | 13578 | 496 | 10745 |
| 14-#11 | 2.53 | MA | 9112 | 2543 | 12867 | 2193 | 15768 | 1833 | 17609 | 1531 | 19972 | 1046 | 25171 | 710 | 18157 |
| 4L-5S | | MI | 5661 | 2543 | 8359 | 2126 | 9889 | 1773 | 10812 | 1475 | 11906 | 1002 | 14533 | 570 | 11024 |
| 14-#11 | 2.53 | MA | 8789 | 2543 | 12347 | 2209 | 15052 | 1848 | 16720 | 1545 | 18737 | 1065 | 23476 | 658 | 17592 |
| 5L-4S | | MI | 5825 | 2543 | 8686 | 2114 | 10336 | 1763 | 11366 | 1467 | 12674 | 989 | 15573 | 636 | 11382 |
| 14-#11 | 2.53 | MA | 8461 | 2543 | 11701 | 2226 | 14378 | 1863 | 15850 | 1567 | 17531 | 1076 | 21843 | 575 | 16981 |
| 6L-3S | | MI | 5972 | 2543 | 9052 | 2102 | 10843 | 1744 | 11987 | 1451 | 13523 | 985 | 16616 | 700 | 11441 |
| 14-#11 | 2.53 | MA | 8175 | 2543 | 11150 | 2236 | 13616 | 1880 | 15013 | 1580 | 16361 | 1096 | 20245 | 532 | 16207 |
| 7L-2S | | MI | 6243 | 2543 | 9577 | 2090 | 11510 | 1734 | 12796 | 1443 | 14614 | 973 | 18095 | 814 | 11462 |
| 14-#14 | 3.65 | MA | 10007 | 2823 | 14902 | 2374 | 18269 | 1970 | 20608 | 1621 | 23990 | 1039 | 30807 | 612 | 25547 |
| 4L-5S | | MI | 6087 | 2823 | 9445 | 2302 | 11188 | 1905 | 12356 | 1558 | 13957 | 990 | 17198 | 404 | 14998 |
| 14-#14 | 3.65 | MA | 9557 | 2823 | 14156 | 2396 | 17243 | 1991 | 19335 | 1639 | 22221 | 1067 | 28374 | 535 | 24224 |
| 5L-4S | | MI | 6312 | 2823 | 9911 | 2286 | 11826 | 1891 | 13146 | 1548 | 15053 | 974 | 18654 | 500 | 15598 |
| 14-#14 | 3.65 | MA | 9116 | 2823 | 13240 | 2420 | 16276 | 2011 | 18089 | 1670 | 20492 | 1081 | 26030 | 412 | 23056 |
| 6L-3S | | MI | 6502 | 2823 | 10433 | 2270 | 12549 | 1866 | 14031 | 1525 | 16262 | 969 | 20117 | 590 | 16026 |


## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

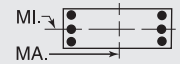

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 3.65 | MA | 8733 | 2823 | 12451 | 2435 | 15196 | 2036 | 16888 | 1689 | 18816 | 1109 | 23731 | 349 | 21613 |
| 7L-2S | | MI | 6860 | 2823 | 11180 | 2254 | 13496 | 1853 | 15179 | 1515 | 17811 | 953 | 22185 | 754 | 16099 |
| 14-#18 | 6.48 | MA | 11422 | 3533 | 18603 | 2871 | 22652 | 2353 | 25805 | 1878 | 30853 | 1067 | 40497 | 213 | 39460 |
| 5L-4S | | MI | 7512 | 3533 | 12872 | 2726 | 15449 | 2219 | 17486 | 1753 | 20862 | 931 | 25879 | 116 | 25207 |
| 14-#18 | 6.48 | MA | 10740 | 3533 | 17025 | 2915 | 20955 | 2386 | 23619 | 1930 | 27822 | 1090 | 36354 | -7 | 36307 |
| 6L-3S | | MI | 7756 | 3533 | 13779 | 2700 | 16702 | 2177 | 19019 | 1717 | 22957 | 929 | 28338 | 268 | 27070 |
| 16-#10 | 2.35 | MA | 9101 | 2499 | 12684 | 2171 | 15620 | 1816 | 17468 | 1521 | 19819 | 1050 | 24950 | 752 | 17137 |
| 4L-6S | | MI | 5533 | 2499 | 7995 | 2124 | 9549 | 1770 | 10411 | 1485 | 11382 | 1016 | 13946 | 577 | 10356 |
| 16-#10 | 2.35 | MA | 8829 | 2499 | 12252 | 2184 | 15033 | 1829 | 16738 | 1533 | 18804 | 1066 | 23560 | 711 | 16880 |
| 5E | | MI | 5699 | 2499 | 8305 | 2109 | 9898 | 1761 | 10860 | 1471 | 12004 | 1012 | 14809 | 648 | 10601 |
| 16-#10 | 2.35 | MA | 8558 | 2499 | 11720 | 2198 | 14471 | 1840 | 16024 | 1551 | 17813 | 1076 | 22221 | 645 | 16351 |
| 6L-4S | | MI | 5841 | 2499 | 8574 | 2099 | 10268 | 1752 | 11318 | 1463 | 12639 | 1000 | 15691 | 702 | 10791 |
| 16-#10 | 2.35 | MA | 8325 | 2499 | 11267 | 2207 | 13844 | 1855 | 15333 | 1562 | 16852 | 1093 | 20917 | 611 | 15932 |
| 7L-3S | | MI | 5963 | 2499 | 8877 | 2088 | 10687 | 1736 | 11832 | 1449 | 13342 | 995 | 16573 | 756 | 10829 |
| 16-#10 | 2.35 | MA | 8090 | 2499 | 10832 | 2217 | 13262 | 1863 | 14598 | 1577 | 15893 | 1102 | 19654 | 564 | 15243 |
| 8L-2S | | MI | 6191 | 2499 | 9314 | 2078 | 11242 | 1727 | 12504 | 1441 | 14249 | 984 | 17827 | 848 | 10844 |
| 16-#11 | 2.89 | MA | 9520 | 2633 | 13732 | 2250 | 16865 | 1875 | 18938 | 1558 | 21768 | 1041 | 27657 | 705 | 20705 |
| 4L-6S | | MI | 5703 | 2633 | 8517 | 2201 | 10133 | 1824 | 11077 | 1518 | 12261 | 1011 | 15057 | 487 | 12259 |
| 16-#11 | 2.89 | MA | 9200 | 2633 | 13211 | 2266 | 16150 | 1889 | 18050 | 1571 | 20532 | 1061 | 25961 | 652 | 20111 |
| 5E | | MI | 5897 | 2633 | 8884 | 2182 | 10556 | 1814 | 11621 | 1501 | 12997 | 998 | 16011 | 561 | 12527 |
| 16-#11 | 2.89 | MA | 8883 | 2633 | 12566 | 2282 | 15475 | 1904 | 17180 | 1593 | 19326 | 1072 | 24329 | 569 | 19520 |
| 6L-4S | | MI | 6060 | 2633 | 9211 | 2170 | 11003 | 1804 | 12175 | 1493 | 13765 | 985 | 17052 | 627 | 12923 |
| 16-#11 | 2.89 | MA | 8611 | 2633 | 12015 | 2293 | 14713 | 1921 | 16343 | 1606 | 18156 | 1091 | 22730 | 526 | 18745 |
| 7L-3S | | MI | 6200 | 2633 | 9577 | 2158 | 11510 | 1786 | 12796 | 1477 | 14614 | 981 | 18095 | 691 | 12992 |
| 16-#11 | 2.89 | MA | 8333 | 2633 | 11486 | 2305 | 14005 | 1931 | 15457 | 1624 | 17007 | 1111 | 21188 | 467 | 17920 |
| 8L-2S | | MI | 6463 | 2633 | 10103 | 2146 | 12177 | 1776 | 13604 | 1469 | 15705 | 968 | 19573 | 804 | 13021 |
| 16-#14 | 4.17 | MA | 10125 | 2953 | 15392 | 2478 | 18811 | 2050 | 21235 | 1677 | 24786 | 1060 | 31926 | 526 | 27850 |
| 5E | | MI | 6413 | 2953 | 10191 | 2384 | 12135 | 1964 | 13504 | 1596 | 15507 | 984 | 19266 | 387 | 17145 |
| 16-#14 | 4.17 | MA | 9704 | 2953 | 14475 | 2502 | 17844 | 2071 | 19989 | 1708 | 23058 | 1075 | 29581 | 403 | 26673 |
| 6L-4S | | MI | 6636 | 2953 | 10657 | 2368 | 12773 | 1951 | 14294 | 1586 | 16602 | 967 | 20721 | 483 | 17716 |
| 16-#14 | 4.17 | MA | 9342 | 2953 | 13687 | 2517 | 16764 | 2096 | 18789 | 1727 | 21381 | 1102 | 27283 | 340 | 25237 |
| 7L-3S | | MI | 6815 | 2953 | 11180 | 2351 | 13496 | 1925 | 15179 | 1563 | 17811 | 963 | 22185 | 573 | 18219 |
| 16-#14 | 4.17 | MA | 8953 | 2953 | 12928 | 2533 | 15749 | 2110 | 17534 | 1753 | 19734 | 1130 | 25069 | 252 | 23553 |
| 8L-2S | | MI | 7156 | 2953 | 11926 | 2335 | 14443 | 1912 | 16327 | 1553 | 19361 | 946 | 24252 | 737 | 18305 |
| 16-#18 | 7.41 | MA | 11726 | 3765 | 19181 | 3060 | 23690 | 2492 | 26935 | 1997 | 32298 | 1079 | 42551 | -23 | 42370 |
| 6L-4S | | MI | 8045 | 3765 | 14158 | 2871 | 17081 | 2325 | 19464 | 1820 | 23532 | 920 | 29327 | 73 | 28894 |
| 18-#10 | 2.65 | MA | 9169 | 2572 | 12965 | 2230 | 15937 | 1862 | 17835 | 1554 | 20284 | 1063 | 25609 | 706 | 18956 |
| 5L-6S | | MI | 5736 | 2572 | 8431 | 2170 | 10103 | 1804 | 11083 | 1507 | 12289 | 1013 | 15200 | 572 | 11617 |
| 18-#10 | 2.65 | MA | 8907 | 2572 | 12433 | 2244 | 15376 | 1874 | 17121 | 1572 | 19293 | 1072 | 24271 | 640 | 18442 |
| 6L-5S | | MI | 5897 | 2572 | 8741 | 2155 | 10453 | 1795 | 11532 | 1492 | 12911 | 1008 | 16063 | 643 | 11853 |
| 18-#10 | 2.65 | MA | 8683 | 2572 | 11980 | 2253 | 14749 | 1888 | 16430 | 1584 | 18332 | 1089 | 22966 | 606 | 18022 |
| 7L-4S | | MI | 6038 | 2572 | 9011 | 2145 | 10822 | 1786 | 11990 | 1485 | 13546 | 997 | 16946 | 697 | 12076 |
| 18-#10 | 2.65 | MA | 8450 | 2572 | 11545 | 2263 | 14166 | 1897 | 15694 | 1598 | 17373 | 1099 | 21703 | 559 | 17342 |
| 8L-3S | | MI | 6155 | 2572 | 9314 | 2134 | 11242 | 1770 | 12504 | 1470 | 14249 | 992 | 17827 | 751 | 12120 |
| 18-#10 | 2.65 | MA | 8181 | 2572 | 11119 | 2274 | 13600 | 1907 | 14980 | 1606 | 16428 | 1116 | 20464 | 515 | 16624 |
| 9L-2S | | MI | 6378 | 2572 | 9751 | 2124 | 11796 | 1761 | 13176 | 1463 | 15156 | 980 | 19082 | 843 | 12140 |
| 18-#11 | 3.25 | MA | 9603 | 2723 | 14076 | 2322 | 17247 | 1931 | 19380 | 1597 | 22327 | 1056 | 28447 | 647 | 22633 |
| 5L-6S | | MI | 5941 | 2723 | 9043 | 2258 | 10799 | 1865 | 11885 | 1544 | 13352 | 1006 | 16535 | 477 | 13777 |
| 18-#11 | 3.25 | MA | 9297 | 2723 | 13431 | 2339 | 16572 | 1945 | 18510 | 1619 | 21121 | 1067 | 26814 | 563 | 22061 |
| 6L-5S | | MI | 6129 | 2723 | 9410 | 2239 | 11222 | 1855 | 12429 | 1527 | 14088 | 994 | 17489 | 551 | 14034 |
| 18-#11 | 3.25 | MA | 9036 | 2723 | 12880 | 2349 | 15811 | 1962 | 17673 | 1633 | 19951 | 1087 | 25216 | 520 | 21285 |
| 7L-4S | | MI | 6291 | 2723 | 9737 | 2227 | 11670 | 1845 | 12983 | 1519 | 14856 | 981 | 18530 | 617 | 14464 |
| 18-#11 | 3.25 | MA | 8762 | 2723 | 12350 | 2362 | 15102 | 1973 | 16787 | 1650 | 18802 | 1107 | 23674 | 461 | 20451 |
| 8L-3S | | MI | 6425 | 2723 | 10103 | 2215 | 12177 | 1827 | 13604 | 1503 | 15705 | 977 | 19573 | 681 | 14541 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

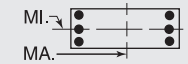



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 3.25 | MA | 8445 | 2723 | 11837 | 2375 | 14413 | 1984 | 15918 | 1660 | 17633 | 1118 | 22155 | 405 | 19408 |
| 9L-2S | | MI | 6681 | 2723 | 10628 | 2203 | 12843 | 1817 | 14412 | 1495 | 16796 | 964 | 21051 | 795 | 14578 |
| 18-#14 | 4.69 | MA | 10278 | 3084 | 15711 | 2583 | 19412 | 2131 | 21890 | 1746 | 25623 | 1069 | 33133 | 395 | 30290 |
| 6L-5S | | MI | 6733 | 3084 | 10937 | 2465 | 13083 | 2024 | 14652 | 1634 | 17056 | 978 | 21333 | 370 | 19298 |
| 18-#14 | 4.69 | MA | 9935 | 3084 | 14922 | 2598 | 18332 | 2156 | 20689 | 1764 | 23946 | 1096 | 30835 | 332 | 28861 |
| 7L-4S | | MI | 6955 | 3084 | 11404 | 2449 | 13720 | 2011 | 15442 | 1623 | 18152 | 961 | 22788 | 466 | 19842 |
| 18-#14 | 4.69 | MA | 9552 | 3084 | 14164 | 2615 | 17317 | 2169 | 19434 | 1790 | 22300 | 1123 | 28621 | 244 | 27165 |
| 8L-3S | | MI | 7136 | 3084 | 11926 | 2433 | 14443 | 1985 | 16327 | 1601 | 19361 | 957 | 24252 | 556 | 20412 |
| 20-#10 | 2.94 | MA | 9250 | 2646 | 13146 | 2290 | 16281 | 1908 | 18217 | 1594 | 20773 | 1069 | 26320 | 635 | 20535 |
| 6E | | MI | 5935 | 2646 | 8868 | 2216 | 10658 | 1838 | 11755 | 1528 | 13196 | 1009 | 16455 | 567 | 12881 |
| 20-#10 | 2.94 | MA | 9034 | 2646 | 12693 | 2299 | 15654 | 1922 | 17526 | 1605 | 19812 | 1086 | 25016 | 601 | 20114 |
| 7L-5S | | MI | 6092 | 2646 | 9178 | 2201 | 11007 | 1829 | 12204 | 1513 | 13818 | 1005 | 17318 | 638 | 13108 |
| 20-#10 | 2.94 | MA | 8803 | 2646 | 12258 | 2309 | 15071 | 1931 | 16791 | 1619 | 18853 | 1095 | 23753 | 555 | 19440 |
| 8L-4S | | MI | 6232 | 2646 | 9448 | 2191 | 11376 | 1820 | 12662 | 1506 | 14453 | 993 | 18200 | 692 | 13360 |
| 20-#10 | 2.94 | MA | 8542 | 2646 | 11832 | 2320 | 14505 | 1940 | 16076 | 1627 | 17908 | 1112 | 22513 | 510 | 18716 |
| 9L-3S | | MI | 6345 | 2646 | 9751 | 2180 | 11796 | 1804 | 13176 | 1491 | 15156 | 988 | 19082 | 746 | 13410 |
| 20-#10 | 2.94 | MA | 8301 | 2646 | 11387 | 2327 | 13914 | 1958 | 15377 | 1637 | 16956 | 1127 | 21170 | 460 | 17991 |
| 10L-2S | | MI | 6562 | 2646 | 10187 | 2170 | 12350 | 1795 | 13848 | 1484 | 16063 | 977 | 20336 | 838 | 13435 |
| 20-#11 | 3.61 | MA | 9703 | 2814 | 14295 | 2395 | 17670 | 1987 | 19840 | 1645 | 22916 | 1063 | 29300 | 557 | 24604 |
| 6E | | MI | 6175 | 2814 | 9568 | 2314 | 11466 | 1907 | 12693 | 1570 | 14443 | 1002 | 18013 | 468 | 15298 |
| 20-#11 | 3.61 | MA | 9453 | 2814 | 13744 | 2406 | 16908 | 2004 | 19003 | 1659 | 21746 | 1083 | 27702 | 514 | 23828 |
| 7L-5S | | MI | 6358 | 2814 | 9935 | 2295 | 11889 | 1897 | 13237 | 1554 | 15179 | 989 | 18968 | 542 | 15546 |
| 20-#11 | 3.61 | MA | 9181 | 2814 | 13215 | 2418 | 16199 | 2014 | 18117 | 1676 | 20597 | 1102 | 26160 | 455 | 22982 |
| 8L-4S | | MI | 6518 | 2814 | 10262 | 2283 | 12336 | 1887 | 13791 | 1546 | 15947 | 977 | 20008 | 608 | 16001 |
| 20-#11 | 3.61 | MA | 8875 | 2814 | 12701 | 2431 | 15510 | 2025 | 17248 | 1686 | 19428 | 1113 | 24641 | 399 | 21944 |
| 9L-3S | | MI | 6647 | 2814 | 10628 | 2271 | 12843 | 1868 | 14412 | 1529 | 16796 | 972 | 21051 | 672 | 16089 |
| 20-#14 | 5.21 | MA | 10515 | 3214 | 16158 | 2680 | 19900 | 2215 | 22590 | 1802 | 26512 | 1090 | 34387 | 323 | 32485 |
| 7L-5S | | MI | 7048 | 3214 | 11684 | 2547 | 14030 | 2083 | 15800 | 1671 | 18606 | 972 | 23400 | 353 | 21455 |
| 20-#14 | 5.21 | MA | 10136 | 3214 | 15400 | 2696 | 18885 | 2229 | 21335 | 1828 | 24865 | 1117 | 32173 | 235 | 30777 |
| 8L-4S | | MI | 7294 | 3214 | 12150 | 2531 | 14667 | 2070 | 16590 | 1661 | 19701 | 955 | 24856 | 449 | 21977 |
| 22-#10 | 3.23 | MA | 9379 | 2719 | 13406 | 2345 | 16558 | 1956 | 18623 | 1626 | 21292 | 1082 | 27065 | 596 | 22207 |
| 7L-6S | | MI | 6131 | 2719 | 9305 | 2262 | 11212 | 1871 | 12427 | 1549 | 14103 | 1006 | 17709 | 562 | 14147 |
| 22-#10 | 3.23 | MA | 9150 | 2719 | 12971 | 2355 | 15976 | 1964 | 17887 | 1640 | 20333 | 1092 | 25802 | 550 | 21539 |
| 8L-5S | | MI | 6285 | 2719 | 9615 | 2247 | 11561 | 1862 | 12875 | 1535 | 14724 | 1001 | 18572 | 633 | 14366 |
| 22-#10 | 3.23 | MA | 8897 | 2719 | 12545 | 2366 | 15409 | 1974 | 17173 | 1649 | 19389 | 1109 | 24563 | 505 | 20808 |
| 9L-4S | | MI | 6424 | 2719 | 9884 | 2237 | 11930 | 1853 | 13333 | 1527 | 15360 | 990 | 19455 | 687 | 14644 |
| 22-#10 | 3.23 | MA | 8664 | 2719 | 12100 | 2373 | 14819 | 1991 | 16473 | 1658 | 18436 | 1124 | 23220 | 455 | 20085 |
| 10L-3S | | MI | 6532 | 2719 | 10187 | 2226 | 12350 | 1837 | 13848 | 1513 | 16063 | 985 | 20336 | 741 | 14699 |
| 22-#11 | 3.97 | MA | 9862 | 2904 | 14609 | 2463 | 18005 | 2045 | 20332 | 1685 | 23542 | 1078 | 30187 | 508 | 26372 |
| 7L-6S | | MI | 6406 | 2904 | 10093 | 2371 | 12133 | 1948 | 13502 | 1596 | 15534 | 998 | 19492 | 459 | 16791 |
| 22-#11 | 3.97 | MA | 9593 | 2904 | 14080 | 2475 | 17296 | 2055 | 19447 | 1702 | 22392 | 1098 | 28645 | 449 | 25513 |
| 8L-5S | | MI | 6583 | 2904 | 10461 | 2352 | 12556 | 1938 | 14045 | 1580 | 16270 | 985 | 20446 | 532 | 17061 |
| 22-#11 | 3.97 | MA | 9297 | 2904 | 13566 | 2488 | 16607 | 2066 | 18577 | 1712 | 21223 | 1109 | 27126 | 393 | 24479 |
| 9L-4S | | MI | 6744 | 2904 | 10787 | 2340 | 13003 | 1928 | 14599 | 1572 | 17038 | 972 | 21487 | 598 | 17499 |
| 22-#14 | 5.73 | MA | 10709 | 3344 | 16635 | 2778 | 20453 | 2289 | 23235 | 1866 | 27430 | 1111 | 35724 | 226 | 34389 |
| 8L-5S | | MI | 7379 | 3344 | 12430 | 2628 | 14977 | 2143 | 16948 | 1709 | 20156 | 966 | 25468 | 336 | 23618 |
| 24-#10 | 3.53 | MA | 9492 | 2793 | 13684 | 2401 | 16880 | 1998 | 18984 | 1662 | 21813 | 1088 | 27851 | 545 | 23637 |
| 8L-6S | | MI | 6325 | 2793 | 9742 | 2308 | 11766 | 1905 | 13098 | 1570 | 15009 | 1002 | 18964 | 557 | 15415 |
| 24-#10 | 3.53 | MA | 9245 | 2793 | 13257 | 2412 | 16314 | 2008 | 18269 | 1670 | 20869 | 1105 | 26612 | 500 | 22900 |
| 9L-5S | | MI | 6475 | 2793 | 10052 | 2293 | 12115 | 1896 | 13547 | 1556 | 15631 | 998 | 19827 | 628 | 15627 |
| 24-#10 | 3.53 | MA | 9020 | 2793 | 12813 | 2419 | 15724 | 2025 | 17570 | 1679 | 19917 | 1120 | 25269 | 450 | 22179 |
| 10L-4S | | MI | 6614 | 2793 | 10321 | 2283 | 12485 | 1887 | 14005 | 1548 | 16266 | 986 | 20709 | 682 | 15928 |
| 24-#11 | 4.33 | MA | 9998 | 2995 | 14944 | 2531 | 18394 | 2097 | 20777 | 1729 | 24188 | 1094 | 31131 | 443 | 28045 |
| 8L-6S | | MI | 6634 | 2995 | 10619 | 2427 | 12800 | 1989 | 14310 | 1622 | 16625 | 993 | 20970 | 449 | 18289 |
| 24-#11 | 4.33 | MA | 9711 | 2995 | 14431 | 2544 | 17705 | 2108 | 19907 | 1738 | 23019 | 1105 | 29612 | 387 | 27014 |
| 9L-5S | | MI | 6807 | 2995 | 10986 | 2408 | 13223 | 1979 | 14853 | 1606 | 17361 | 981 | 21924 | 523 | 18580 |

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

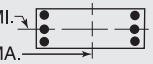
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.75 | MA | 9912 | 2479 | 13944 | 2139 | 17044 | 1789 | 18943 | 1509 | 21315 | 1073 | 26451 | 930 | 14160 |
| 2E | | MI | 5983 | 2479 | 8972 | 2043 | 10558 | 1707 | 11505 | 1437 | 12663 | 1015 | 14969 | 824 | 8362 |
| 6-#11 | 1.03 | MA | 9086 | 2287 | 11903 | 2042 | 14617 | 1721 | 16086 | 1470 | 17531 | 1095 | 21267 | 954 | 8567 |
| 2L-3S | | MI | 5275 | 2287 | 7278 | 1970 | 8556 | 1659 | 9151 | 1416 | 9547 | 1058 | 11133 | 787 | 5215 |
| 6-#11 | 1.03 | MA | 8522 | 2287 | 10982 | 2058 | 13448 | 1736 | 14669 | 1484 | 15619 | 1115 | 18619 | 854 | 8567 |
| 3L-2S | | MI | 5583 | 2287 | 7803 | 1958 | 9223 | 1649 | 9959 | 1408 | 10638 | 1045 | 12612 | 900 | 5191 |
| 6-#14 | 1.48 | MA | 9644 | 2407 | 13159 | 2109 | 16157 | 1769 | 17923 | 1499 | 19987 | 1085 | 24648 | 942 | 12147 |
| 2L-3S | | MI | 5446 | 2407 | 7779 | 2037 | 9141 | 1707 | 9836 | 1444 | 10451 | 1050 | 12277 | 707 | 7261 |
| 6-#14 | 1.48 | MA | 8873 | 2407 | 11842 | 2132 | 14486 | 1790 | 15898 | 1519 | 17252 | 1113 | 20862 | 795 | 12098 |
| 3L-2S | | MI | 5867 | 2407 | 8525 | 2021 | 10089 | 1694 | 10984 | 1434 | 12000 | 1033 | 14344 | 871 | 7245 |
| 6-#18 | 2.63 | MA | 10941 | 2711 | 16245 | 2284 | 19964 | 1895 | 22482 | 1576 | 26091 | 1062 | 33064 | 914 | 20992 |
| 2L-3S | | MI | 5850 | 2711 | 8972 | 2213 | 10558 | 1832 | 11505 | 1518 | 12663 | 1028 | 14969 | 490 | 12103 |
| 6-#18 | 2.63 | MA | 9715 | 2711 | 13944 | 2323 | 17044 | 1931 | 18943 | 1608 | 21315 | 1108 | 26451 | 646 | 20680 |
| 3L-2S | | MI | 6519 | 2711 | 10258 | 2188 | 12190 | 1813 | 13483 | 1504 | 15332 | 1004 | 18417 | 780 | 12207 |
| 8-#10 | 1.11 | MA | 9236 | 2310 | 12079 | 2066 | 14917 | 1740 | 16488 | 1485 | 18110 | 1100 | 22094 | 958 | 9335 |
| 2L-4S | | MI | 5274 | 2310 | 7151 | 2010 | 8429 | 1699 | 9027 | 1449 | 9401 | 1070 | 11106 | 771 | 5664 |
| 8-#10 | 1.11 | MA | 8776 | 2310 | 11320 | 2080 | 13954 | 1753 | 15321 | 1497 | 16534 | 1117 | 19912 | 878 | 9329 |
| 3E | | MI | 5420 | 2310 | 7454 | 1999 | 8849 | 1683 | 9541 | 1435 | 10104 | 1066 | 11988 | 825 | 5657 |
| 8-#10 | 1.11 | MA | 8522 | 2310 | 10805 | 2094 | 13239 | 1773 | 14444 | 1516 | 15333 | 1127 | 18469 | 828 | 9279 |
| 4L-2S | | MI | 5676 | 2310 | 7890 | 1989 | 9403 | 1674 | 10213 | 1427 | 11010 | 1054 | 13242 | 917 | 5642 |
| 8-#11 | 1.37 | MA | 9532 | 2377 | 12824 | 2098 | 15786 | 1762 | 17503 | 1496 | 19444 | 1091 | 23915 | 948 | 11317 |
| 2L-4S | | MI | 5349 | 2377 | 7437 | 2038 | 8715 | 1719 | 9338 | 1459 | 9789 | 1058 | 11569 | 713 | 6786 |
| 8-#11 | 1.37 | MA | 8990 | 2377 | 11903 | 2114 | 14617 | 1777 | 16086 | 1510 | 17531 | 1111 | 21267 | 848 | 11298 |
| 3E | | MI | 5521 | 2377 | 7803 | 2026 | 9223 | 1701 | 9959 | 1442 | 10638 | 1054 | 12612 | 777 | 6794 |
| 8-#11 | 1.37 | MA | 8690 | 2377 | 11277 | 2131 | 13747 | 1801 | 15019 | 1533 | 16070 | 1123 | 19500 | 785 | 11199 |
| 4L-2S | | MI | 5820 | 2377 | 8329 | 2014 | 9889 | 1691 | 10768 | 1434 | 11729 | 1041 | 14090 | 891 | 6779 |
| 8-#14 | 1.97 | MA | 10255 | 2537 | 14476 | 2191 | 17828 | 1829 | 19949 | 1537 | 22721 | 1079 | 28435 | 934 | 16064 |
| 2L-4S | | MI | 5554 | 2537 | 8003 | 2135 | 9366 | 1792 | 10099 | 1505 | 10791 | 1048 | 12880 | 600 | 9378 |
| 8-#14 | 1.97 | MA | 9521 | 2537 | 13159 | 2214 | 16157 | 1850 | 17923 | 1557 | 19987 | 1107 | 24648 | 787 | 15984 |
| 3E | | MI | 5786 | 2537 | 8525 | 2119 | 10089 | 1767 | 10984 | 1482 | 12000 | 1043 | 14344 | 690 | 9474 |
| 8-#14 | 1.97 | MA | 9118 | 2537 | 12262 | 2237 | 14911 | 1884 | 16395 | 1588 | 17895 | 1123 | 22108 | 696 | 15673 |
| 4L-2S | | MI | 6190 | 2537 | 9272 | 2103 | 11036 | 1754 | 12132 | 1472 | 13550 | 1027 | 16411 | 854 | 9483 |
| 8-#18 | 3.51 | MA | 11931 | 2943 | 18545 | 2429 | 22883 | 2001 | 26021 | 1643 | 30868 | 1050 | 39678 | 899 | 27809 |
| 2L-4S | | MI | 6046 | 2943 | 9351 | 2383 | 10937 | 1980 | 11949 | 1620 | 13238 | 1019 | 15959 | 294 | 14418 |
| 8-#18 | 3.51 | MA | 10792 | 2943 | 16245 | 2468 | 19964 | 2037 | 22482 | 1675 | 26091 | 1097 | 33064 | 631 | 27449 |
| 3E | | MI | 6411 | 2943 | 10258 | 2358 | 12190 | 1938 | 13483 | 1585 | 15332 | 1017 | 18417 | 446 | 15859 |
| 8-#18 | 3.51 | MA | 10169 | 2943 | 14670 | 2507 | 17779 | 2094 | 19803 | 1729 | 22425 | 1122 | 28576 | 467 | 24941 |
| 4L-2S | | MI | 7038 | 2943 | 11544 | 2333 | 13822 | 1919 | 15461 | 1571 | 18002 | 993 | 21866 | 737 | 16021 |
| 10-#10 | 1.39 | MA | 9606 | 2384 | 12837 | 2112 | 15880 | 1774 | 17656 | 1506 | 19685 | 1097 | 24276 | 953 | 11597 |
| 2L-5S | | MI | 5340 | 2384 | 7318 | 2066 | 8614 | 1741 | 9241 | 1478 | 9672 | 1078 | 11478 | 713 | 6920 |
| 10-#10 | 1.39 | MA | 9159 | 2384 | 12079 | 2126 | 14917 | 1787 | 16488 | 1518 | 18110 | 1114 | 22094 | 873 | 11580 |
| 3L-4S | | MI | 5486 | 2384 | 7587 | 2056 | 8983 | 1732 | 9699 | 1470 | 10308 | 1067 | 12361 | 766 | 6959 |
| 10-#10 | 1.39 | MA | 8918 | 2384 | 11564 | 2140 | 14202 | 1806 | 15611 | 1537 | 16909 | 1124 | 20650 | 823 | 11517 |
| 4L-3S | | MI | 5626 | 2384 | 7890 | 2045 | 9403 | 1716 | 10213 | 1456 | 11010 | 1062 | 13242 | 820 | 6965 |
| 10-#10 | 1.39 | MA | 8615 | 2384 | 11102 | 2153 | 13578 | 1819 | 14836 | 1549 | 15830 | 1141 | 19176 | 784 | 11353 |
| 5L-2S | | MI | 5874 | 2384 | 8327 | 2035 | 9957 | 1708 | 10885 | 1448 | 11917 | 1051 | 14497 | 912 | 6956 |
| 10-#11 | 1.71 | MA | 9967 | 2468 | 13745 | 2155 | 16955 | 1803 | 18919 | 1523 | 21356 | 1086 | 26563 | 942 | 14058 |
| 2L-5S | | MI | 5431 | 2468 | 7636 | 2107 | 8935 | 1770 | 9592 | 1493 | 10112 | 1067 | 12006 | 638 | 8128 |
| 10-#11 | 1.71 | MA | 9444 | 2468 | 12824 | 2171 | 15786 | 1818 | 17503 | 1537 | 19444 | 1107 | 23915 | 842 | 14024 |
| 3L-4S | | MI | 5598 | 2468 | 7962 | 2095 | 9382 | 1760 | 10147 | 1485 | 10880 | 1054 | 13047 | 704 | 8335 |
| 10-#11 | 1.71 | MA | 9162 | 2468 | 12198 | 2187 | 14916 | 1842 | 16436 | 1559 | 17983 | 1118 | 22149 | 780 | 13909 |
| 4L-3S | | MI | 5762 | 2468 | 8329 | 2083 | 9889 | 1742 | 10768 | 1468 | 11729 | 1050 | 14090 | 768 | 8361 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

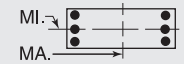
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.71 | MA | 8803 | 2468 | 11641 | 2203 | 14156 | 1857 | 15491 | 1573 | 16670 | 1139 | 20350 | 729 | 13457 |
| 5L-2S | | MI | 6051 | 2468 | 8854 | 2071 | 10556 | 1732 | 11576 | 1460 | 12820 | 1037 | 15568 | 881 | 8357 |
| 10-#14 | 2.47 | MA | 10849 | 2668 | 15794 | 2272 | 19500 | 1888 | 21975 | 1575 | 25456 | 1072 | 32221 | 925 | 19973 |
| 2L-5S | | MI | 5670 | 2668 | 8283 | 2233 | 9675 | 1865 | 10457 | 1552 | 11245 | 1058 | 13492 | 487 | 10838 |
| 10-#14 | 2.47 | MA | 10149 | 2668 | 14476 | 2295 | 17828 | 1910 | 19949 | 1594 | 22721 | 1101 | 28435 | 778 | 19871 |
| 3L-4S | | MI | 5900 | 2668 | 8749 | 2216 | 10313 | 1852 | 11247 | 1542 | 12341 | 1041 | 14948 | 583 | 11522 |
| 10-#14 | 2.47 | MA | 9776 | 2668 | 13579 | 2318 | 16582 | 1943 | 18421 | 1626 | 20629 | 1117 | 25894 | 688 | 19548 |
| 4L-3S | | MI | 6118 | 2668 | 9272 | 2200 | 11036 | 1826 | 12132 | 1520 | 13550 | 1037 | 16411 | 673 | 11676 |
| 10-#14 | 2.47 | MA | 9276 | 2668 | 12787 | 2341 | 15492 | 1964 | 17067 | 1645 | 18748 | 1145 | 23312 | 613 | 18191 |
| 5L-2S | | MI | 6506 | 2668 | 10018 | 2184 | 11983 | 1813 | 13280 | 1509 | 15099 | 1020 | 18479 | 837 | 11709 |
| 10-#18 | 4.39 | MA | 11827 | 3175 | 18545 | 2613 | 22883 | 2143 | 26021 | 1742 | 30868 | 1086 | 39678 | 615 | 34228 |
| 3L-4S | | MI | 6622 | 3175 | 10637 | 2528 | 12569 | 2086 | 13927 | 1687 | 15908 | 1008 | 19407 | 251 | 18039 |
| 10-#18 | 4.39 | MA | 11274 | 3175 | 16971 | 2652 | 20698 | 2200 | 23342 | 1796 | 27201 | 1111 | 35190 | 452 | 31676 |
| 4L-3S | | MI | 6977 | 3175 | 11544 | 2503 | 13822 | 2044 | 15461 | 1652 | 18002 | 1006 | 21866 | 403 | 19614 |
| 10-#18 | 4.39 | MA | 10435 | 3175 | 15578 | 2691 | 18785 | 2236 | 20966 | 1828 | 23900 | 1158 | 30644 | 310 | 29020 |
| 5L-2S | | MI | 7537 | 3175 | 12830 | 2478 | 15454 | 2025 | 17439 | 1638 | 20672 | 982 | 25314 | 694 | 19822 |
| 12-#10 | 1.67 | MA | 9967 | 2457 | 13596 | 2159 | 16844 | 1807 | 18823 | 1527 | 21261 | 1093 | 26457 | 948 | 13854 |
| 2L-6S | | MI | 5373 | 2457 | 7445 | 2127 | 8819 | 1784 | 9464 | 1514 | 9957 | 1080 | 11870 | 636 | 7915 |
| 12-#10 | 1.67 | MA | 9534 | 2457 | 12837 | 2172 | 15880 | 1820 | 17656 | 1539 | 19685 | 1110 | 24276 | 868 | 13828 |
| 3L-5S | | MI | 5549 | 2457 | 7755 | 2112 | 9168 | 1775 | 9913 | 1499 | 10579 | 1075 | 12733 | 708 | 8188 |
| 12-#10 | 1.67 | MA | 9305 | 2457 | 12323 | 2186 | 15166 | 1840 | 16779 | 1558 | 18484 | 1120 | 22832 | 818 | 13755 |
| 4E | | MI | 5693 | 2457 | 8024 | 2102 | 9537 | 1766 | 10371 | 1492 | 11214 | 1063 | 13615 | 761 | 8250 |
| 12-#10 | 1.67 | MA | 9005 | 2457 | 11861 | 2199 | 14542 | 1853 | 16003 | 1570 | 17406 | 1138 | 21358 | 779 | 13586 |
| 5L-3S | | MI | 5827 | 2457 | 8327 | 2091 | 9957 | 1750 | 10885 | 1477 | 11917 | 1059 | 14497 | 815 | 8266 |
| 12-#10 | 1.67 | MA | 8696 | 2457 | 11295 | 2213 | 13940 | 1864 | 15245 | 1589 | 16354 | 1148 | 19938 | 714 | 13002 |
| 6L-2S | | MI | 6069 | 2457 | 8764 | 2081 | 10511 | 1741 | 11557 | 1470 | 12824 | 1047 | 15751 | 907 | 8265 |
| 12-#11 | 2.05 | MA | 10393 | 2558 | 14666 | 2211 | 18125 | 1845 | 20336 | 1549 | 23269 | 1082 | 29211 | 936 | 16795 |
| 2L-6S | | MI | 5469 | 2558 | 7794 | 2182 | 9179 | 1822 | 9857 | 1536 | 10467 | 1075 | 12530 | 555 | 9319 |
| 12-#11 | 2.05 | MA | 9887 | 2558 | 13745 | 2228 | 16955 | 1860 | 18919 | 1563 | 21356 | 1102 | 26563 | 836 | 16749 |
| 3L-5S | | MI | 5676 | 2558 | 8161 | 2163 | 9602 | 1812 | 10401 | 1519 | 11203 | 1062 | 13485 | 628 | 9614 |
| 12-#11 | 2.05 | MA | 9621 | 2558 | 13119 | 2244 | 16085 | 1884 | 17852 | 1585 | 19895 | 1114 | 24797 | 774 | 16622 |
| 4E | | MI | 5842 | 2558 | 8488 | 2151 | 10049 | 1802 | 10955 | 1511 | 11971 | 1049 | 14525 | 694 | 9881 |
| 12-#11 | 2.05 | MA | 9267 | 2558 | 12562 | 2260 | 15325 | 1899 | 16908 | 1599 | 18582 | 1134 | 22998 | 723 | 16132 |
| 5L-3S | | MI | 5998 | 2558 | 8854 | 2139 | 10556 | 1783 | 11576 | 1494 | 12820 | 1045 | 15568 | 759 | 9919 |
| 12-#11 | 2.05 | MA | 8901 | 2558 | 11875 | 2276 | 14602 | 1913 | 15984 | 1622 | 17300 | 1146 | 21265 | 641 | 15435 |
| 6L-2S | | MI | 6279 | 2558 | 9380 | 2128 | 11223 | 1773 | 12384 | 1486 | 13911 | 1033 | 17047 | 872 | 9927 |
| 12-#14 | 2.96 | MA | 10759 | 2798 | 15794 | 2377 | 19500 | 1969 | 21975 | 1632 | 25456 | 1095 | 32221 | 770 | 23758 |
| 3L-5S | | MI | 6011 | 2798 | 9029 | 2314 | 10623 | 1925 | 11605 | 1590 | 12795 | 1052 | 15560 | 470 | 12965 |
| 12-#14 | 2.96 | MA | 10414 | 2798 | 14896 | 2400 | 18254 | 2003 | 20447 | 1664 | 23364 | 1110 | 29681 | 679 | 23427 |
| 4E | | MI | 6237 | 2798 | 9496 | 2298 | 11260 | 1912 | 12395 | 1580 | 13890 | 1035 | 17015 | 566 | 13611 |
| 12-#14 | 2.96 | MA | 9920 | 2798 | 14104 | 2423 | 17164 | 2024 | 19093 | 1683 | 21482 | 1139 | 27099 | 604 | 22050 |
| 5L-3S | | MI | 6443 | 2798 | 10018 | 2282 | 11983 | 1886 | 13280 | 1557 | 15099 | 1031 | 18479 | 656 | 13874 |
| 12-#14 | 2.96 | MA | 9423 | 2798 | 13121 | 2446 | 16137 | 2045 | 17769 | 1715 | 19645 | 1155 | 24612 | 483 | 20886 |
| 6L-2S | | MI | 6817 | 2798 | 10764 | 2266 | 12930 | 1873 | 14428 | 1547 | 16649 | 1014 | 20546 | 820 | 13924 |
| 12-#18 | 5.26 | MA | 12339 | 3407 | 19272 | 2797 | 23618 | 2306 | 26880 | 1863 | 31978 | 1100 | 41803 | 437 | 38423 |
| 4E | | MI | 7222 | 3407 | 11923 | 2673 | 14201 | 2192 | 15905 | 1754 | 18577 | 997 | 22855 | 208 | 21685 |
| 12-#18 | 5.26 | MA | 11512 | 3407 | 17879 | 2836 | 21704 | 2341 | 24504 | 1895 | 28677 | 1147 | 37258 | 295 | 35715 |
| 5L-3S | | MI | 7503 | 3407 | 12830 | 2648 | 15454 | 2150 | 17439 | 1719 | 20672 | 995 | 25314 | 360 | 23373 |
| 12-#18 | 5.26 | MA | 10726 | 3407 | 16182 | 2879 | 19899 | 2377 | 22179 | 1949 | 25452 | 1172 | 32869 | 76 | 32343 |
| 6L-2S | | MI | 8026 | 3407 | 14116 | 2622 | 17086 | 2131 | 19417 | 1705 | 23342 | 971 | 28763 | 650 | 23616 |
| 14-#10 | 1.95 | MA | 9902 | 2531 | 13596 | 2218 | 16844 | 1854 | 18823 | 1560 | 21261 | 1107 | 26457 | 863 | 16076 |
| 3L-6S | | MI | 5583 | 2531 | 7881 | 2173 | 9373 | 1818 | 10136 | 1535 | 10864 | 1076 | 13124 | 631 | 9168 |
| 14-#10 | 1.95 | MA | 9683 | 2531 | 13082 | 2232 | 16129 | 1874 | 17946 | 1579 | 20060 | 1117 | 25014 | 813 | 15994 |
| 4L-5S | | MI | 5754 | 2531 | 8191 | 2158 | 9722 | 1809 | 10584 | 1520 | 11486 | 1071 | 13987 | 703 | 9428 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

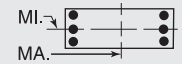


$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 1.95 | MA | 9386 | 2531 | 12620 | 2245 | 15505 | 1887 | 17171 | 1591 | 18982 | 1134 | 23540 | 774 | 15822 |
| 5L-4S | | MI | 5897 | 2531 | 8461 | 2148 | 10092 | 1800 | 11042 | 1513 | 12121 | 1060 | 14870 | 756 | 9538 |
| 14-#10 | 1.95 | MA | 9087 | 2531 | 12054 | 2259 | 14904 | 1898 | 16413 | 1610 | 17929 | 1144 | 22120 | 709 | 15225 |
| 6L-3S | | MI | 6026 | 2531 | 8764 | 2137 | 10511 | 1784 | 11557 | 1498 | 12824 | 1055 | 15751 | 810 | 9563 |
| 14-#10 | 1.95 | MA | 8827 | 2531 | 11573 | 2268 | 14237 | 1913 | 15672 | 1621 | 16909 | 1162 | 20741 | 675 | 14785 |
| 7L-2S | | MI | 6262 | 2531 | 9201 | 2127 | 11066 | 1775 | 12228 | 1491 | 13731 | 1044 | 17006 | 902 | 9569 |
| 14-#11 | 2.39 | MA | 10321 | 2649 | 14666 | 2284 | 18125 | 1901 | 20336 | 1589 | 23269 | 1098 | 29211 | 830 | 19473 |
| 3L-6S | | MI | 5716 | 2649 | 8319 | 2239 | 9846 | 1863 | 10665 | 1562 | 11558 | 1071 | 14009 | 545 | 10828 |
| 14-#11 | 2.39 | MA | 10070 | 2649 | 14040 | 2300 | 17255 | 1925 | 19269 | 1611 | 21808 | 1110 | 27445 | 768 | 19336 |
| 4L-5S | | MI | 5917 | 2649 | 8687 | 2220 | 10269 | 1853 | 11209 | 1545 | 12294 | 1058 | 14963 | 619 | 11109 |
| 14-#11 | 2.39 | MA | 9719 | 2649 | 13484 | 2316 | 16494 | 1940 | 18325 | 1625 | 20495 | 1130 | 25646 | 717 | 18814 |
| 5L-4S | | MI | 6081 | 2649 | 9013 | 2208 | 10716 | 1843 | 11763 | 1537 | 13062 | 1045 | 16004 | 685 | 11424 |
| 14-#11 | 2.39 | MA | 9366 | 2649 | 12796 | 2333 | 15771 | 1954 | 17401 | 1648 | 19213 | 1142 | 23914 | 635 | 18139 |
| 6L-3S | | MI | 6230 | 2649 | 9380 | 2196 | 11223 | 1825 | 12384 | 1521 | 13911 | 1041 | 17047 | 749 | 11474 |
| 14-#11 | 2.39 | MA | 9060 | 2649 | 12210 | 2344 | 14960 | 1972 | 16511 | 1662 | 17970 | 1162 | 22223 | 593 | 17379 |
| 7L-2S | | MI | 6503 | 2649 | 9905 | 2184 | 11890 | 1815 | 13192 | 1513 | 15002 | 1028 | 18525 | 863 | 11492 |
| 14-#14 | 3.45 | MA | 11035 | 2929 | 16213 | 2481 | 19925 | 2062 | 22473 | 1701 | 26098 | 1104 | 33467 | 671 | 27311 |
| 4L-5S | | MI | 6343 | 2929 | 9775 | 2396 | 11570 | 1984 | 12753 | 1628 | 14344 | 1046 | 17627 | 453 | 15101 |
| 14-#14 | 3.45 | MA | 10546 | 2929 | 15421 | 2504 | 18835 | 2084 | 21119 | 1721 | 24217 | 1132 | 30885 | 596 | 25915 |
| 5L-4S | | MI | 6568 | 2929 | 10242 | 2380 | 12208 | 1971 | 13543 | 1618 | 15440 | 1029 | 19082 | 549 | 15714 |
| 14-#14 | 3.45 | MA | 10072 | 2929 | 14438 | 2528 | 17808 | 2105 | 19795 | 1753 | 22379 | 1148 | 28398 | 475 | 24742 |
| 6L-3S | | MI | 6761 | 2929 | 10764 | 2363 | 12930 | 1946 | 14428 | 1595 | 16649 | 1025 | 20546 | 639 | 16069 |
| 14-#14 | 3.45 | MA | 9660 | 2929 | 13598 | 2543 | 16647 | 2129 | 18519 | 1772 | 20598 | 1177 | 25965 | 413 | 23169 |
| 7L-2S | | MI | 7123 | 2929 | 11510 | 2347 | 13877 | 1932 | 15576 | 1585 | 18198 | 1008 | 22613 | 802 | 16135 |
| 14-#18 | 6.14 | MA | 12554 | 3639 | 20179 | 2981 | 24624 | 2447 | 28043 | 1962 | 33453 | 1136 | 43871 | 280 | 42409 |
| 5L-4S | | MI | 7767 | 3639 | 13209 | 2818 | 15833 | 2298 | 17883 | 1821 | 21247 | 986 | 26304 | 164 | 25351 |
| 14-#18 | 6.14 | MA | 11819 | 3639 | 18483 | 3024 | 22819 | 2483 | 25717 | 2016 | 30228 | 1161 | 39482 | 61 | 39063 |
| 6L-3S | | MI | 8018 | 3639 | 14116 | 2793 | 17086 | 2256 | 19417 | 1786 | 23342 | 984 | 28763 | 316 | 27134 |
| 16-#10 | 2.23 | MA | 10054 | 2605 | 13841 | 2278 | 17092 | 1907 | 19113 | 1601 | 21636 | 1113 | 27195 | 808 | 18234 |
| 4L-6S | | MI | 5789 | 2605 | 8318 | 2219 | 9927 | 1851 | 10807 | 1556 | 11771 | 1072 | 14379 | 626 | 10425 |
| 16-#10 | 2.23 | MA | 9760 | 2605 | 13379 | 2291 | 16468 | 1920 | 18338 | 1613 | 20557 | 1131 | 25721 | 769 | 18037 |
| 5E | | MI | 5956 | 2605 | 8628 | 2204 | 10277 | 1842 | 11256 | 1542 | 12393 | 1068 | 15242 | 698 | 10674 |
| 16-#10 | 2.23 | MA | 9469 | 2605 | 12813 | 2305 | 15867 | 1932 | 17580 | 1632 | 19505 | 1141 | 24301 | 704 | 17450 |
| 6L-4S | | MI | 6097 | 2605 | 8898 | 2194 | 10646 | 1833 | 11714 | 1534 | 13028 | 1056 | 16124 | 751 | 10825 |
| 16-#10 | 2.23 | MA | 9219 | 2605 | 12332 | 2314 | 15200 | 1946 | 16839 | 1643 | 18485 | 1158 | 22922 | 670 | 17023 |
| 7L-3S | | MI | 6221 | 2605 | 9201 | 2183 | 11066 | 1817 | 12228 | 1520 | 13731 | 1052 | 17006 | 805 | 10857 |
| 16-#10 | 2.23 | MA | 8964 | 2605 | 11870 | 2324 | 14581 | 1955 | 16057 | 1657 | 17466 | 1168 | 21584 | 625 | 16304 |
| 8L-2S | | MI | 6452 | 2605 | 9637 | 2173 | 11620 | 1808 | 12900 | 1512 | 14638 | 1040 | 18260 | 897 | 10869 |
| 16-#11 | 2.74 | MA | 10509 | 2739 | 14961 | 2357 | 18424 | 1966 | 20686 | 1637 | 23720 | 1105 | 30093 | 762 | 22052 |
| 4L-6S | | MI | 5958 | 2739 | 8845 | 2295 | 10513 | 1904 | 11474 | 1588 | 12649 | 1066 | 15487 | 536 | 12341 |
| 16-#11 | 2.74 | MA | 10162 | 2739 | 14405 | 2373 | 17663 | 1981 | 19742 | 1651 | 22407 | 1126 | 28294 | 711 | 21500 |
| 5E | | MI | 6153 | 2739 | 9212 | 2276 | 10936 | 1894 | 12017 | 1571 | 13385 | 1054 | 16441 | 609 | 12610 |
| 16-#11 | 2.74 | MA | 9821 | 2739 | 13717 | 2389 | 16940 | 1996 | 18818 | 1674 | 21126 | 1137 | 26562 | 629 | 20846 |
| 6L-4S | | MI | 6316 | 2739 | 9539 | 2264 | 11383 | 1884 | 12571 | 1563 | 14153 | 1041 | 17482 | 675 | 12966 |
| 16-#11 | 2.74 | MA | 9528 | 2739 | 13131 | 2400 | 16129 | 2013 | 17928 | 1688 | 19883 | 1158 | 24872 | 587 | 20087 |
| 7L-3S | | MI | 6459 | 2739 | 9905 | 2252 | 11890 | 1866 | 13192 | 1547 | 15002 | 1037 | 18525 | 740 | 13026 |
| 16-#11 | 2.74 | MA | 9226 | 2739 | 12568 | 2413 | 15376 | 2024 | 16977 | 1705 | 18642 | 1169 | 23237 | 529 | 19189 |
| 8L-2S | | MI | 6725 | 2739 | 10431 | 2241 | 12557 | 1856 | 14000 | 1539 | 16093 | 1024 | 20003 | 853 | 13052 |
| 16-#14 | 3.95 | MA | 11157 | 3059 | 16738 | 2586 | 20507 | 2143 | 23145 | 1758 | 26951 | 1126 | 34671 | 587 | 29785 |
| 5E | | MI | 6669 | 3059 | 10522 | 2477 | 12517 | 2044 | 13901 | 1665 | 15894 | 1040 | 19694 | 436 | 17245 |
| 16-#14 | 3.95 | MA | 10704 | 3059 | 15755 | 2610 | 19480 | 2164 | 21821 | 1790 | 25114 | 1142 | 32185 | 466 | 28598 |
| 6L-4S | | MI | 6893 | 3059 | 10988 | 2461 | 13155 | 2031 | 14691 | 1655 | 16989 | 1023 | 21150 | 531 | 17828 |
| 16-#14 | 3.95 | MA | 10314 | 3059 | 14916 | 2625 | 18319 | 2189 | 20545 | 1810 | 23332 | 1170 | 29751 | 404 | 27033 |
| 7L-3S | | MI | 7075 | 3059 | 11510 | 2445 | 13877 | 2005 | 15576 | 1632 | 18198 | 1018 | 22613 | 622 | 18263 |
| 16-#14 | 3.95 | MA | 9892 | 3059 | 14109 | 2642 | 17239 | 2203 | 19195 | 1835 | 21582 | 1199 | 27403 | 319 | 25309 |
| 8L-2S | | MI | 7425 | 3059 | 12257 | 2429 | 14824 | 1992 | 16724 | 1622 | 19748 | 1002 | 24681 | 785 | 18342 |
| 16-#18 | 7.02 | MA | 12878 | 3871 | 20783 | 3169 | 25738 | 2589 | 29256 | 2083 | 35005 | 1150 | 46096 | 45 | 45783 |
| 6L-4S | | MI | 8300 | 3871 | 14495 | 2963 | 17465 | 2404 | 19861 | 1888 | 23917 | 975 | 29752 | 121 | 29033 |

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

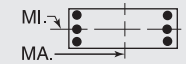
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.51 | MA | 10126 | 2678 | 14138 | 2337 | 17431 | 1954 | 19505 | 1634 | 22133 | 1127 | 27903 | 764 | 20250 |
| 5L-6S | | MI | 5991 | 2678 | 8755 | 2265 | 10482 | 1885 | 11479 | 1577 | 12678 | 1069 | 15633 | 621 | 11685 |
| 18-#10 | 2.51 | MA | 9844 | 2678 | 13572 | 2351 | 16830 | 1965 | 18747 | 1653 | 21080 | 1137 | 26483 | 699 | 19678 |
| 6L-5S | | MI | 6154 | 2678 | 9065 | 2250 | 10831 | 1876 | 11928 | 1563 | 13299 | 1064 | 16496 | 693 | 11924 |
| 18-#10 | 2.51 | MA | 9603 | 2678 | 13090 | 2360 | 16163 | 1980 | 18006 | 1664 | 20060 | 1155 | 25104 | 665 | 19263 |
| 7L-4S | | MI | 6295 | 2678 | 9334 | 2240 | 11200 | 1867 | 12386 | 1555 | 13935 | 1053 | 17379 | 746 | 12111 |
| 18-#10 | 2.51 | MA | 9351 | 2678 | 12628 | 2370 | 15544 | 1989 | 17225 | 1679 | 19042 | 1165 | 23765 | 620 | 18538 |
| 8L-3S | | MI | 6414 | 2678 | 9637 | 2229 | 11620 | 1851 | 12900 | 1541 | 14638 | 1048 | 18260 | 800 | 12149 |
| 18-#10 | 2.51 | MA | 9062 | 2678 | 12172 | 2381 | 14942 | 1999 | 16465 | 1687 | 18039 | 1182 | 22455 | 576 | 17827 |
| 9L-2S | | MI | 6639 | 2678 | 10074 | 2219 | 12174 | 1842 | 13572 | 1533 | 15544 | 1037 | 19515 | 892 | 12166 |
| 18-#11 | 3.08 | MA | 10595 | 2830 | 15326 | 2429 | 18832 | 2023 | 21159 | 1678 | 24320 | 1121 | 30942 | 705 | 24190 |
| 5L-6S | | MI | 6196 | 2830 | 9370 | 2352 | 11180 | 1946 | 12282 | 1614 | 13740 | 1062 | 16965 | 526 | 13858 |
| 18-#11 | 3.08 | MA | 10266 | 2830 | 14638 | 2446 | 18109 | 2037 | 20235 | 1700 | 23038 | 1133 | 29210 | 623 | 23555 |
| 6L-5S | | MI | 6386 | 2830 | 9738 | 2333 | 11603 | 1936 | 12825 | 1597 | 14476 | 1049 | 17920 | 600 | 14116 |
| 18-#11 | 3.08 | MA | 9985 | 2830 | 14052 | 2457 | 17298 | 2055 | 19345 | 1714 | 21795 | 1153 | 27520 | 581 | 22794 |
| 7L-4S | | MI | 6548 | 2830 | 10064 | 2321 | 12050 | 1926 | 13379 | 1589 | 15244 | 1037 | 18960 | 666 | 14508 |
| 18-#11 | 3.08 | MA | 9687 | 2830 | 13490 | 2469 | 16545 | 2065 | 18394 | 1731 | 20554 | 1165 | 25885 | 523 | 21898 |
| 8L-3S | | MI | 6684 | 2830 | 10431 | 2309 | 12557 | 1907 | 14000 | 1573 | 16093 | 1032 | 20003 | 730 | 14577 |
| 18-#11 | 3.08 | MA | 9347 | 2830 | 12940 | 2482 | 15813 | 2077 | 17470 | 1742 | 19333 | 1185 | 24279 | 468 | 20818 |
| 9L-2S | | MI | 6944 | 2830 | 10956 | 2297 | 13223 | 1897 | 14809 | 1565 | 17184 | 1020 | 21482 | 844 | 14610 |
| 18-#14 | 4.44 | MA | 11321 | 3190 | 17072 | 2691 | 21151 | 2224 | 23847 | 1828 | 27848 | 1136 | 35971 | 457 | 32454 |
| 6L-5S | | MI | 6990 | 3190 | 11268 | 2559 | 13464 | 2104 | 15049 | 1703 | 17443 | 1033 | 21762 | 418 | 19395 |
| 18-#14 | 4.44 | MA | 10952 | 3190 | 16233 | 2706 | 19990 | 2248 | 22571 | 1847 | 26067 | 1164 | 33537 | 396 | 30896 |
| 7L-4S | | MI | 7212 | 3190 | 11734 | 2543 | 14102 | 2090 | 15839 | 1693 | 18539 | 1017 | 23217 | 514 | 19952 |
| 18-#14 | 4.44 | MA | 10536 | 3190 | 15426 | 2724 | 18911 | 2263 | 21221 | 1873 | 24317 | 1192 | 31189 | 311 | 29160 |
| 8L-3S | | MI | 7385 | 3190 | 12257 | 2526 | 14824 | 2065 | 16724 | 1670 | 19748 | 1012 | 24681 | 605 | 20457 |
| 20-#10 | 2.79 | MA | 10213 | 2752 | 14331 | 2397 | 17793 | 1999 | 19914 | 1674 | 22656 | 1134 | 28665 | 694 | 21908 |
| 6E | | MI | 6191 | 2752 | 9192 | 2311 | 11036 | 1919 | 12151 | 1599 | 13584 | 1065 | 16888 | 616 | 12948 |
| 20-#10 | 2.79 | MA | 9980 | 2752 | 13849 | 2406 | 17126 | 2014 | 19173 | 1685 | 21636 | 1151 | 27286 | 660 | 21505 |
| 7L-5S | | MI | 6350 | 2752 | 9501 | 2296 | 11385 | 1910 | 12600 | 1584 | 14206 | 1061 | 17751 | 688 | 13178 |
| 20-#10 | 2.79 | MA | 9731 | 2752 | 13387 | 2416 | 16507 | 2023 | 18392 | 1700 | 20617 | 1161 | 25947 | 615 | 20772 |
| 8L-4S | | MI | 6490 | 2752 | 9771 | 2286 | 11754 | 1901 | 13058 | 1577 | 14841 | 1049 | 18633 | 741 | 13396 |
| 20-#10 | 2.79 | MA | 9450 | 2752 | 12931 | 2427 | 15906 | 2033 | 17633 | 1709 | 19615 | 1178 | 24637 | 571 | 20054 |
| 9L-3S | | MI | 6604 | 2752 | 10074 | 2275 | 12174 | 1885 | 13572 | 1562 | 15544 | 1045 | 19515 | 795 | 13440 |
| 20-#10 | 2.79 | MA | 9191 | 2752 | 12459 | 2435 | 15278 | 2050 | 16890 | 1718 | 18592 | 1193 | 23213 | 522 | 19266 |
| 10L-2S | | MI | 6825 | 2752 | 10511 | 2265 | 12728 | 1876 | 14244 | 1555 | 16451 | 1033 | 20769 | 887 | 13462 |
| 20-#11 | 3.42 | MA | 10703 | 2920 | 15559 | 2503 | 19278 | 2078 | 21652 | 1726 | 24951 | 1129 | 31858 | 617 | 26267 |
| 6E | | MI | 6431 | 2920 | 9896 | 2408 | 11846 | 1987 | 13090 | 1640 | 14831 | 1058 | 18444 | 517 | 15378 |
| 20-#11 | 3.42 | MA | 10433 | 2920 | 14973 | 2513 | 18467 | 2096 | 20762 | 1740 | 23708 | 1149 | 30168 | 575 | 25500 |
| 7L-5S | | MI | 6616 | 2920 | 10263 | 2389 | 12269 | 1977 | 13634 | 1624 | 15567 | 1045 | 19398 | 591 | 15626 |
| 20-#11 | 3.42 | MA | 10139 | 2920 | 14411 | 2526 | 17714 | 2106 | 19811 | 1758 | 22467 | 1161 | 28533 | 517 | 24608 |
| 8L-4S | | MI | 6777 | 2920 | 10590 | 2377 | 12716 | 1967 | 14188 | 1616 | 16335 | 1032 | 20439 | 657 | 16050 |
| 20-#11 | 3.42 | MA | 9809 | 2920 | 13861 | 2539 | 16982 | 2118 | 18887 | 1768 | 21245 | 1181 | 26927 | 462 | 23520 |
| 9L-3S | | MI | 6907 | 2920 | 10956 | 2366 | 13223 | 1948 | 14809 | 1599 | 17184 | 1028 | 21482 | 721 | 16126 |
| 20-#11 | 3.42 | MA | 9505 | 2920 | 13287 | 2548 | 16218 | 2139 | 17982 | 1779 | 20019 | 1200 | 25188 | 400 | 22457 |
| 10L-2S | | MI | 7161 | 2920 | 11482 | 2354 | 13890 | 1939 | 15617 | 1591 | 18275 | 1015 | 22960 | 834 | 16166 |
| 20-#14 | 4.93 | MA | 11576 | 3320 | 17550 | 2788 | 21661 | 2308 | 24597 | 1885 | 28801 | 1158 | 37324 | 387 | 34760 |
| 7L-5S | | MI | 7307 | 3320 | 12014 | 2640 | 14411 | 2163 | 16197 | 1741 | 18993 | 1027 | 23829 | 401 | 21551 |
| 20-#14 | 4.93 | MA | 11164 | 3320 | 16744 | 2805 | 20582 | 2323 | 23247 | 1911 | 27051 | 1186 | 34976 | 302 | 33011 |
| 8L-4S | | MI | 7528 | 3320 | 12481 | 2624 | 15049 | 2150 | 16987 | 1730 | 20088 | 1010 | 25284 | 497 | 22083 |
| 22-#10 | 3.06 | MA | 10351 | 2826 | 14608 | 2452 | 18089 | 2047 | 20341 | 1706 | 23212 | 1148 | 29467 | 655 | 23747 |
| 7L-6S | | MI | 6388 | 2825 | 9628 | 2357 | 11590 | 1952 | 12823 | 1620 | 14491 | 1062 | 18142 | 611 | 14213 |
| 22-#10 | 3.06 | MA | 10103 | 2826 | 14146 | 2462 | 17470 | 2056 | 19559 | 1721 | 22193 | 1158 | 28129 | 611 | 23006 |
| 8L-5S | | MI | 6543 | 2826 | 9938 | 2342 | 11939 | 1943 | 13272 | 1605 | 15113 | 1057 | 19005 | 683 | 14435 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

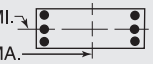
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 3.06 | MA | 9831 | 2825 | 13690 | 2473 | 16869 | 2066 | 18800 | 1730 | 21190 | 1175 | 26818 | 566 | 22281 |
| 9L-4S | | MI | 6683 | 2825 | 10208 | 2332 | 12309 | 1934 | 13730 | 1598 | 15748 | 1046 | 19888 | 736 | 14680 |
| 22-#10 | 3.06 | MA | 9581 | 2826 | 13217 | 2481 | 16242 | 2084 | 18057 | 1739 | 20168 | 1190 | 25395 | 517 | 21495 |
| 10L-3S | | MI | 6793 | 2826 | 10511 | 2321 | 12728 | 1918 | 14244 | 1583 | 16451 | 1041 | 20769 | 790 | 14730 |
| 22-#10 | 3.06 | MA | 9331 | 2826 | 12686 | 2497 | 15642 | 2094 | 17303 | 1756 | 19126 | 1197 | 24092 | 470 | 20634 |
| 11L-2S | | MI | 7009 | 2826 | 10947 | 2311 | 13283 | 1909 | 14915 | 1576 | 17358 | 1030 | 22024 | 882 | 14757 |
| 22-#11 | 3.76 | MA | 10873 | 3010 | 15895 | 2570 | 19636 | 2137 | 22179 | 1766 | 25620 | 1145 | 32816 | 569 | 28207 |
| 7L-6S | | MI | 6662 | 3010 | 10421 | 2465 | 12513 | 2028 | 13898 | 1666 | 15921 | 1053 | 19922 | 507 | 16900 |
| 22-#11 | 3.76 | MA | 10581 | 3010 | 15332 | 2582 | 18883 | 2148 | 21227 | 1784 | 24380 | 1156 | 31181 | 511 | 27317 |
| 8L-5S | | MI | 6842 | 3010 | 10789 | 2446 | 12936 | 2018 | 14442 | 1650 | 16658 | 1041 | 20876 | 581 | 17140 |
| 22-#11 | 3.76 | MA | 10263 | 3010 | 14782 | 2595 | 18151 | 2159 | 20303 | 1794 | 23158 | 1177 | 29575 | 456 | 26221 |
| 9L-4S | | MI | 7003 | 3010 | 11115 | 2434 | 13383 | 2008 | 14996 | 1642 | 17426 | 1028 | 21917 | 647 | 17589 |
| 22-#11 | 3.76 | MA | 9970 | 3010 | 14208 | 2605 | 17387 | 2181 | 19399 | 1805 | 21932 | 1195 | 27837 | 394 | 25151 |
| 10L-3S | | MI | 7128 | 3010 | 11482 | 2422 | 13890 | 1990 | 15617 | 1625 | 18275 | 1024 | 22960 | 711 | 17675 |
| 22-#14 | 5.43 | MA | 11780 | 3451 | 18061 | 2887 | 22253 | 2382 | 25273 | 1948 | 29786 | 1180 | 38762 | 293 | 36862 |
| 8L-5S | | MI | 7640 | 3451 | 12761 | 2722 | 15358 | 2223 | 17345 | 1778 | 20542 | 1021 | 25896 | 384 | 23711 |
| 24-#10 | 3.34 | MA | 10470 | 2899 | 14905 | 2509 | 18433 | 2090 | 20726 | 1742 | 23769 | 1154 | 30310 | 606 | 25240 |
| 8L-6S | | MI | 6583 | 2899 | 10065 | 2403 | 12144 | 1986 | 13494 | 1641 | 15398 | 1058 | 19397 | 606 | 15480 |
| 24-#10 | 3.34 | MA | 10205 | 2899 | 14449 | 2519 | 17832 | 2100 | 19967 | 1751 | 22766 | 1171 | 29000 | 561 | 24509 |
| 9L-5S | | MI | 6734 | 2899 | 10375 | 2388 | 12494 | 1977 | 13943 | 1627 | 16020 | 1054 | 20260 | 678 | 15695 |
| 24-#10 | 3.34 | MA | 9963 | 2899 | 13976 | 2527 | 17205 | 2118 | 19225 | 1760 | 21744 | 1186 | 27577 | 513 | 23725 |
| 10L-4S | | MI | 6873 | 2899 | 10645 | 2378 | 12863 | 1968 | 14401 | 1619 | 16655 | 1042 | 21142 | 731 | 15965 |
| 24-#10 | 3.34 | MA | 9724 | 2899 | 13445 | 2543 | 16605 | 2127 | 18471 | 1777 | 20701 | 1194 | 26274 | 465 | 22858 |
| 11L-3S | | MI | 6979 | 2899 | 10947 | 2367 | 13283 | 1952 | 14915 | 1605 | 17358 | 1038 | 22024 | 785 | 16019 |
| 24-#11 | 4.11 | MA | 11017 | 3101 | 16253 | 2639 | 20052 | 2189 | 22644 | 1810 | 26292 | 1152 | 33829 | 505 | 30026 |
| 8L-6S | | MI | 6891 | 3101 | 10947 | 2521 | 13180 | 2070 | 14706 | 1692 | 17012 | 1049 | 21400 | 498 | 18413 |
| 24-#11 | 4.11 | MA | 10708 | 3101 | 15703 | 2652 | 19320 | 2201 | 21720 | 1820 | 25070 | 1172 | 32223 | 450 | 28923 |
| 9L-5S | | MI | 7066 | 3101 | 11314 | 2502 | 13603 | 2060 | 15250 | 1676 | 17749 | 1036 | 22355 | 572 | 18657 |
| 24-#11 | 4.11 | MA | 10425 | 3101 | 15129 | 2661 | 18556 | 2222 | 20816 | 1831 | 23844 | 1191 | 30485 | 388 | 27846 |
| 10L-4S | | MI | 7226 | 3101 | 11641 | 2490 | 14050 | 2050 | 15804 | 1668 | 18517 | 1024 | 23395 | 638 | 19090 |

## RECTANGULAR TIED COLUMNS 24" x 40"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.67 | MA | 10909 | 2585 | 15161 | 2246 | 18585 | 1880 | 20659 | 1588 | 23201 | 1135 | 28753 | 985 | 15024 |
| 2E | | MI | 6241 | 2585 | 9309 | 2135 | 10942 | 1786 | 11902 | 1506 | 13048 | 1070 | 15394 | 871 | 8395 |
| 6-#14 | 1.41 | MA | 10616 | 2513 | 14322 | 2215 | 17635 | 1860 | 19567 | 1578 | 21779 | 1148 | 26824 | 997 | 12876 |
| 2L-3S | | MI | 5701 | 2513 | 8110 | 2131 | 9523 | 1787 | 10233 | 1514 | 10838 | 1105 | 12705 | 756 | 7292 |
| 6-#14 | 1.41 | MA | 9789 | 2513 | 12923 | 2239 | 15860 | 1881 | 17416 | 1598 | 18875 | 1177 | 22803 | 853 | 12827 |
| 3L-2S | | MI | 6124 | 2513 | 8856 | 2115 | 10470 | 1774 | 11381 | 1503 | 12387 | 1088 | 14772 | 919 | 7271 |
| 6-#18 | 2.50 | MA | 12015 | 2817 | 17607 | 2391 | 21688 | 1986 | 24421 | 1655 | 28278 | 1124 | 35784 | 970 | 22288 |
| 2L-3S | | MI | 6104 | 2817 | 9309 | 2305 | 10942 | 1911 | 11902 | 1586 | 13048 | 1083 | 15394 | 537 | 12159 |
| 6-#18 | 2.50 | MA | 10697 | 2817 | 15161 | 2430 | 18585 | 2023 | 20659 | 1688 | 23201 | 1173 | 28753 | 705 | 21976 |
| 3L-2S | | MI | 6779 | 2817 | 10595 | 2280 | 12574 | 1892 | 13880 | 1573 | 15718 | 1059 | 18842 | 828 | 12246 |
| 8-#10 | 1.06 | MA | 10175 | 2416 | 13170 | 2173 | 16313 | 1831 | 18037 | 1564 | 19777 | 1163 | 24099 | 1013 | 9884 |
| 2L-4S | | MI | 5529 | 2416 | 7474 | 2105 | 8807 | 1780 | 9423 | 1520 | 9789 | 1127 | 11539 | 820 | 5688 |
| 8-#10 | 1.06 | MA | 9683 | 2416 | 12365 | 2187 | 15292 | 1844 | 16799 | 1576 | 18106 | 1180 | 21785 | 934 | 9878 |
| 3E | | MI | 5675 | 2416 | 7777 | 2094 | 9227 | 1764 | 9937 | 1505 | 10492 | 1122 | 12421 | 874 | 5677 |
| 8-#10 | 1.06 | MA | 9411 | 2416 | 11821 | 2200 | 14535 | 1864 | 15870 | 1595 | 16834 | 1191 | 20262 | 884 | 9828 |
| 4L-2S | | MI | 5932 | 2416 | 8214 | 2084 | 9781 | 1755 | 10609 | 1498 | 11399 | 1110 | 13675 | 967 | 5662 |
| 8-#11 | 1.30 | MA | 10495 | 2483 | 13964 | 2204 | 17239 | 1853 | 19117 | 1575 | 21198 | 1153 | 26039 | 1003 | 11991 |
| 2L-4S | | MI | 5603 | 2483 | 7765 | 2132 | 9096 | 1799 | 9735 | 1529 | 10177 | 1114 | 11999 | 762 | 6819 |
| 8-#11 | 1.30 | MA | 9913 | 2483 | 12986 | 2221 | 15998 | 1868 | 17613 | 1590 | 19168 | 1174 | 23228 | 904 | 11972 |
| 3E | | MI | 5776 | 2483 | 8131 | 2120 | 9603 | 1781 | 10356 | 1512 | 11026 | 1110 | 13042 | 826 | 6819 |
| 8-#11 | 1.30 | MA | 9593 | 2483 | 12323 | 2238 | 15076 | 1892 | 16482 | 1613 | 17620 | 1187 | 21364 | 842 | 11873 |
| 4L-2S | | MI | 6077 | 2483 | 8657 | 2109 | 10269 | 1771 | 11164 | 1504 | 12117 | 1097 | 14520 | 940 | 6803 |
| 8-#14 | 1.88 | MA | 11272 | 2643 | 15721 | 2297 | 19410 | 1919 | 21718 | 1616 | 24683 | 1141 | 30844 | 989 | 17036 |
| 2L-4S | | MI | 5807 | 2643 | 8334 | 2228 | 9748 | 1872 | 10496 | 1574 | 11178 | 1103 | 13309 | 649 | 9430 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

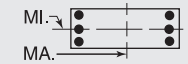
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.88 | MA | 10485 | 2643 | 14322 | 2320 | 17635 | 1941 | 19567 | 1636 | 21779 | 1171 | 26824 | 844 | 16956 |
| 3E | | MI | 6042 | 2643 | 8856 | 2212 | 10470 | 1847 | 11381 | 1551 | 12387 | 1099 | 14772 | 739 | 9509 |
| 8-#14 | 1.88 | MA | 10053 | 2643 | 13371 | 2344 | 16314 | 1975 | 17947 | 1669 | 19561 | 1187 | 24142 | 754 | 16645 |
| 4L-2S | | MI | 6449 | 2643 | 9602 | 2196 | 11417 | 1833 | 12529 | 1541 | 13937 | 1082 | 16840 | 902 | 9512 |
| 8-#18 | 3.33 | MA | 13079 | 3049 | 20052 | 2535 | 24792 | 2092 | 28182 | 1722 | 33356 | 1113 | 42814 | 954 | 29537 |
| 2L-4S | | MI | 6298 | 3049 | 9688 | 2475 | 11321 | 2058 | 12347 | 1689 | 13623 | 1074 | 16383 | 342 | 14579 |
| 8-#18 | 3.33 | MA | 11852 | 3049 | 17607 | 2575 | 21688 | 2129 | 24421 | 1755 | 28278 | 1162 | 35784 | 690 | 29177 |
| 3E | | MI | 6666 | 3049 | 10595 | 2450 | 12574 | 2017 | 13880 | 1653 | 15718 | 1072 | 18842 | 494 | 15918 |
| 8-#18 | 3.33 | MA | 11183 | 3049 | 15937 | 2615 | 19370 | 2187 | 21578 | 1811 | 24388 | 1189 | 31043 | 528 | 26709 |
| 4L-2S | | MI | 7302 | 3049 | 11881 | 2425 | 14206 | 1998 | 15858 | 1640 | 18388 | 1048 | 22291 | 785 | 16063 |
| 10-#10 | 1.32 | MA | 10571 | 2490 | 13975 | 2219 | 17335 | 1864 | 19275 | 1585 | 21448 | 1159 | 26413 | 1008 | 12283 |
| 2L-5S | | MI | 5595 | 2490 | 7641 | 2161 | 8992 | 1822 | 9637 | 1548 | 10061 | 1135 | 11911 | 762 | 6957 |
| 10-#10 | 1.32 | MA | 10093 | 2490 | 13170 | 2233 | 16313 | 1877 | 18037 | 1597 | 19777 | 1177 | 24099 | 929 | 12266 |
| 3L-4S | | MI | 5741 | 2490 | 7911 | 2151 | 9361 | 1813 | 10095 | 1541 | 10696 | 1123 | 12794 | 815 | 6987 |
| 10-#10 | 1.32 | MA | 9835 | 2490 | 12626 | 2247 | 15556 | 1898 | 17108 | 1617 | 18505 | 1188 | 22576 | 879 | 12203 |
| 4L-3S | | MI | 5881 | 2490 | 8214 | 2140 | 9781 | 1797 | 10609 | 1526 | 11399 | 1118 | 13675 | 869 | 6988 |
| 10-#10 | 1.32 | MA | 9509 | 2490 | 12133 | 2259 | 14896 | 1911 | 16287 | 1629 | 17363 | 1205 | 21018 | 841 | 12039 |
| 5L-2S | | MI | 6131 | 2490 | 8650 | 2130 | 10335 | 1789 | 11281 | 1519 | 12306 | 1107 | 14930 | 962 | 6977 |
| 10-#11 | 1.63 | MA | 10962 | 2574 | 14941 | 2261 | 18480 | 1894 | 20621 | 1601 | 23228 | 1149 | 28850 | 997 | 14901 |
| 2L-5S | | MI | 5685 | 2574 | 7964 | 2201 | 9315 | 1851 | 9989 | 1563 | 10499 | 1122 | 12437 | 687 | 8214 |
| 10-#11 | 1.63 | MA | 10400 | 2574 | 13964 | 2277 | 17239 | 1909 | 19117 | 1616 | 21198 | 1170 | 26039 | 898 | 14866 |
| 3L-4S | | MI | 5853 | 2574 | 8290 | 2189 | 9762 | 1841 | 10543 | 1555 | 11268 | 1109 | 13477 | 753 | 8371 |
| 10-#11 | 1.63 | MA | 10098 | 2574 | 13300 | 2294 | 16317 | 1934 | 17986 | 1639 | 19650 | 1182 | 24174 | 836 | 14752 |
| 4L-3S | | MI | 6018 | 2574 | 8657 | 2177 | 10269 | 1822 | 11164 | 1538 | 12117 | 1105 | 14520 | 817 | 8390 |
| 10-#11 | 1.63 | MA | 9711 | 2574 | 12707 | 2310 | 15512 | 1949 | 16986 | 1653 | 18259 | 1203 | 22272 | 788 | 14351 |
| 5L-2S | | MI | 6309 | 2574 | 9182 | 2165 | 10936 | 1812 | 11972 | 1530 | 13208 | 1093 | 15999 | 930 | 8382 |
| 10-#14 | 2.34 | MA | 11910 | 2774 | 17119 | 2378 | 21185 | 1979 | 23870 | 1654 | 27587 | 1135 | 34865 | 980 | 21188 |
| 2L-5S | | MI | 5925 | 2774 | 8614 | 2326 | 10057 | 1945 | 10854 | 1622 | 11632 | 1114 | 13921 | 536 | 10945 |
| 10-#14 | 2.34 | MA | 11158 | 2774 | 15721 | 2402 | 19410 | 2001 | 21718 | 1674 | 24683 | 1164 | 30844 | 835 | 21086 |
| 3L-4S | | MI | 6154 | 2774 | 9080 | 2310 | 10695 | 1932 | 11644 | 1612 | 12728 | 1097 | 15376 | 631 | 11609 |
| 10-#14 | 2.34 | MA | 10758 | 2774 | 14770 | 2425 | 18089 | 2035 | 20098 | 1706 | 22465 | 1181 | 28163 | 746 | 20763 |
| 4L-3S | | MI | 6374 | 2774 | 9602 | 2294 | 11417 | 1906 | 12529 | 1589 | 13937 | 1092 | 16840 | 722 | 11715 |
| 10-#14 | 2.34 | MA | 10218 | 2774 | 13925 | 2448 | 16935 | 2057 | 18665 | 1727 | 20471 | 1210 | 25432 | 673 | 19404 |
| 5L-2S | | MI | 6766 | 2774 | 10349 | 2278 | 12364 | 1893 | 13677 | 1579 | 15486 | 1076 | 18907 | 885 | 11741 |
| 10-#18 | 4.17 | MA | 12963 | 3281 | 20052 | 2720 | 24792 | 2234 | 28182 | 1822 | 33356 | 1151 | 42814 | 675 | 36388 |
| 3L-4S | | MI | 6875 | 3281 | 10974 | 2620 | 12953 | 2164 | 14325 | 1756 | 16293 | 1063 | 19832 | 299 | 18193 |
| 10-#18 | 4.17 | MA | 12368 | 3281 | 18383 | 2760 | 22474 | 2293 | 25340 | 1878 | 29465 | 1178 | 38073 | 513 | 33879 |
| 4L-3S | | MI | 7235 | 3281 | 11881 | 2595 | 14206 | 2123 | 15858 | 1720 | 18388 | 1061 | 22291 | 451 | 19676 |
| 10-#18 | 4.17 | MA | 11460 | 3281 | 16907 | 2800 | 20446 | 2330 | 22821 | 1911 | 25965 | 1227 | 33262 | 376 | 31158 |
| 5L-2S | | MI | 7803 | 3281 | 13167 | 2570 | 15838 | 2103 | 17836 | 1707 | 21058 | 1037 | 25739 | 742 | 19866 |
| 12-#10 | 1.59 | MA | 10959 | 2563 | 14780 | 2265 | 18356 | 1898 | 20513 | 1606 | 23119 | 1156 | 28727 | 1003 | 14677 |
| 2L-6S | | MI | 5627 | 2563 | 7768 | 2222 | 9197 | 1865 | 9860 | 1584 | 10346 | 1136 | 12303 | 685 | 7984 |
| 12-#10 | 1.59 | MA | 10495 | 2563 | 13975 | 2279 | 17335 | 1911 | 19275 | 1618 | 21448 | 1173 | 26413 | 924 | 14651 |
| 3L-5S | | MI | 5804 | 2563 | 8078 | 2207 | 9546 | 1856 | 10309 | 1570 | 10968 | 1131 | 13165 | 757 | 8238 |
| 12-#10 | 1.59 | MA | 10249 | 2563 | 13430 | 2293 | 16578 | 1931 | 18346 | 1638 | 20176 | 1184 | 24890 | 874 | 14578 |
| 4E | | MI | 5948 | 2563 | 8347 | 2197 | 9916 | 1847 | 10767 | 1562 | 11603 | 1120 | 14048 | 810 | 8280 |
| 12-#10 | 1.59 | MA | 9926 | 2563 | 12938 | 2305 | 15917 | 1944 | 17525 | 1650 | 19035 | 1202 | 23332 | 836 | 14409 |
| 5L-3S | | MI | 6084 | 2563 | 8650 | 2186 | 10335 | 1831 | 11281 | 1548 | 12306 | 1115 | 14930 | 864 | 8291 |
| 12-#10 | 1.59 | MA | 9596 | 2563 | 12339 | 2319 | 15276 | 1956 | 16723 | 1669 | 17921 | 1212 | 21831 | 772 | 13832 |
| 6L-2S | | MI | 6328 | 2563 | 9087 | 2176 | 10889 | 1822 | 11953 | 1540 | 13213 | 1103 | 16184 | 957 | 8287 |
| 12-#11 | 1.95 | MA | 11419 | 2664 | 15919 | 2317 | 19720 | 1935 | 22124 | 1628 | 25258 | 1145 | 31660 | 991 | 17806 |
| 2L-6S | | MI | 5723 | 2664 | 8122 | 2276 | 9559 | 1902 | 10254 | 1606 | 10854 | 1131 | 12961 | 603 | 9401 |
| 12-#11 | 1.95 | MA | 10876 | 2664 | 14941 | 2334 | 18480 | 1951 | 20621 | 1642 | 23228 | 1166 | 28850 | 892 | 17760 |
| 3L-5S | | MI | 5931 | 2664 | 8489 | 2257 | 9982 | 1892 | 10797 | 1589 | 11590 | 1118 | 13915 | 677 | 9699 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

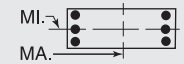



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.95 | MA | 10590 | 2664 | 14278 | 2351 | 17558 | 1975 | 19490 | 1665 | 21680 | 1178 | 26985 | 830 | 17633 |
| 4E | | MI | 6097 | 2664 | 8816 | 2245 | 10429 | 1882 | 11351 | 1581 | 12359 | 1105 | 14956 | 743 | 9919 |
| 12-#11 | 1.95 | MA | 10208 | 2664 | 13684 | 2366 | 16753 | 1990 | 18490 | 1680 | 20289 | 1199 | 25083 | 782 | 17195 |
| 5L-3S | | MI | 6254 | 2664 | 9182 | 2234 | 10936 | 1863 | 11972 | 1564 | 13208 | 1101 | 15999 | 807 | 9951 |
| 12-#11 | 1.95 | MA | 9817 | 2664 | 12955 | 2383 | 15981 | 2005 | 17512 | 1703 | 18932 | 1211 | 23251 | 701 | 16430 |
| 6L-2S | | MI | 6538 | 2664 | 9707 | 2222 | 11603 | 1854 | 12781 | 1556 | 14299 | 1088 | 17477 | 921 | 9954 |
| 12-#14 | 2.81 | MA | 11813 | 2904 | 17119 | 2483 | 21185 | 2060 | 23870 | 1711 | 27587 | 1158 | 34865 | 827 | 25216 |
| 3L-5S | | MI | 6265 | 2904 | 9360 | 2408 | 11004 | 2005 | 12002 | 1660 | 13182 | 1107 | 15988 | 518 | 13068 |
| 12-#14 | 2.81 | MA | 11442 | 2904 | 16168 | 2507 | 19864 | 2095 | 22250 | 1744 | 25369 | 1175 | 32183 | 737 | 24885 |
| 4E | | MI | 6492 | 2904 | 9826 | 2391 | 11642 | 1991 | 12792 | 1649 | 14277 | 1091 | 17444 | 614 | 13728 |
| 12-#14 | 2.81 | MA | 10909 | 2904 | 15323 | 2530 | 18710 | 2116 | 20816 | 1764 | 23375 | 1204 | 29452 | 664 | 23508 |
| 5L-3S | | MI | 6700 | 2904 | 10349 | 2375 | 12364 | 1966 | 13677 | 1627 | 15486 | 1086 | 18907 | 705 | 13915 |
| 12-#14 | 2.81 | MA | 10376 | 2904 | 14279 | 2554 | 17612 | 2137 | 19414 | 1797 | 21429 | 1221 | 26822 | 546 | 22352 |
| 6L-2S | | MI | 7078 | 2904 | 11095 | 2359 | 13311 | 1953 | 14825 | 1616 | 17036 | 1069 | 20974 | 868 | 13958 |
| 12-#18 | 5.00 | MA | 13509 | 3513 | 20828 | 2905 | 25577 | 2399 | 29101 | 1945 | 34543 | 1167 | 45104 | 497 | 41039 |
| 4E | | MI | 7475 | 3513 | 12260 | 2765 | 14585 | 2270 | 16303 | 1823 | 18963 | 1051 | 23280 | 256 | 21833 |
| 12-#18 | 5.00 | MA | 12614 | 3513 | 19353 | 2945 | 23549 | 2436 | 26583 | 1978 | 31042 | 1215 | 40293 | 360 | 38275 |
| 5L-3S | | MI | 7763 | 3513 | 13167 | 2740 | 15838 | 2229 | 17836 | 1787 | 21058 | 1050 | 25739 | 408 | 23436 |
| 12-#18 | 5.00 | MA | 11771 | 3513 | 17537 | 2988 | 21637 | 2472 | 24118 | 2033 | 27623 | 1242 | 35658 | 142 | 34606 |
| 6L-2S | | MI | 8295 | 3513 | 14453 | 2715 | 17470 | 2209 | 19814 | 1774 | 23727 | 1026 | 29187 | 698 | 23661 |
| 14-#10 | 1.85 | MA | 10888 | 2637 | 14780 | 2325 | 18356 | 1945 | 20513 | 1640 | 23119 | 1170 | 28727 | 919 | 17036 |
| 3L-6S | | MI | 5837 | 2637 | 8205 | 2268 | 9751 | 1899 | 10532 | 1605 | 11253 | 1132 | 13557 | 680 | 9236 |
| 14-#10 | 1.85 | MA | 10654 | 2637 | 14235 | 2339 | 17599 | 1965 | 19584 | 1659 | 21847 | 1181 | 27204 | 869 | 16954 |
| 4L-5S | | MI | 6010 | 2637 | 8515 | 2253 | 10101 | 1890 | 10981 | 1591 | 11874 | 1128 | 14420 | 752 | 9501 |
| 14-#10 | 1.85 | MA | 10334 | 2637 | 13743 | 2351 | 16939 | 1978 | 18763 | 1671 | 20706 | 1198 | 25646 | 831 | 16782 |
| 5L-4S | | MI | 6153 | 2637 | 8784 | 2243 | 10470 | 1881 | 11439 | 1583 | 12510 | 1116 | 15303 | 805 | 9570 |
| 14-#10 | 1.85 | MA | 10014 | 2637 | 13143 | 2365 | 16298 | 1989 | 17961 | 1691 | 19592 | 1209 | 24145 | 767 | 16191 |
| 6L-3S | | MI | 6283 | 2637 | 9087 | 2232 | 10889 | 1865 | 11953 | 1569 | 13213 | 1111 | 16184 | 859 | 9590 |
| 14-#10 | 1.85 | MA | 9736 | 2637 | 12633 | 2375 | 15591 | 2004 | 17170 | 1701 | 18512 | 1227 | 22691 | 734 | 15717 |
| 7L-2S | | MI | 6521 | 2637 | 9524 | 2222 | 11444 | 1856 | 12624 | 1561 | 14119 | 1100 | 17439 | 952 | 9593 |
| 14-#11 | 2.27 | MA | 11341 | 2755 | 15919 | 2391 | 19720 | 1992 | 22124 | 1668 | 25258 | 1161 | 31660 | 886 | 20652 |
| 3L-6S | | MI | 5970 | 2755 | 8647 | 2333 | 10226 | 1943 | 11062 | 1632 | 11945 | 1126 | 14439 | 594 | 10908 |
| 14-#11 | 2.27 | MA | 11071 | 2755 | 15256 | 2407 | 18799 | 2016 | 20994 | 1691 | 23709 | 1174 | 29796 | 824 | 20516 |
| 4L-5S | | MI | 6173 | 2755 | 9015 | 2314 | 10649 | 1933 | 11605 | 1615 | 12681 | 1114 | 15393 | 668 | 11191 |
| 14-#11 | 2.27 | MA | 10693 | 2755 | 14662 | 2423 | 17994 | 2032 | 19994 | 1706 | 22319 | 1195 | 27894 | 776 | 20044 |
| 5L-4S | | MI | 6337 | 2755 | 9341 | 2302 | 11096 | 1923 | 12160 | 1607 | 13450 | 1101 | 16434 | 734 | 11464 |
| 14-#11 | 2.27 | MA | 10315 | 2755 | 13933 | 2440 | 17222 | 2046 | 19016 | 1729 | 20961 | 1207 | 26061 | 695 | 19302 |
| 6L-3S | | MI | 6487 | 2755 | 9707 | 2290 | 11603 | 1905 | 12781 | 1591 | 14299 | 1097 | 17477 | 798 | 11507 |
| 14-#11 | 2.27 | MA | 9987 | 2755 | 13312 | 2451 | 16362 | 2064 | 18065 | 1742 | 19646 | 1228 | 24280 | 653 | 18556 |
| 7L-2S | | MI | 6763 | 2755 | 10233 | 2278 | 12270 | 1895 | 13589 | 1583 | 15390 | 1084 | 18955 | 911 | 11521 |
| 14-#14 | 3.28 | MA | 12107 | 3035 | 17567 | 2588 | 21639 | 2154 | 24401 | 1782 | 28272 | 1169 | 36204 | 728 | 29012 |
| 4L-5S | | MI | 6599 | 3035 | 10106 | 2489 | 11951 | 2064 | 13150 | 1697 | 14731 | 1101 | 18055 | 501 | 15202 |
| 14-#14 | 3.28 | MA | 11580 | 3035 | 16722 | 2611 | 20485 | 2176 | 22967 | 1802 | 26279 | 1198 | 33473 | 656 | 27617 |
| 5L-4S | | MI | 6824 | 3035 | 10573 | 2473 | 12589 | 2051 | 13940 | 1687 | 15827 | 1084 | 19511 | 597 | 15827 |
| 14-#14 | 3.28 | MA | 11071 | 3035 | 15678 | 2635 | 19387 | 2197 | 21565 | 1834 | 24333 | 1215 | 30843 | 537 | 26447 |
| 6L-3S | | MI | 7020 | 3035 | 11095 | 2457 | 13311 | 2025 | 14825 | 1664 | 17036 | 1080 | 20974 | 687 | 16112 |
| 14-#14 | 3.28 | MA | 10630 | 3035 | 14788 | 2651 | 18156 | 2222 | 20213 | 1855 | 22446 | 1244 | 28277 | 476 | 24740 |
| 7L-2S | | MI | 7385 | 3035 | 11841 | 2441 | 14259 | 2012 | 15973 | 1654 | 18585 | 1063 | 23042 | 851 | 16170 |
| 14-#18 | 5.83 | MA | 13731 | 3745 | 21798 | 3090 | 26653 | 2542 | 30344 | 2045 | 36120 | 1204 | 47323 | 345 | 45391 |
| 5L-4S | | MI | 8022 | 3745 | 13546 | 2910 | 16217 | 2376 | 18280 | 1890 | 21633 | 1040 | 26729 | 212 | 25493 |
| 14-#18 | 5.83 | MA | 12941 | 3745 | 19982 | 3133 | 24740 | 2578 | 27880 | 2100 | 32701 | 1231 | 42688 | 127 | 41750 |
| 6L-3S | | MI | 8279 | 3745 | 14453 | 2885 | 17470 | 2335 | 19814 | 1854 | 23727 | 1039 | 29187 | 364 | 27197 |
| 16-#10 | 2.12 | MA | 11051 | 2711 | 15040 | 2385 | 18621 | 1998 | 20822 | 1680 | 23519 | 1177 | 29518 | 865 | 19331 |
| 4L-6S | | MI | 6044 | 2711 | 8641 | 2314 | 10306 | 1932 | 11203 | 1627 | 12159 | 1129 | 14812 | 675 | 10492 |
| 16-#10 | 2.12 | MA | 10734 | 2711 | 14548 | 2397 | 17960 | 2012 | 20001 | 1693 | 22377 | 1195 | 27960 | 827 | 19156 |
| 5E | | MI | 6212 | 2711 | 8951 | 2299 | 10655 | 1923 | 11652 | 1612 | 12781 | 1124 | 15674 | 747 | 10745 |
| 16-#10 | 2.12 | MA | 10423 | 2711 | 13948 | 2411 | 17319 | 2023 | 19199 | 1712 | 21263 | 1205 | 26459 | 762 | 18554 |
| 6L-4S | | MI | 6354 | 2711 | 9221 | 2289 | 11024 | 1914 | 12110 | 1605 | 13416 | 1112 | 16557 | 800 | 10857 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

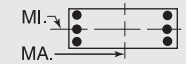



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.12 | MA | 10156 | 2711 | 13438 | 2421 | 16613 | 2038 | 18408 | 1723 | 20183 | 1223 | 25005 | 729 | 18094 |
| 7L-3S | | MI | 6479 | 2711 | 9524 | 2278 | 11444 | 1898 | 12624 | 1590 | 14119 | 1108 | 17439 | 854 | 10885 |
| 16-#10 | 2.12 | MA | 9881 | 2711 | 12949 | 2432 | 15957 | 2047 | 17581 | 1738 | 19106 | 1234 | 23591 | 685 | 17373 |
| 8L-2S | | MI | 6712 | 2711 | 9961 | 2268 | 11998 | 1889 | 13296 | 1583 | 15026 | 1096 | 18693 | 947 | 10894 |
| 16-#11 | 2.60 | MA | 11542 | 2845 | 16233 | 2464 | 20039 | 2058 | 22498 | 1717 | 25739 | 1169 | 32606 | 818 | 23400 |
| 4L-6S | | MI | 6213 | 2845 | 9173 | 2389 | 10893 | 1985 | 11870 | 1658 | 13036 | 1122 | 15917 | 585 | 12420 |
| 16-#11 | 2.60 | MA | 11167 | 2845 | 15640 | 2479 | 19235 | 2073 | 21498 | 1732 | 24349 | 1190 | 30704 | 770 | 22898 |
| 5E | | MI | 6410 | 2845 | 9540 | 2370 | 11316 | 1975 | 12414 | 1641 | 13772 | 1109 | 16872 | 658 | 12691 |
| 16-#11 | 2.60 | MA | 10802 | 2845 | 14910 | 2496 | 18462 | 2087 | 20520 | 1755 | 22991 | 1203 | 28872 | 689 | 22178 |
| 6L-4S | | MI | 6573 | 2845 | 9867 | 2358 | 11763 | 1965 | 12968 | 1633 | 14541 | 1097 | 17912 | 724 | 13008 |
| 16-#11 | 2.60 | MA | 10488 | 2845 | 14290 | 2508 | 17603 | 2105 | 19568 | 1768 | 21676 | 1223 | 27090 | 647 | 21429 |
| 7L-3S | | MI | 6717 | 2845 | 10233 | 2347 | 12270 | 1946 | 13589 | 1617 | 15390 | 1092 | 18955 | 789 | 13061 |
| 16-#11 | 2.60 | MA | 10162 | 2845 | 13694 | 2520 | 16805 | 2116 | 18561 | 1786 | 20362 | 1236 | 25362 | 591 | 20458 |
| 8L-2S | | MI | 6986 | 2845 | 10758 | 2335 | 12937 | 1936 | 14397 | 1609 | 16481 | 1080 | 20434 | 902 | 13082 |
| 16-#14 | 3.75 | MA | 12234 | 3165 | 18121 | 2693 | 22260 | 2236 | 25118 | 1840 | 29183 | 1192 | 37494 | 647 | 31731 |
| 5E | | MI | 6926 | 3165 | 10853 | 2571 | 12898 | 2124 | 14298 | 1735 | 16281 | 1095 | 20123 | 484 | 17343 |
| 16-#14 | 3.75 | MA | 11748 | 3165 | 17077 | 2717 | 21162 | 2256 | 23716 | 1872 | 27237 | 1209 | 34863 | 529 | 30542 |
| 6L-4S | | MI | 7149 | 3165 | 11319 | 2555 | 13536 | 2111 | 15088 | 1725 | 17376 | 1078 | 21578 | 580 | 17938 |
| 16-#14 | 3.75 | MA | 11330 | 3165 | 16187 | 2733 | 19931 | 2281 | 22364 | 1892 | 25349 | 1238 | 32297 | 468 | 28843 |
| 7L-3S | | MI | 7335 | 3165 | 11841 | 2538 | 14259 | 2085 | 15973 | 1702 | 18585 | 1074 | 23042 | 670 | 18307 |
| 16-#14 | 3.75 | MA | 10874 | 3165 | 15333 | 2751 | 18787 | 2297 | 20920 | 1917 | 23466 | 1255 | 29815 | 385 | 27089 |
| 8L-2S | | MI | 7689 | 3165 | 12588 | 2522 | 15206 | 2072 | 17121 | 1692 | 20135 | 1057 | 25109 | 834 | 18378 |
| 16-#18 | 6.67 | MA | 14076 | 3977 | 22428 | 3278 | 27844 | 2684 | 31641 | 2167 | 37778 | 1220 | 49719 | 112 | 48895 |
| 6L-4S | | MI | 8556 | 3977 | 14832 | 3055 | 17849 | 2482 | 20258 | 1957 | 24303 | 1029 | 30177 | 169 | 29170 |
| 18-#10 | 2.38 | MA | 11126 | 2784 | 15353 | 2443 | 18982 | 2045 | 21239 | 1714 | 24048 | 1191 | 30273 | 822 | 21532 |
| 5L-6S | | MI | 6247 | 2784 | 9078 | 2360 | 10860 | 1966 | 11875 | 1648 | 13066 | 1125 | 16066 | 670 | 11751 |
| 18-#10 | 2.38 | MA | 10825 | 2784 | 14753 | 2457 | 18341 | 2057 | 20437 | 1733 | 22934 | 1202 | 28773 | 758 | 20918 |
| 6L-5S | | MI | 6411 | 2784 | 9388 | 2345 | 11209 | 1957 | 12324 | 1633 | 13688 | 1121 | 16929 | 742 | 11994 |
| 18-#10 | 2.38 | MA | 10567 | 2784 | 14243 | 2467 | 17634 | 2071 | 19646 | 1744 | 21855 | 1220 | 27319 | 724 | 20471 |
| 7L-4S | | MI | 6552 | 2784 | 9658 | 2335 | 11578 | 1948 | 12782 | 1626 | 14323 | 1109 | 17812 | 795 | 12144 |
| 18-#10 | 2.38 | MA | 10295 | 2784 | 13754 | 2478 | 16979 | 2081 | 18819 | 1759 | 20777 | 1230 | 25905 | 680 | 19743 |
| 8L-3S | | MI | 6673 | 2784 | 9961 | 2324 | 11998 | 1932 | 13296 | 1611 | 15026 | 1104 | 18693 | 849 | 12178 |
| 18-#10 | 2.38 | MA | 9986 | 2784 | 13268 | 2488 | 16342 | 2091 | 18015 | 1768 | 19716 | 1248 | 24524 | 637 | 19044 |
| 9L-2S | | MI | 6900 | 2784 | 10397 | 2314 | 12552 | 1923 | 13968 | 1604 | 15933 | 1093 | 19948 | 942 | 12193 |
| 18-#11 | 2.92 | MA | 11631 | 2936 | 16617 | 2536 | 20475 | 2114 | 23001 | 1758 | 26379 | 1186 | 33515 | 764 | 25757 |
| 5L-6S | | MI | 6452 | 2936 | 9698 | 2446 | 11560 | 2026 | 12678 | 1684 | 14127 | 1118 | 17396 | 575 | 13936 |
| 18-#11 | 2.92 | MA | 11279 | 2936 | 15888 | 2553 | 19703 | 2129 | 22024 | 1781 | 25021 | 1198 | 31683 | 683 | 25056 |
| 6L-5S | | MI | 6643 | 2936 | 10065 | 2427 | 11983 | 2016 | 13222 | 1667 | 14863 | 1105 | 18350 | 649 | 14195 |
| 18-#11 | 2.92 | MA | 10978 | 2936 | 15267 | 2564 | 18844 | 2146 | 21072 | 1795 | 23705 | 1219 | 29901 | 641 | 24302 |
| 7L-4S | | MI | 6805 | 2936 | 10392 | 2415 | 12430 | 2006 | 13776 | 1659 | 15632 | 1092 | 19391 | 715 | 14551 |
| 18-#11 | 2.92 | MA | 10656 | 2936 | 14671 | 2577 | 18045 | 2157 | 20065 | 1812 | 22392 | 1231 | 28173 | 585 | 23334 |
| 8L-3S | | MI | 6943 | 2936 | 10758 | 2403 | 12937 | 1987 | 14397 | 1643 | 16481 | 1088 | 20434 | 779 | 14612 |
| 18-#11 | 2.92 | MA | 10292 | 2936 | 14085 | 2590 | 17270 | 2170 | 19086 | 1823 | 21099 | 1252 | 26480 | 531 | 22244 |
| 9L-2S | | MI | 7206 | 2936 | 11284 | 2391 | 13604 | 1978 | 15205 | 1635 | 17571 | 1075 | 21912 | 893 | 14641 |
| 18-#14 | 4.22 | MA | 12409 | 3296 | 18475 | 2798 | 22937 | 2316 | 25867 | 1910 | 30140 | 1202 | 38884 | 520 | 34637 |
| 6L-5S | | MI | 7248 | 3296 | 11599 | 2652 | 13845 | 2183 | 15446 | 1773 | 17830 | 1089 | 22190 | 467 | 19491 |
| 18-#14 | 4.22 | MA | 12013 | 3296 | 17585 | 2814 | 21706 | 2341 | 24516 | 1930 | 28253 | 1232 | 36318 | 459 | 32947 |
| 7L-4S | | MI | 7470 | 3296 | 12065 | 2636 | 14483 | 2170 | 16236 | 1762 | 18926 | 1072 | 23645 | 563 | 20059 |
| 18-#14 | 4.22 | MA | 11563 | 3296 | 16731 | 2832 | 20562 | 2356 | 23072 | 1955 | 26370 | 1248 | 33836 | 376 | 31179 |
| 8L-3S | | MI | 7646 | 3296 | 12588 | 2620 | 15206 | 2145 | 17121 | 1740 | 20135 | 1068 | 25109 | 653 | 20501 |
| 18-#14 | 4.22 | MA | 11071 | 3296 | 15897 | 2851 | 19450 | 2373 | 21669 | 1969 | 24515 | 1278 | 31397 | 297 | 29430 |
| 9L-2S | | MI | 7983 | 3296 | 13334 | 2604 | 16153 | 2131 | 18269 | 1729 | 21684 | 1051 | 27176 | 817 | 20584 |
| 20-#10 | 2.65 | MA | 11219 | 2858 | 15558 | 2503 | 19362 | 2090 | 21675 | 1754 | 24605 | 1198 | 31087 | 753 | 23285 |
| 6E | | MI | 6447 | 2858 | 9515 | 2406 | 11414 | 2000 | 12547 | 1669 | 13973 | 1122 | 17321 | 665 | 13013 |
| 20-#10 | 2.65 | MA | 10970 | 2858 | 15048 | 2513 | 18656 | 2105 | 20884 | 1765 | 23526 | 1216 | 29633 | 719 | 22850 |
| 7L-5S | | MI | 6607 | 2858 | 9825 | 2391 | 11763 | 1991 | 12996 | 1655 | 14595 | 1117 | 18183 | 737 | 13247 |
| 20-#10 | 2.65 | MA | 10701 | 2858 | 14559 | 2524 | 18000 | 2114 | 20057 | 1780 | 22448 | 1227 | 28219 | 676 | 22113 |
| 8L-4S | | MI | 6748 | 2858 | 10094 | 2381 | 12133 | 1982 | 13454 | 1647 | 15230 | 1105 | 19066 | 790 | 13430 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

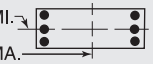



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 2.65 | MA | 10401 | 2858 | 14072 | 2534 | 17364 | 2125 | 19253 | 1789 | 21387 | 1244 | 26838 | 632 | 21407 |
| 9L-3S | | MI | 6864 | 2858 | 10397 | 2370 | 12552 | 1966 | 13968 | 1633 | 15933 | 1101 | 19948 | 844 | 13469 |
| 20-#10 | 2.65 | MA | 10124 | 2858 | 13572 | 2542 | 16700 | 2143 | 18467 | 1799 | 20294 | 1259 | 25334 | 584 | 20552 |
| 10L-2S | | MI | 7087 | 2858 | 10834 | 2360 | 13107 | 1957 | 14640 | 1625 | 16840 | 1089 | 21202 | 937 | 13489 |
| 20-#11 | 3.25 | MA | 11746 | 3026 | 16866 | 2609 | 20944 | 2170 | 23528 | 1807 | 27051 | 1194 | 34493 | 677 | 27936 |
| 6E | | MI | 6687 | 3026 | 10224 | 2502 | 12226 | 2067 | 13487 | 1710 | 15218 | 1113 | 18874 | 566 | 15454 |
| 20-#11 | 3.25 | MA | 11457 | 3026 | 16245 | 2621 | 20084 | 2188 | 22576 | 1821 | 25735 | 1215 | 32712 | 635 | 27175 |
| 7L-5S | | MI | 6873 | 3026 | 10591 | 2483 | 12650 | 2057 | 14030 | 1694 | 15954 | 1101 | 19828 | 639 | 15704 |
| 20-#11 | 3.25 | MA | 11139 | 3026 | 15649 | 2633 | 19286 | 2199 | 21568 | 1839 | 24422 | 1227 | 30984 | 579 | 26210 |
| 8L-4S | | MI | 7035 | 3026 | 10917 | 2472 | 13097 | 2047 | 14584 | 1686 | 16723 | 1088 | 20869 | 705 | 16093 |
| 20-#11 | 3.25 | MA | 10787 | 3026 | 15062 | 2646 | 18511 | 2211 | 20590 | 1849 | 23129 | 1248 | 29291 | 525 | 25112 |
| 9L-3S | | MI | 7167 | 3026 | 11284 | 2460 | 13604 | 2029 | 15205 | 1669 | 17571 | 1084 | 21912 | 770 | 16162 |
| 20-#11 | 3.25 | MA | 10461 | 3026 | 14454 | 2656 | 17702 | 2232 | 19632 | 1860 | 21816 | 1266 | 27453 | 464 | 24042 |
| 10L-2S | | MI | 7424 | 3026 | 11809 | 2448 | 14270 | 2019 | 16013 | 1661 | 18662 | 1071 | 23390 | 883 | 16198 |
| 20-#14 | 4.69 | MA | 12681 | 3426 | 18984 | 2896 | 23481 | 2401 | 26667 | 1968 | 31157 | 1225 | 40339 | 450 | 37050 |
| 7L-5S | | MI | 7565 | 3426 | 12345 | 2734 | 14793 | 2243 | 16594 | 1810 | 19380 | 1082 | 24257 | 450 | 21644 |
| 20-#14 | 4.69 | MA | 12236 | 3426 | 18130 | 2914 | 22337 | 2416 | 25223 | 1993 | 29273 | 1242 | 37856 | 368 | 35268 |
| 8L-4S | | MI | 7786 | 3426 | 12812 | 2718 | 15430 | 2230 | 17384 | 1800 | 20475 | 1066 | 25713 | 546 | 22188 |
| 20-#14 | 4.69 | MA | 11764 | 3426 | 17295 | 2932 | 21225 | 2433 | 23820 | 2007 | 27418 | 1271 | 35418 | 288 | 33509 |
| 9L-3S | | MI | 7964 | 3426 | 13334 | 2701 | 16153 | 2204 | 18269 | 1777 | 21684 | 1061 | 27176 | 636 | 22695 |
| 22-#10 | 2.91 | MA | 11366 | 2932 | 15853 | 2559 | 19677 | 2139 | 22123 | 1786 | 25197 | 1213 | 31947 | 715 | 25230 |
| 7L-6S | | MI | 6645 | 2932 | 9952 | 2452 | 11968 | 2033 | 13219 | 1690 | 14880 | 1118 | 18575 | 660 | 14278 |
| 22-#10 | 2.91 | MA | 11100 | 2932 | 15364 | 2570 | 19022 | 2148 | 21295 | 1801 | 24119 | 1223 | 30533 | 671 | 24483 |
| 8L-5S | | MI | 6801 | 2932 | 10262 | 2437 | 12318 | 2024 | 13668 | 1676 | 15501 | 1114 | 19438 | 732 | 14503 |
| 22-#10 | 2.91 | MA | 10808 | 2932 | 14877 | 2580 | 18385 | 2158 | 20491 | 1811 | 23058 | 1241 | 29152 | 627 | 23769 |
| 9L-4S | | MI | 6941 | 2932 | 10531 | 2427 | 12687 | 2015 | 14126 | 1668 | 16137 | 1102 | 20321 | 785 | 14716 |
| 22-#10 | 2.91 | MA | 10540 | 2932 | 14377 | 2588 | 17722 | 2176 | 19705 | 1820 | 21965 | 1255 | 27648 | 579 | 22917 |
| 10L-3S | | MI | 7053 | 2932 | 10834 | 2416 | 13107 | 1999 | 14640 | 1654 | 16840 | 1097 | 21202 | 839 | 14760 |
| 22-#10 | 2.91 | MA | 10271 | 2932 | 13814 | 2605 | 17081 | 2186 | 18907 | 1838 | 20862 | 1264 | 26271 | 533 | 22051 |
| 11L-2S | | MI | 7271 | 2932 | 11271 | 2406 | 13661 | 1990 | 15311 | 1646 | 17747 | 1086 | 22456 | 932 | 14784 |
| 22-#11 | 3.57 | MA | 11928 | 3117 | 17223 | 2677 | 21325 | 2229 | 24080 | 1847 | 27765 | 1210 | 35522 | 629 | 30048 |
| 7L-6S | | MI | 6919 | 3117 | 10749 | 2559 | 12893 | 2109 | 14295 | 1736 | 16309 | 1109 | 20352 | 556 | 16976 |
| 22-#11 | 3.57 | MA | 11613 | 3117 | 16627 | 2690 | 20527 | 2240 | 23072 | 1865 | 26452 | 1223 | 33794 | 573 | 29086 |
| 8L-5S | | MI | 7101 | 3117 | 11116 | 2540 | 13316 | 2099 | 14838 | 1720 | 17045 | 1096 | 21307 | 630 | 17217 |
| 22-#11 | 3.57 | MA | 11272 | 3117 | 16040 | 2703 | 19751 | 2252 | 22093 | 1875 | 25158 | 1244 | 32101 | 519 | 27980 |
| 9L-4S | | MI | 7261 | 3117 | 11443 | 2528 | 13763 | 2089 | 15392 | 1712 | 17814 | 1084 | 22347 | 696 | 17635 |
| 22-#11 | 3.57 | MA | 10958 | 3117 | 15431 | 2713 | 18943 | 2274 | 21135 | 1887 | 23846 | 1262 | 30264 | 458 | 26902 |
| 10L-3S | | MI | 7389 | 3117 | 11809 | 2516 | 14270 | 2070 | 16013 | 1695 | 18662 | 1079 | 23390 | 760 | 17711 |
| 22-#14 | 5.16 | MA | 12895 | 3557 | 19529 | 2995 | 24111 | 2476 | 27374 | 2030 | 32177 | 1236 | 41877 | 359 | 39358 |
| 8L-5S | | MI | 7901 | 3557 | 13092 | 2815 | 15740 | 2303 | 17742 | 1848 | 20929 | 1076 | 26325 | 433 | 23803 |
| 22-#14 | 5.16 | MA | 12441 | 3557 | 18694 | 3014 | 23000 | 2492 | 25971 | 2045 | 30322 | 1265 | 39438 | 280 | 37587 |
| 9L-4S | | MI | 8123 | 3557 | 13558 | 2799 | 16377 | 2289 | 18532 | 1838 | 22025 | 1059 | 27780 | 528 | 24324 |
| 24-#10 | 3.17 | MA | 11492 | 3005 | 16169 | 2616 | 20043 | 2182 | 22533 | 1823 | 25791 | 1220 | 32847 | 666 | 26853 |
| 8L-6S | | MI | 6840 | 3005 | 10388 | 2498 | 12523 | 2067 | 13891 | 1712 | 15787 | 1115 | 19830 | 655 | 15544 |
| 24-#10 | 3.17 | MA | 11209 | 3005 | 15682 | 2626 | 19407 | 2192 | 21729 | 1832 | 24729 | 1237 | 31466 | 622 | 26132 |
| 9L-5S | | MI | 6993 | 3005 | 10698 | 2483 | 12872 | 2058 | 14339 | 1697 | 16408 | 1110 | 20692 | 727 | 15761 |
| 24-#10 | 3.17 | MA | 10949 | 3005 | 15182 | 2634 | 18743 | 2210 | 20943 | 1842 | 23637 | 1252 | 29962 | 574 | 25282 |
| 10L-4S | | MI | 7132 | 3005 | 10968 | 2473 | 13241 | 2049 | 14797 | 1690 | 17044 | 1098 | 21575 | 780 | 16001 |
| 24-#10 | 3.17 | MA | 10685 | 3005 | 14619 | 2651 | 18103 | 2220 | 20145 | 1859 | 22534 | 1260 | 28585 | 528 | 24410 |
| 11L-3S | | MI | 7240 | 3005 | 11271 | 2462 | 13661 | 2033 | 15311 | 1675 | 17747 | 1094 | 22456 | 834 | 16050 |
| 24-#11 | 3.90 | MA | 12079 | 3207 | 17605 | 2747 | 21768 | 2281 | 24576 | 1891 | 28482 | 1218 | 36605 | 567 | 31962 |
| 8L-6S | | MI | 7148 | 3207 | 11274 | 2615 | 13560 | 2150 | 15103 | 1762 | 17400 | 1105 | 21831 | 547 | 18500 |
| 24-#11 | 3.90 | MA | 11748 | 3207 | 17018 | 2759 | 20992 | 2294 | 23597 | 1901 | 27188 | 1239 | 34912 | 513 | 30847 |
| 9L-5S | | MI | 7326 | 3207 | 11642 | 2596 | 13983 | 2140 | 15646 | 1746 | 18136 | 1092 | 22785 | 621 | 18733 |
| 24-#11 | 3.90 | MA | 11446 | 3207 | 16409 | 2769 | 20184 | 2315 | 22639 | 1913 | 25876 | 1258 | 33075 | 452 | 29762 |
| 10L-4S | | MI | 7486 | 3207 | 11968 | 2585 | 14430 | 2130 | 16201 | 1738 | 18905 | 1079 | 23826 | 687 | 19178 |
| 24-#14 | 5.63 | MA | 13105 | 3687 | 20093 | 3095 | 24775 | 2552 | 28122 | 2082 | 33226 | 1259 | 43459 | 271 | 41666 |
| 9L-5S | | MI | 8207 | 3687 | 13838 | 2897 | 16687 | 2362 | 18889 | 1886 | 22479 | 1070 | 28392 | 416 | 25965 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

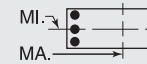



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.59 | MA | 11949 | 2692 | 16420 | 2352 | 20182 | 1970 | 22439 | 1667 | 25153 | 1198 | 31133 | 1040 | 15888 |
| 2E | | MI | 6498 | 2692 | 9646 | 2227 | 11326 | 1864 | 12300 | 1574 | 13433 | 1124 | 15818 | 919 | 8427 |
| 6-#14 | 1.34 | MA | 11632 | 2619 | 15527 | 2321 | 19171 | 1950 | 21275 | 1657 | 23638 | 1210 | 29076 | 1052 | 13605 |
| 2L-3S | | MI | 5956 | 2619 | 8441 | 2224 | 9904 | 1867 | 10630 | 1583 | 11224 | 1160 | 13134 | 805 | 7322 |
| 6-#14 | 1.34 | MA | 10749 | 2619 | 14047 | 2345 | 17293 | 1973 | 18998 | 1678 | 20564 | 1240 | 24821 | 909 | 13556 |
| 3L-2S | | MI | 6381 | 2619 | 9187 | 2208 | 10851 | 1854 | 11778 | 1573 | 12774 | 1143 | 15201 | 968 | 7297 |
| 6-#18 | 2.38 | MA | 13134 | 2923 | 19011 | 2497 | 23470 | 2076 | 26423 | 1734 | 30531 | 1187 | 38580 | 1025 | 23584 |
| 2L-3S | | MI | 6359 | 2923 | 9646 | 2397 | 11326 | 1990 | 12300 | 1655 | 13433 | 1137 | 15818 | 585 | 12213 |
| 6-#18 | 2.38 | MA | 11722 | 2923 | 16420 | 2538 | 20182 | 2114 | 22439 | 1769 | 25153 | 1238 | 31133 | 764 | 23272 |
| 3L-2S | | MI | 7038 | 2923 | 10932 | 2372 | 12958 | 1970 | 14277 | 1641 | 16103 | 1113 | 19267 | 876 | 12283 |
| 8-#10 | 1.01 | MA | 11157 | 2522 | 14304 | 2279 | 17767 | 1921 | 19649 | 1643 | 21510 | 1226 | 26182 | 1068 | 10432 |
| 2L-4S | | MI | 5783 | 2522 | 7797 | 2200 | 9185 | 1861 | 9819 | 1590 | 10178 | 1183 | 11972 | 869 | 5711 |
| 8-#10 | 1.01 | MA | 10632 | 2522 | 13453 | 2293 | 16687 | 1935 | 18340 | 1655 | 19744 | 1244 | 23735 | 990 | 10427 |
| 3E | | MI | 5931 | 2522 | 8100 | 2189 | 9605 | 1845 | 10333 | 1576 | 10881 | 1178 | 12853 | 924 | 5697 |
| 8-#10 | 1.01 | MA | 10343 | 2522 | 12878 | 2307 | 15888 | 1955 | 17359 | 1675 | 18401 | 1255 | 22132 | 940 | 10377 |
| 4L-2S | | MI | 6188 | 2522 | 8537 | 2179 | 10159 | 1836 | 11005 | 1568 | 11788 | 1167 | 14108 | 1016 | 5681 |
| 8-#11 | 1.24 | MA | 11501 | 2589 | 15146 | 2310 | 18749 | 1943 | 20795 | 1654 | 23018 | 1216 | 28240 | 1058 | 12665 |
| 2L-4S | | MI | 5858 | 2589 | 8093 | 2226 | 9476 | 1880 | 10132 | 1599 | 10564 | 1169 | 12429 | 811 | 6850 |
| 8-#11 | 1.24 | MA | 10880 | 2589 | 14111 | 2327 | 17436 | 1959 | 19204 | 1669 | 20871 | 1238 | 25267 | 960 | 12645 |
| 3E | | MI | 6031 | 2589 | 8459 | 2215 | 9983 | 1861 | 10753 | 1582 | 11413 | 1165 | 13472 | 875 | 6844 |
| 8-#11 | 1.24 | MA | 10538 | 2589 | 13411 | 2344 | 16463 | 1984 | 18010 | 1693 | 19235 | 1251 | 23304 | 899 | 12547 |
| 4L-2S | | MI | 6333 | 2589 | 8984 | 2203 | 10650 | 1851 | 11561 | 1574 | 12504 | 1153 | 14951 | 989 | 6826 |
| 8-#14 | 1.79 | MA | 12334 | 2750 | 17007 | 2403 | 21049 | 2010 | 23552 | 1695 | 26711 | 1204 | 33331 | 1044 | 18008 |
| 2L-4S | | MI | 6061 | 2750 | 8665 | 2322 | 10129 | 1952 | 10893 | 1644 | 11565 | 1158 | 13737 | 697 | 9479 |
| 8-#14 | 1.79 | MA | 11492 | 2750 | 15527 | 2427 | 19171 | 2032 | 21275 | 1716 | 23638 | 1234 | 29076 | 901 | 17928 |
| 3E | | MI | 6297 | 2749 | 9187 | 2306 | 10851 | 1926 | 11778 | 1621 | 12774 | 1154 | 15201 | 787 | 9544 |
| 8-#14 | 1.79 | MA | 11031 | 2750 | 14523 | 2451 | 17775 | 2067 | 19563 | 1749 | 21293 | 1252 | 26253 | 812 | 17617 |
| 4L-2S | | MI | 6707 | 2749 | 9933 | 2290 | 11799 | 1913 | 12926 | 1611 | 14324 | 1137 | 17268 | 951 | 9541 |
| 8-#18 | 3.17 | MA | 14273 | 3155 | 21601 | 2642 | 26757 | 2182 | 30407 | 1801 | 35910 | 1176 | 46027 | 1009 | 31265 |
| 2L-4S | | MI | 6550 | 3155 | 10025 | 2568 | 11705 | 2137 | 12744 | 1758 | 14009 | 1128 | 16808 | 390 | 14736 |
| 8-#18 | 3.17 | MA | 12957 | 3155 | 19011 | 2682 | 23470 | 2220 | 26423 | 1836 | 30531 | 1227 | 38580 | 749 | 30905 |
| 3E | | MI | 6922 | 3155 | 10932 | 2542 | 12958 | 2096 | 14277 | 1722 | 16103 | 1126 | 19267 | 542 | 15976 |
| 8-#18 | 3.17 | MA | 12241 | 3155 | 17246 | 2723 | 21019 | 2280 | 23418 | 1892 | 26417 | 1255 | 33587 | 588 | 28469 |
| 4L-2S | | MI | 7564 | 3155 | 12218 | 2517 | 14590 | 2076 | 16255 | 1708 | 18773 | 1102 | 22715 | 833 | 16104 |
| 10-#10 | 1.26 | MA | 11580 | 2596 | 15155 | 2325 | 18847 | 1955 | 20958 | 1664 | 23277 | 1222 | 28628 | 1063 | 12969 |
| 2L-5S | | MI | 5850 | 2596 | 7964 | 2256 | 9370 | 1903 | 10033 | 1619 | 10449 | 1191 | 12344 | 811 | 6991 |
| 10-#10 | 1.26 | MA | 11070 | 2596 | 14304 | 2339 | 17767 | 1968 | 19649 | 1676 | 21510 | 1240 | 26182 | 985 | 12952 |
| 3L-4S | | MI | 5995 | 2596 | 8234 | 2246 | 9740 | 1894 | 10491 | 1612 | 11085 | 1179 | 13227 | 864 | 7013 |
| 10-#10 | 1.26 | MA | 10795 | 2596 | 13729 | 2353 | 16968 | 1989 | 18668 | 1696 | 20167 | 1251 | 24578 | 935 | 12889 |
| 4L-3S | | MI | 6137 | 2596 | 8537 | 2235 | 10159 | 1879 | 11005 | 1597 | 11788 | 1175 | 14108 | 919 | 7010 |
| 10-#10 | 1.26 | MA | 10445 | 2596 | 13207 | 2365 | 16271 | 2002 | 17802 | 1709 | 18963 | 1269 | 22846 | 889 | 12725 |
| 5L-2S | | MI | 6388 | 2596 | 8974 | 2225 | 10713 | 1870 | 11677 | 1590 | 12694 | 1163 | 15362 | 1011 | 6998 |
| 10-#11 | 1.55 | MA | 12000 | 2680 | 16180 | 2367 | 20061 | 1984 | 22386 | 1680 | 25165 | 1212 | 31213 | 1052 | 15743 |
| 2L-5S | | MI | 5940 | 2680 | 8291 | 2295 | 9695 | 1931 | 10386 | 1633 | 10887 | 1178 | 12867 | 736 | 8298 |
| 10-#11 | 1.55 | MA | 11400 | 2680 | 15146 | 2384 | 18749 | 2000 | 20795 | 1695 | 23018 | 1233 | 28240 | 954 | 15709 |
| 3L-4S | | MI | 6107 | 2680 | 8618 | 2283 | 10143 | 1921 | 10940 | 1625 | 11655 | 1165 | 13908 | 802 | 8406 |
| 10-#11 | 1.55 | MA | 11077 | 2680 | 14445 | 2401 | 17775 | 2025 | 19601 | 1719 | 21383 | 1246 | 26277 | 893 | 15594 |
| 4L-3S | | MI | 6273 | 2680 | 8984 | 2271 | 10650 | 1902 | 11561 | 1608 | 12504 | 1161 | 14951 | 866 | 8417 |
| 10-#11 | 1.55 | MA | 10662 | 2680 | 13815 | 2416 | 16926 | 2041 | 18545 | 1734 | 19914 | 1268 | 24272 | 846 | 15253 |
| 5L-2S | | MI | 6567 | 2680 | 9510 | 2259 | 11316 | 1893 | 12369 | 1600 | 13595 | 1148 | 16429 | 979 | 8407 |
| 10-#14 | 2.23 | MA | 13016 | 2880 | 18487 | 2484 | 22928 | 2069 | 25828 | 1733 | 29784 | 1198 | 37587 | 1035 | 22403 |
| 2L-5S | | MI | 6179 | 2880 | 8945 | 2420 | 10438 | 2025 | 11251 | 1691 | 12019 | 1169 | 14349 | 584 | 11048 |
| 10-#14 | 2.23 | MA | 12211 | 2880 | 17007 | 2508 | 21049 | 2092 | 23552 | 1753 | 26711 | 1228 | 33331 | 892 | 22301 |
| 3L-4S | | MI | 6408 | 2880 | 9411 | 2403 | 11076 | 2012 | 12041 | 1681 | 13115 | 1152 | 15805 | 680 | 11661 |
| 10-#14 | 2.23 | MA | 11784 | 2880 | 16003 | 2532 | 19654 | 2127 | 21840 | 1787 | 24367 | 1246 | 30508 | 803 | 21978 |
| 4L-3S | | MI | 6631 | 2880 | 9933 | 2387 | 11799 | 1986 | 12926 | 1659 | 14324 | 1148 | 17268 | 770 | 11752 |
| 10-#14 | 2.23 | MA | 11203 | 2880 | 15104 | 2555 | 18435 | 2149 | 20326 | 1807 | 22261 | 1276 | 27628 | 733 | 20627 |
| 5L-2S | | MI | 7026 | 2880 | 10680 | 2371 | 12746 | 1973 | 14074 | 1648 | 15873 | 1131 | 19336 | 934 | 11772 |


## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

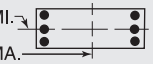

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.97 | MA | 14144 | 3387 | 21601 | 2827 | 26757 | 2326 | 30407 | 1903 | 35910 | 1215 | 46027 | 733 | 38548 |
| 3L-4S | | MI | 7127 | 3387 | 11311 | 2713 | 13337 | 2243 | 14722 | 1825 | 16678 | 1117 | 20257 | 347 | 18344 |
| 10-#18 | 3.97 | MA | 13507 | 3387 | 19837 | 2868 | 24307 | 2386 | 27402 | 1959 | 31795 | 1244 | 41034 | 573 | 36054 |
| 4L-3S | | MI | 7493 | 3387 | 12218 | 2687 | 14590 | 2202 | 16255 | 1789 | 18773 | 1115 | 22715 | 499 | 19736 |
| 10-#18 | 3.97 | MA | 12529 | 3387 | 18279 | 2909 | 22164 | 2424 | 24741 | 1994 | 28096 | 1294 | 35958 | 440 | 33174 |
| 5L-2S | | MI | 8069 | 3387 | 13503 | 2662 | 16222 | 2182 | 18233 | 1775 | 21443 | 1091 | 26164 | 789 | 19909 |
| 12-#10 | 1.51 | MA | 11994 | 2669 | 16006 | 2371 | 19926 | 1988 | 22266 | 1685 | 25044 | 1219 | 31074 | 1058 | 15500 |
| 2L-6S | | MI | 5881 | 2669 | 8091 | 2317 | 9575 | 1946 | 10256 | 1655 | 10735 | 1192 | 12735 | 735 | 8051 |
| 12-#10 | 1.51 | MA | 11498 | 2669 | 15155 | 2385 | 18847 | 2002 | 20958 | 1698 | 23277 | 1237 | 28628 | 980 | 15474 |
| 3L-5S | | MI | 6059 | 2669 | 8401 | 2302 | 9925 | 1937 | 10705 | 1640 | 11356 | 1187 | 13598 | 806 | 8274 |
| 12-#10 | 1.51 | MA | 11236 | 2669 | 14580 | 2399 | 18047 | 2022 | 19977 | 1717 | 21934 | 1248 | 27025 | 931 | 15401 |
| 4E | | MI | 6204 | 2669 | 8671 | 2292 | 10294 | 1928 | 11163 | 1633 | 11992 | 1176 | 14481 | 859 | 8308 |
| 12-#10 | 1.51 | MA | 10890 | 2669 | 14058 | 2412 | 17351 | 2036 | 19111 | 1730 | 20729 | 1266 | 25293 | 884 | 15232 |
| 5L-3S | | MI | 6340 | 2669 | 8974 | 2281 | 10713 | 1912 | 11677 | 1618 | 12694 | 1171 | 15362 | 914 | 8316 |
| 12-#10 | 1.51 | MA | 10538 | 2669 | 13424 | 2426 | 16669 | 2047 | 18265 | 1750 | 19554 | 1277 | 23801 | 831 | 14667 |
| 6L-2S | | MI | 6585 | 2669 | 9410 | 2271 | 11268 | 1903 | 12349 | 1611 | 13601 | 1159 | 16617 | 1006 | 8309 |
| 12-#11 | 1.86 | MA | 12488 | 2770 | 17214 | 2423 | 21374 | 2026 | 23977 | 1706 | 27313 | 1208 | 34186 | 1046 | 18817 |
| 2L-6S | | MI | 5977 | 2770 | 8449 | 2370 | 9939 | 1982 | 10650 | 1676 | 11242 | 1186 | 13391 | 652 | 9480 |
| 12-#11 | 1.86 | MA | 11908 | 2770 | 16180 | 2440 | 20061 | 2042 | 22386 | 1721 | 25165 | 1229 | 31213 | 948 | 18771 |
| 3L-5S | | MI | 6186 | 2770 | 8817 | 2351 | 10362 | 1972 | 11194 | 1659 | 11978 | 1174 | 14345 | 726 | 9781 |
| 12-#11 | 1.86 | MA | 11602 | 2770 | 15480 | 2457 | 19088 | 2066 | 21192 | 1745 | 23530 | 1242 | 29251 | 887 | 18644 |
| 4E | | MI | 6352 | 2770 | 9143 | 2340 | 10809 | 1962 | 11748 | 1651 | 12746 | 1161 | 15386 | 792 | 9956 |
| 12-#11 | 1.86 | MA | 11192 | 2770 | 14849 | 2473 | 18239 | 2082 | 20136 | 1760 | 22062 | 1263 | 27245 | 840 | 18265 |
| 5L-3S | | MI | 6511 | 2770 | 9510 | 2328 | 11316 | 1944 | 12369 | 1634 | 13595 | 1157 | 16429 | 856 | 9981 |
| 12-#11 | 1.86 | MA | 10775 | 2770 | 14078 | 2490 | 17417 | 2096 | 19104 | 1783 | 20629 | 1276 | 25313 | 760 | 17430 |
| 6L-2S | | MI | 6797 | 2770 | 10035 | 2316 | 11983 | 1934 | 13177 | 1626 | 14686 | 1144 | 17907 | 970 | 9981 |
| 12-#14 | 2.68 | MA | 12910 | 3010 | 18487 | 2590 | 22928 | 2151 | 25828 | 1791 | 29784 | 1222 | 37587 | 884 | 26674 |
| 3L-5S | | MI | 6520 | 3010 | 9691 | 2501 | 11385 | 2084 | 12399 | 1729 | 13569 | 1163 | 16417 | 567 | 13169 |
| 12-#14 | 2.68 | MA | 12513 | 3010 | 17483 | 2614 | 21532 | 2186 | 24116 | 1824 | 27440 | 1239 | 34763 | 794 | 26343 |
| 4E | | MI | 6747 | 3010 | 10157 | 2485 | 12023 | 2071 | 13189 | 1719 | 14664 | 1146 | 17872 | 663 | 13842 |
| 12-#14 | 2.68 | MA | 11940 | 3010 | 16585 | 2636 | 20314 | 2209 | 22602 | 1845 | 25334 | 1270 | 31883 | 724 | 24975 |
| 5L-3S | | MI | 6958 | 3010 | 10680 | 2469 | 12746 | 2046 | 14074 | 1696 | 15873 | 1142 | 19336 | 753 | 13954 |
| 12-#14 | 2.68 | MA | 11372 | 3010 | 15480 | 2661 | 19145 | 2229 | 21122 | 1878 | 23279 | 1287 | 29109 | 607 | 23792 |
| 6L-2S | | MI | 7339 | 3010 | 11426 | 2453 | 13693 | 2032 | 15222 | 1686 | 17423 | 1125 | 21403 | 917 | 13991 |
| 12-#18 | 4.76 | MA | 14724 | 3619 | 22427 | 3013 | 27594 | 2492 | 31387 | 2026 | 37174 | 1233 | 48481 | 557 | 43640 |
| 4E | | MI | 7729 | 3619 | 12597 | 2857 | 14969 | 2349 | 16700 | 1891 | 19348 | 1106 | 23705 | 303 | 21978 |
| 12-#18 | 4.76 | MA | 13761 | 3619 | 20869 | 3054 | 25452 | 2530 | 28725 | 2061 | 33474 | 1283 | 43405 | 425 | 40778 |
| 5L-3S | | MI | 8022 | 3619 | 13503 | 2832 | 16222 | 2307 | 18233 | 1856 | 21443 | 1104 | 26164 | 455 | 23497 |
| 12-#18 | 4.76 | MA | 12860 | 3619 | 18934 | 3097 | 23430 | 2567 | 26122 | 2118 | 29861 | 1312 | 38517 | 210 | 36893 |
| 6L-2S | | MI | 8563 | 3619 | 14789 | 2807 | 17854 | 2288 | 20211 | 1842 | 24113 | 1080 | 29612 | 746 | 23706 |
| 14-#10 | 1.76 | MA | 11918 | 2743 | 16006 | 2431 | 19926 | 2035 | 22266 | 1719 | 25044 | 1233 | 31074 | 975 | 17996 |
| 3L-6S | | MI | 6092 | 2743 | 8528 | 2363 | 10130 | 1980 | 10928 | 1676 | 11641 | 1188 | 13990 | 730 | 9302 |
| 14-#10 | 1.76 | MA | 11668 | 2743 | 15431 | 2445 | 19127 | 2056 | 21286 | 1739 | 23701 | 1244 | 29471 | 926 | 17914 |
| 4L-5S | | MI | 6265 | 2743 | 8838 | 2348 | 10479 | 1971 | 11377 | 1662 | 12263 | 1184 | 14853 | 801 | 9556 |
| 14-#10 | 1.76 | MA | 11325 | 2743 | 14909 | 2458 | 18431 | 2069 | 20420 | 1751 | 22496 | 1262 | 27739 | 879 | 17742 |
| 5L-4S | | MI | 6408 | 2743 | 9107 | 2338 | 10848 | 1962 | 11835 | 1654 | 12898 | 1172 | 15736 | 855 | 9600 |
| 14-#10 | 1.76 | MA | 10984 | 2743 | 14275 | 2472 | 17749 | 2080 | 19574 | 1771 | 21321 | 1273 | 26247 | 826 | 17163 |
| 6L-3S | | MI | 6540 | 2743 | 9410 | 2327 | 11268 | 1946 | 12349 | 1640 | 13601 | 1168 | 16617 | 909 | 9615 |
| 14-#10 | 1.76 | MA | 10688 | 2743 | 13737 | 2482 | 17003 | 2096 | 18733 | 1781 | 20182 | 1291 | 24719 | 793 | 16654 |
| 7L-2S | | MI | 6780 | 2743 | 9847 | 2317 | 11822 | 1937 | 13021 | 1632 | 14508 | 1156 | 17871 | 1001 | 9616 |
| 14-#11 | 2.17 | MA | 12404 | 2861 | 17214 | 2497 | 21374 | 2083 | 23977 | 1747 | 27313 | 1225 | 34186 | 943 | 21831 |
| 3L-6S | | MI | 6224 | 2861 | 8975 | 2427 | 10606 | 2024 | 11459 | 1702 | 12333 | 1182 | 14869 | 643 | 10986 |
| 14-#11 | 2.17 | MA | 12115 | 2861 | 16514 | 2514 | 20400 | 2107 | 22782 | 1771 | 25677 | 1238 | 32224 | 881 | 21695 |
| 4L-5S | | MI | 6428 | 2861 | 9342 | 2408 | 11029 | 2014 | 12002 | 1685 | 13069 | 1169 | 15824 | 717 | 11272 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

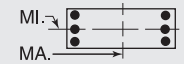
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.17 | MA | 11709 | 2861 | 15883 | 2529 | 19551 | 2123 | 21727 | 1786 | 24209 | 1259 | 30218 | 834 | 21283 |
| 5L-4S | | MI | 6592 | 2861 | 9669 | 2396 | 11476 | 2004 | 12556 | 1677 | 13837 | 1157 | 16864 | 783 | 11503 |
| 14-#11 | 2.17 | MA | 11307 | 2861 | 15112 | 2547 | 18730 | 2137 | 20695 | 1809 | 22776 | 1272 | 28287 | 754 | 20471 |
| 6L-3S | | MI | 6745 | 2861 | 10035 | 2384 | 11983 | 1985 | 13177 | 1661 | 14686 | 1152 | 17907 | 847 | 11539 |
| 14-#11 | 2.17 | MA | 10958 | 2861 | 14456 | 2558 | 17821 | 2156 | 19682 | 1823 | 21387 | 1293 | 26413 | 713 | 19743 |
| 7L-2S | | MI | 7023 | 2861 | 10561 | 2372 | 12650 | 1975 | 13985 | 1653 | 15777 | 1140 | 19386 | 960 | 11550 |
| 14-#14 | 3.13 | MA | 13224 | 3141 | 18963 | 2695 | 23411 | 2246 | 26393 | 1862 | 30513 | 1233 | 39018 | 786 | 30713 |
| 4L-5S | | MI | 6855 | 3141 | 10437 | 2583 | 12333 | 2144 | 13547 | 1767 | 15118 | 1156 | 18484 | 550 | 15300 |
| 14-#14 | 3.13 | MA | 12657 | 3141 | 18065 | 2718 | 22192 | 2268 | 24879 | 1883 | 28407 | 1263 | 36138 | 715 | 29329 |
| 5L-4S | | MI | 7079 | 3141 | 10904 | 2567 | 12970 | 2131 | 14337 | 1757 | 16214 | 1140 | 19939 | 646 | 15938 |
| 14-#14 | 3.13 | MA | 12114 | 3141 | 16961 | 2743 | 21023 | 2289 | 23399 | 1916 | 26352 | 1281 | 33364 | 599 | 28152 |
| 6L-3S | | MI | 7279 | 3141 | 11426 | 2550 | 13693 | 2105 | 15222 | 1734 | 17423 | 1135 | 21403 | 736 | 16153 |
| 14-#14 | 3.13 | MA | 11643 | 3141 | 16020 | 2759 | 19722 | 2314 | 21959 | 1936 | 24360 | 1311 | 30666 | 539 | 26356 |
| 7L-2S | | MI | 7648 | 3141 | 12172 | 2534 | 14640 | 2092 | 16370 | 1724 | 18972 | 1119 | 23470 | 899 | 16205 |
| 14-#18 | 5.56 | MA | 14952 | 3851 | 23460 | 3199 | 28739 | 2636 | 32709 | 2128 | 38852 | 1272 | 50852 | 409 | 48382 |
| 5L-4S | | MI | 8276 | 3851 | 13883 | 3002 | 16601 | 2455 | 18678 | 1958 | 22018 | 1095 | 27153 | 260 | 25633 |
| 14-#18 | 5.56 | MA | 14108 | 3851 | 21525 | 3241 | 26718 | 2673 | 30106 | 2185 | 35240 | 1301 | 45964 | 195 | 44462 |
| 6L-3S | | MI | 8540 | 3851 | 14789 | 2977 | 17854 | 2413 | 20211 | 1923 | 24113 | 1093 | 29612 | 412 | 27259 |
| 14-#18 | 5.56 | MA | 13372 | 3851 | 19874 | 3269 | 24434 | 2717 | 27598 | 2219 | 31736 | 1351 | 41181 | 85 | 40655 |
| 7L-2S | | MI | 9050 | 3851 | 16075 | 2952 | 19486 | 2394 | 22189 | 1909 | 26783 | 1069 | 33061 | 703 | 27498 |
| 16-#10 | 2.02 | MA | 12091 | 2817 | 16282 | 2491 | 20207 | 2090 | 22595 | 1760 | 25468 | 1241 | 31917 | 921 | 20429 |
| 4L-6S | | MI | 6299 | 2817 | 8965 | 2409 | 10684 | 2013 | 11600 | 1697 | 12548 | 1185 | 15244 | 725 | 10557 |
| 16-#10 | 2.02 | MA | 11752 | 2817 | 15760 | 2504 | 19511 | 2103 | 21729 | 1772 | 24263 | 1259 | 30185 | 874 | 20253 |
| 5E | | MI | 6468 | 2817 | 9275 | 2394 | 11033 | 2004 | 12048 | 1683 | 13170 | 1180 | 16107 | 796 | 10814 |
| 16-#10 | 2.02 | MA | 11420 | 2817 | 15126 | 2518 | 18829 | 2114 | 20883 | 1792 | 23087 | 1270 | 28693 | 821 | 19663 |
| 6L-4S | | MI | 6610 | 2817 | 9544 | 2384 | 11402 | 1995 | 12506 | 1675 | 13805 | 1169 | 16990 | 850 | 10889 |
| 16-#10 | 2.02 | MA | 11135 | 2817 | 14587 | 2528 | 18083 | 2129 | 20042 | 1803 | 21948 | 1288 | 27165 | 788 | 19167 |
| 7L-3S | | MI | 6737 | 2817 | 9847 | 2373 | 11822 | 1979 | 13021 | 1661 | 14508 | 1164 | 17871 | 904 | 10912 |
| 16-#10 | 2.02 | MA | 10840 | 2817 | 14071 | 2539 | 17392 | 2139 | 19168 | 1818 | 20812 | 1299 | 25675 | 745 | 18450 |
| 8L-2S | | MI | 6971 | 2817 | 10284 | 2363 | 12376 | 1970 | 13692 | 1653 | 15415 | 1152 | 19126 | 996 | 10919 |
| 16-#11 | 2.48 | MA | 12618 | 2951 | 17548 | 2570 | 21713 | 2149 | 24373 | 1797 | 27824 | 1233 | 35197 | 875 | 24748 |
| 4L-6S | | MI | 6468 | 2951 | 9500 | 2483 | 11273 | 2065 | 12267 | 1728 | 13424 | 1178 | 16348 | 633 | 12497 |
| 16-#11 | 2.48 | MA | 12215 | 2951 | 16917 | 2586 | 20864 | 2165 | 23318 | 1812 | 26356 | 1255 | 33191 | 828 | 24305 |
| 5E | | MI | 6666 | 2951 | 9868 | 2464 | 11696 | 2055 | 12810 | 1711 | 14160 | 1165 | 17302 | 707 | 12770 |
| 16-#11 | 2.48 | MA | 11826 | 2951 | 16146 | 2603 | 20042 | 2179 | 22286 | 1836 | 24923 | 1268 | 31260 | 748 | 23515 |
| 6L-4S | | MI | 6829 | 2951 | 10194 | 2453 | 12143 | 2045 | 13364 | 1703 | 14928 | 1152 | 18343 | 773 | 13048 |
| 16-#11 | 2.48 | MA | 11491 | 2951 | 15490 | 2615 | 19134 | 2197 | 21273 | 1849 | 23535 | 1289 | 29386 | 707 | 22782 |
| 7L-3S | | MI | 6975 | 2951 | 10561 | 2441 | 12650 | 2026 | 13985 | 1687 | 15777 | 1148 | 19386 | 837 | 13094 |
| 16-#11 | 2.48 | MA | 11141 | 2951 | 14861 | 2628 | 18291 | 2208 | 20208 | 1867 | 22148 | 1302 | 27566 | 653 | 21753 |
| 8L-2S | | MI | 7247 | 2951 | 11086 | 2429 | 13317 | 2016 | 14794 | 1679 | 16868 | 1135 | 20864 | 951 | 13112 |
| 16-#14 | 3.57 | MA | 13356 | 3271 | 19545 | 2800 | 24070 | 2328 | 27156 | 1920 | 31480 | 1257 | 40393 | 707 | 33687 |
| 5E | | MI | 7183 | 3271 | 11184 | 2664 | 13280 | 2204 | 14695 | 1804 | 16668 | 1150 | 20551 | 533 | 17439 |
| 16-#14 | 3.57 | MA | 12836 | 3271 | 18441 | 2824 | 22902 | 2348 | 25675 | 1954 | 29425 | 1275 | 37619 | 590 | 32505 |
| 6L-4S | | MI | 7406 | 3271 | 11650 | 2648 | 13918 | 2190 | 15485 | 1794 | 17763 | 1133 | 22007 | 628 | 18047 |
| 16-#14 | 3.57 | MA | 12390 | 3271 | 17501 | 2840 | 21600 | 2374 | 24235 | 1973 | 27433 | 1305 | 34921 | 530 | 30699 |
| 7L-3S | | MI | 7595 | 3271 | 12172 | 2632 | 14640 | 2165 | 16370 | 1772 | 18972 | 1129 | 23470 | 719 | 18349 |
| 16-#14 | 3.57 | MA | 11899 | 3271 | 16599 | 2859 | 20392 | 2390 | 22710 | 1999 | 25444 | 1322 | 32305 | 449 | 28890 |
| 8L-2S | | MI | 7952 | 3271 | 12919 | 2616 | 15587 | 2151 | 17518 | 1761 | 20522 | 1112 | 25538 | 882 | 18414 |
| 16-#18 | 6.35 | MA | 15319 | 4083 | 24115 | 3386 | 30005 | 2779 | 34091 | 2252 | 40618 | 1290 | 53411 | 179 | 52031 |
| 6L-4S | | MI | 8812 | 4083 | 15168 | 3147 | 18233 | 2561 | 20656 | 2025 | 24688 | 1084 | 30602 | 217 | 29305 |
| 16-#18 | 6.35 | MA | 14636 | 4083 | 22465 | 3414 | 27722 | 2823 | 31582 | 2286 | 37115 | 1340 | 48628 | 70 | 48197 |
| 7L-3S | | MI | 9049 | 4083 | 16075 | 3122 | 19486 | 2519 | 22189 | 1990 | 26783 | 1082 | 33061 | 369 | 31024 |
| 18-#10 | 2.27 | MA | 12170 | 2890 | 16611 | 2550 | 20591 | 2137 | 23038 | 1794 | 26030 | 1255 | 32632 | 869 | 22766 |
| 5L-6S | | MI | 6502 | 2890 | 9401 | 2455 | 11238 | 2047 | 12271 | 1719 | 13455 | 1181 | 16499 | 720 | 11816 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

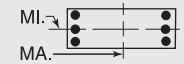



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.27 | MA | 11848 | 2890 | 15977 | 2564 | 19909 | 2148 | 22192 | 1813 | 24854 | 1266 | 31140 | 816 | 22165 |
| 6L-5S | | MI | 6668 | 2890 | 9711 | 2440 | 11587 | 2038 | 12720 | 1704 | 14077 | 1177 | 17362 | 791 | 12062 |
| 18-#10 | 2.27 | MA | 11573 | 2890 | 15438 | 2574 | 19163 | 2163 | 21351 | 1824 | 23715 | 1284 | 29611 | 783 | 21683 |
| 7L-4S | | MI | 6809 | 2890 | 9981 | 2430 | 11957 | 2029 | 13178 | 1697 | 14712 | 1165 | 18245 | 845 | 12177 |
| 18-#10 | 2.27 | MA | 11282 | 2890 | 14922 | 2585 | 18471 | 2173 | 20477 | 1839 | 22578 | 1296 | 28122 | 740 | 20956 |
| 8L-3S | | MI | 6931 | 2890 | 10284 | 2419 | 12376 | 2013 | 13692 | 1682 | 15415 | 1161 | 19126 | 899 | 12206 |
| 18-#10 | 2.27 | MA | 10953 | 2890 | 14406 | 2595 | 17800 | 2183 | 19629 | 1849 | 21449 | 1313 | 26580 | 687 | 20244 |
| 9L-2S | | MI | 7161 | 2890 | 10721 | 2409 | 12930 | 2004 | 14364 | 1675 | 16322 | 1149 | 20380 | 991 | 12218 |
| 18-#11 | 2.79 | MA | 12711 | 3042 | 17951 | 2642 | 22176 | 2206 | 24908 | 1838 | 28504 | 1250 | 36165 | 822 | 27332 |
| 5L-6S | | MI | 6707 | 3042 | 10026 | 2540 | 11940 | 2106 | 13075 | 1754 | 14515 | 1173 | 17826 | 624 | 14011 |
| 18-#11 | 2.79 | MA | 12335 | 3042 | 17181 | 2660 | 21354 | 2220 | 23877 | 1862 | 27071 | 1263 | 34233 | 742 | 26562 |
| 6L-5S | | MI | 6900 | 3042 | 10393 | 2521 | 12363 | 2096 | 13618 | 1737 | 15251 | 1161 | 18780 | 698 | 14273 |
| 18-#11 | 2.79 | MA | 12013 | 3042 | 16525 | 2671 | 20446 | 2238 | 22864 | 1875 | 25682 | 1285 | 32359 | 701 | 25822 |
| 7L-4S | | MI | 7062 | 3042 | 10720 | 2509 | 12810 | 2086 | 14173 | 1729 | 16019 | 1148 | 19821 | 764 | 14592 |
| 18-#11 | 2.79 | MA | 11668 | 3042 | 15896 | 2684 | 19603 | 2250 | 21799 | 1893 | 24296 | 1297 | 30539 | 647 | 24796 |
| 8L-3S | | MI | 7203 | 3042 | 11086 | 2497 | 13317 | 2068 | 14794 | 1713 | 16868 | 1144 | 20864 | 828 | 14647 |
| 18-#11 | 2.79 | MA | 11280 | 3042 | 15272 | 2697 | 18785 | 2262 | 20766 | 1904 | 22931 | 1319 | 28759 | 592 | 23686 |
| 9L-2S | | MI | 7468 | 3042 | 11612 | 2485 | 13984 | 2058 | 15602 | 1705 | 17959 | 1131 | 22342 | 941 | 14672 |
| 18-#14 | 4.02 | MA | 13541 | 3402 | 19921 | 2906 | 24780 | 2408 | 27952 | 1991 | 32498 | 1269 | 41874 | 582 | 36839 |
| 6L-5S | | MI | 7505 | 3402 | 11930 | 2746 | 14227 | 2263 | 15843 | 1842 | 18217 | 1144 | 22619 | 516 | 19585 |
| 18-#14 | 4.02 | MA | 13118 | 3402 | 18981 | 2922 | 23479 | 2433 | 26512 | 2011 | 30506 | 1299 | 39176 | 521 | 35043 |
| 7L-4S | | MI | 7727 | 3402 | 12396 | 2730 | 14865 | 2250 | 16633 | 1832 | 19313 | 1127 | 24074 | 611 | 20165 |
| 18-#14 | 4.02 | MA | 12634 | 3402 | 18079 | 2940 | 22270 | 2449 | 24986 | 2037 | 28517 | 1316 | 36560 | 441 | 33219 |
| 8L-3S | | MI | 7907 | 3402 | 12919 | 2713 | 15587 | 2224 | 17518 | 1809 | 20522 | 1123 | 25538 | 702 | 20544 |
| 18-#14 | 4.02 | MA | 12109 | 3402 | 17191 | 2959 | 21096 | 2467 | 23504 | 2052 | 26559 | 1346 | 33996 | 362 | 31445 |
| 9L-2S | | MI | 8254 | 3402 | 13665 | 2697 | 16534 | 2211 | 18665 | 1799 | 22071 | 1106 | 27605 | 865 | 20621 |
| 18-#18 | 7.14 | MA | 15864 | 4315 | 25055 | 3558 | 31009 | 2929 | 35567 | 2353 | 42493 | 1329 | 56075 | 55 | 55738 |
| 7L-4S | | MI | 9337 | 4315 | 16454 | 3292 | 19865 | 2667 | 22634 | 2092 | 27358 | 1073 | 34050 | 174 | 32992 |
| 20-#10 | 2.52 | MA | 12269 | 2964 | 16828 | 2610 | 20989 | 2181 | 23501 | 1835 | 26621 | 1263 | 33586 | 811 | 24669 |
| 6E | | MI | 6703 | 2964 | 9838 | 2501 | 11792 | 2081 | 12943 | 1740 | 14362 | 1178 | 17753 | 715 | 13077 |
| 20-#10 | 2.52 | MA | 12003 | 2964 | 16289 | 2620 | 20243 | 2197 | 22659 | 1845 | 25482 | 1281 | 32058 | 778 | 24199 |
| 7L-5S | | MI | 6865 | 2964 | 10148 | 2486 | 12142 | 2072 | 13392 | 1725 | 14983 | 1173 | 18616 | 786 | 13314 |
| 20-#10 | 2.52 | MA | 11714 | 2964 | 15773 | 2631 | 19551 | 2206 | 21786 | 1860 | 24345 | 1292 | 30568 | 735 | 23462 |
| 8L-4S | | MI | 7005 | 2964 | 10418 | 2476 | 12511 | 2063 | 13850 | 1718 | 15619 | 1162 | 19499 | 840 | 13464 |
| 20-#10 | 2.52 | MA | 11395 | 2964 | 15256 | 2641 | 18880 | 2217 | 20938 | 1870 | 23216 | 1309 | 29026 | 682 | 22751 |
| 9L-3S | | MI | 7123 | 2964 | 10721 | 2465 | 12930 | 2047 | 14364 | 1703 | 16322 | 1157 | 20380 | 894 | 13499 |
| 20-#10 | 2.52 | MA | 11091 | 2964 | 14728 | 2649 | 18179 | 2235 | 20108 | 1880 | 22062 | 1324 | 27532 | 645 | 21850 |
| 10L-2S | | MI | 7348 | 2964 | 11157 | 2455 | 13485 | 2038 | 15036 | 1696 | 17228 | 1145 | 21635 | 986 | 13515 |
| 20-#11 | 3.10 | MA | 12834 | 3132 | 18215 | 2716 | 22667 | 2261 | 25467 | 1888 | 29218 | 1259 | 37206 | 736 | 29611 |
| 6E | | MI | 6943 | 3132 | 10551 | 2596 | 12607 | 2147 | 13883 | 1780 | 15606 | 1169 | 19304 | 615 | 15529 |
| 20-#11 | 3.10 | MA | 12525 | 3132 | 17559 | 2728 | 21759 | 2279 | 24454 | 1901 | 27829 | 1280 | 35333 | 695 | 28861 |
| 7L-5S | | MI | 7131 | 3132 | 10919 | 2577 | 13030 | 2138 | 14427 | 1764 | 16342 | 1156 | 20259 | 688 | 15781 |
| 20-#11 | 3.10 | MA | 12183 | 3132 | 16930 | 2741 | 20916 | 2291 | 23390 | 1919 | 26443 | 1293 | 33512 | 641 | 27822 |
| 8L-4S | | MI | 7292 | 3132 | 11245 | 2566 | 13477 | 2128 | 14981 | 1756 | 17110 | 1144 | 21299 | 754 | 16135 |
| 20-#11 | 3.10 | MA | 11807 | 3132 | 16306 | 2753 | 20097 | 2303 | 22356 | 1930 | 25078 | 1315 | 31732 | 586 | 26719 |
| 9L-3S | | MI | 7427 | 3132 | 11612 | 2554 | 13984 | 2109 | 15602 | 1739 | 17959 | 1139 | 22342 | 819 | 16198 |
| 20-#11 | 3.10 | MA | 11460 | 3132 | 15663 | 2764 | 19244 | 2325 | 21345 | 1942 | 23679 | 1333 | 29796 | 527 | 25648 |
| 10L-2S | | MI | 7686 | 3132 | 12137 | 2542 | 14651 | 2099 | 16410 | 1731 | 19050 | 1127 | 23821 | 932 | 16230 |
| 20-#14 | 4.46 | MA | 13829 | 3532 | 20461 | 3003 | 25357 | 2493 | 28788 | 2049 | 33579 | 1292 | 43431 | 513 | 39355 |
| 7L-5S | | MI | 7824 | 3532 | 12676 | 2827 | 15174 | 2323 | 16990 | 1880 | 19767 | 1138 | 24686 | 498 | 21736 |
| 20-#14 | 4.46 | MA | 13351 | 3532 | 19559 | 3022 | 24149 | 2509 | 27263 | 2074 | 31591 | 1310 | 40815 | 432 | 37548 |
| 8L-4S | | MI | 8045 | 3532 | 13143 | 2811 | 15812 | 2310 | 17781 | 1870 | 20862 | 1121 | 26141 | 594 | 22292 |
| 20-#14 | 4.46 | MA | 12848 | 3532 | 18671 | 3040 | 22974 | 2526 | 25781 | 2089 | 29632 | 1340 | 38251 | 353 | 35762 |
| 9L-3S | | MI | 8215 | 3532 | 13665 | 2795 | 16534 | 2284 | 18665 | 1847 | 22071 | 1117 | 27605 | 684 | 22739 |
| 22-#10 | 2.77 | MA | 12426 | 3038 | 17140 | 2666 | 21323 | 2230 | 23968 | 1866 | 27249 | 1277 | 34504 | 773 | 26716 |
| 7L-6S | | MI | 6901 | 3038 | 10275 | 2547 | 12347 | 2114 | 13615 | 1761 | 15268 | 1174 | 19008 | 710 | 14340 |
| 22-#10 | 2.77 | MA | 12140 | 3038 | 16624 | 2677 | 20631 | 2240 | 23095 | 1882 | 26112 | 1288 | 33014 | 730 | 25968 |
| 8L-5S | | MI | 7060 | 3038 | 10585 | 2532 | 12696 | 2105 | 14064 | 1747 | 15890 | 1170 | 19871 | 781 | 14569 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



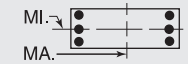

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 2.77 | MA | 11829 | 3038 | 16107 | 2687 | 19959 | 2250 | 22246 | 1891 | 24982 | 1306 | 31473 | 677 | 25258 |
| 9L-4S | | MI | 7199 | 3038 | 10854 | 2522 | 13065 | 2096 | 14522 | 1739 | 16525 | 1158 | 20754 | 835 | 14750 |
| 22-#10 | 2.77 | MA | 11543 | 3038 | 15579 | 2695 | 19259 | 2269 | 21417 | 1901 | 23829 | 1321 | 29978 | 640 | 24351 |
| 10L-3S | | MI | 7313 | 3038 | 11157 | 2511 | 13485 | 2080 | 15036 | 1725 | 17228 | 1154 | 21635 | 889 | 14790 |
| 22-#10 | 2.77 | MA | 11254 | 3038 | 14985 | 2712 | 18579 | 2278 | 20575 | 1919 | 22665 | 1329 | 28529 | 595 | 23484 |
| 11L-2S | | MI | 7533 | 3038 | 11594 | 2501 | 14039 | 2071 | 15708 | 1717 | 18135 | 1142 | 22889 | 981 | 14811 |
| 22-#11 | 3.40 | MA | 13027 | 3223 | 18593 | 2784 | 23071 | 2321 | 26045 | 1927 | 29977 | 1276 | 38306 | 689 | 31900 |
| 7L-6S | | MI | 7176 | 3223 | 11077 | 2653 | 13273 | 2189 | 14691 | 1806 | 16697 | 1165 | 20783 | 605 | 17050 |
| 22-#11 | 3.40 | MA | 12689 | 3223 | 17964 | 2797 | 22228 | 2332 | 24981 | 1945 | 28590 | 1289 | 36485 | 635 | 30865 |
| 8L-5S | | MI | 7359 | 3223 | 11444 | 2634 | 13696 | 2179 | 15235 | 1790 | 17433 | 1152 | 21737 | 679 | 17292 |
| 22-#11 | 3.40 | MA | 12325 | 3223 | 17340 | 2810 | 21410 | 2345 | 23947 | 1956 | 27225 | 1310 | 34705 | 580 | 29753 |
| 9L-4S | | MI | 7520 | 3223 | 11771 | 2622 | 14144 | 2169 | 15789 | 1782 | 18201 | 1139 | 22778 | 745 | 17678 |
| 22-#11 | 3.40 | MA | 11990 | 3223 | 16697 | 2820 | 20556 | 2367 | 22936 | 1968 | 25827 | 1328 | 32769 | 521 | 28674 |
| 10L-3S | | MI | 7650 | 3223 | 12137 | 2610 | 14651 | 2150 | 16410 | 1765 | 19050 | 1135 | 23821 | 809 | 17748 |
| 22-#11 | 3.40 | MA | 11659 | 3223 | 15973 | 2840 | 19736 | 2378 | 21910 | 1989 | 24408 | 1338 | 30997 | 464 | 27429 |
| 11L-2S | | MI | 7903 | 3223 | 12662 | 2598 | 15317 | 2140 | 17218 | 1757 | 20141 | 1122 | 25299 | 923 | 17786 |
| 22-#14 | 4.91 | MA | 14054 | 3663 | 21039 | 3103 | 26027 | 2569 | 29539 | 2112 | 34664 | 1304 | 45070 | 424 | 41876 |
| 8L-5S | | MI | 8138 | 3663 | 13423 | 2909 | 16121 | 2382 | 18138 | 1917 | 21316 | 1132 | 26753 | 481 | 23892 |
| 22-#14 | 4.91 | MA | 13570 | 3663 | 20151 | 3122 | 24853 | 2586 | 28057 | 2127 | 32705 | 1334 | 42506 | 345 | 40078 |
| 9L-4S | | MI | 8383 | 3663 | 13889 | 2893 | 16759 | 2369 | 18929 | 1907 | 22412 | 1115 | 28209 | 577 | 24425 |
| 24-#10 | 3.02 | MA | 12558 | 3111 | 17475 | 2723 | 21711 | 2273 | 24403 | 1903 | 27879 | 1285 | 35460 | 726 | 28474 |
| 8L-6S | | MI | 7097 | 3111 | 10712 | 2593 | 12901 | 2148 | 14287 | 1782 | 16175 | 1171 | 20262 | 705 | 15606 |
| 24-#10 | 3.02 | MA | 12255 | 3111 | 16958 | 2733 | 21039 | 2284 | 23555 | 1912 | 26749 | 1302 | 33919 | 672 | 27765 |
| 9L-5S | | MI | 7252 | 3111 | 11022 | 2578 | 13250 | 2139 | 14736 | 1768 | 16797 | 1166 | 21125 | 776 | 15827 |
| 24-#10 | 3.02 | MA | 11978 | 3111 | 16430 | 2741 | 20339 | 2302 | 22726 | 1923 | 25596 | 1317 | 32425 | 635 | 26851 |
| 10L-4S | | MI | 7391 | 3111 | 11291 | 2568 | 13619 | 2130 | 15194 | 1760 | 17432 | 1155 | 22008 | 830 | 16036 |
| 24-#10 | 3.02 | MA | 11695 | 3111 | 15835 | 2758 | 19659 | 2312 | 21884 | 1940 | 24432 | 1326 | 30975 | 590 | 25979 |
| 11L-3S | | MI | 7501 | 3111 | 11594 | 2557 | 14039 | 2114 | 15708 | 1746 | 18135 | 1150 | 22889 | 884 | 16080 |
| 24-#10 | 3.02 | MA | 11374 | 3111 | 15324 | 2769 | 18979 | 2321 | 21069 | 1951 | 23296 | 1342 | 29506 | 553 | 25071 |
| 12L-2S | | MI | 7717 | 3111 | 12031 | 2547 | 14593 | 2105 | 16379 | 1738 | 19042 | 1138 | 24144 | 976 | 16106 |
| 24-#11 | 3.71 | MA | 13186 | 3313 | 18998 | 2854 | 23541 | 2373 | 26572 | 1972 | 30738 | 1284 | 39458 | 629 | 33908 |
| 8L-6S | | MI | 7406 | 3313 | 11602 | 2709 | 13940 | 2230 | 15500 | 1832 | 17788 | 1161 | 22261 | 596 | 18573 |
| 24-#11 | 3.71 | MA | 12832 | 3313 | 18375 | 2867 | 22722 | 2386 | 25538 | 1982 | 29373 | 1306 | 37678 | 575 | 32787 |
| 9L-5S | | MI | 7585 | 3313 | 11970 | 2691 | 14363 | 2220 | 16043 | 1816 | 18524 | 1148 | 23215 | 669 | 18807 |
| 24-#11 | 3.71 | MA | 12509 | 3313 | 17731 | 2877 | 21869 | 2408 | 24527 | 1994 | 27974 | 1324 | 35742 | 515 | 31700 |
| 10L-4S | | MI | 7745 | 3313 | 12296 | 2679 | 14810 | 2210 | 16597 | 1808 | 19292 | 1135 | 24256 | 735 | 19221 |
| 24-#11 | 3.71 | MA | 12182 | 3313 | 17007 | 2897 | 21048 | 2420 | 23501 | 2015 | 26555 | 1334 | 33970 | 458 | 30459 |
| 11L-3S | | MI | 7870 | 3313 | 12662 | 2667 | 15317 | 2192 | 17218 | 1791 | 20141 | 1131 | 25299 | 800 | 19297 |
| 24-#14 | 5.36 | MA | 14277 | 3793 | 21631 | 3203 | 26731 | 2646 | 30334 | 2165 | 35779 | 1328 | 46761 | 336 | 44395 |
| 9L-5S | | MI | 8469 | 3793 | 14169 | 2990 | 17068 | 2442 | 19286 | 1955 | 22866 | 1125 | 28821 | 464 | 26053 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

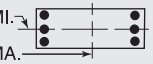



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.52 | MA | 13033 | 2798 | 17722 | 2458 | 21838 | 2061 | 24282 | 1746 | 27171 | 1261 | 33590 | 1095 | 16752 |
| 2E | | MI | 6755 | 2798 | 9983 | 2319 | 11710 | 1943 | 12697 | 1643 | 13819 | 1179 | 16243 | 967 | 8458 |
| 6-#14 | 1.28 | MA | 12691 | 2725 | 16775 | 2427 | 20764 | 2041 | 23047 | 1736 | 25562 | 1273 | 31406 | 1108 | 14334 |
| 2L-3S | | MI | 6210 | 2725 | 8771 | 2318 | 10286 | 1946 | 11027 | 1653 | 11611 | 1216 | 13562 | 853 | 7350 |
| 6-#14 | 1.28 | MA | 11751 | 2725 | 15213 | 2452 | 18782 | 2064 | 20645 | 1758 | 22320 | 1304 | 26917 | 966 | 14285 |
| 3L-2S | | MI | 6638 | 2725 | 9518 | 2302 | 11233 | 1933 | 12175 | 1643 | 13161 | 1199 | 15630 | 1017 | 7323 |
| 6-#18 | 2.27 | MA | 14297 | 3030 | 20458 | 2603 | 25309 | 2167 | 28489 | 1813 | 32850 | 1250 | 41454 | 1080 | 24880 |
| 2L-3S | | MI | 6613 | 3030 | 9983 | 2490 | 11710 | 2068 | 12697 | 1724 | 13819 | 1192 | 16243 | 633 | 12264 |
| 6-#18 | 2.27 | MA | 12790 | 3030 | 17722 | 2645 | 21838 | 2206 | 24282 | 1849 | 27171 | 1302 | 33590 | 822 | 24568 |
| 3L-2S | | MI | 7297 | 3030 | 11268 | 2464 | 13342 | 2049 | 14675 | 1710 | 16489 | 1168 | 19692 | 924 | 12319 |
| 8-#11 | 1.18 | MA | 12549 | 2696 | 16370 | 2416 | 20316 | 2033 | 22537 | 1733 | 24905 | 1279 | 30518 | 1113 | 13339 |
| 2L-4S | | MI | 6112 | 2696 | 8420 | 2321 | 9856 | 1960 | 10528 | 1669 | 10952 | 1225 | 12860 | 860 | 6880 |
| 8-#11 | 1.18 | MA | 11889 | 2696 | 15279 | 2434 | 18932 | 2050 | 20860 | 1748 | 22640 | 1301 | 27382 | 1017 | 13319 |
| 3E | | MI | 6287 | 2696 | 8787 | 2309 | 10363 | 1941 | 11149 | 1652 | 11801 | 1221 | 13903 | 924 | 6869 |
| 8-#11 | 1.18 | MA | 11526 | 2696 | 14542 | 2451 | 17907 | 2075 | 19602 | 1772 | 20917 | 1314 | 25322 | 956 | 13221 |
| 4L-2S | | MI | 6590 | 2696 | 9312 | 2297 | 11030 | 1931 | 11957 | 1644 | 12892 | 1208 | 15381 | 1037 | 6849 |
| 8-#14 | 1.70 | MA | 13439 | 2856 | 18336 | 2509 | 22746 | 2100 | 25449 | 1774 | 28804 | 1267 | 35896 | 1099 | 18980 |
| 2L-4S | | MI | 6315 | 2856 | 8995 | 2415 | 10510 | 2032 | 11290 | 1713 | 11952 | 1214 | 14166 | 746 | 9525 |
| 8-#14 | 1.70 | MA | 12542 | 2856 | 16775 | 2533 | 20764 | 2123 | 23047 | 1795 | 25562 | 1298 | 31406 | 958 | 18900 |
| 3E | | MI | 6553 | 2856 | 9518 | 2399 | 11233 | 2006 | 12175 | 1690 | 13161 | 1209 | 15630 | 836 | 9577 |
| 8-#14 | 1.70 | MA | 12051 | 2856 | 15717 | 2558 | 19294 | 2159 | 21243 | 1829 | 23092 | 1316 | 28441 | 869 | 18589 |
| 4L-2S | | MI | 6965 | 2856 | 10264 | 2383 | 12180 | 1993 | 13323 | 1680 | 14710 | 1193 | 17697 | 999 | 9569 |
| 8-#18 | 3.03 | MA | 15512 | 3261 | 23193 | 2748 | 28781 | 2273 | 32697 | 1880 | 38530 | 1239 | 49317 | 1064 | 32993 |
| 2L-4S | | MI | 6802 | 3261 | 10362 | 2660 | 12089 | 2216 | 13141 | 1826 | 14394 | 1183 | 17233 | 438 | 14891 |
| 8-#18 | 3.03 | MA | 14105 | 3261 | 20458 | 2789 | 25309 | 2312 | 28489 | 1916 | 32850 | 1291 | 41454 | 807 | 32633 |
| 3E | | MI | 7178 | 3261 | 11268 | 2635 | 13342 | 2174 | 14675 | 1791 | 16489 | 1181 | 19692 | 590 | 16032 |
| 8-#18 | 3.03 | MA | 13343 | 3261 | 18598 | 2831 | 22726 | 2373 | 25321 | 1974 | 28512 | 1321 | 36209 | 647 | 30238 |
| 4L-2S | | MI | 7825 | 3261 | 12554 | 2609 | 14974 | 2155 | 16653 | 1777 | 19158 | 1157 | 23140 | 881 | 16145 |
| 10-#10 | 1.20 | MA | 12631 | 2702 | 16377 | 2431 | 20416 | 2045 | 22704 | 1743 | 25172 | 1285 | 30920 | 1118 | 13654 |
| 2L-5S | | MI | 6104 | 2702 | 8288 | 2351 | 9748 | 1984 | 10429 | 1690 | 10838 | 1247 | 12777 | 861 | 7023 |
| 10-#10 | 1.20 | MA | 12089 | 2702 | 15480 | 2445 | 19278 | 2059 | 21325 | 1756 | 23310 | 1303 | 28341 | 1041 | 13637 |
| 3L-4S | | MI | 6250 | 2702 | 8557 | 2341 | 10118 | 1975 | 10887 | 1682 | 11473 | 1235 | 13659 | 914 | 7038 |
| 10-#10 | 1.20 | MA | 11797 | 2702 | 14875 | 2460 | 18436 | 2080 | 20293 | 1776 | 21896 | 1315 | 26658 | 992 | 13574 |
| 4L-3S | | MI | 6393 | 2702 | 8860 | 2330 | 10537 | 1960 | 11401 | 1668 | 12176 | 1231 | 14541 | 968 | 7031 |
| 10-#10 | 1.20 | MA | 11424 | 2702 | 14323 | 2472 | 17703 | 2093 | 19381 | 1788 | 20628 | 1333 | 24837 | 946 | 13411 |
| 5L-2S | | MI | 6645 | 2702 | 9297 | 2320 | 11092 | 1951 | 12073 | 1660 | 13083 | 1219 | 15795 | 1060 | 7018 |
| 10-#11 | 1.48 | MA | 13081 | 2786 | 17461 | 2473 | 21701 | 2075 | 24215 | 1759 | 27169 | 1275 | 33654 | 1107 | 16585 |
| 2L-5S | | MI | 6194 | 2786 | 8619 | 2389 | 10076 | 2011 | 10782 | 1703 | 11275 | 1234 | 13297 | 784 | 8380 |
| 10-#11 | 1.48 | MA | 12442 | 2786 | 16370 | 2490 | 20316 | 2091 | 22537 | 1775 | 24905 | 1297 | 30518 | 1011 | 16551 |
| 3L-4S | | MI | 6362 | 2786 | 8946 | 2377 | 10523 | 2001 | 11336 | 1695 | 12043 | 1221 | 14338 | 850 | 8438 |
| 10-#11 | 1.48 | MA | 12099 | 2786 | 15633 | 2508 | 19291 | 2116 | 21280 | 1798 | 23182 | 1310 | 28458 | 950 | 16437 |
| 4L-3S | | MI | 6529 | 2786 | 9312 | 2365 | 11030 | 1983 | 11957 | 1678 | 12892 | 1217 | 15381 | 915 | 8444 |
| 10-#11 | 1.48 | MA | 11656 | 2786 | 14965 | 2523 | 18397 | 2132 | 20168 | 1814 | 21636 | 1332 | 26234 | 892 | 16150 |
| 5L-2S | | MI | 6824 | 2786 | 9838 | 2353 | 11697 | 1973 | 12766 | 1670 | 13983 | 1204 | 16859 | 1028 | 8432 |
| 10-#14 | 2.13 | MA | 14166 | 2986 | 19898 | 2590 | 24728 | 2160 | 27851 | 1811 | 32047 | 1261 | 40385 | 1090 | 23618 |
| 2L-5S | | MI | 6433 | 2986 | 9275 | 2513 | 10820 | 2104 | 11648 | 1761 | 12406 | 1224 | 14778 | 633 | 11149 |
| 10-#14 | 2.13 | MA | 13308 | 2986 | 18336 | 2615 | 22746 | 2183 | 25449 | 1833 | 28804 | 1292 | 35896 | 949 | 23516 |
| 3L-4S | | MI | 6663 | 2986 | 9742 | 2497 | 11458 | 2091 | 12438 | 1751 | 13501 | 1207 | 16233 | 728 | 11710 |
| 10-#14 | 2.13 | MA | 12852 | 2986 | 17279 | 2639 | 21276 | 2218 | 23645 | 1867 | 26334 | 1310 | 32931 | 860 | 23193 |
| 4L-3S | | MI | 6887 | 2986 | 10264 | 2481 | 12180 | 2066 | 13323 | 1728 | 14710 | 1203 | 17697 | 819 | 11788 |
| 10-#14 | 2.13 | MA | 12231 | 2986 | 16326 | 2662 | 19993 | 2241 | 22051 | 1888 | 24117 | 1341 | 29902 | 792 | 21859 |
| 5L-2S | | MI | 7285 | 2986 | 11010 | 2465 | 13127 | 2052 | 14471 | 1718 | 16260 | 1186 | 19764 | 982 | 11802 |
| 10-#18 | 3.79 | MA | 15369 | 3493 | 23193 | 2934 | 28781 | 2418 | 32697 | 1983 | 38530 | 1280 | 49317 | 792 | 40708 |
| 3L-4S | | MI | 7380 | 3493 | 11648 | 2805 | 13721 | 2322 | 15119 | 1893 | 17064 | 1172 | 20681 | 395 | 18493 |
| 10-#18 | 3.79 | MA | 14689 | 3493 | 21334 | 2976 | 26197 | 2479 | 29528 | 2041 | 34191 | 1310 | 44073 | 632 | 38248 |
| 4L-3S | | MI | 7751 | 3493 | 12554 | 2780 | 14974 | 2280 | 16653 | 1857 | 19158 | 1170 | 23140 | 547 | 19794 |
| 10-#18 | 3.79 | MA | 13641 | 3493 | 19681 | 3017 | 23940 | 2517 | 26724 | 2076 | 30293 | 1362 | 38732 | 503 | 35158 |
| 5L-2S | | MI | 8334 | 3493 | 13840 | 2754 | 16606 | 2261 | 18631 | 1844 | 21828 | 1146 | 26589 | 837 | 19952 |

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

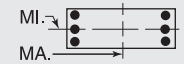
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.44 | MA | 13072 | 2776 | 17274 | 2477 | 21554 | 2079 | 24084 | 1764 | 27034 | 1281 | 33498 | 1113 | 16323 |
| 2L-6S | | MI | 6136 | 2776 | 8415 | 2412 | 9954 | 2027 | 10652 | 1725 | 11123 | 1248 | 13168 | 784 | 8116 |
| 12-#10 | 1.44 | MA | 12545 | 2776 | 16377 | 2491 | 20416 | 2093 | 22704 | 1777 | 25172 | 1300 | 30920 | 1036 | 16297 |
| 3L-5S | | MI | 6314 | 2776 | 8725 | 2397 | 10303 | 2018 | 11101 | 1711 | 11745 | 1244 | 14031 | 856 | 8309 |
| 12-#10 | 1.44 | MA | 12266 | 2776 | 15772 | 2506 | 19575 | 2113 | 21672 | 1797 | 23758 | 1311 | 29237 | 987 | 16224 |
| 4E | | MI | 6459 | 2776 | 8994 | 2387 | 10672 | 2009 | 11559 | 1703 | 12380 | 1232 | 14914 | 909 | 8336 |
| 12-#10 | 1.44 | MA | 11897 | 2776 | 15220 | 2518 | 18842 | 2127 | 20761 | 1810 | 22490 | 1330 | 27416 | 941 | 16055 |
| 5L-3S | | MI | 6596 | 2776 | 9297 | 2376 | 11092 | 1993 | 12073 | 1689 | 13083 | 1227 | 15795 | 963 | 8339 |
| 12-#10 | 1.44 | MA | 11524 | 2776 | 14552 | 2533 | 18120 | 2138 | 19871 | 1830 | 21253 | 1341 | 25848 | 889 | 15506 |
| 6L-2S | | MI | 6843 | 2776 | 9734 | 2366 | 11646 | 1984 | 12745 | 1681 | 13990 | 1216 | 17050 | 1055 | 8331 |
| 12-#11 | 1.77 | MA | 13601 | 2876 | 18552 | 2529 | 23085 | 2116 | 25893 | 1785 | 29434 | 1270 | 36789 | 1101 | 19828 |
| 2L-6S | | MI | 6231 | 2876 | 8777 | 2464 | 10319 | 2062 | 11047 | 1746 | 11630 | 1242 | 13821 | 701 | 9557 |
| 12-#11 | 1.77 | MA | 12983 | 2876 | 17461 | 2547 | 21701 | 2132 | 24215 | 1801 | 27169 | 1292 | 33654 | 1005 | 19781 |
| 3L-5S | | MI | 6441 | 2876 | 9145 | 2445 | 10742 | 2053 | 11590 | 1729 | 12366 | 1229 | 14776 | 775 | 9861 |
| 12-#11 | 1.77 | MA | 12658 | 2876 | 16724 | 2564 | 20675 | 2157 | 22957 | 1825 | 25446 | 1306 | 31593 | 944 | 19655 |
| 4E | | MI | 6607 | 2876 | 9471 | 2434 | 11189 | 2043 | 12145 | 1721 | 13134 | 1217 | 15816 | 841 | 9991 |
| 12-#11 | 1.77 | MA | 12219 | 2876 | 16056 | 2579 | 19781 | 2174 | 21846 | 1840 | 23901 | 1328 | 29370 | 886 | 19344 |
| 5L-3S | | MI | 6768 | 2876 | 9838 | 2422 | 11697 | 2024 | 12766 | 1704 | 13983 | 1212 | 16859 | 905 | 10011 |
| 12-#11 | 1.77 | MA | 11776 | 2876 | 15243 | 2597 | 18911 | 2187 | 20760 | 1864 | 22392 | 1341 | 27453 | 819 | 18435 |
| 6L-2S | | MI | 7055 | 2876 | 10363 | 2410 | 12363 | 2014 | 13574 | 1696 | 15074 | 1200 | 18338 | 1019 | 10007 |
| 12-#14 | 2.56 | MA | 14052 | 3116 | 19898 | 2696 | 24728 | 2242 | 27851 | 1870 | 32047 | 1285 | 40385 | 940 | 28132 |
| 3L-5S | | MI | 6775 | 3116 | 10022 | 2595 | 11767 | 2164 | 12796 | 1799 | 13956 | 1218 | 16845 | 616 | 13267 |
| 12-#14 | 2.56 | MA | 13628 | 3116 | 18840 | 2721 | 23258 | 2278 | 26047 | 1904 | 29577 | 1304 | 37420 | 852 | 27801 |
| 4E | | MI | 7002 | 3116 | 10488 | 2578 | 12405 | 2151 | 13586 | 1788 | 15051 | 1201 | 18301 | 711 | 13893 |
| 12-#14 | 2.56 | MA | 13015 | 3116 | 17888 | 2743 | 21975 | 2301 | 24453 | 1926 | 27359 | 1335 | 34391 | 783 | 26453 |
| 5L-3S | | MI | 7215 | 3116 | 11010 | 2562 | 13127 | 2125 | 14471 | 1766 | 16260 | 1197 | 19764 | 802 | 13993 |
| 12-#14 | 2.56 | MA | 12411 | 3116 | 16724 | 2768 | 20735 | 2321 | 22895 | 1960 | 25196 | 1353 | 31474 | 668 | 25174 |
| 6L-2S | | MI | 7599 | 3116 | 11757 | 2546 | 14074 | 2112 | 15619 | 1755 | 17810 | 1180 | 21832 | 965 | 14024 |
| 12-#18 | 4.55 | MA | 15984 | 3725 | 24069 | 3121 | 29669 | 2585 | 33736 | 2108 | 39871 | 1299 | 51937 | 617 | 46259 |
| 4E | | MI | 7983 | 3725 | 12933 | 2950 | 15353 | 2428 | 17097 | 1960 | 19734 | 1161 | 24130 | 351 | 22121 |
| 12-#18 | 4.55 | MA | 14952 | 3725 | 22416 | 3162 | 27412 | 2623 | 30932 | 2143 | 35972 | 1351 | 46595 | 488 | 43190 |
| 5L-3S | | MI | 8282 | 3725 | 13840 | 2924 | 16606 | 2386 | 18631 | 1924 | 21828 | 1159 | 26589 | 503 | 23557 |
| 12-#18 | 4.55 | MA | 13993 | 3725 | 20374 | 3205 | 25264 | 2660 | 28189 | 2201 | 32166 | 1380 | 41451 | 277 | 39204 |
| 6L-2S | | MI | 8831 | 3725 | 15126 | 2899 | 18238 | 2367 | 20608 | 1911 | 24498 | 1135 | 30037 | 794 | 23751 |
| 14-#10 | 1.68 | MA | 12991 | 2849 | 17274 | 2537 | 21554 | 2126 | 24084 | 1798 | 27034 | 1296 | 33498 | 1031 | 18956 |
| 3L-6S | | MI | 6346 | 2849 | 8851 | 2458 | 10508 | 2061 | 11324 | 1747 | 12030 | 1245 | 14423 | 779 | 9366 |
| 14-#10 | 1.68 | MA | 12725 | 2849 | 16669 | 2552 | 20713 | 2147 | 23052 | 1818 | 25620 | 1308 | 31815 | 982 | 18875 |
| 4L-5S | | MI | 6521 | 2849 | 9161 | 2443 | 10857 | 2052 | 11773 | 1732 | 12652 | 1240 | 15286 | 851 | 9592 |
| 14-#10 | 1.68 | MA | 12359 | 2849 | 16117 | 2564 | 19980 | 2161 | 22141 | 1831 | 24352 | 1326 | 29995 | 936 | 18702 |
| 5L-4S | | MI | 6664 | 2849 | 9431 | 2433 | 11226 | 2043 | 12231 | 1725 | 13287 | 1228 | 16168 | 904 | 9629 |
| 14-#10 | 1.68 | MA | 11997 | 2849 | 15449 | 2579 | 19259 | 2171 | 21251 | 1851 | 23116 | 1338 | 28426 | 884 | 18140 |
| 6L-3S | | MI | 6797 | 2849 | 9734 | 2422 | 11646 | 2027 | 12745 | 1710 | 13990 | 1224 | 17050 | 958 | 9641 |
| 14-#10 | 1.68 | MA | 11683 | 2849 | 14882 | 2589 | 18473 | 2187 | 20359 | 1861 | 21917 | 1356 | 26824 | 851 | 17594 |
| 7L-2S | | MI | 7038 | 2849 | 10171 | 2412 | 12200 | 2018 | 13417 | 1703 | 14897 | 1212 | 18304 | 1050 | 9638 |
| 14-#11 | 2.07 | MA | 13511 | 2967 | 18552 | 2603 | 23085 | 2174 | 25893 | 1827 | 29434 | 1288 | 36789 | 999 | 23011 |
| 3L-6S | | MI | 6479 | 2967 | 9303 | 2521 | 10986 | 2104 | 11855 | 1772 | 12721 | 1238 | 15300 | 692 | 11062 |
| 14-#11 | 2.07 | MA | 13203 | 2967 | 17814 | 2621 | 22060 | 2199 | 24635 | 1851 | 27711 | 1301 | 34729 | 938 | 22874 |
| 4L-5S | | MI | 6684 | 2967 | 9670 | 2502 | 11409 | 2094 | 12399 | 1755 | 13457 | 1225 | 16254 | 766 | 11351 |
| 14-#11 | 2.07 | MA | 12769 | 2967 | 17146 | 2636 | 21166 | 2215 | 23524 | 1866 | 26165 | 1323 | 32505 | 880 | 22530 |
| 5L-4S | | MI | 6848 | 2967 | 9997 | 2490 | 11856 | 2084 | 12953 | 1747 | 14225 | 1212 | 17295 | 832 | 11540 |
| 14-#11 | 2.07 | MA | 12341 | 2967 | 16334 | 2654 | 20295 | 2229 | 22438 | 1890 | 24657 | 1337 | 30589 | 813 | 21645 |
| 6L-3S | | MI | 7002 | 2967 | 10363 | 2478 | 12363 | 2065 | 13574 | 1731 | 15074 | 1208 | 18338 | 896 | 11570 |
| 14-#11 | 2.07 | MA | 11971 | 2967 | 15643 | 2665 | 19338 | 2247 | 21363 | 1903 | 23195 | 1359 | 28624 | 773 | 20942 |
| 7L-2S | | MI | 7282 | 2967 | 10888 | 2466 | 13030 | 2055 | 14382 | 1723 | 16165 | 1195 | 19816 | 1009 | 11577 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

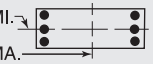



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.98 | MA | 14384 | 3247 | 20402 | 2802 | 25240 | 2337 | 28449 | 1942 | 32819 | 1298 | 41910 | 843 | 32414 |
| 4L-5S | | MI | 7110 | 3247 | 10768 | 2676 | 12714 | 2224 | 13943 | 1836 | 15505 | 1212 | 18913 | 598 | 15396 |
| 14-#14 | 2.98 | MA | 13777 | 3247 | 19450 | 2825 | 23957 | 2360 | 26855 | 1963 | 30602 | 1328 | 38881 | 775 | 31051 |
| 5L-4S | | MI | 7335 | 3247 | 11234 | 2660 | 13352 | 2210 | 14734 | 1826 | 16601 | 1195 | 20368 | 694 | 16048 |
| 14-#14 | 2.98 | MA | 13200 | 3247 | 18286 | 2850 | 22717 | 2380 | 25297 | 1997 | 28438 | 1347 | 35963 | 660 | 29776 |
| 6L-3S | | MI | 7537 | 3247 | 11757 | 2644 | 14074 | 2185 | 15619 | 1803 | 17810 | 1191 | 21832 | 784 | 16193 |
| 14-#14 | 2.98 | MA | 12699 | 3247 | 17295 | 2866 | 21345 | 2407 | 23768 | 2017 | 26340 | 1378 | 33133 | 600 | 27955 |
| 7L-2S | | MI | 7909 | 3247 | 12503 | 2628 | 15021 | 2172 | 16766 | 1793 | 19359 | 1174 | 23899 | 948 | 16239 |
| 14-#18 | 5.30 | MA | 16219 | 3957 | 25151 | 3307 | 30883 | 2729 | 35139 | 2210 | 41651 | 1340 | 54459 | 473 | 51221 |
| 5L-4S | | MI | 8532 | 3957 | 14219 | 3095 | 16985 | 2534 | 19075 | 2027 | 22404 | 1150 | 27578 | 308 | 25771 |
| 14-#18 | 5.30 | MA | 15320 | 3957 | 23109 | 3350 | 28735 | 2766 | 32397 | 2268 | 37845 | 1369 | 49315 | 262 | 47198 |
| 6L-3S | | MI | 8801 | 3957 | 15126 | 3069 | 18238 | 2492 | 20608 | 1991 | 24498 | 1148 | 30037 | 460 | 27320 |
| 14-#18 | 5.30 | MA | 14535 | 3957 | 21369 | 3378 | 26327 | 2811 | 29753 | 2304 | 34154 | 1421 | 44297 | 153 | 43292 |
| 7L-2S | | MI | 9319 | 3957 | 16412 | 3044 | 19870 | 2473 | 22586 | 1978 | 27168 | 1124 | 33485 | 751 | 27544 |
| 16-#10 | 1.92 | MA | 13175 | 2923 | 17566 | 2598 | 21851 | 2181 | 24431 | 1839 | 27483 | 1304 | 34394 | 977 | 21526 |
| 4L-6S | | MI | 6554 | 2923 | 9288 | 2504 | 11062 | 2094 | 11996 | 1768 | 12937 | 1241 | 15677 | 774 | 10621 |
| 16-#10 | 1.92 | MA | 12812 | 2923 | 17014 | 2610 | 21118 | 2194 | 23520 | 1852 | 26215 | 1323 | 32573 | 931 | 21350 |
| 5E | | MI | 6724 | 2923 | 9598 | 2489 | 11411 | 2085 | 12445 | 1753 | 13558 | 1237 | 16540 | 846 | 10875 |
| 16-#10 | 1.92 | MA | 12460 | 2923 | 16346 | 2625 | 20397 | 2205 | 22630 | 1872 | 24978 | 1334 | 31005 | 879 | 20777 |
| 6L-4S | | MI | 6866 | 2923 | 9868 | 2479 | 11781 | 2076 | 12903 | 1746 | 14194 | 1225 | 17423 | 899 | 10919 |
| 16-#10 | 1.92 | MA | 12158 | 2923 | 15779 | 2635 | 19611 | 2221 | 21739 | 1882 | 23780 | 1353 | 29402 | 846 | 20245 |
| 7L-3S | | MI | 6994 | 2923 | 10171 | 2468 | 12200 | 2060 | 13417 | 1731 | 14897 | 1220 | 18304 | 953 | 10938 |
| 16-#10 | 1.92 | MA | 11843 | 2923 | 15236 | 2646 | 18883 | 2230 | 20819 | 1898 | 22584 | 1364 | 27837 | 804 | 19537 |
| 8L-2S | | MI | 7230 | 2923 | 10607 | 2458 | 12754 | 2051 | 14088 | 1724 | 15803 | 1209 | 19559 | 1045 | 10943 |
| 16-#11 | 2.36 | MA | 13738 | 3057 | 18905 | 2677 | 23444 | 2240 | 26313 | 1877 | 29976 | 1297 | 37865 | 932 | 26096 |
| 4L-6S | | MI | 6722 | 3057 | 9828 | 2577 | 11653 | 2145 | 12663 | 1798 | 13812 | 1233 | 16778 | 682 | 12571 |
| 16-#11 | 2.36 | MA | 13307 | 3057 | 18237 | 2692 | 22550 | 2256 | 25201 | 1892 | 28430 | 1319 | 35641 | 874 | 25720 |
| 5E | | MI | 6922 | 3057 | 10195 | 2559 | 12076 | 2135 | 13207 | 1781 | 14548 | 1221 | 17732 | 756 | 12847 |
| 16-#11 | 2.36 | MA | 12893 | 3057 | 17425 | 2710 | 21679 | 2270 | 24116 | 1916 | 26922 | 1332 | 33725 | 807 | 24858 |
| 6L-4S | | MI | 7085 | 3057 | 10522 | 2547 | 12523 | 2125 | 13761 | 1773 | 15316 | 1208 | 18773 | 822 | 13086 |
| 16-#11 | 2.36 | MA | 12538 | 3057 | 16734 | 2722 | 20722 | 2288 | 23041 | 1929 | 25460 | 1354 | 31760 | 767 | 24148 |
| 7L-3S | | MI | 7233 | 3057 | 10888 | 2535 | 13030 | 2107 | 14382 | 1757 | 16165 | 1204 | 19816 | 886 | 13127 |
| 16-#11 | 2.36 | MA | 12164 | 3057 | 16072 | 2735 | 19835 | 2300 | 21920 | 1948 | 24001 | 1368 | 29846 | 713 | 23040 |
| 8L-2S | | MI | 7507 | 3057 | 11414 | 2523 | 13697 | 2097 | 15190 | 1749 | 17256 | 1191 | 21294 | 1000 | 13142 |
| 16-#14 | 3.41 | MA | 14521 | 3377 | 21011 | 2906 | 25939 | 2420 | 29257 | 2001 | 33844 | 1322 | 43370 | 766 | 35654 |
| 5E | | MI | 7439 | 3377 | 11514 | 2758 | 13661 | 2283 | 15091 | 1874 | 17055 | 1206 | 20980 | 581 | 17533 |
| 16-#14 | 3.41 | MA | 13967 | 3377 | 19847 | 2931 | 24699 | 2440 | 27699 | 2035 | 31680 | 1341 | 40453 | 651 | 34377 |
| 6L-4S | | MI | 7662 | 3377 | 11981 | 2742 | 14299 | 2270 | 15882 | 1864 | 18150 | 1189 | 22435 | 677 | 18153 |
| 16-#14 | 3.41 | MA | 13492 | 3377 | 18857 | 2948 | 23327 | 2466 | 26170 | 2054 | 29583 | 1371 | 37622 | 592 | 32539 |
| 7L-3S | | MI | 7854 | 3377 | 12503 | 2725 | 15021 | 2244 | 16766 | 1841 | 19359 | 1184 | 23899 | 767 | 18391 |
| 16-#14 | 3.41 | MA | 12968 | 3377 | 17907 | 2967 | 22054 | 2482 | 24563 | 2080 | 27489 | 1390 | 34872 | 513 | 30713 |
| 8L-2S | | MI | 8215 | 3377 | 13249 | 2709 | 15969 | 2231 | 17914 | 1831 | 20909 | 1168 | 25966 | 931 | 18450 |
| 16-#18 | 6.06 | MA | 16606 | 4189 | 25845 | 3495 | 32207 | 2872 | 36604 | 2335 | 43524 | 1358 | 57179 | 246 | 55192 |
| 6L-4S | | MI | 9068 | 4189 | 15505 | 3240 | 18617 | 2640 | 21053 | 2094 | 25073 | 1139 | 31027 | 265 | 29438 |
| 16-#18 | 6.06 | MA | 15879 | 4189 | 24105 | 3523 | 29799 | 2917 | 33960 | 2371 | 39834 | 1410 | 52161 | 138 | 51256 |
| 7L-3S | | MI | 9311 | 4189 | 16412 | 3214 | 19870 | 2598 | 22586 | 2058 | 27168 | 1137 | 33485 | 417 | 31085 |
| 18-#10 | 2.16 | MA | 13257 | 2996 | 17911 | 2656 | 22257 | 2228 | 24900 | 1874 | 28077 | 1319 | 35152 | 927 | 24001 |
| 5L-6S | | MI | 6758 | 2996 | 9725 | 2550 | 11616 | 2128 | 12667 | 1789 | 13843 | 1238 | 16932 | 769 | 11878 |
| 18-#10 | 2.16 | MA | 12915 | 2996 | 17243 | 2671 | 21535 | 2239 | 24010 | 1893 | 26840 | 1331 | 33584 | 874 | 23416 |
| 6L-5S | | MI | 6924 | 2996 | 10035 | 2535 | 11965 | 2119 | 13116 | 1775 | 14465 | 1233 | 17795 | 841 | 12129 |
| 18-#10 | 2.16 | MA | 12623 | 2996 | 16676 | 2681 | 20750 | 2254 | 23119 | 1904 | 25642 | 1349 | 31981 | 841 | 22898 |
| 7L-4S | | MI | 7066 | 2996 | 10304 | 2525 | 12335 | 2110 | 13574 | 1767 | 15100 | 1221 | 18677 | 894 | 12208 |
| 18-#10 | 2.16 | MA | 12311 | 2996 | 16133 | 2692 | 20021 | 2264 | 22199 | 1919 | 24446 | 1361 | 30416 | 799 | 22178 |
| 8L-3S | | MI | 7189 | 2996 | 10607 | 2514 | 12754 | 2094 | 14088 | 1753 | 15803 | 1217 | 19559 | 948 | 12234 |
| 18-#10 | 2.16 | MA | 11963 | 2996 | 15586 | 2702 | 19315 | 2275 | 21306 | 1929 | 23248 | 1378 | 28799 | 746 | 21419 |
| 9L-2S | | MI | 7421 | 2996 | 11044 | 2504 | 13309 | 2085 | 14760 | 1745 | 16710 | 1205 | 20813 | 1040 | 12243 |
| 18-#11 | 2.66 | MA | 13835 | 3148 | 19328 | 2749 | 23934 | 2298 | 26879 | 1918 | 30695 | 1315 | 38777 | 868 | 28915 |
| 5L-6S | | MI | 6962 | 3148 | 10354 | 2634 | 12320 | 2186 | 13472 | 1824 | 14902 | 1229 | 18256 | 673 | 14085 |

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

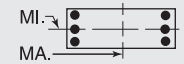
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.66 | MA | 13434 | 3148 | 18515 | 2767 | 23063 | 2311 | 25793 | 1942 | 29186 | 1328 | 36861 | 801 | 28074 |
| 6L-5S | | MI | 7157 | 3148 | 10721 | 2615 | 12743 | 2177 | 14015 | 1807 | 15639 | 1216 | 19211 | 747 | 14349 |
| 18-#11 | 2.66 | MA | 13092 | 3148 | 17825 | 2778 | 22107 | 2330 | 24719 | 1955 | 27725 | 1350 | 34895 | 761 | 27353 |
| 7L-4S | | MI | 7319 | 3148 | 11047 | 2603 | 13190 | 2167 | 14569 | 1799 | 16407 | 1204 | 20251 | 813 | 14632 |
| 18-#11 | 2.66 | MA | 12723 | 3148 | 17162 | 2792 | 21219 | 2341 | 23598 | 1974 | 26266 | 1363 | 32982 | 707 | 26250 |
| 8L-3S | | MI | 7461 | 3148 | 11414 | 2591 | 13697 | 2148 | 15190 | 1783 | 17256 | 1199 | 21294 | 877 | 14681 |
| 18-#11 | 2.66 | MA | 12310 | 3148 | 16502 | 2804 | 20357 | 2354 | 22510 | 1985 | 24823 | 1385 | 31000 | 642 | 25142 |
| 9L-2S | | MI | 7729 | 3148 | 11939 | 2580 | 14364 | 2138 | 15998 | 1775 | 18347 | 1187 | 22773 | 990 | 14703 |
| 18-#14 | 3.84 | MA | 14717 | 3508 | 21409 | 3013 | 26681 | 2500 | 30101 | 2073 | 34923 | 1334 | 44942 | 643 | 38978 |
| 6L-5S | | MI | 7763 | 3508 | 12261 | 2839 | 14608 | 2343 | 16239 | 1912 | 18604 | 1199 | 23047 | 564 | 19677 |
| 18-#14 | 3.84 | MA | 14266 | 3508 | 20418 | 3029 | 25309 | 2526 | 28572 | 2092 | 32825 | 1365 | 42111 | 583 | 37122 |
| 7L-4S | | MI | 7985 | 3508 | 12727 | 2823 | 15246 | 2330 | 17030 | 1901 | 19700 | 1183 | 24503 | 660 | 20269 |
| 18-#14 | 3.84 | MA | 13749 | 3508 | 19468 | 3048 | 24036 | 2542 | 26965 | 2118 | 30732 | 1384 | 39361 | 504 | 35281 |
| 8L-3S | | MI | 8167 | 3508 | 13249 | 2807 | 15969 | 2304 | 17914 | 1879 | 20909 | 1178 | 25966 | 750 | 20587 |
| 18-#14 | 3.84 | MA | 13190 | 3508 | 18527 | 3066 | 22800 | 2560 | 25404 | 2134 | 28670 | 1414 | 36672 | 426 | 33488 |
| 9L-2S | | MI | 8518 | 3508 | 13996 | 2791 | 16916 | 2291 | 19062 | 1868 | 22458 | 1161 | 28033 | 914 | 20658 |
| 18-#18 | 6.82 | MA | 17183 | 4421 | 26840 | 3668 | 33270 | 3023 | 38168 | 2438 | 45513 | 1399 | 60024 | 123 | 59220 |
| 7L-4S | | MI | 9595 | 4421 | 16791 | 3385 | 20249 | 2746 | 23031 | 2161 | 27743 | 1128 | 34475 | 221 | 33121 |
| 20-#10 | 2.41 | MA | 13362 | 3070 | 18140 | 2717 | 22673 | 2272 | 25389 | 1915 | 28703 | 1327 | 36162 | 869 | 26057 |
| 6E | | MI | 6959 | 3070 | 10162 | 2596 | 12171 | 2162 | 13339 | 1810 | 14750 | 1234 | 18186 | 764 | 13139 |
| 20-#10 | 2.41 | MA | 13079 | 3070 | 17573 | 2727 | 21888 | 2288 | 24498 | 1925 | 27504 | 1346 | 34559 | 836 | 25550 |
| 7L-5S | | MI | 7122 | 3070 | 10471 | 2581 | 12520 | 2153 | 13788 | 1796 | 15372 | 1230 | 19049 | 836 | 13379 |
| 20-#10 | 2.41 | MA | 12771 | 3070 | 17030 | 2738 | 21160 | 2298 | 23578 | 1941 | 26308 | 1357 | 32994 | 795 | 24820 |
| 8L-4S | | MI | 7263 | 3070 | 10741 | 2571 | 12889 | 2144 | 14246 | 1788 | 16007 | 1218 | 19932 | 889 | 13496 |
| 20-#10 | 2.41 | MA | 12432 | 3070 | 16483 | 2748 | 20453 | 2309 | 22686 | 1950 | 25111 | 1374 | 31377 | 742 | 24062 |
| 9L-3S | | MI | 7382 | 3070 | 11044 | 2560 | 13309 | 2128 | 14760 | 1774 | 16710 | 1213 | 20813 | 943 | 13527 |
| 20-#10 | 2.41 | MA | 12109 | 3070 | 15927 | 2757 | 19716 | 2327 | 21813 | 1961 | 23897 | 1389 | 29808 | 706 | 23160 |
| 10L-2S | | MI | 7609 | 3070 | 11481 | 2550 | 13863 | 2119 | 15432 | 1766 | 17617 | 1202 | 22068 | 1035 | 13541 |
| 20-#11 | 2.95 | MA | 13965 | 3238 | 19606 | 2823 | 24448 | 2353 | 27471 | 1968 | 31451 | 1324 | 39996 | 795 | 31292 |
| 6E | | MI | 7199 | 3238 | 10879 | 2691 | 12987 | 2228 | 14280 | 1850 | 15993 | 1225 | 19735 | 663 | 15602 |
| 20-#11 | 2.95 | MA | 13636 | 3238 | 18915 | 2835 | 23491 | 2371 | 26397 | 1981 | 29989 | 1346 | 38031 | 755 | 30559 |
| 7L-5S | | MI | 7389 | 3238 | 11246 | 2672 | 13410 | 2218 | 14823 | 1833 | 16730 | 1212 | 20689 | 737 | 15856 |
| 20-#11 | 2.95 | MA | 13270 | 3238 | 18253 | 2848 | 22603 | 2383 | 25276 | 2000 | 28530 | 1359 | 36118 | 701 | 29460 |
| 8L-4S | | MI | 7550 | 3238 | 11573 | 2660 | 13857 | 2208 | 15377 | 1825 | 17498 | 1199 | 21730 | 803 | 16176 |
| 20-#11 | 2.95 | MA | 12871 | 3238 | 17592 | 2861 | 21741 | 2396 | 24187 | 2011 | 27088 | 1380 | 34135 | 636 | 28342 |
| 9L-3S | | MI | 7687 | 3238 | 11939 | 2648 | 14364 | 2189 | 15998 | 1809 | 18347 | 1195 | 22773 | 867 | 16233 |
| 20-#11 | 2.95 | MA | 12502 | 3238 | 16915 | 2871 | 20843 | 2418 | 23123 | 2023 | 25608 | 1398 | 32216 | 589 | 27224 |
| 10L-2S | | MI | 7948 | 3238 | 12465 | 2636 | 15031 | 2179 | 16807 | 1801 | 19438 | 1182 | 24251 | 981 | 16261 |
| 20-#14 | 4.26 | MA | 15022 | 3638 | 21980 | 3111 | 27291 | 2585 | 30974 | 2130 | 36068 | 1359 | 46601 | 575 | 41706 |
| 7L-5S | | MI | 8082 | 3638 | 13007 | 2921 | 15555 | 2402 | 17387 | 1949 | 20154 | 1193 | 25115 | 547 | 21826 |
| 20-#14 | 4.26 | MA | 14511 | 3638 | 21030 | 3130 | 26018 | 2602 | 29367 | 2156 | 33974 | 1377 | 43851 | 496 | 39849 |
| 8L-4S | | MI | 8303 | 3638 | 13473 | 2905 | 16193 | 2389 | 18178 | 1939 | 21249 | 1176 | 26570 | 643 | 22393 |
| 20-#14 | 4.26 | MA | 13975 | 3638 | 20089 | 3148 | 24782 | 2620 | 27806 | 2172 | 31913 | 1408 | 41161 | 418 | 38043 |
| 9L-3S | | MI | 8476 | 3638 | 13996 | 2888 | 16916 | 2364 | 19062 | 1916 | 22458 | 1172 | 28033 | 733 | 22782 |
| 22-#10 | 2.65 | MA | 13528 | 3144 | 18470 | 2773 | 23026 | 2321 | 25878 | 1946 | 29367 | 1342 | 37138 | 832 | 28201 |
| 7L-6S | | MI | 7158 | 3144 | 10598 | 2642 | 12725 | 2195 | 14011 | 1832 | 15657 | 1231 | 19441 | 759 | 14402 |
| 22-#10 | 2.65 | MA | 13223 | 3144 | 17927 | 2784 | 22298 | 2331 | 24958 | 1962 | 28171 | 1354 | 35573 | 790 | 27461 |
| 8L-5S | | MI | 7317 | 3144 | 10908 | 2627 | 13074 | 2186 | 14460 | 1817 | 16279 | 1226 | 20304 | 831 | 14634 |
| 22-#10 | 2.65 | MA | 12892 | 3144 | 17380 | 2794 | 21591 | 2342 | 24065 | 1972 | 26973 | 1371 | 33956 | 737 | 26705 |
| 9L-4S | | MI | 7457 | 3144 | 11178 | 2617 | 13443 | 2177 | 14918 | 1810 | 16914 | 1214 | 21186 | 884 | 14783 |
| 22-#10 | 2.65 | MA | 12581 | 3144 | 16824 | 2803 | 20854 | 2361 | 23192 | 1982 | 25759 | 1386 | 32386 | 701 | 25796 |
| 10L-3S | | MI | 7573 | 3144 | 11481 | 2606 | 13863 | 2161 | 15432 | 1795 | 17617 | 1210 | 22068 | 938 | 14819 |
| 22-#10 | 2.65 | MA | 12280 | 3144 | 16198 | 2820 | 20133 | 2370 | 22307 | 2000 | 24534 | 1395 | 30863 | 656 | 24934 |
| 11L-2S | | MI | 7795 | 3144 | 11917 | 2596 | 14417 | 2152 | 16104 | 1788 | 18524 | 1198 | 23322 | 1030 | 14838 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

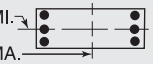



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.25 | MA | 14170 | 3329 | 20006 | 2891 | 24875 | 2412 | 28074 | 2007 | 32254 | 1341 | 41167 | 749 | 33765 |
| 7L-6S | | MI | 7432 | 3329 | 11404 | 2747 | 13653 | 2269 | 15088 | 1876 | 17084 | 1221 | 21213 | 654 | 17122 |
| 22-#11 | 3.25 | MA | 13808 | 3329 | 19344 | 2905 | 23987 | 2424 | 26953 | 2026 | 30795 | 1355 | 39253 | 695 | 32670 |
| 8L-5S | | MI | 7618 | 3329 | 11772 | 2728 | 14077 | 2259 | 15631 | 1860 | 17821 | 1208 | 22167 | 728 | 17366 |
| 22-#11 | 3.25 | MA | 13420 | 3329 | 18683 | 2917 | 23125 | 2437 | 25865 | 2037 | 29353 | 1376 | 37271 | 630 | 31542 |
| 9L-4S | | MI | 7778 | 3329 | 12098 | 2716 | 14524 | 2249 | 16186 | 1852 | 18589 | 1195 | 23208 | 794 | 17720 |
| 22-#11 | 3.25 | MA | 13064 | 3329 | 18006 | 2928 | 22227 | 2459 | 24800 | 2050 | 27873 | 1394 | 35352 | 584 | 30427 |
| 10L-3S | | MI | 7910 | 3329 | 12465 | 2704 | 15031 | 2231 | 16807 | 1835 | 19438 | 1191 | 24251 | 858 | 17783 |
| 22-#11 | 3.25 | MA | 12698 | 3329 | 17243 | 2948 | 21357 | 2471 | 23720 | 2071 | 26379 | 1404 | 33489 | 527 | 29124 |
| 11L-2S | | MI | 8166 | 3329 | 12990 | 2693 | 15697 | 2221 | 17615 | 1827 | 20529 | 1178 | 25729 | 971 | 17818 |
| 22-#14 | 4.69 | MA | 15257 | 3769 | 22592 | 3211 | 28000 | 2661 | 31769 | 2193 | 37216 | 1371 | 48340 | 487 | 44416 |
| 8L-5S | | MI | 8397 | 3769 | 13753 | 3002 | 16503 | 2462 | 18535 | 1987 | 21703 | 1187 | 27182 | 530 | 23981 |
| 22-#14 | 4.69 | MA | 14742 | 3769 | 21651 | 3229 | 26763 | 2679 | 30208 | 2209 | 35155 | 1402 | 45651 | 409 | 42598 |
| 9L-4S | | MI | 8617 | 3769 | 14220 | 2986 | 17140 | 2449 | 19326 | 1977 | 22799 | 1170 | 28637 | 626 | 24525 |
| 24-#10 | 2.89 | MA | 13667 | 3217 | 18824 | 2830 | 23436 | 2365 | 26338 | 1983 | 30033 | 1350 | 38151 | 785 | 30103 |
| 8L-6S | | MI | 7355 | 3217 | 11035 | 2688 | 13279 | 2229 | 14683 | 1853 | 16564 | 1227 | 20695 | 754 | 15667 |
| 24-#10 | 2.89 | MA | 13345 | 3217 | 18277 | 2840 | 22729 | 2376 | 25445 | 1993 | 28835 | 1367 | 36534 | 732 | 29348 |
| 9L-5S | | MI | 7511 | 3217 | 11345 | 2673 | 13628 | 2220 | 15132 | 1838 | 17185 | 1223 | 21558 | 826 | 15891 |
| 24-#10 | 2.89 | MA | 13051 | 3217 | 17721 | 2849 | 21993 | 2394 | 24572 | 2003 | 27621 | 1382 | 34965 | 696 | 28432 |
| 10L-4S | | MI | 7650 | 3217 | 11615 | 2663 | 13998 | 2211 | 15590 | 1831 | 17821 | 1211 | 22441 | 879 | 16070 |
| 24-#10 | 2.89 | MA | 12748 | 3217 | 17095 | 2866 | 21272 | 2404 | 23686 | 2021 | 26396 | 1391 | 33442 | 652 | 27564 |
| 11L-3S | | MI | 7762 | 3217 | 11917 | 2652 | 14417 | 2195 | 16104 | 1816 | 18524 | 1206 | 23322 | 933 | 16110 |
| 24-#10 | 2.89 | MA | 12407 | 3217 | 16556 | 2876 | 20556 | 2413 | 22829 | 2032 | 25201 | 1408 | 31901 | 614 | 26588 |
| 12L-2S | | MI | 7980 | 3217 | 12354 | 2642 | 14971 | 2186 | 16775 | 1809 | 19431 | 1195 | 24577 | 1025 | 16133 |
| 24-#11 | 3.55 | MA | 14336 | 3419 | 20435 | 2961 | 25372 | 2465 | 28631 | 2052 | 33060 | 1350 | 42389 | 689 | 35880 |
| 8L-6S | | MI | 7663 | 3419 | 11930 | 2804 | 14320 | 2310 | 15896 | 1902 | 18175 | 1216 | 22691 | 645 | 18644 |
| 24-#11 | 3.55 | MA | 13960 | 3419 | 19774 | 2974 | 24510 | 2478 | 27543 | 2063 | 31617 | 1372 | 40407 | 624 | 34742 |
| 9L-5S | | MI | 7844 | 3419 | 12297 | 2785 | 14743 | 2300 | 16440 | 1886 | 18911 | 1203 | 23646 | 718 | 18880 |
| 24-#11 | 3.55 | MA | 13616 | 3419 | 19096 | 2984 | 23611 | 2501 | 26478 | 2076 | 30138 | 1390 | 38487 | 578 | 33631 |
| 10L-4S | | MI | 8004 | 3419 | 12624 | 2773 | 15190 | 2291 | 16994 | 1878 | 19680 | 1191 | 24686 | 784 | 19263 |
| 24-#11 | 3.55 | MA | 13267 | 3419 | 18334 | 3005 | 22741 | 2512 | 25398 | 2097 | 28644 | 1400 | 36625 | 521 | 32320 |
| 11L-3S | | MI | 8131 | 3419 | 12990 | 2761 | 15697 | 2272 | 17615 | 1861 | 20529 | 1187 | 25729 | 849 | 19333 |
| 24-#14 | 5.11 | MA | 15493 | 3899 | 23212 | 3311 | 28745 | 2739 | 32610 | 2247 | 38397 | 1396 | 50140 | 400 | 47153 |
| 9L-5S | | MI | 8731 | 3899 | 14500 | 3084 | 17450 | 2522 | 19683 | 2025 | 23253 | 1181 | 29249 | 513 | 26139 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

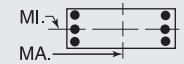
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.45 | MA | 14160 | 2904 | 19066 | 2564 | 23551 | 2151 | 26189 | 1825 | 29255 | 1324 | 36124 | 1150 | 17616 |
| 2E | | MI | 7012 | 2904 | 10319 | 2412 | 12094 | 2022 | 13094 | 1712 | 14204 | 1234 | 16668 | 1015 | 8489 |
| 6-#14 | 1.22 | MA | 13793 | 2831 | 18064 | 2533 | 22415 | 2131 | 24882 | 1815 | 27553 | 1336 | 33813 | 1163 | 15063 |
| 2L-3S | | MI | 6465 | 2831 | 9102 | 2411 | 10667 | 2026 | 11424 | 1722 | 11998 | 1271 | 13991 | 902 | 7378 |
| 6-#14 | 1.22 | MA | 12797 | 2831 | 16421 | 2558 | 20330 | 2154 | 22355 | 1837 | 24141 | 1368 | 29089 | 1023 | 15014 |
| 3L-2S | | MI | 6895 | 2831 | 9849 | 2395 | 11614 | 2013 | 12572 | 1712 | 13548 | 1254 | 16058 | 1065 | 7348 |
| 6-#18 | 2.17 | MA | 15504 | 3136 | 21947 | 2709 | 27206 | 2257 | 30620 | 1892 | 35235 | 1313 | 44404 | 1135 | 26176 |
| 2L-3S | | MI | 6868 | 3136 | 10319 | 2582 | 12094 | 2147 | 13094 | 1792 | 14204 | 1247 | 16668 | 681 | 12314 |
| 6-#18 | 2.17 | MA | 13902 | 3136 | 19066 | 2751 | 23551 | 2297 | 26189 | 1929 | 29255 | 1366 | 36124 | 880 | 25864 |
| 3L-2S | | MI | 7556 | 3136 | 11605 | 2557 | 13726 | 2128 | 15072 | 1779 | 16874 | 1223 | 20117 | 972 | 12355 |
| 8-#11 | 1.13 | MA | 13641 | 2802 | 17637 | 2522 | 21941 | 2124 | 24343 | 1812 | 26857 | 1342 | 32873 | 1168 | 14013 |
| 2L-4S | | MI | 6366 | 2802 | 8748 | 2415 | 10236 | 2040 | 10925 | 1739 | 11340 | 1281 | 13290 | 909 | 6907 |
| 8-#11 | 1.13 | MA | 12941 | 2802 | 16490 | 2540 | 20485 | 2141 | 22579 | 1828 | 24475 | 1364 | 29575 | 1073 | 13993 |
| 3E | | MI | 6542 | 2802 | 9114 | 2403 | 10743 | 2022 | 11546 | 1722 | 12189 | 1277 | 14333 | 973 | 6892 |
| 8-#11 | 1.13 | MA | 12557 | 2802 | 15716 | 2558 | 19408 | 2166 | 21257 | 1852 | 22665 | 1378 | 27417 | 1012 | 13895 |
| 4L-2S | | MI | 6846 | 2802 | 9640 | 2391 | 11410 | 2012 | 12354 | 1714 | 13280 | 1264 | 15811 | 1086 | 6871 |
| 8-#14 | 1.63 | MA | 14588 | 2962 | 19708 | 2615 | 24500 | 2191 | 27410 | 1853 | 30964 | 1330 | 38537 | 1154 | 19952 |
| 2L-4S | | MI | 6569 | 2962 | 9326 | 2509 | 10892 | 2111 | 11687 | 1783 | 12339 | 1269 | 14594 | 794 | 9569 |
| 8-#14 | 1.63 | MA | 13635 | 2962 | 18064 | 2640 | 22415 | 2214 | 24882 | 1875 | 27553 | 1361 | 33813 | 1014 | 19872 |
| 3E | | MI | 6808 | 2962 | 9849 | 2493 | 11614 | 2086 | 12572 | 1760 | 13548 | 1265 | 16058 | 884 | 9609 |
| 8-#14 | 1.63 | MA | 13115 | 2962 | 16954 | 2665 | 20870 | 2250 | 22987 | 1909 | 24957 | 1380 | 30707 | 926 | 19561 |
| 4L-2S | | MI | 7222 | 2962 | 10595 | 2477 | 12561 | 2073 | 13719 | 1750 | 15097 | 1248 | 18125 | 1048 | 9597 |
| 8-#18 | 2.90 | MA | 16795 | 3368 | 24827 | 2854 | 30861 | 2363 | 35050 | 1959 | 41216 | 1302 | 52685 | 1119 | 34721 |
| 2L-4S | | MI | 7054 | 3368 | 10698 | 2752 | 12473 | 2294 | 13539 | 1895 | 14779 | 1237 | 17658 | 486 | 15044 |
| 8-#18 | 2.90 | MA | 15298 | 3368 | 21947 | 2896 | 27206 | 2403 | 30620 | 1996 | 35235 | 1355 | 44404 | 865 | 34361 |
| 3E | | MI | 7433 | 3368 | 11605 | 2727 | 13726 | 2253 | 15072 | 1859 | 16874 | 1236 | 20117 | 638 | 16086 |
| 8-#18 | 2.90 | MA | 14487 | 3368 | 19992 | 2939 | 24490 | 2465 | 27288 | 2055 | 30673 | 1386 | 38908 | 706 | 32024 |
| 4L-2S | | MI | 8086 | 3368 | 12891 | 2702 | 15358 | 2234 | 17050 | 1846 | 19544 | 1212 | 23565 | 929 | 16185 |
| 10-#10 | 1.15 | MA | 13726 | 2808 | 17642 | 2537 | 22043 | 2136 | 24515 | 1822 | 27133 | 1348 | 33289 | 1173 | 14340 |
| 2L-5S | | MI | 6359 | 2808 | 8611 | 2446 | 10127 | 2065 | 10825 | 1760 | 11227 | 1303 | 13210 | 910 | 7053 |
| 10-#10 | 1.15 | MA | 13152 | 2808 | 16699 | 2551 | 20846 | 2150 | 23065 | 1835 | 25175 | 1366 | 30578 | 1097 | 14323 |
| 3L-4S | | MI | 6505 | 2808 | 8881 | 2436 | 10496 | 2057 | 11283 | 1753 | 11862 | 1292 | 14092 | 963 | 7062 |
| 10-#10 | 1.15 | MA | 12842 | 2808 | 16064 | 2566 | 19963 | 2171 | 21981 | 1855 | 23690 | 1378 | 28815 | 1048 | 14260 |
| 4L-3S | | MI | 6648 | 2808 | 9184 | 2425 | 10916 | 2041 | 11797 | 1738 | 12565 | 1287 | 14974 | 1017 | 7052 |
| 10-#10 | 1.15 | MA | 12446 | 2808 | 15481 | 2578 | 19193 | 2184 | 21024 | 1868 | 22359 | 1397 | 26906 | 1003 | 14097 |
| 5L-2S | | MI | 6902 | 2808 | 9620 | 2415 | 11470 | 2032 | 12469 | 1731 | 13472 | 1275 | 16228 | 1110 | 7038 |
| 10-#11 | 1.41 | MA | 14206 | 2892 | 18784 | 2579 | 23397 | 2165 | 26108 | 1838 | 29239 | 1338 | 36172 | 1163 | 17428 |
| 2L-5S | | MI | 6449 | 2892 | 8947 | 2483 | 10456 | 2092 | 11179 | 1773 | 11662 | 1289 | 13728 | 833 | 8432 |
| 10-#11 | 1.41 | MA | 13528 | 2892 | 17637 | 2597 | 21941 | 2182 | 24343 | 1854 | 26857 | 1360 | 32873 | 1067 | 17394 |
| 3L-4S | | MI | 6617 | 2892 | 9273 | 2471 | 10903 | 2082 | 11733 | 1765 | 12431 | 1277 | 14768 | 899 | 8470 |
| 10-#11 | 1.41 | MA | 13164 | 2892 | 16863 | 2614 | 20864 | 2207 | 23022 | 1878 | 25047 | 1374 | 30715 | 1006 | 17279 |
| 4L-3S | | MI | 6785 | 2892 | 9640 | 2459 | 11410 | 2063 | 12354 | 1748 | 13280 | 1272 | 15811 | 964 | 8470 |
| 10-#11 | 1.41 | MA | 12692 | 2892 | 16158 | 2629 | 19926 | 2224 | 21855 | 1894 | 23424 | 1396 | 28382 | 949 | 16992 |
| 5L-2S | | MI | 7082 | 2892 | 10165 | 2448 | 12077 | 2053 | 13162 | 1740 | 14371 | 1260 | 17290 | 1077 | 8456 |
| 10-#14 | 2.04 | MA | 15360 | 3092 | 21351 | 2697 | 26586 | 2250 | 29937 | 1890 | 34376 | 1324 | 43261 | 1145 | 24833 |
| 2L-5S | | MI | 6688 | 3092 | 9606 | 2607 | 11201 | 2184 | 12044 | 1831 | 12793 | 1280 | 15206 | 681 | 11247 |
| 10-#14 | 2.04 | MA | 14447 | 3092 | 19708 | 2721 | 24500 | 2274 | 27410 | 1912 | 30964 | 1355 | 38537 | 1006 | 24731 |
| 3L-4S | | MI | 6917 | 3092 | 10073 | 2590 | 11839 | 2171 | 12835 | 1820 | 13888 | 1263 | 16662 | 777 | 11757 |
| 10-#14 | 2.04 | MA | 13964 | 3092 | 18597 | 2746 | 22955 | 2310 | 25514 | 1947 | 28369 | 1374 | 35431 | 917 | 24408 |
| 4L-3S | | MI | 7144 | 3092 | 10595 | 2574 | 12561 | 2145 | 13719 | 1798 | 15097 | 1258 | 18125 | 867 | 11824 |
| 10-#14 | 2.04 | MA | 13302 | 3092 | 17591 | 2768 | 21608 | 2333 | 23840 | 1969 | 26039 | 1406 | 32079 | 834 | 23100 |
| 5L-2S | | MI | 7544 | 3092 | 11341 | 2558 | 13509 | 2132 | 14867 | 1787 | 16647 | 1242 | 20193 | 1031 | 11832 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.62 | MA | 16639 | 3599 | 24827 | 3041 | 30861 | 2509 | 35050 | 2063 | 41216 | 1344 | 52685 | 850 | 42868 |
| 3L-4S | | MI | 7633 | 3599 | 11984 | 2897 | 14105 | 2400 | 15517 | 1962 | 17449 | 1226 | 21106 | 443 | 18639 |
| 10-#18 | 3.62 | MA | 15914 | 3599 | 22873 | 3084 | 28145 | 2571 | 31719 | 2122 | 36654 | 1375 | 47189 | 691 | 40459 |
| 4L-3S | | MI | 7983 | 3599 | 12891 | 2872 | 15358 | 2359 | 17050 | 1926 | 19544 | 1224 | 23565 | 595 | 19851 |
| 10-#18 | 3.62 | MA | 14797 | 3599 | 21125 | 3124 | 25774 | 2611 | 28772 | 2159 | 32556 | 1429 | 41582 | 566 | 37153 |
| 5L-2S | | MI | 8599 | 3599 | 14177 | 2847 | 16990 | 2340 | 19028 | 1912 | 22214 | 1201 | 27013 | 885 | 19995 |
| 12-#10 | 1.38 | MA | 14194 | 2882 | 18585 | 2583 | 23239 | 2169 | 25966 | 1843 | 29091 | 1344 | 35999 | 1169 | 17146 |
| 2L-6S | | MI | 6390 | 2882 | 8738 | 2507 | 10332 | 2108 | 11048 | 1796 | 11512 | 1304 | 13601 | 833 | 8180 |
| 12-#10 | 1.38 | MA | 13634 | 2882 | 17642 | 2597 | 22043 | 2183 | 24515 | 1856 | 27133 | 1363 | 33289 | 1092 | 17120 |
| 3L-5S | | MI | 6569 | 2882 | 9048 | 2492 | 10681 | 2099 | 11497 | 1782 | 12133 | 1300 | 14464 | 905 | 8341 |
| 12-#10 | 1.38 | MA | 13338 | 2882 | 17007 | 2612 | 21159 | 2204 | 23431 | 1876 | 25648 | 1375 | 31526 | 1043 | 17047 |
| 4E | | MI | 6714 | 2882 | 9317 | 2482 | 11050 | 2090 | 11955 | 1774 | 12769 | 1288 | 15347 | 958 | 8362 |
| 12-#10 | 1.38 | MA | 12946 | 2882 | 16424 | 2624 | 20390 | 2218 | 22475 | 1889 | 24317 | 1394 | 29616 | 998 | 16878 |
| 5L-3S | | MI | 6852 | 2882 | 9620 | 2471 | 11470 | 2074 | 12469 | 1760 | 13472 | 1284 | 16228 | 1012 | 8361 |
| 12-#10 | 1.38 | MA | 12552 | 2882 | 15722 | 2639 | 19628 | 2229 | 21541 | 1910 | 23019 | 1405 | 27972 | 946 | 16351 |
| 6L-2S | | MI | 7100 | 2882 | 10057 | 2461 | 12024 | 2065 | 13141 | 1752 | 14378 | 1272 | 17483 | 1105 | 8352 |
| 12-#11 | 1.70 | MA | 14758 | 2983 | 19932 | 2636 | 24853 | 2207 | 27873 | 1864 | 31621 | 1333 | 39470 | 1157 | 20838 |
| 6L-6S | | MI | 6485 | 2983 | 9105 | 2559 | 10699 | 2143 | 11444 | 1816 | 12017 | 1298 | 14252 | 750 | 9631 |
| 12-#11 | 1.70 | MA | 14101 | 2983 | 18784 | 2653 | 23397 | 2223 | 26108 | 1880 | 29239 | 1356 | 36172 | 1061 | 20792 |
| 3L-5S | | MI | 6696 | 2983 | 9472 | 2540 | 11123 | 2133 | 11987 | 1799 | 12753 | 1285 | 15206 | 824 | 9939 |
| 12-#11 | 1.70 | MA | 13756 | 2983 | 18010 | 2671 | 22320 | 2248 | 24787 | 1904 | 27429 | 1369 | 34013 | 1000 | 20665 |
| 4E | | MI | 6862 | 2983 | 9799 | 2528 | 11570 | 2123 | 12541 | 1791 | 13522 | 1272 | 16247 | 890 | 10025 |
| 12-#11 | 1.70 | MA | 13289 | 2983 | 17305 | 2686 | 21382 | 2265 | 23620 | 1920 | 25806 | 1392 | 31680 | 943 | 20377 |
| 5L-3S | | MI | 7024 | 2983 | 10165 | 2516 | 12077 | 2104 | 13162 | 1774 | 14371 | 1268 | 17290 | 954 | 10040 |
| 12-#11 | 1.70 | MA | 12821 | 2983 | 16451 | 2704 | 20462 | 2279 | 22480 | 1944 | 24222 | 1405 | 29671 | 878 | 19446 |
| 6L-2S | | MI | 7313 | 2983 | 10691 | 2504 | 12743 | 2094 | 13970 | 1766 | 15462 | 1255 | 18768 | 1067 | 10033 |
| 12-#14 | 2.45 | MA | 15237 | 3223 | 21351 | 2803 | 26586 | 2333 | 29937 | 1950 | 34376 | 1349 | 43261 | 997 | 29590 |
| 3L-5S | | MI | 7030 | 3223 | 10353 | 2688 | 12148 | 2244 | 13192 | 1868 | 14342 | 1273 | 17274 | 664 | 13363 |
| 12-#14 | 2.45 | MA | 14786 | 3223 | 20240 | 2828 | 25041 | 2369 | 28042 | 1984 | 31780 | 1368 | 40155 | 909 | 29259 |
| 4E | | MI | 7257 | 3223 | 10819 | 2672 | 12786 | 2231 | 13983 | 1858 | 15438 | 1257 | 18729 | 760 | 13942 |
| 12-#14 | 2.45 | MA | 14133 | 3223 | 19234 | 2850 | 23694 | 2393 | 26367 | 2006 | 29451 | 1399 | 36803 | 825 | 27939 |
| 5L-3S | | MI | 7472 | 3223 | 11341 | 2656 | 13509 | 2205 | 14867 | 1835 | 16647 | 1252 | 20193 | 850 | 14030 |
| 12-#14 | 2.45 | MA | 13493 | 3223 | 18010 | 2875 | 22383 | 2412 | 24731 | 2041 | 27178 | 1419 | 33916 | 729 | 26563 |
| 6L-2S | | MI | 7859 | 3223 | 12088 | 2640 | 14456 | 2192 | 16015 | 1825 | 18196 | 1235 | 22260 | 1014 | 14057 |
| 12-#18 | 4.35 | MA | 17288 | 3831 | 25753 | 3229 | 31801 | 2677 | 36149 | 2189 | 42634 | 1364 | 55469 | 676 | 48895 |
| 4E | | MI | 8237 | 3831 | 13270 | 3042 | 15737 | 2506 | 17494 | 2029 | 20119 | 1215 | 24555 | 399 | 22262 |
| 12-#18 | 4.35 | MA | 16187 | 3831 | 24005 | 3269 | 29429 | 2717 | 33202 | 2226 | 38536 | 1417 | 49863 | 550 | 45613 |
| 5L-3S | | MI | 8541 | 3831 | 14177 | 3017 | 16990 | 2465 | 19028 | 1993 | 22214 | 1213 | 27013 | 551 | 23615 |
| 12-#18 | 4.35 | MA | 15168 | 3831 | 21856 | 3313 | 27155 | 2753 | 30321 | 2285 | 34536 | 1449 | 44463 | 343 | 41539 |
| 6L-2S | | MI | 9097 | 3831 | 15463 | 2991 | 18622 | 2445 | 21006 | 1979 | 24884 | 1189 | 30462 | 842 | 23795 |
| 14-#10 | 1.61 | MA | 14108 | 2955 | 18585 | 2643 | 23239 | 2217 | 25966 | 1877 | 29091 | 1359 | 35999 | 1087 | 19916 |
| 3L-6S | | MI | 6601 | 2955 | 9175 | 2553 | 10886 | 2142 | 11720 | 1817 | 12419 | 1301 | 14856 | 828 | 9429 |
| 14-#10 | 1.61 | MA | 13824 | 2955 | 17950 | 2658 | 22356 | 2238 | 24882 | 1897 | 27606 | 1371 | 34237 | 1038 | 19835 |
| 4L-5S | | MI | 6776 | 2955 | 9485 | 2538 | 11235 | 2133 | 12169 | 1803 | 13040 | 1296 | 15719 | 900 | 9627 |
| 14-#10 | 1.61 | MA | 13436 | 2955 | 17367 | 2670 | 21587 | 2252 | 23925 | 1911 | 26275 | 1390 | 32327 | 993 | 19662 |
| 5L-4S | | MI | 6920 | 2955 | 9754 | 2528 | 11604 | 2124 | 12627 | 1795 | 13675 | 1285 | 16601 | 953 | 9657 |
| 14-#10 | 1.61 | MA | 13053 | 2955 | 16665 | 2685 | 20825 | 2263 | 22991 | 1931 | 24977 | 1402 | 30683 | 941 | 19122 |
| 6L-3S | | MI | 7053 | 2955 | 10057 | 2517 | 12024 | 2108 | 13141 | 1781 | 14378 | 1280 | 17483 | 1007 | 9666 |
| 14-#10 | 1.61 | MA | 12721 | 2955 | 16070 | 2695 | 20000 | 2278 | 22050 | 1941 | 23719 | 1421 | 29006 | 909 | 18537 |
| 7L-2S | | MI | 7296 | 2955 | 10494 | 2507 | 12578 | 2099 | 13813 | 1773 | 15285 | 1268 | 18737 | 1100 | 9661 |
| 14-#11 | 1.98 | MA | 14662 | 3073 | 19932 | 2710 | 24853 | 2265 | 27873 | 1906 | 31621 | 1351 | 39470 | 1055 | 24190 |
| 3L-6S | | MI | 6733 | 3073 | 9630 | 2615 | 11366 | 2184 | 12252 | 1842 | 13108 | 1293 | 15730 | 741 | 11135 |
| 14-#11 | 1.98 | MA | 14334 | 3073 | 19157 | 2727 | 23776 | 2290 | 26551 | 1930 | 29811 | 1365 | 37311 | 994 | 24054 |
| 4L-5S | | MI | 6939 | 3073 | 9998 | 2596 | 11789 | 2174 | 12795 | 1825 | 13844 | 1281 | 16684 | 814 | 11427 |
| 14-#11 | 1.98 | MA | 13872 | 3073 | 18452 | 2742 | 22838 | 2306 | 25385 | 1946 | 28188 | 1387 | 34978 | 937 | 23765 |
| 5L-4S | | MI | 7104 | 3073 | 10324 | 2584 | 12236 | 2164 | 13349 | 1817 | 14613 | 1268 | 17725 | 880 | 11576 |
| 14-#11 | 1.98 | MA | 13419 | 3073 | 17598 | 2760 | 21918 | 2320 | 24245 | 1970 | 26604 | 1401 | 32969 | 872 | 22825 |
| 6L-3S | | MI | 7259 | 3073 | 10691 | 2572 | 12743 | 2146 | 13970 | 1801 | 15462 | 1264 | 18768 | 945 | 11601 |
| 14-#11 | 1.98 | MA | 13026 | 3073 | 16872 | 2772 | 20912 | 2339 | 23109 | 1983 | 25069 | 1424 | 30912 | 832 | 22094 |
| 7L-2S | | MI | 7541 | 3073 | 11216 | 2561 | 13410 | 2136 | 14778 | 1793 | 16553 | 1251 | 20246 | 1058 | 11604 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

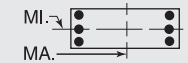
$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.85 | MA | 15588 | 3353 | 21883 | 2909 | 27126 | 2429 | 30569 | 2022 | 35192 | 1362 | 44879 | 900 | 34115 |
| 4L-5S | | MI | 7366 | 3353 | 11099 | 2770 | 13095 | 2303 | 14340 | 1906 | 15892 | 1267 | 19341 | 647 | 15490 |
| 14-#14 | 2.85 | MA | 14941 | 3353 | 20877 | 2931 | 25779 | 2452 | 28895 | 2044 | 32863 | 1393 | 41527 | 816 | 32783 |
| 5L-4S | | MI | 7591 | 3353 | 11565 | 2754 | 13733 | 2290 | 15131 | 1896 | 16987 | 1250 | 20796 | 743 | 16126 |
| 14-#14 | 2.85 | MA | 14329 | 3353 | 19653 | 2957 | 24468 | 2472 | 27259 | 2078 | 30590 | 1412 | 38639 | 720 | 31405 |
| 6L-3S | | MI | 7795 | 3353 | 12088 | 2737 | 14456 | 2265 | 16015 | 1873 | 18196 | 1246 | 22260 | 833 | 16232 |
| 14-#14 | 2.85 | MA | 13798 | 3353 | 18612 | 2974 | 23027 | 2499 | 25641 | 2097 | 28387 | 1444 | 35677 | 662 | 29568 |
| 7L-2S | | MI | 8171 | 3353 | 12834 | 2721 | 15403 | 2251 | 17163 | 1863 | 19746 | 1229 | 24327 | 997 | 16273 |
| 14-#18 | 5.07 | MA | 17531 | 4063 | 26885 | 3414 | 33085 | 2823 | 37632 | 2292 | 44516 | 1406 | 58143 | 535 | 54071 |
| 5L-4S | | MI | 8787 | 4063 | 14556 | 3187 | 17369 | 2612 | 19472 | 2096 | 22789 | 1204 | 28003 | 356 | 25907 |
| 14-#18 | 5.07 | MA | 16575 | 4063 | 24736 | 3458 | 30811 | 2859 | 34751 | 2352 | 40517 | 1438 | 52744 | 327 | 49958 |
| 6L-3S | | MI | 9062 | 4063 | 15463 | 3162 | 18622 | 2571 | 21006 | 2060 | 24884 | 1202 | 30462 | 508 | 27379 |
| 14-#18 | 5.07 | MA | 15742 | 4063 | 22907 | 3486 | 28278 | 2905 | 31950 | 2386 | 36639 | 1491 | 47490 | 220 | 45962 |
| 7L-2S | | MI | 9588 | 4063 | 16749 | 3136 | 20253 | 2551 | 22984 | 2046 | 27554 | 1178 | 33910 | 799 | 27590 |
| 16-#10 | 1.84 | MA | 14301 | 3029 | 18893 | 2704 | 23553 | 2271 | 26332 | 1919 | 29564 | 1368 | 36948 | 1033 | 22623 |
| 4L-6S | | MI | 6809 | 3029 | 9611 | 2599 | 11440 | 2175 | 12392 | 1839 | 13325 | 1297 | 16110 | 823 | 10682 |
| 16-#10 | 1.84 | MA | 13916 | 3029 | 18310 | 2716 | 22784 | 2285 | 25376 | 1932 | 28233 | 1386 | 35038 | 988 | 22448 |
| 5E | | MI | 6980 | 3029 | 9921 | 2584 | 11789 | 2166 | 12841 | 1824 | 13947 | 1293 | 16973 | 895 | 10911 |
| 16-#10 | 1.84 | MA | 13543 | 3029 | 17608 | 2731 | 22022 | 2296 | 24442 | 1952 | 26935 | 1398 | 33394 | 937 | 21896 |
| 6L-4S | | MI | 7122 | 3029 | 10191 | 2574 | 12159 | 2157 | 13299 | 1817 | 14582 | 1281 | 17856 | 948 | 10949 |
| 16-#10 | 1.84 | MA | 13223 | 3029 | 17013 | 2741 | 21197 | 2312 | 23500 | 1962 | 25677 | 1417 | 31717 | 904 | 21326 |
| 7L-3S | | MI | 7252 | 3029 | 10494 | 2563 | 12578 | 2141 | 13813 | 1802 | 15285 | 1277 | 18737 | 1002 | 10964 |
| 16-#10 | 1.84 | MA | 12888 | 3029 | 16443 | 2753 | 20432 | 2322 | 22534 | 1978 | 24422 | 1429 | 30076 | 863 | 20631 |
| 8L-2S | | MI | 7489 | 3029 | 10931 | 2553 | 13133 | 2133 | 14484 | 1795 | 16192 | 1265 | 19992 | 1095 | 10966 |
| 16-#11 | 2.26 | MA | 14901 | 3163 | 20305 | 2784 | 25232 | 2331 | 28316 | 1956 | 32193 | 1361 | 40610 | 988 | 27444 |
| 4L-6S | | MI | 6977 | 3163 | 10156 | 2672 | 12033 | 2225 | 13060 | 1868 | 14199 | 1289 | 17208 | 731 | 12644 |
| 16-#11 | 2.26 | MA | 14443 | 3163 | 19600 | 2799 | 24294 | 2348 | 27149 | 1972 | 30570 | 1383 | 38277 | 931 | 27144 |
| 5E | | MI | 7178 | 3163 | 10523 | 2653 | 12456 | 2215 | 13603 | 1851 | 14935 | 1276 | 18163 | 805 | 12923 |
| 16-#11 | 2.26 | MA | 14004 | 3163 | 18745 | 2817 | 23374 | 2361 | 26009 | 1996 | 28986 | 1397 | 36267 | 866 | 26207 |
| 6L-4S | | MI | 7342 | 3163 | 10850 | 2641 | 12903 | 2206 | 14158 | 1843 | 15704 | 1264 | 19203 | 871 | 13124 |
| 16-#11 | 2.26 | MA | 13627 | 3163 | 18020 | 2829 | 22368 | 2380 | 24873 | 2009 | 27451 | 1419 | 34210 | 826 | 25481 |
| 7L-3S | | MI | 7491 | 3163 | 11216 | 2629 | 13410 | 2187 | 14778 | 1827 | 16553 | 1260 | 20246 | 935 | 13159 |
| 16-#11 | 2.26 | MA | 13228 | 3163 | 17324 | 2842 | 21436 | 2392 | 23696 | 2028 | 25920 | 1433 | 32204 | 773 | 24337 |
| 8L-2S | | MI | 7767 | 3163 | 11742 | 2617 | 14077 | 2177 | 15587 | 1819 | 17643 | 1247 | 21725 | 1049 | 13171 |
| 16-#14 | 3.26 | MA | 15730 | 3483 | 22521 | 3013 | 27864 | 2512 | 31422 | 2082 | 36274 | 1387 | 46251 | 808 | 37631 |
| 5E | | MI | 7696 | 3483 | 11845 | 2851 | 14043 | 2363 | 15488 | 1944 | 17442 | 1261 | 21408 | 630 | 17625 |
| 16-#14 | 3.26 | MA | 15142 | 3483 | 21296 | 3038 | 26553 | 2532 | 29786 | 2116 | 34002 | 1406 | 43363 | 712 | 36248 |
| 6L-4S | | MI | 7919 | 3483 | 12312 | 2835 | 14680 | 2350 | 16279 | 1933 | 18537 | 1244 | 22864 | 726 | 18258 |
| 16-#14 | 3.26 | MA | 14638 | 3483 | 20255 | 3055 | 25112 | 2558 | 28169 | 2135 | 31799 | 1438 | 40401 | 653 | 34392 |
| 7L-3S | | MI | 8113 | 3483 | 12834 | 2819 | 15403 | 2324 | 17163 | 1911 | 19746 | 1240 | 24327 | 816 | 18431 |
| 16-#14 | 3.26 | MA | 14079 | 3483 | 19258 | 3075 | 23774 | 2575 | 26480 | 2162 | 29600 | 1457 | 37517 | 576 | 32558 |
| 8L-2S | | MI | 8478 | 3483 | 13580 | 2803 | 16350 | 2311 | 18311 | 1900 | 21296 | 1223 | 26395 | 979 | 18485 |
| 16-#18 | 5.80 | MA | 17938 | 4295 | 27617 | 3603 | 34466 | 2965 | 39182 | 2418 | 46497 | 1427 | 61024 | 312 | 58376 |
| 6L-4S | | MI | 9324 | 4295 | 15842 | 3332 | 19001 | 2718 | 21450 | 2163 | 25459 | 1193 | 31452 | 313 | 29570 |
| 16-#18 | 5.80 | MA | 17165 | 4295 | 25787 | 3631 | 31933 | 3011 | 36380 | 2453 | 42619 | 1480 | 55771 | 205 | 54349 |
| 7L-3S | | MI | 9574 | 4295 | 16749 | 3307 | 20253 | 2677 | 22984 | 2127 | 27554 | 1191 | 33910 | 465 | 31144 |
| 16-#18 | 5.80 | MA | 16216 | 4295 | 24031 | 3664 | 29581 | 3039 | 33411 | 2499 | 38748 | 1511 | 50678 | 61 | 50345 |
| 8L-2S | | MI | 10073 | 4295 | 18035 | 3281 | 21885 | 2657 | 24962 | 2113 | 30223 | 1167 | 37359 | 755 | 31381 |
| 18-#10 | 2.07 | MA | 14387 | 3103 | 19253 | 2762 | 23980 | 2319 | 26826 | 1953 | 30191 | 1383 | 37749 | 983 | 25235 |
| 5L-6S | | MI | 7013 | 3103 | 10048 | 2645 | 11994 | 2209 | 13064 | 1860 | 14232 | 1294 | 17365 | 818 | 11939 |
| 18-#10 | 2.07 | MA | 14025 | 3103 | 18551 | 2777 | 23219 | 2330 | 25892 | 1973 | 28893 | 1395 | 36105 | 932 | 24672 |
| 6L-5S | | MI | 7181 | 3103 | 10358 | 2630 | 12344 | 2200 | 13512 | 1845 | 14854 | 1289 | 18228 | 890 | 12194 |
| 18-#10 | 2.07 | MA | 13715 | 3103 | 17956 | 2787 | 22394 | 2345 | 24951 | 1984 | 27635 | 1414 | 34428 | 899 | 24113 |
| 7L-4S | | MI | 7322 | 3103 | 10628 | 2620 | 12713 | 2191 | 13970 | 1838 | 15489 | 1278 | 19110 | 943 | 12239 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

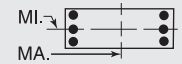



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.07 | MA | 13384 | 3103 | 17386 | 2799 | 21629 | 2356 | 23985 | 1999 | 26380 | 1425 | 32787 | 858 | 23408 |
| 8L-3S | | MI | 7447 | 3103 | 10931 | 2609 | 13133 | 2175 | 14484 | 1823 | 16192 | 1273 | 19992 | 997 | 12261 |
| 18-#10 | 2.07 | MA | 13015 | 3103 | 16809 | 2809 | 20887 | 2367 | 23048 | 2009 | 25114 | 1442 | 31095 | 806 | 22600 |
| 9L-2S | | MI | 7680 | 3103 | 11367 | 2599 | 13687 | 2166 | 15156 | 1816 | 17099 | 1261 | 21246 | 1090 | 12268 |
| 18-#11 | 2.54 | MA | 15002 | 3254 | 20747 | 2855 | 25750 | 2389 | 28914 | 1998 | 32952 | 1379 | 41575 | 925 | 30507 |
| 5L-6S | | MI | 7218 | 3254 | 10681 | 2728 | 12700 | 2267 | 13868 | 1894 | 15290 | 1285 | 18687 | 722 | 14157 |
| 18-#11 | 2.54 | MA | 14577 | 3254 | 19893 | 2873 | 24830 | 2403 | 27774 | 2022 | 31368 | 1393 | 39565 | 860 | 29592 |
| 6L-5S | | MI | 7414 | 3254 | 11049 | 2709 | 13123 | 2257 | 14412 | 1877 | 16026 | 1272 | 19641 | 796 | 14424 |
| 18-#11 | 2.54 | MA | 14214 | 3254 | 19167 | 2885 | 23824 | 2421 | 26638 | 2035 | 29833 | 1415 | 37509 | 820 | 28868 |
| 7L-4S | | MI | 7576 | 3254 | 11375 | 2697 | 13570 | 2247 | 14966 | 1869 | 16795 | 1259 | 20682 | 862 | 14670 |
| 18-#11 | 2.54 | MA | 13821 | 3254 | 18471 | 2899 | 22892 | 2433 | 25460 | 2054 | 28302 | 1429 | 35502 | 767 | 27714 |
| 8L-3S | | MI | 7720 | 3254 | 11742 | 2685 | 14077 | 2228 | 15587 | 1853 | 17643 | 1255 | 21725 | 926 | 14714 |
| 18-#11 | 2.54 | MA | 13384 | 3254 | 17774 | 2911 | 21987 | 2446 | 24317 | 2066 | 26776 | 1450 | 33428 | 702 | 26613 |
| 9L-2S | | MI | 7990 | 3254 | 12267 | 2674 | 14744 | 2218 | 16395 | 1845 | 18734 | 1242 | 23203 | 1039 | 14733 |
| 18-#14 | 3.67 | MA | 15937 | 3614 | 22940 | 3120 | 28639 | 2591 | 32313 | 2154 | 37413 | 1400 | 48087 | 703 | 41090 |
| 6L-5S | | MI | 8020 | 3614 | 12592 | 2933 | 14990 | 2423 | 16636 | 1981 | 18991 | 1255 | 23476 | 613 | 19767 |
| 18-#14 | 3.67 | MA | 15458 | 3614 | 21899 | 3137 | 27197 | 2618 | 30696 | 2173 | 35210 | 1431 | 45124 | 644 | 39215 |
| 7L-4S | | MI | 8242 | 3614 | 13058 | 2917 | 15628 | 2409 | 17427 | 1971 | 20087 | 1238 | 24931 | 708 | 20372 |
| 18-#14 | 3.67 | MA | 14906 | 3614 | 20901 | 3156 | 25860 | 2635 | 29007 | 2199 | 33012 | 1451 | 42241 | 567 | 37364 |
| 8L-3S | | MI | 8427 | 3614 | 13580 | 2900 | 16350 | 2384 | 18311 | 1948 | 21296 | 1234 | 26395 | 799 | 20628 |
| 18-#14 | 3.67 | MA | 14315 | 3614 | 19906 | 3174 | 24561 | 2653 | 27367 | 2216 | 30841 | 1482 | 39252 | 472 | 35446 |
| 9L-2S | | MI | 8782 | 3614 | 14327 | 2884 | 17297 | 2371 | 19459 | 1938 | 22845 | 1217 | 28462 | 962 | 20694 |
| 18-#18 | 6.52 | MA | 18546 | 4527 | 28668 | 3776 | 35589 | 3116 | 40811 | 2520 | 48599 | 1469 | 64051 | 190 | 62736 |
| 7L-4S | | MI | 9852 | 4527 | 17128 | 3477 | 20633 | 2824 | 23428 | 2230 | 28129 | 1182 | 34900 | 269 | 33248 |
| 18-#18 | 6.52 | MA | 17611 | 4527 | 26912 | 3809 | 33237 | 3145 | 37841 | 2566 | 44729 | 1500 | 58959 | 46 | 58709 |
| 8L-3S | | MI | 10078 | 4527 | 18035 | 3452 | 21885 | 2783 | 24962 | 2194 | 30223 | 1180 | 37359 | 421 | 34912 |
| 20-#10 | 2.30 | MA | 14498 | 3176 | 19494 | 2823 | 24415 | 2363 | 27342 | 1995 | 30850 | 1391 | 38816 | 927 | 27450 |
| 6E | | MI | 7215 | 3176 | 10485 | 2691 | 12549 | 2243 | 13735 | 1881 | 15139 | 1290 | 18619 | 813 | 13199 |
| 20-#10 | 2.30 | MA | 14198 | 3176 | 18899 | 2833 | 23590 | 2379 | 26401 | 2005 | 29593 | 1410 | 37139 | 894 | 26900 |
| 7L-5S | | MI | 7379 | 3176 | 10795 | 2676 | 12898 | 2234 | 14184 | 1867 | 15760 | 1286 | 19482 | 885 | 13444 |
| 20-#10 | 2.30 | MA | 13871 | 3176 | 18329 | 2845 | 22826 | 2389 | 25435 | 2021 | 28338 | 1422 | 35498 | 853 | 26186 |
| 8L-4S | | MI | 7520 | 3176 | 11064 | 2666 | 13267 | 2225 | 14642 | 1859 | 16396 | 1274 | 20365 | 938 | 13528 |
| 20-#10 | 2.30 | MA | 13511 | 3176 | 17752 | 2855 | 22084 | 2400 | 24498 | 2031 | 27072 | 1439 | 33805 | 801 | 25379 |
| 9L-3S | | MI | 7641 | 3176 | 11367 | 2655 | 13687 | 2209 | 15156 | 1845 | 17099 | 1270 | 21246 | 992 | 13555 |
| 20-#10 | 2.30 | MA | 13169 | 3176 | 17168 | 2864 | 21310 | 2419 | 23582 | 2041 | 25797 | 1454 | 32161 | 766 | 24480 |
| 10L-2S | | MI | 7869 | 3176 | 11804 | 2645 | 14241 | 2200 | 15828 | 1837 | 18006 | 1258 | 22501 | 1085 | 13567 |
| 20-#11 | 2.83 | MA | 15139 | 3344 | 21040 | 2930 | 26286 | 2444 | 29539 | 2049 | 33750 | 1388 | 42864 | 854 | 32979 |
| 6E | | MI | 7455 | 3344 | 11207 | 2785 | 13367 | 2308 | 14676 | 1920 | 16381 | 1281 | 20165 | 712 | 15673 |
| 20-#11 | 2.83 | MA | 14790 | 3344 | 20314 | 2942 | 25280 | 2463 | 28403 | 2061 | 32215 | 1411 | 40807 | 814 | 32255 |
| 7L-5S | | MI | 7646 | 3344 | 11574 | 2766 | 13790 | 2298 | 15220 | 1903 | 17117 | 1268 | 21119 | 786 | 15929 |
| 20-#11 | 2.83 | MA | 14401 | 3344 | 19619 | 2956 | 24348 | 2475 | 27225 | 2080 | 30684 | 1424 | 38801 | 761 | 31091 |
| 8L-4S | | MI | 7808 | 3344 | 11901 | 2754 | 14237 | 2288 | 15774 | 1895 | 17886 | 1255 | 22160 | 852 | 16216 |
| 20-#11 | 2.83 | MA | 13978 | 3344 | 18921 | 2968 | 23443 | 2488 | 26082 | 2092 | 29158 | 1446 | 36726 | 696 | 29980 |
| 9L-3S | | MI | 7946 | 3344 | 12267 | 2742 | 14744 | 2270 | 16395 | 1879 | 18734 | 1251 | 23203 | 916 | 16267 |
| 20-#11 | 2.83 | MA | 13587 | 3344 | 18209 | 2978 | 22499 | 2510 | 24964 | 2105 | 27604 | 1464 | 34714 | 651 | 28783 |
| 10L-2S | | MI | 8210 | 3344 | 12793 | 2730 | 15411 | 2260 | 17203 | 1871 | 19825 | 1238 | 24681 | 1030 | 16292 |
| 20-#14 | 4.08 | MA | 16259 | 3744 | 23542 | 3218 | 29282 | 2677 | 33223 | 2210 | 38622 | 1425 | 49848 | 636 | 44039 |
| 7L-5S | | MI | 8340 | 3744 | 13338 | 3014 | 15937 | 2482 | 17784 | 2019 | 20541 | 1248 | 25543 | 595 | 21915 |
| 20-#14 | 4.08 | MA | 15714 | 3744 | 22544 | 3238 | 27945 | 2694 | 31534 | 2237 | 36424 | 1444 | 46964 | 559 | 42171 |
| 8L-4S | | MI | 8561 | 3744 | 13804 | 2998 | 16575 | 2469 | 18575 | 2009 | 21636 | 1232 | 26998 | 691 | 22494 |
| 20-#14 | 4.08 | MA | 15145 | 3744 | 21549 | 3256 | 26646 | 2713 | 29895 | 2253 | 34253 | 1475 | 43976 | 464 | 40261 |
| 9L-3S | | MI | 8737 | 3744 | 14327 | 2982 | 17297 | 2443 | 19459 | 1986 | 22845 | 1227 | 28462 | 782 | 22824 |
| 20-#14 | 4.08 | MA | 14619 | 3744 | 20528 | 3271 | 25292 | 2745 | 28291 | 2271 | 32023 | 1501 | 41083 | 397 | 38101 |
| 10L-2S | | MI | 9083 | 3744 | 15073 | 2966 | 18244 | 2430 | 20607 | 1976 | 24395 | 1211 | 30529 | 945 | 22900 |
| 20-#18 | 7.25 | MA | 18969 | 4759 | 29792 | 3954 | 36892 | 3251 | 42272 | 2633 | 50709 | 1489 | 67239 | 31 | 67072 |
| 8L-4S | | MI | 10372 | 4759 | 18414 | 3622 | 22265 | 2930 | 25406 | 2296 | 30799 | 1171 | 38348 | 226 | 36939 |
| 22-#10 | 2.53 | MA | 14674 | 3250 | 19842 | 2879 | 24787 | 2413 | 27852 | 2026 | 31551 | 1407 | 39849 | 890 | 29687 |
| 7L-6S | | MI | 7415 | 3250 | 10922 | 2737 | 13103 | 2276 | 14407 | 1902 | 16046 | 1287 | 19874 | 808 | 14461 |
| 22-#10 | 2.53 | MA | 14349 | 3250 | 19272 | 2891 | 24022 | 2423 | 26886 | 2042 | 30295 | 1418 | 38209 | 849 | 28963 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



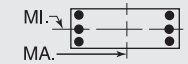

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8L-5S | | MI | 7575 | 3250 | 11232 | 2722 | 13452 | 2267 | 14856 | 1888 | 16667 | 1282 | 20737 | 880 | 14697 |
| 22-#10 | 2.53 | MA | 13999 | 3250 | 18695 | 2901 | 23280 | 2434 | 25948 | 2052 | 29029 | 1435 | 36516 | 796 | 28158 |
| 9L-4S | | MI | 7715 | 3250 | 11501 | 2712 | 13821 | 2258 | 15314 | 1880 | 17303 | 1271 | 21619 | 933 | 14816 |
| 22-#10 | 2.53 | MA | 13669 | 3250 | 18111 | 2910 | 22507 | 2453 | 25032 | 2063 | 27755 | 1451 | 34871 | 761 | 27252 |
| 10L-3S | | MI | 7832 | 3250 | 11804 | 2701 | 14241 | 2242 | 15828 | 1866 | 18006 | 1266 | 22501 | 987 | 14848 |
| 22-#10 | 2.53 | MA | 13349 | 3250 | 17453 | 2927 | 21746 | 2462 | 24102 | 2081 | 26469 | 1460 | 33275 | 717 | 26391 |
| 11L-2S | | MI | 8057 | 3250 | 12241 | 2691 | 14795 | 2233 | 16500 | 1858 | 18912 | 1254 | 23755 | 1080 | 14864 |
| 22-#11 | 3.11 | MA | 15356 | 3435 | 21461 | 2998 | 26736 | 2504 | 30167 | 2087 | 34598 | 1406 | 44105 | 808 | 35641 |
| 7L-6S | | MI | 7689 | 3435 | 11732 | 2841 | 14034 | 2349 | 15485 | 1946 | 17472 | 1276 | 21643 | 703 | 17192 |
| 22-#11 | 3.11 | MA | 14970 | 3435 | 20766 | 3012 | 25804 | 2516 | 28990 | 2106 | 33066 | 1420 | 42099 | 755 | 34467 |
| 8L-5S | | MI | 7876 | 3435 | 12100 | 2822 | 14457 | 2339 | 16028 | 1930 | 18208 | 1263 | 22598 | 777 | 17439 |
| 22-#11 | 3.11 | MA | 14559 | 3435 | 20068 | 3024 | 24899 | 2529 | 27847 | 2118 | 31540 | 1441 | 40024 | 690 | 33346 |
| 9L-4S | | MI | 8036 | 3435 | 12426 | 2810 | 14904 | 2329 | 16582 | 1922 | 18976 | 1251 | 23638 | 843 | 17761 |
| 22-#11 | 3.11 | MA | 14182 | 3435 | 19356 | 3035 | 23955 | 2552 | 26729 | 2131 | 29986 | 1460 | 38012 | 645 | 32153 |
| 10L-3S | | MI | 8170 | 3435 | 12793 | 2799 | 15411 | 2311 | 17203 | 1905 | 19825 | 1247 | 24681 | 907 | 17818 |
| 22-#11 | 3.11 | MA | 13792 | 3435 | 18555 | 3056 | 23036 | 2563 | 25595 | 2152 | 28417 | 1470 | 36059 | 590 | 30837 |
| 11L-2S | | MI | 8429 | 3435 | 13318 | 2787 | 16078 | 2301 | 18011 | 1897 | 20916 | 1234 | 26160 | 1020 | 17849 |
| 22-#14 | 4.48 | MA | 16505 | 3875 | 24187 | 3319 | 30030 | 2754 | 34062 | 2275 | 39835 | 1438 | 51688 | 550 | 46978 |
| 8L-5S | | MI | 8656 | 3875 | 14084 | 3096 | 16884 | 2542 | 18932 | 2056 | 22090 | 1242 | 27610 | 578 | 24067 |
| 22-#14 | 4.48 | MA | 15957 | 3875 | 23192 | 3337 | 28732 | 2772 | 32422 | 2291 | 37665 | 1469 | 48700 | 455 | 45075 |
| 9L-4S | | MI | 8876 | 3875 | 14551 | 3080 | 17522 | 2529 | 19722 | 2046 | 23186 | 1225 | 29066 | 674 | 24623 |
| 22-#14 | 4.48 | MA | 15453 | 3875 | 22172 | 3352 | 27377 | 2804 | 30818 | 2309 | 35435 | 1495 | 45807 | 388 | 42903 |
| 10L-3S | | MI | 9057 | 3875 | 15073 | 3063 | 18244 | 2503 | 20607 | 2024 | 24395 | 1221 | 30529 | 764 | 25020 |
| 24-#10 | 2.76 | MA | 14819 | 3323 | 20215 | 2937 | 25219 | 2457 | 28336 | 2063 | 32253 | 1415 | 40920 | 844 | 31741 |
| 8L-6S | | MI | 7612 | 3323 | 11358 | 2783 | 13657 | 2310 | 15079 | 1924 | 16952 | 1283 | 21128 | 803 | 15726 |
| 24-#10 | 2.76 | MA | 14478 | 3323 | 19638 | 2947 | 24477 | 2468 | 27399 | 2073 | 30987 | 1432 | 39227 | 791 | 30937 |
| 9L-5S | | MI | 7769 | 3323 | 11668 | 2768 | 14006 | 2301 | 15528 | 1909 | 17574 | 1279 | 21991 | 875 | 15954 |
| 24-#10 | 2.76 | MA | 14166 | 3323 | 19054 | 2956 | 23704 | 2486 | 26482 | 2084 | 29713 | 1447 | 37582 | 756 | 30024 |
| 10L-4S | | MI | 7909 | 3323 | 11938 | 2758 | 14376 | 2292 | 15986 | 1902 | 18209 | 1267 | 22874 | 928 | 16103 |
| 24-#10 | 2.76 | MA | 13843 | 3323 | 18396 | 2973 | 22942 | 2495 | 25553 | 2102 | 28427 | 1456 | 35986 | 712 | 29165 |
| 11L-3S | | MI | 8022 | 3323 | 12241 | 2747 | 14795 | 2276 | 16500 | 1887 | 18912 | 1262 | 23755 | 982 | 16140 |
| 24-#10 | 2.76 | MA | 13483 | 3323 | 17831 | 2984 | 22191 | 2505 | 24649 | 2113 | 27172 | 1473 | 34374 | 676 | 28118 |
| 12L-2S | | MI | 8242 | 3323 | 12678 | 2737 | 15350 | 2267 | 17172 | 1880 | 19819 | 1251 | 25010 | 1075 | 16160 |
| 24-#11 | 3.39 | MA | 15530 | 3525 | 21913 | 3069 | 27260 | 2557 | 30754 | 2133 | 35448 | 1416 | 45397 | 750 | 37844 |
| 8L-6S | | MI | 7920 | 3525 | 12258 | 2898 | 14700 | 2391 | 16293 | 1972 | 18563 | 1272 | 23122 | 693 | 18713 |
| 24-#11 | 3.39 | MA | 15131 | 3525 | 21216 | 3081 | 26355 | 2570 | 29611 | 2144 | 33922 | 1437 | 43322 | 684 | 36712 |
| 9L-5S | | MI | 8103 | 3525 | 12625 | 2879 | 15123 | 2381 | 16836 | 1956 | 19299 | 1259 | 24076 | 767 | 18952 |
| 24-#11 | 3.39 | MA | 14766 | 3525 | 20504 | 3091 | 25411 | 2593 | 28494 | 2157 | 32368 | 1455 | 41310 | 639 | 35523 |
| 10L-4S | | MI | 8263 | 3525 | 12952 | 2867 | 15571 | 2371 | 17390 | 1948 | 20067 | 1246 | 25117 | 833 | 19305 |
| 24-#11 | 3.39 | MA | 14394 | 3525 | 19702 | 3112 | 24492 | 2604 | 27359 | 2179 | 30799 | 1466 | 39358 | 584 | 34199 |
| 11L-3S | | MI | 8392 | 3525 | 13318 | 2855 | 16078 | 2352 | 18011 | 1931 | 20916 | 1242 | 26160 | 897 | 19369 |
| 24-#11 | 3.39 | MA | 13958 | 3525 | 19013 | 3125 | 23576 | 2616 | 26261 | 2192 | 29268 | 1486 | 37381 | 538 | 32861 |
| 12L-2S | | MI | 8645 | 3525 | 13843 | 2843 | 16744 | 2342 | 18820 | 1923 | 22007 | 1230 | 27638 | 1011 | 19405 |
| 24-#14 | 4.89 | MA | 16753 | 4005 | 24836 | 3419 | 30817 | 2832 | 34950 | 2329 | 41076 | 1463 | 53424 | 446 | 49889 |
| 9L-5S | | MI | 8969 | 4005 | 14831 | 3177 | 17831 | 2601 | 20080 | 2094 | 23640 | 1236 | 29678 | 561 | 26225 |
| 24-#14 | 4.89 | MA | 16270 | 4005 | 23815 | 3434 | 29463 | 2864 | 33345 | 2346 | 38847 | 1489 | 50531 | 380 | 47705 |
| 10L-4S | | MI | 9213 | 4005 | 15297 | 3161 | 18469 | 2588 | 20870 | 2084 | 24735 | 1219 | 31133 | 657 | 26759 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

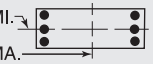



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.39 | MA | 15330 | 3010 | 20453 | 2670 | 25321 | 2242 | 28161 | 1904 | 31405 | 1386 | 38735 | 1205 | 18480 |
| 2E | | MI | 7268 | 3010 | 10656 | 2504 | 12478 | 2100 | 13492 | 1780 | 14590 | 1288 | 17093 | 1063 | 8520 |
| 6-#14 | 1.17 | MA | 14938 | 2937 | 19397 | 2640 | 24123 | 2222 | 26782 | 1894 | 29610 | 1399 | 36297 | 1218 | 15792 |
| 2L-3S | | MI | 6720 | 2937 | 9433 | 2505 | 11049 | 2106 | 11820 | 1792 | 12385 | 1326 | 14419 | 950 | 7405 |
| 6-#14 | 1.17 | MA | 13885 | 2937 | 17672 | 2665 | 21934 | 2245 | 24129 | 1916 | 26029 | 1431 | 31339 | 1079 | 15743 |
| 3L-2S | | MI | 7151 | 2937 | 10179 | 2489 | 11996 | 2093 | 12968 | 1782 | 13935 | 1309 | 16487 | 1114 | 7372 |
| 6-#18 | 2.08 | MA | 16755 | 3242 | 23478 | 2815 | 29160 | 2348 | 32814 | 1971 | 37687 | 1375 | 47432 | 1190 | 27472 |
| 2L-3S | | MI | 7122 | 3242 | 10656 | 2674 | 12478 | 2226 | 13492 | 1861 | 14590 | 1301 | 17093 | 729 | 12361 |
| 6-#18 | 2.08 | MA | 15057 | 3242 | 20453 | 2858 | 25321 | 2388 | 28161 | 2009 | 31405 | 1430 | 38735 | 938 | 27160 |
| 3L-2S | | MI | 7814 | 3242 | 11942 | 2649 | 14110 | 2206 | 15469 | 1847 | 17259 | 1277 | 20541 | 1020 | 12390 |
| 8-#11 | 1.08 | MA | 14776 | 2908 | 18946 | 2629 | 23624 | 2214 | 26213 | 1891 | 28876 | 1405 | 35306 | 1224 | 14687 |
| 2L-4S | | MI | 6621 | 2908 | 9076 | 2509 | 10616 | 2121 | 11321 | 1809 | 11727 | 1337 | 13720 | 958 | 6934 |
| 8-#11 | 1.08 | MA | 14036 | 2908 | 17743 | 2646 | 22096 | 2231 | 24362 | 1907 | 26376 | 1427 | 31845 | 1129 | 14667 |
| 3E | | MI | 6797 | 2908 | 9442 | 2497 | 11123 | 2102 | 11942 | 1792 | 12576 | 1332 | 14763 | 1022 | 6915 |
| 8-#11 | 1.08 | MA | 13631 | 2908 | 16931 | 2664 | 20967 | 2257 | 22977 | 1931 | 24479 | 1442 | 29589 | 1068 | 14569 |
| 4L-2S | | MI | 7103 | 2908 | 9968 | 2485 | 11790 | 2092 | 12750 | 1784 | 13667 | 1320 | 16242 | 1135 | 6893 |
| 8-#14 | 1.56 | MA | 15780 | 3068 | 21122 | 2721 | 26312 | 2281 | 29435 | 1931 | 33190 | 1393 | 41255 | 1209 | 20924 |
| 2L-4S | | MI | 6823 | 3068 | 9657 | 2602 | 11273 | 2191 | 12084 | 1852 | 12726 | 1324 | 15023 | 843 | 9611 |
| 8-#14 | 1.56 | MA | 14771 | 3068 | 19397 | 2746 | 24123 | 2305 | 26782 | 1954 | 29610 | 1425 | 36297 | 1071 | 20844 |
| 3E | | MI | 7064 | 3068 | 10179 | 2586 | 11996 | 2166 | 12968 | 1829 | 13935 | 1320 | 16487 | 933 | 9641 |
| 8-#14 | 1.56 | MA | 14221 | 3068 | 18232 | 2772 | 22504 | 2341 | 24795 | 1989 | 26888 | 1444 | 33050 | 983 | 20533 |
| 4L-2S | | MI | 7480 | 3068 | 10926 | 2570 | 12943 | 2152 | 14116 | 1819 | 15484 | 1303 | 18554 | 1097 | 9624 |
| 8-#18 | 2.78 | MA | 18124 | 3474 | 26504 | 2960 | 33000 | 2454 | 37467 | 2038 | 43968 | 1364 | 56129 | 1175 | 36449 |
| 2L-4S | | MI | 7307 | 3474 | 11035 | 2844 | 12857 | 2373 | 13936 | 1963 | 15165 | 1292 | 18083 | 534 | 15193 |
| 8-#18 | 2.78 | MA | 16534 | 3474 | 23478 | 3003 | 29160 | 2494 | 32814 | 2075 | 37687 | 1419 | 47432 | 923 | 36089 |
| 3E | | MI | 7689 | 3474 | 11942 | 2819 | 14110 | 2332 | 15469 | 1928 | 17259 | 1290 | 20541 | 686 | 16138 |
| 8-#18 | 2.78 | MA | 15675 | 3474 | 21429 | 3047 | 26312 | 2557 | 29319 | 2136 | 32901 | 1451 | 41685 | 765 | 33827 |
| 4L-2S | | MI | 8346 | 3474 | 13228 | 2794 | 15742 | 2312 | 17447 | 1914 | 19929 | 1266 | 23990 | 976 | 16225 |
| 10-#10 | 1.10 | MA | 14864 | 2914 | 18949 | 2643 | 23727 | 2226 | 26390 | 1900 | 29161 | 1410 | 35735 | 1229 | 15026 |
| 2L-5S | | MI | 6614 | 2914 | 8934 | 2541 | 10505 | 2146 | 11221 | 1831 | 11615 | 1359 | 13642 | 959 | 7081 |
| 10-#10 | 1.10 | MA | 14257 | 2914 | 17960 | 2658 | 22472 | 2240 | 24869 | 1914 | 27107 | 1430 | 32891 | 1152 | 15009 |
| 3L-4S | | MI | 6759 | 2914 | 9204 | 2531 | 10874 | 2138 | 11679 | 1823 | 12251 | 1348 | 14525 | 1012 | 7085 |
| 10-#10 | 1.10 | MA | 13930 | 2914 | 17295 | 2673 | 21546 | 2261 | 23733 | 1934 | 25551 | 1442 | 31049 | 1104 | 14946 |
| 4L-3S | | MI | 6904 | 2914 | 9507 | 2520 | 11294 | 2122 | 12194 | 1809 | 12953 | 1343 | 15406 | 1067 | 7073 |
| 10-#10 | 1.10 | MA | 13510 | 2914 | 16682 | 2685 | 20741 | 2276 | 22731 | 1948 | 24157 | 1461 | 29051 | 1060 | 14782 |
| 5L-2S | | MI | 7159 | 2914 | 9944 | 2510 | 11848 | 2113 | 12865 | 1801 | 13860 | 1332 | 16661 | 1159 | 7058 |
| 10-#11 | 1.35 | MA | 15373 | 2998 | 20150 | 2685 | 25151 | 2256 | 28065 | 1917 | 31375 | 1400 | 38766 | 1218 | 18270 |
| 2L-5S | | MI | 6704 | 2998 | 9275 | 2577 | 10836 | 2172 | 11575 | 1843 | 12050 | 1345 | 14158 | 882 | 8471 |
| 10-#11 | 1.35 | MA | 14656 | 2998 | 18946 | 2703 | 23624 | 2273 | 26213 | 1933 | 28876 | 1423 | 35306 | 1123 | 18236 |
| 3L-4S | | MI | 6871 | 2998 | 9601 | 2565 | 11283 | 2162 | 12129 | 1835 | 12818 | 1332 | 15199 | 948 | 8500 |
| 10-#11 | 1.35 | MA | 14272 | 2998 | 18135 | 2721 | 22495 | 2298 | 24828 | 1958 | 26978 | 1437 | 33050 | 1062 | 18121 |
| 4L-3S | | MI | 7041 | 2998 | 9968 | 2553 | 11790 | 2143 | 12750 | 1818 | 13667 | 1328 | 16242 | 1012 | 8496 |
| 10-#11 | 1.35 | MA | 13771 | 2998 | 17393 | 2736 | 21512 | 2315 | 23606 | 1974 | 25277 | 1460 | 30607 | 1006 | 17834 |
| 5L-2S | | MI | 7339 | 2998 | 10493 | 2542 | 12457 | 2133 | 13559 | 1810 | 14758 | 1315 | 17720 | 1126 | 8480 |
| 10-#14 | 1.95 | MA | 16598 | 3198 | 22846 | 2803 | 28501 | 2341 | 32087 | 1969 | 36771 | 1386 | 46213 | 1200 | 26048 |
| 2L-5S | | MI | 6942 | 3198 | 9937 | 2700 | 11583 | 2264 | 12441 | 1900 | 13180 | 1335 | 15635 | 730 | 11344 |
| 10-#14 | 1.95 | MA | 15631 | 3198 | 21122 | 2828 | 26312 | 2365 | 29435 | 1992 | 33190 | 1418 | 41255 | 1062 | 25946 |
| 3L-4S | | MI | 7172 | 3198 | 10403 | 2684 | 12220 | 2251 | 13232 | 1890 | 14275 | 1318 | 17090 | 826 | 11802 |
| 10-#14 | 1.95 | MA | 15118 | 3198 | 19957 | 2853 | 24693 | 2401 | 27448 | 2027 | 30469 | 1438 | 38008 | 974 | 25623 |
| 4L-3S | | MI | 7400 | 3198 | 10926 | 2668 | 12943 | 2225 | 14116 | 1867 | 15484 | 1314 | 18554 | 916 | 11858 |
| 10-#14 | 1.95 | MA | 14415 | 3198 | 18898 | 2875 | 23281 | 2425 | 25693 | 2049 | 28028 | 1470 | 34499 | 892 | 24351 |
| 5L-2S | | MI | 7802 | 3198 | 11672 | 2652 | 13890 | 2212 | 15264 | 1857 | 17034 | 1297 | 20621 | 1079 | 11862 |
| 10-#18 | 3.47 | MA | 17954 | 3706 | 26504 | 3148 | 33000 | 2600 | 37467 | 2142 | 43968 | 1408 | 56129 | 908 | 45028 |
| 3L-4S | | MI | 7886 | 3706 | 12321 | 2989 | 14489 | 2479 | 15914 | 2030 | 17835 | 1281 | 21531 | 490 | 18783 |
| 10-#18 | 3.47 | MA | 17184 | 3706 | 24454 | 3191 | 30151 | 2663 | 33973 | 2202 | 39182 | 1440 | 50382 | 750 | 42688 |
| 4L-3S | | MI | 8240 | 3706 | 13228 | 2964 | 15742 | 2438 | 17447 | 1995 | 19929 | 1279 | 23990 | 642 | 19906 |
| 10-#18 | 3.47 | MA | 15996 | 3706 | 22611 | 3231 | 27665 | 2704 | 30883 | 2240 | 34885 | 1495 | 44511 | 628 | 39160 |
| 5L-2S | | MI | 8863 | 3706 | 14514 | 2939 | 17374 | 2418 | 19425 | 1981 | 22599 | 1255 | 27438 | 933 | 20037 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



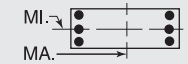

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.32 | MA | 15358 | 2988 | 19938 | 2689 | 24982 | 2260 | 27911 | 1922 | 31214 | 1407 | 38578 | 1224 | 17969 |
| 2L-6S | | MI | 6644 | 2988 | 9061 | 2602 | 10710 | 2189 | 11444 | 1867 | 11900 | 1361 | 14034 | 883 | 8241 |
| 12-#10 | 1.32 | MA | 14767 | 2988 | 18949 | 2704 | 23727 | 2274 | 26390 | 1935 | 29161 | 1426 | 35735 | 1148 | 17943 |
| 3L-5S | | MI | 6824 | 2988 | 9371 | 2587 | 11059 | 2180 | 11893 | 1852 | 12522 | 1356 | 14897 | 954 | 8372 |
| 12-#10 | 1.32 | MA | 14454 | 2988 | 18284 | 2719 | 22801 | 2295 | 25254 | 1956 | 27604 | 1438 | 33892 | 1099 | 17870 |
| 4E | | MI | 6969 | 2988 | 9641 | 2577 | 11428 | 2171 | 12351 | 1845 | 13157 | 1344 | 15780 | 1007 | 8387 |
| 12-#10 | 1.32 | MA | 14038 | 2988 | 17671 | 2731 | 21996 | 2309 | 24253 | 1969 | 26210 | 1457 | 31894 | 1055 | 17701 |
| 5L-3S | | MI | 7108 | 2988 | 9944 | 2566 | 11848 | 2155 | 12865 | 1830 | 13860 | 1340 | 16661 | 1062 | 8384 |
| 12-#10 | 1.32 | MA | 13622 | 2988 | 16935 | 2746 | 21194 | 2320 | 23274 | 1990 | 24851 | 1469 | 30174 | 1004 | 17200 |
| 6L-2S | | MI | 7358 | 2988 | 10380 | 2556 | 12402 | 2146 | 13537 | 1823 | 14767 | 1328 | 17915 | 1154 | 8373 |
| 12-#11 | 1.63 | MA | 15958 | 3089 | 21354 | 2742 | 26679 | 2297 | 29917 | 1943 | 33875 | 1396 | 42227 | 1212 | 21849 |
| 2L-6S | | MI | 6739 | 3089 | 9433 | 2653 | 11080 | 2223 | 11840 | 1886 | 12405 | 1353 | 14682 | 799 | 9703 |
| 12-#11 | 1.63 | MA | 15262 | 3089 | 20150 | 2759 | 25151 | 2314 | 28065 | 1959 | 31375 | 1419 | 38766 | 1117 | 21803 |
| 3L-5S | | MI | 6951 | 3089 | 9800 | 2634 | 11503 | 2213 | 12384 | 1869 | 13141 | 1341 | 15637 | 873 | 10014 |
| 12-#11 | 1.63 | MA | 14897 | 3089 | 19339 | 2777 | 24023 | 2339 | 26680 | 1984 | 29478 | 1433 | 36510 | 1056 | 21676 |
| 4E | | MI | 7117 | 3089 | 10127 | 2622 | 11950 | 2203 | 12938 | 1861 | 13909 | 1328 | 16677 | 939 | 10058 |
| 12-#11 | 1.63 | MA | 14402 | 3089 | 18597 | 2792 | 23040 | 2356 | 25458 | 2000 | 27777 | 1456 | 34068 | 1000 | 21388 |
| 5L-3S | | MI | 7280 | 3089 | 10493 | 2610 | 12457 | 2185 | 13559 | 1844 | 14758 | 1324 | 17720 | 1003 | 10067 |
| 12-#11 | 1.63 | MA | 13907 | 3089 | 17701 | 2810 | 22070 | 2370 | 24264 | 2024 | 26118 | 1470 | 31965 | 936 | 20462 |
| 6L-2S | | MI | 7571 | 3089 | 11018 | 2598 | 13124 | 2175 | 14367 | 1836 | 15849 | 1311 | 19198 | 1116 | 10058 |
| 12-#14 | 2.34 | MA | 16466 | 3329 | 22846 | 2909 | 28501 | 2424 | 32087 | 2029 | 36771 | 1412 | 46213 | 1053 | 31048 |
| 3L-5S | | MI | 7285 | 3329 | 10683 | 2782 | 12530 | 2324 | 13589 | 1938 | 14729 | 1329 | 17702 | 713 | 13457 |
| 12-#14 | 2.34 | MA | 15988 | 3329 | 21682 | 2935 | 26881 | 2460 | 30101 | 2064 | 34050 | 1432 | 42966 | 966 | 30717 |
| 4E | | MI | 7512 | 3329 | 11150 | 2765 | 13168 | 2310 | 14380 | 1927 | 15825 | 1312 | 19158 | 808 | 13990 |
| 12-#14 | 2.34 | MA | 15294 | 3329 | 20623 | 2957 | 25470 | 2484 | 28346 | 2087 | 31609 | 1464 | 39457 | 883 | 29434 |
| 5L-3S | | MI | 7729 | 3329 | 11672 | 2749 | 13890 | 2285 | 15264 | 1905 | 17034 | 1308 | 20621 | 899 | 14067 |
| 12-#14 | 2.34 | MA | 14618 | 3329 | 19338 | 2982 | 24088 | 2504 | 26632 | 2122 | 29227 | 1484 | 36435 | 789 | 27957 |
| 6L-2S | | MI | 8119 | 3329 | 12418 | 2733 | 14837 | 2272 | 16412 | 1895 | 18583 | 1291 | 22689 | 1062 | 14089 |
| 12-#18 | 4.17 | MA | 18637 | 3937 | 27480 | 3336 | 33990 | 2769 | 38626 | 2269 | 45463 | 1429 | 59079 | 735 | 51549 |
| 4E | | MI | 8451 | 3937 | 13607 | 3134 | 16121 | 2585 | 17892 | 2097 | 20504 | 1270 | 24980 | 447 | 22401 |
| 12-#18 | 4.17 | MA | 17466 | 3937 | 25636 | 3376 | 31504 | 2810 | 35537 | 2307 | 41167 | 1484 | 53208 | 612 | 48047 |
| 5L-3S | | MI | 8800 | 3937 | 14514 | 3109 | 17374 | 2544 | 19425 | 2062 | 22599 | 1268 | 27438 | 599 | 23672 |
| 12-#18 | 4.17 | MA | 16388 | 3937 | 23381 | 3421 | 29104 | 2846 | 32517 | 2367 | 36973 | 1516 | 47553 | 408 | 43987 |
| 6L-2S | | MI | 9364 | 3937 | 15800 | 3084 | 19005 | 2524 | 21403 | 2048 | 25269 | 1244 | 30887 | 890 | 23839 |
| 14-#10 | 1.54 | MA | 15267 | 3061 | 19938 | 2750 | 24982 | 2308 | 27911 | 1956 | 31214 | 1423 | 38578 | 1143 | 20876 |
| 3L-6S | | MI | 6856 | 3061 | 9498 | 2648 | 11264 | 2223 | 12116 | 1888 | 12807 | 1357 | 15289 | 878 | 9490 |
| 14-#10 | 1.54 | MA | 14967 | 3061 | 19273 | 2765 | 24057 | 2329 | 26775 | 1977 | 29658 | 1435 | 36736 | 1094 | 20795 |
| 4L-5S | | MI | 7032 | 3061 | 9808 | 2633 | 11613 | 2214 | 12565 | 1873 | 13429 | 1352 | 16151 | 949 | 9660 |
| 14-#10 | 1.54 | MA | 14555 | 3061 | 18660 | 2777 | 23251 | 2343 | 25774 | 1990 | 28264 | 1454 | 34737 | 1050 | 20622 |
| 5L-4S | | MI | 7175 | 3061 | 10077 | 2623 | 11983 | 2205 | 13023 | 1866 | 14064 | 1341 | 17034 | 1002 | 9684 |
| 14-#10 | 1.54 | MA | 14151 | 3061 | 17924 | 2792 | 22449 | 2354 | 24796 | 2011 | 26904 | 1466 | 33017 | 999 | 20109 |
| 6L-3S | | MI | 7310 | 3061 | 10380 | 2612 | 12402 | 2189 | 13537 | 1851 | 14767 | 1336 | 17915 | 1057 | 9689 |
| 14-#10 | 1.54 | MA | 13801 | 3061 | 17301 | 2802 | 21585 | 2369 | 23804 | 2021 | 25587 | 1485 | 31265 | 967 | 19483 |
| 7L-2S | | MI | 7554 | 3061 | 10817 | 2602 | 12957 | 2180 | 14209 | 1844 | 15674 | 1325 | 19170 | 1149 | 9683 |
| 14-#11 | 1.90 | MA | 15856 | 3179 | 21354 | 2816 | 26679 | 2355 | 29917 | 1985 | 33875 | 1414 | 42227 | 1111 | 25369 |
| 3L-6S | | MI | 6988 | 3179 | 9958 | 2709 | 11746 | 2264 | 12648 | 1912 | 13496 | 1349 | 16160 | 790 | 11207 |
| 14-#11 | 1.90 | MA | 15508 | 3179 | 20543 | 2834 | 25550 | 2381 | 28532 | 2010 | 31977 | 1429 | 39971 | 1050 | 25233 |
| 4L-5S | | MI | 7195 | 3179 | 10325 | 2690 | 12169 | 2254 | 13192 | 1895 | 14232 | 1336 | 17115 | 863 | 11503 |
| 14-#11 | 1.90 | MA | 15018 | 3179 | 19800 | 2849 | 24567 | 2398 | 27309 | 2026 | 30276 | 1451 | 37529 | 995 | 24944 |
| 5L-4S | | MI | 7359 | 3179 | 10652 | 2678 | 12617 | 2244 | 13746 | 1887 | 15000 | 1324 | 18155 | 929 | 11611 |
| 14-#11 | 1.90 | MA | 14539 | 3179 | 18905 | 2867 | 23598 | 2411 | 26115 | 2050 | 28617 | 1466 | 35426 | 930 | 24010 |
| 6L-3S | | MI | 7516 | 3179 | 11018 | 2667 | 13124 | 2226 | 14367 | 1871 | 15849 | 1320 | 19198 | 994 | 11631 |
| 14-#11 | 1.90 | MA | 14125 | 3179 | 18144 | 2879 | 22544 | 2430 | 24918 | 2063 | 27010 | 1488 | 33278 | 890 | 23232 |
| 7L-2S | | MI | 7800 | 3179 | 11544 | 2655 | 13790 | 2216 | 15175 | 1863 | 16940 | 1307 | 20677 | 1107 | 11631 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

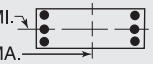



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.73 | MA | 16835 | 3459 | 23407 | 3016 | 29070 | 2520 | 32753 | 2102 | 37631 | 1426 | 47925 | 957 | 35816 |
| 4L-5S | | MI | 7622 | 3459 | 11430 | 2863 | 13477 | 2383 | 14737 | 1975 | 16279 | 1322 | 19770 | 695 | 15582 |
| 14-#14 | 2.73 | MA | 16149 | 3459 | 22347 | 3038 | 27659 | 2544 | 30999 | 2124 | 35190 | 1458 | 44416 | 875 | 34513 |
| 5L-4S | | MI | 7847 | 3459 | 11896 | 2847 | 14115 | 2370 | 15528 | 1965 | 17374 | 1306 | 21225 | 791 | 16176 |
| 14-#14 | 2.73 | MA | 15501 | 3459 | 21063 | 3064 | 26277 | 2564 | 29284 | 2159 | 32808 | 1478 | 41393 | 780 | 33041 |
| 6L-3S | | MI | 8053 | 3459 | 12418 | 2831 | 14837 | 2344 | 16412 | 1942 | 18583 | 1301 | 22689 | 882 | 16271 |
| 14-#14 | 2.73 | MA | 14940 | 3459 | 19972 | 3081 | 24765 | 2591 | 27578 | 2178 | 30500 | 1510 | 38298 | 722 | 31195 |
| 7L-2S | | MI | 8432 | 3459 | 13165 | 2815 | 15784 | 2331 | 17560 | 1932 | 20133 | 1285 | 24756 | 1045 | 16307 |
| 14-#18 | 4.86 | MA | 18887 | 4169 | 28661 | 3521 | 35344 | 2916 | 40190 | 2374 | 47448 | 1473 | 61905 | 597 | 56933 |
| 5L-4S | | MI | 9042 | 4169 | 14893 | 3279 | 17753 | 2691 | 19870 | 2164 | 23174 | 1259 | 28428 | 404 | 26041 |
| 14-#18 | 4.86 | MA | 17874 | 4169 | 26406 | 3566 | 32944 | 2952 | 37170 | 2434 | 43254 | 1505 | 56250 | 392 | 52831 |
| 6L-3S | | MI | 9323 | 4169 | 15800 | 3254 | 19005 | 2650 | 21403 | 2129 | 25269 | 1257 | 30887 | 556 | 27437 |
| 14-#18 | 4.86 | MA | 16992 | 4169 | 24487 | 3595 | 30286 | 2998 | 34211 | 2469 | 39190 | 1560 | 50762 | 286 | 48665 |
| 7L-2S | | MI | 9856 | 4169 | 17086 | 3229 | 20637 | 2630 | 23381 | 2115 | 27939 | 1233 | 34335 | 847 | 27635 |
| 16-#10 | 1.76 | MA | 15471 | 3135 | 20262 | 2811 | 25312 | 2362 | 28297 | 1998 | 31711 | 1431 | 39579 | 1089 | 23720 |
| 4L-6S | | MI | 7064 | 3135 | 9935 | 2694 | 11818 | 2256 | 12788 | 1909 | 13714 | 1354 | 16543 | 873 | 10742 |
| 16-#10 | 1.76 | MA | 15063 | 3135 | 19649 | 2823 | 24506 | 2376 | 27295 | 2012 | 30317 | 1450 | 37580 | 1045 | 23545 |
| 5E | | MI | 7236 | 3135 | 10245 | 2679 | 12168 | 2247 | 13237 | 1895 | 14336 | 1349 | 17406 | 944 | 10945 |
| 16-#10 | 1.76 | MA | 14669 | 3135 | 18913 | 2838 | 23704 | 2387 | 26317 | 2032 | 28958 | 1462 | 35860 | 994 | 23020 |
| 6L-4S | | MI | 7378 | 3135 | 10514 | 2669 | 12537 | 2238 | 13695 | 1887 | 14971 | 1337 | 18289 | 997 | 10978 |
| 16-#10 | 1.76 | MA | 14331 | 3135 | 18290 | 2848 | 22840 | 2403 | 25325 | 2042 | 27641 | 1481 | 34109 | 962 | 22406 |
| 7L-3S | | MI | 7509 | 3135 | 10817 | 2658 | 12957 | 2222 | 14209 | 1873 | 15674 | 1333 | 19170 | 1052 | 10990 |
| 16-#10 | 1.76 | MA | 13976 | 3135 | 17692 | 2860 | 22039 | 2413 | 24313 | 2058 | 26326 | 1493 | 32393 | 922 | 21733 |
| 8L-2S | | MI | 7748 | 3135 | 11254 | 2648 | 13511 | 2214 | 14881 | 1865 | 16581 | 1321 | 20424 | 1144 | 10989 |
| 16-#11 | 2.17 | MA | 16107 | 3270 | 21747 | 2890 | 27078 | 2422 | 30383 | 2036 | 34477 | 1424 | 43432 | 1044 | 28792 |
| 4L-6S | | MI | 7232 | 3270 | 10484 | 2766 | 12413 | 2306 | 13456 | 1938 | 14587 | 1345 | 17639 | 780 | 12715 |
| 16-#11 | 2.17 | MA | 15621 | 3270 | 21004 | 2905 | 26095 | 2439 | 29161 | 2052 | 32776 | 1447 | 40990 | 989 | 28503 |
| 5E | | MI | 7434 | 3270 | 10851 | 2747 | 12836 | 2296 | 14000 | 1921 | 15323 | 1332 | 18593 | 854 | 12997 |
| 16-#11 | 2.17 | MA | 15157 | 3270 | 20108 | 2923 | 25126 | 2452 | 27967 | 2076 | 31117 | 1461 | 38887 | 924 | 27561 |
| 6L-4S | | MI | 7598 | 3270 | 11178 | 2735 | 13283 | 2286 | 14554 | 1913 | 16091 | 1319 | 19634 | 920 | 13160 |
| 16-#11 | 2.17 | MA | 14759 | 3270 | 19348 | 2936 | 24072 | 2471 | 26769 | 2089 | 29509 | 1484 | 36738 | 884 | 26787 |
| 7L-3S | | MI | 7749 | 3270 | 11544 | 2723 | 13790 | 2267 | 15175 | 1897 | 16940 | 1315 | 20677 | 984 | 13190 |
| 16-#11 | 2.17 | MA | 14336 | 3270 | 18619 | 2950 | 23095 | 2484 | 25535 | 2108 | 27905 | 1498 | 34640 | 833 | 25643 |
| 8L-2S | | MI | 8026 | 3270 | 12069 | 2711 | 14457 | 2257 | 15983 | 1889 | 18031 | 1302 | 22155 | 1097 | 13200 |
| 16-#14 | 3.13 | MA | 16983 | 3590 | 24072 | 3120 | 29848 | 2604 | 33652 | 2162 | 38770 | 1452 | 49374 | 866 | 39592 |
| 5E | | MI | 7952 | 3590 | 12176 | 2945 | 14424 | 2443 | 15885 | 2013 | 17828 | 1316 | 21837 | 678 | 17715 |
| 16-#14 | 3.13 | MA | 16361 | 3590 | 22788 | 3145 | 28465 | 2623 | 31937 | 2197 | 36389 | 1471 | 46351 | 772 | 38125 |
| 6L-4S | | MI | 8175 | 3590 | 12642 | 2929 | 15062 | 2430 | 16676 | 2003 | 18924 | 1299 | 23292 | 774 | 18361 |
| 16-#14 | 3.13 | MA | 15827 | 3590 | 21696 | 3163 | 26954 | 2650 | 30231 | 2215 | 34081 | 1504 | 43257 | 713 | 36259 |
| 7L-3S | | MI | 8372 | 3590 | 13165 | 2912 | 15784 | 2404 | 17560 | 1980 | 20133 | 1295 | 24756 | 864 | 18471 |
| 16-#14 | 3.13 | MA | 15234 | 3590 | 20651 | 3182 | 25552 | 2667 | 28460 | 2243 | 31778 | 1523 | 40239 | 638 | 34423 |
| 8L-2S | | MI | 8740 | 3590 | 13911 | 2896 | 16731 | 2391 | 18708 | 1970 | 21682 | 1278 | 26823 | 1028 | 18520 |
| 16-#18 | 5.56 | MA | 19314 | 4401 | 29431 | 3711 | 36783 | 3058 | 41823 | 2501 | 49536 | 1494 | 64947 | 377 | 61583 |
| 6L-4S | | MI | 9581 | 4401 | 16179 | 3424 | 19385 | 2797 | 21848 | 2231 | 25844 | 1248 | 31876 | 361 | 29700 |
| 16-#18 | 5.56 | MA | 18495 | 4401 | 27512 | 3740 | 34126 | 3104 | 38865 | 2536 | 45471 | 1549 | 59459 | 271 | 57476 |
| 7L-3S | | MI | 9836 | 4401 | 17086 | 3399 | 20637 | 2755 | 23381 | 2195 | 27939 | 1246 | 34335 | 513 | 31203 |
| 16-#18 | 5.56 | MA | 17487 | 4401 | 25671 | 3773 | 31659 | 3133 | 35750 | 2582 | 41414 | 1581 | 54128 | 130 | 53380 |
| 8L-2S | | MI | 10343 | 4401 | 18372 | 3374 | 22269 | 2736 | 25359 | 2182 | 30609 | 1222 | 37784 | 803 | 31427 |
| 18-#10 | 1.98 | MA | 15561 | 3209 | 20638 | 2869 | 25761 | 2410 | 28816 | 2033 | 32370 | 1447 | 40424 | 1040 | 26470 |
| 5L-6S | | MI | 7269 | 3209 | 10371 | 2740 | 12373 | 2290 | 13460 | 1930 | 14621 | 1350 | 17798 | 868 | 11999 |
| 18-#10 | 1.98 | MA | 15178 | 3209 | 19902 | 2884 | 24959 | 2421 | 27838 | 2053 | 31011 | 1459 | 38703 | 989 | 25933 |
| 6L-5S | | MI | 7437 | 3209 | 10681 | 2725 | 12722 | 2281 | 13909 | 1916 | 15242 | 1345 | 18660 | 939 | 12229 |
| 18-#10 | 1.98 | MA | 14850 | 3209 | 19279 | 2894 | 24095 | 2437 | 26847 | 2063 | 29694 | 1478 | 36952 | 957 | 25330 |
| 7L-4S | | MI | 7579 | 3209 | 10951 | 2715 | 13091 | 2272 | 14367 | 1908 | 15878 | 1334 | 19543 | 993 | 12269 |
| 18-#10 | 1.98 | MA | 14499 | 3209 | 18681 | 2906 | 23294 | 2447 | 25835 | 2079 | 28380 | 1490 | 35236 | 917 | 24647 |
| 8L-3S | | MI | 7705 | 3209 | 11254 | 2704 | 13511 | 2256 | 14881 | 1894 | 16581 | 1329 | 20424 | 1047 | 12287 |
| 18-#10 | 1.98 | MA | 14103 | 3209 | 18074 | 2915 | 22517 | 2458 | 24853 | 2090 | 27045 | 1507 | 33468 | 864 | 23788 |
| 9L-2S | | MI | 7940 | 3209 | 11691 | 2694 | 14065 | 2247 | 15552 | 1886 | 17487 | 1318 | 21679 | 1139 | 12293 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

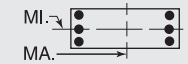
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.44 | MA | 16213 | 3360 | 22208 | 2962 | 27623 | 2480 | 31013 | 2078 | 35275 | 1443 | 44450 | 983 | 32064 |
| 5L-6S | | MI | 7473 | 3360 | 11009 | 2822 | 13080 | 2347 | 14265 | 1964 | 15678 | 1341 | 19117 | 771 | 14227 |
| 18-#11 | 2.44 | MA | 15763 | 3360 | 21312 | 2980 | 26653 | 2494 | 29819 | 2103 | 33616 | 1457 | 42347 | 918 | 31115 |
| 6L-5S | | MI | 7670 | 3360 | 11376 | 2803 | 13503 | 2337 | 14808 | 1947 | 16414 | 1328 | 20072 | 844 | 14497 |
| 18-#11 | 2.44 | MA | 15379 | 3360 | 20552 | 2992 | 25599 | 2513 | 28621 | 2115 | 32008 | 1480 | 40199 | 878 | 30342 |
| 7L-4S | | MI | 7833 | 3360 | 11703 | 2791 | 13950 | 2327 | 15362 | 1939 | 17182 | 1315 | 21112 | 910 | 14708 |
| 18-#11 | 2.44 | MA | 14962 | 3360 | 19823 | 3006 | 24622 | 2525 | 27387 | 2134 | 30404 | 1494 | 38100 | 827 | 29187 |
| 8L-3S | | MI | 7978 | 3360 | 12069 | 2780 | 14457 | 2309 | 15983 | 1923 | 18031 | 1311 | 22155 | 975 | 14746 |
| 18-#11 | 2.44 | MA | 14501 | 3360 | 19088 | 3018 | 23674 | 2538 | 26189 | 2146 | 28794 | 1515 | 35933 | 762 | 28099 |
| 9L-2S | | MI | 8250 | 3360 | 12595 | 2768 | 15124 | 2299 | 16791 | 1915 | 19122 | 1298 | 23633 | 1088 | 14762 |
| 18-#14 | 3.52 | MA | 17201 | 3720 | 24512 | 3227 | 30654 | 2683 | 34590 | 2235 | 39970 | 1465 | 51310 | 763 | 43208 |
| 6L-5S | | MI | 8277 | 3720 | 12922 | 3026 | 15371 | 2502 | 17033 | 2051 | 19378 | 1310 | 23904 | 661 | 19855 |
| 18-#14 | 3.52 | MA | 16693 | 3720 | 23421 | 3244 | 29143 | 2710 | 32884 | 2253 | 37662 | 1497 | 48215 | 705 | 41322 |
| 7L-4S | | MI | 8499 | 3720 | 13389 | 3010 | 16009 | 2489 | 17823 | 2040 | 20473 | 1293 | 25360 | 757 | 20472 |
| 18-#14 | 3.52 | MA | 16107 | 3720 | 22375 | 3264 | 27741 | 2727 | 31113 | 2280 | 35359 | 1517 | 45197 | 629 | 39469 |
| 8L-3S | | MI | 8687 | 3720 | 13911 | 2994 | 16731 | 2464 | 18708 | 2018 | 21682 | 1289 | 26823 | 847 | 20670 |
| 18-#14 | 3.52 | MA | 15482 | 3720 | 21327 | 3281 | 26380 | 2746 | 29395 | 2297 | 33067 | 1548 | 42075 | 535 | 37418 |
| 9L-2S | | MI | 9045 | 3720 | 14657 | 2978 | 17679 | 2450 | 19856 | 2008 | 23232 | 1272 | 28891 | 1011 | 20729 |
| 18-#18 | 6.25 | MA | 19954 | 4633 | 30537 | 3885 | 37965 | 3210 | 43518 | 2603 | 51752 | 1538 | 68156 | 256 | 66286 |
| 7L-4S | | MI | 10110 | 4633 | 17465 | 3569 | 21017 | 2903 | 23826 | 2298 | 28514 | 1237 | 35325 | 317 | 33374 |
| 18-#18 | 6.25 | MA | 18960 | 4633 | 28696 | 3918 | 35498 | 3239 | 40403 | 2649 | 47695 | 1570 | 62825 | 115 | 62165 |
| 8L-3S | | MI | 10342 | 4633 | 18372 | 3544 | 22269 | 2861 | 25359 | 2262 | 30609 | 1235 | 37784 | 469 | 34971 |
| 20-#10 | 2.20 | MA | 15677 | 3282 | 20891 | 2930 | 26215 | 2454 | 29359 | 2075 | 33064 | 1455 | 41547 | 984 | 28849 |
| 6E | | MI | 7471 | 3282 | 10808 | 2786 | 12927 | 2324 | 14131 | 1952 | 15527 | 1347 | 19052 | 863 | 13258 |
| 20-#10 | 2.20 | MA | 15361 | 3282 | 20268 | 2940 | 25350 | 2470 | 28368 | 2084 | 31747 | 1474 | 39795 | 952 | 28254 |
| 7L-5S | | MI | 7636 | 3282 | 11118 | 2771 | 13276 | 2315 | 14580 | 1937 | 16149 | 1342 | 19915 | 934 | 13507 |
| 20-#10 | 2.20 | MA | 15013 | 3282 | 19670 | 2952 | 24549 | 2481 | 27356 | 2101 | 30433 | 1486 | 38079 | 912 | 27560 |
| 8L-4S | | MI | 7777 | 3282 | 11388 | 2761 | 13645 | 2306 | 15038 | 1930 | 16784 | 1330 | 20798 | 988 | 13559 |
| 20-#10 | 2.20 | MA | 14634 | 3282 | 19063 | 2961 | 23772 | 2492 | 26374 | 2111 | 29099 | 1503 | 36311 | 859 | 26704 |
| 9L-3S | | MI | 7899 | 3282 | 11691 | 2750 | 14065 | 2290 | 15552 | 1915 | 17487 | 1326 | 21679 | 1042 | 13583 |
| 20-#10 | 2.20 | MA | 14272 | 3282 | 18451 | 2970 | 22962 | 2511 | 25414 | 2122 | 27764 | 1519 | 34591 | 825 | 25812 |
| 10L-2S | | MI | 8130 | 3282 | 12127 | 2740 | 14619 | 2281 | 16224 | 1908 | 18394 | 1314 | 22933 | 1134 | 13593 |
| 20-#11 | 2.71 | MA | 16357 | 3450 | 22516 | 3037 | 28181 | 2535 | 31670 | 2129 | 36115 | 1453 | 45808 | 912 | 34671 |
| 6E | | MI | 7711 | 3450 | 11534 | 2879 | 13747 | 2388 | 15073 | 1990 | 16769 | 1336 | 20595 | 761 | 15742 |
| 20-#11 | 2.71 | MA | 15988 | 3450 | 21755 | 3049 | 27127 | 2554 | 30473 | 2141 | 34508 | 1475 | 43660 | 872 | 33897 |
| 7L-5S | | MI | 7903 | 3450 | 11902 | 2860 | 14170 | 2378 | 15616 | 1973 | 17505 | 1323 | 21550 | 835 | 16002 |
| 20-#11 | 2.71 | MA | 15575 | 3450 | 21027 | 3063 | 26150 | 2566 | 29238 | 2161 | 32904 | 1490 | 41561 | 821 | 32730 |
| 8L-4S | | MI | 8065 | 3450 | 12228 | 2848 | 14617 | 2368 | 16170 | 1965 | 18273 | 1311 | 22590 | 901 | 16255 |
| 20-#11 | 2.71 | MA | 15127 | 3450 | 20292 | 3075 | 25202 | 2580 | 28041 | 2173 | 31294 | 1510 | 39393 | 756 | 31631 |
| 9L-3S | | MI | 8205 | 3450 | 12595 | 2836 | 15124 | 2350 | 16791 | 1949 | 19122 | 1307 | 23633 | 965 | 16300 |
| 20-#11 | 2.71 | MA | 14701 | 3450 | 19546 | 3086 | 24213 | 2603 | 26870 | 2185 | 29665 | 1529 | 37289 | 712 | 30354 |
| 10L-2S | | MI | 8471 | 3450 | 13120 | 2824 | 15791 | 2340 | 17600 | 1941 | 20213 | 1294 | 25112 | 1079 | 16323 |
| 20-#14 | 3.91 | MA | 17540 | 3850 | 25146 | 3326 | 31331 | 2769 | 35537 | 2291 | 41243 | 1491 | 53173 | 696 | 46385 |
| 7L-5S | | MI | 8598 | 3850 | 13669 | 3108 | 16318 | 2562 | 18181 | 2088 | 20928 | 1304 | 25972 | 644 | 22001 |
| 20-#14 | 3.91 | MA | 16961 | 3850 | 24100 | 3345 | 29929 | 2787 | 33766 | 2318 | 38940 | 1511 | 50155 | 621 | 44514 |
| 8L-4S | | MI | 8819 | 3850 | 14135 | 3092 | 16956 | 2549 | 18971 | 2078 | 22023 | 1287 | 27427 | 740 | 22592 |
| 20-#14 | 3.91 | MA | 16359 | 3850 | 23052 | 3363 | 28568 | 2805 | 32047 | 2335 | 36648 | 1542 | 47033 | 526 | 42472 |
| 9L-3S | | MI | 8998 | 3850 | 14657 | 3075 | 17679 | 2523 | 19856 | 2055 | 23232 | 1283 | 28891 | 830 | 22866 |
| 20-#14 | 3.91 | MA | 15802 | 3850 | 21982 | 3378 | 27149 | 2838 | 30366 | 2353 | 34311 | 1568 | 44007 | 461 | 40277 |
| 10L-2S | | MI | 9347 | 3850 | 15404 | 3059 | 18626 | 2510 | 21004 | 2045 | 24782 | 1266 | 30958 | 994 | 22937 |
| 20-#18 | 6.94 | MA | 20394 | 4865 | 31722 | 4063 | 39338 | 3345 | 45057 | 2716 | 53976 | 1559 | 71522 | 100 | 70950 |
| 8L-4S | | MI | 10630 | 4865 | 18751 | 3714 | 22648 | 3009 | 25803 | 2365 | 31184 | 1226 | 38773 | 274 | 37061 |
| 22-#10 | 2.43 | MA | 15862 | 3356 | 21257 | 2986 | 26605 | 2504 | 29889 | 2106 | 33801 | 1471 | 42638 | 947 | 31177 |
| 7L-6S | | MI | 7671 | 3356 | 11245 | 2832 | 13481 | 2357 | 14803 | 1973 | 16434 | 1343 | 20307 | 858 | 14520 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

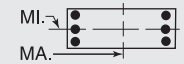



$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 2.43 | MA | 15518 | 3356 | 20659 | 2998 | 25804 | 2514 | 28877 | 2122 | 32486 | 1483 | 40922 | 907 | 30473 |
| 8L-5S | | MI | 7833 | 3356 | 11555 | 2817 | 13830 | 2348 | 15252 | 1958 | 17056 | 1338 | 21169 | 929 | 14760 |
| 22-#10 | 2.43 | MA | 15148 | 3356 | 20052 | 3007 | 25027 | 2526 | 27895 | 2132 | 31152 | 1500 | 39154 | 855 | 29619 |
| 9L-4S | | MI | 7973 | 3356 | 11824 | 2807 | 14200 | 2339 | 15710 | 1951 | 17691 | 1327 | 22052 | 983 | 14848 |
| 22-#10 | 2.43 | MA | 14799 | 3356 | 19440 | 3017 | 24217 | 2545 | 26936 | 2143 | 29817 | 1515 | 37434 | 820 | 28720 |
| 10L-3S | | MI | 8091 | 3356 | 12127 | 2796 | 14619 | 2323 | 16224 | 1936 | 18394 | 1322 | 22933 | 1037 | 14876 |
| 22-#10 | 2.43 | MA | 14460 | 3356 | 18751 | 3034 | 23416 | 2553 | 25962 | 2161 | 28470 | 1525 | 35764 | 778 | 27804 |
| 11L-2S | | MI | 8318 | 3356 | 12564 | 2786 | 15174 | 2314 | 16896 | 1929 | 19301 | 1311 | 24188 | 1129 | 14890 |
| 22-#11 | 2.98 | MA | 16585 | 3541 | 22959 | 3105 | 28655 | 2595 | 32324 | 2167 | 37007 | 1471 | 47121 | 866 | 37451 |
| 7L-6S | | MI | 7945 | 3541 | 12060 | 2935 | 14414 | 2430 | 15881 | 2016 | 17860 | 1332 | 22074 | 752 | 17260 |
| 22-#11 | 2.98 | MA | 16176 | 3541 | 22231 | 3119 | 27678 | 2608 | 31090 | 2187 | 35403 | 1485 | 45022 | 815 | 36274 |
| 8L-5S | | MI | 8134 | 3541 | 12427 | 2916 | 14837 | 2420 | 16425 | 2000 | 18596 | 1319 | 23028 | 826 | 17510 |
| 22-#11 | 2.98 | MA | 15742 | 3541 | 21496 | 3131 | 26730 | 2621 | 29892 | 2199 | 33793 | 1506 | 42854 | 750 | 35164 |
| 9L-4S | | MI | 8295 | 3541 | 12754 | 2905 | 15284 | 2410 | 16979 | 1992 | 19364 | 1306 | 24069 | 892 | 17800 |
| 22-#11 | 2.98 | MA | 15343 | 3541 | 20749 | 3142 | 25741 | 2644 | 28721 | 2212 | 32165 | 1525 | 40749 | 706 | 33891 |
| 10L-3S | | MI | 8430 | 3541 | 13120 | 2893 | 15791 | 2391 | 17600 | 1975 | 20213 | 1302 | 25112 | 956 | 17853 |
| 22-#11 | 2.98 | MA | 14928 | 3541 | 19910 | 3163 | 24772 | 2655 | 27533 | 2234 | 30521 | 1536 | 38707 | 652 | 32567 |
| 11L-2S | | MI | 8691 | 3541 | 13646 | 2881 | 16458 | 2381 | 18408 | 1967 | 21304 | 1290 | 26590 | 1069 | 17881 |
| 22-#14 | 4.30 | MA | 17796 | 3981 | 25825 | 3427 | 32118 | 2846 | 36419 | 2356 | 42521 | 1505 | 55114 | 612 | 49560 |
| 8L-5S | | MI | 8915 | 3981 | 14415 | 3189 | 17265 | 2622 | 19329 | 2126 | 22477 | 1298 | 28039 | 627 | 24153 |
| 22-#14 | 4.30 | MA | 17216 | 3981 | 24777 | 3445 | 30757 | 2865 | 34700 | 2372 | 40229 | 1535 | 51992 | 518 | 47526 |
| 9L-4S | | MI | 9135 | 3981 | 14881 | 3173 | 17903 | 2608 | 20119 | 2116 | 23573 | 1281 | 29494 | 723 | 24720 |
| 22-#14 | 4.30 | MA | 16683 | 3981 | 23706 | 3460 | 29338 | 2897 | 33019 | 2391 | 37892 | 1562 | 48965 | 453 | 45318 |
| 10L-3S | | MI | 9307 | 3981 | 15404 | 3157 | 18626 | 2583 | 21004 | 2093 | 24782 | 1276 | 30958 | 813 | 25062 |
| 24-#10 | 2.65 | MA | 16015 | 3430 | 21648 | 3044 | 27059 | 2548 | 30398 | 2143 | 34540 | 1479 | 43765 | 902 | 33386 |
| 8L-6S | | MI | 7869 | 3430 | 11682 | 2878 | 14035 | 2391 | 15475 | 1994 | 17341 | 1340 | 21561 | 853 | 15784 |
| 24-#10 | 2.65 | MA | 15654 | 3430 | 21041 | 3053 | 26282 | 2559 | 29417 | 2153 | 33205 | 1496 | 41997 | 850 | 32534 |
| 9L-5S | | MI | 8027 | 3430 | 11992 | 2863 | 14385 | 2382 | 15924 | 1980 | 17963 | 1335 | 22424 | 924 | 16016 |
| 24-#10 | 2.65 | MA | 15317 | 3430 | 20429 | 3063 | 25472 | 2578 | 28457 | 2164 | 31871 | 1512 | 40277 | 815 | 31627 |
| 10L-4S | | MI | 8167 | 3430 | 12261 | 2853 | 14754 | 2373 | 16382 | 1972 | 18598 | 1323 | 23307 | 978 | 16135 |
| 24-#10 | 2.65 | MA | 14982 | 3430 | 19740 | 3080 | 24671 | 2587 | 27483 | 2183 | 30524 | 1521 | 38608 | 773 | 30714 |
| 11L-3S | | MI | 8282 | 3430 | 12564 | 2842 | 15174 | 2357 | 16896 | 1958 | 19301 | 1319 | 24188 | 1032 | 16169 |
| 24-#10 | 2.65 | MA | 14602 | 3430 | 19148 | 3091 | 23883 | 2597 | 26531 | 2194 | 29209 | 1538 | 36925 | 736 | 29663 |
| 12L-2S | | MI | 8504 | 3430 | 13001 | 2832 | 15728 | 2348 | 17568 | 1950 | 20208 | 1307 | 25442 | 1124 | 16187 |
| 24-#11 | 3.25 | MA | 16767 | 3631 | 23434 | 3176 | 29206 | 2649 | 32942 | 2213 | 37902 | 1481 | 48482 | 809 | 39817 |
| 8L-6S | | MI | 8177 | 3631 | 12585 | 2992 | 15081 | 2471 | 16689 | 2042 | 18951 | 1328 | 23552 | 742 | 18781 |
| 24-#11 | 3.25 | MA | 16345 | 3631 | 22700 | 3188 | 28257 | 2662 | 31744 | 2225 | 36292 | 1502 | 46315 | 744 | 38696 |
| 9L-5S | | MI | 8361 | 3631 | 12953 | 2973 | 15504 | 2461 | 17233 | 2026 | 19687 | 1315 | 24506 | 816 | 19022 |
| 24-#11 | 3.25 | MA | 15959 | 3631 | 21953 | 3199 | 27269 | 2685 | 30573 | 2238 | 34664 | 1521 | 44210 | 700 | 37427 |
| 10L-4S | | MI | 8522 | 3631 | 13279 | 2961 | 15951 | 2451 | 17787 | 2018 | 20455 | 1302 | 25547 | 882 | 19345 |
| 24-#11 | 3.25 | MA | 15552 | 3631 | 21113 | 3220 | 26300 | 2696 | 29385 | 2260 | 33020 | 1532 | 42168 | 646 | 36095 |
| 11L-3S | | MI | 8653 | 3631 | 13646 | 2949 | 16458 | 2433 | 18408 | 2001 | 21304 | 1298 | 26590 | 946 | 19404 |
| 24-#11 | 3.25 | MA | 15103 | 3631 | 20391 | 3233 | 25340 | 2708 | 28234 | 2274 | 31417 | 1552 | 40103 | 601 | 34749 |
| 12L-2S | | MI | 8908 | 3631 | 14171 | 2937 | 17125 | 2423 | 19216 | 1993 | 22395 | 1285 | 28068 | 1060 | 19438 |
| 24-#14 | 4.69 | MA | 18057 | 4111 | 26502 | 3526 | 32946 | 2925 | 37353 | 2410 | 43810 | 1529 | 56950 | 509 | 52579 |
| 9L-5S | | MI | 9228 | 4111 | 15161 | 3271 | 18213 | 2681 | 20477 | 2164 | 24027 | 1291 | 30106 | 610 | 26309 |
| 24-#14 | 4.69 | MA | 17545 | 4111 | 25431 | 3541 | 31527 | 2957 | 35672 | 2428 | 41473 | 1556 | 53923 | 444 | 50359 |
| 10L-4S | | MI | 9448 | 4111 | 15628 | 3255 | 18850 | 2668 | 21267 | 2153 | 25122 | 1275 | 31562 | 705 | 26854 |

## RECTANGULAR TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.86 | MA | 300 | 318 | 495 | 227 | 531 | 189 | 542 | 156 | 547 | 103 | 575 | 65 | 378 |
| 2L-3S | | MI | 286 | 318 | 464 | 227 | 492 | 190 | 497 | 157 | 490 | 104 | 514 | 43 | 382 |
| 6-#6 | 2.64 | MA | 313 | 341 | 533 | 240 | 573 | 196 | 591 | 159 | 608 | 96 | 651 | 52 | 499 |
| 2L-3S | | MI | 294 | 341 | 490 | 239 | 520 | 198 | 529 | 160 | 530 | 98 | 565 | 21 | 505 |
| 6-#7 | 3.60 | MA | 328 | 368 | 577 | 255 | 622 | 205 | 647 | 162 | 680 | 87 | 725 | 30 | 641 |
| 2L-3S | | MI | 304 | 368 | 520 | 254 | 553 | 207 | 567 | 164 | 577 | 89 | 613 | -12 | 614 |

## RECTANGULAR TIED COLUMNS 10" x 12"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#5 | 1.03 | MA | 416 | 354 | 650 | 266 | 703 | 224 | 723 | 191 | 720 | 140 | 777 | 110 | 341 |
| 2E | | MI | 342 | 354 | 545 | 255 | 575 | 214 | 579 | 181 | 565 | 130 | 593 | 97 | 286 |
| 4-#6 | 1.47 | MA | 429 | 368 | 686 | 274 | 746 | 230 | 774 | 194 | 782 | 137 | 845 | 101 | 455 |
| 2E | | MI | 350 | 368 | 570 | 263 | 603 | 219 | 611 | 182 | 605 | 125 | 643 | 88 | 374 |
| 4-#7 | 2.00 | MA | 444 | 387 | 728 | 284 | 797 | 237 | 832 | 198 | 856 | 132 | 925 | 89 | 589 |
| 2E | | MI | 360 | 387 | 601 | 272 | 636 | 224 | 648 | 184 | 652 | 118 | 691 | 73 | 476 |
| 4-#8 | 2.63 | MA | 461 | 408 | 776 | 296 | 857 | 245 | 899 | 202 | 940 | 127 | 1014 | 74 | 741 |
| 2E | | MI | 372 | 408 | 635 | 284 | 673 | 230 | 690 | 185 | 704 | 110 | 743 | 54 | 590 |
| 4-#9 | 3.33 | MA | 479 | 432 | 828 | 309 | 920 | 255 | 969 | 205 | 1029 | 120 | 1105 | 56 | 902 |
| 2E | | MI | 383 | 432 | 668 | 296 | 710 | 237 | 732 | 186 | 758 | 100 | 794 | 31 | 708 |
| 4-#10 | 4.23 | MA | 501 | 463 | 892 | 327 | 999 | 267 | 1055 | 210 | 1137 | 112 | 1214 | 32 | 1101 |
| 2E | | MI | 398 | 463 | 707 | 311 | 754 | 245 | 783 | 187 | 822 | 87 | 852 | 0 | 852 |
| 4-#11 | 5.20 | MA | 516 | 496 | 948 | 342 | 1046 | 273 | 1106 | 208 | 1201 | 94 | 1299 | 6 | 1278 |
| 2E | | MI | 406 | 496 | 724 | 318 | 770 | 245 | 799 | 179 | 842 | 63 | 842 | -53 | 868 |
| 6-#5 | 1.55 | MA | 433 | 371 | 693 | 277 | 757 | 232 | 788 | 196 | 803 | 138 | 873 | 102 | 478 |
| 2L-3S | | MI | 339 | 371 | 545 | 266 | 575 | 223 | 579 | 186 | 565 | 127 | 593 | 64 | 396 |
| 6-#5 | 1.55 | MA | 413 | 371 | 650 | 278 | 703 | 232 | 723 | 198 | 720 | 139 | 777 | 79 | 483 |
| 3L-2S | | MI | 353 | 371 | 576 | 266 | 613 | 222 | 624 | 185 | 622 | 126 | 653 | 85 | 392 |
| 6-#6 | 2.20 | MA | 452 | 394 | 745 | 290 | 821 | 241 | 865 | 202 | 898 | 133 | 976 | 88 | 642 |
| 2L-3S | | MI | 347 | 394 | 570 | 277 | 603 | 231 | 611 | 189 | 605 | 120 | 643 | 41 | 523 |
| 6-#6 | 2.20 | MA | 426 | 394 | 686 | 290 | 746 | 241 | 774 | 203 | 782 | 135 | 845 | 57 | 648 |
| 3L-2S | | MI | 366 | 394 | 614 | 278 | 656 | 229 | 672 | 187 | 683 | 119 | 730 | 72 | 516 |
| 6-#7 | 3.00 | MA | 474 | 421 | 807 | 305 | 898 | 252 | 953 | 207 | 1010 | 127 | 1097 | 71 | 835 |
| 2L-3S | | MI | 357 | 421 | 601 | 292 | 636 | 240 | 648 | 192 | 652 | 112 | 691 | 8 | 668 |
| 6-#7 | 3.00 | MA | 440 | 421 | 728 | 306 | 797 | 251 | 832 | 209 | 856 | 129 | 925 | 28 | 839 |
| 3L-2S | | MI | 381 | 421 | 658 | 294 | 705 | 238 | 728 | 190 | 754 | 110 | 803 | 50 | 661 |
| 6-#8 | 3.95 | MA | 457 | 454 | 776 | 324 | 857 | 264 | 899 | 216 | 940 | 122 | 1014 | -8 | 1012 |
| 3L-2S | | MI | 398 | 454 | 709 | 312 | 760 | 248 | 791 | 193 | 834 | 98 | 882 | 22 | 823 |
| 6-#9 | 5.00 | MA | 475 | 490 | 828 | 345 | 920 | 278 | 969 | 223 | 1029 | 114 | 1105 | -49 | 1097 |
| 3L-2S | | MI | 416 | 490 | 757 | 331 | 816 | 259 | 855 | 195 | 915 | 84 | 960 | -12 | 964 |
| 6-#10 | 6.35 | MA | 498 | 536 | 892 | 371 | 999 | 296 | 1055 | 232 | 1137 | 102 | 1214 | -104 | 1197 |
| 3L-2S | | MI | 438 | 536 | 815 | 354 | 883 | 272 | 932 | 198 | 1013 | 64 | 1049 | -58 | 1030 |

## RECTANGULAR TIED COLUMNS 10" x 14"

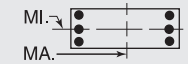
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.26 | MA | 583 | 422 | 907 | 324 | 998 | 272 | 1040 | 231 | 1068 | 169 | 1178 | 134 | 550 |
| 2E | | MI | 403 | 422 | 651 | 301 | 686 | 251 | 692 | 211 | 680 | 148 | 721 | 108 | 388 |
| 4-#7 | 1.71 | MA | 603 | 440 | 961 | 333 | 1064 | 279 | 1119 | 235 | 1170 | 166 | 1294 | 125 | 718 |
| 2E | | MI | 413 | 440 | 682 | 310 | 719 | 256 | 729 | 212 | 726 | 141 | 769 | 93 | 492 |
| 4-#8 | 2.26 | MA | 627 | 461 | 1024 | 345 | 1141 | 287 | 1211 | 240 | 1287 | 163 | 1427 | 114 | 911 |
| 2E | | MI | 425 | 461 | 716 | 322 | 755 | 262 | 771 | 213 | 779 | 133 | 820 | 73 | 609 |
| 4-#9 | 2.86 | MA | 651 | 485 | 1091 | 359 | 1224 | 297 | 1311 | 246 | 1412 | 158 | 1565 | 101 | 1118 |
| 2E | | MI | 436 | 485 | 749 | 333 | 793 | 269 | 813 | 214 | 832 | 123 | 871 | 51 | 730 |
| 4-#10 | 3.63 | MA | 681 | 516 | 1176 | 376 | 1328 | 310 | 1436 | 254 | 1566 | 152 | 1735 | 83 | 1375 |
| 2E | | MI | 451 | 516 | 788 | 348 | 837 | 276 | 863 | 215 | 896 | 109 | 928 | 19 | 876 |
| 4-#11 | 4.46 | MA | 704 | 549 | 1254 | 392 | 1420 | 320 | 1535 | 257 | 1676 | 139 | 1830 | 51 | 1615 |
| 2E | | MI | 459 | 549 | 806 | 355 | 853 | 276 | 879 | 206 | 915 | 84 | 917 | -34 | 935 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 10" x 14"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

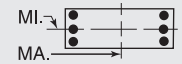
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.33 | MA | 588 | 424 | 915 | 327 | 1010 | 275 | 1056 | 233 | 1095 | 171 | 1213 | 135 | 578 |
| 2L-3S | | MI | 392 | 424 | 625 | 305 | 658 | 256 | 660 | 215 | 640 | 150 | 672 | 84 | 409 |
| 6-#5 | 1.33 | MA | 562 | 424 | 861 | 328 | 943 | 275 | 974 | 236 | 983 | 172 | 1080 | 113 | 583 |
| 3L-2S | | MI | 406 | 424 | 656 | 305 | 696 | 255 | 705 | 214 | 697 | 149 | 732 | 105 | 405 |
| 6-#6 | 1.89 | MA | 613 | 447 | 981 | 339 | 1093 | 283 | 1155 | 239 | 1223 | 168 | 1361 | 125 | 785 |
| 2L-3S | | MI | 400 | 447 | 651 | 316 | 686 | 264 | 692 | 217 | 680 | 143 | 721 | 61 | 540 |
| 6-#6 | 1.89 | MA | 578 | 447 | 907 | 341 | 998 | 284 | 1040 | 241 | 1068 | 169 | 1178 | 93 | 791 |
| 3L-2S | | MI | 419 | 447 | 694 | 317 | 739 | 262 | 753 | 216 | 758 | 142 | 808 | 92 | 532 |
| 6-#7 | 2.57 | MA | 644 | 474 | 1062 | 355 | 1192 | 295 | 1274 | 245 | 1376 | 164 | 1537 | 112 | 1030 |
| 2L-3S | | MI | 409 | 474 | 682 | 330 | 719 | 273 | 729 | 221 | 726 | 134 | 769 | 28 | 689 |
| 6-#7 | 2.57 | MA | 598 | 474 | 961 | 357 | 1064 | 295 | 1119 | 249 | 1170 | 166 | 1294 | 69 | 1034 |
| 3L-2S | | MI | 434 | 474 | 739 | 332 | 788 | 271 | 810 | 219 | 829 | 132 | 881 | 70 | 680 |
| 6-#8 | 3.39 | MA | 622 | 507 | 1024 | 376 | 1141 | 309 | 1211 | 257 | 1287 | 161 | 1427 | 39 | 1308 |
| 3L-2S | | MI | 451 | 507 | 790 | 350 | 843 | 280 | 872 | 221 | 908 | 120 | 960 | 41 | 845 |
| 6-#9 | 4.29 | MA | 647 | 543 | 1091 | 397 | 1224 | 323 | 1311 | 267 | 1412 | 156 | 1565 | 4 | 1557 |
| 3L-2S | | MI | 469 | 543 | 839 | 368 | 899 | 291 | 936 | 223 | 989 | 106 | 1037 | 7 | 1017 |
| 6-#10 | 5.44 | MA | 678 | 589 | 1176 | 424 | 1328 | 342 | 1436 | 279 | 1566 | 148 | 1735 | -42 | 1716 |
| 3L-2S | | MI | 491 | 589 | 897 | 391 | 966 | 303 | 1013 | 225 | 1086 | 87 | 1126 | -39 | 1140 |
| 6-#11 | 6.69 | MA | 702 | 638 | 1254 | 449 | 1420 | 358 | 1535 | 287 | 1676 | 131 | 1830 | -108 | 1793 |
| 3L-2S | | MI | 504 | 638 | 922 | 405 | 990 | 305 | 1038 | 215 | 1118 | 51 | 1113 | -117 | 1124 |
| 8-#5 | 1.77 | MA | 584 | 442 | 915 | 339 | 1010 | 283 | 1056 | 241 | 1095 | 171 | 1213 | 107 | 750 |
| 3E | | MI | 404 | 442 | 656 | 316 | 696 | 264 | 705 | 219 | 697 | 146 | 732 | 72 | 513 |
| 8-#5 | 1.77 | MA | 570 | 442 | 877 | 340 | 957 | 286 | 991 | 241 | 1009 | 172 | 1117 | 97 | 753 |
| 4L-2S | | MI | 418 | 442 | 687 | 316 | 735 | 263 | 750 | 218 | 754 | 145 | 792 | 93 | 508 |
| 8-#6 | 2.51 | MA | 609 | 472 | 981 | 356 | 1093 | 295 | 1155 | 248 | 1223 | 167 | 1361 | 84 | 1019 |
| 3E | | MI | 416 | 472 | 694 | 332 | 739 | 274 | 753 | 223 | 758 | 137 | 808 | 45 | 678 |
| 8-#6 | 2.51 | MA | 590 | 472 | 928 | 358 | 1018 | 299 | 1063 | 248 | 1104 | 169 | 1228 | 71 | 997 |
| 4L-2S | | MI | 435 | 472 | 738 | 333 | 792 | 273 | 815 | 221 | 836 | 136 | 895 | 76 | 672 |
| 8-#7 | 3.43 | MA | 641 | 508 | 1062 | 378 | 1192 | 311 | 1274 | 258 | 1376 | 163 | 1537 | 56 | 1335 |
| 3E | | MI | 431 | 508 | 739 | 352 | 788 | 287 | 810 | 227 | 829 | 126 | 881 | 5 | 867 |
| 8-#7 | 3.43 | MA | 614 | 508 | 990 | 380 | 1091 | 315 | 1151 | 258 | 1218 | 165 | 1360 | 38 | 1243 |
| 4L-2S | | MI | 455 | 508 | 797 | 353 | 858 | 285 | 890 | 225 | 931 | 124 | 993 | 47 | 861 |
| 8-#8 | 4.51 | MA | 645 | 552 | 1061 | 406 | 1176 | 335 | 1252 | 269 | 1349 | 160 | 1510 | -3 | 1510 |
| 4L-2S | | MI | 477 | 552 | 864 | 378 | 931 | 299 | 974 | 229 | 1038 | 108 | 1099 | 9 | 1074 |
| 8-#9 | 5.71 | MA | 677 | 600 | 1137 | 435 | 1267 | 356 | 1361 | 281 | 1488 | 153 | 1667 | -49 | 1659 |
| 4L-2S | | MI | 501 | 600 | 928 | 403 | 1006 | 313 | 1060 | 233 | 1147 | 89 | 1203 | -36 | 1214 |

## RECTANGULAR TIED COLUMNS 10" x 16"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.10 | MA | 758 | 475 | 1153 | 373 | 1280 | 314 | 1338 | 268 | 1379 | 199 | 1550 | 165 | 645 |
| 2E | | MI | 456 | 475 | 732 | 340 | 769 | 284 | 773 | 240 | 755 | 171 | 799 | 128 | 400 |
| 4-#7 | 1.50 | MA | 784 | 493 | 1219 | 383 | 1361 | 321 | 1435 | 272 | 1509 | 197 | 1704 | 158 | 848 |
| 2E | | MI | 466 | 493 | 763 | 349 | 802 | 289 | 810 | 240 | 801 | 164 | 846 | 113 | 507 |
| 4-#8 | 1.98 | MA | 814 | 515 | 1296 | 395 | 1456 | 330 | 1549 | 277 | 1661 | 195 | 1882 | 150 | 1082 |
| 2E | | MI | 478 | 515 | 797 | 360 | 838 | 295 | 852 | 241 | 853 | 155 | 898 | 93 | 626 |
| 4-#9 | 2.50 | MA | 846 | 539 | 1380 | 409 | 1559 | 339 | 1671 | 283 | 1826 | 193 | 2069 | 139 | 1334 |
| 2E | | MI | 489 | 539 | 830 | 371 | 875 | 301 | 894 | 242 | 906 | 145 | 947 | 70 | 750 |
| 4-#10 | 3.17 | MA | 886 | 569 | 1484 | 426 | 1688 | 352 | 1827 | 291 | 2032 | 189 | 2302 | 126 | 1649 |
| 2E | | MI | 504 | 569 | 870 | 385 | 920 | 308 | 944 | 243 | 969 | 131 | 1005 | 39 | 900 |
| 4-#11 | 3.90 | MA | 916 | 602 | 1586 | 442 | 1807 | 363 | 1967 | 296 | 2190 | 179 | 2460 | 101 | 1952 |
| 2E | | MI | 512 | 602 | 888 | 391 | 935 | 306 | 959 | 233 | 987 | 106 | 992 | -15 | 1000 |
| 6-#5 | 1.16 | MA | 764 | 477 | 1161 | 377 | 1295 | 317 | 1358 | 270 | 1407 | 200 | 1592 | 166 | 679 |
| 2L-3S | | MI | 445 | 477 | 706 | 343 | 740 | 289 | 742 | 244 | 715 | 173 | 750 | 104 | 421 |
| 6-#5 | 1.16 | MA | 732 | 477 | 1097 | 378 | 1213 | 318 | 1258 | 273 | 1272 | 202 | 1421 | 144 | 684 |
| 3L-2S | | MI | 459 | 477 | 737 | 344 | 779 | 288 | 787 | 243 | 772 | 172 | 811 | 125 | 417 |
| 6-#6 | 1.65 | MA | 797 | 500 | 1243 | 389 | 1395 | 326 | 1478 | 276 | 1568 | 198 | 1787 | 158 | 927 |
| 2L-3S | | MI | 453 | 500 | 732 | 354 | 769 | 296 | 773 | 246 | 755 | 166 | 799 | 81 | 554 |
| 6-#6 | 1.65 | MA | 752 | 500 | 1153 | 391 | 1280 | 327 | 1338 | 279 | 1379 | 200 | 1550 | 127 | 933 |
| 3L-2S | | MI | 472 | 500 | 775 | 355 | 822 | 295 | 835 | 245 | 833 | 165 | 886 | 112 | 547 |

## RECTANGULAR TIED COLUMNS 10" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 2.25 | MA | 835 | 527 | 1341 | 405 | 1516 | 337 | 1624 | 282 | 1764 | 195 | 2020 | 149 | 1224 |
| 2L-3S | | MI | 462 | 527 | 763 | 368 | 802 | 305 | 810 | 249 | 801 | 157 | 846 | 48 | 707 |
| 6-#7 | 2.25 | MA | 777 | 527 | 1219 | 407 | 1361 | 339 | 1435 | 287 | 1509 | 198 | 1704 | 106 | 1228 |
| 3L-2S | | MI | 487 | 527 | 820 | 370 | 871 | 303 | 891 | 247 | 903 | 155 | 958 | 89 | 698 |
| 6-#8 | 2.96 | MA | 806 | 560 | 1296 | 427 | 1456 | 353 | 1549 | 296 | 1661 | 196 | 1882 | 80 | 1564 |
| 3L-2S | | MI | 504 | 560 | 871 | 388 | 926 | 313 | 953 | 249 | 982 | 143 | 1037 | 61 | 865 |
| 6-#9 | 3.75 | MA | 838 | 596 | 1380 | 448 | 1559 | 368 | 1671 | 306 | 1826 | 193 | 2069 | 50 | 1919 |
| 3L-2S | | MI | 522 | 596 | 920 | 406 | 982 | 323 | 1017 | 251 | 1063 | 128 | 1114 | 27 | 1040 |
| 6-#10 | 4.76 | MA | 882 | 642 | 1484 | 476 | 1688 | 387 | 1827 | 320 | 2032 | 189 | 2302 | 10 | 2280 |
| 3L-2S | | MI | 544 | 642 | 978 | 429 | 1049 | 335 | 1093 | 253 | 1160 | 109 | 1202 | -19 | 1210 |
| 6-#11 | 5.85 | MA | 915 | 692 | 1586 | 502 | 1807 | 404 | 1967 | 330 | 2190 | 176 | 2460 | -47 | 2428 |
| 3L-2S | | MI | 557 | 692 | 1004 | 441 | 1073 | 336 | 1118 | 242 | 1191 | 73 | 1188 | -98 | 1233 |
| 8-#5 | 1.55 | MA | 760 | 495 | 1161 | 389 | 1295 | 326 | 1358 | 278 | 1407 | 201 | 1592 | 139 | 884 |
| 3E | | MI | 457 | 495 | 737 | 355 | 779 | 297 | 787 | 248 | 772 | 169 | 811 | 92 | 527 |
| 8-#5 | 1.55 | MA | 743 | 495 | 1116 | 391 | 1231 | 329 | 1280 | 279 | 1300 | 201 | 1470 | 128 | 887 |
| 4L-2S | | MI | 471 | 495 | 768 | 355 | 818 | 296 | 831 | 247 | 829 | 168 | 871 | 113 | 522 |
| 8-#6 | 2.20 | MA | 792 | 525 | 1243 | 407 | 1395 | 339 | 1478 | 286 | 1568 | 199 | 1787 | 120 | 1209 |
| 3E | | MI | 469 | 525 | 775 | 370 | 822 | 307 | 835 | 251 | 833 | 160 | 886 | 65 | 695 |
| 8-#6 | 2.20 | MA | 768 | 525 | 1179 | 409 | 1306 | 343 | 1368 | 287 | 1418 | 198 | 1617 | 105 | 1205 |
| 4L-2S | | MI | 488 | 525 | 818 | 371 | 875 | 306 | 896 | 250 | 911 | 159 | 973 | 96 | 689 |
| 8-#7 | 3.00 | MA | 830 | 561 | 1341 | 429 | 1516 | 354 | 1624 | 297 | 1764 | 196 | 2020 | 96 | 1594 |
| 3E | | MI | 484 | 561 | 820 | 390 | 871 | 319 | 891 | 255 | 903 | 148 | 958 | 25 | 889 |
| 8-#7 | 3.00 | MA | 799 | 561 | 1255 | 432 | 1396 | 360 | 1476 | 298 | 1569 | 199 | 1793 | 75 | 1514 |
| 4L-2S | | MI | 508 | 561 | 878 | 391 | 940 | 317 | 971 | 253 | 1006 | 146 | 1070 | 66 | 881 |
| 8-#8 | 3.95 | MA | 835 | 605 | 1342 | 458 | 1500 | 380 | 1601 | 310 | 1739 | 197 | 1996 | 40 | 1855 |
| 4L-2S | | MI | 531 | 605 | 945 | 416 | 1014 | 331 | 1055 | 257 | 1112 | 130 | 1177 | 29 | 1097 |
| 8-#9 | 5.00 | MA | 875 | 653 | 1437 | 488 | 1613 | 403 | 1736 | 323 | 1923 | 194 | 2209 | -1 | 2209 |
| 4L-2S | | MI | 554 | 653 | 1010 | 441 | 1088 | 345 | 1141 | 260 | 1220 | 112 | 1280 | -16 | 1286 |
| 8-#10 | 6.35 | MA | 932 | 714 | 1555 | 526 | 1756 | 431 | 1907 | 340 | 2152 | 189 | 2473 | -55 | 2447 |
| 4L-2S | | MI | 584 | 714 | 1087 | 472 | 1178 | 362 | 1243 | 263 | 1350 | 86 | 1399 | -77 | 1374 |

## RECTANGULAR TIED COLUMNS 10" x 18"

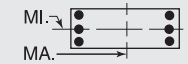
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.33 | MA | 987 | 546 | 1502 | 433 | 1689 | 364 | 1784 | 309 | 1873 | 227 | 2154 | 189 | 978 |
| 2E | | MI | 520 | 546 | 843 | 387 | 884 | 322 | 892 | 269 | 875 | 186 | 924 | 132 | 522 |
| 4-#8 | 1.76 | MA | 1024 | 568 | 1594 | 445 | 1802 | 372 | 1919 | 314 | 2054 | 225 | 2377 | 183 | 1253 |
| 2E | | MI | 531 | 568 | 878 | 398 | 921 | 327 | 933 | 270 | 927 | 177 | 975 | 113 | 643 |
| 4-#9 | 2.22 | MA | 1063 | 592 | 1693 | 458 | 1924 | 382 | 2065 | 320 | 2250 | 222 | 2615 | 175 | 1550 |
| 2E | | MI | 543 | 592 | 912 | 408 | 958 | 333 | 974 | 270 | 980 | 167 | 1024 | 90 | 769 |
| 4-#10 | 2.82 | MA | 1111 | 622 | 1817 | 476 | 2078 | 394 | 2250 | 327 | 2499 | 220 | 2912 | 164 | 1924 |
| 2E | | MI | 557 | 622 | 951 | 422 | 1002 | 340 | 1025 | 270 | 1043 | 153 | 1081 | 58 | 922 |
| 4-#11 | 3.47 | MA | 1152 | 655 | 1942 | 492 | 2225 | 405 | 2423 | 333 | 2728 | 215 | 3135 | 144 | 2289 |
| 2E | | MI | 565 | 656 | 970 | 427 | 1018 | 337 | 1039 | 260 | 1060 | 127 | 1067 | 4 | 1057 |
| 6-#5 | 1.03 | MA | 962 | 530 | 1433 | 426 | 1610 | 359 | 1692 | 307 | 1751 | 230 | 2009 | 196 | 779 |
| 2L-3S | | MI | 498 | 530 | 786 | 382 | 823 | 322 | 823 | 273 | 790 | 196 | 829 | 124 | 431 |
| 6-#5 | 1.03 | MA | 923 | 530 | 1358 | 428 | 1514 | 361 | 1575 | 311 | 1593 | 232 | 1801 | 173 | 784 |
| 3L-2S | | MI | 513 | 530 | 817 | 383 | 862 | 321 | 868 | 272 | 847 | 195 | 889 | 145 | 429 |
| 6-#6 | 1.47 | MA | 1002 | 553 | 1529 | 439 | 1728 | 368 | 1833 | 313 | 1941 | 227 | 2252 | 190 | 1070 |
| 2L-3S | | MI | 506 | 553 | 813 | 393 | 852 | 329 | 855 | 275 | 829 | 189 | 878 | 101 | 568 |
| 6-#6 | 1.47 | MA | 949 | 553 | 1423 | 441 | 1593 | 370 | 1670 | 317 | 1719 | 231 | 1961 | 158 | 1076 |
| 3L-2S | | MI | 525 | 553 | 856 | 394 | 905 | 328 | 916 | 273 | 907 | 187 | 964 | 132 | 562 |
| 6-#7 | 2.00 | MA | 1049 | 580 | 1645 | 454 | 1872 | 379 | 2006 | 319 | 2173 | 225 | 2543 | 183 | 1418 |
| 2L-3S | | MI | 515 | 580 | 843 | 407 | 884 | 338 | 892 | 277 | 875 | 179 | 924 | 68 | 724 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 10" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

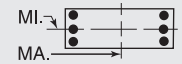
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 2.00 | MA | 979 | 580 | 1502 | 458 | 1689 | 382 | 1784 | 325 | 1873 | 229 | 2154 | 139 | 1423 |
| 3L-2S | | MI | 540 | 580 | 901 | 408 | 954 | 336 | 972 | 275 | 978 | 177 | 1036 | 109 | 714 |
| 6-#8 | 2.63 | MA | 1015 | 613 | 1594 | 478 | 1802 | 396 | 1919 | 335 | 2054 | 227 | 2377 | 116 | 1820 |
| 3L-2S | | MI | 557 | 613 | 952 | 426 | 1009 | 345 | 1034 | 278 | 1057 | 165 | 1114 | 81 | 885 |
| 6-#9 | 3.33 | MA | 1053 | 649 | 1693 | 499 | 1924 | 412 | 2065 | 345 | 2250 | 225 | 2615 | 90 | 2243 |
| 3L-2S | | MI | 575 | 649 | 1001 | 443 | 1065 | 355 | 1098 | 279 | 1137 | 151 | 1191 | 47 | 1063 |
| 6-#10 | 4.23 | MA | 1102 | 695 | 1817 | 528 | 2078 | 432 | 2250 | 359 | 2499 | 222 | 2912 | 55 | 2767 |
| 3L-2S | | MI | 597 | 695 | 1060 | 466 | 1131 | 367 | 1174 | 281 | 1233 | 131 | 1278 | 0 | 1278 |
| 6-#11 | 5.20 | MA | 1150 | 745 | 1942 | 554 | 2225 | 450 | 2423 | 370 | 2728 | 216 | 3135 | 5 | 3124 |
| 3L-2S | | MI | 609 | 745 | 1086 | 477 | 1155 | 367 | 1198 | 269 | 1263 | 94 | 1263 | -79 | 1302 |
| 8-#5 | 1.38 | MA | 958 | 548 | 1433 | 439 | 1610 | 369 | 1692 | 316 | 1751 | 231 | 2009 | 170 | 1017 |
| 3E | | MI | 510 | 548 | 817 | 393 | 862 | 330 | 868 | 276 | 847 | 192 | 889 | 112 | 540 |
| 8-#5 | 1.38 | MA | 937 | 548 | 1381 | 441 | 1536 | 373 | 1601 | 317 | 1627 | 231 | 1862 | 158 | 1021 |
| 4L-2S | | MI | 524 | 548 | 848 | 394 | 901 | 329 | 913 | 275 | 904 | 191 | 950 | 133 | 536 |
| 8-#6 | 1.96 | MA | 996 | 578 | 1529 | 457 | 1728 | 382 | 1833 | 324 | 1941 | 229 | 2252 | 154 | 1399 |
| 3E | | MI | 522 | 578 | 856 | 409 | 905 | 340 | 916 | 280 | 907 | 183 | 964 | 85 | 712 |
| 8-#6 | 1.96 | MA | 968 | 578 | 1455 | 460 | 1624 | 387 | 1706 | 326 | 1767 | 229 | 2046 | 137 | 1396 |
| 4L-2S | | MI | 541 | 578 | 899 | 410 | 958 | 338 | 977 | 278 | 985 | 181 | 1051 | 116 | 705 |
| 8-#7 | 2.67 | MA | 1042 | 614 | 1645 | 479 | 1872 | 398 | 2006 | 335 | 2173 | 227 | 2543 | 133 | 1854 |
| 3E | | MI | 537 | 614 | 901 | 428 | 954 | 352 | 972 | 284 | 978 | 171 | 1036 | 45 | 909 |
| 8-#7 | 2.67 | MA | 1006 | 614 | 1545 | 483 | 1731 | 404 | 1833 | 336 | 1937 | 227 | 2267 | 110 | 1794 |
| 4L-2S | | MI | 561 | 614 | 959 | 430 | 1023 | 350 | 1052 | 282 | 1080 | 169 | 1148 | 86 | 900 |
| 8-#8 | 3.51 | MA | 1051 | 658 | 1649 | 510 | 1856 | 425 | 1982 | 349 | 2136 | 224 | 2522 | 78 | 2202 |
| 4L-2S | | MI | 584 | 658 | 1026 | 454 | 1097 | 363 | 1136 | 285 | 1186 | 153 | 1254 | 48 | 1119 |
| 8-#9 | 4.44 | MA | 1099 | 706 | 1762 | 540 | 1991 | 448 | 2144 | 364 | 2353 | 221 | 2794 | 41 | 2632 |
| 4L-2S | | MI | 607 | 706 | 1091 | 478 | 1171 | 377 | 1221 | 288 | 1294 | 134 | 1357 | 3 | 1348 |
| 8-#10 | 5.64 | MA | 1160 | 767 | 1904 | 579 | 2161 | 478 | 2349 | 382 | 2627 | 216 | 3132 | -8 | 3126 |
| 4L-2S | | MI | 636 | 767 | 1168 | 509 | 1260 | 394 | 1323 | 291 | 1424 | 108 | 1475 | -58 | 1495 |
| 8-#11 | 6.93 | MA | 1224 | 834 | 2044 | 616 | 2322 | 504 | 2538 | 397 | 2900 | 217 | 3385 | -74 | 3332 |
| 4L-2S | | MI | 654 | 834 | 1201 | 528 | 1292 | 396 | 1358 | 277 | 1467 | 61 | 1460 | -162 | 1475 |
| 10-#10 | 7.06 | MA | 1205 | 840 | 1985 | 639 | 2279 | 515 | 2485 | 413 | 2802 | 219 | 3363 | -80 | 3309 |
| 5L-2S | | MI | 677 | 840 | 1277 | 553 | 1389 | 421 | 1473 | 302 | 1614 | 85 | 1672 | -116 | 1642 |

## RECTANGULAR TIED COLUMNS 10" x 20"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.20 | MA | 1212 | 599 | 1810 | 483 | 2048 | 406 | 2166 | 346 | 2270 | 256 | 2642 | 219 | 1107 |
| 2E | | MI | 573 | 599 | 924 | 425 | 967 | 354 | 973 | 297 | 950 | 209 | 1002 | 152 | 535 |
| 4-#8 | 1.58 | MA | 1255 | 621 | 1916 | 495 | 2178 | 415 | 2322 | 351 | 2479 | 254 | 2911 | 214 | 1423 |
| 2E | | MI | 584 | 621 | 959 | 435 | 1004 | 359 | 1014 | 298 | 1001 | 200 | 1052 | 133 | 659 |
| 4-#9 | 2.00 | MA | 1301 | 645 | 2030 | 508 | 2319 | 424 | 2491 | 357 | 2706 | 252 | 3200 | 208 | 1766 |
| 2E | | MI | 596 | 645 | 993 | 446 | 1041 | 365 | 1055 | 298 | 1054 | 189 | 1101 | 109 | 788 |
| 4-#10 | 2.54 | MA | 1359 | 675 | 2175 | 525 | 2498 | 437 | 2706 | 364 | 2995 | 249 | 3562 | 200 | 2198 |
| 2E | | MI | 610 | 675 | 1033 | 460 | 1085 | 372 | 1105 | 298 | 1117 | 175 | 1157 | 77 | 943 |
| 4-#11 | 3.12 | MA | 1409 | 709 | 2323 | 541 | 2673 | 448 | 2911 | 370 | 3268 | 244 | 3853 | 183 | 2626 |
| 2E | | MI | 618 | 709 | 1052 | 463 | 1100 | 368 | 1119 | 287 | 1133 | 149 | 1141 | 23 | 1083 |
| 6-#6 | 1.32 | MA | 1229 | 606 | 1841 | 488 | 2092 | 411 | 2222 | 350 | 2347 | 257 | 2755 | 220 | 1212 |
| 2L-3S | | MI | 559 | 606 | 893 | 432 | 935 | 362 | 936 | 303 | 904 | 212 | 956 | 121 | 581 |
| 6-#6 | 1.32 | MA | 1166 | 606 | 1719 | 492 | 1937 | 413 | 2034 | 354 | 2092 | 261 | 2410 | 189 | 1218 |
| 3L-2S | | MI | 579 | 606 | 936 | 432 | 987 | 361 | 997 | 302 | 982 | 210 | 1043 | 152 | 575 |
| 6-#7 | 1.80 | MA | 1284 | 633 | 1975 | 504 | 2258 | 422 | 2421 | 356 | 2614 | 254 | 3105 | 215 | 1613 |
| 2L-3S | | MI | 568 | 633 | 924 | 445 | 967 | 370 | 973 | 306 | 950 | 202 | 1002 | 87 | 741 |
| 6-#7 | 1.80 | MA | 1203 | 633 | 1810 | 508 | 2048 | 425 | 2166 | 363 | 2270 | 259 | 2642 | 172 | 1617 |
| 3L-2S | | MI | 594 | 633 | 982 | 446 | 1037 | 368 | 1053 | 304 | 1052 | 200 | 1114 | 129 | 731 |
| 6-#8 | 2.37 | MA | 1245 | 666 | 1916 | 528 | 2178 | 439 | 2322 | 373 | 2479 | 258 | 2911 | 151 | 2076 |
| 3L-2S | | MI | 610 | 666 | 1033 | 464 | 1092 | 378 | 1115 | 306 | 1131 | 188 | 1192 | 100 | 904 |
| 6-#9 | 3.00 | MA | 1290 | 702 | 2030 | 550 | 2319 | 455 | 2491 | 384 | 2706 | 256 | 3200 | 127 | 2567 |
| 3L-2S | | MI | 628 | 702 | 1083 | 481 | 1147 | 387 | 1179 | 307 | 1211 | 173 | 1267 | 66 | 1084 |

## RECTANGULAR TIED COLUMNS 10" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 3.81 | MA | 1348 | 748 | 2175 | 579 | 2498 | 476 | 2706 | 398 | 2995 | 254 | 3562 | 95 | 3178 |
| 3L-2S | | MI | 650 | 748 | 1141 | 503 | 1214 | 399 | 1255 | 308 | 1307 | 153 | 1355 | 19 | 1303 |
| 6-#11 | 4.68 | MA | 1399 | 798 | 2323 | 605 | 2673 | 494 | 2911 | 409 | 3268 | 248 | 3853 | 50 | 3717 |
| 3L-2S | | MI | 662 | 798 | 1168 | 514 | 1238 | 398 | 1278 | 296 | 1336 | 115 | 1338 | -60 | 1369 |
| 8-#5 | 1.24 | MA | 1177 | 601 | 1730 | 489 | 1955 | 412 | 2058 | 353 | 2127 | 261 | 2465 | 200 | 1151 |
| 3E | | MI | 563 | 601 | 898 | 432 | 945 | 363 | 950 | 305 | 922 | 215 | 968 | 132 | 552 |
| 8-#5 | 1.24 | MA | 1153 | 601 | 1670 | 492 | 1871 | 416 | 1955 | 354 | 1986 | 262 | 2292 | 188 | 1155 |
| 4L-2S | | MI | 577 | 601 | 929 | 433 | 984 | 362 | 994 | 304 | 979 | 214 | 1028 | 154 | 548 |
| 8-#6 | 1.76 | MA | 1222 | 631 | 1841 | 507 | 2092 | 425 | 2222 | 362 | 2347 | 259 | 2755 | 186 | 1589 |
| 3E | | MI | 575 | 631 | 936 | 447 | 987 | 373 | 997 | 309 | 982 | 206 | 1043 | 105 | 727 |
| 8-#6 | 1.76 | MA | 1190 | 631 | 1756 | 510 | 1973 | 430 | 2076 | 364 | 2148 | 260 | 2512 | 168 | 1586 |
| 4L-2S | | MI | 594 | 631 | 980 | 448 | 1040 | 371 | 1059 | 307 | 1060 | 204 | 1129 | 136 | 720 |
| 8-#7 | 2.40 | MA | 1277 | 667 | 1975 | 530 | 2258 | 441 | 2421 | 372 | 2614 | 257 | 3105 | 167 | 2113 |
| 3E | | MI | 589 | 667 | 982 | 466 | 1037 | 385 | 1053 | 312 | 1052 | 193 | 1114 | 64 | 928 |
| 8-#7 | 2.40 | MA | 1235 | 667 | 1860 | 534 | 2097 | 448 | 2224 | 375 | 2345 | 258 | 2779 | 143 | 2083 |
| 4L-2S | | MI | 614 | 667 | 1039 | 468 | 1106 | 383 | 1133 | 310 | 1155 | 191 | 1226 | 106 | 918 |
| 8-#8 | 3.16 | MA | 1288 | 711 | 1981 | 561 | 2241 | 469 | 2397 | 389 | 2576 | 256 | 3087 | 113 | 2559 |
| 4L-2S | | MI | 637 | 711 | 1107 | 492 | 1179 | 396 | 1217 | 314 | 1260 | 175 | 1331 | 68 | 1140 |
| 8-#9 | 4.00 | MA | 1346 | 759 | 2112 | 592 | 2399 | 493 | 2585 | 403 | 2828 | 254 | 3418 | 79 | 3062 |
| 4L-2S | | MI | 660 | 759 | 1172 | 516 | 1254 | 409 | 1302 | 316 | 1368 | 156 | 1434 | 23 | 1372 |
| 8-#10 | 5.08 | MA | 1419 | 820 | 2278 | 632 | 2597 | 523 | 2823 | 422 | 3147 | 250 | 3833 | 34 | 3685 |
| 4L-2S | | MI | 689 | 820 | 1250 | 547 | 1343 | 426 | 1404 | 319 | 1497 | 130 | 1552 | -39 | 1567 |
| 8-#11 | 6.24 | MA | 1483 | 887 | 2444 | 669 | 2789 | 551 | 3049 | 438 | 3447 | 242 | 4164 | -26 | 4137 |
| 4L-2S | | MI | 707 | 887 | 1283 | 564 | 1375 | 427 | 1438 | 304 | 1539 | 82 | 1534 | -143 | 1597 |
| 10-#10 | 6.35 | MA | 1466 | 893 | 2374 | 693 | 2737 | 562 | 2985 | 456 | 3353 | 255 | 4110 | -33 | 4080 |
| 5L-2S | | MI | 729 | 893 | 1358 | 590 | 1472 | 453 | 1553 | 329 | 1688 | 107 | 1749 | -97 | 1717 |

## RECTANGULAR TIED COLUMNS 12" x 12"

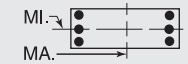
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.29 | MA | 510 | 435 | 806 | 326 | 876 | 274 | 906 | 233 | 914 | 167 | 990 | 127 | 492 |
| 2L-3S | | MI | 489 | 435 | 764 | 326 | 822 | 274 | 841 | 234 | 830 | 168 | 894 | 105 | 497 |
| 6-#6 | 1.83 | MA | 529 | 457 | 858 | 338 | 940 | 282 | 983 | 238 | 1008 | 162 | 1093 | 113 | 659 |
| 2L-3S | | MI | 502 | 457 | 800 | 339 | 865 | 282 | 892 | 239 | 892 | 163 | 962 | 82 | 666 |
| 6-#7 | 2.50 | MA | 551 | 485 | 921 | 353 | 1017 | 293 | 1071 | 243 | 1119 | 156 | 1213 | 96 | 855 |
| 2L-3S | | MI | 516 | 485 | 842 | 354 | 916 | 292 | 950 | 245 | 966 | 158 | 1041 | 53 | 863 |
| 6-#8 | 3.29 | MA | 576 | 517 | 993 | 372 | 1106 | 306 | 1172 | 249 | 1247 | 148 | 1347 | 74 | 1079 |
| 2L-3S | | MI | 533 | 517 | 891 | 372 | 976 | 305 | 1017 | 252 | 1050 | 150 | 1129 | 17 | 1082 |
| 6-#9 | 4.17 | MA | 603 | 553 | 1070 | 392 | 1201 | 321 | 1277 | 255 | 1380 | 138 | 1485 | 47 | 1316 |
| 2L-3S | | MI | 551 | 553 | 943 | 392 | 1039 | 318 | 1087 | 258 | 1138 | 142 | 1220 | -24 | 1216 |
| 6-#10 | 5.29 | MA | 635 | 599 | 1166 | 419 | 1320 | 340 | 1406 | 262 | 1543 | 126 | 1650 | 12 | 1609 |
| 2L-3S | | MI | 573 | 599 | 1008 | 418 | 1119 | 336 | 1173 | 267 | 1246 | 130 | 1328 | -80 | 1318 |

## RECTANGULAR TIED COLUMNS 12" x 14"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.05 | MA | 687 | 496 | 1058 | 382 | 1159 | 322 | 1201 | 275 | 1220 | 204 | 1340 | 164 | 565 |
| 2E | | MI | 582 | 496 | 913 | 371 | 984 | 312 | 1010 | 267 | 1002 | 194 | 1078 | 151 | 483 |
| 4-#7 | 1.43 | MA | 708 | 514 | 1113 | 392 | 1226 | 329 | 1280 | 279 | 1322 | 201 | 1456 | 155 | 735 |
| 2E | | MI | 597 | 514 | 956 | 380 | 1036 | 319 | 1069 | 269 | 1076 | 189 | 1157 | 139 | 622 |
| 4-#8 | 1.88 | MA | 731 | 536 | 1177 | 403 | 1303 | 337 | 1373 | 283 | 1439 | 197 | 1588 | 144 | 931 |
| 2E | | MI | 614 | 536 | 1005 | 391 | 1095 | 327 | 1135 | 273 | 1159 | 184 | 1245 | 124 | 779 |
| 4-#9 | 2.38 | MA | 756 | 560 | 1245 | 416 | 1386 | 346 | 1472 | 289 | 1563 | 192 | 1726 | 130 | 1140 |
| 2E | | MI | 632 | 560 | 1058 | 404 | 1159 | 336 | 1205 | 276 | 1247 | 177 | 1335 | 106 | 946 |
| 4-#10 | 3.02 | MA | 786 | 591 | 1330 | 433 | 1490 | 358 | 1597 | 296 | 1717 | 186 | 1895 | 112 | 1401 |
| 2E | | MI | 654 | 591 | 1123 | 421 | 1238 | 348 | 1290 | 280 | 1355 | 167 | 1443 | 81 | 1151 |
| 4-#11 | 3.71 | MA | 809 | 624 | 1410 | 448 | 1582 | 368 | 1695 | 299 | 1825 | 172 | 1988 | 80 | 1646 |
| 2E | | MI | 669 | 624 | 1180 | 435 | 1284 | 351 | 1340 | 277 | 1416 | 149 | 1524 | 54 | 1339 |
| 4-#14 | 5.36 | MA | 875 | 702 | 1605 | 493 | 1823 | 401 | 1959 | 312 | 2159 | 151 | 2329 | 22 | 2241 |
| 2E | | MI | 716 | 702 | 1324 | 479 | 1436 | 375 | 1513 | 282 | 1636 | 119 | 1736 | -17 | 1741 |

## RECTANGULAR TIED COLUMNS 12" x 14"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

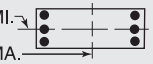
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.11 | MA | 692 | 499 | 1066 | 386 | 1172 | 325 | 1218 | 277 | 1247 | 205 | 1375 | 165 | 593 |
| 2L-3S | | MI | 566 | 499 | 877 | 375 | 941 | 315 | 959 | 270 | 940 | 197 | 1011 | 130 | 509 |
| 6-#5 | 1.11 | MA | 665 | 499 | 1012 | 387 | 1104 | 325 | 1136 | 279 | 1136 | 206 | 1243 | 143 | 597 |
| 3L-2S | | MI | 586 | 499 | 919 | 375 | 995 | 315 | 1025 | 269 | 1024 | 196 | 1107 | 152 | 505 |
| 6-#6 | 1.57 | MA | 718 | 521 | 1133 | 398 | 1254 | 333 | 1317 | 282 | 1375 | 202 | 1523 | 155 | 802 |
| 2L-3S | | MI | 578 | 521 | 913 | 387 | 984 | 323 | 1010 | 275 | 1002 | 192 | 1078 | 107 | 682 |
| 6-#6 | 1.57 | MA | 682 | 521 | 1058 | 399 | 1159 | 334 | 1201 | 285 | 1220 | 204 | 1340 | 124 | 809 |
| 3L-2S | | MI | 605 | 521 | 972 | 386 | 1059 | 324 | 1101 | 274 | 1118 | 191 | 1209 | 139 | 675 |
| 6-#7 | 2.14 | MA | 749 | 548 | 1214 | 413 | 1353 | 344 | 1436 | 288 | 1528 | 198 | 1699 | 142 | 1050 |
| 2L-3S | | MI | 592 | 548 | 956 | 402 | 1036 | 333 | 1069 | 281 | 1076 | 186 | 1157 | 78 | 883 |
| 6-#7 | 2.14 | MA | 701 | 548 | 1113 | 415 | 1226 | 345 | 1280 | 292 | 1322 | 200 | 1456 | 99 | 1057 |
| 3L-2S | | MI | 628 | 548 | 1035 | 401 | 1136 | 334 | 1189 | 279 | 1229 | 184 | 1329 | 121 | 874 |
| 6-#8 | 2.82 | MA | 783 | 581 | 1307 | 431 | 1469 | 357 | 1574 | 296 | 1704 | 193 | 1898 | 126 | 1335 |
| 2L-3S | | MI | 609 | 581 | 1005 | 420 | 1095 | 346 | 1135 | 287 | 1159 | 179 | 1245 | 42 | 1109 |
| 6-#8 | 2.82 | MA | 726 | 581 | 1177 | 434 | 1303 | 358 | 1373 | 300 | 1439 | 195 | 1588 | 69 | 1338 |
| 3L-2S | | MI | 653 | 581 | 1107 | 420 | 1225 | 347 | 1290 | 285 | 1356 | 176 | 1463 | 99 | 1101 |
| 6-#9 | 3.57 | MA | 819 | 617 | 1407 | 452 | 1593 | 372 | 1724 | 305 | 1891 | 186 | 2107 | 106 | 1640 |
| 2L-3S | | MI | 626 | 617 | 1058 | 440 | 1159 | 359 | 1205 | 294 | 1247 | 170 | 1335 | 0 | 1334 |
| 6-#9 | 3.57 | MA | 750 | 617 | 1245 | 454 | 1386 | 372 | 1472 | 310 | 1563 | 190 | 1726 | 34 | 1633 |
| 3L-2S | | MI | 680 | 617 | 1185 | 440 | 1320 | 362 | 1395 | 290 | 1489 | 167 | 1600 | 72 | 1341 |
| 6-#10 | 4.54 | MA | 864 | 663 | 1533 | 479 | 1749 | 391 | 1912 | 317 | 2124 | 178 | 2363 | 79 | 2021 |
| 2L-3S | | MI | 648 | 663 | 1123 | 465 | 1238 | 376 | 1290 | 302 | 1355 | 158 | 1443 | -55 | 1437 |
| 6-#10 | 4.54 | MA | 781 | 663 | 1330 | 481 | 1490 | 391 | 1597 | 322 | 1717 | 182 | 1895 | -12 | 1890 |
| 3L-2S | | MI | 712 | 663 | 1281 | 466 | 1439 | 381 | 1523 | 298 | 1652 | 153 | 1764 | 36 | 1637 |
| 6-#11 | 5.57 | MA | 804 | 713 | 1410 | 505 | 1582 | 406 | 1695 | 328 | 1825 | 164 | 1988 | -79 | 1963 |
| 3L-2S | | MI | 735 | 713 | 1364 | 491 | 1509 | 389 | 1600 | 295 | 1747 | 128 | 1891 | -3 | 1825 |
| 8-#5 | 1.48 | MA | 714 | 516 | 1119 | 397 | 1240 | 333 | 1301 | 282 | 1358 | 204 | 1508 | 159 | 761 |
| 2L-4S | | MI | 571 | 516 | 888 | 387 | 952 | 325 | 972 | 274 | 960 | 195 | 1036 | 113 | 653 |
| 8-#5 | 1.48 | MA | 688 | 516 | 1066 | 398 | 1172 | 333 | 1218 | 284 | 1247 | 205 | 1375 | 137 | 766 |
| 3E | | MI | 583 | 516 | 919 | 386 | 995 | 323 | 1025 | 275 | 1024 | 194 | 1107 | 122 | 647 |
| 8-#5 | 1.48 | MA | 674 | 516 | 1028 | 399 | 1119 | 336 | 1153 | 284 | 1161 | 206 | 1279 | 127 | 771 |
| 4L-2S | | MI | 603 | 516 | 961 | 386 | 1048 | 323 | 1090 | 274 | 1108 | 193 | 1203 | 144 | 642 |
| 8-#6 | 2.10 | MA | 748 | 546 | 1208 | 413 | 1349 | 345 | 1432 | 289 | 1529 | 200 | 1707 | 146 | 1034 |
| 2L-4S | | MI | 586 | 546 | 929 | 403 | 999 | 337 | 1028 | 281 | 1029 | 190 | 1112 | 83 | 874 |
| 8-#6 | 2.10 | MA | 713 | 546 | 1133 | 415 | 1254 | 345 | 1317 | 292 | 1375 | 202 | 1523 | 115 | 1039 |
| 3E | | MI | 602 | 546 | 972 | 403 | 1059 | 335 | 1101 | 282 | 1118 | 189 | 1209 | 94 | 868 |
| 8-#6 | 2.10 | MA | 693 | 546 | 1080 | 416 | 1179 | 349 | 1225 | 292 | 1256 | 203 | 1390 | 101 | 1042 |
| 4L-2S | | MI | 628 | 546 | 1031 | 402 | 1134 | 335 | 1192 | 281 | 1234 | 187 | 1341 | 126 | 862 |
| 8-#7 | 2.86 | MA | 743 | 583 | 1214 | 436 | 1353 | 360 | 1436 | 302 | 1528 | 197 | 1699 | 86 | 1362 |
| 3E | | MI | 624 | 583 | 1035 | 423 | 1136 | 349 | 1189 | 290 | 1229 | 181 | 1329 | 60 | 1126 |
| 8-#7 | 2.86 | MA | 717 | 583 | 1142 | 438 | 1253 | 365 | 1312 | 301 | 1370 | 199 | 1522 | 68 | 1304 |
| 4L-2S | | MI | 658 | 583 | 1114 | 423 | 1237 | 350 | 1310 | 288 | 1383 | 179 | 1501 | 103 | 1121 |
| 8-#8 | 3.76 | MA | 780 | 626 | 1307 | 462 | 1469 | 378 | 1574 | 313 | 1704 | 191 | 1898 | 51 | 1728 |
| 3E | | MI | 649 | 626 | 1107 | 448 | 1225 | 366 | 1290 | 299 | 1356 | 171 | 1463 | 17 | 1417 |
| 8-#8 | 3.76 | MA | 748 | 626 | 1213 | 464 | 1338 | 384 | 1414 | 312 | 1500 | 194 | 1671 | 27 | 1587 |
| 4L-2S | | MI | 691 | 626 | 1210 | 448 | 1355 | 368 | 1444 | 296 | 1553 | 169 | 1681 | 73 | 1416 |
| 8-#9 | 4.76 | MA | 817 | 674 | 1407 | 490 | 1593 | 398 | 1724 | 326 | 1891 | 184 | 2107 | 10 | 2085 |
| 3E | | MI | 676 | 674 | 1185 | 475 | 1320 | 385 | 1395 | 308 | 1489 | 160 | 1600 | -33 | 1594 |
| 8-#9 | 4.76 | MA | 779 | 674 | 1290 | 492 | 1429 | 405 | 1523 | 324 | 1639 | 187 | 1827 | -19 | 1825 |
| 4L-2S | | MI | 727 | 674 | 1312 | 476 | 1482 | 388 | 1585 | 305 | 1730 | 156 | 1865 | 39 | 1729 |
| 8-#10 | 6.05 | MA | 864 | 736 | 1533 | 526 | 1749 | 424 | 1912 | 343 | 2124 | 173 | 2363 | -45 | 2337 |
| 3E | | MI | 710 | 736 | 1281 | 511 | 1439 | 409 | 1523 | 319 | 1652 | 144 | 1764 | -100 | 1748 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

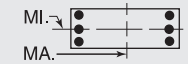
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.25 | MA | 920 | 578 | 1414 | 451 | 1572 | 379 | 1647 | 323 | 1709 | 238 | 1919 | 193 | 865 |
| 2E | | MI | 674 | 578 | 1070 | 428 | 1155 | 360 | 1187 | 305 | 1185 | 218 | 1273 | 164 | 637 |
| 4-#8 | 1.65 | MA | 951 | 599 | 1492 | 463 | 1667 | 388 | 1760 | 328 | 1861 | 235 | 2096 | 185 | 1102 |
| 2E | | MI | 691 | 599 | 1120 | 439 | 1214 | 368 | 1253 | 308 | 1269 | 212 | 1360 | 149 | 797 |
| 4-#9 | 2.08 | MA | 983 | 623 | 1576 | 476 | 1769 | 397 | 1883 | 333 | 2026 | 233 | 2283 | 174 | 1356 |
| 2E | | MI | 709 | 623 | 1173 | 452 | 1278 | 376 | 1323 | 311 | 1356 | 205 | 1450 | 130 | 966 |
| 4-#10 | 2.65 | MA | 1023 | 654 | 1681 | 493 | 1899 | 409 | 2038 | 340 | 2231 | 229 | 2514 | 160 | 1675 |
| 2E | | MI | 731 | 654 | 1238 | 468 | 1357 | 388 | 1408 | 315 | 1464 | 195 | 1557 | 106 | 1174 |
| 4-#11 | 3.25 | MA | 1054 | 687 | 1785 | 508 | 2018 | 419 | 2178 | 345 | 2388 | 219 | 2671 | 135 | 1983 |
| 2E | | MI | 746 | 687 | 1297 | 481 | 1404 | 391 | 1457 | 311 | 1524 | 176 | 1636 | 78 | 1367 |
| 4-#14 | 4.69 | MA | 1140 | 766 | 2031 | 553 | 2323 | 451 | 2544 | 365 | 2840 | 203 | 3167 | 89 | 2727 |
| 2E | | MI | 793 | 766 | 1441 | 525 | 1555 | 413 | 1630 | 316 | 1742 | 146 | 1847 | 6 | 1827 |
| 6-#6 | 1.38 | MA | 933 | 585 | 1437 | 457 | 1605 | 384 | 1690 | 326 | 1768 | 238 | 2002 | 194 | 944 |
| 2L-3S | | MI | 654 | 585 | 1027 | 435 | 1103 | 365 | 1128 | 311 | 1112 | 221 | 1195 | 132 | 697 |
| 6-#6 | 1.38 | MA | 888 | 585 | 1347 | 460 | 1490 | 386 | 1550 | 330 | 1579 | 241 | 1765 | 162 | 951 |
| 3L-2S | | MI | 682 | 585 | 1086 | 435 | 1178 | 365 | 1219 | 310 | 1228 | 219 | 1326 | 164 | 690 |
| 6-#7 | 1.88 | MA | 972 | 612 | 1536 | 473 | 1727 | 395 | 1835 | 333 | 1964 | 236 | 2234 | 184 | 1244 |
| 2L-3S | | MI | 669 | 612 | 1070 | 450 | 1155 | 374 | 1187 | 317 | 1185 | 215 | 1273 | 103 | 902 |
| 6-#7 | 1.88 | MA | 913 | 612 | 1414 | 475 | 1572 | 397 | 1647 | 338 | 1709 | 239 | 1919 | 141 | 1251 |
| 3L-2S | | MI | 704 | 612 | 1149 | 450 | 1255 | 375 | 1308 | 315 | 1339 | 213 | 1445 | 146 | 892 |
| 6-#8 | 2.47 | MA | 1016 | 645 | 1651 | 491 | 1868 | 408 | 2005 | 341 | 2193 | 233 | 2501 | 172 | 1591 |
| 2L-3S | | MI | 685 | 645 | 1120 | 468 | 1214 | 386 | 1253 | 323 | 1269 | 207 | 1360 | 67 | 1132 |
| 6-#8 | 2.47 | MA | 942 | 645 | 1492 | 495 | 1667 | 410 | 1760 | 347 | 1861 | 236 | 2096 | 115 | 1594 |
| 3L-2S | | MI | 730 | 645 | 1222 | 467 | 1344 | 388 | 1408 | 320 | 1465 | 204 | 1578 | 123 | 1121 |
| 6-#9 | 3.13 | MA | 1064 | 680 | 1775 | 512 | 2022 | 423 | 2190 | 349 | 2441 | 230 | 2784 | 157 | 1964 |
| 2L-3S | | MI | 702 | 680 | 1173 | 487 | 1278 | 400 | 1323 | 329 | 1356 | 198 | 1450 | 25 | 1372 |
| 6-#9 | 3.13 | MA | 973 | 680 | 1576 | 516 | 1769 | 425 | 1883 | 357 | 2026 | 233 | 2283 | 85 | 1957 |
| 3L-2S | | MI | 757 | 680 | 1300 | 487 | 1440 | 402 | 1513 | 326 | 1598 | 195 | 1715 | 97 | 1364 |
| 6-#10 | 3.97 | MA | 1121 | 727 | 1930 | 538 | 2215 | 442 | 2423 | 361 | 2750 | 225 | 3134 | 136 | 2432 |
| 2L-3S | | MI | 724 | 727 | 1238 | 513 | 1357 | 417 | 1408 | 337 | 1464 | 186 | 1557 | -31 | 1554 |
| 6-#10 | 3.97 | MA | 1012 | 727 | 1681 | 543 | 1899 | 445 | 2038 | 369 | 2231 | 229 | 2514 | 45 | 2405 |
| 3L-2S | | MI | 789 | 727 | 1396 | 513 | 1559 | 421 | 1641 | 333 | 1760 | 181 | 1878 | 61 | 1664 |
| 6-#11 | 4.88 | MA | 1049 | 776 | 1785 | 568 | 2018 | 461 | 2178 | 379 | 2388 | 216 | 2671 | -13 | 2663 |
| 3L-2S | | MI | 812 | 776 | 1480 | 537 | 1628 | 429 | 1717 | 329 | 1855 | 155 | 2004 | 21 | 1933 |
| 6-#14 | 7.03 | MA | 1142 | 895 | 2031 | 638 | 2323 | 510 | 2544 | 411 | 2840 | 196 | 3167 | -130 | 3089 |
| 3L-2S | | MI | 883 | 895 | 1694 | 605 | 1856 | 465 | 1978 | 339 | 2186 | 111 | 2325 | -85 | 2251 |
| 8-#5 | 1.29 | MA | 928 | 580 | 1419 | 456 | 1587 | 384 | 1669 | 326 | 1742 | 240 | 1978 | 197 | 895 |
| 2L-4S | | MI | 647 | 580 | 1002 | 436 | 1071 | 367 | 1091 | 311 | 1070 | 224 | 1153 | 139 | 666 |
| 8-#5 | 1.29 | MA | 896 | 580 | 1355 | 458 | 1505 | 385 | 1570 | 329 | 1607 | 242 | 1808 | 175 | 900 |
| 3E | | MI | 659 | 580 | 1032 | 435 | 1114 | 365 | 1143 | 312 | 1135 | 223 | 1224 | 147 | 661 |
| 8-#5 | 1.29 | MA | 878 | 580 | 1310 | 460 | 1441 | 388 | 1492 | 330 | 1501 | 241 | 1686 | 164 | 905 |
| 4L-2S | | MI | 680 | 580 | 1074 | 435 | 1167 | 365 | 1208 | 310 | 1218 | 222 | 1320 | 169 | 656 |
| 8-#6 | 1.83 | MA | 971 | 610 | 1528 | 473 | 1720 | 396 | 1829 | 334 | 1957 | 237 | 2239 | 188 | 1224 |
| 2L-4S | | MI | 662 | 610 | 1043 | 452 | 1118 | 378 | 1146 | 317 | 1139 | 219 | 1228 | 108 | 893 |
| 8-#6 | 1.83 | MA | 928 | 610 | 1437 | 475 | 1605 | 397 | 1690 | 337 | 1768 | 239 | 2002 | 156 | 1229 |
| 3E | | MI | 678 | 610 | 1086 | 451 | 1178 | 376 | 1219 | 318 | 1228 | 217 | 1326 | 120 | 885 |
| 8-#6 | 1.83 | MA | 904 | 610 | 1374 | 477 | 1516 | 401 | 1580 | 338 | 1619 | 239 | 1833 | 140 | 1232 |
| 4L-2S | | MI | 705 | 610 | 1145 | 451 | 1253 | 376 | 1311 | 317 | 1344 | 216 | 1457 | 151 | 879 |
| 8-#7 | 2.50 | MA | 966 | 646 | 1536 | 497 | 1727 | 412 | 1835 | 347 | 1964 | 237 | 2234 | 132 | 1621 |
| 3E | | MI | 700 | 646 | 1149 | 471 | 1255 | 390 | 1308 | 326 | 1339 | 209 | 1445 | 85 | 1148 |
| 8-#7 | 2.50 | MA | 934 | 646 | 1450 | 500 | 1606 | 418 | 1687 | 348 | 1769 | 239 | 2008 | 111 | 1587 |
| 4L-2S | | MI | 735 | 646 | 1228 | 471 | 1356 | 391 | 1428 | 324 | 1493 | 207 | 1617 | 128 | 1140 |
| 8-#8 | 3.29 | MA | 1010 | 690 | 1651 | 523 | 1868 | 431 | 2005 | 359 | 2193 | 233 | 2501 | 102 | 2069 |
| 3E | | MI | 725 | 690 | 1222 | 496 | 1344 | 407 | 1408 | 335 | 1465 | 200 | 1578 | 41 | 1444 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

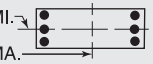
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#8 | 3.29 | MA | 970 | 690 | 1538 | 526 | 1711 | 438 | 1812 | 360 | 1939 | 237 | 2210 | 75 | 1937 |
| 4L-2S | | MI | 768 | 690 | 1324 | 496 | 1475 | 409 | 1562 | 332 | 1662 | 197 | 1796 | 98 | 1439 |
| 8-#9 | 4.17 | MA | 1057 | 738 | 1775 | 551 | 2022 | 451 | 2190 | 373 | 2441 | 230 | 2784 | 67 | 2547 |
| 3E | | MI | 752 | 738 | 1300 | 523 | 1440 | 425 | 1513 | 343 | 1598 | 188 | 1715 | -9 | 1713 |
| 8-#9 | 4.17 | MA | 1009 | 738 | 1633 | 555 | 1824 | 460 | 1948 | 373 | 2122 | 234 | 2422 | 34 | 2304 |
| 4L-2S | | MI | 804 | 738 | 1427 | 523 | 1602 | 428 | 1703 | 340 | 1840 | 185 | 1980 | 63 | 1755 |
| 8-#10 | 5.29 | MA | 1121 | 799 | 1930 | 588 | 2215 | 477 | 2423 | 390 | 2750 | 224 | 3134 | 20 | 3083 |
| 3E | | MI | 786 | 799 | 1396 | 558 | 1559 | 450 | 1641 | 354 | 1760 | 172 | 1878 | -76 | 1868 |
| 8-#10 | 5.29 | MA | 1058 | 799 | 1753 | 593 | 1967 | 488 | 2118 | 390 | 2351 | 229 | 2686 | -20 | 2678 |
| 4L-2S | | MI | 847 | 799 | 1554 | 559 | 1760 | 454 | 1874 | 350 | 2057 | 167 | 2200 | 16 | 2146 |
| 10-#10 | 6.61 | MA | 1174 | 872 | 2002 | 639 | 2284 | 521 | 2503 | 411 | 2870 | 224 | 3305 | -45 | 3272 |
| 4L-3S | | MI | 847 | 872 | 1554 | 603 | 1760 | 482 | 1874 | 371 | 2057 | 158 | 2200 | -121 | 2177 |

## RECTANGULAR TIED COLUMNS 12" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.11 | MA | 1159 | 641 | 1745 | 511 | 1954 | 430 | 2053 | 367 | 2128 | 273 | 2429 | 230 | 995 |
| 2E | | MI | 750 | 641 | 1184 | 476 | 1274 | 401 | 1305 | 341 | 1295 | 246 | 1389 | 189 | 651 |
| 4-#8 | 1.46 | MA | 1196 | 663 | 1838 | 523 | 2067 | 439 | 2187 | 372 | 2308 | 271 | 2651 | 223 | 1273 |
| 2E | | MI | 768 | 663 | 1234 | 487 | 1334 | 408 | 1371 | 344 | 1378 | 240 | 1476 | 173 | 814 |
| 4-#9 | 1.85 | MA | 1236 | 687 | 1937 | 536 | 2189 | 448 | 2333 | 378 | 2504 | 268 | 2888 | 215 | 1572 |
| 2E | | MI | 786 | 687 | 1287 | 499 | 1397 | 417 | 1441 | 347 | 1465 | 233 | 1564 | 155 | 985 |
| 4-#10 | 2.35 | MA | 1284 | 718 | 2063 | 553 | 2344 | 460 | 2518 | 385 | 2752 | 265 | 3184 | 204 | 1949 |
| 2E | | MI | 808 | 718 | 1353 | 515 | 1477 | 428 | 1526 | 350 | 1572 | 223 | 1671 | 130 | 1196 |
| 4-#11 | 2.89 | MA | 1326 | 751 | 2190 | 568 | 2491 | 470 | 2691 | 390 | 2981 | 260 | 3406 | 183 | 2320 |
| 2E | | MI | 822 | 751 | 1413 | 527 | 1523 | 430 | 1574 | 346 | 1632 | 204 | 1749 | 102 | 1394 |
| 4-#14 | 4.17 | MA | 1435 | 830 | 2488 | 613 | 2860 | 502 | 3133 | 409 | 3565 | 251 | 4063 | 147 | 3213 |
| 2E | | MI | 869 | 830 | 1558 | 570 | 1675 | 452 | 1747 | 350 | 1849 | 173 | 1958 | 30 | 1860 |
| 4-#18 | 7.41 | MA | 1683 | 1030 | 3195 | 729 | 3740 | 586 | 4193 | 459 | 4885 | 216 | 5527 | 37 | 5325 |
| 2E | | MI | 974 | 1030 | 1826 | 663 | 1981 | 499 | 2096 | 351 | 2292 | 79 | 2327 | -189 | 2315 |
| 6-#6 | 1.22 | MA | 1174 | 648 | 1772 | 517 | 1993 | 435 | 2102 | 371 | 2196 | 274 | 2528 | 231 | 1087 |
| 2L-3S | | MI | 731 | 648 | 1140 | 484 | 1222 | 406 | 1247 | 347 | 1222 | 249 | 1311 | 157 | 711 |
| 6-#6 | 1.22 | MA | 1121 | 648 | 1666 | 520 | 1858 | 437 | 1938 | 375 | 1974 | 277 | 2237 | 199 | 1094 |
| 3L-2S | | MI | 759 | 648 | 1199 | 483 | 1297 | 406 | 1338 | 346 | 1338 | 248 | 1442 | 189 | 704 |
| 6-#7 | 1.67 | MA | 1222 | 676 | 1889 | 532 | 2137 | 446 | 2274 | 377 | 2428 | 271 | 2818 | 223 | 1439 |
| 2L-3S | | MI | 745 | 676 | 1184 | 498 | 1274 | 416 | 1305 | 352 | 1295 | 243 | 1389 | 128 | 919 |
| 6-#7 | 1.67 | MA | 1151 | 676 | 1745 | 536 | 1954 | 449 | 2053 | 383 | 2128 | 275 | 2429 | 180 | 1446 |
| 3L-2S | | MI | 781 | 676 | 1263 | 498 | 1374 | 416 | 1426 | 350 | 1449 | 241 | 1561 | 171 | 909 |
| 6-#8 | 2.19 | MA | 1276 | 708 | 2024 | 551 | 2305 | 459 | 2476 | 385 | 2699 | 268 | 3153 | 214 | 1847 |
| 2L-3S | | MI | 761 | 708 | 1234 | 516 | 1334 | 427 | 1371 | 358 | 1378 | 235 | 1476 | 91 | 1153 |
| 6-#8 | 2.19 | MA | 1186 | 708 | 1838 | 555 | 2067 | 462 | 2187 | 392 | 2308 | 273 | 2651 | 157 | 1850 |
| 3L-2S | | MI | 807 | 708 | 1336 | 515 | 1464 | 429 | 1526 | 356 | 1575 | 233 | 1694 | 148 | 1141 |
| 6-#9 | 2.78 | MA | 1334 | 744 | 2172 | 571 | 2487 | 474 | 2695 | 394 | 2994 | 265 | 3512 | 202 | 2288 |
| 2L-3S | | MI | 778 | 744 | 1287 | 535 | 1397 | 440 | 1441 | 364 | 1465 | 226 | 1564 | 50 | 1398 |
| 6-#9 | 2.78 | MA | 1225 | 744 | 1937 | 577 | 2189 | 478 | 2333 | 403 | 2504 | 271 | 2888 | 130 | 2281 |
| 3L-2S | | MI | 833 | 744 | 1414 | 535 | 1559 | 443 | 1631 | 361 | 1707 | 223 | 1830 | 122 | 1387 |
| 6-#10 | 3.53 | MA | 1406 | 790 | 2357 | 598 | 2718 | 493 | 2973 | 405 | 3368 | 261 | 3958 | 186 | 2844 |
| 2L-3S | | MI | 800 | 790 | 1353 | 560 | 1477 | 457 | 1526 | 372 | 1572 | 214 | 1671 | -6 | 1671 |
| 6-#10 | 3.53 | MA | 1273 | 790 | 2063 | 605 | 2344 | 497 | 2518 | 416 | 2752 | 268 | 3184 | 95 | 2816 |
| 3L-2S | | MI | 866 | 790 | 1511 | 561 | 1678 | 461 | 1759 | 368 | 1869 | 209 | 1993 | 85 | 1690 |
| 6-#11 | 4.33 | MA | 1314 | 840 | 2190 | 630 | 2491 | 515 | 2691 | 427 | 2981 | 261 | 3406 | 44 | 3296 |
| 3L-2S | | MI | 888 | 840 | 1596 | 583 | 1748 | 468 | 1835 | 364 | 1963 | 183 | 2117 | 45 | 1964 |
| 6-#14 | 6.25 | MA | 1437 | 958 | 2488 | 701 | 2860 | 565 | 3133 | 460 | 3565 | 250 | 4063 | -59 | 4006 |
| 3L-2S | | MI | 960 | 958 | 1811 | 650 | 1975 | 504 | 2095 | 373 | 2293 | 138 | 2436 | -62 | 2363 |
| 8-#5 | 1.15 | MA | 1168 | 644 | 1750 | 516 | 1970 | 435 | 2077 | 371 | 2164 | 275 | 2495 | 234 | 1029 |
| 2L-4S | | MI | 724 | 644 | 1115 | 484 | 1190 | 408 | 1209 | 347 | 1181 | 253 | 1270 | 164 | 679 |
| 8-#5 | 1.15 | MA | 1130 | 644 | 1675 | 518 | 1874 | 436 | 1960 | 374 | 2006 | 277 | 2286 | 211 | 1034 |
| 3E | | MI | 736 | 644 | 1145 | 484 | 1233 | 407 | 1261 | 348 | 1245 | 252 | 1341 | 172 | 673 |

## RECTANGULAR TIED COLUMNS 12" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#5 | 1.15 | MA | 1109 | 644 | 1622 | 520 | 1800 | 440 | 1870 | 375 | 1882 | 278 | 2138 | 199 | 1039 |
| 4L-2S | | MI | 756 | 644 | 1188 | 483 | 1287 | 407 | 1327 | 347 | 1329 | 251 | 1437 | 195 | 669 |
| 8-#6 | 1.63 | MA | 1220 | 673 | 1878 | 533 | 2128 | 446 | 2266 | 378 | 2418 | 272 | 2818 | 226 | 1414 |
| 2L-4S | | MI | 738 | 673 | 1156 | 500 | 1237 | 420 | 1265 | 353 | 1249 | 247 | 1345 | 133 | 910 |
| 8-#6 | 1.63 | MA | 1168 | 673 | 1772 | 535 | 1993 | 449 | 2102 | 382 | 2196 | 275 | 2528 | 195 | 1420 |
| 3E | | MI | 755 | 673 | 1199 | 500 | 1297 | 417 | 1338 | 354 | 1338 | 246 | 1442 | 145 | 902 |
| 8-#6 | 1.63 | MA | 1140 | 673 | 1698 | 538 | 1889 | 454 | 1974 | 384 | 2022 | 276 | 2322 | 178 | 1422 |
| 4L-2S | | MI | 782 | 673 | 1258 | 499 | 1372 | 418 | 1429 | 353 | 1454 | 244 | 1574 | 176 | 895 |
| 8-#7 | 2.22 | MA | 1214 | 710 | 1889 | 557 | 2137 | 464 | 2274 | 393 | 2428 | 273 | 2818 | 173 | 1881 |
| 3E | | MI | 777 | 710 | 1263 | 520 | 1374 | 431 | 1426 | 362 | 1449 | 238 | 1561 | 110 | 1168 |
| 8-#7 | 2.22 | MA | 1177 | 710 | 1788 | 561 | 1996 | 471 | 2102 | 394 | 2192 | 273 | 2542 | 151 | 1870 |
| 4L-2S | | MI | 811 | 710 | 1342 | 519 | 1475 | 432 | 1546 | 360 | 1602 | 236 | 1733 | 153 | 1159 |
| 8-#8 | 2.93 | MA | 1268 | 753 | 2024 | 583 | 2305 | 483 | 2476 | 405 | 2699 | 270 | 3153 | 147 | 2411 |
| 3E | | MI | 802 | 753 | 1336 | 544 | 1464 | 448 | 1526 | 370 | 1575 | 228 | 1694 | 66 | 1469 |
| 8-#8 | 2.93 | MA | 1222 | 753 | 1893 | 588 | 2121 | 491 | 2251 | 407 | 2391 | 270 | 2796 | 118 | 2298 |
| 4L-2S | | MI | 845 | 753 | 1439 | 544 | 1594 | 449 | 1680 | 368 | 1771 | 225 | 1912 | 123 | 1460 |
| 8-#9 | 3.70 | MA | 1326 | 801 | 2172 | 612 | 2487 | 504 | 2695 | 419 | 2994 | 267 | 3512 | 117 | 2979 |
| 3E | | MI | 828 | 801 | 1414 | 570 | 1559 | 466 | 1631 | 379 | 1707 | 216 | 1830 | 16 | 1783 |
| 8-#9 | 3.70 | MA | 1269 | 801 | 2007 | 618 | 2256 | 514 | 2412 | 421 | 2607 | 267 | 3067 | 81 | 2738 |
| 4L-2S | | MI | 881 | 801 | 1541 | 571 | 1721 | 469 | 1820 | 376 | 1949 | 213 | 2095 | 88 | 1780 |
| 8-#10 | 4.70 | MA | 1399 | 863 | 2357 | 650 | 2718 | 530 | 2973 | 437 | 3368 | 264 | 3958 | 77 | 3688 |
| 3E | | MI | 862 | 863 | 1511 | 605 | 1678 | 490 | 1759 | 389 | 1869 | 199 | 1993 | -51 | 1987 |
| 8-#10 | 4.70 | MA | 1330 | 863 | 2150 | 656 | 2427 | 543 | 2617 | 439 | 2881 | 262 | 3405 | 32 | 3281 |
| 4L-2S | | MI | 924 | 863 | 1669 | 606 | 1879 | 494 | 1992 | 385 | 2166 | 195 | 2314 | 40 | 2174 |
| 8-#11 | 5.78 | MA | 1381 | 929 | 2292 | 692 | 2589 | 569 | 2805 | 453 | 3152 | 262 | 3655 | -35 | 3635 |
| 4L-2S | | MI | 955 | 929 | 1780 | 639 | 1972 | 506 | 2095 | 382 | 2294 | 162 | 2484 | -12 | 2397 |
| 10-#10 | 5.88 | MA | 1459 | 935 | 2444 | 702 | 2802 | 576 | 3072 | 460 | 3496 | 258 | 4179 | 14 | 4122 |
| 4L-3S | | MI | 923 | 935 | 1669 | 650 | 1879 | 523 | 1992 | 407 | 2166 | 185 | 2314 | -96 | 2298 |
| 10-#10 | 5.88 | MA | 1375 | 935 | 2231 | 716 | 2545 | 581 | 2754 | 471 | 3055 | 265 | 3636 | -40 | 3611 |
| 5L-2S | | MI | 982 | 935 | 1828 | 651 | 2081 | 527 | 2225 | 402 | 2463 | 181 | 2635 | -5 | 2635 |
| 12-#10 | 7.06 | MA | 1503 | 1008 | 2525 | 762 | 2920 | 614 | 3208 | 491 | 3671 | 260 | 4409 | -58 | 4354 |
| 5L-3S | | MI | 983 | 1008 | 1828 | 696 | 2081 | 556 | 2225 | 424 | 2463 | 171 | 2635 | -141 | 2605 |

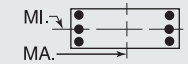
## RECTANGULAR TIED COLUMNS 12" x 20"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.00 | MA | 1424 | 705 | 2106 | 571 | 2374 | 481 | 2498 | 412 | 2586 | 308 | 2985 | 265 | 1124 |
| 2E | | MI | 827 | 705 | 1298 | 525 | 1393 | 442 | 1423 | 377 | 1405 | 275 | 1505 | 214 | 665 |
| 4-#8 | 1.32 | MA | 1468 | 727 | 2213 | 582 | 2504 | 489 | 2653 | 417 | 2795 | 306 | 3253 | 260 | 1443 |
| 2E | | MI | 844 | 727 | 1349 | 535 | 1453 | 449 | 1489 | 380 | 1488 | 268 | 1591 | 198 | 830 |
| 4-#9 | 1.67 | MA | 1515 | 751 | 2329 | 595 | 2646 | 499 | 2823 | 422 | 3022 | 303 | 3541 | 253 | 1788 |
| 2E | | MI | 862 | 751 | 1402 | 547 | 1517 | 457 | 1558 | 382 | 1574 | 261 | 1679 | 180 | 1004 |
| 4-#10 | 2.12 | MA | 1573 | 782 | 2475 | 612 | 2825 | 511 | 3038 | 429 | 3310 | 300 | 3903 | 245 | 2224 |
| 2E | | MI | 884 | 782 | 1468 | 563 | 1596 | 468 | 1643 | 385 | 1681 | 251 | 1786 | 155 | 1217 |
| 4-#11 | 2.60 | MA | 1624 | 815 | 2626 | 627 | 3001 | 521 | 3243 | 434 | 3582 | 295 | 4191 | 228 | 2657 |
| 2E | | MI | 899 | 815 | 1529 | 574 | 1642 | 470 | 1692 | 380 | 1739 | 231 | 1862 | 126 | 1420 |
| 4-#14 | 3.75 | MA | 1758 | 893 | 2974 | 672 | 3433 | 553 | 3762 | 453 | 4280 | 288 | 5012 | 199 | 3699 |
| 2E | | MI | 946 | 893 | 1674 | 616 | 1794 | 491 | 1863 | 384 | 1956 | 200 | 2070 | 53 | 1892 |
| 4-#18 | 6.67 | MA | 2058 | 1093 | 3811 | 789 | 4474 | 637 | 5016 | 504 | 5960 | 270 | 6886 | 109 | 6189 |
| 2E | | MI | 1050 | 1093 | 1944 | 707 | 2100 | 537 | 2211 | 383 | 2397 | 105 | 2436 | -166 | 2508 |
| 6-#6 | 1.10 | MA | 1442 | 712 | 2136 | 577 | 2417 | 486 | 2553 | 415 | 2664 | 309 | 3099 | 266 | 1229 |
| 2L-3S | | MI | 807 | 712 | 1254 | 532 | 1341 | 447 | 1365 | 383 | 1332 | 278 | 1428 | 183 | 723 |
| 6-#6 | 1.10 | MA | 1379 | 712 | 2014 | 580 | 2262 | 488 | 2365 | 420 | 2409 | 313 | 2754 | 234 | 1236 |
| 3L-2S | | MI | 835 | 712 | 1313 | 532 | 1416 | 448 | 1456 | 382 | 1448 | 277 | 1559 | 214 | 718 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 20"

Short columns – no sidesway
Bending on major or minor axis

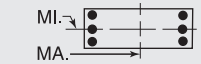



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 1.50 | MA | 1498 | 739 | 2271 | 592 | 2583 | 497 | 2752 | 422 | 2931 | 306 | 3448 | 260 | 1633 |
| 2L-3S | | MI | 821 | 739 | 1298 | 546 | 1393 | 457 | 1423 | 388 | 1405 | 272 | 1505 | 153 | 935 |
| 6-#7 | 1.50 | MA | 1415 | 739 | 2106 | 596 | 2374 | 500 | 2498 | 428 | 2586 | 311 | 2985 | 217 | 1640 |
| 3L-2S | | MI | 858 | 739 | 1377 | 546 | 1494 | 458 | 1544 | 386 | 1558 | 270 | 1677 | 196 | 925 |
| 6-#8 | 1.98 | MA | 1562 | 772 | 2428 | 610 | 2778 | 510 | 2986 | 429 | 3244 | 303 | 3853 | 253 | 2103 |
| 2L-3S | | MI | 837 | 772 | 1349 | 563 | 1453 | 468 | 1489 | 394 | 1488 | 264 | 1591 | 116 | 1173 |
| 6-#8 | 1.98 | MA | 1457 | 772 | 2213 | 616 | 2504 | 514 | 2653 | 438 | 2795 | 310 | 3253 | 196 | 2106 |
| 3L-2S | | MI | 883 | 772 | 1451 | 563 | 1583 | 470 | 1644 | 391 | 1684 | 261 | 1809 | 173 | 1160 |
| 6-#9 | 2.50 | MA | 1631 | 808 | 2598 | 631 | 2989 | 525 | 3240 | 438 | 3586 | 300 | 4288 | 244 | 2612 |
| 2L-3S | | MI | 854 | 808 | 1402 | 582 | 1517 | 481 | 1558 | 400 | 1574 | 254 | 1679 | 74 | 1422 |
| 6-#9 | 2.50 | MA | 1502 | 808 | 2329 | 637 | 2646 | 530 | 2823 | 448 | 3022 | 308 | 3541 | 172 | 2605 |
| 3L-2S | | MI | 910 | 808 | 1529 | 582 | 1678 | 483 | 1748 | 397 | 1816 | 251 | 1945 | 146 | 1408 |
| 6-#10 | 3.17 | MA | 1716 | 854 | 2814 | 658 | 3257 | 544 | 3563 | 450 | 4021 | 296 | 4832 | 232 | 3255 |
| 2L-3S | | MI | 876 | 854 | 1468 | 607 | 1596 | 497 | 1643 | 407 | 1681 | 241 | 1786 | 18 | 1725 |
| 6-#10 | 3.17 | MA | 1560 | 854 | 2475 | 666 | 2825 | 550 | 3038 | 462 | 3310 | 305 | 3903 | 141 | 3228 |
| 3L-2S | | MI | 943 | 854 | 1627 | 608 | 1797 | 501 | 1876 | 403 | 1978 | 237 | 2107 | 110 | 1714 |
| 6-#11 | 3.90 | MA | 1610 | 904 | 2626 | 691 | 3001 | 568 | 3243 | 473 | 3582 | 299 | 4191 | 95 | 3833 |
| 3L-2S | | MI | 965 | 904 | 1712 | 629 | 1867 | 507 | 1952 | 398 | 2070 | 210 | 2229 | 69 | 1993 |
| 6-#14 | 5.63 | MA | 1746 | 1022 | 2974 | 764 | 3433 | 619 | 3762 | 508 | 4280 | 292 | 5012 | 3 | 5004 |
| 3L-2S | | MI | 1036 | 1022 | 1927 | 696 | 2095 | 543 | 2212 | 407 | 2400 | 165 | 2548 | -38 | 2559 |
| 8-#5 | 1.03 | MA | 1434 | 707 | 2110 | 576 | 2390 | 485 | 2524 | 415 | 2625 | 310 | 3057 | 269 | 1163 |
| 2L-4S | | MI | 800 | 707 | 1228 | 533 | 1309 | 450 | 1328 | 383 | 1291 | 282 | 1387 | 189 | 690 |
| 8-#5 | 1.03 | MA | 1389 | 707 | 2024 | 578 | 2280 | 487 | 2390 | 419 | 2444 | 313 | 2810 | 246 | 1168 |
| 3E | | MI | 812 | 707 | 1259 | 533 | 1352 | 448 | 1380 | 384 | 1355 | 281 | 1458 | 198 | 686 |
| 8-#5 | 1.03 | MA | 1365 | 707 | 1964 | 580 | 2196 | 491 | 2287 | 420 | 2303 | 314 | 2636 | 234 | 1173 |
| 4L-2S | | MI | 833 | 707 | 1301 | 532 | 1406 | 448 | 1445 | 383 | 1439 | 280 | 1554 | 220 | 682 |
| 8-#6 | 1.47 | MA | 1496 | 737 | 2257 | 592 | 2572 | 497 | 2742 | 422 | 2918 | 308 | 3444 | 263 | 1604 |
| 2L-4S | | MI | 815 | 737 | 1270 | 549 | 1357 | 461 | 1383 | 389 | 1359 | 276 | 1461 | 159 | 926 |
| 8-#6 | 1.47 | MA | 1435 | 737 | 2136 | 595 | 2417 | 500 | 2553 | 427 | 2664 | 311 | 3099 | 231 | 1610 |
| 3E | | MI | 831 | 737 | 1313 | 548 | 1416 | 459 | 1456 | 390 | 1448 | 275 | 1559 | 170 | 917 |
| 8-#6 | 1.47 | MA | 1402 | 737 | 2052 | 599 | 2299 | 505 | 2408 | 429 | 2465 | 312 | 2856 | 214 | 1612 |
| 4L-2S | | MI | 858 | 737 | 1372 | 548 | 1491 | 459 | 1547 | 389 | 1564 | 273 | 1690 | 202 | 910 |
| 8-#7 | 2.00 | MA | 1490 | 774 | 2271 | 617 | 2583 | 516 | 2752 | 438 | 2931 | 309 | 3448 | 213 | 2140 |
| 3E | | MI | 853 | 774 | 1377 | 568 | 1494 | 472 | 1544 | 398 | 1558 | 267 | 1677 | 135 | 1187 |
| 8-#7 | 2.00 | MA | 1447 | 774 | 2156 | 622 | 2423 | 523 | 2555 | 440 | 2661 | 310 | 3122 | 189 | 2129 |
| 4L-2S | | MI | 888 | 774 | 1456 | 567 | 1594 | 473 | 1665 | 396 | 1712 | 265 | 1849 | 178 | 1178 |
| 8-#8 | 2.63 | MA | 1553 | 817 | 2428 | 644 | 2778 | 535 | 2986 | 451 | 3244 | 307 | 3853 | 190 | 2752 |
| 3E | | MI | 878 | 817 | 1451 | 592 | 1583 | 488 | 1644 | 406 | 1684 | 256 | 1809 | 91 | 1491 |
| 8-#8 | 2.63 | MA | 1499 | 817 | 2278 | 649 | 2568 | 544 | 2728 | 454 | 2892 | 308 | 3430 | 159 | 2670 |
| 4L-2S | | MI | 922 | 817 | 1553 | 591 | 1713 | 490 | 1798 | 403 | 1881 | 254 | 2027 | 148 | 1482 |
| 8-#9 | 3.33 | MA | 1622 | 865 | 2598 | 673 | 2989 | 556 | 3240 | 465 | 3586 | 304 | 4288 | 163 | 3411 |
| 3E | | MI | 904 | 865 | 1529 | 618 | 1678 | 507 | 1748 | 414 | 1816 | 244 | 1945 | 41 | 1811 |
| 8-#9 | 3.33 | MA | 1556 | 865 | 2410 | 679 | 2725 | 567 | 2916 | 468 | 3143 | 305 | 3760 | 124 | 3185 |
| 4L-2S | | MI | 957 | 865 | 1656 | 618 | 1840 | 509 | 1938 | 411 | 2058 | 241 | 2210 | 113 | 1804 |
| 8-#10 | 4.23 | MA | 1708 | 927 | 2814 | 711 | 3257 | 583 | 3563 | 483 | 4021 | 301 | 4832 | 128 | 4237 |
| 3E | | MI | 937 | 927 | 1627 | 652 | 1797 | 530 | 1876 | 424 | 1978 | 227 | 2107 | -27 | 2105 |
| 8-#10 | 4.23 | MA | 1629 | 927 | 2577 | 719 | 2924 | 597 | 3154 | 487 | 3462 | 302 | 4174 | 79 | 3820 |
| 4L-2S | | MI | 1001 | 927 | 1785 | 653 | 1999 | 534 | 2110 | 420 | 2275 | 223 | 2428 | 65 | 2201 |
| 8-#11 | 5.20 | MA | 1692 | 993 | 2746 | 755 | 3117 | 624 | 3380 | 502 | 3760 | 293 | 4502 | 18 | 4423 |
| 4L-2S | | MI | 1031 | 993 | 1896 | 685 | 2092 | 545 | 2212 | 416 | 2402 | 189 | 2597 | 12 | 2555 |
| 8-#14 | 7.50 | MA | 1865 | 1150 | 3143 | 855 | 3595 | 699 | 3953 | 548 | 4565 | 296 | 5437 | -109 | 5326 |
| 4L-2S | | MI | 1127 | 1150 | 2180 | 776 | 2395 | 594 | 2560 | 429 | 2843 | 130 | 3026 | -129 | 2926 |
| 10-#10 | 5.29 | MA | 1781 | 999 | 2916 | 764 | 3356 | 630 | 3679 | 508 | 4173 | 298 | 5103 | 66 | 4796 |
| 4L-3S | | MI | 998 | 999 | 1785 | 698 | 1999 | 563 | 2110 | 442 | 2275 | 213 | 2428 | -72 | 2419 |
| 10-#10 | 5.29 | MA | 1677 | 999 | 2673 | 780 | 3064 | 636 | 3316 | 520 | 3668 | 307 | 4451 | 13 | 4411 |
| 5L-2S | | MI | 1059 | 999 | 1943 | 698 | 2200 | 567 | 2343 | 437 | 2571 | 209 | 2750 | 19 | 2682 |
| 12-#10 | 6.35 | MA | 1826 | 1072 | 3013 | 825 | 3496 | 669 | 3841 | 541 | 4378 | 302 | 5381 | 0 | 5380 |
| 5L-3S | | MI | 1059 | 1072 | 1943 | 743 | 2200 | 596 | 2343 | 459 | 2571 | 199 | 2750 | -117 | 2728 |

## RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.20 | MA | 1766 | 790 | 2618 | 642 | 2978 | 540 | 3159 | 461 | 3320 | 341 | 3901 | 295 | 1614 |
| 2E | | MI | 921 | 790 | 1463 | 583 | 1572 | 490 | 1607 | 415 | 1597 | 297 | 1707 | 223 | 845 |
| 4-#9 | 1.52 | MA | 1821 | 814 | 2750 | 655 | 3139 | 550 | 3351 | 466 | 3579 | 339 | 4241 | 290 | 2004 |
| 2E | | MI | 939 | 814 | 1517 | 594 | 1636 | 498 | 1676 | 418 | 1684 | 289 | 1794 | 204 | 1021 |
| 4-#10 | 1.92 | MA | 1888 | 845 | 2916 | 672 | 3344 | 562 | 3596 | 473 | 3908 | 336 | 4668 | 284 | 2498 |
| 2E | | MI | 961 | 845 | 1584 | 610 | 1715 | 509 | 1761 | 421 | 1790 | 279 | 1900 | 179 | 1238 |
| 4-#11 | 2.36 | MA | 1949 | 878 | 3091 | 687 | 3547 | 572 | 3834 | 479 | 4222 | 330 | 5025 | 269 | 2994 |
| 2E | | MI | 975 | 878 | 1645 | 620 | 1762 | 509 | 1809 | 414 | 1847 | 259 | 1974 | 150 | 1445 |
| 4-#14 | 3.41 | MA | 2105 | 957 | 3491 | 732 | 4043 | 604 | 4429 | 498 | 5023 | 323 | 6012 | 246 | 4185 |
| 2E | | MI | 1022 | 957 | 1791 | 661 | 1913 | 530 | 1980 | 418 | 2063 | 227 | 2181 | 77 | 1923 |
| 4-#18 | 6.06 | MA | 2464 | 1157 | 4456 | 849 | 5245 | 688 | 5877 | 548 | 6973 | 307 | 8302 | 173 | 7053 |
| 2E | | MI | 1126 | 1157 | 2062 | 752 | 2219 | 575 | 2327 | 416 | 2502 | 132 | 2545 | -143 | 2612 |
| 6-#6 | 1.00 | MA | 1735 | 775 | 2530 | 636 | 2878 | 537 | 3044 | 460 | 3170 | 344 | 3710 | 300 | 1372 |
| 2L-3S | | MI | 883 | 775 | 1368 | 581 | 1461 | 489 | 1483 | 419 | 1442 | 307 | 1544 | 208 | 736 |
| 6-#6 | 1.00 | MA | 1663 | 775 | 2392 | 640 | 2703 | 540 | 2832 | 462 | 2883 | 349 | 3312 | 268 | 1379 |
| 3L-2S | | MI | 912 | 775 | 1427 | 580 | 1536 | 489 | 1574 | 418 | 1558 | 305 | 1675 | 239 | 731 |
| 6-#7 | 1.36 | MA | 1800 | 803 | 2683 | 652 | 3067 | 548 | 3270 | 466 | 3473 | 342 | 4124 | 296 | 1827 |
| 2L-3S | | MI | 897 | 803 | 1412 | 595 | 1512 | 498 | 1541 | 424 | 1515 | 300 | 1621 | 178 | 950 |
| 6-#7 | 1.36 | MA | 1705 | 803 | 2497 | 656 | 2830 | 552 | 2982 | 473 | 3084 | 347 | 3586 | 253 | 1835 |
| 3L-2S | | MI | 934 | 803 | 1491 | 594 | 1613 | 499 | 1662 | 422 | 1668 | 298 | 1793 | 221 | 940 |
| 6-#8 | 1.80 | MA | 1875 | 835 | 2861 | 670 | 3287 | 561 | 3535 | 474 | 3829 | 339 | 4599 | 291 | 2359 |
| 2L-3S | | MI | 914 | 835 | 1463 | 611 | 1572 | 509 | 1607 | 430 | 1597 | 292 | 1707 | 141 | 1191 |
| 6-#8 | 1.80 | MA | 1753 | 835 | 2618 | 676 | 2978 | 566 | 3159 | 483 | 3320 | 346 | 3901 | 234 | 2362 |
| 3L-2S | | MI | 960 | 835 | 1565 | 611 | 1702 | 511 | 1762 | 427 | 1794 | 289 | 1925 | 198 | 1178 |
| 6-#9 | 2.27 | MA | 1955 | 871 | 3055 | 691 | 3528 | 576 | 3824 | 483 | 4218 | 335 | 5111 | 284 | 2936 |
| 2L-3S | | MI | 931 | 871 | 1517 | 630 | 1636 | 521 | 1676 | 435 | 1684 | 282 | 1794 | 99 | 1445 |
| 6-#9 | 2.27 | MA | 1806 | 871 | 2750 | 698 | 3139 | 582 | 3351 | 494 | 3579 | 344 | 4241 | 212 | 2929 |
| 3L-2S | | MI | 987 | 871 | 1644 | 630 | 1798 | 524 | 1866 | 432 | 1925 | 279 | 2059 | 171 | 1429 |
| 6-#10 | 2.89 | MA | 2054 | 918 | 3301 | 717 | 3834 | 595 | 4191 | 494 | 4713 | 332 | 5755 | 275 | 3667 |
| 2L-3S | | MI | 952 | 918 | 1584 | 654 | 1715 | 537 | 1761 | 442 | 1790 | 269 | 1900 | 43 | 1753 |
| 6-#10 | 2.89 | MA | 1873 | 918 | 2916 | 726 | 3344 | 602 | 3596 | 508 | 3908 | 342 | 4668 | 183 | 3639 |
| 3L-2S | | MI | 1020 | 918 | 1742 | 655 | 1917 | 542 | 1994 | 438 | 2087 | 265 | 2221 | 134 | 1738 |
| 6-#11 | 3.55 | MA | 1933 | 967 | 3091 | 753 | 3547 | 620 | 3834 | 520 | 4222 | 337 | 5025 | 142 | 4339 |
| 3L-2S | | MI | 1042 | 967 | 1829 | 675 | 1986 | 547 | 2069 | 432 | 2178 | 237 | 2342 | 93 | 2022 |
| 6-#14 | 5.11 | MA | 2092 | 1086 | 3491 | 825 | 4043 | 672 | 4429 | 556 | 5023 | 331 | 6012 | 58 | 5844 |
| 3L-2S | | MI | 1113 | 1086 | 2044 | 741 | 2214 | 581 | 2328 | 440 | 2507 | 192 | 2659 | -14 | 2664 |
| 8-#6 | 1.33 | MA | 1797 | 801 | 2667 | 652 | 3053 | 548 | 3257 | 467 | 3458 | 343 | 4108 | 298 | 1794 |
| 2L-4S | | MI | 891 | 801 | 1384 | 597 | 1476 | 502 | 1501 | 425 | 1469 | 305 | 1578 | 184 | 940 |
| 8-#6 | 1.33 | MA | 1727 | 801 | 2530 | 655 | 2878 | 551 | 3044 | 469 | 3170 | 347 | 3710 | 266 | 1800 |
| 3E | | MI | 907 | 801 | 1427 | 597 | 1536 | 500 | 1574 | 427 | 1558 | 303 | 1675 | 195 | 931 |
| 8-#6 | 1.33 | MA | 1690 | 801 | 2435 | 659 | 2745 | 557 | 2881 | 474 | 2946 | 349 | 3432 | 248 | 1802 |
| 4L-2S | | MI | 935 | 801 | 1485 | 596 | 1611 | 501 | 1665 | 425 | 1674 | 302 | 1807 | 227 | 925 |
| 8-#7 | 1.82 | MA | 1791 | 837 | 2683 | 678 | 3067 | 567 | 3270 | 483 | 3473 | 345 | 4124 | 250 | 2399 |
| 3E | | MI | 929 | 837 | 1491 | 616 | 1613 | 513 | 1662 | 433 | 1668 | 295 | 1793 | 160 | 1205 |
| 8-#7 | 1.82 | MA | 1742 | 837 | 2554 | 682 | 2886 | 575 | 3048 | 486 | 3170 | 347 | 3747 | 225 | 2388 |
| 4L-2S | | MI | 965 | 837 | 1570 | 616 | 1713 | 514 | 1783 | 431 | 1822 | 293 | 1965 | 203 | 1195 |
| 8-#8 | 2.39 | MA | 1865 | 881 | 2861 | 704 | 3287 | 586 | 3535 | 496 | 3829 | 343 | 4599 | 230 | 3093 |
| 3E | | MI | 954 | 881 | 1565 | 639 | 1702 | 529 | 1762 | 441 | 1794 | 285 | 1925 | 116 | 1513 |
| 8-#8 | 2.39 | MA | 1803 | 881 | 2693 | 710 | 3051 | 596 | 3245 | 500 | 3432 | 346 | 4109 | 197 | 3051 |
| 4L-2S | | MI | 999 | 881 | 1667 | 639 | 1832 | 531 | 1916 | 439 | 1990 | 282 | 2143 | 173 | 1502 |
| 8-#9 | 3.03 | MA | 1944 | 929 | 3055 | 734 | 3528 | 607 | 3824 | 510 | 4218 | 341 | 5111 | 206 | 3843 |
| 3E | | MI | 980 | 929 | 1644 | 666 | 1798 | 547 | 1866 | 450 | 1925 | 272 | 2059 | 65 | 1837 |
| 8-#9 | 3.03 | MA | 1869 | 929 | 2844 | 741 | 3231 | 620 | 3459 | 515 | 3719 | 343 | 4499 | 165 | 3642 |
| 4L-2S | | MI | 1034 | 929 | 1771 | 666 | 1959 | 550 | 2056 | 446 | 2167 | 269 | 2325 | 137 | 1827 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

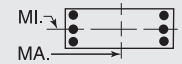
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 3.85 | MA | 2045 | 990 | 3301 | 772 | 3834 | 635 | 4191 | 529 | 4713 | 338 | 5755 | 174 | 4785 |
| 3E | | MI | 1013 | 990 | 1742 | 699 | 1917 | 570 | 1994 | 459 | 2087 | 255 | 2221 | -2 | 2221 |
| 8-#10 | 3.85 | MA | 1954 | 990 | 3034 | 780 | 3458 | 651 | 3731 | 534 | 4083 | 341 | 4990 | 123 | 4372 |
| 4L-2S | | MI | 1078 | 990 | 1900 | 700 | 2118 | 574 | 2227 | 455 | 2383 | 251 | 2543 | 89 | 2227 |
| 8-#11 | 4.73 | MA | 2029 | 1056 | 3230 | 818 | 3682 | 679 | 3993 | 551 | 4429 | 333 | 5397 | 67 | 5073 |
| 4L-2S | | MI | 1108 | 1056 | 2012 | 731 | 2211 | 585 | 2329 | 450 | 2509 | 216 | 2710 | 36 | 2587 |
| 8-#14 | 6.82 | MA | 2232 | 1214 | 3687 | 919 | 4232 | 755 | 4653 | 599 | 5314 | 323 | 6526 | -51 | 6456 |
| 4L-2S | | MI | 1203 | 1214 | 2297 | 822 | 2514 | 633 | 2677 | 463 | 2950 | 157 | 3137 | -106 | 3039 |
| 10-#10 | 4.81 | MA | 2129 | 1063 | 3419 | 826 | 3948 | 684 | 4326 | 555 | 4888 | 336 | 6077 | 114 | 5483 |
| 4L-3S | | MI | 1074 | 1063 | 1900 | 745 | 2118 | 603 | 2227 | 477 | 2383 | 241 | 2543 | -47 | 2537 |
| 10-#10 | 4.81 | MA | 2005 | 1063 | 3146 | 843 | 3619 | 691 | 3918 | 569 | 4321 | 347 | 5314 | 61 | 5096 |
| 5L-2S | | MI | 1136 | 1063 | 2058 | 746 | 2319 | 607 | 2461 | 472 | 2680 | 237 | 2864 | 44 | 2711 |
| 10-#11 | 5.91 | MA | 2093 | 1145 | 3362 | 894 | 3873 | 727 | 4214 | 592 | 4710 | 339 | 5777 | -14 | 5763 |
| 5L-2S | | MI | 1174 | 1145 | 2195 | 787 | 2436 | 622 | 2589 | 469 | 2841 | 195 | 3077 | -20 | 2968 |
| 12-#10 | 5.77 | MA | 2177 | 1135 | 3531 | 888 | 4109 | 724 | 4513 | 589 | 5126 | 343 | 6401 | 52 | 6206 |
| 5L-3S | | MI | 1135 | 1135 | 2058 | 790 | 2319 | 636 | 2461 | 494 | 2680 | 227 | 2864 | -92 | 2849 |
| 12-#10 | 5.77 | MA | 2059 | 1135 | 3293 | 896 | 3785 | 739 | 4111 | 595 | 4583 | 354 | 5702 | -7 | 5695 |
| 6L-2S | | MI | 1194 | 1135 | 2216 | 791 | 2521 | 640 | 2694 | 490 | 2977 | 223 | 3185 | -1 | 3185 |
| 14-#10 | 6.73 | MA | 2234 | 1208 | 3677 | 941 | 4275 | 772 | 4706 | 616 | 5388 | 350 | 6789 | -16 | 6762 |
| 6L-3S | | MI | 1195 | 1208 | 2216 | 835 | 2521 | 669 | 2694 | 511 | 2977 | 213 | 3185 | -138 | 3157 |

## RECTANGULAR TIED COLUMNS 12" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.10 | MA | 2090 | 854 | 3053 | 702 | 3488 | 591 | 3703 | 505 | 3885 | 377 | 4574 | 328 | 1785 |
| 2E | | MI | 997 | 854 | 1577 | 631 | 1691 | 531 | 1725 | 451 | 1707 | 325 | 1822 | 248 | 860 |
| 4-#9 | 1.39 | MA | 2152 | 878 | 3201 | 715 | 3669 | 601 | 3919 | 511 | 4175 | 374 | 4973 | 325 | 2220 |
| 2E | | MI | 1015 | 878 | 1632 | 642 | 1755 | 538 | 1794 | 453 | 1793 | 317 | 1909 | 229 | 1038 |
| 4-#10 | 1.76 | MA | 2230 | 909 | 3387 | 732 | 3899 | 613 | 4194 | 518 | 4544 | 371 | 5479 | 321 | 2772 |
| 2E | | MI | 1037 | 909 | 1699 | 657 | 1835 | 549 | 1879 | 456 | 1899 | 307 | 2014 | 204 | 1257 |
| 4-#11 | 2.17 | MA | 2300 | 942 | 3585 | 747 | 4129 | 623 | 4464 | 523 | 4901 | 366 | 5905 | 309 | 3331 |
| 2E | | MI | 1052 | 942 | 1761 | 666 | 1881 | 549 | 1926 | 449 | 1955 | 286 | 2087 | 174 | 1469 |
| 4-#14 | 3.13 | MA | 2480 | 1021 | 4037 | 792 | 4689 | 655 | 5136 | 542 | 5805 | 359 | 7061 | 290 | 4671 |
| 2E | | MI | 1099 | 1021 | 1908 | 707 | 2032 | 569 | 2097 | 452 | 2170 | 254 | 2293 | 101 | 1953 |
| 4-#18 | 5.56 | MA | 2900 | 1221 | 5131 | 908 | 6052 | 739 | 6778 | 593 | 8016 | 342 | 9773 | 231 | 7917 |
| 2E | | MI | 1202 | 1221 | 2180 | 796 | 2338 | 612 | 2443 | 449 | 2608 | 158 | 2654 | -120 | 2714 |
| 6-#7 | 1.25 | MA | 2128 | 867 | 3125 | 711 | 3587 | 599 | 3826 | 510 | 4054 | 377 | 4810 | 328 | 2022 |
| 2L-3S | | MI | 974 | 867 | 1526 | 643 | 1632 | 539 | 1659 | 460 | 1624 | 329 | 1737 | 203 | 964 |
| 6-#7 | 1.25 | MA | 2020 | 867 | 2917 | 716 | 3323 | 603 | 3506 | 514 | 3620 | 383 | 4209 | 286 | 2029 |
| 3L-2S | | MI | 1011 | 867 | 1605 | 642 | 1732 | 540 | 1780 | 458 | 1778 | 327 | 1909 | 246 | 955 |
| 6-#8 | 1.65 | MA | 2214 | 899 | 3324 | 730 | 3834 | 612 | 4123 | 518 | 4453 | 374 | 5360 | 324 | 2615 |
| 2L-3S | | MI | 990 | 899 | 1577 | 659 | 1691 | 550 | 1725 | 465 | 1707 | 320 | 1822 | 166 | 1209 |
| 6-#8 | 1.65 | MA | 2076 | 899 | 3053 | 736 | 3488 | 617 | 3703 | 523 | 3885 | 382 | 4574 | 268 | 2618 |
| 3L-2S | | MI | 1037 | 899 | 1680 | 659 | 1821 | 551 | 1880 | 463 | 1903 | 318 | 2040 | 223 | 1195 |
| 6-#9 | 2.08 | MA | 2305 | 935 | 3542 | 750 | 4103 | 626 | 4447 | 527 | 4889 | 371 | 5961 | 320 | 3260 |
| 2L-3S | | MI | 1007 | 935 | 1632 | 677 | 1755 | 562 | 1794 | 471 | 1793 | 311 | 1909 | 124 | 1466 |
| 6-#9 | 2.08 | MA | 2136 | 935 | 3201 | 758 | 3669 | 633 | 3919 | 533 | 4175 | 381 | 4973 | 249 | 3253 |
| 3L-2S | | MI | 1063 | 935 | 1759 | 678 | 1917 | 564 | 1984 | 467 | 2034 | 307 | 2174 | 196 | 1449 |
| 6-#10 | 2.65 | MA | 2418 | 981 | 3817 | 777 | 4446 | 646 | 4859 | 538 | 5444 | 367 | 6725 | 315 | 4078 |
| 2L-3S | | MI | 1028 | 981 | 1699 | 701 | 1835 | 578 | 1879 | 477 | 1899 | 297 | 2014 | 67 | 1778 |
| 6-#10 | 2.65 | MA | 2213 | 981 | 3387 | 787 | 3899 | 654 | 4194 | 554 | 4544 | 379 | 5479 | 224 | 4051 |
| 3L-2S | | MI | 1096 | 981 | 1857 | 702 | 2036 | 582 | 2112 | 473 | 2195 | 293 | 2336 | 159 | 1761 |
| 6-#11 | 3.25 | MA | 2282 | 1031 | 3585 | 813 | 4129 | 672 | 4464 | 566 | 4901 | 374 | 5905 | 186 | 4844 |
| 3L-2S | | MI | 1118 | 1031 | 1945 | 722 | 2106 | 586 | 2186 | 467 | 2286 | 265 | 2455 | 117 | 2050 |
| 6-#14 | 4.69 | MA | 2465 | 1149 | 4037 | 887 | 4689 | 725 | 5136 | 602 | 5805 | 369 | 7061 | 109 | 6714 |
| 3L-2S | | MI | 1189 | 1149 | 2161 | 787 | 2333 | 620 | 2445 | 474 | 2614 | 219 | 2771 | 9 | 2740 |

## RECTANGULAR TIED COLUMNS 12" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#6 | 1.22 | MA | 2125 | 864 | 3107 | 712 | 3571 | 599 | 3811 | 511 | 4036 | 378 | 4787 | 329 | 1984 |
| 2L-4S | | MI | 967 | 864 | 1497 | 646 | 1595 | 544 | 1619 | 461 | 1579 | 333 | 1694 | 209 | 953 |
| 8-#6 | 1.22 | MA | 2045 | 864 | 2954 | 715 | 3376 | 602 | 3574 | 514 | 3716 | 383 | 4344 | 298 | 1990 |
| 3E | | MI | 984 | 864 | 1540 | 645 | 1655 | 541 | 1693 | 463 | 1668 | 332 | 1792 | 220 | 945 |
| 8-#6 | 1.22 | MA | 2003 | 864 | 2849 | 719 | 3228 | 609 | 3393 | 520 | 3468 | 385 | 4038 | 280 | 1993 |
| 4L-2S | | MI | 1011 | 864 | 1599 | 645 | 1730 | 542 | 1784 | 461 | 1784 | 331 | 1923 | 252 | 939 |
| 8-#7 | 1.67 | MA | 2118 | 901 | 3125 | 738 | 3587 | 618 | 3826 | 524 | 4054 | 381 | 4810 | 283 | 2658 |
| 3E | | MI | 1005 | 901 | 1605 | 664 | 1732 | 554 | 1780 | 469 | 1778 | 324 | 1909 | 185 | 1221 |
| 8-#7 | 1.67 | MA | 2063 | 901 | 2982 | 743 | 3386 | 627 | 3580 | 531 | 3718 | 384 | 4395 | 258 | 2648 |
| 4L-2S | | MI | 1041 | 901 | 1684 | 664 | 1833 | 555 | 1901 | 467 | 1932 | 322 | 2081 | 228 | 1212 |
| 8-#8 | 2.19 | MA | 2202 | 944 | 3324 | 764 | 3834 | 638 | 4123 | 536 | 4453 | 380 | 5360 | 265 | 3435 |
| 3E | | MI | 1030 | 944 | 1680 | 687 | 1821 | 570 | 1880 | 477 | 1903 | 313 | 2040 | 141 | 1533 |
| 8-#8 | 2.19 | MA | 2133 | 944 | 3138 | 771 | 3571 | 648 | 3801 | 545 | 4012 | 383 | 4814 | 232 | 3397 |
| 4L-2S | | MI | 1076 | 944 | 1782 | 687 | 1952 | 572 | 2034 | 474 | 2100 | 310 | 2258 | 198 | 1521 |
| 8-#9 | 2.78 | MA | 2293 | 992 | 3542 | 794 | 4103 | 659 | 4447 | 549 | 4889 | 378 | 5961 | 244 | 4275 |
| 3E | | MI | 1057 | 992 | 1759 | 713 | 1917 | 588 | 1984 | 485 | 2034 | 300 | 2174 | 90 | 1861 |
| 8-#9 | 2.78 | MA | 2209 | 992 | 3307 | 802 | 3773 | 673 | 4042 | 561 | 4334 | 381 | 5272 | 203 | 4110 |
| 4L-2S | | MI | 1111 | 992 | 1886 | 713 | 2079 | 590 | 2174 | 482 | 2276 | 297 | 2439 | 162 | 1849 |
| 8-#10 | 3.53 | MA | 2407 | 1054 | 3817 | 832 | 4446 | 687 | 4859 | 574 | 5444 | 375 | 6725 | 218 | 5334 |
| 3E | | MI | 1089 | 1054 | 1857 | 747 | 2036 | 611 | 2112 | 494 | 2195 | 283 | 2336 | 22 | 2262 |
| 8-#10 | 3.53 | MA | 2305 | 1054 | 3521 | 842 | 4029 | 704 | 4348 | 581 | 4743 | 379 | 5853 | 165 | 4936 |
| 4L-2S | | MI | 1155 | 1054 | 2015 | 748 | 2237 | 615 | 2345 | 490 | 2492 | 279 | 2657 | 114 | 2253 |
| 8-#11 | 4.33 | MA | 2393 | 1120 | 3744 | 880 | 4284 | 732 | 4646 | 598 | 5138 | 372 | 6340 | 112 | 5736 |
| 4L-2S | | MI | 1185 | 1120 | 2128 | 777 | 2330 | 624 | 2446 | 485 | 2617 | 244 | 2822 | 60 | 2618 |
| 8-#14 | 6.25 | MA | 2627 | 1278 | 4261 | 982 | 4906 | 811 | 5392 | 648 | 6138 | 365 | 7664 | 2 | 7655 |
| 4L-2S | | MI | 1280 | 1278 | 2414 | 867 | 2634 | 672 | 2793 | 497 | 3057 | 184 | 3249 | -82 | 3151 |
| 10-#10 | 4.41 | MA | 2504 | 1126 | 3951 | 887 | 4576 | 736 | 5013 | 602 | 5643 | 375 | 7098 | 159 | 6183 |
| 4L-3S | | MI | 1150 | 1126 | 2015 | 792 | 2237 | 643 | 2345 | 512 | 2492 | 269 | 2657 | -23 | 2655 |
| 10-#10 | 4.41 | MA | 2359 | 1126 | 3648 | 905 | 4212 | 745 | 4559 | 617 | 5013 | 387 | 6224 | 106 | 5803 |
| 5L-2S | | MI | 1213 | 1126 | 2173 | 793 | 2439 | 648 | 2578 | 508 | 2789 | 265 | 2978 | 69 | 2738 |
| 10-#11 | 5.42 | MA | 2460 | 1209 | 3895 | 957 | 4501 | 782 | 4898 | 641 | 5458 | 381 | 6778 | 37 | 6639 |
| 5L-2S | | MI | 1251 | 1209 | 2312 | 833 | 2555 | 662 | 2706 | 503 | 2948 | 222 | 3190 | 4 | 3178 |
| 10-#14 | 7.81 | MA | 2724 | 1406 | 4473 | 1092 | 5212 | 881 | 5746 | 708 | 6588 | 375 | 8276 | -111 | 8125 |
| 5L-2S | | MI | 1370 | 1406 | 2667 | 947 | 2934 | 723 | 3142 | 520 | 3501 | 149 | 3727 | -174 | 3599 |
| 12-#10 | 5.29 | MA | 2554 | 1199 | 4078 | 951 | 4759 | 778 | 5224 | 637 | 5913 | 383 | 7470 | 100 | 7052 |
| 5L-3S | | MI | 1211 | 1199 | 2173 | 837 | 2439 | 676 | 2578 | 529 | 2789 | 255 | 2978 | -68 | 2969 |
| 12-#10 | 5.29 | MA | 2421 | 1199 | 3807 | 958 | 4399 | 794 | 4778 | 644 | 5310 | 395 | 6671 | 40 | 6476 |
| 6L-2S | | MI | 1271 | 1199 | 2331 | 838 | 2640 | 681 | 2812 | 525 | 3086 | 251 | 3299 | 23 | 3219 |
| 12-#11 | 6.50 | MA | 2536 | 1298 | 4092 | 1022 | 4724 | 842 | 5157 | 673 | 5811 | 389 | 7302 | -46 | 7238 |
| 6L-2S | | MI | 1317 | 1298 | 2495 | 889 | 2779 | 699 | 2966 | 521 | 3279 | 201 | 3558 | -53 | 3426 |
| 14-#10 | 6.17 | MA | 2619 | 1271 | 4237 | 1003 | 4947 | 827 | 5443 | 665 | 6210 | 391 | 7917 | 34 | 7745 |
| 6L-3S | | MI | 1270 | 1271 | 2331 | 883 | 2640 | 709 | 2812 | 546 | 3086 | 241 | 3299 | -113 | 3280 |

## RECTANGULAR TIED COLUMNS 14" x 14"

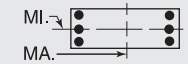
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#6 | 1.35 | MA | 822 | 595 | 1285 | 456 | 1416 | 383 | 1478 | 325 | 1527 | 237 | 1686 | 186 | 818 |
| 2L-3S | | MI | 786 | 595 | 1210 | 458 | 1321 | 384 | 1363 | 328 | 1372 | 238 | 1502 | 154 | 825 |
| 6-#7 | 1.84 | MA | 853 | 623 | 1366 | 471 | 1515 | 394 | 1597 | 332 | 1680 | 232 | 1860 | 172 | 1069 |
| 2L-3S | | MI | 805 | 623 | 1265 | 473 | 1387 | 394 | 1442 | 335 | 1473 | 234 | 1617 | 129 | 1077 |
| 6-#8 | 2.42 | MA | 888 | 655 | 1460 | 489 | 1631 | 407 | 1736 | 339 | 1856 | 227 | 2060 | 156 | 1357 |
| 2L-3S | | MI | 828 | 655 | 1329 | 491 | 1465 | 407 | 1534 | 343 | 1590 | 230 | 1749 | 99 | 1365 |
| 6-#9 | 3.06 | MA | 924 | 691 | 1561 | 509 | 1755 | 421 | 1885 | 348 | 2042 | 220 | 2268 | 136 | 1665 |
| 2L-3S | | MI | 854 | 691 | 1398 | 512 | 1548 | 421 | 1633 | 353 | 1714 | 224 | 1886 | 64 | 1667 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 14"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 3.89 | MA | 969 | 737 | 1687 | 536 | 1911 | 440 | 2073 | 359 | 2274 | 211 | 2523 | 109 | 2049 |
| 2L-3S | | MI | 884 | 737 | 1483 | 538 | 1652 | 440 | 1758 | 364 | 1867 | 216 | 2054 | 18 | 2019 |
| 6-#11 | 4.78 | MA | 1003 | 787 | 1804 | 560 | 2049 | 457 | 2222 | 365 | 2440 | 192 | 2667 | 62 | 2406 |
| 2L-3S | | MI | 907 | 787 | 1565 | 561 | 1745 | 454 | 1856 | 370 | 1975 | 197 | 2146 | -50 | 2132 |
| 8-#6 | 1.80 | MA | 853 | 620 | 1359 | 472 | 1511 | 394 | 1594 | 333 | 1681 | 235 | 1869 | 177 | 1052 |
| 2L-4S | | MI | 797 | 620 | 1231 | 475 | 1341 | 399 | 1387 | 335 | 1408 | 238 | 1553 | 131 | 1064 |
| 8-#7 | 2.45 | MA | 894 | 657 | 1466 | 492 | 1643 | 409 | 1752 | 341 | 1886 | 230 | 2103 | 159 | 1380 |
| 2L-4S | | MI | 821 | 657 | 1294 | 496 | 1414 | 415 | 1474 | 344 | 1521 | 234 | 1683 | 98 | 1362 |
| 8-#8 | 3.22 | MA | 939 | 700 | 1590 | 517 | 1797 | 427 | 1937 | 352 | 2121 | 223 | 2370 | 138 | 1757 |
| 2L-4S | | MI | 848 | 700 | 1366 | 522 | 1499 | 433 | 1575 | 355 | 1652 | 228 | 1832 | 57 | 1652 |
| 8-#9 | 4.08 | MA | 987 | 748 | 1723 | 545 | 1962 | 447 | 2137 | 364 | 2371 | 214 | 2649 | 112 | 2161 |
| 2L-4S | | MI | 881 | 748 | 1443 | 550 | 1591 | 454 | 1684 | 367 | 1790 | 221 | 1987 | 11 | 1955 |

## RECTANGULAR TIED COLUMNS 14" x 16"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.07 | MA | 1057 | 663 | 1610 | 519 | 1782 | 437 | 1859 | 374 | 1909 | 278 | 2134 | 229 | 881 |
| 2E | | MI | 916 | 663 | 1418 | 508 | 1549 | 428 | 1604 | 365 | 1625 | 270 | 1779 | 215 | 767 |
| 4-#8 | 1.41 | MA | 1087 | 684 | 1688 | 531 | 1877 | 445 | 1972 | 378 | 2060 | 275 | 2310 | 220 | 1121 |
| 2E | | MI | 940 | 684 | 1482 | 519 | 1626 | 435 | 1696 | 369 | 1741 | 265 | 1910 | 204 | 968 |
| 4-#9 | 1.79 | MA | 1119 | 708 | 1773 | 543 | 1980 | 454 | 2094 | 383 | 2225 | 273 | 2496 | 209 | 1378 |
| 2E | | MI | 965 | 708 | 1551 | 531 | 1710 | 444 | 1795 | 374 | 1864 | 260 | 2046 | 190 | 1182 |
| 4-#10 | 2.27 | MA | 1159 | 739 | 1879 | 560 | 2109 | 466 | 2249 | 390 | 2429 | 269 | 2727 | 195 | 1699 |
| 2E | | MI | 996 | 739 | 1637 | 548 | 1814 | 456 | 1920 | 381 | 2018 | 254 | 2214 | 172 | 1448 |
| 4-#11 | 2.79 | MA | 1191 | 772 | 1984 | 574 | 2230 | 476 | 2389 | 395 | 2586 | 258 | 2881 | 169 | 2013 |
| 2E | | MI | 1018 | 772 | 1720 | 561 | 1907 | 464 | 2017 | 383 | 2124 | 239 | 2304 | 139 | 1704 |
| 4-#14 | 4.02 | MA | 1278 | 851 | 2232 | 618 | 2535 | 507 | 2755 | 413 | 3036 | 242 | 3376 | 123 | 2764 |
| 2E | | MI | 1085 | 851 | 1917 | 604 | 2148 | 495 | 2280 | 394 | 2456 | 217 | 2642 | 79 | 2313 |
| 4-#18 | 7.14 | MA | 1476 | 1051 | 2812 | 734 | 3255 | 590 | 3584 | 455 | 4053 | 193 | 4439 | -16 | 4429 |
| 2E | | MI | 1234 | 1051 | 2369 | 718 | 2659 | 564 | 2851 | 416 | 3179 | 150 | 3465 | -62 | 3325 |
| 6-#6 | 1.18 | MA | 1069 | 669 | 1632 | 526 | 1815 | 442 | 1901 | 377 | 1969 | 279 | 2218 | 229 | 960 |
| 2L-3S | | MI | 890 | 669 | 1362 | 516 | 1482 | 434 | 1525 | 372 | 1524 | 273 | 1665 | 184 | 839 |
| 6-#6 | 1.18 | MA | 1024 | 669 | 1542 | 528 | 1700 | 444 | 1762 | 381 | 1780 | 281 | 1981 | 198 | 967 |
| 3L-2S | | MI | 926 | 669 | 1436 | 515 | 1577 | 433 | 1640 | 369 | 1679 | 271 | 1848 | 216 | 833 |
| 6-#7 | 1.61 | MA | 1108 | 697 | 1731 | 541 | 1937 | 453 | 2047 | 383 | 2164 | 276 | 2449 | 219 | 1263 |
| 2L-3S | | MI | 909 | 697 | 1418 | 531 | 1549 | 444 | 1604 | 378 | 1625 | 269 | 1779 | 159 | 1096 |
| 6-#7 | 1.61 | MA | 1049 | 697 | 1610 | 543 | 1782 | 455 | 1859 | 388 | 1909 | 279 | 2134 | 176 | 1272 |
| 3L-2S | | MI | 957 | 697 | 1518 | 529 | 1677 | 443 | 1759 | 375 | 1831 | 267 | 2022 | 203 | 1086 |
| 6-#8 | 2.12 | MA | 1153 | 729 | 1847 | 559 | 2079 | 466 | 2217 | 391 | 2392 | 273 | 2715 | 207 | 1613 |
| 2L-3S | | MI | 931 | 729 | 1482 | 549 | 1626 | 456 | 1696 | 386 | 1741 | 264 | 1910 | 129 | 1388 |
| 6-#8 | 2.12 | MA | 1078 | 729 | 1688 | 562 | 1877 | 468 | 1972 | 397 | 2060 | 276 | 2310 | 150 | 1621 |
| 3L-2S | | MI | 993 | 729 | 1612 | 547 | 1792 | 456 | 1897 | 382 | 2007 | 261 | 2221 | 186 | 1377 |
| 6-#9 | 2.68 | MA | 1201 | 765 | 1971 | 579 | 2233 | 480 | 2401 | 400 | 2640 | 269 | 2997 | 192 | 1989 |
| 2L-3S | | MI | 955 | 765 | 1551 | 569 | 1710 | 470 | 1795 | 395 | 1864 | 258 | 2046 | 94 | 1696 |
| 6-#9 | 2.68 | MA | 1109 | 765 | 1773 | 583 | 1980 | 483 | 2094 | 407 | 2225 | 273 | 2496 | 120 | 1991 |
| 3L-2S | | MI | 1029 | 765 | 1714 | 567 | 1917 | 470 | 2046 | 391 | 2193 | 254 | 2428 | 166 | 1688 |
| 6-#10 | 3.40 | MA | 1260 | 812 | 2127 | 606 | 2426 | 499 | 2634 | 411 | 2949 | 264 | 3347 | 171 | 2460 |
| 2L-3S | | MI | 988 | 812 | 1637 | 595 | 1814 | 488 | 1920 | 407 | 2018 | 249 | 2214 | 47 | 2072 |
| 6-#10 | 3.40 | MA | 1148 | 812 | 1879 | 610 | 2109 | 502 | 2249 | 419 | 2429 | 269 | 2727 | 80 | 2447 |
| 3L-2S | | MI | 1074 | 812 | 1841 | 593 | 2073 | 489 | 2234 | 402 | 2425 | 245 | 2682 | 139 | 2075 |
| 6-#11 | 4.18 | MA | 1305 | 861 | 2279 | 630 | 2605 | 516 | 2845 | 420 | 3187 | 250 | 3585 | 134 | 2911 |
| 2L-3S | | MI | 1010 | 861 | 1720 | 617 | 1907 | 502 | 2017 | 412 | 2124 | 231 | 2304 | -21 | 2299 |
| 6-#11 | 4.18 | MA | 1184 | 861 | 1984 | 634 | 2230 | 517 | 2389 | 428 | 2586 | 255 | 2881 | 22 | 2832 |
| 3L-2S | | MI | 1108 | 861 | 1959 | 616 | 2211 | 505 | 2382 | 407 | 2589 | 225 | 2824 | 92 | 2438 |
| 6-#14 | 6.03 | MA | 1275 | 979 | 2232 | 703 | 2535 | 565 | 2755 | 460 | 3036 | 235 | 3376 | -96 | 3322 |
| 3L-2S | | MI | 1207 | 979 | 2251 | 685 | 2573 | 553 | 2778 | 427 | 3090 | 194 | 3338 | 4 | 3323 |
| 8-#6 | 1.57 | MA | 1108 | 695 | 1722 | 541 | 1930 | 454 | 2041 | 384 | 2157 | 277 | 2454 | 223 | 1242 |
| 2L-4S | | MI | 901 | 695 | 1383 | 533 | 1503 | 449 | 1549 | 379 | 1560 | 272 | 1715 | 162 | 1083 |

## RECTANGULAR TIED COLUMNS 14" x 16"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#6 | 1.57 | MA | 1063 | 695 | 1632 | 544 | 1815 | 455 | 1901 | 388 | 1969 | 280 | 2218 | 191 | 1248 |
| 3E | | MI | 921 | 695 | 1436 | 532 | 1577 | 445 | 1640 | 379 | 1679 | 271 | 1848 | 175 | 1076 |
| 8-#6 | 1.57 | MA | 1039 | 695 | 1568 | 546 | 1726 | 460 | 1792 | 389 | 1819 | 279 | 2048 | 176 | 1254 |
| 4L-2S | | MI | 957 | 695 | 1511 | 530 | 1672 | 444 | 1756 | 376 | 1833 | 269 | 2031 | 207 | 1069 |
| 8-#7 | 2.14 | MA | 1159 | 731 | 1853 | 562 | 2092 | 469 | 2235 | 393 | 2419 | 274 | 2765 | 210 | 1639 |
| 2L-4S | | MI | 924 | 731 | 1446 | 554 | 1576 | 464 | 1636 | 388 | 1673 | 268 | 1845 | 128 | 1411 |
| 8-#7 | 2.14 | MA | 1101 | 731 | 1731 | 565 | 1937 | 470 | 2047 | 398 | 2164 | 277 | 2449 | 167 | 1645 |
| 3E | | MI | 951 | 731 | 1518 | 552 | 1677 | 459 | 1759 | 388 | 1831 | 266 | 2022 | 146 | 1407 |
| 8-#7 | 2.14 | MA | 1070 | 731 | 1645 | 568 | 1816 | 476 | 1899 | 399 | 1969 | 280 | 2223 | 146 | 1643 |
| 4L-2S | | MI | 998 | 731 | 1618 | 551 | 1805 | 459 | 1914 | 385 | 2037 | 264 | 2265 | 190 | 1400 |
| 8-#8 | 2.82 | MA | 1218 | 774 | 2005 | 587 | 2281 | 486 | 2462 | 404 | 2724 | 270 | 3121 | 194 | 2098 |
| 2L-4S | | MI | 951 | 774 | 1518 | 579 | 1661 | 483 | 1737 | 398 | 1803 | 262 | 1993 | 87 | 1714 |
| 8-#8 | 2.82 | MA | 1146 | 774 | 1847 | 590 | 2079 | 489 | 2217 | 410 | 2392 | 274 | 2715 | 137 | 2099 |
| 3E | | MI | 988 | 774 | 1612 | 577 | 1792 | 477 | 1897 | 399 | 2007 | 260 | 2221 | 111 | 1786 |
| 8-#8 | 2.82 | MA | 1105 | 774 | 1734 | 594 | 1921 | 496 | 2024 | 411 | 2138 | 277 | 2424 | 110 | 2014 |
| 4L-2S | | MI | 1044 | 774 | 1743 | 575 | 1958 | 476 | 2099 | 395 | 2272 | 257 | 2531 | 168 | 1780 |
| 8-#9 | 3.57 | MA | 1281 | 822 | 2170 | 615 | 2485 | 506 | 2708 | 416 | 3055 | 266 | 3499 | 174 | 2593 |
| 2L-4S | | MI | 984 | 822 | 1596 | 607 | 1753 | 503 | 1846 | 410 | 1941 | 255 | 2148 | 41 | 2023 |
| 8-#9 | 3.57 | MA | 1193 | 822 | 1971 | 619 | 2233 | 509 | 2401 | 423 | 2640 | 270 | 2997 | 102 | 2584 |
| 3E | | MI | 1024 | 822 | 1714 | 605 | 1917 | 496 | 2046 | 412 | 2193 | 252 | 2428 | 70 | 2185 |
| 8-#9 | 3.57 | MA | 1143 | 822 | 1830 | 623 | 2035 | 518 | 2159 | 423 | 2322 | 273 | 2636 | 69 | 2389 |
| 4L-2S | | MI | 1092 | 822 | 1876 | 603 | 2124 | 496 | 2298 | 407 | 2522 | 248 | 2810 | 141 | 2187 |
| 8-#10 | 4.54 | MA | 1257 | 884 | 2127 | 656 | 2426 | 535 | 2634 | 440 | 2949 | 264 | 3347 | 55 | 3184 |
| 3E | | MI | 1071 | 884 | 1841 | 641 | 2073 | 521 | 2234 | 427 | 2425 | 241 | 2682 | 14 | 2649 |
| 8-#10 | 4.54 | MA | 1192 | 884 | 1950 | 660 | 2178 | 545 | 2330 | 440 | 2550 | 268 | 2898 | 14 | 2849 |
| 4L-2S | | MI | 1152 | 884 | 2044 | 638 | 2333 | 522 | 2549 | 422 | 2831 | 237 | 3150 | 106 | 2695 |
| 8-#11 | 5.57 | MA | 1305 | 950 | 2279 | 690 | 2605 | 558 | 2845 | 454 | 3187 | 247 | 3585 | -14 | 3574 |
| 3E | | MI | 1105 | 950 | 1959 | 673 | 2211 | 543 | 2382 | 436 | 2589 | 217 | 2824 | -68 | 2800 |
| 10-#10 | 5.67 | MA | 1308 | 957 | 2199 | 706 | 2494 | 578 | 2715 | 461 | 3069 | 264 | 3518 | -10 | 3511 |
| 4L-3S | | MI | 1152 | 957 | 2044 | 686 | 2333 | 554 | 2549 | 448 | 2831 | 233 | 3150 | -18 | 3139 |

## RECTANGULAR TIED COLUMNS 14" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.25 | MA | 1369 | 759 | 2082 | 600 | 2332 | 505 | 2455 | 430 | 2562 | 317 | 2926 | 263 | 1291 |
| 2E | | MI | 1044 | 759 | 1635 | 577 | 1788 | 485 | 1857 | 412 | 1892 | 300 | 2071 | 234 | 984 |
| 4-#9 | 1.59 | MA | 1408 | 782 | 2182 | 613 | 2455 | 514 | 2601 | 435 | 2758 | 314 | 3162 | 255 | 1594 |
| 2E | | MI | 1069 | 782 | 1704 | 589 | 1872 | 493 | 1956 | 417 | 2015 | 294 | 2207 | 220 | 1201 |
| 4-#10 | 2.02 | MA | 1458 | 813 | 2309 | 630 | 2609 | 526 | 2786 | 442 | 3006 | 311 | 3457 | 244 | 1974 |
| 2E | | MI | 1100 | 813 | 1791 | 605 | 1976 | 504 | 2081 | 423 | 2168 | 287 | 2374 | 201 | 1470 |
| 4-#11 | 2.48 | MA | 1499 | 846 | 2439 | 644 | 2758 | 535 | 2958 | 446 | 3233 | 305 | 3676 | 223 | 2350 |
| 2E | | MI | 1123 | 846 | 1876 | 617 | 2069 | 512 | 2178 | 424 | 2274 | 272 | 2462 | 168 | 1731 |
| 4-#14 | 3.57 | MA | 1610 | 925 | 2738 | 688 | 3127 | 567 | 3401 | 465 | 3817 | 295 | 4332 | 186 | 3250 |
| 2E | | MI | 1189 | 925 | 2073 | 660 | 2311 | 542 | 2440 | 436 | 2605 | 250 | 2799 | 108 | 2346 |
| 4-#18 | 6.35 | MA | 1859 | 1125 | 3448 | 803 | 4008 | 649 | 4460 | 514 | 5134 | 259 | 5792 | 75 | 5377 |
| 2E | | MI | 1339 | 1125 | 2527 | 772 | 2822 | 610 | 3011 | 457 | 3326 | 182 | 3619 | -34 | 3483 |
| 6-#6 | 1.05 | MA | 1347 | 744 | 2014 | 595 | 2258 | 502 | 2370 | 429 | 2451 | 320 | 2804 | 271 | 1103 |
| 2L-3S | | MI | 993 | 744 | 1513 | 574 | 1644 | 483 | 1687 | 415 | 1676 | 307 | 1827 | 215 | 853 |
| 6-#6 | 1.05 | MA | 1292 | 744 | 1908 | 598 | 2123 | 504 | 2206 | 433 | 2230 | 323 | 2513 | 240 | 1110 |
| 3L-2S | | MI | 1030 | 744 | 1588 | 573 | 1739 | 483 | 1802 | 412 | 1831 | 306 | 2010 | 246 | 847 |
| 6-#7 | 1.43 | MA | 1394 | 771 | 2132 | 610 | 2402 | 512 | 2542 | 435 | 2682 | 317 | 3093 | 264 | 1457 |
| 2L-3S | | MI | 1013 | 771 | 1570 | 589 | 1711 | 493 | 1765 | 422 | 1776 | 303 | 1941 | 190 | 1113 |
| 6-#7 | 1.43 | MA | 1323 | 771 | 1988 | 614 | 2219 | 515 | 2321 | 441 | 2383 | 321 | 2704 | 220 | 1466 |
| 3L-2S | | MI | 1061 | 771 | 1670 | 587 | 1838 | 493 | 1921 | 418 | 1983 | 301 | 2184 | 233 | 1103 |
| 6-#8 | 1.88 | MA | 1449 | 804 | 2268 | 628 | 2570 | 525 | 2744 | 443 | 2953 | 314 | 3428 | 254 | 1869 |
| 2L-3S | | MI | 1035 | 804 | 1635 | 607 | 1788 | 506 | 1857 | 429 | 1892 | 298 | 2071 | 159 | 1409 |
| 6-#8 | 1.88 | MA | 1358 | 804 | 2082 | 633 | 2332 | 529 | 2455 | 450 | 2562 | 319 | 2926 | 197 | 1876 |
| 3L-2S | | MI | 1097 | 804 | 1765 | 605 | 1954 | 505 | 2059 | 425 | 2158 | 295 | 2382 | 216 | 1397 |
| 6-#9 | 2.38 | MA | 1507 | 840 | 2416 | 649 | 2753 | 540 | 2963 | 451 | 3248 | 311 | 3785 | 242 | 2313 |
| 2L-3S | | MI | 1059 | 840 | 1704 | 627 | 1872 | 519 | 1956 | 438 | 2015 | 292 | 2207 | 124 | 1722 |

## RECTANGULAR TIED COLUMNS 14" x 18"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

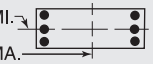
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#9 | 2.38 | MA | 1396 | 840 | 2182 | 654 | 2455 | 544 | 2601 | 460 | 2758 | 317 | 3162 | 170 | 2315 |
| 3L-2S | | MI | 1134 | 840 | 1867 | 624 | 2079 | 519 | 2208 | 433 | 2344 | 288 | 2588 | 196 | 1711 |
| 6-#10 | 3.02 | MA | 1580 | 886 | 2603 | 675 | 2984 | 559 | 3241 | 463 | 3622 | 306 | 4231 | 226 | 2872 |
| 2L-3S | | MI | 1091 | 886 | 1791 | 653 | 1976 | 537 | 2081 | 449 | 2168 | 283 | 2374 | 77 | 2106 |
| 6-#10 | 3.02 | MA | 1444 | 886 | 2309 | 682 | 2609 | 563 | 2786 | 473 | 3006 | 313 | 3457 | 135 | 2858 |
| 3L-2S | | MI | 1179 | 886 | 1994 | 650 | 2236 | 537 | 2395 | 444 | 2575 | 279 | 2842 | 168 | 2101 |
| 6-#11 | 3.71 | MA | 1642 | 936 | 2789 | 699 | 3204 | 575 | 3500 | 472 | 3966 | 300 | 4568 | 196 | 3417 |
| 2L-3S | | MI | 1113 | 936 | 1876 | 674 | 2069 | 550 | 2178 | 454 | 2274 | 264 | 2462 | 9 | 2444 |
| 6-#11 | 3.71 | MA | 1485 | 936 | 2439 | 706 | 2758 | 579 | 2958 | 483 | 3233 | 306 | 3676 | 84 | 3383 |
| 3L-2S | | MI | 1213 | 936 | 2115 | 672 | 2374 | 553 | 2543 | 449 | 2738 | 259 | 2982 | 121 | 2469 |
| 6-#14 | 5.36 | MA | 1607 | 1054 | 2738 | 776 | 3127 | 629 | 3401 | 516 | 3817 | 295 | 4332 | -20 | 4314 |
| 3L-2S | | MI | 1312 | 1054 | 2407 | 740 | 2735 | 601 | 2939 | 468 | 3239 | 227 | 3494 | 33 | 3362 |
| 8-#6 | 1.40 | MA | 1393 | 769 | 2120 | 611 | 2393 | 513 | 2534 | 436 | 2673 | 319 | 3094 | 267 | 1432 |
| 2L-4S | | MI | 1005 | 769 | 1534 | 592 | 1664 | 498 | 1711 | 422 | 1712 | 307 | 1877 | 192 | 1100 |
| 8-#6 | 1.40 | MA | 1340 | 769 | 2014 | 614 | 2258 | 515 | 2370 | 441 | 2451 | 322 | 2804 | 235 | 1438 |
| 3E | | MI | 1025 | 769 | 1588 | 590 | 1739 | 495 | 1802 | 422 | 1831 | 306 | 2010 | 206 | 1092 |
| 8-#6 | 1.40 | MA | 1312 | 769 | 1940 | 616 | 2154 | 520 | 2243 | 442 | 2277 | 322 | 2598 | 218 | 1444 |
| 4L-2S | | MI | 1061 | 769 | 1662 | 589 | 1834 | 494 | 1917 | 419 | 1985 | 304 | 2193 | 237 | 1085 |
| 8-#7 | 1.90 | MA | 1456 | 805 | 2275 | 632 | 2584 | 528 | 2764 | 445 | 2982 | 315 | 3482 | 257 | 1898 |
| 2L-4S | | MI | 1028 | 805 | 1598 | 612 | 1738 | 514 | 1797 | 431 | 1824 | 302 | 2007 | 158 | 1435 |
| 8-#7 | 1.90 | MA | 1387 | 805 | 2132 | 635 | 2402 | 531 | 2542 | 451 | 2682 | 319 | 3093 | 214 | 1904 |
| 3E | | MI | 1055 | 805 | 1670 | 611 | 1838 | 509 | 1921 | 431 | 1983 | 300 | 2184 | 177 | 1427 |
| 8-#7 | 1.90 | MA | 1349 | 805 | 2031 | 639 | 2261 | 537 | 2370 | 452 | 2446 | 319 | 2817 | 191 | 1902 |
| 4L-2S | | MI | 1102 | 805 | 1770 | 609 | 1966 | 508 | 2076 | 428 | 2189 | 298 | 2427 | 220 | 1419 |
| 8-#8 | 2.51 | MA | 1528 | 849 | 2455 | 657 | 2808 | 546 | 3033 | 456 | 3344 | 311 | 3930 | 244 | 2440 |
| 2L-4S | | MI | 1055 | 849 | 1671 | 637 | 1823 | 532 | 1898 | 441 | 1954 | 296 | 2154 | 117 | 1772 |
| 8-#8 | 2.51 | MA | 1440 | 849 | 2268 | 661 | 2570 | 549 | 2744 | 463 | 2953 | 316 | 3428 | 188 | 2441 |
| 3E | | MI | 1089 | 849 | 1765 | 635 | 1954 | 526 | 2059 | 442 | 2158 | 294 | 2382 | 141 | 1810 |
| 8-#8 | 2.51 | MA | 1393 | 849 | 2137 | 666 | 2386 | 558 | 2519 | 465 | 2645 | 316 | 3071 | 158 | 2388 |
| 4L-2S | | MI | 1149 | 849 | 1895 | 633 | 2120 | 526 | 2260 | 438 | 2424 | 291 | 2692 | 198 | 1802 |
| 8-#9 | 3.17 | MA | 1605 | 897 | 2651 | 684 | 3051 | 566 | 3325 | 467 | 3738 | 307 | 4408 | 229 | 3025 |
| 2L-4S | | MI | 1084 | 897 | 1749 | 665 | 1915 | 552 | 2007 | 452 | 2092 | 289 | 2308 | 71 | 2087 |
| 8-#9 | 3.17 | MA | 1498 | 897 | 2416 | 690 | 2753 | 570 | 2963 | 476 | 3248 | 313 | 3785 | 157 | 3016 |
| 3E | | MI | 1128 | 897 | 1867 | 662 | 2079 | 545 | 2208 | 454 | 2344 | 286 | 2588 | 99 | 2215 |
| 8-#9 | 3.17 | MA | 1440 | 897 | 2252 | 695 | 2522 | 580 | 2680 | 479 | 2861 | 312 | 3341 | 121 | 2838 |
| 4L-2S | | MI | 1198 | 897 | 2030 | 660 | 2286 | 545 | 2460 | 449 | 2673 | 283 | 2970 | 171 | 2212 |
| 8-#10 | 4.03 | MA | 1571 | 958 | 2603 | 727 | 2984 | 596 | 3241 | 494 | 3622 | 309 | 4231 | 117 | 3733 |
| 3E | | MI | 1174 | 958 | 1994 | 698 | 2236 | 570 | 2395 | 470 | 2575 | 275 | 2842 | 44 | 2713 |
| 8-#10 | 4.03 | MA | 1500 | 958 | 2396 | 733 | 2693 | 609 | 2885 | 496 | 3134 | 308 | 3678 | 72 | 3390 |
| 4L-2S | | MI | 1257 | 958 | 2198 | 695 | 2495 | 570 | 2710 | 465 | 2982 | 271 | 3310 | 135 | 2723 |
| 8-#11 | 4.95 | MA | 1641 | 1025 | 2789 | 762 | 3204 | 620 | 3500 | 508 | 3966 | 301 | 4568 | 57 | 4405 |
| 3E | | MI | 1209 | 1025 | 2115 | 729 | 2374 | 590 | 2543 | 478 | 2738 | 250 | 2982 | -39 | 2970 |
| 8-#11 | 4.95 | MA | 1550 | 1025 | 2540 | 768 | 2855 | 634 | 3073 | 510 | 3405 | 307 | 3926 | 5 | 3908 |
| 4L-2S | | MI | 1302 | 1025 | 2354 | 728 | 2678 | 593 | 2908 | 473 | 3203 | 245 | 3503 | 73 | 3196 |
| 10-#10 | 5.04 | MA | 1630 | 1031 | 2690 | 779 | 3067 | 642 | 3340 | 517 | 3750 | 303 | 4452 | 54 | 4228 |
| 4L-3S | | MI | 1256 | 1031 | 2198 | 743 | 2495 | 603 | 2710 | 491 | 2982 | 266 | 3310 | 11 | 3282 |
| 10-#10 | 5.04 | MA | 1546 | 1031 | 2477 | 794 | 2811 | 646 | 3022 | 528 | 3309 | 310 | 3908 | -1 | 3908 |
| 5L-2S | | MI | 1334 | 1031 | 2401 | 741 | 2754 | 603 | 3025 | 485 | 3389 | 262 | 3778 | 103 | 3338 |
| 10-#11 | 6.19 | MA | 1715 | 1114 | 2891 | 824 | 3301 | 675 | 3615 | 535 | 4138 | 302 | 4817 | -22 | 4796 |
| 4L-3S | | MI | 1302 | 1114 | 2354 | 785 | 2678 | 631 | 2908 | 502 | 3203 | 237 | 3503 | -86 | 3467 |
| 12-#10 | 6.05 | MA | 1673 | 1103 | 2771 | 839 | 3186 | 679 | 3476 | 548 | 3924 | 306 | 4682 | -18 | 4666 |
| 5L-3S | | MI | 1336 | 1103 | 2401 | 789 | 2754 | 636 | 3025 | 511 | 3389 | 258 | 3778 | -22 | 3764 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

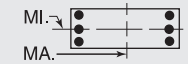
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.13 | MA | 1681 | 833 | 2510 | 670 | 2830 | 564 | 2985 | 482 | 3110 | 358 | 3596 | 305 | 1462 |
| 2E | | MI | 1148 | 833 | 1787 | 634 | 1950 | 534 | 2019 | 455 | 2043 | 334 | 2232 | 264 | 1000 |
| 4-#9 | 1.43 | MA | 1728 | 857 | 2627 | 683 | 2972 | 573 | 3154 | 487 | 3337 | 355 | 3883 | 299 | 1810 |
| 2E | | MI | 1174 | 857 | 1857 | 646 | 2034 | 542 | 2118 | 460 | 2166 | 328 | 2367 | 250 | 1220 |
| 4-#10 | 1.81 | MA | 1787 | 888 | 2774 | 699 | 3152 | 585 | 3369 | 494 | 3625 | 352 | 4243 | 290 | 2248 |
| 2E | | MI | 1205 | 888 | 1945 | 662 | 2138 | 553 | 2242 | 466 | 2319 | 321 | 2534 | 231 | 1492 |
| 4-#11 | 2.23 | MA | 1838 | 921 | 2928 | 713 | 3328 | 594 | 3574 | 498 | 3895 | 346 | 4529 | 272 | 2687 |
| 2E | | MI | 1227 | 921 | 2031 | 673 | 2232 | 560 | 2339 | 466 | 2423 | 305 | 2619 | 197 | 1757 |
| 4-#14 | 3.21 | MA | 1972 | 999 | 3279 | 758 | 3761 | 626 | 4093 | 517 | 4593 | 338 | 5348 | 243 | 3736 |
| 2E | | MI | 1294 | 999 | 2230 | 715 | 2473 | 590 | 2601 | 477 | 2753 | 283 | 2955 | 137 | 2378 |
| 4-#18 | 5.71 | MA | 2277 | 1199 | 4119 | 873 | 4804 | 708 | 5346 | 566 | 6271 | 320 | 7218 | 153 | 6241 |
| 2E | | MI | 1443 | 1199 | 2685 | 826 | 2984 | 656 | 3170 | 497 | 3473 | 214 | 3772 | -6 | 3773 |
| 6-#7 | 1.29 | MA | 1711 | 845 | 2567 | 680 | 2909 | 572 | 3084 | 487 | 3247 | 358 | 3791 | 306 | 1652 |
| 2L-3S | | MI | 1117 | 845 | 1722 | 647 | 1872 | 543 | 1927 | 465 | 1928 | 338 | 2102 | 220 | 1129 |
| 6-#7 | 1.29 | MA | 1627 | 845 | 2402 | 684 | 2700 | 575 | 2829 | 493 | 2902 | 363 | 3328 | 263 | 1661 |
| 3L-2S | | MI | 1166 | 845 | 1822 | 645 | 2000 | 542 | 2082 | 461 | 2134 | 336 | 2345 | 263 | 1119 |
| 6-#8 | 1.69 | MA | 1776 | 878 | 2725 | 698 | 3104 | 585 | 3317 | 495 | 3560 | 355 | 4195 | 299 | 2125 |
| 2L-3S | | MI | 1139 | 878 | 1787 | 665 | 1950 | 555 | 2019 | 472 | 2043 | 332 | 2232 | 189 | 1429 |
| 6-#8 | 1.69 | MA | 1669 | 878 | 2510 | 703 | 2830 | 589 | 2985 | 503 | 3110 | 362 | 3596 | 242 | 2132 |
| 3L-2S | | MI | 1201 | 878 | 1918 | 663 | 2116 | 555 | 2220 | 468 | 2309 | 330 | 2543 | 246 | 1416 |
| 6-#9 | 2.14 | MA | 1845 | 914 | 2897 | 718 | 3316 | 599 | 3571 | 503 | 3902 | 352 | 4629 | 290 | 2637 |
| 2L-3S | | MI | 1163 | 914 | 1857 | 684 | 2034 | 568 | 2118 | 481 | 2166 | 326 | 2367 | 154 | 1746 |
| 6-#9 | 2.14 | MA | 1714 | 914 | 2627 | 725 | 2972 | 604 | 3154 | 513 | 3337 | 359 | 3883 | 218 | 2639 |
| 3L-2S | | MI | 1239 | 914 | 2020 | 682 | 2241 | 568 | 2369 | 476 | 2495 | 322 | 2749 | 225 | 1732 |
| 6-#10 | 2.72 | MA | 1931 | 960 | 3113 | 745 | 3584 | 618 | 3894 | 514 | 4336 | 348 | 5173 | 277 | 3283 |
| 2L-3S | | MI | 1195 | 960 | 1945 | 710 | 2138 | 586 | 2242 | 492 | 2319 | 317 | 2534 | 107 | 2137 |
| 6-#10 | 2.72 | MA | 1772 | 960 | 2774 | 753 | 3152 | 624 | 3369 | 527 | 3625 | 357 | 4243 | 186 | 3270 |
| 3L-2S | | MI | 1284 | 960 | 2148 | 707 | 2398 | 586 | 2557 | 487 | 2725 | 313 | 3002 | 198 | 2126 |
| 6-#11 | 3.34 | MA | 2007 | 1010 | 3334 | 769 | 3845 | 635 | 4202 | 523 | 4745 | 341 | 5611 | 252 | 3922 |
| 2L-3S | | MI | 1216 | 1010 | 2031 | 730 | 2232 | 598 | 2339 | 495 | 2423 | 297 | 2619 | 38 | 2503 |
| 6-#11 | 3.34 | MA | 1821 | 1010 | 2928 | 777 | 3328 | 641 | 3574 | 537 | 3895 | 350 | 4529 | 140 | 3888 |
| 3L-2S | | MI | 1318 | 1010 | 2270 | 729 | 2536 | 600 | 2704 | 490 | 2888 | 292 | 3140 | 150 | 2499 |
| 6-#14 | 4.82 | MA | 1957 | 1128 | 3279 | 849 | 3761 | 692 | 4093 | 572 | 4593 | 342 | 5348 | 47 | 5221 |
| 3L-2S | | MI | 1417 | 1128 | 2563 | 795 | 2898 | 648 | 3099 | 509 | 3387 | 260 | 3651 | 61 | 3399 |
| 8-#6 | 1.26 | MA | 1709 | 843 | 2553 | 681 | 2898 | 573 | 3073 | 488 | 3235 | 360 | 3788 | 309 | 1622 |
| 2L-4S | | MI | 1108 | 843 | 1686 | 650 | 1826 | 548 | 1872 | 466 | 1864 | 342 | 2039 | 222 | 1116 |
| 8-#6 | 1.26 | MA | 1647 | 843 | 2431 | 684 | 2743 | 575 | 2885 | 493 | 2980 | 364 | 3443 | 277 | 1628 |
| 3E | | MI | 1129 | 843 | 1739 | 649 | 1900 | 545 | 1964 | 466 | 1982 | 340 | 2172 | 236 | 1107 |
| 8-#6 | 1.26 | MA | 1614 | 843 | 2347 | 687 | 2624 | 581 | 2739 | 495 | 2781 | 365 | 3200 | 259 | 1634 |
| 4L-2S | | MI | 1165 | 843 | 1814 | 647 | 1995 | 544 | 2079 | 463 | 2137 | 339 | 2356 | 268 | 1100 |
| 8-#7 | 1.71 | MA | 1783 | 880 | 2731 | 701 | 3119 | 587 | 3338 | 497 | 3591 | 356 | 4254 | 301 | 2157 |
| 2L-4S | | MI | 1132 | 880 | 1750 | 670 | 1899 | 563 | 1959 | 474 | 1976 | 337 | 2168 | 188 | 1456 |
| 8-#7 | 1.71 | MA | 1702 | 880 | 2567 | 705 | 2909 | 591 | 3084 | 503 | 3247 | 361 | 3791 | 258 | 2163 |
| 3E | | MI | 1159 | 880 | 1822 | 669 | 2000 | 559 | 2082 | 474 | 2134 | 335 | 2345 | 207 | 1446 |
| 8-#7 | 1.71 | MA | 1659 | 880 | 2453 | 710 | 2748 | 598 | 2887 | 506 | 2977 | 362 | 3465 | 234 | 2161 |
| 4L-2S | | MI | 1207 | 880 | 1922 | 667 | 2128 | 558 | 2237 | 471 | 2340 | 333 | 2588 | 250 | 1437 |
| 8-#8 | 2.26 | MA | 1869 | 923 | 2940 | 726 | 3378 | 605 | 3650 | 507 | 4010 | 353 | 4795 | 292 | 2781 |
| 2L-4S | | MI | 1158 | 923 | 1824 | 695 | 1985 | 581 | 2060 | 484 | 2105 | 331 | 2315 | 147 | 1827 |
| 8-#8 | 2.26 | MA | 1766 | 923 | 2725 | 731 | 3104 | 609 | 3317 | 516 | 3560 | 359 | 4195 | 235 | 2782 |
| 3E | | MI | 1193 | 923 | 1918 | 693 | 2116 | 576 | 2220 | 485 | 2309 | 328 | 2543 | 171 | 1833 |
| 8-#8 | 2.26 | MA | 1711 | 923 | 2576 | 737 | 2894 | 619 | 3059 | 519 | 3208 | 360 | 3772 | 204 | 2760 |
| 4L-2S | | MI | 1254 | 923 | 2048 | 691 | 2282 | 575 | 2422 | 481 | 2575 | 325 | 2853 | 228 | 1823 |
| 8-#9 | 2.86 | MA | 1960 | 971 | 3166 | 754 | 3659 | 625 | 3989 | 519 | 4466 | 349 | 5375 | 280 | 3457 |
| 2L-4S | | MI | 1187 | 971 | 1903 | 722 | 2077 | 601 | 2168 | 495 | 2243 | 323 | 2469 | 100 | 2149 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

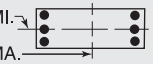
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 2.86 | MA | 1835 | 971 | 2897 | 760 | 3316 | 630 | 3571 | 530 | 3902 | 356 | 4629 | 208 | 3448 |
| 3E | | MI | 1232 | 971 | 2020 | 720 | 2241 | 594 | 2369 | 497 | 2495 | 320 | 2749 | 129 | 2243 |
| 8-#9 | 2.86 | MA | 1767 | 971 | 2709 | 767 | 3051 | 642 | 3247 | 533 | 3459 | 357 | 4101 | 170 | 3299 |
| 4L-2S | | MI | 1303 | 971 | 2183 | 718 | 2448 | 594 | 2621 | 492 | 2824 | 317 | 3130 | 201 | 2236 |
| 8-#10 | 3.63 | MA | 1921 | 1033 | 3113 | 798 | 3584 | 657 | 3894 | 548 | 4336 | 353 | 5173 | 173 | 4282 |
| 3E | | MI | 1278 | 1033 | 2148 | 755 | 2398 | 619 | 2557 | 512 | 2725 | 309 | 3002 | 74 | 2748 |
| 8-#10 | 3.63 | MA | 1839 | 1033 | 2876 | 806 | 3251 | 671 | 3486 | 552 | 3777 | 353 | 4514 | 124 | 3947 |
| 4L-2S | | MI | 1362 | 1033 | 2352 | 753 | 2657 | 619 | 2871 | 507 | 3132 | 304 | 3470 | 165 | 2750 |
| 8-#11 | 4.46 | MA | 1997 | 1099 | 3334 | 833 | 3845 | 681 | 4202 | 563 | 4745 | 345 | 5611 | 120 | 5094 |
| 3E | | MI | 1312 | 1099 | 2270 | 785 | 2536 | 638 | 2704 | 520 | 2888 | 284 | 3140 | -10 | 3137 |
| 8-#11 | 4.46 | MA | 1901 | 1099 | 3048 | 841 | 3445 | 698 | 3711 | 566 | 4074 | 344 | 4839 | 63 | 4562 |
| 4L-2S | | MI | 1407 | 1099 | 2509 | 784 | 2840 | 641 | 3069 | 514 | 3352 | 278 | 3661 | 103 | 3229 |
| 8-#14 | 6.43 | MA | 2073 | 1256 | 3447 | 940 | 3923 | 772 | 4284 | 612 | 4878 | 346 | 5773 | -65 | 5715 |
| 4L-2S | | MI | 1540 | 1256 | 2897 | 876 | 3322 | 706 | 3598 | 541 | 4021 | 237 | 4346 | -14 | 4342 |
| 10-#10 | 4.54 | MA | 1992 | 1105 | 3216 | 851 | 3683 | 704 | 4011 | 572 | 4488 | 349 | 5444 | 111 | 4917 |
| 4L-3S | | MI | 1359 | 1105 | 2352 | 800 | 2657 | 652 | 2871 | 533 | 3132 | 300 | 3470 | 41 | 3354 |
| 10-#10 | 4.54 | MA | 1888 | 1105 | 2973 | 867 | 3391 | 710 | 3647 | 585 | 3983 | 358 | 4791 | 58 | 4602 |
| 5L-2S | | MI | 1440 | 1105 | 2555 | 798 | 2916 | 652 | 3186 | 528 | 3539 | 296 | 3938 | 132 | 3368 |
| 10-#11 | 5.57 | MA | 2081 | 1188 | 3455 | 897 | 3962 | 738 | 4339 | 592 | 4924 | 339 | 5921 | 43 | 5725 |
| 4L-3S | | MI | 1406 | 1188 | 2509 | 841 | 2840 | 679 | 3069 | 544 | 3352 | 270 | 3661 | -57 | 3639 |
| 12-#10 | 5.44 | MA | 2038 | 1178 | 3312 | 912 | 3823 | 743 | 4172 | 606 | 4693 | 354 | 5721 | 45 | 5567 |
| 5L-3S | | MI | 1440 | 1178 | 2555 | 846 | 2916 | 685 | 3186 | 554 | 3539 | 292 | 3938 | 8 | 3917 |

## RECTANGULAR TIED COLUMNS 14" x 22"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.03 | MA | 2024 | 907 | 2973 | 739 | 3371 | 624 | 3560 | 534 | 3704 | 399 | 4319 | 346 | 1633 |
| 2E | | MI | 1252 | 907 | 1940 | 692 | 2112 | 583 | 2180 | 498 | 2195 | 368 | 2393 | 294 | 1016 |
| 4-#9 | 1.30 | MA | 2079 | 931 | 3106 | 752 | 3533 | 633 | 3752 | 539 | 3962 | 396 | 4657 | 341 | 2026 |
| 2E | | MI | 1278 | 931 | 2011 | 704 | 2196 | 591 | 2279 | 503 | 2317 | 362 | 2528 | 280 | 1237 |
| 4-#10 | 1.65 | MA | 2147 | 962 | 3274 | 769 | 3738 | 645 | 3997 | 546 | 4290 | 393 | 5083 | 334 | 2522 |
| 2E | | MI | 1309 | 962 | 2098 | 719 | 2300 | 602 | 2403 | 508 | 2469 | 355 | 2693 | 261 | 1512 |
| 4-#11 | 2.03 | MA | 2208 | 995 | 3452 | 783 | 3942 | 654 | 4235 | 550 | 4603 | 387 | 5437 | 319 | 3024 |
| 2E | | MI | 1332 | 995 | 2186 | 729 | 2394 | 608 | 2499 | 508 | 2572 | 339 | 2777 | 226 | 1782 |
| 4-#14 | 2.92 | MA | 2366 | 1074 | 3854 | 827 | 4438 | 685 | 4830 | 569 | 5403 | 380 | 6423 | 295 | 4222 |
| 2E | | MI | 1398 | 1074 | 2386 | 771 | 2635 | 637 | 2761 | 518 | 2902 | 315 | 3112 | 166 | 2409 |
| 4-#18 | 5.19 | MA | 2730 | 1274 | 4824 | 942 | 5642 | 768 | 6278 | 618 | 7351 | 362 | 8709 | 222 | 7105 |
| 2E | | MI | 1548 | 1274 | 2843 | 880 | 3147 | 702 | 3330 | 537 | 3619 | 246 | 3926 | 22 | 3838 |
| 6-#7 | 1.17 | MA | 2058 | 920 | 3037 | 750 | 3459 | 631 | 3671 | 539 | 3857 | 400 | 4542 | 347 | 1846 |
| 2L-3S | | MI | 1221 | 920 | 1874 | 705 | 2034 | 593 | 2089 | 508 | 2080 | 372 | 2264 | 250 | 1144 |
| 6-#7 | 1.17 | MA | 1961 | 920 | 2851 | 754 | 3222 | 635 | 3383 | 546 | 3468 | 405 | 4005 | 304 | 1855 |
| 3L-2S | | MI | 1270 | 920 | 1974 | 704 | 2162 | 592 | 2244 | 504 | 2286 | 370 | 2507 | 293 | 1135 |
| 6-#8 | 1.54 | MA | 2133 | 952 | 3216 | 768 | 3680 | 644 | 3936 | 546 | 4213 | 396 | 5017 | 342 | 2380 |
| 2L-3S | | MI | 1243 | 952 | 1940 | 723 | 2112 | 604 | 2180 | 515 | 2195 | 366 | 2393 | 219 | 1447 |
| 6-#8 | 1.54 | MA | 2010 | 952 | 2973 | 774 | 3371 | 649 | 3560 | 556 | 3704 | 404 | 4319 | 285 | 2388 |
| 3L-2S | | MI | 1306 | 952 | 2070 | 720 | 2278 | 604 | 2382 | 511 | 2460 | 364 | 2704 | 276 | 1434 |
| 6-#9 | 1.95 | MA | 2214 | 988 | 3412 | 788 | 3922 | 659 | 4225 | 555 | 4601 | 393 | 5528 | 335 | 2961 |
| 2L-3S | | MI | 1267 | 988 | 2011 | 742 | 2196 | 617 | 2279 | 524 | 2317 | 360 | 2528 | 183 | 1769 |
| 6-#9 | 1.95 | MA | 2063 | 988 | 3106 | 795 | 3533 | 665 | 3752 | 566 | 3962 | 402 | 4657 | 263 | 2963 |
| 3L-2S | | MI | 1344 | 988 | 2173 | 739 | 2403 | 617 | 2531 | 519 | 2646 | 356 | 2909 | 255 | 1753 |
| 6-#10 | 2.47 | MA | 2314 | 1034 | 3658 | 814 | 4227 | 677 | 4592 | 566 | 5096 | 389 | 6170 | 325 | 3695 |
| 2L-3S | | MI | 1298 | 1034 | 2098 | 767 | 2300 | 635 | 2403 | 534 | 2469 | 351 | 2693 | 136 | 2164 |
| 6-#10 | 2.47 | MA | 2130 | 1034 | 3274 | 823 | 3738 | 685 | 3997 | 580 | 4290 | 400 | 5083 | 234 | 3681 |
| 3L-2S | | MI | 1389 | 1034 | 2302 | 764 | 2560 | 635 | 2718 | 529 | 2876 | 347 | 3161 | 228 | 2149 |
| 6-#11 | 3.04 | MA | 2404 | 1084 | 3914 | 839 | 4530 | 694 | 4949 | 575 | 5569 | 382 | 6711 | 304 | 4428 |
| 2L-3S | | MI | 1320 | 1084 | 2186 | 786 | 2394 | 646 | 2499 | 537 | 2572 | 330 | 2777 | 67 | 2540 |
| 6-#11 | 3.04 | MA | 2189 | 1084 | 3452 | 848 | 3942 | 702 | 4235 | 591 | 4603 | 394 | 5437 | 192 | 4394 |
| 3L-2S | | MI | 1423 | 1084 | 2425 | 785 | 2698 | 648 | 2865 | 532 | 3037 | 325 | 3298 | 179 | 2528 |

## RECTANGULAR TIED COLUMNS 14" x 22"

Short columns – no sidesway
Bending on major or minor axis

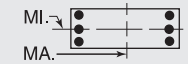



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 4.38 | MA | 2347 | 1202 | 3854 | 921 | 4438 | 754 | 4830 | 627 | 5403 | 387 | 6423 | 108 | 6078 |
| 3L-2S | | MI | 1522 | 1202 | 2719 | 851 | 3060 | 695 | 3260 | 550 | 3536 | 293 | 3807 | 90 | 3435 |
| 6-#18 | 7.79 | MA | 2757 | 1502 | 4824 | 1105 | 5642 | 884 | 6278 | 716 | 7351 | 369 | 8709 | -125 | 8504 |
| 3L-2S | | MI | 1747 | 1502 | 3396 | 1023 | 3826 | 800 | 4117 | 584 | 4622 | 193 | 5044 | -121 | 4825 |
| 8-#6 | 1.14 | MA | 2055 | 917 | 3020 | 750 | 3446 | 632 | 3658 | 540 | 3842 | 401 | 4528 | 349 | 1812 |
| 2L-4S | | MI | 1212 | 917 | 1837 | 708 | 1987 | 598 | 2034 | 509 | 2016 | 376 | 2201 | 253 | 1130 |
| 8-#6 | 1.14 | MA | 1984 | 917 | 2883 | 754 | 3271 | 635 | 3445 | 542 | 3555 | 405 | 4129 | 317 | 1819 |
| 3E | | MI | 1233 | 917 | 1891 | 707 | 2062 | 595 | 2126 | 509 | 2134 | 375 | 2335 | 266 | 1121 |
| 8-#6 | 1.14 | MA | 1946 | 917 | 2788 | 757 | 3137 | 641 | 3282 | 547 | 3331 | 407 | 3852 | 299 | 1824 |
| 4L-2S | | MI | 1270 | 917 | 1965 | 706 | 2157 | 594 | 2241 | 506 | 2289 | 373 | 2518 | 298 | 1115 |
| 8-#7 | 1.56 | MA | 2142 | 954 | 3223 | 771 | 3696 | 647 | 3958 | 548 | 4246 | 398 | 5080 | 344 | 2417 |
| 2L-4S | | MI | 1235 | 954 | 1902 | 729 | 2061 | 613 | 2121 | 517 | 2127 | 371 | 2330 | 219 | 1475 |
| 8-#7 | 1.56 | MA | 2048 | 954 | 3037 | 775 | 3459 | 651 | 3671 | 556 | 3857 | 403 | 4542 | 301 | 2422 |
| 3E | | MI | 1263 | 954 | 1974 | 727 | 2162 | 608 | 2244 | 518 | 2286 | 369 | 2507 | 237 | 1464 |
| 8-#7 | 1.56 | MA | 1998 | 954 | 2909 | 780 | 3279 | 658 | 3449 | 559 | 3554 | 405 | 4166 | 276 | 2421 |
| 4L-2S | | MI | 1311 | 954 | 2075 | 725 | 2290 | 608 | 2399 | 514 | 2492 | 367 | 2750 | 280 | 1454 |
| 8-#8 | 2.05 | MA | 2241 | 997 | 3459 | 796 | 3990 | 665 | 4312 | 559 | 4722 | 394 | 5715 | 337 | 3122 |
| 2L-4S | | MI | 1262 | 997 | 1976 | 753 | 2147 | 631 | 2221 | 527 | 2256 | 365 | 2476 | 177 | 1863 |
| 8-#8 | 2.05 | MA | 2122 | 997 | 3216 | 802 | 3680 | 670 | 3936 | 568 | 4213 | 401 | 5017 | 280 | 3123 |
| 3E | | MI | 1297 | 997 | 2070 | 751 | 2278 | 625 | 2382 | 528 | 2460 | 362 | 2704 | 201 | 1854 |
| 8-#8 | 2.05 | MA | 2059 | 997 | 3048 | 808 | 3444 | 680 | 3646 | 572 | 3816 | 403 | 4527 | 248 | 3101 |
| 4L-2S | | MI | 1358 | 997 | 2201 | 749 | 2444 | 624 | 2584 | 524 | 2726 | 360 | 3014 | 258 | 1843 |
| 8-#9 | 2.60 | MA | 2346 | 1045 | 3717 | 824 | 4311 | 684 | 4697 | 571 | 5241 | 390 | 6398 | 328 | 3889 |
| 2L-4S | | MI | 1291 | 1045 | 2056 | 780 | 2238 | 650 | 2330 | 538 | 2393 | 357 | 2629 | 130 | 2208 |
| 8-#9 | 2.60 | MA | 2202 | 1045 | 3412 | 831 | 3922 | 690 | 4225 | 582 | 4601 | 399 | 5528 | 256 | 3880 |
| 3E | | MI | 1334 | 1045 | 2173 | 777 | 2403 | 643 | 2531 | 540 | 2646 | 354 | 2909 | 159 | 2269 |
| 8-#9 | 2.60 | MA | 2125 | 1045 | 3200 | 838 | 3624 | 703 | 3860 | 587 | 4102 | 401 | 4916 | 216 | 3772 |
| 4L-2S | | MI | 1407 | 1045 | 2336 | 775 | 2610 | 643 | 2782 | 535 | 2974 | 351 | 3291 | 231 | 2259 |
| 8-#10 | 3.30 | MA | 2302 | 1107 | 3658 | 869 | 4227 | 718 | 4592 | 601 | 5096 | 396 | 6170 | 224 | 4830 |
| 3E | | MI | 1382 | 1107 | 2302 | 812 | 2560 | 667 | 2718 | 555 | 2876 | 342 | 3161 | 103 | 2780 |
| 8-#10 | 3.30 | MA | 2209 | 1107 | 3392 | 877 | 3852 | 733 | 4132 | 606 | 4466 | 398 | 5405 | 173 | 4517 |
| 4L-2S | | MI | 1468 | 1107 | 2505 | 810 | 2819 | 668 | 3033 | 550 | 3283 | 338 | 3630 | 195 | 2776 |
| 8-#11 | 4.05 | MA | 2392 | 1173 | 3914 | 904 | 4530 | 742 | 4949 | 616 | 5569 | 388 | 6711 | 177 | 5767 |
| 3E | | MI | 1415 | 1173 | 2425 | 842 | 2698 | 686 | 2865 | 561 | 3037 | 317 | 3298 | 20 | 3252 |
| 8-#11 | 4.05 | MA | 2283 | 1173 | 3592 | 914 | 4077 | 760 | 4394 | 622 | 4811 | 390 | 5810 | 117 | 5232 |
| 4L-2S | | MI | 1512 | 1173 | 2664 | 840 | 3003 | 689 | 3230 | 556 | 3502 | 312 | 3819 | 132 | 3261 |
| 8-#14 | 5.84 | MA | 2485 | 1331 | 4051 | 1014 | 4628 | 837 | 5054 | 670 | 5694 | 380 | 6936 | -2 | 6934 |
| 4L-2S | | MI | 1645 | 1331 | 3053 | 931 | 3485 | 754 | 3758 | 583 | 4170 | 270 | 4503 | 15 | 4444 |
| 10-#10 | 4.12 | MA | 2385 | 1179 | 3776 | 923 | 4342 | 766 | 4727 | 627 | 5271 | 394 | 6492 | 164 | 5621 |
| 4L-3S | | MI | 1463 | 1179 | 2505 | 857 | 2819 | 700 | 3033 | 576 | 3283 | 334 | 3630 | 71 | 3389 |
| 10-#10 | 4.12 | MA | 2260 | 1179 | 3504 | 940 | 4013 | 773 | 4319 | 641 | 4703 | 405 | 5730 | 111 | 5308 |
| 5L-2S | | MI | 1545 | 1179 | 2709 | 855 | 3078 | 701 | 3347 | 570 | 3690 | 330 | 4098 | 162 | 3396 |
| 10-#11 | 5.06 | MA | 2491 | 1262 | 4053 | 970 | 4665 | 801 | 5108 | 647 | 5777 | 385 | 7084 | 102 | 6560 |
| 4L-3S | | MI | 1509 | 1262 | 2664 | 897 | 3003 | 727 | 3230 | 586 | 3502 | 303 | 3819 | -28 | 3809 |
| 10-#11 | 5.06 | MA | 2348 | 1262 | 3723 | 990 | 4268 | 809 | 4615 | 663 | 5092 | 396 | 6190 | 36 | 6062 |
| 5L-2S | | MI | 1601 | 1262 | 2903 | 896 | 3307 | 729 | 3595 | 580 | 3966 | 298 | 4339 | 84 | 3987 |
| 12-#10 | 4.95 | MA | 2433 | 1252 | 3888 | 985 | 4503 | 806 | 4914 | 662 | 5509 | 400 | 6817 | 102 | 6421 |
| 5L-3S | | MI | 1544 | 1252 | 2709 | 903 | 3078 | 733 | 3347 | 596 | 3690 | 326 | 4098 | 38 | 3995 |
| 12-#10 | 4.95 | MA | 2313 | 1252 | 3650 | 993 | 4179 | 822 | 4512 | 667 | 4965 | 411 | 6117 | 44 | 5919 |
| 6L-2S | | MI | 1622 | 1252 | 2912 | 900 | 3337 | 734 | 3662 | 591 | 4097 | 321 | 4566 | 129 | 4012 |
| 12-#11 | 6.08 | MA | 2552 | 1351 | 4185 | 1045 | 4856 | 849 | 5329 | 688 | 6058 | 391 | 7464 | 21 | 7384 |
| 5L-3S | | MI | 1602 | 1351 | 2903 | 953 | 3307 | 767 | 3595 | 610 | 3966 | 290 | 4339 | -75 | 4307 |
| 14-#10 | 5.77 | MA | 2488 | 1324 | 4035 | 1038 | 4669 | 855 | 5107 | 688 | 5771 | 407 | 7204 | 35 | 7042 |
| 6L-3S | | MI | 1623 | 1324 | 2912 | 948 | 3337 | 766 | 3662 | 617 | 4097 | 317 | 4566 | 5 | 4553 |

## RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

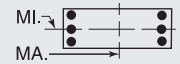
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.19 | MA | 2459 | 1005 | 3620 | 822 | 4136 | 692 | 4397 | 590 | 4633 | 438 | 5472 | 380 | 2242 |
| 2E | | MI | 1382 | 1005 | 2164 | 761 | 2357 | 640 | 2440 | 545 | 2468 | 396 | 2688 | 310 | 1254 |
| 4-#10 | 1.51 | MA | 2538 | 1036 | 3808 | 839 | 4366 | 704 | 4672 | 597 | 5001 | 434 | 5978 | 377 | 2797 |
| 2E | | MI | 1414 | 1036 | 2252 | 776 | 2463 | 651 | 2565 | 551 | 2619 | 389 | 2853 | 290 | 1532 |
| 4-#11 | 1.86 | MA | 2609 | 1069 | 4010 | 853 | 4598 | 713 | 4942 | 602 | 5357 | 428 | 6400 | 364 | 3360 |
| 2E | | MI | 1436 | 1069 | 2341 | 785 | 2556 | 656 | 2660 | 550 | 2722 | 372 | 2935 | 255 | 1806 |
| 4-#14 | 2.68 | MA | 2790 | 1148 | 4465 | 897 | 5159 | 745 | 5614 | 620 | 6260 | 421 | 7554 | 345 | 4708 |
| 2E | | MI | 1503 | 1148 | 2542 | 826 | 2798 | 684 | 2922 | 559 | 3050 | 348 | 3268 | 194 | 2439 |
| 4-#18 | 4.76 | MA | 3216 | 1348 | 5564 | 1012 | 6524 | 827 | 7255 | 670 | 8468 | 403 | 10262 | 285 | 7969 |
| 2E | | MI | 1652 | 1348 | 3002 | 934 | 3309 | 749 | 3489 | 577 | 3766 | 278 | 4079 | 51 | 3881 |
| 6-#7 | 1.07 | MA | 2435 | 994 | 3542 | 819 | 4052 | 691 | 4304 | 590 | 4513 | 441 | 5311 | 384 | 2041 |
| 2L-3S | | MI | 1324 | 994 | 2026 | 763 | 2196 | 642 | 2250 | 551 | 2231 | 406 | 2426 | 280 | 1159 |
| 6-#7 | 1.07 | MA | 2326 | 994 | 3334 | 824 | 3788 | 695 | 3983 | 594 | 4079 | 447 | 4710 | 342 | 2049 |
| 3L-2S | | MI | 1374 | 994 | 2126 | 762 | 2324 | 642 | 2406 | 548 | 2437 | 404 | 2669 | 323 | 1150 |
| 6-#8 | 1.41 | MA | 2521 | 1026 | 3743 | 837 | 4300 | 703 | 4600 | 598 | 4911 | 438 | 5860 | 380 | 2636 |
| 2L-3S | | MI | 1347 | 1026 | 2092 | 780 | 2274 | 654 | 2342 | 558 | 2346 | 401 | 2554 | 249 | 1465 |
| 6-#8 | 1.41 | MA | 2382 | 1026 | 3471 | 844 | 3954 | 709 | 4181 | 603 | 4344 | 446 | 5074 | 324 | 2644 |
| 3L-2S | | MI | 1410 | 1026 | 2223 | 778 | 2440 | 653 | 2543 | 554 | 2612 | 398 | 2865 | 306 | 1451 |
| 6-#9 | 1.79 | MA | 2613 | 1062 | 3961 | 858 | 4570 | 718 | 4924 | 607 | 5347 | 434 | 6461 | 376 | 3285 |
| 2L-3S | | MI | 1370 | 1062 | 2164 | 799 | 2357 | 666 | 2440 | 566 | 2468 | 394 | 2688 | 213 | 1790 |
| 6-#9 | 1.79 | MA | 2442 | 1062 | 3620 | 865 | 4136 | 725 | 4397 | 612 | 4633 | 444 | 5472 | 305 | 3287 |
| 3L-2S | | MI | 1448 | 1062 | 2326 | 797 | 2565 | 666 | 2692 | 562 | 2797 | 391 | 3070 | 285 | 1773 |
| 6-#10 | 2.27 | MA | 2728 | 1109 | 4238 | 884 | 4913 | 737 | 5337 | 618 | 5901 | 430 | 7223 | 371 | 4106 |
| 2L-3S | | MI | 1402 | 1109 | 2252 | 824 | 2463 | 683 | 2565 | 577 | 2619 | 385 | 2853 | 166 | 2190 |
| 6-#10 | 2.27 | MA | 2518 | 1109 | 3808 | 894 | 4366 | 745 | 4672 | 633 | 5001 | 442 | 5978 | 279 | 4093 |
| 3L-2S | | MI | 1494 | 1109 | 2456 | 822 | 2722 | 684 | 2879 | 571 | 3026 | 380 | 3321 | 257 | 2172 |
| 6-#11 | 2.79 | MA | 2832 | 1158 | 4528 | 908 | 5257 | 754 | 5742 | 627 | 6440 | 423 | 7868 | 353 | 4933 |
| 2L-3S | | MI | 1423 | 1158 | 2341 | 842 | 2556 | 694 | 2660 | 579 | 2722 | 364 | 2935 | 96 | 2573 |
| 6-#11 | 2.79 | MA | 2587 | 1158 | 4010 | 919 | 4598 | 763 | 4942 | 644 | 5357 | 437 | 6400 | 241 | 4899 |
| 3L-2S | | MI | 1527 | 1158 | 2580 | 841 | 2860 | 696 | 3026 | 574 | 3186 | 358 | 3456 | 208 | 2556 |
| 6-#14 | 4.02 | MA | 2769 | 1276 | 4465 | 992 | 5159 | 815 | 5614 | 681 | 6260 | 431 | 7554 | 164 | 6807 |
| 3L-2S | | MI | 1627 | 1276 | 2876 | 906 | 3222 | 743 | 3420 | 592 | 3684 | 325 | 3963 | 119 | 3469 |
| 6-#18 | 7.14 | MA | 3243 | 1576 | 5564 | 1178 | 6524 | 948 | 7255 | 772 | 8468 | 416 | 10262 | -49 | 10159 |
| 3L-2S | | MI | 1852 | 1576 | 3554 | 1077 | 3989 | 846 | 4277 | 625 | 4769 | 225 | 5198 | -93 | 4988 |
| 8-#6 | 1.05 | MA | 2432 | 992 | 3522 | 820 | 4036 | 691 | 4288 | 591 | 4495 | 442 | 5289 | 385 | 2002 |
| 2L-4S | | MI | 1316 | 992 | 1989 | 767 | 2149 | 648 | 2196 | 552 | 2167 | 411 | 2364 | 283 | 1143 |
| 8-#6 | 1.05 | MA | 2351 | 992 | 3369 | 824 | 3841 | 695 | 4051 | 594 | 4175 | 447 | 4846 | 355 | 2009 |
| 3E | | MI | 1337 | 992 | 2042 | 765 | 2223 | 644 | 2287 | 553 | 2286 | 409 | 2497 | 297 | 1135 |
| 8-#6 | 1.05 | MA | 2309 | 992 | 3264 | 827 | 3694 | 701 | 3870 | 600 | 3927 | 449 | 4540 | 337 | 2014 |
| 4L-2S | | MI | 1374 | 992 | 2117 | 764 | 2318 | 644 | 2403 | 550 | 2441 | 408 | 2680 | 328 | 1129 |
| 8-#7 | 1.43 | MA | 2530 | 1028 | 3749 | 841 | 4316 | 706 | 4624 | 600 | 4947 | 439 | 5912 | 381 | 2676 |
| 2L-4S | | MI | 1339 | 1028 | 2054 | 787 | 2223 | 662 | 2282 | 560 | 2279 | 406 | 2492 | 249 | 1492 |
| 8-#7 | 1.43 | MA | 2424 | 1028 | 3542 | 845 | 4052 | 710 | 4304 | 604 | 4513 | 445 | 5311 | 339 | 2682 |
| 3E | | MI | 1367 | 1028 | 2126 | 785 | 2324 | 658 | 2406 | 561 | 2437 | 404 | 2669 | 267 | 1481 |
| 8-#7 | 1.43 | MA | 2368 | 1028 | 3399 | 850 | 3852 | 719 | 4058 | 611 | 4176 | 448 | 4896 | 314 | 2680 |
| 4L-2S | | MI | 1415 | 1028 | 2227 | 783 | 2451 | 657 | 2561 | 557 | 2644 | 402 | 2912 | 310 | 1471 |
| 8-#8 | 1.88 | MA | 2643 | 1071 | 4014 | 865 | 4645 | 724 | 5020 | 611 | 5479 | 435 | 6647 | 376 | 3463 |
| 2L-4S | | MI | 1366 | 1071 | 2129 | 811 | 2308 | 680 | 2383 | 570 | 2408 | 399 | 2637 | 207 | 1886 |
| 8-#8 | 1.88 | MA | 2508 | 1071 | 3743 | 872 | 4300 | 729 | 4600 | 616 | 4911 | 443 | 5860 | 321 | 3465 |
| 3E | | MI | 1401 | 1071 | 2223 | 809 | 2440 | 674 | 2543 | 571 | 2612 | 396 | 2865 | 231 | 1875 |
| 8-#8 | 1.88 | MA | 2438 | 1071 | 3556 | 878 | 4037 | 740 | 4278 | 625 | 4470 | 446 | 5314 | 288 | 3442 |
| 4L-2S | | MI | 1463 | 1071 | 2353 | 806 | 2606 | 674 | 2745 | 567 | 2877 | 394 | 3175 | 288 | 1863 |
| 8-#9 | 2.38 | MA | 2764 | 1119 | 4303 | 893 | 5005 | 744 | 5452 | 623 | 6061 | 431 | 7449 | 371 | 4321 |
| 2L-4S | | MI | 1394 | 1119 | 2209 | 837 | 2400 | 699 | 2491 | 581 | 2544 | 391 | 2789 | 160 | 2265 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

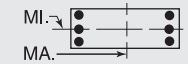
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 2.38 | MA | 2599 | 1119 | 3961 | 901 | 4570 | 751 | 4924 | 628 | 5347 | 441 | 6461 | 300 | 4312 |
| 3E | | MI | 1438 | 1119 | 2326 | 835 | 2565 | 692 | 2692 | 583 | 2797 | 388 | 3070 | 189 | 2293 |
| 8-#9 | 2.38 | MA | 2513 | 1119 | 3727 | 909 | 4240 | 764 | 4519 | 641 | 4792 | 444 | 5771 | 258 | 4254 |
| 4L-2S | | MI | 1512 | 1119 | 2489 | 833 | 2772 | 692 | 2944 | 578 | 3125 | 385 | 3451 | 261 | 2281 |
| 8-#10 | 3.02 | MA | 2714 | 1181 | 4238 | 939 | 4913 | 778 | 5337 | 654 | 5901 | 438 | 7223 | 273 | 5379 |
| 3E | | MI | 1485 | 1181 | 2456 | 869 | 2722 | 716 | 2879 | 597 | 3026 | 376 | 3321 | 133 | 2810 |
| 8-#10 | 3.02 | MA | 2609 | 1181 | 3942 | 949 | 4496 | 795 | 4825 | 660 | 5201 | 442 | 6351 | 220 | 5099 |
| 4L-2S | | MI | 1572 | 1181 | 2659 | 867 | 2981 | 717 | 3194 | 592 | 3433 | 372 | 3789 | 224 | 2801 |
| 8-#11 | 3.71 | MA | 2819 | 1247 | 4528 | 975 | 5257 | 803 | 5742 | 670 | 6440 | 432 | 7868 | 230 | 6441 |
| 3E | | MI | 1519 | 1247 | 2580 | 898 | 2860 | 734 | 3026 | 603 | 3186 | 350 | 3456 | 49 | 3294 |
| 8-#11 | 3.71 | MA | 2696 | 1247 | 4170 | 986 | 4753 | 823 | 5123 | 677 | 5594 | 435 | 6836 | 167 | 5916 |
| 4L-2S | | MI | 1617 | 1247 | 2819 | 897 | 3165 | 737 | 3391 | 598 | 3651 | 345 | 3976 | 161 | 3292 |
| 8-#14 | 5.36 | MA | 2928 | 1405 | 4689 | 1087 | 5376 | 900 | 5869 | 726 | 6593 | 427 | 8157 | 56 | 7863 |
| 4L-2S | | MI | 1750 | 1405 | 3209 | 987 | 3647 | 801 | 3918 | 624 | 4318 | 303 | 4659 | 43 | 4483 |
| 10-#10 | 3.78 | MA | 2809 | 1254 | 4372 | 994 | 5044 | 828 | 5490 | 681 | 6101 | 438 | 7596 | 214 | 6339 |
| 4L-3S | | MI | 1567 | 1254 | 2659 | 915 | 2981 | 749 | 3194 | 618 | 3433 | 368 | 3789 | 100 | 3422 |
| 10-#10 | 3.78 | MA | 2663 | 1254 | 4069 | 1012 | 4679 | 836 | 5037 | 696 | 5470 | 450 | 6722 | 162 | 5958 |
| 5L-2S | | MI | 1650 | 1254 | 2863 | 912 | 3240 | 749 | 3509 | 613 | 3840 | 364 | 4257 | 192 | 3424 |
| 10-#11 | 4.64 | MA | 2933 | 1336 | 4687 | 1042 | 5411 | 863 | 5924 | 702 | 6676 | 430 | 8303 | 156 | 7409 |
| 4L-3S | | MI | 1613 | 1336 | 2819 | 953 | 3165 | 775 | 3391 | 627 | 3651 | 337 | 3976 | 1 | 3973 |
| 10-#11 | 4.64 | MA | 2764 | 1336 | 4320 | 1063 | 4970 | 872 | 5375 | 720 | 5913 | 443 | 7273 | 92 | 6914 |
| 5L-2S | | MI | 1707 | 1336 | 3059 | 952 | 3469 | 777 | 3756 | 622 | 4116 | 331 | 4497 | 114 | 4021 |
| 10-#14 | 6.70 | MA | 3026 | 1533 | 4900 | 1197 | 5681 | 971 | 6223 | 786 | 7043 | 438 | 8769 | -56 | 8697 |
| 5L-2S | | MI | 1872 | 1533 | 3543 | 1067 | 4072 | 859 | 4417 | 656 | 4953 | 280 | 5354 | -32 | 5344 |
| 12-#10 | 4.54 | MA | 2860 | 1326 | 4499 | 1057 | 5226 | 869 | 5702 | 717 | 6370 | 446 | 7968 | 156 | 7224 |
| 5L-3S | | MI | 1648 | 1326 | 2863 | 960 | 3240 | 782 | 3509 | 639 | 3840 | 359 | 4257 | 67 | 4030 |
| 12-#10 | 4.54 | MA | 2724 | 1326 | 4228 | 1065 | 4867 | 885 | 5255 | 724 | 5767 | 458 | 7169 | 95 | 6688 |
| 6L-2S | | MI | 1728 | 1326 | 3066 | 958 | 3499 | 782 | 3823 | 633 | 4247 | 355 | 4726 | 159 | 4042 |
| 12-#11 | 5.57 | MA | 2996 | 1425 | 4838 | 1119 | 5628 | 913 | 6175 | 745 | 6996 | 438 | 8741 | 81 | 8407 |
| 5L-3S | | MI | 1706 | 1425 | 3059 | 1009 | 3469 | 815 | 3756 | 652 | 4116 | 323 | 4497 | -46 | 4479 |
| 12-#11 | 5.57 | MA | 2837 | 1425 | 4517 | 1128 | 5193 | 932 | 5635 | 752 | 6267 | 452 | 7797 | 9 | 7756 |
| 6L-2S | | MI | 1795 | 1425 | 3298 | 1008 | 3774 | 818 | 4122 | 646 | 4580 | 318 | 5018 | 66 | 4742 |
| 14-#10 | 5.29 | MA | 2922 | 1399 | 4658 | 1110 | 5414 | 918 | 5921 | 744 | 6667 | 454 | 8415 | 89 | 7949 |
| 6L-3S | | MI | 1728 | 1399 | 3066 | 1005 | 3499 | 815 | 3823 | 659 | 4247 | 351 | 4726 | 34 | 4628 |
| 14-#11 | 6.50 | MA | 3072 | 1515 | 5034 | 1184 | 5851 | 972 | 6435 | 777 | 7350 | 447 | 9264 | -2 | 9261 |
| 6L-3S | | MI | 1798 | 1515 | 3298 | 1065 | 3774 | 856 | 4122 | 676 | 4580 | 310 | 5018 | -93 | 4974 |

## RECTANGULAR TIED COLUMNS 14" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.10 | MA | 2870 | 1080 | 4169 | 891 | 4782 | 751 | 5087 | 642 | 5349 | 479 | 6309 | 417 | 2458 |
| 2E | | MI | 1486 | 1080 | 2317 | 819 | 2519 | 689 | 2602 | 588 | 2619 | 430 | 2849 | 339 | 1271 |
| 4-#10 | 1.40 | MA | 2959 | 1110 | 4378 | 908 | 5037 | 763 | 5392 | 649 | 5758 | 475 | 6872 | 413 | 3071 |
| 2E | | MI | 1518 | 1110 | 2406 | 833 | 2625 | 699 | 2726 | 593 | 2770 | 423 | 3013 | 320 | 1550 |
| 4-#11 | 1.71 | MA | 3040 | 1143 | 4604 | 922 | 5297 | 773 | 5694 | 653 | 6156 | 470 | 7416 | 407 | 3697 |
| 2E | | MI | 1540 | 1143 | 2497 | 841 | 2718 | 704 | 2821 | 591 | 2871 | 405 | 3093 | 285 | 1829 |
| 4-#14 | 2.47 | MA | 3246 | 1222 | 5110 | 966 | 5921 | 804 | 6443 | 672 | 7162 | 462 | 8740 | 392 | 5194 |
| 2E | | MI | 1607 | 1222 | 2698 | 882 | 2960 | 732 | 3082 | 601 | 3199 | 381 | 3424 | 223 | 2468 |
| 4-#18 | 4.40 | MA | 3728 | 1422 | 6339 | 1082 | 7448 | 887 | 8278 | 721 | 9631 | 445 | 11874 | 343 | 8833 |
| 2E | | MI | 1756 | 1422 | 3160 | 988 | 3471 | 795 | 3649 | 617 | 3913 | 310 | 4233 | 79 | 3922 |
| 6-#8 | 1.30 | MA | 2939 | 1101 | 4304 | 907 | 4962 | 763 | 5311 | 650 | 5656 | 479 | 6736 | 416 | 2892 |
| 2L-3S | | MI | 1451 | 1101 | 2245 | 838 | 2435 | 703 | 2503 | 601 | 2497 | 435 | 2715 | 279 | 1482 |
| 6-#8 | 1.30 | MA | 2783 | 1101 | 4004 | 914 | 4581 | 769 | 4847 | 655 | 5029 | 488 | 5868 | 362 | 2900 |
| 3L-2S | | MI | 1514 | 1101 | 2376 | 836 | 2601 | 702 | 2705 | 597 | 2763 | 432 | 3026 | 336 | 1468 |
| 6-#9 | 1.65 | MA | 3043 | 1137 | 4546 | 927 | 5262 | 777 | 5670 | 658 | 6138 | 475 | 7401 | 412 | 3609 |
| 2L-3S | | MI | 1474 | 1137 | 2317 | 857 | 2519 | 715 | 2602 | 609 | 2619 | 428 | 2849 | 243 | 1810 |
| 6-#9 | 1.65 | MA | 2851 | 1137 | 4169 | 936 | 4782 | 785 | 5087 | 665 | 5349 | 486 | 6309 | 343 | 3611 |
| 3L-2S | | MI | 1552 | 1137 | 2480 | 854 | 2727 | 715 | 2854 | 604 | 2947 | 425 | 3230 | 315 | 1792 |

## RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

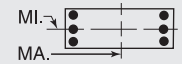
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 2.09 | MA | 3173 | 1183 | 4853 | 954 | 5642 | 796 | 6127 | 670 | 6753 | 471 | 8250 | 407 | 4518 |
| 2L-3S | | MI | 1506 | 1183 | 2406 | 881 | 2625 | 732 | 2726 | 619 | 2770 | 419 | 3013 | 196 | 2214 |
| 6-#10 | 2.09 | MA | 2937 | 1183 | 4378 | 964 | 5037 | 805 | 5392 | 677 | 5758 | 485 | 6872 | 318 | 4504 |
| 3L-2S | | MI | 1598 | 1183 | 2609 | 879 | 2884 | 732 | 3041 | 614 | 3177 | 414 | 3481 | 287 | 2195 |
| 6-#11 | 2.57 | MA | 3292 | 1233 | 5177 | 978 | 6027 | 813 | 6580 | 679 | 7356 | 464 | 9076 | 400 | 5439 |
| 2L-3S | | MI | 1527 | 1233 | 2497 | 898 | 2718 | 742 | 2821 | 621 | 2871 | 397 | 3093 | 125 | 2604 |
| 6-#11 | 2.57 | MA | 3016 | 1233 | 4604 | 990 | 5297 | 823 | 5694 | 697 | 6156 | 480 | 7416 | 287 | 5405 |
| 3L-2S | | MI | 1632 | 1233 | 2736 | 897 | 3023 | 744 | 3186 | 616 | 3336 | 392 | 3614 | 237 | 2583 |
| 6-#14 | 3.71 | MA | 3222 | 1351 | 5110 | 1063 | 5921 | 876 | 6443 | 734 | 7162 | 475 | 8740 | 216 | 7536 |
| 3L-2S | | MI | 1732 | 1351 | 3032 | 962 | 3385 | 790 | 3581 | 633 | 3833 | 358 | 4120 | 148 | 3503 |
| 6-#18 | 6.59 | MA | 3722 | 1650 | 6339 | 1250 | 7448 | 1011 | 8278 | 828 | 9631 | 463 | 11874 | 20 | 11813 |
| 3L-2S | | MI | 1956 | 1650 | 3712 | 1131 | 4151 | 892 | 4436 | 665 | 4916 | 257 | 5351 | -65 | 5147 |
| 8-#7 | 1.32 | MA | 2949 | 1102 | 4310 | 910 | 4979 | 765 | 5336 | 652 | 5694 | 480 | 6792 | 417 | 2935 |
| 2L-4S | | MI | 1443 | 1102 | 2206 | 845 | 2384 | 712 | 2444 | 604 | 2431 | 440 | 2653 | 279 | 1509 |
| 8-#7 | 1.32 | MA | 2830 | 1102 | 4081 | 915 | 4688 | 770 | 4982 | 656 | 5215 | 487 | 6129 | 376 | 2941 |
| 3E | | MI | 1471 | 1102 | 2278 | 843 | 2485 | 707 | 2567 | 604 | 2589 | 438 | 2830 | 297 | 1497 |
| 8-#7 | 1.32 | MA | 2768 | 1102 | 3925 | 921 | 4468 | 779 | 4712 | 664 | 4845 | 490 | 5676 | 352 | 2939 |
| 4L-2S | | MI | 1519 | 1102 | 2379 | 841 | 2613 | 707 | 2722 | 601 | 2795 | 436 | 3073 | 340 | 1487 |
| 8-#8 | 1.74 | MA | 3076 | 1146 | 4603 | 935 | 5344 | 783 | 5774 | 663 | 6283 | 476 | 7604 | 412 | 3805 |
| 2L-4S | | MI | 1469 | 1146 | 2282 | 868 | 2470 | 729 | 2544 | 613 | 2559 | 433 | 2798 | 237 | 1908 |
| 8-#8 | 1.74 | MA | 2925 | 1146 | 4304 | 942 | 4962 | 789 | 5311 | 668 | 5656 | 485 | 6736 | 358 | 3806 |
| 3E | | MI | 1505 | 1146 | 2376 | 866 | 2601 | 723 | 2705 | 614 | 2763 | 431 | 3026 | 261 | 1894 |
| 8-#8 | 1.74 | MA | 2846 | 1146 | 4099 | 949 | 4673 | 801 | 4956 | 678 | 5171 | 489 | 6141 | 326 | 3784 |
| 4L-2S | | MI | 1567 | 1146 | 2506 | 864 | 2767 | 723 | 2907 | 610 | 3028 | 428 | 3336 | 318 | 1882 |
| 8-#9 | 2.20 | MA | 3212 | 1194 | 4923 | 963 | 5741 | 803 | 6252 | 675 | 6927 | 472 | 8493 | 407 | 4753 |
| 2L-4S | | MI | 1498 | 1194 | 2362 | 895 | 2562 | 748 | 2653 | 623 | 2695 | 425 | 2950 | 190 | 2325 |
| 8-#9 | 2.20 | MA | 3028 | 1194 | 4546 | 971 | 5262 | 811 | 5670 | 681 | 6138 | 483 | 7401 | 338 | 4744 |
| 3E | | MI | 1542 | 1194 | 2480 | 892 | 2727 | 741 | 2854 | 625 | 2947 | 422 | 3230 | 219 | 2316 |
| 8-#9 | 2.20 | MA | 2931 | 1194 | 4288 | 980 | 4898 | 825 | 5223 | 694 | 5527 | 487 | 6649 | 297 | 4686 |
| 4L-2S | | MI | 1617 | 1194 | 2642 | 890 | 2934 | 741 | 3105 | 620 | 3276 | 419 | 3612 | 291 | 2303 |
| 8-#10 | 2.79 | MA | 3157 | 1255 | 4853 | 1009 | 5642 | 838 | 6127 | 698 | 6753 | 481 | 8250 | 312 | 5928 |
| 3E | | MI | 1589 | 1255 | 2609 | 926 | 2884 | 765 | 3041 | 640 | 3177 | 410 | 3481 | 163 | 2838 |
| 8-#10 | 2.79 | MA | 3040 | 1255 | 4527 | 1020 | 5183 | 856 | 5563 | 714 | 5981 | 486 | 7297 | 260 | 5694 |
| 4L-2S | | MI | 1677 | 1255 | 2813 | 924 | 3143 | 765 | 3355 | 635 | 3584 | 406 | 3949 | 254 | 2826 |
| 8-#11 | 3.43 | MA | 3276 | 1322 | 5177 | 1045 | 6027 | 864 | 6580 | 723 | 7356 | 474 | 9076 | 280 | 7115 |
| 3E | | MI | 1622 | 1322 | 2736 | 954 | 3023 | 782 | 3186 | 645 | 3336 | 383 | 3614 | 78 | 3330 |
| 8-#11 | 3.43 | MA | 3139 | 1322 | 4782 | 1057 | 5471 | 884 | 5899 | 731 | 6422 | 479 | 7914 | 215 | 6613 |
| 4L-2S | | MI | 1722 | 1322 | 2975 | 953 | 3327 | 785 | 3552 | 640 | 3800 | 378 | 4134 | 190 | 3322 |
| 8-#14 | 4.95 | MA | 3402 | 1479 | 5362 | 1160 | 6166 | 963 | 6731 | 782 | 7537 | 473 | 9434 | 111 | 8798 |
| 4L-2S | | MI | 1855 | 1479 | 3365 | 1042 | 3809 | 848 | 4079 | 665 | 4467 | 335 | 4815 | 72 | 4520 |
| 10-#10 | 3.49 | MA | 3264 | 1328 | 5003 | 1065 | 5788 | 889 | 6299 | 735 | 6976 | 481 | 8674 | 254 | 7069 |
| 4L-3S | | MI | 1671 | 1328 | 2813 | 972 | 3143 | 798 | 3355 | 660 | 3584 | 402 | 3949 | 130 | 3454 |
| 10-#10 | 3.49 | MA | 3097 | 1328 | 4670 | 1084 | 5387 | 898 | 5800 | 742 | 6282 | 495 | 7716 | 205 | 6615 |
| 5L-2S | | MI | 1756 | 1328 | 3016 | 969 | 3402 | 798 | 3670 | 655 | 3991 | 397 | 4417 | 221 | 3450 |
| 10-#11 | 4.29 | MA | 3405 | 1411 | 5355 | 1113 | 6200 | 925 | 6785 | 756 | 7622 | 474 | 9575 | 208 | 8274 |
| 4L-3S | | MI | 1716 | 1411 | 2975 | 1010 | 3327 | 822 | 3552 | 669 | 3800 | 370 | 4134 | 31 | 4046 |
| 10-#11 | 4.29 | MA | 3211 | 1411 | 4952 | 1135 | 5714 | 935 | 6181 | 775 | 6781 | 489 | 8410 | 144 | 7779 |
| 5L-2S | | MI | 1812 | 1411 | 3214 | 1008 | 3632 | 825 | 3917 | 664 | 4265 | 365 | 4655 | 143 | 4053 |
| 10-#14 | 6.18 | MA | 3504 | 1608 | 5601 | 1271 | 6510 | 1035 | 7129 | 844 | 8044 | 486 | 10130 | 4 | 10113 |
| 5L-2S | | MI | 1977 | 1608 | 3699 | 1122 | 4234 | 907 | 4577 | 697 | 5101 | 313 | 5511 | -3 | 5510 |
| 12-#10 | 4.19 | MA | 3317 | 1400 | 5145 | 1129 | 5993 | 931 | 6535 | 763 | 7277 | 491 | 9094 | 199 | 8017 |
| 5L-3S | | MI | 1752 | 1400 | 3016 | 1017 | 3402 | 831 | 3670 | 681 | 3991 | 393 | 4417 | 97 | 4064 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

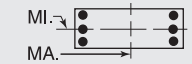
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 4.19 | MA | 3165 | 1400 | 4841 | 1136 | 5597 | 948 | 6045 | 779 | 6614 | 504 | 8223 | 139 | 7473 |
| 6L-2S | | MI | 1833 | 1400 | 3220 | 1015 | 3661 | 831 | 3985 | 676 | 4398 | 389 | 4885 | 188 | 4070 |
| 12-#11 | 5.14 | MA | 3472 | 1500 | 5525 | 1191 | 6444 | 975 | 7067 | 800 | 7981 | 484 | 10071 | 136 | 9454 |
| 5L-3S | | MI | 1809 | 1500 | 3214 | 1065 | 3632 | 863 | 3917 | 693 | 4265 | 356 | 4655 | -17 | 4649 |
| 12-#11 | 5.14 | MA | 3294 | 1500 | 5163 | 1200 | 5965 | 996 | 6473 | 809 | 7178 | 499 | 9007 | 62 | 8676 |
| 6L-2S | | MI | 1901 | 1500 | 3453 | 1064 | 3936 | 866 | 4282 | 688 | 4730 | 351 | 5175 | 96 | 4777 |
| 14-#10 | 4.88 | MA | 3387 | 1473 | 5316 | 1181 | 6203 | 981 | 6780 | 800 | 7609 | 500 | 9600 | 133 | 8873 |
| 6L-3S | | MI | 1832 | 1473 | 3220 | 1062 | 3661 | 864 | 3985 | 702 | 4398 | 385 | 4885 | 64 | 4672 |
| 14-#10 | 4.88 | MA | 3263 | 1473 | 5012 | 1187 | 5815 | 989 | 6309 | 807 | 6933 | 505 | 8617 | 80 | 8285 |
| 7L-2S | | MI | 1910 | 1473 | 3423 | 1060 | 3920 | 864 | 4299 | 696 | 4805 | 381 | 5353 | 155 | 4686 |
| 14-#11 | 6.00 | MA | 3557 | 1589 | 5736 | 1256 | 6695 | 1036 | 7359 | 834 | 8377 | 494 | 10667 | 54 | 10366 |
| 6L-3S | | MI | 1902 | 1589 | 3453 | 1121 | 3936 | 903 | 4282 | 718 | 4730 | 343 | 5175 | -64 | 5148 |
| 16-#10 | 5.58 | MA | 3488 | 1545 | 5487 | 1233 | 6420 | 1022 | 7044 | 828 | 7928 | 501 | 9994 | 74 | 9687 |
| 7L-3S | | MI | 1911 | 1545 | 3423 | 1108 | 3920 | 897 | 4299 | 722 | 4805 | 376 | 5353 | 31 | 5262 |

## RECTANGULAR TIED COLUMNS 14" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.02 | MA | 3311 | 1154 | 4753 | 961 | 5470 | 811 | 5823 | 694 | 6112 | 520 | 7198 | 453 | 2674 |
| 2E | | MI | 1590 | 1154 | 2470 | 876 | 2681 | 738 | 2763 | 631 | 2770 | 464 | 3009 | 369 | 1286 |
| 4-#10 | 1.30 | MA | 3410 | 1185 | 4982 | 978 | 5751 | 823 | 6158 | 701 | 6560 | 517 | 7816 | 449 | 3345 |
| 2E | | MI | 1622 | 1185 | 2560 | 891 | 2787 | 748 | 2887 | 636 | 2920 | 457 | 3172 | 350 | 1569 |
| 4-#11 | 1.59 | MA | 3502 | 1218 | 5232 | 992 | 6039 | 832 | 6493 | 705 | 7002 | 511 | 8418 | 443 | 4034 |
| 2E | | MI | 1645 | 1218 | 2652 | 898 | 2881 | 752 | 2982 | 633 | 3020 | 438 | 3251 | 314 | 1851 |
| 4-#14 | 2.30 | MA | 3733 | 1297 | 5790 | 1036 | 6727 | 863 | 7318 | 724 | 8110 | 503 | 9947 | 434 | 5680 |
| 2E | | MI | 1712 | 1297 | 2855 | 937 | 3122 | 779 | 3243 | 642 | 3347 | 414 | 3581 | 252 | 2497 |
| 4-#18 | 4.08 | MA | 4274 | 1496 | 7149 | 1151 | 8415 | 946 | 9347 | 773 | 10840 | 486 | 13544 | 397 | 9697 |
| 2E | | MI | 1861 | 1496 | 3318 | 1042 | 3634 | 841 | 3808 | 658 | 4060 | 342 | 4387 | 107 | 3963 |
| 6-#8 | 1.21 | MA | 3388 | 1175 | 4899 | 977 | 5667 | 822 | 6067 | 702 | 6446 | 520 | 7664 | 452 | 3148 |
| 2L-3S | | MI | 1554 | 1175 | 2398 | 896 | 2597 | 752 | 2665 | 644 | 2648 | 469 | 2876 | 309 | 1498 |
| 6-#8 | 1.21 | MA | 3214 | 1175 | 4572 | 984 | 5250 | 829 | 5560 | 707 | 5760 | 530 | 6714 | 399 | 3156 |
| 3L-2S | | MI | 1618 | 1175 | 2528 | 894 | 2763 | 752 | 2867 | 640 | 2914 | 466 | 3187 | 366 | 1485 |
| 6-#9 | 1.53 | MA | 3503 | 1211 | 5165 | 997 | 5996 | 837 | 6461 | 710 | 6975 | 517 | 8394 | 448 | 3933 |
| 2L-3S | | MI | 1578 | 1211 | 2470 | 914 | 2681 | 765 | 2763 | 652 | 2770 | 462 | 3009 | 273 | 1829 |
| 6-#9 | 1.53 | MA | 3290 | 1211 | 4753 | 1006 | 5470 | 845 | 5823 | 717 | 6112 | 528 | 7198 | 381 | 3935 |
| 3L-2S | | MI | 1656 | 1211 | 2633 | 912 | 2889 | 764 | 3015 | 647 | 3098 | 459 | 3391 | 345 | 1811 |
| 6-#10 | 1.94 | MA | 3648 | 1257 | 5503 | 1023 | 6414 | 856 | 6963 | 721 | 7650 | 512 | 9325 | 443 | 4929 |
| 2L-3S | | MI | 1608 | 1257 | 2560 | 938 | 2787 | 781 | 2887 | 662 | 2920 | 452 | 3172 | 225 | 2237 |
| 6-#10 | 1.94 | MA | 3386 | 1257 | 4982 | 1034 | 5751 | 865 | 6158 | 730 | 6560 | 527 | 7816 | 357 | 4916 |
| 3L-2S | | MI | 1703 | 1257 | 2763 | 936 | 3046 | 781 | 3202 | 656 | 3327 | 448 | 3641 | 317 | 2216 |
| 6-#11 | 2.39 | MA | 3782 | 1307 | 5861 | 1047 | 6839 | 872 | 7465 | 730 | 8318 | 506 | 10240 | 436 | 5944 |
| 2L-3S | | MI | 1631 | 1307 | 2652 | 954 | 2881 | 789 | 2982 | 663 | 3020 | 430 | 3251 | 154 | 2633 |
| 6-#11 | 2.39 | MA | 3475 | 1307 | 5232 | 1060 | 6039 | 883 | 6493 | 740 | 7002 | 522 | 8418 | 327 | 5910 |
| 3L-2S | | MI | 1736 | 1307 | 2891 | 953 | 3185 | 792 | 3347 | 657 | 3485 | 425 | 3771 | 266 | 2609 |
| 6-#14 | 3.44 | MA | 3706 | 1425 | 5790 | 1134 | 6727 | 937 | 7318 | 773 | 8110 | 518 | 9947 | 263 | 8265 |
| 3L-2S | | MI | 1836 | 1425 | 3188 | 1017 | 3547 | 837 | 3741 | 674 | 3981 | 391 | 4276 | 177 | 3535 |
| 6-#18 | 6.12 | MA | 4265 | 1725 | 7149 | 1322 | 8415 | 1073 | 9347 | 883 | 10840 | 508 | 13544 | 83 | 13262 |
| 3L-2S | | MI | 2060 | 1725 | 3870 | 1185 | 4314 | 938 | 4596 | 705 | 5062 | 289 | 5505 | -36 | 5303 |
| 8-#7 | 1.22 | MA | 3398 | 1177 | 4906 | 980 | 5685 | 825 | 6094 | 704 | 6486 | 521 | 7723 | 453 | 3194 |
| 2L-4S | | MI | 1547 | 1177 | 2358 | 903 | 2546 | 762 | 2606 | 647 | 2582 | 474 | 2815 | 309 | 1524 |
| 8-#7 | 1.22 | MA | 3266 | 1177 | 4656 | 985 | 5367 | 830 | 5707 | 708 | 5963 | 529 | 6998 | 413 | 3200 |
| 3E | | MI | 1575 | 1177 | 2431 | 901 | 2647 | 757 | 2729 | 647 | 2740 | 472 | 2992 | 327 | 1512 |
| 8-#7 | 1.22 | MA | 3198 | 1177 | 4485 | 991 | 5127 | 839 | 5412 | 717 | 5559 | 532 | 6507 | 389 | 3198 |
| 4L-2S | | MI | 1624 | 1177 | 2531 | 899 | 2775 | 756 | 2884 | 644 | 2947 | 470 | 3235 | 371 | 1503 |
| 8-#8 | 1.61 | MA | 3540 | 1220 | 5227 | 1005 | 6084 | 843 | 6573 | 714 | 7132 | 517 | 8614 | 449 | 4146 |
| 2L-4S | | MI | 1573 | 1220 | 2434 | 926 | 2632 | 779 | 2706 | 656 | 2710 | 467 | 2959 | 267 | 1928 |
| 8-#8 | 1.61 | MA | 3372 | 1220 | 4899 | 1012 | 5667 | 849 | 6067 | 720 | 6446 | 527 | 7664 | 396 | 4147 |
| 3E | | MI | 1609 | 1220 | 2528 | 924 | 2763 | 773 | 2867 | 657 | 2914 | 465 | 3187 | 291 | 1913 |

## RECTANGULAR TIED COLUMNS 14" x 28"

Short columns – no sidesway
Bending on major or minor axis

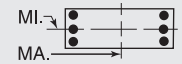



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#8 | 1.61 | MA | 3285 | 1220 | 4676 | 1019 | 5352 | 861 | 5680 | 731 | 5917 | 531 | 7019 | 364 | 4125 |
| 4L-2S | | MI | 1671 | 1220 | 2659 | 922 | 2929 | 772 | 3068 | 653 | 3180 | 462 | 3498 | 348 | 1900 |
| 8-#9 | 2.04 | MA | 3691 | 1268 | 5578 | 1032 | 6521 | 863 | 7099 | 726 | 7838 | 513 | 9589 | 444 | 5185 |
| 2L-4S | | MI | 1601 | 1268 | 2515 | 952 | 2724 | 797 | 2814 | 666 | 2846 | 459 | 3110 | 220 | 2351 |
| 8-#9 | 2.04 | MA | 3486 | 1268 | 5165 | 1041 | 5996 | 871 | 6461 | 733 | 6975 | 525 | 8394 | 376 | 5176 |
| 3E | | MI | 1646 | 1268 | 2633 | 950 | 2889 | 790 | 3015 | 668 | 3098 | 456 | 3391 | 249 | 2338 |
| 8-#9 | 2.04 | MA | 3380 | 1268 | 4884 | 1050 | 5599 | 885 | 5974 | 747 | 6308 | 530 | 7579 | 336 | 5118 |
| 4L-2S | | MI | 1722 | 1268 | 2796 | 948 | 3096 | 790 | 3267 | 663 | 3427 | 453 | 3772 | 321 | 2324 |
| 8-#10 | 2.59 | MA | 3630 | 1330 | 5503 | 1080 | 6414 | 898 | 6963 | 751 | 7650 | 523 | 9325 | 351 | 6476 |
| 3E | | MI | 1693 | 1330 | 2763 | 984 | 3046 | 814 | 3202 | 682 | 3327 | 444 | 3641 | 192 | 2865 |
| 8-#10 | 2.59 | MA | 3501 | 1330 | 5147 | 1091 | 5912 | 917 | 6348 | 768 | 6808 | 529 | 8293 | 299 | 6301 |
| 4L-2S | | MI | 1782 | 1330 | 2967 | 981 | 3305 | 814 | 3517 | 677 | 3734 | 440 | 4109 | 284 | 2850 |
| 8-#11 | 3.18 | MA | 3765 | 1396 | 5861 | 1116 | 6839 | 924 | 7465 | 765 | 8318 | 517 | 10240 | 319 | 7789 |
| 3E | | MI | 1726 | 1396 | 2891 | 1010 | 3185 | 830 | 3347 | 687 | 3485 | 417 | 3771 | 107 | 3364 |
| 8-#11 | 3.18 | MA | 3613 | 1396 | 5430 | 1129 | 6232 | 945 | 6720 | 785 | 7297 | 523 | 8980 | 255 | 7324 |
| 4L-2S | | MI | 1827 | 1396 | 3130 | 1009 | 3489 | 833 | 3713 | 682 | 3950 | 411 | 4292 | 219 | 3351 |
| 8-#14 | 4.59 | MA | 3907 | 1553 | 6070 | 1232 | 7000 | 1025 | 7639 | 837 | 8527 | 519 | 10732 | 159 | 9748 |
| 4L-2S | | MI | 1960 | 1553 | 3522 | 1098 | 3972 | 896 | 4239 | 706 | 4616 | 368 | 4972 | 101 | 4556 |
| 10-#10 | 3.24 | MA | 3749 | 1402 | 5668 | 1136 | 6575 | 949 | 7153 | 788 | 7897 | 525 | 9802 | 293 | 7812 |
| 4L-3S | | MI | 1775 | 1402 | 2967 | 1029 | 3305 | 847 | 3517 | 703 | 3734 | 435 | 4109 | 160 | 3484 |
| 10-#10 | 3.24 | MA | 3561 | 1402 | 5306 | 1155 | 6139 | 959 | 6610 | 797 | 7141 | 539 | 8760 | 247 | 7280 |
| 5L-2S | | MI | 1861 | 1402 | 3170 | 1026 | 3564 | 847 | 3831 | 698 | 4141 | 431 | 4577 | 251 | 3476 |
| 10-#11 | 3.98 | MA | 3908 | 1485 | 6059 | 1184 | 7032 | 986 | 7692 | 810 | 8613 | 518 | 10802 | 248 | 9151 |
| 4L-3S | | MI | 1820 | 1485 | 3130 | 1066 | 3489 | 870 | 3713 | 711 | 3950 | 403 | 4292 | 60 | 4084 |
| 10-#11 | 3.98 | MA | 3688 | 1485 | 5619 | 1207 | 6502 | 997 | 7033 | 820 | 7695 | 535 | 9535 | 187 | 8573 |
| 5L-2S | | MI | 1917 | 1485 | 3369 | 1065 | 3794 | 873 | 4078 | 706 | 4414 | 398 | 4813 | 172 | 4084 |
| 10-#14 | 5.74 | MA | 4014 | 1682 | 6336 | 1345 | 7382 | 1099 | 8081 | 886 | 9090 | 534 | 11512 | 58 | 11279 |
| 5L-2S | | MI | 2082 | 1682 | 3855 | 1178 | 4396 | 954 | 4738 | 739 | 5250 | 345 | 5667 | 25 | 5564 |
| 12-#10 | 3.89 | MA | 3805 | 1475 | 5826 | 1201 | 6802 | 992 | 7415 | 817 | 8230 | 535 | 10269 | 241 | 8819 |
| 5L-3S | | MI | 1856 | 1475 | 3170 | 1074 | 3564 | 880 | 3831 | 724 | 4141 | 427 | 4577 | 127 | 4096 |
| 12-#10 | 3.89 | MA | 3637 | 1475 | 5488 | 1207 | 6390 | 1002 | 6881 | 834 | 7508 | 550 | 9246 | 169 | 8273 |
| 6L-2S | | MI | 1938 | 1475 | 3374 | 1072 | 3823 | 880 | 4146 | 718 | 4548 | 423 | 5045 | 218 | 4098 |
| 12-#11 | 4.78 | MA | 3978 | 1574 | 6248 | 1263 | 7303 | 1038 | 8005 | 845 | 9011 | 530 | 11357 | 180 | 10435 |
| 5L-3S | | MI | 1913 | 1574 | 3369 | 1121 | 3794 | 911 | 4078 | 735 | 4414 | 390 | 4813 | 13 | 4779 |
| 12-#11 | 4.78 | MA | 3781 | 1574 | 5844 | 1272 | 6780 | 1059 | 7357 | 865 | 8135 | 546 | 10204 | 106 | 9613 |
| 6L-2S | | MI | 2006 | 1574 | 3608 | 1120 | 4098 | 913 | 4443 | 730 | 4879 | 384 | 5333 | 125 | 4812 |
| 12-#14 | 6.89 | MA | 4153 | 1810 | 6663 | 1438 | 7774 | 1187 | 8539 | 950 | 9712 | 549 | 12451 | -60 | 12090 |
| 6L-2S | | MI | 2204 | 1810 | 4189 | 1258 | 4821 | 1012 | 5236 | 771 | 5884 | 323 | 6363 | -50 | 6346 |
| 14-#10 | 4.54 | MA | 3883 | 1547 | 6008 | 1252 | 7053 | 1035 | 7686 | 855 | 8598 | 545 | 10755 | 164 | 9812 |
| 6L-3S | | MI | 1936 | 1547 | 3374 | 1120 | 3823 | 912 | 4146 | 744 | 4548 | 419 | 5045 | 94 | 4706 |
| 14-#10 | 4.54 | MA | 3746 | 1547 | 5676 | 1259 | 6603 | 1050 | 7173 | 863 | 7860 | 552 | 9767 | 125 | 9195 |
| 7L-2S | | MI | 2015 | 1547 | 3577 | 1117 | 4082 | 913 | 4461 | 739 | 4955 | 414 | 5513 | 185 | 4715 |
| 14-#11 | 5.57 | MA | 4073 | 1663 | 6473 | 1327 | 7581 | 1099 | 8329 | 890 | 9451 | 541 | 12026 | 99 | 11474 |
| 6L-3S | | MI | 2005 | 1663 | 3608 | 1177 | 4098 | 951 | 4443 | 759 | 4879 | 376 | 5333 | -35 | 5319 |
| 14-#11 | 5.57 | MA | 3912 | 1663 | 6071 | 1335 | 7067 | 1109 | 7706 | 900 | 8556 | 547 | 10726 | 34 | 10580 |
| 7L-2S | | MI | 2094 | 1663 | 3847 | 1176 | 4403 | 954 | 4808 | 754 | 5344 | 371 | 5854 | 77 | 5532 |
| 16-#10 | 5.18 | MA | 3994 | 1620 | 6197 | 1304 | 7266 | 1083 | 7978 | 884 | 8950 | 547 | 11276 | 119 | 10731 |
| 7L-3S | | MI | 2016 | 1620 | 3577 | 1165 | 4082 | 945 | 4461 | 765 | 4955 | 410 | 5513 | 61 | 5313 |
| 16-#10 | 5.18 | MA | 3835 | 1620 | 5878 | 1312 | 6834 | 1090 | 7457 | 900 | 8246 | 562 | 10326 | 67 | 10042 |
| 8L-2S | | MI | 2092 | 1620 | 3781 | 1162 | 4341 | 946 | 4775 | 759 | 5362 | 406 | 5981 | 152 | 5329 |
| 16-#11 | 6.37 | MA | 4208 | 1752 | 6699 | 1390 | 7868 | 1149 | 8678 | 925 | 9872 | 542 | 12548 | 26 | 12433 |
| 7L-3S | | MI | 2097 | 1752 | 3847 | 1233 | 4403 | 992 | 4808 | 784 | 5344 | 363 | 5854 | -82 | 5815 |
| 18-#10 | 5.83 | MA | 4080 | 1692 | 6398 | 1358 | 7497 | 1122 | 8262 | 921 | 9335 | 558 | 11835 | 61 | 11582 |
| 8L-3S | | MI | 2094 | 1692 | 3781 | 1210 | 4341 | 978 | 4775 | 785 | 5362 | 402 | 5981 | 28 | 5896 |

## RECTANGULAR TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

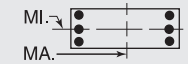
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 1.41 | MA | 1244 | 782 | 1926 | 609 | 2147 | 511 | 2259 | 434 | 2364 | 316 | 2664 | 255 | 1281 |
| 2L-3S | | MI | 1184 | 782 | 1805 | 612 | 1992 | 513 | 2070 | 439 | 2109 | 319 | 2348 | 212 | 1290 |
| 6-#8 | 1.85 | MA | 1290 | 814 | 2042 | 627 | 2289 | 524 | 2429 | 441 | 2592 | 313 | 2930 | 242 | 1633 |
| 2L-3S | | MI | 1213 | 814 | 1884 | 630 | 2087 | 526 | 2183 | 447 | 2260 | 316 | 2524 | 185 | 1644 |
| 6-#9 | 2.34 | MA | 1337 | 850 | 2168 | 647 | 2443 | 538 | 2613 | 450 | 2839 | 309 | 3211 | 227 | 2012 |
| 2L-3S | | MI | 1244 | 850 | 1969 | 651 | 2191 | 540 | 2306 | 457 | 2424 | 313 | 2709 | 155 | 2020 |
| 6-#10 | 2.98 | MA | 1397 | 896 | 2325 | 673 | 2637 | 557 | 2846 | 461 | 3147 | 304 | 3559 | 206 | 2487 |
| 2L-3S | | MI | 1283 | 896 | 2076 | 677 | 2320 | 559 | 2461 | 469 | 2628 | 308 | 2940 | 114 | 2484 |
| 6-#11 | 3.66 | MA | 1443 | 946 | 2479 | 696 | 2816 | 572 | 3056 | 469 | 3384 | 289 | 3795 | 168 | 2943 |
| 2L-3S | | MI | 1319 | 946 | 2184 | 700 | 2441 | 574 | 2600 | 477 | 2783 | 294 | 3091 | 56 | 2926 |
| 6-#14 | 5.27 | MA | 1573 | 1064 | 2846 | 764 | 3273 | 621 | 3605 | 498 | 4063 | 266 | 4542 | 100 | 4052 |
| 2L-3S | | MI | 1409 | 1064 | 2433 | 769 | 2746 | 621 | 2965 | 508 | 3233 | 274 | 3585 | -62 | 3552 |
| 8-#7 | 1.88 | MA | 1296 | 816 | 2048 | 630 | 2302 | 527 | 2447 | 444 | 2619 | 314 | 2979 | 245 | 1659 |
| 2L-4S | | MI | 1205 | 816 | 1840 | 636 | 2026 | 534 | 2111 | 449 | 2169 | 320 | 2438 | 181 | 1670 |
| 8-#8 | 2.47 | MA | 1355 | 859 | 2201 | 655 | 2491 | 544 | 2674 | 454 | 2924 | 310 | 3335 | 229 | 2121 |
| 2L-4S | | MI | 1240 | 859 | 1930 | 662 | 2132 | 554 | 2236 | 461 | 2338 | 317 | 2638 | 145 | 2086 |
| 8-#9 | 3.13 | MA | 1418 | 907 | 2366 | 682 | 2696 | 564 | 2920 | 466 | 3255 | 306 | 3712 | 209 | 2619 |
| 2L-4S | | MI | 1278 | 907 | 2027 | 690 | 2245 | 575 | 2371 | 474 | 2521 | 313 | 2849 | 104 | 2469 |
| 8-#10 | 3.97 | MA | 1495 | 969 | 2574 | 718 | 2954 | 589 | 3230 | 481 | 3666 | 300 | 4179 | 181 | 3243 |
| 2L-4S | | MI | 1326 | 969 | 2147 | 727 | 2389 | 603 | 2541 | 490 | 2749 | 308 | 3111 | 49 | 2938 |

## RECTANGULAR TIED COLUMNS 16" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.10 | MA | 1541 | 854 | 2326 | 678 | 2597 | 571 | 2724 | 488 | 2817 | 363 | 3200 | 304 | 1309 |
| 2E | | MI | 1359 | 854 | 2080 | 666 | 2298 | 561 | 2395 | 479 | 2460 | 356 | 2738 | 290 | 1155 |
| 4-#9 | 1.39 | MA | 1581 | 878 | 2427 | 690 | 2720 | 580 | 2870 | 493 | 3012 | 360 | 3436 | 295 | 1614 |
| 2E | | MI | 1392 | 878 | 2166 | 678 | 2401 | 570 | 2518 | 484 | 2623 | 353 | 2923 | 279 | 1417 |
| 4-#10 | 1.76 | MA | 1630 | 909 | 2555 | 707 | 2875 | 591 | 3054 | 499 | 3260 | 356 | 3730 | 284 | 1997 |
| 2E | | MI | 1432 | 909 | 2273 | 694 | 2531 | 581 | 2672 | 490 | 2827 | 348 | 3152 | 265 | 1745 |
| 4-#11 | 2.17 | MA | 1672 | 942 | 2687 | 720 | 3024 | 600 | 3226 | 503 | 3485 | 350 | 3947 | 262 | 2378 |
| 2E | | MI | 1465 | 942 | 2383 | 706 | 2652 | 588 | 2811 | 493 | 2981 | 336 | 3302 | 238 | 2068 |
| 4-#14 | 3.13 | MA | 1785 | 1021 | 2988 | 763 | 3393 | 631 | 3668 | 521 | 4068 | 340 | 4600 | 225 | 3285 |
| 2E | | MI | 1553 | 1021 | 2633 | 749 | 2958 | 619 | 3176 | 511 | 3430 | 319 | 3794 | 191 | 2832 |
| 4-#18 | 5.56 | MA | 2034 | 1221 | 3701 | 877 | 4275 | 712 | 4727 | 569 | 5384 | 303 | 6058 | 113 | 5427 |
| 2E | | MI | 1751 | 1221 | 3219 | 862 | 3678 | 699 | 4004 | 550 | 4443 | 269 | 4851 | 51 | 4611 |
| 6-#7 | 1.25 | MA | 1567 | 867 | 2375 | 688 | 2667 | 579 | 2811 | 493 | 2937 | 363 | 3368 | 304 | 1475 |
| 2L-3S | | MI | 1320 | 867 | 2000 | 680 | 2202 | 571 | 2282 | 489 | 2309 | 359 | 2563 | 247 | 1308 |
| 6-#7 | 1.25 | MA | 1495 | 867 | 2232 | 692 | 2484 | 582 | 2589 | 499 | 2637 | 367 | 2979 | 261 | 1485 |
| 3L-2S | | MI | 1381 | 867 | 2122 | 677 | 2358 | 569 | 2470 | 485 | 2564 | 357 | 2879 | 290 | 1298 |
| 6-#8 | 1.65 | MA | 1622 | 899 | 2512 | 706 | 2835 | 592 | 3012 | 501 | 3208 | 360 | 3702 | 294 | 1889 |
| 2L-3S | | MI | 1349 | 899 | 2080 | 698 | 2298 | 584 | 2395 | 498 | 2460 | 356 | 2738 | 220 | 1665 |
| 6-#8 | 1.65 | MA | 1530 | 899 | 2326 | 711 | 2597 | 595 | 2724 | 508 | 2817 | 365 | 3200 | 237 | 1900 |
| 3L-2S | | MI | 1426 | 899 | 2238 | 694 | 2500 | 582 | 2640 | 492 | 2791 | 353 | 3144 | 277 | 1653 |
| 6-#9 | 2.08 | MA | 1680 | 935 | 2661 | 726 | 3018 | 606 | 3232 | 509 | 3502 | 356 | 4059 | 282 | 2336 |
| 2L-3S | | MI | 1380 | 935 | 2166 | 718 | 2401 | 598 | 2518 | 507 | 2623 | 353 | 2923 | 190 | 2046 |
| 6-#9 | 2.08 | MA | 1568 | 935 | 2427 | 731 | 2720 | 610 | 2870 | 518 | 3012 | 362 | 3436 | 210 | 2344 |
| 3L-2S | | MI | 1474 | 935 | 2364 | 714 | 2654 | 595 | 2824 | 500 | 3038 | 349 | 3424 | 262 | 2035 |
| 6-#10 | 2.65 | MA | 1753 | 981 | 2849 | 752 | 3250 | 624 | 3509 | 520 | 3875 | 352 | 4504 | 266 | 2898 |
| 2L-3S | | MI | 1418 | 981 | 2273 | 744 | 2531 | 616 | 2672 | 519 | 2827 | 348 | 3152 | 149 | 2517 |
| 6-#10 | 2.65 | MA | 1616 | 981 | 2555 | 759 | 2875 | 629 | 3054 | 531 | 3260 | 359 | 3730 | 175 | 2895 |
| 3L-2S | | MI | 1534 | 981 | 2522 | 740 | 2848 | 614 | 3057 | 511 | 3346 | 344 | 3772 | 241 | 2513 |
| 6-#11 | 3.25 | MA | 1815 | 1031 | 3037 | 775 | 3470 | 640 | 3768 | 528 | 4219 | 345 | 4838 | 235 | 3449 |
| 2L-3S | | MI | 1454 | 1031 | 2383 | 766 | 2652 | 630 | 2811 | 527 | 2981 | 333 | 3302 | 90 | 2969 |
| 6-#11 | 3.25 | MA | 1656 | 1031 | 2687 | 782 | 3024 | 644 | 3226 | 540 | 3485 | 351 | 3947 | 123 | 3431 |
| 3L-2S | | MI | 1581 | 1031 | 2678 | 762 | 3028 | 629 | 3267 | 518 | 3582 | 328 | 4006 | 202 | 2974 |
| 6-#14 | 4.69 | MA | 1978 | 1149 | 3482 | 844 | 4023 | 689 | 4432 | 557 | 5097 | 332 | 5825 | 181 | 4781 |
| 2L-3S | | MI | 1544 | 1149 | 2633 | 834 | 2958 | 677 | 3176 | 557 | 3430 | 312 | 3794 | -28 | 3780 |
| 6-#14 | 4.69 | MA | 1777 | 1149 | 2988 | 852 | 3393 | 693 | 3668 | 572 | 4068 | 339 | 4600 | 19 | 4552 |
| 3L-2S | | MI | 1711 | 1149 | 3047 | 830 | 3485 | 677 | 3816 | 547 | 4259 | 305 | 4751 | 134 | 4091 |

## RECTANGULAR TIED COLUMNS 16" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#7 | 1.67 | MA | 1629 | 901 | 2518 | 710 | 2849 | 595 | 3032 | 503 | 3237 | 361 | 3757 | 297 | 1918 |
| 2L-4S | | MI | 1340 | 901 | 2035 | 704 | 2237 | 592 | 2322 | 500 | 2369 | 360 | 2652 | 217 | 1694 |
| 8-#7 | 1.67 | MA | 1559 | 901 | 2375 | 713 | 2667 | 597 | 2811 | 509 | 2937 | 365 | 3368 | 254 | 1926 |
| 3E | | MI | 1373 | 901 | 2122 | 701 | 2358 | 587 | 2470 | 499 | 2564 | 357 | 2879 | 238 | 1686 |
| 8-#7 | 1.67 | MA | 1520 | 901 | 2275 | 717 | 2526 | 604 | 2638 | 510 | 2701 | 366 | 3092 | 232 | 1930 |
| 4L-2S | | MI | 1432 | 901 | 2243 | 698 | 2513 | 585 | 2659 | 494 | 2818 | 355 | 3194 | 281 | 1678 |
| 8-#8 | 2.19 | MA | 1701 | 944 | 2699 | 734 | 3073 | 612 | 3301 | 513 | 3599 | 357 | 4205 | 285 | 2462 |
| 2L-4S | | MI | 1375 | 944 | 2126 | 729 | 2342 | 612 | 2447 | 511 | 2537 | 357 | 2852 | 180 | 2149 |
| 8-#8 | 2.19 | MA | 1612 | 944 | 2512 | 739 | 2835 | 615 | 3012 | 521 | 3208 | 362 | 3702 | 228 | 2468 |
| 3E | | MI | 1417 | 944 | 2238 | 726 | 2500 | 604 | 2640 | 511 | 2791 | 354 | 3144 | 207 | 2151 |
| 8-#8 | 2.19 | MA | 1564 | 944 | 2381 | 743 | 2651 | 624 | 2787 | 523 | 2900 | 362 | 3345 | 199 | 2457 |
| 4L-2S | | MI | 1492 | 944 | 2397 | 723 | 2702 | 602 | 2886 | 505 | 3123 | 350 | 3549 | 264 | 2143 |
| 8-#9 | 2.78 | MA | 1778 | 992 | 2895 | 762 | 3316 | 632 | 3594 | 525 | 3992 | 353 | 4682 | 269 | 3051 |
| 2L-4S | | MI | 1413 | 992 | 2223 | 758 | 2456 | 633 | 2582 | 524 | 2720 | 353 | 3062 | 139 | 2546 |
| 8-#9 | 2.78 | MA | 1670 | 992 | 2661 | 767 | 3018 | 636 | 3232 | 534 | 3502 | 359 | 4059 | 197 | 3049 |
| 3E | | MI | 1464 | 992 | 2364 | 754 | 2654 | 624 | 2824 | 523 | 3038 | 350 | 3424 | 172 | 2647 |
| 8-#9 | 2.78 | MA | 1611 | 992 | 2497 | 772 | 2787 | 646 | 2949 | 536 | 3115 | 358 | 3615 | 161 | 2931 |
| 4L-2S | | MI | 1555 | 992 | 2563 | 750 | 2907 | 621 | 3131 | 516 | 3454 | 346 | 3925 | 244 | 2644 |
| 8-#10 | 3.53 | MA | 1874 | 1054 | 3143 | 797 | 3624 | 657 | 3964 | 540 | 4491 | 348 | 5278 | 248 | 3792 |
| 2L-4S | | MI | 1461 | 1054 | 2345 | 794 | 2599 | 660 | 2753 | 540 | 2947 | 348 | 3323 | 84 | 3023 |
| 8-#10 | 3.53 | MA | 1743 | 1054 | 2849 | 804 | 3250 | 662 | 3509 | 551 | 3875 | 355 | 4504 | 157 | 3774 |
| 3E | | MI | 1523 | 1054 | 2522 | 790 | 2848 | 649 | 3057 | 540 | 3346 | 344 | 3772 | 125 | 3262 |
| 8-#10 | 3.53 | MA | 1670 | 1054 | 2641 | 810 | 2959 | 675 | 3153 | 554 | 3388 | 353 | 3951 | 112 | 3494 |
| 4L-2S | | MI | 1634 | 1054 | 2771 | 785 | 3165 | 647 | 3442 | 531 | 3865 | 339 | 4391 | 216 | 3271 |
| 8-#11 | 4.33 | MA | 1805 | 1120 | 3037 | 838 | 3470 | 685 | 3768 | 565 | 4219 | 346 | 4838 | 96 | 4471 |
| 3E | | MI | 1576 | 1120 | 2678 | 822 | 3028 | 670 | 3267 | 552 | 3582 | 325 | 4006 | 55 | 3845 |
| 8-#11 | 4.33 | MA | 1720 | 1120 | 2789 | 844 | 3122 | 699 | 3341 | 566 | 3657 | 352 | 4196 | 44 | 4023 |
| 4L-2S | | MI | 1695 | 1120 | 2973 | 818 | 3403 | 669 | 3723 | 543 | 4183 | 320 | 4710 | 167 | 3870 |
| 8-#14 | 6.25 | MA | 1983 | 1278 | 3482 | 932 | 4023 | 752 | 4432 | 609 | 5097 | 331 | 5825 | -24 | 5797 |
| 3E | | MI | 1712 | 1278 | 3047 | 914 | 3485 | 735 | 3816 | 593 | 4259 | 298 | 4751 | -85 | 4692 |
| 10-#10 | 4.41 | MA | 1867 | 1126 | 3143 | 849 | 3624 | 695 | 3964 | 572 | 4491 | 350 | 5278 | 139 | 4649 |
| 3L-4S | | MI | 1568 | 1126 | 2593 | 840 | 2916 | 693 | 3137 | 560 | 3467 | 343 | 3943 | 60 | 3722 |
| 10-#10 | 4.41 | MA | 1800 | 1126 | 2936 | 856 | 3333 | 708 | 3608 | 574 | 4004 | 349 | 4724 | 94 | 4328 |
| 4L-3S | | MI | 1631 | 1126 | 2771 | 835 | 3165 | 682 | 3442 | 560 | 3865 | 339 | 4391 | 101 | 4003 |
| 10-#10 | 4.41 | MA | 1716 | 1126 | 2723 | 871 | 3077 | 712 | 3290 | 585 | 3562 | 356 | 4181 | 39 | 4065 |
| 5L-2S | | MI | 1731 | 1126 | 3020 | 830 | 3482 | 680 | 3826 | 552 | 4384 | 335 | 5011 | 192 | 4024 |
| 10-#11 | 5.42 | MA | 1872 | 1209 | 3139 | 900 | 3568 | 739 | 3883 | 591 | 4390 | 347 | 5088 | 17 | 5017 |
| 4L-3S | | MI | 1695 | 1209 | 2973 | 878 | 3403 | 711 | 3723 | 577 | 4183 | 317 | 4710 | 19 | 4656 |
| 12-#10 | 5.29 | MA | 1928 | 1199 | 3230 | 901 | 3708 | 740 | 4063 | 595 | 4619 | 345 | 5498 | 76 | 5168 |
| 4E | | MI | 1682 | 1199 | 2842 | 885 | 3233 | 726 | 3522 | 581 | 3986 | 339 | 4562 | 35 | 4428 |
| 12-#10 | 5.29 | MA | 1844 | 1199 | 3017 | 916 | 3451 | 745 | 3745 | 606 | 4178 | 352 | 4955 | 22 | 4888 |
| 5L-3S | | MI | 1732 | 1199 | 3020 | 880 | 3482 | 715 | 3826 | 581 | 4384 | 335 | 5011 | 76 | 4743 |

## RECTANGULAR TIED COLUMNS 16" x 20"

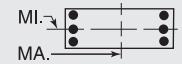
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.25 | MA | 1941 | 963 | 2925 | 770 | 3299 | 648 | 3485 | 552 | 3652 | 407 | 4224 | 344 | 1830 |
| 2E | | MI | 1528 | 963 | 2362 | 746 | 2612 | 627 | 2729 | 534 | 2822 | 392 | 3136 | 314 | 1436 |
| 4-#10 | 1.59 | MA | 2000 | 994 | 3073 | 786 | 3479 | 659 | 3700 | 558 | 3940 | 403 | 4584 | 335 | 2271 |
| 2E | | MI | 1568 | 994 | 2471 | 761 | 2742 | 638 | 2884 | 540 | 3026 | 388 | 3365 | 300 | 1766 |
| 4-#11 | 1.95 | MA | 2052 | 1027 | 3230 | 799 | 3656 | 668 | 3905 | 562 | 4209 | 397 | 4867 | 317 | 2715 |
| 2E | | MI | 1601 | 1027 | 2582 | 772 | 2864 | 645 | 3022 | 542 | 3178 | 375 | 3512 | 272 | 2094 |
| 4-#14 | 2.81 | MA | 2187 | 1106 | 3583 | 843 | 4089 | 699 | 4423 | 580 | 4905 | 389 | 5684 | 287 | 3771 |
| 2E | | MI | 1690 | 1106 | 2834 | 815 | 3170 | 675 | 3387 | 559 | 3626 | 358 | 4002 | 225 | 2864 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

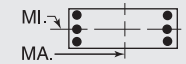
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 5.00 | MA | 2495 | 1305 | 4427 | 957 | 5133 | 780 | 5676 | 629 | 6581 | 369 | 7550 | 196 | 6291 |
| 2E | | MI | 1889 | 1305 | 3422 | 926 | 3890 | 753 | 4213 | 598 | 4638 | 307 | 5056 | 84 | 4658 |
| 6-#7 | 1.13 | MA | 1924 | 951 | 2863 | 768 | 3235 | 647 | 3415 | 552 | 3563 | 410 | 4134 | 352 | 1670 |
| 2L-3S | | MI | 1456 | 951 | 2195 | 748 | 2413 | 629 | 2494 | 540 | 2509 | 400 | 2778 | 282 | 1324 |
| 6-#7 | 1.13 | MA | 1839 | 951 | 2698 | 772 | 3025 | 650 | 3161 | 559 | 3219 | 415 | 3671 | 309 | 1679 |
| 3L-2S | | MI | 1517 | 951 | 2317 | 745 | 2568 | 627 | 2682 | 535 | 2763 | 397 | 3093 | 325 | 1314 |
| 6-#8 | 1.48 | MA | 1989 | 984 | 3022 | 786 | 3430 | 659 | 3648 | 560 | 3876 | 407 | 4538 | 344 | 2145 |
| 2L-3S | | MI | 1485 | 984 | 2276 | 766 | 2508 | 641 | 2607 | 548 | 2659 | 396 | 2952 | 255 | 1685 |
| 6-#8 | 1.48 | MA | 1881 | 984 | 2807 | 791 | 3156 | 664 | 3316 | 568 | 3426 | 413 | 3938 | 287 | 2156 |
| 3L-2S | | MI | 1562 | 984 | 2434 | 762 | 2710 | 639 | 2852 | 542 | 2991 | 393 | 3358 | 312 | 1672 |
| 6-#9 | 1.88 | MA | 2059 | 1020 | 3195 | 806 | 3642 | 674 | 3903 | 568 | 4217 | 403 | 4971 | 335 | 2660 |
| 2L-3S | | MI | 1515 | 1020 | 2362 | 785 | 2612 | 655 | 2729 | 557 | 2822 | 393 | 3136 | 225 | 2070 |
| 6-#9 | 1.88 | MA | 1927 | 1020 | 2925 | 812 | 3299 | 679 | 3485 | 578 | 3652 | 411 | 4224 | 263 | 2668 |
| 3L-2S | | MI | 1610 | 1020 | 2561 | 781 | 2864 | 653 | 3036 | 550 | 3238 | 389 | 3637 | 297 | 2056 |
| 6-#10 | 2.38 | MA | 2146 | 1066 | 3413 | 832 | 3911 | 692 | 4225 | 579 | 4651 | 399 | 5513 | 322 | 3310 |
| 2L-3S | | MI | 1554 | 1066 | 2471 | 811 | 2742 | 673 | 2884 | 569 | 3026 | 388 | 3365 | 184 | 2548 |
| 6-#10 | 2.38 | MA | 1984 | 1066 | 3073 | 839 | 3479 | 698 | 3700 | 592 | 3940 | 408 | 4584 | 231 | 3307 |
| 3L-2S | | MI | 1670 | 1066 | 2719 | 807 | 3059 | 671 | 3268 | 560 | 3545 | 383 | 3984 | 275 | 2537 |
| 6-#11 | 2.92 | MA | 2222 | 1116 | 3636 | 855 | 4173 | 708 | 4533 | 587 | 5059 | 392 | 5949 | 297 | 3954 |
| 2L-3S | | MI | 1585 | 1116 | 2582 | 832 | 2864 | 686 | 3022 | 576 | 3178 | 372 | 3512 | 125 | 3009 |
| 6-#11 | 2.92 | MA | 2033 | 1116 | 3230 | 863 | 3656 | 714 | 3905 | 601 | 4209 | 401 | 4867 | 184 | 3937 |
| 3L-2S | | MI | 1718 | 1116 | 2877 | 828 | 3239 | 685 | 3478 | 567 | 3779 | 367 | 4216 | 237 | 3004 |
| 6-#14 | 4.22 | MA | 2421 | 1234 | 4157 | 923 | 4821 | 757 | 5312 | 617 | 6107 | 381 | 7182 | 253 | 5510 |
| 2L-3S | | MI | 1678 | 1234 | 2834 | 899 | 3170 | 733 | 3387 | 606 | 3626 | 351 | 4002 | 6 | 3989 |
| 6-#14 | 4.22 | MA | 2168 | 1234 | 3583 | 934 | 4089 | 764 | 4423 | 635 | 4905 | 393 | 5684 | 92 | 5422 |
| 3L-2S | | MI | 1848 | 1234 | 3248 | 895 | 3696 | 733 | 4027 | 596 | 4456 | 344 | 4959 | 168 | 4128 |
| 6-#18 | 7.50 | MA | 2510 | 1534 | 4427 | 1114 | 5133 | 891 | 5676 | 720 | 6581 | 369 | 7550 | -167 | 7355 |
| 3L-2S | | MI | 2145 | 1534 | 4117 | 1068 | 4776 | 857 | 5271 | 659 | 5983 | 271 | 6556 | -40 | 6529 |
| 8-#7 | 1.50 | MA | 1997 | 986 | 3028 | 789 | 3444 | 662 | 3670 | 562 | 3907 | 408 | 4597 | 347 | 2177 |
| 2L-4S | | MI | 1476 | 986 | 2231 | 772 | 2447 | 650 | 2534 | 551 | 2569 | 401 | 2867 | 252 | 1715 |
| 8-#7 | 1.50 | MA | 1915 | 986 | 2863 | 793 | 3235 | 666 | 3415 | 569 | 3563 | 413 | 4134 | 304 | 2185 |
| 3E | | MI | 1509 | 986 | 2317 | 769 | 2568 | 645 | 2682 | 550 | 2763 | 398 | 3093 | 273 | 1705 |
| 8-#7 | 1.50 | MA | 1870 | 986 | 2749 | 797 | 3074 | 673 | 3218 | 571 | 3293 | 415 | 3808 | 280 | 2189 |
| 4L-2S | | MI | 1568 | 986 | 2439 | 766 | 2723 | 643 | 2870 | 545 | 3018 | 395 | 3409 | 316 | 1696 |
| 8-#8 | 1.98 | MA | 2083 | 1029 | 3237 | 814 | 3704 | 680 | 3981 | 572 | 4326 | 404 | 5137 | 337 | 2804 |
| 2L-4S | | MI | 1511 | 1029 | 2322 | 797 | 2553 | 669 | 2659 | 562 | 2737 | 397 | 3066 | 216 | 2178 |
| 8-#8 | 1.98 | MA | 1978 | 1029 | 3022 | 819 | 3430 | 684 | 3648 | 581 | 3876 | 411 | 4538 | 281 | 2809 |
| 3E | | MI | 1553 | 1029 | 2434 | 794 | 2710 | 662 | 2852 | 561 | 2991 | 394 | 3358 | 242 | 2174 |
| 8-#8 | 1.98 | MA | 1922 | 1029 | 2873 | 824 | 3220 | 694 | 3391 | 584 | 3523 | 412 | 4114 | 250 | 2798 |
| 4L-2S | | MI | 1628 | 1029 | 2593 | 790 | 2912 | 660 | 3097 | 555 | 3323 | 390 | 3763 | 299 | 2164 |
| 8-#9 | 2.50 | MA | 2174 | 1077 | 3465 | 841 | 3986 | 700 | 4320 | 584 | 4782 | 400 | 5717 | 326 | 3483 |
| 2L-4S | | MI | 1548 | 1077 | 2420 | 825 | 2667 | 690 | 2794 | 574 | 2919 | 393 | 3276 | 174 | 2619 |
| 8-#9 | 2.50 | MA | 2047 | 1077 | 3195 | 848 | 3642 | 705 | 3903 | 594 | 4217 | 408 | 4971 | 254 | 3481 |
| 3E | | MI | 1600 | 1077 | 2561 | 821 | 2864 | 681 | 3036 | 573 | 3238 | 390 | 3637 | 207 | 2675 |
| 8-#9 | 2.50 | MA | 1979 | 1077 | 3007 | 854 | 3378 | 716 | 3579 | 598 | 3774 | 409 | 4443 | 215 | 3407 |
| 4L-2S | | MI | 1692 | 1077 | 2759 | 817 | 3117 | 679 | 3343 | 566 | 3653 | 386 | 4139 | 279 | 2668 |
| 8-#10 | 3.17 | MA | 2288 | 1139 | 3752 | 877 | 4343 | 725 | 4750 | 600 | 5361 | 395 | 6443 | 309 | 4340 |
| 2L-4S | | MI | 1596 | 1139 | 2542 | 862 | 2810 | 717 | 2964 | 590 | 3146 | 387 | 3536 | 119 | 3104 |
| 8-#10 | 3.17 | MA | 2133 | 1139 | 3413 | 885 | 3911 | 731 | 4225 | 612 | 4651 | 404 | 5513 | 218 | 4322 |
| 3E | | MI | 1659 | 1139 | 2719 | 857 | 3059 | 706 | 3268 | 590 | 3545 | 383 | 3984 | 160 | 3296 |
| 8-#10 | 3.17 | MA | 2050 | 1139 | 3176 | 893 | 3578 | 746 | 3817 | 616 | 4092 | 405 | 4855 | 169 | 4066 |
| 4L-2S | | MI | 1771 | 1139 | 2968 | 852 | 3376 | 704 | 3653 | 581 | 4064 | 379 | 4604 | 251 | 3298 |
| 8-#11 | 3.90 | MA | 2209 | 1205 | 3636 | 919 | 4173 | 755 | 4533 | 627 | 5059 | 396 | 5949 | 164 | 5145 |
| 3E | | MI | 1711 | 1205 | 2877 | 888 | 3239 | 727 | 3478 | 601 | 3779 | 364 | 4216 | 89 | 3888 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

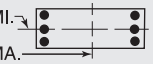
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 3.90 | MA | 2111 | 1205 | 3351 | 927 | 3772 | 771 | 4042 | 630 | 4387 | 395 | 5177 | 108 | 4695 |
| 4L-2S | | MI | 1833 | 1205 | 3172 | 884 | 3614 | 726 | 3934 | 593 | 4381 | 359 | 4920 | 201 | 3903 |
| 8-#14 | 5.63 | MA | 2426 | 1363 | 4157 | 1014 | 4821 | 823 | 5312 | 672 | 6107 | 385 | 7182 | 58 | 7003 |
| 3E | | MI | 1847 | 1363 | 3248 | 980 | 3696 | 791 | 4027 | 642 | 4456 | 337 | 4959 | -51 | 4926 |
| 8-#14 | 5.63 | MA | 2281 | 1363 | 3752 | 1025 | 4252 | 845 | 4615 | 675 | 5190 | 397 | 6109 | -21 | 6093 |
| 4L-2S | | MI | 2005 | 1363 | 3661 | 975 | 4223 | 791 | 4667 | 632 | 5286 | 329 | 5916 | 110 | 5376 |
| 10-#10 | 3.97 | MA | 2280 | 1211 | 3752 | 930 | 4343 | 764 | 4750 | 633 | 5361 | 400 | 6443 | 205 | 5335 |
| 3L-4S | | MI | 1703 | 1211 | 2791 | 907 | 3127 | 750 | 3349 | 610 | 3665 | 383 | 4155 | 95 | 3801 |
| 10-#10 | 3.97 | MA | 2203 | 1211 | 3515 | 938 | 4010 | 779 | 4342 | 637 | 4803 | 400 | 5784 | 156 | 5032 |
| 4L-3S | | MI | 1768 | 1211 | 2968 | 902 | 3376 | 739 | 3653 | 610 | 4064 | 379 | 4604 | 135 | 4040 |
| 10-#10 | 3.97 | MA | 2099 | 1211 | 3272 | 954 | 3717 | 785 | 3979 | 650 | 4298 | 410 | 5132 | 103 | 4774 |
| 5L-2S | | MI | 1869 | 1211 | 3217 | 897 | 3692 | 737 | 4038 | 602 | 4583 | 374 | 5223 | 227 | 4054 |
| 10-#11 | 4.88 | MA | 2291 | 1294 | 3757 | 983 | 4289 | 812 | 4670 | 655 | 5237 | 389 | 6259 | 87 | 5852 |
| 4L-3S | | MI | 1831 | 1294 | 3172 | 944 | 3614 | 767 | 3934 | 626 | 4381 | 356 | 4920 | 53 | 4764 |
| 10-#14 | 7.03 | MA | 2556 | 1491 | 4326 | 1106 | 4983 | 903 | 5503 | 712 | 6392 | 389 | 7607 | -54 | 7533 |
| 4L-3S | | MI | 2012 | 1491 | 3661 | 1060 | 4223 | 849 | 4667 | 678 | 5286 | 322 | 5916 | -109 | 5829 |
| 12-#10 | 4.76 | MA | 2353 | 1284 | 3854 | 983 | 4442 | 811 | 4867 | 658 | 5513 | 396 | 6714 | 143 | 6005 |
| 4E | | MI | 1817 | 1284 | 3040 | 952 | 3444 | 783 | 3734 | 631 | 4184 | 378 | 4775 | 70 | 4505 |
| 12-#10 | 4.76 | MA | 2249 | 1284 | 3611 | 999 | 4150 | 817 | 4503 | 670 | 5008 | 405 | 6062 | 90 | 5744 |
| 5L-3S | | MI | 1869 | 1284 | 3217 | 947 | 3692 | 772 | 4038 | 631 | 4583 | 374 | 5223 | 111 | 4781 |
| 14-#10 | 5.56 | MA | 2397 | 1356 | 3951 | 1045 | 4582 | 850 | 5028 | 691 | 5719 | 401 | 6991 | 77 | 6708 |
| 5L-4S | | MI | 1921 | 1356 | 3288 | 997 | 3761 | 816 | 4118 | 651 | 4704 | 374 | 5394 | 46 | 5214 |

## RECTANGULAR TIED COLUMNS 16" x 22"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#9 | 1.14 | MA | 2336 | 1048 | 3463 | 850 | 3926 | 716 | 4154 | 611 | 4345 | 454 | 5074 | 391 | 2046 |
| 2E | | MI | 1664 | 1048 | 2559 | 813 | 2822 | 685 | 2941 | 584 | 3021 | 432 | 3349 | 349 | 1453 |
| 4-#10 | 1.44 | MA | 2405 | 1079 | 3631 | 866 | 4132 | 727 | 4399 | 618 | 4673 | 450 | 5499 | 384 | 2546 |
| 2E | | MI | 1704 | 1079 | 2668 | 829 | 2953 | 695 | 3095 | 590 | 3224 | 428 | 3577 | 335 | 1786 |
| 4-#11 | 1.77 | MA | 2466 | 1112 | 3813 | 879 | 4337 | 736 | 4636 | 621 | 4985 | 444 | 5850 | 369 | 3052 |
| 2E | | MI | 1737 | 1112 | 2782 | 839 | 3075 | 701 | 3233 | 591 | 3376 | 414 | 3723 | 307 | 2119 |
| 4-#14 | 2.56 | MA | 2625 | 1190 | 4218 | 923 | 4834 | 767 | 5231 | 639 | 5784 | 436 | 6833 | 345 | 4257 |
| 2E | | MI | 1827 | 1190 | 3034 | 880 | 3381 | 730 | 3597 | 608 | 3823 | 397 | 4211 | 259 | 2895 |
| 4-#18 | 4.55 | MA | 2994 | 1390 | 5192 | 1036 | 6040 | 848 | 6678 | 688 | 7729 | 418 | 9116 | 271 | 7155 |
| 2E | | MI | 2026 | 1390 | 3625 | 990 | 4102 | 808 | 4423 | 646 | 4833 | 345 | 5262 | 117 | 4702 |
| 6-#7 | 1.02 | MA | 2315 | 1036 | 3391 | 847 | 3852 | 715 | 4072 | 611 | 4241 | 458 | 4961 | 398 | 1864 |
| 2L-3S | | MI | 1592 | 1036 | 2390 | 816 | 2623 | 687 | 2705 | 591 | 2708 | 440 | 2992 | 318 | 1339 |
| 6-#7 | 1.02 | MA | 2218 | 1036 | 3205 | 852 | 3615 | 719 | 3784 | 619 | 3852 | 463 | 4423 | 355 | 1874 |
| 3L-2S | | MI | 1653 | 1036 | 2512 | 813 | 2778 | 685 | 2894 | 586 | 2963 | 437 | 3308 | 361 | 1329 |
| 6-#8 | 1.35 | MA | 2391 | 1069 | 3572 | 865 | 4074 | 727 | 4337 | 619 | 4597 | 454 | 5434 | 392 | 2401 |
| 2L-3S | | MI | 1620 | 1069 | 2471 | 833 | 2719 | 699 | 2818 | 599 | 2859 | 437 | 3166 | 291 | 1703 |
| 6-#8 | 1.35 | MA | 2267 | 1069 | 3328 | 871 | 3764 | 732 | 3961 | 628 | 4088 | 462 | 4736 | 335 | 2412 |
| 3L-2S | | MI | 1698 | 1069 | 2630 | 830 | 2921 | 697 | 3064 | 593 | 3190 | 433 | 3572 | 347 | 1690 |
| 6-#9 | 1.70 | MA | 2473 | 1105 | 3768 | 885 | 4315 | 742 | 4626 | 627 | 4985 | 451 | 5944 | 385 | 2984 |
| 2L-3S | | MI | 1651 | 1105 | 2559 | 853 | 2822 | 713 | 2941 | 607 | 3021 | 433 | 3349 | 260 | 2093 |
| 6-#9 | 1.70 | MA | 2320 | 1105 | 3463 | 892 | 3926 | 747 | 4154 | 639 | 4345 | 460 | 5074 | 313 | 2992 |
| 3L-2S | | MI | 1747 | 1105 | 2757 | 849 | 3075 | 710 | 3247 | 600 | 3437 | 429 | 3851 | 332 | 2077 |
| 6-#10 | 2.16 | MA | 2574 | 1151 | 4016 | 911 | 4621 | 760 | 4994 | 638 | 5478 | 446 | 6586 | 375 | 3721 |
| 2L-3S | | MI | 1689 | 1151 | 2668 | 879 | 2953 | 731 | 3095 | 619 | 3224 | 427 | 3577 | 219 | 2576 |
| 6-#10 | 2.16 | MA | 2386 | 1151 | 3631 | 920 | 4132 | 767 | 4399 | 652 | 4673 | 457 | 5499 | 284 | 3718 |
| 3L-2S | | MI | 1807 | 1151 | 2917 | 874 | 3270 | 728 | 3480 | 610 | 3744 | 423 | 4197 | 310 | 2561 |
| 6-#11 | 2.66 | MA | 2664 | 1201 | 4275 | 935 | 4925 | 776 | 5350 | 646 | 5951 | 439 | 7124 | 354 | 4460 |
| 2L-3S | | MI | 1720 | 1201 | 2782 | 898 | 3075 | 743 | 3233 | 625 | 3376 | 411 | 3723 | 159 | 3045 |
| 6-#11 | 2.66 | MA | 2446 | 1201 | 3813 | 944 | 4337 | 784 | 4636 | 662 | 4985 | 450 | 5850 | 242 | 4442 |
| 3L-2S | | MI | 1855 | 1201 | 3076 | 894 | 3450 | 742 | 3689 | 616 | 3977 | 406 | 4427 | 271 | 3033 |
| 6-#14 | 3.84 | MA | 2897 | 1319 | 4873 | 1003 | 5668 | 825 | 6243 | 676 | 7154 | 429 | 8607 | 319 | 6239 |
| 2L-3S | | MI | 1813 | 1319 | 3034 | 965 | 3381 | 788 | 3597 | 654 | 3823 | 390 | 4211 | 40 | 4119 |

## RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis



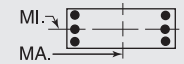

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 3.84 | MA | 2603 | 1319 | 4218 | 1016 | 4834 | 835 | 5231 | 697 | 5784 | 444 | 6833 | 157 | 6151 |
| 3L-2S | | MI | 1986 | 1319 | 3448 | 960 | 3908 | 789 | 4237 | 644 | 4653 | 382 | 5168 | 202 | 4164 |
| 6-#18 | 6.82 | MA | 3010 | 1619 | 5192 | 1198 | 6040 | 965 | 6678 | 785 | 7729 | 425 | 9116 | -77 | 8995 |
| 3L-2S | | MI | 2283 | 1619 | 4320 | 1132 | 4988 | 912 | 5481 | 707 | 6177 | 309 | 6762 | -7 | 6758 |
| 8-#7 | 1.36 | MA | 2400 | 1071 | 3577 | 869 | 4089 | 730 | 4360 | 621 | 4631 | 456 | 5499 | 395 | 2436 |
| 2L-4S | | MI | 1612 | 1071 | 2426 | 840 | 2657 | 708 | 2746 | 601 | 2769 | 441 | 3082 | 287 | 1734 |
| 8-#7 | 1.36 | MA | 2305 | 1071 | 3391 | 873 | 3852 | 734 | 4072 | 628 | 4241 | 461 | 4961 | 352 | 2444 |
| 3E | | MI | 1645 | 1071 | 2512 | 837 | 2778 | 703 | 2894 | 600 | 2963 | 438 | 3308 | 308 | 1723 |
| 8-#7 | 1.36 | MA | 2255 | 1071 | 3263 | 878 | 3671 | 742 | 3850 | 632 | 3938 | 463 | 4584 | 327 | 2448 |
| 4L-2S | | MI | 1705 | 1071 | 2634 | 834 | 2933 | 701 | 3082 | 596 | 3218 | 435 | 3623 | 351 | 1713 |
| 8-#8 | 1.80 | MA | 2500 | 1114 | 3815 | 893 | 4383 | 748 | 4713 | 632 | 5106 | 452 | 6132 | 388 | 3145 |
| 2L-4S | | MI | 1646 | 1114 | 2518 | 865 | 2763 | 727 | 2871 | 612 | 2936 | 437 | 3280 | 251 | 2204 |
| 8-#8 | 1.80 | MA | 2379 | 1114 | 3572 | 899 | 4074 | 753 | 4337 | 641 | 4597 | 459 | 5434 | 331 | 3151 |
| 3E | | MI | 1689 | 1114 | 2630 | 861 | 2921 | 720 | 3064 | 611 | 3190 | 434 | 3572 | 277 | 2195 |
| 8-#8 | 1.80 | MA | 2315 | 1114 | 3404 | 905 | 3837 | 763 | 4047 | 645 | 4200 | 461 | 4945 | 298 | 3140 |
| 4L-2S | | MI | 1765 | 1114 | 2789 | 858 | 3123 | 718 | 3309 | 605 | 3522 | 431 | 3977 | 334 | 2184 |
| 8-#9 | 2.27 | MA | 2606 | 1162 | 4074 | 921 | 4704 | 767 | 5098 | 643 | 5624 | 447 | 6815 | 379 | 3915 |
| 2L-4S | | MI | 1684 | 1162 | 2616 | 893 | 2877 | 748 | 3005 | 624 | 3118 | 433 | 3489 | 209 | 2688 |
| 8-#9 | 2.27 | MA | 2459 | 1162 | 3768 | 928 | 4315 | 773 | 4626 | 655 | 4985 | 456 | 5944 | 307 | 3913 |
| 3E | | MI | 1736 | 1162 | 2757 | 889 | 3075 | 739 | 3247 | 623 | 3437 | 429 | 3851 | 242 | 2701 |
| 8-#9 | 2.27 | MA | 2381 | 1162 | 3557 | 935 | 4018 | 786 | 4261 | 659 | 4485 | 459 | 5333 | 266 | 3874 |
| 4L-2S | | MI | 1829 | 1162 | 2956 | 884 | 3328 | 736 | 3554 | 616 | 3852 | 426 | 4352 | 314 | 2691 |
| 8-#10 | 2.89 | MA | 2739 | 1224 | 4401 | 957 | 5111 | 793 | 5589 | 659 | 6284 | 442 | 7673 | 366 | 4889 |
| 2L-4S | | MI | 1731 | 1224 | 2739 | 929 | 3021 | 774 | 3176 | 640 | 3345 | 427 | 3748 | 154 | 3182 |
| 8-#10 | 2.89 | MA | 2560 | 1224 | 4016 | 965 | 4621 | 800 | 4994 | 673 | 5478 | 453 | 6586 | 275 | 4871 |
| 3E | | MI | 1795 | 1224 | 2917 | 924 | 3270 | 764 | 3480 | 639 | 3744 | 423 | 4197 | 195 | 3329 |
| 8-#10 | 2.89 | MA | 2464 | 1224 | 3749 | 974 | 4246 | 816 | 4533 | 678 | 4849 | 455 | 5821 | 224 | 4653 |
| 4L-2S | | MI | 1908 | 1224 | 3165 | 919 | 3586 | 761 | 3865 | 631 | 4263 | 419 | 4816 | 286 | 3325 |
| 8-#11 | 3.55 | MA | 2649 | 1290 | 4275 | 1000 | 4925 | 824 | 5350 | 688 | 5951 | 445 | 7124 | 227 | 5819 |
| 3E | | MI | 1847 | 1290 | 3076 | 954 | 3450 | 783 | 3689 | 650 | 3977 | 403 | 4427 | 123 | 3929 |
| 8-#11 | 3.55 | MA | 2538 | 1290 | 3953 | 1010 | 4472 | 842 | 4795 | 693 | 5192 | 447 | 6223 | 166 | 5382 |
| 4L-2S | | MI | 1970 | 1290 | 3371 | 950 | 3826 | 782 | 4145 | 642 | 4578 | 398 | 5131 | 235 | 3935 |
| 8-#14 | 5.11 | MA | 2887 | 1447 | 4873 | 1096 | 5668 | 893 | 6243 | 734 | 7154 | 436 | 8607 | 132 | 8091 |
| 3E | | MI | 1982 | 1447 | 3448 | 1045 | 3908 | 847 | 4237 | 691 | 4653 | 375 | 5168 | -18 | 5158 |
| 8-#14 | 5.11 | MA | 2738 | 1447 | 4414 | 1109 | 5024 | 918 | 5454 | 740 | 6075 | 436 | 7347 | 48 | 7119 |
| 4L-2S | | MI | 2143 | 1447 | 3862 | 1041 | 4435 | 847 | 4877 | 681 | 5482 | 368 | 6125 | 144 | 5416 |
| 10-#10 | 3.61 | MA | 2729 | 1296 | 4401 | 1011 | 5111 | 833 | 5589 | 693 | 6284 | 449 | 7673 | 266 | 6021 |
| 3L-4S | | MI | 1838 | 1296 | 2988 | 974 | 3338 | 807 | 3560 | 660 | 3864 | 423 | 4368 | 129 | 3877 |
| 10-#10 | 3.61 | MA | 2641 | 1296 | 4134 | 1020 | 4736 | 849 | 5128 | 699 | 5654 | 451 | 6908 | 215 | 5752 |
| 4L-3S | | MI | 1899 | 1296 | 3165 | 969 | 3586 | 796 | 3865 | 660 | 4263 | 418 | 4816 | 170 | 4075 |
| 10-#10 | 3.61 | MA | 2516 | 1296 | 3861 | 1037 | 4407 | 856 | 4720 | 713 | 5086 | 462 | 6145 | 162 | 5427 |
| 5L-2S | | MI | 2007 | 1296 | 3414 | 964 | 3903 | 794 | 4249 | 651 | 4782 | 414 | 5436 | 262 | 4082 |
| 10-#11 | 4.43 | MA | 2746 | 1379 | 4414 | 1066 | 5060 | 883 | 5509 | 718 | 6159 | 441 | 7497 | 152 | 6704 |
| 4L-3S | | MI | 1967 | 1379 | 3371 | 1010 | 3826 | 824 | 4145 | 675 | 4578 | 395 | 5131 | 88 | 4808 |
| 10-#11 | 4.43 | MA | 2603 | 1379 | 4085 | 1086 | 4663 | 890 | 5016 | 734 | 5473 | 453 | 6603 | 86 | 6291 |
| 5L-2S | | MI | 2084 | 1379 | 3666 | 1006 | 4201 | 823 | 4600 | 667 | 5180 | 390 | 5835 | 200 | 4829 |
| 10-#14 | 6.39 | MA | 3029 | 1576 | 5069 | 1190 | 5857 | 976 | 6467 | 777 | 7445 | 429 | 9121 | 22 | 9010 |
| 4L-3S | | MI | 2147 | 1576 | 3862 | 1125 | 4435 | 905 | 4877 | 727 | 5482 | 361 | 6125 | -75 | 6068 |
| 12-#10 | 4.33 | MA | 2813 | 1369 | 4519 | 1065 | 5226 | 882 | 5723 | 720 | 6459 | 447 | 7995 | 205 | 6859 |
| 4E | | MI | 1944 | 1369 | 3237 | 1019 | 3655 | 840 | 3945 | 681 | 4383 | 418 | 4987 | 105 | 4579 |
| 12-#10 | 4.33 | MA | 2690 | 1369 | 4246 | 1082 | 4897 | 889 | 5315 | 734 | 5891 | 458 | 7232 | 153 | 6552 |
| 5L-3S | | MI | 2006 | 1369 | 3414 | 1015 | 3903 | 829 | 4249 | 681 | 4782 | 414 | 5436 | 146 | 4818 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

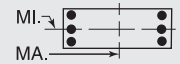
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 4.33 | MA | 2567 | 1369 | 4008 | 1090 | 4573 | 905 | 4913 | 739 | 5348 | 469 | 6533 | 94 | 6096 |
| 6L-2S | | MI | 2104 | 1369 | 3663 | 1010 | 4220 | 827 | 4634 | 672 | 5301 | 410 | 6056 | 237 | 4835 |
| 12-#11 | 5.32 | MA | 2808 | 1468 | 4546 | 1141 | 5251 | 931 | 5730 | 760 | 6440 | 448 | 7876 | 71 | 7605 |
| 5L-3S | | MI | 2085 | 1468 | 3666 | 1065 | 4201 | 864 | 4600 | 701 | 5180 | 387 | 5835 | 52 | 5675 |
| 14-#10 | 5.05 | MA | 2860 | 1441 | 4631 | 1127 | 5387 | 922 | 5910 | 754 | 6697 | 454 | 8319 | 144 | 7681 |
| 5L-4S | | MI | 2057 | 1441 | 3486 | 1065 | 3971 | 873 | 4330 | 701 | 4902 | 414 | 5607 | 81 | 5287 |
| 14-#10 | 5.05 | MA | 2743 | 1441 | 4393 | 1135 | 5063 | 938 | 5508 | 760 | 6154 | 464 | 7620 | 85 | 7214 |
| 6L-3S | | MI | 2106 | 1441 | 3663 | 1060 | 4220 | 862 | 4634 | 701 | 5301 | 409 | 6056 | 122 | 5560 |
| 16-#10 | 5.77 | MA | 2915 | 1514 | 4778 | 1181 | 5552 | 971 | 6103 | 780 | 6959 | 460 | 8707 | 76 | 8335 |
| 6L-4S | | MI | 2160 | 1514 | 3734 | 1110 | 4288 | 906 | 4715 | 722 | 5421 | 409 | 6227 | 56 | 5999 |

## RECTANGULAR TIED COLUMNS 16" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.04 | MA | 2766 | 1133 | 4040 | 929 | 4602 | 783 | 4874 | 670 | 5090 | 501 | 5971 | 436 | 2262 |
| 2E | | MI | 1800 | 1133 | 2755 | 881 | 3033 | 742 | 3152 | 634 | 3221 | 472 | 3563 | 384 | 1470 |
| 4-#10 | 1.32 | MA | 2845 | 1163 | 4229 | 946 | 4833 | 795 | 5149 | 677 | 5459 | 498 | 6476 | 432 | 2820 |
| 2E | | MI | 1841 | 1163 | 2865 | 896 | 3164 | 752 | 3306 | 640 | 3423 | 467 | 3790 | 369 | 1806 |
| 4-#11 | 1.63 | MA | 2916 | 1197 | 4436 | 958 | 5067 | 803 | 5419 | 680 | 5813 | 491 | 6895 | 419 | 3389 |
| 2E | | MI | 1874 | 1197 | 2981 | 905 | 3286 | 758 | 3444 | 640 | 3573 | 453 | 3933 | 341 | 2143 |
| 4-#14 | 2.34 | MA | 3099 | 1275 | 4893 | 1002 | 5628 | 834 | 6091 | 699 | 6714 | 483 | 8047 | 399 | 4743 |
| 2E | | MI | 1964 | 1275 | 3235 | 945 | 3593 | 786 | 3808 | 656 | 4020 | 436 | 4420 | 293 | 2925 |
| 4-#18 | 4.17 | MA | 3526 | 1475 | 5998 | 1116 | 6995 | 916 | 7732 | 747 | 8921 | 465 | 10750 | 338 | 8019 |
| 2E | | MI | 2163 | 1475 | 3828 | 1054 | 4314 | 863 | 4633 | 693 | 5027 | 383 | 5468 | 150 | 4745 |
| 6-#8 | 1.23 | MA | 2828 | 1154 | 4161 | 945 | 4766 | 795 | 5078 | 678 | 5370 | 501 | 6361 | 436 | 2657 |
| 2L-3S | | MI | 1756 | 1154 | 2667 | 901 | 2929 | 757 | 3030 | 649 | 3058 | 477 | 3380 | 326 | 1721 |
| 6-#8 | 1.23 | MA | 2687 | 1154 | 3890 | 951 | 4421 | 801 | 4658 | 683 | 4802 | 509 | 5574 | 380 | 2668 |
| 3L-2S | | MI | 1835 | 1154 | 2826 | 898 | 3131 | 755 | 3275 | 643 | 3390 | 473 | 3786 | 383 | 1707 |
| 6-#9 | 1.56 | MA | 2921 | 1190 | 4381 | 965 | 5037 | 809 | 5402 | 686 | 5805 | 498 | 6960 | 432 | 3308 |
| 2L-3S | | MI | 1787 | 1190 | 2755 | 920 | 3033 | 770 | 3152 | 657 | 3221 | 473 | 3563 | 295 | 2114 |
| 6-#9 | 1.56 | MA | 2748 | 1190 | 4040 | 973 | 4602 | 816 | 4874 | 692 | 5090 | 508 | 5971 | 360 | 3316 |
| 3L-2S | | MI | 1883 | 1190 | 2954 | 916 | 3286 | 768 | 3459 | 650 | 3636 | 469 | 4064 | 367 | 2097 |
| 6-#10 | 1.98 | MA | 3037 | 1236 | 4660 | 991 | 5381 | 828 | 5814 | 697 | 6359 | 493 | 7721 | 426 | 4133 |
| 2L-3S | | MI | 1825 | 1236 | 2865 | 946 | 3164 | 788 | 3306 | 669 | 3423 | 467 | 3790 | 254 | 2601 |
| 6-#10 | 1.98 | MA | 2824 | 1236 | 4229 | 1001 | 4833 | 836 | 5149 | 713 | 5459 | 506 | 6476 | 335 | 4130 |
| 3L-2S | | MI | 1943 | 1236 | 3114 | 941 | 3481 | 785 | 3691 | 660 | 3942 | 463 | 4409 | 345 | 2584 |
| 6-#11 | 2.44 | MA | 3142 | 1286 | 4953 | 1014 | 5726 | 844 | 6219 | 706 | 6896 | 486 | 8363 | 408 | 4965 |
| 2L-3S | | MI | 1856 | 1286 | 2981 | 965 | 3286 | 799 | 3444 | 674 | 3573 | 450 | 3933 | 193 | 3079 |
| 6-#11 | 2.44 | MA | 2893 | 1286 | 4436 | 1025 | 5067 | 853 | 5419 | 723 | 5813 | 499 | 6895 | 296 | 4948 |
| 3L-2S | | MI | 1992 | 1286 | 3276 | 960 | 3662 | 798 | 3900 | 666 | 4175 | 445 | 4637 | 305 | 3061 |
| 6-#14 | 3.52 | MA | 3410 | 1404 | 5628 | 1082 | 6564 | 893 | 7227 | 735 | 8253 | 476 | 10098 | 380 | 6968 |
| 2L-3S | | MI | 1948 | 1404 | 3235 | 1030 | 3593 | 844 | 3808 | 703 | 4020 | 428 | 4420 | 74 | 4186 |
| 6-#14 | 3.52 | MA | 3074 | 1404 | 4893 | 1097 | 5628 | 905 | 6091 | 759 | 6714 | 494 | 8047 | 219 | 6880 |
| 3L-2S | | MI | 2124 | 1404 | 3649 | 1026 | 4120 | 845 | 4448 | 693 | 4849 | 421 | 5377 | 236 | 4198 |
| 6-#18 | 6.25 | MA | 3513 | 1704 | 5998 | 1282 | 6995 | 1037 | 7732 | 849 | 8921 | 478 | 10750 | 4 | 10737 |
| 3L-2S | | MI | 2421 | 1704 | 4523 | 1196 | 5200 | 966 | 5690 | 754 | 6372 | 347 | 6967 | 26 | 6844 |
| 8-#7 | 1.25 | MA | 2837 | 1155 | 4166 | 948 | 4782 | 798 | 5102 | 680 | 5406 | 503 | 6414 | 437 | 2696 |
| 2L-4S | | MI | 1747 | 1155 | 2621 | 908 | 2868 | 766 | 2958 | 652 | 2969 | 481 | 3296 | 323 | 1752 |
| 8-#7 | 1.25 | MA | 2730 | 1155 | 3959 | 953 | 4518 | 802 | 4781 | 684 | 4972 | 509 | 5812 | 395 | 2703 |
| 3E | | MI | 1781 | 1155 | 2707 | 905 | 2988 | 761 | 3106 | 651 | 3163 | 478 | 3523 | 344 | 1740 |
| 8-#7 | 1.25 | MA | 2673 | 1155 | 3816 | 958 | 4318 | 811 | 4535 | 692 | 4635 | 511 | 5397 | 370 | 2707 |
| 4L-2S | | MI | 1841 | 1155 | 2829 | 902 | 3143 | 759 | 3294 | 646 | 3418 | 475 | 3838 | 387 | 1730 |
| 8-#8 | 1.65 | MA | 2951 | 1199 | 4432 | 973 | 5112 | 816 | 5497 | 691 | 5938 | 499 | 7147 | 432 | 3486 |
| 2L-4S | | MI | 1782 | 1199 | 2713 | 933 | 2974 | 785 | 3082 | 662 | 3136 | 477 | 3494 | 286 | 2227 |
| 8-#8 | 1.65 | MA | 2815 | 1199 | 4161 | 979 | 4766 | 821 | 5078 | 695 | 5370 | 507 | 6361 | 376 | 3492 |
| 3E | | MI | 1825 | 1199 | 2826 | 929 | 3131 | 778 | 3275 | 662 | 3390 | 474 | 3786 | 313 | 2216 |
| 8-#8 | 1.65 | MA | 2743 | 1199 | 3975 | 986 | 4504 | 832 | 4756 | 705 | 4929 | 510 | 5815 | 344 | 3481 |
| 4L-2S | | MI | 1901 | 1199 | 2984 | 926 | 3333 | 775 | 3520 | 656 | 3722 | 471 | 4191 | 369 | 2204 |

## RECTANGULAR TIED COLUMNS 16" x 24"

Short columns – no sidesway
Bending on major or minor axis

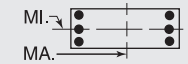



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 2.08 | MA | 3073 | 1247 | 4722 | 1000 | 5471 | 835 | 5929 | 703 | 6519 | 494 | 7949 | 427 | 4347 |
| 2L-4S | | MI | 1819 | 1247 | 2813 | 960 | 3088 | 805 | 3217 | 674 | 3317 | 473 | 3702 | 244 | 2729 |
| 8-#9 | 2.08 | MA | 2906 | 1247 | 4381 | 1008 | 5037 | 842 | 5402 | 708 | 5805 | 504 | 6960 | 356 | 4345 |
| 3E | | MI | 1872 | 1247 | 2954 | 956 | 3286 | 796 | 3459 | 674 | 3636 | 469 | 4064 | 277 | 2725 |
| 8-#9 | 2.08 | MA | 2818 | 1247 | 4146 | 1016 | 4706 | 855 | 4996 | 720 | 5249 | 508 | 6271 | 314 | 4306 |
| 4L-2S | | MI | 1965 | 1247 | 3152 | 952 | 3538 | 794 | 3766 | 666 | 4051 | 466 | 4565 | 349 | 2713 |
| 8-#10 | 2.65 | MA | 3225 | 1308 | 5090 | 1036 | 5928 | 861 | 6479 | 718 | 7259 | 489 | 8966 | 420 | 5438 |
| 2L-4S | | MI | 1866 | 1308 | 2936 | 996 | 3232 | 832 | 3387 | 689 | 3544 | 467 | 3961 | 188 | 3257 |
| 8-#10 | 2.65 | MA | 3021 | 1308 | 4660 | 1046 | 5381 | 869 | 5814 | 733 | 6359 | 501 | 7721 | 329 | 5419 |
| 3E | | MI | 1930 | 1308 | 3114 | 991 | 3481 | 821 | 3691 | 689 | 3942 | 463 | 4409 | 229 | 3359 |
| 8-#10 | 2.65 | MA | 2914 | 1308 | 4363 | 1056 | 4963 | 886 | 5302 | 740 | 5658 | 505 | 6849 | 276 | 5253 |
| 4L-2S | | MI | 2045 | 1308 | 3363 | 986 | 3797 | 818 | 4076 | 681 | 4461 | 458 | 5029 | 321 | 3350 |
| 8-#11 | 3.25 | MA | 3125 | 1375 | 4953 | 1081 | 5726 | 893 | 6219 | 748 | 6896 | 494 | 8363 | 285 | 6493 |
| 3E | | MI | 1982 | 1375 | 3276 | 1020 | 3662 | 840 | 3900 | 699 | 4175 | 442 | 4637 | 158 | 3968 |
| 8-#11 | 3.25 | MA | 3000 | 1375 | 4595 | 1092 | 5221 | 913 | 5601 | 756 | 6049 | 498 | 7331 | 222 | 6086 |
| 4L-2S | | MI | 2108 | 1375 | 3570 | 1016 | 4037 | 838 | 4356 | 691 | 4776 | 437 | 5341 | 270 | 3966 |
| 8-#14 | 4.69 | MA | 3398 | 1532 | 5628 | 1178 | 6564 | 963 | 7227 | 795 | 8253 | 486 | 10098 | 200 | 9063 |
| 3E | | MI | 2117 | 1532 | 3649 | 1111 | 4120 | 903 | 4448 | 739 | 4849 | 414 | 5377 | 16 | 5335 |
| 8-#14 | 4.69 | MA | 3230 | 1532 | 5117 | 1192 | 5845 | 990 | 6347 | 804 | 7047 | 489 | 8650 | 111 | 8060 |
| 4L-2S | | MI | 2281 | 1532 | 4063 | 1106 | 4646 | 903 | 5088 | 729 | 5679 | 407 | 6334 | 178 | 5455 |
| 10-#10 | 3.31 | MA | 3213 | 1381 | 5090 | 1091 | 5928 | 902 | 6479 | 754 | 7259 | 497 | 8966 | 323 | 6707 |
| 3L-4S | | MI | 1973 | 1381 | 3185 | 1041 | 3549 | 865 | 3772 | 710 | 4063 | 462 | 4580 | 164 | 3950 |
| 10-#10 | 3.31 | MA | 3114 | 1381 | 4793 | 1101 | 5511 | 919 | 5967 | 760 | 6558 | 501 | 8094 | 270 | 6487 |
| 4L-3S | | MI | 2034 | 1381 | 3363 | 1036 | 3797 | 854 | 4076 | 710 | 4461 | 458 | 5029 | 205 | 4108 |
| 10-#10 | 3.31 | MA | 2968 | 1381 | 4490 | 1119 | 5146 | 927 | 5514 | 776 | 5927 | 513 | 7221 | 217 | 6089 |
| 5L-2S | | MI | 2145 | 1381 | 3612 | 1032 | 4114 | 851 | 4461 | 701 | 4981 | 454 | 5649 | 296 | 4110 |
| 10-#11 | 4.06 | MA | 3237 | 1464 | 5112 | 1147 | 5880 | 953 | 6401 | 781 | 7132 | 492 | 8798 | 211 | 7572 |
| 4L-3S | | MI | 2103 | 1464 | 3570 | 1076 | 4037 | 880 | 4356 | 725 | 4776 | 434 | 5341 | 122 | 4849 |
| 10-#11 | 4.06 | MA | 3068 | 1464 | 4745 | 1169 | 5438 | 962 | 5852 | 798 | 6369 | 506 | 7768 | 147 | 7145 |
| 5L-2S | | MI | 2222 | 1464 | 3865 | 1072 | 4412 | 879 | 4811 | 716 | 5377 | 429 | 6045 | 234 | 4863 |
| 10-#14 | 5.86 | MA | 3562 | 1661 | 5852 | 1273 | 6781 | 1048 | 7483 | 841 | 8586 | 482 | 10702 | 92 | 10191 |
| 4L-3S | | MI | 2282 | 1661 | 4063 | 1191 | 4646 | 961 | 5088 | 776 | 5679 | 399 | 6334 | -41 | 6304 |
| 10-#14 | 5.86 | MA | 3329 | 1661 | 5328 | 1303 | 6151 | 1060 | 6700 | 865 | 7498 | 500 | 9262 | -2 | 9260 |
| 5L-2S | | MI | 2436 | 1661 | 4476 | 1186 | 5173 | 961 | 5728 | 766 | 6509 | 392 | 7291 | 121 | 6699 |
| 12-#10 | 3.97 | MA | 3310 | 1453 | 5223 | 1146 | 6058 | 952 | 6633 | 781 | 7458 | 497 | 9339 | 264 | 7727 |
| 4E | | MI | 2079 | 1453 | 3434 | 1086 | 3865 | 897 | 4156 | 731 | 4582 | 458 | 5200 | 140 | 4651 |
| 12-#10 | 3.97 | MA | 3165 | 1453 | 4921 | 1164 | 5694 | 960 | 6179 | 796 | 6827 | 509 | 8466 | 211 | 7350 |
| 5L-3S | | MI | 2142 | 1453 | 3612 | 1082 | 4114 | 887 | 4461 | 730 | 4981 | 454 | 5649 | 181 | 4853 |
| 12-#10 | 3.97 | MA | 3027 | 1453 | 4649 | 1172 | 5334 | 977 | 5733 | 803 | 6224 | 522 | 7668 | 151 | 6889 |
| 6L-2S | | MI | 2243 | 1453 | 3860 | 1077 | 4431 | 884 | 4845 | 722 | 5500 | 449 | 6268 | 272 | 4865 |
| 12-#11 | 4.88 | MA | 3302 | 1553 | 5263 | 1224 | 6097 | 1003 | 6652 | 823 | 7452 | 501 | 9236 | 136 | 8661 |
| 5L-3S | | MI | 2221 | 1553 | 3865 | 1132 | 4412 | 921 | 4811 | 750 | 5377 | 426 | 6045 | 87 | 5727 |
| 12-#11 | 4.88 | MA | 3139 | 1553 | 4942 | 1234 | 5661 | 1022 | 6112 | 831 | 6723 | 514 | 8292 | 63 | 7976 |
| 6L-2S | | MI | 2334 | 1553 | 4160 | 1127 | 4788 | 919 | 5267 | 741 | 5978 | 421 | 6749 | 199 | 5753 |
| 12-#14 | 7.03 | MA | 3655 | 1789 | 6063 | 1383 | 7086 | 1119 | 7837 | 901 | 9036 | 492 | 11314 | -21 | 11276 |
| 5L-3S | | MI | 2445 | 1789 | 4476 | 1271 | 5173 | 1019 | 5728 | 812 | 6509 | 385 | 7291 | -98 | 7206 |
| 14-#10 | 4.63 | MA | 3359 | 1526 | 5351 | 1210 | 6241 | 993 | 6844 | 817 | 7727 | 505 | 9711 | 206 | 8615 |
| 5L-4S | | MI | 2192 | 1526 | 3683 | 1132 | 4182 | 930 | 4541 | 751 | 5101 | 453 | 5820 | 116 | 5357 |
| 14-#10 | 4.63 | MA | 3226 | 1526 | 5079 | 1217 | 5881 | 1010 | 6398 | 824 | 7124 | 517 | 8913 | 145 | 8144 |
| 6L-3S | | MI | 2243 | 1526 | 3860 | 1127 | 4431 | 920 | 4845 | 751 | 5500 | 449 | 6268 | 156 | 5597 |
| 14-#11 | 5.69 | MA | 3375 | 1642 | 5459 | 1290 | 6320 | 1063 | 6912 | 856 | 7806 | 509 | 9760 | 53 | 9487 |
| 6L-3S | | MI | 2338 | 1642 | 4160 | 1187 | 4788 | 961 | 5267 | 775 | 5978 | 418 | 6749 | 51 | 6585 |
| 16-#10 | 5.29 | MA | 3422 | 1598 | 5509 | 1262 | 6429 | 1042 | 7063 | 844 | 8024 | 513 | 10158 | 139 | 9402 |
| 6L-4S | | MI | 2295 | 1598 | 3932 | 1177 | 4499 | 963 | 4926 | 772 | 5620 | 449 | 6439 | 91 | 6068 |

## RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

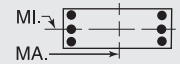
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.22 | MA | 3319 | 1248 | 4867 | 1025 | 5584 | 863 | 5952 | 736 | 6296 | 545 | 7460 | 474 | 3094 |
| 2E | | MI | 1977 | 1248 | 3062 | 963 | 3375 | 810 | 3518 | 690 | 3622 | 507 | 4002 | 404 | 1825 |
| 4-#11 | 1.50 | MA | 3401 | 1281 | 5098 | 1038 | 5845 | 871 | 6254 | 740 | 6693 | 538 | 8000 | 467 | 3726 |
| 2E | | MI | 2010 | 1281 | 3180 | 971 | 3498 | 814 | 3655 | 690 | 3771 | 492 | 4144 | 375 | 2166 |
| 4-#14 | 2.16 | MA | 3609 | 1360 | 5607 | 1082 | 6471 | 902 | 7003 | 758 | 7698 | 530 | 9322 | 451 | 5229 |
| 2E | | MI | 2100 | 1360 | 3436 | 1011 | 3804 | 842 | 4019 | 705 | 4216 | 474 | 4629 | 327 | 2954 |
| 4-#18 | 3.85 | MA | 4094 | 1560 | 6842 | 1195 | 7999 | 984 | 8838 | 806 | 10165 | 512 | 12452 | 402 | 8883 |
| 2E | | MI | 2300 | 1560 | 4031 | 1118 | 4526 | 917 | 4843 | 741 | 5222 | 421 | 5673 | 184 | 4786 |
| 6-#8 | 1.14 | MA | 3300 | 1239 | 4790 | 1024 | 5508 | 863 | 5871 | 737 | 6195 | 548 | 7326 | 477 | 2913 |
| 2L-3S | | MI | 1892 | 1239 | 2863 | 969 | 3140 | 815 | 3242 | 699 | 3258 | 517 | 3594 | 361 | 1738 |
| 6-#8 | 1.14 | MA | 3142 | 1239 | 4490 | 1031 | 5126 | 869 | 5407 | 742 | 5568 | 557 | 6458 | 423 | 2924 |
| 3L-2S | | MI | 1971 | 1239 | 3022 | 965 | 3342 | 813 | 3487 | 693 | 3589 | 513 | 4000 | 418 | 1724 |
| 6-#9 | 1.44 | MA | 3404 | 1275 | 5034 | 1044 | 5808 | 877 | 6230 | 745 | 6677 | 545 | 7990 | 473 | 3632 |
| 2L-3S | | MI | 1922 | 1275 | 2952 | 988 | 3244 | 828 | 3364 | 708 | 3420 | 513 | 3776 | 330 | 2134 |
| 6-#9 | 1.44 | MA | 3210 | 1275 | 4657 | 1053 | 5328 | 885 | 5647 | 752 | 5888 | 556 | 6898 | 404 | 3640 |
| 3L-2S | | MI | 2019 | 1275 | 3150 | 984 | 3496 | 826 | 3670 | 700 | 3835 | 509 | 4277 | 402 | 2116 |
| 6-#10 | 1.83 | MA | 3535 | 1321 | 5343 | 1070 | 6189 | 896 | 6687 | 756 | 7291 | 540 | 8838 | 468 | 4544 |
| 2L-3S | | MI | 1961 | 1321 | 3062 | 1013 | 3375 | 845 | 3518 | 719 | 3622 | 507 | 4002 | 289 | 2626 |
| 6-#10 | 1.83 | MA | 3296 | 1321 | 4867 | 1081 | 5584 | 905 | 5952 | 764 | 6296 | 554 | 7460 | 379 | 4541 |
| 3L-2S | | MI | 2080 | 1321 | 3311 | 1008 | 3691 | 843 | 3903 | 710 | 4141 | 503 | 4622 | 380 | 2606 |
| 6-#11 | 2.25 | MA | 3655 | 1370 | 5671 | 1094 | 6575 | 912 | 7141 | 765 | 7893 | 533 | 9661 | 460 | 5471 |
| 2L-3S | | MI | 1991 | 1370 | 3180 | 1031 | 3498 | 856 | 3655 | 723 | 3771 | 489 | 4144 | 227 | 3109 |
| 6-#11 | 2.25 | MA | 3375 | 1370 | 5098 | 1106 | 5845 | 922 | 6254 | 784 | 6693 | 548 | 8000 | 348 | 5453 |
| 3L-2S | | MI | 2129 | 1370 | 3475 | 1026 | 3873 | 854 | 4111 | 715 | 4372 | 484 | 4848 | 340 | 3088 |
| 6-#14 | 3.25 | MA | 3959 | 1489 | 6422 | 1162 | 7509 | 961 | 8264 | 794 | 9404 | 523 | 11653 | 438 | 7697 |
| 2L-3S | | MI | 2083 | 1489 | 3436 | 1096 | 3804 | 900 | 4019 | 751 | 4216 | 467 | 4629 | 108 | 4231 |
| 6-#14 | 3.25 | MA | 3580 | 1489 | 5607 | 1178 | 6471 | 974 | 7003 | 820 | 7698 | 543 | 9322 | 276 | 7609 |
| 3L-2S | | MI | 2261 | 1489 | 3850 | 1091 | 4331 | 900 | 4659 | 742 | 5046 | 460 | 5586 | 270 | 4232 |
| 6-#18 | 5.77 | MA | 4078 | 1788 | 6842 | 1364 | 7999 | 1108 | 8838 | 913 | 10165 | 530 | 12452 | 79 | 12197 |
| 3L-2S | | MI | 2558 | 1788 | 4726 | 1260 | 5412 | 1021 | 5900 | 802 | 6567 | 385 | 7173 | 60 | 6892 |
| 8-#7 | 1.15 | MA | 3310 | 1240 | 4795 | 1028 | 5524 | 866 | 5896 | 740 | 6234 | 550 | 7383 | 478 | 2955 |
| 2L-4S | | MI | 1883 | 1240 | 2816 | 976 | 3078 | 825 | 3169 | 702 | 3168 | 521 | 3511 | 358 | 1768 |
| 8-#7 | 1.15 | MA | 3189 | 1240 | 4566 | 1033 | 5233 | 871 | 5542 | 744 | 5755 | 557 | 6720 | 437 | 2962 |
| 3E | | MI | 1916 | 1240 | 2902 | 973 | 3199 | 819 | 3317 | 702 | 3363 | 519 | 3737 | 379 | 1756 |
| 8-#7 | 1.15 | MA | 3126 | 1240 | 4410 | 1038 | 5013 | 879 | 5272 | 752 | 5385 | 560 | 6267 | 413 | 2966 |
| 4L-2S | | MI | 1977 | 1240 | 3024 | 970 | 3354 | 817 | 3506 | 697 | 3618 | 516 | 4053 | 422 | 1746 |
| 8-#8 | 1.52 | MA | 3438 | 1284 | 5089 | 1053 | 5889 | 884 | 6334 | 750 | 6822 | 546 | 8194 | 473 | 3828 |
| 2L-4S | | MI | 1917 | 1284 | 2909 | 1000 | 3184 | 843 | 3294 | 713 | 3336 | 517 | 3708 | 321 | 2249 |
| 8-#8 | 1.52 | MA | 3284 | 1284 | 4790 | 1059 | 5508 | 890 | 5871 | 755 | 6195 | 555 | 7326 | 419 | 3833 |
| 3E | | MI | 1960 | 1284 | 3022 | 997 | 3342 | 835 | 3487 | 712 | 3589 | 514 | 4000 | 348 | 2235 |
| 8-#8 | 1.52 | MA | 3204 | 1284 | 4585 | 1066 | 5219 | 901 | 5517 | 766 | 5710 | 558 | 6731 | 387 | 3822 |
| 4L-2S | | MI | 2037 | 1284 | 3180 | 994 | 3544 | 833 | 3732 | 706 | 3921 | 511 | 4405 | 405 | 2223 |
| 8-#9 | 1.92 | MA | 3575 | 1332 | 5411 | 1080 | 6287 | 903 | 6813 | 762 | 7466 | 541 | 9083 | 468 | 4779 |
| 2L-4S | | MI | 1954 | 1332 | 3009 | 1027 | 3299 | 863 | 3428 | 724 | 3517 | 513 | 3916 | 279 | 2757 |
| 8-#9 | 1.92 | MA | 3387 | 1332 | 5034 | 1088 | 5808 | 911 | 6230 | 768 | 6677 | 552 | 7990 | 399 | 4777 |
| 3E | | MI | 2007 | 1332 | 3150 | 1023 | 3496 | 854 | 3670 | 724 | 3835 | 509 | 4277 | 312 | 2748 |
| 8-#9 | 1.92 | MA | 3289 | 1332 | 4776 | 1097 | 5444 | 925 | 5784 | 781 | 6066 | 557 | 7238 | 358 | 4738 |
| 4L-2S | | MI | 2102 | 1332 | 3349 | 1019 | 3749 | 851 | 3977 | 717 | 4250 | 506 | 4779 | 384 | 2735 |
| 8-#10 | 2.44 | MA | 3746 | 1393 | 5818 | 1116 | 6794 | 929 | 7422 | 777 | 8286 | 536 | 10215 | 462 | 5986 |
| 2L-4S | | MI | 2001 | 1393 | 3134 | 1063 | 3443 | 889 | 3598 | 739 | 3742 | 507 | 4173 | 223 | 3329 |
| 8-#10 | 2.44 | MA | 3517 | 1393 | 5343 | 1126 | 6189 | 938 | 6687 | 785 | 7291 | 550 | 8838 | 373 | 5968 |
| 3E | | MI | 2066 | 1393 | 3311 | 1058 | 3691 | 878 | 3903 | 739 | 4141 | 502 | 4622 | 264 | 3387 |
| 8-#10 | 2.44 | MA | 3397 | 1393 | 5017 | 1137 | 5729 | 955 | 6124 | 801 | 6519 | 555 | 7885 | 321 | 5867 |
| 4L-2S | | MI | 2182 | 1393 | 3560 | 1053 | 4008 | 876 | 4287 | 731 | 4660 | 498 | 5242 | 356 | 3375 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

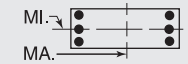
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 3.00 | MA | 3636 | 1460 | 5671 | 1161 | 6575 | 962 | 7141 | 809 | 7893 | 543 | 9661 | 340 | 7167 |
| 3E | | MI | 2118 | 1460 | 3475 | 1086 | 3873 | 896 | 4111 | 748 | 4372 | 481 | 4848 | 192 | 4004 |
| 8-#11 | 3.00 | MA | 3496 | 1460 | 5276 | 1173 | 6019 | 983 | 6459 | 817 | 6959 | 548 | 8499 | 275 | 6803 |
| 4L-2S | | MI | 2245 | 1460 | 3770 | 1082 | 4248 | 895 | 4567 | 740 | 4973 | 476 | 5552 | 304 | 3996 |
| 8-#14 | 4.33 | MA | 3945 | 1617 | 6422 | 1259 | 7509 | 1033 | 8264 | 856 | 9404 | 536 | 11653 | 263 | 10035 |
| 3E | | MI | 2252 | 1617 | 3850 | 1176 | 4331 | 958 | 4659 | 788 | 5046 | 453 | 5586 | 50 | 5453 |
| 8-#14 | 4.33 | MA | 3757 | 1617 | 5859 | 1275 | 6716 | 1061 | 7291 | 867 | 8073 | 541 | 10017 | 171 | 9019 |
| 4L-2S | | MI | 2419 | 1617 | 4263 | 1171 | 4858 | 959 | 5299 | 778 | 5876 | 445 | 6543 | 212 | 5492 |
| 8-#18 | 7.69 | MA | 4397 | 2017 | 7271 | 1533 | 8414 | 1259 | 9327 | 993 | 10801 | 521 | 13601 | -113 | 13370 |
| 4L-2S | | MI | 2814 | 2017 | 5422 | 1403 | 6297 | 1125 | 6957 | 863 | 7912 | 349 | 8673 | -65 | 8627 |
| 10-#10 | 3.05 | MA | 3733 | 1466 | 5818 | 1171 | 6794 | 971 | 7422 | 805 | 8286 | 546 | 10215 | 367 | 7393 |
| 3L-4S | | MI | 2108 | 1466 | 3383 | 1108 | 3760 | 922 | 3983 | 760 | 4262 | 502 | 4793 | 199 | 4021 |
| 10-#10 | 3.05 | MA | 3622 | 1466 | 5492 | 1182 | 6335 | 988 | 6859 | 822 | 7514 | 551 | 9262 | 315 | 7235 |
| 4L-3S | | MI | 2170 | 1466 | 3560 | 1103 | 4008 | 911 | 4287 | 760 | 4660 | 498 | 5242 | 240 | 4140 |
| 10-#10 | 3.05 | MA | 3455 | 1466 | 5160 | 1201 | 5934 | 997 | 6360 | 829 | 6821 | 564 | 8304 | 266 | 6759 |
| 5L-2S | | MI | 2283 | 1466 | 3809 | 1099 | 4325 | 908 | 4672 | 751 | 5179 | 494 | 5861 | 331 | 4136 |
| 10-#11 | 3.75 | MA | 3763 | 1549 | 5849 | 1229 | 6749 | 1023 | 7345 | 843 | 8159 | 543 | 10159 | 268 | 8455 |
| 4L-3S | | MI | 2238 | 1549 | 3770 | 1142 | 4248 | 936 | 4567 | 774 | 4973 | 473 | 5552 | 156 | 4889 |
| 10-#11 | 3.75 | MA | 3568 | 1549 | 5446 | 1251 | 6263 | 1034 | 6741 | 861 | 7318 | 558 | 8995 | 204 | 7944 |
| 5L-2S | | MI | 2360 | 1549 | 4064 | 1138 | 4624 | 935 | 5023 | 765 | 5575 | 468 | 6256 | 269 | 4895 |
| 10-#14 | 5.41 | MA | 4130 | 1746 | 6674 | 1355 | 7754 | 1120 | 8552 | 904 | 9779 | 534 | 12348 | 157 | 11391 |
| 4L-3S | | MI | 2418 | 1746 | 4263 | 1256 | 4858 | 1017 | 5299 | 824 | 5876 | 438 | 6543 | -7 | 6538 |
| 10-#14 | 5.41 | MA | 3861 | 1746 | 6098 | 1387 | 7059 | 1133 | 7689 | 930 | 8579 | 554 | 10712 | 64 | 10449 |
| 5L-2S | | MI | 2575 | 1746 | 4677 | 1252 | 5385 | 1017 | 5939 | 814 | 6705 | 431 | 7500 | 155 | 6740 |
| 12-#10 | 3.66 | MA | 3841 | 1538 | 5968 | 1227 | 6940 | 1021 | 7594 | 842 | 8509 | 546 | 10640 | 309 | 8610 |
| 4E | | MI | 2214 | 1538 | 3631 | 1153 | 4076 | 955 | 4368 | 780 | 4781 | 498 | 5413 | 175 | 4720 |
| 12-#10 | 3.66 | MA | 3676 | 1538 | 5635 | 1246 | 6539 | 1030 | 7095 | 850 | 7815 | 560 | 9682 | 260 | 8156 |
| 5L-3S | | MI | 2279 | 1538 | 3809 | 1149 | 4325 | 944 | 4672 | 780 | 5179 | 493 | 5861 | 216 | 4887 |
| 12-#10 | 3.66 | MA | 3522 | 1538 | 5330 | 1253 | 6144 | 1048 | 6605 | 866 | 7153 | 573 | 8811 | 199 | 7699 |
| 6L-2S | | MI | 2381 | 1538 | 4058 | 1144 | 4642 | 941 | 5057 | 772 | 5698 | 489 | 6481 | 307 | 4893 |
| 12-#11 | 4.50 | MA | 3830 | 1638 | 6019 | 1307 | 6992 | 1074 | 7627 | 887 | 8518 | 553 | 10656 | 197 | 9631 |
| 5L-3S | | MI | 2357 | 1638 | 4064 | 1198 | 4624 | 977 | 5023 | 799 | 5575 | 465 | 6256 | 121 | 5769 |
| 12-#11 | 4.50 | MA | 3649 | 1638 | 5657 | 1316 | 6513 | 1095 | 7033 | 895 | 7714 | 568 | 9591 | 122 | 8923 |
| 6L-2S | | MI | 2473 | 1638 | 4359 | 1193 | 4999 | 976 | 5478 | 791 | 6176 | 460 | 6960 | 233 | 5788 |
| 12-#14 | 6.49 | MA | 4227 | 1874 | 6913 | 1467 | 8097 | 1192 | 8950 | 966 | 10285 | 547 | 13043 | 51 | 12824 |
| 5L-3S | | MI | 2581 | 1874 | 4677 | 1337 | 5385 | 1075 | 5939 | 861 | 6705 | 424 | 7500 | -64 | 7447 |
| 14-#10 | 4.27 | MA | 3893 | 1611 | 6110 | 1291 | 7144 | 1063 | 7831 | 870 | 8810 | 556 | 11060 | 254 | 9557 |
| 5L-4S | | MI | 2328 | 1611 | 3880 | 1199 | 4393 | 988 | 4753 | 801 | 5300 | 493 | 6032 | 150 | 5426 |
| 14-#10 | 4.27 | MA | 3745 | 1611 | 5805 | 1298 | 6749 | 1081 | 7340 | 887 | 8148 | 569 | 10188 | 194 | 9092 |
| 6L-3S | | MI | 2380 | 1611 | 4058 | 1194 | 4642 | 977 | 5057 | 801 | 5698 | 489 | 6481 | 191 | 5632 |
| 14-#10 | 4.27 | MA | 3618 | 1611 | 5501 | 1304 | 6361 | 1088 | 6869 | 894 | 7471 | 574 | 9205 | 141 | 8615 |
| 7L-2S | | MI | 2478 | 1611 | 4306 | 1189 | 4959 | 974 | 5442 | 792 | 6218 | 485 | 7100 | 283 | 5646 |
| 14-#11 | 5.25 | MA | 3914 | 1727 | 6230 | 1371 | 7243 | 1135 | 7919 | 920 | 8914 | 563 | 11252 | 115 | 10605 |
| 6L-3S | | MI | 2474 | 1727 | 4359 | 1253 | 4999 | 1017 | 5478 | 824 | 6176 | 457 | 6960 | 85 | 6647 |
| 16-#10 | 4.88 | MA | 3963 | 1683 | 6281 | 1343 | 7355 | 1114 | 8076 | 907 | 9143 | 565 | 11566 | 188 | 10488 |
| 6L-4S | | MI | 2431 | 1683 | 4129 | 1244 | 4710 | 1021 | 5137 | 822 | 5819 | 489 | 6652 | 126 | 6136 |
| 16-#10 | 4.88 | MA | 3843 | 1683 | 5977 | 1350 | 6966 | 1121 | 7604 | 915 | 8466 | 570 | 10583 | 135 | 10013 |
| 7L-3S | | MI | 2480 | 1683 | 4306 | 1239 | 4959 | 1010 | 5442 | 821 | 6218 | 484 | 7100 | 167 | 6375 |
| 18-#10 | 5.50 | MA | 4064 | 1756 | 6452 | 1395 | 7572 | 1154 | 8339 | 935 | 9461 | 566 | 11960 | 129 | 11412 |
| 7L-4S | | MI | 2533 | 1756 | 4378 | 1289 | 5027 | 1053 | 5522 | 842 | 6338 | 484 | 7271 | 102 | 6849 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis

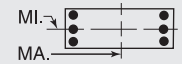



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.13 | MA | 3828 | 1333 | 5545 | 1105 | 6383 | 931 | 6807 | 795 | 7186 | 592 | 8502 | 515 | 3369 |
| 2E | | MI | 2113 | 1333 | 3260 | 1030 | 3585 | 867 | 3729 | 739 | 3821 | 547 | 4215 | 439 | 1843 |
| 4-#11 | 1.39 | MA | 3921 | 1366 | 5800 | 1118 | 6673 | 939 | 7142 | 799 | 7626 | 585 | 9100 | 508 | 4063 |
| 2E | | MI | 2146 | 1366 | 3379 | 1037 | 3709 | 870 | 3866 | 739 | 3968 | 532 | 4354 | 410 | 2188 |
| 4-#14 | 2.01 | MA | 4153 | 1445 | 6361 | 1161 | 7362 | 970 | 7968 | 817 | 8733 | 577 | 10626 | 499 | 5715 |
| 2E | | MI | 2237 | 1445 | 3636 | 1076 | 4016 | 898 | 4230 | 754 | 4413 | 513 | 4838 | 361 | 2983 |
| 4-#18 | 3.57 | MA | 4699 | 1645 | 7727 | 1275 | 9053 | 1051 | 9997 | 865 | 11461 | 559 | 14218 | 461 | 9747 |
| 2E | | MI | 2437 | 1645 | 4234 | 1182 | 4738 | 972 | 5053 | 788 | 5417 | 458 | 5879 | 217 | 4827 |
| 6-#8 | 1.06 | MA | 3805 | 1323 | 5459 | 1104 | 6298 | 931 | 6716 | 796 | 7073 | 595 | 8352 | 518 | 3169 |
| 2L-3S | | MI | 2027 | 1323 | 3059 | 1037 | 3350 | 873 | 3453 | 750 | 3457 | 557 | 3808 | 396 | 1754 |
| 6-#8 | 1.06 | MA | 3630 | 1323 | 5131 | 1111 | 5881 | 937 | 6209 | 802 | 6387 | 605 | 7402 | 466 | 3179 |
| 3L-2S | | MI | 2107 | 1323 | 3217 | 1033 | 3552 | 870 | 3698 | 744 | 3789 | 554 | 4214 | 453 | 1741 |
| 6-#9 | 1.34 | MA | 3922 | 1359 | 5727 | 1124 | 6627 | 945 | 7110 | 805 | 7601 | 592 | 9080 | 514 | 3956 |
| 2L-3S | | MI | 2058 | 1359 | 3148 | 1055 | 3454 | 885 | 3575 | 758 | 3619 | 552 | 3989 | 365 | 2153 |
| 6-#9 | 1.34 | MA | 3706 | 1359 | 5314 | 1133 | 6102 | 953 | 6472 | 812 | 6738 | 604 | 7885 | 447 | 3964 |
| 3L-2S | | MI | 2155 | 1359 | 3347 | 1051 | 3707 | 883 | 3882 | 751 | 4034 | 549 | 4491 | 437 | 2135 |
| 6-#10 | 1.70 | MA | 4068 | 1406 | 6066 | 1150 | 7046 | 964 | 7613 | 816 | 8276 | 587 | 10011 | 509 | 4956 |
| 2L-3S | | MI | 2096 | 1406 | 3260 | 1080 | 3585 | 902 | 3729 | 769 | 3821 | 547 | 4215 | 323 | 2649 |
| 6-#10 | 1.70 | MA | 3802 | 1406 | 5545 | 1161 | 6383 | 973 | 6807 | 824 | 7186 | 602 | 8502 | 422 | 4953 |
| 3L-2S | | MI | 2216 | 1406 | 3509 | 1075 | 3902 | 900 | 4114 | 760 | 4340 | 542 | 4835 | 415 | 2628 |
| 6-#11 | 2.09 | MA | 4203 | 1455 | 6429 | 1173 | 7473 | 980 | 8115 | 824 | 8942 | 580 | 10922 | 501 | 5976 |
| 2L-3S | | MI | 2127 | 1455 | 3379 | 1097 | 3709 | 912 | 3866 | 772 | 3968 | 529 | 4354 | 262 | 3139 |
| 6-#11 | 2.09 | MA | 3892 | 1455 | 5800 | 1186 | 6673 | 991 | 7142 | 833 | 7626 | 597 | 9100 | 392 | 5959 |
| 3L-2S | | MI | 2265 | 1455 | 3674 | 1093 | 4084 | 911 | 4322 | 764 | 4570 | 523 | 5058 | 374 | 3115 |
| 6-#14 | 3.01 | MA | 4544 | 1573 | 7257 | 1241 | 8503 | 1029 | 9353 | 853 | 10608 | 570 | 13221 | 489 | 8426 |
| 2L-3S | | MI | 2218 | 1573 | 3636 | 1161 | 4016 | 956 | 4230 | 800 | 4413 | 506 | 4838 | 142 | 4274 |
| 6-#14 | 3.01 | MA | 4122 | 1573 | 6361 | 1259 | 7362 | 1044 | 7968 | 866 | 8733 | 592 | 10626 | 328 | 8338 |
| 3L-2S | | MI | 2398 | 1573 | 4050 | 1157 | 4543 | 956 | 4869 | 790 | 5243 | 498 | 5795 | 303 | 4264 |
| 6-#18 | 5.36 | MA | 4679 | 1873 | 7727 | 1446 | 9053 | 1179 | 9997 | 975 | 11461 | 581 | 14218 | 147 | 13698 |
| 3L-2S | | MI | 2696 | 1873 | 4929 | 1324 | 5624 | 1075 | 6110 | 849 | 6762 | 422 | 7379 | 93 | 6940 |
| 8-#7 | 1.07 | MA | 3816 | 1325 | 5464 | 1107 | 6315 | 934 | 6743 | 799 | 7114 | 597 | 8412 | 520 | 3214 |
| 2L-4S | | MI | 2019 | 1325 | 3011 | 1044 | 3288 | 883 | 3381 | 753 | 3368 | 562 | 3726 | 393 | 1784 |
| 8-#7 | 1.07 | MA | 3683 | 1325 | 5213 | 1113 | 5997 | 939 | 6356 | 803 | 6590 | 604 | 7687 | 480 | 3222 |
| 3E | | MI | 2052 | 1325 | 3097 | 1041 | 3409 | 877 | 3529 | 752 | 3563 | 559 | 3952 | 414 | 1772 |
| 8-#7 | 1.07 | MA | 3613 | 1325 | 5043 | 1118 | 5757 | 948 | 6061 | 812 | 6186 | 608 | 7196 | 456 | 3226 |
| 4L-2S | | MI | 2113 | 1325 | 3219 | 1038 | 3564 | 875 | 3717 | 747 | 3818 | 556 | 4267 | 457 | 1762 |
| 8-#8 | 1.41 | MA | 3959 | 1369 | 5787 | 1132 | 6715 | 951 | 7223 | 809 | 7759 | 593 | 9301 | 515 | 4169 |
| 2L-4S | | MI | 2053 | 1369 | 3105 | 1068 | 3394 | 900 | 3505 | 763 | 3535 | 558 | 3922 | 356 | 2269 |
| 8-#8 | 1.41 | MA | 3789 | 1369 | 5459 | 1139 | 6298 | 958 | 6716 | 815 | 7073 | 602 | 8352 | 462 | 4174 |
| 3E | | MI | 2096 | 1369 | 3217 | 1065 | 3552 | 893 | 3698 | 762 | 3789 | 554 | 4214 | 383 | 2254 |
| 8-#8 | 1.41 | MA | 3700 | 1369 | 5236 | 1146 | 5983 | 969 | 6330 | 826 | 6544 | 607 | 7707 | 430 | 4163 |
| 4L-2S | | MI | 2174 | 1369 | 3376 | 1061 | 3754 | 891 | 3944 | 756 | 4121 | 551 | 4619 | 440 | 2241 |
| 8-#9 | 1.79 | MA | 4112 | 1416 | 6139 | 1160 | 7152 | 971 | 7748 | 821 | 8465 | 589 | 10276 | 510 | 5211 |
| 2L-4S | | MI | 2090 | 1416 | 3206 | 1095 | 3509 | 920 | 3640 | 774 | 3716 | 553 | 4129 | 314 | 2783 |
| 8-#9 | 1.79 | MA | 3903 | 1416 | 5727 | 1168 | 6627 | 979 | 7110 | 828 | 7601 | 600 | 9080 | 442 | 5209 |
| 3E | | MI | 2143 | 1416 | 3347 | 1091 | 3707 | 911 | 3882 | 774 | 4034 | 549 | 4491 | 347 | 2770 |
| 8-#9 | 1.79 | MA | 3795 | 1416 | 5445 | 1177 | 6230 | 993 | 6623 | 841 | 6934 | 605 | 8266 | 402 | 5170 |
| 4L-2S | | MI | 2238 | 1416 | 3545 | 1087 | 3960 | 909 | 4189 | 767 | 4449 | 545 | 4992 | 419 | 2756 |
| 8-#10 | 2.27 | MA | 4303 | 1478 | 6586 | 1195 | 7709 | 997 | 8418 | 836 | 9366 | 583 | 11520 | 503 | 6535 |
| 2L-4S | | MI | 2136 | 1478 | 3331 | 1130 | 3654 | 946 | 3810 | 789 | 3941 | 546 | 4386 | 258 | 3399 |
| 8-#10 | 2.27 | MA | 4048 | 1478 | 6066 | 1206 | 7046 | 1006 | 7613 | 845 | 8276 | 598 | 10011 | 417 | 6517 |
| 3E | | MI | 2202 | 1478 | 3509 | 1125 | 3902 | 935 | 4114 | 789 | 4340 | 542 | 4835 | 299 | 3413 |
| 8-#10 | 2.27 | MA | 3916 | 1478 | 5710 | 1217 | 6544 | 1025 | 6997 | 862 | 7433 | 604 | 8978 | 365 | 6424 |
| 4L-2S | | MI | 2318 | 1478 | 3757 | 1120 | 4219 | 933 | 4499 | 781 | 4859 | 538 | 5454 | 390 | 3399 |
| 8-#11 | 2.79 | MA | 4182 | 1544 | 6429 | 1242 | 7473 | 1031 | 8115 | 859 | 8942 | 591 | 10922 | 385 | 7841 |
| 3E | | MI | 2249 | 1544 | 3674 | 1152 | 4084 | 952 | 4322 | 798 | 4570 | 520 | 5058 | 226 | 4038 |
| 8-#11 | 2.79 | MA | 4027 | 1544 | 5998 | 1254 | 6866 | 1053 | 7369 | 879 | 7921 | 598 | 9662 | 320 | 7535 |
| 4L-2S | | MI | 2382 | 1544 | 3969 | 1148 | 4460 | 951 | 4778 | 789 | 5171 | 515 | 5762 | 338 | 4025 |

## RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

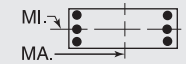
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 4.02 | MA | 4527 | 1702 | 7257 | 1339 | 8503 | 1102 | 9353 | 902 | 10608 | 585 | 13221 | 318 | 11007 |
| 3E | | MI | 2387 | 1702 | 4050 | 1241 | 4543 | 1014 | 4869 | 836 | 5243 | 491 | 5795 | 84 | 5509 |
| 8-#14 | 4.02 | MA | 4320 | 1702 | 6641 | 1357 | 7635 | 1132 | 8288 | 930 | 9150 | 593 | 11412 | 224 | 9994 |
| 4L-2S | | MI | 2556 | 1702 | 4464 | 1237 | 5070 | 1014 | 5509 | 827 | 6072 | 484 | 6752 | 246 | 5528 |
| 8-#18 | 7.14 | MA | 5037 | 2102 | 8205 | 1617 | 9517 | 1333 | 10543 | 1059 | 12172 | 577 | 15528 | -41 | 15428 |
| 4L-2S | | MI | 2952 | 2102 | 5625 | 1467 | 6509 | 1179 | 7167 | 910 | 8107 | 386 | 8878 | -31 | 8859 |
| 10-#10 | 2.83 | MA | 4288 | 1551 | 6586 | 1252 | 7709 | 1039 | 8418 | 865 | 9366 | 594 | 11520 | 411 | 8078 |
| 3L-4S | | MI | 2244 | 1551 | 3580 | 1175 | 3970 | 979 | 4194 | 810 | 4460 | 542 | 5006 | 234 | 4090 |
| 10-#10 | 2.83 | MA | 4165 | 1551 | 6231 | 1263 | 7207 | 1058 | 7803 | 882 | 8523 | 600 | 10487 | 359 | 7975 |
| 4L-3S | | MI | 2306 | 1551 | 3757 | 1170 | 4219 | 968 | 4499 | 810 | 4859 | 538 | 5454 | 275 | 4170 |
| 10-#10 | 2.83 | MA | 3976 | 1551 | 5868 | 1282 | 6771 | 1067 | 7259 | 891 | 7766 | 614 | 9446 | 312 | 7437 |
| 5L-2S | | MI | 2419 | 1551 | 4006 | 1166 | 4536 | 966 | 4884 | 801 | 5378 | 533 | 6074 | 366 | 4162 |
| 10-#11 | 3.48 | MA | 4323 | 1633 | 6627 | 1310 | 7666 | 1093 | 8342 | 904 | 9237 | 593 | 11484 | 313 | 9354 |
| 4L-3S | | MI | 2374 | 1633 | 3969 | 1208 | 4460 | 993 | 4778 | 823 | 5171 | 512 | 5762 | 191 | 4927 |
| 10-#11 | 3.48 | MA | 4103 | 1633 | 6187 | 1333 | 7136 | 1104 | 7682 | 913 | 8319 | 609 | 10217 | 253 | 8752 |
| 5L-2S | | MI | 2497 | 1633 | 4264 | 1204 | 4835 | 992 | 5234 | 814 | 5772 | 507 | 6466 | 303 | 4927 |
| 10-#14 | 5.02 | MA | 4734 | 1830 | 7536 | 1437 | 8775 | 1190 | 9673 | 966 | 11025 | 585 | 14007 | 214 | 12609 |
| 4L-3S | | MI | 2553 | 1830 | 4464 | 1322 | 5070 | 1073 | 5509 | 873 | 6072 | 477 | 6752 | 27 | 6675 |
| 10-#14 | 5.02 | MA | 4428 | 1830 | 6907 | 1470 | 8017 | 1206 | 8731 | 979 | 9713 | 608 | 12192 | 123 | 11659 |
| 5L-2S | | MI | 2713 | 1830 | 4878 | 1317 | 5596 | 1073 | 6149 | 863 | 6902 | 469 | 7709 | 189 | 6779 |
| 12-#10 | 3.40 | MA | 4408 | 1623 | 6752 | 1308 | 7870 | 1090 | 8608 | 903 | 9613 | 596 | 11996 | 353 | 9506 |
| 4E | | MI | 2349 | 1623 | 3829 | 1220 | 4287 | 1012 | 4579 | 830 | 4979 | 537 | 5625 | 210 | 4788 |
| 12-#10 | 3.40 | MA | 4222 | 1623 | 6389 | 1327 | 7434 | 1100 | 8064 | 911 | 8856 | 610 | 10954 | 307 | 8970 |
| 5L-3S | | MI | 2410 | 1623 | 4006 | 1216 | 4536 | 1001 | 4884 | 830 | 5378 | 533 | 6074 | 250 | 4919 |
| 12-#10 | 3.40 | MA | 4051 | 1623 | 6051 | 1334 | 7023 | 1110 | 7530 | 928 | 8134 | 625 | 9931 | 235 | 8525 |
| 6L-2S | | MI | 2519 | 1623 | 4255 | 1211 | 4853 | 999 | 5268 | 822 | 5897 | 529 | 6693 | 342 | 4921 |
| 12-#11 | 4.18 | MA | 4394 | 1723 | 6815 | 1389 | 7937 | 1145 | 8655 | 939 | 9635 | 604 | 12039 | 245 | 10607 |
| 5L-3S | | MI | 2493 | 1723 | 4264 | 1264 | 4835 | 1033 | 5234 | 848 | 5772 | 504 | 6466 | 155 | 5809 |
| 12-#11 | 4.18 | MA | 4193 | 1723 | 6412 | 1397 | 7414 | 1166 | 8006 | 958 | 8759 | 621 | 10886 | 171 | 9888 |
| 6L-2S | | MI | 2611 | 1723 | 4558 | 1260 | 5210 | 1032 | 5689 | 840 | 6374 | 499 | 7170 | 267 | 5823 |
| 12-#14 | 6.03 | MA | 4835 | 1959 | 7803 | 1550 | 9157 | 1264 | 10116 | 1015 | 11588 | 600 | 14787 | 113 | 14283 |
| 5L-3S | | MI | 2717 | 1959 | 4878 | 1402 | 5596 | 1131 | 6149 | 909 | 6902 | 462 | 7709 | -30 | 7685 |
| 12-#14 | 6.03 | MA | 4563 | 1959 | 7235 | 1563 | 8410 | 1294 | 9189 | 1043 | 10335 | 623 | 13131 | 5 | 13105 |
| 6L-2S | | MI | 2868 | 1959 | 5291 | 1397 | 6123 | 1131 | 6789 | 899 | 7732 | 455 | 8666 | 132 | 8022 |
| 14-#10 | 3.97 | MA | 4462 | 1696 | 6910 | 1373 | 8097 | 1133 | 8870 | 932 | 9946 | 606 | 12463 | 301 | 10507 |
| 5L-4S | | MI | 2454 | 1696 | 4077 | 1266 | 4604 | 1045 | 4964 | 851 | 5499 | 533 | 6245 | 185 | 5492 |
| 14-#10 | 3.97 | MA | 4298 | 1696 | 6571 | 1379 | 7686 | 1143 | 8335 | 949 | 9224 | 620 | 11440 | 229 | 10056 |
| 6L-3S | | MI | 2516 | 1696 | 4255 | 1261 | 4853 | 1034 | 5268 | 851 | 5897 | 529 | 6693 | 226 | 5666 |
| 14-#10 | 3.97 | MA | 4158 | 1696 | 6239 | 1386 | 7235 | 1159 | 7822 | 958 | 8486 | 627 | 10453 | 191 | 9514 |
| 7L-2S | | MI | 2617 | 1696 | 4504 | 1256 | 5169 | 1032 | 5653 | 842 | 6416 | 524 | 7313 | 317 | 5676 |
| 14-#11 | 4.88 | MA | 4487 | 1812 | 7041 | 1453 | 8215 | 1207 | 8979 | 984 | 10075 | 615 | 12708 | 164 | 11740 |
| 6L-3S | | MI | 2611 | 1812 | 4558 | 1319 | 5210 | 1074 | 5689 | 873 | 6374 | 496 | 7170 | 120 | 6689 |
| 14-#11 | 4.88 | MA | 4323 | 1812 | 6638 | 1460 | 7701 | 1216 | 8355 | 993 | 9180 | 622 | 11408 | 99 | 10965 |
| 7L-2S | | MI | 2724 | 1812 | 4853 | 1315 | 5586 | 1073 | 6145 | 865 | 6975 | 491 | 7874 | 232 | 6712 |
| 14-#14 | 7.03 | MA | 4975 | 2087 | 8130 | 1643 | 9550 | 1352 | 10573 | 1079 | 12209 | 616 | 15726 | -5 | 15702 |
| 6L-3S | | MI | 2878 | 2087 | 5291 | 1482 | 6123 | 1189 | 6789 | 946 | 7732 | 448 | 8666 | -88 | 8586 |
| 16-#10 | 4.54 | MA | 4540 | 1768 | 7092 | 1424 | 8349 | 1176 | 9141 | 970 | 10314 | 616 | 12949 | 224 | 11591 |
| 6L-4S | | MI | 2567 | 1768 | 4326 | 1311 | 4921 | 1078 | 5349 | 871 | 6018 | 528 | 6864 | 161 | 6201 |
| 16-#10 | 4.54 | MA | 4407 | 1768 | 6760 | 1431 | 7898 | 1191 | 8627 | 978 | 9576 | 622 | 11962 | 185 | 11062 |
| 7L-3S | | MI | 2617 | 1768 | 4504 | 1306 | 5169 | 1067 | 5653 | 871 | 6416 | 524 | 7313 | 202 | 6410 |
| 16-#10 | 4.54 | MA | 4248 | 1768 | 6441 | 1439 | 7467 | 1198 | 8107 | 994 | 8871 | 637 | 11012 | 132 | 10355 |
| 8L-2S | | MI | 2714 | 1768 | 4753 | 1302 | 5486 | 1065 | 6038 | 863 | 6935 | 520 | 7932 | 293 | 6426 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

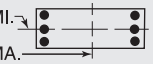
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 5.57 | MA | 4620 | 1901 | 7267 | 1516 | 8502 | 1256 | 9328 | 1018 | 10496 | 617 | 13230 | 92 | 12819 |
| 7L-3S | | MI | 2727 | 1901 | 4853 | 1375 | 5586 | 1114 | 6145 | 899 | 6975 | 488 | 7874 | 84 | 7567 |
| 18-#10 | 5.10 | MA | 4652 | 1841 | 7281 | 1476 | 8561 | 1224 | 9433 | 999 | 10666 | 618 | 13471 | 179 | 12613 |
| 7L-4S | | MI | 2669 | 1841 | 4575 | 1356 | 5238 | 1111 | 5734 | 892 | 6537 | 524 | 7484 | 137 | 6914 |
| 18-#10 | 5.10 | MA | 4494 | 1841 | 6961 | 1484 | 8130 | 1231 | 8912 | 1015 | 9961 | 633 | 12521 | 127 | 11897 |
| 8L-3S | | MI | 2716 | 1841 | 4753 | 1352 | 5486 | 1100 | 6038 | 892 | 6935 | 520 | 7932 | 178 | 7153 |
| 20-#10 | 5.67 | MA | 4736 | 1913 | 7482 | 1530 | 8793 | 1264 | 9717 | 1036 | 11051 | 628 | 14030 | 121 | 13439 |
| 8L-4S | | MI | 2770 | 1913 | 4824 | 1402 | 5554 | 1144 | 6118 | 912 | 7056 | 519 | 8103 | 112 | 7630 |

## RECTANGULAR TIED COLUMNS 16" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.06 | MA | 4371 | 1418 | 6262 | 1184 | 7231 | 999 | 7715 | 854 | 8129 | 639 | 9603 | 556 | 3643 |
| 2E | | MI | 2249 | 1418 | 3457 | 1097 | 3796 | 924 | 3941 | 789 | 4019 | 586 | 4428 | 474 | 1861 |
| 4-#11 | 1.30 | MA | 4475 | 1451 | 6542 | 1197 | 7549 | 1007 | 8083 | 858 | 8611 | 632 | 10260 | 549 | 4400 |
| 2E | | MI | 2282 | 1451 | 3579 | 1103 | 3920 | 927 | 4077 | 788 | 4166 | 571 | 4564 | 444 | 2210 |
| 4-#14 | 1.88 | MA | 4733 | 1530 | 7155 | 1241 | 8303 | 1038 | 8985 | 876 | 9821 | 624 | 11927 | 540 | 6201 |
| 2E | | MI | 2373 | 1530 | 3837 | 1142 | 4228 | 954 | 4440 | 802 | 4610 | 552 | 5047 | 395 | 3010 |
| 4-#18 | 3.33 | MA | 5340 | 1730 | 8652 | 1354 | 10155 | 1119 | 11208 | 924 | 12810 | 606 | 16048 | 518 | 10611 |
| 2E | | MI | 2574 | 1730 | 4437 | 1246 | 4950 | 1026 | 5263 | 836 | 5612 | 496 | 6085 | 250 | 4866 |
| 6-#9 | 1.25 | MA | 4475 | 1444 | 6459 | 1203 | 7496 | 1013 | 8043 | 864 | 8578 | 639 | 10230 | 556 | 4280 |
| 2L-3S | | MI | 2194 | 1444 | 3345 | 1123 | 3665 | 943 | 3787 | 808 | 3818 | 592 | 4203 | 400 | 2171 |
| 6-#9 | 1.25 | MA | 4237 | 1444 | 6011 | 1213 | 6925 | 1021 | 7350 | 871 | 7640 | 651 | 8931 | 489 | 4288 |
| 3L-2S | | MI | 2292 | 1444 | 3543 | 1119 | 3918 | 941 | 4094 | 801 | 4233 | 589 | 4704 | 472 | 2153 |
| 6-#10 | 1.59 | MA | 4636 | 1490 | 6828 | 1230 | 7952 | 1032 | 8590 | 875 | 9313 | 635 | 11243 | 550 | 5367 |
| 2L-3S | | MI | 2232 | 1490 | 3457 | 1147 | 3796 | 959 | 3941 | 818 | 4019 | 586 | 4428 | 358 | 2671 |
| 6-#10 | 1.59 | MA | 4343 | 1490 | 6262 | 1241 | 7231 | 1042 | 7715 | 884 | 8129 | 650 | 9603 | 466 | 5364 |
| 3L-2S | | MI | 2352 | 1490 | 3706 | 1142 | 4113 | 957 | 4325 | 810 | 4538 | 582 | 5047 | 450 | 2649 |
| 6-#11 | 1.95 | MA | 4787 | 1540 | 7226 | 1253 | 8421 | 1047 | 9141 | 883 | 10044 | 627 | 12243 | 542 | 6482 |
| 2L-3S | | MI | 2262 | 1540 | 3579 | 1163 | 3920 | 968 | 4077 | 822 | 4166 | 568 | 4564 | 296 | 3167 |
| 6-#11 | 1.95 | MA | 4443 | 1540 | 6542 | 1266 | 7549 | 1059 | 8083 | 894 | 8611 | 645 | 10260 | 436 | 6464 |
| 3L-2S | | MI | 2402 | 1540 | 3873 | 1159 | 4296 | 967 | 4533 | 813 | 4767 | 563 | 5268 | 408 | 3141 |
| 6-#14 | 2.81 | MA | 5164 | 1658 | 8131 | 1321 | 9545 | 1096 | 10494 | 912 | 11864 | 617 | 14755 | 530 | 9155 |
| 2L-3S | | MI | 2354 | 1658 | 3837 | 1226 | 4228 | 1012 | 4440 | 849 | 4610 | 545 | 5047 | 176 | 4314 |
| 6-#14 | 2.81 | MA | 4698 | 1658 | 7155 | 1340 | 8303 | 1113 | 8985 | 927 | 9821 | 641 | 11927 | 374 | 9067 |
| 3L-2S | | MI | 2535 | 1658 | 4251 | 1222 | 4754 | 1012 | 5080 | 839 | 5439 | 537 | 6004 | 337 | 4296 |
| 6-#18 | 5.00 | MA | 5316 | 1958 | 8652 | 1528 | 10155 | 1249 | 11208 | 1037 | 12810 | 632 | 16048 | 212 | 15238 |
| 3L-2S | | MI | 2833 | 1958 | 5133 | 1388 | 5836 | 1130 | 6320 | 897 | 6957 | 460 | 7585 | 126 | 6987 |
| 8-#7 | 1.00 | MA | 4357 | 1410 | 6172 | 1187 | 7155 | 1002 | 7642 | 858 | 8046 | 644 | 9500 | 561 | 3473 |
| 2L-4S | | MI | 2154 | 1410 | 3206 | 1112 | 3498 | 941 | 3593 | 804 | 3568 | 602 | 3940 | 429 | 1798 |
| 8-#7 | 1.00 | MA | 4210 | 1410 | 5900 | 1193 | 6810 | 1007 | 7222 | 863 | 7478 | 652 | 8713 | 522 | 3481 |
| 3E | | MI | 2188 | 1410 | 3292 | 1109 | 3619 | 935 | 3741 | 803 | 3763 | 599 | 4167 | 450 | 1786 |
| 8-#7 | 1.00 | MA | 4134 | 1410 | 5716 | 1198 | 6550 | 1016 | 6903 | 871 | 7041 | 655 | 8185 | 498 | 3485 |
| 4L-2S | | MI | 2249 | 1410 | 3414 | 1107 | 3774 | 933 | 3929 | 798 | 4018 | 596 | 4482 | 493 | 1777 |
| 8-#8 | 1.32 | MA | 4514 | 1453 | 6523 | 1212 | 7590 | 1019 | 8164 | 868 | 8748 | 640 | 10468 | 556 | 4510 |
| 2L-4S | | MI | 2189 | 1453 | 3301 | 1136 | 3605 | 958 | 3717 | 814 | 3735 | 598 | 4136 | 391 | 2288 |
| 8-#8 | 1.32 | MA | 4327 | 1453 | 6167 | 1219 | 7137 | 1026 | 7614 | 874 | 8003 | 650 | 9436 | 504 | 4516 |
| 3E | | MI | 2232 | 1453 | 3413 | 1132 | 3763 | 951 | 3910 | 813 | 3989 | 594 | 4428 | 418 | 2272 |
| 8-#8 | 1.32 | MA | 4231 | 1453 | 5926 | 1226 | 6796 | 1038 | 7195 | 886 | 7430 | 655 | 8742 | 473 | 4505 |
| 4L-2S | | MI | 2310 | 1453 | 3572 | 1129 | 3965 | 949 | 4155 | 807 | 4320 | 591 | 4833 | 475 | 2259 |
| 8-#9 | 1.67 | MA | 4683 | 1501 | 6907 | 1239 | 8066 | 1039 | 8736 | 880 | 9517 | 636 | 11528 | 551 | 5643 |
| 2L-4S | | MI | 2225 | 1501 | 3402 | 1162 | 3720 | 978 | 3851 | 825 | 3915 | 593 | 4342 | 349 | 2807 |
| 8-#9 | 1.67 | MA | 4454 | 1501 | 6459 | 1248 | 7496 | 1047 | 8043 | 887 | 8578 | 648 | 10230 | 485 | 5641 |
| 3E | | MI | 2279 | 1501 | 3543 | 1158 | 3918 | 969 | 4094 | 824 | 4233 | 589 | 4704 | 382 | 2792 |
| 8-#9 | 1.67 | MA | 4335 | 1501 | 6155 | 1258 | 7066 | 1062 | 7515 | 902 | 7856 | 654 | 9352 | 445 | 5602 |
| 4L-2S | | MI | 2374 | 1501 | 3742 | 1154 | 4170 | 966 | 4400 | 817 | 4649 | 585 | 5205 | 454 | 2776 |
| 8-#10 | 2.12 | MA | 4894 | 1563 | 7394 | 1275 | 8673 | 1064 | 9466 | 895 | 10498 | 630 | 12883 | 544 | 7084 |
| 2L-4S | | MI | 2272 | 1563 | 3528 | 1197 | 3864 | 1003 | 4021 | 839 | 4140 | 586 | 4599 | 293 | 3444 |

## RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

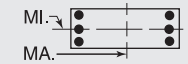
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 2.12 | MA | 4613 | 1563 | 6828 | 1286 | 7952 | 1075 | 8590 | 905 | 9313 | 646 | 11243 | 460 | 7065 |
| 3E | | MI | 2338 | 1563 | 3706 | 1192 | 4113 | 992 | 4325 | 839 | 4538 | 582 | 5047 | 334 | 3439 |
| 8-#10 | 2.12 | MA | 4468 | 1563 | 6443 | 1298 | 7408 | 1094 | 7923 | 922 | 8400 | 653 | 10131 | 409 | 6972 |
| 4L-2S | | MI | 2455 | 1563 | 3955 | 1187 | 4430 | 990 | 4710 | 830 | 5058 | 577 | 5667 | 425 | 3422 |
| 8-#11 | 2.60 | MA | 4763 | 1629 | 7226 | 1322 | 8421 | 1100 | 9141 | 919 | 10044 | 640 | 12243 | 429 | 8515 |
| 3E | | MI | 2385 | 1629 | 3873 | 1219 | 4296 | 1009 | 4533 | 847 | 4767 | 560 | 5268 | 261 | 4070 |
| 8-#11 | 2.60 | MA | 4593 | 1629 | 6759 | 1335 | 7762 | 1122 | 8332 | 940 | 8936 | 647 | 10885 | 365 | 8280 |
| 4L-2S | | MI | 2520 | 1629 | 4168 | 1214 | 4671 | 1008 | 4989 | 838 | 5369 | 554 | 5972 | 373 | 4054 |
| 8-#14 | 3.75 | MA | 5144 | 1787 | 8131 | 1420 | 9545 | 1171 | 10494 | 963 | 11864 | 634 | 14755 | 363 | 11979 |
| 3E | | MI | 2523 | 1787 | 4251 | 1307 | 4754 | 1070 | 5080 | 885 | 5439 | 530 | 6004 | 118 | 5554 |
| 8-#14 | 3.75 | MA | 4917 | 1787 | 7463 | 1439 | 8603 | 1202 | 9338 | 992 | 10281 | 643 | 12804 | 271 | 10986 |
| 4L-2S | | MI | 2694 | 1787 | 4665 | 1302 | 5281 | 1070 | 5720 | 875 | 6269 | 523 | 6961 | 280 | 5563 |
| 8-#18 | 6.67 | MA | 5713 | 2186 | 9179 | 1701 | 10668 | 1405 | 11812 | 1123 | 13596 | 631 | 17520 | 26 | 17353 |
| 4L-2S | | MI | 3090 | 2186 | 5828 | 1531 | 6721 | 1234 | 7377 | 958 | 8301 | 424 | 9084 | 2 | 9076 |
| 10-#10 | 2.65 | MA | 4877 | 1636 | 7394 | 1332 | 8673 | 1108 | 9466 | 925 | 10498 | 642 | 12883 | 454 | 8764 |
| 3L-4S | | MI | 2379 | 1636 | 3777 | 1242 | 4181 | 1036 | 4406 | 860 | 4659 | 581 | 5218 | 269 | 4156 |
| 10-#10 | 2.65 | MA | 4742 | 1636 | 7009 | 1343 | 8129 | 1127 | 8799 | 943 | 9584 | 649 | 11772 | 403 | 8661 |
| 4L-3S | | MI | 2442 | 1636 | 3955 | 1238 | 4430 | 1025 | 4710 | 859 | 5058 | 577 | 5667 | 310 | 4198 |
| 10-#10 | 2.65 | MA | 4532 | 1636 | 6617 | 1363 | 7656 | 1137 | 8210 | 952 | 8765 | 664 | 10646 | 358 | 8123 |
| 5L-2S | | MI | 2556 | 1636 | 4203 | 1233 | 4747 | 1023 | 5095 | 851 | 5577 | 573 | 6286 | 401 | 4188 |
| 10-#11 | 3.25 | MA | 4919 | 1718 | 7444 | 1391 | 8633 | 1163 | 9391 | 965 | 10368 | 642 | 12868 | 358 | 10266 |
| 4L-3S | | MI | 2510 | 1718 | 4168 | 1274 | 4671 | 1049 | 4989 | 872 | 5369 | 551 | 5972 | 225 | 4963 |
| 10-#11 | 3.25 | MA | 4672 | 1718 | 6967 | 1415 | 8059 | 1175 | 8676 | 975 | 9373 | 660 | 11498 | 300 | 9569 |
| 5L-2S | | MI | 2635 | 1718 | 4463 | 1270 | 5046 | 1048 | 5445 | 864 | 5970 | 546 | 6676 | 337 | 4957 |
| 10-#14 | 4.69 | MA | 5374 | 1915 | 8439 | 1519 | 9846 | 1261 | 10847 | 1028 | 12323 | 636 | 15632 | 260 | 13843 |
| 4L-3S | | MI | 2689 | 1915 | 4665 | 1387 | 5281 | 1128 | 5720 | 922 | 6269 | 516 | 6961 | 61 | 6785 |
| 10-#14 | 4.69 | MA | 5030 | 1915 | 7757 | 1553 | 9024 | 1277 | 9825 | 1042 | 10900 | 660 | 13668 | 174 | 12897 |
| 5L-2S | | MI | 2851 | 1915 | 5078 | 1383 | 5808 | 1129 | 6360 | 912 | 7099 | 508 | 7918 | 223 | 6818 |
| 12-#10 | 3.17 | MA | 5010 | 1708 | 7575 | 1389 | 8850 | 1160 | 9674 | 963 | 10769 | 644 | 13412 | 397 | 10351 |
| 4E | | MI | 2485 | 1708 | 4026 | 1288 | 4498 | 1069 | 4791 | 880 | 5178 | 577 | 5838 | 244 | 4853 |
| 12-#10 | 3.17 | MA | 4802 | 1708 | 7183 | 1408 | 8377 | 1170 | 9086 | 973 | 9949 | 660 | 12287 | 353 | 9792 |
| 5L-3S | | MI | 2546 | 1708 | 4203 | 1283 | 4747 | 1058 | 5095 | 880 | 5577 | 573 | 6286 | 285 | 4950 |
| 12-#10 | 3.17 | MA | 4615 | 1708 | 6811 | 1415 | 7933 | 1180 | 8508 | 990 | 9167 | 675 | 11185 | 282 | 9366 |
| 6L-2S | | MI | 2657 | 1708 | 4452 | 1278 | 5063 | 1056 | 5480 | 872 | 6096 | 568 | 6906 | 377 | 4948 |
| 12-#11 | 3.90 | MA | 4993 | 1807 | 7651 | 1471 | 8930 | 1215 | 9735 | 1001 | 10806 | 655 | 13482 | 293 | 11591 |
| 5L-3S | | MI | 2629 | 1807 | 4463 | 1330 | 5046 | 1090 | 5445 | 897 | 5970 | 543 | 6676 | 190 | 5848 |
| 12-#11 | 3.90 | MA | 4772 | 1807 | 7207 | 1479 | 8390 | 1227 | 9032 | 1021 | 9856 | 672 | 12136 | 206 | 10871 |
| 6L-2S | | MI | 2749 | 1807 | 4758 | 1326 | 5422 | 1089 | 5900 | 889 | 6571 | 538 | 7380 | 302 | 5855 |
| 12-#14 | 5.63 | MA | 5478 | 2044 | 8733 | 1633 | 10266 | 1336 | 11334 | 1079 | 12942 | 653 | 16496 | 164 | 15771 |
| 5L-3S | | MI | 2853 | 2044 | 5078 | 1467 | 5808 | 1187 | 6360 | 958 | 7099 | 501 | 7918 | 4 | 7906 |
| 12-#14 | 5.63 | MA | 5179 | 2044 | 8105 | 1645 | 9456 | 1367 | 10329 | 1108 | 11584 | 677 | 14713 | 57 | 14388 |
| 6L-2S | | MI | 3007 | 2044 | 5492 | 1463 | 6335 | 1187 | 7000 | 948 | 7928 | 494 | 8874 | 165 | 8063 |
| 14-#10 | 3.70 | MA | 5066 | 1781 | 7749 | 1454 | 9098 | 1203 | 9961 | 993 | 11134 | 656 | 13927 | 347 | 11465 |
| 5L-4S | | MI | 2590 | 1781 | 4275 | 1333 | 4815 | 1102 | 5175 | 901 | 5697 | 572 | 6457 | 220 | 5557 |
| 14-#10 | 3.70 | MA | 4886 | 1781 | 7377 | 1460 | 8653 | 1213 | 9383 | 1011 | 10352 | 671 | 12826 | 276 | 11037 |
| 6L-3S | | MI | 2653 | 1781 | 4452 | 1328 | 5063 | 1091 | 5480 | 901 | 6096 | 568 | 6906 | 261 | 5699 |
| 14-#10 | 3.70 | MA | 4733 | 1781 | 7017 | 1467 | 8157 | 1228 | 8828 | 1020 | 9554 | 678 | 11760 | 240 | 10410 |
| 7L-2S | | MI | 2755 | 1781 | 4701 | 1323 | 5380 | 1089 | 5864 | 892 | 6615 | 564 | 7525 | 352 | 5704 |
| 14-#11 | 4.55 | MA | 5096 | 1896 | 7891 | 1534 | 9261 | 1267 | 10091 | 1047 | 11288 | 667 | 14119 | 198 | 12894 |
| 6L-3S | | MI | 2747 | 1896 | 4758 | 1386 | 5422 | 1130 | 5900 | 923 | 6571 | 535 | 7380 | 154 | 6730 |
| 14-#11 | 4.55 | MA | 4916 | 1896 | 7455 | 1542 | 8669 | 1287 | 9416 | 1057 | 10319 | 675 | 12820 | 150 | 12083 |
| 7L-2S | | MI | 2862 | 1896 | 5053 | 1381 | 5797 | 1129 | 6356 | 914 | 7172 | 530 | 8084 | 266 | 6747 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

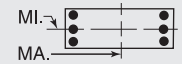
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 6.56 | MA | 5633 | 2172 | 9081 | 1725 | 10699 | 1425 | 11838 | 1144 | 13626 | 670 | 17541 | 47 | 17274 |
| 6L-3S | | MI | 3014 | 2172 | 5492 | 1548 | 6335 | 1245 | 7000 | 994 | 7928 | 487 | 8874 | -54 | 8828 |
| 16-#10 | 4.23 | MA | 5152 | 1853 | 7943 | 1505 | 9374 | 1246 | 10258 | 1031 | 11537 | 667 | 14466 | 270 | 12710 |
| 6L-4S | | MI | 2703 | 1853 | 4524 | 1378 | 5132 | 1135 | 5560 | 921 | 6216 | 568 | 7077 | 196 | 6265 |
| 16-#10 | 4.23 | MA | 5006 | 1853 | 7583 | 1512 | 8878 | 1261 | 9703 | 1041 | 10739 | 674 | 13401 | 234 | 12093 |
| 7L-3S | | MI | 2754 | 1853 | 4701 | 1373 | 5380 | 1124 | 5864 | 921 | 6615 | 564 | 7525 | 237 | 6445 |
| 16-#10 | 4.23 | MA | 4829 | 1853 | 7237 | 1521 | 8411 | 1268 | 9129 | 1057 | 9976 | 689 | 12376 | 184 | 11365 |
| 8L-2S | | MI | 2852 | 1853 | 4950 | 1369 | 5697 | 1122 | 6249 | 913 | 7134 | 559 | 8145 | 328 | 6456 |
| 16-#11 | 5.20 | MA | 5242 | 1986 | 8139 | 1598 | 9540 | 1327 | 10474 | 1082 | 11751 | 669 | 14803 | 143 | 14101 |
| 7L-3S | | MI | 2863 | 1986 | 5053 | 1441 | 5797 | 1171 | 6356 | 948 | 7172 | 527 | 8084 | 119 | 7609 |
| 18-#10 | 4.76 | MA | 5275 | 1926 | 8149 | 1558 | 9598 | 1294 | 10578 | 1061 | 11923 | 670 | 15041 | 228 | 13776 |
| 7L-4S | | MI | 2805 | 1926 | 4772 | 1423 | 5448 | 1168 | 5945 | 942 | 6736 | 563 | 7696 | 171 | 6977 |
| 18-#10 | 4.76 | MA | 5099 | 1926 | 7803 | 1566 | 9131 | 1301 | 10004 | 1077 | 11161 | 685 | 14016 | 178 | 13041 |
| 8L-3S | | MI | 2853 | 1926 | 4950 | 1419 | 5697 | 1157 | 6249 | 942 | 7134 | 559 | 8145 | 212 | 7189 |
| 20-#10 | 5.29 | MA | 5364 | 1998 | 8369 | 1611 | 9852 | 1334 | 10880 | 1098 | 12345 | 681 | 15656 | 172 | 14717 |
| 8L-4S | | MI | 2907 | 1998 | 5021 | 1469 | 5765 | 1201 | 6330 | 962 | 7255 | 559 | 8316 | 147 | 7693 |

## RECTANGULAR TIED COLUMNS 16" x 32"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#11 | 1.22 | MA | 5063 | 1536 | 7324 | 1277 | 8475 | 1075 | 9075 | 917 | 9649 | 679 | 11478 | 591 | 4737 |
| 2E | | MI | 2418 | 1536 | 3778 | 1169 | 4132 | 983 | 4288 | 837 | 4364 | 610 | 4775 | 478 | 2231 |
| 4-#14 | 1.76 | MA | 5347 | 1615 | 7989 | 1320 | 9292 | 1106 | 10054 | 935 | 10962 | 671 | 13287 | 582 | 6687 |
| 2E | | MI | 2510 | 1615 | 4038 | 1207 | 4439 | 1009 | 4651 | 851 | 4806 | 590 | 5256 | 429 | 3037 |
| 4-#18 | 3.13 | MA | 6017 | 1815 | 9616 | 1434 | 11306 | 1187 | 12471 | 983 | 14211 | 653 | 17769 | 560 | 11475 |
| 2E | | MI | 2711 | 1815 | 4640 | 1310 | 5162 | 1081 | 5473 | 883 | 5807 | 534 | 6291 | 283 | 4905 |
| 6-#9 | 1.17 | MA | 5061 | 1529 | 7231 | 1283 | 8413 | 1081 | 9028 | 923 | 9608 | 686 | 11438 | 597 | 4604 |
| 2L-3S | | MI | 2329 | 1529 | 3542 | 1190 | 3876 | 1000 | 3998 | 858 | 4017 | 632 | 4416 | 435 | 2189 |
| 6-#9 | 1.17 | MA | 4802 | 1529 | 6747 | 1293 | 7797 | 1090 | 8280 | 931 | 8595 | 699 | 10036 | 532 | 4612 |
| 3L-2S | | MI | 2428 | 1529 | 3740 | 1186 | 4128 | 998 | 4305 | 851 | 4432 | 629 | 4917 | 507 | 2171 |
| 6-#10 | 1.49 | MA | 5238 | 1575 | 7631 | 1309 | 8907 | 1099 | 9620 | 934 | 10403 | 682 | 12535 | 592 | 5779 |
| 2L-3S | | MI | 2368 | 1575 | 3654 | 1214 | 4007 | 1017 | 4152 | 868 | 4218 | 626 | 4640 | 393 | 2692 |
| 6-#10 | 1.49 | MA | 4918 | 1575 | 7019 | 1321 | 8128 | 1110 | 8675 | 944 | 9124 | 698 | 10763 | 509 | 5776 |
| 3L-2S | | MI | 2489 | 1575 | 3903 | 1209 | 4324 | 1014 | 4537 | 860 | 4737 | 622 | 5260 | 484 | 2669 |
| 6-#11 | 1.83 | MA | 5405 | 1625 | 8064 | 1332 | 9417 | 1115 | 10220 | 942 | 11198 | 674 | 13623 | 584 | 6987 |
| 2L-3S | | MI | 2398 | 1625 | 3778 | 1229 | 4132 | 1025 | 4288 | 871 | 4364 | 607 | 4775 | 330 | 3193 |
| 6-#11 | 1.83 | MA | 5028 | 1625 | 7324 | 1346 | 8475 | 1128 | 9075 | 954 | 9649 | 693 | 11478 | 479 | 6969 |
| 3L-2S | | MI | 2538 | 1625 | 4073 | 1225 | 4507 | 1024 | 4744 | 862 | 4965 | 602 | 5479 | 443 | 3166 |
| 6-#14 | 2.64 | MA | 5820 | 1743 | 9045 | 1401 | 10637 | 1164 | 11687 | 972 | 13172 | 664 | 16347 | 571 | 9884 |
| 2L-3S | | MI | 2489 | 1743 | 4038 | 1292 | 4439 | 1067 | 4651 | 897 | 4806 | 583 | 5256 | 210 | 4351 |
| 6-#14 | 2.64 | MA | 5308 | 1743 | 7989 | 1420 | 9292 | 1182 | 10054 | 987 | 10962 | 690 | 13287 | 418 | 9796 |
| 3L-2S | | MI | 2672 | 1743 | 4451 | 1287 | 4966 | 1068 | 5291 | 887 | 5636 | 576 | 6213 | 371 | 4327 |
| 6-#18 | 4.69 | MA | 5988 | 2043 | 9616 | 1609 | 11306 | 1319 | 12471 | 1072 | 14211 | 682 | 17769 | 260 | 16568 |
| 3L-2S | | MI | 2970 | 2043 | 5336 | 1452 | 6048 | 1185 | 6530 | 944 | 7151 | 498 | 7790 | 159 | 7031 |
| 8-#8 | 1.23 | MA | 5104 | 1538 | 7300 | 1291 | 8514 | 1087 | 9158 | 927 | 9789 | 687 | 11694 | 597 | 4851 |
| 2L-4S | | MI | 2324 | 1538 | 3497 | 1204 | 3815 | 1016 | 3929 | 864 | 3934 | 638 | 4350 | 427 | 2306 |
| 8-#8 | 1.23 | MA | 4900 | 1538 | 6916 | 1299 | 8025 | 1094 | 8564 | 934 | 8985 | 697 | 10581 | 547 | 4857 |
| 3E | | MI | 2368 | 1538 | 3609 | 1200 | 3973 | 1009 | 4122 | 863 | 4188 | 634 | 4642 | 453 | 2290 |
| 8-#8 | 1.23 | MA | 4795 | 1538 | 6656 | 1307 | 7658 | 1106 | 8113 | 946 | 8368 | 703 | 9837 | 515 | 4846 |
| 4L-2S | | MI | 2446 | 1538 | 3768 | 1197 | 4175 | 1007 | 4367 | 857 | 4520 | 631 | 5047 | 510 | 2276 |
| 8-#9 | 1.56 | MA | 5289 | 1586 | 7715 | 1319 | 9029 | 1107 | 9776 | 939 | 10621 | 683 | 12840 | 592 | 6075 |
| 2L-4S | | MI | 2361 | 1586 | 3599 | 1230 | 3931 | 1035 | 4063 | 875 | 4114 | 633 | 4556 | 384 | 2830 |
| 8-#9 | 1.56 | MA | 5038 | 1586 | 7231 | 1328 | 8413 | 1116 | 9028 | 947 | 9608 | 696 | 11438 | 527 | 6073 |
| 3E | | MI | 2415 | 1586 | 3740 | 1226 | 4128 | 1026 | 4305 | 874 | 4432 | 629 | 4917 | 417 | 2812 |
| 8-#9 | 1.56 | MA | 4909 | 1586 | 6903 | 1338 | 7950 | 1131 | 8460 | 962 | 8829 | 702 | 10499 | 488 | 6034 |
| 4L-2S | | MI | 2511 | 1586 | 3938 | 1222 | 4381 | 1024 | 4612 | 867 | 4848 | 625 | 5419 | 489 | 2796 |

## RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis

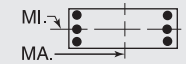



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.98 | MA | 5521 | 1648 | 8242 | 1354 | 9685 | 1132 | 10566 | 955 | 11683 | 677 | 14306 | 586 | 7632 |
| 2L-4S | | MI | 2407 | 1648 | 3726 | 1264 | 4075 | 1060 | 4233 | 889 | 4339 | 626 | 4811 | 328 | 3475 |
| 8-#10 | 1.98 | MA | 5213 | 1648 | 7631 | 1366 | 8907 | 1143 | 9620 | 964 | 10403 | 694 | 12535 | 503 | 7614 |
| 3E | | MI | 2473 | 1648 | 3903 | 1259 | 4324 | 1050 | 4537 | 889 | 4737 | 621 | 5260 | 369 | 3463 |
| 8-#10 | 1.98 | MA | 5055 | 1648 | 7216 | 1378 | 8321 | 1163 | 8902 | 983 | 9419 | 701 | 11344 | 452 | 7521 |
| 4L-2S | | MI | 2591 | 1648 | 4152 | 1255 | 4641 | 1047 | 4922 | 880 | 5256 | 617 | 5879 | 460 | 3445 |
| 8-#11 | 2.44 | MA | 5379 | 1714 | 8064 | 1402 | 9417 | 1168 | 10220 | 979 | 11198 | 688 | 13623 | 472 | 9189 |
| 3E | | MI | 2521 | 1714 | 4073 | 1285 | 4507 | 1065 | 4744 | 896 | 4965 | 599 | 5479 | 295 | 4101 |
| 8-#11 | 2.44 | MA | 5193 | 1714 | 7560 | 1416 | 8706 | 1191 | 9348 | 1000 | 10003 | 696 | 12167 | 409 | 9021 |
| 4L-2S | | MI | 2657 | 1714 | 4368 | 1280 | 4882 | 1064 | 5200 | 888 | 5566 | 594 | 6183 | 407 | 4082 |
| 8-#14 | 3.52 | MA | 5797 | 1872 | 9045 | 1500 | 10637 | 1240 | 11687 | 1023 | 13172 | 682 | 16347 | 408 | 12951 |
| 3E | | MI | 2658 | 1872 | 4451 | 1372 | 4966 | 1126 | 5291 | 934 | 5636 | 569 | 6213 | 152 | 5597 |
| 8-#14 | 3.52 | MA | 5549 | 1872 | 8325 | 1520 | 9620 | 1272 | 10440 | 1054 | 11463 | 694 | 14256 | 316 | 11992 |
| 4L-2S | | MI | 2831 | 1872 | 4865 | 1368 | 5493 | 1126 | 5931 | 924 | 6466 | 561 | 7169 | 314 | 5597 |
| 8-#18 | 6.25 | MA | 6425 | 2271 | 10193 | 1784 | 11869 | 1477 | 13133 | 1187 | 15072 | 684 | 19403 | 77 | 18942 |
| 4L-2S | | MI | 3227 | 2271 | 6031 | 1595 | 6933 | 1288 | 7587 | 1005 | 8496 | 462 | 9290 | 35 | 9125 |
| 10-#10 | 2.48 | MA | 5501 | 1720 | 8242 | 1412 | 9685 | 1176 | 10566 | 985 | 11683 | 689 | 14306 | 497 | 9450 |
| 3L-4S | | MI | 2514 | 1720 | 3974 | 1309 | 4392 | 1093 | 4617 | 909 | 4858 | 621 | 5431 | 303 | 4221 |
| 10-#10 | 2.48 | MA | 5354 | 1720 | 7828 | 1424 | 9100 | 1196 | 9847 | 1003 | 10698 | 697 | 13116 | 446 | 9347 |
| 4L-3S | | MI | 2578 | 1720 | 4152 | 1305 | 4641 | 1083 | 4922 | 909 | 5256 | 617 | 5879 | 344 | 4225 |
| 10-#10 | 2.48 | MA | 5122 | 1720 | 7406 | 1444 | 8591 | 1206 | 9214 | 1013 | 9816 | 713 | 11907 | 404 | 8815 |
| 5L-2S | | MI | 2693 | 1720 | 4401 | 1300 | 4957 | 1080 | 5306 | 901 | 5775 | 613 | 6499 | 436 | 4212 |
| 10-#11 | 3.05 | MA | 5549 | 1803 | 8300 | 1472 | 9649 | 1232 | 10492 | 1026 | 11552 | 691 | 14312 | 402 | 11191 |
| 4L-3S | | MI | 2646 | 1803 | 4368 | 1340 | 4882 | 1106 | 5200 | 921 | 5566 | 591 | 6183 | 259 | 4998 |
| 10-#11 | 3.05 | MA | 5276 | 1803 | 7787 | 1496 | 9030 | 1245 | 9722 | 1037 | 10480 | 710 | 12840 | 347 | 10393 |
| 5L-2S | | MI | 2772 | 1803 | 4662 | 1336 | 5258 | 1104 | 5656 | 913 | 6167 | 585 | 6887 | 372 | 4988 |
| 10-#14 | 4.39 | MA | 6048 | 2000 | 9381 | 1600 | 10965 | 1331 | 12073 | 1090 | 13674 | 686 | 17316 | 306 | 15094 |
| 4L-3S | | MI | 2825 | 2000 | 4865 | 1452 | 5493 | 1184 | 5931 | 970 | 6466 | 554 | 7169 | 95 | 6831 |
| 10-#14 | 4.39 | MA | 5666 | 2000 | 8646 | 1635 | 10079 | 1348 | 10971 | 1105 | 12139 | 712 | 15205 | 224 | 14090 |
| 5L-2S | | MI | 2989 | 2000 | 5279 | 1448 | 6020 | 1184 | 6571 | 960 | 7295 | 547 | 8126 | 257 | 6856 |
| 10-#18 | 7.81 | MA | 6632 | 2500 | 10743 | 1986 | 12657 | 1609 | 14046 | 1276 | 16233 | 713 | 21019 | -99 | 20650 |
| 5L-2S | | MI | 3483 | 2500 | 6726 | 1738 | 7818 | 1392 | 8644 | 1066 | 9841 | 426 | 10790 | -89 | 10725 |
| 12-#10 | 2.98 | MA | 5646 | 1793 | 8439 | 1469 | 9878 | 1228 | 10793 | 1024 | 11978 | 693 | 14887 | 441 | 11174 |
| 4E | | MI | 2620 | 1793 | 4223 | 1355 | 4709 | 1126 | 5002 | 930 | 5377 | 617 | 6050 | 279 | 4917 |
| 12-#10 | 2.98 | MA | 5416 | 1793 | 8017 | 1489 | 9369 | 1239 | 10159 | 1034 | 11095 | 709 | 13679 | 398 | 10621 |
| 5L-3S | | MI | 2682 | 1793 | 4401 | 1350 | 4957 | 1115 | 5306 | 930 | 5775 | 612 | 6499 | 320 | 4981 |
| 12-#10 | 2.98 | MA | 5213 | 1793 | 7611 | 1495 | 8891 | 1250 | 9537 | 1052 | 10254 | 725 | 12499 | 328 | 10203 |
| 6L-2S | | MI | 2794 | 1793 | 4650 | 1345 | 5274 | 1113 | 5691 | 921 | 6295 | 608 | 7118 | 411 | 4974 |
| 12-#11 | 3.66 | MA | 5626 | 1892 | 8527 | 1552 | 9972 | 1285 | 10867 | 1062 | 12029 | 705 | 14984 | 340 | 12584 |
| 5L-3S | | MI | 2766 | 1892 | 4662 | 1396 | 5258 | 1146 | 5656 | 946 | 6167 | 582 | 6887 | 224 | 5885 |
| 12-#11 | 3.66 | MA | 5386 | 1892 | 8042 | 1560 | 9391 | 1298 | 10111 | 1084 | 11005 | 723 | 13542 | 253 | 11869 |
| 6L-2S | | MI | 2887 | 1892 | 4957 | 1392 | 5633 | 1145 | 6111 | 938 | 6769 | 577 | 7591 | 336 | 5887 |
| 12-#14 | 5.27 | MA | 6156 | 2129 | 9702 | 1715 | 11424 | 1407 | 12604 | 1142 | 14350 | 705 | 18265 | 214 | 17234 |
| 5L-3S | | MI | 2988 | 2129 | 5279 | 1533 | 6020 | 1242 | 6571 | 1007 | 7295 | 540 | 8126 | 38 | 8011 |
| 12-#14 | 5.27 | MA | 5830 | 2129 | 9015 | 1727 | 10591 | 1424 | 11522 | 1172 | 12885 | 731 | 16193 | 87 | 15688 |
| 6L-2S | | MI | 3145 | 2129 | 5693 | 1528 | 6546 | 1243 | 7210 | 997 | 8125 | 532 | 9083 | 199 | 8103 |
| 14-#10 | 3.47 | MA | 5705 | 1865 | 8628 | 1535 | 10148 | 1272 | 11105 | 1054 | 12375 | 705 | 15450 | 392 | 12431 |
| 5L-4S | | MI | 2725 | 1865 | 4472 | 1400 | 5026 | 1159 | 5387 | 951 | 5896 | 612 | 6670 | 255 | 5620 |
| 14-#10 | 3.47 | MA | 5509 | 1865 | 8223 | 1541 | 9670 | 1283 | 10483 | 1072 | 11533 | 721 | 14271 | 322 | 12029 |
| 6L-3S | | MI | 2790 | 1865 | 4650 | 1395 | 5274 | 1148 | 5691 | 950 | 6295 | 608 | 7118 | 296 | 5730 |
| 14-#10 | 3.47 | MA | 5342 | 1865 | 7835 | 1548 | 9128 | 1298 | 9886 | 1082 | 10674 | 729 | 13128 | 287 | 11313 |
| 7L-2S | | MI | 2893 | 1865 | 4898 | 1391 | 5591 | 1146 | 6076 | 942 | 6814 | 604 | 7738 | 387 | 5732 |
| 14-#11 | 4.27 | MA | 5739 | 1981 | 8782 | 1615 | 10333 | 1338 | 11255 | 1109 | 12554 | 718 | 15687 | 246 | 14064 |
| 6L-3S | | MI | 2883 | 1981 | 4957 | 1452 | 5633 | 1187 | 6111 | 972 | 6769 | 574 | 7591 | 188 | 6769 |
| 14-#11 | 4.27 | MA | 5543 | 1981 | 8311 | 1624 | 9685 | 1357 | 10528 | 1120 | 11510 | 727 | 14292 | 201 | 13257 |
| 7L-2S | | MI | 3000 | 1981 | 5252 | 1447 | 6008 | 1185 | 6567 | 963 | 7370 | 569 | 8295 | 301 | 6782 |
| 14-#14 | 6.15 | MA | 6325 | 2257 | 10071 | 1807 | 11936 | 1482 | 13155 | 1208 | 15096 | 723 | 19253 | 77 | 18813 |
| 6L-3S | | MI | 3150 | 2257 | 5693 | 1613 | 6546 | 1301 | 7210 | 1043 | 8125 | 525 | 9083 | -20 | 9067 |

## RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 6.15 | MA | 6061 | 2257 | 9397 | 1819 | 11020 | 1510 | 12114 | 1224 | 13601 | 734 | 17252 | 9 | 17209 |
| 7L-2S | | MI | 3300 | 2257 | 6107 | 1609 | 7073 | 1301 | 7850 | 1033 | 8955 | 518 | 10040 | 142 | 9346 |
| 16-#10 | 3.97 | MA | 5799 | 1938 | 8834 | 1586 | 10448 | 1316 | 11428 | 1093 | 12813 | 717 | 16042 | 316 | 13845 |
| 6L-4S | | MI | 2839 | 1938 | 4721 | 1445 | 5342 | 1192 | 5772 | 971 | 6415 | 608 | 7289 | 231 | 6328 |
| 16-#10 | 3.97 | MA | 5640 | 1938 | 8446 | 1593 | 9907 | 1331 | 10831 | 1103 | 11954 | 725 | 14900 | 282 | 13131 |
| 7L-3S | | MI | 2891 | 1938 | 4898 | 1441 | 5591 | 1181 | 6076 | 971 | 6814 | 603 | 7738 | 271 | 6478 |
| 16-#10 | 3.97 | MA | 5444 | 1938 | 8074 | 1602 | 9404 | 1338 | 10204 | 1118 | 11133 | 741 | 13800 | 233 | 12391 |
| 8L-2S | | MI | 2991 | 1938 | 5147 | 1436 | 5908 | 1179 | 6461 | 963 | 7333 | 599 | 8357 | 363 | 6486 |
| 16-#11 | 4.88 | MA | 5899 | 2070 | 9051 | 1680 | 10628 | 1397 | 11673 | 1145 | 13059 | 722 | 16437 | 193 | 15407 |
| 7L-3S | | MI | 3000 | 2070 | 5252 | 1507 | 6008 | 1227 | 6567 | 997 | 7370 | 566 | 8295 | 153 | 7650 |
| 16-#11 | 4.88 | MA | 5667 | 2070 | 8598 | 1690 | 10017 | 1405 | 10924 | 1165 | 12061 | 740 | 15096 | 131 | 14394 |
| 8L-2S | | MI | 3113 | 2070 | 5547 | 1503 | 6383 | 1226 | 7023 | 989 | 7971 | 561 | 8999 | 265 | 7670 |
| 16-#14 | 7.03 | MA | 6562 | 2386 | 10453 | 1899 | 12364 | 1568 | 13747 | 1260 | 15811 | 727 | 20312 | -2 | 20306 |
| 7L-3S | | MI | 3311 | 2386 | 6107 | 1693 | 7073 | 1359 | 7850 | 1079 | 8955 | 511 | 10040 | -77 | 9968 |
| 18-#10 | 4.46 | MA | 5933 | 2010 | 9057 | 1639 | 10685 | 1364 | 11776 | 1123 | 13233 | 720 | 16671 | 276 | 14949 |
| 7L-4S | | MI | 2941 | 2010 | 4970 | 1491 | 5659 | 1225 | 6156 | 992 | 6934 | 603 | 7909 | 206 | 7039 |
| 18-#10 | 4.46 | MA | 5738 | 2010 | 8685 | 1648 | 10182 | 1371 | 11149 | 1139 | 12413 | 737 | 15572 | 227 | 14201 |
| 8L-3S | | MI | 2991 | 2010 | 5147 | 1486 | 5908 | 1214 | 6461 | 992 | 7333 | 599 | 8357 | 247 | 7223 |
| 18-#10 | 4.46 | MA | 5548 | 2010 | 8267 | 1666 | 9665 | 1388 | 10529 | 1146 | 11574 | 744 | 14486 | 183 | 13470 |
| 9L-2S | | MI | 3087 | 2010 | 5396 | 1481 | 6225 | 1212 | 6845 | 983 | 7852 | 595 | 8977 | 339 | 7237 |
| 18-#11 | 5.48 | MA | 6018 | 2159 | 9338 | 1745 | 10959 | 1446 | 12068 | 1190 | 13610 | 735 | 17240 | 124 | 16584 |
| 8L-3S | | MI | 3116 | 2159 | 5547 | 1563 | 6383 | 1267 | 7023 | 1022 | 7971 | 558 | 8999 | 117 | 8529 |
| 20-#10 | 4.96 | MA | 6027 | 2083 | 9296 | 1693 | 10960 | 1404 | 12095 | 1159 | 13692 | 732 | 17343 | 222 | 16012 |
| 8L-4S | | MI | 3043 | 2083 | 5219 | 1536 | 5976 | 1258 | 6541 | 1012 | 7453 | 599 | 8529 | 182 | 7754 |
| 20-#10 | 4.96 | MA | 5844 | 2083 | 8879 | 1711 | 10444 | 1421 | 11475 | 1166 | 12854 | 740 | 16258 | 177 | 15274 |
| 9L-3S | | MI | 3090 | 2083 | 5396 | 1531 | 6225 | 1247 | 6845 | 1012 | 7852 | 594 | 8977 | 223 | 7967 |
| 22-#10 | 5.46 | MA | 6135 | 2155 | 9490 | 1756 | 11222 | 1454 | 12420 | 1187 | 14133 | 736 | 18029 | 171 | 17079 |
| 9L-4S | | MI | 3144 | 2155 | 5467 | 1581 | 6293 | 1291 | 6926 | 1033 | 7973 | 594 | 9148 | 158 | 8471 |

## RECTANGULAR TIED COLUMNS 18" x 18"

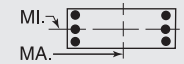
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#8 | 1.46 | MA | 1794 | 995 | 2756 | 784 | 3100 | 658 | 3281 | 558 | 3462 | 406 | 3977 | 335 | 1909 |
| 2L-3S | | MI | 1702 | 995 | 2570 | 788 | 2863 | 661 | 2992 | 566 | 3071 | 411 | 3475 | 278 | 1921 |
| 6-#9 | 1.85 | MA | 1853 | 1031 | 2906 | 803 | 3284 | 672 | 3500 | 566 | 3756 | 402 | 4333 | 323 | 2359 |
| 2L-3S | | MI | 1740 | 1031 | 2672 | 809 | 2986 | 676 | 3138 | 575 | 3266 | 408 | 3709 | 251 | 2370 |
| 6-#10 | 2.35 | MA | 1927 | 1077 | 3095 | 829 | 3515 | 690 | 3777 | 577 | 4129 | 398 | 4777 | 306 | 2924 |
| 2L-3S | | MI | 1787 | 1077 | 2800 | 836 | 3141 | 695 | 3322 | 588 | 3513 | 404 | 4003 | 215 | 2929 |
| 6-#11 | 2.89 | MA | 1989 | 1126 | 3286 | 851 | 3737 | 705 | 4036 | 585 | 4471 | 390 | 5109 | 275 | 3480 |
| 2L-3S | | MI | 1827 | 1126 | 2935 | 858 | 3291 | 709 | 3494 | 596 | 3738 | 396 | 4217 | 163 | 3475 |
| 6-#14 | 4.17 | MA | 2153 | 1245 | 3732 | 919 | 4289 | 753 | 4700 | 614 | 5348 | 376 | 6094 | 220 | 4820 |
| 2L-3S | | MI | 1948 | 1245 | 3238 | 927 | 3660 | 757 | 3936 | 628 | 4319 | 384 | 4869 | 59 | 4721 |
| 6-#18 | 7.41 | MA | 2524 | 1544 | 4793 | 1094 | 5610 | 879 | 6290 | 689 | 7327 | 324 | 8291 | 55 | 7987 |
| 2L-3S | | MI | 2217 | 1544 | 3954 | 1103 | 4543 | 880 | 4994 | 709 | 5633 | 337 | 6323 | -233 | 6148 |
| 8-#8 | 1.95 | MA | 1874 | 1040 | 2943 | 812 | 3338 | 678 | 3569 | 571 | 3853 | 403 | 4479 | 325 | 2484 |
| 2L-4S | | MI | 1735 | 1040 | 2625 | 821 | 2916 | 690 | 3055 | 581 | 3154 | 408 | 3619 | 239 | 2490 |
| 8-#9 | 2.47 | MA | 1952 | 1088 | 3140 | 839 | 3582 | 698 | 3862 | 583 | 4246 | 399 | 4956 | 310 | 3076 |
| 2L-4S | | MI | 1782 | 1088 | 2742 | 850 | 3053 | 712 | 3217 | 594 | 3369 | 404 | 3888 | 201 | 3020 |
| 8-#10 | 3.14 | MA | 2048 | 1149 | 3389 | 874 | 3890 | 723 | 4232 | 598 | 4744 | 393 | 5550 | 288 | 3820 |
| 2L-4S | | MI | 1841 | 1149 | 2887 | 887 | 3225 | 740 | 3421 | 611 | 3642 | 399 | 4223 | 152 | 3593 |
| 8-#11 | 3.85 | MA | 2130 | 1216 | 3636 | 907 | 4183 | 746 | 4578 | 610 | 5204 | 384 | 6000 | 248 | 4544 |
| 2L-4S | | MI | 1890 | 1216 | 3037 | 920 | 3388 | 764 | 3609 | 623 | 3909 | 397 | 4467 | 84 | 4133 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 3.92 | MA | 2169 | 1222 | 3683 | 920 | 4264 | 756 | 4687 | 618 | 5360 | 389 | 6324 | 270 | 4710 |
| 2L-5S | | MI | 1887 | 1222 | 2968 | 948 | 3343 | 778 | 3558 | 642 | 3816 | 401 | 4454 | 79 | 4213 |
| 10-#10 | 3.92 | MA | 2040 | 1222 | 3389 | 926 | 3890 | 760 | 4232 | 629 | 4744 | 396 | 5550 | 179 | 4689 |
| 3L-4S | | MI | 1971 | 1222 | 3181 | 933 | 3599 | 773 | 3876 | 632 | 4257 | 394 | 4997 | 134 | 4423 |
| 10-#11 | 4.81 | MA | 2130 | 1305 | 3636 | 969 | 4183 | 790 | 4578 | 647 | 5204 | 385 | 6000 | 109 | 5560 |
| 3L-4S | | MI | 2043 | 1305 | 3387 | 976 | 3834 | 804 | 4151 | 648 | 4643 | 392 | 5358 | 57 | 5123 |

## RECTANGULAR TIED COLUMNS 18" x 20"

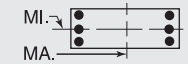
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.11 | MA | 2154 | 1069 | 3223 | 857 | 3625 | 722 | 3817 | 617 | 3968 | 458 | 4566 | 389 | 1849 |
| 2E | | MI | 1926 | 1069 | 2917 | 845 | 3251 | 712 | 3406 | 608 | 3520 | 451 | 3983 | 376 | 1652 |
| 4-#10 | 1.41 | MA | 2213 | 1100 | 3372 | 873 | 3806 | 733 | 4032 | 623 | 4255 | 455 | 4924 | 380 | 2293 |
| 2E | | MI | 1975 | 1100 | 3046 | 861 | 3407 | 723 | 3591 | 614 | 3767 | 447 | 4276 | 364 | 2040 |
| 4-#11 | 1.73 | MA | 2265 | 1133 | 3532 | 885 | 3984 | 741 | 4236 | 626 | 4522 | 448 | 5205 | 361 | 2742 |
| 2E | | MI | 2018 | 1133 | 3184 | 872 | 3557 | 730 | 3762 | 616 | 3990 | 440 | 4488 | 341 | 2431 |
| 4-#14 | 2.50 | MA | 2401 | 1212 | 3887 | 928 | 4418 | 771 | 4754 | 644 | 5218 | 439 | 6020 | 331 | 3804 |
| 2E | | MI | 2131 | 1212 | 3488 | 914 | 3927 | 759 | 4203 | 633 | 4571 | 429 | 5138 | 303 | 3350 |
| 4-#18 | 4.44 | MA | 2712 | 1411 | 4735 | 1041 | 5462 | 851 | 6007 | 691 | 6892 | 419 | 7882 | 240 | 6339 |
| 2E | | MI | 2384 | 1411 | 4208 | 1025 | 4811 | 838 | 5261 | 679 | 5883 | 391 | 6588 | 190 | 5522 |
| 6-#8 | 1.32 | MA | 2202 | 1090 | 3319 | 873 | 3756 | 734 | 3980 | 625 | 4192 | 459 | 4880 | 390 | 2165 |
| 2L-3S | | MI | 1874 | 1090 | 2814 | 866 | 3128 | 727 | 3260 | 623 | 3326 | 457 | 3749 | 318 | 1941 |
| 6-#8 | 1.32 | MA | 2093 | 1090 | 3104 | 879 | 3482 | 738 | 3647 | 633 | 3742 | 465 | 4280 | 333 | 2177 |
| 3L-2S | | MI | 1967 | 1090 | 3000 | 862 | 3366 | 724 | 3549 | 616 | 3717 | 452 | 4251 | 375 | 1928 |
| 6-#9 | 1.67 | MA | 2272 | 1126 | 3493 | 893 | 3969 | 748 | 4234 | 633 | 4533 | 455 | 5312 | 380 | 2683 |
| 2L-3S | | MI | 1911 | 1126 | 2917 | 886 | 3251 | 742 | 3406 | 633 | 3520 | 454 | 3983 | 291 | 2394 |
| 6-#9 | 1.67 | MA | 2139 | 1126 | 3223 | 899 | 3625 | 753 | 3817 | 643 | 3968 | 463 | 4566 | 308 | 2694 |
| 3L-2S | | MI | 2026 | 1126 | 3151 | 881 | 3549 | 738 | 3768 | 624 | 4010 | 448 | 4606 | 363 | 2380 |
| 6-#10 | 2.12 | MA | 2360 | 1172 | 3712 | 919 | 4238 | 766 | 4557 | 644 | 4966 | 451 | 5854 | 367 | 3336 |
| 2L-3S | | MI | 1959 | 1172 | 3046 | 913 | 3407 | 760 | 3591 | 645 | 3767 | 450 | 4276 | 255 | 2960 |
| 6-#10 | 2.12 | MA | 2196 | 1172 | 3372 | 926 | 3806 | 772 | 4032 | 656 | 4255 | 460 | 4924 | 276 | 3340 |
| 3L-2S | | MI | 2100 | 1172 | 3340 | 906 | 3781 | 756 | 4045 | 634 | 4382 | 443 | 5049 | 346 | 2949 |
| 6-#11 | 2.60 | MA | 2436 | 1222 | 3938 | 941 | 4501 | 782 | 4864 | 651 | 5372 | 443 | 6287 | 341 | 3985 |
| 2L-3S | | MI | 1999 | 1222 | 3184 | 934 | 3557 | 774 | 3762 | 653 | 3990 | 441 | 4488 | 202 | 3514 |
| 6-#11 | 2.60 | MA | 2245 | 1222 | 3532 | 949 | 3984 | 788 | 4236 | 665 | 4522 | 452 | 5205 | 229 | 3980 |
| 3L-2S | | MI | 2162 | 1222 | 3534 | 928 | 4003 | 770 | 4304 | 641 | 4723 | 435 | 5379 | 314 | 3510 |
| 6-#14 | 3.75 | MA | 2636 | 1340 | 4462 | 1009 | 5149 | 830 | 5643 | 680 | 6420 | 432 | 7518 | 298 | 5549 |
| 2L-3S | | MI | 2110 | 1340 | 3488 | 1003 | 3927 | 822 | 4203 | 684 | 4571 | 428 | 5138 | 98 | 4814 |
| 6-#14 | 3.75 | MA | 2379 | 1340 | 3887 | 1019 | 4418 | 837 | 4754 | 699 | 5218 | 443 | 6020 | 136 | 5485 |
| 3L-2S | | MI | 2328 | 1340 | 3982 | 994 | 4556 | 818 | 4967 | 670 | 5599 | 421 | 6363 | 260 | 4857 |
| 6-#18 | 6.67 | MA | 3088 | 1640 | 5716 | 1183 | 6711 | 955 | 7524 | 756 | 8940 | 405 | 10328 | 164 | 9283 |
| 2L-3S | | MI | 2385 | 1640 | 4208 | 1177 | 4811 | 943 | 5261 | 764 | 5883 | 381 | 6588 | -194 | 6448 |
| 6-#18 | 6.67 | MA | 2719 | 1640 | 4735 | 1198 | 5462 | 963 | 6007 | 783 | 6892 | 418 | 7882 | -124 | 7743 |
| 3L-2S | | MI | 2700 | 1640 | 5046 | 1168 | 5878 | 942 | 6557 | 744 | 7577 | 367 | 8556 | 93 | 8039 |
| 8-#8 | 1.76 | MA | 2297 | 1135 | 3534 | 902 | 4030 | 755 | 4312 | 638 | 4642 | 456 | 5480 | 383 | 2826 |
| 2L-4S | | MI | 1907 | 1135 | 2869 | 899 | 3182 | 756 | 3324 | 638 | 3408 | 454 | 3894 | 279 | 2519 |
| 8-#8 | 1.76 | MA | 2191 | 1135 | 3319 | 907 | 3756 | 759 | 3980 | 646 | 4192 | 463 | 4880 | 326 | 2834 |
| 3E | | MI | 1956 | 1135 | 3000 | 894 | 3366 | 748 | 3549 | 636 | 3717 | 454 | 4251 | 309 | 2515 |
| 8-#8 | 1.76 | MA | 2134 | 1135 | 3170 | 912 | 3546 | 768 | 3722 | 649 | 3839 | 464 | 4457 | 295 | 2831 |
| 4L-2S | | MI | 2047 | 1135 | 3187 | 890 | 3603 | 745 | 3838 | 629 | 4107 | 449 | 4754 | 365 | 2505 |
| 8-#9 | 2.22 | MA | 2389 | 1183 | 3763 | 929 | 4312 | 774 | 4651 | 649 | 5097 | 452 | 6058 | 371 | 3508 |
| 2L-4S | | MI | 1953 | 1183 | 2986 | 927 | 3318 | 778 | 3485 | 651 | 3623 | 450 | 4162 | 241 | 3094 |
| 8-#9 | 2.22 | MA | 2260 | 1183 | 3493 | 935 | 3969 | 779 | 4234 | 659 | 4533 | 459 | 5312 | 299 | 3511 |
| 3E | | MI | 2014 | 1183 | 3151 | 922 | 3549 | 768 | 3768 | 649 | 4010 | 451 | 4606 | 278 | 3107 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

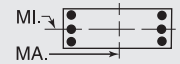
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 2.22 | MA | 2190 | 1183 | 3305 | 941 | 3704 | 791 | 3910 | 663 | 4089 | 460 | 4784 | 260 | 3487 |
| 4L-2S | | MI | 2125 | 1183 | 3385 | 917 | 3847 | 764 | 4130 | 640 | 4500 | 445 | 5229 | 350 | 3099 |
| 8-#10 | 2.82 | MA | 2503 | 1245 | 4051 | 964 | 4670 | 799 | 5081 | 664 | 5676 | 446 | 6784 | 354 | 4369 |
| 2L-4S | | MI | 2012 | 1245 | 3133 | 964 | 3490 | 806 | 3689 | 668 | 3895 | 444 | 4496 | 192 | 3687 |
| 8-#10 | 2.82 | MA | 2346 | 1245 | 3712 | 972 | 4238 | 805 | 4557 | 677 | 4966 | 455 | 5854 | 263 | 4359 |
| 3E | | MI | 2087 | 1245 | 3340 | 958 | 3781 | 793 | 4045 | 666 | 4382 | 446 | 5049 | 237 | 3845 |
| 8-#10 | 2.82 | MA | 2261 | 1245 | 3475 | 980 | 3905 | 820 | 4148 | 681 | 4407 | 456 | 5195 | 215 | 4180 |
| 4L-2S | | MI | 2222 | 1245 | 3635 | 952 | 4156 | 789 | 4500 | 655 | 4998 | 439 | 5823 | 328 | 3847 |
| 8-#11 | 3.47 | MA | 2604 | 1311 | 4345 | 997 | 5018 | 822 | 5492 | 677 | 6222 | 437 | 7368 | 321 | 5218 |
| 2L-4S | | MI | 2061 | 1311 | 3285 | 996 | 3655 | 829 | 3877 | 679 | 4162 | 442 | 4737 | 123 | 4237 |
| 8-#11 | 3.47 | MA | 2421 | 1311 | 3938 | 1005 | 4501 | 828 | 4864 | 691 | 5372 | 447 | 6287 | 209 | 5193 |
| 3E | | MI | 2148 | 1311 | 3534 | 990 | 4003 | 814 | 4304 | 678 | 4723 | 436 | 5379 | 175 | 4562 |
| 8-#11 | 3.47 | MA | 2322 | 1311 | 3653 | 1013 | 4100 | 844 | 4373 | 694 | 4701 | 446 | 5515 | 152 | 4820 |
| 4L-2S | | MI | 2305 | 1311 | 3884 | 983 | 4449 | 811 | 4846 | 667 | 5457 | 429 | 6271 | 287 | 4577 |
| 8-#14 | 5.00 | MA | 2624 | 1469 | 4462 | 1100 | 5149 | 895 | 5643 | 735 | 6420 | 436 | 7518 | 102 | 7186 |
| 3E | | MI | 2326 | 1469 | 3982 | 1083 | 4556 | 880 | 4967 | 721 | 5599 | 420 | 6363 | 54 | 6208 |
| 8-#14 | 5.00 | MA | 2490 | 1469 | 4056 | 1111 | 4580 | 918 | 4946 | 739 | 5503 | 447 | 6445 | 24 | 6343 |
| 4L-2S | | MI | 2520 | 1469 | 4476 | 1075 | 5185 | 876 | 5731 | 706 | 6628 | 413 | 7588 | 216 | 6348 |
| 10-#10 | 3.53 | MA | 2645 | 1317 | 4391 | 1009 | 5102 | 832 | 5606 | 685 | 6386 | 442 | 7713 | 341 | 5396 |
| 2L-5S | | MI | 2059 | 1317 | 3214 | 1025 | 3608 | 843 | 3826 | 700 | 4069 | 447 | 4727 | 119 | 4305 |
| 10-#10 | 3.53 | MA | 2493 | 1317 | 4051 | 1017 | 4670 | 838 | 5081 | 697 | 5676 | 451 | 6784 | 250 | 5375 |
| 3L-4S | | MI | 2142 | 1317 | 3427 | 1010 | 3865 | 839 | 4144 | 689 | 4511 | 440 | 5270 | 174 | 4515 |
| 10-#10 | 3.53 | MA | 2414 | 1317 | 3814 | 1025 | 4337 | 853 | 4673 | 702 | 5118 | 452 | 6125 | 202 | 5142 |
| 4L-3S | | MI | 2212 | 1317 | 3635 | 1003 | 4156 | 826 | 4500 | 686 | 4998 | 442 | 5823 | 219 | 4726 |
| 10-#10 | 3.53 | MA | 2310 | 1317 | 3571 | 1041 | 4044 | 859 | 4310 | 714 | 4613 | 461 | 5472 | 148 | 4875 |
| 5L-2S | | MI | 2343 | 1317 | 3929 | 997 | 4530 | 822 | 4955 | 676 | 5613 | 435 | 6597 | 310 | 4740 |
| 10-#11 | 4.33 | MA | 2595 | 1400 | 4345 | 1061 | 5018 | 868 | 5492 | 716 | 6222 | 441 | 7368 | 189 | 6402 |
| 3L-4S | | MI | 2213 | 1400 | 3636 | 1052 | 4101 | 869 | 4419 | 705 | 4895 | 437 | 5629 | 96 | 5225 |
| 10-#11 | 4.33 | MA | 2502 | 1400 | 4059 | 1069 | 4617 | 885 | 5001 | 719 | 5551 | 440 | 6597 | 132 | 5973 |
| 4L-3S | | MI | 2295 | 1400 | 3884 | 1045 | 4449 | 855 | 4846 | 703 | 5457 | 430 | 6271 | 148 | 5607 |
| 10-#14 | 6.25 | MA | 2742 | 1597 | 4630 | 1191 | 5311 | 976 | 5834 | 775 | 6705 | 440 | 7943 | -10 | 7930 |
| 4L-3S | | MI | 2528 | 1597 | 4476 | 1163 | 5185 | 938 | 5731 | 757 | 6628 | 412 | 7588 | 10 | 7557 |
| 12-#10 | 4.23 | MA | 2639 | 1390 | 4391 | 1062 | 5102 | 871 | 5606 | 718 | 6386 | 447 | 7713 | 237 | 6389 |
| 3L-5S | | MI | 2187 | 1390 | 3508 | 1070 | 3983 | 876 | 4281 | 720 | 4685 | 443 | 5501 | 102 | 5154 |
| 12-#10 | 4.23 | MA | 2564 | 1390 | 4154 | 1070 | 4769 | 886 | 5198 | 722 | 5828 | 448 | 7055 | 189 | 6111 |
| 4E | | MI | 2270 | 1390 | 3721 | 1055 | 4239 | 872 | 4599 | 709 | 5126 | 436 | 6044 | 156 | 5349 |
| 12-#10 | 4.23 | MA | 2461 | 1390 | 3911 | 1086 | 4476 | 892 | 4835 | 735 | 5323 | 457 | 6402 | 135 | 5861 |
| 5L-3S | | MI | 2336 | 1390 | 3929 | 1049 | 4530 | 859 | 4955 | 707 | 5613 | 437 | 6597 | 201 | 5604 |
| 12-#11 | 5.20 | MA | 2679 | 1489 | 4465 | 1125 | 5134 | 925 | 5629 | 745 | 6401 | 435 | 7679 | 112 | 7135 |
| 4E | | MI | 2376 | 1489 | 3986 | 1108 | 4547 | 910 | 4960 | 730 | 5628 | 431 | 6520 | 69 | 6221 |
| 14-#10 | 4.94 | MA | 2712 | 1462 | 4493 | 1116 | 5201 | 919 | 5723 | 743 | 6538 | 444 | 7984 | 175 | 7087 |
| 4L-5S | | MI | 2313 | 1462 | 3802 | 1115 | 4357 | 909 | 4736 | 741 | 5301 | 438 | 6274 | 84 | 5992 |
| 14-#10 | 4.94 | MA | 2610 | 1462 | 4250 | 1132 | 4909 | 925 | 5360 | 755 | 6034 | 453 | 7332 | 122 | 6851 |
| 5L-4S | | MI | 2396 | 1462 | 4015 | 1100 | 4614 | 905 | 5054 | 730 | 5742 | 432 | 6818 | 138 | 6190 |

## RECTANGULAR TIED COLUMNS 18" x 22"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.01 | MA | 2594 | 1164 | 3819 | 947 | 4320 | 799 | 4555 | 683 | 4729 | 511 | 5490 | 442 | 2065 |
| 2E | | MI | 2098 | 1164 | 3162 | 923 | 3517 | 778 | 3674 | 665 | 3774 | 497 | 4257 | 416 | 1669 |
| 4-#10 | 1.28 | MA | 2663 | 1195 | 3989 | 963 | 4526 | 810 | 4800 | 690 | 5056 | 508 | 5915 | 435 | 2568 |
| 2E | | MI | 2148 | 1195 | 3292 | 938 | 3673 | 789 | 3859 | 671 | 4020 | 493 | 4549 | 404 | 2061 |
| 4-#11 | 1.58 | MA | 2725 | 1228 | 4174 | 975 | 4732 | 817 | 5037 | 693 | 5366 | 501 | 6263 | 419 | 3079 |
| 2E | | MI | 2190 | 1228 | 3432 | 948 | 3824 | 794 | 4029 | 673 | 4242 | 485 | 4758 | 381 | 2456 |
| 4-#14 | 2.27 | MA | 2884 | 1307 | 4581 | 1018 | 5230 | 848 | 5632 | 710 | 6164 | 492 | 7244 | 394 | 4290 |
| 2E | | MI | 2304 | 1307 | 3738 | 989 | 4194 | 824 | 4471 | 689 | 4822 | 474 | 5407 | 343 | 3381 |
| 4-#18 | 4.04 | MA | 3256 | 1507 | 5560 | 1130 | 6437 | 928 | 7078 | 757 | 8108 | 473 | 9522 | 319 | 7203 |
| 2E | | MI | 2559 | 1507 | 4461 | 1099 | 5078 | 901 | 5528 | 734 | 6132 | 434 | 6854 | 229 | 5566 |

## RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

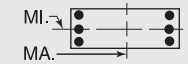
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.20 | MA | 2649 | 1186 | 3927 | 963 | 4467 | 811 | 4738 | 691 | 4980 | 512 | 5852 | 443 | 2421 |
| 2L-3S | | MI | 2045 | 1186 | 3058 | 944 | 3393 | 794 | 3528 | 681 | 3580 | 503 | 4023 | 358 | 1959 |
| 6-#8 | 1.20 | MA | 2524 | 1186 | 3684 | 969 | 4157 | 815 | 4362 | 701 | 4471 | 519 | 5154 | 386 | 2433 |
| 3L-2S | | MI | 2139 | 1186 | 3244 | 939 | 3631 | 790 | 3817 | 674 | 3971 | 498 | 4526 | 415 | 1946 |
| 6-#9 | 1.52 | MA | 2731 | 1221 | 4125 | 982 | 4709 | 824 | 5027 | 699 | 5368 | 508 | 6361 | 436 | 3007 |
| 2L-3S | | MI | 2083 | 1221 | 3162 | 964 | 3517 | 808 | 3674 | 690 | 3774 | 500 | 4257 | 331 | 2417 |
| 6-#9 | 1.52 | MA | 2577 | 1221 | 3819 | 990 | 4320 | 830 | 4555 | 711 | 4729 | 517 | 5490 | 364 | 3018 |
| 3L-2S | | MI | 2199 | 1221 | 3396 | 958 | 3815 | 804 | 4036 | 681 | 4264 | 494 | 4880 | 403 | 2401 |
| 6-#10 | 1.92 | MA | 2833 | 1268 | 4374 | 1008 | 5015 | 843 | 5395 | 710 | 5861 | 504 | 7002 | 426 | 3747 |
| 2L-3S | | MI | 2131 | 1268 | 3292 | 990 | 3673 | 826 | 3859 | 703 | 4020 | 496 | 4549 | 295 | 2987 |
| 6-#10 | 1.92 | MA | 2643 | 1268 | 3989 | 1017 | 4526 | 850 | 4800 | 724 | 5056 | 514 | 5915 | 334 | 3752 |
| 3L-2S | | MI | 2273 | 1268 | 3586 | 983 | 4047 | 821 | 4313 | 692 | 4636 | 489 | 5322 | 386 | 2972 |
| 6-#11 | 2.36 | MA | 2923 | 1317 | 4636 | 1031 | 5320 | 858 | 5751 | 718 | 6332 | 496 | 7537 | 404 | 4491 |
| 2L-3S | | MI | 2170 | 1317 | 3432 | 1010 | 3824 | 839 | 4029 | 709 | 4242 | 486 | 4758 | 242 | 3551 |
| 6-#11 | 2.36 | MA | 2702 | 1317 | 4174 | 1040 | 4732 | 866 | 5037 | 734 | 5366 | 507 | 6263 | 291 | 4486 |
| 3L-2S | | MI | 2335 | 1317 | 3782 | 1004 | 4270 | 835 | 4571 | 698 | 4976 | 480 | 5650 | 354 | 3539 |
| 6-#14 | 3.41 | MA | 3158 | 1436 | 5236 | 1098 | 6064 | 906 | 6644 | 747 | 7534 | 485 | 9018 | 369 | 6278 |
| 2L-3S | | MI | 2281 | 1436 | 3738 | 1078 | 4194 | 886 | 4471 | 740 | 4822 | 473 | 5407 | 137 | 4866 |
| 6-#14 | 3.41 | MA | 2859 | 1436 | 4581 | 1111 | 5230 | 916 | 5632 | 768 | 6164 | 500 | 7244 | 207 | 6214 |
| 3L-2S | | MI | 2503 | 1436 | 4232 | 1070 | 4823 | 882 | 5235 | 726 | 5851 | 465 | 6632 | 299 | 4893 |
| 6-#18 | 6.06 | MA | 3696 | 1735 | 6684 | 1273 | 7867 | 1032 | 8816 | 822 | 10459 | 460 | 12454 | 260 | 10579 |
| 2L-3S | | MI | 2554 | 1735 | 4461 | 1251 | 5078 | 1006 | 5528 | 819 | 6132 | 424 | 6854 | -156 | 6745 |
| 6-#18 | 6.06 | MA | 3238 | 1735 | 5560 | 1292 | 6437 | 1045 | 7078 | 855 | 8108 | 480 | 9522 | -28 | 9480 |
| 3L-2S | | MI | 2876 | 1735 | 5299 | 1242 | 6145 | 1005 | 6824 | 799 | 7826 | 411 | 8821 | 132 | 8090 |
| 8-#8 | 1.60 | MA | 2758 | 1231 | 4170 | 991 | 4776 | 831 | 5114 | 704 | 5489 | 509 | 6550 | 438 | 3167 |
| 2L-4S | | MI | 2078 | 1231 | 3113 | 976 | 3447 | 823 | 3592 | 696 | 3663 | 500 | 4168 | 320 | 2545 |
| 8-#8 | 1.60 | MA | 2636 | 1231 | 3927 | 997 | 4467 | 836 | 4738 | 713 | 4980 | 517 | 5852 | 382 | 3175 |
| 3E | | MI | 2128 | 1231 | 3244 | 972 | 3631 | 814 | 3817 | 694 | 3971 | 500 | 4526 | 349 | 2537 |
| 8-#8 | 1.60 | MA | 2572 | 1231 | 3759 | 1003 | 4230 | 846 | 4448 | 717 | 4584 | 519 | 5362 | 349 | 3173 |
| 4L-2S | | MI | 2220 | 1231 | 3431 | 967 | 3869 | 811 | 4106 | 687 | 4362 | 495 | 5028 | 406 | 2526 |
| 8-#9 | 2.02 | MA | 2865 | 1279 | 4430 | 1018 | 5098 | 850 | 5500 | 716 | 6007 | 505 | 7231 | 429 | 3940 |
| 2L-4S | | MI | 2125 | 1279 | 3231 | 1005 | 3584 | 844 | 3753 | 709 | 3877 | 496 | 4436 | 282 | 3129 |
| 8-#9 | 2.02 | MA | 2716 | 1279 | 4125 | 1025 | 4709 | 856 | 5027 | 727 | 5368 | 514 | 6361 | 357 | 3943 |
| 3E | | MI | 2186 | 1279 | 3396 | 999 | 3815 | 834 | 4036 | 707 | 4264 | 496 | 4880 | 318 | 3133 |
| 8-#9 | 2.02 | MA | 2637 | 1279 | 3913 | 1033 | 4411 | 869 | 4662 | 732 | 4869 | 516 | 5749 | 317 | 3919 |
| 4L-2S | | MI | 2298 | 1279 | 3630 | 994 | 4113 | 830 | 4398 | 698 | 4754 | 490 | 5503 | 390 | 3123 |
| 8-#10 | 2.57 | MA | 2999 | 1340 | 4759 | 1054 | 5505 | 876 | 5990 | 731 | 6667 | 499 | 8089 | 416 | 4917 |
| 2L-4S | | MI | 2183 | 1340 | 3379 | 1041 | 3756 | 872 | 3957 | 726 | 4149 | 490 | 4769 | 232 | 3778 |
| 8-#10 | 2.57 | MA | 2817 | 1340 | 4374 | 1062 | 5015 | 883 | 5395 | 745 | 5861 | 510 | 7002 | 325 | 4908 |
| 3E | | MI | 2259 | 1340 | 3586 | 1035 | 4047 | 859 | 4313 | 723 | 4636 | 491 | 5322 | 277 | 3877 |
| 8-#10 | 2.57 | MA | 2720 | 1340 | 4107 | 1071 | 4640 | 899 | 4934 | 750 | 5232 | 513 | 6236 | 274 | 4782 |
| 4L-2S | | MI | 2396 | 1340 | 3880 | 1029 | 4421 | 854 | 4768 | 712 | 5251 | 485 | 6096 | 368 | 3873 |
| 8-#11 | 3.15 | MA | 3118 | 1406 | 5098 | 1086 | 5908 | 898 | 6465 | 743 | 7299 | 490 | 8811 | 389 | 5892 |
| 2L-4S | | MI | 2231 | 1406 | 3533 | 1072 | 3921 | 894 | 4144 | 736 | 4414 | 487 | 5008 | 163 | 4338 |
| 8-#11 | 3.15 | MA | 2907 | 1406 | 4636 | 1096 | 5320 | 906 | 5751 | 759 | 6332 | 502 | 7537 | 277 | 5867 |
| 3E | | MI | 2320 | 1406 | 3782 | 1066 | 4270 | 879 | 4571 | 735 | 4976 | 481 | 5650 | 215 | 4603 |
| 8-#11 | 3.15 | MA | 2793 | 1406 | 4314 | 1106 | 4867 | 924 | 5196 | 765 | 5574 | 503 | 6636 | 216 | 5526 |
| 4L-2S | | MI | 2478 | 1406 | 4133 | 1059 | 4716 | 875 | 5113 | 723 | 5709 | 474 | 6541 | 327 | 4609 |
| 8-#14 | 4.55 | MA | 3144 | 1564 | 5236 | 1191 | 6064 | 974 | 6644 | 805 | 7534 | 492 | 9018 | 181 | 8158 |
| 3E | | MI | 2497 | 1564 | 4232 | 1158 | 4823 | 944 | 5235 | 777 | 5851 | 465 | 6632 | 93 | 6331 |
| 8-#14 | 4.55 | MA | 2991 | 1564 | 4778 | 1205 | 5420 | 999 | 5855 | 811 | 6455 | 493 | 7758 | 97 | 7286 |
| 4L-2S | | MI | 2695 | 1564 | 4726 | 1150 | 5452 | 940 | 5999 | 762 | 6879 | 457 | 7857 | 255 | 6388 |
| 10-#10 | 3.21 | MA | 3162 | 1413 | 5143 | 1099 | 5995 | 909 | 6585 | 751 | 7472 | 495 | 9176 | 407 | 6081 |
| 2L-5S | | MI | 2230 | 1413 | 3460 | 1102 | 3874 | 909 | 4094 | 757 | 4323 | 492 | 5000 | 159 | 4385 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

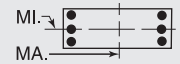
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 3.21 | MA | 2987 | 1413 | 4759 | 1108 | 5505 | 916 | 5990 | 765 | 6667 | 506 | 8089 | 316 | 6061 |
| 3L-4S | | MI | 2313 | 1413 | 3673 | 1087 | 4131 | 905 | 4412 | 746 | 4764 | 486 | 5543 | 214 | 4602 |
| 10-#10 | 3.21 | MA | 2897 | 1413 | 4492 | 1116 | 5130 | 932 | 5530 | 771 | 6037 | 508 | 7324 | 265 | 5877 |
| 4L-3S | | MI | 2384 | 1413 | 3880 | 1080 | 4421 | 892 | 4768 | 744 | 5251 | 487 | 6096 | 259 | 4761 |
| 10-#10 | 3.21 | MA | 2772 | 1413 | 4219 | 1134 | 4801 | 939 | 5121 | 785 | 5469 | 519 | 6561 | 212 | 5539 |
| 5L-2S | | MI | 2517 | 1413 | 4174 | 1074 | 4796 | 887 | 5223 | 733 | 5867 | 480 | 6870 | 350 | 4768 |
| 10-#11 | 3.94 | MA | 3107 | 1496 | 5098 | 1152 | 5908 | 947 | 6465 | 784 | 7299 | 497 | 8811 | 262 | 7245 |
| 3L-4S | | MI | 2384 | 1496 | 3884 | 1128 | 4367 | 934 | 4686 | 761 | 5147 | 482 | 5899 | 136 | 5322 |
| 10-#11 | 3.94 | MA | 3002 | 1496 | 4776 | 1162 | 5455 | 965 | 5910 | 790 | 6540 | 498 | 7909 | 201 | 6841 |
| 4L-3S | | MI | 2467 | 1496 | 4133 | 1122 | 4716 | 920 | 5113 | 760 | 5709 | 475 | 6541 | 188 | 5650 |
| 10-#11 | 3.94 | MA | 2859 | 1496 | 4446 | 1182 | 5058 | 972 | 5417 | 806 | 5855 | 510 | 7015 | 136 | 6483 |
| 5L-2S | | MI | 2619 | 1496 | 4483 | 1115 | 5162 | 916 | 5655 | 748 | 6443 | 469 | 7433 | 300 | 5672 |
| 10-#14 | 5.68 | MA | 3284 | 1693 | 5432 | 1285 | 6253 | 1058 | 6868 | 848 | 7825 | 485 | 9532 | 72 | 9169 |
| 4L-3S | | MI | 2700 | 1693 | 4726 | 1238 | 5452 | 1003 | 5999 | 813 | 6879 | 456 | 7857 | 49 | 7703 |
| 12-#10 | 3.85 | MA | 3155 | 1485 | 5143 | 1153 | 5995 | 949 | 6585 | 786 | 7472 | 502 | 9176 | 307 | 7212 |
| 3L-5S | | MI | 2358 | 1485 | 3754 | 1147 | 4249 | 942 | 4549 | 777 | 4938 | 488 | 5773 | 142 | 5233 |
| 12-#10 | 3.85 | MA | 3070 | 1485 | 4877 | 1162 | 5620 | 964 | 6125 | 792 | 6842 | 504 | 8411 | 256 | 6979 |
| 4E | | MI | 2441 | 1485 | 3967 | 1132 | 4505 | 938 | 4867 | 767 | 5380 | 481 | 6317 | 196 | 5435 |
| 12-#10 | 3.85 | MA | 2947 | 1485 | 4604 | 1179 | 5291 | 972 | 5716 | 806 | 6274 | 515 | 7648 | 203 | 6660 |
| 5L-3S | | MI | 2509 | 1485 | 4174 | 1126 | 4796 | 925 | 5223 | 764 | 5867 | 483 | 6870 | 241 | 5641 |
| 12-#10 | 3.85 | MA | 2822 | 1485 | 4366 | 1187 | 4967 | 987 | 5314 | 811 | 5731 | 526 | 6949 | 144 | 6265 |
| 6L-2S | | MI | 2637 | 1485 | 4469 | 1119 | 5170 | 920 | 5678 | 753 | 6483 | 476 | 7644 | 332 | 5658 |
| 12-#11 | 4.73 | MA | 3206 | 1585 | 5237 | 1217 | 6043 | 1005 | 6624 | 815 | 7506 | 493 | 9183 | 186 | 8167 |
| 4E | | MI | 2534 | 1585 | 4234 | 1184 | 4813 | 974 | 5228 | 786 | 5881 | 476 | 6791 | 109 | 6316 |
| 12-#11 | 4.73 | MA | 3064 | 1585 | 4908 | 1237 | 5646 | 1013 | 6131 | 831 | 6821 | 505 | 8289 | 121 | 7818 |
| 5L-3S | | MI | 2620 | 1585 | 4483 | 1177 | 5162 | 960 | 5655 | 785 | 6443 | 470 | 7433 | 161 | 6695 |
| 14-#10 | 4.49 | MA | 3240 | 1558 | 5261 | 1207 | 6110 | 997 | 6720 | 812 | 7647 | 500 | 9498 | 247 | 8088 |
| 4L-5S | | MI | 2485 | 1558 | 4048 | 1192 | 4623 | 975 | 5004 | 798 | 5554 | 484 | 6547 | 124 | 6086 |
| 14-#10 | 4.49 | MA | 3118 | 1558 | 4989 | 1224 | 5781 | 1005 | 6311 | 826 | 7080 | 511 | 8735 | 194 | 7786 |
| 5L-4S | | MI | 2568 | 1558 | 4261 | 1177 | 4880 | 971 | 5322 | 787 | 5995 | 477 | 7090 | 178 | 6274 |
| 14-#10 | 4.49 | MA | 2998 | 1558 | 4751 | 1232 | 5456 | 1020 | 5909 | 832 | 6536 | 522 | 8036 | 135 | 7378 |
| 6L-3S | | MI | 2632 | 1558 | 4469 | 1171 | 5170 | 958 | 5678 | 785 | 6483 | 479 | 7644 | 223 | 6520 |
| 14-#11 | 5.52 | MA | 3266 | 1674 | 5369 | 1293 | 6234 | 1053 | 6845 | 856 | 7787 | 499 | 9563 | 106 | 9132 |
| 5L-4S | | MI | 2695 | 1674 | 4585 | 1239 | 5260 | 1015 | 5770 | 812 | 6614 | 471 | 7682 | 82 | 7317 |
| 16-#10 | 5.13 | MA | 3286 | 1630 | 5373 | 1270 | 6271 | 1038 | 6906 | 847 | 7885 | 507 | 9822 | 185 | 8915 |
| 5E | | MI | 2610 | 1630 | 4342 | 1238 | 4998 | 1008 | 5458 | 819 | 6170 | 480 | 7321 | 106 | 6941 |
| 16-#10 | 5.13 | MA | 3171 | 1630 | 5135 | 1277 | 5946 | 1053 | 6504 | 852 | 7342 | 518 | 9123 | 126 | 8494 |
| 6L-4S | | MI | 2692 | 1630 | 4555 | 1223 | 5254 | 1003 | 5777 | 808 | 6611 | 473 | 7864 | 160 | 7117 |

## RECTANGULAR TIED COLUMNS 18" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.18 | MA | 3152 | 1291 | 4651 | 1052 | 5300 | 886 | 5626 | 756 | 5916 | 561 | 6974 | 487 | 2842 |
| 2E | | MI | 2320 | 1291 | 3538 | 1015 | 3938 | 854 | 4127 | 728 | 4274 | 539 | 4821 | 444 | 2080 |
| 4-#11 | 1.44 | MA | 3224 | 1324 | 4861 | 1064 | 5535 | 894 | 5896 | 759 | 6268 | 554 | 7391 | 474 | 3416 |
| 2E | | MI | 2362 | 1324 | 3680 | 1024 | 4090 | 859 | 4297 | 729 | 4495 | 530 | 5029 | 420 | 2480 |
| 4-#14 | 2.08 | MA | 3408 | 1403 | 5320 | 1107 | 6098 | 924 | 6568 | 777 | 7169 | 545 | 8539 | 454 | 4776 |
| 2E | | MI | 2477 | 1403 | 3988 | 1065 | 4461 | 888 | 4738 | 745 | 5074 | 518 | 5675 | 382 | 3411 |
| 4-#18 | 3.70 | MA | 3837 | 1602 | 6431 | 1220 | 7466 | 1004 | 8209 | 824 | 9374 | 526 | 11239 | 392 | 8067 |
| 2E | | MI | 2733 | 1602 | 4714 | 1173 | 5346 | 964 | 5794 | 789 | 6382 | 478 | 7119 | 267 | 5609 |
| 6-#8 | 1.10 | MA | 3135 | 1281 | 4579 | 1052 | 5232 | 887 | 5555 | 758 | 5828 | 565 | 6861 | 492 | 2677 |
| 2L-3S | | MI | 2217 | 1281 | 3302 | 1021 | 3658 | 860 | 3797 | 739 | 3834 | 549 | 4298 | 399 | 1977 |
| 6-#8 | 1.10 | MA | 2993 | 1281 | 4308 | 1059 | 4887 | 892 | 5135 | 763 | 5260 | 573 | 6074 | 436 | 2689 |
| 3L-2S | | MI | 2312 | 1281 | 3488 | 1017 | 3896 | 857 | 4085 | 732 | 4225 | 544 | 4800 | 456 | 1963 |
| 6-#9 | 1.39 | MA | 3229 | 1317 | 4801 | 1072 | 5504 | 901 | 5879 | 766 | 6262 | 561 | 7459 | 487 | 3331 |
| 2L-3S | | MI | 2255 | 1317 | 3407 | 1041 | 3782 | 874 | 3942 | 748 | 4028 | 545 | 4530 | 371 | 2438 |
| 6-#9 | 1.39 | MA | 3053 | 1317 | 4460 | 1080 | 5069 | 908 | 5351 | 772 | 5548 | 571 | 6470 | 416 | 3342 |
| 3L-2S | | MI | 2371 | 1317 | 3641 | 1036 | 4080 | 870 | 4304 | 739 | 4518 | 540 | 5154 | 443 | 2421 |

## RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

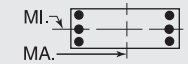
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 1.76 | MA | 3345 | 1363 | 5081 | 1098 | 5848 | 919 | 6292 | 777 | 6816 | 557 | 8219 | 482 | 4158 |
| 2L-3S | | MI | 2302 | 1363 | 3538 | 1067 | 3938 | 892 | 4127 | 760 | 4274 | 541 | 4821 | 335 | 3013 |
| 6-#10 | 1.76 | MA | 3130 | 1363 | 4651 | 1107 | 5300 | 927 | 5626 | 792 | 5916 | 569 | 6974 | 390 | 4163 |
| 3L-2S | | MI | 2445 | 1363 | 3832 | 1060 | 4313 | 887 | 4582 | 749 | 4889 | 534 | 5595 | 426 | 2995 |
| 6-#11 | 2.17 | MA | 3451 | 1413 | 5378 | 1120 | 6194 | 934 | 6696 | 784 | 7351 | 549 | 8858 | 463 | 4996 |
| 2L-3S | | MI | 2342 | 1413 | 3680 | 1086 | 4090 | 904 | 4297 | 766 | 4495 | 531 | 5029 | 281 | 3584 |
| 6-#11 | 2.17 | MA | 3198 | 1413 | 4861 | 1131 | 5535 | 943 | 5896 | 802 | 6268 | 562 | 7391 | 351 | 4991 |
| 3L-2S | | MI | 2508 | 1413 | 4031 | 1080 | 4536 | 900 | 4839 | 754 | 5228 | 525 | 5920 | 393 | 3567 |
| 6-#14 | 3.13 | MA | 3720 | 1531 | 6055 | 1188 | 7033 | 983 | 7705 | 813 | 8707 | 538 | 10591 | 435 | 7007 |
| 2L-3S | | MI | 2452 | 1531 | 3988 | 1153 | 4461 | 950 | 4738 | 796 | 5074 | 518 | 5675 | 176 | 4915 |
| 6-#14 | 3.13 | MA | 3379 | 1531 | 5320 | 1202 | 6098 | 994 | 6568 | 837 | 7169 | 556 | 8539 | 273 | 6943 |
| 3L-2S | | MI | 2677 | 1531 | 4482 | 1145 | 5090 | 946 | 5502 | 782 | 6102 | 510 | 6900 | 338 | 4927 |
| 6-#18 | 5.56 | MA | 4349 | 1831 | 7697 | 1362 | 9079 | 1108 | 10167 | 889 | 12024 | 513 | 14660 | 346 | 11875 |
| 2L-3S | | MI | 2724 | 1831 | 4714 | 1325 | 5346 | 1069 | 5794 | 874 | 6382 | 468 | 7119 | -117 | 7040 |
| 6-#18 | 5.56 | MA | 3816 | 1831 | 6431 | 1385 | 7466 | 1125 | 8209 | 927 | 9374 | 539 | 11239 | 58 | 11061 |
| 3L-2S | | MI | 3051 | 1831 | 5552 | 1316 | 6413 | 1068 | 7091 | 854 | 8076 | 455 | 9087 | 170 | 8140 |
| 8-#8 | 1.46 | MA | 3259 | 1326 | 4851 | 1081 | 5578 | 907 | 5975 | 771 | 6396 | 562 | 7647 | 488 | 3508 |
| 2L-4S | | MI | 2250 | 1326 | 3357 | 1054 | 3712 | 889 | 3860 | 754 | 3917 | 546 | 4443 | 360 | 2569 |
| 8-#8 | 1.46 | MA | 3121 | 1326 | 4579 | 1087 | 5232 | 913 | 5555 | 775 | 5828 | 570 | 6861 | 432 | 3516 |
| 3E | | MI | 2300 | 1326 | 3488 | 1050 | 3896 | 880 | 4085 | 752 | 4225 | 546 | 4800 | 389 | 2557 |
| 8-#8 | 1.46 | MA | 3048 | 1326 | 4393 | 1093 | 4970 | 924 | 5233 | 785 | 5387 | 573 | 6315 | 400 | 3514 |
| 4L-2S | | MI | 2393 | 1326 | 3675 | 1045 | 4134 | 877 | 4374 | 744 | 4616 | 541 | 5302 | 446 | 2545 |
| 8-#9 | 1.85 | MA | 3382 | 1374 | 5142 | 1108 | 5938 | 927 | 6407 | 782 | 6976 | 558 | 8448 | 483 | 4372 |
| 2L-4S | | MI | 2296 | 1374 | 3476 | 1082 | 3849 | 910 | 4021 | 766 | 4131 | 541 | 4709 | 322 | 3161 |
| 8-#9 | 1.85 | MA | 3212 | 1374 | 4801 | 1115 | 5504 | 933 | 5879 | 788 | 6262 | 568 | 7459 | 411 | 4375 |
| 3E | | MI | 2358 | 1374 | 3641 | 1077 | 4080 | 900 | 4304 | 764 | 4518 | 542 | 5154 | 358 | 3157 |
| 8-#9 | 1.85 | MA | 3123 | 1374 | 4566 | 1123 | 5173 | 947 | 5474 | 800 | 5707 | 571 | 6770 | 370 | 4351 |
| 4L-2S | | MI | 2471 | 1374 | 3875 | 1071 | 4378 | 896 | 4666 | 755 | 5008 | 536 | 5777 | 430 | 3145 |
| 8-#10 | 2.35 | MA | 3534 | 1436 | 5511 | 1143 | 6396 | 952 | 6957 | 797 | 7716 | 552 | 9464 | 476 | 5466 |
| 2L-4S | | MI | 2354 | 1436 | 3625 | 1118 | 4022 | 937 | 4225 | 783 | 4402 | 535 | 5042 | 272 | 3865 |
| 8-#10 | 2.35 | MA | 3327 | 1436 | 5081 | 1153 | 5848 | 960 | 6292 | 813 | 6816 | 565 | 8219 | 384 | 5457 |
| 3E | | MI | 2431 | 1436 | 3832 | 1112 | 4313 | 925 | 4582 | 780 | 4889 | 537 | 5595 | 317 | 3908 |
| 8-#10 | 2.35 | MA | 3218 | 1436 | 4784 | 1162 | 5431 | 977 | 5780 | 819 | 6115 | 569 | 7347 | 331 | 5389 |
| 4L-2S | | MI | 2569 | 1436 | 4126 | 1106 | 4687 | 920 | 5036 | 770 | 5505 | 530 | 6369 | 408 | 3899 |
| 8-#11 | 2.89 | MA | 3673 | 1502 | 5895 | 1176 | 6853 | 975 | 7497 | 810 | 8434 | 543 | 10325 | 452 | 6566 |
| 2L-4S | | MI | 2402 | 1502 | 3782 | 1149 | 4187 | 958 | 4412 | 792 | 4666 | 532 | 5278 | 202 | 4435 |
| 8-#11 | 2.89 | MA | 3432 | 1502 | 5378 | 1187 | 6194 | 984 | 6696 | 827 | 7351 | 557 | 8858 | 340 | 6540 |
| 3E | | MI | 2492 | 1502 | 4031 | 1142 | 4536 | 944 | 4839 | 791 | 5228 | 526 | 5920 | 254 | 4642 |
| 8-#11 | 2.89 | MA | 3304 | 1502 | 5020 | 1198 | 5690 | 1003 | 6078 | 834 | 6505 | 560 | 7826 | 277 | 6247 |
| 4L-2S | | MI | 2652 | 1502 | 4381 | 1135 | 4982 | 940 | 5381 | 780 | 5961 | 519 | 6812 | 366 | 4640 |
| 8-#14 | 4.17 | MA | 3704 | 1660 | 6055 | 1283 | 7033 | 1053 | 7705 | 874 | 8707 | 548 | 10591 | 254 | 9130 |
| 3E | | MI | 2669 | 1660 | 4482 | 1234 | 5090 | 1009 | 5502 | 833 | 6102 | 509 | 6900 | 132 | 6384 |
| 8-#14 | 4.17 | MA | 3532 | 1660 | 5544 | 1298 | 6315 | 1080 | 6824 | 883 | 7502 | 552 | 9143 | 166 | 8249 |
| 4L-2S | | MI | 2871 | 1660 | 4976 | 1225 | 5719 | 1005 | 6266 | 818 | 7131 | 502 | 8126 | 294 | 6427 |
| 8-#18 | 7.41 | MA | 4394 | 2059 | 7697 | 1528 | 9079 | 1229 | 10167 | 991 | 12024 | 526 | 14660 | 12 | 14619 |
| 3E | | MI | 3067 | 2059 | 5552 | 1468 | 6413 | 1173 | 7091 | 938 | 8076 | 445 | 9087 | -214 | 8891 |
| 8-#18 | 7.41 | MA | 4090 | 2059 | 6810 | 1551 | 7832 | 1273 | 8640 | 1003 | 9936 | 526 | 12229 | -137 | 12019 |
| 4L-2S | | MI | 3366 | 2059 | 6390 | 1458 | 7480 | 1172 | 8387 | 919 | 9770 | 431 | 11054 | 73 | 10650 |
| 10-#10 | 2.94 | MA | 3720 | 1508 | 5941 | 1188 | 6943 | 985 | 7622 | 818 | 8616 | 548 | 10710 | 470 | 6767 |
| 2L-5S | | MI | 2401 | 1508 | 3706 | 1179 | 4140 | 975 | 4362 | 814 | 4576 | 538 | 5272 | 199 | 4462 |
| 10-#10 | 2.94 | MA | 3521 | 1508 | 5511 | 1198 | 6396 | 993 | 6957 | 833 | 7716 | 560 | 9464 | 378 | 6746 |
| 3L-4S | | MI | 2485 | 1508 | 3919 | 1164 | 4396 | 970 | 4680 | 803 | 5018 | 531 | 5816 | 254 | 4687 |
| 10-#10 | 2.94 | MA | 3419 | 1508 | 5214 | 1208 | 5978 | 1010 | 6445 | 840 | 7015 | 564 | 8592 | 325 | 6627 |
| 4L-3S | | MI | 2557 | 1508 | 4126 | 1157 | 4687 | 957 | 5036 | 801 | 5505 | 533 | 6369 | 299 | 4794 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

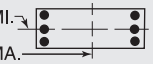
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.94 | MA | 3273 | 1508 | 4912 | 1226 | 5613 | 1018 | 5991 | 855 | 6384 | 577 | 7719 | 273 | 6212 |
| 5L-2S | | MI | 2691 | 1508 | 4420 | 1151 | 5062 | 953 | 5491 | 790 | 6121 | 526 | 7143 | 390 | 4795 |
| 10-#11 | 3.61 | MA | 3660 | 1591 | 5895 | 1242 | 6853 | 1024 | 7497 | 852 | 8434 | 552 | 10325 | 330 | 8087 |
| 3L-4S | | MI | 2555 | 1591 | 4132 | 1204 | 4634 | 999 | 4954 | 818 | 5400 | 527 | 6169 | 175 | 5417 |
| 10-#11 | 3.61 | MA | 3541 | 1591 | 5537 | 1253 | 6349 | 1044 | 6878 | 860 | 7588 | 555 | 9293 | 266 | 7727 |
| 4L-3S | | MI | 2639 | 1591 | 4381 | 1198 | 4982 | 985 | 5381 | 816 | 5961 | 520 | 6812 | 227 | 5692 |
| 10-#11 | 3.61 | MA | 3373 | 1591 | 5170 | 1275 | 5907 | 1053 | 6329 | 877 | 6825 | 569 | 8264 | 202 | 7286 |
| 5L-2S | | MI | 2794 | 1591 | 4731 | 1191 | 5429 | 981 | 5923 | 805 | 6695 | 514 | 7703 | 340 | 5705 |
| 10-#14 | 5.21 | MA | 3865 | 1788 | 6279 | 1378 | 7251 | 1138 | 7960 | 919 | 9040 | 544 | 11195 | 147 | 10370 |
| 4L-3S | | MI | 2872 | 1788 | 4976 | 1314 | 5719 | 1067 | 6266 | 869 | 7131 | 501 | 8126 | 88 | 7844 |
| 10-#14 | 5.21 | MA | 3632 | 1788 | 5756 | 1408 | 6620 | 1150 | 7178 | 943 | 7953 | 562 | 9755 | 53 | 9554 |
| 5L-2S | | MI | 3061 | 1788 | 5470 | 1306 | 6348 | 1063 | 7030 | 854 | 8159 | 493 | 9351 | 250 | 7914 |
| 12-#10 | 3.53 | MA | 3711 | 1581 | 5941 | 1243 | 6943 | 1026 | 7622 | 854 | 8616 | 556 | 10710 | 372 | 8034 |
| 3L-5S | | MI | 2530 | 1581 | 4000 | 1224 | 4514 | 1008 | 4817 | 835 | 5192 | 534 | 6046 | 182 | 5309 |
| 12-#10 | 3.53 | MA | 3616 | 1581 | 5645 | 1253 | 6526 | 1043 | 7110 | 860 | 7915 | 560 | 9837 | 319 | 7863 |
| 4E | | MI | 2613 | 1581 | 4213 | 1209 | 4771 | 1003 | 5135 | 824 | 5633 | 527 | 6589 | 236 | 5518 |
| 12-#10 | 3.53 | MA | 3471 | 1581 | 5342 | 1271 | 6161 | 1051 | 6656 | 876 | 7285 | 572 | 8964 | 267 | 7469 |
| 5L-3S | | MI | 2681 | 1581 | 4420 | 1203 | 5062 | 990 | 5491 | 821 | 6121 | 529 | 7143 | 281 | 5676 |
| 12-#10 | 3.53 | MA | 3331 | 1581 | 5070 | 1278 | 5801 | 1068 | 6210 | 882 | 6682 | 585 | 8166 | 206 | 7081 |
| 6L-2S | | MI | 2812 | 1581 | 4714 | 1196 | 5436 | 986 | 5946 | 811 | 6736 | 522 | 7916 | 372 | 5688 |
| 12-#11 | 4.33 | MA | 3774 | 1680 | 6055 | 1309 | 7007 | 1084 | 7678 | 885 | 8671 | 550 | 10760 | 256 | 9216 |
| 4E | | MI | 2705 | 1680 | 4483 | 1260 | 5080 | 1039 | 5496 | 843 | 6133 | 521 | 7061 | 148 | 6408 |
| 12-#11 | 4.33 | MA | 3607 | 1680 | 5688 | 1330 | 6566 | 1093 | 7130 | 902 | 7908 | 563 | 9731 | 191 | 8800 |
| 5L-3S | | MI | 2793 | 1680 | 4731 | 1253 | 5429 | 1025 | 5923 | 842 | 6695 | 515 | 7703 | 201 | 6738 |
| 12-#11 | 4.33 | MA | 3442 | 1680 | 5367 | 1340 | 6130 | 1113 | 6589 | 909 | 7178 | 577 | 8787 | 118 | 8186 |
| 6L-2S | | MI | 2932 | 1680 | 5082 | 1247 | 5875 | 1021 | 6465 | 830 | 7428 | 509 | 8595 | 313 | 6764 |
| 12-#14 | 6.25 | MA | 3959 | 1916 | 6491 | 1488 | 7556 | 1208 | 8314 | 979 | 9491 | 555 | 11807 | 34 | 11670 |
| 5L-3S | | MI | 3071 | 1916 | 5470 | 1394 | 6348 | 1125 | 7030 | 906 | 8159 | 492 | 9351 | 44 | 9201 |
| 14-#10 | 4.12 | MA | 3809 | 1653 | 6075 | 1298 | 7073 | 1076 | 7775 | 881 | 8816 | 556 | 11083 | 313 | 9105 |
| 4L-5S | | MI | 2657 | 1653 | 4294 | 1269 | 4889 | 1041 | 5272 | 855 | 5808 | 530 | 6820 | 164 | 6159 |
| 14-#10 | 4.12 | MA | 3665 | 1653 | 5772 | 1316 | 6708 | 1084 | 7321 | 896 | 8185 | 568 | 10209 | 261 | 8730 |
| 5L-4S | | MI | 2739 | 1653 | 4507 | 1254 | 5145 | 1036 | 5590 | 844 | 6249 | 523 | 7363 | 218 | 6355 |
| 14-#10 | 4.12 | MA | 3531 | 1653 | 5500 | 1324 | 6349 | 1101 | 6875 | 903 | 7582 | 581 | 9411 | 200 | 8330 |
| 6L-3S | | MI | 2805 | 1653 | 4714 | 1248 | 5436 | 1023 | 5946 | 842 | 6736 | 524 | 7916 | 263 | 6557 |
| 14-#11 | 5.06 | MA | 3836 | 1769 | 6205 | 1386 | 7225 | 1134 | 7930 | 927 | 8991 | 558 | 11198 | 180 | 10319 |
| 5L-4S | | MI | 2867 | 1769 | 4833 | 1316 | 5526 | 1080 | 6038 | 868 | 6866 | 516 | 7952 | 121 | 7407 |
| 14-#11 | 5.06 | MA | 3679 | 1769 | 5884 | 1395 | 6789 | 1153 | 7390 | 935 | 8261 | 572 | 10255 | 108 | 9691 |
| 6L-3S | | MI | 2935 | 1769 | 5082 | 1309 | 5875 | 1066 | 6465 | 867 | 7428 | 510 | 8595 | 174 | 7783 |
| 16-#10 | 4.70 | MA | 3857 | 1726 | 6202 | 1362 | 7256 | 1117 | 7987 | 917 | 9085 | 564 | 11455 | 255 | 9994 |
| 5E | | MI | 2782 | 1726 | 4588 | 1315 | 5263 | 1074 | 5727 | 876 | 6423 | 525 | 7594 | 146 | 7014 |
| 16-#10 | 4.70 | MA | 3727 | 1726 | 5931 | 1369 | 6896 | 1134 | 7540 | 924 | 8482 | 576 | 10656 | 194 | 9583 |
| 6L-4S | | MI | 2864 | 1726 | 4801 | 1300 | 5520 | 1069 | 6045 | 865 | 6865 | 519 | 8137 | 200 | 7197 |
| 16-#11 | 5.78 | MA | 3911 | 1858 | 6402 | 1451 | 7447 | 1193 | 8190 | 960 | 9344 | 567 | 11722 | 97 | 11200 |
| 6L-4S | | MI | 3013 | 1858 | 5183 | 1371 | 5972 | 1120 | 6580 | 893 | 7600 | 511 | 8844 | 95 | 8412 |
| 18-#10 | 5.29 | MA | 3920 | 1798 | 6361 | 1414 | 7444 | 1167 | 8205 | 944 | 9382 | 572 | 11902 | 188 | 10839 |
| 6L-5S | | MI | 2906 | 1798 | 4882 | 1360 | 5638 | 1107 | 6181 | 896 | 7039 | 521 | 8367 | 128 | 7871 |

## RECTANGULAR TIED COLUMNS 18" x 26"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#10 | 1.09 | MA | 3680 | 1386 | 5357 | 1142 | 6130 | 963 | 6512 | 823 | 6835 | 614 | 8048 | 534 | 3116 |
| 2E | | MI | 2492 | 1386 | 3784 | 1092 | 4204 | 920 | 4395 | 786 | 4527 | 584 | 5094 | 484 | 2099 |
| 4-#11 | 1.33 | MA | 3762 | 1419 | 5592 | 1154 | 6394 | 970 | 6815 | 826 | 7230 | 607 | 8585 | 527 | 3753 |
| 2E | | MI | 2535 | 1419 | 3928 | 1100 | 4357 | 924 | 4565 | 786 | 4747 | 575 | 5299 | 460 | 2503 |
| 4-#14 | 1.92 | MA | 3971 | 1498 | 6104 | 1197 | 7020 | 1001 | 7563 | 843 | 8233 | 598 | 9905 | 511 | 5262 |
| 2E | | MI | 2649 | 1498 | 4238 | 1140 | 4728 | 952 | 5006 | 801 | 5325 | 563 | 5944 | 421 | 3440 |
| 4-#18 | 3.42 | MA | 4460 | 1698 | 7346 | 1309 | 8551 | 1081 | 9398 | 891 | 10698 | 579 | 13030 | 461 | 8931 |
| 2E | | MI | 2907 | 1698 | 4967 | 1247 | 5614 | 1027 | 6061 | 844 | 6631 | 522 | 7384 | 305 | 5650 |

## RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

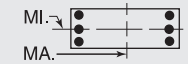
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.01 | MA | 3660 | 1376 | 5276 | 1142 | 6053 | 963 | 6431 | 825 | 6734 | 618 | 7917 | 538 | 2933 |
| 2L-3S | | MI | 2389 | 1376 | 3546 | 1099 | 3924 | 926 | 4065 | 797 | 4089 | 595 | 4572 | 439 | 1994 |
| 6-#8 | 1.01 | MA | 3500 | 1376 | 4977 | 1149 | 5672 | 969 | 5968 | 830 | 6107 | 627 | 7049 | 484 | 2945 |
| 3L-2S | | MI | 2484 | 1376 | 3732 | 1095 | 4161 | 923 | 4354 | 789 | 4480 | 590 | 5075 | 496 | 1980 |
| 6-#9 | 1.28 | MA | 3765 | 1412 | 5522 | 1161 | 6354 | 977 | 6790 | 833 | 7216 | 614 | 8580 | 534 | 3655 |
| 2L-3S | | MI | 2427 | 1412 | 3652 | 1118 | 4048 | 940 | 4210 | 805 | 4282 | 591 | 4804 | 411 | 2458 |
| 6-#9 | 1.28 | MA | 3569 | 1412 | 5145 | 1170 | 5874 | 985 | 6207 | 839 | 6427 | 625 | 7488 | 464 | 3666 |
| 3L-2S | | MI | 2544 | 1412 | 3886 | 1113 | 4346 | 936 | 4572 | 797 | 4772 | 585 | 5427 | 483 | 2440 |
| 6-#10 | 1.63 | MA | 3897 | 1459 | 5832 | 1187 | 6735 | 995 | 7247 | 843 | 7829 | 610 | 9426 | 528 | 4570 |
| 2L-3S | | MI | 2474 | 1459 | 3784 | 1144 | 4204 | 957 | 4395 | 817 | 4527 | 587 | 5094 | 375 | 3037 |
| 6-#10 | 1.63 | MA | 3655 | 1459 | 5357 | 1198 | 6130 | 1005 | 6512 | 851 | 6835 | 623 | 8048 | 440 | 4575 |
| 3L-2S | | MI | 2618 | 1459 | 4078 | 1137 | 4579 | 953 | 4850 | 806 | 5143 | 580 | 5868 | 466 | 3018 |
| 6-#11 | 2.00 | MA | 4017 | 1508 | 6165 | 1210 | 7123 | 1011 | 7701 | 851 | 8429 | 601 | 10246 | 520 | 5502 |
| 2L-3S | | MI | 2514 | 1508 | 3928 | 1162 | 4357 | 969 | 4565 | 823 | 4747 | 576 | 5299 | 321 | 3615 |
| 6-#11 | 2.00 | MA | 3734 | 1508 | 5592 | 1221 | 6394 | 1021 | 6815 | 870 | 7230 | 617 | 8585 | 408 | 5496 |
| 3L-2S | | MI | 2681 | 1508 | 4279 | 1156 | 4803 | 965 | 5107 | 811 | 5480 | 570 | 6191 | 433 | 3594 |
| 6-#14 | 2.88 | MA | 4323 | 1627 | 6919 | 1277 | 8058 | 1059 | 8824 | 880 | 9940 | 591 | 12236 | 498 | 7736 |
| 2L-3S | | MI | 2623 | 1627 | 4238 | 1229 | 4728 | 1015 | 5006 | 852 | 5325 | 562 | 5944 | 215 | 4960 |
| 6-#14 | 2.88 | MA | 3939 | 1627 | 6104 | 1293 | 7020 | 1073 | 7563 | 906 | 8233 | 611 | 9905 | 336 | 7672 |
| 3L-2S | | MI | 2850 | 1627 | 4732 | 1220 | 5357 | 1011 | 5770 | 838 | 6353 | 555 | 7169 | 377 | 4961 |
| 6-#18 | 5.13 | MA | 5040 | 1926 | 8755 | 1452 | 10345 | 1184 | 11577 | 955 | 13647 | 566 | 16945 | 425 | 13171 |
| 2L-3S | | MI | 2894 | 1926 | 4967 | 1399 | 5614 | 1132 | 6061 | 929 | 6631 | 512 | 7384 | -79 | 7333 |
| 6-#18 | 5.13 | MA | 4435 | 1926 | 7346 | 1478 | 8551 | 1205 | 9398 | 997 | 10698 | 597 | 13030 | 138 | 12568 |
| 3L-2S | | MI | 3227 | 1926 | 5805 | 1390 | 6681 | 1131 | 7357 | 909 | 8325 | 499 | 9352 | 209 | 8188 |
| 8-#8 | 1.35 | MA | 3799 | 1422 | 5576 | 1170 | 6434 | 984 | 6894 | 837 | 7361 | 615 | 8785 | 534 | 3849 |
| 2L-4S | | MI | 2422 | 1422 | 3601 | 1132 | 3977 | 955 | 4128 | 812 | 4171 | 592 | 4717 | 400 | 2590 |
| 8-#8 | 1.35 | MA | 3644 | 1422 | 5276 | 1177 | 6053 | 990 | 6431 | 843 | 6734 | 624 | 7917 | 480 | 3857 |
| 3E | | MI | 2472 | 1422 | 3732 | 1127 | 4161 | 947 | 4354 | 810 | 4480 | 592 | 5075 | 430 | 2577 |
| 8-#8 | 1.35 | MA | 3563 | 1422 | 5072 | 1184 | 5764 | 1001 | 6077 | 853 | 6249 | 628 | 7321 | 448 | 3855 |
| 4L-2S | | MI | 2565 | 1422 | 3919 | 1123 | 4399 | 943 | 4642 | 802 | 4871 | 587 | 5577 | 486 | 2564 |
| 8-#9 | 1.71 | MA | 3937 | 1470 | 5899 | 1197 | 6833 | 1003 | 7373 | 849 | 8004 | 611 | 9672 | 529 | 4804 |
| 2L-4S | | MI | 2468 | 1470 | 3721 | 1159 | 4115 | 976 | 4289 | 824 | 4385 | 587 | 4983 | 362 | 3189 |
| 8-#9 | 1.71 | MA | 3747 | 1470 | 5522 | 1206 | 6354 | 1010 | 6790 | 855 | 7216 | 622 | 8580 | 460 | 4807 |
| 3E | | MI | 2530 | 1470 | 3886 | 1154 | 4346 | 966 | 4572 | 822 | 4772 | 588 | 5427 | 398 | 3180 |
| 8-#9 | 1.71 | MA | 3648 | 1470 | 5264 | 1214 | 5990 | 1024 | 6344 | 868 | 6605 | 626 | 7828 | 419 | 4783 |
| 4L-2S | | MI | 2644 | 1470 | 4120 | 1149 | 4644 | 962 | 4935 | 813 | 5262 | 582 | 6050 | 470 | 3167 |
| 8-#10 | 2.17 | MA | 4109 | 1531 | 6308 | 1233 | 7341 | 1028 | 7983 | 864 | 8824 | 605 | 10803 | 523 | 6014 |
| 2L-4S | | MI | 2526 | 1531 | 3870 | 1195 | 4288 | 1003 | 4493 | 840 | 4656 | 581 | 5315 | 312 | 3925 |
| 8-#10 | 2.17 | MA | 3877 | 1531 | 5832 | 1243 | 6735 | 1037 | 7247 | 872 | 7829 | 619 | 9426 | 434 | 6005 |
| 3E | | MI | 2603 | 1531 | 4078 | 1189 | 4579 | 990 | 4850 | 838 | 5143 | 583 | 5868 | 357 | 3935 |
| 8-#10 | 2.17 | MA | 3755 | 1531 | 5506 | 1253 | 6276 | 1055 | 6684 | 888 | 7058 | 624 | 8473 | 381 | 5938 |
| 4L-2S | | MI | 2742 | 1531 | 4372 | 1183 | 4953 | 986 | 5304 | 827 | 5759 | 576 | 6642 | 448 | 3923 |
| 8-#11 | 2.67 | MA | 4268 | 1597 | 6738 | 1265 | 7853 | 1051 | 8587 | 876 | 9629 | 596 | 11907 | 513 | 7240 |
| 2L-4S | | MI | 2573 | 1597 | 4030 | 1225 | 4454 | 1023 | 4680 | 849 | 4919 | 577 | 5548 | 242 | 4529 |
| 8-#11 | 2.67 | MA | 3996 | 1597 | 6165 | 1277 | 7123 | 1061 | 7701 | 895 | 8429 | 612 | 10246 | 401 | 7214 |
| 3E | | MI | 2663 | 1597 | 4279 | 1218 | 4803 | 1009 | 5107 | 848 | 5480 | 571 | 6191 | 294 | 4678 |
| 8-#11 | 2.67 | MA | 3854 | 1597 | 5770 | 1289 | 6567 | 1082 | 7019 | 903 | 7496 | 616 | 9084 | 335 | 6984 |
| 4L-2S | | MI | 2825 | 1597 | 4629 | 1211 | 5249 | 1005 | 5649 | 836 | 6214 | 564 | 7082 | 406 | 4670 |
| 8-#14 | 3.85 | MA | 4305 | 1755 | 6919 | 1374 | 8058 | 1131 | 8824 | 942 | 9940 | 604 | 12236 | 323 | 10102 |
| 3E | | MI | 2841 | 1755 | 4732 | 1309 | 5357 | 1073 | 5770 | 889 | 6353 | 554 | 7169 | 171 | 6433 |
| 8-#14 | 3.85 | MA | 4113 | 1755 | 6356 | 1390 | 7265 | 1160 | 7851 | 953 | 8608 | 610 | 10599 | 230 | 9230 |
| 4L-2S | | MI | 3046 | 1755 | 5226 | 1301 | 5986 | 1069 | 6534 | 874 | 7382 | 546 | 8394 | 333 | 6464 |
| 8-#18 | 6.84 | MA | 5047 | 2155 | 8755 | 1621 | 10345 | 1309 | 11577 | 1062 | 13647 | 584 | 16945 | 102 | 16559 |
| 3E | | MI | 3237 | 2155 | 5805 | 1542 | 6681 | 1236 | 7357 | 993 | 8325 | 488 | 9352 | -176 | 9197 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis

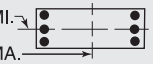



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 6.84 | MA | 4748 | 2155 | 7774 | 1647 | 8966 | 1356 | 9887 | 1077 | 11335 | 589 | 14179 | -54 | 14076 |
| 4L-2S | | MI | 3542 | 2155 | 6643 | 1532 | 7748 | 1235 | 8653 | 974 | 10019 | 475 | 11320 | 112 | 10702 |
| 10-#10 | 2.71 | MA | 4318 | 1604 | 6783 | 1278 | 7946 | 1061 | 8718 | 884 | 9819 | 601 | 12181 | 517 | 7453 |
| 2L-5S | | MI | 2573 | 1604 | 3952 | 1256 | 4406 | 1040 | 4630 | 871 | 4830 | 584 | 5545 | 239 | 4535 |
| 10-#10 | 2.71 | MA | 4094 | 1604 | 6308 | 1288 | 7341 | 1070 | 7983 | 892 | 8824 | 615 | 10803 | 428 | 7432 |
| 3L-4S | | MI | 2656 | 1604 | 4165 | 1241 | 4662 | 1036 | 4948 | 861 | 5271 | 577 | 6089 | 294 | 4769 |
| 10-#10 | 2.71 | MA | 3980 | 1604 | 5982 | 1299 | 6881 | 1088 | 7419 | 908 | 8053 | 620 | 9851 | 376 | 7353 |
| 4L-3S | | MI | 2729 | 1604 | 4372 | 1234 | 4953 | 1023 | 5304 | 858 | 5759 | 578 | 6642 | 339 | 4825 |
| 10-#10 | 2.71 | MA | 3813 | 1604 | 5649 | 1317 | 6480 | 1097 | 6920 | 916 | 7359 | 633 | 8892 | 326 | 6894 |
| 5L-2S | | MI | 2864 | 1604 | 4666 | 1228 | 5328 | 1019 | 5759 | 847 | 6374 | 572 | 7415 | 430 | 4822 |
| 10-#11 | 3.33 | MA | 4253 | 1686 | 6738 | 1333 | 7853 | 1102 | 8587 | 920 | 9629 | 606 | 11907 | 393 | 8930 |
| 3L-4S | | MI | 2726 | 1686 | 4380 | 1280 | 4900 | 1064 | 5222 | 874 | 5652 | 572 | 6440 | 215 | 5508 |
| 10-#11 | 3.33 | MA | 4121 | 1686 | 6343 | 1345 | 7297 | 1122 | 7905 | 929 | 8695 | 611 | 10744 | 328 | 8629 |
| 4L-3S | | MI | 2811 | 1686 | 4629 | 1274 | 5249 | 1050 | 5649 | 873 | 6214 | 565 | 7082 | 267 | 5731 |
| 10-#11 | 3.33 | MA | 3926 | 1686 | 5940 | 1367 | 6811 | 1132 | 7301 | 947 | 7855 | 627 | 9580 | 264 | 8099 |
| 5L-2S | | MI | 2968 | 1686 | 4980 | 1267 | 5695 | 1046 | 6191 | 861 | 6947 | 559 | 7974 | 379 | 5738 |
| 10-#14 | 4.81 | MA | 4487 | 1883 | 7171 | 1470 | 8303 | 1218 | 9112 | 989 | 10315 | 602 | 12930 | 217 | 11592 |
| 4L-3S | | MI | 3044 | 1883 | 5226 | 1389 | 5986 | 1131 | 6534 | 925 | 7382 | 545 | 8394 | 127 | 7902 |
| 10-#14 | 4.81 | MA | 4217 | 1883 | 6595 | 1502 | 7609 | 1232 | 8249 | 1015 | 9115 | 623 | 11295 | 124 | 10774 |
| 5L-2S | | MI | 3237 | 1883 | 5720 | 1381 | 6615 | 1127 | 7298 | 910 | 8411 | 538 | 9619 | 289 | 7955 |
| 12-#10 | 3.26 | MA | 4307 | 1676 | 6783 | 1334 | 7946 | 1103 | 8718 | 913 | 9819 | 610 | 12181 | 422 | 8857 |
| 3L-5S | | MI | 2701 | 1676 | 4246 | 1301 | 4780 | 1073 | 5085 | 892 | 5446 | 579 | 6319 | 222 | 5381 |
| 12-#10 | 3.26 | MA | 4201 | 1676 | 6457 | 1344 | 7487 | 1121 | 8154 | 929 | 9048 | 616 | 11228 | 370 | 8762 |
| 4E | | MI | 2784 | 1676 | 4459 | 1286 | 5037 | 1069 | 5403 | 881 | 5887 | 573 | 6862 | 276 | 5598 |
| 12-#10 | 3.26 | MA | 4035 | 1676 | 6124 | 1363 | 7086 | 1130 | 7656 | 937 | 8354 | 629 | 10270 | 320 | 8286 |
| 5L-3S | | MI | 2854 | 1676 | 4666 | 1280 | 5328 | 1056 | 5759 | 879 | 6374 | 574 | 7415 | 321 | 5710 |
| 12-#10 | 3.26 | MA | 3879 | 1676 | 5820 | 1370 | 6691 | 1147 | 7165 | 953 | 7691 | 643 | 9399 | 260 | 7914 |
| 6L-2S | | MI | 2986 | 1676 | 4960 | 1273 | 5702 | 1052 | 6214 | 868 | 6990 | 567 | 8189 | 412 | 5716 |
| 12-#11 | 4.00 | MA | 4382 | 1776 | 6916 | 1400 | 8027 | 1163 | 8792 | 954 | 9895 | 606 | 12405 | 321 | 10283 |
| 4E | | MI | 2876 | 1776 | 4731 | 1336 | 5346 | 1104 | 5764 | 899 | 6385 | 567 | 7331 | 188 | 6497 |
| 12-#11 | 4.00 | MA | 4189 | 1776 | 6513 | 1423 | 7541 | 1173 | 8187 | 973 | 9054 | 621 | 11240 | 257 | 9780 |
| 5L-3S | | MI | 2957 | 1776 | 4980 | 1329 | 5695 | 1090 | 6191 | 898 | 6947 | 560 | 7974 | 240 | 6780 |
| 12-#11 | 4.00 | MA | 4005 | 1776 | 6151 | 1432 | 7061 | 1193 | 7593 | 981 | 8251 | 637 | 10176 | 182 | 9159 |
| 6L-2S | | MI | 3108 | 1776 | 5330 | 1323 | 6141 | 1086 | 6733 | 887 | 7681 | 554 | 8865 | 352 | 6799 |
| 12-#14 | 5.77 | MA | 4585 | 2012 | 7410 | 1582 | 8647 | 1290 | 9510 | 1052 | 10821 | 615 | 13626 | 110 | 13137 |
| 5L-3S | | MI | 3244 | 2012 | 5720 | 1469 | 6615 | 1190 | 7298 | 962 | 8411 | 537 | 9619 | 83 | 9335 |
| 14-#10 | 3.80 | MA | 4417 | 1749 | 6933 | 1389 | 8092 | 1154 | 8889 | 950 | 10043 | 611 | 12606 | 364 | 10138 |
| 4L-5S | | MI | 2829 | 1749 | 4540 | 1346 | 5155 | 1106 | 5540 | 913 | 6061 | 575 | 7093 | 204 | 6231 |
| 14-#10 | 3.80 | MA | 4253 | 1749 | 6600 | 1408 | 7691 | 1163 | 8391 | 957 | 9349 | 625 | 11648 | 315 | 9682 |
| 5L-4S | | MI | 2911 | 1749 | 4753 | 1331 | 5411 | 1102 | 5858 | 902 | 6503 | 568 | 7636 | 258 | 6433 |
| 14-#10 | 3.80 | MA | 4102 | 1749 | 6295 | 1415 | 7296 | 1180 | 7901 | 973 | 8686 | 638 | 10776 | 254 | 9301 |
| 6L-3S | | MI | 2977 | 1749 | 4960 | 1325 | 5702 | 1089 | 6214 | 899 | 6990 | 570 | 8189 | 303 | 6592 |
| 14-#10 | 3.80 | MA | 3974 | 1749 | 5991 | 1421 | 6908 | 1188 | 7429 | 981 | 8009 | 644 | 9793 | 201 | 8818 |
| 7L-2S | | MI | 3106 | 1749 | 5254 | 1319 | 6077 | 1085 | 6669 | 888 | 7605 | 563 | 8963 | 394 | 6606 |
| 14-#11 | 4.67 | MA | 4447 | 1865 | 7086 | 1478 | 8270 | 1213 | 9074 | 998 | 10254 | 616 | 12901 | 250 | 11466 |
| 5L-4S | | MI | 3025 | 1865 | 5081 | 1392 | 5792 | 1145 | 6306 | 925 | 7119 | 561 | 8223 | 161 | 7494 |
| 14-#11 | 4.67 | MA | 4270 | 1865 | 6724 | 1487 | 7791 | 1234 | 8479 | 1006 | 9451 | 631 | 11837 | 175 | 10833 |
| 6L-3S | | MI | 3109 | 1865 | 5330 | 1385 | 6141 | 1130 | 6733 | 924 | 7681 | 555 | 8865 | 213 | 7826 |
| 16-#10 | 4.34 | MA | 4467 | 1821 | 7075 | 1453 | 8296 | 1196 | 9126 | 978 | 10344 | 621 | 13025 | 309 | 11082 |
| 5E | | MI | 2954 | 1821 | 4834 | 1392 | 5529 | 1139 | 5995 | 933 | 6677 | 571 | 7867 | 186 | 7084 |
| 16-#10 | 4.34 | MA | 4322 | 1821 | 6770 | 1460 | 7901 | 1213 | 8636 | 994 | 9681 | 634 | 12154 | 248 | 10691 |
| 6L-4S | | MI | 3036 | 1821 | 5047 | 1377 | 5786 | 1135 | 6313 | 922 | 7118 | 564 | 8410 | 240 | 7274 |
| 16-#10 | 4.34 | MA | 4199 | 1821 | 6466 | 1466 | 7513 | 1221 | 8165 | 1002 | 9004 | 639 | 11171 | 195 | 10222 |
| 7L-3S | | MI | 3100 | 1821 | 5254 | 1370 | 6077 | 1122 | 6669 | 920 | 7605 | 566 | 8963 | 285 | 7472 |
| 16-#11 | 5.33 | MA | 4531 | 1954 | 7297 | 1543 | 8521 | 1274 | 9366 | 1032 | 10650 | 626 | 13498 | 168 | 12511 |
| 6L-4S | | MI | 3185 | 1954 | 5432 | 1447 | 6239 | 1185 | 6848 | 950 | 7852 | 556 | 9114 | 134 | 8497 |

## RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 4.88 | MA | 4538 | 1894 | 7246 | 1506 | 8507 | 1246 | 9371 | 1015 | 10676 | 630 | 13532 | 243 | 12084 |
| 6L-5S | | MI | 3079 | 1894 | 5128 | 1437 | 5904 | 1172 | 6449 | 954 | 7292 | 567 | 8640 | 168 | 7940 |
| 18-#10 | 4.88 | MA | 4421 | 1894 | 6941 | 1512 | 8118 | 1254 | 8900 | 1022 | 9999 | 635 | 12548 | 189 | 11628 |
| 7L-4S | | MI | 3161 | 1894 | 5341 | 1422 | 6160 | 1168 | 6768 | 943 | 7734 | 560 | 9184 | 222 | 8118 |
| 20-#10 | 5.43 | MA | 4639 | 1966 | 7417 | 1557 | 8724 | 1287 | 9635 | 1043 | 10994 | 631 | 13926 | 184 | 13036 |
| 7L-5S | | MI | 3202 | 1966 | 5422 | 1482 | 6278 | 1205 | 6904 | 974 | 7908 | 563 | 9414 | 150 | 8798 |

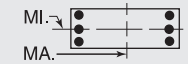
## RECTANGULAR TIED COLUMNS 18" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.01 | MA | 4246 | 1482 | 6108 | 1231 | 7015 | 1039 | 7457 | 889 | 7812 | 667 | 9187 | 581 | 3391 |
| 2E | | MI | 2665 | 1482 | 4029 | 1169 | 4470 | 986 | 4663 | 843 | 4781 | 630 | 5367 | 524 | 2117 |
| 4-#11 | 1.24 | MA | 4339 | 1515 | 6368 | 1243 | 7307 | 1046 | 7792 | 892 | 8250 | 660 | 9782 | 573 | 4090 |
| 2E | | MI | 2707 | 1515 | 4177 | 1176 | 4623 | 989 | 4833 | 842 | 4999 | 620 | 5570 | 499 | 2525 |
| 4-#14 | 1.79 | MA | 4573 | 1594 | 6933 | 1286 | 7998 | 1077 | 8617 | 910 | 9356 | 651 | 11306 | 564 | 5748 |
| 2E | | MI | 2822 | 1594 | 4488 | 1215 | 4995 | 1016 | 5273 | 857 | 5576 | 608 | 6213 | 460 | 3469 |
| 4-#18 | 3.17 | MA | 5123 | 1793 | 8305 | 1399 | 9690 | 1157 | 10647 | 957 | 12082 | 632 | 14893 | 526 | 9795 |
| 2E | | MI | 3081 | 1793 | 5220 | 1321 | 5881 | 1091 | 6328 | 899 | 6880 | 566 | 7649 | 344 | 5691 |
| 6-#9 | 1.19 | MA | 4340 | 1508 | 6288 | 1251 | 7259 | 1054 | 7760 | 899 | 8228 | 667 | 9767 | 580 | 3979 |
| 2L-3S | | MI | 2599 | 1508 | 3896 | 1196 | 4313 | 1006 | 4479 | 863 | 4536 | 637 | 5078 | 452 | 2477 |
| 6-#9 | 1.19 | MA | 4122 | 1508 | 5875 | 1260 | 6733 | 1061 | 7122 | 906 | 7364 | 679 | 8571 | 513 | 3990 |
| 3L-2S | | MI | 2716 | 1508 | 4131 | 1190 | 4611 | 1002 | 4841 | 854 | 5026 | 631 | 5701 | 523 | 2459 |
| 6-#10 | 1.51 | MA | 4487 | 1554 | 6628 | 1277 | 7678 | 1072 | 8262 | 910 | 8902 | 663 | 10696 | 575 | 4981 |
| 2L-3S | | MI | 2646 | 1554 | 4029 | 1221 | 4470 | 1023 | 4663 | 874 | 4781 | 632 | 5367 | 415 | 3060 |
| 6-#10 | 1.51 | MA | 4218 | 1554 | 6108 | 1288 | 7015 | 1082 | 7457 | 918 | 7812 | 677 | 9187 | 488 | 4986 |
| 3L-2S | | MI | 2791 | 1554 | 4324 | 1214 | 4844 | 1019 | 5118 | 864 | 5396 | 626 | 6141 | 506 | 3039 |
| 6-#11 | 1.86 | MA | 4624 | 1604 | 6997 | 1299 | 8107 | 1087 | 8764 | 918 | 9566 | 654 | 11604 | 566 | 6007 |
| 2L-3S | | MI | 2685 | 1604 | 4177 | 1238 | 4623 | 1033 | 4833 | 879 | 4999 | 621 | 5570 | 360 | 3644 |
| 6-#11 | 1.86 | MA | 4308 | 1604 | 6368 | 1312 | 7307 | 1098 | 7792 | 927 | 8250 | 671 | 9782 | 457 | 6002 |
| 3L-2S | | MI | 2854 | 1604 | 4527 | 1232 | 5069 | 1030 | 5375 | 867 | 5733 | 615 | 6461 | 472 | 3620 |
| 6-#14 | 2.68 | MA | 4967 | 1722 | 7828 | 1367 | 9138 | 1135 | 10002 | 946 | 11231 | 644 | 13901 | 554 | 8465 |
| 2L-3S | | MI | 2795 | 1722 | 4488 | 1304 | 4995 | 1079 | 5273 | 908 | 5576 | 607 | 6213 | 254 | 5003 |
| 6-#14 | 2.68 | MA | 4538 | 1722 | 6933 | 1384 | 7998 | 1150 | 8617 | 959 | 9356 | 666 | 11306 | 393 | 8401 |
| 3L-2S | | MI | 3024 | 1722 | 4982 | 1296 | 5624 | 1075 | 6037 | 894 | 6605 | 599 | 7438 | 416 | 4993 |
| 6-#18 | 4.76 | MA | 5770 | 2022 | 9857 | 1541 | 11666 | 1261 | 13046 | 1022 | 15329 | 619 | 19304 | 499 | 14467 |
| 2L-3S | | MI | 3064 | 2022 | 5220 | 1473 | 5881 | 1195 | 6328 | 984 | 6880 | 556 | 7649 | -41 | 7624 |
| 6-#18 | 4.76 | MA | 5094 | 2022 | 8305 | 1570 | 9690 | 1284 | 10647 | 1067 | 12082 | 654 | 14893 | 212 | 14106 |
| 3L-2S | | MI | 3402 | 2022 | 6058 | 1463 | 6948 | 1194 | 7624 | 964 | 8575 | 542 | 9617 | 247 | 8236 |
| 8-#8 | 1.25 | MA | 4377 | 1517 | 6346 | 1260 | 7346 | 1060 | 7872 | 904 | 8386 | 668 | 9989 | 581 | 4191 |
| 2L-4S | | MI | 2593 | 1517 | 3845 | 1209 | 4243 | 1022 | 4397 | 869 | 4426 | 638 | 4992 | 441 | 2610 |
| 8-#8 | 1.25 | MA | 4205 | 1517 | 6018 | 1267 | 6929 | 1066 | 7366 | 910 | 7700 | 678 | 9040 | 528 | 4199 |
| 3E | | MI | 2644 | 1517 | 3976 | 1205 | 4427 | 1013 | 4622 | 867 | 4734 | 638 | 5349 | 470 | 2595 |
| 8-#8 | 1.25 | MA | 4116 | 1517 | 5795 | 1274 | 6614 | 1078 | 6979 | 920 | 7170 | 682 | 8395 | 496 | 4196 |
| 4L-2S | | MI | 2738 | 1517 | 4163 | 1200 | 4664 | 1010 | 4911 | 860 | 5125 | 633 | 5851 | 527 | 2583 |
| 8-#9 | 1.59 | MA | 4532 | 1565 | 6700 | 1287 | 7784 | 1079 | 8398 | 915 | 9091 | 664 | 10963 | 576 | 5236 |
| 2L-4S | | MI | 2639 | 1565 | 3966 | 1237 | 4380 | 1042 | 4558 | 882 | 4639 | 633 | 5257 | 402 | 3215 |
| 8-#9 | 1.59 | MA | 4320 | 1565 | 6288 | 1295 | 7259 | 1087 | 7760 | 922 | 8228 | 676 | 9767 | 508 | 5239 |
| 3E | | MI | 2702 | 1565 | 4131 | 1231 | 4611 | 1032 | 4841 | 879 | 5026 | 634 | 5701 | 438 | 3202 |
| 8-#9 | 1.59 | MA | 4211 | 1565 | 6007 | 1304 | 6862 | 1102 | 7273 | 936 | 7561 | 681 | 8952 | 468 | 5215 |
| 4L-2S | | MI | 2817 | 1565 | 4365 | 1226 | 4909 | 1028 | 5203 | 870 | 5516 | 628 | 6324 | 510 | 3188 |
| 8-#10 | 2.02 | MA | 4724 | 1627 | 7149 | 1322 | 8341 | 1105 | 9067 | 930 | 9992 | 658 | 12205 | 569 | 6563 |
| 2L-4S | | MI | 2697 | 1627 | 4116 | 1272 | 4553 | 1069 | 4761 | 897 | 4909 | 627 | 5588 | 352 | 3961 |
| 8-#10 | 2.02 | MA | 4465 | 1627 | 6628 | 1333 | 7678 | 1115 | 8262 | 939 | 8902 | 673 | 10696 | 482 | 6554 |
| 3E | | MI | 2774 | 1627 | 4324 | 1266 | 4844 | 1056 | 5118 | 895 | 5396 | 628 | 6141 | 397 | 3962 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis

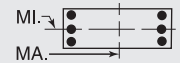



$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 2.02 | MA | 4331 | 1627 | 6273 | 1344 | 7177 | 1133 | 7647 | 956 | 8059 | 679 | 9664 | 431 | 6486 |
| 4L-2S | | MI | 2915 | 1627 | 4618 | 1260 | 5219 | 1052 | 5573 | 884 | 6012 | 621 | 6915 | 488 | 3948 |
| 8-#11 | 2.48 | MA | 4902 | 1693 | 7625 | 1355 | 8908 | 1127 | 9737 | 943 | 10882 | 649 | 13427 | 559 | 7914 |
| 2L-4S | | MI | 2744 | 1693 | 4278 | 1301 | 4720 | 1088 | 4948 | 906 | 5171 | 622 | 5819 | 281 | 4620 |
| 8-#11 | 2.48 | MA | 4600 | 1693 | 6997 | 1367 | 8107 | 1139 | 8764 | 952 | 9566 | 666 | 11604 | 450 | 7888 |
| 3E | | MI | 2835 | 1693 | 4527 | 1294 | 5069 | 1074 | 5375 | 904 | 5733 | 616 | 6461 | 333 | 4712 |
| 8-#11 | 2.48 | MA | 4442 | 1693 | 6566 | 1380 | 7500 | 1160 | 8019 | 972 | 8546 | 672 | 10344 | 386 | 7736 |
| 4L-2S | | MI | 2998 | 1693 | 4878 | 1287 | 5515 | 1070 | 5917 | 893 | 6466 | 609 | 7353 | 445 | 4699 |
| 8-#14 | 3.57 | MA | 4945 | 1850 | 7828 | 1464 | 9138 | 1209 | 10002 | 995 | 11231 | 659 | 13901 | 383 | 11074 |
| 3E | | MI | 3003 | 1850 | 4982 | 1384 | 5624 | 1137 | 6037 | 945 | 6605 | 598 | 7438 | 210 | 6481 |
| 8-#14 | 3.57 | MA | 4733 | 1850 | 7212 | 1482 | 8270 | 1239 | 8938 | 1023 | 9773 | 667 | 12091 | 289 | 10229 |
| 4L-2S | | MI | 3221 | 1850 | 5476 | 1376 | 6253 | 1133 | 6801 | 930 | 7633 | 591 | 8663 | 372 | 6500 |
| 8-#18 | 6.35 | MA | 5776 | 2250 | 9857 | 1713 | 11666 | 1388 | 13046 | 1132 | 15329 | 641 | 19304 | 185 | 18547 |
| 3E | | MI | 3407 | 2250 | 6058 | 1616 | 6948 | 1299 | 7624 | 1048 | 8575 | 532 | 9617 | -138 | 9500 |
| 8-#18 | 6.35 | MA | 5446 | 2250 | 8783 | 1741 | 10154 | 1438 | 11193 | 1150 | 12793 | 650 | 16203 | 23 | 16065 |
| 4L-2S | | MI | 3717 | 2250 | 6896 | 1606 | 8015 | 1298 | 8920 | 1029 | 10269 | 519 | 11585 | 150 | 10753 |
| 10-#10 | 2.52 | MA | 4956 | 1699 | 7670 | 1367 | 9004 | 1138 | 9873 | 951 | 11082 | 654 | 13714 | 563 | 8139 |
| 2L-5S | | MI | 2744 | 1699 | 4197 | 1333 | 4671 | 1106 | 4898 | 929 | 5084 | 629 | 5818 | 279 | 4606 |
| 10-#10 | 2.52 | MA | 4706 | 1699 | 7149 | 1378 | 8341 | 1147 | 9067 | 960 | 9992 | 669 | 12205 | 477 | 8118 |
| 3L-4S | | MI | 2827 | 1699 | 4410 | 1318 | 4928 | 1102 | 5216 | 918 | 5525 | 622 | 6361 | 334 | 4840 |
| 10-#10 | 2.52 | MA | 4581 | 1699 | 6794 | 1389 | 7840 | 1166 | 8452 | 977 | 9149 | 675 | 11173 | 425 | 8039 |
| 4L-3S | | MI | 2901 | 1699 | 4618 | 1311 | 5219 | 1089 | 5573 | 915 | 6012 | 624 | 6915 | 379 | 4856 |
| 10-#10 | 2.52 | MA | 4392 | 1699 | 6431 | 1409 | 7403 | 1175 | 7909 | 985 | 8392 | 689 | 10131 | 378 | 7585 |
| 5L-2S | | MI | 3038 | 1699 | 4912 | 1305 | 5593 | 1084 | 6027 | 905 | 6628 | 617 | 7688 | 470 | 4848 |
| 10-#11 | 3.10 | MA | 4885 | 1782 | 7625 | 1423 | 8908 | 1179 | 9737 | 978 | 10882 | 661 | 13427 | 443 | 9772 |
| 3L-4S | | MI | 2897 | 1782 | 4629 | 1356 | 5167 | 1129 | 5490 | 931 | 5904 | 617 | 6710 | 254 | 5597 |
| 10-#11 | 3.10 | MA | 4739 | 1782 | 7194 | 1436 | 8300 | 1200 | 8991 | 997 | 9861 | 667 | 12166 | 379 | 9546 |
| 4L-3S | | MI | 2983 | 1782 | 4878 | 1350 | 5515 | 1114 | 5917 | 930 | 6466 | 610 | 7353 | 306 | 5769 |
| 10-#11 | 3.10 | MA | 4518 | 1782 | 6754 | 1459 | 7770 | 1212 | 8332 | 1007 | 8944 | 684 | 10899 | 318 | 8920 |
| 5L-2S | | MI | 3141 | 1782 | 5228 | 1343 | 5962 | 1110 | 6459 | 918 | 7199 | 604 | 8244 | 419 | 5769 |
| 10-#14 | 4.46 | MA | 5149 | 1979 | 8108 | 1562 | 9410 | 1297 | 10323 | 1059 | 11648 | 659 | 14686 | 279 | 12832 |
| 4L-3S | | MI | 3217 | 1979 | 5476 | 1464 | 6253 | 1196 | 6801 | 981 | 7633 | 590 | 8663 | 166 | 7952 |
| 10-#14 | 4.46 | MA | 4842 | 1979 | 7479 | 1595 | 8652 | 1312 | 9380 | 1072 | 10336 | 682 | 12871 | 188 | 12025 |
| 5L-2S | | MI | 3413 | 1979 | 5970 | 1456 | 6882 | 1192 | 7566 | 967 | 8662 | 583 | 9888 | 328 | 7994 |
| 10-#18 | 7.94 | MA | 6150 | 2479 | 10335 | 1884 | 12130 | 1542 | 13593 | 1215 | 16041 | 637 | 20614 | -3 | 20603 |
| 4L-3S | | MI | 3742 | 2479 | 6896 | 1758 | 8015 | 1403 | 8920 | 1113 | 10269 | 509 | 11585 | -234 | 11337 |
| 12-#10 | 3.02 | MA | 4943 | 1772 | 7670 | 1424 | 9004 | 1180 | 9873 | 980 | 11082 | 664 | 13714 | 471 | 9680 |
| 3L-5S | | MI | 2873 | 1772 | 4492 | 1378 | 5046 | 1139 | 5353 | 949 | 5699 | 625 | 6592 | 262 | 5450 |
| 12-#10 | 3.02 | MA | 4825 | 1772 | 7315 | 1435 | 8503 | 1199 | 9257 | 997 | 10239 | 671 | 12682 | 419 | 9592 |
| 4E | | MI | 2956 | 1772 | 4705 | 1363 | 5302 | 1135 | 5671 | 938 | 6141 | 618 | 7135 | 316 | 5675 |
| 12-#10 | 3.02 | MA | 4638 | 1772 | 6952 | 1454 | 8066 | 1208 | 8714 | 1006 | 9482 | 685 | 11640 | 372 | 9112 |
| 5L-3S | | MI | 3026 | 1772 | 4912 | 1357 | 5593 | 1122 | 6027 | 936 | 6628 | 620 | 7688 | 361 | 5742 |
| 12-#10 | 3.02 | MA | 4465 | 1772 | 6614 | 1461 | 7655 | 1218 | 8180 | 1023 | 8760 | 700 | 10617 | 301 | 8764 |
| 6L-2S | | MI | 3159 | 1772 | 5206 | 1350 | 5968 | 1117 | 6482 | 925 | 7243 | 613 | 8462 | 452 | 5744 |
| 12-#11 | 3.71 | MA | 5029 | 1871 | 7823 | 1492 | 9101 | 1241 | 9964 | 1023 | 11177 | 662 | 13988 | 371 | 11366 |
| 4E | | MI | 3047 | 1871 | 4979 | 1412 | 5613 | 1169 | 6032 | 956 | 6638 | 612 | 7602 | 227 | 6584 |
| 12-#11 | 3.71 | MA | 4811 | 1871 | 7383 | 1515 | 8571 | 1252 | 9304 | 1032 | 10260 | 678 | 12721 | 311 | 10768 |
| 5L-3S | | MI | 3130 | 1871 | 5228 | 1405 | 5962 | 1155 | 6459 | 955 | 7199 | 605 | 8244 | 280 | 6820 |
| 12-#11 | 3.71 | MA | 4607 | 1871 | 6980 | 1523 | 8048 | 1274 | 8656 | 1052 | 9383 | 695 | 11568 | 237 | 10151 |
| 6L-2S | | MI | 3283 | 1871 | 5578 | 1399 | 6408 | 1151 | 7001 | 943 | 7933 | 599 | 9136 | 392 | 6833 |
| 12-#14 | 5.36 | MA | 5250 | 2107 | 8374 | 1675 | 9792 | 1371 | 10765 | 1108 | 12211 | 674 | 15466 | 178 | 14636 |
| 5L-3S | | MI | 3417 | 2107 | 5970 | 1545 | 6882 | 1254 | 7566 | 1018 | 8662 | 582 | 9888 | 123 | 9420 |
| 12-#14 | 5.36 | MA | 4974 | 2107 | 7806 | 1688 | 9045 | 1401 | 9838 | 1136 | 10958 | 697 | 13810 | 70 | 13423 |
| 6L-2S | | MI | 3603 | 2107 | 6464 | 1537 | 7511 | 1250 | 8330 | 1003 | 9690 | 574 | 11113 | 284 | 9480 |
| 14-#10 | 3.53 | MA | 5065 | 1844 | 7835 | 1480 | 9166 | 1232 | 10063 | 1018 | 11329 | 666 | 14191 | 413 | 11146 |
| 4L-5S | | MI | 3000 | 1844 | 4786 | 1423 | 5420 | 1172 | 5808 | 970 | 6315 | 621 | 7366 | 244 | 6299 |
| 14-#10 | 3.53 | MA | 4880 | 1844 | 7473 | 1499 | 8729 | 1241 | 9519 | 1026 | 10572 | 681 | 13149 | 367 | 10644 |
| 5L-4S | | MI | 3083 | 1844 | 4999 | 1408 | 5677 | 1168 | 6126 | 959 | 6756 | 614 | 7909 | 298 | 6509 |

## RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 3.53 | MA | 4713 | 1844 | 7134 | 1506 | 8318 | 1251 | 8985 | 1043 | 9850 | 695 | 12126 | 295 | 10289 |
| 6L-3S | | MI | 3150 | 1844 | 5206 | 1402 | 5968 | 1155 | 6482 | 957 | 7243 | 616 | 8462 | 343 | 6626 |
| 14-#10 | 3.53 | MA | 4571 | 1844 | 6802 | 1513 | 7867 | 1267 | 8472 | 1052 | 9112 | 702 | 11138 | 257 | 9726 |
| 7L-2S | | MI | 3280 | 1844 | 5500 | 1396 | 6342 | 1150 | 6937 | 946 | 7859 | 609 | 9236 | 434 | 6636 |
| 14-#11 | 4.33 | MA | 5097 | 1960 | 8012 | 1570 | 9371 | 1293 | 10277 | 1057 | 11576 | 673 | 14543 | 304 | 12622 |
| 5L-4S | | MI | 3196 | 1960 | 5330 | 1468 | 6059 | 1210 | 6574 | 981 | 7371 | 606 | 8493 | 200 | 7579 |
| 14-#11 | 4.33 | MA | 4902 | 1960 | 7609 | 1579 | 8849 | 1314 | 9628 | 1077 | 10699 | 690 | 13390 | 230 | 11995 |
| 6L-3S | | MI | 3282 | 1960 | 5578 | 1461 | 6408 | 1195 | 7001 | 980 | 7933 | 600 | 9136 | 253 | 7868 |
| 14-#11 | 4.33 | MA | 4735 | 1960 | 7206 | 1586 | 8335 | 1323 | 9005 | 1087 | 9804 | 696 | 12090 | 164 | 11353 |
| 7L-2S | | MI | 3421 | 1960 | 5929 | 1454 | 6854 | 1191 | 7542 | 968 | 8666 | 594 | 10027 | 365 | 7891 |
| 14-#14 | 6.25 | MA | 5387 | 2236 | 8701 | 1768 | 10185 | 1459 | 11223 | 1172 | 12832 | 690 | 16405 | 60 | 16073 |
| 6L-3S | | MI | 3614 | 2236 | 6464 | 1625 | 7511 | 1312 | 8330 | 1054 | 9690 | 573 | 11113 | 79 | 10831 |
| 16-#10 | 4.03 | MA | 5117 | 1917 | 7994 | 1545 | 9392 | 1274 | 10325 | 1047 | 11662 | 677 | 14658 | 361 | 12180 |
| 5E | | MI | 3126 | 1917 | 5080 | 1469 | 5795 | 1205 | 6263 | 990 | 6930 | 617 | 8139 | 226 | 7152 |
| 16-#10 | 4.03 | MA | 4957 | 1917 | 7655 | 1551 | 8981 | 1284 | 9790 | 1064 | 10939 | 691 | 13635 | 289 | 11817 |
| 6L-4S | | MI | 3208 | 1917 | 5293 | 1454 | 6051 | 1201 | 6581 | 980 | 7372 | 610 | 8683 | 280 | 7348 |
| 16-#10 | 4.03 | MA | 4821 | 1917 | 7323 | 1558 | 8530 | 1300 | 9277 | 1072 | 10202 | 697 | 12647 | 251 | 11268 |
| 7L-3S | | MI | 3273 | 1917 | 5500 | 1447 | 6342 | 1188 | 6937 | 977 | 7859 | 611 | 9236 | 325 | 7508 |
| 16-#10 | 4.03 | MA | 4662 | 1917 | 7003 | 1566 | 8099 | 1306 | 8756 | 1089 | 9497 | 712 | 11697 | 198 | 10653 |
| 8L-2S | | MI | 3400 | 1917 | 5794 | 1441 | 6717 | 1183 | 7392 | 966 | 8474 | 605 | 10010 | 416 | 7523 |
| 16-#11 | 4.95 | MA | 5191 | 2049 | 8238 | 1634 | 9649 | 1354 | 10601 | 1103 | 12015 | 685 | 15213 | 222 | 13842 |
| 6L-4S | | MI | 3357 | 2049 | 5680 | 1523 | 6505 | 1250 | 7115 | 1007 | 8105 | 601 | 9385 | 174 | 8581 |
| 16-#11 | 4.95 | MA | 5032 | 2049 | 7835 | 1642 | 9136 | 1364 | 9977 | 1112 | 11120 | 691 | 13912 | 157 | 13202 |
| 7L-3S | | MI | 3424 | 2049 | 5929 | 1517 | 6854 | 1236 | 7542 | 1005 | 8666 | 595 | 10027 | 226 | 8915 |
| 18-#10 | 4.54 | MA | 5196 | 1989 | 8176 | 1597 | 9644 | 1317 | 10596 | 1084 | 12029 | 687 | 15144 | 284 | 13348 |
| 6L-5S | | MI | 3251 | 1989 | 5374 | 1514 | 6169 | 1238 | 6718 | 1011 | 7546 | 612 | 8913 | 208 | 8007 |
| 18-#10 | 4.54 | MA | 5066 | 1989 | 7844 | 1603 | 9193 | 1333 | 10082 | 1093 | 11292 | 693 | 14156 | 245 | 12812 |
| 7L-4S | | MI | 3333 | 1989 | 5587 | 1499 | 6426 | 1233 | 7036 | 1000 | 7987 | 606 | 9456 | 262 | 8192 |
| 18-#10 | 4.54 | MA | 4908 | 1989 | 7524 | 1611 | 8762 | 1339 | 9561 | 1109 | 10587 | 708 | 13206 | 192 | 12196 |
| 8L-3S | | MI | 3395 | 1989 | 5794 | 1493 | 6717 | 1221 | 7392 | 998 | 8474 | 607 | 10010 | 307 | 8388 |
| 18-#11 | 5.57 | MA | 5324 | 2138 | 8464 | 1698 | 9936 | 1404 | 10950 | 1137 | 12436 | 686 | 15734 | 150 | 15054 |
| 7L-4S | | MI | 3502 | 2138 | 6030 | 1579 | 6951 | 1290 | 7657 | 1032 | 8838 | 596 | 10276 | 147 | 9588 |
| 20-#10 | 5.04 | MA | 5308 | 2062 | 8364 | 1649 | 9856 | 1365 | 10888 | 1113 | 12382 | 689 | 15665 | 239 | 14358 |
| 7L-5S | | MI | 3375 | 2062 | 5668 | 1559 | 6544 | 1271 | 7172 | 1032 | 8161 | 608 | 9687 | 190 | 8864 |
| 20-#10 | 5.04 | MA | 5151 | 2062 | 8045 | 1656 | 9425 | 1372 | 10367 | 1130 | 11677 | 703 | 14715 | 187 | 13739 |
| 8L-4S | | MI | 3456 | 2062 | 5881 | 1544 | 6800 | 1266 | 7490 | 1021 | 8603 | 601 | 10230 | 244 | 9039 |
| 22-#10 | 5.54 | MA | 5390 | 2134 | 8566 | 1702 | 10088 | 1405 | 11172 | 1150 | 12767 | 699 | 16224 | 181 | 15281 |
| 8L-5S | | MI | 3497 | 2134 | 5962 | 1605 | 6918 | 1304 | 7627 | 1052 | 8777 | 604 | 10461 | 172 | 9724 |

## RECTANGULAR TIED COLUMNS 18" x 30"

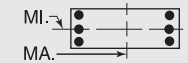
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.16 | MA | 4954 | 1610 | 7189 | 1333 | 8275 | 1123 | 8828 | 959 | 9330 | 713 | 11046 | 620 | 4427 |
| 2E | | MI | 2879 | 1610 | 4425 | 1252 | 4889 | 1054 | 5101 | 899 | 5252 | 665 | 5840 | 539 | 2547 |
| 4-#14 | 1.67 | MA | 5215 | 1689 | 7806 | 1376 | 9030 | 1153 | 9730 | 976 | 10538 | 704 | 12711 | 610 | 6234 |
| 2E | | MI | 2994 | 1689 | 4738 | 1291 | 5262 | 1081 | 5541 | 913 | 5828 | 652 | 6482 | 499 | 3496 |
| 4-#18 | 2.96 | MA | 5826 | 1889 | 9310 | 1488 | 10885 | 1233 | 11954 | 1024 | 13524 | 685 | 16827 | 588 | 10659 |
| 2E | | MI | 3254 | 1889 | 5473 | 1395 | 6149 | 1154 | 6595 | 954 | 7130 | 610 | 7915 | 382 | 5730 |
| 6-#9 | 1.11 | MA | 4954 | 1603 | 7098 | 1340 | 8218 | 1130 | 8788 | 966 | 9299 | 720 | 11021 | 627 | 4303 |
| 2L-3S | | MI | 2770 | 1603 | 4141 | 1273 | 4579 | 1072 | 4747 | 921 | 4790 | 683 | 5351 | 492 | 2495 |
| 6-#9 | 1.11 | MA | 4715 | 1603 | 6650 | 1350 | 7648 | 1138 | 8095 | 973 | 8361 | 732 | 9722 | 561 | 4314 |
| 3L-2S | | MI | 2888 | 1603 | 4375 | 1268 | 4877 | 1068 | 5109 | 912 | 5280 | 677 | 5975 | 564 | 2477 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis

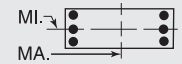



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 1.41 | MA | 5117 | 1650 | 7470 | 1366 | 8676 | 1148 | 9336 | 976 | 10033 | 715 | 12033 | 621 | 5393 |
| 2L-3S | | MI | 2818 | 1650 | 4275 | 1298 | 4736 | 1089 | 4931 | 932 | 5034 | 678 | 5640 | 455 | 3082 |
| 6-#10 | 1.41 | MA | 4821 | 1650 | 6903 | 1378 | 7955 | 1159 | 8460 | 986 | 8849 | 731 | 10393 | 537 | 5398 |
| 3L-2S | | MI | 2963 | 1650 | 4569 | 1291 | 5110 | 1084 | 5386 | 921 | 5650 | 671 | 6414 | 546 | 3060 |
| 6-#11 | 1.73 | MA | 5269 | 1699 | 7873 | 1389 | 9147 | 1163 | 9887 | 984 | 10762 | 707 | 13030 | 613 | 6513 |
| 2L-3S | | MI | 2857 | 1699 | 4425 | 1314 | 4889 | 1098 | 5101 | 936 | 5252 | 666 | 5840 | 400 | 3672 |
| 6-#11 | 1.73 | MA | 4921 | 1699 | 7189 | 1402 | 8275 | 1175 | 8828 | 995 | 9330 | 725 | 11046 | 506 | 6507 |
| 3L-2S | | MI | 3026 | 1699 | 4775 | 1308 | 5336 | 1094 | 5643 | 924 | 5985 | 660 | 6732 | 512 | 3646 |
| 6-#14 | 2.50 | MA | 5650 | 1817 | 8782 | 1456 | 10273 | 1212 | 11239 | 1013 | 12581 | 697 | 15538 | 600 | 9194 |
| 2L-3S | | MI | 2966 | 1817 | 4738 | 1379 | 5262 | 1143 | 5541 | 965 | 5828 | 651 | 6482 | 293 | 5043 |
| 6-#14 | 2.50 | MA | 5175 | 1817 | 7806 | 1475 | 9030 | 1228 | 9730 | 1027 | 10538 | 721 | 12711 | 444 | 9131 |
| 3L-2S | | MI | 3197 | 1817 | 5232 | 1371 | 5891 | 1139 | 6305 | 950 | 6856 | 644 | 7707 | 455 | 5025 |
| 6-#18 | 4.44 | MA | 6542 | 2117 | 11004 | 1631 | 13042 | 1337 | 14574 | 1088 | 17071 | 672 | 21737 | 569 | 15763 |
| 2L-3S | | MI | 3234 | 2117 | 5473 | 1547 | 6149 | 1258 | 6595 | 1038 | 7130 | 599 | 7915 | -2 | 7913 |
| 6-#18 | 4.44 | MA | 5793 | 2117 | 9310 | 1661 | 10885 | 1363 | 11954 | 1136 | 13524 | 711 | 16827 | 282 | 15402 |
| 3L-2S | | MI | 3576 | 2117 | 6311 | 1537 | 7216 | 1257 | 7891 | 1019 | 8824 | 586 | 9882 | 285 | 8283 |
| 8-#8 | 1.17 | MA | 4995 | 1613 | 7161 | 1349 | 8313 | 1136 | 8910 | 970 | 9469 | 721 | 11261 | 627 | 4532 |
| 2L-4S | | MI | 2765 | 1613 | 4089 | 1287 | 4508 | 1088 | 4665 | 927 | 4680 | 684 | 5266 | 481 | 2629 |
| 8-#8 | 1.17 | MA | 4806 | 1613 | 6805 | 1356 | 7859 | 1143 | 8359 | 977 | 8724 | 731 | 10229 | 576 | 4540 |
| 3E | | MI | 2816 | 1613 | 4220 | 1283 | 4692 | 1079 | 4890 | 925 | 4988 | 684 | 5623 | 510 | 2613 |
| 8-#8 | 1.17 | MA | 4708 | 1613 | 6564 | 1364 | 7518 | 1155 | 7941 | 988 | 8151 | 736 | 9535 | 544 | 4538 |
| 4L-2S | | MI | 2910 | 1613 | 4407 | 1278 | 4930 | 1076 | 5179 | 918 | 5379 | 679 | 6126 | 567 | 2600 |
| 8-#9 | 1.48 | MA | 5165 | 1660 | 7546 | 1376 | 8789 | 1156 | 9481 | 982 | 10237 | 717 | 12320 | 622 | 5668 |
| 2L-4S | | MI | 2811 | 1660 | 4211 | 1314 | 4646 | 1108 | 4826 | 939 | 4893 | 679 | 5530 | 442 | 3239 |
| 8-#9 | 1.48 | MA | 4932 | 1660 | 7098 | 1385 | 8218 | 1164 | 8788 | 989 | 9299 | 729 | 11021 | 556 | 5671 |
| 3E | | MI | 2874 | 1660 | 4375 | 1309 | 4877 | 1098 | 5109 | 937 | 5280 | 680 | 5975 | 479 | 3224 |
| 8-#9 | 1.48 | MA | 4812 | 1660 | 6794 | 1395 | 7789 | 1179 | 8261 | 1004 | 8576 | 735 | 10144 | 516 | 5647 |
| 4L-2S | | MI | 2989 | 1660 | 4610 | 1303 | 5175 | 1094 | 5471 | 928 | 5770 | 674 | 6598 | 551 | 3208 |
| 8-#10 | 1.88 | MA | 5378 | 1722 | 8036 | 1412 | 9396 | 1181 | 10211 | 997 | 11218 | 711 | 13674 | 615 | 7112 |
| 2L-4S | | MI | 2869 | 1722 | 4362 | 1350 | 4819 | 1134 | 5029 | 955 | 5163 | 672 | 5860 | 392 | 3993 |
| 8-#10 | 1.88 | MA | 5092 | 1722 | 7470 | 1423 | 8676 | 1191 | 9336 | 1006 | 10033 | 727 | 12033 | 531 | 7102 |
| 3E | | MI | 2946 | 1722 | 4569 | 1343 | 5110 | 1122 | 5386 | 952 | 5650 | 674 | 6414 | 437 | 3987 |
| 8-#10 | 1.88 | MA | 4945 | 1722 | 7085 | 1435 | 8132 | 1210 | 8669 | 1024 | 9120 | 734 | 10922 | 480 | 7035 |
| 4L-2S | | MI | 3088 | 1722 | 4864 | 1337 | 5485 | 1117 | 5841 | 941 | 6266 | 667 | 7187 | 528 | 3971 |
| 8-#11 | 2.31 | MA | 5577 | 1788 | 8558 | 1444 | 10018 | 1204 | 10945 | 1009 | 12195 | 702 | 15013 | 606 | 8588 |
| 2L-4S | | MI | 2916 | 1788 | 4527 | 1377 | 4987 | 1153 | 5215 | 962 | 5423 | 667 | 6089 | 320 | 4708 |
| 8-#11 | 2.31 | MA | 5243 | 1788 | 7873 | 1458 | 9147 | 1216 | 9887 | 1020 | 10762 | 720 | 13030 | 499 | 8562 |
| 3E | | MI | 3007 | 1788 | 4775 | 1370 | 5336 | 1139 | 5643 | 961 | 5985 | 661 | 6732 | 373 | 4744 |
| 8-#11 | 2.31 | MA | 5069 | 1788 | 7406 | 1471 | 8487 | 1238 | 9078 | 1041 | 9654 | 727 | 11671 | 436 | 8435 |
| 4L-2S | | MI | 3171 | 1788 | 5126 | 1363 | 5782 | 1135 | 6184 | 949 | 6718 | 654 | 7623 | 485 | 4728 |
| 8-#14 | 3.33 | MA | 5624 | 1946 | 8782 | 1555 | 10273 | 1286 | 11239 | 1063 | 12581 | 714 | 15538 | 433 | 12046 |
| 3E | | MI | 3174 | 1946 | 5232 | 1460 | 5891 | 1201 | 6305 | 1001 | 6856 | 643 | 7707 | 249 | 6526 |
| 8-#14 | 3.33 | MA | 5392 | 1946 | 8113 | 1574 | 9330 | 1318 | 10084 | 1092 | 10998 | 723 | 13588 | 341 | 11245 |
| 4L-2S | | MI | 3395 | 1946 | 5726 | 1451 | 6520 | 1197 | 7069 | 986 | 7885 | 636 | 8932 | 411 | 6535 |
| 8-#18 | 5.93 | MA | 6546 | 2346 | 11004 | 1804 | 13042 | 1467 | 14574 | 1201 | 17071 | 698 | 21737 | 263 | 20454 |
| 3E | | MI | 3577 | 2346 | 6311 | 1690 | 7216 | 1362 | 7891 | 1103 | 8824 | 576 | 9882 | -99 | 9801 |
| 8-#18 | 5.93 | MA | 6183 | 2346 | 9837 | 1835 | 11398 | 1519 | 12558 | 1223 | 14310 | 710 | 18299 | 96 | 17678 |
| 4L-2S | | MI | 3893 | 2346 | 7149 | 1680 | 8283 | 1361 | 9187 | 1084 | 10518 | 563 | 11850 | 189 | 10804 |
| 10-#10 | 2.35 | MA | 5633 | 1795 | 8602 | 1457 | 10117 | 1214 | 11086 | 1018 | 12403 | 707 | 15314 | 610 | 8825 |
| 2L-5S | | MI | 2916 | 1795 | 4443 | 1410 | 4937 | 1172 | 5166 | 986 | 5337 | 675 | 6091 | 319 | 4674 |
| 10-#10 | 2.35 | MA | 5358 | 1795 | 8036 | 1468 | 9396 | 1224 | 10211 | 1027 | 11218 | 722 | 13674 | 525 | 8804 |
| 3L-4S | | MI | 2999 | 1795 | 4656 | 1395 | 5194 | 1167 | 5484 | 975 | 5778 | 668 | 6634 | 374 | 4876 |
| 10-#10 | 2.35 | MA | 5220 | 1795 | 7651 | 1480 | 8853 | 1243 | 9544 | 1045 | 10304 | 729 | 12562 | 474 | 8724 |
| 4L-3S | | MI | 3073 | 1795 | 4864 | 1388 | 5485 | 1155 | 5841 | 973 | 6266 | 670 | 7187 | 419 | 4883 |
| 10-#10 | 2.35 | MA | 5010 | 1795 | 7258 | 1500 | 8380 | 1254 | 8956 | 1054 | 9485 | 745 | 11437 | 429 | 8283 |
| 5L-2S | | MI | 3211 | 1795 | 5158 | 1382 | 5859 | 1150 | 6295 | 962 | 6881 | 663 | 7961 | 510 | 4873 |
| 10-#11 | 2.89 | MA | 5557 | 1877 | 8558 | 1513 | 10018 | 1256 | 10945 | 1045 | 12195 | 715 | 15013 | 492 | 10614 |
| 3L-4S | | MI | 3068 | 1877 | 4877 | 1432 | 5433 | 1194 | 5757 | 987 | 6157 | 662 | 6981 | 294 | 5683 |

## RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis

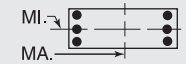



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.89 | MA | 5396 | 1877 | 8090 | 1527 | 9359 | 1278 | 10136 | 1066 | 11087 | 722 | 13655 | 428 | 10474 |
| 4L-3S | | MI | 3155 | 1877 | 5126 | 1426 | 5782 | 1179 | 6184 | 986 | 6718 | 656 | 7623 | 346 | 5805 |
| 10-#11 | 2.89 | MA | 5150 | 1877 | 7614 | 1551 | 8784 | 1290 | 9422 | 1076 | 10092 | 740 | 12285 | 371 | 9751 |
| 5L-2S | | MI | 3315 | 1877 | 5476 | 1419 | 6228 | 1175 | 6726 | 975 | 7452 | 649 | 8515 | 458 | 5800 |
| 10-#14 | 4.17 | MA | 5850 | 2074 | 9089 | 1654 | 10573 | 1376 | 11593 | 1129 | 13040 | 716 | 16416 | 330 | 14090 |
| 4L-3S | | MI | 3389 | 2074 | 5726 | 1540 | 6520 | 1260 | 7069 | 1037 | 7885 | 635 | 8932 | 206 | 8000 |
| 10-#14 | 4.17 | MA | 5506 | 2074 | 8407 | 1688 | 9751 | 1392 | 10571 | 1143 | 11617 | 740 | 14452 | 244 | 13192 |
| 5L-2S | | MI | 3588 | 2074 | 6220 | 1532 | 7149 | 1256 | 7833 | 1023 | 8913 | 627 | 10157 | 367 | 8033 |
| 10-#18 | 7.41 | MA | 6960 | 2574 | 11531 | 1977 | 13556 | 1623 | 15179 | 1287 | 17857 | 697 | 23209 | 77 | 22683 |
| 4L-3S | | MI | 3913 | 2574 | 7149 | 1832 | 8283 | 1466 | 9187 | 1168 | 10518 | 552 | 11850 | -196 | 11650 |
| 10-#18 | 7.41 | MA | 6385 | 2574 | 10338 | 2035 | 12118 | 1649 | 13392 | 1336 | 15371 | 736 | 19765 | -87 | 19474 |
| 5L-2S | | MI | 4207 | 2574 | 7988 | 1823 | 9350 | 1465 | 10483 | 1149 | 12212 | 539 | 13818 | 92 | 13312 |
| 12-#10 | 2.82 | MA | 5619 | 1867 | 8602 | 1514 | 10117 | 1257 | 11086 | 1047 | 12403 | 718 | 15314 | 519 | 10503 |
| 3L-5S | | MI | 3045 | 1867 | 4737 | 1455 | 5312 | 1205 | 5621 | 1007 | 5953 | 671 | 6865 | 302 | 5517 |
| 12-#10 | 2.82 | MA | 5489 | 1867 | 8217 | 1525 | 9574 | 1276 | 10420 | 1065 | 11489 | 725 | 14202 | 468 | 10415 |
| 4E | | MI | 3128 | 1867 | 4950 | 1440 | 5568 | 1200 | 5939 | 996 | 6394 | 664 | 7408 | 356 | 5751 |
| 12-#10 | 2.82 | MA | 5280 | 1867 | 7825 | 1545 | 9101 | 1287 | 9831 | 1074 | 10669 | 741 | 13077 | 424 | 9947 |
| 5L-3S | | MI | 3199 | 1867 | 5158 | 1434 | 5859 | 1188 | 6295 | 993 | 6881 | 665 | 7961 | 401 | 5773 |
| 12-#10 | 2.82 | MA | 5091 | 1867 | 7452 | 1551 | 8656 | 1297 | 9253 | 1092 | 9887 | 756 | 11976 | 353 | 9573 |
| 6L-2S | | MI | 3333 | 1867 | 5452 | 1427 | 6234 | 1183 | 6750 | 982 | 7497 | 659 | 8735 | 492 | 5771 |
| 12-#11 | 3.47 | MA | 5716 | 1966 | 8775 | 1582 | 10230 | 1319 | 11195 | 1091 | 12519 | 717 | 15638 | 421 | 12464 |
| 4E | | MI | 3219 | 1966 | 5227 | 1488 | 5879 | 1234 | 6299 | 1013 | 6890 | 657 | 7872 | 267 | 6668 |
| 12-#11 | 3.47 | MA | 5471 | 1966 | 8298 | 1606 | 9656 | 1331 | 10480 | 1101 | 11524 | 735 | 14268 | 364 | 11766 |
| 5L-3S | | MI | 3302 | 1966 | 5476 | 1481 | 6228 | 1220 | 6726 | 1011 | 7452 | 650 | 8515 | 319 | 6859 |
| 12-#11 | 3.47 | MA | 5248 | 1966 | 7854 | 1614 | 9115 | 1343 | 9778 | 1122 | 10574 | 753 | 12922 | 276 | 11162 |
| 6L-2S | | MI | 3457 | 1966 | 5827 | 1475 | 6674 | 1216 | 7268 | 1000 | 8185 | 644 | 9406 | 431 | 6866 |
| 12-#14 | 5.00 | MA | 5956 | 2203 | 9383 | 1768 | 10993 | 1451 | 12080 | 1179 | 13659 | 733 | 17280 | 234 | 16090 |
| 5L-3S | | MI | 3590 | 2203 | 6220 | 1620 | 7149 | 1318 | 7833 | 1074 | 8913 | 626 | 10157 | 162 | 9470 |
| 12-#14 | 5.00 | MA | 5652 | 2203 | 8755 | 1780 | 10183 | 1482 | 11075 | 1208 | 12301 | 757 | 15497 | 127 | 14756 |
| 6L-2S | | MI | 3779 | 2203 | 6714 | 1612 | 7778 | 1314 | 8597 | 1059 | 9942 | 619 | 11382 | 323 | 9521 |
| 14-#10 | 3.29 | MA | 5753 | 1940 | 8783 | 1571 | 10294 | 1309 | 11295 | 1086 | 12674 | 721 | 15843 | 462 | 12107 |
| 4L-5S | | MI | 3172 | 1940 | 5032 | 1500 | 5686 | 1238 | 6076 | 1027 | 6568 | 666 | 7638 | 284 | 6365 |
| 14-#10 | 3.29 | MA | 5546 | 1940 | 8391 | 1590 | 9821 | 1319 | 10707 | 1095 | 11854 | 736 | 14717 | 418 | 11614 |
| 5L-4S | | MI | 3255 | 1940 | 5244 | 1485 | 5943 | 1233 | 6394 | 1016 | 7010 | 660 | 8182 | 338 | 6583 |
| 14-#10 | 3.29 | MA | 5363 | 1940 | 8018 | 1597 | 9377 | 1330 | 10129 | 1113 | 11072 | 752 | 13616 | 347 | 11256 |
| 6L-3S | | MI | 3323 | 1940 | 5452 | 1479 | 6234 | 1220 | 6750 | 1014 | 7497 | 661 | 8735 | 383 | 6659 |
| 14-#10 | 3.29 | MA | 5208 | 1940 | 7658 | 1604 | 8881 | 1345 | 9573 | 1122 | 10274 | 759 | 12551 | 311 | 10646 |
| 7L-2S | | MI | 3454 | 1940 | 5746 | 1473 | 6608 | 1216 | 7205 | 1003 | 8112 | 654 | 9509 | 474 | 6664 |
| 14-#11 | 4.04 | MA | 5786 | 2056 | 8983 | 1662 | 10527 | 1371 | 11539 | 1127 | 12956 | 730 | 16252 | 356 | 13787 |
| 5L-4S | | MI | 3367 | 2056 | 5578 | 1544 | 6325 | 1274 | 6841 | 1038 | 7623 | 651 | 8764 | 240 | 7662 |
| 14-#11 | 4.04 | MA | 5572 | 2056 | 8538 | 1670 | 9987 | 1383 | 10836 | 1148 | 12007 | 748 | 14906 | 269 | 13175 |
| 6L-3S | | MI | 3447 | 2056 | 5827 | 1537 | 6674 | 1260 | 7268 | 1037 | 8185 | 645 | 9406 | 292 | 7909 |
| 14-#11 | 4.04 | MA | 5389 | 2056 | 8101 | 1678 | 9395 | 1402 | 10161 | 1158 | 11037 | 755 | 13607 | 221 | 12468 |
| 7L-2S | | MI | 3597 | 2056 | 6177 | 1530 | 7120 | 1256 | 7810 | 1025 | 8919 | 639 | 10298 | 404 | 7926 |
| 14-#14 | 5.83 | MA | 6107 | 2331 | 9731 | 1860 | 11426 | 1540 | 12584 | 1245 | 14343 | 750 | 18325 | 117 | 17644 |
| 6L-3S | | MI | 3788 | 2331 | 6714 | 1700 | 7778 | 1377 | 8597 | 1110 | 9942 | 618 | 11382 | 118 | 10939 |
| 16-#10 | 3.76 | MA | 5807 | 2012 | 8957 | 1636 | 10542 | 1352 | 11582 | 1115 | 13039 | 732 | 16358 | 412 | 13286 |
| 5E | | MI | 3298 | 2012 | 5326 | 1546 | 6061 | 1271 | 6531 | 1048 | 7184 | 662 | 8412 | 266 | 7217 |
| 16-#10 | 3.76 | MA | 5630 | 2012 | 8584 | 1642 | 10098 | 1363 | 11004 | 1133 | 12257 | 748 | 15256 | 341 | 12941 |
| 6L-4S | | MI | 3380 | 2012 | 5539 | 1531 | 6317 | 1266 | 6849 | 1037 | 7625 | 655 | 8955 | 320 | 7421 |
| 16-#10 | 3.76 | MA | 5482 | 2012 | 8224 | 1649 | 9601 | 1378 | 10449 | 1142 | 11458 | 755 | 14191 | 305 | 12327 |
| 7L-3S | | MI | 3446 | 2012 | 5746 | 1524 | 6608 | 1253 | 7205 | 1034 | 8112 | 657 | 9509 | 365 | 7542 |
| 16-#10 | 3.76 | MA | 5304 | 2012 | 7878 | 1658 | 9134 | 1385 | 9874 | 1158 | 10696 | 770 | 13166 | 255 | 11694 |
| 8L-2S | | MI | 3574 | 2012 | 6040 | 1518 | 6983 | 1249 | 7660 | 1024 | 8728 | 650 | 10282 | 456 | 7554 |
| 16-#11 | 4.62 | MA | 5890 | 2145 | 9223 | 1726 | 10858 | 1424 | 11895 | 1173 | 13439 | 742 | 16889 | 262 | 15193 |
| 6L-4S | | MI | 3529 | 2145 | 5928 | 1599 | 6772 | 1315 | 7383 | 1063 | 8357 | 646 | 9655 | 213 | 8663 |
| 16-#11 | 4.62 | MA | 5716 | 2145 | 8786 | 1734 | 10266 | 1443 | 11220 | 1183 | 12469 | 750 | 15590 | 214 | 14504 |
| 7L-3S | | MI | 3598 | 2145 | 6177 | 1593 | 7120 | 1301 | 7810 | 1062 | 8919 | 640 | 10298 | 265 | 8957 |

## RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 4.23 | MA | 5893 | 2085 | 9150 | 1687 | 10818 | 1396 | 11879 | 1154 | 13441 | 743 | 16897 | 335 | 14628 |
| 6L-5S | | MI | 3423 | 2085 | 5620 | 1591 | 6435 | 1304 | 6986 | 1068 | 7799 | 658 | 9186 | 248 | 8072 |
| 18-#10 | 4.23 | MA | 5751 | 2085 | 8790 | 1694 | 10322 | 1411 | 11324 | 1163 | 12643 | 750 | 15831 | 299 | 14009 |
| 7L-4S | | MI | 3505 | 2085 | 5833 | 1576 | 6692 | 1299 | 7304 | 1057 | 8241 | 651 | 9729 | 302 | 8264 |
| 18-#10 | 4.23 | MA | 5575 | 2085 | 8445 | 1703 | 9855 | 1418 | 10750 | 1179 | 11881 | 766 | 14806 | 249 | 13371 |
| 8L-3S | | MI | 3568 | 2085 | 6040 | 1570 | 6983 | 1286 | 7660 | 1055 | 8728 | 653 | 10282 | 347 | 8423 |
| 18-#11 | 5.20 | MA | 6037 | 2234 | 9470 | 1789 | 11138 | 1483 | 12278 | 1208 | 13902 | 745 | 17573 | 207 | 16541 |
| 7L-4S | | MI | 3674 | 2234 | 6279 | 1655 | 7218 | 1355 | 7925 | 1088 | 9090 | 641 | 10547 | 186 | 9668 |
| 20-#10 | 4.70 | MA | 6016 | 2157 | 9356 | 1740 | 11043 | 1444 | 12199 | 1183 | 13828 | 746 | 17472 | 293 | 15693 |
| 7L-5S | | MI | 3547 | 2157 | 5914 | 1636 | 6810 | 1337 | 7440 | 1089 | 8415 | 654 | 9960 | 230 | 8929 |
| 20-#10 | 4.70 | MA | 5841 | 2157 | 9011 | 1748 | 10576 | 1451 | 11625 | 1199 | 13065 | 762 | 16447 | 243 | 15048 |
| 8L-4S | | MI | 3629 | 2157 | 6127 | 1621 | 7066 | 1332 | 7759 | 1078 | 8856 | 647 | 10503 | 284 | 9110 |
| 22-#10 | 5.17 | MA | 6104 | 2230 | 9577 | 1793 | 11296 | 1483 | 12501 | 1220 | 14250 | 757 | 18087 | 237 | 16725 |
| 8L-5S | | MI | 3670 | 2230 | 6208 | 1682 | 7184 | 1369 | 7895 | 1109 | 9031 | 650 | 10733 | 212 | 9788 |

## RECTANGULAR TIED COLUMNS 18" x 32"

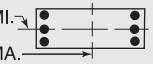
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.08 | MA | 5609 | 1706 | 8054 | 1422 | 9298 | 1199 | 9923 | 1025 | 10468 | 766 | 12377 | 666 | 4763 |
| 2E | | MI | 3052 | 1706 | 4673 | 1328 | 5156 | 1119 | 5368 | 955 | 5504 | 710 | 6111 | 578 | 2568 |
| 4-#14 | 1.56 | MA | 5895 | 1784 | 8724 | 1465 | 10118 | 1230 | 10902 | 1043 | 11779 | 757 | 14183 | 657 | 6720 |
| 2E | | MI | 3167 | 1784 | 4988 | 1366 | 5529 | 1145 | 5808 | 969 | 6079 | 697 | 6750 | 538 | 3523 |
| 4-#18 | 2.78 | MA | 6570 | 1984 | 10359 | 1578 | 12134 | 1310 | 13320 | 1090 | 15026 | 738 | 18659 | 634 | 11523 |
| 2E | | MI | 3428 | 1984 | 5726 | 1469 | 6416 | 1217 | 6862 | 1009 | 7379 | 653 | 8180 | 421 | 5769 |
| 6-#9 | 1.04 | MA | 5607 | 1699 | 7953 | 1430 | 9233 | 1206 | 9876 | 1032 | 10429 | 773 | 12342 | 673 | 4627 |
| 2L-3S | | MI | 2942 | 1699 | 4386 | 1350 | 4844 | 1138 | 5015 | 978 | 5044 | 729 | 5625 | 532 | 2513 |
| 6-#9 | 1.04 | MA | 5345 | 1699 | 7470 | 1440 | 8617 | 1215 | 9127 | 1040 | 9416 | 786 | 10940 | 608 | 4638 |
| 3L-2S | | MI | 3061 | 1699 | 4620 | 1345 | 5142 | 1134 | 5377 | 969 | 5534 | 723 | 6248 | 604 | 2495 |
| 6-#10 | 1.32 | MA | 5785 | 1745 | 8355 | 1456 | 9728 | 1224 | 10468 | 1043 | 11224 | 768 | 13437 | 668 | 5804 |
| 2L-3S | | MI | 2990 | 1745 | 4521 | 1375 | 5001 | 1154 | 5199 | 989 | 5288 | 724 | 5913 | 495 | 3103 |
| 6-#10 | 1.32 | MA | 5462 | 1745 | 7744 | 1468 | 8950 | 1235 | 9523 | 1053 | 9944 | 785 | 11666 | 585 | 5809 |
| 3L-2S | | MI | 3136 | 1745 | 4815 | 1368 | 5376 | 1150 | 5654 | 978 | 5904 | 717 | 6686 | 586 | 3081 |
| 6-#11 | 1.63 | MA | 5954 | 1795 | 8794 | 1478 | 10241 | 1240 | 11068 | 1051 | 12017 | 760 | 14522 | 659 | 7018 |
| 2L-3S | | MI | 3029 | 1795 | 4673 | 1390 | 5156 | 1163 | 5368 | 992 | 5504 | 711 | 6111 | 439 | 3699 |
| 6-#11 | 1.63 | MA | 5572 | 1795 | 8054 | 1492 | 9298 | 1252 | 9923 | 1062 | 10468 | 779 | 12377 | 555 | 7013 |
| 3L-2S | | MI | 3199 | 1795 | 5024 | 1384 | 5602 | 1159 | 5910 | 981 | 6237 | 705 | 7002 | 551 | 3671 |
| 6-#14 | 2.34 | MA | 6372 | 1913 | 9780 | 1546 | 11462 | 1288 | 12535 | 1079 | 13989 | 750 | 17243 | 646 | 9923 |
| 2L-3S | | MI | 3138 | 1913 | 4988 | 1455 | 5529 | 1207 | 5808 | 1021 | 6079 | 696 | 6750 | 332 | 5080 |
| 6-#14 | 2.34 | MA | 5852 | 1913 | 8724 | 1565 | 10118 | 1305 | 10902 | 1095 | 11779 | 776 | 14183 | 493 | 9860 |
| 3L-2S | | MI | 3369 | 1913 | 5482 | 1446 | 6158 | 1203 | 6572 | 1006 | 7108 | 688 | 7975 | 494 | 5056 |
| 6-#18 | 4.17 | MA | 7355 | 2213 | 12196 | 1720 | 14474 | 1413 | 16161 | 1155 | 18871 | 725 | 23983 | 616 | 17059 |
| 2L-3S | | MI | 3405 | 2213 | 5726 | 1621 | 6416 | 1322 | 6862 | 1093 | 7379 | 643 | 8180 | 36 | 8088 |
| 6-#18 | 4.17 | MA | 6531 | 2213 | 10359 | 1753 | 12134 | 1441 | 13320 | 1179 | 15026 | 767 | 18659 | 335 | 16698 |
| 3L-2S | | MI | 3751 | 2213 | 6565 | 1611 | 7484 | 1320 | 8158 | 1074 | 9073 | 630 | 10148 | 324 | 8327 |
| 8-#8 | 1.10 | MA | 5651 | 1708 | 8020 | 1439 | 9334 | 1213 | 10006 | 1037 | 10611 | 774 | 12599 | 674 | 4873 |
| 2L-4S | | MI | 2937 | 1708 | 4333 | 1365 | 4773 | 1154 | 4933 | 985 | 4935 | 730 | 5540 | 521 | 2647 |
| 8-#8 | 1.10 | MA | 5444 | 1708 | 7636 | 1446 | 8845 | 1220 | 9412 | 1043 | 9807 | 785 | 11486 | 623 | 4881 |
| 3E | | MI | 2988 | 1708 | 4464 | 1360 | 4957 | 1146 | 5158 | 983 | 5243 | 730 | 5898 | 551 | 2631 |
| 8-#8 | 1.10 | MA | 5338 | 1708 | 7377 | 1454 | 8478 | 1232 | 8961 | 1055 | 9190 | 790 | 10742 | 592 | 4879 |
| 4L-2S | | MI | 3082 | 1708 | 4651 | 1356 | 5195 | 1142 | 5447 | 976 | 5634 | 725 | 6400 | 607 | 2618 |
| 8-#9 | 1.39 | MA | 5837 | 1756 | 8437 | 1466 | 9850 | 1232 | 10624 | 1048 | 11442 | 770 | 13744 | 669 | 6100 |
| 2L-4S | | MI | 2982 | 1756 | 4456 | 1392 | 4911 | 1174 | 5094 | 997 | 5147 | 725 | 5804 | 483 | 3262 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

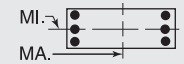
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.39 | MA | 5583 | 1756 | 7953 | 1475 | 9233 | 1241 | 9876 | 1056 | 10429 | 783 | 12342 | 604 | 6103 |
| 3E | | MI | 3046 | 1756 | 4620 | 1386 | 5142 | 1164 | 5377 | 994 | 5534 | 725 | 6248 | 519 | 3244 |
| 8-#9 | 1.39 | MA | 5452 | 1756 | 7626 | 1485 | 8771 | 1256 | 9308 | 1071 | 9650 | 789 | 11403 | 564 | 6079 |
| 4L-2S | | MI | 3162 | 1756 | 4854 | 1381 | 5440 | 1160 | 5739 | 985 | 6024 | 719 | 6871 | 591 | 3228 |
| 8-#10 | 1.76 | MA | 6070 | 1818 | 8967 | 1501 | 10507 | 1257 | 11414 | 1064 | 12503 | 764 | 15209 | 662 | 7660 |
| 2L-4S | | MI | 3040 | 1818 | 4608 | 1427 | 5085 | 1200 | 5298 | 1012 | 5416 | 718 | 6133 | 432 | 4023 |
| 8-#10 | 1.76 | MA | 5758 | 1818 | 8355 | 1513 | 9728 | 1268 | 10468 | 1073 | 11224 | 780 | 13437 | 579 | 7651 |
| 3E | | MI | 3118 | 1818 | 4815 | 1420 | 5376 | 1187 | 5654 | 1009 | 5904 | 719 | 6686 | 477 | 4012 |
| 8-#10 | 1.76 | MA | 5598 | 1818 | 7941 | 1525 | 9143 | 1288 | 9750 | 1092 | 10239 | 788 | 12246 | 528 | 7584 |
| 4L-2S | | MI | 3261 | 1818 | 5109 | 1414 | 5750 | 1183 | 6109 | 999 | 6519 | 713 | 7460 | 568 | 3994 |
| 8-#11 | 2.17 | MA | 6291 | 1884 | 9534 | 1534 | 11183 | 1280 | 12213 | 1076 | 13566 | 755 | 16666 | 652 | 9262 |
| 2L-4S | | MI | 3087 | 1884 | 4775 | 1453 | 5253 | 1218 | 5483 | 1019 | 5675 | 712 | 6360 | 360 | 4773 |
| 8-#11 | 2.17 | MA | 5924 | 1884 | 8794 | 1548 | 10241 | 1293 | 11068 | 1087 | 12017 | 774 | 14522 | 548 | 9236 |
| 3E | | MI | 3179 | 1884 | 5024 | 1446 | 5602 | 1204 | 5910 | 1017 | 6237 | 706 | 7002 | 412 | 4775 |
| 8-#11 | 2.17 | MA | 5735 | 1884 | 8291 | 1562 | 9530 | 1316 | 10196 | 1109 | 10822 | 782 | 13066 | 485 | 9109 |
| 4L-2S | | MI | 3344 | 1884 | 5374 | 1440 | 6048 | 1200 | 6452 | 1006 | 6971 | 700 | 7894 | 524 | 4756 |
| 8-#14 | 3.13 | MA | 6344 | 2041 | 9780 | 1645 | 11462 | 1364 | 12535 | 1131 | 13989 | 768 | 17243 | 483 | 13018 |
| 3E | | MI | 3346 | 2041 | 5482 | 1535 | 6158 | 1266 | 6572 | 1057 | 7108 | 688 | 7975 | 289 | 6569 |
| 8-#14 | 3.13 | MA | 6090 | 2041 | 9059 | 1665 | 10446 | 1396 | 11288 | 1161 | 12281 | 779 | 15152 | 392 | 12277 |
| 4L-2S | | MI | 3569 | 2041 | 5976 | 1527 | 6787 | 1262 | 7336 | 1042 | 8136 | 680 | 9201 | 450 | 6569 |
| 8-#18 | 5.56 | MA | 7356 | 2441 | 12196 | 1895 | 14474 | 1545 | 16161 | 1244 | 18871 | 754 | 23983 | 317 | 22182 |
| 3E | | MI | 3748 | 2441 | 6565 | 1763 | 7484 | 1425 | 8158 | 1158 | 9073 | 620 | 10148 | -61 | 10099 |
| 8-#18 | 5.56 | MA | 6961 | 2441 | 10936 | 1928 | 12697 | 1600 | 13982 | 1294 | 15887 | 769 | 20293 | 151 | 19313 |
| 4L-2S | | MI | 4068 | 2441 | 7403 | 1754 | 8551 | 1424 | 9454 | 1139 | 10768 | 606 | 12115 | 227 | 10853 |
| 10-#10 | 2.20 | MA | 6350 | 1890 | 9578 | 1546 | 11285 | 1290 | 12359 | 1084 | 13783 | 760 | 16981 | 656 | 9510 |
| 2L-5S | | MI | 3087 | 1890 | 4689 | 1487 | 5203 | 1238 | 5434 | 1043 | 5591 | 720 | 6364 | 359 | 4740 |
| 10-#10 | 2.20 | MA | 6048 | 1890 | 8967 | 1558 | 10507 | 1301 | 11414 | 1094 | 12503 | 776 | 15209 | 573 | 9490 |
| 3L-4S | | MI | 3170 | 1890 | 4902 | 1472 | 5459 | 1233 | 5752 | 1032 | 6032 | 714 | 6907 | 414 | 4909 |
| 10-#10 | 2.20 | MA | 5898 | 1890 | 8552 | 1570 | 9921 | 1321 | 10695 | 1112 | 11519 | 784 | 14018 | 523 | 9410 |
| 4L-3S | | MI | 3246 | 1890 | 5109 | 1465 | 5750 | 1220 | 6109 | 1030 | 6519 | 715 | 7460 | 459 | 4910 |
| 10-#10 | 2.20 | MA | 5666 | 1890 | 8130 | 1591 | 9412 | 1332 | 10062 | 1122 | 10636 | 800 | 12810 | 480 | 8989 |
| 5L-2S | | MI | 3384 | 1890 | 5403 | 1459 | 6125 | 1216 | 6564 | 1019 | 7135 | 708 | 8234 | 550 | 4898 |
| 10-#11 | 2.71 | MA | 6269 | 1973 | 9534 | 1603 | 11183 | 1333 | 12213 | 1112 | 13566 | 769 | 16666 | 541 | 11457 |
| 3L-4S | | MI | 3239 | 1973 | 5125 | 1508 | 5700 | 1258 | 6025 | 1044 | 6409 | 707 | 7251 | 333 | 5767 |
| 10-#11 | 2.71 | MA | 6093 | 1973 | 9031 | 1617 | 10472 | 1356 | 11340 | 1134 | 12371 | 777 | 15211 | 478 | 11316 |
| 4L-3S | | MI | 3328 | 1973 | 5374 | 1502 | 6048 | 1244 | 6452 | 1043 | 6971 | 701 | 7894 | 385 | 5840 |
| 10-#11 | 2.71 | MA | 5819 | 1973 | 8518 | 1642 | 9854 | 1369 | 10571 | 1145 | 11298 | 796 | 13738 | 423 | 10590 |
| 5L-2S | | MI | 3488 | 1973 | 5724 | 1495 | 6495 | 1240 | 6994 | 1031 | 7704 | 694 | 8785 | 498 | 5830 |
| 10-#14 | 3.91 | MA | 6591 | 2170 | 10115 | 1745 | 11790 | 1454 | 12921 | 1198 | 14491 | 772 | 18212 | 381 | 15365 |
| 4L-3S | | MI | 3561 | 2170 | 5976 | 1615 | 6787 | 1324 | 7336 | 1093 | 8136 | 679 | 9201 | 245 | 8046 |
| 10-#14 | 3.91 | MA | 6209 | 2170 | 9381 | 1780 | 10905 | 1472 | 11820 | 1213 | 12957 | 798 | 16101 | 299 | 14340 |
| 5L-2S | | MI | 3764 | 2170 | 6470 | 1607 | 7416 | 1320 | 8101 | 1079 | 9165 | 672 | 10426 | 406 | 8071 |
| 10-#18 | 6.94 | MA | 7810 | 2669 | 12773 | 2071 | 15036 | 1704 | 16823 | 1359 | 19732 | 756 | 25617 | 133 | 24755 |
| 4L-3S | | MI | 4084 | 2669 | 7403 | 1906 | 8551 | 1529 | 9454 | 1223 | 10768 | 596 | 12115 | -158 | 11959 |
| 10-#18 | 6.94 | MA | 7170 | 2669 | 11486 | 2130 | 13486 | 1732 | 14895 | 1383 | 17048 | 798 | 21909 | -24 | 21822 |
| 5L-2S | | MI | 4383 | 2669 | 8241 | 1897 | 9618 | 1528 | 10750 | 1203 | 12462 | 583 | 14083 | 130 | 13364 |
| 12-#10 | 2.65 | MA | 6333 | 1963 | 9578 | 1604 | 11285 | 1334 | 12359 | 1115 | 13783 | 772 | 16981 | 567 | 11326 |
| 3L-5S | | MI | 3217 | 1963 | 4983 | 1532 | 5578 | 1270 | 5889 | 1064 | 6206 | 716 | 7137 | 341 | 5582 |
| 12-#10 | 2.65 | MA | 6191 | 1963 | 9164 | 1616 | 10700 | 1354 | 11641 | 1133 | 12798 | 780 | 15790 | 517 | 11238 |
| 4E | | MI | 3299 | 1963 | 5196 | 1517 | 5834 | 1266 | 6207 | 1053 | 6648 | 709 | 7681 | 396 | 5791 |
| 12-#10 | 2.65 | MA | 5961 | 1963 | 8742 | 1636 | 10191 | 1364 | 11007 | 1143 | 11916 | 796 | 14581 | 474 | 10789 |
| 5L-3S | | MI | 3371 | 1963 | 5403 | 1511 | 6125 | 1253 | 6564 | 1051 | 7135 | 711 | 8234 | 441 | 5803 |
| 12-#10 | 2.65 | MA | 5755 | 1963 | 8336 | 1642 | 9713 | 1375 | 10385 | 1161 | 11074 | 812 | 13402 | 404 | 10368 |
| 6L-2S | | MI | 3507 | 1963 | 5698 | 1504 | 6499 | 1249 | 7018 | 1040 | 7750 | 704 | 9008 | 532 | 5797 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis

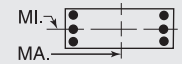



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 3.25 | MA | 6442 | 2062 | 9771 | 1673 | 11415 | 1397 | 12485 | 1159 | 13920 | 772 | 17355 | 471 | 13526 |
| 4E | | MI | 3390 | 2062 | 5476 | 1564 | 6146 | 1299 | 6567 | 1069 | 7142 | 702 | 8143 | 306 | 6751 |
| 12-#11 | 3.25 | MA | 6171 | 2062 | 9258 | 1698 | 10796 | 1409 | 11715 | 1170 | 12847 | 791 | 15883 | 416 | 12773 |
| 5L-3S | | MI | 3474 | 2062 | 5724 | 1557 | 6495 | 1285 | 6994 | 1068 | 7704 | 695 | 8785 | 359 | 6896 |
| 12-#11 | 3.25 | MA | 5927 | 2062 | 8772 | 1705 | 10214 | 1422 | 10959 | 1192 | 11824 | 810 | 14441 | 329 | 12189 |
| 6L-2S | | MI | 3631 | 2062 | 6075 | 1551 | 6941 | 1281 | 7536 | 1056 | 8438 | 689 | 9677 | 471 | 6898 |
| 12-#14 | 4.69 | MA | 6701 | 2298 | 10437 | 1860 | 12249 | 1530 | 13453 | 1250 | 15167 | 790 | 19161 | 289 | 17482 |
| 5L-3S | | MI | 3763 | 2298 | 6470 | 1695 | 7416 | 1382 | 8101 | 1130 | 9165 | 671 | 10426 | 201 | 9519 |
| 12-#14 | 4.69 | MA | 6369 | 2298 | 9749 | 1872 | 11416 | 1548 | 12370 | 1280 | 13703 | 816 | 17089 | 163 | 16093 |
| 6L-2S | | MI | 3955 | 2298 | 6964 | 1687 | 8045 | 1378 | 8865 | 1115 | 10193 | 663 | 11651 | 363 | 9561 |
| 14-#10 | 3.09 | MA | 6480 | 2035 | 9775 | 1661 | 11478 | 1386 | 12586 | 1153 | 14078 | 776 | 17561 | 511 | 13067 |
| 4L-5S | | MI | 3344 | 2035 | 5277 | 1577 | 5952 | 1303 | 6344 | 1084 | 6822 | 712 | 7911 | 324 | 6430 |
| 14-#10 | 3.09 | MA | 6251 | 2035 | 9353 | 1681 | 10969 | 1397 | 11953 | 1163 | 13195 | 792 | 16353 | 468 | 12593 |
| 5L-4S | | MI | 3426 | 2035 | 5490 | 1563 | 6208 | 1299 | 6662 | 1074 | 7263 | 705 | 8455 | 378 | 6655 |
| 14-#10 | 3.09 | MA | 6052 | 2035 | 8947 | 1687 | 10491 | 1408 | 11331 | 1182 | 12354 | 808 | 15173 | 398 | 12188 |
| 6L-3S | | MI | 3496 | 2035 | 5698 | 1556 | 6499 | 1286 | 7018 | 1071 | 7750 | 707 | 9008 | 423 | 6691 |
| 14-#10 | 3.09 | MA | 5882 | 2035 | 8559 | 1695 | 9950 | 1423 | 10734 | 1191 | 11495 | 816 | 14030 | 364 | 11578 |
| 7L-2S | | MI | 3628 | 2035 | 5992 | 1550 | 6874 | 1282 | 7473 | 1060 | 8366 | 700 | 9781 | 514 | 6692 |
| 14-#11 | 3.79 | MA | 6516 | 2151 | 9998 | 1753 | 11738 | 1450 | 12860 | 1196 | 14396 | 786 | 18028 | 408 | 14961 |
| 5L-4S | | MI | 3539 | 2151 | 5826 | 1620 | 6592 | 1339 | 7109 | 1094 | 7876 | 696 | 9034 | 279 | 7743 |
| 14-#11 | 3.79 | MA | 6281 | 2151 | 9512 | 1761 | 11157 | 1462 | 12103 | 1217 | 13373 | 805 | 16585 | 321 | 14374 |
| 6L-3S | | MI | 3620 | 2151 | 6075 | 1613 | 6941 | 1325 | 7536 | 1093 | 8438 | 690 | 9677 | 332 | 7948 |
| 14-#11 | 3.79 | MA | 6082 | 2151 | 9041 | 1770 | 10509 | 1481 | 11377 | 1229 | 12329 | 813 | 15191 | 276 | 13563 |
| 7L-2S | | MI | 3772 | 2151 | 6425 | 1607 | 7387 | 1321 | 8078 | 1082 | 9171 | 684 | 10568 | 444 | 7961 |
| 14-#14 | 5.47 | MA | 6866 | 2427 | 10805 | 1952 | 12761 | 1606 | 14003 | 1316 | 15913 | 809 | 20149 | 152 | 19220 |
| 6L-3S | | MI | 3961 | 2427 | 6964 | 1776 | 8045 | 1441 | 8865 | 1166 | 10193 | 662 | 11651 | 157 | 10989 |
| 14-#14 | 5.47 | MA | 6596 | 2427 | 10132 | 1964 | 11845 | 1633 | 12963 | 1332 | 14418 | 820 | 18147 | 84 | 17727 |
| 7L-2S | | MI | 4145 | 2427 | 7458 | 1768 | 8674 | 1437 | 9629 | 1151 | 11222 | 655 | 12876 | 319 | 11047 |
| 16-#10 | 3.53 | MA | 6536 | 2108 | 9964 | 1727 | 11748 | 1430 | 12898 | 1184 | 14475 | 787 | 18125 | 463 | 14401 |
| 5E | | MI | 3470 | 2108 | 5571 | 1623 | 6326 | 1336 | 6799 | 1105 | 7437 | 708 | 8685 | 306 | 7281 |
| 16-#10 | 3.53 | MA | 6343 | 2108 | 9559 | 1733 | 11270 | 1441 | 12276 | 1202 | 13633 | 804 | 16945 | 392 | 14010 |
| 6L-4S | | MI | 3552 | 2108 | 5784 | 1608 | 6583 | 1332 | 7117 | 1094 | 7879 | 701 | 9228 | 360 | 7492 |
| 16-#10 | 3.53 | MA | 6181 | 2108 | 9170 | 1740 | 10728 | 1456 | 11679 | 1212 | 12774 | 811 | 15802 | 358 | 13397 |
| 7L-3S | | MI | 3619 | 2108 | 5992 | 1601 | 6874 | 1319 | 7473 | 1092 | 8366 | 703 | 9781 | 405 | 7575 |
| 16-#10 | 3.53 | MA | 5985 | 2108 | 8798 | 1749 | 10225 | 1463 | 11052 | 1227 | 11954 | 828 | 14702 | 309 | 12753 |
| 8L-2S | | MI | 3749 | 2108 | 6286 | 1595 | 7248 | 1315 | 7928 | 1081 | 8981 | 696 | 10555 | 496 | 7584 |
| 16-#11 | 4.33 | MA | 6629 | 2240 | 10252 | 1817 | 12099 | 1503 | 13248 | 1243 | 14922 | 799 | 18730 | 314 | 16562 |
| 6L-4S | | MI | 3687 | 2240 | 6177 | 1675 | 7038 | 1380 | 7651 | 1120 | 8609 | 691 | 9926 | 253 | 8742 |
| 16-#11 | 4.33 | MA | 6439 | 2240 | 9781 | 1825 | 11451 | 1522 | 12521 | 1254 | 13878 | 808 | 17336 | 269 | 15764 |
| 7L-3S | | MI | 3772 | 2240 | 6425 | 1669 | 7387 | 1366 | 8078 | 1118 | 9171 | 685 | 10568 | 305 | 8998 |
| 16-#11 | 4.33 | MA | 6207 | 2240 | 9329 | 1835 | 10840 | 1530 | 11772 | 1273 | 12880 | 827 | 15994 | 207 | 14792 |
| 8L-2S | | MI | 3910 | 2240 | 6776 | 1662 | 7833 | 1362 | 8620 | 1107 | 9904 | 679 | 11460 | 417 | 9018 |
| 16-#14 | 6.25 | MA | 7098 | 2555 | 11188 | 2044 | 13190 | 1692 | 14596 | 1368 | 16629 | 812 | 21208 | 74 | 20839 |
| 7L-3S | | MI | 4157 | 2555 | 7458 | 1856 | 8674 | 1499 | 9629 | 1203 | 11222 | 654 | 12876 | 113 | 12449 |
| 18-#10 | 3.97 | MA | 6630 | 2180 | 10170 | 1778 | 12048 | 1474 | 13222 | 1223 | 14913 | 799 | 18717 | 386 | 15834 |
| 6L-5S | | MI | 3596 | 2180 | 5866 | 1668 | 6701 | 1369 | 7254 | 1126 | 8053 | 704 | 9459 | 288 | 8135 |
| 18-#10 | 3.97 | MA | 6475 | 2180 | 9782 | 1785 | 11507 | 1489 | 12624 | 1232 | 14054 | 807 | 17574 | 352 | 15218 |
| 7L-4S | | MI | 3677 | 2180 | 6079 | 1653 | 6957 | 1365 | 7572 | 1115 | 8494 | 697 | 10002 | 342 | 8334 |
| 18-#10 | 3.97 | MA | 6280 | 2180 | 9410 | 1794 | 11004 | 1496 | 11997 | 1248 | 13233 | 823 | 16474 | 304 | 14564 |
| 8L-3S | | MI | 3742 | 2180 | 6286 | 1647 | 7248 | 1352 | 7928 | 1112 | 8981 | 698 | 10555 | 387 | 8458 |
| 18-#10 | 3.97 | MA | 6087 | 2180 | 8992 | 1812 | 10487 | 1513 | 11377 | 1255 | 12395 | 831 | 15389 | 259 | 13864 |
| 9L-2S | | MI | 3869 | 2180 | 6580 | 1640 | 7623 | 1348 | 8383 | 1101 | 9597 | 691 | 11329 | 478 | 8471 |
| 18-#11 | 4.88 | MA | 6789 | 2329 | 10521 | 1881 | 12394 | 1562 | 13666 | 1279 | 15427 | 803 | 19480 | 262 | 17964 |
| 7L-4S | | MI | 3847 | 2329 | 6527 | 1731 | 7484 | 1420 | 8193 | 1145 | 9343 | 686 | 10817 | 226 | 9747 |
| 18-#11 | 4.88 | MA | 6560 | 2329 | 10069 | 1891 | 11783 | 1570 | 12917 | 1299 | 14429 | 821 | 18139 | 200 | 16983 |
| 8L-3S | | MI | 3913 | 2329 | 6776 | 1724 | 7833 | 1406 | 8620 | 1144 | 9904 | 680 | 11460 | 278 | 10045 |

## RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

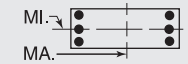
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 4.41 | MA | 6764 | 2253 | 10393 | 1831 | 12285 | 1522 | 13570 | 1253 | 15333 | 803 | 19345 | 346 | 17041 |
| 7L-5S | | MI | 3720 | 2253 | 6160 | 1713 | 7075 | 1402 | 7709 | 1146 | 8669 | 699 | 10232 | 270 | 8991 |
| 20-#10 | 4.41 | MA | 6571 | 2253 | 10021 | 1840 | 11782 | 1529 | 12943 | 1268 | 14513 | 819 | 18246 | 298 | 16376 |
| 8L-4S | | MI | 3801 | 2253 | 6373 | 1698 | 7332 | 1398 | 8027 | 1135 | 9110 | 693 | 10776 | 324 | 9179 |
| 20-#10 | 4.41 | MA | 6384 | 2253 | 9603 | 1858 | 11265 | 1546 | 12323 | 1275 | 13674 | 827 | 17160 | 253 | 15679 |
| 9L-3S | | MI | 3863 | 2253 | 6580 | 1692 | 7623 | 1385 | 8383 | 1133 | 9597 | 694 | 11329 | 369 | 9339 |
| 20-#11 | 5.42 | MA | 6906 | 2418 | 10809 | 1947 | 12725 | 1611 | 14061 | 1324 | 15978 | 816 | 20284 | 193 | 19175 |
| 8L-4S | | MI | 3991 | 2418 | 6877 | 1787 | 7930 | 1461 | 8735 | 1170 | 10076 | 681 | 11709 | 199 | 10755 |
| 22-#10 | 4.85 | MA | 6857 | 2325 | 10632 | 1885 | 12560 | 1562 | 13888 | 1289 | 15792 | 815 | 20017 | 292 | 18187 |
| 8L-5S | | MI | 3843 | 2325 | 6454 | 1759 | 7450 | 1435 | 8163 | 1167 | 9284 | 695 | 11006 | 252 | 9850 |
| 22-#10 | 4.85 | MA | 6676 | 2325 | 10215 | 1903 | 12044 | 1579 | 13268 | 1296 | 14954 | 823 | 18932 | 247 | 17494 |
| 9L-4S | | MI | 3924 | 2325 | 6667 | 1744 | 7706 | 1431 | 8481 | 1156 | 9726 | 688 | 11550 | 306 | 10028 |
| 24-#10 | 5.29 | MA | 6964 | 2398 | 10826 | 1948 | 12822 | 1612 | 14214 | 1316 | 16233 | 818 | 20704 | 241 | 19309 |
| 9L-5S | | MI | 3965 | 2398 | 6748 | 1804 | 7824 | 1468 | 8618 | 1187 | 9900 | 691 | 11780 | 234 | 10710 |

## RECTANGULAR TIED COLUMNS 18" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.02 | MA | 6302 | 1801 | 8964 | 1512 | 10377 | 1275 | 11077 | 1092 | 11665 | 819 | 13774 | 713 | 5100 |
| 2E | | MI | 3224 | 1801 | 4921 | 1404 | 5422 | 1184 | 5636 | 1012 | 5756 | 755 | 6381 | 618 | 2589 |
| 4-#14 | 1.47 | MA | 6615 | 1880 | 9686 | 1555 | 11260 | 1306 | 12133 | 1110 | 13079 | 810 | 15721 | 703 | 7206 |
| 2E | | MI | 3339 | 1880 | 5238 | 1442 | 5796 | 1209 | 6076 | 1025 | 6330 | 741 | 7019 | 577 | 3549 |
| 4-#18 | 2.61 | MA | 7354 | 2080 | 11453 | 1667 | 13439 | 1386 | 14745 | 1157 | 16586 | 791 | 20556 | 681 | 12387 |
| 2E | | MI | 3601 | 2080 | 5980 | 1543 | 6684 | 1280 | 7129 | 1064 | 7629 | 697 | 8445 | 459 | 5807 |
| 6-#10 | 1.25 | MA | 6492 | 1841 | 9286 | 1545 | 10836 | 1301 | 11659 | 1110 | 12473 | 821 | 14908 | 714 | 6216 |
| 2L-3S | | MI | 3161 | 1841 | 4767 | 1452 | 5267 | 1220 | 5467 | 1046 | 5542 | 769 | 6185 | 535 | 3124 |
| 6-#10 | 1.25 | MA | 6141 | 1841 | 8629 | 1558 | 10000 | 1312 | 10644 | 1120 | 11099 | 838 | 13005 | 633 | 6221 |
| 3L-2S | | MI | 3308 | 1841 | 5061 | 1445 | 5642 | 1216 | 5922 | 1035 | 6157 | 762 | 6959 | 626 | 3101 |
| 6-#11 | 1.53 | MA | 6677 | 1890 | 9760 | 1568 | 11390 | 1316 | 12308 | 1117 | 13330 | 813 | 16080 | 706 | 7523 |
| 2L-3S | | MI | 3200 | 1890 | 4921 | 1467 | 5422 | 1228 | 5636 | 1049 | 5756 | 756 | 6381 | 479 | 3724 |
| 6-#11 | 1.53 | MA | 6262 | 1890 | 8964 | 1582 | 10377 | 1329 | 11077 | 1129 | 11665 | 833 | 13774 | 603 | 7518 |
| 3L-2S | | MI | 3371 | 1890 | 5272 | 1460 | 5869 | 1224 | 6178 | 1037 | 6490 | 750 | 7273 | 591 | 3695 |
| 6-#14 | 2.21 | MA | 7134 | 2008 | 10823 | 1635 | 12707 | 1364 | 13890 | 1146 | 15457 | 803 | 19014 | 693 | 10652 |
| 2L-3S | | MI | 3309 | 2008 | 5238 | 1530 | 5796 | 1272 | 6076 | 1077 | 6330 | 741 | 7019 | 372 | 5116 |
| 6-#14 | 2.21 | MA | 6568 | 2008 | 9686 | 1655 | 11260 | 1383 | 12133 | 1162 | 13079 | 830 | 15721 | 543 | 10589 |
| 3L-2S | | MI | 3542 | 2008 | 5732 | 1522 | 6425 | 1268 | 6840 | 1062 | 7359 | 733 | 8244 | 533 | 5087 |
| 6-#18 | 3.92 | MA | 8209 | 2308 | 13433 | 1810 | 15960 | 1490 | 17807 | 1222 | 20730 | 778 | 26294 | 662 | 18355 |
| 2L-3S | | MI | 3576 | 2308 | 5980 | 1695 | 6684 | 1385 | 7129 | 1148 | 7629 | 687 | 8445 | 75 | 8253 |
| 6-#18 | 3.92 | MA | 7309 | 2308 | 11453 | 1844 | 13439 | 1520 | 14745 | 1248 | 16586 | 823 | 20556 | 387 | 17994 |
| 3L-2S | | MI | 3925 | 2308 | 6818 | 1685 | 7751 | 1383 | 8425 | 1129 | 9323 | 674 | 10413 | 362 | 8370 |
| 8-#8 | 1.03 | MA | 6345 | 1803 | 8925 | 1528 | 10411 | 1289 | 11161 | 1104 | 11812 | 827 | 14004 | 720 | 5215 |
| 2L-4S | | MI | 3108 | 1803 | 4578 | 1442 | 5038 | 1220 | 5201 | 1043 | 5189 | 776 | 5815 | 562 | 2664 |
| 8-#8 | 1.03 | MA | 6121 | 1803 | 8512 | 1536 | 9886 | 1296 | 10523 | 1110 | 10949 | 838 | 12809 | 670 | 5223 |
| 3E | | MI | 3160 | 1803 | 4709 | 1438 | 5222 | 1212 | 5427 | 1041 | 5497 | 776 | 6172 | 591 | 2648 |
| 8-#8 | 1.03 | MA | 6006 | 1803 | 8234 | 1544 | 9493 | 1309 | 10040 | 1122 | 10288 | 844 | 12017 | 640 | 5220 |
| 4L-2S | | MI | 3255 | 1803 | 4895 | 1434 | 5460 | 1209 | 5715 | 1033 | 5888 | 771 | 6675 | 648 | 2635 |
| 8-#9 | 1.31 | MA | 6548 | 1851 | 9373 | 1555 | 10965 | 1308 | 11826 | 1115 | 12705 | 823 | 15236 | 715 | 6532 |
| 2L-4S | | MI | 3154 | 1851 | 4701 | 1469 | 5177 | 1240 | 5362 | 1054 | 5401 | 770 | 6078 | 523 | 3283 |
| 8-#9 | 1.31 | MA | 6272 | 1851 | 8854 | 1565 | 10303 | 1318 | 11022 | 1123 | 11618 | 836 | 13730 | 651 | 6535 |
| 3E | | MI | 3218 | 1851 | 4865 | 1464 | 5408 | 1230 | 5645 | 1052 | 5788 | 771 | 6522 | 559 | 3264 |
| 8-#9 | 1.31 | MA | 6131 | 1851 | 8503 | 1575 | 9808 | 1333 | 10414 | 1138 | 10784 | 843 | 12728 | 612 | 6511 |
| 4L-2S | | MI | 3334 | 1851 | 5099 | 1458 | 5706 | 1226 | 6007 | 1043 | 6278 | 765 | 7145 | 631 | 3247 |
| 8-#10 | 1.66 | MA | 6802 | 1913 | 9943 | 1591 | 11672 | 1334 | 12675 | 1130 | 13847 | 817 | 16811 | 708 | 8209 |
| 2L-4S | | MI | 3212 | 1913 | 4854 | 1504 | 5351 | 1266 | 5566 | 1069 | 5670 | 763 | 6406 | 472 | 4051 |
| 8-#10 | 1.66 | MA | 6463 | 1913 | 9286 | 1603 | 10836 | 1345 | 11659 | 1141 | 12473 | 834 | 14908 | 627 | 8200 |
| 3E | | MI | 3290 | 1913 | 5061 | 1497 | 5642 | 1253 | 5922 | 1067 | 6157 | 765 | 6959 | 517 | 4035 |
| 8-#10 | 1.66 | MA | 6289 | 1913 | 8842 | 1615 | 10208 | 1365 | 10890 | 1159 | 11417 | 842 | 13638 | 577 | 8132 |
| 4L-2S | | MI | 3433 | 1913 | 5355 | 1491 | 6016 | 1249 | 6377 | 1056 | 6773 | 758 | 7733 | 608 | 4016 |

## RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

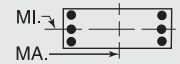
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 2.04 | MA | 7044 | 1979 | 10556 | 1623 | 12403 | 1356 | 13539 | 1142 | 14996 | 808 | 18386 | 699 | 9936 |
| 2L-4S | | MI | 3258 | 1979 | 5023 | 1529 | 5520 | 1283 | 5751 | 1075 | 5928 | 757 | 6630 | 399 | 4811 |
| 8-#11 | 2.04 | MA | 6645 | 1979 | 9760 | 1638 | 11390 | 1370 | 12308 | 1154 | 13330 | 828 | 16080 | 596 | 9910 |
| 3E | | MI | 3351 | 1979 | 5272 | 1522 | 5869 | 1269 | 6178 | 1074 | 6490 | 751 | 7273 | 452 | 4804 |
| 8-#11 | 2.04 | MA | 6440 | 1979 | 9220 | 1652 | 10628 | 1393 | 11372 | 1177 | 12048 | 837 | 14527 | 534 | 9783 |
| 4L-2S | | MI | 3517 | 1979 | 5622 | 1516 | 6315 | 1265 | 6720 | 1062 | 7223 | 745 | 8164 | 564 | 4783 |
| 8-#14 | 2.94 | MA | 7102 | 2137 | 10823 | 1736 | 12707 | 1441 | 13890 | 1199 | 15457 | 823 | 19014 | 533 | 13990 |
| 3E | | MI | 3518 | 2137 | 5732 | 1610 | 6425 | 1330 | 6840 | 1113 | 7359 | 732 | 8244 | 328 | 6610 |
| 8-#14 | 2.94 | MA | 6826 | 2137 | 10050 | 1756 | 11616 | 1474 | 12552 | 1230 | 13623 | 835 | 16782 | 442 | 13325 |
| 4L-2S | | MI | 3743 | 2137 | 6226 | 1602 | 7054 | 1326 | 7604 | 1098 | 8388 | 725 | 9469 | 490 | 6603 |
| 8-#18 | 5.23 | MA | 8206 | 2537 | 13433 | 1987 | 15960 | 1623 | 17807 | 1312 | 20730 | 809 | 26294 | 369 | 23910 |
| 3E | | MI | 3919 | 2537 | 6818 | 1837 | 7751 | 1488 | 8425 | 1213 | 9323 | 663 | 10413 | -22 | 10396 |
| 8-#18 | 5.23 | MA | 7777 | 2537 | 12079 | 2021 | 14051 | 1680 | 15465 | 1365 | 17522 | 828 | 22354 | 205 | 20970 |
| 4L-2S | | MI | 4244 | 2537 | 7656 | 1828 | 8818 | 1487 | 9721 | 1194 | 11017 | 650 | 12381 | 265 | 10902 |
| 10-#10 | 2.08 | MA | 7106 | 1986 | 10599 | 1636 | 12508 | 1367 | 13691 | 1151 | 15222 | 813 | 18714 | 703 | 10196 |
| 2L-5S | | MI | 3259 | 1986 | 4935 | 1564 | 5469 | 1303 | 5702 | 1101 | 5844 | 766 | 6637 | 399 | 4803 |
| 10-#10 | 2.08 | MA | 6778 | 1986 | 9943 | 1648 | 11672 | 1378 | 12675 | 1161 | 13847 | 830 | 16811 | 621 | 10175 |
| 3L-4S | | MI | 3342 | 1986 | 5148 | 1549 | 5725 | 1299 | 6020 | 1090 | 6286 | 759 | 7180 | 454 | 4941 |
| 10-#10 | 2.08 | MA | 6614 | 1986 | 9499 | 1661 | 11045 | 1398 | 11905 | 1180 | 12792 | 838 | 15541 | 571 | 10096 |
| 4L-3S | | MI | 3418 | 1986 | 5355 | 1542 | 6016 | 1286 | 6377 | 1087 | 6773 | 761 | 7733 | 499 | 4937 |
| 10-#10 | 2.08 | MA | 6360 | 1986 | 9046 | 1681 | 10500 | 1409 | 11227 | 1190 | 11847 | 855 | 14249 | 530 | 9703 |
| 5L-2S | | MI | 3557 | 1986 | 5649 | 1536 | 6391 | 1282 | 6832 | 1076 | 7388 | 754 | 8507 | 590 | 4922 |
| 10-#11 | 2.55 | MA | 7019 | 2068 | 10556 | 1693 | 12403 | 1410 | 13539 | 1180 | 14996 | 823 | 18386 | 589 | 12299 |
| 3L-4S | | MI | 3411 | 2068 | 5373 | 1584 | 5966 | 1323 | 6293 | 1100 | 6661 | 752 | 7522 | 373 | 5848 |
| 10-#11 | 2.55 | MA | 6828 | 2068 | 10016 | 1708 | 11641 | 1434 | 12603 | 1202 | 13714 | 832 | 16834 | 527 | 12158 |
| 4L-3S | | MI | 3500 | 2068 | 5622 | 1578 | 6315 | 1309 | 6720 | 1099 | 7223 | 746 | 8164 | 425 | 5873 |
| 10-#11 | 2.55 | MA | 6528 | 2068 | 9467 | 1733 | 10978 | 1447 | 11778 | 1214 | 12564 | 852 | 15259 | 474 | 11438 |
| 5L-2S | | MI | 3661 | 2068 | 5973 | 1571 | 6761 | 1305 | 7262 | 1088 | 7956 | 739 | 9056 | 537 | 5859 |
| 10-#14 | 3.68 | MA | 7371 | 2265 | 11186 | 1836 | 13063 | 1533 | 14309 | 1266 | 16001 | 828 | 20076 | 432 | 16657 |
| 4L-3S | | MI | 3734 | 2265 | 6226 | 1691 | 7054 | 1388 | 7604 | 1149 | 8388 | 724 | 9469 | 284 | 8091 |
| 10-#14 | 3.68 | MA | 6951 | 2265 | 10399 | 1872 | 12114 | 1551 | 13128 | 1283 | 14356 | 855 | 17816 | 353 | 15497 |
| 5L-2S | | MI | 3938 | 2265 | 6720 | 1682 | 7683 | 1384 | 8368 | 1135 | 9416 | 716 | 10694 | 446 | 8107 |
| 10-#18 | 6.54 | MA | 8700 | 2765 | 14059 | 2163 | 16572 | 1784 | 18527 | 1430 | 21666 | 814 | 28092 | 187 | 26843 |
| 4L-3S | | MI | 4255 | 2765 | 7656 | 1980 | 8818 | 1592 | 9721 | 1278 | 11017 | 640 | 12381 | -119 | 12266 |
| 10-#18 | 6.54 | MA | 7995 | 2765 | 12679 | 2224 | 14908 | 1814 | 16457 | 1456 | 18784 | 859 | 24120 | 37 | 23955 |
| 5L-2S | | MI | 4559 | 2765 | 8494 | 1971 | 9885 | 1591 | 11017 | 1258 | 12711 | 627 | 14348 | 168 | 13416 |
| 12-#10 | 2.49 | MA | 7087 | 2058 | 10599 | 1694 | 12508 | 1411 | 13691 | 1182 | 15222 | 826 | 18714 | 615 | 12149 |
| 3L-5S | | MI | 3388 | 2058 | 5229 | 1609 | 5843 | 1336 | 6157 | 1121 | 6460 | 762 | 7410 | 381 | 5645 |
| 12-#10 | 2.49 | MA | 6933 | 2058 | 10155 | 1706 | 11881 | 1431 | 12921 | 1200 | 14166 | 834 | 17444 | 565 | 12061 |
| 4E | | MI | 3471 | 2058 | 5442 | 1594 | 6100 | 1332 | 6475 | 1110 | 6901 | 755 | 7954 | 436 | 5825 |
| 12-#10 | 2.49 | MA | 6681 | 2058 | 9703 | 1727 | 11336 | 1442 | 12242 | 1211 | 13221 | 851 | 16152 | 524 | 11639 |
| 5L-3S | | MI | 3544 | 2058 | 5649 | 1588 | 6391 | 1319 | 6832 | 1108 | 7388 | 757 | 8507 | 481 | 5832 |
| 12-#10 | 2.49 | MA | 6457 | 2058 | 9264 | 1732 | 10823 | 1453 | 11577 | 1230 | 12320 | 868 | 14892 | 455 | 11168 |
| 6L-2S | | MI | 3680 | 2058 | 5943 | 1581 | 6765 | 1314 | 7287 | 1097 | 8004 | 750 | 9281 | 572 | 5823 |
| 12-#11 | 3.06 | MA | 7207 | 2157 | 10812 | 1764 | 12654 | 1474 | 13834 | 1227 | 15379 | 827 | 19140 | 520 | 14537 |
| 4E | | MI | 3562 | 2157 | 5724 | 1640 | 6412 | 1364 | 6835 | 1126 | 7395 | 747 | 8413 | 346 | 6831 |
| 12-#11 | 3.06 | MA | 6910 | 2157 | 10262 | 1789 | 11991 | 1487 | 13009 | 1239 | 14230 | 847 | 17565 | 467 | 13789 |
| 5L-3S | | MI | 3647 | 2157 | 5973 | 1634 | 6761 | 1349 | 7262 | 1124 | 7956 | 740 | 9056 | 398 | 6932 |
| 12-#11 | 3.06 | MA | 6645 | 2157 | 9735 | 1796 | 11369 | 1501 | 12199 | 1261 | 13134 | 866 | 16026 | 380 | 13234 |
| 6L-2S | | MI | 3804 | 2157 | 6323 | 1627 | 7207 | 1346 | 7804 | 1113 | 8690 | 734 | 9947 | 510 | 6929 |
| 12-#14 | 4.41 | MA | 7485 | 2394 | 11535 | 1952 | 13561 | 1609 | 14885 | 1319 | 16734 | 847 | 21110 | 343 | 18883 |
| 5L-3S | | MI | 3935 | 2394 | 6720 | 1771 | 7683 | 1447 | 8368 | 1186 | 9416 | 715 | 10694 | 240 | 9566 |
| 12-#14 | 4.41 | MA | 7125 | 2394 | 10788 | 1963 | 12668 | 1628 | 13724 | 1351 | 15164 | 875 | 18898 | 217 | 17449 |
| 6L-2S | | MI | 4131 | 2394 | 7214 | 1763 | 8312 | 1443 | 9132 | 1171 | 10445 | 708 | 11920 | 402 | 9601 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

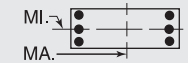
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 7.84 | MA | 8897 | 2993 | 14659 | 2367 | 17429 | 1918 | 19519 | 1521 | 22928 | 846 | 29858 | 19 | 29775 |
| 5L-3S | | MI | 4586 | 2993 | 8494 | 2123 | 9885 | 1696 | 11017 | 1343 | 12711 | 616 | 14348 | -216 | 14103 |
| 14-#10 | 2.91 | MA | 7245 | 2131 | 10812 | 1751 | 12717 | 1464 | 13936 | 1221 | 15541 | 830 | 19347 | 559 | 14027 |
| 4L-5S | | MI | 3516 | 2131 | 5523 | 1654 | 6218 | 1369 | 6612 | 1142 | 7075 | 758 | 8184 | 364 | 6492 |
| 14-#10 | 2.91 | MA | 6995 | 2131 | 10360 | 1772 | 12172 | 1475 | 13258 | 1231 | 14595 | 847 | 18055 | 518 | 13579 |
| 5L-4S | | MI | 3598 | 2131 | 5736 | 1640 | 6474 | 1365 | 6930 | 1131 | 7517 | 751 | 8727 | 418 | 6706 |
| 14-#10 | 2.91 | MA | 6779 | 2131 | 9921 | 1778 | 11659 | 1486 | 12592 | 1250 | 13694 | 863 | 16795 | 450 | 13125 |
| 6L-3S | | MI | 3668 | 2131 | 5943 | 1633 | 6765 | 1352 | 7287 | 1128 | 8004 | 752 | 9281 | 463 | 6721 |
| 14-#10 | 2.91 | MA | 6596 | 2131 | 9505 | 1786 | 11074 | 1501 | 11953 | 1261 | 12775 | 872 | 15578 | 416 | 12521 |
| 7L-2S | | MI | 3802 | 2131 | 6238 | 1627 | 7140 | 1347 | 7741 | 1118 | 8619 | 745 | 10054 | 554 | 6719 |
| 14-#11 | 3.57 | MA | 7284 | 2247 | 11058 | 1844 | 13005 | 1528 | 14239 | 1264 | 15895 | 841 | 19871 | 460 | 16145 |
| 5L-4S | | MI | 3711 | 2247 | 6074 | 1696 | 6858 | 1404 | 7377 | 1151 | 8128 | 741 | 9305 | 319 | 7822 |
| 14-#11 | 3.57 | MA | 7030 | 2247 | 10531 | 1852 | 12382 | 1541 | 13429 | 1287 | 14799 | 861 | 18332 | 373 | 15590 |
| 6L-3S | | MI | 3792 | 2247 | 6323 | 1689 | 7207 | 1390 | 7804 | 1150 | 8690 | 735 | 9947 | 371 | 7986 |
| 14-#11 | 3.57 | MA | 6813 | 2247 | 10026 | 1861 | 11678 | 1559 | 12651 | 1299 | 13680 | 870 | 16843 | 330 | 14667 |
| 7L-2S | | MI | 3947 | 2247 | 6674 | 1683 | 7653 | 1386 | 8346 | 1138 | 9423 | 729 | 10839 | 483 | 7994 |
| 14-#14 | 5.15 | MA | 7664 | 2522 | 11925 | 2043 | 14115 | 1686 | 15482 | 1387 | 17542 | 867 | 22191 | 207 | 20814 |
| 6L-3S | | MI | 4134 | 2522 | 7214 | 1851 | 8312 | 1505 | 9132 | 1222 | 10445 | 707 | 11920 | 196 | 11039 |
| 14-#14 | 5.15 | MA | 7371 | 2522 | 11202 | 2056 | 13119 | 1713 | 14367 | 1403 | 15940 | 880 | 20052 | 142 | 19282 |
| 7L-2S | | MI | 4321 | 2522 | 7708 | 1843 | 8941 | 1501 | 9896 | 1207 | 11473 | 700 | 13145 | 358 | 11088 |
| 16-#10 | 3.32 | MA | 7304 | 2203 | 11016 | 1817 | 13008 | 1508 | 14274 | 1252 | 15970 | 842 | 19958 | 513 | 15523 |
| 5E | | MI | 3643 | 2203 | 5817 | 1700 | 6592 | 1402 | 7067 | 1162 | 7691 | 753 | 8958 | 346 | 7342 |
| 16-#10 | 3.32 | MA | 7095 | 2203 | 10577 | 1823 | 12495 | 1519 | 13608 | 1271 | 15069 | 859 | 18698 | 444 | 15084 |
| 6L-4S | | MI | 3725 | 2203 | 6030 | 1685 | 6849 | 1398 | 7385 | 1151 | 8132 | 747 | 9501 | 400 | 7562 |
| 16-#10 | 3.32 | MA | 6920 | 2203 | 10161 | 1831 | 11910 | 1534 | 12969 | 1281 | 14149 | 868 | 17481 | 410 | 14475 |
| 7L-3S | | MI | 3792 | 2203 | 6238 | 1678 | 7140 | 1385 | 7741 | 1149 | 8619 | 748 | 10054 | 445 | 7607 |
| 16-#10 | 3.32 | MA | 6705 | 2203 | 9763 | 1840 | 11371 | 1542 | 12288 | 1296 | 13271 | 884 | 16306 | 363 | 13828 |
| 8L-2S | | MI | 3923 | 2203 | 6532 | 1672 | 7514 | 1380 | 8196 | 1138 | 9235 | 741 | 10828 | 536 | 7612 |
| 16-#11 | 4.08 | MA | 7407 | 2336 | 11327 | 1907 | 13395 | 1582 | 14660 | 1312 | 16464 | 856 | 20639 | 366 | 17949 |
| 6L-4S | | MI | 3858 | 2336 | 6425 | 1751 | 7305 | 1445 | 7919 | 1176 | 8861 | 736 | 10196 | 292 | 8820 |
| 16-#11 | 4.08 | MA | 7201 | 2336 | 10821 | 1916 | 12692 | 1600 | 13882 | 1324 | 15345 | 865 | 19149 | 323 | 17033 |
| 7L-3S | | MI | 3945 | 2336 | 6674 | 1745 | 7653 | 1430 | 8346 | 1175 | 9423 | 730 | 10839 | 344 | 9037 |
| 16-#11 | 4.08 | MA | 6946 | 2336 | 10336 | 1927 | 12036 | 1609 | 13067 | 1343 | 14277 | 885 | 17715 | 263 | 16044 |
| 8L-2S | | MI | 4085 | 2336 | 7024 | 1738 | 8100 | 1426 | 8888 | 1163 | 10157 | 724 | 11730 | 456 | 9054 |
| 16-#14 | 5.88 | MA | 7916 | 2651 | 12338 | 2136 | 14566 | 1771 | 16124 | 1440 | 18318 | 872 | 23346 | 132 | 22631 |
| 7L-3S | | MI | 4331 | 2651 | 7708 | 1931 | 8941 | 1563 | 9896 | 1259 | 11473 | 699 | 13145 | 152 | 12509 |
| 18-#10 | 3.74 | MA | 7406 | 2276 | 11234 | 1868 | 13332 | 1552 | 14623 | 1291 | 16443 | 855 | 20601 | 438 | 17045 |
| 6L-5S | | MI | 3768 | 2276 | 6111 | 1745 | 6967 | 1435 | 7522 | 1183 | 8307 | 749 | 9732 | 328 | 8196 |
| 18-#10 | 3.74 | MA | 7238 | 2276 | 10818 | 1876 | 12746 | 1567 | 13984 | 1302 | 15523 | 863 | 19383 | 404 | 16430 |
| 7L-4S | | MI | 3850 | 2276 | 6324 | 1730 | 7223 | 1431 | 7840 | 1172 | 8748 | 742 | 10275 | 382 | 8402 |
| 18-#10 | 3.74 | MA | 7025 | 2276 | 10419 | 1885 | 12207 | 1574 | 13303 | 1317 | 14645 | 880 | 18209 | 357 | 15774 |
| 8L-3S | | MI | 3915 | 2276 | 6532 | 1724 | 7514 | 1418 | 8196 | 1170 | 9235 | 744 | 10828 | 427 | 8491 |
| 18-#10 | 3.74 | MA | 6816 | 2276 | 9972 | 1904 | 11653 | 1591 | 12639 | 1324 | 13747 | 889 | 17053 | 313 | 14998 |
| 9L-2S | | MI | 4043 | 2276 | 6826 | 1717 | 7889 | 1413 | 8651 | 1159 | 9851 | 737 | 11602 | 518 | 8502 |
| 18-#11 | 4.59 | MA | 7580 | 2425 | 11617 | 1972 | 13705 | 1640 | 15112 | 1349 | 17011 | 860 | 21455 | 316 | 19400 |
| 7L-4S | | MI | 4019 | 2425 | 6775 | 1807 | 7751 | 1485 | 8461 | 1201 | 9595 | 731 | 11088 | 265 | 9823 |
| 18-#11 | 4.59 | MA | 7328 | 2425 | 11132 | 1983 | 13050 | 1649 | 14298 | 1368 | 15942 | 880 | 20021 | 256 | 18401 |
| 8L-3S | | MI | 4087 | 2425 | 7024 | 1801 | 8100 | 1471 | 8888 | 1200 | 10157 | 725 | 11730 | 317 | 10086 |
| 20-#10 | 4.15 | MA | 7551 | 2348 | 11475 | 1922 | 13582 | 1600 | 15000 | 1322 | 16898 | 859 | 21286 | 398 | 18384 |
| 7L-5S | | MI | 3892 | 2348 | 6405 | 1790 | 7341 | 1468 | 7977 | 1203 | 8922 | 745 | 10505 | 310 | 9052 |
| 20-#10 | 4.15 | MA | 7340 | 2348 | 11076 | 1931 | 13043 | 1607 | 14319 | 1337 | 16020 | 876 | 20112 | 352 | 17721 |
| 8L-4S | | MI | 3974 | 2348 | 6618 | 1775 | 7598 | 1464 | 8295 | 1192 | 9363 | 738 | 11049 | 364 | 9247 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

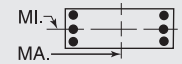
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 4.15 | MA | 7137 | 2348 | 10628 | 1949 | 12490 | 1624 | 13655 | 1344 | 15122 | 884 | 18956 | 307 | 16948 |
| 9L-3S | | MI | 4037 | 2348 | 6826 | 1769 | 7889 | 1451 | 8651 | 1190 | 9851 | 740 | 11602 | 409 | 9373 |
| 20-#10 | 4.15 | MA | 6952 | 2348 | 10215 | 1956 | 11968 | 1634 | 12992 | 1361 | 14247 | 901 | 17785 | 267 | 16140 |
| 10L-2S | | MI | 4163 | 2348 | 7120 | 1763 | 8263 | 1446 | 9106 | 1179 | 10466 | 733 | 12376 | 501 | 9389 |
| 20-#11 | 5.10 | MA | 7704 | 2514 | 11928 | 2039 | 14063 | 1690 | 15528 | 1393 | 17608 | 874 | 22328 | 249 | 20757 |
| 8L-4S | | MI | 4163 | 2514 | 7126 | 1863 | 8197 | 1526 | 9003 | 1227 | 10328 | 726 | 11979 | 238 | 10831 |
| 22-#10 | 4.57 | MA | 7650 | 2421 | 11733 | 1976 | 13879 | 1640 | 15334 | 1358 | 17394 | 872 | 22015 | 346 | 19667 |
| 8L-5S | | MI | 4016 | 2421 | 6700 | 1836 | 7716 | 1501 | 8432 | 1224 | 9538 | 741 | 11279 | 292 | 9910 |
| 22-#10 | 4.57 | MA | 7454 | 2421 | 11285 | 1994 | 13326 | 1657 | 14670 | 1365 | 16496 | 880 | 20859 | 302 | 18898 |
| 9L-4S | | MI | 4097 | 2421 | 6913 | 1821 | 7972 | 1496 | 8750 | 1213 | 9979 | 734 | 11822 | 346 | 10095 |
| 22-#10 | 4.57 | MA | 7275 | 2421 | 10871 | 2001 | 12804 | 1667 | 14008 | 1381 | 15621 | 897 | 19688 | 261 | 18084 |
| 10L-3S | | MI | 4158 | 2421 | 7120 | 1814 | 8263 | 1484 | 9106 | 1211 | 10466 | 735 | 12376 | 391 | 10254 |
| 24-#10 | 4.98 | MA | 7765 | 2493 | 11942 | 2040 | 14162 | 1690 | 15686 | 1386 | 17870 | 876 | 22762 | 296 | 20848 |
| 9L-5S | | MI | 4138 | 2493 | 6994 | 1881 | 8090 | 1534 | 8886 | 1244 | 10153 | 737 | 12053 | 274 | 10770 |
| 24-#10 | 4.98 | MA | 7593 | 2493 | 11528 | 2047 | 13640 | 1700 | 15023 | 1402 | 16996 | 892 | 21591 | 255 | 20028 |
| 10L-4S | | MI | 4220 | 2493 | 7207 | 1866 | 8347 | 1529 | 9204 | 1234 | 10595 | 730 | 12596 | 328 | 10945 |

## RECTANGULAR TIED COLUMNS 18" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.39 | MA | 7373 | 1975 | 10694 | 1644 | 12458 | 1382 | 13422 | 1176 | 14438 | 863 | 17327 | 750 | 7692 |
| 2E | | MI | 3511 | 1975 | 5488 | 1517 | 6063 | 1274 | 6343 | 1081 | 6582 | 786 | 7288 | 616 | 3574 |
| 4-#18 | 2.47 | MA | 8177 | 2175 | 12591 | 1757 | 14798 | 1462 | 16229 | 1223 | 18205 | 844 | 22521 | 727 | 13251 |
| 2E | | MI | 3775 | 2175 | 6233 | 1617 | 6952 | 1343 | 7396 | 1119 | 7878 | 741 | 8710 | 497 | 5844 |
| 6-#10 | 1.18 | MA | 7238 | 1936 | 10261 | 1635 | 11998 | 1377 | 12910 | 1176 | 13781 | 874 | 16446 | 761 | 6627 |
| 2L-3S | | MI | 3333 | 1936 | 5013 | 1529 | 5533 | 1286 | 5735 | 1103 | 5795 | 815 | 6458 | 575 | 3143 |
| 6-#10 | 1.18 | MA | 6859 | 1936 | 9559 | 1647 | 11104 | 1389 | 11824 | 1187 | 12312 | 892 | 14411 | 680 | 6632 |
| 3L-2S | | MI | 3480 | 1936 | 5307 | 1522 | 5907 | 1281 | 6190 | 1093 | 6411 | 808 | 7232 | 666 | 3120 |
| 6-#11 | 1.44 | MA | 7439 | 1986 | 10771 | 1657 | 12594 | 1392 | 13607 | 1184 | 14703 | 866 | 17706 | 752 | 8029 |
| 2L-3S | | MI | 3372 | 1986 | 5170 | 1543 | 5689 | 1293 | 5904 | 1105 | 6008 | 801 | 6651 | 518 | 3749 |
| 6-#11 | 1.44 | MA | 6991 | 1986 | 9920 | 1672 | 11510 | 1406 | 12290 | 1196 | 12921 | 887 | 15238 | 651 | 8024 |
| 3L-2S | | MI | 3544 | 1986 | 5520 | 1536 | 6135 | 1289 | 6446 | 1094 | 6742 | 795 | 7543 | 630 | 3719 |
| 6-#14 | 2.08 | MA | 7935 | 2104 | 11911 | 1725 | 14007 | 1441 | 15304 | 1213 | 16984 | 856 | 20853 | 739 | 11381 |
| 2L-3S | | MI | 3481 | 2104 | 5488 | 1605 | 6063 | 1336 | 6343 | 1133 | 6582 | 785 | 7288 | 411 | 5149 |
| 6-#14 | 2.08 | MA | 7322 | 2104 | 10694 | 1746 | 12458 | 1460 | 13422 | 1230 | 14438 | 884 | 17327 | 592 | 11318 |
| 3L-2S | | MI | 3715 | 2104 | 5982 | 1597 | 6692 | 1332 | 7107 | 1118 | 7610 | 778 | 8513 | 573 | 5117 |
| 6-#18 | 3.70 | MA | 9104 | 2404 | 14714 | 1899 | 17501 | 1566 | 19511 | 1288 | 22648 | 831 | 28672 | 709 | 19651 |
| 2L-3S | | MI | 3746 | 2404 | 6233 | 1769 | 6952 | 1448 | 7396 | 1203 | 7878 | 731 | 8710 | 113 | 8366 |
| 6-#18 | 3.70 | MA | 8127 | 2404 | 12591 | 1935 | 14798 | 1598 | 16229 | 1316 | 18205 | 878 | 22521 | 439 | 19290 |
| 3L-2S | | MI | 4099 | 2404 | 7071 | 1759 | 8019 | 1447 | 8692 | 1184 | 9572 | 717 | 10678 | 401 | 8413 |
| 8-#9 | 1.23 | MA | 7298 | 1947 | 10354 | 1645 | 12136 | 1385 | 13086 | 1182 | 14028 | 876 | 16793 | 761 | 6964 |
| 2L-4S | | MI | 3326 | 1947 | 4945 | 1546 | 5442 | 1306 | 5630 | 1112 | 5655 | 816 | 6351 | 563 | 3303 |
| 8-#9 | 1.23 | MA | 7000 | 1947 | 9798 | 1655 | 11429 | 1394 | 12227 | 1190 | 12866 | 890 | 15184 | 699 | 6967 |
| 3E | | MI | 3390 | 1947 | 5110 | 1541 | 5673 | 1296 | 5913 | 1109 | 6042 | 817 | 6796 | 599 | 3283 |
| 8-#9 | 1.23 | MA | 6848 | 1947 | 9424 | 1665 | 10900 | 1410 | 11578 | 1206 | 11976 | 897 | 14121 | 660 | 6943 |
| 4L-2S | | MI | 3507 | 1947 | 5344 | 1536 | 5971 | 1292 | 6275 | 1100 | 6532 | 811 | 7419 | 671 | 3266 |
| 8-#10 | 1.57 | MA | 7573 | 2009 | 10963 | 1680 | 12892 | 1410 | 13995 | 1197 | 15250 | 870 | 18480 | 755 | 8758 |
| 2L-4S | | MI | 3383 | 2009 | 5099 | 1581 | 5616 | 1332 | 5834 | 1126 | 5924 | 809 | 6679 | 512 | 4077 |
| 8-#10 | 1.57 | MA | 7206 | 2009 | 10261 | 1693 | 11998 | 1422 | 12910 | 1208 | 13781 | 888 | 16446 | 675 | 8748 |
| 3E | | MI | 3462 | 2009 | 5307 | 1574 | 5907 | 1319 | 6190 | 1124 | 6411 | 811 | 7232 | 557 | 4058 |
| 8-#10 | 1.57 | MA | 7019 | 2009 | 9788 | 1705 | 11329 | 1442 | 12088 | 1227 | 12655 | 897 | 15097 | 625 | 8681 |
| 4L-2S | | MI | 3606 | 2009 | 5601 | 1568 | 6282 | 1314 | 6645 | 1113 | 7026 | 804 | 8006 | 648 | 4038 |
| 8-#11 | 1.93 | MA | 7836 | 2075 | 11622 | 1713 | 13678 | 1433 | 14924 | 1209 | 16485 | 861 | 20173 | 745 | 10610 |
| 2L-4S | | MI | 3430 | 2075 | 5271 | 1605 | 5786 | 1348 | 6019 | 1132 | 6180 | 802 | 6901 | 439 | 4847 |
| 8-#11 | 1.93 | MA | 7404 | 2075 | 10771 | 1728 | 12594 | 1447 | 13607 | 1222 | 14703 | 882 | 17706 | 644 | 10584 |
| 3E | | MI | 3523 | 2075 | 5520 | 1598 | 6135 | 1333 | 6446 | 1131 | 6742 | 796 | 7543 | 491 | 4833 |
| 8-#11 | 1.93 | MA | 7183 | 2075 | 10195 | 1743 | 11780 | 1471 | 12608 | 1244 | 13334 | 892 | 16056 | 583 | 10457 |
| 4L-2S | | MI | 3690 | 2075 | 5871 | 1592 | 6581 | 1329 | 6988 | 1119 | 7475 | 790 | 8434 | 603 | 4810 |

## RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis



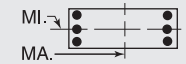

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.78 | MA | 7899 | 2232 | 11911 | 1826 | 14007 | 1518 | 15304 | 1266 | 16984 | 877 | 20853 | 582 | 14962 |
| 3E | | MI | 3690 | 2232 | 5982 | 1686 | 6692 | 1394 | 7107 | 1169 | 7610 | 777 | 8513 | 367 | 6649 |
| 8-#14 | 2.78 | MA | 7602 | 2232 | 11085 | 1847 | 12842 | 1552 | 13874 | 1299 | 15024 | 890 | 18480 | 492 | 14388 |
| 4L-2S | | MI | 3916 | 2232 | 6476 | 1677 | 7321 | 1390 | 7872 | 1154 | 8639 | 769 | 9738 | 529 | 6636 |
| 8-#18 | 4.94 | MA | 9096 | 2632 | 14714 | 2077 | 17501 | 1701 | 19511 | 1381 | 22648 | 865 | 28672 | 420 | 25638 |
| 3E | | MI | 4090 | 2632 | 7071 | 1911 | 8019 | 1551 | 8692 | 1268 | 9572 | 707 | 10678 | 16 | 10632 |
| 8-#18 | 4.94 | MA | 8633 | 2632 | 13268 | 2113 | 15460 | 1760 | 17007 | 1435 | 19217 | 885 | 24482 | 259 | 22621 |
| 4L-2S | | MI | 4419 | 2632 | 7909 | 1902 | 9086 | 1550 | 9988 | 1249 | 11266 | 694 | 12646 | 304 | 10950 |
| 10-#10 | 1.96 | MA | 7901 | 2081 | 11665 | 1725 | 13786 | 1443 | 15081 | 1217 | 16720 | 866 | 20514 | 749 | 10882 |
| 2L-5S | | MI | 3431 | 2081 | 5181 | 1641 | 5735 | 1369 | 5970 | 1158 | 6098 | 812 | 6909 | 439 | 4865 |
| 10-#10 | 1.96 | MA | 7546 | 2081 | 10963 | 1738 | 12892 | 1455 | 13995 | 1228 | 15250 | 883 | 18480 | 669 | 10861 |
| 3L-4S | | MI | 3514 | 2081 | 5394 | 1626 | 5991 | 1365 | 6289 | 1147 | 6539 | 805 | 7453 | 494 | 4971 |
| 10-#10 | 1.96 | MA | 7369 | 2081 | 10490 | 1751 | 12223 | 1475 | 13174 | 1247 | 14124 | 892 | 17131 | 619 | 10782 |
| 4L-3S | | MI | 3590 | 2081 | 5601 | 1619 | 6282 | 1352 | 6645 | 1145 | 7026 | 806 | 8006 | 539 | 4962 |
| 10-#10 | 1.96 | MA | 7093 | 2081 | 10004 | 1771 | 11642 | 1487 | 12451 | 1258 | 13116 | 910 | 15756 | 580 | 10424 |
| 5L-2S | | MI | 3730 | 2081 | 5895 | 1613 | 6656 | 1347 | 7100 | 1134 | 7642 | 799 | 8780 | 630 | 4946 |
| 10-#11 | 2.41 | MA | 7809 | 2164 | 11622 | 1783 | 13678 | 1487 | 14924 | 1247 | 16485 | 876 | 20173 | 637 | 13142 |
| 3L-4S | | MI | 3582 | 2164 | 5622 | 1661 | 6233 | 1388 | 6561 | 1157 | 6914 | 797 | 7792 | 412 | 5901 |
| 10-#11 | 2.41 | MA | 7602 | 2164 | 11046 | 1798 | 12864 | 1511 | 13925 | 1270 | 15116 | 887 | 18523 | 576 | 13001 |
| 4L-3S | | MI | 3672 | 2164 | 5871 | 1654 | 6581 | 1374 | 6988 | 1156 | 7475 | 791 | 8434 | 464 | 5904 |
| 10-#11 | 2.41 | MA | 7275 | 2164 | 10460 | 1824 | 12158 | 1525 | 13045 | 1282 | 13889 | 907 | 16846 | 525 | 12293 |
| 5L-2S | | MI | 3834 | 2164 | 6221 | 1647 | 7027 | 1370 | 7530 | 1144 | 8209 | 784 | 9326 | 577 | 5888 |
| 10-#14 | 3.47 | MA | 8190 | 2361 | 12302 | 1927 | 14391 | 1611 | 15755 | 1335 | 17570 | 883 | 22006 | 482 | 17964 |
| 4L-3S | | MI | 3896 | 2361 | 6476 | 1766 | 7321 | 1453 | 7872 | 1205 | 8639 | 768 | 9738 | 323 | 8134 |
| 10-#14 | 3.47 | MA | 7731 | 2361 | 11462 | 1963 | 13378 | 1630 | 14495 | 1352 | 15814 | 911 | 19599 | 406 | 16665 |
| 5L-2S | | MI | 4113 | 2361 | 6970 | 1758 | 7950 | 1449 | 8636 | 1191 | 9667 | 761 | 10963 | 485 | 8143 |
| 10-#18 | 6.17 | MA | 9631 | 2860 | 15390 | 2256 | 18163 | 1863 | 20290 | 1500 | 23659 | 872 | 30634 | 240 | 28907 |
| 4L-3S | | MI | 4427 | 2860 | 7909 | 2054 | 9086 | 1655 | 9988 | 1333 | 11266 | 684 | 12646 | -81 | 12571 |
| 10-#18 | 6.17 | MA | 8858 | 2860 | 13916 | 2318 | 16386 | 1895 | 18078 | 1528 | 20579 | 919 | 26399 | 96 | 25934 |
| 5L-2S | | MI | 4735 | 2860 | 8747 | 2045 | 10153 | 1654 | 11284 | 1313 | 12961 | 670 | 14614 | 207 | 13467 |
| 12-#10 | 2.35 | MA | 7880 | 2154 | 11665 | 1783 | 13786 | 1488 | 15081 | 1249 | 16720 | 879 | 20514 | 663 | 12972 |
| 3L-5S | | MI | 3560 | 2154 | 5475 | 1686 | 6109 | 1402 | 6425 | 1178 | 6713 | 807 | 7683 | 421 | 5706 |
| 12-#10 | 2.35 | MA | 7713 | 2154 | 11192 | 1796 | 13117 | 1508 | 14259 | 1268 | 15593 | 888 | 19165 | 613 | 12884 |
| 4E | | MI | 3643 | 2154 | 5688 | 1671 | 6365 | 1397 | 6743 | 1168 | 7155 | 801 | 8226 | 476 | 5858 |
| 12-#10 | 2.35 | MA | 7439 | 2154 | 10706 | 1817 | 12536 | 1520 | 13536 | 1279 | 14585 | 906 | 17790 | 574 | 12496 |
| 5L-3S | | MI | 3716 | 2154 | 5895 | 1665 | 6656 | 1385 | 7100 | 1165 | 7642 | 802 | 8780 | 521 | 5859 |
| 12-#10 | 2.35 | MA | 7198 | 2154 | 10237 | 1823 | 11984 | 1531 | 12827 | 1298 | 13625 | 923 | 16449 | 506 | 11973 |
| 6L-2S | | MI | 3853 | 2154 | 6189 | 1658 | 7031 | 1380 | 7555 | 1154 | 8257 | 795 | 9553 | 612 | 5848 |
| 12-#11 | 2.89 | MA | 8012 | 2253 | 11898 | 1854 | 13948 | 1552 | 15242 | 1295 | 16898 | 881 | 20991 | 568 | 15547 |
| 4E | | MI | 3733 | 2253 | 5972 | 1716 | 6679 | 1429 | 7103 | 1182 | 7647 | 792 | 8684 | 385 | 6909 |
| 12-#11 | 2.89 | MA | 7687 | 2253 | 11312 | 1880 | 13242 | 1565 | 14362 | 1308 | 15671 | 902 | 19313 | 518 | 14812 |
| 5L-3S | | MI | 3819 | 2253 | 6221 | 1710 | 7027 | 1414 | 7530 | 1181 | 8209 | 785 | 9326 | 437 | 6968 |
| 12-#11 | 2.89 | MA | 7402 | 2253 | 10743 | 1887 | 12578 | 1579 | 13498 | 1330 | 14502 | 922 | 17677 | 432 | 14216 |
| 6L-2S | | MI | 3978 | 2253 | 6571 | 1703 | 7474 | 1410 | 8072 | 1169 | 8942 | 779 | 10218 | 550 | 6960 |
| 12-#14 | 4.17 | MA | 8308 | 2489 | 12679 | 2044 | 14927 | 1688 | 16376 | 1389 | 18360 | 904 | 23125 | 396 | 20295 |
| 5L-3S | | MI | 4108 | 2489 | 6970 | 1846 | 7950 | 1511 | 8636 | 1242 | 9667 | 760 | 10963 | 279 | 9612 |
| 12-#14 | 4.17 | MA | 7920 | 2489 | 11872 | 2054 | 13975 | 1707 | 15138 | 1421 | 16684 | 932 | 20775 | 271 | 18824 |
| 6L-2S | | MI | 4306 | 2489 | 7464 | 1838 | 8579 | 1507 | 9400 | 1227 | 10696 | 753 | 12188 | 441 | 9640 |
| 12-#18 | 7.41 | MA | 9833 | 3089 | 16039 | 2460 | 19088 | 1999 | 21361 | 1593 | 25022 | 906 | 32551 | 78 | 32174 |
| 5L-3S | | MI | 4758 | 3089 | 8747 | 2197 | 10153 | 1759 | 11284 | 1398 | 12961 | 660 | 14614 | -178 | 14418 |
| 12-#18 | 7.41 | MA | 9212 | 3089 | 14652 | 2480 | 17417 | 2031 | 19188 | 1647 | 22083 | 953 | 28399 | -146 | 27834 |
| 6L-2S | | MI | 5048 | 3089 | 9585 | 2188 | 11220 | 1758 | 12580 | 1378 | 14655 | 647 | 16581 | 110 | 15975 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis

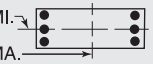



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.74 | MA | 8050 | 2226 | 11894 | 1841 | 14011 | 1541 | 15345 | 1288 | 17062 | 884 | 21200 | 607 | 14987 |
| 4L-5S | | MI | 3688 | 2226 | 5769 | 1731 | 6484 | 1435 | 6880 | 1199 | 7329 | 803 | 8457 | 404 | 6552 |
| 14-#10 | 2.74 | MA | 7778 | 2226 | 11408 | 1862 | 13430 | 1553 | 14622 | 1299 | 16054 | 901 | 19825 | 568 | 14573 |
| 5L-4S | | MI | 3770 | 2226 | 5982 | 1717 | 6740 | 1430 | 7198 | 1188 | 7770 | 796 | 9000 | 458 | 6741 |
| 14-#10 | 2.74 | MA | 7545 | 2226 | 10939 | 1868 | 12878 | 1564 | 13913 | 1319 | 15094 | 919 | 18483 | 501 | 14067 |
| 6L-3S | | MI | 3841 | 2226 | 6189 | 1710 | 7031 | 1418 | 7555 | 1186 | 8257 | 798 | 9553 | 503 | 6751 |
| 14-#10 | 2.74 | MA | 7348 | 2226 | 10495 | 1876 | 12253 | 1579 | 13228 | 1329 | 14113 | 928 | 17192 | 467 | 13468 |
| 7L-2S | | MI | 3975 | 2226 | 6483 | 1704 | 7405 | 1413 | 8009 | 1175 | 8873 | 791 | 10327 | 594 | 6746 |
| 14-#11 | 3.37 | MA | 8091 | 2342 | 12163 | 1935 | 14326 | 1606 | 15678 | 1333 | 17453 | 897 | 21781 | 510 | 17336 |
| 5L-4S | | MI | 3882 | 2342 | 6323 | 1772 | 7125 | 1469 | 7645 | 1207 | 8380 | 786 | 9575 | 358 | 7899 |
| 14-#11 | 3.37 | MA | 7817 | 2342 | 11594 | 1942 | 13662 | 1620 | 14814 | 1356 | 16284 | 917 | 20144 | 425 | 16762 |
| 6L-3S | | MI | 3965 | 2342 | 6571 | 1765 | 7474 | 1455 | 8072 | 1206 | 8942 | 780 | 10218 | 411 | 8024 |
| 14-#11 | 3.37 | MA | 7584 | 2342 | 11055 | 1952 | 12903 | 1638 | 13985 | 1368 | 15090 | 927 | 18562 | 384 | 15782 |
| 7L-2S | | MI | 4120 | 2342 | 6922 | 1759 | 7920 | 1451 | 8614 | 1195 | 9676 | 774 | 11109 | 523 | 8026 |
| 14-#14 | 4.86 | MA | 8502 | 2618 | 13089 | 2134 | 15524 | 1766 | 17019 | 1457 | 19231 | 925 | 24301 | 261 | 22427 |
| 6L-3S | | MI | 4307 | 2618 | 7464 | 1926 | 8579 | 1569 | 9400 | 1278 | 10696 | 752 | 12188 | 235 | 11086 |
| 14-#14 | 4.86 | MA | 8186 | 2618 | 12316 | 2148 | 14448 | 1792 | 15830 | 1475 | 17521 | 939 | 22025 | 199 | 20865 |
| 7L-2S | | MI | 4497 | 2618 | 7958 | 1918 | 9208 | 1565 | 10164 | 1263 | 11724 | 744 | 13414 | 397 | 11128 |
| 16-#10 | 3.14 | MA | 8111 | 2299 | 12110 | 1907 | 14324 | 1586 | 15708 | 1320 | 17524 | 897 | 21859 | 562 | 16654 |
| 5E | | MI | 3815 | 2299 | 6063 | 1777 | 6858 | 1468 | 7335 | 1220 | 7945 | 799 | 9231 | 386 | 7403 |
| 16-#10 | 3.14 | MA | 7886 | 2299 | 11641 | 1913 | 13772 | 1597 | 14998 | 1339 | 16563 | 915 | 20517 | 495 | 16164 |
| 6L-4S | | MI | 3897 | 2299 | 6276 | 1762 | 7114 | 1463 | 7653 | 1209 | 8386 | 792 | 9774 | 440 | 7621 |
| 16-#10 | 3.14 | MA | 7697 | 2299 | 11197 | 1922 | 13147 | 1612 | 14314 | 1350 | 15583 | 924 | 19226 | 462 | 15557 |
| 7L-3S | | MI | 3965 | 2299 | 6483 | 1755 | 7405 | 1450 | 8009 | 1206 | 8873 | 794 | 10327 | 485 | 7639 |
| 16-#10 | 3.14 | MA | 7463 | 2299 | 10772 | 1931 | 12572 | 1620 | 13583 | 1365 | 14647 | 941 | 17977 | 416 | 14903 |
| 8L-2S | | MI | 4097 | 2299 | 6777 | 1749 | 7780 | 1446 | 8464 | 1195 | 9489 | 787 | 11101 | 576 | 7640 |
| 16-#11 | 3.85 | MA | 8224 | 2431 | 12446 | 1998 | 14746 | 1660 | 16131 | 1381 | 18066 | 912 | 22612 | 418 | 19310 |
| 6L-4S | | MI | 4030 | 2431 | 6673 | 1828 | 7571 | 1509 | 8187 | 1233 | 9114 | 781 | 10467 | 332 | 8896 |
| 16-#11 | 3.85 | MA | 8001 | 2431 | 11906 | 2008 | 13987 | 1678 | 15301 | 1393 | 16872 | 922 | 21029 | 376 | 18315 |
| 7L-3S | | MI | 4110 | 2431 | 6922 | 1821 | 7920 | 1495 | 8614 | 1232 | 9676 | 775 | 11109 | 384 | 9076 |
| 16-#11 | 3.85 | MA | 7724 | 2431 | 11389 | 2019 | 13288 | 1687 | 14421 | 1412 | 15733 | 942 | 19504 | 319 | 17315 |
| 8L-2S | | MI | 4261 | 2431 | 7272 | 1814 | 8366 | 1491 | 9156 | 1220 | 10409 | 769 | 12001 | 496 | 9088 |
| 16-#14 | 5.56 | MA | 8774 | 2746 | 13533 | 2228 | 15997 | 1850 | 17712 | 1511 | 20067 | 931 | 25551 | 189 | 24451 |
| 7L-3S | | MI | 4504 | 2746 | 7958 | 2007 | 9208 | 1628 | 10164 | 1315 | 11724 | 743 | 13414 | 191 | 12558 |
| 16-#14 | 5.56 | MA | 8384 | 2746 | 12792 | 2244 | 14996 | 1863 | 16465 | 1538 | 18434 | 960 | 23360 | 103 | 22868 |
| 8L-2S | | MI | 4687 | 2746 | 8452 | 1999 | 9837 | 1624 | 10928 | 1300 | 12753 | 736 | 14639 | 353 | 12613 |
| 18-#10 | 3.53 | MA | 8222 | 2371 | 12343 | 1959 | 14665 | 1629 | 16084 | 1360 | 18032 | 910 | 22552 | 489 | 18262 |
| 6L-5S | | MI | 3940 | 2371 | 6357 | 1822 | 7233 | 1501 | 7790 | 1240 | 8560 | 795 | 10004 | 368 | 8256 |
| 18-#10 | 3.53 | MA | 8040 | 2371 | 11899 | 1967 | 14040 | 1644 | 15399 | 1370 | 17052 | 919 | 21260 | 456 | 17647 |
| 7L-4S | | MI | 4022 | 2371 | 6570 | 1807 | 7489 | 1496 | 8108 | 1229 | 9001 | 788 | 10548 | 422 | 8469 |
| 18-#10 | 3.53 | MA | 7808 | 2371 | 11474 | 1976 | 13465 | 1653 | 14668 | 1385 | 16116 | 937 | 20011 | 410 | 16996 |
| 8L-3S | | MI | 4088 | 2371 | 6777 | 1801 | 7780 | 1483 | 8464 | 1227 | 9489 | 789 | 11101 | 467 | 8524 |
| 18-#10 | 3.53 | MA | 7583 | 2371 | 10993 | 1995 | 12875 | 1670 | 13960 | 1393 | 15159 | 946 | 18785 | 367 | 16147 |
| 9L-2S | | MI | 4217 | 2371 | 7072 | 1794 | 8154 | 1479 | 8919 | 1216 | 10104 | 783 | 11875 | 558 | 8532 |
| 18-#11 | 4.33 | MA | 8411 | 2520 | 12758 | 2063 | 15071 | 1718 | 16618 | 1419 | 18654 | 917 | 23497 | 369 | 20847 |
| 7L-4S | | MI | 4177 | 2520 | 7023 | 1883 | 8017 | 1550 | 8728 | 1258 | 9847 | 776 | 11358 | 305 | 9899 |
| 18-#11 | 4.33 | MA | 8136 | 2520 | 12240 | 2074 | 14372 | 1728 | 15738 | 1437 | 17515 | 937 | 21971 | 311 | 19836 |
| 8L-3S | | MI | 4261 | 2520 | 7272 | 1877 | 8366 | 1536 | 9156 | 1257 | 10409 | 770 | 12001 | 357 | 10126 |
| 18-#11 | 4.33 | MA | 7871 | 2520 | 11660 | 2097 | 13653 | 1748 | 14876 | 1446 | 16349 | 947 | 20469 | 257 | 18848 |
| 9L-2S | | MI | 4398 | 2520 | 7623 | 1870 | 8812 | 1532 | 9697 | 1245 | 11142 | 764 | 12892 | 469 | 10146 |
| 18-#14 | 6.25 | MA | 8964 | 2875 | 14008 | 2324 | 16545 | 1921 | 18347 | 1575 | 20980 | 952 | 26886 | 92 | 26458 |
| 8L-3S | | MI | 4700 | 2875 | 8452 | 2087 | 9837 | 1686 | 10928 | 1351 | 12753 | 735 | 14639 | 147 | 14028 |
| 20-#10 | 3.92 | MA | 8377 | 2444 | 12601 | 2012 | 14934 | 1677 | 16485 | 1391 | 18521 | 915 | 23295 | 450 | 19736 |
| 7L-5S | | MI | 4065 | 2444 | 6651 | 1867 | 7607 | 1534 | 8245 | 1261 | 9176 | 791 | 10778 | 350 | 9111 |
| 20-#10 | 3.92 | MA | 8147 | 2444 | 12176 | 2022 | 14359 | 1685 | 15754 | 1406 | 17585 | 933 | 22045 | 405 | 19075 |
| 8L-4S | | MI | 4146 | 2444 | 6864 | 1853 | 7863 | 1529 | 8563 | 1250 | 9617 | 784 | 11321 | 404 | 9313 |
| 20-#10 | 3.92 | MA | 7929 | 2444 | 11695 | 2040 | 13769 | 1703 | 15046 | 1413 | 16628 | 941 | 20820 | 361 | 18232 |
| 9L-3S | | MI | 4210 | 2444 | 7072 | 1846 | 8154 | 1516 | 8919 | 1247 | 10104 | 785 | 11875 | 449 | 9407 |

## RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 3.92 | MA | 7720 | 2444 | 11253 | 2047 | 13213 | 1712 | 14339 | 1430 | 15684 | 957 | 19474 | 310 | 17414 |
| 10L-2S | | MI | 4337 | 2444 | 7366 | 1840 | 8529 | 1512 | 9374 | 1236 | 10720 | 778 | 12648 | 541 | 9419 |
| 20-#11 | 4.81 | MA | 8541 | 2609 | 13092 | 2130 | 15456 | 1768 | 17055 | 1463 | 19297 | 932 | 24439 | 304 | 22358 |
| 8L-4S | | MI | 4336 | 2609 | 7374 | 1939 | 8463 | 1590 | 9270 | 1283 | 10581 | 771 | 12250 | 278 | 10906 |
| 20-#11 | 4.81 | MA | 8285 | 2609 | 12511 | 2153 | 14737 | 1789 | 16193 | 1471 | 18131 | 942 | 22937 | 250 | 21361 |
| 9L-3S | | MI | 4402 | 2609 | 7623 | 1932 | 8812 | 1576 | 9697 | 1282 | 11142 | 765 | 12892 | 330 | 11175 |
| 22-#10 | 4.31 | MA | 8481 | 2516 | 12878 | 2067 | 15253 | 1718 | 16840 | 1426 | 19054 | 928 | 24080 | 399 | 21163 |
| 8L-5S | | MI | 4188 | 2516 | 6945 | 1913 | 7982 | 1567 | 8700 | 1281 | 9791 | 786 | 11552 | 332 | 9969 |
| 22-#10 | 4.31 | MA | 8270 | 2516 | 12397 | 2085 | 14663 | 1736 | 16131 | 1434 | 18098 | 937 | 22854 | 355 | 20317 |
| 9L-4S | | MI | 4270 | 2516 | 7158 | 1898 | 8238 | 1562 | 9018 | 1270 | 10233 | 779 | 12095 | 386 | 10160 |
| 22-#10 | 4.31 | MA | 8077 | 2516 | 11955 | 2092 | 14107 | 1745 | 15425 | 1451 | 17153 | 953 | 21509 | 304 | 19492 |
| 10L-3S | | MI | 4332 | 2516 | 7366 | 1891 | 8529 | 1549 | 9374 | 1268 | 10720 | 781 | 12648 | 431 | 10289 |
| 22-#11 | 5.30 | MA | 8692 | 2698 | 13363 | 2208 | 15822 | 1829 | 17510 | 1496 | 19913 | 937 | 25404 | 243 | 23874 |
| 9L-4S | | MI | 4479 | 2698 | 7724 | 1995 | 8910 | 1631 | 9812 | 1308 | 11314 | 766 | 13141 | 251 | 11916 |
| 24-#10 | 4.70 | MA | 8606 | 2589 | 13099 | 2131 | 15557 | 1769 | 17217 | 1454 | 19567 | 933 | 24888 | 349 | 22402 |
| 9L-5S | | MI | 4311 | 2589 | 7240 | 1958 | 8356 | 1600 | 9154 | 1302 | 10407 | 782 | 12326 | 314 | 10829 |
| 24-#10 | 4.70 | MA | 8420 | 2589 | 12657 | 2138 | 15001 | 1778 | 16510 | 1471 | 18622 | 949 | 23543 | 298 | 21571 |
| 10L-4S | | MI | 4393 | 2589 | 7453 | 1943 | 8612 | 1595 | 9473 | 1291 | 10848 | 775 | 12869 | 368 | 11010 |

## RECTANGULAR TIED COLUMNS 20" x 20"

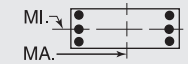
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.19 | MA | 2415 | 1196 | 3616 | 961 | 4082 | 809 | 4311 | 690 | 4508 | 511 | 5222 | 435 | 2184 |
| 2L-3S | | MI | 2306 | 1196 | 3401 | 966 | 3809 | 813 | 3979 | 698 | 4058 | 517 | 4622 | 378 | 2197 |
| 6-#9 | 1.50 | MA | 2486 | 1232 | 3791 | 980 | 4295 | 823 | 4565 | 698 | 4848 | 507 | 5653 | 426 | 2704 |
| 2L-3S | | MI | 2351 | 1232 | 3521 | 987 | 3952 | 828 | 4148 | 708 | 4283 | 514 | 4907 | 354 | 2718 |
| 6-#10 | 1.90 | MA | 2574 | 1278 | 4011 | 1006 | 4565 | 841 | 4888 | 708 | 5280 | 502 | 6194 | 412 | 3360 |
| 2L-3S | | MI | 2408 | 1278 | 3672 | 1013 | 4133 | 847 | 4363 | 721 | 4570 | 511 | 5265 | 321 | 3371 |
| 6-#11 | 2.34 | MA | 2650 | 1328 | 4241 | 1027 | 4829 | 855 | 5195 | 715 | 5686 | 493 | 6624 | 386 | 4015 |
| 2L-3S | | MI | 2457 | 1328 | 3835 | 1035 | 4312 | 861 | 4567 | 729 | 4836 | 503 | 5543 | 274 | 4020 |
| 6-#14 | 3.38 | MA | 2851 | 1446 | 4766 | 1094 | 5477 | 903 | 5973 | 743 | 6733 | 482 | 7854 | 342 | 5586 |
| 2L-3S | | MI | 2590 | 1446 | 4192 | 1105 | 4746 | 910 | 5085 | 762 | 5530 | 494 | 6356 | 180 | 5543 |
| 6-#18 | 6.00 | MA | 3306 | 1746 | 6024 | 1267 | 7041 | 1027 | 7854 | 818 | 9250 | 455 | 10661 | 208 | 9335 |
| 2L-3S | | MI | 2929 | 1746 | 5043 | 1282 | 5792 | 1035 | 6337 | 845 | 7202 | 468 | 8215 | -80 | 8128 |
| 8-#8 | 1.58 | MA | 2510 | 1241 | 3831 | 989 | 4356 | 829 | 4644 | 703 | 4957 | 508 | 5822 | 428 | 2847 |
| 2L-4S | | MI | 2346 | 1241 | 3467 | 1000 | 3872 | 843 | 4054 | 714 | 4155 | 516 | 4799 | 341 | 2861 |
| 8-#9 | 2.00 | MA | 2603 | 1289 | 4061 | 1016 | 4639 | 849 | 4983 | 714 | 5413 | 504 | 6400 | 416 | 3531 |
| 2L-4S | | MI | 2402 | 1289 | 3603 | 1029 | 4031 | 865 | 4241 | 728 | 4405 | 512 | 5126 | 306 | 3526 |
| 8-#10 | 2.54 | MA | 2718 | 1351 | 4351 | 1051 | 4997 | 874 | 5413 | 729 | 5991 | 498 | 7124 | 399 | 4396 |
| 2L-4S | | MI | 2472 | 1351 | 3774 | 1067 | 4232 | 894 | 4480 | 746 | 4722 | 508 | 5536 | 260 | 4288 |
| 8-#11 | 3.12 | MA | 2819 | 1417 | 4647 | 1083 | 5346 | 895 | 5823 | 740 | 6536 | 488 | 7706 | 366 | 5251 |
| 2L-4S | | MI | 2533 | 1417 | 3955 | 1099 | 4428 | 918 | 4704 | 758 | 5015 | 496 | 5853 | 197 | 4941 |
| 8-#14 | 4.50 | MA | 3083 | 1575 | 5340 | 1174 | 6209 | 961 | 6862 | 780 | 7935 | 475 | 9352 | 308 | 7320 |
| 2L-4S | | MI | 2700 | 1575 | 4360 | 1196 | 4908 | 990 | 5277 | 802 | 5815 | 498 | 6781 | 68 | 6484 |
| 10-#10 | 3.17 | MA | 2861 | 1423 | 4690 | 1096 | 5429 | 906 | 5938 | 749 | 6701 | 494 | 8054 | 386 | 5426 |
| 2L-5S | | MI | 2522 | 1423 | 3871 | 1128 | 4371 | 933 | 4641 | 779 | 4928 | 512 | 5813 | 193 | 4969 |
| 10-#10 | 3.17 | MA | 2707 | 1423 | 4351 | 1104 | 4997 | 912 | 5413 | 762 | 5991 | 503 | 7124 | 295 | 5412 |
| 3L-4S | | MI | 2626 | 1423 | 4114 | 1112 | 4664 | 927 | 5004 | 766 | 5432 | 503 | 6465 | 247 | 5247 |
| 10-#11 | 3.90 | MA | 2808 | 1506 | 4647 | 1147 | 5346 | 942 | 5823 | 780 | 6536 | 492 | 7706 | 233 | 6449 |
| 3L-4S | | MI | 2713 | 1506 | 4361 | 1155 | 4945 | 958 | 5332 | 783 | 5865 | 491 | 6935 | 177 | 6089 |
| 10-#14 | 5.63 | MA | 3091 | 1703 | 5340 | 1265 | 6209 | 1027 | 6862 | 835 | 7935 | 479 | 9352 | 113 | 8950 |
| 3L-4S | | MI | 2952 | 1703 | 4935 | 1276 | 5640 | 1049 | 6165 | 839 | 7018 | 490 | 8279 | 34 | 8123 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis

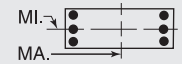



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.15 | MA | 2921 | 1312 | 4347 | 1060 | 4920 | 892 | 5201 | 762 | 5439 | 565 | 6330 | 485 | 2589 |
| 2E | | MI | 2639 | 1312 | 3971 | 1047 | 4459 | 882 | 4694 | 752 | 4885 | 558 | 5605 | 471 | 2335 |
| 4-#11 | 1.42 | MA | 2983 | 1345 | 4535 | 1071 | 5127 | 899 | 5437 | 764 | 5747 | 557 | 6676 | 468 | 3105 |
| 2E | | MI | 2691 | 1345 | 4137 | 1057 | 4639 | 888 | 4898 | 754 | 5150 | 550 | 5881 | 451 | 2792 |
| 4-#14 | 2.05 | MA | 3143 | 1424 | 4945 | 1113 | 5626 | 929 | 6033 | 781 | 6545 | 549 | 7655 | 444 | 4322 |
| 2E | | MI | 2828 | 1424 | 4496 | 1099 | 5075 | 917 | 5416 | 771 | 5843 | 540 | 6692 | 420 | 3867 |
| 4-#18 | 3.64 | MA | 3516 | 1624 | 5929 | 1224 | 6834 | 1008 | 7479 | 827 | 8486 | 529 | 9929 | 368 | 7250 |
| 2E | | MI | 3146 | 1624 | 5351 | 1208 | 6121 | 995 | 6667 | 816 | 7513 | 518 | 8547 | 327 | 6430 |
| 6-#8 | 1.08 | MA | 2907 | 1302 | 4282 | 1060 | 4860 | 894 | 5139 | 764 | 5364 | 570 | 6269 | 494 | 2440 |
| 2L-3S | | MI | 2518 | 1302 | 3699 | 1054 | 4135 | 888 | 4310 | 764 | 4374 | 569 | 4965 | 424 | 2215 |
| 6-#8 | 1.08 | MA | 2781 | 1302 | 4039 | 1066 | 4550 | 899 | 4763 | 773 | 4855 | 577 | 5571 | 437 | 2453 |
| 3L-2S | | MI | 2628 | 1302 | 3914 | 1049 | 4408 | 884 | 4643 | 755 | 4823 | 563 | 5564 | 481 | 2202 |
| 6-#9 | 1.36 | MA | 2989 | 1338 | 4481 | 1080 | 5102 | 907 | 5428 | 772 | 5751 | 566 | 6778 | 486 | 3028 |
| 2L-3S | | MI | 2563 | 1338 | 3820 | 1074 | 4278 | 902 | 4479 | 773 | 4599 | 566 | 5248 | 399 | 2741 |
| 6-#9 | 1.36 | MA | 2833 | 1338 | 4175 | 1087 | 4713 | 913 | 4956 | 783 | 5112 | 575 | 5907 | 414 | 3042 |
| 3L-2S | | MI | 2699 | 1338 | 4089 | 1068 | 4622 | 897 | 4897 | 763 | 5163 | 559 | 5995 | 471 | 2725 |
| 6-#10 | 1.73 | MA | 3091 | 1384 | 4732 | 1105 | 5409 | 925 | 5796 | 782 | 6244 | 561 | 7417 | 476 | 3772 |
| 2L-3S | | MI | 2620 | 1384 | 3971 | 1100 | 4459 | 921 | 4694 | 786 | 4885 | 563 | 5605 | 366 | 3399 |
| 6-#10 | 1.73 | MA | 2900 | 1384 | 4347 | 1114 | 4920 | 933 | 5201 | 796 | 5439 | 572 | 6330 | 385 | 3783 |
| 3L-2S | | MI | 2787 | 1384 | 4310 | 1093 | 4892 | 915 | 5219 | 773 | 5595 | 554 | 6535 | 458 | 3384 |
| 6-#11 | 2.13 | MA | 3182 | 1434 | 4997 | 1126 | 5715 | 940 | 6152 | 789 | 6714 | 552 | 7950 | 453 | 4521 |
| 2L-3S | | MI | 2669 | 1434 | 4137 | 1121 | 4639 | 934 | 4898 | 793 | 5150 | 554 | 5881 | 318 | 4056 |
| 6-#11 | 2.13 | MA | 2959 | 1434 | 4535 | 1136 | 5127 | 947 | 5437 | 805 | 5747 | 564 | 6676 | 341 | 4525 |
| 3L-2S | | MI | 2864 | 1434 | 4543 | 1113 | 5156 | 928 | 5526 | 779 | 5999 | 544 | 6962 | 431 | 4044 |
| 6-#14 | 3.07 | MA | 3418 | 1552 | 5600 | 1193 | 6460 | 987 | 7045 | 817 | 7915 | 541 | 9429 | 418 | 6315 |
| 2L-3S | | MI | 2802 | 1552 | 4496 | 1190 | 5075 | 983 | 5416 | 825 | 5843 | 544 | 6692 | 225 | 5595 |
| 6-#14 | 3.07 | MA | 3116 | 1552 | 4945 | 1206 | 5626 | 997 | 6033 | 839 | 6545 | 556 | 7655 | 256 | 6272 |
| 3L-2S | | MI | 3066 | 1552 | 5070 | 1179 | 5806 | 975 | 6304 | 807 | 7045 | 533 | 8190 | 386 | 5622 |
| 6-#18 | 5.45 | MA | 3962 | 1852 | 7052 | 1367 | 8265 | 1112 | 9216 | 892 | 10838 | 516 | 12860 | 308 | 10631 |
| 2L-3S | | MI | 3138 | 1852 | 5351 | 1366 | 6121 | 1106 | 6667 | 907 | 7513 | 518 | 8547 | -37 | 8508 |
| 6-#18 | 5.45 | MA | 3492 | 1852 | 5929 | 1386 | 6834 | 1125 | 7479 | 925 | 8486 | 536 | 9929 | 21 | 9870 |
| 3L-2S | | MI | 3524 | 1852 | 6332 | 1351 | 7370 | 1098 | 8184 | 880 | 9561 | 504 | 10993 | 251 | 9386 |
| 8-#8 | 1.44 | MA | 3017 | 1347 | 4525 | 1089 | 5169 | 914 | 5515 | 777 | 5873 | 567 | 6967 | 489 | 3188 |
| 2L-4S | | MI | 2558 | 1347 | 3764 | 1087 | 4198 | 918 | 4385 | 780 | 4471 | 567 | 5141 | 386 | 2887 |
| 8-#8 | 1.44 | MA | 2893 | 1347 | 4282 | 1094 | 4860 | 919 | 5139 | 786 | 5364 | 574 | 6269 | 432 | 3198 |
| 3E | | MI | 2616 | 1347 | 3914 | 1082 | 4408 | 908 | 4643 | 776 | 4823 | 566 | 5564 | 417 | 2878 |
| 8-#8 | 1.44 | MA | 2828 | 1347 | 4114 | 1100 | 4623 | 929 | 4849 | 790 | 4967 | 577 | 5780 | 400 | 3202 |
| 4L-2S | | MI | 2723 | 1347 | 4129 | 1077 | 4682 | 904 | 4975 | 768 | 5273 | 560 | 6164 | 474 | 2867 |
| 8-#9 | 1.82 | MA | 3124 | 1395 | 4786 | 1115 | 5491 | 933 | 5901 | 788 | 6391 | 562 | 7648 | 480 | 3963 |
| 2L-4S | | MI | 2613 | 1395 | 3901 | 1116 | 4357 | 940 | 4573 | 793 | 4720 | 564 | 5467 | 351 | 3561 |
| 8-#9 | 1.82 | MA | 2974 | 1395 | 4481 | 1123 | 5102 | 939 | 5428 | 799 | 5751 | 571 | 6778 | 408 | 3971 |
| 3E | | MI | 2685 | 1395 | 4089 | 1110 | 4622 | 928 | 4897 | 789 | 5163 | 563 | 5995 | 390 | 3565 |
| 8-#9 | 1.82 | MA | 2893 | 1395 | 4270 | 1130 | 4805 | 952 | 5063 | 804 | 5252 | 574 | 6166 | 367 | 3958 |
| 4L-2S | | MI | 2816 | 1395 | 4359 | 1103 | 4965 | 923 | 5314 | 779 | 5728 | 555 | 6741 | 462 | 3555 |
| 8-#10 | 2.31 | MA | 3259 | 1457 | 5116 | 1150 | 5899 | 958 | 6391 | 803 | 7049 | 557 | 8504 | 467 | 4944 |
| 2L-4S | | MI | 2684 | 1457 | 4073 | 1153 | 4558 | 968 | 4811 | 810 | 5037 | 559 | 5876 | 305 | 4393 |
| 8-#10 | 2.31 | MA | 3074 | 1457 | 4732 | 1159 | 5409 | 966 | 5796 | 817 | 6244 | 568 | 7417 | 375 | 4942 |
| 3E | | MI | 2771 | 1457 | 4310 | 1146 | 4892 | 954 | 5219 | 806 | 5595 | 558 | 6535 | 353 | 4426 |
| 8-#10 | 2.31 | MA | 2976 | 1457 | 4465 | 1168 | 5034 | 981 | 5336 | 823 | 5614 | 570 | 6652 | 324 | 4894 |
| 4L-2S | | MI | 2932 | 1457 | 4650 | 1138 | 5324 | 948 | 5744 | 794 | 6306 | 549 | 7465 | 445 | 4422 |
| 8-#11 | 2.84 | MA | 3378 | 1523 | 5459 | 1182 | 6303 | 980 | 6866 | 814 | 7680 | 547 | 9223 | 439 | 5925 |
| 2L-4S | | MI | 2744 | 1523 | 4257 | 1185 | 4756 | 991 | 5035 | 822 | 5328 | 547 | 6191 | 242 | 5056 |
| 8-#11 | 2.84 | MA | 3164 | 1523 | 4997 | 1192 | 5715 | 988 | 6152 | 830 | 6714 | 559 | 7950 | 326 | 5910 |
| 3E | | MI | 2846 | 1523 | 4543 | 1177 | 5156 | 975 | 5526 | 818 | 5999 | 548 | 6962 | 298 | 5277 |
| 8-#11 | 2.84 | MA | 3049 | 1523 | 4675 | 1202 | 5263 | 1006 | 5597 | 836 | 5955 | 560 | 7048 | 266 | 5662 |
| 4L-2S | | MI | 3034 | 1523 | 4949 | 1169 | 5673 | 969 | 6154 | 804 | 6849 | 539 | 8044 | 410 | 5283 |
| 8-#14 | 4.09 | MA | 3688 | 1681 | 6254 | 1274 | 7293 | 1046 | 8057 | 854 | 9285 | 534 | 11202 | 393 | 8292 |
| 2L-4S | | MI | 2910 | 1681 | 4665 | 1281 | 5237 | 1063 | 5607 | 866 | 6128 | 548 | 7117 | 112 | 6620 |

## RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

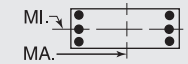
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 4.09 | MA | 3401 | 1681 | 5600 | 1287 | 6460 | 1056 | 7045 | 875 | 7915 | 549 | 9429 | 231 | 8218 |
| 3E | | MI | 3048 | 1681 | 5070 | 1270 | 5806 | 1041 | 6304 | 862 | 7045 | 537 | 8190 | 191 | 7303 |
| 8-#14 | 4.09 | MA | 3246 | 1681 | 5141 | 1300 | 5816 | 1080 | 6256 | 882 | 6836 | 549 | 8169 | 147 | 7446 |
| 4L-2S | | MI | 3301 | 1681 | 5645 | 1259 | 6537 | 1034 | 7193 | 843 | 8247 | 525 | 9688 | 353 | 7360 |
| 8-#18 | 7.27 | MA | 3995 | 2080 | 7052 | 1529 | 8265 | 1228 | 9216 | 990 | 10838 | 522 | 12860 | -39 | 12782 |
| 3E | | MI | 3548 | 2080 | 6332 | 1509 | 7370 | 1210 | 8184 | 972 | 9561 | 504 | 10993 | -113 | 10832 |
| 10-#10 | 2.89 | MA | 3423 | 1529 | 5501 | 1196 | 6389 | 991 | 6986 | 823 | 7855 | 553 | 9591 | 458 | 6111 |
| 2L-5S | | MI | 2734 | 1529 | 4170 | 1215 | 4698 | 1007 | 4972 | 844 | 5243 | 564 | 6153 | 238 | 5059 |
| 10-#10 | 2.89 | MA | 3245 | 1529 | 5116 | 1205 | 5899 | 999 | 6391 | 837 | 7049 | 563 | 8504 | 366 | 6097 |
| 3L-4S | | MI | 2837 | 1529 | 4413 | 1199 | 4991 | 1001 | 5336 | 831 | 5747 | 555 | 6806 | 292 | 5347 |
| 10-#10 | 2.89 | MA | 3153 | 1529 | 4850 | 1213 | 5524 | 1014 | 5931 | 843 | 6420 | 566 | 7739 | 315 | 5996 |
| 4L-3S | | MI | 2920 | 1529 | 4650 | 1191 | 5324 | 987 | 5744 | 827 | 6306 | 554 | 7465 | 340 | 5447 |
| 10-#10 | 2.89 | MA | 3029 | 1529 | 4577 | 1231 | 5195 | 1021 | 5522 | 857 | 5852 | 577 | 6976 | 262 | 5644 |
| 5L-2S | | MI | 3076 | 1529 | 4989 | 1183 | 5756 | 981 | 6269 | 814 | 7016 | 545 | 8394 | 432 | 5454 |
| 10-#11 | 3.55 | MA | 3365 | 1612 | 5459 | 1248 | 6303 | 1028 | 6866 | 856 | 7680 | 554 | 9223 | 311 | 7291 |
| 3L-4S | | MI | 2924 | 1612 | 4664 | 1241 | 5273 | 1032 | 5663 | 847 | 6178 | 542 | 7273 | 221 | 6201 |
| 10-#11 | 3.55 | MA | 3258 | 1612 | 5137 | 1257 | 5850 | 1046 | 6311 | 861 | 6921 | 555 | 8322 | 251 | 6973 |
| 4L-3S | | MI | 3020 | 1612 | 4949 | 1233 | 5673 | 1015 | 6154 | 844 | 6849 | 543 | 8044 | 278 | 6493 |
| 10-#11 | 3.55 | MA | 3115 | 1612 | 4807 | 1278 | 5453 | 1054 | 5818 | 877 | 6236 | 567 | 7428 | 186 | 6604 |
| 5L-2S | | MI | 3201 | 1612 | 5355 | 1224 | 6191 | 1009 | 6782 | 830 | 7699 | 534 | 9126 | 390 | 6514 |
| 10-#14 | 5.11 | MA | 3681 | 1809 | 6254 | 1367 | 7293 | 1114 | 8057 | 912 | 9285 | 541 | 11202 | 205 | 10165 |
| 3L-4S | | MI | 3162 | 1809 | 5239 | 1362 | 5968 | 1122 | 6496 | 902 | 7330 | 541 | 8615 | 79 | 8253 |
| 10-#14 | 5.11 | MA | 3538 | 1809 | 5796 | 1380 | 6649 | 1139 | 7268 | 918 | 8206 | 541 | 9942 | 121 | 9322 |
| 4L-3S | | MI | 3305 | 1809 | 5645 | 1351 | 6537 | 1099 | 7193 | 898 | 8247 | 529 | 9688 | 157 | 9008 |
| 12-#10 | 3.46 | MA | 3414 | 1602 | 5501 | 1250 | 6389 | 1031 | 6986 | 858 | 7855 | 559 | 9591 | 357 | 7250 |
| 3L-5S | | MI | 2885 | 1602 | 4509 | 1260 | 5130 | 1040 | 5497 | 864 | 5953 | 560 | 7083 | 225 | 6041 |
| 12-#10 | 3.46 | MA | 3327 | 1602 | 5234 | 1259 | 6014 | 1047 | 6526 | 864 | 7225 | 562 | 8826 | 306 | 7094 |
| 4E | | MI | 2988 | 1602 | 4752 | 1244 | 5423 | 1034 | 5861 | 852 | 6458 | 551 | 7736 | 279 | 6311 |
| 12-#10 | 3.46 | MA | 3203 | 1602 | 4962 | 1276 | 5685 | 1054 | 6117 | 878 | 6657 | 573 | 8064 | 253 | 6762 |
| 5L-3S | | MI | 3066 | 1602 | 4989 | 1236 | 5756 | 1020 | 6269 | 847 | 7016 | 550 | 8394 | 327 | 6464 |
| 12-#10 | 3.46 | MA | 3078 | 1602 | 4724 | 1284 | 5361 | 1070 | 5715 | 883 | 6114 | 583 | 7364 | 195 | 6427 |
| 6L-2S | | MI | 3217 | 1602 | 5329 | 1229 | 6188 | 1014 | 6794 | 835 | 7727 | 541 | 9324 | 419 | 6481 |
| 12-#11 | 4.25 | MA | 3463 | 1701 | 5599 | 1313 | 6438 | 1087 | 7025 | 886 | 7888 | 550 | 9596 | 236 | 8294 |
| 4E | | MI | 3102 | 1701 | 5070 | 1297 | 5790 | 1072 | 6291 | 873 | 7028 | 537 | 8355 | 201 | 7356 |
| 12-#11 | 4.25 | MA | 3321 | 1701 | 5269 | 1333 | 6041 | 1095 | 6532 | 902 | 7203 | 561 | 8702 | 171 | 7947 |
| 5L-3S | | MI | 3192 | 1701 | 5355 | 1288 | 6191 | 1056 | 6782 | 869 | 7699 | 538 | 9126 | 258 | 7705 |
| 12-#14 | 6.14 | MA | 3824 | 1938 | 6451 | 1460 | 7483 | 1197 | 8281 | 955 | 9576 | 534 | 11716 | 96 | 11210 |
| 4E | | MI | 3434 | 1938 | 5813 | 1442 | 6699 | 1180 | 7384 | 938 | 8532 | 533 | 10113 | 45 | 9899 |
| 14-#10 | 4.04 | MA | 3498 | 1674 | 5619 | 1304 | 6504 | 1080 | 7121 | 884 | 8030 | 557 | 9913 | 297 | 8200 |
| 4L-5S | | MI | 3034 | 1674 | 4849 | 1306 | 5562 | 1073 | 6022 | 885 | 6663 | 556 | 8013 | 212 | 7027 |
| 14-#10 | 4.04 | MA | 3375 | 1674 | 5346 | 1321 | 6175 | 1087 | 6712 | 898 | 7462 | 568 | 9151 | 244 | 7885 |
| 5L-4S | | MI | 3137 | 1674 | 5092 | 1289 | 5855 | 1067 | 6386 | 872 | 7168 | 546 | 8665 | 266 | 7281 |
| 14-#10 | 4.04 | MA | 3254 | 1674 | 5108 | 1329 | 5850 | 1103 | 6310 | 904 | 6919 | 579 | 8451 | 185 | 7535 |
| 6L-3S | | MI | 3210 | 1674 | 5329 | 1282 | 6188 | 1053 | 6794 | 868 | 7727 | 546 | 9324 | 314 | 7480 |
| 14-#11 | 4.96 | MA | 3523 | 1790 | 5730 | 1389 | 6629 | 1135 | 7246 | 928 | 8169 | 556 | 9976 | 156 | 9296 |
| 5L-4S | | MI | 3277 | 1790 | 5476 | 1352 | 6307 | 1112 | 6919 | 898 | 7878 | 532 | 9436 | 181 | 8519 |
| 16-#10 | 4.62 | MA | 3544 | 1747 | 5731 | 1367 | 6665 | 1120 | 7307 | 919 | 8268 | 564 | 10238 | 235 | 9011 |
| 5E | | MI | 3181 | 1747 | 5188 | 1351 | 5994 | 1106 | 6547 | 905 | 7374 | 551 | 8943 | 199 | 8016 |
| 16-#10 | 4.62 | MA | 3427 | 1747 | 5493 | 1374 | 6340 | 1136 | 6905 | 924 | 7725 | 575 | 9538 | 176 | 8647 |
| 6L-4S | | MI | 3284 | 1747 | 5431 | 1335 | 6287 | 1100 | 6911 | 893 | 7879 | 542 | 9595 | 253 | 8257 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis

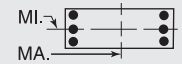



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.06 | MA | 3459 | 1418 | 5072 | 1159 | 5768 | 977 | 6104 | 836 | 6373 | 624 | 7472 | 543 | 2863 |
| 2E | | MI | 2852 | 1418 | 4270 | 1134 | 4786 | 956 | 5025 | 817 | 5200 | 609 | 5946 | 516 | 2354 |
| 4-#11 | 1.30 | MA | 3531 | 1451 | 5286 | 1170 | 6004 | 984 | 6373 | 838 | 6724 | 616 | 7886 | 529 | 3442 |
| 2E | | MI | 2904 | 1451 | 4439 | 1143 | 4967 | 961 | 5229 | 818 | 5463 | 600 | 6219 | 495 | 2816 |
| 4-#14 | 1.88 | MA | 3716 | 1530 | 5748 | 1212 | 6567 | 1014 | 7045 | 855 | 7624 | 608 | 9032 | 508 | 4808 |
| 2E | | MI | 3042 | 1530 | 4800 | 1184 | 5403 | 990 | 5747 | 834 | 6156 | 591 | 7028 | 464 | 3897 |
| 4-#18 | 3.33 | MA | 4147 | 1730 | 6864 | 1323 | 7938 | 1093 | 8686 | 901 | 9826 | 588 | 11727 | 446 | 8114 |
| 2E | | MI | 3360 | 1730 | 5660 | 1292 | 6451 | 1066 | 6998 | 878 | 7824 | 568 | 8879 | 371 | 6473 |
| 6-#9 | 1.25 | MA | 3536 | 1444 | 5221 | 1179 | 5970 | 992 | 6356 | 846 | 6720 | 625 | 7958 | 543 | 3352 |
| 2L-3S | | MI | 2775 | 1444 | 4118 | 1161 | 4605 | 977 | 4811 | 838 | 4914 | 618 | 5590 | 444 | 2762 |
| 6-#9 | 1.25 | MA | 3359 | 1444 | 4879 | 1187 | 5536 | 999 | 5829 | 851 | 6006 | 635 | 6970 | 472 | 3366 |
| 3L-2S | | MI | 2912 | 1444 | 4388 | 1155 | 4948 | 972 | 5228 | 828 | 5479 | 610 | 6336 | 516 | 2745 |
| 6-#10 | 1.59 | MA | 3653 | 1490 | 5502 | 1205 | 6315 | 1010 | 6769 | 856 | 7273 | 620 | 8717 | 537 | 4183 |
| 2L-3S | | MI | 2832 | 1490 | 4270 | 1187 | 4786 | 995 | 5025 | 850 | 5200 | 614 | 5946 | 411 | 3424 |
| 6-#10 | 1.59 | MA | 3435 | 1490 | 5072 | 1214 | 5768 | 1019 | 6104 | 871 | 6373 | 632 | 7472 | 446 | 4194 |
| 3L-2S | | MI | 3000 | 1490 | 4610 | 1180 | 5218 | 989 | 5550 | 838 | 5910 | 605 | 6875 | 503 | 3407 |
| 6-#11 | 1.95 | MA | 3759 | 1540 | 5803 | 1226 | 6663 | 1025 | 7174 | 863 | 7807 | 611 | 9353 | 518 | 5026 |
| 2L-3S | | MI | 2881 | 1540 | 4439 | 1207 | 4967 | 1008 | 5229 | 857 | 5463 | 604 | 6219 | 363 | 4089 |
| 6-#11 | 1.95 | MA | 3504 | 1540 | 5286 | 1237 | 6004 | 1034 | 6373 | 881 | 6724 | 625 | 7886 | 406 | 5030 |
| 3L-2S | | MI | 3077 | 1540 | 4845 | 1199 | 5484 | 1002 | 5857 | 843 | 6313 | 595 | 7300 | 475 | 4072 |
| 6-#14 | 2.81 | MA | 4030 | 1658 | 6483 | 1293 | 7503 | 1072 | 8182 | 891 | 9162 | 600 | 11084 | 490 | 7044 |
| 2L-3S | | MI | 3014 | 1658 | 4800 | 1275 | 5403 | 1055 | 5747 | 889 | 6156 | 595 | 7028 | 269 | 5644 |
| 6-#14 | 2.81 | MA | 3685 | 1658 | 5748 | 1308 | 6567 | 1084 | 7045 | 915 | 7624 | 618 | 9032 | 328 | 7001 |
| 3L-2S | | MI | 3280 | 1658 | 5375 | 1264 | 6134 | 1048 | 6635 | 870 | 7358 | 583 | 8526 | 431 | 5656 |
| 6-#18 | 5.00 | MA | 4666 | 1958 | 8130 | 1466 | 9550 | 1196 | 10644 | 966 | 12476 | 574 | 15149 | 400 | 11927 |
| 2L-3S | | MI | 3330 | 1958 | 5660 | 1450 | 6451 | 1178 | 6998 | 970 | 7824 | 567 | 8879 | 7 | 8860 |
| 6-#18 | 5.00 | MA | 4120 | 1958 | 6864 | 1489 | 7938 | 1214 | 8686 | 1004 | 9826 | 601 | 11727 | 112 | 11374 |
| 3L-2S | | MI | 3742 | 1958 | 6640 | 1435 | 7699 | 1170 | 8515 | 943 | 9872 | 554 | 11325 | 295 | 9436 |
| 8-#8 | 1.32 | MA | 3566 | 1453 | 5269 | 1188 | 6044 | 999 | 6452 | 851 | 6854 | 626 | 8147 | 544 | 3529 |
| 2L-4S | | MI | 2770 | 1453 | 4061 | 1175 | 4524 | 993 | 4716 | 845 | 4787 | 619 | 5483 | 432 | 2910 |
| 8-#8 | 1.32 | MA | 3427 | 1453 | 4998 | 1194 | 5699 | 1005 | 6032 | 855 | 6286 | 634 | 7361 | 488 | 3539 |
| 3E | | MI | 2828 | 1453 | 4211 | 1170 | 4734 | 983 | 4974 | 842 | 5139 | 618 | 5907 | 463 | 2898 |
| 8-#8 | 1.32 | MA | 3353 | 1453 | 4811 | 1201 | 5436 | 1015 | 5710 | 865 | 5845 | 637 | 6815 | 455 | 3543 |
| 4L-2S | | MI | 2936 | 1453 | 4426 | 1164 | 5008 | 979 | 5307 | 833 | 5589 | 612 | 6506 | 519 | 2886 |
| 8-#9 | 1.67 | MA | 3690 | 1501 | 5562 | 1215 | 6405 | 1018 | 6884 | 862 | 7434 | 621 | 8947 | 538 | 4395 |
| 2L-4S | | MI | 2825 | 1501 | 4200 | 1203 | 4684 | 1014 | 4904 | 858 | 5036 | 615 | 5809 | 396 | 3593 |
| 8-#9 | 1.67 | MA | 3518 | 1501 | 5221 | 1223 | 5970 | 1025 | 6356 | 868 | 6720 | 631 | 7958 | 467 | 4403 |
| 3E | | MI | 2897 | 1501 | 4388 | 1197 | 4948 | 1003 | 5228 | 854 | 5479 | 614 | 6336 | 435 | 3589 |
| 8-#9 | 1.67 | MA | 3428 | 1501 | 4986 | 1231 | 5640 | 1038 | 5951 | 880 | 6165 | 635 | 7269 | 425 | 4390 |
| 4L-2S | | MI | 3030 | 1501 | 4657 | 1191 | 5292 | 998 | 5645 | 844 | 6043 | 607 | 7083 | 507 | 3577 |
| 8-#10 | 2.12 | MA | 3843 | 1563 | 5932 | 1250 | 6863 | 1043 | 7434 | 877 | 8173 | 616 | 9962 | 531 | 5493 |
| 2L-4S | | MI | 2895 | 1563 | 4373 | 1240 | 4885 | 1042 | 5142 | 875 | 5352 | 611 | 6217 | 350 | 4436 |
| 8-#10 | 2.12 | MA | 3634 | 1563 | 5502 | 1260 | 6315 | 1051 | 6769 | 892 | 7273 | 628 | 8717 | 440 | 5491 |
| 3E | | MI | 2983 | 1563 | 4610 | 1233 | 5218 | 1028 | 5550 | 871 | 5910 | 610 | 6875 | 398 | 4456 |
| 8-#10 | 2.12 | MA | 3523 | 1563 | 5206 | 1269 | 5898 | 1068 | 6257 | 899 | 6572 | 632 | 7845 | 387 | 5443 |
| 4L-2S | | MI | 3146 | 1563 | 4949 | 1225 | 5651 | 1022 | 6075 | 858 | 6621 | 601 | 7805 | 490 | 4447 |
| 8-#11 | 2.60 | MA | 3983 | 1629 | 6321 | 1282 | 7322 | 1065 | 7974 | 888 | 8890 | 606 | 10820 | 507 | 6599 |
| 2L-4S | | MI | 2955 | 1629 | 4560 | 1271 | 5083 | 1064 | 5366 | 886 | 5642 | 598 | 6529 | 286 | 5168 |
| 8-#11 | 2.60 | MA | 3738 | 1629 | 5803 | 1293 | 6663 | 1074 | 7174 | 906 | 7807 | 620 | 9353 | 395 | 6584 |
| 3E | | MI | 3059 | 1629 | 4845 | 1263 | 5484 | 1048 | 5857 | 882 | 6313 | 599 | 7300 | 343 | 5315 |
| 8-#11 | 2.60 | MA | 3608 | 1629 | 5445 | 1304 | 6158 | 1093 | 6555 | 913 | 6961 | 623 | 8321 | 332 | 6401 |
| 4L-2S | | MI | 3248 | 1629 | 5251 | 1255 | 6001 | 1042 | 6485 | 868 | 7163 | 590 | 8382 | 455 | 5314 |
| 8-#14 | 3.75 | MA | 4339 | 1787 | 7218 | 1373 | 8439 | 1131 | 9318 | 928 | 10700 | 593 | 13135 | 471 | 9264 |
| 2L-4S | | MI | 3120 | 1787 | 4969 | 1367 | 5565 | 1136 | 5938 | 929 | 6441 | 598 | 7453 | 156 | 6751 |
| 8-#14 | 3.75 | MA | 4011 | 1787 | 6483 | 1388 | 7503 | 1143 | 8182 | 952 | 9162 | 611 | 11084 | 309 | 9190 |
| 3E | | MI | 3261 | 1787 | 5375 | 1356 | 6134 | 1114 | 6635 | 925 | 7358 | 587 | 8526 | 235 | 7356 |
| 8-#14 | 3.75 | MA | 3836 | 1787 | 5972 | 1403 | 6784 | 1169 | 7301 | 961 | 7957 | 614 | 9636 | 220 | 8429 |
| 4L-2S | | MI | 3515 | 1787 | 5949 | 1345 | 6865 | 1106 | 7523 | 907 | 8560 | 576 | 10024 | 397 | 7399 |

## RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

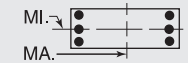
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 6.67 | MA | 4700 | 2186 | 8130 | 1632 | 9550 | 1317 | 10644 | 1069 | 12476 | 587 | 15149 | 66 | 14916 |
| 3E | | MI | 3758 | 2186 | 6640 | 1593 | 7699 | 1281 | 8515 | 1035 | 9872 | 553 | 11325 | -69 | 11230 |
| 8-#18 | 6.67 | MA | 4390 | 2186 | 7243 | 1655 | 8304 | 1361 | 9117 | 1080 | 10388 | 587 | 12717 | -83 | 12599 |
| 4L-2S | | MI | 4117 | 2186 | 7621 | 1578 | 8948 | 1274 | 10031 | 1008 | 11920 | 540 | 13771 | 219 | 12378 |
| 10-#10 | 2.65 | MA | 4031 | 1636 | 6362 | 1295 | 7410 | 1076 | 8099 | 897 | 9073 | 611 | 11208 | 525 | 6797 |
| 2L-5S | | MI | 2945 | 1636 | 4469 | 1302 | 5025 | 1081 | 5304 | 908 | 5558 | 615 | 6494 | 284 | 5145 |
| 10-#10 | 2.65 | MA | 3828 | 1636 | 5932 | 1305 | 6863 | 1084 | 7434 | 913 | 8173 | 624 | 9962 | 434 | 6783 |
| 3L-4S | | MI | 3049 | 1636 | 4712 | 1286 | 5317 | 1075 | 5667 | 896 | 6062 | 606 | 7146 | 337 | 5444 |
| 10-#10 | 2.65 | MA | 3724 | 1636 | 5636 | 1315 | 6445 | 1101 | 6922 | 919 | 7473 | 628 | 9090 | 381 | 6723 |
| 4L-3S | | MI | 3132 | 1636 | 4949 | 1278 | 5651 | 1061 | 6075 | 891 | 6621 | 606 | 7805 | 385 | 5480 |
| 10-#10 | 2.65 | MA | 3579 | 1636 | 5333 | 1333 | 6081 | 1109 | 6469 | 935 | 6842 | 640 | 8217 | 328 | 6328 |
| 5L-2S | | MI | 3290 | 1636 | 5289 | 1270 | 6083 | 1055 | 6600 | 879 | 7331 | 597 | 8735 | 477 | 5481 |
| 10-#11 | 3.25 | MA | 3967 | 1718 | 6321 | 1348 | 7322 | 1115 | 7974 | 931 | 8890 | 614 | 10820 | 384 | 8134 |
| 3L-4S | | MI | 3136 | 1718 | 4966 | 1327 | 5600 | 1105 | 5994 | 911 | 6492 | 593 | 7611 | 266 | 6309 |
| 10-#11 | 3.25 | MA | 3846 | 1718 | 5962 | 1359 | 6817 | 1134 | 7356 | 938 | 8044 | 618 | 9788 | 321 | 7875 |
| 4L-3S | | MI | 3233 | 1718 | 5251 | 1319 | 6001 | 1089 | 6485 | 908 | 7163 | 594 | 8382 | 323 | 6534 |
| 10-#11 | 3.25 | MA | 3678 | 1718 | 5596 | 1381 | 6376 | 1143 | 6807 | 956 | 7281 | 631 | 8759 | 257 | 7419 |
| 5L-2S | | MI | 3416 | 1718 | 5657 | 1310 | 6518 | 1083 | 7113 | 894 | 8013 | 585 | 9464 | 435 | 6548 |
| 10-#14 | 4.69 | MA | 4329 | 1915 | 7218 | 1468 | 8439 | 1201 | 9318 | 988 | 10700 | 603 | 13135 | 290 | 11380 |
| 3L-4S | | MI | 3373 | 1915 | 5543 | 1447 | 6296 | 1194 | 6826 | 965 | 7643 | 591 | 8951 | 123 | 8379 |
| 10-#14 | 4.69 | MA | 4169 | 1915 | 6707 | 1483 | 7720 | 1228 | 8438 | 997 | 9495 | 606 | 11688 | 201 | 10543 |
| 4L-3S | | MI | 3503 | 1915 | 5949 | 1436 | 6865 | 1172 | 7523 | 962 | 8560 | 580 | 10024 | 202 | 9064 |
| 10-#14 | 4.69 | MA | 3936 | 1915 | 6184 | 1513 | 7090 | 1240 | 7655 | 1021 | 8407 | 624 | 10248 | 107 | 9829 |
| 5L-2S | | MI | 3745 | 1915 | 6523 | 1425 | 7597 | 1165 | 8412 | 943 | 9762 | 568 | 11522 | 363 | 9129 |
| 12-#10 | 3.17 | MA | 4019 | 1708 | 6362 | 1350 | 7410 | 1117 | 8099 | 933 | 9073 | 619 | 11208 | 428 | 8073 |
| 3L-5S | | MI | 3097 | 1708 | 4809 | 1347 | 5457 | 1114 | 5829 | 929 | 6268 | 611 | 7424 | 271 | 6125 |
| 12-#10 | 3.17 | MA | 3922 | 1708 | 6066 | 1360 | 6993 | 1134 | 7587 | 940 | 8373 | 623 | 10336 | 375 | 7993 |
| 4E | | MI | 3200 | 1708 | 5052 | 1331 | 5750 | 1108 | 6192 | 916 | 6773 | 602 | 8076 | 324 | 6405 |
| 12-#10 | 3.17 | MA | 3777 | 1708 | 5763 | 1378 | 6628 | 1142 | 7134 | 955 | 7742 | 636 | 9462 | 322 | 7581 |
| 5L-3S | | MI | 3279 | 1708 | 5289 | 1323 | 6083 | 1094 | 6600 | 912 | 7331 | 601 | 8735 | 372 | 6499 |
| 12-#10 | 3.17 | MA | 3635 | 1708 | 5492 | 1385 | 6268 | 1159 | 6687 | 962 | 7139 | 648 | 8664 | 261 | 7264 |
| 6L-2S | | MI | 3433 | 1708 | 5628 | 1316 | 6515 | 1088 | 7125 | 899 | 8042 | 592 | 9665 | 464 | 6511 |
| 12-#11 | 3.90 | MA | 4080 | 1807 | 6480 | 1415 | 7476 | 1174 | 8156 | 963 | 9127 | 613 | 11255 | 311 | 9359 |
| 4E | | MI | 3313 | 1807 | 5372 | 1383 | 6118 | 1145 | 6622 | 937 | 7342 | 588 | 8693 | 246 | 7461 |
| 12-#11 | 3.90 | MA | 3912 | 1807 | 6113 | 1436 | 7034 | 1183 | 7607 | 981 | 8364 | 626 | 10226 | 246 | 8928 |
| 5L-3S | | MI | 3406 | 1807 | 5657 | 1374 | 6518 | 1129 | 7113 | 933 | 8013 | 589 | 9464 | 302 | 7749 |
| 12-#11 | 3.90 | MA | 3746 | 1807 | 5792 | 1446 | 6598 | 1203 | 7067 | 988 | 7634 | 640 | 9283 | 173 | 8387 |
| 6L-2S | | MI | 3583 | 1807 | 6063 | 1366 | 7035 | 1123 | 7741 | 919 | 8863 | 580 | 10546 | 415 | 7775 |
| 12-#14 | 5.63 | MA | 4495 | 2044 | 7442 | 1563 | 8656 | 1286 | 9574 | 1034 | 11033 | 599 | 13739 | 183 | 12669 |
| 4E | | MI | 3620 | 2044 | 6118 | 1527 | 7028 | 1253 | 7715 | 1002 | 8845 | 584 | 10449 | 89 | 10021 |
| 12-#14 | 5.63 | MA | 4264 | 2044 | 6919 | 1593 | 8026 | 1298 | 8791 | 1057 | 9945 | 617 | 12300 | 88 | 11936 |
| 5L-3S | | MI | 3755 | 2044 | 6523 | 1516 | 7597 | 1230 | 8412 | 998 | 9762 | 572 | 11522 | 168 | 10771 |
| 14-#10 | 3.70 | MA | 4116 | 1781 | 6496 | 1405 | 7541 | 1167 | 8252 | 960 | 9273 | 619 | 11581 | 369 | 9231 |
| 4L-5S | | MI | 3247 | 1781 | 5148 | 1393 | 5889 | 1147 | 6354 | 949 | 6978 | 607 | 8353 | 257 | 7109 |
| 14-#10 | 3.70 | MA | 3972 | 1781 | 6193 | 1423 | 7176 | 1175 | 7799 | 976 | 8642 | 632 | 10707 | 316 | 8838 |
| 5L-4S | | MI | 3349 | 1781 | 5391 | 1376 | 6182 | 1141 | 6717 | 937 | 7483 | 598 | 9006 | 311 | 7373 |
| 14-#10 | 3.70 | MA | 3835 | 1781 | 5922 | 1431 | 6816 | 1192 | 7353 | 983 | 8039 | 644 | 9909 | 256 | 8508 |
| 6L-3S | | MI | 3424 | 1781 | 5628 | 1369 | 6515 | 1127 | 7125 | 933 | 8042 | 597 | 9665 | 359 | 7517 |
| 14-#11 | 4.55 | MA | 4143 | 1896 | 6630 | 1492 | 7693 | 1224 | 8407 | 1006 | 9447 | 621 | 11693 | 235 | 10443 |
| 5L-4S | | MI | 3489 | 1896 | 5778 | 1438 | 6635 | 1186 | 7250 | 962 | 8192 | 583 | 9774 | 226 | 8621 |
| 14-#11 | 4.55 | MA | 3982 | 1896 | 6310 | 1501 | 7257 | 1243 | 7867 | 1013 | 8717 | 635 | 10750 | 163 | 9886 |
| 6L-3S | | MI | 3576 | 1896 | 6063 | 1430 | 7035 | 1169 | 7741 | 958 | 8863 | 584 | 10546 | 282 | 8962 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

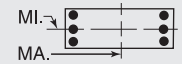
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 6.56 | MA | 4585 | 2172 | 7654 | 1674 | 8961 | 1356 | 9928 | 1094 | 11484 | 609 | 14351 | 70 | 14051 |
| 5L-4S | | MI | 3889 | 2172 | 6692 | 1607 | 7759 | 1311 | 8603 | 1038 | 10047 | 576 | 11947 | 56 | 11674 |
| 16-#10 | 4.23 | MA | 4164 | 1853 | 6623 | 1469 | 7723 | 1208 | 8464 | 996 | 9542 | 627 | 11953 | 311 | 10100 |
| 5E | | MI | 3394 | 1853 | 5487 | 1438 | 6321 | 1180 | 6879 | 970 | 7689 | 603 | 9283 | 244 | 8097 |
| 16-#10 | 4.23 | MA | 4032 | 1853 | 6352 | 1476 | 7363 | 1225 | 8018 | 1003 | 8939 | 640 | 11154 | 250 | 9756 |
| 6L-4S | | MI | 3496 | 1853 | 5730 | 1422 | 6614 | 1174 | 7242 | 957 | 8194 | 594 | 9936 | 298 | 8347 |
| 16-#11 | 5.20 | MA | 4215 | 1986 | 6827 | 1557 | 7916 | 1284 | 8667 | 1039 | 9800 | 629 | 12217 | 152 | 11389 |
| 6L-4S | | MI | 3662 | 1986 | 6184 | 1494 | 7152 | 1226 | 7878 | 987 | 9042 | 578 | 10856 | 205 | 9788 |
| 18-#10 | 4.76 | MA | 4226 | 1926 | 6782 | 1521 | 7911 | 1258 | 8683 | 1024 | 9839 | 635 | 12400 | 244 | 11007 |
| 6L-5S | | MI | 3540 | 1926 | 5827 | 1483 | 6754 | 1213 | 7403 | 991 | 8399 | 599 | 10213 | 231 | 9088 |

## RECTANGULAR TIED COLUMNS 20" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.20 | MA | 4122 | 1557 | 6086 | 1270 | 6942 | 1069 | 7375 | 912 | 7767 | 675 | 9170 | 587 | 3778 |
| 2E | | MI | 3117 | 1557 | 4741 | 1229 | 5295 | 1034 | 5560 | 882 | 5777 | 651 | 6557 | 540 | 2840 |
| 4-#14 | 1.73 | MA | 4332 | 1636 | 6601 | 1312 | 7570 | 1099 | 8124 | 929 | 8769 | 666 | 10487 | 571 | 5294 |
| 2E | | MI | 3255 | 1636 | 5104 | 1269 | 5731 | 1062 | 6078 | 897 | 6468 | 641 | 7364 | 509 | 3926 |
| 4-#18 | 3.08 | MA | 4824 | 1836 | 7849 | 1423 | 9102 | 1178 | 9958 | 975 | 11232 | 647 | 13607 | 520 | 8978 |
| 2E | | MI | 3574 | 1836 | 5968 | 1376 | 6780 | 1138 | 7328 | 940 | 8134 | 618 | 9211 | 414 | 6514 |
| 6-#9 | 1.15 | MA | 4125 | 1550 | 6010 | 1279 | 6900 | 1077 | 7350 | 920 | 7754 | 683 | 9169 | 595 | 3676 |
| 2L-3S | | MI | 2987 | 1550 | 4416 | 1249 | 4931 | 1051 | 5142 | 903 | 5229 | 669 | 5931 | 490 | 2782 |
| 6-#9 | 1.15 | MA | 3927 | 1550 | 5633 | 1287 | 6420 | 1084 | 6767 | 926 | 6966 | 694 | 8077 | 525 | 3690 |
| 3L-2S | | MI | 3125 | 1550 | 4686 | 1242 | 5274 | 1046 | 5559 | 893 | 5794 | 662 | 6678 | 562 | 2764 |
| 6-#10 | 1.47 | MA | 4258 | 1597 | 6322 | 1304 | 7282 | 1095 | 7808 | 930 | 8368 | 679 | 10014 | 589 | 4595 |
| 2L-3S | | MI | 3044 | 1597 | 4570 | 1274 | 5113 | 1069 | 5357 | 915 | 5515 | 666 | 6286 | 457 | 3449 |
| 6-#10 | 1.47 | MA | 4013 | 1597 | 5846 | 1314 | 6677 | 1104 | 7072 | 938 | 7373 | 692 | 8636 | 500 | 4606 |
| 3L-2S | | MI | 3214 | 1597 | 4909 | 1267 | 5545 | 1063 | 5882 | 902 | 6225 | 656 | 7216 | 548 | 3429 |
| 6-#11 | 1.80 | MA | 4379 | 1646 | 6659 | 1325 | 7672 | 1109 | 8261 | 937 | 8966 | 670 | 10831 | 580 | 5532 |
| 2L-3S | | MI | 3093 | 1646 | 4741 | 1293 | 5295 | 1081 | 5560 | 921 | 5777 | 655 | 6557 | 408 | 4120 |
| 6-#11 | 1.80 | MA | 4092 | 1646 | 6086 | 1337 | 6942 | 1120 | 7375 | 956 | 7767 | 685 | 9170 | 468 | 5536 |
| 3L-2S | | MI | 3291 | 1646 | 5147 | 1285 | 5812 | 1075 | 6188 | 907 | 6627 | 646 | 7638 | 520 | 4099 |
| 6-#14 | 2.60 | MA | 4687 | 1764 | 7416 | 1392 | 8608 | 1157 | 9384 | 965 | 10475 | 659 | 12818 | 558 | 7773 |
| 2L-3S | | MI | 3226 | 1764 | 5104 | 1361 | 5731 | 1128 | 6078 | 952 | 6468 | 645 | 7364 | 313 | 5689 |
| 6-#14 | 2.60 | MA | 4297 | 1764 | 6601 | 1409 | 7570 | 1171 | 8124 | 991 | 8769 | 680 | 10487 | 396 | 7730 |
| 3L-2S | | MI | 3494 | 1764 | 5679 | 1350 | 6463 | 1121 | 6966 | 934 | 7670 | 634 | 8862 | 475 | 5690 |
| 6-#18 | 4.62 | MA | 5408 | 2064 | 9258 | 1566 | 10896 | 1281 | 12137 | 1040 | 14181 | 633 | 17522 | 484 | 13223 |
| 2L-3S | | MI | 3541 | 2064 | 5968 | 1534 | 6780 | 1249 | 7328 | 1032 | 8134 | 617 | 9211 | 51 | 9073 |
| 6-#18 | 4.62 | MA | 4792 | 2064 | 7849 | 1592 | 9102 | 1302 | 9958 | 1082 | 11232 | 664 | 13607 | 197 | 12924 |
| 3L-2S | | MI | 3959 | 2064 | 6949 | 1519 | 8029 | 1241 | 8845 | 1005 | 10182 | 604 | 11657 | 338 | 9484 |
| 8-#8 | 1.22 | MA | 4159 | 1559 | 6062 | 1288 | 6980 | 1084 | 7454 | 925 | 7900 | 685 | 9375 | 595 | 3870 |
| 2L-4S | | MI | 2982 | 1559 | 4358 | 1263 | 4850 | 1067 | 5048 | 910 | 5102 | 671 | 5826 | 477 | 2931 |
| 8-#8 | 1.22 | MA | 4003 | 1559 | 5763 | 1294 | 6598 | 1090 | 6991 | 930 | 7274 | 694 | 8507 | 541 | 3880 |
| 3E | | MI | 3040 | 1559 | 4508 | 1257 | 5061 | 1058 | 5306 | 907 | 5455 | 670 | 6249 | 508 | 2918 |
| 8-#8 | 1.22 | MA | 3921 | 1559 | 5558 | 1301 | 6310 | 1101 | 6637 | 940 | 6788 | 697 | 7912 | 509 | 3884 |
| 4L-2S | | MI | 3149 | 1559 | 4723 | 1252 | 5334 | 1054 | 5638 | 898 | 5905 | 664 | 6849 | 565 | 2905 |
| 8-#9 | 1.54 | MA | 4298 | 1607 | 6387 | 1314 | 7379 | 1103 | 7933 | 936 | 8543 | 680 | 10261 | 590 | 4827 |
| 2L-4S | | MI | 3037 | 1607 | 4498 | 1291 | 5010 | 1089 | 5235 | 923 | 5351 | 667 | 6150 | 442 | 3621 |
| 8-#9 | 1.54 | MA | 4106 | 1607 | 6010 | 1323 | 6900 | 1110 | 7350 | 942 | 7754 | 691 | 9169 | 521 | 4835 |
| 3E | | MI | 3109 | 1607 | 4686 | 1284 | 5274 | 1077 | 5559 | 919 | 5794 | 666 | 6678 | 480 | 3612 |
| 8-#9 | 1.54 | MA | 4006 | 1607 | 5752 | 1331 | 6536 | 1124 | 6904 | 955 | 7143 | 695 | 8417 | 480 | 4822 |
| 4L-2S | | MI | 3243 | 1607 | 4955 | 1278 | 5618 | 1072 | 5977 | 909 | 6359 | 659 | 7424 | 552 | 3599 |
| 8-#10 | 1.95 | MA | 4472 | 1669 | 6797 | 1349 | 7887 | 1128 | 8543 | 951 | 9363 | 674 | 11392 | 583 | 6042 |
| 2L-4S | | MI | 3107 | 1669 | 4672 | 1327 | 5212 | 1116 | 5473 | 940 | 5667 | 662 | 6557 | 395 | 4474 |
| 8-#10 | 1.95 | MA | 4236 | 1669 | 6322 | 1360 | 7282 | 1137 | 7808 | 959 | 8368 | 688 | 10014 | 494 | 6040 |
| 3E | | MI | 3196 | 1669 | 4909 | 1320 | 5545 | 1102 | 5882 | 936 | 6225 | 661 | 7216 | 444 | 4484 |
| 8-#10 | 1.95 | MA | 4113 | 1669 | 5996 | 1370 | 6823 | 1155 | 7244 | 975 | 7596 | 693 | 9061 | 442 | 5992 |
| 4L-2S | | MI | 3360 | 1669 | 5248 | 1312 | 5977 | 1096 | 6407 | 923 | 6936 | 652 | 8146 | 535 | 4472 |

## RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

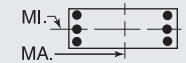
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 2.40 | MA | 4631 | 1735 | 7232 | 1381 | 8401 | 1150 | 9147 | 962 | 10166 | 665 | 12492 | 573 | 7273 |
| 2L-4S | | MI | 3166 | 1735 | 4862 | 1357 | 5411 | 1138 | 5697 | 950 | 5955 | 649 | 6867 | 331 | 5275 |
| 8-#11 | 2.40 | MA | 4356 | 1735 | 6659 | 1393 | 7672 | 1160 | 8261 | 981 | 8966 | 680 | 10831 | 461 | 7258 |
| 3E | | MI | 3271 | 1735 | 5147 | 1349 | 5812 | 1121 | 6188 | 946 | 6627 | 650 | 7638 | 388 | 5352 |
| 8-#11 | 2.40 | MA | 4211 | 1735 | 6264 | 1405 | 7115 | 1181 | 7579 | 990 | 8033 | 685 | 9668 | 395 | 7156 |
| 4L-2S | | MI | 3462 | 1735 | 5553 | 1341 | 6329 | 1115 | 6816 | 932 | 7477 | 641 | 8720 | 500 | 5344 |
| 8-#14 | 3.46 | MA | 5035 | 1893 | 8232 | 1472 | 9645 | 1215 | 10645 | 1002 | 12181 | 652 | 15150 | 544 | 10236 |
| 2L-4S | | MI | 3331 | 1893 | 5273 | 1452 | 5893 | 1209 | 6269 | 992 | 6753 | 649 | 7789 | 201 | 6878 |
| 8-#14 | 3.46 | MA | 4664 | 1893 | 7416 | 1489 | 8608 | 1229 | 9384 | 1028 | 10475 | 672 | 12818 | 382 | 10162 |
| 3E | | MI | 3473 | 1893 | 5679 | 1441 | 6463 | 1186 | 6966 | 989 | 7670 | 638 | 8862 | 279 | 7405 |
| 8-#14 | 3.46 | MA | 4469 | 1893 | 6853 | 1505 | 7814 | 1258 | 8412 | 1039 | 9144 | 678 | 11182 | 290 | 9432 |
| 4L-2S | | MI | 3730 | 1893 | 6253 | 1430 | 7194 | 1179 | 7854 | 970 | 8873 | 626 | 10360 | 441 | 7436 |
| 8-#18 | 6.15 | MA | 5406 | 2293 | 9258 | 1734 | 10896 | 1406 | 12137 | 1146 | 14181 | 651 | 17522 | 161 | 16899 |
| 3E | | MI | 3970 | 2293 | 6949 | 1677 | 8029 | 1353 | 8845 | 1097 | 10182 | 603 | 11657 | -25 | 11623 |
| 8-#18 | 6.15 | MA | 5100 | 2293 | 8277 | 1760 | 9517 | 1453 | 10447 | 1162 | 11868 | 656 | 14757 | 5 | 14729 |
| 4L-2S | | MI | 4335 | 2293 | 7929 | 1662 | 9278 | 1345 | 10362 | 1070 | 12230 | 590 | 14103 | 262 | 12430 |
| 10-#10 | 2.44 | MA | 4683 | 1742 | 7273 | 1395 | 8493 | 1161 | 9278 | 971 | 10358 | 670 | 12769 | 577 | 7483 |
| 2L-5S | | MI | 3157 | 1742 | 4768 | 1389 | 5352 | 1155 | 5635 | 973 | 5872 | 667 | 6834 | 329 | 5227 |
| 10-#10 | 2.44 | MA | 4455 | 1742 | 6797 | 1405 | 7887 | 1170 | 8543 | 979 | 9363 | 684 | 11392 | 489 | 7469 |
| 3L-4S | | MI | 3261 | 1742 | 5011 | 1373 | 5644 | 1149 | 5998 | 960 | 6377 | 658 | 7487 | 382 | 5487 |
| 10-#10 | 2.44 | MA | 4339 | 1742 | 6471 | 1415 | 7428 | 1188 | 7979 | 995 | 8591 | 689 | 10439 | 436 | 7408 |
| 4L-3S | | MI | 3345 | 1742 | 5248 | 1365 | 5977 | 1135 | 6407 | 956 | 6936 | 657 | 8146 | 431 | 5511 |
| 10-#10 | 2.44 | MA | 4172 | 1742 | 6139 | 1434 | 7027 | 1197 | 7481 | 1003 | 7897 | 702 | 9480 | 387 | 7022 |
| 5L-2S | | MI | 3505 | 1742 | 5588 | 1357 | 6410 | 1129 | 6932 | 943 | 7646 | 648 | 9075 | 522 | 5508 |
| 10-#11 | 3.00 | MA | 4614 | 1824 | 7232 | 1449 | 8401 | 1200 | 9147 | 1006 | 10166 | 675 | 12492 | 454 | 8976 |
| 3L-4S | | MI | 3347 | 1824 | 5268 | 1413 | 5928 | 1178 | 6325 | 975 | 6805 | 644 | 7949 | 311 | 6413 |
| 10-#11 | 3.00 | MA | 4479 | 1824 | 6837 | 1461 | 7845 | 1221 | 8466 | 1015 | 9232 | 680 | 11329 | 388 | 8794 |
| 4L-3S | | MI | 3446 | 1824 | 5553 | 1405 | 6329 | 1162 | 6816 | 972 | 7477 | 645 | 8720 | 367 | 6574 |
| 10-#11 | 3.00 | MA | 4284 | 1824 | 6434 | 1483 | 7359 | 1231 | 7861 | 1034 | 8392 | 695 | 10165 | 324 | 8244 |
| 5L-2S | | MI | 3631 | 1824 | 5960 | 1396 | 6846 | 1156 | 7444 | 958 | 8327 | 636 | 9802 | 480 | 6580 |
| 10-#14 | 4.33 | MA | 5023 | 2021 | 8232 | 1569 | 9645 | 1287 | 10645 | 1064 | 12181 | 665 | 15150 | 369 | 12595 |
| 3L-4S | | MI | 3583 | 2021 | 5848 | 1532 | 6625 | 1267 | 7157 | 1029 | 7955 | 642 | 9287 | 167 | 8502 |
| 10-#14 | 4.33 | MA | 4844 | 2021 | 7668 | 1586 | 8852 | 1316 | 9672 | 1075 | 10850 | 670 | 13513 | 277 | 11785 |
| 4L-3S | | MI | 3716 | 2021 | 6253 | 1521 | 7194 | 1245 | 7854 | 1025 | 8873 | 630 | 10360 | 246 | 9117 |
| 10-#14 | 4.33 | MA | 4575 | 2021 | 7092 | 1617 | 8158 | 1330 | 8810 | 1101 | 9651 | 691 | 11877 | 184 | 11086 |
| 5L-2S | | MI | 3963 | 2021 | 6828 | 1510 | 7925 | 1238 | 8743 | 1007 | 10075 | 619 | 11858 | 408 | 9170 |
| 10-#18 | 7.69 | MA | 5734 | 2521 | 9686 | 1903 | 11311 | 1557 | 12626 | 1227 | 14817 | 643 | 18672 | -30 | 18586 |
| 4L-3S | | MI | 4370 | 2521 | 7929 | 1819 | 9278 | 1457 | 10362 | 1162 | 12230 | 589 | 14103 | -102 | 13936 |
| 12-#10 | 2.93 | MA | 4669 | 1814 | 7273 | 1450 | 8493 | 1203 | 9278 | 1000 | 10358 | 680 | 12769 | 483 | 8896 |
| 3L-5S | | MI | 3309 | 1814 | 5108 | 1434 | 5784 | 1188 | 6160 | 994 | 6583 | 663 | 7764 | 316 | 6205 |
| 12-#10 | 2.93 | MA | 4560 | 1814 | 6947 | 1461 | 8033 | 1220 | 8714 | 1016 | 9586 | 685 | 11816 | 430 | 8826 |
| 4E | | MI | 3412 | 1814 | 5351 | 1418 | 6076 | 1182 | 6523 | 981 | 7088 | 654 | 8417 | 369 | 6496 |
| 12-#10 | 2.93 | MA | 4394 | 1814 | 6614 | 1480 | 7632 | 1230 | 8216 | 1024 | 8892 | 698 | 10858 | 381 | 8409 |
| 5L-3S | | MI | 3493 | 1814 | 5588 | 1410 | 6410 | 1168 | 6932 | 977 | 7646 | 653 | 9075 | 418 | 6533 |
| 12-#10 | 2.93 | MA | 4236 | 1814 | 6309 | 1486 | 7237 | 1247 | 7726 | 1040 | 8229 | 712 | 9987 | 321 | 8120 |
| 6L-2S | | MI | 3648 | 1814 | 5927 | 1403 | 6842 | 1162 | 7457 | 964 | 8356 | 644 | 10005 | 509 | 6539 |
| 12-#11 | 3.60 | MA | 4741 | 1913 | 7410 | 1516 | 8575 | 1261 | 9352 | 1040 | 10432 | 675 | 12990 | 381 | 10443 |
| 4E | | MI | 3525 | 1913 | 5674 | 1469 | 6445 | 1219 | 6953 | 1000 | 7655 | 639 | 9031 | 290 | 7562 |
| 12-#11 | 3.60 | MA | 4548 | 1913 | 7007 | 1539 | 8089 | 1272 | 8748 | 1059 | 9591 | 690 | 11825 | 317 | 9920 |
| 5L-3S | | MI | 3619 | 1913 | 5960 | 1460 | 6846 | 1202 | 7444 | 997 | 8327 | 640 | 9802 | 347 | 7791 |
| 12-#11 | 3.60 | MA | 4362 | 1913 | 6645 | 1547 | 7610 | 1292 | 8153 | 1067 | 8788 | 705 | 10761 | 242 | 9385 |
| 6L-2S | | MI | 3798 | 1913 | 6366 | 1452 | 7363 | 1196 | 8072 | 983 | 9176 | 631 | 10883 | 459 | 7810 |
| 12-#14 | 5.19 | MA | 5210 | 2150 | 8483 | 1666 | 9890 | 1374 | 10933 | 1111 | 12556 | 663 | 15844 | 263 | 14150 |
| 4E | | MI | 3831 | 2150 | 6422 | 1612 | 7356 | 1325 | 8046 | 1065 | 9158 | 634 | 10785 | 134 | 10140 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

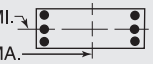
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 5.19 | MA | 4943 | 2150 | 7907 | 1697 | 9196 | 1388 | 10070 | 1137 | 11357 | 683 | 14208 | 170 | 13439 |
| 5L-3S | | MI | 3969 | 2150 | 6828 | 1602 | 7925 | 1303 | 8743 | 1062 | 10075 | 623 | 11858 | 212 | 10825 |
| 14-#10 | 3.42 | MA | 4778 | 1887 | 7422 | 1506 | 8639 | 1253 | 9450 | 1036 | 10581 | 680 | 13194 | 424 | 10244 |
| 4L-5S | | MI | 3459 | 1887 | 5447 | 1480 | 6216 | 1221 | 6685 | 1014 | 7293 | 658 | 8694 | 303 | 7188 |
| 14-#10 | 3.42 | MA | 4613 | 1887 | 7089 | 1525 | 8238 | 1262 | 8951 | 1044 | 9887 | 694 | 12236 | 375 | 9802 |
| 5L-4S | | MI | 3562 | 1887 | 5690 | 1463 | 6509 | 1215 | 7048 | 1001 | 7798 | 649 | 9346 | 356 | 7462 |
| 14-#10 | 3.42 | MA | 4460 | 1887 | 6785 | 1532 | 7843 | 1280 | 8461 | 1060 | 9224 | 708 | 11365 | 315 | 9500 |
| 6L-3S | | MI | 3638 | 1887 | 5927 | 1456 | 6842 | 1201 | 7457 | 997 | 8356 | 649 | 10005 | 405 | 7552 |
| 14-#10 | 3.42 | MA | 4330 | 1887 | 6480 | 1538 | 7454 | 1288 | 7990 | 1068 | 8548 | 713 | 10381 | 262 | 9000 |
| 7L-2S | | MI | 3789 | 1887 | 6267 | 1448 | 7274 | 1195 | 7981 | 985 | 9067 | 640 | 10935 | 496 | 7566 |
| 14-#11 | 4.20 | MA | 4807 | 2003 | 7580 | 1594 | 8819 | 1312 | 9634 | 1084 | 10791 | 685 | 13486 | 310 | 11601 |
| 5L-4S | | MI | 3701 | 2003 | 6080 | 1524 | 6962 | 1259 | 7581 | 1026 | 8505 | 634 | 10112 | 270 | 8720 |
| 14-#11 | 4.20 | MA | 4628 | 2003 | 7218 | 1603 | 8339 | 1333 | 9040 | 1092 | 9987 | 700 | 12422 | 235 | 11052 |
| 6L-3S | | MI | 3790 | 2003 | 6366 | 1516 | 7363 | 1243 | 8072 | 1022 | 9176 | 635 | 10883 | 327 | 9006 |
| 14-#14 | 6.06 | MA | 5304 | 2278 | 8722 | 1777 | 10234 | 1446 | 11331 | 1174 | 13063 | 676 | 16540 | 157 | 15800 |
| 5L-4S | | MI | 4101 | 2278 | 6996 | 1693 | 8087 | 1384 | 8934 | 1102 | 10360 | 627 | 12283 | 100 | 11788 |
| 16-#10 | 3.91 | MA | 4828 | 1959 | 7565 | 1570 | 8843 | 1295 | 9686 | 1065 | 10882 | 690 | 13613 | 369 | 11198 |
| 5E | | MI | 3607 | 1959 | 5787 | 1525 | 6648 | 1254 | 7210 | 1035 | 8004 | 654 | 9624 | 290 | 8174 |
| 16-#10 | 3.91 | MA | 4681 | 1959 | 7260 | 1577 | 8448 | 1313 | 9196 | 1081 | 10219 | 703 | 12742 | 309 | 10885 |
| 6L-4S | | MI | 3709 | 1959 | 6030 | 1509 | 6941 | 1248 | 7573 | 1022 | 8508 | 645 | 10276 | 343 | 8434 |
| 16-#10 | 3.91 | MA | 4556 | 1959 | 6956 | 1583 | 8060 | 1321 | 8725 | 1089 | 9543 | 708 | 11759 | 256 | 10399 |
| 7L-3S | | MI | 3782 | 1959 | 6267 | 1501 | 7274 | 1234 | 7981 | 1018 | 9067 | 645 | 10935 | 392 | 8569 |
| 16-#11 | 4.80 | MA | 4889 | 2092 | 7791 | 1659 | 9069 | 1373 | 9926 | 1118 | 11187 | 695 | 14083 | 228 | 12723 |
| 6L-4S | | MI | 3874 | 2092 | 6486 | 1580 | 7479 | 1300 | 8209 | 1051 | 9355 | 628 | 11194 | 250 | 9885 |
| 18-#10 | 4.40 | MA | 4897 | 2032 | 7735 | 1622 | 9053 | 1346 | 9931 | 1101 | 11214 | 699 | 14120 | 303 | 12273 |
| 6L-5S | | MI | 3753 | 2032 | 6126 | 1570 | 7080 | 1287 | 7735 | 1055 | 8714 | 650 | 10553 | 277 | 9164 |
| 18-#10 | 4.40 | MA | 4778 | 2032 | 7431 | 1629 | 8665 | 1353 | 9460 | 1109 | 10538 | 704 | 13136 | 250 | 11800 |
| 7L-4S | | MI | 3855 | 2032 | 6369 | 1554 | 7373 | 1281 | 8098 | 1043 | 9219 | 641 | 11206 | 330 | 9410 |
| 20-#10 | 4.88 | MA | 4996 | 2104 | 7906 | 1674 | 9270 | 1386 | 10195 | 1130 | 11533 | 700 | 14514 | 244 | 13204 |
| 7L-5S | | MI | 3898 | 2104 | 6466 | 1616 | 7513 | 1320 | 8260 | 1076 | 9425 | 646 | 11483 | 264 | 10156 |

## RECTANGULAR TIED COLUMNS 20" x 28"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#11 | 1.11 | MA | 4756 | 1663 | 6936 | 1369 | 7941 | 1154 | 8442 | 986 | 8875 | 734 | 10464 | 639 | 4115 |
| 2E | | MI | 3330 | 1663 | 5043 | 1315 | 5623 | 1108 | 5891 | 946 | 6090 | 702 | 6895 | 585 | 2862 |
| 4-#14 | 1.61 | MA | 4992 | 1742 | 7504 | 1411 | 8633 | 1184 | 9267 | 1003 | 9979 | 725 | 11985 | 629 | 5780 |
| 2E | | MI | 3468 | 1742 | 5409 | 1355 | 6060 | 1135 | 6409 | 961 | 6781 | 692 | 7700 | 553 | 3955 |
| 4-#18 | 2.86 | MA | 5545 | 1942 | 8883 | 1522 | 10328 | 1262 | 11296 | 1049 | 12702 | 705 | 15567 | 590 | 9842 |
| 2E | | MI | 3788 | 1942 | 6276 | 1460 | 7109 | 1209 | 7658 | 1003 | 8445 | 667 | 9544 | 458 | 6555 |
| 6-#9 | 1.07 | MA | 4758 | 1656 | 6849 | 1378 | 7890 | 1162 | 8409 | 994 | 8854 | 742 | 10454 | 646 | 4000 |
| 2L-3S | | MI | 3199 | 1656 | 4714 | 1336 | 5257 | 1126 | 5474 | 968 | 5545 | 721 | 6273 | 535 | 2801 |
| 6-#9 | 1.07 | MA | 4538 | 1656 | 6436 | 1387 | 7365 | 1170 | 7771 | 1001 | 7991 | 754 | 9258 | 579 | 4014 |
| 3L-2S | | MI | 3338 | 1656 | 4984 | 1330 | 5601 | 1121 | 5891 | 958 | 6109 | 714 | 7019 | 607 | 2783 |
| 6-#10 | 1.36 | MA | 4906 | 1703 | 7191 | 1403 | 8310 | 1180 | 8912 | 1004 | 9528 | 738 | 11382 | 641 | 5006 |
| 2L-3S | | MI | 3256 | 1703 | 4869 | 1361 | 5440 | 1143 | 5688 | 980 | 5830 | 717 | 6627 | 502 | 3472 |
| 6-#10 | 1.36 | MA | 4635 | 1703 | 6671 | 1414 | 7647 | 1190 | 8106 | 1013 | 8438 | 752 | 9873 | 554 | 5017 |
| 3L-2S | | MI | 3427 | 1703 | 5208 | 1354 | 5872 | 1137 | 6213 | 967 | 6540 | 708 | 7556 | 593 | 3451 |
| 6-#11 | 1.67 | MA | 5043 | 1752 | 7564 | 1425 | 8741 | 1194 | 9414 | 1011 | 10191 | 729 | 12286 | 632 | 6037 |
| 2L-3S | | MI | 3305 | 1752 | 5043 | 1379 | 5623 | 1154 | 5891 | 985 | 6090 | 706 | 6895 | 452 | 4150 |
| 6-#11 | 1.67 | MA | 4724 | 1752 | 6936 | 1438 | 7941 | 1205 | 8442 | 1021 | 8875 | 746 | 10464 | 522 | 6041 |
| 3L-2S | | MI | 3504 | 1752 | 5450 | 1371 | 6140 | 1148 | 6519 | 971 | 6940 | 697 | 7976 | 565 | 4126 |
| 6-#14 | 2.41 | MA | 5388 | 1871 | 8399 | 1492 | 9773 | 1242 | 10652 | 1039 | 11854 | 718 | 14580 | 618 | 8502 |
| 2L-3S | | MI | 3437 | 1871 | 5409 | 1446 | 6060 | 1201 | 6409 | 1016 | 6781 | 696 | 7700 | 357 | 5732 |
| 6-#14 | 2.41 | MA | 4954 | 1871 | 7504 | 1509 | 8633 | 1257 | 9267 | 1052 | 9979 | 740 | 11985 | 458 | 8459 |
| 3L-2S | | MI | 3708 | 1871 | 5983 | 1435 | 6791 | 1194 | 7297 | 997 | 7983 | 684 | 9198 | 519 | 5722 |

## RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis



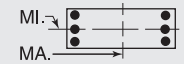

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 4.29 | MA | 6198 | 2170 | 10435 | 1665 | 12304 | 1366 | 13696 | 1114 | 15950 | 692 | 19979 | 564 | 14519 |
| 2L-3S | | MI | 3752 | 2170 | 6276 | 1618 | 7109 | 1321 | 7658 | 1095 | 8445 | 667 | 9544 | 94 | 9281 |
| 6-#18 | 4.29 | MA | 5509 | 2170 | 8883 | 1693 | 10328 | 1390 | 11296 | 1159 | 12702 | 728 | 15567 | 276 | 14220 |
| 3L-2S | | MI | 4176 | 2170 | 7257 | 1603 | 8358 | 1313 | 9175 | 1068 | 10493 | 653 | 11990 | 382 | 9532 |
| 8-#8 | 1.13 | MA | 4795 | 1666 | 6905 | 1387 | 7977 | 1169 | 8522 | 999 | 9012 | 744 | 10677 | 647 | 4212 |
| 2L-4S | | MI | 3194 | 1666 | 4656 | 1350 | 5176 | 1142 | 5379 | 975 | 5418 | 723 | 6168 | 523 | 2952 |
| 8-#8 | 1.13 | MA | 4622 | 1666 | 6578 | 1394 | 7559 | 1175 | 8015 | 1004 | 8327 | 753 | 9727 | 594 | 4222 |
| 3E | | MI | 3253 | 1666 | 4805 | 1345 | 5387 | 1133 | 5637 | 972 | 5771 | 722 | 6591 | 554 | 2937 |
| 8-#8 | 1.13 | MA | 4532 | 1666 | 6355 | 1401 | 7245 | 1187 | 7629 | 1015 | 7797 | 757 | 9083 | 562 | 4226 |
| 4L-2S | | MI | 3362 | 1666 | 5020 | 1340 | 5660 | 1128 | 5969 | 964 | 6221 | 716 | 7191 | 610 | 2924 |
| 8-#9 | 1.43 | MA | 4951 | 1714 | 7261 | 1414 | 8415 | 1188 | 9047 | 1010 | 9718 | 739 | 11649 | 642 | 5259 |
| 2L-4S | | MI | 3249 | 1714 | 4796 | 1378 | 5337 | 1163 | 5567 | 988 | 5666 | 719 | 6491 | 487 | 3647 |
| 8-#9 | 1.43 | MA | 4737 | 1714 | 6849 | 1423 | 7890 | 1196 | 8409 | 1017 | 8854 | 751 | 10454 | 574 | 5267 |
| 3E | | MI | 3322 | 1714 | 4984 | 1372 | 5601 | 1151 | 5891 | 984 | 6109 | 718 | 7019 | 526 | 3634 |
| 8-#9 | 1.43 | MA | 4626 | 1714 | 6568 | 1431 | 7493 | 1210 | 7922 | 1030 | 8187 | 756 | 9639 | 534 | 5254 |
| 4L-2S | | MI | 3457 | 1714 | 5254 | 1365 | 5944 | 1146 | 6308 | 974 | 6674 | 710 | 7765 | 598 | 3620 |
| 8-#10 | 1.81 | MA | 5144 | 1775 | 7712 | 1449 | 8973 | 1213 | 9717 | 1025 | 10618 | 733 | 12891 | 635 | 6590 |
| 2L-4S | | MI | 3319 | 1775 | 4971 | 1414 | 5539 | 1191 | 5805 | 1004 | 5982 | 714 | 6898 | 440 | 4509 |
| 8-#10 | 1.81 | MA | 4882 | 1775 | 7191 | 1460 | 8310 | 1223 | 8912 | 1033 | 9528 | 748 | 11382 | 548 | 6588 |
| 3E | | MI | 3408 | 1775 | 5208 | 1407 | 5872 | 1176 | 6213 | 1000 | 6540 | 713 | 7556 | 489 | 4510 |
| 8-#10 | 1.81 | MA | 4746 | 1775 | 6836 | 1471 | 7809 | 1241 | 8296 | 1050 | 8685 | 754 | 10349 | 497 | 6540 |
| 4L-2S | | MI | 3574 | 1775 | 5548 | 1399 | 6304 | 1170 | 6738 | 988 | 7251 | 704 | 8486 | 580 | 4496 |
| 8-#11 | 2.23 | MA | 5324 | 1841 | 8193 | 1480 | 9542 | 1235 | 10387 | 1036 | 11507 | 724 | 14109 | 624 | 7947 |
| 2L-4S | | MI | 3378 | 1841 | 5164 | 1443 | 5739 | 1211 | 6028 | 1014 | 6269 | 700 | 7205 | 375 | 5363 |
| 8-#11 | 2.23 | MA | 5017 | 1841 | 7564 | 1493 | 8741 | 1246 | 9414 | 1046 | 10191 | 740 | 12286 | 515 | 7932 |
| 3E | | MI | 3483 | 1841 | 5450 | 1435 | 6140 | 1195 | 6519 | 1010 | 6940 | 701 | 7976 | 432 | 5386 |
| 8-#11 | 2.23 | MA | 4857 | 1841 | 7133 | 1506 | 8134 | 1267 | 8669 | 1066 | 9170 | 747 | 11026 | 451 | 7836 |
| 4L-2S | | MI | 3676 | 1841 | 5856 | 1427 | 6657 | 1189 | 7147 | 996 | 7790 | 692 | 9058 | 544 | 5373 |
| 8-#14 | 3.21 | MA | 5776 | 1999 | 9295 | 1572 | 10913 | 1300 | 12037 | 1076 | 13728 | 710 | 17175 | 608 | 11208 |
| 2L-4S | | MI | 3542 | 1999 | 5577 | 1537 | 6222 | 1281 | 6600 | 1056 | 7066 | 699 | 8125 | 245 | 7000 |
| 8-#14 | 3.21 | MA | 5362 | 1999 | 8399 | 1590 | 9773 | 1315 | 10652 | 1088 | 11854 | 733 | 14580 | 448 | 11134 |
| 3E | | MI | 3685 | 1999 | 5983 | 1526 | 6791 | 1259 | 7297 | 1052 | 7983 | 688 | 9198 | 324 | 7453 |
| 8-#14 | 3.21 | MA | 5147 | 1999 | 7783 | 1607 | 8905 | 1345 | 9588 | 1116 | 10397 | 741 | 12771 | 354 | 10453 |
| 4L-2S | | MI | 3945 | 1999 | 6557 | 1515 | 7522 | 1252 | 8185 | 1034 | 9185 | 677 | 10696 | 486 | 7472 |
| 8-#18 | 5.71 | MA | 6193 | 2399 | 10435 | 1836 | 12304 | 1493 | 13696 | 1224 | 15950 | 714 | 19979 | 250 | 18835 |
| 3E | | MI | 4181 | 2399 | 7257 | 1760 | 8358 | 1425 | 9175 | 1159 | 10493 | 653 | 11990 | 18 | 11934 |
| 8-#18 | 5.71 | MA | 5855 | 2399 | 9361 | 1865 | 10792 | 1544 | 11843 | 1242 | 13414 | 723 | 16877 | 87 | 16348 |
| 4L-2S | | MI | 4554 | 2399 | 8238 | 1745 | 9607 | 1417 | 10692 | 1132 | 12541 | 639 | 14436 | 306 | 12481 |
| 10-#10 | 2.27 | MA | 5378 | 1848 | 8233 | 1494 | 9636 | 1246 | 10522 | 1045 | 11707 | 729 | 14400 | 629 | 8169 |
| 2L-5S | | MI | 3369 | 1848 | 5068 | 1476 | 5678 | 1230 | 5966 | 1038 | 6187 | 718 | 7175 | 374 | 5306 |
| 10-#10 | 2.27 | MA | 5125 | 1848 | 7712 | 1505 | 8973 | 1256 | 9717 | 1054 | 10618 | 744 | 12891 | 542 | 8155 |
| 3L-4S | | MI | 3473 | 1848 | 5311 | 1460 | 5971 | 1224 | 6330 | 1025 | 6692 | 709 | 7827 | 427 | 5526 |
| 10-#10 | 2.27 | MA | 4996 | 1848 | 7357 | 1516 | 8472 | 1274 | 9102 | 1071 | 9775 | 750 | 11858 | 491 | 8094 |
| 4L-3S | | MI | 3558 | 1848 | 5548 | 1452 | 6304 | 1209 | 6738 | 1021 | 7251 | 709 | 8486 | 476 | 5541 |
| 10-#10 | 2.27 | MA | 4808 | 1848 | 6994 | 1536 | 8035 | 1284 | 8558 | 1079 | 9018 | 764 | 10816 | 444 | 7724 |
| 5L-2S | | MI | 3719 | 1848 | 5887 | 1444 | 6736 | 1203 | 7263 | 1008 | 7961 | 700 | 9416 | 567 | 5534 |
| 10-#11 | 2.79 | MA | 5304 | 1930 | 8193 | 1549 | 9542 | 1286 | 10387 | 1071 | 11507 | 735 | 14109 | 508 | 9819 |
| 3L-4S | | MI | 3559 | 1930 | 5570 | 1499 | 6256 | 1252 | 6656 | 1039 | 7119 | 695 | 8287 | 355 | 6514 |
| 10-#11 | 2.79 | MA | 5155 | 1930 | 7762 | 1562 | 8934 | 1308 | 9641 | 1091 | 10486 | 741 | 12848 | 444 | 9707 |
| 4L-3S | | MI | 3659 | 1930 | 5856 | 1491 | 6657 | 1235 | 7147 | 1036 | 7790 | 696 | 9058 | 412 | 6611 |
| 10-#11 | 2.79 | MA | 4934 | 1930 | 7322 | 1585 | 8404 | 1319 | 8982 | 1100 | 9568 | 758 | 11581 | 383 | 9079 |
| 5L-2S | | MI | 3846 | 1930 | 6262 | 1482 | 7174 | 1229 | 7775 | 1022 | 8640 | 687 | 10140 | 524 | 6611 |
| 10-#14 | 4.02 | MA | 5761 | 2127 | 9295 | 1670 | 10913 | 1374 | 12037 | 1125 | 13728 | 726 | 17175 | 438 | 13810 |
| 3L-4S | | MI | 3794 | 2127 | 6152 | 1617 | 6953 | 1340 | 7488 | 1092 | 8268 | 692 | 9623 | 211 | 8620 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis

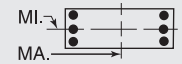


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 4.02 | MA | 5564 | 2127 | 8679 | 1687 | 10046 | 1404 | 10973 | 1152 | 12271 | 733 | 15366 | 344 | 13046 |
| 4L-3S | | MI | 3928 | 2127 | 6557 | 1607 | 7522 | 1318 | 8185 | 1089 | 9185 | 681 | 10696 | 290 | 9167 |
| 10-#14 | 4.02 | MA | 5257 | 2127 | 8050 | 1720 | 9287 | 1419 | 10030 | 1165 | 10960 | 756 | 13551 | 253 | 12250 |
| 5L-2S | | MI | 4180 | 2127 | 7132 | 1596 | 8254 | 1310 | 9073 | 1070 | 10387 | 669 | 12194 | 452 | 9209 |
| 10-#18 | 7.14 | MA | 6561 | 2627 | 10913 | 2007 | 12768 | 1647 | 14243 | 1307 | 16661 | 710 | 21289 | 61 | 20901 |
| 4L-3S | | MI | 4582 | 2627 | 8238 | 1903 | 9607 | 1528 | 10692 | 1224 | 12541 | 639 | 14436 | -58 | 14343 |
| 12-#10 | 2.72 | MA | 5363 | 1920 | 8233 | 1550 | 9636 | 1289 | 10522 | 1074 | 11707 | 739 | 14400 | 537 | 9719 |
| 3L-5S | | MI | 3521 | 1920 | 5407 | 1521 | 6111 | 1263 | 6491 | 1058 | 6898 | 714 | 8105 | 361 | 6282 |
| 12-#10 | 2.72 | MA | 5242 | 1920 | 7877 | 1561 | 9135 | 1307 | 9907 | 1091 | 10865 | 746 | 13367 | 485 | 9649 |
| 4E | | MI | 3624 | 1920 | 5650 | 1505 | 6403 | 1257 | 6855 | 1046 | 7403 | 705 | 8757 | 414 | 6540 |
| 12-#10 | 2.72 | MA | 5055 | 1920 | 7515 | 1581 | 8698 | 1317 | 9364 | 1100 | 10108 | 760 | 12325 | 438 | 9247 |
| 5L-3S | | MI | 3706 | 1920 | 5887 | 1497 | 6736 | 1242 | 7263 | 1041 | 7961 | 704 | 9416 | 463 | 6565 |
| 12-#10 | 2.72 | MA | 4880 | 1920 | 7177 | 1587 | 8287 | 1326 | 8829 | 1117 | 9386 | 775 | 11302 | 367 | 8917 |
| 6L-2S | | MI | 3863 | 1920 | 6227 | 1489 | 7169 | 1236 | 7788 | 1029 | 8671 | 695 | 10346 | 554 | 6567 |
| 12-#11 | 3.34 | MA | 5446 | 2020 | 8391 | 1617 | 9735 | 1348 | 10614 | 1116 | 11802 | 736 | 14670 | 437 | 11543 |
| 4E | | MI | 3737 | 2020 | 5976 | 1555 | 6773 | 1292 | 7284 | 1064 | 7969 | 690 | 9368 | 335 | 7661 |
| 12-#11 | 3.34 | MA | 5227 | 2020 | 7951 | 1640 | 9205 | 1359 | 9954 | 1126 | 10884 | 753 | 13403 | 376 | 10921 |
| 5L-3S | | MI | 3832 | 2020 | 6262 | 1546 | 7174 | 1276 | 7775 | 1061 | 8640 | 691 | 10140 | 392 | 7831 |
| 12-#11 | 3.34 | MA | 5021 | 2020 | 7548 | 1649 | 8682 | 1381 | 9306 | 1146 | 10007 | 769 | 12250 | 302 | 10403 |
| 6L-2S | | MI | 4013 | 2020 | 6668 | 1538 | 7691 | 1270 | 8403 | 1047 | 9490 | 682 | 11221 | 504 | 7844 |
| 12-#14 | 4.82 | MA | 5971 | 2256 | 9575 | 1768 | 11186 | 1462 | 12358 | 1189 | 14145 | 726 | 17961 | 333 | 15652 |
| 4E | | MI | 4042 | 2256 | 6726 | 1698 | 7684 | 1398 | 8376 | 1129 | 9470 | 685 | 11121 | 178 | 10255 |
| 12-#14 | 4.82 | MA | 5666 | 2256 | 8945 | 1800 | 10428 | 1477 | 11415 | 1201 | 12834 | 748 | 16146 | 243 | 14896 |
| 5L-3S | | MI | 4184 | 2256 | 7132 | 1687 | 8254 | 1376 | 9073 | 1125 | 10387 | 673 | 12194 | 257 | 10878 |
| 12-#14 | 4.82 | MA | 5386 | 2256 | 8377 | 1813 | 9680 | 1507 | 10488 | 1229 | 11581 | 771 | 14490 | 135 | 13714 |
| 6L-2S | | MI | 4407 | 2256 | 7706 | 1676 | 8985 | 1369 | 9962 | 1106 | 11589 | 662 | 13692 | 418 | 10938 |
| 14-#10 | 3.17 | MA | 5483 | 1993 | 8398 | 1607 | 9798 | 1340 | 10712 | 1112 | 11955 | 741 | 14876 | 479 | 11204 |
| 4L-5S | | MI | 3671 | 1993 | 5747 | 1567 | 6543 | 1295 | 7016 | 1079 | 7608 | 710 | 9034 | 348 | 7264 |
| 14-#10 | 3.17 | MA | 5298 | 1993 | 8036 | 1626 | 9361 | 1349 | 10169 | 1121 | 11198 | 756 | 13834 | 432 | 10774 |
| 5L-4S | | MI | 3774 | 1993 | 5990 | 1550 | 6835 | 1289 | 7380 | 1066 | 8113 | 701 | 9687 | 401 | 7549 |
| 14-#10 | 3.17 | MA | 5129 | 1993 | 7697 | 1633 | 8950 | 1359 | 9635 | 1137 | 10475 | 770 | 12811 | 361 | 10459 |
| 6L-3S | | MI | 3852 | 1993 | 6227 | 1543 | 7169 | 1275 | 7788 | 1062 | 8671 | 700 | 10346 | 450 | 7586 |
| 14-#10 | 3.17 | MA | 4985 | 1993 | 7365 | 1639 | 8499 | 1375 | 9121 | 1146 | 9738 | 777 | 11824 | 322 | 9927 |
| 7L-2S | | MI | 4005 | 1993 | 6566 | 1535 | 7601 | 1269 | 8313 | 1049 | 9382 | 691 | 11276 | 541 | 7596 |
| 14-#11 | 3.90 | MA | 5515 | 2109 | 8580 | 1696 | 10005 | 1400 | 10926 | 1151 | 12200 | 748 | 15225 | 369 | 12769 |
| 5L-4S | | MI | 3913 | 2109 | 6382 | 1610 | 7290 | 1333 | 7912 | 1090 | 8819 | 684 | 10450 | 315 | 8816 |
| 14-#11 | 3.90 | MA | 5316 | 2109 | 8177 | 1705 | 9483 | 1421 | 10278 | 1171 | 11323 | 764 | 14072 | 295 | 12239 |
| 6L-3S | | MI | 4003 | 2109 | 6668 | 1602 | 7691 | 1316 | 8403 | 1086 | 9490 | 686 | 11221 | 372 | 9048 |
| 14-#11 | 3.90 | MA | 5147 | 2109 | 7774 | 1712 | 8969 | 1431 | 9655 | 1180 | 10428 | 771 | 12772 | 230 | 11605 |
| 7L-2S | | MI | 4180 | 2109 | 7074 | 1594 | 8208 | 1310 | 9031 | 1072 | 10340 | 676 | 12303 | 484 | 9070 |
| 14-#14 | 5.63 | MA | 6067 | 2384 | 9841 | 1881 | 11568 | 1536 | 12800 | 1238 | 14708 | 741 | 18741 | 232 | 17547 |
| 5L-4S | | MI | 4312 | 2384 | 7301 | 1778 | 8416 | 1456 | 9265 | 1165 | 10672 | 677 | 12619 | 144 | 11901 |
| 14-#14 | 5.63 | MA | 5800 | 2384 | 9273 | 1893 | 10820 | 1566 | 11873 | 1265 | 13455 | 764 | 17085 | 125 | 16354 |
| 6L-3S | | MI | 4418 | 2384 | 7706 | 1767 | 8985 | 1434 | 9962 | 1161 | 11589 | 666 | 13692 | 223 | 12588 |
| 16-#10 | 3.63 | MA | 5536 | 2065 | 8556 | 1671 | 10024 | 1382 | 10974 | 1141 | 12288 | 752 | 15343 | 427 | 12306 |
| 5E | | MI | 3820 | 2065 | 6086 | 1612 | 6975 | 1328 | 7541 | 1099 | 8319 | 706 | 9964 | 335 | 8249 |
| 16-#10 | 3.63 | MA | 5373 | 2065 | 8218 | 1678 | 9613 | 1392 | 10440 | 1158 | 11565 | 766 | 14320 | 355 | 12003 |
| 6L-4S | | MI | 3922 | 2065 | 6329 | 1596 | 7268 | 1322 | 7904 | 1087 | 8823 | 697 | 10617 | 388 | 8519 |
| 16-#10 | 3.63 | MA | 5235 | 2065 | 7886 | 1685 | 9162 | 1408 | 9927 | 1167 | 10828 | 772 | 13333 | 316 | 11463 |
| 7L-3S | | MI | 3996 | 2065 | 6566 | 1588 | 7601 | 1308 | 8313 | 1082 | 9382 | 696 | 11276 | 437 | 8605 |
| 16-#10 | 3.63 | MA | 5076 | 2065 | 7566 | 1693 | 8731 | 1414 | 9406 | 1183 | 10123 | 787 | 12383 | 264 | 10924 |
| 8L-2S | | MI | 4146 | 2065 | 6906 | 1580 | 8033 | 1302 | 8838 | 1070 | 10092 | 687 | 12205 | 528 | 8621 |
| 16-#11 | 4.46 | MA | 5606 | 2198 | 8805 | 1760 | 10283 | 1462 | 11250 | 1196 | 12639 | 759 | 15895 | 288 | 14079 |
| 6L-4S | | MI | 4087 | 2198 | 6789 | 1666 | 7807 | 1373 | 8540 | 1115 | 9669 | 679 | 11532 | 295 | 9979 |
| 16-#11 | 4.46 | MA | 5445 | 2198 | 8403 | 1768 | 9770 | 1471 | 10627 | 1206 | 11744 | 765 | 14594 | 222 | 13464 |
| 7L-3S | | MI | 4173 | 2198 | 7074 | 1658 | 8208 | 1357 | 9031 | 1111 | 10340 | 680 | 12303 | 351 | 10262 |
| 16-#14 | 6.43 | MA | 6206 | 2513 | 10168 | 1973 | 11961 | 1624 | 13258 | 1302 | 15329 | 756 | 19680 | 114 | 18999 |
| 6L-4S | | MI | 4553 | 2513 | 7875 | 1858 | 9147 | 1515 | 10153 | 1201 | 11874 | 670 | 14117 | 111 | 13555 |

## RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 4.08 | MA | 5613 | 2138 | 8739 | 1723 | 10276 | 1425 | 11245 | 1179 | 12655 | 762 | 15829 | 349 | 13549 |
| 6L-5S | | MI | 3967 | 2138 | 6425 | 1657 | 7407 | 1361 | 8066 | 1120 | 9029 | 702 | 10894 | 322 | 9238 |
| 18-#10 | 4.08 | MA | 5481 | 2138 | 8406 | 1730 | 9825 | 1441 | 10732 | 1187 | 11918 | 768 | 14842 | 311 | 13002 |
| 7L-4S | | MI | 4068 | 2138 | 6668 | 1641 | 7700 | 1355 | 8429 | 1107 | 9534 | 692 | 11546 | 375 | 9493 |
| 18-#10 | 4.08 | MA | 5323 | 2138 | 8087 | 1738 | 9394 | 1447 | 10211 | 1203 | 11213 | 783 | 13892 | 258 | 12464 |
| 8L-3S | | MI | 4140 | 2138 | 6906 | 1633 | 8033 | 1341 | 8838 | 1103 | 10092 | 692 | 12205 | 424 | 9622 |
| 18-#11 | 5.01 | MA | 5737 | 2287 | 9032 | 1823 | 10570 | 1512 | 11599 | 1231 | 13060 | 760 | 16416 | 215 | 15325 |
| 7L-4S | | MI | 4259 | 2287 | 7195 | 1722 | 8324 | 1413 | 9168 | 1140 | 10519 | 674 | 12614 | 275 | 11147 |
| 20-#10 | 4.54 | MA | 5723 | 2210 | 8927 | 1775 | 10488 | 1474 | 11537 | 1208 | 13007 | 764 | 16351 | 305 | 14543 |
| 7L-5S | | MI | 4112 | 2210 | 6765 | 1703 | 7839 | 1394 | 8591 | 1140 | 9740 | 697 | 11824 | 309 | 10229 |
| 20-#10 | 4.54 | MA | 5567 | 2210 | 8608 | 1783 | 10057 | 1480 | 11016 | 1224 | 12303 | 779 | 15401 | 252 | 14005 |
| 8L-4S | | MI | 4213 | 2210 | 7008 | 1686 | 8132 | 1388 | 8954 | 1128 | 10244 | 688 | 12476 | 362 | 10472 |
| 22-#10 | 4.99 | MA | 5807 | 2283 | 9129 | 1829 | 10720 | 1513 | 11822 | 1245 | 13393 | 774 | 16910 | 247 | 15548 |
| 8L-5S | | MI | 4256 | 2283 | 7104 | 1748 | 8272 | 1427 | 9116 | 1161 | 10450 | 693 | 12753 | 296 | 11223 |

## RECTANGULAR TIED COLUMNS 20" x 30"

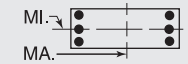
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.04 | MA | 5434 | 1769 | 7835 | 1469 | 9001 | 1239 | 9574 | 1060 | 10048 | 793 | 11833 | 690 | 4452 |
| 2E | | MI | 3542 | 1769 | 5346 | 1401 | 5950 | 1181 | 6222 | 1010 | 6404 | 753 | 7232 | 629 | 2884 |
| 4-#14 | 1.50 | MA | 5696 | 1848 | 8456 | 1511 | 9757 | 1268 | 10476 | 1077 | 11255 | 784 | 13495 | 680 | 6266 |
| 2E | | MI | 3681 | 1848 | 5713 | 1440 | 6388 | 1208 | 6740 | 1024 | 7094 | 742 | 8036 | 597 | 3982 |
| 4-#18 | 2.67 | MA | 6311 | 2048 | 9967 | 1622 | 11615 | 1347 | 12700 | 1123 | 14239 | 764 | 17605 | 657 | 10706 |
| 2E | | MI | 4002 | 2048 | 6584 | 1544 | 7439 | 1281 | 7989 | 1065 | 8755 | 717 | 9876 | 501 | 6594 |
| 6-#9 | 1.00 | MA | 5434 | 1762 | 7737 | 1478 | 8941 | 1247 | 9534 | 1068 | 10019 | 801 | 11813 | 698 | 4324 |
| 2L-3S | | MI | 3412 | 1762 | 5012 | 1423 | 5584 | 1200 | 5805 | 1033 | 5860 | 773 | 6614 | 580 | 2819 |
| 6-#9 | 1.00 | MA | 5192 | 1762 | 7289 | 1487 | 8371 | 1255 | 8841 | 1075 | 9081 | 814 | 10514 | 632 | 4338 |
| 3L-2S | | MI | 3550 | 1762 | 5282 | 1417 | 5927 | 1195 | 6222 | 1023 | 6425 | 765 | 7361 | 652 | 2801 |
| 6-#10 | 1.27 | MA | 5597 | 1809 | 8111 | 1503 | 9399 | 1265 | 10081 | 1078 | 10753 | 796 | 12824 | 692 | 5418 |
| 2L-3S | | MI | 3468 | 1809 | 5168 | 1448 | 5767 | 1217 | 6019 | 1044 | 6145 | 769 | 6967 | 547 | 3494 |
| 6-#10 | 1.27 | MA | 5299 | 1809 | 7545 | 1514 | 8679 | 1275 | 9206 | 1087 | 9569 | 812 | 11183 | 608 | 5428 |
| 3L-2S | | MI | 3640 | 1809 | 5508 | 1440 | 6199 | 1212 | 6544 | 1032 | 6855 | 759 | 7897 | 638 | 3472 |
| 6-#11 | 1.56 | MA | 5751 | 1858 | 8520 | 1524 | 9872 | 1279 | 10632 | 1085 | 11480 | 788 | 13816 | 683 | 6542 |
| 2L-3S | | MI | 3517 | 1858 | 5346 | 1465 | 5950 | 1228 | 6222 | 1049 | 6404 | 757 | 7232 | 497 | 4178 |
| 6-#11 | 1.56 | MA | 5398 | 1858 | 7835 | 1538 | 9001 | 1291 | 9574 | 1095 | 10048 | 806 | 11833 | 577 | 6547 |
| 3L-2S | | MI | 3717 | 1858 | 5752 | 1457 | 6467 | 1222 | 6850 | 1035 | 7254 | 748 | 8314 | 609 | 4151 |
| 6-#14 | 2.25 | MA | 6134 | 1977 | 9432 | 1591 | 11000 | 1327 | 11985 | 1113 | 13298 | 777 | 16322 | 670 | 9231 |
| 2L-3S | | MI | 3649 | 1977 | 5713 | 1531 | 6388 | 1274 | 6740 | 1079 | 7094 | 746 | 8036 | 402 | 5772 |
| 6-#14 | 2.25 | MA | 5653 | 1977 | 8456 | 1610 | 9757 | 1343 | 10476 | 1127 | 11255 | 801 | 13495 | 514 | 9188 |
| 3L-2S | | MI | 3922 | 1977 | 6287 | 1520 | 7119 | 1266 | 7628 | 1061 | 8296 | 735 | 9534 | 563 | 5754 |
| 6-#18 | 4.00 | MA | 7033 | 2276 | 11662 | 1764 | 13772 | 1451 | 15320 | 1188 | 17785 | 751 | 22515 | 639 | 15815 |
| 2L-3S | | MI | 3963 | 2276 | 6584 | 1702 | 7439 | 1392 | 7989 | 1157 | 8755 | 716 | 9876 | 138 | 9466 |
| 6-#18 | 4.00 | MA | 6270 | 2276 | 9967 | 1795 | 11615 | 1477 | 12700 | 1236 | 14239 | 790 | 17605 | 351 | 15516 |
| 3L-2S | | MI | 4392 | 2276 | 7565 | 1687 | 8688 | 1385 | 9506 | 1130 | 10803 | 703 | 12322 | 425 | 9579 |
| 8-#8 | 1.05 | MA | 5474 | 1772 | 7798 | 1486 | 9035 | 1254 | 9655 | 1073 | 10190 | 803 | 12053 | 699 | 4553 |
| 2L-4S | | MI | 3406 | 1772 | 4953 | 1438 | 5503 | 1217 | 5711 | 1040 | 5734 | 775 | 6510 | 568 | 2970 |
| 8-#8 | 1.05 | MA | 5284 | 1772 | 7442 | 1494 | 8582 | 1260 | 9104 | 1079 | 9445 | 812 | 11022 | 647 | 4563 |
| 3E | | MI | 3465 | 1772 | 5102 | 1433 | 5713 | 1207 | 5968 | 1037 | 6087 | 774 | 6933 | 599 | 2955 |
| 8-#8 | 1.05 | MA | 5185 | 1772 | 7201 | 1501 | 8241 | 1272 | 8686 | 1090 | 8872 | 817 | 10328 | 616 | 4567 |
| 4L-2S | | MI | 3575 | 1772 | 5317 | 1427 | 5986 | 1203 | 6301 | 1029 | 6536 | 768 | 7533 | 656 | 2942 |
| 8-#9 | 1.33 | MA | 5646 | 1820 | 8186 | 1513 | 9512 | 1273 | 10227 | 1084 | 10958 | 798 | 13112 | 693 | 5691 |
| 2L-4S | | MI | 3461 | 1820 | 5094 | 1465 | 5663 | 1238 | 5898 | 1053 | 5982 | 771 | 6833 | 532 | 3671 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis

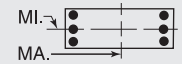



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.33 | MA | 5411 | 1820 | 7737 | 1522 | 8941 | 1281 | 9534 | 1091 | 10019 | 810 | 11813 | 627 | 5699 |
| 3E | | MI | 3534 | 1820 | 5282 | 1459 | 5927 | 1226 | 6222 | 1049 | 6425 | 770 | 7361 | 571 | 3656 |
| 8-#9 | 1.33 | MA | 5289 | 1820 | 7433 | 1532 | 8512 | 1296 | 9006 | 1105 | 9297 | 816 | 10936 | 587 | 5686 |
| 4L-2S | | MI | 3670 | 1820 | 5552 | 1453 | 6271 | 1221 | 6639 | 1039 | 6989 | 762 | 8107 | 643 | 3640 |
| 8-#10 | 1.69 | MA | 5860 | 1881 | 8677 | 1548 | 10120 | 1298 | 10957 | 1099 | 11938 | 792 | 14464 | 686 | 7139 |
| 2L-4S | | MI | 3531 | 1881 | 5271 | 1501 | 5866 | 1265 | 6136 | 1069 | 6297 | 765 | 7238 | 486 | 4542 |
| 8-#10 | 1.69 | MA | 5571 | 1881 | 8111 | 1560 | 9399 | 1308 | 10081 | 1108 | 10753 | 808 | 12824 | 602 | 7137 |
| 3E | | MI | 3621 | 1881 | 5508 | 1494 | 6199 | 1250 | 6544 | 1065 | 6855 | 764 | 7897 | 534 | 4536 |
| 8-#10 | 1.69 | MA | 5422 | 1881 | 7726 | 1571 | 8856 | 1327 | 9414 | 1126 | 9840 | 815 | 11712 | 551 | 7089 |
| 4L-2S | | MI | 3787 | 1881 | 5847 | 1486 | 6631 | 1244 | 7069 | 1052 | 7565 | 755 | 8827 | 625 | 4520 |
| 8-#11 | 2.08 | MA | 6061 | 1947 | 9204 | 1580 | 10744 | 1319 | 11691 | 1110 | 12913 | 783 | 15800 | 676 | 8621 |
| 2L-4S | | MI | 3589 | 1947 | 5466 | 1529 | 6067 | 1285 | 6359 | 1078 | 6583 | 751 | 7543 | 420 | 5407 |
| 8-#11 | 2.08 | MA | 5722 | 1947 | 8520 | 1593 | 9872 | 1331 | 10632 | 1121 | 11480 | 800 | 13816 | 570 | 8606 |
| 3E | | MI | 3696 | 1947 | 5752 | 1521 | 6467 | 1268 | 6850 | 1074 | 7254 | 752 | 8314 | 477 | 5418 |
| 8-#11 | 2.08 | MA | 5546 | 1947 | 8052 | 1607 | 9213 | 1354 | 9824 | 1141 | 10372 | 808 | 12458 | 506 | 8510 |
| 4L-2S | | MI | 3890 | 1947 | 6158 | 1513 | 6984 | 1262 | 7478 | 1060 | 8104 | 743 | 9396 | 589 | 5402 |
| 8-#14 | 3.00 | MA | 6561 | 2105 | 10408 | 1671 | 12242 | 1385 | 13494 | 1150 | 15340 | 769 | 19150 | 660 | 12180 |
| 2L-4S | | MI | 3752 | 2105 | 5882 | 1622 | 6550 | 1354 | 6931 | 1119 | 7379 | 750 | 8461 | 289 | 7120 |
| 8-#14 | 3.00 | MA | 6104 | 2105 | 9432 | 1690 | 11000 | 1401 | 11985 | 1164 | 13298 | 794 | 16322 | 503 | 12106 |
| 3E | | MI | 3897 | 2105 | 6287 | 1612 | 7119 | 1332 | 7628 | 1116 | 8296 | 739 | 9534 | 368 | 7498 |
| 8-#14 | 3.00 | MA | 5867 | 2105 | 8764 | 1709 | 10058 | 1433 | 10829 | 1193 | 11715 | 803 | 14372 | 411 | 11493 |
| 4L-2S | | MI | 4159 | 2105 | 6862 | 1601 | 7851 | 1325 | 8516 | 1097 | 9498 | 727 | 11032 | 530 | 7507 |
| 8-#18 | 5.33 | MA | 7025 | 2505 | 11662 | 1938 | 13772 | 1581 | 15320 | 1301 | 17785 | 777 | 22515 | 333 | 20563 |
| 3E | | MI | 4393 | 2505 | 7565 | 1844 | 8688 | 1496 | 9506 | 1222 | 10803 | 702 | 12322 | 62 | 12128 |
| 8-#18 | 5.33 | MA | 6655 | 2505 | 10495 | 1968 | 12128 | 1633 | 13304 | 1322 | 15025 | 789 | 19077 | 165 | 17992 |
| 4L-2S | | MI | 4772 | 2505 | 8546 | 1829 | 9937 | 1488 | 11022 | 1195 | 12852 | 689 | 14768 | 349 | 12532 |
| 10-#10 | 2.12 | MA | 6118 | 1954 | 9243 | 1594 | 10841 | 1331 | 11832 | 1119 | 13123 | 788 | 16104 | 681 | 8855 |
| 2L-5S | | MI | 3581 | 1954 | 5367 | 1563 | 6005 | 1304 | 6298 | 1102 | 6502 | 770 | 7515 | 419 | 5382 |
| 10-#10 | 2.12 | MA | 5838 | 1954 | 8677 | 1605 | 10120 | 1341 | 10957 | 1128 | 11938 | 803 | 14464 | 596 | 8841 |
| 3L-4S | | MI | 3685 | 1954 | 5610 | 1547 | 6298 | 1298 | 6661 | 1090 | 7007 | 761 | 8168 | 472 | 5562 |
| 10-#10 | 2.12 | MA | 5697 | 1954 | 8292 | 1617 | 9577 | 1360 | 10290 | 1146 | 11024 | 810 | 13352 | 545 | 8780 |
| 4L-3S | | MI | 3771 | 1954 | 5847 | 1539 | 6631 | 1283 | 7069 | 1085 | 7565 | 760 | 8827 | 521 | 5569 |
| 10-#10 | 2.12 | MA | 5487 | 1954 | 7900 | 1637 | 9104 | 1370 | 9701 | 1155 | 10205 | 826 | 12227 | 500 | 8435 |
| 5L-2S | | MI | 3933 | 1954 | 6186 | 1531 | 7063 | 1277 | 7594 | 1073 | 8276 | 751 | 9756 | 612 | 5559 |
| 10-#11 | 2.60 | MA | 6038 | 2037 | 9204 | 1649 | 10744 | 1372 | 11691 | 1146 | 12913 | 795 | 15800 | 562 | 10661 |
| 3L-4S | | MI | 3770 | 2037 | 5872 | 1585 | 6584 | 1325 | 6987 | 1103 | 7433 | 746 | 8625 | 400 | 6612 |
| 10-#11 | 2.60 | MA | 5874 | 2037 | 8737 | 1663 | 10085 | 1394 | 10882 | 1167 | 11805 | 803 | 14441 | 499 | 10549 |
| 4L-3S | | MI | 3871 | 2037 | 6158 | 1577 | 6984 | 1309 | 7478 | 1099 | 8104 | 747 | 9396 | 457 | 6648 |
| 10-#11 | 2.60 | MA | 5627 | 2037 | 8260 | 1686 | 9510 | 1406 | 10167 | 1177 | 10810 | 820 | 13071 | 441 | 9923 |
| 5L-2S | | MI | 4060 | 2037 | 6564 | 1568 | 7502 | 1303 | 8106 | 1085 | 8954 | 738 | 10478 | 569 | 6642 |
| 10-#14 | 3.75 | MA | 6544 | 2234 | 10408 | 1770 | 12242 | 1460 | 13494 | 1200 | 15340 | 786 | 19150 | 493 | 15025 |
| 3L-4S | | MI | 4005 | 2234 | 6456 | 1703 | 7282 | 1413 | 7819 | 1156 | 8581 | 742 | 9959 | 256 | 8736 |
| 10-#14 | 3.75 | MA | 6327 | 2234 | 9740 | 1789 | 11300 | 1491 | 12338 | 1229 | 13757 | 796 | 17199 | 401 | 14327 |
| 4L-3S | | MI | 4141 | 2234 | 6862 | 1692 | 7851 | 1390 | 8516 | 1152 | 9498 | 731 | 11032 | 334 | 9215 |
| 10-#14 | 3.75 | MA | 5982 | 2234 | 9058 | 1823 | 10478 | 1508 | 11316 | 1243 | 12334 | 820 | 15236 | 314 | 13404 |
| 5L-2S | | MI | 4394 | 2234 | 7436 | 1681 | 8582 | 1383 | 9404 | 1133 | 10700 | 720 | 12530 | 496 | 9248 |
| 10-#18 | 6.67 | MA | 7433 | 2733 | 12189 | 2111 | 14286 | 1737 | 15924 | 1387 | 18571 | 776 | 23987 | 147 | 22978 |
| 4L-3S | | MI | 4794 | 2733 | 8546 | 1987 | 9937 | 1600 | 11022 | 1286 | 12852 | 688 | 14768 | -14 | 14745 |
| 10-#18 | 6.67 | MA | 6859 | 2733 | 10996 | 2168 | 12848 | 1763 | 14138 | 1435 | 16086 | 815 | 20543 | -18 | 20486 |
| 5L-2S | | MI | 5146 | 2733 | 9527 | 1972 | 11185 | 1592 | 12539 | 1259 | 14900 | 675 | 17214 | 273 | 15472 |
| 12-#10 | 2.54 | MA | 6101 | 2026 | 9243 | 1650 | 10841 | 1374 | 11832 | 1149 | 13123 | 799 | 16104 | 590 | 10542 |
| 3L-5S | | MI | 3733 | 2026 | 5706 | 1608 | 6437 | 1337 | 6823 | 1123 | 7213 | 766 | 8445 | 406 | 6357 |
| 12-#10 | 2.54 | MA | 5967 | 2026 | 8858 | 1662 | 10297 | 1393 | 11165 | 1167 | 12209 | 806 | 14993 | 539 | 10472 |
| 4E | | MI | 3836 | 2026 | 5949 | 1592 | 6730 | 1331 | 7186 | 1110 | 7717 | 757 | 9098 | 459 | 6578 |
| 12-#10 | 2.54 | MA | 5759 | 2026 | 8466 | 1682 | 9824 | 1403 | 10577 | 1176 | 11389 | 822 | 13867 | 495 | 10093 |
| 5L-3S | | MI | 3919 | 2026 | 6186 | 1584 | 7063 | 1316 | 7594 | 1106 | 8276 | 756 | 9756 | 508 | 6596 |
| 12-#10 | 2.54 | MA | 5567 | 2026 | 8094 | 1688 | 9380 | 1414 | 9999 | 1194 | 10607 | 837 | 12766 | 424 | 9716 |
| 6L-2S | | MI | 4077 | 2026 | 6526 | 1576 | 7495 | 1310 | 8119 | 1093 | 8986 | 747 | 10686 | 599 | 6593 |

## RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis



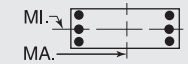

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 3.12 | MA | 6195 | 2126 | 9421 | 1718 | 10956 | 1435 | 11941 | 1192 | 13237 | 797 | 16425 | 492 | 12591 |
| 4E | | MI | 3949 | 2126 | 6279 | 1641 | 7101 | 1365 | 7615 | 1128 | 8283 | 741 | 9706 | 380 | 7757 |
| 12-#11 | 3.12 | MA | 5950 | 2126 | 8945 | 1742 | 10382 | 1447 | 11226 | 1202 | 12242 | 815 | 15055 | 434 | 11932 |
| 5L-3S | | MI | 4045 | 2126 | 6564 | 1632 | 7502 | 1349 | 8106 | 1125 | 8954 | 742 | 10478 | 436 | 7870 |
| 12-#11 | 3.12 | MA | 5723 | 2126 | 8500 | 1750 | 9841 | 1459 | 10524 | 1223 | 11292 | 833 | 13709 | 346 | 11440 |
| 6L-2S | | MI | 4228 | 2126 | 6970 | 1624 | 8019 | 1343 | 8734 | 1111 | 9804 | 732 | 11559 | 549 | 7877 |
| 12-#14 | 4.50 | MA | 6775 | 2362 | 10715 | 1869 | 12542 | 1549 | 13848 | 1266 | 15799 | 788 | 20027 | 390 | 17173 |
| 4E | | MI | 4254 | 2362 | 7030 | 1783 | 8013 | 1471 | 8707 | 1192 | 9783 | 735 | 11457 | 222 | 10367 |
| 12-#14 | 4.50 | MA | 6434 | 2362 | 10033 | 1903 | 11721 | 1566 | 12825 | 1280 | 14377 | 813 | 18064 | 304 | 16292 |
| 5L-3S | | MI | 4382 | 2362 | 7436 | 1772 | 8582 | 1449 | 9404 | 1188 | 10700 | 724 | 12530 | 301 | 10928 |
| 12-#14 | 4.50 | MA | 6126 | 2362 | 9406 | 1915 | 10911 | 1597 | 11820 | 1309 | 13018 | 837 | 16281 | 197 | 15085 |
| 6L-2S | | MI | 4625 | 2362 | 8010 | 1761 | 9313 | 1441 | 10292 | 1170 | 11902 | 712 | 14028 | 463 | 10979 |
| 12-#18 | 8.00 | MA | 7620 | 2962 | 12691 | 2311 | 15006 | 1867 | 16758 | 1500 | 19632 | 802 | 25453 | -36 | 25275 |
| 5L-3S | | MI | 5188 | 2962 | 9527 | 2130 | 11185 | 1704 | 12539 | 1351 | 14900 | 674 | 17214 | -90 | 17048 |
| 14-#10 | 2.96 | MA | 6233 | 2099 | 9424 | 1707 | 11018 | 1426 | 12040 | 1187 | 13394 | 802 | 16633 | 533 | 12164 |
| 4L-5S | | MI | 3884 | 2099 | 6046 | 1654 | 6870 | 1370 | 7348 | 1143 | 7923 | 761 | 9375 | 393 | 7337 |
| 14-#10 | 2.96 | MA | 6026 | 2099 | 9032 | 1727 | 10545 | 1436 | 11452 | 1197 | 12574 | 817 | 15508 | 489 | 11756 |
| 5L-4S | | MI | 3986 | 2099 | 6289 | 1637 | 7162 | 1364 | 7711 | 1131 | 8428 | 752 | 10027 | 446 | 7592 |
| 14-#10 | 2.96 | MA | 5840 | 2099 | 8660 | 1733 | 10101 | 1446 | 10874 | 1214 | 11792 | 833 | 14406 | 418 | 11394 |
| 6L-3S | | MI | 4065 | 2099 | 6526 | 1630 | 7495 | 1349 | 8119 | 1127 | 8986 | 752 | 10686 | 495 | 7619 |
| 14-#10 | 2.96 | MA | 5683 | 2099 | 8299 | 1740 | 9604 | 1462 | 10319 | 1223 | 10994 | 840 | 13341 | 382 | 10867 |
| 7L-2S | | MI | 4220 | 2099 | 6865 | 1622 | 7928 | 1343 | 8644 | 1114 | 9697 | 743 | 11616 | 586 | 7624 |
| 14-#11 | 3.64 | MA | 6266 | 2215 | 9629 | 1798 | 11253 | 1487 | 12284 | 1228 | 13675 | 810 | 17038 | 427 | 13947 |
| 5L-4S | | MI | 4125 | 2215 | 6685 | 1696 | 7618 | 1406 | 8243 | 1154 | 9132 | 735 | 10788 | 360 | 8910 |
| 14-#11 | 3.64 | MA | 6049 | 2215 | 9185 | 1806 | 10713 | 1499 | 11582 | 1248 | 12725 | 828 | 15692 | 339 | 13445 |
| 6L-3S | | MI | 4217 | 2215 | 6970 | 1688 | 8019 | 1390 | 8734 | 1150 | 9804 | 737 | 11559 | 416 | 9088 |
| 14-#11 | 3.64 | MA | 5863 | 2215 | 8748 | 1814 | 10120 | 1518 | 10907 | 1259 | 11755 | 835 | 14393 | 291 | 12714 |
| 7L-2S | | MI | 4395 | 2215 | 7376 | 1680 | 8536 | 1383 | 9362 | 1136 | 10654 | 727 | 12641 | 528 | 9106 |
| 14-#14 | 5.25 | MA | 6875 | 2490 | 11009 | 1983 | 12963 | 1624 | 14334 | 1316 | 16419 | 805 | 20892 | 294 | 19186 |
| 5L-4S | | MI | 4499 | 2490 | 7605 | 1863 | 8744 | 1529 | 9596 | 1228 | 10985 | 728 | 12955 | 188 | 12010 |
| 14-#14 | 5.25 | MA | 6582 | 2490 | 10382 | 1995 | 12153 | 1656 | 13329 | 1345 | 15060 | 830 | 19109 | 187 | 17971 |
| 6L-3S | | MI | 4633 | 2490 | 8010 | 1852 | 9313 | 1507 | 10292 | 1225 | 11902 | 716 | 14028 | 267 | 12640 |
| 16-#10 | 3.39 | MA | 6288 | 2171 | 9598 | 1772 | 11266 | 1469 | 12327 | 1217 | 13759 | 813 | 17148 | 483 | 13423 |
| 5E | | MI | 4033 | 2171 | 6385 | 1699 | 7302 | 1403 | 7872 | 1164 | 8634 | 757 | 10305 | 380 | 8321 |
| 16-#10 | 3.39 | MA | 6109 | 2171 | 9226 | 1779 | 10821 | 1479 | 11749 | 1235 | 12977 | 829 | 16047 | 412 | 13075 |
| 6L-4S | | MI | 4135 | 2171 | 6628 | 1683 | 7594 | 1397 | 8236 | 1151 | 9138 | 748 | 10957 | 433 | 8601 |
| 16-#10 | 3.39 | MA | 5958 | 2171 | 8866 | 1786 | 10325 | 1495 | 11194 | 1244 | 12178 | 836 | 14981 | 376 | 12541 |
| 7L-3S | | MI | 4210 | 2171 | 6865 | 1675 | 7928 | 1382 | 8644 | 1147 | 9697 | 747 | 11616 | 482 | 8639 |
| 16-#10 | 3.39 | MA | 5780 | 2171 | 8520 | 1794 | 9858 | 1501 | 10620 | 1260 | 11416 | 851 | 13956 | 325 | 12032 |
| 8L-2S | | MI | 4361 | 2171 | 7205 | 1667 | 8360 | 1376 | 9169 | 1134 | 10407 | 738 | 12546 | 573 | 8651 |
| 16-#11 | 4.16 | MA | 6368 | 2304 | 9869 | 1861 | 11584 | 1539 | 12640 | 1274 | 14157 | 823 | 17676 | 332 | 15455 |
| 6L-4S | | MI | 4299 | 2304 | 7091 | 1752 | 8135 | 1446 | 8871 | 1179 | 9982 | 730 | 11870 | 339 | 10071 |
| 16-#11 | 4.16 | MA | 6190 | 2304 | 9432 | 1869 | 10992 | 1559 | 11965 | 1284 | 13188 | 830 | 16377 | 284 | 14743 |
| 7L-3S | | MI | 4387 | 2304 | 7376 | 1744 | 8536 | 1430 | 9362 | 1175 | 10654 | 731 | 12641 | 396 | 10305 |
| 16-#14 | 6.00 | MA | 7028 | 2619 | 11357 | 2075 | 13396 | 1714 | 14839 | 1382 | 17102 | 822 | 21937 | 177 | 20862 |
| 6L-4S | | MI | 4766 | 2619 | 8179 | 1944 | 9475 | 1588 | 10484 | 1265 | 12187 | 720 | 14453 | 155 | 13662 |
| 18-#10 | 3.81 | MA | 6373 | 2244 | 9792 | 1824 | 11542 | 1512 | 12625 | 1255 | 14161 | 824 | 17687 | 406 | 14757 |
| 6L-5S | | MI | 4180 | 2244 | 6725 | 1744 | 7734 | 1436 | 8397 | 1185 | 9344 | 753 | 11234 | 367 | 9309 |
| 18-#10 | 3.81 | MA | 6228 | 2244 | 9432 | 1831 | 11046 | 1527 | 12069 | 1265 | 13363 | 831 | 16622 | 370 | 14217 |
| 7L-4S | | MI | 4281 | 2244 | 6968 | 1728 | 8027 | 1430 | 8761 | 1172 | 9849 | 744 | 11887 | 420 | 9574 |
| 18-#10 | 3.81 | MA | 6052 | 2244 | 9086 | 1840 | 10579 | 1534 | 11495 | 1280 | 12601 | 847 | 15597 | 320 | 13710 |
| 8L-3S | | MI | 4354 | 2244 | 7205 | 1720 | 8360 | 1415 | 9169 | 1168 | 10407 | 743 | 12546 | 469 | 9658 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis

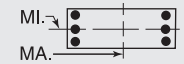



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 4.68 | MA | 6512 | 2393 | 10117 | 1925 | 11863 | 1599 | 13024 | 1309 | 14620 | 825 | 18360 | 277 | 16774 |
| 7L-4S | | MI | 4472 | 2393 | 7497 | 1808 | 8652 | 1487 | 9499 | 1204 | 10832 | 725 | 12952 | 319 | 11238 |
| 20-#10 | 4.23 | MA | 6494 | 2316 | 9998 | 1876 | 11767 | 1560 | 12945 | 1285 | 14548 | 827 | 18262 | 364 | 15895 |
| 7L-5S | | MI | 4325 | 2316 | 7064 | 1789 | 8166 | 1468 | 8922 | 1205 | 10054 | 749 | 12164 | 354 | 10300 |
| 20-#10 | 4.23 | MA | 6319 | 2316 | 9652 | 1885 | 11299 | 1567 | 12371 | 1301 | 13785 | 843 | 17237 | 314 | 15389 |
| 8L-4S | | MI | 4427 | 2316 | 7307 | 1773 | 8459 | 1462 | 9286 | 1192 | 10559 | 740 | 12817 | 407 | 10552 |
| 22-#10 | 4.66 | MA | 6583 | 2389 | 10218 | 1930 | 12020 | 1600 | 13246 | 1322 | 14970 | 838 | 18877 | 308 | 17042 |
| 8L-5S | | MI | 4470 | 2389 | 7404 | 1835 | 8598 | 1501 | 9447 | 1226 | 10765 | 745 | 13094 | 341 | 11292 |
| **RECTANGULAR TIED COLUMNS 20" x 32"** | | | | | | | | | | | | | | | |
| 4-#14 | 1.41 | MA | 6442 | 1954 | 9458 | 1610 | 10943 | 1353 | 11751 | 1151 | 12597 | 843 | 15078 | 732 | 6752 |
| 2E | | MI | 3894 | 1954 | 6017 | 1525 | 6716 | 1281 | 7070 | 1088 | 7406 | 793 | 8372 | 641 | 4009 |
| 4-#18 | 2.50 | MA | 7122 | 2154 | 11101 | 1721 | 12963 | 1432 | 14169 | 1197 | 15841 | 823 | 19549 | 709 | 11570 |
| 2E | | MI | 4216 | 2154 | 6892 | 1628 | 7768 | 1352 | 8319 | 1128 | 9066 | 767 | 10208 | 545 | 6633 |
| 6-#10 | 1.19 | MA | 6332 | 1915 | 9080 | 1602 | 10550 | 1350 | 11316 | 1152 | 12044 | 855 | 14340 | 744 | 5829 |
| 2L-3S | | MI | 3681 | 1915 | 5467 | 1535 | 6093 | 1292 | 6351 | 1109 | 6460 | 820 | 7308 | 592 | 3515 |
| 6-#10 | 1.19 | MA | 6005 | 1915 | 8469 | 1614 | 9771 | 1360 | 10371 | 1162 | 10765 | 871 | 12568 | 661 | 5840 |
| 3L-2S | | MI | 3853 | 1915 | 5807 | 1527 | 6526 | 1286 | 6876 | 1096 | 7170 | 811 | 8237 | 683 | 3492 |
| 6-#11 | 1.46 | MA | 6501 | 1964 | 9525 | 1624 | 11064 | 1364 | 11916 | 1159 | 12836 | 847 | 15420 | 735 | 7048 |
| 2L-3S | | MI | 3729 | 1964 | 5648 | 1551 | 6278 | 1301 | 6553 | 1113 | 6718 | 808 | 7570 | 542 | 4204 |
| 6-#11 | 1.46 | MA | 6116 | 1964 | 8785 | 1638 | 10122 | 1377 | 10772 | 1170 | 11287 | 865 | 13275 | 631 | 7052 |
| 3L-2S | | MI | 3930 | 1964 | 6054 | 1543 | 6795 | 1295 | 7181 | 1099 | 7568 | 799 | 8652 | 654 | 4176 |
| 6-#14 | 2.11 | MA | 6923 | 2083 | 10514 | 1691 | 12288 | 1412 | 13384 | 1187 | 14807 | 836 | 18139 | 722 | 9960 |
| 2L-3S | | MI | 3861 | 2083 | 6017 | 1617 | 6716 | 1346 | 7070 | 1143 | 7406 | 797 | 8372 | 446 | 5809 |
| 6-#14 | 2.11 | MA | 6396 | 2083 | 9458 | 1710 | 10943 | 1429 | 11751 | 1203 | 12597 | 862 | 15078 | 569 | 9917 |
| 3L-2S | | MI | 4136 | 2083 | 6592 | 1606 | 7448 | 1339 | 7959 | 1124 | 8608 | 785 | 9870 | 608 | 5785 |
| 6-#18 | 3.75 | MA | 7914 | 2382 | 12939 | 1864 | 15302 | 1536 | 17010 | 1262 | 19686 | 810 | 24873 | 690 | 17111 |
| 2L-3S | | MI | 4174 | 2382 | 6892 | 1786 | 7768 | 1464 | 8319 | 1219 | 9066 | 766 | 10208 | 181 | 9535 |
| 6-#18 | 3.75 | MA | 7075 | 2382 | 11101 | 1896 | 12963 | 1564 | 14169 | 1286 | 15841 | 852 | 19549 | 409 | 16812 |
| 3L-2S | | MI | 4612 | 2382 | 7873 | 1771 | 9017 | 1456 | 9836 | 1192 | 11114 | 753 | 12654 | 469 | 9623 |
| 8-#9 | 1.25 | MA | 6384 | 1926 | 9160 | 1613 | 10670 | 1357 | 11472 | 1158 | 12263 | 857 | 14648 | 745 | 6123 |
| 2L-4S | | MI | 3673 | 1926 | 5392 | 1553 | 5990 | 1312 | 6230 | 1118 | 6297 | 822 | 7174 | 578 | 3694 |
| 8-#9 | 1.25 | MA | 6127 | 1926 | 8676 | 1622 | 10054 | 1366 | 10724 | 1166 | 11250 | 870 | 13246 | 680 | 6131 |
| 3E | | MI | 3746 | 1926 | 5580 | 1546 | 6254 | 1300 | 6554 | 1114 | 6740 | 821 | 7702 | 616 | 3676 |
| 8-#9 | 1.25 | MA | 5995 | 1926 | 8348 | 1632 | 9591 | 1382 | 10156 | 1180 | 10472 | 876 | 12307 | 640 | 6118 |
| 4L-2S | | MI | 3883 | 1926 | 5850 | 1540 | 6597 | 1295 | 6971 | 1104 | 7305 | 814 | 8448 | 688 | 3660 |
| 8-#10 | 1.59 | MA | 6619 | 1987 | 9691 | 1648 | 11328 | 1382 | 12262 | 1173 | 13324 | 851 | 16111 | 738 | 7687 |
| 2L-4S | | MI | 3742 | 1987 | 5570 | 1588 | 6192 | 1339 | 6467 | 1134 | 6611 | 816 | 7579 | 531 | 4572 |
| 8-#10 | 1.59 | MA | 6303 | 1987 | 9080 | 1660 | 10550 | 1393 | 11316 | 1182 | 12044 | 867 | 14340 | 655 | 7685 |
| 3E | | MI | 3833 | 1987 | 5807 | 1581 | 6526 | 1325 | 6876 | 1130 | 7170 | 816 | 8237 | 579 | 4560 |
| 8-#10 | 1.59 | MA | 6140 | 1987 | 8666 | 1672 | 9964 | 1413 | 10598 | 1201 | 11060 | 875 | 13149 | 605 | 7638 |
| 4L-2S | | MI | 4001 | 1987 | 6146 | 1573 | 6958 | 1319 | 7401 | 1117 | 7880 | 807 | 9167 | 670 | 4543 |
| 8-#11 | 1.95 | MA | 6841 | 2054 | 10265 | 1679 | 12007 | 1404 | 13061 | 1184 | 14385 | 841 | 17565 | 728 | 9295 |
| 2L-4S | | MI | 3801 | 2054 | 5769 | 1615 | 6394 | 1358 | 6690 | 1142 | 6896 | 802 | 7881 | 465 | 5447 |
| 8-#11 | 1.95 | MA | 6470 | 2054 | 9525 | 1693 | 11064 | 1417 | 11916 | 1195 | 12836 | 860 | 15420 | 623 | 9280 |
| 3E | | MI | 3908 | 2054 | 6054 | 1607 | 6795 | 1342 | 7181 | 1138 | 7568 | 803 | 8652 | 521 | 5449 |
| 8-#11 | 1.95 | MA | 6278 | 2054 | 9021 | 1707 | 10354 | 1440 | 11044 | 1217 | 11641 | 869 | 13965 | 561 | 9184 |
| 4L-2S | | MI | 4103 | 2054 | 6460 | 1599 | 7312 | 1335 | 7809 | 1124 | 8417 | 794 | 9734 | 634 | 5430 |
| 8-#14 | 2.81 | MA | 7391 | 2211 | 11570 | 1771 | 13632 | 1470 | 15017 | 1224 | 17017 | 828 | 21199 | 711 | 13152 |
| 2L-4S | | MI | 3964 | 2211 | 6186 | 1708 | 6879 | 1427 | 7262 | 1183 | 7691 | 800 | 8797 | 334 | 7236 |
| 8-#14 | 2.81 | MA | 6890 | 2211 | 10514 | 1790 | 12288 | 1487 | 13384 | 1239 | 14807 | 854 | 18139 | 558 | 13078 |
| 3E | | MI | 4109 | 2211 | 6592 | 1697 | 7448 | 1405 | 7959 | 1179 | 8608 | 789 | 9870 | 412 | 7541 |
| 8-#14 | 2.81 | MA | 6631 | 2211 | 9794 | 1810 | 11271 | 1520 | 12137 | 1269 | 13098 | 865 | 16047 | 467 | 12549 |
| 4L-2S | | MI | 4374 | 2211 | 7166 | 1686 | 8179 | 1397 | 8847 | 1160 | 9810 | 778 | 11368 | 574 | 7541 |
| 8-#18 | 5.00 | MA | 7902 | 2611 | 12939 | 2039 | 15302 | 1668 | 17010 | 1350 | 19686 | 839 | 24873 | 391 | 22291 |
| 3E | | MI | 4604 | 2611 | 7873 | 1928 | 9017 | 1568 | 9836 | 1284 | 11114 | 752 | 12654 | 105 | 12319 |

## RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis

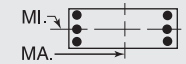



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 5.00 | MA | 7498 | 2611 | 11678 | 2071 | 13525 | 1722 | 14831 | 1401 | 16702 | 854 | 21183 | 226 | 19658 |
| 4L-2S | | MI | 4989 | 2611 | 8854 | 1913 | 10266 | 1560 | 11353 | 1257 | 13162 | 739 | 15100 | 393 | 12581 |
| 10-#10 | 1.98 | MA | 6901 | 2060 | 10303 | 1693 | 12106 | 1415 | 13207 | 1193 | 14603 | 847 | 17883 | 732 | 9540 |
| 2L-5S | | MI | 3793 | 2060 | 5666 | 1650 | 6332 | 1378 | 6629 | 1167 | 6817 | 821 | 7856 | 464 | 5455 |
| 10-#10 | 1.98 | MA | 6595 | 2060 | 9691 | 1705 | 11328 | 1426 | 12262 | 1203 | 13324 | 863 | 16111 | 649 | 9526 |
| 3L-4S | | MI | 3897 | 2060 | 5909 | 1634 | 6625 | 1372 | 6992 | 1154 | 7322 | 812 | 8508 | 518 | 5595 |
| 10-#10 | 1.98 | MA | 6441 | 2060 | 9277 | 1717 | 10743 | 1446 | 11543 | 1221 | 12339 | 871 | 14921 | 599 | 9466 |
| 4L-3S | | MI | 3983 | 2060 | 6146 | 1626 | 6958 | 1358 | 7401 | 1150 | 7880 | 812 | 9167 | 566 | 5596 |
| 10-#10 | 1.98 | MA | 6209 | 2060 | 8855 | 1737 | 10234 | 1457 | 10910 | 1231 | 11457 | 887 | 13712 | 556 | 9153 |
| 5L-2S | | MI | 4147 | 2060 | 6486 | 1618 | 7390 | 1352 | 7925 | 1137 | 8591 | 802 | 10097 | 657 | 5584 |
| 10-#11 | 2.44 | MA | 6816 | 2143 | 10265 | 1749 | 12007 | 1457 | 13061 | 1221 | 14385 | 855 | 17565 | 616 | 11503 |
| 3L-4S | | MI | 3982 | 2143 | 6175 | 1671 | 6911 | 1398 | 7318 | 1167 | 7746 | 797 | 8963 | 445 | 6662 |
| 10-#11 | 2.44 | MA | 6636 | 2143 | 9761 | 1763 | 11296 | 1480 | 12189 | 1242 | 13190 | 863 | 16109 | 553 | 11392 |
| 4L-3S | | MI | 4084 | 2143 | 6460 | 1663 | 7312 | 1382 | 7809 | 1163 | 8417 | 798 | 9734 | 501 | 6682 |
| 10-#11 | 2.44 | MA | 6363 | 2143 | 9248 | 1788 | 10677 | 1493 | 11419 | 1254 | 12117 | 882 | 14637 | 498 | 10776 |
| 5L-2S | | MI | 4274 | 2143 | 6866 | 1654 | 7829 | 1376 | 8437 | 1149 | 9267 | 789 | 10816 | 613 | 6672 |
| 10-#14 | 3.52 | MA | 7371 | 2340 | 11570 | 1871 | 13632 | 1546 | 15017 | 1275 | 17017 | 847 | 21199 | 548 | 16240 |
| 3L-4S | | MI | 4216 | 2340 | 6760 | 1788 | 7610 | 1485 | 8150 | 1219 | 8893 | 793 | 10295 | 300 | 8849 |
| 10-#14 | 3.52 | MA | 7134 | 2340 | 10850 | 1890 | 12616 | 1578 | 13770 | 1306 | 15309 | 858 | 19108 | 457 | 15625 |
| 4L-3S | | MI | 4354 | 2340 | 7166 | 1777 | 8179 | 1463 | 8847 | 1215 | 9810 | 782 | 11368 | 379 | 9261 |
| 10-#14 | 3.52 | MA | 6751 | 2340 | 10115 | 1925 | 11730 | 1596 | 12668 | 1321 | 13775 | 884 | 16996 | 374 | 14568 |
| 5L-2S | | MI | 4609 | 2340 | 7740 | 1766 | 8910 | 1456 | 9735 | 1197 | 11012 | 770 | 12866 | 541 | 9286 |
| 10-#18 | 6.25 | MA | 8349 | 2839 | 13516 | 2214 | 15865 | 1826 | 17672 | 1466 | 20547 | 841 | 26507 | 207 | 25080 |
| 4L-3S | | MI | 5006 | 2839 | 8854 | 2071 | 10266 | 1671 | 11353 | 1349 | 13162 | 738 | 15100 | 29 | 15000 |
| 10-#18 | 6.25 | MA | 7710 | 2839 | 12229 | 2273 | 14314 | 1854 | 15744 | 1490 | 17863 | 883 | 22799 | 50 | 22585 |
| 5L-2S | | MI | 5365 | 2839 | 9835 | 2056 | 11515 | 1664 | 12870 | 1322 | 15210 | 725 | 17546 | 317 | 15524 |
| 12-#10 | 2.38 | MA | 6881 | 2132 | 10303 | 1750 | 12106 | 1459 | 13207 | 1224 | 14603 | 859 | 17883 | 643 | 11365 |
| 3L-5S | | MI | 3946 | 2132 | 6006 | 1695 | 6764 | 1411 | 7154 | 1188 | 7528 | 817 | 8786 | 451 | 6429 |
| 12-#10 | 2.38 | MA | 6736 | 2132 | 9888 | 1762 | 11521 | 1479 | 12489 | 1242 | 13619 | 867 | 16692 | 593 | 11295 |
| 4E | | MI | 4049 | 2132 | 6249 | 1679 | 7057 | 1405 | 7517 | 1175 | 8032 | 808 | 9438 | 505 | 6614 |
| 12-#10 | 2.38 | MA | 6506 | 2132 | 9466 | 1783 | 11012 | 1490 | 11855 | 1252 | 12736 | 883 | 15484 | 550 | 10947 |
| 5L-3S | | MI | 4132 | 2132 | 6486 | 1671 | 7390 | 1390 | 7925 | 1171 | 8591 | 807 | 10097 | 553 | 6626 |
| 12-#10 | 2.38 | MA | 6297 | 2132 | 9060 | 1789 | 10534 | 1500 | 11233 | 1270 | 11895 | 899 | 14304 | 480 | 10521 |
| 6L-2S | | MI | 4291 | 2132 | 6825 | 1663 | 7822 | 1384 | 8450 | 1158 | 9301 | 798 | 11027 | 644 | 6620 |
| 12-#11 | 2.92 | MA | 6987 | 2232 | 10501 | 1819 | 12238 | 1521 | 13333 | 1268 | 14739 | 858 | 18254 | 546 | 13602 |
| 4E | | MI | 4161 | 2232 | 6581 | 1727 | 7429 | 1439 | 7946 | 1192 | 8596 | 791 | 10044 | 424 | 7850 |
| 12-#11 | 2.92 | MA | 6716 | 2232 | 9988 | 1843 | 11620 | 1534 | 12563 | 1279 | 13666 | 877 | 16781 | 491 | 12952 |
| 5L-3S | | MI | 4258 | 2232 | 6866 | 1718 | 7829 | 1422 | 8437 | 1189 | 9267 | 793 | 10816 | 481 | 7907 |
| 12-#11 | 2.92 | MA | 6469 | 2232 | 9502 | 1851 | 11038 | 1546 | 11807 | 1300 | 12643 | 896 | 15339 | 404 | 12467 |
| 6L-2S | | MI | 4443 | 2232 | 7272 | 1710 | 8346 | 1416 | 9065 | 1175 | 10117 | 783 | 11897 | 593 | 7909 |
| 12-#14 | 4.22 | MA | 7624 | 2468 | 11906 | 1971 | 13960 | 1636 | 15403 | 1342 | 17519 | 850 | 22168 | 446 | 18713 |
| 4E | | MI | 4465 | 2468 | 7335 | 1868 | 8341 | 1544 | 9038 | 1255 | 10095 | 785 | 11793 | 266 | 10477 |
| 12-#14 | 4.22 | MA | 7245 | 2468 | 11171 | 2005 | 13075 | 1654 | 14301 | 1357 | 15985 | 876 | 20057 | 364 | 17700 |
| 5L-3S | | MI | 4595 | 2468 | 7740 | 1857 | 8910 | 1521 | 9735 | 1252 | 11012 | 774 | 12866 | 345 | 10977 |
| 12-#14 | 4.22 | MA | 6908 | 2468 | 10484 | 2017 | 12242 | 1671 | 13218 | 1388 | 14520 | 902 | 17984 | 238 | 16477 |
| 6L-2S | | MI | 4842 | 2468 | 8315 | 1846 | 9642 | 1514 | 10623 | 1233 | 12215 | 763 | 14364 | 507 | 11019 |
| 12-#18 | 7.50 | MA | 8542 | 3068 | 14066 | 2416 | 16653 | 1958 | 18585 | 1554 | 21708 | 870 | 28123 | 32 | 27987 |
| 5L-3S | | MI | 5401 | 3068 | 9835 | 2214 | 11515 | 1775 | 12870 | 1414 | 15210 | 724 | 17546 | -47 | 17463 |
| 14-#10 | 2.78 | MA | 7026 | 2205 | 10500 | 1808 | 12299 | 1512 | 13434 | 1262 | 14898 | 862 | 18464 | 587 | 13124 |
| 4L-5S | | MI | 4096 | 2205 | 6345 | 1740 | 7196 | 1444 | 7679 | 1208 | 8238 | 813 | 9715 | 438 | 7408 |
| 14-#10 | 2.78 | MA | 6797 | 2205 | 10078 | 1828 | 11791 | 1522 | 12801 | 1272 | 14016 | 878 | 17255 | 544 | 12746 |
| 5L-4S | | MI | 4199 | 2205 | 6588 | 1724 | 7489 | 1438 | 8042 | 1195 | 8743 | 804 | 10368 | 492 | 7630 |
| 14-#10 | 2.78 | MA | 6595 | 2205 | 9672 | 1834 | 11313 | 1533 | 12179 | 1291 | 13174 | 895 | 16076 | 474 | 12335 |
| 6L-3S | | MI | 4279 | 2205 | 6825 | 1717 | 7822 | 1423 | 8450 | 1191 | 9301 | 803 | 11027 | 540 | 7651 |
| 14-#10 | 2.78 | MA | 6423 | 2205 | 9284 | 1841 | 10771 | 1548 | 11582 | 1300 | 12315 | 902 | 14933 | 440 | 11819 |
| 7L-2S | | MI | 4435 | 2205 | 7165 | 1709 | 8254 | 1417 | 8975 | 1179 | 10012 | 794 | 11957 | 631 | 7652 |
| 14-#11 | 3.41 | MA | 7062 | 2321 | 10728 | 1899 | 12562 | 1574 | 13708 | 1304 | 15215 | 872 | 18926 | 484 | 15134 |
| 5L-4S | | MI | 4337 | 2321 | 6987 | 1782 | 7946 | 1479 | 8575 | 1218 | 9446 | 786 | 11126 | 404 | 9002 |


## RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis

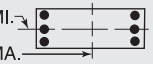



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 3.41 | MA | 6824 | 2321 | 10243 | 1907 | 11980 | 1587 | 12952 | 1326 | 14192 | 891 | 17484 | 397 | 14669 |
| 6L-3S | | MI | 4430 | 2321 | 7272 | 1774 | 8346 | 1463 | 9065 | 1214 | 10117 | 787 | 11897 | 461 | 9128 |
| 14-#11 | 3.41 | MA | 6622 | 2321 | 9771 | 1915 | 11333 | 1605 | 12225 | 1337 | 13148 | 899 | 16090 | 352 | 13838 |
| 7L-2S | | MI | 4611 | 2321 | 7678 | 1766 | 8863 | 1457 | 9693 | 1200 | 10967 | 778 | 12979 | 573 | 9140 |
| 14-#14 | 4.92 | MA | 7728 | 2597 | 12227 | 2085 | 14420 | 1712 | 15934 | 1394 | 18195 | 869 | 23117 | 354 | 20837 |
| 5L-4S | | MI | 4710 | 2597 | 7909 | 1949 | 9072 | 1602 | 9926 | 1292 | 11298 | 778 | 13291 | 233 | 12117 |
| 14-#14 | 4.92 | MA | 7407 | 2597 | 11540 | 2097 | 13586 | 1730 | 14852 | 1424 | 16731 | 895 | 21045 | 228 | 19607 |
| 6L-3S | | MI | 4848 | 2597 | 8315 | 1938 | 9642 | 1580 | 10623 | 1288 | 12215 | 767 | 14364 | 312 | 12690 |
| 14-#14 | 4.92 | MA | 7132 | 2597 | 10866 | 2109 | 12670 | 1757 | 13811 | 1439 | 15236 | 906 | 19043 | 159 | 18226 |
| 7L-2S | | MI | 5068 | 2597 | 8889 | 1927 | 10373 | 1573 | 11512 | 1270 | 13417 | 755 | 15862 | 473 | 12748 |
| 16-#10 | 3.17 | MA | 7083 | 2277 | 10689 | 1873 | 12569 | 1555 | 13746 | 1293 | 15295 | 874 | 19027 | 539 | 14549 |
| 5E | | MI | 4245 | 2277 | 6685 | 1786 | 7629 | 1477 | 8204 | 1229 | 8949 | 809 | 10645 | 425 | 8392 |
| 16-#10 | 3.17 | MA | 6888 | 2277 | 10283 | 1879 | 12091 | 1566 | 13124 | 1311 | 14454 | 890 | 17847 | 468 | 14152 |
| 6L-4S | | MI | 4347 | 2277 | 6928 | 1770 | 7921 | 1471 | 8567 | 1216 | 9453 | 800 | 11298 | 479 | 8644 |
| 16-#10 | 3.17 | MA | 6723 | 2277 | 9895 | 1887 | 11550 | 1581 | 12527 | 1321 | 13595 | 898 | 16705 | 434 | 13631 |
| 7L-3S | | MI | 4424 | 2277 | 7165 | 1762 | 8254 | 1456 | 8975 | 1212 | 10012 | 799 | 11957 | 527 | 8672 |
| 16-#10 | 3.17 | MA | 6527 | 2277 | 9523 | 1896 | 11047 | 1588 | 11900 | 1336 | 12774 | 914 | 15605 | 386 | 13102 |
| 8L-2S | | MI | 4577 | 2277 | 7504 | 1754 | 8687 | 1450 | 9500 | 1199 | 10722 | 790 | 12886 | 618 | 8681 |
| 16-#11 | 3.90 | MA | 7173 | 2410 | 10983 | 1962 | 12923 | 1627 | 14096 | 1351 | 15741 | 886 | 19629 | 390 | 16850 |
| 6L-4S | | MI | 4512 | 2410 | 7393 | 1838 | 8463 | 1520 | 9203 | 1243 | 10296 | 781 | 12208 | 384 | 10161 |
| 16-#11 | 3.90 | MA | 6979 | 2410 | 10512 | 1971 | 12275 | 1646 | 13369 | 1362 | 14697 | 894 | 18234 | 345 | 16036 |
| 7L-3S | | MI | 4601 | 2410 | 7678 | 1830 | 8863 | 1503 | 9693 | 1239 | 10967 | 782 | 12979 | 441 | 10345 |
| 16-#11 | 3.90 | MA | 6748 | 2410 | 10059 | 1981 | 11664 | 1654 | 12620 | 1382 | 13699 | 913 | 16893 | 283 | 15172 |
| 8L-2S | | MI | 4777 | 2410 | 8085 | 1821 | 9380 | 1497 | 10321 | 1225 | 11817 | 773 | 14061 | 553 | 10366 |
| 16-#14 | 5.63 | MA | 7895 | 2725 | 12596 | 2177 | 14931 | 1788 | 16485 | 1460 | 18941 | 887 | 24105 | 217 | 22735 |
| 6L-4S | | MI | 4978 | 2725 | 8483 | 2029 | 9804 | 1660 | 10815 | 1328 | 12500 | 771 | 14789 | 199 | 13767 |
| 16-#14 | 5.63 | MA | 7636 | 2725 | 11923 | 2189 | 14015 | 1815 | 15444 | 1476 | 17446 | 898 | 22104 | 149 | 21339 |
| 7L-3S | | MI | 5081 | 2725 | 8889 | 2018 | 10373 | 1638 | 11512 | 1325 | 13417 | 759 | 15862 | 278 | 14402 |
| 18-#10 | 3.57 | MA | 7176 | 2350 | 10894 | 1924 | 12870 | 1599 | 14070 | 1332 | 15733 | 886 | 19619 | 463 | 15972 |
| 6L-5S | | MI | 4393 | 2350 | 7024 | 1831 | 8061 | 1510 | 8729 | 1249 | 9659 | 804 | 11575 | 412 | 9378 |
| 18-#10 | 3.57 | MA | 7018 | 2350 | 10506 | 1932 | 12328 | 1614 | 13472 | 1342 | 14874 | 894 | 18476 | 428 | 15445 |
| 7L-4S | | MI | 4494 | 2350 | 7267 | 1815 | 8353 | 1504 | 9092 | 1237 | 10164 | 795 | 12227 | 466 | 9653 |
| 18-#10 | 3.57 | MA | 6823 | 2350 | 10134 | 1941 | 11825 | 1621 | 12845 | 1357 | 14054 | 910 | 17376 | 380 | 14925 |
| 8L-3S | | MI | 4569 | 2350 | 7504 | 1807 | 8687 | 1489 | 9500 | 1232 | 10722 | 795 | 12886 | 514 | 9692 |
| 18-#10 | 3.57 | MA | 6628 | 2350 | 9717 | 1959 | 11308 | 1638 | 12225 | 1364 | 13215 | 918 | 16291 | 335 | 14178 |
| 9L-2S | | MI | 4718 | 2350 | 7844 | 1799 | 9119 | 1483 | 10025 | 1220 | 11433 | 786 | 13816 | 605 | 9706 |
| 18-#11 | 4.39 | MA | 7331 | 2499 | 11252 | 2027 | 13217 | 1686 | 14514 | 1387 | 16246 | 889 | 20379 | 338 | 18237 |
| 7L-4S | | MI | 4684 | 2499 | 7799 | 1894 | 8980 | 1560 | 9831 | 1268 | 11146 | 776 | 13289 | 364 | 11326 |
| 18-#11 | 4.39 | MA | 7101 | 2499 | 10799 | 2037 | 12606 | 1694 | 13765 | 1407 | 15248 | 908 | 19038 | 275 | 17364 |
| 8L-3S | | MI | 4770 | 2499 | 8085 | 1885 | 9380 | 1544 | 10321 | 1264 | 11817 | 777 | 14061 | 421 | 11561 |
| 18-#14 | 6.33 | MA | 8129 | 2853 | 12979 | 2269 | 15360 | 1874 | 17077 | 1512 | 19656 | 891 | 25164 | 139 | 24453 |
| 7L-4S | | MI | 5217 | 2853 | 9058 | 2109 | 10535 | 1719 | 11703 | 1365 | 13702 | 763 | 16287 | 166 | 15424 |
| 20-#10 | 3.97 | MA | 7308 | 2422 | 11118 | 1977 | 13106 | 1647 | 14418 | 1362 | 16154 | 890 | 20248 | 422 | 17262 |
| 7L-5S | | MI | 4539 | 2422 | 7363 | 1876 | 8493 | 1543 | 9254 | 1270 | 10369 | 800 | 12505 | 399 | 10368 |
| 20-#10 | 3.97 | MA | 7115 | 2422 | 10746 | 1986 | 12603 | 1654 | 13791 | 1377 | 15333 | 906 | 19148 | 374 | 16748 |
| 8L-4S | | MI | 4640 | 2422 | 7606 | 1860 | 8786 | 1537 | 9617 | 1257 | 10874 | 791 | 13157 | 453 | 10630 |
| 20-#10 | 3.97 | MA | 6925 | 2422 | 10328 | 2004 | 12087 | 1671 | 13171 | 1384 | 14495 | 914 | 18063 | 329 | 15994 |
| 9L-3S | | MI | 4712 | 2422 | 7844 | 1852 | 9119 | 1522 | 10025 | 1253 | 11433 | 791 | 13816 | 501 | 10710 |
| 20-#11 | 4.88 | MA | 7449 | 2588 | 11539 | 2093 | 13549 | 1735 | 14909 | 1432 | 16797 | 902 | 21182 | 268 | 19557 |
| 8L-4S | | MI | 4856 | 2588 | 8205 | 1949 | 9497 | 1601 | 10459 | 1293 | 11996 | 771 | 14371 | 344 | 12496 |
| 22-#10 | 4.37 | MA | 7402 | 2495 | 11357 | 2032 | 13382 | 1687 | 14736 | 1398 | 16613 | 902 | 20920 | 368 | 18566 |
| 8L-5S | | MI | 4684 | 2495 | 7703 | 1922 | 8925 | 1576 | 9779 | 1290 | 11080 | 796 | 13434 | 386 | 11360 |
| 22-#10 | 4.37 | MA | 7218 | 2495 | 10939 | 2050 | 12865 | 1704 | 14116 | 1405 | 15774 | 909 | 19834 | 323 | 17810 |
| 9L-4S | | MI | 4785 | 2495 | 7946 | 1906 | 9218 | 1570 | 10142 | 1278 | 11584 | 787 | 14087 | 439 | 11610 |
| 24-#10 | 4.76 | MA | 7507 | 2567 | 11551 | 2095 | 13643 | 1737 | 15062 | 1425 | 17054 | 905 | 21606 | 318 | 19626 |
| 9L-5S | | MI | 4828 | 2567 | 8042 | 1967 | 9357 | 1609 | 10303 | 1311 | 11790 | 792 | 14364 | 373 | 12354 |

## RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

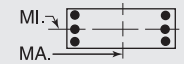
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.32 | MA | 7232 | 2060 | 10510 | 1710 | 12190 | 1438 | 13090 | 1225 | 14004 | 902 | 16736 | 784 | 7238 |
| 2E | | MI | 4107 | 2060 | 6322 | 1611 | 7045 | 1353 | 7401 | 1151 | 7719 | 843 | 8709 | 686 | 4035 |
| 4-#18 | 2.35 | MA | 7976 | 2260 | 12285 | 1821 | 14372 | 1517 | 15703 | 1271 | 17508 | 882 | 21565 | 760 | 12434 |
| 2E | | MI | 4429 | 2260 | 7200 | 1712 | 8098 | 1424 | 8649 | 1190 | 9376 | 816 | 10540 | 588 | 6671 |
| 6-#10 | 1.12 | MA | 7109 | 2021 | 10099 | 1702 | 11761 | 1434 | 12616 | 1226 | 13401 | 914 | 15930 | 796 | 6241 |
| 2L-3S | | MI | 3893 | 2021 | 5767 | 1622 | 6420 | 1366 | 6682 | 1174 | 6774 | 871 | 7648 | 637 | 3535 |
| 6-#10 | 1.12 | MA | 6755 | 2021 | 9442 | 1714 | 10925 | 1446 | 11601 | 1236 | 12026 | 931 | 14027 | 714 | 6251 |
| 3L-2S | | MI | 4065 | 2021 | 6106 | 1614 | 6852 | 1360 | 7207 | 1161 | 7485 | 862 | 8578 | 729 | 3512 |
| 6-#11 | 1.38 | MA | 7295 | 2071 | 10579 | 1723 | 12318 | 1449 | 13265 | 1233 | 14256 | 905 | 17098 | 787 | 7553 |
| 2L-3S | | MI | 3941 | 2071 | 5950 | 1637 | 6606 | 1374 | 6884 | 1177 | 7031 | 859 | 7908 | 586 | 4230 |
| 6-#11 | 1.38 | MA | 6876 | 2071 | 9784 | 1738 | 11305 | 1462 | 12035 | 1245 | 12591 | 925 | 14792 | 684 | 7558 |
| 3L-2S | | MI | 4143 | 2071 | 6356 | 1629 | 7123 | 1368 | 7512 | 1163 | 7881 | 850 | 8990 | 699 | 4201 |
| 6-#14 | 1.99 | MA | 7755 | 2189 | 11646 | 1790 | 13637 | 1496 | 14848 | 1261 | 16382 | 894 | 20029 | 773 | 10689 |
| 2L-3S | | MI | 4073 | 2189 | 6322 | 1702 | 7045 | 1419 | 7401 | 1206 | 7719 | 847 | 8709 | 490 | 5845 |
| 6-#14 | 1.99 | MA | 7182 | 2189 | 10510 | 1810 | 12190 | 1515 | 13090 | 1278 | 14004 | 922 | 16736 | 623 | 10646 |
| 3L-2S | | MI | 4349 | 2189 | 6896 | 1691 | 7776 | 1412 | 8290 | 1187 | 8921 | 836 | 10206 | 652 | 5816 |
| 6-#18 | 3.53 | MA | 8839 | 2489 | 14265 | 1963 | 16893 | 1621 | 18765 | 1336 | 21652 | 869 | 27303 | 742 | 18407 |
| 2L-3S | | MI | 4385 | 2489 | 7200 | 1869 | 8098 | 1535 | 8649 | 1282 | 9376 | 816 | 10540 | 225 | 9600 |
| 6-#18 | 3.53 | MA | 7923 | 2489 | 12285 | 1997 | 14372 | 1651 | 15703 | 1362 | 17508 | 913 | 21565 | 467 | 18108 |
| 3L-2S | | MI | 4826 | 2489 | 8181 | 1854 | 9347 | 1528 | 10166 | 1255 | 11425 | 802 | 12986 | 512 | 9666 |
| 8-#9 | 1.18 | MA | 7165 | 2032 | 10184 | 1712 | 11889 | 1442 | 12783 | 1232 | 13634 | 916 | 16259 | 797 | 6555 |
| 2L-4S | | MI | 3885 | 2032 | 5690 | 1640 | 6316 | 1387 | 6561 | 1183 | 6612 | 874 | 7516 | 623 | 3715 |
| 8-#9 | 1.18 | MA | 6887 | 2032 | 9664 | 1722 | 11228 | 1451 | 11979 | 1240 | 12546 | 929 | 14753 | 733 | 6563 |
| 3E | | MI | 3959 | 2032 | 5878 | 1634 | 6580 | 1375 | 6885 | 1179 | 7056 | 873 | 8043 | 662 | 3696 |
| 8-#9 | 1.18 | MA | 6744 | 2032 | 9313 | 1732 | 10732 | 1467 | 11370 | 1255 | 11712 | 936 | 13752 | 694 | 6550 |
| 4L-2S | | MI | 4096 | 2032 | 6148 | 1627 | 6924 | 1370 | 7302 | 1169 | 7620 | 865 | 8790 | 734 | 3679 |
| 8-#10 | 1.49 | MA | 7421 | 2093 | 10755 | 1747 | 12597 | 1467 | 13632 | 1247 | 14775 | 910 | 17833 | 790 | 8236 |
| 2L-4S | | MI | 3954 | 2093 | 5869 | 1675 | 6519 | 1413 | 6799 | 1198 | 6926 | 868 | 7919 | 576 | 4599 |
| 8-#10 | 1.49 | MA | 7078 | 2093 | 10099 | 1759 | 11761 | 1479 | 12616 | 1257 | 13401 | 927 | 15930 | 708 | 8234 |
| 3E | | MI | 4045 | 2093 | 6106 | 1668 | 6852 | 1399 | 7207 | 1194 | 7485 | 867 | 8578 | 624 | 4584 |
| 8-#10 | 1.49 | MA | 6902 | 2093 | 9655 | 1772 | 11134 | 1498 | 11846 | 1276 | 12345 | 935 | 14660 | 658 | 8186 |
| 4L-2S | | MI | 4214 | 2093 | 6446 | 1660 | 7285 | 1393 | 7732 | 1182 | 8195 | 858 | 9508 | 716 | 4565 |
| 8-#11 | 1.84 | MA | 7664 | 2160 | 11375 | 1779 | 13331 | 1489 | 14496 | 1258 | 15922 | 900 | 19404 | 779 | 9969 |
| 2L-4S | | MI | 4013 | 2160 | 6071 | 1701 | 6722 | 1431 | 7022 | 1206 | 7210 | 853 | 8219 | 509 | 5485 |
| 8-#11 | 1.84 | MA | 7260 | 2160 | 10579 | 1793 | 12318 | 1502 | 13265 | 1270 | 14256 | 920 | 17098 | 677 | 9954 |
| 3E | | MI | 4120 | 2160 | 6356 | 1693 | 7123 | 1415 | 7512 | 1202 | 7881 | 854 | 8990 | 566 | 5478 |
| 8-#11 | 1.84 | MA | 7053 | 2160 | 10040 | 1808 | 11555 | 1526 | 12330 | 1292 | 12974 | 929 | 15545 | 615 | 9858 |
| 4L-2S | | MI | 4317 | 2160 | 6762 | 1685 | 7640 | 1409 | 8140 | 1188 | 8731 | 845 | 10072 | 678 | 5457 |
| 8-#14 | 2.65 | MA | 8266 | 2317 | 12783 | 1870 | 15084 | 1555 | 16605 | 1298 | 18760 | 887 | 23323 | 763 | 14124 |
| 2L-4S | | MI | 4175 | 2317 | 6490 | 1793 | 7207 | 1500 | 7593 | 1246 | 8004 | 851 | 9133 | 378 | 7349 |
| 8-#14 | 2.65 | MA | 7719 | 2317 | 11646 | 1891 | 13637 | 1573 | 14848 | 1314 | 16382 | 914 | 20029 | 613 | 14050 |
| 3E | | MI | 4322 | 2317 | 6896 | 1782 | 7776 | 1477 | 8290 | 1242 | 8921 | 840 | 10206 | 457 | 7582 |
| 8-#14 | 2.65 | MA | 7438 | 2317 | 10874 | 1911 | 12546 | 1606 | 13509 | 1345 | 14548 | 927 | 17797 | 523 | 13622 |
| 4L-2S | | MI | 4588 | 2317 | 7470 | 1771 | 8507 | 1470 | 9178 | 1224 | 10123 | 828 | 11704 | 618 | 7575 |
| 8-#18 | 4.71 | MA | 8824 | 2717 | 14265 | 2140 | 16893 | 1754 | 18765 | 1427 | 21652 | 900 | 27303 | 449 | 24019 |
| 3E | | MI | 4798 | 2717 | 8181 | 2012 | 9347 | 1639 | 10166 | 1347 | 11425 | 802 | 12986 | 149 | 12504 |
| 8-#18 | 4.71 | MA | 8385 | 2717 | 12912 | 2174 | 14984 | 1811 | 16423 | 1479 | 18444 | 918 | 23363 | 285 | 21347 |
| 4L-2S | | MI | 5206 | 2717 | 9162 | 1997 | 10595 | 1631 | 11683 | 1319 | 13473 | 788 | 15432 | 436 | 12630 |
| 10-#10 | 1.87 | MA | 7727 | 2166 | 11412 | 1792 | 13433 | 1500 | 14648 | 1267 | 16149 | 906 | 19736 | 784 | 10226 |
| 2L-5S | | MI | 4005 | 2166 | 5966 | 1737 | 6659 | 1452 | 6960 | 1232 | 7132 | 873 | 8196 | 509 | 5527 |
| 10-#10 | 1.87 | MA | 7395 | 2166 | 10755 | 1805 | 12597 | 1512 | 13632 | 1277 | 14775 | 922 | 17833 | 702 | 10212 |
| 3L-4S | | MI | 4109 | 2166 | 6209 | 1721 | 6951 | 1446 | 7324 | 1219 | 7637 | 864 | 8849 | 563 | 5627 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis

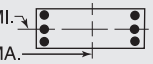


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.87 | MA | 7228 | 2166 | 10312 | 1817 | 11970 | 1531 | 12862 | 1296 | 13720 | 931 | 16563 | 652 | 10152 |
| 4L-3S | | MI | 4196 | 2166 | 6446 | 1713 | 7285 | 1432 | 7732 | 1215 | 8195 | 863 | 9508 | 611 | 5622 |
| 10-#10 | 1.87 | MA | 6974 | 2166 | 9859 | 1838 | 11425 | 1543 | 12184 | 1307 | 12774 | 948 | 15272 | 611 | 9880 |
| 5L-2S | | MI | 4361 | 2166 | 6785 | 1705 | 7717 | 1426 | 8257 | 1202 | 8906 | 854 | 10437 | 703 | 5608 |
| 10-#11 | 2.29 | MA | 7637 | 2249 | 11375 | 1849 | 13331 | 1543 | 14496 | 1295 | 15922 | 915 | 19404 | 670 | 12346 |
| 3L-4S | | MI | 4194 | 2249 | 6477 | 1757 | 7239 | 1472 | 7650 | 1231 | 8060 | 848 | 9301 | 489 | 6704 |
| 10-#11 | 2.29 | MA | 7442 | 2249 | 10835 | 1864 | 12569 | 1566 | 13560 | 1318 | 14640 | 924 | 17852 | 608 | 12234 |
| 4L-3S | | MI | 4297 | 2249 | 6762 | 1749 | 7640 | 1455 | 8140 | 1227 | 8731 | 849 | 10072 | 546 | 6715 |
| 10-#11 | 2.29 | MA | 7141 | 2249 | 10286 | 1889 | 11906 | 1580 | 12736 | 1330 | 13490 | 944 | 16277 | 555 | 11638 |
| 5L-2S | | MI | 4488 | 2249 | 7168 | 1740 | 8157 | 1449 | 8768 | 1213 | 9581 | 839 | 11153 | 658 | 6702 |
| 10-#14 | 3.31 | MA | 8242 | 2446 | 12783 | 1971 | 15084 | 1631 | 16605 | 1350 | 18760 | 907 | 23323 | 603 | 17455 |
| 3L-4S | | MI | 4428 | 2446 | 7065 | 1873 | 7938 | 1558 | 8481 | 1282 | 9206 | 843 | 10631 | 344 | 8959 |
| 10-#14 | 3.31 | MA | 7984 | 2446 | 12010 | 1991 | 13993 | 1665 | 15267 | 1382 | 16926 | 919 | 21091 | 512 | 16941 |
| 4L-3S | | MI | 4566 | 2446 | 7470 | 1862 | 8507 | 1536 | 9178 | 1279 | 10123 | 832 | 11704 | 423 | 9306 |
| 10-#14 | 3.31 | MA | 7563 | 2446 | 11223 | 2027 | 13043 | 1683 | 14085 | 1398 | 15280 | 947 | 18831 | 433 | 15743 |
| 5L-2S | | MI | 4824 | 2446 | 8045 | 1851 | 9239 | 1529 | 10066 | 1260 | 11325 | 821 | 13202 | 585 | 9322 |
| 10-#18 | 5.88 | MA | 9310 | 2945 | 14892 | 2317 | 17505 | 1915 | 19485 | 1544 | 22588 | 905 | 29101 | 267 | 27206 |
| 4L-3S | | MI | 5219 | 2945 | 9162 | 2155 | 10595 | 1743 | 11683 | 1411 | 13473 | 788 | 15432 | 73 | 15180 |
| 10-#18 | 5.88 | MA | 8604 | 2945 | 13511 | 2377 | 15841 | 1945 | 17415 | 1570 | 19706 | 950 | 25129 | 117 | 24591 |
| 5L-2S | | MI | 5583 | 2945 | 10143 | 2140 | 11844 | 1735 | 13200 | 1384 | 15521 | 774 | 17878 | 360 | 15576 |
| 12-#10 | 2.24 | MA | 7706 | 2238 | 11412 | 1850 | 13433 | 1545 | 14648 | 1298 | 16149 | 918 | 19736 | 696 | 12188 |
| 3L-5S | | MI | 4158 | 2238 | 6305 | 1782 | 7091 | 1485 | 7485 | 1252 | 7843 | 869 | 9126 | 496 | 6499 |
| 12-#10 | 2.24 | MA | 7548 | 2238 | 10968 | 1862 | 12806 | 1564 | 13878 | 1317 | 15094 | 927 | 18466 | 646 | 12118 |
| 4E | | MI | 4261 | 2238 | 6548 | 1766 | 7384 | 1479 | 7849 | 1240 | 8347 | 860 | 9779 | 550 | 6648 |
| 12-#10 | 2.24 | MA | 7295 | 2238 | 10516 | 1883 | 12261 | 1576 | 13199 | 1327 | 14149 | 944 | 17174 | 606 | 11810 |
| 5L-3S | | MI | 4345 | 2238 | 6785 | 1758 | 7717 | 1465 | 8257 | 1235 | 8906 | 859 | 10437 | 598 | 6655 |
| 12-#10 | 2.24 | MA | 7069 | 2238 | 10077 | 1889 | 11748 | 1587 | 12534 | 1346 | 13248 | 960 | 15914 | 537 | 11330 |
| 6L-2S | | MI | 4506 | 2238 | 7124 | 1750 | 8149 | 1459 | 8782 | 1223 | 9616 | 850 | 11367 | 690 | 6646 |
| 12-#11 | 2.75 | MA | 7823 | 2338 | 11631 | 1919 | 13582 | 1607 | 14791 | 1343 | 16305 | 919 | 20158 | 600 | 14612 |
| 4E | | MI | 4373 | 2338 | 6883 | 1813 | 7756 | 1512 | 8278 | 1256 | 8910 | 842 | 10382 | 469 | 7918 |
| 12-#11 | 2.75 | MA | 7525 | 2338 | 11082 | 1944 | 12919 | 1620 | 13966 | 1355 | 15156 | 939 | 18583 | 548 | 13981 |
| 5L-3S | | MI | 4471 | 2338 | 7168 | 1804 | 8157 | 1496 | 8768 | 1253 | 9581 | 843 | 11153 | 526 | 7943 |
| 12-#11 | 2.75 | MA | 7257 | 2338 | 10554 | 1952 | 12296 | 1633 | 13156 | 1377 | 14060 | 958 | 17044 | 461 | 13440 |
| 6L-2S | | MI | 4658 | 2338 | 7575 | 1796 | 8674 | 1490 | 9397 | 1239 | 10431 | 834 | 12235 | 638 | 7940 |
| 12-#14 | 3.97 | MA | 8516 | 2574 | 13147 | 2072 | 15439 | 1723 | 17024 | 1418 | 19304 | 912 | 24384 | 502 | 20271 |
| 4E | | MI | 4676 | 2574 | 7639 | 1954 | 8670 | 1616 | 9369 | 1319 | 10408 | 836 | 12129 | 311 | 10584 |
| 12-#14 | 3.97 | MA | 8100 | 2574 | 12359 | 2107 | 14490 | 1742 | 15843 | 1434 | 17659 | 939 | 22125 | 423 | 19118 |
| 5L-3S | | MI | 4808 | 2574 | 8045 | 1943 | 9239 | 1594 | 10066 | 1315 | 11325 | 825 | 13202 | 389 | 11024 |
| 12-#14 | 3.97 | MA | 7735 | 2574 | 11612 | 2118 | 13598 | 1760 | 14682 | 1466 | 16089 | 966 | 19913 | 298 | 17871 |
| 6L-2S | | MI | 5060 | 2574 | 8619 | 1932 | 9970 | 1587 | 10954 | 1297 | 12527 | 813 | 14700 | 551 | 11059 |
| 12-#18 | 7.06 | MA | 9509 | 3174 | 15491 | 2520 | 18362 | 2048 | 20477 | 1635 | 23850 | 937 | 30867 | 98 | 30414 |
| 5L-3S | | MI | 5614 | 3174 | 10143 | 2298 | 11844 | 1847 | 13200 | 1476 | 15521 | 774 | 17878 | -3 | 17873 |
| 14-#10 | 2.61 | MA | 7862 | 2311 | 11625 | 1908 | 13642 | 1597 | 14893 | 1337 | 16468 | 922 | 20369 | 641 | 14084 |
| 4L-5S | | MI | 4309 | 2311 | 6644 | 1827 | 7523 | 1518 | 8010 | 1273 | 8553 | 864 | 10056 | 483 | 7477 |
| 14-#10 | 2.61 | MA | 7611 | 2311 | 11173 | 1928 | 13097 | 1609 | 14215 | 1348 | 15523 | 939 | 19077 | 600 | 13744 |
| 5L-4S | | MI | 4411 | 2311 | 6887 | 1811 | 7816 | 1512 | 8373 | 1260 | 9058 | 855 | 10708 | 537 | 7666 |
| 14-#10 | 2.61 | MA | 7393 | 2311 | 10734 | 1934 | 12585 | 1620 | 13549 | 1367 | 14622 | 956 | 17817 | 531 | 13282 |
| 6L-3S | | MI | 4492 | 2311 | 7124 | 1803 | 8149 | 1498 | 8782 | 1256 | 9616 | 855 | 11367 | 585 | 7682 |
| 14-#10 | 2.61 | MA | 7207 | 2311 | 10318 | 1942 | 11999 | 1634 | 12910 | 1377 | 13702 | 965 | 16600 | 497 | 12783 |
| 7L-2S | | MI | 4649 | 2311 | 7464 | 1796 | 8581 | 1492 | 9307 | 1243 | 10327 | 846 | 12297 | 677 | 7679 |
| 14-#11 | 3.21 | MA | 7901 | 2427 | 11877 | 2000 | 13932 | 1661 | 15197 | 1380 | 16821 | 933 | 20889 | 540 | 16331 |
| 5L-4S | | MI | 4549 | 2427 | 7289 | 1868 | 8273 | 1553 | 8906 | 1282 | 9760 | 837 | 11464 | 449 | 9091 |
| 14-#11 | 3.21 | MA | 7643 | 2427 | 11350 | 2007 | 13310 | 1674 | 14387 | 1402 | 15725 | 953 | 19350 | 454 | 15810 |
| 6L-3S | | MI | 4644 | 2427 | 7575 | 1860 | 8674 | 1536 | 9397 | 1278 | 10431 | 838 | 12235 | 506 | 9166 |
| 14-#11 | 3.21 | MA | 7423 | 2427 | 10845 | 2016 | 12606 | 1692 | 13608 | 1414 | 14606 | 962 | 17861 | 411 | 14975 |
| 7L-2S | | MI | 4826 | 2427 | 7981 | 1852 | 9191 | 1530 | 10025 | 1264 | 11281 | 829 | 13317 | 618 | 9173 |
| 14-#14 | 4.63 | MA | 8624 | 2703 | 13495 | 2187 | 15937 | 1800 | 17600 | 1471 | 20037 | 932 | 25418 | 413 | 22499 |
| 5L-4S | | MI | 4922 | 2703 | 8213 | 2034 | 9401 | 1675 | 10257 | 1355 | 11610 | 829 | 13627 | 277 | 12222 |

## RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis

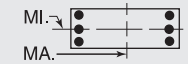



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 4.63 | MA | 8276 | 2703 | 12748 | 2198 | 15045 | 1818 | 16439 | 1502 | 18467 | 959 | 23206 | 287 | 21237 |
| 6L-3S | | MI | 5062 | 2703 | 8619 | 2023 | 9970 | 1653 | 10954 | 1352 | 12527 | 817 | 14700 | 356 | 12740 |
| 14-#14 | 4.63 | MA | 7978 | 2703 | 12025 | 2211 | 14049 | 1845 | 15324 | 1519 | 16864 | 971 | 21067 | 223 | 19831 |
| 7L-2S | | MI | 5287 | 2703 | 9193 | 2012 | 10701 | 1645 | 11842 | 1333 | 13729 | 806 | 16198 | 518 | 12789 |
| 16-#10 | 2.99 | MA | 7922 | 2383 | 11829 | 1974 | 13934 | 1642 | 15231 | 1368 | 16898 | 935 | 20980 | 594 | 15683 |
| 5E | | MI | 4458 | 2383 | 6984 | 1873 | 7955 | 1551 | 8535 | 1293 | 9263 | 860 | 10986 | 470 | 8460 |
| 16-#10 | 2.99 | MA | 7710 | 2383 | 11390 | 1980 | 13421 | 1653 | 14565 | 1387 | 15996 | 952 | 19720 | 525 | 15236 |
| 6L-4S | | MI | 4560 | 2383 | 7227 | 1857 | 8248 | 1545 | 8898 | 1281 | 9768 | 851 | 11638 | 524 | 8682 |
| 16-#10 | 2.99 | MA | 7532 | 2383 | 10974 | 1987 | 12835 | 1667 | 13926 | 1398 | 15077 | 960 | 18503 | 491 | 14734 |
| 7L-3S | | MI | 4638 | 2383 | 7464 | 1849 | 8581 | 1531 | 9307 | 1276 | 10327 | 850 | 12297 | 572 | 8705 |
| 16-#10 | 2.99 | MA | 7316 | 2383 | 10576 | 1997 | 12296 | 1675 | 13245 | 1413 | 14199 | 977 | 17328 | 445 | 14137 |
| 8L-2S | | MI | 4792 | 2383 | 7803 | 1841 | 9013 | 1525 | 9832 | 1264 | 11037 | 841 | 13227 | 663 | 8709 |
| 16-#11 | 3.67 | MA | 8021 | 2516 | 12146 | 2063 | 14323 | 1714 | 15617 | 1428 | 17390 | 948 | 21657 | 447 | 18182 |
| 6L-4S | | MI | 4724 | 2516 | 7695 | 1924 | 8790 | 1593 | 9534 | 1307 | 10610 | 832 | 12546 | 429 | 10248 |
| 16-#11 | 3.67 | MA | 7812 | 2516 | 11641 | 2072 | 13619 | 1733 | 14839 | 1440 | 16271 | 957 | 20167 | 404 | 17343 |
| 7L-3S | | MI | 4815 | 2516 | 7981 | 1916 | 9191 | 1577 | 10025 | 1303 | 11281 | 833 | 13317 | 485 | 10385 |
| 16-#11 | 3.67 | MA | 7557 | 2516 | 11156 | 2083 | 12964 | 1741 | 14025 | 1459 | 15203 | 977 | 18733 | 344 | 16459 |
| 8L-2S | | MI | 4992 | 2516 | 8387 | 1907 | 9708 | 1571 | 10653 | 1289 | 12131 | 824 | 14399 | 598 | 10402 |
| 16-#14 | 5.29 | MA | 8805 | 2831 | 13885 | 2278 | 16492 | 1877 | 18197 | 1539 | 20846 | 951 | 26499 | 277 | 24604 |
| 6L-4S | | MI | 5191 | 2831 | 8788 | 2114 | 10132 | 1733 | 11146 | 1392 | 12812 | 821 | 15125 | 243 | 13869 |
| 16-#14 | 5.29 | MA | 8524 | 2831 | 13162 | 2291 | 15495 | 1903 | 17082 | 1555 | 19243 | 964 | 24361 | 212 | 23182 |
| 7L-3S | | MI | 5296 | 2831 | 9193 | 2103 | 10701 | 1711 | 11842 | 1388 | 13729 | 810 | 16198 | 322 | 14453 |
| 18-#10 | 3.36 | MA | 8023 | 2456 | 12047 | 2025 | 14257 | 1686 | 15580 | 1408 | 17371 | 948 | 21623 | 519 | 17192 |
| 6L-5S | | MI | 4606 | 2456 | 7323 | 1918 | 8388 | 1584 | 9060 | 1314 | 9974 | 856 | 11915 | 457 | 9446 |
| 18-#10 | 3.36 | MA | 7851 | 2456 | 11631 | 2033 | 13671 | 1700 | 14941 | 1418 | 16451 | 956 | 20406 | 485 | 16687 |
| 7L-4S | | MI | 4707 | 2456 | 7566 | 1902 | 8680 | 1578 | 9423 | 1301 | 10479 | 847 | 12568 | 511 | 9697 |
| 18-#10 | 3.36 | MA | 7638 | 2456 | 11232 | 2042 | 13132 | 1708 | 14260 | 1433 | 15573 | 973 | 19231 | 439 | 16096 |
| 8L-3S | | MI | 4783 | 2456 | 7803 | 1894 | 9013 | 1563 | 9832 | 1297 | 11037 | 846 | 13227 | 559 | 9726 |
| 18-#10 | 3.36 | MA | 7426 | 2456 | 10784 | 2060 | 12579 | 1725 | 13596 | 1440 | 14675 | 981 | 18075 | 395 | 15340 |
| 9L-2S | | MI | 4934 | 2456 | 8143 | 1886 | 9446 | 1557 | 10357 | 1284 | 11747 | 837 | 14157 | 650 | 9736 |
| 18-#11 | 4.13 | MA | 8193 | 2605 | 12436 | 2128 | 14633 | 1773 | 16070 | 1465 | 17937 | 952 | 22473 | 397 | 19714 |
| 7L-4S | | MI | 4897 | 2605 | 8101 | 1980 | 9307 | 1634 | 10162 | 1332 | 11460 | 827 | 13627 | 408 | 11412 |
| 18-#11 | 4.13 | MA | 7941 | 2605 | 11951 | 2139 | 13977 | 1782 | 15255 | 1484 | 16868 | 972 | 21039 | 337 | 18817 |
| 8L-3S | | MI | 4984 | 2605 | 8387 | 1971 | 9708 | 1617 | 10653 | 1328 | 12131 | 828 | 14399 | 465 | 11603 |
| 18-#14 | 5.96 | MA | 9059 | 2960 | 14298 | 2371 | 16942 | 1962 | 18839 | 1591 | 21621 | 956 | 27654 | 202 | 26532 |
| 7L-4S | | MI | 5430 | 2960 | 9362 | 2194 | 10863 | 1791 | 12034 | 1428 | 14014 | 814 | 16623 | 210 | 15524 |
| 20-#10 | 3.74 | MA | 8166 | 2528 | 12288 | 2078 | 14507 | 1733 | 15957 | 1439 | 17825 | 952 | 22309 | 480 | 18641 |
| 7L-5S | | MI | 4752 | 2528 | 7663 | 1963 | 8820 | 1617 | 9585 | 1334 | 10684 | 852 | 12845 | 444 | 10435 |
| 20-#10 | 3.74 | MA | 7954 | 2528 | 11889 | 2087 | 13968 | 1741 | 15276 | 1454 | 16947 | 969 | 21134 | 433 | 18054 |
| 8L-4S | | MI | 4854 | 2528 | 7906 | 1947 | 9112 | 1611 | 9948 | 1322 | 11189 | 843 | 13498 | 498 | 10706 |
| 20-#10 | 3.74 | MA | 7749 | 2528 | 11441 | 2106 | 13415 | 1758 | 14612 | 1461 | 16049 | 977 | 19978 | 389 | 17291 |
| 9L-3S | | MI | 4926 | 2528 | 8143 | 1939 | 9446 | 1596 | 10357 | 1318 | 11747 | 842 | 14157 | 546 | 10745 |
| 20-#10 | 3.74 | MA | 7561 | 2528 | 11028 | 2113 | 12893 | 1767 | 13949 | 1477 | 15175 | 994 | 18808 | 348 | 16558 |
| 10L-2S | | MI | 5074 | 2528 | 8482 | 1932 | 9878 | 1590 | 10881 | 1305 | 12458 | 833 | 15086 | 637 | 10760 |
| 20-#11 | 4.59 | MA | 8318 | 2694 | 12747 | 2194 | 14991 | 1822 | 16486 | 1509 | 18534 | 967 | 23346 | 330 | 21175 |
| 8L-4S | | MI | 5069 | 2694 | 8507 | 2035 | 9825 | 1674 | 10790 | 1357 | 12309 | 822 | 14709 | 388 | 12581 |
| 22-#10 | 4.11 | MA | 8266 | 2601 | 12546 | 2133 | 14804 | 1774 | 16291 | 1474 | 18322 | 965 | 23037 | 427 | 20012 |
| 8L-5S | | MI | 4897 | 2601 | 8002 | 2009 | 9252 | 1650 | 10110 | 1355 | 11395 | 848 | 13775 | 431 | 11426 |
| 22-#10 | 4.11 | MA | 8066 | 2601 | 12098 | 2151 | 14251 | 1791 | 15627 | 1481 | 17424 | 973 | 21881 | 383 | 19242 |
| 9L-4S | | MI | 4999 | 2601 | 8245 | 1993 | 9545 | 1644 | 10473 | 1342 | 11899 | 838 | 14428 | 485 | 11685 |
| 22-#10 | 4.11 | MA | 7885 | 2601 | 11684 | 2158 | 13729 | 1800 | 14965 | 1498 | 16549 | 989 | 20710 | 342 | 18503 |
| 10L-3S | | MI | 5069 | 2601 | 8482 | 1985 | 9878 | 1629 | 10881 | 1338 | 12458 | 838 | 15086 | 533 | 11763 |
| 24-#10 | 4.48 | MA | 8379 | 2674 | 12755 | 2196 | 15087 | 1824 | 16643 | 1502 | 18798 | 969 | 23784 | 377 | 21193 |
| 9L-5S | | MI | 5042 | 2674 | 8342 | 2054 | 9684 | 1683 | 10635 | 1376 | 12105 | 843 | 14705 | 418 | 12420 |
| 24-#10 | 4.48 | MA | 8204 | 2674 | 12341 | 2203 | 14565 | 1833 | 15980 | 1518 | 17923 | 985 | 22613 | 336 | 20448 |
| 10L-4S | | MI | 5143 | 2674 | 8585 | 2038 | 9977 | 1677 | 10998 | 1363 | 12610 | 834 | 15357 | 472 | 12667 |

## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

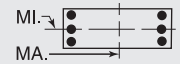
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.25 | MA | 8065 | 2166 | 11612 | 1809 | 13498 | 1523 | 14496 | 1299 | 15476 | 961 | 18469 | 835 | 7724 |
| 2E | | MI | 4319 | 2166 | 6626 | 1696 | 7373 | 1426 | 7732 | 1214 | 8031 | 894 | 9045 | 730 | 4060 |
| 4-#18 | 2.22 | MA | 8875 | 2366 | 13519 | 1920 | 15842 | 1602 | 17302 | 1345 | 19241 | 941 | 23656 | 812 | 13298 |
| 2E | | MI | 4642 | 2366 | 7508 | 1796 | 8427 | 1495 | 8980 | 1252 | 9687 | 866 | 10873 | 632 | 6708 |
| 6-#10 | 1.06 | MA | 7929 | 2127 | 11167 | 1801 | 13033 | 1519 | 13982 | 1300 | 14823 | 973 | 17595 | 847 | 6652 |
| 2L-3S | | MI | 4105 | 2127 | 6066 | 1709 | 6747 | 1440 | 7013 | 1238 | 7089 | 923 | 7989 | 682 | 3555 |
| 6-#10 | 1.06 | MA | 7547 | 2127 | 10465 | 1814 | 12140 | 1531 | 12897 | 1311 | 13353 | 990 | 15560 | 767 | 6663 |
| 3L-2S | | MI | 4278 | 2127 | 6405 | 1701 | 7179 | 1434 | 7538 | 1226 | 7800 | 914 | 8918 | 774 | 3532 |
| 6-#11 | 1.30 | MA | 8132 | 2177 | 11684 | 1823 | 13632 | 1533 | 14680 | 1307 | 15743 | 964 | 18851 | 838 | 8059 |
| 2L-3S | | MI | 4153 | 2177 | 6252 | 1723 | 6934 | 1448 | 7216 | 1241 | 7345 | 910 | 8246 | 631 | 4255 |
| 6-#11 | 1.30 | MA | 7679 | 2177 | 10832 | 1838 | 12548 | 1547 | 13363 | 1319 | 13961 | 985 | 16383 | 737 | 8063 |
| 3L-2S | | MI | 4356 | 2177 | 6659 | 1715 | 7451 | 1442 | 7844 | 1227 | 8195 | 901 | 9328 | 743 | 4225 |
| 6-#14 | 1.88 | MA | 8632 | 2295 | 12828 | 1889 | 15047 | 1581 | 16377 | 1335 | 18022 | 953 | 21994 | 825 | 11418 |
| 2L-3S | | MI | 4285 | 2295 | 6626 | 1787 | 7373 | 1492 | 7732 | 1269 | 8031 | 898 | 9045 | 535 | 5878 |
| 6-#14 | 1.88 | MA | 8010 | 2295 | 11612 | 1911 | 13498 | 1600 | 14496 | 1352 | 15476 | 982 | 18469 | 678 | 11375 |
| 3L-2S | | MI | 4562 | 2295 | 7200 | 1776 | 8104 | 1485 | 8620 | 1251 | 9234 | 886 | 10542 | 696 | 5846 |
| 6-#18 | 3.33 | MA | 9810 | 2595 | 15641 | 2063 | 18545 | 1705 | 20585 | 1410 | 23683 | 928 | 29808 | 794 | 19703 |
| 2L-3S | | MI | 4596 | 2595 | 7508 | 1953 | 8427 | 1607 | 8980 | 1344 | 9687 | 865 | 10873 | 268 | 9662 |
| 6-#18 | 3.33 | MA | 8815 | 2595 | 13519 | 2098 | 15842 | 1737 | 17302 | 1438 | 19241 | 975 | 23656 | 524 | 19404 |
| 3L-2S | | MI | 5040 | 2595 | 8489 | 1938 | 9676 | 1599 | 10497 | 1317 | 11735 | 852 | 13319 | 556 | 9709 |
| 8-#9 | 1.11 | MA | 7989 | 2138 | 11257 | 1812 | 13170 | 1527 | 14159 | 1306 | 15070 | 974 | 17944 | 848 | 6987 |
| 2L-4S | | MI | 4097 | 2138 | 5989 | 1727 | 6642 | 1461 | 6892 | 1247 | 6928 | 926 | 7857 | 668 | 3735 |
| 8-#9 | 1.11 | MA | 7689 | 2138 | 10702 | 1822 | 12463 | 1537 | 13300 | 1314 | 13908 | 988 | 16335 | 785 | 6995 |
| 3E | | MI | 4171 | 2138 | 6177 | 1721 | 6907 | 1449 | 7216 | 1244 | 7371 | 925 | 8385 | 707 | 3715 |
| 8-#9 | 1.11 | MA | 7535 | 2138 | 10328 | 1832 | 11934 | 1553 | 12651 | 1330 | 13018 | 996 | 15271 | 746 | 6982 |
| 4L-2S | | MI | 4308 | 2138 | 6446 | 1715 | 7250 | 1444 | 7633 | 1234 | 7936 | 917 | 9131 | 779 | 3698 |
| 8-#10 | 1.41 | MA | 8266 | 2199 | 11869 | 1847 | 13927 | 1552 | 15068 | 1321 | 16292 | 969 | 19629 | 841 | 8785 |
| 2L-4S | | MI | 4166 | 2199 | 6168 | 1762 | 6846 | 1487 | 7130 | 1263 | 7241 | 919 | 8260 | 621 | 4625 |
| 8-#10 | 1.41 | MA | 7895 | 2199 | 11167 | 1859 | 13033 | 1564 | 13982 | 1331 | 14823 | 986 | 17595 | 761 | 8783 |
| 3E | | MI | 4258 | 2199 | 6405 | 1754 | 7179 | 1473 | 7538 | 1259 | 7800 | 919 | 8918 | 669 | 4607 |
| 8-#10 | 1.41 | MA | 7706 | 2199 | 10694 | 1872 | 12364 | 1584 | 13161 | 1351 | 13696 | 995 | 16246 | 711 | 8735 |
| 4L-2S | | MI | 4427 | 2199 | 6745 | 1747 | 7611 | 1467 | 8063 | 1246 | 8510 | 910 | 9848 | 761 | 4587 |
| 8-#11 | 1.73 | MA | 8531 | 2266 | 12535 | 1878 | 14716 | 1574 | 15997 | 1332 | 17525 | 959 | 21318 | 831 | 10643 |
| 2L-4S | | MI | 4224 | 2266 | 6373 | 1787 | 7050 | 1505 | 7353 | 1270 | 7524 | 904 | 8557 | 554 | 5521 |
| 8-#11 | 1.73 | MA | 8094 | 2266 | 11684 | 1893 | 13632 | 1588 | 14680 | 1345 | 15743 | 980 | 18851 | 730 | 10628 |
| 3E | | MI | 4333 | 2266 | 6659 | 1779 | 7451 | 1488 | 7844 | 1266 | 8195 | 905 | 9328 | 611 | 5507 |
| 8-#11 | 1.73 | MA | 7870 | 2266 | 11108 | 1908 | 12818 | 1612 | 13681 | 1368 | 14373 | 990 | 17201 | 669 | 10532 |
| 4L-2S | | MI | 4530 | 2266 | 7065 | 1771 | 7968 | 1482 | 8472 | 1252 | 9045 | 895 | 10410 | 723 | 5483 |
| 8-#14 | 2.50 | MA | 9184 | 2423 | 14045 | 1970 | 16596 | 1640 | 18259 | 1372 | 20569 | 946 | 25520 | 815 | 15096 |
| 2L-4S | | MI | 4386 | 2423 | 6795 | 1878 | 7535 | 1572 | 7924 | 1310 | 8317 | 901 | 9470 | 422 | 7459 |
| 8-#14 | 2.50 | MA | 8591 | 2423 | 12828 | 1991 | 15047 | 1659 | 16377 | 1389 | 18022 | 974 | 21994 | 667 | 15022 |
| 3E | | MI | 4534 | 2423 | 7200 | 1867 | 8104 | 1550 | 8620 | 1306 | 9234 | 890 | 10542 | 501 | 7621 |
| 8-#14 | 2.50 | MA | 8288 | 2423 | 12003 | 2012 | 13881 | 1693 | 14947 | 1421 | 16062 | 988 | 19622 | 578 | 14712 |
| 4L-2S | | MI | 4802 | 2423 | 7775 | 1856 | 8836 | 1543 | 9509 | 1287 | 10436 | 879 | 12040 | 663 | 7608 |
| 8-#18 | 4.44 | MA | 9790 | 2823 | 15641 | 2241 | 18545 | 1841 | 20585 | 1502 | 23683 | 961 | 29808 | 505 | 25747 |
| 3E | | MI | 5009 | 2823 | 8489 | 2096 | 9676 | 1711 | 10497 | 1409 | 11735 | 851 | 13319 | 192 | 12571 |
| 8-#18 | 4.44 | MA | 9315 | 2823 | 14195 | 2276 | 16504 | 1899 | 18081 | 1557 | 20252 | 982 | 25617 | 344 | 23057 |
| 4L-2S | | MI | 5423 | 2823 | 9470 | 2081 | 10925 | 1703 | 12013 | 1382 | 13783 | 838 | 15765 | 480 | 12678 |
| 10-#10 | 1.76 | MA | 8597 | 2272 | 12571 | 1892 | 14821 | 1585 | 16153 | 1341 | 17761 | 965 | 21663 | 836 | 10912 |
| 2L-5S | | MI | 4217 | 2272 | 6265 | 1824 | 6986 | 1526 | 7292 | 1296 | 7447 | 924 | 8537 | 554 | 5595 |
| 10-#10 | 1.76 | MA | 8237 | 2272 | 11869 | 1905 | 13927 | 1597 | 15068 | 1352 | 16292 | 982 | 19629 | 755 | 10898 |
| 3L-4S | | MI | 4321 | 2272 | 6508 | 1808 | 7278 | 1520 | 7655 | 1284 | 7952 | 915 | 9189 | 608 | 5657 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

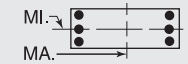
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.76 | MA | 8057 | 2272 | 11396 | 1917 | 13258 | 1617 | 14246 | 1371 | 15165 | 991 | 18280 | 706 | 10837 |
| 4L-3S | | MI | 4409 | 2272 | 6745 | 1800 | 7611 | 1506 | 8063 | 1279 | 8510 | 915 | 9848 | 656 | 5648 |
| 10-#10 | 1.76 | MA | 7781 | 2272 | 10910 | 1938 | 12678 | 1629 | 13523 | 1382 | 14158 | 1008 | 16905 | 666 | 10614 |
| 5L-2S | | MI | 4574 | 2272 | 7084 | 1792 | 8044 | 1500 | 8588 | 1267 | 9221 | 905 | 10778 | 748 | 5632 |
| 10-#11 | 2.17 | MA | 8501 | 2355 | 12535 | 1949 | 14716 | 1628 | 15997 | 1370 | 17525 | 974 | 21318 | 723 | 13188 |
| 3L-4S | | MI | 4406 | 2355 | 6779 | 1843 | 7567 | 1545 | 7981 | 1295 | 8373 | 898 | 9638 | 534 | 6743 |
| 10-#11 | 2.17 | MA | 8290 | 2355 | 11959 | 1964 | 13902 | 1652 | 14998 | 1393 | 16155 | 985 | 19668 | 662 | 13077 |
| 4L-3S | | MI | 4509 | 2355 | 7065 | 1835 | 7968 | 1529 | 8472 | 1291 | 9045 | 900 | 10410 | 591 | 6746 |
| 10-#11 | 2.17 | MA | 7963 | 2355 | 11373 | 1989 | 13196 | 1666 | 14118 | 1405 | 14929 | 1005 | 17991 | 611 | 12508 |
| 5L-2S | | MI | 4702 | 2355 | 7471 | 1826 | 8485 | 1523 | 9100 | 1277 | 9895 | 890 | 11491 | 703 | 6731 |
| 10-#14 | 3.13 | MA | 9157 | 2552 | 14045 | 2071 | 16596 | 1717 | 18259 | 1425 | 20569 | 967 | 25520 | 657 | 18670 |
| 3L-4S | | MI | 4639 | 2552 | 7369 | 1959 | 8267 | 1631 | 8812 | 1346 | 9519 | 894 | 10967 | 389 | 9066 |
| 10-#14 | 3.13 | MA | 8877 | 2552 | 13220 | 2092 | 15431 | 1751 | 16829 | 1458 | 18609 | 980 | 23148 | 567 | 18273 |
| 4L-3S | | MI | 4779 | 2552 | 7775 | 1948 | 8836 | 1609 | 9509 | 1342 | 10436 | 883 | 12040 | 467 | 9349 |
| 10-#14 | 3.13 | MA | 8419 | 2552 | 12380 | 2128 | 14418 | 1770 | 15568 | 1475 | 16852 | 1009 | 20741 | 491 | 16929 |
| 5L-2S | | MI | 5038 | 2552 | 8349 | 1937 | 9567 | 1601 | 10397 | 1324 | 11638 | 871 | 13538 | 629 | 9358 |
| 10-#18 | 5.56 | MA | 10315 | 3051 | 16318 | 2419 | 19206 | 2003 | 21363 | 1622 | 24695 | 969 | 31769 | 325 | 29353 |
| 4L-3S | | MI | 5431 | 3051 | 9470 | 2239 | 10925 | 1814 | 12013 | 1474 | 13783 | 837 | 15765 | 116 | 15357 |
| 10-#18 | 5.56 | MA | 9543 | 3051 | 14843 | 2481 | 17429 | 2034 | 19152 | 1650 | 21615 | 1016 | 27535 | 181 | 26632 |
| 5L-2S | | MI | 5801 | 3051 | 10451 | 2224 | 12174 | 1807 | 13530 | 1447 | 15832 | 824 | 18211 | 404 | 15627 |
| 12-#10 | 2.12 | MA | 8573 | 2345 | 12571 | 1950 | 14821 | 1630 | 16153 | 1372 | 17761 | 978 | 21663 | 749 | 13011 |
| 3L-5S | | MI | 4370 | 2345 | 6604 | 1869 | 7418 | 1559 | 7816 | 1317 | 8157 | 920 | 9467 | 541 | 6567 |
| 12-#10 | 2.12 | MA | 8402 | 2345 | 12098 | 1963 | 14152 | 1650 | 15332 | 1392 | 16635 | 987 | 20315 | 700 | 12941 |
| 4E | | MI | 4473 | 2345 | 6847 | 1853 | 7710 | 1553 | 8180 | 1304 | 8662 | 911 | 10119 | 595 | 6681 |
| 12-#10 | 2.12 | MA | 8128 | 2345 | 11612 | 1983 | 13571 | 1662 | 14609 | 1403 | 15627 | 1004 | 18940 | 660 | 12680 |
| 5L-3S | | MI | 4558 | 2345 | 7084 | 1845 | 8044 | 1539 | 8588 | 1300 | 9221 | 910 | 10778 | 643 | 6682 |
| 12-#10 | 2.12 | MA | 7885 | 2345 | 11143 | 1989 | 13019 | 1673 | 13899 | 1422 | 14666 | 1022 | 17598 | 593 | 12145 |
| 6L-2S | | MI | 4720 | 2345 | 7424 | 1837 | 8476 | 1533 | 9113 | 1287 | 9931 | 901 | 11708 | 735 | 6671 |
| 12-#11 | 2.60 | MA | 8702 | 2444 | 12811 | 2020 | 14986 | 1693 | 16315 | 1418 | 17937 | 979 | 22136 | 654 | 15623 |
| 4E | | MI | 4585 | 2444 | 7185 | 1899 | 8084 | 1585 | 8609 | 1320 | 9223 | 893 | 10720 | 514 | 7960 |
| 12-#11 | 2.60 | MA | 8377 | 2444 | 12225 | 2045 | 14280 | 1707 | 15435 | 1431 | 16711 | 1000 | 20458 | 604 | 15019 |
| 5L-3S | | MI | 4684 | 2444 | 7471 | 1890 | 8485 | 1569 | 9100 | 1317 | 9895 | 894 | 11491 | 570 | 7978 |
| 12-#11 | 2.60 | MA | 8088 | 2444 | 11656 | 2052 | 13616 | 1720 | 14571 | 1454 | 15541 | 1020 | 18822 | 518 | 14419 |
| 6L-2S | | MI | 4872 | 2444 | 7877 | 1882 | 9002 | 1563 | 9728 | 1303 | 10745 | 885 | 12573 | 683 | 7971 |
| 12-#14 | 3.75 | MA | 9453 | 2680 | 14437 | 2173 | 16980 | 1810 | 18710 | 1494 | 21155 | 973 | 26674 | 557 | 21846 |
| 4E | | MI | 4888 | 2680 | 7943 | 2039 | 8998 | 1689 | 9700 | 1382 | 10721 | 886 | 12465 | 355 | 10689 |
| 12-#14 | 3.75 | MA | 8998 | 2680 | 13597 | 2209 | 15967 | 1829 | 17449 | 1511 | 19398 | 1001 | 24267 | 481 | 20547 |
| 5L-3S | | MI | 5021 | 2680 | 8349 | 2028 | 9567 | 1667 | 10397 | 1379 | 11638 | 875 | 13538 | 434 | 11070 |
| 12-#14 | 3.75 | MA | 8604 | 2680 | 12790 | 2219 | 15015 | 1848 | 16211 | 1544 | 17723 | 1030 | 21917 | 357 | 19282 |
| 6L-2S | | MI | 5273 | 2680 | 8923 | 2017 | 10298 | 1660 | 11285 | 1360 | 12840 | 864 | 15036 | 596 | 11098 |
| 12-#18 | 6.67 | MA | 10521 | 3280 | 16966 | 2624 | 20132 | 2138 | 22435 | 1714 | 26058 | 1003 | 33686 | 163 | 32875 |
| 5L-3S | | MI | 5827 | 3280 | 10451 | 2382 | 12174 | 1918 | 13530 | 1538 | 15832 | 823 | 18211 | 40 | 18061 |
| 12-#18 | 6.67 | MA | 9889 | 3280 | 15579 | 2644 | 18460 | 2170 | 20262 | 1769 | 23118 | 1050 | 29534 | -61 | 29300 |
| 6L-2S | | MI | 6175 | 3280 | 11432 | 2367 | 13422 | 1910 | 15047 | 1511 | 17880 | 810 | 20657 | 328 | 18567 |
| 14-#10 | 2.47 | MA | 8742 | 2417 | 12800 | 2008 | 15046 | 1683 | 16418 | 1412 | 18104 | 982 | 22349 | 694 | 15044 |
| 4L-5S | | MI | 4521 | 2417 | 6944 | 1914 | 7850 | 1592 | 8341 | 1337 | 8868 | 916 | 10396 | 528 | 7544 |
| 14-#10 | 2.47 | MA | 8469 | 2417 | 12314 | 2028 | 14465 | 1695 | 15695 | 1423 | 17096 | 1000 | 20974 | 655 | 14751 |
| 5L-4S | | MI | 4624 | 2417 | 7187 | 1898 | 8143 | 1586 | 8705 | 1325 | 9373 | 907 | 11049 | 582 | 7701 |
| 14-#10 | 2.47 | MA | 8233 | 2417 | 11845 | 2034 | 13913 | 1706 | 14985 | 1442 | 16135 | 1017 | 19632 | 587 | 14233 |
| 6L-3S | | MI | 4705 | 2417 | 7424 | 1890 | 8476 | 1572 | 9113 | 1321 | 9931 | 906 | 11708 | 630 | 7712 |
| 14-#10 | 2.47 | MA | 8033 | 2417 | 11401 | 2043 | 13288 | 1721 | 14301 | 1453 | 15155 | 1026 | 18341 | 554 | 13760 |
| 7L-2S | | MI | 4864 | 2417 | 7763 | 1883 | 8908 | 1566 | 9638 | 1308 | 10641 | 897 | 12638 | 722 | 7706 |
| 14-#11 | 3.03 | MA | 8783 | 2533 | 13076 | 2101 | 15364 | 1747 | 16751 | 1456 | 18493 | 995 | 22926 | 596 | 17536 |
| 5L-4S | | MI | 4762 | 2533 | 7591 | 1954 | 8601 | 1626 | 9237 | 1345 | 10073 | 888 | 11802 | 494 | 9174 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis

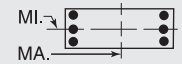



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 3.03 | MA | 8505 | 2533 | 12507 | 2108 | 14700 | 1761 | 15887 | 1479 | 17323 | 1015 | 21289 | 511 | 16957 |
| 6L-3S | | MI | 4857 | 2533 | 7877 | 1946 | 9002 | 1610 | 9728 | 1342 | 10745 | 889 | 12573 | 550 | 9203 |
| 14-#11 | 3.03 | MA | 8268 | 2533 | 11968 | 2117 | 13941 | 1779 | 15058 | 1491 | 16130 | 1025 | 19707 | 470 | 16120 |
| 7L-2S | | MI | 5040 | 2533 | 8283 | 1938 | 9519 | 1604 | 10356 | 1328 | 11594 | 880 | 13655 | 662 | 9206 |
| 14-#14 | 4.38 | MA | 9564 | 2809 | 14813 | 2289 | 17516 | 1887 | 19331 | 1548 | 21945 | 994 | 27793 | 471 | 24171 |
| 5L-4S | | MI | 5134 | 2809 | 8518 | 2119 | 9729 | 1747 | 10588 | 1419 | 11923 | 879 | 13963 | 321 | 12324 |
| 14-#14 | 4.38 | MA | 9188 | 2809 | 14006 | 2299 | 16564 | 1906 | 18093 | 1580 | 20269 | 1022 | 25443 | 346 | 22887 |
| 6L-3S | | MI | 5260 | 2809 | 8923 | 2108 | 10298 | 1725 | 11285 | 1415 | 12840 | 868 | 15036 | 400 | 12787 |
| 14-#14 | 4.38 | MA | 8867 | 2809 | 13234 | 2313 | 15488 | 1933 | 16903 | 1597 | 18559 | 1036 | 23167 | 285 | 21465 |
| 7L-2S | | MI | 5504 | 2809 | 9498 | 2097 | 11030 | 1718 | 12173 | 1397 | 14042 | 856 | 16534 | 562 | 12829 |
| 14-#18 | 7.78 | MA | 10881 | 3508 | 17702 | 2786 | 21163 | 2274 | 23544 | 1834 | 27561 | 1036 | 35685 | -79 | 35255 |
| 6L-3S | | MI | 6217 | 3508 | 11432 | 2524 | 13422 | 2022 | 15047 | 1603 | 17880 | 809 | 20657 | -36 | 20588 |
| 16-#10 | 2.82 | MA | 8804 | 2490 | 13016 | 2074 | 15359 | 1728 | 16780 | 1444 | 18565 | 996 | 23008 | 649 | 16826 |
| 5E | | MI | 4671 | 2490 | 7283 | 1960 | 8282 | 1625 | 8866 | 1358 | 9578 | 912 | 11326 | 515 | 8526 |
| 16-#10 | 2.82 | MA | 8576 | 2490 | 12547 | 2080 | 14807 | 1739 | 16071 | 1463 | 17605 | 1013 | 21667 | 581 | 16324 |
| 6L-4S | | MI | 4773 | 2490 | 7526 | 1944 | 8575 | 1619 | 9230 | 1345 | 10083 | 903 | 11979 | 569 | 8719 |
| 16-#10 | 2.82 | MA | 8383 | 2490 | 12103 | 2088 | 14182 | 1754 | 15386 | 1473 | 16624 | 1022 | 20375 | 548 | 15849 |
| 7L-3S | | MI | 4852 | 2490 | 7763 | 1936 | 8908 | 1605 | 9638 | 1341 | 10641 | 902 | 12638 | 617 | 8736 |
| 16-#10 | 2.82 | MA | 8149 | 2490 | 11678 | 2098 | 13607 | 1762 | 14655 | 1488 | 15688 | 1039 | 19126 | 503 | 15181 |
| 8L-2S | | MI | 5007 | 2490 | 8103 | 1928 | 9340 | 1599 | 10163 | 1328 | 11352 | 893 | 13567 | 709 | 8737 |
| 16-#11 | 3.47 | MA | 8913 | 2622 | 13359 | 2163 | 15784 | 1801 | 17204 | 1504 | 19105 | 1010 | 23757 | 504 | 19498 |
| 6L-4S | | MI | 4937 | 2622 | 7997 | 2010 | 9118 | 1666 | 9865 | 1371 | 10923 | 883 | 12884 | 473 | 10334 |
| 16-#11 | 3.47 | MA | 8687 | 2622 | 12819 | 2173 | 15025 | 1819 | 16374 | 1517 | 17912 | 1020 | 22174 | 462 | 18654 |
| 7L-3S | | MI | 5028 | 2622 | 8283 | 2002 | 9519 | 1650 | 10356 | 1367 | 11594 | 884 | 13655 | 530 | 10424 |
| 16-#11 | 3.47 | MA | 8409 | 2622 | 12302 | 2184 | 14326 | 1829 | 15494 | 1535 | 16772 | 1040 | 20649 | 404 | 17766 |
| 8L-2S | | MI | 5208 | 2622 | 8689 | 1993 | 10036 | 1644 | 10984 | 1353 | 12444 | 875 | 14737 | 642 | 10436 |
| 16-#14 | 5.00 | MA | 9760 | 2937 | 15223 | 2380 | 18113 | 1965 | 19974 | 1616 | 22816 | 1015 | 28969 | 336 | 26492 |
| 6L-4S | | MI | 5377 | 2937 | 9092 | 2199 | 10460 | 1806 | 11476 | 1455 | 13125 | 872 | 15461 | 288 | 13969 |
| 16-#14 | 5.00 | MA | 9456 | 2937 | 14451 | 2393 | 17037 | 1991 | 18785 | 1634 | 21105 | 1029 | 26692 | 274 | 25053 |
| 7L-3S | | MI | 5512 | 2937 | 9498 | 2189 | 11030 | 1784 | 12173 | 1452 | 14042 | 860 | 16534 | 366 | 14502 |
| 16-#14 | 5.00 | MA | 9067 | 2937 | 13709 | 2409 | 16035 | 2004 | 17538 | 1661 | 19472 | 1057 | 24502 | 188 | 23396 |
| 8L-2S | | MI | 5730 | 2937 | 10072 | 2178 | 11761 | 1776 | 13062 | 1433 | 15244 | 849 | 18032 | 528 | 14557 |
| 18-#10 | 3.17 | MA | 8913 | 2562 | 13249 | 2125 | 15701 | 1772 | 17156 | 1483 | 19074 | 1009 | 23701 | 575 | 18417 |
| 6L-5S | | MI | 4819 | 2562 | 7623 | 2005 | 8714 | 1658 | 9391 | 1379 | 10289 | 907 | 12256 | 502 | 9511 |
| 18-#10 | 3.17 | MA | 8728 | 2562 | 12805 | 2133 | 15076 | 1787 | 16472 | 1494 | 18093 | 1018 | 22410 | 542 | 17940 |
| 7L-4S | | MI | 4920 | 2562 | 7866 | 1989 | 9007 | 1652 | 9755 | 1366 | 10793 | 898 | 12908 | 556 | 9735 |
| 18-#10 | 3.17 | MA | 8495 | 2562 | 12380 | 2143 | 14501 | 1795 | 15741 | 1509 | 17158 | 1035 | 21160 | 497 | 17275 |
| 8L-3S | | MI | 4997 | 2562 | 8103 | 1981 | 9340 | 1638 | 10163 | 1362 | 11352 | 898 | 13567 | 604 | 9758 |
| 18-#10 | 3.17 | MA | 8267 | 2562 | 11899 | 2161 | 13910 | 1812 | 15033 | 1517 | 16201 | 1044 | 19935 | 453 | 16517 |
| 9L-2S | | MI | 5149 | 2562 | 8442 | 1973 | 9772 | 1632 | 10688 | 1349 | 12062 | 889 | 14497 | 696 | 9766 |
| 18-#11 | 3.90 | MA | 9098 | 2711 | 13671 | 2229 | 16109 | 1860 | 17691 | 1542 | 19694 | 1015 | 24642 | 455 | 21188 |
| 7L-4S | | MI | 5110 | 2711 | 8404 | 2066 | 9635 | 1707 | 10493 | 1396 | 11773 | 878 | 13965 | 453 | 11497 |
| 18-#11 | 3.90 | MA | 8823 | 2711 | 13153 | 2240 | 15410 | 1869 | 16811 | 1560 | 18554 | 1035 | 23116 | 397 | 20289 |
| 8L-3S | | MI | 5198 | 2711 | 8689 | 2057 | 10036 | 1691 | 10984 | 1392 | 12444 | 879 | 14737 | 510 | 11643 |
| 18-#11 | 3.90 | MA | 8554 | 2711 | 12573 | 2262 | 14691 | 1890 | 15949 | 1569 | 17389 | 1045 | 21614 | 343 | 19302 |
| 9L-2S | | MI | 5374 | 2711 | 9095 | 2049 | 10553 | 1684 | 11612 | 1378 | 13294 | 870 | 15818 | 622 | 11662 |
| 18-#14 | 5.63 | MA | 10034 | 3066 | 15667 | 2473 | 18586 | 2049 | 20667 | 1670 | 23652 | 1021 | 30218 | 264 | 28641 |
| 7L-4S | | MI | 5643 | 3066 | 9666 | 2280 | 11192 | 1864 | 12365 | 1492 | 14327 | 864 | 16959 | 254 | 15623 |
| 18-#14 | 5.63 | MA | 9648 | 3066 | 14926 | 2489 | 17585 | 2062 | 19420 | 1697 | 22018 | 1050 | 28028 | 178 | 26995 |
| 8L-3S | | MI | 5743 | 3066 | 10072 | 2269 | 11761 | 1842 | 13062 | 1488 | 15244 | 853 | 18032 | 333 | 16215 |
| 20-#10 | 3.53 | MA | 9067 | 2635 | 13507 | 2179 | 15969 | 1819 | 17557 | 1515 | 19563 | 1014 | 24444 | 536 | 20033 |
| 7L-5S | | MI | 4965 | 2635 | 7962 | 2050 | 9147 | 1691 | 9916 | 1399 | 10999 | 903 | 13186 | 489 | 10500 |
| 20-#10 | 3.53 | MA | 8836 | 2635 | 13082 | 2188 | 15394 | 1828 | 16827 | 1530 | 18627 | 1031 | 23194 | 491 | 19369 |
| 8L-4S | | MI | 5067 | 2635 | 8205 | 2034 | 9439 | 1685 | 10280 | 1386 | 11504 | 894 | 13838 | 543 | 10749 |
| 20-#10 | 3.53 | MA | 8615 | 2635 | 12601 | 2206 | 14804 | 1845 | 16118 | 1537 | 17670 | 1040 | 21969 | 447 | 18603 |
| 9L-3S | | MI | 5141 | 2635 | 8442 | 2026 | 9772 | 1671 | 10688 | 1382 | 12062 | 893 | 14497 | 591 | 10779 |
| 20-#10 | 3.53 | MA | 8403 | 2635 | 12159 | 2214 | 14248 | 1855 | 15412 | 1554 | 16725 | 1056 | 20624 | 396 | 17869 |
| 10L-2S | | MI | 5290 | 2635 | 8782 | 2019 | 10205 | 1665 | 11213 | 1370 | 12773 | 884 | 15427 | 683 | 10791 |

## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 4.33 | MA | 9230 | 2800 | 14005 | 2296 | 16494 | 1909 | 18128 | 1586 | 20336 | 1030 | 25584 | 390 | 22812 |
| 8L-4S | | MI | 5282 | 2800 | 8810 | 2121 | 10152 | 1747 | 11121 | 1421 | 12623 | 873 | 15047 | 433 | 12665 |
| 20-#11 | 4.33 | MA | 8969 | 2800 | 13424 | 2318 | 15775 | 1930 | 17266 | 1594 | 19171 | 1040 | 24081 | 336 | 21830 |
| 9L-3S | | MI | 5367 | 2800 | 9095 | 2113 | 10553 | 1731 | 11612 | 1418 | 13294 | 874 | 15818 | 490 | 12860 |
| 20-#14 | 6.25 | MA | 10218 | 3194 | 16143 | 2569 | 19134 | 2120 | 21301 | 1734 | 24565 | 1042 | 31554 | 168 | 30595 |
| 8L-4S | | MI | 5880 | 3194 | 10241 | 2360 | 11923 | 1923 | 13253 | 1528 | 15529 | 857 | 18457 | 220 | 17283 |
| 22-#10 | 3.88 | MA | 9172 | 2707 | 13784 | 2234 | 16288 | 1860 | 17912 | 1550 | 20096 | 1027 | 25229 | 485 | 21463 |
| 8L-5S | | MI | 5111 | 2707 | 8301 | 2096 | 9579 | 1724 | 10441 | 1420 | 11710 | 899 | 14115 | 476 | 11491 |
| 22-#10 | 3.88 | MA | 8957 | 2707 | 13303 | 2252 | 15698 | 1878 | 17204 | 1558 | 19139 | 1036 | 24003 | 441 | 20689 |
| 9L-4S | | MI | 5212 | 2707 | 8544 | 2080 | 9871 | 1718 | 10804 | 1407 | 12214 | 890 | 14768 | 530 | 11759 |
| 22-#10 | 3.88 | MA | 8762 | 2707 | 12861 | 2259 | 15142 | 1887 | 16497 | 1575 | 18194 | 1052 | 22658 | 390 | 19948 |
| 10L-3S | | MI | 5284 | 2707 | 8782 | 2072 | 10205 | 1704 | 11213 | 1403 | 12773 | 889 | 15427 | 578 | 11798 |
| 22-#11 | 4.77 | MA | 9378 | 2889 | 14276 | 2374 | 16860 | 1971 | 18583 | 1620 | 20953 | 1035 | 26549 | 329 | 24358 |
| 9L-4S | | MI | 5453 | 2889 | 9216 | 2177 | 10669 | 1788 | 11749 | 1446 | 13473 | 867 | 16129 | 413 | 13837 |
| 24-#10 | 4.23 | MA | 9294 | 2780 | 14005 | 2297 | 16592 | 1911 | 18290 | 1578 | 20608 | 1032 | 26038 | 436 | 22775 |
| 9L-5S | | MI | 5256 | 2780 | 8641 | 2141 | 10011 | 1757 | 10966 | 1440 | 12420 | 895 | 15045 | 463 | 12484 |
| 24-#10 | 4.23 | MA | 9105 | 2780 | 13563 | 2304 | 16036 | 1920 | 17583 | 1595 | 19663 | 1048 | 24692 | 385 | 22028 |
| 10L-4S | | MI | 5357 | 2780 | 8884 | 2125 | 10304 | 1751 | 11329 | 1428 | 12925 | 886 | 15698 | 517 | 12740 |

## RECTANGULAR TIED COLUMNS 20" x 38"

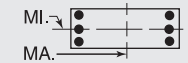
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.18 | MA | 8941 | 2272 | 12763 | 1909 | 14867 | 1608 | 15966 | 1373 | 17014 | 1020 | 20275 | 887 | 8210 |
| 2E | | MI | 4532 | 2272 | 6930 | 1781 | 7701 | 1499 | 8063 | 1278 | 8344 | 944 | 9381 | 774 | 4085 |
| 4-#18 | 2.11 | MA | 9817 | 2472 | 14802 | 2019 | 17373 | 1686 | 18967 | 1419 | 21039 | 1000 | 25822 | 864 | 14162 |
| 2E | | MI | 4856 | 2472 | 7817 | 1879 | 8757 | 1567 | 9310 | 1315 | 9998 | 916 | 11205 | 676 | 6744 |
| 6-#10 | 1.00 | MA | 8792 | 2233 | 12286 | 1901 | 14367 | 1604 | 15413 | 1374 | 16310 | 1032 | 19334 | 899 | 7063 |
| 2L-3S | | MI | 4317 | 2233 | 6365 | 1796 | 7074 | 1514 | 7345 | 1303 | 7404 | 974 | 8329 | 728 | 3574 |
| 6-#10 | 1.00 | MA | 8382 | 2233 | 11538 | 1914 | 13416 | 1616 | 14258 | 1385 | 14746 | 1050 | 17168 | 820 | 7074 |
| 3L-2S | | MI | 4491 | 2233 | 6705 | 1788 | 7506 | 1508 | 7869 | 1290 | 8115 | 965 | 9259 | 819 | 3551 |
| 6-#11 | 1.23 | MA | 9012 | 2283 | 12838 | 1922 | 15008 | 1618 | 16160 | 1381 | 17294 | 1023 | 20677 | 890 | 8564 |
| 2L-3S | | MI | 4366 | 2283 | 6555 | 1809 | 7261 | 1521 | 7547 | 1305 | 7658 | 961 | 8584 | 676 | 4278 |
| 6-#11 | 1.23 | MA | 8524 | 2283 | 11931 | 1937 | 13853 | 1633 | 14757 | 1394 | 15396 | 1044 | 18049 | 791 | 8569 |
| 3L-2S | | MI | 4569 | 2283 | 6961 | 1801 | 7778 | 1515 | 8175 | 1291 | 8508 | 952 | 9666 | 788 | 4248 |
| 6-#14 | 1.78 | MA | 9551 | 2401 | 14060 | 1989 | 16518 | 1666 | 17972 | 1409 | 19728 | 1012 | 24033 | 877 | 12147 |
| 2L-3S | | MI | 4497 | 2401 | 6930 | 1872 | 7701 | 1565 | 8063 | 1333 | 8344 | 948 | 9381 | 579 | 5911 |
| 6-#14 | 1.78 | MA | 8882 | 2401 | 12763 | 2011 | 14867 | 1686 | 15966 | 1427 | 17014 | 1042 | 20275 | 731 | 12104 |
| 3L-2S | | MI | 4776 | 2401 | 7505 | 1861 | 8433 | 1557 | 8951 | 1314 | 9546 | 937 | 10879 | 741 | 5875 |
| 6-#18 | 3.16 | MA | 10825 | 2701 | 17067 | 2162 | 20258 | 1790 | 22471 | 1484 | 25780 | 986 | 32387 | 845 | 20999 |
| 2L-3S | | MI | 4808 | 2701 | 7817 | 2037 | 8757 | 1679 | 9310 | 1407 | 9998 | 915 | 11205 | 312 | 9720 |
| 6-#18 | 3.16 | MA | 9751 | 2701 | 14802 | 2199 | 17373 | 1823 | 18967 | 1513 | 21039 | 1036 | 25822 | 580 | 20700 |
| 3L-2S | | MI | 5255 | 2701 | 8797 | 2022 | 10005 | 1671 | 10827 | 1379 | 12046 | 902 | 13651 | 600 | 9751 |
| 8-#9 | 1.05 | MA | 8856 | 2244 | 12381 | 1911 | 14511 | 1612 | 15600 | 1380 | 16572 | 1033 | 19704 | 900 | 7419 |
| 2L-4S | | MI | 4309 | 2244 | 6287 | 1815 | 6969 | 1536 | 7224 | 1312 | 7243 | 977 | 8199 | 714 | 3755 |
| 8-#9 | 1.05 | MA | 8533 | 2244 | 11790 | 1921 | 13759 | 1622 | 14686 | 1389 | 15335 | 1048 | 17991 | 838 | 7427 |
| 3E | | MI | 4383 | 2244 | 6475 | 1808 | 7233 | 1524 | 7548 | 1309 | 7686 | 976 | 8726 | 752 | 3734 |
| 8-#9 | 1.05 | MA | 8368 | 2244 | 11392 | 1932 | 13197 | 1638 | 13996 | 1404 | 14389 | 1055 | 16865 | 799 | 7414 |
| 4L-2S | | MI | 4521 | 2244 | 6745 | 1802 | 7577 | 1519 | 7965 | 1298 | 8251 | 969 | 9473 | 824 | 3717 |
| 8-#10 | 1.34 | MA | 9154 | 2306 | 13033 | 1946 | 15319 | 1637 | 16569 | 1394 | 17874 | 1028 | 21499 | 893 | 9333 |
| 2L-4S | | MI | 4378 | 2306 | 6468 | 1849 | 7173 | 1562 | 7461 | 1328 | 7556 | 971 | 8600 | 666 | 4650 |
| 8-#10 | 1.34 | MA | 8756 | 2306 | 12286 | 1959 | 14367 | 1649 | 15413 | 1406 | 16310 | 1046 | 19334 | 814 | 9331 |
| 3E | | MI | 4470 | 2306 | 6705 | 1841 | 7506 | 1547 | 7869 | 1324 | 8115 | 970 | 9259 | 715 | 4629 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.34 | MA | 8552 | 2306 | 11783 | 1972 | 13656 | 1670 | 14540 | 1425 | 15113 | 1055 | 17906 | 765 | 9284 |
| 4L-2S | | MI | 4640 | 2306 | 7044 | 1834 | 7938 | 1541 | 8394 | 1311 | 8825 | 961 | 10189 | 806 | 4608 |
| 8-#11 | 1.64 | MA | 9442 | 2372 | 13745 | 1978 | 16163 | 1659 | 17563 | 1406 | 19193 | 1018 | 23306 | 883 | 11316 |
| 2L-4S | | MI | 4436 | 2372 | 6675 | 1873 | 7378 | 1578 | 7684 | 1334 | 7837 | 954 | 8895 | 599 | 5553 |
| 8-#11 | 1.64 | MA | 8971 | 2372 | 12838 | 1993 | 15008 | 1673 | 16160 | 1419 | 17294 | 1039 | 20677 | 783 | 11302 |
| 3E | | MI | 4545 | 2372 | 6961 | 1865 | 7778 | 1562 | 8175 | 1330 | 8508 | 956 | 9666 | 655 | 5534 |
| 8-#11 | 1.64 | MA | 8730 | 2372 | 12226 | 2009 | 14142 | 1698 | 15098 | 1443 | 15838 | 1050 | 18930 | 722 | 11205 |
| 4L-2S | | MI | 4743 | 2372 | 7367 | 1857 | 8295 | 1556 | 8803 | 1316 | 9358 | 946 | 10748 | 768 | 5510 |
| 8-#14 | 2.37 | MA | 10146 | 2529 | 15357 | 2069 | 18169 | 1724 | 19978 | 1445 | 22443 | 1005 | 27792 | 866 | 16068 |
| 2L-4S | | MI | 4597 | 2529 | 7099 | 1964 | 7864 | 1645 | 8254 | 1373 | 8629 | 952 | 9806 | 466 | 7567 |
| 8-#14 | 2.37 | MA | 9506 | 2529 | 14060 | 2091 | 16518 | 1744 | 17972 | 1464 | 19728 | 1034 | 24033 | 721 | 15994 |
| 3E | | MI | 4746 | 2529 | 7505 | 1953 | 8433 | 1623 | 8951 | 1369 | 9546 | 941 | 10879 | 545 | 7659 |
| 8-#14 | 2.37 | MA | 9180 | 2529 | 13183 | 2113 | 15278 | 1779 | 16451 | 1497 | 17643 | 1049 | 21521 | 632 | 15686 |
| 4L-2S | | MI | 5016 | 2529 | 8079 | 1942 | 9164 | 1616 | 9840 | 1351 | 10748 | 929 | 12376 | 707 | 7641 |
| 8-#18 | 4.21 | MA | 10800 | 2929 | 17067 | 2342 | 20258 | 1927 | 22471 | 1578 | 25780 | 1022 | 32387 | 562 | 27475 |
| 3E | | MI | 5221 | 2929 | 8797 | 2180 | 10005 | 1782 | 10827 | 1471 | 12046 | 901 | 13651 | 236 | 12635 |
| 8-#18 | 4.21 | MA | 10289 | 2929 | 15528 | 2378 | 18085 | 1987 | 19804 | 1634 | 22126 | 1045 | 27947 | 401 | 24787 |
| 4L-2S | | MI | 5640 | 2929 | 9778 | 2165 | 11254 | 1775 | 12344 | 1444 | 14094 | 888 | 16097 | 524 | 12725 |
| 10-#10 | 1.67 | MA | 9510 | 2378 | 13780 | 1991 | 16270 | 1670 | 17725 | 1415 | 19438 | 1023 | 23665 | 887 | 11598 |
| 2L-5S | | MI | 4429 | 2378 | 6564 | 1911 | 7312 | 1601 | 7623 | 1361 | 7762 | 976 | 8877 | 600 | 5662 |
| 10-#10 | 1.67 | MA | 9123 | 2378 | 13033 | 2004 | 15319 | 1682 | 16569 | 1426 | 17874 | 1041 | 21499 | 808 | 11584 |
| 3L-4S | | MI | 4533 | 2378 | 6807 | 1895 | 7605 | 1595 | 7986 | 1348 | 8267 | 967 | 9530 | 653 | 5685 |
| 10-#10 | 1.67 | MA | 8930 | 2378 | 12530 | 2017 | 14608 | 1703 | 15696 | 1446 | 16677 | 1051 | 20072 | 759 | 11523 |
| 4L-3S | | MI | 4621 | 2378 | 7044 | 1887 | 7938 | 1580 | 8394 | 1344 | 8825 | 966 | 10189 | 702 | 5672 |
| 10-#10 | 1.67 | MA | 8631 | 2378 | 12010 | 2038 | 13991 | 1715 | 14928 | 1457 | 15606 | 1069 | 18614 | 721 | 11356 |
| 5L-2S | | MI | 4787 | 2378 | 7384 | 1879 | 8370 | 1574 | 8919 | 1331 | 9536 | 957 | 11118 | 793 | 5655 |
| 10-#11 | 2.05 | MA | 9408 | 2461 | 13745 | 2049 | 16163 | 1714 | 17563 | 1444 | 19193 | 1034 | 23306 | 776 | 14031 |
| 3L-4S | | MI | 4618 | 2461 | 7081 | 1929 | 7895 | 1618 | 8312 | 1359 | 8687 | 949 | 9976 | 579 | 6781 |
| 10-#11 | 2.05 | MA | 9182 | 2461 | 13133 | 2064 | 15297 | 1738 | 16501 | 1468 | 17737 | 1045 | 21559 | 715 | 13919 |
| 4L-3S | | MI | 4722 | 2461 | 7367 | 1921 | 8295 | 1602 | 8803 | 1355 | 9358 | 950 | 10748 | 635 | 6777 |
| 10-#11 | 2.05 | MA | 8827 | 2461 | 12506 | 2090 | 14546 | 1752 | 15566 | 1481 | 16433 | 1066 | 19780 | 666 | 13387 |
| 5L-2S | | MI | 4915 | 2461 | 7773 | 1912 | 8813 | 1596 | 9431 | 1341 | 10208 | 941 | 11829 | 747 | 6759 |
| 10-#14 | 2.96 | MA | 10115 | 2658 | 15357 | 2171 | 18169 | 1803 | 19978 | 1500 | 22443 | 1027 | 27792 | 711 | 19885 |
| 3L-4S | | MI | 4850 | 2658 | 7673 | 2044 | 8595 | 1704 | 9143 | 1409 | 9831 | 944 | 11303 | 433 | 9171 |
| 10-#14 | 2.96 | MA | 9814 | 2658 | 14480 | 2193 | 16930 | 1838 | 18456 | 1533 | 20357 | 1041 | 25280 | 622 | 19565 |
| 4L-3S | | MI | 4992 | 2658 | 8079 | 2033 | 9164 | 1681 | 9840 | 1406 | 10748 | 933 | 12376 | 512 | 9391 |
| 10-#14 | 2.96 | MA | 9317 | 2658 | 13587 | 2230 | 15853 | 1857 | 17116 | 1551 | 18489 | 1071 | 22725 | 549 | 18124 |
| 5L-2S | | MI | 5253 | 2658 | 8653 | 2022 | 9895 | 1674 | 10728 | 1387 | 11950 | 922 | 13874 | 673 | 9392 |
| 10-#18 | 5.26 | MA | 11365 | 3157 | 17793 | 2521 | 20969 | 2091 | 23307 | 1699 | 26867 | 1032 | 34512 | 383 | 31500 |
| 4L-3S | | MI | 5644 | 3157 | 9778 | 2323 | 11254 | 1886 | 12344 | 1536 | 14094 | 887 | 16097 | 160 | 15531 |
| 10-#18 | 5.26 | MA | 10525 | 3157 | 16225 | 2584 | 19079 | 2124 | 20954 | 1729 | 23589 | 1081 | 30015 | 244 | 28707 |
| 5L-2S | | MI | 6019 | 3157 | 10759 | 2308 | 12503 | 1878 | 13861 | 1509 | 16142 | 874 | 18543 | 447 | 15677 |
| 12-#10 | 2.01 | MA | 9484 | 2451 | 13780 | 2050 | 16270 | 1715 | 17725 | 1447 | 19438 | 1037 | 23665 | 802 | 13834 |
| 3L-5S | | MI | 4582 | 2451 | 6904 | 1956 | 7745 | 1633 | 8148 | 1382 | 8472 | 972 | 9807 | 587 | 6633 |
| 12-#10 | 2.01 | MA | 9300 | 2451 | 13277 | 2063 | 15559 | 1736 | 16852 | 1466 | 18241 | 1047 | 22237 | 753 | 13764 |
| 4E | | MI | 4685 | 2451 | 7147 | 1940 | 8037 | 1627 | 8511 | 1369 | 8977 | 962 | 10460 | 640 | 6712 |
| 12-#10 | 2.01 | MA | 9004 | 2451 | 12758 | 2083 | 14943 | 1748 | 16084 | 1478 | 17170 | 1065 | 20779 | 715 | 13558 |
| 5L-3S | | MI | 4771 | 2451 | 7384 | 1932 | 8370 | 1613 | 8919 | 1365 | 9536 | 962 | 11118 | 689 | 6708 |
| 12-#10 | 2.01 | MA | 8743 | 2451 | 12259 | 2089 | 14351 | 1758 | 15331 | 1497 | 16122 | 1074 | 19356 | 649 | 12965 |
| 6L-2S | | MI | 4933 | 2451 | 7723 | 1924 | 8803 | 1607 | 9444 | 1352 | 10246 | 953 | 12048 | 780 | 6696 |
| 12-#11 | 2.46 | MA | 9624 | 2550 | 14040 | 2120 | 16452 | 1779 | 17903 | 1493 | 19635 | 1040 | 24188 | 708 | 16634 |
| 4E | | MI | 4797 | 2550 | 7488 | 1985 | 8412 | 1659 | 8940 | 1384 | 9537 | 944 | 11058 | 558 | 8001 |
| 12-#11 | 2.46 | MA | 9272 | 2550 | 13413 | 2145 | 15701 | 1793 | 16968 | 1506 | 18331 | 1061 | 22408 | 659 | 16066 |
| 5L-3S | | MI | 4897 | 2550 | 7773 | 1976 | 8813 | 1642 | 9431 | 1381 | 10208 | 945 | 11829 | 615 | 8012 |
| 12-#11 | 2.46 | MA | 8962 | 2550 | 12807 | 2153 | 14990 | 1806 | 16050 | 1530 | 17089 | 1082 | 20672 | 575 | 15403 |
| 6L-2S | | MI | 5086 | 2550 | 8179 | 1968 | 9330 | 1636 | 10059 | 1367 | 11058 | 936 | 12911 | 727 | 8001 |
| 12-#14 | 3.55 | MA | 10433 | 2786 | 15777 | 2273 | 18581 | 1896 | 20462 | 1570 | 23072 | 1034 | 29038 | 612 | 23439 |
| 4E | | MI | 5100 | 2786 | 8248 | 2124 | 9326 | 1762 | 10031 | 1446 | 11033 | 937 | 12801 | 399 | 10791 |

## RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

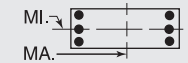
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 3.55 | MA | 9940 | 2786 | 14884 | 2310 | 17505 | 1916 | 19122 | 1588 | 21203 | 1063 | 26484 | 539 | 21986 |
| 5L-3S | | MI | 5234 | 2786 | 8653 | 2113 | 9895 | 1740 | 10728 | 1442 | 11950 | 926 | 13874 | 478 | 11115 |
| 12-#14 | 3.55 | MA | 9516 | 2786 | 14017 | 2320 | 16494 | 1936 | 17806 | 1621 | 19422 | 1093 | 23992 | 416 | 20712 |
| 6L-2S | | MI | 5488 | 2786 | 9228 | 2102 | 10627 | 1732 | 11616 | 1424 | 13152 | 914 | 15372 | 640 | 11136 |
| 12-#18 | 6.32 | MA | 11576 | 3386 | 18491 | 2727 | 21963 | 2227 | 24458 | 1793 | 28331 | 1068 | 36580 | 226 | 35370 |
| 5L-3S | | MI | 6040 | 3386 | 10759 | 2465 | 12503 | 1990 | 13861 | 1601 | 16142 | 873 | 18543 | 84 | 18230 |
| 12-#18 | 6.32 | MA | 10897 | 3386 | 16997 | 2746 | 20186 | 2261 | 22147 | 1849 | 25204 | 1117 | 32181 | 4 | 32155 |
| 6L-2S | | MI | 6394 | 3386 | 11740 | 2450 | 13752 | 1982 | 15377 | 1574 | 18190 | 860 | 20989 | 371 | 18619 |
| 14-#10 | 2.34 | MA | 9664 | 2523 | 14025 | 2108 | 16511 | 1768 | 18007 | 1487 | 19805 | 1042 | 24403 | 747 | 16004 |
| 4L-5S | | MI | 4733 | 2523 | 7243 | 2001 | 8177 | 1666 | 8673 | 1402 | 9183 | 967 | 10737 | 574 | 7609 |
| 14-#10 | 2.34 | MA | 9369 | 2523 | 13505 | 2128 | 15894 | 1781 | 17240 | 1498 | 18734 | 1060 | 22945 | 709 | 15765 |
| 5L-4S | | MI | 4836 | 2523 | 7486 | 1985 | 8470 | 1660 | 9036 | 1389 | 9688 | 958 | 11389 | 627 | 7734 |
| 14-#10 | 2.34 | MA | 9117 | 2523 | 13006 | 2135 | 15302 | 1791 | 16486 | 1518 | 17686 | 1070 | 21522 | 643 | 15191 |
| 6L-3S | | MI | 4919 | 2523 | 7723 | 1977 | 8803 | 1646 | 9444 | 1385 | 10246 | 958 | 12048 | 675 | 7740 |
| 14-#10 | 2.34 | MA | 8902 | 2523 | 12535 | 2143 | 14638 | 1807 | 15752 | 1528 | 16673 | 1088 | 20157 | 610 | 14747 |
| 7L-2S | | MI | 5078 | 2523 | 8062 | 1970 | 9235 | 1640 | 9969 | 1373 | 10956 | 948 | 12978 | 767 | 7732 |
| 14-#11 | 2.87 | MA | 9708 | 2639 | 14320 | 2201 | 16856 | 1833 | 18371 | 1531 | 20230 | 1056 | 25037 | 652 | 18750 |
| 5L-4S | | MI | 4974 | 2639 | 7894 | 2040 | 8929 | 1699 | 9568 | 1409 | 10387 | 939 | 12140 | 538 | 9216 |
| 14-#11 | 2.87 | MA | 9409 | 2639 | 13714 | 2208 | 16145 | 1847 | 17453 | 1555 | 18987 | 1077 | 23301 | 568 | 18109 |
| 6L-3S | | MI | 5070 | 2639 | 8179 | 2032 | 9330 | 1683 | 10059 | 1406 | 11058 | 940 | 12911 | 595 | 9239 |
| 14-#11 | 2.87 | MA | 9156 | 2639 | 13140 | 2218 | 15336 | 1865 | 16572 | 1568 | 17719 | 1087 | 21627 | 527 | 17273 |
| 7L-2S | | MI | 5255 | 2639 | 8585 | 2024 | 9847 | 1677 | 10687 | 1392 | 11908 | 931 | 13993 | 707 | 9237 |
| 14-#14 | 4.14 | MA | 10548 | 2915 | 16181 | 2390 | 19156 | 1974 | 21128 | 1624 | 23918 | 1056 | 30242 | 528 | 25854 |
| 5L-4S | | MI | 5346 | 2915 | 8822 | 2204 | 10058 | 1820 | 10919 | 1482 | 12235 | 929 | 14299 | 366 | 12424 |
| 14-#14 | 4.14 | MA | 10144 | 2915 | 15314 | 2400 | 18145 | 1994 | 19812 | 1657 | 22137 | 1086 | 27750 | 406 | 24555 |
| 6L-3S | | MI | 5474 | 2915 | 9228 | 2194 | 10627 | 1798 | 11616 | 1479 | 13152 | 918 | 15372 | 444 | 12834 |
| 14-#14 | 4.14 | MA | 9799 | 2915 | 14492 | 2414 | 16988 | 2020 | 18548 | 1675 | 20319 | 1100 | 25341 | 346 | 23063 |
| 7L-2S | | MI | 5722 | 2915 | 9802 | 2183 | 11358 | 1791 | 12504 | 1460 | 14355 | 907 | 16870 | 606 | 12869 |
| 14-#18 | 7.37 | MA | 11963 | 3614 | 19263 | 2889 | 23071 | 2364 | 25650 | 1914 | 29945 | 1104 | 38746 | -15 | 38655 |
| 6L-3S | | MI | 6431 | 3614 | 11740 | 2608 | 13752 | 2094 | 15377 | 1665 | 18190 | 859 | 20989 | 8 | 20959 |
| 16-#10 | 2.67 | MA | 9730 | 2596 | 14252 | 2174 | 16846 | 1814 | 18395 | 1519 | 20298 | 1056 | 25111 | 703 | 17976 |
| 5E | | MI | 4883 | 2596 | 7582 | 2047 | 8609 | 1699 | 9198 | 1423 | 9893 | 963 | 11667 | 561 | 8591 |
| 16-#10 | 2.67 | MA | 9484 | 2596 | 13754 | 2180 | 16254 | 1824 | 17642 | 1539 | 19251 | 1066 | 23688 | 637 | 17418 |
| 6L-4S | | MI | 4985 | 2596 | 7825 | 2031 | 8902 | 1693 | 9561 | 1410 | 10398 | 954 | 12319 | 614 | 8754 |
| 16-#10 | 2.67 | MA | 9278 | 2596 | 13282 | 2189 | 15589 | 1840 | 16908 | 1549 | 18237 | 1083 | 22322 | 604 | 16974 |
| 7L-3S | | MI | 5065 | 2596 | 8062 | 2023 | 9235 | 1679 | 9969 | 1406 | 10956 | 953 | 12978 | 662 | 8767 |
| 16-#10 | 2.67 | MA | 9024 | 2596 | 12830 | 2198 | 14979 | 1848 | 16131 | 1564 | 17244 | 1101 | 20998 | 560 | 16234 |
| 8L-2S | | MI | 5222 | 2596 | 8402 | 2015 | 9667 | 1673 | 10494 | 1393 | 11667 | 944 | 13908 | 754 | 8764 |
| 16-#11 | 3.28 | MA | 9848 | 2728 | 14621 | 2264 | 17299 | 1887 | 18856 | 1580 | 20886 | 1071 | 25929 | 561 | 20819 |
| 6L-4S | | MI | 5149 | 2728 | 8300 | 2096 | 9446 | 1740 | 10196 | 1435 | 11237 | 934 | 13222 | 518 | 10418 |
| 16-#11 | 3.28 | MA | 9605 | 2728 | 14048 | 2274 | 16491 | 1906 | 17974 | 1593 | 19618 | 1082 | 24256 | 520 | 19972 |
| 7L-3S | | MI | 5242 | 2728 | 8585 | 2088 | 9847 | 1723 | 10687 | 1431 | 11908 | 935 | 13993 | 575 | 10462 |
| 16-#11 | 3.28 | MA | 9305 | 2728 | 13498 | 2285 | 15748 | 1915 | 17029 | 1611 | 18407 | 1103 | 22639 | 464 | 19092 |
| 8L-2S | | MI | 5423 | 2728 | 8991 | 2079 | 10364 | 1717 | 11315 | 1417 | 12758 | 926 | 15074 | 687 | 10470 |
| 16-#14 | 4.74 | MA | 10758 | 3043 | 16611 | 2481 | 19796 | 2052 | 21817 | 1694 | 24851 | 1078 | 31509 | 395 | 28399 |
| 6L-4S | | MI | 5589 | 3043 | 9396 | 2285 | 10789 | 1879 | 11807 | 1519 | 13437 | 922 | 15797 | 332 | 14068 |
| 16-#14 | 4.74 | MA | 10432 | 3043 | 15789 | 2494 | 18639 | 2078 | 20554 | 1712 | 23033 | 1093 | 29099 | 335 | 26916 |
| 7L-3S | | MI | 5727 | 3043 | 9802 | 2274 | 11358 | 1856 | 12504 | 1515 | 14355 | 911 | 16870 | 411 | 14550 |
| 16-#14 | 4.74 | MA | 10009 | 3043 | 15001 | 2511 | 17574 | 2092 | 19212 | 1739 | 21298 | 1122 | 26776 | 252 | 25135 |
| 8L-2S | | MI | 5948 | 3043 | 10376 | 2263 | 12089 | 1849 | 13392 | 1496 | 15557 | 899 | 18368 | 573 | 14598 |
| 18-#10 | 3.01 | MA | 9846 | 2668 | 14501 | 2225 | 17205 | 1857 | 18798 | 1559 | 20815 | 1061 | 25853 | 631 | 19648 |
| 6L-5S | | MI | 5032 | 2668 | 7922 | 2092 | 9041 | 1732 | 9723 | 1443 | 10604 | 959 | 12596 | 548 | 9575 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

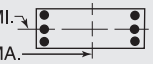


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 3.01 | MA | 9647 | 2668 | 14029 | 2234 | 16541 | 1873 | 18064 | 1569 | 19801 | 1079 | 24488 | 598 | 19200 |
| 7L-4S | | MI | 5133 | 2668 | 8165 | 2076 | 9334 | 1726 | 10086 | 1431 | 11108 | 950 | 13249 | 601 | 9771 |
| 18-#10 | 3.01 | MA | 9396 | 2668 | 13578 | 2244 | 15930 | 1881 | 17287 | 1585 | 18808 | 1097 | 23164 | 554 | 18463 |
| 8L-3S | | MI | 5211 | 2668 | 8402 | 2068 | 9667 | 1712 | 10494 | 1426 | 11667 | 949 | 13908 | 649 | 9790 |
| 18-#10 | 3.01 | MA | 9151 | 2668 | 13063 | 2262 | 15303 | 1899 | 16535 | 1593 | 17792 | 1107 | 21868 | 511 | 17707 |
| 9L-2S | | MI | 5364 | 2668 | 8741 | 2060 | 10099 | 1706 | 11019 | 1414 | 12377 | 940 | 14838 | 741 | 9795 |
| 18-#11 | 3.69 | MA | 10047 | 2817 | 14955 | 2330 | 17646 | 1946 | 19377 | 1618 | 21516 | 1077 | 26885 | 513 | 22672 |
| 7L-4S | | MI | 5323 | 2817 | 8706 | 2152 | 9963 | 1780 | 10824 | 1460 | 12087 | 929 | 14303 | 498 | 11579 |
| 18-#11 | 3.69 | MA | 9749 | 2817 | 14405 | 2341 | 16903 | 1956 | 18432 | 1637 | 20306 | 1098 | 25268 | 457 | 21780 |
| 8L-3S | | MI | 5412 | 2817 | 8991 | 2143 | 10364 | 1764 | 11315 | 1456 | 12758 | 930 | 15074 | 554 | 11682 |
| 18-#11 | 3.69 | MA | 9460 | 2817 | 13784 | 2363 | 16139 | 1977 | 17516 | 1646 | 19068 | 1109 | 23679 | 403 | 20700 |
| 9L-2S | | MI | 5590 | 2817 | 9397 | 2135 | 10881 | 1758 | 11943 | 1442 | 13608 | 921 | 16156 | 667 | 11697 |
| 18-#14 | 5.33 | MA | 11052 | 3172 | 17086 | 2575 | 20291 | 2137 | 22559 | 1748 | 25748 | 1085 | 32858 | 325 | 30768 |
| 7L-4S | | MI | 5857 | 3172 | 9971 | 2365 | 11520 | 1937 | 12696 | 1555 | 14640 | 915 | 17295 | 298 | 15719 |
| 18-#14 | 5.33 | MA | 10633 | 3172 | 16298 | 2591 | 19226 | 2150 | 21218 | 1775 | 24012 | 1115 | 30535 | 241 | 28972 |
| 8L-3S | | MI | 5959 | 3172 | 10376 | 2354 | 12089 | 1915 | 13392 | 1551 | 15557 | 903 | 18368 | 377 | 16264 |
| 20-#10 | 3.34 | MA | 10011 | 2741 | 14777 | 2279 | 17493 | 1905 | 19219 | 1590 | 21365 | 1075 | 26654 | 592 | 21425 |
| 7L-5S | | MI | 5179 | 2741 | 8261 | 2137 | 9473 | 1765 | 10248 | 1464 | 11314 | 955 | 13526 | 535 | 10563 |
| 20-#10 | 3.34 | MA | 9761 | 2741 | 14325 | 2289 | 16882 | 1914 | 18443 | 1605 | 20372 | 1093 | 25330 | 548 | 20693 |
| 8L-4S | | MI | 5280 | 2741 | 8504 | 2121 | 9766 | 1759 | 10611 | 1451 | 11819 | 946 | 14179 | 588 | 10787 |
| 20-#10 | 3.34 | MA | 9524 | 2741 | 13810 | 2307 | 16255 | 1932 | 17690 | 1613 | 19356 | 1102 | 24034 | 505 | 19928 |
| 9L-3S | | MI | 5355 | 2741 | 8741 | 2113 | 10099 | 1745 | 11019 | 1447 | 12377 | 945 | 14838 | 636 | 10812 |
| 20-#10 | 3.34 | MA | 9296 | 2741 | 13341 | 2314 | 15664 | 1942 | 16940 | 1630 | 18341 | 1118 | 22608 | 455 | 19183 |
| 10L-2S | | MI | 5506 | 2741 | 9081 | 2106 | 10531 | 1739 | 11544 | 1434 | 13088 | 936 | 15767 | 728 | 10821 |
| 20-#11 | 4.11 | MA | 10186 | 2906 | 15312 | 2397 | 18058 | 1996 | 19835 | 1662 | 22204 | 1093 | 27896 | 449 | 24468 |
| 8L-4S | | MI | 5495 | 2906 | 9112 | 2207 | 10480 | 1821 | 11452 | 1485 | 12937 | 923 | 15385 | 478 | 12746 |
| 20-#11 | 4.11 | MA | 9906 | 2906 | 14691 | 2419 | 17294 | 2017 | 18919 | 1671 | 20966 | 1104 | 26308 | 396 | 23393 |
| 9L-3S | | MI | 5581 | 2906 | 9397 | 2199 | 10881 | 1804 | 11943 | 1481 | 13608 | 925 | 16156 | 534 | 12900 |
| 20-#11 | 4.11 | MA | 9650 | 2906 | 14121 | 2428 | 16575 | 2029 | 18005 | 1692 | 19750 | 1124 | 24696 | 346 | 22290 |
| 10L-2S | | MI | 5755 | 2906 | 9803 | 2191 | 11398 | 1798 | 12571 | 1468 | 14458 | 915 | 17238 | 646 | 12922 |
| 20-#14 | 5.92 | MA | 11245 | 3300 | 17595 | 2671 | 20877 | 2208 | 23224 | 1811 | 26727 | 1107 | 34293 | 231 | 32809 |
| 8L-4S | | MI | 6094 | 3300 | 10545 | 2445 | 12251 | 1995 | 13584 | 1591 | 15842 | 907 | 18793 | 265 | 17378 |
| 22-#10 | 3.68 | MA | 10122 | 2813 | 15072 | 2334 | 17833 | 1947 | 19599 | 1626 | 21936 | 1089 | 27495 | 543 | 22922 |
| 8L-5S | | MI | 5325 | 2813 | 8601 | 2183 | 9906 | 1798 | 10772 | 1484 | 12025 | 950 | 14456 | 521 | 11554 |
| 22-#10 | 3.68 | MA | 9891 | 2813 | 14557 | 2352 | 17206 | 1965 | 18846 | 1634 | 20920 | 1098 | 26200 | 499 | 22149 |
| 9L-4S | | MI | 5426 | 2813 | 8844 | 2166 | 10198 | 1792 | 11136 | 1472 | 12529 | 941 | 15109 | 575 | 11802 |
| 22-#10 | 3.68 | MA | 9672 | 2813 | 14088 | 2360 | 16616 | 1975 | 18096 | 1651 | 19905 | 1114 | 24774 | 449 | 21407 |
| 10L-3S | | MI | 5498 | 2813 | 9081 | 2159 | 10531 | 1778 | 11544 | 1467 | 13088 | 941 | 15767 | 623 | 11832 |
| 22-#10 | 3.68 | MA | 9429 | 2813 | 13631 | 2368 | 16024 | 1984 | 17361 | 1660 | 18867 | 1121 | 23484 | 403 | 20510 |
| 11L-2S | | MI | 5646 | 2813 | 9420 | 2151 | 10964 | 1772 | 12069 | 1455 | 13798 | 932 | 16697 | 715 | 11846 |
| 22-#11 | 4.52 | MA | 10344 | 2995 | 15598 | 2475 | 18449 | 2058 | 20322 | 1696 | 22865 | 1099 | 28937 | 388 | 26087 |
| 9L-4S | | MI | 5666 | 2995 | 9518 | 2263 | 10997 | 1861 | 12080 | 1510 | 13787 | 918 | 16467 | 457 | 13917 |
| 22-#11 | 4.52 | MA | 10098 | 2995 | 15028 | 2483 | 17730 | 2070 | 19408 | 1717 | 21648 | 1118 | 27325 | 339 | 24975 |
| 10L-3S | | MI | 5750 | 2995 | 9803 | 2255 | 11398 | 1845 | 12571 | 1507 | 14458 | 919 | 17238 | 514 | 14117 |
| 24-#10 | 4.01 | MA | 10253 | 2886 | 15305 | 2398 | 18158 | 1997 | 20002 | 1654 | 22484 | 1094 | 28365 | 493 | 24370 |
| 9L-5S | | MI | 5469 | 2886 | 8940 | 2228 | 10338 | 1831 | 11297 | 1505 | 12735 | 946 | 15386 | 508 | 12546 |
| 24-#10 | 4.01 | MA | 10050 | 2886 | 14836 | 2405 | 17567 | 2007 | 19251 | 1672 | 21469 | 1110 | 26939 | 444 | 23627 |
| 10L-4S | | MI | 5571 | 2886 | 9183 | 2212 | 10630 | 1825 | 11661 | 1492 | 13240 | 937 | 16038 | 562 | 12811 |
| 24-#10 | 4.01 | MA | 9801 | 2886 | 14378 | 2414 | 16976 | 2016 | 18517 | 1681 | 20431 | 1117 | 25650 | 397 | 22728 |
| 11L-3S | | MI | 5641 | 2886 | 9420 | 2204 | 10964 | 1811 | 12069 | 1488 | 13798 | 937 | 16697 | 610 | 12851 |
| 24-#11 | 4.93 | MA | 10539 | 3084 | 15935 | 2539 | 18885 | 2110 | 20811 | 1742 | 23547 | 1113 | 29954 | 332 | 27660 |
| 10L-4S | | MI | 5836 | 3084 | 9924 | 2319 | 11514 | 1902 | 12708 | 1536 | 14637 | 913 | 17548 | 437 | 15092 |

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis

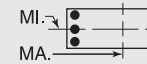



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.13 | MA | 9860 | 2379 | 13964 | 2008 | 16297 | 1692 | 17503 | 1447 | 18617 | 1078 | 22156 | 939 | 8696 |
| 2E | | MI | 4745 | 2379 | 7234 | 1866 | 8030 | 1572 | 8394 | 1341 | 8657 | 995 | 9717 | 819 | 4110 |
| 4-#18 | 2.00 | MA | 10802 | 2578 | 16135 | 2119 | 18966 | 1771 | 20698 | 1493 | 22903 | 1059 | 28061 | 915 | 15026 |
| 2E | | MI | 5069 | 2578 | 8125 | 1963 | 9086 | 1639 | 9640 | 1377 | 10308 | 965 | 11537 | 719 | 6780 |
| 6-#11 | 1.17 | MA | 9934 | 2389 | 14042 | 2021 | 16444 | 1703 | 17706 | 1455 | 18911 | 1082 | 22578 | 941 | 9070 |
| 2L-3S | | MI | 4578 | 2389 | 6857 | 1895 | 7589 | 1594 | 7878 | 1369 | 7972 | 1012 | 8922 | 720 | 4302 |
| 6-#11 | 1.17 | MA | 9413 | 2389 | 13079 | 2037 | 15218 | 1718 | 16217 | 1468 | 16896 | 1104 | 19788 | 844 | 9074 |
| 3L-2S | | MI | 4782 | 2389 | 7263 | 1887 | 8106 | 1588 | 8506 | 1355 | 8822 | 1002 | 10004 | 832 | 4271 |
| 6-#14 | 1.69 | MA | 10514 | 2507 | 15341 | 2088 | 18050 | 1751 | 19632 | 1483 | 21499 | 1071 | 26147 | 928 | 12876 |
| 2L-3S | | MI | 4709 | 2507 | 7234 | 1958 | 8030 | 1637 | 8394 | 1396 | 8657 | 999 | 9717 | 623 | 5942 |
| 6-#14 | 1.69 | MA | 9796 | 2507 | 13964 | 2111 | 16297 | 1771 | 17503 | 1502 | 18617 | 1101 | 22156 | 785 | 12833 |
| 3L-2S | | MI | 4989 | 2507 | 7809 | 1947 | 8761 | 1630 | 9282 | 1378 | 9859 | 987 | 11215 | 785 | 5904 |
| 6-#18 | 3.00 | MA | 11884 | 2807 | 18543 | 2262 | 22032 | 1875 | 24422 | 1558 | 27943 | 1045 | 35040 | 897 | 22295 |
| 2L-3S | | MI | 5019 | 2807 | 8125 | 2121 | 9086 | 1750 | 9640 | 1469 | 10308 | 964 | 11537 | 355 | 9777 |
| 6-#18 | 3.00 | MA | 10729 | 2807 | 16135 | 2299 | 18966 | 1909 | 20698 | 1589 | 22903 | 1096 | 28061 | 636 | 21996 |
| 3L-2S | | MI | 5469 | 2807 | 9106 | 2106 | 10335 | 1742 | 11157 | 1442 | 12356 | 951 | 13983 | 643 | 9792 |
| 8-#9 | 1.00 | MA | 9766 | 2350 | 13554 | 2010 | 15914 | 1697 | 17107 | 1454 | 18139 | 1092 | 21537 | 951 | 7851 |
| 2L-4S | | MI | 4521 | 2350 | 6585 | 1902 | 7295 | 1610 | 7555 | 1377 | 7559 | 1029 | 8540 | 759 | 3773 |
| 8-#9 | 1.00 | MA | 9421 | 2350 | 12927 | 2021 | 15116 | 1707 | 16138 | 1463 | 16828 | 1107 | 19721 | 890 | 7859 |
| 3E | | MI | 4596 | 2350 | 6773 | 1896 | 7560 | 1598 | 7879 | 1374 | 8002 | 1028 | 9068 | 798 | 3752 |
| 8-#9 | 1.00 | MA | 9245 | 2350 | 12507 | 2032 | 14521 | 1723 | 15407 | 1479 | 15826 | 1115 | 18533 | 852 | 7846 |
| 4L-2S | | MI | 4734 | 2350 | 7043 | 1889 | 7903 | 1593 | 8296 | 1363 | 8566 | 1020 | 9814 | 870 | 3735 |
| 8-#10 | 1.27 | MA | 10085 | 2412 | 14246 | 2045 | 16771 | 1722 | 18136 | 1468 | 19522 | 1086 | 23444 | 945 | 9882 |
| 2L-4S | | MI | 4590 | 2412 | 6767 | 1936 | 7500 | 1636 | 7793 | 1392 | 7871 | 1022 | 8941 | 711 | 4674 |
| 8-#10 | 1.27 | MA | 9659 | 2412 | 13454 | 2059 | 15762 | 1734 | 16910 | 1480 | 17863 | 1105 | 21147 | 866 | 9880 |
| 3E | | MI | 4682 | 2412 | 7004 | 1928 | 7833 | 1621 | 8201 | 1388 | 8430 | 1022 | 9599 | 760 | 4651 |
| 8-#10 | 1.27 | MA | 9442 | 2412 | 12921 | 2072 | 15009 | 1755 | 15985 | 1500 | 16595 | 1115 | 19640 | 818 | 9832 |
| 4L-2S | | MI | 4853 | 2412 | 7343 | 1921 | 8265 | 1615 | 8726 | 1376 | 9140 | 1013 | 10529 | 851 | 4629 |
| 8-#11 | 1.56 | MA | 10395 | 2478 | 15005 | 2077 | 17670 | 1744 | 19194 | 1480 | 20927 | 1077 | 25368 | 934 | 11990 |
| 2L-4S | | MI | 4648 | 2478 | 6978 | 1959 | 7705 | 1651 | 8015 | 1398 | 8151 | 1005 | 9233 | 643 | 5584 |
| 8-#11 | 1.56 | MA | 9891 | 2478 | 14042 | 2093 | 16444 | 1758 | 17706 | 1494 | 18911 | 1099 | 22578 | 836 | 11976 |
| 3E | | MI | 4757 | 2478 | 7263 | 1951 | 8106 | 1635 | 8506 | 1394 | 8822 | 1007 | 10004 | 700 | 5561 |
| 8-#11 | 1.56 | MA | 9633 | 2478 | 13394 | 2109 | 15527 | 1783 | 16580 | 1518 | 17368 | 1110 | 20734 | 776 | 11879 |
| 4L-2S | | MI | 4956 | 2478 | 7669 | 1943 | 8623 | 1629 | 9134 | 1380 | 9672 | 997 | 11086 | 812 | 5535 |
| 8-#14 | 2.25 | MA | 11151 | 2635 | 16718 | 2169 | 19804 | 1809 | 21762 | 1519 | 24382 | 1064 | 30138 | 918 | 17040 |
| 2L-4S | | MI | 4809 | 2635 | 7403 | 2049 | 8192 | 1718 | 8585 | 1436 | 8942 | 1002 | 10142 | 511 | 7671 |
| 8-#14 | 2.25 | MA | 10465 | 2635 | 15341 | 2191 | 18050 | 1830 | 19632 | 1538 | 21499 | 1094 | 26147 | 775 | 16966 |
| 3E | | MI | 4958 | 2635 | 7809 | 2038 | 8761 | 1696 | 9282 | 1433 | 9859 | 991 | 11215 | 590 | 7695 |
| 8-#14 | 2.25 | MA | 10116 | 2635 | 14412 | 2213 | 16736 | 1865 | 18020 | 1572 | 19288 | 1110 | 23494 | 687 | 16658 |
| 4L-2S | | MI | 5229 | 2635 | 8383 | 2027 | 9492 | 1688 | 10170 | 1414 | 11061 | 980 | 12712 | 751 | 7672 |
| 8-#18 | 4.00 | MA | 11854 | 3035 | 18543 | 2442 | 22032 | 2013 | 24422 | 1653 | 27943 | 1083 | 35040 | 617 | 29203 |
| 3E | | MI | 5433 | 3035 | 9106 | 2264 | 10335 | 1854 | 11157 | 1534 | 12356 | 951 | 13983 | 279 | 12696 |
| 8-#18 | 4.00 | MA | 11306 | 3035 | 16911 | 2480 | 19727 | 2074 | 21593 | 1711 | 24065 | 1108 | 30350 | 458 | 26501 |
| 4L-2S | | MI | 5856 | 3035 | 10086 | 2249 | 11584 | 1846 | 12674 | 1507 | 14405 | 937 | 16429 | 567 | 12772 |
| 10-#10 | 1.59 | MA | 10466 | 2484 | 15039 | 2091 | 17780 | 1755 | 19362 | 1489 | 21181 | 1082 | 25741 | 939 | 12284 |
| 2L-5S | | MI | 4641 | 2484 | 6863 | 1998 | 7639 | 1675 | 7954 | 1426 | 8077 | 1027 | 9218 | 645 | 5711 |
| 10-#10 | 1.59 | MA | 10051 | 2484 | 14246 | 2104 | 16771 | 1767 | 18136 | 1501 | 19522 | 1101 | 23444 | 861 | 12270 |
| 3L-4S | | MI | 4745 | 2484 | 7106 | 1982 | 7932 | 1669 | 8317 | 1413 | 8582 | 1018 | 9870 | 698 | 5711 |
| 10-#10 | 1.59 | MA | 9845 | 2484 | 13714 | 2117 | 16018 | 1788 | 17211 | 1521 | 18254 | 1111 | 21937 | 812 | 12209 |
| 4L-3S | | MI | 4834 | 2484 | 7343 | 1974 | 8265 | 1654 | 8726 | 1409 | 9140 | 1017 | 10529 | 747 | 5696 |
| 10-#10 | 1.59 | MA | 9524 | 2484 | 13161 | 2138 | 15366 | 1800 | 16399 | 1532 | 17120 | 1129 | 20396 | 775 | 12045 |
| 5L-2S | | MI | 5001 | 2484 | 7683 | 1966 | 8697 | 1648 | 9251 | 1396 | 9850 | 1008 | 11459 | 838 | 5678 |
| 10-#11 | 1.95 | MA | 10359 | 2567 | 15005 | 2149 | 17670 | 1799 | 19194 | 1519 | 20927 | 1093 | 25368 | 829 | 14873 |
| 3L-4S | | MI | 4830 | 2567 | 7384 | 2015 | 8222 | 1692 | 8643 | 1423 | 9001 | 1000 | 10314 | 623 | 6816 |
| 10-#11 | 1.95 | MA | 10116 | 2567 | 14356 | 2164 | 16753 | 1824 | 18069 | 1543 | 19383 | 1105 | 23524 | 769 | 14761 |
| 4L-3S | | MI | 4934 | 2567 | 7669 | 2007 | 8623 | 1675 | 9134 | 1419 | 9672 | 1001 | 11086 | 680 | 6807 |
| 10-#11 | 1.95 | MA | 9734 | 2567 | 13688 | 2190 | 15958 | 1839 | 17079 | 1556 | 18003 | 1127 | 21643 | 721 | 14274 |
| 5L-2S | | MI | 5129 | 2567 | 8075 | 1998 | 9140 | 1669 | 9762 | 1405 | 10522 | 992 | 12167 | 792 | 6787 |

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

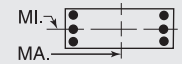
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.81 | MA | 11117 | 2764 | 16718 | 2271 | 19804 | 1888 | 21762 | 1575 | 24382 | 1087 | 30138 | 765 | 21100 |
| 3L-4S | | MI | 5062 | 2764 | 7978 | 2129 | 8923 | 1776 | 9474 | 1473 | 10144 | 995 | 11639 | 477 | 9274 |
| 10-#14 | 2.81 | MA | 10794 | 2764 | 15789 | 2293 | 18490 | 1924 | 20149 | 1609 | 22171 | 1102 | 27486 | 676 | 20780 |
| 4L-3S | | MI | 5204 | 2764 | 8383 | 2118 | 9492 | 1754 | 10170 | 1469 | 11061 | 984 | 12712 | 556 | 9432 |
| 10-#14 | 2.81 | MA | 10258 | 2764 | 14837 | 2330 | 17350 | 1944 | 18730 | 1628 | 20192 | 1133 | 24784 | 606 | 19328 |
| 5L-2S | | MI | 5467 | 2764 | 8958 | 2107 | 10224 | 1747 | 11059 | 1451 | 12263 | 972 | 14210 | 718 | 9427 |
| 10-#18 | 5.00 | MA | 12458 | 3264 | 19319 | 2623 | 22793 | 2178 | 25317 | 1776 | 29105 | 1094 | 37329 | 440 | 33638 |
| 4L-3S | | MI | 5857 | 3264 | 10086 | 2407 | 11584 | 1958 | 12674 | 1598 | 14405 | 937 | 16429 | 203 | 15608 |
| 10-#18 | 5.00 | MA | 11550 | 3264 | 17657 | 2687 | 20790 | 2212 | 22823 | 1807 | 25630 | 1145 | 32570 | 306 | 30814 |
| 5L-2S | | MI | 6237 | 3264 | 11067 | 2392 | 12832 | 1950 | 14191 | 1571 | 16453 | 923 | 18875 | 491 | 15726 |
| 12-#10 | 1.90 | MA | 10437 | 2557 | 15039 | 2149 | 17780 | 1800 | 19362 | 1521 | 21181 | 1096 | 25741 | 855 | 14657 |
| 3L-5S | | MI | 4794 | 2557 | 7203 | 2043 | 8071 | 1708 | 8479 | 1446 | 8787 | 1023 | 10148 | 632 | 6697 |
| 12-#10 | 1.90 | MA | 10241 | 2557 | 14507 | 2163 | 17027 | 1821 | 18437 | 1541 | 19913 | 1106 | 24234 | 806 | 14586 |
| 4E | | MI | 4897 | 2557 | 7446 | 2027 | 8364 | 1702 | 8842 | 1434 | 9292 | 1014 | 10800 | 685 | 6742 |
| 12-#10 | 1.90 | MA | 9922 | 2557 | 13953 | 2183 | 16375 | 1833 | 17624 | 1553 | 18779 | 1125 | 22693 | 769 | 14418 |
| 5L-3S | | MI | 4984 | 2557 | 7683 | 2019 | 8697 | 1687 | 9251 | 1429 | 9850 | 1013 | 11459 | 734 | 6734 |
| 12-#10 | 1.90 | MA | 9643 | 2557 | 13425 | 2189 | 15744 | 1844 | 16827 | 1573 | 17670 | 1135 | 21189 | 704 | 13790 |
| 6L-2S | | MI | 5147 | 2557 | 8022 | 2011 | 9130 | 1681 | 9776 | 1417 | 10561 | 1004 | 12389 | 825 | 6720 |
| 12-#11 | 2.34 | MA | 10589 | 2656 | 15319 | 2220 | 17979 | 1864 | 19558 | 1568 | 21398 | 1100 | 26314 | 761 | 17645 |
| 4E | | MI | 5009 | 2656 | 7790 | 2071 | 8740 | 1732 | 9271 | 1448 | 9851 | 995 | 11396 | 603 | 8039 |
| 12-#11 | 2.34 | MA | 10210 | 2656 | 14651 | 2245 | 17184 | 1879 | 18568 | 1582 | 20018 | 1121 | 24433 | 714 | 17121 |
| 5L-3S | | MI | 5110 | 2656 | 8075 | 2062 | 9140 | 1716 | 9762 | 1444 | 10522 | 996 | 12167 | 660 | 8044 |
| 12-#11 | 2.34 | MA | 9879 | 2656 | 14008 | 2253 | 16424 | 1892 | 17596 | 1606 | 18666 | 1133 | 22597 | 632 | 16392 |
| 6L-2S | | MI | 5300 | 2656 | 8481 | 2054 | 9657 | 1710 | 10390 | 1430 | 11372 | 987 | 13249 | 772 | 8030 |
| 12-#14 | 3.38 | MA | 11456 | 2892 | 17166 | 2374 | 20244 | 1982 | 22279 | 1645 | 25053 | 1095 | 31477 | 666 | 24906 |
| 4E | | MI | 5311 | 2892 | 8552 | 2209 | 9655 | 1835 | 10362 | 1509 | 11346 | 987 | 13137 | 444 | 10892 |
| 12-#14 | 3.38 | MA | 10924 | 2892 | 16215 | 2410 | 19104 | 2003 | 20860 | 1664 | 23074 | 1125 | 28775 | 595 | 23435 |
| 5L-3S | | MI | 5447 | 2892 | 8958 | 2199 | 10224 | 1812 | 11059 | 1506 | 12263 | 976 | 14210 | 522 | 11158 |
| 12-#14 | 3.38 | MA | 10471 | 2892 | 15294 | 2421 | 18023 | 2022 | 19466 | 1698 | 21188 | 1156 | 26139 | 475 | 22161 |
| 6L-2S | | MI | 5703 | 2892 | 9532 | 2188 | 10955 | 1805 | 11947 | 1487 | 13465 | 965 | 15708 | 684 | 11172 |
| 12-#18 | 6.00 | MA | 12676 | 3492 | 20065 | 2830 | 23856 | 2316 | 26547 | 1872 | 30670 | 1132 | 39549 | 288 | 37898 |
| 5L-3S | | MI | 6254 | 3492 | 11067 | 2549 | 12832 | 2061 | 14191 | 1663 | 16453 | 923 | 18875 | 127 | 18395 |
| 12-#18 | 6.00 | MA | 11948 | 3492 | 18466 | 2848 | 21973 | 2351 | 24097 | 1929 | 27355 | 1183 | 34903 | 67 | 34398 |
| 6L-2S | | MI | 6612 | 3492 | 12048 | 2534 | 14081 | 2054 | 15708 | 1636 | 18501 | 909 | 21321 | 415 | 18671 |
| 14-#10 | 2.22 | MA | 10630 | 2629 | 15299 | 2208 | 18037 | 1854 | 19663 | 1562 | 21572 | 1102 | 26531 | 800 | 16965 |
| 4L-5S | | MI | 4946 | 2629 | 7542 | 2088 | 8504 | 1741 | 9004 | 1467 | 9498 | 1019 | 11077 | 619 | 7673 |
| 14-#10 | 2.22 | MA | 10313 | 2629 | 14746 | 2228 | 17384 | 1866 | 18850 | 1573 | 20438 | 1121 | 24990 | 763 | 16787 |
| 5L-4S | | MI | 5048 | 2629 | 7785 | 2072 | 8796 | 1735 | 9367 | 1454 | 10002 | 1010 | 11730 | 672 | 7766 |
| 14-#10 | 2.22 | MA | 10043 | 2629 | 14217 | 2235 | 16753 | 1877 | 18053 | 1593 | 19329 | 1130 | 23486 | 698 | 16153 |
| 6L-3S | | MI | 5132 | 2629 | 8022 | 2064 | 9130 | 1720 | 9776 | 1450 | 10561 | 1009 | 12389 | 721 | 7767 |
| 14-#10 | 2.22 | MA | 9814 | 2629 | 13718 | 2244 | 16049 | 1893 | 17270 | 1603 | 18257 | 1149 | 22047 | 666 | 15697 |
| 7L-2S | | MI | 5292 | 2629 | 8362 | 2057 | 9562 | 1714 | 10301 | 1437 | 11271 | 1000 | 13319 | 812 | 7758 |
| 14-#11 | 2.73 | MA | 10677 | 2745 | 15614 | 2301 | 18410 | 1919 | 20057 | 1607 | 22033 | 1116 | 27223 | 707 | 19973 |
| 5L-4S | | MI | 5186 | 2745 | 8196 | 2126 | 9257 | 1773 | 9899 | 1473 | 10701 | 990 | 12478 | 583 | 9257 |
| 14-#11 | 2.73 | MA | 10357 | 2745 | 14971 | 2309 | 17650 | 1933 | 19085 | 1631 | 20681 | 1128 | 25387 | 625 | 19268 |
| 6L-3S | | MI | 5283 | 2745 | 8481 | 2118 | 9657 | 1756 | 10390 | 1470 | 11372 | 991 | 13249 | 640 | 9274 |
| 14-#11 | 2.73 | MA | 10086 | 2745 | 14363 | 2319 | 16793 | 1951 | 18142 | 1644 | 19374 | 1149 | 23623 | 584 | 18437 |
| 7L-2S | | MI | 5470 | 2745 | 8887 | 2110 | 10174 | 1750 | 11018 | 1456 | 12222 | 982 | 14331 | 752 | 9268 |
| 14-#14 | 3.94 | MA | 11576 | 3021 | 17592 | 2491 | 20857 | 2061 | 22990 | 1700 | 25957 | 1118 | 32766 | 585 | 27548 |
| 5L-4S | | MI | 5558 | 3021 | 9126 | 2290 | 10386 | 1893 | 11250 | 1546 | 12548 | 980 | 14635 | 410 | 12523 |
| 14-#14 | 3.94 | MA | 11143 | 3021 | 16671 | 2501 | 19777 | 2081 | 21596 | 1734 | 24070 | 1148 | 30130 | 465 | 26243 |
| 6L-3S | | MI | 5687 | 3021 | 9532 | 2279 | 10955 | 1871 | 11947 | 1542 | 13465 | 969 | 15708 | 489 | 12879 |
| 14-#14 | 3.94 | MA | 10774 | 3021 | 15800 | 2516 | 18549 | 2107 | 20257 | 1753 | 22145 | 1164 | 27590 | 405 | 24655 |
| 7L-2S | | MI | 5939 | 3021 | 10106 | 2268 | 11686 | 1864 | 12835 | 1523 | 14667 | 957 | 17206 | 650 | 12909 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

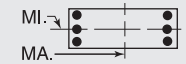
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 7.00 | MA | 13089 | 3720 | 20874 | 2991 | 25039 | 2454 | 27822 | 1994 | 32395 | 1170 | 41882 | 48 | 41516 |
| 6L-3S | | MI | 6645 | 3720 | 12048 | 2692 | 14081 | 2165 | 15708 | 1728 | 18501 | 909 | 21321 | 51 | 21119 |
| 16-#10 | 2.54 | MA | 10698 | 2702 | 15538 | 2274 | 18394 | 1899 | 20076 | 1594 | 22097 | 1116 | 27287 | 757 | 19134 |
| 5E | | MI | 5096 | 2702 | 7882 | 2134 | 8936 | 1773 | 9529 | 1487 | 10208 | 1015 | 12007 | 606 | 8654 |
| 16-#10 | 2.54 | MA | 10436 | 2702 | 15010 | 2280 | 17762 | 1910 | 19279 | 1614 | 20988 | 1126 | 25783 | 692 | 18517 |
| 6L-4S | | MI | 5198 | 2702 | 8125 | 2117 | 9229 | 1767 | 9892 | 1475 | 10713 | 1005 | 12660 | 659 | 8787 |
| 16-#10 | 2.54 | MA | 10215 | 2702 | 14510 | 2289 | 17058 | 1925 | 18495 | 1624 | 19916 | 1145 | 24344 | 660 | 18072 |
| 7L-3S | | MI | 5279 | 2702 | 8362 | 2110 | 9562 | 1753 | 10301 | 1470 | 11271 | 1005 | 13319 | 708 | 8797 |
| 16-#10 | 2.54 | MA | 9942 | 2702 | 14032 | 2299 | 16412 | 1934 | 17673 | 1640 | 18864 | 1163 | 22945 | 617 | 17295 |
| 8L-2S | | MI | 5436 | 2702 | 8701 | 2102 | 9994 | 1747 | 10825 | 1458 | 11982 | 996 | 14248 | 799 | 8791 |
| 16-#11 | 3.12 | MA | 10826 | 2834 | 15934 | 2364 | 18876 | 1973 | 20574 | 1656 | 22696 | 1122 | 28177 | 618 | 22146 |
| 6L-4S | | MI | 5362 | 2834 | 8602 | 2182 | 9774 | 1813 | 10527 | 1499 | 11550 | 985 | 13560 | 563 | 10473 |
| 16-#11 | 3.12 | MA | 10567 | 2834 | 15326 | 2375 | 18019 | 1992 | 19631 | 1669 | 21389 | 1144 | 26413 | 577 | 21302 |
| 7L-3S | | MI | 5455 | 2834 | 8887 | 2174 | 10174 | 1797 | 11018 | 1495 | 12222 | 986 | 14331 | 619 | 10499 |
| 16-#11 | 3.12 | MA | 10243 | 2834 | 14743 | 2386 | 17231 | 2002 | 18630 | 1688 | 20108 | 1166 | 24704 | 522 | 20401 |
| 8L-2S | | MI | 5638 | 2834 | 9294 | 2165 | 10691 | 1791 | 11646 | 1481 | 13072 | 977 | 15412 | 731 | 10502 |
| 16-#14 | 4.50 | MA | 11800 | 3149 | 18049 | 2581 | 21530 | 2139 | 23726 | 1771 | 26953 | 1141 | 34121 | 454 | 30324 |
| 6L-4S | | MI | 5802 | 3149 | 9701 | 2370 | 11117 | 1951 | 12138 | 1582 | 13750 | 972 | 16133 | 376 | 14164 |
| 16-#14 | 4.50 | MA | 11450 | 3149 | 17178 | 2596 | 20303 | 2165 | 22387 | 1789 | 25027 | 1156 | 31581 | 395 | 28748 |
| 7L-3S | | MI | 5942 | 3149 | 10106 | 2359 | 11686 | 1929 | 12835 | 1578 | 14667 | 961 | 17206 | 455 | 14597 |
| 16-#14 | 4.50 | MA | 10995 | 3149 | 16343 | 2612 | 19174 | 2179 | 20952 | 1816 | 23189 | 1187 | 29125 | 314 | 26895 |
| 8L-2S | | MI | 6166 | 3149 | 10681 | 2348 | 12418 | 1922 | 13723 | 1560 | 15869 | 950 | 18704 | 617 | 14639 |
| 18-#10 | 2.86 | MA | 10822 | 2774 | 15803 | 2325 | 18771 | 1943 | 20505 | 1634 | 22647 | 1122 | 28080 | 686 | 20884 |
| 6L-5S | | MI | 5244 | 2774 | 8221 | 2179 | 9368 | 1806 | 10054 | 1508 | 10919 | 1010 | 12937 | 593 | 9638 |
| 18-#10 | 2.86 | MA | 10610 | 2774 | 15303 | 2334 | 18068 | 1958 | 19721 | 1644 | 21575 | 1140 | 26641 | 654 | 20446 |
| 7L-4S | | MI | 5346 | 2774 | 8464 | 2163 | 9661 | 1800 | 10417 | 1495 | 11423 | 1001 | 13589 | 646 | 9806 |
| 18-#10 | 2.86 | MA | 10339 | 2774 | 14825 | 2344 | 17421 | 1967 | 18899 | 1660 | 20523 | 1159 | 25242 | 611 | 19660 |
| 8L-3S | | MI | 5424 | 2774 | 8701 | 2155 | 9994 | 1786 | 10825 | 1491 | 11982 | 1001 | 14248 | 695 | 9821 |
| 18-#10 | 2.86 | MA | 10078 | 2774 | 14276 | 2362 | 16757 | 1985 | 18102 | 1669 | 19448 | 1169 | 23877 | 568 | 18912 |
| 9L-2S | | MI | 5579 | 2774 | 9041 | 2147 | 10426 | 1780 | 11350 | 1478 | 12692 | 992 | 15178 | 786 | 9822 |
| 18-#11 | 3.51 | MA | 11039 | 2923 | 16288 | 2430 | 19245 | 2032 | 21120 | 1694 | 23404 | 1139 | 29203 | 570 | 24168 |
| 7L-4S | | MI | 5536 | 2923 | 9008 | 2238 | 10291 | 1854 | 11155 | 1524 | 12400 | 980 | 14641 | 542 | 11661 |
| 18-#11 | 3.51 | MA | 10717 | 2923 | 15706 | 2442 | 18457 | 2042 | 20119 | 1713 | 22123 | 1161 | 27494 | 515 | 23271 |
| 8L-3S | | MI | 5626 | 2923 | 9294 | 2229 | 10691 | 1837 | 11646 | 1520 | 13072 | 981 | 15412 | 599 | 11720 |
| 18-#11 | 3.51 | MA | 10408 | 2923 | 15044 | 2464 | 17649 | 2064 | 19148 | 1722 | 20812 | 1172 | 25820 | 462 | 22113 |
| 9L-2S | | MI | 5805 | 2923 | 9700 | 2221 | 11209 | 1831 | 12274 | 1506 | 13922 | 971 | 16494 | 711 | 11732 |
| 18-#14 | 5.06 | MA | 12113 | 3278 | 18555 | 2676 | 22057 | 2224 | 24517 | 1826 | 27910 | 1149 | 35572 | 385 | 32840 |
| 7L-4S | | MI | 6070 | 3278 | 10275 | 2450 | 11848 | 2010 | 13026 | 1618 | 14952 | 965 | 17631 | 343 | 15814 |
| 18-#14 | 5.06 | MA | 11662 | 3278 | 17720 | 2693 | 20928 | 2238 | 23082 | 1852 | 26072 | 1179 | 33116 | 304 | 30971 |
| 8L-3S | | MI | 6175 | 3278 | 10681 | 2439 | 12418 | 1988 | 13723 | 1615 | 15869 | 954 | 18704 | 421 | 16313 |
| 18-#14 | 5.06 | MA | 11241 | 3278 | 16777 | 2725 | 19769 | 2268 | 21691 | 1865 | 24192 | 1195 | 30705 | 226 | 29171 |
| 9L-2S | | MI | 6392 | 3278 | 11255 | 2429 | 13149 | 1980 | 14612 | 1596 | 17071 | 942 | 20202 | 583 | 16366 |
| 20-#10 | 3.17 | MA | 10998 | 2847 | 16096 | 2380 | 19077 | 1991 | 20947 | 1665 | 23234 | 1136 | 28938 | 648 | 22820 |
| 7L-5S | | MI | 5392 | 2847 | 8561 | 2224 | 9800 | 1839 | 10579 | 1528 | 11629 | 1006 | 13867 | 580 | 10625 |
| 20-#10 | 3.17 | MA | 10730 | 2847 | 15618 | 2390 | 18430 | 2000 | 20124 | 1681 | 22182 | 1155 | 27539 | 605 | 22025 |
| 8L-4S | | MI | 5493 | 2847 | 8804 | 2208 | 10093 | 1833 | 10942 | 1516 | 12134 | 997 | 14519 | 633 | 10823 |
| 20-#10 | 3.17 | MA | 10476 | 2847 | 15069 | 2407 | 17766 | 2018 | 19328 | 1689 | 21107 | 1165 | 26174 | 562 | 21268 |
| 9L-3S | | MI | 5569 | 2847 | 9041 | 2200 | 10426 | 1819 | 11350 | 1512 | 12692 | 996 | 15178 | 682 | 10844 |
| 20-#10 | 3.17 | MA | 10233 | 2847 | 14572 | 2415 | 17142 | 2028 | 18533 | 1707 | 20023 | 1180 | 24667 | 514 | 20460 |
| 10L-2S | | MI | 5721 | 2847 | 9380 | 2193 | 10858 | 1813 | 11875 | 1499 | 13403 | 987 | 16108 | 773 | 10851 |
| 20-#11 | 3.90 | MA | 11184 | 3012 | 16669 | 2498 | 19683 | 2083 | 21608 | 1738 | 24138 | 1156 | 30284 | 508 | 26122 |
| 8L-4S | | MI | 5708 | 3012 | 9414 | 2293 | 10808 | 1894 | 11783 | 1549 | 13250 | 974 | 15723 | 522 | 12826 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

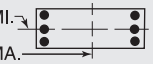
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.90 | MA | 10885 | 3012 | 16007 | 2520 | 18875 | 2105 | 20637 | 1748 | 22827 | 1167 | 28610 | 455 | 24972 |
| 9L-3S | | MI | 5796 | 3012 | 9700 | 2285 | 11209 | 1878 | 12274 | 1545 | 13922 | 975 | 16494 | 579 | 12940 |
| 20-#11 | 3.90 | MA | 10597 | 3012 | 15402 | 2529 | 18113 | 2117 | 19669 | 1769 | 21525 | 1186 | 26769 | 393 | 23857 |
| 10L-2S | | MI | 5971 | 3012 | 10106 | 2277 | 11726 | 1872 | 12902 | 1531 | 14771 | 966 | 17576 | 691 | 12958 |
| 20-#14 | 5.63 | MA | 12316 | 3406 | 19097 | 2773 | 22681 | 2296 | 25212 | 1889 | 28954 | 1172 | 37108 | 293 | 35046 |
| 8L-4S | | MI | 6308 | 3406 | 10849 | 2531 | 12580 | 2068 | 13915 | 1655 | 16154 | 958 | 19129 | 309 | 17471 |
| 20-#14 | 5.63 | MA | 11912 | 3406 | 18155 | 2805 | 21522 | 2327 | 23821 | 1902 | 27075 | 1187 | 34696 | 216 | 33233 |
| 9L-3S | | MI | 6406 | 3406 | 11255 | 2520 | 13149 | 2046 | 14612 | 1651 | 17071 | 946 | 20202 | 388 | 18027 |
| 22-#10 | 3.49 | MA | 11115 | 2919 | 16410 | 2435 | 19439 | 2033 | 21350 | 1701 | 23841 | 1150 | 29836 | 599 | 24390 |
| 8L-5S | | MI | 5538 | 2919 | 8900 | 2270 | 10232 | 1872 | 11104 | 1549 | 12339 | 1002 | 14796 | 567 | 11615 |
| 22-#10 | 3.49 | MA | 10868 | 2919 | 15862 | 2453 | 18776 | 2051 | 20554 | 1710 | 22766 | 1160 | 28471 | 556 | 23624 |
| 9L-4S | | MI | 5639 | 2919 | 9143 | 2253 | 10525 | 1866 | 11467 | 1536 | 12844 | 993 | 15449 | 620 | 11839 |
| 22-#10 | 3.49 | MA | 10634 | 2919 | 15365 | 2460 | 18151 | 2061 | 19759 | 1727 | 21681 | 1176 | 26964 | 508 | 22819 |
| 10L-3S | | MI | 5713 | 2919 | 9380 | 2246 | 10858 | 1852 | 11875 | 1532 | 13403 | 992 | 16108 | 669 | 11865 |
| 22-#10 | 3.49 | MA | 10372 | 2919 | 14880 | 2469 | 17520 | 2070 | 18982 | 1737 | 20582 | 1183 | 25602 | 463 | 21913 |
| 11L-2S | | MI | 5862 | 2919 | 9720 | 2238 | 11290 | 1846 | 12400 | 1519 | 14113 | 983 | 17038 | 760 | 11876 |
| 22-#11 | 4.29 | MA | 11354 | 3101 | 16970 | 2576 | 20100 | 2145 | 22126 | 1773 | 24842 | 1162 | 31400 | 447 | 27831 |
| 9L-4S | | MI | 5880 | 3101 | 9820 | 2349 | 11325 | 1934 | 12411 | 1574 | 14100 | 969 | 16805 | 502 | 13997 |
| 22-#11 | 4.29 | MA | 11090 | 3101 | 16365 | 2585 | 19339 | 2157 | 21158 | 1794 | 23540 | 1181 | 29559 | 386 | 26707 |
| 10L-3S | | MI | 5964 | 3101 | 10106 | 2341 | 11726 | 1918 | 12902 | 1571 | 14771 | 970 | 17576 | 559 | 14157 |
| 22-#14 | 6.19 | MA | 12570 | 3535 | 19532 | 2886 | 23276 | 2385 | 25951 | 1938 | 29957 | 1180 | 38688 | 205 | 37295 |
| 9L-4S | | MI | 6543 | 3535 | 11424 | 2611 | 13311 | 2126 | 14803 | 1691 | 17356 | 950 | 20627 | 275 | 19134 |
| 24-#10 | 3.81 | MA | 11255 | 2992 | 16654 | 2498 | 19785 | 2084 | 21779 | 1730 | 24425 | 1156 | 30768 | 551 | 25980 |
| 9L-5S | | MI | 5683 | 2992 | 9239 | 2315 | 10665 | 1905 | 11629 | 1570 | 13050 | 998 | 15726 | 554 | 12607 |
| 24-#10 | 3.81 | MA | 11029 | 2992 | 16157 | 2506 | 19160 | 2094 | 20985 | 1748 | 23340 | 1171 | 29261 | 502 | 25178 |
| 10L-4S | | MI | 5784 | 2992 | 9482 | 2299 | 10957 | 1899 | 11992 | 1557 | 13555 | 989 | 16379 | 607 | 12855 |
| 24-#10 | 3.81 | MA | 10770 | 2992 | 15673 | 2515 | 18529 | 2103 | 20208 | 1757 | 22241 | 1179 | 27899 | 457 | 24266 |
| 11L-3S | | MI | 5856 | 2992 | 9720 | 2291 | 11290 | 1885 | 12400 | 1553 | 14113 | 988 | 17038 | 656 | 12885 |
| 24-#11 | 4.68 | MA | 11561 | 3190 | 17328 | 2640 | 20565 | 2198 | 22647 | 1819 | 25555 | 1176 | 32349 | 378 | 29558 |
| 10L-4S | | MI | 6050 | 3190 | 10226 | 2405 | 11842 | 1975 | 13039 | 1600 | 14950 | 964 | 17886 | 482 | 15171 |

## RECTANGULAR TIED COLUMNS 22" x 22"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#9 | 1.24 | MA | 3247 | 1455 | 4837 | 1177 | 5496 | 990 | 5829 | 844 | 6135 | 623 | 7194 | 537 | 3049 |
| 2L-3S | | MI | 3090 | 1455 | 4532 | 1184 | 5107 | 996 | 5357 | 856 | 5495 | 632 | 6324 | 465 | 3065 |
| 6-#10 | 1.57 | MA | 3350 | 1501 | 5089 | 1202 | 5803 | 1008 | 6197 | 854 | 6627 | 618 | 7833 | 526 | 3795 |
| 2L-3S | | MI | 3157 | 1501 | 4705 | 1211 | 5313 | 1015 | 5602 | 868 | 5822 | 629 | 6746 | 435 | 3810 |
| 6-#11 | 1.93 | MA | 3441 | 1551 | 5358 | 1222 | 6110 | 1022 | 6552 | 861 | 7095 | 609 | 8362 | 503 | 4550 |
| 2L-3S | | MI | 3215 | 1551 | 4896 | 1232 | 5522 | 1029 | 5838 | 876 | 6129 | 621 | 7089 | 391 | 4562 |
| 6-#14 | 2.79 | MA | 3678 | 1669 | 5963 | 1289 | 6856 | 1069 | 7446 | 888 | 8295 | 598 | 9839 | 468 | 6351 |
| 2L-3S | | MI | 3372 | 1669 | 5309 | 1302 | 6022 | 1079 | 6433 | 910 | 6925 | 613 | 8066 | 306 | 6324 |
| 6-#18 | 4.96 | MA | 4227 | 1969 | 7420 | 1460 | 8662 | 1192 | 9617 | 962 | 11216 | 571 | 13267 | 357 | 10682 |
| 2L-3S | | MI | 3747 | 1969 | 6297 | 1480 | 7231 | 1205 | 7879 | 995 | 8864 | 591 | 10336 | 69 | 10132 |
| 8-#8 | 1.31 | MA | 3275 | 1464 | 4881 | 1186 | 5563 | 998 | 5916 | 849 | 6257 | 625 | 7385 | 540 | 3208 |
| 2L-4S | | MI | 3085 | 1464 | 4470 | 1198 | 5017 | 1013 | 5250 | 863 | 5351 | 634 | 6197 | 450 | 3228 |
| 8-#9 | 1.65 | MA | 3383 | 1512 | 5143 | 1213 | 5885 | 1016 | 6302 | 860 | 6774 | 620 | 8065 | 530 | 3987 |
| 2L-4S | | MI | 3150 | 1512 | 4626 | 1227 | 5198 | 1035 | 5465 | 876 | 5635 | 631 | 6582 | 418 | 3993 |
| 8-#10 | 2.10 | MA | 3518 | 1574 | 5474 | 1247 | 6293 | 1041 | 6792 | 875 | 7432 | 614 | 8920 | 517 | 4971 |
| 2L-4S | | MI | 3232 | 1574 | 4823 | 1265 | 5428 | 1064 | 5737 | 895 | 5997 | 627 | 7068 | 375 | 4942 |
| 8-#11 | 2.58 | MA | 3638 | 1640 | 5820 | 1278 | 6698 | 1062 | 7267 | 886 | 8062 | 604 | 9636 | 488 | 5957 |
| 2L-4S | | MI | 3304 | 1640 | 5036 | 1298 | 5658 | 1088 | 5998 | 907 | 6337 | 617 | 7461 | 316 | 5794 |
| 8-#14 | 3.72 | MA | 3950 | 1797 | 6618 | 1369 | 7689 | 1127 | 8458 | 925 | 9665 | 590 | 11613 | 442 | 8332 |
| 2L-4S | | MI | 3500 | 1797 | 5505 | 1395 | 6212 | 1162 | 6657 | 953 | 7216 | 605 | 8580 | 196 | 7601 |
| 10-#10 | 2.62 | MA | 3684 | 1646 | 5859 | 1293 | 6783 | 1074 | 7387 | 895 | 8237 | 610 | 10007 | 508 | 6140 |
| 2L-5S | | MI | 3285 | 1646 | 4934 | 1328 | 5589 | 1104 | 5923 | 929 | 6235 | 634 | 7392 | 313 | 5744 |

## RECTANGULAR TIED COLUMNS 22" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.62 | MA | 3503 | 1646 | 5474 | 1301 | 6293 | 1081 | 6792 | 910 | 7432 | 621 | 8920 | 417 | 6132 |
| 3L-4S | | MI | 3409 | 1646 | 5207 | 1310 | 5918 | 1097 | 6332 | 915 | 6803 | 623 | 8155 | 366 | 6087 |
| 10-#11 | 3.22 | MA | 3832 | 1729 | 6282 | 1334 | 7286 | 1102 | 7981 | 911 | 9028 | 599 | 10910 | 473 | 7356 |
| 2L-5S | | MI | 3371 | 1729 | 5168 | 1374 | 5848 | 1136 | 6219 | 948 | 6618 | 623 | 7841 | 236 | 6718 |
| 10-#11 | 3.22 | MA | 3623 | 1729 | 5820 | 1344 | 6698 | 1110 | 7267 | 927 | 8062 | 610 | 9636 | 361 | 7335 |
| 3L-4S | | MI | 3514 | 1729 | 5498 | 1353 | 6246 | 1128 | 6712 | 933 | 7303 | 612 | 8735 | 301 | 7100 |
| 10-#14 | 4.65 | MA | 3939 | 1926 | 6618 | 1462 | 7689 | 1195 | 8458 | 983 | 9665 | 598 | 11613 | 255 | 10223 |
| 3L-4S | | MI | 3793 | 1926 | 6160 | 1475 | 7045 | 1220 | 7669 | 989 | 8586 | 598 | 10353 | 171 | 9470 |

## RECTANGULAR TIED COLUMNS 22" x 24"

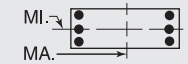
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.18 | MA | 3837 | 1578 | 5711 | 1276 | 6473 | 1074 | 6851 | 917 | 7180 | 679 | 8381 | 584 | 3466 |
| 2E | | MI | 3498 | 1578 | 5258 | 1263 | 5917 | 1063 | 6239 | 907 | 6510 | 671 | 7501 | 568 | 3153 |
| 4-#14 | 1.70 | MA | 4023 | 1657 | 6176 | 1318 | 7037 | 1104 | 7523 | 933 | 8079 | 670 | 9525 | 563 | 4839 |
| 2E | | MI | 3660 | 1657 | 5672 | 1303 | 6418 | 1092 | 6834 | 923 | 7305 | 661 | 8477 | 542 | 4383 |
| 4-#18 | 3.03 | MA | 4457 | 1857 | 7297 | 1427 | 8409 | 1181 | 9163 | 978 | 10279 | 649 | 12216 | 500 | 8158 |
| 2E | | MI | 4036 | 1857 | 6665 | 1412 | 7629 | 1168 | 8279 | 967 | 9243 | 640 | 10742 | 465 | 7337 |
| 6-#9 | 1.14 | MA | 3843 | 1572 | 5640 | 1286 | 6437 | 1084 | 6834 | 925 | 7178 | 688 | 8458 | 599 | 3373 |
| 2L-3S | | MI | 3347 | 1572 | 4888 | 1281 | 5500 | 1079 | 5758 | 928 | 5879 | 690 | 6740 | 515 | 3086 |
| 6-#9 | 1.14 | MA | 3665 | 1572 | 5299 | 1294 | 6003 | 1090 | 6306 | 931 | 6464 | 698 | 7469 | 527 | 3389 |
| 3L-2S | | MI | 3505 | 1572 | 5194 | 1274 | 5889 | 1073 | 6230 | 916 | 6518 | 681 | 7611 | 587 | 3069 |
| 6-#10 | 1.44 | MA | 3960 | 1618 | 5923 | 1311 | 6782 | 1101 | 7246 | 936 | 7730 | 683 | 9215 | 593 | 4207 |
| 2L-3S | | MI | 3413 | 1618 | 5062 | 1308 | 5707 | 1098 | 6003 | 940 | 6204 | 687 | 7161 | 485 | 3836 |
| 6-#10 | 1.44 | MA | 3741 | 1618 | 5493 | 1321 | 6235 | 1110 | 6581 | 951 | 6830 | 695 | 7970 | 501 | 4221 |
| 3L-2S | | MI | 3608 | 1618 | 5447 | 1299 | 6197 | 1091 | 6598 | 926 | 7010 | 676 | 8249 | 576 | 3818 |
| 6-#11 | 1.77 | MA | 4067 | 1667 | 6228 | 1332 | 7131 | 1115 | 7651 | 942 | 8263 | 674 | 9848 | 573 | 5055 |
| 2L-3S | | MI | 3472 | 1667 | 5258 | 1328 | 5917 | 1111 | 6239 | 948 | 6510 | 678 | 7501 | 441 | 4595 |
| 6-#11 | 1.77 | MA | 3810 | 1667 | 5711 | 1343 | 6473 | 1124 | 6851 | 959 | 7180 | 687 | 8381 | 461 | 5067 |
| 3L-2S | | MI | 3700 | 1667 | 5719 | 1318 | 6505 | 1103 | 6953 | 932 | 7477 | 666 | 8775 | 553 | 4578 |
| 6-#14 | 2.56 | MA | 4340 | 1786 | 6911 | 1398 | 7973 | 1162 | 8659 | 970 | 9617 | 662 | 11577 | 544 | 7080 |
| 2L-3S | | MI | 3628 | 1786 | 5672 | 1397 | 6418 | 1160 | 6834 | 981 | 7305 | 669 | 8477 | 355 | 6373 |
| 6-#14 | 2.56 | MA | 3990 | 1786 | 6176 | 1413 | 7037 | 1174 | 7523 | 994 | 8079 | 680 | 9525 | 382 | 7053 |
| 3L-2S | | MI | 3938 | 1786 | 6327 | 1384 | 7252 | 1150 | 7847 | 959 | 8675 | 654 | 10250 | 517 | 6385 |
| 6-#18 | 4.55 | MA | 4982 | 2085 | 8563 | 1570 | 10021 | 1285 | 11121 | 1043 | 12929 | 636 | 15637 | 454 | 11978 |
| 2L-3S | | MI | 4002 | 2085 | 6665 | 1574 | 7629 | 1285 | 8279 | 1065 | 9243 | 647 | 10742 | 118 | 10388 |
| 6-#18 | 4.55 | MA | 4424 | 2085 | 7297 | 1593 | 8409 | 1302 | 9163 | 1081 | 10279 | 662 | 12216 | 166 | 11678 |
| 3L-2S | | MI | 4491 | 2085 | 7788 | 1554 | 9059 | 1272 | 10017 | 1032 | 11594 | 627 | 13674 | 406 | 10732 |
| 8-#8 | 1.20 | MA | 3873 | 1581 | 5687 | 1296 | 6510 | 1091 | 6929 | 931 | 7312 | 690 | 8647 | 600 | 3549 |
| 2L-4S | | MI | 3341 | 1581 | 4825 | 1295 | 5410 | 1096 | 5651 | 935 | 5735 | 692 | 6615 | 501 | 3251 |
| 8-#8 | 1.20 | MA | 3733 | 1581 | 5416 | 1302 | 6165 | 1096 | 6510 | 935 | 6744 | 698 | 7861 | 544 | 3561 |
| 3E | | MI | 3408 | 1581 | 4993 | 1290 | 5646 | 1086 | 5941 | 931 | 6132 | 690 | 7104 | 534 | 3240 |
| 8-#8 | 1.20 | MA | 3658 | 1581 | 5230 | 1308 | 5902 | 1107 | 6188 | 945 | 6303 | 701 | 7315 | 511 | 3569 |
| 4L-2S | | MI | 3532 | 1581 | 5236 | 1284 | 5956 | 1081 | 6317 | 922 | 6641 | 683 | 7802 | 590 | 3228 |
| 8-#9 | 1.52 | MA | 3997 | 1629 | 5981 | 1322 | 6871 | 1110 | 7361 | 942 | 7892 | 685 | 9446 | 594 | 4419 |
| 2L-4S | | MI | 3406 | 1629 | 4983 | 1324 | 5592 | 1118 | 5866 | 949 | 6019 | 689 | 6999 | 468 | 4025 |
| 8-#9 | 1.52 | MA | 3824 | 1629 | 5640 | 1330 | 6437 | 1116 | 6834 | 947 | 7178 | 695 | 8458 | 523 | 4429 |
| 3E | | MI | 3488 | 1629 | 5194 | 1317 | 5889 | 1105 | 6230 | 944 | 6518 | 686 | 7611 | 509 | 4021 |
| 8-#9 | 1.52 | MA | 3733 | 1629 | 5406 | 1338 | 6106 | 1130 | 6428 | 960 | 6623 | 698 | 7768 | 481 | 4425 |
| 4L-2S | | MI | 3641 | 1629 | 5499 | 1310 | 6278 | 1099 | 6703 | 933 | 7157 | 678 | 8481 | 581 | 4009 |
| 8-#10 | 1.92 | MA | 4152 | 1690 | 6353 | 1357 | 7330 | 1134 | 7911 | 956 | 8631 | 679 | 10461 | 587 | 5519 |
| 2L-4S | | MI | 3488 | 1690 | 5180 | 1362 | 5822 | 1147 | 6138 | 967 | 6380 | 685 | 7483 | 425 | 4984 |
| 8-#10 | 1.92 | MA | 3940 | 1690 | 5923 | 1366 | 6782 | 1143 | 7246 | 971 | 7730 | 691 | 9215 | 495 | 5523 |
| 3E | | MI | 3589 | 1690 | 5447 | 1353 | 6197 | 1131 | 6598 | 961 | 7010 | 682 | 8249 | 476 | 5005 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis

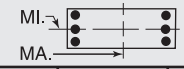



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.92 | MA | 3828 | 1690 | 5627 | 1376 | 6365 | 1159 | 6734 | 978 | 7030 | 695 | 8343 | 442 | 5490 |
| 4L-2S | | MI | 3777 | 1690 | 5832 | 1344 | 6687 | 1124 | 7193 | 947 | 7815 | 671 | 9336 | 567 | 4996 |
| 8-#11 | 2.36 | MA | 4292 | 1757 | 6746 | 1387 | 7790 | 1155 | 8451 | 967 | 9346 | 669 | 11315 | 562 | 6631 |
| 2L-4S | | MI | 3560 | 1757 | 5397 | 1394 | 6053 | 1170 | 6399 | 979 | 6718 | 674 | 7874 | 366 | 5920 |
| 8-#11 | 2.36 | MA | 4044 | 1757 | 6228 | 1398 | 7131 | 1164 | 7651 | 985 | 8263 | 682 | 9848 | 450 | 6625 |
| 3E | | MI | 3678 | 1757 | 5719 | 1384 | 6505 | 1152 | 6953 | 973 | 7477 | 672 | 8775 | 426 | 5989 |
| 8-#11 | 2.36 | MA | 3913 | 1757 | 5870 | 1409 | 6627 | 1184 | 7033 | 992 | 7417 | 686 | 8816 | 387 | 6549 |
| 4L-2S | | MI | 3898 | 1757 | 6181 | 1374 | 7093 | 1144 | 7668 | 957 | 8443 | 661 | 10049 | 538 | 5988 |
| 8-#14 | 3.41 | MA | 4650 | 1914 | 7646 | 1478 | 8908 | 1220 | 9796 | 1006 | 11155 | 655 | 13628 | 525 | 9304 |
| 2L-4S | | MI | 3755 | 1914 | 5868 | 1490 | 6608 | 1243 | 7058 | 1024 | 7596 | 662 | 8990 | 246 | 7749 |
| 8-#14 | 3.41 | MA | 4317 | 1914 | 6911 | 1493 | 7973 | 1232 | 8659 | 1030 | 9617 | 673 | 11577 | 363 | 9247 |
| 3E | | MI | 3915 | 1914 | 6327 | 1477 | 7252 | 1218 | 7847 | 1017 | 8675 | 662 | 10250 | 330 | 8328 |
| 8-#14 | 3.41 | MA | 4139 | 1914 | 6400 | 1508 | 7254 | 1259 | 7778 | 1039 | 8412 | 676 | 10129 | 275 | 8603 |
| 4L-2S | | MI | 4211 | 1914 | 6982 | 1464 | 8085 | 1208 | 8859 | 996 | 10046 | 647 | 12024 | 492 | 8371 |
| 8-#18 | 6.06 | MA | 5006 | 2314 | 8563 | 1736 | 10021 | 1406 | 11121 | 1146 | 12929 | 649 | 15637 | 120 | 15204 |
| 3E | | MI | 4507 | 2314 | 7788 | 1716 | 9059 | 1388 | 10017 | 1129 | 11594 | 634 | 13674 | 59 | 13478 |
| 8-#18 | 6.06 | MA | 4690 | 2314 | 7676 | 1759 | 8775 | 1450 | 9594 | 1157 | 10841 | 648 | 13206 | -29 | 13167 |
| 4L-2S | | MI | 4928 | 2314 | 8912 | 1697 | 10490 | 1375 | 11755 | 1096 | 13946 | 613 | 16605 | 346 | 14106 |
| 10-#10 | 2.41 | MA | 4341 | 1763 | 6783 | 1402 | 7878 | 1167 | 8576 | 977 | 9531 | 675 | 11706 | 581 | 6825 |
| 2L-5S | | MI | 3541 | 1763 | 5292 | 1424 | 5983 | 1187 | 6324 | 1001 | 6618 | 691 | 7808 | 363 | 5839 |
| 10-#10 | 2.41 | MA | 4135 | 1763 | 6353 | 1412 | 7330 | 1176 | 7911 | 992 | 8631 | 687 | 10461 | 489 | 6818 |
| 3L-4S | | MI | 3666 | 1763 | 5565 | 1407 | 6312 | 1180 | 6733 | 987 | 7185 | 681 | 8570 | 416 | 6132 |
| 10-#10 | 2.41 | MA | 4030 | 1763 | 6057 | 1421 | 6913 | 1192 | 7400 | 999 | 7930 | 691 | 9588 | 436 | 6772 |
| 4L-3S | | MI | 3761 | 1763 | 5832 | 1398 | 6687 | 1164 | 7193 | 982 | 7815 | 678 | 9336 | 467 | 6165 |
| 10-#10 | 2.41 | MA | 3884 | 1763 | 5754 | 1440 | 6548 | 1200 | 6946 | 1014 | 7299 | 703 | 8715 | 384 | 6439 |
| 5L-2S | | MI | 3944 | 1763 | 6217 | 1390 | 7177 | 1157 | 7788 | 968 | 8620 | 667 | 10423 | 558 | 6167 |
| 10-#11 | 2.95 | MA | 4513 | 1846 | 7263 | 1443 | 8449 | 1196 | 9251 | 992 | 10429 | 664 | 12783 | 552 | 8199 |
| 2L-5S | | MI | 3627 | 1846 | 5529 | 1470 | 6243 | 1218 | 6619 | 1020 | 6999 | 680 | 8254 | 285 | 6827 |
| 10-#11 | 2.95 | MA | 4275 | 1846 | 6746 | 1454 | 7790 | 1205 | 8451 | 1010 | 9346 | 677 | 11315 | 439 | 8177 |
| 3L-4S | | MI | 3770 | 1846 | 5859 | 1449 | 6641 | 1210 | 7113 | 1004 | 7684 | 669 | 9148 | 351 | 7222 |
| 10-#11 | 2.95 | MA | 4151 | 1846 | 6387 | 1465 | 7286 | 1224 | 7833 | 1017 | 8500 | 680 | 10283 | 376 | 8018 |
| 4L-3S | | MI | 3881 | 1846 | 6181 | 1440 | 7093 | 1192 | 7668 | 998 | 8443 | 667 | 10049 | 411 | 7376 |
| 10-#11 | 2.95 | MA | 3983 | 1846 | 6021 | 1486 | 6844 | 1233 | 7284 | 1034 | 7737 | 694 | 9254 | 312 | 7545 |
| 5L-2S | | MI | 4093 | 1846 | 6643 | 1430 | 7681 | 1184 | 8382 | 982 | 9410 | 656 | 11323 | 523 | 7390 |
| 10-#14 | 4.26 | MA | 4637 | 2043 | 7646 | 1573 | 8908 | 1291 | 9796 | 1066 | 11155 | 666 | 13628 | 345 | 11438 |
| 3L-4S | | MI | 4048 | 2043 | 6523 | 1571 | 7441 | 1301 | 8070 | 1060 | 8967 | 654 | 10764 | 220 | 9613 |
| 10-#14 | 4.26 | MA | 4473 | 2043 | 7135 | 1588 | 8190 | 1317 | 8915 | 1075 | 9950 | 669 | 12181 | 256 | 10709 |
| 4L-3S | | MI | 4196 | 2043 | 6982 | 1557 | 8085 | 1276 | 8859 | 1053 | 10046 | 654 | 12024 | 304 | 10279 |
| 10-#14 | 4.26 | MA | 4240 | 2043 | 6612 | 1618 | 7559 | 1329 | 8132 | 1099 | 8862 | 687 | 10741 | 162 | 10095 |
| 5L-2S | | MI | 4480 | 2043 | 7636 | 1544 | 8919 | 1267 | 9871 | 1032 | 11416 | 639 | 13797 | 466 | 10344 |
| 10-#18 | 7.58 | MA | 5310 | 2542 | 8942 | 1901 | 10387 | 1553 | 11553 | 1222 | 13491 | 635 | 16627 | -76 | 16463 |
| 4L-3S | | MI | 4972 | 2542 | 8912 | 1859 | 10490 | 1492 | 11755 | 1194 | 13946 | 620 | 16605 | -1 | 16602 |
| 12-#10 | 2.89 | MA | 4527 | 1835 | 7213 | 1447 | 8425 | 1200 | 9242 | 997 | 10431 | 670 | 12951 | 575 | 8127 |
| 2L-6S | | MI | 3589 | 1835 | 5439 | 1478 | 6149 | 1235 | 6517 | 1028 | 6880 | 698 | 8195 | 295 | 6733 |
| 12-#10 | 2.89 | MA | 4327 | 1835 | 6783 | 1457 | 7878 | 1208 | 8576 | 1013 | 9531 | 683 | 11706 | 483 | 8110 |
| 3L-5S | | MI | 3717 | 1835 | 5677 | 1470 | 6473 | 1220 | 6919 | 1022 | 7423 | 687 | 8895 | 354 | 6952 |
| 12-#10 | 2.89 | MA | 4227 | 1835 | 6487 | 1467 | 7460 | 1225 | 8065 | 1019 | 8830 | 687 | 10834 | 430 | 8054 |
| 4E | | MI | 3840 | 1835 | 5950 | 1453 | 6802 | 1212 | 7328 | 1008 | 7991 | 676 | 9657 | 407 | 7278 |
| 12-#10 | 2.89 | MA | 4083 | 1835 | 6184 | 1485 | 7095 | 1233 | 7611 | 1035 | 8199 | 699 | 9960 | 378 | 7688 |
| 5L-3S | | MI | 3931 | 1835 | 6217 | 1444 | 7177 | 1197 | 7788 | 1002 | 8620 | 674 | 10423 | 458 | 7322 |
| 12-#10 | 2.89 | MA | 3940 | 1835 | 5913 | 1492 | 6735 | 1250 | 7165 | 1041 | 7596 | 711 | 9162 | 317 | 7440 |
| 6L-2S | | MI | 4108 | 1835 | 6601 | 1435 | 7667 | 1190 | 8383 | 988 | 9426 | 663 | 11510 | 549 | 7334 |
| 12-#11 | 3.55 | MA | 4501 | 1935 | 7263 | 1510 | 8449 | 1245 | 9251 | 1035 | 10429 | 672 | 12783 | 429 | 9727 |
| 3L-5S | | MI | 3834 | 1935 | 5991 | 1525 | 6831 | 1258 | 7334 | 1045 | 7965 | 675 | 9528 | 270 | 8165 |
| 12-#11 | 3.55 | MA | 4385 | 1935 | 6905 | 1521 | 7945 | 1265 | 8633 | 1042 | 9583 | 675 | 11750 | 366 | 9497 |
| 4E | | MI | 3976 | 1935 | 6321 | 1505 | 7229 | 1251 | 7827 | 1029 | 8651 | 663 | 10422 | 336 | 8535 |
| 12-#11 | 3.55 | MA | 4218 | 1935 | 6538 | 1542 | 7503 | 1274 | 8084 | 1060 | 8820 | 689 | 10721 | 301 | 9050 |
| 5L-3S | | MI | 4080 | 1935 | 6643 | 1495 | 7681 | 1232 | 8382 | 1024 | 9410 | 662 | 11323 | 396 | 8760 |

## RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 3.55 | MA | 4049 | 1935 | 6217 | 1552 | 7067 | 1293 | 7544 | 1067 | 8090 | 702 | 9778 | 228 | 8581 |
| 6L-2S | | MI | 4286 | 1935 | 7105 | 1485 | 8269 | 1225 | 9096 | 1008 | 10376 | 650 | 12597 | 508 | 8785 |
| 12-#14 | 5.11 | MA | 4800 | 2171 | 7870 | 1669 | 9125 | 1376 | 10051 | 1112 | 11488 | 661 | 14232 | 237 | 12829 |
| 4E | | MI | 4335 | 2171 | 7178 | 1651 | 8275 | 1360 | 9082 | 1096 | 10337 | 647 | 12538 | 195 | 11490 |
| 12-#14 | 5.11 | MA | 4568 | 2171 | 7347 | 1698 | 8495 | 1388 | 9269 | 1136 | 10400 | 679 | 12793 | 143 | 12193 |
| 5L-3S | | MI | 4473 | 2171 | 7636 | 1638 | 8919 | 1335 | 9871 | 1090 | 11416 | 647 | 13797 | 279 | 12229 |
| 14-#10 | 3.37 | MA | 4517 | 1908 | 7213 | 1502 | 8425 | 1241 | 9242 | 1033 | 10431 | 679 | 12951 | 477 | 9400 |
| 3L-6S | | MI | 3766 | 1908 | 5824 | 1523 | 6638 | 1268 | 7112 | 1048 | 7685 | 694 | 9282 | 286 | 7832 |
| 14-#10 | 3.37 | MA | 4422 | 1908 | 6917 | 1512 | 8008 | 1258 | 8730 | 1040 | 9730 | 682 | 12079 | 424 | 9336 |
| 4L-5S | | MI | 3889 | 1908 | 6062 | 1515 | 6963 | 1253 | 7514 | 1042 | 8228 | 683 | 9982 | 345 | 8070 |
| 14-#10 | 3.37 | MA | 4279 | 1908 | 6614 | 1530 | 7643 | 1266 | 8276 | 1055 | 9099 | 695 | 11206 | 372 | 8942 |
| 5L-4S | | MI | 4012 | 1908 | 6335 | 1498 | 7292 | 1245 | 7923 | 1028 | 8796 | 672 | 10745 | 398 | 8411 |
| 14-#10 | 3.37 | MA | 4140 | 1908 | 6343 | 1537 | 7283 | 1283 | 7830 | 1062 | 8496 | 707 | 10407 | 311 | 8679 |
| 6L-3S | | MI | 4098 | 1908 | 6601 | 1489 | 7667 | 1230 | 8383 | 1023 | 9426 | 670 | 11510 | 449 | 8477 |
| 14-#11 | 4.14 | MA | 4615 | 2024 | 7422 | 1576 | 8603 | 1305 | 9433 | 1067 | 10666 | 670 | 13218 | 355 | 10986 |
| 4L-5S | | MI | 4037 | 2024 | 6453 | 1581 | 7419 | 1299 | 8048 | 1070 | 8932 | 670 | 10801 | 255 | 9508 |
| 14-#11 | 4.14 | MA | 4449 | 2024 | 7055 | 1598 | 8162 | 1314 | 8884 | 1085 | 9903 | 684 | 12188 | 290 | 10562 |
| 5L-4S | | MI | 4178 | 2024 | 6783 | 1561 | 7817 | 1291 | 8541 | 1054 | 9617 | 658 | 11695 | 321 | 9857 |
| 14-#11 | 4.14 | MA | 4287 | 2024 | 6735 | 1607 | 7726 | 1334 | 8344 | 1092 | 9173 | 697 | 11245 | 218 | 10074 |
| 6L-3S | | MI | 4277 | 2024 | 7105 | 1551 | 8269 | 1273 | 9096 | 1049 | 10376 | 657 | 12597 | 381 | 10142 |
| 14-#14 | 5.97 | MA | 4891 | 2300 | 8082 | 1779 | 9431 | 1446 | 10405 | 1172 | 11938 | 672 | 14844 | 124 | 14301 |
| 5L-4S | | MI | 4618 | 2300 | 7832 | 1731 | 9108 | 1418 | 10095 | 1133 | 11707 | 639 | 14311 | 169 | 13378 |
| 16-#10 | 3.85 | MA | 4614 | 1980 | 7347 | 1557 | 8555 | 1291 | 9395 | 1061 | 10630 | 678 | 13324 | 418 | 10593 |
| 4L-6S | | MI | 3940 | 1980 | 6209 | 1568 | 7128 | 1301 | 7707 | 1069 | 8490 | 690 | 10370 | 277 | 8936 |
| 16-#10 | 3.85 | MA | 4471 | 1980 | 7044 | 1575 | 8191 | 1299 | 8941 | 1076 | 9999 | 691 | 12451 | 366 | 10201 |
| 5E | | MI | 4060 | 1980 | 6447 | 1560 | 7453 | 1286 | 8109 | 1063 | 9033 | 679 | 11069 | 336 | 9192 |
| 16-#10 | 3.85 | MA | 4337 | 1980 | 6773 | 1583 | 7831 | 1316 | 8495 | 1083 | 9396 | 703 | 11653 | 305 | 9922 |
| 6L-4S | | MI | 4182 | 1980 | 6719 | 1543 | 7782 | 1278 | 8518 | 1049 | 9601 | 668 | 11832 | 389 | 9517 |
| 16-#11 | 4.73 | MA | 4677 | 2113 | 7573 | 1653 | 8821 | 1355 | 9685 | 1110 | 10986 | 678 | 13656 | 280 | 12078 |
| 5E | | MI | 4238 | 2113 | 6915 | 1637 | 8007 | 1339 | 8762 | 1096 | 9898 | 665 | 12075 | 241 | 10856 |
| 16-#11 | 4.73 | MA | 4520 | 2113 | 7252 | 1663 | 8385 | 1374 | 9144 | 1117 | 10256 | 692 | 12712 | 207 | 11572 |
| 6L-4S | | MI | 4378 | 2113 | 7244 | 1616 | 8405 | 1331 | 9255 | 1080 | 10584 | 653 | 12969 | 306 | 11186 |
| 18-#10 | 4.33 | MA | 4661 | 2053 | 7474 | 1621 | 8738 | 1332 | 9606 | 1096 | 10899 | 686 | 13696 | 360 | 11463 |
| 5L-6S | | MI | 4111 | 2053 | 6593 | 1614 | 7618 | 1334 | 8302 | 1089 | 9295 | 685 | 11457 | 268 | 10044 |
| 18-#10 | 4.33 | MA | 4532 | 2053 | 7203 | 1628 | 8378 | 1349 | 9160 | 1103 | 10296 | 699 | 12898 | 299 | 11169 |
| 6L-5S | | MI | 4228 | 2053 | 6831 | 1606 | 7943 | 1319 | 8704 | 1084 | 9839 | 675 | 12156 | 327 | 10317 |
| 18-#11 | 5.32 | MA | 4750 | 2202 | 7769 | 1719 | 9044 | 1415 | 9945 | 1143 | 11339 | 687 | 14179 | 197 | 13074 |
| 6L-5S | | MI | 4436 | 2202 | 7376 | 1692 | 8595 | 1380 | 9476 | 1121 | 10865 | 659 | 13349 | 226 | 12208 |

## RECTANGULAR TIED COLUMNS 22" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.09 | MA | 4482 | 1695 | 6580 | 1386 | 7490 | 1168 | 7935 | 998 | 8304 | 744 | 9755 | 647 | 3803 |
| 2E | | MI | 3756 | 1695 | 5619 | 1359 | 6313 | 1145 | 6640 | 978 | 6892 | 728 | 7914 | 618 | 3177 |
| 4-#14 | 1.57 | MA | 4693 | 1774 | 7098 | 1427 | 8119 | 1197 | 8684 | 1015 | 9305 | 735 | 11070 | 631 | 5325 |
| 2E | | MI | 3918 | 1774 | 6036 | 1399 | 6814 | 1173 | 7235 | 993 | 7686 | 718 | 8887 | 592 | 4412 |
| 4-#18 | 2.80 | MA | 5188 | 1974 | 8352 | 1536 | 9654 | 1275 | 10518 | 1060 | 11765 | 714 | 14185 | 579 | 9022 |
| 2E | | MI | 4295 | 1974 | 7033 | 1505 | 8026 | 1248 | 8680 | 1037 | 9621 | 695 | 11149 | 514 | 7378 |
| 6-#9 | 1.05 | MA | 4486 | 1688 | 6498 | 1396 | 7446 | 1177 | 7910 | 1007 | 8293 | 753 | 9758 | 655 | 3697 |
| 2L-3S | | MI | 3604 | 1688 | 5245 | 1379 | 5894 | 1162 | 6159 | 1000 | 6262 | 747 | 7157 | 566 | 3106 |
| 6-#9 | 1.05 | MA | 4286 | 1688 | 6121 | 1404 | 6966 | 1184 | 7327 | 1013 | 7504 | 764 | 8666 | 586 | 3713 |
| 3L-2S | | MI | 3762 | 1688 | 5550 | 1372 | 6283 | 1156 | 6631 | 989 | 6901 | 738 | 8027 | 638 | 3088 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 26"

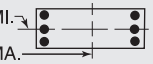
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 1.33 | MA | 4619 | 1734 | 6811 | 1421 | 7829 | 1195 | 8368 | 1017 | 8906 | 748 | 10602 | 650 | 4618 |
| 2L-3S | | MI | 3670 | 1734 | 5420 | 1405 | 6101 | 1181 | 6404 | 1013 | 6587 | 744 | 7577 | 535 | 3860 |
| 6-#10 | 1.33 | MA | 4372 | 1734 | 6336 | 1431 | 7223 | 1204 | 7633 | 1025 | 7911 | 761 | 9224 | 561 | 4633 |
| 3L-2S | | MI | 3866 | 1734 | 5805 | 1396 | 6591 | 1173 | 6999 | 999 | 7393 | 733 | 8664 | 627 | 3841 |
| 6-#11 | 1.64 | MA | 4741 | 1784 | 7153 | 1441 | 8220 | 1208 | 8821 | 1023 | 9503 | 739 | 11416 | 640 | 5560 |
| 2L-3S | | MI | 3729 | 1784 | 5619 | 1424 | 6313 | 1193 | 6640 | 1019 | 6892 | 734 | 7914 | 491 | 4626 |
| 6-#11 | 1.64 | MA | 4451 | 1784 | 6580 | 1453 | 7490 | 1218 | 7935 | 1042 | 8304 | 754 | 9755 | 528 | 5572 |
| 3L-2S | | MI | 3958 | 1784 | 6081 | 1414 | 6901 | 1185 | 7354 | 1003 | 7858 | 723 | 9188 | 603 | 4605 |
| 6-#14 | 2.36 | MA | 5050 | 1902 | 7913 | 1507 | 9157 | 1255 | 9944 | 1051 | 11011 | 727 | 13401 | 617 | 7809 |
| 2L-3S | | MI | 3885 | 1902 | 6036 | 1492 | 6814 | 1241 | 7235 | 1051 | 7686 | 725 | 8887 | 405 | 6418 |
| 6-#14 | 2.36 | MA | 4656 | 1902 | 7098 | 1524 | 8119 | 1269 | 8684 | 1077 | 9305 | 748 | 11070 | 456 | 7782 |
| 3L-2S | | MI | 4197 | 1902 | 6690 | 1479 | 7647 | 1231 | 8247 | 1030 | 9056 | 710 | 10661 | 566 | 6419 |
| 6-#18 | 4.20 | MA | 5775 | 2202 | 9761 | 1679 | 11448 | 1378 | 12698 | 1124 | 14714 | 701 | 18100 | 543 | 13274 |
| 2L-3S | | MI | 4258 | 2202 | 7033 | 1668 | 8026 | 1365 | 8680 | 1134 | 9621 | 702 | 11149 | 167 | 10610 |
| 6-#18 | 4.20 | MA | 5150 | 2202 | 8352 | 1705 | 9654 | 1399 | 10518 | 1166 | 11765 | 732 | 14185 | 256 | 13025 |
| 3L-2S | | MI | 4754 | 2202 | 8157 | 1648 | 9457 | 1352 | 10417 | 1101 | 11973 | 682 | 14080 | 455 | 10780 |
| 8-#8 | 1.10 | MA | 4520 | 1697 | 6549 | 1405 | 7525 | 1184 | 8014 | 1012 | 8440 | 754 | 9965 | 656 | 3891 |
| 2L-4S | | MI | 3598 | 1697 | 5180 | 1393 | 5803 | 1179 | 6053 | 1008 | 6119 | 750 | 7032 | 552 | 3273 |
| 8-#8 | 1.10 | MA | 4362 | 1697 | 6249 | 1412 | 7144 | 1190 | 7551 | 1017 | 7813 | 763 | 9097 | 602 | 3902 |
| 3E | | MI | 3665 | 1697 | 5348 | 1387 | 6039 | 1169 | 6342 | 1004 | 6515 | 748 | 7522 | 584 | 3259 |
| 8-#8 | 1.10 | MA | 4279 | 1697 | 6045 | 1419 | 6855 | 1201 | 7197 | 1028 | 7328 | 767 | 8502 | 570 | 3910 |
| 4L-2S | | MI | 3790 | 1697 | 5591 | 1381 | 6349 | 1164 | 6718 | 994 | 7024 | 740 | 8220 | 641 | 3247 |
| 8-#9 | 1.40 | MA | 4659 | 1745 | 6875 | 1431 | 7925 | 1203 | 8493 | 1023 | 9082 | 749 | 10850 | 651 | 4851 |
| 2L-4S | | MI | 3663 | 1745 | 5339 | 1422 | 5985 | 1201 | 6267 | 1021 | 6402 | 746 | 7416 | 519 | 4053 |
| 8-#9 | 1.40 | MA | 4465 | 1745 | 6498 | 1440 | 7446 | 1210 | 7910 | 1029 | 8293 | 760 | 9758 | 582 | 4861 |
| 3E | | MI | 3745 | 1745 | 5550 | 1414 | 6283 | 1188 | 6631 | 1016 | 6901 | 744 | 8027 | 559 | 4044 |
| 8-#9 | 1.40 | MA | 4364 | 1745 | 6240 | 1448 | 7082 | 1224 | 7464 | 1042 | 7682 | 765 | 9006 | 541 | 4857 |
| 4L-2S | | MI | 3899 | 1745 | 5856 | 1407 | 6672 | 1182 | 7104 | 1005 | 7541 | 735 | 8898 | 631 | 4031 |
| 8-#10 | 1.78 | MA | 4834 | 1807 | 7287 | 1466 | 8434 | 1228 | 9103 | 1038 | 9901 | 744 | 11980 | 644 | 6068 |
| 2L-4S | | MI | 3745 | 1807 | 5538 | 1459 | 6216 | 1229 | 6539 | 1039 | 6763 | 742 | 7899 | 475 | 5023 |
| 8-#10 | 1.78 | MA | 4596 | 1807 | 6811 | 1477 | 7829 | 1237 | 8368 | 1045 | 8906 | 757 | 10602 | 555 | 6072 |
| 3E | | MI | 3846 | 1807 | 5805 | 1450 | 6591 | 1214 | 6999 | 1033 | 7393 | 740 | 8664 | 526 | 5033 |
| 8-#10 | 1.78 | MA | 4471 | 1807 | 6485 | 1487 | 7369 | 1254 | 7804 | 1062 | 8134 | 762 | 9649 | 503 | 6039 |
| 4L-2S | | MI | 4036 | 1807 | 6190 | 1441 | 7081 | 1206 | 7594 | 1019 | 8198 | 729 | 9751 | 618 | 5021 |
| 8-#11 | 2.18 | MA | 4994 | 1873 | 7726 | 1497 | 8949 | 1249 | 9708 | 1048 | 10702 | 733 | 13077 | 633 | 7305 |
| 2L-4S | | MI | 3816 | 1873 | 5759 | 1490 | 6448 | 1251 | 6800 | 1050 | 7099 | 730 | 8287 | 416 | 5989 |
| 8-#11 | 2.18 | MA | 4715 | 1873 | 7153 | 1509 | 8220 | 1259 | 8821 | 1067 | 9503 | 749 | 11416 | 521 | 7299 |
| 3E | | MI | 3935 | 1873 | 6081 | 1480 | 6901 | 1233 | 7354 | 1044 | 7858 | 729 | 9188 | 476 | 6026 |
| 8-#11 | 2.18 | MA | 4569 | 1873 | 6758 | 1521 | 7664 | 1279 | 8140 | 1076 | 8569 | 754 | 10253 | 456 | 7227 |
| 4L-2S | | MI | 4157 | 1873 | 6542 | 1470 | 7489 | 1226 | 8068 | 1028 | 8825 | 717 | 10462 | 588 | 6018 |
| 8-#14 | 3.15 | MA | 5400 | 2031 | 8729 | 1588 | 10195 | 1314 | 11205 | 1087 | 12717 | 720 | 15732 | 604 | 10276 |
| 2L-4S | | MI | 4011 | 2031 | 6232 | 1586 | 7003 | 1324 | 7458 | 1094 | 7977 | 718 | 9401 | 295 | 7893 |
| 8-#14 | 3.15 | MA | 5024 | 2031 | 7913 | 1604 | 9157 | 1327 | 9944 | 1113 | 11011 | 740 | 13401 | 442 | 10219 |
| 3E | | MI | 4172 | 2031 | 6690 | 1572 | 7647 | 1299 | 8247 | 1088 | 9056 | 718 | 10661 | 379 | 8377 |
| 8-#14 | 3.15 | MA | 4826 | 2031 | 7350 | 1620 | 8364 | 1356 | 8972 | 1124 | 9680 | 746 | 11764 | 350 | 9626 |
| 4L-2S | | MI | 4471 | 2031 | 7345 | 1559 | 8481 | 1289 | 9260 | 1066 | 10426 | 703 | 12435 | 541 | 8408 |
| 8-#18 | 5.59 | MA | 5765 | 2430 | 9761 | 1848 | 11448 | 1503 | 12698 | 1231 | 14714 | 719 | 18100 | 220 | 17208 |
| 3E | | MI | 4737 | 2430 | 8157 | 1810 | 9457 | 1468 | 10417 | 1199 | 11973 | 689 | 14080 | 107 | 13715 |
| 8-#18 | 5.59 | MA | 5453 | 2430 | 8780 | 1874 | 10069 | 1550 | 11007 | 1246 | 12401 | 723 | 15334 | 64 | 14975 |
| 4L-2S | | MI | 5194 | 2430 | 9280 | 1791 | 10887 | 1455 | 12155 | 1166 | 14324 | 669 | 17011 | 395 | 14158 |
| 10-#10 | 2.22 | MA | 5046 | 1880 | 7762 | 1511 | 9039 | 1261 | 9838 | 1058 | 10896 | 739 | 13357 | 638 | 7511 |
| 2L-5S | | MI | 3798 | 1880 | 5650 | 1521 | 6377 | 1269 | 6725 | 1073 | 7000 | 749 | 8223 | 413 | 5930 |
| 10-#10 | 2.22 | MA | 4815 | 1880 | 7287 | 1522 | 8434 | 1270 | 9103 | 1066 | 9901 | 753 | 11980 | 549 | 7504 |
| 3L-4S | | MI | 3922 | 1880 | 5923 | 1504 | 6706 | 1262 | 7134 | 1059 | 7568 | 738 | 8986 | 466 | 6173 |
| 10-#10 | 2.22 | MA | 4697 | 1880 | 6961 | 1532 | 7975 | 1287 | 8539 | 1082 | 9129 | 758 | 11027 | 497 | 7458 |
| 4L-3S | | MI | 4019 | 1880 | 6190 | 1495 | 7081 | 1247 | 7594 | 1054 | 8198 | 735 | 9751 | 517 | 6197 |
| 10-#10 | 2.22 | MA | 4530 | 1880 | 6628 | 1551 | 7574 | 1296 | 8041 | 1090 | 8435 | 772 | 10068 | 447 | 7143 |
| 5L-2S | | MI | 4203 | 1880 | 6574 | 1486 | 7571 | 1239 | 8189 | 1040 | 9003 | 725 | 10838 | 609 | 6194 |

## RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

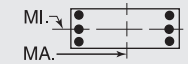
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.73 | MA | 5244 | 1962 | 8299 | 1553 | 9679 | 1289 | 10594 | 1074 | 11902 | 728 | 14737 | 626 | 9041 |
| 2L-5S | | MI | 3883 | 1962 | 5890 | 1565 | 6639 | 1300 | 7020 | 1091 | 7380 | 737 | 8667 | 335 | 6932 |
| 10-#11 | 2.73 | MA | 4975 | 1962 | 7726 | 1564 | 8949 | 1299 | 9708 | 1092 | 10702 | 743 | 13077 | 514 | 9020 |
| 3L-4S | | MI | 4026 | 1962 | 6220 | 1545 | 7036 | 1292 | 7514 | 1075 | 8066 | 725 | 9561 | 401 | 7340 |
| 10-#11 | 2.73 | MA | 4837 | 1962 | 7331 | 1576 | 8393 | 1320 | 9026 | 1101 | 9769 | 748 | 11914 | 448 | 8932 |
| 4L-3S | | MI | 4139 | 1962 | 6542 | 1535 | 7489 | 1274 | 8068 | 1070 | 8825 | 724 | 10462 | 461 | 7416 |
| 10-#11 | 2.73 | MA | 4642 | 1962 | 6928 | 1599 | 7907 | 1330 | 8422 | 1120 | 8928 | 764 | 10749 | 384 | 8382 |
| 5L-2S | | MI | 4353 | 1962 | 7004 | 1526 | 8076 | 1266 | 8783 | 1054 | 9791 | 712 | 11736 | 573 | 7422 |
| 10-#14 | 3.93 | MA | 5384 | 2159 | 8729 | 1684 | 10195 | 1386 | 11205 | 1150 | 12717 | 733 | 15732 | 429 | 12653 |
| 3L-4S | | MI | 4304 | 2159 | 6887 | 1666 | 7837 | 1382 | 8471 | 1131 | 9347 | 711 | 11175 | 270 | 9751 |
| 10-#14 | 3.93 | MA | 5202 | 2159 | 8165 | 1701 | 9402 | 1414 | 10233 | 1161 | 11386 | 738 | 14095 | 336 | 11971 |
| 4L-3S | | MI | 4454 | 2159 | 7345 | 1653 | 8481 | 1358 | 9260 | 1124 | 10426 | 710 | 12435 | 354 | 10332 |
| 10-#14 | 3.93 | MA | 4932 | 2159 | 7589 | 1732 | 8707 | 1428 | 9370 | 1187 | 10186 | 759 | 12460 | 243 | 11278 |
| 5L-2S | | MI | 4741 | 2159 | 8000 | 1640 | 9314 | 1348 | 10272 | 1103 | 11796 | 695 | 14208 | 516 | 10385 |
| 10-#18 | 6.99 | MA | 6088 | 2659 | 10189 | 2017 | 11863 | 1654 | 13186 | 1311 | 15350 | 710 | 19249 | 29 | 19081 |
| 4L-3S | | MI | 5230 | 2659 | 9280 | 1953 | 10887 | 1572 | 12155 | 1264 | 14324 | 676 | 17011 | 48 | 16835 |
| 12-#10 | 2.66 | MA | 5255 | 1952 | 8238 | 1557 | 9645 | 1294 | 10573 | 1079 | 11891 | 735 | 14735 | 632 | 8950 |
| 2L-6S | | MI | 3845 | 1952 | 5797 | 1574 | 6542 | 1318 | 6918 | 1100 | 7262 | 755 | 8611 | 346 | 6839 |
| 12-#10 | 2.66 | MA | 5031 | 1952 | 7762 | 1567 | 9039 | 1303 | 9838 | 1086 | 10896 | 749 | 13357 | 543 | 8933 |
| 3L-5S | | MI | 3974 | 1952 | 6035 | 1567 | 6867 | 1302 | 7320 | 1094 | 7806 | 745 | 9310 | 404 | 7041 |
| 12-#10 | 2.66 | MA | 4919 | 1952 | 7436 | 1578 | 8580 | 1320 | 9275 | 1103 | 10124 | 754 | 12404 | 491 | 8877 |
| 4E | | MI | 4097 | 1952 | 6308 | 1549 | 7196 | 1295 | 7729 | 1080 | 8373 | 734 | 10073 | 457 | 7322 |
| 12-#10 | 2.66 | MA | 4753 | 1952 | 7104 | 1596 | 8179 | 1329 | 8776 | 1110 | 9430 | 767 | 11446 | 442 | 8527 |
| 5L-3S | | MI | 4189 | 1952 | 6574 | 1541 | 7571 | 1279 | 8189 | 1074 | 9003 | 731 | 10838 | 508 | 7356 |
| 12-#10 | 2.66 | MA | 4594 | 1952 | 6799 | 1603 | 7784 | 1347 | 8286 | 1127 | 8768 | 781 | 10575 | 381 | 8241 |
| 6L-2S | | MI | 4368 | 1952 | 6959 | 1532 | 8061 | 1272 | 8784 | 1060 | 9808 | 720 | 11925 | 599 | 7362 |
| 12-#11 | 3.27 | MA | 5229 | 2051 | 8299 | 1620 | 9679 | 1340 | 10594 | 1118 | 11902 | 738 | 14737 | 507 | 10738 |
| 3L-5S | | MI | 4090 | 2051 | 6352 | 1621 | 7226 | 1340 | 7735 | 1116 | 8347 | 732 | 9940 | 320 | 8266 |
| 12-#11 | 3.27 | MA | 5100 | 2051 | 7904 | 1632 | 9123 | 1360 | 9912 | 1126 | 10968 | 743 | 13575 | 441 | 10596 |
| 4E | | MI | 4232 | 2051 | 6682 | 1601 | 7624 | 1332 | 8228 | 1100 | 9032 | 720 | 10834 | 386 | 8650 |
| 12-#11 | 3.27 | MA | 4907 | 2051 | 7501 | 1654 | 8637 | 1370 | 9308 | 1145 | 10128 | 758 | 12410 | 377 | 10053 |
| 5L-3S | | MI | 4339 | 2051 | 7004 | 1591 | 8076 | 1314 | 8783 | 1095 | 9791 | 719 | 11736 | 446 | 8802 |
| 12-#11 | 3.27 | MA | 4719 | 2051 | 7139 | 1663 | 8158 | 1391 | 8714 | 1153 | 9325 | 774 | 11346 | 302 | 9602 |
| 6L-2S | | MI | 4547 | 2051 | 7466 | 1581 | 8664 | 1307 | 9497 | 1079 | 10758 | 707 | 13009 | 558 | 8821 |
| 12-#14 | 4.72 | MA | 5569 | 2288 | 8981 | 1781 | 10440 | 1473 | 11493 | 1197 | 13092 | 731 | 16426 | 323 | 14329 |
| 4E | | MI | 4591 | 2288 | 7541 | 1746 | 8671 | 1441 | 9483 | 1167 | 10717 | 703 | 12948 | 244 | 11624 |
| 12-#14 | 4.72 | MA | 5301 | 2288 | 8404 | 1812 | 9745 | 1486 | 10631 | 1223 | 11892 | 751 | 14791 | 230 | 13674 |
| 5L-3S | | MI | 4732 | 2288 | 8000 | 1733 | 9314 | 1416 | 10272 | 1161 | 11796 | 703 | 14208 | 328 | 12283 |
| 14-#10 | 3.11 | MA | 5244 | 2025 | 8238 | 1612 | 9645 | 1336 | 10573 | 1107 | 11891 | 744 | 14735 | 538 | 10360 |
| 3L-6S | | MI | 4022 | 2025 | 6182 | 1620 | 7032 | 1351 | 7513 | 1120 | 8068 | 751 | 9698 | 336 | 7965 |
| 14-#10 | 3.11 | MA | 5138 | 2025 | 7912 | 1623 | 9185 | 1353 | 10010 | 1123 | 11119 | 750 | 13782 | 485 | 10296 |
| 4L-5S | | MI | 4147 | 2025 | 6419 | 1612 | 7357 | 1335 | 7915 | 1114 | 8611 | 740 | 10397 | 395 | 8157 |
| 14-#10 | 3.11 | MA | 4973 | 2025 | 7579 | 1642 | 8784 | 1362 | 9511 | 1131 | 10425 | 763 | 12824 | 436 | 9916 |
| 5L-4S | | MI | 4270 | 2025 | 6692 | 1595 | 7686 | 1328 | 8324 | 1100 | 9179 | 729 | 11160 | 448 | 8470 |
| 14-#10 | 3.11 | MA | 4818 | 2025 | 7274 | 1649 | 8389 | 1380 | 9021 | 1147 | 9763 | 777 | 11953 | 376 | 9642 |
| 6L-3S | | MI | 4357 | 2025 | 6959 | 1586 | 8061 | 1312 | 8784 | 1095 | 9808 | 727 | 11925 | 499 | 8512 |
| 14-#10 | 3.11 | MA | 4687 | 2025 | 6970 | 1655 | 8001 | 1387 | 8550 | 1155 | 9086 | 782 | 10969 | 322 | 9174 |
| 7L-2S | | MI | 4532 | 2025 | 7344 | 1577 | 8551 | 1305 | 9379 | 1081 | 10614 | 716 | 13012 | 590 | 8526 |
| 14-#11 | 3.82 | MA | 5358 | 2140 | 8478 | 1688 | 9853 | 1401 | 10798 | 1151 | 12168 | 738 | 15236 | 434 | 12248 |
| 4L-5S | | MI | 4294 | 2140 | 6814 | 1677 | 7814 | 1381 | 8449 | 1142 | 9313 | 727 | 11214 | 305 | 9607 |
| 14-#11 | 3.82 | MA | 5166 | 2140 | 8074 | 1710 | 9367 | 1411 | 10194 | 1170 | 11327 | 753 | 14071 | 370 | 11730 |
| 5L-4S | | MI | 4435 | 2140 | 7144 | 1657 | 8212 | 1373 | 8942 | 1126 | 9999 | 715 | 12108 | 371 | 9969 |
| 14-#11 | 3.82 | MA | 4985 | 2140 | 7712 | 1719 | 8887 | 1431 | 9600 | 1179 | 10524 | 769 | 13007 | 295 | 11263 |
| 6L-3S | | MI | 4537 | 2140 | 7466 | 1647 | 8664 | 1355 | 9497 | 1120 | 10758 | 714 | 13009 | 431 | 10185 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

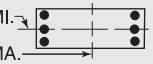
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 5.51 | MA | 5663 | 2416 | 9220 | 1893 | 10783 | 1545 | 11891 | 1259 | 13599 | 744 | 17122 | 217 | 16077 |
| 5L-4S | | MI | 4874 | 2416 | 8196 | 1826 | 9504 | 1499 | 10495 | 1204 | 12087 | 696 | 14722 | 219 | 13508 |
| 16-#10 | 3.55 | MA | 5353 | 2097 | 8387 | 1668 | 9790 | 1386 | 10745 | 1144 | 12114 | 745 | 15160 | 479 | 11716 |
| 4L-6S | | MI | 4196 | 2097 | 6566 | 1665 | 7522 | 1384 | 8108 | 1141 | 8873 | 747 | 10785 | 327 | 9074 |
| 16-#10 | 3.55 | MA | 5189 | 2097 | 8054 | 1687 | 9390 | 1395 | 10246 | 1152 | 11420 | 759 | 14201 | 430 | 11309 |
| 5E | | MI | 4318 | 2097 | 6804 | 1657 | 7847 | 1368 | 8510 | 1135 | 9416 | 736 | 11484 | 386 | 9277 |
| 16-#10 | 3.55 | MA | 5039 | 2097 | 7750 | 1694 | 8994 | 1413 | 9756 | 1168 | 10758 | 772 | 13330 | 370 | 11046 |
| 6L-4S | | MI | 4440 | 2097 | 7077 | 1640 | 8176 | 1361 | 8919 | 1121 | 9984 | 725 | 12247 | 439 | 9615 |
| 16-#10 | 3.55 | MA | 4913 | 2097 | 7445 | 1700 | 8606 | 1420 | 9285 | 1175 | 10081 | 778 | 12347 | 317 | 10568 |
| 7L-3S | | MI | 4524 | 2097 | 7344 | 1631 | 8551 | 1345 | 9379 | 1115 | 10614 | 723 | 13012 | 490 | 9667 |
| 16-#11 | 4.36 | MA | 5422 | 2230 | 8647 | 1766 | 10096 | 1451 | 11081 | 1195 | 12527 | 748 | 15732 | 363 | 13412 |
| 5E | | MI | 4495 | 2230 | 7276 | 1732 | 8402 | 1421 | 9163 | 1167 | 10280 | 721 | 12488 | 290 | 10953 |
| 16-#11 | 4.36 | MA | 5247 | 2230 | 8285 | 1775 | 9617 | 1472 | 10486 | 1204 | 11724 | 763 | 14668 | 288 | 12928 |
| 6L-4S | | MI | 4636 | 2230 | 7606 | 1712 | 8800 | 1413 | 9656 | 1151 | 10965 | 710 | 13382 | 356 | 11295 |
| 18-#10 | 4.00 | MA | 5402 | 2170 | 8530 | 1732 | 9995 | 1428 | 10982 | 1172 | 12415 | 755 | 15579 | 424 | 12705 |
| 5L-6S | | MI | 4368 | 2170 | 6951 | 1710 | 8012 | 1417 | 8703 | 1161 | 9678 | 743 | 11872 | 318 | 10179 |
| 18-#10 | 4.00 | MA | 5257 | 2170 | 8225 | 1739 | 9600 | 1445 | 10491 | 1188 | 11753 | 768 | 14708 | 364 | 12453 |
| 6L-5S | | MI | 4486 | 2170 | 7189 | 1703 | 8337 | 1401 | 9105 | 1156 | 10221 | 732 | 12572 | 377 | 10401 |
| 18-#10 | 4.00 | MA | 5135 | 2170 | 7921 | 1745 | 9212 | 1453 | 10020 | 1196 | 11076 | 773 | 13724 | 311 | 11965 |
| 7L-4S | | MI | 4608 | 2170 | 7462 | 1685 | 8665 | 1394 | 9514 | 1142 | 10789 | 721 | 13334 | 430 | 10723 |
| 18-#11 | 4.91 | MA | 5505 | 2319 | 8858 | 1830 | 10347 | 1512 | 11372 | 1229 | 12923 | 758 | 16328 | 281 | 14598 |
| 6L-5S | | MI | 4694 | 2319 | 7738 | 1788 | 8990 | 1461 | 9877 | 1192 | 11246 | 716 | 13762 | 275 | 12303 |
| 20-#10 | 4.44 | MA | 5472 | 2242 | 8700 | 1785 | 10205 | 1478 | 11227 | 1209 | 12748 | 764 | 16086 | 358 | 13842 |
| 6E | | MI | 4538 | 2242 | 7336 | 1756 | 8502 | 1450 | 9298 | 1182 | 10484 | 739 | 12959 | 309 | 11288 |
| 20-#10 | 4.44 | MA | 5355 | 2242 | 8396 | 1791 | 9817 | 1486 | 10755 | 1217 | 12071 | 769 | 15102 | 305 | 13364 |
| 7L-5S | | MI | 4653 | 2242 | 7574 | 1748 | 8827 | 1434 | 9700 | 1176 | 11027 | 728 | 13659 | 368 | 11527 |

## RECTANGULAR TIED COLUMNS 22" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.01 | MA | 5174 | 1812 | 7504 | 1495 | 8575 | 1261 | 9091 | 1079 | 9499 | 809 | 11146 | 704 | 4140 |
| 2E | | MI | 4013 | 1812 | 5980 | 1455 | 6708 | 1227 | 7041 | 1049 | 7273 | 785 | 8327 | 668 | 3199 |
| 4-#14 | 1.46 | MA | 5411 | 1891 | 8075 | 1536 | 9268 | 1290 | 9917 | 1096 | 10603 | 799 | 12665 | 694 | 5811 |
| 2E | | MI | 4176 | 1891 | 6399 | 1494 | 7210 | 1254 | 7636 | 1064 | 8066 | 774 | 9298 | 641 | 4441 |
| 4-#18 | 2.60 | MA | 5967 | 2090 | 9461 | 1646 | 10966 | 1368 | 11946 | 1141 | 13323 | 779 | 16242 | 654 | 9886 |
| 2E | | MI | 4554 | 2090 | 7401 | 1599 | 8423 | 1328 | 9080 | 1106 | 9999 | 751 | 11556 | 563 | 7419 |
| 6-#10 | 1.24 | MA | 5324 | 1851 | 7754 | 1530 | 8942 | 1288 | 9561 | 1098 | 10154 | 813 | 12067 | 706 | 5030 |
| 2L-3S | | MI | 3927 | 1851 | 5778 | 1502 | 6495 | 1263 | 6805 | 1085 | 6970 | 801 | 7993 | 586 | 3883 |
| 6-#10 | 1.24 | MA | 5051 | 1851 | 7234 | 1541 | 8279 | 1298 | 8756 | 1107 | 9064 | 827 | 10558 | 620 | 5044 |
| 3L-2S | | MI | 4124 | 1851 | 6163 | 1493 | 6985 | 1256 | 7400 | 1071 | 7775 | 790 | 9080 | 677 | 3862 |
| 6-#11 | 1.52 | MA | 5462 | 1901 | 8132 | 1551 | 9375 | 1301 | 10064 | 1105 | 10815 | 803 | 12968 | 697 | 6066 |
| 2L-3S | | MI | 3985 | 1901 | 5980 | 1520 | 6708 | 1275 | 7041 | 1090 | 7273 | 791 | 8327 | 541 | 4655 |
| 6-#11 | 1.52 | MA | 5140 | 1901 | 7504 | 1563 | 8575 | 1313 | 9091 | 1114 | 9499 | 820 | 11146 | 588 | 6078 |
| 3L-2S | | MI | 4216 | 1901 | 6442 | 1510 | 7296 | 1267 | 7755 | 1075 | 8240 | 779 | 9601 | 653 | 4631 |
| 6-#14 | 2.19 | MA | 5810 | 2019 | 8971 | 1617 | 10408 | 1349 | 11302 | 1132 | 12477 | 792 | 15260 | 683 | 8538 |
| 2L-3S | | MI | 4141 | 2019 | 6399 | 1587 | 7210 | 1322 | 7636 | 1122 | 8066 | 782 | 9298 | 454 | 6461 |
| 6-#14 | 2.19 | MA | 5370 | 2019 | 8075 | 1634 | 9268 | 1364 | 9917 | 1145 | 10603 | 815 | 12665 | 523 | 8511 |
| 3L-2S | | MI | 4456 | 2019 | 7054 | 1574 | 8043 | 1312 | 8648 | 1101 | 9436 | 767 | 11072 | 616 | 6451 |
| 6-#18 | 3.90 | MA | 6624 | 2319 | 11013 | 1789 | 12941 | 1472 | 14346 | 1206 | 16571 | 765 | 20653 | 628 | 14570 |
| 2L-3S | | MI | 4513 | 2319 | 7401 | 1761 | 8423 | 1445 | 9080 | 1204 | 9999 | 758 | 11556 | 216 | 10689 |
| 6-#18 | 3.90 | MA | 5924 | 2319 | 9461 | 1817 | 10966 | 1495 | 11946 | 1251 | 13323 | 801 | 16242 | 340 | 14321 |
| 3L-2S | | MI | 5014 | 2319 | 8525 | 1742 | 9854 | 1432 | 10818 | 1171 | 12351 | 738 | 14487 | 503 | 10828 |
| 8-#8 | 1.03 | MA | 5213 | 1814 | 7465 | 1514 | 8607 | 1277 | 9171 | 1093 | 9639 | 819 | 11365 | 713 | 4232 |
| 2L-4S | | MI | 3854 | 1814 | 5535 | 1491 | 6196 | 1262 | 6454 | 1080 | 6502 | 808 | 7450 | 602 | 3293 |
| 8-#8 | 1.03 | MA | 5038 | 1814 | 7137 | 1521 | 8190 | 1284 | 8664 | 1099 | 8953 | 829 | 10415 | 660 | 4243 |
| 3E | | MI | 3921 | 1814 | 5703 | 1485 | 6432 | 1252 | 6744 | 1076 | 6899 | 805 | 7939 | 635 | 3278 |

## RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

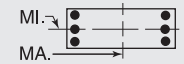
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#8 | 1.03 | MA | 4947 | 1814 | 6914 | 1529 | 7875 | 1295 | 8278 | 1110 | 8424 | 833 | 9770 | 629 | 4252 |
| 4L-2S | | MI | 4048 | 1814 | 5946 | 1479 | 6742 | 1247 | 7120 | 1067 | 7408 | 798 | 8637 | 692 | 3265 |
| 8-#9 | 1.30 | MA | 5369 | 1862 | 7822 | 1541 | 9047 | 1296 | 9697 | 1104 | 10344 | 814 | 12336 | 708 | 5283 |
| 2L-4S | | MI | 3919 | 1862 | 5695 | 1519 | 6379 | 1284 | 6668 | 1093 | 6785 | 804 | 7832 | 569 | 4079 |
| 8-#9 | 1.30 | MA | 5154 | 1862 | 7410 | 1550 | 8521 | 1304 | 9059 | 1111 | 9481 | 826 | 11140 | 640 | 5293 |
| 3E | | MI | 4002 | 1862 | 5907 | 1512 | 6676 | 1271 | 7033 | 1089 | 7285 | 802 | 8444 | 610 | 4066 |
| 8-#9 | 1.30 | MA | 5042 | 1862 | 7129 | 1559 | 8125 | 1319 | 8572 | 1125 | 8814 | 831 | 10326 | 600 | 5289 |
| 4L-2S | | MI | 4157 | 1862 | 6212 | 1504 | 7065 | 1265 | 7505 | 1077 | 7924 | 793 | 9314 | 682 | 4052 |
| 8-#10 | 1.65 | MA | 5564 | 1924 | 8275 | 1576 | 9605 | 1321 | 10367 | 1119 | 11243 | 808 | 13576 | 701 | 6616 |
| 2L-4S | | MI | 4001 | 1924 | 5896 | 1556 | 6610 | 1312 | 6940 | 1111 | 7146 | 799 | 8315 | 526 | 5058 |
| 8-#10 | 1.65 | MA | 5299 | 1924 | 7754 | 1587 | 8942 | 1331 | 9561 | 1128 | 10154 | 823 | 12067 | 614 | 6620 |
| 3E | | MI | 4103 | 1924 | 6163 | 1547 | 6985 | 1296 | 7400 | 1105 | 7775 | 797 | 9080 | 577 | 5059 |
| 8-#10 | 1.65 | MA | 5161 | 1924 | 7399 | 1598 | 8441 | 1349 | 8946 | 1145 | 9311 | 829 | 11035 | 562 | 6588 |
| 4L-2S | | MI | 4294 | 1924 | 6547 | 1538 | 7475 | 1289 | 7995 | 1091 | 8581 | 786 | 10167 | 668 | 5045 |
| 8-#11 | 2.03 | MA | 5745 | 1990 | 8761 | 1606 | 10176 | 1342 | 11036 | 1130 | 12131 | 798 | 14791 | 690 | 7979 |
| 2L-4S | | MI | 4072 | 1990 | 6120 | 1586 | 6843 | 1333 | 7201 | 1121 | 7481 | 787 | 8700 | 465 | 6037 |
| 8-#11 | 2.03 | MA | 5434 | 1990 | 8132 | 1619 | 9375 | 1353 | 10064 | 1139 | 10815 | 815 | 12968 | 581 | 7973 |
| 3E | | MI | 4193 | 1990 | 6442 | 1576 | 7296 | 1315 | 7755 | 1116 | 8240 | 786 | 9601 | 526 | 6060 |
| 8-#11 | 2.03 | MA | 5272 | 1990 | 7701 | 1632 | 8768 | 1375 | 9318 | 1159 | 9794 | 821 | 11708 | 516 | 7901 |
| 4L-2S | | MI | 4416 | 1990 | 6903 | 1566 | 7884 | 1308 | 8469 | 1100 | 9206 | 774 | 10875 | 638 | 6047 |
| 8-#14 | 2.92 | MA | 6199 | 2147 | 9866 | 1697 | 11549 | 1407 | 12687 | 1169 | 14351 | 784 | 17855 | 673 | 11248 |
| 2L-4S | | MI | 4266 | 2147 | 6596 | 1681 | 7399 | 1405 | 7859 | 1165 | 8357 | 774 | 9812 | 344 | 8032 |
| 8-#14 | 2.92 | MA | 5780 | 2147 | 8971 | 1715 | 10408 | 1422 | 11302 | 1181 | 12477 | 807 | 15260 | 513 | 11191 |
| 3E | | MI | 4429 | 2147 | 7054 | 1668 | 8043 | 1381 | 8648 | 1159 | 9436 | 774 | 11072 | 429 | 8425 |
| 8-#14 | 2.92 | MA | 5561 | 2147 | 8355 | 1732 | 9541 | 1452 | 10238 | 1209 | 11020 | 815 | 13450 | 419 | 10669 |
| 4L-2S | | MI | 4731 | 2147 | 7709 | 1655 | 8877 | 1371 | 9660 | 1137 | 10806 | 759 | 12845 | 590 | 8444 |
| 8-#18 | 5.19 | MA | 6611 | 2547 | 11013 | 1960 | 12941 | 1599 | 14346 | 1316 | 16571 | 787 | 20653 | 314 | 18936 |
| 3E | | MI | 4993 | 2547 | 8525 | 1904 | 9854 | 1548 | 10818 | 1269 | 12351 | 745 | 14487 | 156 | 13947 |
| 8-#18 | 5.19 | MA | 6266 | 2547 | 9939 | 1988 | 11430 | 1649 | 12492 | 1334 | 14034 | 796 | 17552 | 151 | 16622 |
| 4L-2S | | MI | 5459 | 2547 | 9648 | 1885 | 11285 | 1536 | 12555 | 1236 | 14702 | 724 | 17418 | 444 | 14209 |
| 10-#10 | 2.06 | MA | 5800 | 1996 | 8796 | 1621 | 10268 | 1354 | 11172 | 1140 | 12333 | 804 | 15085 | 695 | 8197 |
| 2L-5S | | MI | 4054 | 1996 | 6008 | 1618 | 6771 | 1352 | 7126 | 1145 | 7383 | 806 | 8639 | 464 | 6018 |
| 10-#10 | 2.06 | MA | 5543 | 1996 | 8275 | 1632 | 9605 | 1364 | 10367 | 1148 | 11243 | 819 | 13576 | 608 | 8190 |
| 3L-4S | | MI | 4179 | 1996 | 6281 | 1601 | 7100 | 1345 | 7535 | 1131 | 7951 | 795 | 9402 | 517 | 6212 |
| 10-#10 | 2.06 | MA | 5412 | 1996 | 7920 | 1643 | 9104 | 1382 | 9751 | 1165 | 10401 | 825 | 12544 | 557 | 8144 |
| 4L-3S | | MI | 4276 | 1996 | 6547 | 1592 | 7475 | 1329 | 7995 | 1126 | 8581 | 793 | 10167 | 568 | 6227 |
| 10-#10 | 2.06 | MA | 5224 | 1996 | 7557 | 1662 | 8667 | 1392 | 9208 | 1174 | 9644 | 839 | 11502 | 510 | 7856 |
| 5L-2S | | MI | 4462 | 1996 | 6932 | 1583 | 7965 | 1322 | 8590 | 1112 | 9386 | 782 | 11254 | 659 | 6220 |
| 10-#11 | 2.53 | MA | 6022 | 2079 | 9390 | 1662 | 10976 | 1382 | 12009 | 1155 | 13447 | 793 | 16613 | 683 | 9884 |
| 2L-5S | | MI | 4139 | 2079 | 6252 | 1661 | 7034 | 1381 | 7421 | 1162 | 7762 | 794 | 9079 | 385 | 7032 |
| 10-#11 | 2.53 | MA | 5723 | 2079 | 8761 | 1675 | 10176 | 1394 | 11036 | 1165 | 12131 | 810 | 14791 | 573 | 9862 |
| 3L-4S | | MI | 4282 | 2079 | 6582 | 1641 | 7431 | 1374 | 7915 | 1147 | 8447 | 782 | 9973 | 450 | 7413 |
| 10-#11 | 2.53 | MA | 5570 | 2079 | 8330 | 1687 | 9568 | 1415 | 10291 | 1184 | 11110 | 816 | 13530 | 509 | 9774 |
| 4L-3S | | MI | 4396 | 2079 | 6903 | 1631 | 7884 | 1356 | 8469 | 1141 | 9206 | 781 | 10875 | 511 | 7454 |
| 10-#11 | 2.53 | MA | 5350 | 2079 | 7890 | 1711 | 9038 | 1426 | 9631 | 1194 | 10192 | 832 | 12263 | 449 | 9229 |
| 5L-2S | | MI | 4613 | 2079 | 7365 | 1622 | 8472 | 1348 | 9183 | 1125 | 10173 | 769 | 12148 | 623 | 7454 |
| 10-#14 | 3.65 | MA | 6181 | 2276 | 9866 | 1795 | 11549 | 1480 | 12687 | 1218 | 14351 | 800 | 17855 | 502 | 13868 |
| 3L-4S | | MI | 4559 | 2276 | 7250 | 1761 | 8233 | 1464 | 8871 | 1202 | 9727 | 767 | 11586 | 319 | 9886 |
| 10-#14 | 3.65 | MA | 5979 | 2276 | 9250 | 1813 | 10681 | 1510 | 11622 | 1245 | 12894 | 807 | 16045 | 409 | 13253 |
| 4L-3S | | MI | 4712 | 2276 | 7709 | 1748 | 8877 | 1439 | 9660 | 1195 | 10806 | 767 | 12845 | 403 | 10382 |
| 10-#14 | 3.65 | MA | 5672 | 2276 | 8621 | 1845 | 9923 | 1526 | 10680 | 1258 | 11583 | 830 | 14230 | 318 | 12435 |
| 5L-2S | | MI | 5002 | 2276 | 8363 | 1735 | 9710 | 1429 | 10673 | 1174 | 12177 | 752 | 14619 | 565 | 10424 |
| 10-#18 | 6.49 | MA | 6972 | 2776 | 11491 | 2131 | 13405 | 1753 | 14892 | 1399 | 17282 | 783 | 21963 | 125 | 21159 |
| 4L-3S | | MI | 5488 | 2776 | 9648 | 2047 | 11285 | 1652 | 12555 | 1334 | 14702 | 731 | 17418 | 96 | 17058 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis

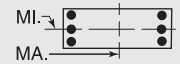



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 2.47 | MA | 6032 | 2069 | 9317 | 1666 | 10931 | 1387 | 11977 | 1160 | 13423 | 800 | 16594 | 689 | 9773 |
| 2L-6S | | MI | 4101 | 2069 | 6155 | 1671 | 6936 | 1401 | 7319 | 1172 | 7645 | 813 | 9027 | 396 | 6923 |
| 12-#10 | 2.47 | MA | 5782 | 2069 | 8796 | 1677 | 10268 | 1397 | 11172 | 1169 | 12333 | 814 | 15085 | 602 | 9756 |
| 3L-5S | | MI | 4230 | 2069 | 6392 | 1664 | 7261 | 1385 | 7721 | 1166 | 8188 | 802 | 9726 | 455 | 7126 |
| 12-#10 | 2.47 | MA | 5659 | 2069 | 8440 | 1688 | 9767 | 1415 | 10557 | 1186 | 11491 | 821 | 14053 | 551 | 9700 |
| 4E | | MI | 4354 | 2069 | 6665 | 1646 | 7590 | 1378 | 8130 | 1152 | 8756 | 791 | 10489 | 507 | 7363 |
| 12-#10 | 2.47 | MA | 5472 | 2069 | 8078 | 1708 | 9330 | 1425 | 10013 | 1194 | 10734 | 835 | 13011 | 504 | 9375 |
| 5L-3S | | MI | 4447 | 2069 | 6932 | 1638 | 7965 | 1362 | 8590 | 1146 | 9386 | 789 | 11254 | 558 | 7388 |
| 12-#10 | 2.47 | MA | 5295 | 2069 | 7739 | 1714 | 8919 | 1434 | 9479 | 1211 | 10011 | 850 | 11988 | 433 | 9042 |
| 6L-2S | | MI | 4628 | 2069 | 7317 | 1629 | 8455 | 1355 | 9185 | 1132 | 10191 | 778 | 12341 | 650 | 7390 |
| 12-#11 | 3.04 | MA | 6006 | 2168 | 9390 | 1730 | 10976 | 1434 | 12009 | 1190 | 13447 | 804 | 16613 | 566 | 11749 |
| 3L-5S | | MI | 4347 | 2168 | 6713 | 1717 | 7622 | 1422 | 8135 | 1188 | 8728 | 789 | 10353 | 370 | 8364 |
| 12-#11 | 3.04 | MA | 5863 | 2168 | 8959 | 1743 | 10369 | 1455 | 11263 | 1210 | 12426 | 811 | 15352 | 502 | 11648 |
| 4E | | MI | 4489 | 2168 | 7043 | 1697 | 8019 | 1414 | 8629 | 1172 | 9414 | 777 | 11247 | 436 | 8761 |
| 12-#11 | 3.04 | MA | 5644 | 2168 | 8519 | 1766 | 9839 | 1467 | 10604 | 1219 | 11508 | 827 | 14085 | 441 | 11066 |
| 5L-3S | | MI | 4597 | 2168 | 7365 | 1687 | 8472 | 1396 | 9183 | 1166 | 10173 | 776 | 12148 | 496 | 8842 |
| 12-#11 | 3.04 | MA | 5435 | 2168 | 8116 | 1775 | 9316 | 1488 | 9955 | 1239 | 10632 | 844 | 12932 | 367 | 10645 |
| 6L-2S | | MI | 4807 | 2168 | 7827 | 1677 | 9060 | 1388 | 9898 | 1150 | 11139 | 764 | 13422 | 608 | 8855 |
| 12-#14 | 4.38 | MA | 6387 | 2404 | 10146 | 1893 | 11821 | 1569 | 13007 | 1282 | 14768 | 800 | 18640 | 398 | 15850 |
| 4E | | MI | 4847 | 2404 | 7905 | 1841 | 9066 | 1522 | 9884 | 1238 | 11098 | 759 | 13359 | 293 | 11754 |
| 12-#14 | 4.38 | MA | 6083 | 2404 | 9517 | 1925 | 11063 | 1584 | 12065 | 1294 | 13457 | 822 | 16825 | 307 | 15073 |
| 5L-3S | | MI | 4991 | 2404 | 8363 | 1828 | 9710 | 1497 | 10673 | 1231 | 12177 | 759 | 14619 | 378 | 12336 |
| 12-#14 | 4.38 | MA | 5798 | 2404 | 8948 | 1938 | 10315 | 1614 | 11138 | 1322 | 12204 | 845 | 15169 | 200 | 13996 |
| 6L-2S | | MI | 5271 | 2404 | 9018 | 1815 | 10544 | 1487 | 11685 | 1210 | 13547 | 744 | 16393 | 539 | 12396 |
| 14-#10 | 2.89 | MA | 6019 | 2141 | 9317 | 1722 | 10931 | 1430 | 11977 | 1189 | 13423 | 810 | 16594 | 597 | 11321 |
| 3L-6S | | MI | 4278 | 2141 | 6539 | 1717 | 7426 | 1434 | 7914 | 1192 | 8451 | 809 | 10114 | 387 | 8048 |
| 14-#10 | 2.89 | MA | 5901 | 2141 | 8961 | 1733 | 10430 | 1448 | 11362 | 1206 | 12580 | 816 | 15562 | 545 | 11256 |
| 4L-5S | | MI | 4404 | 2141 | 6777 | 1709 | 7751 | 1418 | 8316 | 1187 | 8994 | 798 | 10813 | 445 | 8241 |
| 14-#10 | 2.89 | MA | 5715 | 2141 | 8599 | 1753 | 9993 | 1458 | 10818 | 1215 | 11824 | 831 | 14520 | 498 | 10898 |
| 5L-4S | | MI | 4527 | 2141 | 7050 | 1692 | 8080 | 1411 | 8725 | 1172 | 9562 | 787 | 11576 | 498 | 8512 |
| 14-#10 | 2.89 | MA | 5544 | 2141 | 8260 | 1759 | 9582 | 1467 | 10284 | 1232 | 11101 | 845 | 13497 | 427 | 10580 |
| 6L-3S | | MI | 4616 | 2141 | 7317 | 1683 | 8455 | 1395 | 9185 | 1167 | 10191 | 784 | 12341 | 549 | 8546 |
| 14-#10 | 2.89 | MA | 5399 | 2141 | 7928 | 1766 | 9131 | 1483 | 9771 | 1240 | 10364 | 852 | 12509 | 388 | 10119 |
| 7L-2S | | MI | 4793 | 2141 | 7702 | 1674 | 8945 | 1388 | 9780 | 1153 | 10996 | 774 | 13428 | 641 | 8556 |
| 14-#11 | 3.55 | MA | 6150 | 2257 | 9588 | 1799 | 11169 | 1496 | 12236 | 1235 | 13742 | 806 | 17174 | 495 | 13523 |
| 4L-5S | | MI | 4551 | 2257 | 7175 | 1773 | 8210 | 1462 | 8850 | 1213 | 9695 | 783 | 11627 | 355 | 9703 |
| 14-#11 | 3.55 | MA | 5932 | 2257 | 9148 | 1822 | 10639 | 1507 | 11576 | 1244 | 12824 | 822 | 15907 | 434 | 12909 |
| 5L-4S | | MI | 4692 | 2257 | 7505 | 1753 | 8607 | 1455 | 9343 | 1197 | 10380 | 772 | 12521 | 421 | 10077 |
| 14-#11 | 3.55 | MA | 5731 | 2257 | 8744 | 1830 | 10117 | 1529 | 10928 | 1264 | 11948 | 839 | 14755 | 360 | 12473 |
| 6L-3S | | MI | 4795 | 2257 | 7827 | 1743 | 9060 | 1437 | 9898 | 1191 | 11139 | 770 | 13422 | 481 | 10227 |
| 14-#11 | 3.55 | MA | 5560 | 2257 | 8342 | 1838 | 9603 | 1538 | 10304 | 1274 | 11053 | 845 | 13454 | 295 | 11820 |
| 7L-2S | | MI | 5000 | 2257 | 8289 | 1733 | 9647 | 1429 | 10612 | 1176 | 12105 | 759 | 14696 | 593 | 10250 |
| 14-#14 | 5.11 | MA | 6485 | 2533 | 10412 | 2006 | 12203 | 1642 | 13450 | 1331 | 15331 | 815 | 19420 | 297 | 17717 |
| 5L-4S | | MI | 5131 | 2533 | 8560 | 1922 | 9900 | 1580 | 10896 | 1275 | 12468 | 752 | 15133 | 268 | 13634 |
| 14-#14 | 5.11 | MA | 6214 | 2533 | 9844 | 2018 | 11456 | 1672 | 12523 | 1358 | 14078 | 838 | 17764 | 189 | 16626 |
| 6L-3S | | MI | 5265 | 2533 | 9018 | 1909 | 10544 | 1556 | 11685 | 1268 | 13547 | 752 | 16393 | 352 | 14289 |
| 16-#10 | 3.30 | MA | 6140 | 2214 | 9482 | 1779 | 11093 | 1481 | 12167 | 1227 | 13670 | 812 | 17071 | 539 | 12813 |
| 4L-6S | | MI | 4453 | 2214 | 6924 | 1762 | 7916 | 1467 | 8509 | 1213 | 9256 | 804 | 11201 | 378 | 9175 |
| 16-#10 | 3.30 | MA | 5955 | 2214 | 9119 | 1798 | 10656 | 1490 | 11624 | 1235 | 12913 | 827 | 16029 | 492 | 12426 |
| 5E | | MI | 4575 | 2214 | 7162 | 1754 | 8241 | 1451 | 8911 | 1207 | 9799 | 794 | 11900 | 436 | 9359 |
| 16-#10 | 3.30 | MA | 5789 | 2214 | 8781 | 1805 | 10245 | 1500 | 11090 | 1252 | 12191 | 841 | 15006 | 421 | 12120 |
| 6L-4S | | MI | 4698 | 2214 | 7435 | 1737 | 8570 | 1444 | 9320 | 1193 | 10367 | 783 | 12663 | 489 | 9660 |
| 16-#10 | 3.30 | MA | 5649 | 2214 | 8449 | 1811 | 9794 | 1516 | 10576 | 1261 | 11454 | 847 | 14018 | 382 | 11650 |
| 7L-3S | | MI | 4783 | 2214 | 7702 | 1728 | 8945 | 1428 | 9780 | 1187 | 10996 | 780 | 13428 | 540 | 9702 |
| 16-#10 | 3.30 | MA | 5490 | 2214 | 8129 | 1819 | 9363 | 1522 | 10055 | 1277 | 10749 | 862 | 13068 | 330 | 11205 |
| 8L-2S | | MI | 4955 | 2214 | 8086 | 1719 | 9435 | 1421 | 10375 | 1173 | 11802 | 769 | 14515 | 632 | 9718 |
| 16-#11 | 4.05 | MA | 6216 | 2346 | 9776 | 1878 | 11440 | 1548 | 12549 | 1270 | 14140 | 817 | 17729 | 427 | 14758 |
| 5E | | MI | 4753 | 2346 | 7637 | 1828 | 8798 | 1503 | 9564 | 1238 | 10661 | 778 | 12901 | 340 | 11047 |

## RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 4.05 | MA | 6022 | 2346 | 9373 | 1886 | 10917 | 1569 | 11900 | 1290 | 13264 | 834 | 16577 | 353 | 14307 |
| 6L-4S | | MI | 4894 | 2346 | 7967 | 1808 | 9195 | 1495 | 10057 | 1222 | 11347 | 767 | 13795 | 406 | 11401 |
| 16-#11 | 4.05 | MA | 5858 | 2346 | 8971 | 1894 | 10404 | 1578 | 11277 | 1299 | 12369 | 840 | 15276 | 288 | 13672 |
| 7L-3S | | MI | 4992 | 2346 | 8289 | 1798 | 9647 | 1477 | 10612 | 1217 | 12105 | 765 | 14696 | 466 | 11610 |
| 16-#14 | 5.84 | MA | 6620 | 2661 | 10739 | 2099 | 12596 | 1731 | 13908 | 1395 | 15952 | 830 | 20359 | 179 | 19261 |
| 6L-4S | | MI | 5411 | 2661 | 9214 | 2002 | 10734 | 1639 | 11909 | 1311 | 13838 | 745 | 16906 | 243 | 15524 |
| 18-#10 | 3.71 | MA | 6192 | 2286 | 9640 | 1844 | 11319 | 1523 | 12429 | 1256 | 14003 | 822 | 17538 | 487 | 13958 |
| 5L-6S | | MI | 4625 | 2286 | 7309 | 1807 | 8406 | 1499 | 9104 | 1233 | 10061 | 800 | 12288 | 369 | 10305 |
| 18-#10 | 3.71 | MA | 6031 | 2286 | 9302 | 1850 | 10908 | 1533 | 11895 | 1273 | 13281 | 837 | 16515 | 415 | 13663 |
| 6L-5S | | MI | 4745 | 2286 | 7547 | 1800 | 8731 | 1484 | 9506 | 1228 | 10604 | 789 | 12987 | 427 | 10481 |
| 18-#10 | 3.71 | MA | 5896 | 2286 | 8969 | 1857 | 10457 | 1549 | 11381 | 1281 | 12543 | 843 | 15527 | 376 | 13183 |
| 7L-4S | | MI | 4867 | 2286 | 7820 | 1782 | 9059 | 1477 | 9915 | 1214 | 11172 | 778 | 13750 | 480 | 10809 |
| 18-#10 | 3.71 | MA | 5738 | 2286 | 8650 | 1865 | 10026 | 1555 | 10861 | 1298 | 11839 | 858 | 14577 | 324 | 12738 |
| 8L-3S | | MI | 4948 | 2286 | 8086 | 1774 | 9435 | 1461 | 10375 | 1208 | 11802 | 776 | 14515 | 531 | 10857 |
| 18-#11 | 4.56 | MA | 6309 | 2435 | 10002 | 1942 | 11718 | 1610 | 12872 | 1315 | 14580 | 828 | 18399 | 346 | 16145 |
| 6L-5S | | MI | 4952 | 2435 | 8099 | 1884 | 9385 | 1543 | 10278 | 1263 | 11628 | 773 | 14175 | 325 | 12395 |
| 18-#11 | 4.56 | MA | 6151 | 2435 | 9599 | 1949 | 11204 | 1619 | 12249 | 1324 | 13685 | 835 | 17098 | 281 | 15528 |
| 7L-4S | | MI | 5093 | 2435 | 8429 | 1864 | 9783 | 1536 | 10771 | 1248 | 12313 | 761 | 15069 | 391 | 12732 |
| 20-#10 | 4.12 | MA | 6269 | 2359 | 9822 | 1895 | 11571 | 1566 | 12700 | 1293 | 14371 | 833 | 18024 | 409 | 15208 |
| 6E | | MI | 4796 | 2359 | 7694 | 1853 | 8896 | 1532 | 9699 | 1254 | 10866 | 796 | 13375 | 359 | 11416 |
| 20-#10 | 4.12 | MA | 6139 | 2359 | 9490 | 1902 | 11120 | 1582 | 12187 | 1302 | 13633 | 839 | 17036 | 371 | 14719 |
| 7L-5S | | MI | 4912 | 2359 | 7932 | 1845 | 9221 | 1517 | 10101 | 1248 | 11410 | 785 | 14074 | 418 | 11607 |
| 20-#10 | 4.12 | MA | 5982 | 2359 | 9171 | 1910 | 10689 | 1588 | 11666 | 1318 | 12929 | 854 | 16086 | 318 | 14272 |
| 8L-4S | | MI | 5034 | 2359 | 8204 | 1828 | 9549 | 1510 | 10510 | 1234 | 11977 | 774 | 14837 | 471 | 11928 |
| 20-#11 | 5.06 | MA | 6440 | 2524 | 10228 | 2005 | 12005 | 1659 | 13221 | 1350 | 15001 | 829 | 18920 | 273 | 17386 |
| 7L-5S | | MI | 5150 | 2524 | 8560 | 1940 | 9973 | 1584 | 10992 | 1289 | 12594 | 768 | 15449 | 310 | 13747 |
| 22-#10 | 4.54 | MA | 6379 | 2431 | 10011 | 1947 | 11783 | 1615 | 12992 | 1323 | 14723 | 835 | 18545 | 365 | 16258 |
| 7L-6S | | MI | 4965 | 2431 | 8078 | 1898 | 9386 | 1565 | 10294 | 1274 | 11672 | 792 | 14462 | 350 | 12525 |
| 22-#10 | 4.54 | MA | 6223 | 2431 | 9692 | 1955 | 11352 | 1621 | 12471 | 1339 | 14018 | 849 | 17595 | 312 | 15808 |
| 8L-5S | | MI | 5078 | 2431 | 8316 | 1890 | 9710 | 1550 | 10696 | 1269 | 12215 | 781 | 15161 | 409 | 12735 |

## RECTANGULAR TIED COLUMNS 22" x 30"

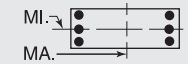
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.36 | MA | 6176 | 2007 | 9107 | 1646 | 10485 | 1384 | 11222 | 1177 | 11972 | 864 | 14279 | 751 | 6297 |
| 2E | | MI | 4434 | 2007 | 6763 | 1589 | 7606 | 1335 | 8036 | 1135 | 8447 | 831 | 9709 | 691 | 4468 |
| 4-#18 | 2.42 | MA | 6796 | 2207 | 10625 | 1755 | 12345 | 1461 | 13446 | 1222 | 14953 | 843 | 18384 | 726 | 10750 |
| 2E | | MI | 4813 | 2207 | 7769 | 1693 | 8821 | 1408 | 9481 | 1176 | 10378 | 807 | 11962 | 612 | 7458 |
| 6-#10 | 1.15 | MA | 6077 | 1968 | 8752 | 1640 | 10123 | 1381 | 10827 | 1180 | 11473 | 877 | 13614 | 763 | 5441 |
| 2L-3S | | MI | 4184 | 1968 | 6136 | 1598 | 6889 | 1346 | 7206 | 1157 | 7353 | 859 | 8408 | 636 | 3905 |
| 6-#10 | 1.15 | MA | 5776 | 1968 | 8186 | 1651 | 9402 | 1392 | 9951 | 1189 | 10289 | 893 | 11973 | 679 | 5456 |
| 3L-2S | | MI | 4381 | 1968 | 6520 | 1590 | 7379 | 1339 | 7801 | 1143 | 8158 | 848 | 9495 | 727 | 3883 |
| 6-#11 | 1.42 | MA | 6231 | 2018 | 9166 | 1660 | 10598 | 1395 | 11378 | 1186 | 12199 | 868 | 14603 | 754 | 6571 |
| 2L-3S | | MI | 4242 | 2018 | 6341 | 1616 | 7103 | 1357 | 7442 | 1162 | 7655 | 848 | 8740 | 590 | 4683 |
| 6-#11 | 1.42 | MA | 5876 | 2018 | 8482 | 1673 | 9727 | 1407 | 10320 | 1196 | 10766 | 886 | 12619 | 647 | 6583 |
| 3L-2S | | MI | 4474 | 2018 | 6803 | 1606 | 7691 | 1349 | 8156 | 1146 | 8621 | 836 | 10014 | 703 | 4657 |
| 6-#14 | 2.05 | MA | 6617 | 2136 | 10082 | 1726 | 11727 | 1442 | 12731 | 1214 | 14015 | 857 | 17106 | 740 | 9267 |
| 2L-3S | | MI | 4398 | 2136 | 6763 | 1683 | 7606 | 1403 | 8036 | 1193 | 8447 | 838 | 9709 | 504 | 6501 |
| 6-#14 | 2.05 | MA | 6131 | 2136 | 9107 | 1745 | 10485 | 1458 | 11222 | 1228 | 11972 | 881 | 14279 | 584 | 9240 |
| 3L-2S | | MI | 4715 | 2136 | 7418 | 1669 | 8439 | 1394 | 9049 | 1172 | 9817 | 823 | 11482 | 665 | 6483 |
| 6-#18 | 3.64 | MA | 7522 | 2435 | 12320 | 1898 | 14502 | 1565 | 16066 | 1287 | 18500 | 830 | 23294 | 708 | 15866 |
| 2L-3S | | MI | 4769 | 2435 | 7769 | 1855 | 8821 | 1525 | 9481 | 1274 | 10378 | 813 | 11962 | 264 | 10762 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis

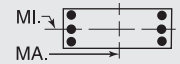



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 3.64 | MA | 6747 | 2435 | 10625 | 1929 | 12345 | 1591 | 13446 | 1335 | 14953 | 869 | 18384 | 420 | 15617 |
| 3L-2S | | MI | 5275 | 2435 | 8893 | 1836 | 10251 | 1512 | 11218 | 1241 | 12729 | 793 | 14893 | 552 | 10875 |
| 8-#9 | 1.21 | MA | 6126 | 1979 | 8825 | 1650 | 10235 | 1390 | 10972 | 1186 | 11678 | 879 | 13903 | 764 | 5715 |
| 2L-4S | | MI | 4176 | 1979 | 6052 | 1616 | 6772 | 1367 | 7069 | 1166 | 7169 | 862 | 8249 | 620 | 4103 |
| 8-#9 | 1.21 | MA | 5889 | 1979 | 8377 | 1659 | 9664 | 1398 | 10279 | 1193 | 10740 | 891 | 12604 | 698 | 5725 |
| 3E | | MI | 4259 | 1979 | 6263 | 1609 | 7070 | 1354 | 7434 | 1161 | 7668 | 859 | 8861 | 660 | 4088 |
| 8-#9 | 1.21 | MA | 5766 | 1979 | 8072 | 1669 | 9235 | 1413 | 9752 | 1207 | 10017 | 897 | 11727 | 658 | 5721 |
| 4L-2S | | MI | 4415 | 1979 | 6569 | 1602 | 7459 | 1348 | 7906 | 1150 | 8307 | 850 | 9731 | 732 | 4072 |
| 8-#10 | 1.54 | MA | 6342 | 2040 | 9318 | 1685 | 10844 | 1414 | 11702 | 1200 | 12658 | 873 | 15254 | 757 | 7165 |
| 2L-4S | | MI | 4257 | 2040 | 6254 | 1653 | 7004 | 1395 | 7341 | 1183 | 7529 | 857 | 8730 | 576 | 5090 |
| 8-#10 | 1.54 | MA | 6050 | 2040 | 8752 | 1696 | 10123 | 1425 | 10827 | 1210 | 11473 | 888 | 13614 | 673 | 7169 |
| 3E | | MI | 4360 | 2040 | 6520 | 1644 | 7379 | 1379 | 7801 | 1177 | 8158 | 854 | 9495 | 627 | 5085 |
| 8-#10 | 1.54 | MA | 5899 | 2040 | 8367 | 1708 | 9580 | 1443 | 10160 | 1227 | 10560 | 895 | 12502 | 622 | 7136 |
| 4L-2S | | MI | 4552 | 2040 | 6905 | 1635 | 7869 | 1372 | 8396 | 1163 | 8963 | 844 | 10582 | 718 | 5068 |
| 8-#11 | 1.89 | MA | 6543 | 2107 | 9851 | 1716 | 11470 | 1435 | 12437 | 1211 | 13631 | 863 | 16586 | 747 | 8653 |
| 2L-4S | | MI | 4328 | 2107 | 6481 | 1682 | 7238 | 1415 | 7602 | 1193 | 7862 | 844 | 9112 | 515 | 6081 |
| 8-#11 | 1.89 | MA | 6201 | 2107 | 9166 | 1729 | 10598 | 1447 | 11378 | 1222 | 12199 | 881 | 14603 | 640 | 8647 |
| 3E | | MI | 4450 | 2107 | 6803 | 1672 | 7691 | 1397 | 8156 | 1187 | 8621 | 843 | 10014 | 575 | 6092 |
| 8-#11 | 1.89 | MA | 6023 | 2107 | 8699 | 1743 | 9939 | 1470 | 10569 | 1242 | 11091 | 888 | 13245 | 576 | 8575 |
| 4L-2S | | MI | 4674 | 2107 | 7265 | 1662 | 8279 | 1389 | 8870 | 1171 | 9588 | 831 | 11287 | 688 | 6076 |
| 8-#14 | 2.73 | MA | 7048 | 2264 | 11058 | 1806 | 12970 | 1500 | 14240 | 1250 | 16057 | 849 | 19934 | 730 | 12220 |
| 2L-4S | | MI | 4521 | 2264 | 6959 | 1776 | 7795 | 1487 | 8260 | 1236 | 8738 | 831 | 10223 | 394 | 8168 |
| 8-#14 | 2.73 | MA | 6584 | 2264 | 10082 | 1825 | 11727 | 1517 | 12731 | 1264 | 14015 | 874 | 17106 | 573 | 12163 |
| 3E | | MI | 4686 | 2264 | 7418 | 1763 | 8439 | 1462 | 9049 | 1229 | 9817 | 831 | 11482 | 478 | 8470 |
| 8-#14 | 2.73 | MA | 6343 | 2264 | 9414 | 1844 | 10785 | 1548 | 11575 | 1293 | 12432 | 883 | 15156 | 481 | 11731 |
| 4L-2S | | MI | 4991 | 2264 | 8072 | 1750 | 9273 | 1452 | 10061 | 1208 | 11187 | 816 | 13256 | 640 | 8479 |
| 8-#18 | 4.85 | MA | 7505 | 2664 | 12320 | 2071 | 14502 | 1695 | 16066 | 1400 | 18500 | 856 | 23294 | 402 | 20664 |
| 3E | | MI | 5250 | 2664 | 8893 | 1998 | 10251 | 1629 | 11218 | 1339 | 12729 | 800 | 14893 | 205 | 14089 |
| 8-#18 | 4.85 | MA | 7127 | 2664 | 11152 | 2102 | 12858 | 1747 | 14050 | 1421 | 15739 | 868 | 19856 | 234 | 18294 |
| 4L-2S | | MI | 5724 | 2664 | 10017 | 1979 | 11682 | 1616 | 12956 | 1306 | 15081 | 780 | 17825 | 492 | 14260 |
| 10-#10 | 1.92 | MA | 6601 | 2113 | 9884 | 1730 | 11564 | 1447 | 12577 | 1221 | 13843 | 869 | 16894 | 752 | 8883 |
| 2L-5S | | MI | 4311 | 2113 | 6365 | 1715 | 7165 | 1435 | 7527 | 1217 | 7766 | 864 | 9055 | 514 | 6102 |
| 10-#10 | 1.92 | MA | 6318 | 2113 | 9318 | 1742 | 10844 | 1458 | 11702 | 1230 | 12658 | 884 | 15254 | 667 | 8876 |
| 3L-4S | | MI | 4435 | 2113 | 6638 | 1698 | 7494 | 1428 | 7936 | 1203 | 8334 | 853 | 9817 | 567 | 6247 |
| 10-#10 | 1.92 | MA | 6175 | 2113 | 8933 | 1753 | 10300 | 1476 | 11035 | 1248 | 11744 | 891 | 14142 | 616 | 8830 |
| 4L-3S | | MI | 4534 | 2113 | 6905 | 1689 | 7869 | 1412 | 8396 | 1198 | 8963 | 850 | 10582 | 618 | 6255 |
| 10-#10 | 1.92 | MA | 5964 | 2113 | 8541 | 1773 | 9828 | 1487 | 10447 | 1257 | 10925 | 907 | 13017 | 571 | 8578 |
| 5L-2S | | MI | 4721 | 2113 | 7290 | 1680 | 8359 | 1405 | 8991 | 1184 | 9769 | 839 | 11670 | 709 | 6245 |
| 10-#11 | 2.36 | MA | 6850 | 2196 | 10535 | 1771 | 12341 | 1476 | 13495 | 1236 | 15064 | 858 | 18570 | 739 | 10726 |
| 2L-5S | | MI | 4396 | 2196 | 6613 | 1757 | 7429 | 1463 | 7822 | 1234 | 8143 | 851 | 9492 | 435 | 7129 |
| 10-#11 | 2.36 | MA | 6519 | 2196 | 9851 | 1785 | 11470 | 1488 | 12437 | 1247 | 13631 | 876 | 16586 | 633 | 10705 |
| 3L-4S | | MI | 4539 | 2196 | 6943 | 1737 | 7826 | 1456 | 8316 | 1218 | 8829 | 839 | 10386 | 500 | 7460 |
| 10-#11 | 2.36 | MA | 6351 | 2196 | 9384 | 1798 | 10810 | 1510 | 11628 | 1268 | 12523 | 883 | 15228 | 569 | 10616 |
| 4L-3S | | MI | 4654 | 2196 | 7265 | 1727 | 8279 | 1438 | 8870 | 1212 | 9588 | 838 | 11287 | 560 | 7490 |
| 10-#11 | 2.36 | MA | 6104 | 2196 | 8907 | 1822 | 10236 | 1522 | 10913 | 1278 | 11528 | 901 | 13858 | 512 | 10086 |
| 5L-2S | | MI | 4872 | 2196 | 7726 | 1718 | 8867 | 1430 | 9584 | 1196 | 10554 | 826 | 12561 | 673 | 7485 |
| 10-#14 | 3.41 | MA | 7026 | 2393 | 11058 | 1905 | 12970 | 1575 | 14240 | 1301 | 16057 | 866 | 19934 | 563 | 15083 |
| 3L-4S | | MI | 4815 | 2393 | 7614 | 1856 | 8629 | 1545 | 9272 | 1272 | 10108 | 823 | 11996 | 368 | 10016 |
| 10-#14 | 3.41 | MA | 6804 | 2393 | 10390 | 1924 | 12027 | 1606 | 13084 | 1330 | 14474 | 876 | 17983 | 471 | 14554 |
| 4L-3S | | MI | 4970 | 2393 | 8072 | 1843 | 9273 | 1520 | 10061 | 1266 | 11187 | 823 | 13256 | 453 | 10430 |
| 10-#14 | 3.41 | MA | 6459 | 2393 | 9708 | 1958 | 11205 | 1623 | 12062 | 1344 | 13051 | 900 | 16020 | 384 | 13605 |
| 5L-2S | | MI | 5263 | 2393 | 8727 | 1830 | 10106 | 1510 | 11074 | 1244 | 12557 | 808 | 15030 | 614 | 10463 |
| 10-#18 | 6.06 | MA | 7906 | 2892 | 12847 | 2245 | 15016 | 1851 | 16670 | 1486 | 19286 | 855 | 24766 | 216 | 23264 |
| 4L-3S | | MI | 5746 | 2892 | 10017 | 2141 | 11682 | 1732 | 12956 | 1403 | 15081 | 787 | 17825 | 145 | 17276 |
| 10-#18 | 6.06 | MA | 7332 | 2892 | 11654 | 2302 | 13578 | 1877 | 14884 | 1534 | 16801 | 894 | 21322 | 51 | 21085 |
| 5L-2S | | MI | 6161 | 2892 | 11140 | 2121 | 13112 | 1719 | 14693 | 1370 | 17432 | 767 | 20756 | 433 | 17632 |
| 12-#10 | 2.31 | MA | 6857 | 2185 | 10450 | 1776 | 12285 | 1480 | 13453 | 1241 | 15027 | 865 | 18535 | 746 | 10596 |
| 2L-6S | | MI | 4357 | 2185 | 6512 | 1768 | 7330 | 1483 | 7720 | 1244 | 8028 | 870 | 9442 | 446 | 7003 |

## RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

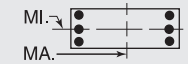
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 2.31 | MA | 6582 | 2185 | 9884 | 1787 | 11564 | 1491 | 12577 | 1251 | 13843 | 880 | 16894 | 661 | 10579 |
| 3L-5S | | MI | 4487 | 2185 | 6750 | 1761 | 7655 | 1468 | 8122 | 1238 | 8571 | 859 | 10142 | 505 | 7209 |
| 12-#10 | 2.31 | MA | 6446 | 2185 | 9499 | 1799 | 11021 | 1509 | 11911 | 1268 | 12929 | 887 | 15783 | 610 | 10523 |
| 4E | | MI | 4611 | 2185 | 7023 | 1743 | 7984 | 1460 | 8531 | 1224 | 9139 | 848 | 10904 | 558 | 7401 |
| 12-#10 | 2.31 | MA | 6237 | 2185 | 9107 | 1819 | 10548 | 1520 | 11322 | 1278 | 12109 | 902 | 14658 | 566 | 10232 |
| 5L-3S | | MI | 4705 | 2185 | 7290 | 1734 | 8359 | 1445 | 8991 | 1218 | 9769 | 846 | 11670 | 609 | 7419 |
| 12-#10 | 2.31 | MA | 6044 | 2185 | 8735 | 1825 | 10104 | 1530 | 10744 | 1295 | 11327 | 918 | 13556 | 495 | 9850 |
| 6L-2S | | MI | 4888 | 2185 | 7675 | 1726 | 8849 | 1438 | 9586 | 1204 | 10574 | 835 | 12757 | 700 | 7416 |
| 12-#11 | 2.84 | MA | 6831 | 2285 | 10535 | 1840 | 12341 | 1528 | 13495 | 1272 | 15064 | 870 | 18570 | 626 | 12760 |
| 3L-5S | | MI | 4603 | 2285 | 7075 | 1813 | 8017 | 1504 | 8536 | 1259 | 9110 | 845 | 10766 | 420 | 8459 |
| 12-#11 | 2.84 | MA | 6673 | 2285 | 10068 | 1854 | 11682 | 1550 | 12686 | 1293 | 13956 | 878 | 17211 | 562 | 12659 |
| 4E | | MI | 4745 | 2285 | 7404 | 1793 | 8414 | 1496 | 9030 | 1243 | 9795 | 834 | 11660 | 485 | 8837 |
| 12-#11 | 2.84 | MA | 6428 | 2285 | 9591 | 1878 | 11107 | 1562 | 11972 | 1303 | 12961 | 896 | 15841 | 505 | 12089 |
| 5L-3S | | MI | 4855 | 2285 | 7726 | 1783 | 8867 | 1478 | 9584 | 1238 | 10554 | 832 | 12561 | 546 | 8881 |
| 12-#11 | 2.84 | MA | 6199 | 2285 | 9147 | 1886 | 10567 | 1574 | 11269 | 1324 | 12011 | 913 | 14496 | 417 | 11659 |
| 6L-2S | | MI | 5067 | 2285 | 8188 | 1773 | 9455 | 1470 | 10299 | 1222 | 11520 | 821 | 13835 | 658 | 8888 |
| 12-#14 | 4.09 | MA | 7254 | 2521 | 11366 | 2004 | 13270 | 1665 | 14593 | 1366 | 16516 | 868 | 20811 | 460 | 17391 |
| 4E | | MI | 5103 | 2521 | 8269 | 1937 | 9462 | 1603 | 10285 | 1309 | 11478 | 816 | 13770 | 343 | 11881 |
| 12-#14 | 4.09 | MA | 6912 | 2521 | 10684 | 2038 | 12448 | 1681 | 13571 | 1380 | 15094 | 893 | 18848 | 374 | 16484 |
| 5L-3S | | MI | 5249 | 2521 | 8727 | 1923 | 10106 | 1579 | 11074 | 1302 | 12557 | 816 | 15030 | 427 | 12386 |
| 12-#14 | 4.09 | MA | 6600 | 2521 | 10056 | 2050 | 11638 | 1712 | 12566 | 1409 | 13735 | 917 | 17065 | 268 | 15396 |
| 6L-2S | | MI | 5533 | 2521 | 9382 | 1910 | 10940 | 1569 | 12086 | 1281 | 13927 | 801 | 16803 | 589 | 12437 |
| 12-#18 | 7.27 | MA | 8096 | 3121 | 13349 | 2445 | 15736 | 1981 | 17504 | 1599 | 20347 | 881 | 26232 | 33 | 26071 |
| 5L-3S | | MI | 6205 | 3121 | 11140 | 2283 | 13112 | 1836 | 14693 | 1468 | 17432 | 774 | 20756 | 86 | 20412 |
| 14-#10 | 2.69 | MA | 6842 | 2258 | 10450 | 1832 | 12285 | 1523 | 13453 | 1271 | 15027 | 876 | 18535 | 655 | 12281 |
| 3L-6S | | MI | 4534 | 2258 | 6897 | 1814 | 7820 | 1516 | 8315 | 1264 | 8833 | 866 | 10529 | 437 | 8127 |
| 14-#10 | 2.69 | MA | 6713 | 2258 | 10065 | 1844 | 11742 | 1542 | 12786 | 1289 | 14114 | 883 | 17423 | 604 | 12216 |
| 4L-5S | | MI | 4661 | 2258 | 7135 | 1806 | 8145 | 1501 | 8717 | 1259 | 9377 | 855 | 11229 | 496 | 8322 |
| 14-#10 | 2.69 | MA | 6505 | 2258 | 9673 | 1864 | 11269 | 1553 | 12198 | 1298 | 13294 | 898 | 16298 | 560 | 11891 |
| 5L-4S | | MI | 4784 | 2258 | 7408 | 1789 | 8474 | 1493 | 9126 | 1245 | 9944 | 844 | 11991 | 549 | 8552 |
| 14-#10 | 2.69 | MA | 6318 | 2258 | 9301 | 1870 | 10824 | 1563 | 11620 | 1316 | 12512 | 914 | 15196 | 489 | 11523 |
| 6L-3S | | MI | 4874 | 2258 | 7675 | 1780 | 8849 | 1478 | 9586 | 1239 | 10574 | 842 | 12757 | 600 | 8579 |
| 14-#10 | 2.69 | MA | 6158 | 2258 | 8941 | 1877 | 10328 | 1578 | 11064 | 1325 | 11714 | 921 | 14131 | 453 | 11077 |
| 7L-2S | | MI | 5053 | 2258 | 8059 | 1771 | 9339 | 1470 | 10181 | 1225 | 11379 | 831 | 13844 | 691 | 8584 |
| 14-#11 | 3.31 | MA | 6990 | 2374 | 10752 | 1910 | 12553 | 1591 | 13745 | 1318 | 15388 | 873 | 19195 | 555 | 14702 |
| 4L-5S | | MI | 4808 | 2374 | 7536 | 1869 | 8605 | 1544 | 9250 | 1284 | 10076 | 840 | 12040 | 405 | 9796 |
| 14-#11 | 3.31 | MA | 6746 | 2374 | 10276 | 1933 | 11979 | 1603 | 13030 | 1329 | 14393 | 890 | 17825 | 497 | 14099 |
| 5L-4S | | MI | 4950 | 2374 | 7866 | 1849 | 9002 | 1536 | 9744 | 1268 | 10762 | 829 | 12934 | 470 | 10183 |
| 14-#11 | 3.31 | MA | 6525 | 2374 | 9831 | 1941 | 11438 | 1615 | 12328 | 1349 | 13443 | 908 | 16479 | 410 | 13686 |
| 6L-3S | | MI | 5054 | 2374 | 8188 | 1839 | 9455 | 1518 | 10299 | 1263 | 11520 | 827 | 13835 | 531 | 10268 |
| 14-#11 | 3.31 | MA | 6337 | 2374 | 9395 | 1950 | 10846 | 1634 | 11653 | 1360 | 12474 | 916 | 15180 | 362 | 12950 |
| 7L-2S | | MI | 5261 | 2374 | 8650 | 1829 | 10043 | 1511 | 11013 | 1247 | 12487 | 816 | 15109 | 643 | 10285 |
| 14-#14 | 4.77 | MA | 7355 | 2650 | 11660 | 2118 | 13690 | 1739 | 15080 | 1417 | 17136 | 885 | 21676 | 364 | 19371 |
| 5L-4S | | MI | 5387 | 2650 | 8923 | 2017 | 10296 | 1662 | 11297 | 1345 | 12848 | 808 | 15544 | 317 | 13757 |
| 14-#14 | 4.77 | MA | 7057 | 2650 | 11032 | 2130 | 12880 | 1771 | 14075 | 1446 | 15777 | 910 | 19893 | 257 | 18272 |
| 6L-3S | | MI | 5525 | 2650 | 9382 | 2004 | 10940 | 1637 | 12086 | 1339 | 13927 | 808 | 16803 | 402 | 14341 |
| 16-#10 | 3.08 | MA | 6975 | 2330 | 10631 | 1889 | 12462 | 1575 | 13661 | 1309 | 15298 | 879 | 19063 | 598 | 13910 |
| 4L-6S | | MI | 4709 | 2330 | 7282 | 1859 | 8310 | 1549 | 8910 | 1285 | 9639 | 862 | 11616 | 428 | 9253 |
| 16-#10 | 3.08 | MA | 6769 | 2330 | 10239 | 1909 | 11990 | 1586 | 13073 | 1319 | 14479 | 894 | 17938 | 554 | 13554 |
| 5E | | MI | 4833 | 2330 | 7520 | 1851 | 8635 | 1534 | 9312 | 1279 | 10182 | 851 | 12316 | 487 | 9439 |
| 16-#10 | 3.08 | MA | 6587 | 2330 | 9867 | 1915 | 11545 | 1596 | 12495 | 1336 | 13697 | 909 | 16837 | 483 | 13200 |
| 6L-4S | | MI | 4956 | 2330 | 7793 | 1834 | 8964 | 1526 | 9721 | 1265 | 10750 | 840 | 13078 | 540 | 9702 |
| 16-#10 | 3.08 | MA | 6434 | 2330 | 9507 | 1923 | 11049 | 1611 | 11940 | 1346 | 12898 | 916 | 15771 | 447 | 12745 |
| 7L-3S | | MI | 5042 | 2330 | 8059 | 1825 | 9339 | 1511 | 10181 | 1259 | 11379 | 838 | 13844 | 591 | 9736 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

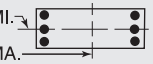
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 3.08 | MA | 6256 | 2330 | 9161 | 1931 | 10582 | 1618 | 11365 | 1361 | 12136 | 932 | 14747 | 396 | 12271 |
| 8L-2S | | MI | 5217 | 2330 | 8444 | 1816 | 9829 | 1503 | 10776 | 1245 | 12185 | 827 | 14931 | 682 | 9748 |
| 16-#11 | 3.78 | MA | 7059 | 2463 | 10960 | 1989 | 12850 | 1643 | 14089 | 1354 | 15826 | 885 | 19808 | 490 | 16114 |
| 5E | | MI | 5010 | 2463 | 7998 | 1924 | 9193 | 1585 | 9965 | 1310 | 11043 | 835 | 13314 | 390 | 11138 |
| 16-#11 | 3.78 | MA | 6846 | 2463 | 10516 | 1997 | 12310 | 1655 | 13386 | 1375 | 14876 | 903 | 18462 | 403 | 15707 |
| 6L-4S | | MI | 5151 | 2463 | 8328 | 1904 | 9590 | 1577 | 10458 | 1294 | 11728 | 823 | 14208 | 456 | 11505 |
| 16-#11 | 3.78 | MA | 6666 | 2463 | 10079 | 2005 | 11718 | 1674 | 12711 | 1385 | 13906 | 910 | 17163 | 355 | 14971 |
| 7L-3S | | MI | 5251 | 2463 | 8650 | 1894 | 10043 | 1559 | 11013 | 1288 | 12487 | 822 | 15109 | 516 | 11652 |
| 16-#14 | 5.45 | MA | 7505 | 2778 | 12008 | 2210 | 14123 | 1829 | 15584 | 1482 | 17819 | 902 | 22720 | 247 | 21153 |
| 6L-4S | | MI | 5668 | 2778 | 9578 | 2097 | 11129 | 1720 | 12309 | 1382 | 14218 | 801 | 17317 | 292 | 15644 |
| 18-#10 | 3.46 | MA | 7029 | 2403 | 10805 | 1954 | 12710 | 1619 | 13948 | 1339 | 15663 | 890 | 19579 | 548 | 15221 |
| 5L-6S | | MI | 4882 | 2403 | 7667 | 1904 | 8800 | 1582 | 9505 | 1305 | 10444 | 858 | 12703 | 419 | 10382 |
| 18-#10 | 3.46 | MA | 6852 | 2403 | 10433 | 1961 | 12266 | 1629 | 13370 | 1357 | 14881 | 905 | 18477 | 477 | 14879 |
| 6L-5S | | MI | 5003 | 2403 | 7904 | 1896 | 9125 | 1566 | 9907 | 1300 | 10987 | 847 | 13403 | 478 | 10560 |
| 18-#10 | 3.46 | MA | 6705 | 2403 | 10073 | 1968 | 11770 | 1644 | 12815 | 1366 | 14083 | 912 | 17412 | 441 | 14416 |
| 7L-4S | | MI | 5125 | 2403 | 8177 | 1879 | 9453 | 1559 | 10316 | 1286 | 11555 | 836 | 14165 | 530 | 10851 |
| 18-#10 | 3.46 | MA | 6528 | 2403 | 9727 | 1976 | 11303 | 1651 | 12241 | 1382 | 13321 | 928 | 16387 | 391 | 13955 |
| 8L-3S | | MI | 5208 | 2403 | 8444 | 1870 | 9829 | 1544 | 10776 | 1280 | 12185 | 833 | 14931 | 581 | 10892 |
| 18-#11 | 4.25 | MA | 7161 | 2552 | 11200 | 2053 | 13181 | 1696 | 14445 | 1400 | 16308 | 898 | 20446 | 395 | 17714 |
| 6L-5S | | MI | 5210 | 2552 | 8460 | 1980 | 9781 | 1625 | 10679 | 1335 | 12009 | 830 | 14588 | 375 | 12485 |
| 18-#11 | 4.25 | MA | 6988 | 2552 | 10763 | 2061 | 12589 | 1715 | 13770 | 1410 | 15338 | 905 | 19147 | 348 | 16996 |
| 7L-4S | | MI | 5351 | 2552 | 8790 | 1960 | 10178 | 1617 | 11172 | 1319 | 12695 | 818 | 15481 | 441 | 12833 |
| 20-#10 | 3.85 | MA | 7114 | 2475 | 10999 | 2006 | 12986 | 1662 | 14246 | 1378 | 16066 | 901 | 20117 | 472 | 16561 |
| 6E | | MI | 5053 | 2475 | 8051 | 1950 | 9290 | 1615 | 10100 | 1326 | 11249 | 853 | 13791 | 410 | 11514 |
| 20-#10 | 3.85 | MA | 6972 | 2475 | 10639 | 2013 | 12490 | 1677 | 13690 | 1387 | 15268 | 908 | 19052 | 435 | 16089 |
| 7L-5S | | MI | 5171 | 2475 | 8289 | 1942 | 9615 | 1599 | 10502 | 1320 | 11792 | 842 | 14490 | 468 | 11684 |
| 20-#10 | 3.85 | MA | 6797 | 2475 | 10293 | 2022 | 12023 | 1684 | 13116 | 1403 | 14505 | 923 | 18027 | 385 | 15639 |
| 8L-4S | | MI | 5293 | 2475 | 8562 | 1925 | 9943 | 1592 | 10911 | 1306 | 12360 | 832 | 15253 | 521 | 12000 |
| 20-#11 | 4.73 | MA | 7306 | 2641 | 11448 | 2117 | 13461 | 1755 | 14828 | 1436 | 16771 | 900 | 21130 | 340 | 19023 |
| 7L-5S | | MI | 5408 | 2641 | 8922 | 2036 | 10369 | 1666 | 11393 | 1360 | 12976 | 825 | 15861 | 360 | 13835 |
| 22-#10 | 4.23 | MA | 7236 | 2548 | 11205 | 2058 | 13211 | 1710 | 14566 | 1407 | 16452 | 904 | 20692 | 429 | 17765 |
| 7L-6S | | MI | 5222 | 2548 | 8436 | 1995 | 9780 | 1648 | 10695 | 1346 | 12054 | 849 | 14878 | 401 | 12647 |
| 22-#10 | 4.23 | MA | 7062 | 2548 | 10859 | 2067 | 12744 | 1717 | 13992 | 1423 | 15690 | 919 | 19668 | 379 | 17325 |
| 8L-5S | | MI | 5338 | 2548 | 8674 | 1987 | 10104 | 1632 | 11097 | 1341 | 12598 | 838 | 15577 | 459 | 12811 |
| 24-#10 | 4.62 | MA | 7323 | 2620 | 11425 | 2112 | 13465 | 1750 | 14867 | 1444 | 16875 | 915 | 21308 | 373 | 19013 |
| 8L-6S | | MI | 5390 | 2620 | 8821 | 2040 | 10270 | 1681 | 11290 | 1367 | 12860 | 845 | 15965 | 391 | 13758 |

## RECTANGULAR TIED COLUMNS 22" x 32"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.28 | MA | 6989 | 2124 | 10193 | 1755 | 11768 | 1477 | 12599 | 1259 | 13414 | 929 | 15974 | 807 | 6783 |
| 2E | | MI | 4691 | 2124 | 7127 | 1684 | 8002 | 1416 | 8437 | 1206 | 8827 | 887 | 10120 | 740 | 4495 |
| 4-#18 | 2.27 | MA | 7673 | 2324 | 11844 | 1865 | 13791 | 1554 | 15017 | 1304 | 16656 | 908 | 20439 | 783 | 11614 |
| 2E | | MI | 5072 | 2324 | 8137 | 1787 | 9218 | 1488 | 9881 | 1246 | 10756 | 862 | 12369 | 660 | 7497 |
| 6-#10 | 1.08 | MA | 6878 | 2085 | 9804 | 1749 | 11371 | 1475 | 12164 | 1261 | 12865 | 942 | 15242 | 820 | 5853 |
| 2L-3S | | MI | 4440 | 2085 | 6493 | 1695 | 7283 | 1429 | 7607 | 1229 | 7736 | 916 | 8824 | 686 | 3926 |
| 6-#10 | 1.08 | MA | 6549 | 2085 | 9193 | 1761 | 10593 | 1486 | 11219 | 1271 | 11585 | 958 | 13471 | 737 | 5867 |
| 3L-2S | | MI | 4639 | 2085 | 6878 | 1687 | 7773 | 1421 | 8202 | 1215 | 8541 | 905 | 9911 | 778 | 3904 |
| 6-#11 | 1.33 | MA | 7048 | 2134 | 10255 | 1769 | 11888 | 1488 | 12765 | 1267 | 13655 | 933 | 16319 | 811 | 7077 |
| 2L-3S | | MI | 4499 | 2134 | 6702 | 1712 | 7498 | 1438 | 7843 | 1233 | 8036 | 905 | 9153 | 640 | 4710 |
| 6-#11 | 1.33 | MA | 6659 | 2134 | 9515 | 1783 | 10946 | 1501 | 11620 | 1278 | 12106 | 952 | 14174 | 706 | 7089 |
| 3L-2S | | MI | 4732 | 2134 | 7164 | 1702 | 8086 | 1431 | 8557 | 1217 | 9003 | 893 | 10427 | 752 | 4682 |
| 6-#14 | 1.92 | MA | 7472 | 2252 | 11249 | 1835 | 13113 | 1535 | 14232 | 1295 | 15625 | 921 | 19035 | 797 | 9996 |
| 2L-3S | | MI | 4655 | 2252 | 7127 | 1778 | 8002 | 1485 | 8437 | 1264 | 8827 | 894 | 10120 | 553 | 6538 |
| 6-#14 | 1.92 | MA | 6940 | 2252 | 10193 | 1855 | 11768 | 1553 | 12599 | 1310 | 13414 | 947 | 15974 | 644 | 9969 |
| 3L-2S | | MI | 4973 | 2252 | 7781 | 1765 | 8835 | 1475 | 9450 | 1242 | 10197 | 879 | 11893 | 715 | 6514 |

## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis



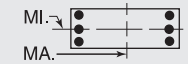

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 3.41 | MA | 8470 | 2552 | 13681 | 2007 | 16131 | 1658 | 17858 | 1368 | 20501 | 895 | 25763 | 765 | 17162 |
| 2L-3S | | MI | 5025 | 2552 | 8137 | 1949 | 9218 | 1605 | 9881 | 1344 | 10756 | 869 | 12369 | 313 | 10831 |
| 6-#18 | 3.41 | MA | 7618 | 2552 | 11844 | 2040 | 13791 | 1686 | 15017 | 1392 | 16656 | 937 | 20439 | 484 | 16913 |
| 3L-2S | | MI | 5535 | 2552 | 9261 | 1930 | 10649 | 1592 | 11619 | 1311 | 13107 | 849 | 15300 | 601 | 10919 |
| 8-#9 | 1.14 | MA | 6930 | 2095 | 9882 | 1760 | 11491 | 1483 | 12320 | 1267 | 13084 | 944 | 15552 | 821 | 6147 |
| 2L-4S | | MI | 4432 | 2095 | 6408 | 1713 | 7166 | 1450 | 7470 | 1238 | 7552 | 919 | 8666 | 670 | 4126 |
| 8-#9 | 1.14 | MA | 6672 | 2095 | 9398 | 1769 | 10875 | 1492 | 11572 | 1275 | 12071 | 957 | 14150 | 756 | 6157 |
| 3E | | MI | 4516 | 2095 | 6620 | 1706 | 7463 | 1437 | 7835 | 1233 | 8051 | 917 | 9277 | 711 | 4108 |
| 8-#9 | 1.14 | MA | 6538 | 2095 | 9071 | 1779 | 10412 | 1507 | 11003 | 1290 | 11293 | 963 | 13210 | 717 | 6153 |
| 4L-2S | | MI | 4673 | 2095 | 6925 | 1699 | 7852 | 1431 | 8307 | 1222 | 8691 | 908 | 10148 | 783 | 4092 |
| 8-#10 | 1.44 | MA | 7167 | 2157 | 10416 | 1794 | 12149 | 1508 | 13110 | 1282 | 14144 | 938 | 17014 | 814 | 7714 |
| 2L-4S | | MI | 4514 | 2157 | 6611 | 1750 | 7398 | 1477 | 7742 | 1255 | 7911 | 914 | 9146 | 626 | 5121 |
| 8-#10 | 1.44 | MA | 6848 | 2157 | 9804 | 1806 | 11371 | 1518 | 12164 | 1292 | 12865 | 954 | 15242 | 731 | 7718 |
| 3E | | MI | 4617 | 2157 | 6878 | 1741 | 7773 | 1462 | 8202 | 1249 | 8541 | 912 | 9911 | 677 | 5109 |
| 8-#10 | 1.44 | MA | 6683 | 2157 | 9390 | 1818 | 10786 | 1538 | 11446 | 1310 | 11880 | 962 | 14051 | 681 | 7685 |
| 4L-2S | | MI | 4811 | 2157 | 7263 | 1732 | 8263 | 1454 | 8797 | 1235 | 9346 | 901 | 10998 | 769 | 5091 |
| 8-#11 | 1.77 | MA | 7390 | 2223 | 10995 | 1825 | 12831 | 1529 | 13909 | 1292 | 15204 | 928 | 18463 | 803 | 9326 |
| 2L-4S | | MI | 4585 | 2223 | 6842 | 1777 | 7633 | 1497 | 8002 | 1264 | 8244 | 901 | 9525 | 565 | 6121 |
| 8-#11 | 1.77 | MA | 7014 | 2223 | 10255 | 1839 | 11888 | 1541 | 12765 | 1304 | 13655 | 946 | 16319 | 699 | 9321 |
| 3E | | MI | 4707 | 2223 | 7164 | 1768 | 8086 | 1479 | 8557 | 1258 | 9003 | 900 | 10427 | 625 | 6123 |
| 8-#11 | 1.77 | MA | 6820 | 2223 | 9752 | 1853 | 11177 | 1564 | 11892 | 1325 | 12459 | 955 | 14863 | 636 | 9249 |
| 4L-2S | | MI | 4933 | 2223 | 7626 | 1758 | 8674 | 1471 | 9271 | 1242 | 9969 | 888 | 11700 | 737 | 6103 |
| 8-#14 | 2.56 | MA | 7944 | 2381 | 12305 | 1916 | 14458 | 1594 | 15865 | 1331 | 17835 | 914 | 22095 | 787 | 13192 |
| 2L-4S | | MI | 4777 | 2381 | 7323 | 1871 | 8191 | 1568 | 8661 | 1307 | 9118 | 887 | 10633 | 443 | 8299 |
| 8-#14 | 2.56 | MA | 7435 | 2381 | 11249 | 1935 | 13113 | 1611 | 14232 | 1347 | 15625 | 940 | 19035 | 634 | 13135 |
| 3E | | MI | 4944 | 2381 | 7781 | 1858 | 8835 | 1543 | 9450 | 1300 | 10197 | 887 | 11893 | 528 | 8513 |
| 8-#14 | 2.56 | MA | 7172 | 2381 | 10528 | 1955 | 12096 | 1643 | 12985 | 1377 | 13916 | 951 | 16943 | 542 | 12810 |
| 4L-2S | | MI | 5250 | 2381 | 8436 | 1845 | 9669 | 1533 | 10462 | 1279 | 11567 | 872 | 13667 | 689 | 8513 |
| 8-#18 | 4.55 | MA | 8449 | 2781 | 13681 | 2183 | 16131 | 1790 | 17858 | 1457 | 20501 | 924 | 25763 | 466 | 22392 |
| 3E | | MI | 5506 | 2781 | 9261 | 2092 | 10649 | 1709 | 11619 | 1408 | 13107 | 856 | 15300 | 253 | 14162 |
| 8-#18 | 4.55 | MA | 8036 | 2781 | 12421 | 2215 | 14354 | 1845 | 15679 | 1508 | 17517 | 939 | 22073 | 300 | 19991 |
| 4L-2S | | MI | 5988 | 2781 | 10385 | 2072 | 12079 | 1696 | 13356 | 1375 | 15459 | 836 | 18231 | 541 | 14309 |
| 10-#10 | 1.80 | MA | 7451 | 2230 | 11027 | 1840 | 12928 | 1541 | 14055 | 1302 | 15424 | 934 | 18786 | 808 | 9569 |
| 2L-5S | | MI | 4567 | 2230 | 6723 | 1812 | 7559 | 1517 | 7928 | 1290 | 8149 | 921 | 9470 | 564 | 6184 |
| 10-#10 | 1.80 | MA | 7141 | 2230 | 10416 | 1852 | 12149 | 1551 | 13110 | 1312 | 14144 | 950 | 17014 | 725 | 9561 |
| 3L-4S | | MI | 4692 | 2230 | 6996 | 1795 | 7888 | 1510 | 8337 | 1276 | 8717 | 910 | 10233 | 617 | 6281 |
| 10-#10 | 1.80 | MA | 6985 | 2230 | 10001 | 1864 | 11564 | 1571 | 12391 | 1330 | 13160 | 958 | 15823 | 675 | 9516 |
| 4L-3S | | MI | 4791 | 2230 | 7263 | 1786 | 8263 | 1495 | 8797 | 1270 | 9346 | 908 | 10998 | 668 | 6282 |
| 10-#10 | 1.80 | MA | 6752 | 2230 | 9580 | 1884 | 11055 | 1582 | 11758 | 1340 | 12277 | 974 | 14615 | 632 | 9309 |
| 5L-2S | | MI | 4980 | 2230 | 7648 | 1777 | 8753 | 1487 | 9392 | 1256 | 10152 | 897 | 12085 | 760 | 6270 |
| 10-#11 | 2.22 | MA | 7726 | 2312 | 11735 | 1881 | 13773 | 1569 | 15054 | 1318 | 16753 | 922 | 20608 | 796 | 11568 |
| 2L-5S | | MI | 4652 | 2312 | 6974 | 1853 | 7824 | 1545 | 8223 | 1305 | 8525 | 907 | 9905 | 485 | 7222 |
| 10-#11 | 2.22 | MA | 7362 | 2312 | 10995 | 1895 | 12831 | 1582 | 13909 | 1329 | 15204 | 941 | 18463 | 692 | 11547 |
| 3L-4S | | MI | 4795 | 2312 | 7304 | 1833 | 8221 | 1537 | 8717 | 1289 | 9210 | 896 | 10799 | 550 | 7505 |
| 10-#11 | 2.22 | MA | 7180 | 2312 | 10492 | 1909 | 12120 | 1605 | 13037 | 1351 | 14008 | 950 | 17008 | 629 | 11459 |
| 4L-3S | | MI | 4911 | 2312 | 7626 | 1823 | 8674 | 1519 | 9271 | 1284 | 9969 | 894 | 11700 | 610 | 7525 |
| 10-#11 | 2.22 | MA | 6906 | 2312 | 9979 | 1933 | 11501 | 1617 | 12267 | 1362 | 12936 | 968 | 15535 | 574 | 10953 |
| 5L-2S | | MI | 5131 | 2312 | 8088 | 1813 | 9262 | 1512 | 9985 | 1268 | 10935 | 883 | 12974 | 722 | 7515 |
| 10-#14 | 3.20 | MA | 7919 | 2509 | 12305 | 2016 | 14458 | 1669 | 15865 | 1383 | 17835 | 932 | 22095 | 623 | 16298 |
| 3L-4S | | MI | 5071 | 2509 | 7977 | 1952 | 9025 | 1626 | 9673 | 1343 | 10488 | 880 | 12407 | 418 | 10144 |
| 10-#14 | 3.20 | MA | 7677 | 2509 | 11585 | 2035 | 13441 | 1702 | 14618 | 1413 | 16126 | 943 | 20003 | 532 | 15875 |
| 4L-3S | | MI | 5227 | 2509 | 8436 | 1938 | 9669 | 1601 | 10462 | 1337 | 11567 | 880 | 13667 | 502 | 10476 |
| 10-#14 | 3.20 | MA | 7294 | 2509 | 10850 | 2070 | 12556 | 1719 | 13516 | 1429 | 14592 | 969 | 17892 | 450 | 14785 |
| 5L-2S | | MI | 5524 | 2509 | 9090 | 1925 | 10502 | 1592 | 11474 | 1315 | 12937 | 865 | 15440 | 664 | 10501 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

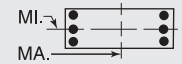


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 5.68 | MA | 8889 | 3009 | 14258 | 2358 | 16693 | 1949 | 18520 | 1572 | 21362 | 926 | 27397 | 282 | 25395 |
| 4L-3S | | MI | 6005 | 3009 | 10385 | 2235 | 12079 | 1812 | 13356 | 1473 | 15459 | 842 | 18231 | 194 | 17489 |
| 10-#18 | 5.68 | MA | 8250 | 3009 | 12971 | 2417 | 15142 | 1977 | 16592 | 1596 | 18678 | 968 | 23689 | 125 | 23143 |
| 5L-2S | | MI | 6426 | 3009 | 11508 | 2215 | 13510 | 1799 | 15094 | 1440 | 17810 | 822 | 21163 | 481 | 17684 |
| 12-#10 | 2.16 | MA | 7730 | 2302 | 11639 | 1885 | 13706 | 1573 | 15000 | 1323 | 16703 | 929 | 20557 | 803 | 11418 |
| 2L-6S | | MI | 4613 | 2302 | 6870 | 1865 | 7724 | 1566 | 8121 | 1316 | 8411 | 928 | 9858 | 497 | 7080 |
| 12-#10 | 2.16 | MA | 7429 | 2302 | 11027 | 1897 | 12928 | 1584 | 14055 | 1333 | 15424 | 946 | 18786 | 720 | 11402 |
| 3L-5S | | MI | 4744 | 2302 | 7108 | 1857 | 8049 | 1550 | 8523 | 1310 | 8954 | 917 | 10557 | 555 | 7289 |
| 12-#10 | 2.16 | MA | 7281 | 2302 | 10613 | 1909 | 12342 | 1604 | 13337 | 1351 | 14439 | 953 | 17595 | 669 | 11346 |
| 4E | | MI | 4868 | 2302 | 7381 | 1840 | 8378 | 1543 | 8932 | 1296 | 9522 | 906 | 11320 | 608 | 7437 |
| 12-#10 | 2.16 | MA | 7050 | 2302 | 10191 | 1929 | 11834 | 1615 | 12703 | 1361 | 13557 | 969 | 16386 | 626 | 11098 |
| 5L-3S | | MI | 4963 | 2302 | 7648 | 1831 | 8753 | 1527 | 9392 | 1290 | 10152 | 903 | 12085 | 659 | 7449 |
| 12-#10 | 2.16 | MA | 6839 | 2302 | 9785 | 1935 | 11356 | 1626 | 12081 | 1379 | 12715 | 986 | 15207 | 556 | 10663 |
| 6L-2S | | MI | 5147 | 2302 | 8032 | 1823 | 9243 | 1520 | 9987 | 1276 | 10957 | 892 | 13172 | 750 | 7443 |
| 12-#11 | 2.66 | MA | 7704 | 2401 | 11735 | 1950 | 13773 | 1622 | 15054 | 1354 | 16753 | 936 | 20608 | 685 | 13771 |
| 3L-5S | | MI | 4860 | 2401 | 7436 | 1909 | 8412 | 1586 | 8937 | 1330 | 9491 | 902 | 11179 | 470 | 8550 |
| 12-#11 | 2.66 | MA | 7532 | 2401 | 11232 | 1964 | 13062 | 1645 | 14181 | 1376 | 15557 | 945 | 19153 | 622 | 13670 |
| 4E | | MI | 5002 | 2401 | 7766 | 1889 | 8809 | 1578 | 9431 | 1314 | 10177 | 890 | 12073 | 535 | 8884 |
| 12-#11 | 2.66 | MA | 7260 | 2401 | 10719 | 1989 | 12444 | 1658 | 13412 | 1387 | 14485 | 963 | 17680 | 567 | 13122 |
| 5L-3S | | MI | 5113 | 2401 | 8088 | 1879 | 9262 | 1560 | 9985 | 1309 | 10935 | 889 | 12974 | 595 | 8918 |
| 12-#11 | 2.66 | MA | 7011 | 2401 | 10233 | 1997 | 11862 | 1670 | 12655 | 1409 | 13462 | 982 | 16238 | 480 | 12636 |
| 6L-2S | | MI | 5327 | 2401 | 8549 | 1869 | 9850 | 1552 | 10699 | 1293 | 11902 | 878 | 14248 | 708 | 8920 |
| 12-#14 | 3.84 | MA | 8169 | 2638 | 12641 | 2116 | 14786 | 1760 | 16251 | 1450 | 18337 | 936 | 23064 | 522 | 18953 |
| 4E | | MI | 5360 | 2638 | 8632 | 2032 | 9858 | 1685 | 10685 | 1380 | 11858 | 872 | 14181 | 392 | 12004 |
| 12-#14 | 3.84 | MA | 7790 | 2638 | 11906 | 2150 | 13900 | 1778 | 15150 | 1465 | 16802 | 962 | 20953 | 439 | 17907 |
| 5L-3S | | MI | 5507 | 2638 | 9090 | 2019 | 10502 | 1660 | 11474 | 1373 | 12937 | 872 | 15440 | 477 | 12435 |
| 12-#14 | 3.84 | MA | 7449 | 2638 | 11219 | 2162 | 13067 | 1795 | 14067 | 1495 | 15338 | 988 | 18880 | 313 | 16819 |
| 6L-2S | | MI | 5794 | 2638 | 9745 | 2006 | 11336 | 1650 | 12487 | 1352 | 14308 | 857 | 17214 | 638 | 12477 |
| 12-#18 | 6.82 | MA | 9085 | 3237 | 14809 | 2559 | 17482 | 2081 | 19433 | 1661 | 22523 | 955 | 29013 | 107 | 28548 |
| 5L-3S | | MI | 6465 | 3237 | 11508 | 2377 | 13510 | 1916 | 15094 | 1538 | 17810 | 829 | 21163 | 134 | 20618 |
| 14-#10 | 2.53 | MA | 7713 | 2375 | 11639 | 1942 | 13706 | 1617 | 15000 | 1353 | 16703 | 941 | 20557 | 714 | 13241 |
| 3L-6S | | MI | 4790 | 2375 | 7255 | 1911 | 8214 | 1599 | 8716 | 1336 | 9216 | 923 | 10945 | 487 | 8202 |
| 14-#10 | 2.53 | MA | 7572 | 2375 | 11224 | 1954 | 13121 | 1637 | 14282 | 1371 | 15719 | 949 | 19366 | 663 | 13177 |
| 4L-5S | | MI | 4918 | 2375 | 7493 | 1903 | 8539 | 1583 | 9118 | 1331 | 9759 | 912 | 11644 | 546 | 8400 |
| 14-#10 | 2.53 | MA | 7342 | 2375 | 10802 | 1975 | 12612 | 1648 | 13649 | 1381 | 14836 | 965 | 18158 | 621 | 12892 |
| 5L-4S | | MI | 5042 | 2375 | 7766 | 1886 | 8868 | 1576 | 9527 | 1317 | 10327 | 902 | 12407 | 599 | 8590 |
| 14-#10 | 2.53 | MA | 7138 | 2375 | 10396 | 1980 | 12134 | 1658 | 13027 | 1400 | 13995 | 981 | 16978 | 550 | 12473 |
| 6L-3S | | MI | 5133 | 2375 | 8032 | 1877 | 9243 | 1560 | 9987 | 1311 | 10957 | 899 | 13172 | 650 | 8611 |
| 14-#10 | 2.53 | MA | 6965 | 2375 | 10008 | 1988 | 11593 | 1673 | 12430 | 1409 | 13136 | 989 | 15835 | 516 | 12048 |
| 7L-2S | | MI | 5313 | 2375 | 8417 | 1868 | 9733 | 1553 | 10582 | 1297 | 11762 | 888 | 14259 | 741 | 8612 |
| 14-#11 | 3.10 | MA | 7878 | 2490 | 11972 | 2020 | 14004 | 1686 | 15326 | 1401 | 17106 | 939 | 21297 | 615 | 15882 |
| 4L-5S | | MI | 5065 | 2490 | 7898 | 1965 | 9000 | 1626 | 9651 | 1356 | 10458 | 897 | 12453 | 455 | 9886 |
| 14-#11 | 3.10 | MA | 7608 | 2490 | 11459 | 2045 | 13386 | 1698 | 14556 | 1412 | 16034 | 958 | 19825 | 560 | 15299 |
| 5L-4S | | MI | 5207 | 2490 | 8227 | 1944 | 9397 | 1618 | 10145 | 1340 | 11143 | 885 | 13347 | 520 | 10262 |
| 14-#11 | 3.10 | MA | 7367 | 2490 | 10973 | 2052 | 12804 | 1711 | 13800 | 1434 | 15011 | 977 | 18383 | 473 | 14831 |
| 6L-3S | | MI | 5313 | 2490 | 8549 | 1935 | 9850 | 1600 | 10699 | 1334 | 11902 | 884 | 14248 | 580 | 10307 |
| 14-#11 | 3.10 | MA | 7162 | 2490 | 10502 | 2061 | 12157 | 1730 | 13073 | 1445 | 13967 | 985 | 16988 | 428 | 14094 |
| 7L-2S | | MI | 5522 | 2490 | 9011 | 1925 | 10438 | 1593 | 11414 | 1318 | 12868 | 872 | 15522 | 693 | 10320 |
| 14-#14 | 4.47 | MA | 8274 | 2766 | 12962 | 2230 | 15245 | 1836 | 16783 | 1502 | 19013 | 954 | 24013 | 429 | 21036 |
| 5L-4S | | MI | 5644 | 2766 | 9287 | 2112 | 10692 | 1743 | 11698 | 1416 | 13229 | 865 | 15954 | 367 | 13878 |
| 14-#14 | 4.47 | MA | 7949 | 2766 | 12275 | 2242 | 14412 | 1853 | 15700 | 1532 | 17548 | 980 | 21940 | 303 | 19942 |
| 6L-3S | | MI | 5784 | 2766 | 9745 | 2099 | 11336 | 1718 | 12487 | 1410 | 14308 | 865 | 17214 | 451 | 14391 |
| 14-#14 | 4.47 | MA | 7670 | 2766 | 11601 | 2254 | 13496 | 1881 | 14659 | 1547 | 16053 | 991 | 19939 | 235 | 18707 |
| 7L-2S | | MI | 6062 | 2766 | 10400 | 2086 | 12169 | 1708 | 13499 | 1388 | 15678 | 850 | 18988 | 613 | 14449 |
| 16-#10 | 2.89 | MA | 7859 | 2447 | 11836 | 2000 | 13899 | 1670 | 15227 | 1392 | 16998 | 945 | 21138 | 657 | 15007 |
| 4L-6S | | MI | 4966 | 2447 | 7640 | 1956 | 8704 | 1632 | 9311 | 1357 | 10021 | 919 | 12032 | 478 | 9328 |
| 16-#10 | 2.89 | MA | 7631 | 2447 | 11414 | 2020 | 13391 | 1680 | 14594 | 1402 | 16116 | 961 | 19929 | 615 | 14690 |
| 5E | | MI | 5091 | 2447 | 7877 | 1948 | 9029 | 1616 | 9713 | 1351 | 10565 | 908 | 12731 | 537 | 9516 |

## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

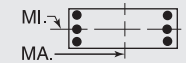
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.89 | MA | 7432 | 2447 | 11008 | 2026 | 12913 | 1691 | 13972 | 1420 | 15274 | 977 | 18750 | 545 | 14286 |
| 6L-4S | | MI | 5213 | 2447 | 8150 | 1931 | 9357 | 1609 | 10122 | 1337 | 11133 | 897 | 13494 | 590 | 9742 |
| 16-#10 | 2.89 | MA | 7265 | 2447 | 10620 | 2033 | 12371 | 1706 | 13375 | 1430 | 14415 | 985 | 17607 | 510 | 13854 |
| 7L-3S | | MI | 5301 | 2447 | 8417 | 1922 | 9733 | 1593 | 10582 | 1332 | 11762 | 895 | 14259 | 641 | 9770 |
| 16-#10 | 2.89 | MA | 7069 | 2447 | 10247 | 2042 | 11868 | 1713 | 12748 | 1445 | 13595 | 1001 | 16507 | 462 | 13319 |
| 8L-2S | | MI | 5477 | 2447 | 8802 | 1913 | 10223 | 1586 | 11177 | 1317 | 12567 | 884 | 15346 | 732 | 9778 |
| 16-#11 | 3.55 | MA | 7950 | 2580 | 12199 | 2100 | 14328 | 1739 | 15701 | 1438 | 17583 | 953 | 21970 | 553 | 17480 |
| 5E | | MI | 5268 | 2580 | 8359 | 2020 | 9588 | 1666 | 10365 | 1381 | 11424 | 892 | 13727 | 440 | 11226 |
| 16-#11 | 3.55 | MA | 7717 | 2580 | 11713 | 2108 | 13747 | 1751 | 14944 | 1459 | 16560 | 972 | 20527 | 466 | 17030 |
| 6L-4S | | MI | 5409 | 2580 | 8689 | 2000 | 9985 | 1659 | 10859 | 1365 | 12110 | 880 | 14620 | 505 | 11605 |
| 16-#11 | 3.55 | MA | 7521 | 2580 | 11242 | 2117 | 13099 | 1770 | 14218 | 1470 | 15516 | 980 | 19133 | 420 | 16285 |
| 7L-3S | | MI | 5510 | 2580 | 9011 | 1990 | 10438 | 1641 | 11414 | 1359 | 12868 | 879 | 15522 | 566 | 11693 |
| 16-#11 | 3.55 | MA | 7289 | 2580 | 10790 | 2127 | 12488 | 1778 | 13469 | 1490 | 14518 | 999 | 17791 | 358 | 15536 |
| 8L-2S | | MI | 5714 | 2580 | 9473 | 1980 | 11026 | 1633 | 12128 | 1343 | 13835 | 867 | 16796 | 678 | 11714 |
| 16-#14 | 5.11 | MA | 8438 | 2895 | 13331 | 2322 | 15756 | 1912 | 17333 | 1568 | 19759 | 973 | 25001 | 293 | 23070 |
| 6L-4S | | MI | 5925 | 2895 | 9941 | 2192 | 11525 | 1801 | 12710 | 1453 | 14599 | 857 | 17728 | 341 | 15761 |
| 16-#14 | 5.11 | MA | 8174 | 2895 | 12657 | 2334 | 14841 | 1939 | 16293 | 1584 | 18264 | 984 | 22999 | 224 | 21822 |
| 7L-3S | | MI | 6057 | 2895 | 10400 | 2179 | 12169 | 1776 | 13499 | 1446 | 15678 | 857 | 18988 | 426 | 16346 |
| 18-#10 | 3.25 | MA | 7915 | 2520 | 12025 | 2065 | 14169 | 1713 | 15540 | 1422 | 17395 | 957 | 21701 | 609 | 16493 |
| 5L-6S | | MI | 5139 | 2520 | 8024 | 2001 | 9194 | 1665 | 9906 | 1377 | 10827 | 915 | 13119 | 469 | 10456 |
| 18-#10 | 3.25 | MA | 7722 | 2520 | 11619 | 2071 | 13691 | 1724 | 14918 | 1441 | 16554 | 973 | 20521 | 539 | 16102 |
| 6L-5S | | MI | 5261 | 2520 | 8262 | 1993 | 9519 | 1649 | 10309 | 1372 | 11370 | 904 | 13818 | 528 | 10636 |
| 18-#10 | 3.25 | MA | 7561 | 2520 | 11231 | 2079 | 13149 | 1739 | 14320 | 1451 | 15695 | 981 | 19379 | 504 | 15663 |
| 7L-4S | | MI | 5383 | 2520 | 8535 | 1976 | 9847 | 1642 | 10717 | 1358 | 11938 | 893 | 14581 | 581 | 10892 |
| 18-#10 | 3.25 | MA | 7366 | 2520 | 10859 | 2088 | 12646 | 1746 | 13693 | 1466 | 14875 | 997 | 18279 | 456 | 15140 |
| 8L-3S | | MI | 5468 | 2520 | 8802 | 1967 | 10223 | 1626 | 11177 | 1352 | 12567 | 891 | 15346 | 632 | 10926 |
| 18-#10 | 3.25 | MA | 7168 | 2520 | 10441 | 2106 | 12130 | 1763 | 13073 | 1473 | 14036 | 1005 | 17194 | 411 | 14477 |
| 9L-2S | | MI | 5640 | 2520 | 9187 | 1959 | 10713 | 1619 | 11772 | 1338 | 13373 | 880 | 16433 | 723 | 10940 |
| 18-#11 | 3.99 | MA | 8061 | 2669 | 12453 | 2164 | 14689 | 1792 | 16089 | 1484 | 18109 | 967 | 22672 | 458 | 19231 |
| 6L-5S | | MI | 5468 | 2669 | 8821 | 2076 | 10176 | 1707 | 11080 | 1406 | 12391 | 887 | 15000 | 425 | 12572 |
| 18-#11 | 3.99 | MA | 7873 | 2669 | 11982 | 2172 | 14041 | 1810 | 15362 | 1496 | 17065 | 975 | 21278 | 413 | 18479 |
| 7L-4S | | MI | 5609 | 2669 | 9151 | 2056 | 10573 | 1699 | 11573 | 1390 | 13076 | 875 | 15894 | 490 | 12932 |
| 18-#11 | 3.99 | MA | 7643 | 2669 | 11530 | 2183 | 13430 | 1819 | 14613 | 1515 | 16067 | 994 | 19936 | 351 | 17730 |
| 8L-3S | | MI | 5706 | 2669 | 9473 | 2046 | 11026 | 1681 | 12128 | 1385 | 13835 | 874 | 16796 | 551 | 13078 |
| 18-#14 | 5.75 | MA | 8669 | 3023 | 13713 | 2414 | 16185 | 1997 | 17926 | 1620 | 20474 | 977 | 26060 | 214 | 24937 |
| 7L-4S | | MI | 6203 | 3023 | 10596 | 2273 | 12359 | 1860 | 13723 | 1489 | 15969 | 850 | 19502 | 316 | 17654 |
| 20-#10 | 3.61 | MA | 8008 | 2592 | 12230 | 2116 | 14469 | 1757 | 15863 | 1461 | 17833 | 969 | 22293 | 533 | 17920 |
| 6E | | MI | 5310 | 2592 | 8409 | 2047 | 9684 | 1698 | 10501 | 1398 | 11632 | 911 | 14206 | 460 | 11587 |
| 20-#10 | 3.61 | MA | 7852 | 2592 | 11842 | 2124 | 13928 | 1772 | 15266 | 1471 | 16974 | 977 | 21150 | 498 | 17473 |
| 7L-5S | | MI | 5429 | 2592 | 8647 | 2039 | 10008 | 1682 | 10904 | 1392 | 12175 | 900 | 14905 | 519 | 11759 |
| 20-#10 | 3.61 | MA | 7659 | 2592 | 11470 | 2133 | 13425 | 1779 | 14639 | 1486 | 16154 | 993 | 20051 | 450 | 16962 |
| 8L-4S | | MI | 5551 | 2592 | 8920 | 2021 | 10337 | 1675 | 11312 | 1378 | 12743 | 889 | 15668 | 572 | 12042 |
| 20-#10 | 3.61 | MA | 7467 | 2592 | 11053 | 2151 | 12908 | 1796 | 14019 | 1493 | 15315 | 1000 | 18965 | 405 | 16294 |
| 9L-3S | | MI | 5633 | 2592 | 9187 | 2013 | 10713 | 1659 | 11772 | 1373 | 13373 | 886 | 16433 | 623 | 12082 |
| 20-#11 | 4.43 | MA | 8220 | 2758 | 12722 | 2228 | 14983 | 1851 | 16507 | 1521 | 18614 | 970 | 23422 | 406 | 20675 |
| 7L-5S | | MI | 5667 | 2758 | 9283 | 2132 | 10764 | 1747 | 11794 | 1431 | 13357 | 881 | 16274 | 410 | 13921 |
| 20-#11 | 4.43 | MA | 7992 | 2758 | 12270 | 2238 | 14373 | 1859 | 15758 | 1540 | 17616 | 989 | 22081 | 344 | 19923 |
| 8L-4S | | MI | 5807 | 2758 | 9613 | 2111 | 11161 | 1740 | 12287 | 1415 | 14042 | 870 | 17168 | 476 | 14264 |
| 22-#10 | 3.97 | MA | 8140 | 2665 | 12454 | 2169 | 14706 | 1805 | 16211 | 1492 | 18254 | 972 | 22922 | 493 | 19286 |
| 7L-6S | | MI | 5480 | 2665 | 8794 | 2092 | 10174 | 1731 | 11096 | 1419 | 12437 | 906 | 15293 | 451 | 12719 |
| 22-#10 | 3.97 | MA | 7948 | 2665 | 12081 | 2178 | 14203 | 1812 | 15584 | 1507 | 17434 | 989 | 21822 | 444 | 18786 |
| 8L-5S | | MI | 5597 | 2665 | 9032 | 2084 | 10498 | 1715 | 11499 | 1413 | 12980 | 896 | 15993 | 510 | 12885 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

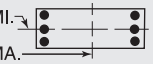
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 3.97 | MA | 7761 | 2665 | 11664 | 2196 | 13686 | 1829 | 14964 | 1514 | 16595 | 996 | 20737 | 400 | 18111 |
| 9L-4S | | MI | 5718 | 2665 | 9305 | 2067 | 10827 | 1708 | 11907 | 1399 | 13548 | 885 | 16755 | 562 | 13191 |
| 22-#11 | 4.88 | MA | 8336 | 2847 | 13010 | 2294 | 15315 | 1900 | 16902 | 1566 | 19165 | 983 | 24226 | 337 | 22116 |
| 8L-5S | | MI | 5864 | 2847 | 9745 | 2187 | 11352 | 1788 | 12508 | 1457 | 14323 | 876 | 17548 | 395 | 15273 |
| 24-#10 | 4.33 | MA | 8233 | 2737 | 12693 | 2224 | 14982 | 1845 | 16529 | 1528 | 18713 | 984 | 23594 | 438 | 20611 |
| 8L-6S | | MI | 5648 | 2737 | 9179 | 2137 | 10664 | 1764 | 11691 | 1439 | 13243 | 902 | 16380 | 442 | 13853 |
| 24-#10 | 4.33 | MA | 8051 | 2737 | 12275 | 2242 | 14465 | 1862 | 15909 | 1534 | 17874 | 992 | 22508 | 394 | 19928 |
| 9L-5S | | MI | 5762 | 2737 | 9417 | 2129 | 10988 | 1748 | 12094 | 1433 | 13786 | 891 | 17080 | 501 | 14013 |

## RECTANGULAR TIED COLUMNS 22" x 34"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.20 | MA | 7849 | 2241 | 11334 | 1865 | 13119 | 1570 | 14048 | 1340 | 14928 | 994 | 17751 | 864 | 7269 |
| 2E | | MI | 4949 | 2241 | 7490 | 1780 | 8398 | 1498 | 8838 | 1277 | 9207 | 943 | 10530 | 790 | 4521 |
| 4-#18 | 2.14 | MA | 8598 | 2440 | 13118 | 1974 | 15305 | 1648 | 16661 | 1385 | 18430 | 973 | 22574 | 840 | 12478 |
| 2E | | MI | 5330 | 2440 | 8506 | 1881 | 9615 | 1568 | 10281 | 1316 | 11134 | 918 | 12776 | 709 | 7535 |
| 6-#10 | 1.02 | MA | 7725 | 2201 | 10912 | 1858 | 12686 | 1568 | 13573 | 1342 | 14328 | 1007 | 16952 | 877 | 6264 |
| 2L-3S | | MI | 4697 | 2201 | 6851 | 1792 | 7677 | 1511 | 8008 | 1301 | 8119 | 973 | 9240 | 737 | 3947 |
| 6-#10 | 1.02 | MA | 7368 | 2201 | 10255 | 1871 | 11850 | 1579 | 12558 | 1353 | 12954 | 1024 | 15049 | 795 | 6279 |
| 3L-2S | | MI | 4897 | 2201 | 7236 | 1783 | 8167 | 1504 | 8603 | 1287 | 8924 | 962 | 10327 | 828 | 3924 |
| 6-#11 | 1.25 | MA | 7912 | 2251 | 11399 | 1879 | 13246 | 1581 | 14223 | 1349 | 15182 | 998 | 18116 | 867 | 7582 |
| 2L-3S | | MI | 4756 | 2251 | 7063 | 1808 | 7893 | 1520 | 8244 | 1304 | 8418 | 961 | 9566 | 690 | 4735 |
| 6-#11 | 1.25 | MA | 7490 | 2251 | 10603 | 1893 | 12232 | 1595 | 12992 | 1361 | 13517 | 1017 | 15810 | 765 | 7594 |
| 3L-2S | | MI | 4989 | 2251 | 7525 | 1798 | 8481 | 1513 | 8958 | 1289 | 9384 | 950 | 10839 | 802 | 4706 |
| 6-#14 | 1.80 | MA | 8376 | 2369 | 12470 | 1945 | 14566 | 1628 | 15805 | 1376 | 17307 | 986 | 21044 | 854 | 10725 |
| 2L-3S | | MI | 4911 | 2369 | 7490 | 1873 | 8398 | 1566 | 8838 | 1335 | 9207 | 951 | 10530 | 602 | 6574 |
| 6-#14 | 1.80 | MA | 7796 | 2369 | 11334 | 1965 | 13119 | 1647 | 14048 | 1393 | 14928 | 1013 | 17751 | 704 | 10698 |
| 3L-2S | | MI | 5232 | 2369 | 8145 | 1860 | 9231 | 1556 | 9850 | 1313 | 10578 | 936 | 12304 | 764 | 6545 |
| 6-#18 | 3.21 | MA | 9467 | 2669 | 15098 | 2117 | 17826 | 1751 | 19723 | 1450 | 22574 | 960 | 28312 | 822 | 18458 |
| 2L-3S | | MI | 5281 | 2669 | 8506 | 2043 | 9615 | 1685 | 10281 | 1413 | 11134 | 924 | 12776 | 362 | 10896 |
| 6-#18 | 3.21 | MA | 8537 | 2669 | 13118 | 2151 | 15305 | 1782 | 16661 | 1476 | 18430 | 1004 | 22574 | 547 | 18209 |
| 3L-2S | | MI | 5795 | 2669 | 9629 | 2023 | 11046 | 1672 | 12019 | 1380 | 13486 | 904 | 15707 | 649 | 10962 |
| 8-#9 | 1.07 | MA | 7782 | 2212 | 10994 | 1869 | 12814 | 1576 | 13739 | 1348 | 14562 | 1008 | 17283 | 878 | 6579 |
| 2L-4S | | MI | 4689 | 2212 | 6765 | 1811 | 7559 | 1533 | 7871 | 1310 | 7935 | 977 | 9082 | 721 | 4147 |
| 8-#9 | 1.07 | MA | 7501 | 2212 | 10475 | 1879 | 12152 | 1585 | 12936 | 1357 | 13475 | 1022 | 15777 | 814 | 6589 |
| 3E | | MI | 4773 | 2212 | 6976 | 1803 | 7857 | 1520 | 8236 | 1306 | 8434 | 974 | 9694 | 761 | 4128 |
| 8-#9 | 1.07 | MA | 7357 | 2212 | 10124 | 1889 | 11656 | 1601 | 12327 | 1372 | 12640 | 1029 | 14775 | 775 | 6585 |
| 4L-2S | | MI | 4930 | 2212 | 7282 | 1796 | 8246 | 1514 | 8708 | 1294 | 9074 | 965 | 10564 | 833 | 4111 |
| 8-#10 | 1.36 | MA | 8039 | 2274 | 11568 | 1904 | 13522 | 1601 | 14589 | 1363 | 15703 | 1003 | 18855 | 871 | 8262 |
| 2L-4S | | MI | 4770 | 2274 | 6969 | 1846 | 7792 | 1560 | 8143 | 1327 | 8294 | 972 | 9561 | 677 | 5148 |
| 8-#10 | 1.36 | MA | 7693 | 2274 | 10912 | 1916 | 12686 | 1612 | 13573 | 1373 | 14328 | 1019 | 16952 | 789 | 8266 |
| 3E | | MI | 4874 | 2274 | 7236 | 1838 | 8167 | 1544 | 8603 | 1321 | 8924 | 969 | 10327 | 728 | 5133 |
| 8-#10 | 1.36 | MA | 7515 | 2274 | 10468 | 1928 | 12059 | 1632 | 12803 | 1392 | 13273 | 1028 | 15682 | 739 | 8234 |
| 4L-2S | | MI | 5069 | 2274 | 7621 | 1829 | 8657 | 1537 | 9198 | 1307 | 9729 | 958 | 11414 | 819 | 5114 |
| 8-#11 | 1.67 | MA | 8284 | 2340 | 12194 | 1934 | 14259 | 1622 | 15453 | 1374 | 16848 | 992 | 20422 | 860 | 10000 |
| 2L-4S | | MI | 4841 | 2340 | 7203 | 1873 | 8028 | 1579 | 8403 | 1335 | 8625 | 958 | 9938 | 615 | 6159 |
| 8-#11 | 1.67 | MA | 7876 | 2340 | 11399 | 1949 | 13246 | 1635 | 14223 | 1386 | 15182 | 1012 | 18116 | 758 | 9995 |
| 3E | | MI | 4964 | 2340 | 7525 | 1864 | 8481 | 1561 | 8958 | 1330 | 9384 | 956 | 10839 | 675 | 6152 |
| 8-#11 | 1.67 | MA | 7665 | 2340 | 10859 | 1964 | 12483 | 1659 | 13287 | 1408 | 13900 | 1021 | 16563 | 696 | 9923 |
| 4L-2S | | MI | 5191 | 2340 | 7987 | 1854 | 9069 | 1553 | 9672 | 1314 | 10350 | 945 | 12113 | 787 | 6131 |
| 8-#14 | 2.41 | MA | 8890 | 2498 | 13607 | 2025 | 16013 | 1687 | 17563 | 1413 | 19685 | 979 | 24338 | 843 | 14164 |
| 2L-4S | | MI | 5033 | 2498 | 7686 | 1966 | 8587 | 1649 | 9061 | 1378 | 9499 | 943 | 11044 | 493 | 8428 |
| 8-#14 | 2.41 | MA | 8335 | 2498 | 12470 | 2046 | 14566 | 1705 | 15805 | 1429 | 17307 | 1006 | 21044 | 693 | 14107 |
| 3E | | MI | 5201 | 2498 | 8145 | 1953 | 9231 | 1624 | 9850 | 1371 | 10578 | 943 | 12304 | 577 | 8554 |
| 8-#14 | 2.41 | MA | 8050 | 2498 | 11697 | 2066 | 13475 | 1739 | 14467 | 1460 | 15472 | 1018 | 18812 | 603 | 13854 |
| 4L-2S | | MI | 5510 | 2498 | 8799 | 1940 | 10065 | 1614 | 10863 | 1350 | 11948 | 928 | 14078 | 739 | 8547 |
| 8-#18 | 4.28 | MA | 9442 | 2897 | 15098 | 2294 | 17826 | 1885 | 19723 | 1541 | 22574 | 991 | 28312 | 528 | 24120 |
| 3E | | MI | 5763 | 2897 | 9629 | 2186 | 11046 | 1789 | 12019 | 1478 | 13486 | 911 | 15707 | 302 | 14232 |

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

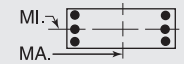
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 4.28 | MA | 8993 | 2897 | 13744 | 2328 | 15917 | 1942 | 17381 | 1593 | 19366 | 1009 | 24372 | 365 | 21710 |
| 4L-2S | | MI | 6251 | 2897 | 10753 | 2166 | 12476 | 1776 | 13756 | 1445 | 15837 | 891 | 18638 | 590 | 14358 |
| 10-#10 | 1.70 | MA | 8348 | 2346 | 12225 | 1949 | 14358 | 1634 | 15605 | 1384 | 17077 | 998 | 20758 | 865 | 10254 |
| 2L-5S | | MI | 4824 | 2346 | 7081 | 1909 | 7953 | 1600 | 8329 | 1362 | 8532 | 978 | 9886 | 615 | 6263 |
| 10-#10 | 1.70 | MA | 8011 | 2346 | 11568 | 1961 | 13522 | 1645 | 14589 | 1394 | 15703 | 1015 | 18855 | 784 | 10247 |
| 3L-4S | | MI | 4949 | 2346 | 7354 | 1892 | 8282 | 1593 | 8738 | 1348 | 9100 | 967 | 10648 | 668 | 6313 |
| 10-#10 | 1.70 | MA | 7842 | 2346 | 11124 | 1974 | 12895 | 1665 | 13819 | 1413 | 14647 | 1024 | 17585 | 734 | 10201 |
| 4L-3S | | MI | 5049 | 2346 | 7621 | 1883 | 8657 | 1577 | 9198 | 1342 | 9729 | 965 | 11414 | 719 | 6308 |
| 10-#10 | 1.70 | MA | 7587 | 2346 | 10672 | 1994 | 12350 | 1676 | 13141 | 1423 | 13702 | 1040 | 16294 | 693 | 10048 |
| 5L-2S | | MI | 5239 | 2346 | 8005 | 1874 | 9147 | 1570 | 9793 | 1328 | 10534 | 954 | 12501 | 810 | 6294 |
| 10-#11 | 2.09 | MA | 8649 | 2429 | 12990 | 1990 | 15272 | 1662 | 16684 | 1399 | 18513 | 987 | 22728 | 853 | 12411 |
| 2L-5S | | MI | 4909 | 2429 | 7335 | 1949 | 8219 | 1627 | 8624 | 1376 | 8906 | 964 | 10318 | 534 | 7312 |
| 10-#11 | 2.09 | MA | 8254 | 2429 | 12194 | 2005 | 14259 | 1676 | 15453 | 1411 | 16848 | 1007 | 20422 | 751 | 12389 |
| 3L-4S | | MI | 5051 | 2429 | 7665 | 1929 | 8616 | 1619 | 9117 | 1361 | 9592 | 952 | 11212 | 600 | 7546 |
| 10-#11 | 2.09 | MA | 8055 | 2429 | 11655 | 2019 | 13496 | 1699 | 14518 | 1433 | 15566 | 1016 | 18870 | 688 | 12301 |
| 4L-3S | | MI | 5169 | 2429 | 7987 | 1919 | 9069 | 1601 | 9672 | 1355 | 10350 | 951 | 12113 | 660 | 7557 |
| 10-#11 | 2.09 | MA | 7755 | 2429 | 11105 | 2044 | 12834 | 1712 | 13693 | 1445 | 14416 | 1036 | 17295 | 636 | 11828 |
| 5L-2S | | MI | 5390 | 2429 | 8449 | 1909 | 9657 | 1593 | 10386 | 1339 | 11317 | 939 | 13387 | 772 | 7544 |
| 10-#14 | 3.01 | MA | 8861 | 2626 | 13607 | 2126 | 16013 | 1764 | 17563 | 1466 | 19685 | 999 | 24338 | 683 | 17513 |
| 3L-4S | | MI | 5327 | 2626 | 8341 | 2047 | 9421 | 1707 | 10074 | 1414 | 10869 | 936 | 12818 | 467 | 10268 |
| 10-#14 | 3.01 | MA | 8597 | 2626 | 12834 | 2146 | 14922 | 1797 | 16224 | 1497 | 17851 | 1011 | 22106 | 593 | 17214 |
| 4L-3S | | MI | 5485 | 2626 | 8799 | 2034 | 10065 | 1683 | 10863 | 1408 | 11948 | 936 | 14078 | 552 | 10521 |
| 10-#14 | 3.01 | MA | 8176 | 2626 | 12046 | 2182 | 13973 | 1815 | 15043 | 1513 | 16205 | 1038 | 19846 | 514 | 15977 |
| 5L-2S | | MI | 5784 | 2626 | 9454 | 2021 | 10898 | 1673 | 11875 | 1386 | 13318 | 921 | 15851 | 713 | 10537 |
| 10-#18 | 5.35 | MA | 9921 | 3126 | 15724 | 2470 | 18438 | 2046 | 20443 | 1658 | 23510 | 996 | 30110 | 346 | 27550 |
| 4L-3S | | MI | 6235 | 3126 | 10753 | 2328 | 12476 | 1892 | 13756 | 1543 | 15837 | 898 | 18638 | 243 | 17566 |
| 10-#18 | 5.35 | MA | 9215 | 3126 | 14344 | 2531 | 16774 | 2076 | 18373 | 1684 | 20628 | 1041 | 26138 | 196 | 25207 |
| 5L-2S | | MI | 6692 | 3126 | 11876 | 2309 | 13907 | 1879 | 15494 | 1510 | 18189 | 878 | 21569 | 530 | 17736 |
| 12-#10 | 2.04 | MA | 8652 | 2419 | 12882 | 1994 | 15195 | 1667 | 16620 | 1404 | 18452 | 994 | 22661 | 859 | 12241 |
| 2L-6S | | MI | 4869 | 2419 | 7228 | 1962 | 8118 | 1649 | 8522 | 1388 | 8794 | 985 | 10273 | 547 | 7154 |
| 12-#10 | 2.04 | MA | 8324 | 2419 | 12225 | 2007 | 14358 | 1678 | 15605 | 1414 | 17077 | 1011 | 20758 | 778 | 12225 |
| 3L-5S | | MI | 5001 | 2419 | 7466 | 1954 | 8443 | 1633 | 8925 | 1382 | 9337 | 974 | 10973 | 606 | 7366 |
| 12-#10 | 2.04 | MA | 8163 | 2419 | 11781 | 2019 | 13731 | 1698 | 14835 | 1433 | 16022 | 1019 | 19488 | 728 | 12169 |
| 4E | | MI | 5125 | 2419 | 7739 | 1937 | 8772 | 1626 | 9333 | 1368 | 9905 | 963 | 11735 | 658 | 7471 |
| 12-#10 | 2.04 | MA | 7910 | 2419 | 11329 | 2040 | 13187 | 1709 | 14156 | 1444 | 15077 | 1036 | 18197 | 687 | 11972 |
| 5L-3S | | MI | 5221 | 2419 | 8005 | 1928 | 9147 | 1610 | 9793 | 1362 | 10534 | 961 | 12501 | 709 | 7477 |
| 12-#10 | 2.04 | MA | 7682 | 2419 | 10890 | 2045 | 12674 | 1720 | 13491 | 1462 | 14175 | 1053 | 16936 | 618 | 11482 |
| 6L-2S | | MI | 5407 | 2419 | 8390 | 1919 | 9637 | 1603 | 10388 | 1348 | 11340 | 950 | 13588 | 801 | 7469 |
| 12-#11 | 2.50 | MA | 8625 | 2518 | 12990 | 2060 | 15272 | 1716 | 16684 | 1436 | 18513 | 1002 | 22728 | 743 | 14782 |
| 3L-5S | | MI | 5117 | 2518 | 7797 | 2005 | 8807 | 1667 | 9338 | 1402 | 9873 | 959 | 11592 | 520 | 8639 |
| 12-#11 | 2.50 | MA | 8438 | 2518 | 12450 | 2075 | 14510 | 1740 | 15748 | 1459 | 17231 | 1011 | 21176 | 681 | 14681 |
| 4E | | MI | 5259 | 2518 | 8127 | 1985 | 9204 | 1660 | 9832 | 1386 | 10558 | 947 | 12486 | 585 | 8929 |
| 12-#11 | 2.50 | MA | 8139 | 2518 | 11901 | 2100 | 13847 | 1753 | 14924 | 1471 | 16082 | 1031 | 19601 | 628 | 14165 |
| 5L-3S | | MI | 5371 | 2518 | 8449 | 1975 | 9657 | 1642 | 10386 | 1380 | 11317 | 946 | 13387 | 645 | 8954 |
| 12-#11 | 2.50 | MA | 7869 | 2518 | 11374 | 2107 | 13224 | 1766 | 14113 | 1493 | 14986 | 1050 | 18062 | 542 | 13618 |
| 6L-2S | | MI | 5587 | 2518 | 8911 | 1965 | 10245 | 1634 | 11100 | 1364 | 12283 | 934 | 14661 | 757 | 8951 |
| 12-#14 | 3.61 | MA | 9132 | 2754 | 13970 | 2227 | 16369 | 1855 | 17981 | 1533 | 20229 | 1003 | 25399 | 582 | 20533 |
| 4E | | MI | 5616 | 2754 | 8996 | 2127 | 10254 | 1766 | 11086 | 1451 | 12239 | 929 | 14591 | 442 | 12125 |
| 12-#14 | 3.61 | MA | 8715 | 2754 | 13183 | 2262 | 15420 | 1874 | 16800 | 1550 | 18584 | 1031 | 23140 | 503 | 19342 |
| 5L-3S | | MI | 5766 | 2754 | 9454 | 2114 | 10898 | 1741 | 11875 | 1444 | 13318 | 928 | 15851 | 526 | 12482 |
| 12-#14 | 3.61 | MA | 8345 | 2754 | 12436 | 2273 | 14527 | 1892 | 15640 | 1581 | 17013 | 1058 | 20928 | 378 | 18265 |
| 6L-2S | | MI | 6055 | 2754 | 10109 | 2101 | 11732 | 1731 | 12888 | 1422 | 14688 | 913 | 17625 | 688 | 12517 |
| 12-#18 | 6.42 | MA | 10123 | 3354 | 16324 | 2674 | 19295 | 2179 | 21435 | 1749 | 24772 | 1027 | 31876 | 178 | 31032 |
| 5L-3S | | MI | 6724 | 3354 | 11876 | 2471 | 13907 | 1996 | 15494 | 1608 | 18189 | 885 | 21569 | 183 | 20820 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis

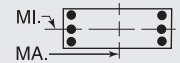



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.38 | MA | 8632 | 2491 | 12882 | 2052 | 15195 | 1711 | 16620 | 1435 | 18452 | 1007 | 22661 | 772 | 14201 |
| 3L-6S | | MI | 5047 | 2491 | 7613 | 2007 | 8608 | 1682 | 9117 | 1408 | 9599 | 981 | 11361 | 538 | 8275 |
| 14-#10 | 2.38 | MA | 8479 | 2491 | 12438 | 2064 | 14567 | 1731 | 15850 | 1454 | 17396 | 1015 | 21391 | 722 | 14137 |
| 4L-5S | | MI | 5176 | 2491 | 7850 | 2000 | 8933 | 1666 | 9520 | 1403 | 10142 | 970 | 12060 | 596 | 8476 |
| 14-#10 | 2.38 | MA | 8227 | 2491 | 11986 | 2085 | 14023 | 1742 | 15172 | 1464 | 16451 | 1032 | 20100 | 681 | 13902 |
| 5L-4S | | MI | 5299 | 2491 | 8123 | 1982 | 9262 | 1659 | 9928 | 1389 | 10710 | 959 | 12823 | 649 | 8626 |
| 14-#10 | 2.38 | MA | 8006 | 2491 | 11546 | 2091 | 13510 | 1753 | 14506 | 1483 | 15550 | 1049 | 18839 | 612 | 13428 |
| 6L-3S | | MI | 5391 | 2491 | 8390 | 1974 | 9637 | 1643 | 10388 | 1383 | 11340 | 956 | 13588 | 700 | 8642 |
| 14-#10 | 2.38 | MA | 7818 | 2491 | 11130 | 2099 | 12924 | 1768 | 13867 | 1493 | 14630 | 1057 | 17622 | 578 | 13032 |
| 7L-2S | | MI | 5573 | 2491 | 8775 | 1965 | 10127 | 1636 | 10983 | 1369 | 12145 | 946 | 14675 | 792 | 8639 |
| 14-#11 | 2.92 | MA | 8814 | 2607 | 13246 | 2131 | 15523 | 1780 | 16979 | 1484 | 18897 | 1006 | 23482 | 674 | 17061 |
| 4L-5S | | MI | 5322 | 2607 | 8259 | 2061 | 9395 | 1708 | 10052 | 1427 | 10839 | 954 | 12866 | 505 | 9973 |
| 14-#11 | 2.92 | MA | 8517 | 2607 | 12697 | 2156 | 14860 | 1793 | 16154 | 1496 | 17747 | 1026 | 21907 | 621 | 16508 |
| 5L-4S | | MI | 5464 | 2607 | 8589 | 2040 | 9792 | 1700 | 10546 | 1411 | 11525 | 942 | 13759 | 570 | 10309 |
| 14-#11 | 2.92 | MA | 8256 | 2607 | 12169 | 2163 | 14237 | 1807 | 15344 | 1518 | 16651 | 1045 | 20368 | 535 | 15982 |
| 6L-3S | | MI | 5571 | 2607 | 8911 | 2031 | 10245 | 1682 | 11100 | 1405 | 12283 | 941 | 14661 | 630 | 10345 |
| 14-#11 | 2.92 | MA | 8034 | 2607 | 11664 | 2172 | 13534 | 1825 | 14566 | 1530 | 15532 | 1055 | 18879 | 492 | 15253 |
| 7L-2S | | MI | 5782 | 2607 | 9372 | 2021 | 10833 | 1674 | 11814 | 1390 | 13250 | 929 | 15935 | 742 | 10353 |
| 14-#14 | 4.21 | MA | 9242 | 2883 | 14319 | 2342 | 16867 | 1932 | 18558 | 1586 | 20962 | 1023 | 26433 | 493 | 22713 |
| 5L-4S | | MI | 5901 | 2883 | 9650 | 2207 | 11088 | 1824 | 12099 | 1487 | 13609 | 921 | 16365 | 416 | 13995 |
| 14-#14 | 4.21 | MA | 8888 | 2883 | 13572 | 2353 | 15974 | 1950 | 17397 | 1617 | 19392 | 1051 | 24221 | 368 | 21635 |
| 6L-3S | | MI | 6043 | 2883 | 10109 | 2194 | 11732 | 1799 | 12888 | 1480 | 14688 | 921 | 17625 | 501 | 14441 |
| 14-#14 | 4.21 | MA | 8586 | 2883 | 12849 | 2366 | 14978 | 1977 | 16282 | 1634 | 17789 | 1063 | 22082 | 303 | 20385 |
| 7L-2S | | MI | 6324 | 2883 | 10763 | 2181 | 12565 | 1789 | 13900 | 1459 | 16058 | 906 | 19398 | 662 | 14490 |
| 16-#10 | 2.72 | MA | 8790 | 2564 | 13094 | 2110 | 15403 | 1764 | 16866 | 1474 | 18770 | 1011 | 23294 | 716 | 16105 |
| 4L-6S | | MI | 5222 | 2564 | 7997 | 2053 | 9098 | 1715 | 9712 | 1429 | 10404 | 976 | 12448 | 529 | 9400 |
| 16-#10 | 2.72 | MA | 8540 | 2564 | 12642 | 2130 | 14859 | 1775 | 16188 | 1485 | 17825 | 1028 | 22003 | 675 | 15836 |
| 5E | | MI | 5348 | 2564 | 8235 | 2045 | 9423 | 1699 | 10115 | 1423 | 10947 | 966 | 13147 | 587 | 9591 |
| 16-#10 | 2.72 | MA | 8325 | 2564 | 12203 | 2136 | 14346 | 1786 | 15522 | 1504 | 16924 | 1045 | 20742 | 606 | 15378 |
| 6L-4S | | MI | 5471 | 2564 | 8508 | 2028 | 9751 | 1692 | 10523 | 1409 | 11515 | 955 | 13910 | 640 | 9779 |
| 16-#10 | 2.72 | MA | 8144 | 2564 | 11787 | 2144 | 13760 | 1801 | 14883 | 1514 | 16004 | 1053 | 19525 | 573 | 14976 |
| 7L-3S | | MI | 5560 | 2564 | 8775 | 2019 | 10127 | 1676 | 10983 | 1404 | 12145 | 952 | 14675 | 691 | 9802 |
| 16-#10 | 2.72 | MA | 7928 | 2564 | 11388 | 2153 | 13221 | 1809 | 14202 | 1529 | 15126 | 1070 | 18350 | 526 | 14376 |
| 8L-2S | | MI | 5738 | 2564 | 9160 | 2010 | 10617 | 1669 | 11578 | 1390 | 12950 | 941 | 15762 | 783 | 9807 |
| 16-#11 | 3.34 | MA | 8889 | 2696 | 13492 | 2211 | 15873 | 1834 | 17385 | 1521 | 19413 | 1020 | 24213 | 614 | 18856 |
| 5E | | MI | 5525 | 2696 | 8720 | 2116 | 9983 | 1748 | 10766 | 1452 | 11806 | 949 | 14139 | 490 | 11312 |
| 16-#11 | 3.34 | MA | 8636 | 2696 | 12965 | 2219 | 15251 | 1847 | 16575 | 1543 | 18316 | 1040 | 22675 | 528 | 18349 |
| 6L-4S | | MI | 5666 | 2696 | 9050 | 2096 | 10380 | 1741 | 11260 | 1436 | 12491 | 937 | 15033 | 555 | 11687 |
| 16-#11 | 3.34 | MA | 8423 | 2696 | 12460 | 2228 | 14547 | 1865 | 15796 | 1555 | 17197 | 1049 | 21185 | 485 | 17613 |
| 7L-3S | | MI | 5769 | 2696 | 9372 | 2086 | 10833 | 1723 | 11814 | 1431 | 13250 | 936 | 15935 | 615 | 11733 |
| 16-#11 | 3.34 | MA | 8168 | 2696 | 11975 | 2238 | 13892 | 1874 | 14982 | 1574 | 16129 | 1069 | 19751 | 425 | 16898 |
| 8L-2S | | MI | 5975 | 2696 | 9834 | 2076 | 11421 | 1715 | 12529 | 1415 | 14216 | 924 | 17208 | 728 | 11749 |
| 16-#14 | 4.81 | MA | 9419 | 3011 | 14708 | 2433 | 17421 | 2009 | 19154 | 1654 | 21770 | 1043 | 27514 | 358 | 25010 |
| 6L-4S | | MI | 6182 | 3011 | 10305 | 2288 | 11921 | 1882 | 13111 | 1523 | 14979 | 914 | 18139 | 391 | 15876 |
| 16-#14 | 4.81 | MA | 9133 | 3011 | 13985 | 2446 | 16425 | 2036 | 18039 | 1670 | 20168 | 1056 | 25376 | 293 | 23762 |
| 7L-3S | | MI | 6317 | 3011 | 10763 | 2275 | 12565 | 1858 | 13900 | 1517 | 16058 | 914 | 19398 | 475 | 16397 |
| 18-#10 | 3.06 | MA | 8848 | 2636 | 13299 | 2176 | 15695 | 1808 | 17203 | 1505 | 19200 | 1024 | 23906 | 669 | 17774 |
| 5L-6S | | MI | 5396 | 2636 | 8382 | 2098 | 9588 | 1747 | 10307 | 1449 | 11210 | 972 | 13535 | 519 | 10527 |
| 18-#10 | 3.06 | MA | 8639 | 2636 | 12860 | 2181 | 15182 | 1819 | 16537 | 1524 | 18299 | 1040 | 22645 | 601 | 17330 |
| 6L-5S | | MI | 5519 | 2636 | 8620 | 2090 | 9913 | 1732 | 10710 | 1444 | 11753 | 961 | 14234 | 578 | 10710 |
| 18-#10 | 3.06 | MA | 8465 | 2636 | 12444 | 2189 | 14596 | 1834 | 15898 | 1535 | 17379 | 1049 | 21428 | 567 | 16922 |
| 7L-4S | | MI | 5641 | 2636 | 8893 | 2073 | 10241 | 1725 | 11118 | 1430 | 12321 | 951 | 14997 | 631 | 10931 |
| 18-#10 | 3.06 | MA | 8251 | 2636 | 12045 | 2199 | 14057 | 1842 | 15217 | 1550 | 16501 | 1066 | 20253 | 520 | 16335 |
| 8L-3S | | MI | 5727 | 2636 | 9160 | 2064 | 10617 | 1709 | 11578 | 1424 | 12950 | 948 | 15762 | 682 | 10960 |
| 18-#10 | 3.06 | MA | 8037 | 2636 | 11597 | 2217 | 13504 | 1859 | 14553 | 1557 | 15603 | 1074 | 19098 | 476 | 15665 |
| 9L-2S | | MI | 5901 | 2636 | 9544 | 2055 | 11107 | 1702 | 12173 | 1410 | 13756 | 937 | 16849 | 773 | 10971 |
| 18-#11 | 3.75 | MA | 9010 | 2785 | 13761 | 2274 | 16264 | 1888 | 17805 | 1569 | 19982 | 1035 | 24981 | 521 | 20718 |
| 6L-5S | | MI | 5726 | 2785 | 9182 | 2172 | 10571 | 1789 | 11481 | 1477 | 12772 | 943 | 15413 | 475 | 12656 |

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 3.75 | MA | 8805 | 2785 | 13256 | 2283 | 15560 | 1906 | 17027 | 1581 | 18863 | 1044 | 23491 | 478 | 19977 |
| 7L-4S | | MI | 5867 | 2785 | 9512 | 2152 | 10968 | 1781 | 11974 | 1462 | 13457 | 932 | 16307 | 540 | 13028 |
| 18-#11 | 3.75 | MA | 8553 | 2785 | 12771 | 2294 | 14905 | 1915 | 16213 | 1600 | 17794 | 1064 | 22057 | 418 | 19257 |
| 8L-3S | | MI | 5966 | 2785 | 9834 | 2142 | 11421 | 1763 | 12529 | 1456 | 14216 | 930 | 17208 | 600 | 13119 |
| 18-#14 | 5.41 | MA | 9670 | 3140 | 15122 | 2526 | 17872 | 2094 | 19797 | 1707 | 22546 | 1048 | 28669 | 283 | 27064 |
| 7L-4S | | MI | 6461 | 3140 | 10960 | 2368 | 12755 | 1941 | 14123 | 1560 | 16349 | 906 | 19912 | 365 | 17766 |
| 20-#10 | 3.40 | MA | 8949 | 2709 | 13516 | 2227 | 16018 | 1852 | 17553 | 1545 | 19673 | 1036 | 24548 | 595 | 19284 |
| 6E | | MI | 5568 | 2709 | 8767 | 2143 | 10078 | 1780 | 10902 | 1470 | 12015 | 968 | 14622 | 510 | 11657 |
| 20-#10 | 3.40 | MA | 8780 | 2709 | 13101 | 2235 | 15433 | 1867 | 16914 | 1555 | 18753 | 1045 | 23331 | 561 | 18871 |
| 7L-5S | | MI | 5688 | 2709 | 9005 | 2136 | 10402 | 1765 | 11305 | 1464 | 12558 | 957 | 15321 | 569 | 11832 |
| 20-#10 | 3.40 | MA | 8568 | 2709 | 12702 | 2244 | 14894 | 1875 | 16233 | 1570 | 17875 | 1061 | 22156 | 514 | 18295 |
| 8L-4S | | MI | 5810 | 2709 | 9278 | 2118 | 10731 | 1758 | 11713 | 1450 | 13126 | 946 | 16084 | 622 | 12082 |
| 20-#10 | 3.40 | MA | 8360 | 2709 | 12254 | 2262 | 14340 | 1892 | 15569 | 1577 | 16977 | 1070 | 21001 | 470 | 17617 |
| 9L-3S | | MI | 5892 | 2709 | 9544 | 2110 | 11107 | 1742 | 12173 | 1445 | 13756 | 944 | 16849 | 673 | 12117 |
| 20-#10 | 3.40 | MA | 8170 | 2709 | 11841 | 2269 | 13819 | 1901 | 14906 | 1594 | 16102 | 1086 | 19830 | 429 | 16959 |
| 10L-2S | | MI | 6064 | 2709 | 9929 | 2101 | 11596 | 1735 | 12768 | 1431 | 14561 | 933 | 17936 | 764 | 12132 |
| 20-#11 | 4.17 | MA | 9182 | 2874 | 14051 | 2339 | 16574 | 1946 | 18258 | 1606 | 20528 | 1039 | 25797 | 471 | 22343 |
| 7L-5S | | MI | 5925 | 2874 | 9644 | 2228 | 11159 | 1829 | 12195 | 1503 | 13738 | 938 | 16687 | 460 | 14004 |
| 20-#11 | 4.17 | MA | 8932 | 2874 | 13566 | 2350 | 15918 | 1955 | 17443 | 1625 | 19460 | 1059 | 24364 | 411 | 21616 |
| 8L-4S | | MI | 6065 | 2874 | 9974 | 2207 | 11556 | 1822 | 12688 | 1487 | 14424 | 927 | 17581 | 525 | 14358 |
| 22-#10 | 3.74 | MA | 9092 | 2781 | 13757 | 2280 | 16269 | 1900 | 17929 | 1576 | 20128 | 1040 | 25234 | 555 | 20821 |
| 7L-6S | | MI | 5738 | 2781 | 9152 | 2189 | 10568 | 1813 | 11497 | 1491 | 12820 | 964 | 15709 | 501 | 12789 |
| 22-#10 | 3.74 | MA | 8881 | 2781 | 13359 | 2289 | 15730 | 1907 | 17248 | 1591 | 19249 | 1057 | 24059 | 508 | 20257 |
| 8L-5S | | MI | 5855 | 2781 | 9389 | 2181 | 10892 | 1798 | 11900 | 1485 | 13363 | 953 | 16408 | 560 | 12957 |
| 22-#10 | 3.74 | MA | 8679 | 2781 | 12911 | 2308 | 15176 | 1924 | 16584 | 1598 | 18352 | 1066 | 22904 | 464 | 19569 |
| 9L-4S | | MI | 5977 | 2781 | 9662 | 2164 | 11221 | 1790 | 12308 | 1471 | 13931 | 942 | 17171 | 613 | 13233 |
| 22-#10 | 3.74 | MA | 8495 | 2781 | 12497 | 2314 | 14655 | 1934 | 15922 | 1614 | 17477 | 1082 | 21733 | 423 | 18905 |
| 10L-3S | | MI | 6057 | 2781 | 9929 | 2155 | 11596 | 1775 | 12768 | 1465 | 14561 | 940 | 17936 | 664 | 13272 |
| 22-#11 | 4.59 | MA | 9304 | 2963 | 14362 | 2405 | 16932 | 1995 | 18674 | 1650 | 21125 | 1054 | 26670 | 403 | 23933 |
| 8L-5S | | MI | 6122 | 2963 | 10106 | 2283 | 11747 | 1870 | 12909 | 1528 | 14705 | 933 | 17961 | 445 | 15355 |
| 24-#10 | 4.07 | MA | 9190 | 2854 | 14015 | 2335 | 16566 | 1940 | 18264 | 1611 | 20624 | 1053 | 25962 | 503 | 22219 |
| 8L-6S | | MI | 5907 | 2854 | 9536 | 2234 | 11058 | 1846 | 12092 | 1511 | 13625 | 960 | 16796 | 492 | 13922 |
| 24-#10 | 4.07 | MA | 8993 | 2854 | 13567 | 2353 | 16012 | 1957 | 17600 | 1618 | 19726 | 1061 | 24807 | 458 | 21521 |
| 9L-5S | | MI | 6022 | 2854 | 9774 | 2226 | 11382 | 1831 | 12495 | 1506 | 14169 | 949 | 17495 | 551 | 14084 |
| 24-#10 | 4.07 | MA | 8815 | 2854 | 13154 | 2360 | 15491 | 1967 | 16937 | 1635 | 18851 | 1078 | 23636 | 417 | 20851 |
| 10L-4S | | MI | 6143 | 2854 | 10047 | 2209 | 11711 | 1823 | 12903 | 1491 | 14736 | 938 | 18258 | 604 | 14382 |

## RECTANGULAR TIED COLUMNS 22" x 36"

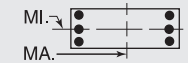
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.14 | MA | 8757 | 2357 | 12529 | 1974 | 14538 | 1663 | 15569 | 1421 | 16514 | 1058 | 19610 | 921 | 7755 |
| 2E | | MI | 5206 | 2357 | 7854 | 1875 | 8793 | 1579 | 9239 | 1348 | 9588 | 1000 | 10941 | 839 | 4546 |
| 4-#18 | 2.02 | MA | 9571 | 2557 | 14446 | 2083 | 16886 | 1741 | 18376 | 1466 | 20276 | 1038 | 24792 | 897 | 13342 |
| 2E | | MI | 5589 | 2557 | 8874 | 1975 | 10013 | 1648 | 10682 | 1385 | 11512 | 973 | 13182 | 758 | 7572 |
| 6-#11 | 1.18 | MA | 8824 | 2368 | 12597 | 1988 | 14670 | 1675 | 15753 | 1430 | 16782 | 1062 | 19996 | 924 | 8088 |
| 2L-3S | | MI | 5012 | 2368 | 7425 | 1904 | 8288 | 1602 | 8645 | 1376 | 8799 | 1018 | 9978 | 740 | 4760 |
| 6-#11 | 1.18 | MA | 8367 | 2368 | 11745 | 2003 | 13586 | 1689 | 14436 | 1443 | 15000 | 1083 | 17528 | 823 | 8100 |
| 3L-2S | | MI | 5247 | 2368 | 7886 | 1894 | 8876 | 1594 | 9359 | 1360 | 9765 | 1007 | 11252 | 852 | 4730 |
| 6-#14 | 1.70 | MA | 9327 | 2486 | 13746 | 2054 | 16087 | 1722 | 17451 | 1458 | 19061 | 1051 | 23136 | 911 | 11454 |
| 2L-3S | | MI | 5168 | 2486 | 7854 | 1968 | 8793 | 1647 | 9239 | 1406 | 9588 | 1007 | 10941 | 652 | 6607 |
| 6-#14 | 1.70 | MA | 8699 | 2486 | 12529 | 2075 | 14538 | 1741 | 15569 | 1475 | 16514 | 1079 | 19610 | 763 | 11427 |
| 3L-2S | | MI | 5490 | 2486 | 8508 | 1955 | 9627 | 1637 | 10251 | 1384 | 10958 | 992 | 12715 | 814 | 6575 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis

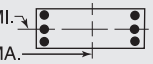



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 3.03 | MA | 10514 | 2786 | 16569 | 2226 | 19589 | 1845 | 21659 | 1531 | 24719 | 1024 | 30943 | 878 | 19754 |
| 2L-3S | | MI | 5537 | 2786 | 8874 | 2137 | 10013 | 1765 | 10682 | 1483 | 11512 | 980 | 13182 | 411 | 10958 |
| 6-#18 | 3.03 | MA | 9504 | 2786 | 14446 | 2262 | 16886 | 1876 | 18376 | 1559 | 20276 | 1071 | 24792 | 609 | 19505 |
| 3L-2S | | MI | 6054 | 2786 | 9997 | 2117 | 11443 | 1752 | 12419 | 1450 | 13864 | 960 | 16113 | 698 | 11005 |
| 8-#9 | 1.01 | MA | 8680 | 2329 | 12161 | 1978 | 14204 | 1669 | 15231 | 1430 | 16112 | 1073 | 19095 | 935 | 7011 |
| 2L-4S | | MI | 4945 | 2329 | 7121 | 1908 | 7953 | 1616 | 8272 | 1383 | 8319 | 1034 | 9499 | 771 | 4167 |
| 8-#9 | 1.01 | MA | 8377 | 2329 | 11606 | 1989 | 13497 | 1679 | 14372 | 1438 | 14950 | 1087 | 17486 | 872 | 7021 |
| 3E | | MI | 5030 | 2329 | 7333 | 1901 | 8250 | 1603 | 8637 | 1378 | 8818 | 1032 | 10110 | 812 | 4147 |
| 8-#9 | 1.01 | MA | 8222 | 2329 | 11232 | 1999 | 12968 | 1695 | 13723 | 1454 | 14060 | 1094 | 16422 | 833 | 7017 |
| 4L-2S | | MI | 5188 | 2329 | 7638 | 1894 | 8639 | 1597 | 9109 | 1367 | 9457 | 1023 | 10981 | 884 | 4130 |
| 8-#10 | 1.28 | MA | 8959 | 2390 | 12775 | 2013 | 14962 | 1694 | 16140 | 1444 | 17333 | 1067 | 20778 | 928 | 8811 |
| 2L-4S | | MI | 5027 | 2390 | 7327 | 1943 | 8186 | 1643 | 8544 | 1399 | 8677 | 1029 | 9977 | 727 | 5174 |
| 8-#10 | 1.28 | MA | 8585 | 2390 | 12073 | 2026 | 14069 | 1706 | 15055 | 1455 | 15864 | 1085 | 18744 | 847 | 8815 |
| 3E | | MI | 5131 | 2390 | 7594 | 1935 | 8561 | 1627 | 9004 | 1393 | 9307 | 1026 | 10742 | 778 | 5156 |
| 8-#10 | 1.28 | MA | 8393 | 2390 | 11600 | 2038 | 13399 | 1726 | 14233 | 1474 | 14738 | 1094 | 17395 | 798 | 8782 |
| 4L-2S | | MI | 5326 | 2390 | 7978 | 1926 | 9051 | 1620 | 9599 | 1379 | 10112 | 1016 | 11829 | 869 | 5135 |
| 8-#11 | 1.58 | MA | 9226 | 2457 | 13448 | 2044 | 15754 | 1715 | 17070 | 1455 | 18564 | 1057 | 22463 | 917 | 10674 |
| 2L-4S | | MI | 5097 | 2457 | 7564 | 1969 | 8424 | 1661 | 8804 | 1407 | 9007 | 1014 | 10351 | 665 | 6194 |
| 8-#11 | 1.58 | MA | 8784 | 2457 | 12597 | 2059 | 14670 | 1729 | 15753 | 1468 | 16782 | 1078 | 19996 | 816 | 10668 |
| 3E | | MI | 5221 | 2457 | 7886 | 1960 | 8876 | 1643 | 9359 | 1401 | 9765 | 1013 | 11252 | 725 | 6181 |
| 8-#11 | 1.58 | MA | 8557 | 2457 | 12021 | 2074 | 13856 | 1753 | 14754 | 1491 | 15413 | 1088 | 18346 | 755 | 10597 |
| 4L-2S | | MI | 5449 | 2457 | 8348 | 1950 | 9464 | 1635 | 10073 | 1385 | 10732 | 1001 | 12526 | 837 | 6157 |
| 8-#14 | 2.27 | MA | 9883 | 2614 | 14963 | 2135 | 17636 | 1780 | 19332 | 1494 | 21607 | 1043 | 26662 | 900 | 15136 |
| 2L-4S | | MI | 5289 | 2614 | 8050 | 2062 | 8983 | 1730 | 9462 | 1449 | 9879 | 1000 | 11455 | 542 | 8541 |
| 8-#14 | 2.27 | MA | 9282 | 2614 | 13746 | 2156 | 16087 | 1799 | 17451 | 1511 | 19061 | 1072 | 23136 | 753 | 15079 |
| 3E | | MI | 5458 | 2614 | 8508 | 2049 | 9627 | 1706 | 10251 | 1442 | 10958 | 1000 | 12715 | 626 | 8593 |
| 8-#14 | 2.27 | MA | 8974 | 2614 | 12921 | 2177 | 14921 | 1834 | 16020 | 1544 | 17101 | 1085 | 20764 | 663 | 14826 |
| 4L-2S | | MI | 5769 | 2614 | 9163 | 2035 | 10461 | 1696 | 11264 | 1420 | 12328 | 985 | 14488 | 788 | 8580 |
| 8-#18 | 4.04 | MA | 10483 | 3014 | 16569 | 2404 | 19589 | 1980 | 21659 | 1624 | 24719 | 1058 | 30943 | 590 | 25848 |
| 3E | | MI | 6019 | 3014 | 9997 | 2279 | 11443 | 1869 | 12419 | 1548 | 13864 | 967 | 16113 | 351 | 14299 |
| 8-#18 | 4.04 | MA | 9998 | 3014 | 15122 | 2440 | 17547 | 2038 | 19154 | 1678 | 21288 | 1079 | 26753 | 428 | 23452 |
| 4L-2S | | MI | 6512 | 3014 | 11121 | 2260 | 12874 | 1856 | 14157 | 1515 | 16216 | 947 | 19045 | 639 | 14406 |
| 10-#10 | 1.60 | MA | 9292 | 2463 | 13477 | 2058 | 15856 | 1727 | 17226 | 1465 | 18803 | 1063 | 22813 | 922 | 10940 |
| 2L-5S | | MI | 5081 | 2463 | 7439 | 2006 | 8347 | 1683 | 8731 | 1434 | 8914 | 1036 | 10301 | 665 | 6327 |
| 10-#10 | 1.60 | MA | 8928 | 2463 | 12775 | 2071 | 14962 | 1739 | 16140 | 1476 | 17333 | 1080 | 20778 | 842 | 10933 |
| 3L-4S | | MI | 5205 | 2463 | 7712 | 1989 | 8676 | 1675 | 9139 | 1420 | 9482 | 1025 | 11064 | 718 | 6343 |
| 10-#10 | 1.60 | MA | 8745 | 2463 | 12302 | 2084 | 14293 | 1759 | 15319 | 1495 | 16207 | 1089 | 19429 | 792 | 10887 |
| 4L-3S | | MI | 5306 | 2463 | 7978 | 1980 | 9051 | 1660 | 9599 | 1414 | 10112 | 1022 | 11829 | 769 | 6333 |
| 10-#10 | 1.60 | MA | 8469 | 2463 | 11816 | 2104 | 13713 | 1771 | 14596 | 1506 | 15199 | 1107 | 18055 | 753 | 10757 |
| 5L-2S | | MI | 5497 | 2463 | 8363 | 1971 | 9541 | 1653 | 10194 | 1400 | 10917 | 1011 | 12916 | 860 | 6318 |
| 10-#11 | 1.97 | MA | 9621 | 2546 | 14300 | 2099 | 16838 | 1756 | 18387 | 1480 | 20346 | 1052 | 24930 | 910 | 13253 |
| 2L-5S | | MI | 5165 | 2546 | 7696 | 2045 | 8614 | 1709 | 9025 | 1448 | 9288 | 1021 | 10731 | 584 | 7400 |
| 10-#11 | 1.97 | MA | 9193 | 2546 | 13448 | 2115 | 15754 | 1769 | 17070 | 1493 | 18564 | 1072 | 22463 | 809 | 13232 |
| 3L-4S | | MI | 5308 | 2546 | 8026 | 2025 | 9012 | 1701 | 9518 | 1432 | 9973 | 1009 | 11625 | 650 | 7586 |
| 10-#11 | 1.97 | MA | 8978 | 2546 | 12872 | 2130 | 14940 | 1794 | 16071 | 1516 | 17195 | 1083 | 20813 | 747 | 13144 |
| 4L-3S | | MI | 5426 | 2546 | 8348 | 2015 | 9464 | 1683 | 10073 | 1426 | 10732 | 1008 | 12526 | 710 | 7589 |
| 10-#11 | 1.97 | MA | 8651 | 2546 | 12286 | 2155 | 14234 | 1807 | 15191 | 1528 | 15969 | 1103 | 19136 | 697 | 12713 |
| 5L-2S | | MI | 5649 | 2546 | 8810 | 2005 | 10052 | 1675 | 10787 | 1410 | 11698 | 996 | 13800 | 822 | 7573 |
| 10-#14 | 2.84 | MA | 9851 | 2743 | 14963 | 2236 | 17636 | 1858 | 19332 | 1548 | 21607 | 1064 | 26662 | 742 | 18728 |
| 3L-4S | | MI | 5583 | 2743 | 8705 | 2142 | 9817 | 1789 | 10475 | 1485 | 11249 | 992 | 13229 | 517 | 10389 |
| 10-#14 | 2.84 | MA | 9565 | 2743 | 14138 | 2257 | 16471 | 1892 | 17902 | 1580 | 19647 | 1078 | 24290 | 653 | 18460 |
| 4L-3S | | MI | 5743 | 2743 | 9163 | 2129 | 10461 | 1764 | 11264 | 1478 | 12328 | 992 | 14488 | 601 | 10564 |
| 10-#14 | 2.84 | MA | 9106 | 2743 | 13298 | 2293 | 15458 | 1911 | 16641 | 1597 | 17890 | 1106 | 21883 | 577 | 17179 |
| 5L-2S | | MI | 6044 | 2743 | 9818 | 2116 | 11294 | 1754 | 12276 | 1457 | 13698 | 977 | 16262 | 763 | 10573 |
| 10-#18 | 5.05 | MA | 11001 | 3242 | 17245 | 2583 | 20250 | 2142 | 22437 | 1743 | 25730 | 1065 | 32904 | 410 | 29728 |
| 4L-3S | | MI | 6493 | 3242 | 11121 | 2422 | 12874 | 1972 | 14157 | 1613 | 16216 | 953 | 19045 | 291 | 17636 |
| 10-#18 | 5.05 | MA | 10228 | 3242 | 15771 | 2644 | 18473 | 2174 | 20226 | 1771 | 22651 | 1113 | 28670 | 266 | 27307 |
| 5L-2S | | MI | 6956 | 3242 | 12245 | 2403 | 14304 | 1959 | 15894 | 1580 | 18567 | 933 | 21976 | 579 | 17787 |

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

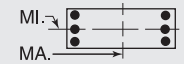
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.92 | MA | 9620 | 2535 | 14179 | 2104 | 16750 | 1760 | 18312 | 1485 | 20272 | 1059 | 24847 | 916 | 13064 |
| 2L-6S | | MI | 5125 | 2535 | 7585 | 2059 | 8512 | 1731 | 8923 | 1460 | 9177 | 1042 | 10689 | 597 | 7225 |
| 12-#10 | 1.92 | MA | 9266 | 2535 | 13477 | 2116 | 15856 | 1772 | 17226 | 1496 | 18803 | 1076 | 22813 | 836 | 13048 |
| 3L-5S | | MI | 5258 | 2535 | 7823 | 2051 | 8837 | 1716 | 9326 | 1454 | 9720 | 1031 | 11388 | 656 | 7441 |
| 12-#10 | 1.92 | MA | 9092 | 2535 | 13004 | 2129 | 15187 | 1792 | 16404 | 1516 | 17676 | 1085 | 21464 | 786 | 12992 |
| 4E | | MI | 5382 | 2535 | 8096 | 2034 | 9166 | 1708 | 9734 | 1440 | 10288 | 1020 | 12151 | 709 | 7504 |
| 12-#10 | 1.92 | MA | 8817 | 2535 | 12518 | 2150 | 14607 | 1804 | 15682 | 1526 | 16668 | 1103 | 20089 | 747 | 12855 |
| 5L-3S | | MI | 5479 | 2535 | 8363 | 2025 | 9541 | 1693 | 10194 | 1435 | 10917 | 1018 | 12916 | 760 | 7505 |
| 12-#10 | 1.92 | MA | 8572 | 2535 | 12049 | 2156 | 14054 | 1815 | 14972 | 1546 | 15708 | 1120 | 18747 | 679 | 12306 |
| 6L-2S | | MI | 5665 | 2535 | 8748 | 2016 | 10031 | 1686 | 10789 | 1420 | 11723 | 1007 | 14003 | 851 | 7494 |
| 12-#11 | 2.36 | MA | 9594 | 2635 | 14300 | 2170 | 16838 | 1810 | 18387 | 1518 | 20346 | 1067 | 24930 | 802 | 15792 |
| 3L-5S | | MI | 5374 | 2635 | 8158 | 2101 | 9202 | 1749 | 9739 | 1473 | 10254 | 1016 | 12005 | 569 | 8725 |
| 12-#11 | 2.36 | MA | 9391 | 2635 | 13724 | 2185 | 16024 | 1834 | 17388 | 1541 | 18977 | 1077 | 23280 | 740 | 15691 |
| 4E | | MI | 5516 | 2635 | 8488 | 2081 | 9600 | 1742 | 10233 | 1457 | 10940 | 1004 | 12899 | 635 | 8971 |
| 12-#11 | 2.36 | MA | 9066 | 2635 | 13138 | 2211 | 15318 | 1848 | 16508 | 1554 | 17751 | 1098 | 21603 | 689 | 15216 |
| 5L-3S | | MI | 5629 | 2635 | 8810 | 2071 | 10052 | 1723 | 10787 | 1452 | 11698 | 1003 | 13800 | 695 | 8989 |
| 12-#11 | 2.36 | MA | 8775 | 2635 | 12569 | 2218 | 14654 | 1862 | 15643 | 1577 | 16581 | 1118 | 19967 | 604 | 14607 |
| 6L-2S | | MI | 5846 | 2635 | 9272 | 2061 | 10640 | 1716 | 11501 | 1436 | 12665 | 991 | 15074 | 807 | 8982 |
| 12-#14 | 3.41 | MA | 10143 | 2871 | 15355 | 2337 | 18020 | 1950 | 19784 | 1617 | 22194 | 1071 | 27815 | 643 | 22098 |
| 4E | | MI | 5872 | 2871 | 9359 | 2222 | 10650 | 1847 | 11487 | 1521 | 12619 | 985 | 15002 | 491 | 12243 |
| 12-#14 | 3.41 | MA | 9688 | 2871 | 14514 | 2373 | 17007 | 1969 | 18523 | 1634 | 20437 | 1099 | 25409 | 567 | 20787 |
| 5L-3S | | MI | 6024 | 2871 | 9818 | 2209 | 11294 | 1822 | 12276 | 1515 | 13698 | 985 | 16262 | 576 | 12528 |
| 12-#14 | 3.41 | MA | 9289 | 2871 | 13707 | 2384 | 16055 | 1989 | 17284 | 1666 | 18761 | 1128 | 23059 | 442 | 19721 |
| 6L-2S | | MI | 6316 | 2871 | 10472 | 2196 | 12128 | 1812 | 13288 | 1493 | 15068 | 970 | 18036 | 737 | 12556 |
| 12-#18 | 6.06 | MA | 11210 | 3471 | 17893 | 2787 | 21176 | 2278 | 23508 | 1836 | 27093 | 1099 | 34821 | 248 | 33553 |
| 5L-3S | | MI | 6983 | 3471 | 12245 | 2565 | 14304 | 2076 | 15894 | 1677 | 18567 | 940 | 21976 | 232 | 20972 |
| 12-#18 | 6.06 | MA | 10568 | 3471 | 16506 | 2807 | 19504 | 2309 | 21335 | 1890 | 24154 | 1146 | 30669 | 24 | 30585 |
| 6L-2S | | MI | 7393 | 3471 | 13368 | 2546 | 15735 | 2063 | 17632 | 1644 | 20919 | 920 | 24907 | 519 | 21159 |
| 14-#10 | 2.24 | MA | 9599 | 2608 | 14179 | 2162 | 16750 | 1805 | 18312 | 1517 | 20272 | 1072 | 24847 | 830 | 15161 |
| 3L-6S | | MI | 5303 | 2608 | 7970 | 2104 | 9002 | 1764 | 9518 | 1480 | 9982 | 1038 | 11776 | 588 | 8345 |
| 14-#10 | 2.24 | MA | 9433 | 2608 | 13706 | 2174 | 16081 | 1825 | 17490 | 1536 | 19145 | 1081 | 23498 | 780 | 15097 |
| 4L-5S | | MI | 5433 | 2608 | 8208 | 2097 | 9327 | 1749 | 9921 | 1475 | 10525 | 1027 | 12475 | 647 | 8550 |
| 14-#10 | 2.24 | MA | 9159 | 2608 | 13220 | 2195 | 15501 | 1837 | 16767 | 1547 | 18137 | 1098 | 22123 | 741 | 14920 |
| 5L-4S | | MI | 5556 | 2608 | 8481 | 2079 | 9656 | 1741 | 10329 | 1461 | 11093 | 1016 | 13238 | 700 | 8661 |
| 14-#10 | 2.24 | MA | 8921 | 2608 | 12751 | 2201 | 14948 | 1848 | 16058 | 1566 | 17177 | 1116 | 20781 | 674 | 14389 |
| 6L-3S | | MI | 5649 | 2608 | 8748 | 2071 | 10031 | 1726 | 10789 | 1455 | 11723 | 1014 | 14003 | 751 | 8672 |
| 14-#10 | 2.24 | MA | 8719 | 2608 | 12307 | 2209 | 14323 | 1863 | 15373 | 1577 | 16196 | 1125 | 19490 | 640 | 14010 |
| 7L-2S | | MI | 5832 | 2608 | 9133 | 2062 | 10521 | 1718 | 11384 | 1441 | 12528 | 1003 | 15090 | 842 | 8666 |
| 14-#11 | 2.76 | MA | 9797 | 2724 | 14575 | 2241 | 17108 | 1874 | 18704 | 1566 | 20759 | 1072 | 25748 | 733 | 18240 |
| 4L-5S | | MI | 5579 | 2724 | 8620 | 2157 | 9790 | 1790 | 10453 | 1498 | 11221 | 1011 | 13278 | 554 | 10057 |
| 14-#11 | 2.76 | MA | 9474 | 2724 | 13989 | 2266 | 16402 | 1888 | 17824 | 1579 | 19533 | 1093 | 24071 | 682 | 17726 |
| 5L-4S | | MI | 5721 | 2724 | 8950 | 2136 | 10187 | 1782 | 10947 | 1482 | 11906 | 999 | 14172 | 620 | 10353 |
| 14-#11 | 2.76 | MA | 9192 | 2724 | 13420 | 2273 | 15738 | 1902 | 16960 | 1602 | 18363 | 1113 | 22434 | 597 | 17139 |
| 6L-3S | | MI | 5829 | 2724 | 9272 | 2127 | 10640 | 1764 | 11501 | 1477 | 12665 | 998 | 15074 | 680 | 10382 |
| 14-#11 | 2.76 | MA | 8953 | 2724 | 12881 | 2283 | 14979 | 1920 | 16131 | 1614 | 17169 | 1123 | 20852 | 556 | 16425 |
| 7L-2S | | MI | 6042 | 2724 | 9733 | 2117 | 11228 | 1756 | 12215 | 1461 | 13631 | 986 | 16347 | 792 | 10385 |
| 14-#14 | 3.98 | MA | 10257 | 3000 | 15731 | 2454 | 18556 | 2028 | 20404 | 1670 | 22983 | 1092 | 28934 | 556 | 24401 |
| 5L-4S | | MI | 6158 | 3000 | 10014 | 2303 | 11484 | 1905 | 12499 | 1558 | 13989 | 977 | 16776 | 466 | 14110 |
| 14-#14 | 3.98 | MA | 9875 | 3000 | 14924 | 2464 | 17604 | 2047 | 19166 | 1703 | 21308 | 1120 | 26584 | 432 | 23327 |
| 6L-3S | | MI | 6301 | 3000 | 10472 | 2289 | 12128 | 1881 | 13288 | 1551 | 15068 | 977 | 18036 | 550 | 14488 |
| 14-#14 | 3.98 | MA | 9549 | 3000 | 14152 | 2478 | 16528 | 2073 | 17977 | 1720 | 19597 | 1134 | 24308 | 370 | 21943 |
| 7L-2S | | MI | 6585 | 3000 | 11127 | 2276 | 12961 | 1871 | 14301 | 1530 | 16439 | 962 | 19809 | 712 | 14530 |
| 14-#18 | 7.07 | MA | 11563 | 3699 | 18629 | 2950 | 22207 | 2413 | 24618 | 1955 | 28597 | 1133 | 36821 | 6 | 36782 |
| 6L-3S | | MI | 7438 | 3699 | 13368 | 2708 | 15735 | 2180 | 17632 | 1742 | 20919 | 927 | 24907 | 172 | 24163 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis

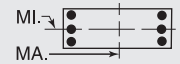



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.57 | MA | 9768 | 2680 | 14408 | 2220 | 16975 | 1858 | 18576 | 1557 | 20615 | 1077 | 25532 | 775 | 17202 |
| 4L-6S | | MI | 5479 | 2680 | 8355 | 2150 | 9492 | 1797 | 10113 | 1501 | 10787 | 1034 | 12863 | 579 | 9469 |
| 16-#10 | 2.57 | MA | 9497 | 2680 | 13922 | 2240 | 16394 | 1870 | 17853 | 1568 | 19607 | 1094 | 24157 | 735 | 16990 |
| 5E | | MI | 5606 | 2680 | 8593 | 2142 | 9817 | 1782 | 10516 | 1495 | 11330 | 1023 | 13563 | 638 | 9664 |
| 16-#10 | 2.57 | MA | 9265 | 2680 | 13453 | 2246 | 15842 | 1881 | 17143 | 1587 | 18646 | 1112 | 22816 | 668 | 16475 |
| 6L-4S | | MI | 5728 | 2680 | 8866 | 2125 | 10145 | 1774 | 10924 | 1481 | 11898 | 1012 | 14325 | 690 | 9816 |
| 16-#10 | 2.57 | MA | 9070 | 2680 | 13009 | 2255 | 15217 | 1896 | 16459 | 1597 | 17666 | 1121 | 21524 | 634 | 16108 |
| 7L-3S | | MI | 5818 | 2680 | 9133 | 2116 | 10521 | 1759 | 11384 | 1476 | 12528 | 1010 | 15090 | 741 | 9833 |
| 16-#10 | 2.57 | MA | 8835 | 2680 | 12584 | 2264 | 14642 | 1904 | 15728 | 1612 | 16730 | 1138 | 20275 | 589 | 15443 |
| 8L-2S | | MI | 5998 | 2680 | 9517 | 2107 | 11011 | 1751 | 11979 | 1462 | 13333 | 999 | 16178 | 833 | 9834 |
| 16-#11 | 3.15 | MA | 9875 | 2813 | 14841 | 2322 | 17486 | 1929 | 19141 | 1604 | 21315 | 1087 | 26538 | 675 | 20242 |
| 5E | | MI | 5783 | 2813 | 9082 | 2212 | 10378 | 1830 | 11167 | 1524 | 12187 | 1005 | 14552 | 539 | 11396 |
| 16-#11 | 3.15 | MA | 9602 | 2813 | 14272 | 2329 | 16822 | 1943 | 18277 | 1627 | 20145 | 1108 | 24901 | 590 | 19674 |
| 6L-4S | | MI | 5924 | 2813 | 9412 | 2192 | 10775 | 1822 | 11661 | 1508 | 12872 | 994 | 15446 | 605 | 11733 |
| 16-#11 | 3.15 | MA | 9373 | 2813 | 13732 | 2339 | 16063 | 1960 | 17447 | 1640 | 18951 | 1118 | 23319 | 548 | 18956 |
| 7L-3S | | MI | 6028 | 2813 | 9733 | 2182 | 11228 | 1804 | 12215 | 1502 | 13631 | 992 | 16347 | 665 | 11772 |
| 16-#11 | 3.15 | MA | 9095 | 2813 | 13215 | 2350 | 15363 | 1970 | 16567 | 1658 | 17812 | 1138 | 21794 | 490 | 18190 |
| 8L-2S | | MI | 6236 | 2813 | 10195 | 2172 | 11816 | 1797 | 12929 | 1486 | 14598 | 981 | 17621 | 777 | 11784 |
| 16-#14 | 4.55 | MA | 10449 | 3128 | 16141 | 2544 | 19153 | 2105 | 21048 | 1739 | 23854 | 1113 | 30110 | 422 | 26934 |
| 6L-4S | | MI | 6440 | 3128 | 10669 | 2383 | 12317 | 1964 | 13512 | 1594 | 15360 | 970 | 18549 | 440 | 15989 |
| 16-#14 | 4.55 | MA | 10140 | 3128 | 15368 | 2558 | 18077 | 2132 | 19858 | 1756 | 22144 | 1126 | 27834 | 360 | 25559 |
| 7L-3S | | MI | 6576 | 3128 | 11127 | 2370 | 12961 | 1939 | 14301 | 1588 | 16439 | 970 | 19809 | 525 | 16446 |
| 16-#14 | 4.55 | MA | 9750 | 3128 | 14627 | 2573 | 17075 | 2144 | 18612 | 1784 | 20510 | 1155 | 25644 | 274 | 23904 |
| 8L-2S | | MI | 6853 | 3128 | 11782 | 2357 | 13795 | 1929 | 15313 | 1566 | 17809 | 955 | 21583 | 686 | 16501 |
| 18-#10 | 2.89 | MA | 9829 | 2753 | 14624 | 2286 | 17288 | 1903 | 18938 | 1588 | 21076 | 1090 | 26192 | 729 | 19064 |
| 5L-6S | | MI | 5653 | 2753 | 8740 | 2195 | 9982 | 1830 | 10708 | 1522 | 11592 | 1030 | 13950 | 570 | 10596 |
| 18-#10 | 2.89 | MA | 9604 | 2753 | 14155 | 2292 | 16736 | 1914 | 18229 | 1607 | 20115 | 1107 | 24850 | 662 | 18564 |
| 6L-5S | | MI | 5777 | 2753 | 8978 | 2187 | 10307 | 1814 | 11111 | 1516 | 12136 | 1019 | 14650 | 629 | 10782 |
| 18-#10 | 2.89 | MA | 9416 | 2753 | 13711 | 2300 | 16111 | 1929 | 17544 | 1618 | 19135 | 1116 | 23559 | 629 | 18195 |
| 7L-4S | | MI | 5899 | 2753 | 9251 | 2170 | 10635 | 1807 | 11519 | 1502 | 12703 | 1008 | 15412 | 681 | 10969 |
| 18-#10 | 2.89 | MA | 9183 | 2753 | 13286 | 2309 | 15536 | 1937 | 16814 | 1633 | 18199 | 1134 | 22309 | 583 | 17538 |
| 8L-3S | | MI | 5986 | 2753 | 9517 | 2161 | 11011 | 1792 | 11979 | 1496 | 13333 | 1005 | 16178 | 732 | 10993 |
| 18-#10 | 2.89 | MA | 8953 | 2753 | 12805 | 2328 | 14946 | 1954 | 16105 | 1640 | 17242 | 1143 | 21084 | 540 | 16868 |
| 9L-2S | | MI | 6162 | 2753 | 9902 | 2152 | 11501 | 1784 | 12574 | 1482 | 14138 | 995 | 17265 | 824 | 11000 |
| 18-#11 | 3.55 | MA | 10006 | 2902 | 15123 | 2385 | 17906 | 1983 | 19594 | 1652 | 21927 | 1103 | 27369 | 583 | 22212 |
| 6L-5S | | MI | 5984 | 2902 | 9543 | 2268 | 10966 | 1871 | 11881 | 1549 | 13153 | 1000 | 15826 | 525 | 12739 |
| 18-#11 | 3.55 | MA | 9785 | 2902 | 14584 | 2394 | 17147 | 2001 | 18764 | 1665 | 20733 | 1113 | 25786 | 541 | 21489 |
| 7L-4S | | MI | 6124 | 2902 | 9873 | 2248 | 11363 | 1863 | 12375 | 1533 | 13839 | 989 | 16720 | 590 | 13112 |
| 18-#11 | 3.55 | MA | 9510 | 2902 | 14066 | 2405 | 16448 | 2010 | 17884 | 1684 | 19594 | 1133 | 24261 | 483 | 20729 |
| 8L-3S | | MI | 6225 | 2902 | 10195 | 2238 | 11816 | 1845 | 12929 | 1527 | 14598 | 987 | 17621 | 650 | 13159 |
| 18-#11 | 3.55 | MA | 9238 | 2902 | 13486 | 2428 | 15729 | 2031 | 17022 | 1692 | 18429 | 1143 | 22759 | 429 | 19695 |
| 9L-2S | | MI | 6429 | 2902 | 10657 | 2228 | 12404 | 1837 | 13644 | 1511 | 15564 | 976 | 18895 | 762 | 13178 |
| 18-#14 | 5.11 | MA | 10719 | 3257 | 16585 | 2638 | 19626 | 2190 | 21740 | 1793 | 24690 | 1119 | 31360 | 350 | 29175 |
| 7L-4S | | MI | 6719 | 3257 | 11323 | 2463 | 13151 | 2022 | 14524 | 1631 | 16730 | 963 | 20323 | 415 | 17876 |
| 18-#14 | 5.11 | MA | 10333 | 3257 | 15844 | 2654 | 18625 | 2203 | 20493 | 1820 | 23057 | 1147 | 29169 | 264 | 27505 |
| 8L-3S | | MI | 6849 | 3257 | 11782 | 2450 | 13795 | 1997 | 15313 | 1624 | 17809 | 962 | 21583 | 499 | 18402 |
| 20-#10 | 3.21 | MA | 9938 | 2826 | 14857 | 2337 | 17630 | 1947 | 19314 | 1628 | 21585 | 1103 | 26884 | 656 | 20655 |
| 6E | | MI | 5825 | 2826 | 9125 | 2240 | 10472 | 1863 | 11304 | 1542 | 12398 | 1025 | 15037 | 561 | 11725 |
| 20-#10 | 3.21 | MA | 9756 | 2826 | 14413 | 2345 | 17005 | 1961 | 18630 | 1638 | 20604 | 1112 | 25593 | 623 | 20282 |
| 7L-5S | | MI | 5946 | 2826 | 9362 | 2233 | 10796 | 1847 | 11706 | 1536 | 12941 | 1015 | 15737 | 619 | 11903 |
| 20-#10 | 3.21 | MA | 9525 | 2826 | 13988 | 2355 | 16430 | 1970 | 17899 | 1653 | 19668 | 1130 | 24344 | 578 | 19633 |
| 8L-4S | | MI | 6068 | 2826 | 9635 | 2215 | 11125 | 1840 | 12114 | 1522 | 13509 | 1004 | 16499 | 672 | 12121 |
| 20-#10 | 3.21 | MA | 9301 | 2826 | 13507 | 2373 | 15839 | 1987 | 17191 | 1661 | 18711 | 1139 | 23118 | 534 | 18955 |
| 9L-3S | | MI | 6152 | 2826 | 9902 | 2206 | 11501 | 1825 | 12574 | 1517 | 14138 | 1001 | 17265 | 723 | 12150 |
| 20-#10 | 3.21 | MA | 9087 | 2826 | 13066 | 2380 | 15283 | 1997 | 16484 | 1678 | 17766 | 1155 | 21773 | 483 | 18249 |
| 10L-2S | | MI | 6325 | 2826 | 10287 | 2198 | 11990 | 1817 | 13169 | 1503 | 14944 | 990 | 18352 | 815 | 12163 |
| 20-#11 | 3.94 | MA | 10192 | 2991 | 15435 | 2450 | 18231 | 2041 | 20081 | 1690 | 22515 | 1108 | 28254 | 534 | 24025 |
| 7L-5S | | MI | 6184 | 2991 | 10005 | 2324 | 11554 | 1911 | 12596 | 1574 | 14120 | 995 | 17100 | 510 | 14086 |

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.94 | MA | 9919 | 2991 | 14918 | 2461 | 17532 | 2051 | 19201 | 1709 | 21376 | 1128 | 26728 | 476 | 23267 |
| 8L-4S | | MI | 6323 | 2991 | 10335 | 2303 | 11951 | 1903 | 13089 | 1558 | 14805 | 983 | 17994 | 575 | 14451 |
| 20-#11 | 3.94 | MA | 9654 | 2991 | 14337 | 2484 | 16813 | 2071 | 18339 | 1717 | 20211 | 1138 | 25226 | 422 | 22225 |
| 9L-3S | | MI | 6420 | 2991 | 10657 | 2294 | 12404 | 1885 | 13644 | 1553 | 15564 | 982 | 18895 | 635 | 14544 |
| 20-#14 | 5.68 | MA | 10905 | 3385 | 17061 | 2734 | 20174 | 2261 | 22375 | 1856 | 25603 | 1140 | 32695 | 253 | 31105 |
| 8L-4S | | MI | 6995 | 3385 | 11978 | 2543 | 13984 | 2080 | 15537 | 1667 | 18100 | 955 | 22097 | 389 | 19771 |
| 22-#10 | 3.53 | MA | 10092 | 2898 | 15115 | 2391 | 17898 | 1994 | 19716 | 1659 | 22073 | 1108 | 27627 | 617 | 22370 |
| 7L-6S | | MI | 5996 | 2898 | 9509 | 2286 | 10962 | 1896 | 11899 | 1563 | 13203 | 1021 | 16124 | 552 | 12857 |
| 22-#10 | 3.53 | MA | 9863 | 2898 | 14690 | 2400 | 17323 | 2002 | 18985 | 1674 | 21137 | 1125 | 26378 | 572 | 21728 |
| 8L-5S | | MI | 6114 | 2898 | 9747 | 2278 | 11286 | 1880 | 12301 | 1557 | 13746 | 1010 | 16824 | 610 | 13027 |
| 22-#10 | 3.53 | MA | 9644 | 2898 | 14209 | 2418 | 16733 | 2020 | 18276 | 1682 | 20181 | 1134 | 25152 | 528 | 21042 |
| 9L-4S | | MI | 6236 | 2898 | 10020 | 2261 | 11615 | 1873 | 12709 | 1543 | 14314 | 999 | 17586 | 663 | 13272 |
| 22-#10 | 3.53 | MA | 9438 | 2898 | 13768 | 2425 | 16177 | 2030 | 17570 | 1698 | 19236 | 1150 | 23807 | 477 | 20338 |
| 10L-3S | | MI | 6317 | 2898 | 10287 | 2252 | 11990 | 1857 | 13169 | 1537 | 14944 | 997 | 18352 | 714 | 13307 |
| 22-#11 | 4.33 | MA | 10321 | 3080 | 15769 | 2517 | 18616 | 2091 | 20517 | 1734 | 23158 | 1123 | 29196 | 469 | 25805 |
| 8L-5S | | MI | 6381 | 3080 | 10467 | 2379 | 12142 | 1952 | 13310 | 1599 | 15086 | 990 | 18374 | 495 | 15436 |
| 22-#11 | 4.33 | MA | 10064 | 3080 | 15189 | 2539 | 17898 | 2112 | 19656 | 1743 | 21993 | 1133 | 27694 | 415 | 24754 |
| 9L-4S | | MI | 6521 | 3080 | 10797 | 2359 | 12539 | 1944 | 13803 | 1583 | 15772 | 978 | 19268 | 560 | 15785 |
| 24-#10 | 3.85 | MA | 10196 | 2971 | 15392 | 2445 | 18217 | 2035 | 20070 | 1695 | 22607 | 1121 | 28412 | 566 | 23822 |
| 8L-6S | | MI | 6165 | 2971 | 9894 | 2331 | 11452 | 1929 | 12494 | 1583 | 14008 | 1017 | 17211 | 542 | 13990 |
| 24-#10 | 3.85 | MA | 9983 | 2971 | 14911 | 2464 | 17627 | 2053 | 19362 | 1702 | 21650 | 1130 | 27187 | 522 | 23129 |
| 9L-5S | | MI | 6281 | 2971 | 10132 | 2323 | 11776 | 1913 | 12896 | 1578 | 14551 | 1006 | 17911 | 601 | 14153 |
| 24-#10 | 3.85 | MA | 9791 | 2971 | 14470 | 2471 | 17071 | 2062 | 18656 | 1719 | 20705 | 1146 | 25841 | 471 | 22428 |
| 10L-4S | | MI | 6402 | 2971 | 10405 | 2306 | 12105 | 1906 | 13304 | 1564 | 15119 | 995 | 18674 | 654 | 14423 |
| 24-#11 | 4.73 | MA | 10469 | 3169 | 16040 | 2595 | 18982 | 2152 | 20972 | 1768 | 23775 | 1128 | 30161 | 407 | 27283 |
| 9L-5S | | MI | 6578 | 3169 | 10929 | 2435 | 12730 | 1992 | 14024 | 1625 | 16053 | 985 | 19647 | 480 | 16789 |

## RECTANGULAR TIED COLUMNS 22" x 38"

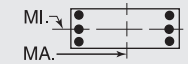
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.08 | MA | 9711 | 2474 | 13780 | 2083 | 16023 | 1757 | 17162 | 1503 | 18172 | 1123 | 21551 | 978 | 8241 |
| 2E | | MI | 5464 | 2474 | 8217 | 1970 | 9189 | 1660 | 9640 | 1418 | 9968 | 1056 | 11352 | 889 | 4571 |
| 4-#18 | 1.91 | MA | 10592 | 2674 | 15829 | 2193 | 18534 | 1834 | 20164 | 1548 | 22195 | 1102 | 27091 | 954 | 14206 |
| 2E | | MI | 5847 | 2674 | 9242 | 2068 | 10410 | 1728 | 11082 | 1455 | 11891 | 1029 | 13589 | 807 | 7608 |
| 6-#11 | 1.12 | MA | 9782 | 2484 | 13850 | 2098 | 16162 | 1768 | 17355 | 1511 | 18454 | 1127 | 21956 | 981 | 8593 |
| 2L-3S | | MI | 5269 | 2484 | 7786 | 2000 | 8683 | 1684 | 9046 | 1447 | 9180 | 1075 | 10391 | 790 | 4784 |
| 6-#11 | 1.12 | MA | 9291 | 2484 | 12943 | 2113 | 15007 | 1782 | 15952 | 1524 | 16556 | 1148 | 19328 | 882 | 8605 |
| 3L-2S | | MI | 5505 | 2484 | 8248 | 1990 | 9271 | 1676 | 9760 | 1431 | 10147 | 1063 | 11665 | 902 | 4754 |
| 6-#14 | 1.61 | MA | 10325 | 2602 | 15077 | 2164 | 17674 | 1815 | 19168 | 1539 | 20887 | 1116 | 25309 | 967 | 12183 |
| 2L-3S | | MI | 5424 | 2602 | 8217 | 2064 | 9189 | 1728 | 9640 | 1476 | 9968 | 1064 | 11352 | 701 | 6640 |
| 6-#14 | 1.61 | MA | 9649 | 2602 | 13780 | 2185 | 16023 | 1835 | 17162 | 1557 | 18172 | 1145 | 21551 | 822 | 12156 |
| 3L-2S | | MI | 5748 | 2602 | 8872 | 2050 | 10023 | 1719 | 10652 | 1455 | 11338 | 1049 | 13126 | 863 | 6604 |
| 6-#18 | 2.87 | MA | 11608 | 2902 | 18094 | 2336 | 21418 | 1938 | 23667 | 1613 | 26936 | 1089 | 33656 | 935 | 21050 |
| 2L-3S | | MI | 5793 | 2902 | 9242 | 2231 | 10410 | 1845 | 11082 | 1553 | 11891 | 1036 | 13589 | 459 | 11016 |
| 6-#18 | 2.87 | MA | 10518 | 2902 | 15829 | 2372 | 18534 | 1971 | 20164 | 1642 | 22195 | 1138 | 27091 | 670 | 20801 |
| 3L-2S | | MI | 6313 | 2902 | 10366 | 2211 | 11840 | 1832 | 12820 | 1520 | 14242 | 1015 | 16520 | 747 | 11047 |
| 8-#10 | 1.22 | MA | 9926 | 2507 | 14037 | 2122 | 16470 | 1787 | 17764 | 1526 | 19036 | 1132 | 22783 | 985 | 9360 |
| 2L-4S | | MI | 5283 | 2507 | 7685 | 2040 | 8580 | 1725 | 8945 | 1471 | 9060 | 1086 | 10393 | 777 | 5199 |
| 8-#10 | 1.22 | MA | 9524 | 2507 | 13290 | 2135 | 15518 | 1800 | 16608 | 1537 | 17472 | 1150 | 20617 | 905 | 9364 |
| 3E | | MI | 5388 | 2507 | 7951 | 2031 | 8955 | 1710 | 9405 | 1466 | 9690 | 1084 | 11158 | 828 | 5178 |
| 8-#10 | 1.22 | MA | 9318 | 2507 | 12787 | 2148 | 14807 | 1820 | 15735 | 1557 | 16275 | 1159 | 19190 | 856 | 9331 |
| 4L-2S | | MI | 5584 | 2507 | 8336 | 2023 | 9445 | 1702 | 10000 | 1451 | 10495 | 1073 | 12245 | 920 | 5157 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

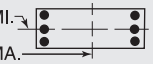



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.49 | MA | 10215 | 2573 | 14757 | 2153 | 17317 | 1808 | 18758 | 1537 | 20353 | 1122 | 24585 | 974 | 11348 |
| 2L-4S | | MI | 5354 | 2573 | 7926 | 2065 | 8819 | 1742 | 9205 | 1478 | 9388 | 1071 | 10764 | 714 | 6227 |
| 8-#11 | 1.49 | MA | 9739 | 2573 | 13850 | 2169 | 16162 | 1823 | 17355 | 1550 | 18454 | 1143 | 21956 | 875 | 11342 |
| 3E | | MI | 5478 | 2573 | 8248 | 2055 | 9271 | 1724 | 9760 | 1472 | 10147 | 1070 | 11665 | 775 | 6208 |
| 8-#11 | 1.49 | MA | 9496 | 2573 | 13238 | 2184 | 15297 | 1847 | 16293 | 1573 | 16998 | 1154 | 20210 | 813 | 11271 |
| 4L-2S | | MI | 5707 | 2573 | 8709 | 2046 | 9859 | 1717 | 10474 | 1457 | 11113 | 1058 | 12939 | 887 | 6184 |
| 8-#14 | 2.15 | MA | 10924 | 2731 | 16374 | 2244 | 19326 | 1873 | 21173 | 1575 | 23601 | 1108 | 29068 | 957 | 16108 |
| 2L-4S | | MI | 5545 | 2731 | 8414 | 2157 | 9379 | 1812 | 9863 | 1519 | 10259 | 1056 | 11866 | 592 | 8594 |
| 8-#14 | 2.15 | MA | 10276 | 2731 | 15077 | 2266 | 17674 | 1893 | 19168 | 1594 | 20887 | 1138 | 25309 | 812 | 16051 |
| 3E | | MI | 5715 | 2731 | 8872 | 2144 | 10023 | 1787 | 10652 | 1513 | 11338 | 1056 | 13126 | 676 | 8631 |
| 8-#14 | 2.15 | MA | 9945 | 2731 | 14200 | 2287 | 16435 | 1928 | 17646 | 1627 | 18801 | 1152 | 22797 | 723 | 15798 |
| 4L-2S | | MI | 6027 | 2731 | 9527 | 2131 | 10856 | 1777 | 11664 | 1491 | 12709 | 1041 | 14899 | 838 | 8613 |
| 8-#18 | 3.83 | MA | 11572 | 3131 | 18094 | 2515 | 21418 | 2075 | 23667 | 1707 | 26936 | 1125 | 33656 | 652 | 27576 |
| 3E | | MI | 6276 | 3131 | 10366 | 2373 | 11840 | 1949 | 12820 | 1618 | 14242 | 1022 | 16520 | 400 | 14363 |
| 8-#18 | 3.83 | MA | 11051 | 3131 | 16555 | 2552 | 19245 | 2135 | 21000 | 1763 | 23281 | 1148 | 29216 | 491 | 25216 |
| 4L-2S | | MI | 6773 | 3131 | 11489 | 2354 | 13271 | 1936 | 14557 | 1585 | 16594 | 1002 | 19451 | 687 | 14453 |
| 10-#10 | 1.52 | MA | 10284 | 2580 | 14785 | 2168 | 17421 | 1820 | 18919 | 1546 | 20600 | 1128 | 24949 | 979 | 11626 |
| 2L-5S | | MI | 5337 | 2580 | 7796 | 2103 | 8741 | 1765 | 9132 | 1506 | 9297 | 1093 | 10717 | 715 | 6363 |
| 10-#10 | 1.52 | MA | 9892 | 2580 | 14037 | 2181 | 16470 | 1833 | 17764 | 1557 | 19036 | 1146 | 22783 | 900 | 11619 |
| 3L-4S | | MI | 5462 | 2580 | 8069 | 2086 | 9070 | 1758 | 9540 | 1492 | 9865 | 1082 | 11480 | 768 | 6371 |
| 10-#10 | 1.52 | MA | 9696 | 2580 | 13534 | 2194 | 15759 | 1853 | 16891 | 1577 | 17839 | 1155 | 21355 | 850 | 11573 |
| 4L-3S | | MI | 5563 | 2580 | 8336 | 2077 | 9445 | 1742 | 10000 | 1486 | 10495 | 1080 | 12245 | 819 | 6358 |
| 10-#10 | 1.52 | MA | 9397 | 2580 | 13015 | 2214 | 15143 | 1865 | 16123 | 1588 | 16768 | 1173 | 19897 | 812 | 11443 |
| 5L-2S | | MI | 5755 | 2580 | 8721 | 2068 | 9935 | 1735 | 10595 | 1472 | 11300 | 1069 | 13332 | 911 | 6341 |
| 10-#11 | 1.87 | MA | 10640 | 2662 | 15664 | 2209 | 18472 | 1849 | 20161 | 1562 | 22251 | 1117 | 27214 | 967 | 14096 |
| 2L-5S | | MI | 5422 | 2662 | 8057 | 2141 | 9009 | 1791 | 9426 | 1519 | 9669 | 1078 | 11144 | 634 | 7485 |
| 10-#11 | 1.87 | MA | 10179 | 2662 | 14757 | 2224 | 17317 | 1863 | 18758 | 1575 | 20353 | 1138 | 24585 | 867 | 14074 |
| 3L-4S | | MI | 5564 | 2662 | 8387 | 2121 | 9407 | 1783 | 9919 | 1503 | 10355 | 1066 | 12038 | 700 | 7623 |
| 10-#11 | 1.87 | MA | 9948 | 2662 | 14145 | 2240 | 16451 | 1888 | 17696 | 1598 | 18896 | 1149 | 22838 | 806 | 13986 |
| 4L-3S | | MI | 5683 | 2662 | 8709 | 2111 | 9859 | 1765 | 10474 | 1498 | 11113 | 1065 | 12939 | 760 | 7619 |
| 10-#11 | 1.87 | MA | 9593 | 2662 | 13518 | 2265 | 15701 | 1902 | 16761 | 1611 | 17593 | 1170 | 21059 | 757 | 13606 |
| 5L-2S | | MI | 5908 | 2662 | 9171 | 2101 | 10447 | 1757 | 11188 | 1482 | 12080 | 1053 | 14213 | 872 | 7601 |
| 10-#14 | 2.69 | MA | 10888 | 2859 | 16374 | 2346 | 19326 | 1952 | 21173 | 1630 | 23601 | 1130 | 29068 | 802 | 19943 |
| 3L-4S | | MI | 5839 | 2859 | 9068 | 2237 | 10213 | 1870 | 10875 | 1556 | 11630 | 1049 | 13639 | 566 | 10507 |
| 10-#14 | 2.69 | MA | 10581 | 2859 | 15497 | 2368 | 18086 | 1987 | 19652 | 1663 | 21516 | 1145 | 26555 | 713 | 19675 |
| 4L-3S | | MI | 6000 | 2859 | 9527 | 2224 | 10856 | 1845 | 11664 | 1549 | 12709 | 1049 | 14899 | 650 | 10606 |
| 10-#14 | 2.69 | MA | 10083 | 2859 | 14604 | 2404 | 17010 | 2007 | 18312 | 1681 | 19648 | 1174 | 24001 | 640 | 18392 |
| 5L-2S | | MI | 6303 | 2859 | 10181 | 2211 | 11690 | 1835 | 12677 | 1528 | 14079 | 1034 | 16673 | 812 | 10607 |
| 10-#18 | 4.78 | MA | 12129 | 3359 | 18821 | 2694 | 22130 | 2238 | 24503 | 1828 | 28023 | 1134 | 35781 | 473 | 31930 |
| 4L-3S | | MI | 6750 | 3359 | 11489 | 2516 | 13271 | 2052 | 14557 | 1682 | 16594 | 1009 | 19451 | 340 | 17703 |
| 10-#18 | 4.78 | MA | 11289 | 3359 | 17252 | 2758 | 20239 | 2272 | 22151 | 1857 | 24745 | 1184 | 31284 | 334 | 29443 |
| 5L-2S | | MI | 7221 | 3359 | 12613 | 2497 | 14702 | 2039 | 16295 | 1649 | 18945 | 989 | 22383 | 628 | 17837 |
| 12-#10 | 1.82 | MA | 10637 | 2652 | 15532 | 2213 | 18373 | 1853 | 20075 | 1567 | 22164 | 1124 | 27114 | 973 | 13887 |
| 2L-6S | | MI | 5382 | 2652 | 7943 | 2156 | 8906 | 1814 | 9324 | 1532 | 9559 | 1100 | 11105 | 647 | 7293 |
| 12-#10 | 1.82 | MA | 10255 | 2652 | 14785 | 2226 | 17421 | 1865 | 18919 | 1578 | 20600 | 1142 | 24949 | 894 | 13871 |
| 3L-5S | | MI | 5515 | 2652 | 8181 | 2148 | 9231 | 1798 | 9727 | 1526 | 10103 | 1089 | 11804 | 706 | 7514 |
| 12-#10 | 1.82 | MA | 10068 | 2652 | 14282 | 2239 | 16710 | 1886 | 18046 | 1598 | 19403 | 1151 | 23521 | 845 | 13815 |
| 4E | | MI | 5639 | 2652 | 8454 | 2131 | 9560 | 1791 | 10135 | 1512 | 10670 | 1078 | 12567 | 759 | 7535 |
| 12-#10 | 1.82 | MA | 9771 | 2652 | 13762 | 2260 | 16094 | 1898 | 17279 | 1609 | 18332 | 1169 | 22063 | 806 | 13678 |
| 5L-3S | | MI | 5736 | 2652 | 8721 | 2122 | 9935 | 1775 | 10595 | 1507 | 11300 | 1075 | 13332 | 810 | 7531 |
| 12-#10 | 1.82 | MA | 9508 | 2652 | 13263 | 2266 | 15502 | 1909 | 16525 | 1629 | 17284 | 1178 | 20640 | 740 | 13136 |
| 6L-2S | | MI | 5924 | 2652 | 9106 | 2113 | 10425 | 1768 | 11190 | 1493 | 12105 | 1065 | 14419 | 901 | 7519 |
| 12-#11 | 2.24 | MA | 10610 | 2751 | 15664 | 2280 | 18472 | 1904 | 20161 | 1600 | 22251 | 1133 | 27214 | 860 | 16803 |
| 3L-5S | | MI | 5630 | 2751 | 8519 | 2197 | 9597 | 1831 | 10140 | 1544 | 10636 | 1072 | 12417 | 619 | 8809 |
| 12-#11 | 2.24 | MA | 10392 | 2751 | 15052 | 2295 | 17606 | 1928 | 19099 | 1624 | 20795 | 1143 | 25467 | 799 | 16702 |
| 4E | | MI | 5772 | 2751 | 8849 | 2177 | 9995 | 1823 | 10633 | 1529 | 11321 | 1061 | 13311 | 685 | 9011 |
| 12-#11 | 2.24 | MA | 10040 | 2751 | 14425 | 2321 | 16856 | 1943 | 18164 | 1637 | 19491 | 1165 | 23688 | 750 | 16277 |
| 5L-3S | | MI | 5887 | 2751 | 9171 | 2167 | 10447 | 1805 | 11188 | 1523 | 12080 | 1060 | 14213 | 745 | 9023 |

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis



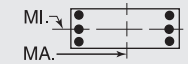

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.24 | MA | 9727 | 2751 | 13819 | 2328 | 16144 | 1956 | 17246 | 1660 | 18249 | 1186 | 21951 | 667 | 15602 |
| 6L-2S | | MI | 6106 | 2751 | 9633 | 2157 | 11035 | 1798 | 11902 | 1507 | 13046 | 1048 | 15486 | 857 | 9012 |
| 12-#14 | 3.23 | MA | 11202 | 2988 | 16794 | 2448 | 19737 | 2045 | 21658 | 1700 | 24230 | 1137 | 30314 | 702 | 23556 |
| 4E | | MI | 6129 | 2988 | 9723 | 2318 | 11046 | 1928 | 11888 | 1592 | 13000 | 1041 | 15413 | 541 | 12358 |
| 12-#14 | 3.23 | MA | 10708 | 2988 | 15901 | 2485 | 18661 | 2065 | 20317 | 1718 | 22362 | 1167 | 27760 | 629 | 22243 |
| 5L-3S | | MI | 6282 | 2988 | 10181 | 2304 | 11690 | 1903 | 12677 | 1586 | 14079 | 1041 | 16673 | 625 | 12573 |
| 12-#14 | 3.23 | MA | 10280 | 2988 | 15034 | 2495 | 17650 | 2085 | 19001 | 1751 | 20581 | 1196 | 25267 | 507 | 21187 |
| 6L-2S | | MI | 6576 | 2988 | 10836 | 2291 | 12523 | 1894 | 13689 | 1564 | 15449 | 1026 | 18446 | 787 | 12594 |
| 12-#18 | 5.74 | MA | 12345 | 3587 | 19518 | 2900 | 23124 | 2375 | 25654 | 1922 | 29487 | 1170 | 37849 | 316 | 36109 |
| 5L-3S | | MI | 7243 | 3587 | 12613 | 2659 | 14702 | 2156 | 16295 | 1747 | 18945 | 996 | 22383 | 280 | 21041 |
| 12-#18 | 5.74 | MA | 11655 | 3587 | 18025 | 2919 | 21347 | 2408 | 23343 | 1978 | 26360 | 1219 | 33450 | 94 | 32853 |
| 6L-2S | | MI | 7659 | 3587 | 13736 | 2639 | 16132 | 2143 | 18032 | 1714 | 21297 | 976 | 25314 | 568 | 21211 |
| 14-#10 | 2.13 | MA | 10613 | 2725 | 15532 | 2271 | 18373 | 1898 | 20075 | 1599 | 22164 | 1137 | 27114 | 888 | 16121 |
| 3L-6S | | MI | 5560 | 2725 | 8328 | 2201 | 9396 | 1847 | 9919 | 1553 | 10365 | 1095 | 12192 | 638 | 8413 |
| 14-#10 | 2.13 | MA | 10434 | 2725 | 15029 | 2284 | 17662 | 1919 | 19202 | 1618 | 20967 | 1147 | 25687 | 839 | 16057 |
| 4L-5S | | MI | 5690 | 2725 | 8566 | 2194 | 9721 | 1831 | 10322 | 1547 | 10908 | 1085 | 12891 | 697 | 8622 |
| 14-#10 | 2.13 | MA | 10139 | 2725 | 14509 | 2305 | 17046 | 1931 | 18434 | 1630 | 19896 | 1165 | 24229 | 801 | 15915 |
| 5L-4S | | MI | 5813 | 2725 | 8839 | 2176 | 10050 | 1824 | 10730 | 1533 | 11476 | 1074 | 13654 | 750 | 8694 |
| 14-#10 | 2.13 | MA | 9883 | 2725 | 14011 | 2311 | 16454 | 1942 | 17681 | 1649 | 18848 | 1174 | 22806 | 734 | 15356 |
| 6L-3S | | MI | 5907 | 2725 | 9106 | 2167 | 10425 | 1808 | 11190 | 1527 | 12105 | 1071 | 14419 | 801 | 8700 |
| 14-#10 | 2.13 | MA | 9667 | 2725 | 13539 | 2320 | 15789 | 1957 | 16947 | 1659 | 17835 | 1192 | 21440 | 702 | 14944 |
| 7L-2S | | MI | 6092 | 2725 | 9490 | 2159 | 10915 | 1801 | 11785 | 1513 | 12911 | 1060 | 15506 | 892 | 8692 |
| 14-#11 | 2.61 | MA | 10828 | 2841 | 15959 | 2351 | 18761 | 1969 | 20501 | 1649 | 22693 | 1138 | 28096 | 792 | 19420 |
| 4L-5S | | MI | 5836 | 2841 | 8981 | 2252 | 10185 | 1872 | 10854 | 1570 | 11602 | 1067 | 13691 | 604 | 10140 |
| 14-#11 | 2.61 | MA | 10478 | 2841 | 15332 | 2376 | 18011 | 1983 | 19566 | 1662 | 21390 | 1159 | 26316 | 743 | 18954 |
| 5L-4S | | MI | 5978 | 2841 | 9311 | 2232 | 10583 | 1864 | 11348 | 1554 | 12287 | 1056 | 14585 | 670 | 10396 |
| 14-#11 | 2.61 | MA | 10176 | 2841 | 14726 | 2384 | 17299 | 1997 | 18648 | 1685 | 20147 | 1181 | 24580 | 659 | 18302 |
| 6L-3S | | MI | 6088 | 2841 | 9633 | 2222 | 11035 | 1846 | 11902 | 1548 | 13046 | 1054 | 15486 | 730 | 10418 |
| 14-#11 | 2.61 | MA | 9919 | 2841 | 14152 | 2394 | 16491 | 2015 | 17767 | 1698 | 18879 | 1191 | 22907 | 618 | 17610 |
| 7L-2S | | MI | 6302 | 2841 | 10095 | 2213 | 11623 | 1838 | 12616 | 1532 | 14013 | 1043 | 16760 | 842 | 10417 |
| 14-#14 | 3.77 | MA | 11320 | 3116 | 17198 | 2565 | 20312 | 2123 | 22323 | 1754 | 25076 | 1159 | 31518 | 619 | 26100 |
| 5L-4S | | MI | 6415 | 3116 | 10377 | 2398 | 11880 | 1987 | 12900 | 1629 | 14370 | 1034 | 17187 | 515 | 14223 |
| 14-#14 | 3.77 | MA | 10909 | 3116 | 16331 | 2575 | 19301 | 2143 | 21007 | 1787 | 23295 | 1189 | 29026 | 496 | 25032 |
| 6L-3S | | MI | 6560 | 3116 | 10836 | 2385 | 12523 | 1962 | 13689 | 1622 | 15449 | 1034 | 18446 | 599 | 14535 |
| 14-#14 | 3.77 | MA | 10560 | 3116 | 15509 | 2589 | 18144 | 2169 | 19743 | 1805 | 21477 | 1204 | 26617 | 436 | 23517 |
| 7L-2S | | MI | 6847 | 3116 | 11491 | 2372 | 13357 | 1952 | 14702 | 1600 | 16819 | 1019 | 20220 | 761 | 14570 |
| 14-#18 | 6.70 | MA | 12724 | 3816 | 20290 | 3062 | 24231 | 2512 | 26846 | 2043 | 31101 | 1206 | 40015 | 75 | 39553 |
| 6L-3S | | MI | 7698 | 3816 | 13736 | 2802 | 16132 | 2260 | 18032 | 1812 | 21297 | 982 | 25314 | 221 | 24352 |
| 16-#10 | 2.43 | MA | 10795 | 2797 | 15776 | 2330 | 18613 | 1952 | 20358 | 1639 | 22531 | 1143 | 27852 | 833 | 18299 |
| 4L-6S | | MI | 5736 | 2797 | 8713 | 2247 | 9886 | 1880 | 10515 | 1573 | 11170 | 1091 | 13279 | 629 | 9537 |
| 16-#10 | 2.43 | MA | 10501 | 2797 | 15257 | 2350 | 17997 | 1964 | 19590 | 1650 | 21460 | 1161 | 26394 | 795 | 18152 |
| 5E | | MI | 5863 | 2797 | 8951 | 2239 | 10211 | 1864 | 10917 | 1567 | 11713 | 1080 | 13978 | 688 | 9735 |
| 16-#10 | 2.43 | MA | 10252 | 2797 | 14758 | 2356 | 17405 | 1975 | 18837 | 1670 | 20412 | 1170 | 24971 | 729 | 17578 |
| 6L-4S | | MI | 5986 | 2797 | 9224 | 2222 | 10539 | 1857 | 11325 | 1553 | 12281 | 1069 | 14741 | 741 | 9851 |
| 16-#10 | 2.43 | MA | 10043 | 2797 | 14286 | 2365 | 16741 | 1990 | 18103 | 1680 | 19399 | 1188 | 23606 | 696 | 17179 |
| 7L-3S | | MI | 6077 | 2797 | 9490 | 2213 | 10915 | 1841 | 11785 | 1548 | 12911 | 1067 | 15506 | 792 | 9864 |
| 16-#10 | 2.43 | MA | 9789 | 2797 | 13835 | 2375 | 16130 | 1999 | 17326 | 1695 | 18405 | 1206 | 22282 | 652 | 16513 |
| 8L-2S | | MI | 6258 | 2797 | 9875 | 2204 | 11405 | 1834 | 12380 | 1534 | 13716 | 1056 | 16593 | 883 | 9862 |
| 16-#11 | 2.99 | MA | 10909 | 2930 | 16239 | 2432 | 19166 | 2023 | 20969 | 1687 | 23288 | 1154 | 28945 | 736 | 21637 |
| 5E | | MI | 6040 | 2930 | 9443 | 2308 | 10773 | 1912 | 11568 | 1595 | 12568 | 1062 | 14965 | 589 | 11477 |
| 16-#11 | 2.99 | MA | 10616 | 2930 | 15633 | 2439 | 18454 | 2037 | 20051 | 1711 | 22046 | 1175 | 27209 | 652 | 21005 |
| 6L-4S | | MI | 6181 | 2930 | 9773 | 2288 | 11171 | 1904 | 12062 | 1579 | 13254 | 1050 | 15859 | 655 | 11778 |
| 16-#11 | 2.99 | MA | 10370 | 2930 | 15059 | 2449 | 17646 | 2055 | 19169 | 1724 | 20778 | 1186 | 25535 | 611 | 20312 |
| 7L-3S | | MI | 6287 | 2930 | 10095 | 2278 | 11623 | 1886 | 12616 | 1573 | 14013 | 1049 | 16760 | 715 | 11810 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

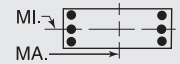



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.99 | MA | 10069 | 2930 | 14509 | 2461 | 16902 | 2065 | 18224 | 1742 | 19567 | 1207 | 23918 | 555 | 19462 |
| 8L-2S | | MI | 6496 | 2930 | 10556 | 2268 | 12211 | 1879 | 13330 | 1558 | 14979 | 1038 | 18034 | 827 | 11818 |
| 16-#14 | 4.31 | MA | 11526 | 3245 | 17628 | 2655 | 20953 | 2202 | 23013 | 1824 | 26010 | 1182 | 32784 | 486 | 28877 |
| 6L-4S | | MI | 6697 | 3245 | 11032 | 2478 | 12713 | 2045 | 13913 | 1665 | 15740 | 1026 | 18960 | 490 | 16099 |
| 16-#14 | 4.31 | MA | 11194 | 3245 | 16806 | 2669 | 19796 | 2227 | 21749 | 1842 | 24192 | 1196 | 30375 | 426 | 27372 |
| 7L-3S | | MI | 6836 | 3245 | 11491 | 2465 | 13357 | 2020 | 14702 | 1658 | 16819 | 1026 | 20220 | 574 | 16494 |
| 16-#14 | 4.31 | MA | 10772 | 3245 | 16018 | 2685 | 18731 | 2241 | 20408 | 1869 | 22456 | 1226 | 28052 | 343 | 25684 |
| 8L-2S | | MI | 7115 | 3245 | 12145 | 2452 | 14191 | 2010 | 15714 | 1637 | 18189 | 1011 | 21994 | 736 | 16542 |
| 18-#10 | 2.73 | MA | 10858 | 2870 | 16004 | 2395 | 18949 | 1997 | 20746 | 1671 | 23024 | 1156 | 28560 | 789 | 20362 |
| 5L-6S | | MI | 5910 | 2870 | 9098 | 2292 | 10376 | 1913 | 11110 | 1594 | 11975 | 1087 | 14366 | 620 | 10663 |
| 18-#10 | 2.73 | MA | 10616 | 2870 | 15505 | 2402 | 18357 | 2008 | 19992 | 1690 | 21976 | 1166 | 27137 | 723 | 19804 |
| 6L-5S | | MI | 6034 | 2870 | 9335 | 2284 | 10700 | 1897 | 11512 | 1588 | 12518 | 1076 | 15065 | 679 | 10852 |
| 18-#10 | 2.73 | MA | 10414 | 2870 | 15034 | 2410 | 17692 | 2023 | 19258 | 1701 | 20963 | 1184 | 25772 | 690 | 19416 |
| 7L-4S | | MI | 6157 | 2870 | 9608 | 2267 | 11029 | 1890 | 11920 | 1574 | 13086 | 1065 | 15828 | 732 | 11005 |
| 18-#10 | 2.73 | MA | 10162 | 2870 | 14582 | 2420 | 17081 | 2031 | 18482 | 1716 | 19969 | 1202 | 24448 | 646 | 18744 |
| 8L-3S | | MI | 6245 | 2870 | 9875 | 2258 | 11405 | 1874 | 12380 | 1568 | 13716 | 1063 | 16593 | 783 | 11025 |
| 18-#10 | 2.73 | MA | 9915 | 2870 | 14067 | 2438 | 16454 | 2049 | 17729 | 1724 | 18953 | 1211 | 23152 | 603 | 18086 |
| 9L-2S | | MI | 6422 | 2870 | 10260 | 2249 | 11895 | 1867 | 12975 | 1554 | 14521 | 1052 | 17680 | 874 | 11029 |
| 18-#11 | 3.36 | MA | 11050 | 3019 | 16540 | 2495 | 19609 | 2078 | 21454 | 1736 | 23944 | 1170 | 29837 | 645 | 23711 |
| 6L-5S | | MI | 6242 | 3019 | 9905 | 2364 | 11361 | 1952 | 12282 | 1620 | 13535 | 1057 | 16239 | 574 | 12819 |
| 18-#11 | 3.36 | MA | 10813 | 3019 | 15966 | 2505 | 18801 | 2096 | 20572 | 1749 | 22676 | 1181 | 28164 | 604 | 23015 |
| 7L-4S | | MI | 6382 | 3019 | 10234 | 2344 | 11758 | 1945 | 12776 | 1604 | 14220 | 1045 | 17133 | 640 | 13158 |
| 18-#11 | 3.36 | MA | 10515 | 3019 | 15417 | 2517 | 18057 | 2106 | 19627 | 1767 | 21466 | 1202 | 26547 | 548 | 22166 |
| 8L-3S | | MI | 6484 | 3019 | 10556 | 2334 | 12211 | 1927 | 13330 | 1599 | 14979 | 1044 | 18034 | 700 | 13198 |
| 18-#11 | 3.36 | MA | 10222 | 3019 | 14796 | 2539 | 17294 | 2127 | 18711 | 1776 | 20228 | 1213 | 24959 | 494 | 21123 |
| 9L-2S | | MI | 6690 | 3019 | 11018 | 2324 | 12799 | 1919 | 14045 | 1583 | 15946 | 1032 | 19308 | 812 | 13214 |
| 18-#14 | 4.84 | MA | 11816 | 3373 | 18103 | 2750 | 21447 | 2286 | 23755 | 1878 | 26906 | 1189 | 34133 | 416 | 31227 |
| 7L-4S | | MI | 6977 | 3373 | 11687 | 2558 | 13547 | 2103 | 14925 | 1701 | 17110 | 1019 | 20734 | 464 | 17984 |
| 18-#14 | 4.84 | MA | 11398 | 3373 | 17315 | 2766 | 20382 | 2299 | 22414 | 1905 | 25171 | 1218 | 31810 | 332 | 29524 |
| 8L-3S | | MI | 7109 | 3373 | 12145 | 2545 | 14191 | 2079 | 15714 | 1695 | 18189 | 1019 | 21994 | 549 | 18451 |
| 20-#10 | 3.04 | MA | 10975 | 2942 | 16253 | 2447 | 19308 | 2041 | 21148 | 1711 | 23540 | 1162 | 29302 | 717 | 22031 |
| 6E | | MI | 6082 | 2942 | 9482 | 2337 | 10866 | 1946 | 11705 | 1614 | 12781 | 1083 | 15453 | 611 | 11792 |
| 20-#10 | 3.04 | MA | 10779 | 2942 | 15781 | 2456 | 18644 | 2056 | 20414 | 1721 | 22527 | 1180 | 27937 | 684 | 21654 |
| 7L-5S | | MI | 6204 | 2942 | 9720 | 2329 | 11190 | 1930 | 12107 | 1609 | 13324 | 1072 | 16152 | 670 | 11972 |
| 20-#10 | 3.04 | MA | 10529 | 2942 | 15329 | 2465 | 18033 | 2064 | 19637 | 1736 | 21534 | 1197 | 26613 | 640 | 20974 |
| 8L-4S | | MI | 6326 | 2942 | 9993 | 2312 | 11519 | 1923 | 12515 | 1594 | 13892 | 1061 | 16915 | 723 | 12159 |
| 20-#10 | 3.04 | MA | 10289 | 2942 | 14814 | 2483 | 17406 | 2082 | 18885 | 1745 | 20518 | 1207 | 25318 | 597 | 20308 |
| 9L-3S | | MI | 6412 | 2942 | 10260 | 2303 | 11895 | 1907 | 12975 | 1589 | 14521 | 1059 | 17680 | 774 | 12183 |
| 20-#10 | 3.04 | MA | 10059 | 2942 | 14345 | 2491 | 16816 | 2092 | 18134 | 1762 | 19503 | 1222 | 23892 | 547 | 19537 |
| 10L-2S | | MI | 6586 | 2942 | 10645 | 2295 | 12384 | 1900 | 13570 | 1575 | 15326 | 1048 | 18767 | 865 | 12193 |
| 20-#11 | 3.73 | MA | 11249 | 3108 | 16873 | 2561 | 19956 | 2136 | 21975 | 1774 | 24575 | 1176 | 30793 | 597 | 25720 |
| 7L-5S | | MI | 6442 | 3108 | 10366 | 2419 | 11949 | 1993 | 12996 | 1645 | 14501 | 1052 | 17513 | 559 | 14165 |
| 20-#11 | 3.73 | MA | 10953 | 3108 | 16324 | 2572 | 19212 | 2146 | 21030 | 1792 | 23364 | 1197 | 29175 | 541 | 24871 |
| 8L-4S | | MI | 6582 | 3108 | 10696 | 2399 | 12346 | 1985 | 13490 | 1629 | 15187 | 1040 | 18407 | 625 | 14537 |
| 20-#11 | 3.73 | MA | 10669 | 3108 | 15703 | 2595 | 18449 | 2167 | 20114 | 1802 | 22126 | 1208 | 27587 | 487 | 23818 |
| 9L-3S | | MI | 6680 | 3108 | 11018 | 2389 | 12799 | 1967 | 14045 | 1624 | 15946 | 1039 | 19308 | 685 | 14585 |
| 20-#11 | 3.73 | MA | 10410 | 3108 | 15132 | 2603 | 17730 | 2179 | 19200 | 1822 | 20910 | 1228 | 25975 | 438 | 22809 |
| 10L-2S | | MI | 6881 | 3108 | 11480 | 2380 | 13387 | 1959 | 14759 | 1608 | 16912 | 1027 | 20582 | 797 | 14606 |
| 20-#14 | 5.38 | MA | 12012 | 3502 | 18612 | 2846 | 22033 | 2357 | 24419 | 1941 | 27885 | 1211 | 35569 | 322 | 33363 |
| 8L-4S | | MI | 7254 | 3502 | 12341 | 2639 | 14380 | 2162 | 15937 | 1738 | 18480 | 1011 | 22507 | 439 | 19877 |
| 22-#10 | 3.34 | MA | 11140 | 3015 | 16528 | 2501 | 19595 | 2089 | 21570 | 1742 | 24091 | 1175 | 30103 | 678 | 23894 |
| 7L-6S | | MI | 6253 | 3015 | 9867 | 2383 | 11356 | 1979 | 12300 | 1635 | 13586 | 1079 | 16540 | 602 | 12923 |
| 22-#10 | 3.34 | MA | 10892 | 3015 | 16077 | 2511 | 18984 | 2097 | 20793 | 1757 | 23098 | 1193 | 28779 | 634 | 23205 |
| 8L-5S | | MI | 6373 | 3015 | 10105 | 2375 | 11680 | 1963 | 12702 | 1629 | 14129 | 1068 | 17239 | 661 | 13096 |
| 22-#10 | 3.34 | MA | 10657 | 3015 | 15562 | 2529 | 18357 | 2115 | 20041 | 1765 | 22082 | 1203 | 27483 | 591 | 22530 |
| 9L-4S | | MI | 6495 | 3015 | 10378 | 2358 | 12009 | 1956 | 13110 | 1615 | 14697 | 1057 | 18002 | 713 | 13311 |
| 22-#10 | 3.34 | MA | 10436 | 3015 | 15093 | 2536 | 17767 | 2125 | 19290 | 1782 | 21067 | 1218 | 26057 | 541 | 21762 |
| 10L-3S | | MI | 6577 | 3015 | 10645 | 2349 | 12384 | 1940 | 13570 | 1609 | 15326 | 1054 | 18767 | 764 | 13341 |

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 3.34 | MA | 10192 | 3015 | 14635 | 2545 | 17176 | 2134 | 18556 | 1792 | 20029 | 1225 | 24768 | 495 | 20945 |
| 11L-2S | | MI | 6748 | 3015 | 11029 | 2340 | 12874 | 1933 | 14165 | 1595 | 16132 | 1043 | 19854 | 856 | 13354 |
| 22-#11 | 4.11 | MA | 11385 | 3197 | 17231 | 2628 | 20367 | 2186 | 22433 | 1818 | 25263 | 1192 | 31804 | 533 | 27576 |
| 8L-5S | | MI | 6640 | 3197 | 10828 | 2475 | 12537 | 2033 | 13711 | 1671 | 15468 | 1047 | 18786 | 545 | 15514 |
| 22-#11 | 4.11 | MA | 11110 | 3197 | 16610 | 2650 | 19604 | 2208 | 21517 | 1827 | 24025 | 1203 | 30216 | 480 | 26513 |
| 9L-4S | | MI | 6780 | 3197 | 11158 | 2455 | 12934 | 2026 | 14204 | 1655 | 16153 | 1035 | 19680 | 610 | 15875 |
| 22-#11 | 4.11 | MA | 10859 | 3197 | 16039 | 2659 | 18885 | 2219 | 20603 | 1847 | 22808 | 1222 | 28604 | 430 | 25495 |
| 10L-3S | | MI | 6874 | 3197 | 11480 | 2445 | 13387 | 2008 | 14759 | 1649 | 16912 | 1034 | 20582 | 670 | 15970 |
| 24-#10 | 3.65 | MA | 11249 | 3087 | 16824 | 2556 | 19936 | 2130 | 21949 | 1778 | 24662 | 1189 | 30944 | 628 | 25435 |
| 8L-6S | | MI | 6423 | 3087 | 10252 | 2428 | 11846 | 2012 | 12895 | 1655 | 14391 | 1074 | 17627 | 593 | 14055 |
| 24-#10 | 3.65 | MA | 11021 | 3087 | 16309 | 2574 | 19309 | 2148 | 21196 | 1786 | 23646 | 1199 | 29649 | 585 | 24752 |
| 9L-5S | | MI | 6540 | 3087 | 10490 | 2420 | 12170 | 1996 | 13297 | 1650 | 14934 | 1063 | 18326 | 651 | 14222 |
| 24-#10 | 3.65 | MA | 10814 | 3087 | 15840 | 2582 | 18719 | 2158 | 20446 | 1803 | 22631 | 1214 | 28223 | 535 | 23987 |
| 10L-4S | | MI | 6661 | 3087 | 10763 | 2403 | 12499 | 1989 | 13705 | 1636 | 15502 | 1053 | 19089 | 704 | 14462 |
| 24-#10 | 3.65 | MA | 10565 | 3087 | 15382 | 2590 | 18127 | 2167 | 19711 | 1812 | 21593 | 1221 | 26934 | 489 | 23163 |
| 11L-3S | | MI | 6741 | 3087 | 11029 | 2394 | 12874 | 1973 | 14165 | 1630 | 16132 | 1050 | 19854 | 755 | 14497 |
| 24-#11 | 4.48 | MA | 11544 | 3286 | 17517 | 2706 | 20759 | 2248 | 22920 | 1852 | 25923 | 1197 | 32845 | 472 | 29208 |
| 9L-5S | | MI | 6837 | 3286 | 11290 | 2531 | 13125 | 2074 | 14425 | 1696 | 16434 | 1041 | 20060 | 530 | 16867 |
| 24-#11 | 4.48 | MA | 11302 | 3286 | 16946 | 2715 | 20039 | 2260 | 22006 | 1873 | 24707 | 1217 | 31233 | 423 | 28182 |
| 10L-4S | | MI | 6976 | 3286 | 11620 | 2511 | 13522 | 2066 | 14918 | 1680 | 17120 | 1030 | 20954 | 595 | 17212 |

## RECTANGULAR TIED COLUMNS 22" x 40"

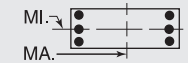
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.02 | MA | 10713 | 2591 | 15085 | 2193 | 17576 | 1850 | 18827 | 1584 | 19902 | 1188 | 23573 | 1035 | 8727 |
| 2E | | MI | 5721 | 2591 | 8581 | 2065 | 9585 | 1741 | 10040 | 1489 | 10349 | 1112 | 11763 | 938 | 4596 |
| 4-#18 | 1.82 | MA | 11661 | 2791 | 17266 | 2302 | 20249 | 1928 | 22023 | 1629 | 24185 | 1167 | 29471 | 1010 | 15070 |
| 2E | | MI | 6105 | 2791 | 9610 | 2162 | 10807 | 1808 | 11482 | 1525 | 12269 | 1084 | 13996 | 855 | 7644 |
| 6-#11 | 1.06 | MA | 10788 | 2601 | 15157 | 2207 | 17721 | 1861 | 19029 | 1593 | 20198 | 1192 | 23999 | 1038 | 9099 |
| 2L-3S | | MI | 5526 | 2601 | 8147 | 2096 | 9079 | 1766 | 9447 | 1519 | 9562 | 1132 | 10804 | 839 | 4807 |
| 6-#11 | 1.06 | MA | 10262 | 2601 | 14195 | 2223 | 16495 | 1876 | 17541 | 1606 | 18183 | 1214 | 21209 | 940 | 9110 |
| 3L-2S | | MI | 5762 | 2601 | 8609 | 2086 | 9667 | 1758 | 10161 | 1503 | 10528 | 1120 | 12078 | 952 | 4776 |
| 6-#14 | 1.53 | MA | 11371 | 2719 | 16462 | 2273 | 19329 | 1908 | 20957 | 1620 | 22785 | 1180 | 27564 | 1024 | 12912 |
| 2L-3S | | MI | 5681 | 2719 | 8581 | 2159 | 9585 | 1810 | 10040 | 1547 | 10349 | 1120 | 11763 | 751 | 6671 |
| 6-#14 | 1.53 | MA | 10646 | 2719 | 15085 | 2295 | 17576 | 1929 | 18827 | 1639 | 19902 | 1211 | 23573 | 881 | 12885 |
| 3L-2S | | MI | 6006 | 2719 | 9235 | 2146 | 10419 | 1800 | 11053 | 1526 | 11719 | 1105 | 13536 | 913 | 6633 |
| 6-#18 | 2.73 | MA | 12752 | 3019 | 19675 | 2445 | 23316 | 2031 | 25747 | 1694 | 29225 | 1154 | 36450 | 992 | 22346 |
| 2L-3S | | MI | 6049 | 3019 | 9610 | 2324 | 10807 | 1925 | 11482 | 1623 | 12269 | 1091 | 13996 | 508 | 11073 |
| 6-#18 | 2.73 | MA | 11580 | 3019 | 17266 | 2483 | 20249 | 2066 | 22023 | 1725 | 24185 | 1205 | 29471 | 731 | 22097 |
| 3L-2S | | MI | 6573 | 3019 | 10734 | 2305 | 12238 | 1912 | 13220 | 1590 | 14621 | 1071 | 16927 | 796 | 11088 |
| 8-#10 | 1.15 | MA | 10940 | 2624 | 15354 | 2232 | 18044 | 1881 | 19459 | 1607 | 20810 | 1197 | 24869 | 1041 | 9908 |
| 2L-4S | | MI | 5540 | 2624 | 8042 | 2137 | 8974 | 1808 | 9346 | 1543 | 9443 | 1144 | 10808 | 828 | 5222 |
| 8-#10 | 1.15 | MA | 10510 | 2624 | 14561 | 2245 | 17035 | 1893 | 18233 | 1619 | 19151 | 1215 | 22572 | 963 | 9912 |
| 3E | | MI | 5645 | 2624 | 8309 | 2128 | 9349 | 1792 | 9806 | 1538 | 10072 | 1141 | 11573 | 879 | 5199 |
| 8-#10 | 1.15 | MA | 10290 | 2624 | 14029 | 2258 | 16282 | 1914 | 17309 | 1639 | 17883 | 1225 | 21066 | 914 | 9880 |
| 4L-2S | | MI | 5842 | 2624 | 8694 | 2120 | 9839 | 1785 | 10401 | 1524 | 10878 | 1130 | 12660 | 970 | 5178 |
| 8-#11 | 1.42 | MA | 11251 | 2690 | 16120 | 2263 | 18947 | 1902 | 20518 | 1618 | 22213 | 1187 | 26789 | 1031 | 12022 |
| 2L-4S | | MI | 5610 | 2690 | 8287 | 2161 | 9214 | 1824 | 9606 | 1549 | 9770 | 1128 | 11177 | 764 | 6258 |
| 8-#11 | 1.42 | MA | 10742 | 2690 | 15157 | 2278 | 17721 | 1916 | 19029 | 1631 | 20198 | 1208 | 23999 | 933 | 12016 |
| 3E | | MI | 5735 | 2690 | 8609 | 2151 | 9667 | 1806 | 10161 | 1544 | 10528 | 1127 | 12078 | 824 | 6235 |
| 8-#11 | 1.42 | MA | 10482 | 2690 | 14509 | 2294 | 16804 | 1942 | 17904 | 1655 | 18655 | 1220 | 22155 | 872 | 11945 |
| 4L-2S | | MI | 5965 | 2690 | 9070 | 2142 | 10254 | 1799 | 10875 | 1528 | 11495 | 1115 | 13352 | 937 | 6209 |
| 8-#14 | 2.05 | MA | 12013 | 2848 | 17839 | 2353 | 21083 | 1967 | 23087 | 1657 | 25667 | 1173 | 31555 | 1014 | 17080 |
| 2L-4S | | MI | 5801 | 2848 | 8777 | 2252 | 9775 | 1893 | 10264 | 1590 | 10640 | 1113 | 12277 | 641 | 8643 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis

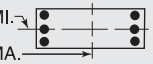



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.05 | MA | 11318 | 2848 | 16462 | 2376 | 19329 | 1987 | 20957 | 1676 | 22785 | 1203 | 27564 | 871 | 17023 |
| 3E | | MI | 5972 | 2848 | 9235 | 2239 | 10419 | 1868 | 11053 | 1584 | 11719 | 1113 | 13536 | 725 | 8667 |
| 8-#14 | 2.05 | MA | 10964 | 2848 | 15533 | 2398 | 18015 | 2023 | 19344 | 1710 | 20574 | 1219 | 24912 | 783 | 16770 |
| 4L-2S | | MI | 6286 | 2848 | 9890 | 2226 | 11252 | 1858 | 12065 | 1562 | 13089 | 1098 | 15310 | 887 | 8644 |
| 8-#18 | 3.64 | MA | 12710 | 3247 | 19675 | 2625 | 23316 | 2170 | 25747 | 1790 | 29225 | 1192 | 36450 | 712 | 29304 |
| 3E | | MI | 6533 | 3247 | 10734 | 2467 | 12238 | 2029 | 13220 | 1688 | 14621 | 1078 | 16927 | 448 | 14424 |
| 8-#18 | 3.64 | MA | 12151 | 3247 | 18043 | 2663 | 21010 | 2231 | 22917 | 1847 | 25347 | 1216 | 31761 | 554 | 27001 |
| 4L-2S | | MI | 7033 | 3247 | 11857 | 2448 | 13668 | 2016 | 14958 | 1655 | 16972 | 1058 | 19858 | 736 | 14500 |
| 10-#10 | 1.44 | MA | 11323 | 2696 | 16146 | 2277 | 19054 | 1914 | 20685 | 1628 | 22469 | 1193 | 27166 | 1036 | 12312 |
| 2L-5S | | MI | 5594 | 2696 | 8154 | 2200 | 9135 | 1848 | 9533 | 1578 | 9680 | 1150 | 11133 | 766 | 6397 |
| 10-#10 | 1.44 | MA | 10904 | 2696 | 15354 | 2290 | 18044 | 1926 | 19459 | 1639 | 20810 | 1211 | 24869 | 957 | 12305 |
| 3L-4S | | MI | 5719 | 2696 | 8427 | 2183 | 9464 | 1841 | 9941 | 1564 | 10248 | 1139 | 11895 | 818 | 6397 |
| 10-#10 | 1.44 | MA | 10694 | 2696 | 14822 | 2304 | 17292 | 1947 | 18534 | 1659 | 19542 | 1221 | 23363 | 909 | 12259 |
| 4L-3S | | MI | 5820 | 2696 | 8694 | 2174 | 9839 | 1825 | 10401 | 1558 | 10878 | 1137 | 12660 | 869 | 6382 |
| 10-#10 | 1.44 | MA | 10373 | 2696 | 14268 | 2324 | 16639 | 1959 | 17722 | 1671 | 18409 | 1239 | 21822 | 872 | 12129 |
| 5L-2S | | MI | 6013 | 2696 | 9079 | 2165 | 10329 | 1818 | 10996 | 1544 | 11683 | 1126 | 13748 | 961 | 6364 |
| 10-#11 | 1.77 | MA | 11707 | 2779 | 17083 | 2318 | 20173 | 1942 | 22007 | 1643 | 24228 | 1181 | 29579 | 1023 | 14938 |
| 2L-5S | | MI | 5678 | 2779 | 8419 | 2237 | 9405 | 1872 | 9827 | 1591 | 10051 | 1134 | 11556 | 684 | 7568 |
| 10-#11 | 1.77 | MA | 11212 | 2779 | 16120 | 2334 | 18947 | 1957 | 20518 | 1657 | 22213 | 1203 | 26789 | 926 | 14917 |
| 3L-4S | | MI | 5821 | 2779 | 8749 | 2217 | 9802 | 1865 | 10320 | 1575 | 10736 | 1123 | 12450 | 749 | 7659 |
| 10-#11 | 1.77 | MA | 10966 | 2779 | 15472 | 2350 | 18030 | 1982 | 19393 | 1681 | 20670 | 1215 | 24945 | 865 | 14828 |
| 4L-3S | | MI | 5941 | 2779 | 9070 | 2207 | 10254 | 1847 | 10875 | 1569 | 11495 | 1121 | 13352 | 810 | 7649 |
| 10-#11 | 1.77 | MA | 10583 | 2779 | 14804 | 2375 | 17235 | 1997 | 18403 | 1694 | 19289 | 1236 | 23064 | 817 | 14508 |
| 5L-2S | | MI | 6166 | 2779 | 9532 | 2197 | 10842 | 1839 | 11589 | 1553 | 12461 | 1110 | 14625 | 922 | 7629 |
| 10-#14 | 2.56 | MA | 11973 | 2976 | 17839 | 2456 | 21083 | 2046 | 23087 | 1712 | 25667 | 1196 | 31555 | 860 | 21158 |
| 3L-4S | | MI | 6095 | 2976 | 9432 | 2333 | 10608 | 1951 | 11276 | 1627 | 12010 | 1105 | 14050 | 616 | 10595 |
| 10-#14 | 2.56 | MA | 11644 | 2976 | 16910 | 2478 | 19769 | 2081 | 21474 | 1746 | 23456 | 1211 | 28903 | 772 | 20890 |
| 4L-3S | | MI | 6258 | 2976 | 9890 | 2319 | 11252 | 1926 | 12065 | 1620 | 13089 | 1105 | 15310 | 700 | 10647 |
| 10-#14 | 2.56 | MA | 11107 | 2976 | 15958 | 2515 | 18629 | 2102 | 20054 | 1765 | 21477 | 1242 | 26201 | 702 | 19614 |
| 5L-2S | | MI | 6563 | 2976 | 10545 | 2306 | 12086 | 1916 | 13078 | 1598 | 14459 | 1090 | 17084 | 862 | 10642 |
| 10-#18 | 4.55 | MA | 13306 | 3476 | 20451 | 2806 | 24076 | 2334 | 26642 | 1912 | 30387 | 1203 | 38740 | 535 | 34153 |
| 4L-3S | | MI | 7007 | 3476 | 11857 | 2610 | 13668 | 2132 | 14958 | 1752 | 16972 | 1065 | 19858 | 389 | 17768 |
| 10-#18 | 4.55 | MA | 12398 | 3476 | 18789 | 2870 | 22073 | 2369 | 24148 | 1943 | 26912 | 1254 | 33980 | 401 | 31571 |
| 5L-2S | | MI | 7485 | 3476 | 12981 | 2590 | 15099 | 2119 | 16695 | 1719 | 19324 | 1044 | 22789 | 676 | 17886 |
| 12-#10 | 1.73 | MA | 11701 | 2769 | 16939 | 2323 | 20063 | 1947 | 21911 | 1648 | 24128 | 1188 | 29463 | 1030 | 14710 |
| 2L-6S | | MI | 5638 | 2769 | 8301 | 2253 | 9300 | 1897 | 9726 | 1604 | 9942 | 1157 | 11520 | 698 | 7359 |
| 12-#10 | 1.73 | MA | 11292 | 2769 | 16146 | 2336 | 19054 | 1959 | 20685 | 1660 | 22469 | 1207 | 27166 | 952 | 14694 |
| 3L-5S | | MI | 5771 | 2769 | 8539 | 2245 | 9625 | 1881 | 10128 | 1598 | 10485 | 1146 | 12220 | 757 | 7552 |
| 12-#10 | 1.73 | MA | 11092 | 2769 | 15614 | 2349 | 18301 | 1980 | 19760 | 1680 | 21201 | 1217 | 25660 | 903 | 14638 |
| 4E | | MI | 5895 | 2769 | 8812 | 2228 | 9954 | 1874 | 10536 | 1584 | 11053 | 1135 | 12982 | 809 | 7565 |
| 12-#10 | 1.73 | MA | 10772 | 2769 | 15061 | 2369 | 17649 | 1992 | 18948 | 1691 | 20068 | 1235 | 24119 | 866 | 14501 |
| 5L-3S | | MI | 5994 | 2769 | 9079 | 2219 | 10329 | 1858 | 10996 | 1579 | 11683 | 1133 | 13748 | 860 | 7557 |
| 12-#10 | 1.73 | MA | 10492 | 2769 | 14532 | 2376 | 17017 | 2003 | 18151 | 1711 | 18959 | 1245 | 22614 | 801 | 13971 |
| 6L-2S | | MI | 6183 | 2769 | 9463 | 2210 | 10819 | 1851 | 11591 | 1565 | 12488 | 1122 | 14835 | 952 | 7543 |
| 12-#11 | 2.13 | MA | 11674 | 2868 | 17083 | 2390 | 20173 | 1997 | 22007 | 1682 | 24228 | 1198 | 29579 | 918 | 17814 |
| 3L-5S | | MI | 5887 | 2868 | 8880 | 2293 | 9992 | 1913 | 10541 | 1616 | 11017 | 1129 | 12830 | 669 | 8890 |
| 12-#11 | 2.13 | MA | 11440 | 2868 | 16435 | 2406 | 19256 | 2022 | 20882 | 1706 | 22685 | 1209 | 27735 | 858 | 17713 |
| 4E | | MI | 6029 | 2868 | 9210 | 2273 | 10390 | 1905 | 11034 | 1600 | 11702 | 1118 | 13724 | 734 | 9050 |
| 12-#11 | 2.13 | MA | 11061 | 2868 | 15766 | 2431 | 18461 | 2037 | 19891 | 1720 | 21304 | 1231 | 25854 | 810 | 17346 |
| 5L-3S | | MI | 6144 | 2868 | 9532 | 2263 | 10842 | 1887 | 11589 | 1594 | 12461 | 1116 | 14625 | 795 | 9054 |
| 12-#11 | 2.13 | MA | 10727 | 2868 | 15123 | 2438 | 17701 | 2050 | 18920 | 1743 | 19953 | 1243 | 24017 | 728 | 16603 |
| 6L-2S | | MI | 6365 | 2868 | 9994 | 2253 | 11430 | 1879 | 12303 | 1578 | 13428 | 1105 | 15899 | 907 | 9041 |
| 12-#14 | 3.07 | MA | 12309 | 3105 | 18287 | 2559 | 21523 | 2140 | 23604 | 1782 | 26339 | 1204 | 32894 | 762 | 25014 |
| 4E | | MI | 6385 | 3105 | 10086 | 2413 | 11442 | 2009 | 12289 | 1663 | 13380 | 1098 | 15824 | 590 | 12471 |
| 12-#14 | 3.07 | MA | 11776 | 3105 | 17336 | 2595 | 20383 | 2160 | 22184 | 1801 | 24359 | 1234 | 30193 | 691 | 23709 |
| 5L-3S | | MI | 6540 | 3105 | 10545 | 2400 | 12086 | 1985 | 13078 | 1656 | 14459 | 1098 | 17084 | 674 | 12616 |
| 12-#14 | 3.07 | MA | 11318 | 3105 | 16415 | 2606 | 19302 | 2180 | 20790 | 1835 | 22473 | 1265 | 27556 | 571 | 22673 |
| 6L-2S | | MI | 6837 | 3105 | 11199 | 2387 | 12919 | 1975 | 14090 | 1635 | 15829 | 1083 | 18857 | 836 | 12630 |

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

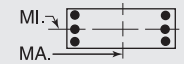
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 5.45 | MA | 13528 | 3704 | 21197 | 3013 | 25139 | 2472 | 27872 | 2008 | 31952 | 1241 | 40959 | 383 | 38700 |
| 5L-3S | | MI | 7502 | 3704 | 12981 | 2753 | 15099 | 2236 | 16695 | 1817 | 19324 | 1051 | 22789 | 329 | 21109 |
| 12-#18 | 5.45 | MA | 12789 | 3704 | 19598 | 3032 | 23257 | 2507 | 25422 | 2066 | 28637 | 1292 | 36314 | 162 | 35148 |
| 6L-2S | | MI | 7924 | 3704 | 14104 | 2733 | 16529 | 2223 | 18433 | 1784 | 21675 | 1031 | 25720 | 617 | 21263 |
| 14-#10 | 2.02 | MA | 11674 | 2841 | 16939 | 2381 | 20063 | 1992 | 21911 | 1680 | 24128 | 1203 | 29463 | 946 | 17081 |
| 3L-6S | | MI | 5816 | 2841 | 8686 | 2298 | 9790 | 1930 | 10321 | 1625 | 10748 | 1153 | 12607 | 689 | 8479 |
| 14-#10 | 2.02 | MA | 11483 | 2841 | 16407 | 2394 | 19310 | 2013 | 20986 | 1700 | 22860 | 1212 | 27957 | 897 | 17017 |
| 4L-5S | | MI | 5947 | 2841 | 8924 | 2290 | 10115 | 1914 | 10723 | 1619 | 11291 | 1142 | 13307 | 747 | 8692 |
| 14-#10 | 2.02 | MA | 11165 | 2841 | 15853 | 2415 | 18658 | 2025 | 20174 | 1712 | 21727 | 1231 | 26416 | 860 | 16875 |
| 5L-4S | | MI | 6070 | 2841 | 9197 | 2273 | 10443 | 1907 | 11131 | 1605 | 11859 | 1131 | 14069 | 800 | 8726 |
| 14-#10 | 2.02 | MA | 10892 | 2841 | 15325 | 2421 | 18026 | 2036 | 19376 | 1732 | 20618 | 1241 | 24911 | 795 | 16327 |
| 6L-3S | | MI | 6165 | 2841 | 9463 | 2264 | 10819 | 1891 | 11591 | 1599 | 12488 | 1129 | 14835 | 851 | 8727 |
| 14-#10 | 2.02 | MA | 10661 | 2841 | 14825 | 2430 | 17323 | 2052 | 18593 | 1742 | 19545 | 1259 | 23473 | 762 | 15881 |
| 7L-2S | | MI | 6351 | 2841 | 9848 | 2256 | 11309 | 1884 | 12186 | 1585 | 13293 | 1118 | 15922 | 943 | 8718 |
| 14-#11 | 2.48 | MA | 11907 | 2957 | 17397 | 2461 | 20482 | 2063 | 22370 | 1731 | 24700 | 1204 | 30525 | 851 | 20599 |
| 4L-5S | | MI | 6093 | 2957 | 9342 | 2348 | 10580 | 1953 | 11255 | 1641 | 11983 | 1124 | 14104 | 654 | 10220 |
| 14-#11 | 2.48 | MA | 11530 | 2957 | 16729 | 2486 | 19687 | 2078 | 21380 | 1745 | 23319 | 1226 | 28644 | 803 | 20191 |
| 5L-4S | | MI | 6235 | 2957 | 9672 | 2328 | 10978 | 1946 | 11748 | 1625 | 12669 | 1112 | 14998 | 720 | 10437 |
| 14-#11 | 2.48 | MA | 11207 | 2957 | 16086 | 2494 | 18926 | 2091 | 20409 | 1769 | 21968 | 1237 | 26807 | 721 | 19471 |
| 6L-3S | | MI | 6346 | 2957 | 9994 | 2318 | 11430 | 1928 | 12303 | 1620 | 13428 | 1111 | 15899 | 780 | 10454 |
| 14-#11 | 2.48 | MA | 10932 | 2957 | 15478 | 2504 | 18070 | 2110 | 19466 | 1781 | 20661 | 1259 | 25043 | 681 | 18806 |
| 7L-2S | | MI | 6561 | 2957 | 10456 | 2309 | 12018 | 1920 | 13017 | 1604 | 14394 | 1099 | 17173 | 892 | 10448 |
| 14-#14 | 3.58 | MA | 12431 | 3233 | 18713 | 2675 | 22136 | 2219 | 24314 | 1838 | 27242 | 1227 | 34184 | 681 | 27810 |
| 5L-4S | | MI | 6672 | 3233 | 10741 | 2493 | 12275 | 2068 | 13301 | 1699 | 14750 | 1090 | 17597 | 565 | 14333 |
| 14-#14 | 3.58 | MA | 11991 | 3233 | 17792 | 2686 | 21055 | 2238 | 22920 | 1872 | 25355 | 1258 | 31547 | 560 | 26756 |
| 6L-3S | | MI | 6819 | 3233 | 11199 | 2480 | 12919 | 2043 | 14090 | 1693 | 15829 | 1090 | 18857 | 649 | 14580 |
| 14-#14 | 3.58 | MA | 11618 | 3233 | 16921 | 2700 | 19828 | 2264 | 21581 | 1890 | 23430 | 1273 | 29007 | 501 | 25105 |
| 7L-2S | | MI | 7108 | 3233 | 11854 | 2467 | 13753 | 2033 | 15102 | 1671 | 17199 | 1075 | 20631 | 811 | 14610 |
| 14-#18 | 6.36 | MA | 13933 | 3932 | 22006 | 3174 | 26323 | 2611 | 29147 | 2130 | 33678 | 1278 | 43293 | 144 | 42270 |
| 6L-3S | | MI | 7958 | 3932 | 14104 | 2895 | 16529 | 2340 | 18433 | 1882 | 21675 | 1038 | 25720 | 270 | 24448 |
| 16-#10 | 2.31 | MA | 11868 | 2914 | 17200 | 2440 | 20319 | 2046 | 22212 | 1721 | 24519 | 1208 | 30254 | 891 | 19397 |
| 4L-6S | | MI | 5992 | 2914 | 9070 | 2344 | 10280 | 1963 | 10916 | 1645 | 11553 | 1149 | 13694 | 680 | 9602 |
| 16-#10 | 2.31 | MA | 11553 | 2914 | 16646 | 2460 | 19667 | 2058 | 21399 | 1733 | 23386 | 1227 | 28713 | 854 | 19250 |
| 5E | | MI | 6120 | 2914 | 9308 | 2336 | 10605 | 1947 | 11318 | 1639 | 12096 | 1138 | 14394 | 738 | 9804 |
| 16-#10 | 2.31 | MA | 11287 | 2914 | 16117 | 2467 | 19036 | 2069 | 20602 | 1753 | 22277 | 1237 | 27208 | 789 | 18687 |
| 6L-4S | | MI | 6243 | 2914 | 9581 | 2318 | 10933 | 1940 | 11726 | 1625 | 12664 | 1127 | 15156 | 791 | 9885 |
| 16-#10 | 2.31 | MA | 11063 | 2914 | 15618 | 2475 | 18332 | 2084 | 19819 | 1763 | 21204 | 1255 | 25769 | 757 | 18253 |
| 7L-3S | | MI | 6335 | 2914 | 9848 | 2310 | 11309 | 1924 | 12186 | 1620 | 13293 | 1124 | 15922 | 842 | 9894 |
| 16-#10 | 2.31 | MA | 10790 | 2914 | 15140 | 2485 | 17685 | 2093 | 18996 | 1778 | 20153 | 1273 | 24371 | 714 | 17593 |
| 8L-2S | | MI | 6517 | 2914 | 10233 | 2301 | 11799 | 1917 | 12781 | 1606 | 14099 | 1113 | 17009 | 933 | 9889 |
| 16-#11 | 2.84 | MA | 11991 | 3046 | 17692 | 2542 | 20913 | 2118 | 22869 | 1770 | 25334 | 1221 | 31434 | 796 | 23041 |
| 5E | | MI | 6298 | 3046 | 9804 | 2404 | 11168 | 1994 | 11969 | 1666 | 12950 | 1119 | 15378 | 639 | 11556 |
| 16-#11 | 2.84 | MA | 11678 | 3046 | 17049 | 2550 | 20152 | 2131 | 21898 | 1794 | 23983 | 1232 | 29597 | 714 | 22342 |
| 6L-4S | | MI | 6438 | 3046 | 10134 | 2384 | 11566 | 1986 | 12463 | 1650 | 13635 | 1107 | 16272 | 705 | 11821 |
| 16-#11 | 2.84 | MA | 11414 | 3046 | 16441 | 2560 | 19296 | 2150 | 20955 | 1807 | 22676 | 1254 | 27833 | 673 | 21673 |
| 7L-3S | | MI | 6545 | 3046 | 10456 | 2374 | 12018 | 1968 | 13017 | 1645 | 14394 | 1106 | 17173 | 765 | 11847 |
| 16-#11 | 2.84 | MA | 11090 | 3046 | 15859 | 2572 | 18508 | 2160 | 19954 | 1825 | 21394 | 1276 | 26124 | 619 | 20743 |
| 8L-2S | | MI | 6757 | 3046 | 10918 | 2364 | 12606 | 1960 | 13731 | 1629 | 15361 | 1094 | 18447 | 877 | 11850 |
| 16-#14 | 4.09 | MA | 12651 | 3361 | 19170 | 2766 | 22809 | 2296 | 25050 | 1908 | 28238 | 1250 | 35539 | 550 | 30839 |
| 6L-4S | | MI | 6954 | 3361 | 11396 | 2573 | 13109 | 2126 | 14313 | 1736 | 16120 | 1083 | 19371 | 539 | 16207 |
| 16-#14 | 4.09 | MA | 12296 | 3361 | 18298 | 2781 | 21582 | 2323 | 23711 | 1927 | 26312 | 1266 | 32998 | 491 | 29200 |
| 7L-3S | | MI | 7095 | 3361 | 11854 | 2560 | 13753 | 2101 | 15102 | 1729 | 17199 | 1083 | 20631 | 623 | 16541 |
| 16-#14 | 4.09 | MA | 11840 | 3361 | 17464 | 2797 | 20453 | 2337 | 22276 | 1953 | 24474 | 1296 | 30543 | 410 | 27488 |
| 8L-2S | | MI | 7377 | 3361 | 12509 | 2547 | 14586 | 2092 | 16115 | 1708 | 18570 | 1068 | 22404 | 785 | 16583 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis

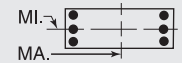



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.60 | MA | 11934 | 2986 | 17439 | 2505 | 20676 | 2091 | 22625 | 1753 | 25045 | 1222 | 31010 | 848 | 21627 |
| 5L-6S | | MI | 6167 | 2986 | 9455 | 2389 | 10770 | 1995 | 11511 | 1666 | 12358 | 1144 | 14781 | 670 | 10728 |
| 18-#10 | 2.60 | MA | 11675 | 2986 | 16910 | 2512 | 20045 | 2102 | 21828 | 1773 | 23936 | 1232 | 29505 | 783 | 21049 |
| 6L-5S | | MI | 6292 | 2986 | 9693 | 2381 | 11094 | 1980 | 11913 | 1660 | 12901 | 1133 | 15481 | 729 | 10920 |
| 18-#10 | 2.60 | MA | 11459 | 2986 | 16411 | 2521 | 19341 | 2117 | 21044 | 1783 | 22863 | 1251 | 28066 | 751 | 20627 |
| 7L-4S | | MI | 6415 | 2986 | 9966 | 2364 | 11423 | 1973 | 12321 | 1646 | 13469 | 1123 | 16244 | 782 | 11041 |
| 18-#10 | 2.60 | MA | 11189 | 2986 | 15933 | 2531 | 18694 | 2126 | 20222 | 1799 | 21812 | 1269 | 26668 | 708 | 19959 |
| 8L-3S | | MI | 6504 | 2986 | 10233 | 2355 | 11799 | 1957 | 12781 | 1640 | 14099 | 1120 | 17009 | 833 | 11056 |
| 18-#10 | 2.60 | MA | 10918 | 2986 | 15384 | 2549 | 18031 | 2144 | 19425 | 1807 | 20737 | 1279 | 25302 | 665 | 19319 |
| 9L-2S | | MI | 6683 | 2986 | 10618 | 2346 | 12288 | 1950 | 13376 | 1626 | 14904 | 1109 | 18096 | 924 | 11057 |
| 18-#11 | 3.19 | MA | 12142 | 3135 | 18012 | 2605 | 21378 | 2172 | 23387 | 1819 | 25998 | 1227 | 32388 | 707 | 25216 |
| 6L-5S | | MI | 6500 | 3135 | 10266 | 2460 | 11756 | 2034 | 12683 | 1692 | 13916 | 1114 | 16652 | 624 | 12898 |
| 18-#11 | 3.19 | MA | 11888 | 3135 | 17404 | 2616 | 20522 | 2191 | 22444 | 1832 | 24691 | 1249 | 30624 | 666 | 24540 |
| 7L-4S | | MI | 6640 | 3135 | 10596 | 2440 | 12154 | 2027 | 13177 | 1676 | 14602 | 1102 | 17546 | 690 | 13202 |
| 18-#11 | 3.19 | MA | 11566 | 3135 | 16822 | 2628 | 19734 | 2201 | 21443 | 1851 | 23409 | 1271 | 28914 | 611 | 23614 |
| 8L-3S | | MI | 6743 | 3135 | 10918 | 2430 | 12606 | 2009 | 13731 | 1670 | 15361 | 1101 | 18447 | 750 | 13237 |
| 18-#11 | 3.19 | MA | 11254 | 3135 | 16159 | 2650 | 18925 | 2222 | 20472 | 1860 | 22099 | 1282 | 27240 | 558 | 22567 |
| 9L-2S | | MI | 6950 | 3135 | 11379 | 2420 | 13194 | 2001 | 14445 | 1654 | 16327 | 1089 | 19721 | 862 | 13249 |
| 18-#14 | 4.60 | MA | 12961 | 3490 | 19676 | 2861 | 23336 | 2381 | 25841 | 1963 | 29195 | 1258 | 36989 | 481 | 33294 |
| 7L-4S | | MI | 7234 | 3490 | 12050 | 2654 | 13943 | 2185 | 15326 | 1772 | 17490 | 1075 | 21145 | 514 | 18090 |
| 18-#14 | 4.60 | MA | 12509 | 3490 | 18841 | 2878 | 22207 | 2395 | 24406 | 1990 | 27357 | 1289 | 34534 | 400 | 31566 |
| 8L-3S | | MI | 7369 | 3490 | 12509 | 2641 | 14586 | 2160 | 16115 | 1766 | 18570 | 1075 | 22404 | 598 | 18500 |
| 18-#14 | 4.60 | MA | 12083 | 3490 | 17898 | 2910 | 21048 | 2426 | 23016 | 2003 | 25478 | 1304 | 32123 | 322 | 29891 |
| 9L-2S | | MI | 7644 | 3490 | 13163 | 2627 | 15420 | 2150 | 17127 | 1744 | 19940 | 1060 | 24178 | 760 | 18553 |
| 20-#10 | 2.89 | MA | 12059 | 3059 | 17703 | 2557 | 21054 | 2135 | 23054 | 1794 | 25595 | 1228 | 31802 | 777 | 23413 |
| 6E | | MI | 6340 | 3059 | 9840 | 2434 | 11260 | 2028 | 12106 | 1686 | 13163 | 1140 | 15869 | 661 | 11856 |
| 20-#10 | 2.89 | MA | 11850 | 3059 | 17203 | 2566 | 20350 | 2150 | 22270 | 1804 | 24522 | 1247 | 30363 | 745 | 23003 |
| 7L-5S | | MI | 6462 | 3059 | 10078 | 2426 | 11584 | 2013 | 12508 | 1681 | 13706 | 1129 | 16568 | 720 | 12040 |
| 20-#10 | 2.89 | MA | 11581 | 3059 | 16725 | 2576 | 19704 | 2159 | 21448 | 1819 | 23471 | 1265 | 28965 | 702 | 22325 |
| 8L-4S | | MI | 6585 | 3059 | 10351 | 2409 | 11913 | 2006 | 12916 | 1667 | 14274 | 1118 | 17331 | 773 | 12195 |
| 20-#10 | 2.89 | MA | 11324 | 3059 | 16176 | 2594 | 19040 | 2177 | 20651 | 1828 | 22396 | 1275 | 27599 | 659 | 21676 |
| 9L-3S | | MI | 6671 | 3059 | 10618 | 2400 | 12288 | 1990 | 13376 | 1661 | 14904 | 1116 | 18096 | 824 | 12216 |
| 20-#10 | 2.89 | MA | 11078 | 3059 | 15680 | 2602 | 18415 | 2187 | 19857 | 1845 | 21311 | 1290 | 26093 | 610 | 20837 |
| 10L-2S | | MI | 6847 | 3059 | 11002 | 2391 | 12778 | 1983 | 13971 | 1647 | 15709 | 1105 | 19183 | 915 | 12223 |
| 20-#11 | 3.55 | MA | 12354 | 3224 | 18367 | 2671 | 21747 | 2231 | 23933 | 1857 | 26706 | 1244 | 33414 | 659 | 27407 |
| 7L-5S | | MI | 6700 | 3224 | 10728 | 2515 | 12344 | 2075 | 13397 | 1717 | 14883 | 1109 | 17925 | 609 | 14243 |
| 20-#11 | 3.55 | MA | 12035 | 3224 | 17784 | 2683 | 20960 | 2241 | 22931 | 1876 | 25424 | 1265 | 31704 | 604 | 26485 |
| 8L-4S | | MI | 6840 | 3224 | 11057 | 2495 | 12742 | 2067 | 13891 | 1701 | 15568 | 1097 | 18819 | 675 | 14583 |
| 20-#11 | 3.55 | MA | 11732 | 3224 | 17122 | 2705 | 20151 | 2263 | 21961 | 1886 | 24114 | 1277 | 30030 | 551 | 25428 |
| 9L-3S | | MI | 6940 | 3224 | 11379 | 2485 | 13194 | 2049 | 14445 | 1695 | 16327 | 1096 | 19721 | 735 | 14624 |
| 20-#11 | 3.55 | MA | 11441 | 3224 | 16517 | 2714 | 19390 | 2275 | 20993 | 1906 | 22812 | 1296 | 28190 | 489 | 24417 |
| 10L-2S | | MI | 7143 | 3224 | 11841 | 2476 | 13782 | 2041 | 15160 | 1679 | 17293 | 1084 | 20994 | 847 | 14642 |
| 20-#14 | 5.11 | MA | 13166 | 3618 | 20218 | 2958 | 23960 | 2454 | 26536 | 2026 | 30239 | 1281 | 38525 | 389 | 35643 |
| 8L-4S | | MI | 7512 | 3618 | 12705 | 2734 | 14776 | 2243 | 16338 | 1809 | 18861 | 1068 | 22918 | 488 | 19981 |
| 20-#14 | 5.11 | MA | 12755 | 3618 | 19275 | 2990 | 22801 | 2484 | 25145 | 2039 | 28360 | 1297 | 36114 | 311 | 33954 |
| 9L-3S | | MI | 7640 | 3618 | 13163 | 2721 | 15420 | 2218 | 17127 | 1802 | 19940 | 1068 | 24178 | 573 | 20457 |
| 22-#10 | 3.17 | MA | 12235 | 3131 | 17996 | 2611 | 21359 | 2183 | 23496 | 1824 | 26181 | 1242 | 32660 | 739 | 25380 |
| 7L-6S | | MI | 6511 | 3131 | 10225 | 2479 | 11750 | 2061 | 12701 | 1707 | 13969 | 1136 | 16956 | 652 | 12987 |
| 22-#10 | 3.17 | MA | 11968 | 3131 | 17518 | 2621 | 20713 | 2192 | 22674 | 1840 | 25130 | 1261 | 31262 | 696 | 24691 |
| 8L-5S | | MI | 6631 | 3131 | 10463 | 2472 | 12074 | 2046 | 13103 | 1701 | 14512 | 1125 | 17655 | 711 | 13163 |
| 22-#10 | 3.17 | MA | 11717 | 3131 | 16969 | 2639 | 20049 | 2210 | 21877 | 1848 | 24055 | 1271 | 29896 | 653 | 24033 |
| 9L-4S | | MI | 6753 | 3131 | 10736 | 2454 | 12403 | 2038 | 13511 | 1687 | 15080 | 1114 | 18418 | 764 | 13348 |
| 22-#10 | 3.17 | MA | 11480 | 3131 | 16472 | 2647 | 19424 | 2220 | 21082 | 1866 | 22970 | 1286 | 28390 | 605 | 23198 |
| 10L-3S | | MI | 6837 | 3131 | 11002 | 2446 | 12778 | 2023 | 13971 | 1681 | 15709 | 1112 | 19183 | 815 | 13374 |
| 22-#10 | 3.17 | MA | 11218 | 3131 | 15988 | 2656 | 18793 | 2229 | 20305 | 1875 | 21871 | 1293 | 27028 | 559 | 22381 |
| 11L-2S | | MI | 7010 | 3131 | 11387 | 2437 | 13268 | 2016 | 14566 | 1667 | 16515 | 1101 | 20270 | 906 | 13385 |
| 22-#11 | 3.90 | MA | 12497 | 3314 | 18747 | 2739 | 22186 | 2282 | 24420 | 1901 | 27439 | 1260 | 34494 | 597 | 29356 |
| 8L-5S | | MI | 6899 | 3314 | 11189 | 2571 | 12932 | 2115 | 14112 | 1742 | 15849 | 1103 | 19199 | 594 | 15591 |

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.90 | MA | 12202 | 3314 | 18085 | 2761 | 21377 | 2303 | 23450 | 1911 | 26129 | 1272 | 32820 | 544 | 28288 |
| 9L-4S | | MI | 7038 | 3314 | 11519 | 2551 | 13329 | 2107 | 14605 | 1726 | 16535 | 1092 | 20093 | 660 | 15962 |
| 22-#11 | 3.90 | MA | 11935 | 3314 | 17480 | 2770 | 20616 | 2315 | 22482 | 1932 | 24827 | 1291 | 30980 | 482 | 27269 |
| 10L-3S | | MI | 7134 | 3314 | 11841 | 2541 | 13782 | 2089 | 15160 | 1721 | 17293 | 1090 | 20994 | 720 | 16011 |
| 22-#14 | 5.63 | MA | 13416 | 3747 | 20653 | 3070 | 24555 | 2543 | 27275 | 2076 | 31242 | 1289 | 40105 | 301 | 38018 |
| 9L-4S | | MI | 7787 | 3747 | 13360 | 2814 | 15610 | 2301 | 17351 | 1845 | 20231 | 1060 | 24692 | 463 | 21878 |
| 24-#10 | 3.46 | MA | 12350 | 3204 | 18311 | 2667 | 21722 | 2225 | 23899 | 1861 | 26789 | 1257 | 33559 | 690 | 27057 |
| 8L-6S | | MI | 6681 | 3204 | 10610 | 2525 | 12240 | 2094 | 13296 | 1727 | 14774 | 1132 | 18043 | 643 | 14119 |
| 24-#10 | 3.46 | MA | 12106 | 3204 | 17762 | 2685 | 21058 | 2243 | 23103 | 1869 | 25714 | 1266 | 32193 | 647 | 26390 |
| 9L-5S | | MI | 6799 | 3204 | 10847 | 2517 | 12564 | 2079 | 13698 | 1722 | 15317 | 1121 | 18742 | 702 | 14288 |
| 24-#10 | 3.46 | MA | 11877 | 3204 | 17265 | 2692 | 20433 | 2253 | 22308 | 1886 | 24629 | 1282 | 30687 | 599 | 25558 |
| 10L-4S | | MI | 6920 | 3204 | 11120 | 2500 | 12893 | 2071 | 14106 | 1708 | 15885 | 1110 | 19505 | 755 | 14501 |
| 24-#10 | 3.46 | MA | 11617 | 3204 | 16781 | 2701 | 19802 | 2262 | 21531 | 1896 | 23530 | 1289 | 29325 | 554 | 24734 |
| 11L-3S | | MI | 7002 | 3204 | 11387 | 2491 | 13268 | 2056 | 14566 | 1702 | 16515 | 1107 | 20270 | 806 | 14531 |
| 24-#11 | 4.25 | MA | 12666 | 3403 | 19048 | 2817 | 22603 | 2344 | 24939 | 1936 | 28144 | 1266 | 35610 | 537 | 31149 |
| 9L-5S | | MI | 7096 | 3403 | 11651 | 2627 | 13520 | 2156 | 14826 | 1767 | 16816 | 1098 | 20473 | 579 | 16943 |
| 24-#11 | 4.25 | MA | 12407 | 3403 | 18443 | 2826 | 21842 | 2356 | 23971 | 1957 | 26842 | 1286 | 33770 | 475 | 30120 |
| 10L-4S | | MI | 7235 | 3403 | 11981 | 2607 | 13917 | 2148 | 15319 | 1751 | 17501 | 1087 | 21367 | 645 | 17299 |

## RECTANGULAR TIED COLUMNS 22" x 42"

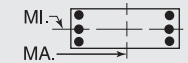
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.73 | MA | 12778 | 2907 | 18759 | 2412 | 22032 | 2021 | 23954 | 1710 | 26247 | 1232 | 31934 | 1067 | 15934 |
| 2E | | MI | 6363 | 2907 | 9978 | 2256 | 11205 | 1888 | 11883 | 1595 | 12647 | 1140 | 14402 | 904 | 7679 |
| 6-#11 | 1.01 | MA | 11841 | 2718 | 16520 | 2316 | 19347 | 1955 | 20776 | 1674 | 22014 | 1257 | 26123 | 1095 | 9604 |
| 2L-3S | | MI | 5782 | 2718 | 8508 | 2192 | 9474 | 1848 | 9848 | 1590 | 9943 | 1189 | 11217 | 889 | 4829 |
| 6-#11 | 1.01 | MA | 11280 | 2718 | 15501 | 2332 | 18050 | 1970 | 19201 | 1688 | 19883 | 1279 | 23172 | 998 | 9616 |
| 3L-2S | | MI | 6019 | 2718 | 8970 | 2182 | 10062 | 1840 | 10562 | 1574 | 10910 | 1177 | 12491 | 1001 | 4799 |
| 6-#14 | 1.46 | MA | 12464 | 2836 | 17902 | 2382 | 21051 | 2002 | 22818 | 1702 | 24755 | 1245 | 29901 | 1081 | 13641 |
| 2L-3S | | MI | 5938 | 2836 | 8944 | 2254 | 9981 | 1891 | 10441 | 1618 | 10729 | 1176 | 12173 | 800 | 6701 |
| 6-#14 | 1.46 | MA | 11691 | 2836 | 16445 | 2405 | 19196 | 2023 | 20564 | 1721 | 21704 | 1276 | 25677 | 940 | 13614 |
| 3L-2S | | MI | 6264 | 2836 | 9599 | 2241 | 10815 | 1881 | 11454 | 1596 | 12099 | 1161 | 13947 | 962 | 6661 |
| 6-#18 | 2.60 | MA | 13944 | 3136 | 21310 | 2554 | 25280 | 2125 | 27899 | 1775 | 31586 | 1219 | 39326 | 1049 | 23642 |
| 2L-3S | | MI | 6306 | 3136 | 9978 | 2418 | 11205 | 2005 | 11883 | 1693 | 12647 | 1147 | 14402 | 557 | 11127 |
| 6-#18 | 2.60 | MA | 12689 | 3136 | 18759 | 2593 | 22032 | 2160 | 23954 | 1808 | 26247 | 1271 | 31934 | 791 | 23393 |
| 3L-2S | | MI | 6832 | 3136 | 11102 | 2399 | 12635 | 1992 | 13620 | 1660 | 14999 | 1126 | 17333 | 844 | 11128 |
| 8-#10 | 1.10 | MA | 12001 | 2740 | 16725 | 2341 | 19686 | 1974 | 21226 | 1688 | 22657 | 1262 | 27037 | 1098 | 10457 |
| 2L-4S | | MI | 5796 | 2740 | 8400 | 2234 | 9368 | 1891 | 9747 | 1615 | 9826 | 1201 | 11224 | 878 | 5245 |
| 8-#10 | 1.10 | MA | 11543 | 2740 | 15887 | 2355 | 18619 | 1987 | 19930 | 1700 | 20903 | 1280 | 24609 | 1021 | 10461 |
| 3E | | MI | 5902 | 2740 | 8667 | 2225 | 9743 | 1875 | 10207 | 1610 | 10455 | 1199 | 11989 | 929 | 5220 |
| 8-#10 | 1.10 | MA | 11309 | 2740 | 15325 | 2368 | 17825 | 2008 | 18954 | 1721 | 19564 | 1291 | 23024 | 972 | 10428 |
| 4L-2S | | MI | 6099 | 2740 | 9051 | 2216 | 10233 | 1868 | 10802 | 1596 | 11260 | 1188 | 13076 | 1020 | 5198 |
| 8-#11 | 1.35 | MA | 12335 | 2807 | 17538 | 2372 | 20644 | 1995 | 22351 | 1699 | 24146 | 1251 | 29075 | 1087 | 12696 |
| 2L-4S | | MI | 5866 | 2807 | 8648 | 2257 | 9609 | 1906 | 10007 | 1621 | 10151 | 1185 | 11589 | 814 | 6288 |
| 8-#11 | 1.35 | MA | 11792 | 2807 | 16520 | 2388 | 19347 | 2010 | 20776 | 1713 | 22014 | 1274 | 26123 | 991 | 12690 |
| 3E | | MI | 5992 | 2807 | 8970 | 2247 | 10062 | 1888 | 10562 | 1615 | 10910 | 1183 | 12491 | 874 | 6261 |
| 8-#11 | 1.35 | MA | 11514 | 2807 | 15835 | 2404 | 18379 | 2036 | 19587 | 1738 | 20384 | 1286 | 24183 | 930 | 12619 |
| 4L-2S | | MI | 6223 | 2807 | 9432 | 2238 | 10650 | 1880 | 11276 | 1599 | 11876 | 1172 | 13764 | 986 | 6234 |
| 8-#14 | 1.95 | MA | 13150 | 2964 | 19360 | 2463 | 22907 | 2060 | 25072 | 1738 | 27805 | 1238 | 34124 | 1071 | 18052 |
| 2L-4S | | MI | 6057 | 2964 | 9141 | 2347 | 10171 | 1974 | 10665 | 1661 | 11020 | 1169 | 12687 | 691 | 8690 |
| 8-#14 | 1.95 | MA | 12407 | 2964 | 17902 | 2486 | 21051 | 2081 | 22818 | 1758 | 24755 | 1269 | 29901 | 929 | 17995 |
| 3E | | MI | 6229 | 2964 | 9599 | 2334 | 10815 | 1949 | 11454 | 1654 | 12099 | 1169 | 13947 | 775 | 8702 |
| 8-#14 | 1.95 | MA | 12029 | 2964 | 16921 | 2508 | 19663 | 2117 | 21114 | 1792 | 22418 | 1285 | 27109 | 842 | 17742 |
| 4L-2S | | MI | 6545 | 2964 | 10254 | 2321 | 11648 | 1939 | 12466 | 1633 | 13469 | 1154 | 15721 | 937 | 8676 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

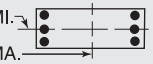



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.46 | MA | 13895 | 3364 | 21310 | 2736 | 25280 | 2264 | 27899 | 1872 | 31586 | 1258 | 39326 | 773 | 31032 |
| 3E | | MI | 6789 | 3364 | 11102 | 2561 | 12635 | 2109 | 13620 | 1757 | 14999 | 1133 | 17333 | 497 | 14484 |
| 8-#18 | 3.46 | MA | 13298 | 3364 | 19585 | 2775 | 22842 | 2326 | 24907 | 1931 | 27485 | 1284 | 34388 | 615 | 28795 |
| 4L-2S | | MI | 7293 | 3364 | 12225 | 2542 | 14066 | 2096 | 15358 | 1724 | 17350 | 1113 | 20265 | 785 | 14544 |
| 10-#10 | 1.37 | MA | 12410 | 2813 | 17563 | 2387 | 20753 | 2007 | 22522 | 1709 | 24411 | 1257 | 29466 | 1092 | 12998 |
| 2L-5S | | MI | 5851 | 2813 | 8512 | 2297 | 9529 | 1931 | 9934 | 1650 | 10063 | 1208 | 11548 | 816 | 6429 |
| 10-#10 | 1.37 | MA | 11963 | 2813 | 16725 | 2400 | 19686 | 2020 | 21226 | 1721 | 22657 | 1276 | 27037 | 1015 | 12990 |
| 3L-4S | | MI | 5975 | 2813 | 8785 | 2279 | 9858 | 1923 | 10342 | 1636 | 10631 | 1197 | 12311 | 869 | 6423 |
| 10-#10 | 1.37 | MA | 11739 | 2813 | 16163 | 2414 | 18892 | 2041 | 20250 | 1741 | 21318 | 1286 | 25452 | 967 | 12945 |
| 4L-3S | | MI | 6078 | 2813 | 9051 | 2271 | 10233 | 1908 | 10802 | 1630 | 11260 | 1194 | 13076 | 920 | 6405 |
| 10-#10 | 1.37 | MA | 11395 | 2813 | 15576 | 2434 | 18204 | 2054 | 19393 | 1753 | 20122 | 1305 | 23828 | 931 | 12815 |
| 5L-2S | | MI | 6271 | 2813 | 9436 | 2262 | 10723 | 1901 | 11397 | 1616 | 12066 | 1183 | 14163 | 1011 | 6386 |
| 10-#11 | 1.69 | MA | 12821 | 2896 | 18557 | 2428 | 21941 | 2036 | 23926 | 1724 | 26277 | 1246 | 32026 | 1080 | 15780 |
| 2L-5S | | MI | 5935 | 2896 | 8780 | 2333 | 9800 | 1954 | 10228 | 1662 | 10432 | 1191 | 11969 | 734 | 7648 |
| 10-#11 | 1.69 | MA | 12293 | 2896 | 17538 | 2444 | 20644 | 2051 | 22351 | 1739 | 24146 | 1268 | 29075 | 984 | 15759 |
| 3L-4S | | MI | 6078 | 2896 | 9110 | 2313 | 10197 | 1947 | 10721 | 1646 | 11117 | 1180 | 12863 | 799 | 7692 |
| 10-#11 | 1.69 | MA | 12030 | 2896 | 16854 | 2460 | 19676 | 2076 | 21162 | 1763 | 22515 | 1280 | 27134 | 923 | 15671 |
| 4L-3S | | MI | 6198 | 2896 | 9432 | 2303 | 10650 | 1929 | 11276 | 1640 | 11876 | 1178 | 13764 | 859 | 7678 |
| 10-#11 | 1.69 | MA | 11620 | 2896 | 16144 | 2485 | 18837 | 2091 | 20116 | 1777 | 21058 | 1303 | 25150 | 877 | 15417 |
| 5L-2S | | MI | 6424 | 2896 | 9893 | 2293 | 11238 | 1921 | 11990 | 1624 | 12843 | 1167 | 15038 | 972 | 7657 |
| 10-#14 | 2.44 | MA | 13106 | 3093 | 19360 | 2566 | 22907 | 2140 | 25072 | 1794 | 27805 | 1261 | 34124 | 919 | 22373 |
| 3L-4S | | MI | 6352 | 3093 | 9795 | 2428 | 11004 | 2032 | 11677 | 1697 | 12390 | 1161 | 14461 | 665 | 10646 |
| 10-#14 | 2.44 | MA | 12754 | 3093 | 18378 | 2589 | 21519 | 2176 | 23368 | 1829 | 25469 | 1278 | 31332 | 832 | 22105 |
| 4L-3S | | MI | 6515 | 3093 | 10254 | 2415 | 11648 | 2008 | 12466 | 1691 | 13469 | 1161 | 15721 | 749 | 10686 |
| 10-#14 | 2.44 | MA | 12178 | 3093 | 17367 | 2625 | 20316 | 2197 | 21869 | 1848 | 23378 | 1309 | 28483 | 763 | 20847 |
| 5L-2S | | MI | 6822 | 3093 | 10908 | 2402 | 12482 | 1998 | 13478 | 1669 | 14840 | 1146 | 17494 | 911 | 10676 |
| 10-#18 | 4.33 | MA | 14530 | 3592 | 22136 | 2917 | 26090 | 2430 | 28852 | 1996 | 32824 | 1271 | 41780 | 597 | 36358 |
| 4L-3S | | MI | 7265 | 3592 | 12225 | 2704 | 14066 | 2212 | 15358 | 1822 | 17350 | 1120 | 20265 | 437 | 17831 |
| 10-#18 | 4.33 | MA | 13554 | 3592 | 20380 | 2983 | 23974 | 2466 | 26217 | 2029 | 29151 | 1324 | 36759 | 467 | 33560 |
| 5L-2S | | MI | 7748 | 3592 | 13349 | 2684 | 15496 | 2200 | 17095 | 1789 | 19702 | 1100 | 23196 | 725 | 17935 |
| 12-#10 | 1.65 | MA | 12812 | 2886 | 18401 | 2432 | 21820 | 2040 | 23818 | 1729 | 26164 | 1253 | 31894 | 1087 | 15533 |
| 2L-6S | | MI | 5894 | 2886 | 8659 | 2350 | 9694 | 1979 | 10127 | 1676 | 10325 | 1214 | 11936 | 748 | 7424 |
| 12-#10 | 1.65 | MA | 12376 | 2886 | 17563 | 2445 | 20753 | 2053 | 22522 | 1741 | 24411 | 1272 | 29466 | 1009 | 15517 |
| 3L-5S | | MI | 6028 | 2886 | 8897 | 2342 | 10019 | 1964 | 10529 | 1670 | 10868 | 1203 | 12635 | 807 | 7587 |
| 12-#10 | 1.65 | MA | 12162 | 2886 | 17001 | 2459 | 19958 | 2074 | 21546 | 1762 | 23072 | 1282 | 27880 | 961 | 15461 |
| 4E | | MI | 6152 | 2886 | 9170 | 2325 | 10348 | 1956 | 10937 | 1656 | 11436 | 1193 | 13398 | 860 | 7593 |
| 12-#10 | 1.65 | MA | 11821 | 2886 | 16414 | 2479 | 19271 | 2087 | 20689 | 1774 | 21876 | 1301 | 26256 | 925 | 15324 |
| 5L-3S | | MI | 6251 | 2886 | 9436 | 2316 | 10723 | 1941 | 11397 | 1651 | 12066 | 1190 | 14163 | 911 | 7582 |
| 12-#10 | 1.65 | MA | 11522 | 2886 | 15856 | 2486 | 18600 | 2097 | 19848 | 1794 | 20706 | 1311 | 24671 | 861 | 14811 |
| 6L-2S | | MI | 6441 | 2886 | 9821 | 2307 | 11213 | 1934 | 11992 | 1637 | 12871 | 1179 | 15250 | 1002 | 7567 |
| 12-#11 | 2.03 | MA | 12785 | 2985 | 18557 | 2499 | 21941 | 2091 | 23926 | 1764 | 26277 | 1263 | 32026 | 976 | 18825 |
| 3L-5S | | MI | 6144 | 2985 | 9242 | 2389 | 10388 | 1995 | 10942 | 1687 | 11398 | 1186 | 13243 | 719 | 8969 |
| 12-#11 | 2.03 | MA | 12536 | 2985 | 17872 | 2516 | 20972 | 2117 | 22737 | 1788 | 24647 | 1275 | 30085 | 916 | 18724 |
| 4E | | MI | 6286 | 2985 | 9571 | 2369 | 10785 | 1987 | 11435 | 1671 | 12084 | 1174 | 14137 | 784 | 9087 |
| 12-#11 | 2.03 | MA | 12129 | 2985 | 17162 | 2541 | 20133 | 2132 | 21691 | 1802 | 23189 | 1298 | 28102 | 870 | 18424 |
| 5L-3S | | MI | 6402 | 2985 | 9893 | 2359 | 11238 | 1969 | 11990 | 1666 | 12843 | 1173 | 15038 | 844 | 9086 |
| 12-#11 | 2.03 | MA | 11774 | 2985 | 16483 | 2548 | 19325 | 2145 | 20666 | 1827 | 21763 | 1309 | 26166 | 789 | 17609 |
| 6L-2S | | MI | 6623 | 2985 | 10355 | 2349 | 11825 | 1961 | 12704 | 1650 | 13809 | 1161 | 16312 | 957 | 9071 |
| 12-#14 | 2.92 | MA | 13463 | 3221 | 19836 | 2669 | 23375 | 2234 | 25622 | 1865 | 28519 | 1270 | 35556 | 821 | 26472 |
| 4E | | MI | 6642 | 3221 | 10450 | 2508 | 11838 | 2091 | 12689 | 1734 | 13761 | 1154 | 16235 | 640 | 12582 |
| 12-#14 | 2.92 | MA | 12892 | 3221 | 18824 | 2705 | 22172 | 2255 | 24123 | 1885 | 26429 | 1302 | 32707 | 753 | 25186 |
| 5L-3S | | MI | 6798 | 3221 | 10908 | 2495 | 12482 | 2066 | 13478 | 1727 | 14840 | 1154 | 17494 | 724 | 12658 |
| 12-#14 | 2.92 | MA | 12403 | 3221 | 17851 | 2716 | 21021 | 2274 | 22651 | 1919 | 24383 | 1318 | 29927 | 634 | 24068 |
| 6L-2S | | MI | 7097 | 3221 | 11563 | 2482 | 13315 | 2056 | 14491 | 1706 | 16210 | 1139 | 19268 | 886 | 12666 |
| 12-#18 | 5.19 | MA | 14760 | 3821 | 22931 | 3125 | 27222 | 2569 | 30162 | 2093 | 34490 | 1310 | 44151 | 449 | 41149 |
| 5L-3S | | MI | 7761 | 3821 | 13349 | 2846 | 15496 | 2316 | 17095 | 1887 | 19702 | 1107 | 23196 | 378 | 21174 |
| 12-#18 | 5.19 | MA | 13971 | 3821 | 21225 | 3143 | 25232 | 2605 | 27574 | 2152 | 30988 | 1363 | 39251 | 231 | 37467 |
| 6L-2S | | MI | 8189 | 3821 | 14473 | 2827 | 16927 | 2303 | 18833 | 1854 | 22054 | 1087 | 26127 | 665 | 21314 |

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

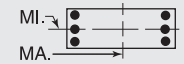
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 1.92 | MA | 12783 | 2958 | 18401 | 2491 | 21820 | 2086 | 23818 | 1762 | 26164 | 1268 | 31894 | 1003 | 18041 |
| 3L-6S | | MI | 6073 | 2958 | 9043 | 2395 | 10184 | 2012 | 10722 | 1697 | 11130 | 1210 | 13023 | 739 | 8543 |
| 14-#10 | 1.92 | MA | 12579 | 2958 | 17839 | 2504 | 21025 | 2107 | 22842 | 1782 | 24826 | 1278 | 30309 | 955 | 17977 |
| 4L-5S | | MI | 6204 | 2958 | 9281 | 2387 | 10509 | 1997 | 11124 | 1691 | 11673 | 1199 | 13722 | 798 | 8741 |
| 14-#10 | 1.92 | MA | 12239 | 2958 | 17252 | 2524 | 20337 | 2120 | 21985 | 1794 | 23629 | 1297 | 28685 | 919 | 17835 |
| 5L-4S | | MI | 6327 | 2958 | 9554 | 2370 | 10837 | 1989 | 11532 | 1677 | 12241 | 1188 | 14485 | 851 | 8757 |
| 14-#10 | 1.92 | MA | 11948 | 2958 | 16694 | 2531 | 19666 | 2130 | 21144 | 1815 | 22459 | 1307 | 27099 | 855 | 17304 |
| 6L-3S | | MI | 6423 | 2958 | 9821 | 2361 | 11213 | 1974 | 11992 | 1671 | 12871 | 1186 | 15250 | 902 | 8754 |
| 14-#10 | 1.92 | MA | 11703 | 2958 | 16166 | 2540 | 18923 | 2146 | 20311 | 1824 | 21328 | 1326 | 25587 | 823 | 16822 |
| 7L-2S | | MI | 6610 | 2958 | 10206 | 2352 | 11703 | 1966 | 12587 | 1657 | 13676 | 1175 | 16337 | 993 | 8743 |
| 14-#11 | 2.36 | MA | 13033 | 3074 | 18891 | 2571 | 22269 | 2157 | 24312 | 1813 | 26778 | 1270 | 33037 | 909 | 21778 |
| 4L-5S | | MI | 6350 | 3074 | 9703 | 2444 | 10976 | 2035 | 11656 | 1712 | 12365 | 1181 | 14517 | 704 | 10299 |
| 14-#11 | 2.36 | MA | 12629 | 3074 | 18181 | 2596 | 21430 | 2172 | 23266 | 1827 | 25321 | 1292 | 31053 | 863 | 21436 |
| 5L-4S | | MI | 6492 | 3074 | 10033 | 2424 | 11373 | 2027 | 12149 | 1696 | 13050 | 1169 | 15411 | 769 | 10476 |
| 14-#11 | 2.36 | MA | 12284 | 3074 | 17501 | 2604 | 20621 | 2185 | 22241 | 1852 | 23894 | 1304 | 29117 | 782 | 20645 |
| 6L-3S | | MI | 6604 | 3074 | 10355 | 2414 | 11825 | 2009 | 12704 | 1691 | 13809 | 1168 | 16312 | 830 | 10488 |
| 14-#11 | 2.36 | MA | 11993 | 3074 | 16859 | 2615 | 19716 | 2204 | 21237 | 1864 | 22515 | 1327 | 27262 | 742 | 20007 |
| 7L-2S | | MI | 6821 | 3074 | 10817 | 2405 | 12413 | 2002 | 13418 | 1675 | 14776 | 1156 | 17586 | 942 | 10478 |
| 14-#14 | 3.41 | MA | 13590 | 3350 | 20282 | 2785 | 24027 | 2314 | 26377 | 1921 | 29479 | 1294 | 36931 | 742 | 29530 |
| 5L-4S | | MI | 6929 | 3350 | 11105 | 2588 | 12671 | 2149 | 13702 | 1770 | 15131 | 1147 | 18008 | 614 | 14442 |
| 14-#14 | 3.41 | MA | 13121 | 3350 | 19308 | 2796 | 22877 | 2333 | 24905 | 1956 | 27433 | 1311 | 34151 | 624 | 28423 |
| 6L-3S | | MI | 7077 | 3350 | 11563 | 2575 | 13315 | 2124 | 14491 | 1764 | 16210 | 1146 | 19268 | 698 | 14624 |
| 14-#14 | 3.41 | MA | 12723 | 3350 | 18388 | 2811 | 21580 | 2360 | 23479 | 1974 | 25454 | 1342 | 31480 | 566 | 26708 |
| 7L-2S | | MI | 7369 | 3350 | 12218 | 2562 | 14149 | 2114 | 15503 | 1742 | 17580 | 1131 | 21042 | 860 | 14648 |
| 14-#18 | 6.06 | MA | 15190 | 4049 | 23776 | 3286 | 28480 | 2708 | 31519 | 2217 | 36326 | 1350 | 46644 | 213 | 45013 |
| 6L-3S | | MI | 8219 | 4049 | 14473 | 2989 | 16927 | 2420 | 18833 | 1952 | 22054 | 1094 | 26127 | 318 | 24516 |
| 14-#18 | 6.06 | MA | 14554 | 4049 | 22160 | 3311 | 26205 | 2754 | 29035 | 2250 | 32752 | 1376 | 41909 | 106 | 41220 |
| 7L-2S | | MI | 8625 | 4049 | 15596 | 2970 | 18357 | 2407 | 20571 | 1919 | 24405 | 1073 | 29058 | 606 | 24685 |
| 16-#10 | 2.20 | MA | 12989 | 3031 | 18677 | 2550 | 22092 | 2140 | 24138 | 1803 | 26579 | 1274 | 32737 | 949 | 20494 |
| 4L-6S | | MI | 6249 | 3031 | 9428 | 2440 | 10674 | 2045 | 11317 | 1717 | 11936 | 1206 | 14110 | 730 | 9665 |
| 16-#10 | 2.20 | MA | 12651 | 3031 | 18090 | 2570 | 21404 | 2152 | 23281 | 1815 | 25383 | 1293 | 31113 | 913 | 20348 |
| 5E | | MI | 6378 | 3031 | 9666 | 2433 | 10999 | 2030 | 11719 | 1712 | 12479 | 1195 | 14809 | 789 | 9872 |
| 16-#10 | 2.20 | MA | 12368 | 3031 | 17532 | 2576 | 20733 | 2163 | 22440 | 1835 | 24213 | 1303 | 29527 | 849 | 19800 |
| 6L-4S | | MI | 6501 | 3031 | 9939 | 2415 | 11327 | 2022 | 12127 | 1697 | 13047 | 1184 | 15572 | 841 | 9917 |
| 16-#10 | 2.20 | MA | 12130 | 3031 | 17004 | 2586 | 19990 | 2179 | 21606 | 1845 | 23082 | 1322 | 28015 | 817 | 19331 |
| 7L-3S | | MI | 6594 | 3031 | 10206 | 2407 | 11703 | 2007 | 12587 | 1692 | 13676 | 1182 | 16337 | 892 | 9922 |
| 16-#10 | 2.20 | MA | 11838 | 3031 | 16500 | 2596 | 19308 | 2188 | 20738 | 1861 | 21973 | 1341 | 26541 | 775 | 18681 |
| 8L-2S | | MI | 6777 | 3031 | 10591 | 2398 | 12193 | 1999 | 13182 | 1678 | 14482 | 1171 | 17424 | 984 | 9915 |
| 16-#11 | 2.70 | MA | 13121 | 3163 | 19199 | 2652 | 22727 | 2213 | 24841 | 1853 | 27452 | 1287 | 34004 | 856 | 24454 |
| 5E | | MI | 6555 | 3163 | 10165 | 2500 | 11563 | 2076 | 12370 | 1738 | 13331 | 1176 | 15791 | 689 | 11634 |
| 16-#11 | 2.70 | MA | 12786 | 3163 | 18520 | 2660 | 21918 | 2226 | 23816 | 1877 | 26026 | 1299 | 32068 | 775 | 23685 |
| 6L-4S | | MI | 6696 | 3163 | 10495 | 2480 | 11961 | 2068 | 12863 | 1722 | 14017 | 1164 | 16685 | 754 | 11862 |
| 16-#11 | 2.70 | MA | 12506 | 3163 | 17878 | 2670 | 21013 | 2245 | 22812 | 1890 | 24646 | 1321 | 30214 | 735 | 23040 |
| 7L-3S | | MI | 6804 | 3163 | 10817 | 2470 | 12413 | 2050 | 13418 | 1716 | 14776 | 1163 | 17586 | 815 | 11883 |
| 16-#11 | 2.70 | MA | 12158 | 3163 | 17263 | 2683 | 20181 | 2255 | 21755 | 1909 | 23294 | 1344 | 28413 | 682 | 22033 |
| 8L-2S | | MI | 7017 | 3163 | 11279 | 2460 | 13001 | 2042 | 14132 | 1700 | 15742 | 1151 | 18860 | 927 | 11882 |
| 16-#14 | 3.90 | MA | 13824 | 3478 | 20766 | 2877 | 24732 | 2391 | 27160 | 1992 | 30484 | 1303 | 38375 | 614 | 32777 |
| 6L-4S | | MI | 7212 | 3478 | 11759 | 2669 | 13505 | 2207 | 14714 | 1807 | 16501 | 1139 | 19782 | 589 | 16313 |
| 16-#14 | 3.90 | MA | 13445 | 3478 | 19846 | 2892 | 23435 | 2418 | 25733 | 2010 | 28505 | 1335 | 35703 | 555 | 31042 |
| 7L-3S | | MI | 7354 | 3478 | 12218 | 2656 | 14149 | 2183 | 15503 | 1800 | 17580 | 1139 | 21042 | 673 | 16587 |
| 16-#14 | 3.90 | MA | 12956 | 3478 | 18964 | 2909 | 22243 | 2433 | 24217 | 2037 | 26565 | 1366 | 33115 | 476 | 29315 |
| 8L-2S | | MI | 7638 | 3478 | 12872 | 2642 | 14982 | 2173 | 16515 | 1779 | 18950 | 1124 | 22815 | 835 | 16623 |
| 16-#18 | 6.93 | MA | 15787 | 4278 | 24711 | 3454 | 29453 | 2858 | 32980 | 2314 | 38091 | 1363 | 49301 | 88 | 48732 |
| 7L-3S | | MI | 8670 | 4278 | 15596 | 3132 | 18357 | 2524 | 20571 | 2016 | 24405 | 1080 | 29058 | 259 | 27857 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

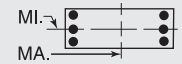



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.47 | MA | 13058 | 3103 | 18928 | 2615 | 22471 | 2185 | 24576 | 1835 | 27137 | 1288 | 33541 | 907 | 22861 |
| 5L-6S | | MI | 6424 | 3103 | 9813 | 2486 | 11164 | 2078 | 11912 | 1738 | 12741 | 1202 | 15197 | 721 | 10791 |
| 18-#10 | 2.47 | MA | 12782 | 3103 | 18370 | 2622 | 21800 | 2196 | 23736 | 1856 | 25967 | 1299 | 31956 | 843 | 22299 |
| 6L-5S | | MI | 6550 | 3103 | 10051 | 2478 | 11488 | 2062 | 12314 | 1732 | 13284 | 1191 | 15896 | 779 | 10987 |
| 18-#10 | 2.47 | MA | 12552 | 3103 | 17842 | 2631 | 21057 | 2212 | 22902 | 1866 | 24836 | 1318 | 30443 | 811 | 21843 |
| 7L-4S | | MI | 6672 | 3103 | 10324 | 2461 | 11817 | 2055 | 12722 | 1718 | 13852 | 1180 | 16659 | 832 | 11075 |
| 18-#10 | 2.47 | MA | 12262 | 3103 | 17338 | 2641 | 20374 | 2221 | 22034 | 1882 | 23727 | 1336 | 28970 | 769 | 21182 |
| 8L-3S | | MI | 6762 | 3103 | 10591 | 2452 | 12193 | 2040 | 13182 | 1712 | 14482 | 1177 | 17424 | 883 | 11086 |
| 18-#10 | 2.47 | MA | 11973 | 3103 | 16755 | 2659 | 19674 | 2239 | 21193 | 1890 | 22582 | 1346 | 27535 | 727 | 20509 |
| 9L-2S | | MI | 6943 | 3103 | 10975 | 2443 | 12682 | 2032 | 13777 | 1698 | 15287 | 1167 | 18511 | 975 | 11084 |
| 18-#11 | 3.04 | MA | 13281 | 3252 | 19538 | 2715 | 23215 | 2266 | 25391 | 1902 | 28157 | 1294 | 35020 | 768 | 26728 |
| 6L-5S | | MI | 6757 | 3252 | 10627 | 2556 | 12151 | 2116 | 13084 | 1763 | 14298 | 1171 | 17064 | 674 | 12974 |
| 18-#11 | 3.04 | MA | 13010 | 3252 | 18896 | 2726 | 22310 | 2285 | 24387 | 1915 | 26778 | 1316 | 33165 | 728 | 26073 |
| 7L-4S | | MI | 6898 | 3252 | 10957 | 2536 | 12549 | 2108 | 13578 | 1747 | 14983 | 1159 | 17958 | 740 | 13245 |
| 18-#11 | 3.04 | MA | 12665 | 3252 | 18281 | 2738 | 21478 | 2296 | 23330 | 1934 | 25425 | 1339 | 31364 | 674 | 25071 |
| 8L-3S | | MI | 7002 | 3252 | 11279 | 2526 | 13001 | 2090 | 14132 | 1741 | 15742 | 1158 | 18860 | 800 | 13274 |
| 18-#11 | 3.04 | MA | 12332 | 3252 | 17578 | 2760 | 20624 | 2318 | 22305 | 1944 | 24042 | 1351 | 29604 | 621 | 24026 |
| 9L-2S | | MI | 7211 | 3252 | 11741 | 2516 | 13589 | 2083 | 14846 | 1725 | 16708 | 1146 | 20133 | 912 | 13283 |
| 18-#14 | 4.38 | MA | 14153 | 3607 | 21303 | 2972 | 25291 | 2476 | 27987 | 2047 | 31556 | 1327 | 39927 | 545 | 35376 |
| 7L-4S | | MI | 7492 | 3607 | 12414 | 2749 | 14338 | 2266 | 15727 | 1843 | 17871 | 1132 | 21555 | 563 | 18194 |
| 18-#14 | 4.38 | MA | 13669 | 3607 | 20421 | 2989 | 24099 | 2491 | 26471 | 2074 | 29615 | 1358 | 37339 | 466 | 33631 |
| 8L-3S | | MI | 7628 | 3607 | 12872 | 2736 | 14982 | 2241 | 16515 | 1836 | 18950 | 1132 | 22815 | 647 | 18547 |
| 18-#14 | 4.38 | MA | 13214 | 3607 | 19419 | 3021 | 22875 | 2522 | 25002 | 2088 | 27631 | 1375 | 34804 | 389 | 31938 |
| 9L-2S | | MI | 7906 | 3607 | 13527 | 2723 | 15816 | 2231 | 17528 | 1815 | 20320 | 1117 | 24589 | 809 | 18595 |
| 20-#10 | 2.75 | MA | 13190 | 3176 | 19208 | 2667 | 22867 | 2229 | 25031 | 1876 | 27721 | 1295 | 34384 | 837 | 24800 |
| 6E | | MI | 6597 | 3176 | 10198 | 2531 | 11654 | 2111 | 12507 | 1758 | 13546 | 1197 | 16284 | 712 | 11919 |
| 20-#10 | 2.75 | MA | 12967 | 3176 | 18680 | 2676 | 22124 | 2245 | 24198 | 1886 | 26589 | 1313 | 32871 | 805 | 24356 |
| 7L-5S | | MI | 6721 | 3176 | 10436 | 2523 | 11978 | 2095 | 12909 | 1753 | 14089 | 1187 | 16984 | 770 | 12106 |
| 20-#10 | 2.75 | MA | 12680 | 3176 | 18176 | 2686 | 21441 | 2254 | 23330 | 1902 | 25480 | 1332 | 31398 | 763 | 23684 |
| 8L-4S | | MI | 6843 | 3176 | 10709 | 2506 | 12307 | 2088 | 13317 | 1739 | 14657 | 1176 | 17746 | 823 | 12230 |
| 20-#10 | 2.75 | MA | 12406 | 3176 | 17593 | 2704 | 20741 | 2272 | 22489 | 1911 | 24336 | 1342 | 29963 | 721 | 23013 |
| 9L-3S | | MI | 6930 | 3176 | 10975 | 2497 | 12682 | 2073 | 13777 | 1733 | 15287 | 1173 | 18511 | 874 | 12247 |
| 20-#10 | 2.75 | MA | 12144 | 3176 | 17069 | 2712 | 20082 | 2282 | 21651 | 1929 | 23192 | 1357 | 28376 | 673 | 22150 |
| 10L-2S | | MI | 7107 | 3176 | 11360 | 2488 | 13172 | 2065 | 14372 | 1719 | 16092 | 1162 | 19599 | 966 | 12251 |
| 20-#11 | 3.38 | MA | 13507 | 3341 | 19914 | 2782 | 23606 | 2326 | 25962 | 1940 | 28909 | 1311 | 36116 | 721 | 29106 |
| 7L-5S | | MI | 6958 | 3341 | 11089 | 2611 | 12739 | 2157 | 13798 | 1788 | 15264 | 1165 | 18338 | 659 | 14319 |
| 20-#11 | 3.38 | MA | 13165 | 3341 | 19300 | 2794 | 22775 | 2336 | 24905 | 1959 | 27557 | 1333 | 34315 | 667 | 28109 |
| 8L-4S | | MI | 7098 | 3341 | 11419 | 2591 | 13137 | 2149 | 14292 | 1772 | 15950 | 1154 | 19232 | 725 | 14627 |
| 20-#11 | 3.38 | MA | 12841 | 3341 | 18596 | 2816 | 21921 | 2358 | 23880 | 1969 | 26174 | 1345 | 32556 | 614 | 27053 |
| 9L-3S | | MI | 7199 | 3341 | 11741 | 2581 | 13589 | 2131 | 14846 | 1767 | 16708 | 1152 | 20133 | 785 | 14663 |
| 20-#11 | 3.38 | MA | 12531 | 3341 | 17957 | 2825 | 21117 | 2370 | 22859 | 1991 | 24786 | 1364 | 30616 | 554 | 26038 |
| 10L-2S | | MI | 7404 | 3341 | 12202 | 2572 | 14177 | 2123 | 15560 | 1751 | 17675 | 1141 | 21407 | 897 | 14678 |
| 20-#14 | 4.87 | MA | 14369 | 3735 | 21879 | 3069 | 25955 | 2549 | 28725 | 2110 | 32666 | 1351 | 41563 | 455 | 37946 |
| 8L-4S | | MI | 7770 | 3735 | 13069 | 2829 | 15172 | 2324 | 16739 | 1879 | 19241 | 1124 | 23329 | 538 | 20083 |
| 20-#14 | 4.87 | MA | 13930 | 3735 | 20877 | 3101 | 24731 | 2581 | 27256 | 2124 | 30682 | 1367 | 39028 | 378 | 36239 |
| 9L-3S | | MI | 7901 | 3735 | 13527 | 2816 | 15816 | 2299 | 17528 | 1873 | 20320 | 1124 | 24589 | 622 | 20505 |
| 22-#10 | 3.02 | MA | 13378 | 3248 | 19518 | 2721 | 23191 | 2278 | 25494 | 1907 | 28343 | 1309 | 35300 | 799 | 26870 |
| 7L-6S | | MI | 6768 | 3248 | 10583 | 2576 | 12144 | 2144 | 13102 | 1779 | 14351 | 1193 | 17371 | 703 | 13049 |
| 22-#10 | 3.02 | MA | 13091 | 3248 | 19014 | 2732 | 22508 | 2287 | 24626 | 1923 | 27234 | 1328 | 33826 | 758 | 26185 |
| 8L-5S | | MI | 6890 | 3248 | 10820 | 2569 | 12468 | 2128 | 13504 | 1773 | 14895 | 1182 | 18071 | 761 | 13228 |
| 22-#10 | 3.02 | MA | 12825 | 3248 | 18431 | 2750 | 21808 | 2305 | 23785 | 1931 | 26090 | 1338 | 32391 | 715 | 25516 |
| 9L-4S | | MI | 7012 | 3248 | 11093 | 2551 | 12797 | 2121 | 13912 | 1759 | 15462 | 1172 | 18833 | 814 | 13385 |
| 22-#10 | 3.02 | MA | 12572 | 3248 | 17907 | 2757 | 21149 | 2315 | 22947 | 1949 | 24945 | 1353 | 30804 | 667 | 24646 |
| 10L-3S | | MI | 7096 | 3248 | 11360 | 2543 | 13172 | 2105 | 14372 | 1754 | 16092 | 1169 | 19599 | 865 | 13406 |
| 22-#10 | 3.02 | MA | 12291 | 3248 | 17395 | 2766 | 20478 | 2324 | 22127 | 1959 | 23786 | 1361 | 29370 | 623 | 23833 |
| 11L-2S | | MI | 7271 | 3248 | 11745 | 2534 | 13662 | 2098 | 14967 | 1739 | 16897 | 1158 | 20686 | 956 | 13415 |
| 22-#11 | 3.71 | MA | 13657 | 3430 | 20318 | 2850 | 24071 | 2377 | 26480 | 1984 | 29688 | 1328 | 37267 | 660 | 31147 |
| 8L-5S | | MI | 7157 | 3430 | 11550 | 2667 | 13327 | 2197 | 14512 | 1813 | 16231 | 1160 | 19612 | 644 | 15667 |

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.71 | MA | 13343 | 3430 | 19615 | 2872 | 23218 | 2399 | 25455 | 1994 | 28306 | 1340 | 35507 | 607 | 30079 |
| 9L-4S | | MI | 7297 | 3430 | 11880 | 2647 | 13725 | 2189 | 15006 | 1797 | 16916 | 1149 | 20506 | 710 | 16008 |
| 22-#11 | 3.71 | MA | 13045 | 3430 | 18976 | 2881 | 22414 | 2411 | 24434 | 2016 | 26917 | 1359 | 33567 | 547 | 29064 |
| 10L-3S | | MI | 7394 | 3430 | 12202 | 2637 | 14177 | 2171 | 15560 | 1792 | 17675 | 1147 | 21407 | 770 | 16050 |
| 22-#11 | 3.71 | MA | 12710 | 3430 | 18353 | 2892 | 21605 | 2422 | 23434 | 2027 | 25504 | 1368 | 31814 | 490 | 27836 |
| 11L-2S | | MI | 7596 | 3430 | 12664 | 2627 | 14765 | 2164 | 16275 | 1776 | 18641 | 1136 | 22681 | 882 | 16071 |
| 22-#14 | 5.36 | MA | 14634 | 3864 | 22334 | 3182 | 26586 | 2639 | 29510 | 2160 | 33732 | 1360 | 43252 | 368 | 40539 |
| 9L-4S | | MI | 8046 | 3864 | 13723 | 2909 | 16005 | 2382 | 17751 | 1916 | 20611 | 1117 | 25103 | 512 | 21979 |
| 24-#10 | 3.30 | MA | 13498 | 3321 | 19852 | 2777 | 23575 | 2319 | 25922 | 1943 | 28988 | 1324 | 36255 | 752 | 28687 |
| 8L-6S | | MI | 6939 | 3321 | 10967 | 2622 | 12634 | 2177 | 13697 | 1799 | 15157 | 1189 | 18458 | 693 | 14181 |
| 24-#10 | 3.30 | MA | 13238 | 3321 | 19269 | 2795 | 22875 | 2338 | 25081 | 1952 | 27844 | 1333 | 34820 | 709 | 28008 |
| 9L-5S | | MI | 7058 | 3321 | 11205 | 2614 | 12958 | 2161 | 14099 | 1794 | 15700 | 1178 | 19158 | 752 | 14353 |
| 24-#10 | 3.30 | MA | 12994 | 3321 | 18745 | 2803 | 22216 | 2348 | 24243 | 1970 | 26699 | 1349 | 33233 | 662 | 27141 |
| 10L-4S | | MI | 7179 | 3321 | 11478 | 2597 | 13287 | 2154 | 14507 | 1780 | 16268 | 1167 | 19920 | 805 | 14538 |
| 24-#10 | 3.30 | MA | 12715 | 3321 | 18233 | 2812 | 21545 | 2357 | 23422 | 1980 | 25539 | 1357 | 31798 | 617 | 26322 |
| 11L-3S | | MI | 7262 | 3321 | 11745 | 2588 | 13662 | 2138 | 14967 | 1774 | 16897 | 1165 | 20686 | 856 | 14564 |
| 24-#10 | 3.30 | MA | 12438 | 3321 | 17733 | 2822 | 20832 | 2374 | 22602 | 1998 | 24411 | 1374 | 30345 | 581 | 25432 |
| 12L-2S | | MI | 7433 | 3321 | 12130 | 2579 | 14152 | 2131 | 15562 | 1760 | 17703 | 1154 | 21773 | 947 | 14577 |
| 24-#11 | 4.05 | MA | 13837 | 3519 | 20633 | 2927 | 24515 | 2439 | 27030 | 2020 | 30437 | 1335 | 38458 | 600 | 33106 |
| 9L-5S | | MI | 7355 | 3519 | 12012 | 2723 | 13915 | 2237 | 15227 | 1839 | 17197 | 1155 | 20886 | 629 | 17018 |
| 24-#11 | 4.05 | MA | 13560 | 3519 | 19994 | 2937 | 23711 | 2451 | 26009 | 2041 | 29049 | 1354 | 36519 | 540 | 32081 |
| 10L-4S | | MI | 7494 | 3519 | 12342 | 2703 | 14313 | 2230 | 15720 | 1823 | 17883 | 1143 | 21780 | 695 | 17384 |
| 24-#11 | 4.05 | MA | 13219 | 3519 | 19371 | 2947 | 22902 | 2462 | 25009 | 2053 | 27635 | 1363 | 34765 | 483 | 30858 |
| 11L-3S | | MI | 7589 | 3519 | 12664 | 2693 | 14765 | 2212 | 16275 | 1817 | 18641 | 1142 | 22681 | 755 | 17436 |

## RECTANGULAR TIED COLUMNS 22" x 44"

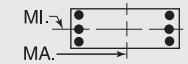
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.65 | MA | 13942 | 3024 | 20306 | 2521 | 23882 | 2114 | 25957 | 1792 | 28382 | 1297 | 34477 | 1124 | 16798 |
| 2E | | MI | 6621 | 3024 | 10346 | 2350 | 11602 | 1968 | 12283 | 1665 | 13026 | 1195 | 14809 | 953 | 7713 |
| 6-#14 | 1.39 | MA | 13605 | 2953 | 19397 | 2492 | 22841 | 2095 | 24751 | 1783 | 26797 | 1310 | 32319 | 1138 | 14370 |
| 2L-3S | | MI | 6194 | 2953 | 9308 | 2349 | 10377 | 1972 | 10842 | 1689 | 11110 | 1233 | 12584 | 850 | 6731 |
| 6-#14 | 1.39 | MA | 12782 | 2953 | 17859 | 2515 | 20883 | 2117 | 22373 | 1803 | 23578 | 1342 | 27862 | 998 | 14343 |
| 3L-2S | | MI | 6521 | 2953 | 9963 | 2336 | 11211 | 1962 | 11854 | 1667 | 12480 | 1218 | 14358 | 1012 | 6688 |
| 6-#18 | 2.48 | MA | 15184 | 3252 | 23000 | 2664 | 27311 | 2218 | 30123 | 1857 | 34019 | 1283 | 42283 | 1106 | 24938 |
| 2L-3S | | MI | 6562 | 3252 | 10346 | 2512 | 11602 | 2085 | 12283 | 1762 | 13026 | 1202 | 14809 | 605 | 11179 |
| 6-#18 | 2.48 | MA | 13846 | 3252 | 20306 | 2703 | 23882 | 2255 | 25957 | 1890 | 28382 | 1338 | 34477 | 851 | 24689 |
| 3L-2S | | MI | 7091 | 3252 | 11470 | 2493 | 13032 | 2072 | 14021 | 1729 | 15377 | 1182 | 17740 | 893 | 11168 |
| 8-#10 | 1.05 | MA | 13109 | 2857 | 18151 | 2451 | 21395 | 2067 | 23066 | 1770 | 24575 | 1326 | 29287 | 1155 | 11006 |
| 2L-4S | | MI | 6053 | 2857 | 8758 | 2331 | 9762 | 1973 | 10148 | 1687 | 10208 | 1258 | 11639 | 928 | 5266 |
| 8-#10 | 1.05 | MA | 12622 | 2857 | 17268 | 2464 | 20271 | 2080 | 21700 | 1782 | 22727 | 1345 | 26727 | 1079 | 11010 |
| 3E | | MI | 6159 | 2857 | 9024 | 2322 | 10137 | 1958 | 10608 | 1682 | 10838 | 1256 | 12405 | 979 | 5241 |
| 8-#10 | 1.05 | MA | 12375 | 2857 | 16677 | 2478 | 19434 | 2102 | 20672 | 1803 | 21317 | 1356 | 25063 | 1030 | 10977 |
| 4L-2S | | MI | 6357 | 2857 | 9409 | 2313 | 10627 | 1950 | 11203 | 1668 | 11643 | 1245 | 13492 | 1071 | 5218 |
| 8-#11 | 1.29 | MA | 13466 | 2923 | 19011 | 2481 | 22408 | 2088 | 24255 | 1781 | 26150 | 1316 | 31442 | 1144 | 13370 |
| 2L-4S | | MI | 6123 | 2923 | 9009 | 2353 | 10004 | 1988 | 10408 | 1692 | 10532 | 1242 | 12002 | 864 | 6316 |
| 8-#11 | 1.29 | MA | 12888 | 2923 | 17937 | 2498 | 21041 | 2104 | 22594 | 1795 | 23902 | 1339 | 28329 | 1049 | 13364 |
| 3E | | MI | 6248 | 2923 | 9331 | 2343 | 10457 | 1970 | 10963 | 1686 | 11291 | 1240 | 12903 | 924 | 6287 |
| 8-#11 | 1.29 | MA | 12594 | 2923 | 17216 | 2514 | 20021 | 2130 | 21341 | 1820 | 22185 | 1351 | 26292 | 989 | 13293 |
| 4L-2S | | MI | 6481 | 2923 | 9793 | 2333 | 11045 | 1962 | 11677 | 1671 | 12258 | 1229 | 14177 | 1036 | 6259 |
| 8-#14 | 1.86 | MA | 14334 | 3081 | 20935 | 2572 | 24799 | 2153 | 27129 | 1819 | 30015 | 1302 | 36775 | 1127 | 19024 |
| 2L-4S | | MI | 6313 | 3081 | 9504 | 2443 | 10567 | 2055 | 11065 | 1732 | 11401 | 1225 | 13098 | 740 | 8734 |
| 8-#14 | 1.86 | MA | 13543 | 3081 | 19397 | 2595 | 22841 | 2175 | 24751 | 1840 | 26797 | 1334 | 32319 | 988 | 18967 |
| 3E | | MI | 6486 | 3081 | 9963 | 2430 | 11211 | 2030 | 11854 | 1725 | 12480 | 1225 | 14358 | 824 | 8736 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

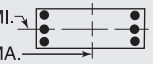



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.86 | MA | 13142 | 3081 | 18363 | 2619 | 21378 | 2212 | 22955 | 1875 | 24335 | 1352 | 29387 | 901 | 18714 |
| 4L-2S | | MI | 6803 | 3081 | 10617 | 2416 | 12044 | 2021 | 12867 | 1704 | 13850 | 1210 | 16132 | 986 | 8706 |
| 8-#18 | 3.31 | MA | 15129 | 3481 | 23000 | 2846 | 27311 | 2358 | 30123 | 1955 | 34019 | 1324 | 42283 | 833 | 32760 |
| 3E | | MI | 7046 | 3481 | 11470 | 2655 | 13032 | 2189 | 14021 | 1827 | 15377 | 1189 | 17740 | 546 | 14542 |
| 8-#18 | 3.31 | MA | 14493 | 3481 | 21182 | 2886 | 24742 | 2422 | 26969 | 2015 | 29695 | 1352 | 37097 | 676 | 30583 |
| 4L-2S | | MI | 7553 | 3481 | 12594 | 2635 | 14463 | 2176 | 15758 | 1794 | 17729 | 1169 | 20671 | 833 | 14588 |
| 10-#10 | 1.31 | MA | 13543 | 2930 | 19034 | 2496 | 22520 | 2100 | 24432 | 1790 | 26424 | 1322 | 31847 | 1149 | 13683 |
| 2L-5S | | MI | 6107 | 2930 | 8870 | 2394 | 9923 | 2013 | 10335 | 1722 | 10446 | 1265 | 11964 | 866 | 6459 |
| 10-#10 | 1.31 | MA | 13068 | 2930 | 18151 | 2510 | 21395 | 2113 | 23066 | 1803 | 24575 | 1341 | 29287 | 1073 | 13676 |
| 3L-4S | | MI | 6232 | 2930 | 9142 | 2376 | 10252 | 2006 | 10743 | 1708 | 11014 | 1254 | 12726 | 919 | 6447 |
| 10-#10 | 1.31 | MA | 12831 | 2930 | 17560 | 2523 | 20559 | 2135 | 22038 | 1823 | 23166 | 1352 | 27623 | 1024 | 13631 |
| 4L-3S | | MI | 6335 | 2930 | 9409 | 2368 | 10627 | 1990 | 11203 | 1702 | 11643 | 1252 | 13492 | 970 | 6428 |
| 10-#10 | 1.31 | MA | 12465 | 2930 | 16939 | 2543 | 19835 | 2148 | 21136 | 1835 | 21907 | 1371 | 25916 | 989 | 13500 |
| 5L-2S | | MI | 6529 | 2930 | 9794 | 2359 | 11117 | 1983 | 11798 | 1688 | 12449 | 1241 | 14579 | 1061 | 6408 |
| 10-#11 | 1.61 | MA | 13982 | 3012 | 20085 | 2537 | 23776 | 2129 | 25916 | 1806 | 28398 | 1311 | 34554 | 1137 | 16623 |
| 2L-5S | | MI | 6191 | 3012 | 9141 | 2429 | 10195 | 2036 | 10629 | 1733 | 10814 | 1248 | 12382 | 784 | 7717 |
| 10-#11 | 1.61 | MA | 13421 | 3012 | 19011 | 2554 | 22408 | 2144 | 24255 | 1820 | 26150 | 1334 | 31442 | 1041 | 16601 |
| 3L-4S | | MI | 6334 | 3012 | 9471 | 2409 | 10592 | 2028 | 11122 | 1717 | 11499 | 1236 | 13276 | 849 | 7724 |
| 10-#11 | 1.61 | MA | 13141 | 3012 | 18290 | 2570 | 21388 | 2170 | 23002 | 1845 | 24433 | 1346 | 29404 | 982 | 16513 |
| 4L-3S | | MI | 6455 | 3012 | 9793 | 2399 | 11045 | 2010 | 11677 | 1712 | 12258 | 1235 | 14177 | 909 | 7706 |
| 10-#11 | 1.61 | MA | 12704 | 3012 | 17539 | 2595 | 20506 | 2185 | 21902 | 1859 | 22898 | 1369 | 27319 | 937 | 16279 |
| 5L-2S | | MI | 6682 | 3012 | 10255 | 2389 | 11633 | 2003 | 12391 | 1696 | 13224 | 1223 | 15451 | 1021 | 7683 |
| 10-#14 | 2.32 | MA | 14287 | 3209 | 20935 | 2676 | 24799 | 2233 | 27129 | 1876 | 30015 | 1327 | 36775 | 978 | 23588 |
| 3L-4S | | MI | 6608 | 3209 | 10159 | 2523 | 11400 | 2114 | 12078 | 1768 | 12771 | 1218 | 14872 | 715 | 10694 |
| 10-#14 | 2.32 | MA | 13912 | 3209 | 19901 | 2699 | 23336 | 2270 | 25333 | 1911 | 27553 | 1344 | 33844 | 891 | 23320 |
| 4L-3S | | MI | 6773 | 3209 | 10617 | 2510 | 12044 | 2089 | 12867 | 1762 | 13850 | 1218 | 16132 | 799 | 10724 |
| 10-#14 | 2.32 | MA | 13297 | 3209 | 18830 | 2735 | 22070 | 2292 | 23755 | 1931 | 25352 | 1376 | 30847 | 824 | 22089 |
| 5L-2S | | MI | 7081 | 3209 | 11272 | 2497 | 12878 | 2079 | 13879 | 1740 | 15220 | 1203 | 17905 | 961 | 10709 |
| 10-#18 | 4.13 | MA | 15802 | 3709 | 23876 | 3029 | 28172 | 2525 | 31134 | 2080 | 35333 | 1339 | 44903 | 658 | 38570 |
| 4L-3S | | MI | 7522 | 3709 | 12594 | 2798 | 14463 | 2293 | 15758 | 1892 | 17729 | 1176 | 20671 | 486 | 17893 |
| 10-#18 | 4.13 | MA | 14758 | 3709 | 22014 | 3093 | 25942 | 2562 | 28358 | 2114 | 31462 | 1393 | 39619 | 532 | 35560 |
| 5L-2S | | MI | 8010 | 3709 | 13717 | 2778 | 15894 | 2280 | 17496 | 1859 | 20080 | 1156 | 23602 | 774 | 17983 |
| 12-#10 | 1.57 | MA | 13971 | 3002 | 19917 | 2541 | 23645 | 2133 | 25798 | 1811 | 28273 | 1318 | 34406 | 1143 | 16356 |
| 2L-6S | | MI | 6151 | 3002 | 9016 | 2447 | 10088 | 2062 | 10528 | 1748 | 10708 | 1272 | 12351 | 798 | 7486 |
| 12-#10 | 1.57 | MA | 13507 | 3002 | 19034 | 2555 | 22520 | 2146 | 24432 | 1823 | 26424 | 1337 | 31847 | 1067 | 16340 |
| 3L-5S | | MI | 6285 | 3002 | 9254 | 2439 | 10413 | 2046 | 10930 | 1743 | 11251 | 1261 | 13051 | 857 | 7620 |
| 12-#10 | 1.57 | MA | 13280 | 3002 | 18443 | 2569 | 21683 | 2168 | 23404 | 1844 | 25014 | 1348 | 30183 | 1019 | 16284 |
| 4E | | MI | 6409 | 3002 | 9527 | 2422 | 10742 | 2039 | 11338 | 1728 | 11819 | 1250 | 13814 | 910 | 7620 |
| 12-#10 | 1.57 | MA | 12916 | 3002 | 17822 | 2589 | 20960 | 2181 | 22502 | 1856 | 23756 | 1367 | 28476 | 984 | 16147 |
| 5L-3S | | MI | 6509 | 3002 | 9794 | 2413 | 11117 | 2023 | 11798 | 1723 | 12449 | 1247 | 14579 | 961 | 7607 |
| 12-#10 | 1.57 | MA | 12599 | 3002 | 17234 | 2596 | 20249 | 2191 | 21617 | 1877 | 22524 | 1378 | 26809 | 920 | 15656 |
| 6L-2S | | MI | 6700 | 3002 | 10179 | 2404 | 11607 | 2016 | 12393 | 1709 | 13254 | 1237 | 15666 | 1052 | 7591 |
| 12-#11 | 1.93 | MA | 13944 | 3102 | 20085 | 2609 | 23776 | 2185 | 25916 | 1845 | 28398 | 1329 | 34554 | 1034 | 19836 |
| 3L-5S | | MI | 6401 | 3102 | 9603 | 2485 | 10783 | 2077 | 11343 | 1758 | 11780 | 1243 | 13656 | 769 | 9047 |
| 12-#11 | 1.93 | MA | 13678 | 3102 | 19364 | 2626 | 22756 | 2211 | 24664 | 1870 | 26681 | 1341 | 32517 | 974 | 19735 |
| 4E | | MI | 6543 | 3102 | 9933 | 2464 | 11180 | 2069 | 11836 | 1743 | 12465 | 1231 | 14550 | 834 | 9123 |
| 12-#11 | 1.93 | MA | 13244 | 3102 | 18613 | 2650 | 21873 | 2226 | 23563 | 1885 | 25146 | 1364 | 30431 | 930 | 19496 |
| 5L-3S | | MI | 6659 | 3102 | 10255 | 2455 | 11633 | 2051 | 12391 | 1737 | 13224 | 1230 | 15451 | 894 | 9116 |
| 12-#11 | 1.93 | MA | 12867 | 3102 | 17897 | 2659 | 21016 | 2239 | 22484 | 1909 | 23644 | 1376 | 28396 | 850 | 18621 |
| 6L-2S | | MI | 6882 | 3102 | 10716 | 2445 | 12221 | 2043 | 13105 | 1721 | 14191 | 1218 | 16725 | 1006 | 9099 |
| 12-#14 | 2.79 | MA | 14665 | 3338 | 21439 | 2779 | 25295 | 2328 | 27712 | 1948 | 30772 | 1337 | 38300 | 880 | 27930 |
| 4E | | MI | 6899 | 3338 | 10814 | 2603 | 12234 | 2172 | 13090 | 1805 | 14141 | 1210 | 16645 | 689 | 12649 |
| 12-#14 | 2.79 | MA | 14055 | 3338 | 20368 | 2815 | 24028 | 2350 | 26133 | 1968 | 28570 | 1369 | 35304 | 814 | 26672 |
| 5L-3S | | MI | 7056 | 3338 | 11272 | 2590 | 12878 | 2147 | 13879 | 1798 | 15220 | 1210 | 17905 | 773 | 12699 |
| 12-#14 | 2.79 | MA | 13536 | 3338 | 19341 | 2827 | 22807 | 2369 | 24585 | 2003 | 26416 | 1386 | 32380 | 697 | 25459 |
| 6L-2S | | MI | 7356 | 3338 | 11927 | 2577 | 13711 | 2137 | 14891 | 1777 | 16590 | 1195 | 19679 | 935 | 12701 |
| 12-#18 | 4.96 | MA | 16039 | 3937 | 24708 | 3236 | 29372 | 2666 | 32524 | 2178 | 37099 | 1380 | 47425 | 514 | 43576 |
| 5L-3S | | MI | 7991 | 3937 | 13717 | 2940 | 15894 | 2396 | 17496 | 1957 | 20080 | 1162 | 23602 | 427 | 21238 |

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

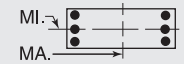
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 4.96 | MA | 15200 | 3937 | 22908 | 3255 | 27258 | 2700 | 29798 | 2238 | 33410 | 1434 | 42269 | 300 | 39810 |
| 6L-2S | | MI | 8453 | 3937 | 14841 | 2921 | 17324 | 2383 | 19233 | 1924 | 22432 | 1142 | 26534 | 714 | 21364 |
| 14-#10 | 1.84 | MA | 13939 | 3075 | 19917 | 2600 | 23645 | 2179 | 25798 | 1844 | 28273 | 1333 | 34406 | 1061 | 19002 |
| 3L-6S | | MI | 6329 | 3075 | 9401 | 2492 | 10578 | 2095 | 11123 | 1769 | 11513 | 1267 | 13439 | 789 | 8604 |
| 14-#10 | 1.84 | MA | 13722 | 3075 | 19326 | 2614 | 22808 | 2201 | 24770 | 1864 | 26863 | 1344 | 32742 | 1013 | 18937 |
| 4L-5S | | MI | 6461 | 3075 | 9639 | 2484 | 10903 | 2079 | 11525 | 1763 | 12056 | 1257 | 14138 | 848 | 8776 |
| 14-#10 | 1.84 | MA | 13360 | 3075 | 18705 | 2634 | 22084 | 2214 | 23868 | 1877 | 25604 | 1363 | 31035 | 978 | 18795 |
| 5L-4S | | MI | 6584 | 3075 | 9912 | 2467 | 11231 | 2072 | 11933 | 1749 | 12624 | 1246 | 14901 | 901 | 8787 |
| 14-#10 | 1.84 | MA | 13052 | 3075 | 18117 | 2641 | 21374 | 2224 | 22983 | 1897 | 24373 | 1373 | 29369 | 915 | 18286 |
| 6L-3S | | MI | 6681 | 3075 | 10179 | 2458 | 11607 | 2056 | 12393 | 1743 | 13254 | 1243 | 15666 | 952 | 8780 |
| 14-#10 | 1.84 | MA | 12791 | 3075 | 17562 | 2650 | 20591 | 2240 | 22100 | 1907 | 23183 | 1393 | 27782 | 883 | 17766 |
| 7L-2S | | MI | 6868 | 3075 | 10564 | 2449 | 12097 | 2049 | 12988 | 1729 | 14059 | 1232 | 16753 | 1043 | 8768 |
| 14-#11 | 2.26 | MA | 14206 | 3191 | 20438 | 2681 | 24124 | 2251 | 26325 | 1896 | 28929 | 1336 | 35630 | 967 | 22958 |
| 4L-5S | | MI | 6607 | 3191 | 10065 | 2540 | 11371 | 2117 | 12057 | 1784 | 12746 | 1238 | 14930 | 754 | 10375 |
| 14-#11 | 2.26 | MA | 13775 | 3191 | 19687 | 2706 | 23241 | 2266 | 25225 | 1910 | 27394 | 1359 | 33544 | 922 | 22690 |
| 5L-4S | | MI | 6749 | 3191 | 10394 | 2520 | 11768 | 2109 | 12550 | 1768 | 13432 | 1226 | 15824 | 819 | 10514 |
| 14-#11 | 2.26 | MA | 13409 | 3191 | 18971 | 2714 | 22383 | 2279 | 24145 | 1935 | 25892 | 1371 | 31508 | 843 | 21826 |
| 6L-3S | | MI | 6862 | 3191 | 10716 | 2510 | 12221 | 2091 | 13105 | 1762 | 14191 | 1225 | 16725 | 879 | 10520 |
| 14-#11 | 2.26 | MA | 13100 | 3191 | 18295 | 2725 | 21430 | 2299 | 23081 | 1947 | 24441 | 1394 | 29563 | 803 | 21191 |
| 7L-2S | | MI | 7080 | 3191 | 11178 | 2500 | 12809 | 2084 | 13819 | 1746 | 15157 | 1213 | 17999 | 992 | 10509 |
| 14-#14 | 3.25 | MA | 14796 | 3466 | 21905 | 2895 | 25986 | 2408 | 28511 | 2004 | 31789 | 1361 | 39760 | 803 | 31261 |
| 5L-4S | | MI | 7185 | 3466 | 11468 | 2684 | 13067 | 2230 | 14103 | 1841 | 15511 | 1203 | 18419 | 664 | 14548 |
| 14-#14 | 3.25 | MA | 14298 | 3466 | 20879 | 2907 | 24765 | 2427 | 26963 | 2039 | 29634 | 1378 | 36836 | 687 | 30055 |
| 6L-3S | | MI | 7336 | 3466 | 11927 | 2670 | 13711 | 2206 | 14891 | 1834 | 16590 | 1203 | 19679 | 748 | 14668 |
| 14-#14 | 3.25 | MA | 13875 | 3466 | 19909 | 2922 | 23398 | 2455 | 25448 | 2057 | 27551 | 1411 | 34034 | 629 | 28326 |
| 7L-2S | | MI | 7629 | 3466 | 12581 | 2657 | 14545 | 2196 | 15904 | 1813 | 17960 | 1188 | 21452 | 910 | 14687 |
| 14-#18 | 5.79 | MA | 16495 | 4166 | 25601 | 3398 | 30688 | 2804 | 33964 | 2303 | 39048 | 1421 | 50075 | 282 | 47779 |
| 6L-3S | | MI | 8479 | 4166 | 14841 | 3083 | 17324 | 2500 | 19233 | 2021 | 22432 | 1149 | 26534 | 367 | 24581 |
| 14-#18 | 5.79 | MA | 15819 | 4166 | 23897 | 3423 | 28288 | 2851 | 31345 | 2337 | 35282 | 1448 | 45107 | 176 | 43896 |
| 7L-2S | | MI | 8891 | 4166 | 15964 | 3064 | 18755 | 2487 | 20971 | 1988 | 24783 | 1129 | 29465 | 655 | 24737 |
| 16-#10 | 2.10 | MA | 14158 | 3147 | 20210 | 2659 | 23933 | 2234 | 26136 | 1885 | 28712 | 1339 | 35302 | 1007 | 21591 |
| 4L-6S | | MI | 6506 | 3147 | 9786 | 2537 | 11068 | 2128 | 11718 | 1789 | 12318 | 1263 | 14526 | 780 | 9727 |
| 16-#10 | 2.10 | MA | 13797 | 3147 | 19589 | 2679 | 23209 | 2247 | 25234 | 1897 | 27453 | 1358 | 33595 | 972 | 21445 |
| 5E | | MI | 6635 | 3147 | 10024 | 2530 | 11393 | 2112 | 12120 | 1784 | 12862 | 1252 | 15225 | 839 | 9930 |
| 16-#10 | 2.10 | MA | 13497 | 3147 | 19000 | 2686 | 22498 | 2257 | 24349 | 1918 | 26222 | 1369 | 31928 | 909 | 20919 |
| 6L-4S | | MI | 6758 | 3147 | 10297 | 2512 | 11721 | 2105 | 12528 | 1770 | 13429 | 1242 | 15988 | 892 | 9949 |
| 16-#10 | 2.10 | MA | 13245 | 3147 | 18445 | 2696 | 21716 | 2273 | 23466 | 1927 | 25031 | 1388 | 30342 | 877 | 20413 |
| 7L-3S | | MI | 6852 | 3147 | 10564 | 2503 | 12097 | 2089 | 12988 | 1764 | 14059 | 1239 | 16753 | 943 | 9950 |
| 16-#10 | 2.10 | MA | 12933 | 3147 | 17915 | 2706 | 20997 | 2282 | 22552 | 1944 | 23865 | 1408 | 28794 | 836 | 19777 |
| 8L-2S | | MI | 7036 | 3147 | 10948 | 2495 | 12587 | 2082 | 13583 | 1750 | 14864 | 1228 | 17840 | 1034 | 9941 |
| 16-#11 | 2.58 | MA | 14298 | 3280 | 20761 | 2762 | 24608 | 2307 | 26886 | 1935 | 29642 | 1353 | 36657 | 915 | 25875 |
| 5E | | MI | 6812 | 3280 | 10526 | 2596 | 11959 | 2158 | 12771 | 1809 | 13713 | 1232 | 16203 | 739 | 11710 |
| 16-#11 | 2.58 | MA | 13942 | 3280 | 20045 | 2770 | 23751 | 2320 | 25806 | 1960 | 28141 | 1366 | 34621 | 836 | 25034 |
| 6L-4S | | MI | 6953 | 3280 | 10856 | 2576 | 12356 | 2150 | 13264 | 1793 | 14398 | 1221 | 17097 | 804 | 11902 |
| 16-#11 | 2.58 | MA | 13644 | 3280 | 19369 | 2781 | 22798 | 2339 | 24742 | 1972 | 26689 | 1389 | 32676 | 796 | 24408 |
| 7L-3S | | MI | 7062 | 3280 | 11178 | 2566 | 12809 | 2132 | 13819 | 1787 | 15157 | 1220 | 17999 | 864 | 11918 |
| 16-#11 | 2.58 | MA | 13273 | 3280 | 18722 | 2793 | 21922 | 2350 | 23628 | 1992 | 25265 | 1411 | 30783 | 744 | 23333 |
| 8L-2S | | MI | 7276 | 3280 | 11640 | 2556 | 13396 | 2124 | 14533 | 1772 | 16123 | 1208 | 19272 | 977 | 11914 |
| 16-#14 | 3.72 | MA | 15044 | 3595 | 22417 | 2987 | 26723 | 2486 | 29341 | 2076 | 32853 | 1371 | 41293 | 676 | 34650 |
| 6L-4S | | MI | 7469 | 3595 | 12123 | 2764 | 13901 | 2289 | 15115 | 1877 | 16881 | 1195 | 20193 | 638 | 16418 |
| 16-#14 | 3.72 | MA | 14642 | 3595 | 21447 | 3002 | 25356 | 2513 | 27826 | 2094 | 30770 | 1403 | 38491 | 619 | 32899 |
| 7L-3S | | MI | 7613 | 3595 | 12581 | 2751 | 14545 | 2264 | 15904 | 1871 | 17960 | 1195 | 21452 | 722 | 16632 |
| 16-#14 | 3.72 | MA | 14119 | 3595 | 20519 | 3020 | 24100 | 2528 | 26229 | 2121 | 28727 | 1435 | 35770 | 541 | 31164 |
| 8L-2S | | MI | 7899 | 3595 | 13236 | 2738 | 15378 | 2254 | 16916 | 1849 | 19330 | 1180 | 23226 | 884 | 16663 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

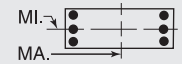



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 6.61 | MA | 17128 | 4394 | 26591 | 3566 | 31718 | 2955 | 35511 | 2401 | 40919 | 1435 | 52913 | 158 | 51829 |
| 7L-3S | | MI | 8931 | 4394 | 15964 | 3226 | 18755 | 2604 | 20971 | 2086 | 24783 | 1136 | 29465 | 307 | 27924 |
| 18-#10 | 2.36 | MA | 14229 | 3220 | 20472 | 2725 | 24334 | 2279 | 26600 | 1918 | 29301 | 1354 | 36154 | 966 | 24096 |
| 5L-6S | | MI | 6681 | 3220 | 10171 | 2583 | 11558 | 2161 | 12313 | 1810 | 13124 | 1259 | 15613 | 771 | 10852 |
| 18-#10 | 2.36 | MA | 13936 | 3220 | 19884 | 2732 | 23623 | 2290 | 25715 | 1938 | 28070 | 1365 | 34488 | 903 | 23555 |
| 6L-5S | | MI | 6807 | 3220 | 10409 | 2575 | 11882 | 2145 | 12715 | 1804 | 13667 | 1248 | 16312 | 830 | 11053 |
| 18-#10 | 2.36 | MA | 13692 | 3220 | 19329 | 2741 | 22840 | 2306 | 24832 | 1948 | 26880 | 1384 | 32902 | 871 | 23062 |
| 7L-4S | | MI | 6930 | 3220 | 10682 | 2558 | 12211 | 2138 | 13123 | 1790 | 14235 | 1237 | 17075 | 883 | 11108 |
| 18-#10 | 2.36 | MA | 13382 | 3220 | 18798 | 2751 | 22122 | 2315 | 23918 | 1964 | 25713 | 1403 | 31354 | 830 | 22415 |
| 8L-3S | | MI | 7021 | 3220 | 10948 | 2549 | 12587 | 2122 | 13583 | 1784 | 14864 | 1235 | 17840 | 934 | 11116 |
| 18-#10 | 2.36 | MA | 13076 | 3220 | 18182 | 2769 | 21385 | 2334 | 23033 | 1973 | 24500 | 1413 | 29849 | 788 | 21693 |
| 9L-2S | | MI | 7202 | 3220 | 11333 | 2540 | 13076 | 2115 | 14178 | 1770 | 15670 | 1224 | 18927 | 1025 | 11111 |
| 18-#11 | 2.90 | MA | 14467 | 3369 | 21119 | 2826 | 25118 | 2360 | 27467 | 1985 | 30389 | 1361 | 37734 | 829 | 28245 |
| 6L-5S | | MI | 7015 | 3369 | 10988 | 2652 | 12547 | 2198 | 13485 | 1834 | 14679 | 1227 | 17477 | 724 | 13049 |
| 18-#11 | 2.90 | MA | 14180 | 3369 | 20443 | 2837 | 24165 | 2380 | 26403 | 1997 | 28937 | 1384 | 35788 | 789 | 27618 |
| 7L-4S | | MI | 7155 | 3369 | 11318 | 2631 | 12944 | 2190 | 13979 | 1818 | 15365 | 1216 | 18371 | 789 | 13287 |
| 18-#11 | 2.90 | MA | 13811 | 3369 | 19796 | 2849 | 23289 | 2390 | 25289 | 2017 | 27513 | 1406 | 33896 | 737 | 26538 |
| 8L-3S | | MI | 7261 | 3369 | 11640 | 2622 | 13396 | 2172 | 14533 | 1813 | 16123 | 1214 | 19272 | 850 | 13311 |
| 18-#11 | 2.90 | MA | 13448 | 3369 | 19051 | 2871 | 22391 | 2413 | 24210 | 2027 | 26052 | 1418 | 32050 | 684 | 25501 |
| 9L-2S | | MI | 7471 | 3369 | 12102 | 2612 | 13984 | 2164 | 15247 | 1797 | 17090 | 1203 | 20546 | 962 | 13315 |
| 18-#14 | 4.18 | MA | 15393 | 3723 | 22985 | 3083 | 27314 | 2571 | 30205 | 2130 | 33988 | 1396 | 42947 | 608 | 37472 |
| 7L-4S | | MI | 7750 | 3723 | 12778 | 2844 | 14734 | 2347 | 16127 | 1914 | 18251 | 1188 | 21966 | 613 | 18297 |
| 18-#14 | 4.18 | MA | 14876 | 3723 | 22057 | 3100 | 26058 | 2587 | 28608 | 2158 | 31946 | 1428 | 40227 | 531 | 35718 |
| 8L-3S | | MI | 7888 | 3723 | 13236 | 2831 | 15378 | 2322 | 16916 | 1907 | 19330 | 1188 | 23226 | 697 | 18594 |
| 18-#14 | 4.18 | MA | 14392 | 3723 | 20995 | 3132 | 24769 | 2618 | 27060 | 2172 | 29857 | 1445 | 37568 | 455 | 33964 |
| 9L-2S | | MI | 8168 | 3723 | 13891 | 2818 | 16212 | 2312 | 17929 | 1886 | 20700 | 1173 | 25000 | 859 | 18636 |
| 20-#10 | 2.62 | MA | 14369 | 3292 | 20767 | 2777 | 24748 | 2323 | 27081 | 1959 | 29919 | 1361 | 37048 | 897 | 26193 |
| 6E | | MI | 6854 | 3292 | 10555 | 2628 | 12048 | 2194 | 12908 | 1830 | 13929 | 1255 | 16700 | 762 | 11980 |
| 20-#10 | 2.62 | MA | 14132 | 3292 | 20212 | 2786 | 23965 | 2339 | 26198 | 1968 | 28729 | 1380 | 35461 | 865 | 25712 |
| 7L-5S | | MI | 6978 | 3292 | 10793 | 2620 | 12372 | 2178 | 13310 | 1825 | 14472 | 1244 | 17399 | 821 | 12171 |
| 20-#10 | 2.62 | MA | 13825 | 3292 | 19681 | 2797 | 23246 | 2348 | 25284 | 1985 | 27562 | 1399 | 33913 | 824 | 25052 |
| 8L-4S | | MI | 7101 | 3292 | 11066 | 2603 | 12701 | 2171 | 13718 | 1811 | 15040 | 1233 | 18162 | 874 | 12265 |
| 20-#10 | 2.62 | MA | 13528 | 3292 | 19065 | 2814 | 22509 | 2367 | 24399 | 1994 | 26349 | 1408 | 32408 | 782 | 24333 |
| 9L-3S | | MI | 7189 | 3292 | 11333 | 2594 | 13076 | 2155 | 14178 | 1805 | 15670 | 1231 | 18927 | 925 | 12278 |
| 20-#10 | 2.62 | MA | 13257 | 3292 | 18512 | 2823 | 21816 | 2377 | 23517 | 2012 | 25144 | 1424 | 30741 | 735 | 23474 |
| 10L-2S | | MI | 7367 | 3292 | 11718 | 2585 | 13566 | 2148 | 14773 | 1791 | 16475 | 1220 | 20014 | 1016 | 12279 |
| 20-#11 | 3.22 | MA | 14707 | 3458 | 21517 | 2892 | 25533 | 2420 | 28064 | 2023 | 31185 | 1378 | 38901 | 782 | 30816 |
| 7L-5S | | MI | 7216 | 3458 | 11450 | 2707 | 13134 | 2238 | 14199 | 1859 | 15646 | 1222 | 18751 | 709 | 14393 |
| 20-#11 | 3.22 | MA | 14341 | 3458 | 20870 | 2905 | 24657 | 2431 | 26950 | 2042 | 29761 | 1401 | 37008 | 730 | 29742 |
| 8L-4S | | MI | 7356 | 3458 | 11780 | 2687 | 13532 | 2231 | 14693 | 1844 | 16331 | 1210 | 19645 | 774 | 14670 |
| 20-#11 | 3.22 | MA | 13998 | 3458 | 20125 | 2927 | 23758 | 2453 | 25871 | 2053 | 28300 | 1413 | 35163 | 677 | 28693 |
| 9L-3S | | MI | 7458 | 3458 | 12102 | 2677 | 13984 | 2213 | 15247 | 1838 | 17090 | 1209 | 20546 | 835 | 14701 |
| 20-#11 | 3.22 | MA | 13668 | 3458 | 19452 | 2936 | 22912 | 2466 | 24796 | 2074 | 26832 | 1432 | 33124 | 618 | 27602 |
| 10L-2S | | MI | 7665 | 3458 | 12563 | 2667 | 14572 | 2205 | 15961 | 1822 | 18056 | 1198 | 21820 | 947 | 14713 |
| 20-#14 | 4.65 | MA | 15619 | 3852 | 23595 | 3181 | 28016 | 2645 | 30986 | 2194 | 35164 | 1420 | 44683 | 521 | 40272 |
| 8L-4S | | MI | 8028 | 3852 | 13432 | 2924 | 15568 | 2405 | 17140 | 1950 | 19621 | 1181 | 23740 | 587 | 20184 |
| 20-#14 | 4.65 | MA | 15153 | 3852 | 22533 | 3212 | 26727 | 2677 | 29438 | 2209 | 33076 | 1437 | 42024 | 444 | 38526 |
| 9L-3S | | MI | 8161 | 3852 | 13891 | 2911 | 16212 | 2381 | 17929 | 1944 | 20700 | 1180 | 25000 | 671 | 20553 |
| 22-#10 | 2.89 | MA | 14568 | 3365 | 21095 | 2832 | 25090 | 2372 | 27564 | 1989 | 30577 | 1376 | 38021 | 860 | 28364 |
| 7L-6S | | MI | 7026 | 3365 | 10940 | 2673 | 12538 | 2227 | 13503 | 1851 | 14734 | 1251 | 17787 | 753 | 13110 |
| 22-#10 | 2.89 | MA | 14262 | 3365 | 20564 | 2842 | 24371 | 2381 | 26650 | 2005 | 29411 | 1395 | 36473 | 819 | 27689 |
| 8L-5S | | MI | 7148 | 3365 | 11178 | 2666 | 12862 | 2211 | 13905 | 1845 | 15277 | 1240 | 18486 | 812 | 13293 |
| 22-#10 | 2.89 | MA | 13979 | 3365 | 19948 | 2860 | 23634 | 2400 | 25765 | 2014 | 28197 | 1404 | 34968 | 776 | 26972 |
| 9L-4S | | MI | 7270 | 3365 | 11451 | 2648 | 13191 | 2204 | 14313 | 1831 | 15845 | 1229 | 19249 | 864 | 13420 |
| 22-#10 | 2.89 | MA | 13710 | 3365 | 19396 | 2868 | 22940 | 2410 | 24883 | 2032 | 26993 | 1420 | 33301 | 730 | 26105 |
| 10L-3S | | MI | 7356 | 3365 | 11718 | 2639 | 13566 | 2188 | 14773 | 1826 | 16475 | 1226 | 20014 | 915 | 13438 |
| 22-#10 | 2.89 | MA | 13411 | 3365 | 18858 | 2877 | 22230 | 2419 | 24020 | 2043 | 25772 | 1428 | 31794 | 686 | 25303 |
| 11L-2S | | MI | 7531 | 3365 | 12103 | 2631 | 14056 | 2181 | 15369 | 1812 | 17280 | 1216 | 21101 | 1007 | 13445 |

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.55 | MA | 14864 | 3547 | 21944 | 2960 | 26025 | 2471 | 28611 | 2067 | 32010 | 1396 | 40121 | 723 | 32946 |
| 8L-5S | | MI | 7415 | 3547 | 11912 | 2763 | 13722 | 2279 | 14913 | 1885 | 16612 | 1217 | 20025 | 694 | 15741 |
| 22-#11 | 3.55 | MA | 14530 | 3547 | 21199 | 2982 | 25126 | 2494 | 27533 | 2078 | 30548 | 1408 | 38275 | 670 | 31886 |
| 9L-4S | | MI | 7555 | 3547 | 12242 | 2743 | 14120 | 2271 | 15407 | 1869 | 17298 | 1205 | 20919 | 760 | 16052 |
| 22-#11 | 3.55 | MA | 14213 | 3547 | 20526 | 2992 | 24280 | 2506 | 26457 | 2100 | 29080 | 1427 | 36237 | 611 | 30798 |
| 10L-3S | | MI | 7654 | 3547 | 12563 | 2733 | 14572 | 2253 | 15961 | 1863 | 18056 | 1204 | 21820 | 820 | 16089 |
| 22-#11 | 3.55 | MA | 13856 | 3547 | 19870 | 3003 | 23422 | 2517 | 25404 | 2112 | 27592 | 1436 | 34395 | 556 | 29554 |
| 11L-2S | | MI | 7857 | 3547 | 13025 | 2723 | 15160 | 2245 | 16676 | 1847 | 19023 | 1192 | 23094 | 932 | 16107 |
| 22-#14 | 5.11 | MA | 15899 | 3980 | 24070 | 3293 | 28685 | 2735 | 31817 | 2245 | 36294 | 1430 | 46481 | 434 | 43089 |
| 9L-4S | | MI | 8305 | 3980 | 14087 | 3005 | 16401 | 2464 | 18152 | 1987 | 20992 | 1173 | 25513 | 562 | 22078 |
| 24-#10 | 3.15 | MA | 14694 | 3437 | 21448 | 2887 | 25496 | 2414 | 28016 | 2026 | 31259 | 1391 | 39033 | 813 | 30326 |
| 8L-6S | | MI | 7196 | 3437 | 11325 | 2719 | 13028 | 2260 | 14098 | 1871 | 15540 | 1246 | 18874 | 744 | 14241 |
| 24-#10 | 3.15 | MA | 14418 | 3437 | 20831 | 2905 | 24758 | 2432 | 27131 | 2035 | 30046 | 1400 | 37528 | 770 | 29612 |
| 9L-5S | | MI | 7316 | 3437 | 11563 | 2711 | 13352 | 2244 | 14500 | 1866 | 16083 | 1236 | 19573 | 802 | 14417 |
| 24-#10 | 3.15 | MA | 14158 | 3437 | 20279 | 2913 | 24065 | 2443 | 26249 | 2053 | 28841 | 1416 | 35860 | 724 | 28736 |
| 10L-4S | | MI | 7438 | 3437 | 11836 | 2694 | 13681 | 2237 | 14908 | 1852 | 16651 | 1225 | 20336 | 855 | 14574 |
| 24-#10 | 3.15 | MA | 13861 | 3437 | 19741 | 2922 | 23354 | 2452 | 25386 | 2063 | 27621 | 1424 | 34354 | 680 | 27926 |
| 11L-3S | | MI | 7521 | 3437 | 12103 | 2685 | 14056 | 2221 | 15369 | 1846 | 17280 | 1222 | 21101 | 906 | 14597 |
| 24-#10 | 3.15 | MA | 13567 | 3437 | 19215 | 2932 | 22604 | 2469 | 24523 | 2082 | 26434 | 1441 | 32830 | 644 | 26967 |
| 12L-2S | | MI | 7694 | 3437 | 12487 | 2676 | 14546 | 2214 | 15964 | 1832 | 18085 | 1211 | 22188 | 998 | 14607 |
| 24-#11 | 3.87 | MA | 15054 | 3636 | 22273 | 3038 | 26493 | 2534 | 29194 | 2103 | 32796 | 1403 | 41388 | 663 | 35078 |
| 9L-5S | | MI | 7613 | 3636 | 12373 | 2819 | 14310 | 2319 | 15627 | 1910 | 17579 | 1212 | 21299 | 679 | 17091 |
| 24-#11 | 3.87 | MA | 14750 | 3636 | 21600 | 3047 | 25647 | 2547 | 28118 | 2125 | 31328 | 1422 | 39350 | 604 | 33995 |
| 10L-4S | | MI | 7753 | 3636 | 12703 | 2798 | 14708 | 2312 | 16121 | 1894 | 18264 | 1200 | 22193 | 745 | 17433 |
| 24-#11 | 3.87 | MA | 14396 | 3636 | 20944 | 3058 | 24790 | 2558 | 27065 | 2137 | 29840 | 1431 | 37507 | 549 | 32742 |
| 11L-3S | | MI | 7849 | 3636 | 13025 | 2789 | 15160 | 2294 | 16676 | 1888 | 19023 | 1199 | 23094 | 805 | 17476 |

## RECTANGULAR TIED COLUMNS 24" x 24"

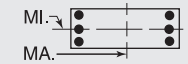
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#9 | 1.04 | MA | 4149 | 1699 | 6060 | 1394 | 6904 | 1175 | 7311 | 1005 | 7636 | 751 | 8957 | 654 | 3393 |
| 2L-3S | | MI | 3970 | 1699 | 5719 | 1401 | 6469 | 1182 | 6784 | 1011 | 6922 | 762 | 7968 | 583 | 3410 |
| 6-#10 | 1.32 | MA | 4268 | 1745 | 6344 | 1418 | 7250 | 1193 | 7724 | 1015 | 8188 | 746 | 9713 | 648 | 4230 |
| 2L-3S | | MI | 4046 | 1745 | 5914 | 1428 | 6702 | 1201 | 7059 | 1030 | 7288 | 759 | 8468 | 557 | 4247 |
| 6-#11 | 1.63 | MA | 4374 | 1795 | 6653 | 1438 | 7600 | 1205 | 8128 | 1021 | 8719 | 737 | 10343 | 628 | 5083 |
| 2L-3S | | MI | 4115 | 1795 | 6136 | 1449 | 6941 | 1214 | 7328 | 1038 | 7636 | 750 | 8876 | 516 | 5100 |
| 6-#14 | 2.34 | MA | 4649 | 1913 | 7339 | 1503 | 8442 | 1252 | 9136 | 1048 | 10072 | 725 | 12070 | 599 | 7114 |
| 2L-3S | | MI | 4295 | 1913 | 6604 | 1518 | 7506 | 1264 | 8000 | 1072 | 8534 | 743 | 10018 | 437 | 7102 |
| 6-#18 | 4.17 | MA | 5289 | 2213 | 8996 | 1674 | 10493 | 1373 | 11598 | 1120 | 13381 | 697 | 16126 | 508 | 12028 |
| 2L-3S | | MI | 4728 | 2213 | 7730 | 1697 | 8880 | 1391 | 9640 | 1158 | 10731 | 723 | 12704 | 220 | 11822 |
| 8-#8 | 1.10 | MA | 4180 | 1708 | 6106 | 1403 | 6976 | 1183 | 7407 | 1011 | 7771 | 753 | 9148 | 655 | 3569 |
| 2L-4S | | MI | 3964 | 1708 | 5648 | 1416 | 6368 | 1199 | 6665 | 1025 | 6762 | 764 | 7815 | 567 | 3592 |
| 8-#9 | 1.39 | MA | 4305 | 1756 | 6401 | 1429 | 7338 | 1201 | 7839 | 1021 | 8350 | 748 | 9946 | 650 | 4441 |
| 2L-4S | | MI | 4038 | 1756 | 5825 | 1445 | 6573 | 1221 | 6906 | 1039 | 7081 | 762 | 8267 | 537 | 4457 |
| 8-#10 | 1.76 | MA | 4460 | 1818 | 6774 | 1464 | 7797 | 1225 | 8389 | 1036 | 9088 | 742 | 10959 | 642 | 5545 |
| 2L-4S | | MI | 4133 | 1818 | 6048 | 1483 | 6832 | 1250 | 7212 | 1058 | 7487 | 758 | 8841 | 498 | 5533 |
| 8-#11 | 2.17 | MA | 4601 | 1884 | 7171 | 1493 | 8259 | 1246 | 8928 | 1046 | 9802 | 731 | 11810 | 617 | 6662 |
| 2L-4S | | MI | 4217 | 1884 | 6295 | 1515 | 7096 | 1274 | 7510 | 1070 | 7873 | 748 | 9311 | 442 | 6611 |
| 8-#14 | 3.13 | MA | 4961 | 2041 | 8074 | 1583 | 9378 | 1310 | 10273 | 1084 | 11610 | 717 | 14121 | 580 | 9343 |
| 2L-4S | | MI | 4443 | 2041 | 6828 | 1613 | 7724 | 1349 | 8256 | 1117 | 8867 | 738 | 10622 | 330 | 8770 |
| 8-#18 | 5.56 | MA | 5799 | 2441 | 10263 | 1816 | 12105 | 1477 | 13556 | 1185 | 16032 | 684 | 19547 | 461 | 15834 |
| 2L-4S | | MI | 4990 | 2441 | 8109 | 1862 | 9246 | 1538 | 10071 | 1234 | 11293 | 710 | 13694 | 25 | 13567 |
| 10-#10 | 2.20 | MA | 4650 | 1890 | 7204 | 1509 | 8345 | 1258 | 9054 | 1056 | 9988 | 738 | 12204 | 636 | 6853 |
| 2L-5S | | MI | 4189 | 1890 | 6175 | 1546 | 7015 | 1292 | 7423 | 1094 | 7756 | 766 | 9213 | 439 | 6544 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

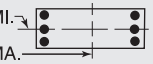
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.20 | MA | 4442 | 1890 | 6774 | 1519 | 7797 | 1267 | 8389 | 1072 | 9088 | 750 | 10959 | 545 | 6851 |
| 3L-4S | | MI | 4335 | 1890 | 6478 | 1528 | 7380 | 1283 | 7877 | 1078 | 8387 | 754 | 10087 | 492 | 6818 |
| 10-#11 | 2.71 | MA | 4823 | 1973 | 7688 | 1549 | 8918 | 1286 | 9729 | 1071 | 10885 | 726 | 13278 | 607 | 8233 |
| 2L-5S | | MI | 4288 | 1973 | 6446 | 1592 | 7313 | 1324 | 7761 | 1113 | 8193 | 757 | 9749 | 367 | 7665 |
| 10-#11 | 2.71 | MA | 4582 | 1973 | 7171 | 1560 | 8259 | 1295 | 8928 | 1089 | 9802 | 740 | 11810 | 494 | 8219 |
| 3L-4S | | MI | 4456 | 1973 | 6812 | 1571 | 7754 | 1315 | 8310 | 1096 | 8956 | 743 | 10778 | 431 | 8150 |
| 10-#14 | 3.91 | MA | 5267 | 2170 | 8809 | 1664 | 10314 | 1368 | 11409 | 1121 | 13148 | 710 | 16173 | 561 | 11559 |
| 2L-5S | | MI | 4544 | 2170 | 7040 | 1723 | 8029 | 1419 | 8609 | 1178 | 9317 | 749 | 11234 | 217 | 10281 |
| 10-#14 | 3.91 | MA | 4944 | 2170 | 8074 | 1679 | 9378 | 1380 | 10273 | 1145 | 11610 | 728 | 14121 | 399 | 11494 |
| 3L-4S | | MI | 4777 | 2170 | 7563 | 1693 | 8659 | 1407 | 9392 | 1154 | 10405 | 731 | 12673 | 311 | 10870 |
| 10-#18 | 6.94 | MA | 5845 | 2669 | 10263 | 1982 | 12105 | 1598 | 13556 | 1288 | 16032 | 697 | 19547 | 127 | 19038 |
| 3L-4S | | MI | 5554 | 2669 | 9375 | 2005 | 10859 | 1642 | 12029 | 1299 | 13944 | 697 | 17115 | -22 | 17071 |

## RECTANGULAR TIED COLUMNS 24" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.00 | MA | 4842 | 1833 | 7074 | 1501 | 8038 | 1267 | 8495 | 1084 | 8840 | 812 | 10340 | 707 | 3827 |
| 2E | | MI | 4450 | 1833 | 6561 | 1488 | 7410 | 1255 | 7805 | 1074 | 8092 | 804 | 9371 | 693 | 3514 |
| 4-#14 | 1.44 | MA | 5054 | 1912 | 7595 | 1542 | 8668 | 1295 | 9244 | 1100 | 9840 | 803 | 11652 | 691 | 5355 |
| 2E | | MI | 4638 | 1912 | 7032 | 1528 | 7976 | 1283 | 8477 | 1090 | 8988 | 794 | 10511 | 672 | 4898 |
| 4-#18 | 2.56 | MA | 5551 | 2112 | 8855 | 1650 | 10205 | 1372 | 11079 | 1144 | 12298 | 781 | 14763 | 638 | 9065 |
| 2E | | MI | 5075 | 2112 | 8163 | 1635 | 9352 | 1358 | 10117 | 1133 | 11184 | 772 | 13193 | 608 | 8242 |
| 6-#10 | 1.22 | MA | 4979 | 1872 | 7301 | 1538 | 8375 | 1294 | 8928 | 1104 | 9444 | 817 | 11190 | 710 | 4641 |
| 2L-3S | | MI | 4352 | 1872 | 6335 | 1535 | 7169 | 1292 | 7536 | 1110 | 7745 | 822 | 8966 | 612 | 4272 |
| 6-#10 | 1.22 | MA | 4731 | 1872 | 6825 | 1548 | 7770 | 1303 | 8193 | 1112 | 8449 | 830 | 9812 | 621 | 4659 |
| 3L-2S | | MI | 4575 | 1872 | 6765 | 1525 | 7717 | 1284 | 8201 | 1095 | 8645 | 810 | 10212 | 703 | 4252 |
| 6-#11 | 1.50 | MA | 5102 | 1922 | 7647 | 1557 | 8768 | 1307 | 9382 | 1109 | 10040 | 807 | 12001 | 700 | 5588 |
| 2L-3S | | MI | 4421 | 1922 | 6561 | 1555 | 7410 | 1305 | 7805 | 1117 | 8092 | 813 | 9371 | 571 | 5131 |
| 6-#11 | 1.50 | MA | 4810 | 1922 | 7074 | 1569 | 8038 | 1317 | 8495 | 1128 | 8840 | 822 | 10340 | 588 | 5606 |
| 3L-2S | | MI | 4682 | 1922 | 7078 | 1544 | 8069 | 1296 | 8606 | 1099 | 9175 | 799 | 10838 | 683 | 5110 |
| 6-#14 | 2.16 | MA | 5413 | 2040 | 8411 | 1622 | 9706 | 1353 | 10505 | 1137 | 11547 | 795 | 13983 | 677 | 7843 |
| 2L-3S | | MI | 4601 | 2040 | 7032 | 1623 | 7976 | 1353 | 8477 | 1150 | 8988 | 805 | 10511 | 492 | 7147 |
| 6-#14 | 2.16 | MA | 5015 | 2040 | 7595 | 1639 | 8668 | 1367 | 9244 | 1162 | 9840 | 816 | 11652 | 515 | 7831 |
| 3L-2S | | MI | 4957 | 2040 | 7767 | 1608 | 8912 | 1341 | 9614 | 1126 | 10527 | 787 | 12563 | 653 | 7148 |
| 6-#18 | 3.85 | MA | 6141 | 2340 | 10264 | 1793 | 11999 | 1475 | 13258 | 1209 | 15247 | 768 | 18678 | 602 | 13324 |
| 2L-3S | | MI | 5033 | 2340 | 8163 | 1800 | 9352 | 1479 | 10117 | 1235 | 11184 | 785 | 13193 | 274 | 11906 |
| 6-#18 | 3.85 | MA | 5507 | 2340 | 8855 | 1819 | 10205 | 1496 | 11079 | 1251 | 12298 | 799 | 14763 | 315 | 13118 |
| 3L-2S | | MI | 5600 | 2340 | 9429 | 1777 | 10964 | 1462 | 12075 | 1197 | 13834 | 759 | 16614 | 561 | 12076 |
| 8-#8 | 1.01 | MA | 4880 | 1835 | 7035 | 1522 | 8071 | 1284 | 8574 | 1099 | 8979 | 824 | 10556 | 717 | 3910 |
| 2L-4S | | MI | 4269 | 1835 | 6066 | 1523 | 6835 | 1291 | 7142 | 1105 | 7220 | 828 | 8316 | 623 | 3614 |
| 8-#8 | 1.01 | MA | 4721 | 1835 | 6736 | 1529 | 7689 | 1290 | 8111 | 1105 | 8352 | 833 | 9688 | 663 | 3922 |
| 3E | | MI | 4344 | 1835 | 6253 | 1517 | 7097 | 1280 | 7464 | 1095 | 7661 | 825 | 8862 | 656 | 3601 |
| 8-#8 | 1.01 | MA | 4638 | 1835 | 6531 | 1536 | 7401 | 1302 | 7757 | 1115 | 7867 | 836 | 9092 | 631 | 3934 |
| 4L-2S | | MI | 4487 | 1835 | 6524 | 1511 | 7443 | 1274 | 7884 | 1091 | 8229 | 817 | 9648 | 711 | 3588 |
| 8-#9 | 1.28 | MA | 5020 | 1883 | 7362 | 1549 | 8471 | 1303 | 9053 | 1110 | 9621 | 819 | 11440 | 712 | 4873 |
| 2L-4S | | MI | 4344 | 1883 | 6245 | 1552 | 7040 | 1313 | 7383 | 1119 | 7538 | 825 | 8767 | 592 | 4485 |
| 8-#9 | 1.28 | MA | 4825 | 1883 | 6986 | 1557 | 7992 | 1310 | 8470 | 1117 | 8832 | 830 | 10347 | 642 | 4885 |
| 3E | | MI | 4436 | 1883 | 6480 | 1544 | 7370 | 1299 | 7789 | 1107 | 8093 | 822 | 9456 | 634 | 4476 |
| 8-#9 | 1.28 | MA | 4722 | 1883 | 6728 | 1565 | 7628 | 1324 | 8024 | 1129 | 8221 | 834 | 9595 | 601 | 4889 |
| 4L-2S | | MI | 4612 | 1883 | 6821 | 1536 | 7805 | 1293 | 8316 | 1101 | 8808 | 812 | 10445 | 705 | 4463 |
| 8-#10 | 1.63 | MA | 5196 | 1945 | 7776 | 1583 | 8981 | 1327 | 9663 | 1124 | 10439 | 813 | 12568 | 704 | 6093 |
| 2L-4S | | MI | 4438 | 1945 | 6469 | 1590 | 7299 | 1342 | 7689 | 1137 | 7944 | 822 | 9339 | 553 | 5571 |
| 8-#10 | 1.63 | MA | 4955 | 1945 | 7301 | 1593 | 8375 | 1336 | 8928 | 1132 | 9444 | 826 | 11190 | 616 | 6102 |
| 3E | | MI | 4552 | 1945 | 6765 | 1580 | 7717 | 1325 | 8201 | 1130 | 8645 | 818 | 10212 | 606 | 5581 |
| 8-#10 | 1.63 | MA | 4829 | 1945 | 6975 | 1604 | 7916 | 1354 | 8364 | 1148 | 8673 | 831 | 10237 | 563 | 6081 |
| 4L-2S | | MI | 4768 | 1945 | 7195 | 1570 | 8264 | 1317 | 8866 | 1115 | 9545 | 805 | 11457 | 698 | 5569 |
| 8-#11 | 2.00 | MA | 5357 | 2011 | 8220 | 1613 | 9498 | 1347 | 10268 | 1135 | 11239 | 802 | 13661 | 693 | 7336 |
| 2L-4S | | MI | 4522 | 2011 | 6720 | 1621 | 7564 | 1364 | 7987 | 1149 | 8329 | 811 | 9806 | 497 | 6663 |
| 8-#11 | 2.00 | MA | 5075 | 2011 | 7647 | 1625 | 8768 | 1358 | 9382 | 1153 | 10040 | 817 | 12001 | 581 | 7337 |
| 3E | | MI | 4657 | 2011 | 7078 | 1610 | 8069 | 1345 | 8606 | 1142 | 9175 | 808 | 10838 | 560 | 6700 |

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis



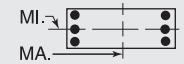

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 2.00 | MA | 4927 | 2011 | 7252 | 1637 | 8212 | 1378 | 8700 | 1162 | 9106 | 822 | 10838 | 516 | 7285 |
| 4L-2S | | MI | 4909 | 2011 | 7596 | 1599 | 8727 | 1336 | 9406 | 1125 | 10258 | 794 | 12306 | 672 | 6692 |
| 8-#14 | 2.88 | MA | 5765 | 2169 | 9226 | 1703 | 10744 | 1412 | 11765 | 1173 | 13253 | 788 | 16314 | 664 | 10315 |
| 2L-4S | | MI | 4747 | 2169 | 7256 | 1718 | 8193 | 1439 | 8733 | 1195 | 9321 | 801 | 11115 | 384 | 8932 |
| 8-#14 | 2.88 | MA | 5384 | 2169 | 8411 | 1719 | 9706 | 1426 | 10505 | 1199 | 11547 | 808 | 13983 | 502 | 10272 |
| 3E | | MI | 4929 | 2169 | 7767 | 1703 | 8912 | 1412 | 9614 | 1186 | 10527 | 797 | 12563 | 473 | 9349 |
| 8-#14 | 2.88 | MA | 5183 | 2169 | 7847 | 1736 | 8913 | 1454 | 9532 | 1210 | 10215 | 814 | 12347 | 410 | 9813 |
| 4L-2S | | MI | 5271 | 2169 | 8502 | 1689 | 9848 | 1400 | 10750 | 1162 | 12065 | 779 | 14614 | 635 | 9380 |
| 8-#18 | 5.13 | MA | 6720 | 2568 | 11673 | 1936 | 13793 | 1579 | 15437 | 1274 | 18196 | 755 | 22593 | 567 | 17562 |
| 2L-4S | | MI | 5292 | 2568 | 8542 | 1966 | 9718 | 1627 | 10548 | 1311 | 11746 | 771 | 14183 | 79 | 13774 |
| 8-#18 | 5.13 | MA | 6125 | 2568 | 10264 | 1962 | 11999 | 1600 | 13258 | 1316 | 15247 | 786 | 18678 | 279 | 17301 |
| 3E | | MI | 5581 | 2568 | 9429 | 1943 | 10964 | 1583 | 12075 | 1300 | 13834 | 772 | 16614 | 227 | 15659 |
| 8-#18 | 5.13 | MA | 5807 | 2568 | 9283 | 1988 | 10620 | 1647 | 11567 | 1331 | 12935 | 791 | 15912 | 123 | 15213 |
| 4L-2S | | MI | 6116 | 2568 | 10696 | 1920 | 12576 | 1566 | 14033 | 1262 | 16484 | 745 | 20035 | 515 | 15886 |
| 10-#10 | 2.04 | MA | 5409 | 2017 | 8252 | 1628 | 9586 | 1360 | 10398 | 1145 | 11434 | 808 | 13945 | 699 | 7539 |
| 2L-5S | | MI | 4495 | 2017 | 6596 | 1653 | 7482 | 1383 | 7901 | 1173 | 8214 | 830 | 9711 | 495 | 6644 |
| 10-#10 | 2.04 | MA | 5175 | 2017 | 7776 | 1639 | 8981 | 1369 | 9663 | 1153 | 10439 | 822 | 12568 | 610 | 7537 |
| 3L-4S | | MI | 4640 | 2017 | 6899 | 1635 | 7847 | 1374 | 8354 | 1158 | 8844 | 817 | 10585 | 547 | 6859 |
| 10-#10 | 2.04 | MA | 5056 | 2017 | 7450 | 1649 | 8521 | 1387 | 9100 | 1169 | 9668 | 827 | 11615 | 557 | 7503 |
| 4L-3S | | MI | 4749 | 2017 | 7195 | 1625 | 8264 | 1358 | 8866 | 1151 | 9545 | 813 | 11457 | 600 | 6883 |
| 10-#10 | 2.04 | MA | 4889 | 2017 | 7118 | 1668 | 8120 | 1396 | 8601 | 1177 | 8974 | 841 | 10657 | 508 | 7258 |
| 5L-2S | | MI | 4959 | 2017 | 7625 | 1616 | 8812 | 1350 | 9531 | 1136 | 10445 | 801 | 12702 | 692 | 6879 |
| 10-#11 | 2.50 | MA | 5607 | 2100 | 8793 | 1668 | 10227 | 1388 | 11154 | 1160 | 12439 | 797 | 15322 | 686 | 9075 |
| 2L-5S | | MI | 4593 | 2100 | 6871 | 1698 | 7781 | 1414 | 8239 | 1192 | 8649 | 819 | 10244 | 422 | 7780 |
| 10-#11 | 2.50 | MA | 5335 | 2100 | 8220 | 1680 | 9498 | 1398 | 10268 | 1179 | 11239 | 812 | 13661 | 574 | 9061 |
| 3L-4S | | MI | 4762 | 2100 | 7237 | 1677 | 8223 | 1405 | 8787 | 1174 | 9412 | 806 | 11274 | 486 | 8205 |
| 10-#11 | 2.50 | MA | 5195 | 2100 | 7825 | 1692 | 8942 | 1419 | 9586 | 1187 | 10306 | 817 | 12499 | 508 | 8992 |
| 4L-3S | | MI | 4889 | 2100 | 7596 | 1666 | 8727 | 1385 | 9406 | 1167 | 10258 | 802 | 12306 | 549 | 8258 |
| 10-#11 | 2.50 | MA | 5001 | 2100 | 7422 | 1715 | 8456 | 1429 | 8982 | 1206 | 9465 | 832 | 11334 | 444 | 8513 |
| 5L-2S | | MI | 5133 | 2100 | 8113 | 1655 | 9386 | 1376 | 10206 | 1150 | 11341 | 789 | 13773 | 662 | 8265 |
| 10-#14 | 3.61 | MA | 6110 | 2297 | 10041 | 1783 | 11782 | 1470 | 13026 | 1209 | 14959 | 780 | 18646 | 650 | 12774 |
| 2L-5S | | MI | 4849 | 2297 | 7467 | 1829 | 8499 | 1509 | 9087 | 1256 | 9772 | 811 | 11727 | 271 | 10423 |
| 10-#14 | 3.61 | MA | 5745 | 2297 | 9226 | 1799 | 10744 | 1484 | 11765 | 1235 | 13253 | 801 | 16314 | 489 | 12709 |
| 3L-4S | | MI | 5082 | 2297 | 7991 | 1799 | 9129 | 1497 | 9869 | 1232 | 10859 | 793 | 13166 | 365 | 11026 |
| 10-#14 | 3.61 | MA | 5559 | 2297 | 8662 | 1816 | 9951 | 1512 | 10793 | 1246 | 11922 | 806 | 14678 | 396 | 12150 |
| 4L-3S | | MI | 5251 | 2297 | 8502 | 1784 | 9848 | 1470 | 10750 | 1223 | 12065 | 790 | 14614 | 454 | 11547 |
| 10-#14 | 3.61 | MA | 5290 | 2297 | 8086 | 1847 | 9257 | 1526 | 9930 | 1272 | 10722 | 827 | 13042 | 303 | 11440 |
| 5L-2S | | MI | 5579 | 2297 | 9237 | 1769 | 10783 | 1458 | 11887 | 1199 | 13603 | 772 | 16666 | 616 | 11600 |
| 10-#18 | 6.41 | MA | 6728 | 2797 | 11673 | 2104 | 13793 | 1703 | 15437 | 1380 | 18196 | 773 | 22593 | 244 | 21491 |
| 3L-4S | | MI | 5856 | 2797 | 9808 | 2109 | 11330 | 1730 | 12506 | 1376 | 14396 | 758 | 17604 | 32 | 17429 |
| 10-#18 | 6.41 | MA | 6442 | 2797 | 10692 | 2130 | 12414 | 1751 | 13746 | 1396 | 15884 | 777 | 19827 | 88 | 19307 |
| 4L-3S | | MI | 6153 | 2797 | 10696 | 2086 | 12576 | 1687 | 14033 | 1365 | 16484 | 758 | 20035 | 181 | 19300 |
| 12-#10 | 2.44 | MA | 5619 | 2090 | 8727 | 1674 | 10191 | 1393 | 11134 | 1166 | 12429 | 804 | 15323 | 693 | 8980 |
| 2L-6S | | MI | 4549 | 2090 | 6755 | 1706 | 7670 | 1432 | 8120 | 1200 | 8511 | 838 | 10158 | 428 | 7642 |
| 12-#10 | 2.44 | MA | 5392 | 2090 | 8252 | 1684 | 9586 | 1402 | 10398 | 1173 | 11434 | 818 | 13945 | 604 | 8968 |
| 3L-5S | | MI | 4694 | 2090 | 7026 | 1699 | 8030 | 1416 | 8566 | 1194 | 9114 | 825 | 10957 | 489 | 7888 |
| 12-#10 | 2.44 | MA | 5278 | 2090 | 7926 | 1694 | 9126 | 1420 | 9835 | 1190 | 10663 | 823 | 12992 | 552 | 8924 |
| 4E | | MI | 4839 | 2090 | 7329 | 1680 | 8395 | 1407 | 9019 | 1178 | 9745 | 813 | 11830 | 541 | 8145 |
| 12-#10 | 2.44 | MA | 5113 | 2090 | 7593 | 1713 | 8726 | 1429 | 9336 | 1197 | 9969 | 836 | 12034 | 502 | 8639 |
| 5L-3S | | MI | 4943 | 2090 | 7625 | 1671 | 8812 | 1391 | 9531 | 1172 | 10445 | 809 | 12702 | 594 | 8179 |
| 12-#10 | 2.44 | MA | 4952 | 2090 | 7288 | 1720 | 8330 | 1446 | 8846 | 1213 | 9306 | 850 | 11163 | 442 | 8350 |
| 6L-2S | | MI | 5147 | 2090 | 8056 | 1661 | 9360 | 1383 | 10196 | 1156 | 11345 | 797 | 13947 | 686 | 8185 |
| 12-#11 | 3.00 | MA | 5855 | 2189 | 9366 | 1724 | 10957 | 1428 | 12041 | 1185 | 13638 | 792 | 16983 | 679 | 10807 |
| 2L-6S | | MI | 4658 | 2189 | 7067 | 1763 | 8004 | 1474 | 8499 | 1224 | 9002 | 828 | 10768 | 338 | 8949 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

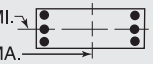


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 3.00 | MA | 5591 | 2189 | 8793 | 1736 | 10227 | 1439 | 11154 | 1204 | 12439 | 807 | 15322 | 567 | 10782 |
| 3L-5S | | MI | 4829 | 2189 | 7388 | 1754 | 8440 | 1454 | 9039 | 1217 | 9732 | 814 | 11711 | 411 | 9279 |
| 12-#11 | 3.00 | MA | 5459 | 2189 | 8398 | 1748 | 9671 | 1459 | 10472 | 1212 | 11505 | 812 | 14160 | 501 | 10699 |
| 4E | | MI | 4997 | 2189 | 7755 | 1733 | 8882 | 1445 | 9588 | 1200 | 10494 | 801 | 12741 | 476 | 9745 |
| 12-#11 | 3.00 | MA | 5266 | 2189 | 7995 | 1770 | 9185 | 1469 | 9868 | 1231 | 10665 | 827 | 12995 | 437 | 10180 |
| 5L-3S | | MI | 5117 | 2189 | 8113 | 1722 | 9386 | 1426 | 10206 | 1193 | 11341 | 797 | 13773 | 539 | 9813 |
| 12-#11 | 3.00 | MA | 5076 | 2189 | 7633 | 1779 | 8706 | 1490 | 9274 | 1239 | 9861 | 842 | 11931 | 362 | 9812 |
| 6L-2S | | MI | 5354 | 2189 | 8631 | 1711 | 10045 | 1417 | 11006 | 1175 | 12424 | 784 | 15240 | 651 | 9832 |
| 12-#14 | 4.33 | MA | 6100 | 2426 | 10041 | 1880 | 11782 | 1542 | 13026 | 1272 | 14959 | 793 | 18646 | 475 | 15145 |
| 3L-5S | | MI | 5179 | 2426 | 8202 | 1909 | 9434 | 1567 | 10223 | 1292 | 11310 | 804 | 13778 | 252 | 12567 |
| 12-#14 | 4.33 | MA | 5927 | 2426 | 9478 | 1896 | 10989 | 1571 | 12054 | 1283 | 13628 | 799 | 17009 | 383 | 14501 |
| 4E | | MI | 5410 | 2426 | 8726 | 1879 | 10065 | 1555 | 11006 | 1268 | 12398 | 786 | 15218 | 346 | 13134 |
| 12-#14 | 4.33 | MA | 5660 | 2426 | 8901 | 1927 | 10295 | 1585 | 11191 | 1309 | 12428 | 820 | 15373 | 290 | 13830 |
| 5L-3S | | MI | 5568 | 2426 | 9237 | 1864 | 10783 | 1528 | 11887 | 1259 | 13603 | 783 | 16666 | 435 | 13741 |
| 12-#18 | 7.69 | MA | 7062 | 3025 | 12101 | 2273 | 14208 | 1854 | 15925 | 1460 | 18833 | 764 | 23742 | 52 | 23420 |
| 4E | | MI | 6467 | 3025 | 11075 | 2252 | 12942 | 1834 | 14465 | 1441 | 17046 | 745 | 21025 | -14 | 20988 |
| 14-#10 | 2.85 | MA | 5606 | 2162 | 8727 | 1729 | 10191 | 1435 | 11134 | 1194 | 12429 | 814 | 15323 | 598 | 10397 |
| 3L-6S | | MI | 4750 | 2162 | 7185 | 1751 | 8218 | 1465 | 8785 | 1221 | 9411 | 834 | 11404 | 422 | 8903 |
| 14-#10 | 2.85 | MA | 5498 | 2162 | 8401 | 1740 | 9732 | 1453 | 10570 | 1210 | 11657 | 819 | 14370 | 546 | 10345 |
| 4L-5S | | MI | 4891 | 2162 | 7456 | 1744 | 8577 | 1449 | 9231 | 1214 | 10014 | 821 | 12202 | 483 | 9137 |
| 14-#10 | 2.85 | MA | 5333 | 2162 | 8069 | 1759 | 9331 | 1462 | 10071 | 1218 | 10964 | 832 | 13412 | 496 | 10024 |
| 5L-4S | | MI | 5035 | 2162 | 7759 | 1726 | 8942 | 1440 | 9684 | 1199 | 10645 | 809 | 13075 | 535 | 9430 |
| 14-#10 | 2.85 | MA | 5177 | 2162 | 7764 | 1765 | 8936 | 1479 | 9581 | 1234 | 10301 | 846 | 12541 | 436 | 9748 |
| 6L-3S | | MI | 5134 | 2162 | 8056 | 1716 | 9360 | 1424 | 10196 | 1192 | 11345 | 805 | 13947 | 588 | 9472 |
| 14-#10 | 2.85 | MA | 5044 | 2162 | 7459 | 1771 | 8548 | 1487 | 9110 | 1242 | 9624 | 851 | 11557 | 383 | 9341 |
| 7L-2S | | MI | 5333 | 2162 | 8486 | 1706 | 9907 | 1415 | 10861 | 1177 | 12246 | 793 | 15193 | 680 | 9486 |
| 14-#11 | 3.50 | MA | 5843 | 2278 | 9366 | 1792 | 10957 | 1479 | 12041 | 1229 | 13638 | 802 | 16983 | 560 | 12500 |
| 3L-6S | | MI | 4896 | 2278 | 7585 | 1819 | 8663 | 1514 | 9299 | 1250 | 10085 | 823 | 12235 | 328 | 10431 |
| 14-#11 | 3.50 | MA | 5718 | 2278 | 8971 | 1804 | 10401 | 1500 | 11359 | 1238 | 12705 | 807 | 15820 | 494 | 12392 |
| 4L-5S | | MI | 5061 | 2278 | 7906 | 1810 | 9099 | 1495 | 9839 | 1242 | 10814 | 809 | 13179 | 400 | 10784 |
| 14-#11 | 3.50 | MA | 5526 | 2278 | 8568 | 1826 | 9915 | 1510 | 10754 | 1256 | 11864 | 822 | 14656 | 430 | 11854 |
| 5L-4S | | MI | 5228 | 2278 | 8272 | 1788 | 9541 | 1486 | 10388 | 1225 | 11577 | 795 | 14208 | 465 | 11240 |
| 14-#11 | 3.50 | MA | 5343 | 2278 | 8206 | 1835 | 9436 | 1530 | 10160 | 1265 | 11061 | 837 | 13592 | 355 | 11466 |
| 6L-3S | | MI | 5342 | 2278 | 8631 | 1777 | 10045 | 1466 | 11006 | 1218 | 12424 | 792 | 15240 | 528 | 11364 |
| 14-#14 | 5.05 | MA | 6289 | 2554 | 10293 | 1976 | 12027 | 1629 | 13314 | 1319 | 15334 | 792 | 19340 | 369 | 16864 |
| 4L-5S | | MI | 5502 | 2554 | 8937 | 1989 | 10370 | 1626 | 11360 | 1329 | 12848 | 796 | 15830 | 233 | 14719 |
| 14-#14 | 5.05 | MA | 6023 | 2554 | 9717 | 2008 | 11333 | 1643 | 12452 | 1345 | 14134 | 812 | 17705 | 276 | 16227 |
| 5L-4S | | MI | 5732 | 2554 | 9461 | 1959 | 11000 | 1614 | 12142 | 1305 | 13936 | 778 | 17270 | 328 | 15254 |
| 16-#10 | 3.26 | MA | 5714 | 2235 | 8877 | 1785 | 10337 | 1486 | 11305 | 1231 | 12652 | 815 | 15748 | 540 | 11765 |
| 4L-6S | | MI | 4948 | 2235 | 7615 | 1796 | 8765 | 1498 | 9450 | 1241 | 10311 | 829 | 12649 | 416 | 10168 |
| 16-#10 | 3.26 | MA | 5550 | 2235 | 8544 | 1804 | 9936 | 1495 | 10807 | 1238 | 11959 | 828 | 14790 | 491 | 11415 |
| 5E | | MI | 5085 | 2235 | 7887 | 1789 | 9125 | 1482 | 9896 | 1235 | 10914 | 817 | 13447 | 477 | 10391 |
| 16-#10 | 3.26 | MA | 5398 | 2235 | 8239 | 1811 | 9541 | 1512 | 10316 | 1255 | 11296 | 842 | 13918 | 430 | 11150 |
| 6L-4S | | MI | 5229 | 2235 | 8189 | 1771 | 9490 | 1473 | 10350 | 1219 | 11545 | 805 | 14321 | 529 | 10714 |
| 16-#10 | 3.26 | MA | 5270 | 2235 | 7935 | 1817 | 9153 | 1520 | 9845 | 1262 | 10619 | 847 | 12935 | 377 | 10731 |
| 7L-3S | | MI | 5323 | 2235 | 8486 | 1761 | 9907 | 1457 | 10861 | 1213 | 12246 | 801 | 15193 | 582 | 10764 |
| 16-#11 | 4.00 | MA | 5974 | 2367 | 9545 | 1859 | 11131 | 1540 | 12245 | 1263 | 13904 | 801 | 17481 | 487 | 14048 |
| 4L-6S | | MI | 5130 | 2367 | 8102 | 1875 | 9322 | 1555 | 10099 | 1275 | 11168 | 817 | 13702 | 317 | 11919 |
| 16-#11 | 4.00 | MA | 5783 | 2367 | 9141 | 1882 | 10645 | 1550 | 11641 | 1282 | 13064 | 817 | 16317 | 423 | 13533 |
| 5E | | MI | 5291 | 2367 | 8423 | 1865 | 9758 | 1535 | 10639 | 1268 | 11897 | 804 | 14646 | 390 | 12295 |
| 16-#11 | 4.00 | MA | 5605 | 2367 | 8779 | 1890 | 10165 | 1571 | 11046 | 1290 | 12260 | 832 | 15252 | 348 | 13126 |
| 6L-4S | | MI | 5456 | 2367 | 8790 | 1844 | 10200 | 1526 | 11188 | 1250 | 12660 | 790 | 15675 | 454 | 12728 |
| 16-#14 | 5.77 | MA | 6380 | 2683 | 10532 | 2088 | 12371 | 1701 | 13712 | 1381 | 15840 | 805 | 20036 | 263 | 18630 |
| 5E | | MI | 5821 | 2683 | 9672 | 2069 | 11306 | 1684 | 12496 | 1365 | 14386 | 789 | 17882 | 215 | 16877 |
| 18-#10 | 3.66 | MA | 5764 | 2307 | 9019 | 1849 | 10541 | 1528 | 11542 | 1259 | 12954 | 824 | 16167 | 485 | 12809 |
| 5L-6S | | MI | 5144 | 2307 | 8045 | 1842 | 9313 | 1531 | 10115 | 1262 | 11211 | 825 | 13894 | 410 | 11434 |
| 18-#10 | 3.66 | MA | 5617 | 2307 | 8715 | 1856 | 10146 | 1545 | 11052 | 1275 | 12291 | 837 | 15296 | 425 | 12555 |
| 6L-5S | | MI | 5277 | 2307 | 8317 | 1835 | 9673 | 1514 | 10561 | 1255 | 11814 | 813 | 14692 | 471 | 11649 |

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 3.66 | MA | 5493 | 2307 | 8410 | 1862 | 9758 | 1553 | 10580 | 1283 | 11614 | 842 | 14313 | 371 | 12123 |
| 7L-4S | | MI | 5420 | 2307 | 8619 | 1816 | 10037 | 1506 | 11015 | 1240 | 12445 | 801 | 15566 | 523 | 11998 |
| 18-#11 | 4.50 | MA | 6036 | 2456 | 9714 | 1937 | 11374 | 1591 | 12527 | 1307 | 14263 | 811 | 17977 | 416 | 15216 |
| 5L-6S | | MI | 5361 | 2456 | 8620 | 1930 | 9981 | 1595 | 10899 | 1300 | 12251 | 812 | 15170 | 307 | 13413 |
| 18-#11 | 4.50 | MA | 5864 | 2456 | 9352 | 1946 | 10895 | 1611 | 11933 | 1315 | 13460 | 827 | 16913 | 341 | 14791 |
| 6L-5S | | MI | 5517 | 2456 | 8941 | 1921 | 10417 | 1576 | 11439 | 1293 | 12980 | 799 | 16113 | 379 | 13810 |
| 20-#10 | 4.07 | MA | 5832 | 2380 | 9190 | 1901 | 10752 | 1578 | 11787 | 1296 | 13286 | 833 | 16674 | 419 | 13961 |
| 6E | | MI | 5337 | 2380 | 8475 | 1887 | 9860 | 1564 | 10780 | 1283 | 12111 | 821 | 15139 | 404 | 12704 |
| 20-#10 | 4.07 | MA | 5713 | 2380 | 8886 | 1907 | 10364 | 1586 | 11315 | 1303 | 12609 | 838 | 15690 | 366 | 13519 |
| 7L-5S | | MI | 5467 | 2380 | 8747 | 1880 | 10220 | 1547 | 11226 | 1276 | 12714 | 809 | 15938 | 465 | 12910 |
| 20-#11 | 5.00 | MA | 6119 | 2546 | 9925 | 2002 | 11625 | 1652 | 12819 | 1340 | 14659 | 822 | 18574 | 334 | 16460 |
| 6E | | MI | 5589 | 2546 | 9137 | 1986 | 10640 | 1636 | 11699 | 1325 | 13334 | 807 | 16637 | 296 | 14912 |

## RECTANGULAR TIED COLUMNS 24" x 28"

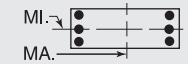
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.34 | MA | 5829 | 2039 | 8646 | 1661 | 9903 | 1397 | 10567 | 1189 | 11226 | 873 | 13344 | 759 | 5841 |
| 2E | | MI | 4945 | 2039 | 7460 | 1633 | 8446 | 1373 | 8954 | 1168 | 9443 | 857 | 11004 | 727 | 4927 |
| 4-#18 | 2.38 | MA | 6388 | 2239 | 10039 | 1770 | 11603 | 1473 | 12596 | 1233 | 13944 | 852 | 16916 | 718 | 9929 |
| 2E | | MI | 5384 | 2239 | 8596 | 1738 | 9823 | 1447 | 10594 | 1210 | 11636 | 833 | 13681 | 662 | 8283 |
| 6-#10 | 1.13 | MA | 5742 | 2000 | 8317 | 1657 | 9574 | 1396 | 10211 | 1193 | 10779 | 888 | 12753 | 772 | 5053 |
| 2L-3S | | MI | 4658 | 2000 | 6756 | 1642 | 7637 | 1383 | 8013 | 1189 | 8202 | 885 | 9464 | 668 | 4295 |
| 6-#10 | 1.13 | MA | 5467 | 2000 | 7797 | 1668 | 8911 | 1406 | 9406 | 1201 | 9690 | 902 | 11244 | 686 | 5070 |
| 3L-2S | | MI | 4881 | 2000 | 7186 | 1632 | 8184 | 1375 | 8678 | 1174 | 9102 | 873 | 10710 | 759 | 4274 |
| 6-#11 | 1.39 | MA | 5881 | 2049 | 8700 | 1676 | 10009 | 1409 | 10714 | 1198 | 11439 | 878 | 13650 | 762 | 6094 |
| 2L-3S | | MI | 4726 | 2049 | 6986 | 1660 | 7878 | 1395 | 8283 | 1196 | 8548 | 875 | 9866 | 626 | 5160 |
| 6-#11 | 1.39 | MA | 5556 | 2049 | 8071 | 1689 | 9209 | 1420 | 9741 | 1208 | 10123 | 894 | 11828 | 653 | 6111 |
| 3L-2S | | MI | 4989 | 2049 | 7503 | 1649 | 8537 | 1386 | 9083 | 1178 | 9631 | 862 | 11333 | 738 | 5137 |
| 6-#14 | 2.01 | MA | 6230 | 2168 | 9542 | 1742 | 11044 | 1455 | 11952 | 1225 | 13100 | 866 | 15939 | 748 | 8572 |
| 2L-3S | | MI | 4906 | 2168 | 7460 | 1728 | 8446 | 1443 | 8954 | 1228 | 9443 | 867 | 11004 | 546 | 7190 |
| 6-#14 | 2.01 | MA | 5786 | 2168 | 8646 | 1759 | 9903 | 1470 | 10567 | 1238 | 11226 | 889 | 13344 | 588 | 8560 |
| 3L-2S | | MI | 5266 | 2168 | 8195 | 1713 | 9381 | 1431 | 10091 | 1204 | 10981 | 849 | 13056 | 708 | 7180 |
| 6-#18 | 3.57 | MA | 7048 | 2467 | 11591 | 1912 | 13579 | 1577 | 14996 | 1298 | 17192 | 839 | 21327 | 692 | 14620 |
| 2L-3S | | MI | 5337 | 2467 | 8596 | 1904 | 9823 | 1568 | 10594 | 1312 | 11636 | 846 | 13681 | 328 | 11985 |
| 6-#18 | 3.57 | MA | 6339 | 2467 | 10039 | 1941 | 11603 | 1601 | 12596 | 1343 | 13944 | 874 | 16916 | 404 | 14414 |
| 3L-2S | | MI | 5911 | 2467 | 9862 | 1881 | 11435 | 1551 | 12552 | 1275 | 14287 | 820 | 17103 | 615 | 12124 |
| 8-#9 | 1.19 | MA | 5787 | 2011 | 8384 | 1668 | 9678 | 1405 | 10346 | 1199 | 10970 | 889 | 13023 | 774 | 5305 |
| 2L-4S | | MI | 4649 | 2011 | 6665 | 1659 | 7506 | 1404 | 7860 | 1199 | 7996 | 889 | 9266 | 648 | 4511 |
| 8-#9 | 1.19 | MA | 5570 | 2011 | 7971 | 1677 | 9153 | 1413 | 9708 | 1206 | 10107 | 901 | 11827 | 706 | 5317 |
| 3E | | MI | 4742 | 2011 | 6899 | 1652 | 7837 | 1391 | 8266 | 1186 | 8551 | 885 | 9955 | 690 | 4498 |
| 8-#9 | 1.19 | MA | 5457 | 2011 | 7690 | 1686 | 8756 | 1427 | 9221 | 1219 | 9440 | 906 | 11012 | 666 | 5321 |
| 4L-2S | | MI | 4919 | 2011 | 7240 | 1644 | 8272 | 1384 | 8794 | 1181 | 9265 | 875 | 10944 | 761 | 4484 |
| 8-#10 | 1.51 | MA | 5983 | 2072 | 8838 | 1702 | 10237 | 1429 | 11016 | 1213 | 11869 | 883 | 14262 | 766 | 6642 |
| 2L-4S | | MI | 4743 | 2072 | 6890 | 1697 | 7767 | 1433 | 8167 | 1217 | 8402 | 885 | 9838 | 609 | 5606 |
| 8-#10 | 1.51 | MA | 5716 | 2072 | 8317 | 1713 | 9574 | 1439 | 10211 | 1222 | 10779 | 898 | 12753 | 680 | 6651 |
| 3E | | MI | 4858 | 2072 | 7186 | 1687 | 8184 | 1416 | 8678 | 1210 | 9102 | 881 | 10710 | 662 | 5608 |
| 8-#10 | 1.51 | MA | 5577 | 2072 | 7962 | 1724 | 9073 | 1457 | 9596 | 1239 | 9937 | 904 | 11720 | 628 | 6630 |
| 4L-2S | | MI | 5076 | 2072 | 7617 | 1677 | 8732 | 1408 | 9343 | 1195 | 10002 | 869 | 11955 | 753 | 5593 |
| 8-#11 | 1.86 | MA | 6165 | 2138 | 9329 | 1732 | 10810 | 1449 | 11686 | 1223 | 12755 | 873 | 15473 | 755 | 8009 |
| 2L-4S | | MI | 4827 | 2138 | 7145 | 1727 | 8033 | 1455 | 8465 | 1228 | 8784 | 874 | 10301 | 552 | 6711 |
| 8-#11 | 1.86 | MA | 5851 | 2138 | 8700 | 1745 | 10009 | 1460 | 10714 | 1233 | 11439 | 889 | 13650 | 646 | 8011 |
| 3E | | MI | 4963 | 2138 | 7503 | 1716 | 8537 | 1435 | 9083 | 1221 | 9631 | 870 | 11333 | 615 | 6734 |
| 8-#11 | 1.86 | MA | 5687 | 2138 | 8269 | 1758 | 9402 | 1482 | 9968 | 1253 | 10418 | 895 | 12390 | 582 | 7959 |
| 4L-2S | | MI | 5217 | 2138 | 8021 | 1705 | 9196 | 1426 | 9883 | 1203 | 10714 | 857 | 12801 | 727 | 6721 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

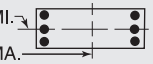



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.68 | MA | 6622 | 2296 | 10437 | 1822 | 12184 | 1514 | 13336 | 1262 | 14974 | 858 | 18534 | 738 | 11287 |
| 2L-4S | | MI | 5051 | 2296 | 7684 | 1824 | 8663 | 1528 | 9210 | 1274 | 9776 | 863 | 11608 | 439 | 9089 |
| 8-#14 | 2.68 | MA | 6197 | 2296 | 9542 | 1840 | 11044 | 1529 | 11952 | 1274 | 13100 | 881 | 15939 | 578 | 11244 |
| 3E | | MI | 5236 | 2296 | 8195 | 1809 | 9381 | 1501 | 10091 | 1265 | 10981 | 860 | 13056 | 527 | 9397 |
| 8-#14 | 2.68 | MA | 5975 | 2296 | 8926 | 1857 | 10176 | 1559 | 10887 | 1302 | 11643 | 889 | 14130 | 484 | 10877 |
| 4L-2S | | MI | 5580 | 2296 | 8929 | 1794 | 10317 | 1489 | 11227 | 1241 | 12519 | 842 | 15107 | 689 | 9416 |
| 8-#18 | 4.76 | MA | 7694 | 2696 | 13143 | 2055 | 15555 | 1681 | 17395 | 1363 | 20439 | 825 | 25739 | 666 | 19290 |
| 2L-4S | | MI | 5594 | 2696 | 8975 | 2070 | 10189 | 1715 | 11025 | 1389 | 12198 | 833 | 14671 | 132 | 13975 |
| 8-#18 | 4.76 | MA | 7028 | 2696 | 11591 | 2084 | 13579 | 1704 | 14996 | 1408 | 17192 | 861 | 21327 | 378 | 19029 |
| 3E | | MI | 5887 | 2696 | 9862 | 2047 | 11435 | 1671 | 12552 | 1377 | 14287 | 833 | 17103 | 281 | 15741 |
| 8-#18 | 4.76 | MA | 6677 | 2696 | 10517 | 2112 | 12067 | 1754 | 13142 | 1426 | 14655 | 870 | 18226 | 216 | 16887 |
| 4L-2S | | MI | 6432 | 2696 | 11129 | 2024 | 13047 | 1654 | 14510 | 1339 | 16937 | 807 | 20524 | 569 | 15937 |
| 10-#10 | 1.89 | MA | 6220 | 2145 | 9359 | 1748 | 10900 | 1462 | 11821 | 1234 | 12959 | 879 | 15771 | 761 | 8224 |
| 2L-5S | | MI | 4800 | 2145 | 7017 | 1760 | 7949 | 1474 | 8378 | 1252 | 8671 | 893 | 10209 | 550 | 6741 |
| 10-#10 | 1.89 | MA | 5961 | 2145 | 8838 | 1759 | 10237 | 1472 | 11016 | 1242 | 11869 | 894 | 14262 | 674 | 8223 |
| 3L-4S | | MI | 4946 | 2145 | 7320 | 1742 | 8314 | 1466 | 8832 | 1237 | 9302 | 881 | 11083 | 603 | 6897 |
| 10-#10 | 1.89 | MA | 5828 | 2145 | 8483 | 1770 | 9736 | 1490 | 10401 | 1259 | 11027 | 900 | 13229 | 622 | 8189 |
| 4L-3S | | MI | 5055 | 2145 | 7617 | 1732 | 8732 | 1449 | 9343 | 1230 | 10002 | 877 | 11955 | 656 | 6913 |
| 10-#10 | 1.89 | MA | 5640 | 2145 | 8120 | 1789 | 9299 | 1500 | 9857 | 1268 | 10270 | 914 | 12187 | 576 | 7982 |
| 5L-2S | | MI | 5267 | 2145 | 8047 | 1723 | 9279 | 1441 | 10009 | 1215 | 10903 | 864 | 13200 | 747 | 6905 |
| 10-#11 | 2.32 | MA | 6444 | 2227 | 9958 | 1788 | 11610 | 1490 | 12658 | 1249 | 14071 | 867 | 17295 | 748 | 9917 |
| 2L-5S | | MI | 4898 | 2227 | 7296 | 1804 | 8250 | 1504 | 8716 | 1271 | 9104 | 882 | 10739 | 477 | 7890 |
| 10-#11 | 2.32 | MA | 6141 | 2227 | 9329 | 1800 | 10810 | 1501 | 11686 | 1258 | 12755 | 884 | 15473 | 639 | 9904 |
| 3L-4S | | MI | 5067 | 2227 | 7663 | 1783 | 8692 | 1495 | 9265 | 1253 | 9867 | 868 | 11769 | 541 | 8256 |
| 10-#11 | 2.32 | MA | 5986 | 2227 | 8898 | 1813 | 10202 | 1522 | 10941 | 1278 | 11734 | 890 | 14212 | 574 | 9834 |
| 4L-3S | | MI | 5195 | 2227 | 8021 | 1772 | 9196 | 1476 | 9883 | 1246 | 10714 | 865 | 12801 | 604 | 8296 |
| 10-#11 | 2.32 | MA | 5765 | 2227 | 8458 | 1836 | 9672 | 1533 | 10281 | 1287 | 10816 | 907 | 12945 | 514 | 9372 |
| 5L-2S | | MI | 5442 | 2227 | 8538 | 1761 | 9855 | 1467 | 10683 | 1229 | 11797 | 852 | 14268 | 717 | 8296 |
| 10-#14 | 3.35 | MA | 7007 | 2424 | 11333 | 1902 | 13324 | 1572 | 14721 | 1298 | 16848 | 851 | 21129 | 728 | 13989 |
| 2L-5S | | MI | 5154 | 2424 | 7895 | 1934 | 8968 | 1599 | 9564 | 1334 | 10226 | 873 | 12220 | 326 | 10560 |
| 10-#14 | 3.35 | MA | 6600 | 2424 | 10437 | 1920 | 12184 | 1587 | 13336 | 1311 | 14974 | 874 | 18534 | 567 | 13924 |
| 3L-4S | | MI | 5386 | 2424 | 8419 | 1904 | 9598 | 1587 | 10347 | 1310 | 11314 | 855 | 13659 | 420 | 11177 |
| 10-#14 | 3.35 | MA | 6394 | 2424 | 9822 | 1938 | 11316 | 1617 | 12272 | 1338 | 13517 | 881 | 16725 | 474 | 13452 |
| 4L-3S | | MI | 5559 | 2424 | 8929 | 1889 | 10317 | 1560 | 11227 | 1301 | 12519 | 852 | 15107 | 508 | 11597 |
| 10-#14 | 3.35 | MA | 6087 | 2424 | 9192 | 1970 | 10558 | 1632 | 11330 | 1351 | 12206 | 904 | 14909 | 383 | 12612 |
| 5L-2S | | MI | 5890 | 2424 | 9664 | 1874 | 11253 | 1548 | 12364 | 1277 | 14058 | 834 | 17159 | 670 | 11639 |
| 10-#18 | 5.95 | MA | 7700 | 2924 | 13143 | 2226 | 15555 | 1808 | 17395 | 1472 | 20439 | 847 | 25739 | 352 | 23651 |
| 3L-4S | | MI | 6158 | 2924 | 10242 | 2213 | 11801 | 1819 | 12983 | 1453 | 14849 | 819 | 18092 | 86 | 17620 |
| 10-#18 | 5.95 | MA | 7385 | 2924 | 12069 | 2255 | 14043 | 1858 | 15542 | 1491 | 17903 | 856 | 22638 | 189 | 21410 |
| 4L-3S | | MI | 6461 | 2924 | 11129 | 2190 | 13047 | 1775 | 14510 | 1442 | 16937 | 820 | 20524 | 235 | 19500 |
| 12-#10 | 2.27 | MA | 6454 | 2217 | 9879 | 1793 | 11563 | 1495 | 12627 | 1254 | 14049 | 875 | 17279 | 755 | 9803 |
| 2L-6S | | MI | 4854 | 2217 | 7176 | 1813 | 8137 | 1523 | 8597 | 1280 | 8968 | 901 | 10656 | 483 | 7733 |
| 12-#10 | 2.27 | MA | 6201 | 2217 | 9359 | 1804 | 10900 | 1505 | 11821 | 1263 | 12959 | 889 | 15771 | 668 | 9791 |
| 3L-5S | | MI | 5000 | 2217 | 7447 | 1805 | 8497 | 1507 | 9043 | 1273 | 9571 | 889 | 11455 | 544 | 7982 |
| 12-#10 | 2.27 | MA | 6076 | 2217 | 9003 | 1815 | 10399 | 1523 | 11206 | 1280 | 12116 | 896 | 14738 | 617 | 9747 |
| 4E | | MI | 5145 | 2217 | 7750 | 1787 | 8862 | 1499 | 9497 | 1258 | 10202 | 876 | 12328 | 597 | 8185 |
| 12-#10 | 2.27 | MA | 5888 | 2217 | 8641 | 1834 | 9962 | 1533 | 10663 | 1288 | 11360 | 910 | 13696 | 570 | 9497 |
| 5L-3S | | MI | 5250 | 2217 | 8047 | 1778 | 9279 | 1482 | 10009 | 1251 | 10903 | 872 | 13200 | 650 | 8211 |
| 12-#10 | 2.27 | MA | 5710 | 2217 | 8302 | 1841 | 9551 | 1543 | 10129 | 1305 | 10637 | 925 | 12673 | 499 | 9159 |
| 6L-2S | | MI | 5456 | 2217 | 8477 | 1768 | 9827 | 1474 | 10674 | 1236 | 11803 | 860 | 14446 | 741 | 8212 |
| 12-#11 | 2.79 | MA | 6720 | 2317 | 10586 | 1843 | 12411 | 1530 | 13631 | 1274 | 15387 | 862 | 19117 | 741 | 11818 |
| 2L-6S | | MI | 4962 | 2317 | 7492 | 1869 | 8473 | 1564 | 8976 | 1303 | 9458 | 890 | 11263 | 393 | 9112 |
| 12-#11 | 2.79 | MA | 6425 | 2317 | 9958 | 1856 | 11610 | 1541 | 12658 | 1283 | 14071 | 879 | 17295 | 632 | 11793 |
| 3L-5S | | MI | 5135 | 2317 | 7813 | 1860 | 8909 | 1545 | 9516 | 1296 | 10187 | 877 | 12206 | 466 | 9386 |
| 12-#11 | 2.79 | MA | 6279 | 2317 | 9527 | 1869 | 11003 | 1563 | 11913 | 1303 | 13050 | 885 | 16034 | 567 | 11710 |
| 4E | | MI | 5302 | 2317 | 8180 | 1838 | 9351 | 1536 | 10065 | 1278 | 10950 | 863 | 13236 | 531 | 9799 |
| 12-#11 | 2.79 | MA | 6060 | 2317 | 9087 | 1892 | 10473 | 1574 | 11253 | 1313 | 12132 | 902 | 14767 | 507 | 11205 |
| 5L-3S | | MI | 5424 | 2317 | 8538 | 1827 | 9855 | 1516 | 10683 | 1271 | 11797 | 860 | 14268 | 594 | 9853 |

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

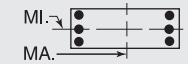
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.79 | MA | 5850 | 2317 | 8683 | 1900 | 9950 | 1595 | 10605 | 1333 | 11256 | 918 | 13614 | 433 | 10827 |
| 6L-2S | | MI | 5664 | 2317 | 9056 | 1816 | 10514 | 1507 | 11483 | 1254 | 12880 | 846 | 15735 | 706 | 9866 |
| 12-#14 | 4.02 | MA | 6995 | 2553 | 11333 | 2000 | 13324 | 1645 | 14721 | 1347 | 16848 | 866 | 21129 | 557 | 16603 |
| 3L-5S | | MI | 5484 | 2553 | 8630 | 2014 | 9904 | 1657 | 10700 | 1370 | 11765 | 866 | 14271 | 307 | 12699 |
| 12-#14 | 4.02 | MA | 6803 | 2553 | 10717 | 2018 | 12456 | 1676 | 13657 | 1375 | 15391 | 874 | 19320 | 463 | 16041 |
| 4E | | MI | 5715 | 2553 | 9153 | 1984 | 10534 | 1645 | 11483 | 1346 | 12852 | 848 | 15711 | 401 | 13280 |
| 12-#14 | 4.02 | MA | 6499 | 2553 | 10088 | 2050 | 11698 | 1691 | 12715 | 1387 | 14080 | 896 | 17505 | 372 | 15243 |
| 5L-3S | | MI | 5876 | 2553 | 9664 | 1969 | 11253 | 1618 | 12364 | 1337 | 14058 | 845 | 17159 | 490 | 13794 |
| 12-#14 | 4.02 | MA | 6212 | 2553 | 9520 | 2063 | 10951 | 1721 | 11788 | 1415 | 12827 | 919 | 15849 | 265 | 14267 |
| 6L-2S | | MI | 6196 | 2553 | 10399 | 1954 | 12189 | 1606 | 13500 | 1314 | 15596 | 827 | 19210 | 651 | 13854 |
| 12-#18 | 7.14 | MA | 8074 | 3152 | 13620 | 2397 | 16019 | 1962 | 17942 | 1556 | 21150 | 843 | 27049 | 163 | 25953 |
| 4E | | MI | 6770 | 3152 | 11508 | 2355 | 13414 | 1923 | 14942 | 1518 | 17499 | 806 | 21514 | 40 | 21288 |
| 14-#10 | 2.65 | MA | 6439 | 2290 | 9879 | 1849 | 11563 | 1538 | 12627 | 1283 | 14049 | 885 | 17279 | 662 | 11357 |
| 3L-6S | | MI | 5055 | 2290 | 7606 | 1858 | 8685 | 1556 | 9262 | 1300 | 9868 | 897 | 11902 | 477 | 8993 |
| 14-#10 | 2.65 | MA | 6319 | 2290 | 9524 | 1860 | 11062 | 1556 | 12011 | 1300 | 13206 | 891 | 16247 | 611 | 11305 |
| 4L-5S | | MI | 5198 | 2290 | 7878 | 1851 | 9045 | 1540 | 9708 | 1294 | 10471 | 884 | 12700 | 538 | 9229 |
| 14-#10 | 2.65 | MA | 6133 | 2290 | 9162 | 1880 | 10625 | 1566 | 11468 | 1309 | 12449 | 906 | 15205 | 564 | 11017 |
| 5L-4S | | MI | 5342 | 2290 | 8180 | 1833 | 9410 | 1531 | 10162 | 1278 | 11102 | 872 | 13573 | 591 | 9472 |
| 14-#10 | 2.65 | MA | 5960 | 2290 | 8823 | 1886 | 10214 | 1575 | 10934 | 1326 | 11727 | 920 | 14182 | 493 | 10694 |
| 6L-3S | | MI | 5442 | 2290 | 8477 | 1823 | 9827 | 1515 | 10674 | 1272 | 11803 | 868 | 14446 | 644 | 9506 |
| 14-#10 | 2.65 | MA | 5813 | 2290 | 8491 | 1893 | 9763 | 1591 | 10420 | 1335 | 10990 | 927 | 13194 | 454 | 10302 |
| 7L-2S | | MI | 5643 | 2290 | 8907 | 1813 | 10375 | 1507 | 11339 | 1256 | 12703 | 856 | 15691 | 735 | 9516 |
| 14-#11 | 3.25 | MA | 6706 | 2406 | 10586 | 1912 | 12411 | 1582 | 13631 | 1309 | 15387 | 874 | 19117 | 624 | 13680 |
| 3L-6S | | MI | 5200 | 2406 | 8010 | 1925 | 9132 | 1605 | 9776 | 1328 | 10541 | 885 | 12730 | 383 | 10601 |
| 14-#11 | 3.25 | MA | 6568 | 2406 | 10155 | 1925 | 11803 | 1603 | 12885 | 1328 | 14366 | 880 | 17856 | 560 | 13586 |
| 4L-5S | | MI | 5368 | 2406 | 8331 | 1915 | 9568 | 1585 | 10316 | 1321 | 11270 | 872 | 13674 | 455 | 10889 |
| 14-#11 | 3.25 | MA | 6350 | 2406 | 9715 | 1948 | 11273 | 1614 | 12226 | 1338 | 13448 | 897 | 16589 | 499 | 13044 |
| 5L-4S | | MI | 5534 | 2406 | 8697 | 1894 | 10009 | 1576 | 10865 | 1304 | 12033 | 858 | 14703 | 520 | 11341 |
| 14-#11 | 3.25 | MA | 6147 | 2406 | 9312 | 1956 | 10750 | 1636 | 11577 | 1358 | 12572 | 913 | 15437 | 425 | 12683 |
| 6L-3S | | MI | 5650 | 2406 | 9056 | 1883 | 10514 | 1557 | 11483 | 1297 | 12880 | 855 | 15735 | 583 | 11406 |
| 14-#11 | 3.25 | MA | 5973 | 2406 | 8910 | 1964 | 10237 | 1645 | 10954 | 1367 | 11677 | 919 | 14136 | 360 | 12026 |
| 7L-2S | | MI | 5884 | 2406 | 9573 | 1872 | 11173 | 1548 | 12284 | 1279 | 13962 | 841 | 17202 | 695 | 11429 |
| 14-#14 | 4.69 | MA | 7205 | 2681 | 11613 | 2098 | 13596 | 1734 | 15042 | 1411 | 17266 | 866 | 21915 | 453 | 18643 |
| 4L-5S | | MI | 5808 | 2681 | 9365 | 2094 | 10840 | 1715 | 11837 | 1407 | 13303 | 858 | 16323 | 288 | 14847 |
| 14-#14 | 4.69 | MA | 6903 | 2681 | 10984 | 2131 | 12838 | 1749 | 14099 | 1424 | 15954 | 889 | 20100 | 362 | 17881 |
| 5L-4S | | MI | 6038 | 2681 | 9888 | 2064 | 11470 | 1703 | 12620 | 1383 | 14391 | 840 | 17762 | 382 | 15396 |
| 14-#14 | 4.69 | MA | 6627 | 2681 | 10415 | 2143 | 12091 | 1779 | 13172 | 1451 | 14701 | 912 | 18444 | 254 | 16888 |
| 6L-3S | | MI | 6189 | 2681 | 10399 | 2050 | 12189 | 1676 | 13500 | 1374 | 15596 | 837 | 19210 | 471 | 15990 |
| 16-#10 | 3.02 | MA | 6559 | 2362 | 10045 | 1906 | 11725 | 1589 | 12817 | 1321 | 14296 | 887 | 17756 | 605 | 12862 |
| 4L-6S | | MI | 5254 | 2362 | 8036 | 1903 | 9232 | 1589 | 9927 | 1321 | 10768 | 893 | 13147 | 472 | 10255 |
| 16-#10 | 3.02 | MA | 6373 | 2362 | 9682 | 1925 | 11288 | 1599 | 12273 | 1330 | 13539 | 902 | 16714 | 558 | 12542 |
| 5E | | MI | 5392 | 2362 | 8308 | 1896 | 9592 | 1573 | 10373 | 1314 | 11371 | 880 | 13945 | 532 | 10481 |
| 16-#10 | 3.02 | MA | 6206 | 2362 | 9344 | 1931 | 10877 | 1608 | 11739 | 1347 | 12817 | 916 | 15691 | 487 | 12231 |
| 6L-4S | | MI | 5536 | 2362 | 8611 | 1878 | 9957 | 1564 | 10827 | 1299 | 12002 | 868 | 14819 | 585 | 10758 |
| 16-#10 | 3.02 | MA | 6064 | 2362 | 9012 | 1938 | 10426 | 1624 | 11226 | 1355 | 12079 | 922 | 14703 | 448 | 11829 |
| 7L-3S | | MI | 5632 | 2362 | 8907 | 1868 | 10375 | 1548 | 11339 | 1292 | 12703 | 864 | 15691 | 638 | 10799 |
| 16-#10 | 3.02 | MA | 5905 | 2362 | 8692 | 1946 | 9995 | 1630 | 10705 | 1371 | 11375 | 937 | 13754 | 396 | 11407 |
| 8L-2S | | MI | 5828 | 2362 | 9337 | 1859 | 10922 | 1540 | 12004 | 1277 | 13603 | 852 | 16936 | 729 | 10815 |
| 16-#11 | 3.71 | MA | 6852 | 2495 | 10784 | 1980 | 12604 | 1644 | 13858 | 1354 | 15682 | 875 | 19678 | 553 | 15463 |
| 4L-6S | | MI | 5435 | 2495 | 8527 | 1981 | 9791 | 1645 | 10576 | 1354 | 11624 | 880 | 14198 | 372 | 12086 |
| 16-#11 | 3.71 | MA | 6635 | 2495 | 10344 | 2003 | 12074 | 1655 | 13198 | 1363 | 14764 | 891 | 18411 | 492 | 14888 |
| 5E | | MI | 5597 | 2495 | 8848 | 1971 | 10226 | 1626 | 11117 | 1346 | 12353 | 867 | 15141 | 445 | 12397 |
| 16-#11 | 3.71 | MA | 6438 | 2495 | 9941 | 2012 | 11551 | 1676 | 12550 | 1383 | 13888 | 908 | 17259 | 418 | 14527 |
| 6L-4S | | MI | 5763 | 2495 | 9215 | 1950 | 10668 | 1617 | 11665 | 1329 | 13116 | 853 | 16170 | 509 | 12847 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

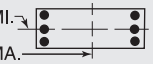
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 3.71 | MA | 6272 | 2495 | 9538 | 2019 | 11038 | 1686 | 11926 | 1393 | 12993 | 914 | 15958 | 353 | 13873 |
| 7L-3S | | MI | 5874 | 2495 | 9573 | 1939 | 11173 | 1597 | 12284 | 1322 | 13962 | 850 | 17202 | 573 | 12958 |
| 16-#14 | 5.36 | MA | 7300 | 2810 | 11879 | 2211 | 13979 | 1807 | 15484 | 1460 | 17828 | 882 | 22695 | 352 | 20525 |
| 5E | | MI | 6128 | 2810 | 10100 | 2175 | 11775 | 1774 | 12973 | 1443 | 14841 | 851 | 18374 | 269 | 17002 |
| 16-#14 | 5.36 | MA | 7035 | 2810 | 11311 | 2224 | 13231 | 1837 | 14557 | 1488 | 16576 | 904 | 21039 | 244 | 19516 |
| 6L-4S | | MI | 6357 | 2810 | 10623 | 2145 | 12406 | 1762 | 13756 | 1419 | 15929 | 833 | 19814 | 363 | 17522 |
| 18-#10 | 3.40 | MA | 6611 | 2435 | 10203 | 1970 | 11951 | 1632 | 13079 | 1350 | 14629 | 898 | 18223 | 552 | 14071 |
| 5L-6S | | MI | 5450 | 2435 | 8466 | 1949 | 9780 | 1622 | 10592 | 1341 | 11668 | 888 | 14392 | 466 | 11521 |
| 18-#10 | 3.40 | MA | 6448 | 2435 | 9865 | 1977 | 11540 | 1641 | 12544 | 1367 | 13907 | 912 | 17200 | 481 | 13772 |
| 6L-5S | | MI | 5585 | 2435 | 8738 | 1941 | 10140 | 1606 | 11038 | 1335 | 12271 | 876 | 15191 | 527 | 11737 |
| 18-#10 | 3.40 | MA | 6311 | 2435 | 9532 | 1983 | 11089 | 1657 | 12031 | 1376 | 13169 | 918 | 16212 | 442 | 13358 |
| 7L-4S | | MI | 5728 | 2435 | 9041 | 1923 | 10505 | 1597 | 11492 | 1319 | 12902 | 864 | 16064 | 579 | 12043 |
| 18-#10 | 3.40 | MA | 6153 | 2435 | 9213 | 1991 | 10658 | 1663 | 11510 | 1392 | 12465 | 933 | 15263 | 390 | 12948 |
| 8L-3S | | MI | 5819 | 2435 | 9337 | 1914 | 10922 | 1581 | 12004 | 1313 | 13603 | 860 | 16936 | 632 | 12091 |
| 18-#11 | 4.18 | MA | 6916 | 2584 | 10973 | 2059 | 12874 | 1695 | 14171 | 1388 | 16080 | 886 | 20233 | 485 | 16737 |
| 5L-6S | | MI | 5667 | 2584 | 9045 | 2036 | 10449 | 1686 | 11377 | 1379 | 12706 | 875 | 15665 | 362 | 13575 |
| 18-#11 | 4.18 | MA | 6726 | 2584 | 10570 | 2067 | 12352 | 1717 | 13522 | 1408 | 15204 | 903 | 19081 | 411 | 16359 |
| 6L-5S | | MI | 5824 | 2584 | 9366 | 2027 | 10885 | 1666 | 11917 | 1372 | 13436 | 861 | 16608 | 434 | 13910 |
| 18-#11 | 4.18 | MA | 6566 | 2584 | 10167 | 2075 | 11838 | 1726 | 12899 | 1418 | 14309 | 909 | 17780 | 346 | 15723 |
| 7L-4S | | MI | 5990 | 2584 | 9732 | 2005 | 11327 | 1657 | 12466 | 1354 | 14199 | 848 | 17638 | 499 | 14340 |
| 18-#14 | 6.03 | MA | 7437 | 2938 | 12206 | 2304 | 14371 | 1896 | 15942 | 1524 | 18450 | 897 | 23634 | 234 | 22149 |
| 6L-5S | | MI | 6444 | 2938 | 10835 | 2255 | 12711 | 1832 | 14110 | 1480 | 16379 | 844 | 20426 | 250 | 19162 |
| 20-#10 | 3.78 | MA | 6687 | 2507 | 10385 | 2022 | 12203 | 1674 | 13350 | 1388 | 14996 | 908 | 18709 | 475 | 15314 |
| 6E | | MI | 5643 | 2507 | 8897 | 1994 | 10328 | 1655 | 11257 | 1362 | 12568 | 884 | 15637 | 460 | 12788 |
| 20-#10 | 3.78 | MA | 6555 | 2507 | 10053 | 2029 | 11752 | 1690 | 12836 | 1396 | 14259 | 914 | 17721 | 436 | 14889 |
| 7L-5S | | MI | 5775 | 2507 | 9168 | 1987 | 10687 | 1639 | 11704 | 1355 | 13171 | 872 | 16436 | 521 | 12997 |
| 20-#10 | 3.78 | MA | 6398 | 2507 | 9734 | 2037 | 11321 | 1696 | 12315 | 1413 | 13554 | 929 | 16772 | 384 | 14491 |
| 8L-4S | | MI | 5917 | 2507 | 9471 | 1969 | 11052 | 1630 | 12157 | 1340 | 13802 | 860 | 17309 | 573 | 13328 |
| 20-#11 | 4.64 | MA | 7009 | 2673 | 11199 | 2123 | 13152 | 1757 | 14495 | 1434 | 16520 | 898 | 20903 | 404 | 18196 |
| 6E | | MI | 5896 | 2673 | 9562 | 2092 | 11108 | 1726 | 12177 | 1404 | 13789 | 870 | 17132 | 351 | 15070 |
| 20-#11 | 4.64 | MA | 6856 | 2673 | 10796 | 2131 | 12639 | 1767 | 13871 | 1443 | 15625 | 904 | 19602 | 339 | 17576 |
| 7L-5S | | MI | 6049 | 2673 | 9883 | 2082 | 11544 | 1707 | 12717 | 1397 | 14519 | 856 | 18075 | 423 | 15427 |
| 22-#10 | 4.16 | MA | 6796 | 2580 | 10574 | 2074 | 12415 | 1723 | 13642 | 1417 | 15349 | 910 | 19230 | 431 | 16424 |
| 7L-6S | | MI | 5835 | 2580 | 9327 | 2039 | 10875 | 1688 | 11922 | 1383 | 13469 | 880 | 16883 | 454 | 14058 |
| 22-#10 | 4.16 | MA | 6640 | 2580 | 10254 | 2082 | 11984 | 1729 | 13121 | 1433 | 14644 | 924 | 18281 | 378 | 16035 |
| 8L-5S | | MI | 5964 | 2580 | 9598 | 2032 | 11235 | 1671 | 12369 | 1376 | 14072 | 868 | 17681 | 515 | 14259 |
| 22-#11 | 5.11 | MA | 7142 | 2762 | 11425 | 2186 | 13440 | 1807 | 14844 | 1468 | 16941 | 899 | 21424 | 332 | 19432 |
| 7L-6S | | MI | 6122 | 2762 | 10080 | 2148 | 11767 | 1766 | 12977 | 1429 | 14872 | 865 | 18599 | 340 | 16569 |

## RECTANGULAR TIED COLUMNS 24" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.25 | MA | 6656 | 2166 | 9757 | 1781 | 11212 | 1499 | 11968 | 1278 | 12690 | 944 | 15062 | 821 | 6327 |
| 2E | | MI | 5251 | 2166 | 7887 | 1738 | 8915 | 1462 | 9431 | 1246 | 9898 | 919 | 11497 | 781 | 4954 |
| 4-#18 | 2.22 | MA | 7279 | 2366 | 11283 | 1889 | 13075 | 1575 | 14192 | 1322 | 15668 | 922 | 19162 | 796 | 10793 |
| 2E | | MI | 5692 | 2366 | 9029 | 1842 | 10294 | 1535 | 11071 | 1287 | 12089 | 895 | 14170 | 716 | 8322 |
| 6-#10 | 1.06 | MA | 6557 | 2127 | 9393 | 1776 | 10847 | 1498 | 11572 | 1281 | 12193 | 958 | 14404 | 834 | 5464 |
| 2L-3S | | MI | 4963 | 2127 | 7178 | 1749 | 8104 | 1474 | 8491 | 1269 | 8659 | 948 | 9963 | 723 | 4317 |
| 6-#10 | 1.06 | MA | 6254 | 2127 | 8827 | 1788 | 10126 | 1508 | 10697 | 1291 | 11008 | 974 | 12764 | 750 | 5482 |
| 3L-2S | | MI | 5188 | 2127 | 7608 | 1739 | 8651 | 1466 | 9156 | 1254 | 9560 | 936 | 11208 | 814 | 4295 |
| 6-#11 | 1.30 | MA | 6712 | 2177 | 9813 | 1796 | 11324 | 1511 | 12124 | 1287 | 12917 | 948 | 15389 | 824 | 6599 |
| 2L-3S | | MI | 5032 | 2177 | 7411 | 1766 | 8347 | 1485 | 8760 | 1274 | 9004 | 938 | 10361 | 681 | 5188 |
| 6-#11 | 1.30 | MA | 6354 | 2177 | 9129 | 1809 | 10453 | 1523 | 11065 | 1297 | 11484 | 966 | 13406 | 718 | 6617 |
| 3L-2S | | MI | 5296 | 2177 | 7929 | 1755 | 9006 | 1476 | 9560 | 1257 | 10087 | 925 | 11829 | 793 | 5162 |
| 6-#14 | 1.88 | MA | 7099 | 2295 | 10733 | 1861 | 12454 | 1557 | 13477 | 1314 | 14732 | 937 | 17890 | 810 | 9301 |
| 2L-3S | | MI | 5212 | 2295 | 7887 | 1834 | 8915 | 1533 | 9431 | 1306 | 9898 | 929 | 11497 | 601 | 7230 |
| 6-#14 | 1.88 | MA | 6609 | 2295 | 9757 | 1880 | 11212 | 1573 | 11968 | 1328 | 12690 | 961 | 15062 | 654 | 9289 |
| 3L-2S | | MI | 5573 | 2295 | 8622 | 1819 | 9851 | 1521 | 10568 | 1282 | 11436 | 911 | 13549 | 763 | 7212 |

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

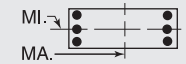
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 3.33 | MA | 8010 | 2595 | 12978 | 2032 | 15232 | 1679 | 16812 | 1387 | 19214 | 909 | 24072 | 777 | 15916 |
| 2L-3S | | MI | 5642 | 2595 | 9029 | 2008 | 10294 | 1656 | 11071 | 1390 | 12089 | 908 | 14170 | 382 | 12058 |
| 6-#18 | 3.33 | MA | 7224 | 2595 | 11283 | 2062 | 13075 | 1705 | 14192 | 1435 | 15668 | 948 | 19162 | 490 | 15710 |
| 3L-2S | | MI | 6221 | 2595 | 10296 | 1985 | 11906 | 1639 | 13029 | 1352 | 14739 | 882 | 17591 | 669 | 12171 |
| 8-#9 | 1.11 | MA | 6606 | 2138 | 9464 | 1787 | 10958 | 1506 | 11718 | 1288 | 12399 | 960 | 14695 | 836 | 5737 |
| 2L-4S | | MI | 4954 | 2138 | 7084 | 1767 | 7973 | 1496 | 8338 | 1278 | 8454 | 952 | 9765 | 704 | 4535 |
| 8-#9 | 1.11 | MA | 6367 | 2138 | 9016 | 1797 | 10387 | 1515 | 11025 | 1295 | 11460 | 972 | 13396 | 769 | 5749 |
| 3E | | MI | 5048 | 2138 | 7319 | 1759 | 8304 | 1482 | 8743 | 1266 | 9009 | 949 | 10455 | 745 | 4520 |
| 8-#9 | 1.11 | MA | 6244 | 2138 | 8712 | 1806 | 9957 | 1530 | 10497 | 1309 | 10738 | 978 | 12519 | 729 | 5753 |
| 4L-2S | | MI | 5226 | 2138 | 7660 | 1751 | 8738 | 1475 | 9271 | 1261 | 9723 | 939 | 11443 | 817 | 4504 |
| 8-#10 | 1.41 | MA | 6823 | 2199 | 9959 | 1822 | 11567 | 1531 | 12448 | 1302 | 13378 | 954 | 16044 | 828 | 7191 |
| 2L-4S | | MI | 5048 | 2199 | 7311 | 1804 | 8234 | 1524 | 8644 | 1296 | 8859 | 948 | 10336 | 664 | 5639 |
| 8-#10 | 1.41 | MA | 6528 | 2199 | 9393 | 1833 | 10847 | 1541 | 11572 | 1311 | 12193 | 969 | 14404 | 744 | 7199 |
| 3E | | MI | 5164 | 2199 | 7608 | 1794 | 8651 | 1507 | 9156 | 1289 | 9560 | 944 | 11208 | 717 | 5633 |
| 8-#10 | 1.41 | MA | 6376 | 2199 | 9008 | 1845 | 10303 | 1560 | 10905 | 1329 | 11279 | 976 | 13292 | 693 | 7179 |
| 4L-2S | | MI | 5383 | 2199 | 8038 | 1784 | 9199 | 1499 | 9821 | 1274 | 10460 | 932 | 12453 | 809 | 5617 |
| 8-#11 | 1.73 | MA | 7026 | 2266 | 10497 | 1851 | 12195 | 1551 | 13182 | 1312 | 14349 | 943 | 17373 | 817 | 8683 |
| 2L-4S | | MI | 5132 | 2266 | 7570 | 1833 | 8502 | 1545 | 8942 | 1307 | 9240 | 936 | 10797 | 607 | 6755 |
| 8-#11 | 1.73 | MA | 6679 | 2266 | 9813 | 1865 | 11324 | 1563 | 12124 | 1323 | 12917 | 961 | 15389 | 710 | 8685 |
| 3E | | MI | 5269 | 2266 | 7929 | 1822 | 9006 | 1526 | 9560 | 1300 | 10087 | 933 | 11829 | 670 | 6766 |
| 8-#11 | 1.73 | MA | 6499 | 2266 | 9346 | 1878 | 10665 | 1585 | 11315 | 1343 | 11809 | 968 | 14031 | 647 | 8633 |
| 4L-2S | | MI | 5525 | 2266 | 8446 | 1811 | 9665 | 1517 | 10360 | 1282 | 11169 | 919 | 13296 | 782 | 6749 |
| 8-#14 | 2.50 | MA | 7533 | 2423 | 11709 | 1941 | 13697 | 1615 | 14986 | 1350 | 16774 | 929 | 20718 | 800 | 12259 |
| 2L-4S | | MI | 5356 | 2423 | 8111 | 1929 | 9132 | 1618 | 9687 | 1352 | 10231 | 925 | 12101 | 493 | 9241 |
| 8-#14 | 2.50 | MA | 7063 | 2423 | 10733 | 1960 | 12454 | 1632 | 13477 | 1365 | 14732 | 953 | 17890 | 644 | 12216 |
| 3E | | MI | 5542 | 2423 | 8622 | 1914 | 9851 | 1591 | 10568 | 1343 | 11436 | 922 | 13549 | 582 | 9442 |
| 8-#14 | 2.50 | MA | 6819 | 2423 | 10065 | 1979 | 11512 | 1663 | 12321 | 1394 | 13149 | 963 | 15939 | 551 | 11959 |
| 4L-2S | | MI | 5890 | 2423 | 9357 | 1899 | 10787 | 1579 | 11705 | 1319 | 12974 | 904 | 15600 | 744 | 9451 |
| 8-#18 | 4.44 | MA | 8723 | 2823 | 14672 | 2174 | 17390 | 1783 | 19433 | 1451 | 22761 | 896 | 28982 | 759 | 21018 |
| 2L-4S | | MI | 5896 | 2823 | 9408 | 2174 | 10660 | 1804 | 11502 | 1466 | 12651 | 894 | 15160 | 186 | 14171 |
| 8-#18 | 4.44 | MA | 7985 | 2823 | 12978 | 2205 | 15232 | 1809 | 16812 | 1499 | 19214 | 935 | 24072 | 471 | 20757 |
| 3E | | MI | 6193 | 2823 | 10296 | 2151 | 11906 | 1760 | 13029 | 1454 | 14739 | 894 | 17591 | 335 | 15817 |
| 8-#18 | 4.44 | MA | 7600 | 2823 | 11810 | 2236 | 13588 | 1861 | 14796 | 1521 | 16454 | 947 | 20634 | 304 | 18587 |
| 4L-2S | | MI | 6741 | 2823 | 11562 | 2128 | 13519 | 1743 | 14987 | 1417 | 17389 | 868 | 21012 | 623 | 15988 |
| 10-#10 | 1.76 | MA | 7084 | 2272 | 10525 | 1867 | 12288 | 1564 | 13323 | 1323 | 14562 | 950 | 17685 | 823 | 8910 |
| 2L-5S | | MI | 5105 | 2272 | 7439 | 1867 | 8417 | 1565 | 8855 | 1332 | 9128 | 956 | 10708 | 606 | 6834 |
| 10-#10 | 1.76 | MA | 6798 | 2272 | 9959 | 1878 | 11567 | 1574 | 12448 | 1332 | 13378 | 965 | 16044 | 738 | 8909 |
| 3L-4S | | MI | 5251 | 2272 | 7741 | 1849 | 8782 | 1557 | 9309 | 1317 | 9759 | 944 | 11581 | 658 | 6933 |
| 10-#10 | 1.76 | MA | 6653 | 2272 | 9574 | 1890 | 11024 | 1593 | 11781 | 1349 | 12464 | 972 | 14933 | 687 | 8875 |
| 4L-3S | | MI | 5362 | 2272 | 8038 | 1839 | 9199 | 1540 | 9821 | 1310 | 10460 | 940 | 12453 | 711 | 6941 |
| 10-#10 | 1.76 | MA | 6442 | 2272 | 9182 | 1910 | 10551 | 1603 | 11192 | 1359 | 11645 | 988 | 13808 | 642 | 8716 |
| 5L-2S | | MI | 5575 | 2272 | 8468 | 1829 | 9747 | 1532 | 10486 | 1295 | 11360 | 928 | 13698 | 803 | 6931 |
| 10-#11 | 2.17 | MA | 7334 | 2355 | 11182 | 1907 | 13067 | 1591 | 14241 | 1337 | 15782 | 938 | 19356 | 810 | 10760 |
| 2L-5S | | MI | 5203 | 2355 | 7721 | 1910 | 8719 | 1595 | 9193 | 1349 | 9560 | 945 | 11234 | 532 | 7996 |
| 10-#11 | 2.17 | MA | 6999 | 2355 | 10497 | 1920 | 12195 | 1603 | 13182 | 1348 | 14349 | 956 | 17373 | 703 | 10746 |
| 3L-4S | | MI | 5372 | 2355 | 8088 | 1889 | 9160 | 1586 | 9742 | 1332 | 10323 | 931 | 12264 | 596 | 8303 |
| 10-#11 | 2.17 | MA | 6829 | 2355 | 10030 | 1934 | 11536 | 1626 | 12374 | 1369 | 13241 | 963 | 16015 | 640 | 10677 |
| 4L-3S | | MI | 5502 | 2355 | 8446 | 1878 | 9665 | 1566 | 10360 | 1325 | 11169 | 928 | 13296 | 659 | 8332 |
| 10-#11 | 2.17 | MA | 6581 | 2355 | 9554 | 1958 | 10962 | 1638 | 11659 | 1379 | 12246 | 981 | 14645 | 582 | 10242 |
| 5L-2S | | MI | 5751 | 2355 | 8963 | 1867 | 10324 | 1557 | 11161 | 1307 | 12252 | 914 | 14763 | 772 | 8327 |
| 10-#14 | 3.13 | MA | 7958 | 2552 | 12685 | 2022 | 14939 | 1674 | 16495 | 1387 | 18816 | 922 | 23546 | 790 | 15204 |
| 2L-5S | | MI | 5459 | 2552 | 8323 | 2039 | 9438 | 1688 | 10041 | 1412 | 10681 | 936 | 12713 | 380 | 10691 |
| 10-#14 | 3.13 | MA | 7507 | 2552 | 11709 | 2040 | 13697 | 1690 | 14986 | 1401 | 16774 | 946 | 20718 | 633 | 15139 |
| 3L-4S | | MI | 5691 | 2552 | 8846 | 2009 | 10068 | 1676 | 10824 | 1388 | 11769 | 918 | 14152 | 474 | 11323 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

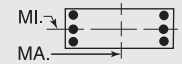



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 3.13 | MA | 7281 | 2552 | 11041 | 2059 | 12755 | 1721 | 13830 | 1430 | 15191 | 956 | 18767 | 541 | 14774 |
| 4L-3S | | MI | 5866 | 2552 | 9357 | 1994 | 10787 | 1649 | 11705 | 1379 | 12974 | 915 | 15600 | 563 | 11645 |
| 10-#14 | 3.13 | MA | 6936 | 2552 | 10359 | 2093 | 11933 | 1738 | 12808 | 1444 | 13768 | 980 | 16804 | 455 | 13796 |
| 5L-2S | | MI | 6201 | 2552 | 10092 | 1979 | 11722 | 1638 | 12841 | 1355 | 14512 | 896 | 17652 | 725 | 11678 |
| 10-#18 | 5.56 | MA | 8726 | 3051 | 14672 | 2348 | 17390 | 1912 | 19433 | 1564 | 22761 | 922 | 28982 | 453 | 25811 |
| 3L-4S | | MI | 6460 | 3051 | 10675 | 2317 | 12273 | 1907 | 13460 | 1530 | 15301 | 881 | 18581 | 140 | 17807 |
| 10-#18 | 5.56 | MA | 8381 | 3051 | 13505 | 2378 | 15746 | 1965 | 17416 | 1586 | 20000 | 934 | 25544 | 285 | 23541 |
| 4L-3S | | MI | 6731 | 3051 | 11562 | 2293 | 13519 | 1864 | 14987 | 1519 | 17389 | 881 | 21012 | 289 | 19579 |
| 10-#18 | 5.56 | MA | 7807 | 3051 | 12312 | 2435 | 14308 | 1991 | 15630 | 1634 | 17515 | 973 | 22100 | 121 | 21532 |
| 5L-2S | | MI | 7249 | 3051 | 12828 | 2270 | 15131 | 1847 | 16945 | 1481 | 20040 | 855 | 24434 | 577 | 19792 |
| 12-#10 | 2.12 | MA | 7341 | 2345 | 11091 | 1912 | 13009 | 1597 | 14198 | 1343 | 15747 | 946 | 19325 | 817 | 10625 |
| 2L-6S | | MI | 5159 | 2345 | 7597 | 1920 | 8604 | 1615 | 9074 | 1359 | 9425 | 964 | 11155 | 539 | 7820 |
| 12-#10 | 2.12 | MA | 7063 | 2345 | 10525 | 1924 | 12288 | 1607 | 13323 | 1352 | 14562 | 961 | 17685 | 732 | 10614 |
| 3L-5S | | MI | 5306 | 2345 | 7869 | 1912 | 8964 | 1598 | 9521 | 1352 | 10028 | 952 | 11953 | 600 | 8073 |
| 12-#10 | 2.12 | MA | 6925 | 2345 | 10141 | 1935 | 11745 | 1626 | 12656 | 1370 | 13649 | 968 | 16573 | 681 | 10570 |
| 4E | | MI | 5451 | 2345 | 8171 | 1894 | 9329 | 1590 | 9974 | 1337 | 10659 | 940 | 12826 | 652 | 8224 |
| 12-#10 | 2.12 | MA | 6715 | 2345 | 9748 | 1955 | 11272 | 1636 | 12068 | 1379 | 12829 | 983 | 15448 | 637 | 10365 |
| 5L-3S | | MI | 5557 | 2345 | 8468 | 1884 | 9747 | 1573 | 10486 | 1330 | 11360 | 936 | 13698 | 705 | 8242 |
| 12-#10 | 2.12 | MA | 6520 | 2345 | 9376 | 1961 | 10827 | 1647 | 11490 | 1397 | 12047 | 999 | 14346 | 566 | 9975 |
| 6L-2S | | MI | 5765 | 2345 | 8898 | 1875 | 10294 | 1565 | 11151 | 1315 | 12260 | 923 | 14944 | 797 | 8239 |
| 12-#11 | 2.60 | MA | 7638 | 2444 | 11866 | 1963 | 13938 | 1632 | 15299 | 1363 | 17214 | 933 | 21340 | 803 | 12829 |
| 2L-6S | | MI | 5267 | 2444 | 7917 | 1975 | 8942 | 1654 | 9453 | 1382 | 9913 | 953 | 11758 | 448 | 9215 |
| 12-#11 | 2.60 | MA | 7313 | 2444 | 11182 | 1976 | 13067 | 1644 | 14241 | 1373 | 15782 | 951 | 19356 | 696 | 12804 |
| 3L-5S | | MI | 5440 | 2444 | 8238 | 1966 | 9377 | 1635 | 9993 | 1375 | 10643 | 940 | 12702 | 521 | 9490 |
| 12-#11 | 2.60 | MA | 7152 | 2444 | 10715 | 1990 | 12408 | 1666 | 13432 | 1394 | 14674 | 958 | 17998 | 633 | 12721 |
| 4E | | MI | 5608 | 2444 | 8605 | 1944 | 9819 | 1626 | 10542 | 1357 | 11406 | 926 | 13731 | 586 | 9848 |
| 12-#11 | 2.60 | MA | 6906 | 2444 | 10238 | 2013 | 11833 | 1678 | 12717 | 1404 | 13679 | 976 | 16628 | 575 | 12240 |
| 5L-3S | | MI | 5732 | 2444 | 8963 | 1933 | 10324 | 1607 | 11161 | 1350 | 12252 | 923 | 14763 | 649 | 9892 |
| 12-#11 | 2.60 | MA | 6676 | 2444 | 9794 | 2021 | 11293 | 1690 | 12015 | 1425 | 12729 | 994 | 15282 | 487 | 11807 |
| 6L-2S | | MI | 5974 | 2444 | 9481 | 1922 | 10982 | 1598 | 11961 | 1333 | 13335 | 909 | 16230 | 761 | 9899 |
| 12-#14 | 3.75 | MA | 7943 | 2680 | 12685 | 2121 | 14939 | 1748 | 16495 | 1437 | 18816 | 939 | 23546 | 623 | 18061 |
| 3L-5S | | MI | 5789 | 2680 | 9058 | 2119 | 10374 | 1747 | 11178 | 1449 | 12219 | 928 | 14764 | 362 | 12827 |
| 12-#14 | 3.75 | MA | 7732 | 2680 | 12016 | 2139 | 13997 | 1780 | 15339 | 1466 | 17233 | 948 | 21595 | 530 | 17603 |
| 4E | | MI | 6020 | 2680 | 9581 | 2089 | 11004 | 1735 | 11960 | 1425 | 13307 | 910 | 16204 | 456 | 13422 |
| 12-#14 | 3.75 | MA | 7390 | 2680 | 11334 | 2173 | 13175 | 1796 | 14317 | 1480 | 15811 | 972 | 19632 | 444 | 16668 |
| 5L-3S | | MI | 6184 | 2680 | 10092 | 2074 | 11722 | 1708 | 12841 | 1416 | 14512 | 907 | 17652 | 544 | 13844 |
| 12-#14 | 3.75 | MA | 7075 | 2680 | 10707 | 2185 | 12365 | 1827 | 13312 | 1509 | 14452 | 997 | 17849 | 338 | 15696 |
| 6L-2S | | MI | 6508 | 2680 | 10827 | 2060 | 12658 | 1696 | 13978 | 1392 | 16051 | 889 | 19703 | 706 | 13895 |
| 12-#18 | 6.67 | MA | 9141 | 3280 | 15199 | 2521 | 17903 | 2069 | 20037 | 1650 | 23547 | 921 | 30454 | 267 | 28515 |
| 4E | | MI | 7013 | 3280 | 11941 | 2459 | 13885 | 2011 | 15419 | 1595 | 17951 | 868 | 22002 | 94 | 21467 |
| 12-#18 | 6.67 | MA | 8572 | 3280 | 14006 | 2578 | 16466 | 2095 | 18250 | 1698 | 21062 | 960 | 27010 | 102 | 26501 |
| 5L-3S | | MI | 7295 | 3280 | 12828 | 2436 | 15131 | 1967 | 16945 | 1584 | 20040 | 868 | 24434 | 243 | 23343 |
| 14-#10 | 2.47 | MA | 7324 | 2417 | 11091 | 1969 | 13009 | 1640 | 14198 | 1373 | 15747 | 957 | 19325 | 726 | 12317 |
| 3L-6S | | MI | 5361 | 2417 | 8027 | 1965 | 9152 | 1648 | 9739 | 1380 | 10325 | 960 | 12400 | 533 | 9078 |
| 14-#10 | 2.47 | MA | 7192 | 2417 | 10707 | 1981 | 12465 | 1659 | 13531 | 1391 | 14833 | 964 | 18213 | 675 | 12265 |
| 4L-5S | | MI | 5504 | 2417 | 8299 | 1958 | 9512 | 1631 | 10186 | 1373 | 10928 | 948 | 13198 | 594 | 9318 |
| 14-#10 | 2.47 | MA | 6984 | 2417 | 10314 | 2001 | 11993 | 1669 | 12943 | 1400 | 14014 | 979 | 17088 | 631 | 12019 |
| 5L-4S | | MI | 5648 | 2417 | 8602 | 1940 | 9877 | 1623 | 10639 | 1358 | 11559 | 935 | 14072 | 646 | 9512 |
| 14-#10 | 2.47 | MA | 6795 | 2417 | 9942 | 2007 | 11548 | 1680 | 12365 | 1417 | 13232 | 995 | 15987 | 560 | 11645 |
| 6L-3S | | MI | 5750 | 2417 | 8898 | 1930 | 10294 | 1606 | 11151 | 1351 | 12260 | 932 | 14944 | 699 | 9539 |
| 14-#10 | 2.47 | MA | 6634 | 2417 | 9582 | 2014 | 11052 | 1695 | 11810 | 1427 | 12434 | 1002 | 14921 | 524 | 11278 |
| 7L-2S | | MI | 5953 | 2417 | 9328 | 1920 | 10842 | 1598 | 11816 | 1336 | 13160 | 919 | 16189 | 791 | 9544 |
| 14-#11 | 3.03 | MA | 7622 | 2533 | 11866 | 2032 | 13938 | 1684 | 15299 | 1398 | 17214 | 945 | 21340 | 689 | 14859 |
| 3L-6S | | MI | 5505 | 2533 | 8435 | 2031 | 9600 | 1695 | 10253 | 1407 | 10996 | 948 | 13225 | 438 | 10729 |
| 14-#11 | 3.03 | MA | 7469 | 2533 | 11399 | 2045 | 13279 | 1707 | 14490 | 1419 | 16106 | 953 | 19981 | 625 | 14765 |
| 4L-5S | | MI | 5674 | 2533 | 8756 | 2021 | 10036 | 1676 | 10794 | 1400 | 11726 | 934 | 14169 | 510 | 10990 |
| 14-#11 | 3.03 | MA | 7226 | 2533 | 10922 | 2069 | 12705 | 1719 | 13776 | 1430 | 15111 | 971 | 18611 | 568 | 14245 |
| 5L-4S | | MI | 5841 | 2533 | 9122 | 2000 | 10478 | 1666 | 11342 | 1382 | 12489 | 921 | 15198 | 575 | 11392 |

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis



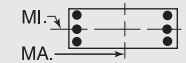

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 3.03 | MA | 7002 | 2533 | 10478 | 2077 | 12164 | 1731 | 13073 | 1450 | 14162 | 988 | 17266 | 480 | 13830 |
| 6L-3S | | MI | 5959 | 2533 | 9481 | 1989 | 10982 | 1647 | 11961 | 1375 | 13335 | 917 | 16230 | 638 | 11447 |
| 14-#11 | 3.03 | MA | 6812 | 2533 | 10041 | 2085 | 11572 | 1750 | 12398 | 1461 | 13192 | 996 | 15966 | 432 | 13175 |
| 7L-2S | | MI | 6194 | 2533 | 9998 | 1978 | 11641 | 1638 | 12761 | 1358 | 14418 | 904 | 17698 | 750 | 11464 |
| 14-#14 | 4.38 | MA | 8175 | 2809 | 12992 | 2220 | 15239 | 1838 | 16848 | 1503 | 19276 | 941 | 24423 | 520 | 20443 |
| 4L-5S | | MI | 6114 | 2809 | 9793 | 2199 | 11309 | 1805 | 12314 | 1485 | 13757 | 921 | 16816 | 343 | 14971 |
| 14-#14 | 4.38 | MA | 7835 | 2809 | 12310 | 2253 | 14418 | 1855 | 15826 | 1517 | 17853 | 965 | 22459 | 434 | 19547 |
| 5L-4S | | MI | 6344 | 2809 | 10316 | 2170 | 11940 | 1793 | 13097 | 1461 | 14845 | 903 | 18255 | 437 | 15533 |
| 14-#14 | 4.38 | MA | 7533 | 2809 | 11682 | 2265 | 13608 | 1886 | 14821 | 1546 | 16494 | 989 | 20677 | 327 | 18563 |
| 6L-3S | | MI | 6498 | 2809 | 10827 | 2155 | 12658 | 1766 | 13978 | 1452 | 16051 | 900 | 19703 | 525 | 16042 |
| 14-#18 | 7.78 | MA | 9320 | 3508 | 15701 | 2721 | 18623 | 2199 | 20871 | 1763 | 24608 | 947 | 31920 | 84 | 31482 |
| 5L-4S | | MI | 7617 | 3508 | 13207 | 2602 | 15497 | 2115 | 17377 | 1660 | 20602 | 854 | 25423 | 47 | 25146 |
| 16-#10 | 2.82 | MA | 7456 | 2490 | 11273 | 2026 | 13186 | 1692 | 14407 | 1411 | 16018 | 960 | 19854 | 669 | 13960 |
| 4L-6S | | MI | 5559 | 2490 | 8458 | 2010 | 9700 | 1680 | 10405 | 1400 | 11225 | 956 | 13645 | 527 | 10339 |
| 16-#10 | 2.82 | MA | 7249 | 2490 | 10880 | 2046 | 12713 | 1702 | 13818 | 1420 | 15199 | 975 | 18728 | 625 | 13679 |
| 5E | | MI | 5699 | 2490 | 8729 | 2003 | 10059 | 1664 | 10851 | 1394 | 11828 | 944 | 14443 | 588 | 10569 |
| 16-#10 | 2.82 | MA | 7065 | 2490 | 10508 | 2052 | 12269 | 1713 | 13240 | 1438 | 14417 | 990 | 17627 | 554 | 13319 |
| 6L-4S | | MI | 5843 | 2490 | 9032 | 1985 | 10424 | 1656 | 11304 | 1378 | 12459 | 931 | 15317 | 640 | 10799 |
| 16-#10 | 2.82 | MA | 6910 | 2490 | 10148 | 2059 | 11773 | 1728 | 12685 | 1447 | 13618 | 997 | 16562 | 518 | 12941 |
| 7L-3S | | MI | 5940 | 2490 | 9328 | 1975 | 10842 | 1639 | 11816 | 1372 | 13160 | 927 | 16189 | 693 | 10834 |
| 16-#10 | 2.82 | MA | 6732 | 2490 | 9802 | 2068 | 11306 | 1734 | 12111 | 1463 | 12856 | 1013 | 15537 | 467 | 12458 |
| 8L-2S | | MI | 6139 | 2490 | 9758 | 1965 | 11389 | 1631 | 12481 | 1356 | 14060 | 915 | 17434 | 785 | 10846 |
| 16-#11 | 3.47 | MA | 7782 | 2622 | 12084 | 2101 | 14151 | 1747 | 15549 | 1444 | 17539 | 948 | 21965 | 618 | 16811 |
| 4L-6S | | MI | 5740 | 2622 | 8952 | 2086 | 10259 | 1735 | 11054 | 1432 | 12079 | 943 | 14693 | 427 | 12247 |
| 16-#11 | 3.47 | MA | 7540 | 2622 | 11607 | 2125 | 13576 | 1759 | 14834 | 1455 | 16544 | 966 | 20595 | 561 | 16255 |
| 5E | | MI | 5904 | 2622 | 9273 | 2077 | 10695 | 1716 | 11594 | 1425 | 12809 | 929 | 15636 | 500 | 12497 |
| 16-#11 | 3.47 | MA | 7324 | 2622 | 11162 | 2133 | 13036 | 1771 | 14132 | 1476 | 15594 | 983 | 19249 | 473 | 15857 |
| 6L-4S | | MI | 6070 | 2622 | 9640 | 2056 | 11137 | 1707 | 12143 | 1408 | 13572 | 916 | 16665 | 564 | 12936 |
| 16-#11 | 3.47 | MA | 7141 | 2622 | 10726 | 2141 | 12444 | 1790 | 13457 | 1486 | 14624 | 991 | 17950 | 425 | 15190 |
| 7L-3S | | MI | 6183 | 2622 | 9998 | 2045 | 11641 | 1687 | 12761 | 1401 | 14418 | 912 | 17698 | 628 | 13000 |
| 16-#14 | 5.00 | MA | 8273 | 2937 | 13286 | 2334 | 15660 | 1913 | 17335 | 1553 | 19895 | 958 | 25287 | 424 | 22433 |
| 5E | | MI | 6435 | 2937 | 10528 | 2280 | 12245 | 1863 | 13451 | 1521 | 15296 | 913 | 18867 | 324 | 17122 |
| 16-#14 | 5.00 | MA | 7982 | 2937 | 12658 | 2346 | 14850 | 1944 | 16330 | 1582 | 18537 | 982 | 23504 | 317 | 21435 |
| 6L-4S | | MI | 6664 | 2937 | 11051 | 2250 | 12875 | 1851 | 14233 | 1497 | 16383 | 895 | 20307 | 418 | 17656 |
| 18-#10 | 3.17 | MA | 7511 | 2562 | 11446 | 2091 | 13434 | 1735 | 14694 | 1441 | 16383 | 971 | 20369 | 619 | 15343 |
| 5L-6S | | MI | 5756 | 2562 | 8888 | 2056 | 10247 | 1713 | 11070 | 1421 | 12126 | 952 | 14890 | 521 | 11603 |
| 18-#10 | 3.17 | MA | 7332 | 2562 | 11074 | 2097 | 12990 | 1746 | 14116 | 1459 | 15601 | 986 | 19267 | 548 | 14995 |
| 6L-5S | | MI | 5892 | 2562 | 9159 | 2048 | 10607 | 1697 | 11516 | 1414 | 12729 | 939 | 15689 | 582 | 11823 |
| 18-#10 | 3.17 | MA | 7182 | 2562 | 10714 | 2105 | 12493 | 1761 | 13560 | 1468 | 14803 | 993 | 18202 | 512 | 14607 |
| 7L-4S | | MI | 6035 | 2562 | 9462 | 2030 | 10972 | 1689 | 11969 | 1399 | 13359 | 927 | 16562 | 634 | 12086 |
| 18-#10 | 3.17 | MA | 7005 | 2562 | 10368 | 2113 | 12026 | 1767 | 12986 | 1484 | 14040 | 1009 | 17177 | 462 | 14136 |
| 8L-3S | | MI | 6129 | 2562 | 9758 | 2020 | 11389 | 1672 | 12481 | 1392 | 14060 | 923 | 17434 | 687 | 12126 |
| 18-#11 | 3.90 | MA | 7850 | 2711 | 12291 | 2180 | 14448 | 1800 | 15893 | 1480 | 17976 | 960 | 22578 | 554 | 18270 |
| 5L-6S | | MI | 5972 | 2711 | 9470 | 2142 | 10918 | 1776 | 11854 | 1458 | 13162 | 938 | 16160 | 416 | 13733 |
| 18-#11 | 3.90 | MA | 7640 | 2711 | 11847 | 2188 | 13907 | 1811 | 15190 | 1501 | 17026 | 978 | 21232 | 466 | 17886 |
| 6L-5S | | MI | 6132 | 2711 | 9791 | 2133 | 11354 | 1756 | 12394 | 1450 | 13892 | 924 | 17103 | 489 | 14008 |
| 18-#11 | 3.90 | MA | 7465 | 2711 | 11410 | 2197 | 13315 | 1831 | 14515 | 1511 | 16057 | 986 | 19933 | 418 | 17209 |
| 7L-4S | | MI | 6297 | 2711 | 10157 | 2111 | 11796 | 1747 | 12943 | 1433 | 14655 | 910 | 18133 | 554 | 14452 |
| 18-#14 | 5.63 | MA | 8424 | 3066 | 13634 | 2426 | 16093 | 2003 | 17839 | 1619 | 20579 | 975 | 26332 | 307 | 24312 |
| 6L-5S | | MI | 6751 | 3066 | 11263 | 2360 | 13181 | 1922 | 14587 | 1558 | 16834 | 906 | 20919 | 305 | 19279 |
| 20-#10 | 3.53 | MA | 7595 | 2635 | 11640 | 2143 | 13710 | 1778 | 14991 | 1479 | 16786 | 982 | 20908 | 543 | 16674 |
| 6E | | MI | 5950 | 2635 | 9318 | 2101 | 10795 | 1746 | 11735 | 1441 | 13026 | 947 | 16136 | 515 | 12869 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 3.53 | MA | 7450 | 2635 | 11280 | 2150 | 13214 | 1794 | 14436 | 1488 | 15988 | 989 | 19842 | 506 | 16276 |
| 7L-5S | | MI | 6083 | 2635 | 9589 | 2094 | 11155 | 1730 | 12181 | 1435 | 13629 | 935 | 16934 | 576 | 13081 |
| 20-#10 | 3.53 | MA | 7275 | 2635 | 10934 | 2158 | 12747 | 1800 | 13862 | 1504 | 15225 | 1004 | 18817 | 456 | 15816 |
| 8L-4S | | MI | 6226 | 2635 | 9892 | 2075 | 11520 | 1721 | 12634 | 1419 | 14260 | 923 | 17807 | 628 | 13372 |
| 20-#11 | 4.33 | MA | 7952 | 2800 | 12531 | 2244 | 14779 | 1852 | 16249 | 1526 | 18459 | 973 | 23216 | 459 | 19919 |
| 6E | | MI | 6202 | 2800 | 9987 | 2198 | 11577 | 1816 | 12654 | 1483 | 14245 | 932 | 17627 | 406 | 15224 |
| 20-#11 | 4.33 | MA | 7783 | 2800 | 12095 | 2252 | 14186 | 1871 | 15574 | 1536 | 17489 | 980 | 21917 | 411 | 19230 |
| 7L-5S | | MI | 6357 | 2800 | 10308 | 2188 | 12013 | 1797 | 13194 | 1476 | 14975 | 919 | 18571 | 478 | 15523 |
| 22-#10 | 3.88 | MA | 7715 | 2707 | 11846 | 2195 | 13935 | 1827 | 15311 | 1509 | 17172 | 985 | 21483 | 500 | 17947 |
| 7L-6S | | MI | 6142 | 2707 | 9748 | 2146 | 11342 | 1779 | 12400 | 1462 | 13926 | 943 | 17381 | 509 | 14138 |
| 22-#10 | 3.88 | MA | 7540 | 2707 | 11500 | 2204 | 13468 | 1833 | 14737 | 1525 | 16410 | 1000 | 20458 | 450 | 17498 |
| 8L-5S | | MI | 6272 | 2707 | 10019 | 2139 | 11702 | 1763 | 12846 | 1455 | 14529 | 931 | 18179 | 570 | 14342 |
| 22-#11 | 4.77 | MA | 8098 | 2889 | 12779 | 2308 | 15058 | 1911 | 16632 | 1562 | 18922 | 975 | 23900 | 404 | 21254 |
| 7L-6S | | MI | 6429 | 2889 | 10505 | 2254 | 12236 | 1857 | 13454 | 1508 | 15328 | 927 | 19094 | 395 | 16720 |
| 24-#10 | 4.23 | MA | 7803 | 2780 | 12066 | 2249 | 14188 | 1866 | 15612 | 1545 | 17594 | 996 | 22098 | 444 | 19182 |
| 8L-6S | | MI | 6333 | 2780 | 10178 | 2191 | 11890 | 1812 | 13065 | 1483 | 14826 | 939 | 18626 | 503 | 15408 |

## RECTANGULAR TIED COLUMNS 24" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.17 | MA | 7535 | 2294 | 10927 | 1900 | 12594 | 1600 | 13447 | 1366 | 14232 | 1015 | 16870 | 883 | 6813 |
| 2E | | MI | 5558 | 2294 | 8315 | 1844 | 9385 | 1552 | 9909 | 1324 | 10353 | 981 | 11990 | 836 | 4981 |
| 4-#18 | 2.08 | MA | 8222 | 2494 | 12587 | 2008 | 14620 | 1677 | 15866 | 1411 | 17471 | 993 | 21329 | 858 | 11657 |
| 2E | | MI | 6000 | 2494 | 9462 | 1946 | 10765 | 1624 | 11547 | 1364 | 12541 | 956 | 14658 | 769 | 8361 |
| 6-#11 | 1.22 | MA | 7595 | 2304 | 10986 | 1915 | 12712 | 1612 | 13613 | 1376 | 14473 | 1019 | 17217 | 886 | 7105 |
| 2L-3S | | MI | 5337 | 2304 | 7836 | 1872 | 8816 | 1576 | 9237 | 1353 | 9459 | 1001 | 10856 | 736 | 5215 |
| 6-#11 | 1.22 | MA | 7203 | 2304 | 10246 | 1929 | 11770 | 1625 | 12468 | 1387 | 12924 | 1038 | 15073 | 782 | 7122 |
| 3L-2S | | MI | 5603 | 2304 | 8354 | 1861 | 9475 | 1566 | 10038 | 1336 | 10542 | 987 | 12324 | 848 | 5187 |
| 6-#14 | 1.76 | MA | 8021 | 2422 | 11984 | 1980 | 13938 | 1659 | 15081 | 1403 | 16442 | 1007 | 19930 | 872 | 10030 |
| 2L-3S | | MI | 5517 | 2422 | 8315 | 1939 | 9385 | 1622 | 9909 | 1385 | 10353 | 992 | 11990 | 655 | 7267 |
| 6-#14 | 1.76 | MA | 7483 | 2422 | 10927 | 2000 | 12594 | 1676 | 13447 | 1418 | 14232 | 1033 | 16870 | 719 | 10018 |
| 3L-2S | | MI | 5881 | 2422 | 9050 | 1924 | 10321 | 1611 | 11045 | 1361 | 11891 | 974 | 14041 | 817 | 7243 |
| 6-#18 | 3.13 | MA | 9025 | 2722 | 14424 | 2151 | 16959 | 1781 | 18707 | 1475 | 21316 | 980 | 26653 | 839 | 17212 |
| 2L-3S | | MI | 5947 | 2722 | 9462 | 2112 | 10765 | 1745 | 11547 | 1467 | 12541 | 969 | 14658 | 436 | 12127 |
| 6-#18 | 3.13 | MA | 8161 | 2722 | 12587 | 2183 | 14620 | 1809 | 15866 | 1499 | 17471 | 1022 | 21329 | 558 | 17006 |
| 3L-2S | | MI | 6531 | 2722 | 10729 | 2089 | 12378 | 1728 | 13506 | 1429 | 15192 | 943 | 18080 | 723 | 12215 |
| 8-#9 | 1.04 | MA | 7476 | 2265 | 10605 | 1907 | 12311 | 1608 | 13168 | 1376 | 13905 | 1031 | 16456 | 898 | 6169 |
| 2L-4S | | MI | 5260 | 2265 | 7504 | 1874 | 8440 | 1587 | 8815 | 1358 | 8912 | 1015 | 10264 | 759 | 4558 |
| 8-#9 | 1.04 | MA | 7216 | 2265 | 10121 | 1916 | 11695 | 1617 | 12419 | 1384 | 12892 | 1044 | 15054 | 833 | 6181 |
| 3E | | MI | 5354 | 2265 | 7739 | 1866 | 8771 | 1574 | 9221 | 1346 | 9467 | 1012 | 10954 | 801 | 4540 |
| 8-#9 | 1.04 | MA | 7081 | 2265 | 9793 | 1926 | 11232 | 1632 | 11851 | 1399 | 12114 | 1050 | 14114 | 793 | 6185 |
| 4L-2S | | MI | 5532 | 2265 | 8080 | 1858 | 9205 | 1567 | 9748 | 1340 | 10181 | 1002 | 11942 | 872 | 4524 |
| 8-#10 | 1.32 | MA | 7714 | 2327 | 11140 | 1941 | 12971 | 1633 | 13958 | 1391 | 14965 | 1025 | 17916 | 890 | 7739 |
| 2L-4S | | MI | 5354 | 2327 | 7732 | 1910 | 8701 | 1615 | 9121 | 1376 | 9316 | 1011 | 10834 | 720 | 5669 |
| 8-#10 | 1.32 | MA | 7392 | 2327 | 10529 | 1953 | 12192 | 1644 | 13012 | 1401 | 13685 | 1041 | 16145 | 807 | 7748 |
| 3E | | MI | 5470 | 2327 | 8029 | 1901 | 9119 | 1598 | 9633 | 1369 | 10017 | 1007 | 11706 | 773 | 5658 |
| 8-#10 | 1.32 | MA | 7226 | 2327 | 10115 | 1965 | 11607 | 1663 | 12294 | 1419 | 12701 | 1049 | 14954 | 757 | 7727 |
| 4L-2S | | MI | 5690 | 2327 | 8459 | 1891 | 9666 | 1590 | 10298 | 1354 | 10917 | 995 | 12951 | 864 | 5640 |
| 8-#11 | 1.63 | MA | 7938 | 2393 | 11726 | 1971 | 13654 | 1653 | 14757 | 1401 | 16022 | 1014 | 19362 | 879 | 9357 |
| 2L-4S | | MI | 5437 | 2393 | 7995 | 1939 | 8970 | 1635 | 9419 | 1385 | 9696 | 999 | 11292 | 662 | 6795 |
| 8-#11 | 1.63 | MA | 7559 | 2393 | 10986 | 1985 | 12712 | 1665 | 13613 | 1412 | 14473 | 1033 | 17217 | 775 | 9359 |
| 3E | | MI | 5575 | 2393 | 8354 | 1928 | 9475 | 1616 | 10038 | 1378 | 10542 | 996 | 12324 | 725 | 6796 |
| 8-#11 | 1.63 | MA | 7363 | 2393 | 10482 | 1999 | 12001 | 1688 | 12741 | 1434 | 13278 | 1041 | 15762 | 712 | 9307 |
| 4L-2S | | MI | 5833 | 2393 | 8871 | 1917 | 10133 | 1607 | 10838 | 1361 | 11625 | 982 | 13791 | 837 | 6777 |
| 8-#14 | 2.34 | MA | 8496 | 2551 | 13040 | 2061 | 15283 | 1717 | 16714 | 1439 | 18653 | 1000 | 22991 | 862 | 13231 |
| 2L-4S | | MI | 5660 | 2551 | 8539 | 2034 | 9602 | 1708 | 10164 | 1430 | 10686 | 987 | 12594 | 548 | 9389 |
| 8-#14 | 2.34 | MA | 7981 | 2551 | 11984 | 2080 | 13938 | 1735 | 15081 | 1455 | 16442 | 1026 | 19930 | 709 | 13188 |
| 3E | | MI | 5848 | 2551 | 9050 | 2019 | 10321 | 1681 | 11045 | 1421 | 11891 | 984 | 14041 | 637 | 9485 |

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

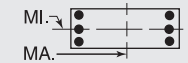
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.34 | MA | 7714 | 2551 | 11263 | 2100 | 12922 | 1767 | 13833 | 1485 | 14734 | 1037 | 17839 | 618 | 12981 |
| 4L-2S | | MI | 6198 | 2551 | 9785 | 2004 | 11256 | 1669 | 12182 | 1397 | 13429 | 966 | 16093 | 798 | 9485 |
| 8-#18 | 4.17 | MA | 9807 | 2950 | 16261 | 2294 | 19298 | 1884 | 21548 | 1540 | 25161 | 967 | 31977 | 821 | 22746 |
| 2L-4S | | MI | 6198 | 2950 | 9841 | 2278 | 11132 | 1892 | 11979 | 1543 | 13103 | 956 | 15648 | 240 | 14362 |
| 8-#18 | 4.17 | MA | 8996 | 2950 | 14424 | 2326 | 16959 | 1913 | 18707 | 1564 | 21316 | 1009 | 26653 | 540 | 22485 |
| 3E | | MI | 6498 | 2950 | 10729 | 2255 | 12378 | 1848 | 13506 | 1532 | 15192 | 956 | 18080 | 389 | 15890 |
| 8-#18 | 4.17 | MA | 8575 | 2950 | 13164 | 2359 | 15182 | 1967 | 16528 | 1614 | 18332 | 1024 | 22963 | 375 | 20312 |
| 4L-2S | | MI | 7052 | 2950 | 11995 | 2231 | 13990 | 1831 | 15464 | 1494 | 17842 | 930 | 21501 | 677 | 16037 |
| 10-#10 | 1.65 | MA | 7999 | 2399 | 11752 | 1986 | 13749 | 1666 | 14903 | 1411 | 16244 | 1020 | 19688 | 885 | 9596 |
| 2L-5S | | MI | 5411 | 2399 | 7860 | 1974 | 8884 | 1656 | 9333 | 1411 | 9585 | 1019 | 11206 | 661 | 6924 |
| 10-#10 | 1.65 | MA | 7686 | 2399 | 11140 | 1998 | 12971 | 1676 | 13958 | 1421 | 14965 | 1037 | 17916 | 801 | 9594 |
| 3L-4S | | MI | 5557 | 2399 | 8163 | 1956 | 9249 | 1648 | 9786 | 1396 | 10216 | 1007 | 12079 | 714 | 6967 |
| 10-#10 | 1.65 | MA | 7528 | 2399 | 10726 | 2010 | 12385 | 1696 | 13239 | 1439 | 13980 | 1044 | 16726 | 751 | 9561 |
| 4L-3S | | MI | 5668 | 2399 | 8459 | 1946 | 9666 | 1631 | 10298 | 1389 | 10917 | 1003 | 12951 | 767 | 6968 |
| 10-#10 | 1.65 | MA | 7296 | 2399 | 10304 | 2031 | 11877 | 1707 | 12606 | 1449 | 13098 | 1060 | 15517 | 708 | 9458 |
| 5L-2S | | MI | 5883 | 2399 | 8889 | 1936 | 10214 | 1623 | 10963 | 1374 | 11817 | 991 | 14197 | 858 | 6956 |
| 10-#11 | 2.03 | MA | 8276 | 2482 | 12466 | 2026 | 14597 | 1693 | 15902 | 1426 | 17571 | 1009 | 21507 | 872 | 11602 |
| 2L-5S | | MI | 5509 | 2482 | 8146 | 2016 | 9187 | 1685 | 9671 | 1428 | 10016 | 1007 | 11730 | 587 | 8099 |
| 10-#11 | 2.03 | MA | 7909 | 2482 | 11726 | 2040 | 13654 | 1706 | 14757 | 1437 | 16022 | 1027 | 19362 | 767 | 11588 |
| 3L-4S | | MI | 5677 | 2482 | 8513 | 1995 | 9629 | 1676 | 10219 | 1411 | 10779 | 994 | 12759 | 651 | 8347 |
| 10-#11 | 2.03 | MA | 7723 | 2482 | 11222 | 2054 | 12944 | 1729 | 13885 | 1459 | 14827 | 1036 | 17906 | 705 | 11519 |
| 4L-3S | | MI | 5808 | 2482 | 8871 | 1984 | 10133 | 1656 | 10838 | 1404 | 11625 | 990 | 13791 | 714 | 8367 |
| 10-#11 | 2.03 | MA | 7449 | 2482 | 10709 | 2079 | 12325 | 1742 | 13115 | 1470 | 13755 | 1055 | 16434 | 650 | 11121 |
| 5L-2S | | MI | 6059 | 2482 | 9388 | 1973 | 10792 | 1647 | 11638 | 1386 | 12708 | 977 | 15258 | 827 | 8357 |
| 10-#14 | 2.93 | MA | 8962 | 2679 | 14096 | 2141 | 16628 | 1776 | 18347 | 1476 | 20863 | 992 | 26051 | 852 | 16419 |
| 2L-5S | | MI | 5763 | 2679 | 8751 | 2144 | 9907 | 1778 | 10518 | 1490 | 11136 | 998 | 13206 | 435 | 10818 |
| 10-#14 | 2.93 | MA | 8467 | 2679 | 13040 | 2161 | 15283 | 1793 | 16714 | 1491 | 18653 | 1018 | 22991 | 699 | 16354 |
| 3L-4S | | MI | 5996 | 2679 | 9274 | 2114 | 10538 | 1766 | 11301 | 1466 | 12224 | 980 | 14645 | 529 | 11466 |
| 10-#14 | 2.93 | MA | 8220 | 2679 | 12319 | 2180 | 14266 | 1825 | 15467 | 1521 | 16944 | 1029 | 20899 | 607 | 16116 |
| 4L-3S | | MI | 6172 | 2679 | 9785 | 2099 | 11256 | 1739 | 12182 | 1457 | 13429 | 977 | 16093 | 618 | 11691 |
| 10-#14 | 2.93 | MA | 7837 | 2679 | 11584 | 2215 | 13381 | 1843 | 14365 | 1537 | 15410 | 1055 | 18788 | 525 | 14992 |
| 5L-2S | | MI | 6511 | 2679 | 10520 | 2084 | 12192 | 1727 | 13318 | 1434 | 14967 | 959 | 18145 | 779 | 11716 |
| 10-#18 | 5.21 | MA | 9807 | 3179 | 16261 | 2469 | 19298 | 2016 | 21548 | 1629 | 25161 | 995 | 31977 | 522 | 27971 |
| 3L-4S | | MI | 6763 | 3179 | 11108 | 2420 | 12744 | 1996 | 13937 | 1608 | 15754 | 942 | 19069 | 194 | 17990 |
| 10-#18 | 5.21 | MA | 9430 | 3179 | 15001 | 2501 | 17522 | 2071 | 19369 | 1679 | 22177 | 1011 | 28287 | 356 | 25699 |
| 4L-3S | | MI | 7038 | 3179 | 11995 | 2397 | 13990 | 1952 | 15464 | 1596 | 17842 | 943 | 21501 | 343 | 19654 |
| 10-#18 | 5.21 | MA | 8790 | 3179 | 13714 | 2560 | 15971 | 2099 | 17441 | 1703 | 19493 | 1053 | 24579 | 200 | 23667 |
| 5L-2S | | MI | 7566 | 3179 | 13261 | 2374 | 15602 | 1935 | 17422 | 1558 | 20492 | 916 | 24922 | 630 | 19844 |
| 12-#10 | 1.98 | MA | 8281 | 2472 | 12363 | 2032 | 14528 | 1699 | 15848 | 1432 | 17524 | 1016 | 21460 | 879 | 11448 |
| 2L-6S | | MI | 5464 | 2472 | 8018 | 2026 | 9072 | 1706 | 9552 | 1439 | 9882 | 1028 | 11653 | 594 | 7903 |
| 12-#10 | 1.98 | MA | 7976 | 2472 | 11752 | 2044 | 13749 | 1709 | 14903 | 1442 | 16244 | 1032 | 19688 | 796 | 11437 |
| 3L-5S | | MI | 5612 | 2472 | 8290 | 2019 | 9432 | 1689 | 9998 | 1432 | 10485 | 1015 | 12451 | 655 | 8161 |
| 12-#10 | 1.98 | MA | 7825 | 2472 | 11337 | 2056 | 13164 | 1729 | 14185 | 1460 | 15260 | 1040 | 18497 | 745 | 11393 |
| 4E | | MI | 5757 | 2472 | 8593 | 2001 | 9796 | 1681 | 10451 | 1417 | 11116 | 1003 | 13324 | 708 | 8260 |
| 12-#10 | 1.98 | MA | 7594 | 2472 | 10915 | 2076 | 12655 | 1740 | 13551 | 1470 | 14377 | 1056 | 17289 | 703 | 11242 |
| 5L-3S | | MI | 5864 | 2472 | 8889 | 1991 | 10214 | 1664 | 10963 | 1410 | 11817 | 999 | 14197 | 761 | 8272 |
| 12-#10 | 1.98 | MA | 7382 | 2472 | 10510 | 2082 | 12177 | 1751 | 12929 | 1488 | 13536 | 1072 | 16109 | 632 | 10797 |
| 6L-2S | | MI | 6074 | 2472 | 9319 | 1982 | 10761 | 1656 | 11628 | 1395 | 12717 | 987 | 15442 | 852 | 8266 |
| 12-#11 | 2.44 | MA | 8609 | 2571 | 13206 | 2082 | 15539 | 1734 | 17046 | 1451 | 19120 | 1004 | 23651 | 865 | 13840 |
| 2L-6S | | MI | 5571 | 2571 | 8343 | 2081 | 9410 | 1745 | 9931 | 1461 | 10369 | 1016 | 12253 | 503 | 9313 |
| 12-#11 | 2.44 | MA | 8252 | 2571 | 12466 | 2096 | 14597 | 1746 | 15902 | 1463 | 17571 | 1022 | 21507 | 760 | 13814 |
| 3L-5S | | MI | 5746 | 2571 | 8663 | 2072 | 9846 | 1725 | 10471 | 1453 | 11099 | 1002 | 13197 | 576 | 9590 |
| 12-#11 | 2.44 | MA | 8076 | 2571 | 11962 | 2110 | 13886 | 1769 | 15030 | 1484 | 16376 | 1031 | 20051 | 698 | 13732 |
| 4E | | MI | 5914 | 2571 | 9030 | 2050 | 10288 | 1716 | 11020 | 1436 | 11862 | 989 | 14226 | 641 | 9895 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

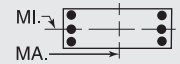


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.44 | MA | 7804 | 2571 | 11449 | 2135 | 13267 | 1782 | 14260 | 1495 | 15304 | 1050 | 18579 | 642 | 13285 |
| 5L-3S | | MI | 6039 | 2571 | 9388 | 2039 | 10792 | 1697 | 11638 | 1429 | 12708 | 985 | 15258 | 704 | 9929 |
| 12-#11 | 2.44 | MA | 7553 | 2571 | 10963 | 2142 | 12686 | 1795 | 13504 | 1517 | 14281 | 1068 | 17137 | 556 | 12793 |
| 6L-2S | | MI | 6283 | 2571 | 9906 | 2028 | 11451 | 1688 | 12438 | 1411 | 13791 | 972 | 16725 | 816 | 9930 |
| 12-#14 | 3.52 | MA | 8944 | 2808 | 14096 | 2241 | 16628 | 1851 | 18347 | 1527 | 20863 | 1011 | 26051 | 688 | 19519 |
| 3L-5S | | MI | 6095 | 2808 | 9486 | 2224 | 10843 | 1836 | 11655 | 1527 | 12674 | 990 | 15257 | 416 | 12950 |
| 12-#14 | 3.52 | MA | 8713 | 2808 | 13375 | 2261 | 15611 | 1884 | 17100 | 1558 | 19154 | 1022 | 23960 | 597 | 19185 |
| 4E | | MI | 6326 | 2808 | 10009 | 2195 | 11473 | 1824 | 12438 | 1503 | 13762 | 972 | 16697 | 510 | 13560 |
| 12-#14 | 3.52 | MA | 8334 | 2808 | 12641 | 2295 | 14726 | 1901 | 15998 | 1573 | 17620 | 1048 | 21848 | 515 | 18106 |
| 5L-3S | | MI | 6492 | 2808 | 10520 | 2180 | 12192 | 1798 | 13318 | 1494 | 14967 | 969 | 18145 | 599 | 13893 |
| 12-#14 | 3.52 | MA | 7989 | 2808 | 11953 | 2306 | 13892 | 1919 | 14915 | 1603 | 16156 | 1074 | 19776 | 388 | 17149 |
| 6L-2S | | MI | 6819 | 2808 | 11255 | 2165 | 13128 | 1786 | 14455 | 1470 | 16505 | 951 | 20196 | 761 | 13935 |
| 12-#18 | 6.25 | MA | 10262 | 3407 | 16838 | 2644 | 19861 | 2175 | 22210 | 1744 | 26022 | 998 | 33611 | 338 | 31105 |
| 4E | | MI | 7316 | 3407 | 12374 | 2563 | 14356 | 2100 | 15895 | 1672 | 18404 | 929 | 22491 | 147 | 21642 |
| 12-#18 | 6.25 | MA | 9628 | 3407 | 15551 | 2703 | 18310 | 2203 | 20282 | 1768 | 23338 | 1040 | 29903 | 181 | 29083 |
| 5L-3S | | MI | 7605 | 3407 | 13261 | 2540 | 15602 | 2056 | 17422 | 1661 | 20492 | 929 | 24922 | 296 | 23419 |
| 14-#10 | 2.32 | MA | 8262 | 2544 | 12363 | 2089 | 14528 | 1742 | 15848 | 1462 | 17524 | 1028 | 21460 | 790 | 13278 |
| 3L-6S | | MI | 5666 | 2544 | 8449 | 2072 | 9619 | 1739 | 10217 | 1459 | 10783 | 1023 | 12898 | 588 | 9160 |
| 14-#10 | 2.32 | MA | 8118 | 2544 | 11949 | 2101 | 13942 | 1762 | 15130 | 1480 | 16539 | 1036 | 20269 | 739 | 13225 |
| 4L-5S | | MI | 5810 | 2544 | 8720 | 2064 | 9979 | 1722 | 10663 | 1452 | 11386 | 1011 | 13696 | 649 | 9405 |
| 14-#10 | 2.32 | MA | 7888 | 2544 | 11527 | 2121 | 13434 | 1773 | 14497 | 1490 | 15657 | 1052 | 19060 | 697 | 13031 |
| 5L-4S | | MI | 5954 | 2544 | 9023 | 2046 | 10344 | 1714 | 11117 | 1437 | 12017 | 999 | 14570 | 702 | 9550 |
| 14-#10 | 2.32 | MA | 7682 | 2544 | 11121 | 2127 | 12956 | 1784 | 13875 | 1509 | 14815 | 1068 | 17881 | 627 | 12603 |
| 6L-3S | | MI | 6057 | 2544 | 9319 | 2037 | 10761 | 1697 | 11628 | 1430 | 12717 | 995 | 15442 | 755 | 9571 |
| 14-#10 | 2.32 | MA | 7506 | 2544 | 10733 | 2135 | 12414 | 1798 | 13278 | 1518 | 13956 | 1076 | 16738 | 592 | 12267 |
| 7L-2S | | MI | 6262 | 2544 | 9749 | 2027 | 11309 | 1689 | 12293 | 1415 | 13617 | 982 | 16687 | 846 | 9572 |
| 14-#11 | 2.84 | MA | 8590 | 2660 | 13206 | 2152 | 15539 | 1787 | 17046 | 1488 | 19120 | 1017 | 23651 | 753 | 16038 |
| 3L-6S | | MI | 5810 | 2660 | 8860 | 2137 | 10069 | 1785 | 10731 | 1486 | 11452 | 1011 | 13721 | 493 | 10826 |
| 14-#11 | 2.84 | MA | 8424 | 2660 | 12702 | 2166 | 14828 | 1810 | 16174 | 1509 | 17925 | 1026 | 22196 | 690 | 15945 |
| 4L-5S | | MI | 5980 | 2660 | 9181 | 2127 | 10505 | 1766 | 11271 | 1479 | 12182 | 997 | 14664 | 565 | 11089 |
| 14-#11 | 2.84 | MA | 8153 | 2660 | 12189 | 2190 | 14210 | 1822 | 15404 | 1521 | 16853 | 1044 | 20723 | 635 | 15456 |
| 5L-4S | | MI | 6147 | 2660 | 9548 | 2106 | 10947 | 1757 | 11820 | 1461 | 12945 | 983 | 15693 | 630 | 11441 |
| 14-#11 | 2.84 | MA | 7910 | 2660 | 11703 | 2198 | 13628 | 1835 | 14648 | 1542 | 15830 | 1063 | 19281 | 548 | 14984 |
| 6L-3S | | MI | 6266 | 2660 | 9906 | 2095 | 11451 | 1737 | 12438 | 1454 | 13791 | 980 | 16725 | 693 | 11486 |
| 14-#11 | 2.84 | MA | 7703 | 2660 | 11232 | 2207 | 12980 | 1854 | 13921 | 1554 | 14786 | 1072 | 17887 | 503 | 14339 |
| 7L-2S | | MI | 6505 | 2660 | 10423 | 2084 | 12110 | 1728 | 13238 | 1437 | 14874 | 967 | 18193 | 805 | 11499 |
| 14-#14 | 4.10 | MA | 9198 | 2936 | 14431 | 2341 | 16956 | 1942 | 18733 | 1594 | 21365 | 1014 | 27020 | 587 | 22265 |
| 4L-5S | | MI | 6420 | 2936 | 10221 | 2305 | 11779 | 1895 | 12791 | 1563 | 14212 | 983 | 17309 | 397 | 15091 |
| 14-#14 | 4.10 | MA | 8821 | 2936 | 13697 | 2375 | 16070 | 1960 | 17631 | 1609 | 19830 | 1040 | 24909 | 504 | 21227 |
| 5L-4S | | MI | 6650 | 2936 | 10744 | 2275 | 12409 | 1883 | 13574 | 1539 | 15300 | 965 | 18748 | 491 | 15668 |
| 14-#14 | 4.10 | MA | 8490 | 2936 | 13009 | 2387 | 15237 | 1977 | 16548 | 1640 | 18366 | 1066 | 22836 | 378 | 20262 |
| 6L-3S | | MI | 6807 | 2936 | 11255 | 2260 | 13128 | 1856 | 14455 | 1530 | 16505 | 962 | 20196 | 580 | 16092 |
| 14-#14 | 4.10 | MA | 8209 | 2936 | 12336 | 2399 | 14321 | 2004 | 15508 | 1655 | 16871 | 1077 | 20835 | 310 | 19163 |
| 7L-2S | | MI | 7125 | 2936 | 11990 | 2245 | 14064 | 1844 | 15591 | 1506 | 18043 | 944 | 22248 | 742 | 16150 |
| 14-#18 | 7.29 | MA | 10446 | 3635 | 17389 | 2846 | 20649 | 2307 | 23123 | 1833 | 27184 | 1026 | 35227 | 163 | 34498 |
| 5L-4S | | MI | 7922 | 3635 | 13640 | 2706 | 15968 | 2203 | 17854 | 1737 | 21054 | 916 | 25912 | 101 | 25314 |
| 16-#10 | 2.65 | MA | 8406 | 2617 | 12560 | 2146 | 14721 | 1795 | 16075 | 1501 | 17819 | 1032 | 22040 | 734 | 15057 |
| 4L-6S | | MI | 5865 | 2617 | 8879 | 2117 | 10167 | 1772 | 10882 | 1480 | 11683 | 1019 | 14143 | 583 | 10419 |
| 16-#10 | 2.65 | MA | 8177 | 2617 | 12138 | 2167 | 14212 | 1806 | 15442 | 1511 | 16936 | 1048 | 20832 | 691 | 14826 |
| 5E | | MI | 6006 | 2617 | 9150 | 2110 | 10527 | 1755 | 11328 | 1473 | 12286 | 1007 | 14942 | 643 | 10653 |
| 16-#10 | 2.65 | MA | 7977 | 2617 | 11732 | 2172 | 13734 | 1816 | 14820 | 1529 | 16095 | 1064 | 19652 | 621 | 14412 |
| 6L-4S | | MI | 6149 | 2617 | 9453 | 2092 | 10892 | 1747 | 11782 | 1458 | 12917 | 994 | 15815 | 696 | 10839 |
| 16-#10 | 2.65 | MA | 7808 | 2617 | 11344 | 2180 | 13192 | 1831 | 14223 | 1539 | 15236 | 1072 | 18510 | 586 | 14068 |
| 7L-3S | | MI | 6248 | 2617 | 9749 | 2082 | 11309 | 1730 | 12293 | 1451 | 13617 | 991 | 16687 | 749 | 10867 |
| 16-#10 | 2.65 | MA | 7611 | 2617 | 10972 | 2189 | 12689 | 1838 | 13596 | 1554 | 14416 | 1088 | 17410 | 538 | 13520 |
| 8L-2S | | MI | 6449 | 2617 | 10179 | 2072 | 11857 | 1722 | 12959 | 1436 | 14518 | 978 | 17932 | 840 | 10875 |
| 16-#11 | 3.25 | MA | 8766 | 2749 | 13443 | 2222 | 15770 | 1850 | 17319 | 1535 | 19474 | 1020 | 24341 | 683 | 18159 |
| 4L-6S | | MI | 6046 | 2749 | 9377 | 2192 | 10728 | 1826 | 11531 | 1511 | 12535 | 1005 | 15188 | 482 | 12342 |

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

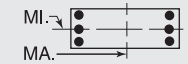
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 3.25 | MA | 8497 | 2749 | 12929 | 2246 | 15152 | 1863 | 16549 | 1546 | 18402 | 1039 | 22868 | 628 | 17633 |
| 5E | | MI | 6211 | 2749 | 9698 | 2183 | 11164 | 1806 | 12071 | 1504 | 13265 | 992 | 16131 | 555 | 12593 |
| 16-#11 | 3.25 | MA | 8261 | 2749 | 12444 | 2254 | 14570 | 1876 | 15793 | 1568 | 17379 | 1058 | 21426 | 541 | 17178 |
| 6L-4S | | MI | 6377 | 2749 | 10065 | 2162 | 11605 | 1797 | 12620 | 1486 | 14028 | 978 | 17161 | 619 | 12986 |
| 16-#11 | 3.25 | MA | 8062 | 2749 | 11972 | 2262 | 13923 | 1894 | 15066 | 1579 | 16335 | 1066 | 20031 | 496 | 16524 |
| 7L-3S | | MI | 6491 | 2749 | 10423 | 2151 | 12110 | 1778 | 13238 | 1479 | 14874 | 975 | 18193 | 682 | 13041 |
| 16-#11 | 3.25 | MA | 7830 | 2749 | 11520 | 2273 | 13312 | 1902 | 14317 | 1598 | 15337 | 1085 | 18690 | 434 | 15904 |
| 8L-2S | | MI | 6724 | 2749 | 10941 | 2140 | 12769 | 1769 | 14038 | 1462 | 15957 | 961 | 19660 | 795 | 13062 |
| 16-#14 | 4.69 | MA | 9299 | 3064 | 14753 | 2456 | 17415 | 2018 | 19264 | 1646 | 22041 | 1033 | 27969 | 494 | 24354 |
| 5E | | MI | 6742 | 3064 | 10956 | 2385 | 12715 | 1953 | 13928 | 1600 | 15750 | 976 | 19360 | 378 | 17239 |
| 16-#14 | 4.69 | MA | 8982 | 3064 | 14065 | 2467 | 16582 | 2035 | 18182 | 1676 | 20576 | 1059 | 25897 | 368 | 23380 |
| 6L-4S | | MI | 6970 | 3064 | 11479 | 2355 | 13345 | 1941 | 14711 | 1576 | 16838 | 957 | 20800 | 472 | 17786 |
| 16-#14 | 4.69 | MA | 8714 | 3064 | 13392 | 2479 | 15666 | 2063 | 17141 | 1691 | 19081 | 1070 | 23895 | 300 | 22302 |
| 7L-3S | | MI | 7119 | 3064 | 11990 | 2340 | 14064 | 1914 | 15591 | 1567 | 18043 | 954 | 22248 | 561 | 18290 |
| 18-#10 | 2.98 | MA | 8463 | 2689 | 12750 | 2212 | 14990 | 1838 | 16388 | 1531 | 18216 | 1044 | 22604 | 685 | 16625 |
| 5L-6S | | MI | 6062 | 2689 | 9309 | 2162 | 10714 | 1805 | 11547 | 1500 | 12583 | 1015 | 15388 | 577 | 11682 |
| 18-#10 | 2.98 | MA | 8267 | 2689 | 12344 | 2218 | 14512 | 1849 | 15766 | 1550 | 17374 | 1060 | 21424 | 615 | 16225 |
| 6L-5S | | MI | 6199 | 2689 | 9580 | 2155 | 11074 | 1788 | 11993 | 1494 | 13186 | 1003 | 16187 | 638 | 11906 |
| 18-#10 | 2.98 | MA | 8104 | 2689 | 11956 | 2225 | 13971 | 1864 | 15168 | 1560 | 16515 | 1068 | 20281 | 580 | 15871 |
| 7L-4S | | MI | 6342 | 2689 | 9883 | 2137 | 11439 | 1780 | 12447 | 1478 | 13817 | 990 | 17060 | 690 | 12127 |
| 18-#10 | 2.98 | MA | 7909 | 2689 | 11583 | 2234 | 13468 | 1871 | 14541 | 1575 | 15695 | 1084 | 19181 | 532 | 15336 |
| 8L-3S | | MI | 6438 | 2689 | 10179 | 2127 | 11857 | 1763 | 12959 | 1472 | 14518 | 986 | 17932 | 743 | 12161 |
| 18-#10 | 2.98 | MA | 7710 | 2689 | 11166 | 2252 | 12951 | 1888 | 13921 | 1582 | 14856 | 1091 | 18096 | 487 | 14761 |
| 9L-2S | | MI | 6635 | 2689 | 10609 | 2118 | 12404 | 1755 | 13624 | 1456 | 15418 | 974 | 19178 | 834 | 12175 |
| 18-#11 | 3.66 | MA | 8836 | 2838 | 13670 | 2302 | 16094 | 1903 | 17694 | 1571 | 19951 | 1034 | 25013 | 621 | 19814 |
| 5L-6S | | MI | 6278 | 2838 | 9895 | 2248 | 11387 | 1866 | 12331 | 1536 | 13618 | 1000 | 16655 | 471 | 13862 |
| 18-#11 | 3.66 | MA | 8607 | 2838 | 13184 | 2309 | 15513 | 1916 | 16937 | 1593 | 18928 | 1053 | 23571 | 534 | 19375 |
| 6L-5S | | MI | 6439 | 2838 | 10216 | 2239 | 11823 | 1847 | 12871 | 1529 | 14348 | 987 | 17598 | 544 | 14102 |
| 18-#11 | 3.66 | MA | 8415 | 2838 | 12713 | 2318 | 14865 | 1935 | 16211 | 1604 | 17883 | 1061 | 22176 | 489 | 18711 |
| 7L-4S | | MI | 6605 | 2838 | 10582 | 2217 | 12264 | 1838 | 13420 | 1512 | 15111 | 973 | 18628 | 609 | 14531 |
| 18-#11 | 3.66 | MA | 8186 | 2838 | 12260 | 2328 | 14254 | 1943 | 15461 | 1624 | 16886 | 1080 | 20835 | 427 | 18092 |
| 8L-3S | | MI | 6714 | 2838 | 10941 | 2206 | 12769 | 1818 | 14038 | 1505 | 15957 | 970 | 19660 | 672 | 14594 |
| 18-#14 | 5.27 | MA | 9464 | 3193 | 15122 | 2547 | 17926 | 2094 | 19815 | 1712 | 22787 | 1051 | 28957 | 357 | 26502 |
| 6L-5S | | MI | 7059 | 3193 | 11691 | 2465 | 13650 | 2011 | 15064 | 1636 | 17289 | 968 | 21412 | 360 | 19393 |
| 18-#14 | 5.27 | MA | 9209 | 3193 | 14448 | 2559 | 17011 | 2121 | 18774 | 1728 | 21292 | 1062 | 26956 | 289 | 25441 |
| 7L-4S | | MI | 7287 | 3193 | 12214 | 2435 | 14281 | 1999 | 15847 | 1612 | 18376 | 950 | 22851 | 454 | 19914 |
| 20-#10 | 3.31 | MA | 8555 | 2762 | 12955 | 2263 | 15291 | 1882 | 16711 | 1570 | 18654 | 1056 | 23196 | 609 | 18040 |
| 6E | | MI | 6257 | 2762 | 9739 | 2208 | 11262 | 1838 | 12212 | 1521 | 13483 | 1011 | 16634 | 571 | 12948 |
| 20-#10 | 3.31 | MA | 8397 | 2762 | 12567 | 2271 | 14749 | 1897 | 16114 | 1580 | 17795 | 1063 | 22053 | 575 | 17677 |
| 7L-5S | | MI | 6391 | 2762 | 10010 | 2200 | 11622 | 1821 | 12658 | 1514 | 14086 | 998 | 17432 | 632 | 13163 |
| 20-#10 | 3.31 | MA | 8203 | 2762 | 12195 | 2280 | 14246 | 1904 | 15487 | 1596 | 16975 | 1080 | 20953 | 526 | 17154 |
| 8L-4S | | MI | 6534 | 2762 | 10313 | 2182 | 11987 | 1813 | 13112 | 1499 | 14717 | 986 | 18306 | 684 | 13414 |
| 20-#10 | 3.31 | MA | 8009 | 2762 | 11777 | 2298 | 13729 | 1921 | 14867 | 1602 | 16136 | 1087 | 19868 | 481 | 16580 |
| 9L-3S | | MI | 6625 | 2762 | 10609 | 2173 | 12404 | 1796 | 13624 | 1492 | 15418 | 982 | 19178 | 737 | 13454 |
| 20-#11 | 4.06 | MA | 8948 | 2927 | 13924 | 2365 | 16455 | 1957 | 18082 | 1618 | 20477 | 1048 | 25715 | 527 | 21575 |
| 6E | | MI | 6508 | 2927 | 10412 | 2304 | 12046 | 1907 | 13131 | 1562 | 14701 | 995 | 18122 | 461 | 15375 |
| 20-#11 | 4.06 | MA | 8764 | 2927 | 13453 | 2374 | 15807 | 1975 | 17355 | 1629 | 19432 | 1056 | 24321 | 482 | 20901 |
| 7L-5S | | MI | 6665 | 2927 | 10733 | 2294 | 12481 | 1887 | 13672 | 1554 | 15431 | 981 | 19066 | 533 | 15616 |
| 20-#11 | 4.06 | MA | 8536 | 2927 | 13000 | 2384 | 15196 | 1983 | 16606 | 1649 | 18435 | 1075 | 22979 | 420 | 20283 |
| 8L-4S | | MI | 6830 | 2927 | 11100 | 2273 | 12923 | 1878 | 14220 | 1537 | 16194 | 968 | 20095 | 598 | 16056 |
| 20-#14 | 5.86 | MA | 9697 | 3321 | 15504 | 2640 | 18355 | 2179 | 20408 | 1764 | 23502 | 1055 | 30016 | 279 | 28579 |
| 7L-5S | | MI | 7373 | 3321 | 12426 | 2546 | 14586 | 2070 | 16201 | 1672 | 18827 | 961 | 23463 | 341 | 21553 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

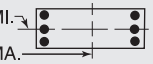
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 3.64 | MA | 8685 | 2834 | 13178 | 2316 | 15528 | 1930 | 17059 | 1601 | 19074 | 1059 | 23825 | 569 | 19485 |
| 7L-6S | | MI | 6449 | 2834 | 10169 | 2253 | 11810 | 1870 | 12877 | 1541 | 14383 | 1006 | 17879 | 565 | 14215 |
| 22-#10 | 3.64 | MA | 8493 | 2834 | 12806 | 2325 | 15025 | 1937 | 16432 | 1616 | 18254 | 1075 | 22725 | 520 | 18973 |
| 8L-5S | | MI | 6581 | 2834 | 10440 | 2246 | 12170 | 1854 | 13323 | 1535 | 14986 | 994 | 18677 | 626 | 14422 |
| 22-#10 | 3.64 | MA | 8303 | 2834 | 12388 | 2343 | 14508 | 1954 | 15812 | 1623 | 17415 | 1083 | 21639 | 476 | 18399 |
| 9L-4S | | MI | 6723 | 2834 | 10743 | 2228 | 12534 | 1846 | 13777 | 1519 | 15617 | 982 | 19551 | 678 | 14700 |
| 22-#11 | 4.47 | MA | 9107 | 3017 | 14193 | 2429 | 16750 | 2016 | 18500 | 1654 | 20981 | 1051 | 26466 | 475 | 23094 |
| 7L-6S | | MI | 6736 | 3017 | 10930 | 2359 | 12704 | 1947 | 13932 | 1587 | 15784 | 990 | 19589 | 450 | 16868 |
| 22-#11 | 4.47 | MA | 8881 | 3017 | 13740 | 2440 | 16139 | 2024 | 17751 | 1674 | 19984 | 1070 | 25124 | 412 | 22475 |
| 8L-5S | | MI | 6889 | 3017 | 11251 | 2350 | 13140 | 1928 | 14472 | 1580 | 16514 | 976 | 20533 | 523 | 17133 |
| 24-#10 | 3.97 | MA | 8779 | 2907 | 13417 | 2370 | 15803 | 1970 | 17377 | 1637 | 19534 | 1071 | 24496 | 515 | 20793 |
| 8L-6S | | MI | 6640 | 2907 | 10599 | 2298 | 12357 | 1903 | 13542 | 1562 | 15283 | 1002 | 19124 | 559 | 15485 |
| 24-#10 | 3.97 | MA | 8595 | 2907 | 13000 | 2388 | 15286 | 1987 | 16757 | 1643 | 18695 | 1079 | 23411 | 470 | 20217 |
| 9L-5S | | MI | 6769 | 2907 | 10870 | 2291 | 12717 | 1887 | 13989 | 1555 | 15886 | 990 | 19923 | 620 | 15684 |
| 24-#11 | 4.88 | MA | 9221 | 3106 | 14481 | 2495 | 17081 | 2064 | 18895 | 1699 | 21533 | 1065 | 27269 | 405 | 24670 |
| 8L-6S | | MI | 6961 | 3106 | 11447 | 2415 | 13363 | 1988 | 14732 | 1612 | 16867 | 985 | 21057 | 440 | 18365 |

## RECTANGULAR TIED COLUMNS 24" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.10 | MA | 8465 | 2421 | 12158 | 2020 | 14049 | 1702 | 15006 | 1455 | 15853 | 1085 | 18766 | 945 | 7299 |
| 2E | | MI | 5865 | 2421 | 8743 | 1949 | 9854 | 1642 | 10386 | 1402 | 10807 | 1043 | 12483 | 891 | 5007 |
| 4-#18 | 1.96 | MA | 9218 | 2621 | 13950 | 2128 | 16238 | 1779 | 17619 | 1499 | 19352 | 1064 | 23583 | 920 | 12521 |
| 2E | | MI | 6307 | 2621 | 9895 | 2050 | 11237 | 1712 | 12024 | 1441 | 12994 | 1018 | 15147 | 823 | 8399 |
| 6-#11 | 1.15 | MA | 8529 | 2431 | 12218 | 2034 | 14173 | 1714 | 15180 | 1464 | 16108 | 1090 | 19134 | 948 | 7610 |
| 2L-3S | | MI | 5643 | 2431 | 8261 | 1978 | 9284 | 1666 | 9715 | 1432 | 9915 | 1063 | 11352 | 791 | 5241 |
| 6-#11 | 1.15 | MA | 8103 | 2431 | 11422 | 2049 | 13160 | 1727 | 13950 | 1476 | 14443 | 1109 | 16828 | 846 | 7627 |
| 3L-2S | | MI | 5909 | 2431 | 8779 | 1967 | 9943 | 1657 | 10515 | 1414 | 10998 | 1050 | 12819 | 903 | 5212 |
| 6-#14 | 1.65 | MA | 8995 | 2549 | 13294 | 2100 | 15496 | 1761 | 16763 | 1492 | 18231 | 1078 | 22059 | 934 | 10759 |
| 2L-3S | | MI | 5823 | 2549 | 8743 | 2044 | 9854 | 1712 | 10386 | 1463 | 10807 | 1054 | 12483 | 710 | 7303 |
| 6-#14 | 1.65 | MA | 8409 | 2549 | 12158 | 2120 | 14049 | 1779 | 15006 | 1508 | 15853 | 1105 | 18766 | 784 | 10747 |
| 3L-2S | | MI | 6189 | 2549 | 9478 | 2029 | 10790 | 1700 | 11522 | 1439 | 12346 | 1036 | 14534 | 872 | 7274 |
| 6-#18 | 2.94 | MA | 10094 | 2849 | 15930 | 2270 | 18759 | 1882 | 20681 | 1564 | 23496 | 1050 | 29321 | 901 | 18508 |
| 2L-3S | | MI | 6252 | 2849 | 9895 | 2216 | 11237 | 1833 | 12024 | 1544 | 12994 | 1031 | 15147 | 489 | 12192 |
| 6-#18 | 2.94 | MA | 9151 | 2849 | 13950 | 2304 | 16238 | 1912 | 17619 | 1590 | 19352 | 1095 | 23583 | 626 | 18302 |
| 3L-2S | | MI | 6840 | 2849 | 11162 | 2193 | 12849 | 1816 | 13983 | 1506 | 15644 | 1004 | 18568 | 777 | 12258 |
| 8-#10 | 1.25 | MA | 8656 | 2454 | 12381 | 2060 | 14448 | 1734 | 15546 | 1479 | 16631 | 1095 | 19877 | 952 | 8288 |
| 2L-4S | | MI | 5659 | 2454 | 8154 | 2017 | 9168 | 1706 | 9599 | 1455 | 9773 | 1075 | 11332 | 775 | 5697 |
| 8-#10 | 1.25 | MA | 8307 | 2454 | 11724 | 2073 | 13611 | 1746 | 14530 | 1490 | 15256 | 1112 | 17974 | 871 | 8297 |
| 3E | | MI | 5776 | 2454 | 8450 | 2008 | 9586 | 1689 | 10110 | 1448 | 10474 | 1071 | 12204 | 828 | 5681 |
| 8-#10 | 1.25 | MA | 8127 | 2454 | 11281 | 2085 | 12984 | 1766 | 13760 | 1509 | 14201 | 1120 | 16705 | 821 | 8276 |
| 4L-2S | | MI | 5997 | 2454 | 8880 | 1998 | 10133 | 1681 | 10776 | 1433 | 11374 | 1058 | 13449 | 919 | 5662 |
| 8-#11 | 1.53 | MA | 8903 | 2520 | 13014 | 2090 | 15187 | 1755 | 16411 | 1490 | 17774 | 1084 | 21440 | 941 | 10031 |
| 2L-4S | | MI | 5742 | 2520 | 8420 | 2045 | 9439 | 1726 | 9897 | 1464 | 10152 | 1062 | 11787 | 717 | 6833 |
| 8-#11 | 1.53 | MA | 8491 | 2520 | 12218 | 2105 | 14173 | 1768 | 15180 | 1502 | 16108 | 1104 | 19134 | 839 | 10033 |
| 3E | | MI | 5881 | 2520 | 8779 | 2034 | 9943 | 1706 | 10515 | 1457 | 10998 | 1058 | 12819 | 780 | 6826 |
| 8-#11 | 1.53 | MA | 8278 | 2520 | 11678 | 2119 | 13411 | 1791 | 14245 | 1524 | 14826 | 1113 | 17581 | 776 | 9981 |
| 4L-2S | | MI | 6140 | 2520 | 9296 | 2023 | 10602 | 1697 | 11315 | 1440 | 12081 | 1045 | 14286 | 892 | 6805 |
| 8-#14 | 2.21 | MA | 9512 | 2678 | 14430 | 2180 | 16943 | 1819 | 18520 | 1528 | 20610 | 1070 | 25353 | 924 | 14203 |
| 2L-4S | | MI | 5965 | 2678 | 8967 | 2139 | 10071 | 1797 | 10642 | 1508 | 11140 | 1050 | 13087 | 603 | 9457 |
| 8-#14 | 2.21 | MA | 8951 | 2678 | 13294 | 2200 | 15496 | 1837 | 16763 | 1544 | 18231 | 1098 | 22059 | 774 | 14160 |
| 3E | | MI | 6154 | 2678 | 9478 | 2124 | 10790 | 1771 | 11522 | 1499 | 12346 | 1046 | 14534 | 691 | 9526 |
| 8-#14 | 2.21 | MA | 8662 | 2678 | 12521 | 2221 | 14405 | 1871 | 15424 | 1576 | 16397 | 1110 | 19827 | 683 | 13953 |
| 4L-2S | | MI | 6507 | 2678 | 10213 | 2109 | 11726 | 1759 | 12659 | 1475 | 13884 | 1028 | 16586 | 853 | 9519 |
| 8-#18 | 3.92 | MA | 10946 | 3078 | 17910 | 2413 | 21280 | 1986 | 23743 | 1629 | 27640 | 1037 | 35059 | 883 | 24474 |
| 2L-4S | | MI | 6501 | 3078 | 10275 | 2381 | 11603 | 1981 | 12456 | 1620 | 13556 | 1017 | 16137 | 294 | 14548 |
| 8-#18 | 3.92 | MA | 10059 | 3078 | 15930 | 2447 | 18759 | 2016 | 20681 | 1655 | 23496 | 1082 | 29321 | 608 | 24213 |
| 3E | | MI | 6804 | 3078 | 11162 | 2358 | 12849 | 1937 | 13983 | 1609 | 15644 | 1017 | 18568 | 443 | 15960 |

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

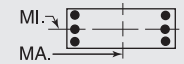
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.92 | MA | 9602 | 3078 | 14577 | 2481 | 16850 | 2073 | 18339 | 1707 | 20288 | 1100 | 25381 | 445 | 22061 |
| 4L-2S | | MI | 7364 | 3078 | 12428 | 2335 | 14461 | 1920 | 15941 | 1571 | 18294 | 991 | 21989 | 731 | 16086 |
| 10-#10 | 1.56 | MA | 8967 | 2527 | 13038 | 2106 | 15284 | 1767 | 16562 | 1500 | 18005 | 1091 | 21780 | 946 | 10282 |
| 2L-5S | | MI | 5716 | 2527 | 8281 | 2081 | 9351 | 1747 | 9810 | 1491 | 10043 | 1083 | 11704 | 717 | 6973 |
| 10-#10 | 1.56 | MA | 8627 | 2527 | 12381 | 2118 | 14448 | 1779 | 15546 | 1510 | 16631 | 1108 | 19877 | 865 | 10280 |
| 3L-4S | | MI | 5862 | 2527 | 8584 | 2063 | 9716 | 1739 | 10264 | 1476 | 10674 | 1070 | 12577 | 769 | 6999 |
| 10-#10 | 1.56 | MA | 8455 | 2527 | 11937 | 2130 | 13820 | 1799 | 14776 | 1529 | 15575 | 1116 | 18607 | 815 | 10247 |
| 4L-3S | | MI | 5975 | 2527 | 8880 | 2053 | 10133 | 1722 | 10776 | 1469 | 11374 | 1066 | 13449 | 822 | 6994 |
| 10-#10 | 1.56 | MA | 8200 | 2527 | 11485 | 2151 | 13276 | 1810 | 14098 | 1540 | 14630 | 1133 | 17316 | 774 | 10144 |
| 5L-2S | | MI | 6191 | 2527 | 9310 | 2043 | 10681 | 1714 | 11441 | 1454 | 12274 | 1054 | 14695 | 914 | 6980 |
| 10-#11 | 1.91 | MA | 9270 | 2609 | 13809 | 2146 | 16200 | 1795 | 17641 | 1515 | 19439 | 1079 | 23746 | 934 | 12445 |
| 2L-5S | | MI | 5814 | 2609 | 8571 | 2122 | 9656 | 1775 | 10148 | 1507 | 10472 | 1070 | 12225 | 642 | 8198 |
| 10-#11 | 1.91 | MA | 8870 | 2609 | 13014 | 2160 | 15187 | 1808 | 16411 | 1527 | 17774 | 1099 | 21440 | 831 | 12431 |
| 3L-4S | | MI | 5983 | 2609 | 8938 | 2100 | 10098 | 1766 | 10697 | 1489 | 11235 | 1056 | 13254 | 706 | 8389 |
| 10-#11 | 1.91 | MA | 8669 | 2609 | 12474 | 2175 | 14424 | 1832 | 15475 | 1549 | 16492 | 1108 | 19888 | 769 | 12362 |
| 4L-3S | | MI | 6115 | 2609 | 9296 | 2089 | 10602 | 1747 | 11315 | 1482 | 12081 | 1053 | 14286 | 769 | 8400 |
| 10-#11 | 1.91 | MA | 8368 | 2609 | 11924 | 2200 | 13762 | 1845 | 14650 | 1561 | 15342 | 1128 | 18313 | 716 | 12010 |
| 5L-2S | | MI | 6367 | 2609 | 9814 | 2078 | 11261 | 1738 | 12115 | 1465 | 13164 | 1040 | 15753 | 882 | 8387 |
| 10-#14 | 2.76 | MA | 10019 | 2806 | 15567 | 2260 | 18390 | 1877 | 20278 | 1564 | 22988 | 1063 | 28646 | 914 | 17634 |
| 2L-5S | | MI | 6068 | 2806 | 9179 | 2249 | 10377 | 1868 | 10995 | 1569 | 11591 | 1060 | 13699 | 490 | 10940 |
| 10-#14 | 2.76 | MA | 9480 | 2806 | 14430 | 2281 | 16943 | 1896 | 18520 | 1581 | 20610 | 1090 | 25353 | 764 | 17569 |
| 3L-4S | | MI | 6301 | 2806 | 9702 | 2219 | 11007 | 1856 | 11778 | 1545 | 12679 | 1042 | 15138 | 584 | 11605 |
| 10-#14 | 2.76 | MA | 9211 | 2806 | 13658 | 2301 | 15852 | 1929 | 17182 | 1612 | 18775 | 1103 | 23121 | 673 | 17343 |
| 4L-3S | | MI | 6479 | 2806 | 10213 | 2205 | 11726 | 1829 | 12659 | 1536 | 13884 | 1039 | 16586 | 672 | 11736 |
| 10-#14 | 2.76 | MA | 8789 | 2806 | 12870 | 2337 | 14903 | 1947 | 16000 | 1628 | 17130 | 1130 | 20861 | 594 | 16199 |
| 5L-2S | | MI | 6821 | 2806 | 10948 | 2190 | 12662 | 1817 | 13796 | 1512 | 15422 | 1021 | 18638 | 834 | 11752 |
| 10-#18 | 4.90 | MA | 10942 | 3306 | 17910 | 2590 | 21280 | 2120 | 23743 | 1720 | 27640 | 1069 | 35059 | 590 | 30131 |
| 3L-4S | | MI | 7066 | 3306 | 11541 | 2524 | 13215 | 2084 | 14414 | 1685 | 16206 | 1004 | 19558 | 248 | 18168 |
| 10-#18 | 4.90 | MA | 10532 | 3306 | 16557 | 2624 | 19371 | 2177 | 21401 | 1772 | 24432 | 1087 | 31119 | 426 | 27883 |
| 4L-3S | | MI | 7345 | 3306 | 12428 | 2501 | 14461 | 2041 | 15941 | 1673 | 18294 | 1004 | 21989 | 397 | 19726 |
| 10-#18 | 4.90 | MA | 9826 | 3306 | 15176 | 2684 | 17707 | 2207 | 19331 | 1798 | 21550 | 1132 | 27147 | 276 | 25804 |
| 5L-2S | | MI | 7882 | 3306 | 13694 | 2478 | 16074 | 2024 | 17899 | 1636 | 20945 | 978 | 25411 | 684 | 19896 |
| 12-#10 | 1.87 | MA | 9273 | 2599 | 13695 | 2151 | 16120 | 1800 | 17577 | 1521 | 19379 | 1087 | 23683 | 941 | 12271 |
| 2L-6S | | MI | 5769 | 2599 | 8440 | 2133 | 9539 | 1797 | 10029 | 1518 | 10340 | 1091 | 12151 | 650 | 7983 |
| 12-#10 | 1.87 | MA | 8941 | 2599 | 13038 | 2163 | 15284 | 1812 | 16562 | 1531 | 18005 | 1104 | 21780 | 859 | 12260 |
| 3L-5S | | MI | 5918 | 2599 | 8711 | 2126 | 9899 | 1780 | 10475 | 1511 | 10943 | 1078 | 12949 | 711 | 8246 |
| 12-#10 | 1.87 | MA | 8777 | 2599 | 12594 | 2176 | 14656 | 1831 | 15792 | 1550 | 16949 | 1112 | 20510 | 809 | 12216 |
| 4E | | MI | 6063 | 2599 | 9014 | 2108 | 10264 | 1772 | 10929 | 1496 | 11574 | 1066 | 13823 | 763 | 8294 |
| 12-#10 | 1.87 | MA | 8524 | 2599 | 12142 | 2196 | 14112 | 1843 | 15113 | 1560 | 16004 | 1129 | 19219 | 768 | 12104 |
| 5L-3S | | MI | 6171 | 2599 | 9310 | 2098 | 10681 | 1755 | 11441 | 1489 | 12274 | 1062 | 14695 | 816 | 8300 |
| 12-#10 | 1.87 | MA | 8295 | 2599 | 11703 | 2202 | 13599 | 1854 | 14448 | 1579 | 15103 | 1146 | 17958 | 699 | 11624 |
| 6L-2S | | MI | 6382 | 2599 | 9740 | 2089 | 11229 | 1747 | 12106 | 1474 | 13175 | 1050 | 15940 | 908 | 8292 |
| 12-#11 | 2.29 | MA | 9632 | 2698 | 14605 | 2201 | 17213 | 1836 | 18872 | 1540 | 21105 | 1074 | 26052 | 927 | 14851 |
| 2L-6S | | MI | 5876 | 2698 | 8768 | 2187 | 9879 | 1835 | 10408 | 1539 | 10825 | 1078 | 12748 | 558 | 9407 |
| 12-#11 | 2.29 | MA | 9244 | 2698 | 13809 | 2216 | 16200 | 1849 | 17641 | 1552 | 19439 | 1094 | 23746 | 824 | 14825 |
| 3L-5S | | MI | 6052 | 2698 | 9089 | 2177 | 10315 | 1816 | 10948 | 1532 | 11555 | 1065 | 13692 | 631 | 9687 |
| 12-#11 | 2.29 | MA | 9053 | 2698 | 13270 | 2231 | 15437 | 1872 | 16706 | 1574 | 18157 | 1103 | 22194 | 762 | 14743 |
| 4E | | MI | 6219 | 2698 | 9455 | 2156 | 10756 | 1807 | 11497 | 1515 | 12318 | 1051 | 14721 | 696 | 9940 |
| 12-#11 | 2.29 | MA | 8754 | 2698 | 12720 | 2255 | 14775 | 1886 | 15881 | 1586 | 17008 | 1123 | 20619 | 709 | 14340 |
| 5L-3S | | MI | 6346 | 2698 | 9814 | 2145 | 11261 | 1787 | 12115 | 1508 | 13164 | 1048 | 15753 | 759 | 9965 |
| 12-#11 | 2.29 | MA | 8481 | 2698 | 12193 | 2263 | 14152 | 1899 | 15071 | 1609 | 15912 | 1142 | 19080 | 623 | 13786 |
| 6L-2S | | MI | 6592 | 2698 | 10331 | 2134 | 11920 | 1778 | 12915 | 1490 | 14247 | 1034 | 17221 | 871 | 9962 |
| 12-#14 | 3.31 | MA | 9998 | 2935 | 15567 | 2361 | 18390 | 1954 | 20278 | 1617 | 22988 | 1083 | 28646 | 753 | 20977 |
| 3L-5S | | MI | 6400 | 2935 | 9914 | 2330 | 11313 | 1926 | 12132 | 1605 | 13129 | 1053 | 15750 | 471 | 13069 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

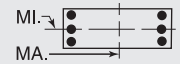


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 3.31 | MA | 9747 | 2935 | 14794 | 2381 | 17299 | 1987 | 18939 | 1648 | 21154 | 1095 | 26414 | 663 | 20736 |
| 4E | | MI | 6631 | 2935 | 10437 | 2300 | 11943 | 1914 | 12915 | 1581 | 14217 | 1035 | 17190 | 565 | 13695 |
| 12-#14 | 3.31 | MA | 9330 | 2935 | 14007 | 2417 | 16349 | 2006 | 17758 | 1665 | 19508 | 1122 | 24155 | 584 | 19555 |
| 5L-3S | | MI | 6800 | 2935 | 10948 | 2285 | 12662 | 1887 | 13796 | 1572 | 15422 | 1032 | 18638 | 653 | 13940 |
| 12-#14 | 3.31 | MA | 8956 | 2935 | 13259 | 2428 | 15457 | 2024 | 16597 | 1696 | 17938 | 1150 | 21943 | 459 | 18626 |
| 6L-2S | | MI | 7130 | 2935 | 11683 | 2270 | 13597 | 1875 | 14932 | 1548 | 16960 | 1014 | 20689 | 815 | 13975 |
| 12-#18 | 5.88 | MA | 11437 | 3534 | 18537 | 2767 | 21892 | 2280 | 24463 | 1837 | 28576 | 1074 | 36856 | 408 | 33722 |
| 4E | | MI | 7620 | 3534 | 12807 | 2667 | 14827 | 2188 | 16372 | 1750 | 18857 | 990 | 22979 | 201 | 21814 |
| 12-#18 | 5.88 | MA | 10737 | 3534 | 17156 | 2827 | 20228 | 2310 | 22393 | 1863 | 25694 | 1118 | 32885 | 258 | 31631 |
| 5L-3S | | MI | 7915 | 3534 | 13694 | 2644 | 16074 | 2144 | 17899 | 1738 | 20945 | 991 | 25411 | 350 | 23493 |
| 14-#10 | 2.18 | MA | 9251 | 2672 | 13695 | 2209 | 16120 | 1845 | 17577 | 1551 | 19379 | 1099 | 23683 | 853 | 14238 |
| 3L-6S | | MI | 5971 | 2672 | 8870 | 2179 | 10087 | 1830 | 10694 | 1539 | 11240 | 1087 | 13396 | 644 | 9238 |
| 14-#10 | 2.18 | MA | 9095 | 2672 | 13251 | 2221 | 15493 | 1864 | 16807 | 1570 | 18324 | 1108 | 22413 | 803 | 14185 |
| 4L-5S | | MI | 6116 | 2672 | 9141 | 2171 | 10446 | 1813 | 11140 | 1532 | 11843 | 1074 | 14194 | 705 | 9488 |
| 14-#10 | 2.18 | MA | 8843 | 2672 | 12798 | 2242 | 14948 | 1876 | 16129 | 1581 | 17379 | 1125 | 21122 | 762 | 14052 |
| 5L-4S | | MI | 6261 | 2672 | 9444 | 2153 | 10811 | 1805 | 11594 | 1517 | 12474 | 1062 | 15068 | 757 | 9586 |
| 14-#10 | 2.18 | MA | 8620 | 2672 | 12359 | 2247 | 14435 | 1887 | 15463 | 1599 | 16478 | 1141 | 19861 | 693 | 13567 |
| 6L-3S | | MI | 6365 | 2672 | 9740 | 2144 | 11229 | 1788 | 12106 | 1510 | 13175 | 1058 | 15940 | 810 | 9602 |
| 14-#10 | 2.18 | MA | 8430 | 2672 | 11943 | 2255 | 13849 | 1902 | 14824 | 1610 | 15558 | 1150 | 18644 | 660 | 13226 |
| 7L-2S | | MI | 6572 | 2672 | 10170 | 2134 | 11776 | 1780 | 12771 | 1495 | 14075 | 1046 | 17185 | 902 | 9599 |
| 14-#11 | 2.68 | MA | 9611 | 2788 | 14605 | 2272 | 17213 | 1889 | 18872 | 1577 | 21105 | 1089 | 26052 | 817 | 17218 |
| 3L-6S | | MI | 6115 | 2788 | 9285 | 2243 | 10538 | 1876 | 11208 | 1565 | 11908 | 1073 | 14216 | 548 | 10918 |
| 14-#11 | 2.68 | MA | 9430 | 2788 | 14065 | 2286 | 16451 | 1913 | 17936 | 1600 | 19823 | 1098 | 24500 | 755 | 17124 |
| 4L-5S | | MI | 6286 | 2788 | 9606 | 2233 | 10974 | 1856 | 11748 | 1557 | 12638 | 1060 | 15159 | 620 | 11184 |
| 14-#11 | 2.68 | MA | 9133 | 2788 | 13516 | 2311 | 15788 | 1926 | 17112 | 1611 | 18673 | 1118 | 22925 | 702 | 16677 |
| 5L-4S | | MI | 6453 | 2788 | 9973 | 2212 | 11415 | 1847 | 12297 | 1540 | 13401 | 1046 | 16188 | 685 | 11488 |
| 14-#11 | 2.68 | MA | 8869 | 2788 | 12989 | 2318 | 15165 | 1939 | 16301 | 1634 | 17577 | 1137 | 21386 | 616 | 16144 |
| 6L-3S | | MI | 6574 | 2788 | 10331 | 2201 | 11920 | 1828 | 12915 | 1533 | 14247 | 1043 | 17221 | 748 | 11525 |
| 14-#11 | 2.68 | MA | 8645 | 2788 | 12483 | 2328 | 14462 | 1958 | 15523 | 1646 | 16458 | 1147 | 19897 | 573 | 15519 |
| 7L-2S | | MI | 6815 | 2788 | 10848 | 2190 | 12578 | 1819 | 13716 | 1515 | 15330 | 1029 | 18688 | 860 | 11532 |
| 14-#14 | 3.86 | MA | 10273 | 3063 | 15930 | 2462 | 18746 | 2046 | 20696 | 1685 | 23532 | 1088 | 29707 | 652 | 24107 |
| 4L-5S | | MI | 6727 | 3063 | 10649 | 2410 | 12248 | 1984 | 13269 | 1641 | 14667 | 1045 | 17802 | 452 | 15207 |
| 14-#14 | 3.86 | MA | 9859 | 3063 | 15143 | 2497 | 17796 | 2064 | 19515 | 1701 | 21887 | 1115 | 27448 | 574 | 22918 |
| 5L-4S | | MI | 6956 | 3063 | 11172 | 2380 | 12879 | 1972 | 14051 | 1617 | 15755 | 1027 | 19241 | 546 | 15799 |
| 14-#14 | 3.86 | MA | 9500 | 3063 | 14396 | 2508 | 16904 | 2083 | 18355 | 1733 | 20317 | 1142 | 25236 | 448 | 21985 |
| 6L-3S | | MI | 7116 | 3063 | 11683 | 2365 | 13597 | 1946 | 14932 | 1608 | 16960 | 1024 | 20689 | 635 | 16142 |
| 14-#14 | 3.86 | MA | 9195 | 3063 | 13673 | 2521 | 15908 | 2109 | 17240 | 1749 | 18714 | 1155 | 23097 | 384 | 20731 |
| 7L-2S | | MI | 7437 | 3063 | 12418 | 2350 | 14533 | 1934 | 16069 | 1585 | 18498 | 1006 | 22741 | 796 | 16191 |
| 14-#18 | 6.86 | MA | 11626 | 3763 | 19136 | 2970 | 22749 | 2414 | 25455 | 1928 | 29838 | 1105 | 38623 | 239 | 37458 |
| 5L-4S | | MI | 8227 | 3763 | 14074 | 2810 | 16440 | 2292 | 18331 | 1814 | 21507 | 977 | 26400 | 155 | 25479 |
| 16-#10 | 2.49 | MA | 9407 | 2744 | 13907 | 2266 | 16329 | 1897 | 17823 | 1591 | 19698 | 1104 | 24316 | 797 | 16154 |
| 4L-6S | | MI | 6171 | 2744 | 9300 | 2224 | 10634 | 1863 | 11359 | 1559 | 12140 | 1082 | 14641 | 638 | 10497 |
| 16-#10 | 2.49 | MA | 9157 | 2744 | 13455 | 2287 | 15784 | 1909 | 17144 | 1601 | 18753 | 1120 | 23025 | 756 | 15982 |
| 5E | | MI | 6312 | 2744 | 9571 | 2217 | 10994 | 1846 | 11805 | 1552 | 12743 | 1070 | 15440 | 699 | 10735 |
| 16-#10 | 2.49 | MA | 8940 | 2744 | 13016 | 2293 | 15271 | 1920 | 16479 | 1620 | 17852 | 1137 | 21764 | 688 | 15512 |
| 6L-4S | | MI | 6456 | 2744 | 9874 | 2199 | 11359 | 1838 | 12259 | 1537 | 13374 | 1058 | 16313 | 751 | 10877 |
| 16-#10 | 2.49 | MA | 8756 | 2744 | 12600 | 2301 | 14686 | 1935 | 15840 | 1630 | 16932 | 1146 | 20547 | 654 | 15183 |
| 7L-3S | | MI | 6557 | 2744 | 10170 | 2189 | 11776 | 1821 | 12771 | 1530 | 14075 | 1054 | 17185 | 804 | 10899 |
| 16-#10 | 2.49 | MA | 8541 | 2744 | 12201 | 2310 | 14147 | 1942 | 15159 | 1645 | 16054 | 1163 | 19372 | 607 | 14593 |
| 8L-2S | | MI | 6759 | 2744 | 10600 | 2179 | 12324 | 1813 | 13436 | 1515 | 14975 | 1041 | 18431 | 896 | 10904 |
| 16-#11 | 3.06 | MA | 9802 | 2877 | 14861 | 2342 | 17464 | 1953 | 19167 | 1625 | 21488 | 1093 | 26806 | 748 | 19506 |
| 4L-6S | | MI | 6351 | 2877 | 9803 | 2298 | 11197 | 1916 | 12008 | 1590 | 12991 | 1068 | 15683 | 537 | 12434 |
| 16-#11 | 3.06 | MA | 9506 | 2877 | 14312 | 2367 | 16801 | 1967 | 18342 | 1637 | 20339 | 1112 | 25231 | 695 | 19021 |
| 5E | | MI | 6518 | 2877 | 10123 | 2289 | 11632 | 1897 | 12548 | 1583 | 13721 | 1055 | 16626 | 610 | 12687 |
| 16-#11 | 3.06 | MA | 9250 | 2877 | 13784 | 2374 | 16178 | 1980 | 17532 | 1659 | 19242 | 1132 | 23693 | 609 | 18506 |
| 6L-4S | | MI | 6684 | 2877 | 10490 | 2267 | 12074 | 1888 | 13097 | 1565 | 14484 | 1041 | 17656 | 674 | 13035 |
| 16-#11 | 3.06 | MA | 9035 | 2877 | 13279 | 2383 | 15475 | 1998 | 16754 | 1671 | 18123 | 1141 | 22203 | 566 | 17872 |
| 7L-3S | | MI | 6800 | 2877 | 10848 | 2256 | 12578 | 1868 | 13716 | 1558 | 15330 | 1038 | 18688 | 737 | 13081 |

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

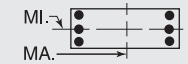
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 3.06 | MA | 8780 | 2877 | 12794 | 2394 | 14820 | 2007 | 15939 | 1690 | 17055 | 1161 | 20769 | 506 | 17189 |
| 8L-2S | | MI | 7035 | 2877 | 11366 | 2245 | 13237 | 1859 | 14516 | 1541 | 16413 | 1024 | 20155 | 850 | 13097 |
| 16-#14 | 4.41 | MA | 10378 | 3192 | 16279 | 2577 | 19243 | 2123 | 21273 | 1738 | 24265 | 1108 | 30741 | 563 | 26287 |
| 5E | | MI | 7048 | 3192 | 11384 | 2490 | 13184 | 2043 | 14405 | 1678 | 16205 | 1038 | 19853 | 433 | 17353 |
| 16-#14 | 4.41 | MA | 10034 | 3192 | 15532 | 2588 | 18351 | 2141 | 20112 | 1769 | 22695 | 1135 | 28529 | 438 | 25349 |
| 6L-4S | | MI | 7277 | 3192 | 11907 | 2460 | 13814 | 2031 | 15188 | 1654 | 17293 | 1020 | 21293 | 527 | 17914 |
| 16-#14 | 4.41 | MA | 9743 | 3192 | 14809 | 2601 | 17355 | 2168 | 18997 | 1785 | 21092 | 1147 | 26391 | 373 | 24110 |
| 7L-3S | | MI | 7428 | 3192 | 12418 | 2445 | 14533 | 2004 | 16069 | 1645 | 18498 | 1017 | 22741 | 616 | 18341 |
| 18-#10 | 2.80 | MA | 9467 | 2817 | 14112 | 2332 | 16620 | 1942 | 18160 | 1622 | 20127 | 1116 | 24928 | 751 | 17916 |
| 5L-6S | | MI | 6368 | 2817 | 9730 | 2269 | 11182 | 1896 | 12024 | 1580 | 13040 | 1078 | 15887 | 632 | 11759 |
| 18-#10 | 2.80 | MA | 9255 | 2817 | 13673 | 2338 | 16107 | 1953 | 17494 | 1641 | 19226 | 1133 | 23667 | 682 | 17461 |
| 6L-5S | | MI | 6507 | 2817 | 10001 | 2262 | 11542 | 1879 | 12471 | 1573 | 13643 | 1066 | 16685 | 693 | 11987 |
| 18-#10 | 2.80 | MA | 9078 | 2817 | 13257 | 2346 | 15522 | 1967 | 16855 | 1651 | 18307 | 1141 | 22450 | 648 | 17141 |
| 7L-4S | | MI | 6650 | 2817 | 10304 | 2244 | 11906 | 1871 | 12924 | 1558 | 14274 | 1053 | 17558 | 745 | 12166 |
| 18-#10 | 2.80 | MA | 8864 | 2817 | 12858 | 2355 | 14983 | 1975 | 16174 | 1666 | 17428 | 1158 | 21275 | 601 | 16546 |
| 8L-3S | | MI | 6746 | 2817 | 10600 | 2234 | 12324 | 1854 | 13436 | 1551 | 14975 | 1050 | 18431 | 798 | 12194 |
| 18-#10 | 2.80 | MA | 8648 | 2817 | 12410 | 2374 | 14429 | 1992 | 15510 | 1673 | 16531 | 1167 | 20120 | 557 | 15976 |
| 9L-2S | | MI | 6945 | 2817 | 11030 | 2224 | 12871 | 1846 | 14101 | 1536 | 15875 | 1037 | 19676 | 890 | 12205 |
| 18-#11 | 3.44 | MA | 9874 | 2966 | 15107 | 2422 | 17814 | 2007 | 19573 | 1662 | 22004 | 1107 | 27537 | 688 | 21369 |
| 5L-6S | | MI | 6584 | 2966 | 10320 | 2354 | 11855 | 1956 | 12808 | 1615 | 14074 | 1063 | 17150 | 526 | 13953 |
| 18-#11 | 3.44 | MA | 9626 | 2966 | 14580 | 2430 | 17192 | 2020 | 18763 | 1684 | 20908 | 1127 | 25999 | 601 | 20871 |
| 6L-5S | | MI | 6747 | 2966 | 10641 | 2344 | 12291 | 1937 | 13349 | 1608 | 14804 | 1049 | 18094 | 599 | 14195 |
| 18-#11 | 3.44 | MA | 9418 | 2966 | 14075 | 2439 | 16488 | 2039 | 17984 | 1696 | 19789 | 1136 | 24509 | 558 | 20229 |
| 7L-4S | | MI | 6912 | 2966 | 11008 | 2323 | 12733 | 1928 | 13897 | 1590 | 15567 | 1036 | 19123 | 664 | 14580 |
| 18-#11 | 3.44 | MA | 9166 | 2966 | 13590 | 2450 | 15833 | 2047 | 17170 | 1715 | 18720 | 1156 | 23075 | 499 | 19561 |
| 8L-3S | | MI | 7024 | 2966 | 11366 | 2312 | 13237 | 1909 | 14516 | 1583 | 16413 | 1032 | 20155 | 727 | 14635 |
| 18-#14 | 4.96 | MA | 10558 | 3320 | 16669 | 2669 | 19798 | 2199 | 21869 | 1805 | 25073 | 1127 | 31823 | 428 | 28718 |
| 6L-5S | | MI | 7366 | 3320 | 12119 | 2570 | 14120 | 2101 | 15542 | 1714 | 17743 | 1030 | 21905 | 414 | 19504 |
| 18-#14 | 4.96 | MA | 10281 | 3320 | 15946 | 2681 | 18802 | 2226 | 20754 | 1822 | 23471 | 1140 | 29684 | 363 | 27488 |
| 7L-4S | | MI | 7594 | 3320 | 12642 | 2541 | 14750 | 2089 | 16324 | 1690 | 18831 | 1012 | 23344 | 508 | 20039 |
| 20-#10 | 3.11 | MA | 9566 | 2889 | 14329 | 2383 | 16943 | 1986 | 18510 | 1661 | 20601 | 1129 | 25570 | 676 | 19412 |
| 6E | | MI | 6563 | 2889 | 10160 | 2315 | 11729 | 1929 | 12689 | 1600 | 13940 | 1074 | 17132 | 626 | 13023 |
| 20-#10 | 3.11 | MA | 9395 | 2889 | 13913 | 2391 | 16358 | 2000 | 17871 | 1672 | 19681 | 1137 | 24353 | 642 | 19092 |
| 7L-5S | | MI | 6699 | 2889 | 10431 | 2307 | 12089 | 1912 | 13136 | 1594 | 14543 | 1062 | 17930 | 687 | 13242 |
| 20-#10 | 3.11 | MA | 9183 | 2889 | 13515 | 2401 | 15819 | 2008 | 17190 | 1687 | 18803 | 1154 | 23178 | 596 | 18502 |
| 8L-4S | | MI | 6841 | 2889 | 10734 | 2289 | 12454 | 1904 | 13589 | 1578 | 15174 | 1049 | 18804 | 739 | 13454 |
| 20-#10 | 3.11 | MA | 8972 | 2889 | 13067 | 2419 | 15265 | 2025 | 16526 | 1694 | 17905 | 1162 | 22023 | 551 | 17929 |
| 9L-3S | | MI | 6935 | 2889 | 11030 | 2279 | 12871 | 1887 | 14101 | 1572 | 15875 | 1045 | 19676 | 793 | 13488 |
| 20-#10 | 3.11 | MA | 8772 | 2889 | 12653 | 2426 | 14744 | 2034 | 15863 | 1710 | 17030 | 1179 | 20852 | 510 | 17265 |
| 10L-2S | | MI | 7130 | 2889 | 11461 | 2270 | 13419 | 1879 | 14766 | 1556 | 16775 | 1033 | 20921 | 884 | 13503 |
| 20-#11 | 3.82 | MA | 9996 | 3055 | 15376 | 2485 | 18205 | 2061 | 19993 | 1710 | 22573 | 1122 | 28305 | 594 | 23239 |
| 6E | | MI | 6815 | 3055 | 10837 | 2410 | 12514 | 1997 | 13609 | 1640 | 15157 | 1058 | 18617 | 516 | 15474 |
| 20-#11 | 3.82 | MA | 9796 | 3055 | 14871 | 2495 | 17501 | 2079 | 19215 | 1721 | 21454 | 1131 | 26815 | 551 | 22588 |
| 7L-5S | | MI | 6973 | 3055 | 11158 | 2400 | 12950 | 1978 | 14149 | 1633 | 15887 | 1044 | 19561 | 588 | 15707 |
| 20-#11 | 3.82 | MA | 9545 | 3055 | 14386 | 2505 | 16846 | 2088 | 18401 | 1741 | 20386 | 1151 | 25382 | 491 | 21936 |
| 8L-4S | | MI | 7138 | 3055 | 11525 | 2379 | 13392 | 1968 | 14698 | 1616 | 16650 | 1031 | 20590 | 653 | 16126 |
| 20-#14 | 5.51 | MA | 10810 | 3449 | 17082 | 2762 | 20248 | 2284 | 22512 | 1858 | 25849 | 1132 | 32977 | 353 | 30866 |
| 7L-5S | | MI | 7681 | 3449 | 12854 | 2651 | 15056 | 2160 | 16678 | 1751 | 19282 | 1023 | 23956 | 395 | 21661 |
| 22-#10 | 3.42 | MA | 9708 | 2962 | 14570 | 2437 | 17194 | 2033 | 18886 | 1692 | 21055 | 1133 | 26256 | 636 | 21037 |
| 7L-6S | | MI | 6756 | 2962 | 10590 | 2360 | 12277 | 1962 | 13355 | 1621 | 14840 | 1070 | 18377 | 620 | 14290 |
| 22-#10 | 3.42 | MA | 9497 | 2962 | 14171 | 2446 | 16655 | 2041 | 18205 | 1707 | 20177 | 1150 | 25081 | 590 | 20458 |
| 8L-5S | | MI | 6889 | 2962 | 10861 | 2353 | 12637 | 1945 | 13801 | 1614 | 15443 | 1057 | 19175 | 681 | 14501 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

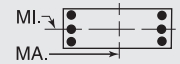
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 3.42 | MA | 9292 | 2962 | 13724 | 2464 | 16101 | 2058 | 17541 | 1714 | 19279 | 1158 | 23926 | 546 | 19882 |
| 9L-4S | | MI | 7031 | 2962 | 11164 | 2335 | 13002 | 1937 | 14254 | 1599 | 16074 | 1045 | 20049 | 733 | 14741 |
| 22-#10 | 3.42 | MA | 9106 | 2962 | 13310 | 2471 | 15580 | 2067 | 16879 | 1731 | 18404 | 1175 | 22755 | 505 | 19220 |
| 10L-3S | | MI | 7122 | 2962 | 11461 | 2325 | 13419 | 1920 | 14766 | 1592 | 16775 | 1041 | 20921 | 787 | 14781 |
| 22-#11 | 4.21 | MA | 10169 | 3144 | 15666 | 2550 | 18515 | 2119 | 20446 | 1747 | 23120 | 1126 | 29121 | 544 | 24950 |
| 7L-6S | | MI | 7043 | 3144 | 11355 | 2465 | 13173 | 2037 | 14409 | 1666 | 16240 | 1053 | 20085 | 505 | 16999 |
| 22-#11 | 4.21 | MA | 9920 | 3144 | 15181 | 2561 | 17859 | 2128 | 19631 | 1766 | 22051 | 1146 | 27688 | 484 | 24313 |
| 8L-5S | | MI | 7198 | 3144 | 11676 | 2456 | 13609 | 2018 | 14949 | 1658 | 16970 | 1039 | 21028 | 578 | 17222 |
| 24-#10 | 3.74 | MA | 9807 | 3034 | 14828 | 2491 | 17491 | 2074 | 19221 | 1728 | 21552 | 1146 | 26984 | 584 | 22417 |
| 8L-6S | | MI | 6948 | 3034 | 11020 | 2405 | 12825 | 1995 | 14020 | 1641 | 15741 | 1065 | 19622 | 614 | 15559 |
| 24-#10 | 3.74 | MA | 9607 | 3034 | 14380 | 2509 | 16938 | 2091 | 18557 | 1735 | 20654 | 1154 | 25829 | 540 | 21835 |
| 9L-5S | | MI | 7078 | 3034 | 11291 | 2398 | 13184 | 1978 | 14466 | 1635 | 16344 | 1053 | 20421 | 675 | 15762 |
| 24-#10 | 3.74 | MA | 9427 | 3034 | 13967 | 2516 | 16416 | 2100 | 17894 | 1751 | 19779 | 1170 | 24658 | 499 | 21175 |
| 10L-4S | | MI | 7220 | 3034 | 11594 | 2380 | 13549 | 1970 | 14919 | 1619 | 16974 | 1041 | 21294 | 727 | 16028 |
| 24-#11 | 4.59 | MA | 10290 | 3233 | 15977 | 2617 | 18873 | 2169 | 20862 | 1791 | 23717 | 1140 | 29994 | 477 | 26688 |
| 8L-6S | | MI | 7269 | 3233 | 11872 | 2521 | 13832 | 2078 | 15209 | 1691 | 17323 | 1047 | 21552 | 495 | 18506 |

## RECTANGULAR TIED COLUMNS 24" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.04 | MA | 9447 | 2548 | 13447 | 2139 | 15577 | 1804 | 16642 | 1544 | 17553 | 1156 | 20752 | 1007 | 7785 |
| 2E | | MI | 6171 | 2548 | 9171 | 2054 | 10324 | 1732 | 10863 | 1481 | 11262 | 1106 | 12976 | 945 | 5032 |
| 4-#18 | 1.85 | MA | 10266 | 2748 | 15373 | 2247 | 17929 | 1880 | 19450 | 1588 | 21312 | 1134 | 25927 | 982 | 13385 |
| 2E | | MI | 6615 | 2748 | 10329 | 2154 | 11708 | 1801 | 12501 | 1519 | 13446 | 1079 | 15635 | 877 | 8436 |
| 6-#11 | 1.08 | MA | 9515 | 2559 | 13510 | 2154 | 15708 | 1816 | 16826 | 1553 | 17822 | 1160 | 21140 | 1010 | 8116 |
| 2L-3S | | MI | 5948 | 2559 | 8686 | 2084 | 9753 | 1756 | 10192 | 1511 | 10371 | 1126 | 11847 | 846 | 5265 |
| 6-#11 | 1.08 | MA | 9055 | 2559 | 12658 | 2169 | 14624 | 1830 | 15509 | 1566 | 16040 | 1181 | 18673 | 909 | 8133 |
| 3L-2S | | MI | 6216 | 2559 | 9204 | 2073 | 10412 | 1747 | 10992 | 1493 | 11454 | 1113 | 13314 | 958 | 5236 |
| 6-#14 | 1.56 | MA | 10021 | 2677 | 14664 | 2219 | 17127 | 1862 | 18524 | 1580 | 20099 | 1148 | 24278 | 996 | 11488 |
| 2L-3S | | MI | 6128 | 2677 | 9171 | 2149 | 10324 | 1802 | 10863 | 1541 | 11262 | 1116 | 12976 | 765 | 7336 |
| 6-#14 | 1.56 | MA | 9387 | 2677 | 13447 | 2240 | 15577 | 1882 | 16642 | 1598 | 17553 | 1177 | 20752 | 849 | 11476 |
| 3L-2S | | MI | 6496 | 2677 | 9906 | 2134 | 11260 | 1790 | 12000 | 1517 | 12800 | 1098 | 15027 | 926 | 7304 |
| 6-#18 | 2.78 | MA | 11215 | 2976 | 17496 | 2390 | 20632 | 1984 | 22733 | 1653 | 25755 | 1121 | 32078 | 963 | 19804 |
| 2L-3S | | MI | 6557 | 2976 | 10329 | 2319 | 11708 | 1922 | 12501 | 1621 | 13446 | 1092 | 15635 | 543 | 12254 |
| 6-#18 | 2.78 | MA | 10192 | 2976 | 15373 | 2425 | 17929 | 2016 | 19450 | 1681 | 21312 | 1168 | 25927 | 693 | 19598 |
| 3L-2S | | MI | 7150 | 2976 | 11595 | 2296 | 13320 | 1905 | 14460 | 1583 | 16097 | 1066 | 19057 | 831 | 12301 |
| 8-#10 | 1.18 | MA | 9651 | 2581 | 13682 | 2180 | 15998 | 1836 | 17213 | 1568 | 18375 | 1166 | 21927 | 1014 | 8836 |
| 2L-4S | | MI | 5964 | 2581 | 8575 | 2124 | 9636 | 1797 | 10076 | 1535 | 10231 | 1138 | 11830 | 830 | 5723 |
| 8-#10 | 1.18 | MA | 9274 | 2581 | 12980 | 2192 | 15104 | 1848 | 16127 | 1579 | 16906 | 1183 | 19893 | 934 | 8845 |
| 3E | | MI | 6082 | 2581 | 8871 | 2114 | 10053 | 1781 | 10588 | 1528 | 10931 | 1134 | 12702 | 884 | 5704 |
| 8-#10 | 1.18 | MA | 9080 | 2581 | 12506 | 2205 | 14435 | 1868 | 15306 | 1598 | 15779 | 1192 | 18544 | 884 | 8825 |
| 4L-2S | | MI | 6304 | 2581 | 9301 | 2105 | 10601 | 1772 | 11253 | 1512 | 11832 | 1122 | 13948 | 975 | 5684 |
| 8-#11 | 1.44 | MA | 9919 | 2648 | 14361 | 2209 | 16792 | 1856 | 18143 | 1578 | 19604 | 1155 | 23608 | 1003 | 10705 |
| 2L-4S | | MI | 6048 | 2648 | 8845 | 2151 | 9907 | 1816 | 10374 | 1543 | 10608 | 1124 | 12282 | 772 | 6868 |
| 8-#11 | 1.44 | MA | 9473 | 2648 | 13510 | 2224 | 15708 | 1870 | 16826 | 1591 | 17822 | 1176 | 21140 | 902 | 10707 |
| 3E | | MI | 6187 | 2648 | 9204 | 2140 | 10412 | 1797 | 10992 | 1536 | 11454 | 1121 | 13314 | 835 | 6855 |
| 8-#11 | 1.44 | MA | 9244 | 2648 | 12934 | 2239 | 14894 | 1894 | 15827 | 1614 | 16453 | 1186 | 19490 | 841 | 10655 |
| 4L-2S | | MI | 6447 | 2648 | 9721 | 2129 | 11071 | 1788 | 11792 | 1518 | 12537 | 1107 | 14781 | 947 | 6831 |
| 8-#14 | 2.08 | MA | 10580 | 2805 | 15881 | 2299 | 18676 | 1921 | 20405 | 1617 | 22645 | 1141 | 27803 | 986 | 15175 |
| 2L-4S | | MI | 6270 | 2805 | 9395 | 2244 | 10541 | 1887 | 11119 | 1586 | 11595 | 1112 | 13579 | 657 | 9513 |
| 8-#14 | 2.08 | MA | 9972 | 2805 | 14664 | 2321 | 17127 | 1940 | 18524 | 1634 | 20099 | 1169 | 24278 | 838 | 15132 |
| 3E | | MI | 6460 | 2805 | 9906 | 2229 | 11260 | 1860 | 12000 | 1577 | 12800 | 1109 | 15027 | 746 | 9565 |
| 8-#14 | 2.08 | MA | 9660 | 2805 | 13839 | 2342 | 15961 | 1974 | 17094 | 1666 | 18139 | 1183 | 21905 | 749 | 14925 |
| 4L-2S | | MI | 6815 | 2805 | 10641 | 2215 | 12195 | 1848 | 13136 | 1554 | 14339 | 1091 | 17079 | 908 | 9552 |
| 8-#18 | 3.70 | MA | 12139 | 3205 | 19619 | 2532 | 23335 | 2088 | 26015 | 1717 | 30197 | 1108 | 38230 | 945 | 26202 |
| 2L-4S | | MI | 6804 | 3205 | 10708 | 2485 | 12074 | 2069 | 12933 | 1697 | 14009 | 1078 | 16625 | 348 | 14730 |
| 8-#18 | 3.70 | MA | 11175 | 3205 | 17496 | 2568 | 20632 | 2120 | 22733 | 1745 | 25755 | 1155 | 32078 | 675 | 25941 |
| 3E | | MI | 7110 | 3205 | 11595 | 2462 | 13320 | 2026 | 14460 | 1686 | 16097 | 1079 | 19057 | 497 | 16027 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

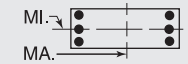
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.70 | MA | 10682 | 3205 | 16050 | 2603 | 18591 | 2178 | 20228 | 1800 | 22323 | 1175 | 27888 | 513 | 23834 |
| 4L-2S | | MI | 7674 | 3205 | 12861 | 2439 | 14933 | 2008 | 16418 | 1648 | 18747 | 1053 | 22478 | 785 | 16134 |
| 10-#10 | 1.47 | MA | 9986 | 2654 | 14384 | 2225 | 16891 | 1869 | 18299 | 1589 | 19844 | 1162 | 23962 | 1008 | 10968 |
| 2L-5S | | MI | 6022 | 2654 | 8702 | 2188 | 9818 | 1838 | 10287 | 1570 | 10500 | 1146 | 12202 | 772 | 7012 |
| 10-#10 | 1.47 | MA | 9618 | 2654 | 13682 | 2238 | 15998 | 1881 | 17213 | 1600 | 18375 | 1179 | 21927 | 928 | 10966 |
| 3L-4S | | MI | 6168 | 2654 | 9005 | 2169 | 10183 | 1830 | 10741 | 1555 | 11131 | 1134 | 13075 | 825 | 7029 |
| 10-#10 | 1.47 | MA | 9434 | 2654 | 13208 | 2250 | 15328 | 1901 | 16391 | 1619 | 17248 | 1188 | 20579 | 879 | 10932 |
| 4L-3S | | MI | 6281 | 2654 | 9301 | 2160 | 10601 | 1814 | 11253 | 1548 | 11832 | 1130 | 13948 | 878 | 7019 |
| 10-#10 | 1.47 | MA | 9156 | 2654 | 12722 | 2271 | 14748 | 1913 | 15668 | 1630 | 16241 | 1205 | 19204 | 839 | 10829 |
| 5L-2S | | MI | 6498 | 2654 | 9731 | 2150 | 11148 | 1805 | 11918 | 1533 | 12732 | 1117 | 15193 | 969 | 7004 |
| 10-#11 | 1.81 | MA | 10317 | 2737 | 15213 | 2265 | 17876 | 1897 | 19459 | 1604 | 21386 | 1150 | 26075 | 996 | 13287 |
| 2L-5S | | MI | 6119 | 2737 | 8996 | 2228 | 10125 | 1866 | 10625 | 1586 | 10928 | 1133 | 12720 | 696 | 8295 |
| 10-#11 | 1.81 | MA | 9884 | 2737 | 14361 | 2280 | 16792 | 1911 | 18143 | 1616 | 19604 | 1170 | 23608 | 895 | 13273 |
| 3L-4S | | MI | 6288 | 2737 | 9363 | 2206 | 10566 | 1856 | 11174 | 1568 | 11691 | 1119 | 13749 | 761 | 8428 |
| 10-#11 | 1.81 | MA | 9666 | 2737 | 13785 | 2295 | 15978 | 1935 | 17144 | 1639 | 18235 | 1180 | 21958 | 833 | 13204 |
| 4L-3S | | MI | 6421 | 2737 | 9721 | 2195 | 11071 | 1837 | 11792 | 1561 | 12537 | 1116 | 14781 | 824 | 8431 |
| 10-#11 | 1.81 | MA | 9338 | 2737 | 13199 | 2321 | 15272 | 1949 | 16264 | 1652 | 17008 | 1201 | 20281 | 783 | 12908 |
| 5L-2S | | MI | 6675 | 2737 | 10239 | 2184 | 11729 | 1828 | 12593 | 1544 | 13620 | 1102 | 16248 | 937 | 8416 |
| 10-#14 | 2.60 | MA | 11129 | 2934 | 17097 | 2380 | 20225 | 1979 | 22287 | 1653 | 25192 | 1134 | 31329 | 976 | 18849 |
| 2L-5S | | MI | 6373 | 2934 | 9607 | 2354 | 10847 | 1957 | 11473 | 1647 | 12045 | 1122 | 14191 | 544 | 11059 |
| 10-#14 | 2.60 | MA | 10544 | 2934 | 15881 | 2401 | 18676 | 1998 | 20405 | 1670 | 22645 | 1162 | 27803 | 828 | 18784 |
| 3L-4S | | MI | 6606 | 2934 | 10130 | 2325 | 11477 | 1946 | 12255 | 1623 | 13133 | 1104 | 15631 | 638 | 11701 |
| 10-#14 | 2.60 | MA | 10253 | 2934 | 15056 | 2422 | 17510 | 2032 | 18975 | 1703 | 20685 | 1176 | 25431 | 739 | 18558 |
| 4L-3S | | MI | 6786 | 2934 | 10641 | 2310 | 12195 | 1919 | 13136 | 1614 | 14339 | 1101 | 17079 | 727 | 11779 |
| 10-#14 | 2.60 | MA | 9794 | 2934 | 14216 | 2458 | 16498 | 2052 | 17714 | 1720 | 18929 | 1204 | 23025 | 663 | 17418 |
| 5L-2S | | MI | 7130 | 2934 | 11376 | 2295 | 13131 | 1907 | 14273 | 1590 | 15877 | 1083 | 19130 | 889 | 11788 |
| 10-#18 | 4.63 | MA | 12131 | 3433 | 19619 | 2711 | 23335 | 2223 | 26015 | 1810 | 30197 | 1142 | 38230 | 657 | 32291 |
| 3L-4S | | MI | 7370 | 3433 | 11974 | 2628 | 13686 | 2173 | 14891 | 1762 | 16659 | 1065 | 20046 | 302 | 18343 |
| 10-#18 | 4.63 | MA | 11687 | 3433 | 18172 | 2746 | 21294 | 2282 | 23511 | 1865 | 26766 | 1162 | 34040 | 495 | 30091 |
| 4L-3S | | MI | 7652 | 3433 | 12861 | 2605 | 14933 | 2129 | 16418 | 1751 | 18747 | 1065 | 22478 | 451 | 19796 |
| 10-#18 | 4.63 | MA | 10914 | 3433 | 16698 | 2808 | 19517 | 2313 | 21299 | 1893 | 23686 | 1209 | 29805 | 351 | 27961 |
| 5L-2S | | MI | 8198 | 3433 | 14128 | 2582 | 16545 | 2112 | 18376 | 1713 | 21397 | 1039 | 25899 | 738 | 19947 |
| 12-#10 | 1.76 | MA | 10317 | 2726 | 15086 | 2270 | 17785 | 1902 | 19384 | 1609 | 21313 | 1157 | 25996 | 1003 | 13094 |
| 2L-6S | | MI | 6074 | 2726 | 8861 | 2240 | 10006 | 1888 | 10506 | 1598 | 10797 | 1154 | 12649 | 705 | 8060 |
| 12-#10 | 1.76 | MA | 9958 | 2726 | 14384 | 2283 | 16891 | 1914 | 18299 | 1620 | 19844 | 1175 | 23962 | 922 | 13083 |
| 3L-5S | | MI | 6223 | 2726 | 9132 | 2233 | 10366 | 1871 | 10953 | 1591 | 11400 | 1142 | 13447 | 766 | 8299 |
| 12-#10 | 1.76 | MA | 9781 | 2726 | 13910 | 2296 | 16222 | 1934 | 17477 | 1639 | 18718 | 1184 | 22613 | 873 | 13039 |
| 4E | | MI | 6368 | 2726 | 9435 | 2215 | 10731 | 1863 | 11406 | 1576 | 12031 | 1129 | 14321 | 819 | 8327 |
| 12-#10 | 1.76 | MA | 9506 | 2726 | 13424 | 2316 | 15642 | 1946 | 16754 | 1650 | 17710 | 1201 | 21238 | 833 | 12927 |
| 5L-3S | | MI | 6478 | 2726 | 9731 | 2205 | 11148 | 1846 | 11918 | 1569 | 12732 | 1125 | 15193 | 872 | 8328 |
| 12-#10 | 1.76 | MA | 9259 | 2726 | 12955 | 2322 | 15090 | 1957 | 16045 | 1669 | 16749 | 1219 | 19896 | 766 | 12458 |
| 6L-2S | | MI | 6690 | 2726 | 10161 | 2195 | 11696 | 1838 | 12583 | 1554 | 13632 | 1113 | 16438 | 963 | 8317 |
| 12-#11 | 2.17 | MA | 10708 | 2826 | 16064 | 2321 | 18960 | 1937 | 20776 | 1629 | 23168 | 1145 | 28543 | 989 | 15862 |
| 2L-6S | | MI | 6181 | 2826 | 9193 | 2293 | 10348 | 1925 | 10885 | 1618 | 11281 | 1141 | 13244 | 613 | 9498 |
| 12-#11 | 2.17 | MA | 10287 | 2826 | 15213 | 2336 | 17876 | 1951 | 19459 | 1641 | 21386 | 1165 | 26075 | 888 | 15836 |
| 3L-5S | | MI | 6357 | 2826 | 9514 | 2283 | 10783 | 1906 | 11425 | 1611 | 12011 | 1128 | 14187 | 686 | 9782 |
| 12-#11 | 2.17 | MA | 10081 | 2826 | 14637 | 2351 | 17062 | 1975 | 18461 | 1664 | 20017 | 1175 | 24425 | 826 | 15754 |
| 4E | | MI | 6525 | 2826 | 9880 | 2262 | 11225 | 1897 | 11974 | 1593 | 12774 | 1114 | 15216 | 751 | 9982 |
| 12-#11 | 2.17 | MA | 9755 | 2826 | 14051 | 2376 | 16356 | 1989 | 17581 | 1677 | 18790 | 1196 | 22748 | 775 | 15405 |
| 5L-3S | | MI | 6653 | 2826 | 10239 | 2251 | 11729 | 1878 | 12593 | 1586 | 13620 | 1111 | 16248 | 814 | 10000 |
| 12-#11 | 2.17 | MA | 9461 | 2826 | 13482 | 2383 | 15692 | 2003 | 16716 | 1700 | 17621 | 1216 | 21112 | 690 | 14785 |
| 6L-2S | | MI | 6901 | 2826 | 10756 | 2240 | 12388 | 1868 | 13393 | 1569 | 14703 | 1097 | 17716 | 926 | 9992 |
| 12-#14 | 3.13 | MA | 11105 | 3062 | 17097 | 2481 | 20225 | 2057 | 22287 | 1707 | 25192 | 1155 | 31329 | 818 | 22435 |
| 3L-5S | | MI | 6706 | 3062 | 10342 | 2435 | 11782 | 2016 | 12609 | 1683 | 13584 | 1115 | 16243 | 525 | 13185 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

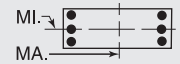



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 3.13 | MA | 10833 | 3062 | 16272 | 2502 | 19060 | 2091 | 20857 | 1739 | 23232 | 1168 | 28957 | 728 | 22194 |
| 4E | | MI | 6937 | 3062 | 10865 | 2405 | 12413 | 2004 | 13392 | 1659 | 14671 | 1097 | 17683 | 619 | 13827 |
| 12-#14 | 3.13 | MA | 10377 | 3062 | 15432 | 2538 | 18047 | 2110 | 19596 | 1756 | 21475 | 1197 | 26550 | 652 | 21016 |
| 5L-3S | | MI | 7107 | 3062 | 11376 | 2390 | 13131 | 1977 | 14273 | 1650 | 15877 | 1094 | 19130 | 708 | 13986 |
| 12-#14 | 3.13 | MA | 9974 | 3062 | 14625 | 2549 | 17095 | 2129 | 18358 | 1789 | 19799 | 1225 | 24200 | 528 | 20125 |
| 6L-2S | | MI | 7441 | 3062 | 12111 | 2375 | 14067 | 1965 | 15409 | 1626 | 17415 | 1076 | 21182 | 870 | 14014 |
| 12-#18 | 5.56 | MA | 12665 | 3662 | 20295 | 2889 | 23996 | 2385 | 26793 | 1929 | 31209 | 1149 | 40191 | 477 | 36364 |
| 4E | | MI | 7924 | 3662 | 13240 | 2771 | 15299 | 2277 | 16849 | 1827 | 19309 | 1052 | 23468 | 255 | 21982 |
| 12-#18 | 5.56 | MA | 11899 | 3662 | 18821 | 2951 | 22219 | 2417 | 24582 | 1957 | 28129 | 1196 | 35957 | 333 | 34209 |
| 5L-3S | | MI | 8225 | 3662 | 14128 | 2748 | 16545 | 2233 | 18376 | 1815 | 21397 | 1052 | 25899 | 404 | 23564 |
| 12-#18 | 5.56 | MA | 11249 | 3662 | 17433 | 2971 | 20548 | 2449 | 22409 | 2012 | 25190 | 1243 | 31805 | 109 | 31128 |
| 6L-2S | | MI | 8699 | 3662 | 15394 | 2725 | 18157 | 2216 | 20335 | 1778 | 24048 | 1026 | 29321 | 692 | 23751 |
| 14-#10 | 2.06 | MA | 10292 | 2799 | 15086 | 2328 | 17785 | 1947 | 19384 | 1641 | 21313 | 1171 | 25996 | 916 | 15198 |
| 3L-6S | | MI | 6276 | 2799 | 9291 | 2285 | 10554 | 1921 | 11171 | 1618 | 11697 | 1150 | 13894 | 699 | 9314 |
| 14-#10 | 2.06 | MA | 10123 | 2799 | 14612 | 2341 | 17116 | 1967 | 18563 | 1660 | 20187 | 1180 | 24647 | 867 | 15145 |
| 4L-5S | | MI | 6422 | 2799 | 9562 | 2278 | 10914 | 1904 | 11618 | 1611 | 12300 | 1137 | 14693 | 760 | 9569 |
| 14-#10 | 2.06 | MA | 9850 | 2799 | 14126 | 2362 | 16536 | 1979 | 17840 | 1671 | 19179 | 1197 | 23272 | 827 | 15027 |
| 5L-4S | | MI | 6567 | 2799 | 9865 | 2260 | 11278 | 1896 | 12071 | 1596 | 12931 | 1125 | 15566 | 813 | 9621 |
| 14-#10 | 2.06 | MA | 9609 | 2799 | 13657 | 2368 | 15983 | 1990 | 17130 | 1690 | 18218 | 1214 | 21931 | 760 | 14536 |
| 6L-3S | | MI | 6672 | 2799 | 10161 | 2250 | 11696 | 1879 | 12583 | 1589 | 13632 | 1121 | 16438 | 866 | 9632 |
| 14-#10 | 2.06 | MA | 9405 | 2799 | 13214 | 2376 | 15358 | 2005 | 16446 | 1701 | 17238 | 1223 | 20639 | 727 | 14163 |
| 7L-2S | | MI | 6880 | 2799 | 10591 | 2241 | 12243 | 1871 | 13248 | 1574 | 14532 | 1109 | 17683 | 957 | 9626 |
| 14-#11 | 2.53 | MA | 10684 | 2915 | 16064 | 2391 | 18960 | 1992 | 20776 | 1667 | 23168 | 1160 | 28543 | 881 | 18397 |
| 3L-6S | | MI | 6420 | 2915 | 9710 | 2348 | 11006 | 1966 | 11685 | 1643 | 12364 | 1136 | 14711 | 603 | 11008 |
| 14-#11 | 2.53 | MA | 10488 | 2915 | 15488 | 2406 | 18146 | 2016 | 19777 | 1690 | 21799 | 1170 | 26893 | 819 | 18303 |
| 4L-5S | | MI | 6592 | 2915 | 10031 | 2339 | 11442 | 1946 | 12226 | 1636 | 13094 | 1122 | 15654 | 675 | 11277 |
| 14-#11 | 2.53 | MA | 10165 | 2915 | 14902 | 2432 | 17440 | 2030 | 18897 | 1702 | 20572 | 1191 | 25215 | 768 | 17909 |
| 5L-4S | | MI | 6759 | 2915 | 10398 | 2318 | 11884 | 1937 | 12774 | 1619 | 13857 | 1109 | 16684 | 740 | 11532 |
| 14-#11 | 2.53 | MA | 9880 | 2915 | 14333 | 2439 | 16776 | 2043 | 18033 | 1725 | 19403 | 1211 | 23579 | 683 | 17310 |
| 6L-3S | | MI | 6882 | 2915 | 10756 | 2307 | 12388 | 1918 | 13393 | 1612 | 14703 | 1105 | 17716 | 803 | 11562 |
| 14-#11 | 2.53 | MA | 9638 | 2915 | 13794 | 2449 | 16017 | 2061 | 17204 | 1738 | 18209 | 1221 | 21997 | 642 | 16712 |
| 7L-2S | | MI | 7124 | 2915 | 11274 | 2296 | 13047 | 1909 | 14193 | 1594 | 15786 | 1092 | 19183 | 915 | 11564 |
| 14-#14 | 3.65 | MA | 11402 | 3191 | 17489 | 2583 | 20609 | 2149 | 22738 | 1776 | 25778 | 1161 | 32483 | 718 | 25834 |
| 4L-5S | | MI | 7033 | 3191 | 11077 | 2515 | 12718 | 2074 | 13746 | 1720 | 15122 | 1107 | 18295 | 507 | 15320 |
| 14-#14 | 3.65 | MA | 10949 | 3191 | 16649 | 2619 | 19596 | 2168 | 21478 | 1793 | 24021 | 1189 | 30076 | 642 | 24621 |
| 5L-4S | | MI | 7262 | 3191 | 11600 | 2485 | 13348 | 2062 | 14529 | 1696 | 16210 | 1089 | 19734 | 601 | 15928 |
| 14-#14 | 3.65 | MA | 10562 | 3191 | 15842 | 2629 | 18644 | 2188 | 20239 | 1825 | 22346 | 1218 | 27726 | 518 | 23732 |
| 6L-3S | | MI | 7424 | 3191 | 12111 | 2470 | 14067 | 2035 | 15409 | 1687 | 17415 | 1086 | 21182 | 689 | 16189 |
| 14-#14 | 3.65 | MA | 10232 | 3191 | 15070 | 2642 | 17568 | 2214 | 19050 | 1842 | 20636 | 1231 | 25450 | 456 | 22316 |
| 7L-2S | | MI | 7748 | 3191 | 12846 | 2455 | 15003 | 2023 | 16546 | 1663 | 18953 | 1068 | 23234 | 851 | 16231 |
| 14-#18 | 6.48 | MA | 12859 | 3890 | 20943 | 3093 | 24922 | 2521 | 27865 | 2022 | 32572 | 1183 | 42108 | 314 | 40457 |
| 5L-4S | | MI | 8532 | 3890 | 14507 | 2913 | 16911 | 2380 | 18808 | 1891 | 21959 | 1039 | 26889 | 209 | 25642 |
| 14-#18 | 6.48 | MA | 12245 | 3890 | 19556 | 3113 | 23250 | 2552 | 25692 | 2077 | 29632 | 1230 | 37956 | 91 | 37407 |
| 6L-3S | | MI | 8745 | 3890 | 15394 | 2890 | 18157 | 2337 | 20335 | 1880 | 24048 | 1039 | 29321 | 358 | 27333 |
| 16-#10 | 2.35 | MA | 10461 | 2871 | 15314 | 2386 | 18010 | 2000 | 19648 | 1680 | 21656 | 1175 | 26682 | 861 | 17251 |
| 4L-6S | | MI | 6476 | 2871 | 9721 | 2331 | 11101 | 1954 | 11837 | 1639 | 12597 | 1146 | 15139 | 693 | 10572 |
| 16-#10 | 2.35 | MA | 10189 | 2871 | 14828 | 2407 | 17430 | 2012 | 18925 | 1691 | 20648 | 1193 | 25307 | 822 | 17128 |
| 5E | | MI | 6619 | 2871 | 9992 | 2324 | 11461 | 1937 | 12283 | 1632 | 13200 | 1133 | 15938 | 754 | 10815 |
| 16-#10 | 2.35 | MA | 9954 | 2871 | 14359 | 2413 | 16877 | 2023 | 18216 | 1711 | 19688 | 1210 | 23965 | 754 | 16618 |
| 6L-4S | | MI | 6763 | 2871 | 10295 | 2305 | 11826 | 1929 | 12736 | 1617 | 13831 | 1121 | 16811 | 807 | 10913 |
| 16-#10 | 2.35 | MA | 9757 | 2871 | 13916 | 2421 | 16252 | 2038 | 17531 | 1721 | 18707 | 1219 | 22674 | 721 | 16256 |
| 7L-3S | | MI | 6864 | 2871 | 10591 | 2296 | 12243 | 1912 | 13248 | 1610 | 14532 | 1117 | 17683 | 860 | 10931 |
| 16-#10 | 2.35 | MA | 9522 | 2871 | 13490 | 2431 | 15677 | 2046 | 16801 | 1736 | 17771 | 1237 | 21424 | 676 | 15676 |
| 8L-2S | | MI | 7069 | 2871 | 11022 | 2286 | 12791 | 1904 | 13913 | 1595 | 15432 | 1105 | 18929 | 951 | 10932 |
| 16-#11 | 2.89 | MA | 10890 | 3004 | 16340 | 2462 | 19231 | 2056 | 21094 | 1715 | 23581 | 1165 | 29360 | 812 | 20854 |
| 4L-6S | | MI | 6656 | 3004 | 10228 | 2404 | 11665 | 2006 | 12486 | 1669 | 13447 | 1131 | 16178 | 592 | 12522 |
| 16-#11 | 2.89 | MA | 10568 | 3004 | 15753 | 2488 | 18524 | 2070 | 20214 | 1727 | 22354 | 1185 | 27683 | 761 | 20418 |
| 5E | | MI | 6824 | 3004 | 10548 | 2395 | 12101 | 1987 | 13026 | 1661 | 14177 | 1117 | 17121 | 665 | 12778 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.89 | MA | 10292 | 3004 | 15185 | 2495 | 17860 | 2084 | 19350 | 1750 | 21185 | 1206 | 26046 | 676 | 19840 |
| 6L-4S | | MI | 6990 | 3004 | 10915 | 2373 | 12543 | 1978 | 13575 | 1644 | 14940 | 1104 | 18151 | 729 | 13081 |
| 16-#11 | 2.89 | MA | 10059 | 3004 | 14645 | 2504 | 17101 | 2102 | 18520 | 1763 | 19991 | 1216 | 24464 | 634 | 19235 |
| 7L-3S | | MI | 7108 | 3004 | 11274 | 2362 | 13047 | 1958 | 14193 | 1637 | 15786 | 1100 | 19183 | 792 | 13120 |
| 16-#11 | 2.89 | MA | 9781 | 3004 | 14128 | 2515 | 16401 | 2111 | 17640 | 1781 | 18852 | 1236 | 22938 | 576 | 18475 |
| 8L-2S | | MI | 7345 | 3004 | 11791 | 2351 | 13706 | 1949 | 14993 | 1619 | 16869 | 1087 | 20650 | 905 | 13132 |
| 16-#14 | 4.17 | MA | 11510 | 3319 | 17866 | 2699 | 21145 | 2227 | 23359 | 1829 | 26568 | 1182 | 33602 | 632 | 28233 |
| 5E | | MI | 7355 | 3319 | 11811 | 2595 | 13654 | 2133 | 14882 | 1756 | 16660 | 1100 | 20346 | 488 | 17463 |
| 16-#14 | 4.17 | MA | 11138 | 3319 | 17059 | 2709 | 20193 | 2246 | 22121 | 1862 | 24892 | 1210 | 31252 | 507 | 27343 |
| 6L-4S | | MI | 7584 | 3319 | 12335 | 2565 | 14284 | 2121 | 15665 | 1732 | 17748 | 1082 | 21786 | 582 | 18040 |
| 16-#14 | 4.17 | MA | 10824 | 3319 | 16286 | 2723 | 19117 | 2272 | 20931 | 1879 | 23182 | 1224 | 28976 | 446 | 25934 |
| 7L-3S | | MI | 7738 | 3319 | 12846 | 2551 | 15003 | 2094 | 16546 | 1723 | 18953 | 1079 | 23234 | 670 | 18390 |
| 16-#14 | 4.17 | MA | 10435 | 3319 | 15545 | 2738 | 18115 | 2285 | 19685 | 1906 | 21549 | 1252 | 26785 | 360 | 24392 |
| 8L-2S | | MI | 8053 | 3319 | 13581 | 2536 | 15938 | 2082 | 17682 | 1699 | 20491 | 1061 | 25285 | 832 | 18445 |
| 16-#18 | 7.41 | MA | 13219 | 4118 | 21679 | 3256 | 25953 | 2656 | 28974 | 2141 | 34075 | 1217 | 44107 | 72 | 43686 |
| 6L-4S | | MI | 9068 | 4118 | 15773 | 3056 | 18523 | 2484 | 20766 | 1956 | 24610 | 1025 | 30310 | 163 | 29318 |
| 18-#10 | 2.65 | MA | 10523 | 2944 | 15530 | 2452 | 18323 | 2045 | 20011 | 1712 | 22117 | 1189 | 27341 | 816 | 19217 |
| 5L-6S | | MI | 6674 | 2944 | 10151 | 2376 | 11649 | 1987 | 12502 | 1659 | 13497 | 1141 | 16385 | 688 | 11833 |
| 18-#10 | 2.65 | MA | 10294 | 2944 | 15061 | 2458 | 17771 | 2056 | 19301 | 1731 | 21157 | 1206 | 25999 | 748 | 18703 |
| 6L-5S | | MI | 6814 | 2944 | 10422 | 2369 | 12009 | 1970 | 12948 | 1652 | 14100 | 1129 | 17183 | 748 | 12066 |
| 18-#10 | 2.65 | MA | 10103 | 2944 | 14618 | 2466 | 17146 | 2071 | 18617 | 1742 | 20176 | 1215 | 24708 | 715 | 18352 |
| 7L-4S | | MI | 6957 | 2944 | 10725 | 2351 | 12374 | 1962 | 13401 | 1637 | 14731 | 1117 | 18057 | 801 | 12203 |
| 18-#10 | 2.65 | MA | 9871 | 2944 | 14192 | 2476 | 16571 | 2079 | 17886 | 1757 | 19240 | 1232 | 23459 | 670 | 17767 |
| 8L-3S | | MI | 7055 | 2944 | 11022 | 2341 | 12791 | 1945 | 13913 | 1630 | 15432 | 1113 | 18929 | 854 | 12227 |
| 18-#10 | 2.65 | MA | 9638 | 2944 | 13711 | 2494 | 15981 | 2096 | 17178 | 1764 | 18284 | 1241 | 22233 | 626 | 17233 |
| 9L-2S | | MI | 7255 | 2944 | 11452 | 2331 | 13339 | 1937 | 14578 | 1615 | 16332 | 1100 | 20174 | 945 | 12235 |
| 18-#11 | 3.25 | MA | 10965 | 3093 | 16605 | 2543 | 19608 | 2110 | 21531 | 1753 | 24136 | 1180 | 30150 | 754 | 22933 |
| 5L-6S | | MI | 6890 | 3093 | 10745 | 2460 | 12324 | 2047 | 13286 | 1694 | 14530 | 1126 | 17645 | 581 | 14040 |
| 18-#11 | 3.25 | MA | 10697 | 3093 | 16036 | 2550 | 18944 | 2124 | 20667 | 1775 | 22967 | 1201 | 28514 | 669 | 22373 |
| 6L-5S | | MI | 7054 | 3093 | 11066 | 2450 | 12760 | 2027 | 13826 | 1687 | 15260 | 1112 | 18589 | 654 | 14284 |
| 18-#11 | 3.25 | MA | 10473 | 3093 | 15497 | 2560 | 18185 | 2142 | 19837 | 1788 | 21773 | 1211 | 26931 | 627 | 21761 |
| 7L-4S | | MI | 7219 | 3093 | 11433 | 2429 | 13202 | 2018 | 14375 | 1669 | 16023 | 1098 | 19618 | 719 | 14628 |
| 18-#11 | 3.25 | MA | 10197 | 3093 | 14979 | 2571 | 17486 | 2151 | 18957 | 1807 | 20634 | 1231 | 25406 | 569 | 21015 |
| 8L-3S | | MI | 7332 | 3093 | 11791 | 2418 | 13706 | 1999 | 14993 | 1662 | 16869 | 1095 | 20650 | 782 | 14675 |
| 18-#11 | 3.25 | MA | 9922 | 3093 | 14399 | 2594 | 16767 | 2172 | 18095 | 1815 | 19468 | 1241 | 23904 | 515 | 20071 |
| 9L-2S | | MI | 7565 | 3093 | 12308 | 2407 | 14365 | 1990 | 15793 | 1645 | 17952 | 1082 | 22117 | 894 | 14695 |
| 18-#14 | 4.69 | MA | 11704 | 3448 | 18275 | 2790 | 21742 | 2304 | 24002 | 1898 | 27439 | 1203 | 34778 | 497 | 30958 |
| 6L-5S | | MI | 7674 | 3448 | 12546 | 2676 | 14590 | 2191 | 16019 | 1792 | 18198 | 1093 | 22398 | 469 | 19613 |
| 18-#14 | 4.69 | MA | 11405 | 3448 | 17503 | 2803 | 20666 | 2331 | 22813 | 1915 | 25728 | 1216 | 32502 | 435 | 29552 |
| 7L-4S | | MI | 7902 | 3448 | 13070 | 2646 | 15220 | 2179 | 16802 | 1769 | 19286 | 1075 | 23837 | 563 | 20162 |
| 18-#14 | 4.69 | MA | 11019 | 3448 | 16762 | 2819 | 19664 | 2343 | 21566 | 1943 | 24095 | 1245 | 30311 | 349 | 27995 |
| 8L-3S | | MI | 8048 | 3448 | 13581 | 2631 | 15938 | 2152 | 17682 | 1760 | 20491 | 1071 | 25285 | 651 | 20589 |
| 20-#10 | 2.94 | MA | 10630 | 3016 | 15763 | 2504 | 18665 | 2089 | 20387 | 1752 | 22626 | 1202 | 28034 | 742 | 20790 |
| 6E | | MI | 6870 | 3016 | 10581 | 2421 | 12197 | 2020 | 13167 | 1680 | 14398 | 1137 | 17630 | 682 | 13097 |
| 20-#10 | 2.94 | MA | 10445 | 3016 | 15320 | 2512 | 18040 | 2104 | 19703 | 1762 | 21646 | 1211 | 26742 | 709 | 20449 |
| 7L-5S | | MI | 7006 | 3016 | 10852 | 2414 | 12556 | 2003 | 13613 | 1673 | 15001 | 1125 | 18428 | 743 | 13320 |
| 20-#10 | 2.94 | MA | 10214 | 3016 | 14894 | 2521 | 17465 | 2112 | 18972 | 1777 | 20710 | 1228 | 25493 | 664 | 19860 |
| 8L-4S | | MI | 7149 | 3016 | 11155 | 2396 | 12921 | 1995 | 14067 | 1658 | 15631 | 1113 | 19302 | 795 | 13493 |
| 20-#10 | 2.94 | MA | 9987 | 3016 | 14413 | 2539 | 16875 | 2129 | 18263 | 1785 | 19753 | 1237 | 24267 | 620 | 19321 |
| 9L-3S | | MI | 7244 | 3016 | 11452 | 2386 | 13339 | 1978 | 14578 | 1651 | 16332 | 1109 | 20174 | 848 | 13522 |
| 20-#10 | 2.94 | MA | 9771 | 3016 | 13972 | 2547 | 16319 | 2139 | 17557 | 1802 | 18808 | 1253 | 22922 | 569 | 18562 |
| 10L-2S | | MI | 7441 | 3016 | 11882 | 2377 | 13886 | 1970 | 15244 | 1636 | 17232 | 1096 | 21419 | 939 | 13534 |
| 20-#11 | 3.61 | MA | 11097 | 3182 | 16888 | 2606 | 20028 | 2165 | 21983 | 1801 | 24749 | 1196 | 30981 | 662 | 24909 |
| 6E | | MI | 7121 | 3182 | 11262 | 2516 | 12983 | 2087 | 14086 | 1719 | 15613 | 1120 | 19113 | 571 | 15561 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

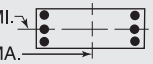
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.61 | MA | 10881 | 3182 | 16348 | 2616 | 19269 | 2183 | 21154 | 1813 | 23555 | 1206 | 29399 | 620 | 24290 |
| 7L-5S | | MI | 7281 | 3182 | 11583 | 2506 | 13419 | 2068 | 14626 | 1712 | 16343 | 1107 | 20056 | 643 | 15795 |
| 20-#11 | 3.61 | MA | 10607 | 3182 | 15831 | 2627 | 18570 | 2192 | 20274 | 1832 | 22416 | 1226 | 27873 | 562 | 23555 |
| 8L-4S | | MI | 7446 | 3182 | 11950 | 2485 | 13860 | 2059 | 15175 | 1694 | 17106 | 1093 | 21085 | 708 | 16175 |
| 20-#11 | 3.61 | MA | 10340 | 3182 | 15250 | 2649 | 17851 | 2213 | 19412 | 1841 | 21250 | 1236 | 26371 | 508 | 22602 |
| 9L-3S | | MI | 7555 | 3182 | 12308 | 2474 | 14365 | 2039 | 15793 | 1687 | 17952 | 1090 | 22117 | 771 | 16229 |
| 20-#14 | 5.21 | MA | 11976 | 3576 | 18720 | 2883 | 22215 | 2389 | 24695 | 1952 | 28275 | 1209 | 36027 | 425 | 33169 |
| 7L-5S | | MI | 7989 | 3576 | 13281 | 2756 | 15525 | 2249 | 17155 | 1829 | 19736 | 1085 | 24449 | 450 | 21768 |
| 20-#14 | 5.21 | MA | 11593 | 3576 | 17979 | 2899 | 21214 | 2402 | 23448 | 1979 | 26641 | 1237 | 33837 | 339 | 31597 |
| 8L-4S | | MI | 8216 | 3576 | 13805 | 2726 | 16156 | 2237 | 17938 | 1805 | 20824 | 1067 | 25889 | 544 | 22291 |
| 22-#10 | 3.23 | MA | 10783 | 3089 | 16022 | 2557 | 18934 | 2136 | 20788 | 1783 | 23115 | 1207 | 28777 | 703 | 22548 |
| 7L-6S | | MI | 7063 | 3089 | 11011 | 2467 | 12744 | 2053 | 13832 | 1700 | 15298 | 1133 | 18875 | 676 | 14363 |
| 22-#10 | 3.23 | MA | 10553 | 3089 | 15596 | 2567 | 18359 | 2145 | 20057 | 1798 | 22179 | 1224 | 27527 | 658 | 21955 |
| 8L-5S | | MI | 7197 | 3089 | 11283 | 2459 | 13104 | 2036 | 14278 | 1694 | 15901 | 1121 | 19674 | 737 | 14577 |
| 22-#10 | 3.23 | MA | 10332 | 3089 | 15115 | 2585 | 17768 | 2162 | 19349 | 1805 | 21222 | 1233 | 26302 | 614 | 21409 |
| 9L-4S | | MI | 7340 | 3089 | 11585 | 2441 | 13469 | 2028 | 14732 | 1678 | 16532 | 1108 | 20547 | 789 | 14781 |
| 22-#10 | 3.23 | MA | 10124 | 3089 | 14674 | 2592 | 17212 | 2172 | 18642 | 1822 | 20277 | 1249 | 24956 | 563 | 20653 |
| 10L-3S | | MI | 7431 | 3089 | 11882 | 2432 | 13886 | 2011 | 15244 | 1672 | 17232 | 1104 | 21419 | 842 | 14815 |
| 22-#11 | 3.97 | MA | 11283 | 3271 | 17199 | 2671 | 20353 | 2223 | 22470 | 1839 | 25337 | 1200 | 31866 | 613 | 26821 |
| 7L-6S | | MI | 7350 | 3271 | 11780 | 2571 | 13642 | 2128 | 14886 | 1744 | 16696 | 1115 | 20580 | 560 | 17084 |
| 22-#11 | 3.97 | MA | 11011 | 3271 | 16682 | 2682 | 19654 | 2232 | 21590 | 1857 | 24197 | 1221 | 30341 | 555 | 26094 |
| 8L-5S | | MI | 7506 | 3271 | 12101 | 2562 | 14077 | 2108 | 15426 | 1737 | 17425 | 1102 | 21523 | 633 | 17309 |
| 22-#11 | 3.97 | MA | 10751 | 3271 | 16102 | 2705 | 18935 | 2253 | 20729 | 1866 | 23032 | 1231 | 28839 | 500 | 25132 |
| 9L-4S | | MI | 7670 | 3271 | 12467 | 2540 | 14519 | 2099 | 15975 | 1720 | 18188 | 1088 | 22553 | 698 | 17720 |
| 22-#14 | 5.73 | MA | 12158 | 3704 | 19195 | 2979 | 22763 | 2460 | 25329 | 2015 | 29188 | 1230 | 37363 | 329 | 35200 |
| 8L-5S | | MI | 8302 | 3704 | 14016 | 2836 | 16461 | 2308 | 18292 | 1865 | 21274 | 1078 | 26501 | 431 | 23927 |
| 24-#10 | 3.53 | MA | 10888 | 3161 | 16298 | 2612 | 19252 | 2177 | 21143 | 1818 | 23648 | 1220 | 29561 | 652 | 24050 |
| 8L-6S | | MI | 7255 | 3161 | 11441 | 2512 | 13292 | 2086 | 14497 | 1721 | 16198 | 1129 | 20121 | 670 | 15630 |
| 24-#10 | 3.53 | MA | 10672 | 3161 | 15817 | 2630 | 18662 | 2195 | 20435 | 1826 | 22691 | 1229 | 28336 | 609 | 23468 |
| 9L-5S | | MI | 7387 | 3161 | 11713 | 2505 | 13652 | 2069 | 14943 | 1714 | 16801 | 1116 | 20919 | 731 | 15837 |
| 24-#10 | 3.53 | MA | 10477 | 3161 | 15376 | 2637 | 18106 | 2204 | 19728 | 1843 | 21746 | 1245 | 26991 | 557 | 22744 |
| 10L-4S | | MI | 7529 | 3161 | 12015 | 2487 | 14016 | 2061 | 15397 | 1699 | 17432 | 1104 | 21792 | 783 | 16069 |
| 24-#11 | 4.33 | MA | 11410 | 3360 | 17534 | 2738 | 20738 | 2273 | 22907 | 1882 | 25979 | 1216 | 32808 | 548 | 28634 |
| 8L-6S | | MI | 7576 | 3360 | 12297 | 2627 | 14300 | 2168 | 15686 | 1770 | 17779 | 1110 | 22047 | 550 | 18610 |
| 24-#11 | 4.33 | MA | 11157 | 3360 | 16953 | 2761 | 20020 | 2294 | 22045 | 1891 | 24814 | 1226 | 31306 | 493 | 27662 |
| 9L-5S | | MI | 7729 | 3360 | 12618 | 2617 | 14736 | 2149 | 16227 | 1762 | 18508 | 1096 | 22990 | 622 | 18827 |

## RECTANGULAR TIED COLUMNS 24" x 38"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.75 | MA | 11367 | 2875 | 16856 | 2366 | 19694 | 1982 | 21360 | 1677 | 23350 | 1205 | 28360 | 1044 | 14249 |
| 2E | | MI | 6922 | 2875 | 10762 | 2257 | 12179 | 1889 | 12978 | 1596 | 13899 | 1141 | 16124 | 931 | 8472 |
| 6-#11 | 1.03 | MA | 10552 | 2686 | 14861 | 2273 | 17316 | 1918 | 18550 | 1642 | 19614 | 1231 | 23236 | 1072 | 8621 |
| 2L-3S | | MI | 6254 | 2686 | 9111 | 2190 | 10222 | 1846 | 10669 | 1589 | 10827 | 1189 | 12342 | 901 | 5289 |
| 6-#11 | 1.03 | MA | 10058 | 2686 | 13954 | 2289 | 16161 | 1932 | 17148 | 1655 | 17716 | 1252 | 20607 | 973 | 8638 |
| 3L-2S | | MI | 6522 | 2686 | 9629 | 2179 | 10880 | 1837 | 11469 | 1572 | 11910 | 1175 | 13809 | 1013 | 5259 |
| 6-#14 | 1.48 | MA | 11098 | 2804 | 16094 | 2338 | 18831 | 1964 | 20363 | 1669 | 22045 | 1219 | 26585 | 1058 | 12217 |
| 2L-3S | | MI | 6434 | 2804 | 9599 | 2254 | 10794 | 1892 | 11340 | 1619 | 11717 | 1178 | 13469 | 819 | 7369 |
| 6-#14 | 1.48 | MA | 10416 | 2804 | 14797 | 2360 | 17179 | 1984 | 18357 | 1687 | 19331 | 1249 | 22827 | 913 | 12205 |
| 3L-2S | | MI | 6803 | 2804 | 10334 | 2239 | 11729 | 1880 | 12477 | 1595 | 13255 | 1160 | 15520 | 981 | 7333 |
| 6-#18 | 2.63 | MA | 12390 | 3104 | 19121 | 2509 | 22579 | 2086 | 24863 | 1741 | 28092 | 1192 | 34925 | 1025 | 21100 |
| 2L-3S | | MI | 6862 | 3104 | 10762 | 2423 | 12179 | 2010 | 12978 | 1698 | 13899 | 1153 | 16124 | 597 | 12312 |
| 6-#18 | 2.63 | MA | 11285 | 3104 | 16856 | 2546 | 19694 | 2119 | 21360 | 1771 | 23350 | 1241 | 28360 | 760 | 20894 |
| 3L-2S | | MI | 7458 | 3104 | 12028 | 2400 | 13792 | 1993 | 14937 | 1660 | 16549 | 1127 | 19545 | 885 | 12343 |
| 8-#10 | 1.11 | MA | 10696 | 2709 | 15042 | 2299 | 17621 | 1938 | 18958 | 1657 | 20198 | 1236 | 24067 | 1076 | 9385 |
| 2L-4S | | MI | 6270 | 2709 | 8996 | 2231 | 10103 | 1888 | 10553 | 1614 | 10688 | 1201 | 12328 | 886 | 5747 |
| 8-#10 | 1.11 | MA | 10291 | 2709 | 14294 | 2312 | 16670 | 1950 | 17803 | 1668 | 18633 | 1254 | 21901 | 997 | 9394 |
| 3E | | MI | 6388 | 2709 | 9292 | 2221 | 10520 | 1872 | 11065 | 1607 | 11389 | 1197 | 13200 | 939 | 5726 |

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

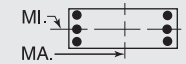
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.11 | MA | 10084 | 2709 | 13792 | 2325 | 15959 | 1971 | 16930 | 1688 | 17436 | 1264 | 20473 | 948 | 9373 |
| 4L-2S | | MI | 6611 | 2709 | 9722 | 2212 | 11068 | 1863 | 11730 | 1592 | 12289 | 1185 | 14446 | 1030 | 5705 |
| 8-#11 | 1.37 | MA | 10987 | 2775 | 15769 | 2329 | 18471 | 1958 | 19953 | 1667 | 21513 | 1226 | 25864 | 1065 | 11379 |
| 2L-4S | | MI | 6353 | 2775 | 9270 | 2257 | 10376 | 1906 | 10851 | 1622 | 11064 | 1187 | 12777 | 827 | 6901 |
| 8-#11 | 1.37 | MA | 10507 | 2775 | 14861 | 2344 | 17316 | 1972 | 18550 | 1680 | 19614 | 1247 | 23236 | 966 | 11381 |
| 3E | | MI | 6493 | 2775 | 9629 | 2246 | 10880 | 1887 | 11469 | 1615 | 11910 | 1184 | 13809 | 890 | 6882 |
| 8-#11 | 1.37 | MA | 10261 | 2775 | 14249 | 2360 | 16451 | 1997 | 17488 | 1704 | 18158 | 1258 | 21489 | 905 | 11329 |
| 4L-2S | | MI | 6754 | 2775 | 10146 | 2235 | 11539 | 1878 | 12270 | 1597 | 12993 | 1170 | 15276 | 1002 | 6857 |
| 8-#14 | 1.97 | MA | 11701 | 2932 | 17391 | 2419 | 20482 | 2023 | 22369 | 1705 | 24760 | 1212 | 30343 | 1048 | 16147 |
| 2L-4S | | MI | 6575 | 2932 | 9823 | 2350 | 11011 | 1977 | 11596 | 1665 | 12050 | 1174 | 14072 | 712 | 9566 |
| 8-#14 | 1.97 | MA | 11046 | 2932 | 16094 | 2441 | 18831 | 2043 | 20363 | 1724 | 22045 | 1241 | 26585 | 903 | 16104 |
| 3E | | MI | 6766 | 2932 | 10334 | 2335 | 11729 | 1950 | 12477 | 1656 | 13255 | 1171 | 15520 | 800 | 9603 |
| 8-#14 | 1.97 | MA | 10710 | 2932 | 15216 | 2462 | 17591 | 2077 | 18842 | 1757 | 19960 | 1256 | 24073 | 814 | 15897 |
| 4L-2S | | MI | 7123 | 2932 | 11069 | 2320 | 12665 | 1938 | 13613 | 1632 | 14793 | 1153 | 17572 | 962 | 9585 |
| 8-#18 | 3.51 | MA | 13385 | 3332 | 21387 | 2652 | 25463 | 2190 | 28367 | 1806 | 32833 | 1178 | 41490 | 1007 | 27930 |
| 2L-4S | | MI | 7108 | 3332 | 11141 | 2589 | 12545 | 2158 | 13410 | 1774 | 14461 | 1140 | 17114 | 402 | 14908 |
| 8-#18 | 3.51 | MA | 12344 | 3332 | 19121 | 2688 | 22579 | 2223 | 24863 | 1836 | 28092 | 1228 | 34925 | 742 | 27669 |
| 3E | | MI | 7416 | 3332 | 12028 | 2566 | 13792 | 2114 | 14937 | 1763 | 16549 | 1140 | 19545 | 551 | 16091 |
| 8-#18 | 3.51 | MA | 11813 | 3332 | 17582 | 2725 | 20406 | 2283 | 22196 | 1892 | 24437 | 1250 | 30485 | 581 | 25630 |
| 4L-2S | | MI | 7985 | 3332 | 13294 | 2543 | 15404 | 2097 | 16895 | 1725 | 19200 | 1114 | 22966 | 838 | 16181 |
| 10-#10 | 1.39 | MA | 11057 | 2781 | 15789 | 2344 | 18573 | 1971 | 20114 | 1677 | 21762 | 1232 | 26232 | 1070 | 11653 |
| 2L-5S | | MI | 6327 | 2781 | 9123 | 2294 | 10286 | 1930 | 10765 | 1650 | 10957 | 1209 | 12700 | 828 | 7049 |
| 10-#10 | 1.39 | MA | 10662 | 2781 | 15042 | 2357 | 17621 | 1983 | 18958 | 1689 | 20198 | 1250 | 24067 | 991 | 11652 |
| 3L-4S | | MI | 6473 | 2781 | 9426 | 2276 | 10651 | 1921 | 11218 | 1635 | 11588 | 1197 | 13574 | 880 | 7056 |
| 10-#10 | 1.39 | MA | 10463 | 2781 | 14539 | 2370 | 16910 | 2004 | 18085 | 1708 | 19000 | 1260 | 22639 | 942 | 11618 |
| 4L-3S | | MI | 6587 | 2781 | 9722 | 2267 | 11068 | 1905 | 11730 | 1628 | 12289 | 1193 | 14446 | 933 | 7044 |
| 10-#10 | 1.39 | MA | 10164 | 2781 | 14019 | 2391 | 16294 | 2016 | 17318 | 1720 | 17930 | 1278 | 21181 | 904 | 11515 |
| 5L-2S | | MI | 6805 | 2781 | 10152 | 2257 | 11616 | 1896 | 12395 | 1613 | 13189 | 1181 | 15691 | 1025 | 7027 |
| 10-#11 | 1.71 | MA | 11415 | 2864 | 16676 | 2384 | 19626 | 1999 | 21356 | 1692 | 23411 | 1221 | 28493 | 1058 | 14129 |
| 2L-5S | | MI | 6425 | 2864 | 9421 | 2334 | 10593 | 1956 | 11103 | 1664 | 11384 | 1195 | 13215 | 751 | 8389 |
| 10-#11 | 1.71 | MA | 10949 | 2864 | 15769 | 2400 | 18471 | 2013 | 19953 | 1705 | 21513 | 1242 | 25864 | 958 | 14116 |
| 3L-4S | | MI | 6593 | 2864 | 9788 | 2312 | 11035 | 1947 | 11651 | 1647 | 12147 | 1182 | 14244 | 816 | 8465 |
| 10-#11 | 1.71 | MA | 10715 | 2864 | 15156 | 2415 | 17606 | 2038 | 18891 | 1729 | 20056 | 1252 | 24117 | 897 | 14046 |
| 4L-3S | | MI | 6728 | 2864 | 10146 | 2301 | 11539 | 1927 | 12270 | 1640 | 12993 | 1178 | 15276 | 879 | 8462 |
| 10-#11 | 1.71 | MA | 10360 | 2864 | 14530 | 2441 | 16855 | 2052 | 17956 | 1742 | 18753 | 1274 | 22338 | 848 | 13815 |
| 5L-2S | | MI | 6983 | 2864 | 10664 | 2290 | 12198 | 1918 | 13070 | 1622 | 14076 | 1165 | 16744 | 991 | 8444 |
| 10-#14 | 2.47 | MA | 12292 | 3061 | 18688 | 2499 | 22133 | 2081 | 24375 | 1742 | 27474 | 1204 | 34102 | 1038 | 20064 |
| 2L-5S | | MI | 6679 | 3061 | 10034 | 2460 | 11316 | 2047 | 11950 | 1725 | 12500 | 1185 | 14684 | 599 | 11175 |
| 10-#14 | 2.47 | MA | 11661 | 3061 | 17391 | 2521 | 20482 | 2101 | 22369 | 1760 | 24760 | 1234 | 30343 | 892 | 19999 |
| 3L-4S | | MI | 6911 | 3061 | 10558 | 2430 | 11946 | 2035 | 12733 | 1701 | 13588 | 1167 | 16124 | 693 | 11757 |
| 10-#14 | 2.47 | MA | 11348 | 3061 | 16513 | 2543 | 19243 | 2136 | 20847 | 1793 | 22674 | 1248 | 27831 | 804 | 19773 |
| 4L-3S | | MI | 7093 | 3061 | 11069 | 2415 | 12665 | 2008 | 13613 | 1692 | 14793 | 1164 | 17572 | 782 | 11821 |
| 10-#14 | 2.47 | MA | 10849 | 3061 | 15621 | 2579 | 18166 | 2156 | 19507 | 1811 | 20806 | 1278 | 25277 | 730 | 18647 |
| 5L-2S | | MI | 7439 | 3061 | 11804 | 2400 | 13601 | 1996 | 14750 | 1668 | 16331 | 1146 | 19623 | 943 | 11822 |
| 10-#18 | 4.39 | MA | 13373 | 3561 | 21387 | 2831 | 25463 | 2327 | 28367 | 1901 | 32833 | 1214 | 41490 | 723 | 34451 |
| 3L-4S | | MI | 7673 | 3561 | 12407 | 2732 | 14158 | 2262 | 15368 | 1839 | 17111 | 1127 | 20535 | 355 | 18514 |
| 10-#18 | 4.39 | MA | 12895 | 3561 | 19848 | 2868 | 23290 | 2386 | 25699 | 1957 | 29178 | 1237 | 37050 | 563 | 32323 |
| 4L-3S | | MI | 7959 | 3561 | 13294 | 2709 | 15404 | 2218 | 16895 | 1828 | 19200 | 1127 | 22966 | 504 | 19863 |
| 10-#18 | 4.39 | MA | 12054 | 3561 | 18279 | 2931 | 21400 | 2419 | 23347 | 1986 | 25901 | 1286 | 32553 | 424 | 30005 |
| 5L-2S | | MI | 8504 | 3561 | 14561 | 2686 | 17016 | 2201 | 18853 | 1790 | 21850 | 1101 | 26388 | 792 | 19997 |
| 12-#10 | 1.67 | MA | 11412 | 2854 | 16536 | 2390 | 19524 | 2004 | 21270 | 1698 | 23326 | 1228 | 28398 | 1065 | 13917 |
| 2L-6S | | MI | 6379 | 2854 | 9282 | 2347 | 10473 | 1979 | 10984 | 1677 | 11254 | 1217 | 13147 | 761 | 8134 |
| 12-#10 | 1.67 | MA | 11026 | 2854 | 15789 | 2403 | 18573 | 2016 | 20114 | 1709 | 21762 | 1246 | 26232 | 985 | 13906 |
| 3L-5S | | MI | 6529 | 2854 | 9553 | 2340 | 10833 | 1963 | 11430 | 1670 | 11857 | 1205 | 13945 | 822 | 8338 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

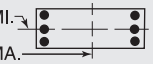


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.67 | MA | 10836 | 2854 | 15286 | 2416 | 17862 | 2037 | 19241 | 1729 | 20564 | 1255 | 24805 | 936 | 13862 |
| 4E | | MI | 6674 | 2854 | 9856 | 2322 | 11198 | 1954 | 11884 | 1655 | 12488 | 1193 | 14819 | 874 | 8358 |
| 12-#10 | 1.67 | MA | 10539 | 2854 | 14766 | 2436 | 17245 | 2049 | 18473 | 1740 | 19494 | 1273 | 23347 | 898 | 13750 |
| 5L-3S | | MI | 6784 | 2854 | 10152 | 2312 | 11616 | 1938 | 12395 | 1648 | 13189 | 1189 | 15691 | 927 | 8354 |
| 12-#10 | 1.67 | MA | 10274 | 2854 | 14268 | 2442 | 16653 | 2059 | 17720 | 1760 | 18446 | 1283 | 21924 | 832 | 13297 |
| 6L-2S | | MI | 6998 | 2854 | 10583 | 2302 | 12163 | 1929 | 13060 | 1633 | 14089 | 1176 | 16936 | 1019 | 8342 |
| 12-#11 | 2.05 | MA | 11836 | 2953 | 17583 | 2440 | 20781 | 2039 | 22759 | 1718 | 25310 | 1215 | 31122 | 1051 | 16873 |
| 2L-6S | | MI | 6486 | 2953 | 9618 | 2399 | 10816 | 2016 | 11362 | 1697 | 11737 | 1204 | 13739 | 668 | 9585 |
| 12-#11 | 2.05 | MA | 11383 | 2953 | 16676 | 2456 | 19626 | 2053 | 21356 | 1731 | 23411 | 1237 | 28493 | 951 | 16847 |
| 3L-5S | | MI | 6663 | 2953 | 9939 | 2389 | 11252 | 1996 | 11903 | 1690 | 12467 | 1190 | 14682 | 741 | 9874 |
| 12-#11 | 2.05 | MA | 11161 | 2953 | 16064 | 2471 | 18761 | 2078 | 20294 | 1754 | 21955 | 1247 | 26746 | 890 | 16764 |
| 4E | | MI | 6831 | 2953 | 10305 | 2368 | 11694 | 1987 | 12452 | 1672 | 13230 | 1177 | 15712 | 806 | 10022 |
| 12-#11 | 2.05 | MA | 10808 | 2953 | 15437 | 2496 | 18010 | 2092 | 19359 | 1767 | 20651 | 1268 | 24967 | 841 | 16479 |
| 5L-3S | | MI | 6960 | 2953 | 10664 | 2357 | 12198 | 1968 | 13070 | 1665 | 14076 | 1173 | 16744 | 869 | 10033 |
| 12-#11 | 2.05 | MA | 10493 | 2953 | 14830 | 2504 | 17298 | 2106 | 18441 | 1791 | 19409 | 1290 | 23230 | 758 | 15790 |
| 6L-2S | | MI | 7209 | 2953 | 11181 | 2346 | 12857 | 1959 | 13870 | 1648 | 15159 | 1160 | 18211 | 981 | 10023 |
| 12-#14 | 2.96 | MA | 12264 | 3189 | 18688 | 2601 | 22133 | 2159 | 24375 | 1796 | 27474 | 1226 | 34102 | 882 | 23893 |
| 3L-5S | | MI | 7011 | 3189 | 10769 | 2540 | 12252 | 2106 | 13086 | 1761 | 14038 | 1177 | 16736 | 580 | 13298 |
| 12-#14 | 2.96 | MA | 11971 | 3189 | 17810 | 2623 | 20894 | 2194 | 22853 | 1830 | 25389 | 1241 | 31590 | 793 | 23652 |
| 4E | | MI | 7242 | 3189 | 11293 | 2510 | 12882 | 2094 | 13869 | 1738 | 15126 | 1159 | 18175 | 674 | 13946 |
| 12-#14 | 2.96 | MA | 11477 | 3189 | 16918 | 2659 | 19817 | 2214 | 21513 | 1848 | 23520 | 1270 | 29035 | 720 | 22488 |
| 5L-3S | | MI | 7415 | 3189 | 11804 | 2495 | 13601 | 2067 | 14750 | 1729 | 16331 | 1156 | 19623 | 763 | 14031 |
| 12-#14 | 2.96 | MA | 11044 | 3189 | 16051 | 2670 | 18806 | 2234 | 20197 | 1881 | 21739 | 1300 | 26543 | 597 | 21579 |
| 6L-2S | | MI | 7751 | 3189 | 12539 | 2480 | 14537 | 2055 | 15887 | 1705 | 17870 | 1138 | 21675 | 924 | 14052 |
| 12-#18 | 5.26 | MA | 13946 | 3789 | 22113 | 3011 | 26174 | 2490 | 29203 | 2022 | 33920 | 1224 | 43615 | 545 | 39032 |
| 4E | | MI | 8228 | 3789 | 13673 | 2874 | 15770 | 2365 | 17326 | 1904 | 19762 | 1113 | 23956 | 309 | 22147 |
| 12-#18 | 5.26 | MA | 13113 | 3789 | 20545 | 3074 | 24284 | 2523 | 26850 | 2051 | 30642 | 1273 | 39118 | 406 | 36747 |
| 5L-3S | | MI | 8493 | 3789 | 14561 | 2851 | 17016 | 2322 | 18853 | 1893 | 21850 | 1114 | 26388 | 458 | 23633 |
| 12-#18 | 5.26 | MA | 12414 | 3789 | 19052 | 3093 | 22507 | 2556 | 24539 | 2107 | 27515 | 1322 | 34719 | 184 | 33442 |
| 6L-2S | | MI | 9016 | 3789 | 15827 | 2828 | 18629 | 2304 | 20811 | 1855 | 24500 | 1087 | 29809 | 746 | 23803 |
| 14-#10 | 1.95 | MA | 11386 | 2926 | 16536 | 2448 | 19524 | 2049 | 21270 | 1730 | 23326 | 1242 | 28398 | 980 | 16158 |
| 3L-6S | | MI | 6582 | 2926 | 9712 | 2392 | 11021 | 2012 | 11649 | 1698 | 12154 | 1213 | 14392 | 755 | 9387 |
| 14-#10 | 1.95 | MA | 11204 | 2926 | 16033 | 2461 | 18813 | 2069 | 20397 | 1749 | 22129 | 1251 | 26970 | 930 | 16105 |
| 4L-5S | | MI | 6728 | 2926 | 9983 | 2385 | 11381 | 1995 | 12095 | 1691 | 12757 | 1201 | 15191 | 816 | 9625 |
| 14-#10 | 1.95 | MA | 10908 | 2926 | 15514 | 2481 | 18197 | 2082 | 19629 | 1761 | 21058 | 1269 | 25512 | 892 | 15987 |
| 5L-4S | | MI | 6873 | 2926 | 10286 | 2367 | 11746 | 1987 | 12549 | 1676 | 13388 | 1188 | 16064 | 868 | 9654 |
| 14-#10 | 1.95 | MA | 10650 | 2926 | 15015 | 2488 | 17605 | 2092 | 18876 | 1780 | 20010 | 1279 | 24089 | 826 | 15512 |
| 6L-3S | | MI | 6979 | 2926 | 10583 | 2357 | 12163 | 1971 | 13060 | 1669 | 14089 | 1184 | 16936 | 921 | 9660 |
| 14-#10 | 1.95 | MA | 10431 | 2926 | 14543 | 2496 | 16940 | 2108 | 18142 | 1791 | 18997 | 1297 | 22724 | 793 | 15103 |
| 7L-2S | | MI | 7189 | 2926 | 11013 | 2348 | 12711 | 1962 | 13726 | 1654 | 14989 | 1172 | 18182 | 1013 | 9652 |
| 14-#11 | 2.39 | MA | 11810 | 3042 | 17583 | 2511 | 20781 | 2094 | 22759 | 1756 | 25310 | 1231 | 31122 | 944 | 19576 |
| 3L-6S | | MI | 6725 | 3042 | 10135 | 2454 | 11475 | 2056 | 12163 | 1722 | 12820 | 1199 | 15206 | 658 | 11094 |
| 14-#11 | 2.39 | MA | 11598 | 3042 | 16971 | 2527 | 19916 | 2118 | 21697 | 1779 | 23853 | 1242 | 29375 | 883 | 19483 |
| 4L-5S | | MI | 6898 | 3042 | 10456 | 2445 | 11911 | 2037 | 12703 | 1715 | 13550 | 1185 | 16149 | 730 | 11367 |
| 14-#11 | 2.39 | MA | 11248 | 3042 | 16344 | 2552 | 19165 | 2133 | 20761 | 1792 | 22550 | 1263 | 27595 | 834 | 19149 |
| 5L-4S | | MI | 7065 | 3042 | 10823 | 2424 | 12353 | 2028 | 13252 | 1697 | 14313 | 1171 | 17179 | 795 | 11575 |
| 14-#11 | 2.39 | MA | 10942 | 3042 | 15738 | 2559 | 18453 | 2146 | 19844 | 1816 | 21307 | 1284 | 25859 | 751 | 18483 |
| 6L-3S | | MI | 7189 | 3042 | 11181 | 2413 | 12857 | 2008 | 13870 | 1690 | 15159 | 1168 | 18211 | 858 | 11598 |
| 14-#11 | 2.39 | MA | 10683 | 3042 | 15164 | 2569 | 17645 | 2165 | 18962 | 1829 | 20039 | 1295 | 24186 | 710 | 17920 |
| 7L-2S | | MI | 7433 | 3042 | 11699 | 2402 | 13516 | 1999 | 14670 | 1673 | 16242 | 1155 | 19678 | 970 | 11596 |
| 14-#14 | 3.45 | MA | 12582 | 3318 | 19107 | 2703 | 22545 | 2252 | 24859 | 1866 | 28103 | 1233 | 35348 | 783 | 27535 |
| 4L-5S | | MI | 7339 | 3318 | 11504 | 2620 | 13188 | 2164 | 14223 | 1798 | 15577 | 1170 | 18787 | 561 | 15430 |
| 14-#14 | 3.45 | MA | 12091 | 3318 | 18215 | 2740 | 21469 | 2272 | 23519 | 1884 | 26235 | 1263 | 32794 | 710 | 26336 |
| 5L-4S | | MI | 7568 | 3318 | 12028 | 2590 | 13818 | 2152 | 15006 | 1774 | 16664 | 1152 | 20227 | 655 | 16054 |
| 14-#14 | 3.45 | MA | 11675 | 3318 | 17348 | 2750 | 20458 | 2292 | 22203 | 1917 | 24454 | 1292 | 30302 | 587 | 25456 |
| 6L-3S | | MI | 7732 | 3318 | 12539 | 2575 | 14537 | 2125 | 15887 | 1765 | 17870 | 1149 | 21675 | 744 | 16236 |
| 14-#14 | 3.45 | MA | 11321 | 3318 | 16526 | 2764 | 19301 | 2318 | 20939 | 1935 | 22636 | 1307 | 27892 | 527 | 23918 |
| 7L-2S | | MI | 8060 | 3318 | 13274 | 2561 | 15472 | 2113 | 17023 | 1741 | 19408 | 1131 | 23726 | 906 | 16271 |
| 14-#18 | 6.14 | MA | 14146 | 4017 | 22810 | 3216 | 27169 | 2627 | 30354 | 2116 | 35384 | 1260 | 45683 | 388 | 43487 |
| 5L-4S | | MI | 8774 | 4017 | 14940 | 3017 | 17382 | 2469 | 19285 | 1969 | 22412 | 1100 | 27377 | 263 | 25801 |

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

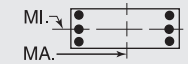



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 6.14 | MA | 13486 | 4017 | 21317 | 3236 | 25392 | 2660 | 28042 | 2172 | 32257 | 1309 | 41284 | 165 | 40144 |
| 6L-3S | | MI | 9057 | 4017 | 15827 | 2994 | 18629 | 2425 | 20811 | 1957 | 24500 | 1100 | 29809 | 412 | 27404 |
| 16-#10 | 2.23 | MA | 11566 | 2999 | 16781 | 2506 | 19765 | 2102 | 21552 | 1770 | 23693 | 1247 | 29136 | 925 | 18349 |
| 4L-6S | | MI | 6782 | 2999 | 10142 | 2438 | 11569 | 2045 | 12314 | 1718 | 13055 | 1209 | 15638 | 749 | 10644 |
| 16-#10 | 2.23 | MA | 11272 | 2999 | 16261 | 2527 | 19148 | 2115 | 20785 | 1781 | 22622 | 1265 | 27678 | 886 | 18225 |
| 5E | | MI | 6925 | 2999 | 10413 | 2430 | 11928 | 2028 | 12760 | 1711 | 13658 | 1196 | 16436 | 810 | 10893 |
| 16-#10 | 2.23 | MA | 11020 | 2999 | 15762 | 2533 | 18556 | 2125 | 20031 | 1801 | 21574 | 1274 | 26255 | 820 | 17730 |
| 6L-4S | | MI | 7069 | 2999 | 10716 | 2412 | 12293 | 2020 | 13214 | 1696 | 14288 | 1184 | 17309 | 862 | 10948 |
| 16-#10 | 2.23 | MA | 10809 | 2999 | 15291 | 2541 | 17892 | 2141 | 19297 | 1811 | 20561 | 1292 | 24890 | 787 | 17334 |
| 7L-3S | | MI | 7172 | 2999 | 11013 | 2403 | 12711 | 2003 | 13726 | 1689 | 14989 | 1180 | 18182 | 915 | 10961 |
| 16-#10 | 2.23 | MA | 10555 | 2999 | 14839 | 2551 | 17281 | 2149 | 18521 | 1827 | 19567 | 1310 | 23566 | 743 | 16768 |
| 8L-2S | | MI | 7378 | 2999 | 11443 | 2393 | 13258 | 1995 | 14391 | 1674 | 15889 | 1168 | 19427 | 1007 | 10959 |
| 16-#11 | 2.74 | MA | 12030 | 3131 | 17878 | 2582 | 21071 | 2159 | 23099 | 1805 | 25752 | 1237 | 32003 | 876 | 22202 |
| 4L-6S | | MI | 6962 | 3131 | 10653 | 2510 | 12134 | 2097 | 12963 | 1747 | 13903 | 1193 | 16673 | 647 | 12607 |
| 16-#11 | 2.74 | MA | 11681 | 3131 | 17251 | 2608 | 20320 | 2173 | 22164 | 1818 | 24448 | 1258 | 30224 | 827 | 21826 |
| 5E | | MI | 7131 | 3131 | 10974 | 2501 | 12570 | 2077 | 13503 | 1740 | 14632 | 1180 | 17617 | 720 | 12867 |
| 16-#11 | 2.74 | MA | 11384 | 3131 | 16645 | 2615 | 19608 | 2187 | 21246 | 1841 | 23206 | 1279 | 28488 | 743 | 21181 |
| 6L-4S | | MI | 7297 | 3131 | 11340 | 2479 | 13011 | 2068 | 14052 | 1723 | 15395 | 1166 | 18646 | 784 | 13125 |
| 16-#11 | 2.74 | MA | 11135 | 3131 | 16071 | 2625 | 18800 | 2205 | 20365 | 1854 | 21938 | 1290 | 26814 | 702 | 20613 |
| 7L-3S | | MI | 7416 | 3131 | 11699 | 2468 | 13516 | 2049 | 14670 | 1715 | 16242 | 1163 | 19678 | 847 | 13157 |
| 16-#11 | 2.74 | MA | 10834 | 3131 | 15521 | 2636 | 18056 | 2215 | 19420 | 1872 | 20727 | 1311 | 25197 | 646 | 19765 |
| 8L-2S | | MI | 7655 | 3131 | 12216 | 2457 | 14175 | 2040 | 15470 | 1698 | 17325 | 1149 | 21145 | 960 | 13166 |
| 16-#14 | 3.95 | MA | 12695 | 3446 | 19512 | 2820 | 23120 | 2331 | 25524 | 1921 | 28949 | 1255 | 36552 | 699 | 30190 |
| 5E | | MI | 7662 | 3446 | 12239 | 2700 | 14123 | 2222 | 15360 | 1834 | 17115 | 1162 | 20839 | 542 | 17571 |
| 16-#14 | 3.95 | MA | 12294 | 3446 | 18645 | 2830 | 22109 | 2351 | 24208 | 1954 | 27168 | 1285 | 34060 | 577 | 29331 |
| 6L-4S | | MI | 7891 | 3446 | 12763 | 2671 | 14754 | 2210 | 16142 | 1810 | 18203 | 1144 | 22279 | 636 | 18163 |
| 16-#14 | 3.95 | MA | 11957 | 3446 | 17823 | 2844 | 20952 | 2376 | 22945 | 1972 | 25350 | 1300 | 31651 | 517 | 27775 |
| 7L-3S | | MI | 8047 | 3446 | 13274 | 2656 | 15472 | 2183 | 17023 | 1801 | 19408 | 1141 | 23726 | 725 | 18438 |
| 16-#14 | 3.95 | MA | 11535 | 3446 | 17035 | 2860 | 19887 | 2390 | 21604 | 1999 | 23615 | 1329 | 29328 | 433 | 26214 |
| 8L-2S | | MI | 8366 | 3446 | 14008 | 2641 | 16408 | 2171 | 18160 | 1777 | 20946 | 1123 | 25778 | 887 | 18486 |
| 16-#18 | 7.02 | MA | 14532 | 4246 | 23583 | 3378 | 28276 | 2764 | 31546 | 2237 | 36998 | 1296 | 47850 | 147 | 46846 |
| 6L-4S | | MI | 9375 | 4246 | 16206 | 3160 | 18995 | 2573 | 21243 | 2033 | 25062 | 1087 | 30799 | 216 | 29473 |
| 18-#10 | 2.51 | MA | 11631 | 3071 | 17008 | 2572 | 20100 | 2147 | 21940 | 1802 | 24186 | 1261 | 29843 | 881 | 20464 |
| 5L-6S | | MI | 6980 | 3071 | 10572 | 2483 | 12116 | 2078 | 12979 | 1739 | 13955 | 1205 | 16883 | 743 | 11905 |
| 18-#10 | 2.51 | MA | 11385 | 3071 | 16510 | 2578 | 19508 | 2158 | 21187 | 1822 | 23138 | 1270 | 28420 | 814 | 19951 |
| 6L-5S | | MI | 7121 | 3071 | 10844 | 2476 | 12476 | 2061 | 13425 | 1732 | 14558 | 1192 | 17681 | 804 | 12142 |
| 18-#10 | 2.51 | MA | 11180 | 3071 | 16038 | 2587 | 18844 | 2174 | 20453 | 1832 | 22125 | 1288 | 27055 | 782 | 19566 |
| 7L-4S | | MI | 7264 | 3071 | 11146 | 2458 | 12841 | 2053 | 13879 | 1717 | 15189 | 1180 | 18555 | 856 | 12240 |
| 18-#10 | 2.51 | MA | 10929 | 3071 | 15586 | 2597 | 18233 | 2182 | 19676 | 1847 | 21131 | 1306 | 25731 | 738 | 18998 |
| 8L-3S | | MI | 7363 | 3071 | 11443 | 2448 | 13258 | 2036 | 14391 | 1710 | 15889 | 1176 | 19427 | 909 | 12259 |
| 18-#10 | 2.51 | MA | 10673 | 3071 | 15071 | 2615 | 17606 | 2200 | 18924 | 1855 | 20115 | 1316 | 24436 | 694 | 18418 |
| 9L-2S | | MI | 7565 | 3071 | 11873 | 2438 | 13806 | 2028 | 15056 | 1695 | 16789 | 1164 | 20672 | 1001 | 12263 |
| 18-#11 | 3.08 | MA | 12108 | 3220 | 18158 | 2663 | 21475 | 2214 | 23567 | 1843 | 26347 | 1253 | 32853 | 820 | 24508 |
| 5L-6S | | MI | 7196 | 3220 | 11170 | 2566 | 12793 | 2137 | 13763 | 1772 | 14986 | 1188 | 18140 | 636 | 14124 |
| 18-#11 | 3.08 | MA | 11820 | 3220 | 17552 | 2671 | 20763 | 2227 | 22649 | 1866 | 25104 | 1274 | 31116 | 736 | 23881 |
| 6L-5S | | MI | 7361 | 3220 | 11491 | 2556 | 13228 | 2118 | 14303 | 1765 | 15715 | 1175 | 19084 | 709 | 14372 |
| 18-#11 | 3.08 | MA | 11579 | 3220 | 16978 | 2681 | 19955 | 2245 | 21767 | 1879 | 23836 | 1285 | 29443 | 695 | 23308 |
| 7L-4S | | MI | 7526 | 3220 | 11858 | 2535 | 13670 | 2109 | 14852 | 1748 | 16478 | 1161 | 20113 | 774 | 14674 |
| 18-#11 | 3.08 | MA | 11281 | 3220 | 16428 | 2692 | 19211 | 2255 | 20822 | 1898 | 22625 | 1306 | 27826 | 639 | 22472 |
| 8L-3S | | MI | 7641 | 3220 | 12216 | 2524 | 14175 | 2089 | 15470 | 1741 | 17325 | 1158 | 21145 | 837 | 14715 |
| 18-#11 | 3.08 | MA | 10985 | 3220 | 15807 | 2714 | 18448 | 2276 | 19906 | 1907 | 21388 | 1317 | 26238 | 585 | 21528 |
| 9L-2S | | MI | 7876 | 3220 | 12733 | 2513 | 14833 | 2080 | 16271 | 1723 | 18408 | 1144 | 22612 | 949 | 14730 |
| 18-#14 | 4.44 | MA | 12903 | 3575 | 19942 | 2910 | 23760 | 2409 | 26214 | 1990 | 29883 | 1278 | 37819 | 566 | 33182 |
| 6L-5S | | MI | 7981 | 3575 | 12974 | 2781 | 15059 | 2281 | 16496 | 1871 | 18653 | 1155 | 22891 | 523 | 19719 |
| 18-#14 | 4.44 | MA | 12581 | 3575 | 19120 | 2924 | 22604 | 2435 | 24950 | 2008 | 28065 | 1292 | 35409 | 506 | 31631 |
| 7L-4S | | MI | 8209 | 3575 | 13498 | 2751 | 15689 | 2269 | 17279 | 1847 | 19741 | 1137 | 24330 | 617 | 20282 |
| 18-#14 | 4.44 | MA | 12162 | 3575 | 18332 | 2941 | 21538 | 2448 | 23609 | 2035 | 26329 | 1322 | 33086 | 423 | 30054 |
| 8L-3S | | MI | 8358 | 3575 | 14008 | 2736 | 16408 | 2242 | 18160 | 1838 | 20946 | 1134 | 25778 | 706 | 20638 |

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

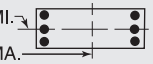



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 2.79 | MA | 11746 | 3144 | 17257 | 2624 | 20460 | 2191 | 22343 | 1842 | 24702 | 1266 | 30586 | 808 | 22175 |
| 6E | | MI | 7176 | 3144 | 11002 | 2528 | 12664 | 2111 | 13644 | 1759 | 14855 | 1200 | 18128 | 737 | 13168 |
| 20-#10 | 2.79 | MA | 11547 | 3144 | 16785 | 2632 | 19795 | 2207 | 21609 | 1852 | 23689 | 1284 | 29221 | 776 | 21800 |
| 7L-5S | | MI | 7314 | 3144 | 11274 | 2521 | 13024 | 2094 | 14090 | 1753 | 15458 | 1188 | 18926 | 798 | 13395 |
| 20-#10 | 2.79 | MA | 11297 | 3144 | 16334 | 2642 | 19184 | 2215 | 20832 | 1868 | 22695 | 1302 | 27897 | 732 | 21229 |
| 8L-4S | | MI | 7457 | 3144 | 11576 | 2503 | 13389 | 2086 | 14544 | 1737 | 16089 | 1176 | 19800 | 850 | 13530 |
| 20-#10 | 2.79 | MA | 11054 | 3144 | 15819 | 2660 | 18557 | 2233 | 20080 | 1876 | 21679 | 1311 | 26601 | 688 | 20651 |
| 9L-3S | | MI | 7553 | 3144 | 11873 | 2493 | 13806 | 2069 | 15056 | 1730 | 16789 | 1172 | 20672 | 903 | 13555 |
| 20-#10 | 2.79 | MA | 10822 | 3144 | 15350 | 2667 | 17967 | 2243 | 19329 | 1893 | 20665 | 1327 | 25175 | 639 | 19873 |
| 10L-2S | | MI | 7751 | 3144 | 12303 | 2484 | 14354 | 2061 | 15721 | 1715 | 17690 | 1160 | 21917 | 995 | 13565 |
| 20-#11 | 3.42 | MA | 12249 | 3309 | 18459 | 2726 | 21918 | 2268 | 24052 | 1892 | 27003 | 1269 | 33745 | 729 | 26585 |
| 6E | | MI | 7427 | 3309 | 11688 | 2621 | 13451 | 2178 | 14563 | 1798 | 16069 | 1183 | 19608 | 626 | 15644 |
| 20-#11 | 3.42 | MA | 12017 | 3309 | 17885 | 2736 | 21110 | 2286 | 23170 | 1905 | 25735 | 1280 | 32072 | 688 | 26007 |
| 7L-5S | | MI | 7588 | 3309 | 12008 | 2612 | 13887 | 2158 | 15103 | 1791 | 16798 | 1170 | 20551 | 698 | 15881 |
| 20-#11 | 3.42 | MA | 11721 | 3309 | 17335 | 2748 | 20366 | 2296 | 22225 | 1923 | 24524 | 1301 | 30454 | 632 | 25178 |
| 8L-4S | | MI | 7753 | 3309 | 12375 | 2591 | 14329 | 2149 | 15652 | 1773 | 17561 | 1156 | 21580 | 763 | 16222 |
| 20-#11 | 3.42 | MA | 11434 | 3309 | 16714 | 2770 | 19603 | 2317 | 21309 | 1932 | 23286 | 1312 | 28866 | 578 | 24224 |
| 9L-3S | | MI | 7864 | 3309 | 12733 | 2580 | 14833 | 2130 | 16271 | 1766 | 18408 | 1153 | 22612 | 826 | 16270 |
| 20-#11 | 3.42 | MA | 11159 | 3309 | 16144 | 2779 | 18884 | 2329 | 20395 | 1953 | 22070 | 1331 | 27254 | 529 | 23309 |
| 10L-2S | | MI | 8094 | 3309 | 13251 | 2569 | 15492 | 2121 | 17071 | 1749 | 19491 | 1139 | 24080 | 938 | 16291 |
| 20-#14 | 4.93 | MA | 13194 | 3703 | 20417 | 3005 | 24255 | 2493 | 26956 | 2045 | 30779 | 1285 | 39168 | 496 | 35488 |
| 7L-5S | | MI | 8297 | 3703 | 13709 | 2861 | 15995 | 2339 | 17633 | 1907 | 20191 | 1147 | 24942 | 505 | 21872 |
| 20-#14 | 4.93 | MA | 12779 | 3703 | 19629 | 3021 | 23190 | 2507 | 25615 | 2071 | 29044 | 1314 | 36845 | 413 | 33895 |
| 8L-4S | | MI | 8525 | 3703 | 14232 | 2831 | 16625 | 2327 | 18415 | 1883 | 21279 | 1129 | 26382 | 599 | 22409 |
| 22-#10 | 3.06 | MA | 11910 | 3216 | 17533 | 2677 | 20747 | 2239 | 22764 | 1873 | 25253 | 1280 | 31387 | 770 | 24036 |
| 7L-6S | | MI | 7370 | 3216 | 11432 | 2574 | 13211 | 2144 | 14309 | 1780 | 15755 | 1196 | 19373 | 731 | 14433 |
| 22-#10 | 3.06 | MA | 11661 | 3216 | 17081 | 2687 | 20136 | 2248 | 21988 | 1888 | 24259 | 1298 | 30063 | 726 | 23461 |
| 8L-5S | | MI | 7505 | 3216 | 11704 | 2566 | 13571 | 2127 | 14755 | 1773 | 16358 | 1184 | 20172 | 792 | 14652 |
| 22-#10 | 3.06 | MA | 11424 | 3216 | 16566 | 2705 | 19509 | 2266 | 21235 | 1896 | 23243 | 1307 | 28767 | 683 | 22884 |
| 9L-4S | | MI | 7648 | 3216 | 12007 | 2548 | 13936 | 2119 | 15209 | 1758 | 16989 | 1172 | 21045 | 844 | 14820 |
| 22-#10 | 3.06 | MA | 11200 | 3216 | 16097 | 2713 | 18918 | 2276 | 20485 | 1913 | 22229 | 1323 | 27341 | 633 | 22099 |
| 10L-3S | | MI | 7741 | 3216 | 12303 | 2539 | 14354 | 2102 | 15721 | 1751 | 17690 | 1168 | 21917 | 898 | 14849 |
| 22-#10 | 3.06 | MA | 10956 | 3216 | 15639 | 2721 | 18327 | 2285 | 19750 | 1923 | 21190 | 1330 | 26052 | 586 | 21361 |
| 11L-2S | | MI | 7936 | 3216 | 12733 | 2529 | 14901 | 2094 | 16386 | 1736 | 18590 | 1155 | 23163 | 989 | 14863 |
| 22-#11 | 3.76 | MA | 12449 | 3398 | 18792 | 2792 | 22265 | 2326 | 24573 | 1930 | 27633 | 1274 | 34701 | 681 | 28707 |
| 7L-6S | | MI | 7656 | 3398 | 12205 | 2677 | 14110 | 2218 | 15363 | 1823 | 17152 | 1178 | 21075 | 615 | 17167 |
| 22-#11 | 3.76 | MA | 12155 | 3398 | 18242 | 2803 | 21521 | 2336 | 23628 | 1948 | 26422 | 1296 | 33083 | 625 | 27884 |
| 8L-5S | | MI | 7814 | 3398 | 12526 | 2668 | 14546 | 2199 | 15904 | 1816 | 17881 | 1164 | 22018 | 688 | 17395 |
| 22-#11 | 3.76 | MA | 11875 | 3398 | 17622 | 2826 | 20758 | 2357 | 22712 | 1957 | 25185 | 1306 | 31495 | 571 | 26920 |
| 9L-4S | | MI | 7979 | 3398 | 12893 | 2646 | 14988 | 2190 | 16452 | 1798 | 18644 | 1151 | 23048 | 752 | 17769 |
| 22-#11 | 3.76 | MA | 11622 | 3398 | 17051 | 2834 | 20039 | 2369 | 21798 | 1978 | 23968 | 1326 | 29883 | 522 | 25996 |
| 10L-3S | | MI | 8086 | 3398 | 13251 | 2635 | 15492 | 2170 | 17071 | 1791 | 19491 | 1147 | 24080 | 816 | 17823 |
| 22-#14 | 5.43 | MA | 13386 | 3832 | 20926 | 3101 | 24841 | 2565 | 27621 | 2108 | 31758 | 1307 | 40603 | 402 | 37736 |
| 8L-5S | | MI | 8610 | 3832 | 14444 | 2941 | 16931 | 2397 | 18769 | 1944 | 21729 | 1140 | 26994 | 486 | 24029 |
| 24-#10 | 3.34 | MA | 12020 | 3289 | 17828 | 2733 | 21087 | 2281 | 23144 | 1909 | 25823 | 1293 | 32228 | 720 | 25695 |
| 8L-6S | | MI | 7563 | 3289 | 11862 | 2619 | 13759 | 2177 | 14974 | 1800 | 16655 | 1192 | 20619 | 725 | 15700 |
| 24-#10 | 3.34 | MA | 11789 | 3289 | 17313 | 2751 | 20460 | 2299 | 22391 | 1917 | 24807 | 1303 | 30933 | 677 | 25117 |
| 9L-5S | | MI | 7695 | 3289 | 12134 | 2612 | 14119 | 2160 | 15421 | 1794 | 17258 | 1180 | 21417 | 786 | 15911 |
| 24-#10 | 3.34 | MA | 11572 | 3289 | 16844 | 2758 | 19870 | 2308 | 21641 | 1934 | 23793 | 1319 | 29507 | 627 | 24325 |
| 10L-4S | | MI | 7837 | 3289 | 12437 | 2594 | 14484 | 2152 | 15874 | 1778 | 17889 | 1167 | 22291 | 838 | 16108 |
| 24-#10 | 3.34 | MA | 11330 | 3289 | 16387 | 2767 | 19278 | 2317 | 20906 | 1943 | 22754 | 1326 | 28217 | 581 | 23581 |
| 11L-3S | | MI | 7928 | 3289 | 12733 | 2584 | 14901 | 2135 | 16386 | 1772 | 18590 | 1163 | 23163 | 892 | 16143 |
| 24-#11 | 4.11 | MA | 12583 | 3487 | 19150 | 2859 | 22676 | 2377 | 25031 | 1973 | 28321 | 1290 | 35712 | 617 | 30590 |
| 8L-6S | | MI | 7883 | 3487 | 12722 | 2733 | 14769 | 2258 | 16164 | 1848 | 18235 | 1173 | 22542 | 605 | 18692 |
| 24-#11 | 4.11 | MA | 12311 | 3487 | 18529 | 2882 | 21913 | 2398 | 24115 | 1983 | 27083 | 1301 | 34124 | 564 | 29616 |
| 9L-5S | | MI | 8038 | 3487 | 13043 | 2723 | 15205 | 2239 | 16704 | 1841 | 18964 | 1159 | 23486 | 677 | 18911 |
| 24-#11 | 4.11 | MA | 12065 | 3487 | 17958 | 2890 | 21194 | 2409 | 23201 | 2003 | 25867 | 1321 | 32512 | 514 | 28684 |
| 10L-4S | | MI | 8202 | 3487 | 13410 | 2702 | 15647 | 2230 | 17253 | 1824 | 19727 | 1146 | 24515 | 742 | 19315 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

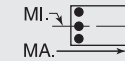
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.67 | MA | 12519 | 3003 | 18398 | 2486 | 21533 | 2084 | 23348 | 1765 | 25467 | 1276 | 30882 | 1106 | 15113 |
| 2E | | MI | 7230 | 3003 | 11195 | 2361 | 12651 | 1978 | 13455 | 1673 | 14352 | 1202 | 16612 | 985 | 8508 |
| 6-#14 | 1.41 | MA | 12227 | 2931 | 17583 | 2458 | 20608 | 2066 | 22281 | 1758 | 24070 | 1290 | 28981 | 1120 | 12946 |
| 2L-3S | | MI | 6739 | 2931 | 10027 | 2359 | 11263 | 1981 | 11818 | 1697 | 12172 | 1241 | 13962 | 874 | 7400 |
| 6-#14 | 1.41 | MA | 11496 | 2931 | 16206 | 2480 | 18855 | 2087 | 20151 | 1777 | 21187 | 1320 | 24990 | 977 | 12934 |
| 3L-2S | | MI | 7110 | 2931 | 10762 | 2345 | 12199 | 1969 | 12954 | 1674 | 13710 | 1223 | 16013 | 1036 | 7362 |
| 6-#18 | 2.50 | MA | 13617 | 3231 | 20806 | 2628 | 24599 | 2188 | 27072 | 1830 | 30507 | 1262 | 37860 | 1087 | 22396 |
| 2L-3S | | MI | 7168 | 3231 | 11195 | 2527 | 12651 | 2099 | 13455 | 1776 | 14352 | 1215 | 16612 | 651 | 12369 |
| 6-#18 | 2.50 | MA | 12431 | 3231 | 18398 | 2666 | 21533 | 2222 | 23348 | 1861 | 25467 | 1313 | 30882 | 826 | 22190 |
| 3L-2S | | MI | 7767 | 3231 | 12461 | 2504 | 14263 | 2082 | 15413 | 1738 | 17002 | 1189 | 20034 | 939 | 12384 |
| 8-#10 | 1.06 | MA | 11793 | 2836 | 16461 | 2418 | 19318 | 2040 | 20782 | 1746 | 22099 | 1307 | 26295 | 1138 | 9934 |
| 2L-4S | | MI | 6575 | 2836 | 9417 | 2338 | 10570 | 1980 | 11031 | 1693 | 11145 | 1264 | 12826 | 941 | 5771 |
| 8-#10 | 1.06 | MA | 11360 | 2836 | 15669 | 2432 | 18309 | 2052 | 19557 | 1757 | 20440 | 1325 | 23998 | 1060 | 9943 |
| 3E | | MI | 6694 | 2836 | 9713 | 2328 | 10988 | 1963 | 11543 | 1687 | 11846 | 1260 | 13699 | 995 | 5748 |
| 8-#10 | 1.06 | MA | 11139 | 2836 | 15136 | 2445 | 17556 | 2073 | 18632 | 1777 | 19172 | 1335 | 22491 | 1011 | 9922 |
| 4L-2S | | MI | 6917 | 2836 | 10144 | 2318 | 11535 | 1955 | 12208 | 1671 | 12746 | 1248 | 14944 | 1086 | 5726 |
| 8-#11 | 1.30 | MA | 12107 | 2902 | 17236 | 2448 | 20223 | 2060 | 21842 | 1756 | 23500 | 1296 | 28210 | 1127 | 12053 |
| 2L-4S | | MI | 6658 | 2902 | 9696 | 2362 | 10845 | 1997 | 11328 | 1700 | 11520 | 1250 | 13272 | 882 | 6932 |
| 8-#11 | 1.30 | MA | 11593 | 2902 | 16273 | 2464 | 18997 | 2075 | 20353 | 1769 | 21485 | 1318 | 25420 | 1029 | 12055 |
| 3E | | MI | 6798 | 2902 | 10054 | 2351 | 11349 | 1977 | 11947 | 1693 | 12366 | 1246 | 14304 | 945 | 6909 |
| 8-#11 | 1.30 | MA | 11330 | 2902 | 15624 | 2480 | 18081 | 2100 | 19228 | 1793 | 19941 | 1330 | 23576 | 968 | 12003 |
| 4L-2S | | MI | 7061 | 2902 | 10571 | 2340 | 12008 | 1968 | 12747 | 1676 | 13449 | 1233 | 15771 | 1057 | 6883 |
| 8-#14 | 1.88 | MA | 12874 | 3060 | 18960 | 2538 | 22362 | 2124 | 24411 | 1794 | 26952 | 1282 | 32973 | 1110 | 17119 |
| 2L-4S | | MI | 6879 | 3060 | 10251 | 2455 | 11480 | 2067 | 12073 | 1743 | 12505 | 1236 | 14565 | 766 | 9615 |
| 8-#14 | 1.88 | MA | 12170 | 3060 | 17583 | 2560 | 20608 | 2145 | 22281 | 1813 | 24070 | 1313 | 28981 | 967 | 17076 |
| 3E | | MI | 7072 | 3060 | 10762 | 2440 | 12199 | 2040 | 12954 | 1734 | 13710 | 1233 | 16013 | 855 | 9639 |
| 8-#14 | 1.88 | MA | 11812 | 3060 | 16654 | 2583 | 19294 | 2180 | 20668 | 1847 | 21859 | 1328 | 26329 | 879 | 16869 |
| 4L-2S | | MI | 7431 | 3060 | 11497 | 2425 | 13135 | 2028 | 14091 | 1710 | 15248 | 1215 | 18065 | 1017 | 9616 |
| 8-#18 | 3.33 | MA | 14685 | 3459 | 23215 | 2771 | 27665 | 2292 | 30796 | 1895 | 35548 | 1249 | 44839 | 1069 | 29658 |
| 2L-4S | | MI | 7411 | 3459 | 11574 | 2693 | 13017 | 2246 | 13887 | 1852 | 14914 | 1201 | 17602 | 456 | 15083 |
| 8-#18 | 3.33 | MA | 13565 | 3459 | 20806 | 2809 | 24599 | 2326 | 27072 | 1926 | 30507 | 1300 | 37860 | 808 | 29397 |
| 3E | | MI | 7722 | 3459 | 12461 | 2670 | 14263 | 2203 | 15413 | 1840 | 17002 | 1202 | 20034 | 605 | 16152 |
| 8-#18 | 3.33 | MA | 12996 | 3459 | 19174 | 2847 | 22293 | 2387 | 24242 | 1984 | 26629 | 1325 | 33171 | 649 | 27448 |
| 4L-2S | | MI | 8295 | 3459 | 13727 | 2647 | 15875 | 2185 | 17372 | 1802 | 19652 | 1175 | 23455 | 892 | 16228 |
| 10-#10 | 1.32 | MA | 12179 | 2908 | 17254 | 2464 | 20327 | 2073 | 22008 | 1766 | 23758 | 1303 | 28592 | 1132 | 12339 |
| 2L-5S | | MI | 6633 | 2908 | 9544 | 2401 | 10753 | 2021 | 11242 | 1729 | 11414 | 1272 | 13198 | 883 | 7083 |
| 10-#10 | 1.32 | MA | 11756 | 2908 | 16461 | 2477 | 19318 | 2085 | 20782 | 1778 | 22099 | 1321 | 26295 | 1054 | 12338 |
| 3L-4S | | MI | 6779 | 2908 | 9847 | 2383 | 11118 | 2012 | 11696 | 1714 | 12045 | 1260 | 14072 | 936 | 7083 |
| 10-#10 | 1.32 | MA | 11544 | 2908 | 15929 | 2490 | 18565 | 2106 | 19858 | 1798 | 20831 | 1331 | 24788 | 1005 | 12304 |
| 4L-3S | | MI | 6893 | 2908 | 10144 | 2373 | 11535 | 1996 | 12208 | 1707 | 12746 | 1256 | 14944 | 989 | 7068 |
| 10-#10 | 1.32 | MA | 11222 | 2908 | 15376 | 2510 | 17913 | 2118 | 19045 | 1809 | 19698 | 1350 | 23247 | 968 | 12201 |
| 5L-2S | | MI | 7113 | 2908 | 10574 | 2364 | 12083 | 1988 | 12873 | 1692 | 13646 | 1244 | 16189 | 1080 | 7050 |
| 10-#11 | 1.63 | MA | 12565 | 2991 | 18198 | 2504 | 21449 | 2100 | 23331 | 1781 | 25515 | 1291 | 31000 | 1120 | 14972 |
| 2L-5S | | MI | 6730 | 2991 | 9846 | 2439 | 11062 | 2046 | 11580 | 1743 | 11839 | 1258 | 13710 | 806 | 8475 |
| 10-#11 | 1.63 | MA | 12065 | 2991 | 17236 | 2520 | 20223 | 2115 | 21842 | 1795 | 23500 | 1313 | 28210 | 1022 | 14958 |
| 3L-4S | | MI | 6899 | 2991 | 10213 | 2418 | 11504 | 2037 | 12129 | 1726 | 12602 | 1244 | 14739 | 871 | 8501 |
| 10-#11 | 1.63 | MA | 11815 | 2991 | 16587 | 2535 | 19307 | 2140 | 20717 | 1819 | 21956 | 1324 | 26366 | 961 | 14889 |
| 4L-3S | | MI | 7034 | 2991 | 10571 | 2407 | 12008 | 2018 | 12747 | 1718 | 13449 | 1241 | 15771 | 934 | 8491 |
| 10-#11 | 1.63 | MA | 11433 | 2991 | 15919 | 2560 | 18512 | 2155 | 19726 | 1832 | 20576 | 1346 | 24484 | 914 | 14697 |
| 5L-2S | | MI | 7291 | 2991 | 11089 | 2396 | 12667 | 2009 | 13547 | 1701 | 14532 | 1228 | 17239 | 1046 | 8472 |
| 10-#14 | 2.34 | MA | 13507 | 3188 | 20338 | 2618 | 24115 | 2183 | 26541 | 1831 | 29835 | 1275 | 36964 | 1099 | 21279 |
| 2L-5S | | MI | 6984 | 3188 | 10462 | 2565 | 11786 | 2137 | 12427 | 1803 | 12955 | 1247 | 15177 | 654 | 11287 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

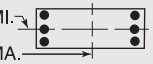



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.34 | MA | 12829 | 3188 | 18960 | 2641 | 22362 | 2203 | 24411 | 1850 | 26952 | 1305 | 32973 | 956 | 21214 |
| 3L-4S | | MI | 7216 | 3188 | 10986 | 2535 | 12416 | 2125 | 13210 | 1779 | 14043 | 1229 | 16617 | 748 | 11810 |
| 10-#14 | 2.34 | MA | 12494 | 3188 | 18031 | 2663 | 21048 | 2239 | 22798 | 1883 | 24741 | 1321 | 30320 | 868 | 20988 |
| 4L-3S | | MI | 7399 | 3188 | 11497 | 2520 | 13135 | 2098 | 14091 | 1770 | 15248 | 1226 | 18065 | 836 | 11862 |
| 10-#14 | 2.34 | MA | 11956 | 3188 | 17079 | 2699 | 19908 | 2259 | 21378 | 1902 | 22762 | 1351 | 27619 | 797 | 19887 |
| 5L-2S | | MI | 7748 | 3188 | 12231 | 2505 | 14070 | 2086 | 15227 | 1746 | 16786 | 1208 | 20116 | 998 | 11857 |
| 10-#18 | 4.17 | MA | 14668 | 3688 | 23215 | 2952 | 27665 | 2430 | 30796 | 1991 | 35548 | 1287 | 44839 | 789 | 36611 |
| 3L-4S | | MI | 7977 | 3688 | 12840 | 2835 | 14629 | 2350 | 15845 | 1916 | 17564 | 1188 | 21023 | 409 | 18682 |
| 10-#18 | 4.17 | MA | 14154 | 3688 | 21583 | 2989 | 25360 | 2491 | 27967 | 2048 | 31670 | 1311 | 40150 | 630 | 34578 |
| 4L-3S | | MI | 8266 | 3688 | 13727 | 2812 | 15875 | 2306 | 17372 | 1905 | 19652 | 1188 | 23455 | 558 | 19928 |
| 10-#18 | 4.17 | MA | 13246 | 3688 | 19921 | 3054 | 23356 | 2525 | 25473 | 2080 | 28194 | 1362 | 35391 | 496 | 32006 |
| 5L-2S | | MI | 8815 | 3688 | 14994 | 2789 | 17488 | 2289 | 19330 | 1867 | 22302 | 1162 | 26876 | 846 | 20046 |
| 12-#10 | 1.59 | MA | 12559 | 2981 | 18047 | 2509 | 21336 | 2106 | 23234 | 1787 | 25417 | 1299 | 30889 | 1127 | 14740 |
| 2L-6S | | MI | 6684 | 2981 | 9703 | 2454 | 10941 | 2070 | 11461 | 1757 | 11712 | 1280 | 13645 | 816 | 8206 |
| 12-#10 | 1.59 | MA | 12146 | 2981 | 17254 | 2522 | 20327 | 2118 | 22008 | 1798 | 23758 | 1317 | 28592 | 1048 | 14729 |
| 3L-5S | | MI | 6835 | 2981 | 9974 | 2447 | 11300 | 2054 | 11907 | 1750 | 12315 | 1268 | 14444 | 877 | 8375 |
| 12-#10 | 1.59 | MA | 11943 | 2981 | 16722 | 2535 | 19574 | 2139 | 21084 | 1818 | 22490 | 1327 | 27085 | 999 | 14685 |
| 4E | | MI | 6980 | 2981 | 10277 | 2428 | 11665 | 2045 | 12361 | 1735 | 12946 | 1256 | 15317 | 930 | 8388 |
| 12-#10 | 1.59 | MA | 11623 | 2981 | 16168 | 2556 | 18922 | 2151 | 20271 | 1830 | 21356 | 1345 | 25544 | 963 | 14573 |
| 5L-3S | | MI | 7091 | 2981 | 10574 | 2419 | 12083 | 2029 | 12873 | 1728 | 13646 | 1252 | 16189 | 983 | 8380 |
| 12-#10 | 1.59 | MA | 11340 | 2981 | 15640 | 2562 | 18291 | 2162 | 19474 | 1850 | 20247 | 1355 | 24040 | 897 | 14141 |
| 6L-2S | | MI | 7306 | 2981 | 11004 | 2409 | 12630 | 2021 | 13538 | 1713 | 14546 | 1240 | 17434 | 1074 | 8366 |
| 12-#11 | 1.95 | MA | 13016 | 3080 | 19161 | 2559 | 22675 | 2141 | 24820 | 1806 | 27530 | 1286 | 33790 | 1113 | 17883 |
| 2L-6S | | MI | 6791 | 3080 | 10043 | 2505 | 11285 | 2106 | 11840 | 1775 | 12193 | 1266 | 14234 | 723 | 9670 |
| 12-#11 | 1.95 | MA | 12530 | 3080 | 18198 | 2575 | 21449 | 2156 | 23331 | 1820 | 25515 | 1308 | 31000 | 1015 | 17858 |
| 3L-5S | | MI | 6969 | 3080 | 10364 | 2495 | 11721 | 2087 | 12380 | 1768 | 12922 | 1253 | 15177 | 796 | 9963 |
| 12-#11 | 1.95 | MA | 12292 | 3080 | 17550 | 2591 | 20532 | 2181 | 22205 | 1844 | 23971 | 1319 | 29156 | 954 | 17775 |
| 4E | | MI | 7137 | 3080 | 10730 | 2474 | 12162 | 2078 | 12929 | 1751 | 13685 | 1239 | 16207 | 861 | 10061 |
| 12-#11 | 1.95 | MA | 11912 | 3080 | 16882 | 2616 | 19738 | 2195 | 21215 | 1857 | 22591 | 1341 | 27274 | 906 | 17562 |
| 5L-3S | | MI | 7266 | 3080 | 11089 | 2463 | 12667 | 2058 | 13547 | 1744 | 14532 | 1236 | 17239 | 924 | 10065 |
| 12-#11 | 1.95 | MA | 11575 | 3080 | 16239 | 2624 | 18977 | 2209 | 20244 | 1881 | 21239 | 1352 | 25438 | 824 | 16801 |
| 6L-2S | | MI | 7518 | 3080 | 11606 | 2452 | 13326 | 2049 | 14347 | 1726 | 15615 | 1222 | 18706 | 1036 | 10052 |
| 12-#14 | 2.81 | MA | 13475 | 3317 | 20338 | 2721 | 24115 | 2262 | 26541 | 1886 | 29835 | 1298 | 36964 | 946 | 25351 |
| 3L-5S | | MI | 7317 | 3317 | 11197 | 2645 | 12721 | 2195 | 13564 | 1840 | 14493 | 1239 | 17229 | 635 | 13407 |
| 12-#14 | 2.81 | MA | 13161 | 3317 | 19408 | 2743 | 22802 | 2297 | 24928 | 1920 | 27624 | 1313 | 34311 | 858 | 25110 |
| 4E | | MI | 7548 | 3317 | 11721 | 2615 | 13352 | 2183 | 14346 | 1816 | 15581 | 1221 | 18668 | 729 | 14002 |
| 12-#14 | 2.81 | MA | 12628 | 3317 | 18456 | 2780 | 21662 | 2318 | 23508 | 1939 | 25645 | 1344 | 31610 | 787 | 23971 |
| 5L-3S | | MI | 7722 | 3317 | 12231 | 2600 | 14070 | 2156 | 15227 | 1807 | 16786 | 1218 | 20116 | 817 | 14074 |
| 12-#14 | 2.81 | MA | 12165 | 3317 | 17536 | 2790 | 20581 | 2337 | 22115 | 1973 | 23758 | 1374 | 28974 | 667 | 22972 |
| 6L-2S | | MI | 8061 | 3317 | 12966 | 2585 | 15006 | 2144 | 16364 | 1783 | 18324 | 1200 | 22168 | 979 | 14088 |
| 12-#18 | 5.00 | MA | 15280 | 3916 | 23991 | 3132 | 28426 | 2594 | 31691 | 2113 | 36710 | 1298 | 47129 | 612 | 41723 |
| 4E | | MI | 8532 | 3916 | 14107 | 2978 | 16241 | 2454 | 17803 | 1981 | 20214 | 1175 | 24445 | 363 | 22309 |
| 12-#18 | 5.00 | MA | 14380 | 3916 | 22329 | 3196 | 26422 | 2629 | 29197 | 2144 | 33234 | 1349 | 42369 | 478 | 39174 |
| 5L-3S | | MI | 8801 | 3916 | 14994 | 2955 | 17488 | 2410 | 19330 | 1970 | 22302 | 1175 | 26876 | 512 | 23701 |
| 12-#18 | 5.00 | MA | 13631 | 3916 | 20729 | 3215 | 24540 | 2663 | 26747 | 2202 | 29920 | 1400 | 37724 | 257 | 35782 |
| 6L-2S | | MI | 9332 | 3916 | 16260 | 2932 | 19100 | 2393 | 21288 | 1932 | 24953 | 1149 | 30297 | 800 | 23855 |
| 14-#10 | 1.85 | MA | 12530 | 3054 | 18047 | 2568 | 21336 | 2151 | 23234 | 1819 | 25417 | 1313 | 30889 | 1043 | 17118 |
| 3L-6S | | MI | 6887 | 3054 | 10133 | 2499 | 11488 | 2103 | 12126 | 1777 | 12612 | 1276 | 14890 | 810 | 9458 |
| 14-#10 | 1.85 | MA | 12335 | 3054 | 17514 | 2581 | 20583 | 2172 | 22309 | 1839 | 24149 | 1323 | 29382 | 994 | 17065 |
| 4L-5S | | MI | 7034 | 3054 | 10405 | 2492 | 11848 | 2087 | 12572 | 1770 | 13215 | 1264 | 15689 | 871 | 9664 |
| 14-#10 | 1.85 | MA | 12017 | 3054 | 16961 | 2601 | 19931 | 2184 | 21497 | 1851 | 23015 | 1341 | 27841 | 957 | 16947 |
| 5L-4S | | MI | 7179 | 3054 | 10707 | 2474 | 12213 | 2078 | 13026 | 1755 | 13846 | 1252 | 16562 | 924 | 9687 |
| 14-#10 | 1.85 | MA | 11742 | 3054 | 16432 | 2608 | 19300 | 2195 | 20700 | 1871 | 21906 | 1351 | 26337 | 892 | 16492 |
| 6L-3S | | MI | 7286 | 3054 | 11004 | 2464 | 12630 | 2062 | 13538 | 1748 | 14546 | 1248 | 17434 | 977 | 9687 |
| 14-#10 | 1.85 | MA | 11509 | 3054 | 15933 | 2616 | 18596 | 2211 | 19916 | 1881 | 20834 | 1370 | 24898 | 859 | 16048 |
| 7L-2S | | MI | 7497 | 3054 | 11434 | 2454 | 13178 | 2053 | 14203 | 1733 | 15447 | 1235 | 18680 | 1068 | 9678 |
| 14-#11 | 2.27 | MA | 12987 | 3169 | 19161 | 2631 | 22675 | 2196 | 24820 | 1845 | 27530 | 1303 | 33790 | 1007 | 20756 |
| 3L-6S | | MI | 7031 | 3169 | 10560 | 2560 | 11944 | 2147 | 12640 | 1801 | 13276 | 1261 | 15701 | 713 | 11177 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

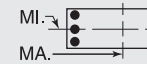
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.27 | MA | 12760 | 3169 | 18513 | 2647 | 21758 | 2221 | 23694 | 1869 | 25987 | 1314 | 31946 | 947 | 20662 |
| 4L-5S | | MI | 7204 | 3169 | 10881 | 2551 | 12379 | 2127 | 13180 | 1794 | 14005 | 1248 | 16644 | 785 | 11455 |
| 14-#11 | 2.27 | MA | 12383 | 3169 | 17845 | 2672 | 20963 | 2236 | 22704 | 1883 | 24606 | 1336 | 30064 | 899 | 20399 |
| 5L-4S | | MI | 7371 | 3169 | 11248 | 2529 | 12821 | 2118 | 13729 | 1776 | 14768 | 1234 | 17674 | 850 | 11616 |
| 14-#11 | 2.27 | MA | 12056 | 3169 | 17202 | 2679 | 20203 | 2249 | 21733 | 1907 | 23254 | 1347 | 28228 | 817 | 19662 |
| 6L-3S | | MI | 7496 | 3169 | 11606 | 2518 | 13326 | 2099 | 14347 | 1769 | 15615 | 1231 | 18706 | 913 | 11633 |
| 14-#11 | 2.27 | MA | 11779 | 3169 | 16594 | 2690 | 19346 | 2268 | 20790 | 1919 | 21948 | 1369 | 26464 | 777 | 19132 |
| 7L-2S | | MI | 7742 | 3169 | 12124 | 2507 | 13984 | 2090 | 15148 | 1752 | 16698 | 1217 | 20173 | 1025 | 11627 |
| 14-#14 | 3.28 | MA | 13815 | 3445 | 20785 | 2824 | 24555 | 2356 | 27058 | 1956 | 30506 | 1306 | 38303 | 848 | 29236 |
| 4L-5S | | MI | 7645 | 3445 | 11932 | 2725 | 13657 | 2254 | 14700 | 1876 | 16031 | 1232 | 19280 | 616 | 15538 |
| 14-#14 | 3.28 | MA | 13286 | 3445 | 19834 | 2860 | 23415 | 2376 | 25638 | 1975 | 28527 | 1336 | 35601 | 777 | 28062 |
| 5L-4S | | MI | 7875 | 3445 | 12455 | 2696 | 14287 | 2242 | 15483 | 1852 | 17119 | 1214 | 20720 | 710 | 16177 |
| 14-#14 | 3.28 | MA | 12841 | 3445 | 18913 | 2871 | 22334 | 2396 | 24245 | 2009 | 26641 | 1367 | 32965 | 656 | 27089 |
| 6L-3S | | MI | 8040 | 3445 | 12966 | 2681 | 15006 | 2215 | 16364 | 1843 | 18324 | 1211 | 22168 | 798 | 16281 |
| 14-#14 | 3.28 | MA | 12462 | 3445 | 18042 | 2885 | 21107 | 2422 | 22906 | 2028 | 24715 | 1382 | 30424 | 597 | 25534 |
| 7L-2S | | MI | 8371 | 3445 | 13701 | 2666 | 15942 | 2203 | 17500 | 1819 | 19863 | 1193 | 24219 | 960 | 16311 |
| 14-#18 | 5.83 | MA | 15486 | 4145 | 24737 | 3339 | 29489 | 2733 | 32921 | 2209 | 38274 | 1336 | 49348 | 460 | 46341 |
| 5L-4S | | MI | 9078 | 4145 | 15373 | 3121 | 17854 | 2558 | 19761 | 2046 | 22865 | 1161 | 27866 | 317 | 25958 |
| 14-#18 | 5.83 | MA | 14778 | 4145 | 23138 | 3358 | 27606 | 2767 | 30472 | 2267 | 34960 | 1387 | 44703 | 239 | 42908 |
| 6L-3S | | MI | 9367 | 4145 | 16260 | 3098 | 19100 | 2514 | 21288 | 2034 | 24953 | 1162 | 30297 | 466 | 27472 |
| 16-#10 | 2.12 | MA | 12723 | 3126 | 18307 | 2626 | 21593 | 2205 | 23535 | 1860 | 25808 | 1319 | 31679 | 988 | 19446 |
| 4L-6S | | MI | 7088 | 3126 | 10563 | 2544 | 12036 | 2136 | 12791 | 1798 | 13512 | 1272 | 16136 | 804 | 10715 |
| 16-#10 | 2.12 | MA | 12406 | 3126 | 17754 | 2646 | 20941 | 2217 | 22723 | 1871 | 24674 | 1337 | 30138 | 951 | 19322 |
| 5E | | MI | 7232 | 3126 | 10835 | 2537 | 12396 | 2120 | 13238 | 1791 | 14115 | 1260 | 16934 | 865 | 10952 |
| 16-#10 | 2.12 | MA | 12138 | 3126 | 17225 | 2653 | 20309 | 2228 | 21925 | 1891 | 23565 | 1347 | 28634 | 886 | 18847 |
| 6L-4S | | MI | 7376 | 3126 | 11137 | 2519 | 12761 | 2111 | 13691 | 1776 | 14746 | 1247 | 17808 | 918 | 10982 |
| 16-#10 | 2.12 | MA | 11912 | 3126 | 16726 | 2662 | 19605 | 2243 | 21142 | 1901 | 22493 | 1365 | 27195 | 853 | 18415 |
| 7L-3S | | MI | 7480 | 3126 | 11434 | 2509 | 13178 | 2095 | 14203 | 1769 | 15447 | 1244 | 18680 | 971 | 10991 |
| 16-#10 | 2.12 | MA | 11639 | 3126 | 16248 | 2672 | 18959 | 2252 | 20319 | 1917 | 21442 | 1384 | 25796 | 810 | 17871 |
| 8L-2S | | MI | 7687 | 3126 | 11864 | 2500 | 13726 | 2086 | 14868 | 1754 | 16347 | 1231 | 19925 | 1062 | 10986 |
| 16-#11 | 2.60 | MA | 13222 | 3258 | 19476 | 2702 | 22984 | 2262 | 25183 | 1894 | 28002 | 1309 | 34736 | 940 | 23550 |
| 4L-6S | | MI | 7267 | 3258 | 11078 | 2616 | 12602 | 2187 | 13440 | 1826 | 14359 | 1256 | 17168 | 702 | 12690 |
| 16-#11 | 2.60 | MA | 12846 | 3258 | 18807 | 2727 | 22189 | 2276 | 24193 | 1908 | 26621 | 1331 | 32855 | 892 | 23243 |
| 5E | | MI | 7437 | 3258 | 11399 | 2606 | 13038 | 2168 | 13980 | 1819 | 15088 | 1243 | 18112 | 775 | 12953 |
| 16-#11 | 2.60 | MA | 12529 | 3258 | 18164 | 2735 | 21429 | 2290 | 23222 | 1932 | 25269 | 1342 | 31018 | 810 | 22528 |
| 6L-4S | | MI | 7603 | 3258 | 11765 | 2585 | 13480 | 2158 | 14529 | 1801 | 15851 | 1229 | 19141 | 839 | 13168 |
| 16-#11 | 2.60 | MA | 12262 | 3258 | 17556 | 2745 | 20572 | 2308 | 22279 | 1945 | 23963 | 1364 | 29254 | 770 | 22004 |
| 7L-3S | | MI | 7724 | 3258 | 12124 | 2574 | 13984 | 2139 | 15148 | 1794 | 16698 | 1226 | 20173 | 902 | 13194 |
| 16-#11 | 2.60 | MA | 11938 | 3258 | 16974 | 2757 | 19785 | 2318 | 21278 | 1963 | 22681 | 1385 | 27545 | 715 | 21066 |
| 8L-2S | | MI | 7965 | 3258 | 12641 | 2563 | 14643 | 2130 | 15948 | 1777 | 17780 | 1212 | 21640 | 1015 | 13198 |
| 16-#14 | 3.75 | MA | 13932 | 3574 | 21211 | 2940 | 25169 | 2434 | 27768 | 2012 | 31410 | 1329 | 39592 | 766 | 32159 |
| 5E | | MI | 7968 | 3574 | 12667 | 2806 | 14593 | 2312 | 15837 | 1912 | 17570 | 1225 | 21332 | 597 | 17677 |
| 16-#14 | 3.75 | MA | 13503 | 3574 | 20291 | 2951 | 24088 | 2454 | 26374 | 2045 | 29523 | 1359 | 36956 | 646 | 31205 |
| 6L-4S | | MI | 8197 | 3574 | 13190 | 2776 | 15223 | 2300 | 16620 | 1889 | 18657 | 1207 | 22772 | 691 | 18283 |
| 16-#14 | 3.75 | MA | 13142 | 3574 | 19419 | 2965 | 22861 | 2480 | 25036 | 2064 | 27598 | 1375 | 34415 | 587 | 29631 |
| 7L-3S | | MI | 8356 | 3574 | 13701 | 2761 | 15942 | 2273 | 17500 | 1880 | 19863 | 1203 | 24219 | 780 | 18485 |
| 16-#14 | 3.75 | MA | 12686 | 3574 | 18585 | 2982 | 21732 | 2494 | 23601 | 2090 | 25760 | 1405 | 31960 | 506 | 28059 |
| 8L-2S | | MI | 8677 | 3574 | 14436 | 2746 | 16878 | 2261 | 18637 | 1856 | 21401 | 1185 | 26271 | 941 | 18527 |
| 16-#18 | 6.67 | MA | 15898 | 4373 | 25546 | 3500 | 30672 | 2871 | 34196 | 2331 | 40000 | 1374 | 51682 | 220 | 50033 |
| 6L-4S | | MI | 9681 | 4373 | 16639 | 3264 | 19466 | 2661 | 21720 | 2111 | 25515 | 1148 | 31287 | 270 | 29625 |
| 18-#10 | 2.38 | MA | 12790 | 3199 | 18546 | 2692 | 21950 | 2250 | 23948 | 1892 | 26333 | 1333 | 32435 | 945 | 21699 |
| 5L-6S | | MI | 7286 | 3199 | 10993 | 2590 | 12583 | 2169 | 13456 | 1818 | 14412 | 1268 | 17381 | 798 | 11974 |
| 18-#10 | 2.38 | MA | 12528 | 3199 | 18018 | 2698 | 21318 | 2261 | 23151 | 1912 | 25224 | 1343 | 30931 | 880 | 21204 |
| 6L-5S | | MI | 7427 | 3199 | 11265 | 2583 | 12943 | 2152 | 13903 | 1811 | 15015 | 1256 | 18179 | 859 | 12217 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

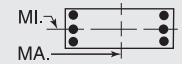



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.38 | MA | 12309 | 3199 | 17518 | 2707 | 20614 | 2276 | 22368 | 1922 | 24152 | 1361 | 29492 | 848 | 20785 |
| 7L-4S | | MI | 7571 | 3199 | 11568 | 2564 | 13308 | 2144 | 14356 | 1796 | 15646 | 1243 | 19053 | 912 | 12275 |
| 18-#10 | 2.38 | MA | 12038 | 3199 | 17040 | 2717 | 19968 | 2285 | 21545 | 1937 | 23101 | 1379 | 28093 | 805 | 20238 |
| 8L-3S | | MI | 7671 | 3199 | 11864 | 2555 | 13726 | 2128 | 14868 | 1789 | 16347 | 1239 | 19925 | 965 | 12290 |
| 18-#10 | 2.38 | MA | 11765 | 3199 | 16491 | 2735 | 19304 | 2303 | 20749 | 1946 | 22025 | 1389 | 26728 | 762 | 19602 |
| 9L-2S | | MI | 7875 | 3199 | 12294 | 2545 | 14273 | 2119 | 15533 | 1774 | 17247 | 1227 | 21170 | 1056 | 12291 |
| 18-#11 | 2.92 | MA | 13303 | 3348 | 19770 | 2783 | 23415 | 2317 | 25682 | 1933 | 28636 | 1325 | 35645 | 885 | 26092 |
| 5L-6S | | MI | 7502 | 3348 | 11595 | 2672 | 13261 | 2227 | 14240 | 1851 | 15442 | 1251 | 18636 | 691 | 14206 |
| 18-#11 | 2.92 | MA | 12995 | 3348 | 19127 | 2791 | 22655 | 2330 | 24710 | 1957 | 27284 | 1337 | 33808 | 803 | 25396 |
| 6L-5S | | MI | 7668 | 3348 | 11916 | 2662 | 13697 | 2208 | 14781 | 1844 | 16171 | 1237 | 19579 | 764 | 14457 |
| 18-#11 | 2.92 | MA | 12737 | 3348 | 18519 | 2801 | 21798 | 2349 | 23768 | 1970 | 25978 | 1359 | 32044 | 763 | 24870 |
| 7L-4S | | MI | 7833 | 3348 | 12283 | 2641 | 14139 | 2199 | 15329 | 1827 | 16934 | 1224 | 20608 | 829 | 14719 |
| 18-#11 | 2.92 | MA | 12415 | 3348 | 17937 | 2813 | 21011 | 2359 | 22766 | 1989 | 24696 | 1380 | 30335 | 708 | 23938 |
| 8L-3S | | MI | 7950 | 3348 | 12641 | 2630 | 14643 | 2180 | 15948 | 1819 | 17780 | 1220 | 21640 | 892 | 14753 |
| 18-#11 | 2.92 | MA | 12100 | 3348 | 17275 | 2835 | 20202 | 2380 | 21796 | 1998 | 23386 | 1392 | 28661 | 654 | 23001 |
| 9L-2S | | MI | 8186 | 3348 | 13159 | 2619 | 15302 | 2170 | 16748 | 1802 | 18863 | 1207 | 23108 | 1004 | 14765 |
| 18-#14 | 4.22 | MA | 14154 | 3702 | 21668 | 3031 | 25842 | 2512 | 28504 | 2082 | 32405 | 1352 | 40947 | 636 | 35321 |
| 6L-5S | | MI | 8288 | 3702 | 13402 | 2886 | 15529 | 2370 | 16973 | 1949 | 19108 | 1217 | 23384 | 578 | 19822 |
| 18-#14 | 4.22 | MA | 13809 | 3702 | 20797 | 3046 | 24615 | 2539 | 27165 | 2101 | 30480 | 1367 | 38407 | 577 | 33727 |
| 7L-4S | | MI | 8516 | 3702 | 13925 | 2856 | 16159 | 2358 | 17756 | 1925 | 20196 | 1199 | 24823 | 672 | 20400 |
| 18-#14 | 4.22 | MA | 13357 | 3702 | 19962 | 3062 | 23486 | 2553 | 25731 | 2127 | 28642 | 1398 | 35951 | 495 | 32138 |
| 8L-3S | | MI | 8668 | 3702 | 14436 | 2841 | 16878 | 2331 | 18637 | 1916 | 21401 | 1196 | 26271 | 761 | 20687 |
| 18-#14 | 4.22 | MA | 12925 | 3702 | 19019 | 3095 | 22327 | 2583 | 24340 | 2140 | 26763 | 1414 | 33540 | 418 | 30584 |
| 9L-2S | | MI | 8982 | 3702 | 15171 | 2826 | 17813 | 2320 | 19773 | 1892 | 22939 | 1178 | 28323 | 922 | 20740 |
| 20-#10 | 2.65 | MA | 12913 | 3271 | 18810 | 2744 | 22328 | 2294 | 24377 | 1932 | 26883 | 1339 | 33228 | 874 | 23565 |
| 6E | | MI | 7482 | 3271 | 11423 | 2635 | 13131 | 2202 | 14122 | 1839 | 15312 | 1264 | 18626 | 793 | 13237 |
| 20-#10 | 2.65 | MA | 12701 | 3271 | 18311 | 2752 | 21624 | 2309 | 23593 | 1942 | 25811 | 1357 | 31789 | 842 | 23156 |
| 7L-5S | | MI | 7621 | 3271 | 11695 | 2628 | 13491 | 2185 | 14568 | 1832 | 15915 | 1251 | 19425 | 854 | 13469 |
| 20-#10 | 2.65 | MA | 12432 | 3271 | 17833 | 2762 | 20977 | 2318 | 22771 | 1958 | 24760 | 1375 | 30390 | 799 | 22607 |
| 8L-4S | | MI | 7764 | 3271 | 11998 | 2610 | 13856 | 2177 | 15021 | 1817 | 16546 | 1239 | 20298 | 906 | 13567 |
| 20-#10 | 2.65 | MA | 12172 | 3271 | 17284 | 2780 | 20313 | 2336 | 21974 | 1966 | 23684 | 1385 | 29025 | 756 | 21971 |
| 9L-3S | | MI | 7861 | 3271 | 12294 | 2600 | 14273 | 2161 | 15533 | 1810 | 17247 | 1235 | 21170 | 959 | 13587 |
| 20-#10 | 2.65 | MA | 11924 | 3271 | 16787 | 2788 | 19688 | 2346 | 21180 | 1984 | 22600 | 1400 | 27518 | 707 | 21197 |
| 10L-2S | | MI | 8062 | 3271 | 12724 | 2590 | 14821 | 2152 | 16198 | 1795 | 18147 | 1223 | 22415 | 1050 | 13594 |
| 20-#11 | 3.25 | MA | 13454 | 3437 | 20090 | 2846 | 23881 | 2370 | 26199 | 1982 | 29300 | 1332 | 36598 | 796 | 28268 |
| 6E | | MI | 7733 | 3437 | 12113 | 2727 | 13920 | 2268 | 15041 | 1876 | 16524 | 1246 | 20103 | 681 | 15725 |
| 20-#11 | 3.25 | MA | 13206 | 3437 | 19482 | 2857 | 23024 | 2389 | 25257 | 1995 | 27993 | 1353 | 34834 | 755 | 27738 |
| 7L-5S | | MI | 7896 | 3437 | 12434 | 2718 | 14356 | 2248 | 15581 | 1869 | 17254 | 1232 | 21046 | 753 | 15966 |
| 20-#11 | 3.25 | MA | 12886 | 3437 | 18900 | 2869 | 22236 | 2399 | 24255 | 2014 | 26711 | 1375 | 33125 | 701 | 26811 |
| 8L-4S | | MI | 8061 | 3437 | 12800 | 2696 | 14798 | 2239 | 16130 | 1852 | 18017 | 1219 | 22076 | 818 | 16267 |
| 20-#11 | 3.25 | MA | 12579 | 3437 | 18237 | 2891 | 21428 | 2421 | 23285 | 2023 | 25401 | 1386 | 31451 | 647 | 25863 |
| 9L-3S | | MI | 8173 | 3437 | 13159 | 2685 | 15302 | 2220 | 16748 | 1845 | 18863 | 1215 | 23108 | 881 | 16309 |
| 20-#11 | 3.25 | MA | 12285 | 3437 | 17633 | 2900 | 20667 | 2433 | 22317 | 2044 | 24098 | 1406 | 29611 | 585 | 24896 |
| 10L-2S | | MI | 8405 | 3437 | 13676 | 2674 | 15961 | 2211 | 17548 | 1827 | 19946 | 1202 | 24575 | 993 | 16327 |
| 20-#14 | 4.69 | MA | 14465 | 3831 | 22174 | 3126 | 26368 | 2597 | 29295 | 2137 | 33363 | 1360 | 42398 | 566 | 37823 |
| 7L-5S | | MI | 8605 | 3831 | 14137 | 2966 | 16464 | 2429 | 18110 | 1985 | 20646 | 1210 | 25435 | 559 | 21973 |
| 20-#14 | 4.69 | MA | 14017 | 3831 | 21339 | 3143 | 25239 | 2611 | 27861 | 2163 | 31525 | 1390 | 39942 | 485 | 36217 |
| 8L-4S | | MI | 8833 | 3831 | 14660 | 2936 | 17095 | 2417 | 18893 | 1961 | 21734 | 1192 | 26875 | 653 | 22525 |
| 20-#14 | 4.69 | MA | 13600 | 3831 | 20396 | 3175 | 24080 | 2642 | 26470 | 2177 | 29645 | 1406 | 37531 | 407 | 34652 |
| 9L-3S | | MI | 8977 | 3831 | 15171 | 2922 | 17813 | 2390 | 19773 | 1952 | 22939 | 1188 | 28323 | 742 | 22887 |
| 22-#10 | 2.91 | MA | 13088 | 3344 | 19103 | 2798 | 22633 | 2342 | 24819 | 1963 | 27470 | 1353 | 34086 | 836 | 25529 |
| 7L-6S | | MI | 7677 | 3344 | 11854 | 2680 | 13679 | 2235 | 14787 | 1859 | 16212 | 1259 | 19872 | 787 | 14501 |
| 22-#10 | 2.91 | MA | 12820 | 3344 | 18626 | 2808 | 21986 | 2351 | 23997 | 1979 | 26418 | 1371 | 32687 | 793 | 24975 |
| 8L-5S | | MI | 7813 | 3344 | 12125 | 2673 | 14038 | 2218 | 15233 | 1853 | 16815 | 1247 | 20670 | 848 | 14725 |
| 22-#10 | 2.91 | MA | 12567 | 3344 | 18077 | 2826 | 21322 | 2369 | 23200 | 1987 | 25343 | 1381 | 31322 | 750 | 24340 |
| 9L-4S | | MI | 7956 | 3344 | 12428 | 2655 | 14403 | 2210 | 15686 | 1837 | 17446 | 1235 | 21543 | 900 | 14857 |
| 22-#10 | 2.91 | MA | 12327 | 3344 | 17580 | 2833 | 20698 | 2379 | 22406 | 2004 | 24259 | 1396 | 29815 | 701 | 23558 |
| 10L-3S | | MI | 8050 | 3344 | 12724 | 2645 | 14821 | 2193 | 16198 | 1831 | 18147 | 1231 | 22415 | 953 | 14883 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidewise
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 2.91 | MA | 12065 | 3344 | 17095 | 2842 | 20066 | 2388 | 21628 | 2014 | 23160 | 1404 | 28454 | 656 | 22828 |
| 11L-2S | | MI | 8247 | 3344 | 13154 | 2636 | 15368 | 2185 | 16863 | 1815 | 19047 | 1219 | 23661 | 1044 | 14894 |
| 22-#11 | 3.57 | MA | 13668 | 3526 | 20445 | 2912 | 24250 | 2430 | 26746 | 2020 | 30008 | 1348 | 37624 | 748 | 30608 |
| 7L-6S | | MI | 7963 | 3526 | 12630 | 2783 | 14579 | 2308 | 15841 | 1902 | 17607 | 1241 | 21570 | 670 | 17247 |
| 22-#11 | 3.57 | MA | 13350 | 3526 | 19862 | 2924 | 23462 | 2440 | 25744 | 2039 | 28726 | 1370 | 35915 | 693 | 29683 |
| 8L-5S | | MI | 8122 | 3526 | 12951 | 2773 | 15015 | 2289 | 16381 | 1895 | 18337 | 1227 | 22513 | 743 | 17478 |
| 22-#11 | 3.57 | MA | 13051 | 3526 | 19200 | 2947 | 22654 | 2461 | 24774 | 2049 | 27416 | 1381 | 34241 | 640 | 28725 |
| 9L-4S | | MI | 8287 | 3526 | 13318 | 2752 | 15456 | 2280 | 16930 | 1877 | 19100 | 1213 | 23543 | 807 | 17815 |
| 22-#11 | 3.57 | MA | 12769 | 3526 | 18596 | 2956 | 21892 | 2473 | 23806 | 2070 | 26113 | 1401 | 32401 | 578 | 27761 |
| 10L-3S | | MI | 8395 | 3526 | 13676 | 2741 | 15961 | 2260 | 17548 | 1870 | 19946 | 1210 | 24575 | 871 | 17864 |
| 22-#14 | 5.16 | MA | 14666 | 3959 | 22716 | 3223 | 26993 | 2669 | 29990 | 2200 | 34407 | 1383 | 43933 | 475 | 40296 |
| 8L-5S | | MI | 8919 | 3959 | 14872 | 3047 | 17400 | 2487 | 19246 | 2022 | 22184 | 1202 | 27487 | 540 | 24129 |
| 22-#14 | 5.16 | MA | 14263 | 3959 | 21774 | 3255 | 25834 | 2700 | 28600 | 2213 | 32528 | 1399 | 41522 | 397 | 38717 |
| 9L-4S | | MI | 9146 | 3959 | 15395 | 3017 | 18030 | 2475 | 20029 | 1998 | 23272 | 1184 | 28926 | 634 | 24657 |
| 24-#10 | 3.17 | MA | 13204 | 3416 | 19418 | 2853 | 22995 | 2384 | 25223 | 1999 | 28077 | 1367 | 34984 | 787 | 27342 |
| 8L-6S | | MI | 7870 | 3416 | 12284 | 2726 | 14226 | 2268 | 15452 | 1880 | 17112 | 1255 | 21117 | 781 | 15768 |
| 24-#10 | 3.17 | MA | 12957 | 3416 | 18869 | 2871 | 22332 | 2402 | 24426 | 2008 | 27002 | 1377 | 33619 | 744 | 26709 |
| 9L-5S | | MI | 8004 | 3416 | 12555 | 2719 | 14586 | 2251 | 15898 | 1873 | 17715 | 1243 | 21915 | 842 | 15984 |
| 24-#10 | 3.17 | MA | 12725 | 3416 | 18372 | 2879 | 21707 | 2412 | 23632 | 2025 | 25918 | 1392 | 32112 | 696 | 25919 |
| 10L-4S | | MI | 8146 | 3416 | 12858 | 2700 | 14951 | 2243 | 16352 | 1858 | 18346 | 1231 | 22789 | 894 | 16147 |
| 24-#10 | 3.17 | MA | 12464 | 3416 | 17888 | 2887 | 21076 | 2421 | 22854 | 2035 | 24819 | 1399 | 30751 | 650 | 25183 |
| 11L-3S | | MI | 8237 | 3416 | 13154 | 2691 | 15368 | 2226 | 16863 | 1851 | 19047 | 1227 | 23661 | 947 | 16177 |
| 24-#11 | 3.90 | MA | 13808 | 3615 | 20825 | 2980 | 24688 | 2480 | 27233 | 2064 | 30741 | 1365 | 38705 | 686 | 32556 |
| 8L-6S | | MI | 8191 | 3615 | 13148 | 2839 | 15238 | 2349 | 16641 | 1927 | 18690 | 1235 | 23037 | 660 | 18771 |
| 24-#11 | 3.90 | MA | 13517 | 3615 | 20163 | 3002 | 23880 | 2502 | 26263 | 2074 | 29431 | 1376 | 37031 | 633 | 31587 |
| 9L-5S | | MI | 8347 | 3615 | 13468 | 2829 | 15674 | 2329 | 17181 | 1920 | 19420 | 1222 | 23981 | 732 | 18994 |
| 24-#11 | 3.90 | MA | 13254 | 3615 | 19558 | 3011 | 23118 | 2514 | 25295 | 2095 | 28128 | 1395 | 35191 | 571 | 30627 |
| 10L-4S | | MI | 8511 | 3615 | 13835 | 2808 | 16115 | 2320 | 17730 | 1902 | 20183 | 1208 | 25010 | 797 | 19363 |
| 24-#14 | 5.63 | MA | 14916 | 4088 | 23151 | 3335 | 27588 | 2758 | 30729 | 2249 | 35410 | 1391 | 45513 | 387 | 42782 |
| 9L-5S | | MI | 9230 | 4088 | 15607 | 3127 | 18336 | 2545 | 20383 | 2058 | 23722 | 1195 | 29538 | 521 | 26289 |

## RECTANGULAR TIED COLUMNS 24" x 42"

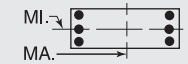
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.59 | MA | 13723 | 3130 | 20000 | 2605 | 23444 | 2186 | 25415 | 1854 | 27663 | 1346 | 33493 | 1168 | 15977 |
| 2E | | MI | 7537 | 3130 | 11628 | 2465 | 13122 | 2066 | 13932 | 1750 | 14804 | 1263 | 17101 | 1039 | 8543 |
| 6-#14 | 1.34 | MA | 13408 | 3059 | 19132 | 2577 | 22459 | 2168 | 24277 | 1846 | 26173 | 1360 | 31467 | 1182 | 13675 |
| 2L-3S | | MI | 7045 | 3059 | 10454 | 2465 | 11733 | 2071 | 12295 | 1776 | 12627 | 1303 | 14455 | 929 | 7430 |
| 6-#14 | 1.34 | MA | 12627 | 3059 | 17674 | 2600 | 20603 | 2189 | 22023 | 1866 | 23123 | 1392 | 27243 | 1041 | 13663 |
| 3L-2S | | MI | 7417 | 3059 | 11189 | 2450 | 12668 | 2059 | 13431 | 1752 | 14165 | 1285 | 16506 | 1090 | 7390 |
| 6-#18 | 2.38 | MA | 14897 | 3358 | 22551 | 2748 | 26692 | 2290 | 29360 | 1919 | 33002 | 1333 | 40885 | 1149 | 23692 |
| 2L-3S | | MI | 7473 | 3358 | 11628 | 2631 | 13122 | 2187 | 13932 | 1853 | 14804 | 1276 | 17101 | 705 | 12423 |
| 6-#18 | 2.38 | MA | 13627 | 3358 | 20000 | 2786 | 23444 | 2325 | 25415 | 1951 | 27663 | 1386 | 33493 | 892 | 23486 |
| 3L-2S | | MI | 8076 | 3358 | 12894 | 2608 | 14734 | 2170 | 15890 | 1815 | 17454 | 1250 | 20522 | 993 | 12424 |
| 8-#10 | 1.01 | MA | 12942 | 2963 | 17941 | 2538 | 21088 | 2142 | 22685 | 1834 | 24079 | 1378 | 28612 | 1200 | 10482 |
| 2L-4S | | MI | 6880 | 2963 | 9838 | 2445 | 11037 | 2071 | 11508 | 1773 | 11603 | 1327 | 13325 | 997 | 5793 |
| 8-#10 | 1.01 | MA | 12480 | 2963 | 17103 | 2551 | 20021 | 2154 | 21389 | 1846 | 22325 | 1397 | 26184 | 1123 | 10491 |
| 3E | | MI | 6999 | 2963 | 10135 | 2435 | 11455 | 2054 | 12020 | 1766 | 12303 | 1324 | 14197 | 1050 | 5769 |
| 8-#10 | 1.01 | MA | 12245 | 2963 | 16541 | 2565 | 19226 | 2175 | 20413 | 1867 | 20986 | 1407 | 24599 | 1074 | 10471 |
| 4L-2S | | MI | 7224 | 2963 | 10565 | 2425 | 12002 | 2046 | 12685 | 1751 | 13203 | 1311 | 15442 | 1141 | 5747 |
| 8-#11 | 1.24 | MA | 13278 | 3029 | 18762 | 2567 | 22049 | 2162 | 23810 | 1845 | 25566 | 1367 | 30644 | 1189 | 12727 |
| 2L-4S | | MI | 6963 | 3029 | 10121 | 2468 | 11313 | 2087 | 11806 | 1779 | 11975 | 1312 | 13767 | 937 | 6961 |
| 8-#11 | 1.24 | MA | 12730 | 3029 | 17744 | 2584 | 20752 | 2177 | 22235 | 1859 | 23434 | 1389 | 27693 | 1092 | 12729 |
| 3E | | MI | 7104 | 3029 | 10479 | 2457 | 11818 | 2068 | 12424 | 1772 | 12822 | 1309 | 14799 | 1000 | 6935 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidewise
Bending on major or minor axis

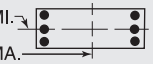



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.24 | MA | 12450 | 3029 | 17059 | 2600 | 19784 | 2202 | 21046 | 1883 | 21804 | 1401 | 25752 | 1032 | 12676 |
| 4L-2S | | MI | 7368 | 3029 | 10996 | 2446 | 12477 | 2059 | 13224 | 1754 | 13905 | 1295 | 16267 | 1112 | 6908 |
| 8-#14 | 1.79 | MA | 14098 | 3187 | 20590 | 2657 | 24315 | 2226 | 26531 | 1883 | 29224 | 1353 | 35691 | 1172 | 18091 |
| 2L-4S | | MI | 7184 | 3187 | 10678 | 2560 | 11950 | 2156 | 12551 | 1821 | 12959 | 1299 | 15058 | 821 | 9662 |
| 8-#14 | 1.79 | MA | 13347 | 3187 | 19132 | 2680 | 22459 | 2247 | 24277 | 1902 | 26173 | 1384 | 31467 | 1030 | 18048 |
| 3E | | MI | 7378 | 3187 | 11189 | 2545 | 12668 | 2129 | 13431 | 1812 | 14165 | 1295 | 16506 | 910 | 9674 |
| 8-#14 | 1.79 | MA | 12964 | 3187 | 18150 | 2703 | 21071 | 2283 | 22573 | 1937 | 23837 | 1401 | 28675 | 943 | 17841 |
| 4L-2S | | MI | 7739 | 3187 | 11924 | 2530 | 13604 | 2117 | 14568 | 1788 | 15703 | 1277 | 18558 | 1071 | 9648 |
| 8-#18 | 3.17 | MA | 16038 | 3587 | 25102 | 2890 | 29940 | 2393 | 33304 | 1984 | 38341 | 1320 | 48277 | 1131 | 31386 |
| 2L-4S | | MI | 7715 | 3587 | 12007 | 2796 | 13488 | 2335 | 14364 | 1929 | 15366 | 1263 | 18091 | 510 | 15254 |
| 8-#18 | 3.17 | MA | 14839 | 3587 | 22551 | 2929 | 26692 | 2429 | 29360 | 2016 | 33002 | 1372 | 40885 | 873 | 31125 |
| 3E | | MI | 8028 | 3587 | 12894 | 2773 | 14734 | 2291 | 15890 | 1917 | 17454 | 1263 | 20522 | 659 | 16212 |
| 8-#18 | 3.17 | MA | 14231 | 3587 | 20826 | 2968 | 24255 | 2491 | 26367 | 2075 | 28900 | 1399 | 35947 | 716 | 29287 |
| 4L-2S | | MI | 8605 | 3587 | 14161 | 2750 | 16347 | 2274 | 17849 | 1880 | 20105 | 1237 | 23943 | 946 | 16272 |
| 10-#10 | 1.26 | MA | 13353 | 3036 | 18779 | 2583 | 22155 | 2175 | 23981 | 1855 | 25833 | 1374 | 31041 | 1194 | 13025 |
| 2L-5S | | MI | 6938 | 3036 | 9966 | 2508 | 11220 | 2112 | 11720 | 1809 | 11872 | 1336 | 13696 | 939 | 7114 |
| 10-#10 | 1.26 | MA | 12902 | 3036 | 17941 | 2596 | 21088 | 2187 | 22685 | 1867 | 24079 | 1392 | 28612 | 1117 | 13023 |
| 3L-4S | | MI | 7084 | 3036 | 10268 | 2490 | 11585 | 2104 | 12173 | 1793 | 12503 | 1323 | 14570 | 991 | 7109 |
| 10-#10 | 1.26 | MA | 12676 | 3036 | 17379 | 2610 | 20293 | 2208 | 21709 | 1887 | 22740 | 1403 | 27027 | 1068 | 12990 |
| 4L-3S | | MI | 7199 | 3036 | 10565 | 2480 | 12002 | 2087 | 12685 | 1787 | 13203 | 1319 | 15442 | 1044 | 7091 |
| 10-#10 | 1.26 | MA | 12332 | 3036 | 16792 | 2630 | 19605 | 2221 | 20851 | 1899 | 21544 | 1421 | 25403 | 1033 | 12887 |
| 5L-2S | | MI | 7420 | 3036 | 10995 | 2471 | 12550 | 2079 | 13350 | 1771 | 14104 | 1307 | 16687 | 1135 | 7072 |
| 10-#11 | 1.55 | MA | 13767 | 3119 | 19781 | 2623 | 23346 | 2202 | 25385 | 1870 | 27697 | 1362 | 33596 | 1182 | 15814 |
| 2L-5S | | MI | 7036 | 3119 | 10271 | 2545 | 11530 | 2137 | 12057 | 1822 | 12295 | 1321 | 14205 | 861 | 8518 |
| 10-#11 | 1.55 | MA | 13233 | 3119 | 18762 | 2639 | 22049 | 2217 | 23810 | 1884 | 25566 | 1384 | 30644 | 1085 | 15800 |
| 3L-4S | | MI | 7204 | 3119 | 10638 | 2524 | 11972 | 2127 | 12606 | 1804 | 13058 | 1307 | 15235 | 926 | 8535 |
| 10-#11 | 1.55 | MA | 12967 | 3119 | 18078 | 2655 | 21081 | 2243 | 22621 | 1908 | 23935 | 1396 | 28704 | 1025 | 15731 |
| 4L-3S | | MI | 7340 | 3119 | 10996 | 2513 | 12477 | 2108 | 13224 | 1797 | 13905 | 1304 | 16267 | 989 | 8520 |
| 10-#11 | 1.55 | MA | 12557 | 3119 | 17368 | 2680 | 20242 | 2258 | 21576 | 1922 | 22478 | 1418 | 26720 | 979 | 15539 |
| 5L-2S | | MI | 7598 | 3119 | 11514 | 2502 | 13135 | 2099 | 14024 | 1780 | 14987 | 1290 | 17734 | 1101 | 8499 |
| 10-#14 | 2.23 | MA | 14774 | 3316 | 22047 | 2738 | 26171 | 2284 | 28785 | 1919 | 32274 | 1345 | 39915 | 1161 | 22494 |
| 2L-5S | | MI | 7289 | 3316 | 10890 | 2670 | 12255 | 2227 | 12904 | 1881 | 13410 | 1309 | 15670 | 708 | 11396 |
| 10-#14 | 2.23 | MA | 14050 | 3316 | 20590 | 2761 | 24315 | 2306 | 26531 | 1939 | 29224 | 1377 | 35691 | 1020 | 22429 |
| 3L-4S | | MI | 7522 | 3316 | 11413 | 2640 | 12886 | 2215 | 13687 | 1858 | 14498 | 1291 | 17110 | 802 | 11861 |
| 10-#14 | 2.23 | MA | 13692 | 3316 | 19608 | 2783 | 22927 | 2342 | 24827 | 1973 | 26887 | 1393 | 32899 | 933 | 22203 |
| 4L-3S | | MI | 7706 | 3316 | 11924 | 2625 | 13604 | 2188 | 14568 | 1849 | 15703 | 1288 | 18558 | 891 | 11901 |
| 10-#14 | 2.23 | MA | 13115 | 3316 | 18597 | 2820 | 21723 | 2363 | 23328 | 1993 | 24797 | 1424 | 30050 | 864 | 21137 |
| 5L-2S | | MI | 8057 | 3316 | 12659 | 2610 | 14540 | 2176 | 15704 | 1825 | 17241 | 1270 | 20609 | 1053 | 11891 |
| 10-#18 | 3.97 | MA | 16015 | 3815 | 25102 | 3072 | 29940 | 2533 | 33304 | 2081 | 38341 | 1359 | 48277 | 855 | 38771 |
| 3L-4S | | MI | 8281 | 3815 | 13273 | 2939 | 15100 | 2439 | 16322 | 1994 | 18017 | 1249 | 21512 | 463 | 18847 |
| 10-#18 | 3.97 | MA | 15466 | 3815 | 23377 | 3111 | 27503 | 2595 | 30312 | 2140 | 34239 | 1385 | 43339 | 697 | 36856 |
| 4L-3S | | MI | 8573 | 3815 | 14161 | 2916 | 16347 | 2395 | 17849 | 1982 | 20105 | 1250 | 23943 | 612 | 19991 |
| 10-#18 | 3.97 | MA | 14489 | 3815 | 21622 | 3176 | 25386 | 2630 | 27677 | 2172 | 30566 | 1438 | 38318 | 568 | 34020 |
| 5L-2S | | MI | 9127 | 3815 | 15427 | 2893 | 17959 | 2378 | 19807 | 1944 | 22755 | 1224 | 27365 | 900 | 20095 |
| 12-#10 | 1.51 | MA | 13758 | 3108 | 19617 | 2628 | 23222 | 2207 | 25277 | 1876 | 27586 | 1369 | 33469 | 1189 | 15563 |
| 2L-6S | | MI | 6990 | 3108 | 10124 | 2561 | 11408 | 2161 | 11938 | 1836 | 12169 | 1344 | 14143 | 872 | 8276 |
| 12-#10 | 1.51 | MA | 13317 | 3108 | 18779 | 2642 | 22155 | 2220 | 23981 | 1887 | 25833 | 1388 | 31041 | 1111 | 15552 |
| 3L-5S | | MI | 7140 | 3108 | 10396 | 2553 | 11768 | 2145 | 12385 | 1829 | 12772 | 1331 | 14942 | 933 | 8410 |
| 12-#10 | 1.51 | MA | 13100 | 3108 | 18217 | 2655 | 21360 | 2241 | 23005 | 1908 | 24494 | 1398 | 29455 | 1063 | 15508 |
| 4E | | MI | 7286 | 3108 | 10698 | 2535 | 12133 | 2137 | 12838 | 1814 | 13403 | 1319 | 15815 | 985 | 8416 |
| 12-#10 | 1.51 | MA | 12758 | 3108 | 17630 | 2675 | 20672 | 2254 | 22147 | 1920 | 23298 | 1417 | 27831 | 1027 | 15396 |
| 5L-3S | | MI | 7397 | 3108 | 10995 | 2526 | 12550 | 2120 | 13350 | 1807 | 14104 | 1315 | 16687 | 1038 | 8405 |
| 12-#10 | 1.51 | MA | 12458 | 3108 | 17071 | 2682 | 20001 | 2264 | 21306 | 1940 | 22128 | 1428 | 26246 | 963 | 14991 |
| 6L-2S | | MI | 7613 | 3108 | 11425 | 2516 | 13098 | 2112 | 14015 | 1792 | 15004 | 1303 | 17933 | 1130 | 8390 |
| 12-#11 | 1.86 | MA | 14248 | 3208 | 20799 | 2679 | 24642 | 2243 | 26960 | 1895 | 29829 | 1357 | 36547 | 1174 | 18894 |
| 2L-6S | | MI | 7096 | 3208 | 10468 | 2610 | 11753 | 2196 | 12317 | 1854 | 12649 | 1329 | 14729 | 778 | 9752 |
| 12-#11 | 1.86 | MA | 13728 | 3208 | 19781 | 2695 | 23346 | 2258 | 25385 | 1909 | 27697 | 1379 | 33596 | 1078 | 18869 |
| 3L-5S | | MI | 7274 | 3208 | 10789 | 2601 | 12189 | 2177 | 12857 | 1847 | 13378 | 1316 | 15672 | 851 | 10050 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis



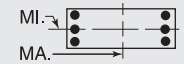

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.86 | MA | 13474 | 3208 | 19096 | 2711 | 22377 | 2283 | 24196 | 1933 | 26067 | 1391 | 31655 | 1018 | 18786 |
| 4E | | MI | 7442 | 3208 | 11156 | 2580 | 12631 | 2168 | 13406 | 1830 | 14141 | 1302 | 16702 | 916 | 10098 |
| 12-#11 | 1.86 | MA | 13067 | 3208 | 18386 | 2736 | 21539 | 2298 | 23151 | 1947 | 24609 | 1413 | 29672 | 971 | 18587 |
| 5L-3S | | MI | 7573 | 3208 | 11514 | 2569 | 13135 | 2148 | 14024 | 1822 | 14987 | 1299 | 17734 | 979 | 10097 |
| 12-#11 | 1.86 | MA | 12709 | 3208 | 17707 | 2744 | 20730 | 2311 | 22125 | 1972 | 23183 | 1425 | 27736 | 891 | 17818 |
| 6L-2S | | MI | 7826 | 3208 | 12031 | 2558 | 13794 | 2139 | 14825 | 1805 | 16070 | 1285 | 19201 | 1091 | 10081 |
| 12-#14 | 2.68 | MA | 14738 | 3444 | 22047 | 2841 | 26171 | 2364 | 28785 | 1975 | 32274 | 1369 | 39915 | 1010 | 26809 |
| 3L-5S | | MI | 7622 | 3444 | 11625 | 2750 | 13191 | 2285 | 14041 | 1918 | 14948 | 1302 | 17722 | 689 | 13514 |
| 12-#14 | 2.68 | MA | 14403 | 3444 | 21066 | 2864 | 24783 | 2400 | 27081 | 2010 | 29938 | 1386 | 37122 | 922 | 26568 |
| 4E | | MI | 7853 | 3444 | 12148 | 2720 | 13821 | 2273 | 14824 | 1894 | 16036 | 1284 | 19161 | 783 | 14056 |
| 12-#14 | 2.68 | MA | 13831 | 3444 | 20054 | 2900 | 23579 | 2421 | 25582 | 2029 | 27847 | 1417 | 34274 | 854 | 25464 |
| 5L-3S | | MI | 8029 | 3444 | 12659 | 2706 | 14540 | 2246 | 15704 | 1885 | 17241 | 1281 | 20609 | 872 | 14116 |
| 12-#14 | 2.68 | MA | 13337 | 3444 | 19081 | 2911 | 22428 | 2441 | 24111 | 2064 | 25801 | 1433 | 31493 | 735 | 24371 |
| 6L-2S | | MI | 8370 | 3444 | 13394 | 2691 | 15476 | 2234 | 16841 | 1861 | 18779 | 1263 | 22661 | 1034 | 14124 |
| 12-#18 | 4.76 | MA | 16667 | 4044 | 25928 | 3253 | 30751 | 2699 | 34257 | 2205 | 39578 | 1372 | 50731 | 679 | 44438 |
| 4E | | MI | 8837 | 4044 | 14540 | 3082 | 16713 | 2542 | 18280 | 2058 | 20667 | 1236 | 24933 | 417 | 22469 |
| 12-#18 | 4.76 | MA | 15700 | 4044 | 24173 | 3319 | 28634 | 2734 | 31622 | 2237 | 35905 | 1425 | 45710 | 549 | 41615 |
| 5L-3S | | MI | 9109 | 4044 | 15427 | 3059 | 17959 | 2499 | 19807 | 2047 | 22755 | 1236 | 27365 | 566 | 23766 |
| 12-#18 | 4.76 | MA | 14900 | 4044 | 22467 | 3337 | 26645 | 2770 | 29035 | 2296 | 32403 | 1477 | 40810 | 332 | 38149 |
| 6L-2S | | MI | 9648 | 4044 | 16693 | 3036 | 19571 | 2481 | 21765 | 2009 | 25405 | 1210 | 30786 | 854 | 23906 |
| 14-#10 | 1.76 | MA | 13727 | 3181 | 19617 | 2687 | 23222 | 2253 | 25277 | 1908 | 27586 | 1384 | 33469 | 1105 | 18078 |
| 3L-6S | | MI | 7193 | 3181 | 10554 | 2606 | 11955 | 2194 | 12604 | 1857 | 13069 | 1340 | 15389 | 866 | 9527 |
| 14-#10 | 1.76 | MA | 13519 | 3181 | 19055 | 2701 | 22427 | 2274 | 24300 | 1928 | 26248 | 1394 | 31884 | 1057 | 18026 |
| 4L-5S | | MI | 7340 | 3181 | 10826 | 2599 | 12315 | 2178 | 13050 | 1850 | 13672 | 1327 | 16187 | 927 | 9701 |
| 14-#10 | 1.76 | MA | 13178 | 3181 | 18468 | 2721 | 21739 | 2287 | 23443 | 1940 | 25051 | 1413 | 30259 | 1021 | 17907 |
| 5L-4S | | MI | 7485 | 3181 | 11129 | 2581 | 12680 | 2170 | 13503 | 1835 | 14303 | 1315 | 17060 | 979 | 9718 |
| 14-#10 | 1.76 | MA | 12885 | 3181 | 17909 | 2728 | 21068 | 2297 | 22602 | 1961 | 23881 | 1423 | 28674 | 957 | 17479 |
| 6L-3S | | MI | 7593 | 3181 | 11425 | 2571 | 13098 | 2153 | 14015 | 1828 | 15004 | 1311 | 17933 | 1032 | 9714 |
| 14-#10 | 1.76 | MA | 12637 | 3181 | 17382 | 2737 | 20325 | 2313 | 21769 | 1970 | 22750 | 1442 | 27161 | 925 | 16996 |
| 7L-2S | | MI | 7805 | 3181 | 11855 | 2561 | 13645 | 2145 | 14680 | 1813 | 15904 | 1299 | 19178 | 1124 | 9703 |
| 14-#11 | 2.17 | MA | 14216 | 3297 | 20799 | 2751 | 24642 | 2298 | 26960 | 1934 | 29829 | 1374 | 36547 | 1071 | 21935 |
| 3L-6S | | MI | 7336 | 3297 | 10985 | 2666 | 12412 | 2237 | 13117 | 1879 | 13731 | 1324 | 16196 | 768 | 11258 |
| 14-#11 | 2.17 | MA | 13974 | 3297 | 20115 | 2767 | 23674 | 2324 | 25771 | 1959 | 28198 | 1386 | 34606 | 1010 | 21842 |
| 4L-5S | | MI | 7510 | 3297 | 11306 | 2657 | 12848 | 2217 | 13658 | 1872 | 14461 | 1310 | 17140 | 840 | 11541 |
| 14-#11 | 2.17 | MA | 13569 | 3297 | 19405 | 2792 | 22835 | 2339 | 24726 | 1973 | 26741 | 1408 | 32623 | 964 | 21636 |
| 5L-4S | | MI | 7677 | 3297 | 11673 | 2635 | 13290 | 2208 | 14206 | 1855 | 15224 | 1297 | 18169 | 905 | 11656 |
| 14-#11 | 2.17 | MA | 13221 | 3297 | 18725 | 2800 | 22026 | 2352 | 23700 | 1997 | 25314 | 1420 | 30687 | 884 | 20847 |
| 6L-3S | | MI | 7804 | 3297 | 12031 | 2624 | 13794 | 2189 | 14825 | 1848 | 16070 | 1293 | 19201 | 968 | 11667 |
| 14-#11 | 2.17 | MA | 12926 | 3297 | 18083 | 2810 | 21121 | 2371 | 22697 | 2010 | 23935 | 1442 | 28832 | 844 | 20277 |
| 7L-2S | | MI | 8051 | 3297 | 12549 | 2613 | 14453 | 2180 | 15625 | 1830 | 17153 | 1280 | 20668 | 1080 | 11658 |
| 14-#14 | 3.13 | MA | 15100 | 3572 | 22523 | 2944 | 26638 | 2458 | 29335 | 2046 | 32988 | 1378 | 41346 | 912 | 30937 |
| 4L-5S | | MI | 7951 | 3572 | 12360 | 2831 | 14127 | 2343 | 15177 | 1954 | 16486 | 1294 | 19773 | 670 | 15643 |
| 14-#14 | 3.13 | MA | 14532 | 3572 | 21512 | 2980 | 25435 | 2480 | 27836 | 2066 | 30898 | 1410 | 38497 | 843 | 29798 |
| 5L-4S | | MI | 8181 | 3572 | 12883 | 2801 | 14757 | 2331 | 15960 | 1930 | 17574 | 1276 | 21213 | 764 | 16248 |
| 14-#14 | 3.13 | MA | 14057 | 3572 | 20538 | 2991 | 24284 | 2499 | 26365 | 2100 | 28852 | 1426 | 35717 | 725 | 28729 |
| 6L-3S | | MI | 8348 | 3572 | 13394 | 2786 | 15476 | 2304 | 16841 | 1921 | 18779 | 1273 | 22661 | 853 | 16325 |
| 14-#14 | 3.13 | MA | 13654 | 3572 | 19618 | 3006 | 22987 | 2526 | 24938 | 2119 | 26873 | 1457 | 33046 | 667 | 27166 |
| 7L-2S | | MI | 8681 | 3572 | 14129 | 2771 | 16411 | 2293 | 17978 | 1897 | 20317 | 1255 | 24712 | 1015 | 16349 |
| 14-#18 | 5.56 | MA | 16879 | 4272 | 26724 | 3461 | 31882 | 2838 | 35567 | 2302 | 41244 | 1412 | 53102 | 531 | 49208 |
| 5L-4S | | MI | 9384 | 4272 | 15806 | 3225 | 18325 | 2646 | 20238 | 2123 | 23317 | 1223 | 28354 | 371 | 26113 |
| 14-#18 | 5.56 | MA | 16123 | 4272 | 25018 | 3479 | 29893 | 2873 | 32980 | 2361 | 37742 | 1464 | 48203 | 313 | 45698 |
| 6L-3S | | MI | 9678 | 4272 | 16693 | 3202 | 19571 | 2602 | 21765 | 2112 | 25405 | 1223 | 30786 | 520 | 27540 |
| 14-#18 | 5.56 | MA | 15477 | 4272 | 23402 | 3504 | 27617 | 2919 | 30495 | 2393 | 34167 | 1490 | 43468 | 207 | 42102 |
| 7L-2S | | MI | 10148 | 4272 | 17959 | 3179 | 21184 | 2585 | 23724 | 2074 | 28055 | 1197 | 34207 | 807 | 27709 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

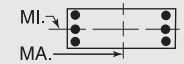


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.02 | MA | 13931 | 3253 | 19893 | 2746 | 23494 | 2307 | 25596 | 1949 | 28001 | 1390 | 34312 | 1051 | 20543 |
| 4L-6S | | MI | 7393 | 3253 | 10984 | 2651 | 12503 | 2227 | 13269 | 1877 | 13969 | 1335 | 16634 | 860 | 10783 |
| 16-#10 | 2.02 | MA | 13593 | 3253 | 19306 | 2766 | 22806 | 2320 | 24739 | 1961 | 26805 | 1409 | 32688 | 1015 | 20420 |
| 5E | | MI | 7538 | 3253 | 11256 | 2644 | 12863 | 2211 | 13715 | 1870 | 14572 | 1323 | 17432 | 921 | 10990 |
| 16-#10 | 2.02 | MA | 13306 | 3253 | 18747 | 2773 | 22135 | 2330 | 23898 | 1981 | 25635 | 1419 | 31102 | 951 | 19970 |
| 6L-4S | | MI | 7682 | 3253 | 11559 | 2626 | 13228 | 2202 | 14168 | 1855 | 15203 | 1311 | 18306 | 973 | 11015 |
| 16-#10 | 2.02 | MA | 13066 | 3253 | 18220 | 2782 | 21392 | 2346 | 23065 | 1991 | 24504 | 1438 | 29590 | 919 | 19501 |
| 7L-3S | | MI | 7787 | 3253 | 11855 | 2616 | 13645 | 2186 | 14680 | 1848 | 15904 | 1307 | 19178 | 1026 | 11020 |
| 16-#10 | 2.02 | MA | 12774 | 3253 | 17716 | 2792 | 20709 | 2355 | 22197 | 2007 | 23395 | 1457 | 28116 | 877 | 18980 |
| 8L-2S | | MI | 7996 | 3253 | 12285 | 2607 | 14193 | 2178 | 15345 | 1833 | 16804 | 1294 | 20423 | 1118 | 11012 |
| 16-#11 | 2.48 | MA | 14466 | 3386 | 21133 | 2822 | 24971 | 2364 | 27346 | 1984 | 30330 | 1381 | 37558 | 1003 | 24898 |
| 4L-6S | | MI | 7573 | 3386 | 11503 | 2722 | 13071 | 2277 | 13917 | 1905 | 14814 | 1319 | 17663 | 757 | 12770 |
| 16-#11 | 2.48 | MA | 14063 | 3386 | 20423 | 2847 | 24132 | 2379 | 26301 | 1998 | 28872 | 1403 | 35574 | 957 | 24669 |
| 5E | | MI | 7744 | 3386 | 11824 | 2712 | 13507 | 2258 | 14458 | 1898 | 15544 | 1305 | 18607 | 830 | 13038 |
| 16-#11 | 2.48 | MA | 13725 | 3386 | 19744 | 2855 | 23323 | 2392 | 25275 | 2022 | 27446 | 1415 | 33638 | 876 | 23881 |
| 6L-4S | | MI | 7910 | 3386 | 12190 | 2691 | 13949 | 2249 | 15007 | 1880 | 16307 | 1292 | 19636 | 894 | 13210 |
| 16-#11 | 2.48 | MA | 13441 | 3386 | 19102 | 2866 | 22418 | 2411 | 24272 | 2035 | 26066 | 1437 | 31784 | 836 | 23327 |
| 7L-3S | | MI | 8032 | 3386 | 12549 | 2680 | 14453 | 2229 | 15625 | 1873 | 17153 | 1288 | 20668 | 957 | 13230 |
| 16-#11 | 2.48 | MA | 13093 | 3386 | 18487 | 2878 | 21586 | 2422 | 23214 | 2054 | 24714 | 1459 | 29983 | 783 | 22376 |
| 8L-2S | | MI | 8275 | 3386 | 13066 | 2669 | 15112 | 2220 | 16425 | 1855 | 18236 | 1275 | 22136 | 1070 | 13230 |
| 16-#14 | 3.57 | MA | 15221 | 3701 | 22969 | 3060 | 27291 | 2538 | 30090 | 2102 | 33948 | 1402 | 42721 | 833 | 34139 |
| 5E | | MI | 8275 | 3701 | 13095 | 2911 | 15063 | 2402 | 16314 | 1991 | 18024 | 1287 | 21825 | 652 | 17780 |
| 16-#14 | 3.57 | MA | 14763 | 3701 | 21996 | 3071 | 26140 | 2557 | 28619 | 2137 | 31902 | 1418 | 39941 | 715 | 33086 |
| 6L-4S | | MI | 8504 | 3701 | 13618 | 2881 | 15693 | 2390 | 17097 | 1967 | 19112 | 1269 | 23264 | 746 | 18401 |
| 16-#14 | 3.57 | MA | 14378 | 3701 | 21075 | 3086 | 24843 | 2584 | 27192 | 2155 | 29923 | 1450 | 37270 | 656 | 31502 |
| 7L-3S | | MI | 8664 | 3701 | 14129 | 2866 | 16411 | 2363 | 17978 | 1958 | 20317 | 1266 | 24712 | 834 | 18531 |
| 16-#14 | 3.57 | MA | 13889 | 3701 | 20194 | 3103 | 23651 | 2599 | 25676 | 2182 | 27983 | 1481 | 34682 | 577 | 29929 |
| 8L-2S | | MI | 8989 | 3701 | 14864 | 2851 | 17347 | 2351 | 19114 | 1934 | 21856 | 1248 | 26764 | 996 | 18567 |
| 16-#18 | 6.35 | MA | 17317 | 4500 | 27569 | 3622 | 33140 | 2977 | 36925 | 2426 | 43081 | 1451 | 55595 | 295 | 53247 |
| 6L-4S | | MI | 9988 | 4500 | 17072 | 3367 | 19937 | 2750 | 22197 | 2188 | 25967 | 1210 | 31776 | 324 | 29775 |
| 16-#18 | 6.35 | MA | 16713 | 4500 | 25953 | 3647 | 30865 | 3023 | 34440 | 2458 | 39506 | 1477 | 50860 | 188 | 49616 |
| 7L-3S | | MI | 10196 | 4500 | 17959 | 3344 | 21184 | 2706 | 23724 | 2176 | 28055 | 1210 | 34207 | 473 | 31313 |
| 18-#10 | 2.27 | MA | 14001 | 3326 | 20144 | 2811 | 23873 | 2353 | 26035 | 1981 | 28559 | 1405 | 35116 | 1009 | 22933 |
| 5L-6S | | MI | 7592 | 3326 | 11415 | 2697 | 13051 | 2260 | 13934 | 1898 | 14869 | 1331 | 17879 | 854 | 12042 |
| 18-#10 | 2.27 | MA | 13722 | 3326 | 19585 | 2818 | 23202 | 2363 | 25194 | 2002 | 27389 | 1415 | 33531 | 945 | 22464 |
| 6L-5S | | MI | 7734 | 3326 | 11686 | 2689 | 13411 | 2244 | 14380 | 1891 | 15472 | 1319 | 18677 | 915 | 12278 |
| 18-#10 | 2.27 | MA | 13489 | 3326 | 19058 | 2827 | 22459 | 2379 | 24361 | 2012 | 26258 | 1434 | 32018 | 913 | 22007 |
| 7L-4S | | MI | 7878 | 3326 | 11989 | 2671 | 13775 | 2235 | 14834 | 1876 | 16103 | 1306 | 19551 | 967 | 12309 |
| 18-#10 | 2.27 | MA | 13199 | 3326 | 18554 | 2838 | 21776 | 2388 | 23493 | 2028 | 25149 | 1453 | 30545 | 871 | 21483 |
| 8L-3S | | MI | 7979 | 3326 | 12285 | 2662 | 14193 | 2219 | 15345 | 1869 | 16804 | 1303 | 20423 | 1020 | 12321 |
| 18-#10 | 2.27 | MA | 12907 | 3326 | 17971 | 2855 | 21076 | 2406 | 22652 | 2036 | 24004 | 1462 | 29110 | 829 | 20794 |
| 9L-2S | | MI | 8184 | 3326 | 12715 | 2652 | 14740 | 2210 | 16010 | 1854 | 17704 | 1290 | 21668 | 1112 | 12319 |
| 18-#11 | 2.79 | MA | 14551 | 3475 | 21442 | 2903 | 25429 | 2420 | 27876 | 2023 | 31004 | 1398 | 38526 | 950 | 27685 |
| 5L-6S | | MI | 7807 | 3475 | 12020 | 2778 | 13730 | 2318 | 14718 | 1930 | 15897 | 1314 | 19131 | 746 | 14285 |
| 18-#11 | 2.79 | MA | 14221 | 3475 | 20762 | 2911 | 24620 | 2433 | 26850 | 2048 | 29577 | 1410 | 36590 | 869 | 26918 |
| 6L-5S | | MI | 7975 | 3475 | 12341 | 2768 | 14166 | 2298 | 15258 | 1923 | 16627 | 1300 | 20074 | 819 | 14541 |
| 18-#11 | 2.79 | MA | 13947 | 3475 | 20120 | 2922 | 23715 | 2452 | 25847 | 2060 | 28198 | 1432 | 34735 | 829 | 26380 |
| 7L-4S | | MI | 8140 | 3475 | 12708 | 2747 | 14607 | 2289 | 15807 | 1905 | 17390 | 1286 | 21103 | 884 | 14762 |
| 18-#11 | 2.79 | MA | 13602 | 3475 | 19505 | 2934 | 22883 | 2462 | 24789 | 2079 | 26845 | 1454 | 32934 | 776 | 25415 |
| 8L-3S | | MI | 8258 | 3475 | 13066 | 2736 | 15112 | 2270 | 16425 | 1898 | 18236 | 1283 | 22136 | 947 | 14790 |
| 18-#11 | 2.79 | MA | 13266 | 3475 | 18802 | 2956 | 22030 | 2484 | 23764 | 2089 | 25462 | 1466 | 31174 | 723 | 24491 |
| 9L-2S | | MI | 8496 | 3475 | 13584 | 2725 | 15771 | 2261 | 17225 | 1881 | 19319 | 1270 | 23603 | 1059 | 14799 |
| 18-#14 | 4.02 | MA | 15457 | 3829 | 23454 | 3152 | 27996 | 2616 | 30873 | 2173 | 34953 | 1411 | 44165 | 704 | 37442 |
| 6L-5S | | MI | 8596 | 3829 | 13830 | 2991 | 15998 | 2460 | 17451 | 2027 | 19562 | 1279 | 23876 | 633 | 19923 |
| 18-#14 | 4.02 | MA | 15089 | 3829 | 22533 | 3167 | 26699 | 2642 | 29447 | 2192 | 32974 | 1442 | 41493 | 646 | 35838 |
| 7L-4S | | MI | 8824 | 3829 | 14353 | 2961 | 16629 | 2448 | 18233 | 2003 | 20650 | 1261 | 25316 | 727 | 20515 |
| 18-#14 | 4.02 | MA | 14604 | 3829 | 21651 | 3184 | 25507 | 2657 | 27931 | 2219 | 31034 | 1474 | 38906 | 567 | 34246 |
| 8L-3S | | MI | 8977 | 3829 | 14864 | 2946 | 17347 | 2421 | 19114 | 1994 | 21856 | 1258 | 26764 | 815 | 20734 |
| 18-#14 | 4.02 | MA | 14144 | 3829 | 20649 | 3216 | 24282 | 2688 | 26461 | 2232 | 29050 | 1490 | 36370 | 490 | 32563 |
| 9L-2S | | MI | 9294 | 3829 | 15599 | 2932 | 18283 | 2409 | 20251 | 1970 | 23394 | 1240 | 28815 | 977 | 20782 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

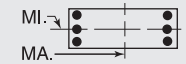
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 7.14 | MA | 17920 | 4729 | 28504 | 3790 | 34113 | 3127 | 38385 | 2523 | 44845 | 1464 | 58252 | 170 | 57130 |
| 7L-4S | | MI | 10519 | 4729 | 18339 | 3510 | 21550 | 2854 | 24155 | 2252 | 28618 | 1196 | 35197 | 278 | 33452 |
| 20-#10 | 2.52 | MA | 14132 | 3398 | 20423 | 2863 | 24269 | 2396 | 26490 | 2022 | 29143 | 1411 | 35959 | 939 | 24960 |
| 6E | | MI | 7789 | 3398 | 11845 | 2742 | 13598 | 2293 | 14599 | 1918 | 15769 | 1327 | 19124 | 848 | 13304 |
| 20-#10 | 2.52 | MA | 13906 | 3398 | 19896 | 2873 | 23526 | 2412 | 25657 | 2032 | 28011 | 1430 | 34446 | 907 | 24515 |
| 7L-5S | | MI | 7928 | 3398 | 12116 | 2735 | 13958 | 2277 | 15045 | 1911 | 16372 | 1315 | 19923 | 909 | 13542 |
| 20-#10 | 2.52 | MA | 13618 | 3398 | 19392 | 2883 | 22843 | 2421 | 24788 | 2048 | 26902 | 1448 | 32973 | 865 | 23985 |
| 8L-4S | | MI | 8071 | 3398 | 12419 | 2717 | 14323 | 2268 | 15499 | 1896 | 17003 | 1302 | 20796 | 961 | 13602 |
| 20-#10 | 2.52 | MA | 13335 | 3398 | 18809 | 2901 | 22143 | 2439 | 23948 | 2057 | 25758 | 1458 | 31538 | 823 | 23299 |
| 9L-3S | | MI | 8170 | 3398 | 12715 | 2707 | 14740 | 2252 | 16010 | 1889 | 17704 | 1298 | 21668 | 1014 | 13619 |
| 20-#10 | 2.52 | MA | 13077 | 3398 | 18284 | 2908 | 21483 | 2450 | 23109 | 2075 | 24614 | 1474 | 29951 | 775 | 22533 |
| 10L-2S | | MI | 8372 | 3398 | 13145 | 2697 | 15288 | 2243 | 16676 | 1874 | 18604 | 1286 | 22914 | 1106 | 13623 |
| 20-#11 | 3.10 | MA | 14711 | 3564 | 21781 | 2967 | 25917 | 2473 | 28425 | 2073 | 31709 | 1404 | 39541 | 862 | 29957 |
| 6E | | MI | 8040 | 3564 | 12538 | 2833 | 14389 | 2358 | 15518 | 1955 | 16980 | 1308 | 20598 | 736 | 15804 |
| 20-#11 | 3.10 | MA | 14446 | 3564 | 21139 | 2977 | 25012 | 2492 | 27422 | 2085 | 30329 | 1427 | 37686 | 822 | 29434 |
| 7L-5S | | MI | 8203 | 3564 | 12859 | 2824 | 14825 | 2339 | 16058 | 1948 | 17710 | 1295 | 21541 | 808 | 16048 |
| 20-#11 | 3.10 | MA | 14103 | 3564 | 20524 | 2989 | 24180 | 2503 | 26364 | 2104 | 28977 | 1449 | 35885 | 769 | 28454 |
| 8L-4S | | MI | 8368 | 3564 | 13225 | 2802 | 15266 | 2330 | 16607 | 1931 | 18473 | 1281 | 22571 | 873 | 16312 |
| 20-#11 | 3.10 | MA | 13776 | 3564 | 19820 | 3011 | 23326 | 2525 | 25339 | 2115 | 27594 | 1461 | 34125 | 716 | 27519 |
| 9L-3S | | MI | 8482 | 3564 | 13584 | 2791 | 15771 | 2310 | 17225 | 1923 | 19319 | 1278 | 23603 | 936 | 16348 |
| 20-#11 | 3.10 | MA | 13463 | 3564 | 19181 | 3021 | 22523 | 2537 | 24318 | 2136 | 26206 | 1480 | 32186 | 655 | 26472 |
| 10L-2S | | MI | 8716 | 3564 | 14101 | 2780 | 16429 | 2301 | 18025 | 1906 | 20402 | 1264 | 25070 | 1048 | 16363 |
| 20-#14 | 4.46 | MA | 15788 | 3958 | 23991 | 3247 | 28555 | 2701 | 31701 | 2228 | 36025 | 1435 | 45717 | 636 | 40173 |
| 7L-5S | | MI | 8913 | 3958 | 14565 | 3071 | 16934 | 2518 | 18587 | 2064 | 21101 | 1272 | 25928 | 614 | 22073 |
| 20-#14 | 4.46 | MA | 15307 | 3958 | 23109 | 3264 | 27362 | 2715 | 30185 | 2255 | 34084 | 1466 | 43129 | 557 | 38563 |
| 8L-4S | | MI | 9140 | 3958 | 15088 | 3042 | 17564 | 2506 | 19370 | 2040 | 22188 | 1254 | 27368 | 708 | 22638 |
| 20-#14 | 4.46 | MA | 14862 | 3958 | 22107 | 3296 | 26138 | 2747 | 28716 | 2269 | 32100 | 1483 | 40594 | 479 | 36888 |
| 9L-3S | | MI | 9287 | 3958 | 15599 | 3027 | 18283 | 2480 | 20251 | 2031 | 23394 | 1251 | 28815 | 796 | 22935 |
| 22-#10 | 2.77 | MA | 14318 | 3471 | 20734 | 2918 | 24593 | 2445 | 26952 | 2053 | 29765 | 1425 | 36875 | 901 | 27025 |
| 7L-6S | | MI | 7984 | 3471 | 12275 | 2787 | 14146 | 2326 | 15264 | 1939 | 16670 | 1323 | 20370 | 842 | 14568 |
| 22-#10 | 2.77 | MA | 14031 | 3471 | 20230 | 2928 | 23910 | 2454 | 26084 | 2069 | 28656 | 1444 | 35401 | 860 | 26488 |
| 8L-5S | | MI | 8121 | 3471 | 12546 | 2780 | 14506 | 2309 | 15710 | 1932 | 17273 | 1310 | 21168 | 903 | 14796 |
| 22-#10 | 2.77 | MA | 13761 | 3471 | 19647 | 2946 | 23210 | 2472 | 25243 | 2077 | 27512 | 1454 | 33966 | 817 | 25804 |
| 9L-4S | | MI | 8263 | 3471 | 12849 | 2762 | 14871 | 2301 | 16164 | 1917 | 17903 | 1298 | 22042 | 955 | 14893 |
| 22-#10 | 2.77 | MA | 13505 | 3471 | 19122 | 2954 | 22550 | 2483 | 24405 | 2095 | 26367 | 1469 | 32379 | 769 | 25029 |
| 10L-3S | | MI | 8359 | 3471 | 13145 | 2752 | 15288 | 2285 | 16676 | 1910 | 18604 | 1294 | 22914 | 1009 | 14915 |
| 22-#10 | 2.77 | MA | 13225 | 3471 | 18611 | 2963 | 21879 | 2492 | 23585 | 2105 | 25207 | 1477 | 30945 | 725 | 24282 |
| 11L-2S | | MI | 8558 | 3471 | 13575 | 2743 | 15836 | 2276 | 17341 | 1895 | 19504 | 1282 | 24159 | 1100 | 14924 |
| 22-#11 | 3.40 | MA | 14938 | 3653 | 22157 | 3033 | 26308 | 2533 | 28997 | 2111 | 32461 | 1422 | 40638 | 815 | 32490 |
| 7L-6S | | MI | 8270 | 3653 | 13055 | 2889 | 15047 | 2399 | 16318 | 1980 | 18063 | 1303 | 22065 | 725 | 17325 |
| 22-#11 | 3.40 | MA | 14597 | 3653 | 21542 | 3045 | 25477 | 2543 | 27939 | 2130 | 31108 | 1444 | 38837 | 762 | 31493 |
| 8L-5S | | MI | 8430 | 3653 | 13376 | 2879 | 15483 | 2379 | 16858 | 1973 | 18793 | 1290 | 23009 | 798 | 17560 |
| 22-#11 | 3.40 | MA | 14279 | 3653 | 20839 | 3067 | 24623 | 2565 | 26914 | 2140 | 29725 | 1456 | 37077 | 709 | 30546 |
| 9L-4S | | MI | 8595 | 3653 | 13743 | 2858 | 15925 | 2370 | 17407 | 1956 | 19556 | 1276 | 24038 | 862 | 17861 |
| 22-#11 | 3.40 | MA | 13977 | 3653 | 20200 | 3076 | 23819 | 2578 | 25893 | 2161 | 28337 | 1475 | 35137 | 648 | 29504 |
| 10L-3S | | MI | 8705 | 3653 | 14101 | 2847 | 16429 | 2351 | 18025 | 1949 | 20402 | 1273 | 25070 | 926 | 17904 |
| 22-#11 | 3.40 | MA | 13643 | 3653 | 19577 | 3087 | 23011 | 2589 | 24893 | 2173 | 26924 | 1484 | 33384 | 592 | 28369 |
| 11L-2S | | MI | 8935 | 3653 | 14619 | 2836 | 17088 | 2342 | 18826 | 1931 | 21485 | 1259 | 26537 | 1038 | 17924 |
| 22-#14 | 4.91 | MA | 15998 | 4086 | 24567 | 3344 | 29218 | 2774 | 32439 | 2291 | 37135 | 1459 | 47353 | 546 | 42880 |
| 8L-5S | | MI | 9228 | 4086 | 15300 | 3152 | 17870 | 2577 | 19724 | 2100 | 22639 | 1264 | 27980 | 595 | 24227 |
| 22-#14 | 4.91 | MA | 15568 | 4086 | 23564 | 3376 | 27994 | 2805 | 30970 | 2305 | 35151 | 1475 | 44818 | 469 | 41214 |
| 9L-4S | | MI | 9454 | 4086 | 15823 | 3122 | 18500 | 2565 | 20506 | 2076 | 23727 | 1246 | 29419 | 689 | 24768 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

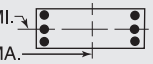
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#10 | 3.02 | MA | 14440 | 3543 | 21068 | 2973 | 24977 | 2487 | 27380 | 2089 | 30410 | 1440 | 37830 | 854 | 28990 |
| 8L-6S | | MI | 8177 | 3543 | 12705 | 2833 | 14693 | 2359 | 15929 | 1959 | 17570 | 1318 | 21615 | 836 | 15834 |
| 24-#10 | 3.02 | MA | 14176 | 3543 | 20485 | 2991 | 24276 | 2505 | 26539 | 2098 | 29266 | 1450 | 36394 | 811 | 28309 |
| 9L-5S | | MI | 8312 | 3543 | 12976 | 2825 | 15053 | 2342 | 16375 | 1953 | 18173 | 1306 | 22413 | 897 | 16054 |
| 24-#10 | 3.02 | MA | 13929 | 3543 | 19960 | 2999 | 23617 | 2516 | 25701 | 2116 | 28121 | 1465 | 34807 | 764 | 27526 |
| 10L-4S | | MI | 8454 | 3543 | 13279 | 2807 | 15418 | 2334 | 16829 | 1937 | 18804 | 1294 | 23287 | 949 | 16184 |
| 24-#10 | 3.02 | MA | 13650 | 3543 | 19449 | 3008 | 22946 | 2524 | 24881 | 2126 | 26961 | 1473 | 33373 | 719 | 26781 |
| 11L-3S | | MI | 8547 | 3543 | 13575 | 2798 | 15836 | 2318 | 17341 | 1931 | 19504 | 1290 | 24159 | 1003 | 16210 |
| 24-#10 | 3.02 | MA | 13371 | 3543 | 18949 | 3018 | 22234 | 2541 | 24060 | 2144 | 25833 | 1490 | 31920 | 683 | 25881 |
| 12L-2S | | MI | 8742 | 3543 | 14005 | 2788 | 16383 | 2309 | 18006 | 1915 | 20404 | 1278 | 25404 | 1094 | 16223 |
| 24-#11 | 3.71 | MA | 15085 | 3742 | 22561 | 3101 | 26773 | 2584 | 29514 | 2155 | 33240 | 1439 | 41788 | 754 | 34532 |
| 8L-6S | | MI | 8498 | 3742 | 13573 | 2945 | 15706 | 2439 | 17118 | 2006 | 19146 | 1298 | 23532 | 714 | 18849 |
| 24-#11 | 3.71 | MA | 14775 | 3742 | 21857 | 3123 | 25920 | 2606 | 28489 | 2165 | 31857 | 1451 | 40028 | 701 | 33574 |
| 9L-5S | | MI | 8655 | 3742 | 13893 | 2935 | 16142 | 2420 | 17658 | 1999 | 19876 | 1285 | 24476 | 787 | 19075 |
| 24-#11 | 3.71 | MA | 14494 | 3742 | 21218 | 3132 | 25116 | 2618 | 27468 | 2186 | 30469 | 1470 | 38089 | 641 | 32536 |
| 10L-4S | | MI | 8819 | 3742 | 14260 | 2914 | 16584 | 2411 | 18207 | 1981 | 20639 | 1271 | 25505 | 852 | 19409 |
| 24-#11 | 3.71 | MA | 14153 | 3742 | 20595 | 3143 | 24307 | 2629 | 26468 | 2198 | 29055 | 1478 | 36335 | 585 | 31392 |
| 11L-3S | | MI | 8926 | 3742 | 14619 | 2903 | 17088 | 2391 | 18826 | 1974 | 21485 | 1268 | 26537 | 915 | 19458 |
| 24-#14 | 5.36 | MA | 16264 | 4215 | 25022 | 3457 | 29850 | 2863 | 33224 | 2342 | 38201 | 1468 | 49042 | 459 | 45540 |
| 9L-5S | | MI | 9540 | 4215 | 16035 | 3232 | 18806 | 2635 | 20860 | 2136 | 24177 | 1257 | 30031 | 576 | 26386 |

## RECTANGULAR TIED COLUMNS 24" x 44"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.52 | MA | 14979 | 3257 | 21662 | 2724 | 25429 | 2288 | 27560 | 1943 | 29937 | 1417 | 36193 | 1230 | 16841 |
| 2E | | MI | 7844 | 3257 | 12061 | 2569 | 13593 | 2155 | 14409 | 1827 | 15257 | 1325 | 17589 | 1093 | 8577 |
| 6-#14 | 1.28 | MA | 14640 | 3186 | 20741 | 2697 | 24383 | 2270 | 26352 | 1935 | 28355 | 1431 | 34041 | 1244 | 14404 |
| 2L-3S | | MI | 7351 | 3186 | 10882 | 2570 | 12202 | 2161 | 12772 | 1854 | 13081 | 1365 | 14947 | 983 | 7460 |
| 6-#14 | 1.28 | MA | 13810 | 3186 | 19203 | 2720 | 22425 | 2291 | 23974 | 1955 | 25136 | 1463 | 29585 | 1104 | 14392 |
| 3L-2S | | MI | 7724 | 3186 | 11617 | 2555 | 13138 | 2149 | 13909 | 1830 | 14619 | 1347 | 16999 | 1145 | 7417 |
| 6-#18 | 2.27 | MA | 16229 | 3486 | 24356 | 2867 | 28859 | 2391 | 31726 | 2008 | 35574 | 1404 | 43999 | 1211 | 24988 |
| 2L-3S | | MI | 7778 | 3486 | 12061 | 2734 | 13593 | 2276 | 14409 | 1930 | 15257 | 1338 | 17589 | 759 | 12475 |
| 6-#18 | 2.27 | MA | 14876 | 3486 | 21662 | 2907 | 25429 | 2428 | 27560 | 2041 | 29937 | 1458 | 36193 | 957 | 24782 |
| 3L-2S | | MI | 8384 | 3486 | 13327 | 2711 | 15206 | 2259 | 16367 | 1892 | 17907 | 1312 | 21011 | 1046 | 12464 |
| 8-#11 | 1.18 | MA | 14500 | 3157 | 20348 | 2687 | 23948 | 2264 | 25856 | 1933 | 27710 | 1438 | 33168 | 1251 | 13401 |
| 2L-4S | | MI | 7268 | 3157 | 10546 | 2574 | 11782 | 2177 | 12283 | 1858 | 12431 | 1375 | 14262 | 992 | 6990 |
| 8-#11 | 1.18 | MA | 13918 | 3157 | 19274 | 2703 | 22580 | 2279 | 24195 | 1948 | 25462 | 1460 | 30056 | 1155 | 13403 |
| 3E | | MI | 7410 | 3157 | 10904 | 2563 | 12286 | 2158 | 12901 | 1851 | 13277 | 1372 | 15294 | 1055 | 6961 |
| 8-#11 | 1.18 | MA | 13621 | 3157 | 18554 | 2720 | 21561 | 2305 | 22942 | 1972 | 23745 | 1473 | 28018 | 1095 | 13350 |
| 4L-2S | | MI | 7675 | 3157 | 11422 | 2552 | 12945 | 2149 | 13702 | 1833 | 14360 | 1358 | 16762 | 1167 | 6933 |
| 8-#14 | 1.70 | MA | 15374 | 3314 | 22279 | 2777 | 26341 | 2328 | 28730 | 1972 | 31574 | 1423 | 38498 | 1234 | 19063 |
| 2L-4S | | MI | 7489 | 3314 | 11106 | 2665 | 12419 | 2246 | 13028 | 1899 | 13414 | 1361 | 15551 | 876 | 9706 |
| 8-#14 | 1.70 | MA | 14574 | 3314 | 20741 | 2800 | 24383 | 2350 | 26352 | 1992 | 28355 | 1456 | 34041 | 1094 | 19020 |
| 3E | | MI | 7684 | 3314 | 11617 | 2650 | 13138 | 2219 | 13909 | 1890 | 14619 | 1358 | 16999 | 964 | 9708 |
| 8-#14 | 1.70 | MA | 14168 | 3314 | 19707 | 2823 | 22921 | 2386 | 24557 | 2027 | 25893 | 1473 | 31110 | 1007 | 18813 |
| 4L-2S | | MI | 8047 | 3314 | 12352 | 2635 | 14074 | 2207 | 15045 | 1866 | 16158 | 1340 | 19051 | 1126 | 9678 |
| 8-#18 | 3.03 | MA | 17444 | 3714 | 27049 | 3010 | 32289 | 2495 | 35891 | 2072 | 41212 | 1390 | 51805 | 1193 | 33114 |
| 2L-4S | | MI | 8019 | 3714 | 12440 | 2900 | 13959 | 2423 | 14840 | 2006 | 15819 | 1324 | 18579 | 564 | 15421 |
| 8-#18 | 3.03 | MA | 16164 | 3714 | 24356 | 3049 | 28859 | 2532 | 31726 | 2106 | 35574 | 1445 | 43999 | 938 | 32853 |
| 3E | | MI | 8334 | 3714 | 13327 | 2877 | 15206 | 2380 | 16367 | 1995 | 17907 | 1324 | 21011 | 712 | 16270 |
| 8-#18 | 3.03 | MA | 15517 | 3714 | 22538 | 3089 | 26289 | 2595 | 28571 | 2166 | 31250 | 1472 | 38812 | 782 | 31147 |
| 4L-2S | | MI | 8914 | 3714 | 14594 | 2854 | 16818 | 2362 | 18326 | 1957 | 20557 | 1298 | 24432 | 1000 | 16316 |
| 10-#10 | 1.20 | MA | 14578 | 3163 | 20363 | 2702 | 24056 | 2276 | 26032 | 1944 | 27986 | 1444 | 33578 | 1256 | 13711 |
| 2L-5S | | MI | 7244 | 3163 | 10387 | 2615 | 11687 | 2203 | 12197 | 1888 | 12329 | 1399 | 14195 | 994 | 7144 |
| 10-#10 | 1.20 | MA | 14099 | 3163 | 19480 | 2716 | 22932 | 2289 | 24666 | 1956 | 26137 | 1463 | 31019 | 1180 | 13709 |
| 3L-4S | | MI | 7390 | 3163 | 10690 | 2597 | 12052 | 2195 | 12650 | 1873 | 12960 | 1387 | 15068 | 1046 | 7133 |
| 10-#10 | 1.20 | MA | 13859 | 3163 | 18889 | 2730 | 22095 | 2311 | 23638 | 1977 | 24728 | 1474 | 29355 | 1132 | 13676 |
| 4L-3S | | MI | 7505 | 3163 | 10986 | 2587 | 12470 | 2178 | 13162 | 1866 | 13661 | 1383 | 15940 | 1100 | 7114 |

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

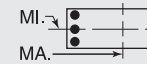
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.20 | MA | 13492 | 3163 | 18268 | 2750 | 21371 | 2324 | 22736 | 1989 | 23469 | 1493 | 27648 | 1097 | 13573 |
| 5L-2S | | MI | 7726 | 3163 | 11416 | 2577 | 13017 | 2170 | 13827 | 1851 | 14561 | 1370 | 17185 | 1191 | 7094 |
| 10-#11 | 1.48 | MA | 15020 | 3246 | 21423 | 2742 | 25316 | 2304 | 27517 | 1959 | 29958 | 1432 | 36281 | 1244 | 16657 |
| 2L-5S | | MI | 7341 | 3246 | 10696 | 2651 | 11999 | 2227 | 12534 | 1901 | 12751 | 1383 | 14700 | 916 | 8559 |
| 10-#11 | 1.48 | MA | 14452 | 3246 | 20348 | 2759 | 23948 | 2319 | 25856 | 1973 | 27710 | 1455 | 33168 | 1148 | 16643 |
| 3L-4S | | MI | 7510 | 3246 | 11063 | 2630 | 12441 | 2218 | 13083 | 1883 | 13514 | 1370 | 15730 | 981 | 8567 |
| 10-#11 | 1.48 | MA | 14169 | 3246 | 19628 | 2775 | 22928 | 2345 | 24603 | 1998 | 25993 | 1468 | 31131 | 1088 | 16574 |
| 4L-3S | | MI | 7646 | 3246 | 11422 | 2619 | 12945 | 2198 | 13702 | 1876 | 14360 | 1366 | 16762 | 1044 | 8549 |
| 10-#11 | 1.48 | MA | 13732 | 3246 | 18877 | 2800 | 22045 | 2361 | 23503 | 2012 | 24458 | 1490 | 29045 | 1043 | 16382 |
| 5L-2S | | MI | 7905 | 3246 | 11939 | 2608 | 13604 | 2189 | 14502 | 1858 | 15443 | 1353 | 18229 | 1156 | 8526 |
| 10-#14 | 2.13 | MA | 16094 | 3443 | 23816 | 2857 | 28299 | 2386 | 31109 | 2008 | 34792 | 1416 | 42954 | 1223 | 23709 |
| 2L-5S | | MI | 7594 | 3443 | 11318 | 2775 | 12725 | 2316 | 13382 | 1960 | 13865 | 1371 | 16163 | 763 | 11503 |
| 10-#14 | 2.13 | MA | 15322 | 3443 | 22279 | 2880 | 26341 | 2408 | 28730 | 2028 | 31574 | 1448 | 38498 | 1084 | 23644 |
| 3L-4S | | MI | 7827 | 3443 | 11841 | 2745 | 13355 | 2304 | 14164 | 1936 | 14952 | 1353 | 17603 | 857 | 11909 |
| 10-#14 | 2.13 | MA | 14941 | 3443 | 21245 | 2904 | 24879 | 2445 | 26935 | 2063 | 29111 | 1465 | 35566 | 997 | 23418 |
| 4L-3S | | MI | 8012 | 3443 | 12352 | 2730 | 14074 | 2278 | 15045 | 1927 | 16158 | 1350 | 19051 | 945 | 11939 |
| 10-#14 | 2.13 | MA | 14325 | 3443 | 20174 | 2940 | 23612 | 2466 | 25356 | 2084 | 26910 | 1497 | 32570 | 930 | 22397 |
| 5L-2S | | MI | 8365 | 3443 | 13087 | 2716 | 15010 | 2266 | 16182 | 1903 | 17696 | 1332 | 21102 | 1107 | 11924 |
| 10-#18 | 3.79 | MA | 17416 | 3942 | 27049 | 3192 | 32289 | 2635 | 35891 | 2171 | 41212 | 1431 | 51805 | 920 | 40931 |
| 3L-4S | | MI | 8585 | 3942 | 13706 | 3043 | 15572 | 2527 | 16799 | 2071 | 18469 | 1311 | 22000 | 517 | 19009 |
| 10-#18 | 3.79 | MA | 16831 | 3942 | 25232 | 3232 | 29719 | 2699 | 32737 | 2231 | 36888 | 1459 | 46618 | 764 | 39150 |
| 4L-3S | | MI | 8879 | 3942 | 14594 | 3020 | 16818 | 2483 | 18326 | 2059 | 20557 | 1311 | 24432 | 666 | 20053 |
| 10-#18 | 3.79 | MA | 15785 | 3942 | 23370 | 3297 | 27490 | 2735 | 29960 | 2265 | 33017 | 1513 | 41334 | 638 | 36047 |
| 5L-2S | | MI | 9438 | 3942 | 15860 | 2997 | 18430 | 2466 | 20284 | 2021 | 23208 | 1285 | 27853 | 954 | 20143 |
| 12-#10 | 1.44 | MA | 15008 | 3236 | 21246 | 2748 | 25181 | 2309 | 27398 | 1964 | 29834 | 1440 | 36138 | 1250 | 16386 |
| 2L-6S | | MI | 7295 | 3236 | 10545 | 2668 | 11875 | 2253 | 12416 | 1915 | 12626 | 1407 | 14641 | 927 | 8344 |
| 12-#10 | 1.44 | MA | 14540 | 3236 | 20363 | 2761 | 24056 | 2322 | 26032 | 1976 | 27986 | 1459 | 33578 | 1174 | 16375 |
| 3L-5S | | MI | 7446 | 3236 | 10817 | 2660 | 12235 | 2236 | 12862 | 1909 | 13229 | 1395 | 15440 | 988 | 8443 |
| 12-#10 | 1.44 | MA | 14309 | 3236 | 19772 | 2775 | 23219 | 2344 | 25004 | 1997 | 26576 | 1470 | 31914 | 1126 | 16331 |
| 4E | | MI | 7591 | 3236 | 11120 | 2642 | 12600 | 2228 | 13316 | 1893 | 13860 | 1382 | 16313 | 1041 | 8443 |
| 12-#10 | 1.44 | MA | 13945 | 3236 | 19151 | 2795 | 22496 | 2357 | 24102 | 2009 | 25318 | 1489 | 30207 | 1091 | 16219 |
| 5L-3S | | MI | 7704 | 3236 | 11416 | 2633 | 13017 | 2211 | 13827 | 1887 | 14561 | 1378 | 17185 | 1094 | 8430 |
| 12-#10 | 1.44 | MA | 13626 | 3236 | 18563 | 2802 | 21785 | 2367 | 23217 | 2030 | 24086 | 1500 | 28541 | 1027 | 15846 |
| 6L-2S | | MI | 7921 | 3236 | 11846 | 2623 | 13565 | 2203 | 14493 | 1871 | 15461 | 1366 | 18431 | 1185 | 8414 |
| 12-#11 | 1.77 | MA | 15532 | 3335 | 22497 | 2798 | 26683 | 2344 | 29178 | 1984 | 32206 | 1427 | 39394 | 1236 | 19905 |
| 2L-6S | | MI | 7401 | 3335 | 10893 | 2716 | 12222 | 2287 | 12794 | 1933 | 13104 | 1392 | 15224 | 833 | 9831 |
| 12-#11 | 1.77 | MA | 14979 | 3335 | 21423 | 2815 | 25316 | 2360 | 27517 | 1998 | 29958 | 1450 | 36281 | 1141 | 19880 |
| 3L-5S | | MI | 7580 | 3335 | 11214 | 2707 | 12658 | 2267 | 13335 | 1926 | 13834 | 1378 | 16167 | 906 | 10111 |
| 12-#11 | 1.77 | MA | 14708 | 3335 | 20702 | 2831 | 24296 | 2386 | 26264 | 2023 | 28241 | 1463 | 34243 | 1081 | 19797 |
| 4E | | MI | 7748 | 3335 | 11581 | 2686 | 13100 | 2258 | 13883 | 1908 | 14597 | 1365 | 17197 | 971 | 10134 |
| 12-#11 | 1.77 | MA | 14274 | 3335 | 19951 | 2856 | 23413 | 2401 | 25164 | 2037 | 26706 | 1485 | 32158 | 1036 | 19597 |
| 5L-3S | | MI | 7880 | 3335 | 11939 | 2675 | 13604 | 2239 | 14502 | 1901 | 15443 | 1361 | 18229 | 1034 | 10127 |
| 12-#11 | 1.77 | MA | 13894 | 3335 | 19235 | 2864 | 22555 | 2414 | 24085 | 2062 | 25204 | 1498 | 30122 | 957 | 18841 |
| 6L-2S | | MI | 8134 | 3335 | 12456 | 2664 | 14263 | 2230 | 15302 | 1884 | 16526 | 1348 | 19696 | 1146 | 10110 |
| 12-#14 | 2.56 | MA | 16054 | 3571 | 23816 | 2961 | 28299 | 2466 | 31109 | 2065 | 34792 | 1441 | 42954 | 1073 | 28267 |
| 3L-5S | | MI | 7928 | 3571 | 12053 | 2855 | 13661 | 2375 | 14518 | 1996 | 15403 | 1364 | 18215 | 744 | 13619 |
| 12-#14 | 2.56 | MA | 15696 | 3571 | 22783 | 2984 | 26837 | 2503 | 29313 | 2100 | 32330 | 1458 | 40023 | 987 | 28026 |
| 4E | | MI | 8159 | 3571 | 12576 | 2826 | 14291 | 2363 | 15301 | 1972 | 16491 | 1346 | 19654 | 838 | 14107 |
| 12-#14 | 2.56 | MA | 15085 | 3571 | 21712 | 3020 | 25570 | 2525 | 27735 | 2120 | 30129 | 1490 | 37027 | 920 | 26968 |
| 5L-3S | | MI | 8336 | 3571 | 13087 | 2811 | 15010 | 2336 | 16182 | 1963 | 17696 | 1343 | 21102 | 927 | 14157 |
| 12-#14 | 2.56 | MA | 14561 | 3571 | 20685 | 3031 | 24349 | 2544 | 26186 | 2155 | 27974 | 1507 | 34102 | 803 | 25777 |
| 6L-2S | | MI | 8680 | 3571 | 13822 | 2796 | 15945 | 2324 | 17318 | 1939 | 19234 | 1325 | 23154 | 1088 | 14159 |
| 12-#18 | 4.55 | MA | 18107 | 4171 | 27925 | 3374 | 33149 | 2802 | 36902 | 2296 | 42525 | 1446 | 54424 | 745 | 47140 |
| 4E | | MI | 9141 | 4171 | 14973 | 3186 | 17184 | 2631 | 18757 | 2135 | 21119 | 1298 | 25422 | 471 | 22625 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

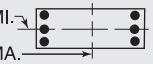



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 4.55 | MA | 17071 | 4171 | 26064 | 3439 | 30920 | 2839 | 34126 | 2329 | 38654 | 1500 | 49140 | 619 | 44068 |
| 5L-3S | | MI | 9417 | 4171 | 15860 | 3163 | 18430 | 2587 | 20284 | 2124 | 23208 | 1298 | 27853 | 620 | 23830 |
| 12-#18 | 4.55 | MA | 16221 | 4171 | 24264 | 3458 | 28805 | 2874 | 31401 | 2390 | 34965 | 1554 | 43984 | 405 | 40541 |
| 6L-2S | | MI | 9964 | 4171 | 17126 | 3140 | 20043 | 2570 | 22242 | 2086 | 25858 | 1272 | 31274 | 907 | 23956 |
| 14-#10 | 1.68 | MA | 14975 | 3308 | 21246 | 2807 | 25181 | 2355 | 27398 | 1997 | 29834 | 1455 | 36138 | 1168 | 19038 |
| 3L-6S | | MI | 7498 | 3308 | 10976 | 2713 | 12423 | 2286 | 13081 | 1936 | 13526 | 1403 | 15887 | 921 | 9594 |
| 14-#10 | 1.68 | MA | 14753 | 3308 | 20655 | 2820 | 24344 | 2377 | 26370 | 2018 | 28425 | 1466 | 34474 | 1120 | 18986 |
| 4L-5S | | MI | 7646 | 3308 | 11247 | 2706 | 12783 | 2269 | 13527 | 1929 | 14129 | 1390 | 16685 | 982 | 9736 |
| 14-#10 | 1.68 | MA | 14391 | 3308 | 20034 | 2840 | 23620 | 2390 | 25468 | 2030 | 27166 | 1485 | 32767 | 1085 | 18867 |
| 5L-4S | | MI | 7791 | 3308 | 11550 | 2688 | 13147 | 2261 | 13981 | 1914 | 14760 | 1378 | 17559 | 1035 | 9748 |
| 14-#10 | 1.68 | MA | 14080 | 3308 | 19446 | 2847 | 22910 | 2400 | 24583 | 2051 | 25935 | 1496 | 31100 | 1022 | 18470 |
| 6L-3S | | MI | 7900 | 3308 | 11846 | 2678 | 13565 | 2244 | 14493 | 1907 | 15461 | 1374 | 18431 | 1088 | 9740 |
| 14-#10 | 1.68 | MA | 13817 | 3308 | 18891 | 2857 | 22127 | 2416 | 23700 | 2060 | 24745 | 1515 | 29514 | 990 | 17948 |
| 7L-2S | | MI | 8113 | 3308 | 12276 | 2668 | 14112 | 2236 | 15158 | 1892 | 16361 | 1362 | 19676 | 1179 | 9728 |
| 14-#11 | 2.07 | MA | 15497 | 3424 | 22497 | 2870 | 26683 | 2400 | 29178 | 2023 | 32206 | 1445 | 39394 | 1134 | 23114 |
| 3L-6S | | MI | 7641 | 3424 | 11410 | 2772 | 12881 | 2327 | 13595 | 1958 | 14187 | 1387 | 16691 | 823 | 11337 |
| 14-#11 | 2.07 | MA | 15239 | 3424 | 21776 | 2887 | 25663 | 2426 | 27926 | 2048 | 30489 | 1457 | 37356 | 1074 | 23021 |
| 4L-5S | | MI | 7816 | 3424 | 11731 | 2763 | 13317 | 2308 | 14135 | 1951 | 14917 | 1373 | 17635 | 895 | 11624 |
| 14-#11 | 2.07 | MA | 14807 | 3424 | 21025 | 2911 | 24781 | 2442 | 26825 | 2063 | 28954 | 1480 | 35270 | 1029 | 22815 |
| 5L-4S | | MI | 7983 | 3424 | 12098 | 2741 | 13758 | 2299 | 14684 | 1934 | 15680 | 1359 | 18664 | 960 | 11694 |
| 14-#11 | 2.07 | MA | 14438 | 3424 | 20309 | 2920 | 23923 | 2454 | 25746 | 2087 | 27452 | 1493 | 33235 | 949 | 22038 |
| 6L-3S | | MI | 8111 | 3424 | 12456 | 2730 | 14263 | 2279 | 15302 | 1926 | 16526 | 1356 | 19696 | 1023 | 11699 |
| 14-#11 | 2.07 | MA | 14125 | 3424 | 19632 | 2931 | 22970 | 2474 | 24682 | 2100 | 26001 | 1515 | 31289 | 910 | 21426 |
| 7L-2S | | MI | 8360 | 3424 | 12974 | 2719 | 14922 | 2270 | 16102 | 1909 | 17609 | 1343 | 21163 | 1135 | 11688 |
| 14-#14 | 2.98 | MA | 16437 | 3700 | 24321 | 3064 | 28795 | 2561 | 31691 | 2136 | 35549 | 1450 | 44479 | 976 | 32638 |
| 4L-5S | | MI | 8257 | 3700 | 12788 | 2936 | 14596 | 2433 | 15655 | 2032 | 16941 | 1356 | 20266 | 725 | 15745 |
| 14-#14 | 2.98 | MA | 15831 | 3700 | 23249 | 3100 | 27528 | 2583 | 30113 | 2156 | 33347 | 1482 | 41483 | 909 | 31546 |
| 5L-4S | | MI | 8487 | 3700 | 13311 | 2906 | 15227 | 2421 | 16437 | 2009 | 18029 | 1338 | 21706 | 819 | 16301 |
| 14-#14 | 2.98 | MA | 15326 | 3700 | 22223 | 3111 | 26307 | 2602 | 28564 | 2192 | 31193 | 1500 | 38559 | 793 | 30375 |
| 6L-3S | | MI | 8656 | 3700 | 13822 | 2891 | 15945 | 2394 | 17318 | 2000 | 19234 | 1335 | 23154 | 908 | 16369 |
| 14-#14 | 2.98 | MA | 14898 | 3700 | 21253 | 3127 | 24941 | 2629 | 27050 | 2209 | 29109 | 1532 | 35757 | 735 | 28813 |
| 7L-2S | | MI | 8991 | 3700 | 14557 | 2876 | 16881 | 2382 | 18455 | 1976 | 20772 | 1317 | 25205 | 1069 | 16388 |
| 14-#18 | 5.30 | MA | 18325 | 4399 | 28758 | 3582 | 34349 | 2943 | 38292 | 2394 | 44292 | 1487 | 56946 | 601 | 52088 |
| 5L-4S | | MI | 9689 | 4399 | 16239 | 3328 | 18796 | 2735 | 20715 | 2200 | 23770 | 1284 | 28843 | 424 | 26264 |
| 14-#18 | 5.30 | MA | 17520 | 4399 | 26957 | 3601 | 32235 | 2978 | 35566 | 2454 | 40603 | 1541 | 51790 | 387 | 48514 |
| 6L-3S | | MI | 9989 | 4399 | 17126 | 3305 | 20043 | 2691 | 22242 | 2189 | 25858 | 1285 | 31274 | 573 | 27605 |
| 14-#18 | 5.30 | MA | 16833 | 4399 | 25254 | 3626 | 29835 | 3024 | 32947 | 2488 | 36837 | 1569 | 46822 | 282 | 44847 |
| 7L-2S | | MI | 10466 | 4399 | 18393 | 3282 | 21655 | 2674 | 24201 | 2151 | 28508 | 1258 | 34696 | 861 | 27761 |
| 16-#10 | 1.92 | MA | 15191 | 3381 | 21539 | 2866 | 25469 | 2410 | 27736 | 2038 | 30274 | 1461 | 37034 | 1114 | 21640 |
| 4L-6S | | MI | 7699 | 3381 | 11406 | 2758 | 12970 | 2318 | 13746 | 1957 | 14426 | 1399 | 17132 | 915 | 10849 |
| 16-#10 | 1.92 | MA | 14830 | 3381 | 20918 | 2886 | 24745 | 2423 | 26834 | 2050 | 29015 | 1481 | 35326 | 1079 | 21517 |
| 5E | | MI | 7844 | 3381 | 11677 | 2751 | 13330 | 2302 | 14192 | 1950 | 15029 | 1386 | 17930 | 976 | 11028 |
| 16-#10 | 1.92 | MA | 14527 | 3381 | 20329 | 2893 | 24034 | 2433 | 25949 | 2071 | 27783 | 1491 | 33660 | 1016 | 21098 |
| 6L-4S | | MI | 7989 | 3381 | 11980 | 2733 | 13695 | 2294 | 14646 | 1935 | 15660 | 1374 | 18804 | 1029 | 11046 |
| 16-#10 | 1.92 | MA | 14271 | 3381 | 19774 | 2902 | 23252 | 2449 | 25066 | 2081 | 26593 | 1510 | 32074 | 984 | 20590 |
| 7L-3S | | MI | 8094 | 3381 | 12276 | 2723 | 14112 | 2277 | 15158 | 1928 | 16361 | 1370 | 19676 | 1082 | 11047 |
| 16-#10 | 1.92 | MA | 13960 | 3381 | 19243 | 2912 | 22533 | 2458 | 24152 | 2097 | 25427 | 1530 | 30526 | 943 | 20095 |
| 8L-2S | | MI | 8304 | 3381 | 12706 | 2713 | 14660 | 2269 | 15823 | 1913 | 17261 | 1358 | 20921 | 1173 | 11038 |
| 16-#11 | 2.36 | MA | 15761 | 3513 | 22850 | 2942 | 27031 | 2467 | 29587 | 2073 | 32737 | 1452 | 40469 | 1067 | 26246 |
| 4L-6S | | MI | 7878 | 3513 | 11928 | 2828 | 13540 | 2368 | 14395 | 1983 | 15270 | 1381 | 18159 | 812 | 12848 |
| 16-#11 | 2.36 | MA | 15332 | 3513 | 22099 | 2967 | 26148 | 2482 | 28487 | 2088 | 31202 | 1475 | 38383 | 1022 | 26036 |
| 5E | | MI | 8050 | 3513 | 12249 | 2818 | 13976 | 2348 | 14935 | 1976 | 16000 | 1368 | 19102 | 885 | 13121 |
| 16-#11 | 2.36 | MA | 14972 | 3513 | 21383 | 2975 | 25291 | 2495 | 27407 | 2113 | 29700 | 1487 | 36347 | 942 | 25240 |
| 6L-4S | | MI | 8216 | 3513 | 12615 | 2797 | 14417 | 2339 | 15484 | 1959 | 16763 | 1354 | 20131 | 949 | 13250 |
| 16-#11 | 2.36 | MA | 14671 | 3513 | 20706 | 2986 | 24337 | 2514 | 26343 | 2125 | 28249 | 1510 | 34402 | 903 | 24645 |
| 7L-3S | | MI | 8339 | 3513 | 12974 | 2786 | 14922 | 2320 | 16102 | 1952 | 17609 | 1351 | 21163 | 1012 | 13266 |
| 16-#11 | 2.36 | MA | 14299 | 3513 | 20059 | 2999 | 23462 | 2525 | 25229 | 2144 | 26825 | 1533 | 32510 | 851 | 23696 |
| 8L-2S | | MI | 8584 | 3513 | 13491 | 2775 | 15580 | 2311 | 16902 | 1934 | 18692 | 1337 | 22631 | 1125 | 13262 |

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

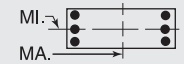
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.41 | MA | 16562 | 3828 | 24787 | 3180 | 29486 | 2641 | 32491 | 2193 | 36566 | 1475 | 45940 | 899 | 36129 |
| 5E | | MI | 8582 | 3828 | 13523 | 3016 | 15532 | 2491 | 16791 | 2069 | 18479 | 1349 | 22318 | 706 | 17880 |
| 16-#14 | 3.41 | MA | 16075 | 3828 | 23761 | 3192 | 28265 | 2660 | 30942 | 2228 | 34411 | 1492 | 43015 | 783 | 34973 |
| 6L-4S | | MI | 8811 | 3828 | 14046 | 2986 | 16162 | 2479 | 17574 | 2045 | 19567 | 1331 | 23757 | 800 | 18494 |
| 16-#14 | 3.41 | MA | 15667 | 3828 | 22791 | 3207 | 26899 | 2688 | 29428 | 2246 | 32328 | 1524 | 40213 | 725 | 33388 |
| 7L-3S | | MI | 8973 | 3828 | 14557 | 2971 | 16881 | 2453 | 18455 | 2036 | 20772 | 1328 | 25205 | 889 | 18576 |
| 16-#14 | 3.41 | MA | 15143 | 3828 | 21863 | 3225 | 25643 | 2703 | 27831 | 2273 | 30285 | 1556 | 37493 | 648 | 31822 |
| 8L-2S | | MI | 9300 | 3828 | 15292 | 2956 | 17817 | 2441 | 19591 | 2012 | 22310 | 1310 | 27257 | 1051 | 18607 |
| 16-#18 | 6.06 | MA | 18788 | 4628 | 29651 | 3744 | 35665 | 3081 | 39732 | 2519 | 46240 | 1528 | 59596 | 369 | 56486 |
| 6L-4S | | MI | 10295 | 4628 | 17505 | 3471 | 20409 | 2838 | 22674 | 2265 | 26420 | 1271 | 32264 | 378 | 29922 |
| 16-#18 | 6.06 | MA | 18145 | 4628 | 27947 | 3769 | 33265 | 3128 | 37113 | 2553 | 42475 | 1555 | 54628 | 264 | 52782 |
| 7L-3S | | MI | 10507 | 4628 | 18393 | 3448 | 21655 | 2795 | 24201 | 2254 | 28508 | 1271 | 34696 | 527 | 31380 |
| 18-#10 | 2.16 | MA | 15264 | 3453 | 21801 | 2931 | 25870 | 2455 | 28200 | 2071 | 30863 | 1476 | 37886 | 1073 | 24167 |
| 5L-6S | | MI | 7898 | 3453 | 11836 | 2804 | 13518 | 2351 | 14411 | 1977 | 15327 | 1394 | 18377 | 909 | 12108 |
| 18-#10 | 2.16 | MA | 14968 | 3453 | 21213 | 2938 | 25159 | 2466 | 27315 | 2092 | 29632 | 1487 | 36220 | 1010 | 23728 |
| 6L-5S | | MI | 8041 | 3453 | 12107 | 2796 | 13878 | 2335 | 14857 | 1970 | 15930 | 1382 | 19176 | 970 | 12317 |
| 18-#10 | 2.16 | MA | 14720 | 3453 | 20658 | 2947 | 24376 | 2482 | 26432 | 2101 | 28442 | 1506 | 34633 | 978 | 23233 |
| 7L-4S | | MI | 8184 | 3453 | 12410 | 2778 | 14243 | 2327 | 15311 | 1955 | 16560 | 1370 | 20049 | 1023 | 12342 |
| 18-#10 | 2.16 | MA | 14410 | 3453 | 20127 | 2958 | 23658 | 2491 | 25518 | 2118 | 27275 | 1525 | 33085 | 937 | 22733 |
| 8L-3S | | MI | 8287 | 3453 | 12706 | 2768 | 14660 | 2310 | 15823 | 1948 | 17261 | 1366 | 20921 | 1076 | 12351 |
| 18-#10 | 2.16 | MA | 14101 | 3453 | 19510 | 2975 | 22921 | 2510 | 24633 | 2127 | 26062 | 1535 | 31580 | 895 | 21993 |
| 9L-2S | | MI | 8493 | 3453 | 13136 | 2759 | 15208 | 2302 | 16488 | 1933 | 18161 | 1353 | 22166 | 1167 | 12346 |
| 18-#11 | 2.66 | MA | 15849 | 3602 | 23173 | 3023 | 27516 | 2522 | 30148 | 2113 | 33450 | 1470 | 41496 | 1015 | 29258 |
| 5L-6S | | MI | 8113 | 3602 | 12445 | 2883 | 14198 | 2408 | 15195 | 2009 | 16353 | 1376 | 19626 | 801 | 14363 |
| 18-#11 | 2.66 | MA | 15500 | 3602 | 22457 | 3031 | 26658 | 2535 | 29068 | 2138 | 31948 | 1482 | 39460 | 935 | 28445 |
| 6L-5S | | MI | 8281 | 3602 | 12766 | 2874 | 14634 | 2389 | 15735 | 2002 | 17083 | 1363 | 20569 | 874 | 14623 |
| 18-#11 | 2.66 | MA | 15208 | 3602 | 21781 | 3042 | 25705 | 2555 | 28004 | 2150 | 30497 | 1505 | 37515 | 896 | 27866 |
| 7L-4S | | MI | 8447 | 3602 | 13133 | 2853 | 15076 | 2380 | 16284 | 1984 | 17846 | 1349 | 21599 | 939 | 14803 |
| 18-#11 | 2.66 | MA | 14839 | 3602 | 21133 | 3054 | 24829 | 2566 | 26890 | 2170 | 29073 | 1528 | 35622 | 843 | 26902 |
| 8L-3S | | MI | 8566 | 3602 | 13491 | 2842 | 15580 | 2360 | 16902 | 1977 | 18692 | 1346 | 22631 | 1002 | 14827 |
| 18-#11 | 2.66 | MA | 14473 | 3602 | 20388 | 3076 | 23930 | 2588 | 25811 | 2180 | 27612 | 1540 | 33777 | 791 | 25997 |
| 9L-2S | | MI | 8806 | 3602 | 14009 | 2831 | 16239 | 2351 | 17703 | 1959 | 19775 | 1332 | 24098 | 1114 | 14832 |
| 18-#14 | 3.84 | MA | 16812 | 3957 | 25299 | 3272 | 30223 | 2719 | 33321 | 2264 | 37630 | 1485 | 47472 | 772 | 39571 |
| 6L-5S | | MI | 8903 | 3957 | 14258 | 3096 | 16468 | 2550 | 17928 | 2105 | 20017 | 1342 | 24369 | 687 | 20023 |
| 18-#14 | 3.84 | MA | 16421 | 3957 | 24329 | 3287 | 28857 | 2746 | 31806 | 2282 | 35547 | 1517 | 44670 | 715 | 37963 |
| 7L-4S | | MI | 9131 | 3957 | 14781 | 3067 | 17098 | 2538 | 18711 | 2081 | 21105 | 1324 | 25809 | 781 | 20629 |
| 18-#14 | 3.84 | MA | 15903 | 3957 | 23401 | 3305 | 27601 | 2761 | 30209 | 2310 | 33504 | 1549 | 41950 | 637 | 36377 |
| 8L-3S | | MI | 9286 | 3957 | 15292 | 3052 | 17817 | 2511 | 19591 | 2072 | 22310 | 1320 | 27257 | 870 | 20781 |
| 18-#14 | 3.84 | MA | 15414 | 3957 | 22339 | 3337 | 26311 | 2793 | 28662 | 2324 | 31415 | 1566 | 39291 | 561 | 34560 |
| 9L-2S | | MI | 9606 | 3957 | 16027 | 3037 | 18753 | 2499 | 20728 | 2048 | 23848 | 1302 | 29308 | 1032 | 20823 |
| 18-#18 | 6.82 | MA | 19427 | 4856 | 30641 | 3912 | 36695 | 3232 | 41279 | 2617 | 48112 | 1542 | 62434 | 245 | 60717 |
| 7L-4S | | MI | 10827 | 4856 | 18772 | 3614 | 22021 | 2942 | 24632 | 2330 | 29070 | 1258 | 35685 | 332 | 33596 |
| 20-#10 | 2.41 | MA | 15403 | 3526 | 22096 | 2983 | 26284 | 2499 | 28681 | 2112 | 31481 | 1483 | 38779 | 1004 | 26362 |
| 6E | | MI | 8095 | 3526 | 12266 | 2849 | 14066 | 2384 | 15076 | 1998 | 16227 | 1390 | 19623 | 904 | 13369 |
| 20-#10 | 2.41 | MA | 15162 | 3526 | 21541 | 2993 | 25501 | 2515 | 27798 | 2122 | 30291 | 1502 | 37193 | 972 | 25879 |
| 7L-5S | | MI | 8235 | 3526 | 12537 | 2842 | 14425 | 2368 | 15522 | 1991 | 16830 | 1378 | 20421 | 964 | 13605 |
| 20-#10 | 2.41 | MA | 14855 | 3526 | 21010 | 3003 | 24782 | 2524 | 26884 | 2138 | 29124 | 1521 | 35645 | 932 | 25371 |
| 8L-4S | | MI | 8378 | 3526 | 12840 | 2823 | 14790 | 2359 | 15976 | 1976 | 17461 | 1365 | 21294 | 1017 | 13636 |
| 20-#10 | 2.41 | MA | 14555 | 3526 | 20394 | 3021 | 24045 | 2543 | 25999 | 2147 | 27911 | 1531 | 34140 | 889 | 24634 |
| 9L-3S | | MI | 8478 | 3526 | 13136 | 2814 | 15208 | 2343 | 16488 | 1969 | 18161 | 1362 | 22166 | 1070 | 13650 |
| 20-#10 | 2.41 | MA | 14281 | 3526 | 19841 | 3029 | 23352 | 2553 | 25117 | 2165 | 26706 | 1547 | 32473 | 843 | 23881 |
| 10L-2S | | MI | 8681 | 3526 | 13566 | 2804 | 15755 | 2335 | 17153 | 1954 | 19061 | 1349 | 23412 | 1161 | 13651 |
| 20-#11 | 2.95 | MA | 16019 | 3691 | 23531 | 3087 | 28026 | 2576 | 30729 | 2163 | 34196 | 1477 | 42573 | 928 | 31652 |
| 6E | | MI | 8346 | 3691 | 12963 | 2939 | 14857 | 2449 | 15995 | 2034 | 17436 | 1371 | 21093 | 791 | 15881 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

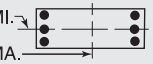


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.95 | MA | 15737 | 3691 | 22855 | 3098 | 27072 | 2595 | 29665 | 2175 | 32745 | 1500 | 40627 | 888 | 31088 |
| 7L-5S | | MI | 8511 | 3691 | 13284 | 2930 | 15293 | 2429 | 16535 | 2027 | 18166 | 1358 | 22036 | 863 | 16129 |
| 20-#11 | 2.95 | MA | 15371 | 3691 | 22207 | 3110 | 26197 | 2606 | 28551 | 2195 | 31321 | 1523 | 38735 | 836 | 30108 |
| 8L-4S | | MI | 8676 | 3691 | 13650 | 2908 | 15735 | 2420 | 17084 | 2009 | 18929 | 1344 | 23066 | 928 | 16355 |
| 20-#11 | 2.95 | MA | 15024 | 3691 | 21463 | 3132 | 25298 | 2628 | 27472 | 2205 | 29860 | 1535 | 36889 | 784 | 29190 |
| 9L-3S | | MI | 8791 | 3691 | 14009 | 2897 | 16239 | 2401 | 17703 | 2002 | 19775 | 1341 | 24098 | 991 | 16386 |
| 20-#11 | 2.95 | MA | 14691 | 3691 | 20790 | 3141 | 24452 | 2641 | 26397 | 2227 | 28391 | 1554 | 34851 | 724 | 28063 |
| 10L-2S | | MI | 9027 | 3691 | 14526 | 2886 | 16898 | 2392 | 18503 | 1985 | 20858 | 1327 | 25565 | 1103 | 16398 |
| 20-#14 | 4.26 | MA | 17163 | 4085 | 25867 | 3368 | 30815 | 2804 | 34184 | 2319 | 38765 | 1509 | 49126 | 704 | 42538 |
| 7L-5S | | MI | 9221 | 4085 | 14993 | 3177 | 17404 | 2608 | 19064 | 2142 | 21555 | 1334 | 26421 | 668 | 22171 |
| 20-#14 | 4.26 | MA | 16649 | 4085 | 24939 | 3385 | 29559 | 2819 | 32587 | 2346 | 36723 | 1541 | 46406 | 627 | 40932 |
| 8L-4S | | MI | 9448 | 4085 | 15516 | 3147 | 18034 | 2596 | 19847 | 2118 | 22643 | 1316 | 27861 | 762 | 22750 |
| 20-#14 | 4.26 | MA | 16176 | 4085 | 23877 | 3417 | 28269 | 2851 | 31040 | 2361 | 34634 | 1559 | 43747 | 551 | 39125 |
| 9L-3S | | MI | 9597 | 4085 | 16027 | 3132 | 18753 | 2569 | 20728 | 2109 | 23848 | 1313 | 29308 | 851 | 22983 |
| 22-#10 | 2.65 | MA | 15600 | 3598 | 22424 | 3038 | 26626 | 2548 | 29164 | 2142 | 32139 | 1498 | 39753 | 967 | 28526 |
| 7L-6S | | MI | 8290 | 3598 | 12696 | 2894 | 14613 | 2417 | 15741 | 2018 | 17127 | 1386 | 20868 | 898 | 14633 |
| 22-#10 | 2.65 | MA | 15294 | 3598 | 21893 | 3048 | 25907 | 2557 | 28250 | 2159 | 30973 | 1517 | 38205 | 926 | 28009 |
| 8L-5S | | MI | 8428 | 3598 | 12967 | 2887 | 14973 | 2401 | 16188 | 2011 | 17730 | 1374 | 21666 | 959 | 14866 |
| 22-#10 | 2.65 | MA | 15002 | 3598 | 21277 | 3066 | 25170 | 2575 | 27365 | 2168 | 29759 | 1526 | 36700 | 883 | 27275 |
| 9L-4S | | MI | 8571 | 3598 | 13270 | 2869 | 15338 | 2392 | 16641 | 1996 | 18361 | 1361 | 22540 | 1011 | 14929 |
| 22-#10 | 2.65 | MA | 14735 | 3598 | 20725 | 3074 | 24476 | 2586 | 26483 | 2186 | 28555 | 1542 | 35032 | 837 | 26513 |
| 10L-3S | | MI | 8668 | 3598 | 13566 | 2859 | 15755 | 2376 | 17153 | 1989 | 19061 | 1357 | 23412 | 1064 | 14947 |
| 22-#10 | 2.65 | MA | 14436 | 3598 | 20186 | 3083 | 23766 | 2595 | 25620 | 2196 | 27334 | 1551 | 33526 | 793 | 25711 |
| 11L-2S | | MI | 8868 | 3598 | 13996 | 2849 | 16303 | 2367 | 17818 | 1974 | 19962 | 1345 | 24657 | 1155 | 14954 |
| 22-#11 | 3.25 | MA | 16260 | 3780 | 23929 | 3153 | 28440 | 2636 | 31326 | 2201 | 34993 | 1495 | 43740 | 881 | 34307 |
| 7L-6S | | MI | 8576 | 3780 | 13480 | 2995 | 15516 | 2489 | 16795 | 2059 | 18519 | 1366 | 22560 | 780 | 17402 |
| 22-#11 | 3.25 | MA | 15896 | 3780 | 23282 | 3166 | 27564 | 2646 | 30212 | 2220 | 33569 | 1517 | 41848 | 829 | 33313 |
| 8L-5S | | MI | 8738 | 3780 | 13801 | 2985 | 15952 | 2470 | 17336 | 2052 | 19249 | 1352 | 23504 | 853 | 17640 |
| 22-#11 | 3.25 | MA | 15558 | 3780 | 22537 | 3188 | 26666 | 2669 | 29133 | 2231 | 32108 | 1530 | 40002 | 777 | 32384 |
| 9L-4S | | MI | 8903 | 3780 | 14168 | 2964 | 16394 | 2461 | 17884 | 2035 | 20012 | 1339 | 24533 | 917 | 17905 |
| 22-#11 | 3.25 | MA | 15237 | 3780 | 21864 | 3197 | 25820 | 2682 | 28058 | 2252 | 30640 | 1548 | 37964 | 717 | 31261 |
| 10L-3S | | MI | 9014 | 3780 | 14526 | 2953 | 16898 | 2441 | 18503 | 2027 | 20858 | 1335 | 25565 | 980 | 17943 |
| 22-#11 | 3.25 | MA | 14880 | 3780 | 21208 | 3208 | 24962 | 2692 | 27005 | 2264 | 29151 | 1558 | 36121 | 662 | 30124 |
| 11L-2S | | MI | 9246 | 3780 | 15044 | 2942 | 17557 | 2432 | 19303 | 2010 | 21941 | 1322 | 27032 | 1093 | 17960 |
| 22-#14 | 4.69 | MA | 17383 | 4214 | 26476 | 3466 | 31517 | 2878 | 34965 | 2383 | 39941 | 1534 | 50862 | 617 | 45488 |
| 8L-5S | | MI | 9536 | 4214 | 15728 | 3257 | 18339 | 2666 | 20201 | 2178 | 23094 | 1327 | 28473 | 650 | 24324 |
| 22-#14 | 4.69 | MA | 16926 | 4214 | 25414 | 3497 | 30228 | 2910 | 33418 | 2397 | 37853 | 1551 | 48204 | 540 | 43690 |
| 9L-4S | | MI | 9763 | 4214 | 16251 | 3227 | 18970 | 2654 | 20984 | 2154 | 24181 | 1309 | 29912 | 744 | 24878 |
| 24-#10 | 2.89 | MA | 15728 | 3671 | 22777 | 3094 | 27032 | 2590 | 29616 | 2179 | 32821 | 1513 | 40764 | 920 | 30647 |
| 8L-6S | | MI | 8484 | 3671 | 13126 | 2939 | 15161 | 2450 | 16406 | 2039 | 18027 | 1382 | 22113 | 892 | 15899 |
| 24-#10 | 2.89 | MA | 15448 | 3671 | 22160 | 3111 | 26295 | 2608 | 28731 | 2188 | 31608 | 1522 | 39259 | 878 | 29915 |
| 9L-5S | | MI | 8620 | 3671 | 13397 | 2932 | 15521 | 2434 | 16853 | 2032 | 18630 | 1369 | 22911 | 953 | 16124 |
| 24-#10 | 2.89 | MA | 15184 | 3671 | 21608 | 3119 | 25601 | 2619 | 27849 | 2206 | 30403 | 1538 | 37592 | 831 | 29145 |
| 10L-4S | | MI | 8762 | 3671 | 13700 | 2914 | 15885 | 2425 | 17306 | 2017 | 19261 | 1357 | 23785 | 1005 | 16220 |
| 24-#10 | 2.89 | MA | 14887 | 3671 | 21070 | 3129 | 24890 | 2628 | 26986 | 2217 | 29183 | 1546 | 36085 | 788 | 28345 |
| 11L-3S | | MI | 8856 | 3671 | 13996 | 2904 | 16303 | 2409 | 17818 | 2010 | 19962 | 1353 | 24657 | 1058 | 16243 |
| 24-#10 | 2.89 | MA | 14591 | 3671 | 20544 | 3139 | 24140 | 2645 | 26123 | 2236 | 27996 | 1563 | 34562 | 751 | 27445 |
| 12L-2S | | MI | 9053 | 3671 | 14427 | 2895 | 16850 | 2400 | 18483 | 1995 | 20862 | 1341 | 25902 | 1149 | 16253 |
| 24-#11 | 3.55 | MA | 16414 | 3869 | 24356 | 3221 | 28932 | 2687 | 31873 | 2245 | 35817 | 1512 | 44960 | 822 | 36519 |
| 8L-6S | | MI | 8805 | 3869 | 13998 | 3050 | 16175 | 2529 | 17596 | 2084 | 19602 | 1361 | 24027 | 769 | 18925 |
| 24-#11 | 3.55 | MA | 16084 | 3869 | 23611 | 3243 | 28033 | 2709 | 30795 | 2256 | 34356 | 1524 | 43115 | 769 | 35577 |
| 9L-5S | | MI | 8963 | 3869 | 14319 | 3041 | 16611 | 2510 | 18136 | 2077 | 20332 | 1347 | 24971 | 842 | 19154 |
| 24-#11 | 3.55 | MA | 15775 | 3869 | 22938 | 3253 | 27187 | 2722 | 29719 | 2278 | 32888 | 1543 | 41076 | 710 | 34459 |
| 10L-4S | | MI | 9128 | 3869 | 14685 | 3020 | 17053 | 2501 | 18685 | 2060 | 21095 | 1334 | 26000 | 907 | 19454 |
| 24-#11 | 3.55 | MA | 15421 | 3869 | 22282 | 3264 | 26330 | 2733 | 28666 | 2289 | 31399 | 1553 | 39234 | 655 | 33312 |
| 11L-3S | | MI | 9236 | 3869 | 15044 | 3009 | 17557 | 2482 | 19303 | 2053 | 21941 | 1330 | 27032 | 970 | 19498 |
| 24-#14 | 5.11 | MA | 17664 | 4342 | 26952 | 3578 | 32186 | 2968 | 35796 | 2434 | 41071 | 1544 | 52660 | 530 | 48254 |
| 9L-5S | | MI | 9849 | 4342 | 16463 | 3337 | 19275 | 2725 | 21337 | 2215 | 24632 | 1319 | 30524 | 631 | 26481 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

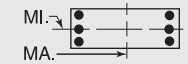
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.45 | MA | 16286 | 3385 | 23383 | 2844 | 27488 | 2389 | 29784 | 2032 | 32289 | 1487 | 38982 | 1292 | 17705 |
| 2E | | MI | 8150 | 3385 | 12494 | 2673 | 14065 | 2243 | 14886 | 1904 | 15709 | 1386 | 18078 | 1147 | 8611 |
| 6-#14 | 1.22 | MA | 15924 | 3313 | 22409 | 2816 | 26381 | 2371 | 28506 | 2024 | 30615 | 1502 | 36705 | 1306 | 15133 |
| 2L-3S | | MI | 7656 | 3313 | 11310 | 2675 | 12672 | 2251 | 13249 | 1932 | 13536 | 1427 | 15440 | 1038 | 7488 |
| 6-#14 | 1.22 | MA | 15044 | 3313 | 20791 | 2839 | 24320 | 2394 | 26003 | 2045 | 27229 | 1534 | 32016 | 1168 | 15121 |
| 3L-2S | | MI | 8031 | 3313 | 12045 | 2660 | 13608 | 2239 | 14386 | 1908 | 15074 | 1409 | 17492 | 1200 | 7445 |
| 6-#18 | 2.17 | MA | 17614 | 3613 | 26220 | 2986 | 31099 | 2493 | 34170 | 2096 | 38226 | 1474 | 47201 | 1273 | 26284 |
| 2L-3S | | MI | 8083 | 3613 | 12494 | 2838 | 14065 | 2364 | 14886 | 2007 | 15709 | 1399 | 18078 | 813 | 12525 |
| 6-#18 | 2.17 | MA | 16176 | 3613 | 23383 | 3027 | 27488 | 2531 | 29784 | 2131 | 32289 | 1530 | 38982 | 1022 | 26078 |
| 3L-2S | | MI | 8692 | 3613 | 13760 | 2815 | 15677 | 2347 | 16844 | 1969 | 18360 | 1373 | 21499 | 1100 | 12503 |
| 8-#11 | 1.13 | MA | 15774 | 3284 | 21994 | 2806 | 25920 | 2365 | 27980 | 2022 | 29933 | 1508 | 35781 | 1313 | 14075 |
| 2L-4S | | MI | 7574 | 3284 | 10971 | 2680 | 12251 | 2268 | 12760 | 1937 | 12887 | 1438 | 14758 | 1047 | 7017 |
| 8-#11 | 1.13 | MA | 15157 | 3284 | 20865 | 2823 | 24482 | 2381 | 26233 | 2037 | 27568 | 1532 | 32507 | 1218 | 14076 |
| 3E | | MI | 7716 | 3284 | 11329 | 2669 | 12755 | 2248 | 13379 | 1929 | 13733 | 1434 | 15790 | 1110 | 6986 |
| 8-#11 | 1.13 | MA | 14843 | 3284 | 20108 | 2839 | 23411 | 2407 | 24917 | 2062 | 25764 | 1544 | 30373 | 1159 | 14024 |
| 4L-2S | | MI | 7981 | 3284 | 11847 | 2658 | 13414 | 2239 | 14179 | 1912 | 14816 | 1421 | 17257 | 1222 | 6957 |
| 8-#14 | 1.63 | MA | 16702 | 3442 | 24027 | 2896 | 28441 | 2430 | 31008 | 2060 | 34002 | 1494 | 41394 | 1296 | 20035 |
| 2L-4S | | MI | 7794 | 3442 | 11534 | 2770 | 12889 | 2336 | 13505 | 1978 | 13869 | 1423 | 16044 | 930 | 9748 |
| 8-#14 | 1.63 | MA | 15854 | 3442 | 22409 | 2920 | 26381 | 2452 | 28506 | 2081 | 30615 | 1527 | 36705 | 1158 | 19992 |
| 3E | | MI | 7990 | 3442 | 12045 | 2755 | 13608 | 2309 | 14386 | 1969 | 15074 | 1420 | 17492 | 1019 | 9740 |
| 8-#14 | 1.63 | MA | 15423 | 3442 | 21323 | 2943 | 24844 | 2489 | 26619 | 2117 | 28028 | 1545 | 33634 | 1071 | 19785 |
| 4L-2S | | MI | 8354 | 3442 | 12780 | 2740 | 14543 | 2297 | 15522 | 1945 | 16612 | 1402 | 19543 | 1181 | 9709 |
| 8-#18 | 2.90 | MA | 18903 | 3841 | 29056 | 3129 | 34710 | 2597 | 38556 | 2161 | 44162 | 1461 | 55421 | 1255 | 34842 |
| 2L-4S | | MI | 8323 | 3841 | 12873 | 3004 | 14431 | 2512 | 15317 | 2083 | 16271 | 1386 | 19067 | 617 | 15586 |
| 8-#18 | 2.90 | MA | 17542 | 3841 | 26220 | 3170 | 31099 | 2634 | 34170 | 2196 | 38226 | 1517 | 47201 | 1003 | 34581 |
| 3E | | MI | 8640 | 3841 | 13760 | 2981 | 15677 | 2468 | 16844 | 2072 | 18360 | 1386 | 21499 | 766 | 16325 |
| 8-#18 | 2.90 | MA | 16855 | 3841 | 24309 | 3210 | 28398 | 2699 | 30853 | 2257 | 33678 | 1546 | 41766 | 848 | 33004 |
| 4L-2S | | MI | 9224 | 3841 | 15027 | 2958 | 17289 | 2451 | 18803 | 2034 | 21010 | 1360 | 24920 | 1054 | 16359 |
| 10-#10 | 1.15 | MA | 15854 | 3290 | 22007 | 2822 | 26031 | 2378 | 28161 | 2032 | 30218 | 1515 | 36205 | 1318 | 14397 |
| 2L-5S | | MI | 7549 | 3290 | 10808 | 2722 | 12155 | 2294 | 12674 | 1968 | 12786 | 1462 | 14693 | 1050 | 7172 |
| 10-#10 | 1.15 | MA | 15347 | 3290 | 21079 | 2836 | 24848 | 2391 | 26725 | 2045 | 28274 | 1534 | 33514 | 1243 | 14395 |
| 3L-4S | | MI | 7695 | 3290 | 11111 | 2704 | 12519 | 2286 | 13128 | 1952 | 13417 | 1450 | 15566 | 1102 | 7157 |
| 10-#10 | 1.15 | MA | 15093 | 3290 | 20458 | 2850 | 23970 | 2413 | 25646 | 2066 | 26794 | 1545 | 31772 | 1194 | 14361 |
| 4L-3S | | MI | 7811 | 3290 | 11407 | 2694 | 12937 | 2269 | 13640 | 1946 | 14118 | 1446 | 16438 | 1155 | 7136 |
| 10-#10 | 1.15 | MA | 14704 | 3290 | 19803 | 2869 | 23210 | 2426 | 24699 | 2078 | 25472 | 1565 | 29981 | 1160 | 14258 |
| 5L-2S | | MI | 8033 | 3290 | 11837 | 2684 | 13484 | 2261 | 14305 | 1930 | 15018 | 1434 | 17684 | 1246 | 7116 |
| 10-#11 | 1.41 | MA | 16325 | 3373 | 23124 | 2862 | 27359 | 2406 | 29727 | 2047 | 32297 | 1503 | 39055 | 1306 | 17499 |
| 2L-5S | | MI | 7646 | 3373 | 11122 | 2757 | 12468 | 2317 | 13012 | 1979 | 13207 | 1446 | 15195 | 971 | 8598 |
| 10-#11 | 1.41 | MA | 15723 | 3373 | 21994 | 2878 | 25920 | 2422 | 27980 | 2062 | 29933 | 1526 | 35781 | 1211 | 17485 |
| 3L-4S | | MI | 7815 | 3373 | 11488 | 2736 | 12909 | 2308 | 13561 | 1962 | 13970 | 1432 | 16225 | 1036 | 8597 |
| 10-#11 | 1.41 | MA | 15423 | 3373 | 21238 | 2895 | 24849 | 2448 | 26665 | 2087 | 28128 | 1539 | 33647 | 1151 | 17416 |
| 4L-3S | | MI | 7952 | 3373 | 11847 | 2725 | 13414 | 2289 | 14179 | 1955 | 14816 | 1429 | 17257 | 1099 | 8576 |
| 10-#11 | 1.41 | MA | 14958 | 3373 | 20445 | 2920 | 23922 | 2463 | 25509 | 2102 | 26517 | 1562 | 31459 | 1108 | 17224 |
| 5L-2S | | MI | 8213 | 3373 | 12364 | 2714 | 14073 | 2280 | 14979 | 1937 | 15899 | 1416 | 18724 | 1211 | 8552 |
| 10-#14 | 2.04 | MA | 17465 | 3570 | 25645 | 2976 | 30501 | 2488 | 33510 | 2097 | 37389 | 1487 | 46083 | 1285 | 24924 |
| 2L-5S | | MI | 7899 | 3570 | 11746 | 2880 | 13194 | 2406 | 13859 | 2038 | 14319 | 1434 | 16656 | 817 | 11607 |
| 10-#14 | 2.04 | MA | 16645 | 3570 | 24027 | 3000 | 28441 | 2510 | 31008 | 2118 | 34002 | 1519 | 41394 | 1147 | 24859 |
| 3L-4S | | MI | 8132 | 3570 | 12269 | 2851 | 13825 | 2394 | 14642 | 2014 | 15407 | 1416 | 18096 | 911 | 11956 |
| 10-#14 | 2.04 | MA | 16241 | 3570 | 22941 | 3024 | 26904 | 2547 | 29121 | 2153 | 31414 | 1537 | 38323 | 1061 | 24633 |
| 4L-3S | | MI | 8319 | 3570 | 12780 | 2836 | 14543 | 2367 | 15522 | 2005 | 16612 | 1413 | 19543 | 1000 | 11975 |
| 10-#14 | 2.04 | MA | 15586 | 3570 | 21810 | 3059 | 25574 | 2570 | 27463 | 2174 | 29102 | 1570 | 35180 | 996 | 23667 |
| 5L-2S | | MI | 8673 | 3570 | 13515 | 2821 | 15479 | 2355 | 16659 | 1981 | 18151 | 1395 | 21595 | 1162 | 11956 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

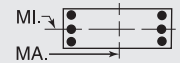



$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.62 | MA | 18869 | 4070 | 29056 | 3312 | 34710 | 2738 | 38556 | 2261 | 44162 | 1503 | 55421 | 985 | 43091 |
| 3L-4S | | MI | 8890 | 4070 | 14140 | 3147 | 16043 | 2616 | 17276 | 2148 | 18922 | 1372 | 22489 | 571 | 19168 |
| 10-#18 | 3.62 | MA | 18247 | 4070 | 27146 | 3353 | 32009 | 2802 | 35240 | 2322 | 39615 | 1532 | 49985 | 830 | 41418 |
| 4L-3S | | MI | 9186 | 4070 | 15027 | 3124 | 17289 | 2572 | 18803 | 2137 | 21010 | 1373 | 24920 | 720 | 20112 |
| 10-#18 | 3.62 | MA | 17132 | 4070 | 25178 | 3417 | 29667 | 2840 | 32322 | 2357 | 35546 | 1588 | 44440 | 707 | 38086 |
| 5L-2S | | MI | 9748 | 4070 | 16293 | 3101 | 18902 | 2555 | 20761 | 2099 | 23660 | 1346 | 28342 | 1008 | 20191 |
| 12-#10 | 1.38 | MA | 16310 | 3363 | 22936 | 2867 | 27213 | 2411 | 29597 | 2053 | 32161 | 1511 | 38896 | 1312 | 17209 |
| 2L-6S | | MI | 7600 | 3363 | 10967 | 2774 | 12342 | 2344 | 12893 | 1995 | 13083 | 1470 | 15140 | 983 | 8409 |
| 12-#10 | 1.38 | MA | 15813 | 3363 | 22007 | 2881 | 26031 | 2424 | 28161 | 2065 | 30218 | 1530 | 36205 | 1237 | 17198 |
| 3L-5S | | MI | 7752 | 3363 | 11238 | 2767 | 12702 | 2327 | 13339 | 1988 | 13686 | 1458 | 15938 | 1044 | 8474 |
| 12-#10 | 1.38 | MA | 15570 | 3363 | 21387 | 2895 | 25152 | 2446 | 27082 | 2086 | 28737 | 1541 | 34463 | 1189 | 17154 |
| 4E | | MI | 7897 | 3363 | 11541 | 2749 | 13067 | 2319 | 13793 | 1973 | 14317 | 1446 | 16811 | 1096 | 8469 |
| 12-#10 | 1.38 | MA | 15182 | 3363 | 20732 | 2915 | 24393 | 2459 | 26135 | 2099 | 27416 | 1561 | 32672 | 1155 | 17042 |
| 5L-3S | | MI | 8010 | 3363 | 11837 | 2739 | 13484 | 2302 | 14305 | 1966 | 15018 | 1442 | 17684 | 1149 | 8454 |
| 12-#10 | 1.38 | MA | 14846 | 3363 | 20114 | 2922 | 23642 | 2469 | 25207 | 2120 | 26124 | 1572 | 30925 | 1092 | 16706 |
| 6L-2S | | MI | 8228 | 3363 | 12267 | 2730 | 14032 | 2294 | 14970 | 1951 | 15918 | 1429 | 18929 | 1241 | 8437 |
| 12-#11 | 1.70 | MA | 16867 | 3462 | 24254 | 2917 | 28797 | 2446 | 31474 | 2072 | 34662 | 1498 | 42329 | 1298 | 20916 |
| 2L-6S | | MI | 7706 | 3462 | 11318 | 2822 | 12691 | 2377 | 13272 | 2012 | 13560 | 1454 | 15719 | 888 | 9908 |
| 12-#11 | 1.70 | MA | 16280 | 3462 | 23124 | 2934 | 27359 | 2462 | 29727 | 2087 | 32297 | 1521 | 39055 | 1204 | 20891 |
| 3L-5S | | MI | 7886 | 3462 | 11639 | 2813 | 13127 | 2358 | 13812 | 2005 | 14290 | 1441 | 16663 | 961 | 10153 |
| 12-#11 | 1.70 | MA | 15994 | 3462 | 22367 | 2951 | 26288 | 2488 | 28412 | 2112 | 30493 | 1534 | 36921 | 1144 | 20808 |
| 4E | | MI | 8054 | 3462 | 12006 | 2791 | 13568 | 2349 | 14361 | 1987 | 15053 | 1427 | 17692 | 1026 | 10168 |
| 12-#11 | 1.70 | MA | 15532 | 3462 | 21575 | 2975 | 25361 | 2504 | 27257 | 2127 | 28881 | 1557 | 34733 | 1101 | 20608 |
| 5L-3S | | MI | 8186 | 3462 | 12364 | 2780 | 14073 | 2329 | 14979 | 1980 | 15899 | 1424 | 18724 | 1089 | 10157 |
| 12-#11 | 1.70 | MA | 15130 | 3462 | 20822 | 2984 | 24455 | 2517 | 26124 | 2152 | 27305 | 1570 | 32598 | 1022 | 19869 |
| 6L-2S | | MI | 8441 | 3462 | 12881 | 2769 | 14731 | 2320 | 15779 | 1962 | 16982 | 1410 | 20191 | 1201 | 10138 |
| 12-#14 | 2.45 | MA | 17421 | 3699 | 25645 | 3080 | 30501 | 2569 | 33510 | 2154 | 37389 | 1512 | 46083 | 1137 | 29725 |
| 3L-5S | | MI | 8233 | 3699 | 12481 | 2961 | 14130 | 2464 | 14995 | 2074 | 15857 | 1426 | 18708 | 799 | 13721 |
| 12-#14 | 2.45 | MA | 17041 | 3699 | 24560 | 3104 | 28965 | 2606 | 31623 | 2190 | 34801 | 1530 | 43012 | 1051 | 29484 |
| 4E | | MI | 8465 | 3699 | 13004 | 2931 | 14760 | 2452 | 15778 | 2050 | 16945 | 1408 | 20147 | 893 | 14156 |
| 12-#14 | 2.45 | MA | 16391 | 3699 | 23429 | 3140 | 27634 | 2628 | 29966 | 2210 | 32488 | 1563 | 39869 | 986 | 28482 |
| 5L-3S | | MI | 8643 | 3699 | 13515 | 2916 | 15479 | 2426 | 16659 | 2041 | 18151 | 1405 | 21595 | 981 | 14197 |
| 12-#14 | 2.45 | MA | 15836 | 3699 | 22350 | 3152 | 26343 | 2647 | 28339 | 2246 | 30226 | 1580 | 36801 | 871 | 27189 |
| 6L-2S | | MI | 8989 | 3699 | 14250 | 2901 | 16415 | 2414 | 17795 | 2017 | 19689 | 1387 | 23647 | 1143 | 14194 |
| 12-#18 | 4.35 | MA | 19599 | 4298 | 29982 | 3495 | 35620 | 2906 | 39626 | 2387 | 45551 | 1519 | 58205 | 811 | 49833 |
| 4E | | MI | 9446 | 4298 | 15406 | 3290 | 17655 | 2719 | 19234 | 2213 | 21572 | 1359 | 25910 | 525 | 22779 |
| 12-#18 | 4.35 | MA | 18495 | 4298 | 28015 | 3560 | 33278 | 2944 | 36708 | 2421 | 41483 | 1575 | 52660 | 689 | 46533 |
| 5L-3S | | MI | 9724 | 4298 | 16293 | 3266 | 18902 | 2676 | 20761 | 2201 | 23660 | 1359 | 28342 | 674 | 23893 |
| 12-#18 | 4.35 | MA | 17594 | 4298 | 26120 | 3579 | 31040 | 2978 | 33845 | 2483 | 37500 | 1604 | 47248 | 478 | 42959 |
| 6L-2S | | MI | 10267 | 4298 | 17559 | 3243 | 20514 | 2658 | 22719 | 2163 | 26310 | 1333 | 31763 | 961 | 24006 |
| 14-#10 | 1.61 | MA | 16274 | 3435 | 22936 | 2926 | 27213 | 2457 | 29597 | 2086 | 32161 | 1526 | 38896 | 1231 | 19998 |
| 3L-6S | | MI | 7803 | 3435 | 11397 | 2820 | 12890 | 2377 | 13558 | 2015 | 13984 | 1466 | 16385 | 977 | 9659 |
| 14-#10 | 1.61 | MA | 16039 | 3435 | 22315 | 2940 | 26334 | 2479 | 28518 | 2107 | 30681 | 1537 | 37153 | 1183 | 19946 |
| 4L-5S | | MI | 7952 | 3435 | 11668 | 2812 | 13250 | 2360 | 14004 | 2009 | 14587 | 1454 | 17183 | 1038 | 9770 |
| 14-#10 | 1.61 | MA | 15654 | 3435 | 21660 | 2960 | 25575 | 2492 | 27571 | 2119 | 29359 | 1556 | 35363 | 1149 | 19828 |
| 5L-4S | | MI | 8097 | 3435 | 11971 | 2794 | 13615 | 2352 | 14458 | 1993 | 15217 | 1441 | 18057 | 1090 | 9776 |
| 14-#10 | 1.61 | MA | 15325 | 3435 | 21042 | 2967 | 24825 | 2502 | 26643 | 2140 | 28067 | 1568 | 33616 | 1086 | 19467 |
| 6L-3S | | MI | 8207 | 3435 | 12267 | 2785 | 14032 | 2335 | 14970 | 1987 | 15918 | 1437 | 18929 | 1143 | 9766 |
| 14-#10 | 1.61 | MA | 15047 | 3435 | 20459 | 2977 | 24003 | 2519 | 25710 | 2150 | 26818 | 1587 | 31956 | 1055 | 18904 |
| 7L-2S | | MI | 8421 | 3435 | 12697 | 2775 | 14580 | 2327 | 15635 | 1971 | 16818 | 1425 | 20174 | 1235 | 9752 |
| 14-#11 | 1.98 | MA | 16829 | 3551 | 24254 | 2990 | 28797 | 2502 | 31474 | 2113 | 34662 | 1516 | 42329 | 1197 | 24294 |
| 3L-6S | | MI | 7946 | 3551 | 11836 | 2878 | 13349 | 2417 | 14072 | 2037 | 14643 | 1449 | 17186 | 878 | 11414 |
| 14-#11 | 1.98 | MA | 16555 | 3551 | 23497 | 3006 | 27726 | 2529 | 30159 | 2138 | 32858 | 1529 | 40195 | 1137 | 24200 |
| 4L-5S | | MI | 8122 | 3551 | 12156 | 2868 | 13785 | 2398 | 14612 | 2030 | 15373 | 1436 | 18130 | 950 | 11703 |
| 14-#11 | 1.98 | MA | 16096 | 3551 | 22705 | 3031 | 26799 | 2544 | 29004 | 2152 | 31246 | 1552 | 38007 | 1093 | 23995 |
| 5L-4S | | MI | 8289 | 3551 | 12523 | 2847 | 14227 | 2389 | 15161 | 2012 | 16136 | 1422 | 19159 | 1015 | 11731 |
| 14-#11 | 1.98 | MA | 15705 | 3551 | 21952 | 3040 | 25893 | 2557 | 27871 | 2178 | 29669 | 1565 | 35872 | 1015 | 23235 |
| 6L-3S | | MI | 8418 | 3551 | 12881 | 2836 | 14731 | 2370 | 15779 | 2005 | 16982 | 1419 | 20191 | 1078 | 11731 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

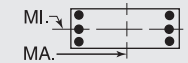
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.98 | MA | 15375 | 3551 | 21241 | 3051 | 24891 | 2577 | 26745 | 2190 | 28145 | 1588 | 33836 | 976 | 22578 |
| 7L-2S | | MI | 8668 | 3551 | 13399 | 2825 | 15390 | 2361 | 16579 | 1988 | 18065 | 1405 | 21659 | 1190 | 11718 |
| 14-#14 | 2.85 | MA | 17826 | 3827 | 26178 | 3184 | 31025 | 2664 | 34126 | 2226 | 38188 | 1522 | 47701 | 1040 | 34339 |
| 4L-5S | | MI | 8563 | 3827 | 13216 | 3041 | 15066 | 2523 | 16132 | 2111 | 17396 | 1419 | 20759 | 780 | 15846 |
| 14-#14 | 2.85 | MA | 17181 | 3827 | 25047 | 3220 | 29695 | 2686 | 32468 | 2247 | 35875 | 1555 | 44558 | 975 | 33303 |
| 5L-4S | | MI | 8793 | 3827 | 13739 | 3011 | 15696 | 2511 | 16915 | 2087 | 18483 | 1401 | 22199 | 874 | 16353 |
| 14-#14 | 2.85 | MA | 16646 | 3827 | 23968 | 3232 | 28404 | 2705 | 30842 | 2282 | 33612 | 1573 | 41490 | 860 | 32028 |
| 6L-3S | | MI | 8964 | 3827 | 14250 | 2996 | 16415 | 2484 | 17795 | 2078 | 19689 | 1398 | 23647 | 962 | 16411 |
| 14-#14 | 2.85 | MA | 16192 | 3827 | 22949 | 3248 | 26967 | 2733 | 29239 | 2300 | 31425 | 1606 | 38557 | 803 | 30475 |
| 7L-2S | | MI | 9301 | 3827 | 14985 | 2981 | 17351 | 2472 | 18932 | 2054 | 21227 | 1380 | 25698 | 1124 | 16424 |
| 14-#18 | 5.07 | MA | 19824 | 4526 | 30851 | 3703 | 36890 | 3047 | 41095 | 2486 | 47419 | 1561 | 60879 | 670 | 54980 |
| 5L-4S | | MI | 9994 | 4526 | 16672 | 3432 | 19268 | 2823 | 21192 | 2277 | 24222 | 1346 | 29331 | 478 | 26414 |
| 14-#18 | 5.07 | MA | 18969 | 4526 | 28957 | 3722 | 34651 | 3082 | 38231 | 2547 | 43437 | 1590 | 55468 | 460 | 51354 |
| 6L-3S | | MI | 10256 | 4526 | 17559 | 3409 | 20514 | 2779 | 22719 | 2266 | 26310 | 1346 | 31763 | 627 | 27670 |
| 14-#18 | 5.07 | MA | 18241 | 4526 | 27165 | 3749 | 32127 | 3129 | 35457 | 2580 | 39585 | 1646 | 50267 | 356 | 47627 |
| 7L-2S | | MI | 10782 | 4526 | 18826 | 3386 | 22126 | 2762 | 24677 | 2228 | 28961 | 1320 | 35184 | 915 | 27813 |
| 16-#10 | 1.84 | MA | 16502 | 3508 | 23244 | 2985 | 27517 | 2512 | 29954 | 2128 | 32624 | 1533 | 39844 | 1177 | 22738 |
| 4L-6S | | MI | 8005 | 3508 | 11827 | 2865 | 13438 | 2410 | 14223 | 2036 | 14884 | 1462 | 17630 | 971 | 10914 |
| 16-#10 | 1.84 | MA | 16119 | 3508 | 22589 | 3005 | 26757 | 2525 | 29007 | 2140 | 31303 | 1552 | 38054 | 1143 | 22614 |
| 5E | | MI | 8151 | 3508 | 12098 | 2858 | 13797 | 2393 | 14670 | 2029 | 15487 | 1449 | 18428 | 1032 | 11063 |
| 16-#10 | 1.84 | MA | 15798 | 3508 | 21971 | 3013 | 26007 | 2535 | 28079 | 2161 | 30010 | 1563 | 36307 | 1080 | 22231 |
| 6L-4S | | MI | 8295 | 3508 | 12401 | 2840 | 14162 | 2385 | 15123 | 2014 | 16118 | 1437 | 19302 | 1084 | 11077 |
| 16-#10 | 1.84 | MA | 15528 | 3508 | 21388 | 3022 | 25185 | 2551 | 27146 | 2170 | 28761 | 1583 | 34647 | 1049 | 21683 |
| 7L-3S | | MI | 8401 | 3508 | 12697 | 2830 | 14580 | 2368 | 15635 | 2007 | 16818 | 1433 | 20174 | 1137 | 11074 |
| 16-#10 | 1.84 | MA | 15197 | 3508 | 20831 | 3033 | 24431 | 2561 | 26187 | 2187 | 27537 | 1602 | 33024 | 1009 | 21218 |
| 8L-2S | | MI | 8612 | 3508 | 13127 | 2820 | 15127 | 2360 | 16300 | 1992 | 17718 | 1421 | 21419 | 1229 | 11064 |
| 16-#11 | 2.26 | MA | 17109 | 3640 | 24627 | 3062 | 29165 | 2569 | 31906 | 2163 | 35222 | 1524 | 43469 | 1130 | 27593 |
| 4L-6S | | MI | 8184 | 3640 | 12353 | 2934 | 14008 | 2458 | 14872 | 2062 | 15726 | 1444 | 18654 | 867 | 12924 |
| 16-#11 | 2.26 | MA | 16652 | 3640 | 23834 | 3087 | 28238 | 2585 | 30751 | 2178 | 33610 | 1547 | 41281 | 1086 | 27383 |
| 5E | | MI | 8356 | 3640 | 12674 | 2924 | 14444 | 2439 | 15412 | 2055 | 16456 | 1431 | 19597 | 940 | 13202 |
| 16-#11 | 2.26 | MA | 16271 | 3640 | 23082 | 3095 | 27332 | 2597 | 29618 | 2203 | 32034 | 1560 | 39146 | 1008 | 26605 |
| 6L-4S | | MI | 8523 | 3640 | 13041 | 2903 | 14886 | 2429 | 15961 | 2038 | 17219 | 1417 | 20626 | 1004 | 13289 |
| 16-#11 | 2.26 | MA | 15952 | 3640 | 22371 | 3106 | 26330 | 2617 | 28493 | 2215 | 30509 | 1583 | 37110 | 969 | 25967 |
| 7L-3S | | MI | 8647 | 3640 | 13399 | 2892 | 15390 | 2410 | 16579 | 2030 | 18065 | 1414 | 21659 | 1067 | 13300 |
| 16-#11 | 2.26 | MA | 15557 | 3640 | 21691 | 3119 | 25410 | 2628 | 27322 | 2235 | 29015 | 1606 | 35126 | 918 | 25026 |
| 8L-2S | | MI | 8893 | 3640 | 13916 | 2881 | 16049 | 2401 | 17380 | 2013 | 19148 | 1400 | 23126 | 1180 | 13293 |
| 16-#14 | 3.26 | MA | 17956 | 3956 | 26665 | 3300 | 31755 | 2745 | 34971 | 2283 | 39262 | 1548 | 49247 | 965 | 38130 |
| 5E | | MI | 8888 | 3956 | 13951 | 3121 | 16002 | 2581 | 17268 | 2147 | 18934 | 1411 | 22811 | 761 | 17979 |
| 16-#14 | 3.26 | MA | 17439 | 3956 | 25586 | 3312 | 30464 | 2763 | 33344 | 2319 | 36999 | 1566 | 46179 | 850 | 36867 |
| 6L-4S | | MI | 9117 | 3956 | 14474 | 3091 | 16632 | 2569 | 18051 | 2123 | 20022 | 1393 | 24250 | 855 | 18547 |
| 16-#14 | 3.26 | MA | 17006 | 3956 | 24567 | 3328 | 29027 | 2791 | 31742 | 2336 | 34811 | 1598 | 43246 | 793 | 35289 |
| 7L-3S | | MI | 9281 | 3956 | 14985 | 3077 | 17351 | 2542 | 18932 | 2114 | 21227 | 1390 | 25698 | 943 | 18620 |
| 16-#14 | 3.26 | MA | 16449 | 3956 | 23591 | 3346 | 27708 | 2807 | 30064 | 2365 | 32666 | 1631 | 40394 | 717 | 33737 |
| 8L-2S | | MI | 9611 | 3956 | 15720 | 3062 | 18286 | 2530 | 20069 | 2090 | 22765 | 1372 | 27750 | 1105 | 18646 |
| 16-#18 | 5.80 | MA | 20312 | 4755 | 31793 | 3865 | 38263 | 3185 | 42618 | 2612 | 49373 | 1577 | 63687 | 441 | 59750 |
| 6L-4S | | MI | 10535 | 4755 | 17938 | 3575 | 20880 | 2927 | 23151 | 2342 | 26872 | 1332 | 32753 | 432 | 30068 |
| 16-#18 | 5.80 | MA | 19630 | 4755 | 30002 | 3891 | 35739 | 3233 | 39843 | 2645 | 45522 | 1633 | 58486 | 337 | 55984 |
| 7L-3S | | MI | 10819 | 4755 | 18826 | 3552 | 22126 | 2883 | 24677 | 2331 | 28961 | 1333 | 35184 | 581 | 31445 |
| 16-#18 | 5.80 | MA | 18682 | 4755 | 28286 | 3922 | 33418 | 3259 | 36892 | 2693 | 41745 | 1688 | 53449 | 197 | 52295 |
| 8L-2S | | MI | 11281 | 4755 | 20092 | 3529 | 23738 | 2866 | 26636 | 2293 | 31611 | 1307 | 38606 | 869 | 31615 |
| 18-#10 | 2.07 | MA | 16579 | 3580 | 23518 | 3051 | 27940 | 2558 | 30443 | 2161 | 33246 | 1548 | 40745 | 1137 | 25402 |
| 5L-6S | | MI | 8204 | 3580 | 12257 | 2910 | 13985 | 2443 | 14888 | 2057 | 15784 | 1458 | 18875 | 965 | 12172 |
| 18-#10 | 2.07 | MA | 16264 | 3580 | 22900 | 3058 | 27189 | 2568 | 29515 | 2182 | 31954 | 1559 | 38998 | 1075 | 24998 |
| 6L-5S | | MI | 8347 | 3580 | 12528 | 2903 | 14345 | 2426 | 15335 | 2050 | 16387 | 1445 | 19674 | 1026 | 12354 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

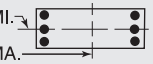


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.07 | MA | 16002 | 3580 | 22317 | 3067 | 26367 | 2584 | 28582 | 2191 | 30705 | 1579 | 37338 | 1043 | 24464 |
| 7L-4S | | MI | 8491 | 3580 | 12831 | 2885 | 14710 | 2418 | 15788 | 2035 | 17018 | 1433 | 20547 | 1078 | 12375 |
| 18-#10 | 2.07 | MA | 15674 | 3580 | 21759 | 3078 | 25613 | 2594 | 27623 | 2208 | 29481 | 1598 | 35715 | 1003 | 23992 |
| 8L-3S | | MI | 8595 | 3580 | 13127 | 2875 | 15127 | 2401 | 16300 | 2028 | 17718 | 1429 | 21419 | 1131 | 12379 |
| 18-#10 | 2.07 | MA | 15346 | 3580 | 21110 | 3095 | 24839 | 2613 | 26694 | 2217 | 28198 | 1607 | 34141 | 961 | 23200 |
| 9L-2S | | MI | 8802 | 3580 | 13557 | 2866 | 15675 | 2393 | 16965 | 2013 | 18619 | 1417 | 22665 | 1223 | 12372 |
| 18-#11 | 2.54 | MA | 17200 | 3729 | 24964 | 3142 | 29676 | 2625 | 32498 | 2203 | 35975 | 1542 | 44555 | 1079 | 30774 |
| 5L-6S | | MI | 8419 | 3729 | 12870 | 2989 | 14667 | 2498 | 15672 | 2087 | 16809 | 1439 | 20121 | 856 | 14438 |
| 18-#11 | 2.54 | MA | 16829 | 3729 | 24211 | 3151 | 28770 | 2638 | 31365 | 2228 | 34398 | 1555 | 42420 | 1001 | 29978 |
| 6L-5S | | MI | 8588 | 3729 | 13191 | 2980 | 15103 | 2479 | 16213 | 2080 | 17539 | 1425 | 21064 | 929 | 14703 |
| 18-#11 | 2.54 | MA | 16520 | 3729 | 23501 | 3162 | 27768 | 2658 | 30240 | 2240 | 32874 | 1578 | 40384 | 961 | 29355 |
| 7L-4S | | MI | 8754 | 3729 | 13558 | 2958 | 15545 | 2470 | 16761 | 2063 | 18302 | 1412 | 22094 | 994 | 14844 |
| 18-#11 | 2.54 | MA | 16128 | 3729 | 22821 | 3175 | 26848 | 2669 | 29070 | 2260 | 31380 | 1601 | 38400 | 910 | 28398 |
| 8L-3S | | MI | 8874 | 3729 | 13916 | 2947 | 16049 | 2450 | 17380 | 2056 | 19148 | 1408 | 23126 | 1057 | 14863 |
| 18-#11 | 2.54 | MA | 15740 | 3729 | 22035 | 3197 | 25905 | 2691 | 27937 | 2271 | 29834 | 1613 | 36468 | 858 | 27478 |
| 9L-2S | | MI | 9116 | 3729 | 14434 | 2936 | 16708 | 2441 | 18180 | 2038 | 20231 | 1395 | 24593 | 1169 | 14864 |
| 18-#14 | 3.67 | MA | 18219 | 4084 | 27204 | 3392 | 32524 | 2822 | 35847 | 2355 | 40386 | 1558 | 50868 | 840 | 41706 |
| 6L-5S | | MI | 9210 | 4084 | 14686 | 3202 | 16937 | 2639 | 18405 | 2184 | 20472 | 1404 | 24862 | 742 | 20120 |
| 18-#14 | 3.67 | MA | 17805 | 4084 | 26185 | 3408 | 31088 | 2849 | 34244 | 2373 | 38198 | 1591 | 47936 | 783 | 40104 |
| 7L-4S | | MI | 9438 | 4084 | 15209 | 3172 | 17568 | 2628 | 19188 | 2160 | 21560 | 1386 | 26302 | 836 | 20741 |
| 18-#14 | 3.67 | MA | 17253 | 4084 | 25210 | 3426 | 29768 | 2865 | 32566 | 2401 | 36053 | 1624 | 45083 | 707 | 38531 |
| 8L-3S | | MI | 9595 | 4084 | 15720 | 3157 | 18286 | 2601 | 20069 | 2151 | 22765 | 1383 | 27750 | 925 | 20826 |
| 18-#14 | 3.67 | MA | 16735 | 4084 | 24088 | 3458 | 28414 | 2897 | 30940 | 2416 | 33854 | 1641 | 42300 | 631 | 36577 |
| 9L-2S | | MI | 9918 | 4084 | 16455 | 3142 | 19222 | 2589 | 21205 | 2127 | 24303 | 1365 | 29801 | 1086 | 20863 |
| 18-#18 | 6.52 | MA | 20983 | 4983 | 32838 | 4034 | 39350 | 3337 | 44229 | 2710 | 51458 | 1619 | 66706 | 319 | 64341 |
| 7L-4S | | MI | 11135 | 4983 | 19205 | 3718 | 22492 | 3031 | 25109 | 2407 | 29523 | 1319 | 36174 | 386 | 33737 |
| 18-#18 | 6.52 | MA | 20049 | 4983 | 31122 | 4064 | 37029 | 3363 | 41279 | 2757 | 47682 | 1675 | 61668 | 178 | 60623 |
| 8L-3S | | MI | 11333 | 4983 | 20092 | 3695 | 23738 | 2987 | 26636 | 2395 | 31611 | 1320 | 38606 | 535 | 35221 |
| 20-#10 | 2.30 | MA | 16725 | 3653 | 23828 | 3103 | 28372 | 2601 | 30951 | 2202 | 33897 | 1555 | 41689 | 1069 | 27768 |
| 6E | | MI | 8401 | 3653 | 12687 | 2956 | 14533 | 2476 | 15554 | 2077 | 16684 | 1453 | 20121 | 959 | 13433 |
| 20-#10 | 2.30 | MA | 16470 | 3653 | 23245 | 3113 | 27550 | 2617 | 30018 | 2211 | 32648 | 1574 | 40029 | 1037 | 27246 |
| 7L-5S | | MI | 8542 | 3653 | 12958 | 2948 | 14893 | 2459 | 16000 | 2070 | 17287 | 1441 | 20919 | 1020 | 13643 |
| 20-#10 | 2.30 | MA | 16144 | 3653 | 22688 | 3123 | 26795 | 2627 | 29059 | 2228 | 31424 | 1594 | 38406 | 997 | 26765 |
| 8L-4S | | MI | 8686 | 3653 | 13261 | 2930 | 15257 | 2451 | 16453 | 2055 | 17918 | 1429 | 21793 | 1072 | 13670 |
| 20-#10 | 2.30 | MA | 15826 | 3653 | 22038 | 3141 | 26021 | 2646 | 28130 | 2237 | 30142 | 1603 | 36832 | 955 | 25976 |
| 9L-3S | | MI | 8786 | 3653 | 13557 | 2921 | 15675 | 2434 | 16965 | 2048 | 18619 | 1425 | 22665 | 1125 | 13680 |
| 20-#10 | 2.30 | MA | 15536 | 3653 | 21458 | 3149 | 25294 | 2657 | 27204 | 2256 | 28877 | 1619 | 35084 | 909 | 25241 |
| 10L-2S | | MI | 8991 | 3653 | 13988 | 2911 | 16222 | 2426 | 17630 | 2033 | 19519 | 1412 | 23910 | 1217 | 13678 |
| 20-#11 | 2.83 | MA | 17380 | 3819 | 25341 | 3207 | 30209 | 2678 | 33112 | 2253 | 36763 | 1550 | 45694 | 994 | 33354 |
| 6E | | MI | 8652 | 3819 | 13388 | 3045 | 15326 | 2539 | 16472 | 2113 | 17892 | 1434 | 21588 | 846 | 15956 |
| 20-#11 | 2.83 | MA | 17081 | 3819 | 24631 | 3218 | 29207 | 2698 | 31987 | 2265 | 35239 | 1573 | 43658 | 954 | 32741 |
| 7L-5S | | MI | 8818 | 3819 | 13709 | 3035 | 15762 | 2519 | 17013 | 2106 | 18622 | 1420 | 22532 | 918 | 16208 |
| 20-#11 | 2.83 | MA | 16691 | 3819 | 23951 | 3231 | 28287 | 2709 | 30817 | 2285 | 33744 | 1596 | 41674 | 903 | 31771 |
| 8L-4S | | MI | 8983 | 3819 | 14075 | 3014 | 16204 | 2510 | 17562 | 2088 | 19385 | 1407 | 23561 | 983 | 16397 |
| 20-#11 | 2.83 | MA | 16316 | 3819 | 23165 | 3252 | 27343 | 2732 | 29684 | 2296 | 32198 | 1608 | 39742 | 851 | 30853 |
| 9L-3S | | MI | 9100 | 3819 | 14434 | 3003 | 16708 | 2491 | 18180 | 2081 | 20231 | 1403 | 24593 | 1046 | 16423 |
| 20-#11 | 2.83 | MA | 15971 | 3819 | 22457 | 3262 | 26455 | 2745 | 28554 | 2318 | 30656 | 1627 | 37605 | 793 | 29666 |
| 10L-2S | | MI | 9337 | 3819 | 14951 | 2992 | 17367 | 2482 | 18980 | 2063 | 21314 | 1390 | 26060 | 1158 | 16432 |
| 20-#14 | 4.08 | MA | 18590 | 4212 | 27803 | 3488 | 33148 | 2908 | 36747 | 2409 | 41585 | 1583 | 52625 | 772 | 44918 |
| 7L-5S | | MI | 9528 | 4212 | 15421 | 3282 | 17873 | 2698 | 19542 | 2220 | 22010 | 1396 | 26914 | 723 | 22266 |
| 20-#14 | 4.08 | MA | 18042 | 4212 | 26828 | 3506 | 31828 | 2923 | 35068 | 2437 | 39440 | 1616 | 49772 | 697 | 43324 |
| 8L-4S | | MI | 9756 | 4212 | 15944 | 3252 | 18503 | 2686 | 20324 | 2196 | 23098 | 1378 | 28353 | 817 | 22860 |
| 20-#14 | 4.08 | MA | 17542 | 4212 | 25706 | 3538 | 30474 | 2955 | 33443 | 2452 | 37240 | 1634 | 46990 | 621 | 41380 |
| 9L-3S | | MI | 9907 | 4212 | 16455 | 3237 | 19222 | 2659 | 21205 | 2187 | 24303 | 1375 | 29801 | 906 | 23030 |
| 20-#14 | 4.08 | MA | 17059 | 4212 | 24692 | 3552 | 29199 | 2974 | 31822 | 2484 | 35027 | 1661 | 43917 | 535 | 39440 |
| 10L-2S | | MI | 10223 | 4212 | 17190 | 3222 | 20158 | 2647 | 22342 | 2163 | 25841 | 1357 | 31853 | 1067 | 23077 |
| 20-#18 | 7.25 | MA | 21387 | 5212 | 33959 | 4207 | 40641 | 3466 | 45665 | 2822 | 53618 | 1662 | 69888 | 160 | 68950 |
| 8L-4S | | MI | 11661 | 5212 | 20471 | 3860 | 24104 | 3134 | 27067 | 2472 | 32173 | 1306 | 39595 | 339 | 37420 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



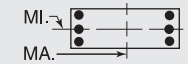

$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 2.53 | MA | 16933 | 3725 | 24174 | 3158 | 28732 | 2650 | 31455 | 2232 | 34592 | 1570 | 42720 | 1032 | 30030 |
| 7L-6S | | MI | 8597 | 3725 | 13117 | 3001 | 15080 | 2508 | 16219 | 2098 | 17584 | 1449 | 21366 | 953 | 14697 |
| 22-#10 | 2.53 | MA | 16608 | 3725 | 23617 | 3169 | 27978 | 2660 | 30495 | 2249 | 33368 | 1590 | 41097 | 991 | 29539 |
| 8L-5S | | MI | 8736 | 3725 | 13388 | 2994 | 15440 | 2492 | 16665 | 2091 | 18187 | 1437 | 22164 | 1014 | 14931 |
| 22-#10 | 2.53 | MA | 16299 | 3725 | 22967 | 3186 | 27204 | 2679 | 29566 | 2258 | 32085 | 1599 | 39523 | 949 | 28753 |
| 9L-4S | | MI | 8878 | 3725 | 13691 | 2976 | 15805 | 2484 | 17118 | 2076 | 18818 | 1425 | 23038 | 1066 | 14963 |
| 22-#10 | 2.53 | MA | 16016 | 3725 | 22387 | 3194 | 26476 | 2690 | 28640 | 2276 | 30820 | 1615 | 37775 | 904 | 28009 |
| 10L-3S | | MI | 8976 | 3725 | 13988 | 2966 | 16222 | 2467 | 17630 | 2069 | 19519 | 1421 | 23910 | 1119 | 14979 |
| 22-#10 | 2.53 | MA | 15699 | 3725 | 21821 | 3204 | 25725 | 2698 | 27734 | 2287 | 29539 | 1624 | 36196 | 861 | 27150 |
| 11L-2S | | MI | 9178 | 3725 | 14418 | 2956 | 16770 | 2459 | 18295 | 2054 | 20419 | 1408 | 25155 | 1211 | 14982 |
| 22-#11 | 3.11 | MA | 17634 | 3908 | 25760 | 3273 | 30645 | 2738 | 33734 | 2291 | 37603 | 1568 | 46932 | 947 | 36126 |
| 7L-6S | | MI | 8883 | 3908 | 13905 | 3101 | 15985 | 2579 | 17273 | 2138 | 18975 | 1429 | 23055 | 835 | 17476 |
| 22-#11 | 3.11 | MA | 17247 | 3908 | 25081 | 3286 | 29725 | 2750 | 32564 | 2310 | 36109 | 1591 | 44948 | 896 | 35143 |
| 8L-5S | | MI | 9045 | 3908 | 14226 | 3091 | 16421 | 2560 | 17813 | 2131 | 19705 | 1415 | 23999 | 908 | 17718 |
| 22-#11 | 3.11 | MA | 16888 | 3908 | 24294 | 3308 | 28782 | 2772 | 31431 | 2321 | 34563 | 1603 | 43016 | 844 | 34227 |
| 9L-4S | | MI | 9210 | 3908 | 14593 | 3070 | 16862 | 2551 | 18362 | 2113 | 20468 | 1401 | 25028 | 972 | 17948 |
| 22-#11 | 3.11 | MA | 16548 | 3908 | 23587 | 3318 | 27893 | 2785 | 30301 | 2343 | 33021 | 1622 | 40879 | 786 | 33030 |
| 10L-3S | | MI | 9323 | 3908 | 14951 | 3059 | 17367 | 2531 | 18980 | 2106 | 21314 | 1398 | 26060 | 1035 | 17981 |
| 22-#11 | 3.11 | MA | 16168 | 3908 | 22898 | 3329 | 26987 | 2796 | 29196 | 2356 | 31458 | 1632 | 38948 | 732 | 31896 |
| 11L-2S | | MI | 9557 | 3908 | 15469 | 3048 | 18026 | 2522 | 19780 | 2089 | 22397 | 1385 | 27527 | 1148 | 17995 |
| 22-#14 | 4.48 | MA | 18819 | 4341 | 28446 | 3587 | 33889 | 2982 | 37571 | 2474 | 42826 | 1609 | 54461 | 686 | 48118 |
| 8L-5S | | MI | 9844 | 4341 | 16156 | 3362 | 18809 | 2756 | 20678 | 2256 | 23548 | 1389 | 28965 | 704 | 24418 |
| 22-#14 | 4.48 | MA | 18335 | 4341 | 27324 | 3618 | 32534 | 3014 | 35945 | 2489 | 40627 | 1626 | 51679 | 610 | 46184 |
| 9L-4S | | MI | 10071 | 4341 | 16679 | 3332 | 19439 | 2744 | 21461 | 2232 | 24636 | 1371 | 30405 | 798 | 24986 |
| 22-#14 | 4.48 | MA | 17895 | 4341 | 26310 | 3632 | 31260 | 3032 | 34324 | 2520 | 38414 | 1653 | 48607 | 525 | 44229 |
| 10L-3S | | MI | 10217 | 4341 | 17190 | 3317 | 20158 | 2717 | 22342 | 2223 | 25841 | 1368 | 31853 | 887 | 25232 |
| 24-#10 | 2.76 | MA | 17067 | 3798 | 24545 | 3214 | 29160 | 2693 | 31931 | 2269 | 35311 | 1585 | 43788 | 986 | 32313 |
| 8L-6S | | MI | 8791 | 3798 | 13547 | 3046 | 15628 | 2541 | 16884 | 2118 | 18484 | 1445 | 22611 | 947 | 15962 |
| 24-#10 | 2.76 | MA | 16766 | 3798 | 23895 | 3231 | 28386 | 2711 | 31002 | 2278 | 34029 | 1595 | 42214 | 944 | 31529 |
| 9L-5S | | MI | 8928 | 3798 | 13818 | 3039 | 15988 | 2525 | 17330 | 2111 | 19087 | 1433 | 23410 | 1008 | 16192 |
| 24-#10 | 2.76 | MA | 16491 | 3798 | 23315 | 3240 | 27658 | 2722 | 30076 | 2297 | 32764 | 1611 | 40466 | 898 | 30776 |
| 10L-4S | | MI | 9070 | 3798 | 14121 | 3021 | 16353 | 2516 | 17784 | 2096 | 19718 | 1420 | 24283 | 1060 | 16256 |
| 24-#10 | 2.76 | MA | 16175 | 3798 | 22750 | 3249 | 26908 | 2731 | 29170 | 2307 | 31482 | 1619 | 38887 | 855 | 29920 |
| 11L-3S | | MI | 9165 | 3798 | 14418 | 3011 | 16770 | 2500 | 18295 | 2089 | 20419 | 1416 | 25155 | 1114 | 16275 |
| 24-#10 | 2.76 | MA | 15862 | 3798 | 22198 | 3259 | 26120 | 2748 | 28259 | 2326 | 30237 | 1637 | 37293 | 819 | 29025 |
| 12L-2S | | MI | 9364 | 3798 | 14848 | 3002 | 17318 | 2492 | 18961 | 2074 | 21319 | 1404 | 26400 | 1205 | 16283 |
| 24-#11 | 3.39 | MA | 17795 | 3997 | 26210 | 3342 | 31164 | 2790 | 34311 | 2336 | 38473 | 1586 | 48222 | 889 | 38515 |
| 8L-6S | | MI | 9112 | 3997 | 14423 | 3156 | 16644 | 2620 | 18073 | 2163 | 20058 | 1423 | 24523 | 824 | 18999 |
| 24-#11 | 3.39 | MA | 17446 | 3997 | 25424 | 3364 | 30220 | 2813 | 33178 | 2346 | 36927 | 1597 | 46290 | 837 | 37596 |
| 9L-5S | | MI | 9272 | 3997 | 14744 | 3147 | 17079 | 2600 | 18613 | 2156 | 20788 | 1410 | 25466 | 897 | 19232 |
| 24-#11 | 3.39 | MA | 17117 | 3997 | 24717 | 3373 | 29332 | 2826 | 32049 | 2368 | 35385 | 1617 | 44153 | 779 | 36394 |
| 10L-4S | | MI | 9436 | 3997 | 15110 | 3125 | 17521 | 2591 | 19162 | 2139 | 21551 | 1396 | 26495 | 962 | 19499 |
| 24-#11 | 3.39 | MA | 16741 | 3997 | 24028 | 3385 | 28426 | 2836 | 30944 | 2381 | 33822 | 1626 | 42222 | 725 | 35251 |
| 11L-3S | | MI | 9546 | 3997 | 15469 | 3114 | 18026 | 2572 | 19780 | 2131 | 22397 | 1393 | 27527 | 1025 | 19537 |
| 24-#11 | 3.39 | MA | 16368 | 3997 | 23354 | 3397 | 27466 | 2857 | 29838 | 2404 | 32302 | 1647 | 40266 | 680 | 34062 |
| 12L-2S | | MI | 9775 | 3997 | 15986 | 3103 | 18684 | 2563 | 20580 | 2114 | 23480 | 1379 | 28995 | 1137 | 19557 |
| 24-#14 | 4.89 | MA | 19116 | 4469 | 28942 | 3699 | 34595 | 3072 | 38448 | 2525 | 44014 | 1619 | 56368 | 600 | 50988 |
| 9L-5S | | MI | 10158 | 4469 | 16890 | 3442 | 19745 | 2815 | 21815 | 2293 | 25086 | 1381 | 31017 | 685 | 26574 |
| 24-#14 | 4.89 | MA | 18692 | 4469 | 27928 | 3712 | 33320 | 3090 | 36827 | 2556 | 41801 | 1646 | 53296 | 515 | 49018 |
| 10L-4S | | MI | 10384 | 4469 | 17414 | 3413 | 20375 | 2803 | 22597 | 2269 | 26174 | 1363 | 32457 | 779 | 27119 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

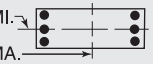



$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.39 | MA | 17645 | 3512 | 25164 | 2963 | 29619 | 2491 | 32086 | 2120 | 34721 | 1558 | 41860 | 1354 | 18569 |
| 2E | | MI | 8457 | 3512 | 12927 | 2776 | 14536 | 2332 | 15363 | 1982 | 16162 | 1448 | 18566 | 1201 | 8644 |
| 6-#14 | 1.17 | MA | 17259 | 3441 | 24137 | 2935 | 28452 | 2473 | 30737 | 2113 | 32954 | 1572 | 39458 | 1368 | 15862 |
| 2L-3S | | MI | 7962 | 3441 | 11738 | 2780 | 13141 | 2340 | 13726 | 2010 | 13991 | 1490 | 15933 | 1092 | 7516 |
| 6-#14 | 1.17 | MA | 16329 | 3441 | 22439 | 2959 | 26289 | 2496 | 28111 | 2134 | 29400 | 1606 | 34536 | 1231 | 15850 |
| 3L-2S | | MI | 8337 | 3441 | 12473 | 2765 | 14077 | 2328 | 14863 | 1986 | 15529 | 1472 | 17985 | 1254 | 7471 |
| 6-#18 | 2.08 | MA | 19050 | 3740 | 28144 | 3106 | 33412 | 2595 | 36693 | 2185 | 40956 | 1545 | 50493 | 1335 | 27580 |
| 2L-3S | | MI | 8389 | 3740 | 12927 | 2942 | 14536 | 2453 | 15363 | 2084 | 16162 | 1461 | 18566 | 867 | 12573 |
| 6-#18 | 2.08 | MA | 17527 | 3740 | 25164 | 3147 | 29619 | 2633 | 32086 | 2221 | 34721 | 1602 | 41860 | 1086 | 27374 |
| 3L-2S | | MI | 9000 | 3740 | 14194 | 2919 | 16148 | 2436 | 17321 | 2046 | 18812 | 1434 | 21988 | 1154 | 12541 |
| 8-#11 | 1.08 | MA | 17099 | 3411 | 23700 | 2925 | 27966 | 2467 | 30183 | 2111 | 32234 | 1579 | 38483 | 1375 | 14749 |
| 2L-4S | | MI | 7879 | 3411 | 11396 | 2786 | 12719 | 2358 | 13238 | 2015 | 13343 | 1500 | 15253 | 1102 | 7043 |
| 8-#11 | 1.08 | MA | 16447 | 3411 | 22515 | 2942 | 26457 | 2483 | 28350 | 2126 | 29753 | 1603 | 35048 | 1281 | 14750 |
| 3E | | MI | 8022 | 3411 | 11754 | 2775 | 13224 | 2339 | 13856 | 2008 | 14189 | 1497 | 16285 | 1165 | 7010 |
| 8-#11 | 1.08 | MA | 16116 | 3411 | 21722 | 2959 | 25334 | 2510 | 26971 | 2151 | 27862 | 1616 | 32817 | 1222 | 14698 |
| 4L-2S | | MI | 8288 | 3411 | 12272 | 2764 | 13882 | 2329 | 14656 | 1991 | 15272 | 1483 | 17752 | 1277 | 6981 |
| 8-#14 | 1.56 | MA | 18082 | 3569 | 25836 | 3015 | 30614 | 2532 | 33364 | 2149 | 36509 | 1565 | 44380 | 1358 | 21007 |
| 2L-4S | | MI | 8099 | 3569 | 11962 | 2875 | 13358 | 2425 | 13982 | 2056 | 14324 | 1485 | 16537 | 985 | 9788 |
| 8-#14 | 1.56 | MA | 17184 | 3569 | 24137 | 3039 | 28452 | 2554 | 30737 | 2170 | 32954 | 1598 | 39458 | 1221 | 20964 |
| 3E | | MI | 8296 | 3569 | 12473 | 2861 | 14077 | 2399 | 14863 | 2047 | 15529 | 1482 | 17985 | 1073 | 9772 |
| 8-#14 | 1.56 | MA | 16729 | 3569 | 22999 | 3063 | 26841 | 2592 | 28759 | 2207 | 30241 | 1617 | 36247 | 1135 | 20757 |
| 4L-2S | | MI | 8661 | 3569 | 13208 | 2846 | 15013 | 2387 | 16000 | 2023 | 17067 | 1464 | 20036 | 1235 | 9738 |
| 8-#18 | 2.78 | MA | 20415 | 3969 | 31123 | 3248 | 37206 | 2699 | 41300 | 2250 | 47191 | 1532 | 59126 | 1317 | 36570 |
| 2L-4S | | MI | 8627 | 3969 | 13306 | 3108 | 14902 | 2600 | 15794 | 2160 | 16724 | 1447 | 19556 | 671 | 15748 |
| 8-#18 | 2.78 | MA | 18971 | 3969 | 28144 | 3290 | 33412 | 2737 | 36693 | 2286 | 40956 | 1588 | 50493 | 1068 | 36309 |
| 3E | | MI | 8946 | 3969 | 14194 | 3085 | 16148 | 2557 | 17321 | 2149 | 18812 | 1447 | 21988 | 820 | 16380 |
| 8-#18 | 2.78 | MA | 18245 | 3969 | 26140 | 3331 | 30579 | 2802 | 33214 | 2348 | 36185 | 1619 | 44809 | 913 | 34866 |
| 4L-2S | | MI | 9533 | 3969 | 15460 | 3062 | 17761 | 2539 | 19280 | 2111 | 21462 | 1421 | 25409 | 1108 | 16401 |
| 10-#10 | 1.10 | MA | 17182 | 3418 | 23711 | 2941 | 28079 | 2480 | 30369 | 2121 | 32528 | 1585 | 38921 | 1380 | 15082 |
| 2L-5S | | MI | 7855 | 3418 | 11229 | 2829 | 12622 | 2385 | 13152 | 2047 | 13244 | 1525 | 15191 | 1105 | 7198 |
| 10-#10 | 1.10 | MA | 16646 | 3418 | 22737 | 2955 | 26839 | 2493 | 28863 | 2134 | 30490 | 1605 | 36099 | 1305 | 15081 |
| 3L-4S | | MI | 8001 | 3418 | 11532 | 2811 | 12987 | 2377 | 13605 | 2032 | 13875 | 1513 | 16064 | 1157 | 7180 |
| 10-#10 | 1.10 | MA | 16379 | 3418 | 22087 | 2969 | 25918 | 2515 | 27733 | 2155 | 28939 | 1617 | 34277 | 1257 | 15047 |
| 4L-3S | | MI | 8117 | 3418 | 11828 | 2801 | 13404 | 2360 | 14117 | 2025 | 14575 | 1509 | 16936 | 1211 | 7158 |
| 10-#10 | 1.10 | MA | 15967 | 3418 | 21398 | 2989 | 25123 | 2529 | 26741 | 2168 | 27555 | 1636 | 32404 | 1224 | 14944 |
| 5L-2S | | MI | 8340 | 3418 | 12258 | 2791 | 13952 | 2352 | 14782 | 2010 | 15475 | 1497 | 18182 | 1302 | 7137 |
| 10-#11 | 1.35 | MA | 17681 | 3500 | 24885 | 2981 | 29475 | 2508 | 32016 | 2136 | 34715 | 1574 | 41918 | 1368 | 18341 |
| 2L-5S | | MI | 7952 | 3500 | 11547 | 2863 | 12936 | 2407 | 13489 | 2058 | 13663 | 1509 | 15691 | 1026 | 8635 |
| 10-#11 | 1.35 | MA | 17045 | 3500 | 23700 | 2998 | 27966 | 2524 | 30183 | 2151 | 32234 | 1597 | 38483 | 1274 | 18328 |
| 3L-4S | | MI | 8121 | 3500 | 11913 | 2842 | 13378 | 2398 | 14038 | 2041 | 14426 | 1495 | 16720 | 1091 | 8627 |
| 10-#11 | 1.35 | MA | 16728 | 3500 | 22907 | 3015 | 26843 | 2550 | 28804 | 2177 | 30343 | 1611 | 36252 | 1215 | 18258 |
| 4L-3S | | MI | 8258 | 3500 | 12272 | 2831 | 13882 | 2379 | 14656 | 2033 | 15272 | 1492 | 17752 | 1154 | 8603 |
| 10-#11 | 1.35 | MA | 16235 | 3500 | 22073 | 3040 | 25873 | 2566 | 27594 | 2192 | 28654 | 1634 | 33963 | 1172 | 18067 |
| 5L-2S | | MI | 8520 | 3500 | 12789 | 2820 | 14541 | 2370 | 15456 | 2016 | 16355 | 1478 | 19219 | 1266 | 8578 |
| 10-#14 | 1.95 | MA | 18889 | 3697 | 27534 | 3096 | 32776 | 2590 | 35990 | 2186 | 40064 | 1557 | 49301 | 1347 | 26139 |
| 2L-5S | | MI | 8205 | 3697 | 12174 | 2986 | 13664 | 2496 | 14336 | 2116 | 14774 | 1496 | 17149 | 872 | 11709 |
| 10-#14 | 1.95 | MA | 18020 | 3697 | 25836 | 3120 | 30614 | 2612 | 33364 | 2207 | 36509 | 1591 | 44380 | 1211 | 26074 |
| 3L-4S | | MI | 8437 | 3697 | 12697 | 2956 | 14294 | 2484 | 15119 | 2092 | 15862 | 1478 | 18589 | 966 | 12000 |
| 10-#14 | 1.95 | MA | 17593 | 3697 | 24698 | 3144 | 29003 | 2650 | 31386 | 2243 | 33796 | 1609 | 41169 | 1125 | 25848 |
| 4L-3S | | MI | 8625 | 3697 | 13208 | 2941 | 15013 | 2457 | 16000 | 2083 | 17067 | 1475 | 20036 | 1055 | 12011 |
| 10-#14 | 1.95 | MA | 16898 | 3697 | 23507 | 3179 | 27610 | 2673 | 29649 | 2264 | 31372 | 1643 | 37878 | 1061 | 24946 |
| 5L-2S | | MI | 8981 | 3697 | 13943 | 2926 | 15949 | 2445 | 17136 | 2059 | 18605 | 1457 | 22088 | 1216 | 11989 |
| 10-#18 | 3.47 | MA | 20374 | 4197 | 31123 | 3432 | 37206 | 2841 | 41300 | 2350 | 47191 | 1575 | 59126 | 1050 | 45251 |
| 3L-4S | | MI | 9194 | 4197 | 14573 | 3251 | 16514 | 2704 | 17753 | 2225 | 19374 | 1434 | 22977 | 625 | 19324 |
| 10-#18 | 3.47 | MA | 19714 | 4197 | 29120 | 3474 | 34372 | 2906 | 37821 | 2413 | 42420 | 1605 | 53443 | 895 | 43705 |
| 4L-3S | | MI | 9493 | 4197 | 15460 | 3228 | 17761 | 2660 | 19280 | 2214 | 21462 | 1434 | 25409 | 774 | 20170 |
| 10-#18 | 3.47 | MA | 18531 | 4197 | 27046 | 3538 | 31917 | 2944 | 34762 | 2448 | 38154 | 1662 | 47635 | 776 | 40137 |
| 5L-2S | | MI | 10059 | 4197 | 16726 | 3205 | 19373 | 2643 | 21238 | 2176 | 24113 | 1408 | 28830 | 1062 | 20238 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

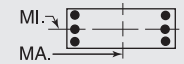
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.32 | MA | 17663 | 3490 | 24685 | 2986 | 29319 | 2513 | 31875 | 2142 | 34566 | 1581 | 41743 | 1374 | 18032 |
| 2L-6S | | MI | 7905 | 3490 | 11388 | 2881 | 12810 | 2435 | 13371 | 2074 | 13541 | 1533 | 15638 | 1038 | 8474 |
| 12-#10 | 1.32 | MA | 17139 | 3490 | 23711 | 3000 | 28079 | 2526 | 30369 | 2154 | 32528 | 1601 | 38921 | 1299 | 18021 |
| 3L-5S | | MI | 8057 | 3490 | 11659 | 2874 | 13169 | 2418 | 13817 | 2068 | 14144 | 1521 | 16436 | 1099 | 8504 |
| 12-#10 | 1.32 | MA | 16881 | 3490 | 23061 | 3015 | 27158 | 2548 | 29239 | 2176 | 30977 | 1612 | 37100 | 1252 | 17977 |
| 4E | | MI | 8203 | 3490 | 11962 | 2856 | 13534 | 2410 | 14270 | 2052 | 14775 | 1509 | 17310 | 1152 | 8494 |
| 12-#10 | 1.32 | MA | 16471 | 3490 | 22372 | 3034 | 26363 | 2562 | 28247 | 2188 | 29593 | 1632 | 35227 | 1218 | 17865 |
| 5L-3S | | MI | 8316 | 3490 | 12258 | 2846 | 13952 | 2393 | 14782 | 2046 | 15475 | 1505 | 18182 | 1205 | 8478 |
| 12-#10 | 1.32 | MA | 16116 | 3490 | 21724 | 3042 | 25573 | 2572 | 27275 | 2210 | 28239 | 1644 | 33398 | 1156 | 17571 |
| 6L-2S | | MI | 8535 | 3490 | 12688 | 2837 | 14499 | 2385 | 15447 | 2030 | 16376 | 1493 | 19427 | 1296 | 8460 |
| 12-#11 | 1.63 | MA | 18254 | 3590 | 26071 | 3037 | 30985 | 2548 | 33850 | 2161 | 37196 | 1569 | 45353 | 1360 | 21927 |
| 2L-6S | | MI | 8011 | 3590 | 11743 | 2928 | 13159 | 2467 | 13749 | 2090 | 14016 | 1517 | 16214 | 943 | 9984 |
| 12-#11 | 1.63 | MA | 17634 | 3590 | 24885 | 3054 | 29475 | 2564 | 32016 | 2176 | 34715 | 1592 | 41918 | 1267 | 21901 |
| 3L-5S | | MI | 8191 | 3590 | 12064 | 2919 | 13595 | 2448 | 14289 | 2083 | 14746 | 1504 | 17158 | 1016 | 10193 |
| 12-#11 | 1.63 | MA | 17331 | 3590 | 24093 | 3071 | 28353 | 2590 | 30638 | 2202 | 32824 | 1606 | 39687 | 1207 | 21819 |
| 4E | | MI | 8359 | 3590 | 12431 | 2897 | 14037 | 2439 | 14838 | 2066 | 15509 | 1490 | 18187 | 1081 | 10201 |
| 12-#11 | 1.63 | MA | 16841 | 3590 | 23258 | 3095 | 27382 | 2606 | 29427 | 2217 | 31135 | 1629 | 37398 | 1165 | 21619 |
| 5L-3S | | MI | 8493 | 3590 | 12789 | 2886 | 14541 | 2419 | 15456 | 2059 | 16355 | 1487 | 19219 | 1144 | 10186 |
| 12-#11 | 1.63 | MA | 16417 | 3590 | 22469 | 3104 | 26427 | 2619 | 28241 | 2242 | 29484 | 1642 | 35163 | 1087 | 20903 |
| 6L-2S | | MI | 8749 | 3590 | 13307 | 2875 | 15200 | 2410 | 16257 | 2041 | 17438 | 1473 | 20686 | 1256 | 10166 |
| 12-#14 | 2.34 | MA | 18841 | 3826 | 27534 | 3200 | 32776 | 2671 | 35990 | 2243 | 40064 | 1583 | 49301 | 1200 | 31183 |
| 3L-5S | | MI | 8539 | 3826 | 12909 | 3066 | 14600 | 2554 | 15473 | 2153 | 16312 | 1488 | 19201 | 853 | 13821 |
| 12-#14 | 2.34 | MA | 18438 | 3826 | 26396 | 3224 | 31166 | 2708 | 34012 | 2279 | 37351 | 1602 | 46091 | 1114 | 30942 |
| 4E | | MI | 8770 | 3826 | 13432 | 3036 | 15230 | 2542 | 16255 | 2129 | 17400 | 1470 | 20640 | 947 | 14204 |
| 12-#14 | 2.34 | MA | 17748 | 3826 | 25205 | 3260 | 29772 | 2731 | 32275 | 2301 | 34927 | 1635 | 42800 | 1051 | 30005 |
| 5L-3S | | MI | 8950 | 3826 | 13943 | 3021 | 15949 | 2515 | 17136 | 2120 | 18605 | 1467 | 22088 | 1036 | 14237 |
| 12-#14 | 2.34 | MA | 17163 | 3826 | 24073 | 3272 | 28411 | 2749 | 30572 | 2337 | 32556 | 1654 | 39588 | 938 | 28607 |
| 6L-2S | | MI | 9298 | 3826 | 14678 | 3006 | 16884 | 2503 | 18273 | 2096 | 20143 | 1449 | 24140 | 1198 | 14228 |
| 12-#18 | 4.17 | MA | 21143 | 4425 | 32099 | 3616 | 38165 | 3010 | 42428 | 2477 | 48655 | 1592 | 62076 | 877 | 52544 |
| 4E | | MI | 9751 | 4425 | 15839 | 3393 | 18127 | 2808 | 19711 | 2290 | 22024 | 1420 | 26399 | 579 | 22931 |
| 12-#18 | 4.17 | MA | 19971 | 4425 | 30025 | 3680 | 35710 | 3048 | 39370 | 2513 | 44389 | 1649 | 56269 | 758 | 49011 |
| 5L-3S | | MI | 10032 | 4425 | 16726 | 3370 | 19373 | 2764 | 21238 | 2278 | 24113 | 1421 | 28830 | 728 | 23954 |
| 12-#18 | 4.17 | MA | 19018 | 4425 | 28037 | 3700 | 33347 | 3082 | 36368 | 2575 | 40214 | 1679 | 50601 | 550 | 45400 |
| 6L-2S | | MI | 10578 | 4425 | 17993 | 3347 | 20985 | 2747 | 23196 | 2241 | 26763 | 1395 | 32251 | 1015 | 24056 |
| 14-#10 | 1.54 | MA | 17624 | 3563 | 24685 | 3046 | 29319 | 2559 | 31875 | 2175 | 34566 | 1597 | 41743 | 1293 | 20959 |
| 3L-6S | | MI | 8109 | 3563 | 11818 | 2927 | 13357 | 2468 | 14036 | 2095 | 14441 | 1529 | 16883 | 1032 | 9723 |
| 14-#10 | 1.54 | MA | 17376 | 3563 | 24035 | 3060 | 28398 | 2581 | 30745 | 2196 | 33015 | 1608 | 39922 | 1246 | 20906 |
| 4L-5S | | MI | 8258 | 3563 | 12089 | 2919 | 13717 | 2451 | 14482 | 2088 | 15044 | 1517 | 17681 | 1093 | 9802 |
| 14-#10 | 1.54 | MA | 16969 | 3563 | 23346 | 3080 | 27603 | 2594 | 29753 | 2209 | 31631 | 1628 | 38049 | 1212 | 20788 |
| 5L-4S | | MI | 8403 | 3563 | 12392 | 2901 | 14082 | 2443 | 14935 | 2073 | 15675 | 1505 | 18555 | 1146 | 9803 |
| 14-#10 | 1.54 | MA | 16622 | 3563 | 22698 | 3087 | 26813 | 2604 | 28781 | 2230 | 30278 | 1639 | 36220 | 1151 | 20469 |
| 6L-3S | | MI | 8513 | 3563 | 12688 | 2892 | 14499 | 2426 | 15447 | 2066 | 16376 | 1501 | 19427 | 1199 | 9791 |
| 14-#10 | 1.54 | MA | 16329 | 3563 | 22088 | 3097 | 25952 | 2621 | 27799 | 2239 | 28970 | 1659 | 34487 | 1120 | 19863 |
| 7L-2S | | MI | 8729 | 3563 | 13118 | 2882 | 15047 | 2418 | 16112 | 2051 | 17276 | 1488 | 20672 | 1290 | 9777 |
| 14-#11 | 1.90 | MA | 18213 | 3679 | 26071 | 3109 | 30985 | 2605 | 33850 | 2202 | 37196 | 1587 | 45353 | 1260 | 25473 |
| 3L-6S | | MI | 8252 | 3679 | 12261 | 2984 | 13818 | 2508 | 14549 | 2116 | 15099 | 1512 | 17682 | 933 | 11488 |
| 14-#11 | 1.90 | MA | 17923 | 3679 | 25278 | 3126 | 29862 | 2631 | 32471 | 2227 | 35305 | 1600 | 43123 | 1200 | 25380 |
| 4L-5S | | MI | 8428 | 3679 | 12582 | 2974 | 14254 | 2488 | 15089 | 2109 | 15829 | 1498 | 18625 | 1005 | 11745 |
| 14-#11 | 1.90 | MA | 17437 | 3679 | 24444 | 3151 | 28891 | 2647 | 31261 | 2242 | 33616 | 1624 | 40833 | 1158 | 25174 |
| 5L-4S | | MI | 8595 | 3679 | 12948 | 2953 | 14696 | 2479 | 15638 | 2091 | 16592 | 1485 | 19654 | 1070 | 11767 |
| 14-#11 | 1.90 | MA | 17024 | 3679 | 23654 | 3159 | 27936 | 2659 | 30074 | 2268 | 31965 | 1637 | 38598 | 1080 | 24437 |
| 6L-3S | | MI | 8724 | 3679 | 13307 | 2942 | 15200 | 2460 | 16257 | 2084 | 17438 | 1481 | 20686 | 1133 | 11762 |
| 14-#11 | 1.90 | MA | 16675 | 3679 | 22910 | 3171 | 26886 | 2679 | 28887 | 2279 | 30368 | 1661 | 36472 | 1041 | 23735 |
| 7L-2S | | MI | 8976 | 3679 | 13824 | 2931 | 15859 | 2451 | 17057 | 2066 | 18521 | 1468 | 22154 | 1245 | 11747 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

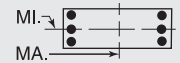


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.73 | MA | 19267 | 3954 | 28094 | 3304 | 33328 | 2767 | 36639 | 2316 | 40905 | 1594 | 51012 | 1104 | 36040 |
| 4L-5S | | MI | 8869 | 3954 | 13644 | 3146 | 15536 | 2612 | 16609 | 2189 | 17850 | 1481 | 21252 | 834 | 15944 |
| 14-#14 | 2.73 | MA | 18582 | 3954 | 26904 | 3340 | 31935 | 2789 | 34902 | 2337 | 38482 | 1628 | 47722 | 1041 | 35070 |
| 5L-4S | | MI | 9099 | 3954 | 14167 | 3116 | 16166 | 2601 | 17392 | 2165 | 18938 | 1463 | 22692 | 928 | 16403 |
| 14-#14 | 2.73 | MA | 18017 | 3954 | 25772 | 3352 | 30573 | 2808 | 33198 | 2373 | 36111 | 1646 | 44510 | 927 | 33688 |
| 6L-3S | | MI | 9271 | 3954 | 14678 | 3101 | 16884 | 2574 | 18273 | 2156 | 20143 | 1460 | 24140 | 1017 | 16453 |
| 14-#14 | 2.73 | MA | 17538 | 3954 | 24703 | 3368 | 29067 | 2836 | 31508 | 2390 | 33819 | 1680 | 41447 | 871 | 32151 |
| 7L-2S | | MI | 9611 | 3954 | 15413 | 3086 | 17820 | 2562 | 19409 | 2132 | 21682 | 1442 | 26191 | 1179 | 16460 |
| 14-#18 | 4.86 | MA | 21375 | 4654 | 33004 | 3823 | 39503 | 3152 | 43977 | 2578 | 50625 | 1636 | 64902 | 739 | 57884 |
| 5L-4S | | MI | 10299 | 4654 | 17105 | 3536 | 19739 | 2912 | 21669 | 2355 | 24675 | 1407 | 29820 | 532 | 26561 |
| 14-#18 | 4.86 | MA | 20471 | 4654 | 31016 | 3843 | 37140 | 3185 | 40975 | 2640 | 46450 | 1666 | 59234 | 532 | 54220 |
| 6L-3S | | MI | 10564 | 4654 | 17993 | 3513 | 20985 | 2868 | 23196 | 2343 | 26763 | 1408 | 32251 | 681 | 27733 |
| 14-#18 | 4.86 | MA | 19701 | 4654 | 29137 | 3870 | 34492 | 3234 | 38044 | 2672 | 42413 | 1723 | 53801 | 429 | 50444 |
| 7L-2S | | MI | 11099 | 4654 | 19259 | 3490 | 22597 | 2851 | 25154 | 2305 | 29413 | 1381 | 35673 | 969 | 27865 |
| 16-#10 | 1.76 | MA | 17865 | 3635 | 25009 | 3105 | 29638 | 2614 | 32251 | 2217 | 35054 | 1604 | 42744 | 1240 | 23835 |
| 4L-6S | | MI | 8310 | 3635 | 12248 | 2972 | 13905 | 2501 | 14701 | 2115 | 15341 | 1525 | 18128 | 1026 | 10977 |
| 16-#10 | 1.76 | MA | 17459 | 3635 | 24320 | 3125 | 28843 | 2627 | 31259 | 2229 | 33670 | 1624 | 40871 | 1207 | 23711 |
| 5E | | MI | 8457 | 3635 | 12519 | 2965 | 14265 | 2484 | 15147 | 2109 | 15944 | 1513 | 18927 | 1087 | 11097 |
| 16-#10 | 1.76 | MA | 17121 | 3635 | 23672 | 3132 | 28053 | 2637 | 30287 | 2251 | 32316 | 1635 | 39043 | 1145 | 23370 |
| 6L-4S | | MI | 8601 | 3635 | 12822 | 2947 | 14630 | 2476 | 15601 | 2093 | 16575 | 1500 | 19800 | 1140 | 11107 |
| 16-#10 | 1.76 | MA | 16836 | 3635 | 23062 | 3142 | 27192 | 2654 | 29305 | 2260 | 31008 | 1655 | 37309 | 1114 | 22779 |
| 7L-3S | | MI | 8708 | 3635 | 13118 | 2937 | 15047 | 2459 | 16112 | 2087 | 17276 | 1496 | 20672 | 1193 | 11101 |
| 16-#10 | 1.76 | MA | 16486 | 3635 | 22478 | 3153 | 26401 | 2664 | 28299 | 2277 | 29726 | 1675 | 35612 | 1074 | 22290 |
| 8L-2S | | MI | 8920 | 3635 | 13548 | 2927 | 15595 | 2451 | 16777 | 2071 | 18176 | 1484 | 21918 | 1284 | 11089 |
| 16-#11 | 2.17 | MA | 18508 | 3768 | 26463 | 3182 | 31371 | 2671 | 34304 | 2252 | 37786 | 1595 | 46558 | 1193 | 28941 |
| 4L-6S | | MI | 8490 | 3768 | 12778 | 3040 | 14477 | 2548 | 15349 | 2141 | 16182 | 1507 | 19149 | 922 | 12998 |
| 16-#11 | 2.17 | MA | 18024 | 3768 | 25629 | 3207 | 30401 | 2687 | 33094 | 2267 | 36097 | 1619 | 44268 | 1150 | 28731 |
| 5E | | MI | 8663 | 3768 | 13099 | 3030 | 14913 | 2529 | 15890 | 2134 | 16912 | 1493 | 20092 | 994 | 13281 |
| 16-#11 | 2.17 | MA | 17622 | 3768 | 24840 | 3215 | 29446 | 2700 | 31907 | 2293 | 34446 | 1632 | 42033 | 1073 | 27975 |
| 6L-4S | | MI | 8829 | 3768 | 13466 | 3009 | 15355 | 2520 | 16438 | 2116 | 17675 | 1480 | 21122 | 1059 | 13327 |
| 16-#11 | 2.17 | MA | 17284 | 3768 | 24095 | 3227 | 28396 | 2720 | 30721 | 2305 | 32849 | 1656 | 39907 | 1034 | 27290 |
| 7L-3S | | MI | 8954 | 3768 | 13824 | 2998 | 15859 | 2500 | 17057 | 2109 | 18521 | 1476 | 22154 | 1122 | 13333 |
| 16-#11 | 2.17 | MA | 16865 | 3768 | 23383 | 3240 | 27432 | 2731 | 29494 | 2325 | 31284 | 1679 | 37831 | 984 | 26365 |
| 8L-2S | | MI | 9201 | 3768 | 14341 | 2987 | 16518 | 2491 | 17857 | 2092 | 19604 | 1463 | 23621 | 1235 | 13323 |
| 16-#14 | 3.13 | MA | 19401 | 4083 | 28602 | 3420 | 34097 | 2848 | 37528 | 2373 | 42036 | 1620 | 52644 | 1030 | 40141 |
| 5E | | MI | 9195 | 4083 | 14379 | 3226 | 16471 | 2671 | 17746 | 2225 | 19389 | 1474 | 23304 | 815 | 18076 |
| 16-#14 | 3.13 | MA | 18855 | 4083 | 27470 | 3432 | 32736 | 2866 | 35825 | 2410 | 39665 | 1639 | 49432 | 917 | 38767 |
| 6L-4S | | MI | 9424 | 4083 | 14902 | 3197 | 17102 | 2659 | 18528 | 2201 | 20476 | 1456 | 24743 | 909 | 18599 |
| 16-#14 | 3.13 | MA | 18397 | 4083 | 26402 | 3448 | 31230 | 2894 | 34134 | 2427 | 37373 | 1672 | 46369 | 860 | 37205 |
| 7L-3S | | MI | 9589 | 4083 | 15413 | 3182 | 17820 | 2632 | 19409 | 2192 | 21682 | 1452 | 26191 | 998 | 18664 |
| 16-#14 | 3.13 | MA | 17806 | 4083 | 25380 | 3467 | 29846 | 2910 | 32375 | 2455 | 35126 | 1705 | 43384 | 786 | 35563 |
| 8L-2S | | MI | 9921 | 4083 | 16148 | 3167 | 18756 | 2620 | 20546 | 2168 | 23220 | 1434 | 28243 | 1160 | 18685 |
| 16-#18 | 5.56 | MA | 21889 | 4882 | 33995 | 3986 | 40934 | 3289 | 45583 | 2705 | 52685 | 1653 | 67868 | 513 | 63039 |
| 6L-4S | | MI | 10841 | 4882 | 18372 | 3679 | 21351 | 3015 | 23627 | 2419 | 27325 | 1394 | 33241 | 486 | 30211 |
| 16-#18 | 5.56 | MA | 21167 | 4882 | 32116 | 4013 | 38285 | 3338 | 42651 | 2737 | 48648 | 1710 | 62434 | 410 | 59222 |
| 7L-3S | | MI | 11131 | 4882 | 19259 | 3656 | 22597 | 2972 | 25154 | 2408 | 29413 | 1394 | 35673 | 635 | 31510 |
| 16-#18 | 5.56 | MA | 20160 | 4882 | 30317 | 4044 | 35852 | 3364 | 39557 | 2786 | 44689 | 1766 | 57161 | 273 | 55288 |
| 8L-2S | | MI | 11598 | 4882 | 20525 | 3633 | 24210 | 2954 | 27113 | 2370 | 32063 | 1368 | 39094 | 922 | 31668 |
| 18-#10 | 1.98 | MA | 17944 | 3708 | 25294 | 3170 | 30083 | 2660 | 32765 | 2250 | 35708 | 1620 | 43694 | 1201 | 26636 |
| 5L-6S | | MI | 8510 | 3708 | 12678 | 3017 | 14452 | 2534 | 15366 | 2136 | 16241 | 1521 | 19374 | 1020 | 12235 |
| 18-#10 | 1.98 | MA | 17613 | 3708 | 24646 | 3178 | 29293 | 2670 | 31793 | 2271 | 34354 | 1631 | 41865 | 1139 | 26274 |
| 6L-5S | | MI | 8654 | 3708 | 12949 | 3010 | 14812 | 2517 | 15812 | 2129 | 16844 | 1508 | 20172 | 1081 | 12390 |
| 18-#10 | 1.98 | MA | 17336 | 3708 | 24036 | 3187 | 28432 | 2687 | 30811 | 2280 | 33046 | 1651 | 40131 | 1108 | 25697 |
| 7L-4S | | MI | 8798 | 3708 | 13252 | 2992 | 15177 | 2509 | 16266 | 2114 | 17475 | 1496 | 21045 | 1134 | 12406 |
| 18-#10 | 1.98 | MA | 16988 | 3708 | 23452 | 3198 | 27641 | 2697 | 29805 | 2297 | 31764 | 1671 | 38434 | 1069 | 25212 |
| 8L-3S | | MI | 8902 | 3708 | 13548 | 2982 | 15595 | 2492 | 16777 | 2107 | 18176 | 1492 | 21918 | 1187 | 12407 |
| 18-#10 | 1.98 | MA | 16642 | 3708 | 22768 | 3216 | 26831 | 2716 | 28832 | 2307 | 30413 | 1679 | 36790 | 1027 | 24413 |
| 9L-2S | | MI | 9111 | 3708 | 13979 | 2972 | 16142 | 2484 | 17443 | 2092 | 19076 | 1480 | 23163 | 1278 | 12399 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

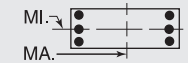
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.44 | MA | 18602 | 3857 | 26815 | 3262 | 31910 | 2728 | 34927 | 2293 | 38578 | 1614 | 47704 | 1143 | 32290 |
| 5L-6S | | MI | 8725 | 3857 | 13296 | 3095 | 15136 | 2589 | 16150 | 2166 | 17265 | 1502 | 20616 | 911 | 14512 |
| 18-#11 | 2.44 | MA | 18211 | 3857 | 26025 | 3271 | 30955 | 2740 | 33741 | 2318 | 36927 | 1627 | 45469 | 1066 | 31517 |
| 6L-5S | | MI | 8895 | 3857 | 13616 | 3086 | 15572 | 2569 | 16690 | 2159 | 17995 | 1488 | 21559 | 984 | 14781 |
| 18-#11 | 2.44 | MA | 17884 | 3857 | 25281 | 3282 | 29905 | 2760 | 32554 | 2330 | 35330 | 1651 | 43342 | 1027 | 30843 |
| 7L-4S | | MI | 9061 | 3857 | 13983 | 3064 | 16013 | 2560 | 17239 | 2142 | 18758 | 1474 | 22589 | 1049 | 14883 |
| 18-#11 | 2.44 | MA | 17468 | 3857 | 24569 | 3295 | 28941 | 2772 | 31328 | 2350 | 33765 | 1674 | 41267 | 977 | 29904 |
| 8L-3S | | MI | 9182 | 3857 | 14341 | 3053 | 16518 | 2541 | 17857 | 2134 | 19604 | 1471 | 23621 | 1112 | 14899 |
| 18-#11 | 2.44 | MA | 17058 | 3857 | 23741 | 3317 | 27952 | 2795 | 30141 | 2361 | 32134 | 1686 | 39250 | 925 | 28943 |
| 9L-2S | | MI | 9425 | 3857 | 14859 | 3042 | 17177 | 2532 | 18657 | 2117 | 20687 | 1458 | 25088 | 1224 | 14896 |
| 18-#14 | 3.52 | MA | 19679 | 4211 | 29169 | 3513 | 34898 | 2924 | 38451 | 2446 | 43220 | 1631 | 54354 | 907 | 43847 |
| 6L-5S | | MI | 9517 | 4211 | 15113 | 3307 | 17407 | 2729 | 18882 | 2262 | 20927 | 1466 | 25355 | 797 | 20215 |
| 18-#14 | 3.52 | MA | 19240 | 4211 | 28100 | 3529 | 33392 | 2953 | 36761 | 2463 | 40928 | 1665 | 51291 | 850 | 42259 |
| 7L-4S | | MI | 9745 | 4211 | 15637 | 3277 | 18037 | 2717 | 19665 | 2238 | 22015 | 1448 | 26795 | 891 | 20794 |
| 18-#14 | 3.52 | MA | 18655 | 4211 | 27078 | 3547 | 32009 | 2969 | 35001 | 2492 | 38681 | 1698 | 48306 | 776 | 40623 |
| 8L-3S | | MI | 9904 | 4211 | 16148 | 3262 | 18756 | 2690 | 20546 | 2229 | 23220 | 1445 | 28243 | 979 | 20871 |
| 18-#14 | 3.52 | MA | 18108 | 4211 | 25897 | 3578 | 30590 | 3001 | 33298 | 2507 | 36359 | 1715 | 45400 | 701 | 38611 |
| 9L-2S | | MI | 10229 | 4211 | 16883 | 3247 | 19692 | 2678 | 21682 | 2205 | 24758 | 1427 | 30294 | 1141 | 20903 |
| 18-#18 | 6.25 | MA | 22591 | 5111 | 35095 | 4156 | 42079 | 3442 | 47259 | 2802 | 54883 | 1696 | 71068 | 392 | 68000 |
| 7L-4S | | MI | 11443 | 5111 | 19638 | 3822 | 22963 | 3119 | 25586 | 2484 | 29975 | 1381 | 36662 | 440 | 33877 |
| 18-#18 | 6.25 | MA | 21603 | 5111 | 33296 | 4187 | 39645 | 3468 | 44164 | 2850 | 50924 | 1753 | 65795 | 254 | 64094 |
| 8L-3S | | MI | 11646 | 5111 | 20525 | 3798 | 24210 | 3075 | 27113 | 2473 | 32063 | 1381 | 39094 | 589 | 35287 |
| 20-#10 | 2.20 | MA | 18099 | 3780 | 25620 | 3223 | 30533 | 2703 | 33300 | 2292 | 36393 | 1627 | 44687 | 1133 | 29180 |
| 6E | | MI | 8707 | 3780 | 13108 | 3063 | 15000 | 2567 | 16031 | 2157 | 17141 | 1517 | 20619 | 1014 | 13495 |
| 20-#10 | 2.20 | MA | 17830 | 3780 | 25009 | 3233 | 29672 | 2720 | 32317 | 2301 | 35085 | 1647 | 42954 | 1102 | 28617 |
| 7L-5S | | MI | 8849 | 3780 | 13379 | 3055 | 15360 | 2550 | 16477 | 2150 | 17744 | 1504 | 21417 | 1075 | 13680 |
| 20-#10 | 2.20 | MA | 17484 | 3780 | 24426 | 3243 | 28881 | 2729 | 31312 | 2318 | 33803 | 1666 | 41257 | 1063 | 28134 |
| 8L-4S | | MI | 8993 | 3780 | 13682 | 3037 | 15725 | 2542 | 16931 | 2135 | 18375 | 1492 | 22291 | 1128 | 13702 |
| 20-#10 | 2.20 | MA | 17148 | 3780 | 23742 | 3261 | 28071 | 2748 | 30338 | 2327 | 32451 | 1675 | 39612 | 1021 | 27325 |
| 9L-3S | | MI | 9094 | 3780 | 13979 | 3028 | 16142 | 2525 | 17443 | 2128 | 19076 | 1488 | 23163 | 1181 | 13710 |
| 20-#10 | 2.20 | MA | 16843 | 3780 | 23134 | 3269 | 27309 | 2760 | 29369 | 2346 | 31126 | 1692 | 37784 | 976 | 26613 |
| 10L-2S | | MI | 9300 | 3780 | 14409 | 3018 | 16690 | 2517 | 18108 | 2113 | 19976 | 1476 | 24408 | 1272 | 13706 |
| 20-#11 | 2.71 | MA | 18792 | 3946 | 27211 | 3326 | 32465 | 2781 | 35574 | 2343 | 39408 | 1622 | 48904 | 1059 | 35061 |
| 6E | | MI | 8958 | 3946 | 13813 | 3151 | 15795 | 2629 | 16950 | 2191 | 18348 | 1496 | 22083 | 901 | 16029 |
| 20-#11 | 2.71 | MA | 18475 | 3946 | 26466 | 3338 | 31414 | 2801 | 34387 | 2355 | 37811 | 1645 | 46778 | 1020 | 34397 |
| 7L-5S | | MI | 9125 | 3946 | 14134 | 3141 | 16230 | 2610 | 17490 | 2184 | 19078 | 1483 | 23027 | 973 | 16286 |
| 20-#11 | 2.71 | MA | 18063 | 3946 | 25754 | 3351 | 30450 | 2812 | 33161 | 2375 | 36246 | 1669 | 44702 | 970 | 33443 |
| 8L-4S | | MI | 9290 | 3946 | 14501 | 3120 | 16672 | 2601 | 18039 | 2167 | 19841 | 1469 | 24056 | 1038 | 16438 |
| 20-#11 | 2.71 | MA | 17665 | 3946 | 24926 | 3372 | 29461 | 2835 | 31974 | 2386 | 34615 | 1680 | 42685 | 918 | 32485 |
| 9L-3S | | MI | 9408 | 3946 | 14859 | 3109 | 17177 | 2581 | 18657 | 2160 | 20687 | 1466 | 25088 | 1101 | 16460 |
| 20-#11 | 2.71 | MA | 17302 | 3946 | 24185 | 3382 | 28531 | 2848 | 30790 | 2409 | 32999 | 1700 | 40449 | 861 | 31283 |
| 10L-2S | | MI | 9647 | 3946 | 15376 | 3098 | 17835 | 2572 | 19457 | 2142 | 21770 | 1452 | 26555 | 1213 | 16465 |
| 20-#14 | 3.91 | MA | 20069 | 4340 | 29799 | 3609 | 35555 | 3011 | 39387 | 2500 | 44483 | 1657 | 56212 | 840 | 47312 |
| 7L-5S | | MI | 9836 | 4340 | 15848 | 3387 | 18343 | 2788 | 20019 | 2298 | 22465 | 1459 | 27407 | 778 | 22360 |
| 20-#14 | 3.91 | MA | 19488 | 4340 | 28777 | 3627 | 34171 | 3027 | 37628 | 2528 | 42236 | 1691 | 53228 | 766 | 45684 |
| 8L-4S | | MI | 10064 | 4340 | 16372 | 3357 | 18973 | 2776 | 20802 | 2274 | 23553 | 1441 | 28846 | 872 | 22968 |
| 20-#14 | 3.91 | MA | 18959 | 4340 | 27595 | 3659 | 32752 | 3060 | 35924 | 2544 | 39914 | 1707 | 50322 | 690 | 43654 |
| 9L-3S | | MI | 10217 | 4340 | 16883 | 3342 | 19692 | 2749 | 21682 | 2265 | 24758 | 1437 | 30294 | 960 | 23076 |
| 20-#14 | 3.91 | MA | 18449 | 4340 | 26532 | 3673 | 31416 | 3078 | 34226 | 2575 | 37594 | 1735 | 47107 | 606 | 41699 |
| 10L-2S | | MI | 10535 | 4340 | 17618 | 3327 | 20627 | 2737 | 22819 | 2241 | 26296 | 1419 | 32346 | 1122 | 23118 |
| 20-#18 | 6.94 | MA | 23016 | 5339 | 36275 | 4330 | 43438 | 3572 | 48771 | 2915 | 57160 | 1740 | 74428 | 236 | 72900 |
| 8L-4S | | MI | 11970 | 5339 | 20904 | 3964 | 24576 | 3223 | 27544 | 2549 | 32626 | 1367 | 40084 | 393 | 37556 |
| 22-#10 | 2.43 | MA | 18317 | 3853 | 25983 | 3278 | 30912 | 2753 | 33823 | 2322 | 37123 | 1642 | 45776 | 1096 | 31538 |
| 7L-6S | | MI | 8903 | 3853 | 13538 | 3108 | 15548 | 2600 | 16696 | 2177 | 18041 | 1512 | 21864 | 1009 | 14759 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

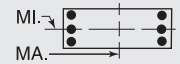


$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 2.43 | MA | 17973 | 3853 | 25400 | 3289 | 30121 | 2762 | 32818 | 2338 | 35841 | 1662 | 44079 | 1057 | 31055 |
| 8L-5S | | MI | 9043 | 3853 | 13810 | 3101 | 15907 | 2583 | 17142 | 2170 | 18644 | 1500 | 22662 | 1070 | 14970 |
| 22-#10 | 2.43 | MA | 17647 | 3853 | 24716 | 3306 | 29311 | 2781 | 31845 | 2348 | 34489 | 1671 | 42435 | 1015 | 30238 |
| 9L-4S | | MI | 9186 | 3853 | 14112 | 3083 | 16272 | 2575 | 17596 | 2155 | 19275 | 1488 | 23536 | 1122 | 14997 |
| 22-#10 | 2.43 | MA | 17349 | 3853 | 24108 | 3315 | 28549 | 2793 | 30875 | 2367 | 33165 | 1688 | 40607 | 970 | 29516 |
| 10L-3S | | MI | 9285 | 3853 | 14409 | 3073 | 16690 | 2558 | 18108 | 2148 | 19976 | 1484 | 24408 | 1175 | 15009 |
| 22-#10 | 2.43 | MA | 17012 | 3853 | 23516 | 3324 | 27758 | 2801 | 29926 | 2377 | 31823 | 1696 | 38955 | 928 | 28599 |
| 11L-2S | | MI | 9487 | 3853 | 14839 | 3063 | 17237 | 2550 | 18773 | 2133 | 20876 | 1472 | 25653 | 1266 | 15010 |
| 22-#11 | 2.98 | MA | 19059 | 4035 | 27652 | 3394 | 32924 | 2841 | 36221 | 2380 | 40292 | 1640 | 50213 | 1013 | 37950 |
| 7L-6S | | MI | 9189 | 4035 | 14330 | 3207 | 16453 | 2670 | 17750 | 2217 | 19431 | 1491 | 23550 | 890 | 17549 |
| 22-#11 | 2.98 | MA | 18649 | 4035 | 26939 | 3407 | 31960 | 2853 | 34994 | 2401 | 38727 | 1664 | 48137 | 963 | 36982 |
| 8L-5S | | MI | 9353 | 4035 | 14651 | 3197 | 16889 | 2650 | 18290 | 2210 | 20161 | 1478 | 24494 | 963 | 17795 |
| 22-#11 | 2.98 | MA | 18270 | 4035 | 26112 | 3428 | 30971 | 2875 | 33807 | 2412 | 37096 | 1675 | 46120 | 911 | 36026 |
| 9L-4S | | MI | 9518 | 4035 | 15018 | 3176 | 17331 | 2641 | 18839 | 2192 | 20924 | 1464 | 25523 | 1027 | 17990 |
| 22-#11 | 2.98 | MA | 17911 | 4035 | 25370 | 3438 | 30040 | 2889 | 32624 | 2434 | 35480 | 1695 | 43884 | 854 | 34813 |
| 10L-3S | | MI | 9632 | 4035 | 15376 | 3165 | 17835 | 2622 | 19457 | 2185 | 21770 | 1461 | 26555 | 1090 | 18019 |
| 22-#11 | 2.98 | MA | 17508 | 4035 | 24648 | 3450 | 29085 | 2899 | 31466 | 2447 | 33843 | 1705 | 41864 | 801 | 33688 |
| 11L-2S | | MI | 9867 | 4035 | 15894 | 3154 | 18494 | 2613 | 20258 | 2167 | 22853 | 1447 | 28023 | 1203 | 18030 |
| 22-#14 | 4.30 | MA | 20308 | 4468 | 30475 | 3708 | 36334 | 3085 | 40255 | 2565 | 45790 | 1683 | 58150 | 755 | 50744 |
| 8L-5S | | MI | 10152 | 4468 | 16583 | 3467 | 19279 | 2846 | 21155 | 2335 | 24003 | 1451 | 29458 | 759 | 24511 |
| 22-#14 | 4.30 | MA | 19796 | 4468 | 29294 | 3739 | 34915 | 3118 | 38551 | 2580 | 43468 | 1700 | 55243 | 680 | 48697 |
| 9L-4S | | MI | 10379 | 4468 | 17107 | 3437 | 19909 | 2834 | 21938 | 2311 | 25091 | 1433 | 30898 | 853 | 25092 |
| 22-#14 | 4.30 | MA | 19309 | 4468 | 28230 | 3753 | 33579 | 3137 | 36852 | 2612 | 41149 | 1728 | 52029 | 596 | 46726 |
| 10L-3S | | MI | 10527 | 4468 | 17618 | 3423 | 20627 | 2807 | 22819 | 2302 | 26296 | 1430 | 32346 | 941 | 25279 |
| 24-#10 | 2.65 | MA | 18457 | 3925 | 26374 | 3334 | 31361 | 2795 | 34324 | 2359 | 37879 | 1658 | 46901 | 1051 | 33977 |
| 8L-6S | | MI | 9098 | 3925 | 13968 | 3153 | 16095 | 2633 | 17361 | 2198 | 18941 | 1508 | 23109 | 1003 | 16024 |
| 24-#10 | 2.65 | MA | 18139 | 3925 | 25690 | 3351 | 30551 | 2814 | 33351 | 2368 | 36528 | 1667 | 45257 | 1009 | 33150 |
| 9L-5S | | MI | 9235 | 3925 | 14240 | 3146 | 16455 | 2616 | 17807 | 2191 | 19544 | 1496 | 23908 | 1064 | 16258 |
| 24-#10 | 2.65 | MA | 17849 | 3925 | 25082 | 3360 | 29789 | 2826 | 32381 | 2387 | 35203 | 1683 | 43429 | 964 | 32418 |
| 10L-4S | | MI | 9378 | 3925 | 14542 | 3128 | 16820 | 2608 | 18261 | 2176 | 20175 | 1484 | 24781 | 1116 | 16290 |
| 24-#10 | 2.65 | MA | 17514 | 3925 | 24490 | 3370 | 28998 | 2834 | 31432 | 2398 | 33861 | 1692 | 41777 | 923 | 31504 |
| 11L-3S | | MI | 9474 | 3925 | 14839 | 3118 | 17237 | 2591 | 18773 | 2169 | 20876 | 1480 | 25653 | 1169 | 16307 |
| 24-#10 | 2.65 | MA | 17185 | 3925 | 23912 | 3380 | 28173 | 2851 | 30473 | 2417 | 32556 | 1710 | 40113 | 887 | 30618 |
| 12L-2S | | MI | 9674 | 3925 | 15269 | 3108 | 17785 | 2583 | 19438 | 2154 | 21776 | 1467 | 26899 | 1260 | 16313 |
| 24-#11 | 3.25 | MA | 19228 | 4124 | 28125 | 3462 | 33469 | 2893 | 36827 | 2426 | 41208 | 1659 | 51572 | 956 | 40520 |
| 8L-6S | | MI | 9419 | 4124 | 14848 | 3262 | 17112 | 2710 | 18550 | 2242 | 20514 | 1486 | 25018 | 879 | 19071 |
| 24-#11 | 3.25 | MA | 18858 | 4124 | 27297 | 3484 | 32480 | 2916 | 35640 | 2437 | 39577 | 1670 | 49555 | 904 | 39551 |
| 9L-5S | | MI | 9580 | 4124 | 15169 | 3253 | 17548 | 2691 | 19090 | 2235 | 21243 | 1473 | 25961 | 952 | 19308 |
| 24-#11 | 3.25 | MA | 18511 | 4124 | 26556 | 3494 | 31550 | 2929 | 34457 | 2459 | 37961 | 1690 | 47320 | 847 | 38343 |
| 10L-4S | | MI | 9744 | 4124 | 15535 | 3231 | 17990 | 2682 | 19639 | 2217 | 22006 | 1459 | 26991 | 1017 | 19542 |
| 24-#11 | 3.25 | MA | 18112 | 4124 | 25834 | 3505 | 30595 | 2940 | 33299 | 2472 | 36324 | 1700 | 45299 | 794 | 37208 |
| 11L-3S | | MI | 9855 | 4124 | 15894 | 3220 | 18494 | 2662 | 20258 | 2210 | 22853 | 1456 | 28023 | 1080 | 19576 |
| 24-#11 | 3.25 | MA | 17719 | 4124 | 25128 | 3518 | 29589 | 2961 | 32141 | 2495 | 34732 | 1721 | 43257 | 749 | 35936 |
| 12L-2S | | MI | 10086 | 4124 | 16411 | 3209 | 19153 | 2653 | 21058 | 2193 | 23936 | 1442 | 29490 | 1192 | 19593 |
| 24-#14 | 4.69 | MA | 20620 | 4597 | 30992 | 3819 | 37077 | 3176 | 41177 | 2617 | 47023 | 1693 | 60165 | 670 | 53740 |
| 9L-5S | | MI | 10466 | 4597 | 17318 | 3548 | 20214 | 2904 | 22292 | 2371 | 25541 | 1444 | 31510 | 740 | 26666 |
| 24-#14 | 4.69 | MA | 20172 | 4597 | 29929 | 3833 | 35741 | 3195 | 39479 | 2648 | 44704 | 1720 | 56950 | 586 | 51753 |
| 10L-4S | | MI | 10693 | 4597 | 17842 | 3518 | 20845 | 2892 | 23075 | 2347 | 26629 | 1426 | 32950 | 834 | 27224 |

## RECTANGULAR TIED COLUMNS 10" x 10"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.86 | MA | 389 | 405 | 643 | 257 | 656 | 214 | 651 | 177 | 633 | 120 | 665 | 85 | 395 |
| 2L-3S | | MI | 380 | 405 | 613 | 256 | 618 | 215 | 607 | 179 | 577 | 122 | 601 | 62 | 400 |
| 6-#6 | 2.64 | MA | 402 | 427 | 678 | 268 | 696 | 220 | 698 | 179 | 693 | 112 | 729 | 68 | 521 |
| 2L-3S | | MI | 390 | 427 | 636 | 267 | 645 | 222 | 638 | 181 | 616 | 114 | 642 | 36 | 530 |
| 6-#7 | 3.60 | MA | 418 | 453 | 720 | 283 | 743 | 229 | 752 | 182 | 762 | 103 | 802 | 45 | 668 |
| 2L-3S | | MI | 403 | 453 | 664 | 286 | 676 | 231 | 673 | 184 | 661 | 105 | 690 | 4 | 679 |

## RECTANGULAR TIED COLUMNS 10" x 12"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#5 | 1.03 | MA | 542 | 459 | 874 | 303 | 893 | 256 | 888 | 219 | 851 | 162 | 891 | 129 | 355 |
| 2E | | MI | 448 | 459 | 723 | 291 | 727 | 245 | 711 | 207 | 670 | 151 | 695 | 119 | 301 |
| 4-#6 | 1.47 | MA | 555 | 473 | 907 | 311 | 934 | 261 | 937 | 222 | 912 | 158 | 957 | 119 | 472 |
| 2E | | MI | 457 | 473 | 747 | 298 | 753 | 248 | 741 | 208 | 708 | 145 | 736 | 107 | 393 |
| 4-#7 | 2.00 | MA | 570 | 491 | 947 | 320 | 983 | 267 | 994 | 224 | 984 | 153 | 1034 | 107 | 610 |
| 2E | | MI | 467 | 491 | 775 | 307 | 784 | 253 | 776 | 209 | 754 | 138 | 783 | 91 | 499 |
| 4-#8 | 2.63 | MA | 588 | 512 | 992 | 331 | 1040 | 275 | 1058 | 228 | 1066 | 147 | 1156 | 101 | 767 |
| 2E | | MI | 480 | 512 | 806 | 317 | 818 | 259 | 816 | 210 | 804 | 129 | 835 | 72 | 618 |
| 4-#9 | 3.33 | MA | 606 | 535 | 1041 | 344 | 1101 | 284 | 1126 | 231 | 1152 | 140 | 1252 | 85 | 932 |
| 2E | | MI | 492 | 535 | 836 | 328 | 853 | 264 | 856 | 210 | 856 | 119 | 885 | 49 | 742 |
| 4-#10 | 4.23 | MA | 629 | 565 | 1102 | 360 | 1177 | 296 | 1208 | 235 | 1257 | 131 | 1369 | 63 | 1137 |
| 2E | | MI | 508 | 565 | 872 | 343 | 895 | 271 | 904 | 210 | 918 | 105 | 942 | 18 | 892 |
| 4-#11 | 5.20 | MA | 647 | 597 | 1151 | 375 | 1218 | 300 | 1254 | 231 | 1317 | 112 | 1410 | 25 | 1323 |
| 2E | | MI | 519 | 597 | 884 | 349 | 906 | 270 | 916 | 201 | 934 | 79 | 930 | -35 | 951 |
| 6-#5 | 1.55 | MA | 559 | 476 | 915 | 314 | 946 | 264 | 952 | 224 | 934 | 159 | 986 | 120 | 495 |
| 2L-3S | | MI | 451 | 476 | 723 | 301 | 727 | 253 | 711 | 212 | 670 | 148 | 695 | 85 | 415 |
| 6-#5 | 1.55 | MA | 545 | 476 | 874 | 314 | 893 | 266 | 888 | 225 | 851 | 161 | 891 | 98 | 501 |
| 3L-2S | | MI | 460 | 476 | 753 | 302 | 764 | 252 | 755 | 211 | 726 | 147 | 759 | 108 | 410 |
| 6-#6 | 2.20 | MA | 578 | 497 | 964 | 326 | 1007 | 272 | 1027 | 228 | 1026 | 154 | 1086 | 106 | 664 |
| 2L-3S | | MI | 461 | 497 | 747 | 311 | 753 | 260 | 741 | 215 | 708 | 141 | 736 | 59 | 549 |
| 6-#6 | 2.20 | MA | 560 | 497 | 907 | 326 | 934 | 275 | 937 | 230 | 912 | 156 | 957 | 75 | 673 |
| 3L-2S | | MI | 473 | 497 | 788 | 313 | 805 | 258 | 801 | 213 | 785 | 139 | 823 | 91 | 540 |
| 6-#7 | 3.00 | MA | 601 | 524 | 1023 | 341 | 1081 | 282 | 1112 | 233 | 1135 | 147 | 1203 | 88 | 862 |
| 2L-3S | | MI | 473 | 524 | 775 | 330 | 784 | 269 | 776 | 217 | 754 | 131 | 783 | 27 | 703 |
| 6-#7 | 3.00 | MA | 577 | 524 | 947 | 340 | 983 | 286 | 994 | 236 | 984 | 150 | 1034 | 45 | 874 |
| 3L-2S | | MI | 489 | 524 | 830 | 327 | 851 | 266 | 855 | 215 | 854 | 129 | 895 | 68 | 690 |
| 6-#8 | 3.95 | MA | 598 | 555 | 992 | 358 | 1040 | 299 | 1058 | 242 | 1066 | 142 | 1156 | 19 | 1099 |
| 3L-2S | | MI | 507 | 555 | 878 | 345 | 904 | 276 | 915 | 217 | 932 | 116 | 974 | 40 | 858 |
| 6-#9 | 5.00 | MA | 620 | 590 | 1041 | 377 | 1101 | 314 | 1126 | 248 | 1152 | 133 | 1252 | -21 | 1207 |
| 3L-2S | | MI | 526 | 590 | 923 | 362 | 957 | 285 | 977 | 218 | 1010 | 101 | 1051 | 6 | 1034 |
| 6-#10 | 6.35 | MA | 647 | 635 | 1102 | 402 | 1177 | 333 | 1208 | 256 | 1257 | 121 | 1369 | -73 | 1309 |
| 3L-2S | | MI | 550 | 635 | 977 | 385 | 1020 | 297 | 1050 | 219 | 1105 | 81 | 1139 | -40 | 1156 |

## RECTANGULAR TIED COLUMNS 10" x 14"

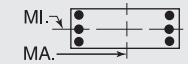
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.26 | MA | 752 | 544 | 1218 | 368 | 1263 | 310 | 1270 | 264 | 1251 | 195 | 1336 | 156 | 567 |
| 2E | | MI | 528 | 544 | 857 | 342 | 861 | 286 | 845 | 241 | 801 | 172 | 830 | 130 | 408 |
| 4-#7 | 1.71 | MA | 772 | 561 | 1270 | 377 | 1326 | 316 | 1347 | 268 | 1351 | 192 | 1449 | 147 | 740 |
| 2E | | MI | 538 | 561 | 885 | 351 | 892 | 291 | 880 | 242 | 846 | 164 | 876 | 114 | 517 |
| 4-#8 | 2.26 | MA | 795 | 582 | 1329 | 389 | 1400 | 324 | 1436 | 272 | 1465 | 188 | 1579 | 135 | 937 |
| 2E | | MI | 550 | 582 | 917 | 361 | 926 | 296 | 919 | 242 | 896 | 155 | 927 | 95 | 639 |
| 4-#9 | 2.86 | MA | 820 | 606 | 1392 | 401 | 1480 | 333 | 1532 | 277 | 1586 | 183 | 1713 | 121 | 1148 |
| 2E | | MI | 563 | 606 | 947 | 372 | 961 | 301 | 959 | 242 | 947 | 145 | 977 | 72 | 765 |
| 4-#10 | 3.63 | MA | 852 | 636 | 1472 | 418 | 1580 | 345 | 1653 | 284 | 1737 | 176 | 1879 | 102 | 1411 |
| 2E | | MI | 579 | 636 | 983 | 386 | 1002 | 308 | 1006 | 242 | 1008 | 130 | 1034 | 40 | 919 |
| 4-#11 | 4.46 | MA | 877 | 668 | 1544 | 432 | 1665 | 354 | 1746 | 286 | 1842 | 162 | 1968 | 69 | 1660 |
| 2E | | MI | 590 | 668 | 995 | 391 | 1012 | 306 | 1017 | 232 | 1023 | 104 | 1019 | -13 | 1028 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 10" x 14"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

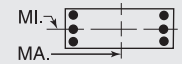
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.33 | MA | 756 | 546 | 1228 | 372 | 1277 | 313 | 1288 | 266 | 1278 | 197 | 1371 | 157 | 596 |
| 2L-3S | | MI | 522 | 546 | 834 | 346 | 835 | 292 | 815 | 246 | 763 | 175 | 789 | 108 | 428 |
| 6-#5 | 1.33 | MA | 739 | 546 | 1176 | 372 | 1211 | 316 | 1207 | 269 | 1169 | 198 | 1241 | 135 | 601 |
| 3L-2S | | MI | 530 | 546 | 864 | 346 | 873 | 290 | 859 | 244 | 819 | 173 | 854 | 131 | 425 |
| 6-#6 | 1.89 | MA | 781 | 568 | 1291 | 383 | 1356 | 321 | 1383 | 271 | 1404 | 193 | 1516 | 147 | 806 |
| 2L-3S | | MI | 532 | 568 | 857 | 356 | 861 | 298 | 845 | 248 | 801 | 167 | 830 | 82 | 566 |
| 6-#6 | 1.89 | MA | 758 | 568 | 1218 | 384 | 1263 | 325 | 1270 | 274 | 1251 | 195 | 1336 | 116 | 816 |
| 3L-2S | | MI | 544 | 568 | 899 | 357 | 913 | 296 | 905 | 246 | 878 | 165 | 917 | 114 | 557 |
| 6-#7 | 2.57 | MA | 812 | 595 | 1367 | 398 | 1451 | 331 | 1499 | 277 | 1554 | 188 | 1688 | 133 | 1056 |
| 2L-3S | | MI | 544 | 595 | 885 | 374 | 892 | 307 | 880 | 250 | 846 | 158 | 876 | 50 | 724 |
| 6-#7 | 2.57 | MA | 780 | 595 | 1270 | 399 | 1326 | 336 | 1347 | 281 | 1351 | 191 | 1449 | 90 | 1068 |
| 3L-2S | | MI | 560 | 595 | 941 | 371 | 960 | 304 | 958 | 247 | 946 | 155 | 988 | 91 | 711 |
| 6-#8 | 3.39 | MA | 806 | 626 | 1329 | 417 | 1400 | 350 | 1436 | 289 | 1465 | 186 | 1579 | 60 | 1355 |
| 3L-2S | | MI | 578 | 626 | 988 | 388 | 1012 | 313 | 1018 | 249 | 1023 | 142 | 1067 | 63 | 882 |
| 6-#9 | 4.29 | MA | 834 | 661 | 1392 | 437 | 1480 | 366 | 1532 | 298 | 1586 | 180 | 1713 | 24 | 1658 |
| 3L-2S | | MI | 597 | 661 | 1034 | 406 | 1064 | 322 | 1079 | 250 | 1102 | 127 | 1143 | 29 | 1061 |
| 6-#10 | 5.44 | MA | 868 | 706 | 1472 | 463 | 1580 | 386 | 1653 | 310 | 1737 | 171 | 1879 | -22 | 1871 |
| 3L-2S | | MI | 621 | 706 | 1088 | 428 | 1128 | 334 | 1152 | 251 | 1195 | 106 | 1231 | -18 | 1239 |
| 6-#11 | 6.69 | MA | 898 | 754 | 1544 | 486 | 1665 | 402 | 1746 | 316 | 1842 | 153 | 1968 | -90 | 1947 |
| 3L-2S | | MI | 638 | 754 | 1106 | 439 | 1146 | 334 | 1173 | 239 | 1223 | 69 | 1216 | -96 | 1266 |
| 8-#5 | 1.77 | MA | 761 | 564 | 1228 | 383 | 1277 | 323 | 1288 | 273 | 1278 | 197 | 1371 | 129 | 772 |
| 3E | | MI | 533 | 564 | 864 | 356 | 873 | 299 | 859 | 249 | 819 | 170 | 854 | 98 | 537 |
| 8-#5 | 1.77 | MA | 754 | 564 | 1187 | 387 | 1224 | 324 | 1224 | 273 | 1195 | 198 | 1278 | 119 | 779 |
| 4L-2S | | MI | 542 | 564 | 894 | 357 | 911 | 298 | 903 | 248 | 875 | 169 | 918 | 121 | 532 |
| 8-#6 | 2.51 | MA | 787 | 592 | 1291 | 399 | 1356 | 336 | 1383 | 281 | 1404 | 193 | 1516 | 106 | 1049 |
| 3E | | MI | 548 | 592 | 899 | 371 | 913 | 309 | 905 | 252 | 878 | 161 | 917 | 66 | 710 |
| 8-#6 | 2.51 | MA | 778 | 592 | 1234 | 404 | 1282 | 336 | 1293 | 280 | 1287 | 195 | 1386 | 93 | 1056 |
| 4L-2S | | MI | 560 | 592 | 941 | 373 | 965 | 307 | 965 | 250 | 954 | 159 | 1003 | 98 | 701 |
| 8-#7 | 3.43 | MA | 820 | 628 | 1367 | 420 | 1451 | 351 | 1499 | 290 | 1554 | 188 | 1688 | 77 | 1376 |
| 3E | | MI | 566 | 628 | 941 | 395 | 960 | 320 | 958 | 256 | 946 | 148 | 988 | 26 | 910 |
| 8-#7 | 3.43 | MA | 806 | 628 | 1290 | 426 | 1351 | 351 | 1377 | 289 | 1399 | 190 | 1515 | 59 | 1316 |
| 4L-2S | | MI | 581 | 628 | 997 | 392 | 1027 | 318 | 1037 | 253 | 1047 | 146 | 1101 | 68 | 898 |
| 8-#8 | 4.51 | MA | 840 | 670 | 1355 | 453 | 1432 | 370 | 1474 | 299 | 1527 | 184 | 1662 | 18 | 1603 |
| 4L-2S | | MI | 606 | 670 | 1060 | 416 | 1097 | 330 | 1118 | 256 | 1150 | 129 | 1206 | 31 | 1119 |
| 8-#9 | 5.71 | MA | 875 | 716 | 1424 | 482 | 1519 | 390 | 1580 | 310 | 1663 | 177 | 1815 | -29 | 1815 |
| 4L-2S | | MI | 631 | 716 | 1120 | 440 | 1168 | 343 | 1200 | 259 | 1256 | 109 | 1309 | -14 | 1315 |

## RECTANGULAR TIED COLUMNS 10" x 16"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.10 | MA | 978 | 614 | 1570 | 425 | 1636 | 359 | 1648 | 307 | 1624 | 230 | 1763 | 191 | 662 |
| 2E | | MI | 598 | 614 | 968 | 387 | 970 | 324 | 948 | 274 | 893 | 198 | 924 | 153 | 421 |
| 4-#7 | 1.50 | MA | 1003 | 632 | 1633 | 435 | 1713 | 365 | 1741 | 311 | 1751 | 227 | 1913 | 184 | 869 |
| 2E | | MI | 609 | 632 | 996 | 395 | 1000 | 328 | 983 | 274 | 938 | 190 | 970 | 137 | 533 |
| 4-#8 | 1.98 | MA | 1032 | 653 | 1706 | 446 | 1804 | 373 | 1851 | 315 | 1900 | 225 | 2086 | 174 | 1108 |
| 2E | | MI | 621 | 653 | 1027 | 405 | 1034 | 333 | 1022 | 275 | 987 | 181 | 1020 | 118 | 658 |
| 4-#9 | 2.50 | MA | 1063 | 676 | 1784 | 459 | 1902 | 382 | 1970 | 320 | 2062 | 222 | 2270 | 164 | 1364 |
| 2E | | MI | 634 | 676 | 1057 | 415 | 1068 | 338 | 1061 | 275 | 1038 | 170 | 1069 | 94 | 788 |
| 4-#10 | 3.17 | MA | 1102 | 706 | 1884 | 475 | 2027 | 394 | 2120 | 326 | 2263 | 218 | 2497 | 149 | 1686 |
| 2E | | MI | 650 | 706 | 1093 | 429 | 1109 | 345 | 1109 | 274 | 1099 | 156 | 1125 | 63 | 945 |
| 4-#11 | 3.90 | MA | 1136 | 738 | 1977 | 490 | 2138 | 403 | 2253 | 331 | 2415 | 206 | 2648 | 123 | 1997 |
| 2E | | MI | 661 | 738 | 1105 | 433 | 1119 | 342 | 1118 | 263 | 1113 | 129 | 1109 | 8 | 1086 |
| 6-#5 | 1.16 | MA | 983 | 617 | 1580 | 429 | 1651 | 362 | 1668 | 309 | 1653 | 231 | 1805 | 192 | 696 |
| 2L-3S | | MI | 592 | 617 | 944 | 390 | 944 | 330 | 919 | 279 | 856 | 201 | 884 | 132 | 440 |
| 6-#5 | 1.16 | MA | 962 | 617 | 1518 | 430 | 1572 | 365 | 1571 | 312 | 1520 | 233 | 1637 | 170 | 702 |
| 3L-2S | | MI | 601 | 617 | 974 | 391 | 981 | 328 | 963 | 278 | 912 | 200 | 948 | 155 | 438 |
| 6-#6 | 1.65 | MA | 1014 | 639 | 1657 | 441 | 1748 | 370 | 1784 | 314 | 1811 | 228 | 1996 | 184 | 949 |
| 2L-3S | | MI | 602 | 639 | 968 | 400 | 970 | 336 | 948 | 281 | 893 | 194 | 924 | 105 | 581 |
| 6-#6 | 1.65 | MA | 985 | 639 | 1570 | 442 | 1636 | 375 | 1648 | 318 | 1624 | 231 | 1763 | 153 | 958 |
| 3L-2S | | MI | 614 | 639 | 1009 | 402 | 1021 | 334 | 1008 | 279 | 970 | 192 | 1010 | 137 | 574 |

## RECTANGULAR TIED COLUMNS 10" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 2.25 | MA | 1051 | 665 | 1751 | 455 | 1864 | 380 | 1926 | 320 | 2002 | 225 | 2223 | 173 | 1251 |
| 2L-3S | | MI | 615 | 665 | 996 | 419 | 1000 | 344 | 983 | 283 | 938 | 184 | 970 | 72 | 743 |
| 6-#7 | 2.25 | MA | 1012 | 665 | 1633 | 458 | 1713 | 387 | 1741 | 325 | 1751 | 228 | 1913 | 131 | 1262 |
| 3L-2S | | MI | 630 | 665 | 1051 | 416 | 1068 | 342 | 1062 | 280 | 1038 | 181 | 1082 | 114 | 730 |
| 6-#8 | 2.96 | MA | 1044 | 697 | 1706 | 476 | 1804 | 401 | 1851 | 334 | 1900 | 225 | 2086 | 104 | 1611 |
| 3L-2S | | MI | 649 | 697 | 1099 | 432 | 1119 | 350 | 1121 | 282 | 1115 | 168 | 1159 | 85 | 905 |
| 6-#9 | 3.75 | MA | 1079 | 732 | 1784 | 496 | 1902 | 417 | 1970 | 343 | 2062 | 222 | 2270 | 74 | 1982 |
| 3L-2S | | MI | 668 | 732 | 1144 | 449 | 1172 | 359 | 1182 | 283 | 1193 | 153 | 1235 | 51 | 1088 |
| 6-#10 | 4.76 | MA | 1122 | 777 | 1884 | 523 | 2027 | 437 | 2120 | 356 | 2263 | 217 | 2497 | 33 | 2417 |
| 3L-2S | | MI | 692 | 777 | 1198 | 471 | 1235 | 370 | 1254 | 283 | 1286 | 132 | 1322 | 5 | 1309 |
| 6-#11 | 5.85 | MA | 1161 | 825 | 1977 | 546 | 2138 | 455 | 2253 | 365 | 2415 | 203 | 2648 | -25 | 2635 |
| 3L-2S | | MI | 708 | 825 | 1216 | 481 | 1252 | 369 | 1274 | 270 | 1312 | 94 | 1305 | -75 | 1347 |
| 8-#5 | 1.55 | MA | 988 | 634 | 1580 | 441 | 1651 | 373 | 1668 | 317 | 1653 | 231 | 1805 | 166 | 905 |
| 3E | | MI | 604 | 634 | 974 | 401 | 981 | 337 | 963 | 282 | 912 | 197 | 948 | 121 | 551 |
| 8-#5 | 1.55 | MA | 979 | 634 | 1532 | 445 | 1589 | 374 | 1591 | 317 | 1552 | 234 | 1686 | 155 | 913 |
| 4L-2S | | MI | 613 | 634 | 1004 | 402 | 1019 | 336 | 1007 | 281 | 968 | 196 | 1012 | 144 | 547 |
| 8-#6 | 2.20 | MA | 1021 | 663 | 1657 | 458 | 1748 | 386 | 1784 | 324 | 1811 | 229 | 1996 | 146 | 1239 |
| 3E | | MI | 619 | 663 | 1009 | 416 | 1021 | 347 | 1008 | 285 | 970 | 187 | 1010 | 90 | 729 |
| 8-#6 | 2.20 | MA | 1009 | 663 | 1589 | 463 | 1659 | 387 | 1676 | 325 | 1669 | 232 | 1830 | 131 | 1246 |
| 4L-2S | | MI | 631 | 663 | 1051 | 417 | 1073 | 345 | 1068 | 283 | 1047 | 185 | 1097 | 121 | 720 |
| 8-#7 | 3.00 | MA | 1061 | 699 | 1751 | 478 | 1864 | 401 | 1926 | 334 | 2002 | 226 | 2223 | 121 | 1636 |
| 3E | | MI | 637 | 699 | 1051 | 439 | 1068 | 358 | 1062 | 289 | 1038 | 174 | 1082 | 49 | 932 |
| 8-#7 | 3.00 | MA | 1045 | 699 | 1658 | 486 | 1745 | 403 | 1779 | 334 | 1812 | 229 | 2002 | 101 | 1598 |
| 4L-2S | | MI | 652 | 699 | 1107 | 436 | 1135 | 355 | 1140 | 286 | 1139 | 172 | 1194 | 91 | 920 |
| 8-#8 | 3.95 | MA | 1087 | 741 | 1739 | 513 | 1845 | 422 | 1900 | 346 | 1978 | 226 | 2200 | 65 | 1953 |
| 4L-2S | | MI | 676 | 741 | 1170 | 460 | 1205 | 368 | 1221 | 289 | 1242 | 155 | 1299 | 53 | 1144 |
| 8-#9 | 5.00 | MA | 1132 | 787 | 1825 | 543 | 1953 | 443 | 2030 | 358 | 2158 | 222 | 2409 | 23 | 2325 |
| 4L-2S | | MI | 702 | 787 | 1231 | 483 | 1276 | 380 | 1302 | 291 | 1347 | 135 | 1401 | 8 | 1378 |
| 8-#10 | 6.35 | MA | 1188 | 847 | 1934 | 581 | 2090 | 470 | 2195 | 373 | 2383 | 217 | 2668 | -32 | 2660 |
| 4L-2S | | MI | 734 | 847 | 1303 | 513 | 1360 | 396 | 1400 | 292 | 1473 | 108 | 1519 | -53 | 1541 |

## RECTANGULAR TIED COLUMNS 10" x 18"

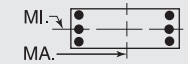
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.33 | MA | 1263 | 703 | 2036 | 492 | 2144 | 414 | 2180 | 353 | 2186 | 261 | 2424 | 219 | 999 |
| 2E | | MI | 680 | 703 | 1106 | 439 | 1108 | 366 | 1086 | 307 | 1030 | 217 | 1063 | 160 | 549 |
| 4-#8 | 1.76 | MA | 1297 | 724 | 2123 | 504 | 2252 | 422 | 2310 | 358 | 2363 | 259 | 2642 | 212 | 1279 |
| 2E | | MI | 692 | 724 | 1138 | 449 | 1142 | 371 | 1125 | 307 | 1079 | 207 | 1112 | 140 | 676 |
| 4-#9 | 2.22 | MA | 1335 | 747 | 2216 | 516 | 2369 | 431 | 2451 | 363 | 2555 | 256 | 2875 | 203 | 1580 |
| 2E | | MI | 704 | 747 | 1168 | 459 | 1176 | 375 | 1164 | 307 | 1129 | 196 | 1161 | 117 | 809 |
| 4-#10 | 2.82 | MA | 1382 | 777 | 2335 | 533 | 2517 | 443 | 2631 | 369 | 2799 | 252 | 3166 | 191 | 1960 |
| 2E | | MI | 720 | 777 | 1204 | 472 | 1217 | 382 | 1211 | 306 | 1190 | 181 | 1216 | 85 | 969 |
| 4-#11 | 3.47 | MA | 1424 | 809 | 2450 | 547 | 2655 | 452 | 2795 | 374 | 3021 | 246 | 3381 | 170 | 2334 |
| 2E | | MI | 731 | 809 | 1215 | 474 | 1225 | 377 | 1219 | 294 | 1202 | 154 | 1198 | 30 | 1116 |
| 6-#5 | 1.03 | MA | 1239 | 688 | 1973 | 486 | 2070 | 411 | 2092 | 352 | 2068 | 265 | 2285 | 226 | 796 |
| 2L-3S | | MI | 663 | 688 | 1055 | 435 | 1052 | 368 | 1023 | 312 | 948 | 228 | 978 | 155 | 452 |
| 6-#5 | 1.03 | MA | 1213 | 688 | 1900 | 488 | 1976 | 415 | 1978 | 355 | 1913 | 267 | 2079 | 204 | 802 |
| 3L-2S | | MI | 672 | 688 | 1085 | 436 | 1090 | 367 | 1067 | 311 | 1005 | 226 | 1042 | 178 | 451 |
| 6-#6 | 1.47 | MA | 1276 | 710 | 2064 | 498 | 2183 | 419 | 2229 | 356 | 2255 | 262 | 2522 | 220 | 1091 |
| 2L-3S | | MI | 673 | 710 | 1078 | 445 | 1078 | 374 | 1052 | 314 | 986 | 220 | 1017 | 129 | 596 |
| 6-#6 | 1.47 | MA | 1240 | 710 | 1962 | 500 | 2052 | 424 | 2069 | 361 | 2036 | 266 | 2236 | 189 | 1101 |
| 3L-2S | | MI | 685 | 710 | 1120 | 446 | 1130 | 372 | 1112 | 312 | 1063 | 218 | 1104 | 160 | 590 |
| 6-#7 | 2.00 | MA | 1320 | 736 | 2175 | 513 | 2322 | 429 | 2397 | 362 | 2482 | 259 | 2807 | 211 | 1445 |
| 2L-3S | | MI | 685 | 736 | 1106 | 463 | 1108 | 382 | 1086 | 316 | 1030 | 210 | 1063 | 95 | 761 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 10" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

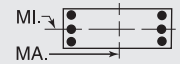
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 2.00 | MA | 1273 | 736 | 2036 | 516 | 2144 | 436 | 2180 | 369 | 2186 | 264 | 2424 | 169 | 1457 |
| 3L-2S | | MI | 701 | 736 | 1162 | 460 | 1176 | 379 | 1165 | 313 | 1130 | 207 | 1175 | 137 | 749 |
| 6-#8 | 2.63 | MA | 1312 | 768 | 2123 | 534 | 2252 | 451 | 2310 | 378 | 2363 | 261 | 2642 | 145 | 1867 |
| 3L-2S | | MI | 719 | 768 | 1209 | 476 | 1227 | 388 | 1224 | 314 | 1206 | 194 | 1252 | 108 | 927 |
| 6-#9 | 3.33 | MA | 1353 | 802 | 2216 | 555 | 2369 | 467 | 2451 | 388 | 2555 | 258 | 2875 | 118 | 2306 |
| 3L-2S | | MI | 738 | 802 | 1255 | 493 | 1280 | 396 | 1284 | 315 | 1284 | 178 | 1327 | 74 | 1113 |
| 6-#10 | 4.23 | MA | 1406 | 847 | 2335 | 582 | 2517 | 488 | 2631 | 401 | 2799 | 255 | 3166 | 82 | 2850 |
| 3L-2S | | MI | 762 | 847 | 1309 | 514 | 1342 | 407 | 1357 | 315 | 1377 | 157 | 1413 | 27 | 1338 |
| 6-#11 | 5.20 | MA | 1453 | 895 | 2450 | 606 | 2655 | 507 | 2795 | 411 | 3021 | 247 | 3381 | 31 | 3300 |
| 3L-2S | | MI | 779 | 895 | 1327 | 523 | 1359 | 405 | 1375 | 301 | 1401 | 119 | 1395 | -53 | 1426 |
| 8-#5 | 1.38 | MA | 1244 | 705 | 1973 | 499 | 2070 | 422 | 2092 | 360 | 2068 | 266 | 2285 | 201 | 1039 |
| 3E | | MI | 675 | 705 | 1085 | 446 | 1090 | 376 | 1067 | 316 | 1005 | 224 | 1042 | 145 | 565 |
| 8-#5 | 1.38 | MA | 1233 | 705 | 1917 | 503 | 1997 | 423 | 2002 | 361 | 1951 | 269 | 2140 | 189 | 1047 |
| 4L-2S | | MI | 684 | 705 | 1115 | 447 | 1128 | 374 | 1110 | 314 | 1061 | 222 | 1107 | 167 | 561 |
| 8-#6 | 1.96 | MA | 1284 | 734 | 2064 | 516 | 2183 | 435 | 2229 | 368 | 2255 | 264 | 2522 | 183 | 1429 |
| 3E | | MI | 690 | 734 | 1120 | 460 | 1130 | 385 | 1112 | 319 | 1063 | 213 | 1104 | 113 | 746 |
| 8-#6 | 1.96 | MA | 1268 | 734 | 1985 | 522 | 2081 | 437 | 2103 | 369 | 2090 | 267 | 2321 | 167 | 1436 |
| 4L-2S | | MI | 701 | 734 | 1162 | 462 | 1181 | 383 | 1172 | 317 | 1139 | 211 | 1191 | 144 | 738 |
| 8-#7 | 2.67 | MA | 1332 | 769 | 2175 | 537 | 2322 | 451 | 2397 | 378 | 2482 | 261 | 2807 | 162 | 1895 |
| 3E | | MI | 707 | 769 | 1162 | 484 | 1176 | 396 | 1165 | 322 | 1130 | 200 | 1175 | 72 | 953 |
| 8-#7 | 2.67 | MA | 1311 | 769 | 2067 | 545 | 2182 | 453 | 2226 | 379 | 2259 | 266 | 2537 | 140 | 1889 |
| 4L-2S | | MI | 723 | 769 | 1218 | 481 | 1243 | 393 | 1243 | 319 | 1231 | 198 | 1287 | 114 | 941 |
| 8-#8 | 3.51 | MA | 1361 | 811 | 2163 | 572 | 2302 | 473 | 2369 | 391 | 2457 | 263 | 2787 | 107 | 2313 |
| 4L-2S | | MI | 747 | 811 | 1281 | 503 | 1313 | 405 | 1323 | 321 | 1334 | 181 | 1391 | 76 | 1169 |
| 8-#9 | 4.44 | MA | 1415 | 858 | 2267 | 603 | 2431 | 495 | 2526 | 404 | 2672 | 261 | 3054 | 69 | 2759 |
| 4L-2S | | MI | 773 | 858 | 1341 | 527 | 1383 | 417 | 1405 | 323 | 1438 | 161 | 1493 | 31 | 1406 |
| 8-#10 | 5.64 | MA | 1484 | 918 | 2397 | 642 | 2595 | 523 | 2723 | 421 | 2945 | 257 | 3386 | 19 | 3308 |
| 4L-2S | | MI | 804 | 918 | 1414 | 556 | 1468 | 433 | 1502 | 324 | 1564 | 133 | 1610 | -31 | 1625 |
| 8-#11 | 6.93 | MA | 1547 | 982 | 2522 | 679 | 2745 | 548 | 2903 | 434 | 3192 | 248 | 3630 | -48 | 3609 |
| 4L-2S | | MI | 827 | 982 | 1438 | 572 | 1492 | 433 | 1530 | 308 | 1601 | 84 | 1591 | -136 | 1660 |
| 10-#10 | 7.06 | MA | 1521 | 988 | 2494 | 691 | 2710 | 569 | 2857 | 452 | 3092 | 249 | 3617 | -53 | 3591 |
| 5L-2S | | MI | 847 | 988 | 1518 | 598 | 1593 | 458 | 1648 | 333 | 1751 | 109 | 1808 | -89 | 1842 |

## RECTANGULAR TIED COLUMNS 10" x 20"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.20 | MA | 1551 | 774 | 2479 | 550 | 2618 | 463 | 2662 | 396 | 2663 | 295 | 2982 | 253 | 1129 |
| 2E | | MI | 750 | 774 | 1217 | 483 | 1216 | 404 | 1189 | 340 | 1122 | 243 | 1156 | 183 | 564 |
| 4-#8 | 1.58 | MA | 1592 | 795 | 2580 | 561 | 2743 | 471 | 2813 | 400 | 2867 | 293 | 3246 | 247 | 1449 |
| 2E | | MI | 762 | 795 | 1248 | 493 | 1250 | 408 | 1227 | 340 | 1171 | 233 | 1205 | 163 | 694 |
| 4-#9 | 2.00 | MA | 1636 | 818 | 2689 | 574 | 2879 | 480 | 2977 | 405 | 3090 | 290 | 3529 | 240 | 1796 |
| 2E | | MI | 775 | 818 | 1278 | 502 | 1284 | 413 | 1266 | 339 | 1221 | 222 | 1253 | 139 | 829 |
| 4-#10 | 2.54 | MA | 1691 | 848 | 2826 | 590 | 3051 | 492 | 3186 | 412 | 3373 | 286 | 3883 | 231 | 2234 |
| 2E | | MI | 791 | 848 | 1314 | 515 | 1324 | 418 | 1313 | 338 | 1280 | 207 | 1308 | 107 | 993 |
| 4-#11 | 3.12 | MA | 1742 | 880 | 2963 | 605 | 3215 | 501 | 3381 | 417 | 3637 | 280 | 4165 | 213 | 2671 |
| 2E | | MI | 802 | 880 | 1325 | 516 | 1332 | 413 | 1320 | 326 | 1291 | 179 | 1288 | 52 | 1145 |
| 6-#6 | 1.32 | MA | 1566 | 780 | 2512 | 556 | 2663 | 468 | 2719 | 399 | 2740 | 296 | 3095 | 254 | 1234 |
| 2L-3S | | MI | 744 | 780 | 1189 | 490 | 1186 | 412 | 1155 | 347 | 1078 | 246 | 1111 | 152 | 609 |
| 6-#6 | 1.32 | MA | 1524 | 780 | 2394 | 558 | 2512 | 474 | 2534 | 405 | 2489 | 300 | 2755 | 223 | 1243 |
| 3L-2S | | MI | 756 | 780 | 1230 | 491 | 1238 | 410 | 1215 | 345 | 1155 | 244 | 1198 | 183 | 604 |
| 6-#7 | 1.80 | MA | 1618 | 807 | 2639 | 570 | 2823 | 478 | 2912 | 405 | 3002 | 293 | 3438 | 247 | 1640 |
| 2L-3S | | MI | 756 | 807 | 1217 | 507 | 1216 | 420 | 1189 | 349 | 1122 | 236 | 1156 | 118 | 778 |
| 6-#7 | 1.80 | MA | 1563 | 807 | 2479 | 574 | 2618 | 486 | 2662 | 412 | 2663 | 298 | 2982 | 205 | 1651 |
| 3L-2S | | MI | 772 | 807 | 1272 | 504 | 1284 | 417 | 1268 | 346 | 1222 | 233 | 1268 | 160 | 767 |
| 6-#8 | 2.37 | MA | 1608 | 838 | 2580 | 593 | 2743 | 501 | 2813 | 422 | 2867 | 296 | 3246 | 184 | 2123 |
| 3L-2S | | MI | 790 | 838 | 1320 | 520 | 1335 | 425 | 1327 | 347 | 1298 | 220 | 1345 | 131 | 948 |
| 6-#9 | 3.00 | MA | 1656 | 873 | 2689 | 614 | 2879 | 518 | 2977 | 432 | 3090 | 294 | 3529 | 159 | 2630 |
| 3L-2S | | MI | 809 | 873 | 1365 | 536 | 1387 | 434 | 1387 | 347 | 1375 | 204 | 1419 | 96 | 1137 |

## RECTANGULAR TIED COLUMNS 10" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 3.81 | MA | 1718 | 918 | 2826 | 641 | 3051 | 539 | 3186 | 445 | 3373 | 291 | 3883 | 127 | 3262 |
| 3L-2S | | MI | 833 | 918 | 1419 | 557 | 1450 | 444 | 1459 | 347 | 1467 | 183 | 1505 | 49 | 1365 |
| 6-#11 | 4.68 | MA | 1775 | 966 | 2963 | 665 | 3215 | 558 | 3381 | 456 | 3637 | 284 | 4165 | 80 | 3880 |
| 3L-2S | | MI | 850 | 966 | 1437 | 565 | 1465 | 441 | 1475 | 332 | 1491 | 144 | 1484 | -31 | 1504 |
| 8-#5 | 1.24 | MA | 1529 | 776 | 2406 | 557 | 2532 | 472 | 2560 | 403 | 2526 | 301 | 2811 | 235 | 1173 |
| 3E | | MI | 746 | 776 | 1195 | 491 | 1199 | 414 | 1170 | 349 | 1098 | 250 | 1137 | 168 | 578 |
| 8-#5 | 1.24 | MA | 1515 | 776 | 2342 | 561 | 2449 | 473 | 2458 | 404 | 2393 | 304 | 2641 | 222 | 1181 |
| 4L-2S | | MI | 754 | 776 | 1225 | 492 | 1236 | 412 | 1214 | 348 | 1154 | 249 | 1201 | 191 | 575 |
| 8-#6 | 1.76 | MA | 1575 | 805 | 2512 | 573 | 2663 | 485 | 2719 | 411 | 2740 | 298 | 3095 | 219 | 1619 |
| 3E | | MI | 760 | 805 | 1230 | 505 | 1238 | 422 | 1215 | 352 | 1155 | 240 | 1198 | 136 | 762 |
| 8-#6 | 1.76 | MA | 1555 | 805 | 2421 | 580 | 2546 | 487 | 2574 | 413 | 2553 | 303 | 2858 | 202 | 1626 |
| 4L-2S | | MI | 772 | 805 | 1272 | 506 | 1289 | 421 | 1275 | 350 | 1232 | 238 | 1285 | 167 | 754 |
| 8-#7 | 2.40 | MA | 1631 | 840 | 2639 | 595 | 2823 | 501 | 2912 | 421 | 3002 | 296 | 3438 | 200 | 2154 |
| 3E | | MI | 778 | 840 | 1272 | 528 | 1284 | 433 | 1268 | 355 | 1222 | 227 | 1268 | 95 | 973 |
| 8-#7 | 2.40 | MA | 1605 | 840 | 2516 | 603 | 2664 | 504 | 2717 | 423 | 2748 | 302 | 3119 | 177 | 2153 |
| 4L-2S | | MI | 793 | 840 | 1328 | 525 | 1351 | 431 | 1347 | 352 | 1323 | 224 | 1380 | 137 | 961 |
| 8-#8 | 3.16 | MA | 1663 | 882 | 2627 | 631 | 2802 | 524 | 2883 | 436 | 2978 | 300 | 3422 | 146 | 2684 |
| 4L-2S | | MI | 818 | 882 | 1391 | 547 | 1421 | 442 | 1426 | 354 | 1425 | 207 | 1484 | 99 | 1192 |
| 8-#9 | 4.00 | MA | 1726 | 929 | 2748 | 662 | 2952 | 546 | 3065 | 449 | 3228 | 298 | 3747 | 111 | 3205 |
| 4L-2S | | MI | 843 | 929 | 1452 | 570 | 1491 | 455 | 1507 | 355 | 1529 | 186 | 1585 | 53 | 1433 |
| 8-#10 | 5.08 | MA | 1806 | 988 | 2901 | 702 | 3143 | 575 | 3296 | 467 | 3546 | 296 | 4154 | 65 | 3847 |
| 4L-2S | | MI | 875 | 988 | 1524 | 599 | 1575 | 470 | 1605 | 356 | 1654 | 159 | 1702 | -9 | 1706 |
| 8-#11 | 6.24 | MA | 1882 | 1052 | 3050 | 740 | 3323 | 601 | 3510 | 481 | 3841 | 288 | 4475 | 4 | 4459 |
| 4L-2S | | MI | 897 | 1052 | 1548 | 614 | 1599 | 469 | 1631 | 339 | 1690 | 109 | 1681 | -114 | 1742 |
| 10-#10 | 6.35 | MA | 1850 | 1059 | 3015 | 752 | 3279 | 622 | 3454 | 500 | 3720 | 290 | 4432 | -1 | 4431 |
| 5L-2S | | MI | 917 | 1059 | 1629 | 641 | 1700 | 495 | 1750 | 365 | 1841 | 135 | 1899 | -67 | 1927 |

## RECTANGULAR TIED COLUMNS 12" x 12"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.29 | MA | 660 | 561 | 1074 | 370 | 1104 | 312 | 1105 | 266 | 1071 | 193 | 1126 | 149 | 511 |
| 2L-3S | | MI | 647 | 561 | 1033 | 371 | 1051 | 314 | 1041 | 267 | 988 | 194 | 1032 | 127 | 515 |
| 6-#6 | 1.83 | MA | 680 | 582 | 1123 | 382 | 1165 | 319 | 1178 | 270 | 1162 | 187 | 1226 | 135 | 683 |
| 2L-3S | | MI | 662 | 582 | 1066 | 382 | 1092 | 322 | 1089 | 272 | 1049 | 189 | 1097 | 104 | 692 |
| 6-#7 | 2.50 | MA | 703 | 609 | 1182 | 396 | 1238 | 330 | 1264 | 274 | 1271 | 180 | 1342 | 116 | 884 |
| 2L-3S | | MI | 679 | 609 | 1105 | 396 | 1140 | 333 | 1145 | 277 | 1120 | 183 | 1174 | 74 | 897 |
| 6-#8 | 3.29 | MA | 729 | 640 | 1250 | 414 | 1324 | 342 | 1361 | 280 | 1395 | 172 | 1526 | 108 | 1114 |
| 2L-3S | | MI | 700 | 640 | 1151 | 413 | 1197 | 346 | 1209 | 283 | 1202 | 175 | 1294 | 47 | 1129 |
| 6-#9 | 4.17 | MA | 757 | 675 | 1323 | 433 | 1415 | 356 | 1462 | 285 | 1525 | 161 | 1672 | 84 | 1358 |
| 2L-3S | | MI | 722 | 675 | 1200 | 432 | 1257 | 361 | 1276 | 289 | 1287 | 166 | 1390 | 8 | 1371 |
| 6-#10 | 5.29 | MA | 791 | 720 | 1414 | 459 | 1530 | 374 | 1587 | 291 | 1684 | 147 | 1848 | 52 | 1659 |
| 2L-3S | | MI | 748 | 720 | 1261 | 457 | 1333 | 379 | 1358 | 297 | 1392 | 153 | 1506 | -45 | 1450 |

## RECTANGULAR TIED COLUMNS 12" x 14"

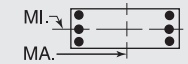
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#6 | 1.05 | MA | 891 | 643 | 1433 | 436 | 1479 | 367 | 1479 | 314 | 1441 | 235 | 1531 | 191 | 583 |
| 2E | | MI | 759 | 643 | 1224 | 423 | 1249 | 356 | 1241 | 305 | 1185 | 224 | 1237 | 177 | 503 |
| 4-#7 | 1.43 | MA | 911 | 660 | 1485 | 444 | 1542 | 373 | 1555 | 318 | 1539 | 232 | 1644 | 181 | 759 |
| 2E | | MI | 774 | 660 | 1264 | 431 | 1298 | 362 | 1297 | 307 | 1256 | 219 | 1313 | 164 | 647 |
| 4-#8 | 1.88 | MA | 934 | 681 | 1544 | 455 | 1615 | 381 | 1644 | 322 | 1653 | 227 | 1772 | 169 | 959 |
| 2E | | MI | 792 | 681 | 1310 | 442 | 1354 | 369 | 1360 | 310 | 1337 | 213 | 1433 | 158 | 809 |
| 4-#9 | 2.38 | MA | 959 | 705 | 1608 | 468 | 1695 | 390 | 1740 | 327 | 1774 | 222 | 1906 | 155 | 1174 |
| 2E | | MI | 810 | 705 | 1359 | 454 | 1414 | 378 | 1427 | 312 | 1422 | 205 | 1528 | 142 | 981 |
| 4-#10 | 3.02 | MA | 990 | 735 | 1688 | 484 | 1795 | 401 | 1861 | 333 | 1924 | 215 | 2071 | 136 | 1440 |
| 2E | | MI | 833 | 735 | 1419 | 470 | 1490 | 389 | 1509 | 316 | 1527 | 195 | 1643 | 120 | 1193 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 14"

Short columns – no sidesway
Bending on major or minor axis

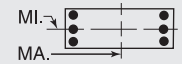



$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 3.71 | MA | 1016 | 767 | 1760 | 497 | 1879 | 410 | 1952 | 335 | 2027 | 200 | 2158 | 103 | 1695 |
| 2E | | MI | 851 | 767 | 1469 | 482 | 1529 | 391 | 1552 | 311 | 1583 | 175 | 1680 | 80 | 1392 |
| 4-#14 | 5.36 | MA | 1086 | 843 | 1944 | 540 | 2110 | 440 | 2207 | 345 | 2352 | 177 | 2603 | 69 | 2306 |
| 2E | | MI | 902 | 843 | 1604 | 524 | 1673 | 412 | 1718 | 314 | 1795 | 143 | 1890 | 8 | 1861 |
| 6-#5 | 1.11 | MA | 895 | 646 | 1442 | 439 | 1492 | 370 | 1497 | 317 | 1468 | 237 | 1567 | 192 | 611 |
| 2L-3S | | MI | 749 | 646 | 1191 | 427 | 1209 | 362 | 1193 | 309 | 1126 | 227 | 1173 | 157 | 529 |
| 6-#5 | 1.11 | MA | 878 | 646 | 1390 | 440 | 1426 | 373 | 1417 | 319 | 1359 | 238 | 1437 | 171 | 616 |
| 3L-2S | | MI | 762 | 646 | 1232 | 427 | 1261 | 360 | 1257 | 308 | 1208 | 226 | 1267 | 179 | 525 |
| 6-#6 | 1.57 | MA | 920 | 667 | 1506 | 451 | 1571 | 378 | 1592 | 321 | 1593 | 233 | 1712 | 182 | 825 |
| 2L-3S | | MI | 763 | 667 | 1224 | 438 | 1249 | 370 | 1241 | 313 | 1185 | 222 | 1237 | 133 | 708 |
| 6-#6 | 1.57 | MA | 896 | 667 | 1433 | 452 | 1479 | 382 | 1479 | 324 | 1441 | 235 | 1531 | 151 | 834 |
| 3L-2S | | MI | 782 | 667 | 1281 | 438 | 1322 | 367 | 1330 | 312 | 1299 | 220 | 1366 | 164 | 700 |
| 6-#7 | 2.14 | MA | 950 | 694 | 1582 | 465 | 1666 | 388 | 1707 | 327 | 1743 | 228 | 1883 | 168 | 1079 |
| 2L-3S | | MI | 781 | 694 | 1264 | 452 | 1298 | 381 | 1297 | 318 | 1256 | 216 | 1313 | 103 | 918 |
| 6-#7 | 2.14 | MA | 919 | 694 | 1485 | 466 | 1542 | 394 | 1555 | 331 | 1539 | 231 | 1644 | 125 | 1092 |
| 3L-2S | | MI | 805 | 694 | 1341 | 452 | 1396 | 377 | 1415 | 316 | 1407 | 213 | 1482 | 145 | 905 |
| 6-#8 | 2.82 | MA | 985 | 725 | 1670 | 483 | 1777 | 401 | 1842 | 334 | 1915 | 222 | 2077 | 150 | 1370 |
| 2L-3S | | MI | 802 | 725 | 1310 | 468 | 1354 | 393 | 1360 | 324 | 1337 | 208 | 1433 | 76 | 1155 |
| 6-#8 | 2.82 | MA | 944 | 725 | 1544 | 484 | 1615 | 407 | 1644 | 339 | 1653 | 226 | 1772 | 94 | 1385 |
| 3L-2S | | MI | 831 | 725 | 1409 | 469 | 1481 | 389 | 1512 | 321 | 1531 | 204 | 1664 | 136 | 1138 |
| 6-#9 | 3.57 | MA | 1023 | 760 | 1766 | 502 | 1897 | 414 | 1987 | 342 | 2098 | 215 | 2281 | 129 | 1682 |
| 2L-3S | | MI | 823 | 760 | 1359 | 487 | 1414 | 408 | 1427 | 330 | 1422 | 198 | 1528 | 36 | 1403 |
| 6-#9 | 3.57 | MA | 972 | 760 | 1608 | 504 | 1695 | 422 | 1740 | 348 | 1774 | 219 | 1906 | 59 | 1695 |
| 3L-2S | | MI | 859 | 760 | 1482 | 488 | 1572 | 402 | 1613 | 326 | 1660 | 194 | 1810 | 113 | 1385 |
| 6-#10 | 4.54 | MA | 1070 | 805 | 1885 | 528 | 2047 | 432 | 2169 | 352 | 2325 | 205 | 2530 | 101 | 2070 |
| 2L-3S | | MI | 850 | 805 | 1419 | 511 | 1490 | 426 | 1509 | 337 | 1527 | 185 | 1643 | -17 | 1642 |
| 6-#10 | 4.54 | MA | 1007 | 805 | 1688 | 529 | 1795 | 442 | 1861 | 359 | 1924 | 211 | 2071 | 12 | 2045 |
| 3L-2S | | MI | 893 | 805 | 1573 | 513 | 1686 | 420 | 1737 | 332 | 1819 | 180 | 1985 | 80 | 1690 |
| 6-#11 | 5.57 | MA | 1037 | 853 | 1760 | 551 | 1879 | 458 | 1952 | 364 | 2027 | 192 | 2158 | -57 | 2147 |
| 3L-2S | | MI | 920 | 853 | 1647 | 536 | 1748 | 427 | 1807 | 327 | 1908 | 153 | 2048 | 23 | 1966 |
| 8-#5 | 1.48 | MA | 916 | 663 | 1494 | 450 | 1559 | 378 | 1578 | 322 | 1578 | 235 | 1698 | 186 | 783 |
| 2L-4S | | MI | 760 | 663 | 1199 | 441 | 1219 | 369 | 1205 | 313 | 1145 | 226 | 1198 | 140 | 678 |
| 8-#5 | 1.48 | MA | 899 | 663 | 1442 | 451 | 1492 | 381 | 1497 | 324 | 1468 | 237 | 1567 | 164 | 789 |
| 3E | | MI | 766 | 663 | 1232 | 438 | 1261 | 370 | 1257 | 314 | 1208 | 225 | 1267 | 148 | 671 |
| 8-#5 | 1.48 | MA | 892 | 663 | 1401 | 455 | 1440 | 381 | 1433 | 324 | 1384 | 238 | 1474 | 155 | 797 |
| 4L-2S | | MI | 779 | 663 | 1273 | 438 | 1314 | 367 | 1321 | 312 | 1291 | 223 | 1361 | 170 | 665 |
| 8-#6 | 2.10 | MA | 950 | 691 | 1578 | 466 | 1664 | 389 | 1705 | 328 | 1745 | 231 | 1892 | 172 | 1062 |
| 2L-4S | | MI | 778 | 691 | 1236 | 457 | 1263 | 380 | 1262 | 322 | 1212 | 220 | 1271 | 109 | 911 |
| 8-#6 | 2.10 | MA | 926 | 691 | 1506 | 467 | 1571 | 393 | 1592 | 331 | 1593 | 233 | 1712 | 141 | 1070 |
| 3E | | MI | 786 | 691 | 1281 | 453 | 1322 | 381 | 1330 | 320 | 1299 | 218 | 1366 | 120 | 900 |
| 8-#6 | 2.10 | MA | 916 | 691 | 1448 | 472 | 1497 | 393 | 1502 | 330 | 1477 | 235 | 1582 | 128 | 1081 |
| 4L-2S | | MI | 804 | 691 | 1339 | 453 | 1395 | 378 | 1419 | 318 | 1413 | 216 | 1495 | 151 | 891 |
| 8-#7 | 2.86 | MA | 958 | 727 | 1582 | 487 | 1666 | 409 | 1707 | 340 | 1743 | 227 | 1883 | 111 | 1403 |
| 3E | | MI | 811 | 727 | 1341 | 472 | 1396 | 396 | 1415 | 327 | 1407 | 210 | 1482 | 84 | 1169 |
| 8-#7 | 2.86 | MA | 945 | 727 | 1505 | 494 | 1567 | 409 | 1585 | 339 | 1587 | 230 | 1710 | 94 | 1392 |
| 4L-2S | | MI | 835 | 727 | 1417 | 473 | 1494 | 392 | 1533 | 324 | 1559 | 207 | 1651 | 126 | 1157 |
| 8-#8 | 3.76 | MA | 996 | 769 | 1670 | 511 | 1777 | 427 | 1842 | 351 | 1915 | 220 | 2077 | 75 | 1784 |
| 3E | | MI | 842 | 769 | 1409 | 496 | 1481 | 413 | 1512 | 335 | 1531 | 200 | 1664 | 55 | 1473 |
| 8-#8 | 3.76 | MA | 978 | 769 | 1570 | 520 | 1647 | 427 | 1682 | 349 | 1715 | 224 | 1856 | 53 | 1680 |
| 4L-2S | | MI | 870 | 769 | 1508 | 496 | 1608 | 409 | 1663 | 332 | 1724 | 196 | 1896 | 115 | 1460 |
| 8-#9 | 4.76 | MA | 1036 | 815 | 1766 | 538 | 1897 | 447 | 1987 | 363 | 2098 | 212 | 2281 | 33 | 2187 |
| 3E | | MI | 873 | 815 | 1482 | 522 | 1572 | 432 | 1613 | 343 | 1660 | 187 | 1810 | 7 | 1792 |
| 8-#9 | 4.76 | MA | 1014 | 815 | 1640 | 548 | 1734 | 446 | 1787 | 360 | 1851 | 217 | 2008 | 6 | 1989 |
| 4L-2S | | MI | 907 | 815 | 1605 | 523 | 1730 | 427 | 1799 | 339 | 1898 | 183 | 2091 | 84 | 1781 |
| 8-#10 | 6.05 | MA | 1087 | 875 | 1885 | 573 | 2047 | 474 | 2169 | 378 | 2325 | 201 | 2530 | -23 | 2520 |
| 3E | | MI | 912 | 875 | 1573 | 555 | 1686 | 457 | 1737 | 353 | 1819 | 170 | 1985 | -56 | 1899 |

## RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

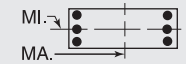
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.25 | MA | 1184 | 745 | 1912 | 513 | 1995 | 432 | 2016 | 369 | 2001 | 274 | 2172 | 225 | 888 |
| 2E | | MI | 876 | 745 | 1423 | 487 | 1455 | 410 | 1448 | 349 | 1393 | 252 | 1452 | 193 | 663 |
| 4-#8 | 1.65 | MA | 1213 | 766 | 1985 | 524 | 2086 | 440 | 2125 | 373 | 2149 | 271 | 2344 | 215 | 1130 |
| 2E | | MI | 894 | 766 | 1469 | 497 | 1511 | 417 | 1511 | 351 | 1473 | 245 | 1572 | 187 | 829 |
| 4-#9 | 2.08 | MA | 1244 | 790 | 2064 | 537 | 2184 | 448 | 2243 | 378 | 2310 | 268 | 2527 | 204 | 1390 |
| 2E | | MI | 912 | 790 | 1518 | 509 | 1571 | 425 | 1578 | 353 | 1558 | 238 | 1666 | 170 | 1004 |
| 4-#10 | 2.65 | MA | 1283 | 819 | 2164 | 553 | 2308 | 460 | 2393 | 384 | 2511 | 263 | 2753 | 189 | 1715 |
| 2E | | MI | 935 | 819 | 1578 | 524 | 1647 | 435 | 1659 | 356 | 1662 | 227 | 1780 | 148 | 1219 |
| 4-#11 | 3.25 | MA | 1318 | 852 | 2258 | 566 | 2419 | 468 | 2525 | 388 | 2661 | 252 | 2901 | 162 | 2032 |
| 2E | | MI | 953 | 852 | 1628 | 535 | 1685 | 436 | 1701 | 350 | 1716 | 207 | 1815 | 108 | 1423 |
| 4-#14 | 4.69 | MA | 1409 | 928 | 2491 | 609 | 2712 | 499 | 2880 | 405 | 3102 | 234 | 3385 | 114 | 2792 |
| 2E | | MI | 1004 | 928 | 1763 | 576 | 1828 | 457 | 1866 | 353 | 1927 | 174 | 2023 | 36 | 1901 |
| 6-#6 | 1.38 | MA | 1195 | 752 | 1936 | 520 | 2030 | 437 | 2059 | 372 | 2061 | 275 | 2255 | 225 | 968 |
| 2L-3S | | MI | 865 | 752 | 1383 | 494 | 1407 | 418 | 1393 | 355 | 1322 | 255 | 1377 | 162 | 724 |
| 6-#6 | 1.38 | MA | 1166 | 752 | 1849 | 521 | 1918 | 442 | 1922 | 377 | 1875 | 278 | 2022 | 194 | 977 |
| 3L-2S | | MI | 883 | 752 | 1440 | 494 | 1480 | 415 | 1482 | 353 | 1436 | 253 | 1506 | 193 | 717 |
| 6-#7 | 1.88 | MA | 1233 | 779 | 2030 | 534 | 2147 | 447 | 2200 | 378 | 2252 | 271 | 2482 | 214 | 1273 |
| 2L-3S | | MI | 882 | 779 | 1423 | 507 | 1455 | 428 | 1448 | 360 | 1393 | 249 | 1452 | 132 | 938 |
| 6-#7 | 1.88 | MA | 1193 | 779 | 1912 | 536 | 1995 | 454 | 2016 | 384 | 2001 | 275 | 2172 | 172 | 1286 |
| 3L-2S | | MI | 907 | 779 | 1499 | 508 | 1553 | 425 | 1567 | 357 | 1544 | 246 | 1621 | 174 | 925 |
| 6-#8 | 2.47 | MA | 1276 | 810 | 2139 | 552 | 2283 | 460 | 2365 | 385 | 2476 | 268 | 2743 | 201 | 1626 |
| 2L-3S | | MI | 902 | 810 | 1469 | 524 | 1511 | 441 | 1511 | 365 | 1473 | 241 | 1572 | 105 | 1179 |
| 6-#8 | 2.47 | MA | 1225 | 810 | 1985 | 554 | 2086 | 468 | 2125 | 392 | 2149 | 272 | 2344 | 145 | 1641 |
| 3L-2S | | MI | 933 | 810 | 1568 | 524 | 1638 | 436 | 1663 | 362 | 1667 | 237 | 1803 | 165 | 1161 |
| 6-#9 | 3.13 | MA | 1323 | 845 | 2257 | 571 | 2431 | 473 | 2544 | 393 | 2719 | 263 | 3019 | 185 | 2006 |
| 2L-3S | | MI | 925 | 845 | 1518 | 542 | 1571 | 454 | 1578 | 371 | 1558 | 231 | 1666 | 65 | 1432 |
| 6-#9 | 3.13 | MA | 1260 | 845 | 2064 | 574 | 2184 | 483 | 2243 | 401 | 2310 | 268 | 2527 | 114 | 2019 |
| 3L-2S | | MI | 961 | 845 | 1641 | 543 | 1729 | 449 | 1764 | 366 | 1795 | 226 | 1948 | 141 | 1412 |
| 6-#10 | 3.97 | MA | 1381 | 890 | 2405 | 597 | 2617 | 491 | 2770 | 403 | 3022 | 258 | 3362 | 163 | 2482 |
| 2L-3S | | MI | 952 | 890 | 1578 | 566 | 1647 | 472 | 1659 | 378 | 1662 | 218 | 1780 | 12 | 1741 |
| 6-#10 | 3.97 | MA | 1303 | 890 | 2164 | 600 | 2308 | 504 | 2393 | 413 | 2511 | 263 | 2753 | 73 | 2487 |
| 3L-2S | | MI | 995 | 890 | 1732 | 568 | 1843 | 467 | 1887 | 372 | 1954 | 212 | 2122 | 109 | 1720 |
| 6-#11 | 4.88 | MA | 1342 | 938 | 2258 | 623 | 2419 | 520 | 2525 | 422 | 2661 | 249 | 2901 | 14 | 2866 |
| 3L-2S | | MI | 1021 | 938 | 1806 | 589 | 1904 | 472 | 1956 | 367 | 2042 | 184 | 2183 | 51 | 2003 |
| 6-#14 | 7.03 | MA | 1443 | 1052 | 2491 | 689 | 2712 | 572 | 2880 | 451 | 3102 | 227 | 3385 | -105 | 3336 |
| 3L-2S | | MI | 1098 | 1052 | 2008 | 654 | 2121 | 506 | 2206 | 373 | 2363 | 137 | 2501 | -56 | 2519 |
| 8-#5 | 1.29 | MA | 1190 | 748 | 1921 | 519 | 2014 | 437 | 2041 | 373 | 2036 | 276 | 2233 | 229 | 917 |
| 2L-4S | | MI | 862 | 748 | 1358 | 497 | 1377 | 417 | 1357 | 354 | 1282 | 260 | 1338 | 169 | 692 |
| 8-#5 | 1.29 | MA | 1169 | 748 | 1859 | 520 | 1934 | 441 | 1943 | 376 | 1904 | 278 | 2065 | 207 | 923 |
| 3E | | MI | 867 | 748 | 1391 | 494 | 1419 | 418 | 1409 | 356 | 1345 | 258 | 1407 | 177 | 685 |
| 8-#5 | 1.29 | MA | 1160 | 748 | 1810 | 524 | 1871 | 441 | 1866 | 376 | 1803 | 281 | 1946 | 196 | 930 |
| 4L-2S | | MI | 880 | 748 | 1431 | 494 | 1471 | 416 | 1473 | 354 | 1428 | 257 | 1502 | 199 | 681 |
| 8-#6 | 1.83 | MA | 1232 | 776 | 2024 | 535 | 2142 | 448 | 2196 | 379 | 2247 | 273 | 2488 | 218 | 1252 |
| 2L-4S | | MI | 880 | 776 | 1394 | 513 | 1421 | 428 | 1414 | 364 | 1349 | 253 | 1411 | 138 | 930 |
| 8-#6 | 1.83 | MA | 1202 | 776 | 1936 | 537 | 2030 | 453 | 2059 | 383 | 2061 | 276 | 2255 | 187 | 1261 |
| 3E | | MI | 888 | 776 | 1440 | 509 | 1480 | 429 | 1482 | 362 | 1436 | 251 | 1506 | 149 | 919 |
| 8-#6 | 1.83 | MA | 1190 | 776 | 1868 | 542 | 1942 | 454 | 1951 | 384 | 1920 | 278 | 2090 | 172 | 1271 |
| 4L-2S | | MI | 906 | 776 | 1497 | 509 | 1553 | 426 | 1571 | 360 | 1550 | 250 | 1635 | 180 | 910 |
| 8-#7 | 2.50 | MA | 1242 | 812 | 2030 | 557 | 2147 | 469 | 2200 | 393 | 2252 | 272 | 2482 | 162 | 1663 |
| 3E | | MI | 913 | 812 | 1499 | 528 | 1553 | 443 | 1567 | 369 | 1544 | 243 | 1621 | 113 | 1192 |
| 8-#7 | 2.50 | MA | 1226 | 812 | 1938 | 564 | 2027 | 470 | 2053 | 393 | 2061 | 276 | 2261 | 142 | 1670 |
| 4L-2S | | MI | 937 | 812 | 1576 | 528 | 1651 | 439 | 1685 | 366 | 1695 | 240 | 1790 | 155 | 1179 |
| 8-#8 | 3.29 | MA | 1289 | 854 | 2139 | 582 | 2283 | 487 | 2365 | 404 | 2476 | 268 | 2743 | 131 | 2125 |
| 3E | | MI | 943 | 854 | 1568 | 551 | 1638 | 460 | 1663 | 376 | 1667 | 232 | 1803 | 83 | 1500 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

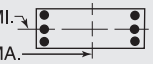
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#8 | 3.29 | MA | 1268 | 854 | 2018 | 591 | 2127 | 489 | 2174 | 404 | 2227 | 272 | 2458 | 105 | 2043 |
| 4L-2S | | MI | 972 | 854 | 1667 | 552 | 1765 | 456 | 1814 | 373 | 1860 | 229 | 2034 | 144 | 1486 |
| 8-#9 | 4.17 | MA | 1339 | 900 | 2257 | 609 | 2431 | 508 | 2544 | 416 | 2719 | 264 | 3019 | 95 | 2619 |
| 3E | | MI | 974 | 900 | 1641 | 577 | 1729 | 479 | 1764 | 384 | 1795 | 220 | 1948 | 36 | 1825 |
| 8-#9 | 4.17 | MA | 1313 | 900 | 2105 | 621 | 2235 | 509 | 2304 | 416 | 2407 | 269 | 2666 | 63 | 2426 |
| 4L-2S | | MI | 1009 | 900 | 1764 | 578 | 1887 | 474 | 1950 | 380 | 2033 | 215 | 2229 | 112 | 1810 |
| 8-#10 | 5.29 | MA | 1403 | 960 | 2405 | 644 | 2617 | 535 | 2770 | 432 | 3022 | 257 | 3362 | 47 | 3231 |
| 3E | | MI | 1013 | 960 | 1732 | 610 | 1843 | 504 | 1887 | 394 | 1954 | 202 | 2122 | -28 | 2120 |
| 8-#10 | 5.29 | MA | 1369 | 960 | 2215 | 659 | 2371 | 536 | 2469 | 431 | 2631 | 263 | 2924 | 8 | 2894 |
| 4L-2S | | MI | 1055 | 960 | 1885 | 612 | 2040 | 498 | 2116 | 388 | 2245 | 196 | 2464 | 69 | 2211 |
| 10-#10 | 6.61 | MA | 1470 | 1030 | 2456 | 703 | 2680 | 568 | 2846 | 450 | 3143 | 257 | 3533 | -18 | 3524 |
| 4L-3S | | MI | 1074 | 1030 | 1885 | 653 | 2040 | 535 | 2116 | 409 | 2245 | 187 | 2464 | -67 | 2348 |

## RECTANGULAR TIED COLUMNS 12" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.11 | MA | 1492 | 830 | 2388 | 582 | 2501 | 491 | 2529 | 420 | 2505 | 315 | 2756 | 266 | 1018 |
| 2E | | MI | 978 | 830 | 1582 | 542 | 1612 | 457 | 1600 | 390 | 1529 | 285 | 1591 | 222 | 679 |
| 4-#8 | 1.46 | MA | 1527 | 851 | 2475 | 593 | 2609 | 499 | 2659 | 424 | 2681 | 312 | 2973 | 258 | 1301 |
| 2E | | MI | 996 | 851 | 1628 | 552 | 1668 | 464 | 1663 | 392 | 1609 | 278 | 1710 | 215 | 847 |
| 4-#9 | 1.85 | MA | 1564 | 874 | 2569 | 606 | 2726 | 507 | 2800 | 429 | 2873 | 309 | 3205 | 249 | 1606 |
| 2E | | MI | 1014 | 874 | 1677 | 564 | 1728 | 471 | 1728 | 394 | 1693 | 270 | 1804 | 199 | 1025 |
| 4-#10 | 2.35 | MA | 1611 | 904 | 2688 | 622 | 2874 | 519 | 2979 | 435 | 3116 | 305 | 3494 | 238 | 1989 |
| 2E | | MI | 1037 | 904 | 1737 | 579 | 1803 | 482 | 1809 | 397 | 1796 | 260 | 1917 | 176 | 1244 |
| 4-#11 | 2.89 | MA | 1654 | 936 | 2804 | 635 | 3012 | 527 | 3142 | 439 | 3336 | 298 | 3707 | 215 | 2369 |
| 2E | | MI | 1054 | 936 | 1788 | 589 | 1841 | 482 | 1851 | 390 | 1849 | 239 | 1950 | 136 | 1453 |
| 4-#14 | 4.17 | MA | 1765 | 1013 | 3087 | 678 | 3366 | 557 | 3571 | 456 | 3908 | 288 | 4348 | 177 | 3278 |
| 2E | | MI | 1106 | 1013 | 1922 | 629 | 1984 | 502 | 2014 | 392 | 2059 | 206 | 2157 | 63 | 1938 |
| 4-#18 | 7.41 | MA | 2029 | 1206 | 3761 | 789 | 4215 | 636 | 4601 | 502 | 5199 | 248 | 5777 | 60 | 5431 |
| 2E | | MI | 1222 | 1206 | 2169 | 716 | 2270 | 543 | 2345 | 388 | 2485 | 107 | 2519 | -156 | 2601 |
| 6-#6 | 1.22 | MA | 1505 | 837 | 2416 | 589 | 2541 | 496 | 2579 | 424 | 2574 | 316 | 2855 | 267 | 1110 |
| 2L-3S | | MI | 967 | 837 | 1542 | 550 | 1564 | 466 | 1545 | 397 | 1459 | 289 | 1517 | 191 | 738 |
| 6-#6 | 1.22 | MA | 1469 | 837 | 2313 | 591 | 2410 | 501 | 2418 | 429 | 2356 | 319 | 2569 | 236 | 1119 |
| 3L-2S | | MI | 985 | 837 | 1599 | 550 | 1637 | 463 | 1634 | 395 | 1573 | 287 | 1646 | 222 | 732 |
| 6-#7 | 1.67 | MA | 1550 | 863 | 2526 | 603 | 2679 | 506 | 2746 | 429 | 2801 | 312 | 3139 | 258 | 1468 |
| 2L-3S | | MI | 984 | 863 | 1582 | 563 | 1612 | 476 | 1600 | 401 | 1529 | 282 | 1591 | 161 | 956 |
| 6-#7 | 1.67 | MA | 1502 | 863 | 2388 | 606 | 2501 | 513 | 2529 | 436 | 2505 | 317 | 2756 | 216 | 1480 |
| 3L-2S | | MI | 1009 | 863 | 1658 | 563 | 1711 | 472 | 1718 | 399 | 1680 | 279 | 1760 | 203 | 944 |
| 6-#8 | 2.19 | MA | 1602 | 895 | 2656 | 621 | 2841 | 518 | 2942 | 436 | 3066 | 308 | 3468 | 248 | 1882 |
| 2L-3S | | MI | 1004 | 895 | 1628 | 579 | 1668 | 488 | 1663 | 406 | 1609 | 273 | 1710 | 133 | 1201 |
| 6-#8 | 2.19 | MA | 1541 | 895 | 2475 | 624 | 2609 | 528 | 2659 | 445 | 2681 | 314 | 2973 | 192 | 1897 |
| 3L-2S | | MI | 1035 | 895 | 1727 | 580 | 1795 | 483 | 1814 | 403 | 1802 | 270 | 1941 | 194 | 1183 |
| 6-#9 | 2.78 | MA | 1658 | 930 | 2796 | 640 | 3017 | 532 | 3155 | 444 | 3356 | 304 | 3818 | 235 | 2330 |
| 2L-3S | | MI | 1027 | 930 | 1677 | 597 | 1728 | 501 | 1728 | 412 | 1693 | 263 | 1804 | 93 | 1459 |
| 6-#9 | 2.78 | MA | 1582 | 930 | 2569 | 644 | 2726 | 544 | 2800 | 454 | 2873 | 311 | 3205 | 165 | 2343 |
| 3L-2S | | MI | 1063 | 930 | 1800 | 598 | 1886 | 496 | 1914 | 407 | 1931 | 259 | 2086 | 170 | 1437 |
| 6-#10 | 3.53 | MA | 1728 | 975 | 2973 | 666 | 3240 | 550 | 3425 | 455 | 3722 | 299 | 4256 | 218 | 2893 |
| 2L-3S | | MI | 1053 | 975 | 1737 | 620 | 1803 | 519 | 1809 | 418 | 1796 | 250 | 1917 | 40 | 1773 |
| 6-#10 | 3.53 | MA | 1635 | 975 | 2688 | 671 | 2874 | 564 | 2979 | 467 | 3116 | 307 | 3494 | 128 | 2899 |
| 3L-2S | | MI | 1097 | 975 | 1891 | 623 | 2000 | 513 | 2038 | 413 | 2088 | 244 | 2259 | 137 | 1749 |
| 6-#11 | 4.33 | MA | 1682 | 1023 | 2804 | 694 | 3012 | 582 | 3142 | 476 | 3336 | 299 | 3707 | 76 | 3438 |
| 3L-2S | | MI | 1123 | 1023 | 1965 | 643 | 2060 | 518 | 2105 | 407 | 2175 | 216 | 2318 | 79 | 2038 |
| 6-#14 | 6.25 | MA | 1806 | 1137 | 3087 | 761 | 3366 | 635 | 3571 | 508 | 3908 | 287 | 4348 | -29 | 4325 |
| 3L-2S | | MI | 1200 | 1137 | 2167 | 707 | 2276 | 551 | 2355 | 413 | 2495 | 168 | 2635 | -28 | 2645 |
| 8-#5 | 1.15 | MA | 1499 | 832 | 2397 | 588 | 2521 | 496 | 2556 | 424 | 2544 | 317 | 2824 | 270 | 1051 |
| 2L-4S | | MI | 964 | 832 | 1516 | 553 | 1534 | 465 | 1509 | 396 | 1420 | 293 | 1479 | 199 | 704 |
| 8-#5 | 1.15 | MA | 1473 | 832 | 2324 | 590 | 2428 | 500 | 2442 | 428 | 2389 | 320 | 2618 | 248 | 1057 |
| 3E | | MI | 969 | 832 | 1549 | 550 | 1577 | 466 | 1561 | 398 | 1483 | 292 | 1548 | 206 | 699 |

## RECTANGULAR TIED COLUMNS 12" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#5 | 1.15 | MA | 1462 | 832 | 2267 | 594 | 2355 | 501 | 2352 | 428 | 2272 | 323 | 2474 | 236 | 1064 |
| 4L-2S | | MI | 982 | 832 | 1590 | 550 | 1629 | 464 | 1625 | 396 | 1565 | 290 | 1642 | 228 | 695 |
| 8-#6 | 1.63 | MA | 1548 | 861 | 2518 | 604 | 2673 | 507 | 2740 | 430 | 2793 | 314 | 3141 | 261 | 1442 |
| 2L-4S | | MI | 982 | 861 | 1553 | 569 | 1578 | 476 | 1566 | 405 | 1486 | 287 | 1551 | 167 | 947 |
| 8-#6 | 1.63 | MA | 1513 | 861 | 2416 | 606 | 2541 | 512 | 2579 | 435 | 2574 | 317 | 2855 | 230 | 1451 |
| 3E | | MI | 990 | 861 | 1599 | 565 | 1637 | 477 | 1634 | 403 | 1573 | 285 | 1646 | 178 | 936 |
| 8-#6 | 1.63 | MA | 1497 | 861 | 2336 | 612 | 2438 | 514 | 2453 | 436 | 2410 | 321 | 2653 | 214 | 1461 |
| 4L-2S | | MI | 1008 | 861 | 1656 | 565 | 1711 | 474 | 1723 | 401 | 1687 | 283 | 1774 | 209 | 928 |
| 8-#7 | 2.22 | MA | 1561 | 897 | 2526 | 627 | 2679 | 528 | 2746 | 445 | 2801 | 314 | 3139 | 208 | 1922 |
| 3E | | MI | 1015 | 897 | 1658 | 584 | 1711 | 491 | 1718 | 410 | 1680 | 276 | 1760 | 142 | 1213 |
| 8-#7 | 2.22 | MA | 1540 | 897 | 2419 | 635 | 2540 | 530 | 2575 | 446 | 2578 | 319 | 2869 | 187 | 1930 |
| 4L-2S | | MI | 1039 | 897 | 1735 | 584 | 1809 | 487 | 1836 | 407 | 1831 | 273 | 1929 | 184 | 1200 |
| 8-#8 | 2.93 | MA | 1617 | 939 | 2656 | 652 | 2841 | 547 | 2942 | 456 | 3066 | 311 | 3468 | 181 | 2467 |
| 3E | | MI | 1045 | 939 | 1727 | 606 | 1795 | 507 | 1814 | 417 | 1802 | 265 | 1941 | 112 | 1526 |
| 8-#8 | 2.93 | MA | 1590 | 939 | 2515 | 662 | 2659 | 550 | 2718 | 458 | 2776 | 317 | 3118 | 153 | 2419 |
| 4L-2S | | MI | 1074 | 939 | 1826 | 607 | 1922 | 503 | 1965 | 414 | 1996 | 262 | 2173 | 172 | 1510 |
| 8-#9 | 3.70 | MA | 1677 | 985 | 2796 | 679 | 3017 | 568 | 3155 | 469 | 3356 | 307 | 3818 | 150 | 3051 |
| 3E | | MI | 1076 | 985 | 1800 | 631 | 1886 | 526 | 1914 | 425 | 1931 | 252 | 2086 | 64 | 1856 |
| 8-#9 | 3.70 | MA | 1644 | 985 | 2619 | 692 | 2788 | 571 | 2874 | 471 | 2990 | 314 | 3384 | 115 | 2877 |
| 4L-2S | | MI | 1111 | 985 | 1923 | 633 | 2044 | 521 | 2100 | 421 | 2168 | 248 | 2367 | 141 | 1838 |
| 8-#10 | 4.70 | MA | 1754 | 1045 | 2973 | 715 | 3240 | 596 | 3425 | 486 | 3722 | 302 | 4256 | 108 | 3780 |
| 3E | | MI | 1115 | 1045 | 1891 | 664 | 2000 | 550 | 2038 | 434 | 2088 | 234 | 2259 | 1 | 2258 |
| 8-#10 | 4.70 | MA | 1713 | 1045 | 2750 | 731 | 2952 | 599 | 3071 | 487 | 3262 | 310 | 3715 | 65 | 3439 |
| 4L-2S | | MI | 1157 | 1045 | 2044 | 666 | 2196 | 545 | 2266 | 429 | 2380 | 229 | 2601 | 98 | 2243 |
| 8-#11 | 5.78 | MA | 1776 | 1109 | 2876 | 767 | 3102 | 623 | 3249 | 499 | 3507 | 300 | 3956 | -3 | 3955 |
| 4L-2S | | MI | 1192 | 1109 | 2143 | 696 | 2279 | 554 | 2359 | 423 | 2500 | 193 | 2686 | 22 | 2609 |
| 10-#10 | 5.88 | MA | 1832 | 1115 | 3035 | 775 | 3317 | 630 | 3517 | 506 | 3869 | 304 | 4476 | 45 | 4277 |
| 4L-3S | | MI | 1176 | 1115 | 2044 | 708 | 2196 | 582 | 2266 | 450 | 2380 | 219 | 2601 | -39 | 2597 |
| 10-#10 | 5.88 | MA | 1750 | 1115 | 2847 | 780 | 3067 | 645 | 3205 | 518 | 3409 | 301 | 3945 | -7 | 3943 |
| 5L-2S | | MI | 1217 | 1115 | 2197 | 710 | 2393 | 576 | 2494 | 444 | 2672 | 213 | 2942 | 58 | 2731 |
| 12-#10 | 7.06 | MA | 1870 | 1185 | 3132 | 824 | 3432 | 676 | 3651 | 538 | 4016 | 296 | 4707 | -27 | 4687 |
| 5L-3S | | MI | 1237 | 1185 | 2197 | 752 | 2393 | 613 | 2494 | 466 | 2672 | 204 | 2942 | -78 | 2796 |

## RECTANGULAR TIED COLUMNS 12" x 20"

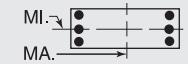
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.00 | MA | 1834 | 915 | 2912 | 651 | 3060 | 550 | 3095 | 472 | 3060 | 356 | 3396 | 306 | 1147 |
| 2E | | MI | 1080 | 915 | 1740 | 598 | 1770 | 505 | 1751 | 431 | 1665 | 318 | 1731 | 251 | 693 |
| 4-#8 | 1.32 | MA | 1875 | 936 | 3012 | 662 | 3185 | 558 | 3245 | 476 | 3264 | 353 | 3659 | 300 | 1471 |
| 2E | | MI | 1097 | 936 | 1786 | 608 | 1826 | 511 | 1814 | 433 | 1745 | 311 | 1849 | 244 | 865 |
| 4-#9 | 1.67 | MA | 1919 | 959 | 3122 | 675 | 3321 | 566 | 3409 | 480 | 3486 | 349 | 3940 | 293 | 1822 |
| 2E | | MI | 1116 | 959 | 1835 | 619 | 1885 | 518 | 1879 | 435 | 1828 | 303 | 1942 | 227 | 1045 |
| 4-#10 | 2.12 | MA | 1974 | 989 | 3260 | 691 | 3493 | 577 | 3617 | 487 | 3768 | 346 | 4294 | 283 | 2263 |
| 2E | | MI | 1139 | 989 | 1896 | 633 | 1960 | 528 | 1960 | 437 | 1931 | 292 | 2055 | 205 | 1267 |
| 4-#11 | 2.60 | MA | 2025 | 1021 | 3398 | 704 | 3656 | 586 | 3811 | 490 | 4030 | 339 | 4572 | 264 | 2706 |
| 2E | | MI | 1156 | 1021 | 1947 | 642 | 1997 | 528 | 2000 | 430 | 1982 | 270 | 2085 | 164 | 1482 |
| 4-#14 | 3.75 | MA | 2156 | 1098 | 3730 | 747 | 4073 | 616 | 4315 | 508 | 4714 | 330 | 5375 | 233 | 3764 |
| 2E | | MI | 1207 | 1098 | 2081 | 681 | 2139 | 547 | 2162 | 432 | 2191 | 237 | 2290 | 90 | 1974 |
| 4-#18 | 6.67 | MA | 2470 | 1291 | 4528 | 858 | 5078 | 695 | 5535 | 553 | 6361 | 308 | 7207 | 138 | 6295 |
| 2E | | MI | 1323 | 1291 | 2328 | 767 | 2424 | 587 | 2491 | 426 | 2615 | 137 | 2650 | -130 | 2723 |
| 6-#6 | 1.10 | MA | 1849 | 922 | 2943 | 658 | 3105 | 555 | 3152 | 475 | 3138 | 356 | 3510 | 307 | 1253 |
| 2L-3S | | MI | 1069 | 922 | 1700 | 606 | 1722 | 514 | 1696 | 438 | 1596 | 322 | 1657 | 220 | 752 |
| 6-#6 | 1.10 | MA | 1807 | 922 | 2825 | 660 | 2954 | 561 | 2967 | 480 | 2887 | 361 | 3170 | 276 | 1262 |
| 3L-2S | | MI | 1087 | 922 | 1757 | 606 | 1795 | 511 | 1786 | 436 | 1710 | 320 | 1786 | 251 | 747 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 20"

Short columns – no sidesway
Bending on major or minor axis

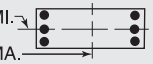



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 1.50 | MA | 1902 | 948 | 3071 | 672 | 3264 | 565 | 3344 | 481 | 3399 | 353 | 3852 | 300 | 1662 |
| 2L-3S | | MI | 1086 | 948 | 1740 | 619 | 1770 | 523 | 1751 | 443 | 1665 | 315 | 1731 | 190 | 972 |
| 6-#7 | 1.50 | MA | 1846 | 948 | 2912 | 675 | 3060 | 573 | 3095 | 488 | 3060 | 359 | 3396 | 258 | 1675 |
| 3L-2S | | MI | 1110 | 948 | 1817 | 619 | 1868 | 519 | 1869 | 440 | 1816 | 312 | 1900 | 232 | 961 |
| 6-#8 | 1.98 | MA | 1963 | 980 | 3221 | 690 | 3452 | 577 | 3571 | 488 | 3707 | 349 | 4249 | 292 | 2138 |
| 2L-3S | | MI | 1106 | 980 | 1786 | 634 | 1826 | 535 | 1814 | 448 | 1745 | 306 | 1849 | 162 | 1221 |
| 6-#8 | 1.98 | MA | 1891 | 980 | 3012 | 694 | 3185 | 587 | 3245 | 497 | 3264 | 356 | 3659 | 236 | 2153 |
| 3L-2S | | MI | 1137 | 980 | 1885 | 635 | 1953 | 531 | 1965 | 444 | 1938 | 303 | 2080 | 223 | 1204 |
| 6-#9 | 2.50 | MA | 2028 | 1015 | 3383 | 709 | 3656 | 591 | 3818 | 495 | 4042 | 345 | 4675 | 282 | 2654 |
| 2L-3S | | MI | 1128 | 1015 | 1835 | 652 | 1885 | 548 | 1879 | 453 | 1828 | 296 | 1942 | 122 | 1483 |
| 6-#9 | 2.50 | MA | 1939 | 1015 | 3122 | 714 | 3321 | 604 | 3409 | 507 | 3486 | 354 | 3940 | 212 | 2667 |
| 3L-2S | | MI | 1165 | 1015 | 1959 | 653 | 2043 | 543 | 2065 | 448 | 2066 | 291 | 2223 | 198 | 1461 |
| 6-#10 | 3.17 | MA | 2111 | 1059 | 3589 | 735 | 3915 | 609 | 4132 | 506 | 4468 | 340 | 5209 | 268 | 3305 |
| 2L-3S | | MI | 1155 | 1059 | 1896 | 675 | 1960 | 565 | 1960 | 459 | 1931 | 282 | 2055 | 68 | 1803 |
| 6-#10 | 3.17 | MA | 2001 | 1059 | 3260 | 741 | 3493 | 625 | 3617 | 520 | 3768 | 351 | 4294 | 179 | 3310 |
| 3L-2S | | MI | 1199 | 1059 | 2050 | 677 | 2157 | 560 | 2188 | 453 | 2223 | 276 | 2396 | 165 | 1777 |
| 6-#11 | 3.90 | MA | 2058 | 1108 | 3398 | 765 | 3656 | 643 | 3811 | 530 | 4030 | 343 | 4572 | 132 | 3943 |
| 3L-2S | | MI | 1225 | 1108 | 2124 | 696 | 2216 | 564 | 2254 | 446 | 2308 | 247 | 2453 | 107 | 2071 |
| 6-#14 | 5.63 | MA | 2205 | 1222 | 3730 | 833 | 4073 | 697 | 4315 | 563 | 4714 | 334 | 5375 | 38 | 5268 |
| 3L-2S | | MI | 1302 | 1222 | 2326 | 759 | 2432 | 596 | 2503 | 452 | 2627 | 199 | 2768 | -1 | 2768 |
| 8-#5 | 1.03 | MA | 1842 | 917 | 2921 | 657 | 3081 | 555 | 3125 | 475 | 3102 | 358 | 3470 | 310 | 1185 |
| 2L-4S | | MI | 1066 | 917 | 1675 | 610 | 1692 | 513 | 1661 | 438 | 1557 | 326 | 1620 | 228 | 716 |
| 8-#5 | 1.03 | MA | 1812 | 917 | 2837 | 659 | 2974 | 559 | 2994 | 479 | 2924 | 361 | 3227 | 288 | 1191 |
| 3E | | MI | 1071 | 917 | 1707 | 607 | 1735 | 514 | 1713 | 440 | 1620 | 325 | 1689 | 236 | 712 |
| 8-#5 | 1.03 | MA | 1797 | 917 | 2773 | 664 | 2890 | 560 | 2891 | 480 | 2791 | 364 | 3057 | 276 | 1198 |
| 4L-2S | | MI | 1084 | 917 | 1748 | 607 | 1787 | 512 | 1777 | 438 | 1702 | 324 | 1783 | 258 | 709 |
| 8-#6 | 1.47 | MA | 1899 | 946 | 3061 | 673 | 3256 | 566 | 3336 | 482 | 3389 | 354 | 3850 | 303 | 1632 |
| 2L-4S | | MI | 1084 | 946 | 1711 | 625 | 1736 | 524 | 1718 | 447 | 1623 | 320 | 1691 | 196 | 962 |
| 8-#6 | 1.47 | MA | 1858 | 946 | 2943 | 675 | 3105 | 572 | 3152 | 487 | 3138 | 359 | 3510 | 272 | 1641 |
| 3E | | MI | 1092 | 946 | 1757 | 621 | 1795 | 524 | 1786 | 445 | 1710 | 318 | 1786 | 207 | 952 |
| 8-#6 | 1.47 | MA | 1838 | 946 | 2853 | 682 | 2987 | 574 | 3008 | 489 | 2950 | 363 | 3273 | 255 | 1651 |
| 4L-2S | | MI | 1110 | 946 | 1814 | 621 | 1868 | 522 | 1875 | 443 | 1824 | 316 | 1914 | 238 | 945 |
| 8-#7 | 2.00 | MA | 1914 | 981 | 3071 | 696 | 3264 | 588 | 3344 | 497 | 3399 | 356 | 3852 | 253 | 2181 |
| 3E | | MI | 1117 | 981 | 1817 | 639 | 1868 | 538 | 1869 | 451 | 1816 | 309 | 1900 | 171 | 1233 |
| 8-#7 | 2.00 | MA | 1888 | 981 | 2948 | 705 | 3105 | 590 | 3149 | 499 | 3145 | 362 | 3533 | 229 | 2189 |
| 4L-2S | | MI | 1141 | 981 | 1893 | 640 | 1966 | 534 | 1988 | 449 | 1967 | 306 | 2069 | 213 | 1220 |
| 8-#8 | 2.63 | MA | 1979 | 1023 | 3221 | 721 | 3452 | 607 | 3571 | 509 | 3707 | 353 | 4249 | 228 | 2808 |
| 3E | | MI | 1147 | 1023 | 1885 | 662 | 1953 | 555 | 1965 | 459 | 1938 | 298 | 2080 | 141 | 1550 |
| 8-#8 | 2.63 | MA | 1946 | 1023 | 3060 | 733 | 3244 | 610 | 3316 | 511 | 3374 | 360 | 3835 | 199 | 2801 |
| 4L-2S | | MI | 1176 | 1023 | 1984 | 662 | 2080 | 550 | 2116 | 455 | 2132 | 294 | 2311 | 201 | 1533 |
| 8-#9 | 3.33 | MA | 2050 | 1070 | 3383 | 749 | 3656 | 628 | 3818 | 522 | 4042 | 349 | 4675 | 201 | 3483 |
| 3E | | MI | 1178 | 1070 | 1959 | 686 | 2043 | 573 | 2065 | 466 | 2066 | 285 | 2223 | 93 | 1884 |
| 8-#9 | 3.33 | MA | 2009 | 1070 | 3181 | 763 | 3394 | 632 | 3497 | 524 | 3624 | 358 | 4159 | 163 | 3340 |
| 4L-2S | | MI | 1213 | 1070 | 2082 | 688 | 2201 | 568 | 2251 | 461 | 2304 | 280 | 2505 | 169 | 1865 |
| 8-#10 | 4.23 | MA | 2140 | 1130 | 3589 | 785 | 3915 | 656 | 4132 | 539 | 4468 | 345 | 5209 | 164 | 4329 |
| 3E | | MI | 1216 | 1130 | 2050 | 719 | 2157 | 597 | 2188 | 475 | 2223 | 267 | 2396 | 29 | 2294 |
| 8-#10 | 4.23 | MA | 2089 | 1130 | 3335 | 803 | 3585 | 661 | 3727 | 542 | 3941 | 355 | 4565 | 117 | 3998 |
| 4L-2S | | MI | 1259 | 1130 | 2203 | 721 | 2353 | 591 | 2416 | 469 | 2515 | 261 | 2738 | 126 | 2274 |
| 8-#11 | 5.20 | MA | 2165 | 1194 | 3485 | 839 | 3764 | 686 | 3940 | 555 | 4234 | 347 | 4883 | 55 | 4625 |
| 4L-2S | | MI | 1294 | 1194 | 2302 | 750 | 2435 | 600 | 2508 | 463 | 2633 | 225 | 2821 | 50 | 2646 |
| 8-#14 | 7.50 | MA | 2358 | 1347 | 3851 | 939 | 4223 | 757 | 4495 | 598 | 4999 | 338 | 5800 | -75 | 5746 |
| 4L-2S | | MI | 1397 | 1347 | 2572 | 837 | 2724 | 644 | 2843 | 472 | 3063 | 162 | 3246 | -93 | 3273 |
| 10-#10 | 5.29 | MA | 2228 | 1200 | 3663 | 847 | 4007 | 692 | 4242 | 561 | 4641 | 350 | 5480 | 102 | 4969 |
| 4L-3S | | MI | 1277 | 1200 | 2203 | 763 | 2353 | 628 | 2416 | 491 | 2515 | 251 | 2738 | -10 | 2737 |
| 10-#10 | 5.29 | MA | 2133 | 1200 | 3449 | 853 | 3721 | 708 | 3885 | 575 | 4115 | 349 | 4842 | 51 | 4665 |
| 5L-2S | | MI | 1319 | 1200 | 2356 | 765 | 2550 | 623 | 2645 | 485 | 2807 | 246 | 3079 | 87 | 2764 |
| 12-#10 | 6.35 | MA | 2273 | 1270 | 3777 | 897 | 4143 | 740 | 4400 | 594 | 4815 | 343 | 5757 | 36 | 5626 |
| 5L-3S | | MI | 1338 | 1270 | 2356 | 806 | 2550 | 660 | 2645 | 506 | 2807 | 236 | 3079 | -50 | 3073 |

## RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

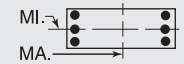
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.20 | MA | 2257 | 1021 | 3598 | 731 | 3813 | 616 | 3885 | 527 | 3896 | 393 | 4399 | 340 | 1642 |
| 2E | | MI | 1199 | 1021 | 1945 | 663 | 1983 | 558 | 1965 | 474 | 1881 | 344 | 1987 | 273 | 881 |
| 4-#9 | 1.52 | MA | 2308 | 1044 | 3723 | 744 | 3967 | 625 | 4072 | 532 | 4149 | 390 | 4732 | 334 | 2038 |
| 2E | | MI | 1218 | 1044 | 1994 | 673 | 2042 | 565 | 2030 | 476 | 1964 | 335 | 2080 | 256 | 1065 |
| 4-#10 | 1.92 | MA | 2372 | 1074 | 3881 | 760 | 4164 | 636 | 4309 | 538 | 4470 | 386 | 5150 | 327 | 2538 |
| 2E | | MI | 1241 | 1074 | 2055 | 688 | 2117 | 575 | 2110 | 478 | 2066 | 324 | 2192 | 233 | 1289 |
| 4-#11 | 2.36 | MA | 2431 | 1106 | 4041 | 773 | 4354 | 645 | 4534 | 542 | 4774 | 380 | 5495 | 311 | 3043 |
| 2E | | MI | 1258 | 1106 | 2106 | 695 | 2153 | 573 | 2149 | 470 | 2116 | 302 | 2220 | 191 | 1509 |
| 4-#14 | 3.41 | MA | 2584 | 1182 | 4422 | 816 | 4832 | 675 | 5113 | 559 | 5559 | 371 | 6462 | 285 | 4250 |
| 2E | | MI | 1309 | 1182 | 2240 | 734 | 2294 | 591 | 2310 | 471 | 2323 | 268 | 2423 | 118 | 2009 |
| 4-#18 | 6.06 | MA | 2948 | 1376 | 5344 | 927 | 5993 | 754 | 6521 | 604 | 7471 | 350 | 8705 | 206 | 7159 |
| 2E | | MI | 1425 | 1376 | 2487 | 818 | 2578 | 630 | 2637 | 463 | 2744 | 167 | 2780 | -104 | 2842 |
| 6-#6 | 1.00 | MA | 2228 | 1007 | 3519 | 727 | 3721 | 614 | 3777 | 526 | 3752 | 397 | 4215 | 345 | 1395 |
| 2L-3S | | MI | 1171 | 1007 | 1859 | 662 | 1879 | 561 | 1848 | 480 | 1732 | 355 | 1797 | 249 | 765 |
| 6-#6 | 1.00 | MA | 2179 | 1007 | 3386 | 729 | 3550 | 620 | 3569 | 532 | 3469 | 402 | 3822 | 315 | 1404 |
| 3L-2S | | MI | 1189 | 1007 | 1916 | 662 | 1953 | 558 | 1937 | 478 | 1846 | 353 | 1926 | 280 | 761 |
| 6-#7 | 1.36 | MA | 2288 | 1033 | 3664 | 741 | 3902 | 624 | 3996 | 532 | 4048 | 394 | 4621 | 341 | 1856 |
| 2L-3S | | MI | 1188 | 1033 | 1899 | 674 | 1927 | 571 | 1903 | 484 | 1801 | 348 | 1870 | 219 | 988 |
| 6-#7 | 1.36 | MA | 2223 | 1033 | 3484 | 745 | 3671 | 632 | 3714 | 540 | 3665 | 400 | 4091 | 299 | 1869 |
| 3L-2S | | MI | 1212 | 1033 | 1976 | 675 | 2025 | 567 | 2021 | 481 | 1953 | 345 | 2039 | 261 | 978 |
| 6-#8 | 1.80 | MA | 2358 | 1065 | 3834 | 759 | 4115 | 636 | 4254 | 539 | 4397 | 390 | 5087 | 335 | 2394 |
| 2L-3S | | MI | 1208 | 1065 | 1945 | 690 | 1983 | 582 | 1965 | 489 | 1881 | 339 | 1987 | 191 | 1241 |
| 6-#8 | 1.80 | MA | 2275 | 1065 | 3598 | 764 | 3813 | 647 | 3885 | 549 | 3896 | 398 | 4399 | 279 | 2409 |
| 3L-2S | | MI | 1239 | 1065 | 2044 | 690 | 2110 | 578 | 2116 | 485 | 2074 | 335 | 2219 | 251 | 1224 |
| 6-#9 | 2.27 | MA | 2434 | 1099 | 4019 | 778 | 4347 | 650 | 4535 | 547 | 4778 | 386 | 5589 | 327 | 2978 |
| 2L-3S | | MI | 1230 | 1099 | 1994 | 707 | 2042 | 595 | 2030 | 493 | 1964 | 328 | 2080 | 150 | 1506 |
| 6-#9 | 2.27 | MA | 2331 | 1099 | 3723 | 784 | 3967 | 663 | 4072 | 559 | 4149 | 396 | 4732 | 256 | 2991 |
| 3L-2S | | MI | 1266 | 1099 | 2117 | 708 | 2200 | 590 | 2216 | 489 | 2201 | 324 | 2361 | 227 | 1484 |
| 6-#10 | 2.89 | MA | 2529 | 1144 | 4254 | 804 | 4642 | 668 | 4892 | 557 | 5264 | 381 | 6221 | 316 | 3716 |
| 2L-3S | | MI | 1257 | 1144 | 2055 | 729 | 2117 | 612 | 2110 | 499 | 2066 | 314 | 2192 | 96 | 1832 |
| 6-#10 | 2.89 | MA | 2402 | 1144 | 3881 | 811 | 4164 | 685 | 4309 | 573 | 4470 | 393 | 5150 | 226 | 3721 |
| 3L-2S | | MI | 1301 | 1144 | 2209 | 732 | 2313 | 606 | 2338 | 494 | 2358 | 309 | 2533 | 194 | 1803 |
| 6-#11 | 3.55 | MA | 2468 | 1192 | 4041 | 835 | 4354 | 703 | 4534 | 583 | 4774 | 386 | 5495 | 184 | 4448 |
| 3L-2S | | MI | 1327 | 1192 | 2283 | 749 | 2372 | 609 | 2403 | 486 | 2441 | 279 | 2588 | 134 | 2104 |
| 6-#14 | 5.11 | MA | 2638 | 1307 | 4422 | 904 | 4832 | 758 | 5113 | 617 | 5559 | 378 | 6462 | 98 | 6149 |
| 3L-2S | | MI | 1404 | 1307 | 2486 | 812 | 2587 | 640 | 2651 | 491 | 2759 | 230 | 2901 | 26 | 2812 |
| 8-#6 | 1.33 | MA | 2285 | 1031 | 3652 | 742 | 3892 | 624 | 3986 | 533 | 4035 | 395 | 4607 | 343 | 1822 |
| 2L-4S | | MI | 1186 | 1031 | 1870 | 681 | 1893 | 571 | 1870 | 489 | 1759 | 353 | 1831 | 225 | 977 |
| 8-#6 | 1.33 | MA | 2237 | 1031 | 3519 | 745 | 3721 | 631 | 3777 | 539 | 3752 | 400 | 4215 | 312 | 1831 |
| 3E | | MI | 1194 | 1031 | 1916 | 677 | 1953 | 572 | 1937 | 487 | 1846 | 351 | 1926 | 236 | 967 |
| 8-#6 | 1.33 | MA | 2214 | 1031 | 3417 | 752 | 3589 | 633 | 3616 | 541 | 3541 | 405 | 3943 | 294 | 1841 |
| 4L-2S | | MI | 1212 | 1031 | 1973 | 677 | 2026 | 569 | 2027 | 485 | 1960 | 349 | 2054 | 267 | 961 |
| 8-#7 | 1.82 | MA | 2302 | 1066 | 3664 | 766 | 3902 | 647 | 3996 | 549 | 4048 | 398 | 4621 | 295 | 2440 |
| 3E | | MI | 1219 | 1066 | 1976 | 695 | 2025 | 586 | 2021 | 493 | 1953 | 342 | 2039 | 200 | 1251 |
| 8-#7 | 1.82 | MA | 2270 | 1066 | 3526 | 775 | 3723 | 650 | 3777 | 551 | 3762 | 404 | 4252 | 271 | 2448 |
| 4L-2S | | MI | 1243 | 1066 | 2052 | 695 | 2123 | 582 | 2139 | 490 | 2104 | 339 | 2208 | 242 | 1240 |
| 8-#8 | 2.39 | MA | 2377 | 1108 | 3834 | 791 | 4115 | 667 | 4254 | 561 | 4397 | 395 | 5087 | 273 | 3149 |
| 3E | | MI | 1249 | 1108 | 2044 | 717 | 2110 | 602 | 2116 | 500 | 2074 | 331 | 2219 | 169 | 1573 |
| 8-#8 | 2.39 | MA | 2336 | 1108 | 3654 | 803 | 3881 | 671 | 3966 | 564 | 4023 | 403 | 4608 | 242 | 3143 |
| 4L-2S | | MI | 1278 | 1108 | 2143 | 718 | 2237 | 597 | 2268 | 496 | 2268 | 327 | 2450 | 230 | 1556 |
| 8-#9 | 3.03 | MA | 2458 | 1155 | 4019 | 819 | 4347 | 688 | 4535 | 574 | 4778 | 392 | 5589 | 248 | 3915 |
| 3E | | MI | 1279 | 1155 | 2117 | 741 | 2200 | 620 | 2216 | 507 | 2201 | 317 | 2361 | 121 | 1911 |
| 8-#9 | 3.03 | MA | 2408 | 1155 | 3792 | 834 | 4052 | 693 | 4173 | 578 | 4308 | 402 | 4990 | 209 | 3816 |
| 4L-2S | | MI | 1315 | 1155 | 2241 | 743 | 2358 | 615 | 2402 | 502 | 2439 | 313 | 2643 | 198 | 1891 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 12" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

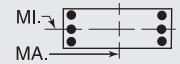
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 3.85 | MA | 2561 | 1215 | 4254 | 855 | 4642 | 716 | 4892 | 592 | 5264 | 387 | 6221 | 215 | 4877 |
| 3E | | MI | 1318 | 1215 | 2209 | 773 | 2313 | 643 | 2338 | 515 | 2358 | 299 | 2533 | 57 | 2326 |
| 8-#10 | 3.85 | MA | 2499 | 1215 | 3967 | 874 | 4271 | 722 | 4436 | 596 | 4670 | 400 | 5472 | 166 | 4570 |
| 4L-2S | | MI | 1361 | 1215 | 2362 | 775 | 2510 | 638 | 2567 | 510 | 2650 | 293 | 2875 | 154 | 2303 |
| 8-#11 | 4.73 | MA | 2587 | 1279 | 4143 | 911 | 4480 | 748 | 4684 | 610 | 5010 | 393 | 5868 | 109 | 5298 |
| 4L-2S | | MI | 1396 | 1279 | 2461 | 803 | 2591 | 645 | 2658 | 502 | 2767 | 256 | 2956 | 78 | 2682 |
| 8-#14 | 6.82 | MA | 2808 | 1431 | 4564 | 1013 | 5008 | 821 | 5323 | 655 | 5890 | 386 | 6976 | -12 | 6964 |
| 4L-2S | | MI | 1499 | 1431 | 2731 | 889 | 2880 | 689 | 2991 | 511 | 3195 | 193 | 3379 | -65 | 3401 |
| 10-#10 | 4.81 | MA | 2659 | 1285 | 4340 | 918 | 4748 | 754 | 5019 | 615 | 5463 | 394 | 6543 | 155 | 5675 |
| 4L-3S | | MI | 1379 | 1285 | 2362 | 817 | 2510 | 675 | 2567 | 531 | 2650 | 284 | 2875 | 18 | 2813 |
| 10-#10 | 4.81 | MA | 2550 | 1285 | 4099 | 925 | 4428 | 771 | 4618 | 631 | 4871 | 395 | 5796 | 104 | 5387 |
| 5L-2S | | MI | 1421 | 1285 | 2515 | 819 | 2706 | 669 | 2795 | 525 | 2942 | 278 | 3217 | 115 | 2796 |
| 10-#11 | 5.91 | MA | 2647 | 1365 | 4298 | 973 | 4665 | 807 | 4900 | 651 | 5248 | 386 | 6248 | 28 | 6142 |
| 5L-2S | | MI | 1465 | 1365 | 2639 | 857 | 2810 | 681 | 2912 | 519 | 3092 | 233 | 3323 | 21 | 3252 |
| 12-#10 | 5.77 | MA | 2710 | 1355 | 4472 | 969 | 4906 | 802 | 5202 | 650 | 5665 | 390 | 6867 | 93 | 6485 |
| 5L-3S | | MI | 1440 | 1355 | 2515 | 861 | 2706 | 706 | 2795 | 547 | 2942 | 268 | 3217 | -21 | 3215 |
| 12-#10 | 5.77 | MA | 2632 | 1355 | 4224 | 987 | 4586 | 808 | 4804 | 654 | 5131 | 402 | 6184 | 36 | 6008 |
| 6L-2S | | MI | 1480 | 1355 | 2669 | 863 | 2903 | 701 | 3023 | 541 | 3233 | 262 | 3558 | 76 | 3284 |
| 14-#10 | 6.73 | MA | 2794 | 1425 | 4597 | 1030 | 5064 | 840 | 5387 | 673 | 5925 | 396 | 7255 | 25 | 7129 |
| 6L-3S | | MI | 1501 | 1425 | 2669 | 905 | 2903 | 738 | 3023 | 563 | 3233 | 253 | 3558 | -61 | 3388 |

## RECTANGULAR TIED COLUMNS 12" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.10 | MA | 2674 | 1106 | 4233 | 800 | 4493 | 675 | 4578 | 578 | 4579 | 434 | 5174 | 377 | 1813 |
| 2E | | MI | 1301 | 1106 | 2104 | 718 | 2140 | 605 | 2116 | 515 | 2016 | 376 | 2126 | 302 | 897 |
| 4-#9 | 1.39 | MA | 2732 | 1129 | 4372 | 812 | 4667 | 684 | 4787 | 583 | 4862 | 431 | 5565 | 374 | 2254 |
| 2E | | MI | 1320 | 1129 | 2153 | 728 | 2199 | 612 | 2181 | 517 | 2099 | 368 | 2218 | 284 | 1083 |
| 4-#10 | 1.76 | MA | 2804 | 1159 | 4550 | 829 | 4887 | 695 | 5053 | 589 | 5223 | 427 | 6062 | 369 | 2812 |
| 2E | | MI | 1343 | 1159 | 2214 | 742 | 2273 | 621 | 2260 | 518 | 2201 | 356 | 2329 | 261 | 1311 |
| 4-#11 | 2.17 | MA | 2872 | 1191 | 4732 | 842 | 5103 | 704 | 5310 | 593 | 5568 | 421 | 6475 | 355 | 3380 |
| 2E | | MI | 1360 | 1191 | 2265 | 749 | 2309 | 619 | 2298 | 509 | 2249 | 334 | 2355 | 219 | 1536 |
| 4-#14 | 3.13 | MA | 3046 | 1267 | 5162 | 885 | 5643 | 734 | 5963 | 610 | 6454 | 412 | 7608 | 334 | 4736 |
| 2E | | MI | 1411 | 1267 | 2400 | 787 | 2450 | 636 | 2459 | 510 | 2455 | 299 | 2557 | 145 | 2042 |
| 4-#18 | 5.56 | MA | 3462 | 1461 | 6208 | 996 | 6960 | 812 | 7560 | 656 | 8623 | 391 | 10267 | 269 | 8023 |
| 2E | | MI | 1527 | 1461 | 2646 | 869 | 2732 | 674 | 2783 | 501 | 2874 | 198 | 2910 | -77 | 2959 |
| 6-#7 | 1.25 | MA | 2708 | 1118 | 4305 | 810 | 4592 | 682 | 4701 | 583 | 4747 | 435 | 5409 | 377 | 2051 |
| 2L-3S | | MI | 1290 | 1118 | 2058 | 730 | 2085 | 618 | 2054 | 525 | 1938 | 381 | 2009 | 248 | 1003 |
| 6-#7 | 1.25 | MA | 2635 | 1118 | 4104 | 814 | 4334 | 686 | 4386 | 591 | 4320 | 442 | 4817 | 336 | 2064 |
| 3L-2S | | MI | 1314 | 1118 | 2134 | 730 | 2183 | 614 | 2172 | 523 | 2089 | 378 | 2178 | 290 | 995 |
| 6-#8 | 1.65 | MA | 2788 | 1149 | 4496 | 827 | 4830 | 695 | 4989 | 590 | 5138 | 431 | 5949 | 373 | 2650 |
| 2L-3S | | MI | 1310 | 1149 | 2104 | 745 | 2140 | 629 | 2116 | 530 | 2016 | 372 | 2126 | 220 | 1259 |
| 6-#8 | 1.65 | MA | 2693 | 1149 | 4233 | 833 | 4493 | 706 | 4578 | 601 | 4579 | 440 | 5174 | 318 | 2665 |
| 3L-2S | | MI | 1340 | 1149 | 2203 | 746 | 2267 | 625 | 2267 | 526 | 2210 | 368 | 2357 | 280 | 1243 |
| 6-#9 | 2.08 | MA | 2873 | 1184 | 4703 | 847 | 5090 | 709 | 5304 | 598 | 5565 | 427 | 6540 | 368 | 3302 |
| 2L-3S | | MI | 1332 | 1184 | 2153 | 762 | 2199 | 642 | 2181 | 534 | 2099 | 361 | 2218 | 179 | 1528 |
| 6-#9 | 2.08 | MA | 2756 | 1184 | 4372 | 854 | 4667 | 723 | 4787 | 611 | 4862 | 438 | 5565 | 298 | 3315 |
| 3L-2S | | MI | 1368 | 1184 | 2276 | 763 | 2357 | 637 | 2367 | 530 | 2337 | 356 | 2499 | 255 | 1506 |
| 6-#10 | 2.65 | MA | 2982 | 1229 | 4966 | 873 | 5422 | 727 | 5705 | 608 | 6110 | 422 | 7289 | 361 | 4127 |
| 2L-3S | | MI | 1358 | 1229 | 2214 | 784 | 2273 | 658 | 2260 | 540 | 2201 | 347 | 2329 | 125 | 1858 |
| 6-#10 | 2.65 | MA | 2837 | 1229 | 4550 | 881 | 4887 | 745 | 5053 | 625 | 5223 | 435 | 6062 | 272 | 4133 |
| 3L-2S | | MI | 1403 | 1229 | 2368 | 786 | 2470 | 653 | 2489 | 534 | 2492 | 341 | 2670 | 222 | 1829 |
| 6-#11 | 3.25 | MA | 2913 | 1277 | 4732 | 905 | 5103 | 764 | 5310 | 636 | 5568 | 429 | 6475 | 232 | 4954 |
| 3L-2S | | MI | 1429 | 1277 | 2443 | 803 | 2528 | 655 | 2552 | 526 | 2574 | 311 | 2723 | 162 | 2135 |
| 6-#14 | 4.69 | MA | 3107 | 1392 | 5162 | 975 | 5643 | 819 | 5963 | 670 | 6454 | 422 | 7608 | 153 | 6896 |
| 3L-2S | | MI | 1506 | 1392 | 2645 | 864 | 2742 | 685 | 2799 | 530 | 2891 | 262 | 3035 | 53 | 2851 |

## RECTANGULAR TIED COLUMNS 12" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#6 | 1.22 | MA | 2705 | 1116 | 4291 | 811 | 4579 | 683 | 4688 | 584 | 4732 | 436 | 5388 | 379 | 2012 |
| 2L-4S | | MI | 1288 | 1116 | 2029 | 737 | 2051 | 619 | 2021 | 530 | 1896 | 386 | 1971 | 255 | 990 |
| 8-#6 | 1.22 | MA | 2651 | 1116 | 4143 | 814 | 4389 | 686 | 4456 | 590 | 4416 | 441 | 4951 | 349 | 2021 |
| 3E | | MI | 1296 | 1116 | 2075 | 733 | 2110 | 620 | 2089 | 528 | 1983 | 384 | 2066 | 265 | 982 |
| 8-#6 | 1.22 | MA | 2623 | 1116 | 4030 | 821 | 4243 | 693 | 4277 | 593 | 4182 | 447 | 4652 | 331 | 2031 |
| 4L-2S | | MI | 1314 | 1116 | 2132 | 733 | 2183 | 617 | 2178 | 526 | 2097 | 382 | 2194 | 296 | 976 |
| 8-#7 | 1.67 | MA | 2723 | 1151 | 4305 | 835 | 4592 | 701 | 4701 | 600 | 4747 | 439 | 5409 | 333 | 2699 |
| 3E | | MI | 1321 | 1151 | 2134 | 751 | 2183 | 633 | 2172 | 534 | 2089 | 375 | 2178 | 229 | 1269 |
| 8-#7 | 1.67 | MA | 2686 | 1151 | 4152 | 845 | 4394 | 710 | 4457 | 604 | 4430 | 446 | 5002 | 309 | 2707 |
| 4L-2S | | MI | 1345 | 1151 | 2211 | 751 | 2281 | 629 | 2291 | 531 | 2240 | 372 | 2347 | 271 | 1258 |
| 8-#8 | 2.19 | MA | 2808 | 1193 | 4496 | 860 | 4830 | 726 | 4989 | 613 | 5138 | 436 | 5949 | 313 | 3490 |
| 3E | | MI | 1350 | 1193 | 2203 | 772 | 2267 | 649 | 2267 | 541 | 2210 | 363 | 2357 | 198 | 1594 |
| 8-#8 | 2.19 | MA | 2760 | 1193 | 4295 | 873 | 4570 | 731 | 4670 | 617 | 4722 | 445 | 5415 | 282 | 3484 |
| 4L-2S | | MI | 1380 | 1193 | 2302 | 773 | 2394 | 645 | 2419 | 537 | 2403 | 360 | 2589 | 259 | 1578 |
| 8-#9 | 2.78 | MA | 2900 | 1240 | 4703 | 888 | 5090 | 748 | 5304 | 626 | 5565 | 433 | 6540 | 292 | 4347 |
| 3E | | MI | 1381 | 1240 | 2276 | 796 | 2357 | 667 | 2367 | 548 | 2337 | 350 | 2499 | 150 | 1937 |
| 8-#9 | 2.78 | MA | 2841 | 1240 | 4451 | 904 | 4763 | 753 | 4902 | 631 | 5042 | 445 | 5865 | 252 | 4303 |
| 4L-2S | | MI | 1417 | 1240 | 2400 | 798 | 2515 | 662 | 2553 | 543 | 2574 | 345 | 2781 | 226 | 1916 |
| 8-#10 | 3.53 | MA | 3017 | 1299 | 4966 | 925 | 5422 | 776 | 5705 | 644 | 6110 | 430 | 7289 | 264 | 5426 |
| 3E | | MI | 1420 | 1299 | 2368 | 828 | 2470 | 690 | 2489 | 556 | 2492 | 331 | 2670 | 86 | 2357 |
| 8-#10 | 3.53 | MA | 2944 | 1299 | 4648 | 944 | 5009 | 783 | 5198 | 650 | 5449 | 443 | 6436 | 213 | 5156 |
| 4L-2S | | MI | 1463 | 1299 | 2521 | 830 | 2666 | 684 | 2717 | 550 | 2784 | 326 | 3012 | 183 | 2332 |
| 8-#11 | 4.33 | MA | 3043 | 1364 | 4848 | 982 | 5247 | 810 | 5481 | 665 | 5837 | 438 | 6910 | 159 | 5986 |
| 4L-2S | | MI | 1498 | 1364 | 2620 | 857 | 2747 | 691 | 2807 | 542 | 2900 | 288 | 3091 | 105 | 2717 |
| 8-#14 | 6.25 | MA | 3294 | 1516 | 5325 | 1085 | 5845 | 884 | 6203 | 711 | 6833 | 433 | 8212 | 46 | 7958 |
| 4L-2S | | MI | 1600 | 1516 | 2890 | 942 | 3035 | 734 | 3139 | 550 | 3327 | 224 | 3513 | -38 | 3527 |
| 10-#10 | 4.41 | MA | 3124 | 1370 | 5065 | 988 | 5543 | 815 | 5850 | 669 | 6336 | 438 | 7662 | 205 | 6395 |
| 4L-3S | | MI | 1481 | 1370 | 2521 | 872 | 2666 | 721 | 2717 | 572 | 2784 | 316 | 3012 | 46 | 2847 |
| 10-#10 | 4.41 | MA | 3001 | 1370 | 4797 | 997 | 5187 | 833 | 5405 | 685 | 5678 | 440 | 6807 | 154 | 6044 |
| 5L-2S | | MI | 1523 | 1370 | 2674 | 874 | 2863 | 716 | 2945 | 566 | 3076 | 310 | 3354 | 143 | 2827 |
| 10-#11 | 5.42 | MA | 3112 | 1450 | 5026 | 1046 | 5459 | 869 | 5727 | 707 | 6109 | 432 | 7348 | 83 | 7001 |
| 5L-2S | | MI | 1566 | 1450 | 2798 | 911 | 2966 | 727 | 3061 | 558 | 3225 | 265 | 3458 | 48 | 3289 |
| 10-#14 | 7.81 | MA | 3391 | 1641 | 5575 | 1175 | 6143 | 970 | 6550 | 771 | 7215 | 424 | 8824 | -67 | 8749 |
| 5L-2S | | MI | 1695 | 1641 | 3135 | 1020 | 3328 | 783 | 3480 | 570 | 3762 | 187 | 3991 | -129 | 4026 |
| 12-#10 | 5.29 | MA | 3182 | 1440 | 5214 | 1040 | 5721 | 864 | 6057 | 704 | 6565 | 435 | 8034 | 146 | 7310 |
| 5L-3S | | MI | 1541 | 1440 | 2674 | 916 | 2863 | 753 | 2945 | 588 | 3076 | 300 | 3354 | 7 | 3331 |
| 12-#10 | 5.29 | MA | 3094 | 1440 | 4953 | 1046 | 5367 | 871 | 5616 | 710 | 5973 | 448 | 7254 | 87 | 6784 |
| 6L-2S | | MI | 1582 | 1440 | 2828 | 918 | 3059 | 747 | 3174 | 582 | 3368 | 295 | 3695 | 104 | 3317 |
| 12-#11 | 6.50 | MA | 3223 | 1536 | 5193 | 1121 | 5672 | 916 | 5977 | 736 | 6459 | 441 | 7872 | 0 | 7872 |
| 6L-2S | | MI | 1635 | 1536 | 2976 | 965 | 3185 | 763 | 3316 | 575 | 3551 | 242 | 3826 | -9 | 3828 |
| 14-#10 | 6.17 | MA | 3277 | 1510 | 5370 | 1090 | 5901 | 902 | 6268 | 729 | 6860 | 443 | 8481 | 80 | 8041 |
| 6L-3S | | MI | 1602 | 1510 | 2828 | 959 | 3059 | 784 | 3174 | 603 | 3368 | 285 | 3695 | -32 | 3692 |

## RECTANGULAR TIED COLUMNS 14" x 14"

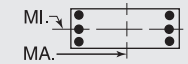
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#6 | 1.35 | MA | 1059 | 766 | 1720 | 518 | 1787 | 436 | 1801 | 371 | 1782 | 273 | 1907 | 217 | 843 |
| 2L-3S | | MI | 1035 | 766 | 1648 | 519 | 1694 | 440 | 1688 | 375 | 1630 | 275 | 1727 | 186 | 851 |
| 6-#7 | 1.84 | MA | 1089 | 793 | 1797 | 532 | 1882 | 446 | 1916 | 377 | 1931 | 268 | 2077 | 202 | 1100 |
| 2L-3S | | MI | 1057 | 793 | 1700 | 534 | 1757 | 451 | 1764 | 381 | 1728 | 270 | 1838 | 160 | 1113 |
| 6-#8 | 2.42 | MA | 1124 | 824 | 1886 | 550 | 1992 | 458 | 2050 | 383 | 2103 | 262 | 2271 | 185 | 1394 |
| 2L-3S | | MI | 1083 | 824 | 1759 | 551 | 1830 | 464 | 1852 | 389 | 1842 | 265 | 1966 | 129 | 1411 |
| 6-#9 | 3.06 | MA | 1161 | 859 | 1981 | 569 | 2112 | 471 | 2194 | 391 | 2286 | 254 | 2474 | 164 | 1709 |
| 2L-3S | | MI | 1111 | 859 | 1823 | 570 | 1910 | 479 | 1948 | 397 | 1962 | 259 | 2099 | 93 | 1727 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 14"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

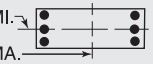
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 3.89 | MA | 1208 | 904 | 2101 | 594 | 2262 | 489 | 2376 | 401 | 2512 | 244 | 2722 | 135 | 2102 |
| 2L-3S | | MI | 1146 | 904 | 1904 | 595 | 2009 | 498 | 2068 | 408 | 2111 | 250 | 2263 | 46 | 2117 |
| 6-#11 | 4.78 | MA | 1247 | 952 | 2208 | 616 | 2390 | 504 | 2516 | 405 | 2670 | 223 | 2858 | 87 | 2471 |
| 2L-3S | | MI | 1175 | 952 | 1976 | 615 | 2093 | 513 | 2158 | 412 | 2213 | 230 | 2347 | -23 | 2344 |
| 8-#6 | 1.80 | MA | 1088 | 790 | 1793 | 533 | 1879 | 447 | 1914 | 378 | 1935 | 271 | 2087 | 207 | 1081 |
| 2L-4S | | MI | 1055 | 790 | 1663 | 539 | 1713 | 451 | 1711 | 381 | 1666 | 275 | 1777 | 163 | 1101 |
| 8-#7 | 2.45 | MA | 1128 | 826 | 1894 | 553 | 2006 | 461 | 2068 | 386 | 2135 | 264 | 2316 | 189 | 1416 |
| 2L-4S | | MI | 1084 | 826 | 1720 | 561 | 1782 | 466 | 1794 | 389 | 1776 | 270 | 1904 | 129 | 1440 |
| 8-#8 | 3.22 | MA | 1175 | 868 | 2012 | 577 | 2154 | 477 | 2247 | 395 | 2365 | 257 | 2576 | 165 | 1801 |
| 2L-4S | | MI | 1117 | 868 | 1785 | 586 | 1863 | 484 | 1891 | 399 | 1903 | 264 | 2049 | 88 | 1764 |
| 8-#9 | 4.08 | MA | 1225 | 914 | 2139 | 603 | 2314 | 496 | 2441 | 406 | 2609 | 247 | 2848 | 138 | 2213 |
| 2L-4S | | MI | 1153 | 914 | 1855 | 615 | 1949 | 503 | 1995 | 409 | 2038 | 256 | 2200 | 40 | 2069 |

## RECTANGULAR TIED COLUMNS 14" x 16"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#7 | 1.07 | MA | 1365 | 858 | 2191 | 592 | 2277 | 499 | 2290 | 427 | 2251 | 321 | 2430 | 265 | 906 |
| 2E | | MI | 1188 | 858 | 1915 | 579 | 1972 | 488 | 1972 | 418 | 1917 | 311 | 2033 | 251 | 793 |
| 4-#8 | 1.41 | MA | 1394 | 879 | 2265 | 603 | 2368 | 507 | 2399 | 431 | 2399 | 317 | 2602 | 256 | 1151 |
| 2E | | MI | 1211 | 879 | 1974 | 589 | 2046 | 495 | 2060 | 421 | 2030 | 306 | 2159 | 239 | 999 |
| 4-#9 | 1.79 | MA | 1425 | 903 | 2344 | 615 | 2466 | 515 | 2517 | 436 | 2559 | 314 | 2783 | 244 | 1413 |
| 2E | | MI | 1236 | 903 | 2039 | 601 | 2125 | 503 | 2155 | 425 | 2150 | 300 | 2292 | 224 | 1220 |
| 4-#10 | 2.27 | MA | 1464 | 933 | 2444 | 630 | 2590 | 526 | 2667 | 442 | 2759 | 309 | 3008 | 229 | 1742 |
| 2E | | MI | 1268 | 933 | 2119 | 616 | 2224 | 514 | 2275 | 431 | 2299 | 293 | 2455 | 205 | 1493 |
| 4-#11 | 2.79 | MA | 1499 | 965 | 2539 | 643 | 2700 | 534 | 2797 | 445 | 2907 | 297 | 3154 | 202 | 2066 |
| 2E | | MI | 1294 | 965 | 2192 | 627 | 2307 | 520 | 2365 | 431 | 2398 | 277 | 2537 | 170 | 1760 |
| 4-#14 | 4.02 | MA | 1590 | 1041 | 2773 | 685 | 2993 | 563 | 3151 | 461 | 3347 | 279 | 3636 | 153 | 2833 |
| 2E | | MI | 1364 | 1041 | 2377 | 668 | 2538 | 549 | 2617 | 441 | 2721 | 253 | 2978 | 136 | 2387 |
| 4-#18 | 7.14 | MA | 1800 | 1235 | 3324 | 794 | 3685 | 640 | 3953 | 498 | 4339 | 226 | 4668 | 8 | 4626 |
| 2E | | MI | 1524 | 1235 | 2803 | 776 | 3025 | 613 | 3166 | 458 | 3423 | 181 | 3709 | -27 | 3714 |
| 6-#6 | 1.18 | MA | 1376 | 865 | 2215 | 599 | 2312 | 504 | 2334 | 431 | 2311 | 321 | 2514 | 266 | 985 |
| 2L-3S | | MI | 1174 | 865 | 1863 | 587 | 1910 | 498 | 1897 | 425 | 1820 | 315 | 1922 | 221 | 866 |
| 6-#6 | 1.18 | MA | 1347 | 865 | 2128 | 600 | 2200 | 509 | 2197 | 435 | 2125 | 324 | 2282 | 235 | 994 |
| 3L-2S | | MI | 1197 | 865 | 1935 | 586 | 2002 | 493 | 2010 | 422 | 1972 | 313 | 2102 | 252 | 859 |
| 6-#7 | 1.61 | MA | 1414 | 892 | 2309 | 613 | 2429 | 514 | 2475 | 437 | 2502 | 318 | 2741 | 255 | 1294 |
| 2L-3S | | MI | 1196 | 892 | 1915 | 601 | 1972 | 508 | 1972 | 431 | 1917 | 310 | 2033 | 195 | 1132 |
| 6-#7 | 1.61 | MA | 1374 | 892 | 2191 | 615 | 2277 | 521 | 2290 | 442 | 2251 | 321 | 2430 | 213 | 1307 |
| 3L-2S | | MI | 1228 | 892 | 2012 | 599 | 2097 | 503 | 2124 | 427 | 2120 | 308 | 2271 | 237 | 1119 |
| 6-#8 | 2.12 | MA | 1457 | 923 | 2418 | 630 | 2565 | 526 | 2639 | 443 | 2726 | 314 | 3001 | 241 | 1650 |
| 2L-3S | | MI | 1222 | 923 | 1974 | 618 | 2046 | 521 | 2060 | 438 | 2030 | 305 | 2159 | 164 | 1435 |
| 6-#8 | 2.12 | MA | 1406 | 923 | 2265 | 633 | 2368 | 535 | 2399 | 450 | 2399 | 318 | 2602 | 186 | 1667 |
| 3L-2S | | MI | 1262 | 923 | 2101 | 616 | 2208 | 515 | 2258 | 433 | 2292 | 301 | 2465 | 219 | 1417 |
| 6-#9 | 2.68 | MA | 1504 | 958 | 2537 | 649 | 2713 | 540 | 2818 | 451 | 2968 | 310 | 3276 | 225 | 2033 |
| 2L-3S | | MI | 1249 | 958 | 2039 | 636 | 2125 | 536 | 2155 | 446 | 2150 | 298 | 2292 | 128 | 1756 |
| 6-#9 | 2.68 | MA | 1441 | 958 | 2344 | 652 | 2466 | 550 | 2517 | 459 | 2559 | 314 | 2783 | 155 | 2051 |
| 3L-2S | | MI | 1300 | 958 | 2196 | 635 | 2327 | 528 | 2402 | 440 | 2473 | 293 | 2667 | 198 | 1736 |
| 6-#10 | 3.40 | MA | 1562 | 1003 | 2685 | 674 | 2899 | 557 | 3044 | 461 | 3270 | 303 | 3617 | 203 | 2513 |
| 2L-3S | | MI | 1284 | 1003 | 2119 | 661 | 2224 | 555 | 2275 | 457 | 2299 | 289 | 2455 | 80 | 2153 |
| 6-#10 | 3.40 | MA | 1484 | 1003 | 2444 | 678 | 2590 | 570 | 2667 | 471 | 2759 | 309 | 3008 | 114 | 2529 |
| 3L-2S | | MI | 1347 | 1003 | 2316 | 660 | 2477 | 545 | 2584 | 450 | 2699 | 283 | 2914 | 170 | 2132 |
| 6-#11 | 4.18 | MA | 1614 | 1051 | 2824 | 697 | 3066 | 572 | 3244 | 468 | 3499 | 287 | 3845 | 164 | 2977 |
| 2L-3S | | MI | 1314 | 1051 | 2192 | 680 | 2307 | 569 | 2365 | 460 | 2398 | 269 | 2537 | 11 | 2529 |
| 6-#11 | 4.18 | MA | 1523 | 1051 | 2539 | 699 | 2700 | 586 | 2797 | 478 | 2907 | 294 | 3154 | 54 | 2986 |
| 3L-2S | | MI | 1386 | 1051 | 2424 | 681 | 2604 | 559 | 2722 | 454 | 2855 | 262 | 3047 | 121 | 2508 |
| 6-#14 | 6.03 | MA | 1624 | 1166 | 2773 | 764 | 2993 | 636 | 3151 | 508 | 3347 | 272 | 3636 | -66 | 3608 |
| 3L-2S | | MI | 1490 | 1166 | 2700 | 746 | 2952 | 605 | 3105 | 470 | 3344 | 227 | 3717 | 71 | 3416 |
| 8-#6 | 1.57 | MA | 1413 | 889 | 2303 | 614 | 2424 | 515 | 2471 | 438 | 2497 | 320 | 2747 | 259 | 1272 |
| 2L-4S | | MI | 1194 | 889 | 1878 | 607 | 1928 | 509 | 1919 | 431 | 1856 | 314 | 1972 | 198 | 1120 |

## RECTANGULAR TIED COLUMNS 14" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#6 | 1.57 | MA | 1383 | 889 | 2215 | 616 | 2312 | 520 | 2334 | 442 | 2311 | 322 | 2514 | 228 | 1280 |
| 3E | | MI | 1203 | 889 | 1935 | 602 | 2002 | 508 | 2010 | 431 | 1972 | 313 | 2102 | 211 | 1109 |
| 8-#6 | 1.57 | MA | 1371 | 889 | 2147 | 621 | 2224 | 521 | 2225 | 442 | 2170 | 325 | 2349 | 213 | 1292 |
| 4L-2S | | MI | 1227 | 889 | 2007 | 601 | 2095 | 504 | 2123 | 428 | 2124 | 311 | 2282 | 242 | 1100 |
| 8-#7 | 2.14 | MA | 1462 | 925 | 2427 | 634 | 2580 | 529 | 2659 | 446 | 2753 | 315 | 3051 | 245 | 1675 |
| 2L-4S | | MI | 1222 | 925 | 1935 | 628 | 1997 | 523 | 2002 | 439 | 1965 | 309 | 2099 | 164 | 1465 |
| 8-#7 | 2.14 | MA | 1423 | 925 | 2309 | 636 | 2429 | 536 | 2475 | 451 | 2502 | 319 | 2741 | 203 | 1687 |
| 3E | | MI | 1236 | 925 | 2012 | 621 | 2097 | 523 | 2124 | 440 | 2120 | 307 | 2271 | 181 | 1451 |
| 8-#7 | 2.14 | MA | 1407 | 925 | 2217 | 643 | 2309 | 537 | 2328 | 451 | 2311 | 322 | 2520 | 183 | 1699 |
| 4L-2S | | MI | 1267 | 925 | 2109 | 620 | 2222 | 518 | 2276 | 436 | 2323 | 304 | 2510 | 223 | 1438 |
| 8-#8 | 2.82 | MA | 1520 | 967 | 2572 | 657 | 2762 | 546 | 2880 | 455 | 3053 | 310 | 3400 | 227 | 2142 |
| 2L-4S | | MI | 1256 | 967 | 2000 | 653 | 2078 | 541 | 2099 | 448 | 2092 | 303 | 2243 | 122 | 1831 |
| 8-#8 | 2.82 | MA | 1470 | 967 | 2418 | 660 | 2565 | 554 | 2639 | 462 | 2726 | 315 | 3001 | 171 | 2155 |
| 3E | | MI | 1273 | 967 | 2101 | 645 | 2208 | 541 | 2258 | 450 | 2292 | 300 | 2465 | 145 | 1841 |
| 8-#8 | 2.82 | MA | 1449 | 967 | 2298 | 669 | 2409 | 555 | 2448 | 462 | 2477 | 319 | 2716 | 146 | 2128 |
| 4L-2S | | MI | 1313 | 967 | 2227 | 644 | 2370 | 534 | 2456 | 445 | 2553 | 296 | 2770 | 200 | 1827 |
| 8-#9 | 3.57 | MA | 1582 | 1013 | 2729 | 684 | 2959 | 565 | 3118 | 466 | 3377 | 305 | 3769 | 206 | 2645 |
| 2L-4S | | MI | 1291 | 1013 | 2070 | 681 | 2164 | 560 | 2203 | 459 | 2226 | 295 | 2393 | 75 | 2144 |
| 8-#9 | 3.57 | MA | 1520 | 1013 | 2537 | 687 | 2713 | 575 | 2818 | 474 | 2968 | 310 | 3276 | 135 | 2656 |
| 3E | | MI | 1313 | 1013 | 2196 | 671 | 2327 | 561 | 2402 | 461 | 2473 | 291 | 2667 | 102 | 2257 |
| 8-#9 | 3.57 | MA | 1494 | 1013 | 2385 | 699 | 2517 | 576 | 2578 | 474 | 2656 | 315 | 2923 | 104 | 2520 |
| 4L-2S | | MI | 1363 | 1013 | 2354 | 670 | 2529 | 553 | 2649 | 455 | 2797 | 286 | 3041 | 172 | 2242 |
| 8-#10 | 4.54 | MA | 1584 | 1073 | 2685 | 722 | 2899 | 601 | 3044 | 490 | 3270 | 303 | 3617 | 87 | 3278 |
| 3E | | MI | 1364 | 1073 | 2316 | 705 | 2477 | 586 | 2584 | 476 | 2699 | 279 | 2914 | 46 | 2771 |
| 8-#10 | 4.54 | MA | 1551 | 1073 | 2495 | 736 | 2653 | 602 | 2742 | 489 | 2879 | 309 | 3179 | 48 | 2999 |
| 4L-2S | | MI | 1426 | 1073 | 2514 | 704 | 2730 | 577 | 2892 | 469 | 3100 | 273 | 3373 | 135 | 2760 |
| 8-#11 | 5.57 | MA | 1639 | 1137 | 2824 | 753 | 3066 | 624 | 3244 | 502 | 3499 | 284 | 3845 | 16 | 3801 |
| 3E | | MI | 1413 | 1137 | 2424 | 734 | 2604 | 607 | 2722 | 483 | 2855 | 253 | 3047 | -39 | 3039 |
| 10-#10 | 5.67 | MA | 1651 | 1143 | 2736 | 780 | 2962 | 634 | 3119 | 508 | 3391 | 303 | 3788 | 22 | 3703 |
| 4L-3S | | MI | 1444 | 1143 | 2514 | 749 | 2730 | 618 | 2892 | 495 | 3100 | 269 | 3373 | 11 | 3345 |

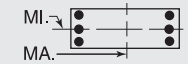
## RECTANGULAR TIED COLUMNS 14" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.25 | MA | 1756 | 978 | 2827 | 683 | 2967 | 575 | 3007 | 491 | 3000 | 365 | 3304 | 305 | 1321 |
| 2E | | MI | 1350 | 978 | 2190 | 656 | 2261 | 552 | 2269 | 471 | 2218 | 346 | 2353 | 273 | 1018 |
| 4-#9 | 1.59 | MA | 1793 | 1002 | 2921 | 695 | 3084 | 584 | 3148 | 496 | 3191 | 362 | 3535 | 296 | 1629 |
| 2E | | MI | 1375 | 1002 | 2254 | 667 | 2340 | 560 | 2363 | 475 | 2337 | 340 | 2485 | 259 | 1241 |
| 4-#10 | 2.02 | MA | 1841 | 1032 | 3041 | 711 | 3232 | 594 | 3327 | 502 | 3433 | 358 | 3823 | 284 | 2016 |
| 2E | | MI | 1406 | 1032 | 2335 | 682 | 2439 | 570 | 2483 | 480 | 2486 | 332 | 2646 | 239 | 1518 |
| 4-#11 | 2.48 | MA | 1883 | 1064 | 3158 | 723 | 3368 | 602 | 3488 | 505 | 3651 | 350 | 4032 | 261 | 2403 |
| 2E | | MI | 1433 | 1064 | 2408 | 692 | 2522 | 576 | 2571 | 479 | 2583 | 315 | 2726 | 204 | 1790 |
| 4-#14 | 3.57 | MA | 1994 | 1140 | 3441 | 765 | 3723 | 632 | 3917 | 521 | 4222 | 339 | 4672 | 222 | 3319 |
| 2E | | MI | 1503 | 1140 | 2593 | 732 | 2751 | 604 | 2822 | 488 | 2905 | 291 | 3166 | 169 | 2424 |
| 4-#18 | 6.35 | MA | 2260 | 1334 | 4117 | 875 | 4571 | 709 | 4945 | 565 | 5510 | 298 | 6096 | 105 | 5490 |
| 2E | | MI | 1663 | 1334 | 3020 | 839 | 3237 | 666 | 3369 | 504 | 3604 | 218 | 3893 | 6 | 3870 |
| 6-#6 | 1.05 | MA | 1734 | 964 | 2767 | 679 | 2899 | 573 | 2928 | 491 | 2894 | 369 | 3187 | 314 | 1128 |
| 2L-3S | | MI | 1312 | 964 | 2078 | 654 | 2125 | 555 | 2106 | 475 | 2009 | 355 | 2117 | 256 | 881 |
| 6-#6 | 1.05 | MA | 1699 | 964 | 2664 | 681 | 2767 | 579 | 2768 | 496 | 2676 | 373 | 2901 | 283 | 1136 |
| 3L-2S | | MI | 1336 | 964 | 2150 | 653 | 2218 | 551 | 2219 | 472 | 2161 | 353 | 2297 | 287 | 875 |
| 6-#7 | 1.43 | MA | 1779 | 991 | 2878 | 693 | 3037 | 583 | 3095 | 496 | 3120 | 365 | 3471 | 305 | 1488 |
| 2L-3S | | MI | 1334 | 991 | 2130 | 668 | 2188 | 566 | 2181 | 481 | 2106 | 350 | 2227 | 230 | 1150 |
| 6-#7 | 1.43 | MA | 1731 | 991 | 2739 | 696 | 2859 | 590 | 2878 | 503 | 2825 | 370 | 3088 | 263 | 1501 |
| 3L-2S | | MI | 1366 | 991 | 2227 | 667 | 2312 | 560 | 2333 | 477 | 2309 | 347 | 2466 | 272 | 1138 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 18"

Short columns – no sidesway
Bending on major or minor axis

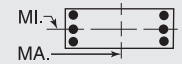



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.88 | MA | 1831 | 1022 | 3008 | 710 | 3199 | 595 | 3290 | 503 | 3385 | 361 | 3798 | 294 | 1906 |
| 2L-3S | | MI | 1360 | 1022 | 2190 | 684 | 2261 | 578 | 2269 | 488 | 2218 | 344 | 2353 | 199 | 1457 |
| 6-#8 | 1.88 | MA | 1770 | 1022 | 2827 | 714 | 2967 | 604 | 3007 | 511 | 3000 | 367 | 3304 | 239 | 1923 |
| 3L-2S | | MI | 1401 | 1022 | 2316 | 683 | 2423 | 572 | 2466 | 483 | 2480 | 341 | 2658 | 254 | 1439 |
| 6-#9 | 2.38 | MA | 1887 | 1057 | 3148 | 730 | 3374 | 608 | 3503 | 511 | 3673 | 357 | 4148 | 281 | 2357 |
| 2L-3S | | MI | 1388 | 1057 | 2254 | 703 | 2340 | 592 | 2363 | 496 | 2337 | 337 | 2485 | 162 | 1783 |
| 6-#9 | 2.38 | MA | 1811 | 1057 | 2921 | 734 | 3084 | 620 | 3148 | 521 | 3191 | 364 | 3535 | 211 | 2375 |
| 3L-2S | | MI | 1439 | 1057 | 2412 | 702 | 2542 | 584 | 2610 | 490 | 2661 | 333 | 2859 | 233 | 1761 |
| 6-#10 | 3.02 | MA | 1958 | 1102 | 3326 | 755 | 3597 | 626 | 3773 | 521 | 4039 | 352 | 4584 | 264 | 2925 |
| 2L-3S | | MI | 1423 | 1102 | 2335 | 727 | 2439 | 611 | 2483 | 506 | 2486 | 328 | 2646 | 115 | 2185 |
| 6-#10 | 3.02 | MA | 1864 | 1102 | 3041 | 760 | 3232 | 640 | 3327 | 533 | 3433 | 360 | 3823 | 174 | 2940 |
| 3L-2S | | MI | 1486 | 1102 | 2532 | 726 | 2692 | 601 | 2791 | 499 | 2886 | 322 | 3106 | 204 | 2160 |
| 6-#11 | 3.71 | MA | 2021 | 1150 | 3497 | 777 | 3804 | 641 | 4019 | 528 | 4373 | 343 | 4909 | 232 | 3482 |
| 2L-3S | | MI | 1453 | 1150 | 2408 | 745 | 2522 | 624 | 2571 | 509 | 2583 | 307 | 2726 | 45 | 2570 |
| 6-#11 | 3.71 | MA | 1911 | 1150 | 3158 | 782 | 3368 | 657 | 3488 | 541 | 3651 | 351 | 4032 | 122 | 3492 |
| 3L-2S | | MI | 1525 | 1150 | 2640 | 746 | 2819 | 614 | 2929 | 502 | 3041 | 300 | 3237 | 154 | 2543 |
| 6-#14 | 5.36 | MA | 2035 | 1265 | 3441 | 849 | 3723 | 709 | 3917 | 572 | 4222 | 338 | 4672 | 16 | 4629 |
| 3L-2S | | MI | 1629 | 1265 | 2916 | 810 | 3166 | 660 | 3310 | 518 | 3528 | 265 | 3904 | 104 | 3459 |
| 8-#6 | 1.40 | MA | 1778 | 988 | 2870 | 694 | 3031 | 584 | 3089 | 498 | 3113 | 367 | 3474 | 308 | 1462 |
| 2L-4S | | MI | 1332 | 988 | 2093 | 674 | 2144 | 566 | 2128 | 481 | 2045 | 354 | 2167 | 233 | 1137 |
| 8-#6 | 1.40 | MA | 1742 | 988 | 2767 | 697 | 2899 | 590 | 2928 | 502 | 2894 | 371 | 3187 | 277 | 1471 |
| 3E | | MI | 1342 | 988 | 2150 | 670 | 2218 | 566 | 2219 | 482 | 2161 | 352 | 2297 | 246 | 1126 |
| 8-#6 | 1.40 | MA | 1726 | 988 | 2687 | 703 | 2796 | 591 | 2802 | 503 | 2730 | 374 | 2986 | 261 | 1482 |
| 4L-2S | | MI | 1365 | 988 | 2222 | 669 | 2310 | 562 | 2332 | 478 | 2313 | 351 | 2477 | 277 | 1118 |
| 8-#7 | 1.90 | MA | 1837 | 1024 | 3017 | 714 | 3215 | 598 | 3312 | 505 | 3415 | 363 | 3853 | 297 | 1935 |
| 2L-4S | | MI | 1361 | 1024 | 2150 | 695 | 2213 | 580 | 2211 | 489 | 2154 | 349 | 2293 | 199 | 1487 |
| 8-#7 | 1.90 | MA | 1790 | 1024 | 2878 | 717 | 3037 | 605 | 3095 | 512 | 3120 | 368 | 3471 | 255 | 1946 |
| 3E | | MI | 1374 | 1024 | 2227 | 689 | 2312 | 580 | 2333 | 490 | 2309 | 347 | 2466 | 216 | 1472 |
| 8-#7 | 1.90 | MA | 1769 | 1024 | 2770 | 725 | 2898 | 607 | 2924 | 513 | 2897 | 372 | 3201 | 234 | 1958 |
| 4L-2S | | MI | 1406 | 1024 | 2324 | 687 | 2437 | 575 | 2485 | 486 | 2512 | 344 | 2705 | 258 | 1459 |
| 8-#8 | 2.51 | MA | 1906 | 1066 | 3189 | 738 | 3431 | 615 | 3573 | 515 | 3770 | 358 | 4293 | 283 | 2484 |
| 2L-4S | | MI | 1394 | 1066 | 2215 | 720 | 2293 | 598 | 2307 | 498 | 2280 | 343 | 2437 | 157 | 1883 |
| 8-#8 | 2.51 | MA | 1846 | 1066 | 3008 | 741 | 3199 | 624 | 3290 | 523 | 3385 | 364 | 3798 | 228 | 2497 |
| 3E | | MI | 1412 | 1066 | 2316 | 712 | 2423 | 598 | 2466 | 500 | 2480 | 339 | 2658 | 179 | 1867 |
| 8-#8 | 2.51 | MA | 1819 | 1066 | 2867 | 752 | 3017 | 626 | 3067 | 524 | 3094 | 370 | 3449 | 200 | 2502 |
| 4L-2S | | MI | 1452 | 1066 | 2442 | 710 | 2585 | 591 | 2664 | 495 | 2742 | 336 | 2963 | 235 | 1851 |
| 8-#9 | 3.17 | MA | 1981 | 1112 | 3375 | 764 | 3665 | 633 | 3858 | 526 | 4156 | 353 | 4761 | 267 | 3077 |
| 2L-4S | | MI | 1430 | 1112 | 2286 | 747 | 2379 | 616 | 2411 | 508 | 2414 | 335 | 2586 | 109 | 2230 |
| 8-#9 | 3.17 | MA | 1906 | 1112 | 3148 | 768 | 3374 | 645 | 3503 | 536 | 3673 | 360 | 4148 | 196 | 3088 |
| 3E | | MI | 1452 | 1112 | 2412 | 737 | 2542 | 617 | 2610 | 511 | 2661 | 330 | 2859 | 137 | 2288 |
| 8-#9 | 3.17 | MA | 1873 | 1112 | 2972 | 782 | 3146 | 647 | 3222 | 537 | 3308 | 367 | 3714 | 162 | 2986 |
| 4L-2S | | MI | 1502 | 1112 | 2570 | 736 | 2744 | 609 | 2857 | 505 | 2985 | 326 | 3234 | 207 | 2270 |
| 8-#10 | 4.03 | MA | 1983 | 1172 | 3326 | 804 | 3597 | 672 | 3773 | 552 | 4039 | 355 | 4584 | 155 | 3827 |
| 3E | | MI | 1503 | 1172 | 2532 | 771 | 2692 | 642 | 2791 | 525 | 2886 | 318 | 3106 | 80 | 2808 |
| 8-#10 | 4.03 | MA | 1942 | 1172 | 3103 | 820 | 3309 | 675 | 3419 | 553 | 3580 | 363 | 4044 | 111 | 3561 |
| 4L-2S | | MI | 1565 | 1172 | 2729 | 770 | 2945 | 633 | 3100 | 518 | 3287 | 312 | 3565 | 169 | 2792 |
| 8-#11 | 4.95 | MA | 2052 | 1236 | 3497 | 836 | 3804 | 696 | 4019 | 565 | 4373 | 344 | 4909 | 93 | 4542 |
| 3E | | MI | 1546 | 1236 | 2640 | 799 | 2819 | 663 | 2929 | 531 | 3041 | 292 | 3237 | -5 | 3297 |
| 8-#11 | 4.95 | MA | 2005 | 1236 | 3231 | 855 | 3459 | 698 | 3596 | 564 | 3822 | 352 | 4282 | 43 | 4103 |
| 4L-2S | | MI | 1616 | 1236 | 2871 | 800 | 3116 | 653 | 3286 | 524 | 3498 | 285 | 3747 | 105 | 3283 |
| 10-#10 | 5.04 | MA | 2061 | 1242 | 3388 | 864 | 3674 | 706 | 3865 | 572 | 4186 | 357 | 4805 | 92 | 4396 |
| 4L-3S | | MI | 1583 | 1242 | 2729 | 815 | 2945 | 674 | 3100 | 544 | 3287 | 308 | 3565 | 45 | 3425 |
| 10-#10 | 5.04 | MA | 1979 | 1242 | 3200 | 869 | 3424 | 721 | 3553 | 585 | 3726 | 354 | 4274 | 39 | 4151 |
| 5L-2S | | MI | 1644 | 1242 | 2926 | 814 | 3197 | 664 | 3408 | 538 | 3688 | 302 | 4025 | 134 | 3417 |
| 10-#11 | 6.19 | MA | 2147 | 1323 | 3570 | 908 | 3894 | 737 | 4127 | 588 | 4545 | 345 | 5158 | 14 | 5100 |
| 4L-3S | | MI | 1645 | 1323 | 2871 | 853 | 3116 | 701 | 3286 | 554 | 3498 | 277 | 3747 | -55 | 3733 |
| 12-#10 | 6.05 | MA | 2099 | 1313 | 3485 | 913 | 3790 | 752 | 3999 | 604 | 4333 | 349 | 5035 | 19 | 4972 |
| 5L-3S | | MI | 1662 | 1313 | 2926 | 859 | 3197 | 706 | 3408 | 564 | 3688 | 298 | 4025 | 10 | 3996 |

## RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

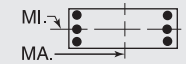
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.13 | MA | 2158 | 1077 | 3445 | 764 | 3626 | 644 | 3678 | 551 | 3660 | 413 | 4071 | 352 | 1492 |
| 2E | | MI | 1489 | 1077 | 2405 | 723 | 2476 | 609 | 2477 | 521 | 2407 | 385 | 2547 | 308 | 1035 |
| 4-#9 | 1.43 | MA | 2202 | 1101 | 3555 | 775 | 3762 | 652 | 3841 | 555 | 3881 | 409 | 4352 | 345 | 1845 |
| 2E | | MI | 1514 | 1101 | 2470 | 733 | 2555 | 616 | 2571 | 524 | 2525 | 379 | 2678 | 293 | 1261 |
| 4-#10 | 1.81 | MA | 2258 | 1131 | 3694 | 791 | 3935 | 663 | 4049 | 561 | 4163 | 405 | 4705 | 335 | 2291 |
| 2E | | MI | 1545 | 1131 | 2550 | 748 | 2654 | 626 | 2690 | 529 | 2673 | 371 | 2838 | 273 | 1541 |
| 4-#11 | 2.23 | MA | 2308 | 1163 | 3833 | 804 | 4098 | 671 | 4242 | 564 | 4422 | 398 | 4979 | 316 | 2740 |
| 2E | | MI | 1572 | 1163 | 2624 | 757 | 2736 | 631 | 2777 | 528 | 2769 | 354 | 2916 | 238 | 1819 |
| 4-#14 | 3.21 | MA | 2440 | 1239 | 4166 | 846 | 4514 | 700 | 4744 | 581 | 5105 | 388 | 5780 | 284 | 3805 |
| 2E | | MI | 1641 | 1239 | 2809 | 796 | 2965 | 658 | 3027 | 536 | 3089 | 329 | 3354 | 202 | 2460 |
| 4-#18 | 5.71 | MA | 2754 | 1433 | 4966 | 955 | 5518 | 777 | 5962 | 625 | 6749 | 365 | 7607 | 188 | 6354 |
| 2E | | MI | 1802 | 1433 | 3237 | 901 | 3450 | 719 | 3572 | 550 | 3786 | 255 | 4077 | 38 | 3922 |
| 6-#7 | 1.29 | MA | 2185 | 1090 | 3503 | 774 | 3706 | 651 | 3777 | 556 | 3796 | 413 | 4266 | 353 | 1683 |
| 2L-3S | | MI | 1473 | 1090 | 2345 | 735 | 2403 | 623 | 2389 | 531 | 2295 | 390 | 2422 | 265 | 1167 |
| 6-#7 | 1.29 | MA | 2128 | 1090 | 3344 | 777 | 3502 | 659 | 3528 | 563 | 3457 | 419 | 3810 | 311 | 1696 |
| 3L-2S | | MI | 1505 | 1090 | 2442 | 734 | 2528 | 617 | 2541 | 527 | 2498 | 387 | 2660 | 307 | 1156 |
| 6-#8 | 1.69 | MA | 2246 | 1121 | 3653 | 791 | 3893 | 664 | 4003 | 563 | 4103 | 409 | 4662 | 344 | 2162 |
| 2L-3S | | MI | 1499 | 1121 | 2405 | 751 | 2476 | 635 | 2477 | 538 | 2407 | 384 | 2547 | 233 | 1477 |
| 6-#8 | 1.69 | MA | 2173 | 1121 | 3445 | 795 | 3626 | 674 | 3678 | 572 | 3660 | 416 | 4071 | 289 | 2179 |
| 3L-2S | | MI | 1540 | 1121 | 2531 | 750 | 2638 | 629 | 2674 | 532 | 2668 | 380 | 2852 | 289 | 1460 |
| 6-#9 | 2.14 | MA | 2312 | 1156 | 3816 | 810 | 4097 | 677 | 4250 | 570 | 4437 | 405 | 5087 | 334 | 2681 |
| 2L-3S | | MI | 1527 | 1156 | 2470 | 769 | 2555 | 649 | 2571 | 545 | 2525 | 376 | 2678 | 197 | 1807 |
| 6-#9 | 2.14 | MA | 2222 | 1156 | 3555 | 815 | 3762 | 690 | 3841 | 582 | 3881 | 413 | 4352 | 264 | 2699 |
| 3L-2S | | MI | 1577 | 1156 | 2627 | 768 | 2757 | 641 | 2818 | 539 | 2849 | 372 | 3052 | 267 | 1785 |
| 6-#10 | 2.72 | MA | 2395 | 1201 | 4023 | 835 | 4356 | 695 | 4563 | 581 | 4863 | 400 | 5620 | 320 | 3336 |
| 2L-3S | | MI | 1561 | 1201 | 2550 | 793 | 2654 | 667 | 2690 | 555 | 2673 | 367 | 2838 | 149 | 2215 |
| 6-#10 | 2.72 | MA | 2284 | 1201 | 3694 | 842 | 3935 | 710 | 4049 | 595 | 4163 | 410 | 4705 | 231 | 3352 |
| 3L-2S | | MI | 1624 | 1201 | 2748 | 792 | 2907 | 658 | 2998 | 548 | 3073 | 361 | 3298 | 238 | 2188 |
| 6-#11 | 3.34 | MA | 2471 | 1249 | 4227 | 857 | 4602 | 710 | 4857 | 588 | 5260 | 391 | 6044 | 293 | 3988 |
| 2L-3S | | MI | 1591 | 1249 | 2624 | 810 | 2736 | 679 | 2777 | 557 | 2769 | 345 | 2916 | 78 | 2608 |
| 6-#11 | 3.34 | MA | 2340 | 1249 | 3833 | 864 | 4098 | 728 | 4242 | 604 | 4422 | 402 | 4979 | 184 | 3997 |
| 3L-2S | | MI | 1663 | 1249 | 2856 | 811 | 3033 | 670 | 3135 | 550 | 3226 | 338 | 3426 | 188 | 2577 |
| 6-#14 | 4.82 | MA | 2487 | 1364 | 4166 | 932 | 4514 | 781 | 4744 | 636 | 5105 | 392 | 5780 | 89 | 5515 |
| 3L-2S | | MI | 1768 | 1364 | 3133 | 874 | 3379 | 714 | 3515 | 566 | 3713 | 303 | 4092 | 137 | 3501 |
| 8-#6 | 1.26 | MA | 2183 | 1087 | 3493 | 775 | 3698 | 653 | 3769 | 557 | 3786 | 415 | 4265 | 356 | 1652 |
| 2L-4S | | MI | 1471 | 1087 | 2307 | 742 | 2359 | 624 | 2337 | 531 | 2234 | 394 | 2362 | 268 | 1152 |
| 8-#6 | 1.26 | MA | 2141 | 1087 | 3375 | 777 | 3547 | 659 | 3585 | 563 | 3535 | 419 | 3925 | 325 | 1661 |
| 3E | | MI | 1480 | 1087 | 2365 | 737 | 2433 | 624 | 2428 | 532 | 2351 | 392 | 2492 | 281 | 1142 |
| 8-#6 | 1.26 | MA | 2121 | 1087 | 3284 | 784 | 3429 | 661 | 3441 | 564 | 3348 | 423 | 3688 | 308 | 1672 |
| 4L-2S | | MI | 1504 | 1087 | 2437 | 736 | 2526 | 620 | 2541 | 529 | 2503 | 390 | 2673 | 312 | 1135 |
| 8-#7 | 1.71 | MA | 2252 | 1123 | 3663 | 794 | 3911 | 666 | 4027 | 565 | 4136 | 410 | 4722 | 348 | 2194 |
| 2L-4S | | MI | 1500 | 1123 | 2365 | 762 | 2428 | 638 | 2419 | 539 | 2343 | 389 | 2487 | 234 | 1508 |
| 8-#7 | 1.71 | MA | 2197 | 1123 | 3503 | 798 | 3706 | 674 | 3777 | 572 | 3796 | 416 | 4266 | 305 | 2206 |
| 3E | | MI | 1513 | 1123 | 2442 | 756 | 2528 | 638 | 2541 | 540 | 2498 | 386 | 2660 | 251 | 1492 |
| 8-#7 | 1.71 | MA | 2171 | 1123 | 3380 | 807 | 3547 | 677 | 3582 | 574 | 3542 | 422 | 3947 | 282 | 2217 |
| 4L-2S | | MI | 1544 | 1123 | 2539 | 755 | 2653 | 632 | 2694 | 536 | 2701 | 384 | 2899 | 293 | 1479 |
| 8-#8 | 2.26 | MA | 2333 | 1165 | 3862 | 818 | 4161 | 683 | 4329 | 575 | 4546 | 406 | 5253 | 337 | 2825 |
| 2L-4S | | MI | 1533 | 1165 | 2431 | 787 | 2508 | 655 | 2515 | 548 | 2468 | 382 | 2630 | 192 | 1910 |
| 8-#8 | 2.26 | MA | 2262 | 1165 | 3653 | 823 | 3893 | 693 | 4003 | 584 | 4103 | 413 | 4662 | 281 | 2838 |
| 3E | | MI | 1550 | 1165 | 2531 | 778 | 2638 | 655 | 2674 | 549 | 2668 | 379 | 2852 | 214 | 1891 |
| 8-#8 | 2.26 | MA | 2229 | 1165 | 3493 | 834 | 3685 | 697 | 3748 | 586 | 3770 | 420 | 4248 | 251 | 2843 |
| 4L-2S | | MI | 1591 | 1165 | 2658 | 777 | 2800 | 648 | 2872 | 544 | 2930 | 375 | 3157 | 269 | 1875 |
| 8-#9 | 2.86 | MA | 2421 | 1211 | 4078 | 845 | 4433 | 702 | 4659 | 586 | 4994 | 400 | 5822 | 323 | 3509 |
| 2L-4S | | MI | 1569 | 1211 | 2501 | 814 | 2594 | 673 | 2618 | 557 | 2602 | 374 | 2779 | 144 | 2297 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

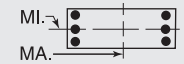
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 2.86 | MA | 2333 | 1211 | 3816 | 850 | 4097 | 715 | 4250 | 597 | 4437 | 409 | 5087 | 253 | 3520 |
| 3E | | MI | 1591 | 1211 | 2627 | 804 | 2757 | 674 | 2818 | 560 | 2849 | 369 | 3052 | 171 | 2316 |
| 8-#9 | 2.86 | MA | 2292 | 1211 | 3615 | 864 | 3836 | 718 | 3929 | 600 | 4019 | 418 | 4571 | 216 | 3466 |
| 4L-2S | | MI | 1641 | 1211 | 2785 | 803 | 2959 | 666 | 3064 | 554 | 3173 | 365 | 3427 | 241 | 2297 |
| 8-#10 | 3.63 | MA | 2423 | 1271 | 4023 | 886 | 4356 | 742 | 4563 | 614 | 4863 | 404 | 5620 | 216 | 4375 |
| 3E | | MI | 1641 | 1271 | 2748 | 837 | 2907 | 699 | 2998 | 574 | 3073 | 357 | 3298 | 114 | 2842 |
| 8-#10 | 3.63 | MA | 2372 | 1271 | 3768 | 903 | 4027 | 747 | 4159 | 617 | 4336 | 415 | 4975 | 170 | 4138 |
| 4L-2S | | MI | 1704 | 1271 | 2945 | 836 | 3159 | 689 | 3307 | 568 | 3474 | 351 | 3757 | 203 | 2823 |
| 8-#11 | 4.46 | MA | 2505 | 1335 | 4227 | 918 | 4602 | 766 | 4857 | 627 | 5260 | 395 | 6044 | 161 | 5216 |
| 3E | | MI | 1685 | 1335 | 2856 | 864 | 3033 | 718 | 3135 | 579 | 3226 | 330 | 3426 | 29 | 3340 |
| 8-#11 | 4.46 | MA | 2448 | 1335 | 3920 | 939 | 4206 | 771 | 4370 | 629 | 4626 | 406 | 5290 | 107 | 4781 |
| 4L-2S | | MI | 1755 | 1335 | 3087 | 865 | 3330 | 709 | 3492 | 573 | 3683 | 323 | 3937 | 138 | 3320 |
| 8-#14 | 6.43 | MA | 2641 | 1488 | 4288 | 1038 | 4664 | 841 | 4924 | 671 | 5390 | 396 | 6205 | -24 | 6191 |
| 4L-2S | | MI | 1894 | 1488 | 3456 | 952 | 3793 | 770 | 4003 | 596 | 4336 | 278 | 4831 | 72 | 4525 |
| 10-#10 | 4.54 | MA | 2511 | 1341 | 4097 | 947 | 4448 | 778 | 4673 | 636 | 5036 | 409 | 5891 | 155 | 5105 |
| 4L-3S | | MI | 1721 | 1341 | 2945 | 881 | 3159 | 730 | 3307 | 593 | 3474 | 347 | 3757 | 79 | 3463 |
| 10-#10 | 4.54 | MA | 2415 | 1341 | 3882 | 953 | 4163 | 794 | 4317 | 650 | 4510 | 409 | 5253 | 103 | 4870 |
| 5L-2S | | MI | 1783 | 1341 | 3142 | 880 | 3412 | 721 | 3615 | 587 | 3875 | 342 | 4217 | 169 | 3450 |
| 10-#11 | 5.57 | MA | 2613 | 1422 | 4314 | 993 | 4710 | 809 | 4986 | 653 | 5463 | 399 | 6354 | 84 | 5940 |
| 4L-3S | | MI | 1783 | 1422 | 3087 | 918 | 3330 | 757 | 3492 | 602 | 3683 | 315 | 3937 | -21 | 3932 |
| 12-#10 | 5.44 | MA | 2555 | 1412 | 4211 | 997 | 4584 | 825 | 4831 | 669 | 5210 | 403 | 6168 | 88 | 5836 |
| 5L-3S | | MI | 1801 | 1412 | 3142 | 925 | 3412 | 762 | 3615 | 613 | 3875 | 337 | 4217 | 44 | 4079 |

## RECTANGULAR TIED COLUMNS 14" x 22"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.03 | MA | 2600 | 1177 | 4120 | 844 | 4347 | 713 | 4410 | 611 | 4378 | 460 | 4903 | 399 | 1663 |
| 2E | | MI | 1627 | 1177 | 2620 | 789 | 2691 | 666 | 2685 | 570 | 2595 | 425 | 2740 | 343 | 1052 |
| 4-#9 | 1.30 | MA | 2651 | 1200 | 4245 | 856 | 4502 | 721 | 4596 | 615 | 4630 | 457 | 5235 | 393 | 2061 |
| 2E | | MI | 1652 | 1200 | 2685 | 800 | 2770 | 673 | 2779 | 574 | 2713 | 418 | 2870 | 328 | 1281 |
| 4-#10 | 1.65 | MA | 2715 | 1230 | 4403 | 872 | 4699 | 732 | 4833 | 621 | 4951 | 453 | 5652 | 385 | 2565 |
| 2E | | MI | 1684 | 1230 | 2766 | 814 | 2869 | 683 | 2897 | 578 | 2860 | 410 | 3030 | 307 | 1564 |
| 4-#11 | 2.03 | MA | 2774 | 1262 | 4565 | 884 | 4888 | 739 | 5057 | 624 | 5252 | 446 | 5993 | 368 | 3076 |
| 2E | | MI | 1710 | 1262 | 2840 | 822 | 2950 | 686 | 2983 | 576 | 2954 | 392 | 3105 | 271 | 1846 |
| 4-#14 | 2.92 | MA | 2927 | 1338 | 4947 | 926 | 5366 | 769 | 5634 | 641 | 6035 | 436 | 6957 | 342 | 4291 |
| 2E | | MI | 1780 | 1338 | 3026 | 861 | 3179 | 713 | 3233 | 584 | 3273 | 367 | 3542 | 236 | 2495 |
| 4-#18 | 5.19 | MA | 3292 | 1532 | 5872 | 1036 | 6526 | 846 | 7040 | 685 | 7944 | 414 | 9195 | 263 | 7218 |
| 2E | | MI | 1940 | 1532 | 3453 | 964 | 3662 | 772 | 3775 | 597 | 3967 | 292 | 4261 | 70 | 3972 |
| 6-#7 | 1.17 | MA | 2630 | 1189 | 4185 | 854 | 4437 | 720 | 4521 | 616 | 4531 | 461 | 5126 | 400 | 1877 |
| 2L-3S | | MI | 1612 | 1189 | 2560 | 802 | 2619 | 680 | 2598 | 581 | 2484 | 429 | 2616 | 300 | 1183 |
| 6-#7 | 1.17 | MA | 2565 | 1189 | 4004 | 858 | 4206 | 729 | 4239 | 624 | 4148 | 467 | 4596 | 358 | 1890 |
| 3L-2S | | MI | 1643 | 1189 | 2657 | 801 | 2743 | 675 | 2750 | 576 | 2687 | 427 | 2855 | 342 | 1173 |
| 6-#8 | 1.54 | MA | 2701 | 1220 | 4355 | 871 | 4649 | 732 | 4778 | 623 | 4879 | 457 | 5591 | 393 | 2418 |
| 2L-3S | | MI | 1637 | 1220 | 2620 | 818 | 2691 | 692 | 2685 | 587 | 2595 | 423 | 2740 | 268 | 1497 |
| 6-#8 | 1.54 | MA | 2617 | 1220 | 4120 | 876 | 4347 | 743 | 4410 | 633 | 4378 | 465 | 4903 | 337 | 2435 |
| 3L-2S | | MI | 1678 | 1220 | 2746 | 817 | 2853 | 686 | 2882 | 582 | 2857 | 420 | 3046 | 324 | 1480 |
| 6-#9 | 1.95 | MA | 2776 | 1255 | 4541 | 891 | 4882 | 746 | 5059 | 630 | 5260 | 452 | 6092 | 385 | 3005 |
| 2L-3S | | MI | 1665 | 1255 | 2685 | 836 | 2770 | 706 | 2779 | 595 | 2713 | 416 | 2870 | 231 | 1830 |
| 6-#9 | 1.95 | MA | 2673 | 1255 | 4245 | 897 | 4502 | 759 | 4596 | 643 | 4630 | 462 | 5235 | 315 | 3023 |
| 3L-2S | | MI | 1716 | 1255 | 2843 | 834 | 2972 | 698 | 3025 | 589 | 3037 | 411 | 3245 | 302 | 1808 |
| 6-#10 | 2.47 | MA | 2872 | 1300 | 4776 | 916 | 5177 | 763 | 5416 | 640 | 5744 | 447 | 6722 | 374 | 3748 |
| 2L-3S | | MI | 1700 | 1300 | 2766 | 859 | 2869 | 724 | 2897 | 604 | 2860 | 406 | 3030 | 183 | 2243 |
| 6-#10 | 2.47 | MA | 2744 | 1300 | 4403 | 923 | 4699 | 780 | 4833 | 656 | 4951 | 459 | 5652 | 284 | 3763 |
| 3L-2S | | MI | 1763 | 1300 | 2963 | 858 | 3121 | 714 | 3206 | 597 | 3261 | 400 | 3490 | 273 | 2214 |
| 6-#11 | 3.04 | MA | 2961 | 1348 | 5013 | 938 | 5462 | 778 | 5756 | 648 | 6204 | 439 | 7247 | 351 | 4493 |
| 2L-3S | | MI | 1730 | 1348 | 2840 | 875 | 2950 | 735 | 2983 | 605 | 2954 | 384 | 3105 | 112 | 2644 |
| 6-#11 | 3.04 | MA | 2810 | 1348 | 4565 | 946 | 4888 | 798 | 5057 | 665 | 5252 | 452 | 5993 | 241 | 4503 |
| 3L-2S | | MI | 1802 | 1348 | 3072 | 876 | 3247 | 725 | 3341 | 598 | 3411 | 377 | 3616 | 222 | 2609 |

## RECTANGULAR TIED COLUMNS 14" x 22"

Short columns – no sidesway
Bending on major or minor axis

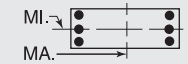



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 4.38 | MA | 2980 | 1463 | 4947 | 1014 | 5366 | 852 | 5634 | 699 | 6035 | 444 | 6957 | 155 | 6247 |
| 3L-2S | | MI | 1907 | 1463 | 3349 | 938 | 3593 | 769 | 3721 | 613 | 3897 | 341 | 4280 | 170 | 3541 |
| 6-#18 | 7.79 | MA | 3390 | 1753 | 5872 | 1189 | 6526 | 989 | 7040 | 783 | 7944 | 421 | 9195 | -85 | 9075 |
| 3L-2S | | MI | 2148 | 1753 | 3989 | 1102 | 4325 | 866 | 4545 | 640 | 4953 | 234 | 5380 | -73 | 5387 |
| 8-#6 | 1.14 | MA | 2628 | 1186 | 4172 | 855 | 4426 | 721 | 4511 | 617 | 4519 | 462 | 5113 | 402 | 1842 |
| 2L-4S | | MI | 1609 | 1186 | 2522 | 809 | 2575 | 681 | 2546 | 581 | 2424 | 434 | 2558 | 303 | 1167 |
| 8-#6 | 1.14 | MA | 2580 | 1186 | 4039 | 858 | 4256 | 728 | 4303 | 623 | 4235 | 467 | 4721 | 371 | 1851 |
| 3E | | MI | 1619 | 1186 | 2579 | 805 | 2649 | 681 | 2637 | 582 | 2540 | 432 | 2688 | 316 | 1157 |
| 8-#6 | 1.14 | MA | 2556 | 1186 | 3937 | 865 | 4124 | 730 | 4141 | 625 | 4025 | 472 | 4449 | 353 | 1862 |
| 4L-2S | | MI | 1643 | 1186 | 2652 | 804 | 2742 | 677 | 2750 | 579 | 2692 | 430 | 2868 | 347 | 1151 |
| 8-#7 | 1.56 | MA | 2708 | 1222 | 4365 | 875 | 4668 | 735 | 4803 | 625 | 4915 | 458 | 5656 | 396 | 2453 |
| 2L-4S | | MI | 1638 | 1222 | 2580 | 829 | 2644 | 695 | 2628 | 588 | 2532 | 429 | 2682 | 268 | 1526 |
| 8-#7 | 1.56 | MA | 2644 | 1222 | 4185 | 879 | 4437 | 744 | 4521 | 633 | 4531 | 464 | 5126 | 354 | 2465 |
| 3E | | MI | 1651 | 1222 | 2657 | 823 | 2743 | 695 | 2750 | 590 | 2687 | 426 | 2855 | 286 | 1511 |
| 8-#7 | 1.56 | MA | 2612 | 1222 | 4047 | 888 | 4258 | 747 | 4302 | 635 | 4245 | 471 | 4757 | 330 | 2477 |
| 4L-2S | | MI | 1683 | 1222 | 2754 | 822 | 2868 | 690 | 2902 | 585 | 2890 | 423 | 3093 | 328 | 1499 |
| 8-#8 | 2.05 | MA | 2801 | 1264 | 4591 | 899 | 4952 | 752 | 5147 | 635 | 5381 | 453 | 6278 | 387 | 3166 |
| 2L-4S | | MI | 1672 | 1264 | 2646 | 854 | 2723 | 712 | 2723 | 597 | 2657 | 422 | 2824 | 226 | 1934 |
| 8-#8 | 2.05 | MA | 2719 | 1264 | 4355 | 904 | 4649 | 763 | 4778 | 645 | 4879 | 461 | 5591 | 332 | 3179 |
| 3E | | MI | 1689 | 1264 | 2746 | 845 | 2853 | 712 | 2882 | 599 | 2857 | 418 | 3046 | 249 | 1914 |
| 8-#8 | 2.05 | MA | 2678 | 1264 | 4175 | 916 | 4416 | 767 | 4491 | 648 | 4505 | 470 | 5112 | 300 | 3184 |
| 4L-2S | | MI | 1729 | 1264 | 2873 | 844 | 3015 | 705 | 3080 | 594 | 3118 | 415 | 3351 | 304 | 1897 |
| 8-#9 | 2.60 | MA | 2902 | 1310 | 4837 | 925 | 5261 | 770 | 5522 | 645 | 5890 | 448 | 6949 | 377 | 3941 |
| 2L-4S | | MI | 1707 | 1310 | 2717 | 880 | 2809 | 730 | 2826 | 607 | 2789 | 413 | 2972 | 178 | 2362 |
| 8-#9 | 2.60 | MA | 2800 | 1310 | 4541 | 931 | 4882 | 784 | 5059 | 658 | 5260 | 458 | 6092 | 307 | 3952 |
| 3E | | MI | 1729 | 1310 | 2843 | 870 | 2972 | 731 | 3025 | 610 | 3037 | 409 | 3245 | 206 | 2343 |
| 8-#9 | 2.60 | MA | 2750 | 1310 | 4314 | 946 | 4587 | 789 | 4697 | 661 | 4789 | 468 | 5493 | 267 | 3937 |
| 4L-2S | | MI | 1779 | 1310 | 3000 | 869 | 3174 | 723 | 3272 | 604 | 3360 | 404 | 3620 | 276 | 2323 |
| 8-#10 | 3.30 | MA | 2904 | 1370 | 4776 | 967 | 5177 | 812 | 5416 | 675 | 5744 | 454 | 6722 | 273 | 4924 |
| 3E | | MI | 1780 | 1370 | 2963 | 903 | 3121 | 755 | 3206 | 623 | 3261 | 396 | 3490 | 148 | 2875 |
| 8-#10 | 3.30 | MA | 2841 | 1370 | 4490 | 986 | 4805 | 818 | 4960 | 679 | 5150 | 466 | 5974 | 224 | 4730 |
| 4L-2S | | MI | 1842 | 1370 | 3160 | 902 | 3374 | 746 | 3514 | 617 | 3661 | 390 | 3949 | 238 | 2852 |
| 8-#11 | 4.05 | MA | 3000 | 1434 | 5013 | 1000 | 5462 | 837 | 5756 | 689 | 6204 | 445 | 7247 | 224 | 5890 |
| 3E | | MI | 1823 | 1434 | 3072 | 929 | 3247 | 773 | 3341 | 628 | 3411 | 369 | 3616 | 62 | 3381 |
| 8-#11 | 4.05 | MA | 2929 | 1434 | 4667 | 1022 | 5014 | 843 | 5207 | 693 | 5488 | 458 | 6366 | 166 | 5475 |
| 4L-2S | | MI | 1894 | 1434 | 3303 | 930 | 3544 | 764 | 3699 | 621 | 3869 | 362 | 4126 | 172 | 3356 |
| 8-#14 | 5.84 | MA | 3151 | 1587 | 5090 | 1123 | 5542 | 915 | 5844 | 737 | 6367 | 451 | 7471 | 45 | 7242 |
| 4L-2S | | MI | 2033 | 1587 | 3672 | 1016 | 4007 | 825 | 4209 | 643 | 4521 | 316 | 5018 | 105 | 4569 |
| 10-#10 | 4.12 | MA | 3001 | 1440 | 4862 | 1030 | 5283 | 849 | 5543 | 698 | 5944 | 460 | 7044 | 213 | 5829 |
| 4L-3S | | MI | 1860 | 1440 | 3160 | 947 | 3374 | 787 | 3514 | 643 | 3661 | 386 | 3949 | 114 | 3499 |
| 10-#10 | 4.12 | MA | 2892 | 1440 | 4621 | 1037 | 4962 | 866 | 5142 | 714 | 5352 | 461 | 6298 | 162 | 5529 |
| 5L-2S | | MI | 1921 | 1440 | 3358 | 946 | 3627 | 777 | 3823 | 636 | 4062 | 381 | 4409 | 203 | 3482 |
| 10-#11 | 5.06 | MA | 3119 | 1521 | 5114 | 1076 | 5588 | 881 | 5906 | 716 | 6440 | 452 | 7620 | 149 | 6797 |
| 4L-3S | | MI | 1921 | 1521 | 3303 | 983 | 3544 | 812 | 3699 | 650 | 3869 | 353 | 4126 | 13 | 4110 |
| 10-#11 | 5.06 | MA | 2989 | 1521 | 4823 | 1084 | 5200 | 901 | 5423 | 734 | 5726 | 451 | 6745 | 86 | 6414 |
| 5L-2S | | MI | 1985 | 1521 | 3535 | 984 | 3841 | 803 | 4056 | 643 | 4326 | 346 | 4636 | 122 | 4094 |
| 12-#10 | 4.95 | MA | 3052 | 1511 | 4994 | 1081 | 5440 | 898 | 5725 | 733 | 6145 | 456 | 7369 | 151 | 6655 |
| 5L-3S | | MI | 1939 | 1511 | 3358 | 991 | 3627 | 818 | 3823 | 662 | 4062 | 376 | 4409 | 79 | 4118 |
| 12-#10 | 4.95 | MA | 2973 | 1511 | 4747 | 1099 | 5121 | 904 | 5328 | 737 | 5612 | 468 | 6686 | 95 | 6217 |
| 6L-2S | | MI | 2001 | 1511 | 3555 | 990 | 3880 | 809 | 4131 | 655 | 4463 | 371 | 4868 | 168 | 4107 |
| 12-#11 | 6.08 | MA | 3180 | 1607 | 5270 | 1138 | 5773 | 940 | 6122 | 757 | 6679 | 444 | 7999 | 68 | 7722 |
| 5L-3S | | MI | 2015 | 1607 | 3535 | 1037 | 3841 | 851 | 4056 | 673 | 4326 | 338 | 4636 | -37 | 4627 |
| 14-#10 | 5.77 | MA | 3135 | 1581 | 5120 | 1142 | 5598 | 935 | 5911 | 756 | 6405 | 463 | 7756 | 83 | 7332 |
| 6L-3S | | MI | 2019 | 1581 | 3555 | 1035 | 3880 | 850 | 4131 | 681 | 4463 | 367 | 4868 | 44 | 4733 |

## RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

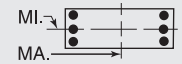
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.19 | MA | 3139 | 1299 | 4991 | 936 | 5303 | 789 | 5412 | 675 | 5438 | 504 | 6168 | 438 | 2277 |
| 2E | | MI | 1791 | 1299 | 2900 | 866 | 2985 | 730 | 2987 | 623 | 2901 | 458 | 3063 | 362 | 1299 |
| 4-#10 | 1.51 | MA | 3212 | 1329 | 5169 | 952 | 5524 | 800 | 5678 | 681 | 5798 | 500 | 6664 | 433 | 2839 |
| 2E | | MI | 1822 | 1329 | 2982 | 880 | 3083 | 739 | 3105 | 627 | 3047 | 449 | 3222 | 342 | 1585 |
| 4-#11 | 1.86 | MA | 3280 | 1361 | 5353 | 964 | 5740 | 808 | 5934 | 684 | 6141 | 493 | 7073 | 419 | 3413 |
| 2E | | MI | 1849 | 1361 | 3056 | 887 | 3164 | 742 | 3189 | 624 | 3140 | 431 | 3295 | 305 | 1873 |
| 4-#14 | 2.68 | MA | 3454 | 1437 | 5785 | 1006 | 6279 | 837 | 6585 | 701 | 7025 | 484 | 8203 | 397 | 4777 |
| 2E | | MI | 1919 | 1437 | 3242 | 925 | 3392 | 768 | 3438 | 631 | 3457 | 405 | 3729 | 269 | 2528 |
| 4-#18 | 4.76 | MA | 3872 | 1631 | 6834 | 1116 | 7596 | 915 | 8180 | 745 | 9190 | 461 | 10856 | 331 | 8082 |
| 2E | | MI | 2079 | 1631 | 3670 | 1026 | 3874 | 826 | 3978 | 643 | 4149 | 329 | 4445 | 103 | 4020 |
| 6-#7 | 1.07 | MA | 3116 | 1288 | 4922 | 935 | 5228 | 789 | 5327 | 676 | 5325 | 508 | 6015 | 442 | 2072 |
| 2L-3S | | MI | 1750 | 1288 | 2775 | 869 | 2834 | 737 | 2806 | 631 | 2673 | 469 | 2810 | 335 | 1198 |
| 6-#7 | 1.07 | MA | 3042 | 1288 | 4721 | 939 | 4971 | 792 | 5013 | 684 | 4897 | 515 | 5422 | 401 | 2085 |
| 3L-2S | | MI | 1782 | 1288 | 2872 | 868 | 2959 | 732 | 2958 | 626 | 2876 | 467 | 3049 | 377 | 1189 |
| 6-#8 | 1.41 | MA | 3195 | 1319 | 5113 | 952 | 5467 | 801 | 5615 | 683 | 5715 | 504 | 6553 | 437 | 2674 |
| 2L-3S | | MI | 1776 | 1319 | 2835 | 885 | 2907 | 749 | 2893 | 637 | 2783 | 463 | 2934 | 303 | 1515 |
| 6-#8 | 1.41 | MA | 3100 | 1319 | 4850 | 957 | 5130 | 812 | 5204 | 693 | 5155 | 513 | 5779 | 383 | 2691 |
| 3L-2S | | MI | 1817 | 1319 | 2962 | 884 | 3069 | 743 | 3091 | 632 | 3045 | 459 | 3239 | 358 | 1499 |
| 6-#9 | 1.79 | MA | 3282 | 1354 | 5322 | 971 | 5727 | 814 | 5929 | 690 | 6141 | 500 | 7142 | 432 | 3329 |
| 2L-3S | | MI | 1804 | 1354 | 2900 | 902 | 2985 | 762 | 2987 | 644 | 2901 | 455 | 3063 | 266 | 1852 |
| 6-#9 | 1.79 | MA | 3164 | 1354 | 4991 | 978 | 5303 | 829 | 5412 | 703 | 5438 | 511 | 6168 | 362 | 3347 |
| 3L-2S | | MI | 1855 | 1354 | 3058 | 901 | 3187 | 754 | 3233 | 638 | 3224 | 451 | 3438 | 336 | 1830 |
| 6-#10 | 2.27 | MA | 3390 | 1399 | 5586 | 996 | 6058 | 832 | 6330 | 700 | 6685 | 495 | 7891 | 425 | 4159 |
| 2L-3S | | MI | 1839 | 1399 | 2982 | 925 | 3083 | 780 | 3105 | 653 | 3047 | 445 | 3222 | 217 | 2269 |
| 6-#10 | 2.27 | MA | 3244 | 1399 | 5169 | 1004 | 5524 | 850 | 5678 | 717 | 5798 | 508 | 6664 | 336 | 4175 |
| 3L-2S | | MI | 1902 | 1399 | 3179 | 924 | 3336 | 770 | 3413 | 647 | 3448 | 439 | 3682 | 307 | 2240 |
| 6-#11 | 2.79 | MA | 3492 | 1447 | 5855 | 1018 | 6383 | 847 | 6718 | 707 | 7207 | 486 | 8518 | 406 | 4999 |
| 2L-3S | | MI | 1868 | 1447 | 3056 | 940 | 3164 | 790 | 3189 | 653 | 3140 | 422 | 3295 | 146 | 2677 |
| 6-#11 | 2.79 | MA | 3320 | 1447 | 5353 | 1028 | 5740 | 868 | 5934 | 727 | 6141 | 502 | 7073 | 296 | 5008 |
| 3L-2S | | MI | 1942 | 1447 | 3288 | 941 | 3461 | 780 | 3547 | 647 | 3597 | 415 | 3805 | 255 | 2640 |
| 6-#14 | 4.02 | MA | 3513 | 1562 | 5785 | 1097 | 6279 | 923 | 6585 | 761 | 7025 | 494 | 8203 | 216 | 6976 |
| 3L-2S | | MI | 2046 | 1562 | 3565 | 1002 | 3806 | 824 | 3926 | 661 | 4081 | 379 | 4468 | 204 | 3580 |
| 6-#18 | 7.14 | MA | 3983 | 1852 | 6834 | 1273 | 7596 | 1062 | 8180 | 847 | 9190 | 474 | 10856 | -3 | 10850 |
| 3L-2S | | MI | 2287 | 1852 | 4205 | 1165 | 4537 | 919 | 4748 | 686 | 5134 | 271 | 5564 | -40 | 5570 |
| 8-#6 | 1.05 | MA | 3113 | 1285 | 4907 | 936 | 5216 | 790 | 5315 | 677 | 5310 | 510 | 5995 | 443 | 2032 |
| 2L-4S | | MI | 1748 | 1285 | 2737 | 877 | 2790 | 739 | 2755 | 632 | 2613 | 474 | 2753 | 338 | 1180 |
| 8-#6 | 1.05 | MA | 3058 | 1285 | 4759 | 939 | 5026 | 793 | 5083 | 683 | 4994 | 515 | 5558 | 414 | 2041 |
| 3E | | MI | 1758 | 1285 | 2794 | 872 | 2864 | 739 | 2846 | 632 | 2729 | 472 | 2883 | 351 | 1172 |
| 8-#6 | 1.05 | MA | 3030 | 1285 | 4646 | 946 | 4880 | 799 | 4903 | 686 | 4760 | 521 | 5259 | 396 | 2052 |
| 4L-2S | | MI | 1781 | 1285 | 2866 | 871 | 2957 | 735 | 2959 | 629 | 2882 | 470 | 3063 | 382 | 1166 |
| 8-#7 | 1.43 | MA | 3203 | 1321 | 5123 | 955 | 5486 | 804 | 5641 | 685 | 5752 | 506 | 6607 | 438 | 2712 |
| 2L-4S | | MI | 1777 | 1321 | 2795 | 897 | 2859 | 752 | 2836 | 638 | 2721 | 468 | 2876 | 303 | 1544 |
| 8-#7 | 1.43 | MA | 3131 | 1321 | 4922 | 960 | 5228 | 807 | 5327 | 693 | 5325 | 513 | 6015 | 397 | 2724 |
| 3E | | MI | 1790 | 1321 | 2872 | 890 | 2959 | 752 | 2958 | 640 | 2876 | 466 | 3049 | 321 | 1529 |
| 8-#7 | 1.43 | MA | 3093 | 1321 | 4769 | 969 | 5030 | 816 | 5083 | 696 | 5007 | 520 | 5608 | 373 | 2736 |
| 4L-2S | | MI | 1822 | 1321 | 2969 | 889 | 3083 | 747 | 3111 | 635 | 3079 | 463 | 3288 | 363 | 1517 |
| 8-#8 | 1.88 | MA | 3309 | 1363 | 5376 | 979 | 5804 | 820 | 6026 | 694 | 6274 | 501 | 7328 | 432 | 3508 |
| 2L-4S | | MI | 1810 | 1363 | 2861 | 920 | 2939 | 768 | 2931 | 647 | 2845 | 461 | 3018 | 261 | 1957 |
| 8-#8 | 1.88 | MA | 3216 | 1363 | 5113 | 985 | 5467 | 832 | 5615 | 705 | 5715 | 510 | 6553 | 378 | 3520 |
| 3E | | MI | 1827 | 1363 | 2962 | 912 | 3069 | 769 | 3091 | 649 | 3045 | 458 | 3239 | 283 | 1936 |
| 8-#8 | 1.88 | MA | 3168 | 1363 | 4913 | 997 | 5207 | 837 | 5296 | 709 | 5299 | 519 | 6019 | 346 | 3525 |
| 4L-2S | | MI | 1868 | 1363 | 3088 | 911 | 3231 | 762 | 3288 | 644 | 3307 | 454 | 3544 | 339 | 1919 |
| 8-#9 | 2.38 | MA | 3423 | 1409 | 5652 | 1006 | 6151 | 839 | 6446 | 705 | 6844 | 496 | 8117 | 426 | 4373 |
| 2L-4S | | MI | 1846 | 1409 | 2932 | 947 | 3024 | 786 | 3034 | 656 | 2977 | 453 | 3165 | 213 | 2392 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 2.38 | MA | 3308 | 1409 | 5322 | 1012 | 5727 | 853 | 5929 | 719 | 6141 | 507 | 7142 | 356 | 4384 |
| 3E | | MI | 1868 | 1409 | 3058 | 937 | 3187 | 787 | 3233 | 659 | 3224 | 448 | 3438 | 240 | 2369 |
| 8-#9 | 2.38 | MA | 3248 | 1409 | 5069 | 1028 | 5400 | 859 | 5527 | 723 | 5618 | 518 | 6468 | 316 | 4369 |
| 4L-2S | | MI | 1918 | 1409 | 3216 | 935 | 3389 | 779 | 3480 | 653 | 3548 | 444 | 3813 | 310 | 2348 |
| 8-#10 | 3.02 | MA | 3425 | 1469 | 5586 | 1048 | 6058 | 881 | 6330 | 736 | 6685 | 503 | 7891 | 328 | 5473 |
| 3E | | MI | 1918 | 1469 | 3179 | 969 | 3336 | 811 | 3413 | 673 | 3448 | 435 | 3682 | 183 | 2905 |
| 8-#10 | 3.02 | MA | 3351 | 1469 | 5267 | 1068 | 5645 | 888 | 5823 | 741 | 6024 | 517 | 7037 | 277 | 5336 |
| 4L-2S | | MI | 1981 | 1469 | 3376 | 968 | 3589 | 802 | 3722 | 666 | 3848 | 430 | 4141 | 272 | 2881 |
| 8-#11 | 3.71 | MA | 3535 | 1533 | 5855 | 1082 | 6383 | 907 | 6718 | 750 | 7207 | 495 | 8518 | 283 | 6564 |
| 3E | | MI | 1962 | 1533 | 3288 | 994 | 3461 | 829 | 3547 | 676 | 3597 | 407 | 3805 | 96 | 3419 |
| 8-#11 | 3.71 | MA | 3451 | 1533 | 5470 | 1105 | 5884 | 914 | 6105 | 756 | 6409 | 510 | 7508 | 222 | 6185 |
| 4L-2S | | MI | 2033 | 1533 | 3520 | 995 | 3758 | 819 | 3905 | 669 | 4054 | 400 | 4316 | 206 | 3391 |
| 8-#14 | 5.36 | MA | 3701 | 1686 | 5948 | 1207 | 6481 | 988 | 6826 | 801 | 7403 | 505 | 8806 | 109 | 8192 |
| 4L-2S | | MI | 2172 | 1686 | 3888 | 1080 | 4221 | 879 | 4414 | 691 | 4705 | 354 | 5206 | 138 | 4612 |
| 10-#10 | 3.78 | MA | 3532 | 1539 | 5684 | 1112 | 6179 | 920 | 6475 | 761 | 6911 | 511 | 8264 | 269 | 6569 |
| 4L-3S | | MI | 1998 | 1539 | 3376 | 1013 | 3589 | 843 | 3722 | 692 | 3848 | 425 | 4141 | 148 | 3532 |
| 10-#10 | 3.78 | MA | 3408 | 1539 | 5417 | 1120 | 5823 | 938 | 6030 | 777 | 6253 | 513 | 7409 | 218 | 6196 |
| 5L-2S | | MI | 2060 | 1539 | 3573 | 1012 | 3842 | 833 | 4030 | 685 | 4249 | 420 | 4601 | 237 | 3513 |
| 10-#11 | 4.64 | MA | 3666 | 1620 | 5971 | 1159 | 6526 | 953 | 6889 | 779 | 7476 | 503 | 8953 | 209 | 7670 |
| 4L-3S | | MI | 2060 | 1620 | 3520 | 1048 | 3758 | 867 | 3905 | 698 | 4054 | 392 | 4316 | 46 | 4152 |
| 10-#11 | 4.64 | MA | 3519 | 1620 | 5647 | 1168 | 6095 | 974 | 6351 | 798 | 6681 | 505 | 7946 | 147 | 7279 |
| 5L-2S | | MI | 2124 | 1620 | 3751 | 1049 | 4055 | 858 | 4263 | 692 | 4511 | 385 | 4826 | 156 | 4132 |
| 10-#14 | 6.70 | MA | 3798 | 1811 | 6198 | 1297 | 6779 | 1073 | 7172 | 862 | 7785 | 495 | 9418 | -4 | 9414 |
| 5L-2S | | MI | 2298 | 1811 | 4211 | 1158 | 4635 | 935 | 4902 | 721 | 5328 | 329 | 5944 | 73 | 5634 |
| 12-#10 | 4.54 | MA | 3589 | 1610 | 5833 | 1164 | 6358 | 969 | 6682 | 796 | 7140 | 508 | 8636 | 211 | 7457 |
| 5L-3S | | MI | 2078 | 1610 | 3573 | 1057 | 3842 | 874 | 4030 | 711 | 4249 | 415 | 4601 | 113 | 4154 |
| 12-#10 | 4.54 | MA | 3501 | 1610 | 5573 | 1170 | 6003 | 976 | 6241 | 802 | 6548 | 522 | 7856 | 152 | 7020 |
| 6L-2S | | MI | 2139 | 1610 | 3770 | 1056 | 4095 | 865 | 4338 | 704 | 4650 | 410 | 5060 | 202 | 4140 |
| 12-#11 | 5.57 | MA | 3735 | 1706 | 6148 | 1222 | 6738 | 1013 | 7135 | 822 | 7748 | 498 | 9391 | 134 | 8788 |
| 5L-3S | | MI | 2153 | 1706 | 3751 | 1102 | 4055 | 906 | 4263 | 721 | 4511 | 377 | 4826 | -3 | 4879 |
| 12-#11 | 5.57 | MA | 3629 | 1706 | 5815 | 1243 | 6309 | 1020 | 6601 | 827 | 7031 | 513 | 8470 | 64 | 8132 |
| 6L-2S | | MI | 2215 | 1706 | 3983 | 1102 | 4352 | 897 | 4620 | 714 | 4969 | 370 | 5336 | 107 | 4866 |
| 14-#10 | 5.29 | MA | 3684 | 1680 | 5990 | 1214 | 6537 | 1008 | 6893 | 821 | 7434 | 516 | 9083 | 144 | 8271 |
| 6L-3S | | MI | 2158 | 1680 | 3770 | 1101 | 4095 | 906 | 4338 | 730 | 4650 | 406 | 5060 | 78 | 4773 |
| 14-#11 | 6.50 | MA | 3847 | 1792 | 6316 | 1297 | 6951 | 1059 | 7385 | 851 | 8098 | 506 | 9915 | 51 | 9638 |
| 6L-3S | | MI | 2246 | 1792 | 3983 | 1156 | 4352 | 945 | 4620 | 743 | 4969 | 361 | 5336 | -53 | 5321 |

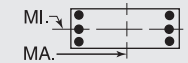
## RECTANGULAR TIED COLUMNS 14" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.10 | MA | 3668 | 1398 | 5793 | 1017 | 6165 | 858 | 6291 | 735 | 6304 | 552 | 7136 | 480 | 2493 |
| 2E | | MI | 1930 | 1398 | 3116 | 933 | 3200 | 786 | 3194 | 672 | 3089 | 497 | 3256 | 397 | 1317 |
| 4-#10 | 1.40 | MA | 3750 | 1428 | 5991 | 1033 | 6410 | 869 | 6586 | 741 | 6703 | 548 | 7688 | 475 | 3113 |
| 2E | | MI | 1961 | 1428 | 3197 | 946 | 3298 | 795 | 3312 | 677 | 3234 | 488 | 3414 | 376 | 1606 |
| 4-#11 | 1.71 | MA | 3827 | 1460 | 6198 | 1045 | 6653 | 877 | 6872 | 744 | 7088 | 541 | 8216 | 467 | 3750 |
| 2E | | MI | 1988 | 1460 | 3272 | 952 | 3378 | 797 | 3395 | 672 | 3325 | 469 | 3484 | 339 | 1898 |
| 4-#14 | 2.47 | MA | 4023 | 1536 | 6679 | 1087 | 7254 | 906 | 7599 | 760 | 8072 | 531 | 9514 | 450 | 5263 |
| 2E | | MI | 2058 | 1536 | 3458 | 989 | 3606 | 822 | 3643 | 679 | 3641 | 442 | 3917 | 302 | 2560 |
| 4-#18 | 4.40 | MA | 4493 | 1730 | 7852 | 1197 | 8727 | 983 | 9383 | 805 | 10493 | 509 | 12587 | 395 | 8946 |
| 2E | | MI | 2218 | 1730 | 3886 | 1089 | 4087 | 879 | 4181 | 690 | 4330 | 366 | 4630 | 135 | 4067 |
| 6-#8 | 1.30 | MA | 3730 | 1418 | 5928 | 1032 | 6345 | 869 | 6513 | 742 | 6608 | 552 | 7559 | 479 | 2930 |
| 2L-3S | | MI | 1915 | 1418 | 3050 | 952 | 3122 | 806 | 3101 | 687 | 2972 | 502 | 3128 | 337 | 1532 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis

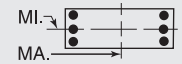



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.30 | MA | 3624 | 1418 | 5638 | 1038 | 5973 | 874 | 6059 | 754 | 5991 | 562 | 6704 | 426 | 2947 |
| 3L-2S | | MI | 1956 | 1418 | 3177 | 950 | 3284 | 800 | 3299 | 681 | 3233 | 499 | 3433 | 393 | 1518 |
| 6-#9 | 1.65 | MA | 3827 | 1453 | 6159 | 1051 | 6633 | 883 | 6862 | 750 | 7081 | 548 | 8212 | 474 | 3653 |
| 2L-3S | | MI | 1942 | 1453 | 3116 | 969 | 3200 | 819 | 3194 | 693 | 3089 | 494 | 3256 | 300 | 1873 |
| 6-#9 | 1.65 | MA | 3694 | 1453 | 5793 | 1059 | 6165 | 889 | 6291 | 764 | 6304 | 560 | 7136 | 406 | 3671 |
| 3L-2S | | MI | 1993 | 1453 | 3273 | 967 | 3402 | 811 | 3441 | 687 | 3412 | 490 | 3631 | 371 | 1851 |
| 6-#10 | 2.09 | MA | 3948 | 1498 | 6452 | 1077 | 7001 | 900 | 7306 | 760 | 7684 | 542 | 9045 | 467 | 4571 |
| 2L-3S | | MI | 1977 | 1498 | 3197 | 991 | 3298 | 836 | 3312 | 702 | 3234 | 484 | 3414 | 252 | 2295 |
| 6-#10 | 2.09 | MA | 3784 | 1498 | 5991 | 1086 | 6410 | 908 | 6586 | 778 | 6703 | 557 | 7688 | 380 | 4586 |
| 3L-2S | | MI | 2040 | 1498 | 3394 | 990 | 3551 | 827 | 3620 | 696 | 3635 | 478 | 3874 | 341 | 2265 |
| 6-#11 | 2.57 | MA | 4064 | 1546 | 6753 | 1099 | 7364 | 915 | 7741 | 767 | 8269 | 534 | 9852 | 458 | 5504 |
| 2L-3S | | MI | 2007 | 1546 | 3272 | 1005 | 3378 | 845 | 3395 | 702 | 3325 | 461 | 3484 | 179 | 2709 |
| 6-#11 | 2.57 | MA | 3870 | 1546 | 6198 | 1109 | 6653 | 938 | 6872 | 788 | 7088 | 551 | 8216 | 348 | 5514 |
| 3L-2S | | MI | 2080 | 1546 | 3504 | 1006 | 3675 | 836 | 3753 | 695 | 3782 | 454 | 3995 | 289 | 2670 |
| 6-#14 | 3.71 | MA | 4087 | 1661 | 6679 | 1179 | 7254 | 993 | 7599 | 823 | 8072 | 544 | 9514 | 275 | 7705 |
| 3L-2S | | MI | 2185 | 1661 | 3781 | 1067 | 4020 | 878 | 4131 | 709 | 4265 | 417 | 4655 | 237 | 3618 |
| 6-#18 | 6.59 | MA | 4616 | 1951 | 7852 | 1356 | 8727 | 1134 | 9383 | 911 | 10493 | 527 | 12587 | 72 | 12338 |
| 3L-2S | | MI | 2425 | 1951 | 4422 | 1227 | 4750 | 972 | 4952 | 733 | 5316 | 308 | 5748 | -8 | 5750 |
| 8-#7 | 1.32 | MA | 3739 | 1420 | 5938 | 1036 | 6365 | 872 | 6542 | 745 | 6649 | 553 | 7616 | 480 | 2971 |
| 2L-4S | | MI | 1915 | 1420 | 3010 | 964 | 3074 | 810 | 3045 | 688 | 2909 | 508 | 3071 | 338 | 1560 |
| 8-#7 | 1.32 | MA | 3657 | 1420 | 5716 | 1040 | 6081 | 876 | 6195 | 753 | 6177 | 561 | 6963 | 440 | 2983 |
| 3E | | MI | 1929 | 1420 | 3087 | 957 | 3174 | 810 | 3167 | 690 | 3065 | 505 | 3244 | 356 | 1546 |
| 8-#7 | 1.32 | MA | 3615 | 1420 | 5548 | 1050 | 5863 | 886 | 5927 | 757 | 5828 | 568 | 6520 | 417 | 2995 |
| 4L-2S | | MI | 1960 | 1420 | 3184 | 956 | 3299 | 804 | 3319 | 685 | 3268 | 503 | 3482 | 398 | 1535 |
| 8-#8 | 1.74 | MA | 3857 | 1462 | 6218 | 1060 | 6717 | 889 | 6967 | 754 | 7226 | 548 | 8414 | 474 | 3849 |
| 2L-4S | | MI | 1949 | 1462 | 3076 | 987 | 3154 | 825 | 3139 | 697 | 3033 | 501 | 3211 | 296 | 1978 |
| 8-#8 | 1.74 | MA | 3752 | 1462 | 5928 | 1065 | 6345 | 894 | 6513 | 766 | 6608 | 558 | 7559 | 421 | 3862 |
| 3E | | MI | 1966 | 1462 | 3177 | 979 | 3284 | 826 | 3299 | 698 | 3233 | 497 | 3433 | 318 | 1956 |
| 8-#8 | 1.74 | MA | 3697 | 1462 | 5708 | 1078 | 6059 | 906 | 6162 | 770 | 6151 | 568 | 6976 | 390 | 3867 |
| 4L-2S | | MI | 2007 | 1462 | 3303 | 978 | 3446 | 819 | 3496 | 693 | 3495 | 494 | 3738 | 374 | 1940 |
| 8-#9 | 2.20 | MA | 3984 | 1508 | 6524 | 1086 | 7101 | 908 | 7433 | 765 | 7858 | 543 | 9288 | 468 | 4805 |
| 2L-4S | | MI | 1985 | 1508 | 3148 | 1013 | 3239 | 843 | 3242 | 705 | 3165 | 492 | 3358 | 247 | 2419 |
| 8-#9 | 2.20 | MA | 3855 | 1508 | 6159 | 1093 | 6633 | 914 | 6862 | 779 | 7081 | 555 | 8212 | 400 | 4816 |
| 3E | | MI | 2006 | 1508 | 3273 | 1003 | 3402 | 844 | 3441 | 708 | 3412 | 487 | 3631 | 275 | 2393 |
| 8-#9 | 2.20 | MA | 3787 | 1508 | 5881 | 1109 | 6273 | 929 | 6420 | 784 | 6505 | 567 | 7476 | 360 | 4801 |
| 4L-2S | | MI | 2057 | 1508 | 3431 | 1002 | 3604 | 836 | 3688 | 702 | 3736 | 483 | 4005 | 345 | 2372 |
| 8-#10 | 2.79 | MA | 3986 | 1568 | 6452 | 1129 | 7001 | 940 | 7306 | 797 | 7684 | 552 | 9045 | 373 | 6021 |
| 3E | | MI | 2057 | 1568 | 3394 | 1035 | 3551 | 868 | 3620 | 722 | 3635 | 474 | 3874 | 217 | 2935 |
| 8-#10 | 2.79 | MA | 3901 | 1568 | 6101 | 1150 | 6546 | 959 | 6748 | 803 | 6956 | 567 | 8112 | 322 | 5955 |
| 4L-2S | | MI | 2120 | 1568 | 3592 | 1034 | 3804 | 858 | 3929 | 715 | 4036 | 469 | 4333 | 306 | 2908 |
| 8-#11 | 3.43 | MA | 4111 | 1632 | 6753 | 1163 | 7364 | 976 | 7741 | 811 | 8269 | 544 | 9852 | 339 | 7238 |
| 3E | | MI | 2100 | 1632 | 3504 | 1059 | 3675 | 884 | 3753 | 724 | 3782 | 445 | 3995 | 130 | 3456 |
| 8-#11 | 3.43 | MA | 4013 | 1632 | 6329 | 1187 | 6814 | 985 | 7065 | 818 | 7389 | 561 | 8714 | 276 | 6910 |
| 4L-2S | | MI | 2172 | 1632 | 3736 | 1059 | 3972 | 875 | 4111 | 717 | 4240 | 438 | 4505 | 239 | 3424 |
| 8-#14 | 4.95 | MA | 4292 | 1785 | 6863 | 1290 | 7481 | 1060 | 7870 | 865 | 8498 | 557 | 10208 | 169 | 9159 |
| 4L-2S | | MI | 2311 | 1785 | 4105 | 1144 | 4434 | 934 | 4619 | 739 | 4889 | 392 | 5394 | 172 | 4654 |
| 10-#10 | 3.49 | MA | 4102 | 1638 | 6562 | 1194 | 7137 | 990 | 7468 | 822 | 7936 | 561 | 9470 | 314 | 7321 |
| 4L-3S | | MI | 2137 | 1638 | 3592 | 1079 | 3804 | 899 | 3929 | 741 | 4036 | 464 | 4333 | 182 | 3565 |
| 10-#10 | 3.49 | MA | 3965 | 1638 | 6269 | 1203 | 6746 | 998 | 6979 | 840 | 7213 | 565 | 8532 | 267 | 6871 |
| 5L-2S | | MI | 2199 | 1638 | 3789 | 1078 | 4057 | 890 | 4237 | 734 | 4436 | 459 | 4793 | 271 | 3543 |
| 10-#11 | 4.29 | MA | 4253 | 1719 | 6884 | 1241 | 7526 | 1024 | 7933 | 842 | 8571 | 554 | 10350 | 266 | 8559 |
| 4L-3S | | MI | 2194 | 1719 | 3736 | 1113 | 3972 | 923 | 4111 | 747 | 4240 | 430 | 4505 | 80 | 4192 |
| 10-#11 | 4.29 | MA | 4089 | 1719 | 6528 | 1251 | 7052 | 1046 | 7341 | 862 | 7695 | 557 | 9210 | 204 | 8085 |
| 5L-2S | | MI | 2263 | 1719 | 3967 | 1113 | 4269 | 913 | 4469 | 740 | 4697 | 423 | 5015 | 190 | 4168 |
| 10-#14 | 6.18 | MA | 4401 | 1910 | 7144 | 1382 | 7817 | 1147 | 8259 | 927 | 8929 | 551 | 10904 | 62 | 10630 |
| 5L-2S | | MI | 2437 | 1910 | 4428 | 1222 | 4849 | 990 | 5107 | 768 | 5513 | 366 | 6132 | 106 | 5679 |
| 12-#10 | 4.19 | MA | 4167 | 1709 | 6729 | 1247 | 7336 | 1029 | 7700 | 859 | 8193 | 559 | 9889 | 259 | 8267 |
| 5L-3S | | MI | 2216 | 1709 | 3789 | 1123 | 4057 | 931 | 4237 | 760 | 4436 | 455 | 4793 | 147 | 4189 |

## RECTANGULAR TIED COLUMNS 14" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

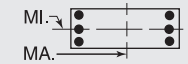
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 4.19 | MA | 4069 | 1709 | 6436 | 1252 | 6947 | 1048 | 7216 | 865 | 7542 | 574 | 9038 | 201 | 7840 |
| 6L-2S | | MI | 2278 | 1709 | 3986 | 1122 | 4309 | 921 | 4546 | 753 | 4837 | 449 | 5252 | 237 | 4172 |
| 12-#11 | 5.14 | MA | 4330 | 1805 | 7083 | 1305 | 7764 | 1085 | 8210 | 886 | 8877 | 550 | 10846 | 195 | 9771 |
| 5L-3S | | MI | 2291 | 1805 | 3967 | 1167 | 4269 | 962 | 4469 | 769 | 4697 | 415 | 5015 | 30 | 4922 |
| 12-#11 | 5.14 | MA | 4213 | 1805 | 6736 | 1312 | 7292 | 1093 | 7622 | 892 | 8088 | 567 | 9807 | 122 | 9091 |
| 6L-2S | | MI | 2354 | 1805 | 4199 | 1167 | 4566 | 952 | 4827 | 762 | 5154 | 408 | 5526 | 140 | 4905 |
| 14-#10 | 4.88 | MA | 4272 | 1779 | 6897 | 1296 | 7537 | 1080 | 7936 | 884 | 8522 | 568 | 10396 | 193 | 9228 |
| 6L-3S | | MI | 2296 | 1779 | 3986 | 1167 | 4309 | 962 | 4546 | 779 | 4837 | 445 | 5252 | 112 | 4810 |
| 14-#10 | 4.88 | MA | 4172 | 1779 | 6566 | 1312 | 7158 | 1086 | 7474 | 902 | 7888 | 583 | 9514 | 154 | 8784 |
| 7L-2S | | MI | 2357 | 1779 | 4183 | 1166 | 4562 | 953 | 4854 | 772 | 5237 | 439 | 5711 | 202 | 4797 |
| 14-#11 | 6.00 | MA | 4457 | 1891 | 7291 | 1366 | 8004 | 1132 | 8491 | 916 | 9269 | 560 | 11443 | 113 | 10766 |
| 6L-3S | | MI | 2384 | 1891 | 4199 | 1221 | 4566 | 1000 | 4827 | 792 | 5154 | 400 | 5526 | -19 | 5647 |
| 16-#10 | 5.58 | MA | 4375 | 1849 | 7027 | 1356 | 7749 | 1117 | 8194 | 921 | 8868 | 578 | 10871 | 146 | 10173 |
| 7L-3S | | MI | 2376 | 1849 | 4183 | 1211 | 4562 | 994 | 4854 | 798 | 5237 | 435 | 5711 | 78 | 5427 |

## RECTANGULAR TIED COLUMNS 14" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.02 | MA | 4236 | 1497 | 6652 | 1097 | 7088 | 927 | 7231 | 795 | 7228 | 600 | 8166 | 522 | 2709 |
| 2E | | MI | 2068 | 1497 | 3331 | 999 | 3415 | 843 | 3402 | 722 | 3276 | 536 | 3449 | 431 | 1334 |
| 4-#10 | 1.30 | MA | 4327 | 1527 | 6869 | 1113 | 7357 | 938 | 7555 | 801 | 7667 | 596 | 8772 | 517 | 3388 |
| 2E | | MI | 2100 | 1527 | 3413 | 1012 | 3513 | 851 | 3519 | 726 | 3422 | 527 | 3606 | 410 | 1626 |
| 4-#11 | 1.59 | MA | 4414 | 1559 | 7098 | 1125 | 7626 | 945 | 7873 | 804 | 8093 | 588 | 9358 | 509 | 4087 |
| 2E | | MI | 2126 | 1559 | 3488 | 1017 | 3592 | 852 | 3601 | 721 | 3511 | 507 | 3674 | 372 | 1923 |
| 4-#14 | 2.30 | MA | 4631 | 1635 | 7629 | 1167 | 8289 | 975 | 8674 | 820 | 9179 | 579 | 10857 | 498 | 5749 |
| 2E | | MI | 2196 | 1635 | 3675 | 1053 | 3819 | 877 | 3848 | 727 | 3825 | 480 | 4105 | 335 | 2592 |
| 4-#18 | 4.08 | MA | 5156 | 1829 | 8927 | 1277 | 9918 | 1052 | 10647 | 865 | 11856 | 557 | 14387 | 455 | 9810 |
| 2E | | MI | 2356 | 1829 | 4103 | 1151 | 4299 | 932 | 4384 | 736 | 4512 | 403 | 4814 | 168 | 4112 |
| 6-#8 | 1.21 | MA | 4305 | 1517 | 6799 | 1113 | 7284 | 938 | 7474 | 802 | 7561 | 600 | 8628 | 521 | 3186 |
| 2L-3S | | MI | 2053 | 1517 | 3266 | 1018 | 3337 | 863 | 3309 | 736 | 3160 | 542 | 3321 | 372 | 1549 |
| 6-#8 | 1.21 | MA | 4187 | 1517 | 6481 | 1119 | 6877 | 943 | 6977 | 814 | 6885 | 610 | 7692 | 469 | 3203 |
| 3L-2S | | MI | 2094 | 1517 | 3392 | 1017 | 3499 | 856 | 3507 | 731 | 3422 | 538 | 3627 | 428 | 1536 |
| 6-#9 | 1.53 | MA | 4412 | 1552 | 7052 | 1132 | 7601 | 951 | 7856 | 810 | 8079 | 595 | 9344 | 515 | 3977 |
| 2L-3S | | MI | 2081 | 1552 | 3331 | 1035 | 3415 | 876 | 3402 | 743 | 3276 | 534 | 3449 | 335 | 1893 |
| 6-#9 | 1.53 | MA | 4265 | 1552 | 6652 | 1140 | 7088 | 958 | 7231 | 824 | 7228 | 608 | 8166 | 449 | 3995 |
| 3L-2S | | MI | 2132 | 1552 | 3489 | 1034 | 3617 | 868 | 3649 | 737 | 3600 | 529 | 3824 | 405 | 1872 |
| 6-#10 | 1.94 | MA | 4547 | 1597 | 7374 | 1157 | 8004 | 969 | 8344 | 820 | 8741 | 590 | 10259 | 509 | 4982 |
| 2L-3S | | MI | 2116 | 1597 | 3413 | 1057 | 3513 | 892 | 3519 | 752 | 3422 | 523 | 3606 | 286 | 2319 |
| 6-#10 | 1.94 | MA | 4364 | 1597 | 6869 | 1167 | 7357 | 977 | 7555 | 838 | 7667 | 606 | 8772 | 424 | 4998 |
| 3L-2S | | MI | 2179 | 1597 | 3610 | 1056 | 3766 | 883 | 3828 | 745 | 3822 | 518 | 4066 | 375 | 2289 |
| 6-#11 | 2.39 | MA | 4676 | 1645 | 7708 | 1179 | 8408 | 984 | 8826 | 827 | 9390 | 581 | 11153 | 500 | 6010 |
| 2L-3S | | MI | 2146 | 1645 | 3488 | 1070 | 3592 | 901 | 3601 | 750 | 3511 | 499 | 3674 | 213 | 2739 |
| 6-#11 | 2.39 | MA | 4460 | 1645 | 7098 | 1190 | 7626 | 993 | 7873 | 849 | 8093 | 600 | 9358 | 393 | 6019 |
| 3L-2S | | MI | 2219 | 1645 | 3720 | 1070 | 3889 | 891 | 3959 | 743 | 3968 | 492 | 4184 | 323 | 2700 |
| 6-#14 | 3.44 | MA | 4702 | 1760 | 7629 | 1260 | 8289 | 1063 | 8674 | 884 | 9179 | 594 | 10857 | 327 | 8434 |
| 3L-2S | | MI | 2323 | 1760 | 3998 | 1131 | 4234 | 933 | 4336 | 756 | 4449 | 455 | 4843 | 270 | 3654 |
| 6-#18 | 6.12 | MA | 5291 | 2050 | 8927 | 1439 | 9918 | 1206 | 10647 | 974 | 11856 | 579 | 14387 | 141 | 13851 |
| 3L-2S | | MI | 2564 | 2050 | 4638 | 1290 | 4962 | 1026 | 5155 | 779 | 5497 | 345 | 5932 | 25 | 5832 |
| 8-#7 | 1.22 | MA | 4314 | 1519 | 6809 | 1116 | 7306 | 941 | 7504 | 804 | 7603 | 601 | 8689 | 522 | 3231 |
| 2L-4S | | MI | 2054 | 1519 | 3225 | 1031 | 3290 | 867 | 3253 | 738 | 3098 | 548 | 3265 | 373 | 1576 |
| 8-#7 | 1.22 | MA | 4224 | 1519 | 6567 | 1121 | 6995 | 945 | 7124 | 814 | 7087 | 609 | 7974 | 483 | 3242 |
| 3E | | MI | 2067 | 1519 | 3302 | 1024 | 3389 | 867 | 3375 | 739 | 3254 | 545 | 3438 | 390 | 1562 |
| 8-#7 | 1.22 | MA | 4175 | 1519 | 6384 | 1131 | 6758 | 955 | 6832 | 817 | 6707 | 617 | 7494 | 460 | 3254 |
| 4L-2S | | MI | 2099 | 1519 | 3399 | 1023 | 3514 | 862 | 3528 | 735 | 3457 | 543 | 3677 | 433 | 1552 |
| 8-#8 | 1.61 | MA | 4445 | 1561 | 7116 | 1140 | 7691 | 958 | 7970 | 814 | 8236 | 596 | 9564 | 516 | 4190 |
| 2L-4S | | MI | 2087 | 1561 | 3291 | 1054 | 3369 | 882 | 3348 | 746 | 3222 | 540 | 3405 | 330 | 1998 |
| 8-#8 | 1.61 | MA | 4329 | 1561 | 6799 | 1146 | 7284 | 963 | 7474 | 826 | 7561 | 606 | 8628 | 464 | 4203 |
| 3E | | MI | 2105 | 1561 | 3392 | 1046 | 3499 | 883 | 3507 | 748 | 3422 | 537 | 3627 | 353 | 1976 |

## RECTANGULAR TIED COLUMNS 14" x 28"

Short columns – no sidesway
Bending on major or minor axis

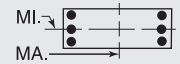



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#8 | 1.61 | MA | 4266 | 1561 | 6559 | 1159 | 6973 | 976 | 7091 | 831 | 7062 | 617 | 7997 | 434 | 4208 |
| 4L-2S | | MI | 2145 | 1561 | 3518 | 1044 | 3661 | 876 | 3704 | 743 | 3683 | 533 | 3932 | 408 | 1960 |
| 8-#9 | 2.04 | MA | 4586 | 1607 | 7452 | 1166 | 8113 | 976 | 8481 | 825 | 8930 | 591 | 10522 | 509 | 5237 |
| 2L-4S | | MI | 2123 | 1607 | 3363 | 1080 | 3455 | 900 | 3449 | 755 | 3353 | 531 | 3550 | 282 | 2444 |
| 8-#9 | 2.04 | MA | 4443 | 1607 | 7052 | 1174 | 7601 | 983 | 7856 | 840 | 8079 | 604 | 9344 | 443 | 5248 |
| 3E | | MI | 2145 | 1607 | 3489 | 1070 | 3617 | 901 | 3649 | 758 | 3600 | 527 | 3824 | 309 | 2417 |
| 8-#9 | 2.04 | MA | 4365 | 1607 | 6750 | 1191 | 7208 | 999 | 7374 | 845 | 7450 | 617 | 8547 | 404 | 5233 |
| 4L-2S | | MI | 2195 | 1607 | 3647 | 1068 | 3819 | 893 | 3895 | 752 | 3924 | 522 | 4198 | 379 | 2395 |
| 8-#10 | 2.59 | MA | 4587 | 1667 | 7374 | 1211 | 8004 | 1009 | 8344 | 857 | 8741 | 600 | 10259 | 417 | 6570 |
| 3E | | MI | 2196 | 1667 | 3610 | 1101 | 3766 | 924 | 3828 | 771 | 3822 | 513 | 4066 | 251 | 2962 |
| 8-#10 | 2.59 | MA | 4491 | 1667 | 6992 | 1231 | 7508 | 1029 | 7735 | 865 | 7947 | 616 | 9249 | 367 | 6514 |
| 4L-2S | | MI | 2258 | 1667 | 3807 | 1100 | 4019 | 915 | 4136 | 764 | 4223 | 508 | 4525 | 341 | 2935 |
| 8-#11 | 3.18 | MA | 4726 | 1731 | 7708 | 1244 | 8408 | 1032 | 8826 | 872 | 9390 | 593 | 11153 | 383 | 7912 |
| 3E | | MI | 2239 | 1731 | 3720 | 1124 | 3889 | 939 | 3959 | 772 | 3968 | 484 | 4184 | 163 | 3491 |
| 8-#11 | 3.18 | MA | 4614 | 1731 | 7244 | 1269 | 7806 | 1055 | 8087 | 880 | 8427 | 611 | 9919 | 321 | 7648 |
| 4L-2S | | MI | 2310 | 1731 | 3952 | 1124 | 4187 | 930 | 4317 | 766 | 4425 | 477 | 4695 | 273 | 3457 |
| 8-#14 | 4.59 | MA | 4923 | 1884 | 7835 | 1373 | 8543 | 1132 | 8976 | 928 | 9651 | 609 | 11643 | 223 | 10143 |
| 4L-2S | | MI | 2450 | 1884 | 4321 | 1208 | 4648 | 989 | 4824 | 786 | 5073 | 430 | 5581 | 205 | 4695 |
| 10-#10 | 3.24 | MA | 4713 | 1737 | 7496 | 1275 | 8155 | 1060 | 8524 | 884 | 9020 | 611 | 10736 | 359 | 8071 |
| 4L-3S | | MI | 2275 | 1737 | 3807 | 1145 | 4019 | 956 | 4136 | 790 | 4223 | 503 | 4525 | 216 | 3596 |
| 10-#10 | 3.24 | MA | 4561 | 1737 | 7177 | 1285 | 7729 | 1069 | 7991 | 902 | 8231 | 615 | 9716 | 314 | 7554 |
| 5L-2S | | MI | 2337 | 1737 | 4004 | 1144 | 4271 | 946 | 4445 | 783 | 4623 | 498 | 4985 | 306 | 3572 |
| 10-#11 | 3.98 | MA | 4881 | 1818 | 7854 | 1323 | 8587 | 1094 | 9040 | 904 | 9724 | 604 | 11714 | 312 | 9463 |
| 4L-3S | | MI | 2332 | 1818 | 3952 | 1178 | 4187 | 978 | 4317 | 795 | 4425 | 469 | 4695 | 114 | 4230 |
| 10-#11 | 3.98 | MA | 4699 | 1818 | 7465 | 1334 | 8070 | 1104 | 8393 | 925 | 8767 | 609 | 10474 | 254 | 8899 |
| 5L-2S | | MI | 2402 | 1818 | 4183 | 1178 | 4484 | 969 | 4675 | 788 | 4882 | 462 | 5205 | 224 | 4204 |
| 10-#14 | 5.74 | MA | 5044 | 2009 | 8147 | 1466 | 8916 | 1220 | 9409 | 992 | 10131 | 604 | 12423 | 122 | 11856 |
| 5L-2S | | MI | 2576 | 2009 | 4644 | 1286 | 5062 | 1045 | 5312 | 816 | 5697 | 404 | 6320 | 140 | 5723 |
| 12-#10 | 3.89 | MA | 4785 | 1808 | 7681 | 1329 | 8376 | 1100 | 8780 | 921 | 9305 | 610 | 11203 | 307 | 9086 |
| 5L-3S | | MI | 2355 | 1808 | 4004 | 1189 | 4271 | 987 | 4445 | 809 | 4623 | 494 | 4985 | 182 | 4222 |
| 12-#10 | 3.89 | MA | 4676 | 1808 | 7356 | 1334 | 7952 | 1120 | 8252 | 928 | 8596 | 626 | 10283 | 249 | 8677 |
| 6L-2S | | MI | 2417 | 1808 | 4202 | 1188 | 4524 | 978 | 4753 | 802 | 5024 | 488 | 5444 | 271 | 4203 |
| 12-#11 | 4.78 | MA | 4966 | 1904 | 8075 | 1388 | 8851 | 1142 | 9346 | 949 | 10064 | 602 | 12269 | 244 | 10752 |
| 5L-3S | | MI | 2430 | 1904 | 4183 | 1232 | 4484 | 1017 | 4675 | 817 | 4882 | 453 | 5205 | 64 | 4963 |
| 12-#11 | 4.78 | MA | 4837 | 1904 | 7687 | 1395 | 8336 | 1165 | 8705 | 956 | 9203 | 620 | 11144 | 172 | 10068 |
| 6L-2S | | MI | 2493 | 1904 | 4415 | 1232 | 4781 | 1007 | 5033 | 811 | 5340 | 446 | 5715 | 174 | 4943 |
| 12-#14 | 6.89 | MA | 5241 | 2133 | 8469 | 1554 | 9292 | 1289 | 9850 | 1036 | 10747 | 620 | 13362 | 4 | 13341 |
| 6L-2S | | MI | 2703 | 2133 | 4967 | 1364 | 5477 | 1100 | 5800 | 846 | 6320 | 379 | 7058 | 75 | 6743 |
| 14-#10 | 4.54 | MA | 4901 | 1878 | 7860 | 1378 | 8599 | 1151 | 9042 | 948 | 9669 | 620 | 11769 | 241 | 10202 |
| 6L-3S | | MI | 2435 | 1878 | 4202 | 1233 | 4524 | 1019 | 4753 | 828 | 5024 | 484 | 5444 | 147 | 4845 |
| 14-#10 | 4.54 | MA | 4788 | 1878 | 7499 | 1394 | 8177 | 1157 | 8538 | 966 | 8978 | 636 | 10813 | 204 | 9692 |
| 7L-2S | | MI | 2496 | 1878 | 4399 | 1232 | 4777 | 1009 | 5061 | 821 | 5425 | 478 | 5903 | 236 | 4830 |
| 14-#11 | 5.57 | MA | 5106 | 1990 | 8296 | 1449 | 9118 | 1204 | 9658 | 980 | 10499 | 613 | 12939 | 163 | 11912 |
| 6L-3S | | MI | 2523 | 1990 | 4415 | 1286 | 4781 | 1056 | 5033 | 840 | 5340 | 438 | 5715 | 14 | 5691 |
| 14-#11 | 5.57 | MA | 4974 | 1990 | 7859 | 1468 | 8616 | 1212 | 9047 | 1002 | 9660 | 632 | 11773 | 114 | 11219 |
| 7L-2S | | MI | 2584 | 1990 | 4647 | 1286 | 5078 | 1046 | 5391 | 833 | 5797 | 431 | 6226 | 124 | 5677 |
| 16-#10 | 5.18 | MA | 5012 | 1948 | 8004 | 1438 | 8824 | 1188 | 9327 | 985 | 10052 | 630 | 12299 | 197 | 11235 |
| 7L-3S | | MI | 2514 | 1948 | 4399 | 1277 | 4777 | 1050 | 5061 | 847 | 5425 | 474 | 5903 | 112 | 5465 |
| 16-#10 | 5.18 | MA | 4888 | 1948 | 7687 | 1445 | 8386 | 1204 | 8831 | 1003 | 9316 | 635 | 11251 | 131 | 10589 |
| 8L-2S | | MI | 2575 | 1948 | 4596 | 1276 | 5030 | 1041 | 5370 | 841 | 5825 | 468 | 6363 | 201 | 5454 |
| 16-#11 | 6.37 | MA | 5242 | 2077 | 8468 | 1522 | 9397 | 1251 | 9999 | 1025 | 10957 | 625 | 13568 | 105 | 13061 |
| 7L-3S | | MI | 2615 | 2077 | 4647 | 1340 | 5078 | 1094 | 5391 | 862 | 5797 | 423 | 6226 | -35 | 6416 |
| 18-#10 | 5.83 | MA | 5113 | 2019 | 8191 | 1489 | 9033 | 1236 | 9621 | 1022 | 10389 | 630 | 12737 | 123 | 12122 |
| 8L-3S | | MI | 2594 | 2019 | 4596 | 1321 | 5030 | 1082 | 5370 | 866 | 5825 | 464 | 6363 | 77 | 6081 |

## RECTANGULAR TIED COLUMNS 16" x 16"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

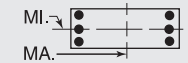
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 1.41 | MA | 1595 | 1005 | 2589 | 691 | 2711 | 581 | 2749 | 495 | 2752 | 364 | 2999 | 296 | 1314 |
| 2L-3S | | MI | 1555 | 1005 | 2471 | 694 | 2560 | 588 | 2564 | 500 | 2501 | 368 | 2689 | 254 | 1326 |
| 6-#8 | 1.85 | MA | 1638 | 1036 | 2698 | 708 | 2847 | 593 | 2913 | 501 | 2975 | 360 | 3259 | 282 | 1673 |
| 2L-3S | | MI | 1587 | 1036 | 2544 | 711 | 2650 | 601 | 2673 | 508 | 2648 | 364 | 2860 | 226 | 1691 |
| 6-#9 | 2.34 | MA | 1685 | 1071 | 2816 | 727 | 2994 | 606 | 3091 | 509 | 3217 | 356 | 3533 | 266 | 2060 |
| 2L-3S | | MI | 1622 | 1071 | 2624 | 730 | 2748 | 616 | 2791 | 517 | 2807 | 360 | 3040 | 195 | 2080 |
| 6-#10 | 2.98 | MA | 1744 | 1116 | 2965 | 752 | 3181 | 624 | 3317 | 519 | 3518 | 349 | 3873 | 243 | 2543 |
| 2L-3S | | MI | 1665 | 1116 | 2724 | 755 | 2872 | 636 | 2940 | 528 | 3007 | 355 | 3264 | 154 | 2564 |
| 6-#11 | 3.66 | MA | 1795 | 1164 | 3105 | 773 | 3348 | 637 | 3516 | 525 | 3745 | 332 | 4099 | 204 | 3014 |
| 2L-3S | | MI | 1704 | 1164 | 2820 | 776 | 2981 | 651 | 3069 | 535 | 3153 | 339 | 3407 | 94 | 3034 |
| 6-#14 | 5.27 | MA | 1932 | 1279 | 3455 | 838 | 3787 | 683 | 4049 | 551 | 4408 | 307 | 4826 | 132 | 4145 |
| 2L-3S | | MI | 1805 | 1279 | 3054 | 840 | 3273 | 700 | 3422 | 564 | 3591 | 317 | 3887 | -27 | 3876 |
| 8-#7 | 1.88 | MA | 1644 | 1038 | 2707 | 712 | 2862 | 596 | 2933 | 504 | 3003 | 362 | 3309 | 286 | 1698 |
| 2L-4S | | MI | 1588 | 1038 | 2496 | 722 | 2591 | 604 | 2602 | 510 | 2561 | 369 | 2778 | 224 | 1724 |
| 8-#8 | 2.47 | MA | 1701 | 1080 | 2852 | 736 | 3044 | 613 | 3154 | 513 | 3302 | 357 | 3658 | 268 | 2168 |
| 2L-4S | | MI | 1630 | 1080 | 2577 | 748 | 2691 | 622 | 2722 | 520 | 2726 | 365 | 2973 | 187 | 2195 |
| 8-#9 | 3.13 | MA | 1763 | 1127 | 3009 | 762 | 3241 | 631 | 3392 | 524 | 3626 | 351 | 4026 | 246 | 2674 |
| 2L-4S | | MI | 1675 | 1127 | 2665 | 776 | 2799 | 642 | 2851 | 532 | 2904 | 361 | 3180 | 144 | 2609 |
| 8-#10 | 3.97 | MA | 1842 | 1186 | 3207 | 796 | 3490 | 655 | 3694 | 538 | 4029 | 343 | 4482 | 217 | 3309 |
| 2L-4S | | MI | 1732 | 1186 | 2775 | 814 | 2935 | 668 | 3015 | 546 | 3127 | 355 | 3435 | 89 | 3098 |

## RECTANGULAR TIED COLUMNS 16" x 18"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#8 | 1.10 | MA | 1985 | 1106 | 3179 | 773 | 3324 | 652 | 3356 | 558 | 3318 | 418 | 3635 | 352 | 1341 |
| 2E | | MI | 1756 | 1106 | 2824 | 759 | 2932 | 640 | 2947 | 548 | 2897 | 410 | 3117 | 337 | 1188 |
| 4-#9 | 1.39 | MA | 2023 | 1129 | 3274 | 784 | 3441 | 660 | 3496 | 562 | 3509 | 415 | 3865 | 342 | 1652 |
| 2E | | MI | 1787 | 1129 | 2904 | 770 | 3030 | 648 | 3064 | 552 | 3056 | 406 | 3297 | 325 | 1457 |
| 4-#10 | 1.76 | MA | 2070 | 1159 | 3394 | 800 | 3589 | 670 | 3675 | 568 | 3750 | 410 | 4152 | 330 | 2042 |
| 2E | | MI | 1827 | 1159 | 3005 | 785 | 3153 | 658 | 3213 | 557 | 3255 | 401 | 3520 | 310 | 1792 |
| 4-#11 | 2.17 | MA | 2112 | 1191 | 3512 | 811 | 3725 | 677 | 3835 | 570 | 3966 | 402 | 4358 | 307 | 2434 |
| 2E | | MI | 1861 | 1191 | 3101 | 795 | 3263 | 664 | 3341 | 558 | 3399 | 387 | 3660 | 281 | 2127 |
| 4-#14 | 3.13 | MA | 2224 | 1267 | 3796 | 852 | 4079 | 706 | 4262 | 586 | 4535 | 391 | 4995 | 267 | 3359 |
| 2E | | MI | 1952 | 1267 | 3336 | 836 | 3554 | 692 | 3693 | 574 | 3836 | 369 | 4138 | 232 | 2910 |
| 4-#18 | 5.56 | MA | 2488 | 1461 | 4473 | 960 | 4926 | 782 | 5288 | 629 | 5820 | 349 | 6415 | 149 | 5545 |
| 2E | | MI | 2163 | 1461 | 3888 | 942 | 4244 | 766 | 4491 | 608 | 4823 | 313 | 5162 | 85 | 4734 |
| 6-#7 | 1.25 | MA | 2008 | 1118 | 3230 | 783 | 3395 | 660 | 3444 | 563 | 3439 | 419 | 3802 | 352 | 1508 |
| 2L-3S | | MI | 1736 | 1118 | 2750 | 772 | 2842 | 655 | 2839 | 559 | 2751 | 414 | 2948 | 295 | 1344 |
| 6-#7 | 1.25 | MA | 1960 | 1118 | 3091 | 786 | 3217 | 667 | 3227 | 570 | 3144 | 424 | 3420 | 310 | 1521 |
| 3L-2S | | MI | 1776 | 1118 | 2868 | 770 | 2993 | 648 | 3023 | 553 | 3002 | 411 | 3258 | 337 | 1332 |
| 6-#8 | 1.65 | MA | 2061 | 1149 | 3360 | 800 | 3556 | 671 | 3639 | 570 | 3704 | 415 | 4129 | 341 | 1929 |
| 2L-3S | | MI | 1768 | 1149 | 2824 | 789 | 2932 | 668 | 2947 | 567 | 2897 | 411 | 3117 | 267 | 1713 |
| 6-#8 | 1.65 | MA | 1999 | 1149 | 3179 | 804 | 3324 | 681 | 3356 | 578 | 3318 | 420 | 3635 | 285 | 1947 |
| 3L-2S | | MI | 1819 | 1149 | 2978 | 787 | 3129 | 660 | 3187 | 560 | 3224 | 407 | 3516 | 323 | 1695 |
| 6-#9 | 2.08 | MA | 2117 | 1184 | 3501 | 819 | 3732 | 685 | 3851 | 577 | 3991 | 410 | 4478 | 328 | 2384 |
| 2L-3S | | MI | 1803 | 1184 | 2904 | 808 | 3030 | 683 | 3064 | 575 | 3056 | 407 | 3297 | 236 | 2107 |
| 6-#9 | 2.08 | MA | 2040 | 1184 | 3274 | 823 | 3441 | 696 | 3496 | 587 | 3509 | 417 | 3865 | 257 | 2404 |
| 3L-2S | | MI | 1866 | 1184 | 3096 | 805 | 3276 | 673 | 3365 | 567 | 3465 | 402 | 3790 | 306 | 2085 |
| 6-#10 | 2.65 | MA | 2188 | 1229 | 3679 | 844 | 3954 | 702 | 4120 | 587 | 4357 | 405 | 4913 | 310 | 2955 |
| 2L-3S | | MI | 1846 | 1229 | 3005 | 833 | 3153 | 702 | 3213 | 586 | 3255 | 401 | 3520 | 194 | 2596 |
| 6-#10 | 2.65 | MA | 2093 | 1229 | 3394 | 849 | 3589 | 716 | 3675 | 599 | 3750 | 413 | 4152 | 221 | 2976 |
| 3L-2S | | MI | 1925 | 1229 | 3246 | 829 | 3462 | 690 | 3590 | 576 | 3766 | 395 | 4129 | 283 | 2572 |
| 6-#11 | 3.25 | MA | 2251 | 1277 | 3852 | 865 | 4161 | 716 | 4366 | 593 | 4689 | 395 | 5234 | 277 | 3519 |
| 2L-3S | | MI | 1885 | 1277 | 3101 | 852 | 3263 | 716 | 3341 | 592 | 3399 | 384 | 3660 | 133 | 3075 |
| 6-#11 | 3.25 | MA | 2140 | 1277 | 3512 | 870 | 3725 | 732 | 3835 | 607 | 3966 | 403 | 4358 | 168 | 3540 |
| 3L-2S | | MI | 1976 | 1277 | 3386 | 849 | 3629 | 703 | 3787 | 582 | 3991 | 377 | 4352 | 243 | 3048 |
| 6-#14 | 4.69 | MA | 2418 | 1392 | 4275 | 930 | 4693 | 762 | 5011 | 620 | 5548 | 380 | 6199 | 220 | 4874 |
| 2L-3S | | MI | 1986 | 1392 | 3336 | 916 | 3554 | 765 | 3693 | 620 | 3836 | 362 | 4138 | 13 | 4107 |
| 6-#14 | 4.69 | MA | 2264 | 1392 | 3796 | 936 | 4079 | 783 | 4262 | 637 | 4535 | 390 | 4995 | 61 | 4828 |
| 3L-2S | | MI | 2114 | 1392 | 3737 | 914 | 4068 | 748 | 4320 | 608 | 4653 | 352 | 5077 | 171 | 4188 |

## RECTANGULAR TIED COLUMNS 16" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#7 | 1.67 | MA | 2066 | 1151 | 3369 | 804 | 3572 | 675 | 3661 | 572 | 3734 | 416 | 4185 | 344 | 1957 |
| 2L-4S | | MI | 1769 | 1151 | 2776 | 800 | 2873 | 671 | 2877 | 568 | 2811 | 415 | 3037 | 264 | 1746 |
| 8-#7 | 1.67 | MA | 2019 | 1151 | 3230 | 807 | 3395 | 682 | 3444 | 579 | 3439 | 421 | 3802 | 302 | 1969 |
| 3E | | MI | 1785 | 1151 | 2868 | 793 | 2993 | 670 | 3023 | 568 | 3002 | 412 | 3258 | 284 | 1731 |
| 8-#7 | 1.67 | MA | 1998 | 1151 | 3122 | 815 | 3255 | 684 | 3273 | 580 | 3216 | 426 | 3532 | 280 | 1983 |
| 4L-2S | | MI | 1825 | 1151 | 2986 | 791 | 3144 | 663 | 3208 | 563 | 3253 | 408 | 3568 | 326 | 1719 |
| 8-#8 | 2.19 | MA | 2136 | 1193 | 3541 | 828 | 3788 | 691 | 3922 | 582 | 4089 | 411 | 4623 | 330 | 2509 |
| 2L-4S | | MI | 1811 | 1193 | 2857 | 826 | 2973 | 689 | 2996 | 578 | 2975 | 411 | 3231 | 227 | 2224 |
| 8-#8 | 2.19 | MA | 2075 | 1193 | 3360 | 831 | 3556 | 700 | 3639 | 590 | 3704 | 417 | 4129 | 274 | 2524 |
| 3E | | MI | 1832 | 1193 | 2978 | 816 | 3129 | 688 | 3187 | 578 | 3224 | 407 | 3516 | 253 | 2208 |
| 8-#8 | 2.19 | MA | 2048 | 1193 | 3219 | 842 | 3374 | 703 | 3416 | 591 | 3413 | 423 | 3780 | 247 | 2536 |
| 4L-2S | | MI | 1882 | 1193 | 3131 | 814 | 3326 | 679 | 3428 | 572 | 3551 | 403 | 3915 | 308 | 2193 |
| 8-#9 | 2.78 | MA | 2211 | 1240 | 3728 | 854 | 4023 | 709 | 4206 | 592 | 4474 | 406 | 5091 | 313 | 3106 |
| 2L-4S | | MI | 1856 | 1240 | 2945 | 854 | 3081 | 709 | 3125 | 590 | 3153 | 407 | 3437 | 185 | 2712 |
| 8-#9 | 2.78 | MA | 2135 | 1240 | 3501 | 858 | 3732 | 721 | 3851 | 602 | 3991 | 413 | 4478 | 243 | 3121 |
| 3E | | MI | 1882 | 1240 | 3096 | 843 | 3276 | 708 | 3365 | 590 | 3465 | 402 | 3790 | 216 | 2720 |
| 8-#9 | 2.78 | MA | 2102 | 1240 | 3324 | 871 | 3503 | 724 | 3571 | 603 | 3626 | 420 | 4043 | 208 | 3089 |
| 4L-2S | | MI | 1945 | 1240 | 3289 | 840 | 3523 | 697 | 3666 | 582 | 3874 | 397 | 4283 | 287 | 2702 |
| 8-#10 | 3.53 | MA | 2305 | 1299 | 3964 | 888 | 4320 | 733 | 4566 | 606 | 4963 | 399 | 5674 | 290 | 3857 |
| 2L-4S | | MI | 1913 | 1299 | 3055 | 891 | 3216 | 734 | 3288 | 604 | 3375 | 400 | 3691 | 129 | 3192 |
| 8-#10 | 3.53 | MA | 2212 | 1299 | 3679 | 893 | 3954 | 748 | 4120 | 618 | 4357 | 407 | 4913 | 201 | 3869 |
| 3E | | MI | 1945 | 1299 | 3246 | 877 | 3462 | 733 | 3590 | 605 | 3766 | 395 | 4129 | 168 | 3357 |
| 8-#10 | 3.53 | MA | 2171 | 1299 | 3456 | 909 | 3666 | 751 | 3767 | 619 | 3897 | 415 | 4372 | 158 | 3676 |
| 4L-2S | | MI | 2023 | 1299 | 3487 | 873 | 3771 | 721 | 3967 | 595 | 4277 | 389 | 4738 | 257 | 3341 |
| 8-#11 | 4.33 | MA | 2281 | 1364 | 3852 | 924 | 4161 | 771 | 4366 | 630 | 4689 | 396 | 5234 | 138 | 4596 |
| 3E | | MI | 2001 | 1364 | 3386 | 906 | 3629 | 755 | 3787 | 615 | 3991 | 374 | 4352 | 96 | 3971 |
| 8-#11 | 4.33 | MA | 2235 | 1364 | 3585 | 942 | 3815 | 773 | 3943 | 630 | 4138 | 404 | 4607 | 88 | 4231 |
| 4L-2S | | MI | 2091 | 1364 | 3672 | 903 | 3995 | 741 | 4234 | 605 | 4583 | 368 | 5043 | 205 | 3957 |
| 8-#14 | 6.25 | MA | 2461 | 1516 | 4275 | 1013 | 4693 | 839 | 5011 | 671 | 5548 | 379 | 6199 | 14 | 6157 |
| 3E | | MI | 2149 | 1516 | 3737 | 993 | 4068 | 821 | 4320 | 654 | 4653 | 345 | 5077 | -48 | 5052 |
| 10-#10 | 4.41 | MA | 2330 | 1370 | 3964 | 937 | 4320 | 779 | 4566 | 637 | 4963 | 402 | 5674 | 181 | 4755 |
| 3L-4S | | MI | 2013 | 1370 | 3297 | 935 | 3525 | 766 | 3665 | 623 | 3886 | 395 | 4300 | 103 | 3892 |
| 10-#10 | 4.41 | MA | 2291 | 1370 | 3741 | 953 | 4032 | 782 | 4213 | 639 | 4503 | 410 | 5133 | 138 | 4507 |
| 4L-3S | | MI | 2044 | 1370 | 3487 | 921 | 3771 | 765 | 3967 | 624 | 4277 | 389 | 4738 | 142 | 4111 |
| 10-#10 | 4.41 | MA | 2208 | 1370 | 3553 | 958 | 3781 | 797 | 3901 | 651 | 4044 | 407 | 4603 | 85 | 4324 |
| 5L-2S | | MI | 2121 | 1370 | 3728 | 917 | 4081 | 753 | 4344 | 615 | 4789 | 383 | 5347 | 231 | 4103 |
| 10-#11 | 5.42 | MA | 2377 | 1450 | 3924 | 996 | 4251 | 812 | 4474 | 653 | 4860 | 397 | 5484 | 59 | 5224 |
| 4L-3S | | MI | 2117 | 1450 | 3672 | 960 | 3995 | 793 | 4234 | 639 | 4583 | 365 | 5043 | 58 | 4857 |
| 12-#10 | 5.29 | MA | 2409 | 1440 | 4026 | 997 | 4397 | 814 | 4659 | 658 | 5110 | 404 | 5895 | 118 | 5347 |
| 4E | | MI | 2113 | 1440 | 3538 | 979 | 3835 | 797 | 4042 | 642 | 4398 | 389 | 4909 | 76 | 4598 |
| 12-#10 | 5.29 | MA | 2328 | 1440 | 3838 | 1002 | 4147 | 828 | 4347 | 670 | 4650 | 401 | 5364 | 65 | 5142 |
| 5L-3S | | MI | 2143 | 1440 | 3728 | 964 | 4081 | 796 | 4344 | 644 | 4789 | 383 | 5347 | 115 | 4860 |

## RECTANGULAR TIED COLUMNS 16" x 20"

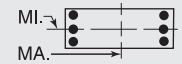
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.25 | MA | 2485 | 1242 | 3988 | 876 | 4204 | 738 | 4273 | 630 | 4276 | 469 | 4764 | 398 | 1868 |
| 2E | | MI | 1969 | 1242 | 3184 | 848 | 3312 | 714 | 3338 | 610 | 3305 | 452 | 3554 | 366 | 1477 |
| 4-#10 | 1.59 | MA | 2541 | 1272 | 4128 | 892 | 4376 | 749 | 4480 | 636 | 4557 | 465 | 5115 | 388 | 2316 |
| 2E | | MI | 2008 | 1272 | 3285 | 863 | 3435 | 724 | 3486 | 615 | 3503 | 447 | 3776 | 350 | 1816 |
| 4-#11 | 1.95 | MA | 2591 | 1304 | 4269 | 903 | 4539 | 756 | 4672 | 638 | 4815 | 457 | 5386 | 368 | 2771 |
| 2E | | MI | 2042 | 1304 | 3382 | 872 | 3544 | 729 | 3613 | 615 | 3645 | 432 | 3913 | 321 | 2156 |
| 4-#14 | 2.81 | MA | 2723 | 1380 | 4602 | 944 | 4955 | 784 | 5174 | 654 | 5496 | 447 | 6185 | 335 | 3845 |
| 2E | | MI | 2134 | 1380 | 3617 | 911 | 3835 | 756 | 3964 | 630 | 4081 | 413 | 4389 | 271 | 2946 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

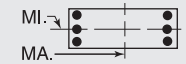
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 5.00 | MA | 3037 | 1574 | 5404 | 1052 | 5958 | 860 | 6388 | 697 | 7136 | 422 | 8007 | 238 | 6409 |
| 2E | | MI | 2345 | 1574 | 4171 | 1016 | 4523 | 829 | 4760 | 663 | 5064 | 357 | 5409 | 123 | 4786 |
| 6-#7 | 1.13 | MA | 2468 | 1231 | 3935 | 875 | 4148 | 738 | 4210 | 632 | 4193 | 473 | 4680 | 406 | 1702 |
| 2L-3S | | MI | 1917 | 1231 | 3029 | 851 | 3124 | 722 | 3113 | 617 | 3000 | 461 | 3206 | 335 | 1361 |
| 6-#7 | 1.13 | MA | 2411 | 1231 | 3776 | 879 | 3944 | 746 | 3960 | 639 | 3854 | 479 | 4224 | 364 | 1715 |
| 3L-2S | | MI | 1957 | 1231 | 3147 | 849 | 3275 | 716 | 3298 | 612 | 3252 | 458 | 3516 | 378 | 1350 |
| 6-#8 | 1.48 | MA | 2529 | 1263 | 4086 | 892 | 4335 | 750 | 4436 | 638 | 4499 | 469 | 5075 | 397 | 2185 |
| 2L-3S | | MI | 1949 | 1263 | 3104 | 867 | 3214 | 735 | 3221 | 625 | 3146 | 457 | 3375 | 308 | 1733 |
| 6-#8 | 1.48 | MA | 2456 | 1263 | 3878 | 896 | 4068 | 760 | 4110 | 647 | 4056 | 476 | 4484 | 341 | 2203 |
| 3L-2S | | MI | 2001 | 1263 | 3257 | 865 | 3411 | 727 | 3461 | 618 | 3473 | 453 | 3774 | 363 | 1716 |
| 6-#9 | 1.88 | MA | 2595 | 1298 | 4250 | 911 | 4539 | 763 | 4682 | 645 | 4833 | 464 | 5499 | 387 | 2708 |
| 2L-3S | | MI | 1984 | 1298 | 3184 | 886 | 3312 | 749 | 3338 | 633 | 3305 | 453 | 3554 | 276 | 2131 |
| 6-#9 | 1.88 | MA | 2505 | 1298 | 3988 | 916 | 4204 | 776 | 4273 | 657 | 4276 | 473 | 4764 | 316 | 2728 |
| 3L-2S | | MI | 2047 | 1298 | 3376 | 883 | 3558 | 739 | 3639 | 625 | 3714 | 448 | 4047 | 346 | 2109 |
| 6-#10 | 2.38 | MA | 2678 | 1342 | 4457 | 936 | 4798 | 780 | 4995 | 655 | 5257 | 459 | 6030 | 373 | 3366 |
| 2L-3S | | MI | 2027 | 1342 | 3285 | 910 | 3435 | 768 | 3486 | 644 | 3503 | 447 | 3776 | 234 | 2626 |
| 6-#10 | 2.38 | MA | 2566 | 1342 | 4128 | 942 | 4376 | 796 | 4480 | 669 | 4557 | 469 | 5115 | 283 | 3387 |
| 3L-2S | | MI | 2106 | 1342 | 3526 | 907 | 3744 | 756 | 3863 | 634 | 4014 | 441 | 4385 | 324 | 2599 |
| 6-#11 | 2.92 | MA | 2754 | 1390 | 4662 | 957 | 5043 | 794 | 5287 | 662 | 5652 | 450 | 6451 | 345 | 4024 |
| 2L-3S | | MI | 2066 | 1390 | 3382 | 928 | 3544 | 781 | 3613 | 649 | 3645 | 429 | 3913 | 173 | 3114 |
| 6-#11 | 2.92 | MA | 2623 | 1390 | 4269 | 964 | 4539 | 812 | 4672 | 677 | 4815 | 461 | 5386 | 235 | 4045 |
| 3L-2S | | MI | 2157 | 1390 | 3668 | 926 | 3910 | 768 | 4059 | 639 | 4237 | 423 | 4605 | 283 | 3082 |
| 6-#14 | 4.22 | MA | 2951 | 1505 | 5159 | 1022 | 5668 | 840 | 6044 | 688 | 6680 | 437 | 7658 | 298 | 5603 |
| 2L-3S | | MI | 2167 | 1505 | 3617 | 991 | 3835 | 829 | 3964 | 676 | 4081 | 406 | 4389 | 52 | 4250 |
| 6-#14 | 4.22 | MA | 2770 | 1505 | 4602 | 1030 | 4955 | 865 | 5174 | 709 | 5496 | 451 | 6185 | 140 | 5589 |
| 3L-2S | | MI | 2295 | 1505 | 4018 | 989 | 4349 | 812 | 4591 | 664 | 4898 | 396 | 5328 | 210 | 4230 |
| 6-#18 | 7.50 | MA | 3121 | 1795 | 5404 | 1201 | 5958 | 998 | 6388 | 789 | 7136 | 422 | 8007 | -125 | 7883 |
| 3L-2S | | MI | 2609 | 1795 | 4844 | 1155 | 5387 | 929 | 5796 | 720 | 6388 | 317 | 6879 | -7 | 6910 |
| 8-#7 | 1.50 | MA | 2535 | 1264 | 4095 | 896 | 4353 | 753 | 4459 | 641 | 4532 | 471 | 5136 | 400 | 2216 |
| 2L-4S | | MI | 1950 | 1264 | 3055 | 879 | 3156 | 738 | 3151 | 627 | 3061 | 462 | 3295 | 305 | 1767 |
| 8-#7 | 1.50 | MA | 2480 | 1264 | 3935 | 899 | 4148 | 761 | 4210 | 648 | 4193 | 476 | 4680 | 358 | 2228 |
| 3E | | MI | 1966 | 1264 | 3147 | 872 | 3275 | 737 | 3298 | 626 | 3252 | 458 | 3516 | 325 | 1751 |
| 8-#7 | 1.50 | MA | 2453 | 1264 | 3813 | 908 | 3989 | 764 | 4015 | 650 | 3939 | 482 | 4361 | 335 | 2242 |
| 4L-2S | | MI | 2006 | 1264 | 3265 | 869 | 3426 | 730 | 3482 | 621 | 3503 | 455 | 3827 | 367 | 1739 |
| 8-#8 | 1.98 | MA | 2617 | 1306 | 4294 | 919 | 4602 | 770 | 4761 | 650 | 4942 | 466 | 5665 | 389 | 2851 |
| 2L-4S | | MI | 1992 | 1306 | 3137 | 904 | 3255 | 756 | 3270 | 637 | 3224 | 458 | 3489 | 268 | 2251 |
| 8-#8 | 1.98 | MA | 2545 | 1306 | 4086 | 924 | 4335 | 780 | 4436 | 659 | 4499 | 473 | 5075 | 334 | 2865 |
| 3E | | MI | 2013 | 1306 | 3257 | 895 | 3411 | 754 | 3461 | 637 | 3473 | 454 | 3774 | 293 | 2232 |
| 8-#8 | 1.98 | MA | 2511 | 1306 | 3925 | 935 | 4127 | 783 | 4180 | 662 | 4167 | 480 | 4661 | 304 | 2877 |
| 4L-2S | | MI | 2064 | 1306 | 3411 | 892 | 3608 | 746 | 3702 | 630 | 3800 | 449 | 4173 | 349 | 2216 |
| 8-#9 | 2.50 | MA | 2704 | 1353 | 4511 | 946 | 4874 | 788 | 5091 | 661 | 5389 | 460 | 6234 | 376 | 3538 |
| 2L-4S | | MI | 2037 | 1353 | 3225 | 932 | 3362 | 775 | 3399 | 647 | 3402 | 453 | 3693 | 225 | 2765 |
| 8-#9 | 2.50 | MA | 2616 | 1353 | 4250 | 951 | 4539 | 801 | 4682 | 672 | 4833 | 469 | 5499 | 305 | 3553 |
| 3E | | MI | 2063 | 1353 | 3376 | 920 | 3558 | 774 | 3639 | 648 | 3714 | 448 | 4047 | 257 | 2748 |
| 8-#9 | 2.50 | MA | 2574 | 1353 | 4048 | 965 | 4278 | 805 | 4361 | 675 | 4415 | 477 | 4983 | 268 | 3553 |
| 4L-2S | | MI | 2126 | 1353 | 3569 | 918 | 3805 | 764 | 3939 | 640 | 4123 | 443 | 4539 | 327 | 2729 |
| 8-#10 | 3.17 | MA | 2815 | 1413 | 4786 | 980 | 5219 | 812 | 5509 | 674 | 5957 | 453 | 6946 | 358 | 4406 |
| 2L-4S | | MI | 2094 | 1413 | 3336 | 969 | 3498 | 801 | 3561 | 662 | 3623 | 446 | 3947 | 169 | 3282 |
| 8-#10 | 3.17 | MA | 2706 | 1413 | 4457 | 986 | 4798 | 828 | 4995 | 688 | 5257 | 464 | 6030 | 268 | 4417 |
| 3E | | MI | 2126 | 1413 | 3526 | 954 | 3744 | 800 | 3863 | 663 | 4014 | 441 | 4385 | 208 | 3391 |
| 8-#10 | 3.17 | MA | 2655 | 1413 | 4202 | 1004 | 4468 | 832 | 4590 | 691 | 4730 | 474 | 5386 | 222 | 4270 |
| 4L-2S | | MI | 2204 | 1413 | 3767 | 951 | 4053 | 787 | 4240 | 653 | 4525 | 435 | 4994 | 297 | 3371 |
| 8-#11 | 3.90 | MA | 2788 | 1477 | 4662 | 1017 | 5043 | 851 | 5287 | 701 | 5652 | 454 | 6451 | 213 | 5269 |
| 3E | | MI | 2182 | 1477 | 3668 | 982 | 3910 | 820 | 4059 | 672 | 4237 | 420 | 4605 | 135 | 4014 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

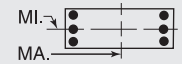
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 3.90 | MA | 2730 | 1477 | 4356 | 1038 | 4647 | 855 | 4800 | 703 | 5019 | 465 | 5697 | 158 | 4928 |
| 4L-2S | | MI | 2273 | 1477 | 3953 | 980 | 4276 | 807 | 4506 | 662 | 4829 | 413 | 5296 | 245 | 3994 |
| 8-#14 | 5.63 | MA | 3002 | 1629 | 5159 | 1108 | 5668 | 921 | 6044 | 743 | 6680 | 441 | 7658 | 103 | 7302 |
| 3E | | MI | 2330 | 1629 | 4018 | 1069 | 4349 | 885 | 4591 | 710 | 4898 | 389 | 5328 | -9 | 5324 |
| 8-#14 | 5.63 | MA | 2924 | 1629 | 4724 | 1136 | 5105 | 925 | 5353 | 744 | 5781 | 454 | 6610 | 28 | 6484 |
| 4L-2S | | MI | 2456 | 1629 | 4419 | 1067 | 4863 | 868 | 5218 | 698 | 5714 | 379 | 6267 | 149 | 5497 |
| 10-#10 | 3.97 | MA | 2844 | 1483 | 4786 | 1030 | 5219 | 859 | 5509 | 708 | 5957 | 458 | 6946 | 253 | 5441 |
| 3L-4S | | MI | 2194 | 1483 | 3577 | 1013 | 3807 | 832 | 3939 | 681 | 4134 | 440 | 4556 | 143 | 3980 |
| 10-#10 | 3.97 | MA | 2794 | 1483 | 4531 | 1048 | 4890 | 864 | 5104 | 710 | 5430 | 469 | 6301 | 207 | 5233 |
| 4L-3S | | MI | 2225 | 1483 | 3767 | 998 | 4053 | 831 | 4240 | 682 | 4525 | 435 | 4994 | 182 | 4149 |
| 10-#10 | 3.97 | MA | 2698 | 1483 | 4316 | 1054 | 4604 | 880 | 4748 | 724 | 4905 | 468 | 5663 | 155 | 4985 |
| 5L-2S | | MI | 2302 | 1483 | 4008 | 995 | 4362 | 819 | 4617 | 672 | 5037 | 429 | 5603 | 271 | 4136 |
| 10-#11 | 4.88 | MA | 2896 | 1563 | 4749 | 1092 | 5151 | 894 | 5416 | 726 | 5856 | 458 | 6761 | 136 | 6082 |
| 4L-3S | | MI | 2298 | 1563 | 3953 | 1036 | 4276 | 858 | 4506 | 696 | 4829 | 410 | 5296 | 97 | 4906 |
| 10-#14 | 7.03 | MA | 3156 | 1754 | 5280 | 1214 | 5818 | 981 | 6223 | 778 | 6965 | 444 | 8083 | -10 | 8073 |
| 4L-3S | | MI | 2493 | 1754 | 4419 | 1147 | 4863 | 941 | 5218 | 744 | 5714 | 372 | 6267 | -70 | 6224 |
| 12-#10 | 4.76 | MA | 2932 | 1553 | 4860 | 1091 | 5311 | 895 | 5619 | 730 | 6130 | 463 | 7217 | 192 | 6203 |
| 4E | | MI | 2293 | 1553 | 3818 | 1056 | 4116 | 864 | 4316 | 700 | 4646 | 435 | 5165 | 117 | 4685 |
| 12-#10 | 4.76 | MA | 2838 | 1553 | 4645 | 1098 | 5026 | 911 | 5262 | 744 | 5604 | 462 | 6579 | 140 | 5974 |
| 5L-3S | | MI | 2324 | 1553 | 4008 | 1042 | 4362 | 863 | 4617 | 701 | 5037 | 429 | 5603 | 156 | 4902 |
| 14-#10 | 5.56 | MA | 2977 | 1623 | 4974 | 1142 | 5448 | 943 | 5777 | 763 | 6304 | 457 | 7494 | 125 | 6966 |
| 5L-4S | | MI | 2393 | 1623 | 4059 | 1100 | 4425 | 895 | 4693 | 719 | 5157 | 429 | 5774 | 90 | 5395 |

## RECTANGULAR TIED COLUMNS 16" x 22"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#9 | 1.14 | MA | 2993 | 1355 | 4767 | 968 | 5037 | 817 | 5120 | 699 | 5111 | 523 | 5737 | 451 | 2084 |
| 2E | | MI | 2150 | 1355 | 3464 | 926 | 3593 | 781 | 3612 | 668 | 3553 | 498 | 3811 | 406 | 1497 |
| 4-#10 | 1.44 | MA | 3057 | 1385 | 4926 | 984 | 5233 | 827 | 5357 | 704 | 5432 | 519 | 6153 | 443 | 2591 |
| 2E | | MI | 2189 | 1385 | 3565 | 940 | 3717 | 790 | 3759 | 672 | 3750 | 493 | 4032 | 390 | 1838 |
| 4-#11 | 1.77 | MA | 3117 | 1417 | 5089 | 995 | 5423 | 834 | 5579 | 707 | 5730 | 511 | 6491 | 426 | 3108 |
| 2E | | MI | 2223 | 1417 | 3663 | 948 | 3825 | 794 | 3885 | 672 | 3891 | 478 | 4166 | 360 | 2183 |
| 4-#14 | 2.56 | MA | 3270 | 1494 | 5473 | 1036 | 5900 | 863 | 6155 | 723 | 6512 | 501 | 7453 | 399 | 4331 |
| 2E | | MI | 2315 | 1494 | 3899 | 987 | 4115 | 821 | 4235 | 686 | 4325 | 458 | 4640 | 310 | 2981 |
| 4-#18 | 4.55 | MA | 3635 | 1687 | 6399 | 1144 | 7060 | 939 | 7559 | 766 | 8417 | 478 | 9685 | 319 | 7273 |
| 2E | | MI | 2526 | 1687 | 4453 | 1090 | 4803 | 893 | 5029 | 718 | 5306 | 401 | 5656 | 162 | 4836 |
| 6-#7 | 1.02 | MA | 2973 | 1344 | 4705 | 967 | 4972 | 817 | 5046 | 700 | 5014 | 528 | 5631 | 458 | 1897 |
| 2L-3S | | MI | 2098 | 1344 | 3309 | 930 | 3406 | 789 | 3388 | 676 | 3250 | 508 | 3465 | 376 | 1377 |
| 6-#7 | 1.02 | MA | 2908 | 1344 | 4525 | 971 | 4740 | 825 | 4764 | 708 | 4631 | 534 | 5101 | 416 | 1910 |
| 3L-2S | | MI | 2138 | 1344 | 3427 | 927 | 3557 | 783 | 3572 | 670 | 3501 | 504 | 3775 | 418 | 1367 |
| 6-#8 | 1.35 | MA | 3043 | 1376 | 4876 | 984 | 5184 | 828 | 5303 | 707 | 5362 | 523 | 6095 | 452 | 2441 |
| 2L-3S | | MI | 2130 | 1376 | 3383 | 946 | 3496 | 802 | 3495 | 683 | 3396 | 503 | 3633 | 348 | 1753 |
| 6-#8 | 1.35 | MA | 2959 | 1376 | 4641 | 989 | 4882 | 839 | 4934 | 717 | 4860 | 532 | 5407 | 396 | 2459 |
| 3L-2S | | MI | 2182 | 1376 | 3537 | 943 | 3693 | 793 | 3735 | 676 | 3723 | 499 | 4032 | 404 | 1736 |
| 6-#9 | 1.70 | MA | 3119 | 1411 | 5063 | 1003 | 5416 | 841 | 5583 | 714 | 5741 | 519 | 6595 | 443 | 3032 |
| 2L-3S | | MI | 2165 | 1411 | 3464 | 964 | 3593 | 816 | 3612 | 691 | 3553 | 499 | 3811 | 317 | 2154 |
| 6-#9 | 1.70 | MA | 3015 | 1411 | 4767 | 1009 | 5037 | 855 | 5120 | 726 | 5111 | 529 | 5737 | 373 | 3052 |
| 3L-2S | | MI | 2228 | 1411 | 3656 | 961 | 3840 | 806 | 3912 | 683 | 3963 | 494 | 4303 | 387 | 2132 |
| 6-#10 | 2.16 | MA | 3215 | 1455 | 5299 | 1028 | 5711 | 859 | 5940 | 724 | 6225 | 513 | 7224 | 432 | 3778 |
| 2L-3S | | MI | 2208 | 1455 | 3565 | 988 | 3717 | 834 | 3759 | 701 | 3750 | 493 | 4032 | 275 | 2655 |
| 6-#10 | 2.16 | MA | 3086 | 1455 | 4926 | 1035 | 5233 | 876 | 5357 | 739 | 5432 | 526 | 6153 | 343 | 3798 |
| 3L-2S | | MI | 2287 | 1455 | 3806 | 984 | 4026 | 822 | 4136 | 691 | 4262 | 487 | 4641 | 364 | 2626 |
| 6-#11 | 2.66 | MA | 3304 | 1504 | 5537 | 1049 | 5996 | 873 | 6279 | 730 | 6682 | 504 | 7745 | 409 | 4530 |
| 2L-3S | | MI | 2247 | 1504 | 3663 | 1005 | 3825 | 846 | 3885 | 706 | 3891 | 475 | 4166 | 213 | 3149 |
| 6-#11 | 2.66 | MA | 3152 | 1504 | 5089 | 1057 | 5423 | 892 | 5579 | 748 | 5730 | 518 | 6491 | 299 | 4551 |
| 3L-2S | | MI | 2339 | 1504 | 3949 | 1002 | 4191 | 833 | 4331 | 695 | 4483 | 468 | 4858 | 323 | 3114 |
| 6-#14 | 3.84 | MA | 3532 | 1618 | 6107 | 1114 | 6713 | 919 | 7148 | 756 | 7862 | 491 | 9198 | 370 | 6332 |
| 2L-3S | | MI | 2348 | 1618 | 3899 | 1067 | 4115 | 894 | 4235 | 732 | 4325 | 451 | 4640 | 91 | 4302 |

## RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

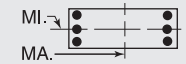
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 3.84 | MA | 3322 | 1618 | 5473 | 1124 | 5900 | 946 | 6155 | 780 | 6512 | 509 | 7453 | 212 | 6318 |
| 3L-2S | | MI | 2476 | 1618 | 4300 | 1065 | 4629 | 877 | 4862 | 720 | 5142 | 441 | 5579 | 249 | 4270 |
| 6-#18 | 6.82 | MA | 3732 | 1909 | 6399 | 1297 | 7060 | 1082 | 7559 | 863 | 8417 | 485 | 9685 | -28 | 9646 |
| 3L-2S | | MI | 2791 | 1909 | 5127 | 1229 | 5667 | 992 | 6065 | 775 | 6630 | 360 | 7126 | 32 | 6967 |
| 8-#7 | 1.36 | MA | 3050 | 1377 | 4885 | 988 | 5203 | 831 | 5328 | 709 | 5398 | 525 | 6161 | 455 | 2475 |
| 2L-4S | | MI | 2131 | 1377 | 3334 | 958 | 3438 | 805 | 3425 | 685 | 3311 | 508 | 3554 | 346 | 1786 |
| 8-#7 | 1.36 | MA | 2986 | 1377 | 4705 | 992 | 4972 | 840 | 5046 | 717 | 5014 | 531 | 5631 | 412 | 2488 |
| 3E | | MI | 2147 | 1377 | 3427 | 950 | 3557 | 804 | 3572 | 685 | 3501 | 505 | 3775 | 366 | 1770 |
| 8-#7 | 1.36 | MA | 2954 | 1377 | 4567 | 1001 | 4793 | 843 | 4827 | 719 | 4728 | 538 | 5262 | 388 | 2502 |
| 4L-2S | | MI | 2187 | 1377 | 3545 | 948 | 3709 | 797 | 3757 | 679 | 3752 | 501 | 4085 | 408 | 1758 |
| 8-#8 | 1.80 | MA | 3144 | 1420 | 5112 | 1011 | 5486 | 848 | 5671 | 718 | 5863 | 520 | 6782 | 446 | 3192 |
| 2L-4S | | MI | 2173 | 1420 | 3416 | 983 | 3537 | 822 | 3544 | 695 | 3474 | 504 | 3747 | 308 | 2276 |
| 8-#8 | 1.80 | MA | 3061 | 1420 | 4876 | 1016 | 5184 | 859 | 5303 | 729 | 5362 | 528 | 6095 | 390 | 3207 |
| 3E | | MI | 2194 | 1420 | 3537 | 973 | 3693 | 821 | 3735 | 695 | 3723 | 500 | 4032 | 334 | 2255 |
| 8-#8 | 1.80 | MA | 3020 | 1420 | 4696 | 1028 | 4950 | 863 | 5016 | 732 | 4987 | 536 | 5616 | 359 | 3219 |
| 4L-2S | | MI | 2245 | 1420 | 3691 | 970 | 3890 | 813 | 3976 | 688 | 4050 | 496 | 4431 | 390 | 2238 |
| 8-#9 | 2.27 | MA | 3245 | 1466 | 5359 | 1038 | 5796 | 866 | 6046 | 729 | 6371 | 514 | 7452 | 435 | 3970 |
| 2L-4S | | MI | 2218 | 1466 | 3505 | 1010 | 3644 | 842 | 3672 | 705 | 3650 | 499 | 3950 | 266 | 2796 |
| 8-#9 | 2.27 | MA | 3143 | 1466 | 5063 | 1044 | 5416 | 880 | 5583 | 741 | 5741 | 525 | 6595 | 365 | 3985 |
| 3E | | MI | 2244 | 1466 | 3656 | 998 | 3840 | 840 | 3912 | 706 | 3963 | 494 | 4303 | 297 | 2775 |
| 8-#9 | 2.27 | MA | 3092 | 1466 | 4836 | 1058 | 5122 | 885 | 5221 | 745 | 5271 | 535 | 5996 | 326 | 3985 |
| 4L-2S | | MI | 2307 | 1466 | 3849 | 995 | 4086 | 830 | 4213 | 698 | 4372 | 490 | 4796 | 368 | 2755 |
| 8-#10 | 2.89 | MA | 3372 | 1526 | 5672 | 1072 | 6189 | 890 | 6523 | 743 | 7018 | 508 | 8294 | 421 | 4955 |
| 2L-4S | | MI | 2275 | 1526 | 3616 | 1046 | 3780 | 867 | 3835 | 719 | 3871 | 492 | 4203 | 209 | 3391 |
| 8-#10 | 2.89 | MA | 3246 | 1526 | 5299 | 1079 | 5711 | 907 | 5940 | 758 | 6225 | 520 | 7224 | 332 | 4966 |
| 3E | | MI | 2307 | 1526 | 3806 | 1032 | 4026 | 866 | 4136 | 721 | 4262 | 487 | 4641 | 248 | 3423 |
| 8-#10 | 2.89 | MA | 3184 | 1526 | 5012 | 1098 | 5340 | 913 | 5484 | 763 | 5631 | 532 | 6475 | 282 | 4881 |
| 4L-2S | | MI | 2385 | 1526 | 4047 | 1028 | 4335 | 853 | 4513 | 711 | 4773 | 481 | 5249 | 338 | 3401 |
| 8-#11 | 3.55 | MA | 3342 | 1590 | 5537 | 1111 | 5996 | 931 | 6279 | 771 | 6682 | 511 | 7745 | 282 | 5943 |
| 3E | | MI | 2363 | 1590 | 3949 | 1059 | 4191 | 885 | 4331 | 729 | 4483 | 465 | 4858 | 175 | 4055 |
| 8-#11 | 3.55 | MA | 3271 | 1590 | 5191 | 1133 | 5548 | 937 | 5729 | 775 | 5967 | 524 | 6863 | 224 | 5642 |
| 4L-2S | | MI | 2454 | 1590 | 4234 | 1056 | 4557 | 872 | 4778 | 719 | 5076 | 458 | 5549 | 285 | 4030 |
| 8-#14 | 5.11 | MA | 3589 | 1743 | 6107 | 1202 | 6713 | 1002 | 7148 | 814 | 7862 | 499 | 9198 | 183 | 8274 |
| 3E | | MI | 2511 | 1743 | 4300 | 1145 | 4629 | 950 | 4862 | 766 | 5142 | 434 | 5579 | 30 | 5495 |
| 8-#14 | 5.11 | MA | 3493 | 1743 | 5615 | 1233 | 6076 | 1009 | 6365 | 819 | 6844 | 516 | 7966 | 102 | 7438 |
| 4L-2S | | MI | 2637 | 1743 | 4701 | 1143 | 5143 | 933 | 5489 | 754 | 5959 | 424 | 6518 | 189 | 5541 |
| 10-#10 | 3.61 | MA | 3405 | 1596 | 5672 | 1123 | 6189 | 939 | 6523 | 777 | 7018 | 514 | 8294 | 320 | 6126 |
| 3L-4S | | MI | 2375 | 1596 | 3857 | 1090 | 4089 | 898 | 4212 | 738 | 4382 | 486 | 4812 | 183 | 4064 |
| 10-#10 | 3.61 | MA | 3343 | 1596 | 5385 | 1142 | 5818 | 945 | 6067 | 782 | 6424 | 527 | 7546 | 271 | 5975 |
| 4L-3S | | MI | 2406 | 1596 | 4047 | 1076 | 4335 | 897 | 4513 | 740 | 4773 | 481 | 5249 | 222 | 4185 |
| 10-#10 | 3.61 | MA | 3234 | 1596 | 5144 | 1149 | 5497 | 962 | 5666 | 797 | 5833 | 528 | 6799 | 221 | 5656 |
| 5L-2S | | MI | 2483 | 1596 | 4288 | 1072 | 4644 | 885 | 4891 | 730 | 5285 | 475 | 5858 | 311 | 4168 |
| 10-#11 | 4.43 | MA | 3461 | 1676 | 5639 | 1187 | 6122 | 976 | 6429 | 799 | 6919 | 517 | 8117 | 206 | 6958 |
| 4L-3S | | MI | 2479 | 1676 | 4234 | 1113 | 4557 | 924 | 4778 | 753 | 5076 | 455 | 5549 | 137 | 4952 |
| 10-#11 | 4.43 | MA | 3331 | 1676 | 5347 | 1195 | 5734 | 996 | 5945 | 816 | 6205 | 517 | 7243 | 143 | 6629 |
| 5L-2S | | MI | 2569 | 1676 | 4520 | 1110 | 4923 | 910 | 5225 | 742 | 5668 | 448 | 6240 | 247 | 4936 |
| 10-#14 | 6.39 | MA | 3760 | 1867 | 6250 | 1311 | 6889 | 1065 | 7357 | 852 | 8193 | 506 | 9712 | 73 | 9319 |
| 4L-3S | | MI | 2674 | 1867 | 4701 | 1222 | 5143 | 1006 | 5489 | 800 | 5959 | 417 | 6518 | -30 | 6501 |
| 12-#10 | 4.33 | MA | 3502 | 1666 | 5758 | 1185 | 6296 | 976 | 6650 | 801 | 7218 | 521 | 8616 | 260 | 7077 |
| 4E | | MI | 2474 | 1666 | 4098 | 1134 | 4398 | 930 | 4589 | 758 | 4894 | 480 | 5421 | 157 | 4768 |
| 12-#10 | 4.33 | MA | 3394 | 1666 | 5517 | 1193 | 5975 | 993 | 6249 | 816 | 6626 | 522 | 7870 | 209 | 6779 |
| 5L-3S | | MI | 2505 | 1666 | 4288 | 1119 | 4644 | 929 | 4891 | 759 | 5285 | 475 | 5858 | 196 | 4941 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

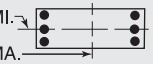
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 4.33 | MA | 3315 | 1666 | 5269 | 1211 | 5655 | 999 | 5852 | 821 | 6092 | 534 | 7187 | 153 | 6415 |
| 6L-2S | | MI | 2581 | 1666 | 4530 | 1116 | 4953 | 916 | 5268 | 749 | 5796 | 469 | 6467 | 285 | 4930 |
| 12-#11 | 5.32 | MA | 3522 | 1763 | 5794 | 1249 | 6308 | 1034 | 6645 | 840 | 7157 | 510 | 8497 | 126 | 7973 |
| 5L-3S | | MI | 2595 | 1763 | 4520 | 1167 | 4923 | 962 | 5225 | 776 | 5668 | 445 | 6240 | 99 | 5842 |
| 14-#10 | 5.05 | MA | 3554 | 1737 | 5889 | 1237 | 6453 | 1025 | 6832 | 835 | 7419 | 517 | 8941 | 198 | 7906 |
| 5L-4S | | MI | 2574 | 1737 | 4339 | 1178 | 4707 | 961 | 4966 | 777 | 5405 | 475 | 6029 | 131 | 5477 |
| 14-#10 | 5.05 | MA | 3477 | 1737 | 5642 | 1254 | 6133 | 1031 | 6435 | 840 | 6886 | 529 | 8258 | 142 | 7524 |
| 6L-3S | | MI | 2604 | 1737 | 4530 | 1163 | 4953 | 960 | 5268 | 778 | 5796 | 469 | 6467 | 170 | 5693 |
| 16-#10 | 5.77 | MA | 3637 | 1807 | 6015 | 1298 | 6611 | 1062 | 7018 | 859 | 7679 | 523 | 9328 | 131 | 8637 |
| 6L-4S | | MI | 2673 | 1807 | 4580 | 1222 | 5016 | 993 | 5343 | 796 | 5917 | 469 | 6638 | 104 | 6191 |

## RECTANGULAR TIED COLUMNS 16" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.04 | MA | 3547 | 1468 | 5610 | 1060 | 5939 | 895 | 6038 | 767 | 6013 | 578 | 6771 | 502 | 2300 |
| 2E | | MI | 2331 | 1468 | 3744 | 1004 | 3875 | 847 | 3885 | 725 | 3802 | 545 | 4067 | 447 | 1515 |
| 4-#10 | 1.32 | MA | 3620 | 1498 | 5788 | 1076 | 6160 | 906 | 6303 | 773 | 6373 | 573 | 7265 | 497 | 2865 |
| 2E | | MI | 2370 | 1498 | 3845 | 1018 | 3998 | 856 | 4033 | 730 | 3998 | 539 | 4287 | 430 | 1860 |
| 4-#11 | 1.63 | MA | 3688 | 1530 | 5975 | 1087 | 6376 | 912 | 6557 | 775 | 6713 | 566 | 7670 | 482 | 3445 |
| 2E | | MI | 2404 | 1530 | 3944 | 1025 | 4106 | 859 | 4157 | 729 | 4137 | 523 | 4419 | 400 | 2210 |
| 4-#14 | 2.34 | MA | 3863 | 1607 | 6408 | 1128 | 6915 | 941 | 7208 | 791 | 7595 | 556 | 8797 | 460 | 4817 |
| 2E | | MI | 2496 | 1607 | 4180 | 1063 | 4396 | 885 | 4506 | 742 | 4570 | 503 | 4891 | 349 | 3014 |
| 4-#18 | 4.17 | MA | 4280 | 1800 | 7459 | 1236 | 8232 | 1017 | 8801 | 834 | 9756 | 532 | 11445 | 393 | 8137 |
| 2E | | MI | 2708 | 1800 | 4735 | 1164 | 5083 | 956 | 5298 | 773 | 5548 | 445 | 5903 | 200 | 4884 |
| 6-#8 | 1.23 | MA | 3603 | 1489 | 5731 | 1076 | 6103 | 907 | 6241 | 775 | 6291 | 578 | 7157 | 502 | 2697 |
| 2L-3S | | MI | 2311 | 1489 | 3663 | 1024 | 3778 | 868 | 3769 | 741 | 3645 | 550 | 3890 | 389 | 1771 |
| 6-#8 | 1.23 | MA | 3508 | 1489 | 5468 | 1081 | 5766 | 918 | 5830 | 786 | 5732 | 587 | 6383 | 447 | 2715 |
| 3L-2S | | MI | 2363 | 1489 | 3817 | 1021 | 3975 | 860 | 4009 | 734 | 3972 | 546 | 4289 | 445 | 1755 |
| 6-#9 | 1.56 | MA | 3689 | 1524 | 5940 | 1095 | 6363 | 920 | 6555 | 782 | 6717 | 573 | 7745 | 496 | 3356 |
| 2L-3S | | MI | 2346 | 1524 | 3744 | 1042 | 3875 | 882 | 3885 | 749 | 3802 | 545 | 4067 | 357 | 2176 |
| 6-#9 | 1.56 | MA | 3571 | 1524 | 5610 | 1102 | 5939 | 934 | 6038 | 796 | 6013 | 584 | 6771 | 427 | 3376 |
| 3L-2S | | MI | 2410 | 1524 | 3936 | 1039 | 4122 | 872 | 4186 | 741 | 4211 | 540 | 4560 | 427 | 2154 |
| 6-#10 | 1.98 | MA | 3798 | 1569 | 6205 | 1120 | 6694 | 937 | 6955 | 792 | 7260 | 568 | 8492 | 489 | 4189 |
| 2L-3S | | MI | 2389 | 1569 | 3845 | 1065 | 3998 | 900 | 4033 | 759 | 3998 | 538 | 4287 | 315 | 2681 |
| 6-#10 | 1.98 | MA | 3651 | 1569 | 5788 | 1128 | 6160 | 955 | 6303 | 809 | 6373 | 582 | 7265 | 400 | 4210 |
| 3L-2S | | MI | 2468 | 1569 | 4087 | 1062 | 4307 | 888 | 4410 | 749 | 4510 | 533 | 4896 | 404 | 2651 |
| 6-#11 | 2.44 | MA | 3900 | 1617 | 6476 | 1141 | 7019 | 951 | 7341 | 798 | 7780 | 559 | 9115 | 469 | 5035 |
| 2L-3S | | MI | 2428 | 1617 | 3944 | 1081 | 4106 | 911 | 4157 | 762 | 4137 | 520 | 4419 | 252 | 3183 |
| 6-#11 | 2.44 | MA | 3727 | 1617 | 5975 | 1150 | 6376 | 972 | 6557 | 818 | 6713 | 574 | 7670 | 359 | 5056 |
| 3L-2S | | MI | 2520 | 1617 | 4230 | 1079 | 4472 | 898 | 4603 | 752 | 4729 | 513 | 5111 | 362 | 3146 |
| 6-#14 | 3.52 | MA | 4160 | 1731 | 7120 | 1206 | 7828 | 997 | 8322 | 825 | 9111 | 546 | 10817 | 438 | 7061 |
| 2L-3S | | MI | 2529 | 1731 | 4180 | 1142 | 4396 | 958 | 4506 | 789 | 4570 | 496 | 4891 | 130 | 4348 |
| 6-#14 | 3.52 | MA | 3921 | 1731 | 6408 | 1218 | 6915 | 1026 | 7208 | 851 | 7595 | 566 | 8797 | 280 | 7047 |
| 3L-2S | | MI | 2657 | 1731 | 4581 | 1140 | 4910 | 941 | 5133 | 776 | 5387 | 486 | 5830 | 289 | 4309 |
| 6-#18 | 6.25 | MA | 4389 | 2022 | 7459 | 1393 | 8232 | 1164 | 8801 | 937 | 9756 | 545 | 11445 | 59 | 11249 |
| 3L-2S | | MI | 2973 | 2022 | 5409 | 1302 | 5946 | 1055 | 6334 | 830 | 6871 | 404 | 7373 | 70 | 7022 |
| 8-#7 | 1.25 | MA | 3611 | 1491 | 5740 | 1080 | 6122 | 910 | 6268 | 777 | 6330 | 579 | 7212 | 503 | 2734 |
| 2L-4S | | MI | 2312 | 1491 | 3613 | 1036 | 3720 | 872 | 3700 | 744 | 3560 | 555 | 3812 | 387 | 1803 |
| 8-#7 | 1.25 | MA | 3538 | 1491 | 5539 | 1084 | 5865 | 914 | 5953 | 786 | 5902 | 586 | 6620 | 462 | 2747 |
| 3E | | MI | 2328 | 1491 | 3706 | 1029 | 3839 | 871 | 3847 | 743 | 3751 | 551 | 4033 | 407 | 1788 |
| 8-#7 | 1.25 | MA | 3501 | 1491 | 5386 | 1094 | 5667 | 922 | 5710 | 789 | 5585 | 594 | 6213 | 438 | 2761 |
| 4L-2S | | MI | 2368 | 1491 | 3824 | 1027 | 3991 | 865 | 4031 | 738 | 4002 | 548 | 4344 | 449 | 1776 |
| 8-#8 | 1.65 | MA | 3717 | 1533 | 5994 | 1103 | 6440 | 926 | 6652 | 787 | 6851 | 574 | 7932 | 497 | 3533 |
| 2L-4S | | MI | 2354 | 1533 | 3696 | 1061 | 3819 | 889 | 3818 | 753 | 3723 | 550 | 4004 | 349 | 2298 |
| 8-#8 | 1.65 | MA | 3623 | 1533 | 5731 | 1109 | 6103 | 938 | 6241 | 798 | 6291 | 583 | 7157 | 442 | 3548 |
| 3E | | MI | 2375 | 1533 | 3817 | 1051 | 3975 | 888 | 4009 | 753 | 3972 | 546 | 4289 | 375 | 2277 |
| 8-#8 | 1.65 | MA | 3575 | 1533 | 5531 | 1121 | 5843 | 943 | 5922 | 801 | 5875 | 592 | 6623 | 411 | 3560 |
| 4L-2S | | MI | 2426 | 1533 | 3970 | 1049 | 4172 | 880 | 4250 | 746 | 4299 | 542 | 4688 | 430 | 2260 |

## RECTANGULAR TIED COLUMNS 16" x 24"

Short columns – no sidesway
Bending on major or minor axis

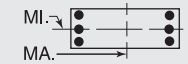



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 2.08 | MA | 3831 | 1579 | 6271 | 1129 | 6787 | 945 | 7072 | 797 | 7420 | 569 | 8719 | 490 | 4402 |
| 2L-4S | | MI | 2399 | 1579 | 3785 | 1088 | 3926 | 908 | 3946 | 763 | 3899 | 545 | 4207 | 306 | 2824 |
| 8-#9 | 2.08 | MA | 3715 | 1579 | 5940 | 1136 | 6363 | 959 | 6555 | 811 | 6717 | 580 | 7745 | 420 | 4417 |
| 3E | | MI | 2425 | 1579 | 3936 | 1076 | 4122 | 907 | 4186 | 764 | 4211 | 541 | 4560 | 338 | 2801 |
| 8-#9 | 2.08 | MA | 3656 | 1579 | 5688 | 1152 | 6036 | 965 | 6153 | 815 | 6193 | 591 | 7071 | 380 | 4417 |
| 4L-2S | | MI | 2488 | 1579 | 4129 | 1073 | 4368 | 897 | 4487 | 756 | 4620 | 536 | 5053 | 408 | 2780 |
| 8-#10 | 2.65 | MA | 3976 | 1639 | 6622 | 1164 | 7229 | 969 | 7607 | 811 | 8146 | 562 | 9719 | 481 | 5503 |
| 2L-4S | | MI | 2456 | 1639 | 3896 | 1124 | 4061 | 933 | 4108 | 777 | 4119 | 538 | 4459 | 250 | 3472 |
| 8-#10 | 2.65 | MA | 3832 | 1639 | 6205 | 1172 | 6694 | 987 | 6955 | 828 | 7260 | 576 | 8492 | 392 | 5515 |
| 3E | | MI | 2488 | 1639 | 4087 | 1109 | 4307 | 932 | 4410 | 778 | 4510 | 533 | 4896 | 289 | 3454 |
| 8-#10 | 2.65 | MA | 3758 | 1639 | 5887 | 1191 | 6281 | 994 | 6448 | 833 | 6599 | 590 | 7639 | 341 | 5482 |
| 4L-2S | | MI | 2566 | 1639 | 4328 | 1106 | 4616 | 920 | 4787 | 768 | 5021 | 527 | 5505 | 378 | 3429 |
| 8-#11 | 3.25 | MA | 3942 | 1703 | 6476 | 1204 | 7019 | 1011 | 7341 | 841 | 7780 | 567 | 9115 | 346 | 6617 |
| 3E | | MI | 2544 | 1703 | 4230 | 1135 | 4472 | 950 | 4603 | 786 | 4729 | 510 | 5111 | 215 | 4093 |
| 8-#11 | 3.25 | MA | 3858 | 1703 | 6091 | 1227 | 6520 | 1018 | 6728 | 847 | 6982 | 582 | 8105 | 286 | 6373 |
| 4L-2S | | MI | 2635 | 1703 | 4515 | 1132 | 4838 | 937 | 5050 | 776 | 5322 | 503 | 5802 | 324 | 4065 |
| 8-#14 | 4.69 | MA | 4224 | 1856 | 7120 | 1296 | 7828 | 1082 | 8322 | 885 | 9111 | 556 | 10817 | 257 | 9246 |
| 3E | | MI | 2692 | 1856 | 4581 | 1220 | 4910 | 1014 | 5133 | 823 | 5387 | 479 | 5830 | 70 | 5602 |
| 8-#14 | 4.69 | MA | 4108 | 1856 | 6571 | 1328 | 7117 | 1092 | 7448 | 892 | 7974 | 577 | 9401 | 172 | 8412 |
| 4L-2S | | MI | 2818 | 1856 | 4982 | 1218 | 5424 | 997 | 5760 | 810 | 6204 | 469 | 6769 | 228 | 5584 |
| 10-#10 | 3.31 | MA | 4011 | 1709 | 6622 | 1216 | 7229 | 1018 | 7607 | 847 | 8146 | 570 | 9719 | 384 | 6812 |
| 3L-4S | | MI | 2556 | 1709 | 4137 | 1168 | 4370 | 964 | 4485 | 796 | 4630 | 532 | 5067 | 223 | 4145 |
| 10-#10 | 3.31 | MA | 3939 | 1709 | 6303 | 1235 | 6816 | 1025 | 7100 | 852 | 7486 | 584 | 8865 | 333 | 6732 |
| 4L-3S | | MI | 2587 | 1709 | 4328 | 1153 | 4616 | 963 | 4787 | 797 | 5021 | 527 | 5505 | 262 | 4218 |
| 10-#10 | 3.31 | MA | 3815 | 1709 | 6036 | 1244 | 6460 | 1043 | 6655 | 869 | 6828 | 587 | 8010 | 283 | 6337 |
| 5L-2S | | MI | 2664 | 1709 | 4569 | 1150 | 4926 | 951 | 5164 | 787 | 5533 | 521 | 6114 | 352 | 4199 |
| 10-#11 | 4.06 | MA | 4073 | 1789 | 6592 | 1281 | 7163 | 1057 | 7512 | 870 | 8049 | 576 | 9550 | 273 | 7851 |
| 4L-3S | | MI | 2660 | 1789 | 4515 | 1189 | 4838 | 989 | 5050 | 809 | 5322 | 500 | 5802 | 177 | 4994 |
| 10-#11 | 4.06 | MA | 3926 | 1789 | 6269 | 1290 | 6732 | 1078 | 6974 | 889 | 7254 | 577 | 8543 | 210 | 7441 |
| 5L-2S | | MI | 2750 | 1789 | 4801 | 1186 | 5204 | 976 | 5497 | 799 | 5914 | 493 | 6493 | 286 | 4974 |
| 10-#14 | 5.86 | MA | 4411 | 1980 | 7283 | 1406 | 8030 | 1148 | 8562 | 926 | 9489 | 567 | 11421 | 150 | 10530 |
| 4L-3S | | MI | 2855 | 1980 | 4982 | 1298 | 5424 | 1070 | 5760 | 856 | 6204 | 462 | 6769 | 9 | 6743 |
| 10-#14 | 5.86 | MA | 4205 | 1980 | 6821 | 1419 | 7415 | 1177 | 7795 | 952 | 8356 | 567 | 10013 | 59 | 9770 |
| 5L-2S | | MI | 2979 | 1980 | 5383 | 1296 | 5938 | 1053 | 6387 | 844 | 7021 | 452 | 7708 | 167 | 6849 |
| 12-#10 | 3.97 | MA | 4118 | 1779 | 6720 | 1279 | 7350 | 1057 | 7751 | 871 | 8372 | 578 | 10092 | 325 | 7967 |
| 4E | | MI | 2655 | 1779 | 4378 | 1212 | 4680 | 996 | 4862 | 815 | 5142 | 526 | 5676 | 197 | 4848 |
| 12-#10 | 3.97 | MA | 3997 | 1779 | 6453 | 1287 | 6994 | 1075 | 7307 | 888 | 7715 | 581 | 9237 | 275 | 7594 |
| 5L-3S | | MI | 2686 | 1779 | 4569 | 1197 | 4926 | 995 | 5164 | 817 | 5533 | 521 | 6114 | 236 | 4977 |
| 12-#10 | 3.97 | MA | 3908 | 1779 | 6192 | 1293 | 6639 | 1082 | 6866 | 893 | 7122 | 595 | 8457 | 216 | 7244 |
| 6L-2S | | MI | 2762 | 1779 | 4810 | 1194 | 5235 | 983 | 5541 | 807 | 6044 | 515 | 6723 | 325 | 4963 |
| 12-#11 | 4.88 | MA | 4142 | 1876 | 6770 | 1344 | 7374 | 1117 | 7759 | 913 | 8321 | 570 | 9988 | 197 | 8955 |
| 5L-3S | | MI | 2776 | 1876 | 4801 | 1243 | 5204 | 1028 | 5497 | 833 | 5914 | 490 | 6493 | 139 | 5890 |
| 12-#11 | 4.88 | MA | 4036 | 1876 | 6436 | 1366 | 6945 | 1124 | 7225 | 918 | 7604 | 586 | 9067 | 127 | 8377 |
| 6L-2S | | MI | 2865 | 1876 | 5087 | 1240 | 5571 | 1014 | 5943 | 823 | 6506 | 483 | 7185 | 249 | 5877 |
| 12-#14 | 7.03 | MA | 4510 | 2105 | 7533 | 1496 | 8328 | 1233 | 8908 | 986 | 9871 | 557 | 12033 | 37 | 11874 |
| 5L-3S | | MI | 3017 | 2105 | 5383 | 1376 | 5938 | 1126 | 6387 | 890 | 7021 | 445 | 7708 | -52 | 7674 |
| 14-#10 | 4.63 | MA | 4177 | 1850 | 6870 | 1331 | 7528 | 1106 | 7958 | 907 | 8602 | 575 | 10464 | 267 | 8855 |
| 5L-4S | | MI | 2755 | 1850 | 4620 | 1255 | 4989 | 1027 | 5239 | 834 | 5653 | 520 | 6285 | 171 | 5557 |
| 14-#10 | 4.63 | MA | 4090 | 1850 | 6609 | 1337 | 7174 | 1113 | 7518 | 913 | 8009 | 589 | 9684 | 208 | 8488 |
| 6L-3S | | MI | 2785 | 1850 | 4810 | 1241 | 5235 | 1026 | 5541 | 836 | 6044 | 515 | 6723 | 210 | 5733 |
| 14-#11 | 5.69 | MA | 4254 | 1962 | 6938 | 1420 | 7588 | 1163 | 8009 | 942 | 8671 | 579 | 10512 | 114 | 9877 |
| 6L-3S | | MI | 2892 | 1962 | 5087 | 1297 | 5571 | 1066 | 5943 | 856 | 6506 | 481 | 7185 | 101 | 6777 |
| 16-#10 | 5.29 | MA | 4272 | 1920 | 7026 | 1381 | 7708 | 1145 | 8169 | 932 | 8896 | 583 | 10911 | 200 | 9737 |
| 6L-4S | | MI | 2854 | 1920 | 4861 | 1299 | 5298 | 1059 | 5616 | 854 | 6165 | 515 | 6894 | 145 | 6270 |

## RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

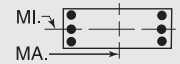
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.22 | MA | 4228 | 1612 | 6715 | 1168 | 7157 | 984 | 7321 | 841 | 7381 | 628 | 8398 | 545 | 3139 |
| 2E | | MI | 2551 | 1612 | 4126 | 1096 | 4280 | 923 | 4306 | 788 | 4246 | 585 | 4543 | 471 | 1880 |
| 4-#11 | 1.50 | MA | 4306 | 1644 | 6924 | 1179 | 7399 | 991 | 7606 | 843 | 7763 | 620 | 8922 | 537 | 3782 |
| 2E | | MI | 2585 | 1644 | 4225 | 1101 | 4387 | 925 | 4428 | 786 | 4383 | 568 | 4672 | 440 | 2235 |
| 4-#14 | 2.16 | MA | 4502 | 1720 | 7407 | 1220 | 8000 | 1020 | 8331 | 859 | 8745 | 610 | 10217 | 519 | 5303 |
| 2E | | MI | 2677 | 1720 | 4462 | 1138 | 4677 | 950 | 4777 | 798 | 4815 | 548 | 5142 | 389 | 3046 |
| 4-#18 | 3.85 | MA | 4973 | 1914 | 8584 | 1328 | 9473 | 1095 | 10113 | 902 | 11162 | 587 | 13284 | 463 | 9001 |
| 2E | | MI | 2889 | 1914 | 5017 | 1238 | 5362 | 1019 | 5567 | 828 | 5790 | 488 | 6150 | 239 | 4931 |
| 6-#8 | 1.14 | MA | 4209 | 1602 | 6650 | 1168 | 7092 | 985 | 7249 | 843 | 7288 | 632 | 8272 | 549 | 2953 |
| 2L-3S | | MI | 2492 | 1602 | 3943 | 1102 | 4060 | 935 | 4043 | 799 | 3894 | 596 | 4148 | 430 | 1788 |
| 6-#8 | 1.14 | MA | 4102 | 1602 | 6360 | 1174 | 6720 | 990 | 6795 | 855 | 6670 | 642 | 7417 | 496 | 2970 |
| 3L-2S | | MI | 2544 | 1602 | 4096 | 1100 | 4257 | 927 | 4283 | 793 | 4221 | 592 | 4547 | 485 | 1774 |
| 6-#9 | 1.44 | MA | 4306 | 1637 | 6882 | 1187 | 7380 | 998 | 7597 | 851 | 7759 | 628 | 8924 | 544 | 3680 |
| 2L-3S | | MI | 2527 | 1637 | 4024 | 1120 | 4157 | 949 | 4159 | 807 | 4051 | 591 | 4324 | 397 | 2197 |
| 6-#9 | 1.44 | MA | 4172 | 1637 | 6517 | 1194 | 6912 | 1005 | 7026 | 865 | 6982 | 640 | 7848 | 476 | 3700 |
| 3L-2S | | MI | 2591 | 1637 | 4216 | 1117 | 4404 | 939 | 4460 | 798 | 4460 | 586 | 4817 | 468 | 2175 |
| 6-#10 | 1.83 | MA | 4428 | 1682 | 7176 | 1212 | 7748 | 1016 | 8041 | 860 | 8361 | 622 | 9755 | 537 | 4601 |
| 2L-3S | | MI | 2570 | 1682 | 4126 | 1143 | 4280 | 966 | 4306 | 817 | 4246 | 584 | 4543 | 355 | 2706 |
| 6-#10 | 1.83 | MA | 4262 | 1682 | 6715 | 1221 | 7157 | 1023 | 7321 | 878 | 7381 | 637 | 8398 | 450 | 4621 |
| 3L-2S | | MI | 2649 | 1682 | 4367 | 1139 | 4589 | 954 | 4683 | 807 | 4758 | 579 | 5152 | 444 | 2676 |
| 6-#11 | 2.25 | MA | 4543 | 1730 | 7480 | 1233 | 8111 | 1030 | 8474 | 867 | 8944 | 613 | 10558 | 527 | 5541 |
| 2L-3S | | MI | 2609 | 1730 | 4225 | 1157 | 4387 | 976 | 4428 | 819 | 4383 | 565 | 4672 | 292 | 3214 |
| 6-#11 | 2.25 | MA | 4348 | 1730 | 6924 | 1243 | 7399 | 1052 | 7606 | 887 | 7763 | 630 | 8922 | 418 | 5561 |
| 3L-2S | | MI | 2701 | 1730 | 4511 | 1155 | 4753 | 963 | 4875 | 809 | 4976 | 558 | 5364 | 402 | 3176 |
| 6-#14 | 3.25 | MA | 4835 | 1844 | 8197 | 1298 | 9013 | 1075 | 9567 | 893 | 10426 | 600 | 12513 | 502 | 7790 |
| 2L-3S | | MI | 2710 | 1844 | 4462 | 1218 | 4677 | 1023 | 4777 | 845 | 4815 | 541 | 5142 | 170 | 4391 |
| 6-#14 | 3.25 | MA | 4565 | 1844 | 7407 | 1312 | 8000 | 1106 | 8331 | 922 | 8745 | 623 | 10217 | 344 | 7776 |
| 3L-2S | | MI | 2838 | 1844 | 4863 | 1216 | 5191 | 1006 | 5404 | 832 | 5632 | 531 | 6081 | 328 | 4347 |
| 6-#18 | 5.77 | MA | 5094 | 2135 | 8584 | 1488 | 9473 | 1246 | 10113 | 1009 | 11162 | 605 | 13284 | 140 | 12777 |
| 3L-2S | | MI | 3154 | 2135 | 5691 | 1376 | 6226 | 1118 | 6602 | 885 | 7113 | 448 | 7620 | 108 | 7075 |
| 8-#7 | 1.15 | MA | 4217 | 1604 | 6660 | 1172 | 7112 | 988 | 7278 | 846 | 7329 | 634 | 8331 | 551 | 2994 |
| 2L-4S | | MI | 2494 | 1604 | 3893 | 1115 | 4002 | 939 | 3974 | 802 | 3810 | 601 | 4071 | 428 | 1820 |
| 8-#7 | 1.15 | MA | 4136 | 1604 | 6438 | 1176 | 6828 | 992 | 6931 | 855 | 6857 | 641 | 7678 | 511 | 3006 |
| 3E | | MI | 2509 | 1604 | 3985 | 1108 | 4122 | 938 | 4121 | 802 | 4001 | 598 | 4292 | 448 | 1805 |
| 8-#7 | 1.15 | MA | 4093 | 1604 | 6270 | 1186 | 6610 | 1002 | 6663 | 858 | 6508 | 649 | 7234 | 487 | 3020 |
| 4L-2S | | MI | 2549 | 1604 | 4103 | 1105 | 4273 | 932 | 4306 | 796 | 4252 | 595 | 4602 | 490 | 1794 |
| 8-#8 | 1.52 | MA | 4336 | 1646 | 6941 | 1195 | 7464 | 1005 | 7703 | 855 | 7905 | 629 | 9127 | 545 | 3874 |
| 2L-4S | | MI | 2535 | 1646 | 3976 | 1139 | 4101 | 956 | 4092 | 811 | 3972 | 597 | 4262 | 390 | 2319 |
| 8-#8 | 1.52 | MA | 4230 | 1646 | 6650 | 1201 | 7092 | 1010 | 7249 | 867 | 7288 | 639 | 8272 | 492 | 3889 |
| 3E | | MI | 2556 | 1646 | 4096 | 1130 | 4257 | 955 | 4283 | 811 | 4221 | 593 | 4547 | 415 | 2298 |
| 8-#8 | 1.52 | MA | 4175 | 1646 | 6430 | 1214 | 6806 | 1022 | 6898 | 871 | 6830 | 648 | 7690 | 461 | 3901 |
| 4L-2S | | MI | 2607 | 1646 | 4250 | 1127 | 4454 | 947 | 4524 | 804 | 4548 | 588 | 4946 | 471 | 2281 |
| 8-#9 | 1.92 | MA | 4464 | 1692 | 7247 | 1221 | 7848 | 1023 | 8168 | 866 | 8536 | 623 | 10000 | 538 | 4834 |
| 2L-4S | | MI | 2580 | 1692 | 4065 | 1166 | 4208 | 975 | 4220 | 821 | 4148 | 591 | 4464 | 347 | 2851 |
| 8-#9 | 1.92 | MA | 4333 | 1692 | 6882 | 1229 | 7380 | 1029 | 7597 | 880 | 7759 | 635 | 8924 | 470 | 4849 |
| 3E | | MI | 2606 | 1692 | 4216 | 1154 | 4404 | 973 | 4460 | 822 | 4460 | 587 | 4817 | 378 | 2825 |
| 8-#9 | 1.92 | MA | 4265 | 1692 | 6605 | 1245 | 7020 | 1044 | 7155 | 885 | 7183 | 647 | 8188 | 431 | 4849 |
| 4L-2S | | MI | 2669 | 1692 | 4409 | 1151 | 4650 | 963 | 4760 | 814 | 4869 | 582 | 5310 | 448 | 2804 |
| 8-#10 | 2.44 | MA | 4625 | 1752 | 7637 | 1255 | 8338 | 1047 | 8762 | 880 | 9341 | 617 | 11113 | 530 | 6052 |
| 2L-4S | | MI | 2637 | 1752 | 4176 | 1201 | 4343 | 999 | 4381 | 835 | 4367 | 584 | 4714 | 290 | 3508 |
| 8-#10 | 2.44 | MA | 4464 | 1752 | 7176 | 1264 | 7748 | 1055 | 8041 | 897 | 8361 | 632 | 9755 | 443 | 6063 |
| 3E | | MI | 2669 | 1752 | 4367 | 1187 | 4589 | 998 | 4683 | 836 | 4758 | 578 | 5152 | 329 | 3483 |
| 8-#10 | 2.44 | MA | 4379 | 1752 | 6826 | 1285 | 7293 | 1074 | 7483 | 903 | 7634 | 646 | 8823 | 392 | 6031 |
| 4L-2S | | MI | 2748 | 1752 | 4608 | 1183 | 4898 | 986 | 5060 | 826 | 5269 | 573 | 5761 | 418 | 3457 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

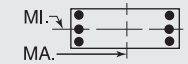
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 3.00 | MA | 4589 | 1816 | 7480 | 1297 | 8111 | 1091 | 8474 | 911 | 8944 | 623 | 10558 | 408 | 7291 |
| 3E | | MI | 2725 | 1816 | 4511 | 1211 | 4753 | 1015 | 4875 | 843 | 4976 | 555 | 5364 | 254 | 4130 |
| 8-#11 | 3.00 | MA | 4491 | 1816 | 7055 | 1321 | 7561 | 1099 | 7798 | 918 | 8064 | 640 | 9420 | 345 | 7119 |
| 4L-2S | | MI | 2816 | 1816 | 4796 | 1209 | 5119 | 1002 | 5322 | 833 | 5568 | 548 | 6055 | 364 | 4098 |
| 8-#14 | 4.33 | MA | 4905 | 1969 | 8197 | 1389 | 9013 | 1162 | 9567 | 956 | 10426 | 613 | 12513 | 327 | 10218 |
| 3E | | MI | 2873 | 1969 | 4863 | 1296 | 5191 | 1079 | 5404 | 879 | 5632 | 524 | 6081 | 109 | 5654 |
| 8-#14 | 4.33 | MA | 4770 | 1969 | 7592 | 1423 | 8228 | 1174 | 8602 | 964 | 9171 | 636 | 10911 | 238 | 9406 |
| 4L-2S | | MI | 2999 | 1969 | 5264 | 1294 | 5705 | 1062 | 6031 | 866 | 6448 | 514 | 7020 | 267 | 5626 |
| 8-#18 | 7.69 | MA | 5453 | 2356 | 8895 | 1683 | 9859 | 1362 | 10572 | 1080 | 11886 | 623 | 14433 | -52 | 14349 |
| 4L-2S | | MI | 3418 | 2356 | 6365 | 1515 | 7090 | 1217 | 7638 | 941 | 8436 | 408 | 9090 | -22 | 9081 |
| 10-#10 | 3.05 | MA | 4664 | 1822 | 7637 | 1308 | 8338 | 1086 | 8762 | 916 | 9341 | 626 | 11113 | 435 | 7498 |
| 3L-4S | | MI | 2737 | 1822 | 4418 | 1245 | 4652 | 1030 | 4758 | 854 | 4878 | 578 | 5323 | 264 | 4253 |
| 10-#10 | 3.05 | MA | 4581 | 1822 | 7286 | 1329 | 7884 | 1105 | 8203 | 923 | 8614 | 641 | 10180 | 385 | 7454 |
| 4L-3S | | MI | 2768 | 1822 | 4608 | 1231 | 4898 | 1029 | 5060 | 855 | 5269 | 572 | 5761 | 303 | 4250 |
| 10-#10 | 3.05 | MA | 4442 | 1822 | 6993 | 1338 | 7493 | 1113 | 7714 | 940 | 7890 | 645 | 9242 | 337 | 7026 |
| 5L-2S | | MI | 2846 | 1822 | 4849 | 1227 | 5207 | 1017 | 5437 | 845 | 5781 | 567 | 6370 | 392 | 4229 |
| 10-#11 | 3.75 | MA | 4731 | 1903 | 7611 | 1375 | 8273 | 1138 | 8667 | 941 | 9246 | 633 | 11056 | 336 | 8762 |
| 4L-3S | | MI | 2841 | 1903 | 4796 | 1265 | 5119 | 1054 | 5322 | 866 | 5568 | 545 | 6055 | 216 | 5034 |
| 10-#11 | 3.75 | MA | 4566 | 1903 | 7255 | 1385 | 7799 | 1160 | 8075 | 962 | 8370 | 636 | 9916 | 274 | 8261 |
| 5L-2S | | MI | 2931 | 1903 | 5082 | 1263 | 5486 | 1041 | 5769 | 856 | 6160 | 539 | 6746 | 326 | 5011 |
| 10-#14 | 5.41 | MA | 5109 | 2093 | 8382 | 1501 | 9241 | 1229 | 9838 | 998 | 10852 | 626 | 13208 | 221 | 11762 |
| 4L-3S | | MI | 3035 | 2093 | 5264 | 1374 | 5705 | 1135 | 6031 | 913 | 6448 | 507 | 7020 | 48 | 6874 |
| 10-#14 | 5.41 | MA | 4878 | 2093 | 7873 | 1515 | 8564 | 1261 | 8992 | 1026 | 9602 | 629 | 11607 | 132 | 11013 |
| 5L-2S | | MI | 3160 | 2093 | 5665 | 1372 | 6219 | 1117 | 6658 | 900 | 7265 | 497 | 7959 | 206 | 6894 |
| 12-#10 | 3.66 | MA | 4781 | 1893 | 7747 | 1373 | 8474 | 1137 | 8924 | 942 | 9594 | 635 | 11537 | 377 | 8872 |
| 4E | | MI | 2836 | 1893 | 4659 | 1289 | 4961 | 1062 | 5135 | 873 | 5390 | 572 | 5932 | 237 | 4925 |
| 12-#10 | 3.66 | MA | 4645 | 1893 | 7453 | 1382 | 8083 | 1144 | 8435 | 959 | 8871 | 639 | 10600 | 329 | 8417 |
| 5L-3S | | MI | 2867 | 1893 | 4849 | 1274 | 5207 | 1061 | 5437 | 874 | 5781 | 567 | 6370 | 276 | 5012 |
| 12-#10 | 3.66 | MA | 4546 | 1893 | 7160 | 1387 | 7694 | 1163 | 7951 | 966 | 8220 | 654 | 9749 | 271 | 8091 |
| 6L-2S | | MI | 2944 | 1893 | 5090 | 1271 | 5516 | 1049 | 5814 | 864 | 6292 | 561 | 6979 | 366 | 4995 |
| 12-#11 | 4.50 | MA | 4808 | 1989 | 7810 | 1439 | 8511 | 1199 | 8943 | 985 | 9551 | 629 | 11553 | 264 | 9942 |
| 5L-3S | | MI | 2957 | 1989 | 5082 | 1319 | 5486 | 1093 | 5769 | 890 | 6160 | 536 | 6746 | 178 | 5932 |
| 12-#11 | 4.50 | MA | 4690 | 1989 | 7462 | 1446 | 8039 | 1207 | 8356 | 992 | 8762 | 646 | 10513 | 192 | 9367 |
| 6L-2S | | MI | 3047 | 1989 | 5368 | 1317 | 5852 | 1079 | 6215 | 880 | 6752 | 529 | 7438 | 288 | 5916 |
| 12-#14 | 6.49 | MA | 5220 | 2218 | 8663 | 1593 | 9576 | 1316 | 10227 | 1060 | 11283 | 619 | 13903 | 115 | 13360 |
| 5L-3S | | MI | 3198 | 2218 | 5665 | 1451 | 6219 | 1190 | 6658 | 947 | 7265 | 490 | 7959 | -13 | 7951 |
| 14-#10 | 4.27 | MA | 4846 | 1963 | 7914 | 1425 | 8674 | 1176 | 9155 | 978 | 9851 | 633 | 11957 | 322 | 9813 |
| 5L-4S | | MI | 2936 | 1963 | 4900 | 1333 | 5270 | 1093 | 5512 | 892 | 5901 | 566 | 6541 | 211 | 5633 |
| 14-#10 | 4.27 | MA | 4750 | 1963 | 7621 | 1431 | 8284 | 1195 | 8671 | 985 | 9200 | 648 | 11106 | 263 | 9472 |
| 6L-3S | | MI | 2966 | 1963 | 5090 | 1318 | 5516 | 1092 | 5814 | 893 | 6292 | 561 | 6979 | 250 | 5770 |
| 14-#10 | 4.27 | MA | 4650 | 1963 | 7290 | 1447 | 7905 | 1201 | 8209 | 1002 | 8566 | 663 | 10224 | 224 | 9015 |
| 7L-2S | | MI | 3041 | 1963 | 5331 | 1315 | 5825 | 1080 | 6191 | 883 | 6804 | 555 | 7588 | 339 | 5757 |
| 14-#11 | 5.25 | MA | 4934 | 2075 | 8018 | 1500 | 8751 | 1246 | 9224 | 1015 | 9944 | 640 | 12149 | 182 | 11034 |
| 6L-3S | | MI | 3073 | 2075 | 5368 | 1373 | 5852 | 1131 | 6215 | 913 | 6752 | 526 | 7438 | 140 | 6827 |
| 16-#10 | 4.88 | MA | 4952 | 2033 | 8082 | 1475 | 8875 | 1226 | 9392 | 1004 | 10180 | 643 | 12463 | 255 | 10857 |
| 6L-4S | | MI | 3035 | 2033 | 5141 | 1377 | 5579 | 1125 | 5889 | 911 | 6413 | 560 | 7150 | 185 | 6346 |
| 16-#10 | 4.88 | MA | 4853 | 2033 | 7751 | 1491 | 8496 | 1233 | 8929 | 1022 | 9546 | 658 | 11582 | 216 | 10415 |
| 7L-3S | | MI | 3064 | 2033 | 5331 | 1362 | 5825 | 1124 | 6191 | 912 | 6804 | 555 | 7588 | 224 | 6525 |
| 18-#10 | 5.50 | MA | 5055 | 2103 | 8212 | 1535 | 9086 | 1264 | 9650 | 1041 | 10526 | 652 | 12939 | 208 | 11817 |
| 7L-4S | | MI | 3134 | 2103 | 5382 | 1421 | 5888 | 1157 | 6266 | 930 | 6924 | 554 | 7759 | 159 | 7062 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis

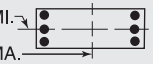



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.13 | MA | 4882 | 1725 | 7706 | 1260 | 8224 | 1062 | 8409 | 910 | 8456 | 682 | 9601 | 593 | 3414 |
| 2E | | MI | 2732 | 1725 | 4406 | 1173 | 4562 | 989 | 4579 | 845 | 4494 | 630 | 4799 | 511 | 1901 |
| 4-#11 | 1.39 | MA | 4969 | 1757 | 7938 | 1271 | 8493 | 1069 | 8725 | 912 | 8879 | 674 | 10181 | 585 | 4119 |
| 2E | | MI | 2766 | 1757 | 4506 | 1177 | 4668 | 990 | 4700 | 842 | 4629 | 613 | 4925 | 479 | 2260 |
| 4-#14 | 2.01 | MA | 5187 | 1833 | 8471 | 1312 | 9155 | 1098 | 9525 | 928 | 9963 | 664 | 11678 | 573 | 5789 |
| 2E | | MI | 2858 | 1833 | 4744 | 1214 | 4957 | 1014 | 5048 | 855 | 5059 | 592 | 5393 | 428 | 3078 |
| 4-#18 | 3.57 | MA | 5713 | 2027 | 9772 | 1420 | 10784 | 1174 | 11496 | 971 | 12635 | 641 | 15201 | 529 | 9865 |
| 2E | | MI | 3071 | 2027 | 5300 | 1312 | 5642 | 1082 | 5836 | 883 | 6032 | 532 | 6397 | 277 | 4976 |
| 6-#8 | 1.06 | MA | 4860 | 1715 | 7634 | 1260 | 8150 | 1064 | 8328 | 912 | 8351 | 687 | 9459 | 597 | 3209 |
| 2L-3S | | MI | 2673 | 1715 | 4222 | 1181 | 4342 | 1002 | 4317 | 858 | 4143 | 642 | 4406 | 470 | 1805 |
| 6-#8 | 1.06 | MA | 4741 | 1715 | 7316 | 1266 | 7743 | 1069 | 7832 | 923 | 7675 | 697 | 8524 | 545 | 3226 |
| 3L-2S | | MI | 2725 | 1715 | 4376 | 1178 | 4539 | 994 | 4557 | 851 | 4470 | 638 | 4805 | 526 | 1791 |
| 6-#9 | 1.34 | MA | 4967 | 1750 | 7888 | 1279 | 8467 | 1077 | 8710 | 919 | 8869 | 682 | 10174 | 592 | 4004 |
| 2L-3S | | MI | 2708 | 1750 | 4304 | 1198 | 4439 | 1015 | 4432 | 865 | 4299 | 637 | 4581 | 438 | 2217 |
| 6-#9 | 1.34 | MA | 4819 | 1750 | 7488 | 1286 | 7955 | 1083 | 8085 | 934 | 8018 | 695 | 8996 | 526 | 4024 |
| 3L-2S | | MI | 2772 | 1750 | 4496 | 1195 | 4686 | 1005 | 4733 | 856 | 4709 | 632 | 5074 | 508 | 2196 |
| 6-#10 | 1.70 | MA | 5103 | 1795 | 8211 | 1303 | 8871 | 1094 | 9198 | 929 | 9530 | 677 | 11087 | 585 | 5012 |
| 2L-3S | | MI | 2751 | 1795 | 4406 | 1220 | 4562 | 1032 | 4579 | 874 | 4494 | 630 | 4799 | 395 | 2730 |
| 6-#10 | 1.70 | MA | 4919 | 1795 | 7706 | 1313 | 8224 | 1102 | 8409 | 947 | 8456 | 693 | 9601 | 500 | 5033 |
| 3L-2S | | MI | 2831 | 1795 | 4647 | 1217 | 4871 | 1020 | 4956 | 864 | 5006 | 625 | 5408 | 485 | 2700 |
| 6-#11 | 2.09 | MA | 5232 | 1843 | 8548 | 1325 | 9274 | 1108 | 9678 | 935 | 10176 | 667 | 11977 | 575 | 6046 |
| 2L-3S | | MI | 2790 | 1843 | 4506 | 1234 | 4668 | 1042 | 4700 | 876 | 4629 | 610 | 4925 | 332 | 3244 |
| 6-#11 | 2.09 | MA | 5014 | 1843 | 7938 | 1336 | 8493 | 1117 | 8725 | 957 | 8879 | 686 | 10181 | 468 | 6067 |
| 3L-2S | | MI | 2882 | 1843 | 4792 | 1231 | 5034 | 1028 | 5147 | 866 | 5222 | 603 | 5617 | 442 | 3205 |
| 6-#14 | 3.01 | MA | 5557 | 1958 | 9339 | 1390 | 10268 | 1154 | 10882 | 962 | 11809 | 654 | 14235 | 559 | 8519 |
| 2L-3S | | MI | 2891 | 1958 | 4744 | 1294 | 4957 | 1087 | 5048 | 901 | 5059 | 585 | 5393 | 209 | 4432 |
| 6-#14 | 3.01 | MA | 5256 | 1958 | 8471 | 1405 | 9155 | 1186 | 9525 | 992 | 9963 | 680 | 11678 | 402 | 8505 |
| 3L-2S | | MI | 3019 | 1958 | 5145 | 1292 | 5471 | 1070 | 5675 | 889 | 5876 | 575 | 6332 | 367 | 4383 |
| 6-#18 | 5.36 | MA | 5845 | 2248 | 9772 | 1582 | 10784 | 1328 | 11496 | 1081 | 12635 | 663 | 15201 | 215 | 14326 |
| 3L-2S | | MI | 3336 | 2248 | 5973 | 1450 | 6506 | 1181 | 6871 | 940 | 7355 | 492 | 7867 | 147 | 7128 |
| 8-#7 | 1.07 | MA | 4869 | 1717 | 7643 | 1264 | 8172 | 1067 | 8359 | 914 | 8395 | 688 | 9522 | 598 | 3253 |
| 2L-4S | | MI | 2675 | 1717 | 4172 | 1194 | 4284 | 1006 | 4249 | 861 | 4060 | 648 | 4330 | 469 | 1835 |
| 8-#7 | 1.07 | MA | 4778 | 1717 | 7401 | 1269 | 7861 | 1071 | 7980 | 923 | 7879 | 696 | 8807 | 559 | 3265 |
| 3E | | MI | 2691 | 1717 | 4265 | 1186 | 4404 | 1005 | 4395 | 860 | 4251 | 645 | 4551 | 488 | 1822 |
| 8-#7 | 1.07 | MA | 4730 | 1717 | 7218 | 1279 | 7624 | 1081 | 7687 | 927 | 7498 | 704 | 8327 | 536 | 3279 |
| 4L-2S | | MI | 2730 | 1717 | 4383 | 1184 | 4555 | 999 | 4580 | 855 | 4502 | 641 | 4861 | 531 | 1812 |
| 8-#8 | 1.41 | MA | 5000 | 1759 | 7951 | 1287 | 8558 | 1083 | 8825 | 924 | 9027 | 683 | 10395 | 592 | 4216 |
| 2L-4S | | MI | 2716 | 1759 | 4255 | 1217 | 4383 | 1023 | 4366 | 869 | 4221 | 643 | 4520 | 430 | 2339 |
| 8-#8 | 1.41 | MA | 4883 | 1759 | 7634 | 1293 | 8150 | 1089 | 8328 | 935 | 8351 | 694 | 9459 | 541 | 4230 |
| 3E | | MI | 2737 | 1759 | 4376 | 1208 | 4539 | 1022 | 4557 | 870 | 4470 | 639 | 4805 | 456 | 2318 |
| 8-#8 | 1.41 | MA | 4821 | 1759 | 7394 | 1307 | 7839 | 1101 | 7945 | 940 | 7852 | 704 | 8829 | 510 | 4242 |
| 4L-2S | | MI | 2788 | 1759 | 4530 | 1205 | 4736 | 1013 | 4798 | 863 | 4797 | 635 | 5204 | 512 | 2301 |
| 8-#9 | 1.79 | MA | 5142 | 1805 | 8288 | 1313 | 8980 | 1102 | 9336 | 934 | 9719 | 678 | 11352 | 586 | 5266 |
| 2L-4S | | MI | 2761 | 1805 | 4345 | 1244 | 4490 | 1041 | 4493 | 879 | 4396 | 638 | 4721 | 387 | 2876 |
| 8-#9 | 1.79 | MA | 4997 | 1805 | 7888 | 1321 | 8467 | 1108 | 8710 | 949 | 8869 | 691 | 10174 | 520 | 5281 |
| 3E | | MI | 2787 | 1805 | 4496 | 1232 | 4686 | 1040 | 4733 | 880 | 4709 | 633 | 5074 | 419 | 2849 |
| 8-#9 | 1.79 | MA | 4919 | 1805 | 7586 | 1338 | 8075 | 1124 | 8228 | 955 | 8240 | 703 | 9377 | 481 | 5281 |
| 4L-2S | | MI | 2850 | 1805 | 4688 | 1229 | 4932 | 1030 | 5034 | 872 | 5118 | 628 | 5567 | 489 | 2827 |
| 8-#10 | 2.27 | MA | 5321 | 1865 | 8716 | 1347 | 9517 | 1126 | 9987 | 948 | 10603 | 671 | 12574 | 577 | 6601 |
| 2L-4S | | MI | 2818 | 1865 | 4457 | 1279 | 4625 | 1065 | 4654 | 892 | 4615 | 630 | 4970 | 330 | 3539 |
| 8-#10 | 2.27 | MA | 5142 | 1865 | 8211 | 1357 | 8871 | 1134 | 9198 | 966 | 9530 | 687 | 11087 | 493 | 6612 |
| 3E | | MI | 2850 | 1865 | 4647 | 1264 | 4871 | 1064 | 4956 | 893 | 5006 | 624 | 5408 | 369 | 3511 |
| 8-#10 | 2.27 | MA | 5045 | 1865 | 7829 | 1378 | 8375 | 1154 | 8588 | 973 | 8735 | 703 | 10077 | 443 | 6580 |
| 4L-2S | | MI | 2929 | 1865 | 4888 | 1261 | 5180 | 1052 | 5333 | 884 | 5517 | 619 | 6017 | 458 | 3484 |
| 8-#11 | 2.79 | MA | 5281 | 1929 | 8548 | 1390 | 9274 | 1156 | 9678 | 980 | 10176 | 679 | 11977 | 459 | 7965 |
| 3E | | MI | 2906 | 1929 | 4792 | 1288 | 5034 | 1080 | 5147 | 900 | 5222 | 600 | 5617 | 294 | 4165 |
| 8-#11 | 2.79 | MA | 5169 | 1929 | 8084 | 1414 | 8673 | 1179 | 8939 | 988 | 9213 | 697 | 10743 | 397 | 7881 |
| 4L-2S | | MI | 2997 | 1929 | 5077 | 1285 | 5401 | 1067 | 5594 | 889 | 5814 | 594 | 6308 | 404 | 4131 |

## RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

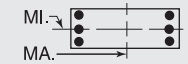
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 4.02 | MA | 5632 | 2082 | 9339 | 1483 | 10268 | 1242 | 10882 | 1026 | 11809 | 670 | 14235 | 388 | 11190 |
| 3E | | MI | 3054 | 2082 | 5145 | 1371 | 5471 | 1143 | 5675 | 935 | 5876 | 568 | 6332 | 148 | 5699 |
| 8-#14 | 4.02 | MA | 5477 | 2082 | 8677 | 1518 | 9409 | 1255 | 9827 | 1036 | 10435 | 695 | 12464 | 298 | 10417 |
| 4L-2S | | MI | 3180 | 2082 | 5545 | 1369 | 5985 | 1126 | 6302 | 923 | 6693 | 558 | 7271 | 306 | 5667 |
| 8-#18 | 7.14 | MA | 6234 | 2469 | 10122 | 1780 | 11216 | 1446 | 12010 | 1155 | 13443 | 686 | 16511 | 26 | 16343 |
| 4L-2S | | MI | 3600 | 2469 | 6647 | 1589 | 7369 | 1280 | 7907 | 996 | 8678 | 451 | 9337 | 17 | 9251 |
| 10-#10 | 2.83 | MA | 5363 | 1935 | 8716 | 1401 | 9517 | 1165 | 9987 | 985 | 10603 | 681 | 12574 | 485 | 8184 |
| 3L-4S | | MI | 2918 | 1935 | 4698 | 1323 | 4934 | 1097 | 5031 | 911 | 5126 | 624 | 5579 | 304 | 4301 |
| 10-#10 | 2.83 | MA | 5268 | 1935 | 8333 | 1422 | 9021 | 1185 | 9378 | 993 | 9809 | 697 | 11564 | 435 | 8139 |
| 4L-3S | | MI | 2949 | 1935 | 4888 | 1308 | 5180 | 1096 | 5333 | 913 | 5517 | 618 | 6017 | 343 | 4281 |
| 10-#10 | 2.83 | MA | 5115 | 1935 | 8014 | 1431 | 8595 | 1193 | 8845 | 1011 | 9020 | 702 | 10545 | 390 | 7723 |
| 5L-2S | | MI | 3027 | 1935 | 5129 | 1305 | 5489 | 1083 | 5710 | 903 | 6029 | 613 | 6626 | 432 | 4258 |
| 10-#11 | 3.48 | MA | 5435 | 2016 | 8693 | 1468 | 9454 | 1218 | 9892 | 1012 | 10510 | 690 | 12538 | 387 | 9687 |
| 4L-3S | | MI | 3022 | 2016 | 5077 | 1342 | 5401 | 1119 | 5594 | 923 | 5814 | 591 | 6308 | 256 | 5073 |
| 10-#11 | 3.48 | MA | 5253 | 2016 | 8305 | 1479 | 8937 | 1227 | 9246 | 1033 | 9553 | 695 | 11298 | 329 | 9092 |
| 5L-2S | | MI | 3113 | 2016 | 5363 | 1339 | 5767 | 1106 | 6041 | 913 | 6406 | 584 | 7000 | 366 | 5046 |
| 10-#14 | 5.02 | MA | 5853 | 2207 | 9544 | 1595 | 10522 | 1311 | 11184 | 1070 | 12282 | 685 | 15020 | 284 | 13013 |
| 4L-3S | | MI | 3216 | 2207 | 5545 | 1449 | 5985 | 1199 | 6302 | 969 | 6693 | 551 | 7271 | 87 | 6954 |
| 10-#14 | 5.02 | MA | 5598 | 2207 | 8989 | 1611 | 9782 | 1343 | 10260 | 1100 | 10915 | 690 | 13243 | 197 | 12287 |
| 5L-2S | | MI | 3341 | 2207 | 5946 | 1447 | 6499 | 1182 | 6929 | 956 | 7510 | 541 | 8210 | 246 | 6938 |
| 12-#10 | 3.40 | MA | 5489 | 2006 | 8838 | 1466 | 9668 | 1217 | 10167 | 1012 | 10883 | 692 | 13051 | 427 | 9699 |
| 4E | | MI | 3017 | 2006 | 4939 | 1367 | 5243 | 1128 | 5408 | 930 | 5638 | 618 | 6188 | 278 | 5036 |
| 12-#10 | 3.40 | MA | 5339 | 2006 | 8519 | 1475 | 9242 | 1225 | 9634 | 1030 | 10094 | 696 | 12031 | 383 | 9250 |
| 5L-3S | | MI | 3048 | 2006 | 5129 | 1352 | 5489 | 1127 | 5710 | 932 | 6029 | 612 | 6626 | 317 | 5045 |
| 12-#10 | 3.40 | MA | 5230 | 2006 | 8193 | 1480 | 8818 | 1245 | 9106 | 1037 | 9384 | 712 | 11111 | 325 | 8955 |
| 6L-2S | | MI | 3125 | 2006 | 5370 | 1349 | 5798 | 1115 | 6087 | 922 | 6540 | 607 | 7235 | 406 | 5026 |
| 12-#11 | 4.18 | MA | 5521 | 2102 | 8915 | 1533 | 9718 | 1266 | 10198 | 1057 | 10849 | 688 | 13093 | 320 | 10938 |
| 5L-3S | | MI | 3138 | 2102 | 5363 | 1396 | 5767 | 1158 | 6041 | 947 | 6406 | 581 | 7000 | 218 | 5974 |
| 12-#11 | 4.18 | MA | 5391 | 2102 | 8527 | 1540 | 9203 | 1289 | 9558 | 1065 | 9988 | 706 | 11968 | 248 | 10375 |
| 6L-2S | | MI | 3228 | 2102 | 5649 | 1393 | 6133 | 1145 | 6487 | 936 | 6998 | 574 | 7691 | 328 | 5954 |
| 12-#14 | 6.03 | MA | 5976 | 2331 | 9857 | 1688 | 10895 | 1399 | 11617 | 1134 | 12761 | 680 | 15800 | 183 | 14880 |
| 5L-3S | | MI | 3379 | 2331 | 5946 | 1527 | 6499 | 1255 | 6929 | 1003 | 7510 | 534 | 8210 | 26 | 8125 |
| 12-#14 | 6.03 | MA | 5794 | 2331 | 9311 | 1699 | 10158 | 1412 | 10701 | 1144 | 11531 | 705 | 14183 | 79 | 13711 |
| 6L-2S | | MI | 3503 | 2331 | 6347 | 1525 | 7013 | 1238 | 7556 | 990 | 8327 | 524 | 9149 | 185 | 8201 |
| 14-#10 | 3.97 | MA | 5561 | 2076 | 9023 | 1519 | 9889 | 1257 | 10423 | 1049 | 11167 | 691 | 13518 | 375 | 10781 |
| 5L-4S | | MI | 3117 | 2076 | 5180 | 1410 | 5552 | 1160 | 5785 | 950 | 6149 | 612 | 6797 | 251 | 5707 |
| 14-#10 | 3.97 | MA | 5455 | 2076 | 8698 | 1524 | 9465 | 1276 | 9895 | 1056 | 10458 | 707 | 12598 | 317 | 10473 |
| 6L-3S | | MI | 3147 | 2076 | 5370 | 1396 | 5798 | 1159 | 6087 | 951 | 6540 | 607 | 7235 | 290 | 5805 |
| 14-#10 | 3.97 | MA | 5342 | 2076 | 8336 | 1541 | 9043 | 1282 | 9392 | 1075 | 9767 | 723 | 11641 | 280 | 9936 |
| 7L-2S | | MI | 3223 | 2076 | 5611 | 1393 | 6107 | 1146 | 6464 | 941 | 7052 | 601 | 7844 | 380 | 5790 |
| 14-#11 | 4.88 | MA | 5660 | 2188 | 9136 | 1594 | 9984 | 1328 | 10511 | 1088 | 11285 | 699 | 13763 | 238 | 12210 |
| 6L-3S | | MI | 3254 | 2188 | 5649 | 1450 | 6133 | 1197 | 6487 | 970 | 6998 | 571 | 7691 | 180 | 6870 |
| 14-#11 | 4.88 | MA | 5528 | 2188 | 8699 | 1614 | 9482 | 1336 | 9899 | 1110 | 10446 | 718 | 12597 | 190 | 11625 |
| 7L-2S | | MI | 3343 | 2188 | 5934 | 1447 | 6499 | 1183 | 6934 | 960 | 7590 | 564 | 8382 | 290 | 6857 |
| 14-#14 | 7.03 | MA | 6175 | 2456 | 10179 | 1776 | 11271 | 1468 | 12059 | 1178 | 13377 | 695 | 16739 | 65 | 16348 |
| 6L-3S | | MI | 3541 | 2456 | 6347 | 1605 | 7013 | 1311 | 7556 | 1037 | 8327 | 517 | 9149 | -34 | 9126 |
| 16-#10 | 4.54 | MA | 5678 | 2146 | 9202 | 1568 | 10112 | 1308 | 10685 | 1076 | 11532 | 701 | 14084 | 309 | 11995 |
| 6L-4S | | MI | 3216 | 2146 | 5421 | 1454 | 5861 | 1191 | 6163 | 969 | 6661 | 606 | 7406 | 225 | 6419 |
| 16-#10 | 4.54 | MA | 5567 | 2146 | 8841 | 1585 | 9690 | 1313 | 10181 | 1094 | 10840 | 717 | 13128 | 273 | 11473 |
| 7L-3S | | MI | 3245 | 2146 | 5611 | 1440 | 6107 | 1190 | 6464 | 970 | 7052 | 601 | 7844 | 264 | 6562 |
| 16-#10 | 4.54 | MA | 5442 | 2146 | 8524 | 1591 | 9252 | 1329 | 9685 | 1112 | 10104 | 722 | 12079 | 207 | 10929 |
| 8L-2S | | MI | 3320 | 2146 | 5853 | 1437 | 6416 | 1178 | 6841 | 960 | 7563 | 595 | 8452 | 353 | 6551 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

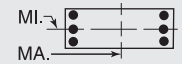
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 5.57 | MA | 5796 | 2275 | 9308 | 1668 | 10263 | 1374 | 10852 | 1133 | 11742 | 711 | 14392 | 180 | 13462 |
| 7L-3S | | MI | 3370 | 2275 | 5934 | 1504 | 6499 | 1235 | 6934 | 994 | 7590 | 561 | 8382 | 142 | 7761 |
| 18-#10 | 5.10 | MA | 5789 | 2217 | 9345 | 1629 | 10337 | 1345 | 10970 | 1113 | 11914 | 711 | 14614 | 265 | 13012 |
| 7L-4S | | MI | 3315 | 2217 | 5662 | 1498 | 6170 | 1223 | 6540 | 988 | 7172 | 600 | 8015 | 199 | 7135 |
| 18-#10 | 5.10 | MA | 5667 | 2217 | 9028 | 1635 | 9899 | 1361 | 10474 | 1131 | 11178 | 716 | 13566 | 199 | 12465 |
| 8L-3S | | MI | 3343 | 2217 | 5853 | 1484 | 6416 | 1222 | 6841 | 989 | 7563 | 595 | 8452 | 238 | 7316 |
| 20-#10 | 5.67 | MA | 5890 | 2287 | 9533 | 1679 | 10546 | 1392 | 11264 | 1150 | 12252 | 711 | 15052 | 191 | 14002 |
| 8L-4S | | MI | 3413 | 2287 | 5903 | 1542 | 6479 | 1254 | 6917 | 1007 | 7683 | 594 | 8623 | 173 | 7854 |

## RECTANGULAR TIED COLUMNS 16" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.06 | MA | 5582 | 1838 | 8762 | 1351 | 9360 | 1141 | 9568 | 978 | 9598 | 737 | 10876 | 641 | 3688 |
| 2E | | MI | 2913 | 1838 | 4686 | 1251 | 4843 | 1055 | 4852 | 903 | 4742 | 676 | 5055 | 551 | 1920 |
| 4-#11 | 1.30 | MA | 5678 | 1870 | 9017 | 1363 | 9656 | 1148 | 9915 | 980 | 10063 | 729 | 11513 | 632 | 4456 |
| 2E | | MI | 2947 | 1870 | 4787 | 1254 | 4949 | 1055 | 4972 | 899 | 4876 | 658 | 5179 | 519 | 2284 |
| 4-#14 | 1.88 | MA | 5918 | 1946 | 9599 | 1404 | 10380 | 1176 | 10789 | 996 | 11247 | 719 | 13149 | 621 | 6275 |
| 2E | | MI | 3039 | 1946 | 5025 | 1289 | 5238 | 1079 | 5318 | 911 | 5304 | 637 | 5644 | 467 | 3108 |
| 4-#18 | 3.33 | MA | 6500 | 2140 | 11025 | 1512 | 12166 | 1252 | 12949 | 1039 | 14175 | 696 | 17195 | 592 | 10729 |
| 2E | | MI | 3252 | 2140 | 5582 | 1386 | 5921 | 1145 | 6105 | 938 | 6274 | 576 | 6644 | 315 | 5021 |
| 6-#9 | 1.25 | MA | 5675 | 1863 | 8959 | 1371 | 9624 | 1155 | 9894 | 987 | 10045 | 737 | 11497 | 639 | 4328 |
| 2L-3S | | MI | 2889 | 1863 | 4584 | 1276 | 4721 | 1081 | 4706 | 923 | 4548 | 683 | 4838 | 478 | 2236 |
| 6-#9 | 1.25 | MA | 5512 | 1863 | 8524 | 1379 | 9067 | 1162 | 9215 | 1003 | 9121 | 750 | 10217 | 575 | 4348 |
| 3L-2S | | MI | 2953 | 1863 | 4776 | 1273 | 4967 | 1071 | 5007 | 914 | 4957 | 678 | 5331 | 549 | 2216 |
| 6-#10 | 1.59 | MA | 5823 | 1908 | 9311 | 1395 | 10063 | 1172 | 10426 | 997 | 10765 | 731 | 12492 | 633 | 5424 |
| 2L-3S | | MI | 2932 | 1908 | 4686 | 1298 | 4843 | 1099 | 4852 | 932 | 4742 | 676 | 5055 | 436 | 2753 |
| 6-#10 | 1.59 | MA | 5621 | 1908 | 8762 | 1406 | 9360 | 1181 | 9568 | 1016 | 9598 | 748 | 10876 | 550 | 5444 |
| 3L-2S | | MI | 3012 | 1908 | 4927 | 1294 | 5152 | 1086 | 5229 | 922 | 5254 | 670 | 5664 | 525 | 2723 |
| 6-#11 | 1.95 | MA | 5966 | 1956 | 9680 | 1417 | 10506 | 1186 | 10952 | 1004 | 11474 | 722 | 13467 | 623 | 6552 |
| 2L-3S | | MI | 2971 | 1956 | 4787 | 1310 | 4949 | 1107 | 4972 | 933 | 4876 | 656 | 5179 | 371 | 3273 |
| 6-#11 | 1.95 | MA | 5727 | 1956 | 9017 | 1428 | 9656 | 1197 | 9915 | 1026 | 10063 | 741 | 11513 | 519 | 6572 |
| 3L-2S | | MI | 3063 | 1956 | 5073 | 1308 | 5315 | 1094 | 5419 | 923 | 5468 | 649 | 5870 | 481 | 3234 |
| 6-#14 | 2.81 | MA | 6325 | 2071 | 10545 | 1482 | 11593 | 1232 | 12268 | 1030 | 13259 | 709 | 15935 | 607 | 9248 |
| 2L-3S | | MI | 3072 | 2071 | 5025 | 1369 | 5238 | 1152 | 5318 | 957 | 5304 | 630 | 5644 | 248 | 4472 |
| 6-#14 | 2.81 | MA | 5992 | 2071 | 9599 | 1498 | 10380 | 1246 | 10789 | 1061 | 11247 | 736 | 13149 | 454 | 9234 |
| 3L-2S | | MI | 3200 | 2071 | 5426 | 1367 | 5752 | 1135 | 5946 | 945 | 6121 | 620 | 6583 | 406 | 4419 |
| 6-#18 | 5.00 | MA | 6642 | 2361 | 11025 | 1676 | 12166 | 1409 | 12949 | 1152 | 14175 | 721 | 17195 | 286 | 15622 |
| 3L-2S | | MI | 3517 | 2361 | 6256 | 1524 | 6785 | 1244 | 7140 | 995 | 7597 | 535 | 8114 | 185 | 7179 |
| 8-#7 | 1.00 | MA | 5567 | 1830 | 8691 | 1356 | 9302 | 1145 | 9510 | 983 | 9528 | 743 | 10785 | 646 | 3512 |
| 2L-4S | | MI | 2856 | 1830 | 4451 | 1272 | 4566 | 1073 | 4523 | 919 | 4310 | 695 | 4588 | 509 | 1850 |
| 8-#7 | 1.00 | MA | 5467 | 1830 | 8428 | 1361 | 8964 | 1150 | 9099 | 992 | 8968 | 751 | 10009 | 608 | 3524 |
| 3E | | MI | 2872 | 1830 | 4544 | 1265 | 4686 | 1072 | 4670 | 919 | 4501 | 691 | 4809 | 529 | 1837 |
| 8-#7 | 1.00 | MA | 5413 | 1830 | 8230 | 1371 | 8707 | 1160 | 8782 | 996 | 8556 | 759 | 9493 | 585 | 3538 |
| 4L-2S | | MI | 2911 | 1830 | 4662 | 1263 | 4837 | 1066 | 4854 | 913 | 4752 | 688 | 5119 | 572 | 1828 |
| 8-#8 | 1.32 | MA | 5710 | 1872 | 9027 | 1379 | 9721 | 1162 | 10017 | 992 | 10215 | 738 | 11735 | 640 | 4557 |
| 2L-4S | | MI | 2898 | 1872 | 4535 | 1296 | 4665 | 1090 | 4640 | 928 | 4471 | 689 | 4777 | 471 | 2358 |
| 8-#8 | 1.32 | MA | 5582 | 1872 | 8682 | 1386 | 9279 | 1167 | 9478 | 1004 | 9481 | 748 | 10719 | 589 | 4572 |
| 3E | | MI | 2918 | 1872 | 4656 | 1286 | 4821 | 1088 | 4831 | 928 | 4720 | 685 | 5062 | 497 | 2337 |
| 8-#8 | 1.32 | MA | 5511 | 1872 | 8422 | 1399 | 8942 | 1180 | 9063 | 1009 | 8941 | 759 | 10040 | 559 | 4584 |
| 4L-2S | | MI | 2969 | 1872 | 4809 | 1284 | 5018 | 1080 | 5072 | 921 | 5047 | 681 | 5461 | 552 | 2321 |
| 8-#9 | 1.67 | MA | 5866 | 1919 | 9393 | 1405 | 10181 | 1180 | 10574 | 1002 | 10969 | 732 | 12777 | 633 | 5698 |
| 2L-4S | | MI | 2942 | 1919 | 4625 | 1322 | 4772 | 1108 | 4767 | 937 | 4645 | 684 | 4977 | 427 | 2899 |
| 8-#9 | 1.67 | MA | 5707 | 1919 | 8959 | 1413 | 9624 | 1187 | 9894 | 1018 | 10045 | 746 | 11497 | 569 | 5713 |
| 3E | | MI | 2968 | 1919 | 4776 | 1310 | 4967 | 1106 | 5007 | 938 | 4957 | 679 | 5331 | 459 | 2871 |
| 8-#9 | 1.67 | MA | 5619 | 1919 | 8631 | 1430 | 9199 | 1203 | 9371 | 1024 | 9364 | 759 | 10639 | 530 | 5713 |
| 4L-2S | | MI | 3032 | 1919 | 4968 | 1307 | 5214 | 1096 | 5308 | 929 | 5366 | 674 | 5823 | 529 | 2850 |
| 8-#10 | 2.12 | MA | 6063 | 1978 | 9859 | 1439 | 10767 | 1204 | 11284 | 1016 | 11932 | 725 | 14108 | 625 | 7149 |
| 2L-4S | | MI | 2999 | 1978 | 4737 | 1356 | 4906 | 1131 | 4927 | 950 | 4863 | 676 | 5226 | 370 | 3569 |

## RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

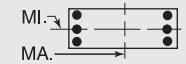
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 2.12 | MA | 5865 | 1978 | 9311 | 1449 | 10063 | 1213 | 10426 | 1035 | 10765 | 742 | 12492 | 542 | 7161 |
| 3E | | MI | 3031 | 1978 | 4927 | 1342 | 5152 | 1130 | 5229 | 951 | 5254 | 670 | 5664 | 409 | 3538 |
| 8-#10 | 2.12 | MA | 5757 | 1978 | 8896 | 1471 | 9526 | 1233 | 9765 | 1043 | 9904 | 759 | 11404 | 493 | 7128 |
| 4L-2S | | MI | 3110 | 1978 | 5168 | 1338 | 5462 | 1118 | 5606 | 941 | 5765 | 665 | 6273 | 499 | 3510 |
| 8-#11 | 2.60 | MA | 6019 | 2043 | 9680 | 1482 | 10506 | 1235 | 10952 | 1050 | 11474 | 734 | 13467 | 509 | 8639 |
| 3E | | MI | 3087 | 2043 | 5073 | 1364 | 5315 | 1146 | 5419 | 956 | 5468 | 646 | 5870 | 334 | 4198 |
| 8-#11 | 2.60 | MA | 5893 | 2043 | 9177 | 1508 | 9854 | 1259 | 10151 | 1058 | 10429 | 754 | 12138 | 448 | 8566 |
| 4L-2S | | MI | 3178 | 2043 | 5358 | 1362 | 5682 | 1132 | 5866 | 946 | 6060 | 639 | 6561 | 443 | 4163 |
| 8-#14 | 3.75 | MA | 6406 | 2195 | 10545 | 1576 | 11593 | 1302 | 12268 | 1095 | 13259 | 726 | 15935 | 440 | 12162 |
| 3E | | MI | 3235 | 2195 | 5426 | 1447 | 5752 | 1208 | 5946 | 991 | 6121 | 613 | 6583 | 187 | 5744 |
| 8-#14 | 3.75 | MA | 6231 | 2195 | 9826 | 1612 | 10660 | 1336 | 11122 | 1107 | 11767 | 753 | 14026 | 351 | 11446 |
| 4L-2S | | MI | 3362 | 2195 | 5827 | 1445 | 6266 | 1190 | 6573 | 979 | 6938 | 603 | 7522 | 346 | 5707 |
| 8-#18 | 6.67 | MA | 7061 | 2583 | 11412 | 1876 | 12644 | 1530 | 13518 | 1229 | 15066 | 747 | 18667 | 100 | 17975 |
| 4L-2S | | MI | 3782 | 2583 | 6930 | 1663 | 7649 | 1344 | 8176 | 1051 | 8920 | 495 | 9584 | 55 | 9307 |
| 10-#10 | 2.65 | MA | 6108 | 2049 | 9859 | 1493 | 10767 | 1244 | 11284 | 1054 | 11932 | 737 | 14108 | 535 | 8870 |
| 3L-4S | | MI | 3099 | 2049 | 4978 | 1400 | 5216 | 1163 | 5305 | 969 | 5374 | 670 | 5835 | 344 | 4334 |
| 10-#10 | 2.65 | MA | 6001 | 2049 | 9445 | 1515 | 10229 | 1265 | 10623 | 1062 | 11071 | 753 | 13020 | 485 | 8825 |
| 4L-3S | | MI | 3130 | 2049 | 5168 | 1386 | 5462 | 1162 | 5606 | 970 | 5765 | 664 | 6273 | 383 | 4311 |
| 10-#10 | 2.65 | MA | 5834 | 2049 | 9100 | 1525 | 9768 | 1274 | 10046 | 1081 | 10217 | 759 | 11920 | 443 | 8429 |
| 5L-2S | | MI | 3208 | 2049 | 5410 | 1382 | 5771 | 1149 | 5983 | 960 | 6277 | 659 | 6882 | 472 | 4287 |
| 10-#11 | 3.25 | MA | 6185 | 2129 | 9841 | 1562 | 10704 | 1298 | 11188 | 1082 | 11841 | 747 | 14093 | 438 | 10613 |
| 4L-3S | | MI | 3203 | 2129 | 5358 | 1418 | 5682 | 1184 | 5866 | 980 | 6060 | 636 | 6561 | 296 | 5110 |
| 10-#11 | 3.25 | MA | 5985 | 2129 | 9420 | 1573 | 10144 | 1308 | 10487 | 1104 | 10803 | 753 | 12752 | 383 | 9931 |
| 5L-2S | | MI | 3294 | 2129 | 5644 | 1416 | 6048 | 1171 | 6312 | 970 | 6652 | 629 | 7253 | 405 | 5081 |
| 10-#14 | 4.69 | MA | 6644 | 2320 | 10772 | 1690 | 11873 | 1392 | 12601 | 1141 | 13779 | 743 | 16812 | 337 | 14282 |
| 4L-3S | | MI | 3397 | 2320 | 5827 | 1525 | 6266 | 1263 | 6573 | 1025 | 6938 | 596 | 7522 | 126 | 7005 |
| 10-#14 | 4.69 | MA | 6363 | 2320 | 10170 | 1706 | 11071 | 1406 | 11599 | 1172 | 12295 | 750 | 14890 | 254 | 13447 |
| 5L-2S | | MI | 3523 | 2320 | 6228 | 1523 | 6780 | 1246 | 7200 | 1013 | 7755 | 586 | 8461 | 285 | 6980 |
| 12-#10 | 3.17 | MA | 6244 | 2119 | 9994 | 1559 | 10932 | 1296 | 11480 | 1081 | 12238 | 748 | 14637 | 478 | 10522 |
| 4E | | MI | 3198 | 2119 | 5219 | 1444 | 5525 | 1194 | 5682 | 988 | 5886 | 664 | 6444 | 318 | 5094 |
| 12-#10 | 3.17 | MA | 6079 | 2119 | 9648 | 1569 | 10471 | 1305 | 10904 | 1101 | 11384 | 753 | 13536 | 435 | 10090 |
| 5L-3S | | MI | 3229 | 2119 | 5410 | 1430 | 5771 | 1193 | 5983 | 989 | 6277 | 658 | 6882 | 357 | 5077 |
| 12-#10 | 3.17 | MA | 5960 | 2119 | 9290 | 1573 | 10013 | 1325 | 10333 | 1108 | 10616 | 770 | 12546 | 378 | 9755 |
| 6L-2S | | MI | 3306 | 2119 | 5651 | 1426 | 6080 | 1181 | 6360 | 979 | 6788 | 653 | 7490 | 446 | 5057 |
| 12-#11 | 3.90 | MA | 6279 | 2215 | 10084 | 1627 | 10994 | 1347 | 11525 | 1128 | 12215 | 746 | 14706 | 374 | 11944 |
| 5L-3S | | MI | 3319 | 2215 | 5644 | 1472 | 6048 | 1223 | 6312 | 1003 | 6652 | 626 | 7253 | 258 | 6014 |
| 12-#11 | 3.90 | MA | 6136 | 2215 | 9656 | 1634 | 10437 | 1371 | 10831 | 1137 | 11282 | 765 | 13495 | 303 | 11402 |
| 6L-2S | | MI | 3409 | 2215 | 5930 | 1470 | 6414 | 1210 | 6759 | 993 | 7244 | 619 | 7944 | 368 | 5991 |
| 12-#14 | 5.63 | MA | 6779 | 2444 | 11116 | 1784 | 12283 | 1461 | 13078 | 1206 | 14307 | 740 | 17676 | 241 | 16338 |
| 5L-3S | | MI | 3560 | 2444 | 6228 | 1603 | 6780 | 1319 | 7200 | 1059 | 7755 | 579 | 8461 | 66 | 8247 |
| 12-#14 | 5.63 | MA | 6579 | 2444 | 10512 | 1793 | 11485 | 1495 | 12085 | 1218 | 12973 | 767 | 15935 | 138 | 15069 |
| 6L-2S | | MI | 3684 | 2444 | 6629 | 1601 | 7294 | 1302 | 7827 | 1047 | 8572 | 569 | 9401 | 224 | 8246 |
| 14-#10 | 3.70 | MA | 6322 | 2189 | 10197 | 1613 | 11174 | 1337 | 11762 | 1120 | 12551 | 748 | 15152 | 427 | 11757 |
| 5L-4S | | MI | 3297 | 2189 | 5460 | 1488 | 5834 | 1226 | 6059 | 1007 | 6397 | 658 | 7053 | 292 | 5820 |
| 14-#10 | 3.70 | MA | 6206 | 2189 | 9838 | 1617 | 10716 | 1357 | 11190 | 1128 | 11783 | 765 | 14162 | 370 | 11436 |
| 6L-3S | | MI | 3328 | 2189 | 5651 | 1473 | 6080 | 1225 | 6360 | 1009 | 6788 | 652 | 7490 | 331 | 5839 |
| 14-#10 | 3.70 | MA | 6080 | 2189 | 9447 | 1634 | 10251 | 1362 | 10646 | 1147 | 11035 | 781 | 13001 | 320 | 10870 |
| 7L-2S | | MI | 3404 | 2189 | 5892 | 1470 | 6389 | 1212 | 6737 | 999 | 7300 | 647 | 8099 | 420 | 5822 |
| 14-#11 | 4.55 | MA | 6432 | 2301 | 10320 | 1688 | 11287 | 1410 | 11868 | 1160 | 12693 | 759 | 15449 | 293 | 13406 |
| 6L-3S | | MI | 3435 | 2301 | 5930 | 1526 | 6414 | 1262 | 6759 | 1027 | 7244 | 616 | 7944 | 220 | 6912 |
| 14-#11 | 4.55 | MA | 6284 | 2301 | 9845 | 1708 | 10733 | 1417 | 11206 | 1183 | 11784 | 778 | 14191 | 248 | 12739 |
| 7L-2S | | MI | 3524 | 2301 | 6215 | 1524 | 6780 | 1249 | 7206 | 1017 | 7836 | 609 | 8635 | 330 | 6896 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

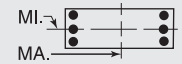
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 6.56 | MA | 6998 | 2569 | 11458 | 1871 | 12698 | 1551 | 13564 | 1252 | 14985 | 757 | 18721 | 124 | 17942 |
| 6L-3S | | MI | 3722 | 2569 | 6629 | 1680 | 7294 | 1375 | 7827 | 1093 | 8572 | 562 | 9401 | 5 | 9384 |
| 16-#10 | 4.23 | MA | 6451 | 2259 | 10387 | 1661 | 11419 | 1389 | 12048 | 1147 | 12950 | 759 | 15778 | 362 | 13120 |
| 6L-4S | | MI | 3397 | 2259 | 5701 | 1532 | 6143 | 1257 | 6436 | 1026 | 6909 | 652 | 7662 | 265 | 6491 |
| 16-#10 | 4.23 | MA | 6326 | 2259 | 9995 | 1678 | 10954 | 1394 | 11503 | 1166 | 12202 | 776 | 14617 | 312 | 12544 |
| 7L-3S | | MI | 3426 | 2259 | 5892 | 1517 | 6389 | 1256 | 6737 | 1028 | 7300 | 647 | 8099 | 304 | 6598 |
| 16-#10 | 4.23 | MA | 6189 | 2259 | 9652 | 1685 | 10480 | 1410 | 10937 | 1172 | 11405 | 781 | 13614 | 264 | 11996 |
| 8L-2S | | MI | 3502 | 2259 | 6133 | 1514 | 6698 | 1244 | 7115 | 1018 | 7811 | 641 | 8708 | 394 | 6585 |
| 16-#11 | 5.20 | MA | 6578 | 2388 | 10508 | 1762 | 11583 | 1456 | 12243 | 1206 | 13195 | 771 | 16145 | 238 | 14767 |
| 7L-3S | | MI | 3551 | 2388 | 6215 | 1580 | 6780 | 1300 | 7206 | 1050 | 7836 | 606 | 8635 | 182 | 7808 |
| 18-#10 | 4.76 | MA | 6570 | 2330 | 10544 | 1722 | 11657 | 1425 | 12361 | 1185 | 13369 | 770 | 16233 | 305 | 14220 |
| 7L-4S | | MI | 3496 | 2330 | 5943 | 1576 | 6452 | 1289 | 6813 | 1046 | 7420 | 646 | 8270 | 239 | 7206 |
| 18-#10 | 4.76 | MA | 6436 | 2330 | 10200 | 1729 | 11183 | 1442 | 11795 | 1191 | 12572 | 776 | 15230 | 256 | 13664 |
| 8L-3S | | MI | 3524 | 2330 | 6133 | 1561 | 6698 | 1288 | 7115 | 1047 | 7811 | 641 | 8708 | 278 | 7354 |
| 20-#10 | 5.29 | MA | 6680 | 2400 | 10749 | 1773 | 11886 | 1473 | 12653 | 1210 | 13740 | 770 | 16846 | 249 | 15332 |
| 8L-4S | | MI | 3594 | 2400 | 6184 | 1620 | 6761 | 1320 | 7190 | 1065 | 7931 | 640 | 8879 | 213 | 7925 |

## RECTANGULAR TIED COLUMNS 16" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.22 | MA | 6432 | 1983 | 10159 | 1455 | 10889 | 1226 | 11176 | 1048 | 11313 | 783 | 12917 | 680 | 4793 |
| 2E | | MI | 3128 | 1983 | 5068 | 1330 | 5230 | 1120 | 5244 | 956 | 5122 | 704 | 5432 | 559 | 2307 |
| 4-#14 | 1.76 | MA | 6696 | 2059 | 10791 | 1496 | 11675 | 1255 | 12124 | 1064 | 12598 | 773 | 14691 | 668 | 6761 |
| 2E | | MI | 3220 | 2059 | 5307 | 1365 | 5519 | 1143 | 5589 | 967 | 5549 | 682 | 5895 | 506 | 3138 |
| 4-#18 | 3.13 | MA | 7333 | 2253 | 12342 | 1604 | 13617 | 1331 | 14473 | 1108 | 15782 | 750 | 19092 | 640 | 11593 |
| 2E | | MI | 3433 | 2253 | 5864 | 1460 | 6201 | 1208 | 6374 | 993 | 6515 | 620 | 6891 | 354 | 5064 |
| 6-#9 | 1.17 | MA | 6427 | 1976 | 10094 | 1463 | 10850 | 1234 | 11149 | 1056 | 11288 | 791 | 12892 | 687 | 4652 |
| 2L-3S | | MI | 3070 | 1976 | 4864 | 1353 | 5003 | 1148 | 4980 | 981 | 4797 | 729 | 5095 | 519 | 2254 |
| 6-#9 | 1.17 | MA | 6250 | 1976 | 9625 | 1471 | 10249 | 1241 | 10415 | 1071 | 10290 | 805 | 11510 | 624 | 4672 |
| 3L-2S | | MI | 3134 | 1976 | 5056 | 1350 | 5249 | 1138 | 5281 | 972 | 5206 | 725 | 5587 | 589 | 2235 |
| 6-#10 | 1.49 | MA | 6590 | 2021 | 10474 | 1487 | 11326 | 1251 | 11724 | 1065 | 12068 | 785 | 13968 | 681 | 5835 |
| 2L-3S | | MI | 3113 | 2021 | 4967 | 1375 | 5125 | 1165 | 5125 | 990 | 4990 | 722 | 5311 | 476 | 2775 |
| 6-#10 | 1.49 | MA | 6368 | 2021 | 9882 | 1498 | 10567 | 1260 | 10797 | 1085 | 10807 | 803 | 12223 | 599 | 5856 |
| 3L-2S | | MI | 3193 | 2021 | 5208 | 1372 | 5434 | 1152 | 5502 | 980 | 5502 | 716 | 5920 | 565 | 2746 |
| 6-#11 | 1.83 | MA | 6747 | 2069 | 10877 | 1508 | 11808 | 1265 | 12297 | 1072 | 12839 | 776 | 15030 | 671 | 7057 |
| 2L-3S | | MI | 3152 | 2069 | 5068 | 1387 | 5230 | 1172 | 5244 | 990 | 5122 | 701 | 5432 | 411 | 3301 |
| 6-#11 | 1.83 | MA | 6484 | 2069 | 10159 | 1521 | 10889 | 1276 | 11176 | 1095 | 11313 | 797 | 12917 | 569 | 7078 |
| 3L-2S | | MI | 3244 | 2069 | 5354 | 1384 | 5597 | 1159 | 5691 | 979 | 5714 | 694 | 6123 | 521 | 3261 |
| 6-#14 | 2.64 | MA | 7139 | 2184 | 11815 | 1574 | 12987 | 1311 | 13725 | 1098 | 14775 | 763 | 17707 | 655 | 9977 |
| 2L-3S | | MI | 3253 | 2184 | 5307 | 1445 | 5519 | 1216 | 5589 | 1013 | 5549 | 675 | 5895 | 287 | 4509 |
| 6-#14 | 2.64 | MA | 6774 | 2184 | 10791 | 1591 | 11675 | 1326 | 12124 | 1131 | 12598 | 792 | 14691 | 505 | 9963 |
| 3L-2S | | MI | 3381 | 2184 | 5708 | 1443 | 6033 | 1199 | 6217 | 1001 | 6366 | 665 | 6834 | 446 | 4454 |
| 6-#18 | 4.69 | MA | 7485 | 2474 | 12342 | 1770 | 13617 | 1454 | 14473 | 1223 | 15782 | 779 | 19092 | 341 | 16918 |
| 3L-2S | | MI | 3699 | 2474 | 6538 | 1598 | 7065 | 1307 | 7409 | 1050 | 7839 | 579 | 8361 | 224 | 7229 |
| 8-#8 | 1.23 | MA | 6466 | 1985 | 10166 | 1471 | 10954 | 1240 | 11281 | 1060 | 11471 | 792 | 13147 | 688 | 4898 |
| 2L-4S | | MI | 3079 | 1985 | 4815 | 1374 | 4947 | 1156 | 4914 | 986 | 4720 | 736 | 5035 | 512 | 2375 |
| 8-#8 | 1.23 | MA | 6325 | 1985 | 9794 | 1478 | 10477 | 1246 | 10699 | 1073 | 10679 | 803 | 12050 | 638 | 4913 |
| 3E | | MI | 3099 | 1985 | 4935 | 1364 | 5103 | 1155 | 5106 | 986 | 4969 | 732 | 5320 | 537 | 2355 |
| 8-#8 | 1.23 | MA | 6248 | 1985 | 9514 | 1492 | 10114 | 1259 | 10252 | 1078 | 10097 | 815 | 11324 | 608 | 4925 |
| 4L-2S | | MI | 3150 | 1985 | 5089 | 1362 | 5300 | 1147 | 5346 | 979 | 5296 | 727 | 5719 | 593 | 2340 |
| 8-#9 | 1.56 | MA | 6636 | 2032 | 10563 | 1497 | 11451 | 1258 | 11882 | 1071 | 12286 | 787 | 14273 | 681 | 6130 |
| 2L-4S | | MI | 3123 | 2032 | 4905 | 1400 | 5054 | 1174 | 5040 | 995 | 4893 | 730 | 5234 | 468 | 2921 |
| 8-#9 | 1.56 | MA | 6461 | 2032 | 10094 | 1506 | 10850 | 1266 | 11149 | 1086 | 11288 | 801 | 12892 | 618 | 6145 |
| 3E | | MI | 3149 | 2032 | 5056 | 1388 | 5249 | 1173 | 5281 | 996 | 5206 | 725 | 5587 | 499 | 2893 |
| 8-#9 | 1.56 | MA | 6365 | 2032 | 9741 | 1523 | 10392 | 1283 | 10586 | 1093 | 10555 | 815 | 11973 | 580 | 6145 |
| 4L-2S | | MI | 3213 | 2032 | 5248 | 1385 | 5496 | 1163 | 5581 | 987 | 5615 | 720 | 6080 | 570 | 2872 |

## RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

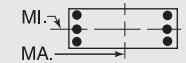
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.98 | MA | 6851 | 2091 | 11067 | 1531 | 12086 | 1282 | 12650 | 1085 | 13328 | 780 | 15714 | 673 | 7698 |
| 2L-4S | | MI | 3180 | 2091 | 5017 | 1434 | 5188 | 1197 | 5201 | 1007 | 5111 | 722 | 5482 | 411 | 3597 |
| 8-#10 | 1.98 | MA | 6634 | 2091 | 10474 | 1542 | 11326 | 1292 | 11724 | 1104 | 12068 | 797 | 13968 | 592 | 7709 |
| 3E | | MI | 3212 | 2091 | 5208 | 1419 | 5434 | 1196 | 5502 | 1009 | 5502 | 716 | 5920 | 450 | 3564 |
| 8-#10 | 1.98 | MA | 6514 | 2091 | 10029 | 1564 | 10747 | 1313 | 11012 | 1113 | 11140 | 815 | 12804 | 543 | 7677 |
| 4L-2S | | MI | 3291 | 2091 | 5449 | 1416 | 5743 | 1184 | 5879 | 999 | 6013 | 710 | 6529 | 539 | 3535 |
| 8-#11 | 2.44 | MA | 6803 | 2156 | 10877 | 1575 | 11808 | 1314 | 12297 | 1119 | 12839 | 790 | 15030 | 559 | 9313 |
| 3E | | MI | 3268 | 2156 | 5354 | 1441 | 5597 | 1211 | 5691 | 1013 | 5714 | 691 | 6123 | 373 | 4230 |
| 8-#11 | 2.44 | MA | 6663 | 2156 | 10335 | 1601 | 11105 | 1339 | 11433 | 1128 | 11713 | 810 | 13606 | 499 | 9240 |
| 4L-2S | | MI | 3360 | 2156 | 5640 | 1438 | 5963 | 1197 | 6138 | 1003 | 6306 | 684 | 6814 | 483 | 4194 |
| 8-#14 | 3.52 | MA | 7225 | 2308 | 11815 | 1668 | 12987 | 1381 | 13725 | 1165 | 14775 | 782 | 17707 | 491 | 13134 |
| 3E | | MI | 3416 | 2308 | 5708 | 1523 | 6033 | 1272 | 6217 | 1047 | 6366 | 658 | 6834 | 226 | 5787 |
| 8-#14 | 3.52 | MA | 7030 | 2308 | 11040 | 1705 | 11981 | 1416 | 12488 | 1178 | 13165 | 810 | 15660 | 403 | 12491 |
| 4L-2S | | MI | 3543 | 2308 | 6109 | 1521 | 6547 | 1255 | 6844 | 1035 | 7183 | 648 | 7773 | 385 | 5745 |
| 8-#18 | 6.25 | MA | 7935 | 2696 | 12767 | 1972 | 14142 | 1612 | 15097 | 1303 | 16757 | 808 | 20726 | 157 | 19628 |
| 4L-2S | | MI | 3963 | 2696 | 7212 | 1737 | 7929 | 1407 | 8445 | 1106 | 9162 | 539 | 9831 | 93 | 9362 |
| 10-#10 | 2.48 | MA | 6898 | 2162 | 11067 | 1586 | 12086 | 1323 | 12650 | 1123 | 13328 | 792 | 15714 | 584 | 9555 |
| 3L-4S | | MI | 3280 | 2162 | 5258 | 1478 | 5497 | 1229 | 5578 | 1027 | 5622 | 716 | 6091 | 384 | 4366 |
| 10-#10 | 2.48 | MA | 6780 | 2162 | 10621 | 1608 | 11507 | 1344 | 11938 | 1132 | 12400 | 809 | 14549 | 535 | 9511 |
| 4L-3S | | MI | 3311 | 2162 | 5449 | 1463 | 5743 | 1228 | 5879 | 1028 | 6013 | 710 | 6529 | 423 | 4340 |
| 10-#10 | 2.48 | MA | 6598 | 2162 | 10249 | 1618 | 11011 | 1354 | 11318 | 1152 | 11480 | 816 | 13367 | 495 | 9142 |
| 5L-2S | | MI | 3389 | 2162 | 5690 | 1460 | 6052 | 1216 | 6257 | 1018 | 6525 | 704 | 7137 | 513 | 4314 |
| 10-#11 | 3.05 | MA | 6981 | 2242 | 11052 | 1655 | 12025 | 1378 | 12554 | 1152 | 13239 | 804 | 15719 | 489 | 11455 |
| 4L-3S | | MI | 3384 | 2242 | 5640 | 1495 | 5963 | 1249 | 6138 | 1037 | 6306 | 681 | 6814 | 335 | 5145 |
| 10-#11 | 3.05 | MA | 6763 | 2242 | 10600 | 1667 | 11421 | 1389 | 11800 | 1175 | 12121 | 810 | 14278 | 436 | 10778 |
| 5L-2S | | MI | 3475 | 2242 | 5925 | 1492 | 6329 | 1236 | 6584 | 1027 | 6898 | 674 | 7506 | 445 | 5115 |
| 10-#14 | 4.39 | MA | 7480 | 2433 | 12063 | 1783 | 13293 | 1472 | 14089 | 1212 | 15343 | 800 | 18675 | 390 | 15568 |
| 4L-3S | | MI | 3578 | 2433 | 6109 | 1600 | 6547 | 1328 | 6844 | 1081 | 7183 | 641 | 7773 | 166 | 7051 |
| 10-#14 | 4.39 | MA | 7174 | 2433 | 11416 | 1800 | 12430 | 1487 | 13009 | 1244 | 13743 | 809 | 16609 | 311 | 14606 |
| 5L-2S | | MI | 3704 | 2433 | 6510 | 1598 | 7061 | 1311 | 7471 | 1069 | 7999 | 631 | 8712 | 324 | 7022 |
| 10-#18 | 7.81 | MA | 8189 | 2917 | 13413 | 2138 | 14911 | 1735 | 15991 | 1418 | 17748 | 801 | 22342 | -18 | 22282 |
| 5L-2S | | MI | 4227 | 2917 | 7886 | 1875 | 8792 | 1506 | 9480 | 1163 | 10485 | 498 | 11301 | -37 | 11284 |
| 12-#10 | 2.98 | MA | 7044 | 2232 | 11213 | 1651 | 12266 | 1376 | 12865 | 1151 | 13661 | 804 | 16295 | 528 | 11345 |
| 4E | | MI | 3379 | 2232 | 5499 | 1522 | 5806 | 1260 | 5955 | 1046 | 6134 | 710 | 6700 | 358 | 5128 |
| 12-#10 | 2.98 | MA | 6864 | 2232 | 10842 | 1662 | 11770 | 1385 | 12244 | 1171 | 12741 | 810 | 15112 | 487 | 10939 |
| 5L-3S | | MI | 3410 | 2232 | 5690 | 1507 | 6052 | 1259 | 6257 | 1047 | 6525 | 704 | 7137 | 397 | 5109 |
| 12-#10 | 2.98 | MA | 6735 | 2232 | 10451 | 1667 | 11277 | 1406 | 11630 | 1179 | 11914 | 828 | 14053 | 430 | 10557 |
| 6L-2S | | MI | 3487 | 2232 | 5931 | 1504 | 6361 | 1247 | 6634 | 1037 | 7036 | 699 | 7746 | 486 | 5086 |
| 12-#11 | 3.66 | MA | 7083 | 2328 | 11317 | 1721 | 12341 | 1428 | 12921 | 1199 | 13647 | 803 | 16391 | 427 | 12958 |
| 5L-3S | | MI | 3500 | 2328 | 5925 | 1548 | 6329 | 1288 | 6584 | 1060 | 6898 | 671 | 7506 | 297 | 6052 |
| 12-#11 | 3.66 | MA | 6928 | 2328 | 10850 | 1727 | 11741 | 1452 | 12174 | 1208 | 12642 | 824 | 15095 | 357 | 12447 |
| 6L-2S | | MI | 3590 | 2328 | 6211 | 1546 | 6695 | 1275 | 7031 | 1050 | 7490 | 664 | 8197 | 407 | 6027 |
| 12-#14 | 5.27 | MA | 7627 | 2557 | 12439 | 1878 | 13742 | 1543 | 14610 | 1278 | 15921 | 799 | 19625 | 297 | 17740 |
| 5L-3S | | MI | 3740 | 2557 | 6510 | 1678 | 7061 | 1384 | 7471 | 1115 | 7999 | 624 | 8712 | 105 | 8305 |
| 12-#14 | 5.27 | MA | 7410 | 2557 | 11778 | 1887 | 12882 | 1578 | 13540 | 1291 | 14482 | 827 | 17760 | 195 | 16430 |
| 6L-2S | | MI | 3865 | 2557 | 6911 | 1676 | 7575 | 1367 | 8098 | 1103 | 8816 | 614 | 9652 | 263 | 8290 |
| 14-#10 | 3.47 | MA | 7129 | 2302 | 11434 | 1706 | 12530 | 1417 | 13171 | 1190 | 14001 | 804 | 16858 | 479 | 12741 |
| 5L-4S | | MI | 3478 | 2302 | 5741 | 1565 | 6115 | 1292 | 6332 | 1065 | 6645 | 704 | 7308 | 332 | 5886 |
| 14-#10 | 3.47 | MA | 7003 | 2302 | 11044 | 1710 | 12036 | 1437 | 12556 | 1198 | 13175 | 822 | 15799 | 423 | 12374 |
| 6L-3S | | MI | 3509 | 2302 | 5931 | 1551 | 6361 | 1291 | 6634 | 1066 | 7036 | 698 | 7746 | 371 | 5872 |
| 14-#10 | 3.47 | MA | 6864 | 2302 | 10621 | 1728 | 11529 | 1442 | 11970 | 1218 | 12370 | 840 | 14553 | 374 | 11815 |
| 7L-2S | | MI | 3585 | 2302 | 6172 | 1548 | 6670 | 1279 | 7011 | 1056 | 7547 | 693 | 8355 | 460 | 5854 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 16" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

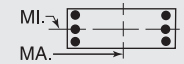
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 4.27 | MA | 7250 | 2415 | 11567 | 1781 | 12660 | 1491 | 13296 | 1232 | 14168 | 817 | 17208 | 347 | 14620 |
| 6L-3S | | MI | 3616 | 2415 | 6211 | 1602 | 6695 | 1327 | 7031 | 1084 | 7490 | 661 | 8197 | 259 | 6953 |
| 14-#11 | 4.27 | MA | 7086 | 2415 | 11055 | 1802 | 12054 | 1498 | 12583 | 1255 | 13189 | 837 | 15689 | 285 | 13854 |
| 7L-2S | | MI | 3705 | 2415 | 6496 | 1600 | 7061 | 1314 | 7478 | 1074 | 8082 | 654 | 8888 | 369 | 6934 |
| 14-#14 | 6.15 | MA | 7866 | 2682 | 12801 | 1965 | 14194 | 1634 | 15140 | 1325 | 16660 | 817 | 20775 | 181 | 19540 |
| 6L-3S | | MI | 3902 | 2682 | 6911 | 1756 | 7575 | 1440 | 8098 | 1149 | 8816 | 607 | 9652 | 44 | 9501 |
| 14-#14 | 6.15 | MA | 7637 | 2682 | 12069 | 1994 | 13337 | 1644 | 14119 | 1358 | 15259 | 846 | 18837 | 116 | 18207 |
| 7L-2S | | MI | 4026 | 2682 | 7311 | 1754 | 8089 | 1423 | 8725 | 1137 | 9633 | 597 | 10591 | 203 | 9552 |
| 16-#10 | 3.97 | MA | 7269 | 2373 | 11636 | 1754 | 12796 | 1469 | 13483 | 1217 | 14435 | 816 | 17544 | 415 | 14194 |
| 6L-4S | | MI | 3578 | 2373 | 5982 | 1609 | 6424 | 1323 | 6709 | 1084 | 7157 | 698 | 7917 | 306 | 6606 |
| 16-#10 | 3.97 | MA | 7131 | 2373 | 11214 | 1772 | 12288 | 1474 | 12897 | 1237 | 13631 | 834 | 16298 | 367 | 13627 |
| 7L-3S | | MI | 3607 | 2373 | 6172 | 1595 | 6670 | 1322 | 7011 | 1085 | 7547 | 692 | 8355 | 345 | 6632 |
| 16-#10 | 3.97 | MA | 6982 | 2373 | 10844 | 1779 | 11777 | 1491 | 12278 | 1243 | 12773 | 840 | 15222 | 320 | 13077 |
| 8L-2S | | MI | 3683 | 2373 | 6413 | 1592 | 6980 | 1310 | 7388 | 1075 | 8059 | 687 | 8964 | 434 | 6617 |
| 16-#11 | 4.88 | MA | 7406 | 2501 | 11772 | 1856 | 12973 | 1536 | 13705 | 1279 | 14715 | 831 | 17802 | 276 | 16046 |
| 7L-3S | | MI | 3732 | 2501 | 6496 | 1656 | 7061 | 1366 | 7478 | 1107 | 8082 | 652 | 8888 | 222 | 7850 |
| 16-#11 | 4.88 | MA | 7229 | 2501 | 11323 | 1864 | 12352 | 1557 | 12965 | 1286 | 13673 | 837 | 16489 | 216 | 15176 |
| 8L-2S | | MI | 3820 | 2501 | 6782 | 1654 | 7427 | 1352 | 7925 | 1097 | 8675 | 645 | 9580 | 331 | 7836 |
| 16-#14 | 7.03 | MA | 8091 | 2806 | 13092 | 2072 | 14649 | 1700 | 15720 | 1392 | 17436 | 836 | 21852 | 102 | 21296 |
| 7L-3S | | MI | 4064 | 2806 | 7311 | 1834 | 8089 | 1496 | 8725 | 1183 | 9633 | 590 | 10591 | -17 | 10579 |
| 18-#10 | 4.46 | MA | 7396 | 2443 | 11806 | 1816 | 13048 | 1505 | 13823 | 1256 | 14891 | 828 | 18044 | 359 | 15441 |
| 7L-4S | | MI | 3676 | 2443 | 6223 | 1653 | 6734 | 1355 | 7086 | 1103 | 7668 | 692 | 8526 | 279 | 7276 |
| 18-#10 | 4.46 | MA | 7250 | 2443 | 11437 | 1823 | 12537 | 1523 | 13204 | 1262 | 14034 | 835 | 16968 | 312 | 14879 |
| 8L-3S | | MI | 3706 | 2443 | 6413 | 1639 | 6980 | 1354 | 7388 | 1105 | 8059 | 686 | 8964 | 318 | 7390 |
| 18-#10 | 4.46 | MA | 7116 | 2443 | 11045 | 1843 | 12047 | 1529 | 12595 | 1278 | 13239 | 852 | 15907 | 270 | 14177 |
| 9L-2S | | MI | 3781 | 2443 | 6654 | 1635 | 7289 | 1342 | 7765 | 1095 | 8570 | 681 | 9573 | 408 | 7378 |
| 18-#11 | 5.48 | MA | 7551 | 2587 | 12040 | 1918 | 13272 | 1595 | 14087 | 1310 | 15199 | 830 | 18602 | 206 | 17356 |
| 8L-3S | | MI | 3848 | 2587 | 6782 | 1710 | 7427 | 1404 | 7925 | 1131 | 8675 | 642 | 9580 | 184 | 8745 |
| 20-#10 | 4.96 | MA | 7516 | 2513 | 12029 | 1867 | 13296 | 1554 | 14131 | 1281 | 15295 | 829 | 18713 | 305 | 16681 |
| 8L-4S | | MI | 3775 | 2513 | 6464 | 1697 | 7043 | 1386 | 7463 | 1122 | 8179 | 686 | 9135 | 253 | 7994 |
| 20-#10 | 4.96 | MA | 7387 | 2513 | 11637 | 1886 | 12807 | 1561 | 13522 | 1298 | 14499 | 847 | 17652 | 262 | 15984 |
| 9L-3S | | MI | 3804 | 2513 | 6654 | 1683 | 7289 | 1385 | 7765 | 1124 | 8570 | 681 | 9573 | 292 | 8147 |
| 22-#10 | 5.46 | MA | 7656 | 2583 | 12230 | 1930 | 13566 | 1592 | 14448 | 1317 | 15760 | 841 | 19398 | 254 | 17791 |
| 9L-4S | | MI | 3873 | 2583 | 6705 | 1741 | 7352 | 1418 | 7840 | 1142 | 8691 | 680 | 9744 | 227 | 8715 |

## RECTANGULAR TIED COLUMNS 18" x 18"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#8 | 1.46 | MA | 2290 | 1277 | 3712 | 890 | 3914 | 748 | 3988 | 637 | 4022 | 468 | 4460 | 387 | 1951 |
| 2L-3S | | MI | 2228 | 1277 | 3531 | 894 | 3682 | 757 | 3705 | 645 | 3637 | 474 | 3966 | 332 | 1969 |
| 6-#9 | 1.85 | MA | 2346 | 1312 | 3853 | 908 | 4089 | 761 | 4200 | 644 | 4309 | 463 | 4808 | 374 | 2409 |
| 2L-3S | | MI | 2269 | 1312 | 3627 | 913 | 3798 | 772 | 3845 | 654 | 3826 | 470 | 4194 | 304 | 2431 |
| 6-#10 | 2.35 | MA | 2417 | 1356 | 4032 | 933 | 4312 | 778 | 4468 | 653 | 4674 | 457 | 5242 | 356 | 2983 |
| 2L-3S | | MI | 2322 | 1356 | 3747 | 938 | 3946 | 792 | 4023 | 665 | 4067 | 465 | 4480 | 267 | 3008 |
| 6-#11 | 2.89 | MA | 2480 | 1405 | 4206 | 953 | 4517 | 791 | 4713 | 659 | 5004 | 447 | 5560 | 323 | 3554 |
| 2L-3S | | MI | 2369 | 1405 | 3866 | 958 | 4082 | 807 | 4182 | 672 | 4281 | 455 | 4684 | 213 | 3581 |
| 6-#14 | 4.17 | MA | 2647 | 1519 | 4630 | 1017 | 5049 | 836 | 5357 | 685 | 5862 | 431 | 6522 | 265 | 4917 |
| 2L-3S | | MI | 2493 | 1519 | 4151 | 1023 | 4435 | 857 | 4608 | 702 | 4849 | 441 | 5319 | 107 | 4922 |
| 6-#18 | 7.41 | MA | 3043 | 1810 | 5641 | 1184 | 6323 | 954 | 6902 | 753 | 7799 | 372 | 8666 | 90 | 8147 |
| 2L-3S | | MI | 2787 | 1810 | 4829 | 1189 | 5282 | 986 | 5632 | 777 | 6131 | 389 | 6734 | -191 | 6619 |
| 8-#8 | 1.95 | MA | 2365 | 1321 | 3893 | 917 | 4146 | 768 | 4271 | 648 | 4407 | 464 | 4954 | 377 | 2534 |
| 2L-4S | | MI | 2277 | 1320 | 3571 | 931 | 3732 | 779 | 3764 | 658 | 3731 | 476 | 4111 | 293 | 2566 |
| 8-#9 | 2.47 | MA | 2440 | 1367 | 4080 | 943 | 4380 | 786 | 4554 | 659 | 4792 | 459 | 5421 | 360 | 3134 |
| 2L-4S | | MI | 2332 | 1367 | 3677 | 960 | 3861 | 800 | 3919 | 670 | 3944 | 473 | 4373 | 255 | 3162 |
| 8-#10 | 3.14 | MA | 2534 | 1427 | 4317 | 977 | 4677 | 809 | 4914 | 672 | 5280 | 452 | 6003 | 336 | 3889 |
| 2L-4S | | MI | 2400 | 1427 | 3809 | 998 | 4024 | 827 | 4115 | 686 | 4214 | 468 | 4701 | 204 | 3785 |

## RECTANGULAR TIED COLUMNS 18" x 18"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 3.85 | MA | 2619 | 1491 | 4545 | 1007 | 4953 | 830 | 5244 | 682 | 5726 | 441 | 6437 | 294 | 4631 |
| 2L-4S | | MI | 2464 | 1491 | 3939 | 1030 | 4172 | 848 | 4289 | 695 | 4453 | 456 | 4933 | 134 | 4353 |
| 10-#10 | 3.92 | MA | 2651 | 1497 | 4602 | 1021 | 5042 | 841 | 5360 | 691 | 5887 | 446 | 6764 | 317 | 4789 |
| 2L-5S | | MI | 2437 | 1497 | 3906 | 1047 | 4139 | 872 | 4249 | 717 | 4361 | 460 | 4932 | 132 | 4420 |
| 10-#10 | 3.92 | MA | 2559 | 1497 | 4317 | 1026 | 4677 | 855 | 4914 | 704 | 5280 | 454 | 6003 | 227 | 4797 |
| 3L-4S | | MI | 2520 | 1497 | 4094 | 1042 | 4389 | 858 | 4561 | 705 | 4820 | 463 | 5462 | 184 | 4614 |
| 10-#11 | 4.81 | MA | 2650 | 1577 | 4545 | 1066 | 4953 | 884 | 5244 | 719 | 5726 | 442 | 6437 | 155 | 5699 |
| 3L-4S | | MI | 2606 | 1577 | 4278 | 1084 | 4608 | 886 | 4820 | 719 | 5175 | 449 | 5809 | 105 | 5343 |

## RECTANGULAR TIED COLUMNS 18" x 20"

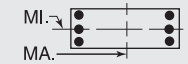
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.11 | MA | 2768 | 1384 | 4421 | 977 | 4646 | 824 | 4705 | 705 | 4672 | 529 | 5176 | 450 | 1889 |
| 2E | | MI | 2481 | 1384 | 3979 | 963 | 4156 | 812 | 4193 | 695 | 4144 | 520 | 4524 | 435 | 1693 |
| 4-#10 | 1.41 | MA | 2824 | 1413 | 4561 | 992 | 4818 | 835 | 4912 | 711 | 4952 | 524 | 5526 | 440 | 2341 |
| 2E | | MI | 2528 | 1413 | 4100 | 978 | 4303 | 822 | 4370 | 700 | 4384 | 516 | 4809 | 422 | 2090 |
| 4-#11 | 1.73 | MA | 2874 | 1446 | 4704 | 1002 | 4980 | 840 | 5102 | 712 | 5207 | 516 | 5794 | 419 | 2801 |
| 2E | | MI | 2571 | 1446 | 4220 | 987 | 4439 | 827 | 4528 | 701 | 4596 | 506 | 5009 | 398 | 2493 |
| 4-#14 | 2.50 | MA | 3006 | 1522 | 5039 | 1043 | 5395 | 868 | 5603 | 727 | 5886 | 505 | 6590 | 386 | 3882 |
| 2E | | MI | 2682 | 1522 | 4506 | 1026 | 4792 | 854 | 4954 | 715 | 5162 | 494 | 5642 | 357 | 3432 |
| 4-#18 | 4.44 | MA | 3321 | 1716 | 5842 | 1149 | 6398 | 943 | 6815 | 769 | 7524 | 480 | 8407 | 289 | 6462 |
| 2E | | MI | 2947 | 1716 | 5185 | 1131 | 5637 | 927 | 5975 | 756 | 6441 | 450 | 7053 | 238 | 5650 |
| 6-#8 | 1.32 | MA | 2812 | 1404 | 4519 | 993 | 4777 | 836 | 4868 | 713 | 4895 | 529 | 5488 | 450 | 2207 |
| 2L-3S | | MI | 2457 | 1404 | 3883 | 983 | 4039 | 834 | 4054 | 712 | 3955 | 527 | 4296 | 378 | 1989 |
| 6-#8 | 1.32 | MA | 2739 | 1404 | 4310 | 998 | 4510 | 847 | 4542 | 723 | 4452 | 536 | 4897 | 394 | 2225 |
| 3L-2S | | MI | 2519 | 1404 | 4064 | 980 | 4271 | 825 | 4337 | 703 | 4341 | 521 | 4791 | 434 | 1972 |
| 6-#9 | 1.67 | MA | 2878 | 1439 | 4683 | 1012 | 4981 | 849 | 5114 | 721 | 5228 | 524 | 5911 | 439 | 2733 |
| 2L-3S | | MI | 2498 | 1439 | 3979 | 1002 | 4156 | 849 | 4193 | 720 | 4144 | 523 | 4524 | 350 | 2455 |
| 6-#9 | 1.67 | MA | 2788 | 1439 | 4421 | 1017 | 4646 | 862 | 4705 | 732 | 4672 | 533 | 5176 | 369 | 2755 |
| 3L-2S | | MI | 2575 | 1439 | 4206 | 998 | 4447 | 837 | 4548 | 710 | 4627 | 516 | 5137 | 421 | 2433 |
| 6-#10 | 2.12 | MA | 2961 | 1484 | 4890 | 1036 | 5239 | 866 | 5426 | 730 | 5652 | 518 | 6441 | 425 | 3395 |
| 2L-3S | | MI | 2551 | 1484 | 4100 | 1027 | 4303 | 868 | 4370 | 732 | 4384 | 518 | 4809 | 313 | 3038 |
| 6-#10 | 2.12 | MA | 2849 | 1484 | 4561 | 1043 | 4818 | 882 | 4912 | 744 | 4952 | 529 | 5526 | 335 | 3419 |
| 3L-2S | | MI | 2646 | 1484 | 4385 | 1022 | 4669 | 854 | 4816 | 719 | 4991 | 510 | 5570 | 403 | 3011 |
| 6-#11 | 2.60 | MA | 3037 | 1532 | 5097 | 1056 | 5485 | 879 | 5717 | 736 | 6045 | 509 | 6858 | 397 | 4059 |
| 2L-3S | | MI | 2598 | 1532 | 4220 | 1046 | 4439 | 882 | 4528 | 737 | 4596 | 507 | 5009 | 259 | 3619 |
| 6-#11 | 2.60 | MA | 2906 | 1532 | 4704 | 1063 | 4980 | 897 | 5102 | 751 | 5207 | 520 | 5794 | 287 | 4086 |
| 3L-2S | | MI | 2710 | 1532 | 4560 | 1041 | 4874 | 866 | 5059 | 724 | 5319 | 499 | 5886 | 369 | 3588 |
| 6-#14 | 3.75 | MA | 3235 | 1646 | 5595 | 1120 | 6109 | 924 | 6473 | 761 | 7071 | 495 | 8063 | 349 | 5646 |
| 2L-3S | | MI | 2722 | 1646 | 4506 | 1110 | 4792 | 932 | 4954 | 767 | 5162 | 493 | 5642 | 152 | 4979 |
| 6-#14 | 3.75 | MA | 3052 | 1646 | 5039 | 1129 | 5395 | 949 | 5603 | 782 | 5886 | 509 | 6590 | 191 | 5651 |
| 3L-2S | | MI | 2877 | 1646 | 4985 | 1104 | 5406 | 910 | 5702 | 749 | 6176 | 483 | 6846 | 310 | 4959 |
| 6-#18 | 6.67 | MA | 3705 | 1937 | 6792 | 1287 | 7617 | 1042 | 8302 | 830 | 9541 | 461 | 10811 | 207 | 9443 |
| 2L-3S | | MI | 3016 | 1937 | 5185 | 1274 | 5637 | 1059 | 5975 | 840 | 6441 | 440 | 7053 | -147 | 6970 |
| 6-#18 | 6.67 | MA | 3404 | 1937 | 5842 | 1298 | 6398 | 1081 | 6815 | 861 | 7524 | 479 | 8407 | -75 | 8337 |
| 3L-2S | | MI | 3274 | 1937 | 5997 | 1269 | 6678 | 1027 | 7245 | 816 | 8110 | 422 | 8985 | 135 | 8206 |
| 8-#8 | 1.76 | MA | 2900 | 1448 | 4727 | 1021 | 5044 | 856 | 5194 | 725 | 5339 | 525 | 6078 | 442 | 2875 |
| 2L-4S | | MI | 2506 | 1448 | 3923 | 1021 | 4089 | 856 | 4113 | 725 | 4050 | 529 | 4441 | 340 | 2592 |
| 8-#8 | 1.76 | MA | 2828 | 1448 | 4519 | 1025 | 4777 | 866 | 4868 | 735 | 4895 | 533 | 5488 | 386 | 2891 |
| 3E | | MI | 2533 | 1448 | 4064 | 1011 | 4271 | 854 | 4337 | 723 | 4341 | 523 | 4791 | 368 | 2574 |
| 8-#8 | 1.76 | MA | 2794 | 1448 | 4358 | 1036 | 4569 | 869 | 4613 | 737 | 4563 | 540 | 5074 | 356 | 2907 |
| 4L-2S | | MI | 2595 | 1448 | 4245 | 1007 | 4503 | 844 | 4620 | 715 | 4726 | 517 | 5285 | 423 | 2557 |
| 8-#9 | 2.22 | MA | 2988 | 1494 | 4944 | 1046 | 5316 | 874 | 5523 | 736 | 5785 | 520 | 6645 | 428 | 3566 |
| 2L-4S | | MI | 2561 | 1494 | 4029 | 1050 | 4218 | 876 | 4267 | 736 | 4262 | 525 | 4703 | 301 | 3197 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 20"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

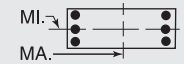
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 2.22 | MA | 2899 | 1494 | 4683 | 1052 | 4981 | 887 | 5114 | 747 | 5228 | 528 | 5911 | 358 | 3584 |
| 3E | | MI | 2594 | 1494 | 4206 | 1037 | 4447 | 874 | 4548 | 735 | 4627 | 518 | 5137 | 336 | 3180 |
| 8-#9 | 2.22 | MA | 2857 | 1494 | 4481 | 1066 | 4719 | 891 | 4793 | 750 | 4810 | 537 | 5394 | 321 | 3594 |
| 4L-2S | | MI | 2669 | 1494 | 4433 | 1032 | 4737 | 862 | 4903 | 725 | 5110 | 512 | 5750 | 406 | 3161 |
| 8-#10 | 2.82 | MA | 3099 | 1554 | 5219 | 1080 | 5661 | 898 | 5941 | 749 | 6352 | 513 | 7356 | 410 | 4438 |
| 2L-4S | | MI | 2630 | 1554 | 4162 | 1087 | 4381 | 903 | 4463 | 752 | 4531 | 521 | 5030 | 250 | 3889 |
| 8-#10 | 2.82 | MA | 2989 | 1554 | 4890 | 1087 | 5239 | 913 | 5426 | 763 | 5652 | 523 | 6441 | 320 | 4454 |
| 3E | | MI | 2670 | 1554 | 4385 | 1071 | 4669 | 900 | 4816 | 751 | 4991 | 513 | 5570 | 293 | 3940 |
| 8-#10 | 2.82 | MA | 2937 | 1554 | 4636 | 1104 | 4910 | 918 | 5021 | 766 | 5125 | 534 | 5797 | 274 | 4396 |
| 4L-2S | | MI | 2764 | 1554 | 4670 | 1066 | 5034 | 885 | 5262 | 738 | 5597 | 504 | 6331 | 383 | 3920 |
| 8-#11 | 3.47 | MA | 3200 | 1618 | 5491 | 1110 | 5989 | 918 | 6333 | 759 | 6882 | 502 | 7922 | 374 | 5305 |
| 2L-4S | | MI | 2693 | 1618 | 4293 | 1118 | 4529 | 923 | 4636 | 760 | 4768 | 508 | 5259 | 180 | 4469 |
| 8-#11 | 3.47 | MA | 3071 | 1618 | 5097 | 1117 | 5485 | 936 | 5717 | 775 | 6045 | 513 | 6858 | 264 | 5319 |
| 3E | | MI | 2739 | 1618 | 4560 | 1100 | 4874 | 921 | 5059 | 761 | 5319 | 500 | 5886 | 230 | 4688 |
| 8-#11 | 3.47 | MA | 3013 | 1618 | 4791 | 1137 | 5088 | 940 | 5231 | 777 | 5411 | 524 | 6104 | 210 | 5067 |
| 4L-2S | | MI | 2848 | 1618 | 4899 | 1095 | 5310 | 905 | 5590 | 748 | 6041 | 493 | 6762 | 339 | 4668 |
| 8-#14 | 5.00 | MA | 3284 | 1771 | 5595 | 1207 | 6109 | 1005 | 6473 | 816 | 7071 | 499 | 8063 | 154 | 7370 |
| 3E | | MI | 2919 | 1771 | 4985 | 1188 | 5406 | 988 | 5702 | 800 | 6176 | 482 | 6846 | 104 | 6461 |
| 8-#14 | 5.00 | MA | 3206 | 1771 | 5160 | 1235 | 5546 | 1010 | 5782 | 818 | 6171 | 513 | 7014 | 79 | 6648 |
| 4L-2S | | MI | 3070 | 1771 | 5463 | 1182 | 6019 | 966 | 6451 | 783 | 7189 | 472 | 8050 | 263 | 6469 |
| 10-#10 | 3.53 | MA | 3235 | 1624 | 5548 | 1124 | 6083 | 929 | 6455 | 768 | 7052 | 507 | 8271 | 395 | 5474 |
| 2L-5S | | MI | 2666 | 1624 | 4259 | 1136 | 4496 | 948 | 4597 | 783 | 4678 | 512 | 5260 | 178 | 4511 |
| 10-#10 | 3.53 | MA | 3127 | 1624 | 5219 | 1130 | 5661 | 945 | 5941 | 782 | 6352 | 518 | 7356 | 305 | 5483 |
| 3L-4S | | MI | 2749 | 1624 | 4447 | 1131 | 4746 | 934 | 4909 | 771 | 5137 | 515 | 5791 | 230 | 4715 |
| 10-#10 | 3.53 | MA | 3077 | 1624 | 4965 | 1148 | 5331 | 950 | 5536 | 785 | 5825 | 528 | 6712 | 259 | 5355 |
| 4L-3S | | MI | 2789 | 1624 | 4670 | 1115 | 5034 | 931 | 5262 | 770 | 5597 | 507 | 6331 | 273 | 4835 |
| 10-#10 | 3.53 | MA | 2981 | 1624 | 4750 | 1154 | 5046 | 965 | 5179 | 799 | 5299 | 527 | 6074 | 207 | 5093 |
| 5L-2S | | MI | 2881 | 1624 | 4955 | 1110 | 5400 | 917 | 5708 | 758 | 6204 | 499 | 7093 | 363 | 4822 |
| 10-#11 | 4.33 | MA | 3235 | 1705 | 5491 | 1171 | 5989 | 975 | 6333 | 798 | 6882 | 506 | 7922 | 242 | 6542 |
| 3L-4S | | MI | 2835 | 1705 | 4632 | 1172 | 4964 | 961 | 5167 | 784 | 5490 | 501 | 6135 | 150 | 5456 |
| 10-#11 | 4.33 | MA | 3178 | 1705 | 5184 | 1191 | 5593 | 979 | 5846 | 800 | 6248 | 517 | 7169 | 187 | 6217 |
| 4L-3S | | MI | 2879 | 1705 | 4899 | 1153 | 5310 | 959 | 5590 | 784 | 6041 | 494 | 6762 | 200 | 5749 |
| 10-#14 | 6.25 | MA | 3439 | 1895 | 5716 | 1313 | 6259 | 1065 | 6653 | 851 | 7356 | 503 | 8488 | 42 | 8287 |
| 4L-3S | | MI | 3115 | 1895 | 5463 | 1265 | 6019 | 1043 | 6451 | 834 | 7189 | 471 | 8050 | 57 | 7859 |
| 12-#10 | 4.23 | MA | 3265 | 1695 | 5548 | 1174 | 6083 | 976 | 6455 | 802 | 7052 | 512 | 8271 | 290 | 6506 |
| 3L-5S | | MI | 2786 | 1695 | 4544 | 1180 | 4861 | 980 | 5042 | 802 | 5284 | 507 | 6021 | 158 | 5363 |
| 12-#10 | 4.23 | MA | 3215 | 1695 | 5294 | 1192 | 5753 | 981 | 6050 | 804 | 6525 | 523 | 7627 | 244 | 6322 |
| 4E | | MI | 2867 | 1695 | 4732 | 1175 | 5112 | 966 | 5354 | 790 | 5744 | 510 | 6552 | 210 | 5550 |
| 12-#10 | 4.23 | MA | 3121 | 1695 | 5079 | 1198 | 5467 | 997 | 5694 | 818 | 5999 | 522 | 6989 | 192 | 6079 |
| 5L-3S | | MI | 2907 | 1695 | 4955 | 1159 | 5400 | 963 | 5708 | 789 | 6204 | 501 | 7093 | 253 | 5725 |
| 12-#11 | 5.20 | MA | 3343 | 1791 | 5578 | 1245 | 6097 | 1018 | 6461 | 824 | 7086 | 510 | 8233 | 165 | 7377 |
| 4E | | MI | 2975 | 1791 | 4972 | 1226 | 5400 | 1000 | 5698 | 807 | 6213 | 495 | 7012 | 121 | 6452 |
| 14-#10 | 4.94 | MA | 3353 | 1765 | 5623 | 1236 | 6175 | 1013 | 6565 | 823 | 7225 | 517 | 8542 | 229 | 7296 |
| 4L-5S | | MI | 2905 | 1765 | 4829 | 1224 | 5227 | 1011 | 5488 | 821 | 5891 | 501 | 6782 | 138 | 6218 |
| 14-#10 | 4.94 | MA | 3260 | 1765 | 5408 | 1242 | 5889 | 1028 | 6208 | 838 | 6699 | 516 | 7904 | 177 | 7069 |
| 5L-4S | | MI | 2986 | 1765 | 5017 | 1219 | 5477 | 997 | 5800 | 809 | 6350 | 504 | 7313 | 190 | 6390 |

## RECTANGULAR TIED COLUMNS 18" x 22"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#9 | 1.01 | MA | 3336 | 1511 | 5289 | 1081 | 5571 | 912 | 5644 | 782 | 5593 | 590 | 6240 | 510 | 2105 |
| 2E | | MI | 2710 | 1511 | 4332 | 1053 | 4513 | 889 | 4542 | 762 | 4462 | 573 | 4854 | 482 | 1713 |
| 4-#10 | 1.28 | MA | 3400 | 1541 | 5448 | 1096 | 5768 | 923 | 5880 | 788 | 5912 | 585 | 6655 | 501 | 2615 |
| 2E | | MI | 2758 | 1541 | 4453 | 1067 | 4661 | 898 | 4718 | 766 | 4702 | 568 | 5138 | 469 | 2112 |
| 4-#11 | 1.58 | MA | 3459 | 1573 | 5614 | 1106 | 5957 | 929 | 6102 | 789 | 6209 | 577 | 6989 | 483 | 3138 |
| 2E | | MI | 2800 | 1573 | 4574 | 1075 | 4796 | 902 | 4875 | 766 | 4911 | 558 | 5335 | 443 | 2520 |
| 4-#14 | 2.27 | MA | 3612 | 1649 | 5999 | 1146 | 6434 | 957 | 6677 | 804 | 6988 | 566 | 7948 | 456 | 4368 |
| 2E | | MI | 2911 | 1649 | 4861 | 1113 | 5148 | 929 | 5299 | 780 | 5476 | 545 | 5965 | 403 | 3467 |

## RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

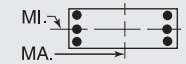
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 4.04 | MA | 3978 | 1843 | 6927 | 1253 | 7593 | 1031 | 8078 | 846 | 8890 | 542 | 10175 | 375 | 7326 |
| 2E | | MI | 3176 | 1843 | 5541 | 1217 | 5993 | 1000 | 6319 | 820 | 6752 | 501 | 7372 | 282 | 5700 |
| 6-#8 | 1.20 | MA | 3386 | 1531 | 5398 | 1097 | 5719 | 924 | 5828 | 790 | 5844 | 590 | 6599 | 510 | 2463 |
| 2L-3S | | MI | 2686 | 1531 | 4235 | 1073 | 4397 | 911 | 4402 | 778 | 4274 | 580 | 4627 | 425 | 2009 |
| 6-#8 | 1.20 | MA | 3301 | 1531 | 5162 | 1102 | 5417 | 936 | 5459 | 800 | 5343 | 598 | 5911 | 455 | 2481 |
| 3L-2S | | MI | 2748 | 1531 | 4416 | 1070 | 4629 | 901 | 4685 | 770 | 4659 | 574 | 5121 | 481 | 1992 |
| 6-#9 | 1.52 | MA | 3462 | 1566 | 5585 | 1115 | 5951 | 937 | 6107 | 797 | 6223 | 585 | 7098 | 502 | 3057 |
| 2L-3S | | MI | 2728 | 1566 | 4332 | 1092 | 4513 | 925 | 4542 | 787 | 4462 | 576 | 4854 | 397 | 2478 |
| 6-#9 | 1.52 | MA | 3357 | 1566 | 5289 | 1121 | 5571 | 951 | 5644 | 810 | 5593 | 595 | 6240 | 431 | 3079 |
| 3L-2S | | MI | 2805 | 1566 | 4558 | 1087 | 4804 | 913 | 4896 | 777 | 4945 | 569 | 5467 | 467 | 2456 |
| 6-#10 | 1.92 | MA | 3558 | 1611 | 5821 | 1140 | 6246 | 954 | 6463 | 807 | 6706 | 580 | 7725 | 490 | 3806 |
| 2L-3S | | MI | 2780 | 1611 | 4453 | 1116 | 4661 | 944 | 4718 | 798 | 4702 | 571 | 5138 | 359 | 3066 |
| 6-#10 | 1.92 | MA | 3428 | 1611 | 5448 | 1147 | 5768 | 971 | 5880 | 822 | 5912 | 592 | 6655 | 401 | 3831 |
| 3L-2S | | MI | 2876 | 1611 | 4738 | 1111 | 5026 | 930 | 5164 | 785 | 5308 | 563 | 5899 | 449 | 3037 |
| 6-#11 | 2.36 | MA | 3647 | 1659 | 6061 | 1160 | 6531 | 967 | 6801 | 813 | 7161 | 570 | 8243 | 466 | 4565 |
| 2L-3S | | MI | 2827 | 1659 | 4574 | 1133 | 4796 | 957 | 4875 | 803 | 4911 | 559 | 5335 | 304 | 3655 |
| 6-#11 | 2.36 | MA | 3494 | 1659 | 5614 | 1168 | 5957 | 987 | 6102 | 830 | 6209 | 583 | 6989 | 356 | 4592 |
| 3L-2S | | MI | 2939 | 1659 | 4914 | 1129 | 5231 | 941 | 5406 | 789 | 5634 | 551 | 6211 | 414 | 3620 |
| 6-#14 | 3.41 | MA | 3875 | 1774 | 6633 | 1224 | 7247 | 1012 | 7669 | 838 | 8338 | 556 | 9693 | 428 | 6375 |
| 2L-3S | | MI | 2951 | 1774 | 4861 | 1197 | 5148 | 1006 | 5299 | 831 | 5476 | 544 | 5965 | 197 | 5031 |
| 6-#14 | 3.41 | MA | 3664 | 1774 | 5999 | 1235 | 6434 | 1040 | 6677 | 862 | 6988 | 574 | 7948 | 269 | 6380 |
| 3L-2S | | MI | 3106 | 1774 | 5339 | 1191 | 5762 | 985 | 6048 | 814 | 6489 | 534 | 7169 | 355 | 4999 |
| 6-#18 | 6.06 | MA | 4422 | 2064 | 8016 | 1391 | 8989 | 1130 | 9781 | 907 | 11207 | 525 | 13058 | 310 | 10739 |
| 2L-3S | | MI | 3245 | 2064 | 5541 | 1360 | 5993 | 1132 | 6319 | 904 | 6752 | 490 | 7372 | -102 | 7317 |
| 6-#18 | 6.06 | MA | 4073 | 2064 | 6927 | 1406 | 7593 | 1174 | 8078 | 944 | 8890 | 549 | 10175 | 28 | 10088 |
| 3L-2S | | MI | 3505 | 2064 | 6353 | 1355 | 7034 | 1100 | 7589 | 880 | 8420 | 473 | 9303 | 179 | 8263 |
| 8-#8 | 1.60 | MA | 3487 | 1575 | 5633 | 1124 | 6021 | 944 | 6196 | 802 | 6345 | 587 | 7287 | 505 | 3216 |
| 2L-4S | | MI | 2735 | 1575 | 4276 | 1111 | 4447 | 933 | 4462 | 791 | 4368 | 582 | 4772 | 386 | 2617 |
| 8-#8 | 1.60 | MA | 3404 | 1575 | 5398 | 1129 | 5719 | 955 | 5828 | 812 | 5844 | 595 | 6599 | 449 | 3232 |
| 3E | | MI | 2762 | 1575 | 4416 | 1100 | 4629 | 930 | 4685 | 790 | 4659 | 576 | 5121 | 414 | 2597 |
| 8-#8 | 1.60 | MA | 3363 | 1575 | 5217 | 1141 | 5485 | 959 | 5540 | 816 | 5470 | 603 | 6120 | 418 | 3248 |
| 4L-2S | | MI | 2824 | 1575 | 4597 | 1097 | 4861 | 921 | 4968 | 782 | 5044 | 571 | 5616 | 470 | 2580 |
| 8-#9 | 2.02 | MA | 3588 | 1622 | 5881 | 1150 | 6330 | 962 | 6570 | 813 | 6853 | 581 | 7955 | 494 | 3998 |
| 2L-4S | | MI | 2790 | 1622 | 4382 | 1139 | 4575 | 953 | 4616 | 803 | 4580 | 578 | 5033 | 347 | 3228 |
| 8-#9 | 2.02 | MA | 3485 | 1622 | 5585 | 1156 | 5951 | 976 | 6107 | 825 | 6223 | 591 | 7098 | 423 | 4016 |
| 3E | | MI | 2823 | 1622 | 4558 | 1126 | 4804 | 950 | 4896 | 802 | 4945 | 571 | 5467 | 382 | 3207 |
| 8-#9 | 2.02 | MA | 3435 | 1622 | 5357 | 1171 | 5657 | 981 | 5746 | 829 | 5752 | 601 | 6499 | 384 | 4026 |
| 4L-2S | | MI | 2899 | 1622 | 4785 | 1122 | 5095 | 938 | 5251 | 792 | 5428 | 564 | 6080 | 453 | 3187 |
| 8-#10 | 2.57 | MA | 3715 | 1681 | 6194 | 1184 | 6724 | 986 | 7047 | 826 | 7499 | 574 | 8796 | 479 | 4986 |
| 2L-4S | | MI | 2859 | 1681 | 4515 | 1176 | 4738 | 979 | 4811 | 818 | 4848 | 573 | 5358 | 296 | 3984 |
| 8-#10 | 2.57 | MA | 3588 | 1681 | 5821 | 1191 | 6246 | 1003 | 6463 | 842 | 6706 | 586 | 7725 | 390 | 5003 |
| 3E | | MI | 2899 | 1681 | 4738 | 1160 | 5026 | 975 | 5164 | 817 | 5308 | 565 | 5899 | 339 | 3972 |
| 8-#10 | 2.57 | MA | 3526 | 1681 | 5535 | 1210 | 5874 | 1009 | 6007 | 846 | 6112 | 599 | 6977 | 341 | 4989 |
| 4L-2S | | MI | 2993 | 1681 | 5023 | 1155 | 5391 | 961 | 5610 | 805 | 5914 | 557 | 6660 | 429 | 3949 |
| 8-#11 | 3.15 | MA | 3833 | 1746 | 6509 | 1214 | 7104 | 1006 | 7501 | 836 | 8113 | 563 | 9497 | 449 | 5978 |
| 2L-4S | | MI | 2922 | 1746 | 4647 | 1206 | 4886 | 998 | 4982 | 826 | 5083 | 560 | 5584 | 225 | 4581 |
| 8-#11 | 3.15 | MA | 3684 | 1746 | 6061 | 1222 | 6531 | 1026 | 6801 | 854 | 7161 | 576 | 8243 | 339 | 5993 |
| 3E | | MI | 2968 | 1746 | 4914 | 1187 | 5231 | 995 | 5406 | 826 | 5634 | 552 | 6211 | 275 | 4729 |
| 8-#11 | 3.15 | MA | 3613 | 1746 | 5715 | 1244 | 6083 | 1032 | 6251 | 858 | 6445 | 590 | 7361 | 281 | 5800 |
| 4L-2S | | MI | 3078 | 1746 | 5253 | 1183 | 5666 | 980 | 5937 | 813 | 6356 | 545 | 7088 | 385 | 4704 |
| 8-#14 | 4.55 | MA | 3932 | 1898 | 6633 | 1312 | 7247 | 1096 | 7669 | 896 | 8338 | 564 | 9693 | 240 | 8342 |
| 3E | | MI | 3148 | 1898 | 5339 | 1275 | 5762 | 1062 | 6048 | 865 | 6489 | 533 | 7169 | 150 | 6519 |
| 8-#14 | 4.55 | MA | 3835 | 1898 | 6141 | 1343 | 6610 | 1103 | 6887 | 900 | 7320 | 581 | 8462 | 160 | 7624 |
| 4L-2S | | MI | 3300 | 1898 | 5818 | 1269 | 6376 | 1040 | 6797 | 848 | 7502 | 523 | 8373 | 308 | 6513 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

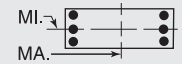
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 3.21 | MA | 3872 | 1752 | 6567 | 1227 | 7202 | 1017 | 7630 | 845 | 8292 | 568 | 9866 | 468 | 6160 |
| 2L-5S | | MI | 2895 | 1752 | 4612 | 1225 | 4853 | 1024 | 4945 | 849 | 4995 | 565 | 5589 | 224 | 4597 |
| 10-#10 | 3.21 | MA | 3747 | 1752 | 6194 | 1235 | 6724 | 1034 | 7047 | 861 | 7499 | 581 | 8796 | 379 | 6169 |
| 3L-4S | | MI | 2978 | 1752 | 4800 | 1220 | 5104 | 1010 | 5257 | 837 | 5455 | 568 | 6120 | 276 | 4813 |
| 10-#10 | 3.21 | MA | 3686 | 1752 | 5907 | 1254 | 6352 | 1040 | 6590 | 865 | 6905 | 593 | 8047 | 330 | 6113 |
| 4L-3S | | MI | 3018 | 1752 | 5023 | 1204 | 5391 | 1007 | 5610 | 836 | 5914 | 560 | 6660 | 320 | 4870 |
| 10-#10 | 3.21 | MA | 3576 | 1752 | 5666 | 1261 | 6032 | 1057 | 6190 | 880 | 6313 | 594 | 7301 | 279 | 5776 |
| 5L-2S | | MI | 3110 | 1752 | 5308 | 1199 | 5757 | 993 | 6056 | 824 | 6521 | 551 | 7421 | 409 | 4854 |
| 10-#11 | 3.94 | MA | 3873 | 1832 | 6509 | 1276 | 7104 | 1065 | 7501 | 877 | 8113 | 569 | 9497 | 322 | 7384 |
| 3L-4S | | MI | 3064 | 1832 | 4986 | 1260 | 5321 | 1036 | 5513 | 849 | 5805 | 553 | 6461 | 196 | 5565 |
| 10-#11 | 3.94 | MA | 3803 | 1832 | 6163 | 1298 | 6656 | 1071 | 6951 | 881 | 7397 | 583 | 8615 | 264 | 7111 |
| 4L-3S | | MI | 3108 | 1832 | 5253 | 1241 | 5666 | 1034 | 5937 | 850 | 6356 | 546 | 7088 | 246 | 5795 |
| 10-#11 | 3.94 | MA | 3673 | 1832 | 5871 | 1306 | 6269 | 1090 | 6467 | 899 | 6683 | 582 | 7741 | 201 | 6767 |
| 5L-2S | | MI | 3216 | 1832 | 5593 | 1236 | 6102 | 1018 | 6468 | 836 | 7079 | 538 | 7964 | 356 | 5779 |
| 10-#14 | 5.68 | MA | 4103 | 2023 | 6775 | 1421 | 7423 | 1159 | 7879 | 934 | 8670 | 571 | 10207 | 131 | 9498 |
| 4L-3S | | MI | 3344 | 2023 | 5818 | 1352 | 6376 | 1118 | 6797 | 899 | 7502 | 523 | 8373 | 102 | 8000 |
| 12-#10 | 3.85 | MA | 3905 | 1822 | 6567 | 1279 | 7202 | 1066 | 7630 | 880 | 8292 | 575 | 9866 | 368 | 7329 |
| 3L-5S | | MI | 3015 | 1822 | 4897 | 1269 | 5219 | 1056 | 5390 | 868 | 5602 | 559 | 6350 | 204 | 5448 |
| 12-#10 | 3.85 | MA | 3845 | 1822 | 6280 | 1297 | 6830 | 1072 | 7174 | 884 | 7698 | 587 | 9118 | 318 | 7211 |
| 4E | | MI | 3097 | 1822 | 5085 | 1264 | 5469 | 1042 | 5702 | 856 | 6061 | 562 | 6881 | 256 | 5645 |
| 12-#10 | 3.85 | MA | 3736 | 1822 | 6039 | 1305 | 6510 | 1089 | 6773 | 900 | 7107 | 588 | 8372 | 268 | 6895 |
| 5L-3S | | MI | 3136 | 1822 | 5308 | 1248 | 5757 | 1039 | 6056 | 855 | 6521 | 554 | 7421 | 300 | 5764 |
| 12-#10 | 3.85 | MA | 3657 | 1822 | 5792 | 1323 | 6190 | 1095 | 6376 | 904 | 6573 | 601 | 7689 | 211 | 6602 |
| 6L-2S | | MI | 3227 | 1822 | 5593 | 1243 | 6122 | 1024 | 6501 | 843 | 7127 | 546 | 8182 | 389 | 5753 |
| 12-#11 | 4.73 | MA | 3992 | 1918 | 6610 | 1352 | 7230 | 1109 | 7651 | 905 | 8349 | 576 | 9869 | 247 | 8432 |
| 4E | | MI | 3204 | 1918 | 5326 | 1314 | 5757 | 1075 | 6045 | 873 | 6528 | 547 | 7337 | 167 | 6559 |
| 12-#11 | 4.73 | MA | 3864 | 1918 | 6319 | 1360 | 6842 | 1129 | 7167 | 922 | 7635 | 576 | 8995 | 184 | 8112 |
| 5L-3S | | MI | 3247 | 1918 | 5593 | 1295 | 6102 | 1073 | 6468 | 873 | 7079 | 539 | 7964 | 217 | 6853 |
| 14-#10 | 4.49 | MA | 4003 | 1892 | 6653 | 1341 | 7308 | 1103 | 7757 | 903 | 8492 | 582 | 10188 | 307 | 8317 |
| 4L-5S | | MI | 3134 | 1892 | 5182 | 1313 | 5584 | 1087 | 5836 | 888 | 6208 | 554 | 7111 | 184 | 6302 |
| 14-#10 | 4.49 | MA | 3896 | 1892 | 6412 | 1349 | 6988 | 1120 | 7356 | 919 | 7900 | 583 | 9442 | 257 | 8019 |
| 5L-4S | | MI | 3215 | 1892 | 5370 | 1308 | 5834 | 1073 | 6148 | 875 | 6668 | 557 | 7642 | 237 | 6484 |
| 14-#10 | 4.49 | MA | 3819 | 1892 | 6165 | 1366 | 6668 | 1126 | 6959 | 923 | 7366 | 595 | 8759 | 200 | 7707 |
| 6L-3S | | MI | 3254 | 1892 | 5593 | 1292 | 6122 | 1070 | 6501 | 874 | 7127 | 548 | 8182 | 280 | 6653 |
| 14-#11 | 5.52 | MA | 4053 | 2004 | 6766 | 1414 | 7416 | 1168 | 7867 | 946 | 8587 | 569 | 10249 | 166 | 9463 |
| 5L-4S | | MI | 3344 | 2004 | 5666 | 1368 | 6192 | 1114 | 6576 | 896 | 7251 | 540 | 8214 | 138 | 7561 |
| 16-#10 | 5.13 | MA | 4055 | 1962 | 6785 | 1393 | 7466 | 1152 | 7939 | 938 | 8693 | 577 | 10513 | 245 | 9147 |
| 5E | | MI | 3253 | 1962 | 5467 | 1357 | 5949 | 1119 | 6282 | 907 | 6814 | 548 | 7872 | 164 | 7160 |
| 16-#10 | 5.13 | MA | 3979 | 1962 | 6537 | 1410 | 7146 | 1158 | 7542 | 942 | 8160 | 589 | 9830 | 189 | 8815 |
| 6L-4S | | MI | 3333 | 1962 | 5655 | 1352 | 6200 | 1105 | 6594 | 895 | 7274 | 551 | 8403 | 217 | 7329 |

## RECTANGULAR TIED COLUMNS 18" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.18 | MA | 4028 | 1668 | 6408 | 1199 | 6797 | 1011 | 6928 | 865 | 6948 | 647 | 7867 | 561 | 2889 |
| 2E | | MI | 2987 | 1668 | 4806 | 1156 | 5018 | 974 | 5066 | 833 | 5019 | 621 | 5466 | 515 | 2134 |
| 4-#11 | 1.44 | MA | 4096 | 1700 | 6596 | 1209 | 7012 | 1017 | 7181 | 866 | 7285 | 638 | 8268 | 546 | 3475 |
| 2E | | MI | 3029 | 1700 | 4928 | 1163 | 5153 | 977 | 5221 | 831 | 5226 | 610 | 5661 | 489 | 2547 |
| 4-#14 | 2.08 | MA | 4271 | 1777 | 7031 | 1250 | 7551 | 1045 | 7830 | 881 | 8166 | 628 | 9392 | 523 | 4854 |
| 2E | | MI | 3141 | 1777 | 5215 | 1200 | 5505 | 1003 | 5645 | 845 | 5790 | 597 | 6289 | 448 | 3500 |
| 4-#18 | 3.70 | MA | 4689 | 1970 | 8085 | 1356 | 8867 | 1119 | 9421 | 923 | 10323 | 603 | 12034 | 455 | 8190 |
| 2E | | MI | 3405 | 1970 | 5897 | 1302 | 6348 | 1073 | 6662 | 883 | 7062 | 551 | 7691 | 326 | 5748 |
| 6-#8 | 1.10 | MA | 4011 | 1659 | 6349 | 1200 | 6740 | 1013 | 6867 | 867 | 6868 | 651 | 7762 | 566 | 2719 |
| 2L-3S | | MI | 2915 | 1659 | 4587 | 1163 | 4754 | 987 | 4751 | 845 | 4593 | 633 | 4958 | 472 | 2027 |
| 6-#8 | 1.10 | MA | 3915 | 1659 | 6086 | 1206 | 6402 | 1024 | 6455 | 878 | 6308 | 660 | 6987 | 512 | 2737 |
| 3L-2S | | MI | 2978 | 1659 | 4768 | 1159 | 4986 | 978 | 5034 | 837 | 4978 | 627 | 5452 | 527 | 2011 |
| 6-#9 | 1.39 | MA | 4097 | 1694 | 6559 | 1219 | 7000 | 1026 | 7180 | 874 | 7293 | 647 | 8348 | 561 | 3381 |
| 2L-3S | | MI | 2957 | 1694 | 4684 | 1181 | 4871 | 1001 | 4890 | 853 | 4780 | 629 | 5184 | 443 | 2500 |

## RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis

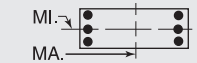



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#9 | 1.39 | MA | 3978 | 1694 | 6228 | 1225 | 6576 | 1040 | 6663 | 888 | 6589 | 658 | 7374 | 491 | 3403 |
| 3L-2S | | MI | 3034 | 1694 | 4911 | 1177 | 5161 | 990 | 5245 | 843 | 5263 | 622 | 5797 | 513 | 2478 |
| 6-#10 | 1.76 | MA | 4206 | 1738 | 6824 | 1243 | 7331 | 1043 | 7580 | 884 | 7834 | 641 | 9094 | 553 | 4218 |
| 2L-3S | | MI | 3009 | 1738 | 4806 | 1205 | 5018 | 1020 | 5066 | 864 | 5019 | 624 | 5466 | 406 | 3092 |
| 6-#10 | 1.76 | MA | 4058 | 1738 | 6408 | 1251 | 6797 | 1061 | 6928 | 900 | 6948 | 655 | 7867 | 464 | 4242 |
| 3L-2S | | MI | 3105 | 1738 | 5091 | 1200 | 5383 | 1006 | 5512 | 852 | 5625 | 615 | 6228 | 495 | 3063 |
| 6-#11 | 2.17 | MA | 4308 | 1786 | 7098 | 1263 | 7655 | 1056 | 7965 | 889 | 8352 | 631 | 9713 | 533 | 5070 |
| 2L-3S | | MI | 3056 | 1786 | 4928 | 1221 | 5153 | 1032 | 5221 | 868 | 5226 | 611 | 5661 | 350 | 3688 |
| 6-#11 | 2.17 | MA | 4134 | 1786 | 6596 | 1272 | 7012 | 1077 | 7181 | 909 | 7285 | 646 | 8268 | 423 | 5097 |
| 3L-2S | | MI | 3168 | 1786 | 5268 | 1216 | 5588 | 1016 | 5752 | 855 | 5949 | 603 | 6537 | 460 | 3651 |
| 6-#14 | 3.13 | MA | 4569 | 1901 | 7743 | 1327 | 8464 | 1101 | 8944 | 915 | 9681 | 618 | 11412 | 501 | 7104 |
| 2L-3S | | MI | 3180 | 1901 | 5215 | 1284 | 5505 | 1080 | 5645 | 896 | 5790 | 596 | 6289 | 242 | 5077 |
| 6-#14 | 3.13 | MA | 4328 | 1901 | 7031 | 1340 | 7551 | 1130 | 7830 | 942 | 8166 | 638 | 9392 | 343 | 7109 |
| 3L-2S | | MI | 3335 | 1901 | 5694 | 1278 | 6119 | 1059 | 6394 | 879 | 6803 | 586 | 7493 | 400 | 5038 |
| 6-#18 | 5.56 | MA | 5193 | 2191 | 9312 | 1494 | 10440 | 1219 | 11340 | 984 | 12934 | 586 | 15401 | 403 | 12035 |
| 2L-3S | | MI | 3474 | 2191 | 5897 | 1445 | 6348 | 1205 | 6662 | 967 | 7062 | 541 | 7691 | -58 | 7661 |
| 6-#18 | 5.56 | MA | 4796 | 2191 | 8085 | 1513 | 8867 | 1267 | 9421 | 1026 | 10323 | 616 | 12034 | 121 | 11618 |
| 3L-2S | | MI | 3732 | 2191 | 6709 | 1440 | 7389 | 1173 | 7932 | 943 | 8731 | 523 | 9622 | 223 | 8318 |
| 8-#8 | 1.46 | MA | 4125 | 1702 | 6612 | 1228 | 7077 | 1032 | 7278 | 879 | 7427 | 648 | 8536 | 561 | 3558 |
| 2L-4S | | MI | 2965 | 1702 | 4628 | 1201 | 4804 | 1009 | 4811 | 858 | 4687 | 635 | 5103 | 433 | 2639 |
| 8-#8 | 1.46 | MA | 4030 | 1702 | 6349 | 1233 | 6740 | 1044 | 6867 | 890 | 6868 | 657 | 7762 | 507 | 3574 |
| 3E | | MI | 2991 | 1702 | 4768 | 1190 | 4986 | 1007 | 5034 | 857 | 4978 | 630 | 5452 | 461 | 2618 |
| 8-#8 | 1.46 | MA | 3982 | 1702 | 6149 | 1246 | 6480 | 1049 | 6547 | 894 | 6452 | 666 | 7227 | 475 | 3590 |
| 4L-2S | | MI | 3053 | 1702 | 4949 | 1187 | 5218 | 997 | 5317 | 849 | 5363 | 624 | 5947 | 517 | 2601 |
| 8-#9 | 1.85 | MA | 4239 | 1749 | 6889 | 1253 | 7424 | 1050 | 7697 | 889 | 7996 | 642 | 9322 | 554 | 4430 |
| 2L-4S | | MI | 3019 | 1749 | 4734 | 1229 | 4933 | 1029 | 4964 | 869 | 4897 | 631 | 5363 | 394 | 3256 |
| 8-#9 | 1.85 | MA | 4123 | 1749 | 6559 | 1260 | 7000 | 1065 | 7180 | 903 | 7293 | 653 | 8348 | 485 | 4448 |
| 3E | | MI | 3052 | 1749 | 4911 | 1216 | 5161 | 1026 | 5245 | 868 | 5263 | 624 | 5797 | 429 | 3233 |
| 8-#9 | 1.85 | MA | 4063 | 1749 | 6306 | 1276 | 6673 | 1070 | 6778 | 907 | 6769 | 665 | 7673 | 445 | 4458 |
| 4L-2S | | MI | 3128 | 1749 | 5138 | 1211 | 5452 | 1014 | 5600 | 858 | 5746 | 617 | 6410 | 499 | 3212 |
| 8-#10 | 2.35 | MA | 4384 | 1809 | 7241 | 1287 | 7865 | 1074 | 8232 | 903 | 8721 | 635 | 10320 | 546 | 5535 |
| 2L-4S | | MI | 3088 | 1809 | 4868 | 1265 | 5095 | 1054 | 5159 | 884 | 5165 | 626 | 5687 | 342 | 4022 |
| 8-#10 | 2.35 | MA | 4239 | 1809 | 6824 | 1295 | 7331 | 1092 | 7580 | 920 | 7834 | 649 | 9094 | 456 | 5551 |
| 3E | | MI | 3128 | 1809 | 5091 | 1249 | 5383 | 1051 | 5512 | 883 | 5625 | 618 | 6228 | 386 | 4003 |
| 8-#10 | 2.35 | MA | 4166 | 1809 | 6506 | 1315 | 6918 | 1099 | 7073 | 925 | 7174 | 663 | 8240 | 405 | 5538 |
| 4L-2S | | MI | 3223 | 1809 | 5376 | 1244 | 5749 | 1037 | 5958 | 871 | 6232 | 610 | 6989 | 475 | 3978 |
| 8-#11 | 2.89 | MA | 4520 | 1873 | 7599 | 1317 | 8298 | 1094 | 8749 | 913 | 9419 | 624 | 11158 | 520 | 6652 |
| 2L-4S | | MI | 3151 | 1873 | 5001 | 1294 | 5243 | 1073 | 5329 | 891 | 5398 | 612 | 5910 | 271 | 4688 |
| 8-#11 | 2.89 | MA | 4350 | 1873 | 7098 | 1326 | 7655 | 1115 | 7965 | 932 | 8352 | 640 | 9713 | 410 | 6667 |
| 3E | | MI | 3197 | 1873 | 5268 | 1275 | 5588 | 1070 | 5752 | 892 | 5949 | 604 | 6537 | 321 | 4767 |
| 8-#11 | 2.89 | MA | 4265 | 1873 | 6713 | 1349 | 7156 | 1123 | 7352 | 938 | 7554 | 655 | 8703 | 349 | 6551 |
| 4L-2S | | MI | 3307 | 1873 | 5608 | 1270 | 6023 | 1054 | 6284 | 878 | 6671 | 597 | 7413 | 431 | 4739 |
| 8-#14 | 4.17 | MA | 4631 | 2026 | 7743 | 1418 | 8464 | 1186 | 8944 | 976 | 9681 | 628 | 11412 | 320 | 9314 |
| 3E | | MI | 3377 | 2026 | 5694 | 1362 | 6119 | 1136 | 6394 | 930 | 6803 | 585 | 7493 | 195 | 6574 |
| 8-#14 | 4.17 | MA | 4516 | 2026 | 7194 | 1450 | 7753 | 1195 | 8071 | 982 | 8544 | 649 | 9995 | 235 | 8622 |
| 4L-2S | | MI | 3529 | 2026 | 6173 | 1356 | 6732 | 1115 | 7142 | 913 | 7816 | 575 | 8697 | 353 | 6556 |
| 8-#18 | 7.41 | MA | 5312 | 2413 | 9312 | 1651 | 10440 | 1366 | 11340 | 1086 | 12934 | 599 | 15401 | 69 | 15139 |
| 3E | | MI | 3805 | 2413 | 6709 | 1584 | 7389 | 1304 | 7932 | 1028 | 8731 | 513 | 9622 | -161 | 9505 |
| 8-#18 | 7.41 | MA | 5126 | 2413 | 8359 | 1705 | 9207 | 1379 | 9826 | 1093 | 10964 | 629 | 13023 | -74 | 12937 |
| 4L-2S | | MI | 4058 | 2413 | 7521 | 1579 | 8431 | 1272 | 9203 | 1004 | 10399 | 495 | 11554 | 121 | 10863 |
| 10-#10 | 2.94 | MA | 4561 | 1879 | 7658 | 1331 | 8399 | 1106 | 8884 | 922 | 9608 | 630 | 11547 | 538 | 6846 |
| 2L-5S | | MI | 3124 | 1879 | 4965 | 1314 | 5211 | 1100 | 5292 | 915 | 5312 | 618 | 5918 | 270 | 4680 |
| 10-#10 | 2.94 | MA | 4419 | 1879 | 7241 | 1339 | 7865 | 1124 | 8232 | 939 | 8721 | 643 | 10320 | 448 | 6854 |
| 3L-4S | | MI | 3207 | 1879 | 5153 | 1309 | 5461 | 1086 | 5604 | 903 | 5772 | 621 | 6448 | 323 | 4906 |
| 10-#10 | 2.94 | MA | 4347 | 1879 | 6923 | 1359 | 7452 | 1130 | 7725 | 944 | 8060 | 657 | 9467 | 397 | 6827 |
| 4L-3S | | MI | 3247 | 1879 | 5376 | 1293 | 5749 | 1083 | 5958 | 902 | 6232 | 612 | 6989 | 366 | 4904 |
| 10-#10 | 2.94 | MA | 4222 | 1879 | 6655 | 1367 | 7096 | 1149 | 7280 | 961 | 7403 | 660 | 8612 | 347 | 6469 |
| 5L-2S | | MI | 3340 | 1879 | 5661 | 1288 | 6114 | 1069 | 6404 | 890 | 6838 | 604 | 7750 | 455 | 4885 |

## RECTANGULAR TIED COLUMNS 18" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

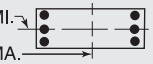
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 3.61 | MA | 4564 | 1959 | 7599 | 1380 | 8298 | 1154 | 8749 | 956 | 9419 | 633 | 11158 | 397 | 8226 |
| 3L-4S | | MI | 3293 | 1959 | 5341 | 1348 | 5678 | 1111 | 5860 | 915 | 6121 | 606 | 6786 | 242 | 5670 |
| 10-#11 | 3.61 | MA | 4481 | 1959 | 7214 | 1403 | 7799 | 1161 | 8136 | 961 | 8621 | 648 | 10148 | 336 | 8024 |
| 4L-3S | | MI | 3337 | 1959 | 5608 | 1329 | 6023 | 1109 | 6284 | 915 | 6671 | 598 | 7413 | 292 | 5836 |
| 10-#11 | 3.61 | MA | 4333 | 1959 | 6890 | 1413 | 7368 | 1183 | 7598 | 980 | 7826 | 650 | 9141 | 274 | 7591 |
| 5L-2S | | MI | 3446 | 1959 | 5947 | 1324 | 6459 | 1093 | 6815 | 902 | 7394 | 590 | 8290 | 401 | 5816 |
| 10-#14 | 5.21 | MA | 4819 | 2150 | 7906 | 1528 | 8666 | 1251 | 9185 | 1016 | 10060 | 639 | 12016 | 213 | 10732 |
| 4L-3S | | MI | 3573 | 2150 | 6173 | 1440 | 6732 | 1192 | 7142 | 964 | 7816 | 574 | 8697 | 147 | 8059 |
| 10-#14 | 5.21 | MA | 4611 | 2150 | 7444 | 1540 | 8051 | 1281 | 8417 | 1042 | 8926 | 639 | 10607 | 122 | 10093 |
| 5L-2S | | MI | 3723 | 2150 | 6652 | 1434 | 7346 | 1171 | 7891 | 947 | 8829 | 564 | 9901 | 306 | 8064 |
| 12-#10 | 3.53 | MA | 4598 | 1949 | 7658 | 1383 | 8399 | 1155 | 8884 | 958 | 9608 | 638 | 11547 | 440 | 8152 |
| 3L-5S | | MI | 3244 | 1949 | 5250 | 1358 | 5576 | 1132 | 5738 | 935 | 5919 | 612 | 6679 | 250 | 5529 |
| 12-#10 | 3.53 | MA | 4526 | 1949 | 7340 | 1403 | 7986 | 1162 | 8376 | 963 | 8947 | 652 | 10694 | 389 | 8114 |
| 4E | | MI | 3326 | 1949 | 5438 | 1353 | 5826 | 1117 | 6050 | 922 | 6378 | 615 | 7209 | 303 | 5737 |
| 12-#10 | 3.53 | MA | 4404 | 1949 | 7072 | 1411 | 7630 | 1180 | 7932 | 980 | 8290 | 654 | 9839 | 339 | 7722 |
| 5L-3S | | MI | 3365 | 1949 | 5661 | 1337 | 6114 | 1114 | 6404 | 921 | 6838 | 607 | 7750 | 346 | 5800 |
| 12-#10 | 3.53 | MA | 4315 | 1949 | 6812 | 1417 | 7276 | 1187 | 7491 | 985 | 7697 | 668 | 9059 | 280 | 7456 |
| 6L-2S | | MI | 3457 | 1949 | 5946 | 1332 | 6480 | 1100 | 6849 | 909 | 7445 | 598 | 8511 | 435 | 5786 |
| 12-#11 | 4.33 | MA | 4694 | 2045 | 7715 | 1457 | 8442 | 1200 | 8920 | 985 | 9688 | 641 | 11593 | 323 | 9507 |
| 4E | | MI | 3433 | 2045 | 5680 | 1402 | 6113 | 1150 | 6391 | 938 | 6843 | 599 | 7663 | 212 | 6662 |
| 12-#11 | 4.33 | MA | 4549 | 2045 | 7391 | 1467 | 8011 | 1221 | 8382 | 1004 | 8893 | 643 | 10586 | 261 | 9102 |
| 5L-3S | | MI | 3476 | 2045 | 5947 | 1383 | 6459 | 1148 | 6815 | 939 | 7394 | 591 | 8290 | 262 | 6900 |
| 12-#11 | 4.33 | MA | 4443 | 2045 | 7058 | 1488 | 7581 | 1229 | 7848 | 1009 | 8176 | 658 | 9665 | 191 | 8611 |
| 6L-2S | | MI | 3584 | 2045 | 6287 | 1378 | 6894 | 1132 | 7346 | 925 | 8117 | 583 | 9166 | 372 | 6888 |
| 12-#14 | 6.25 | MA | 4917 | 2274 | 8156 | 1618 | 8964 | 1336 | 9531 | 1076 | 10442 | 629 | 12628 | 100 | 12187 |
| 5L-3S | | MI | 3769 | 2274 | 6652 | 1517 | 7346 | 1248 | 7891 | 998 | 8829 | 563 | 9901 | 100 | 9537 |
| 14-#10 | 4.12 | MA | 4705 | 2019 | 7756 | 1447 | 8521 | 1194 | 9028 | 982 | 9834 | 646 | 11920 | 381 | 9355 |
| 4L-5S | | MI | 3363 | 2019 | 5535 | 1402 | 5941 | 1163 | 6184 | 954 | 6525 | 606 | 7440 | 230 | 6383 |
| 14-#10 | 4.12 | MA | 4584 | 2019 | 7489 | 1455 | 8165 | 1212 | 8583 | 999 | 9177 | 648 | 11065 | 331 | 8980 |
| 5L-4S | | MI | 3444 | 2019 | 5723 | 1397 | 6192 | 1149 | 6496 | 942 | 6985 | 609 | 7971 | 283 | 6575 |
| 14-#10 | 4.12 | MA | 4497 | 2019 | 7228 | 1461 | 7810 | 1218 | 8143 | 1004 | 8584 | 662 | 10286 | 272 | 8695 |
| 6L-3S | | MI | 3483 | 2019 | 5946 | 1381 | 6480 | 1146 | 6849 | 941 | 7445 | 601 | 8511 | 326 | 6694 |
| 14-#11 | 5.06 | MA | 4764 | 2132 | 7893 | 1520 | 8654 | 1260 | 9166 | 1027 | 9960 | 636 | 12031 | 248 | 10618 |
| 5L-4S | | MI | 3573 | 2132 | 6020 | 1456 | 6549 | 1189 | 6922 | 962 | 7566 | 592 | 8539 | 183 | 7662 |
| 14-#11 | 5.06 | MA | 4660 | 2132 | 7559 | 1542 | 8224 | 1267 | 8632 | 1033 | 9243 | 651 | 11110 | 178 | 10104 |
| 6L-3S | | MI | 3616 | 2132 | 6287 | 1437 | 6894 | 1187 | 7346 | 962 | 8117 | 584 | 9166 | 233 | 7957 |
| 16-#10 | 4.70 | MA | 4763 | 2090 | 7906 | 1499 | 8699 | 1243 | 9235 | 1018 | 10063 | 643 | 12292 | 323 | 10242 |
| 5E | | MI | 3482 | 2090 | 5820 | 1446 | 6307 | 1195 | 6630 | 973 | 7132 | 601 | 8201 | 211 | 7240 |
| 16-#10 | 4.70 | MA | 4679 | 2090 | 7645 | 1505 | 8344 | 1250 | 8794 | 1024 | 9471 | 657 | 11512 | 264 | 9939 |
| 6L-4S | | MI | 3562 | 2090 | 6008 | 1441 | 6557 | 1181 | 6942 | 961 | 7591 | 604 | 8732 | 263 | 7418 |
| 16-#11 | 5.78 | MA | 4877 | 2218 | 8061 | 1596 | 8867 | 1306 | 9417 | 1056 | 10310 | 644 | 12555 | 165 | 11603 |
| 6L-4S | | MI | 3712 | 2218 | 6359 | 1510 | 6984 | 1228 | 7453 | 985 | 8288 | 585 | 9416 | 154 | 8669 |
| 18-#10 | 5.29 | MA | 4859 | 2160 | 8062 | 1549 | 8879 | 1282 | 9446 | 1043 | 10358 | 651 | 12739 | 256 | 11186 |
| 6L-5S | | MI | 3600 | 2160 | 6105 | 1490 | 6672 | 1226 | 7075 | 992 | 7738 | 595 | 8962 | 191 | 8099 |

## RECTANGULAR TIED COLUMNS 18" x 26"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#10 | 1.09 | MA | 4707 | 1795 | 7439 | 1303 | 7904 | 1099 | 8056 | 942 | 8058 | 708 | 9108 | 615 | 3164 |
| 2E | | MI | 3216 | 1795 | 5159 | 1245 | 5375 | 1050 | 5414 | 899 | 5336 | 674 | 5795 | 561 | 2155 |
| 4-#11 | 1.33 | MA | 4784 | 1827 | 7651 | 1313 | 8146 | 1105 | 8339 | 943 | 8437 | 699 | 9628 | 606 | 3812 |
| 2E | | MI | 3258 | 1827 | 5282 | 1250 | 5509 | 1052 | 5568 | 897 | 5541 | 662 | 5986 | 535 | 2572 |
| 4-#14 | 1.92 | MA | 4981 | 1904 | 8136 | 1353 | 8747 | 1133 | 9064 | 958 | 9418 | 689 | 10920 | 588 | 5340 |
| 2E | | MI | 3370 | 1904 | 5570 | 1288 | 5861 | 1077 | 5990 | 910 | 6103 | 648 | 6612 | 493 | 3532 |
| 4-#18 | 3.42 | MA | 5453 | 2097 | 9315 | 1459 | 10220 | 1207 | 10843 | 1000 | 11831 | 665 | 13981 | 531 | 9054 |
| 2E | | MI | 3634 | 2097 | 6253 | 1388 | 6704 | 1146 | 7006 | 947 | 7373 | 602 | 8009 | 371 | 5795 |

## RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

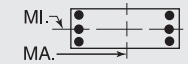
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.01 | MA | 4687 | 1786 | 7373 | 1304 | 7839 | 1101 | 7985 | 944 | 7967 | 713 | 8986 | 620 | 2975 |
| 2L-3S | | MI | 3144 | 1786 | 4939 | 1253 | 5112 | 1064 | 5100 | 912 | 4911 | 686 | 5289 | 518 | 2044 |
| 6-#8 | 1.01 | MA | 4580 | 1786 | 7082 | 1310 | 7467 | 1106 | 7531 | 956 | 7349 | 722 | 8131 | 567 | 2992 |
| 3L-2S | | MI | 3207 | 1786 | 5120 | 1249 | 5344 | 1054 | 5383 | 904 | 5296 | 680 | 5783 | 574 | 2030 |
| 6-#9 | 1.28 | MA | 4784 | 1821 | 7605 | 1322 | 8127 | 1114 | 8333 | 951 | 8438 | 708 | 9636 | 614 | 3705 |
| 2L-3S | | MI | 3186 | 1821 | 5037 | 1270 | 5228 | 1078 | 5238 | 920 | 5098 | 682 | 5514 | 490 | 2521 |
| 6-#9 | 1.28 | MA | 4650 | 1821 | 7240 | 1329 | 7659 | 1120 | 7762 | 965 | 7661 | 720 | 8560 | 547 | 3727 |
| 3L-2S | | MI | 3263 | 1821 | 5264 | 1266 | 5519 | 1066 | 5593 | 910 | 5581 | 675 | 6127 | 560 | 2499 |
| 6-#10 | 1.63 | MA | 4906 | 1866 | 7900 | 1347 | 8495 | 1131 | 8776 | 961 | 9039 | 702 | 10466 | 607 | 4629 |
| 2L-3S | | MI | 3238 | 1866 | 5159 | 1294 | 5375 | 1096 | 5414 | 930 | 5336 | 676 | 5795 | 452 | 3118 |
| 6-#10 | 1.63 | MA | 4740 | 1866 | 7439 | 1356 | 7904 | 1138 | 8056 | 978 | 8058 | 717 | 9108 | 521 | 4654 |
| 3L-2S | | MI | 3334 | 1866 | 5444 | 1289 | 5741 | 1082 | 5860 | 918 | 5942 | 668 | 6556 | 541 | 3088 |
| 6-#11 | 2.00 | MA | 5022 | 1914 | 8206 | 1367 | 8858 | 1144 | 9208 | 966 | 9619 | 692 | 11264 | 597 | 5576 |
| 2L-3S | | MI | 3285 | 1914 | 5282 | 1309 | 5509 | 1107 | 5568 | 933 | 5541 | 663 | 5986 | 396 | 3720 |
| 6-#11 | 2.00 | MA | 4826 | 1914 | 7651 | 1377 | 8146 | 1166 | 8339 | 987 | 8437 | 709 | 9628 | 487 | 5603 |
| 3L-2S | | MI | 3398 | 1914 | 5622 | 1304 | 5945 | 1091 | 6099 | 920 | 6264 | 655 | 6863 | 505 | 3681 |
| 6-#14 | 2.88 | MA | 5315 | 2028 | 8926 | 1431 | 9760 | 1189 | 10299 | 992 | 11099 | 679 | 13216 | 571 | 7833 |
| 2L-3S | | MI | 3409 | 2028 | 5570 | 1371 | 5861 | 1154 | 5990 | 961 | 6103 | 647 | 6612 | 287 | 5120 |
| 6-#14 | 2.88 | MA | 5043 | 2028 | 8136 | 1445 | 8747 | 1220 | 9064 | 1021 | 9418 | 702 | 10920 | 413 | 7838 |
| 3L-2S | | MI | 3565 | 2028 | 6049 | 1365 | 6475 | 1133 | 6739 | 943 | 7116 | 637 | 7816 | 446 | 5076 |
| 6-#18 | 5.13 | MA | 6019 | 2319 | 10681 | 1598 | 11970 | 1307 | 12978 | 1060 | 14737 | 647 | 17836 | 490 | 13331 |
| 2L-3S | | MI | 3703 | 2319 | 6253 | 1531 | 6704 | 1278 | 7006 | 1031 | 7373 | 591 | 8009 | -14 | 8003 |
| 6-#18 | 5.13 | MA | 5571 | 2319 | 9315 | 1619 | 10220 | 1358 | 10843 | 1107 | 11831 | 683 | 13981 | 208 | 13152 |
| 3L-2S | | MI | 3961 | 2319 | 7065 | 1526 | 7745 | 1245 | 8276 | 1007 | 9041 | 574 | 9941 | 268 | 8371 |
| 8-#8 | 1.35 | MA | 4814 | 1830 | 7663 | 1331 | 8211 | 1121 | 8439 | 956 | 8585 | 709 | 9841 | 615 | 3899 |
| 2L-4S | | MI | 3194 | 1830 | 4980 | 1291 | 5162 | 1086 | 5159 | 925 | 5005 | 689 | 5434 | 480 | 2660 |
| 8-#8 | 1.35 | MA | 4708 | 1830 | 7373 | 1337 | 7839 | 1126 | 7985 | 967 | 7967 | 719 | 8986 | 562 | 3915 |
| 3E | | MI | 3221 | 1830 | 5120 | 1280 | 5344 | 1083 | 5383 | 924 | 5296 | 683 | 5783 | 508 | 2639 |
| 8-#8 | 1.35 | MA | 4653 | 1830 | 7153 | 1350 | 7553 | 1138 | 7634 | 972 | 7510 | 729 | 8403 | 531 | 3931 |
| 4L-2S | | MI | 3282 | 1830 | 5301 | 1276 | 5576 | 1074 | 5666 | 916 | 5681 | 677 | 6277 | 563 | 2622 |
| 8-#9 | 1.71 | MA | 4943 | 1876 | 7970 | 1357 | 8595 | 1139 | 8904 | 966 | 9215 | 703 | 10712 | 608 | 4862 |
| 2L-4S | | MI | 3248 | 1876 | 5087 | 1318 | 5290 | 1105 | 5312 | 936 | 5215 | 684 | 5692 | 440 | 3283 |
| 8-#9 | 1.71 | MA | 4811 | 1876 | 7605 | 1364 | 8127 | 1145 | 8333 | 980 | 8438 | 716 | 9636 | 540 | 4880 |
| 3E | | MI | 3281 | 1876 | 5264 | 1305 | 5519 | 1102 | 5593 | 935 | 5581 | 677 | 6127 | 475 | 3257 |
| 8-#9 | 1.71 | MA | 4743 | 1876 | 7328 | 1380 | 7767 | 1160 | 7891 | 986 | 7862 | 728 | 8900 | 501 | 4890 |
| 4L-2S | | MI | 3357 | 1876 | 5490 | 1301 | 5810 | 1091 | 5948 | 925 | 6063 | 670 | 6740 | 545 | 3236 |
| 8-#10 | 2.17 | MA | 5105 | 1936 | 8361 | 1390 | 9085 | 1162 | 9497 | 980 | 10019 | 696 | 11823 | 600 | 6084 |
| 2L-4S | | MI | 3317 | 1936 | 5221 | 1354 | 5453 | 1130 | 5507 | 950 | 5482 | 679 | 6016 | 389 | 4056 |
| 8-#10 | 2.17 | MA | 4942 | 1936 | 7900 | 1399 | 8495 | 1170 | 8776 | 997 | 9039 | 711 | 10466 | 513 | 6100 |
| 3E | | MI | 3357 | 1936 | 5444 | 1338 | 5741 | 1127 | 5860 | 949 | 5942 | 671 | 6556 | 432 | 4032 |
| 8-#10 | 2.17 | MA | 4857 | 1936 | 7550 | 1420 | 8040 | 1189 | 8218 | 1004 | 8311 | 726 | 9533 | 462 | 6087 |
| 4L-2S | | MI | 3452 | 1936 | 5729 | 1333 | 6106 | 1113 | 6306 | 937 | 6549 | 662 | 7317 | 521 | 4006 |
| 8-#11 | 2.67 | MA | 5258 | 2000 | 8762 | 1420 | 9570 | 1182 | 10076 | 990 | 10801 | 685 | 12901 | 587 | 7326 |
| 2L-4S | | MI | 3380 | 2000 | 5355 | 1382 | 5600 | 1148 | 5676 | 956 | 5713 | 664 | 6235 | 317 | 4823 |
| 8-#11 | 2.67 | MA | 5067 | 2000 | 8206 | 1431 | 8858 | 1205 | 9208 | 1010 | 9619 | 702 | 11264 | 478 | 7341 |
| 3E | | MI | 3426 | 2000 | 5622 | 1363 | 5945 | 1145 | 6099 | 957 | 6264 | 657 | 6863 | 366 | 4804 |
| 8-#11 | 2.67 | MA | 4969 | 2000 | 7782 | 1455 | 8308 | 1213 | 8532 | 1017 | 8739 | 719 | 10126 | 415 | 7295 |
| 4L-2S | | MI | 3536 | 2000 | 5962 | 1358 | 6380 | 1129 | 6630 | 944 | 6987 | 649 | 7739 | 476 | 4772 |
| 8-#14 | 3.85 | MA | 5383 | 2153 | 8926 | 1522 | 9760 | 1276 | 10299 | 1054 | 11099 | 692 | 13216 | 396 | 10286 |
| 3E | | MI | 3606 | 2153 | 6049 | 1449 | 6475 | 1210 | 6739 | 995 | 7116 | 636 | 7816 | 240 | 6626 |
| 8-#14 | 3.85 | MA | 5248 | 2153 | 8320 | 1556 | 8975 | 1287 | 9335 | 1063 | 9844 | 715 | 11615 | 307 | 9640 |
| 4L-2S | | MI | 3759 | 2153 | 6528 | 1443 | 7089 | 1189 | 7488 | 977 | 8130 | 627 | 9020 | 398 | 6598 |
| 8-#18 | 6.84 | MA | 6151 | 2540 | 10681 | 1758 | 11970 | 1458 | 12978 | 1167 | 14737 | 665 | 17836 | 167 | 17145 |
| 3E | | MI | 4034 | 2540 | 7065 | 1669 | 7745 | 1377 | 8276 | 1091 | 9041 | 564 | 9941 | -117 | 9861 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis

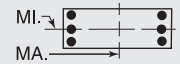



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 6.84 | MA | 5931 | 2540 | 9627 | 1815 | 10605 | 1474 | 11303 | 1178 | 12555 | 700 | 15130 | 16 | 15034 |
| 4L-2S | | MI | 4288 | 2540 | 7877 | 1664 | 8786 | 1345 | 9546 | 1067 | 10709 | 546 | 11873 | 165 | 10924 |
| 10-#10 | 2.71 | MA | 5302 | 2006 | 8822 | 1434 | 9676 | 1194 | 10217 | 999 | 10999 | 691 | 13180 | 592 | 7532 |
| 2L-5S | | MI | 3353 | 2006 | 5318 | 1403 | 5568 | 1176 | 5640 | 982 | 5629 | 670 | 6246 | 316 | 4758 |
| 10-#10 | 2.71 | MA | 5143 | 2006 | 8361 | 1443 | 9085 | 1201 | 9497 | 1017 | 10019 | 706 | 11823 | 505 | 7540 |
| 3L-4S | | MI | 3436 | 2006 | 5506 | 1398 | 5818 | 1162 | 5952 | 969 | 6089 | 673 | 6777 | 369 | 4951 |
| 10-#10 | 2.71 | MA | 5059 | 2006 | 8010 | 1464 | 8631 | 1220 | 8938 | 1023 | 9291 | 721 | 10891 | 455 | 7513 |
| 4L-3S | | MI | 3476 | 2006 | 5729 | 1382 | 6106 | 1159 | 6306 | 968 | 6549 | 665 | 7317 | 412 | 4936 |
| 10-#10 | 2.71 | MA | 4920 | 2006 | 7717 | 1473 | 8240 | 1228 | 8449 | 1041 | 8568 | 724 | 9953 | 407 | 7170 |
| 5L-2S | | MI | 3569 | 2006 | 6014 | 1377 | 6471 | 1145 | 6751 | 956 | 7155 | 657 | 8079 | 501 | 4915 |
| 10-#11 | 3.33 | MA | 5306 | 2086 | 8762 | 1485 | 9570 | 1243 | 10076 | 1034 | 10801 | 695 | 12901 | 468 | 9069 |
| 3L-4S | | MI | 3522 | 2086 | 5695 | 1436 | 6035 | 1186 | 6207 | 980 | 6436 | 658 | 7112 | 287 | 5771 |
| 10-#11 | 3.33 | MA | 5210 | 2086 | 8337 | 1509 | 9020 | 1252 | 9400 | 1041 | 9921 | 712 | 11763 | 405 | 8953 |
| 4L-3S | | MI | 3566 | 2086 | 5962 | 1417 | 6380 | 1184 | 6630 | 980 | 6987 | 650 | 7739 | 337 | 5876 |
| 10-#11 | 3.33 | MA | 5044 | 2086 | 7981 | 1519 | 8546 | 1274 | 8808 | 1061 | 9045 | 716 | 10623 | 343 | 8426 |
| 5L-2S | | MI | 3675 | 2086 | 6301 | 1412 | 6815 | 1168 | 7161 | 967 | 7709 | 642 | 8616 | 447 | 5853 |
| 10-#14 | 4.81 | MA | 5588 | 2277 | 9110 | 1634 | 9988 | 1343 | 10570 | 1097 | 11525 | 705 | 13911 | 290 | 11987 |
| 4L-3S | | MI | 3802 | 2277 | 6528 | 1527 | 7089 | 1266 | 7488 | 1029 | 8130 | 626 | 9020 | 193 | 8115 |
| 10-#14 | 4.81 | MA | 5356 | 2277 | 8601 | 1648 | 9310 | 1374 | 9724 | 1125 | 10275 | 708 | 12310 | 201 | 11364 |
| 5L-2S | | MI | 3953 | 2277 | 7007 | 1521 | 7702 | 1245 | 8237 | 1011 | 9143 | 616 | 10224 | 351 | 8109 |
| 12-#10 | 3.26 | MA | 5342 | 2076 | 8822 | 1487 | 9676 | 1233 | 10217 | 1036 | 10999 | 700 | 13180 | 497 | 8975 |
| 3L-5S | | MI | 3473 | 2076 | 5603 | 1447 | 5933 | 1208 | 6086 | 1001 | 6236 | 665 | 7007 | 297 | 5607 |
| 12-#10 | 3.26 | MA | 5259 | 2076 | 8471 | 1507 | 9221 | 1252 | 9659 | 1042 | 10272 | 715 | 12248 | 447 | 8937 |
| 4E | | MI | 3555 | 2076 | 5791 | 1442 | 6183 | 1193 | 6398 | 989 | 6695 | 668 | 7538 | 349 | 5826 |
| 12-#10 | 3.26 | MA | 5123 | 2076 | 8178 | 1516 | 8830 | 1260 | 9170 | 1060 | 9548 | 719 | 11310 | 399 | 8558 |
| 5L-3S | | MI | 3594 | 2076 | 6014 | 1426 | 6471 | 1190 | 6751 | 988 | 7155 | 659 | 8079 | 392 | 5835 |
| 12-#10 | 3.26 | MA | 5024 | 2076 | 7885 | 1522 | 8441 | 1278 | 8686 | 1066 | 8897 | 734 | 10459 | 341 | 8306 |
| 6L-2S | | MI | 3687 | 2076 | 6299 | 1421 | 6837 | 1176 | 7197 | 975 | 7762 | 651 | 8840 | 482 | 5818 |
| 12-#11 | 4.00 | MA | 5449 | 2173 | 8893 | 1563 | 9732 | 1291 | 10269 | 1064 | 11102 | 706 | 13399 | 396 | 10600 |
| 4E | | MI | 3662 | 2173 | 6034 | 1490 | 6470 | 1225 | 6738 | 1003 | 7158 | 651 | 7988 | 258 | 6762 |
| 12-#11 | 4.00 | MA | 5286 | 2173 | 8537 | 1573 | 9258 | 1313 | 9677 | 1085 | 10226 | 709 | 12259 | 334 | 10102 |
| 5L-3S | | MI | 3706 | 2173 | 6301 | 1471 | 6815 | 1223 | 7161 | 1004 | 7709 | 643 | 8616 | 308 | 6943 |
| 12-#11 | 4.00 | MA | 5168 | 2173 | 8189 | 1580 | 8786 | 1321 | 9089 | 1091 | 9437 | 726 | 11219 | 261 | 9629 |
| 6L-2S | | MI | 3813 | 2173 | 6641 | 1466 | 7251 | 1207 | 7692 | 991 | 8432 | 635 | 9492 | 418 | 6927 |
| 12-#14 | 5.77 | MA | 5698 | 2402 | 9391 | 1726 | 10323 | 1430 | 10960 | 1159 | 11956 | 698 | 14606 | 184 | 13716 |
| 5L-3S | | MI | 3998 | 2402 | 7007 | 1604 | 7702 | 1322 | 8237 | 1063 | 9143 | 615 | 10224 | 145 | 9598 |
| 14-#10 | 3.80 | MA | 5459 | 2147 | 8932 | 1551 | 9812 | 1283 | 10379 | 1061 | 11252 | 710 | 13605 | 439 | 10361 |
| 4L-5S | | MI | 3592 | 2147 | 5888 | 1491 | 6299 | 1239 | 6532 | 1020 | 6842 | 659 | 7769 | 277 | 6460 |
| 14-#10 | 3.80 | MA | 5324 | 2147 | 8638 | 1560 | 9421 | 1291 | 9890 | 1079 | 10528 | 713 | 12667 | 392 | 9950 |
| 5L-4S | | MI | 3673 | 2147 | 6076 | 1486 | 6549 | 1225 | 6844 | 1008 | 7302 | 662 | 8299 | 329 | 6662 |
| 14-#10 | 3.80 | MA | 5227 | 2147 | 8345 | 1566 | 9031 | 1310 | 9406 | 1085 | 9878 | 728 | 11816 | 333 | 9704 |
| 6L-3S | | MI | 3712 | 2147 | 6299 | 1470 | 6837 | 1222 | 7197 | 1007 | 7762 | 654 | 8840 | 372 | 6730 |
| 14-#10 | 3.80 | MA | 5128 | 2147 | 8014 | 1582 | 8652 | 1316 | 8944 | 1103 | 9243 | 743 | 10935 | 294 | 9224 |
| 7L-2S | | MI | 3803 | 2147 | 6584 | 1464 | 7202 | 1208 | 7643 | 994 | 8368 | 646 | 9601 | 462 | 6718 |
| 14-#11 | 4.67 | MA | 5526 | 2259 | 9092 | 1627 | 9970 | 1352 | 10545 | 1108 | 11408 | 702 | 13895 | 324 | 11783 |
| 5L-4S | | MI | 3802 | 2259 | 6374 | 1544 | 6906 | 1264 | 7269 | 1027 | 7881 | 644 | 8865 | 229 | 7761 |
| 14-#11 | 4.67 | MA | 5411 | 2259 | 8744 | 1634 | 9498 | 1360 | 9958 | 1115 | 10619 | 719 | 12855 | 252 | 11288 |
| 6L-3S | | MI | 3845 | 2259 | 6641 | 1525 | 7251 | 1262 | 7692 | 1028 | 8432 | 636 | 9492 | 279 | 8006 |
| 16-#10 | 4.34 | MA | 5524 | 2217 | 9099 | 1604 | 10011 | 1323 | 10611 | 1098 | 11509 | 708 | 14024 | 384 | 11347 |
| 5E | | MI | 3711 | 2217 | 6173 | 1535 | 6664 | 1271 | 6978 | 1039 | 7449 | 653 | 8530 | 257 | 7317 |
| 16-#10 | 4.34 | MA | 5430 | 2217 | 8806 | 1610 | 9622 | 1342 | 10127 | 1104 | 10858 | 723 | 13174 | 326 | 11083 |
| 6L-4S | | MI | 3791 | 2217 | 6361 | 1530 | 6914 | 1256 | 7290 | 1027 | 7908 | 656 | 9060 | 309 | 7504 |
| 16-#10 | 4.34 | MA | 5331 | 2217 | 8475 | 1626 | 9243 | 1348 | 9664 | 1122 | 10223 | 737 | 12292 | 286 | 10619 |
| 7L-3S | | MI | 3830 | 2217 | 6584 | 1513 | 7202 | 1253 | 7643 | 1026 | 8368 | 648 | 9601 | 352 | 7622 |
| 16-#11 | 5.33 | MA | 5653 | 2345 | 9300 | 1688 | 10210 | 1399 | 10826 | 1138 | 11801 | 712 | 14492 | 242 | 12954 |
| 6L-4S | | MI | 3941 | 2345 | 6713 | 1598 | 7341 | 1303 | 7800 | 1051 | 8603 | 637 | 9741 | 200 | 8766 |

## RECTANGULAR TIED COLUMNS 18" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 4.88 | MA | 5631 | 2287 | 9267 | 1654 | 10213 | 1373 | 10847 | 1124 | 11838 | 717 | 14531 | 318 | 12466 |
| 6L-5S | | MI | 3829 | 2287 | 6458 | 1579 | 7029 | 1302 | 7423 | 1058 | 8055 | 648 | 9291 | 237 | 8176 |
| 18-#10 | 4.88 | MA | 5533 | 2287 | 8936 | 1670 | 9833 | 1379 | 10385 | 1141 | 11204 | 732 | 13649 | 278 | 12016 |
| 7L-4S | | MI | 3909 | 2287 | 6646 | 1574 | 7280 | 1288 | 7735 | 1046 | 8515 | 651 | 9821 | 289 | 8350 |
| 20-#10 | 5.43 | MA | 5733 | 2358 | 9397 | 1714 | 10424 | 1411 | 11105 | 1160 | 12184 | 726 | 15007 | 271 | 13416 |
| 7L-5S | | MI | 3947 | 2358 | 6743 | 1623 | 7395 | 1334 | 7869 | 1077 | 8662 | 642 | 10052 | 217 | 9037 |

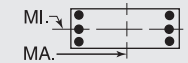
## RECTANGULAR TIED COLUMNS 18" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.01 | MA | 5437 | 1923 | 8544 | 1406 | 9090 | 1187 | 9263 | 1018 | 9245 | 769 | 10429 | 669 | 3438 |
| 2E | | MI | 3445 | 1923 | 5512 | 1334 | 5733 | 1126 | 5762 | 965 | 5653 | 726 | 6124 | 607 | 2175 |
| 4-#11 | 1.24 | MA | 5524 | 1955 | 8778 | 1416 | 9359 | 1193 | 9577 | 1020 | 9665 | 760 | 11005 | 660 | 4149 |
| 2E | | MI | 3488 | 1955 | 5637 | 1338 | 5866 | 1127 | 5915 | 962 | 5857 | 714 | 6312 | 580 | 2597 |
| 4-#14 | 1.79 | MA | 5743 | 2031 | 9313 | 1456 | 10022 | 1221 | 10376 | 1035 | 10746 | 750 | 12499 | 648 | 5826 |
| 2E | | MI | 3599 | 2031 | 5925 | 1375 | 6218 | 1151 | 6336 | 974 | 6417 | 700 | 6936 | 538 | 3564 |
| 4-#18 | 3.17 | MA | 6270 | 2225 | 10618 | 1563 | 11651 | 1296 | 12345 | 1077 | 13415 | 726 | 16015 | 603 | 9918 |
| 2E | | MI | 3864 | 2225 | 6609 | 1473 | 7059 | 1219 | 7349 | 1010 | 7683 | 652 | 8328 | 415 | 5840 |
| 6-#9 | 1.19 | MA | 5522 | 1948 | 8724 | 1426 | 9333 | 1202 | 9565 | 1028 | 9658 | 769 | 11004 | 668 | 4029 |
| 2L-3S | | MI | 3415 | 1948 | 5389 | 1360 | 5585 | 1154 | 5587 | 986 | 5416 | 735 | 5843 | 536 | 2541 |
| 6-#9 | 1.19 | MA | 5374 | 1948 | 8324 | 1433 | 8821 | 1209 | 8940 | 1043 | 8808 | 782 | 9826 | 602 | 4051 |
| 3L-2S | | MI | 3492 | 1948 | 5616 | 1356 | 5876 | 1142 | 5941 | 976 | 5899 | 728 | 6456 | 606 | 2520 |
| 6-#10 | 1.51 | MA | 5658 | 1993 | 9048 | 1450 | 9737 | 1219 | 10052 | 1038 | 10318 | 763 | 11916 | 661 | 5041 |
| 2L-3S | | MI | 3467 | 1993 | 5512 | 1383 | 5733 | 1172 | 5762 | 996 | 5653 | 729 | 6124 | 498 | 3141 |
| 6-#10 | 1.51 | MA | 5473 | 1993 | 8544 | 1460 | 9090 | 1227 | 9263 | 1056 | 9245 | 779 | 10429 | 576 | 5065 |
| 3L-2S | | MI | 3564 | 1993 | 5797 | 1378 | 6098 | 1157 | 6208 | 984 | 6259 | 721 | 6885 | 587 | 3112 |
| 6-#11 | 1.86 | MA | 5787 | 2041 | 9388 | 1470 | 10140 | 1232 | 10530 | 1043 | 10961 | 753 | 12800 | 651 | 6081 |
| 2L-3S | | MI | 3514 | 2041 | 5637 | 1397 | 5866 | 1182 | 5915 | 999 | 5857 | 715 | 6312 | 441 | 3750 |
| 6-#11 | 1.86 | MA | 5569 | 2041 | 8778 | 1481 | 9359 | 1241 | 9577 | 1065 | 9665 | 772 | 11005 | 544 | 6108 |
| 3L-2S | | MI | 3627 | 2041 | 5976 | 1392 | 6302 | 1166 | 6446 | 985 | 6579 | 708 | 7188 | 551 | 3711 |
| 6-#14 | 2.68 | MA | 6113 | 2156 | 10181 | 1534 | 11134 | 1277 | 11733 | 1069 | 12593 | 740 | 15055 | 634 | 8562 |
| 2L-3S | | MI | 3638 | 2156 | 5925 | 1458 | 6218 | 1229 | 6336 | 1026 | 6417 | 699 | 6936 | 333 | 5161 |
| 6-#14 | 2.68 | MA | 5810 | 2156 | 9313 | 1549 | 10022 | 1310 | 10376 | 1099 | 10746 | 765 | 12499 | 477 | 8567 |
| 3L-2S | | MI | 3794 | 2156 | 6404 | 1452 | 6831 | 1207 | 7085 | 1008 | 7430 | 689 | 8139 | 491 | 5112 |
| 6-#18 | 4.76 | MA | 6898 | 2446 | 12121 | 1701 | 13578 | 1395 | 14696 | 1137 | 16615 | 708 | 20360 | 571 | 14627 |
| 2L-3S | | MI | 3932 | 2446 | 6609 | 1616 | 7059 | 1350 | 7349 | 1094 | 7683 | 642 | 8328 | 31 | 8245 |
| 6-#18 | 4.76 | MA | 6398 | 2446 | 10618 | 1725 | 11651 | 1450 | 12345 | 1187 | 13415 | 748 | 16015 | 289 | 14448 |
| 3L-2S | | MI | 4190 | 2446 | 7421 | 1611 | 8100 | 1318 | 8619 | 1071 | 9352 | 624 | 10260 | 312 | 8424 |
| 8-#8 | 1.25 | MA | 5555 | 1957 | 8787 | 1434 | 9424 | 1209 | 9680 | 1033 | 9817 | 770 | 11227 | 669 | 4240 |
| 2L-4S | | MI | 3423 | 1957 | 5332 | 1380 | 5519 | 1162 | 5508 | 992 | 5324 | 742 | 5764 | 526 | 2680 |
| 8-#8 | 1.25 | MA | 5438 | 1957 | 8469 | 1441 | 9017 | 1214 | 9183 | 1045 | 9142 | 781 | 10291 | 617 | 4256 |
| 3E | | MI | 3450 | 1957 | 5473 | 1370 | 5701 | 1160 | 5732 | 991 | 5615 | 736 | 6114 | 554 | 2659 |
| 8-#8 | 1.25 | MA | 5375 | 1957 | 8229 | 1454 | 8705 | 1227 | 8800 | 1050 | 8643 | 791 | 9660 | 586 | 4272 |
| 4L-2S | | MI | 3512 | 1957 | 5653 | 1366 | 5933 | 1151 | 6015 | 982 | 6000 | 730 | 6608 | 610 | 2643 |
| 8-#9 | 1.59 | MA | 5698 | 2003 | 9124 | 1460 | 9846 | 1227 | 10190 | 1043 | 10509 | 765 | 12182 | 662 | 5294 |
| 2L-4S | | MI | 3477 | 2003 | 5439 | 1407 | 5648 | 1181 | 5661 | 1002 | 5533 | 737 | 6022 | 487 | 3308 |
| 8-#9 | 1.59 | MA | 5552 | 2003 | 8724 | 1468 | 9333 | 1234 | 9565 | 1058 | 9658 | 777 | 11004 | 596 | 5312 |
| 3E | | MI | 3510 | 2003 | 5616 | 1394 | 5876 | 1179 | 5941 | 1001 | 5899 | 730 | 6456 | 521 | 3281 |
| 8-#9 | 1.59 | MA | 5474 | 2003 | 8422 | 1484 | 8941 | 1249 | 9082 | 1064 | 9030 | 790 | 10207 | 557 | 5322 |
| 4L-2S | | MI | 3587 | 2003 | 5843 | 1390 | 6167 | 1167 | 6296 | 991 | 6381 | 723 | 7070 | 592 | 3259 |
| 8-#10 | 2.02 | MA | 5877 | 2063 | 9553 | 1494 | 10384 | 1250 | 10841 | 1057 | 11392 | 758 | 13403 | 653 | 6632 |
| 2L-4S | | MI | 3546 | 2063 | 5574 | 1443 | 5810 | 1206 | 5855 | 1016 | 5800 | 731 | 6344 | 435 | 4088 |
| 8-#10 | 2.02 | MA | 5696 | 2063 | 9048 | 1503 | 9737 | 1259 | 10052 | 1075 | 10318 | 774 | 11916 | 569 | 6649 |
| 3E | | MI | 3586 | 2063 | 5797 | 1427 | 6098 | 1203 | 6208 | 1015 | 6259 | 723 | 6885 | 478 | 4060 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis

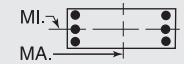



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 2.02 | MA | 5600 | 2063 | 8666 | 1524 | 9241 | 1278 | 9442 | 1082 | 9524 | 790 | 10906 | 519 | 6635 |
| 4L-2S | | MI | 3681 | 2063 | 6082 | 1422 | 6463 | 1189 | 6654 | 1003 | 6866 | 715 | 7646 | 567 | 4032 |
| 8-#11 | 2.48 | MA | 6049 | 2127 | 9997 | 1524 | 10921 | 1271 | 11483 | 1067 | 12258 | 747 | 14596 | 641 | 8000 |
| 2L-4S | | MI | 3609 | 2127 | 5709 | 1470 | 5956 | 1223 | 6022 | 1022 | 6028 | 716 | 6561 | 362 | 4866 |
| 8-#11 | 2.48 | MA | 5836 | 2127 | 9388 | 1535 | 10140 | 1280 | 10530 | 1088 | 10961 | 765 | 12800 | 534 | 8015 |
| 3E | | MI | 3655 | 2127 | 5976 | 1451 | 6302 | 1220 | 6446 | 1022 | 6579 | 709 | 7188 | 412 | 4838 |
| 8-#11 | 2.48 | MA | 5723 | 2127 | 8924 | 1560 | 9539 | 1303 | 9791 | 1096 | 9999 | 783 | 11567 | 472 | 7969 |
| 4L-2S | | MI | 3766 | 2127 | 6316 | 1446 | 6737 | 1204 | 6977 | 1009 | 7302 | 701 | 8065 | 522 | 4805 |
| 8-#14 | 3.57 | MA | 6187 | 2280 | 10181 | 1627 | 11134 | 1366 | 11733 | 1133 | 12593 | 755 | 15055 | 463 | 11258 |
| 3E | | MI | 3835 | 2280 | 6404 | 1536 | 6831 | 1285 | 7085 | 1059 | 7430 | 688 | 8139 | 285 | 6671 |
| 8-#14 | 3.57 | MA | 6032 | 2280 | 9519 | 1662 | 10276 | 1378 | 10678 | 1143 | 11219 | 780 | 13284 | 373 | 10677 |
| 4L-2S | | MI | 3988 | 2280 | 6883 | 1530 | 7445 | 1263 | 7834 | 1042 | 8443 | 678 | 9343 | 444 | 6639 |
| 8-#18 | 6.35 | MA | 7042 | 2667 | 12121 | 1864 | 13578 | 1549 | 14696 | 1247 | 16615 | 730 | 20360 | 257 | 19078 |
| 3E | | MI | 4263 | 2667 | 7421 | 1755 | 8100 | 1450 | 8619 | 1155 | 9352 | 614 | 10260 | -72 | 10213 |
| 8-#18 | 6.35 | MA | 6788 | 2667 | 10967 | 1923 | 12083 | 1568 | 12859 | 1262 | 14222 | 770 | 17325 | 101 | 16675 |
| 4L-2S | | MI | 4519 | 2667 | 8233 | 1750 | 9142 | 1418 | 9890 | 1131 | 11020 | 596 | 12192 | 209 | 10979 |
| 10-#10 | 2.52 | MA | 6095 | 2133 | 10057 | 1538 | 11031 | 1282 | 11630 | 1076 | 12466 | 752 | 14889 | 646 | 8218 |
| 2L-5S | | MI | 3582 | 2133 | 5671 | 1492 | 5925 | 1252 | 5988 | 1048 | 5946 | 723 | 6575 | 363 | 4834 |
| 10-#10 | 2.52 | MA | 5918 | 2133 | 9553 | 1547 | 10384 | 1290 | 10841 | 1094 | 11392 | 768 | 13403 | 561 | 8226 |
| 3L-4S | | MI | 3665 | 2133 | 5859 | 1487 | 6175 | 1238 | 6300 | 1036 | 6406 | 726 | 7106 | 415 | 4987 |
| 10-#10 | 2.52 | MA | 5823 | 2133 | 9171 | 1568 | 9888 | 1310 | 10231 | 1102 | 10598 | 784 | 12393 | 511 | 8198 |
| 4L-3S | | MI | 3705 | 2133 | 6082 | 1471 | 6463 | 1235 | 6654 | 1035 | 6866 | 718 | 7646 | 458 | 4967 |
| 10-#10 | 2.52 | MA | 5669 | 2133 | 8851 | 1578 | 9462 | 1318 | 9699 | 1120 | 9809 | 789 | 11373 | 466 | 7881 |
| 5L-2S | | MI | 3799 | 2133 | 6367 | 1466 | 6829 | 1221 | 7099 | 1022 | 7472 | 709 | 8407 | 548 | 4944 |
| 10-#11 | 3.10 | MA | 6101 | 2214 | 9997 | 1589 | 10921 | 1319 | 11483 | 1112 | 12258 | 758 | 14596 | 525 | 9911 |
| 3L-4S | | MI | 3751 | 2214 | 6049 | 1524 | 6392 | 1261 | 6553 | 1045 | 6751 | 710 | 7438 | 333 | 5913 |
| 10-#11 | 3.10 | MA | 5990 | 2214 | 9533 | 1614 | 10320 | 1342 | 10744 | 1120 | 11295 | 776 | 13362 | 463 | 9850 |
| 4L-3S | | MI | 3795 | 2214 | 6316 | 1505 | 6737 | 1259 | 6977 | 1046 | 7302 | 702 | 8065 | 383 | 5915 |
| 10-#11 | 3.10 | MA | 5807 | 2214 | 9145 | 1625 | 9803 | 1351 | 10098 | 1141 | 10339 | 781 | 12122 | 405 | 9271 |
| 5L-2S | | MI | 3904 | 2214 | 6655 | 1500 | 7172 | 1243 | 7508 | 1033 | 8024 | 694 | 8941 | 493 | 5889 |
| 10-#14 | 4.46 | MA | 6408 | 2405 | 10386 | 1740 | 11388 | 1434 | 12035 | 1177 | 13065 | 770 | 15841 | 359 | 13263 |
| 4L-3S | | MI | 4031 | 2405 | 6883 | 1614 | 7445 | 1340 | 7834 | 1093 | 8443 | 677 | 9343 | 238 | 8169 |
| 10-#14 | 4.46 | MA | 6152 | 2405 | 9831 | 1755 | 10649 | 1467 | 11111 | 1207 | 11699 | 776 | 14064 | 272 | 12520 |
| 5L-2S | | MI | 4182 | 2405 | 7361 | 1608 | 8059 | 1319 | 8582 | 1076 | 9456 | 667 | 10547 | 396 | 8153 |
| 10-#18 | 7.94 | MA | 7431 | 2889 | 12471 | 2061 | 14010 | 1667 | 15211 | 1322 | 17422 | 752 | 21670 | 68 | 21211 |
| 4L-3S | | MI | 4593 | 2889 | 8233 | 1893 | 9142 | 1549 | 9890 | 1215 | 11020 | 586 | 12192 | -175 | 12042 |
| 12-#10 | 3.02 | MA | 6139 | 2204 | 10057 | 1591 | 11031 | 1322 | 11630 | 1113 | 12466 | 762 | 14889 | 553 | 9798 |
| 3L-5S | | MI | 3702 | 2204 | 5956 | 1536 | 6290 | 1284 | 6434 | 1067 | 6553 | 717 | 7336 | 343 | 5682 |
| 12-#10 | 3.02 | MA | 6044 | 2204 | 9675 | 1612 | 10535 | 1342 | 11021 | 1121 | 11671 | 778 | 13879 | 503 | 9760 |
| 4E | | MI | 3784 | 2204 | 6144 | 1531 | 6541 | 1269 | 6746 | 1055 | 7013 | 720 | 7867 | 395 | 5881 |
| 12-#10 | 3.02 | MA | 5893 | 2204 | 9356 | 1622 | 10108 | 1350 | 10488 | 1139 | 10882 | 783 | 12860 | 459 | 9403 |
| 5L-3S | | MI | 3823 | 2204 | 6367 | 1515 | 6829 | 1266 | 7099 | 1054 | 7472 | 712 | 8407 | 438 | 5868 |
| 12-#10 | 3.02 | MA | 5784 | 2204 | 9030 | 1627 | 9685 | 1370 | 9960 | 1146 | 10173 | 799 | 11939 | 401 | 9107 |
| 6L-2S | | MI | 3916 | 2204 | 6652 | 1510 | 7194 | 1252 | 7545 | 1041 | 8079 | 704 | 9168 | 528 | 5849 |
| 12-#11 | 3.71 | MA | 6255 | 2300 | 10143 | 1668 | 11101 | 1381 | 11697 | 1143 | 12592 | 769 | 15157 | 453 | 11710 |
| 4E | | MI | 3891 | 2300 | 6388 | 1578 | 6827 | 1300 | 7084 | 1069 | 7473 | 703 | 8314 | 304 | 6858 |
| 12-#11 | 3.71 | MA | 6075 | 2300 | 9755 | 1679 | 10584 | 1390 | 11051 | 1165 | 11635 | 774 | 13917 | 395 | 11113 |
| 5L-3S | | MI | 3935 | 2300 | 6655 | 1559 | 7172 | 1298 | 7508 | 1069 | 8024 | 695 | 8941 | 354 | 6985 |
| 12-#11 | 3.71 | MA | 5944 | 2300 | 9367 | 1685 | 10069 | 1413 | 10410 | 1173 | 10774 | 792 | 12791 | 323 | 10666 |
| 6L-2S | | MI | 4043 | 2300 | 6995 | 1554 | 7608 | 1282 | 8039 | 1056 | 8747 | 687 | 9818 | 463 | 6965 |
| 12-#14 | 5.36 | MA | 6530 | 2529 | 10699 | 1833 | 11761 | 1522 | 12469 | 1241 | 13545 | 766 | 16621 | 258 | 15160 |
| 5L-3S | | MI | 4227 | 2529 | 7361 | 1691 | 8059 | 1396 | 8582 | 1127 | 9456 | 666 | 10547 | 191 | 9655 |
| 12-#14 | 5.36 | MA | 6347 | 2529 | 10153 | 1843 | 11025 | 1535 | 11553 | 1251 | 12314 | 791 | 15003 | 154 | 14051 |
| 6L-2S | | MI | 4376 | 2529 | 7840 | 1686 | 8673 | 1375 | 9331 | 1110 | 10470 | 656 | 11751 | 349 | 9659 |
| 14-#10 | 3.53 | MA | 6264 | 2274 | 10180 | 1656 | 11181 | 1373 | 11810 | 1140 | 12745 | 773 | 15366 | 496 | 11322 |
| 4L-5S | | MI | 3821 | 2274 | 6241 | 1580 | 6656 | 1315 | 6880 | 1086 | 7159 | 712 | 8097 | 323 | 6535 |
| 14-#10 | 3.53 | MA | 6116 | 2274 | 9860 | 1666 | 10755 | 1381 | 11277 | 1158 | 11956 | 777 | 14346 | 451 | 10930 |
| 5L-4S | | MI | 3902 | 2274 | 6429 | 1575 | 6906 | 1301 | 7192 | 1074 | 7619 | 715 | 8628 | 375 | 6747 |

## RECTANGULAR TIED COLUMNS 18" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 3.53 | MA | 6009 | 2274 | 9535 | 1671 | 10331 | 1401 | 10749 | 1165 | 11246 | 793 | 13426 | 393 | 10648 |
| 6L-3S | | MI | 3942 | 2274 | 6652 | 1559 | 7194 | 1298 | 7545 | 1073 | 8079 | 706 | 9168 | 418 | 6765 |
| 14-#10 | 3.53 | MA | 5897 | 2274 | 9173 | 1687 | 9909 | 1407 | 10246 | 1184 | 10555 | 809 | 12470 | 356 | 10166 |
| 7L-2S | | MI | 4033 | 2274 | 6937 | 1553 | 7559 | 1284 | 7991 | 1061 | 8685 | 698 | 9930 | 508 | 6750 |
| 14-#11 | 4.33 | MA | 6341 | 2386 | 10364 | 1733 | 11365 | 1429 | 12004 | 1188 | 12932 | 767 | 15712 | 385 | 12959 |
| 5L-4S | | MI | 4031 | 2386 | 6728 | 1632 | 7262 | 1339 | 7615 | 1092 | 8196 | 696 | 9191 | 274 | 7856 |
| 14-#11 | 4.33 | MA | 6214 | 2386 | 9976 | 1739 | 10850 | 1452 | 11363 | 1196 | 12071 | 785 | 14587 | 314 | 12494 |
| 6L-3S | | MI | 4074 | 2386 | 6995 | 1613 | 7608 | 1337 | 8039 | 1093 | 8747 | 688 | 9818 | 324 | 8050 |
| 14-#11 | 4.33 | MA | 6082 | 2386 | 9539 | 1759 | 10349 | 1460 | 10751 | 1218 | 11232 | 804 | 13420 | 265 | 11893 |
| 7L-2S | | MI | 4181 | 2386 | 7334 | 1608 | 8043 | 1321 | 8570 | 1080 | 9469 | 680 | 10694 | 434 | 8036 |
| 14-#14 | 6.25 | MA | 6729 | 2654 | 11021 | 1921 | 12137 | 1591 | 12910 | 1285 | 14161 | 781 | 17560 | 140 | 16677 |
| 6L-3S | | MI | 4422 | 2654 | 7840 | 1769 | 8673 | 1452 | 9331 | 1161 | 10470 | 656 | 11751 | 143 | 11138 |
| 16-#10 | 4.03 | MA | 6337 | 2344 | 10365 | 1710 | 11402 | 1413 | 12066 | 1177 | 13030 | 772 | 15833 | 443 | 12461 |
| 5E | | MI | 3940 | 2344 | 6526 | 1624 | 7021 | 1347 | 7326 | 1105 | 7766 | 706 | 8858 | 303 | 7391 |
| 16-#10 | 4.03 | MA | 6233 | 2344 | 10039 | 1715 | 10978 | 1433 | 11538 | 1185 | 12320 | 788 | 14913 | 385 | 12191 |
| 6L-4S | | MI | 4021 | 2344 | 6714 | 1619 | 7272 | 1332 | 7637 | 1093 | 8225 | 709 | 9389 | 355 | 7588 |
| 16-#10 | 4.03 | MA | 6121 | 2344 | 9678 | 1731 | 10556 | 1438 | 11035 | 1203 | 11629 | 804 | 13956 | 349 | 11697 |
| 7L-3S | | MI | 4059 | 2344 | 6937 | 1602 | 7559 | 1329 | 7991 | 1092 | 8685 | 701 | 9930 | 399 | 7659 |
| 16-#10 | 4.03 | MA | 5996 | 2344 | 9361 | 1738 | 10118 | 1454 | 10539 | 1221 | 10893 | 809 | 12907 | 283 | 11239 |
| 8L-2S | | MI | 4150 | 2344 | 7222 | 1597 | 7925 | 1315 | 8437 | 1080 | 9292 | 693 | 10691 | 488 | 7648 |
| 16-#11 | 4.95 | MA | 6481 | 2473 | 10586 | 1793 | 11631 | 1491 | 12316 | 1220 | 13367 | 779 | 16382 | 304 | 14326 |
| 6L-4S | | MI | 4171 | 2473 | 7068 | 1686 | 7698 | 1378 | 8147 | 1116 | 8918 | 689 | 10067 | 245 | 8860 |
| 16-#11 | 4.95 | MA | 6350 | 2473 | 10148 | 1813 | 11130 | 1498 | 11704 | 1241 | 12528 | 797 | 15216 | 256 | 13745 |
| 7L-3S | | MI | 4213 | 2473 | 7334 | 1667 | 8043 | 1375 | 8570 | 1116 | 9469 | 681 | 10694 | 295 | 9109 |
| 18-#10 | 4.54 | MA | 6455 | 2415 | 10544 | 1759 | 11625 | 1464 | 12328 | 1204 | 13394 | 782 | 16399 | 378 | 13737 |
| 6L-5S | | MI | 4058 | 2415 | 6811 | 1668 | 7387 | 1378 | 7771 | 1124 | 8372 | 700 | 9619 | 283 | 8250 |
| 18-#10 | 4.54 | MA | 6344 | 2415 | 10183 | 1775 | 11203 | 1470 | 11824 | 1222 | 12703 | 798 | 15443 | 341 | 13231 |
| 7L-4S | | MI | 4138 | 2415 | 6999 | 1663 | 7637 | 1364 | 8083 | 1112 | 8832 | 703 | 10150 | 335 | 8433 |
| 18-#10 | 4.54 | MA | 6221 | 2415 | 9866 | 1782 | 10765 | 1486 | 11328 | 1240 | 11967 | 803 | 14394 | 275 | 12768 |
| 8L-3S | | MI | 4177 | 2415 | 7222 | 1646 | 7925 | 1361 | 8437 | 1111 | 9292 | 695 | 10691 | 379 | 8550 |
| 18-#11 | 5.57 | MA | 6617 | 2559 | 10757 | 1867 | 11911 | 1537 | 12657 | 1265 | 13825 | 790 | 17011 | 246 | 15601 |
| 7L-4S | | MI | 4310 | 2559 | 7407 | 1739 | 8133 | 1416 | 8678 | 1139 | 9641 | 682 | 10943 | 216 | 9869 |
| 20-#10 | 5.04 | MA | 6565 | 2485 | 10687 | 1819 | 11850 | 1501 | 12613 | 1241 | 13776 | 793 | 16930 | 333 | 14767 |
| 7L-5S | | MI | 4176 | 2485 | 7096 | 1712 | 7752 | 1410 | 8217 | 1144 | 8979 | 695 | 10381 | 263 | 9111 |
| 20-#10 | 5.04 | MA | 6444 | 2485 | 10370 | 1825 | 11412 | 1517 | 12117 | 1259 | 13040 | 797 | 15881 | 267 | 14300 |
| 8L-4S | | MI | 4256 | 2485 | 7284 | 1707 | 8002 | 1395 | 8529 | 1131 | 9438 | 698 | 10911 | 316 | 9282 |
| 22-#10 | 5.54 | MA | 6666 | 2555 | 10875 | 1869 | 12059 | 1549 | 12907 | 1278 | 14114 | 792 | 17367 | 259 | 15833 |
| 8L-5S | | MI | 4294 | 2555 | 7381 | 1755 | 8117 | 1441 | 8663 | 1163 | 9585 | 689 | 11142 | 243 | 9973 |

## RECTANGULAR TIED COLUMNS 18" x 30"

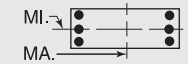
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.16 | MA | 6315 | 2082 | 9978 | 1519 | 10650 | 1281 | 10895 | 1097 | 10968 | 822 | 12464 | 714 | 4486 |
| 2E | | MI | 3717 | 2082 | 5991 | 1426 | 6223 | 1202 | 6261 | 1027 | 6172 | 766 | 6637 | 626 | 2621 |
| 4-#14 | 1.67 | MA | 6556 | 2158 | 10562 | 1560 | 11375 | 1309 | 11768 | 1112 | 12150 | 811 | 14096 | 702 | 6312 |
| 2E | | MI | 3828 | 2158 | 6280 | 1462 | 6574 | 1226 | 6682 | 1039 | 6730 | 751 | 7259 | 583 | 3594 |
| 4-#18 | 2.96 | MA | 7139 | 2352 | 11993 | 1666 | 13160 | 1384 | 13926 | 1154 | 15074 | 787 | 18135 | 673 | 10782 |
| 2E | | MI | 4093 | 2352 | 6965 | 1558 | 7415 | 1292 | 7693 | 1074 | 7994 | 703 | 8647 | 460 | 5885 |
| 6-#9 | 1.11 | MA | 6312 | 2075 | 9916 | 1529 | 10618 | 1290 | 10876 | 1105 | 10954 | 830 | 12454 | 722 | 4353 |
| 2L-3S | | MI | 3644 | 2075 | 5742 | 1449 | 5943 | 1230 | 5935 | 1053 | 5734 | 788 | 6173 | 582 | 2560 |
| 6-#9 | 1.11 | MA | 6148 | 2075 | 9481 | 1537 | 10061 | 1297 | 10197 | 1120 | 10030 | 844 | 11174 | 657 | 4375 |
| 3L-2S | | MI | 3722 | 2075 | 5969 | 1445 | 6234 | 1218 | 6290 | 1043 | 6216 | 781 | 6786 | 653 | 2540 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis

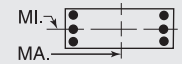



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 1.41 | MA | 6461 | 2120 | 10269 | 1553 | 11058 | 1307 | 11407 | 1115 | 11673 | 825 | 13447 | 715 | 5452 |
| 2L-3S | | MI | 3696 | 2120 | 5865 | 1472 | 6090 | 1248 | 6110 | 1062 | 5970 | 782 | 6453 | 544 | 3164 |
| 6-#10 | 1.41 | MA | 6257 | 2120 | 9720 | 1563 | 10355 | 1316 | 10549 | 1134 | 10506 | 841 | 11831 | 632 | 5477 |
| 3L-2S | | MI | 3793 | 2120 | 6150 | 1467 | 6455 | 1233 | 6556 | 1050 | 6577 | 773 | 7214 | 634 | 3135 |
| 6-#11 | 1.73 | MA | 6604 | 2168 | 10641 | 1573 | 11501 | 1320 | 11932 | 1120 | 12379 | 815 | 14418 | 704 | 6587 |
| 2L-3S | | MI | 3743 | 2168 | 5991 | 1485 | 6223 | 1257 | 6261 | 1064 | 6172 | 767 | 6637 | 487 | 3779 |
| 6-#11 | 1.73 | MA | 6363 | 2168 | 9978 | 1585 | 10650 | 1330 | 10895 | 1143 | 10968 | 834 | 12464 | 600 | 6614 |
| 3L-2S | | MI | 3856 | 2168 | 6330 | 1480 | 6658 | 1241 | 6792 | 1051 | 6894 | 760 | 7514 | 597 | 3739 |
| 6-#14 | 2.50 | MA | 6963 | 2283 | 11508 | 1638 | 12587 | 1365 | 13247 | 1146 | 14162 | 801 | 16882 | 688 | 9291 |
| 2L-3S | | MI | 3867 | 2283 | 6280 | 1545 | 6574 | 1303 | 6682 | 1090 | 6730 | 750 | 7259 | 378 | 5201 |
| 6-#14 | 2.50 | MA | 6629 | 2283 | 10562 | 1654 | 11375 | 1379 | 11768 | 1177 | 12150 | 828 | 14096 | 535 | 9296 |
| 3L-2S | | MI | 4023 | 2283 | 6759 | 1539 | 7188 | 1282 | 7430 | 1073 | 7744 | 740 | 8463 | 536 | 5148 |
| 6-#18 | 4.44 | MA | 7830 | 2573 | 13635 | 1805 | 15265 | 1483 | 16494 | 1214 | 18568 | 769 | 22972 | 648 | 15923 |
| 2L-3S | | MI | 4161 | 2573 | 6965 | 1702 | 7415 | 1423 | 7693 | 1158 | 7994 | 693 | 8647 | 75 | 8439 |
| 6-#18 | 4.44 | MA | 7278 | 2573 | 11993 | 1831 | 13160 | 1540 | 13926 | 1267 | 15074 | 813 | 18135 | 366 | 15744 |
| 3L-2S | | MI | 4420 | 2573 | 7777 | 1697 | 8456 | 1391 | 8963 | 1134 | 9662 | 675 | 10579 | 357 | 8475 |
| 8-#8 | 1.17 | MA | 6348 | 2084 | 9982 | 1538 | 10715 | 1297 | 11000 | 1110 | 11125 | 832 | 12694 | 722 | 4581 |
| 2L-4S | | MI | 3652 | 2084 | 5684 | 1470 | 5877 | 1239 | 5857 | 1059 | 5642 | 795 | 6095 | 573 | 2699 |
| 8-#8 | 1.17 | MA | 6218 | 2084 | 9638 | 1544 | 10273 | 1303 | 10461 | 1122 | 10391 | 842 | 11678 | 672 | 4597 |
| 3E | | MI | 3679 | 2084 | 5825 | 1460 | 6059 | 1237 | 6080 | 1057 | 5933 | 789 | 6445 | 601 | 2678 |
| 8-#8 | 1.17 | MA | 6148 | 2084 | 9378 | 1558 | 9936 | 1316 | 10046 | 1127 | 9851 | 853 | 10999 | 642 | 4613 |
| 4L-2S | | MI | 3741 | 2084 | 6006 | 1456 | 6291 | 1227 | 6363 | 1049 | 6318 | 783 | 6939 | 656 | 2662 |
| 8-#9 | 1.48 | MA | 6504 | 2131 | 10350 | 1564 | 11175 | 1315 | 11556 | 1120 | 11878 | 826 | 13734 | 716 | 5726 |
| 2L-4S | | MI | 3706 | 2131 | 5792 | 1497 | 6005 | 1258 | 6009 | 1069 | 5851 | 790 | 6352 | 533 | 3331 |
| 8-#9 | 1.48 | MA | 6343 | 2131 | 9916 | 1572 | 10618 | 1322 | 10876 | 1135 | 10954 | 839 | 12454 | 651 | 5744 |
| 3E | | MI | 3739 | 2131 | 5969 | 1484 | 6234 | 1255 | 6290 | 1068 | 6216 | 783 | 6786 | 568 | 3303 |
| 8-#9 | 1.48 | MA | 6256 | 2131 | 9588 | 1589 | 10193 | 1338 | 10353 | 1142 | 10273 | 853 | 11596 | 613 | 5754 |
| 4L-2S | | MI | 3816 | 2131 | 6195 | 1480 | 6524 | 1243 | 6645 | 1058 | 6699 | 776 | 7399 | 638 | 3282 |
| 8-#10 | 1.88 | MA | 6701 | 2191 | 10817 | 1597 | 11761 | 1339 | 12265 | 1134 | 12840 | 819 | 15063 | 707 | 7181 |
| 2L-4S | | MI | 3775 | 2191 | 5927 | 1532 | 6167 | 1282 | 6202 | 1083 | 6117 | 784 | 6673 | 481 | 4118 |
| 8-#10 | 1.88 | MA | 6502 | 2191 | 10269 | 1607 | 11058 | 1348 | 11407 | 1153 | 11673 | 836 | 13447 | 624 | 7197 |
| 3E | | MI | 3815 | 2191 | 6150 | 1516 | 6455 | 1279 | 6556 | 1082 | 6577 | 776 | 7214 | 524 | 4087 |
| 8-#10 | 1.88 | MA | 6394 | 2191 | 9855 | 1629 | 10520 | 1368 | 10746 | 1161 | 10812 | 853 | 12360 | 575 | 7184 |
| 4L-2S | | MI | 3911 | 2191 | 6435 | 1511 | 6821 | 1265 | 7001 | 1069 | 7183 | 768 | 7975 | 614 | 4059 |
| 8-#11 | 2.31 | MA | 6891 | 2255 | 11304 | 1627 | 12351 | 1359 | 12970 | 1144 | 13790 | 808 | 16372 | 695 | 8674 |
| 2L-4S | | MI | 3838 | 2255 | 6063 | 1558 | 6313 | 1298 | 6369 | 1087 | 6343 | 768 | 6887 | 408 | 4905 |
| 8-#11 | 2.31 | MA | 6656 | 2255 | 10641 | 1639 | 11501 | 1369 | 11932 | 1166 | 12379 | 827 | 14418 | 591 | 8689 |
| 3E | | MI | 3884 | 2255 | 6330 | 1539 | 6658 | 1295 | 6792 | 1088 | 6894 | 761 | 7514 | 458 | 4872 |
| 8-#11 | 2.31 | MA | 6529 | 2255 | 10139 | 1665 | 10848 | 1393 | 11131 | 1175 | 11334 | 847 | 13089 | 529 | 8643 |
| 4L-2S | | MI | 3995 | 2255 | 6670 | 1534 | 7094 | 1279 | 7323 | 1074 | 7617 | 753 | 8390 | 568 | 4837 |
| 8-#14 | 3.33 | MA | 7043 | 2407 | 11508 | 1732 | 12587 | 1435 | 13247 | 1211 | 14162 | 818 | 16882 | 521 | 12230 |
| 3E | | MI | 4064 | 2407 | 6759 | 1623 | 7188 | 1359 | 7430 | 1124 | 7744 | 740 | 8463 | 330 | 6716 |
| 8-#14 | 3.33 | MA | 6867 | 2407 | 10789 | 1768 | 11655 | 1469 | 12101 | 1223 | 12669 | 845 | 14973 | 432 | 11732 |
| 4L-2S | | MI | 4218 | 2407 | 7238 | 1617 | 7802 | 1337 | 8179 | 1107 | 8757 | 730 | 9667 | 489 | 6679 |
| 8-#18 | 5.93 | MA | 7986 | 2795 | 13635 | 1969 | 15265 | 1640 | 16494 | 1327 | 18568 | 795 | 22972 | 342 | 20806 |
| 3E | | MI | 4492 | 2795 | 7777 | 1840 | 8456 | 1523 | 8963 | 1218 | 9662 | 665 | 10579 | -28 | 10562 |
| 8-#18 | 5.93 | MA | 7698 | 2795 | 12380 | 2031 | 13638 | 1661 | 14495 | 1344 | 15965 | 838 | 19607 | 180 | 18342 |
| 4L-2S | | MI | 4746 | 2795 | 8589 | 1835 | 9497 | 1491 | 10233 | 1194 | 11330 | 647 | 12511 | 254 | 11035 |
| 10-#10 | 2.35 | MA | 6940 | 2261 | 11366 | 1641 | 12464 | 1370 | 13123 | 1153 | 14007 | 813 | 16679 | 699 | 8903 |
| 2L-5S | | MI | 3811 | 2261 | 6024 | 1581 | 6282 | 1328 | 6336 | 1114 | 6264 | 776 | 6904 | 409 | 4924 |
| 10-#10 | 2.35 | MA | 6745 | 2261 | 10817 | 1651 | 11761 | 1379 | 12265 | 1172 | 12840 | 830 | 15063 | 617 | 8912 |
| 3L-4S | | MI | 3894 | 2261 | 6212 | 1576 | 6533 | 1314 | 6648 | 1102 | 6723 | 779 | 7434 | 461 | 5020 |
| 10-#10 | 2.35 | MA | 6638 | 2261 | 10403 | 1673 | 11223 | 1399 | 11604 | 1180 | 11979 | 847 | 13976 | 567 | 8884 |
| 4L-3S | | MI | 3934 | 2261 | 6435 | 1560 | 6821 | 1311 | 7001 | 1101 | 7183 | 770 | 7975 | 504 | 4997 |
| 10-#10 | 2.35 | MA | 6470 | 2261 | 10058 | 1683 | 10762 | 1408 | 11027 | 1199 | 11124 | 853 | 12875 | 525 | 8601 |
| 5L-2S | | MI | 4028 | 2261 | 6720 | 1555 | 7186 | 1296 | 7447 | 1089 | 7789 | 762 | 8736 | 594 | 4972 |
| 10-#11 | 2.89 | MA | 6947 | 2341 | 11304 | 1693 | 12351 | 1408 | 12970 | 1190 | 13790 | 820 | 16372 | 581 | 10754 |
| 3L-4S | | MI | 3980 | 2341 | 6403 | 1612 | 6749 | 1336 | 6900 | 1111 | 7066 | 762 | 7763 | 379 | 5973 |

## RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

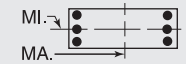
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.89 | MA | 6822 | 2341 | 10802 | 1719 | 11699 | 1432 | 12168 | 1198 | 12746 | 840 | 15043 | 520 | 10692 |
| 4L-3S | | MI | 4024 | 2341 | 6670 | 1593 | 7094 | 1334 | 7323 | 1111 | 7617 | 754 | 8390 | 428 | 5952 |
| 10-#11 | 2.89 | MA | 6621 | 2341 | 10382 | 1730 | 11138 | 1442 | 11467 | 1221 | 11708 | 846 | 13702 | 465 | 10126 |
| 5L-2S | | MI | 4134 | 2341 | 7009 | 1588 | 7529 | 1318 | 7854 | 1098 | 8339 | 746 | 9267 | 538 | 5923 |
| 10-#14 | 4.17 | MA | 7281 | 2532 | 11735 | 1846 | 12867 | 1525 | 13580 | 1257 | 14681 | 835 | 17759 | 418 | 14557 |
| 4L-3S | | MI | 4260 | 2532 | 7238 | 1701 | 7802 | 1415 | 8179 | 1158 | 8757 | 729 | 9667 | 283 | 8220 |
| 10-#14 | 4.17 | MA | 6999 | 2532 | 11134 | 1862 | 12065 | 1539 | 12578 | 1288 | 13198 | 842 | 15837 | 335 | 13687 |
| 5L-2S | | MI | 4412 | 2532 | 7716 | 1695 | 8415 | 1393 | 8928 | 1141 | 9770 | 719 | 10871 | 441 | 8195 |
| 10-#18 | 7.41 | MA | 8405 | 3016 | 14022 | 2169 | 15743 | 1761 | 17063 | 1404 | 19459 | 821 | 24444 | 156 | 23307 |
| 4L-3S | | MI | 4822 | 3016 | 8589 | 1978 | 9497 | 1622 | 10233 | 1279 | 11330 | 637 | 12511 | -131 | 12404 |
| 10-#18 | 7.41 | MA | 7928 | 3016 | 12969 | 2195 | 14341 | 1818 | 15311 | 1457 | 16868 | 829 | 21073 | -3 | 21066 |
| 5L-2S | | MI | 5072 | 3016 | 9402 | 1973 | 10538 | 1590 | 11503 | 1255 | 12998 | 619 | 14443 | 151 | 13579 |
| 12-#10 | 2.82 | MA | 6987 | 2331 | 11366 | 1695 | 12464 | 1411 | 13123 | 1191 | 14007 | 825 | 16679 | 609 | 10621 |
| 3L-5S | | MI | 3931 | 2331 | 6309 | 1625 | 6648 | 1359 | 6782 | 1133 | 6870 | 770 | 7665 | 389 | 5754 |
| 12-#10 | 2.82 | MA | 6881 | 2331 | 10952 | 1717 | 11927 | 1431 | 12462 | 1199 | 13146 | 841 | 15592 | 560 | 10583 |
| 4E | | MI | 4013 | 2331 | 6497 | 1620 | 6898 | 1345 | 7094 | 1121 | 7330 | 773 | 8195 | 441 | 5917 |
| 12-#10 | 2.82 | MA | 6715 | 2331 | 10606 | 1727 | 11465 | 1440 | 11885 | 1218 | 12292 | 847 | 14491 | 517 | 10257 |
| 5L-3S | | MI | 4053 | 2331 | 6720 | 1604 | 7186 | 1342 | 7447 | 1120 | 7789 | 765 | 8736 | 485 | 5900 |
| 12-#10 | 2.82 | MA | 6596 | 2331 | 10248 | 1731 | 11007 | 1460 | 11314 | 1226 | 11524 | 864 | 13501 | 460 | 9913 |
| 6L-2S | | MI | 4146 | 2331 | 7005 | 1599 | 7551 | 1328 | 7893 | 1108 | 8396 | 756 | 9497 | 574 | 5880 |
| 12-#11 | 3.47 | MA | 7113 | 2427 | 11465 | 1772 | 12549 | 1471 | 13205 | 1222 | 14157 | 833 | 16997 | 510 | 12741 |
| 4E | | MI | 4120 | 2427 | 6742 | 1665 | 7184 | 1375 | 7431 | 1134 | 7788 | 755 | 8640 | 349 | 6952 |
| 12-#11 | 3.47 | MA | 6915 | 2427 | 11045 | 1784 | 11989 | 1481 | 12505 | 1245 | 13120 | 839 | 15656 | 455 | 12133 |
| 5L-3S | | MI | 4164 | 2427 | 7009 | 1647 | 7529 | 1373 | 7854 | 1135 | 8339 | 747 | 9267 | 399 | 7024 |
| 12-#11 | 3.47 | MA | 6772 | 2427 | 10618 | 1790 | 11431 | 1505 | 11811 | 1253 | 12187 | 858 | 14446 | 384 | 11724 |
| 6L-2S | | MI | 4272 | 2427 | 7349 | 1642 | 7964 | 1357 | 8385 | 1121 | 9062 | 739 | 10143 | 509 | 7002 |
| 12-#14 | 5.00 | MA | 7415 | 2656 | 12079 | 1940 | 13278 | 1595 | 14057 | 1322 | 15210 | 832 | 18623 | 322 | 16569 |
| 5L-3S | | MI | 4456 | 2656 | 7716 | 1779 | 8415 | 1471 | 8928 | 1192 | 9770 | 718 | 10871 | 236 | 9710 |
| 12-#14 | 5.00 | MA | 7214 | 2656 | 11476 | 1949 | 12480 | 1628 | 13064 | 1334 | 13876 | 859 | 16882 | 219 | 15447 |
| 6L-2S | | MI | 4606 | 2656 | 8195 | 1773 | 9029 | 1449 | 9677 | 1175 | 10783 | 708 | 12075 | 394 | 9704 |
| 14-#10 | 3.29 | MA | 7122 | 2401 | 11500 | 1760 | 12630 | 1462 | 13320 | 1218 | 14313 | 836 | 17208 | 552 | 12282 |
| 4L-5S | | MI | 4050 | 2401 | 6594 | 1669 | 7013 | 1391 | 7228 | 1152 | 7477 | 764 | 8426 | 369 | 6607 |
| 14-#10 | 3.29 | MA | 6959 | 2401 | 11155 | 1771 | 12169 | 1471 | 12743 | 1237 | 13459 | 841 | 16107 | 509 | 11919 |
| 5L-4S | | MI | 4132 | 2401 | 6782 | 1664 | 7263 | 1377 | 7540 | 1140 | 7936 | 767 | 8957 | 421 | 6809 |
| 14-#10 | 3.29 | MA | 6842 | 2401 | 10797 | 1775 | 11710 | 1492 | 12172 | 1245 | 12691 | 858 | 15117 | 452 | 11590 |
| 6L-3S | | MI | 4171 | 2401 | 7005 | 1648 | 7551 | 1374 | 7893 | 1139 | 8396 | 759 | 9497 | 465 | 6799 |
| 14-#10 | 3.29 | MA | 6717 | 2401 | 10405 | 1792 | 11245 | 1497 | 11627 | 1264 | 11943 | 875 | 13957 | 402 | 11122 |
| 7L-2S | | MI | 4263 | 2401 | 7290 | 1642 | 7917 | 1359 | 8339 | 1127 | 9002 | 751 | 10258 | 554 | 6783 |
| 14-#11 | 4.04 | MA | 7207 | 2514 | 11708 | 1838 | 12839 | 1520 | 13542 | 1268 | 14531 | 832 | 17611 | 446 | 14146 |
| 5L-4S | | MI | 4260 | 2514 | 7082 | 1719 | 7619 | 1414 | 7962 | 1158 | 8511 | 748 | 9516 | 320 | 7948 |
| 14-#11 | 4.04 | MA | 7068 | 2514 | 11281 | 1844 | 12281 | 1544 | 12848 | 1277 | 13598 | 851 | 16400 | 375 | 13719 |
| 6L-3S | | MI | 4303 | 2514 | 7349 | 1701 | 7964 | 1412 | 8385 | 1158 | 9062 | 740 | 10143 | 370 | 8092 |
| 14-#11 | 4.04 | MA | 6920 | 2514 | 10806 | 1865 | 11727 | 1551 | 12186 | 1299 | 12689 | 871 | 15142 | 329 | 13021 |
| 7L-2S | | MI | 4411 | 2514 | 7689 | 1696 | 8400 | 1396 | 8917 | 1145 | 9785 | 732 | 11020 | 480 | 8075 |
| 14-#14 | 5.83 | MA | 7633 | 2781 | 12421 | 2027 | 13692 | 1684 | 14543 | 1368 | 15888 | 849 | 19668 | 205 | 18318 |
| 6L-3S | | MI | 4651 | 2781 | 8195 | 1856 | 9029 | 1526 | 9677 | 1226 | 10783 | 707 | 12075 | 188 | 11195 |
| 16-#10 | 3.76 | MA | 7201 | 2472 | 11703 | 1815 | 12872 | 1503 | 13601 | 1256 | 14626 | 836 | 17723 | 502 | 13585 |
| 5E | | MI | 4169 | 2472 | 6879 | 1713 | 7378 | 1423 | 7673 | 1171 | 8083 | 759 | 9187 | 349 | 7462 |
| 16-#10 | 3.76 | MA | 7087 | 2472 | 11345 | 1819 | 12413 | 1523 | 13030 | 1264 | 13858 | 853 | 16733 | 444 | 13270 |
| 6L-4S | | MI | 4250 | 2472 | 7067 | 1708 | 7629 | 1408 | 7985 | 1159 | 8543 | 762 | 9718 | 402 | 7669 |
| 16-#10 | 3.76 | MA | 6962 | 2472 | 10953 | 1836 | 11949 | 1529 | 12485 | 1283 | 13110 | 869 | 15573 | 394 | 12790 |
| 7L-3S | | MI | 4289 | 2472 | 7290 | 1691 | 7917 | 1405 | 8339 | 1158 | 9002 | 753 | 10258 | 445 | 7695 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

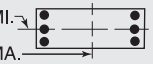
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 3.76 | MA | 6825 | 2472 | 10610 | 1843 | 11474 | 1545 | 11918 | 1289 | 12313 | 875 | 14570 | 346 | 12347 |
| 8L-2S | | MI | 4380 | 2472 | 7575 | 1686 | 8282 | 1391 | 8784 | 1146 | 9609 | 745 | 11019 | 534 | 7682 |
| 16-#11 | 4.62 | MA | 7361 | 2600 | 11944 | 1898 | 13132 | 1582 | 13885 | 1300 | 15009 | 844 | 18354 | 365 | 15720 |
| 6L-4S | | MI | 4400 | 2600 | 7422 | 1773 | 8054 | 1452 | 8493 | 1181 | 9234 | 741 | 10393 | 291 | 8952 |
| 16-#11 | 4.62 | MA | 7215 | 2600 | 11469 | 1919 | 12578 | 1589 | 13223 | 1323 | 14100 | 864 | 17096 | 320 | 15042 |
| 7L-3S | | MI | 4442 | 2600 | 7689 | 1755 | 8400 | 1450 | 8917 | 1182 | 9785 | 733 | 11020 | 341 | 9156 |
| 18-#10 | 4.23 | MA | 7330 | 2542 | 11894 | 1863 | 13116 | 1555 | 13888 | 1283 | 15025 | 847 | 18349 | 437 | 14952 |
| 6L-5S | | MI | 4287 | 2542 | 7164 | 1757 | 7744 | 1454 | 8119 | 1191 | 8689 | 753 | 9948 | 329 | 8321 |
| 18-#10 | 4.23 | MA | 7206 | 2542 | 11502 | 1880 | 12652 | 1560 | 13343 | 1302 | 14277 | 864 | 17189 | 387 | 14460 |
| 7L-4S | | MI | 4368 | 2542 | 7352 | 1752 | 7994 | 1440 | 8431 | 1178 | 9149 | 756 | 10479 | 382 | 8514 |
| 18-#10 | 4.23 | MA | 7072 | 2542 | 11159 | 1887 | 12177 | 1577 | 12776 | 1308 | 13480 | 869 | 16186 | 338 | 14014 |
| 8L-3S | | MI | 4406 | 2542 | 7575 | 1735 | 8282 | 1437 | 8784 | 1177 | 9609 | 748 | 11019 | 425 | 8588 |
| 18-#11 | 5.20 | MA | 7507 | 2686 | 12132 | 1973 | 13428 | 1628 | 14260 | 1346 | 15512 | 857 | 19050 | 310 | 17065 |
| 7L-4S | | MI | 4539 | 2686 | 7761 | 1827 | 8490 | 1491 | 9024 | 1205 | 9956 | 734 | 11269 | 262 | 9960 |
| 20-#10 | 4.70 | MA | 7449 | 2612 | 12050 | 1924 | 13355 | 1592 | 14201 | 1322 | 15444 | 858 | 18805 | 379 | 16133 |
| 7L-5S | | MI | 4406 | 2612 | 7449 | 1801 | 8109 | 1486 | 8565 | 1210 | 9296 | 748 | 10709 | 309 | 9182 |
| 20-#10 | 4.70 | MA | 7316 | 2612 | 11707 | 1931 | 12880 | 1608 | 13634 | 1328 | 14648 | 864 | 17802 | 331 | 15684 |
| 8L-4S | | MI | 4485 | 2612 | 7637 | 1796 | 8360 | 1471 | 8877 | 1198 | 9756 | 750 | 11240 | 362 | 9362 |
| 22-#10 | 5.17 | MA | 7560 | 2682 | 12256 | 1975 | 13584 | 1640 | 14492 | 1347 | 15815 | 858 | 19418 | 323 | 17356 |
| 8L-5S | | MI | 4524 | 2682 | 7734 | 1845 | 8475 | 1517 | 9011 | 1229 | 9902 | 742 | 11470 | 290 | 10044 |

## RECTANGULAR TIED COLUMNS 18" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.08 | MA | 7157 | 2209 | 11250 | 1623 | 12020 | 1370 | 12292 | 1174 | 12346 | 883 | 14003 | 768 | 4823 |
| 2E | | MI | 3946 | 2209 | 6345 | 1514 | 6580 | 1277 | 6608 | 1093 | 6487 | 818 | 6963 | 672 | 2644 |
| 4-#14 | 1.56 | MA | 7421 | 2286 | 11884 | 1663 | 12807 | 1398 | 13240 | 1189 | 13628 | 872 | 15774 | 755 | 6798 |
| 2E | | MI | 4058 | 2286 | 6635 | 1549 | 6931 | 1300 | 7027 | 1104 | 7044 | 803 | 7582 | 629 | 3624 |
| 4-#18 | 2.78 | MA | 8060 | 2479 | 13440 | 1770 | 14748 | 1472 | 15586 | 1231 | 16808 | 848 | 20167 | 726 | 11646 |
| 2E | | MI | 4322 | 2479 | 7321 | 1644 | 7770 | 1365 | 8036 | 1137 | 8304 | 753 | 8966 | 504 | 5928 |
| 6-#9 | 1.04 | MA | 7152 | 2203 | 11179 | 1632 | 11981 | 1378 | 12267 | 1182 | 12325 | 891 | 13985 | 775 | 4677 |
| 2L-3S | | MI | 3873 | 2203 | 6094 | 1539 | 6300 | 1306 | 6283 | 1119 | 6051 | 840 | 6503 | 629 | 2578 |
| 6-#9 | 1.04 | MA | 6974 | 2203 | 10710 | 1641 | 11380 | 1386 | 11534 | 1198 | 11327 | 906 | 12604 | 712 | 4699 |
| 3L-2S | | MI | 3951 | 2203 | 6321 | 1534 | 6591 | 1295 | 6638 | 1109 | 6534 | 833 | 7116 | 699 | 2559 |
| 6-#10 | 1.32 | MA | 7315 | 2248 | 11562 | 1657 | 12457 | 1395 | 12842 | 1191 | 13103 | 886 | 15060 | 769 | 5864 |
| 2L-3S | | MI | 3925 | 2248 | 6218 | 1561 | 6447 | 1324 | 6458 | 1129 | 6287 | 834 | 6781 | 590 | 3186 |
| 6-#10 | 1.32 | MA | 7092 | 2248 | 10969 | 1667 | 11698 | 1405 | 11915 | 1211 | 11843 | 903 | 13315 | 687 | 5888 |
| 3L-2S | | MI | 4022 | 2248 | 6503 | 1556 | 6812 | 1309 | 6904 | 1116 | 6894 | 826 | 7542 | 680 | 3157 |
| 6-#11 | 1.63 | MA | 7473 | 2296 | 11967 | 1677 | 12940 | 1408 | 13414 | 1197 | 13872 | 876 | 16116 | 758 | 7092 |
| 2L-3S | | MI | 3973 | 2296 | 6345 | 1573 | 6580 | 1332 | 6608 | 1129 | 6487 | 819 | 6963 | 533 | 3806 |
| 6-#11 | 1.63 | MA | 7208 | 2296 | 11250 | 1689 | 12020 | 1419 | 12292 | 1220 | 12346 | 896 | 14003 | 656 | 7119 |
| 3L-2S | | MI | 4085 | 2296 | 6684 | 1568 | 7015 | 1316 | 7139 | 1116 | 7209 | 812 | 7840 | 642 | 3767 |
| 6-#14 | 2.34 | MA | 7865 | 2410 | 12908 | 1741 | 14119 | 1454 | 14840 | 1223 | 15806 | 862 | 18789 | 742 | 10020 |
| 2L-3S | | MI | 4096 | 2410 | 6635 | 1632 | 6931 | 1377 | 7027 | 1155 | 7044 | 802 | 7582 | 423 | 5238 |
| 6-#14 | 2.34 | MA | 7498 | 2410 | 11884 | 1758 | 12807 | 1469 | 13240 | 1256 | 13628 | 891 | 15774 | 592 | 10025 |
| 3L-2S | | MI | 4253 | 2410 | 7114 | 1627 | 7544 | 1356 | 7776 | 1138 | 8057 | 792 | 8786 | 581 | 5183 |
| 6-#18 | 4.17 | MA | 8814 | 2701 | 15220 | 1908 | 17031 | 1571 | 18370 | 1291 | 20596 | 831 | 25412 | 702 | 17219 |
| 2L-3S | | MI | 4390 | 2701 | 7321 | 1787 | 7770 | 1496 | 8036 | 1222 | 8304 | 743 | 8966 | 119 | 8561 |
| 6-#18 | 4.17 | MA | 8209 | 2701 | 13440 | 1936 | 14748 | 1595 | 15586 | 1346 | 16808 | 877 | 20167 | 427 | 17040 |
| 3L-2S | | MI | 4649 | 2701 | 8133 | 1782 | 8811 | 1464 | 9306 | 1198 | 9973 | 726 | 10898 | 401 | 8525 |
| 8-#8 | 1.10 | MA | 7191 | 2212 | 11251 | 1641 | 12085 | 1385 | 12400 | 1187 | 12509 | 893 | 14242 | 776 | 4923 |
| 2L-4S | | MI | 3881 | 2212 | 6036 | 1560 | 6234 | 1316 | 6206 | 1125 | 5961 | 848 | 6426 | 619 | 2717 |
| 8-#8 | 1.10 | MA | 7050 | 2212 | 10879 | 1648 | 11608 | 1391 | 11818 | 1199 | 11717 | 904 | 13145 | 727 | 4939 |
| 3E | | MI | 3908 | 2212 | 6177 | 1549 | 6416 | 1313 | 6429 | 1124 | 6252 | 842 | 6775 | 647 | 2696 |
| 8-#8 | 1.10 | MA | 6972 | 2212 | 10599 | 1662 | 11245 | 1405 | 11371 | 1205 | 11135 | 915 | 12419 | 697 | 4955 |
| 4L-2S | | MI | 3970 | 2212 | 6358 | 1546 | 6648 | 1304 | 6712 | 1116 | 6637 | 836 | 7270 | 703 | 2681 |

## RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis



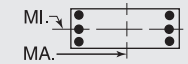

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.39 | MA | 7361 | 2258 | 11648 | 1667 | 12582 | 1403 | 13001 | 1197 | 13323 | 887 | 15367 | 769 | 6158 |
| 2L-4S | | MI | 3935 | 2258 | 6144 | 1586 | 6362 | 1334 | 6357 | 1135 | 6169 | 843 | 6682 | 579 | 3353 |
| 8-#9 | 1.39 | MA | 7186 | 2258 | 11179 | 1676 | 11981 | 1411 | 12267 | 1213 | 12325 | 901 | 13985 | 706 | 6176 |
| 3E | | MI | 3968 | 2258 | 6321 | 1573 | 6591 | 1331 | 6638 | 1134 | 6534 | 836 | 7116 | 614 | 3325 |
| 8-#9 | 1.39 | MA | 7089 | 2258 | 10827 | 1693 | 11523 | 1427 | 11704 | 1220 | 11591 | 915 | 13067 | 668 | 6186 |
| 4L-2S | | MI | 4045 | 2258 | 6548 | 1569 | 6882 | 1320 | 6993 | 1124 | 7017 | 829 | 7729 | 685 | 3304 |
| 8-#10 | 1.76 | MA | 7577 | 2318 | 12154 | 1701 | 13217 | 1427 | 13768 | 1211 | 14364 | 880 | 16805 | 761 | 7730 |
| 2L-4S | | MI | 4004 | 2318 | 6280 | 1621 | 6525 | 1358 | 6550 | 1149 | 6434 | 837 | 7002 | 527 | 4146 |
| 8-#10 | 1.76 | MA | 7359 | 2318 | 11562 | 1711 | 12457 | 1436 | 12842 | 1230 | 13103 | 898 | 15060 | 680 | 7746 |
| 3E | | MI | 4045 | 2318 | 6503 | 1605 | 6812 | 1355 | 6904 | 1148 | 6894 | 829 | 7542 | 571 | 4112 |
| 8-#10 | 1.76 | MA | 7239 | 2318 | 11116 | 1733 | 11878 | 1457 | 12130 | 1239 | 12176 | 915 | 13895 | 631 | 7733 |
| 4L-2S | | MI | 4140 | 2318 | 6788 | 1600 | 7178 | 1341 | 7349 | 1136 | 7500 | 820 | 8304 | 660 | 4084 |
| 8-#11 | 2.17 | MA | 7786 | 2382 | 12684 | 1731 | 13859 | 1447 | 14535 | 1221 | 15398 | 869 | 18229 | 748 | 9348 |
| 2L-4S | | MI | 4067 | 2382 | 6417 | 1645 | 6670 | 1372 | 6715 | 1152 | 6658 | 820 | 7212 | 453 | 4942 |
| 8-#11 | 2.17 | MA | 7528 | 2382 | 11967 | 1743 | 12940 | 1458 | 13414 | 1244 | 13872 | 890 | 16116 | 646 | 9363 |
| 3E | | MI | 4113 | 2382 | 6684 | 1627 | 7015 | 1370 | 7139 | 1153 | 7209 | 813 | 7840 | 503 | 4904 |
| 8-#11 | 2.17 | MA | 7387 | 2382 | 11425 | 1769 | 12236 | 1483 | 12549 | 1253 | 12745 | 910 | 14693 | 586 | 9317 |
| 4L-2S | | MI | 4224 | 2382 | 7024 | 1622 | 7450 | 1354 | 7670 | 1140 | 7932 | 805 | 8716 | 613 | 4868 |
| 8-#14 | 3.13 | MA | 7950 | 2535 | 12908 | 1836 | 14119 | 1524 | 14840 | 1290 | 15806 | 881 | 18789 | 578 | 13202 |
| 3E | | MI | 4293 | 2535 | 7114 | 1710 | 7544 | 1433 | 7776 | 1189 | 8057 | 791 | 8786 | 376 | 6759 |
| 8-#14 | 3.13 | MA | 7754 | 2535 | 12133 | 1873 | 13113 | 1559 | 13604 | 1302 | 14195 | 909 | 16743 | 490 | 12805 |
| 4L-2S | | MI | 4447 | 2535 | 7592 | 1704 | 8158 | 1412 | 8525 | 1172 | 9070 | 781 | 9990 | 534 | 6717 |
| 8-#18 | 5.56 | MA | 8982 | 2922 | 15220 | 2074 | 17031 | 1695 | 18370 | 1406 | 20596 | 859 | 25412 | 403 | 22534 |
| 3E | | MI | 4721 | 2922 | 8133 | 1925 | 8811 | 1596 | 9306 | 1282 | 9973 | 715 | 10898 | 16 | 10847 |
| 8-#18 | 5.56 | MA | 8659 | 2922 | 13865 | 2138 | 15273 | 1754 | 16210 | 1426 | 17783 | 906 | 21801 | 243 | 20031 |
| 4L-2S | | MI | 4976 | 2922 | 8945 | 1921 | 9853 | 1563 | 10577 | 1258 | 11641 | 698 | 12830 | 298 | 11090 |
| 10-#10 | 2.20 | MA | 7837 | 2388 | 12746 | 1745 | 13976 | 1458 | 14695 | 1230 | 15625 | 875 | 18551 | 753 | 9589 |
| 2L-5S | | MI | 4040 | 2388 | 6376 | 1670 | 6640 | 1404 | 6684 | 1180 | 6581 | 828 | 7232 | 455 | 4994 |
| 10-#10 | 2.20 | MA | 7623 | 2388 | 12154 | 1755 | 13217 | 1468 | 13768 | 1249 | 14364 | 892 | 16805 | 672 | 9598 |
| 3L-4S | | MI | 4123 | 2388 | 6565 | 1665 | 6890 | 1390 | 6996 | 1168 | 7040 | 831 | 7763 | 507 | 5052 |
| 10-#10 | 2.20 | MA | 7505 | 2388 | 11708 | 1777 | 12638 | 1489 | 13056 | 1258 | 13436 | 910 | 15641 | 623 | 9570 |
| 4L-3S | | MI | 4163 | 2388 | 6788 | 1649 | 7178 | 1387 | 7349 | 1167 | 7500 | 823 | 8304 | 551 | 5026 |
| 10-#10 | 2.20 | MA | 7322 | 2388 | 11337 | 1788 | 12142 | 1498 | 12436 | 1278 | 12516 | 916 | 14458 | 583 | 9328 |
| 5L-2S | | MI | 4258 | 2388 | 7073 | 1644 | 7543 | 1372 | 7795 | 1155 | 8107 | 815 | 9065 | 640 | 5000 |
| 10-#11 | 2.71 | MA | 7845 | 2468 | 12684 | 1797 | 13859 | 1497 | 14535 | 1267 | 15398 | 883 | 18229 | 637 | 11596 |
| 3L-4S | | MI | 4209 | 2468 | 6757 | 1699 | 7105 | 1411 | 7246 | 1176 | 7381 | 814 | 8089 | 424 | 6014 |
| 10-#11 | 2.71 | MA | 7706 | 2468 | 12143 | 1823 | 13156 | 1522 | 13671 | 1277 | 14271 | 903 | 16806 | 577 | 11534 |
| 4L-3S | | MI | 4253 | 2468 | 7024 | 1681 | 7450 | 1409 | 7670 | 1177 | 7932 | 806 | 8716 | 474 | 5988 |
| 10-#11 | 2.71 | MA | 7487 | 2468 | 11691 | 1835 | 12553 | 1532 | 12916 | 1300 | 13153 | 910 | 15365 | 524 | 10990 |
| 5L-2S | | MI | 4363 | 2468 | 7364 | 1676 | 7886 | 1393 | 8201 | 1163 | 8654 | 798 | 9592 | 584 | 5957 |
| 10-#14 | 3.91 | MA | 8205 | 2659 | 13156 | 1951 | 14425 | 1615 | 15204 | 1336 | 16373 | 899 | 19758 | 476 | 15870 |
| 4L-3S | | MI | 4489 | 2659 | 7592 | 1788 | 8158 | 1489 | 8525 | 1223 | 9070 | 780 | 9990 | 328 | 8266 |
| 10-#14 | 3.91 | MA | 7898 | 2659 | 12509 | 1968 | 13561 | 1630 | 14124 | 1369 | 14773 | 908 | 17692 | 398 | 14865 |
| 5L-2S | | MI | 4641 | 2659 | 8071 | 1782 | 8772 | 1468 | 9274 | 1206 | 10084 | 770 | 11194 | 487 | 8237 |
| 10-#18 | 6.94 | MA | 9431 | 3143 | 15646 | 2276 | 17555 | 1853 | 18994 | 1486 | 21571 | 888 | 27047 | 219 | 25429 |
| 4L-3S | | MI | 5051 | 3143 | 8945 | 2064 | 9853 | 1695 | 10577 | 1342 | 11641 | 687 | 12830 | -87 | 12762 |
| 10-#18 | 6.94 | MA | 8911 | 3143 | 14510 | 2304 | 16043 | 1877 | 17104 | 1541 | 18773 | 899 | 23417 | 68 | 23101 |
| 5L-2S | | MI | 5303 | 3143 | 9758 | 2059 | 10894 | 1663 | 11847 | 1318 | 13309 | 670 | 14762 | 195 | 13640 |
| 12-#10 | 2.65 | MA | 7886 | 2458 | 12746 | 1799 | 13976 | 1499 | 14695 | 1269 | 15625 | 886 | 18551 | 664 | 11444 |
| 3L-5S | | MI | 4160 | 2458 | 6661 | 1714 | 7005 | 1435 | 7130 | 1199 | 7187 | 823 | 7993 | 435 | 5847 |
| 12-#10 | 2.65 | MA | 7769 | 2458 | 12301 | 1821 | 13397 | 1520 | 13983 | 1277 | 14697 | 904 | 17386 | 616 | 11406 |
| 4E | | MI | 4242 | 2458 | 6850 | 1709 | 7255 | 1421 | 7442 | 1187 | 7647 | 826 | 8524 | 488 | 5951 |
| 12-#10 | 2.65 | MA | 7588 | 2458 | 11929 | 1831 | 12901 | 1530 | 13362 | 1297 | 13776 | 910 | 16204 | 575 | 11120 |
| 5L-3S | | MI | 4282 | 2458 | 7073 | 1693 | 7543 | 1418 | 7795 | 1186 | 8107 | 817 | 9065 | 531 | 5932 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis

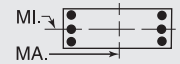



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 2.65 | MA | 7458 | 2458 | 11538 | 1836 | 12408 | 1550 | 12748 | 1305 | 12950 | 928 | 15145 | 518 | 10726 |
| 6L-2S | | MI | 4375 | 2458 | 7358 | 1688 | 7909 | 1404 | 8241 | 1174 | 8713 | 809 | 9826 | 620 | 5909 |
| 12-#11 | 3.25 | MA | 8022 | 2555 | 12860 | 1877 | 14075 | 1560 | 14792 | 1301 | 15798 | 896 | 18919 | 567 | 13752 |
| 4E | | MI | 4350 | 2555 | 7097 | 1753 | 7541 | 1450 | 7778 | 1200 | 8104 | 807 | 8965 | 395 | 7079 |
| 12-#11 | 3.25 | MA | 7807 | 2555 | 12408 | 1889 | 13472 | 1571 | 14038 | 1324 | 14679 | 903 | 17478 | 514 | 13163 |
| 5L-3S | | MI | 4393 | 2555 | 7364 | 1735 | 7886 | 1448 | 8201 | 1200 | 8654 | 799 | 9592 | 445 | 7063 |
| 12-#11 | 3.25 | MA | 7651 | 2555 | 11940 | 1895 | 12872 | 1596 | 13291 | 1333 | 13675 | 923 | 16182 | 444 | 12729 |
| 6L-2S | | MI | 4502 | 2555 | 7703 | 1730 | 8321 | 1432 | 8732 | 1187 | 9377 | 791 | 10469 | 555 | 7038 |
| 12-#14 | 4.69 | MA | 8351 | 2784 | 13532 | 2046 | 14873 | 1686 | 15725 | 1403 | 16951 | 898 | 20707 | 384 | 17989 |
| 5L-3S | | MI | 4685 | 2784 | 8071 | 1866 | 8772 | 1545 | 9274 | 1257 | 10084 | 769 | 11194 | 281 | 9763 |
| 12-#14 | 4.69 | MA | 8133 | 2784 | 12871 | 2055 | 14014 | 1721 | 14655 | 1416 | 15513 | 926 | 18843 | 282 | 16866 |
| 6L-2S | | MI | 4835 | 2784 | 8550 | 1860 | 9386 | 1523 | 10022 | 1240 | 11097 | 759 | 12398 | 439 | 9748 |
| 14-#10 | 3.09 | MA | 8031 | 2529 | 12893 | 1865 | 14157 | 1552 | 14909 | 1296 | 15957 | 898 | 19132 | 608 | 13242 |
| 4L-5S | | MI | 4279 | 2529 | 6947 | 1758 | 7370 | 1467 | 7576 | 1219 | 7794 | 817 | 8755 | 415 | 6676 |
| 14-#10 | 3.09 | MA | 7853 | 2529 | 12522 | 1875 | 13661 | 1561 | 14289 | 1316 | 15037 | 905 | 17949 | 567 | 12916 |
| 5L-4S | | MI | 4361 | 2529 | 7135 | 1753 | 7621 | 1453 | 7888 | 1206 | 8253 | 820 | 9285 | 468 | 6846 |
| 14-#10 | 3.09 | MA | 7726 | 2529 | 12131 | 1880 | 13167 | 1582 | 13674 | 1324 | 14211 | 922 | 16890 | 511 | 12538 |
| 6L-3S | | MI | 4400 | 2529 | 7358 | 1737 | 7909 | 1450 | 8241 | 1205 | 8713 | 812 | 9826 | 511 | 6832 |
| 14-#10 | 3.09 | MA | 7588 | 2529 | 11709 | 1897 | 12660 | 1587 | 13088 | 1344 | 13406 | 940 | 15644 | 462 | 12090 |
| 7L-2S | | MI | 4492 | 2529 | 7643 | 1732 | 8274 | 1435 | 8687 | 1193 | 9320 | 804 | 10587 | 600 | 6814 |
| 14-#11 | 3.79 | MA | 8125 | 2641 | 13125 | 1943 | 14391 | 1610 | 15160 | 1347 | 16205 | 896 | 19591 | 505 | 15342 |
| 5L-4S | | MI | 4489 | 2641 | 7436 | 1807 | 7976 | 1489 | 8309 | 1223 | 8826 | 800 | 9842 | 366 | 8039 |
| 14-#11 | 3.79 | MA | 7973 | 2641 | 12658 | 1949 | 13791 | 1635 | 14412 | 1357 | 15201 | 917 | 18295 | 435 | 14927 |
| 6L-3S | | MI | 4532 | 2641 | 7703 | 1789 | 8321 | 1486 | 8732 | 1224 | 9377 | 792 | 10469 | 416 | 8133 |
| 14-#11 | 3.79 | MA | 7810 | 2641 | 12145 | 1970 | 13185 | 1641 | 13700 | 1380 | 14222 | 937 | 16775 | 373 | 14163 |
| 7L-2S | | MI | 4640 | 2641 | 8043 | 1784 | 8756 | 1471 | 9263 | 1210 | 10100 | 784 | 11345 | 525 | 8113 |
| 14-#14 | 5.47 | MA | 8589 | 2908 | 13894 | 2132 | 15326 | 1777 | 16256 | 1450 | 17690 | 917 | 21858 | 268 | 19982 |
| 6L-3S | | MI | 4881 | 2908 | 8550 | 1943 | 9386 | 1601 | 10022 | 1291 | 11097 | 759 | 12398 | 234 | 11251 |
| 14-#14 | 5.47 | MA | 8360 | 2908 | 13162 | 2162 | 14469 | 1787 | 15235 | 1482 | 16289 | 945 | 19920 | 203 | 18785 |
| 7L-2S | | MI | 5029 | 2908 | 9029 | 1938 | 9999 | 1579 | 10771 | 1273 | 12110 | 749 | 13602 | 392 | 11253 |
| 16-#10 | 3.53 | MA | 8117 | 2599 | 13114 | 1919 | 14420 | 1593 | 15215 | 1335 | 16298 | 899 | 19695 | 559 | 14717 |
| 5E | | MI | 4398 | 2599 | 7232 | 1802 | 7736 | 1498 | 8021 | 1238 | 8400 | 811 | 9516 | 395 | 7532 |
| 16-#10 | 3.53 | MA | 7993 | 2599 | 12723 | 1924 | 13927 | 1614 | 14601 | 1343 | 15471 | 917 | 18636 | 503 | 14354 |
| 6L-4S | | MI | 4479 | 2599 | 7420 | 1797 | 7986 | 1484 | 8333 | 1225 | 8860 | 814 | 10046 | 448 | 7737 |
| 16-#10 | 3.53 | MA | 7855 | 2599 | 12301 | 1941 | 13419 | 1618 | 14015 | 1363 | 14666 | 934 | 17390 | 455 | 13895 |
| 7L-3S | | MI | 4518 | 2599 | 7643 | 1780 | 8274 | 1481 | 8687 | 1224 | 9320 | 806 | 10587 | 491 | 7730 |
| 16-#10 | 3.53 | MA | 7706 | 2599 | 11932 | 1949 | 12908 | 1636 | 13396 | 1369 | 13809 | 941 | 16314 | 408 | 13408 |
| 8L-2S | | MI | 4609 | 2599 | 7928 | 1775 | 8639 | 1467 | 9132 | 1212 | 9926 | 798 | 11348 | 580 | 7715 |
| 16-#11 | 4.33 | MA | 8293 | 2727 | 13375 | 2003 | 14711 | 1673 | 15534 | 1380 | 16727 | 910 | 20408 | 425 | 17129 |
| 6L-4S | | MI | 4629 | 2727 | 7776 | 1861 | 8411 | 1527 | 8840 | 1247 | 9549 | 793 | 10718 | 337 | 9041 |
| 16-#11 | 4.33 | MA | 8130 | 2727 | 12862 | 2024 | 14104 | 1680 | 14821 | 1404 | 15748 | 930 | 18888 | 363 | 16352 |
| 7L-3S | | MI | 4672 | 2727 | 8043 | 1843 | 8756 | 1525 | 9263 | 1247 | 10100 | 785 | 11345 | 386 | 9198 |
| 16-#11 | 4.33 | MA | 7952 | 2727 | 12413 | 2033 | 13484 | 1700 | 14082 | 1411 | 14706 | 937 | 17576 | 303 | 15613 |
| 8L-2S | | MI | 4778 | 2727 | 8382 | 1838 | 9192 | 1509 | 9794 | 1234 | 10822 | 777 | 12222 | 496 | 9184 |
| 16-#14 | 6.25 | MA | 8814 | 3033 | 14185 | 2240 | 15781 | 1843 | 16835 | 1516 | 18467 | 935 | 22935 | 189 | 21877 |
| 7L-3S | | MI | 5076 | 3033 | 9029 | 2021 | 9999 | 1657 | 10771 | 1325 | 12110 | 748 | 13602 | 186 | 12735 |
| 18-#10 | 3.97 | MA | 8257 | 2669 | 13316 | 1968 | 14686 | 1645 | 15527 | 1363 | 16732 | 911 | 20381 | 495 | 16172 |
| 6L-5S | | MI | 4516 | 2669 | 7517 | 1846 | 8101 | 1530 | 8467 | 1257 | 9007 | 806 | 10277 | 376 | 8390 |
| 18-#10 | 3.97 | MA | 8120 | 2669 | 12893 | 1985 | 14179 | 1650 | 14941 | 1382 | 15927 | 929 | 19135 | 447 | 15702 |
| 7L-4S | | MI | 4597 | 2669 | 7705 | 1841 | 8351 | 1516 | 8779 | 1245 | 9466 | 809 | 10808 | 428 | 8592 |
| 18-#10 | 3.97 | MA | 7974 | 2669 | 12524 | 1993 | 13668 | 1667 | 14322 | 1388 | 15070 | 935 | 18059 | 400 | 15227 |
| 8L-3S | | MI | 4636 | 2669 | 7928 | 1824 | 8639 | 1513 | 9132 | 1244 | 9926 | 801 | 11348 | 471 | 8624 |
| 18-#10 | 3.97 | MA | 7840 | 2669 | 12132 | 2012 | 13178 | 1674 | 13713 | 1404 | 14274 | 953 | 16998 | 358 | 14567 |
| 9L-2S | | MI | 4726 | 2669 | 8213 | 1819 | 9005 | 1498 | 9578 | 1231 | 10533 | 792 | 12109 | 561 | 8613 |
| 18-#11 | 4.88 | MA | 8448 | 2814 | 13580 | 2078 | 15024 | 1719 | 15943 | 1427 | 17274 | 923 | 21001 | 353 | 18544 |
| 7L-4S | | MI | 4768 | 2814 | 8115 | 1915 | 8847 | 1566 | 9371 | 1270 | 10271 | 786 | 11595 | 307 | 10049 |
| 18-#11 | 4.88 | MA | 8274 | 2814 | 13130 | 2086 | 14403 | 1739 | 15204 | 1435 | 16232 | 930 | 19689 | 294 | 17793 |
| 8L-3S | | MI | 4811 | 2814 | 8382 | 1897 | 9192 | 1564 | 9794 | 1271 | 10822 | 778 | 12222 | 357 | 10261 |

## RECTANGULAR TIED COLUMNS 18" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

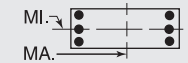
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 4.41 | MA | 8384 | 2739 | 13486 | 2029 | 14938 | 1682 | 15868 | 1401 | 17188 | 923 | 20881 | 439 | 17512 |
| 7L-5S | | MI | 4635 | 2739 | 7802 | 1890 | 8467 | 1562 | 8913 | 1276 | 9613 | 800 | 11038 | 356 | 9251 |
| 20-#10 | 4.41 | MA | 8240 | 2739 | 13116 | 2036 | 14427 | 1699 | 15249 | 1407 | 16330 | 929 | 19805 | 393 | 17044 |
| 8L-4S | | MI | 4715 | 2739 | 7990 | 1885 | 8717 | 1547 | 9225 | 1264 | 10073 | 803 | 11569 | 408 | 9440 |
| 20-#10 | 4.41 | MA | 8111 | 2739 | 12724 | 2056 | 13938 | 1705 | 14640 | 1424 | 15535 | 947 | 18744 | 350 | 16376 |
| 9L-3S | | MI | 4753 | 2739 | 8213 | 1868 | 9005 | 1544 | 9578 | 1263 | 10533 | 795 | 12109 | 451 | 9518 |
| 20-#11 | 5.42 | MA | 8593 | 2900 | 13848 | 2140 | 15322 | 1778 | 16325 | 1458 | 17758 | 923 | 21802 | 284 | 19974 |
| 8L-4S | | MI | 4907 | 2900 | 8455 | 1969 | 9282 | 1605 | 9902 | 1294 | 10994 | 779 | 12471 | 278 | 11061 |
| 22-#10 | 4.85 | MA | 8505 | 2810 | 13709 | 2080 | 15187 | 1730 | 16175 | 1426 | 17591 | 924 | 21550 | 385 | 18862 |
| 8L-5S | | MI | 4753 | 2810 | 8087 | 1934 | 8832 | 1593 | 9359 | 1295 | 10220 | 795 | 11799 | 336 | 10113 |
| 22-#10 | 4.85 | MA | 8380 | 2810 | 13317 | 2100 | 14697 | 1737 | 15566 | 1443 | 16796 | 941 | 20489 | 342 | 18184 |
| 9L-4S | | MI | 4832 | 2810 | 8275 | 1928 | 9082 | 1579 | 9671 | 1283 | 10679 | 798 | 12330 | 388 | 10291 |
| 24-#10 | 5.29 | MA | 8647 | 2880 | 13909 | 2144 | 15456 | 1768 | 16493 | 1462 | 18056 | 936 | 22234 | 334 | 19993 |
| 9L-5S | | MI | 4871 | 2880 | 8372 | 1977 | 9197 | 1625 | 9804 | 1314 | 10826 | 789 | 12560 | 316 | 10977 |

## RECTANGULAR TIED COLUMNS 18" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.02 | MA | 8051 | 2337 | 12594 | 1726 | 13469 | 1458 | 13769 | 1250 | 13799 | 944 | 15624 | 821 | 5160 |
| 2E | | MI | 4175 | 2337 | 6699 | 1602 | 6937 | 1352 | 6954 | 1158 | 6802 | 870 | 7289 | 717 | 2667 |
| 4-#14 | 1.47 | MA | 8338 | 2413 | 13279 | 1767 | 14317 | 1486 | 14791 | 1266 | 15182 | 934 | 17534 | 809 | 7284 |
| 2E | | MI | 4287 | 2413 | 6990 | 1636 | 7287 | 1374 | 7373 | 1169 | 7357 | 854 | 7906 | 674 | 3652 |
| 4-#18 | 2.61 | MA | 9033 | 2607 | 14960 | 1873 | 16415 | 1560 | 17326 | 1308 | 18617 | 910 | 22279 | 780 | 12510 |
| 2E | | MI | 4551 | 2607 | 7677 | 1729 | 8126 | 1438 | 8380 | 1201 | 8615 | 804 | 9285 | 548 | 5970 |
| 6-#10 | 1.25 | MA | 8220 | 2375 | 12927 | 1760 | 13935 | 1484 | 14356 | 1268 | 14609 | 947 | 16754 | 822 | 6275 |
| 2L-3S | | MI | 4155 | 2375 | 6571 | 1650 | 6804 | 1399 | 6806 | 1195 | 6604 | 887 | 7110 | 637 | 3208 |
| 6-#10 | 1.25 | MA | 7979 | 2375 | 12291 | 1771 | 13120 | 1494 | 13361 | 1289 | 13255 | 965 | 14879 | 743 | 6300 |
| 3L-2S | | MI | 4251 | 2375 | 6856 | 1645 | 7170 | 1385 | 7252 | 1183 | 7211 | 879 | 7871 | 726 | 3179 |
| 6-#11 | 1.53 | MA | 8392 | 2423 | 13366 | 1780 | 14457 | 1497 | 14975 | 1274 | 15440 | 937 | 17896 | 812 | 7597 |
| 2L-3S | | MI | 4202 | 2423 | 6699 | 1661 | 6937 | 1407 | 6954 | 1195 | 6802 | 871 | 7289 | 578 | 3833 |
| 6-#11 | 1.53 | MA | 8105 | 2423 | 12594 | 1793 | 13469 | 1508 | 13769 | 1298 | 13799 | 959 | 15624 | 712 | 7624 |
| 3L-2S | | MI | 4315 | 2423 | 7038 | 1656 | 7372 | 1391 | 7485 | 1182 | 7524 | 864 | 8165 | 688 | 3794 |
| 6-#14 | 2.21 | MA | 8819 | 2537 | 14380 | 1844 | 15729 | 1542 | 16513 | 1300 | 17525 | 924 | 20778 | 795 | 10749 |
| 2L-3S | | MI | 4325 | 2537 | 6990 | 1719 | 7287 | 1452 | 7373 | 1220 | 7357 | 853 | 7906 | 468 | 5274 |
| 6-#14 | 2.21 | MA | 8420 | 2537 | 13279 | 1862 | 14317 | 1558 | 14791 | 1334 | 15182 | 953 | 17534 | 649 | 10754 |
| 3L-2S | | MI | 4482 | 2537 | 7468 | 1714 | 7901 | 1430 | 8122 | 1202 | 8371 | 844 | 9110 | 627 | 5217 |
| 6-#18 | 3.92 | MA | 9852 | 2828 | 16878 | 2011 | 18875 | 1660 | 20327 | 1368 | 22700 | 892 | 27932 | 756 | 18515 |
| 2L-3S | | MI | 4619 | 2828 | 7677 | 1873 | 8126 | 1569 | 8380 | 1285 | 8615 | 794 | 9285 | 164 | 8626 |
| 6-#18 | 3.92 | MA | 9192 | 2828 | 14960 | 2041 | 16415 | 1685 | 17326 | 1425 | 18617 | 941 | 22279 | 487 | 18336 |
| 3L-2S | | MI | 4878 | 2828 | 8489 | 1868 | 9167 | 1537 | 9650 | 1261 | 10283 | 776 | 11217 | 445 | 8574 |
| 8-#8 | 1.03 | MA | 8086 | 2339 | 12591 | 1745 | 13534 | 1473 | 13879 | 1264 | 13967 | 954 | 15871 | 830 | 5264 |
| 2L-4S | | MI | 4110 | 2339 | 6388 | 1650 | 6592 | 1392 | 6554 | 1192 | 6279 | 901 | 6757 | 666 | 2734 |
| 8-#8 | 1.03 | MA | 7932 | 2339 | 12192 | 1752 | 13022 | 1480 | 13254 | 1277 | 13117 | 966 | 14694 | 781 | 5280 |
| 3E | | MI | 4137 | 2339 | 6529 | 1639 | 6774 | 1390 | 6778 | 1191 | 6570 | 895 | 7106 | 694 | 2714 |
| 8-#8 | 1.03 | MA | 7847 | 2339 | 11893 | 1766 | 12633 | 1493 | 12776 | 1282 | 12460 | 970 | 13920 | 751 | 5296 |
| 4L-2S | | MI | 4199 | 2339 | 6710 | 1636 | 7006 | 1380 | 7061 | 1183 | 6955 | 889 | 7600 | 750 | 2700 |
| 8-#9 | 1.31 | MA | 8270 | 2385 | 13019 | 1770 | 14069 | 1491 | 14525 | 1274 | 14843 | 948 | 17081 | 823 | 6590 |
| 2L-4S | | MI | 4165 | 2385 | 6497 | 1676 | 6720 | 1410 | 6706 | 1202 | 6487 | 896 | 7012 | 626 | 3374 |
| 8-#9 | 1.31 | MA | 8080 | 2385 | 12516 | 1779 | 13423 | 1499 | 13738 | 1290 | 13772 | 963 | 15597 | 761 | 6608 |
| 3E | | MI | 4197 | 2385 | 6674 | 1663 | 6948 | 1407 | 6986 | 1201 | 6852 | 889 | 7446 | 661 | 3346 |
| 8-#9 | 1.31 | MA | 7974 | 2385 | 12138 | 1797 | 12933 | 1516 | 13134 | 1297 | 12985 | 977 | 14618 | 723 | 6618 |
| 4L-2S | | MI | 4275 | 2385 | 6900 | 1658 | 7239 | 1396 | 7341 | 1191 | 7335 | 882 | 8059 | 731 | 3325 |
| 8-#10 | 1.66 | MA | 8504 | 2445 | 13563 | 1804 | 14751 | 1515 | 15351 | 1288 | 15963 | 941 | 18629 | 814 | 8278 |
| 2L-4S | | MI | 4233 | 2445 | 6633 | 1710 | 6882 | 1434 | 6898 | 1215 | 6751 | 890 | 7331 | 574 | 4172 |
| 8-#10 | 1.66 | MA | 8267 | 2445 | 12927 | 1815 | 13935 | 1525 | 14356 | 1308 | 14609 | 960 | 16754 | 735 | 8295 |
| 3E | | MI | 4274 | 2445 | 6856 | 1694 | 7170 | 1431 | 7252 | 1214 | 7211 | 881 | 7871 | 617 | 4137 |
| 8-#10 | 1.66 | MA | 8135 | 2445 | 12449 | 1837 | 13315 | 1546 | 13593 | 1317 | 13614 | 978 | 15512 | 687 | 8281 |
| 4L-2S | | MI | 4369 | 2445 | 7141 | 1689 | 7535 | 1417 | 7697 | 1202 | 7817 | 873 | 8632 | 706 | 4109 |

## RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

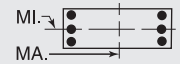
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 2.04 | MA | 8731 | 2509 | 14137 | 1834 | 15446 | 1535 | 16181 | 1298 | 17081 | 930 | 20168 | 802 | 10022 |
| 2L-4S | | MI | 4297 | 2509 | 6772 | 1733 | 7027 | 1447 | 7062 | 1218 | 6974 | 872 | 7538 | 499 | 4977 |
| 8-#11 | 2.04 | MA | 8451 | 2509 | 13366 | 1847 | 14457 | 1547 | 14975 | 1322 | 15440 | 952 | 17896 | 702 | 10037 |
| 3E | | MI | 4342 | 2509 | 7038 | 1715 | 7372 | 1445 | 7485 | 1218 | 7524 | 865 | 8165 | 549 | 4936 |
| 8-#11 | 2.04 | MA | 8295 | 2509 | 12785 | 1874 | 13703 | 1572 | 14047 | 1332 | 14232 | 973 | 16378 | 642 | 9991 |
| 4L-2S | | MI | 4454 | 2509 | 7378 | 1710 | 7807 | 1429 | 8016 | 1205 | 8247 | 857 | 9042 | 659 | 4898 |
| 8-#14 | 2.94 | MA | 8909 | 2662 | 14380 | 1940 | 15729 | 1614 | 16513 | 1367 | 17525 | 944 | 20778 | 635 | 14174 |
| 3E | | MI | 4522 | 2662 | 7468 | 1797 | 7901 | 1507 | 8122 | 1254 | 8371 | 843 | 9110 | 421 | 6800 |
| 8-#14 | 2.94 | MA | 8693 | 2662 | 13549 | 1978 | 14649 | 1649 | 15186 | 1381 | 15797 | 973 | 18595 | 548 | 13895 |
| 4L-2S | | MI | 4676 | 2662 | 7947 | 1791 | 8514 | 1486 | 8870 | 1236 | 9384 | 833 | 10314 | 579 | 6755 |
| 8-#18 | 5.23 | MA | 10031 | 3049 | 16878 | 2179 | 18875 | 1785 | 20327 | 1485 | 22700 | 923 | 27932 | 462 | 24262 |
| 3E | | MI | 4950 | 3049 | 8489 | 2011 | 9167 | 1668 | 9650 | 1345 | 10283 | 766 | 11217 | 61 | 11027 |
| 8-#18 | 5.23 | MA | 9672 | 3049 | 15423 | 2244 | 16986 | 1846 | 18005 | 1507 | 19676 | 972 | 24077 | 305 | 21744 |
| 4L-2S | | MI | 5205 | 3049 | 9302 | 2006 | 10208 | 1636 | 10920 | 1321 | 11951 | 748 | 13149 | 342 | 11144 |
| 10-#10 | 2.08 | MA | 8785 | 2515 | 14200 | 1848 | 15567 | 1547 | 16346 | 1307 | 17317 | 936 | 20503 | 807 | 10275 |
| 2L-5S | | MI | 4270 | 2515 | 6729 | 1759 | 6997 | 1480 | 7032 | 1246 | 6898 | 881 | 7561 | 501 | 5061 |
| 10-#10 | 2.08 | MA | 8553 | 2515 | 13563 | 1859 | 14751 | 1557 | 15351 | 1327 | 15963 | 954 | 18629 | 727 | 10283 |
| 3L-4S | | MI | 4353 | 2515 | 6918 | 1754 | 7247 | 1466 | 7344 | 1234 | 7357 | 884 | 8092 | 554 | 5082 |
| 10-#10 | 2.08 | MA | 8422 | 2515 | 13086 | 1881 | 14131 | 1578 | 14588 | 1336 | 14968 | 972 | 17387 | 679 | 10256 |
| 4L-3S | | MI | 4392 | 2515 | 7141 | 1738 | 7535 | 1463 | 7697 | 1233 | 7817 | 876 | 8632 | 597 | 5054 |
| 10-#10 | 2.08 | MA | 8224 | 2515 | 12687 | 1892 | 13600 | 1588 | 13923 | 1356 | 13983 | 979 | 16123 | 640 | 10064 |
| 5L-2S | | MI | 4487 | 2515 | 7426 | 1733 | 7900 | 1448 | 8143 | 1221 | 8424 | 867 | 9393 | 686 | 5027 |
| 10-#11 | 2.55 | MA | 8794 | 2596 | 14137 | 1901 | 15446 | 1586 | 16181 | 1345 | 17081 | 945 | 20168 | 693 | 12438 |
| 3L-4S | | MI | 4438 | 2596 | 7111 | 1787 | 7462 | 1486 | 7593 | 1241 | 7696 | 866 | 8414 | 470 | 6053 |
| 10-#11 | 2.55 | MA | 8641 | 2596 | 13556 | 1928 | 14692 | 1611 | 15253 | 1355 | 15872 | 966 | 18649 | 633 | 12377 |
| 4L-3S | | MI | 4482 | 2596 | 7378 | 1769 | 7807 | 1484 | 8016 | 1242 | 8247 | 858 | 9042 | 520 | 6023 |
| 10-#11 | 2.55 | MA | 8404 | 2596 | 13072 | 1940 | 14045 | 1622 | 14445 | 1379 | 14674 | 974 | 17109 | 582 | 11862 |
| 5L-2S | | MI | 4593 | 2596 | 7718 | 1764 | 8243 | 1468 | 8548 | 1229 | 8970 | 850 | 9918 | 630 | 5990 |
| 10-#14 | 3.68 | MA | 9181 | 2786 | 14650 | 2056 | 16061 | 1705 | 16908 | 1415 | 18140 | 963 | 21839 | 534 | 17201 |
| 4L-3S | | MI | 4718 | 2786 | 7947 | 1875 | 8514 | 1563 | 8870 | 1288 | 9384 | 832 | 10314 | 374 | 8311 |
| 10-#14 | 3.68 | MA | 8848 | 2786 | 13956 | 2074 | 15135 | 1721 | 15750 | 1449 | 16424 | 973 | 19629 | 459 | 16055 |
| 5L-2S | | MI | 4871 | 2786 | 8426 | 1869 | 9128 | 1542 | 9619 | 1270 | 10397 | 822 | 11518 | 532 | 8278 |
| 10-#18 | 6.54 | MA | 10509 | 3271 | 17342 | 2383 | 19446 | 1945 | 21006 | 1567 | 23759 | 955 | 29729 | 280 | 27575 |
| 4L-3S | | MI | 5280 | 3271 | 9302 | 2149 | 10208 | 1768 | 10920 | 1406 | 11951 | 738 | 13149 | -42 | 13117 |
| 10-#18 | 6.54 | MA | 9946 | 3271 | 16124 | 2412 | 17823 | 1971 | 18977 | 1625 | 20754 | 969 | 25843 | 136 | 25154 |
| 5L-2S | | MI | 5534 | 3271 | 10114 | 2144 | 11249 | 1736 | 12190 | 1382 | 13619 | 720 | 15081 | 239 | 13696 |
| 12-#10 | 2.49 | MA | 8837 | 2586 | 14200 | 1903 | 15567 | 1588 | 16346 | 1346 | 17317 | 948 | 20503 | 719 | 12267 |
| 3L-5S | | MI | 4389 | 2586 | 7014 | 1803 | 7362 | 1511 | 7478 | 1266 | 7504 | 875 | 8322 | 481 | 5914 |
| 12-#10 | 2.49 | MA | 8708 | 2586 | 13722 | 1925 | 14946 | 1609 | 15583 | 1355 | 16323 | 967 | 19262 | 671 | 12229 |
| 4E | | MI | 4471 | 2586 | 7203 | 1798 | 7613 | 1497 | 7790 | 1253 | 7964 | 878 | 8853 | 534 | 5984 |
| 12-#10 | 2.49 | MA | 8513 | 2586 | 13324 | 1936 | 14415 | 1619 | 14919 | 1375 | 15337 | 974 | 17998 | 632 | 11991 |
| 5L-3S | | MI | 4511 | 2586 | 7426 | 1782 | 7900 | 1494 | 8143 | 1252 | 8424 | 870 | 9393 | 577 | 5962 |
| 12-#10 | 2.49 | MA | 8372 | 2586 | 12901 | 1940 | 13886 | 1640 | 14261 | 1384 | 14452 | 992 | 16867 | 577 | 11543 |
| 6L-2S | | MI | 4605 | 2586 | 7711 | 1777 | 8266 | 1480 | 8589 | 1240 | 9030 | 862 | 10154 | 666 | 5938 |
| 12-#11 | 3.06 | MA | 8983 | 2682 | 14327 | 1982 | 15680 | 1650 | 16459 | 1379 | 17513 | 959 | 20921 | 623 | 14763 |
| 4E | | MI | 4579 | 2682 | 7451 | 1841 | 7897 | 1525 | 8124 | 1265 | 8419 | 859 | 9291 | 441 | 7121 |
| 12-#11 | 3.06 | MA | 8750 | 2682 | 13843 | 1994 | 15034 | 1661 | 15651 | 1403 | 16315 | 967 | 19381 | 573 | 14201 |
| 5L-3S | | MI | 4622 | 2682 | 7718 | 1823 | 8243 | 1523 | 8548 | 1265 | 8970 | 851 | 9918 | 490 | 7100 |
| 12-#11 | 3.06 | MA | 8582 | 2682 | 13336 | 2000 | 14392 | 1687 | 14850 | 1413 | 15238 | 988 | 17999 | 503 | 13711 |
| 6L-2S | | MI | 4731 | 2682 | 8057 | 1818 | 8678 | 1507 | 9079 | 1252 | 9692 | 843 | 10795 | 600 | 7073 |
| 12-#14 | 4.41 | MA | 9339 | 2911 | 15057 | 2152 | 16547 | 1777 | 17472 | 1483 | 18767 | 963 | 22873 | 445 | 19420 |
| 5L-3S | | MI | 4914 | 2911 | 8426 | 1953 | 9128 | 1619 | 9619 | 1322 | 10397 | 821 | 11518 | 326 | 9815 |
| 12-#14 | 4.41 | MA | 9103 | 2911 | 14338 | 2160 | 15626 | 1813 | 16326 | 1497 | 17225 | 993 | 20886 | 344 | 18297 |
| 6L-2S | | MI | 5065 | 2911 | 8905 | 1947 | 9742 | 1598 | 10368 | 1304 | 11410 | 811 | 12722 | 485 | 9792 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

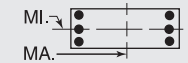
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 7.84 | MA | 10790 | 3492 | 18043 | 2551 | 20283 | 2070 | 21977 | 1685 | 24837 | 951 | 31496 | 112 | 30930 |
| 5L-3S | | MI | 5609 | 3492 | 10114 | 2288 | 11249 | 1867 | 12190 | 1466 | 13619 | 710 | 15081 | -145 | 14948 |
| 14-#10 | 2.91 | MA | 8992 | 2656 | 14358 | 1969 | 15762 | 1641 | 16578 | 1374 | 17677 | 961 | 21137 | 663 | 14202 |
| 4L-5S | | MI | 4508 | 2656 | 7299 | 1847 | 7728 | 1543 | 7923 | 1285 | 8111 | 870 | 9083 | 462 | 6744 |
| 14-#10 | 2.91 | MA | 8799 | 2656 | 13960 | 1980 | 15231 | 1651 | 15914 | 1394 | 16691 | 968 | 19873 | 624 | 13922 |
| 5L-4S | | MI | 4590 | 2656 | 7488 | 1842 | 7978 | 1529 | 8235 | 1272 | 8570 | 873 | 9614 | 514 | 6881 |
| 14-#10 | 2.91 | MA | 8662 | 2656 | 13537 | 1984 | 14702 | 1672 | 15256 | 1403 | 15806 | 986 | 18742 | 569 | 13492 |
| 6L-3S | | MI | 4629 | 2656 | 7711 | 1826 | 8266 | 1526 | 8589 | 1271 | 9030 | 864 | 10154 | 557 | 6865 |
| 14-#10 | 2.91 | MA | 8510 | 2656 | 13085 | 2002 | 14153 | 1677 | 14629 | 1424 | 14944 | 1004 | 17414 | 522 | 13071 |
| 7L-2S | | MI | 4722 | 2656 | 7996 | 1821 | 8631 | 1511 | 9034 | 1259 | 9637 | 856 | 10916 | 646 | 6845 |
| 14-#11 | 3.57 | MA | 9094 | 2768 | 14614 | 2048 | 16023 | 1700 | 16857 | 1426 | 17956 | 960 | 21653 | 563 | 16547 |
| 5L-4S | | MI | 4719 | 2768 | 7790 | 1895 | 8333 | 1564 | 8655 | 1288 | 9141 | 852 | 10167 | 411 | 8185 |
| 14-#11 | 3.57 | MA | 8930 | 2768 | 14107 | 2054 | 15380 | 1725 | 16056 | 1437 | 16879 | 981 | 20271 | 494 | 16077 |
| 6L-3S | | MI | 4762 | 2768 | 8057 | 1877 | 8678 | 1561 | 9079 | 1289 | 9692 | 844 | 10795 | 461 | 8172 |
| 14-#11 | 3.57 | MA | 8750 | 2768 | 13557 | 2075 | 14721 | 1731 | 15293 | 1461 | 15831 | 1003 | 18647 | 434 | 15319 |
| 7L-2S | | MI | 4870 | 2768 | 8397 | 1872 | 9113 | 1545 | 9610 | 1276 | 10415 | 836 | 11671 | 571 | 8150 |
| 14-#14 | 5.15 | MA | 9597 | 3035 | 15440 | 2238 | 17038 | 1869 | 18048 | 1531 | 19568 | 983 | 24130 | 330 | 21645 |
| 6L-3S | | MI | 5110 | 3035 | 8905 | 2031 | 9742 | 1675 | 10368 | 1355 | 11410 | 810 | 12722 | 279 | 11305 |
| 14-#14 | 5.15 | MA | 9345 | 3035 | 14653 | 2268 | 16105 | 1878 | 16954 | 1565 | 18066 | 1013 | 21800 | 241 | 20437 |
| 7L-2S | | MI | 5258 | 3035 | 9383 | 2025 | 10356 | 1654 | 11117 | 1338 | 12424 | 800 | 13926 | 437 | 11299 |
| 16-#10 | 3.32 | MA | 9084 | 2726 | 14597 | 2024 | 16047 | 1682 | 16909 | 1414 | 18045 | 962 | 21748 | 617 | 15859 |
| 5E | | MI | 4627 | 2726 | 7585 | 1891 | 8093 | 1574 | 8369 | 1304 | 8717 | 864 | 9844 | 442 | 7599 |
| 16-#10 | 3.32 | MA | 8950 | 2726 | 14174 | 2028 | 15518 | 1703 | 16251 | 1422 | 17160 | 981 | 20617 | 561 | 15444 |
| 6L-4S | | MI | 4708 | 2726 | 7773 | 1886 | 8343 | 1560 | 8681 | 1292 | 9177 | 867 | 10375 | 494 | 7775 |
| 16-#10 | 3.32 | MA | 8799 | 2726 | 13721 | 2046 | 14969 | 1708 | 15624 | 1443 | 16298 | 999 | 19289 | 514 | 15013 |
| 7L-3S | | MI | 4747 | 2726 | 7996 | 1869 | 8631 | 1557 | 9034 | 1291 | 9637 | 859 | 10916 | 537 | 7764 |
| 16-#10 | 3.32 | MA | 8638 | 2726 | 13325 | 2054 | 14421 | 1726 | 14952 | 1448 | 15381 | 1006 | 18140 | 469 | 14460 |
| 8L-2S | | MI | 4839 | 2726 | 8281 | 1864 | 8997 | 1543 | 9480 | 1278 | 10243 | 851 | 11677 | 627 | 7747 |
| 16-#11 | 4.08 | MA | 9276 | 2855 | 14878 | 2108 | 16369 | 1764 | 17262 | 1460 | 18520 | 974 | 22543 | 484 | 18446 |
| 6L-4S | | MI | 4858 | 2855 | 8130 | 1949 | 8768 | 1602 | 9186 | 1312 | 9864 | 845 | 11044 | 382 | 9128 |
| 16-#11 | 4.08 | MA | 9097 | 2855 | 14328 | 2129 | 15710 | 1770 | 16499 | 1484 | 17471 | 996 | 20919 | 424 | 17677 |
| 7L-3S | | MI | 4901 | 2855 | 8397 | 1930 | 9113 | 1600 | 9610 | 1312 | 10415 | 837 | 11671 | 432 | 9240 |
| 16-#11 | 4.08 | MA | 8905 | 2855 | 13847 | 2138 | 15044 | 1791 | 15695 | 1491 | 16355 | 1003 | 19517 | 367 | 16932 |
| 8L-2S | | MI | 5008 | 2855 | 8736 | 1926 | 9549 | 1584 | 10141 | 1299 | 11137 | 829 | 12548 | 542 | 9223 |
| 16-#14 | 5.88 | MA | 9837 | 3160 | 15754 | 2346 | 17517 | 1934 | 18676 | 1599 | 20410 | 1003 | 25044 | 227 | 23764 |
| 7L-3S | | MI | 5305 | 3160 | 9383 | 2108 | 10356 | 1731 | 11117 | 1389 | 12424 | 799 | 13926 | 231 | 12792 |
| 18-#10 | 3.74 | MA | 9236 | 2796 | 14810 | 2072 | 16334 | 1735 | 17247 | 1442 | 18514 | 975 | 22492 | 554 | 17398 |
| 6L-5S | | MI | 4746 | 2796 | 7870 | 1935 | 8458 | 1606 | 8815 | 1323 | 9324 | 858 | 10606 | 422 | 8458 |
| 18-#10 | 3.74 | MA | 9086 | 2796 | 14357 | 2090 | 15785 | 1740 | 16620 | 1462 | 17652 | 993 | 21164 | 506 | 16958 |
| 7L-4S | | MI | 4826 | 2796 | 8058 | 1930 | 8709 | 1592 | 9127 | 1311 | 9783 | 861 | 11136 | 474 | 8666 |
| 18-#10 | 3.74 | MA | 8927 | 2796 | 13962 | 2098 | 15237 | 1757 | 15948 | 1467 | 16735 | 1000 | 20014 | 462 | 16412 |
| 8L-3S | | MI | 4865 | 2796 | 8281 | 1913 | 8997 | 1589 | 9480 | 1310 | 10243 | 853 | 11677 | 517 | 8660 |
| 18-#10 | 3.74 | MA | 8782 | 2796 | 13541 | 2117 | 14712 | 1764 | 15295 | 1484 | 15883 | 1018 | 18885 | 419 | 15754 |
| 9L-2S | | MI | 4956 | 2796 | 8566 | 1908 | 9362 | 1574 | 9926 | 1297 | 10850 | 845 | 12438 | 607 | 8646 |
| 18-#11 | 4.59 | MA | 9442 | 2941 | 15099 | 2183 | 16698 | 1809 | 17705 | 1508 | 19112 | 989 | 23191 | 415 | 20038 |
| 7L-4S | | MI | 4997 | 2941 | 8469 | 2003 | 9203 | 1641 | 9717 | 1335 | 10586 | 838 | 11920 | 353 | 10135 |
| 18-#11 | 4.59 | MA | 9253 | 2941 | 14618 | 2192 | 16032 | 1830 | 16901 | 1515 | 17995 | 997 | 21789 | 357 | 19277 |
| 8L-3S | | MI | 5040 | 2941 | 8736 | 1984 | 9549 | 1639 | 10141 | 1336 | 11137 | 830 | 12548 | 403 | 10305 |
| 20-#10 | 4.15 | MA | 9371 | 2867 | 14994 | 2134 | 16600 | 1771 | 17615 | 1481 | 19006 | 988 | 23038 | 499 | 18905 |
| 7L-5S | | MI | 4864 | 2867 | 8155 | 1979 | 8824 | 1637 | 9261 | 1342 | 9930 | 853 | 11367 | 402 | 9318 |
| 20-#10 | 4.15 | MA | 9215 | 2867 | 14598 | 2142 | 16053 | 1789 | 16943 | 1486 | 18089 | 995 | 21889 | 454 | 18365 |
| 8L-4S | | MI | 4944 | 2867 | 8343 | 1974 | 9074 | 1623 | 9573 | 1330 | 10390 | 856 | 11897 | 454 | 9516 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 18" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

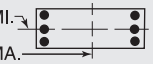
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 4.15 | MA | 9075 | 2867 | 14178 | 2161 | 15528 | 1796 | 16290 | 1503 | 17237 | 1013 | 20760 | 412 | 17697 |
| 9L-3S | | MI | 4982 | 2867 | 8566 | 1957 | 9362 | 1620 | 9926 | 1329 | 10850 | 848 | 12438 | 497 | 9554 |
| 20-#10 | 4.15 | MA | 8909 | 2867 | 13768 | 2167 | 15002 | 1815 | 15655 | 1521 | 16389 | 1031 | 19615 | 373 | 16995 |
| 10L-2S | | MI | 5073 | 2867 | 8851 | 1952 | 9727 | 1606 | 10372 | 1317 | 11456 | 839 | 13199 | 587 | 9543 |
| 20-#11 | 5.10 | MA | 9598 | 3027 | 15389 | 2246 | 17021 | 1868 | 18107 | 1538 | 19636 | 990 | 24061 | 348 | 21622 |
| 8L-4S | | MI | 5137 | 3027 | 8809 | 2057 | 9639 | 1680 | 10248 | 1359 | 11309 | 831 | 12797 | 324 | 11147 |
| 22-#10 | 4.57 | MA | 9501 | 2937 | 15234 | 2185 | 16869 | 1820 | 17938 | 1505 | 19443 | 989 | 23764 | 446 | 20318 |
| 8L-5S | | MI | 4982 | 2937 | 8440 | 2023 | 9189 | 1669 | 9706 | 1361 | 10537 | 847 | 12128 | 382 | 10181 |
| 22-#10 | 4.57 | MA | 9365 | 2937 | 14814 | 2205 | 16344 | 1828 | 17285 | 1522 | 18591 | 1007 | 22635 | 404 | 19640 |
| 9L-4S | | MI | 5062 | 2937 | 8628 | 2017 | 9439 | 1655 | 10018 | 1349 | 10996 | 850 | 12659 | 434 | 10367 |
| 22-#10 | 4.57 | MA | 9200 | 2937 | 14404 | 2211 | 15818 | 1847 | 16650 | 1540 | 17744 | 1025 | 21490 | 365 | 18930 |
| 10L-3S | | MI | 5100 | 2937 | 8851 | 2001 | 9727 | 1652 | 10372 | 1348 | 11456 | 842 | 13199 | 478 | 10447 |
| 24-#10 | 4.98 | MA | 9654 | 3007 | 15451 | 2249 | 17160 | 1859 | 18281 | 1542 | 19945 | 1002 | 24509 | 396 | 21583 |
| 9L-5S | | MI | 5100 | 3007 | 8725 | 2066 | 9555 | 1701 | 10152 | 1380 | 11143 | 842 | 12889 | 362 | 11044 |
| 24-#10 | 4.98 | MA | 9490 | 3007 | 15040 | 2255 | 16634 | 1878 | 17645 | 1559 | 19098 | 1019 | 23365 | 357 | 20864 |
| 10L-4S | | MI | 5179 | 3007 | 8913 | 2061 | 9805 | 1686 | 10464 | 1368 | 11603 | 845 | 13420 | 414 | 11220 |

## RECTANGULAR TIED COLUMNS 18" x 36"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.39 | MA | 9305 | 2540 | 14745 | 1870 | 15906 | 1574 | 16421 | 1343 | 16811 | 995 | 19374 | 863 | 7770 |
| 2E | | MI | 4516 | 2540 | 7344 | 1723 | 7643 | 1449 | 7718 | 1233 | 7671 | 906 | 8229 | 719 | 3680 |
| 4-#18 | 2.47 | MA | 10058 | 2734 | 16552 | 1977 | 18161 | 1649 | 19145 | 1385 | 20502 | 971 | 24472 | 834 | 13374 |
| 2E | | MI | 4781 | 2734 | 8033 | 1815 | 8481 | 1511 | 8723 | 1264 | 8925 | 855 | 9604 | 593 | 6012 |
| 6-#10 | 1.18 | MA | 9177 | 2502 | 14365 | 1864 | 15492 | 1572 | 15950 | 1345 | 16190 | 1008 | 18529 | 876 | 6687 |
| 2L-3S | | MI | 4384 | 2502 | 6924 | 1739 | 7162 | 1475 | 7154 | 1261 | 6922 | 940 | 7439 | 683 | 3228 |
| 6-#10 | 1.18 | MA | 8916 | 2502 | 13684 | 1875 | 14620 | 1582 | 14886 | 1366 | 14742 | 1027 | 16525 | 798 | 6711 |
| 3L-2S | | MI | 4480 | 2502 | 7209 | 1734 | 7527 | 1461 | 7599 | 1249 | 7528 | 931 | 8200 | 772 | 3201 |
| 6-#11 | 1.44 | MA | 9363 | 2550 | 14836 | 1884 | 16054 | 1585 | 16615 | 1351 | 17083 | 998 | 19757 | 865 | 8103 |
| 2L-3S | | MI | 4431 | 2550 | 7053 | 1749 | 7293 | 1481 | 7301 | 1260 | 7117 | 923 | 7614 | 624 | 3859 |
| 6-#11 | 1.44 | MA | 9053 | 2550 | 14011 | 1897 | 14996 | 1597 | 15325 | 1376 | 15328 | 1021 | 17326 | 767 | 8130 |
| 3L-2S | | MI | 4544 | 2550 | 7393 | 1744 | 7729 | 1465 | 7832 | 1247 | 7840 | 916 | 8491 | 734 | 3820 |
| 6-#14 | 2.08 | MA | 9824 | 2665 | 15925 | 1948 | 17417 | 1630 | 18265 | 1377 | 19320 | 985 | 22848 | 849 | 11478 |
| 2L-3S | | MI | 4554 | 2665 | 7344 | 1806 | 7643 | 1526 | 7718 | 1285 | 7671 | 905 | 8229 | 513 | 5309 |
| 6-#14 | 2.08 | MA | 9392 | 2665 | 14745 | 1967 | 15906 | 1647 | 16421 | 1411 | 16811 | 1016 | 19374 | 705 | 11483 |
| 3L-2S | | MI | 4711 | 2665 | 7823 | 1801 | 8257 | 1504 | 8467 | 1267 | 8684 | 895 | 9433 | 672 | 5250 |
| 6-#18 | 3.70 | MA | 10942 | 2955 | 18609 | 2115 | 20798 | 1748 | 22362 | 1445 | 24879 | 953 | 30533 | 809 | 19811 |
| 2L-3S | | MI | 4848 | 2955 | 8033 | 1958 | 8481 | 1642 | 8723 | 1349 | 8925 | 844 | 9604 | 208 | 8686 |
| 6-#18 | 3.70 | MA | 10226 | 2955 | 16552 | 2146 | 18161 | 1775 | 19145 | 1504 | 20502 | 1005 | 24472 | 545 | 19632 |
| 3L-2S | | MI | 5108 | 2955 | 8845 | 1953 | 9522 | 1610 | 9993 | 1325 | 10594 | 827 | 11536 | 490 | 8622 |
| 8-#9 | 1.23 | MA | 9230 | 2513 | 14462 | 1874 | 15633 | 1580 | 16129 | 1351 | 16438 | 1009 | 18876 | 877 | 7022 |
| 2L-4S | | MI | 4394 | 2513 | 6849 | 1765 | 7077 | 1486 | 7054 | 1268 | 6805 | 949 | 7341 | 672 | 3394 |
| 8-#9 | 1.23 | MA | 9025 | 2513 | 13924 | 1883 | 14944 | 1588 | 15287 | 1367 | 15293 | 1025 | 17291 | 815 | 7040 |
| 3E | | MI | 4427 | 2513 | 7026 | 1752 | 7306 | 1484 | 7335 | 1267 | 7170 | 942 | 7776 | 707 | 3367 |
| 8-#9 | 1.23 | MA | 8909 | 2513 | 13522 | 1901 | 14420 | 1605 | 14644 | 1375 | 14409 | 1031 | 16251 | 778 | 7050 |
| 4L-2S | | MI | 4504 | 2513 | 7253 | 1748 | 7597 | 1472 | 7690 | 1257 | 7653 | 935 | 8389 | 777 | 3346 |
| 8-#10 | 1.57 | MA | 9482 | 2572 | 15045 | 1908 | 16364 | 1603 | 17013 | 1364 | 17637 | 1003 | 20533 | 868 | 8827 |
| 2L-4S | | MI | 4463 | 2572 | 6986 | 1799 | 7239 | 1510 | 7246 | 1281 | 7068 | 942 | 7659 | 620 | 4197 |
| 8-#10 | 1.57 | MA | 9226 | 2572 | 14365 | 1919 | 15492 | 1614 | 15950 | 1385 | 16190 | 1021 | 18529 | 790 | 8843 |
| 3E | | MI | 4503 | 2572 | 7209 | 1783 | 7527 | 1507 | 7599 | 1280 | 7528 | 934 | 8200 | 663 | 4162 |
| 8-#10 | 1.57 | MA | 9082 | 2572 | 13855 | 1941 | 14830 | 1635 | 15135 | 1395 | 15071 | 1029 | 17210 | 742 | 8830 |
| 4L-2S | | MI | 4598 | 2572 | 7494 | 1778 | 7892 | 1493 | 8045 | 1268 | 8134 | 926 | 8961 | 752 | 4133 |
| 8-#11 | 1.93 | MA | 9729 | 2637 | 15661 | 1938 | 17111 | 1624 | 17905 | 1374 | 18839 | 991 | 22188 | 856 | 10696 |
| 2L-4S | | MI | 4526 | 2637 | 7126 | 1821 | 7384 | 1522 | 7409 | 1283 | 7289 | 924 | 7864 | 545 | 5009 |
| 8-#11 | 1.93 | MA | 9425 | 2637 | 14836 | 1951 | 16054 | 1636 | 16615 | 1399 | 17083 | 1014 | 19757 | 757 | 10711 |
| 3E | | MI | 4571 | 2637 | 7393 | 1803 | 7729 | 1520 | 7832 | 1284 | 7840 | 917 | 8491 | 595 | 4966 |
| 8-#11 | 1.93 | MA | 9255 | 2637 | 14216 | 1978 | 15248 | 1661 | 15625 | 1410 | 15793 | 1036 | 18144 | 698 | 10664 |
| 4L-2S | | MI | 4683 | 2637 | 7732 | 1798 | 8164 | 1504 | 8363 | 1270 | 8562 | 909 | 9367 | 704 | 4928 |

## RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis



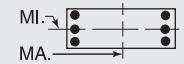

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.78 | MA | 9919 | 2789 | 15925 | 2044 | 17417 | 1703 | 18265 | 1445 | 19320 | 1006 | 22848 | 691 | 15146 |
| 3E | | MI | 4751 | 2789 | 7823 | 1884 | 8257 | 1582 | 8467 | 1318 | 8684 | 894 | 9433 | 466 | 6840 |
| 8-#14 | 2.78 | MA | 9682 | 2789 | 15037 | 2083 | 16265 | 1739 | 16847 | 1460 | 17473 | 1037 | 20528 | 605 | 14947 |
| 4L-2S | | MI | 4906 | 2789 | 8302 | 1879 | 8871 | 1560 | 9216 | 1301 | 9697 | 884 | 10637 | 624 | 6792 |
| 8-#18 | 4.94 | MA | 11131 | 3177 | 18609 | 2284 | 20798 | 1874 | 22362 | 1564 | 24879 | 987 | 30533 | 521 | 25990 |
| 3E | | MI | 5179 | 3177 | 8845 | 2096 | 9522 | 1741 | 9993 | 1409 | 10594 | 816 | 11536 | 105 | 11204 |
| 8-#18 | 4.94 | MA | 10736 | 3177 | 17053 | 2351 | 18778 | 1937 | 19880 | 1588 | 21645 | 1038 | 26434 | 365 | 23478 |
| 4L-2S | | MI | 5434 | 3177 | 9658 | 2091 | 10564 | 1709 | 11264 | 1385 | 12262 | 799 | 13468 | 387 | 11197 |
| 10-#10 | 1.96 | MA | 9785 | 2643 | 15725 | 1951 | 17236 | 1635 | 18077 | 1384 | 19085 | 997 | 22537 | 860 | 10961 |
| 2L-5S | | MI | 4499 | 2643 | 7082 | 1848 | 7354 | 1556 | 7380 | 1313 | 7215 | 934 | 7890 | 548 | 5127 |
| 10-#10 | 1.96 | MA | 9534 | 2643 | 15045 | 1963 | 16364 | 1645 | 17013 | 1404 | 17637 | 1016 | 20533 | 782 | 10969 |
| 3L-4S | | MI | 4582 | 2643 | 7271 | 1843 | 7604 | 1541 | 7692 | 1300 | 7675 | 937 | 8420 | 600 | 5111 |
| 10-#10 | 1.96 | MA | 9391 | 2643 | 14535 | 1985 | 15702 | 1667 | 16199 | 1414 | 16518 | 1023 | 19214 | 734 | 10942 |
| 4L-3S | | MI | 4622 | 2643 | 7494 | 1827 | 7892 | 1538 | 8045 | 1299 | 8134 | 928 | 8961 | 643 | 5081 |
| 10-#10 | 1.96 | MA | 9178 | 2643 | 14107 | 1996 | 15136 | 1677 | 15491 | 1434 | 15525 | 1042 | 17870 | 697 | 10808 |
| 5L-2S | | MI | 4716 | 2643 | 7779 | 1822 | 8258 | 1524 | 8491 | 1287 | 8741 | 920 | 9722 | 732 | 5054 |
| 10-#11 | 2.41 | MA | 9795 | 2723 | 15661 | 2005 | 17111 | 1674 | 17905 | 1423 | 18839 | 1007 | 22188 | 748 | 13281 |
| 3L-4S | | MI | 4667 | 2723 | 7465 | 1875 | 7819 | 1561 | 7940 | 1307 | 8011 | 918 | 8740 | 516 | 6090 |
| 10-#11 | 2.41 | MA | 9627 | 2723 | 15042 | 2032 | 16306 | 1700 | 16915 | 1433 | 17549 | 1029 | 20575 | 689 | 13219 |
| 4L-3S | | MI | 4711 | 2723 | 7732 | 1857 | 8164 | 1559 | 8363 | 1307 | 8562 | 910 | 9367 | 565 | 6056 |
| 10-#11 | 2.41 | MA | 9372 | 2723 | 14526 | 2045 | 15617 | 1712 | 16053 | 1458 | 16270 | 1037 | 18934 | 640 | 12743 |
| 5L-2S | | MI | 4822 | 2723 | 8072 | 1852 | 8599 | 1543 | 8894 | 1294 | 9285 | 902 | 10244 | 675 | 6022 |
| 10-#14 | 3.47 | MA | 10208 | 2914 | 16216 | 2161 | 17776 | 1795 | 18691 | 1494 | 19982 | 1027 | 24001 | 591 | 18549 |
| 4L-3S | | MI | 4947 | 2914 | 8302 | 1962 | 8871 | 1638 | 9216 | 1352 | 9697 | 883 | 10637 | 419 | 8355 |
| 10-#14 | 3.47 | MA | 9850 | 2914 | 15476 | 2179 | 16788 | 1812 | 17456 | 1529 | 18150 | 1038 | 21647 | 519 | 17254 |
| 5L-2S | | MI | 5100 | 2914 | 8781 | 1956 | 9485 | 1616 | 9965 | 1335 | 10711 | 873 | 11841 | 577 | 8319 |
| 10-#18 | 6.17 | MA | 11639 | 3398 | 19110 | 2489 | 21415 | 2036 | 23097 | 1648 | 26022 | 1021 | 32494 | 341 | 29744 |
| 4L-3S | | MI | 5509 | 3398 | 9658 | 2235 | 10564 | 1841 | 11264 | 1469 | 12262 | 789 | 13468 | 2 | 13460 |
| 10-#18 | 6.17 | MA | 11032 | 3398 | 17811 | 2520 | 19682 | 2064 | 20929 | 1707 | 22811 | 1037 | 28351 | 203 | 27242 |
| 5L-2S | | MI | 5764 | 3398 | 10470 | 2230 | 11605 | 1809 | 12534 | 1445 | 13930 | 771 | 15399 | 284 | 13752 |
| 12-#10 | 2.35 | MA | 9839 | 2713 | 15725 | 2007 | 17236 | 1677 | 18077 | 1423 | 19085 | 1010 | 22537 | 774 | 13090 |
| 3L-5S | | MI | 4618 | 2713 | 7367 | 1892 | 7720 | 1587 | 7826 | 1332 | 7822 | 928 | 8651 | 528 | 5979 |
| 12-#10 | 2.35 | MA | 9698 | 2713 | 15216 | 2029 | 16574 | 1698 | 17263 | 1433 | 17966 | 1018 | 21219 | 727 | 13052 |
| 4E | | MI | 4701 | 2713 | 7556 | 1887 | 7970 | 1573 | 8138 | 1319 | 8281 | 931 | 9181 | 580 | 6016 |
| 12-#10 | 2.35 | MA | 9489 | 2713 | 14788 | 2040 | 16008 | 1709 | 16555 | 1453 | 16972 | 1037 | 19874 | 689 | 12869 |
| 5L-3S | | MI | 4740 | 2713 | 7779 | 1871 | 8258 | 1570 | 8491 | 1318 | 8741 | 923 | 9722 | 623 | 5991 |
| 12-#10 | 2.35 | MA | 9337 | 2713 | 14336 | 2045 | 15439 | 1730 | 15854 | 1463 | 16029 | 1055 | 18670 | 635 | 12366 |
| 6L-2S | | MI | 4834 | 2713 | 8064 | 1866 | 8623 | 1556 | 8937 | 1306 | 9347 | 915 | 10483 | 713 | 5967 |
| 12-#11 | 2.89 | MA | 9995 | 2809 | 15867 | 2086 | 17364 | 1739 | 18206 | 1457 | 19305 | 1022 | 23006 | 679 | 15774 |
| 4E | | MI | 4808 | 2809 | 7805 | 1929 | 8254 | 1600 | 8471 | 1330 | 8734 | 911 | 9617 | 486 | 7162 |
| 12-#11 | 2.89 | MA | 9745 | 2809 | 15351 | 2099 | 16675 | 1751 | 17343 | 1482 | 18025 | 1030 | 21365 | 631 | 15249 |
| 5L-3S | | MI | 4851 | 2809 | 8072 | 1910 | 8599 | 1598 | 8894 | 1331 | 9285 | 903 | 10244 | 536 | 7137 |
| 12-#11 | 2.89 | MA | 9563 | 2809 | 14803 | 2105 | 15990 | 1777 | 16490 | 1492 | 16877 | 1053 | 19896 | 562 | 14699 |
| 6L-2S | | MI | 4961 | 2809 | 8411 | 1906 | 9035 | 1582 | 9425 | 1317 | 10007 | 895 | 11120 | 646 | 7108 |
| 12-#14 | 4.17 | MA | 10378 | 3038 | 16655 | 2257 | 18300 | 1868 | 19300 | 1563 | 20658 | 1028 | 25120 | 505 | 20862 |
| 5L-3S | | MI | 5143 | 3038 | 8781 | 2040 | 9485 | 1693 | 9965 | 1386 | 10711 | 872 | 11841 | 371 | 9860 |
| 12-#14 | 4.17 | MA | 10124 | 3038 | 15878 | 2265 | 17318 | 1904 | 18076 | 1578 | 19013 | 1059 | 23010 | 405 | 19737 |
| 6L-2S | | MI | 5294 | 3038 | 9260 | 2034 | 10098 | 1672 | 10713 | 1369 | 11724 | 863 | 13045 | 530 | 9835 |
| 12-#18 | 7.41 | MA | 11942 | 3619 | 19868 | 2658 | 22319 | 2163 | 24146 | 1767 | 27188 | 1019 | 34411 | 178 | 33436 |
| 5L-3S | | MI | 5838 | 3619 | 10470 | 2373 | 11605 | 1940 | 12534 | 1530 | 13930 | 761 | 15399 | -101 | 15311 |
| 12-#18 | 7.41 | MA | 11512 | 3619 | 18533 | 2674 | 20595 | 2226 | 21999 | 1791 | 24301 | 1071 | 30678 | -2 | 30669 |
| 6L-2S | | MI | 6086 | 3619 | 11282 | 2368 | 12646 | 1908 | 13804 | 1506 | 15598 | 743 | 17331 | 181 | 16294 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis

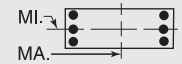


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.74 | MA | 10004 | 2783 | 15896 | 2073 | 17446 | 1730 | 18327 | 1452 | 19413 | 1012 | 23223 | 719 | 15162 |
| 4L-5S | | MI | 4737 | 2783 | 7652 | 1936 | 8085 | 1619 | 8271 | 1351 | 8428 | 922 | 9412 | 508 | 6836 |
| 14-#10 | 2.74 | MA | 9797 | 2783 | 15468 | 2084 | 16881 | 1740 | 17618 | 1473 | 18420 | 1031 | 21878 | 681 | 14937 |
| 5L-4S | | MI | 4819 | 2783 | 7841 | 1931 | 8335 | 1605 | 8583 | 1339 | 8888 | 925 | 9943 | 560 | 6915 |
| 14-#10 | 2.74 | MA | 9649 | 2783 | 15016 | 2088 | 16311 | 1761 | 16918 | 1482 | 17476 | 1050 | 20675 | 627 | 14451 |
| 6L-3S | | MI | 4858 | 2783 | 8064 | 1915 | 8623 | 1601 | 8937 | 1338 | 9347 | 917 | 10483 | 603 | 6896 |
| 14-#10 | 2.74 | MA | 9484 | 2783 | 14533 | 2107 | 15725 | 1766 | 16246 | 1502 | 16500 | 1057 | 19265 | 581 | 14064 |
| 7L-2S | | MI | 4951 | 2783 | 8349 | 1910 | 8989 | 1587 | 9382 | 1325 | 9954 | 909 | 11244 | 693 | 6875 |
| 14-#11 | 3.37 | MA | 10115 | 2896 | 16176 | 2153 | 17732 | 1790 | 18634 | 1505 | 19781 | 1023 | 23796 | 621 | 17761 |
| 5L-4S | | MI | 4948 | 2896 | 8144 | 1983 | 8690 | 1639 | 9002 | 1354 | 9456 | 904 | 10493 | 457 | 8228 |
| 14-#11 | 3.37 | MA | 9938 | 2896 | 15628 | 2158 | 17047 | 1816 | 17780 | 1516 | 18633 | 1046 | 22327 | 553 | 17232 |
| 6L-3S | | MI | 4991 | 2896 | 8411 | 1964 | 9035 | 1636 | 9425 | 1354 | 10007 | 896 | 11120 | 507 | 8211 |
| 14-#11 | 3.37 | MA | 9742 | 2896 | 15041 | 2180 | 16336 | 1821 | 16966 | 1541 | 17515 | 1068 | 20601 | 494 | 16488 |
| 7L-2S | | MI | 5099 | 2896 | 8751 | 1960 | 9470 | 1620 | 9956 | 1341 | 10730 | 888 | 11997 | 617 | 8187 |
| 14-#14 | 4.86 | MA | 10657 | 3163 | 17057 | 2343 | 18829 | 1960 | 19920 | 1612 | 21522 | 1049 | 26484 | 391 | 23323 |
| 6L-3S | | MI | 5339 | 3163 | 9260 | 2118 | 10098 | 1749 | 10713 | 1420 | 11724 | 862 | 13045 | 324 | 11358 |
| 14-#14 | 4.86 | MA | 10381 | 3163 | 16217 | 2374 | 17821 | 1969 | 18753 | 1646 | 19919 | 1080 | 24003 | 305 | 22060 |
| 7L-2S | | MI | 5488 | 3163 | 9738 | 2112 | 10712 | 1728 | 11462 | 1403 | 12737 | 852 | 14249 | 482 | 11344 |
| 16-#10 | 3.14 | MA | 10103 | 2853 | 16148 | 2128 | 17753 | 1772 | 18682 | 1492 | 19867 | 1025 | 23882 | 674 | 17008 |
| 5E | | MI | 4856 | 2853 | 7937 | 1980 | 8450 | 1650 | 8717 | 1370 | 9034 | 917 | 10173 | 488 | 7665 |
| 16-#10 | 3.14 | MA | 9958 | 2853 | 15697 | 2132 | 17183 | 1793 | 17981 | 1501 | 18924 | 1044 | 22679 | 620 | 16539 |
| 6L-4S | | MI | 4937 | 2853 | 8126 | 1975 | 8701 | 1636 | 9029 | 1358 | 9494 | 920 | 10704 | 540 | 7811 |
| 16-#10 | 3.14 | MA | 9794 | 2853 | 15214 | 2150 | 16597 | 1798 | 17310 | 1522 | 17948 | 1052 | 21269 | 573 | 16144 |
| 7L-3S | | MI | 4976 | 2853 | 8349 | 1958 | 8989 | 1633 | 9382 | 1357 | 9954 | 912 | 11244 | 583 | 7797 |
| 16-#10 | 3.14 | MA | 9616 | 2853 | 14792 | 2159 | 16013 | 1816 | 16589 | 1527 | 17028 | 1070 | 20047 | 530 | 15519 |
| 8L-2S | | MI | 5068 | 2853 | 8634 | 1953 | 9354 | 1619 | 9828 | 1345 | 10560 | 903 | 12005 | 673 | 7778 |
| 16-#11 | 3.85 | MA | 10310 | 2982 | 16453 | 2212 | 18105 | 1854 | 19070 | 1539 | 20388 | 1039 | 24758 | 543 | 19769 |
| 6L-4S | | MI | 5087 | 2982 | 8484 | 2037 | 9125 | 1677 | 9533 | 1377 | 10179 | 897 | 11370 | 428 | 9279 |
| 16-#11 | 3.85 | MA | 10116 | 2982 | 15866 | 2234 | 17393 | 1860 | 18257 | 1564 | 19270 | 1061 | 23032 | 485 | 19015 |
| 7L-3S | | MI | 5130 | 2982 | 8751 | 2018 | 9470 | 1675 | 9956 | 1378 | 10730 | 889 | 11997 | 478 | 9281 |
| 16-#11 | 3.85 | MA | 9908 | 2982 | 15353 | 2244 | 16683 | 1882 | 17388 | 1571 | 18079 | 1069 | 21540 | 429 | 18271 |
| 8L-2S | | MI | 5237 | 2982 | 9090 | 2013 | 9905 | 1659 | 10487 | 1365 | 11452 | 881 | 12873 | 587 | 9261 |
| 16-#14 | 5.56 | MA | 10911 | 3287 | 17396 | 2451 | 19332 | 2025 | 20597 | 1680 | 22428 | 1070 | 27476 | 291 | 25660 |
| 7L-3S | | MI | 5534 | 3287 | 9738 | 2195 | 10712 | 1805 | 11462 | 1454 | 12737 | 851 | 14249 | 277 | 12847 |
| 16-#14 | 5.56 | MA | 10619 | 3287 | 16660 | 2465 | 18315 | 2055 | 19367 | 1690 | 20721 | 1081 | 25333 | 209 | 23976 |
| 8L-2S | | MI | 5682 | 3287 | 10217 | 2190 | 11326 | 1784 | 12211 | 1437 | 13750 | 841 | 15453 | 435 | 12848 |
| 18-#10 | 3.53 | MA | 10266 | 2924 | 16377 | 2176 | 18055 | 1824 | 19045 | 1520 | 20371 | 1038 | 24683 | 612 | 18630 |
| 6L-5S | | MI | 4975 | 2924 | 8222 | 2024 | 8816 | 1682 | 9163 | 1389 | 9641 | 911 | 10934 | 468 | 8523 |
| 18-#10 | 3.53 | MA | 10102 | 2924 | 15894 | 2194 | 17469 | 1829 | 18374 | 1541 | 19395 | 1046 | 23273 | 565 | 18226 |
| 7L-4S | | MI | 5055 | 2924 | 8411 | 2019 | 9066 | 1668 | 9475 | 1377 | 10101 | 914 | 11465 | 520 | 8705 |
| 18-#10 | 3.53 | MA | 9929 | 2924 | 15472 | 2203 | 16885 | 1847 | 17652 | 1546 | 18475 | 1065 | 22051 | 522 | 17607 |
| 8L-3S | | MI | 5094 | 2924 | 8634 | 2002 | 9354 | 1665 | 9828 | 1376 | 10560 | 906 | 12005 | 564 | 8694 |
| 18-#10 | 3.53 | MA | 9776 | 2924 | 15020 | 2222 | 16326 | 1855 | 16957 | 1563 | 17568 | 1084 | 20854 | 480 | 16956 |
| 9L-2S | | MI | 5185 | 2924 | 8919 | 1997 | 9719 | 1650 | 10274 | 1364 | 11167 | 898 | 12767 | 653 | 8679 |
| 18-#11 | 4.33 | MA | 10486 | 3068 | 16691 | 2288 | 18451 | 1899 | 19547 | 1588 | 21026 | 1054 | 25463 | 475 | 21539 |
| 7L-4S | | MI | 5227 | 3068 | 8824 | 2091 | 9560 | 1716 | 10064 | 1401 | 10901 | 890 | 12246 | 399 | 10220 |
| 18-#11 | 4.33 | MA | 10283 | 3068 | 16178 | 2298 | 17741 | 1920 | 18678 | 1594 | 19835 | 1062 | 23971 | 420 | 20780 |
| 8L-3S | | MI | 5269 | 3068 | 9090 | 2072 | 9905 | 1714 | 10487 | 1401 | 11452 | 882 | 12873 | 448 | 10347 |
| 18-#11 | 4.33 | MA | 10095 | 3068 | 15633 | 2322 | 17060 | 1929 | 17831 | 1615 | 18730 | 1085 | 22502 | 368 | 19784 |
| 9L-2S | | MI | 5376 | 3068 | 9430 | 2067 | 10341 | 1698 | 11018 | 1388 | 12175 | 874 | 13750 | 558 | 10332 |
| 18-#14 | 6.25 | MA | 11151 | 3412 | 17839 | 2542 | 19826 | 2111 | 21211 | 1724 | 23230 | 1071 | 28807 | 195 | 27555 |
| 8L-3S | | MI | 5729 | 3412 | 10217 | 2273 | 11326 | 1861 | 12211 | 1488 | 13750 | 840 | 15453 | 229 | 14332 |
| 20-#10 | 3.92 | MA | 10409 | 2994 | 16574 | 2238 | 18341 | 1861 | 19438 | 1560 | 20843 | 1040 | 25278 | 557 | 20310 |
| 7L-5S | | MI | 5093 | 2994 | 8508 | 2068 | 9181 | 1713 | 9609 | 1408 | 10247 | 906 | 11695 | 448 | 9384 |
| 20-#10 | 3.92 | MA | 10241 | 2994 | 16152 | 2246 | 17757 | 1879 | 18716 | 1565 | 19923 | 1059 | 24055 | 514 | 19695 |
| 8L-4S | | MI | 5173 | 2994 | 8696 | 2063 | 9431 | 1699 | 9921 | 1396 | 10707 | 909 | 12226 | 500 | 9590 |
| 20-#10 | 3.92 | MA | 10090 | 2994 | 15700 | 2266 | 17198 | 1886 | 18020 | 1583 | 19015 | 1078 | 22858 | 472 | 19033 |
| 9L-3S | | MI | 5212 | 2994 | 8919 | 2046 | 9719 | 1696 | 10274 | 1395 | 11167 | 900 | 12767 | 544 | 9590 |

## RECTANGULAR TIED COLUMNS 18" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 3.92 | MA | 9910 | 2994 | 15263 | 2272 | 16637 | 1906 | 17343 | 1601 | 18041 | 1084 | 21641 | 435 | 18337 |
| 10L-2S | | MI | 5302 | 2994 | 9204 | 2041 | 10085 | 1682 | 10720 | 1383 | 11773 | 892 | 13528 | 633 | 9577 |
| 20-#11 | 4.81 | MA | 10655 | 3154 | 17003 | 2351 | 18798 | 1959 | 19969 | 1618 | 21590 | 1055 | 26401 | 410 | 23290 |
| 8L-4S | | MI | 5366 | 3154 | 9163 | 2145 | 9996 | 1755 | 10595 | 1424 | 11624 | 883 | 13123 | 369 | 11231 |
| 20-#11 | 4.81 | MA | 10474 | 3154 | 16458 | 2376 | 18118 | 1968 | 19122 | 1638 | 20485 | 1078 | 24933 | 358 | 22301 |
| 9L-3S | | MI | 5408 | 3154 | 9430 | 2126 | 10341 | 1753 | 11018 | 1425 | 12175 | 875 | 13750 | 419 | 11411 |
| 22-#10 | 4.31 | MA | 10549 | 3064 | 16832 | 2290 | 18629 | 1910 | 19780 | 1584 | 21370 | 1054 | 26060 | 506 | 21783 |
| 8L-5S | | MI | 5211 | 3064 | 8793 | 2112 | 9546 | 1745 | 10054 | 1428 | 10854 | 900 | 12457 | 428 | 10246 |
| 22-#10 | 4.31 | MA | 10402 | 3064 | 16380 | 2310 | 18070 | 1918 | 19084 | 1602 | 20463 | 1072 | 24862 | 464 | 21111 |
| 9L-4S | | MI | 5291 | 3064 | 8981 | 2106 | 9797 | 1731 | 10366 | 1415 | 11313 | 903 | 12987 | 481 | 10440 |
| 22-#10 | 4.31 | MA | 10223 | 3064 | 15943 | 2316 | 17509 | 1937 | 18407 | 1620 | 19489 | 1079 | 23645 | 427 | 20405 |
| 10L-3S | | MI | 5329 | 3064 | 9204 | 2090 | 10085 | 1728 | 10720 | 1414 | 11773 | 895 | 13528 | 524 | 10483 |
| 22-#11 | 5.30 | MA | 10850 | 3241 | 17283 | 2430 | 19175 | 2006 | 20412 | 1662 | 22241 | 1071 | 27364 | 349 | 24818 |
| 9L-4S | | MI | 5505 | 3241 | 9503 | 2199 | 10431 | 1794 | 11126 | 1448 | 12347 | 876 | 13999 | 340 | 12245 |
| 24-#10 | 4.70 | MA | 10712 | 3135 | 17061 | 2354 | 18942 | 1949 | 20148 | 1621 | 21910 | 1067 | 26866 | 457 | 23188 |
| 9L-5S | | MI | 5329 | 3135 | 9078 | 2155 | 9912 | 1776 | 10500 | 1447 | 11460 | 894 | 13218 | 408 | 11110 |
| 24-#10 | 4.70 | MA | 10534 | 3135 | 16623 | 2360 | 18381 | 1969 | 19471 | 1639 | 20936 | 1073 | 25650 | 419 | 22473 |
| 10L-4S | | MI | 5408 | 3135 | 9266 | 2150 | 10162 | 1762 | 10812 | 1434 | 11920 | 897 | 13748 | 461 | 11293 |

## RECTANGULAR TIED COLUMNS 20" x 20"

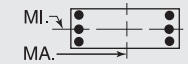
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.19 | MA | 3095 | 1546 | 4951 | 1095 | 5219 | 923 | 5300 | 789 | 5291 | 589 | 5901 | 502 | 2228 |
| 2L-3S | | MI | 3022 | 1546 | 4743 | 1099 | 4952 | 933 | 4975 | 798 | 4848 | 596 | 5310 | 447 | 2245 |
| 6-#9 | 1.50 | MA | 3161 | 1580 | 5116 | 1113 | 5422 | 935 | 5546 | 796 | 5624 | 584 | 6322 | 491 | 2757 |
| 2L-3S | | MI | 3070 | 1580 | 4854 | 1118 | 5087 | 948 | 5137 | 807 | 5067 | 593 | 5588 | 421 | 2779 |
| 6-#10 | 1.90 | MA | 3245 | 1625 | 5324 | 1137 | 5681 | 952 | 5858 | 805 | 6047 | 578 | 6852 | 477 | 3422 |
| 2L-3S | | MI | 3132 | 1625 | 4995 | 1143 | 5259 | 968 | 5343 | 819 | 5347 | 588 | 5936 | 388 | 3449 |
| 6-#11 | 2.34 | MA | 3321 | 1673 | 5532 | 1156 | 5926 | 964 | 6147 | 810 | 6437 | 567 | 7265 | 448 | 4093 |
| 2L-3S | | MI | 3188 | 1673 | 5139 | 1162 | 5421 | 982 | 5532 | 825 | 5600 | 578 | 6201 | 338 | 4124 |
| 6-#14 | 3.38 | MA | 3518 | 1788 | 6031 | 1219 | 6550 | 1008 | 6902 | 835 | 7462 | 554 | 8468 | 401 | 5688 |
| 2L-3S | | MI | 3335 | 1788 | 5475 | 1227 | 5836 | 1033 | 6032 | 856 | 6277 | 567 | 6994 | 242 | 5708 |
| 6-#18 | 6.00 | MA | 3989 | 2078 | 7230 | 1384 | 8057 | 1125 | 8729 | 902 | 9929 | 519 | 11211 | 257 | 9502 |
| 2L-3S | | MI | 3686 | 2078 | 6280 | 1395 | 6838 | 1164 | 7242 | 933 | 7911 | 536 | 8807 | -25 | 8785 |
| 8-#8 | 1.58 | MA | 3183 | 1589 | 5159 | 1122 | 5486 | 942 | 5626 | 801 | 5735 | 585 | 6491 | 494 | 2899 |
| 2L-4S | | MI | 3077 | 1589 | 4791 | 1138 | 5011 | 956 | 5045 | 812 | 4959 | 600 | 5487 | 409 | 2934 |
| 8-#9 | 2.00 | MA | 3271 | 1636 | 5377 | 1147 | 5758 | 960 | 5955 | 811 | 6180 | 580 | 7057 | 481 | 3593 |
| 2L-4S | | MI | 3140 | 1636 | 4914 | 1167 | 5161 | 977 | 5224 | 825 | 5206 | 597 | 5806 | 373 | 3629 |
| 8-#10 | 2.54 | MA | 3382 | 1695 | 5653 | 1181 | 6103 | 983 | 6372 | 824 | 6747 | 572 | 7767 | 462 | 4468 |
| 2L-4S | | MI | 3220 | 1695 | 5069 | 1205 | 5351 | 1004 | 5453 | 841 | 5520 | 593 | 6207 | 326 | 4489 |
| 8-#11 | 3.12 | MA | 3483 | 1760 | 5926 | 1210 | 6430 | 1003 | 6763 | 833 | 7274 | 561 | 8330 | 426 | 5342 |
| 2L-4S | | MI | 3296 | 1760 | 5226 | 1237 | 5529 | 1025 | 5661 | 851 | 5803 | 582 | 6511 | 262 | 5200 |
| 8-#14 | 4.50 | MA | 3746 | 1912 | 6588 | 1297 | 7263 | 1064 | 7773 | 869 | 8646 | 544 | 9941 | 364 | 7441 |
| 2L-4S | | MI | 3489 | 1912 | 5596 | 1334 | 5987 | 1094 | 6211 | 891 | 6562 | 571 | 7419 | 130 | 6805 |
| 10-#10 | 3.17 | MA | 3519 | 1766 | 5982 | 1225 | 6524 | 1015 | 6886 | 843 | 7446 | 567 | 8682 | 447 | 5508 |
| 2L-5S | | MI | 3263 | 1766 | 5183 | 1255 | 5487 | 1051 | 5611 | 874 | 5694 | 587 | 6484 | 260 | 5194 |
| 10-#10 | 3.17 | MA | 3410 | 1766 | 5653 | 1231 | 6103 | 1031 | 6372 | 857 | 6747 | 577 | 7767 | 358 | 5521 |
| 3L-4S | | MI | 3360 | 1766 | 5398 | 1249 | 5773 | 1035 | 5967 | 860 | 6220 | 588 | 7122 | 311 | 5471 |
| 10-#11 | 3.90 | MA | 3518 | 1846 | 5926 | 1270 | 6430 | 1059 | 6763 | 872 | 7274 | 565 | 8330 | 293 | 6591 |
| 3L-4S | | MI | 3461 | 1846 | 5620 | 1291 | 6034 | 1064 | 6276 | 874 | 6641 | 576 | 7576 | 239 | 6346 |
| 10-#14 | 5.63 | MA | 3798 | 2037 | 6588 | 1383 | 7263 | 1145 | 7773 | 924 | 8646 | 547 | 9941 | 168 | 9152 |
| 3L-4S | | MI | 3721 | 2037 | 6153 | 1411 | 6700 | 1149 | 7082 | 925 | 7747 | 561 | 8892 | 93 | 8439 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis

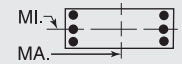



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.15 | MA | 3742 | 1696 | 5971 | 1208 | 6302 | 1018 | 6404 | 871 | 6393 | 652 | 7156 | 559 | 2639 |
| 2E | | MI | 3390 | 1696 | 5429 | 1193 | 5701 | 1006 | 5775 | 860 | 5741 | 643 | 6347 | 544 | 2387 |
| 4-#11 | 1.42 | MA | 3802 | 1728 | 6138 | 1217 | 6491 | 1023 | 6624 | 871 | 6687 | 642 | 7487 | 541 | 3167 |
| 2E | | MI | 3441 | 1728 | 5574 | 1201 | 5863 | 1010 | 5962 | 860 | 5992 | 633 | 6608 | 522 | 2857 |
| 4-#14 | 2.05 | MA | 3955 | 1805 | 6524 | 1256 | 6968 | 1050 | 7198 | 886 | 7465 | 631 | 8443 | 514 | 4404 |
| 2E | | MI | 3573 | 1805 | 5911 | 1240 | 6277 | 1036 | 6461 | 874 | 6668 | 622 | 7399 | 489 | 3953 |
| 4-#18 | 3.64 | MA | 4321 | 1998 | 7455 | 1361 | 8127 | 1124 | 8598 | 927 | 9363 | 606 | 10664 | 432 | 7378 |
| 2E | | MI | 3887 | 1998 | 6718 | 1343 | 7279 | 1108 | 7669 | 914 | 8299 | 594 | 9206 | 389 | 6564 |
| 6-#8 | 1.08 | MA | 3728 | 1687 | 5919 | 1210 | 6254 | 1021 | 6352 | 874 | 6326 | 657 | 7103 | 569 | 2484 |
| 2L-3S | | MI | 3305 | 1687 | 5175 | 1200 | 5394 | 1019 | 5407 | 873 | 5244 | 656 | 5723 | 499 | 2264 |
| 6-#8 | 1.08 | MA | 3644 | 1687 | 5683 | 1215 | 5952 | 1032 | 5984 | 884 | 5825 | 665 | 6415 | 513 | 2501 |
| 3L-2S | | MI | 3378 | 1687 | 5384 | 1196 | 5661 | 1009 | 5733 | 864 | 5688 | 649 | 6314 | 555 | 2248 |
| 6-#9 | 1.36 | MA | 3805 | 1722 | 6106 | 1228 | 6486 | 1033 | 6632 | 881 | 6704 | 652 | 7600 | 560 | 3081 |
| 2L-3S | | MI | 3353 | 1722 | 5288 | 1219 | 5529 | 1034 | 5569 | 882 | 5463 | 652 | 5999 | 473 | 2802 |
| 6-#9 | 1.36 | MA | 3700 | 1722 | 5810 | 1234 | 6106 | 1047 | 6169 | 894 | 6074 | 662 | 6743 | 490 | 3103 |
| 3L-2S | | MI | 3444 | 1722 | 5549 | 1214 | 5864 | 1021 | 5978 | 871 | 6019 | 644 | 6734 | 544 | 2780 |
| 6-#10 | 1.73 | MA | 3901 | 1767 | 6344 | 1252 | 6780 | 1050 | 6987 | 890 | 7186 | 646 | 8227 | 548 | 3834 |
| 2L-3S | | MI | 3415 | 1767 | 5429 | 1244 | 5701 | 1053 | 5775 | 894 | 5741 | 648 | 6347 | 440 | 3477 |
| 6-#10 | 1.73 | MA | 3770 | 1767 | 5971 | 1259 | 6302 | 1067 | 6404 | 906 | 6393 | 658 | 7156 | 459 | 3861 |
| 3L-2S | | MI | 3528 | 1767 | 5758 | 1237 | 6123 | 1038 | 6289 | 879 | 6441 | 637 | 7262 | 529 | 3449 |
| 6-#11 | 2.13 | MA | 3990 | 1815 | 6586 | 1271 | 7065 | 1062 | 7324 | 895 | 7639 | 635 | 8741 | 524 | 4598 |
| 2L-3S | | MI | 3471 | 1815 | 5574 | 1262 | 5863 | 1067 | 5962 | 899 | 5992 | 637 | 6608 | 390 | 4160 |
| 6-#11 | 2.13 | MA | 3836 | 1815 | 6138 | 1279 | 6491 | 1082 | 6624 | 913 | 6687 | 649 | 7487 | 414 | 4630 |
| 3L-2S | | MI | 3604 | 1815 | 5968 | 1255 | 6367 | 1049 | 6577 | 883 | 6829 | 626 | 7672 | 500 | 4125 |
| 6-#14 | 3.07 | MA | 4218 | 1929 | 7158 | 1334 | 7782 | 1106 | 8190 | 920 | 8815 | 622 | 10189 | 485 | 6417 |
| 2L-3S | | MI | 3618 | 1929 | 5911 | 1326 | 6277 | 1117 | 6461 | 929 | 6668 | 626 | 7399 | 293 | 5760 |
| 6-#14 | 3.07 | MA | 4006 | 1929 | 6524 | 1345 | 6968 | 1134 | 7198 | 944 | 7465 | 639 | 8443 | 326 | 6437 |
| 3L-2S | | MI | 3801 | 1929 | 6467 | 1318 | 6991 | 1092 | 7331 | 908 | 7852 | 612 | 8872 | 452 | 5728 |
| 6-#18 | 5.45 | MA | 4766 | 2220 | 8544 | 1499 | 9523 | 1223 | 10300 | 987 | 11680 | 589 | 13547 | 366 | 10798 |
| 2L-3S | | MI | 3969 | 2220 | 6718 | 1492 | 7279 | 1246 | 7669 | 1005 | 8299 | 594 | 9206 | 26 | 9132 |
| 6-#18 | 5.45 | MA | 4415 | 2220 | 7455 | 1514 | 8127 | 1267 | 8598 | 1025 | 9363 | 613 | 10664 | 84 | 10397 |
| 3L-2S | | MI | 4272 | 2220 | 7668 | 1481 | 8497 | 1208 | 9156 | 974 | 10317 | 576 | 11610 | 307 | 9559 |
| 8-#8 | 1.44 | MA | 3829 | 1731 | 6154 | 1237 | 6556 | 1040 | 6721 | 886 | 6827 | 653 | 7791 | 563 | 3240 |
| 2L-4S | | MI | 3360 | 1731 | 5223 | 1239 | 5453 | 1042 | 5477 | 888 | 5355 | 660 | 5899 | 461 | 2958 |
| 8-#8 | 1.44 | MA | 3746 | 1731 | 5919 | 1242 | 6254 | 1051 | 6352 | 896 | 6326 | 662 | 7103 | 508 | 3256 |
| 3E | | MI | 3394 | 1731 | 5384 | 1228 | 5661 | 1039 | 5733 | 885 | 5688 | 653 | 6314 | 491 | 2938 |
| 8-#8 | 1.44 | MA | 3705 | 1731 | 5738 | 1254 | 6020 | 1055 | 6065 | 899 | 5952 | 670 | 6624 | 476 | 3275 |
| 4L-2S | | MI | 3466 | 1731 | 5592 | 1223 | 5928 | 1029 | 6058 | 876 | 6131 | 645 | 6904 | 547 | 2921 |
| 8-#9 | 1.82 | MA | 3931 | 1777 | 6402 | 1262 | 6865 | 1058 | 7095 | 896 | 7334 | 648 | 8458 | 552 | 4025 |
| 2L-4S | | MI | 3423 | 1777 | 5347 | 1268 | 5603 | 1063 | 5656 | 900 | 5601 | 657 | 6218 | 425 | 3660 |
| 8-#9 | 1.82 | MA | 3827 | 1777 | 6106 | 1268 | 6486 | 1072 | 6632 | 909 | 6704 | 658 | 7600 | 482 | 4044 |
| 3E | | MI | 3465 | 1777 | 5549 | 1254 | 5864 | 1059 | 5978 | 897 | 6019 | 648 | 6734 | 463 | 3639 |
| 8-#9 | 1.82 | MA | 3777 | 1777 | 5879 | 1283 | 6191 | 1077 | 6270 | 912 | 6233 | 668 | 7002 | 443 | 4061 |
| 4L-2S | | MI | 3554 | 1777 | 5811 | 1248 | 6199 | 1046 | 6386 | 886 | 6576 | 639 | 7469 | 533 | 3619 |
| 8-#10 | 2.31 | MA | 4058 | 1837 | 6717 | 1296 | 7258 | 1081 | 7570 | 909 | 7979 | 640 | 9297 | 537 | 5017 |
| 2L-4S | | MI | 3503 | 1837 | 5503 | 1305 | 5793 | 1089 | 5884 | 915 | 5914 | 653 | 6618 | 378 | 4533 |
| 8-#10 | 2.31 | MA | 3930 | 1837 | 6344 | 1303 | 6780 | 1098 | 6987 | 925 | 7186 | 653 | 8227 | 448 | 5037 |
| 3E | | MI | 3554 | 1837 | 5758 | 1288 | 6123 | 1085 | 6289 | 913 | 6441 | 642 | 7262 | 425 | 4521 |
| 8-#10 | 2.31 | MA | 3868 | 1837 | 6057 | 1322 | 6409 | 1104 | 6531 | 929 | 6592 | 665 | 7478 | 399 | 5038 |
| 4L-2S | | MI | 3665 | 1837 | 6087 | 1281 | 6544 | 1069 | 6803 | 899 | 7141 | 632 | 8177 | 514 | 4498 |
| 8-#11 | 2.84 | MA | 4177 | 1901 | 7033 | 1324 | 7639 | 1101 | 8024 | 919 | 8591 | 629 | 9995 | 506 | 6016 |
| 2L-4S | | MI | 3579 | 1901 | 5661 | 1336 | 5971 | 1110 | 6091 | 925 | 6196 | 641 | 6919 | 313 | 5328 |
| 8-#11 | 2.84 | MA | 4026 | 1901 | 6586 | 1333 | 7065 | 1120 | 7324 | 936 | 7639 | 642 | 8741 | 397 | 6036 |
| 3E | | MI | 3636 | 1901 | 5968 | 1316 | 6367 | 1105 | 6577 | 923 | 6829 | 630 | 7672 | 367 | 5403 |
| 8-#11 | 2.84 | MA | 3956 | 1901 | 6240 | 1354 | 6617 | 1126 | 6774 | 940 | 6923 | 655 | 7859 | 339 | 5951 |
| 4L-2S | | MI | 3766 | 1901 | 6361 | 1309 | 6872 | 1087 | 7193 | 907 | 7667 | 619 | 8737 | 477 | 5378 |
| 8-#14 | 4.09 | MA | 4480 | 2054 | 7793 | 1412 | 8595 | 1162 | 9182 | 954 | 10165 | 612 | 11934 | 456 | 8413 |
| 2L-4S | | MI | 3772 | 2054 | 6032 | 1432 | 6428 | 1178 | 6640 | 964 | 6953 | 629 | 7824 | 181 | 6956 |

## RECTANGULAR TIED COLUMNS 20" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

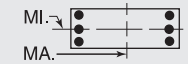
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 4.09 | MA | 4274 | 2054 | 7158 | 1422 | 7782 | 1189 | 8190 | 978 | 8815 | 629 | 10189 | 297 | 8405 |
| 3E | | MI | 3850 | 2054 | 6467 | 1404 | 6991 | 1173 | 7331 | 963 | 7852 | 616 | 8872 | 256 | 7491 |
| 8-#14 | 4.09 | MA | 4177 | 2054 | 6666 | 1453 | 7144 | 1197 | 7408 | 982 | 7797 | 647 | 8957 | 217 | 7802 |
| 4L-2S | | MI | 4029 | 2054 | 7024 | 1395 | 7704 | 1148 | 8202 | 942 | 9037 | 602 | 10346 | 415 | 7485 |
| 8-#18 | 7.27 | MA | 4869 | 2441 | 8544 | 1653 | 9523 | 1366 | 10300 | 1085 | 11680 | 596 | 13547 | 19 | 13482 |
| 3E | | MI | 4361 | 2441 | 7668 | 1630 | 8497 | 1346 | 9156 | 1066 | 10317 | 575 | 11610 | -56 | 11543 |
| 10-#10 | 2.89 | MA | 4215 | 1907 | 7089 | 1339 | 7736 | 1113 | 8153 | 929 | 8773 | 635 | 10368 | 526 | 6193 |
| 2L-5S | | MI | 3546 | 1907 | 5617 | 1355 | 5929 | 1137 | 6042 | 949 | 6089 | 646 | 6895 | 312 | 5291 |
| 10-#10 | 2.89 | MA | 4090 | 1907 | 6717 | 1347 | 7258 | 1130 | 7570 | 944 | 7979 | 647 | 9297 | 437 | 6207 |
| 3L-4S | | MI | 3643 | 1907 | 5832 | 1349 | 6215 | 1121 | 6399 | 935 | 6614 | 647 | 7533 | 363 | 5555 |
| 10-#10 | 2.89 | MA | 4028 | 1907 | 6430 | 1366 | 6887 | 1136 | 7114 | 948 | 7386 | 659 | 8549 | 388 | 6193 |
| 4L-3S | | MI | 3693 | 1907 | 6087 | 1331 | 6544 | 1116 | 6803 | 932 | 7141 | 637 | 8177 | 410 | 5556 |
| 10-#10 | 2.89 | MA | 3918 | 1907 | 6189 | 1373 | 6566 | 1153 | 6714 | 964 | 6794 | 660 | 7802 | 337 | 5889 |
| 5L-2S | | MI | 3802 | 1907 | 6416 | 1325 | 6966 | 1101 | 7318 | 918 | 7841 | 626 | 9093 | 499 | 5539 |
| 10-#11 | 3.55 | MA | 4216 | 1987 | 7033 | 1387 | 7639 | 1159 | 8024 | 960 | 8591 | 635 | 9995 | 379 | 7434 |
| 3L-4S | | MI | 3744 | 1987 | 6055 | 1390 | 6475 | 1148 | 6706 | 948 | 7033 | 634 | 7983 | 291 | 6470 |
| 10-#11 | 3.55 | MA | 4146 | 1987 | 6687 | 1408 | 7191 | 1165 | 7474 | 964 | 7875 | 648 | 9113 | 322 | 7257 |
| 4L-3S | | MI | 3801 | 1987 | 6361 | 1370 | 6872 | 1144 | 7193 | 946 | 7667 | 623 | 8737 | 345 | 6637 |
| 10-#11 | 3.55 | MA | 4015 | 1987 | 6395 | 1417 | 6803 | 1185 | 6990 | 981 | 7161 | 648 | 8239 | 258 | 6896 |
| 5L-2S | | MI | 3929 | 1987 | 6755 | 1363 | 7376 | 1126 | 7808 | 930 | 8504 | 612 | 9801 | 455 | 6621 |
| 10-#14 | 5.11 | MA | 4540 | 2178 | 7793 | 1500 | 8595 | 1245 | 9182 | 1012 | 10165 | 619 | 11934 | 269 | 10367 |
| 3L-4S | | MI | 4004 | 2178 | 6589 | 1510 | 7141 | 1234 | 7511 | 998 | 8138 | 619 | 9297 | 144 | 8585 |
| 10-#14 | 5.11 | MA | 4445 | 2178 | 7301 | 1531 | 7958 | 1253 | 8400 | 1016 | 9146 | 637 | 10702 | 188 | 9670 |
| 4L-3S | | MI | 4081 | 2178 | 7024 | 1482 | 7704 | 1229 | 8202 | 997 | 9037 | 606 | 10346 | 219 | 9215 |
| 12-#10 | 3.46 | MA | 4248 | 1977 | 7089 | 1391 | 7736 | 1161 | 8153 | 963 | 8773 | 641 | 10368 | 426 | 7371 |
| 3L-5S | | MI | 3686 | 1977 | 5946 | 1399 | 6351 | 1168 | 6557 | 968 | 6789 | 641 | 7810 | 297 | 6273 |
| 12-#10 | 3.46 | MA | 4187 | 1977 | 6803 | 1409 | 7365 | 1167 | 7697 | 967 | 8179 | 654 | 9619 | 377 | 7339 |
| 4E | | MI | 3781 | 1977 | 6161 | 1393 | 6636 | 1153 | 6913 | 954 | 7314 | 642 | 8448 | 348 | 6544 |
| 12-#10 | 3.46 | MA | 4078 | 1977 | 6562 | 1417 | 7044 | 1184 | 7297 | 983 | 7587 | 655 | 8873 | 326 | 7006 |
| 5L-3S | | MI | 3831 | 1977 | 6416 | 1375 | 6966 | 1148 | 7318 | 951 | 7841 | 631 | 9093 | 395 | 6587 |
| 12-#10 | 3.46 | MA | 3999 | 1977 | 6314 | 1435 | 6724 | 1190 | 6899 | 987 | 7054 | 667 | 8190 | 269 | 6782 |
| 6L-2S | | MI | 3939 | 1977 | 6745 | 1369 | 7388 | 1132 | 7832 | 937 | 8541 | 621 | 10008 | 484 | 6576 |
| 12-#11 | 4.25 | MA | 4335 | 2074 | 7135 | 1462 | 7765 | 1204 | 8173 | 987 | 8827 | 642 | 10367 | 304 | 8575 |
| 4E | | MI | 3909 | 2074 | 6448 | 1444 | 6980 | 1187 | 7322 | 972 | 7871 | 628 | 9047 | 268 | 7624 |
| 12-#11 | 4.25 | MA | 4206 | 2074 | 6843 | 1470 | 7377 | 1224 | 7690 | 1005 | 8113 | 641 | 9493 | 241 | 8238 |
| 5L-3S | | MI | 3965 | 2074 | 6755 | 1424 | 7376 | 1183 | 7808 | 970 | 8504 | 617 | 9801 | 322 | 7864 |
| 12-#14 | 6.14 | MA | 4711 | 2303 | 7935 | 1609 | 8771 | 1309 | 9392 | 1050 | 10496 | 627 | 12448 | 159 | 11552 |
| 4E | | MI | 4235 | 2303 | 7145 | 1588 | 7855 | 1289 | 8381 | 1032 | 9322 | 610 | 10770 | 107 | 10228 |
| 14-#10 | 4.04 | MA | 4346 | 2048 | 7176 | 1453 | 7843 | 1199 | 8280 | 987 | 8972 | 648 | 10690 | 366 | 8442 |
| 4L-5S | | MI | 3825 | 2048 | 6275 | 1443 | 6772 | 1200 | 7071 | 987 | 7488 | 635 | 8725 | 282 | 7260 |
| 14-#10 | 4.04 | MA | 4238 | 2048 | 6935 | 1461 | 7522 | 1216 | 7880 | 1002 | 8381 | 649 | 9944 | 315 | 8127 |
| 5L-4S | | MI | 3920 | 2048 | 6490 | 1437 | 7058 | 1184 | 7428 | 973 | 8014 | 636 | 9363 | 333 | 7513 |
| 14-#10 | 4.04 | MA | 4161 | 2048 | 6687 | 1478 | 7202 | 1222 | 7482 | 1006 | 7847 | 661 | 9261 | 258 | 7881 |
| 6L-3S | | MI | 3969 | 2048 | 6745 | 1419 | 7388 | 1179 | 7832 | 970 | 8541 | 625 | 10008 | 380 | 7613 |
| 14-#11 | 4.96 | MA | 4396 | 2160 | 7290 | 1524 | 7950 | 1262 | 8389 | 1028 | 9065 | 634 | 10747 | 224 | 9586 |
| 5L-4S | | MI | 4072 | 2160 | 6842 | 1498 | 7484 | 1226 | 7937 | 995 | 8708 | 621 | 10112 | 245 | 8786 |
| 16-#10 | 4.62 | MA | 4397 | 2118 | 7307 | 1505 | 8000 | 1247 | 8463 | 1021 | 9174 | 643 | 11014 | 304 | 9253 |
| 5E | | MI | 3964 | 2118 | 6604 | 1487 | 7194 | 1231 | 7586 | 1006 | 8188 | 630 | 9641 | 267 | 8251 |
| 16-#10 | 4.62 | MA | 4321 | 2118 | 7060 | 1522 | 7680 | 1253 | 8066 | 1025 | 8640 | 656 | 10331 | 247 | 8986 |
| 6L-4S | | MI | 4057 | 2118 | 6819 | 1481 | 7480 | 1216 | 7942 | 992 | 8714 | 630 | 10279 | 318 | 8488 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis

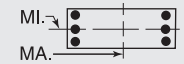



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#10 | 1.06 | MA | 4435 | 1838 | 7027 | 1323 | 7433 | 1116 | 7553 | 956 | 7523 | 720 | 8468 | 625 | 2913 |
| 2E | | MI | 3673 | 1838 | 5863 | 1294 | 6142 | 1092 | 6206 | 935 | 6136 | 703 | 6757 | 596 | 2408 |
| 4-#11 | 1.30 | MA | 4504 | 1870 | 7218 | 1332 | 7649 | 1121 | 7804 | 957 | 7858 | 710 | 8865 | 609 | 3504 |
| 2E | | MI | 3724 | 1870 | 6009 | 1300 | 6304 | 1095 | 6392 | 934 | 6385 | 692 | 7015 | 574 | 2884 |
| 4-#14 | 1.88 | MA | 4678 | 1946 | 7654 | 1371 | 8188 | 1148 | 8453 | 972 | 8736 | 699 | 9986 | 586 | 4890 |
| 2E | | MI | 3856 | 1946 | 6347 | 1338 | 6718 | 1121 | 6890 | 947 | 7059 | 680 | 7804 | 540 | 3986 |
| 4-#18 | 3.33 | MA | 5098 | 2140 | 8711 | 1476 | 9503 | 1222 | 10041 | 1012 | 10890 | 674 | 12622 | 518 | 8242 |
| 2E | | MI | 4171 | 2140 | 7155 | 1440 | 7719 | 1191 | 8096 | 986 | 8686 | 652 | 9606 | 440 | 6612 |
| 6-#9 | 1.25 | MA | 4505 | 1863 | 7177 | 1343 | 7636 | 1131 | 7806 | 966 | 7868 | 720 | 8951 | 625 | 3405 |
| 2L-3S | | MI | 3636 | 1863 | 5721 | 1320 | 5971 | 1120 | 6001 | 957 | 5858 | 712 | 6411 | 526 | 2824 |
| 6-#9 | 1.25 | MA | 4386 | 1863 | 6847 | 1349 | 7212 | 1146 | 7289 | 980 | 7165 | 731 | 7977 | 555 | 3427 |
| 3L-2S | | MI | 3727 | 1863 | 5982 | 1315 | 6306 | 1107 | 6409 | 946 | 6415 | 703 | 7146 | 596 | 2802 |
| 6-#10 | 1.59 | MA | 4614 | 1908 | 7444 | 1367 | 7967 | 1148 | 8205 | 976 | 8409 | 714 | 9695 | 618 | 4245 |
| 2L-3S | | MI | 3698 | 1908 | 5863 | 1344 | 6142 | 1139 | 6206 | 968 | 6136 | 707 | 6757 | 492 | 3504 |
| 6-#10 | 1.59 | MA | 4466 | 1908 | 7027 | 1375 | 7433 | 1166 | 7553 | 992 | 7523 | 728 | 8468 | 528 | 4272 |
| 3L-2S | | MI | 3811 | 1908 | 6191 | 1338 | 6564 | 1123 | 6720 | 954 | 6836 | 697 | 7673 | 581 | 3474 |
| 6-#11 | 1.95 | MA | 4717 | 1956 | 7719 | 1385 | 8292 | 1160 | 8588 | 980 | 8925 | 703 | 10310 | 596 | 5104 |
| 2L-3S | | MI | 3754 | 1956 | 6009 | 1361 | 6304 | 1151 | 6392 | 973 | 6385 | 696 | 7015 | 442 | 4193 |
| 6-#11 | 1.95 | MA | 4541 | 1956 | 7218 | 1395 | 7649 | 1181 | 7804 | 1000 | 7858 | 719 | 8865 | 486 | 5135 |
| 3L-2S | | MI | 3887 | 1956 | 6403 | 1354 | 6808 | 1133 | 7008 | 957 | 7222 | 685 | 8080 | 551 | 4157 |
| 6-#14 | 2.81 | MA | 4977 | 2071 | 8366 | 1449 | 9101 | 1204 | 9567 | 1006 | 10252 | 690 | 12006 | 564 | 7146 |
| 2L-3S | | MI | 3901 | 2071 | 6347 | 1425 | 6718 | 1201 | 6890 | 1002 | 7059 | 684 | 7804 | 345 | 5806 |
| 6-#14 | 2.81 | MA | 4735 | 2071 | 7654 | 1461 | 8188 | 1234 | 8453 | 1032 | 8736 | 710 | 9986 | 406 | 7166 |
| 3L-2S | | MI | 4085 | 2071 | 6904 | 1416 | 7432 | 1176 | 7760 | 981 | 8243 | 670 | 9277 | 503 | 5767 |
| 6-#18 | 5.00 | MA | 5603 | 2361 | 9938 | 1614 | 11076 | 1321 | 11960 | 1073 | 13501 | 657 | 15989 | 465 | 12094 |
| 2L-3S | | MI | 4251 | 2361 | 7155 | 1589 | 7719 | 1329 | 8096 | 1077 | 8686 | 651 | 9606 | 76 | 9380 |
| 6-#18 | 5.00 | MA | 5203 | 2361 | 8711 | 1633 | 9503 | 1369 | 10041 | 1115 | 10890 | 687 | 12622 | 184 | 11964 |
| 3L-2S | | MI | 4556 | 2361 | 8106 | 1578 | 8937 | 1290 | 9583 | 1046 | 10704 | 633 | 12010 | 358 | 9614 |
| 8-#8 | 1.32 | MA | 4532 | 1872 | 7230 | 1352 | 7713 | 1138 | 7904 | 972 | 8004 | 721 | 9140 | 626 | 3581 |
| 2L-4S | | MI | 3643 | 1872 | 5656 | 1340 | 5894 | 1129 | 5909 | 963 | 5751 | 720 | 6312 | 514 | 2981 |
| 8-#8 | 1.32 | MA | 4438 | 1872 | 6967 | 1357 | 7376 | 1150 | 7493 | 982 | 7444 | 730 | 8366 | 571 | 3598 |
| 3E | | MI | 3677 | 1872 | 5816 | 1329 | 6102 | 1125 | 6165 | 961 | 6084 | 712 | 6726 | 544 | 2960 |
| 8-#8 | 1.32 | MA | 4390 | 1872 | 6766 | 1370 | 7116 | 1155 | 7173 | 986 | 7029 | 740 | 7831 | 540 | 3616 |
| 4L-2S | | MI | 3749 | 1872 | 6025 | 1325 | 6369 | 1115 | 6491 | 951 | 6527 | 705 | 7317 | 600 | 2943 |
| 8-#9 | 1.67 | MA | 4647 | 1919 | 7508 | 1377 | 8060 | 1156 | 8323 | 982 | 8572 | 716 | 9925 | 619 | 4457 |
| 2L-4S | | MI | 3706 | 1919 | 5780 | 1369 | 6044 | 1149 | 6088 | 975 | 5997 | 716 | 6630 | 478 | 3688 |
| 8-#9 | 1.67 | MA | 4530 | 1919 | 7177 | 1384 | 7636 | 1170 | 7806 | 995 | 7868 | 727 | 8951 | 549 | 4476 |
| 3E | | MI | 3748 | 1919 | 5982 | 1354 | 6306 | 1145 | 6409 | 972 | 6415 | 708 | 7146 | 515 | 3665 |
| 8-#9 | 1.67 | MA | 4470 | 1919 | 6925 | 1400 | 7309 | 1176 | 7404 | 999 | 7345 | 738 | 8276 | 509 | 4493 |
| 4L-2S | | MI | 3838 | 1919 | 6244 | 1349 | 6641 | 1132 | 6818 | 961 | 6971 | 699 | 7881 | 585 | 3644 |
| 8-#10 | 2.12 | MA | 4792 | 1978 | 7861 | 1410 | 8502 | 1179 | 8857 | 995 | 9296 | 708 | 10922 | 610 | 5566 |
| 2L-4S | | MI | 3786 | 1978 | 5937 | 1406 | 6234 | 1175 | 6316 | 990 | 6309 | 712 | 7028 | 430 | 4571 |
| 8-#10 | 2.12 | MA | 4647 | 1978 | 7444 | 1419 | 7967 | 1197 | 8205 | 1011 | 8409 | 722 | 9695 | 520 | 5586 |
| 3E | | MI | 3837 | 1978 | 6191 | 1388 | 6564 | 1171 | 6720 | 987 | 6836 | 702 | 7673 | 477 | 4551 |
| 8-#10 | 2.12 | MA | 4573 | 1978 | 7125 | 1438 | 7554 | 1204 | 7698 | 1017 | 7749 | 736 | 8841 | 469 | 5587 |
| 4L-2S | | MI | 3949 | 1978 | 6520 | 1382 | 6986 | 1155 | 7235 | 973 | 7536 | 691 | 8588 | 566 | 4527 |
| 8-#11 | 2.60 | MA | 4928 | 2043 | 8221 | 1439 | 8934 | 1199 | 9373 | 1004 | 9992 | 697 | 11755 | 583 | 6690 |
| 2L-4S | | MI | 3862 | 2043 | 6096 | 1435 | 6412 | 1194 | 6521 | 998 | 6588 | 700 | 7326 | 365 | 5450 |
| 8-#11 | 2.60 | MA | 4757 | 2043 | 7719 | 1449 | 8292 | 1220 | 8588 | 1023 | 8925 | 712 | 10310 | 473 | 6710 |
| 3E | | MI | 3919 | 2043 | 6403 | 1415 | 6808 | 1190 | 7008 | 997 | 7222 | 689 | 8080 | 419 | 5441 |
| 8-#11 | 2.60 | MA | 4673 | 2043 | 7334 | 1472 | 7792 | 1227 | 7975 | 1029 | 8127 | 727 | 9300 | 413 | 6687 |
| 4L-2S | | MI | 4050 | 2043 | 6796 | 1408 | 7313 | 1172 | 7623 | 981 | 8059 | 678 | 9144 | 529 | 5412 |
| 8-#14 | 3.75 | MA | 5274 | 2195 | 9078 | 1527 | 10013 | 1260 | 10681 | 1040 | 11767 | 680 | 14027 | 542 | 9385 |
| 2L-4S | | MI | 4055 | 2195 | 6468 | 1531 | 6869 | 1262 | 7069 | 1037 | 7344 | 688 | 8229 | 232 | 7101 |
| 8-#14 | 3.75 | MA | 5039 | 2195 | 8366 | 1539 | 9101 | 1290 | 9567 | 1066 | 10252 | 700 | 12006 | 384 | 9377 |
| 3E | | MI | 4132 | 2195 | 6904 | 1502 | 7432 | 1257 | 7760 | 1036 | 8243 | 674 | 9277 | 308 | 7546 |
| 8-#14 | 3.75 | MA | 4923 | 2195 | 7817 | 1571 | 8389 | 1299 | 8694 | 1072 | 9115 | 721 | 10590 | 298 | 8822 |
| 4L-2S | | MI | 4313 | 2195 | 7460 | 1494 | 8145 | 1232 | 8631 | 1015 | 9428 | 660 | 10750 | 466 | 7528 |

## RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis



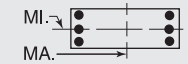

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 6.67 | MA | 5719 | 2583 | 9938 | 1771 | 11076 | 1468 | 11960 | 1175 | 13501 | 670 | 15989 | 131 | 15479 |
| 3E | | MI | 4643 | 2583 | 8106 | 1727 | 8937 | 1428 | 9583 | 1138 | 10704 | 633 | 12010 | -6 | 12003 |
| 8-#18 | 6.67 | MA | 5533 | 2583 | 8985 | 1825 | 9843 | 1481 | 10447 | 1182 | 11531 | 700 | 13612 | -12 | 13600 |
| 4L-2S | | MI | 4940 | 2583 | 9056 | 1717 | 10156 | 1390 | 11069 | 1106 | 12722 | 615 | 14414 | 275 | 12591 |
| 10-#10 | 2.65 | MA | 4970 | 2049 | 8277 | 1454 | 9036 | 1211 | 9509 | 1014 | 10183 | 703 | 12149 | 602 | 6879 |
| 2L-5S | | MI | 3829 | 2049 | 6051 | 1456 | 6371 | 1223 | 6474 | 1023 | 6483 | 706 | 7306 | 364 | 5383 |
| 10-#10 | 2.65 | MA | 4827 | 2049 | 7861 | 1463 | 8502 | 1229 | 8857 | 1031 | 9296 | 716 | 10922 | 512 | 6892 |
| 3L-4S | | MI | 3925 | 2049 | 6266 | 1450 | 6656 | 1207 | 6830 | 1009 | 7009 | 707 | 7944 | 415 | 5598 |
| 10-#10 | 2.65 | MA | 4754 | 2049 | 7542 | 1482 | 8089 | 1236 | 8350 | 1036 | 8635 | 730 | 10068 | 461 | 6879 |
| 4L-3S | | MI | 3976 | 2049 | 6520 | 1432 | 6986 | 1202 | 7235 | 1007 | 7536 | 696 | 8588 | 462 | 5590 |
| 10-#10 | 2.65 | MA | 4629 | 2049 | 7275 | 1490 | 7733 | 1254 | 7905 | 1053 | 7978 | 733 | 9213 | 411 | 6593 |
| 5L-2S | | MI | 4086 | 2049 | 6849 | 1426 | 7408 | 1186 | 7749 | 993 | 8236 | 686 | 9503 | 551 | 5570 |
| 10-#11 | 3.25 | MA | 4971 | 2129 | 8221 | 1503 | 8934 | 1258 | 9373 | 1047 | 9992 | 705 | 11755 | 460 | 8276 |
| 3L-4S | | MI | 4027 | 2129 | 6490 | 1489 | 6916 | 1233 | 7136 | 1022 | 7426 | 693 | 8390 | 342 | 6590 |
| 10-#11 | 3.25 | MA | 4888 | 2129 | 7835 | 1526 | 8435 | 1266 | 8760 | 1052 | 9193 | 720 | 10745 | 400 | 8188 |
| 4L-3S | | MI | 4084 | 2129 | 6796 | 1469 | 7313 | 1229 | 7623 | 1020 | 8059 | 682 | 9144 | 396 | 6679 |
| 10-#11 | 3.25 | MA | 4740 | 2129 | 7512 | 1535 | 8004 | 1287 | 8222 | 1071 | 8398 | 722 | 9738 | 337 | 7733 |
| 5L-2S | | MI | 4212 | 2129 | 7190 | 1462 | 7817 | 1211 | 8238 | 1004 | 8897 | 671 | 10208 | 506 | 6659 |
| 10-#14 | 4.69 | MA | 5340 | 2320 | 9078 | 1617 | 10013 | 1345 | 10681 | 1100 | 11767 | 690 | 14027 | 361 | 11582 |
| 3L-4S | | MI | 4287 | 2320 | 7025 | 1609 | 7582 | 1318 | 7940 | 1071 | 8528 | 678 | 9702 | 195 | 8726 |
| 10-#14 | 4.69 | MA | 5226 | 2320 | 8529 | 1649 | 9302 | 1355 | 9807 | 1106 | 10630 | 711 | 12610 | 276 | 10925 |
| 4L-3S | | MI | 4363 | 2320 | 7460 | 1580 | 8145 | 1313 | 8631 | 1070 | 9428 | 664 | 10750 | 270 | 9274 |
| 10-#14 | 4.69 | MA | 5018 | 2320 | 8067 | 1662 | 8687 | 1384 | 9040 | 1133 | 9497 | 711 | 11202 | 185 | 10396 |
| 5L-2S | | MI | 4540 | 2320 | 8017 | 1572 | 8859 | 1288 | 9501 | 1049 | 10612 | 650 | 12224 | 429 | 9279 |
| 12-#10 | 3.17 | MA | 5006 | 2119 | 8277 | 1507 | 9036 | 1260 | 9509 | 1050 | 10183 | 711 | 12149 | 504 | 8194 |
| 3L-5S | | MI | 3969 | 2119 | 6380 | 1500 | 6792 | 1254 | 6988 | 1043 | 7183 | 700 | 8221 | 349 | 6364 |
| 12-#10 | 3.17 | MA | 4934 | 2119 | 7959 | 1526 | 8623 | 1267 | 9001 | 1055 | 9522 | 725 | 11295 | 453 | 8169 |
| 4E | | MI | 4064 | 2119 | 6595 | 1493 | 7078 | 1238 | 7345 | 1029 | 7709 | 701 | 8859 | 401 | 6620 |
| 12-#10 | 3.17 | MA | 4811 | 2119 | 7692 | 1534 | 8267 | 1285 | 8557 | 1072 | 8865 | 727 | 10440 | 403 | 7843 |
| 5L-3S | | MI | 4114 | 2119 | 6849 | 1476 | 7408 | 1234 | 7749 | 1026 | 8236 | 691 | 9503 | 447 | 6623 |
| 12-#10 | 3.17 | MA | 4722 | 2119 | 7431 | 1540 | 7912 | 1292 | 8116 | 1077 | 8272 | 741 | 9660 | 344 | 7630 |
| 6L-2S | | MI | 4222 | 2119 | 7178 | 1469 | 7829 | 1218 | 8264 | 1012 | 8936 | 680 | 10418 | 536 | 6609 |
| 12-#11 | 3.90 | MA | 5102 | 2215 | 8337 | 1580 | 9078 | 1305 | 9544 | 1076 | 10260 | 713 | 12191 | 387 | 9667 |
| 4E | | MI | 4191 | 2215 | 6883 | 1543 | 7421 | 1272 | 7752 | 1046 | 8263 | 686 | 9455 | 320 | 7741 |
| 12-#11 | 3.90 | MA | 4956 | 2215 | 8013 | 1589 | 8647 | 1326 | 9006 | 1095 | 9465 | 715 | 11183 | 324 | 9240 |
| 5L-3S | | MI | 4247 | 2215 | 7190 | 1523 | 7817 | 1268 | 8238 | 1044 | 8897 | 675 | 10208 | 374 | 7911 |
| 12-#11 | 3.90 | MA | 4850 | 2215 | 7679 | 1610 | 8218 | 1333 | 8472 | 1100 | 8748 | 730 | 10262 | 254 | 8835 |
| 6L-2S | | MI | 4374 | 2215 | 7583 | 1516 | 8322 | 1250 | 8854 | 1028 | 9734 | 664 | 11273 | 484 | 7899 |
| 12-#14 | 5.63 | MA | 5528 | 2444 | 9242 | 1727 | 10215 | 1411 | 10921 | 1140 | 12146 | 701 | 14630 | 254 | 13043 |
| 4E | | MI | 4518 | 2444 | 7581 | 1686 | 8296 | 1374 | 8810 | 1105 | 9713 | 668 | 11175 | 158 | 10366 |
| 12-#14 | 5.63 | MA | 5324 | 2444 | 8779 | 1739 | 9600 | 1440 | 10154 | 1167 | 11012 | 701 | 13222 | 163 | 12489 |
| 5L-3S | | MI | 4593 | 2444 | 8017 | 1658 | 8859 | 1369 | 9501 | 1104 | 10612 | 654 | 12224 | 233 | 10997 |
| 14-#10 | 3.70 | MA | 5113 | 2189 | 8376 | 1570 | 9157 | 1299 | 9653 | 1074 | 10409 | 719 | 12522 | 445 | 9459 |
| 4L-5S | | MI | 4108 | 2189 | 6709 | 1544 | 7214 | 1286 | 7503 | 1062 | 7883 | 695 | 9136 | 334 | 7350 |
| 14-#10 | 3.70 | MA | 4991 | 2189 | 8108 | 1578 | 8801 | 1317 | 9208 | 1091 | 9751 | 721 | 11667 | 395 | 9099 |
| 5L-4S | | MI | 4203 | 2189 | 6924 | 1537 | 7500 | 1270 | 7859 | 1048 | 8409 | 695 | 9774 | 386 | 7615 |
| 14-#10 | 3.70 | MA | 4904 | 2189 | 7848 | 1584 | 8447 | 1324 | 8768 | 1096 | 9159 | 735 | 10887 | 336 | 8893 |
| 6L-3S | | MI | 4252 | 2189 | 7178 | 1520 | 7829 | 1265 | 8264 | 1045 | 8936 | 685 | 10418 | 432 | 7654 |
| 14-#11 | 4.55 | MA | 5171 | 2301 | 8514 | 1643 | 9290 | 1364 | 9790 | 1118 | 10532 | 708 | 12628 | 311 | 10753 |
| 5L-4S | | MI | 4355 | 2301 | 7277 | 1597 | 7925 | 1311 | 8367 | 1069 | 9101 | 679 | 10519 | 297 | 8901 |
| 14-#11 | 4.55 | MA | 5067 | 2301 | 8181 | 1664 | 8860 | 1372 | 9256 | 1124 | 9815 | 723 | 11707 | 241 | 10322 |
| 6L-3S | | MI | 4411 | 2301 | 7583 | 1577 | 8322 | 1306 | 8854 | 1067 | 9734 | 668 | 11273 | 351 | 9136 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

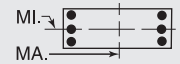
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 6.56 | MA | 5627 | 2569 | 9491 | 1817 | 10513 | 1496 | 11267 | 1201 | 12528 | 691 | 15242 | 141 | 14585 |
| 5L-4S | | MI | 4748 | 2569 | 8138 | 1764 | 9009 | 1429 | 9681 | 1139 | 10897 | 658 | 12648 | 121 | 12016 |
| 16-#10 | 4.23 | MA | 5171 | 2259 | 8525 | 1622 | 9335 | 1348 | 9860 | 1110 | 10638 | 716 | 12894 | 387 | 10358 |
| 5E | | MI | 4247 | 2259 | 7038 | 1588 | 7636 | 1317 | 8017 | 1081 | 8583 | 689 | 10051 | 319 | 8339 |
| 16-#10 | 4.23 | MA | 5086 | 2259 | 8264 | 1628 | 8981 | 1355 | 9419 | 1115 | 10046 | 730 | 12114 | 328 | 10132 |
| 6L-4S | | MI | 4340 | 2259 | 7253 | 1581 | 7921 | 1301 | 8373 | 1067 | 9109 | 690 | 10689 | 371 | 8589 |
| 16-#11 | 5.20 | MA | 5284 | 2388 | 8682 | 1718 | 9503 | 1411 | 10040 | 1147 | 10882 | 717 | 13152 | 228 | 11815 |
| 6L-4S | | MI | 4519 | 2388 | 7670 | 1651 | 8430 | 1349 | 8983 | 1093 | 9938 | 673 | 11583 | 274 | 10068 |
| 18-#10 | 4.76 | MA | 5266 | 2330 | 8681 | 1672 | 9515 | 1387 | 10071 | 1135 | 10933 | 724 | 13341 | 320 | 11375 |
| 6L-5S | | MI | 4385 | 2330 | 7367 | 1632 | 8057 | 1349 | 8531 | 1100 | 9283 | 683 | 10967 | 304 | 9332 |

## RECTANGULAR TIED COLUMNS 20" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.20 | MA | 5263 | 2011 | 8378 | 1446 | 8893 | 1219 | 9073 | 1042 | 9112 | 778 | 10334 | 676 | 3841 |
| 2E | | MI | 4007 | 2011 | 6444 | 1400 | 6745 | 1179 | 6822 | 1008 | 6777 | 751 | 7423 | 626 | 2909 |
| 4-#14 | 1.73 | MA | 5459 | 2088 | 8864 | 1486 | 9494 | 1246 | 9796 | 1057 | 10091 | 767 | 11623 | 657 | 5376 |
| 2E | | MI | 4139 | 2088 | 6783 | 1437 | 7159 | 1205 | 7319 | 1021 | 7450 | 738 | 8209 | 591 | 4018 |
| 4-#18 | 3.08 | MA | 5933 | 2281 | 10047 | 1591 | 10966 | 1320 | 11573 | 1098 | 12500 | 742 | 14678 | 599 | 9106 |
| 2E | | MI | 4454 | 2281 | 7593 | 1537 | 8159 | 1274 | 8523 | 1058 | 9074 | 709 | 10006 | 490 | 6659 |
| 6-#9 | 1.15 | MA | 5263 | 2005 | 8329 | 1458 | 8874 | 1229 | 9068 | 1052 | 9116 | 788 | 10348 | 685 | 3729 |
| 2L-3S | | MI | 3919 | 2005 | 6154 | 1421 | 6412 | 1206 | 6432 | 1032 | 6254 | 772 | 6823 | 578 | 2845 |
| 6-#9 | 1.15 | MA | 5129 | 2005 | 7963 | 1465 | 8406 | 1235 | 8497 | 1066 | 8339 | 800 | 9272 | 617 | 3751 |
| 3L-2S | | MI | 4010 | 2005 | 6415 | 1416 | 6748 | 1193 | 6841 | 1021 | 6810 | 763 | 7558 | 649 | 2823 |
| 6-#10 | 1.47 | MA | 5385 | 2050 | 8624 | 1481 | 9242 | 1246 | 9511 | 1061 | 9716 | 782 | 11176 | 678 | 4657 |
| 2L-3S | | MI | 3980 | 2050 | 6296 | 1445 | 6584 | 1225 | 6637 | 1043 | 6531 | 767 | 7168 | 544 | 3529 |
| 6-#10 | 1.47 | MA | 5218 | 2050 | 8164 | 1490 | 8651 | 1254 | 8791 | 1079 | 8736 | 797 | 9819 | 591 | 4684 |
| 3L-2S | | MI | 4094 | 2050 | 6625 | 1438 | 7006 | 1209 | 7152 | 1029 | 7231 | 756 | 8083 | 633 | 3499 |
| 6-#11 | 1.80 | MA | 5501 | 2098 | 8933 | 1500 | 9605 | 1258 | 9941 | 1066 | 10294 | 772 | 11971 | 666 | 5609 |
| 2L-3S | | MI | 4037 | 2098 | 6444 | 1460 | 6745 | 1236 | 6822 | 1047 | 6777 | 755 | 7423 | 493 | 4225 |
| 6-#11 | 1.80 | MA | 5304 | 2098 | 8378 | 1511 | 8893 | 1280 | 9073 | 1086 | 9112 | 788 | 10334 | 557 | 5641 |
| 3L-2S | | MI | 4170 | 2098 | 6838 | 1454 | 7250 | 1218 | 7438 | 1031 | 7614 | 744 | 8487 | 603 | 4187 |
| 6-#14 | 2.60 | MA | 5794 | 2212 | 9654 | 1564 | 10507 | 1302 | 11032 | 1091 | 11772 | 758 | 13919 | 640 | 7875 |
| 2L-3S | | MI | 4183 | 2212 | 6783 | 1523 | 7159 | 1285 | 7319 | 1076 | 7450 | 742 | 8209 | 396 | 5849 |
| 6-#14 | 2.60 | MA | 5521 | 2212 | 8864 | 1578 | 9494 | 1333 | 9796 | 1119 | 10091 | 781 | 11623 | 482 | 7895 |
| 3L-2S | | MI | 4368 | 2212 | 7340 | 1515 | 7873 | 1261 | 8189 | 1055 | 8634 | 729 | 9682 | 554 | 5805 |
| 6-#18 | 4.62 | MA | 6499 | 2503 | 11412 | 1729 | 12717 | 1419 | 13709 | 1158 | 15406 | 725 | 18533 | 558 | 13390 |
| 2L-3S | | MI | 4534 | 2503 | 7593 | 1686 | 8159 | 1412 | 8523 | 1150 | 9074 | 708 | 10006 | 126 | 9622 |
| 6-#18 | 4.62 | MA | 6049 | 2503 | 10047 | 1751 | 10966 | 1470 | 11573 | 1204 | 12500 | 760 | 14678 | 276 | 13260 |
| 3L-2S | | MI | 4839 | 2503 | 8544 | 1675 | 9377 | 1373 | 10010 | 1118 | 11092 | 691 | 12410 | 408 | 9667 |
| 8-#8 | 1.22 | MA | 5293 | 2014 | 8385 | 1467 | 8958 | 1236 | 9175 | 1057 | 9264 | 789 | 10554 | 686 | 3922 |
| 2L-4S | | MI | 3926 | 2014 | 6088 | 1442 | 6336 | 1215 | 6342 | 1038 | 6147 | 780 | 6725 | 567 | 3002 |
| 8-#8 | 1.22 | MA | 5187 | 2014 | 8095 | 1473 | 8586 | 1241 | 8721 | 1068 | 8646 | 799 | 9699 | 633 | 3939 |
| 3E | | MI | 3960 | 2014 | 6249 | 1430 | 6544 | 1212 | 6597 | 1036 | 6480 | 772 | 7139 | 597 | 2980 |
| 8-#8 | 1.22 | MA | 5131 | 2014 | 7875 | 1486 | 8300 | 1254 | 8370 | 1073 | 8189 | 809 | 9116 | 601 | 3958 |
| 4L-2S | | MI | 4032 | 2014 | 6457 | 1426 | 6811 | 1201 | 6923 | 1027 | 6923 | 765 | 7730 | 652 | 2964 |
| 8-#9 | 1.54 | MA | 5422 | 2060 | 8694 | 1492 | 9342 | 1254 | 9639 | 1067 | 9893 | 784 | 11424 | 678 | 4889 |
| 2L-4S | | MI | 3989 | 2060 | 6213 | 1469 | 6486 | 1235 | 6520 | 1050 | 6392 | 776 | 7042 | 530 | 3715 |
| 8-#9 | 1.54 | MA | 5290 | 2060 | 8329 | 1499 | 8874 | 1260 | 9068 | 1081 | 9116 | 796 | 10348 | 611 | 4908 |
| 3E | | MI | 4030 | 2060 | 6415 | 1455 | 6748 | 1231 | 6841 | 1047 | 6810 | 767 | 7558 | 567 | 3689 |
| 8-#9 | 1.54 | MA | 5221 | 2060 | 8051 | 1516 | 8514 | 1275 | 8626 | 1086 | 8540 | 808 | 9612 | 571 | 4925 |
| 4L-2S | | MI | 4121 | 2060 | 6677 | 1450 | 7083 | 1218 | 7250 | 1036 | 7367 | 759 | 8292 | 638 | 3668 |
| 8-#10 | 1.95 | MA | 5584 | 2120 | 9085 | 1525 | 9832 | 1277 | 10232 | 1080 | 10696 | 776 | 12533 | 670 | 6114 |
| 2L-4S | | MI | 4069 | 2120 | 6371 | 1506 | 6676 | 1261 | 6747 | 1065 | 6704 | 772 | 7439 | 483 | 4605 |
| 8-#10 | 1.95 | MA | 5420 | 2120 | 8624 | 1534 | 9242 | 1285 | 9511 | 1098 | 9716 | 791 | 11176 | 583 | 6134 |
| 3E | | MI | 4120 | 2120 | 6625 | 1489 | 7006 | 1256 | 7152 | 1062 | 7231 | 761 | 8083 | 529 | 4580 |
| 8-#10 | 1.95 | MA | 5335 | 2120 | 8274 | 1555 | 8787 | 1304 | 8953 | 1104 | 8989 | 806 | 10244 | 532 | 6135 |
| 4L-2S | | MI | 4232 | 2120 | 6954 | 1482 | 7427 | 1240 | 7666 | 1048 | 7931 | 751 | 8999 | 618 | 4554 |

## RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

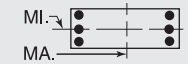
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 2.40 | MA | 5738 | 2184 | 9488 | 1554 | 10317 | 1297 | 10810 | 1089 | 11476 | 765 | 13607 | 657 | 7363 |
| 2L-4S | | MI | 4145 | 2184 | 6532 | 1535 | 6853 | 1279 | 6951 | 1072 | 6981 | 759 | 7733 | 416 | 5498 |
| 8-#11 | 2.40 | MA | 5545 | 2184 | 8933 | 1565 | 9605 | 1319 | 9941 | 1110 | 10294 | 782 | 11971 | 547 | 7384 |
| 3E | | MI | 4202 | 2184 | 6838 | 1514 | 7250 | 1275 | 7438 | 1070 | 7614 | 748 | 8487 | 471 | 5477 |
| 8-#11 | 2.40 | MA | 5447 | 2184 | 8509 | 1589 | 9055 | 1327 | 9266 | 1117 | 9414 | 799 | 10833 | 484 | 7361 |
| 4L-2S | | MI | 4333 | 2184 | 7232 | 1508 | 7754 | 1257 | 8053 | 1055 | 8452 | 737 | 9551 | 580 | 5446 |
| 8-#14 | 3.46 | MA | 6127 | 2337 | 10444 | 1642 | 11520 | 1358 | 12267 | 1125 | 13453 | 748 | 16216 | 623 | 10357 |
| 2L-4S | | MI | 4338 | 2337 | 6904 | 1629 | 7310 | 1346 | 7498 | 1111 | 7735 | 746 | 8634 | 283 | 7241 |
| 8-#14 | 3.46 | MA | 5861 | 2337 | 9654 | 1656 | 10507 | 1389 | 11032 | 1153 | 11772 | 771 | 13919 | 465 | 10349 |
| 3E | | MI | 4415 | 2337 | 7340 | 1601 | 7873 | 1341 | 8189 | 1110 | 8634 | 732 | 9682 | 359 | 7598 |
| 8-#14 | 3.46 | MA | 5726 | 2337 | 9049 | 1689 | 9722 | 1401 | 10067 | 1162 | 10517 | 794 | 12318 | 376 | 9864 |
| 4L-2S | | MI | 4596 | 2337 | 7896 | 1593 | 8586 | 1316 | 9060 | 1089 | 9819 | 719 | 11155 | 517 | 7570 |
| 8-#18 | 6.15 | MA | 6629 | 2724 | 11412 | 1889 | 12717 | 1570 | 13709 | 1265 | 15406 | 743 | 18533 | 235 | 17461 |
| 3E | | MI | 4926 | 2724 | 8544 | 1824 | 9377 | 1511 | 10010 | 1210 | 11092 | 690 | 12410 | 44 | 12262 |
| 8-#18 | 6.15 | MA | 6409 | 2724 | 10359 | 1946 | 11352 | 1586 | 12033 | 1276 | 13224 | 778 | 15827 | 85 | 15321 |
| 4L-2S | | MI | 5224 | 2724 | 9494 | 1814 | 10596 | 1472 | 11496 | 1178 | 13109 | 672 | 14814 | 326 | 12652 |
| 10-#10 | 2.44 | MA | 5782 | 2190 | 9546 | 1569 | 10423 | 1309 | 10952 | 1099 | 11677 | 771 | 13891 | 662 | 7565 |
| 2L-5S | | MI | 4112 | 2190 | 6485 | 1556 | 6812 | 1308 | 6905 | 1098 | 6878 | 765 | 7716 | 416 | 5471 |
| 10-#10 | 2.44 | MA | 5621 | 2190 | 9085 | 1578 | 9832 | 1317 | 10232 | 1117 | 10696 | 786 | 12533 | 575 | 7578 |
| 3L-4S | | MI | 4208 | 2190 | 6700 | 1550 | 7098 | 1292 | 7262 | 1084 | 7404 | 766 | 8354 | 468 | 5637 |
| 10-#10 | 2.44 | MA | 5537 | 2190 | 8735 | 1599 | 9378 | 1335 | 9673 | 1123 | 9969 | 801 | 11601 | 525 | 7565 |
| 4L-3S | | MI | 4259 | 2190 | 6954 | 1532 | 7427 | 1288 | 7666 | 1081 | 7931 | 756 | 8999 | 514 | 5622 |
| 10-#10 | 2.44 | MA | 5398 | 2190 | 8441 | 1608 | 8986 | 1343 | 9184 | 1141 | 9246 | 804 | 10663 | 477 | 7307 |
| 5L-2S | | MI | 4369 | 2190 | 7283 | 1526 | 7849 | 1272 | 8181 | 1067 | 8631 | 745 | 9914 | 604 | 5600 |
| 10-#11 | 3.00 | MA | 5785 | 2270 | 9488 | 1618 | 10317 | 1358 | 10810 | 1133 | 11476 | 775 | 13607 | 538 | 9118 |
| 3L-4S | | MI | 4310 | 2270 | 6925 | 1589 | 7358 | 1318 | 7566 | 1096 | 7818 | 752 | 8797 | 394 | 6705 |
| 10-#11 | 3.00 | MA | 5688 | 2270 | 9064 | 1643 | 9767 | 1366 | 10134 | 1140 | 10595 | 792 | 12469 | 475 | 9077 |
| 4L-3S | | MI | 4367 | 2270 | 7232 | 1568 | 7754 | 1314 | 8053 | 1094 | 8452 | 741 | 9551 | 448 | 6719 |
| 10-#11 | 3.00 | MA | 5522 | 2270 | 8708 | 1653 | 9293 | 1388 | 9542 | 1161 | 9720 | 795 | 11329 | 413 | 8582 |
| 5L-2S | | MI | 4496 | 2270 | 7625 | 1562 | 8259 | 1296 | 8669 | 1078 | 9289 | 730 | 10616 | 558 | 6695 |
| 10-#14 | 4.33 | MA | 6199 | 2461 | 10444 | 1733 | 11520 | 1445 | 12267 | 1187 | 13453 | 761 | 16216 | 448 | 12797 |
| 3L-4S | | MI | 4570 | 2461 | 7461 | 1707 | 8023 | 1402 | 8369 | 1145 | 8919 | 736 | 10107 | 246 | 8863 |
| 10-#14 | 4.33 | MA | 6066 | 2461 | 9839 | 1767 | 10735 | 1456 | 11303 | 1196 | 12198 | 784 | 14614 | 359 | 12203 |
| 4L-3S | | MI | 4646 | 2461 | 7896 | 1679 | 8586 | 1397 | 9060 | 1143 | 9819 | 722 | 11155 | 322 | 9330 |
| 10-#14 | 4.33 | MA | 5833 | 2461 | 9330 | 1781 | 10057 | 1487 | 10457 | 1224 | 10948 | 787 | 13013 | 270 | 11556 |
| 5L-2S | | MI | 4824 | 2461 | 8453 | 1670 | 9300 | 1372 | 9930 | 1122 | 11003 | 709 | 12628 | 480 | 9324 |
| 10-#18 | 7.69 | MA | 6989 | 2945 | 11724 | 2084 | 13102 | 1685 | 14168 | 1336 | 16129 | 761 | 19682 | 43 | 19413 |
| 4L-3S | | MI | 5316 | 2945 | 9494 | 1962 | 10596 | 1610 | 11496 | 1270 | 13109 | 672 | 14814 | -38 | 14761 |
| 12-#10 | 2.93 | MA | 5821 | 2260 | 9546 | 1622 | 10423 | 1348 | 10952 | 1136 | 11677 | 780 | 13891 | 567 | 9017 |
| 3L-5S | | MI | 4252 | 2260 | 6814 | 1600 | 7234 | 1340 | 7420 | 1117 | 7578 | 760 | 8631 | 401 | 6450 |
| 12-#10 | 2.93 | MA | 5738 | 2260 | 9195 | 1642 | 9968 | 1367 | 10394 | 1142 | 10949 | 795 | 12958 | 517 | 8992 |
| 4E | | MI | 4347 | 2260 | 7028 | 1594 | 7519 | 1324 | 7776 | 1103 | 8104 | 761 | 9269 | 453 | 6663 |
| 12-#10 | 2.93 | MA | 5601 | 2260 | 8902 | 1651 | 9577 | 1375 | 9905 | 1160 | 10226 | 799 | 12020 | 470 | 8691 |
| 5L-3S | | MI | 4397 | 2260 | 7283 | 1576 | 7849 | 1319 | 8181 | 1100 | 8631 | 750 | 9914 | 499 | 6658 |
| 12-#10 | 2.93 | MA | 5501 | 2260 | 8609 | 1657 | 9188 | 1394 | 9421 | 1166 | 9575 | 814 | 11170 | 411 | 8434 |
| 6L-2S | | MI | 4506 | 2260 | 7612 | 1570 | 8271 | 1304 | 8695 | 1086 | 9330 | 740 | 10829 | 589 | 6641 |
| 12-#11 | 3.60 | MA | 5927 | 2357 | 9620 | 1696 | 10479 | 1405 | 11003 | 1164 | 11777 | 785 | 14105 | 465 | 10778 |
| 4E | | MI | 4474 | 2357 | 7319 | 1643 | 7862 | 1357 | 8182 | 1119 | 8656 | 745 | 9862 | 371 | 7854 |
| 12-#11 | 3.60 | MA | 5764 | 2357 | 9264 | 1707 | 10005 | 1427 | 10410 | 1184 | 10901 | 788 | 12965 | 403 | 10253 |
| 5L-3S | | MI | 4530 | 2357 | 7625 | 1622 | 8259 | 1352 | 8669 | 1118 | 9289 | 734 | 10616 | 425 | 7954 |
| 12-#11 | 3.60 | MA | 5645 | 2357 | 8916 | 1714 | 9533 | 1436 | 9823 | 1191 | 10112 | 805 | 11925 | 331 | 9879 |
| 6L-2S | | MI | 4658 | 2357 | 8019 | 1616 | 8763 | 1334 | 9284 | 1102 | 10127 | 723 | 11680 | 535 | 7938 |
| 12-#14 | 5.19 | MA | 6403 | 2586 | 10629 | 1845 | 11747 | 1512 | 12538 | 1230 | 13879 | 774 | 16910 | 343 | 14556 |
| 4E | | MI | 4801 | 2586 | 8018 | 1785 | 8737 | 1458 | 9239 | 1179 | 10104 | 726 | 11580 | 209 | 10499 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

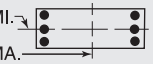
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 5.19 | MA | 6175 | 2586 | 10120 | 1859 | 11070 | 1543 | 11692 | 1258 | 12629 | 777 | 15310 | 253 | 13949 |
| 5L-3S | | MI | 4876 | 2586 | 8453 | 1757 | 9300 | 1453 | 9930 | 1177 | 11003 | 712 | 12628 | 285 | 11056 |
| 14-#10 | 3.42 | MA | 5938 | 2331 | 9656 | 1686 | 10559 | 1399 | 11114 | 1162 | 11929 | 789 | 14316 | 509 | 10419 |
| 4L-5S | | MI | 4391 | 2331 | 7142 | 1644 | 7655 | 1371 | 7934 | 1136 | 8278 | 754 | 9547 | 386 | 7435 |
| 14-#10 | 3.42 | MA | 5802 | 2331 | 9363 | 1695 | 10168 | 1406 | 10625 | 1179 | 11206 | 793 | 13378 | 462 | 10080 |
| 5L-4S | | MI | 4486 | 2331 | 7357 | 1638 | 7941 | 1355 | 8290 | 1122 | 8804 | 755 | 10185 | 438 | 7685 |
| 14-#10 | 3.42 | MA | 5705 | 2331 | 9070 | 1701 | 9778 | 1425 | 10141 | 1186 | 10555 | 808 | 12527 | 403 | 9836 |
| 6L-3S | | MI | 4535 | 2331 | 7612 | 1620 | 8271 | 1351 | 8695 | 1120 | 9330 | 744 | 10829 | 484 | 7690 |
| 14-#10 | 3.42 | MA | 5606 | 2331 | 8739 | 1717 | 9399 | 1431 | 9679 | 1203 | 9921 | 823 | 11645 | 364 | 9422 |
| 7L-2S | | MI | 4643 | 2331 | 7941 | 1614 | 8692 | 1335 | 9210 | 1106 | 10030 | 734 | 11744 | 574 | 7678 |
| 14-#11 | 4.20 | MA | 6004 | 2443 | 9819 | 1761 | 10717 | 1466 | 11279 | 1208 | 12083 | 781 | 14601 | 394 | 11931 |
| 5L-4S | | MI | 4638 | 2443 | 7712 | 1697 | 8367 | 1395 | 8797 | 1143 | 9493 | 738 | 10926 | 349 | 9012 |
| 14-#11 | 4.20 | MA | 5889 | 2443 | 9471 | 1768 | 10245 | 1474 | 10692 | 1214 | 11294 | 798 | 13562 | 321 | 11532 |
| 6L-3S | | MI | 4694 | 2443 | 8019 | 1676 | 8763 | 1391 | 9284 | 1141 | 10127 | 727 | 11680 | 403 | 9185 |
| 14-#14 | 6.06 | MA | 6514 | 2710 | 10910 | 1937 | 12083 | 1599 | 12928 | 1292 | 14309 | 767 | 17606 | 236 | 16350 |
| 5L-4S | | MI | 5031 | 2710 | 8574 | 1863 | 9450 | 1513 | 10110 | 1212 | 11288 | 716 | 13053 | 172 | 12147 |
| 16-#10 | 3.91 | MA | 6003 | 2401 | 9823 | 1739 | 10758 | 1438 | 11346 | 1198 | 12186 | 787 | 14735 | 454 | 11474 |
| 5E | | MI | 4530 | 2401 | 7471 | 1688 | 8077 | 1403 | 8448 | 1156 | 8978 | 749 | 10462 | 371 | 8424 |
| 16-#10 | 3.91 | MA | 5908 | 2401 | 9530 | 1745 | 10369 | 1457 | 10862 | 1205 | 11535 | 802 | 13884 | 396 | 11241 |
| 6L-4S | | MI | 4624 | 2401 | 7686 | 1682 | 8363 | 1387 | 8805 | 1142 | 9503 | 749 | 11100 | 423 | 8686 |
| 16-#10 | 3.91 | MA | 5809 | 2401 | 9199 | 1761 | 9990 | 1463 | 10399 | 1222 | 10901 | 817 | 13003 | 356 | 10812 |
| 7L-3S | | MI | 4673 | 2401 | 7941 | 1664 | 8692 | 1382 | 9210 | 1139 | 10030 | 739 | 11744 | 469 | 8719 |
| 16-#11 | 4.80 | MA | 6131 | 2529 | 10026 | 1822 | 10957 | 1513 | 11560 | 1238 | 12476 | 791 | 15198 | 312 | 13191 |
| 6L-4S | | MI | 4802 | 2529 | 8106 | 1751 | 8871 | 1434 | 9413 | 1166 | 10330 | 731 | 11990 | 326 | 10177 |
| 18-#10 | 4.40 | MA | 6109 | 2471 | 9991 | 1789 | 10960 | 1488 | 11582 | 1224 | 12516 | 797 | 15241 | 388 | 12649 |
| 6L-5S | | MI | 4668 | 2471 | 7800 | 1732 | 8499 | 1434 | 8963 | 1175 | 9678 | 743 | 11377 | 356 | 9416 |
| 18-#10 | 4.40 | MA | 6011 | 2471 | 9660 | 1805 | 10580 | 1494 | 11120 | 1241 | 11881 | 812 | 14360 | 348 | 12205 |
| 7L-4S | | MI | 4761 | 2471 | 8015 | 1726 | 8784 | 1419 | 9319 | 1161 | 10203 | 744 | 12015 | 408 | 9663 |
| 20-#10 | 4.88 | MA | 6211 | 2541 | 10121 | 1849 | 11171 | 1526 | 11840 | 1261 | 12861 | 806 | 15717 | 341 | 13600 |
| 7L-5S | | MI | 4806 | 2541 | 8129 | 1776 | 8921 | 1466 | 9477 | 1194 | 10378 | 737 | 12292 | 341 | 10410 |

## RECTANGULAR TIED COLUMNS 20" x 28"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#11 | 1.11 | MA | 6079 | 2153 | 9618 | 1561 | 10225 | 1317 | 10430 | 1128 | 10451 | 846 | 11829 | 736 | 4178 |
| 2E | | MI | 4290 | 2153 | 6880 | 1499 | 7186 | 1264 | 7252 | 1082 | 7170 | 810 | 7830 | 677 | 2934 |
| 4-#14 | 1.61 | MA | 6298 | 2229 | 10155 | 1601 | 10888 | 1345 | 11227 | 1143 | 11530 | 836 | 13319 | 723 | 5862 |
| 2E | | MI | 4422 | 2229 | 7219 | 1536 | 7600 | 1289 | 7748 | 1094 | 7841 | 797 | 8613 | 642 | 4050 |
| 4-#18 | 2.86 | MA | 6826 | 2423 | 11463 | 1706 | 12517 | 1418 | 13194 | 1183 | 14194 | 810 | 16829 | 677 | 9970 |
| 2E | | MI | 4737 | 2423 | 8031 | 1634 | 8599 | 1356 | 8950 | 1130 | 9461 | 767 | 10406 | 540 | 6704 |
| 6-#9 | 1.07 | MA | 6077 | 2146 | 9560 | 1572 | 10199 | 1327 | 10419 | 1137 | 10448 | 856 | 11834 | 744 | 4053 |
| 2L-3S | | MI | 4202 | 2146 | 6587 | 1522 | 6854 | 1292 | 6864 | 1107 | 6649 | 832 | 7235 | 631 | 2865 |
| 6-#9 | 1.07 | MA | 5928 | 2146 | 9161 | 1580 | 9687 | 1334 | 9794 | 1152 | 9597 | 869 | 10657 | 678 | 4075 |
| 3L-2S | | MI | 4293 | 2146 | 6849 | 1516 | 7189 | 1279 | 7273 | 1096 | 7206 | 823 | 7970 | 701 | 2844 |
| 6-#10 | 1.36 | MA | 6213 | 2191 | 9885 | 1596 | 10603 | 1344 | 10906 | 1147 | 11107 | 850 | 12744 | 737 | 5068 |
| 2L-3S | | MI | 4263 | 2191 | 6730 | 1545 | 7026 | 1310 | 7069 | 1118 | 6925 | 826 | 7579 | 596 | 3553 |
| 6-#10 | 1.36 | MA | 6027 | 2191 | 9381 | 1606 | 9956 | 1352 | 10117 | 1165 | 10033 | 866 | 11258 | 653 | 5095 |
| 3L-2S | | MI | 4377 | 2191 | 7059 | 1539 | 7447 | 1295 | 7583 | 1104 | 7625 | 816 | 8494 | 686 | 3523 |
| 6-#11 | 1.67 | MA | 6343 | 2239 | 10228 | 1615 | 11006 | 1356 | 11383 | 1151 | 11747 | 840 | 13624 | 726 | 6115 |
| 2L-3S | | MI | 4320 | 2239 | 6880 | 1560 | 7186 | 1321 | 7252 | 1121 | 7170 | 814 | 7830 | 545 | 4255 |
| 6-#11 | 1.67 | MA | 6123 | 2239 | 9618 | 1626 | 10225 | 1365 | 10430 | 1173 | 10451 | 858 | 11829 | 619 | 6146 |
| 3L-2S | | MI | 4453 | 2239 | 7273 | 1553 | 7691 | 1303 | 7868 | 1105 | 8007 | 803 | 8894 | 655 | 4216 |
| 6-#14 | 2.41 | MA | 6669 | 2354 | 11023 | 1679 | 12001 | 1400 | 12585 | 1177 | 13376 | 826 | 15876 | 709 | 8604 |
| 2L-3S | | MI | 4466 | 2354 | 7219 | 1622 | 7600 | 1369 | 7748 | 1149 | 7841 | 801 | 8613 | 447 | 5890 |
| 6-#14 | 2.41 | MA | 6364 | 2354 | 10155 | 1694 | 10888 | 1433 | 11227 | 1207 | 11530 | 851 | 13319 | 552 | 8624 |
| 3L-2S | | MI | 4651 | 2354 | 7776 | 1613 | 8314 | 1345 | 8619 | 1128 | 9025 | 787 | 10087 | 605 | 5841 |

## RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis



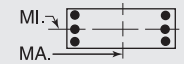

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 4.29 | MA | 7455 | 2644 | 12967 | 1844 | 14444 | 1517 | 15545 | 1244 | 17394 | 793 | 21174 | 645 | 14686 |
| 2L-3S | | MI | 4817 | 2644 | 8031 | 1783 | 8599 | 1494 | 8950 | 1222 | 9461 | 766 | 10406 | 177 | 9717 |
| 6-#18 | 4.29 | MA | 6952 | 2644 | 11463 | 1868 | 12517 | 1571 | 13194 | 1293 | 14194 | 833 | 16829 | 364 | 14556 |
| 3L-2S | | MI | 5123 | 2644 | 8982 | 1772 | 9818 | 1456 | 10437 | 1190 | 11479 | 748 | 12810 | 458 | 9720 |
| 8-#8 | 1.13 | MA | 6110 | 2155 | 9622 | 1582 | 10290 | 1334 | 10535 | 1143 | 10608 | 857 | 12058 | 745 | 4264 |
| 2L-4S | | MI | 4209 | 2155 | 6521 | 1543 | 6778 | 1301 | 6774 | 1113 | 6544 | 840 | 7138 | 619 | 3021 |
| 8-#8 | 1.13 | MA | 5992 | 2155 | 9304 | 1588 | 9883 | 1340 | 10038 | 1154 | 9932 | 868 | 11123 | 693 | 4280 |
| 3E | | MI | 4242 | 2155 | 6682 | 1531 | 6986 | 1298 | 7030 | 1111 | 6876 | 832 | 7552 | 649 | 3000 |
| 8-#8 | 1.13 | MA | 5929 | 2155 | 9064 | 1601 | 9571 | 1352 | 9655 | 1159 | 9433 | 878 | 10492 | 663 | 4299 |
| 4L-2S | | MI | 4315 | 2155 | 6890 | 1527 | 7253 | 1288 | 7355 | 1102 | 7319 | 825 | 8143 | 705 | 2984 |
| 8-#9 | 1.43 | MA | 6253 | 2201 | 9960 | 1607 | 10712 | 1352 | 11044 | 1152 | 11298 | 852 | 13012 | 738 | 5321 |
| 2L-4S | | MI | 4272 | 2201 | 6647 | 1570 | 6928 | 1321 | 6952 | 1125 | 6788 | 836 | 7453 | 583 | 3740 |
| 8-#9 | 1.43 | MA | 6106 | 2201 | 9560 | 1615 | 10199 | 1359 | 10419 | 1167 | 10448 | 864 | 11834 | 672 | 5340 |
| 3E | | MI | 4313 | 2201 | 6849 | 1556 | 7189 | 1317 | 7273 | 1122 | 7206 | 827 | 7970 | 620 | 3713 |
| 8-#9 | 1.43 | MA | 6028 | 2201 | 9258 | 1631 | 9807 | 1375 | 9937 | 1173 | 9819 | 877 | 11037 | 633 | 5357 |
| 4L-2S | | MI | 4404 | 2201 | 7110 | 1551 | 7524 | 1304 | 7682 | 1111 | 7762 | 818 | 8704 | 690 | 3691 |
| 8-#10 | 1.81 | MA | 6433 | 2261 | 10390 | 1640 | 11250 | 1375 | 11695 | 1166 | 12180 | 844 | 14231 | 729 | 6663 |
| 2L-4S | | MI | 4352 | 2261 | 6804 | 1607 | 7118 | 1347 | 7179 | 1140 | 7098 | 831 | 7850 | 535 | 4637 |
| 8-#10 | 1.81 | MA | 6251 | 2261 | 9885 | 1650 | 10603 | 1384 | 10906 | 1184 | 11107 | 860 | 12744 | 645 | 6683 |
| 3E | | MI | 4403 | 2261 | 7059 | 1589 | 7447 | 1342 | 7583 | 1137 | 7625 | 821 | 8494 | 581 | 4608 |
| 8-#10 | 1.81 | MA | 6154 | 2261 | 9503 | 1671 | 10107 | 1403 | 10296 | 1191 | 10312 | 876 | 11734 | 595 | 6684 |
| 4L-2S | | MI | 4515 | 2261 | 7388 | 1583 | 7869 | 1326 | 8098 | 1123 | 8325 | 810 | 9409 | 671 | 4581 |
| 8-#11 | 2.23 | MA | 6605 | 2325 | 10837 | 1669 | 11788 | 1395 | 12336 | 1175 | 13044 | 833 | 15420 | 716 | 8037 |
| 2L-4S | | MI | 4428 | 2325 | 6967 | 1634 | 7294 | 1364 | 7381 | 1146 | 7373 | 818 | 8140 | 468 | 5540 |
| 8-#11 | 2.23 | MA | 6390 | 2325 | 10228 | 1680 | 11006 | 1404 | 11383 | 1196 | 11747 | 851 | 13624 | 610 | 8058 |
| 3E | | MI | 4485 | 2325 | 7273 | 1614 | 7691 | 1360 | 7868 | 1144 | 8007 | 807 | 8894 | 522 | 5512 |
| 8-#11 | 2.23 | MA | 6278 | 2325 | 9764 | 1705 | 10405 | 1427 | 10644 | 1204 | 10785 | 869 | 12391 | 548 | 8035 |
| 4L-2S | | MI | 4616 | 2325 | 7667 | 1607 | 8195 | 1342 | 8483 | 1129 | 8844 | 796 | 9959 | 632 | 5479 |
| 8-#14 | 3.21 | MA | 7038 | 2478 | 11890 | 1757 | 13113 | 1456 | 13942 | 1210 | 15223 | 816 | 18433 | 695 | 11329 |
| 2L-4S | | MI | 4621 | 2478 | 7341 | 1728 | 7751 | 1430 | 7928 | 1184 | 8126 | 804 | 9038 | 335 | 7377 |
| 8-#14 | 3.21 | MA | 6742 | 2478 | 11023 | 1772 | 12001 | 1489 | 12585 | 1241 | 13376 | 841 | 15876 | 539 | 11321 |
| 3E | | MI | 4698 | 2478 | 7776 | 1700 | 8314 | 1425 | 8619 | 1183 | 9025 | 791 | 10087 | 410 | 7643 |
| 8-#14 | 3.21 | MA | 6586 | 2478 | 10360 | 1807 | 11142 | 1501 | 11530 | 1251 | 12003 | 866 | 14105 | 448 | 10925 |
| 4L-2S | | MI | 4880 | 2478 | 8333 | 1691 | 9027 | 1400 | 9489 | 1162 | 10209 | 777 | 11560 | 568 | 7611 |
| 8-#18 | 5.71 | MA | 7596 | 2865 | 12967 | 2006 | 14444 | 1671 | 15545 | 1354 | 17394 | 815 | 21174 | 331 | 19189 |
| 3E | | MI | 5208 | 2865 | 8982 | 1921 | 9818 | 1594 | 10437 | 1282 | 11479 | 748 | 12810 | 95 | 12489 |
| 8-#18 | 5.71 | MA | 7343 | 2865 | 11813 | 2066 | 12949 | 1690 | 13708 | 1368 | 15002 | 855 | 18139 | 175 | 16994 |
| 4L-2S | | MI | 5507 | 2865 | 9932 | 1910 | 11036 | 1555 | 11923 | 1250 | 13497 | 730 | 15214 | 376 | 12707 |
| 10-#10 | 2.27 | MA | 6652 | 2331 | 10895 | 1684 | 11897 | 1407 | 12484 | 1185 | 13254 | 839 | 15718 | 722 | 8251 |
| 2L-5S | | MI | 4394 | 2331 | 6918 | 1657 | 7254 | 1394 | 7337 | 1173 | 7273 | 825 | 8127 | 468 | 5555 |
| 10-#10 | 2.27 | MA | 6473 | 2331 | 10390 | 1694 | 11250 | 1415 | 11695 | 1203 | 12180 | 855 | 14231 | 637 | 8264 |
| 3L-4S | | MI | 4491 | 2331 | 7133 | 1651 | 7539 | 1378 | 7693 | 1159 | 7798 | 826 | 8765 | 520 | 5673 |
| 10-#10 | 2.27 | MA | 6378 | 2331 | 10008 | 1715 | 10754 | 1435 | 11085 | 1210 | 11386 | 871 | 13221 | 587 | 8251 |
| 4L-3S | | MI | 4542 | 2331 | 7388 | 1633 | 7869 | 1374 | 8098 | 1156 | 8325 | 815 | 9409 | 566 | 5653 |
| 10-#10 | 2.27 | MA | 6224 | 2331 | 9688 | 1724 | 10328 | 1443 | 10553 | 1229 | 10597 | 875 | 12202 | 543 | 8031 |
| 5L-2S | | MI | 4652 | 2331 | 7717 | 1627 | 8291 | 1358 | 8612 | 1142 | 9025 | 805 | 10324 | 656 | 5630 |
| 10-#11 | 2.79 | MA | 6656 | 2412 | 10837 | 1734 | 11788 | 1443 | 12336 | 1220 | 13044 | 844 | 15420 | 600 | 9961 |
| 3L-4S | | MI | 4593 | 2412 | 7360 | 1688 | 7799 | 1403 | 7996 | 1170 | 8211 | 811 | 9205 | 445 | 6772 |
| 10-#11 | 2.79 | MA | 6545 | 2412 | 10373 | 1759 | 11186 | 1466 | 11597 | 1228 | 12081 | 862 | 14186 | 538 | 9920 |
| 4L-3S | | MI | 4649 | 2412 | 7667 | 1668 | 8195 | 1398 | 8483 | 1168 | 8844 | 800 | 9959 | 500 | 6757 |
| 10-#11 | 2.79 | MA | 6361 | 2412 | 9985 | 1770 | 10669 | 1475 | 10950 | 1249 | 11125 | 867 | 12946 | 480 | 9441 |
| 5L-2S | | MI | 4779 | 2412 | 8060 | 1661 | 8700 | 1380 | 9099 | 1152 | 9682 | 789 | 11023 | 609 | 6731 |
| 10-#14 | 4.02 | MA | 7116 | 2603 | 11890 | 1849 | 13113 | 1545 | 13942 | 1274 | 15223 | 831 | 18433 | 525 | 14012 |
| 3L-4S | | MI | 4853 | 2603 | 7897 | 1806 | 8464 | 1486 | 8798 | 1218 | 9310 | 794 | 10512 | 298 | 8995 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis

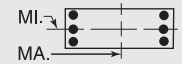


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 4.02 | MA | 6963 | 2603 | 11228 | 1885 | 12254 | 1557 | 12887 | 1285 | 13849 | 856 | 16661 | 434 | 13501 |
| 4L-3S | | MI | 4929 | 2603 | 8333 | 1777 | 9027 | 1481 | 9489 | 1217 | 10209 | 781 | 11560 | 373 | 9384 |
| 10-#14 | 4.02 | MA | 6706 | 2603 | 10673 | 1900 | 11515 | 1590 | 11963 | 1315 | 12482 | 861 | 14885 | 347 | 12729 |
| 5L-2S | | MI | 5107 | 2603 | 8889 | 1769 | 9741 | 1456 | 10359 | 1196 | 11394 | 767 | 13033 | 531 | 9368 |
| 10-#18 | 7.14 | MA | 7986 | 3087 | 13317 | 2204 | 14876 | 1789 | 16060 | 1428 | 18201 | 837 | 22484 | 143 | 21514 |
| 4L-3S | | MI | 5598 | 3087 | 9932 | 2059 | 11036 | 1693 | 11923 | 1342 | 13497 | 729 | 15214 | 12 | 15169 |
| 12-#10 | 2.72 | MA | 6694 | 2402 | 10895 | 1738 | 11897 | 1447 | 12484 | 1222 | 13254 | 849 | 15718 | 629 | 9840 |
| 3L-5S | | MI | 4534 | 2402 | 7247 | 1701 | 7675 | 1425 | 7851 | 1192 | 7973 | 819 | 9042 | 453 | 6534 |
| 12-#10 | 2.72 | MA | 6599 | 2402 | 10512 | 1759 | 11401 | 1466 | 11874 | 1230 | 12460 | 865 | 14708 | 580 | 9815 |
| 4E | | MI | 4630 | 2402 | 7462 | 1694 | 7961 | 1410 | 8207 | 1178 | 8498 | 820 | 9680 | 505 | 6704 |
| 12-#10 | 2.72 | MA | 6448 | 2402 | 10193 | 1768 | 10975 | 1475 | 11342 | 1248 | 11671 | 870 | 13688 | 535 | 9548 |
| 5L-3S | | MI | 4680 | 2402 | 7717 | 1677 | 8291 | 1405 | 8612 | 1175 | 9025 | 810 | 10324 | 551 | 6691 |
| 12-#10 | 2.72 | MA | 6338 | 2402 | 9867 | 1773 | 10551 | 1494 | 10814 | 1255 | 10961 | 886 | 12768 | 477 | 9244 |
| 6L-2S | | MI | 4790 | 2402 | 8046 | 1670 | 8712 | 1389 | 9127 | 1161 | 9725 | 799 | 11240 | 641 | 6672 |
| 12-#11 | 3.34 | MA | 6810 | 2498 | 10983 | 1813 | 11968 | 1505 | 12550 | 1251 | 13378 | 856 | 15981 | 529 | 11803 |
| 4E | | MI | 4757 | 2498 | 7754 | 1742 | 8303 | 1441 | 8612 | 1193 | 9048 | 804 | 10269 | 423 | 7963 |
| 12-#11 | 3.34 | MA | 6629 | 2498 | 10595 | 1824 | 11450 | 1514 | 11903 | 1273 | 12421 | 860 | 14741 | 470 | 11277 |
| 5L-3S | | MI | 4813 | 2498 | 8060 | 1722 | 8700 | 1437 | 9099 | 1191 | 9682 | 793 | 11023 | 477 | 7995 |
| 12-#11 | 3.34 | MA | 6498 | 2498 | 10207 | 1831 | 10935 | 1537 | 11263 | 1281 | 11560 | 878 | 13615 | 399 | 10944 |
| 6L-2S | | MI | 4941 | 2498 | 8454 | 1715 | 9204 | 1419 | 9714 | 1176 | 10519 | 782 | 12087 | 587 | 7976 |
| 12-#14 | 4.82 | MA | 7337 | 2727 | 12096 | 1962 | 13367 | 1613 | 14244 | 1319 | 15696 | 846 | 19218 | 421 | 16092 |
| 4E | | MI | 5084 | 2727 | 8454 | 1883 | 9178 | 1542 | 9668 | 1252 | 10494 | 785 | 11985 | 260 | 10628 |
| 12-#14 | 4.82 | MA | 7084 | 2727 | 11541 | 1977 | 12627 | 1646 | 13320 | 1349 | 14329 | 851 | 17441 | 333 | 15362 |
| 5L-3S | | MI | 5159 | 2727 | 8889 | 1855 | 9741 | 1537 | 10359 | 1251 | 11394 | 771 | 13033 | 336 | 11113 |
| 12-#14 | 4.82 | MA | 6900 | 2727 | 10995 | 1988 | 11891 | 1658 | 12404 | 1359 | 13098 | 876 | 15824 | 229 | 14377 |
| 6L-2S | | MI | 5335 | 2727 | 9446 | 1847 | 10454 | 1512 | 11230 | 1230 | 12578 | 757 | 14506 | 494 | 11117 |
| 14-#10 | 3.17 | MA | 6820 | 2472 | 11017 | 1803 | 12048 | 1498 | 12664 | 1249 | 13534 | 859 | 16194 | 572 | 11379 |
| 4L-5S | | MI | 4674 | 2472 | 7576 | 1745 | 8097 | 1457 | 8365 | 1211 | 8672 | 814 | 9957 | 438 | 7518 |
| 14-#10 | 3.17 | MA | 6670 | 2472 | 10697 | 1812 | 11622 | 1506 | 12131 | 1267 | 12744 | 864 | 15175 | 527 | 11071 |
| 5L-4S | | MI | 4769 | 2472 | 7791 | 1738 | 8383 | 1441 | 8722 | 1197 | 9198 | 814 | 10595 | 490 | 7728 |
| 14-#10 | 3.17 | MA | 6563 | 2472 | 10372 | 1817 | 11198 | 1526 | 11603 | 1274 | 12035 | 880 | 14254 | 469 | 10782 |
| 6L-3S | | MI | 4818 | 2472 | 8046 | 1721 | 8712 | 1437 | 9127 | 1194 | 9725 | 804 | 11240 | 536 | 7725 |
| 14-#10 | 3.17 | MA | 6451 | 2472 | 10011 | 1834 | 10776 | 1532 | 11099 | 1293 | 11344 | 896 | 13298 | 432 | 10385 |
| 7L-2S | | MI | 4926 | 2472 | 8375 | 1714 | 9134 | 1421 | 9641 | 1180 | 10425 | 793 | 12155 | 626 | 7711 |
| 14-#11 | 3.90 | MA | 6895 | 2584 | 11204 | 1878 | 12231 | 1553 | 12856 | 1296 | 13717 | 853 | 16536 | 461 | 13120 |
| 5L-4S | | MI | 4921 | 2584 | 8147 | 1796 | 8808 | 1480 | 9227 | 1217 | 9886 | 797 | 11333 | 400 | 9119 |
| 14-#11 | 3.90 | MA | 6768 | 2584 | 10816 | 1885 | 11717 | 1576 | 12216 | 1304 | 12856 | 871 | 15410 | 389 | 12765 |
| 6L-3S | | MI | 4977 | 2584 | 8454 | 1776 | 9204 | 1476 | 9714 | 1215 | 10519 | 786 | 12087 | 455 | 9229 |
| 14-#11 | 3.90 | MA | 6636 | 2584 | 10379 | 1904 | 11215 | 1584 | 11604 | 1326 | 12017 | 890 | 14244 | 341 | 12138 |
| 7L-2S | | MI | 5103 | 2584 | 8847 | 1769 | 9709 | 1458 | 10330 | 1199 | 11356 | 775 | 13151 | 564 | 9215 |
| 14-#14 | 5.63 | MA | 7460 | 2852 | 12409 | 2055 | 13740 | 1702 | 14677 | 1383 | 16175 | 841 | 19998 | 319 | 18003 |
| 5L-4S | | MI | 5314 | 2852 | 9010 | 1961 | 9891 | 1598 | 10539 | 1286 | 11679 | 775 | 13458 | 223 | 12273 |
| 14-#14 | 5.63 | MA | 7282 | 2852 | 11863 | 2065 | 13003 | 1714 | 13761 | 1393 | 14945 | 866 | 18381 | 215 | 16993 |
| 6L-3S | | MI | 5389 | 2852 | 9446 | 1933 | 10454 | 1593 | 11230 | 1285 | 12578 | 761 | 14506 | 299 | 12839 |
| 16-#10 | 3.63 | MA | 6892 | 2542 | 11202 | 1856 | 12268 | 1538 | 12920 | 1286 | 13818 | 859 | 16662 | 519 | 12599 |
| 5E | | MI | 4813 | 2542 | 7905 | 1789 | 8519 | 1489 | 8880 | 1230 | 9372 | 808 | 10872 | 423 | 8506 |
| 16-#10 | 3.63 | MA | 6787 | 2542 | 10877 | 1861 | 11845 | 1558 | 12392 | 1293 | 13109 | 875 | 15741 | 462 | 12322 |
| 6L-4S | | MI | 4907 | 2542 | 8120 | 1782 | 8804 | 1473 | 9236 | 1216 | 9898 | 809 | 11510 | 475 | 8751 |
| 16-#10 | 3.63 | MA | 6675 | 2542 | 10515 | 1878 | 11423 | 1563 | 11889 | 1312 | 12417 | 890 | 14785 | 425 | 11910 |
| 7L-3S | | MI | 4956 | 2542 | 8375 | 1765 | 9134 | 1468 | 9641 | 1213 | 10425 | 798 | 12155 | 521 | 8756 |
| 16-#10 | 3.63 | MA | 6549 | 2542 | 10198 | 1884 | 10985 | 1579 | 11393 | 1330 | 11681 | 895 | 13736 | 359 | 11528 |
| 8L-2S | | MI | 5063 | 2542 | 8704 | 1758 | 9556 | 1452 | 10155 | 1199 | 11125 | 788 | 13070 | 611 | 8746 |
| 16-#11 | 4.46 | MA | 7035 | 2671 | 11426 | 1939 | 12498 | 1615 | 13168 | 1328 | 14153 | 865 | 17206 | 380 | 14591 |
| 6L-4S | | MI | 5085 | 2671 | 8541 | 1850 | 9312 | 1519 | 9843 | 1240 | 10723 | 790 | 12398 | 378 | 10283 |
| 16-#11 | 4.46 | MA | 6904 | 2671 | 10988 | 1958 | 11996 | 1622 | 12557 | 1349 | 13314 | 883 | 16040 | 331 | 13984 |
| 7L-3S | | MI | 5140 | 2671 | 8847 | 1830 | 9709 | 1515 | 10330 | 1238 | 11356 | 779 | 13151 | 432 | 10457 |
| 16-#14 | 6.43 | MA | 7660 | 2976 | 12730 | 2143 | 14116 | 1770 | 15118 | 1427 | 16791 | 856 | 20937 | 201 | 19616 |
| 6L-4S | | MI | 5543 | 2976 | 9567 | 2039 | 10605 | 1653 | 11409 | 1320 | 12863 | 765 | 14931 | 186 | 13928 |

## RECTANGULAR TIED COLUMNS 20" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 4.08 | MA | 7009 | 2613 | 11381 | 1905 | 12491 | 1589 | 13181 | 1313 | 14182 | 869 | 17228 | 454 | 13865 |
| 6L-5S | | MI | 4951 | 2613 | 8234 | 1833 | 8940 | 1520 | 9394 | 1249 | 10072 | 802 | 11788 | 408 | 9497 |
| 18-#10 | 4.08 | MA | 6898 | 2613 | 11020 | 1922 | 12069 | 1595 | 12678 | 1331 | 13491 | 885 | 16271 | 417 | 13439 |
| 7L-4S | | MI | 5044 | 2613 | 8449 | 1826 | 9226 | 1504 | 9751 | 1235 | 10598 | 803 | 12426 | 460 | 9756 |
| 18-#10 | 4.08 | MA | 6774 | 2613 | 10703 | 1928 | 11631 | 1611 | 12182 | 1349 | 12755 | 890 | 15223 | 351 | 13059 |
| 8L-3S | | MI | 5093 | 2613 | 8704 | 1809 | 9556 | 1500 | 10155 | 1233 | 11125 | 793 | 13070 | 506 | 9785 |
| 18-#11 | 5.01 | MA | 7171 | 2757 | 11597 | 2012 | 12777 | 1661 | 13510 | 1373 | 14610 | 876 | 17835 | 322 | 15833 |
| 7L-4S | | MI | 5248 | 2757 | 8934 | 1904 | 9817 | 1558 | 10458 | 1264 | 11560 | 783 | 13462 | 355 | 11452 |
| 20-#10 | 4.54 | MA | 7120 | 2683 | 11524 | 1965 | 12716 | 1626 | 13467 | 1350 | 14565 | 879 | 17758 | 409 | 14970 |
| 7L-5S | | MI | 5089 | 2683 | 8563 | 1876 | 9362 | 1552 | 9909 | 1269 | 10772 | 797 | 12703 | 393 | 10491 |
| 20-#10 | 4.54 | MA | 6998 | 2683 | 11207 | 1972 | 12278 | 1642 | 12971 | 1368 | 13829 | 884 | 16709 | 343 | 14584 |
| 8L-4S | | MI | 5182 | 2683 | 8778 | 1870 | 9648 | 1536 | 10265 | 1255 | 11298 | 798 | 13341 | 445 | 10736 |
| 22-#10 | 4.99 | MA | 7221 | 2753 | 11712 | 2016 | 12925 | 1674 | 13760 | 1387 | 14902 | 878 | 18196 | 335 | 16112 |
| 8L-5S | | MI | 5227 | 2753 | 8892 | 1920 | 9784 | 1583 | 10423 | 1288 | 11472 | 791 | 13618 | 379 | 11487 |

## RECTANGULAR TIED COLUMNS 20" x 30"

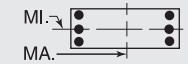
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.04 | MA | 6952 | 2294 | 10939 | 1676 | 11645 | 1415 | 11875 | 1213 | 11873 | 914 | 13414 | 795 | 4514 |
| 2E | | MI | 4573 | 2294 | 7315 | 1599 | 7628 | 1349 | 7682 | 1155 | 7562 | 868 | 8237 | 729 | 2958 |
| 4-#14 | 1.50 | MA | 7194 | 2371 | 11526 | 1716 | 12369 | 1443 | 12747 | 1228 | 13052 | 904 | 15043 | 783 | 6348 |
| 2E | | MI | 4705 | 2371 | 7656 | 1634 | 8041 | 1373 | 8177 | 1167 | 8232 | 855 | 9018 | 694 | 4080 |
| 4-#18 | 2.67 | MA | 7777 | 2564 | 12960 | 1821 | 14155 | 1516 | 14902 | 1269 | 15972 | 878 | 19075 | 753 | 10834 |
| 2E | | MI | 5020 | 2564 | 8469 | 1731 | 9039 | 1439 | 9377 | 1202 | 9849 | 824 | 10806 | 591 | 6749 |
| 6-#9 | 1.00 | MA | 6949 | 2288 | 10873 | 1687 | 11612 | 1425 | 11858 | 1223 | 11863 | 924 | 13411 | 804 | 4377 |
| 2L-3S | | MI | 4485 | 2288 | 7020 | 1623 | 7296 | 1378 | 7296 | 1182 | 7045 | 891 | 7647 | 683 | 2884 |
| 6-#9 | 1.00 | MA | 6785 | 2288 | 10438 | 1696 | 11055 | 1433 | 11179 | 1238 | 10939 | 938 | 12132 | 739 | 4399 |
| 3L-2S | | MI | 4576 | 2288 | 7282 | 1617 | 7631 | 1365 | 7705 | 1171 | 7601 | 883 | 8381 | 753 | 2864 |
| 6-#10 | 1.27 | MA | 7098 | 2332 | 11227 | 1711 | 12052 | 1442 | 12389 | 1232 | 12581 | 918 | 14403 | 797 | 5480 |
| 2L-3S | | MI | 4546 | 2332 | 7164 | 1646 | 7467 | 1396 | 7500 | 1192 | 7320 | 886 | 7989 | 648 | 3576 |
| 6-#10 | 1.27 | MA | 6894 | 2332 | 10678 | 1721 | 11349 | 1451 | 11531 | 1251 | 11414 | 935 | 12787 | 714 | 5507 |
| 3L-2S | | MI | 4660 | 2332 | 7493 | 1639 | 7889 | 1380 | 8015 | 1178 | 8020 | 875 | 8904 | 738 | 3546 |
| 6-#11 | 1.56 | MA | 7242 | 2381 | 11602 | 1730 | 12495 | 1454 | 12912 | 1237 | 13284 | 908 | 15368 | 786 | 6620 |
| 2L-3S | | MI | 4603 | 2381 | 7315 | 1659 | 7628 | 1406 | 7682 | 1195 | 7562 | 872 | 8237 | 596 | 4284 |
| 6-#11 | 1.56 | MA | 6999 | 2381 | 10939 | 1742 | 11645 | 1464 | 11875 | 1259 | 11873 | 927 | 13414 | 682 | 6652 |
| 3L-2S | | MI | 4736 | 2381 | 7708 | 1652 | 8132 | 1388 | 8298 | 1179 | 8399 | 862 | 9301 | 706 | 4245 |
| 6-#14 | 2.25 | MA | 7602 | 2495 | 12471 | 1794 | 13582 | 1498 | 14226 | 1262 | 15064 | 894 | 17829 | 769 | 9333 |
| 2L-3S | | MI | 4749 | 2495 | 7656 | 1720 | 8041 | 1453 | 8177 | 1222 | 8232 | 859 | 9018 | 498 | 5930 |
| 6-#14 | 2.25 | MA | 7265 | 2495 | 11526 | 1810 | 12369 | 1512 | 12747 | 1293 | 13052 | 920 | 15043 | 616 | 9353 |
| 3L-2S | | MI | 4934 | 2495 | 8212 | 1712 | 8755 | 1429 | 9048 | 1201 | 9416 | 845 | 10491 | 656 | 5877 |
| 6-#18 | 4.00 | MA | 8470 | 2786 | 14602 | 1959 | 16260 | 1615 | 17470 | 1329 | 19466 | 861 | 23912 | 728 | 15982 |
| 2L-3S | | MI | 5099 | 2786 | 8469 | 1880 | 9039 | 1577 | 9377 | 1294 | 9849 | 823 | 10806 | 227 | 9789 |
| 6-#18 | 4.00 | MA | 7914 | 2786 | 12960 | 1985 | 14155 | 1672 | 14902 | 1382 | 15972 | 904 | 19075 | 447 | 15852 |
| 3L-2S | | MI | 5406 | 2786 | 9419 | 1869 | 10258 | 1538 | 10864 | 1262 | 11867 | 806 | 13210 | 509 | 9771 |
| 8-#8 | 1.05 | MA | 6985 | 2296 | 10938 | 1697 | 11709 | 1432 | 11982 | 1228 | 12035 | 925 | 13652 | 805 | 4605 |
| 2L-4S | | MI | 4492 | 2296 | 6954 | 1644 | 7220 | 1388 | 7206 | 1189 | 6940 | 899 | 7551 | 672 | 3040 |
| 8-#8 | 1.05 | MA | 6855 | 2296 | 10593 | 1703 | 11267 | 1438 | 11443 | 1240 | 11301 | 936 | 12636 | 754 | 4621 |
| 3E | | MI | 4525 | 2296 | 7114 | 1633 | 7428 | 1384 | 7462 | 1186 | 7272 | 892 | 7965 | 702 | 3019 |
| 8-#8 | 1.05 | MA | 6784 | 2296 | 10334 | 1717 | 10930 | 1451 | 11028 | 1245 | 10761 | 947 | 11958 | 724 | 4640 |
| 4L-2S | | MI | 4598 | 2296 | 7323 | 1628 | 7695 | 1374 | 7788 | 1177 | 7716 | 885 | 8556 | 757 | 3004 |
| 8-#9 | 1.33 | MA | 7141 | 2343 | 11307 | 1722 | 12169 | 1450 | 12538 | 1238 | 12787 | 920 | 14691 | 798 | 5753 |
| 2L-4S | | MI | 4555 | 2343 | 7080 | 1671 | 7369 | 1407 | 7384 | 1200 | 7183 | 896 | 7865 | 635 | 3763 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis

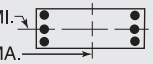



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.33 | MA | 6980 | 2343 | 10873 | 1730 | 11612 | 1457 | 11858 | 1253 | 11863 | 933 | 13411 | 733 | 5772 |
| 3E | | MI | 4596 | 2343 | 7282 | 1657 | 7631 | 1403 | 7705 | 1197 | 7601 | 887 | 8381 | 672 | 3735 |
| 8-#9 | 1.33 | MA | 6893 | 2343 | 10545 | 1747 | 11187 | 1473 | 11336 | 1260 | 11182 | 947 | 12554 | 695 | 5789 |
| 4L-2S | | MI | 4687 | 2343 | 7543 | 1652 | 7966 | 1390 | 8114 | 1186 | 8157 | 878 | 9116 | 743 | 3714 |
| 8-#10 | 1.69 | MA | 7339 | 2403 | 11775 | 1755 | 12755 | 1473 | 13247 | 1251 | 13748 | 912 | 16019 | 789 | 7212 |
| 2L-4S | | MI | 4635 | 2403 | 7238 | 1707 | 7559 | 1432 | 7610 | 1214 | 7493 | 891 | 8260 | 587 | 4666 |
| 8-#10 | 1.69 | MA | 7139 | 2403 | 11227 | 1765 | 12052 | 1482 | 12389 | 1270 | 12581 | 929 | 14403 | 706 | 7232 |
| 3E | | MI | 4686 | 2403 | 7493 | 1689 | 7889 | 1428 | 8015 | 1212 | 8020 | 880 | 8904 | 633 | 4635 |
| 8-#10 | 1.69 | MA | 7030 | 2403 | 10813 | 1787 | 11514 | 1503 | 11728 | 1278 | 11720 | 946 | 13315 | 657 | 7233 |
| 4L-2S | | MI | 4798 | 2403 | 7822 | 1683 | 8311 | 1412 | 8529 | 1198 | 8720 | 870 | 9820 | 723 | 4607 |
| 8-#11 | 2.08 | MA | 7530 | 2467 | 12266 | 1784 | 13345 | 1493 | 13950 | 1260 | 14695 | 901 | 17323 | 776 | 8711 |
| 2L-4S | | MI | 4710 | 2467 | 7402 | 1734 | 7736 | 1449 | 7811 | 1220 | 7766 | 877 | 8548 | 520 | 5579 |
| 8-#11 | 2.08 | MA | 7293 | 2467 | 11602 | 1796 | 12495 | 1503 | 12912 | 1283 | 13284 | 920 | 15368 | 672 | 8732 |
| 3E | | MI | 4768 | 2467 | 7708 | 1713 | 8132 | 1444 | 8298 | 1218 | 8399 | 866 | 9301 | 574 | 5546 |
| 8-#11 | 2.08 | MA | 7166 | 2467 | 11100 | 1821 | 11843 | 1527 | 12111 | 1292 | 12239 | 940 | 14040 | 611 | 8709 |
| 4L-2S | | MI | 4899 | 2467 | 8102 | 1706 | 8637 | 1426 | 8913 | 1203 | 9237 | 855 | 10366 | 684 | 5511 |
| 8-#14 | 3.00 | MA | 8007 | 2620 | 13417 | 1871 | 14794 | 1554 | 15705 | 1296 | 17077 | 884 | 20615 | 755 | 12301 |
| 2L-4S | | MI | 4904 | 2620 | 7777 | 1826 | 8191 | 1514 | 8357 | 1257 | 8517 | 863 | 9443 | 386 | 7509 |
| 8-#14 | 3.00 | MA | 7679 | 2620 | 12471 | 1888 | 13582 | 1568 | 14226 | 1327 | 15064 | 911 | 17829 | 602 | 12293 |
| 3E | | MI | 4981 | 2620 | 8212 | 1798 | 8755 | 1509 | 9048 | 1256 | 9416 | 849 | 10491 | 461 | 7688 |
| 8-#14 | 3.00 | MA | 7504 | 2620 | 11753 | 1924 | 12649 | 1602 | 13080 | 1339 | 13572 | 937 | 15920 | 513 | 12006 |
| 4L-2S | | MI | 5163 | 2620 | 8769 | 1790 | 9468 | 1485 | 9918 | 1235 | 10600 | 835 | 11965 | 619 | 7651 |
| 8-#18 | 5.33 | MA | 8623 | 3007 | 14602 | 2124 | 16260 | 1771 | 17470 | 1442 | 19466 | 886 | 23912 | 422 | 20917 |
| 3E | | MI | 5491 | 3007 | 9419 | 2018 | 10258 | 1676 | 10864 | 1354 | 11867 | 805 | 13210 | 145 | 12711 |
| 8-#18 | 5.33 | MA | 8334 | 3007 | 13348 | 2185 | 14633 | 1793 | 15471 | 1459 | 16863 | 930 | 20547 | 261 | 18693 |
| 4L-2S | | MI | 5791 | 3007 | 10370 | 2007 | 11476 | 1638 | 12350 | 1323 | 13885 | 787 | 15614 | 426 | 12763 |
| 10-#10 | 2.12 | MA | 7579 | 2473 | 12324 | 1799 | 13458 | 1505 | 14104 | 1270 | 14915 | 907 | 17635 | 781 | 8937 |
| 2L-5S | | MI | 4677 | 2473 | 7352 | 1757 | 7695 | 1480 | 7768 | 1248 | 7667 | 884 | 8537 | 520 | 5637 |
| 10-#10 | 2.12 | MA | 7382 | 2473 | 11775 | 1809 | 12755 | 1514 | 13247 | 1289 | 13748 | 924 | 16019 | 699 | 8950 |
| 3L-4S | | MI | 4774 | 2473 | 7567 | 1751 | 7981 | 1464 | 8124 | 1234 | 8193 | 885 | 9175 | 572 | 5706 |
| 10-#10 | 2.12 | MA | 7275 | 2473 | 11361 | 1831 | 12218 | 1534 | 12586 | 1297 | 12887 | 940 | 14931 | 650 | 8936 |
| 4L-3S | | MI | 4825 | 2473 | 7822 | 1733 | 8311 | 1459 | 8529 | 1231 | 8720 | 875 | 9820 | 619 | 5683 |
| 10-#10 | 2.12 | MA | 7106 | 2473 | 11016 | 1841 | 11757 | 1543 | 12009 | 1316 | 12032 | 946 | 13830 | 607 | 8763 |
| 5L-2S | | MI | 4936 | 2473 | 8151 | 1727 | 8732 | 1443 | 9044 | 1217 | 9420 | 864 | 10735 | 708 | 5658 |
| 10-#11 | 2.60 | MA | 7584 | 2553 | 12266 | 1850 | 13345 | 1542 | 13950 | 1306 | 14695 | 913 | 17323 | 662 | 10803 |
| 3L-4S | | MI | 4876 | 2553 | 7795 | 1788 | 8240 | 1488 | 8427 | 1244 | 8603 | 870 | 9612 | 497 | 6816 |
| 10-#11 | 2.60 | MA | 7459 | 2553 | 11763 | 1875 | 12693 | 1566 | 13148 | 1315 | 13651 | 933 | 15994 | 601 | 10762 |
| 4L-3S | | MI | 4932 | 2553 | 8102 | 1767 | 8637 | 1483 | 8913 | 1242 | 9237 | 859 | 10366 | 551 | 6794 |
| 10-#11 | 2.60 | MA | 7258 | 2553 | 11343 | 1887 | 12133 | 1576 | 12447 | 1338 | 12613 | 938 | 14653 | 546 | 10310 |
| 5L-2S | | MI | 5062 | 2553 | 8495 | 1760 | 9141 | 1465 | 9529 | 1226 | 10074 | 848 | 11430 | 661 | 6766 |
| 10-#14 | 3.75 | MA | 8090 | 2744 | 13417 | 1965 | 14794 | 1624 | 15705 | 1361 | 17077 | 901 | 20615 | 588 | 15227 |
| 3L-4S | | MI | 5136 | 2744 | 8333 | 1904 | 8905 | 1570 | 9227 | 1291 | 9701 | 853 | 10916 | 349 | 9123 |
| 10-#14 | 3.75 | MA | 7918 | 2744 | 12699 | 2002 | 13862 | 1658 | 14559 | 1373 | 15584 | 927 | 18706 | 499 | 14820 |
| 4L-3S | | MI | 5212 | 2744 | 8769 | 1876 | 9468 | 1565 | 9918 | 1290 | 10600 | 839 | 11965 | 424 | 9435 |
| 10-#14 | 3.75 | MA | 7635 | 2744 | 12097 | 2018 | 13060 | 1672 | 13557 | 1404 | 14101 | 934 | 16784 | 416 | 13914 |
| 5L-2S | | MI | 5391 | 2744 | 9325 | 1867 | 10182 | 1540 | 10789 | 1269 | 11785 | 825 | 13438 | 582 | 9410 |
| 10-#18 | 6.67 | MA | 9042 | 3228 | 14990 | 2323 | 16738 | 1892 | 18039 | 1519 | 20357 | 912 | 25384 | 236 | 23642 |
| 4L-3S | | MI | 5881 | 3228 | 10370 | 2156 | 11476 | 1776 | 12350 | 1414 | 13885 | 787 | 15614 | 63 | 15383 |
| 10-#18 | 6.67 | MA | 8564 | 3228 | 13937 | 2350 | 15336 | 1949 | 16288 | 1572 | 17767 | 920 | 22013 | 78 | 21626 |
| 5L-2S | | MI | 6175 | 3228 | 11320 | 2146 | 12695 | 1737 | 13836 | 1383 | 15902 | 769 | 18018 | 344 | 15739 |
| 12-#10 | 2.54 | MA | 7624 | 2543 | 12324 | 1853 | 13458 | 1545 | 14104 | 1309 | 14915 | 918 | 17635 | 691 | 10663 |
| 3L-5S | | MI | 4817 | 2543 | 7681 | 1801 | 8117 | 1511 | 8282 | 1267 | 8367 | 879 | 9453 | 506 | 6614 |
| 12-#10 | 2.54 | MA | 7518 | 2543 | 11910 | 1875 | 12921 | 1566 | 13443 | 1316 | 14054 | 935 | 16547 | 642 | 10638 |
| 4E | | MI | 4913 | 2543 | 7896 | 1795 | 8403 | 1495 | 8639 | 1253 | 8893 | 879 | 10091 | 557 | 6740 |
| 12-#10 | 2.54 | MA | 7352 | 2543 | 11564 | 1885 | 12460 | 1575 | 12867 | 1335 | 13200 | 940 | 15447 | 599 | 10415 |
| 5L-3S | | MI | 4963 | 2543 | 8151 | 1777 | 8732 | 1491 | 9044 | 1250 | 9420 | 869 | 10735 | 604 | 6723 |
| 12-#10 | 2.54 | MA | 7232 | 2543 | 11206 | 1889 | 12001 | 1595 | 12296 | 1343 | 12432 | 957 | 14457 | 542 | 10060 |
| 6L-2S | | MI | 5073 | 2543 | 8479 | 1771 | 9154 | 1475 | 9558 | 1236 | 10120 | 858 | 11650 | 693 | 6703 |

## RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis



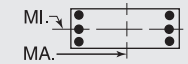

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 3.12 | MA | 7750 | 2639 | 12426 | 1929 | 13543 | 1604 | 14185 | 1339 | 15062 | 926 | 17948 | 592 | 12814 |
| 4E | | MI | 5040 | 2639 | 8189 | 1841 | 8745 | 1526 | 9042 | 1267 | 9441 | 863 | 10676 | 474 | 8044 |
| 12-#11 | 3.12 | MA | 7552 | 2639 | 12006 | 1941 | 12983 | 1615 | 13485 | 1361 | 14025 | 932 | 16607 | 537 | 12312 |
| 5L-3S | | MI | 5096 | 2639 | 8495 | 1821 | 9141 | 1522 | 9529 | 1265 | 10074 | 852 | 11430 | 529 | 8035 |
| 12-#11 | 3.12 | MA | 7408 | 2639 | 11579 | 1947 | 12426 | 1639 | 12791 | 1370 | 13092 | 951 | 15396 | 466 | 11926 |
| 6L-2S | | MI | 5225 | 2639 | 8889 | 1814 | 9646 | 1504 | 10144 | 1250 | 10912 | 841 | 12494 | 638 | 8013 |
| 12-#14 | 4.50 | MA | 8328 | 2869 | 13644 | 2079 | 15074 | 1714 | 16038 | 1407 | 17596 | 918 | 21492 | 486 | 17649 |
| 4E | | MI | 5367 | 2869 | 8890 | 1982 | 9618 | 1626 | 10098 | 1325 | 10885 | 843 | 12390 | 312 | 10754 |
| 12-#14 | 4.50 | MA | 8051 | 2869 | 13043 | 2096 | 14272 | 1728 | 15036 | 1438 | 16113 | 925 | 19570 | 403 | 16788 |
| 5L-3S | | MI | 5442 | 2869 | 9325 | 1954 | 10182 | 1621 | 10789 | 1324 | 11785 | 829 | 13438 | 387 | 11168 |
| 12-#14 | 4.50 | MA | 7850 | 2869 | 12439 | 2105 | 13474 | 1761 | 14043 | 1450 | 14779 | 951 | 17829 | 300 | 15807 |
| 6L-2S | | MI | 5618 | 2869 | 9882 | 1945 | 10895 | 1596 | 11659 | 1303 | 12969 | 815 | 14911 | 545 | 11162 |
| 12-#18 | 8.00 | MA | 9277 | 3449 | 15579 | 2488 | 17441 | 2049 | 18856 | 1632 | 21261 | 903 | 26850 | 53 | 26572 |
| 5L-3S | | MI | 6270 | 3449 | 11320 | 2295 | 12695 | 1875 | 13836 | 1475 | 15902 | 768 | 18018 | -19 | 17988 |
| 14-#10 | 2.96 | MA | 7760 | 2613 | 12458 | 1918 | 13624 | 1597 | 14301 | 1336 | 15221 | 929 | 18164 | 634 | 12339 |
| 4L-5S | | MI | 4957 | 2613 | 8010 | 1845 | 8539 | 1543 | 8797 | 1286 | 9067 | 873 | 10368 | 491 | 7597 |
| 14-#10 | 2.96 | MA | 7596 | 2613 | 12113 | 1929 | 13163 | 1606 | 13725 | 1355 | 14367 | 935 | 17063 | 591 | 12072 |
| 5L-4S | | MI | 5052 | 2613 | 8225 | 1839 | 8824 | 1527 | 9153 | 1272 | 9593 | 874 | 11006 | 542 | 7769 |
| 14-#10 | 2.96 | MA | 7478 | 2613 | 11755 | 1933 | 12704 | 1626 | 13154 | 1362 | 13599 | 952 | 16073 | 534 | 11733 |
| 6L-3S | | MI | 5101 | 2613 | 8479 | 1821 | 9154 | 1522 | 9558 | 1269 | 10120 | 863 | 11650 | 589 | 7759 |
| 14-#10 | 2.96 | MA | 7353 | 2613 | 11363 | 1950 | 12240 | 1632 | 12609 | 1382 | 12851 | 968 | 14912 | 484 | 11361 |
| 7L-2S | | MI | 5210 | 2613 | 8808 | 1815 | 9576 | 1507 | 10072 | 1255 | 10820 | 853 | 12565 | 678 | 7743 |
| 14-#11 | 3.64 | MA | 7844 | 2726 | 12670 | 1995 | 13833 | 1653 | 14522 | 1385 | 15436 | 925 | 18561 | 527 | 14319 |
| 5L-4S | | MI | 5204 | 2726 | 8583 | 1895 | 9249 | 1565 | 9657 | 1291 | 10278 | 856 | 11741 | 452 | 9224 |
| 14-#11 | 3.64 | MA | 7704 | 2726 | 12242 | 2001 | 13276 | 1677 | 13828 | 1393 | 14503 | 944 | 17350 | 456 | 13952 |
| 6L-3S | | MI | 5260 | 2726 | 8889 | 1875 | 9646 | 1561 | 10144 | 1289 | 10912 | 845 | 12494 | 506 | 9271 |
| 14-#11 | 3.64 | MA | 7556 | 2726 | 11767 | 2021 | 12722 | 1684 | 13166 | 1416 | 13594 | 964 | 16092 | 411 | 13289 |
| 7L-2S | | MI | 5387 | 2726 | 9282 | 1868 | 10150 | 1543 | 10760 | 1273 | 11749 | 834 | 13559 | 616 | 9254 |
| 14-#14 | 5.25 | MA | 8464 | 2993 | 13988 | 2173 | 15484 | 1783 | 16515 | 1472 | 18125 | 915 | 22356 | 389 | 19669 |
| 5L-4S | | MI | 5597 | 2993 | 9447 | 2060 | 10332 | 1682 | 10968 | 1359 | 12070 | 833 | 13863 | 275 | 12397 |
| 14-#14 | 5.25 | MA | 8269 | 2993 | 13385 | 2183 | 14686 | 1817 | 15522 | 1484 | 16791 | 941 | 20615 | 286 | 18667 |
| 6L-3S | | MI | 5672 | 2993 | 9882 | 2032 | 10895 | 1677 | 11659 | 1358 | 12969 | 819 | 14911 | 350 | 12896 |
| 16-#10 | 3.39 | MA | 7838 | 2684 | 12661 | 1972 | 13866 | 1638 | 14582 | 1374 | 15534 | 929 | 18679 | 584 | 13735 |
| 5E | | MI | 5096 | 2684 | 8339 | 1889 | 8960 | 1574 | 9311 | 1305 | 9767 | 867 | 11283 | 476 | 8585 |
| 16-#10 | 3.39 | MA | 7723 | 2684 | 12303 | 1977 | 13407 | 1658 | 14011 | 1382 | 14766 | 946 | 17689 | 527 | 13410 |
| 6L-4S | | MI | 5190 | 2684 | 8554 | 1883 | 9246 | 1558 | 9668 | 1291 | 10293 | 868 | 11921 | 527 | 8794 |
| 16-#10 | 3.39 | MA | 7598 | 2684 | 11911 | 1994 | 12943 | 1663 | 13467 | 1401 | 14018 | 963 | 16528 | 476 | 13023 |
| 7L-3S | | MI | 5239 | 2684 | 8808 | 1865 | 9576 | 1554 | 10072 | 1288 | 10820 | 858 | 12565 | 574 | 8792 |
| 16-#10 | 3.39 | MA | 7461 | 2684 | 11568 | 2001 | 12468 | 1680 | 12900 | 1407 | 13221 | 968 | 15525 | 428 | 12581 |
| 8L-2S | | MI | 5346 | 2684 | 9137 | 1859 | 9997 | 1538 | 10587 | 1274 | 11520 | 847 | 13481 | 663 | 8779 |
| 16-#11 | 4.16 | MA | 7997 | 2812 | 12905 | 2055 | 14126 | 1716 | 14865 | 1417 | 15914 | 937 | 19304 | 447 | 15982 |
| 6L-4S | | MI | 5368 | 2812 | 8976 | 1949 | 9754 | 1604 | 10273 | 1314 | 11115 | 849 | 12805 | 429 | 10386 |
| 16-#11 | 4.16 | MA | 7851 | 2812 | 12430 | 2075 | 13572 | 1723 | 14203 | 1439 | 15005 | 957 | 18046 | 401 | 15302 |
| 7L-3S | | MI | 5423 | 2812 | 9282 | 1929 | 10150 | 1599 | 10760 | 1312 | 11749 | 838 | 13559 | 484 | 10503 |
| 16-#14 | 6.00 | MA | 8684 | 3118 | 14330 | 2261 | 15899 | 1873 | 17001 | 1518 | 18803 | 932 | 23401 | 272 | 21533 |
| 6L-4S | | MI | 5827 | 3118 | 10003 | 2138 | 11045 | 1737 | 11838 | 1393 | 13254 | 823 | 15336 | 238 | 14049 |
| 18-#10 | 3.81 | MA | 7967 | 2754 | 12852 | 2021 | 14111 | 1689 | 14869 | 1401 | 15933 | 940 | 19305 | 519 | 15089 |
| 6L-5S | | MI | 5234 | 2754 | 8668 | 1933 | 9382 | 1606 | 9826 | 1324 | 10467 | 862 | 12198 | 461 | 9575 |
| 18-#10 | 3.81 | MA | 7843 | 2754 | 12460 | 2038 | 13646 | 1695 | 14324 | 1420 | 15185 | 957 | 18144 | 469 | 14688 |
| 7L-4S | | MI | 5328 | 2754 | 8883 | 1927 | 9668 | 1590 | 10182 | 1310 | 10993 | 863 | 12836 | 512 | 9816 |
| 18-#10 | 3.81 | MA | 7707 | 2754 | 12117 | 2045 | 13171 | 1711 | 13758 | 1426 | 14388 | 963 | 17141 | 420 | 14259 |
| 8L-3S | | MI | 5377 | 2754 | 9137 | 1909 | 9997 | 1585 | 10587 | 1307 | 11520 | 852 | 13481 | 559 | 9823 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

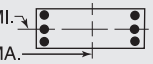
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 4.68 | MA | 8143 | 2898 | 13094 | 2129 | 14422 | 1762 | 15240 | 1463 | 16417 | 950 | 20000 | 392 | 17320 |
| 7L-4S | | MI | 5531 | 2898 | 9370 | 2003 | 10258 | 1642 | 10888 | 1338 | 11953 | 842 | 13869 | 407 | 11554 |
| 20-#10 | 4.23 | MA | 8086 | 2824 | 13009 | 2082 | 14349 | 1726 | 15182 | 1439 | 16352 | 952 | 19760 | 461 | 16356 |
| 7L-5S | | MI | 5372 | 2824 | 8997 | 1977 | 9804 | 1637 | 10340 | 1343 | 11167 | 856 | 13114 | 446 | 10569 |
| 20-#10 | 4.23 | MA | 7952 | 2824 | 12665 | 2089 | 13875 | 1743 | 14616 | 1445 | 15555 | 957 | 18757 | 413 | 15938 |
| 8L-4S | | MI | 5465 | 2824 | 9212 | 1971 | 10089 | 1622 | 10696 | 1329 | 11693 | 857 | 13752 | 497 | 10825 |
| 22-#10 | 4.66 | MA | 8196 | 2895 | 13214 | 2133 | 14578 | 1774 | 15474 | 1464 | 16723 | 952 | 20373 | 405 | 17619 |
| 8L-5S | | MI | 5510 | 2895 | 9326 | 2021 | 10225 | 1669 | 10855 | 1362 | 11867 | 851 | 14029 | 431 | 11564 |

## RECTANGULAR TIED COLUMNS 20" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.41 | MA | 8146 | 2512 | 12977 | 1831 | 13938 | 1541 | 14355 | 1313 | 14659 | 972 | 16857 | 842 | 6834 |
| 2E | | MI | 4988 | 2512 | 8092 | 1733 | 8482 | 1457 | 8606 | 1241 | 8623 | 913 | 9423 | 745 | 4110 |
| 4-#18 | 2.50 | MA | 8787 | 2706 | 14538 | 1936 | 15880 | 1614 | 16699 | 1354 | 17834 | 946 | 21242 | 812 | 11698 |
| 2E | | MI | 5303 | 2706 | 8907 | 1828 | 9479 | 1522 | 9804 | 1274 | 10237 | 881 | 11206 | 641 | 6792 |
| 6-#10 | 1.19 | MA | 8040 | 2474 | 12649 | 1826 | 13588 | 1540 | 13960 | 1317 | 14139 | 986 | 16151 | 857 | 5891 |
| 2L-3S | | MI | 4829 | 2474 | 7597 | 1746 | 7909 | 1482 | 7932 | 1267 | 7715 | 945 | 8400 | 701 | 3598 |
| 6-#10 | 1.19 | MA | 7817 | 2474 | 12056 | 1837 | 12829 | 1549 | 13033 | 1337 | 12878 | 1004 | 14406 | 775 | 5918 |
| 3L-2S | | MI | 4943 | 2474 | 7926 | 1740 | 8331 | 1466 | 8446 | 1253 | 8415 | 935 | 9315 | 790 | 3569 |
| 6-#11 | 1.46 | MA | 8198 | 2522 | 13058 | 1845 | 14071 | 1552 | 14530 | 1322 | 14904 | 976 | 17203 | 845 | 7126 |
| 2L-3S | | MI | 4885 | 2522 | 7750 | 1759 | 8069 | 1491 | 8112 | 1269 | 7955 | 931 | 8644 | 648 | 4312 |
| 6-#11 | 1.46 | MA | 7933 | 2522 | 12341 | 1857 | 13151 | 1563 | 13409 | 1346 | 13378 | 996 | 15090 | 743 | 7157 |
| 3L-2S | | MI | 5019 | 2522 | 8144 | 1752 | 8573 | 1472 | 8728 | 1253 | 8792 | 920 | 9709 | 758 | 4272 |
| 6-#14 | 2.11 | MA | 8592 | 2637 | 14001 | 1909 | 15250 | 1596 | 15956 | 1347 | 16836 | 962 | 19872 | 828 | 10062 |
| 2L-3S | | MI | 5032 | 2637 | 8092 | 1819 | 8482 | 1537 | 8606 | 1295 | 8623 | 917 | 9423 | 549 | 5967 |
| 6-#14 | 2.11 | MA | 8222 | 2637 | 12977 | 1926 | 13938 | 1611 | 14355 | 1380 | 14659 | 990 | 16857 | 679 | 10082 |
| 3L-2S | | MI | 5217 | 2637 | 8648 | 1810 | 9196 | 1513 | 9477 | 1274 | 9807 | 904 | 10896 | 708 | 5912 |
| 6-#18 | 3.75 | MA | 9543 | 2927 | 16318 | 2074 | 18162 | 1713 | 19483 | 1415 | 21622 | 929 | 26487 | 788 | 17278 |
| 2L-3S | | MI | 5382 | 2927 | 8907 | 1977 | 9479 | 1660 | 9804 | 1366 | 10237 | 881 | 11206 | 277 | 9857 |
| 6-#18 | 3.75 | MA | 8933 | 2927 | 14538 | 2102 | 15880 | 1737 | 16699 | 1469 | 17834 | 975 | 21242 | 513 | 17148 |
| 3L-2S | | MI | 5689 | 2927 | 9857 | 1966 | 10698 | 1621 | 11290 | 1334 | 12254 | 863 | 13610 | 559 | 9821 |
| 8-#9 | 1.25 | MA | 8087 | 2484 | 12734 | 1837 | 13713 | 1548 | 14119 | 1323 | 14360 | 988 | 16460 | 857 | 6185 |
| 2L-4S | | MI | 4837 | 2484 | 7513 | 1772 | 7811 | 1493 | 7816 | 1275 | 7579 | 955 | 8277 | 687 | 3785 |
| 8-#9 | 1.25 | MA | 7910 | 2484 | 12265 | 1845 | 13112 | 1556 | 13386 | 1339 | 13362 | 1002 | 15079 | 794 | 6204 |
| 3E | | MI | 4879 | 2484 | 7715 | 1758 | 8073 | 1489 | 8137 | 1272 | 7997 | 947 | 8793 | 725 | 3757 |
| 8-#9 | 1.25 | MA | 7813 | 2484 | 11913 | 1863 | 12654 | 1572 | 12823 | 1346 | 12628 | 1016 | 14160 | 756 | 6221 |
| 4L-2S | | MI | 4970 | 2484 | 7976 | 1753 | 8408 | 1476 | 8546 | 1261 | 8553 | 938 | 9528 | 795 | 3736 |
| 8-#10 | 1.59 | MA | 8303 | 2544 | 13241 | 1870 | 14348 | 1571 | 14886 | 1337 | 15400 | 980 | 17897 | 849 | 7760 |
| 2L-4S | | MI | 4917 | 2544 | 7672 | 1808 | 8001 | 1518 | 8041 | 1289 | 7888 | 950 | 8671 | 639 | 4694 |
| 8-#10 | 1.59 | MA | 8083 | 2544 | 12649 | 1881 | 13588 | 1581 | 13960 | 1356 | 14139 | 998 | 16151 | 768 | 7780 |
| 3E | | MI | 4969 | 2544 | 7926 | 1790 | 8331 | 1513 | 8446 | 1286 | 8415 | 940 | 9315 | 686 | 4661 |
| 8-#10 | 1.59 | MA | 7963 | 2544 | 12203 | 1903 | 13009 | 1602 | 13248 | 1365 | 13211 | 1016 | 14987 | 719 | 7781 |
| 4L-2S | | MI | 5081 | 2544 | 8255 | 1784 | 8752 | 1498 | 8961 | 1272 | 9115 | 929 | 10230 | 775 | 4633 |
| 8-#11 | 1.95 | MA | 8512 | 2608 | 13775 | 1899 | 14990 | 1591 | 15652 | 1346 | 16430 | 969 | 19316 | 836 | 9385 |
| 2L-4S | | MI | 4993 | 2608 | 7837 | 1833 | 8177 | 1534 | 8241 | 1294 | 8158 | 935 | 8955 | 571 | 5616 |
| 8-#11 | 1.95 | MA | 8252 | 2608 | 13058 | 1911 | 14071 | 1602 | 14530 | 1369 | 14904 | 989 | 17203 | 734 | 9406 |
| 3E | | MI | 5051 | 2608 | 8144 | 1812 | 8573 | 1529 | 8728 | 1292 | 8792 | 924 | 9709 | 625 | 5578 |
| 8-#11 | 1.95 | MA | 8111 | 2608 | 12516 | 1938 | 13368 | 1626 | 13666 | 1379 | 13778 | 1010 | 15779 | 673 | 9383 |
| 4L-2S | | MI | 5183 | 2608 | 8537 | 1806 | 9078 | 1511 | 9343 | 1276 | 9629 | 913 | 10773 | 735 | 5542 |
| 8-#14 | 2.81 | MA | 9033 | 2761 | 15024 | 1986 | 16562 | 1652 | 17556 | 1381 | 19014 | 952 | 22887 | 815 | 13273 |
| 2L-4S | | MI | 5186 | 2761 | 8213 | 1925 | 8632 | 1598 | 8786 | 1331 | 8908 | 921 | 9848 | 437 | 7636 |
| 8-#14 | 2.81 | MA | 8675 | 2761 | 14001 | 2003 | 15250 | 1667 | 15956 | 1414 | 16836 | 980 | 19872 | 665 | 13265 |
| 3E | | MI | 5264 | 2761 | 8648 | 1897 | 9196 | 1593 | 9477 | 1329 | 9807 | 907 | 10896 | 512 | 7731 |
| 8-#14 | 2.81 | MA | 8479 | 2761 | 13226 | 2041 | 14244 | 1702 | 14719 | 1427 | 15226 | 1009 | 17826 | 577 | 13105 |
| 4L-2S | | MI | 5446 | 2761 | 9205 | 1888 | 9909 | 1569 | 10347 | 1308 | 10991 | 894 | 12369 | 671 | 7689 |
| 8-#18 | 5.00 | MA | 9707 | 3148 | 16318 | 2240 | 18162 | 1836 | 19483 | 1530 | 21622 | 958 | 26487 | 489 | 22645 |
| 3E | | MI | 5774 | 3148 | 9857 | 2115 | 10698 | 1759 | 11290 | 1426 | 12254 | 862 | 13610 | 195 | 12798 |

## RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

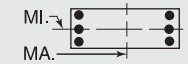
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 5.00 | MA | 9383 | 3148 | 14963 | 2304 | 16405 | 1895 | 17323 | 1549 | 18808 | 1004 | 22876 | 329 | 20417 |
| 4L-2S | | MI | 6074 | 3148 | 10808 | 2104 | 11916 | 1720 | 12777 | 1395 | 14272 | 845 | 16014 | 477 | 12818 |
| 10-#10 | 1.98 | MA | 8563 | 2614 | 13834 | 1914 | 15107 | 1603 | 15813 | 1356 | 16660 | 975 | 19642 | 841 | 9622 |
| 2L-5S | | MI | 4960 | 2614 | 7786 | 1858 | 8137 | 1565 | 8199 | 1322 | 8062 | 944 | 8948 | 573 | 5735 |
| 10-#10 | 1.98 | MA | 8348 | 2614 | 13241 | 1925 | 14348 | 1612 | 14886 | 1375 | 15400 | 992 | 17897 | 760 | 9636 |
| 3L-4S | | MI | 5057 | 2614 | 8001 | 1852 | 8423 | 1550 | 8556 | 1308 | 8588 | 945 | 9586 | 624 | 5738 |
| 10-#10 | 1.98 | MA | 8229 | 2614 | 12795 | 1946 | 13769 | 1633 | 14174 | 1384 | 14472 | 1010 | 16732 | 711 | 9622 |
| 4L-3S | | MI | 5108 | 2614 | 8255 | 1834 | 8752 | 1545 | 8961 | 1305 | 9115 | 934 | 10230 | 671 | 5712 |
| 10-#10 | 1.98 | MA | 8046 | 2614 | 12424 | 1957 | 13273 | 1643 | 13554 | 1404 | 13552 | 1016 | 15550 | 671 | 9504 |
| 5L-2S | | MI | 5219 | 2614 | 8584 | 1828 | 9174 | 1529 | 9475 | 1291 | 9815 | 924 | 11145 | 760 | 5686 |
| 10-#11 | 2.44 | MA | 8570 | 2695 | 13775 | 1965 | 14990 | 1640 | 15652 | 1393 | 16430 | 982 | 19316 | 724 | 11646 |
| 3L-4S | | MI | 5159 | 2695 | 8231 | 1887 | 8681 | 1572 | 8857 | 1318 | 8996 | 928 | 10019 | 549 | 6856 |
| 10-#11 | 2.44 | MA | 8430 | 2695 | 13233 | 1991 | 14287 | 1665 | 14787 | 1402 | 15304 | 1003 | 17892 | 664 | 11605 |
| 4L-3S | | MI | 5215 | 2695 | 8537 | 1866 | 9078 | 1568 | 9343 | 1316 | 9629 | 918 | 10773 | 603 | 6830 |
| 10-#11 | 2.44 | MA | 8211 | 2695 | 12781 | 2004 | 13684 | 1676 | 14033 | 1425 | 14186 | 1009 | 16451 | 611 | 11189 |
| 5L-2S | | MI | 5346 | 2695 | 8931 | 1860 | 9582 | 1550 | 9959 | 1300 | 10467 | 907 | 11837 | 713 | 6799 |
| 10-#14 | 3.52 | MA | 9123 | 2885 | 15024 | 2081 | 16562 | 1723 | 17556 | 1448 | 19014 | 970 | 22887 | 651 | 16442 |
| 3L-4S | | MI | 5418 | 2885 | 8770 | 2003 | 9346 | 1654 | 9656 | 1364 | 10092 | 911 | 11321 | 400 | 9248 |
| 10-#14 | 3.52 | MA | 8930 | 2885 | 14249 | 2118 | 15556 | 1758 | 16320 | 1461 | 17403 | 999 | 20841 | 563 | 16159 |
| 4L-3S | | MI | 5495 | 2885 | 9205 | 1974 | 9909 | 1649 | 10347 | 1363 | 10991 | 897 | 12369 | 475 | 9481 |
| 10-#14 | 3.52 | MA | 8622 | 2885 | 13602 | 2135 | 14692 | 1773 | 15240 | 1494 | 15804 | 1007 | 18775 | 485 | 15110 |
| 5L-2S | | MI | 5674 | 2885 | 9761 | 1966 | 10623 | 1624 | 11218 | 1342 | 12175 | 884 | 13843 | 634 | 9452 |
| 10-#18 | 6.25 | MA | 10156 | 3370 | 16743 | 2442 | 18687 | 1995 | 20107 | 1610 | 22597 | 986 | 28122 | 305 | 25797 |
| 4L-3S | | MI | 6164 | 3370 | 10808 | 2253 | 11916 | 1858 | 12777 | 1486 | 14272 | 844 | 16014 | 113 | 15593 |
| 10-#18 | 6.25 | MA | 9634 | 3370 | 15608 | 2470 | 17174 | 2018 | 18217 | 1665 | 19799 | 997 | 24492 | 154 | 23752 |
| 5L-2S | | MI | 6459 | 3370 | 11758 | 2243 | 13135 | 1820 | 14263 | 1455 | 16290 | 826 | 18418 | 395 | 15800 |
| 12-#10 | 2.38 | MA | 8611 | 2685 | 13834 | 1969 | 15107 | 1644 | 15813 | 1395 | 16660 | 987 | 19642 | 752 | 11486 |
| 3L-5S | | MI | 5100 | 2685 | 8115 | 1902 | 8559 | 1597 | 8714 | 1341 | 8762 | 938 | 9863 | 558 | 6692 |
| 12-#10 | 2.38 | MA | 8494 | 2685 | 13388 | 1990 | 14528 | 1665 | 15101 | 1403 | 15732 | 1004 | 18478 | 704 | 11461 |
| 4E | | MI | 5196 | 2685 | 8330 | 1895 | 8844 | 1581 | 9070 | 1327 | 9288 | 939 | 10501 | 609 | 6774 |
| 12-#10 | 2.38 | MA | 8313 | 2685 | 13016 | 2001 | 14032 | 1674 | 14480 | 1423 | 14812 | 1011 | 17295 | 663 | 11291 |
| 5L-3S | | MI | 5246 | 2685 | 8584 | 1878 | 9174 | 1577 | 9475 | 1325 | 9815 | 928 | 11145 | 656 | 6755 |
| 12-#10 | 2.38 | MA | 8182 | 2685 | 12625 | 2005 | 13539 | 1695 | 13866 | 1431 | 13986 | 1028 | 16236 | 606 | 10882 |
| 6L-2S | | MI | 5356 | 2685 | 8913 | 1871 | 9596 | 1561 | 9989 | 1311 | 10514 | 918 | 12061 | 745 | 6732 |
| 12-#11 | 2.92 | MA | 8747 | 2781 | 13950 | 2045 | 15207 | 1704 | 15909 | 1426 | 16830 | 996 | 20005 | 654 | 13825 |
| 4E | | MI | 5323 | 2781 | 8624 | 1941 | 9186 | 1611 | 9472 | 1341 | 9833 | 922 | 11083 | 526 | 8090 |
| 12-#11 | 2.92 | MA | 8531 | 2781 | 13498 | 2058 | 14603 | 1715 | 15154 | 1449 | 15712 | 1003 | 18564 | 602 | 13356 |
| 5L-3S | | MI | 5379 | 2781 | 8931 | 1920 | 9582 | 1607 | 9959 | 1339 | 10467 | 911 | 11837 | 580 | 8074 |
| 12-#11 | 2.92 | MA | 8375 | 2781 | 13031 | 2064 | 14003 | 1739 | 14407 | 1459 | 14707 | 1023 | 17268 | 531 | 12913 |
| 6L-2S | | MI | 5508 | 2781 | 9324 | 1914 | 10087 | 1589 | 10574 | 1323 | 11304 | 900 | 12902 | 690 | 8049 |
| 12-#14 | 4.22 | MA | 9377 | 3010 | 15273 | 2196 | 16868 | 1814 | 17920 | 1495 | 19581 | 989 | 23856 | 550 | 19227 |
| 4E | | MI | 5650 | 3010 | 9326 | 2081 | 10059 | 1710 | 10527 | 1398 | 11276 | 901 | 12794 | 363 | 10877 |
| 12-#14 | 4.22 | MA | 9075 | 3010 | 14625 | 2213 | 16004 | 1829 | 16840 | 1527 | 17981 | 997 | 21790 | 471 | 18225 |
| 5L-3S | | MI | 5725 | 3010 | 9761 | 2052 | 10623 | 1705 | 11218 | 1397 | 12175 | 887 | 13843 | 438 | 11221 |
| 12-#14 | 4.22 | MA | 8856 | 3010 | 13964 | 2222 | 15145 | 1864 | 15771 | 1540 | 16543 | 1026 | 19926 | 369 | 17261 |
| 6L-2S | | MI | 5902 | 3010 | 10318 | 2044 | 11336 | 1680 | 12088 | 1376 | 13360 | 874 | 15316 | 597 | 11206 |
| 12-#18 | 7.50 | MA | 10413 | 3591 | 17389 | 2608 | 19457 | 2118 | 21001 | 1725 | 23588 | 980 | 29738 | 130 | 29115 |
| 5L-3S | | MI | 6552 | 3591 | 11758 | 2392 | 13135 | 1958 | 14263 | 1547 | 16290 | 826 | 18418 | 31 | 18296 |
| 14-#10 | 2.78 | MA | 8757 | 2755 | 13980 | 2034 | 15288 | 1696 | 16027 | 1422 | 16993 | 999 | 20223 | 696 | 13299 |
| 4L-5S | | MI | 5239 | 2755 | 8444 | 1946 | 8980 | 1628 | 9228 | 1361 | 9462 | 933 | 10778 | 543 | 7674 |
| 14-#10 | 2.78 | MA | 8578 | 2755 | 13609 | 2045 | 14792 | 1706 | 15407 | 1442 | 16073 | 1005 | 19041 | 655 | 13083 |
| 5L-4S | | MI | 5335 | 2755 | 8659 | 1939 | 9266 | 1613 | 9585 | 1347 | 9988 | 933 | 11416 | 594 | 7806 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis

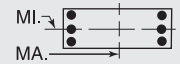


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.78 | MA | 8450 | 2755 | 13218 | 2049 | 14298 | 1727 | 14792 | 1450 | 15246 | 1023 | 17982 | 599 | 12691 |
| 6L-3S | | MI | 5385 | 2755 | 8913 | 1922 | 9596 | 1608 | 9989 | 1344 | 10514 | 923 | 12061 | 641 | 7793 |
| 14-#10 | 2.78 | MA | 8312 | 2755 | 12796 | 2067 | 13791 | 1731 | 14206 | 1470 | 14442 | 1040 | 16736 | 550 | 12350 |
| 7L-2S | | MI | 5493 | 2755 | 9242 | 1915 | 10017 | 1592 | 10504 | 1330 | 11214 | 912 | 12976 | 730 | 7774 |
| 14-#11 | 3.41 | MA | 8849 | 2867 | 14216 | 2112 | 15523 | 1753 | 16276 | 1473 | 17238 | 996 | 20677 | 592 | 15529 |
| 5L-4S | | MI | 5487 | 2867 | 9018 | 1995 | 9690 | 1650 | 10088 | 1365 | 10671 | 915 | 12148 | 503 | 9316 |
| 14-#11 | 3.41 | MA | 8697 | 2867 | 13748 | 2118 | 14923 | 1778 | 15529 | 1482 | 16233 | 1016 | 19381 | 522 | 15107 |
| 6L-3S | | MI | 5543 | 2867 | 9324 | 1974 | 10087 | 1645 | 10574 | 1363 | 11304 | 904 | 12902 | 558 | 9312 |
| 14-#11 | 3.41 | MA | 8533 | 2867 | 13236 | 2138 | 14316 | 1785 | 14816 | 1505 | 15255 | 1037 | 17862 | 460 | 14455 |
| 7L-2S | | MI | 5670 | 2867 | 9718 | 1968 | 10591 | 1627 | 11190 | 1347 | 12141 | 893 | 13966 | 668 | 9292 |
| 14-#14 | 4.92 | MA | 9525 | 3134 | 15649 | 2291 | 17316 | 1885 | 18441 | 1561 | 20159 | 987 | 24805 | 457 | 21347 |
| 5L-4S | | MI | 5880 | 3134 | 9883 | 2158 | 10773 | 1766 | 11397 | 1432 | 12460 | 891 | 14268 | 326 | 12517 |
| 14-#14 | 4.92 | MA | 9313 | 3134 | 14987 | 2300 | 16457 | 1920 | 17371 | 1574 | 18721 | 1016 | 22941 | 355 | 20366 |
| 6L-3S | | MI | 5955 | 3134 | 10318 | 2130 | 11336 | 1761 | 12088 | 1431 | 13360 | 877 | 15316 | 401 | 12952 |
| 14-#14 | 4.92 | MA | 9083 | 3134 | 14255 | 2329 | 15600 | 1930 | 16350 | 1607 | 17319 | 1044 | 21003 | 290 | 19340 |
| 7L-2S | | MI | 6129 | 3134 | 10875 | 2122 | 12050 | 1736 | 12958 | 1410 | 14544 | 864 | 16789 | 559 | 12954 |
| 16-#10 | 3.17 | MA | 8842 | 2825 | 14201 | 2089 | 15551 | 1737 | 16333 | 1461 | 17333 | 999 | 20786 | 647 | 14879 |
| 5E | | MI | 5378 | 2825 | 8773 | 1990 | 9402 | 1660 | 9743 | 1380 | 10162 | 927 | 11694 | 528 | 8661 |
| 16-#10 | 3.17 | MA | 8717 | 2825 | 13810 | 2093 | 15058 | 1758 | 15719 | 1469 | 16507 | 1017 | 19727 | 591 | 14503 |
| 6L-4S | | MI | 5473 | 2825 | 8988 | 1983 | 9688 | 1644 | 10099 | 1366 | 10687 | 928 | 12332 | 579 | 8835 |
| 16-#10 | 3.17 | MA | 8579 | 2825 | 13388 | 2111 | 14550 | 1763 | 15133 | 1489 | 15702 | 1035 | 18481 | 543 | 14149 |
| 7L-3S | | MI | 5522 | 2825 | 9242 | 1966 | 10017 | 1640 | 10504 | 1363 | 11214 | 917 | 12976 | 626 | 8827 |
| 16-#10 | 3.17 | MA | 8429 | 2825 | 13019 | 2118 | 14039 | 1780 | 14514 | 1495 | 14845 | 1041 | 17405 | 496 | 13645 |
| 8L-2S | | MI | 5630 | 2825 | 9571 | 1959 | 10439 | 1624 | 11018 | 1349 | 11914 | 907 | 13891 | 715 | 8812 |
| 16-#11 | 3.90 | MA | 9017 | 2954 | 14465 | 2172 | 15842 | 1817 | 16651 | 1506 | 17759 | 1009 | 21494 | 512 | 17303 |
| 6L-4S | | MI | 5651 | 2954 | 9411 | 2049 | 10195 | 1688 | 10703 | 1388 | 11508 | 908 | 13212 | 481 | 10486 |
| 16-#11 | 3.90 | MA | 8854 | 2954 | 13953 | 2192 | 15236 | 1824 | 15938 | 1529 | 16781 | 1030 | 19975 | 450 | 16636 |
| 7L-3S | | MI | 5706 | 2954 | 9718 | 2028 | 10591 | 1684 | 11190 | 1386 | 12141 | 897 | 13966 | 535 | 10546 |
| 16-#11 | 3.90 | MA | 8675 | 2954 | 13504 | 2201 | 14615 | 1844 | 15198 | 1536 | 15738 | 1037 | 18662 | 391 | 16018 |
| 8L-2S | | MI | 5832 | 2954 | 10111 | 2022 | 11096 | 1666 | 11805 | 1371 | 12979 | 886 | 15030 | 645 | 10532 |
| 16-#14 | 5.63 | MA | 9765 | 3259 | 16011 | 2378 | 17769 | 1975 | 18972 | 1608 | 20898 | 1006 | 25956 | 341 | 23476 |
| 6L-4S | | MI | 6110 | 3259 | 10439 | 2236 | 11486 | 1822 | 12267 | 1466 | 13645 | 881 | 15741 | 289 | 14168 |
| 16-#14 | 5.63 | MA | 9538 | 3259 | 15278 | 2407 | 16912 | 1985 | 17951 | 1641 | 19497 | 1034 | 24018 | 276 | 22434 |
| 7L-3S | | MI | 6184 | 3259 | 10875 | 2208 | 12050 | 1817 | 12958 | 1465 | 14544 | 868 | 16789 | 364 | 14679 |
| 18-#10 | 3.57 | MA | 8982 | 2895 | 14403 | 2137 | 15817 | 1790 | 16645 | 1489 | 17768 | 1011 | 21473 | 583 | 16318 |
| 6L-5S | | MI | 5517 | 2895 | 9101 | 2034 | 9824 | 1692 | 10257 | 1399 | 10862 | 921 | 12609 | 513 | 9651 |
| 18-#10 | 3.57 | MA | 8845 | 2895 | 13981 | 2155 | 15310 | 1795 | 16059 | 1508 | 16963 | 1029 | 20227 | 535 | 15951 |
| 7L-4S | | MI | 5611 | 2895 | 9316 | 2027 | 10109 | 1676 | 10613 | 1385 | 11387 | 922 | 13247 | 564 | 9859 |
| 18-#10 | 3.57 | MA | 8698 | 2895 | 13611 | 2162 | 14799 | 1812 | 15440 | 1514 | 16105 | 1035 | 19151 | 488 | 15460 |
| 8L-3S | | MI | 5660 | 2895 | 9571 | 2010 | 10439 | 1671 | 11018 | 1382 | 11914 | 912 | 13891 | 611 | 9859 |
| 18-#10 | 3.57 | MA | 8564 | 2895 | 13219 | 2181 | 14309 | 1818 | 14831 | 1530 | 15310 | 1053 | 18090 | 446 | 14905 |
| 9L-2S | | MI | 5766 | 2895 | 9900 | 2003 | 10861 | 1655 | 11533 | 1368 | 12614 | 901 | 14806 | 700 | 9847 |
| 18-#11 | 4.39 | MA | 9173 | 3040 | 14670 | 2246 | 16155 | 1862 | 17059 | 1552 | 18307 | 1023 | 22088 | 441 | 18822 |
| 7L-4S | | MI | 5814 | 3040 | 9805 | 2103 | 10699 | 1727 | 11318 | 1412 | 12345 | 901 | 14276 | 458 | 11653 |
| 18-#11 | 4.39 | MA | 8997 | 3040 | 14221 | 2255 | 15534 | 1882 | 16320 | 1560 | 17264 | 1030 | 20775 | 381 | 18200 |
| 8L-3S | | MI | 5869 | 3040 | 10111 | 2082 | 11096 | 1723 | 11805 | 1410 | 12979 | 890 | 15030 | 513 | 11778 |
| 18-#14 | 6.33 | MA | 9989 | 3383 | 16302 | 2485 | 18224 | 2041 | 19551 | 1675 | 21675 | 1024 | 27033 | 263 | 25528 |
| 7L-4S | | MI | 6339 | 3383 | 10996 | 2314 | 12200 | 1877 | 13138 | 1500 | 14829 | 871 | 17214 | 252 | 15826 |
| 20-#10 | 3.97 | MA | 9109 | 2966 | 14573 | 2198 | 16069 | 1826 | 16986 | 1527 | 18223 | 1023 | 21972 | 527 | 17755 |
| 7L-5S | | MI | 5655 | 2966 | 9430 | 2077 | 10245 | 1723 | 10772 | 1418 | 11562 | 916 | 13524 | 498 | 10644 |
| 20-#10 | 3.97 | MA | 8964 | 2966 | 14204 | 2206 | 15558 | 1843 | 16367 | 1533 | 17366 | 1030 | 20896 | 481 | 17276 |
| 8L-4S | | MI | 5748 | 2966 | 9645 | 2071 | 10531 | 1707 | 11128 | 1404 | 12087 | 916 | 14162 | 549 | 10881 |
| 20-#10 | 3.97 | MA | 8834 | 2966 | 13812 | 2225 | 15068 | 1850 | 15758 | 1550 | 16571 | 1047 | 19835 | 438 | 16715 |
| 9L-3S | | MI | 5797 | 2966 | 9900 | 2053 | 10861 | 1703 | 11533 | 1401 | 12614 | 906 | 14806 | 596 | 10890 |
| 20-#11 | 4.88 | MA | 9317 | 3126 | 14938 | 2309 | 16454 | 1921 | 17442 | 1583 | 18791 | 1023 | 22888 | 372 | 20384 |
| 8L-4S | | MI | 5977 | 3126 | 10198 | 2157 | 11204 | 1766 | 11934 | 1435 | 13183 | 894 | 15341 | 436 | 12826 |

## RECTANGULAR TIED COLUMNS 20" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 4.37 | MA | 9229 | 3036 | 14796 | 2250 | 16318 | 1875 | 17293 | 1552 | 18627 | 1024 | 22642 | 473 | 19094 |
| 8L-5S | | MI | 5793 | 3036 | 9759 | 2121 | 10667 | 1755 | 11286 | 1437 | 12262 | 910 | 14439 | 483 | 11640 |
| 22-#10 | 4.37 | MA | 9103 | 3036 | 14404 | 2269 | 15828 | 1881 | 16684 | 1569 | 17831 | 1042 | 21581 | 430 | 18525 |
| 9L-4S | | MI | 5885 | 3036 | 9974 | 2115 | 10953 | 1739 | 11642 | 1423 | 12787 | 911 | 15077 | 534 | 11894 |
| 24-#10 | 4.76 | MA | 9370 | 3106 | 14996 | 2313 | 16587 | 1913 | 17611 | 1588 | 19092 | 1036 | 23326 | 422 | 20334 |
| 9L-5S | | MI | 5931 | 3106 | 10088 | 2165 | 11089 | 1786 | 11800 | 1456 | 12961 | 905 | 15355 | 468 | 12637 |

## RECTANGULAR TIED COLUMNS 20" x 34"

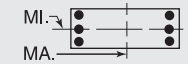
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.32 | MA | 9156 | 2653 | 14509 | 1946 | 15594 | 1639 | 16051 | 1399 | 16348 | 1040 | 18761 | 902 | 7320 |
| 2E | | MI | 5271 | 2653 | 8528 | 1831 | 8923 | 1541 | 9035 | 1314 | 9013 | 972 | 9828 | 796 | 4138 |
| 4-#18 | 2.35 | MA | 9853 | 2847 | 16196 | 2051 | 17693 | 1712 | 18584 | 1440 | 19779 | 1014 | 23498 | 872 | 12562 |
| 2E | | MI | 5586 | 2847 | 9345 | 1925 | 9920 | 1604 | 10231 | 1346 | 10624 | 939 | 11606 | 691 | 6834 |
| 6-#10 | 1.12 | MA | 9039 | 2615 | 14151 | 1941 | 15212 | 1638 | 15619 | 1403 | 15781 | 1054 | 17990 | 916 | 6303 |
| 2L-3S | | MI | 5112 | 2615 | 8031 | 1847 | 8350 | 1568 | 8363 | 1342 | 8110 | 1005 | 8810 | 753 | 3619 |
| 6-#10 | 1.12 | MA | 8796 | 2615 | 13515 | 1952 | 14396 | 1648 | 14624 | 1423 | 14427 | 1072 | 16116 | 837 | 6330 |
| 3L-2S | | MI | 5226 | 2615 | 8360 | 1840 | 8772 | 1552 | 8878 | 1328 | 8809 | 994 | 9726 | 842 | 3591 |
| 6-#11 | 1.38 | MA | 9211 | 2663 | 14594 | 1960 | 15734 | 1650 | 16237 | 1408 | 16609 | 1044 | 19127 | 905 | 7631 |
| 2L-3S | | MI | 5168 | 2663 | 8185 | 1858 | 8510 | 1575 | 8543 | 1343 | 8347 | 990 | 9052 | 700 | 4338 |
| 6-#11 | 1.38 | MA | 8923 | 2663 | 13822 | 1973 | 14746 | 1662 | 15031 | 1432 | 14968 | 1065 | 16855 | 805 | 7663 |
| 3L-2S | | MI | 5302 | 2663 | 8579 | 1851 | 9015 | 1557 | 9158 | 1327 | 9184 | 979 | 10116 | 809 | 4299 |
| 6-#14 | 1.99 | MA | 9639 | 2778 | 15611 | 2023 | 17006 | 1694 | 17774 | 1433 | 18692 | 1030 | 22005 | 888 | 10791 |
| 2L-3S | | MI | 5314 | 2778 | 8528 | 1917 | 8923 | 1621 | 9035 | 1369 | 9013 | 976 | 9828 | 600 | 6003 |
| 6-#14 | 1.99 | MA | 9237 | 2778 | 14509 | 2041 | 15594 | 1710 | 16051 | 1467 | 16348 | 1059 | 18761 | 742 | 10811 |
| 3L-2S | | MI | 5501 | 2778 | 9084 | 1909 | 9636 | 1597 | 9906 | 1348 | 10198 | 962 | 11301 | 759 | 5946 |
| 6-#18 | 3.53 | MA | 10675 | 3068 | 18114 | 2189 | 20152 | 1811 | 21585 | 1500 | 23861 | 997 | 29151 | 848 | 18574 |
| 2L-3S | | MI | 5665 | 3068 | 9345 | 2074 | 9920 | 1742 | 10231 | 1438 | 10624 | 938 | 11606 | 328 | 9922 |
| 6-#18 | 3.53 | MA | 10009 | 3068 | 16196 | 2218 | 17693 | 1837 | 18584 | 1557 | 19779 | 1046 | 23498 | 579 | 18444 |
| 3L-2S | | MI | 5973 | 3068 | 10295 | 2063 | 11138 | 1704 | 11717 | 1406 | 12642 | 920 | 14010 | 609 | 9870 |
| 8-#9 | 1.18 | MA | 9089 | 2626 | 14242 | 1952 | 15345 | 1646 | 15789 | 1409 | 16016 | 1056 | 18320 | 917 | 6617 |
| 2L-4S | | MI | 5120 | 2626 | 7946 | 1873 | 8253 | 1579 | 8248 | 1350 | 7974 | 1015 | 8689 | 740 | 3806 |
| 8-#9 | 1.18 | MA | 8897 | 2626 | 13738 | 1961 | 14699 | 1654 | 15002 | 1425 | 14945 | 1070 | 16836 | 855 | 6636 |
| 3E | | MI | 5162 | 2626 | 8148 | 1859 | 8514 | 1575 | 8569 | 1347 | 8392 | 1006 | 9205 | 777 | 3778 |
| 8-#9 | 1.18 | MA | 8791 | 2626 | 13361 | 1978 | 14209 | 1671 | 14398 | 1432 | 14158 | 1085 | 15857 | 817 | 6653 |
| 4L-2S | | MI | 5253 | 2626 | 8409 | 1854 | 8849 | 1562 | 8978 | 1336 | 8948 | 998 | 9940 | 847 | 3757 |
| 8-#10 | 1.49 | MA | 9323 | 2686 | 14787 | 1985 | 16028 | 1669 | 16615 | 1422 | 17135 | 1048 | 19865 | 908 | 8309 |
| 2L-4S | | MI | 5200 | 2686 | 8106 | 1908 | 8442 | 1604 | 8473 | 1364 | 8283 | 1010 | 9081 | 691 | 4721 |
| 8-#10 | 1.49 | MA | 9085 | 2686 | 14151 | 1996 | 15212 | 1679 | 15619 | 1442 | 15781 | 1067 | 17990 | 829 | 8329 |
| 3E | | MI | 5251 | 2686 | 8360 | 1890 | 8772 | 1599 | 8878 | 1361 | 8809 | 999 | 9726 | 738 | 4686 |
| 8-#10 | 1.49 | MA | 8952 | 2686 | 13673 | 2018 | 14591 | 1701 | 14856 | 1451 | 14786 | 1085 | 16749 | 781 | 8330 |
| 4L-2S | | MI | 5364 | 2686 | 8689 | 1884 | 9194 | 1583 | 9392 | 1347 | 9509 | 989 | 10641 | 827 | 4657 |
| 8-#11 | 1.84 | MA | 9551 | 2750 | 15365 | 2014 | 16723 | 1689 | 17443 | 1431 | 18249 | 1037 | 21399 | 895 | 10059 |
| 2L-4S | | MI | 5276 | 2750 | 8272 | 1932 | 8618 | 1618 | 8671 | 1368 | 8551 | 994 | 9362 | 623 | 5650 |
| 8-#11 | 1.84 | MA | 9269 | 2750 | 14594 | 2027 | 15734 | 1700 | 16237 | 1455 | 16609 | 1058 | 19127 | 795 | 10080 |
| 3E | | MI | 5333 | 2750 | 8579 | 1912 | 9015 | 1614 | 9158 | 1366 | 9184 | 983 | 10116 | 677 | 5609 |
| 8-#11 | 1.84 | MA | 9113 | 2750 | 14013 | 2053 | 14980 | 1726 | 15309 | 1465 | 15400 | 1079 | 17609 | 736 | 10057 |
| 4L-2S | | MI | 5466 | 2750 | 8972 | 1905 | 9519 | 1596 | 9773 | 1350 | 10022 | 972 | 11180 | 787 | 5572 |
| 8-#14 | 2.65 | MA | 10118 | 2902 | 16712 | 2101 | 18417 | 1750 | 19496 | 1467 | 21035 | 1020 | 25250 | 874 | 14245 |
| 2L-4S | | MI | 5469 | 2902 | 8649 | 2024 | 9073 | 1682 | 9215 | 1404 | 9298 | 979 | 10253 | 488 | 7761 |
| 8-#14 | 2.65 | MA | 9727 | 2902 | 15611 | 2119 | 17006 | 1766 | 17774 | 1501 | 18692 | 1049 | 22005 | 728 | 14237 |
| 3E | | MI | 5546 | 2902 | 9084 | 1995 | 9636 | 1677 | 9906 | 1403 | 10198 | 966 | 11301 | 563 | 7772 |
| 8-#14 | 2.65 | MA | 9510 | 2902 | 14779 | 2157 | 15926 | 1802 | 16447 | 1515 | 16963 | 1079 | 19822 | 641 | 14088 |
| 4L-2S | | MI | 5729 | 2902 | 9641 | 1987 | 10350 | 1653 | 10776 | 1382 | 11382 | 952 | 12774 | 722 | 7727 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis

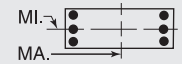



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 4.71 | MA | 10849 | 3290 | 18114 | 2357 | 20152 | 1936 | 21585 | 1617 | 23861 | 1028 | 29151 | 554 | 24373 |
| 3E | | MI | 6056 | 3290 | 10295 | 2212 | 11138 | 1842 | 11717 | 1498 | 12642 | 920 | 14010 | 246 | 12870 |
| 8-#18 | 4.71 | MA | 10489 | 3290 | 16659 | 2422 | 18264 | 1997 | 19263 | 1639 | 20837 | 1077 | 25296 | 397 | 22165 |
| 4L-2S | | MI | 6358 | 3290 | 11246 | 2201 | 12356 | 1803 | 13204 | 1467 | 14660 | 902 | 16414 | 527 | 12872 |
| 10-#10 | 1.87 | MA | 9605 | 2756 | 15424 | 2029 | 16843 | 1701 | 17610 | 1441 | 18489 | 1043 | 21740 | 901 | 10308 |
| 2L-5S | | MI | 5243 | 2756 | 8219 | 1958 | 8578 | 1651 | 8631 | 1397 | 8457 | 1003 | 9359 | 625 | 5789 |
| 10-#10 | 1.87 | MA | 9371 | 2756 | 14787 | 2040 | 16028 | 1711 | 16615 | 1461 | 17135 | 1061 | 19865 | 821 | 10321 |
| 3L-4S | | MI | 5340 | 2756 | 8434 | 1952 | 8864 | 1635 | 8987 | 1383 | 8982 | 1004 | 9997 | 676 | 5768 |
| 10-#10 | 1.87 | MA | 9240 | 2756 | 14310 | 2062 | 15407 | 1732 | 15851 | 1470 | 16140 | 1079 | 18623 | 773 | 10308 |
| 4L-3S | | MI | 5391 | 2756 | 8689 | 1934 | 9194 | 1631 | 9392 | 1380 | 9509 | 994 | 10641 | 723 | 5740 |
| 10-#10 | 1.87 | MA | 9042 | 2756 | 13912 | 2073 | 14876 | 1742 | 15187 | 1491 | 15154 | 1086 | 17360 | 734 | 10236 |
| 5L-2S | | MI | 5502 | 2756 | 9018 | 1928 | 9615 | 1615 | 9906 | 1366 | 10209 | 983 | 11556 | 812 | 5713 |
| 10-#11 | 2.29 | MA | 9612 | 2836 | 15365 | 2081 | 16723 | 1739 | 17443 | 1479 | 18249 | 1051 | 21399 | 786 | 12488 |
| 3L-4S | | MI | 5441 | 2836 | 8666 | 1986 | 9123 | 1657 | 9287 | 1391 | 9388 | 987 | 10426 | 600 | 6895 |
| 10-#11 | 2.29 | MA | 9459 | 2836 | 14784 | 2107 | 15969 | 1764 | 16515 | 1489 | 17041 | 1073 | 19881 | 726 | 12447 |
| 4L-3S | | MI | 5498 | 2836 | 8972 | 1966 | 9519 | 1653 | 9773 | 1390 | 10022 | 976 | 11180 | 654 | 6865 |
| 10-#11 | 2.29 | MA | 9221 | 2836 | 14300 | 2120 | 15322 | 1776 | 15707 | 1513 | 15842 | 1080 | 18340 | 676 | 12077 |
| 5L-2S | | MI | 5629 | 2836 | 9366 | 1959 | 10024 | 1635 | 10389 | 1374 | 10859 | 965 | 12245 | 764 | 6833 |
| 10-#14 | 3.31 | MA | 10212 | 3027 | 16712 | 2197 | 18417 | 1822 | 19496 | 1535 | 21035 | 1039 | 25250 | 714 | 17657 |
| 3L-4S | | MI | 5701 | 3027 | 9206 | 2101 | 9787 | 1738 | 10085 | 1438 | 10483 | 969 | 11726 | 451 | 9370 |
| 10-#14 | 3.31 | MA | 9999 | 3027 | 15880 | 2235 | 17338 | 1858 | 18169 | 1548 | 19306 | 1069 | 23066 | 627 | 17487 |
| 4L-3S | | MI | 5778 | 3027 | 9641 | 2073 | 10350 | 1733 | 10776 | 1437 | 11382 | 956 | 12774 | 526 | 9526 |
| 10-#14 | 3.31 | MA | 9665 | 3027 | 15187 | 2253 | 16412 | 1874 | 17011 | 1582 | 17590 | 1079 | 20856 | 552 | 16318 |
| 5L-2S | | MI | 5958 | 3027 | 10198 | 2065 | 11064 | 1709 | 11647 | 1416 | 12566 | 942 | 14247 | 685 | 9493 |
| 10-#18 | 5.88 | MA | 11328 | 3511 | 18577 | 2560 | 20723 | 2096 | 22264 | 1699 | 24920 | 1060 | 30949 | 372 | 27977 |
| 4L-3S | | MI | 6446 | 3511 | 11246 | 2350 | 12356 | 1941 | 13204 | 1559 | 14660 | 901 | 16414 | 163 | 15798 |
| 10-#18 | 5.88 | MA | 10762 | 3511 | 17360 | 2590 | 19100 | 2122 | 20235 | 1756 | 21916 | 1074 | 27062 | 228 | 25871 |
| 5L-2S | | MI | 6742 | 3511 | 12196 | 2340 | 13575 | 1902 | 14690 | 1527 | 16677 | 884 | 18818 | 445 | 15856 |
| 12-#10 | 2.24 | MA | 9656 | 2826 | 15424 | 2084 | 16843 | 1742 | 17610 | 1481 | 18489 | 1055 | 21740 | 813 | 12309 |
| 3L-5S | | MI | 5383 | 2826 | 8548 | 2002 | 9000 | 1683 | 9145 | 1416 | 9157 | 998 | 10274 | 610 | 6795 |
| 12-#10 | 2.24 | MA | 9526 | 2826 | 14946 | 2106 | 16223 | 1764 | 16847 | 1490 | 17494 | 1074 | 20498 | 765 | 12284 |
| 4E | | MI | 5479 | 2826 | 8763 | 1996 | 9286 | 1667 | 9502 | 1402 | 9682 | 998 | 10912 | 661 | 6807 |
| 12-#10 | 2.24 | MA | 9331 | 2826 | 14548 | 2117 | 15692 | 1774 | 16182 | 1510 | 16508 | 1081 | 19235 | 726 | 12175 |
| 5L-3S | | MI | 5529 | 2826 | 9018 | 1978 | 9615 | 1662 | 9906 | 1399 | 10209 | 988 | 11556 | 708 | 6785 |
| 12-#10 | 2.24 | MA | 9189 | 2826 | 14125 | 2121 | 15163 | 1795 | 15524 | 1519 | 15624 | 1099 | 18104 | 671 | 11710 |
| 6L-2S | | MI | 5640 | 2826 | 9347 | 1972 | 10037 | 1646 | 10421 | 1385 | 10909 | 977 | 12471 | 797 | 6761 |
| 12-#11 | 2.75 | MA | 9802 | 2922 | 15555 | 2161 | 16957 | 1803 | 17721 | 1513 | 18682 | 1066 | 22153 | 717 | 14836 |
| 4E | | MI | 5606 | 2922 | 9059 | 2040 | 9627 | 1696 | 9902 | 1415 | 10226 | 980 | 11491 | 578 | 8132 |
| 12-#11 | 2.75 | MA | 9568 | 2922 | 15071 | 2174 | 16311 | 1815 | 16913 | 1537 | 17483 | 1073 | 20612 | 666 | 14410 |
| 5L-3S | | MI | 5662 | 2922 | 9366 | 2020 | 10024 | 1691 | 10389 | 1413 | 10859 | 969 | 12245 | 632 | 8111 |
| 12-#11 | 2.75 | MA | 9399 | 2922 | 14564 | 2180 | 15668 | 1840 | 16112 | 1547 | 16407 | 1095 | 19230 | 597 | 13907 |
| 6L-2S | | MI | 5791 | 2922 | 9759 | 2013 | 10528 | 1673 | 11004 | 1397 | 11697 | 958 | 13309 | 742 | 8084 |
| 12-#14 | 3.97 | MA | 10484 | 3151 | 16982 | 2313 | 18750 | 1914 | 19891 | 1582 | 21649 | 1059 | 26311 | 613 | 20823 |
| 4E | | MI | 5933 | 3151 | 9762 | 2179 | 10500 | 1794 | 10956 | 1472 | 11667 | 960 | 13199 | 414 | 10996 |
| 12-#14 | 3.97 | MA | 10156 | 3151 | 16288 | 2331 | 17824 | 1930 | 18733 | 1616 | 19933 | 1069 | 24100 | 538 | 19674 |
| 5L-3S | | MI | 6008 | 3151 | 10198 | 2151 | 11064 | 1789 | 11647 | 1471 | 12566 | 946 | 14247 | 489 | 11273 |
| 12-#14 | 3.97 | MA | 9919 | 3151 | 15569 | 2339 | 16903 | 1965 | 17587 | 1630 | 18391 | 1099 | 22113 | 437 | 18739 |
| 6L-2S | | MI | 6186 | 3151 | 10754 | 2142 | 11777 | 1764 | 12517 | 1450 | 13751 | 932 | 15721 | 648 | 11250 |
| 12-#18 | 7.06 | MA | 11607 | 3732 | 19279 | 2728 | 21560 | 2221 | 23236 | 1817 | 25998 | 1056 | 32715 | 204 | 31651 |
| 5L-3S | | MI | 6835 | 3732 | 12196 | 2489 | 13575 | 2040 | 14690 | 1619 | 16677 | 883 | 18818 | 81 | 18496 |
| 14-#10 | 2.61 | MA | 9811 | 2896 | 15582 | 2150 | 17039 | 1795 | 17842 | 1509 | 18848 | 1068 | 22373 | 757 | 14259 |
| 4L-5S | | MI | 5522 | 2896 | 8877 | 2046 | 9422 | 1714 | 9660 | 1435 | 9857 | 992 | 11189 | 595 | 7749 |
| 14-#10 | 2.61 | MA | 9617 | 2896 | 15184 | 2161 | 16508 | 1805 | 17177 | 1529 | 17863 | 1075 | 21110 | 718 | 14102 |
| 5L-4S | | MI | 5618 | 2896 | 9092 | 2040 | 9707 | 1698 | 10016 | 1421 | 10382 | 993 | 11827 | 646 | 7841 |
| 14-#10 | 2.61 | MA | 9479 | 2896 | 14761 | 2165 | 15979 | 1826 | 16520 | 1538 | 16978 | 1093 | 19979 | 663 | 13655 |
| 6L-3S | | MI | 5668 | 2896 | 9347 | 2022 | 10037 | 1694 | 10421 | 1418 | 10909 | 982 | 12471 | 693 | 7825 |
| 14-#10 | 2.61 | MA | 9327 | 2896 | 14309 | 2183 | 15430 | 1831 | 15893 | 1558 | 16116 | 1112 | 18650 | 616 | 13353 |
| 7L-2S | | MI | 5777 | 2896 | 9676 | 2016 | 10459 | 1678 | 10935 | 1404 | 11609 | 972 | 13387 | 782 | 7805 |

## RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

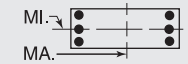
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 3.21 | MA | 9912 | 3009 | 15842 | 2228 | 17299 | 1853 | 18119 | 1560 | 19124 | 1066 | 22884 | 657 | 16749 |
| 5L-4S | | MI | 5770 | 3009 | 9453 | 2094 | 10132 | 1735 | 10518 | 1439 | 11063 | 974 | 12555 | 555 | 9364 |
| 14-#11 | 3.21 | MA | 9747 | 3009 | 15335 | 2234 | 16657 | 1879 | 17318 | 1570 | 18048 | 1088 | 21502 | 587 | 16267 |
| 6L-3S | | MI | 5826 | 3009 | 9759 | 2074 | 10528 | 1730 | 11004 | 1437 | 11697 | 963 | 13309 | 609 | 9352 |
| 14-#11 | 3.21 | MA | 9568 | 3009 | 14785 | 2255 | 15998 | 1885 | 16555 | 1594 | 16999 | 1109 | 19879 | 527 | 15635 |
| 7L-2S | | MI | 5954 | 3009 | 10153 | 2067 | 11033 | 1712 | 11620 | 1421 | 12534 | 952 | 14373 | 719 | 9330 |
| 14-#14 | 4.63 | MA | 10643 | 3276 | 17389 | 2408 | 19236 | 1986 | 20455 | 1650 | 22276 | 1059 | 27345 | 524 | 23038 |
| 5L-4S | | MI | 6163 | 3276 | 10319 | 2257 | 11214 | 1850 | 11826 | 1506 | 12851 | 950 | 14672 | 377 | 12635 |
| 14-#14 | 4.63 | MA | 10414 | 3276 | 16670 | 2417 | 18315 | 2021 | 19309 | 1664 | 20734 | 1089 | 25357 | 423 | 22089 |
| 6L-3S | | MI | 6238 | 3276 | 10754 | 2229 | 11777 | 1845 | 12517 | 1504 | 13751 | 936 | 15721 | 452 | 13006 |
| 14-#14 | 4.63 | MA | 10161 | 3276 | 15884 | 2447 | 17382 | 2031 | 18215 | 1698 | 19233 | 1119 | 23027 | 334 | 20913 |
| 7L-2S | | MI | 6413 | 3276 | 11311 | 2220 | 12491 | 1820 | 13388 | 1483 | 14935 | 922 | 17194 | 611 | 13000 |
| 16-#10 | 2.99 | MA | 9902 | 2967 | 15821 | 2205 | 17323 | 1837 | 18172 | 1548 | 19217 | 1069 | 22984 | 711 | 16033 |
| 5E | | MI | 5661 | 2967 | 9206 | 2090 | 9844 | 1746 | 10174 | 1455 | 10556 | 986 | 12104 | 580 | 8735 |
| 16-#10 | 2.99 | MA | 9767 | 2967 | 15398 | 2209 | 16794 | 1858 | 17515 | 1557 | 18332 | 1088 | 21853 | 655 | 15603 |
| 6L-4S | | MI | 5756 | 2967 | 9421 | 2084 | 10129 | 1730 | 10530 | 1440 | 11082 | 987 | 12742 | 631 | 8873 |
| 16-#10 | 2.99 | MA | 9616 | 2967 | 14945 | 2227 | 16245 | 1863 | 16888 | 1577 | 17470 | 1106 | 20525 | 608 | 15289 |
| 7L-3S | | MI | 5805 | 2967 | 9676 | 2066 | 10459 | 1725 | 10935 | 1438 | 11609 | 977 | 13387 | 678 | 8861 |
| 16-#10 | 2.99 | MA | 9455 | 2967 | 14550 | 2235 | 15698 | 1880 | 16216 | 1582 | 16552 | 1113 | 19376 | 563 | 14719 |
| 8L-2S | | MI | 5914 | 2967 | 10005 | 2060 | 10881 | 1709 | 11450 | 1424 | 12309 | 966 | 14302 | 767 | 8844 |
| 16-#11 | 3.67 | MA | 10093 | 3095 | 16106 | 2288 | 17646 | 1917 | 18524 | 1594 | 19688 | 1081 | 23774 | 577 | 18631 |
| 6L-4S | | MI | 5934 | 3095 | 9846 | 2148 | 10636 | 1773 | 11133 | 1462 | 11900 | 967 | 13619 | 532 | 10584 |
| 16-#11 | 3.67 | MA | 9915 | 3095 | 15556 | 2309 | 16986 | 1924 | 17761 | 1618 | 18640 | 1102 | 22150 | 518 | 17985 |
| 7L-3S | | MI | 5989 | 3095 | 10153 | 2128 | 11033 | 1769 | 11620 | 1460 | 12534 | 956 | 14373 | 587 | 10588 |
| 16-#11 | 3.67 | MA | 9721 | 3095 | 15075 | 2318 | 16321 | 1944 | 16957 | 1625 | 17523 | 1110 | 20748 | 460 | 17361 |
| 8L-2S | | MI | 6116 | 3095 | 10546 | 2121 | 11537 | 1751 | 12235 | 1444 | 13371 | 945 | 15437 | 697 | 10571 |
| 16-#14 | 5.29 | MA | 10904 | 3400 | 17772 | 2495 | 19727 | 2077 | 21031 | 1698 | 23078 | 1079 | 28602 | 409 | 25444 |
| 6L-4S | | MI | 6393 | 3400 | 10875 | 2335 | 11927 | 1906 | 12697 | 1540 | 14036 | 940 | 16146 | 340 | 14284 |
| 16-#14 | 5.29 | MA | 10654 | 3400 | 16985 | 2525 | 18794 | 2087 | 19937 | 1732 | 21576 | 1109 | 26271 | 320 | 24277 |
| 7L-3S | | MI | 6467 | 3400 | 11311 | 2306 | 12491 | 1901 | 13388 | 1538 | 14935 | 926 | 17194 | 415 | 14736 |
| 18-#10 | 3.36 | MA | 10054 | 3037 | 16034 | 2253 | 17610 | 1889 | 18510 | 1576 | 19686 | 1082 | 23728 | 648 | 17553 |
| 6L-5S | | MI | 5800 | 3037 | 9535 | 2134 | 10265 | 1777 | 10689 | 1474 | 11256 | 981 | 13019 | 565 | 9725 |
| 18-#10 | 3.36 | MA | 9903 | 3037 | 15582 | 2271 | 17061 | 1894 | 17883 | 1596 | 18824 | 1100 | 22400 | 600 | 17228 |
| 7L-4S | | MI | 5894 | 3037 | 9750 | 2128 | 10551 | 1761 | 11045 | 1460 | 11782 | 982 | 13657 | 617 | 9900 |
| 18-#10 | 3.36 | MA | 9744 | 3037 | 15186 | 2279 | 16513 | 1912 | 17211 | 1602 | 17907 | 1107 | 21251 | 556 | 16671 |
| 8L-3S | | MI | 5943 | 3037 | 10005 | 2110 | 10881 | 1757 | 11450 | 1457 | 12309 | 971 | 14302 | 663 | 9894 |
| 18-#10 | 3.36 | MA | 9599 | 3037 | 14766 | 2298 | 15989 | 1919 | 16558 | 1619 | 17055 | 1126 | 20122 | 513 | 16122 |
| 9L-2S | | MI | 6050 | 3037 | 10334 | 2104 | 11302 | 1741 | 11964 | 1443 | 13009 | 961 | 15217 | 752 | 9881 |
| 18-#11 | 4.13 | MA | 10259 | 3181 | 16327 | 2363 | 17975 | 1962 | 18967 | 1641 | 20281 | 1095 | 24422 | 508 | 20339 |
| 7L-4S | | MI | 6097 | 3181 | 10240 | 2202 | 11141 | 1812 | 11749 | 1486 | 12738 | 960 | 14684 | 510 | 11750 |
| 18-#11 | 4.13 | MA | 10069 | 3181 | 15846 | 2372 | 17309 | 1983 | 18163 | 1648 | 19164 | 1103 | 23020 | 451 | 19726 |
| 8L-3S | | MI | 6152 | 3181 | 10546 | 2182 | 11537 | 1808 | 12235 | 1484 | 13371 | 949 | 15437 | 564 | 11821 |
| 18-#14 | 5.96 | MA | 11142 | 3525 | 18086 | 2603 | 20206 | 2142 | 21659 | 1766 | 23919 | 1099 | 29516 | 307 | 27640 |
| 7L-4S | | MI | 6622 | 3525 | 11432 | 2413 | 12641 | 1961 | 13567 | 1574 | 15220 | 930 | 17619 | 303 | 15941 |
| 20-#10 | 3.74 | MA | 10189 | 3107 | 16218 | 2315 | 17877 | 1926 | 18878 | 1616 | 20178 | 1095 | 24275 | 593 | 19169 |
| 7L-5S | | MI | 5938 | 3107 | 9864 | 2178 | 10687 | 1809 | 11203 | 1493 | 11956 | 975 | 13935 | 550 | 10718 |
| 20-#10 | 3.74 | MA | 10032 | 3107 | 15822 | 2322 | 17329 | 1943 | 18206 | 1621 | 19261 | 1102 | 23126 | 548 | 18625 |
| 8L-4S | | MI | 6031 | 3107 | 10079 | 2172 | 10973 | 1793 | 11559 | 1479 | 12482 | 976 | 14573 | 602 | 10924 |
| 20-#10 | 3.74 | MA | 9892 | 3107 | 15402 | 2342 | 16805 | 1950 | 17554 | 1638 | 18409 | 1120 | 21996 | 505 | 18066 |
| 9L-3S | | MI | 6080 | 3107 | 10334 | 2154 | 11302 | 1788 | 11964 | 1476 | 13009 | 965 | 15217 | 648 | 10925 |
| 20-#10 | 3.74 | MA | 9726 | 3107 | 14992 | 2348 | 16279 | 1969 | 16918 | 1655 | 17561 | 1138 | 20852 | 467 | 17427 |
| 10L-2S | | MI | 6186 | 3107 | 10663 | 2148 | 11724 | 1773 | 12479 | 1462 | 13709 | 955 | 16132 | 737 | 10915 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

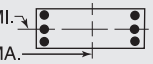
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 4.59 | MA | 10415 | 3268 | 16617 | 2426 | 18298 | 2022 | 19369 | 1672 | 20805 | 1096 | 25292 | 441 | 22079 |
| 8L-4S | | MI | 6260 | 3268 | 10633 | 2256 | 11645 | 1851 | 12364 | 1509 | 13575 | 953 | 15748 | 487 | 12921 |
| 22-#10 | 4.11 | MA | 10319 | 3177 | 16459 | 2366 | 18145 | 1975 | 19201 | 1640 | 20615 | 1096 | 25001 | 540 | 20580 |
| 8L-5S | | MI | 6076 | 3177 | 10193 | 2222 | 11109 | 1840 | 11717 | 1512 | 12656 | 970 | 14850 | 535 | 11713 |
| 22-#10 | 4.11 | MA | 10182 | 3177 | 16038 | 2386 | 17620 | 1982 | 18549 | 1657 | 19763 | 1114 | 23871 | 498 | 20010 |
| 9L-4S | | MI | 6169 | 3177 | 10408 | 2216 | 11394 | 1824 | 12074 | 1498 | 13182 | 970 | 15488 | 587 | 11946 |
| 22-#10 | 4.11 | MA | 10017 | 3177 | 15628 | 2392 | 17094 | 2001 | 17913 | 1675 | 18915 | 1132 | 22727 | 459 | 19375 |
| 10L-3S | | MI | 6217 | 3177 | 10663 | 2198 | 11724 | 1820 | 12479 | 1495 | 13709 | 960 | 16132 | 633 | 11956 |
| 24-#10 | 4.48 | MA | 10471 | 3248 | 16675 | 2430 | 18436 | 2013 | 19544 | 1676 | 21117 | 1109 | 25746 | 490 | 21953 |
| 9L-5S | | MI | 6214 | 3248 | 10522 | 2266 | 11530 | 1872 | 12232 | 1531 | 13356 | 964 | 15765 | 520 | 12710 |
| 24-#10 | 4.48 | MA | 10307 | 3248 | 16265 | 2436 | 17910 | 2032 | 18908 | 1694 | 20269 | 1126 | 24602 | 451 | 21323 |
| 10L-4S | | MI | 6306 | 3248 | 10737 | 2259 | 11816 | 1856 | 12588 | 1517 | 13882 | 965 | 16403 | 572 | 12962 |

## RECTANGULAR TIED COLUMNS 20" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.25 | MA | 10223 | 2795 | 16122 | 2061 | 17337 | 1737 | 17836 | 1484 | 18122 | 1108 | 20755 | 962 | 7806 |
| 2E | | MI | 5554 | 2795 | 8964 | 1930 | 9364 | 1625 | 9464 | 1387 | 9404 | 1030 | 10233 | 847 | 4166 |
| 4-#18 | 2.22 | MA | 10978 | 2989 | 17934 | 2165 | 19593 | 1810 | 20558 | 1525 | 21807 | 1082 | 25845 | 932 | 13426 |
| 2E | | MI | 5869 | 2989 | 9783 | 2022 | 10360 | 1687 | 10658 | 1418 | 11012 | 996 | 12005 | 742 | 6876 |
| 6-#10 | 1.06 | MA | 10095 | 2757 | 15734 | 2056 | 16923 | 1736 | 17367 | 1488 | 17506 | 1122 | 19920 | 976 | 6714 |
| 2L-3S | | MI | 5395 | 2757 | 8465 | 1947 | 8792 | 1653 | 8795 | 1417 | 8504 | 1064 | 9221 | 805 | 3639 |
| 6-#10 | 1.06 | MA | 9833 | 2757 | 15054 | 2067 | 16051 | 1746 | 16303 | 1509 | 16059 | 1141 | 17915 | 897 | 6741 |
| 3L-2S | | MI | 5509 | 2757 | 8794 | 1941 | 9214 | 1638 | 9309 | 1403 | 9204 | 1054 | 10136 | 894 | 3612 |
| 6-#11 | 1.30 | MA | 10281 | 2805 | 16210 | 2075 | 17485 | 1748 | 18031 | 1493 | 18396 | 1112 | 21142 | 965 | 8136 |
| 2L-3S | | MI | 5451 | 2805 | 8620 | 1957 | 8952 | 1660 | 8973 | 1416 | 8740 | 1049 | 9459 | 751 | 4364 |
| 6-#11 | 1.30 | MA | 9969 | 2805 | 15385 | 2088 | 16427 | 1760 | 16741 | 1518 | 16641 | 1134 | 18711 | 866 | 8168 |
| 3L-2S | | MI | 5585 | 2805 | 9014 | 1951 | 9456 | 1642 | 9588 | 1401 | 9577 | 1038 | 10523 | 861 | 4326 |
| 6-#14 | 1.88 | MA | 10744 | 2919 | 17301 | 2138 | 18849 | 1792 | 19680 | 1518 | 20631 | 1098 | 24229 | 948 | 11520 |
| 2L-3S | | MI | 5597 | 2919 | 8964 | 2016 | 9364 | 1706 | 9464 | 1442 | 9404 | 1034 | 10233 | 652 | 6038 |
| 6-#14 | 1.88 | MA | 10309 | 2919 | 16122 | 2157 | 17337 | 1809 | 17836 | 1553 | 18122 | 1129 | 20755 | 804 | 11540 |
| 3L-2S | | MI | 5784 | 2919 | 9521 | 2008 | 10077 | 1681 | 10335 | 1421 | 10589 | 1020 | 11706 | 810 | 5979 |
| 6-#18 | 3.33 | MA | 11864 | 3210 | 19991 | 2304 | 22230 | 1909 | 23775 | 1585 | 26184 | 1065 | 31905 | 907 | 19870 |
| 2L-3S | | MI | 5947 | 3210 | 9783 | 2171 | 10360 | 1825 | 10658 | 1510 | 11012 | 995 | 12005 | 378 | 9982 |
| 6-#18 | 3.33 | MA | 11142 | 3210 | 17934 | 2335 | 19593 | 1936 | 20558 | 1644 | 21807 | 1116 | 25845 | 643 | 19740 |
| 3L-2S | | MI | 6256 | 3210 | 10733 | 2160 | 11578 | 1786 | 12144 | 1479 | 13029 | 978 | 14409 | 660 | 9918 |
| 8-#9 | 1.11 | MA | 10148 | 2767 | 15830 | 2067 | 17064 | 1744 | 17547 | 1494 | 17756 | 1124 | 20269 | 977 | 7049 |
| 2L-4S | | MI | 5403 | 2767 | 8379 | 1974 | 8694 | 1665 | 8680 | 1425 | 8369 | 1075 | 9101 | 792 | 3826 |
| 8-#9 | 1.11 | MA | 9941 | 2767 | 15292 | 2076 | 16374 | 1752 | 16706 | 1511 | 16611 | 1139 | 18684 | 916 | 7068 |
| 3E | | MI | 5445 | 2767 | 8581 | 1960 | 8956 | 1661 | 9001 | 1422 | 8788 | 1066 | 9617 | 829 | 3799 |
| 8-#9 | 1.11 | MA | 9825 | 2767 | 14889 | 2094 | 15851 | 1770 | 16062 | 1518 | 15726 | 1145 | 17644 | 878 | 7085 |
| 4L-2S | | MI | 5536 | 2767 | 8843 | 1955 | 9291 | 1649 | 9410 | 1411 | 9344 | 1057 | 10351 | 900 | 3778 |
| 8-#10 | 1.41 | MA | 10400 | 2827 | 16414 | 2100 | 17795 | 1767 | 18431 | 1508 | 18954 | 1116 | 21924 | 968 | 8858 |
| 2L-4S | | MI | 5483 | 2827 | 8539 | 2009 | 8884 | 1689 | 8904 | 1439 | 8677 | 1069 | 9492 | 744 | 4746 |
| 8-#10 | 1.41 | MA | 10143 | 2827 | 15734 | 2111 | 16923 | 1778 | 17367 | 1528 | 17506 | 1135 | 19920 | 890 | 8878 |
| 3E | | MI | 5534 | 2827 | 8794 | 1991 | 9214 | 1685 | 9309 | 1436 | 9204 | 1059 | 10136 | 790 | 4710 |
| 8-#10 | 1.41 | MA | 9998 | 2827 | 15224 | 2134 | 16261 | 1799 | 16553 | 1538 | 16387 | 1143 | 18601 | 842 | 8879 |
| 4L-2S | | MI | 5648 | 2827 | 9123 | 1985 | 9635 | 1669 | 9823 | 1422 | 9904 | 1048 | 11051 | 879 | 4682 |
| 8-#11 | 1.73 | MA | 10648 | 2891 | 17035 | 2129 | 18542 | 1787 | 19321 | 1517 | 20152 | 1105 | 23573 | 955 | 10733 |
| 2L-4S | | MI | 5559 | 2891 | 8707 | 2032 | 9059 | 1703 | 9101 | 1442 | 8943 | 1053 | 9769 | 674 | 5683 |
| 8-#11 | 1.73 | MA | 10342 | 2891 | 16210 | 2142 | 17485 | 1799 | 18031 | 1541 | 18396 | 1127 | 21142 | 857 | 10754 |
| 3E | | MI | 5616 | 2891 | 9014 | 2011 | 9456 | 1699 | 9588 | 1440 | 9577 | 1042 | 10523 | 729 | 5640 |
| 8-#11 | 1.73 | MA | 10172 | 2891 | 15590 | 2169 | 16680 | 1825 | 17041 | 1552 | 17106 | 1149 | 19529 | 798 | 10731 |
| 4L-2S | | MI | 5749 | 2891 | 9407 | 2005 | 9960 | 1681 | 10204 | 1424 | 10414 | 1031 | 11587 | 838 | 5602 |
| 8-#14 | 2.50 | MA | 11259 | 3044 | 18480 | 2216 | 20360 | 1848 | 21524 | 1552 | 23139 | 1088 | 27702 | 934 | 15217 |
| 2L-4S | | MI | 5752 | 3044 | 9085 | 2122 | 9514 | 1766 | 9644 | 1477 | 9689 | 1038 | 10657 | 539 | 7846 |
| 8-#14 | 2.50 | MA | 10837 | 3044 | 17301 | 2235 | 18849 | 1865 | 19680 | 1587 | 20631 | 1119 | 24229 | 790 | 15209 |
| 3E | | MI | 5829 | 3044 | 9521 | 2094 | 10077 | 1761 | 10335 | 1476 | 10589 | 1024 | 11706 | 615 | 7812 |

## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

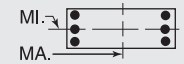
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.50 | MA | 10599 | 3044 | 16413 | 2273 | 17696 | 1902 | 18262 | 1602 | 18784 | 1150 | 21909 | 704 | 15060 |
| 4L-2S | | MI | 6013 | 3044 | 10077 | 2085 | 10791 | 1737 | 11205 | 1455 | 11773 | 1010 | 13179 | 773 | 7764 |
| 8-#18 | 4.44 | MA | 12049 | 3431 | 19991 | 2473 | 22230 | 2036 | 23775 | 1705 | 26184 | 1099 | 31905 | 619 | 26101 |
| 3E | | MI | 6339 | 3431 | 10733 | 2309 | 11578 | 1924 | 12144 | 1570 | 13029 | 977 | 14409 | 296 | 12939 |
| 8-#18 | 4.44 | MA | 11653 | 3431 | 18435 | 2539 | 20210 | 2098 | 21292 | 1728 | 22950 | 1150 | 27806 | 463 | 23937 |
| 4L-2S | | MI | 6641 | 3431 | 11684 | 2298 | 12797 | 1886 | 13631 | 1539 | 15047 | 959 | 16813 | 577 | 12925 |
| 10-#10 | 1.76 | MA | 10704 | 2897 | 17094 | 2144 | 18667 | 1799 | 19495 | 1527 | 20401 | 1111 | 23928 | 960 | 10994 |
| 2L-5S | | MI | 5526 | 2897 | 8653 | 2059 | 9020 | 1737 | 9062 | 1472 | 8851 | 1063 | 9769 | 677 | 5823 |
| 10-#10 | 1.76 | MA | 10451 | 2897 | 16414 | 2155 | 17795 | 1809 | 18431 | 1547 | 18954 | 1130 | 21924 | 882 | 11007 |
| 3L-4S | | MI | 5623 | 2897 | 8868 | 2053 | 9306 | 1721 | 9419 | 1458 | 9377 | 1064 | 10407 | 729 | 5797 |
| 10-#10 | 1.76 | MA | 10308 | 2897 | 15905 | 2178 | 17133 | 1831 | 17617 | 1557 | 17835 | 1137 | 20605 | 834 | 10994 |
| 4L-3S | | MI | 5673 | 2897 | 9123 | 2035 | 9635 | 1716 | 9823 | 1455 | 9904 | 1053 | 11051 | 775 | 5767 |
| 10-#10 | 1.76 | MA | 10095 | 2897 | 15477 | 2188 | 16567 | 1841 | 16908 | 1577 | 16841 | 1156 | 19260 | 797 | 10922 |
| 5L-2S | | MI | 5785 | 2897 | 9452 | 2029 | 10057 | 1701 | 10338 | 1441 | 10604 | 1043 | 11967 | 864 | 5740 |
| 10-#11 | 2.17 | MA | 10712 | 2977 | 17035 | 2196 | 18542 | 1838 | 19321 | 1565 | 20152 | 1120 | 23573 | 847 | 13330 |
| 3L-4S | | MI | 5724 | 2977 | 9101 | 2086 | 9564 | 1742 | 9717 | 1465 | 9781 | 1046 | 10834 | 652 | 6932 |
| 10-#11 | 2.17 | MA | 10544 | 2977 | 16415 | 2223 | 17737 | 1863 | 18331 | 1576 | 18862 | 1142 | 21960 | 788 | 13289 |
| 4L-3S | | MI | 5781 | 2977 | 9407 | 2065 | 9960 | 1738 | 10204 | 1463 | 10414 | 1035 | 11587 | 706 | 6899 |
| 10-#11 | 2.17 | MA | 10288 | 2977 | 15899 | 2237 | 17048 | 1875 | 17469 | 1600 | 17583 | 1150 | 20319 | 740 | 12974 |
| 5L-2S | | MI | 5912 | 2977 | 9801 | 2059 | 10465 | 1719 | 10819 | 1448 | 11252 | 1024 | 12652 | 816 | 6865 |
| 10-#14 | 3.13 | MA | 11359 | 3168 | 18480 | 2313 | 20360 | 1921 | 21524 | 1621 | 23139 | 1109 | 27702 | 776 | 18872 |
| 3L-4S | | MI | 5984 | 3168 | 9642 | 2200 | 10228 | 1822 | 10514 | 1511 | 10874 | 1028 | 12131 | 502 | 9489 |
| 10-#14 | 3.13 | MA | 11126 | 3168 | 17592 | 2351 | 19207 | 1958 | 20106 | 1636 | 21292 | 1140 | 25382 | 690 | 18702 |
| 4L-3S | | MI | 6060 | 3168 | 10077 | 2172 | 10791 | 1817 | 11205 | 1510 | 11773 | 1014 | 13179 | 578 | 9570 |
| 10-#14 | 3.13 | MA | 10766 | 3168 | 16852 | 2370 | 18220 | 1974 | 18870 | 1671 | 19460 | 1151 | 23028 | 618 | 17537 |
| 5L-2S | | MI | 6241 | 3168 | 10634 | 2163 | 11504 | 1793 | 12076 | 1489 | 12957 | 1000 | 14652 | 736 | 9534 |
| 10-#18 | 5.56 | MA | 12557 | 3652 | 20492 | 2678 | 22847 | 2198 | 24509 | 1789 | 27327 | 1132 | 33866 | 439 | 30181 |
| 4L-3S | | MI | 6729 | 3652 | 11684 | 2447 | 12797 | 2024 | 13631 | 1631 | 15047 | 959 | 16813 | 214 | 15880 |
| 10-#18 | 5.56 | MA | 11947 | 3652 | 19193 | 2709 | 21114 | 2225 | 22341 | 1848 | 24116 | 1149 | 29723 | 301 | 28028 |
| 5L-2S | | MI | 7026 | 3652 | 12634 | 2437 | 14015 | 1985 | 15117 | 1599 | 17065 | 941 | 19217 | 495 | 15912 |
| 12-#10 | 2.12 | MA | 10757 | 2968 | 17094 | 2199 | 18667 | 1841 | 19495 | 1566 | 20401 | 1124 | 23928 | 874 | 13132 |
| 3L-5S | | MI | 5666 | 2968 | 8982 | 2103 | 9442 | 1768 | 9577 | 1491 | 9551 | 1057 | 10684 | 662 | 6856 |
| 12-#10 | 2.12 | MA | 10616 | 2968 | 16585 | 2222 | 18005 | 1863 | 18681 | 1576 | 19282 | 1132 | 22609 | 827 | 13107 |
| 4E | | MI | 5762 | 2968 | 9197 | 2096 | 9727 | 1753 | 9933 | 1477 | 10077 | 1058 | 11322 | 714 | 6839 |
| 12-#10 | 2.12 | MA | 10405 | 2968 | 16157 | 2232 | 17439 | 1873 | 17972 | 1597 | 18289 | 1150 | 21264 | 789 | 13026 |
| 5L-3S | | MI | 5812 | 2968 | 9452 | 2079 | 10057 | 1748 | 10338 | 1474 | 10604 | 1047 | 11967 | 760 | 6814 |
| 12-#10 | 2.12 | MA | 10253 | 2968 | 15705 | 2237 | 16869 | 1894 | 17271 | 1606 | 17345 | 1169 | 20061 | 735 | 12544 |
| 6L-2S | | MI | 5923 | 2968 | 9781 | 2072 | 10479 | 1732 | 10852 | 1460 | 11304 | 1037 | 12882 | 849 | 6790 |
| 12-#11 | 2.60 | MA | 10913 | 3064 | 17240 | 2277 | 18795 | 1902 | 19622 | 1599 | 20617 | 1135 | 24391 | 779 | 15847 |
| 4E | | MI | 5889 | 3064 | 9495 | 2140 | 10068 | 1781 | 10332 | 1489 | 10618 | 1039 | 11898 | 629 | 8173 |
| 12-#11 | 2.60 | MA | 10661 | 3064 | 16724 | 2291 | 18106 | 1914 | 18759 | 1624 | 19338 | 1144 | 22750 | 730 | 15473 |
| 5L-3S | | MI | 5945 | 3064 | 9801 | 2119 | 10465 | 1776 | 10819 | 1487 | 11252 | 1028 | 12652 | 683 | 8148 |
| 12-#11 | 2.60 | MA | 10479 | 3064 | 16177 | 2296 | 17421 | 1940 | 17906 | 1635 | 18190 | 1166 | 21281 | 662 | 14906 |
| 6L-2S | | MI | 6075 | 3064 | 10194 | 2112 | 10969 | 1758 | 11434 | 1471 | 12089 | 1017 | 13716 | 793 | 8119 |
| 12-#14 | 3.75 | MA | 11648 | 3293 | 18771 | 2429 | 20719 | 2013 | 21950 | 1670 | 23801 | 1130 | 28856 | 676 | 22347 |
| 4E | | MI | 6215 | 3293 | 10198 | 2278 | 10941 | 1878 | 11385 | 1545 | 12058 | 1018 | 13604 | 465 | 11113 |
| 12-#14 | 3.75 | MA | 11295 | 3293 | 18031 | 2448 | 19731 | 2030 | 20714 | 1704 | 21969 | 1141 | 26501 | 604 | 21134 |
| 5L-3S | | MI | 6291 | 3293 | 10634 | 2249 | 11504 | 1873 | 12076 | 1544 | 12957 | 1004 | 14652 | 541 | 11318 |
| 12-#14 | 3.75 | MA | 11040 | 3293 | 17255 | 2456 | 18749 | 2067 | 19491 | 1719 | 20323 | 1172 | 24391 | 504 | 20239 |
| 6L-2S | | MI | 6469 | 3293 | 11190 | 2241 | 12218 | 1848 | 12946 | 1523 | 14141 | 990 | 16125 | 699 | 11293 |
| 12-#18 | 6.67 | MA | 12858 | 3874 | 21250 | 2847 | 23751 | 2324 | 25558 | 1908 | 28493 | 1131 | 35784 | 277 | 34225 |
| 5L-3S | | MI | 7118 | 3874 | 12634 | 2585 | 14015 | 2123 | 15117 | 1691 | 17065 | 940 | 19217 | 132 | 18692 |
| 12-#18 | 6.67 | MA | 12426 | 3874 | 19915 | 2863 | 22027 | 2387 | 23412 | 1931 | 25606 | 1182 | 32050 | 96 | 31345 |
| 6L-2S | | MI | 7410 | 3874 | 13584 | 2575 | 15234 | 2084 | 16604 | 1659 | 19083 | 923 | 21621 | 413 | 18886 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis

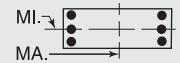



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.47 | MA | 10922 | 3038 | 17265 | 2266 | 18877 | 1894 | 19744 | 1595 | 20730 | 1126 | 24613 | 819 | 15219 |
| 4L-5S | | MI | 5805 | 3038 | 9311 | 2147 | 9863 | 1800 | 10091 | 1510 | 10251 | 1052 | 11600 | 647 | 7855 |
| 14-#10 | 2.47 | MA | 10714 | 3038 | 16837 | 2276 | 18311 | 1904 | 19036 | 1616 | 19736 | 1145 | 23269 | 781 | 15129 |
| 5L-4S | | MI | 5901 | 3038 | 9526 | 2140 | 10149 | 1784 | 10448 | 1496 | 10777 | 1052 | 12238 | 699 | 7875 |
| 14-#10 | 2.47 | MA | 10565 | 3038 | 16386 | 2281 | 17741 | 1925 | 18335 | 1625 | 18793 | 1164 | 22065 | 727 | 14624 |
| 6L-3S | | MI | 5951 | 3038 | 9781 | 2123 | 10479 | 1779 | 10852 | 1493 | 11304 | 1042 | 12882 | 745 | 7856 |
| 14-#10 | 2.47 | MA | 10400 | 3038 | 15903 | 2299 | 17156 | 1930 | 17664 | 1646 | 17817 | 1171 | 20656 | 681 | 14296 |
| 7L-2S | | MI | 6060 | 3038 | 10110 | 2116 | 10900 | 1764 | 11367 | 1479 | 12004 | 1031 | 13797 | 834 | 7835 |
| 14-#11 | 3.03 | MA | 11032 | 3150 | 17549 | 2344 | 19164 | 1953 | 20050 | 1647 | 21094 | 1137 | 25181 | 721 | 17978 |
| 5L-4S | | MI | 6053 | 3150 | 9888 | 2194 | 10573 | 1819 | 10948 | 1512 | 11456 | 1032 | 12962 | 607 | 9407 |
| 14-#11 | 3.03 | MA | 10854 | 3150 | 17002 | 2350 | 18479 | 1979 | 19196 | 1658 | 19946 | 1159 | 23712 | 652 | 17434 |
| 6L-3S | | MI | 6109 | 3150 | 10194 | 2173 | 10969 | 1815 | 11434 | 1511 | 12089 | 1021 | 13716 | 661 | 9390 |
| 14-#11 | 3.03 | MA | 10659 | 3150 | 16415 | 2371 | 17767 | 1985 | 18382 | 1683 | 18827 | 1181 | 21986 | 594 | 16829 |
| 7L-2S | | MI | 6237 | 3150 | 10588 | 2166 | 11474 | 1797 | 12050 | 1495 | 12926 | 1010 | 14780 | 771 | 9366 |
| 14-#14 | 4.38 | MA | 11819 | 3417 | 19210 | 2525 | 21243 | 2086 | 22558 | 1738 | 24478 | 1131 | 29975 | 590 | 24739 |
| 5L-4S | | MI | 6446 | 3417 | 10755 | 2356 | 11655 | 1934 | 12255 | 1579 | 13242 | 1008 | 15077 | 428 | 12749 |
| 14-#14 | 4.38 | MA | 11572 | 3417 | 18434 | 2533 | 20261 | 2123 | 21335 | 1753 | 22832 | 1162 | 27865 | 490 | 23828 |
| 6L-3S | | MI | 6521 | 3417 | 11190 | 2327 | 12218 | 1929 | 12946 | 1578 | 14141 | 994 | 16125 | 503 | 13059 |
| 14-#14 | 4.38 | MA | 11297 | 3417 | 17593 | 2564 | 19252 | 2131 | 20168 | 1788 | 21230 | 1193 | 25384 | 404 | 22502 |
| 7L-2S | | MI | 6697 | 3417 | 11747 | 2319 | 12931 | 1904 | 13817 | 1557 | 15326 | 980 | 17599 | 662 | 13045 |
| 14-#18 | 7.78 | MA | 13345 | 4095 | 21972 | 3001 | 24664 | 2486 | 26629 | 1992 | 29983 | 1165 | 38110 | 71 | 37586 |
| 6L-3S | | MI | 7506 | 4095 | 13584 | 2724 | 15234 | 2222 | 16604 | 1751 | 19083 | 922 | 21621 | 49 | 21416 |
| 16-#10 | 2.82 | MA | 11020 | 3108 | 17517 | 2320 | 19183 | 1936 | 20100 | 1635 | 21184 | 1139 | 25273 | 773 | 17196 |
| 5E | | MI | 5944 | 3108 | 9640 | 2191 | 10285 | 1831 | 10606 | 1529 | 10951 | 1046 | 12515 | 632 | 8808 |
| 16-#10 | 2.82 | MA | 10875 | 3108 | 17066 | 2325 | 18614 | 1957 | 19399 | 1644 | 20240 | 1158 | 24070 | 720 | 16708 |
| 6L-4S | | MI | 6039 | 3108 | 9855 | 2184 | 10571 | 1816 | 10962 | 1515 | 11477 | 1047 | 13153 | 684 | 8908 |
| 16-#10 | 2.82 | MA | 10711 | 3108 | 16583 | 2343 | 18028 | 1962 | 18728 | 1665 | 19264 | 1166 | 22660 | 673 | 16391 |
| 7L-3S | | MI | 6089 | 3108 | 10110 | 2167 | 10900 | 1811 | 11367 | 1512 | 12004 | 1036 | 13797 | 730 | 8894 |
| 16-#10 | 2.82 | MA | 10532 | 3108 | 16161 | 2351 | 17443 | 1980 | 18006 | 1670 | 18344 | 1184 | 21438 | 629 | 15804 |
| 8L-2S | | MI | 6197 | 3108 | 10438 | 2160 | 11322 | 1795 | 11881 | 1498 | 12704 | 1026 | 14712 | 820 | 8876 |
| 16-#11 | 3.47 | MA | 11227 | 3236 | 17827 | 2404 | 19536 | 2018 | 20486 | 1682 | 21701 | 1152 | 26143 | 643 | 19965 |
| 6L-4S | | MI | 6217 | 3236 | 10282 | 2248 | 11077 | 1858 | 11563 | 1536 | 12293 | 1025 | 14027 | 584 | 10638 |
| 16-#11 | 3.47 | MA | 11032 | 3236 | 17240 | 2425 | 18825 | 2023 | 19673 | 1706 | 20583 | 1174 | 24417 | 584 | 19349 |
| 7L-3S | | MI | 6272 | 3236 | 10588 | 2227 | 11474 | 1854 | 12050 | 1534 | 12926 | 1014 | 14780 | 638 | 10628 |
| 16-#11 | 3.47 | MA | 10824 | 3236 | 16726 | 2435 | 18114 | 2045 | 18804 | 1713 | 19392 | 1182 | 22925 | 529 | 18643 |
| 8L-2S | | MI | 6399 | 3236 | 10982 | 2220 | 11978 | 1836 | 12665 | 1518 | 13764 | 1004 | 15845 | 748 | 10609 |
| 16-#14 | 5.00 | MA | 12100 | 3542 | 19613 | 2611 | 21772 | 2179 | 23179 | 1787 | 25341 | 1152 | 31338 | 476 | 27416 |
| 6L-4S | | MI | 6676 | 3542 | 11312 | 2433 | 12368 | 1990 | 13126 | 1613 | 14426 | 998 | 16550 | 391 | 14397 |
| 16-#14 | 5.00 | MA | 11827 | 3542 | 18772 | 2642 | 20764 | 2187 | 22012 | 1822 | 23739 | 1183 | 28857 | 390 | 26104 |
| 7L-3S | | MI | 6750 | 3542 | 11747 | 2405 | 12931 | 1985 | 13817 | 1612 | 15326 | 984 | 17599 | 466 | 14791 |
| 16-#14 | 5.00 | MA | 11534 | 3542 | 18037 | 2655 | 19746 | 2217 | 20782 | 1832 | 22032 | 1194 | 26714 | 308 | 24644 |
| 8L-2S | | MI | 6924 | 3542 | 12303 | 2397 | 13645 | 1960 | 14687 | 1591 | 16510 | 970 | 19072 | 625 | 14792 |
| 18-#10 | 3.17 | MA | 11183 | 3178 | 17746 | 2369 | 19486 | 1988 | 20463 | 1663 | 21688 | 1152 | 26074 | 712 | 18795 |
| 6L-5S | | MI | 6083 | 3178 | 9969 | 2235 | 10707 | 1863 | 11120 | 1548 | 11651 | 1040 | 13430 | 617 | 9797 |
| 18-#10 | 3.17 | MA | 11019 | 3178 | 17263 | 2387 | 18900 | 1993 | 19792 | 1684 | 20712 | 1160 | 24664 | 665 | 18487 |
| 7L-4S | | MI | 6177 | 3178 | 10184 | 2228 | 10992 | 1847 | 11476 | 1534 | 12177 | 1041 | 14068 | 669 | 9940 |
| 18-#10 | 3.17 | MA | 10845 | 3178 | 16841 | 2395 | 18315 | 2011 | 19070 | 1689 | 19791 | 1179 | 23442 | 622 | 17893 |
| 8L-3S | | MI | 6226 | 3178 | 10438 | 2211 | 11322 | 1843 | 11881 | 1532 | 12704 | 1031 | 14712 | 715 | 9929 |
| 18-#10 | 3.17 | MA | 10692 | 3178 | 16389 | 2415 | 17756 | 2019 | 18374 | 1706 | 18884 | 1198 | 22244 | 580 | 17353 |
| 9L-2S | | MI | 6334 | 3178 | 10767 | 2204 | 11744 | 1827 | 12396 | 1517 | 13404 | 1020 | 15628 | 805 | 9914 |
| 18-#11 | 3.90 | MA | 11403 | 3323 | 18065 | 2479 | 19882 | 2062 | 20963 | 1730 | 22339 | 1167 | 26848 | 575 | 21871 |
| 7L-4S | | MI | 6380 | 3323 | 10675 | 2301 | 11582 | 1897 | 12179 | 1559 | 13130 | 1019 | 15091 | 561 | 11845 |
| 18-#11 | 3.90 | MA | 11199 | 3323 | 17551 | 2489 | 19172 | 2083 | 20094 | 1736 | 21148 | 1176 | 25355 | 519 | 21174 |
| 8L-3S | | MI | 6435 | 3323 | 10982 | 2281 | 11978 | 1892 | 12665 | 1558 | 13764 | 1008 | 15845 | 616 | 11863 |
| 18-#11 | 3.90 | MA | 11011 | 3323 | 17007 | 2513 | 18491 | 2092 | 19247 | 1757 | 20043 | 1198 | 23887 | 467 | 20275 |
| 9L-2S | | MI | 6561 | 3323 | 11375 | 2274 | 12483 | 1874 | 13281 | 1542 | 14601 | 997 | 16909 | 726 | 11848 |
| 18-#14 | 5.63 | MA | 12352 | 3666 | 19951 | 2720 | 22275 | 2243 | 23856 | 1856 | 26247 | 1173 | 32331 | 377 | 29706 |
| 7L-4S | | MI | 6905 | 3666 | 11868 | 2511 | 13082 | 2046 | 13996 | 1647 | 15611 | 988 | 18024 | 354 | 16052 |

## RECTANGULAR TIED COLUMNS 20" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 5.63 | MA | 12066 | 3666 | 19216 | 2733 | 21257 | 2273 | 22626 | 1866 | 24541 | 1184 | 30188 | 294 | 28225 |
| 8L-3S | | MI | 6979 | 3666 | 12303 | 2483 | 13645 | 2041 | 14687 | 1646 | 16510 | 974 | 19072 | 429 | 16519 |
| 20-#10 | 3.53 | MA | 11326 | 3249 | 17943 | 2431 | 19772 | 2025 | 20855 | 1703 | 22159 | 1154 | 26668 | 657 | 20586 |
| 7L-5S | | MI | 6221 | 3249 | 10298 | 2278 | 11128 | 1895 | 11634 | 1568 | 12351 | 1035 | 14345 | 602 | 10789 |
| 20-#10 | 3.53 | MA | 11158 | 3249 | 17521 | 2439 | 19188 | 2043 | 20134 | 1708 | 21239 | 1173 | 25446 | 614 | 19983 |
| 8L-4S | | MI | 6315 | 3249 | 10513 | 2272 | 11414 | 1879 | 11991 | 1553 | 12877 | 1035 | 14983 | 654 | 10965 |
| 20-#10 | 3.53 | MA | 11006 | 3249 | 17069 | 2458 | 18628 | 2050 | 19438 | 1726 | 20332 | 1192 | 24249 | 572 | 19432 |
| 9L-3S | | MI | 6364 | 3249 | 10767 | 2254 | 11744 | 1874 | 12396 | 1551 | 13404 | 1025 | 15628 | 700 | 10961 |
| 20-#10 | 3.53 | MA | 10826 | 3249 | 16632 | 2464 | 18068 | 2070 | 18760 | 1744 | 19358 | 1198 | 23032 | 535 | 18758 |
| 10L-2S | | MI | 6470 | 3249 | 11096 | 2248 | 12165 | 1858 | 12910 | 1537 | 14104 | 1014 | 16543 | 790 | 10949 |
| 20-#11 | 4.33 | MA | 11571 | 3409 | 18376 | 2543 | 20229 | 2122 | 21385 | 1760 | 22903 | 1169 | 27786 | 510 | 23706 |
| 8L-4S | | MI | 6544 | 3409 | 11069 | 2355 | 12086 | 1935 | 12794 | 1583 | 13968 | 1012 | 16155 | 539 | 13015 |
| 20-#11 | 4.33 | MA | 11390 | 3409 | 17832 | 2567 | 19549 | 2131 | 20538 | 1781 | 21798 | 1191 | 26318 | 457 | 22793 |
| 9L-3S | | MI | 6598 | 3409 | 11375 | 2335 | 12483 | 1931 | 13281 | 1581 | 14601 | 1001 | 16909 | 593 | 13095 |
| 20-#14 | 6.25 | MA | 12594 | 3791 | 20395 | 2811 | 22769 | 2329 | 24469 | 1900 | 27049 | 1174 | 33661 | 280 | 31806 |
| 8L-4S | | MI | 7134 | 3791 | 12425 | 2589 | 13795 | 2101 | 14867 | 1681 | 16795 | 978 | 19497 | 317 | 17715 |
| 22-#10 | 3.88 | MA | 11466 | 3319 | 18202 | 2483 | 20060 | 2074 | 21198 | 1727 | 22686 | 1168 | 27450 | 606 | 22076 |
| 8L-5S | | MI | 6359 | 3319 | 10627 | 2322 | 11550 | 1926 | 12149 | 1587 | 13051 | 1029 | 15260 | 587 | 11784 |
| 22-#10 | 3.88 | MA | 11318 | 3319 | 17750 | 2502 | 19500 | 2082 | 20502 | 1745 | 21779 | 1186 | 26253 | 564 | 21510 |
| 9L-4S | | MI | 6452 | 3319 | 10842 | 2316 | 11836 | 1910 | 12505 | 1573 | 13577 | 1030 | 15898 | 639 | 11989 |
| 22-#10 | 3.88 | MA | 11139 | 3319 | 17312 | 2508 | 18940 | 2101 | 19824 | 1763 | 20805 | 1192 | 25036 | 527 | 20841 |
| 10L-3S | | MI | 6501 | 3319 | 11096 | 2298 | 12165 | 1906 | 12910 | 1570 | 14104 | 1019 | 16543 | 685 | 11992 |
| 22-#11 | 4.77 | MA | 11766 | 3495 | 18657 | 2621 | 20607 | 2170 | 21828 | 1804 | 23554 | 1184 | 28749 | 448 | 25312 |
| 9L-4S | | MI | 6706 | 3495 | 11462 | 2409 | 12591 | 1974 | 13410 | 1607 | 14805 | 1005 | 17220 | 516 | 14190 |
| 24-#10 | 4.23 | MA | 11628 | 3389 | 18430 | 2546 | 20372 | 2114 | 21566 | 1764 | 23227 | 1181 | 28257 | 557 | 23588 |
| 9L-5S | | MI | 6497 | 3389 | 10956 | 2366 | 11972 | 1958 | 12663 | 1606 | 13751 | 1023 | 16176 | 572 | 12781 |
| 24-#10 | 4.23 | MA | 11450 | 3389 | 17992 | 2552 | 19812 | 2133 | 20888 | 1782 | 22253 | 1187 | 27040 | 519 | 22893 |
| 10L-4S | | MI | 6589 | 3389 | 11171 | 2360 | 12257 | 1942 | 13020 | 1592 | 14277 | 1024 | 16814 | 624 | 13012 |

## RECTANGULAR TIED COLUMNS 20" x 38"

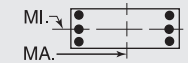
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.18 | MA | 11347 | 2936 | 17815 | 2176 | 19168 | 1835 | 19709 | 1570 | 19979 | 1176 | 22840 | 1021 | 8292 |
| 2E | | MI | 5837 | 2936 | 9400 | 2028 | 9805 | 1709 | 9894 | 1460 | 9795 | 1088 | 10637 | 898 | 4194 |
| 4-#18 | 2.11 | MA | 12159 | 3130 | 19753 | 2280 | 21580 | 1908 | 22619 | 1611 | 23920 | 1151 | 28282 | 991 | 14290 |
| 2E | | MI | 6152 | 3130 | 10220 | 2119 | 10800 | 1770 | 11085 | 1490 | 11399 | 1053 | 12405 | 792 | 6916 |
| 6-#10 | 1.00 | MA | 11207 | 2898 | 17397 | 2171 | 18721 | 1834 | 19203 | 1574 | 19315 | 1190 | 21939 | 1036 | 7126 |
| 2L-3S | | MI | 5678 | 2898 | 8899 | 2048 | 9234 | 1739 | 9226 | 1491 | 8899 | 1124 | 9632 | 857 | 3659 |
| 6-#10 | 1.00 | MA | 10926 | 2898 | 16673 | 2183 | 17793 | 1845 | 18071 | 1595 | 17774 | 1209 | 19805 | 958 | 7153 |
| 3L-2S | | MI | 5792 | 2898 | 9228 | 2041 | 9655 | 1723 | 9740 | 1477 | 9599 | 1113 | 10547 | 947 | 3633 |
| 6-#11 | 1.23 | MA | 11408 | 2946 | 17907 | 2190 | 19323 | 1846 | 19914 | 1579 | 20268 | 1180 | 23247 | 1024 | 8642 |
| 2L-3S | | MI | 5734 | 2946 | 9056 | 2057 | 9393 | 1745 | 9403 | 1490 | 9132 | 1108 | 9866 | 803 | 4389 |
| 6-#11 | 1.23 | MA | 11073 | 2946 | 17028 | 2204 | 18196 | 1859 | 18539 | 1604 | 18398 | 1202 | 20657 | 928 | 8673 |
| 3L-2S | | MI | 5868 | 2946 | 9449 | 2050 | 9897 | 1727 | 10018 | 1475 | 9969 | 1097 | 10930 | 913 | 4351 |
| 6-#14 | 1.78 | MA | 11905 | 3061 | 19072 | 2253 | 20779 | 1890 | 21674 | 1604 | 22653 | 1166 | 26542 | 1007 | 12249 |
| 2L-3S | | MI | 5880 | 3061 | 9400 | 2115 | 9805 | 1790 | 9894 | 1515 | 9795 | 1092 | 10637 | 703 | 6071 |
| 6-#14 | 1.78 | MA | 11437 | 3061 | 17815 | 2273 | 19168 | 1908 | 19709 | 1639 | 19979 | 1198 | 22840 | 866 | 12269 |
| 3L-2S | | MI | 6067 | 3061 | 9957 | 2106 | 10518 | 1765 | 10764 | 1494 | 10979 | 1079 | 12111 | 861 | 6012 |
| 6-#18 | 3.16 | MA | 13111 | 3351 | 21948 | 2419 | 24394 | 2007 | 26053 | 1671 | 28591 | 1133 | 34750 | 967 | 21166 |
| 2L-3S | | MI | 6230 | 3351 | 10220 | 2267 | 10800 | 1908 | 11085 | 1582 | 11399 | 1053 | 12405 | 428 | 10038 |
| 6-#18 | 3.16 | MA | 12333 | 3351 | 19753 | 2451 | 21580 | 2036 | 22619 | 1731 | 23920 | 1186 | 28282 | 708 | 21036 |
| 3L-2S | | MI | 6539 | 3351 | 11171 | 2257 | 12018 | 1869 | 12571 | 1551 | 13417 | 1035 | 14809 | 710 | 9965 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

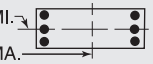



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.05 | MA | 11264 | 2909 | 17499 | 2182 | 18870 | 1842 | 19394 | 1580 | 19580 | 1192 | 22309 | 1036 | 7481 |
| 2L-4S | | MI | 5686 | 2909 | 8812 | 2075 | 9136 | 1751 | 9112 | 1500 | 8765 | 1134 | 9512 | 845 | 3845 |
| 8-#9 | 1.05 | MA | 11042 | 2909 | 16926 | 2191 | 18136 | 1851 | 18498 | 1596 | 18361 | 1207 | 20622 | 976 | 7500 |
| 3E | | MI | 5728 | 2909 | 9014 | 2061 | 9398 | 1747 | 9433 | 1497 | 9183 | 1126 | 10029 | 882 | 3818 |
| 8-#9 | 1.05 | MA | 10917 | 2909 | 16498 | 2209 | 17580 | 1868 | 17814 | 1604 | 17421 | 1214 | 19521 | 939 | 7517 |
| 4L-2S | | MI | 5819 | 2909 | 9276 | 2056 | 9733 | 1735 | 9842 | 1486 | 9739 | 1117 | 10763 | 952 | 3798 |
| 8-#10 | 1.34 | MA | 11535 | 2968 | 18121 | 2215 | 19649 | 1866 | 20336 | 1593 | 20856 | 1184 | 24073 | 1028 | 9406 |
| 2L-4S | | MI | 5766 | 2968 | 8973 | 2109 | 9326 | 1775 | 9336 | 1513 | 9072 | 1129 | 9902 | 796 | 4770 |
| 8-#10 | 1.34 | MA | 11258 | 2968 | 17397 | 2227 | 18721 | 1876 | 19203 | 1614 | 19315 | 1204 | 21939 | 950 | 9426 |
| 3E | | MI | 5817 | 2968 | 9228 | 2091 | 9655 | 1771 | 9740 | 1510 | 9599 | 1118 | 10547 | 842 | 4734 |
| 8-#10 | 1.34 | MA | 11101 | 2968 | 16856 | 2249 | 18018 | 1898 | 18338 | 1624 | 18126 | 1212 | 20543 | 903 | 9427 |
| 4L-2S | | MI | 5931 | 2968 | 9556 | 2085 | 10077 | 1755 | 10255 | 1496 | 10299 | 1108 | 11462 | 932 | 4705 |
| 8-#11 | 1.64 | MA | 11801 | 3033 | 18786 | 2244 | 20449 | 1885 | 21289 | 1602 | 22138 | 1173 | 25837 | 1015 | 11407 |
| 2L-4S | | MI | 5842 | 3033 | 9143 | 2131 | 9501 | 1788 | 9532 | 1516 | 9336 | 1112 | 10177 | 726 | 5714 |
| 8-#11 | 1.64 | MA | 11472 | 3033 | 17907 | 2258 | 19323 | 1897 | 19914 | 1627 | 20268 | 1196 | 23247 | 918 | 11427 |
| 3E | | MI | 5899 | 3033 | 9449 | 2111 | 9897 | 1784 | 10018 | 1514 | 9969 | 1101 | 10930 | 780 | 5669 |
| 8-#11 | 1.64 | MA | 11287 | 3033 | 17248 | 2285 | 18467 | 1924 | 18861 | 1639 | 18821 | 1205 | 21539 | 859 | 11405 |
| 4L-2S | | MI | 6032 | 3033 | 9843 | 2104 | 10402 | 1765 | 10634 | 1498 | 10807 | 1090 | 11995 | 890 | 5631 |
| 8-#14 | 2.37 | MA | 12459 | 3185 | 20328 | 2331 | 22390 | 1946 | 23640 | 1638 | 25328 | 1156 | 30245 | 994 | 16189 |
| 2L-4S | | MI | 6035 | 3185 | 9521 | 2221 | 9955 | 1850 | 10073 | 1550 | 10080 | 1096 | 11062 | 590 | 7892 |
| 8-#14 | 2.37 | MA | 12003 | 3185 | 19072 | 2350 | 20779 | 1964 | 21674 | 1673 | 22653 | 1188 | 26542 | 852 | 16181 |
| 3E | | MI | 6112 | 3185 | 9957 | 2192 | 10518 | 1845 | 10764 | 1549 | 10979 | 1082 | 12111 | 666 | 7851 |
| 8-#14 | 2.37 | MA | 11744 | 3185 | 18127 | 2390 | 19553 | 2001 | 20166 | 1689 | 20688 | 1220 | 24086 | 767 | 16032 |
| 4L-2S | | MI | 6296 | 3185 | 10513 | 2184 | 11232 | 1821 | 11634 | 1528 | 12164 | 1069 | 13584 | 824 | 7801 |
| 8-#18 | 4.21 | MA | 13306 | 3573 | 21948 | 2589 | 24394 | 2135 | 26053 | 1792 | 28591 | 1169 | 34750 | 683 | 27829 |
| 3E | | MI | 6622 | 3573 | 11171 | 2406 | 12018 | 2007 | 12571 | 1642 | 13417 | 1034 | 14809 | 346 | 13006 |
| 8-#18 | 4.21 | MA | 12874 | 3573 | 20292 | 2657 | 22244 | 2199 | 23409 | 1817 | 25147 | 1222 | 30407 | 529 | 25730 |
| 4L-2S | | MI | 6925 | 3573 | 12121 | 2395 | 13237 | 1968 | 14058 | 1611 | 15435 | 1017 | 17213 | 628 | 12977 |
| 10-#10 | 1.67 | MA | 11860 | 3039 | 18845 | 2259 | 20578 | 1897 | 21468 | 1612 | 22397 | 1179 | 26206 | 1020 | 11680 |
| 2L-5S | | MI | 5809 | 3039 | 9087 | 2159 | 9462 | 1823 | 9494 | 1547 | 9246 | 1122 | 10180 | 729 | 5854 |
| 10-#10 | 1.67 | MA | 11588 | 3039 | 18121 | 2270 | 19649 | 1908 | 20336 | 1633 | 20856 | 1198 | 24073 | 943 | 11693 |
| 3L-4S | | MI | 5906 | 3039 | 9302 | 2153 | 9747 | 1807 | 9850 | 1532 | 9772 | 1123 | 10818 | 781 | 5824 |
| 10-#10 | 1.67 | MA | 11433 | 3039 | 17580 | 2293 | 18946 | 1930 | 19470 | 1643 | 19667 | 1206 | 22677 | 895 | 11680 |
| 4L-3S | | MI | 5956 | 3039 | 9556 | 2135 | 10077 | 1802 | 10255 | 1530 | 10299 | 1113 | 11462 | 827 | 5793 |
| 10-#10 | 1.67 | MA | 11204 | 3039 | 17122 | 2304 | 18345 | 1940 | 18718 | 1664 | 18611 | 1226 | 21251 | 859 | 11608 |
| 5L-2S | | MI | 6069 | 3039 | 9885 | 2129 | 10499 | 1786 | 10769 | 1516 | 10999 | 1102 | 12377 | 917 | 5765 |
| 10-#11 | 2.05 | MA | 11869 | 3119 | 18786 | 2311 | 20449 | 1936 | 21289 | 1651 | 22138 | 1189 | 25837 | 908 | 14173 |
| 3L-4S | | MI | 6007 | 3119 | 9536 | 2185 | 10005 | 1827 | 10147 | 1539 | 10173 | 1105 | 11241 | 703 | 6968 |
| 10-#11 | 2.05 | MA | 11686 | 3119 | 18127 | 2339 | 19593 | 1962 | 20236 | 1662 | 20691 | 1198 | 24129 | 850 | 14132 |
| 4L-3S | | MI | 6064 | 3119 | 9843 | 2165 | 10402 | 1822 | 10634 | 1537 | 10807 | 1094 | 11995 | 758 | 6931 |
| 10-#11 | 2.05 | MA | 11412 | 3119 | 17575 | 2352 | 18861 | 1975 | 19319 | 1687 | 19407 | 1221 | 22389 | 803 | 13880 |
| 5L-2S | | MI | 6195 | 3119 | 10236 | 2158 | 10906 | 1804 | 11249 | 1522 | 11644 | 1083 | 13059 | 867 | 6897 |
| 10-#14 | 2.96 | MA | 12564 | 3310 | 20328 | 2428 | 22390 | 2020 | 23640 | 1707 | 25328 | 1178 | 30245 | 838 | 20087 |
| 3L-4S | | MI | 6267 | 3310 | 10078 | 2298 | 10669 | 1906 | 10943 | 1584 | 11264 | 1086 | 12536 | 553 | 9605 |
| 10-#14 | 2.96 | MA | 12309 | 3310 | 19384 | 2467 | 21164 | 2057 | 22132 | 1723 | 23363 | 1210 | 27789 | 753 | 19917 |
| 4L-3S | | MI | 6343 | 3310 | 10513 | 2270 | 11232 | 1901 | 11634 | 1583 | 12164 | 1072 | 13584 | 629 | 9613 |
| 10-#14 | 2.96 | MA | 11923 | 3310 | 18599 | 2487 | 20115 | 2074 | 20818 | 1758 | 21414 | 1222 | 25290 | 683 | 18766 |
| 5L-2S | | MI | 6524 | 3310 | 11070 | 2262 | 11945 | 1877 | 12505 | 1562 | 13348 | 1059 | 15057 | 787 | 9573 |
| 10-#18 | 5.26 | MA | 13844 | 3794 | 22487 | 2795 | 25059 | 2298 | 26842 | 1877 | 29818 | 1205 | 36875 | 505 | 32408 |
| 4L-3S | | MI | 7012 | 3794 | 12121 | 2544 | 13237 | 2106 | 14058 | 1703 | 15435 | 1016 | 17213 | 264 | 15952 |
| 10-#18 | 5.26 | MA | 13190 | 3794 | 21106 | 2827 | 23215 | 2327 | 24536 | 1938 | 26400 | 1223 | 32475 | 372 | 30222 |
| 5L-2S | | MI | 7309 | 3794 | 13072 | 2534 | 14455 | 2068 | 15544 | 1671 | 17453 | 998 | 19617 | 546 | 15968 |
| 12-#10 | 2.01 | MA | 11916 | 3109 | 18845 | 2314 | 20578 | 1939 | 21468 | 1652 | 22397 | 1193 | 26206 | 935 | 13955 |
| 3L-5S | | MI | 5948 | 3109 | 9416 | 2203 | 9883 | 1854 | 10008 | 1566 | 9946 | 1117 | 11095 | 714 | 6891 |
| 12-#10 | 2.01 | MA | 11762 | 3109 | 18304 | 2337 | 19875 | 1961 | 20603 | 1662 | 21208 | 1201 | 24811 | 888 | 13930 |
| 4E | | MI | 6045 | 3109 | 9631 | 2197 | 10169 | 1838 | 10365 | 1552 | 10472 | 1117 | 11733 | 766 | 6869 |
| 12-#10 | 2.01 | MA | 11537 | 3109 | 17846 | 2348 | 19274 | 1972 | 19851 | 1683 | 20152 | 1220 | 23385 | 851 | 13849 |
| 5L-3S | | MI | 6095 | 3109 | 9885 | 2179 | 10499 | 1834 | 10769 | 1549 | 10999 | 1107 | 12377 | 812 | 6843 |

## RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

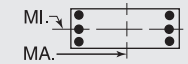



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 2.01 | MA | 11374 | 3109 | 17366 | 2353 | 18663 | 1993 | 19107 | 1693 | 19151 | 1239 | 22109 | 799 | 13383 |
| 6L-2S | | MI | 6206 | 3109 | 10214 | 2173 | 10920 | 1818 | 11284 | 1535 | 11699 | 1096 | 13292 | 902 | 6818 |
| 12-#11 | 2.46 | MA | 12082 | 3205 | 19006 | 2393 | 20720 | 2001 | 21610 | 1686 | 22562 | 1191 | 26719 | 840 | 16858 |
| 4E | | MI | 6172 | 3205 | 9930 | 2239 | 10510 | 1865 | 10762 | 1563 | 11011 | 1098 | 12305 | 681 | 8211 |
| 12-#11 | 2.46 | MA | 11812 | 3205 | 18454 | 2406 | 19988 | 2014 | 20694 | 1711 | 21277 | 1214 | 24978 | 793 | 16545 |
| 5L-3S | | MI | 6228 | 3205 | 10236 | 2219 | 10906 | 1861 | 11249 | 1561 | 11644 | 1087 | 13059 | 735 | 8183 |
| 12-#11 | 2.46 | MA | 11617 | 3205 | 17870 | 2412 | 19254 | 2039 | 19787 | 1722 | 20057 | 1237 | 23421 | 727 | 15912 |
| 6L-2S | | MI | 6358 | 3205 | 10630 | 2212 | 11411 | 1843 | 11865 | 1545 | 12482 | 1076 | 14123 | 845 | 8153 |
| 12-#14 | 3.55 | MA | 12869 | 3434 | 20641 | 2545 | 22775 | 2113 | 24097 | 1757 | 26037 | 1200 | 31491 | 739 | 23805 |
| 4E | | MI | 6498 | 3434 | 10635 | 2376 | 11382 | 1962 | 11814 | 1618 | 12449 | 1076 | 14009 | 516 | 11226 |
| 12-#14 | 3.55 | MA | 12491 | 3434 | 19855 | 2564 | 21726 | 2130 | 22784 | 1792 | 24089 | 1212 | 28993 | 669 | 22605 |
| 5L-3S | | MI | 6574 | 3434 | 11070 | 2348 | 11945 | 1957 | 12505 | 1617 | 13348 | 1062 | 15057 | 592 | 11364 |
| 12-#14 | 3.55 | MA | 12217 | 3434 | 19021 | 2572 | 20683 | 2168 | 21484 | 1808 | 22340 | 1244 | 26756 | 571 | 21741 |
| 6L-2S | | MI | 6753 | 3434 | 11626 | 2340 | 12659 | 1933 | 13375 | 1596 | 14532 | 1049 | 16530 | 750 | 11335 |
| 12-#18 | 6.32 | MA | 14167 | 4015 | 23301 | 2966 | 26029 | 2427 | 27970 | 1998 | 31072 | 1205 | 38943 | 348 | 36836 |
| 5L-3S | | MI | 7401 | 4015 | 13072 | 2682 | 14455 | 2206 | 15544 | 1763 | 17453 | 998 | 19617 | 182 | 18885 |
| 12-#18 | 6.32 | MA | 13704 | 4015 | 21864 | 2980 | 24196 | 2491 | 25686 | 2023 | 28001 | 1259 | 34991 | 168 | 33665 |
| 6L-2S | | MI | 7694 | 4015 | 14022 | 2672 | 15674 | 2167 | 17031 | 1732 | 19470 | 980 | 22021 | 463 | 18948 |
| 14-#10 | 2.34 | MA | 12090 | 3179 | 19028 | 2381 | 20803 | 1993 | 21735 | 1681 | 22749 | 1195 | 26944 | 880 | 16179 |
| 4L-5S | | MI | 6088 | 3179 | 9745 | 2247 | 10305 | 1886 | 10523 | 1585 | 10646 | 1111 | 12010 | 699 | 7922 |
| 14-#10 | 2.34 | MA | 11867 | 3179 | 18570 | 2392 | 20202 | 2003 | 20983 | 1702 | 21693 | 1214 | 25518 | 844 | 16091 |
| 5L-4S | | MI | 6184 | 3179 | 9960 | 2241 | 10591 | 1870 | 10879 | 1571 | 11172 | 1112 | 12648 | 751 | 7908 |
| 14-#10 | 2.34 | MA | 11708 | 3179 | 18090 | 2397 | 19592 | 2024 | 20239 | 1712 | 20692 | 1234 | 24243 | 791 | 15599 |
| 6L-3S | | MI | 6234 | 3179 | 10214 | 2223 | 10920 | 1865 | 11284 | 1568 | 11699 | 1101 | 13292 | 797 | 7887 |
| 14-#10 | 2.34 | MA | 11529 | 3179 | 17577 | 2415 | 18969 | 2030 | 19519 | 1732 | 19655 | 1242 | 22751 | 745 | 15237 |
| 7L-2S | | MI | 6343 | 3179 | 10543 | 2217 | 11342 | 1849 | 11798 | 1554 | 12398 | 1091 | 14208 | 887 | 7864 |
| 14-#11 | 2.87 | MA | 12209 | 3292 | 19333 | 2460 | 21115 | 2052 | 22069 | 1734 | 23147 | 1207 | 27568 | 784 | 19217 |
| 5L-4S | | MI | 6336 | 3292 | 10323 | 2293 | 11014 | 1904 | 11378 | 1586 | 11848 | 1091 | 13369 | 658 | 9449 |
| 14-#11 | 2.87 | MA | 12019 | 3292 | 18749 | 2466 | 20381 | 2078 | 21162 | 1746 | 21927 | 1230 | 26011 | 717 | 18607 |
| 6L-3S | | MI | 6392 | 3292 | 10630 | 2272 | 11411 | 1900 | 11865 | 1584 | 12482 | 1080 | 14123 | 713 | 9428 |
| 14-#11 | 2.87 | MA | 11806 | 3292 | 18125 | 2488 | 19623 | 2084 | 20297 | 1771 | 20665 | 1239 | 24184 | 659 | 18038 |
| 7L-2S | | MI | 6520 | 3292 | 11023 | 2266 | 11915 | 1882 | 12480 | 1569 | 13319 | 1069 | 15188 | 822 | 9402 |
| 14-#14 | 4.14 | MA | 13053 | 3559 | 21112 | 2642 | 23337 | 2186 | 24749 | 1826 | 26763 | 1202 | 32696 | 656 | 26452 |
| 5L-4S | | MI | 6729 | 3559 | 11191 | 2454 | 12096 | 2018 | 12684 | 1652 | 13633 | 1066 | 15482 | 479 | 12862 |
| 14-#14 | 4.14 | MA | 12788 | 3559 | 20278 | 2650 | 22294 | 2224 | 23450 | 1842 | 25014 | 1234 | 30459 | 557 | 25566 |
| 6L-3S | | MI | 6804 | 3559 | 11626 | 2426 | 12659 | 2013 | 13375 | 1651 | 14532 | 1052 | 16530 | 555 | 13110 |
| 14-#14 | 4.14 | MA | 12489 | 3559 | 19383 | 2681 | 21209 | 2232 | 22210 | 1878 | 23311 | 1266 | 27831 | 473 | 24107 |
| 7L-2S | | MI | 6980 | 3559 | 12183 | 2417 | 13372 | 1988 | 14246 | 1630 | 15717 | 1039 | 18003 | 713 | 13089 |
| 14-#18 | 7.37 | MA | 14690 | 4237 | 24060 | 3119 | 27011 | 2590 | 29120 | 2084 | 32672 | 1241 | 41459 | 144 | 40327 |
| 6L-3S | | MI | 7789 | 4237 | 14022 | 2821 | 15674 | 2305 | 17031 | 1823 | 19470 | 979 | 22021 | 100 | 21604 |
| 16-#10 | 2.67 | MA | 12195 | 3249 | 19295 | 2436 | 21130 | 2035 | 22116 | 1722 | 23234 | 1209 | 27652 | 836 | 18334 |
| 5E | | MI | 6227 | 3249 | 10074 | 2291 | 10727 | 1917 | 11037 | 1604 | 11346 | 1105 | 12925 | 684 | 8878 |
| 16-#10 | 2.67 | MA | 12039 | 3249 | 18814 | 2440 | 20520 | 2056 | 21372 | 1731 | 22233 | 1228 | 26376 | 783 | 17819 |
| 6L-4S | | MI | 6322 | 3249 | 10289 | 2285 | 11012 | 1901 | 11393 | 1590 | 11872 | 1106 | 13563 | 736 | 8943 |
| 16-#10 | 2.67 | MA | 11862 | 3249 | 18301 | 2459 | 19897 | 2061 | 20652 | 1751 | 21196 | 1236 | 24885 | 737 | 17469 |
| 7L-3S | | MI | 6372 | 3249 | 10543 | 2267 | 11342 | 1897 | 11798 | 1587 | 12398 | 1096 | 14208 | 782 | 8926 |
| 16-#10 | 2.67 | MA | 11670 | 3249 | 17853 | 2467 | 19277 | 2079 | 19885 | 1757 | 20219 | 1255 | 23590 | 695 | 16897 |
| 8L-2S | | MI | 6481 | 3249 | 10872 | 2261 | 11764 | 1881 | 12313 | 1573 | 13098 | 1085 | 15123 | 872 | 8907 |
| 16-#11 | 3.28 | MA | 12417 | 3378 | 19628 | 2520 | 21508 | 2117 | 22537 | 1769 | 23798 | 1223 | 28600 | 708 | 21306 |
| 6L-4S | | MI | 6500 | 3378 | 10717 | 2347 | 11519 | 1943 | 11993 | 1610 | 12685 | 1084 | 14434 | 636 | 10682 |
| 16-#11 | 3.28 | MA | 12207 | 3378 | 19004 | 2542 | 20750 | 2123 | 21672 | 1795 | 22535 | 1232 | 26774 | 650 | 20726 |
| 7L-3S | | MI | 6555 | 3378 | 11023 | 2326 | 11915 | 1938 | 12480 | 1608 | 13319 | 1073 | 15188 | 690 | 10668 |
| 16-#11 | 3.28 | MA | 11977 | 3378 | 18458 | 2552 | 19995 | 2145 | 20739 | 1801 | 21345 | 1255 | 25192 | 596 | 19936 |
| 8L-2S | | MI | 6683 | 3378 | 11417 | 2320 | 12420 | 1920 | 13095 | 1592 | 14156 | 1062 | 16252 | 800 | 10647 |
| 16-#14 | 4.74 | MA | 13353 | 3683 | 21534 | 2728 | 23905 | 2279 | 25415 | 1876 | 27688 | 1224 | 34162 | 543 | 29391 |
| 6L-4S | | MI | 6959 | 3683 | 11748 | 2532 | 12809 | 2074 | 13555 | 1686 | 14817 | 1056 | 16955 | 442 | 14508 |
| 16-#14 | 4.74 | MA | 13057 | 3683 | 20640 | 2759 | 22820 | 2288 | 24176 | 1912 | 25985 | 1256 | 31534 | 459 | 27947 |
| 7L-3S | | MI | 7033 | 3683 | 12183 | 2504 | 13372 | 2069 | 14246 | 1685 | 15717 | 1043 | 18003 | 518 | 14844 |


## RECTANGULAR TIED COLUMNS 20" x 38"

Short columns – no sidesway
Bending on major or minor axis

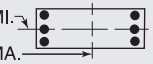


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 4.74 | MA | 12743 | 3683 | 19858 | 2773 | 21738 | 2319 | 22852 | 1921 | 24171 | 1268 | 29261 | 379 | 26473 |
| 8L-2S | | MI | 7207 | 3683 | 12740 | 2495 | 14086 | 2044 | 15116 | 1664 | 16901 | 1029 | 19477 | 676 | 14837 |
| 18-#10 | 3.01 | MA | 12369 | 3320 | 19538 | 2484 | 21448 | 2087 | 22504 | 1751 | 23774 | 1222 | 28510 | 776 | 20041 |
| 6L-5S | | MI | 6366 | 3320 | 10403 | 2335 | 11148 | 1949 | 11551 | 1623 | 12046 | 1100 | 13841 | 669 | 9867 |
| 18-#10 | 3.01 | MA | 12192 | 3320 | 19025 | 2503 | 20826 | 2093 | 21784 | 1771 | 22737 | 1231 | 27019 | 729 | 19702 |
| 7L-4S | | MI | 6460 | 3320 | 10618 | 2329 | 11434 | 1933 | 11908 | 1609 | 12571 | 1101 | 14479 | 721 | 9975 |
| 18-#10 | 3.01 | MA | 12005 | 3320 | 18577 | 2511 | 20205 | 2111 | 21017 | 1776 | 21760 | 1250 | 25723 | 687 | 19123 |
| 8L-3S | | MI | 6509 | 3320 | 10872 | 2311 | 11764 | 1928 | 12313 | 1606 | 13098 | 1090 | 15123 | 767 | 9962 |
| 18-#10 | 3.01 | MA | 11841 | 3320 | 18093 | 2531 | 19611 | 2119 | 20278 | 1794 | 20797 | 1269 | 24458 | 646 | 18593 |
| 9L-2S | | MI | 6617 | 3320 | 11201 | 2305 | 12185 | 1912 | 12827 | 1592 | 13798 | 1080 | 16038 | 857 | 9946 |
| 18-#11 | 3.69 | MA | 12604 | 3464 | 19883 | 2596 | 21877 | 2162 | 23047 | 1818 | 24406 | 1225 | 29364 | 640 | 23417 |
| 7L-4S | | MI | 6664 | 3464 | 11110 | 2401 | 12023 | 1982 | 12609 | 1633 | 13523 | 1077 | 15498 | 613 | 11910 |
| 18-#11 | 3.69 | MA | 12385 | 3464 | 19337 | 2606 | 21122 | 2184 | 22114 | 1824 | 23215 | 1248 | 27782 | 586 | 22633 |
| 8L-3S | | MI | 6719 | 3464 | 11417 | 2380 | 12420 | 1977 | 13095 | 1631 | 14156 | 1066 | 16252 | 667 | 11904 |
| 18-#11 | 3.69 | MA | 12183 | 3464 | 18754 | 2630 | 20398 | 2193 | 21214 | 1845 | 22041 | 1271 | 26230 | 535 | 21736 |
| 9L-2S | | MI | 6845 | 3464 | 11810 | 2374 | 12924 | 1959 | 13711 | 1616 | 14994 | 1055 | 17316 | 777 | 11887 |
| 18-#14 | 5.33 | MA | 13620 | 3808 | 21897 | 2837 | 24432 | 2344 | 26141 | 1945 | 28660 | 1246 | 35237 | 445 | 31787 |
| 7L-4S | | MI | 7188 | 3808 | 12304 | 2610 | 13523 | 2130 | 14425 | 1720 | 16002 | 1046 | 18428 | 405 | 16162 |
| 18-#14 | 5.33 | MA | 13314 | 3808 | 21115 | 2850 | 23349 | 2374 | 24817 | 1955 | 26846 | 1258 | 32964 | 365 | 30292 |
| 8L-3S | | MI | 7262 | 3808 | 12740 | 2581 | 14086 | 2125 | 15116 | 1719 | 16901 | 1033 | 19477 | 481 | 16575 |
| 20-#10 | 3.34 | MA | 12521 | 3390 | 19749 | 2547 | 21754 | 2124 | 22917 | 1790 | 24278 | 1225 | 29152 | 721 | 21937 |
| 7L-5S | | MI | 6504 | 3390 | 10732 | 2379 | 11570 | 1980 | 12066 | 1642 | 12746 | 1094 | 14756 | 654 | 10859 |
| 20-#10 | 3.34 | MA | 12340 | 3390 | 19301 | 2555 | 21133 | 2142 | 22150 | 1795 | 23301 | 1244 | 27857 | 679 | 21347 |
| 8L-4S | | MI | 6598 | 3390 | 10947 | 2373 | 11856 | 1964 | 12422 | 1628 | 13271 | 1095 | 15394 | 706 | 11006 |
| 20-#10 | 3.34 | MA | 12177 | 3390 | 18817 | 2574 | 20539 | 2150 | 21411 | 1813 | 22338 | 1264 | 26591 | 638 | 20813 |
| 9L-3S | | MI | 6647 | 3390 | 11201 | 2355 | 12185 | 1960 | 12827 | 1625 | 13798 | 1084 | 16038 | 752 | 10996 |
| 20-#10 | 3.34 | MA | 11983 | 3390 | 18352 | 2581 | 19944 | 2170 | 20691 | 1832 | 21292 | 1269 | 25302 | 602 | 20073 |
| 10L-2S | | MI | 6754 | 3390 | 11530 | 2349 | 12607 | 1944 | 13341 | 1611 | 14498 | 1074 | 16953 | 842 | 10982 |
| 20-#11 | 4.11 | MA | 12784 | 3550 | 20216 | 2659 | 22248 | 2222 | 23488 | 1848 | 25085 | 1241 | 30372 | 577 | 25330 |
| 8L-4S | | MI | 6827 | 3550 | 11504 | 2455 | 12528 | 2020 | 13224 | 1657 | 14360 | 1070 | 16562 | 590 | 13107 |
| 20-#11 | 4.11 | MA | 12589 | 3550 | 19633 | 2684 | 21525 | 2231 | 22588 | 1869 | 23912 | 1264 | 28820 | 525 | 24420 |
| 9L-3S | | MI | 6881 | 3550 | 11810 | 2434 | 12924 | 2016 | 13711 | 1655 | 14994 | 1059 | 17316 | 645 | 13138 |
| 20-#11 | 4.11 | MA | 12358 | 3550 | 19067 | 2690 | 20800 | 2255 | 21712 | 1891 | 22658 | 1271 | 27245 | 479 | 23464 |
| 10L-2S | | MI | 7006 | 3550 | 12204 | 2428 | 13429 | 1998 | 14326 | 1639 | 15831 | 1049 | 18381 | 755 | 13125 |
| 20-#14 | 5.92 | MA | 13879 | 3932 | 22372 | 2928 | 24960 | 2430 | 26783 | 1989 | 29520 | 1248 | 36667 | 352 | 34110 |
| 8L-4S | | MI | 7417 | 3932 | 12861 | 2688 | 14236 | 2185 | 15296 | 1754 | 17186 | 1036 | 19902 | 368 | 17823 |
| 22-#10 | 3.68 | MA | 12670 | 3460 | 20025 | 2599 | 22062 | 2174 | 23282 | 1815 | 24842 | 1239 | 29991 | 672 | 23572 |
| 8L-5S | | MI | 6642 | 3460 | 11061 | 2423 | 11992 | 2012 | 12580 | 1661 | 13446 | 1089 | 15671 | 639 | 11854 |
| 22-#10 | 3.68 | MA | 12511 | 3460 | 19542 | 2618 | 21468 | 2182 | 22543 | 1832 | 23879 | 1258 | 28725 | 630 | 23026 |
| 9L-4S | | MI | 6735 | 3460 | 11275 | 2416 | 12277 | 1996 | 12937 | 1647 | 13971 | 1089 | 16309 | 691 | 12031 |
| 22-#10 | 3.68 | MA | 12318 | 3460 | 19076 | 2624 | 20872 | 2202 | 21824 | 1851 | 22833 | 1264 | 27436 | 594 | 22291 |
| 10L-3S | | MI | 6784 | 3460 | 11530 | 2399 | 12607 | 1991 | 13341 | 1645 | 14498 | 1079 | 16953 | 737 | 12028 |
| 22-#10 | 3.68 | MA | 12138 | 3460 | 18627 | 2632 | 20281 | 2209 | 21081 | 1859 | 21840 | 1280 | 26186 | 550 | 21523 |
| 11L-2S | | MI | 6890 | 3460 | 11859 | 2393 | 13029 | 1976 | 13856 | 1631 | 15198 | 1068 | 17869 | 827 | 12017 |
| 22-#11 | 4.52 | MA | 12991 | 3637 | 20512 | 2737 | 22652 | 2270 | 23963 | 1893 | 25782 | 1257 | 31410 | 516 | 27104 |
| 9L-4S | | MI | 6990 | 3637 | 11897 | 2509 | 13032 | 2059 | 13840 | 1680 | 15197 | 1064 | 17627 | 568 | 14281 |
| 22-#11 | 4.52 | MA | 12761 | 3637 | 19946 | 2744 | 21927 | 2294 | 23087 | 1915 | 24528 | 1265 | 29834 | 469 | 26136 |
| 10L-3S | | MI | 7044 | 3637 | 12204 | 2488 | 13429 | 2055 | 14326 | 1679 | 15831 | 1053 | 18381 | 622 | 14370 |
| 24-#10 | 4.01 | MA | 12843 | 3531 | 20266 | 2662 | 22396 | 2213 | 23676 | 1852 | 25420 | 1252 | 30858 | 622 | 25239 |
| 9L-5S | | MI | 6780 | 3531 | 11389 | 2467 | 12413 | 2043 | 13095 | 1681 | 14145 | 1083 | 16586 | 624 | 12850 |
| 24-#10 | 4.01 | MA | 12651 | 3531 | 19801 | 2668 | 21801 | 2233 | 22956 | 1870 | 24374 | 1258 | 29570 | 586 | 24508 |
| 10L-4S | | MI | 6873 | 3531 | 11604 | 2460 | 12699 | 2027 | 13451 | 1667 | 14671 | 1084 | 17224 | 676 | 13055 |
| 24-#10 | 4.01 | MA | 12474 | 3531 | 19351 | 2676 | 21209 | 2241 | 22214 | 1878 | 23381 | 1275 | 28319 | 542 | 23732 |
| 11L-3S | | MI | 6921 | 3531 | 11859 | 2443 | 13029 | 2023 | 13856 | 1664 | 15198 | 1073 | 17869 | 722 | 13058 |
| 24-#11 | 4.93 | MA | 13162 | 3723 | 20825 | 2798 | 23054 | 2333 | 24461 | 1938 | 26399 | 1258 | 32424 | 460 | 28808 |
| 10L-4S | | MI | 7152 | 3723 | 12291 | 2563 | 13537 | 2098 | 14455 | 1704 | 16035 | 1057 | 18691 | 545 | 15459 |

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

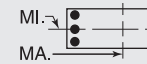
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.13 | MA | 12528 | 3078 | 19588 | 2290 | 21086 | 1933 | 21670 | 1655 | 21920 | 1244 | 25014 | 1081 | 8778 |
| 2E | | MI | 6120 | 3078 | 9836 | 2127 | 10246 | 1793 | 10323 | 1534 | 10186 | 1147 | 11042 | 949 | 4221 |
| 4-#18 | 2.00 | MA | 13398 | 3271 | 21652 | 2395 | 23655 | 2006 | 24769 | 1696 | 26116 | 1219 | 30809 | 1051 | 15154 |
| 2E | | MI | 6435 | 3271 | 10658 | 2216 | 11240 | 1852 | 11512 | 1562 | 11787 | 1111 | 12805 | 842 | 6956 |
| 6-#11 | 1.17 | MA | 12592 | 3088 | 19684 | 2305 | 21248 | 1944 | 21885 | 1664 | 22223 | 1248 | 25443 | 1084 | 9147 |
| 2L-3S | | MI | 6017 | 3088 | 9491 | 2156 | 9834 | 1830 | 9833 | 1564 | 9525 | 1167 | 10273 | 854 | 4413 |
| 6-#11 | 1.17 | MA | 12233 | 3088 | 18751 | 2319 | 20052 | 1957 | 20426 | 1690 | 20238 | 1271 | 22694 | 989 | 9179 |
| 3L-2S | | MI | 6151 | 3088 | 9884 | 2149 | 10338 | 1811 | 10448 | 1548 | 10362 | 1156 | 11338 | 964 | 4376 |
| 6-#14 | 1.69 | MA | 13124 | 3202 | 20923 | 2368 | 22797 | 1988 | 23757 | 1689 | 24760 | 1234 | 28947 | 1067 | 12978 |
| 2L-3S | | MI | 6163 | 3202 | 9836 | 2213 | 10246 | 1874 | 10323 | 1589 | 10186 | 1151 | 11042 | 754 | 6103 |
| 6-#14 | 1.69 | MA | 12622 | 3202 | 19588 | 2388 | 21086 | 2007 | 21670 | 1726 | 21920 | 1267 | 25014 | 927 | 12998 |
| 3L-2S | | MI | 6350 | 3202 | 10393 | 2205 | 10959 | 1849 | 11193 | 1568 | 11370 | 1137 | 12515 | 912 | 6043 |
| 6-#18 | 3.00 | MA | 14416 | 3493 | 23986 | 2534 | 26646 | 2105 | 28419 | 1756 | 31082 | 1201 | 37684 | 1027 | 22462 |
| 2L-3S | | MI | 6513 | 3493 | 10658 | 2364 | 11240 | 1990 | 11512 | 1654 | 11787 | 1110 | 12805 | 479 | 10092 |
| 6-#18 | 3.00 | MA | 13581 | 3493 | 21652 | 2567 | 23655 | 2135 | 24769 | 1818 | 26116 | 1256 | 30809 | 771 | 22332 |
| 3L-2S | | MI | 6822 | 3493 | 11609 | 2354 | 12458 | 1952 | 12998 | 1623 | 13805 | 1092 | 15209 | 760 | 10011 |
| 8-#9 | 1.00 | MA | 12437 | 3050 | 19248 | 2297 | 20764 | 1940 | 21328 | 1665 | 21487 | 1260 | 24439 | 1096 | 7913 |
| 2L-4S | | MI | 5969 | 3050 | 9246 | 2176 | 9578 | 1837 | 9543 | 1575 | 9160 | 1194 | 9924 | 897 | 3864 |
| 8-#9 | 1.00 | MA | 12199 | 3050 | 18640 | 2306 | 19985 | 1949 | 20379 | 1682 | 20195 | 1275 | 22650 | 1037 | 7932 |
| 3E | | MI | 6011 | 3050 | 9447 | 2162 | 9839 | 1833 | 9865 | 1572 | 9579 | 1185 | 10440 | 934 | 3838 |
| 8-#9 | 1.00 | MA | 12064 | 3050 | 18188 | 2324 | 19397 | 1967 | 19655 | 1690 | 19199 | 1282 | 21489 | 1000 | 7949 |
| 4L-2S | | MI | 6102 | 3050 | 9709 | 2156 | 10175 | 1821 | 10273 | 1561 | 10135 | 1177 | 11175 | 1005 | 3818 |
| 8-#10 | 1.27 | MA | 12726 | 3110 | 19909 | 2330 | 21591 | 1964 | 22329 | 1678 | 22842 | 1252 | 26312 | 1087 | 9955 |
| 2L-4S | | MI | 6049 | 3110 | 9407 | 2210 | 9767 | 1861 | 9767 | 1588 | 9467 | 1188 | 10313 | 848 | 4793 |
| 8-#10 | 1.27 | MA | 12430 | 3110 | 19141 | 2342 | 20607 | 1975 | 21128 | 1700 | 21208 | 1272 | 24049 | 1011 | 9975 |
| 3E | | MI | 6100 | 3110 | 9661 | 2192 | 10097 | 1856 | 10172 | 1585 | 9994 | 1178 | 10957 | 894 | 4757 |
| 8-#10 | 1.27 | MA | 12261 | 3110 | 18568 | 2365 | 19862 | 1997 | 20211 | 1710 | 19948 | 1281 | 22576 | 964 | 9976 |
| 4L-2S | | MI | 6214 | 3110 | 9990 | 2186 | 10519 | 1841 | 10686 | 1571 | 10693 | 1167 | 11873 | 984 | 4728 |
| 8-#11 | 1.56 | MA | 13012 | 3174 | 20617 | 2359 | 22444 | 1983 | 23344 | 1688 | 24208 | 1241 | 28191 | 1075 | 12081 |
| 2L-4S | | MI | 6125 | 3174 | 9578 | 2230 | 9942 | 1873 | 9962 | 1590 | 9728 | 1171 | 10584 | 778 | 5744 |
| 8-#11 | 1.56 | MA | 12659 | 3174 | 19684 | 2373 | 21248 | 1996 | 21885 | 1713 | 22223 | 1264 | 25443 | 979 | 12101 |
| 3E | | MI | 6182 | 3174 | 9884 | 2210 | 10338 | 1868 | 10448 | 1588 | 10362 | 1160 | 11338 | 832 | 5697 |
| 8-#11 | 1.56 | MA | 12459 | 3174 | 18986 | 2401 | 20341 | 2023 | 20769 | 1725 | 20690 | 1274 | 23640 | 921 | 12079 |
| 4L-2S | | MI | 6315 | 3174 | 10278 | 2203 | 10843 | 1850 | 11064 | 1572 | 11199 | 1149 | 12402 | 942 | 5659 |
| 8-#14 | 2.25 | MA | 13715 | 3327 | 22257 | 2446 | 24508 | 2044 | 25845 | 1723 | 27600 | 1224 | 32879 | 1053 | 17161 |
| 2L-4S | | MI | 6318 | 3327 | 9958 | 2319 | 10396 | 1934 | 10502 | 1624 | 10471 | 1154 | 11467 | 642 | 7936 |
| 8-#14 | 2.25 | MA | 13227 | 3327 | 20923 | 2466 | 22797 | 2062 | 23757 | 1759 | 24760 | 1257 | 28947 | 914 | 17153 |
| 3E | | MI | 6395 | 3327 | 10393 | 2291 | 10959 | 1930 | 11193 | 1623 | 11370 | 1141 | 12515 | 717 | 7888 |
| 8-#14 | 2.25 | MA | 12947 | 3327 | 19922 | 2506 | 21497 | 2100 | 22159 | 1776 | 22563 | 1270 | 26353 | 829 | 17004 |
| 4L-2S | | MI | 6579 | 3327 | 10949 | 2283 | 11673 | 1905 | 12064 | 1602 | 12555 | 1127 | 13989 | 875 | 7836 |
| 8-#18 | 4.00 | MA | 14620 | 3714 | 23986 | 2705 | 26646 | 2234 | 28419 | 1879 | 31082 | 1239 | 37684 | 747 | 29557 |
| 3E | | MI | 6904 | 3714 | 11609 | 2503 | 12458 | 2090 | 12998 | 1714 | 13805 | 1092 | 15209 | 397 | 13070 |
| 8-#18 | 4.00 | MA | 14152 | 3714 | 22229 | 2774 | 24366 | 2300 | 25614 | 1905 | 27428 | 1294 | 33098 | 594 | 27545 |
| 4L-2S | | MI | 7208 | 3714 | 12559 | 2492 | 13677 | 2051 | 14485 | 1683 | 15822 | 1074 | 17613 | 678 | 13028 |
| 10-#10 | 1.59 | MA | 13073 | 3180 | 20677 | 2374 | 22576 | 1995 | 23530 | 1698 | 24477 | 1247 | 28575 | 1080 | 12366 |
| 2L-5S | | MI | 6091 | 3180 | 9521 | 2260 | 9903 | 1908 | 9925 | 1621 | 9641 | 1182 | 10590 | 781 | 5884 |
| 10-#10 | 1.59 | MA | 12782 | 3180 | 19909 | 2386 | 21591 | 2006 | 22329 | 1719 | 22842 | 1267 | 26312 | 1003 | 12379 |
| 3L-4S | | MI | 6189 | 3180 | 9736 | 2253 | 10189 | 1892 | 10282 | 1607 | 10166 | 1182 | 11228 | 833 | 5851 |
| 10-#10 | 1.59 | MA | 12615 | 3180 | 19336 | 2409 | 20847 | 2028 | 21412 | 1729 | 21583 | 1275 | 24839 | 956 | 12365 |
| 4L-3S | | MI | 6239 | 3180 | 9990 | 2236 | 10519 | 1888 | 10686 | 1604 | 10693 | 1172 | 11873 | 879 | 5819 |
| 10-#10 | 1.59 | MA | 12371 | 3180 | 18848 | 2419 | 20211 | 2039 | 20616 | 1751 | 20466 | 1295 | 23332 | 921 | 12293 |
| 5L-2S | | MI | 6352 | 3180 | 10319 | 2230 | 10940 | 1872 | 11201 | 1590 | 11393 | 1161 | 12788 | 969 | 5791 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis

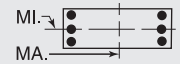



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.95 | MA | 13083 | 3260 | 20617 | 2427 | 22444 | 2034 | 23344 | 1737 | 24208 | 1257 | 28191 | 969 | 15015 |
| 3L-4S | | MI | 6290 | 3260 | 9971 | 2284 | 10446 | 1911 | 10577 | 1613 | 10566 | 1164 | 11648 | 755 | 7002 |
| 10-#11 | 1.95 | MA | 12885 | 3260 | 19919 | 2455 | 21537 | 2061 | 22228 | 1749 | 22675 | 1267 | 26389 | 911 | 14974 |
| 4L-3S | | MI | 6347 | 3260 | 10278 | 2264 | 10843 | 1907 | 11064 | 1611 | 11199 | 1153 | 12402 | 809 | 6963 |
| 10-#11 | 1.95 | MA | 12592 | 3260 | 19330 | 2468 | 20762 | 2074 | 21258 | 1774 | 21314 | 1290 | 24549 | 866 | 14795 |
| 5L-2S | | MI | 6478 | 3260 | 10671 | 2257 | 11347 | 1889 | 11679 | 1596 | 12037 | 1142 | 13466 | 919 | 6928 |
| 10-#14 | 2.81 | MA | 13825 | 3451 | 22257 | 2544 | 24508 | 2118 | 25845 | 1793 | 27600 | 1247 | 32879 | 900 | 21302 |
| 3L-4S | | MI | 6550 | 3451 | 10514 | 2397 | 11110 | 1990 | 11373 | 1658 | 11655 | 1144 | 12940 | 605 | 9683 |
| 10-#14 | 2.81 | MA | 13550 | 3451 | 21257 | 2583 | 23208 | 2156 | 24246 | 1810 | 25403 | 1260 | 30285 | 815 | 21132 |
| 4L-3S | | MI | 6626 | 3451 | 10949 | 2369 | 11673 | 1985 | 12064 | 1657 | 12555 | 1131 | 13989 | 680 | 9654 |
| 10-#14 | 2.81 | MA | 13138 | 3451 | 20419 | 2602 | 22097 | 2174 | 22855 | 1846 | 23452 | 1293 | 27643 | 748 | 20006 |
| 5L-2S | | MI | 6808 | 3451 | 11506 | 2360 | 12386 | 1961 | 12934 | 1635 | 13739 | 1117 | 15462 | 838 | 9612 |
| 10-#18 | 5.00 | MA | 15189 | 3935 | 24563 | 2912 | 27357 | 2399 | 29264 | 1966 | 32393 | 1276 | 39974 | 570 | 34658 |
| 4L-3S | | MI | 7295 | 3935 | 12559 | 2641 | 13677 | 2189 | 14485 | 1775 | 15822 | 1073 | 17613 | 314 | 16021 |
| 10-#18 | 5.00 | MA | 14489 | 3935 | 23100 | 2946 | 25404 | 2429 | 26820 | 2028 | 28769 | 1296 | 35318 | 442 | 32261 |
| 5L-2S | | MI | 7593 | 3935 | 13510 | 2630 | 14895 | 2150 | 15971 | 1743 | 17840 | 1056 | 20017 | 596 | 16023 |
| 12-#10 | 1.90 | MA | 13131 | 3250 | 20677 | 2430 | 22576 | 2038 | 23530 | 1738 | 24477 | 1261 | 28575 | 996 | 14778 |
| 3L-5S | | MI | 6231 | 3250 | 9850 | 2304 | 10325 | 1940 | 10440 | 1640 | 10341 | 1176 | 11506 | 766 | 6924 |
| 12-#10 | 1.90 | MA | 12966 | 3250 | 20104 | 2453 | 21831 | 2060 | 22614 | 1748 | 23217 | 1270 | 27102 | 949 | 14753 |
| 4E | | MI | 6328 | 3250 | 10065 | 2297 | 10611 | 1924 | 10796 | 1626 | 10866 | 1177 | 12144 | 818 | 6899 |
| 12-#10 | 1.90 | MA | 12725 | 3250 | 19616 | 2463 | 21196 | 2071 | 21817 | 1770 | 22100 | 1289 | 25595 | 914 | 14672 |
| 5L-3S | | MI | 6378 | 3250 | 10319 | 2280 | 10940 | 1919 | 11201 | 1624 | 11393 | 1166 | 12788 | 864 | 6871 |
| 12-#10 | 1.90 | MA | 12552 | 3250 | 19107 | 2468 | 20545 | 2091 | 21030 | 1780 | 21040 | 1309 | 24247 | 862 | 14227 |
| 6L-2S | | MI | 6489 | 3250 | 10648 | 2273 | 11362 | 1904 | 11715 | 1609 | 12093 | 1156 | 13703 | 954 | 6845 |
| 12-#11 | 2.34 | MA | 13307 | 3347 | 20852 | 2509 | 22733 | 2100 | 23688 | 1772 | 24660 | 1260 | 29138 | 902 | 17869 |
| 4E | | MI | 6455 | 3347 | 10365 | 2338 | 10951 | 1950 | 11192 | 1637 | 11403 | 1157 | 12712 | 732 | 8249 |
| 12-#11 | 2.34 | MA | 13019 | 3347 | 20263 | 2522 | 21958 | 2113 | 22717 | 1798 | 23299 | 1284 | 27297 | 857 | 17626 |
| 5L-3S | | MI | 6511 | 3347 | 10671 | 2318 | 11347 | 1946 | 11679 | 1635 | 12037 | 1146 | 13466 | 787 | 8218 |
| 12-#11 | 2.34 | MA | 12811 | 3347 | 19644 | 2528 | 21174 | 2138 | 21758 | 1810 | 22008 | 1307 | 25651 | 791 | 16923 |
| 6L-2S | | MI | 6641 | 3347 | 11065 | 2311 | 11852 | 1928 | 12295 | 1619 | 12874 | 1135 | 14531 | 896 | 8186 |
| 12-#14 | 3.38 | MA | 14148 | 3576 | 22591 | 2661 | 24919 | 2212 | 26333 | 1844 | 28243 | 1250 | 34217 | 802 | 25263 |
| 4E | | MI | 6781 | 3576 | 11071 | 2475 | 11823 | 2046 | 12243 | 1692 | 12840 | 1135 | 14414 | 568 | 11338 |
| 12-#14 | 3.38 | MA | 13743 | 3576 | 21754 | 2680 | 23808 | 2230 | 24942 | 1880 | 26292 | 1283 | 31575 | 734 | 24087 |
| 5L-3S | | MI | 6857 | 3576 | 11506 | 2447 | 12386 | 2041 | 12934 | 1690 | 13739 | 1121 | 15462 | 643 | 11408 |
| 12-#14 | 3.38 | MA | 13451 | 3576 | 20867 | 2688 | 22693 | 2267 | 23565 | 1897 | 24439 | 1316 | 29210 | 638 | 23175 |
| 6L-2S | | MI | 7036 | 3576 | 12063 | 2438 | 13100 | 2017 | 13804 | 1669 | 14923 | 1107 | 16935 | 801 | 11376 |
| 12-#18 | 6.00 | MA | 15533 | 4157 | 25434 | 3084 | 28395 | 2528 | 30469 | 2088 | 33734 | 1279 | 42193 | 417 | 39402 |
| 5L-3S | | MI | 7683 | 4157 | 13510 | 2779 | 14895 | 2288 | 15971 | 1835 | 17840 | 1055 | 20017 | 232 | 18962 |
| 12-#18 | 6.00 | MA | 15039 | 4157 | 23894 | 3098 | 26453 | 2594 | 28050 | 2115 | 30479 | 1334 | 38023 | 239 | 36012 |
| 6L-2S | | MI | 7977 | 4157 | 14460 | 2769 | 16114 | 2250 | 17458 | 1804 | 19858 | 1037 | 22421 | 514 | 19004 |
| 14-#10 | 2.22 | MA | 13315 | 3321 | 20872 | 2497 | 22816 | 2091 | 23815 | 1768 | 24851 | 1264 | 29365 | 941 | 17139 |
| 4L-5S | | MI | 6371 | 3321 | 10179 | 2348 | 10747 | 1971 | 10954 | 1660 | 11041 | 1171 | 12421 | 751 | 7958 |
| 14-#10 | 2.22 | MA | 13077 | 3321 | 20384 | 2507 | 22180 | 2102 | 23019 | 1789 | 23734 | 1284 | 27858 | 906 | 17051 |
| 5L-4S | | MI | 6467 | 3321 | 10393 | 2341 | 11032 | 1956 | 11310 | 1645 | 11566 | 1171 | 13059 | 803 | 7940 |
| 14-#10 | 2.22 | MA | 12907 | 3321 | 19875 | 2512 | 21529 | 2123 | 22231 | 1799 | 22674 | 1304 | 26510 | 854 | 16579 |
| 6L-3S | | MI | 6517 | 3321 | 10648 | 2324 | 11362 | 1951 | 11715 | 1643 | 12093 | 1161 | 13703 | 849 | 7917 |
| 14-#10 | 2.22 | MA | 12715 | 3321 | 19331 | 2531 | 20870 | 2129 | 21462 | 1819 | 21578 | 1312 | 24937 | 808 | 16182 |
| 7L-2S | | MI | 6627 | 3321 | 10977 | 2317 | 11784 | 1935 | 12230 | 1629 | 12793 | 1150 | 14618 | 939 | 7893 |
| 14-#11 | 2.73 | MA | 13443 | 3433 | 21196 | 2576 | 23154 | 2152 | 24176 | 1821 | 25285 | 1277 | 30046 | 847 | 20465 |
| 5L-4S | | MI | 6619 | 3433 | 10758 | 2392 | 11455 | 1989 | 11808 | 1660 | 12240 | 1150 | 13777 | 710 | 9489 |
| 14-#11 | 2.73 | MA | 13240 | 3433 | 20577 | 2581 | 22370 | 2177 | 23217 | 1833 | 23993 | 1300 | 28400 | 782 | 19786 |
| 6L-3S | | MI | 6675 | 3433 | 11065 | 2372 | 11852 | 1984 | 12295 | 1658 | 12874 | 1139 | 14531 | 764 | 9465 |
| 14-#11 | 2.73 | MA | 13011 | 3433 | 19915 | 2604 | 21567 | 2184 | 22292 | 1858 | 22656 | 1310 | 26473 | 724 | 19259 |
| 7L-2S | | MI | 6804 | 3433 | 11458 | 2365 | 12356 | 1966 | 12910 | 1643 | 13711 | 1128 | 15595 | 874 | 9437 |
| 14-#14 | 3.94 | MA | 14343 | 3700 | 23088 | 2758 | 25519 | 2286 | 27029 | 1914 | 29132 | 1273 | 35507 | 720 | 28176 |
| 5L-4S | | MI | 7012 | 3700 | 11627 | 2553 | 12537 | 2102 | 13113 | 1726 | 14024 | 1125 | 15887 | 530 | 12972 |
| 14-#14 | 3.94 | MA | 14060 | 3700 | 22202 | 2766 | 24404 | 2323 | 25653 | 1930 | 27279 | 1306 | 33142 | 624 | 27282 |
| 6L-3S | | MI | 7087 | 3700 | 12063 | 2524 | 13100 | 2097 | 13804 | 1724 | 14923 | 1111 | 16935 | 606 | 13156 |

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis



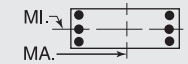

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 3.94 | MA | 13738 | 3700 | 21254 | 2798 | 23254 | 2332 | 24339 | 1967 | 25362 | 1319 | 30370 | 541 | 25727 |
| 7L-2S | | MI | 7264 | 3700 | 12619 | 2516 | 13813 | 2072 | 14675 | 1703 | 16107 | 1097 | 18408 | 764 | 13132 |
| 14-#18 | 7.00 | MA | 16092 | 4378 | 26227 | 3236 | 29445 | 2693 | 31699 | 2175 | 35445 | 1317 | 44899 | 215 | 43094 |
| 6L-3S | | MI | 8071 | 4378 | 14460 | 2918 | 16114 | 2388 | 17458 | 1895 | 19858 | 1037 | 22421 | 150 | 21789 |
| 16-#10 | 2.54 | MA | 13427 | 3391 | 21152 | 2551 | 23165 | 2134 | 24220 | 1808 | 25369 | 1278 | 30121 | 898 | 19431 |
| 5E | | MI | 6510 | 3391 | 10507 | 2392 | 11168 | 2003 | 11468 | 1679 | 11741 | 1165 | 13336 | 736 | 8983 |
| 16-#10 | 2.54 | MA | 13261 | 3391 | 20643 | 2556 | 22514 | 2154 | 23433 | 1818 | 24309 | 1298 | 28773 | 847 | 18935 |
| 6L-4S | | MI | 6605 | 3391 | 10722 | 2385 | 11454 | 1987 | 11825 | 1665 | 12266 | 1166 | 13974 | 788 | 8977 |
| 16-#10 | 2.54 | MA | 13070 | 3391 | 20099 | 2575 | 21854 | 2160 | 22664 | 1838 | 23212 | 1306 | 27200 | 801 | 18551 |
| 7L-3S | | MI | 6655 | 3391 | 10977 | 2368 | 11784 | 1982 | 12230 | 1662 | 12793 | 1155 | 14618 | 835 | 8958 |
| 16-#10 | 2.54 | MA | 12864 | 3391 | 19625 | 2583 | 21197 | 2179 | 21852 | 1844 | 22178 | 1326 | 25832 | 760 | 17997 |
| 8L-2S | | MI | 6764 | 3391 | 11306 | 2361 | 12205 | 1967 | 12744 | 1648 | 13493 | 1145 | 15533 | 924 | 8937 |
| 16-#11 | 3.12 | MA | 13665 | 3519 | 21510 | 2635 | 23566 | 2216 | 24676 | 1857 | 25978 | 1293 | 31148 | 772 | 22652 |
| 6L-4S | | MI | 6783 | 3519 | 11152 | 2446 | 11960 | 2028 | 12423 | 1684 | 13078 | 1143 | 14841 | 687 | 10724 |
| 16-#11 | 3.12 | MA | 13438 | 3519 | 20848 | 2658 | 22763 | 2222 | 23751 | 1882 | 24641 | 1303 | 29222 | 715 | 22117 |
| 7L-3S | | MI | 6839 | 3519 | 11458 | 2426 | 12356 | 2023 | 12910 | 1682 | 13711 | 1132 | 15595 | 742 | 10707 |
| 16-#11 | 3.12 | MA | 13192 | 3519 | 20270 | 2668 | 21963 | 2245 | 22762 | 1888 | 23381 | 1326 | 27550 | 663 | 21238 |
| 8L-2S | | MI | 6966 | 3519 | 11852 | 2419 | 12861 | 2005 | 13526 | 1666 | 14549 | 1121 | 16659 | 851 | 10683 |
| 16-#14 | 4.50 | MA | 14664 | 3825 | 23536 | 2844 | 26115 | 2379 | 27740 | 1964 | 30119 | 1296 | 37075 | 610 | 31386 |
| 6L-4S | | MI | 7242 | 3825 | 12184 | 2630 | 13250 | 2158 | 13984 | 1759 | 15208 | 1115 | 17360 | 493 | 14616 |
| 16-#14 | 4.50 | MA | 14344 | 3825 | 22589 | 2876 | 24964 | 2388 | 26427 | 2001 | 28202 | 1309 | 34302 | 527 | 29806 |
| 7L-3S | | MI | 7316 | 3825 | 12619 | 2602 | 13813 | 2153 | 14675 | 1758 | 16107 | 1101 | 18408 | 569 | 14896 |
| 16-#14 | 4.50 | MA | 14009 | 3825 | 21760 | 2890 | 23817 | 2419 | 25010 | 2010 | 26395 | 1342 | 31900 | 449 | 28327 |
| 8L-2S | | MI | 7491 | 3825 | 13176 | 2594 | 14527 | 2128 | 15545 | 1737 | 17292 | 1087 | 19882 | 727 | 14883 |
| 18-#10 | 2.86 | MA | 13612 | 3461 | 21411 | 2600 | 23499 | 2186 | 24634 | 1837 | 25943 | 1292 | 31036 | 839 | 21294 |
| 6L-5S | | MI | 6649 | 3461 | 10836 | 2436 | 11590 | 2034 | 11983 | 1698 | 12440 | 1159 | 14251 | 722 | 9935 |
| 18-#10 | 2.86 | MA | 13422 | 3461 | 20868 | 2619 | 22839 | 2192 | 23865 | 1857 | 24846 | 1301 | 29463 | 793 | 20921 |
| 7L-4S | | MI | 6743 | 3461 | 11051 | 2429 | 11876 | 2019 | 12339 | 1684 | 12966 | 1160 | 14889 | 773 | 10010 |
| 18-#10 | 2.86 | MA | 13221 | 3461 | 20393 | 2627 | 22182 | 2210 | 23053 | 1863 | 23813 | 1321 | 28095 | 752 | 20356 |
| 8L-3S | | MI | 6793 | 3461 | 11306 | 2412 | 12205 | 2014 | 12744 | 1681 | 13493 | 1150 | 15533 | 820 | 9995 |
| 18-#10 | 2.86 | MA | 13047 | 3461 | 19878 | 2647 | 21553 | 2218 | 22270 | 1881 | 22793 | 1340 | 26762 | 711 | 19780 |
| 9L-2S | | MI | 6901 | 3461 | 11635 | 2405 | 12627 | 1998 | 13258 | 1667 | 14193 | 1139 | 16449 | 909 | 9977 |
| 18-#11 | 3.51 | MA | 13862 | 3606 | 21781 | 2712 | 23959 | 2261 | 25210 | 1905 | 26627 | 1296 | 31971 | 705 | 24977 |
| 7L-4S | | MI | 6947 | 3606 | 11545 | 2500 | 12464 | 2066 | 13039 | 1707 | 13915 | 1136 | 15905 | 665 | 11956 |
| 18-#11 | 3.51 | MA | 13628 | 3606 | 21203 | 2722 | 23159 | 2283 | 24222 | 1912 | 25366 | 1319 | 30299 | 653 | 24102 |
| 8L-3S | | MI | 7002 | 3606 | 11852 | 2480 | 12861 | 2062 | 13526 | 1705 | 14549 | 1125 | 16659 | 719 | 11945 |
| 18-#11 | 3.51 | MA | 13412 | 3606 | 20581 | 2746 | 22393 | 2293 | 23268 | 1933 | 24124 | 1343 | 28663 | 602 | 23215 |
| 9L-2S | | MI | 7128 | 3606 | 12245 | 2473 | 13365 | 2044 | 14141 | 1690 | 15386 | 1114 | 17723 | 829 | 11926 |
| 18-#14 | 5.06 | MA | 14945 | 3949 | 23923 | 2954 | 26675 | 2444 | 28514 | 2035 | 31042 | 1299 | 38234 | 513 | 33884 |
| 7L-4S | | MI | 7471 | 3949 | 12740 | 2708 | 13964 | 2214 | 14854 | 1793 | 16393 | 1105 | 18833 | 456 | 16269 |
| 18-#14 | 5.06 | MA | 14618 | 3949 | 23094 | 2968 | 25528 | 2475 | 27097 | 2043 | 29235 | 1332 | 35832 | 436 | 32382 |
| 8L-3S | | MI | 7545 | 3949 | 13176 | 2680 | 14527 | 2209 | 15545 | 1792 | 17292 | 1091 | 19882 | 532 | 16629 |
| 18-#14 | 5.06 | MA | 14313 | 3949 | 22210 | 3002 | 24430 | 2488 | 25731 | 2074 | 27453 | 1365 | 33476 | 361 | 30750 |
| 9L-2S | | MI | 7718 | 3949 | 13732 | 2672 | 15240 | 2184 | 16416 | 1771 | 18476 | 1077 | 21355 | 690 | 16629 |
| 20-#10 | 3.17 | MA | 13772 | 3531 | 21636 | 2663 | 23824 | 2223 | 25066 | 1876 | 26481 | 1295 | 31726 | 785 | 23293 |
| 7L-5S | | MI | 6787 | 3531 | 11165 | 2479 | 12012 | 2066 | 12497 | 1717 | 13140 | 1154 | 15166 | 707 | 10927 |
| 20-#10 | 3.17 | MA | 13576 | 3531 | 21161 | 2671 | 23166 | 2242 | 24254 | 1882 | 25447 | 1315 | 30358 | 744 | 22715 |
| 8L-4S | | MI | 6881 | 3531 | 11380 | 2473 | 12297 | 2050 | 12854 | 1703 | 13666 | 1154 | 15804 | 758 | 11042 |
| 20-#10 | 3.17 | MA | 13405 | 3531 | 20646 | 2690 | 22538 | 2250 | 23472 | 1901 | 24428 | 1335 | 29025 | 703 | 22142 |
| 9L-3S | | MI | 6930 | 3531 | 11635 | 2455 | 12627 | 2046 | 13258 | 1700 | 14193 | 1144 | 16449 | 805 | 11030 |
| 20-#10 | 3.17 | MA | 13197 | 3531 | 20153 | 2697 | 21907 | 2270 | 22688 | 1908 | 23311 | 1340 | 27664 | 668 | 21401 |
| 10L-2S | | MI | 7037 | 3531 | 11964 | 2449 | 13049 | 2030 | 13773 | 1686 | 14893 | 1133 | 17364 | 894 | 11015 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 20" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

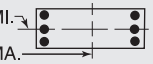
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.90 | MA | 14053 | 3692 | 22136 | 2776 | 24355 | 2322 | 25681 | 1935 | 27352 | 1313 | 33048 | 643 | 26965 |
| 8L-4S | | MI | 7110 | 3692 | 11939 | 2554 | 12969 | 2105 | 13654 | 1731 | 14753 | 1129 | 16970 | 642 | 13182 |
| 20-#11 | 3.90 | MA | 13845 | 3692 | 21514 | 2800 | 23589 | 2332 | 24727 | 1957 | 26109 | 1336 | 31412 | 592 | 26063 |
| 9L-3S | | MI | 7165 | 3692 | 12245 | 2534 | 13365 | 2101 | 14141 | 1729 | 15386 | 1118 | 17723 | 696 | 13180 |
| 20-#11 | 3.90 | MA | 13596 | 3692 | 20915 | 2807 | 22821 | 2356 | 23799 | 1980 | 24767 | 1343 | 29748 | 547 | 25115 |
| 10L-2S | | MI | 7290 | 3692 | 12639 | 2527 | 13870 | 2083 | 14756 | 1713 | 16223 | 1107 | 18788 | 806 | 13165 |
| 20-#14 | 5.63 | MA | 15221 | 4074 | 24429 | 3046 | 27239 | 2531 | 29184 | 2077 | 32074 | 1322 | 39764 | 422 | 36437 |
| 8L-4S | | MI | 7700 | 4074 | 13297 | 2786 | 14677 | 2270 | 15725 | 1827 | 17577 | 1095 | 20306 | 419 | 17929 |
| 20-#14 | 5.63 | MA | 14929 | 4074 | 23544 | 3080 | 26141 | 2544 | 27818 | 2108 | 30293 | 1355 | 37408 | 348 | 34786 |
| 9L-3S | | MI | 7773 | 4074 | 13732 | 2758 | 15240 | 2265 | 16416 | 1826 | 18476 | 1081 | 21355 | 495 | 18358 |
| 22-#10 | 3.49 | MA | 13929 | 3602 | 21929 | 2715 | 24151 | 2273 | 25456 | 1902 | 27081 | 1309 | 32621 | 736 | 25075 |
| 8L-5S | | MI | 6925 | 3602 | 11494 | 2523 | 12433 | 2097 | 13012 | 1736 | 13840 | 1148 | 16082 | 692 | 11922 |
| 22-#10 | 3.49 | MA | 13761 | 3602 | 21414 | 2734 | 23522 | 2282 | 24673 | 1920 | 26062 | 1329 | 31288 | 695 | 24505 |
| 9L-4S | | MI | 7019 | 3602 | 11709 | 2517 | 12719 | 2082 | 13368 | 1722 | 14366 | 1149 | 16720 | 743 | 12071 |
| 22-#10 | 3.49 | MA | 13553 | 3602 | 20921 | 2741 | 22892 | 2302 | 23889 | 1927 | 24945 | 1335 | 29927 | 660 | 23753 |
| 10L-3S | | MI | 7067 | 3602 | 11964 | 2499 | 13049 | 2077 | 13773 | 1719 | 14893 | 1138 | 17364 | 790 | 12063 |
| 22-#10 | 3.49 | MA | 13362 | 3602 | 20445 | 2748 | 22261 | 2309 | 23126 | 1947 | 23893 | 1352 | 28606 | 617 | 22993 |
| 11L-2S | | MI | 7174 | 3602 | 12293 | 2493 | 13470 | 2061 | 14287 | 1705 | 15593 | 1128 | 18279 | 879 | 12051 |
| 22-#11 | 4.29 | MA | 14274 | 3778 | 22447 | 2854 | 24785 | 2370 | 26186 | 1981 | 28095 | 1329 | 34161 | 583 | 28912 |
| 9L-4S | | MI | 7273 | 3778 | 12333 | 2608 | 13473 | 2144 | 14270 | 1754 | 15590 | 1122 | 18034 | 619 | 14370 |
| 22-#11 | 4.29 | MA | 14027 | 3778 | 21848 | 2861 | 24017 | 2394 | 25258 | 2003 | 26752 | 1336 | 32497 | 538 | 27951 |
| 10L-3S | | MI | 7327 | 3778 | 12639 | 2588 | 13870 | 2139 | 14756 | 1752 | 16223 | 1111 | 18788 | 674 | 14413 |
| 22-#14 | 6.19 | MA | 15539 | 4198 | 24879 | 3158 | 27852 | 2600 | 29905 | 2142 | 33132 | 1345 | 41340 | 334 | 38822 |
| 9L-4S | | MI | 7929 | 4198 | 13854 | 2864 | 15391 | 2325 | 16595 | 1861 | 18761 | 1085 | 21780 | 382 | 19595 |
| 24-#10 | 3.81 | MA | 14114 | 3672 | 22182 | 2778 | 24507 | 2313 | 25874 | 1939 | 27697 | 1324 | 33551 | 688 | 26867 |
| 9L-5S | | MI | 7063 | 3672 | 11823 | 2567 | 12855 | 2129 | 13526 | 1755 | 14540 | 1142 | 16997 | 677 | 12918 |
| 24-#10 | 3.81 | MA | 13908 | 3672 | 21689 | 2785 | 23877 | 2333 | 25091 | 1947 | 26579 | 1329 | 32190 | 653 | 26105 |
| 10L-4S | | MI | 7156 | 3672 | 12038 | 2561 | 13141 | 2113 | 13882 | 1741 | 15066 | 1143 | 17635 | 728 | 13096 |
| 24-#10 | 3.81 | MA | 13720 | 3672 | 21213 | 2792 | 23246 | 2341 | 24327 | 1966 | 25528 | 1346 | 30869 | 609 | 25336 |
| 11L-3S | | MI | 7205 | 3672 | 12293 | 2543 | 13470 | 2109 | 14287 | 1738 | 15593 | 1133 | 18279 | 775 | 13095 |
| 24-#11 | 4.68 | MA | 14454 | 3865 | 22780 | 2915 | 25213 | 2433 | 26717 | 2027 | 28738 | 1329 | 35246 | 528 | 30787 |
| 10L-4S | | MI | 7435 | 3865 | 12726 | 2662 | 13978 | 2182 | 14885 | 1778 | 16427 | 1115 | 19098 | 597 | 15548 |

## RECTANGULAR TIED COLUMNS 22" x 22"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#9 | 1.24 | MA | 4147 | 1877 | 6628 | 1340 | 7020 | 1129 | 7156 | 965 | 7186 | 718 | 8103 | 618 | 3104 |
| 2L-3S | | MI | 4042 | 1877 | 6332 | 1346 | 6641 | 1143 | 6693 | 977 | 6556 | 729 | 7246 | 548 | 3126 |
| 6-#10 | 1.57 | MA | 4243 | 1922 | 6866 | 1364 | 7315 | 1145 | 7511 | 973 | 7667 | 712 | 8728 | 606 | 3860 |
| 2L-3S | | MI | 4113 | 1922 | 6493 | 1371 | 6837 | 1162 | 6928 | 989 | 6873 | 725 | 7658 | 517 | 3889 |
| 6-#11 | 1.93 | MA | 4332 | 1970 | 7110 | 1381 | 7599 | 1156 | 7846 | 977 | 8117 | 701 | 9238 | 581 | 4631 |
| 2L-3S | | MI | 4179 | 1970 | 6662 | 1390 | 7026 | 1176 | 7146 | 995 | 7165 | 714 | 7984 | 472 | 4665 |
| 6-#14 | 2.79 | MA | 4561 | 2085 | 7684 | 1444 | 8316 | 1200 | 8712 | 1002 | 9291 | 687 | 10684 | 542 | 6457 |
| 2L-3S | | MI | 4348 | 2085 | 7050 | 1455 | 7502 | 1227 | 7720 | 1026 | 7941 | 704 | 8938 | 383 | 6489 |
| 6-#18 | 4.96 | MA | 5109 | 2375 | 9071 | 1608 | 10056 | 1315 | 10820 | 1068 | 12153 | 653 | 14037 | 422 | 10855 |
| 2L-3S | | MI | 4757 | 2375 | 7983 | 1623 | 8661 | 1359 | 9117 | 1105 | 9836 | 677 | 11154 | 141 | 10696 |
| 8-#8 | 1.31 | MA | 4172 | 1886 | 6676 | 1350 | 7091 | 1136 | 7245 | 970 | 7310 | 720 | 8295 | 622 | 3262 |
| 2L-4S | | MI | 4047 | 1886 | 6259 | 1367 | 6555 | 1152 | 6590 | 983 | 6434 | 737 | 7128 | 535 | 3299 |
| 8-#9 | 1.65 | MA | 4273 | 1933 | 6924 | 1375 | 7400 | 1154 | 7619 | 980 | 7816 | 714 | 8961 | 611 | 4051 |
| 2L-4S | | MI | 4119 | 1933 | 6401 | 1396 | 6726 | 1172 | 6794 | 996 | 6715 | 734 | 7505 | 501 | 4092 |
| 8-#10 | 2.10 | MA | 4401 | 1992 | 7239 | 1408 | 7793 | 1177 | 8094 | 993 | 8460 | 707 | 9799 | 595 | 5047 |
| 2L-4S | | MI | 4210 | 1992 | 6580 | 1434 | 6944 | 1200 | 7055 | 1012 | 7073 | 731 | 7980 | 457 | 5081 |
| 8-#11 | 2.58 | MA | 4520 | 2057 | 7557 | 1435 | 8173 | 1195 | 8546 | 1001 | 9069 | 694 | 10492 | 564 | 6052 |
| 2L-4S | | MI | 4298 | 2057 | 6764 | 1465 | 7152 | 1221 | 7296 | 1022 | 7401 | 721 | 8357 | 396 | 6072 |
| 8-#14 | 3.72 | MA | 4824 | 2209 | 8318 | 1522 | 9129 | 1256 | 9704 | 1036 | 10641 | 677 | 12429 | 513 | 8457 |
| 2L-4S | | MI | 4519 | 2209 | 7192 | 1563 | 7679 | 1291 | 7930 | 1064 | 8273 | 712 | 9452 | 274 | 7973 |
| 10-#10 | 2.62 | MA | 4558 | 2063 | 7612 | 1451 | 8271 | 1208 | 8677 | 1012 | 9253 | 701 | 10869 | 584 | 6225 |
| 2L-5S | | MI | 4260 | 2063 | 6711 | 1485 | 7101 | 1248 | 7237 | 1047 | 7274 | 727 | 8304 | 395 | 5996 |

## RECTANGULAR TIED COLUMNS 22" x 22"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.62 | MA | 4432 | 2063 | 7239 | 1459 | 7793 | 1225 | 8094 | 1027 | 8460 | 713 | 9799 | 495 | 6242 |
| 3L-4S | | MI | 4370 | 2063 | 6952 | 1478 | 7422 | 1231 | 7638 | 1031 | 7866 | 726 | 9050 | 446 | 6241 |
| 10-#11 | 3.22 | MA | 4706 | 2143 | 8005 | 1489 | 8747 | 1234 | 9246 | 1024 | 10022 | 687 | 11747 | 547 | 7464 |
| 2L-5S | | MI | 4357 | 2143 | 6920 | 1527 | 7337 | 1279 | 7512 | 1064 | 7639 | 714 | 8737 | 316 | 7018 |
| 10-#11 | 3.22 | MA | 4558 | 2143 | 7557 | 1497 | 8173 | 1254 | 8546 | 1042 | 9069 | 701 | 10492 | 437 | 7479 |
| 3L-4S | | MI | 4488 | 2143 | 7212 | 1519 | 7725 | 1260 | 7996 | 1046 | 8353 | 714 | 9611 | 379 | 7398 |
| 10-#14 | 4.65 | MA | 4882 | 2334 | 8318 | 1610 | 9129 | 1339 | 9704 | 1094 | 10641 | 684 | 12429 | 326 | 10430 |
| 3L-4S | | MI | 4787 | 2334 | 7826 | 1641 | 8492 | 1347 | 8922 | 1098 | 9623 | 702 | 11198 | 245 | 9836 |

## RECTANGULAR TIED COLUMNS 22" x 24"

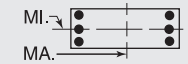
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.18 | MA | 4911 | 2040 | 7839 | 1454 | 8285 | 1226 | 8428 | 1048 | 8430 | 783 | 9463 | 673 | 3531 |
| 2E | | MI | 4487 | 2040 | 7187 | 1438 | 7560 | 1212 | 7669 | 1036 | 7643 | 774 | 8482 | 656 | 3221 |
| 4-#14 | 1.70 | MA | 5086 | 2116 | 8277 | 1493 | 8824 | 1252 | 9076 | 1062 | 9307 | 771 | 10581 | 650 | 4925 |
| 2E | | MI | 4640 | 2116 | 7575 | 1476 | 8037 | 1238 | 8241 | 1050 | 8418 | 762 | 9433 | 628 | 4472 |
| 4-#18 | 3.03 | MA | 5506 | 2310 | 9336 | 1596 | 10139 | 1324 | 10662 | 1102 | 11457 | 745 | 13211 | 580 | 8292 |
| 2E | | MI | 5007 | 2310 | 8510 | 1578 | 9194 | 1309 | 9636 | 1088 | 10309 | 735 | 11644 | 544 | 7476 |
| 6-#9 | 1.14 | MA | 4913 | 2033 | 7796 | 1467 | 8273 | 1237 | 8431 | 1059 | 8444 | 793 | 9554 | 689 | 3428 |
| 2L-3S | | MI | 4384 | 2033 | 6854 | 1459 | 7176 | 1239 | 7217 | 1061 | 7037 | 795 | 7749 | 606 | 3148 |
| 6-#9 | 1.14 | MA | 4793 | 2033 | 7465 | 1473 | 7849 | 1251 | 7914 | 1072 | 7741 | 804 | 8580 | 620 | 3450 |
| 3L-2S | | MI | 4490 | 2033 | 7150 | 1453 | 7555 | 1225 | 7680 | 1048 | 7667 | 785 | 8606 | 677 | 3126 |
| 6-#10 | 1.44 | MA | 5022 | 2078 | 8063 | 1490 | 8604 | 1253 | 8830 | 1067 | 8984 | 787 | 10297 | 682 | 4272 |
| 2L-3S | | MI | 4455 | 2078 | 7016 | 1483 | 7372 | 1258 | 7452 | 1072 | 7354 | 791 | 8159 | 575 | 3915 |
| 6-#10 | 1.44 | MA | 4873 | 2078 | 7646 | 1498 | 8069 | 1271 | 8178 | 1084 | 8097 | 801 | 9070 | 592 | 4300 |
| 3L-2S | | MI | 4586 | 2078 | 7389 | 1476 | 7850 | 1241 | 8035 | 1057 | 8147 | 779 | 9230 | 665 | 3886 |
| 6-#11 | 1.77 | MA | 5124 | 2126 | 8341 | 1508 | 8928 | 1264 | 9212 | 1071 | 9497 | 776 | 10908 | 660 | 5136 |
| 2L-3S | | MI | 4521 | 2126 | 7187 | 1500 | 7560 | 1271 | 7669 | 1078 | 7643 | 780 | 8482 | 529 | 4699 |
| 6-#11 | 1.77 | MA | 4949 | 2126 | 7839 | 1517 | 8285 | 1285 | 8428 | 1091 | 8430 | 791 | 9463 | 550 | 5171 |
| 3L-2S | | MI | 4675 | 2126 | 7634 | 1492 | 8134 | 1251 | 8369 | 1060 | 8595 | 767 | 9736 | 639 | 4662 |
| 6-#14 | 2.56 | MA | 5386 | 2240 | 8989 | 1570 | 9737 | 1308 | 10189 | 1096 | 10822 | 761 | 12601 | 627 | 7186 |
| 2L-3S | | MI | 4690 | 2240 | 7575 | 1565 | 8037 | 1321 | 8241 | 1108 | 8418 | 769 | 9433 | 441 | 6535 |
| 6-#14 | 2.56 | MA | 5142 | 2240 | 8277 | 1583 | 8824 | 1337 | 9076 | 1122 | 9307 | 782 | 10581 | 469 | 7218 |
| 3L-2S | | MI | 4904 | 2240 | 8210 | 1554 | 8850 | 1294 | 9233 | 1084 | 9768 | 752 | 11179 | 599 | 6496 |
| 6-#18 | 4.55 | MA | 6012 | 2531 | 10563 | 1734 | 11712 | 1423 | 12581 | 1162 | 14068 | 728 | 16578 | 528 | 12151 |
| 2L-3S | | MI | 5099 | 2531 | 8510 | 1731 | 9194 | 1452 | 9636 | 1186 | 10309 | 742 | 11644 | 197 | 10854 |
| 6-#18 | 4.55 | MA | 5610 | 2531 | 9336 | 1753 | 10139 | 1471 | 10662 | 1204 | 11457 | 758 | 13211 | 246 | 12061 |
| 3L-2S | | MI | 5452 | 2531 | 9599 | 1716 | 10590 | 1408 | 11339 | 1149 | 12626 | 717 | 14527 | 478 | 10910 |
| 8-#8 | 1.20 | MA | 4940 | 2042 | 7847 | 1476 | 8350 | 1244 | 8530 | 1064 | 8580 | 795 | 9745 | 690 | 3604 |
| 2L-4S | | MI | 4389 | 2042 | 6781 | 1479 | 7089 | 1248 | 7114 | 1067 | 6916 | 803 | 7632 | 593 | 3322 |
| 8-#8 | 1.20 | MA | 4845 | 2042 | 7585 | 1482 | 8012 | 1256 | 8118 | 1075 | 8021 | 804 | 8970 | 636 | 3620 |
| 3E | | MI | 4430 | 2042 | 6961 | 1467 | 7323 | 1244 | 7402 | 1064 | 7290 | 795 | 8111 | 625 | 3301 |
| 8-#8 | 1.20 | MA | 4797 | 2042 | 7384 | 1494 | 7753 | 1261 | 7799 | 1079 | 7605 | 813 | 8436 | 604 | 3641 |
| 4L-2S | | MI | 4514 | 2042 | 7197 | 1462 | 7625 | 1233 | 7770 | 1054 | 7792 | 787 | 8799 | 680 | 3284 |
| 8-#9 | 1.52 | MA | 5055 | 2088 | 8126 | 1501 | 8697 | 1262 | 8948 | 1074 | 9148 | 789 | 10528 | 683 | 4483 |
| 2L-4S | | MI | 4461 | 2088 | 6923 | 1508 | 7261 | 1268 | 7319 | 1079 | 7196 | 801 | 8007 | 559 | 4120 |
| 8-#9 | 1.52 | MA | 4937 | 2088 | 7796 | 1508 | 8273 | 1276 | 8431 | 1087 | 8444 | 800 | 9554 | 613 | 4503 |
| 3E | | MI | 4512 | 2088 | 7150 | 1493 | 7555 | 1263 | 7680 | 1076 | 7667 | 791 | 8606 | 599 | 4097 |
| 8-#9 | 1.52 | MA | 4878 | 2088 | 7544 | 1523 | 7946 | 1282 | 8029 | 1092 | 7921 | 811 | 8879 | 573 | 4524 |
| 4L-2S | | MI | 4616 | 2088 | 7446 | 1487 | 7935 | 1250 | 8143 | 1063 | 8297 | 781 | 9463 | 669 | 4076 |
| 8-#10 | 1.92 | MA | 5201 | 2148 | 8480 | 1534 | 9138 | 1285 | 9482 | 1087 | 9871 | 781 | 11523 | 674 | 5595 |
| 2L-4S | | MI | 4553 | 2148 | 7102 | 1546 | 7478 | 1295 | 7579 | 1096 | 7553 | 797 | 8481 | 515 | 5119 |
| 8-#10 | 1.92 | MA | 5054 | 2148 | 8063 | 1542 | 8604 | 1303 | 8830 | 1103 | 8984 | 795 | 10297 | 584 | 5618 |
| 3E | | MI | 4615 | 2148 | 7389 | 1527 | 7850 | 1289 | 8035 | 1091 | 8147 | 785 | 9230 | 564 | 5100 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis

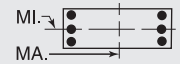



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.92 | MA | 4981 | 2148 | 7745 | 1562 | 8191 | 1310 | 8323 | 1109 | 8323 | 809 | 9443 | 533 | 5630 |
| 4L-2S | | MI | 4744 | 2148 | 7762 | 1520 | 8328 | 1272 | 8618 | 1076 | 8941 | 773 | 10300 | 654 | 5075 |
| 8-#11 | 2.36 | MA | 5336 | 2212 | 8842 | 1562 | 9571 | 1303 | 9996 | 1095 | 10564 | 769 | 12353 | 647 | 6726 |
| 2L-4S | | MI | 4640 | 2212 | 7288 | 1576 | 7686 | 1315 | 7819 | 1105 | 7880 | 787 | 8855 | 454 | 6124 |
| 8-#11 | 2.36 | MA | 5164 | 2212 | 8341 | 1571 | 8928 | 1324 | 9212 | 1114 | 9497 | 784 | 10908 | 537 | 6750 |
| 3E | | MI | 4711 | 2212 | 7634 | 1554 | 8134 | 1309 | 8369 | 1101 | 8595 | 773 | 9736 | 512 | 6115 |
| 8-#11 | 2.36 | MA | 5080 | 2212 | 7956 | 1594 | 8429 | 1331 | 8599 | 1120 | 8699 | 800 | 9898 | 476 | 6746 |
| 4L-2S | | MI | 4862 | 2212 | 8082 | 1546 | 8708 | 1290 | 9068 | 1083 | 9548 | 760 | 10990 | 622 | 6086 |
| 8-#14 | 3.41 | MA | 5683 | 2365 | 9701 | 1648 | 10650 | 1364 | 11303 | 1130 | 12338 | 752 | 14621 | 605 | 9429 |
| 2L-4S | | MI | 4862 | 2365 | 7717 | 1673 | 8213 | 1385 | 8451 | 1146 | 8750 | 777 | 9947 | 331 | 8138 |
| 8-#14 | 3.41 | MA | 5446 | 2365 | 8989 | 1661 | 9737 | 1393 | 10189 | 1156 | 10822 | 772 | 12601 | 447 | 9435 |
| 3E | | MI | 4958 | 2365 | 8210 | 1643 | 8850 | 1377 | 9233 | 1142 | 9768 | 759 | 11179 | 412 | 8518 |
| 8-#14 | 3.41 | MA | 5330 | 2365 | 8440 | 1693 | 9026 | 1403 | 9316 | 1163 | 9685 | 793 | 11185 | 361 | 9015 |
| 4L-2S | | MI | 5167 | 2365 | 8844 | 1632 | 9663 | 1350 | 10225 | 1118 | 11118 | 742 | 12925 | 570 | 8500 |
| 8-#18 | 6.06 | MA | 6126 | 2752 | 10563 | 1891 | 11712 | 1571 | 12581 | 1265 | 14068 | 741 | 16578 | 194 | 15809 |
| 3E | | MI | 5553 | 2752 | 9599 | 1870 | 10590 | 1551 | 11339 | 1246 | 12626 | 724 | 14527 | 131 | 14046 |
| 8-#18 | 6.06 | MA | 5940 | 2752 | 9611 | 1945 | 10478 | 1583 | 11067 | 1271 | 12097 | 771 | 14201 | 51 | 13922 |
| 4L-2S | | MI | 5896 | 2752 | 10688 | 1855 | 11986 | 1507 | 13042 | 1209 | 14943 | 699 | 17410 | 413 | 14319 |
| 10-#10 | 2.41 | MA | 5378 | 2218 | 8897 | 1578 | 9672 | 1316 | 10134 | 1106 | 10758 | 776 | 12750 | 666 | 6911 |
| 2L-5S | | MI | 4602 | 2218 | 7234 | 1597 | 7636 | 1344 | 7761 | 1130 | 7755 | 793 | 8805 | 453 | 6098 |
| 10-#10 | 2.41 | MA | 5234 | 2218 | 8480 | 1586 | 9138 | 1334 | 9482 | 1122 | 9871 | 790 | 11523 | 576 | 6928 |
| 3L-4S | | MI | 4713 | 2218 | 7475 | 1590 | 7956 | 1327 | 8162 | 1115 | 8347 | 792 | 9552 | 504 | 6284 |
| 10-#10 | 2.41 | MA | 5162 | 2218 | 8161 | 1606 | 8725 | 1341 | 8975 | 1128 | 9210 | 803 | 10670 | 525 | 6926 |
| 4L-3S | | MI | 4774 | 2218 | 7762 | 1571 | 8328 | 1321 | 8618 | 1111 | 8941 | 780 | 10300 | 553 | 6276 |
| 10-#10 | 2.41 | MA | 5037 | 2218 | 7894 | 1614 | 8369 | 1359 | 8530 | 1144 | 8553 | 806 | 9815 | 475 | 6711 |
| 5L-2S | | MI | 4901 | 2218 | 8134 | 1563 | 8806 | 1304 | 9201 | 1095 | 9734 | 767 | 11371 | 642 | 6256 |
| 10-#11 | 2.95 | MA | 5548 | 2299 | 9343 | 1616 | 10213 | 1342 | 10780 | 1118 | 11631 | 762 | 13798 | 634 | 8306 |
| 2L-5S | | MI | 4699 | 2299 | 7444 | 1638 | 7872 | 1374 | 8035 | 1146 | 8118 | 779 | 9235 | 374 | 7135 |
| 10-#11 | 2.95 | MA | 5379 | 2299 | 8842 | 1625 | 9571 | 1363 | 9996 | 1138 | 10564 | 777 | 12353 | 524 | 8322 |
| 3L-4S | | MI | 4830 | 2299 | 7736 | 1630 | 8260 | 1354 | 8519 | 1128 | 8832 | 780 | 10109 | 437 | 7512 |
| 10-#11 | 2.95 | MA | 5295 | 2299 | 8457 | 1648 | 9072 | 1370 | 9383 | 1143 | 9766 | 793 | 11343 | 463 | 8298 |
| 4L-3S | | MI | 4900 | 2299 | 8082 | 1608 | 8708 | 1348 | 9068 | 1125 | 9548 | 766 | 10990 | 494 | 7521 |
| 10-#11 | 2.95 | MA | 5147 | 2299 | 8133 | 1657 | 8641 | 1391 | 8845 | 1162 | 8971 | 794 | 10336 | 401 | 7868 |
| 5L-2S | | MI | 5049 | 2299 | 8529 | 1600 | 9281 | 1328 | 9768 | 1107 | 10500 | 753 | 12244 | 604 | 7501 |
| 10-#14 | 4.26 | MA | 5748 | 2489 | 9701 | 1738 | 10650 | 1449 | 11303 | 1190 | 12338 | 762 | 14621 | 424 | 11645 |
| 3L-4S | | MI | 5129 | 2489 | 8352 | 1751 | 9026 | 1440 | 9443 | 1180 | 10099 | 767 | 11693 | 302 | 9995 |
| 10-#14 | 4.26 | MA | 5634 | 2489 | 9152 | 1771 | 9939 | 1459 | 10430 | 1197 | 11201 | 783 | 13205 | 339 | 11111 |
| 4L-3S | | MI | 5224 | 2489 | 8844 | 1720 | 9663 | 1433 | 10225 | 1176 | 11118 | 749 | 12925 | 383 | 10489 |
| 10-#14 | 4.26 | MA | 5425 | 2489 | 8690 | 1783 | 9323 | 1488 | 9662 | 1223 | 10067 | 783 | 11797 | 249 | 10562 |
| 5L-2S | | MI | 5429 | 2489 | 9478 | 1710 | 10476 | 1406 | 11217 | 1152 | 12468 | 732 | 14670 | 541 | 10494 |
| 10-#18 | 7.58 | MA | 6457 | 2974 | 10838 | 2083 | 12052 | 1683 | 12986 | 1332 | 14708 | 754 | 17568 | -2 | 17565 |
| 4L-3S | | MI | 6004 | 2974 | 10688 | 2008 | 11986 | 1650 | 13042 | 1307 | 14943 | 706 | 17410 | 65 | 17152 |
| 12-#10 | 2.89 | MA | 5555 | 2289 | 9313 | 1622 | 10207 | 1348 | 10785 | 1125 | 11645 | 770 | 13977 | 658 | 8222 |
| 2L-6S | | MI | 4683 | 2289 | 7359 | 1658 | 7794 | 1381 | 7947 | 1154 | 8015 | 800 | 9193 | 385 | 7032 |
| 12-#10 | 2.89 | MA | 5413 | 2289 | 8897 | 1630 | 9672 | 1366 | 10134 | 1142 | 10758 | 784 | 12750 | 569 | 8233 |
| 3L-5S | | MI | 4763 | 2289 | 7607 | 1641 | 8114 | 1375 | 8344 | 1149 | 8548 | 787 | 9876 | 442 | 7210 |
| 12-#10 | 2.89 | MA | 5342 | 2289 | 8578 | 1650 | 9259 | 1373 | 9626 | 1147 | 10097 | 798 | 11897 | 517 | 8220 |
| 4E | | MI | 4872 | 2289 | 7848 | 1633 | 8434 | 1358 | 8745 | 1134 | 9140 | 786 | 10622 | 493 | 7443 |
| 12-#10 | 2.89 | MA | 5218 | 2289 | 8311 | 1658 | 8903 | 1391 | 9182 | 1164 | 9439 | 800 | 11042 | 467 | 7959 |
| 5L-3S | | MI | 4933 | 2289 | 8134 | 1615 | 8806 | 1353 | 9201 | 1130 | 9734 | 774 | 11371 | 542 | 7446 |
| 12-#10 | 2.89 | MA | 5129 | 2289 | 8050 | 1664 | 8549 | 1398 | 8741 | 1169 | 8847 | 814 | 10262 | 408 | 7741 |
| 6L-2S | | MI | 5058 | 2289 | 8507 | 1607 | 9284 | 1335 | 9784 | 1114 | 10527 | 762 | 12442 | 631 | 7432 |
| 12-#11 | 3.55 | MA | 5592 | 2385 | 9343 | 1679 | 10213 | 1402 | 10780 | 1161 | 11631 | 771 | 13798 | 511 | 9885 |
| 3L-5S | | MI | 4890 | 2385 | 7892 | 1692 | 8446 | 1413 | 8734 | 1170 | 9070 | 772 | 10489 | 356 | 8473 |
| 12-#11 | 3.55 | MA | 5510 | 2385 | 8958 | 1702 | 9714 | 1409 | 10167 | 1167 | 10833 | 786 | 12788 | 450 | 9820 |
| 4E | | MI | 5020 | 2385 | 8183 | 1684 | 8833 | 1393 | 9218 | 1152 | 9784 | 773 | 11363 | 419 | 8843 |
| 12-#11 | 3.55 | MA | 5363 | 2385 | 8634 | 1711 | 9283 | 1430 | 9629 | 1186 | 10038 | 787 | 11781 | 388 | 9372 |
| 5L-3S | | MI | 5089 | 2385 | 8529 | 1662 | 9281 | 1387 | 9768 | 1148 | 10500 | 759 | 12244 | 477 | 8922 |

## RECTANGULAR TIED COLUMNS 22" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

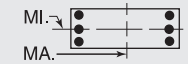
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 3.55 | MA | 5257 | 2385 | 8301 | 1733 | 8854 | 1437 | 9095 | 1191 | 9321 | 803 | 10860 | 318 | 9049 |
| 6L-2S | | MI | 5235 | 2385 | 8977 | 1654 | 9855 | 1367 | 10468 | 1130 | 11452 | 746 | 13498 | 587 | 8910 |
| 12-#14 | 5.11 | MA | 5935 | 2614 | 9864 | 1849 | 10852 | 1514 | 11544 | 1231 | 12716 | 773 | 15225 | 317 | 13222 |
| 4E | | MI | 5395 | 2614 | 8986 | 1829 | 9839 | 1496 | 10435 | 1214 | 11449 | 757 | 13438 | 273 | 11867 |
| 12-#14 | 5.11 | MA | 5731 | 2614 | 9402 | 1861 | 10236 | 1544 | 10776 | 1257 | 11583 | 773 | 13817 | 226 | 12711 |
| 5L-3S | | MI | 5489 | 2614 | 9478 | 1798 | 10476 | 1489 | 11217 | 1210 | 12468 | 739 | 14670 | 354 | 12455 |
| 14-#10 | 3.37 | MA | 5592 | 2359 | 9313 | 1674 | 10207 | 1397 | 10785 | 1161 | 11645 | 778 | 13977 | 561 | 9534 |
| 3L-6S | | MI | 4845 | 2359 | 7732 | 1702 | 8272 | 1413 | 8530 | 1173 | 8808 | 794 | 10264 | 374 | 8161 |
| 14-#10 | 3.37 | MA | 5521 | 2359 | 8995 | 1694 | 9794 | 1404 | 10278 | 1166 | 10984 | 792 | 13123 | 509 | 9511 |
| 4L-5S | | MI | 4923 | 2359 | 7980 | 1685 | 8591 | 1407 | 8927 | 1169 | 9342 | 782 | 10947 | 431 | 8329 |
| 14-#10 | 3.37 | MA | 5399 | 2359 | 8728 | 1702 | 9438 | 1422 | 9833 | 1183 | 10326 | 795 | 12268 | 459 | 9211 |
| 5L-4S | | MI | 5031 | 2359 | 8221 | 1677 | 8912 | 1390 | 9328 | 1153 | 9934 | 781 | 11693 | 482 | 8600 |
| 14-#10 | 3.37 | MA | 5311 | 2359 | 8467 | 1708 | 9083 | 1429 | 9393 | 1188 | 9734 | 808 | 11488 | 400 | 9006 |
| 6L-3S | | MI | 5091 | 2359 | 8507 | 1659 | 9284 | 1384 | 9784 | 1149 | 10527 | 768 | 12442 | 531 | 8614 |
| 14-#11 | 4.14 | MA | 5723 | 2471 | 9460 | 1756 | 10357 | 1448 | 10952 | 1190 | 11900 | 779 | 14233 | 437 | 11304 |
| 4L-5S | | MI | 5080 | 2471 | 8339 | 1746 | 9019 | 1451 | 9434 | 1193 | 10022 | 765 | 11743 | 339 | 9817 |
| 14-#11 | 4.14 | MA | 5578 | 2471 | 9136 | 1765 | 9926 | 1469 | 10413 | 1209 | 11105 | 781 | 13226 | 375 | 10882 |
| 5L-4S | | MI | 5208 | 2471 | 8631 | 1738 | 9407 | 1432 | 9918 | 1175 | 10736 | 766 | 12617 | 402 | 10163 |
| 14-#11 | 4.14 | MA | 5474 | 2471 | 8802 | 1787 | 9497 | 1476 | 9880 | 1215 | 10388 | 796 | 12305 | 305 | 10531 |
| 6L-3S | | MI | 5276 | 2471 | 8977 | 1716 | 9855 | 1426 | 10468 | 1172 | 11452 | 753 | 13498 | 460 | 10316 |
| 14-#14 | 5.97 | MA | 6034 | 2738 | 10114 | 1939 | 11149 | 1600 | 11890 | 1291 | 13098 | 763 | 15837 | 204 | 14867 |
| 5L-4S | | MI | 5660 | 2738 | 9620 | 1906 | 10652 | 1552 | 11427 | 1248 | 12799 | 747 | 15184 | 244 | 13752 |
| 16-#10 | 3.85 | MA | 5699 | 2429 | 9412 | 1737 | 10328 | 1436 | 10930 | 1185 | 11871 | 786 | 14350 | 502 | 10801 |
| 4L-6S | | MI | 5005 | 2429 | 8105 | 1746 | 8750 | 1444 | 9113 | 1192 | 9602 | 788 | 11334 | 363 | 9293 |
| 16-#10 | 3.85 | MA | 5579 | 2429 | 9144 | 1746 | 9972 | 1454 | 10485 | 1202 | 11213 | 789 | 13495 | 451 | 10469 |
| 5E | | MI | 5082 | 2429 | 8352 | 1729 | 9069 | 1438 | 9511 | 1188 | 10135 | 776 | 12017 | 420 | 9451 |
| 16-#10 | 3.85 | MA | 5493 | 2429 | 8884 | 1752 | 9617 | 1461 | 10044 | 1207 | 10621 | 803 | 12715 | 392 | 10274 |
| 6L-4S | | MI | 5189 | 2429 | 8594 | 1721 | 9390 | 1421 | 9911 | 1172 | 10727 | 775 | 12763 | 471 | 9755 |
| 16-#11 | 4.73 | MA | 5792 | 2558 | 9637 | 1819 | 10569 | 1508 | 11198 | 1233 | 12172 | 774 | 14671 | 362 | 12397 |
| 5E | | MI | 5269 | 2558 | 8787 | 1800 | 9593 | 1490 | 10134 | 1217 | 10974 | 759 | 12997 | 322 | 11166 |
| 16-#11 | 4.73 | MA | 5690 | 2558 | 9304 | 1841 | 10139 | 1515 | 10664 | 1238 | 11455 | 789 | 13750 | 292 | 12019 |
| 6L-4S | | MI | 5396 | 2558 | 9078 | 1792 | 9981 | 1470 | 10618 | 1199 | 11688 | 759 | 13871 | 385 | 11491 |
| 18-#10 | 4.33 | MA | 5757 | 2499 | 9561 | 1790 | 10506 | 1485 | 11137 | 1221 | 12100 | 783 | 14722 | 443 | 11730 |
| 5L-6S | | MI | 5165 | 2499 | 8478 | 1790 | 9228 | 1476 | 9696 | 1211 | 10395 | 783 | 12405 | 352 | 10411 |
| 18-#10 | 4.33 | MA | 5673 | 2499 | 9301 | 1795 | 10152 | 1492 | 10696 | 1226 | 11508 | 797 | 13942 | 384 | 11544 |
| 6L-5S | | MI | 5240 | 2499 | 8725 | 1773 | 9547 | 1470 | 10094 | 1207 | 10929 | 770 | 13088 | 409 | 10577 |
| 18-#11 | 5.32 | MA | 5906 | 2644 | 9805 | 1895 | 10782 | 1554 | 11448 | 1262 | 12522 | 782 | 15195 | 279 | 13513 |
| 6L-5S | | MI | 5457 | 2644 | 9234 | 1854 | 10166 | 1529 | 10834 | 1240 | 11926 | 752 | 14251 | 304 | 12518 |

## RECTANGULAR TIED COLUMNS 22" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.09 | MA | 5741 | 2195 | 9104 | 1580 | 9640 | 1333 | 9807 | 1142 | 9787 | 858 | 11041 | 745 | 3868 |
| 2E | | MI | 4829 | 2195 | 7711 | 1549 | 8095 | 1307 | 8191 | 1119 | 8122 | 839 | 8980 | 714 | 3246 |
| 4-#14 | 1.57 | MA | 5938 | 2272 | 9592 | 1619 | 10241 | 1360 | 10529 | 1156 | 10764 | 846 | 12326 | 726 | 5411 |
| 2E | | MI | 4983 | 2272 | 8101 | 1586 | 8571 | 1332 | 8762 | 1132 | 8894 | 827 | 9929 | 685 | 4504 |
| 4-#18 | 2.80 | MA | 6412 | 2465 | 10778 | 1722 | 11713 | 1432 | 12304 | 1196 | 13169 | 820 | 15375 | 668 | 9156 |
| 2E | | MI | 5350 | 2465 | 9038 | 1686 | 9728 | 1401 | 10155 | 1169 | 10782 | 799 | 12134 | 600 | 7523 |
| 6-#9 | 1.05 | MA | 5741 | 2189 | 9052 | 1593 | 9621 | 1345 | 9804 | 1153 | 9795 | 868 | 11060 | 755 | 3752 |
| 2L-3S | | MI | 4726 | 2189 | 7376 | 1571 | 7710 | 1334 | 7741 | 1144 | 7519 | 862 | 8252 | 665 | 3169 |
| 6-#9 | 1.05 | MA | 5607 | 2189 | 8687 | 1600 | 9153 | 1351 | 9233 | 1167 | 9018 | 880 | 9984 | 687 | 3774 |
| 3L-2S | | MI | 4832 | 2189 | 7672 | 1565 | 8090 | 1321 | 8204 | 1132 | 8149 | 852 | 9109 | 735 | 3147 |
| 6-#10 | 1.33 | MA | 5864 | 2233 | 9349 | 1616 | 9988 | 1361 | 10246 | 1161 | 10394 | 862 | 11887 | 748 | 4683 |
| 2L-3S | | MI | 4797 | 2233 | 7538 | 1595 | 7906 | 1353 | 7975 | 1155 | 7835 | 857 | 8661 | 633 | 3940 |
| 6-#10 | 1.33 | MA | 5696 | 2233 | 8888 | 1625 | 9398 | 1369 | 9526 | 1179 | 9413 | 877 | 10529 | 661 | 4712 |
| 3L-2S | | MI | 4929 | 2233 | 7911 | 1588 | 8384 | 1336 | 8559 | 1140 | 8628 | 845 | 9731 | 723 | 3911 |
| 6-#11 | 1.64 | MA | 5980 | 2282 | 9660 | 1634 | 10352 | 1372 | 10675 | 1165 | 10969 | 851 | 12677 | 736 | 5642 |
| 2L-3S | | MI | 4863 | 2282 | 7711 | 1611 | 8095 | 1365 | 8191 | 1160 | 8122 | 846 | 8980 | 587 | 4731 |

## RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

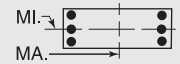
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.64 | MA | 5782 | 2282 | 9104 | 1644 | 9640 | 1394 | 9807 | 1186 | 9787 | 868 | 11041 | 626 | 5676 |
| 3L-2S | | MI | 5018 | 2282 | 8158 | 1603 | 8668 | 1346 | 8891 | 1142 | 9074 | 832 | 10234 | 696 | 4692 |
| 6-#14 | 2.36 | MA | 6274 | 2396 | 10382 | 1697 | 11254 | 1416 | 11764 | 1190 | 12445 | 836 | 14623 | 709 | 7915 |
| 2L-3S | | MI | 5033 | 2396 | 8101 | 1675 | 8571 | 1415 | 8762 | 1190 | 8894 | 834 | 9929 | 498 | 6578 |
| 6-#14 | 2.36 | MA | 5999 | 2396 | 9592 | 1711 | 10241 | 1447 | 10529 | 1218 | 10764 | 859 | 12326 | 551 | 7947 |
| 3L-2S | | MI | 5247 | 2396 | 8735 | 1664 | 9384 | 1388 | 9755 | 1166 | 10244 | 817 | 11674 | 656 | 6534 |
| 6-#18 | 4.20 | MA | 6980 | 2687 | 12144 | 1861 | 13463 | 1531 | 14439 | 1256 | 16075 | 803 | 19229 | 626 | 13447 |
| 2L-3S | | MI | 5441 | 2687 | 9038 | 1840 | 9728 | 1544 | 10155 | 1267 | 10782 | 806 | 12134 | 253 | 10936 |
| 6-#18 | 4.20 | MA | 6526 | 2687 | 10778 | 1882 | 11713 | 1583 | 12304 | 1302 | 13169 | 838 | 15375 | 345 | 13357 |
| 3L-2S | | MI | 5796 | 2687 | 10127 | 1825 | 11123 | 1500 | 11858 | 1229 | 13099 | 781 | 15017 | 535 | 10963 |
| 8-#8 | 1.10 | MA | 5771 | 2197 | 9108 | 1603 | 9705 | 1352 | 9911 | 1158 | 9943 | 870 | 11268 | 756 | 3945 |
| 2L-4S | | MI | 4732 | 2197 | 7302 | 1592 | 7624 | 1344 | 7639 | 1151 | 7398 | 870 | 8136 | 652 | 3343 |
| 8-#8 | 1.10 | MA | 5665 | 2197 | 8818 | 1608 | 9333 | 1357 | 9457 | 1169 | 9326 | 880 | 10412 | 703 | 3962 |
| 3E | | MI | 4773 | 2197 | 7482 | 1580 | 7858 | 1340 | 7926 | 1148 | 7773 | 862 | 8615 | 683 | 3322 |
| 8-#8 | 1.10 | MA | 5609 | 2197 | 8598 | 1621 | 9047 | 1369 | 9106 | 1174 | 8868 | 889 | 9830 | 672 | 3982 |
| 4L-2S | | MI | 4857 | 2197 | 7718 | 1575 | 8160 | 1329 | 8295 | 1138 | 8274 | 854 | 9303 | 739 | 3305 |
| 8-#9 | 1.40 | MA | 5900 | 2244 | 9417 | 1628 | 10089 | 1370 | 10375 | 1168 | 10572 | 864 | 12136 | 749 | 4915 |
| 2L-4S | | MI | 4804 | 2244 | 7445 | 1620 | 7795 | 1364 | 7843 | 1163 | 7678 | 867 | 8510 | 618 | 4147 |
| 8-#9 | 1.40 | MA | 5768 | 2244 | 9052 | 1635 | 9621 | 1376 | 9804 | 1182 | 9795 | 876 | 11060 | 681 | 4935 |
| 3E | | MI | 4854 | 2244 | 7672 | 1606 | 8090 | 1359 | 8204 | 1159 | 8149 | 857 | 9109 | 657 | 4121 |
| 8-#9 | 1.40 | MA | 5699 | 2244 | 8775 | 1651 | 9261 | 1391 | 9362 | 1187 | 9219 | 888 | 10324 | 642 | 4956 |
| 4L-2S | | MI | 4959 | 2244 | 7968 | 1599 | 8469 | 1346 | 8667 | 1147 | 8778 | 847 | 9966 | 727 | 4100 |
| 8-#10 | 1.78 | MA | 6063 | 2304 | 9809 | 1660 | 10579 | 1393 | 10967 | 1181 | 11374 | 856 | 13244 | 740 | 6144 |
| 2L-4S | | MI | 4895 | 2304 | 7625 | 1658 | 8013 | 1391 | 8102 | 1179 | 8034 | 864 | 8983 | 573 | 5154 |
| 8-#10 | 1.78 | MA | 5899 | 2304 | 9349 | 1669 | 9988 | 1400 | 10246 | 1198 | 10394 | 871 | 11887 | 653 | 6167 |
| 3E | | MI | 4957 | 2304 | 7911 | 1639 | 8384 | 1385 | 8559 | 1175 | 8628 | 851 | 9731 | 622 | 5129 |
| 8-#10 | 1.78 | MA | 5813 | 2304 | 8998 | 1690 | 9534 | 1419 | 9688 | 1205 | 9666 | 886 | 10954 | 603 | 6179 |
| 4L-2S | | MI | 5087 | 2304 | 8284 | 1632 | 8862 | 1368 | 9142 | 1159 | 9421 | 839 | 10802 | 712 | 5103 |
| 8-#11 | 2.18 | MA | 6217 | 2368 | 10215 | 1688 | 11064 | 1411 | 11544 | 1189 | 12151 | 844 | 14313 | 726 | 7399 |
| 2L-4S | | MI | 4983 | 2368 | 7813 | 1687 | 8220 | 1410 | 8341 | 1187 | 8358 | 852 | 9353 | 512 | 6172 |
| 8-#11 | 2.18 | MA | 6023 | 2368 | 9660 | 1698 | 10352 | 1433 | 10675 | 1209 | 10969 | 861 | 12677 | 617 | 7424 |
| 3E | | MI | 5053 | 2368 | 8158 | 1665 | 8668 | 1404 | 8891 | 1183 | 9074 | 839 | 10234 | 569 | 6151 |
| 8-#11 | 2.18 | MA | 5925 | 2368 | 9236 | 1722 | 9802 | 1442 | 9999 | 1216 | 10089 | 878 | 11539 | 554 | 7420 |
| 4L-2S | | MI | 5205 | 2368 | 8606 | 1657 | 9242 | 1384 | 9591 | 1166 | 10026 | 825 | 11488 | 679 | 6120 |
| 8-#14 | 3.15 | MA | 6607 | 2521 | 11172 | 1775 | 12266 | 1472 | 13000 | 1224 | 14126 | 826 | 16919 | 692 | 10401 |
| 2L-4S | | MI | 5204 | 2521 | 8243 | 1783 | 8747 | 1478 | 8972 | 1228 | 9226 | 842 | 10442 | 388 | 8297 |
| 8-#14 | 3.15 | MA | 6339 | 2521 | 10382 | 1789 | 11254 | 1503 | 11764 | 1252 | 12445 | 849 | 14623 | 534 | 10407 |
| 3E | | MI | 5300 | 2521 | 8735 | 1753 | 9384 | 1471 | 9755 | 1224 | 10244 | 824 | 11674 | 469 | 8570 |
| 8-#14 | 3.15 | MA | 6204 | 2521 | 9777 | 1822 | 10469 | 1514 | 10800 | 1261 | 11190 | 872 | 13021 | 445 | 10078 |
| 4L-2S | | MI | 5510 | 2521 | 9369 | 1742 | 10197 | 1444 | 10747 | 1200 | 11594 | 807 | 13420 | 627 | 8542 |
| 8-#18 | 5.59 | MA | 7106 | 2908 | 12144 | 2020 | 13463 | 1682 | 14439 | 1362 | 16075 | 820 | 19229 | 303 | 17562 |
| 3E | | MI | 5895 | 2908 | 10127 | 1978 | 11123 | 1644 | 11858 | 1327 | 13099 | 788 | 15017 | 187 | 14289 |
| 8-#18 | 5.59 | MA | 6887 | 2908 | 11090 | 2077 | 12098 | 1698 | 12763 | 1373 | 13893 | 856 | 16524 | 153 | 15597 |
| 4L-2S | | MI | 6240 | 2908 | 11216 | 1963 | 12519 | 1600 | 13561 | 1289 | 15416 | 764 | 17900 | 469 | 14380 |
| 10-#10 | 2.22 | MA | 6261 | 2374 | 10270 | 1704 | 11170 | 1424 | 11687 | 1200 | 12354 | 851 | 14601 | 732 | 7597 |
| 2L-5S | | MI | 4944 | 2374 | 7756 | 1709 | 8170 | 1439 | 8285 | 1213 | 8236 | 859 | 9307 | 511 | 6195 |
| 10-#10 | 2.22 | MA | 6100 | 2374 | 9809 | 1713 | 10579 | 1432 | 10967 | 1217 | 11374 | 866 | 13244 | 645 | 7614 |
| 3L-4S | | MI | 5055 | 2374 | 7998 | 1702 | 8491 | 1422 | 8686 | 1198 | 8827 | 858 | 10053 | 562 | 6323 |
| 10-#10 | 2.22 | MA | 6015 | 2374 | 9459 | 1734 | 10125 | 1451 | 10408 | 1224 | 10646 | 881 | 12311 | 595 | 7612 |
| 4L-3S | | MI | 5117 | 2374 | 8284 | 1683 | 8862 | 1416 | 9142 | 1194 | 9421 | 846 | 10802 | 611 | 6308 |
| 10-#10 | 2.22 | MA | 5876 | 2374 | 9166 | 1743 | 9733 | 1458 | 9919 | 1241 | 9923 | 884 | 11374 | 547 | 7437 |
| 5L-2S | | MI | 5244 | 2374 | 8657 | 1675 | 9340 | 1399 | 9725 | 1178 | 10215 | 834 | 11872 | 701 | 6286 |
| 10-#11 | 2.73 | MA | 6453 | 2454 | 10771 | 1742 | 11776 | 1450 | 12412 | 1212 | 13332 | 837 | 15949 | 717 | 9148 |
| 2L-5S | | MI | 5041 | 2454 | 7968 | 1749 | 8406 | 1469 | 8557 | 1228 | 8596 | 845 | 9733 | 431 | 7247 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

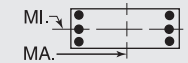
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 2.73 | MA | 6263 | 2454 | 10215 | 1752 | 11064 | 1472 | 11544 | 1233 | 12151 | 854 | 14313 | 607 | 9164 |
| 3L-4S | | MI | 5173 | 2454 | 8260 | 1741 | 8794 | 1449 | 9041 | 1211 | 9310 | 845 | 10607 | 494 | 7565 |
| 10-#11 | 2.73 | MA | 6166 | 2454 | 9791 | 1776 | 10514 | 1480 | 10868 | 1240 | 11270 | 871 | 13175 | 544 | 9140 |
| 4L-3S | | MI | 5243 | 2454 | 8606 | 1719 | 9242 | 1443 | 9591 | 1207 | 10026 | 832 | 11488 | 552 | 7561 |
| 10-#11 | 2.73 | MA | 6000 | 2454 | 9435 | 1787 | 10040 | 1503 | 10275 | 1260 | 10394 | 874 | 12035 | 482 | 8730 |
| 5L-2S | | MI | 5392 | 2454 | 9053 | 1711 | 9816 | 1423 | 10291 | 1189 | 10978 | 819 | 12742 | 662 | 7538 |
| 10-#14 | 3.93 | MA | 6677 | 2645 | 11172 | 1866 | 12266 | 1559 | 13000 | 1286 | 14126 | 839 | 16919 | 517 | 12860 |
| 3L-4S | | MI | 5472 | 2645 | 8877 | 1861 | 9560 | 1534 | 9964 | 1262 | 10576 | 832 | 12188 | 359 | 10149 |
| 10-#14 | 3.93 | MA | 6544 | 2645 | 10567 | 1900 | 11482 | 1570 | 12035 | 1295 | 12871 | 862 | 15317 | 428 | 12410 |
| 4L-3S | | MI | 5566 | 2645 | 9369 | 1830 | 10197 | 1527 | 10747 | 1258 | 11594 | 815 | 13420 | 440 | 10545 |
| 10-#14 | 3.93 | MA | 6311 | 2645 | 10058 | 1914 | 10804 | 1601 | 11190 | 1323 | 11620 | 866 | 13716 | 339 | 11738 |
| 5L-2S | | MI | 5772 | 2645 | 10004 | 1820 | 11011 | 1500 | 11739 | 1234 | 12944 | 797 | 15165 | 598 | 10539 |
| 10-#18 | 6.99 | MA | 7467 | 3129 | 12456 | 2216 | 13849 | 1797 | 14899 | 1434 | 16798 | 838 | 20379 | 111 | 19677 |
| 4L-3S | | MI | 6346 | 3129 | 11216 | 2116 | 12519 | 1743 | 13561 | 1387 | 15416 | 770 | 17900 | 122 | 17413 |
| 12-#10 | 2.66 | MA | 6459 | 2444 | 10731 | 1748 | 11760 | 1456 | 12408 | 1219 | 13335 | 845 | 15958 | 724 | 9045 |
| 2L-6S | | MI | 5025 | 2444 | 7882 | 1770 | 8328 | 1477 | 8471 | 1237 | 8495 | 866 | 9695 | 443 | 7123 |
| 12-#10 | 2.66 | MA | 6300 | 2444 | 10270 | 1757 | 11170 | 1463 | 11687 | 1237 | 12354 | 860 | 14601 | 637 | 9056 |
| 3L-5S | | MI | 5105 | 2444 | 8129 | 1753 | 8648 | 1471 | 8868 | 1233 | 9029 | 854 | 10378 | 500 | 7306 |
| 12-#10 | 2.66 | MA | 6216 | 2444 | 9920 | 1777 | 10715 | 1482 | 11129 | 1243 | 11627 | 875 | 13669 | 587 | 9043 |
| 4E | | MI | 5215 | 2444 | 8370 | 1745 | 8969 | 1454 | 9269 | 1217 | 9621 | 853 | 11124 | 551 | 7486 |
| 12-#10 | 2.66 | MA | 6079 | 2444 | 9626 | 1786 | 10324 | 1490 | 10640 | 1260 | 10903 | 879 | 12731 | 540 | 8817 |
| 5L-3S | | MI | 5276 | 2444 | 8657 | 1727 | 9340 | 1448 | 9725 | 1213 | 10215 | 840 | 11872 | 600 | 7481 |
| 12-#10 | 2.66 | MA | 5979 | 2444 | 9333 | 1792 | 9935 | 1509 | 10156 | 1267 | 10252 | 894 | 11880 | 481 | 8553 |
| 6L-2S | | MI | 5401 | 2444 | 9030 | 1719 | 9818 | 1431 | 10308 | 1197 | 11008 | 828 | 12943 | 690 | 7464 |
| 12-#11 | 3.27 | MA | 6501 | 2540 | 10771 | 1806 | 11776 | 1511 | 12412 | 1256 | 13332 | 847 | 15949 | 598 | 10896 |
| 3L-5S | | MI | 5232 | 2540 | 8416 | 1803 | 8980 | 1507 | 9257 | 1252 | 9548 | 838 | 10987 | 414 | 8583 |
| 12-#11 | 3.27 | MA | 6406 | 2540 | 10346 | 1830 | 11226 | 1519 | 11736 | 1263 | 12452 | 864 | 14811 | 535 | 10858 |
| 4E | | MI | 5362 | 2540 | 8708 | 1795 | 9368 | 1488 | 9741 | 1234 | 10262 | 838 | 11861 | 477 | 8953 |
| 12-#11 | 3.27 | MA | 6242 | 2540 | 9990 | 1841 | 10752 | 1541 | 11144 | 1284 | 11576 | 867 | 13671 | 473 | 10397 |
| 5L-3S | | MI | 5431 | 2540 | 9053 | 1773 | 9816 | 1482 | 10291 | 1231 | 10978 | 825 | 12742 | 535 | 8965 |
| 12-#11 | 3.27 | MA | 6123 | 2540 | 9642 | 1848 | 10280 | 1550 | 10557 | 1290 | 10787 | 884 | 12632 | 400 | 10113 |
| 6L-2S | | MI | 5578 | 2540 | 9501 | 1765 | 10389 | 1462 | 10990 | 1213 | 11930 | 812 | 13996 | 645 | 8949 |
| 12-#14 | 4.72 | MA | 6882 | 2770 | 11357 | 1978 | 12494 | 1626 | 13271 | 1329 | 14552 | 852 | 17613 | 412 | 14757 |
| 4E | | MI | 5738 | 2770 | 9512 | 1939 | 10373 | 1590 | 10957 | 1296 | 11926 | 822 | 13934 | 330 | 12017 |
| 12-#14 | 4.72 | MA | 6653 | 2770 | 10848 | 1992 | 11817 | 1657 | 12425 | 1357 | 13301 | 856 | 16013 | 322 | 14126 |
| 5L-3S | | MI | 5832 | 2770 | 10004 | 1908 | 11011 | 1583 | 11739 | 1291 | 12944 | 805 | 15165 | 411 | 12514 |
| 14-#10 | 3.11 | MA | 6499 | 2514 | 10731 | 1801 | 11760 | 1495 | 12408 | 1256 | 13335 | 854 | 15958 | 630 | 10494 |
| 3L-6S | | MI | 5187 | 2514 | 8255 | 1814 | 8806 | 1508 | 9054 | 1256 | 9289 | 860 | 10765 | 432 | 8251 |
| 14-#10 | 3.11 | MA | 6416 | 2514 | 10380 | 1821 | 11306 | 1514 | 11849 | 1262 | 12607 | 869 | 15026 | 579 | 10471 |
| 4L-5S | | MI | 5265 | 2514 | 8502 | 1797 | 9126 | 1502 | 9451 | 1252 | 9822 | 848 | 11448 | 489 | 8423 |
| 14-#10 | 3.11 | MA | 6280 | 2514 | 10087 | 1830 | 10915 | 1521 | 11360 | 1280 | 11884 | 873 | 14088 | 532 | 10204 |
| 5L-4S | | MI | 5373 | 2514 | 8743 | 1789 | 9447 | 1485 | 9852 | 1236 | 10414 | 847 | 12194 | 540 | 8645 |
| 14-#10 | 3.11 | MA | 6183 | 2514 | 9794 | 1836 | 10525 | 1540 | 10876 | 1286 | 11233 | 888 | 13237 | 473 | 9953 |
| 6L-3S | | MI | 5434 | 2514 | 9030 | 1771 | 9818 | 1480 | 10308 | 1232 | 11008 | 835 | 12943 | 589 | 8650 |
| 14-#10 | 3.11 | MA | 6083 | 2514 | 9463 | 1852 | 10146 | 1546 | 10414 | 1304 | 10598 | 903 | 12356 | 434 | 9611 |
| 7L-2S | | MI | 5558 | 2514 | 9403 | 1763 | 10296 | 1463 | 10891 | 1217 | 11801 | 822 | 14014 | 678 | 8638 |
| 14-#11 | 3.82 | MA | 6644 | 2627 | 10902 | 1884 | 11938 | 1558 | 12605 | 1287 | 13634 | 857 | 16447 | 525 | 12575 |
| 4L-5S | | MI | 5422 | 2627 | 8863 | 1857 | 9554 | 1546 | 9957 | 1276 | 10500 | 831 | 12241 | 397 | 9925 |
| 14-#11 | 3.82 | MA | 6483 | 2627 | 10546 | 1895 | 11464 | 1580 | 12012 | 1307 | 12758 | 860 | 15307 | 463 | 12071 |
| 5L-4S | | MI | 5551 | 2627 | 9155 | 1849 | 9941 | 1526 | 10441 | 1258 | 11214 | 831 | 13115 | 460 | 10288 |
| 14-#11 | 3.82 | MA | 6366 | 2627 | 10198 | 1902 | 10992 | 1588 | 11425 | 1314 | 11969 | 877 | 14268 | 391 | 11766 |
| 6L-3S | | MI | 5619 | 2627 | 9501 | 1827 | 10389 | 1520 | 10990 | 1254 | 11930 | 818 | 13996 | 517 | 10365 |
| 14-#14 | 5.51 | MA | 6992 | 2894 | 11638 | 2070 | 12830 | 1713 | 13660 | 1391 | 14982 | 846 | 18309 | 305 | 16521 |
| 5L-4S | | MI | 6003 | 2894 | 10146 | 2017 | 11187 | 1646 | 11949 | 1329 | 13276 | 812 | 15679 | 301 | 13898 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

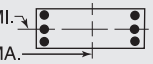
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 3.55 | MA | 6615 | 2585 | 10841 | 1865 | 11896 | 1545 | 12570 | 1281 | 13587 | 864 | 16383 | 571 | 11899 |
| 4L-6S | | MI | 5347 | 2585 | 8627 | 1858 | 9284 | 1540 | 9637 | 1275 | 10082 | 855 | 11836 | 421 | 9382 |
| 16-#10 | 3.55 | MA | 6481 | 2585 | 10548 | 1874 | 11505 | 1553 | 12081 | 1299 | 12864 | 867 | 15445 | 524 | 11595 |
| 5E | | MI | 5424 | 2585 | 8875 | 1841 | 9604 | 1534 | 10034 | 1271 | 10616 | 842 | 12519 | 478 | 9544 |
| 16-#10 | 3.55 | MA | 6385 | 2585 | 10254 | 1880 | 11116 | 1572 | 11597 | 1305 | 12213 | 882 | 14595 | 466 | 11356 |
| 6L-4S | | MI | 5532 | 2585 | 9116 | 1833 | 9925 | 1517 | 10435 | 1255 | 11207 | 841 | 13265 | 529 | 9803 |
| 16-#10 | 3.55 | MA | 6287 | 2585 | 9924 | 1896 | 10737 | 1578 | 11134 | 1323 | 11578 | 897 | 13713 | 426 | 10997 |
| 7L-3S | | MI | 5592 | 2585 | 9403 | 1815 | 10296 | 1511 | 10891 | 1251 | 11801 | 829 | 14014 | 578 | 9817 |
| 16-#11 | 4.36 | MA | 6722 | 2713 | 11101 | 1948 | 12176 | 1619 | 12881 | 1331 | 13940 | 853 | 16944 | 454 | 13751 |
| 5E | | MI | 5611 | 2713 | 9311 | 1911 | 10127 | 1585 | 10657 | 1299 | 11452 | 824 | 13495 | 379 | 11272 |
| 16-#11 | 4.36 | MA | 6608 | 2713 | 10753 | 1956 | 11704 | 1627 | 12294 | 1337 | 13151 | 870 | 15904 | 381 | 13420 |
| 6L-4S | | MI | 5739 | 2713 | 9603 | 1903 | 10515 | 1565 | 11140 | 1281 | 12166 | 825 | 14369 | 442 | 11613 |
| 18-#10 | 4.00 | MA | 6681 | 2655 | 11008 | 1918 | 12096 | 1584 | 12801 | 1318 | 13844 | 862 | 16803 | 516 | 12989 |
| 5L-6S | | MI | 5507 | 2655 | 9000 | 1902 | 9762 | 1571 | 10220 | 1294 | 10876 | 849 | 12906 | 410 | 10516 |
| 18-#10 | 4.00 | MA | 6587 | 2655 | 10715 | 1924 | 11707 | 1603 | 12317 | 1324 | 13193 | 877 | 15952 | 458 | 12762 |
| 6L-5S | | MI | 5583 | 2655 | 9248 | 1885 | 10082 | 1566 | 10617 | 1290 | 11409 | 837 | 13589 | 467 | 10669 |
| 18-#10 | 4.00 | MA | 6489 | 2655 | 10384 | 1940 | 11327 | 1610 | 11855 | 1342 | 12559 | 892 | 15070 | 418 | 12385 |
| 7L-4S | | MI | 5689 | 2655 | 9489 | 1877 | 10403 | 1548 | 11018 | 1275 | 12001 | 836 | 14335 | 518 | 10959 |
| 18-#11 | 4.91 | MA | 6849 | 2799 | 11309 | 2010 | 12416 | 1666 | 13162 | 1361 | 14332 | 863 | 17540 | 372 | 15079 |
| 6L-5S | | MI | 5800 | 2799 | 9758 | 1965 | 10701 | 1623 | 11356 | 1323 | 12405 | 817 | 14749 | 362 | 12624 |
| 20-#10 | 4.44 | MA | 6787 | 2725 | 11176 | 1968 | 12297 | 1635 | 13037 | 1343 | 14173 | 871 | 17309 | 450 | 14170 |
| 6E | | MI | 5667 | 2725 | 9373 | 1946 | 10240 | 1603 | 10803 | 1313 | 11669 | 843 | 13977 | 399 | 11651 |
| 20-#10 | 4.44 | MA | 6689 | 2725 | 10845 | 1983 | 11918 | 1641 | 12575 | 1361 | 13539 | 886 | 16428 | 411 | 13777 |
| 7L-5S | | MI | 5741 | 2725 | 9621 | 1929 | 10560 | 1597 | 11201 | 1309 | 12203 | 831 | 14660 | 456 | 11797 |

## RECTANGULAR TIED COLUMNS 22" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.01 | MA | 6634 | 2351 | 10458 | 1707 | 11092 | 1441 | 11282 | 1236 | 11236 | 932 | 12653 | 811 | 4205 |
| 2E | | MI | 5172 | 2351 | 8235 | 1660 | 8629 | 1401 | 8714 | 1201 | 8600 | 905 | 9478 | 771 | 3271 |
| 4-#14 | 1.46 | MA | 6853 | 2427 | 10997 | 1745 | 11754 | 1468 | 12079 | 1250 | 12314 | 921 | 14140 | 798 | 5897 |
| 2E | | MI | 5325 | 2427 | 8626 | 1696 | 9105 | 1426 | 9284 | 1214 | 9371 | 892 | 10424 | 742 | 4536 |
| 4-#18 | 2.60 | MA | 7382 | 2621 | 12309 | 1849 | 13383 | 1539 | 14043 | 1290 | 14974 | 895 | 17643 | 752 | 10020 |
| 2E | | MI | 5693 | 2621 | 9566 | 1795 | 10261 | 1493 | 10675 | 1249 | 11255 | 863 | 12624 | 657 | 7568 |
| 6-#10 | 1.24 | MA | 6768 | 2389 | 10723 | 1743 | 11469 | 1469 | 11760 | 1255 | 11895 | 937 | 13573 | 813 | 5095 |
| 2L-3S | | MI | 5139 | 2389 | 8061 | 1707 | 8441 | 1449 | 8499 | 1239 | 8315 | 923 | 9162 | 692 | 3964 |
| 6-#10 | 1.24 | MA | 6582 | 2389 | 10218 | 1752 | 10822 | 1477 | 10971 | 1274 | 10822 | 953 | 12086 | 729 | 5123 |
| 3L-2S | | MI | 5271 | 2389 | 8434 | 1700 | 8919 | 1432 | 9082 | 1223 | 9109 | 911 | 10233 | 781 | 3935 |
| 6-#11 | 1.52 | MA | 6898 | 2437 | 11068 | 1761 | 11873 | 1480 | 12235 | 1259 | 12533 | 926 | 14448 | 802 | 6147 |
| 2L-3S | | MI | 5205 | 2437 | 8235 | 1722 | 8629 | 1460 | 8714 | 1242 | 8600 | 911 | 9478 | 644 | 4761 |
| 6-#11 | 1.52 | MA | 6677 | 2437 | 10458 | 1772 | 11092 | 1489 | 11282 | 1281 | 11236 | 944 | 12653 | 695 | 6182 |
| 3L-2S | | MI | 5360 | 2437 | 8683 | 1714 | 9203 | 1440 | 9413 | 1225 | 9552 | 898 | 10732 | 754 | 4722 |
| 6-#14 | 2.19 | MA | 7225 | 2552 | 11864 | 1823 | 12867 | 1524 | 13436 | 1284 | 14160 | 911 | 16697 | 784 | 8644 |
| 2L-3S | | MI | 5375 | 2552 | 8626 | 1785 | 9105 | 1509 | 9284 | 1272 | 9371 | 900 | 10424 | 555 | 6619 |
| 6-#14 | 2.19 | MA | 6919 | 2552 | 10997 | 1838 | 11754 | 1556 | 12079 | 1314 | 12314 | 936 | 14140 | 627 | 8676 |
| 3L-2S | | MI | 5590 | 2552 | 9261 | 1774 | 9918 | 1482 | 10276 | 1248 | 10721 | 882 | 12169 | 713 | 6570 |
| 6-#18 | 3.90 | MA | 8013 | 2842 | 13813 | 1987 | 15311 | 1639 | 16394 | 1350 | 18174 | 877 | 21988 | 719 | 14743 |
| 2L-3S | | MI | 5783 | 2842 | 9566 | 1948 | 10261 | 1637 | 10675 | 1347 | 11255 | 870 | 12624 | 310 | 11013 |
| 6-#18 | 3.90 | MA | 7506 | 2842 | 12309 | 2011 | 13383 | 1693 | 14043 | 1400 | 14974 | 917 | 17643 | 438 | 14653 |
| 3L-2S | | MI | 6139 | 2842 | 10655 | 1933 | 11657 | 1593 | 12377 | 1310 | 13572 | 845 | 15507 | 591 | 11016 |
| 8-#8 | 1.03 | MA | 6665 | 2353 | 10457 | 1729 | 11156 | 1460 | 11389 | 1252 | 11398 | 945 | 12890 | 822 | 4286 |
| 2L-4S | | MI | 5074 | 2353 | 7823 | 1705 | 8159 | 1440 | 8164 | 1235 | 7881 | 937 | 8640 | 710 | 3363 |
| 8-#8 | 1.03 | MA | 6547 | 2353 | 10139 | 1735 | 10749 | 1465 | 10893 | 1264 | 10723 | 955 | 11954 | 770 | 4303 |
| 3E | | MI | 5115 | 2353 | 8003 | 1693 | 8393 | 1436 | 8451 | 1232 | 8255 | 929 | 9119 | 742 | 3341 |
| 8-#8 | 1.03 | MA | 6484 | 2353 | 9899 | 1748 | 10437 | 1478 | 10510 | 1269 | 10224 | 965 | 11323 | 739 | 4323 |
| 4L-2S | | MI | 5199 | 2353 | 8239 | 1688 | 8695 | 1425 | 8819 | 1222 | 8756 | 920 | 9807 | 797 | 3325 |
| 8-#9 | 1.30 | MA | 6808 | 2399 | 10796 | 1754 | 11578 | 1477 | 11899 | 1262 | 12088 | 938 | 13842 | 814 | 5347 |
| 2L-4S | | MI | 5146 | 2399 | 7967 | 1733 | 8330 | 1460 | 8367 | 1247 | 8159 | 934 | 9013 | 676 | 4172 |

## RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

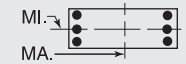
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.30 | MA | 6661 | 2399 | 10396 | 1762 | 11066 | 1484 | 11274 | 1276 | 11237 | 951 | 12664 | 748 | 5367 |
| 3E | | MI | 5196 | 2399 | 8194 | 1718 | 8625 | 1455 | 8729 | 1243 | 8630 | 924 | 9612 | 715 | 4145 |
| 8-#9 | 1.30 | MA | 6583 | 2399 | 10094 | 1778 | 10673 | 1500 | 10791 | 1282 | 10609 | 964 | 11867 | 709 | 5388 |
| 4L-2S | | MI | 5301 | 2399 | 8490 | 1712 | 9004 | 1441 | 9192 | 1230 | 9260 | 914 | 10469 | 786 | 4123 |
| 8-#10 | 1.65 | MA | 6989 | 2459 | 11227 | 1787 | 12116 | 1500 | 12549 | 1275 | 12969 | 931 | 15059 | 805 | 6693 |
| 2L-4S | | MI | 5237 | 2459 | 8147 | 1770 | 8548 | 1486 | 8626 | 1262 | 8515 | 930 | 9484 | 631 | 5185 |
| 8-#10 | 1.65 | MA | 6806 | 2459 | 10723 | 1796 | 11469 | 1509 | 11760 | 1293 | 11895 | 947 | 13573 | 721 | 6715 |
| 3E | | MI | 5300 | 2459 | 8434 | 1751 | 8919 | 1480 | 9082 | 1258 | 9109 | 918 | 10233 | 680 | 5157 |
| 8-#10 | 1.65 | MA | 6709 | 2459 | 10340 | 1817 | 10973 | 1528 | 11150 | 1300 | 11101 | 963 | 12563 | 671 | 6727 |
| 4L-2S | | MI | 5429 | 2459 | 8807 | 1744 | 9397 | 1463 | 9665 | 1242 | 9902 | 905 | 11303 | 770 | 5130 |
| 8-#11 | 2.03 | MA | 7161 | 2523 | 11677 | 1815 | 12654 | 1519 | 13188 | 1283 | 13829 | 919 | 16243 | 792 | 8073 |
| 2L-4S | | MI | 5325 | 2523 | 8337 | 1798 | 8755 | 1505 | 8864 | 1270 | 8836 | 918 | 9851 | 569 | 6214 |
| 8-#11 | 2.03 | MA | 6945 | 2523 | 11068 | 1826 | 11873 | 1528 | 12235 | 1305 | 12533 | 937 | 14448 | 685 | 8098 |
| 3E | | MI | 5396 | 2523 | 8683 | 1776 | 9203 | 1499 | 9413 | 1266 | 9552 | 904 | 10732 | 627 | 6186 |
| 8-#11 | 2.03 | MA | 6832 | 2523 | 10604 | 1850 | 11272 | 1551 | 11496 | 1312 | 11570 | 955 | 13215 | 623 | 8094 |
| 4L-2S | | MI | 5548 | 2523 | 9130 | 1768 | 9776 | 1479 | 10113 | 1248 | 10504 | 891 | 11986 | 737 | 6153 |
| 8-#14 | 2.92 | MA | 7594 | 2676 | 12732 | 1901 | 13979 | 1580 | 14793 | 1318 | 16007 | 901 | 19253 | 770 | 11373 |
| 2L-4S | | MI | 5546 | 2676 | 8768 | 1893 | 9281 | 1572 | 9494 | 1310 | 9703 | 907 | 10938 | 445 | 8450 |
| 8-#14 | 2.92 | MA | 7296 | 2676 | 11864 | 1916 | 12867 | 1612 | 13436 | 1348 | 14160 | 926 | 16697 | 614 | 11379 |
| 3E | | MI | 5642 | 2676 | 9261 | 1863 | 9918 | 1565 | 10276 | 1305 | 10721 | 890 | 12169 | 526 | 8615 |
| 8-#14 | 2.92 | MA | 7141 | 2676 | 11202 | 1951 | 12008 | 1625 | 12381 | 1358 | 12786 | 951 | 14925 | 523 | 11163 |
| 4L-2S | | MI | 5853 | 2676 | 9895 | 1852 | 10731 | 1538 | 11268 | 1281 | 12071 | 872 | 13915 | 684 | 8583 |
| 8-#18 | 5.19 | MA | 8151 | 3063 | 13813 | 2149 | 15311 | 1793 | 16394 | 1460 | 18174 | 899 | 21988 | 405 | 19290 |
| 3E | | MI | 6237 | 3063 | 10655 | 2086 | 11657 | 1736 | 12377 | 1408 | 13572 | 852 | 15507 | 244 | 14372 |
| 8-#18 | 5.19 | MA | 7897 | 3063 | 12658 | 2209 | 13815 | 1812 | 14557 | 1474 | 15781 | 939 | 18953 | 249 | 17301 |
| 4L-2S | | MI | 6583 | 3063 | 11743 | 2071 | 13053 | 1692 | 14080 | 1370 | 15889 | 828 | 18390 | 525 | 14435 |
| 10-#10 | 2.06 | MA | 7208 | 2530 | 11732 | 1831 | 12763 | 1532 | 13338 | 1294 | 14043 | 925 | 16546 | 798 | 8283 |
| 2L-5S | | MI | 5286 | 2530 | 8279 | 1821 | 8705 | 1535 | 8809 | 1297 | 8716 | 925 | 9808 | 569 | 6289 |
| 10-#10 | 2.06 | MA | 7028 | 2530 | 11227 | 1840 | 12116 | 1540 | 12549 | 1312 | 12969 | 941 | 15059 | 713 | 8299 |
| 3L-4S | | MI | 5397 | 2530 | 8520 | 1814 | 9026 | 1518 | 9209 | 1281 | 9308 | 924 | 10555 | 620 | 6358 |
| 10-#10 | 2.06 | MA | 6932 | 2530 | 10845 | 1861 | 11620 | 1560 | 11939 | 1319 | 12175 | 957 | 14049 | 663 | 8298 |
| 4L-3S | | MI | 5459 | 2530 | 8807 | 1795 | 9397 | 1512 | 9665 | 1277 | 9902 | 912 | 11303 | 669 | 6339 |
| 10-#10 | 2.06 | MA | 6778 | 2530 | 10525 | 1871 | 11194 | 1568 | 11406 | 1338 | 11386 | 962 | 13030 | 619 | 8172 |
| 5L-2S | | MI | 5587 | 2530 | 9179 | 1787 | 9875 | 1495 | 10249 | 1262 | 10695 | 900 | 12374 | 759 | 6316 |
| 10-#11 | 2.53 | MA | 7422 | 2610 | 12286 | 1869 | 13435 | 1557 | 14141 | 1306 | 15126 | 912 | 18039 | 782 | 9991 |
| 2L-5S | | MI | 5383 | 2610 | 8493 | 1860 | 8941 | 1563 | 9080 | 1311 | 9074 | 910 | 10230 | 489 | 7354 |
| 10-#11 | 2.53 | MA | 7210 | 2610 | 11677 | 1880 | 12654 | 1567 | 13188 | 1328 | 13829 | 930 | 16243 | 676 | 10007 |
| 3L-4S | | MI | 5515 | 2610 | 8784 | 1852 | 9329 | 1543 | 9563 | 1293 | 9788 | 911 | 11105 | 552 | 7615 |
| 10-#11 | 2.53 | MA | 7099 | 2610 | 11213 | 1904 | 12053 | 1590 | 12449 | 1336 | 12867 | 948 | 15010 | 614 | 9982 |
| 4L-3S | | MI | 5585 | 2610 | 9130 | 1830 | 9776 | 1537 | 10113 | 1289 | 10504 | 898 | 11986 | 610 | 7600 |
| 10-#11 | 2.53 | MA | 6916 | 2610 | 10825 | 1915 | 11535 | 1599 | 11803 | 1357 | 11910 | 953 | 13769 | 555 | 9602 |
| 5L-2S | | MI | 5735 | 2610 | 9578 | 1822 | 10350 | 1518 | 10813 | 1272 | 11456 | 884 | 13240 | 719 | 7573 |
| 10-#14 | 3.65 | MA | 7671 | 2801 | 12732 | 1994 | 13979 | 1668 | 14793 | 1382 | 16007 | 916 | 19253 | 600 | 14075 |
| 3L-4S | | MI | 5814 | 2801 | 9403 | 1971 | 10094 | 1628 | 10486 | 1343 | 11053 | 897 | 12683 | 416 | 10298 |
| 10-#14 | 3.65 | MA | 7518 | 2801 | 12070 | 2029 | 13121 | 1681 | 13738 | 1392 | 14633 | 941 | 17482 | 509 | 13731 |
| 4L-3S | | MI | 5909 | 2801 | 9895 | 1940 | 10731 | 1621 | 11268 | 1339 | 12071 | 880 | 13915 | 497 | 10599 |
| 10-#14 | 3.65 | MA | 7260 | 2801 | 11515 | 2044 | 12381 | 1713 | 12814 | 1422 | 13266 | 947 | 15705 | 422 | 12927 |
| 5L-2S | | MI | 6116 | 2801 | 10529 | 1930 | 11545 | 1594 | 12260 | 1315 | 13421 | 862 | 15660 | 655 | 10583 |
| 10-#18 | 6.49 | MA | 8541 | 3285 | 14162 | 2347 | 15743 | 1911 | 16909 | 1534 | 18981 | 922 | 23298 | 217 | 21807 |
| 4L-3S | | MI | 6688 | 3285 | 11743 | 2225 | 13053 | 1835 | 14080 | 1468 | 15889 | 835 | 18390 | 178 | 17668 |
| 12-#10 | 2.47 | MA | 7426 | 2600 | 12236 | 1875 | 13410 | 1563 | 14127 | 1313 | 15116 | 920 | 18033 | 790 | 9868 |
| 2L-6S | | MI | 5367 | 2600 | 8404 | 1882 | 8863 | 1572 | 8995 | 1320 | 8976 | 932 | 10196 | 502 | 7210 |
| 12-#10 | 2.47 | MA | 7249 | 2600 | 11732 | 1884 | 12763 | 1572 | 13338 | 1331 | 14043 | 936 | 16546 | 705 | 9879 |
| 3L-5S | | MI | 5447 | 2600 | 8652 | 1865 | 9183 | 1566 | 9392 | 1316 | 9510 | 920 | 10879 | 558 | 7399 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis

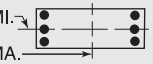



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 2.47 | MA | 7154 | 2600 | 11349 | 1905 | 12267 | 1591 | 12728 | 1338 | 13248 | 952 | 15536 | 656 | 9866 |
| 4E | | MI | 5557 | 2600 | 8893 | 1857 | 9504 | 1549 | 9792 | 1300 | 10101 | 919 | 11625 | 609 | 7527 |
| 12-#10 | 2.47 | MA | 7002 | 2600 | 11030 | 1915 | 11841 | 1600 | 12196 | 1357 | 12459 | 956 | 14517 | 611 | 9686 |
| 5L-3S | | MI | 5618 | 2600 | 9179 | 1839 | 9875 | 1544 | 10249 | 1296 | 10695 | 907 | 12374 | 658 | 7514 |
| 12-#10 | 2.47 | MA | 6892 | 2600 | 10704 | 1920 | 11417 | 1619 | 11668 | 1364 | 11750 | 972 | 13596 | 553 | 9372 |
| 6L-2S | | MI | 5744 | 2600 | 9552 | 1831 | 10353 | 1526 | 10832 | 1281 | 11489 | 894 | 13445 | 748 | 7495 |
| 12-#11 | 3.04 | MA | 7474 | 2696 | 12286 | 1934 | 13435 | 1606 | 14141 | 1352 | 15126 | 923 | 18039 | 666 | 11907 |
| 3L-5S | | MI | 5574 | 2696 | 8940 | 1914 | 9514 | 1602 | 9779 | 1334 | 10026 | 904 | 11484 | 471 | 8689 |
| 12-#11 | 3.04 | MA | 7365 | 2696 | 11823 | 1958 | 12834 | 1629 | 13402 | 1359 | 14163 | 942 | 16805 | 604 | 11869 |
| 4E | | MI | 5704 | 2696 | 9232 | 1906 | 9902 | 1582 | 10263 | 1317 | 10740 | 904 | 12359 | 534 | 9005 |
| 12-#11 | 3.04 | MA | 7184 | 2696 | 11435 | 1969 | 12317 | 1638 | 12756 | 1381 | 13207 | 946 | 15565 | 546 | 11434 |
| 5L-3S | | MI | 5774 | 2696 | 9578 | 1884 | 10350 | 1576 | 10813 | 1313 | 11456 | 891 | 13240 | 592 | 9006 |
| 12-#11 | 3.04 | MA | 7052 | 2696 | 11047 | 1976 | 11802 | 1661 | 12115 | 1389 | 12346 | 964 | 14439 | 474 | 11097 |
| 6L-2S | | MI | 5922 | 2696 | 10025 | 1876 | 10924 | 1556 | 11513 | 1295 | 12408 | 877 | 14494 | 702 | 8987 |
| 12-#14 | 4.38 | MA | 7892 | 2925 | 12938 | 2107 | 14233 | 1736 | 15095 | 1426 | 16479 | 931 | 20039 | 496 | 16314 |
| 4E | | MI | 6080 | 2925 | 10037 | 2049 | 10908 | 1684 | 11478 | 1377 | 12402 | 887 | 14429 | 387 | 12163 |
| 12-#14 | 4.38 | MA | 7639 | 2925 | 12383 | 2122 | 13494 | 1769 | 14171 | 1456 | 15113 | 937 | 18262 | 408 | 15554 |
| 5L-3S | | MI | 6174 | 2925 | 10529 | 2018 | 11545 | 1677 | 12260 | 1373 | 13421 | 870 | 15660 | 468 | 12571 |
| 12-#14 | 4.38 | MA | 7454 | 2925 | 11837 | 2132 | 12757 | 1782 | 13255 | 1466 | 13882 | 962 | 16644 | 304 | 14689 |
| 6L-2S | | MI | 6377 | 2925 | 11164 | 2008 | 12358 | 1649 | 13252 | 1349 | 14770 | 852 | 17406 | 627 | 12575 |
| 14-#10 | 2.89 | MA | 7469 | 2670 | 12236 | 1928 | 13410 | 1603 | 14127 | 1350 | 15116 | 930 | 18033 | 698 | 11454 |
| 3L-6S | | MI | 5529 | 2670 | 8777 | 1926 | 9341 | 1604 | 9578 | 1339 | 9769 | 926 | 11267 | 491 | 8337 |
| 14-#10 | 2.89 | MA | 7375 | 2670 | 11854 | 1949 | 12914 | 1623 | 13517 | 1358 | 14322 | 946 | 17023 | 648 | 11431 |
| 4L-5S | | MI | 5607 | 2670 | 9025 | 1909 | 9661 | 1598 | 9975 | 1335 | 10303 | 914 | 11950 | 547 | 8514 |
| 14-#10 | 2.89 | MA | 7225 | 2670 | 11535 | 1959 | 12488 | 1631 | 12985 | 1376 | 13533 | 951 | 16003 | 603 | 11206 |
| 5L-4S | | MI | 5716 | 2670 | 9266 | 1901 | 9982 | 1581 | 10376 | 1320 | 10895 | 913 | 12696 | 598 | 8688 |
| 14-#10 | 2.89 | MA | 7117 | 2670 | 11209 | 1964 | 12064 | 1651 | 12457 | 1383 | 12824 | 967 | 15083 | 545 | 10907 |
| 6L-3S | | MI | 5776 | 2670 | 9552 | 1883 | 10353 | 1575 | 10832 | 1315 | 11489 | 901 | 13445 | 647 | 8685 |
| 14-#10 | 2.89 | MA | 7005 | 2670 | 10848 | 1980 | 11642 | 1657 | 11953 | 1402 | 12132 | 983 | 14126 | 509 | 10592 |
| 7L-2S | | MI | 5901 | 2670 | 9925 | 1875 | 10831 | 1558 | 11415 | 1300 | 12282 | 889 | 14515 | 737 | 8671 |
| 14-#11 | 3.55 | MA | 7629 | 2782 | 12432 | 2012 | 13615 | 1667 | 14355 | 1383 | 15460 | 935 | 18600 | 595 | 13755 |
| 4L-5S | | MI | 5764 | 2782 | 9388 | 1968 | 10088 | 1641 | 10479 | 1358 | 10978 | 897 | 12739 | 454 | 10029 |
| 14-#11 | 3.55 | MA | 7450 | 2782 | 12044 | 2023 | 13098 | 1677 | 13709 | 1404 | 14503 | 939 | 17360 | 536 | 13273 |
| 5L-4S | | MI | 5893 | 2782 | 9679 | 1960 | 10476 | 1621 | 10963 | 1340 | 11693 | 897 | 13613 | 517 | 10394 |
| 14-#11 | 3.55 | MA | 7322 | 2782 | 11656 | 2030 | 12583 | 1700 | 13068 | 1412 | 13642 | 958 | 16234 | 465 | 12953 |
| 6L-3S | | MI | 5962 | 2782 | 10025 | 1938 | 10924 | 1615 | 11513 | 1336 | 12408 | 884 | 14494 | 575 | 10408 |
| 14-#11 | 3.55 | MA | 7190 | 2782 | 11219 | 2050 | 12081 | 1708 | 12456 | 1434 | 12803 | 976 | 15068 | 416 | 12371 |
| 7L-2S | | MI | 6108 | 2782 | 10473 | 1930 | 11497 | 1595 | 12213 | 1319 | 13361 | 870 | 15748 | 685 | 10395 |
| 14-#14 | 5.11 | MA | 8015 | 3050 | 13251 | 2200 | 14606 | 1825 | 15528 | 1490 | 16959 | 927 | 20819 | 395 | 18189 |
| 5L-4S | | MI | 6345 | 3050 | 10672 | 2127 | 11721 | 1740 | 12470 | 1411 | 13752 | 877 | 16174 | 359 | 14040 |
| 14-#14 | 5.11 | MA | 7836 | 3050 | 12704 | 2210 | 13870 | 1838 | 14612 | 1500 | 15728 | 952 | 19201 | 290 | 17297 |
| 6L-3S | | MI | 6438 | 3050 | 11164 | 2096 | 12358 | 1733 | 13252 | 1407 | 14770 | 860 | 17406 | 439 | 14540 |
| 16-#10 | 3.30 | MA | 7595 | 2740 | 12359 | 1993 | 13561 | 1654 | 14307 | 1377 | 15396 | 941 | 18509 | 640 | 12996 |
| 4L-6S | | MI | 5689 | 2740 | 9150 | 1970 | 9819 | 1635 | 10161 | 1358 | 10563 | 921 | 12337 | 479 | 9468 |
| 16-#10 | 3.30 | MA | 7447 | 2740 | 12039 | 2002 | 13135 | 1663 | 13774 | 1395 | 14607 | 945 | 17490 | 595 | 12731 |
| 5E | | MI | 5767 | 2740 | 9397 | 1953 | 10139 | 1630 | 10558 | 1354 | 11096 | 909 | 13020 | 536 | 9634 |
| 16-#10 | 3.30 | MA | 7341 | 2740 | 11714 | 2008 | 12711 | 1682 | 13246 | 1402 | 13897 | 961 | 16570 | 538 | 12446 |
| 6L-4S | | MI | 5874 | 2740 | 9639 | 1945 | 10460 | 1612 | 10959 | 1339 | 11688 | 908 | 13766 | 587 | 9848 |
| 16-#10 | 3.30 | MA | 7229 | 2740 | 11352 | 2024 | 12289 | 1688 | 12742 | 1421 | 13206 | 977 | 15613 | 501 | 12113 |
| 7L-3S | | MI | 5934 | 2740 | 9925 | 1927 | 10831 | 1607 | 11415 | 1335 | 12282 | 895 | 14515 | 636 | 9854 |
| 16-#10 | 3.30 | MA | 7103 | 2740 | 11035 | 2031 | 11851 | 1704 | 12247 | 1438 | 12470 | 982 | 14564 | 435 | 11720 |
| 8L-2S | | MI | 6057 | 2740 | 10298 | 1919 | 11309 | 1590 | 11998 | 1319 | 13075 | 883 | 15586 | 726 | 9843 |
| 16-#11 | 4.05 | MA | 7715 | 2869 | 12653 | 2077 | 13879 | 1716 | 14661 | 1428 | 15800 | 932 | 19155 | 527 | 15117 |
| 5E | | MI | 5954 | 2869 | 9835 | 2022 | 10662 | 1679 | 11179 | 1382 | 11931 | 890 | 13993 | 437 | 11375 |
| 16-#11 | 4.05 | MA | 7589 | 2869 | 12266 | 2084 | 13364 | 1739 | 14021 | 1436 | 14939 | 951 | 18029 | 455 | 14812 |
| 6L-4S | | MI | 6081 | 2869 | 10127 | 2014 | 11049 | 1660 | 11663 | 1364 | 12645 | 890 | 14867 | 500 | 11732 |
| 16-#11 | 4.05 | MA | 7459 | 2869 | 11828 | 2104 | 12862 | 1746 | 13409 | 1457 | 14100 | 969 | 16863 | 407 | 14212 |
| 7L-3S | | MI | 6149 | 2869 | 10473 | 1992 | 11497 | 1654 | 12213 | 1360 | 13361 | 877 | 15748 | 558 | 11805 |

## RECTANGULAR TIED COLUMNS 22" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 5.84 | MA | 8214 | 3174 | 13572 | 2288 | 14982 | 1893 | 15970 | 1534 | 17575 | 942 | 21758 | 276 | 19911 |
| 6L-4S | | MI | 6610 | 3174 | 11306 | 2204 | 12534 | 1796 | 13462 | 1445 | 15102 | 867 | 17920 | 330 | 15928 |
| 18-#10 | 3.71 | MA | 7667 | 2811 | 12544 | 2046 | 13782 | 1694 | 14563 | 1414 | 15680 | 940 | 18977 | 587 | 14260 |
| 5L-6S | | MI | 5849 | 2811 | 9523 | 2014 | 10297 | 1667 | 10744 | 1378 | 11356 | 915 | 13408 | 468 | 10601 |
| 18-#10 | 3.71 | MA | 7564 | 2811 | 12218 | 2051 | 13358 | 1714 | 14035 | 1421 | 14971 | 956 | 18056 | 530 | 13986 |
| 6L-5S | | MI | 5925 | 2811 | 9770 | 1997 | 10617 | 1661 | 11141 | 1373 | 11890 | 903 | 14091 | 525 | 10758 |
| 18-#10 | 3.71 | MA | 7452 | 2811 | 11857 | 2068 | 12936 | 1720 | 13532 | 1440 | 14280 | 972 | 17100 | 493 | 13638 |
| 7L-4S | | MI | 6032 | 2811 | 10011 | 1989 | 10938 | 1644 | 11542 | 1358 | 12481 | 902 | 14837 | 576 | 11005 |
| 18-#10 | 3.71 | MA | 7328 | 2811 | 11540 | 2075 | 12498 | 1736 | 13036 | 1458 | 13544 | 976 | 16051 | 427 | 13256 |
| 8L-3S | | MI | 6092 | 2811 | 10298 | 1971 | 11309 | 1638 | 11998 | 1354 | 13075 | 890 | 15586 | 625 | 11019 |
| 18-#11 | 4.56 | MA | 7855 | 2955 | 12875 | 2138 | 14145 | 1778 | 14974 | 1459 | 16235 | 944 | 19825 | 446 | 16669 |
| 6L-5S | | MI | 6142 | 2955 | 10283 | 2076 | 11235 | 1718 | 11879 | 1405 | 12883 | 883 | 15247 | 419 | 12726 |
| 18-#11 | 4.56 | MA | 7725 | 2955 | 12437 | 2157 | 13643 | 1785 | 14362 | 1481 | 15396 | 962 | 18659 | 397 | 16056 |
| 7L-4S | | MI | 6269 | 2955 | 10574 | 2068 | 11623 | 1698 | 12363 | 1387 | 13597 | 883 | 16121 | 483 | 13062 |
| 20-#10 | 4.12 | MA | 7785 | 2881 | 12723 | 2095 | 14004 | 1746 | 14824 | 1441 | 16045 | 950 | 19543 | 522 | 15530 |
| 6E | | MI | 6009 | 2881 | 9896 | 2058 | 10775 | 1698 | 11327 | 1397 | 12149 | 910 | 14479 | 457 | 11736 |
| 20-#10 | 4.12 | MA | 7674 | 2881 | 12362 | 2112 | 13583 | 1751 | 14321 | 1459 | 15353 | 966 | 18586 | 485 | 15165 |
| 7L-5S | | MI | 6084 | 2881 | 10143 | 2041 | 11095 | 1693 | 11724 | 1393 | 12683 | 897 | 15161 | 514 | 11885 |
| 20-#10 | 4.12 | MA | 7552 | 2881 | 12045 | 2118 | 13145 | 1767 | 13825 | 1477 | 14617 | 971 | 17538 | 419 | 14795 |
| 8L-4S | | MI | 6189 | 2881 | 10384 | 2033 | 11416 | 1676 | 12125 | 1377 | 13275 | 896 | 15908 | 565 | 12162 |
| 20-#11 | 5.06 | MA | 7991 | 3041 | 13047 | 2211 | 14425 | 1824 | 15315 | 1504 | 16693 | 955 | 20454 | 388 | 17903 |
| 7L-5S | | MI | 6330 | 3041 | 10730 | 2130 | 11809 | 1757 | 12579 | 1429 | 13835 | 876 | 16501 | 402 | 14079 |
| 22-#10 | 4.54 | MA | 7895 | 2951 | 12866 | 2156 | 14229 | 1783 | 15110 | 1478 | 16427 | 960 | 20073 | 477 | 16695 |
| 7L-6S | | MI | 6168 | 2951 | 10269 | 2102 | 11253 | 1730 | 11910 | 1416 | 12943 | 904 | 15549 | 446 | 12872 |
| 22-#10 | 4.54 | MA | 7775 | 2951 | 12549 | 2162 | 13791 | 1799 | 14614 | 1496 | 15691 | 965 | 19024 | 411 | 16335 |
| 8L-5S | | MI | 6241 | 2951 | 10516 | 2084 | 11573 | 1724 | 12307 | 1412 | 13476 | 892 | 16232 | 503 | 13014 |

## RECTANGULAR TIED COLUMNS 22" x 30"

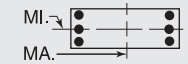
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.36 | MA | 7831 | 2583 | 12489 | 1872 | 13364 | 1576 | 13726 | 1344 | 13955 | 996 | 15990 | 864 | 6383 |
| 2E | | MI | 5668 | 2583 | 9152 | 1806 | 9639 | 1520 | 9805 | 1295 | 9848 | 957 | 10919 | 799 | 4566 |
| 4-#18 | 2.42 | MA | 8416 | 2776 | 13928 | 1975 | 15149 | 1647 | 15879 | 1384 | 16871 | 970 | 20015 | 833 | 10884 |
| 2E | | MI | 6035 | 2776 | 10094 | 1903 | 10795 | 1586 | 11194 | 1330 | 11728 | 927 | 13114 | 713 | 7613 |
| 6-#10 | 1.15 | MA | 7735 | 2545 | 12185 | 1869 | 13046 | 1577 | 13370 | 1349 | 13489 | 1011 | 15358 | 879 | 5506 |
| 2L-3S | | MI | 5482 | 2545 | 8583 | 1819 | 8976 | 1544 | 9023 | 1322 | 8796 | 990 | 9664 | 750 | 3987 |
| 6-#10 | 1.15 | MA | 7530 | 2545 | 11636 | 1879 | 12343 | 1586 | 12512 | 1369 | 12322 | 1028 | 13742 | 796 | 5535 |
| 3L-2S | | MI | 5614 | 2545 | 8956 | 1812 | 9454 | 1527 | 9606 | 1307 | 9589 | 977 | 10734 | 839 | 3958 |
| 6-#11 | 1.42 | MA | 7879 | 2593 | 12564 | 1887 | 13489 | 1588 | 13892 | 1353 | 14189 | 1000 | 16319 | 867 | 6653 |
| 2L-3S | | MI | 5547 | 2593 | 8760 | 1833 | 9164 | 1554 | 9236 | 1325 | 9078 | 977 | 9976 | 702 | 4790 |
| 6-#11 | 1.42 | MA | 7636 | 2593 | 11901 | 1899 | 12639 | 1598 | 12855 | 1376 | 12778 | 1020 | 14365 | 763 | 6687 |
| 3L-2S | | MI | 5703 | 2593 | 9207 | 1825 | 9737 | 1535 | 9936 | 1307 | 10030 | 964 | 11230 | 812 | 4750 |
| 6-#14 | 2.05 | MA | 8240 | 2707 | 13435 | 1950 | 14576 | 1631 | 15205 | 1378 | 15967 | 986 | 18776 | 850 | 9373 |
| 2L-3S | | MI | 5717 | 2707 | 9152 | 1895 | 9639 | 1603 | 9805 | 1353 | 9848 | 965 | 10919 | 612 | 6659 |
| 6-#14 | 2.05 | MA | 7901 | 2707 | 12489 | 1966 | 13364 | 1645 | 13726 | 1409 | 13955 | 1013 | 15990 | 697 | 9405 |
| 3L-2S | | MI | 5933 | 2707 | 9786 | 1884 | 10452 | 1576 | 10797 | 1329 | 11197 | 947 | 12665 | 770 | 6606 |
| 6-#18 | 3.64 | MA | 9110 | 2998 | 15570 | 2113 | 17254 | 1747 | 18447 | 1444 | 20365 | 952 | 24852 | 808 | 16039 |
| 2L-3S | | MI | 6125 | 2998 | 10094 | 2057 | 10795 | 1729 | 11194 | 1428 | 11728 | 934 | 13114 | 366 | 11085 |
| 6-#18 | 3.64 | MA | 8550 | 2998 | 13928 | 2140 | 15149 | 1804 | 15879 | 1496 | 16871 | 996 | 20015 | 527 | 15949 |
| 3L-2S | | MI | 6482 | 2998 | 11182 | 2041 | 12190 | 1685 | 12897 | 1390 | 14045 | 910 | 15997 | 647 | 11067 |
| 8-#9 | 1.21 | MA | 7778 | 2555 | 12264 | 1880 | 13163 | 1585 | 13520 | 1356 | 13696 | 1013 | 15648 | 880 | 5779 |
| 2L-4S | | MI | 5488 | 2555 | 8488 | 1845 | 8865 | 1556 | 8891 | 1330 | 8641 | 1000 | 9516 | 734 | 4195 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis

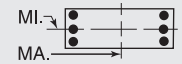



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.21 | MA | 7616 | 2555 | 11830 | 1888 | 12606 | 1592 | 12840 | 1371 | 12772 | 1027 | 14369 | 815 | 5799 |
| 3E | | MI | 5539 | 2555 | 8715 | 1830 | 9159 | 1551 | 9253 | 1326 | 9111 | 990 | 10115 | 774 | 4167 |
| 8-#9 | 1.21 | MA | 7529 | 2555 | 11502 | 1905 | 12181 | 1609 | 12318 | 1377 | 12091 | 1040 | 13511 | 777 | 5820 |
| 4L-2S | | MI | 5644 | 2555 | 9012 | 1824 | 9539 | 1537 | 9716 | 1314 | 9741 | 980 | 10972 | 844 | 4146 |
| 8-#10 | 1.54 | MA | 7977 | 2615 | 12734 | 1913 | 13749 | 1608 | 14228 | 1369 | 14656 | 1006 | 16974 | 871 | 7241 |
| 2L-4S | | MI | 5580 | 2615 | 8670 | 1882 | 9082 | 1582 | 9150 | 1345 | 8995 | 996 | 9986 | 690 | 5215 |
| 8-#10 | 1.54 | MA | 7775 | 2615 | 12185 | 1923 | 13046 | 1617 | 13370 | 1388 | 13489 | 1023 | 15358 | 788 | 7264 |
| 3E | | MI | 5642 | 2615 | 8956 | 1863 | 9454 | 1576 | 9606 | 1341 | 9589 | 984 | 10734 | 739 | 5184 |
| 8-#10 | 1.54 | MA | 7667 | 2615 | 11771 | 1945 | 12509 | 1637 | 12709 | 1396 | 12628 | 1040 | 14271 | 739 | 7276 |
| 4L-2S | | MI | 5772 | 2615 | 9329 | 1856 | 9932 | 1559 | 10189 | 1326 | 10382 | 972 | 11805 | 828 | 5156 |
| 8-#11 | 1.89 | MA | 8168 | 2679 | 13227 | 1941 | 14340 | 1626 | 14930 | 1377 | 15600 | 993 | 18273 | 858 | 8747 |
| 2L-4S | | MI | 5667 | 2679 | 8861 | 1909 | 9289 | 1599 | 9386 | 1352 | 9314 | 983 | 10348 | 627 | 6253 |
| 8-#11 | 1.89 | MA | 7929 | 2679 | 12564 | 1953 | 13489 | 1637 | 13892 | 1399 | 14189 | 1013 | 16319 | 753 | 8772 |
| 3E | | MI | 5738 | 2679 | 9207 | 1887 | 9737 | 1593 | 9936 | 1348 | 10030 | 970 | 11230 | 684 | 6220 |
| 8-#11 | 1.89 | MA | 7803 | 2679 | 12061 | 1978 | 12837 | 1661 | 13091 | 1408 | 13144 | 1032 | 14990 | 692 | 8767 |
| 4L-2S | | MI | 5891 | 2679 | 9655 | 1879 | 10311 | 1573 | 10636 | 1331 | 10982 | 957 | 12484 | 794 | 6185 |
| 8-#14 | 2.73 | MA | 8646 | 2832 | 14381 | 2027 | 15788 | 1687 | 16684 | 1412 | 17979 | 976 | 21562 | 836 | 12345 |
| 2L-4S | | MI | 5888 | 2832 | 9294 | 2003 | 9815 | 1666 | 10015 | 1391 | 10179 | 972 | 11433 | 502 | 8599 |
| 8-#14 | 2.73 | MA | 8316 | 2832 | 13435 | 2044 | 14576 | 1701 | 15205 | 1443 | 15967 | 1003 | 18776 | 683 | 12351 |
| 3E | | MI | 5985 | 2832 | 9786 | 1973 | 10452 | 1659 | 10797 | 1387 | 11197 | 955 | 12665 | 583 | 8660 |
| 8-#14 | 2.73 | MA | 8140 | 2832 | 12716 | 2080 | 13644 | 1735 | 14059 | 1455 | 14475 | 1030 | 16867 | 594 | 12242 |
| 4L-2S | | MI | 6196 | 2832 | 10420 | 1962 | 11266 | 1632 | 11789 | 1363 | 12547 | 937 | 14410 | 742 | 8623 |
| 8-#18 | 4.85 | MA | 9259 | 3219 | 15570 | 2278 | 17254 | 1903 | 18447 | 1557 | 20365 | 978 | 24852 | 502 | 21018 |
| 3E | | MI | 6579 | 3219 | 11182 | 2195 | 12190 | 1829 | 12897 | 1488 | 14045 | 916 | 15997 | 300 | 14451 |
| 8-#18 | 4.85 | MA | 8970 | 3219 | 14315 | 2339 | 15627 | 1925 | 16448 | 1574 | 17761 | 1021 | 21487 | 341 | 19031 |
| 4L-2S | | MI | 6927 | 3219 | 12271 | 2180 | 13586 | 1785 | 14599 | 1451 | 16362 | 892 | 18880 | 582 | 14491 |
| 10-#10 | 1.92 | MA | 8217 | 2685 | 13282 | 1957 | 14453 | 1640 | 15086 | 1388 | 15823 | 1000 | 18590 | 863 | 8968 |
| 2L-5S | | MI | 5629 | 2685 | 8801 | 1933 | 9239 | 1630 | 9333 | 1380 | 9197 | 992 | 10310 | 628 | 6380 |
| 10-#10 | 1.92 | MA | 8019 | 2685 | 12734 | 1967 | 13749 | 1649 | 14228 | 1407 | 14656 | 1017 | 16974 | 781 | 8985 |
| 3L-4S | | MI | 5740 | 2685 | 9043 | 1926 | 9560 | 1613 | 9733 | 1365 | 9789 | 991 | 11056 | 678 | 6392 |
| 10-#10 | 1.92 | MA | 7912 | 2685 | 12319 | 1989 | 13212 | 1669 | 13567 | 1415 | 13795 | 1034 | 15887 | 732 | 8984 |
| 4L-3S | | MI | 5802 | 2685 | 9329 | 1907 | 9932 | 1608 | 10189 | 1360 | 10382 | 978 | 11805 | 728 | 6369 |
| 10-#10 | 1.92 | MA | 7743 | 2685 | 11974 | 1999 | 12751 | 1678 | 12990 | 1434 | 12940 | 1040 | 14786 | 689 | 8917 |
| 5L-2S | | MI | 5930 | 2685 | 9702 | 1899 | 10410 | 1590 | 10772 | 1345 | 11176 | 966 | 12876 | 817 | 6344 |
| 10-#11 | 2.36 | MA | 8455 | 2765 | 13890 | 1995 | 15190 | 1665 | 15967 | 1400 | 17011 | 987 | 20227 | 848 | 10833 |
| 2L-5S | | MI | 5725 | 2765 | 9017 | 1971 | 9475 | 1658 | 9602 | 1393 | 9552 | 976 | 10728 | 546 | 7458 |
| 10-#11 | 2.36 | MA | 8221 | 2765 | 13227 | 2007 | 14340 | 1675 | 14930 | 1423 | 15600 | 1006 | 18273 | 744 | 10849 |
| 3L-4S | | MI | 5857 | 2765 | 9309 | 1963 | 9863 | 1638 | 10086 | 1376 | 10267 | 977 | 11602 | 609 | 7658 |
| 10-#11 | 2.36 | MA | 8096 | 2765 | 12724 | 2032 | 13687 | 1699 | 14128 | 1432 | 14556 | 1026 | 16944 | 683 | 10825 |
| 4L-3S | | MI | 5927 | 2765 | 9655 | 1941 | 10311 | 1632 | 10636 | 1372 | 10982 | 963 | 12484 | 667 | 7637 |
| 10-#11 | 2.36 | MA | 7894 | 2765 | 12304 | 2044 | 13127 | 1710 | 13427 | 1454 | 13518 | 1031 | 15604 | 628 | 10485 |
| 5L-2S | | MI | 6078 | 2765 | 10102 | 1933 | 10884 | 1612 | 11336 | 1354 | 11935 | 950 | 13738 | 777 | 7608 |
| 10-#14 | 3.41 | MA | 8728 | 2956 | 14381 | 2121 | 15788 | 1757 | 16684 | 1477 | 17979 | 993 | 21562 | 669 | 15290 |
| 3L-4S | | MI | 6156 | 2956 | 9928 | 2081 | 10628 | 1722 | 11007 | 1425 | 11529 | 962 | 13178 | 473 | 10443 |
| 10-#14 | 3.41 | MA | 8555 | 2956 | 13662 | 2158 | 14856 | 1791 | 15538 | 1489 | 16487 | 1020 | 19653 | 580 | 15073 |
| 4L-3S | | MI | 6251 | 2956 | 10420 | 2050 | 11266 | 1715 | 11789 | 1421 | 12547 | 945 | 14410 | 554 | 10650 |
| 10-#14 | 3.41 | MA | 8271 | 2956 | 13061 | 2174 | 14054 | 1805 | 14536 | 1520 | 15004 | 1027 | 17731 | 497 | 14129 |
| 5L-2S | | MI | 6459 | 2956 | 11055 | 2040 | 12079 | 1687 | 12782 | 1397 | 13897 | 927 | 16156 | 713 | 10625 |
| 10-#18 | 6.06 | MA | 9679 | 3440 | 15957 | 2478 | 17732 | 2024 | 19016 | 1634 | 21255 | 1004 | 26324 | 316 | 23965 |
| 4L-3S | | MI | 7030 | 3440 | 12271 | 2333 | 13586 | 1928 | 14599 | 1549 | 16362 | 899 | 18880 | 234 | 17809 |
| 10-#18 | 6.06 | MA | 9199 | 3440 | 14904 | 2504 | 16330 | 2081 | 17264 | 1687 | 18665 | 1012 | 22953 | 158 | 22150 |
| 5L-2S | | MI | 7370 | 3440 | 13360 | 2318 | 14982 | 1884 | 16302 | 1511 | 18678 | 874 | 21763 | 516 | 17899 |
| 12-#10 | 2.31 | MA | 8456 | 2755 | 13831 | 2001 | 15156 | 1671 | 15944 | 1407 | 16990 | 995 | 20206 | 856 | 10691 |
| 2L-6S | | MI | 5710 | 2755 | 8927 | 1994 | 9398 | 1668 | 9518 | 1403 | 9457 | 998 | 10698 | 560 | 7293 |
| 12-#10 | 2.31 | MA | 8261 | 2755 | 13282 | 2011 | 14453 | 1680 | 15086 | 1426 | 15823 | 1011 | 18590 | 773 | 10702 |
| 3L-5S | | MI | 5789 | 2755 | 9174 | 1977 | 9717 | 1662 | 9916 | 1399 | 9990 | 986 | 11381 | 617 | 7488 |
| 12-#10 | 2.31 | MA | 8155 | 2755 | 12868 | 2032 | 13915 | 1700 | 14425 | 1434 | 14962 | 1028 | 17503 | 724 | 10688 |
| 4E | | MI | 5899 | 2755 | 9415 | 1969 | 10038 | 1645 | 10316 | 1384 | 10582 | 985 | 12127 | 667 | 7562 |

## RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

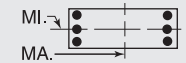
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 2.31 | MA | 7988 | 2755 | 12522 | 2043 | 13454 | 1709 | 13848 | 1453 | 14108 | 1034 | 16402 | 681 | 10565 |
| 5L-3S | | MI | 5961 | 2755 | 9702 | 1951 | 10410 | 1639 | 10772 | 1379 | 11176 | 973 | 12876 | 716 | 7546 |
| 12-#10 | 2.31 | MA | 7868 | 2755 | 12164 | 2047 | 12995 | 1730 | 13277 | 1461 | 13340 | 1051 | 15412 | 624 | 10198 |
| 6L-2S | | MI | 6087 | 2755 | 10075 | 1943 | 10888 | 1622 | 11355 | 1364 | 11969 | 961 | 13946 | 806 | 7526 |
| 12-#11 | 2.84 | MA | 8511 | 2852 | 13890 | 2061 | 15190 | 1714 | 15967 | 1447 | 17011 | 999 | 20227 | 734 | 12918 |
| 3L-5S | | MI | 5916 | 2852 | 9465 | 2025 | 10049 | 1696 | 10302 | 1417 | 10505 | 969 | 11982 | 529 | 8791 |
| 12-#11 | 2.84 | MA | 8387 | 2852 | 13388 | 2086 | 14538 | 1738 | 15165 | 1455 | 15967 | 1019 | 18898 | 673 | 12880 |
| 4E | | MI | 6047 | 2852 | 9756 | 2017 | 10437 | 1677 | 10786 | 1399 | 11219 | 970 | 12856 | 592 | 9055 |
| 12-#11 | 2.84 | MA | 8188 | 2852 | 12968 | 2098 | 13977 | 1748 | 14465 | 1478 | 14930 | 1024 | 17558 | 618 | 12481 |
| 5L-3S | | MI | 6116 | 2852 | 10102 | 1995 | 10884 | 1671 | 11336 | 1395 | 11935 | 956 | 13738 | 650 | 9046 |
| 12-#11 | 2.84 | MA | 8044 | 2852 | 12540 | 2104 | 13420 | 1772 | 13771 | 1486 | 13997 | 1044 | 16347 | 547 | 12088 |
| 6L-2S | | MI | 6265 | 2852 | 10550 | 1987 | 11458 | 1651 | 12035 | 1378 | 12887 | 943 | 14992 | 760 | 9023 |
| 12-#14 | 4.09 | MA | 8966 | 3081 | 14608 | 2235 | 16068 | 1847 | 17017 | 1523 | 18499 | 1010 | 22439 | 567 | 17893 |
| 4E | | MI | 6423 | 3081 | 10563 | 2159 | 11442 | 1778 | 11999 | 1459 | 12879 | 952 | 14924 | 445 | 12305 |
| 12-#14 | 4.09 | MA | 8687 | 3081 | 14006 | 2252 | 15267 | 1861 | 16015 | 1554 | 17016 | 1017 | 20517 | 484 | 16995 |
| 5L-3S | | MI | 6516 | 3081 | 11055 | 2128 | 12079 | 1771 | 12782 | 1455 | 13897 | 935 | 16156 | 525 | 12626 |
| 12-#14 | 4.09 | MA | 8485 | 3081 | 13403 | 2261 | 14469 | 1894 | 15022 | 1566 | 15681 | 1044 | 18776 | 381 | 16153 |
| 6L-2S | | MI | 6721 | 3081 | 11689 | 2118 | 12892 | 1743 | 13774 | 1431 | 15247 | 917 | 17901 | 684 | 12620 |
| 12-#18 | 7.27 | MA | 9913 | 3662 | 16546 | 2642 | 18435 | 2180 | 19832 | 1747 | 22159 | 994 | 27790 | 133 | 27079 |
| 5L-3S | | MI | 7479 | 3662 | 13360 | 2471 | 14982 | 2027 | 16302 | 1609 | 18678 | 881 | 21763 | 169 | 21033 |
| 14-#10 | 2.69 | MA | 8502 | 2826 | 13831 | 2055 | 15156 | 1712 | 15944 | 1445 | 16990 | 1006 | 20206 | 765 | 12414 |
| 3L-6S | | MI | 5871 | 2826 | 9300 | 2038 | 9876 | 1699 | 10101 | 1423 | 10250 | 993 | 11768 | 549 | 8420 |
| 14-#10 | 2.69 | MA | 8397 | 2826 | 13416 | 2076 | 14618 | 1732 | 15283 | 1453 | 16129 | 1023 | 19119 | 716 | 12391 |
| 4L-5S | | MI | 5949 | 2826 | 9547 | 2021 | 10195 | 1693 | 10499 | 1418 | 10784 | 980 | 12451 | 605 | 8602 |
| 14-#10 | 2.69 | MA | 8232 | 2826 | 13071 | 2087 | 14157 | 1741 | 14706 | 1472 | 15275 | 1028 | 18018 | 673 | 12219 |
| 5L-4S | | MI | 6058 | 2826 | 9788 | 2013 | 10516 | 1676 | 10899 | 1403 | 11375 | 979 | 13197 | 656 | 8729 |
| 14-#10 | 2.69 | MA | 8114 | 2826 | 12713 | 2091 | 13699 | 1761 | 14135 | 1480 | 14507 | 1045 | 17028 | 616 | 11868 |
| 6L-3S | | MI | 6119 | 2826 | 10075 | 1995 | 10888 | 1671 | 11355 | 1399 | 11969 | 967 | 13946 | 705 | 8720 |
| 14-#10 | 2.69 | MA | 7989 | 2826 | 12321 | 2108 | 13234 | 1766 | 13590 | 1499 | 13759 | 1062 | 15867 | 566 | 11588 |
| 7L-2S | | MI | 6244 | 2826 | 10448 | 1987 | 11366 | 1654 | 11939 | 1383 | 12763 | 955 | 15017 | 795 | 8703 |
| 14-#11 | 3.31 | MA | 8676 | 2938 | 14051 | 2140 | 15388 | 1777 | 16203 | 1479 | 17378 | 1012 | 20853 | 664 | 14934 |
| 4L-5S | | MI | 6106 | 2938 | 9912 | 2079 | 10622 | 1735 | 11002 | 1440 | 11457 | 962 | 13236 | 512 | 10130 |
| 14-#11 | 3.31 | MA | 8480 | 2938 | 13631 | 2152 | 14828 | 1787 | 15502 | 1501 | 16341 | 1017 | 19512 | 608 | 14485 |
| 5L-4S | | MI | 6236 | 2938 | 10204 | 2071 | 11010 | 1715 | 11485 | 1423 | 12171 | 963 | 14111 | 575 | 10446 |
| 14-#11 | 3.31 | MA | 8340 | 2938 | 13203 | 2158 | 14270 | 1811 | 14808 | 1510 | 15408 | 1037 | 18301 | 538 | 14110 |
| 6L-3S | | MI | 6304 | 2938 | 10550 | 2049 | 11458 | 1709 | 12035 | 1419 | 12887 | 949 | 14992 | 633 | 10450 |
| 14-#11 | 3.31 | MA | 8192 | 2938 | 12728 | 2178 | 13716 | 1818 | 14146 | 1533 | 14499 | 1056 | 17043 | 492 | 13544 |
| 7L-2S | | MI | 6451 | 2938 | 10997 | 2041 | 12032 | 1690 | 12735 | 1401 | 13839 | 936 | 16246 | 742 | 10434 |
| 14-#14 | 4.77 | MA | 9100 | 3205 | 14952 | 2329 | 16479 | 1917 | 17494 | 1588 | 19028 | 1007 | 23303 | 470 | 19870 |
| 5L-4S | | MI | 6688 | 3205 | 11197 | 2237 | 12255 | 1834 | 12991 | 1493 | 14229 | 942 | 16669 | 416 | 14179 |
| 14-#14 | 4.77 | MA | 8904 | 3205 | 14348 | 2339 | 15681 | 1950 | 16501 | 1600 | 17693 | 1034 | 21562 | 367 | 19003 |
| 6L-3S | | MI | 6781 | 3205 | 11689 | 2206 | 12892 | 1826 | 13774 | 1489 | 15247 | 925 | 17901 | 496 | 14597 |
| 16-#10 | 3.08 | MA | 8638 | 2896 | 13965 | 2120 | 15321 | 1763 | 16141 | 1472 | 17297 | 1017 | 20735 | 708 | 14093 |
| 4L-6S | | MI | 6032 | 2896 | 9673 | 2082 | 10354 | 1731 | 10685 | 1442 | 11043 | 987 | 12839 | 538 | 9550 |
| 16-#10 | 3.08 | MA | 8475 | 2896 | 13619 | 2130 | 14860 | 1772 | 15564 | 1491 | 16442 | 1023 | 19634 | 666 | 13877 |
| 5E | | MI | 6109 | 2896 | 9920 | 2065 | 10673 | 1725 | 11082 | 1437 | 11577 | 975 | 13522 | 594 | 9721 |
| 16-#10 | 3.08 | MA | 8360 | 2896 | 13261 | 2135 | 14402 | 1793 | 14993 | 1499 | 15674 | 1039 | 18644 | 609 | 13541 |
| 6L-4S | | MI | 6217 | 2896 | 10161 | 2057 | 10994 | 1708 | 11482 | 1422 | 12169 | 974 | 14268 | 645 | 9891 |
| 16-#10 | 3.08 | MA | 8235 | 2896 | 12870 | 2152 | 13937 | 1798 | 14448 | 1518 | 14926 | 1056 | 17484 | 558 | 13245 |
| 7L-3S | | MI | 6277 | 2896 | 10448 | 2039 | 11366 | 1702 | 11939 | 1418 | 12763 | 962 | 15017 | 694 | 9889 |
| 16-#10 | 3.08 | MA | 8097 | 2896 | 12526 | 2159 | 13462 | 1815 | 13882 | 1524 | 14129 | 1062 | 16481 | 510 | 12789 |
| 8L-2S | | MI | 6401 | 2896 | 10821 | 2031 | 11844 | 1685 | 12522 | 1402 | 13556 | 949 | 16087 | 784 | 9876 |
| 16-#11 | 3.78 | MA | 8771 | 3024 | 14294 | 2206 | 15678 | 1826 | 16539 | 1525 | 17752 | 1011 | 21466 | 599 | 16494 |
| 5E | | MI | 6296 | 3024 | 10359 | 2133 | 11196 | 1774 | 11701 | 1464 | 12409 | 955 | 14490 | 494 | 11475 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

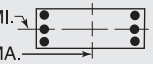
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 3.78 | MA | 8633 | 3024 | 13867 | 2212 | 15121 | 1850 | 15845 | 1534 | 16819 | 1030 | 20255 | 528 | 16136 |
| 6L-4S | | MI | 6424 | 3024 | 10651 | 2125 | 11584 | 1754 | 12185 | 1446 | 13123 | 956 | 15365 | 557 | 11834 |
| 16-#11 | 3.78 | MA | 8487 | 3024 | 13392 | 2232 | 14567 | 1857 | 15183 | 1556 | 15910 | 1050 | 18997 | 482 | 15551 |
| 7L-3S | | MI | 6492 | 3024 | 10997 | 2103 | 12032 | 1748 | 12735 | 1442 | 13839 | 942 | 16246 | 615 | 11851 |
| 16-#14 | 5.45 | MA | 9320 | 3330 | 15294 | 2417 | 16893 | 2006 | 17980 | 1634 | 19705 | 1024 | 24348 | 353 | 21860 |
| 6L-4S | | MI | 6952 | 3330 | 11831 | 2314 | 13068 | 1890 | 13984 | 1527 | 15579 | 932 | 18415 | 387 | 16064 |
| 18-#10 | 3.46 | MA | 8717 | 2966 | 14168 | 2174 | 15563 | 1804 | 16422 | 1510 | 17609 | 1017 | 21250 | 658 | 15541 |
| 5L-6S | | MI | 6192 | 2966 | 10045 | 2126 | 10832 | 1762 | 11268 | 1461 | 11837 | 982 | 13909 | 527 | 10682 |
| 18-#10 | 3.46 | MA | 8603 | 2966 | 13810 | 2179 | 15105 | 1824 | 15851 | 1518 | 16841 | 1034 | 20260 | 601 | 15218 |
| 6L-5S | | MI | 6268 | 2966 | 10293 | 2109 | 11151 | 1757 | 11665 | 1457 | 12370 | 969 | 14592 | 583 | 10844 |
| 18-#10 | 3.46 | MA | 8479 | 2966 | 13418 | 2196 | 14640 | 1830 | 15306 | 1537 | 16093 | 1051 | 19100 | 551 | 14905 |
| 7L-4S | | MI | 6375 | 2966 | 10534 | 2101 | 11472 | 1740 | 12066 | 1441 | 12962 | 968 | 15339 | 634 | 11050 |
| 18-#10 | 3.46 | MA | 8344 | 2966 | 13075 | 2203 | 14166 | 1846 | 14739 | 1543 | 15296 | 1056 | 18097 | 502 | 14462 |
| 8L-3S | | MI | 6435 | 2966 | 10821 | 2083 | 11844 | 1734 | 12522 | 1437 | 13556 | 956 | 16087 | 683 | 11057 |
| 18-#11 | 4.25 | MA | 8925 | 3111 | 14530 | 2266 | 15971 | 1889 | 16883 | 1557 | 18231 | 1023 | 22209 | 518 | 18166 |
| 6L-5S | | MI | 6485 | 3111 | 10807 | 2187 | 11770 | 1813 | 12401 | 1487 | 13361 | 949 | 15744 | 477 | 12824 |
| 18-#11 | 4.25 | MA | 8780 | 3111 | 14055 | 2286 | 15417 | 1896 | 16220 | 1580 | 17322 | 1043 | 20951 | 473 | 17563 |
| 7L-4S | | MI | 6611 | 3111 | 11099 | 2179 | 12157 | 1793 | 12885 | 1470 | 14075 | 949 | 16619 | 540 | 13175 |
| 20-#10 | 3.85 | MA | 8846 | 3036 | 14358 | 2223 | 15808 | 1856 | 16709 | 1537 | 18008 | 1028 | 21876 | 593 | 16896 |
| 6E | | MI | 6351 | 3036 | 10418 | 2170 | 11310 | 1794 | 11851 | 1480 | 12630 | 976 | 14980 | 515 | 11817 |
| 20-#10 | 3.85 | MA | 8722 | 3036 | 13967 | 2240 | 15343 | 1861 | 16164 | 1556 | 17260 | 1045 | 20716 | 543 | 16569 |
| 7L-5S | | MI | 6426 | 3036 | 10666 | 2153 | 11629 | 1788 | 12248 | 1476 | 13164 | 964 | 15663 | 572 | 11970 |
| 20-#10 | 3.85 | MA | 8589 | 3036 | 13623 | 2247 | 14869 | 1878 | 15597 | 1562 | 16463 | 1051 | 19713 | 495 | 16137 |
| 8L-4S | | MI | 6532 | 3036 | 10907 | 2145 | 11950 | 1771 | 12649 | 1460 | 13755 | 963 | 16409 | 623 | 12208 |
| 20-#11 | 4.73 | MA | 9071 | 3197 | 14718 | 2340 | 16267 | 1934 | 17258 | 1603 | 18733 | 1036 | 22905 | 463 | 19577 |
| 7L-5S | | MI | 6673 | 3197 | 11254 | 2241 | 12343 | 1851 | 13101 | 1511 | 14313 | 942 | 16998 | 460 | 14177 |
| 22-#10 | 4.23 | MA | 8964 | 3107 | 14515 | 2284 | 16047 | 1893 | 17022 | 1576 | 18427 | 1039 | 22332 | 535 | 18234 |
| 7L-6S | | MI | 6510 | 3107 | 10791 | 2214 | 11788 | 1825 | 12434 | 1499 | 13423 | 970 | 16051 | 504 | 12953 |
| 22-#10 | 4.23 | MA | 8832 | 3107 | 14172 | 2291 | 15572 | 1909 | 16455 | 1582 | 17631 | 1045 | 21329 | 487 | 17814 |
| 8L-5S | | MI | 6584 | 3107 | 11038 | 2196 | 12107 | 1820 | 12831 | 1495 | 13957 | 958 | 16733 | 561 | 13098 |
| 24-#10 | 4.62 | MA | 9075 | 3177 | 14720 | 2335 | 16275 | 1941 | 17313 | 1601 | 18798 | 1039 | 22945 | 479 | 19493 |
| 8L-6S | | MI | 6669 | 3177 | 11164 | 2258 | 12266 | 1857 | 13017 | 1518 | 14217 | 965 | 17121 | 493 | 14090 |

## RECTANGULAR TIED COLUMNS 22" x 32"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.28 | MA | 8871 | 2738 | 14070 | 1998 | 15069 | 1683 | 15471 | 1438 | 15689 | 1071 | 17939 | 929 | 6869 |
| 2E | | MI | 6010 | 2738 | 9677 | 1917 | 10173 | 1614 | 10327 | 1377 | 10324 | 1022 | 11414 | 856 | 4596 |
| 4-#18 | 2.27 | MA | 9513 | 2932 | 15635 | 2101 | 17011 | 1755 | 17812 | 1478 | 18859 | 1045 | 22317 | 899 | 11748 |
| 2E | | MI | 6378 | 2932 | 10621 | 2012 | 11328 | 1678 | 11713 | 1411 | 12201 | 991 | 13603 | 769 | 7656 |
| 6-#10 | 1.08 | MA | 8765 | 2700 | 13736 | 1996 | 14719 | 1684 | 15078 | 1443 | 15175 | 1086 | 17243 | 945 | 5918 |
| 2L-3S | | MI | 5824 | 2700 | 9106 | 1931 | 9510 | 1640 | 9547 | 1405 | 9276 | 1056 | 10165 | 808 | 4009 |
| 6-#10 | 1.08 | MA | 8541 | 2700 | 13143 | 2006 | 13960 | 1694 | 14151 | 1463 | 13914 | 1104 | 15498 | 863 | 5946 |
| 3L-2S | | MI | 5956 | 2700 | 9479 | 1924 | 9988 | 1623 | 10130 | 1390 | 10070 | 1044 | 11236 | 897 | 3980 |
| 6-#11 | 1.33 | MA | 8923 | 2748 | 14148 | 2013 | 15202 | 1696 | 15647 | 1447 | 15937 | 1075 | 18289 | 933 | 7158 |
| 2L-3S | | MI | 5890 | 2748 | 9284 | 1944 | 9698 | 1649 | 9759 | 1407 | 9556 | 1043 | 10474 | 759 | 4817 |
| 6-#11 | 1.33 | MA | 8657 | 2748 | 13431 | 2026 | 14283 | 1706 | 14525 | 1471 | 14411 | 1096 | 16176 | 831 | 7193 |
| 3L-2S | | MI | 6045 | 2748 | 9731 | 1936 | 10272 | 1629 | 10458 | 1390 | 10509 | 1029 | 11728 | 869 | 4778 |
| 6-#14 | 1.92 | MA | 9318 | 2863 | 15094 | 2076 | 16381 | 1739 | 17071 | 1472 | 17866 | 1061 | 20954 | 915 | 10102 |
| 2L-3S | | MI | 6059 | 2863 | 9677 | 2005 | 10173 | 1697 | 10327 | 1435 | 10324 | 1030 | 11414 | 669 | 6696 |
| 6-#14 | 1.92 | MA | 8947 | 2863 | 14070 | 2093 | 15069 | 1754 | 15471 | 1505 | 15689 | 1089 | 17939 | 766 | 10134 |
| 3L-2S | | MI | 6275 | 2863 | 10312 | 1994 | 10987 | 1670 | 11319 | 1411 | 11674 | 1012 | 13160 | 828 | 6641 |
| 6-#18 | 3.41 | MA | 10271 | 3153 | 17416 | 2240 | 19294 | 1854 | 20596 | 1538 | 22648 | 1027 | 27562 | 874 | 17335 |
| 2L-3S | | MI | 6467 | 3153 | 10621 | 2165 | 11328 | 1822 | 11713 | 1509 | 12201 | 998 | 13603 | 422 | 11153 |
| 6-#18 | 3.41 | MA | 9656 | 3153 | 15635 | 2268 | 17011 | 1878 | 17812 | 1593 | 18859 | 1073 | 22317 | 599 | 17245 |
| 3L-2S | | MI | 6825 | 3153 | 11710 | 2150 | 12724 | 1778 | 13416 | 1471 | 14518 | 974 | 16487 | 704 | 11117 |

## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

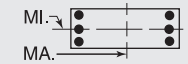
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.14 | MA | 8812 | 2711 | 13820 | 2007 | 14844 | 1693 | 15238 | 1450 | 15397 | 1088 | 17554 | 946 | 6211 |
| 2L-4S | | MI | 5831 | 2711 | 9010 | 1958 | 9400 | 1652 | 9416 | 1414 | 9122 | 1067 | 10019 | 793 | 4217 |
| 8-#9 | 1.14 | MA | 8635 | 2711 | 13351 | 2015 | 14243 | 1701 | 14504 | 1465 | 14399 | 1102 | 16172 | 882 | 6231 |
| 3E | | MI | 5881 | 2711 | 9237 | 1943 | 9694 | 1647 | 9777 | 1410 | 9593 | 1057 | 10617 | 832 | 4189 |
| 8-#9 | 1.14 | MA | 8538 | 2711 | 12999 | 2033 | 13785 | 1717 | 13941 | 1472 | 13665 | 1116 | 15253 | 844 | 6252 |
| 4L-2S | | MI | 5986 | 2711 | 9533 | 1937 | 10073 | 1633 | 10240 | 1398 | 10223 | 1047 | 11475 | 902 | 4168 |
| 8-#10 | 1.44 | MA | 9028 | 2770 | 14328 | 2040 | 15479 | 1716 | 16004 | 1463 | 16435 | 1081 | 18988 | 937 | 7790 |
| 2L-4S | | MI | 5922 | 2770 | 9192 | 1994 | 9617 | 1677 | 9674 | 1429 | 9476 | 1063 | 10487 | 748 | 5243 |
| 8-#10 | 1.44 | MA | 8808 | 2770 | 13736 | 2050 | 14719 | 1725 | 15078 | 1482 | 15175 | 1098 | 17243 | 856 | 7812 |
| 3E | | MI | 5984 | 2770 | 9479 | 1975 | 9988 | 1672 | 10130 | 1424 | 10070 | 1050 | 11236 | 797 | 5210 |
| 8-#10 | 1.44 | MA | 8687 | 2770 | 13290 | 2072 | 14140 | 1746 | 14366 | 1491 | 14247 | 1116 | 16078 | 807 | 7825 |
| 4L-2S | | MI | 6115 | 2770 | 9852 | 1967 | 10466 | 1654 | 10713 | 1409 | 10863 | 1038 | 12306 | 886 | 5181 |
| 8-#11 | 1.77 | MA | 9238 | 2835 | 14866 | 2067 | 16122 | 1734 | 16768 | 1471 | 17463 | 1068 | 20402 | 923 | 9421 |
| 2L-4S | | MI | 6009 | 2835 | 9386 | 2020 | 9824 | 1694 | 9908 | 1435 | 9793 | 1049 | 10846 | 684 | 6290 |
| 8-#11 | 1.77 | MA | 8977 | 2835 | 14148 | 2080 | 15202 | 1745 | 15647 | 1494 | 15937 | 1089 | 18289 | 821 | 9446 |
| 3E | | MI | 6080 | 2835 | 9731 | 1998 | 10272 | 1688 | 10458 | 1431 | 10509 | 1036 | 11728 | 742 | 6252 |
| 8-#11 | 1.77 | MA | 8835 | 2835 | 13607 | 2106 | 14499 | 1770 | 14782 | 1504 | 14811 | 1109 | 16865 | 761 | 9441 |
| 4L-2S | | MI | 6233 | 2835 | 10179 | 1990 | 10845 | 1668 | 11158 | 1413 | 11461 | 1022 | 12982 | 852 | 6216 |
| 8-#14 | 2.56 | MA | 9760 | 2987 | 16117 | 2154 | 17693 | 1795 | 18672 | 1506 | 20044 | 1051 | 23970 | 902 | 13317 |
| 2L-4S | | MI | 6231 | 2987 | 9819 | 2113 | 10349 | 1760 | 10537 | 1473 | 10656 | 1037 | 11928 | 560 | 8711 |
| 8-#14 | 2.56 | MA | 9399 | 2987 | 15094 | 2171 | 16381 | 1810 | 17071 | 1539 | 17866 | 1079 | 20954 | 752 | 13323 |
| 3E | | MI | 6327 | 2987 | 10312 | 2083 | 10987 | 1753 | 11319 | 1469 | 11674 | 1020 | 13160 | 640 | 8703 |
| 8-#14 | 2.56 | MA | 9203 | 2987 | 14319 | 2208 | 15376 | 1845 | 15835 | 1551 | 16256 | 1108 | 18908 | 664 | 13214 |
| 4L-2S | | MI | 6539 | 2987 | 10946 | 2072 | 11800 | 1725 | 12311 | 1445 | 13024 | 1002 | 14905 | 799 | 8661 |
| 8-#18 | 4.55 | MA | 10431 | 3375 | 17416 | 2406 | 19294 | 1978 | 20596 | 1653 | 22648 | 1056 | 27562 | 575 | 22746 |
| 3E | | MI | 6921 | 3375 | 11710 | 2303 | 12724 | 1921 | 13416 | 1569 | 14518 | 981 | 16487 | 356 | 14526 |
| 8-#18 | 4.55 | MA | 10107 | 3375 | 16061 | 2470 | 17536 | 2037 | 18436 | 1673 | 19834 | 1102 | 23951 | 415 | 20788 |
| 4L-2S | | MI | 7270 | 3375 | 12799 | 2288 | 14120 | 1877 | 15119 | 1531 | 16835 | 956 | 19370 | 638 | 14546 |
| 10-#10 | 1.80 | MA | 9290 | 2841 | 14921 | 2084 | 16238 | 1748 | 16931 | 1482 | 17696 | 1075 | 20734 | 929 | 9654 |
| 2L-5S | | MI | 5971 | 2841 | 9324 | 2045 | 9774 | 1726 | 9856 | 1463 | 9678 | 1058 | 10812 | 686 | 6439 |
| 10-#10 | 1.80 | MA | 9073 | 2841 | 14328 | 2094 | 15479 | 1757 | 16004 | 1501 | 16435 | 1093 | 18988 | 848 | 9671 |
| 3L-4S | | MI | 6082 | 2841 | 9565 | 2037 | 10095 | 1709 | 10257 | 1448 | 10269 | 1057 | 11558 | 737 | 6423 |
| 10-#10 | 1.80 | MA | 8954 | 2841 | 13882 | 2116 | 14900 | 1778 | 15292 | 1510 | 15508 | 1110 | 17824 | 799 | 9670 |
| 4L-3S | | MI | 6144 | 2841 | 9852 | 2019 | 10466 | 1703 | 10713 | 1444 | 10863 | 1045 | 12306 | 786 | 6397 |
| 10-#10 | 1.80 | MA | 8770 | 2841 | 13511 | 2126 | 14404 | 1787 | 14672 | 1530 | 14587 | 1117 | 16641 | 759 | 9620 |
| 5L-2S | | MI | 6273 | 2841 | 10225 | 2011 | 10944 | 1686 | 11296 | 1428 | 11656 | 1032 | 13377 | 875 | 6372 |
| 10-#11 | 2.22 | MA | 9550 | 2921 | 15583 | 2121 | 17041 | 1773 | 17890 | 1494 | 18989 | 1061 | 22515 | 914 | 11676 |
| 2L-5S | | MI | 6068 | 2921 | 9541 | 2082 | 10010 | 1752 | 10124 | 1476 | 10031 | 1042 | 11226 | 604 | 7558 |
| 10-#11 | 2.22 | MA | 9294 | 2921 | 14866 | 2134 | 16122 | 1784 | 16768 | 1518 | 17463 | 1082 | 20402 | 812 | 11691 |
| 3L-4S | | MI | 6200 | 2921 | 9833 | 2074 | 10397 | 1732 | 10608 | 1458 | 10745 | 1042 | 12100 | 667 | 7699 |
| 10-#11 | 2.22 | MA | 9155 | 2921 | 14324 | 2160 | 15418 | 1809 | 15904 | 1527 | 16337 | 1102 | 18978 | 751 | 11667 |
| 4L-3S | | MI | 6270 | 2921 | 10179 | 2052 | 10845 | 1726 | 11158 | 1454 | 11461 | 1029 | 12982 | 725 | 7673 |
| 10-#11 | 2.22 | MA | 8935 | 2921 | 13872 | 2172 | 14815 | 1820 | 15149 | 1551 | 15219 | 1109 | 17538 | 699 | 11378 |
| 5L-2S | | MI | 6421 | 2921 | 10626 | 2044 | 11419 | 1707 | 11858 | 1437 | 12413 | 1015 | 14236 | 835 | 7642 |
| 10-#14 | 3.20 | MA | 9848 | 3112 | 16117 | 2249 | 17693 | 1866 | 18672 | 1573 | 20044 | 1069 | 23970 | 738 | 16505 |
| 3L-4S | | MI | 6499 | 3112 | 10454 | 2191 | 11163 | 1816 | 11529 | 1507 | 12006 | 1027 | 13674 | 531 | 10584 |
| 10-#14 | 3.20 | MA | 9655 | 3112 | 15342 | 2286 | 16688 | 1901 | 17435 | 1585 | 18434 | 1098 | 21923 | 650 | 16372 |
| 4L-3S | | MI | 6593 | 3112 | 10946 | 2161 | 11800 | 1809 | 12311 | 1503 | 13024 | 1010 | 14905 | 611 | 10696 |
| 10-#14 | 3.20 | MA | 9345 | 3112 | 14695 | 2303 | 15824 | 1916 | 16355 | 1618 | 16834 | 1106 | 19857 | 572 | 15342 |
| 5L-2S | | MI | 6802 | 3112 | 11580 | 2150 | 12613 | 1781 | 13303 | 1479 | 14374 | 992 | 16651 | 770 | 10667 |
| 10-#18 | 5.68 | MA | 10881 | 3596 | 17841 | 2608 | 19818 | 2136 | 21221 | 1733 | 23622 | 1085 | 29197 | 391 | 26151 |
| 4L-3S | | MI | 7372 | 3596 | 12799 | 2442 | 14120 | 2020 | 15119 | 1629 | 16835 | 963 | 19370 | 291 | 17889 |
| 10-#18 | 5.68 | MA | 10357 | 3596 | 16706 | 2636 | 18306 | 2160 | 19330 | 1788 | 20825 | 1096 | 25567 | 240 | 24343 |
| 5L-2S | | MI | 7713 | 3596 | 13888 | 2427 | 15516 | 1976 | 16821 | 1592 | 19151 | 938 | 22253 | 572 | 17960 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

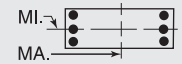


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 2.16 | MA | 9550 | 2911 | 15513 | 2127 | 16998 | 1779 | 17858 | 1501 | 18957 | 1069 | 22479 | 921 | 11514 |
| 2L-6S | | MI | 6052 | 2911 | 9449 | 2106 | 9932 | 1763 | 10042 | 1487 | 9937 | 1065 | 11199 | 618 | 7373 |
| 12-#10 | 2.16 | MA | 9337 | 2911 | 14921 | 2138 | 16238 | 1789 | 16931 | 1521 | 17696 | 1087 | 20734 | 840 | 11525 |
| 3L-5S | | MI | 6132 | 2911 | 9697 | 2089 | 10252 | 1757 | 10439 | 1482 | 10471 | 1052 | 11882 | 675 | 7574 |
| 12-#10 | 2.16 | MA | 9218 | 2911 | 14475 | 2160 | 15659 | 1809 | 16219 | 1529 | 16768 | 1105 | 19569 | 792 | 11511 |
| 4E | | MI | 6242 | 2911 | 9938 | 2081 | 10573 | 1740 | 10840 | 1467 | 11063 | 1051 | 12628 | 726 | 7597 |
| 12-#10 | 2.16 | MA | 9037 | 2911 | 14103 | 2170 | 15163 | 1819 | 15598 | 1549 | 15848 | 1111 | 18387 | 751 | 11452 |
| 5L-3S | | MI | 6303 | 2911 | 10225 | 2063 | 10944 | 1735 | 11296 | 1463 | 11656 | 1039 | 13377 | 775 | 7578 |
| 12-#10 | 2.16 | MA | 8906 | 2911 | 13713 | 2175 | 14670 | 1840 | 14984 | 1557 | 15021 | 1129 | 17328 | 694 | 11030 |
| 6L-2S | | MI | 6430 | 2911 | 10597 | 2055 | 11422 | 1718 | 11879 | 1447 | 12450 | 1027 | 14448 | 864 | 7555 |
| 12-#11 | 2.66 | MA | 9610 | 3007 | 15583 | 2188 | 17041 | 1823 | 17890 | 1541 | 18989 | 1075 | 22515 | 802 | 13929 |
| 3L-5S | | MI | 6259 | 3007 | 9989 | 2136 | 10583 | 1791 | 10824 | 1499 | 10983 | 1035 | 12480 | 587 | 8889 |
| 12-#11 | 2.66 | MA | 9472 | 3007 | 15041 | 2214 | 16338 | 1847 | 17026 | 1551 | 17863 | 1096 | 21091 | 742 | 13891 |
| 4E | | MI | 6389 | 3007 | 10281 | 2128 | 10971 | 1771 | 11308 | 1482 | 11697 | 1035 | 13354 | 650 | 9101 |
| 12-#11 | 2.66 | MA | 9255 | 3007 | 14589 | 2226 | 15735 | 1858 | 16271 | 1574 | 16745 | 1102 | 19651 | 689 | 13539 |
| 5L-3S | | MI | 6459 | 3007 | 10626 | 2106 | 11419 | 1765 | 11858 | 1478 | 12413 | 1022 | 14236 | 707 | 9085 |
| 12-#11 | 2.66 | MA | 9099 | 3007 | 14122 | 2232 | 15135 | 1883 | 15524 | 1584 | 15740 | 1123 | 18354 | 619 | 13086 |
| 6L-2S | | MI | 6608 | 3007 | 11074 | 2098 | 11992 | 1745 | 12558 | 1460 | 13365 | 1008 | 15490 | 817 | 9060 |
| 12-#14 | 3.84 | MA | 10103 | 3236 | 16366 | 2364 | 18000 | 1957 | 19036 | 1619 | 20611 | 1088 | 24939 | 637 | 19494 |
| 4E | | MI | 6765 | 3236 | 11088 | 2269 | 11976 | 1872 | 12521 | 1541 | 13355 | 1017 | 15419 | 502 | 12442 |
| 12-#14 | 3.84 | MA | 9799 | 3236 | 15718 | 2381 | 17136 | 1972 | 17956 | 1652 | 19012 | 1096 | 22872 | 558 | 18449 |
| 5L-3S | | MI | 6859 | 3236 | 11580 | 2238 | 12613 | 1864 | 13303 | 1537 | 14374 | 1000 | 16651 | 582 | 12679 |
| 12-#14 | 3.84 | MA | 9579 | 3236 | 15057 | 2390 | 16277 | 2007 | 16886 | 1665 | 17573 | 1125 | 21008 | 456 | 17641 |
| 6L-2S | | MI | 7064 | 3236 | 12215 | 2228 | 13426 | 1837 | 14295 | 1513 | 15723 | 982 | 18396 | 741 | 12664 |
| 12-#18 | 6.82 | MA | 11136 | 3817 | 18486 | 2774 | 20588 | 2259 | 22114 | 1848 | 24613 | 1078 | 30813 | 216 | 29712 |
| 5L-3S | | MI | 7822 | 3817 | 13888 | 2580 | 15516 | 2120 | 16821 | 1689 | 19151 | 945 | 22253 | 225 | 21247 |
| 14-#10 | 2.53 | MA | 9599 | 2981 | 15513 | 2182 | 16998 | 1820 | 17858 | 1540 | 18957 | 1081 | 22479 | 832 | 13374 |
| 3L-6S | | MI | 6213 | 2981 | 9822 | 2150 | 10410 | 1795 | 10625 | 1506 | 10731 | 1059 | 12270 | 607 | 8499 |
| 14-#10 | 2.53 | MA | 9482 | 2981 | 15067 | 2204 | 16419 | 1841 | 17145 | 1548 | 18029 | 1099 | 21315 | 784 | 13352 |
| 4L-5S | | MI | 6292 | 2981 | 10070 | 2133 | 10730 | 1789 | 11023 | 1502 | 11264 | 1047 | 12953 | 664 | 8687 |
| 14-#10 | 2.53 | MA | 9303 | 2981 | 14696 | 2214 | 15923 | 1850 | 16525 | 1568 | 17108 | 1105 | 20132 | 743 | 13241 |
| 5L-4S | | MI | 6401 | 2981 | 10311 | 2125 | 11051 | 1772 | 11423 | 1486 | 11856 | 1046 | 13699 | 714 | 8766 |
| 14-#10 | 2.53 | MA | 9174 | 2981 | 14305 | 2219 | 15429 | 1871 | 15910 | 1576 | 16282 | 1123 | 19073 | 687 | 12835 |
| 6L-3S | | MI | 6462 | 2981 | 10597 | 2107 | 11422 | 1766 | 11879 | 1482 | 12450 | 1033 | 14448 | 764 | 8753 |
| 14-#10 | 2.53 | MA | 9036 | 2981 | 13883 | 2236 | 14922 | 1876 | 15324 | 1596 | 15477 | 1140 | 17827 | 638 | 12572 |
| 7L-2S | | MI | 6587 | 2981 | 10970 | 2099 | 11900 | 1749 | 12462 | 1466 | 13243 | 1021 | 15518 | 853 | 8734 |
| 14-#11 | 3.10 | MA | 9788 | 3094 | 15758 | 2268 | 17257 | 1886 | 18147 | 1574 | 19389 | 1089 | 23204 | 732 | 16113 |
| 4L-5S | | MI | 6449 | 3094 | 10436 | 2190 | 11157 | 1830 | 11524 | 1523 | 11935 | 1028 | 13734 | 569 | 10227 |
| 14-#11 | 3.10 | MA | 9574 | 3094 | 15306 | 2280 | 16654 | 1897 | 17393 | 1598 | 18271 | 1095 | 21764 | 680 | 15708 |
| 5L-4S | | MI | 6578 | 3094 | 10728 | 2182 | 11545 | 1810 | 12008 | 1505 | 12649 | 1028 | 14608 | 632 | 10496 |
| 14-#11 | 3.10 | MA | 9421 | 3094 | 14839 | 2286 | 16054 | 1922 | 16646 | 1607 | 17266 | 1116 | 20467 | 609 | 15275 |
| 6L-3S | | MI | 6647 | 3094 | 11074 | 2160 | 11992 | 1804 | 12558 | 1501 | 13365 | 1015 | 15490 | 690 | 10491 |
| 14-#11 | 3.10 | MA | 9257 | 3094 | 14326 | 2307 | 15447 | 1928 | 15933 | 1631 | 16287 | 1136 | 18948 | 547 | 14732 |
| 7L-2S | | MI | 6794 | 3094 | 11521 | 2152 | 12566 | 1784 | 13258 | 1484 | 14317 | 1002 | 16744 | 800 | 10472 |
| 14-#14 | 4.47 | MA | 10249 | 3361 | 16742 | 2459 | 18448 | 2028 | 19556 | 1686 | 21189 | 1086 | 25888 | 544 | 21564 |
| 5L-4S | | MI | 7031 | 3361 | 11723 | 2347 | 12789 | 1928 | 13513 | 1575 | 14705 | 1008 | 17165 | 473 | 14314 |
| 14-#14 | 4.47 | MA | 10036 | 3361 | 16080 | 2467 | 17588 | 2062 | 18487 | 1699 | 19751 | 1115 | 24023 | 442 | 20735 |
| 6L-3S | | MI | 7123 | 3361 | 12215 | 2316 | 13426 | 1920 | 14295 | 1571 | 15723 | 990 | 18396 | 554 | 14653 |
| 14-#14 | 4.47 | MA | 9807 | 3361 | 15348 | 2497 | 16731 | 2072 | 17466 | 1732 | 18350 | 1143 | 22085 | 377 | 19691 |
| 7L-2S | | MI | 7325 | 3361 | 12849 | 2306 | 14240 | 1893 | 15287 | 1547 | 17073 | 973 | 20142 | 712 | 14655 |
| 16-#10 | 2.89 | MA | 9744 | 3051 | 15660 | 2248 | 17178 | 1872 | 18072 | 1567 | 19289 | 1093 | 23060 | 776 | 15191 |
| 4L-6S | | MI | 6374 | 3051 | 10195 | 2194 | 10888 | 1826 | 11208 | 1525 | 11524 | 1053 | 13340 | 596 | 9629 |
| 16-#10 | 2.89 | MA | 9567 | 3051 | 15288 | 2258 | 16682 | 1882 | 17451 | 1587 | 18369 | 1100 | 21878 | 735 | 15034 |
| 5E | | MI | 6451 | 3051 | 10442 | 2177 | 11208 | 1821 | 11606 | 1521 | 12058 | 1041 | 14023 | 653 | 9805 |
| 16-#10 | 2.89 | MA | 9441 | 3051 | 14897 | 2263 | 16189 | 1903 | 16837 | 1595 | 17543 | 1117 | 20819 | 679 | 14644 |
| 6L-4S | | MI | 6559 | 3051 | 10684 | 2169 | 11529 | 1803 | 12006 | 1505 | 12649 | 1040 | 14769 | 703 | 9932 |
| 16-#10 | 2.89 | MA | 9303 | 3051 | 14475 | 2280 | 15681 | 1908 | 16251 | 1615 | 16738 | 1135 | 19573 | 631 | 14390 |
| 7L-3S | | MI | 6620 | 3051 | 10970 | 2151 | 11900 | 1798 | 12462 | 1501 | 13243 | 1028 | 15518 | 752 | 9924 |

## RECTANGULAR TIED COLUMNS 22" x 32"

Short columns – no sidesway
Bending on major or minor axis

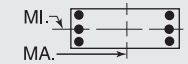



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.89 | MA | 9153 | 3051 | 14106 | 2288 | 15170 | 1925 | 15632 | 1621 | 15881 | 1141 | 18497 | 584 | 13870 |
| 8L-2S | | MI | 6744 | 3051 | 11343 | 2143 | 12378 | 1781 | 13045 | 1486 | 14037 | 1016 | 16589 | 842 | 9909 |
| 16-#11 | 3.55 | MA | 9890 | 3180 | 16023 | 2334 | 17573 | 1936 | 18514 | 1621 | 19797 | 1088 | 23877 | 670 | 17883 |
| 5E | | MI | 6638 | 3180 | 10884 | 2244 | 11730 | 1868 | 12224 | 1546 | 12887 | 1021 | 14988 | 552 | 11571 |
| 16-#11 | 3.55 | MA | 9741 | 3180 | 15556 | 2340 | 16973 | 1961 | 17767 | 1631 | 18792 | 1109 | 22580 | 600 | 17467 |
| 6L-4S | | MI | 6766 | 3180 | 11176 | 2235 | 12118 | 1849 | 12708 | 1529 | 13601 | 1021 | 15862 | 615 | 11887 |
| 16-#11 | 3.55 | MA | 9578 | 3180 | 15044 | 2361 | 16367 | 1967 | 17054 | 1654 | 17813 | 1129 | 21061 | 538 | 16907 |
| 7L-3S | | MI | 6835 | 3180 | 11521 | 2214 | 12566 | 1843 | 13258 | 1525 | 14317 | 1008 | 16744 | 673 | 11894 |
| 16-#11 | 3.55 | MA | 9399 | 3180 | 14595 | 2369 | 15746 | 1987 | 16315 | 1662 | 16771 | 1136 | 19748 | 478 | 16342 |
| 8L-2S | | MI | 6980 | 3180 | 11969 | 2205 | 13140 | 1823 | 13957 | 1507 | 15269 | 995 | 17998 | 783 | 11880 |
| 16-#14 | 5.11 | MA | 10489 | 3485 | 17104 | 2545 | 18900 | 2118 | 20087 | 1733 | 21929 | 1105 | 27039 | 428 | 23835 |
| 6L-4S | | MI | 7295 | 3485 | 12357 | 2424 | 13602 | 1984 | 14505 | 1609 | 16055 | 998 | 18910 | 444 | 16196 |
| 16-#14 | 5.11 | MA | 10261 | 3485 | 16371 | 2575 | 18043 | 2128 | 19066 | 1765 | 20527 | 1133 | 25100 | 363 | 22821 |
| 7L-3S | | MI | 7387 | 3485 | 12849 | 2394 | 14240 | 1976 | 15287 | 1605 | 17073 | 980 | 20142 | 525 | 16623 |
| 18-#10 | 3.25 | MA | 9829 | 3122 | 15881 | 2302 | 17441 | 1913 | 18378 | 1606 | 19630 | 1094 | 23623 | 728 | 16831 |
| 5L-6S | | MI | 6534 | 3122 | 10568 | 2238 | 11366 | 1858 | 11791 | 1544 | 12317 | 1048 | 14411 | 585 | 10761 |
| 18-#10 | 3.25 | MA | 9706 | 3122 | 15490 | 2307 | 16948 | 1934 | 17763 | 1615 | 18803 | 1112 | 22564 | 671 | 16456 |
| 6L-5S | | MI | 6610 | 3122 | 10815 | 2221 | 11686 | 1852 | 12189 | 1540 | 12851 | 1036 | 15094 | 641 | 10927 |
| 18-#10 | 3.25 | MA | 9569 | 3122 | 15068 | 2324 | 16441 | 1939 | 17177 | 1634 | 17998 | 1129 | 21318 | 623 | 16188 |
| 7L-4S | | MI | 6718 | 3122 | 11056 | 2213 | 12007 | 1835 | 12589 | 1524 | 13443 | 1035 | 15840 | 692 | 11093 |
| 18-#10 | 3.25 | MA | 9421 | 3122 | 14698 | 2331 | 15930 | 1956 | 16558 | 1640 | 17141 | 1136 | 20242 | 576 | 15679 |
| 8L-3S | | MI | 6777 | 3122 | 11343 | 2195 | 12378 | 1829 | 13045 | 1520 | 14037 | 1022 | 16589 | 741 | 11093 |
| 18-#10 | 3.25 | MA | 9287 | 3122 | 14306 | 2351 | 15440 | 1963 | 15949 | 1656 | 16346 | 1153 | 19181 | 534 | 15215 |
| 9L-2S | | MI | 6900 | 3122 | 11716 | 2187 | 12856 | 1812 | 13629 | 1505 | 14830 | 1010 | 17659 | 831 | 11082 |
| 18-#11 | 3.99 | MA | 10058 | 3266 | 16273 | 2394 | 17893 | 1999 | 18889 | 1654 | 20318 | 1102 | 24693 | 590 | 19664 |
| 6L-5S | | MI | 6827 | 3266 | 11331 | 2298 | 12304 | 1907 | 12924 | 1570 | 13839 | 1014 | 16242 | 535 | 12920 |
| 18-#11 | 3.99 | MA | 9897 | 3266 | 15761 | 2415 | 17286 | 2006 | 18176 | 1678 | 19339 | 1123 | 23174 | 528 | 19086 |
| 7L-4S | | MI | 6954 | 3266 | 11623 | 2289 | 12692 | 1887 | 13407 | 1552 | 14553 | 1015 | 17116 | 598 | 13275 |
| 18-#11 | 3.99 | MA | 9721 | 3266 | 15312 | 2423 | 16666 | 2026 | 17437 | 1685 | 18297 | 1129 | 21861 | 469 | 18537 |
| 8L-3S | | MI | 7022 | 3266 | 11969 | 2268 | 13140 | 1881 | 13957 | 1548 | 15269 | 1001 | 17998 | 656 | 13294 |
| 18-#14 | 5.75 | MA | 10713 | 3610 | 17395 | 2652 | 19355 | 2184 | 20667 | 1799 | 22705 | 1123 | 28116 | 350 | 25955 |
| 7L-4S | | MI | 7559 | 3610 | 12991 | 2502 | 14416 | 2039 | 15497 | 1643 | 17405 | 988 | 20656 | 415 | 18088 |
| 20-#10 | 3.61 | MA | 9970 | 3192 | 16082 | 2351 | 17708 | 1966 | 18690 | 1634 | 20064 | 1106 | 24310 | 663 | 18270 |
| 6E | | MI | 6693 | 3192 | 10941 | 2282 | 11844 | 1889 | 12375 | 1563 | 13111 | 1042 | 15482 | 574 | 11895 |
| 20-#10 | 3.61 | MA | 9833 | 3192 | 15660 | 2368 | 17200 | 1971 | 18104 | 1653 | 19259 | 1124 | 23064 | 615 | 17987 |
| 7L-5S | | MI | 6769 | 3192 | 11188 | 2265 | 12164 | 1884 | 12772 | 1559 | 13644 | 1030 | 16164 | 630 | 12052 |
| 20-#10 | 3.61 | MA | 9688 | 3192 | 15291 | 2375 | 16689 | 1988 | 17485 | 1659 | 18402 | 1130 | 21988 | 569 | 17491 |
| 8L-4S | | MI | 6875 | 3192 | 11429 | 2257 | 12485 | 1867 | 13172 | 1544 | 14236 | 1029 | 16911 | 681 | 12253 |
| 20-#10 | 3.61 | MA | 9558 | 3192 | 14899 | 2395 | 16199 | 1994 | 16876 | 1676 | 17606 | 1148 | 20927 | 526 | 17022 |
| 9L-3S | | MI | 6935 | 3192 | 11716 | 2238 | 12856 | 1861 | 13629 | 1539 | 14830 | 1017 | 17659 | 730 | 12262 |
| 20-#11 | 4.43 | MA | 10214 | 3352 | 16478 | 2469 | 18206 | 2045 | 19298 | 1701 | 20865 | 1116 | 25287 | 519 | 21269 |
| 7L-5S | | MI | 7015 | 3352 | 11779 | 2351 | 12878 | 1946 | 13623 | 1593 | 14791 | 1007 | 17496 | 517 | 14272 |
| 20-#11 | 4.43 | MA | 10041 | 3352 | 16029 | 2477 | 17585 | 2065 | 18558 | 1709 | 19823 | 1122 | 23974 | 459 | 20734 |
| 8L-4S | | MI | 7141 | 3352 | 12070 | 2343 | 13266 | 1926 | 14107 | 1576 | 15505 | 1008 | 18370 | 580 | 14619 |
| 22-#10 | 3.97 | MA | 10096 | 3262 | 16253 | 2412 | 17960 | 2002 | 19031 | 1673 | 20520 | 1118 | 24809 | 607 | 19789 |
| 7L-6S | | MI | 6852 | 3262 | 11314 | 2326 | 12322 | 1921 | 12958 | 1582 | 13904 | 1037 | 16552 | 563 | 13030 |
| 22-#10 | 3.97 | MA | 9953 | 3262 | 15883 | 2419 | 17449 | 2019 | 18411 | 1678 | 19662 | 1124 | 23733 | 561 | 19305 |
| 8L-5S | | MI | 6927 | 3262 | 11561 | 2308 | 12642 | 1915 | 13355 | 1578 | 14438 | 1024 | 17235 | 619 | 13180 |
| 22-#10 | 3.97 | MA | 9827 | 3262 | 15491 | 2439 | 16959 | 2026 | 17802 | 1695 | 18867 | 1142 | 22672 | 518 | 18831 |
| 9L-4S | | MI | 7032 | 3262 | 11802 | 2301 | 12963 | 1898 | 13756 | 1563 | 15029 | 1023 | 17981 | 670 | 13411 |
| 22-#11 | 4.88 | MA | 10359 | 3439 | 16746 | 2531 | 18504 | 2104 | 19680 | 1732 | 21349 | 1115 | 26087 | 449 | 22928 |
| 8L-5S | | MI | 7203 | 3439 | 12226 | 2405 | 13451 | 1985 | 14323 | 1617 | 15744 | 1000 | 18750 | 500 | 15627 |
| 24-#10 | 4.33 | MA | 10217 | 3333 | 16476 | 2463 | 18208 | 2051 | 19338 | 1697 | 20923 | 1119 | 25479 | 553 | 21120 |
| 8L-6S | | MI | 7011 | 3333 | 11686 | 2370 | 12800 | 1953 | 13541 | 1602 | 14697 | 1031 | 17623 | 551 | 14168 |
| 24-#10 | 4.33 | MA | 10094 | 3333 | 16084 | 2483 | 17718 | 2057 | 18729 | 1714 | 20128 | 1136 | 24418 | 510 | 20641 |
| 9L-5S | | MI | 7084 | 3333 | 11934 | 2352 | 13120 | 1947 | 13938 | 1597 | 15231 | 1019 | 18306 | 608 | 14311 |

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

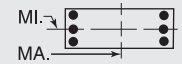
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.20 | MA | 9975 | 2894 | 15740 | 2125 | 16871 | 1791 | 17312 | 1532 | 17515 | 1145 | 19988 | 995 | 7355 |
| 2E | | MI | 6353 | 2894 | 10203 | 2027 | 10708 | 1708 | 10848 | 1459 | 10801 | 1087 | 11909 | 914 | 4624 |
| 4-#18 | 2.14 | MA | 10673 | 3088 | 17431 | 2228 | 18970 | 1863 | 19842 | 1572 | 20940 | 1119 | 24718 | 964 | 12612 |
| 2E | | MI | 6720 | 3088 | 11149 | 2120 | 11862 | 1771 | 12232 | 1491 | 12674 | 1056 | 14093 | 826 | 7698 |
| 6-#10 | 1.02 | MA | 9857 | 2856 | 15375 | 2122 | 16488 | 1792 | 16883 | 1537 | 16953 | 1161 | 19227 | 1010 | 6329 |
| 2L-3S | | MI | 6166 | 2856 | 9628 | 2043 | 10045 | 1736 | 10071 | 1489 | 9757 | 1122 | 10667 | 866 | 4031 |
| 6-#10 | 1.02 | MA | 9614 | 2856 | 14739 | 2133 | 15673 | 1802 | 15888 | 1558 | 15599 | 1179 | 17352 | 930 | 6358 |
| 3L-2S | | MI | 6299 | 2856 | 10001 | 2036 | 10523 | 1718 | 10654 | 1473 | 10550 | 1110 | 11737 | 955 | 4002 |
| 6-#11 | 1.25 | MA | 10030 | 2904 | 15822 | 2140 | 17011 | 1803 | 17498 | 1541 | 17777 | 1150 | 20359 | 998 | 7663 |
| 2L-3S | | MI | 6232 | 2904 | 9808 | 2055 | 10232 | 1744 | 10281 | 1490 | 10035 | 1108 | 10972 | 817 | 4844 |
| 6-#11 | 1.25 | MA | 9740 | 2904 | 15051 | 2153 | 16022 | 1815 | 16292 | 1565 | 16136 | 1171 | 18087 | 898 | 7698 |
| 3L-2S | | MI | 6388 | 2904 | 10256 | 2047 | 10806 | 1724 | 10981 | 1472 | 10987 | 1095 | 12226 | 927 | 4805 |
| 6-#14 | 1.80 | MA | 10459 | 3018 | 16841 | 2203 | 18283 | 1847 | 19034 | 1566 | 19858 | 1136 | 23232 | 981 | 10831 |
| 2L-3S | | MI | 6401 | 3018 | 10203 | 2115 | 10708 | 1791 | 10848 | 1517 | 10801 | 1095 | 11909 | 726 | 6732 |
| 6-#14 | 1.80 | MA | 10055 | 3018 | 15740 | 2220 | 16871 | 1863 | 17312 | 1600 | 17515 | 1165 | 19988 | 834 | 10863 |
| 3L-2S | | MI | 6618 | 3018 | 10837 | 2104 | 11521 | 1763 | 11840 | 1493 | 12150 | 1077 | 13655 | 885 | 6675 |
| 6-#18 | 3.21 | MA | 11497 | 3309 | 19350 | 2366 | 21430 | 1962 | 22843 | 1632 | 25023 | 1102 | 30370 | 940 | 18631 |
| 2L-3S | | MI | 6809 | 3309 | 11149 | 2273 | 11862 | 1914 | 12232 | 1589 | 12674 | 1062 | 14093 | 478 | 11218 |
| 6-#18 | 3.21 | MA | 10826 | 3309 | 17431 | 2396 | 18970 | 1988 | 19842 | 1689 | 20940 | 1151 | 24718 | 671 | 18541 |
| 3L-2S | | MI | 7168 | 3309 | 12238 | 2258 | 13258 | 1870 | 13935 | 1552 | 14991 | 1038 | 16976 | 760 | 11166 |
| 8-#9 | 1.07 | MA | 9907 | 2866 | 15465 | 2133 | 16621 | 1801 | 17053 | 1544 | 17189 | 1163 | 19558 | 1011 | 6643 |
| 2L-4S | | MI | 6173 | 2866 | 9532 | 2070 | 9934 | 1748 | 9940 | 1497 | 9604 | 1133 | 10522 | 851 | 4238 |
| 8-#9 | 1.07 | MA | 9715 | 2866 | 14961 | 2142 | 15976 | 1809 | 16265 | 1560 | 16118 | 1178 | 18075 | 949 | 6663 |
| 3E | | MI | 6223 | 2866 | 9759 | 2055 | 10229 | 1743 | 10301 | 1494 | 10074 | 1123 | 11120 | 890 | 4210 |
| 8-#9 | 1.07 | MA | 9609 | 2866 | 14584 | 2160 | 15485 | 1826 | 15662 | 1567 | 15332 | 1192 | 17095 | 911 | 6684 |
| 4L-2S | | MI | 6329 | 2866 | 10055 | 2049 | 10608 | 1729 | 10764 | 1481 | 10704 | 1113 | 11978 | 961 | 4189 |
| 8-#10 | 1.36 | MA | 10142 | 2926 | 16012 | 2166 | 17304 | 1824 | 17878 | 1557 | 18307 | 1156 | 21102 | 1002 | 8338 |
| 2L-4S | | MI | 6264 | 2926 | 9715 | 2106 | 10152 | 1773 | 10198 | 1512 | 9956 | 1129 | 10989 | 806 | 5269 |
| 8-#10 | 1.36 | MA | 9903 | 2926 | 15375 | 2177 | 16488 | 1834 | 16883 | 1577 | 16953 | 1174 | 19227 | 923 | 8361 |
| 3E | | MI | 6326 | 2926 | 10001 | 2087 | 10523 | 1767 | 10654 | 1508 | 10550 | 1117 | 11737 | 855 | 5235 |
| 8-#10 | 1.36 | MA | 9770 | 2926 | 14898 | 2199 | 15868 | 1855 | 16120 | 1586 | 15958 | 1192 | 17985 | 875 | 8373 |
| 4L-2S | | MI | 6457 | 2926 | 10374 | 2079 | 11001 | 1750 | 11237 | 1492 | 11344 | 1104 | 12808 | 944 | 5206 |
| 8-#11 | 1.67 | MA | 10371 | 2990 | 16593 | 2194 | 17999 | 1842 | 18704 | 1565 | 19418 | 1143 | 22630 | 989 | 10095 |
| 2L-4S | | MI | 6352 | 2990 | 9910 | 2131 | 10358 | 1788 | 10431 | 1517 | 10271 | 1115 | 11344 | 742 | 6324 |
| 8-#11 | 1.67 | MA | 10086 | 2990 | 15822 | 2207 | 17011 | 1854 | 17498 | 1589 | 17777 | 1164 | 20359 | 889 | 10120 |
| 3E | | MI | 6422 | 2990 | 10256 | 2109 | 10806 | 1782 | 10981 | 1513 | 10987 | 1101 | 12226 | 800 | 6283 |
| 8-#11 | 1.67 | MA | 9931 | 2990 | 15241 | 2233 | 16257 | 1879 | 16571 | 1599 | 16569 | 1186 | 18840 | 829 | 10115 |
| 4L-2S | | MI | 6576 | 2990 | 10703 | 2101 | 11380 | 1763 | 11681 | 1496 | 11939 | 1088 | 13480 | 909 | 6246 |
| 8-#14 | 2.41 | MA | 10938 | 3143 | 17943 | 2280 | 19694 | 1903 | 20757 | 1600 | 22201 | 1126 | 26477 | 967 | 14289 |
| 2L-4S | | MI | 6573 | 3143 | 10345 | 2223 | 10884 | 1854 | 11058 | 1555 | 11132 | 1102 | 12423 | 617 | 8766 |
| 8-#14 | 2.41 | MA | 10545 | 3143 | 16841 | 2298 | 18283 | 1919 | 19034 | 1634 | 19858 | 1155 | 23232 | 821 | 14295 |
| 3E | | MI | 6669 | 3143 | 10837 | 2193 | 11521 | 1847 | 11840 | 1551 | 12150 | 1085 | 13655 | 697 | 8744 |
| 8-#14 | 2.41 | MA | 10328 | 3143 | 16010 | 2336 | 17203 | 1955 | 17707 | 1648 | 18129 | 1185 | 21049 | 734 | 14186 |
| 4L-2S | | MI | 6882 | 3143 | 11472 | 2182 | 12334 | 1819 | 12832 | 1527 | 13500 | 1068 | 15401 | 856 | 8699 |
| 8-#18 | 4.28 | MA | 11667 | 3530 | 19350 | 2534 | 21430 | 2087 | 22843 | 1749 | 25023 | 1133 | 30370 | 646 | 24474 |
| 3E | | MI | 7263 | 3530 | 12238 | 2412 | 13258 | 2014 | 13935 | 1649 | 14991 | 1045 | 16976 | 413 | 14598 |
| 8-#18 | 4.28 | MA | 11307 | 3530 | 17895 | 2599 | 19541 | 2148 | 20522 | 1771 | 21999 | 1182 | 26515 | 489 | 22570 |
| 4L-2S | | MI | 7613 | 3530 | 13327 | 2397 | 14653 | 1970 | 15638 | 1612 | 17308 | 1020 | 19859 | 694 | 14600 |
| 10-#10 | 1.70 | MA | 10425 | 2996 | 16648 | 2210 | 18120 | 1855 | 18873 | 1576 | 19661 | 1150 | 22977 | 995 | 10340 |
| 2L-5S | | MI | 6313 | 2996 | 9846 | 2157 | 10309 | 1821 | 10380 | 1547 | 10158 | 1124 | 11313 | 744 | 6475 |
| 10-#10 | 1.70 | MA | 10189 | 2996 | 16012 | 2221 | 17304 | 1865 | 17878 | 1596 | 18307 | 1168 | 21102 | 915 | 10357 |
| 3L-4S | | MI | 6424 | 2996 | 10088 | 2149 | 10630 | 1804 | 10781 | 1531 | 10750 | 1123 | 12059 | 795 | 6454 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

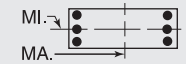
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.70 | MA | 10058 | 2996 | 15534 | 2243 | 16684 | 1886 | 17115 | 1605 | 17312 | 1186 | 19860 | 867 | 10355 |
| 4L-3S | | MI | 6486 | 2996 | 10374 | 2131 | 11001 | 1799 | 11237 | 1527 | 11344 | 1111 | 12808 | 844 | 6425 |
| 10-#10 | 1.70 | MA | 9859 | 2996 | 15136 | 2254 | 16153 | 1896 | 16450 | 1625 | 16326 | 1193 | 18596 | 828 | 10306 |
| 5L-2S | | MI | 6616 | 2996 | 10747 | 2123 | 11479 | 1782 | 11820 | 1511 | 12137 | 1099 | 13879 | 933 | 6399 |
| 10-#11 | 2.09 | MA | 10709 | 3076 | 17364 | 2248 | 18988 | 1881 | 19910 | 1588 | 21059 | 1136 | 24902 | 979 | 12518 |
| 2L-5S | | MI | 6410 | 3076 | 10066 | 2193 | 10544 | 1847 | 10647 | 1558 | 10509 | 1107 | 11724 | 661 | 7655 |
| 10-#11 | 2.09 | MA | 10431 | 3076 | 16593 | 2261 | 17999 | 1892 | 18704 | 1612 | 19418 | 1158 | 22630 | 879 | 12534 |
| 3L-4S | | MI | 6542 | 3076 | 10357 | 2185 | 10932 | 1827 | 11131 | 1541 | 11223 | 1108 | 12598 | 725 | 7738 |
| 10-#11 | 2.09 | MA | 10277 | 3076 | 16012 | 2287 | 17245 | 1918 | 17777 | 1623 | 18210 | 1179 | 21112 | 820 | 12510 |
| 4L-3S | | MI | 6612 | 3076 | 10703 | 2163 | 11380 | 1821 | 11681 | 1537 | 11939 | 1094 | 13480 | 782 | 7707 |
| 10-#11 | 2.09 | MA | 10038 | 3076 | 15528 | 2300 | 16599 | 1929 | 16969 | 1647 | 17011 | 1187 | 19571 | 769 | 12281 |
| 5L-2S | | MI | 6764 | 3076 | 11151 | 2154 | 11953 | 1801 | 12380 | 1519 | 12891 | 1081 | 14734 | 892 | 7675 |
| 10-#14 | 3.01 | MA | 11031 | 3267 | 17943 | 2376 | 19694 | 1975 | 20757 | 1668 | 22201 | 1145 | 26477 | 807 | 17720 |
| 3L-4S | | MI | 6841 | 3267 | 10979 | 2301 | 11697 | 1910 | 12050 | 1589 | 12482 | 1093 | 14169 | 588 | 10721 |
| 10-#14 | 3.01 | MA | 10817 | 3267 | 17111 | 2414 | 18615 | 2011 | 19429 | 1682 | 20472 | 1175 | 24293 | 720 | 17587 |
| 4L-3S | | MI | 6936 | 3267 | 11472 | 2271 | 12334 | 1902 | 12832 | 1585 | 13500 | 1075 | 15401 | 669 | 10741 |
| 10-#14 | 3.01 | MA | 10482 | 3267 | 16418 | 2432 | 17689 | 2026 | 18272 | 1715 | 18756 | 1185 | 22083 | 645 | 16568 |
| 5L-2S | | MI | 7145 | 3267 | 12106 | 2260 | 13147 | 1875 | 13824 | 1561 | 14850 | 1058 | 17146 | 827 | 10708 |
| 10-#18 | 5.35 | MA | 12146 | 3751 | 19813 | 2737 | 22001 | 2248 | 23522 | 1831 | 26081 | 1165 | 32168 | 464 | 28363 |
| 4L-3S | | MI | 7714 | 3751 | 13327 | 2550 | 14653 | 2113 | 15638 | 1710 | 17308 | 1027 | 19859 | 347 | 17966 |
| 10-#18 | 5.35 | MA | 11579 | 3751 | 18596 | 2767 | 20378 | 2273 | 21493 | 1888 | 23077 | 1179 | 28281 | 321 | 26563 |
| 5L-2S | | MI | 8057 | 3751 | 14415 | 2535 | 16049 | 2069 | 17341 | 1672 | 19624 | 1003 | 22742 | 628 | 18016 |
| 12-#10 | 2.04 | MA | 10706 | 3067 | 17284 | 2254 | 18936 | 1887 | 19868 | 1595 | 21015 | 1144 | 24851 | 987 | 12337 |
| 2L-6S | | MI | 6394 | 3067 | 9972 | 2218 | 10467 | 1859 | 10566 | 1570 | 10418 | 1131 | 11701 | 676 | 7449 |
| 12-#10 | 2.04 | MA | 10475 | 3067 | 16648 | 2265 | 18120 | 1897 | 18873 | 1615 | 19661 | 1163 | 22977 | 907 | 12348 |
| 3L-5S | | MI | 6474 | 3067 | 10219 | 2201 | 10787 | 1853 | 10963 | 1566 | 10951 | 1119 | 12384 | 733 | 7642 |
| 12-#10 | 2.04 | MA | 10345 | 3067 | 16170 | 2287 | 17499 | 1918 | 18110 | 1624 | 18666 | 1181 | 21735 | 859 | 12334 |
| 4E | | MI | 6584 | 3067 | 10460 | 2193 | 11108 | 1836 | 11364 | 1550 | 11543 | 1118 | 13130 | 784 | 7630 |
| 12-#10 | 2.04 | MA | 10148 | 3067 | 15772 | 2298 | 16968 | 1928 | 17445 | 1644 | 17680 | 1188 | 20471 | 820 | 12275 |
| 5L-3S | | MI | 6645 | 3067 | 10747 | 2175 | 11479 | 1830 | 11820 | 1546 | 12137 | 1105 | 13879 | 833 | 7608 |
| 12-#10 | 2.04 | MA | 10007 | 3067 | 15349 | 2302 | 16439 | 1949 | 16788 | 1653 | 16796 | 1206 | 19340 | 765 | 11867 |
| 6L-2S | | MI | 6773 | 3067 | 11120 | 2167 | 11957 | 1813 | 12403 | 1531 | 12930 | 1093 | 14949 | 922 | 7584 |
| 12-#11 | 2.50 | MA | 10772 | 3163 | 17364 | 2315 | 18988 | 1931 | 19910 | 1636 | 21059 | 1151 | 24902 | 870 | 14940 |
| 3L-5S | | MI | 6601 | 3163 | 10513 | 2247 | 11118 | 1886 | 11347 | 1582 | 11461 | 1100 | 12978 | 644 | 8985 |
| 12-#11 | 2.50 | MA | 10620 | 3163 | 16783 | 2341 | 18234 | 1956 | 18983 | 1646 | 19851 | 1172 | 23384 | 810 | 14902 |
| 4E | | MI | 6732 | 3163 | 10805 | 2238 | 11505 | 1866 | 11830 | 1564 | 12175 | 1101 | 13852 | 707 | 9143 |
| 12-#11 | 2.50 | MA | 10385 | 3163 | 16299 | 2354 | 17588 | 1968 | 18175 | 1670 | 18652 | 1180 | 21843 | 760 | 14607 |
| 5L-3S | | MI | 6801 | 3163 | 11151 | 2217 | 11953 | 1860 | 12380 | 1560 | 12891 | 1087 | 14734 | 765 | 9122 |
| 12-#11 | 2.50 | MA | 10216 | 3163 | 15792 | 2360 | 16945 | 1993 | 17374 | 1680 | 17575 | 1201 | 20462 | 690 | 14090 |
| 6L-2S | | MI | 6951 | 3163 | 11598 | 2208 | 12527 | 1840 | 13080 | 1543 | 13843 | 1074 | 15988 | 875 | 9095 |
| 12-#14 | 3.61 | MA | 11303 | 3392 | 18212 | 2492 | 20027 | 2066 | 21152 | 1715 | 22815 | 1165 | 27538 | 706 | 20990 |
| 4E | | MI | 7107 | 3392 | 11614 | 2379 | 12510 | 1966 | 13042 | 1623 | 13832 | 1083 | 15914 | 559 | 12576 |
| 12-#14 | 3.61 | MA | 10974 | 3392 | 17519 | 2510 | 19101 | 2082 | 19994 | 1749 | 21099 | 1175 | 25327 | 631 | 19915 |
| 5L-3S | | MI | 7201 | 3392 | 12106 | 2348 | 13147 | 1958 | 13824 | 1619 | 14850 | 1065 | 17146 | 640 | 12731 |
| 12-#14 | 3.61 | MA | 10736 | 3392 | 16800 | 2518 | 18181 | 2118 | 18847 | 1763 | 19557 | 1205 | 23340 | 530 | 19153 |
| 6L-2S | | MI | 7407 | 3392 | 12740 | 2338 | 13961 | 1931 | 14817 | 1595 | 16200 | 1048 | 18892 | 798 | 12708 |
| 12-#18 | 6.42 | MA | 12424 | 3973 | 20515 | 2905 | 22837 | 2373 | 24494 | 1949 | 27160 | 1161 | 33934 | 296 | 32346 |
| 5L-3S | | MI | 8164 | 3973 | 14415 | 2688 | 16049 | 2212 | 17341 | 1770 | 19624 | 1009 | 22742 | 281 | 21327 |
| 14-#10 | 2.38 | MA | 10758 | 3137 | 17284 | 2309 | 18936 | 1928 | 19868 | 1634 | 21015 | 1157 | 24851 | 899 | 14334 |
| 3L-6S | | MI | 6555 | 3137 | 10345 | 2262 | 10945 | 1890 | 11149 | 1589 | 11211 | 1125 | 12771 | 665 | 8575 |
| 14-#10 | 2.38 | MA | 10629 | 3137 | 16807 | 2331 | 18315 | 1950 | 19105 | 1643 | 20020 | 1175 | 23610 | 851 | 14312 |
| 4L-5S | | MI | 6634 | 3137 | 10592 | 2245 | 11265 | 1885 | 11546 | 1585 | 11745 | 1113 | 13454 | 722 | 8769 |
| 14-#10 | 2.38 | MA | 10435 | 3137 | 16409 | 2342 | 17784 | 1960 | 18441 | 1663 | 19034 | 1182 | 22346 | 812 | 14244 |
| 5L-4S | | MI | 6743 | 3137 | 10833 | 2237 | 11586 | 1867 | 11947 | 1569 | 12337 | 1112 | 14200 | 773 | 8802 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis

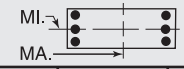



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.38 | MA | 10297 | 3137 | 15986 | 2346 | 17255 | 1981 | 17783 | 1672 | 18150 | 1200 | 21215 | 757 | 13808 |
| 6L-3S | | MI | 6804 | 3137 | 11120 | 2219 | 11957 | 1862 | 12403 | 1565 | 12930 | 1100 | 14949 | 822 | 8785 |
| 14-#10 | 2.38 | MA | 10145 | 3137 | 15533 | 2364 | 16706 | 1985 | 17156 | 1693 | 17288 | 1219 | 19887 | 710 | 13513 |
| 7L-2S | | MI | 6931 | 3137 | 11493 | 2211 | 12435 | 1845 | 12986 | 1550 | 13724 | 1087 | 16020 | 911 | 8765 |
| 14-#11 | 2.92 | MA | 10962 | 3249 | 17554 | 2395 | 19222 | 1995 | 20189 | 1670 | 21491 | 1165 | 25656 | 800 | 17293 |
| 4L-5S | | MI | 6791 | 3249 | 10961 | 2301 | 11691 | 1924 | 12046 | 1605 | 12413 | 1094 | 14232 | 627 | 10322 |
| 14-#11 | 2.92 | MA | 10730 | 3249 | 17070 | 2408 | 18576 | 2007 | 19381 | 1694 | 20293 | 1173 | 24115 | 750 | 16942 |
| 5L-4S | | MI | 6921 | 3249 | 11252 | 2292 | 12079 | 1905 | 12530 | 1588 | 13127 | 1094 | 15106 | 690 | 10544 |
| 14-#11 | 2.92 | MA | 10564 | 3249 | 16563 | 2414 | 17934 | 2032 | 18580 | 1704 | 19216 | 1194 | 22734 | 680 | 16446 |
| 6L-3S | | MI | 6989 | 3249 | 11598 | 2271 | 12527 | 1899 | 13080 | 1584 | 13843 | 1081 | 15988 | 748 | 10531 |
| 14-#11 | 2.92 | MA | 10385 | 3249 | 16013 | 2435 | 17275 | 2038 | 17817 | 1728 | 18168 | 1216 | 21110 | 621 | 15936 |
| 7L-2S | | MI | 7137 | 3249 | 12046 | 2262 | 13101 | 1879 | 13780 | 1566 | 14795 | 1067 | 17242 | 858 | 10509 |
| 14-#14 | 4.21 | MA | 11462 | 3516 | 18620 | 2587 | 20513 | 2138 | 21716 | 1783 | 23443 | 1165 | 28572 | 617 | 23271 |
| 5L-4S | | MI | 7373 | 3516 | 12248 | 2457 | 13323 | 2022 | 14034 | 1657 | 15182 | 1073 | 17660 | 530 | 14445 |
| 14-#14 | 4.21 | MA | 11230 | 3516 | 17901 | 2596 | 19592 | 2174 | 20570 | 1797 | 21901 | 1195 | 26585 | 516 | 22492 |
| 6L-3S | | MI | 7466 | 3516 | 12740 | 2426 | 13961 | 2014 | 14817 | 1653 | 16200 | 1055 | 18892 | 611 | 14707 |
| 14-#14 | 4.21 | MA | 10978 | 3516 | 17115 | 2626 | 18659 | 2183 | 19476 | 1831 | 20399 | 1225 | 24254 | 427 | 21302 |
| 7L-2S | | MI | 7669 | 3516 | 13375 | 2416 | 14774 | 1987 | 15809 | 1629 | 17550 | 1038 | 20637 | 769 | 14701 |
| 16-#10 | 2.72 | MA | 10913 | 3207 | 17443 | 2375 | 19131 | 1981 | 20100 | 1662 | 21374 | 1170 | 25485 | 844 | 16288 |
| 4L-6S | | MI | 6716 | 3207 | 10718 | 2306 | 11423 | 1922 | 11732 | 1608 | 12005 | 1120 | 13842 | 654 | 9704 |
| 16-#10 | 2.72 | MA | 10721 | 3207 | 17045 | 2386 | 18600 | 1991 | 19436 | 1683 | 20388 | 1177 | 24221 | 805 | 16200 |
| 5E | | MI | 6794 | 3207 | 10965 | 2289 | 11743 | 1916 | 12129 | 1604 | 12538 | 1107 | 14525 | 711 | 9886 |
| 16-#10 | 2.72 | MA | 10585 | 3207 | 16622 | 2390 | 18071 | 2012 | 18778 | 1692 | 19504 | 1195 | 23090 | 749 | 15752 |
| 6L-4S | | MI | 6902 | 3207 | 11206 | 2281 | 12064 | 1899 | 12530 | 1589 | 13130 | 1106 | 15271 | 762 | 9970 |
| 16-#10 | 2.72 | MA | 10434 | 3207 | 16170 | 2408 | 17522 | 2017 | 18151 | 1712 | 18642 | 1213 | 21762 | 702 | 15468 |
| 7L-3S | | MI | 6962 | 3207 | 11493 | 2263 | 12435 | 1893 | 12986 | 1584 | 13724 | 1094 | 16020 | 811 | 9958 |
| 16-#10 | 2.72 | MA | 10272 | 3207 | 15774 | 2416 | 16974 | 2034 | 17479 | 1717 | 17724 | 1220 | 20613 | 657 | 14961 |
| 8L-2S | | MI | 7087 | 3207 | 11866 | 2255 | 12913 | 1876 | 13569 | 1569 | 14517 | 1082 | 17090 | 900 | 9941 |
| 16-#11 | 3.34 | MA | 11072 | 3335 | 17841 | 2462 | 19565 | 2045 | 20586 | 1717 | 21934 | 1166 | 26387 | 740 | 19282 |
| 5E | | MI | 6980 | 3335 | 11408 | 2354 | 12265 | 1963 | 12746 | 1629 | 13365 | 1087 | 15486 | 609 | 11665 |
| 16-#11 | 3.34 | MA | 10911 | 3335 | 17334 | 2468 | 18922 | 2071 | 19786 | 1728 | 20857 | 1187 | 25005 | 671 | 18805 |
| 6L-4S | | MI | 7109 | 3335 | 11700 | 2346 | 12653 | 1943 | 13230 | 1611 | 14079 | 1087 | 16360 | 673 | 11937 |
| 16-#11 | 3.34 | MA | 10732 | 3335 | 16784 | 2489 | 18263 | 2077 | 19023 | 1752 | 19809 | 1209 | 23382 | 611 | 18279 |
| 7L-3S | | MI | 7177 | 3335 | 12046 | 2324 | 13101 | 1937 | 13780 | 1607 | 14795 | 1074 | 17242 | 730 | 11936 |
| 16-#11 | 3.34 | MA | 10538 | 3335 | 16303 | 2498 | 17598 | 2098 | 18219 | 1759 | 18692 | 1216 | 21979 | 554 | 17639 |
| 8L-2S | | MI | 7323 | 3335 | 12493 | 2316 | 13674 | 1917 | 14480 | 1590 | 15747 | 1060 | 18496 | 840 | 11919 |
| 16-#14 | 4.81 | MA | 11721 | 3641 | 19002 | 2674 | 21004 | 2230 | 22292 | 1831 | 24244 | 1185 | 29829 | 502 | 25836 |
| 6L-4S | | MI | 7638 | 3641 | 12883 | 2535 | 14137 | 2077 | 15026 | 1691 | 16532 | 1063 | 19405 | 501 | 16326 |
| 16-#14 | 4.81 | MA | 11471 | 3641 | 18216 | 2704 | 20071 | 2239 | 21198 | 1865 | 22742 | 1215 | 27498 | 413 | 24668 |
| 7L-3S | | MI | 7730 | 3641 | 13375 | 2504 | 14774 | 2070 | 15809 | 1687 | 17550 | 1045 | 20637 | 582 | 16680 |
| 18-#10 | 3.06 | MA | 11005 | 3277 | 17681 | 2430 | 19416 | 2023 | 20431 | 1702 | 21742 | 1171 | 26096 | 797 | 18132 |
| 5L-6S | | MI | 6876 | 3277 | 11090 | 2350 | 11901 | 1953 | 12315 | 1627 | 12798 | 1114 | 14912 | 643 | 10836 |
| 18-#10 | 3.06 | MA | 10871 | 3277 | 17258 | 2434 | 18887 | 2044 | 19773 | 1711 | 20858 | 1189 | 24965 | 742 | 17700 |
| 6L-5S | | MI | 6953 | 3277 | 11338 | 2333 | 12221 | 1948 | 12713 | 1623 | 13332 | 1102 | 15595 | 700 | 11008 |
| 18-#10 | 3.06 | MA | 10721 | 3277 | 16806 | 2452 | 18338 | 2048 | 19146 | 1731 | 19996 | 1207 | 23637 | 694 | 17425 |
| 7L-4S | | MI | 7060 | 3277 | 11579 | 2325 | 12542 | 1931 | 13113 | 1608 | 13923 | 1101 | 16342 | 750 | 11135 |
| 18-#10 | 3.06 | MA | 10562 | 3277 | 16410 | 2460 | 17790 | 2066 | 18474 | 1736 | 19078 | 1214 | 22488 | 649 | 16908 |
| 8L-3S | | MI | 7120 | 3277 | 11866 | 2306 | 12913 | 1925 | 13569 | 1603 | 14517 | 1089 | 17090 | 800 | 11129 |
| 18-#10 | 3.06 | MA | 10416 | 3277 | 15990 | 2479 | 17265 | 2073 | 17822 | 1753 | 18227 | 1233 | 21358 | 607 | 16467 |
| 9L-2S | | MI | 7244 | 3277 | 12238 | 2299 | 13391 | 1908 | 14152 | 1588 | 15311 | 1076 | 18161 | 889 | 11115 |
| 18-#11 | 3.75 | MA | 11255 | 3422 | 18105 | 2521 | 19911 | 2110 | 20992 | 1751 | 22498 | 1180 | 27277 | 661 | 21168 |
| 6L-5S | | MI | 7169 | 3422 | 11856 | 2408 | 12839 | 2002 | 13446 | 1652 | 14318 | 1080 | 16740 | 592 | 13013 |
| 18-#11 | 3.75 | MA | 11077 | 3422 | 17555 | 2543 | 19252 | 2116 | 20229 | 1775 | 21449 | 1202 | 25654 | 602 | 20626 |
| 7L-4S | | MI | 7297 | 3422 | 12147 | 2400 | 13226 | 1982 | 13930 | 1635 | 15032 | 1080 | 17614 | 655 | 13327 |
| 18-#11 | 3.75 | MA | 10886 | 3422 | 17074 | 2552 | 18586 | 2137 | 19425 | 1782 | 20333 | 1209 | 24251 | 544 | 20002 |
| 8L-3S | | MI | 7365 | 3422 | 12493 | 2378 | 13674 | 1976 | 14480 | 1631 | 15747 | 1067 | 18496 | 713 | 13337 |
| 18-#14 | 5.41 | MA | 11959 | 3765 | 19317 | 2782 | 21483 | 2295 | 22920 | 1899 | 25085 | 1205 | 30743 | 400 | 28034 |
| 7L-4S | | MI | 7901 | 3765 | 13517 | 2612 | 14950 | 2133 | 16019 | 1725 | 17881 | 1053 | 21151 | 472 | 18215 |

## RECTANGULAR TIED COLUMNS 22" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#10 | 3.40 | MA | 11157 | 3348 | 17895 | 2478 | 19702 | 2075 | 20769 | 1730 | 22212 | 1184 | 26840 | 734 | 19650 |
| 6E | | MI | 7036 | 3348 | 11463 | 2394 | 12379 | 1985 | 12898 | 1647 | 13591 | 1108 | 15983 | 632 | 11970 |
| 20-#10 | 3.40 | MA | 11007 | 3348 | 17442 | 2496 | 19153 | 2080 | 20142 | 1750 | 21350 | 1202 | 25512 | 686 | 19383 |
| 7L-5S | | MI | 7111 | 3348 | 11711 | 2376 | 12699 | 1979 | 13296 | 1642 | 14125 | 1096 | 16666 | 689 | 12133 |
| 20-#10 | 3.40 | MA | 10850 | 3348 | 17046 | 2503 | 18606 | 2097 | 19470 | 1755 | 20432 | 1209 | 24362 | 642 | 18856 |
| 8L-4S | | MI | 7218 | 3348 | 11952 | 2369 | 13020 | 1962 | 13696 | 1627 | 14717 | 1095 | 17412 | 739 | 12296 |
| 20-#10 | 3.40 | MA | 10709 | 3348 | 16626 | 2523 | 18081 | 2105 | 18817 | 1772 | 19581 | 1227 | 23233 | 599 | 18412 |
| 9L-3S | | MI | 7278 | 3348 | 12238 | 2350 | 13391 | 1956 | 14152 | 1623 | 15311 | 1083 | 18161 | 789 | 12297 |
| 20-#10 | 3.40 | MA | 10543 | 3348 | 16216 | 2529 | 17555 | 2124 | 18181 | 1790 | 18733 | 1245 | 22089 | 560 | 17779 |
| 10L-2S | | MI | 7400 | 3348 | 12611 | 2343 | 13869 | 1939 | 14735 | 1607 | 16104 | 1071 | 19231 | 878 | 12287 |
| 20-#11 | 4.17 | MA | 11420 | 3508 | 18326 | 2597 | 20240 | 2154 | 21435 | 1799 | 23090 | 1195 | 27926 | 592 | 22976 |
| 7L-5S | | MI | 7358 | 3508 | 12303 | 2462 | 13412 | 2040 | 14146 | 1676 | 15270 | 1073 | 17994 | 575 | 14364 |
| 20-#11 | 4.17 | MA | 11232 | 3508 | 17845 | 2606 | 19575 | 2175 | 20631 | 1806 | 21974 | 1202 | 26523 | 535 | 22368 |
| 8L-4S | | MI | 7484 | 3508 | 12595 | 2454 | 13800 | 2021 | 14630 | 1658 | 15984 | 1073 | 18868 | 638 | 14716 |
| 22-#10 | 3.74 | MA | 11291 | 3418 | 18079 | 2540 | 19969 | 2111 | 21137 | 1769 | 22704 | 1196 | 27386 | 679 | 21344 |
| 7L-6S | | MI | 7195 | 3418 | 11836 | 2438 | 12857 | 2017 | 13481 | 1666 | 14385 | 1103 | 17054 | 621 | 13106 |
| 22-#10 | 3.74 | MA | 11136 | 3418 | 17683 | 2547 | 19421 | 2129 | 20465 | 1774 | 21786 | 1203 | 26237 | 634 | 20806 |
| 8L-5S | | MI | 7269 | 3418 | 12084 | 2420 | 13177 | 2011 | 13879 | 1661 | 14918 | 1091 | 17736 | 677 | 13260 |
| 22-#10 | 3.74 | MA | 10999 | 3418 | 17263 | 2567 | 18897 | 2136 | 19812 | 1791 | 20935 | 1221 | 25108 | 592 | 20359 |
| 9L-4S | | MI | 7375 | 3418 | 12325 | 2413 | 13498 | 1994 | 14279 | 1646 | 15510 | 1090 | 18483 | 728 | 13455 |
| 22-#10 | 3.74 | MA | 10834 | 3418 | 16852 | 2573 | 18371 | 2155 | 19177 | 1809 | 20087 | 1239 | 23963 | 553 | 19728 |
| 10L-3S | | MI | 7435 | 3418 | 12611 | 2394 | 13869 | 1988 | 14735 | 1642 | 16104 | 1077 | 19231 | 777 | 13464 |
| 22-#11 | 4.59 | MA | 11577 | 3594 | 18616 | 2660 | 20563 | 2214 | 21837 | 1829 | 23614 | 1196 | 28795 | 525 | 24736 |
| 8L-5S | | MI | 7546 | 3594 | 12751 | 2516 | 13986 | 2079 | 14846 | 1699 | 16222 | 1066 | 19248 | 558 | 15719 |
| 24-#10 | 4.07 | MA | 11421 | 3488 | 18319 | 2591 | 20237 | 2161 | 21460 | 1794 | 23141 | 1198 | 28112 | 626 | 22758 |
| 8L-6S | | MI | 7353 | 3488 | 12209 | 2482 | 13335 | 2048 | 14065 | 1685 | 15178 | 1097 | 18124 | 610 | 14243 |
| 24-#10 | 4.07 | MA | 11288 | 3488 | 17899 | 2611 | 19713 | 2168 | 20807 | 1811 | 22289 | 1216 | 26983 | 584 | 22306 |
| 9L-5S | | MI | 7427 | 3488 | 12456 | 2464 | 13655 | 2042 | 14462 | 1681 | 15712 | 1085 | 18807 | 666 | 14390 |
| 24-#10 | 4.07 | MA | 11124 | 3488 | 17489 | 2616 | 19187 | 2187 | 20172 | 1828 | 21441 | 1234 | 25838 | 545 | 21678 |
| 10L-4S | | MI | 7532 | 3488 | 12698 | 2457 | 13976 | 2025 | 14862 | 1665 | 16303 | 1084 | 19553 | 717 | 14614 |

## RECTANGULAR TIED COLUMNS 22" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.14 | MA | 11141 | 3049 | 17498 | 2251 | 18769 | 1899 | 19251 | 1626 | 19432 | 1220 | 22136 | 1061 | 7841 |
| 2E | | MI | 6695 | 3049 | 10728 | 2137 | 11242 | 1801 | 11369 | 1541 | 11277 | 1153 | 12405 | 971 | 4652 |
| 4-#18 | 2.02 | MA | 11897 | 3243 | 19316 | 2354 | 21024 | 1971 | 21970 | 1666 | 23113 | 1194 | 27217 | 1030 | 13476 |
| 2E | | MI | 7063 | 3243 | 11677 | 2228 | 12395 | 1863 | 12751 | 1572 | 13147 | 1120 | 14583 | 882 | 7740 |
| 6-#11 | 1.18 | MA | 11199 | 3059 | 17583 | 2266 | 18916 | 1911 | 19447 | 1635 | 19709 | 1225 | 22527 | 1064 | 8169 |
| 2L-3S | | MI | 6574 | 3059 | 10333 | 2166 | 10767 | 1838 | 10803 | 1572 | 10513 | 1174 | 11470 | 874 | 4870 |
| 6-#11 | 1.18 | MA | 10886 | 3059 | 16758 | 2280 | 17858 | 1923 | 18157 | 1660 | 17954 | 1247 | 20096 | 966 | 8204 |
| 3L-2S | | MI | 6730 | 3059 | 10780 | 2157 | 11340 | 1818 | 11503 | 1555 | 11465 | 1160 | 12724 | 984 | 4831 |
| 6-#14 | 1.70 | MA | 11662 | 3174 | 18677 | 2329 | 20280 | 1955 | 21095 | 1660 | 21941 | 1210 | 25609 | 1047 | 11560 |
| 2L-3S | | MI | 6744 | 3174 | 10728 | 2225 | 11242 | 1885 | 11369 | 1599 | 11277 | 1160 | 12405 | 784 | 6767 |
| 6-#14 | 1.70 | MA | 11225 | 3174 | 17498 | 2348 | 18769 | 1972 | 19251 | 1695 | 19432 | 1241 | 22136 | 903 | 11592 |
| 3L-2S | | MI | 6960 | 3174 | 11363 | 2214 | 12055 | 1857 | 12362 | 1575 | 12627 | 1143 | 14150 | 942 | 6708 |
| 6-#18 | 3.03 | MA | 12786 | 3464 | 21373 | 2493 | 23661 | 2070 | 25187 | 1726 | 27490 | 1177 | 33278 | 1005 | 19927 |
| 2L-3S | | MI | 7151 | 3464 | 11677 | 2382 | 12395 | 2007 | 12751 | 1670 | 13147 | 1127 | 14583 | 535 | 11278 |
| 6-#18 | 3.03 | MA | 12059 | 3464 | 19316 | 2524 | 21024 | 2097 | 21970 | 1785 | 23113 | 1228 | 27217 | 742 | 19837 |
| 3L-2S | | MI | 7511 | 3464 | 12766 | 2367 | 13791 | 1963 | 14454 | 1632 | 15464 | 1102 | 17466 | 816 | 11214 |
| 8-#9 | 1.01 | MA | 11065 | 3022 | 17198 | 2260 | 18494 | 1909 | 18965 | 1638 | 19073 | 1238 | 21662 | 1077 | 7075 |
| 2L-4S | | MI | 6515 | 3022 | 10054 | 2182 | 10469 | 1844 | 10464 | 1581 | 10085 | 1200 | 11024 | 909 | 4258 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 36"

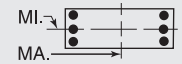
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#9 | 1.01 | MA | 10858 | 3022 | 16660 | 2269 | 17804 | 1917 | 18124 | 1654 | 17929 | 1253 | 20077 | 1016 | 7095 |
| 3E | | MI | 6566 | 3022 | 10281 | 2168 | 10763 | 1839 | 10826 | 1577 | 10556 | 1190 | 11623 | 949 | 4231 |
| 8-#9 | 1.01 | MA | 10742 | 3022 | 16257 | 2286 | 17281 | 1934 | 17480 | 1662 | 17044 | 1259 | 19037 | 978 | 7116 |
| 4L-2S | | MI | 6671 | 3022 | 10577 | 2161 | 11143 | 1825 | 11289 | 1565 | 11186 | 1180 | 12480 | 1019 | 4210 |
| 8-#10 | 1.28 | MA | 11318 | 3082 | 17783 | 2292 | 19226 | 1932 | 19849 | 1651 | 20270 | 1230 | 23314 | 1068 | 8887 |
| 2L-4S | | MI | 6606 | 3082 | 10237 | 2218 | 10686 | 1868 | 10721 | 1595 | 10437 | 1195 | 11490 | 864 | 5295 |
| 8-#10 | 1.28 | MA | 11060 | 3082 | 17103 | 2304 | 18353 | 1942 | 18785 | 1671 | 18822 | 1249 | 21310 | 990 | 8910 |
| 3E | | MI | 6669 | 3082 | 10524 | 2199 | 11058 | 1863 | 11178 | 1591 | 11031 | 1183 | 12239 | 913 | 5259 |
| 8-#10 | 1.28 | MA | 10915 | 3082 | 16594 | 2326 | 17692 | 1964 | 17970 | 1681 | 17703 | 1257 | 19992 | 942 | 8922 |
| 4L-2S | | MI | 6800 | 3082 | 10897 | 2191 | 11536 | 1846 | 11761 | 1576 | 11824 | 1171 | 13309 | 1002 | 5230 |
| 8-#11 | 1.58 | MA | 11566 | 3146 | 18408 | 2320 | 19974 | 1950 | 20737 | 1659 | 21465 | 1218 | 24958 | 1055 | 10769 |
| 2L-4S | | MI | 6694 | 3146 | 10434 | 2241 | 10893 | 1883 | 10953 | 1600 | 10749 | 1180 | 11842 | 799 | 6357 |
| 8-#11 | 1.58 | MA | 11259 | 3146 | 17583 | 2334 | 18916 | 1962 | 19447 | 1684 | 19709 | 1240 | 22527 | 956 | 10794 |
| 3E | | MI | 6765 | 3146 | 10780 | 2220 | 11340 | 1877 | 11503 | 1596 | 11465 | 1167 | 12724 | 857 | 6314 |
| 8-#11 | 1.58 | MA | 11088 | 3146 | 16963 | 2361 | 18111 | 1988 | 18457 | 1694 | 18419 | 1262 | 20914 | 897 | 10789 |
| 4L-2S | | MI | 6919 | 3146 | 11228 | 2211 | 11914 | 1857 | 12203 | 1578 | 12417 | 1154 | 13978 | 967 | 6276 |
| 8-#14 | 2.27 | MA | 12180 | 3298 | 19856 | 2407 | 21792 | 2011 | 22939 | 1694 | 24450 | 1200 | 29083 | 1033 | 15261 |
| 2L-4S | | MI | 6915 | 3298 | 10871 | 2333 | 11418 | 1948 | 11579 | 1637 | 11609 | 1168 | 12918 | 674 | 8818 |
| 8-#14 | 2.27 | MA | 11754 | 3298 | 18677 | 2425 | 20280 | 2028 | 21095 | 1729 | 21941 | 1231 | 25609 | 889 | 15267 |
| 3E | | MI | 7011 | 3298 | 11363 | 2303 | 12055 | 1940 | 12362 | 1633 | 12627 | 1150 | 14150 | 755 | 8784 |
| 8-#14 | 2.27 | MA | 11516 | 3298 | 17789 | 2464 | 19127 | 2064 | 19677 | 1744 | 20094 | 1262 | 23289 | 803 | 15158 |
| 4L-2S | | MI | 7225 | 3298 | 11997 | 2292 | 12868 | 1913 | 13354 | 1609 | 13977 | 1133 | 15896 | 913 | 8736 |
| 8-#18 | 4.04 | MA | 12966 | 3686 | 21373 | 2662 | 23661 | 2197 | 25187 | 1845 | 27490 | 1210 | 33278 | 717 | 26202 |
| 3E | | MI | 7605 | 3686 | 12766 | 2520 | 13791 | 2106 | 14454 | 1730 | 15464 | 1109 | 17466 | 469 | 14667 |
| 8-#18 | 4.04 | MA | 12570 | 3686 | 19817 | 2728 | 21642 | 2259 | 22704 | 1869 | 24256 | 1262 | 29178 | 561 | 24376 |
| 4L-2S | | MI | 7956 | 3686 | 13854 | 2505 | 15187 | 2062 | 16157 | 1693 | 17781 | 1084 | 20349 | 751 | 14653 |
| 10-#10 | 1.60 | MA | 11623 | 3152 | 18464 | 2336 | 20098 | 1963 | 20912 | 1670 | 21717 | 1225 | 25319 | 1060 | 11026 |
| 2L-5S | | MI | 6655 | 3152 | 10369 | 2269 | 10843 | 1917 | 10904 | 1630 | 10639 | 1191 | 11815 | 802 | 6509 |
| 10-#10 | 1.60 | MA | 11368 | 3152 | 17783 | 2348 | 19226 | 1974 | 19849 | 1690 | 20270 | 1244 | 23314 | 982 | 11043 |
| 3L-4S | | MI | 6767 | 3152 | 10610 | 2261 | 11164 | 1900 | 11304 | 1614 | 11230 | 1190 | 12561 | 853 | 6483 |
| 10-#10 | 1.60 | MA | 11225 | 3152 | 17274 | 2370 | 18564 | 1995 | 19034 | 1700 | 19151 | 1251 | 21996 | 934 | 11041 |
| 4L-3S | | MI | 6829 | 3152 | 10897 | 2243 | 11536 | 1894 | 11761 | 1610 | 11824 | 1177 | 13309 | 902 | 6452 |
| 10-#10 | 1.60 | MA | 11011 | 3152 | 16846 | 2381 | 17998 | 2005 | 18326 | 1721 | 18157 | 1270 | 20651 | 897 | 10992 |
| 5L-2S | | MI | 6958 | 3152 | 11270 | 2235 | 12014 | 1877 | 12344 | 1595 | 12618 | 1165 | 14380 | 991 | 6425 |
| 10-#11 | 1.97 | MA | 11931 | 3232 | 19233 | 2374 | 21031 | 1989 | 22028 | 1682 | 23221 | 1211 | 27389 | 1045 | 13360 |
| 2L-5S | | MI | 6752 | 3232 | 10590 | 2304 | 11078 | 1941 | 11169 | 1641 | 10987 | 1173 | 12222 | 719 | 7776 |
| 10-#11 | 1.97 | MA | 11629 | 3232 | 18408 | 2387 | 19974 | 2001 | 20737 | 1707 | 21465 | 1233 | 24958 | 947 | 13376 |
| 3L-4S | | MI | 6884 | 3232 | 10882 | 2295 | 11466 | 1922 | 11653 | 1623 | 11701 | 1173 | 13096 | 782 | 7775 |
| 10-#11 | 1.97 | MA | 11461 | 3232 | 17788 | 2415 | 19168 | 2027 | 19747 | 1718 | 20175 | 1255 | 23345 | 887 | 13352 |
| 4L-3S | | MI | 6954 | 3232 | 11228 | 2273 | 11914 | 1916 | 12203 | 1619 | 12417 | 1160 | 13978 | 840 | 7741 |
| 10-#11 | 1.97 | MA | 11204 | 3232 | 17273 | 2428 | 18479 | 2039 | 18885 | 1743 | 18896 | 1264 | 21704 | 839 | 13193 |
| 5L-2S | | MI | 7106 | 3232 | 11675 | 2265 | 12488 | 1896 | 12903 | 1602 | 13369 | 1147 | 15232 | 950 | 7707 |
| 10-#14 | 2.84 | MA | 12277 | 3423 | 19856 | 2503 | 21792 | 2083 | 22939 | 1763 | 24450 | 1221 | 29083 | 875 | 18935 |
| 3L-4S | | MI | 7183 | 3423 | 11505 | 2411 | 12231 | 2004 | 12571 | 1671 | 12959 | 1158 | 14664 | 645 | 10793 |
| 10-#14 | 2.84 | MA | 12043 | 3423 | 18968 | 2542 | 20639 | 2120 | 21521 | 1777 | 22603 | 1252 | 26763 | 789 | 18802 |
| 4L-3S | | MI | 7278 | 3423 | 11997 | 2381 | 12868 | 1996 | 13354 | 1667 | 13977 | 1140 | 15896 | 726 | 10785 |
| 10-#14 | 2.84 | MA | 11682 | 3423 | 18229 | 2560 | 19651 | 2137 | 20285 | 1812 | 20771 | 1264 | 24408 | 717 | 17805 |
| 5L-2S | | MI | 7488 | 3423 | 12631 | 2370 | 13681 | 1969 | 14346 | 1643 | 15327 | 1123 | 17641 | 884 | 10749 |
| 10-#18 | 5.05 | MA | 13475 | 3907 | 21874 | 2867 | 24279 | 2359 | 25921 | 1929 | 28633 | 1244 | 35239 | 537 | 30601 |
| 4L-3S | | MI | 8057 | 3907 | 13854 | 2658 | 15187 | 2205 | 16157 | 1790 | 17781 | 1091 | 20349 | 403 | 18040 |
| 10-#18 | 5.05 | MA | 12863 | 3907 | 20575 | 2898 | 22546 | 2386 | 23754 | 1988 | 25421 | 1260 | 31096 | 399 | 28689 |
| 5L-2S | | MI | 8401 | 3907 | 14943 | 2643 | 16583 | 2161 | 17860 | 1753 | 20097 | 1067 | 23232 | 685 | 18072 |
| 12-#10 | 1.92 | MA | 11926 | 3222 | 19144 | 2380 | 20970 | 1995 | 21976 | 1689 | 23165 | 1219 | 27323 | 1052 | 13160 |
| 2L-6S | | MI | 6736 | 3222 | 10494 | 2330 | 11002 | 1954 | 11090 | 1653 | 10898 | 1197 | 12202 | 734 | 7523 |
| 12-#10 | 1.92 | MA | 11675 | 3222 | 18464 | 2392 | 20098 | 2005 | 20912 | 1710 | 21717 | 1238 | 25319 | 974 | 13171 |
| 3L-5S | | MI | 6816 | 3222 | 10742 | 2313 | 11321 | 1949 | 11487 | 1649 | 11432 | 1185 | 12885 | 791 | 7679 |
| 12-#10 | 1.92 | MA | 11533 | 3222 | 17954 | 2414 | 19436 | 2027 | 20098 | 1719 | 20598 | 1245 | 24000 | 926 | 13157 |
| 4E | | MI | 6927 | 3222 | 10983 | 2305 | 11642 | 1931 | 11888 | 1634 | 12024 | 1184 | 13631 | 842 | 7662 |

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

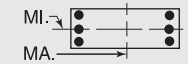
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.92 | MA | 11322 | 3222 | 17526 | 2425 | 18870 | 2037 | 19390 | 1740 | 19605 | 1264 | 22655 | 889 | 13098 |
| 5L-3S | | MI | 6988 | 3222 | 11270 | 2287 | 12014 | 1926 | 12344 | 1629 | 12618 | 1172 | 14380 | 891 | 7637 |
| 12-#10 | 1.92 | MA | 11170 | 3222 | 17075 | 2429 | 18300 | 2058 | 18689 | 1749 | 18662 | 1283 | 21452 | 835 | 12711 |
| 6L-2S | | MI | 7116 | 3222 | 11642 | 2279 | 12492 | 1909 | 12927 | 1614 | 13411 | 1159 | 15451 | 980 | 7613 |
| 12-#11 | 2.36 | MA | 11998 | 3318 | 19233 | 2441 | 21031 | 2039 | 22028 | 1731 | 23221 | 1226 | 27389 | 937 | 15951 |
| 3L-5S | | MI | 6943 | 3318 | 11037 | 2357 | 11652 | 1980 | 11869 | 1664 | 11939 | 1166 | 13476 | 702 | 9077 |
| 12-#11 | 2.36 | MA | 11831 | 3318 | 18614 | 2469 | 20226 | 2065 | 21038 | 1741 | 21930 | 1248 | 25775 | 878 | 15913 |
| 4E | | MI | 7074 | 3318 | 11329 | 2349 | 12040 | 1960 | 12353 | 1647 | 12653 | 1166 | 14350 | 765 | 9184 |
| 12-#11 | 2.36 | MA | 11578 | 3318 | 18098 | 2482 | 19537 | 2077 | 20175 | 1766 | 20651 | 1257 | 24135 | 829 | 15685 |
| 5L-3S | | MI | 7143 | 3318 | 11675 | 2327 | 12488 | 1954 | 12903 | 1643 | 13369 | 1153 | 15232 | 823 | 9159 |
| 12-#11 | 2.36 | MA | 11395 | 3318 | 17550 | 2487 | 18852 | 2103 | 19322 | 1777 | 19503 | 1279 | 22666 | 761 | 15101 |
| 6L-2S | | MI | 7294 | 3318 | 12122 | 2319 | 13061 | 1935 | 13603 | 1625 | 14321 | 1140 | 16486 | 932 | 9130 |
| 12-#14 | 3.41 | MA | 12566 | 3547 | 20148 | 2619 | 22150 | 2176 | 23365 | 1811 | 25112 | 1242 | 30237 | 775 | 22448 |
| 4E | | MI | 7450 | 3547 | 12139 | 2489 | 13044 | 2060 | 13564 | 1705 | 14308 | 1148 | 16410 | 616 | 12707 |
| 12-#14 | 3.41 | MA | 12212 | 3547 | 19408 | 2638 | 21163 | 2193 | 22129 | 1846 | 23279 | 1254 | 27882 | 703 | 21393 |
| 5L-3S | | MI | 7544 | 3547 | 12631 | 2458 | 13681 | 2052 | 14346 | 1701 | 15327 | 1130 | 17641 | 697 | 12776 |
| 12-#14 | 3.41 | MA | 11955 | 3547 | 18631 | 2646 | 20181 | 2229 | 20906 | 1861 | 21634 | 1285 | 25772 | 603 | 20653 |
| 6L-2S | | MI | 7751 | 3547 | 13266 | 2448 | 14495 | 2025 | 15338 | 1677 | 16677 | 1113 | 19387 | 855 | 12751 |
| 12-#18 | 6.06 | MA | 13774 | 4128 | 22632 | 3036 | 25183 | 2485 | 26971 | 2048 | 29798 | 1243 | 37156 | 375 | 34985 |
| 5L-3S | | MI | 8506 | 4128 | 14943 | 2797 | 16583 | 2305 | 17860 | 1851 | 20097 | 1074 | 23232 | 338 | 21405 |
| 12-#18 | 6.06 | MA | 13340 | 4128 | 21297 | 3051 | 23459 | 2548 | 24824 | 2072 | 26912 | 1294 | 33422 | 194 | 31970 |
| 6L-2S | | MI | 8844 | 4128 | 16032 | 2782 | 17978 | 2261 | 19563 | 1813 | 22414 | 1049 | 26115 | 619 | 21478 |
| 14-#10 | 2.24 | MA | 11980 | 3292 | 19144 | 2435 | 20970 | 2037 | 21976 | 1729 | 23165 | 1232 | 27323 | 966 | 15294 |
| 3L-6S | | MI | 6897 | 3292 | 10867 | 2374 | 11480 | 1986 | 11673 | 1672 | 11692 | 1192 | 13273 | 723 | 8649 |
| 14-#10 | 2.24 | MA | 11840 | 3292 | 18634 | 2458 | 20308 | 2058 | 21162 | 1738 | 22046 | 1240 | 26004 | 919 | 15272 |
| 4L-5S | | MI | 6976 | 3292 | 11115 | 2357 | 11799 | 1980 | 12070 | 1668 | 12225 | 1179 | 13956 | 780 | 8845 |
| 14-#10 | 2.24 | MA | 11631 | 3292 | 18206 | 2469 | 19742 | 2069 | 20454 | 1759 | 21052 | 1259 | 24659 | 881 | 15204 |
| 5L-4S | | MI | 7086 | 3292 | 11356 | 2349 | 12120 | 1963 | 12471 | 1653 | 12817 | 1178 | 14702 | 831 | 8836 |
| 14-#10 | 2.24 | MA | 11481 | 3292 | 17755 | 2473 | 19172 | 2089 | 19753 | 1768 | 20109 | 1277 | 23456 | 827 | 14787 |
| 6L-3S | | MI | 7147 | 3292 | 11642 | 2331 | 12492 | 1957 | 12927 | 1648 | 13411 | 1166 | 15451 | 880 | 8816 |
| 14-#10 | 2.24 | MA | 11316 | 3292 | 17272 | 2491 | 18586 | 2095 | 19081 | 1789 | 19133 | 1285 | 22046 | 780 | 14458 |
| 7L-2S | | MI | 7273 | 3292 | 12015 | 2323 | 12970 | 1940 | 13510 | 1633 | 14204 | 1154 | 16521 | 969 | 8795 |
| 14-#11 | 2.76 | MA | 12198 | 3405 | 19439 | 2522 | 21284 | 2104 | 22328 | 1765 | 23686 | 1242 | 28206 | 868 | 18472 |
| 4L-5S | | MI | 7133 | 3405 | 11485 | 2411 | 12226 | 2019 | 12569 | 1688 | 12892 | 1159 | 14730 | 684 | 10414 |
| 14-#11 | 2.76 | MA | 11949 | 3405 | 18923 | 2536 | 20595 | 2116 | 21466 | 1790 | 22407 | 1250 | 26566 | 820 | 18185 |
| 5L-4S | | MI | 7263 | 3405 | 11777 | 2403 | 12613 | 1999 | 13053 | 1670 | 13606 | 1160 | 15604 | 747 | 10587 |
| 14-#11 | 2.76 | MA | 11771 | 3405 | 18375 | 2541 | 19910 | 2142 | 20612 | 1800 | 21258 | 1272 | 25097 | 751 | 17623 |
| 6L-3S | | MI | 7332 | 3405 | 12122 | 2381 | 13061 | 1993 | 13603 | 1666 | 14321 | 1146 | 16486 | 805 | 10570 |
| 14-#11 | 2.76 | MA | 11575 | 3405 | 17788 | 2563 | 19198 | 2148 | 19798 | 1825 | 20140 | 1294 | 23371 | 693 | 17154 |
| 7L-2S | | MI | 7480 | 3405 | 12570 | 2373 | 13635 | 1973 | 14302 | 1649 | 15274 | 1133 | 17740 | 915 | 10546 |
| 14-#14 | 3.98 | MA | 12737 | 3672 | 20587 | 2716 | 22674 | 2249 | 23973 | 1880 | 25788 | 1244 | 31356 | 689 | 24990 |
| 5L-4S | | MI | 7716 | 3672 | 12774 | 2567 | 13858 | 2115 | 14556 | 1739 | 15658 | 1138 | 18155 | 587 | 14574 |
| 14-#14 | 3.98 | MA | 12488 | 3672 | 19810 | 2724 | 21692 | 2285 | 22750 | 1895 | 24143 | 1275 | 29246 | 589 | 24273 |
| 6L-3S | | MI | 7809 | 3672 | 13266 | 2536 | 14495 | 2108 | 15338 | 1735 | 16677 | 1120 | 19387 | 668 | 14760 |
| 14-#14 | 3.98 | MA | 12213 | 3672 | 18970 | 2755 | 20684 | 2294 | 21583 | 1930 | 22540 | 1306 | 26764 | 503 | 22922 |
| 7L-2S | | MI | 8012 | 3672 | 13900 | 2526 | 15308 | 2081 | 16330 | 1711 | 18026 | 1103 | 21132 | 826 | 14746 |
| 14-#18 | 7.07 | MA | 14259 | 4350 | 23354 | 3190 | 26096 | 2647 | 28041 | 2132 | 31289 | 1277 | 39483 | 169 | 38214 |
| 6L-3S | | MI | 8954 | 4350 | 16032 | 2935 | 17978 | 2404 | 19563 | 1911 | 22414 | 1056 | 26115 | 272 | 24766 |
| 16-#10 | 2.57 | MA | 12144 | 3363 | 19315 | 2502 | 21180 | 2090 | 22226 | 1757 | 23493 | 1234 | 28008 | 911 | 17385 |
| 4L-6S | | MI | 7058 | 3363 | 11240 | 2418 | 11958 | 2017 | 12256 | 1692 | 12485 | 1186 | 14343 | 712 | 9778 |
| 16-#10 | 2.57 | MA | 11938 | 3363 | 18887 | 2513 | 20614 | 2100 | 21517 | 1778 | 22500 | 1253 | 26664 | 873 | 17311 |
| 5E | | MI | 7136 | 3363 | 11487 | 2401 | 12277 | 2012 | 12653 | 1687 | 13019 | 1174 | 15026 | 769 | 9966 |
| 16-#10 | 2.57 | MA | 11791 | 3363 | 18435 | 2517 | 20044 | 2121 | 20817 | 1787 | 21557 | 1272 | 25460 | 820 | 16867 |
| 6L-4S | | MI | 7245 | 3363 | 11729 | 2393 | 12598 | 1995 | 13054 | 1672 | 13610 | 1173 | 15772 | 820 | 10006 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis

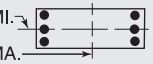


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.57 | MA | 11627 | 3363 | 17952 | 2535 | 19458 | 2126 | 20145 | 1808 | 20581 | 1279 | 24051 | 773 | 16549 |
| 7L-3S | | MI | 7305 | 3363 | 12015 | 2375 | 12970 | 1989 | 13510 | 1668 | 14204 | 1160 | 16521 | 869 | 9991 |
| 16-#10 | 2.57 | MA | 11448 | 3363 | 17530 | 2543 | 18874 | 2144 | 19424 | 1813 | 19660 | 1298 | 22828 | 729 | 16063 |
| 8L-2S | | MI | 7431 | 3363 | 12388 | 2367 | 13448 | 1972 | 14093 | 1652 | 14998 | 1148 | 17592 | 958 | 9973 |
| 16-#11 | 3.15 | MA | 12318 | 3491 | 19748 | 2590 | 21652 | 2155 | 22756 | 1813 | 24162 | 1243 | 28997 | 810 | 20691 |
| 5E | | MI | 7323 | 3491 | 11932 | 2465 | 12799 | 2058 | 13269 | 1711 | 13844 | 1152 | 15984 | 667 | 11756 |
| 16-#11 | 3.15 | MA | 12143 | 3491 | 19200 | 2595 | 20968 | 2181 | 21902 | 1824 | 23014 | 1265 | 27528 | 742 | 20150 |
| 6L-4S | | MI | 7452 | 3491 | 12224 | 2457 | 13187 | 2038 | 13753 | 1694 | 14558 | 1153 | 16858 | 730 | 11986 |
| 16-#11 | 3.15 | MA | 11949 | 3491 | 18613 | 2617 | 20256 | 2187 | 21089 | 1849 | 21896 | 1287 | 25802 | 684 | 19666 |
| 7L-3S | | MI | 7520 | 3491 | 12570 | 2435 | 13635 | 2032 | 14302 | 1690 | 15274 | 1139 | 17740 | 788 | 11976 |
| 16-#11 | 3.15 | MA | 11740 | 3491 | 18100 | 2626 | 19545 | 2208 | 20220 | 1855 | 20705 | 1296 | 24310 | 628 | 18947 |
| 8L-2S | | MI | 7667 | 3491 | 13017 | 2427 | 14209 | 2012 | 15002 | 1672 | 16226 | 1126 | 18994 | 898 | 11957 |
| 16-#14 | 4.55 | MA | 13016 | 3796 | 20989 | 2802 | 23204 | 2341 | 24594 | 1929 | 26651 | 1265 | 32719 | 575 | 27862 |
| 6L-4S | | MI | 7980 | 3796 | 13408 | 2645 | 14671 | 2171 | 15548 | 1773 | 17008 | 1128 | 19901 | 558 | 16452 |
| 16-#14 | 4.55 | MA | 12743 | 3796 | 20149 | 2832 | 22195 | 2350 | 23427 | 1964 | 25049 | 1296 | 30238 | 489 | 26526 |
| 7L-3S | | MI | 8073 | 3796 | 13900 | 2614 | 15308 | 2164 | 16330 | 1768 | 18026 | 1110 | 21132 | 639 | 16735 |
| 16-#14 | 4.55 | MA | 12449 | 3796 | 19413 | 2846 | 21177 | 2380 | 22196 | 1974 | 23342 | 1307 | 28095 | 407 | 25200 |
| 8L-2S | | MI | 8274 | 3796 | 14535 | 2603 | 16121 | 2137 | 17322 | 1744 | 19376 | 1093 | 22878 | 797 | 16736 |
| 18-#10 | 2.89 | MA | 12243 | 3433 | 19567 | 2557 | 21486 | 2132 | 22581 | 1797 | 23947 | 1247 | 28668 | 866 | 19418 |
| 5L-6S | | MI | 7218 | 3433 | 11613 | 2462 | 12436 | 2049 | 12839 | 1711 | 13279 | 1180 | 15414 | 701 | 10909 |
| 18-#10 | 2.89 | MA | 12100 | 3433 | 19115 | 2561 | 20916 | 2152 | 21880 | 1807 | 23004 | 1266 | 27464 | 812 | 18950 |
| 6L-5S | | MI | 7295 | 3433 | 11860 | 2445 | 12755 | 2043 | 13236 | 1706 | 13812 | 1168 | 16097 | 758 | 11087 |
| 18-#10 | 2.89 | MA | 11936 | 3433 | 18633 | 2579 | 20330 | 2158 | 21209 | 1827 | 22028 | 1274 | 26055 | 765 | 18643 |
| 7L-4S | | MI | 7403 | 3433 | 12102 | 2437 | 13076 | 2026 | 13637 | 1691 | 14404 | 1167 | 16843 | 809 | 11174 |
| 18-#10 | 2.89 | MA | 11761 | 3433 | 18211 | 2587 | 19746 | 2175 | 20488 | 1832 | 21108 | 1293 | 24833 | 722 | 18146 |
| 8L-3S | | MI | 7463 | 3433 | 12388 | 2418 | 13448 | 2020 | 14093 | 1687 | 14998 | 1155 | 17592 | 858 | 11163 |
| 18-#10 | 2.89 | MA | 11608 | 3433 | 17759 | 2607 | 19187 | 2183 | 19792 | 1850 | 20201 | 1311 | 23635 | 680 | 17675 |
| 9L-2S | | MI | 7587 | 3433 | 12761 | 2411 | 13926 | 2003 | 14676 | 1671 | 15791 | 1143 | 18662 | 947 | 11148 |
| 18-#11 | 3.55 | MA | 12514 | 3577 | 20025 | 2649 | 22025 | 2219 | 23193 | 1848 | 24770 | 1258 | 29959 | 732 | 22680 |
| 6L-5S | | MI | 7512 | 3577 | 12380 | 2519 | 13373 | 2096 | 13968 | 1735 | 14796 | 1145 | 17238 | 650 | 13103 |
| 18-#11 | 3.55 | MA | 12320 | 3577 | 19438 | 2671 | 21314 | 2225 | 22379 | 1872 | 23652 | 1280 | 28233 | 674 | 22181 |
| 7L-4S | | MI | 7639 | 3577 | 12672 | 2511 | 13761 | 2077 | 14452 | 1717 | 15510 | 1146 | 18112 | 713 | 13378 |
| 18-#11 | 3.55 | MA | 12115 | 3577 | 18925 | 2680 | 20603 | 2247 | 21510 | 1879 | 22461 | 1289 | 26740 | 618 | 21479 |
| 8L-3S | | MI | 7707 | 3577 | 13017 | 2489 | 14209 | 2071 | 15002 | 1713 | 16226 | 1132 | 18994 | 771 | 13379 |
| 18-#11 | 3.55 | MA | 11927 | 3577 | 18380 | 2704 | 19922 | 2255 | 20663 | 1899 | 21356 | 1311 | 25272 | 566 | 20697 |
| 9L-2S | | MI | 7853 | 3577 | 13465 | 2481 | 14782 | 2051 | 15702 | 1696 | 17178 | 1119 | 20248 | 880 | 13365 |
| 18-#14 | 5.11 | MA | 13269 | 3921 | 21328 | 2910 | 23706 | 2406 | 25271 | 1997 | 27558 | 1286 | 33712 | 476 | 30130 |
| 7L-4S | | MI | 8244 | 3921 | 14042 | 2722 | 15484 | 2227 | 16540 | 1807 | 18358 | 1118 | 21646 | 529 | 18339 |
| 18-#14 | 5.11 | MA | 12981 | 3921 | 20592 | 2923 | 22689 | 2436 | 24040 | 2007 | 25851 | 1297 | 31568 | 393 | 28784 |
| 8L-3S | | MI | 8336 | 3921 | 14535 | 2692 | 16121 | 2220 | 17322 | 1802 | 19376 | 1100 | 22878 | 610 | 18706 |
| 20-#10 | 3.21 | MA | 12406 | 3503 | 19796 | 2605 | 21788 | 2184 | 22944 | 1826 | 24452 | 1261 | 29469 | 804 | 21036 |
| 6E | | MI | 7378 | 3503 | 11986 | 2506 | 12914 | 2080 | 13422 | 1730 | 14072 | 1175 | 16485 | 690 | 12043 |
| 20-#10 | 3.21 | MA | 12244 | 3503 | 19313 | 2623 | 21202 | 2189 | 22273 | 1846 | 23476 | 1268 | 28059 | 757 | 20738 |
| 7L-5S | | MI | 7454 | 3503 | 12233 | 2488 | 13233 | 2075 | 13819 | 1726 | 14606 | 1162 | 17167 | 747 | 12211 |
| 20-#10 | 3.21 | MA | 12074 | 3503 | 18891 | 2631 | 20618 | 2207 | 21551 | 1851 | 22555 | 1287 | 26837 | 714 | 20232 |
| 8L-4S | | MI | 7561 | 3503 | 12474 | 2481 | 13554 | 2058 | 14220 | 1710 | 15197 | 1161 | 17914 | 798 | 12337 |
| 20-#10 | 3.21 | MA | 11922 | 3503 | 18439 | 2651 | 20059 | 2215 | 20856 | 1869 | 21648 | 1306 | 25639 | 672 | 19768 |
| 9L-3S | | MI | 7621 | 3503 | 12761 | 2462 | 13926 | 2052 | 14676 | 1706 | 15791 | 1149 | 18662 | 847 | 12333 |
| 20-#10 | 3.21 | MA | 11742 | 3503 | 18001 | 2657 | 19498 | 2234 | 20178 | 1887 | 20674 | 1312 | 24423 | 635 | 19106 |
| 10L-2S | | MI | 7743 | 3503 | 13134 | 2455 | 14404 | 2035 | 15259 | 1690 | 16584 | 1137 | 19733 | 936 | 12321 |
| 20-#11 | 3.94 | MA | 12689 | 3664 | 20263 | 2725 | 22371 | 2264 | 23669 | 1896 | 25407 | 1274 | 30664 | 664 | 24699 |
| 7L-5S | | MI | 7700 | 3664 | 12827 | 2573 | 13947 | 2135 | 14668 | 1758 | 15748 | 1138 | 18492 | 632 | 14454 |
| 20-#11 | 3.94 | MA | 12487 | 3664 | 19750 | 2734 | 21661 | 2285 | 22801 | 1902 | 24216 | 1282 | 29171 | 609 | 24014 |
| 8L-4S | | MI | 7827 | 3664 | 13119 | 2565 | 14334 | 2115 | 15152 | 1741 | 16462 | 1139 | 19366 | 696 | 14768 |
| 20-#11 | 3.94 | MA | 12305 | 3664 | 19205 | 2758 | 20980 | 2294 | 21954 | 1923 | 23111 | 1304 | 27703 | 557 | 23217 |
| 9L-3S | | MI | 7894 | 3664 | 13465 | 2543 | 14782 | 2109 | 15702 | 1737 | 17178 | 1126 | 20248 | 753 | 14780 |
| 20-#14 | 5.68 | MA | 13510 | 4045 | 21771 | 3001 | 24200 | 2492 | 25884 | 2041 | 28360 | 1287 | 35042 | 379 | 32367 |
| 8L-4S | | MI | 8507 | 4045 | 14677 | 2800 | 16297 | 2283 | 17532 | 1840 | 19708 | 1108 | 23392 | 500 | 20234 |

## RECTANGULAR TIED COLUMNS 22" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 3.53 | MA | 12549 | 3573 | 19993 | 2667 | 22074 | 2221 | 23337 | 1865 | 24923 | 1263 | 30063 | 749 | 22835 |
| 7L-6S | | MI | 7537 | 3573 | 12359 | 2550 | 13392 | 2112 | 14005 | 1749 | 14865 | 1169 | 17555 | 679 | 13179 |
| 22-#10 | 3.53 | MA | 12382 | 3573 | 19571 | 2675 | 21490 | 2239 | 22615 | 1870 | 24003 | 1281 | 28841 | 706 | 22319 |
| 8L-5S | | MI | 7612 | 3573 | 12606 | 2532 | 13711 | 2106 | 14403 | 1745 | 15399 | 1157 | 18238 | 736 | 13338 |
| 22-#10 | 3.53 | MA | 12234 | 3573 | 19119 | 2695 | 20931 | 2246 | 21919 | 1888 | 23096 | 1300 | 27643 | 664 | 21861 |
| 9L-4S | | MI | 7718 | 3573 | 12847 | 2525 | 14032 | 2089 | 14803 | 1729 | 15991 | 1156 | 18984 | 787 | 13498 |
| 22-#10 | 3.53 | MA | 12055 | 3573 | 18681 | 2701 | 20370 | 2266 | 21242 | 1906 | 22122 | 1306 | 26427 | 627 | 21190 |
| 10L-3S | | MI | 7778 | 3573 | 13134 | 2506 | 14404 | 2083 | 15259 | 1725 | 16584 | 1144 | 19733 | 836 | 13501 |
| 22-#11 | 4.33 | MA | 12857 | 3750 | 20575 | 2788 | 22718 | 2324 | 24091 | 1926 | 25972 | 1275 | 31602 | 599 | 26550 |
| 8L-5S | | MI | 7888 | 3750 | 13275 | 2627 | 14520 | 2174 | 15368 | 1782 | 16700 | 1132 | 19746 | 615 | 15808 |
| 22-#11 | 4.33 | MA | 12681 | 3750 | 20030 | 2812 | 22038 | 2333 | 23244 | 1946 | 24867 | 1297 | 30134 | 547 | 25737 |
| 9L-4S | | MI | 8014 | 3750 | 13567 | 2619 | 14908 | 2154 | 15852 | 1764 | 17414 | 1132 | 20620 | 678 | 16157 |
| 24-#10 | 3.85 | MA | 12689 | 3644 | 20251 | 2719 | 22362 | 2270 | 23679 | 1890 | 25450 | 1276 | 30845 | 698 | 24408 |
| 8L-6S | | MI | 7696 | 3644 | 12731 | 2594 | 13870 | 2144 | 14588 | 1768 | 15659 | 1164 | 18626 | 668 | 14316 |
| 24-#10 | 3.85 | MA | 12545 | 3644 | 19799 | 2739 | 21803 | 2278 | 22983 | 1907 | 24543 | 1295 | 29648 | 656 | 23954 |
| 9L-5S | | MI | 7770 | 3644 | 12979 | 2576 | 14189 | 2138 | 14986 | 1764 | 16192 | 1151 | 19309 | 725 | 14467 |
| 24-#10 | 3.85 | MA | 12366 | 3644 | 19362 | 2744 | 21242 | 2297 | 22306 | 1925 | 23569 | 1301 | 28431 | 619 | 23274 |
| 10L-4S | | MI | 7875 | 3644 | 13220 | 2569 | 14510 | 2121 | 15386 | 1748 | 16784 | 1150 | 20055 | 775 | 14658 |
| 24-#11 | 4.73 | MA | 13055 | 3836 | 20855 | 2866 | 23096 | 2372 | 24535 | 1970 | 26623 | 1290 | 32565 | 538 | 28257 |
| 9L-5S | | MI | 8076 | 3836 | 13722 | 2681 | 15094 | 2213 | 16068 | 1805 | 17652 | 1125 | 21000 | 598 | 17165 |

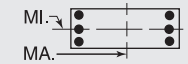
## RECTANGULAR TIED COLUMNS 22" x 38"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.08 | MA | 12369 | 3205 | 19345 | 2378 | 20763 | 2007 | 21287 | 1720 | 21442 | 1295 | 24383 | 1126 | 8327 |
| 2E | | MI | 7038 | 3205 | 11254 | 2247 | 11776 | 1895 | 11891 | 1623 | 11754 | 1218 | 12900 | 1028 | 4680 |
| 4-#18 | 1.91 | MA | 13183 | 3399 | 21289 | 2481 | 23175 | 2079 | 24195 | 1760 | 25378 | 1269 | 29816 | 1095 | 14340 |
| 2E | | MI | 7406 | 3399 | 12204 | 2337 | 12929 | 1956 | 13271 | 1653 | 13620 | 1184 | 15073 | 938 | 7780 |
| 6-#11 | 1.12 | MA | 12431 | 3215 | 19433 | 2393 | 20917 | 2019 | 21493 | 1729 | 21734 | 1300 | 24795 | 1130 | 8674 |
| 2L-3S | | MI | 6916 | 3215 | 10857 | 2276 | 11301 | 1933 | 11326 | 1655 | 10991 | 1239 | 11967 | 932 | 4894 |
| 6-#11 | 1.12 | MA | 12094 | 3215 | 18554 | 2406 | 19790 | 2032 | 20118 | 1755 | 19863 | 1322 | 22205 | 1033 | 8709 |
| 3L-2S | | MI | 7073 | 3215 | 11304 | 2268 | 11875 | 1913 | 12026 | 1637 | 11943 | 1226 | 13221 | 1042 | 4857 |
| 6-#14 | 1.61 | MA | 12929 | 3330 | 20602 | 2455 | 22374 | 2063 | 23252 | 1754 | 24116 | 1285 | 28086 | 1112 | 12289 |
| 2L-3S | | MI | 7086 | 3330 | 11254 | 2335 | 11776 | 1978 | 11891 | 1681 | 11754 | 1225 | 12900 | 841 | 6800 |
| 6-#14 | 1.61 | MA | 12458 | 3330 | 19345 | 2475 | 20763 | 2080 | 21287 | 1790 | 21442 | 1317 | 24383 | 971 | 12321 |
| 3L-2S | | MI | 7303 | 3330 | 11888 | 2324 | 12589 | 1951 | 12883 | 1657 | 13103 | 1208 | 14645 | 999 | 6741 |
| 6-#18 | 2.87 | MA | 14138 | 3620 | 23484 | 2619 | 25989 | 2178 | 27628 | 1820 | 30049 | 1251 | 36284 | 1071 | 21223 |
| 2L-3S | | MI | 7493 | 3620 | 12204 | 2490 | 12929 | 2099 | 13271 | 1750 | 13620 | 1191 | 15073 | 591 | 11334 |
| 6-#18 | 2.87 | MA | 13354 | 3620 | 21289 | 2651 | 23175 | 2207 | 24195 | 1880 | 25378 | 1305 | 29816 | 812 | 21133 |
| 3L-2S | | MI | 7853 | 3620 | 13293 | 2475 | 14325 | 2055 | 14973 | 1713 | 15937 | 1166 | 17956 | 873 | 11261 |
| 8-#10 | 1.22 | MA | 12557 | 3237 | 19644 | 2419 | 21243 | 2039 | 21916 | 1745 | 22325 | 1305 | 25626 | 1134 | 9436 |
| 2L-4S | | MI | 6949 | 3237 | 10760 | 2330 | 11221 | 1964 | 11245 | 1679 | 10918 | 1261 | 11992 | 922 | 5319 |
| 8-#10 | 1.22 | MA | 12280 | 3237 | 18920 | 2430 | 20315 | 2050 | 20784 | 1766 | 20784 | 1324 | 23493 | 1056 | 9458 |
| 3E | | MI | 7011 | 3237 | 11046 | 2311 | 11592 | 1958 | 11701 | 1674 | 11512 | 1249 | 12740 | 971 | 5282 |
| 8-#10 | 1.22 | MA | 12123 | 3237 | 18378 | 2453 | 19611 | 2072 | 19918 | 1776 | 19595 | 1333 | 22097 | 1009 | 9470 |
| 4L-2S | | MI | 7142 | 3237 | 11419 | 2303 | 12070 | 1941 | 12284 | 1659 | 12305 | 1237 | 13811 | 1061 | 5254 |
| 8-#11 | 1.49 | MA | 12824 | 3301 | 20313 | 2447 | 22044 | 2058 | 22868 | 1753 | 23604 | 1293 | 27385 | 1120 | 11443 |
| 2L-4S | | MI | 7036 | 3301 | 10959 | 2352 | 11427 | 1977 | 11476 | 1682 | 11227 | 1246 | 12340 | 857 | 6388 |
| 8-#11 | 1.49 | MA | 12494 | 3301 | 19433 | 2460 | 20917 | 2070 | 21493 | 1778 | 21734 | 1316 | 24795 | 1023 | 11468 |
| 3E | | MI | 7107 | 3301 | 11304 | 2330 | 11875 | 1971 | 12026 | 1678 | 11943 | 1233 | 13221 | 915 | 6343 |
| 8-#11 | 1.49 | MA | 12308 | 3301 | 18775 | 2488 | 20061 | 2097 | 20440 | 1790 | 20287 | 1325 | 23087 | 965 | 11463 |
| 4L-2S | | MI | 7261 | 3301 | 11752 | 2322 | 12448 | 1952 | 12725 | 1660 | 12895 | 1219 | 14475 | 1025 | 6305 |
| 8-#14 | 2.15 | MA | 13484 | 3454 | 21859 | 2533 | 23985 | 2119 | 25218 | 1788 | 26791 | 1275 | 31789 | 1099 | 16233 |
| 2L-4S | | MI | 7258 | 3454 | 11396 | 2443 | 11952 | 2042 | 12101 | 1719 | 12085 | 1233 | 13414 | 731 | 8864 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

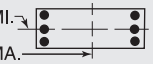



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.15 | MA | 13025 | 3454 | 20602 | 2552 | 22374 | 2136 | 23252 | 1823 | 24116 | 1307 | 28086 | 957 | 16239 |
| 3E | | MI | 7354 | 3454 | 11888 | 2413 | 12589 | 2034 | 12883 | 1715 | 13103 | 1215 | 14645 | 812 | 8823 |
| 8-#14 | 2.15 | MA | 12766 | 3454 | 19658 | 2592 | 21148 | 2173 | 21744 | 1839 | 22151 | 1339 | 25629 | 872 | 16130 |
| 4L-2S | | MI | 7567 | 3454 | 12523 | 2402 | 13402 | 2007 | 13875 | 1691 | 14453 | 1198 | 16391 | 970 | 8773 |
| 8-#18 | 3.83 | MA | 14328 | 3841 | 23484 | 2790 | 25989 | 2306 | 27628 | 1941 | 30049 | 1287 | 36284 | 787 | 27930 |
| 3E | | MI | 7947 | 3841 | 13293 | 2629 | 14325 | 2198 | 14973 | 1811 | 15937 | 1173 | 17956 | 525 | 14734 |
| 8-#18 | 3.83 | MA | 13896 | 3841 | 21828 | 2857 | 23839 | 2370 | 24984 | 1966 | 26605 | 1341 | 31941 | 633 | 26206 |
| 4L-2S | | MI | 8299 | 3841 | 14382 | 2614 | 15720 | 2155 | 16676 | 1773 | 18254 | 1149 | 20839 | 807 | 14705 |
| 10-#10 | 1.52 | MA | 12883 | 3307 | 20368 | 2463 | 22171 | 2071 | 23049 | 1764 | 23866 | 1300 | 27760 | 1126 | 11712 |
| 2L-5S | | MI | 6998 | 3307 | 10891 | 2381 | 11378 | 2013 | 11428 | 1713 | 11119 | 1257 | 12316 | 860 | 6540 |
| 10-#10 | 1.52 | MA | 12610 | 3307 | 19644 | 2474 | 21243 | 2082 | 21916 | 1785 | 22325 | 1319 | 25626 | 1049 | 11728 |
| 3L-4S | | MI | 7109 | 3307 | 11133 | 2373 | 11699 | 1995 | 11828 | 1698 | 11711 | 1256 | 13062 | 911 | 6510 |
| 10-#10 | 1.52 | MA | 12455 | 3307 | 19102 | 2497 | 20540 | 2104 | 21051 | 1795 | 21136 | 1327 | 24231 | 1001 | 11727 |
| 4L-3S | | MI | 7171 | 3307 | 11419 | 2355 | 12070 | 1990 | 12284 | 1693 | 12305 | 1244 | 13811 | 960 | 6479 |
| 10-#10 | 1.52 | MA | 12225 | 3307 | 18644 | 2508 | 19939 | 2114 | 20299 | 1816 | 20081 | 1346 | 22805 | 965 | 11677 |
| 5L-2S | | MI | 7301 | 3307 | 11792 | 2347 | 12548 | 1973 | 12868 | 1678 | 13098 | 1231 | 14882 | 1050 | 6451 |
| 10-#11 | 1.87 | MA | 13216 | 3388 | 21192 | 2501 | 23171 | 2096 | 24242 | 1776 | 25474 | 1286 | 29975 | 1111 | 14203 |
| 2L-5S | | MI | 7094 | 3388 | 11114 | 2414 | 11613 | 2036 | 11692 | 1723 | 11465 | 1239 | 12720 | 777 | 7836 |
| 10-#11 | 1.87 | MA | 12891 | 3388 | 20313 | 2514 | 22044 | 2109 | 22868 | 1802 | 23604 | 1309 | 27385 | 1014 | 14219 |
| 3L-4S | | MI | 7227 | 3388 | 11406 | 2406 | 12001 | 2016 | 12176 | 1705 | 12180 | 1239 | 13594 | 840 | 7810 |
| 10-#11 | 1.87 | MA | 12708 | 3388 | 19654 | 2542 | 21188 | 2135 | 21815 | 1813 | 22157 | 1318 | 25677 | 955 | 14194 |
| 4L-3S | | MI | 7297 | 3388 | 11752 | 2384 | 12448 | 2010 | 12725 | 1702 | 12895 | 1226 | 14475 | 897 | 7774 |
| 10-#11 | 1.87 | MA | 12433 | 3388 | 19102 | 2555 | 20456 | 2148 | 20898 | 1838 | 20872 | 1341 | 23936 | 908 | 14087 |
| 5L-2S | | MI | 7449 | 3388 | 12199 | 2376 | 13022 | 1990 | 13425 | 1684 | 13848 | 1212 | 15729 | 1007 | 7739 |
| 10-#14 | 2.69 | MA | 13587 | 3579 | 21859 | 2630 | 23985 | 2192 | 25218 | 1857 | 26791 | 1297 | 31789 | 943 | 20150 |
| 3L-4S | | MI | 7525 | 3579 | 12030 | 2521 | 12765 | 2098 | 13093 | 1753 | 13435 | 1223 | 15159 | 702 | 10847 |
| 10-#14 | 2.69 | MA | 13332 | 3579 | 20914 | 2669 | 22759 | 2229 | 23710 | 1873 | 24826 | 1329 | 29332 | 858 | 20017 |
| 4L-3S | | MI | 7620 | 3579 | 12523 | 2491 | 13402 | 2090 | 13875 | 1749 | 14453 | 1205 | 16391 | 783 | 10828 |
| 10-#14 | 2.69 | MA | 12944 | 3579 | 20129 | 2689 | 21709 | 2247 | 22396 | 1909 | 22877 | 1341 | 26833 | 788 | 19053 |
| 5L-2S | | MI | 7831 | 3579 | 13157 | 2480 | 14216 | 2063 | 14867 | 1725 | 15803 | 1188 | 18136 | 941 | 10788 |
| 10-#18 | 4.78 | MA | 14867 | 4063 | 24023 | 2996 | 26654 | 2469 | 28418 | 2026 | 31276 | 1323 | 38409 | 609 | 32863 |
| 4L-3S | | MI | 8399 | 4063 | 14382 | 2767 | 15720 | 2298 | 16676 | 1871 | 18254 | 1155 | 20839 | 460 | 18112 |
| 10-#18 | 4.78 | MA | 14210 | 4063 | 22642 | 3028 | 24810 | 2498 | 26112 | 2087 | 27858 | 1341 | 34010 | 476 | 30708 |
| 5L-2S | | MI | 8744 | 4063 | 15471 | 2752 | 17116 | 2254 | 18379 | 1834 | 20570 | 1131 | 23722 | 741 | 18128 |
| 12-#10 | 1.82 | MA | 13208 | 3378 | 21092 | 2507 | 23100 | 2103 | 24181 | 1783 | 25407 | 1294 | 29894 | 1118 | 13983 |
| 2L-6S | | MI | 7078 | 3378 | 11017 | 2442 | 11536 | 2050 | 11613 | 1737 | 11379 | 1264 | 12704 | 792 | 7595 |
| 12-#10 | 1.82 | MA | 12938 | 3378 | 20368 | 2518 | 22171 | 2113 | 23049 | 1804 | 23866 | 1313 | 27760 | 1041 | 13994 |
| 3L-5S | | MI | 7158 | 3378 | 11264 | 2425 | 11856 | 2044 | 12011 | 1732 | 11913 | 1251 | 13387 | 849 | 7714 |
| 12-#10 | 1.82 | MA | 12785 | 3378 | 19827 | 2541 | 21468 | 2135 | 22183 | 1814 | 22677 | 1321 | 26364 | 994 | 13980 |
| 4E | | MI | 7269 | 3378 | 11505 | 2417 | 12177 | 2027 | 12411 | 1717 | 12504 | 1250 | 14133 | 900 | 7692 |
| 12-#10 | 1.82 | MA | 12558 | 3378 | 19369 | 2552 | 20867 | 2146 | 21431 | 1835 | 21622 | 1341 | 24938 | 957 | 13921 |
| 5L-3S | | MI | 7330 | 3378 | 11792 | 2399 | 12548 | 2021 | 12868 | 1713 | 13098 | 1238 | 14882 | 949 | 7666 |
| 12-#10 | 1.82 | MA | 12395 | 3378 | 18888 | 2557 | 20257 | 2166 | 20687 | 1845 | 20620 | 1360 | 23663 | 905 | 13560 |
| 6L-2S | | MI | 7459 | 3378 | 12165 | 2391 | 13026 | 2004 | 13451 | 1697 | 13892 | 1226 | 15952 | 1038 | 7641 |
| 12-#11 | 2.24 | MA | 13286 | 3474 | 21192 | 2568 | 23171 | 2148 | 24242 | 1825 | 25474 | 1302 | 29975 | 1004 | 16962 |
| 3L-5S | | MI | 7285 | 3474 | 11562 | 2468 | 12186 | 2075 | 12392 | 1747 | 12418 | 1232 | 13974 | 759 | 9205 |
| 12-#11 | 2.24 | MA | 13104 | 3474 | 20533 | 2596 | 22315 | 2174 | 23189 | 1837 | 24028 | 1311 | 28267 | 946 | 16924 |
| 4E | | MI | 7416 | 3474 | 11854 | 2460 | 12574 | 2055 | 12875 | 1729 | 13132 | 1232 | 14848 | 822 | 9222 |
| 12-#11 | 2.24 | MA | 12833 | 3474 | 19981 | 2609 | 21583 | 2187 | 22273 | 1862 | 22743 | 1334 | 26526 | 899 | 16773 |
| 5L-3S | | MI | 7486 | 3474 | 12199 | 2438 | 13022 | 2049 | 13425 | 1725 | 13848 | 1219 | 15729 | 880 | 9194 |
| 12-#11 | 2.24 | MA | 12638 | 3474 | 19397 | 2615 | 20848 | 2212 | 21366 | 1873 | 21523 | 1357 | 24969 | 832 | 16118 |
| 6L-2S | | MI | 7637 | 3474 | 12647 | 2430 | 13596 | 2029 | 14125 | 1708 | 14800 | 1205 | 16983 | 990 | 9164 |
| 12-#14 | 3.23 | MA | 13892 | 3703 | 22171 | 2747 | 24370 | 2285 | 25675 | 1907 | 27500 | 1319 | 33035 | 844 | 23906 |
| 4E | | MI | 7792 | 3703 | 12665 | 2599 | 13578 | 2153 | 14085 | 1787 | 14785 | 1213 | 16905 | 673 | 12819 |
| 12-#14 | 3.23 | MA | 13512 | 3703 | 21386 | 2766 | 23320 | 2303 | 24362 | 1943 | 25552 | 1332 | 30536 | 774 | 22882 |
| 5L-3S | | MI | 7886 | 3703 | 13157 | 2569 | 14216 | 2146 | 14867 | 1782 | 15803 | 1195 | 18136 | 754 | 12822 |
| 12-#14 | 3.23 | MA | 13237 | 3703 | 20551 | 2774 | 22277 | 2340 | 23062 | 1958 | 23803 | 1364 | 28300 | 676 | 22061 |
| 6L-2S | | MI | 8094 | 3703 | 13791 | 2558 | 15029 | 2119 | 15859 | 1758 | 17153 | 1178 | 19882 | 912 | 12793 |

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

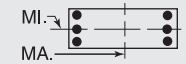
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 5.74 | MA | 15188 | 4284 | 24838 | 3166 | 27625 | 2597 | 29545 | 2147 | 32529 | 1324 | 40478 | 452 | 37430 |
| 5L-3S | | MI | 8849 | 4284 | 15471 | 2905 | 17116 | 2397 | 18379 | 1931 | 20570 | 1138 | 23722 | 394 | 21480 |
| 12-#18 | 5.74 | MA | 14723 | 4284 | 23400 | 3181 | 25791 | 2662 | 27262 | 2172 | 29459 | 1377 | 36526 | 272 | 34341 |
| 6L-2S | | MI | 9187 | 4284 | 16560 | 2890 | 18512 | 2353 | 20082 | 1894 | 22887 | 1113 | 26605 | 675 | 21540 |
| 14-#10 | 2.13 | MA | 13265 | 3448 | 21092 | 2562 | 23100 | 2145 | 24181 | 1823 | 25407 | 1308 | 29894 | 1033 | 16254 |
| 3L-6S | | MI | 7239 | 3448 | 11390 | 2486 | 12014 | 2081 | 12197 | 1756 | 12172 | 1258 | 13774 | 781 | 8720 |
| 14-#10 | 2.13 | MA | 13113 | 3448 | 20551 | 2585 | 22396 | 2167 | 23316 | 1833 | 24218 | 1316 | 28498 | 986 | 16232 |
| 4L-5S | | MI | 7319 | 3448 | 11637 | 2469 | 12334 | 2076 | 12594 | 1751 | 12706 | 1246 | 14457 | 838 | 8883 |
| 14-#10 | 2.13 | MA | 12889 | 3448 | 20093 | 2596 | 21796 | 2177 | 22564 | 1854 | 23163 | 1335 | 27072 | 950 | 16164 |
| 5L-4S | | MI | 7428 | 3448 | 11878 | 2461 | 12655 | 2059 | 12994 | 1736 | 13298 | 1245 | 15203 | 889 | 8868 |
| 14-#10 | 2.13 | MA | 12729 | 3448 | 19613 | 2600 | 21185 | 2198 | 21820 | 1864 | 22161 | 1354 | 25796 | 897 | 15772 |
| 6L-3S | | MI | 7489 | 3448 | 12165 | 2443 | 13026 | 2053 | 13451 | 1732 | 13892 | 1232 | 15952 | 938 | 8847 |
| 14-#10 | 2.13 | MA | 12550 | 3448 | 19099 | 2619 | 20562 | 2204 | 21100 | 1884 | 21125 | 1362 | 24305 | 851 | 15408 |
| 7L-2S | | MI | 7616 | 3448 | 12538 | 2435 | 13504 | 2036 | 14034 | 1716 | 14685 | 1220 | 17023 | 1027 | 8824 |
| 14-#11 | 2.61 | MA | 13498 | 3560 | 21412 | 2650 | 23441 | 2213 | 24564 | 1860 | 25898 | 1304 | 30856 | 936 | 19651 |
| 4L-5S | | MI | 7475 | 3560 | 12009 | 2522 | 12760 | 2113 | 13091 | 1770 | 13370 | 1225 | 15228 | 742 | 10503 |
| 14-#11 | 2.61 | MA | 13231 | 3560 | 20860 | 2663 | 22709 | 2225 | 23648 | 1885 | 24613 | 1327 | 29116 | 889 | 19438 |
| 5L-4S | | MI | 7605 | 3560 | 12301 | 2514 | 13148 | 2094 | 13575 | 1753 | 14084 | 1225 | 16102 | 805 | 10628 |
| 14-#11 | 2.61 | MA | 13039 | 3560 | 20276 | 2668 | 21975 | 2251 | 22741 | 1897 | 23393 | 1350 | 27558 | 822 | 18807 |
| 6L-3S | | MI | 7674 | 3560 | 12647 | 2492 | 13596 | 2088 | 14125 | 1749 | 14800 | 1212 | 16983 | 863 | 10607 |
| 14-#11 | 2.61 | MA | 12827 | 3560 | 19652 | 2691 | 21217 | 2257 | 21876 | 1922 | 22130 | 1359 | 25732 | 765 | 18387 |
| 7L-2S | | MI | 7823 | 3560 | 13094 | 2484 | 14169 | 2068 | 14825 | 1731 | 15752 | 1198 | 18237 | 973 | 10581 |
| 14-#14 | 3.77 | MA | 14075 | 3828 | 22642 | 2844 | 24932 | 2359 | 26327 | 1977 | 28226 | 1322 | 34239 | 761 | 26720 |
| 5L-4S | | MI | 8058 | 3828 | 13299 | 2677 | 14392 | 2209 | 15077 | 1821 | 16135 | 1203 | 18650 | 644 | 14700 |
| 14-#14 | 3.77 | MA | 13808 | 3828 | 21808 | 2852 | 23888 | 2396 | 25027 | 1992 | 26477 | 1354 | 32003 | 662 | 25931 |
| 6L-3S | | MI | 8151 | 3828 | 13791 | 2646 | 15029 | 2202 | 15859 | 1816 | 17153 | 1185 | 19882 | 725 | 14811 |
| 14-#14 | 3.77 | MA | 13509 | 3828 | 20914 | 2883 | 22804 | 2404 | 23788 | 2028 | 24774 | 1386 | 29375 | 578 | 24557 |
| 7L-2S | | MI | 8356 | 3828 | 14426 | 2636 | 15842 | 2175 | 16851 | 1792 | 18503 | 1168 | 21628 | 883 | 14790 |
| 14-#18 | 6.70 | MA | 15709 | 4505 | 25596 | 3319 | 28606 | 2761 | 30695 | 2233 | 34130 | 1360 | 42994 | 248 | 41007 |
| 6L-3S | | MI | 9297 | 4505 | 16560 | 3044 | 18512 | 2496 | 20082 | 1992 | 22887 | 1120 | 26605 | 328 | 24844 |
| 16-#10 | 2.43 | MA | 13439 | 3518 | 21275 | 2629 | 23325 | 2198 | 24449 | 1852 | 25759 | 1310 | 30632 | 978 | 18482 |
| 4L-6S | | MI | 7400 | 3518 | 11763 | 2530 | 12492 | 2113 | 12780 | 1775 | 12966 | 1252 | 14845 | 770 | 9849 |
| 16-#10 | 2.43 | MA | 13218 | 3518 | 20817 | 2639 | 22724 | 2209 | 23696 | 1873 | 24704 | 1329 | 29206 | 942 | 18408 |
| 5E | | MI | 7478 | 3518 | 12010 | 2513 | 12812 | 2107 | 13177 | 1771 | 13499 | 1240 | 15528 | 827 | 10043 |
| 16-#10 | 2.43 | MA | 13061 | 3518 | 20337 | 2644 | 22114 | 2230 | 22952 | 1883 | 23702 | 1349 | 27930 | 889 | 17987 |
| 6L-4S | | MI | 7587 | 3518 | 12251 | 2505 | 13133 | 2090 | 13578 | 1755 | 14091 | 1239 | 16274 | 878 | 10040 |
| 16-#10 | 2.43 | MA | 12883 | 3518 | 19823 | 2663 | 21491 | 2235 | 22232 | 1903 | 22665 | 1357 | 26439 | 843 | 17635 |
| 7L-3S | | MI | 7648 | 3518 | 12538 | 2487 | 13504 | 2084 | 14034 | 1751 | 14685 | 1227 | 17023 | 927 | 10024 |
| 16-#10 | 2.43 | MA | 12691 | 3518 | 19375 | 2671 | 20870 | 2253 | 21465 | 1909 | 21688 | 1376 | 25144 | 801 | 17175 |
| 8L-2S | | MI | 7774 | 3518 | 12911 | 2479 | 13982 | 2067 | 14617 | 1735 | 15478 | 1214 | 18093 | 1016 | 10004 |
| 16-#11 | 2.99 | MA | 13626 | 3647 | 21739 | 2717 | 23836 | 2264 | 25022 | 1909 | 26483 | 1320 | 31706 | 880 | 22110 |
| 5E | | MI | 7665 | 3647 | 12457 | 2576 | 13334 | 2152 | 13791 | 1794 | 14322 | 1218 | 16482 | 725 | 11845 |
| 16-#11 | 2.99 | MA | 13439 | 3647 | 21155 | 2722 | 23102 | 2290 | 24116 | 1920 | 25263 | 1343 | 30148 | 813 | 21501 |
| 6L-4S | | MI | 7794 | 3647 | 12748 | 2568 | 13722 | 2132 | 14275 | 1776 | 15036 | 1218 | 17356 | 788 | 12030 |
| 16-#11 | 2.99 | MA | 13228 | 3647 | 20531 | 2745 | 22344 | 2296 | 23251 | 1945 | 24001 | 1352 | 28322 | 755 | 21067 |
| 7L-3S | | MI | 7863 | 3647 | 13094 | 2546 | 14169 | 2126 | 14825 | 1772 | 15752 | 1205 | 18237 | 846 | 12016 |
| 16-#11 | 2.99 | MA | 12998 | 3647 | 19985 | 2754 | 21589 | 2318 | 22318 | 1951 | 22810 | 1375 | 26740 | 701 | 20267 |
| 8L-2S | | MI | 8010 | 3647 | 13542 | 2538 | 14743 | 2107 | 15525 | 1755 | 16704 | 1192 | 19491 | 955 | 11994 |
| 16-#14 | 4.31 | MA | 14374 | 3952 | 23064 | 2930 | 25500 | 2452 | 26993 | 2026 | 29151 | 1344 | 35706 | 648 | 29805 |
| 6L-4S | | MI | 8323 | 3952 | 13934 | 2755 | 15205 | 2265 | 16069 | 1854 | 17485 | 1193 | 20396 | 615 | 16576 |
| 16-#14 | 4.31 | MA | 14078 | 3952 | 22170 | 2961 | 24415 | 2460 | 25753 | 2062 | 27448 | 1376 | 33078 | 564 | 28400 |
| 7L-3S | | MI | 8415 | 3952 | 14426 | 2724 | 15842 | 2258 | 16851 | 1850 | 18503 | 1175 | 21628 | 696 | 16788 |
| 16-#14 | 4.31 | MA | 13763 | 3952 | 21388 | 2975 | 23333 | 2491 | 24429 | 2071 | 25634 | 1388 | 30805 | 484 | 27076 |
| 8L-2S | | MI | 8617 | 3952 | 15060 | 2714 | 16655 | 2230 | 17844 | 1826 | 19853 | 1158 | 23373 | 854 | 16781 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis

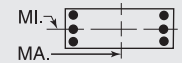


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.73 | MA | 13544 | 3588 | 21541 | 2683 | 23652 | 2240 | 24829 | 1892 | 26244 | 1324 | 31339 | 934 | 20652 |
| 5L-6S | | MI | 7560 | 3588 | 12135 | 2574 | 12970 | 2144 | 13363 | 1794 | 13759 | 1247 | 15915 | 759 | 10980 |
| 18-#10 | 2.73 | MA | 13390 | 3588 | 21061 | 2688 | 23042 | 2261 | 24085 | 1902 | 25243 | 1343 | 30064 | 881 | 20206 |
| 6L-5S | | MI | 7637 | 3588 | 12383 | 2557 | 13290 | 2139 | 13760 | 1790 | 14293 | 1234 | 16598 | 816 | 11163 |
| 18-#10 | 2.73 | MA | 13214 | 3588 | 20548 | 2707 | 22419 | 2267 | 23365 | 1922 | 24206 | 1351 | 28572 | 835 | 19865 |
| 7L-4S | | MI | 7746 | 3588 | 12624 | 2549 | 13611 | 2122 | 14161 | 1774 | 14884 | 1233 | 17345 | 867 | 11210 |
| 18-#10 | 2.73 | MA | 13026 | 3588 | 20099 | 2715 | 21798 | 2285 | 22598 | 1928 | 23229 | 1371 | 27277 | 793 | 19396 |
| 8L-3S | | MI | 7806 | 3588 | 12911 | 2530 | 13982 | 2116 | 14617 | 1770 | 15478 | 1221 | 18093 | 916 | 11197 |
| 18-#10 | 2.73 | MA | 12861 | 3588 | 19616 | 2734 | 21205 | 2293 | 21859 | 1946 | 22266 | 1390 | 26011 | 752 | 18870 |
| 9L-2S | | MI | 7930 | 3588 | 13283 | 2523 | 14460 | 2099 | 15200 | 1755 | 16272 | 1209 | 19164 | 1005 | 11180 |
| 18-#11 | 3.36 | MA | 13835 | 3733 | 22034 | 2776 | 24229 | 2329 | 25491 | 1944 | 27134 | 1336 | 32738 | 803 | 24198 |
| 6L-5S | | MI | 7854 | 3733 | 12904 | 2630 | 13907 | 2191 | 14491 | 1817 | 15274 | 1211 | 17736 | 707 | 13191 |
| 18-#11 | 3.36 | MA | 13626 | 3733 | 21410 | 2798 | 23471 | 2335 | 24626 | 1969 | 25871 | 1345 | 30912 | 746 | 23751 |
| 7L-4S | | MI | 7982 | 3733 | 13196 | 2622 | 14295 | 2171 | 14975 | 1800 | 15988 | 1211 | 18610 | 770 | 13426 |
| 18-#11 | 3.36 | MA | 13406 | 3733 | 20864 | 2808 | 22716 | 2356 | 23693 | 1975 | 24681 | 1368 | 29330 | 692 | 22968 |
| 8L-3S | | MI | 8050 | 3733 | 13542 | 2600 | 14743 | 2165 | 15525 | 1796 | 16704 | 1198 | 19491 | 828 | 13421 |
| 18-#11 | 3.36 | MA | 13204 | 3733 | 20281 | 2832 | 21993 | 2366 | 22793 | 1996 | 23507 | 1391 | 27778 | 640 | 22191 |
| 9L-2S | | MI | 8196 | 3733 | 13989 | 2592 | 15317 | 2145 | 16224 | 1778 | 17656 | 1185 | 20745 | 938 | 13404 |
| 18-#14 | 4.84 | MA | 14642 | 4076 | 23427 | 3039 | 26026 | 2516 | 27719 | 2096 | 30123 | 1366 | 36780 | 550 | 32242 |
| 7L-4S | | MI | 8587 | 4076 | 14568 | 2832 | 16018 | 2321 | 17061 | 1888 | 18835 | 1183 | 22141 | 586 | 18461 |
| 18-#14 | 4.84 | MA | 14334 | 4076 | 22645 | 3052 | 24944 | 2547 | 26395 | 2105 | 28309 | 1378 | 34508 | 470 | 30896 |
| 8L-3S | | MI | 8679 | 4076 | 15060 | 2802 | 16655 | 2314 | 17844 | 1884 | 19853 | 1166 | 23373 | 667 | 18762 |
| 20-#10 | 3.04 | MA | 13719 | 3659 | 21785 | 2732 | 23970 | 2293 | 25217 | 1921 | 26784 | 1338 | 32197 | 874 | 22428 |
| 6E | | MI | 7720 | 3659 | 12508 | 2618 | 13448 | 2176 | 13946 | 1813 | 14552 | 1241 | 16986 | 748 | 12114 |
| 20-#10 | 3.04 | MA | 13543 | 3659 | 21272 | 2751 | 23348 | 2298 | 24497 | 1941 | 25747 | 1346 | 30706 | 827 | 22097 |
| 7L-5S | | MI | 7796 | 3659 | 12756 | 2600 | 13768 | 2170 | 14343 | 1809 | 15086 | 1229 | 17669 | 805 | 12287 |
| 20-#10 | 3.04 | MA | 13359 | 3659 | 20824 | 2759 | 22727 | 2316 | 23730 | 1947 | 24770 | 1365 | 29411 | 785 | 21618 |
| 8L-4S | | MI | 7904 | 3659 | 12997 | 2593 | 14089 | 2153 | 14744 | 1793 | 15678 | 1228 | 18415 | 856 | 12377 |
| 20-#10 | 3.04 | MA | 13197 | 3659 | 20340 | 2778 | 22133 | 2324 | 22991 | 1965 | 23807 | 1384 | 28145 | 744 | 21099 |
| 9L-3S | | MI | 7963 | 3659 | 13283 | 2574 | 14460 | 2147 | 15200 | 1789 | 16272 | 1215 | 19164 | 905 | 12368 |
| 20-#10 | 3.04 | MA | 13004 | 3659 | 19875 | 2784 | 21537 | 2344 | 22272 | 1983 | 22762 | 1390 | 26856 | 708 | 20447 |
| 10L-2S | | MI | 8087 | 3659 | 13656 | 2567 | 14938 | 2130 | 15783 | 1774 | 17065 | 1203 | 20234 | 994 | 12354 |
| 20-#11 | 3.73 | MA | 14021 | 3819 | 22289 | 2852 | 24598 | 2373 | 26000 | 1992 | 27742 | 1338 | 33502 | 736 | 26438 |
| 7L-5S | | MI | 8043 | 3819 | 13352 | 2684 | 14481 | 2230 | 15191 | 1841 | 16226 | 1204 | 18990 | 690 | 14542 |
| 20-#11 | 3.73 | MA | 13805 | 3819 | 21743 | 2862 | 23843 | 2395 | 25067 | 1999 | 26551 | 1361 | 31919 | 682 | 25669 |
| 8L-4S | | MI | 8170 | 3819 | 13643 | 2676 | 14869 | 2210 | 15675 | 1823 | 16940 | 1205 | 19864 | 753 | 14818 |
| 20-#11 | 3.73 | MA | 13609 | 3819 | 21160 | 2886 | 23119 | 2404 | 24167 | 2020 | 25378 | 1384 | 30368 | 631 | 24876 |
| 9L-3S | | MI | 8237 | 3819 | 13989 | 2654 | 15317 | 2204 | 16224 | 1819 | 17656 | 1191 | 20745 | 811 | 14823 |
| 20-#11 | 3.73 | MA | 13378 | 3819 | 20594 | 2893 | 22394 | 2428 | 23291 | 2042 | 24124 | 1391 | 28792 | 584 | 23989 |
| 10L-2S | | MI | 8382 | 3819 | 14437 | 2646 | 15890 | 2184 | 16924 | 1802 | 18608 | 1178 | 21999 | 921 | 14810 |
| 20-#14 | 5.38 | MA | 14900 | 4201 | 23902 | 3130 | 26555 | 2603 | 28361 | 2139 | 30983 | 1368 | 38211 | 457 | 34716 |
| 8L-4S | | MI | 8850 | 4201 | 15202 | 2910 | 16831 | 2377 | 18053 | 1922 | 20184 | 1173 | 23887 | 557 | 20355 |
| 22-#10 | 3.34 | MA | 13870 | 3729 | 21996 | 2795 | 24276 | 2330 | 25630 | 1961 | 27288 | 1340 | 32840 | 820 | 24330 |
| 7L-6S | | MI | 7879 | 3729 | 12881 | 2662 | 13926 | 2208 | 14529 | 1832 | 15346 | 1235 | 18057 | 737 | 13249 |
| 22-#10 | 3.34 | MA | 13691 | 3729 | 21548 | 2803 | 23655 | 2348 | 24863 | 1966 | 26311 | 1359 | 31544 | 777 | 23842 |
| 8L-5S | | MI | 7955 | 3729 | 13129 | 2644 | 14246 | 2202 | 14926 | 1828 | 15879 | 1223 | 18739 | 794 | 13414 |
| 22-#10 | 3.34 | MA | 13532 | 3729 | 21064 | 2822 | 23061 | 2356 | 24124 | 1984 | 25348 | 1379 | 30279 | 736 | 23327 |
| 9L-4S | | MI | 8061 | 3729 | 13370 | 2637 | 14567 | 2185 | 15327 | 1813 | 16471 | 1222 | 19486 | 845 | 13540 |
| 22-#10 | 3.34 | MA | 13339 | 3729 | 20599 | 2828 | 22466 | 2376 | 23404 | 2003 | 24302 | 1384 | 28990 | 700 | 22665 |
| 10L-3S | | MI | 8121 | 3729 | 13656 | 2618 | 14938 | 2179 | 15783 | 1808 | 17065 | 1210 | 20234 | 894 | 13537 |
| 22-#10 | 3.34 | MA | 13159 | 3729 | 20149 | 2836 | 21875 | 2383 | 22662 | 2010 | 23309 | 1401 | 27740 | 655 | 21995 |
| 11L-2S | | MI | 8243 | 3729 | 14029 | 2611 | 15416 | 2162 | 16366 | 1793 | 17858 | 1198 | 21305 | 983 | 13526 |
| 22-#11 | 4.11 | MA | 14201 | 3906 | 22622 | 2916 | 24970 | 2434 | 26442 | 2022 | 28422 | 1354 | 34509 | 673 | 28368 |
| 8L-5S | | MI | 8231 | 3906 | 13799 | 2738 | 15055 | 2268 | 15891 | 1864 | 17178 | 1197 | 20244 | 673 | 15895 |
| 22-#11 | 4.11 | MA | 14012 | 3906 | 22039 | 2940 | 24246 | 2443 | 25542 | 2043 | 27248 | 1377 | 32957 | 621 | 27561 |
| 9L-4S | | MI | 8357 | 3906 | 14091 | 2730 | 15442 | 2249 | 16374 | 1847 | 17892 | 1198 | 21118 | 736 | 16209 |
| 22-#11 | 4.11 | MA | 13782 | 3906 | 21473 | 2947 | 23521 | 2467 | 24666 | 2065 | 25994 | 1385 | 31382 | 574 | 26679 |
| 10L-3S | | MI | 8424 | 3906 | 14437 | 2708 | 15890 | 2243 | 16924 | 1843 | 18608 | 1184 | 21999 | 794 | 16223 |

## RECTANGULAR TIED COLUMNS 22" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#10 | 3.65 | MA | 14019 | 3799 | 22272 | 2847 | 24584 | 2379 | 25996 | 1985 | 27852 | 1354 | 33678 | 770 | 26068 |
| 8L-6S | | MI | 8038 | 3799 | 13254 | 2706 | 14404 | 2239 | 15112 | 1851 | 16139 | 1230 | 19127 | 726 | 14386 |
| 24-#10 | 3.65 | MA | 13864 | 3799 | 21788 | 2866 | 23990 | 2387 | 25256 | 2003 | 26889 | 1373 | 32412 | 728 | 25556 |
| 9L-5S | | MI | 8113 | 3799 | 13501 | 2688 | 14724 | 2233 | 15509 | 1847 | 16673 | 1218 | 19810 | 783 | 14543 |
| 24-#10 | 3.65 | MA | 13672 | 3799 | 21323 | 2872 | 23394 | 2407 | 24537 | 2022 | 25843 | 1379 | 31123 | 692 | 24884 |
| 10L-4S | | MI | 8218 | 3799 | 13743 | 2681 | 15045 | 2216 | 15910 | 1832 | 17265 | 1216 | 20556 | 834 | 14700 |
| 24-#10 | 3.65 | MA | 13494 | 3799 | 20873 | 2879 | 22803 | 2415 | 23794 | 2030 | 24850 | 1396 | 29873 | 648 | 24205 |
| 11L-3S | | MI | 8278 | 3799 | 14029 | 2662 | 15416 | 2210 | 16366 | 1827 | 17858 | 1204 | 21305 | 883 | 14704 |
| 24-#11 | 4.48 | MA | 14412 | 3992 | 22918 | 2994 | 25373 | 2482 | 26917 | 2067 | 29118 | 1370 | 35547 | 612 | 30246 |
| 9L-5S | | MI | 8418 | 3992 | 14247 | 2792 | 15628 | 2307 | 16590 | 1888 | 18130 | 1190 | 21498 | 655 | 17251 |
| 24-#11 | 4.48 | MA | 14183 | 3992 | 22352 | 3001 | 24648 | 2506 | 26040 | 2089 | 27864 | 1378 | 33972 | 565 | 29370 |
| 10L-4S | | MI | 8544 | 3992 | 14538 | 2784 | 16016 | 2287 | 17074 | 1870 | 18845 | 1191 | 22372 | 719 | 17598 |

## RECTANGULAR TIED COLUMNS 22" x 40"

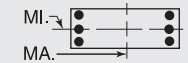
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.02 | MA | 13660 | 3361 | 21280 | 2504 | 22852 | 2115 | 23420 | 1814 | 23544 | 1370 | 26729 | 1192 | 8813 |
| 2E | | MI | 7380 | 3361 | 11779 | 2357 | 12310 | 1989 | 12412 | 1705 | 12230 | 1283 | 13395 | 1085 | 4707 |
| 4-#18 | 1.82 | MA | 14533 | 3554 | 23350 | 2607 | 25422 | 2186 | 26516 | 1854 | 27735 | 1344 | 32515 | 1161 | 15204 |
| 2E | | MI | 7748 | 3554 | 12732 | 2445 | 13462 | 2048 | 13790 | 1733 | 14093 | 1248 | 15563 | 995 | 7820 |
| 6-#11 | 1.06 | MA | 13725 | 3371 | 21372 | 2519 | 23014 | 2127 | 23636 | 1823 | 23850 | 1374 | 27162 | 1195 | 9180 |
| 2L-3S | | MI | 7259 | 3371 | 11381 | 2387 | 11836 | 2027 | 11848 | 1737 | 11469 | 1305 | 12465 | 990 | 4918 |
| 6-#11 | 1.06 | MA | 13365 | 3371 | 20439 | 2533 | 21818 | 2140 | 22177 | 1849 | 21865 | 1398 | 24413 | 1100 | 9214 |
| 3L-2S | | MI | 7415 | 3371 | 11829 | 2379 | 12409 | 2008 | 12548 | 1719 | 12422 | 1292 | 13719 | 1099 | 4882 |
| 6-#14 | 1.53 | MA | 14258 | 3485 | 22615 | 2582 | 24563 | 2171 | 25507 | 1848 | 26384 | 1360 | 30662 | 1178 | 13018 |
| 2L-3S | | MI | 7428 | 3485 | 11779 | 2445 | 12310 | 2072 | 12412 | 1763 | 12230 | 1290 | 13395 | 898 | 6832 |
| 6-#14 | 1.53 | MA | 13754 | 3485 | 21280 | 2602 | 22852 | 2189 | 23420 | 1884 | 23544 | 1393 | 26729 | 1038 | 13050 |
| 3L-2S | | MI | 7646 | 3485 | 12414 | 2435 | 13123 | 2045 | 13404 | 1739 | 13580 | 1273 | 15141 | 1056 | 6772 |
| 6-#18 | 2.73 | MA | 15554 | 3776 | 25684 | 2745 | 28413 | 2286 | 30166 | 1914 | 32700 | 1326 | 39390 | 1137 | 22519 |
| 2L-3S | | MI | 7835 | 3776 | 12732 | 2599 | 13462 | 2192 | 13790 | 1831 | 14093 | 1255 | 15563 | 647 | 11388 |
| 6-#18 | 2.73 | MA | 14712 | 3776 | 23350 | 2779 | 25422 | 2316 | 26516 | 1976 | 27735 | 1382 | 32515 | 881 | 22429 |
| 3L-2S | | MI | 8196 | 3776 | 13821 | 2584 | 14858 | 2148 | 15493 | 1794 | 16410 | 1230 | 18446 | 929 | 11307 |
| 8-#10 | 1.15 | MA | 13859 | 3393 | 21593 | 2545 | 23357 | 2147 | 24081 | 1839 | 24473 | 1380 | 28038 | 1199 | 9984 |
| 2L-4S | | MI | 7291 | 3393 | 11282 | 2442 | 11756 | 2059 | 11769 | 1762 | 11398 | 1328 | 12493 | 980 | 5342 |
| 8-#10 | 1.15 | MA | 13562 | 3393 | 20824 | 2557 | 22372 | 2158 | 22880 | 1860 | 22838 | 1400 | 25775 | 1123 | 10007 |
| 3E | | MI | 7353 | 3393 | 11569 | 2423 | 12127 | 2054 | 12225 | 1758 | 11992 | 1315 | 13242 | 1029 | 5305 |
| 8-#10 | 1.15 | MA | 13393 | 3393 | 20251 | 2580 | 21627 | 2181 | 21963 | 1870 | 21579 | 1408 | 24302 | 1076 | 10019 |
| 4L-2S | | MI | 7485 | 3393 | 11942 | 2415 | 12605 | 2037 | 12808 | 1742 | 12786 | 1303 | 14312 | 1119 | 5277 |
| 8-#11 | 1.42 | MA | 14145 | 3457 | 22305 | 2573 | 24210 | 2166 | 25095 | 1847 | 25835 | 1368 | 29911 | 1186 | 12117 |
| 2L-4S | | MI | 7378 | 3457 | 11483 | 2463 | 11961 | 2072 | 11998 | 1764 | 11706 | 1311 | 12838 | 915 | 6418 |
| 8-#11 | 1.42 | MA | 13791 | 3457 | 21372 | 2587 | 23014 | 2179 | 23636 | 1873 | 23850 | 1391 | 27162 | 1090 | 12142 |
| 3E | | MI | 7449 | 3457 | 11829 | 2441 | 12409 | 2066 | 12548 | 1761 | 12422 | 1298 | 13719 | 972 | 6371 |
| 8-#11 | 1.42 | MA | 13591 | 3457 | 20674 | 2615 | 22107 | 2205 | 22520 | 1884 | 22317 | 1401 | 25360 | 1032 | 12137 |
| 4L-2S | | MI | 7604 | 3457 | 12276 | 2433 | 12983 | 2046 | 13248 | 1743 | 13374 | 1285 | 14973 | 1082 | 6333 |
| 8-#14 | 2.05 | MA | 14851 | 3610 | 23949 | 2660 | 26274 | 2226 | 27594 | 1882 | 29224 | 1350 | 34594 | 1164 | 17205 |
| 2L-4S | | MI | 7600 | 3610 | 11922 | 2553 | 12486 | 2136 | 12622 | 1801 | 12562 | 1298 | 13909 | 788 | 8908 |
| 8-#14 | 2.05 | MA | 14359 | 3610 | 22615 | 2679 | 24563 | 2245 | 25507 | 1918 | 26384 | 1383 | 30662 | 1025 | 17211 |
| 3E | | MI | 7696 | 3610 | 12414 | 2523 | 13123 | 2128 | 13404 | 1796 | 13580 | 1280 | 15141 | 869 | 8860 |
| 8-#14 | 2.05 | MA | 14079 | 3610 | 21614 | 2719 | 23264 | 2283 | 23908 | 1935 | 24187 | 1396 | 28068 | 940 | 17102 |
| 4L-2S | | MI | 7910 | 3610 | 13048 | 2512 | 13937 | 2101 | 14396 | 1772 | 14930 | 1263 | 16886 | 1027 | 8808 |
| 8-#18 | 3.64 | MA | 15753 | 3997 | 25684 | 2917 | 28413 | 2415 | 30166 | 2036 | 32700 | 1364 | 39390 | 857 | 29658 |
| 3E | | MI | 8289 | 3997 | 13821 | 2737 | 14858 | 2291 | 15493 | 1891 | 16410 | 1237 | 18446 | 582 | 14798 |
| 8-#18 | 3.64 | MA | 15284 | 3997 | 23928 | 2986 | 26133 | 2480 | 27361 | 2063 | 29046 | 1419 | 34804 | 704 | 28059 |
| 4L-2S | | MI | 8642 | 3997 | 14910 | 2722 | 16254 | 2247 | 17195 | 1854 | 18727 | 1213 | 21329 | 863 | 14756 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis

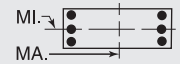



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.44 | MA | 14207 | 3463 | 22361 | 2589 | 24341 | 2179 | 25282 | 1858 | 26107 | 1374 | 30301 | 1192 | 12397 |
| 2L-5S | | MI | 7340 | 3463 | 11414 | 2493 | 11913 | 2108 | 11952 | 1796 | 11600 | 1323 | 12818 | 918 | 6570 |
| 10-#10 | 1.44 | MA | 13914 | 3463 | 21593 | 2601 | 23357 | 2190 | 24081 | 1879 | 24473 | 1394 | 28038 | 1115 | 12414 |
| 3L-4S | | MI | 7451 | 3463 | 11655 | 2485 | 12234 | 2091 | 12352 | 1781 | 12192 | 1322 | 13564 | 969 | 6537 |
| 10-#10 | 1.44 | MA | 13747 | 3463 | 21019 | 2624 | 22612 | 2212 | 23165 | 1889 | 23213 | 1403 | 26565 | 1068 | 12413 |
| 4L-3S | | MI | 7513 | 3463 | 11942 | 2467 | 12605 | 2085 | 12808 | 1777 | 12786 | 1310 | 14312 | 1018 | 6504 |
| 10-#10 | 1.44 | MA | 13502 | 3463 | 20531 | 2635 | 21976 | 2223 | 22369 | 1911 | 22096 | 1422 | 25058 | 1033 | 12363 |
| 5L-2S | | MI | 7643 | 3463 | 12315 | 2459 | 13083 | 2068 | 13391 | 1761 | 13579 | 1298 | 15383 | 1108 | 6477 |
| 10-#11 | 1.77 | MA | 14563 | 3543 | 23238 | 2627 | 25406 | 2204 | 26554 | 1870 | 27820 | 1361 | 32660 | 1176 | 15045 |
| 2L-5S | | MI | 7436 | 3543 | 11639 | 2525 | 12147 | 2130 | 12214 | 1806 | 11944 | 1304 | 13218 | 834 | 7876 |
| 10-#11 | 1.77 | MA | 14215 | 3543 | 22305 | 2641 | 24210 | 2217 | 25095 | 1896 | 25835 | 1384 | 29911 | 1081 | 15061 |
| 3L-4S | | MI | 7569 | 3543 | 11930 | 2517 | 12535 | 2111 | 12698 | 1788 | 12658 | 1305 | 14092 | 897 | 7844 |
| 10-#11 | 1.77 | MA | 14017 | 3543 | 21607 | 2669 | 23303 | 2244 | 23979 | 1908 | 24302 | 1394 | 28108 | 1022 | 15037 |
| 4L-3S | | MI | 7639 | 3543 | 12276 | 2495 | 12983 | 2105 | 13248 | 1784 | 13374 | 1291 | 14973 | 955 | 7806 |
| 10-#11 | 1.77 | MA | 13724 | 3543 | 21018 | 2682 | 22528 | 2257 | 23009 | 1934 | 22941 | 1417 | 26268 | 977 | 14929 |
| 5L-2S | | MI | 7792 | 3543 | 12724 | 2487 | 13556 | 2085 | 13948 | 1766 | 14326 | 1278 | 16227 | 1065 | 7770 |
| 10-#14 | 2.56 | MA | 14959 | 3734 | 23949 | 2757 | 26274 | 2300 | 27594 | 1952 | 29224 | 1373 | 34594 | 1011 | 21365 |
| 3L-4S | | MI | 7868 | 3734 | 12556 | 2631 | 13299 | 2191 | 13614 | 1834 | 13912 | 1288 | 15654 | 759 | 10898 |
| 10-#14 | 2.56 | MA | 14683 | 3734 | 22949 | 2797 | 24975 | 2338 | 25995 | 1969 | 27027 | 1386 | 32000 | 926 | 21232 |
| 4L-3S | | MI | 7963 | 3734 | 13048 | 2601 | 13937 | 2184 | 14396 | 1830 | 14930 | 1270 | 16886 | 840 | 10869 |
| 10-#14 | 2.56 | MA | 14269 | 3734 | 22111 | 2816 | 23863 | 2357 | 24604 | 2005 | 25076 | 1419 | 29358 | 859 | 20312 |
| 5L-2S | | MI | 8174 | 3734 | 13683 | 2590 | 14750 | 2157 | 15389 | 1806 | 16280 | 1253 | 18632 | 998 | 10827 |
| 10-#18 | 4.55 | MA | 16323 | 4218 | 26261 | 3124 | 29125 | 2580 | 31011 | 2123 | 34012 | 1402 | 41680 | 680 | 35149 |
| 4L-3S | | MI | 8741 | 4218 | 14910 | 2875 | 16254 | 2390 | 17195 | 1952 | 18727 | 1220 | 21329 | 516 | 18181 |
| 10-#18 | 4.55 | MA | 15620 | 4218 | 24798 | 3157 | 27171 | 2610 | 28567 | 2185 | 30387 | 1422 | 37024 | 552 | 32741 |
| 5L-2S | | MI | 9087 | 4218 | 15999 | 2860 | 17650 | 2346 | 18898 | 1914 | 21043 | 1195 | 24212 | 797 | 18183 |
| 12-#10 | 1.73 | MA | 14552 | 3533 | 23129 | 2633 | 25326 | 2210 | 26484 | 1877 | 27742 | 1369 | 32564 | 1184 | 14806 |
| 2L-6S | | MI | 7420 | 3533 | 11539 | 2554 | 12071 | 2145 | 12137 | 1820 | 11860 | 1330 | 13205 | 850 | 7679 |
| 12-#10 | 1.73 | MA | 14264 | 3533 | 22361 | 2645 | 24341 | 2221 | 25282 | 1898 | 26107 | 1389 | 30301 | 1107 | 14817 |
| 3L-5S | | MI | 7501 | 3533 | 11787 | 2537 | 12391 | 2140 | 12535 | 1816 | 12393 | 1318 | 13888 | 907 | 7747 |
| 12-#10 | 1.73 | MA | 14098 | 3533 | 21788 | 2668 | 23597 | 2244 | 24366 | 1909 | 24847 | 1397 | 28828 | 1061 | 14803 |
| 4E | | MI | 7611 | 3533 | 12028 | 2529 | 12712 | 2123 | 12935 | 1800 | 12985 | 1316 | 14634 | 958 | 7722 |
| 12-#10 | 1.73 | MA | 13857 | 3533 | 21300 | 2678 | 22961 | 2255 | 23570 | 1930 | 23730 | 1417 | 27321 | 1026 | 14744 |
| 5L-3S | | MI | 7673 | 3533 | 12315 | 2511 | 13083 | 2117 | 13391 | 1796 | 13579 | 1304 | 15383 | 1007 | 7694 |
| 12-#10 | 1.73 | MA | 13683 | 3533 | 20791 | 2684 | 22310 | 2275 | 22783 | 1940 | 22671 | 1437 | 25973 | 974 | 14415 |
| 6L-2S | | MI | 7802 | 3533 | 12687 | 2503 | 13561 | 2100 | 13974 | 1780 | 14372 | 1292 | 16454 | 1097 | 7668 |
| 12-#11 | 2.13 | MA | 14636 | 3630 | 23238 | 2695 | 25406 | 2256 | 26554 | 1920 | 27820 | 1377 | 32660 | 1071 | 17972 |
| 3L-5S | | MI | 7627 | 3630 | 12086 | 2579 | 12721 | 2169 | 12914 | 1829 | 12896 | 1297 | 14472 | 817 | 9280 |
| 12-#11 | 2.13 | MA | 14440 | 3630 | 22540 | 2723 | 24499 | 2283 | 25438 | 1932 | 26287 | 1387 | 30857 | 1013 | 17934 |
| 4E | | MI | 7759 | 3630 | 12378 | 2571 | 13109 | 2149 | 13398 | 1811 | 13610 | 1298 | 15346 | 880 | 9260 |
| 12-#11 | 2.13 | MA | 14151 | 3630 | 21951 | 2736 | 23724 | 2296 | 24468 | 1957 | 24926 | 1410 | 29017 | 968 | 17815 |
| 5L-3S | | MI | 7828 | 3630 | 12724 | 2549 | 13556 | 2143 | 13948 | 1808 | 14326 | 1284 | 16227 | 938 | 9229 |
| 12-#11 | 2.13 | MA | 13942 | 3630 | 21332 | 2742 | 22940 | 2321 | 23508 | 1969 | 23634 | 1434 | 27371 | 902 | 17141 |
| 6L-2S | | MI | 7979 | 3630 | 13171 | 2541 | 14130 | 2124 | 14647 | 1790 | 15278 | 1271 | 17481 | 1048 | 9197 |
| 12-#14 | 3.07 | MA | 15281 | 3859 | 24283 | 2875 | 26686 | 2394 | 28083 | 2003 | 29867 | 1376 | 35933 | 912 | 25364 |
| 4E | | MI | 8135 | 3859 | 13190 | 2709 | 14113 | 2247 | 14606 | 1868 | 15261 | 1278 | 17400 | 730 | 12874 |
| 12-#14 | 3.07 | MA | 14875 | 3859 | 23445 | 2894 | 25574 | 2412 | 26691 | 2039 | 27916 | 1409 | 33290 | 845 | 24383 |
| 5L-3S | | MI | 8229 | 3859 | 13683 | 2679 | 14750 | 2240 | 15389 | 1864 | 16280 | 1261 | 18632 | 811 | 12866 |
| 12-#14 | 3.07 | MA | 14582 | 3859 | 22559 | 2902 | 24459 | 2449 | 25315 | 2055 | 26063 | 1442 | 30925 | 749 | 23476 |
| 6L-2S | | MI | 8437 | 3859 | 14317 | 2668 | 15563 | 2213 | 16381 | 1840 | 17630 | 1243 | 20377 | 969 | 12834 |
| 12-#18 | 5.45 | MA | 16665 | 4440 | 27132 | 3296 | 30163 | 2709 | 32216 | 2246 | 35353 | 1404 | 43899 | 527 | 39888 |
| 5L-3S | | MI | 9191 | 4440 | 15999 | 3014 | 17650 | 2490 | 18898 | 2012 | 21043 | 1202 | 24212 | 450 | 21554 |
| 12-#18 | 5.45 | MA | 16168 | 4440 | 25592 | 3310 | 28220 | 2774 | 29797 | 2272 | 32098 | 1460 | 39729 | 349 | 36740 |
| 6L-2S | | MI | 9531 | 4440 | 17087 | 2999 | 19046 | 2446 | 20601 | 1975 | 23360 | 1177 | 27095 | 732 | 21596 |
| 14-#10 | 2.02 | MA | 14613 | 3604 | 23129 | 2689 | 25326 | 2253 | 26484 | 1918 | 27742 | 1383 | 32564 | 1100 | 17215 |
| 3L-6S | | MI | 7582 | 3604 | 11912 | 2598 | 12549 | 2177 | 12720 | 1839 | 12653 | 1324 | 14276 | 839 | 8789 |
| 14-#10 | 2.02 | MA | 14448 | 3604 | 22556 | 2712 | 24581 | 2275 | 25567 | 1928 | 26482 | 1391 | 31091 | 1053 | 17192 |
| 4L-5S | | MI | 7661 | 3604 | 12160 | 2581 | 12869 | 2171 | 13118 | 1835 | 13187 | 1312 | 14959 | 896 | 8918 |

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis



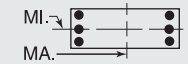

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.02 | MA | 14209 | 3604 | 22068 | 2722 | 23946 | 2286 | 24771 | 1949 | 25365 | 1411 | 29584 | 1018 | 17124 |
| 5L-4S | | MI | 7771 | 3604 | 12401 | 2573 | 13190 | 2154 | 13518 | 1819 | 13778 | 1311 | 15705 | 947 | 8900 |
| 14-#10 | 2.02 | MA | 14039 | 3604 | 21559 | 2728 | 23295 | 2307 | 23984 | 1959 | 24305 | 1431 | 28236 | 966 | 16762 |
| 6L-3S | | MI | 7832 | 3604 | 12687 | 2555 | 13561 | 2148 | 13974 | 1815 | 14372 | 1299 | 16454 | 996 | 8877 |
| 14-#10 | 2.02 | MA | 13847 | 3604 | 21015 | 2746 | 22635 | 2312 | 23215 | 1979 | 23208 | 1440 | 26663 | 920 | 16361 |
| 7L-2S | | MI | 7959 | 3604 | 13060 | 2547 | 14039 | 2131 | 14558 | 1800 | 15166 | 1286 | 17524 | 1086 | 8853 |
| 14-#11 | 2.48 | MA | 14861 | 3716 | 23473 | 2777 | 25695 | 2322 | 26897 | 1955 | 28272 | 1380 | 33606 | 1003 | 20831 |
| 4L-5S | | MI | 7818 | 3716 | 12534 | 2633 | 13294 | 2208 | 13614 | 1853 | 13848 | 1290 | 15726 | 799 | 10590 |
| 14-#11 | 2.48 | MA | 14575 | 3716 | 22884 | 2790 | 24920 | 2334 | 25927 | 1981 | 26911 | 1403 | 31766 | 958 | 20701 |
| 5L-4S | | MI | 7948 | 3716 | 12825 | 2625 | 13682 | 2188 | 14098 | 1835 | 14562 | 1291 | 16600 | 863 | 10668 |
| 14-#11 | 2.48 | MA | 14371 | 3716 | 22265 | 2796 | 24136 | 2360 | 24967 | 1993 | 25620 | 1427 | 30119 | 893 | 19998 |
| 6L-3S | | MI | 8017 | 3716 | 13171 | 2603 | 14130 | 2182 | 14647 | 1831 | 15278 | 1277 | 17481 | 920 | 10644 |
| 14-#11 | 2.48 | MA | 14142 | 3716 | 21604 | 2818 | 23333 | 2366 | 24043 | 2017 | 24283 | 1437 | 28193 | 836 | 19538 |
| 7L-2S | | MI | 8166 | 3716 | 13619 | 2595 | 14704 | 2162 | 15347 | 1813 | 16230 | 1264 | 18735 | 1030 | 10617 |
| 14-#14 | 3.58 | MA | 15476 | 3983 | 24780 | 2971 | 27285 | 2468 | 28779 | 2073 | 30756 | 1399 | 37222 | 831 | 28462 |
| 5L-4S | | MI | 8400 | 3983 | 13825 | 2787 | 14926 | 2303 | 15598 | 1902 | 16611 | 1268 | 19145 | 701 | 14823 |
| 14-#14 | 3.58 | MA | 15191 | 3983 | 23894 | 2980 | 26170 | 2505 | 27402 | 2089 | 28903 | 1432 | 34857 | 735 | 27589 |
| 6L-3S | | MI | 8494 | 3983 | 14317 | 2756 | 15563 | 2296 | 16381 | 1898 | 17630 | 1251 | 20377 | 782 | 14857 |
| 14-#14 | 3.58 | MA | 14869 | 3983 | 22946 | 3011 | 25020 | 2514 | 26089 | 2125 | 26986 | 1445 | 32085 | 652 | 26209 |
| 7L-2S | | MI | 8699 | 3983 | 14951 | 2746 | 16376 | 2268 | 17373 | 1874 | 18979 | 1233 | 22123 | 940 | 14833 |
| 14-#18 | 6.36 | MA | 17222 | 4661 | 27926 | 3448 | 31212 | 2874 | 33446 | 2333 | 37063 | 1442 | 46604 | 325 | 43826 |
| 6L-3S | | MI | 9639 | 4661 | 17087 | 3152 | 19046 | 2589 | 20601 | 2072 | 23360 | 1184 | 27095 | 384 | 24920 |
| 16-#10 | 2.31 | MA | 14796 | 3674 | 23324 | 2756 | 25566 | 2307 | 26768 | 1947 | 28116 | 1386 | 33354 | 1045 | 19580 |
| 4L-6S | | MI | 7742 | 3674 | 12285 | 2642 | 13027 | 2208 | 13303 | 1858 | 13446 | 1319 | 15346 | 828 | 9918 |
| 16-#10 | 2.31 | MA | 14560 | 3674 | 22836 | 2766 | 24930 | 2318 | 25972 | 1968 | 26999 | 1406 | 31847 | 1010 | 19505 |
| 5E | | MI | 7821 | 3674 | 12533 | 2625 | 13347 | 2203 | 13701 | 1854 | 13980 | 1306 | 16029 | 885 | 10086 |
| 16-#10 | 2.31 | MA | 14392 | 3674 | 22327 | 2771 | 24279 | 2338 | 25185 | 1979 | 25939 | 1425 | 30499 | 958 | 19114 |
| 6L-4S | | MI | 7930 | 3674 | 12774 | 2617 | 13668 | 2186 | 14101 | 1838 | 14572 | 1305 | 16775 | 936 | 10074 |
| 16-#10 | 2.31 | MA | 14201 | 3674 | 21783 | 2790 | 23620 | 2344 | 24416 | 1998 | 24842 | 1434 | 28926 | 912 | 18725 |
| 7L-3S | | MI | 7990 | 3674 | 13060 | 2599 | 14039 | 2180 | 14558 | 1834 | 15166 | 1293 | 17524 | 985 | 10055 |
| 16-#10 | 2.31 | MA | 13995 | 3674 | 21309 | 2799 | 22962 | 2362 | 23604 | 2004 | 23809 | 1454 | 27558 | 872 | 18297 |
| 8L-2S | | MI | 8117 | 3674 | 13433 | 2591 | 14517 | 2163 | 15141 | 1819 | 15959 | 1281 | 18595 | 1074 | 10034 |
| 16-#11 | 2.84 | MA | 14996 | 3802 | 23817 | 2844 | 26116 | 2373 | 27386 | 2004 | 28897 | 1397 | 34514 | 949 | 23539 |
| 5E | | MI | 8007 | 3802 | 12981 | 2687 | 13868 | 2247 | 14314 | 1876 | 14800 | 1284 | 16980 | 782 | 11931 |
| 16-#11 | 2.84 | MA | 14797 | 3802 | 23198 | 2850 | 25332 | 2399 | 26426 | 2016 | 27605 | 1420 | 32868 | 883 | 22859 |
| 6L-4S | | MI | 8137 | 3802 | 13273 | 2679 | 14256 | 2227 | 14797 | 1859 | 15514 | 1284 | 17854 | 845 | 12072 |
| 16-#11 | 2.84 | MA | 14570 | 3802 | 22537 | 2872 | 24529 | 2405 | 25502 | 2041 | 26268 | 1430 | 30942 | 826 | 22414 |
| 7L-3S | | MI | 8205 | 3802 | 13619 | 2657 | 14704 | 2221 | 15347 | 1855 | 16230 | 1271 | 18735 | 903 | 12055 |
| 16-#11 | 2.84 | MA | 14323 | 3802 | 21959 | 2882 | 23729 | 2427 | 24513 | 2048 | 25008 | 1453 | 29270 | 774 | 21595 |
| 8L-2S | | MI | 8353 | 3802 | 14066 | 2649 | 15277 | 2201 | 16047 | 1837 | 17182 | 1257 | 19989 | 1013 | 12031 |
| 16-#14 | 4.09 | MA | 15795 | 4108 | 25228 | 3057 | 27881 | 2561 | 29489 | 2123 | 31743 | 1422 | 38790 | 721 | 31704 |
| 6L-4S | | MI | 8665 | 4108 | 14459 | 2865 | 15739 | 2359 | 16591 | 1936 | 17961 | 1258 | 20891 | 672 | 16697 |
| 16-#14 | 4.09 | MA | 15476 | 4108 | 24280 | 3089 | 26731 | 2570 | 28176 | 2159 | 29826 | 1435 | 36017 | 638 | 30290 |
| 7L-3S | | MI | 8758 | 4108 | 14951 | 2834 | 16376 | 2352 | 17373 | 1932 | 18979 | 1241 | 22123 | 753 | 16840 |
| 16-#14 | 4.09 | MA | 15129 | 4108 | 23452 | 3103 | 25584 | 2602 | 26760 | 2168 | 28019 | 1468 | 33615 | 560 | 28977 |
| 8L-2S | | MI | 8961 | 4108 | 15586 | 2824 | 17190 | 2324 | 18365 | 1908 | 20329 | 1223 | 23868 | 912 | 16827 |
| 18-#10 | 2.60 | MA | 14908 | 3744 | 23604 | 2810 | 25915 | 2349 | 27174 | 1987 | 28634 | 1400 | 34110 | 1002 | 21887 |
| 5L-6S | | MI | 7903 | 3744 | 12658 | 2686 | 13505 | 2240 | 13887 | 1877 | 14240 | 1313 | 16417 | 817 | 11049 |
| 18-#10 | 2.60 | MA | 14744 | 3744 | 23095 | 2815 | 25264 | 2370 | 26386 | 1998 | 27574 | 1420 | 32762 | 951 | 21468 |
| 6L-5S | | MI | 7980 | 3744 | 12905 | 2669 | 13825 | 2234 | 14284 | 1873 | 14773 | 1301 | 17100 | 874 | 11238 |
| 18-#10 | 2.60 | MA | 14554 | 3744 | 22551 | 2834 | 24604 | 2375 | 25617 | 2017 | 26477 | 1428 | 31189 | 905 | 21091 |
| 7L-4S | | MI | 8088 | 3744 | 13147 | 2661 | 14146 | 2217 | 14684 | 1858 | 15365 | 1300 | 17846 | 925 | 11245 |
| 18-#10 | 2.60 | MA | 14353 | 3744 | 22077 | 2843 | 23947 | 2394 | 24805 | 2023 | 25443 | 1448 | 29821 | 864 | 20655 |
| 8L-3S | | MI | 8148 | 3744 | 13433 | 2642 | 14517 | 2211 | 15141 | 1853 | 15959 | 1287 | 18595 | 974 | 11230 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis

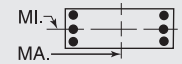


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.60 | MA | 14178 | 3744 | 21561 | 2862 | 23318 | 2402 | 24023 | 2042 | 24424 | 1468 | 28488 | 823 | 20073 |
| 9L-2S | | MI | 8274 | 3744 | 13806 | 2635 | 14995 | 2194 | 15724 | 1838 | 16752 | 1275 | 19665 | 1063 | 11212 |
| 18-#11 | 3.19 | MA | 15220 | 3888 | 24131 | 2904 | 26528 | 2437 | 27886 | 2040 | 29590 | 1413 | 35617 | 874 | 25723 |
| 6L-5S | | MI | 8197 | 3888 | 13429 | 2741 | 14442 | 2285 | 15013 | 1900 | 15752 | 1277 | 18234 | 765 | 13277 |
| 18-#11 | 3.19 | MA | 14994 | 3888 | 23470 | 2926 | 25725 | 2444 | 26961 | 2064 | 28253 | 1423 | 33690 | 817 | 25293 |
| 7L-4S | | MI | 8325 | 3888 | 13720 | 2733 | 14830 | 2266 | 15497 | 1882 | 16466 | 1277 | 19108 | 828 | 13473 |
| 18-#11 | 3.19 | MA | 14754 | 3888 | 22892 | 2936 | 24925 | 2466 | 25972 | 2071 | 26993 | 1446 | 32019 | 764 | 24460 |
| 8L-3S | | MI | 8393 | 3888 | 14066 | 2711 | 15277 | 2260 | 16047 | 1878 | 17182 | 1264 | 19989 | 886 | 13461 |
| 18-#11 | 3.19 | MA | 14543 | 3888 | 22270 | 2960 | 24159 | 2476 | 25019 | 2093 | 25751 | 1470 | 30383 | 713 | 23703 |
| 9L-2S | | MI | 8539 | 3888 | 14514 | 2703 | 15851 | 2240 | 16747 | 1861 | 18134 | 1250 | 21243 | 996 | 13442 |
| 18-#14 | 4.60 | MA | 16077 | 4232 | 25615 | 3167 | 28442 | 2626 | 30263 | 2193 | 32666 | 1425 | 39949 | 624 | 34371 |
| 7L-4S | | MI | 8930 | 4232 | 15093 | 2943 | 16552 | 2415 | 17583 | 1970 | 19311 | 1248 | 22637 | 644 | 18581 |
| 18-#14 | 4.60 | MA | 15748 | 4232 | 24786 | 3181 | 27295 | 2657 | 28847 | 2202 | 30859 | 1458 | 37547 | 546 | 33034 |
| 8L-3S | | MI | 9022 | 4232 | 15586 | 2912 | 17190 | 2407 | 18365 | 1966 | 20329 | 1231 | 23868 | 724 | 18816 |
| 18-#14 | 4.60 | MA | 15443 | 4232 | 23901 | 3216 | 26197 | 2671 | 27480 | 2233 | 29077 | 1491 | 35191 | 472 | 31452 |
| 9L-2S | | MI | 9222 | 4232 | 16220 | 2901 | 18003 | 2380 | 19357 | 1942 | 21679 | 1213 | 25614 | 883 | 18816 |
| 20-#10 | 2.89 | MA | 15094 | 3814 | 23863 | 2859 | 26249 | 2401 | 27587 | 2017 | 29208 | 1414 | 35025 | 943 | 23826 |
| 6E | | MI | 8062 | 3814 | 13031 | 2730 | 13983 | 2272 | 14470 | 1896 | 15033 | 1307 | 17488 | 806 | 12183 |
| 20-#10 | 2.89 | MA | 14905 | 3814 | 23319 | 2878 | 25589 | 2407 | 26819 | 2037 | 28111 | 1423 | 33452 | 897 | 23460 |
| 7L-5S | | MI | 8139 | 3814 | 13278 | 2712 | 14303 | 2266 | 14867 | 1892 | 15567 | 1295 | 18170 | 863 | 12361 |
| 20-#10 | 2.89 | MA | 14708 | 3814 | 22845 | 2887 | 24932 | 2426 | 26007 | 2043 | 27077 | 1442 | 32084 | 856 | 23014 |
| 8L-4S | | MI | 8246 | 3814 | 13519 | 2705 | 14624 | 2249 | 15268 | 1877 | 16158 | 1294 | 18917 | 914 | 12413 |
| 20-#10 | 2.89 | MA | 14536 | 3814 | 22329 | 2906 | 24303 | 2434 | 25224 | 2061 | 26058 | 1462 | 30751 | 815 | 22437 |
| 9L-3S | | MI | 8306 | 3814 | 13806 | 2686 | 14995 | 2243 | 15724 | 1872 | 16752 | 1282 | 19665 | 963 | 12402 |
| 20-#10 | 2.89 | MA | 14328 | 3814 | 21837 | 2912 | 23673 | 2454 | 24441 | 2068 | 24941 | 1468 | 29390 | 780 | 21800 |
| 10L-2S | | MI | 8430 | 3814 | 14179 | 2679 | 15473 | 2226 | 16307 | 1857 | 17546 | 1269 | 20736 | 1052 | 12387 |
| 20-#11 | 3.55 | MA | 15416 | 3975 | 24403 | 2980 | 26921 | 2483 | 28420 | 2088 | 30239 | 1416 | 36439 | 807 | 28173 |
| 7L-5S | | MI | 8385 | 3975 | 13876 | 2795 | 15015 | 2324 | 15713 | 1923 | 16704 | 1270 | 19488 | 748 | 14627 |
| 20-#11 | 3.55 | MA | 15185 | 3975 | 23825 | 2990 | 26121 | 2505 | 27431 | 2095 | 28978 | 1439 | 34767 | 755 | 27325 |
| 8L-4S | | MI | 8512 | 3975 | 14168 | 2787 | 15403 | 2304 | 16197 | 1906 | 17418 | 1270 | 20362 | 811 | 14867 |
| 20-#11 | 3.55 | MA | 14975 | 3975 | 23203 | 3014 | 25355 | 2514 | 26478 | 2116 | 27736 | 1463 | 33132 | 704 | 26553 |
| 9L-3S | | MI | 8580 | 3975 | 14514 | 2765 | 15851 | 2298 | 16747 | 1902 | 18134 | 1257 | 21243 | 869 | 14865 |
| 20-#11 | 3.55 | MA | 14727 | 3975 | 22603 | 3021 | 24587 | 2539 | 25550 | 2139 | 26394 | 1470 | 31468 | 659 | 25585 |
| 10L-2S | | MI | 8725 | 3975 | 14961 | 2757 | 16425 | 2279 | 17447 | 1884 | 19087 | 1243 | 22497 | 978 | 14850 |
| 20-#14 | 5.11 | MA | 16352 | 4357 | 26121 | 3259 | 29006 | 2713 | 30934 | 2236 | 33698 | 1448 | 41479 | 533 | 37091 |
| 8L-4S | | MI | 9193 | 4357 | 15728 | 3020 | 17366 | 2471 | 18575 | 2004 | 20661 | 1238 | 24382 | 615 | 20473 |
| 20-#14 | 5.11 | MA | 16059 | 4357 | 25236 | 3294 | 27908 | 2726 | 29568 | 2267 | 31917 | 1481 | 39123 | 458 | 35521 |
| 9L-3S | | MI | 9284 | 4357 | 16220 | 2990 | 18003 | 2463 | 19357 | 2000 | 21679 | 1221 | 25614 | 695 | 20788 |
| 22-#10 | 3.17 | MA | 15253 | 3885 | 24087 | 2922 | 26574 | 2439 | 28020 | 2056 | 29746 | 1417 | 35715 | 889 | 25829 |
| 7L-6S | | MI | 8222 | 3885 | 13404 | 2774 | 14461 | 2303 | 15053 | 1916 | 15826 | 1302 | 18558 | 795 | 13318 |
| 22-#10 | 3.17 | MA | 15061 | 3885 | 23613 | 2931 | 25916 | 2457 | 27208 | 2062 | 28712 | 1437 | 34347 | 848 | 25376 |
| 8L-5S | | MI | 8297 | 3885 | 13651 | 2756 | 14781 | 2297 | 15450 | 1911 | 16360 | 1289 | 19241 | 852 | 13488 |
| 22-#10 | 3.17 | MA | 14892 | 3885 | 23097 | 2950 | 25288 | 2465 | 26425 | 2080 | 27693 | 1457 | 33014 | 807 | 24801 |
| 9L-4S | | MI | 8404 | 3885 | 13892 | 2749 | 15101 | 2280 | 15851 | 1896 | 16952 | 1288 | 19987 | 903 | 13580 |
| 22-#10 | 3.17 | MA | 14684 | 3885 | 22605 | 2956 | 24657 | 2485 | 25642 | 2088 | 26575 | 1462 | 31652 | 772 | 24153 |
| 10L-3S | | MI | 8464 | 3885 | 14179 | 2730 | 15473 | 2274 | 16307 | 1892 | 17546 | 1276 | 20736 | 952 | 13572 |
| 22-#10 | 3.17 | MA | 14493 | 3885 | 22128 | 2963 | 24027 | 2493 | 24878 | 2107 | 25524 | 1479 | 30332 | 729 | 23474 |
| 11L-2S | | MI | 8586 | 3885 | 14552 | 2723 | 15951 | 2257 | 16890 | 1876 | 18339 | 1264 | 21807 | 1041 | 13559 |
| 22-#11 | 3.90 | MA | 15608 | 4061 | 24757 | 3044 | 27317 | 2544 | 28890 | 2118 | 30963 | 1432 | 37516 | 745 | 30190 |
| 8L-5S | | MI | 8573 | 4061 | 14323 | 2849 | 15589 | 2363 | 16413 | 1947 | 17657 | 1263 | 20742 | 730 | 15980 |
| 22-#11 | 3.90 | MA | 15405 | 4061 | 24136 | 3068 | 26551 | 2553 | 27937 | 2140 | 29721 | 1456 | 35880 | 694 | 29403 |
| 9L-4S | | MI | 8700 | 4061 | 14615 | 2841 | 15977 | 2343 | 16897 | 1929 | 18371 | 1263 | 21616 | 793 | 16259 |
| 22-#11 | 3.90 | MA | 15157 | 4061 | 23536 | 3075 | 25783 | 2577 | 27009 | 2162 | 28379 | 1463 | 34216 | 649 | 28441 |
| 10L-3S | | MI | 8767 | 4061 | 14961 | 2819 | 16425 | 2337 | 17447 | 1925 | 19087 | 1250 | 22497 | 851 | 16266 |
| 22-#14 | 5.63 | MA | 16669 | 4481 | 26571 | 3372 | 29619 | 2782 | 31655 | 2301 | 34756 | 1471 | 43055 | 445 | 39590 |
| 9L-4S | | MI | 9456 | 4481 | 16362 | 3098 | 18179 | 2527 | 19567 | 2038 | 22011 | 1228 | 26128 | 586 | 22371 |
| 24-#10 | 3.46 | MA | 15412 | 3955 | 24381 | 2974 | 26901 | 2489 | 28409 | 2081 | 30346 | 1431 | 36610 | 840 | 27739 |
| 8L-6S | | MI | 8381 | 3955 | 13776 | 2818 | 14939 | 2335 | 15636 | 1935 | 16620 | 1296 | 19629 | 784 | 14455 |

## RECTANGULAR TIED COLUMNS 22" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#10 | 3.46 | MA | 15246 | 3955 | 23866 | 2994 | 26272 | 2497 | 27627 | 2099 | 29327 | 1451 | 35277 | 799 | 27165 |
| 9L-5S | | MI | 8455 | 3955 | 14024 | 2800 | 15259 | 2329 | 16033 | 1930 | 17153 | 1284 | 20312 | 841 | 14616 |
| 24-#10 | 3.46 | MA | 15039 | 3955 | 23373 | 3000 | 25642 | 2517 | 26843 | 2107 | 28210 | 1456 | 33915 | 764 | 26507 |
| 10L-4S | | MI | 8561 | 3955 | 14265 | 2793 | 15579 | 2312 | 16434 | 1915 | 17745 | 1283 | 21058 | 892 | 14742 |
| 24-#10 | 3.46 | MA | 14850 | 3955 | 22897 | 3007 | 25011 | 2524 | 26079 | 2126 | 27158 | 1474 | 32595 | 721 | 25830 |
| 11L-3S | | MI | 8621 | 3955 | 14552 | 2774 | 15951 | 2306 | 16890 | 1911 | 18339 | 1271 | 21807 | 941 | 14740 |
| 24-#11 | 4.25 | MA | 15831 | 4147 | 25069 | 3122 | 27747 | 2592 | 29396 | 2163 | 31706 | 1449 | 38629 | 685 | 32253 |
| 9L-5S | | MI | 8761 | 4147 | 14771 | 2903 | 16163 | 2402 | 17113 | 1970 | 18609 | 1256 | 21996 | 713 | 17336 |
| 24-#11 | 4.25 | MA | 15585 | 4147 | 24469 | 3129 | 26979 | 2616 | 28468 | 2186 | 30364 | 1456 | 36965 | 639 | 31297 |
| 10L-4S | | MI | 8887 | 4147 | 15063 | 2895 | 16550 | 2382 | 17597 | 1953 | 19323 | 1256 | 22870 | 776 | 17650 |

## RECTANGULAR TIED COLUMNS 22" x 42"

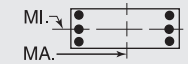
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.73 | MA | 15945 | 3710 | 25500 | 2734 | 27765 | 2294 | 28935 | 1948 | 30184 | 1419 | 35312 | 1227 | 16068 |
| 2E | | MI | 8091 | 3710 | 13260 | 2554 | 13996 | 2141 | 14309 | 1814 | 14566 | 1312 | 16053 | 1051 | 7858 |
| 6-#11 | 1.01 | MA | 15082 | 3526 | 23399 | 2646 | 25207 | 2235 | 25876 | 1917 | 26058 | 1449 | 29629 | 1261 | 9685 |
| 2L-3S | | MI | 7601 | 3526 | 11906 | 2498 | 12370 | 2122 | 12371 | 1819 | 11948 | 1371 | 12963 | 1047 | 4942 |
| 6-#11 | 1.01 | MA | 14698 | 3526 | 22412 | 2660 | 23942 | 2248 | 24332 | 1944 | 23958 | 1473 | 26721 | 1167 | 9720 |
| 3L-2S | | MI | 7758 | 3526 | 12353 | 2490 | 12944 | 2102 | 13071 | 1802 | 12900 | 1357 | 14217 | 1157 | 4906 |
| 6-#14 | 1.46 | MA | 15650 | 3641 | 24716 | 2708 | 26849 | 2278 | 27859 | 1942 | 28743 | 1435 | 33337 | 1244 | 13747 |
| 2L-3S | | MI | 7770 | 3641 | 12305 | 2555 | 12844 | 2166 | 12934 | 1844 | 12707 | 1355 | 13890 | 955 | 6864 |
| 6-#14 | 1.46 | MA | 15112 | 3641 | 23304 | 2728 | 25038 | 2297 | 25650 | 1979 | 25738 | 1469 | 29175 | 1106 | 13779 |
| 3L-2S | | MI | 7988 | 3641 | 12939 | 2545 | 13657 | 2139 | 13926 | 1820 | 14057 | 1338 | 15636 | 1113 | 6804 |
| 6-#18 | 2.60 | MA | 17033 | 3931 | 27972 | 2872 | 30934 | 2394 | 32801 | 2008 | 35444 | 1401 | 42595 | 1202 | 23815 |
| 2L-3S | | MI | 8178 | 3931 | 13260 | 2707 | 13996 | 2284 | 14309 | 1912 | 14566 | 1319 | 16053 | 704 | 11440 |
| 6-#18 | 2.60 | MA | 16133 | 3931 | 25500 | 2906 | 27765 | 2425 | 28935 | 2071 | 30184 | 1458 | 35312 | 951 | 23725 |
| 3L-2S | | MI | 8539 | 3931 | 14349 | 2692 | 15392 | 2240 | 16012 | 1874 | 16883 | 1295 | 18936 | 985 | 11353 |
| 8-#10 | 1.10 | MA | 15223 | 3548 | 23630 | 2672 | 25566 | 2255 | 26343 | 1933 | 26712 | 1455 | 30548 | 1265 | 10533 |
| 2L-4S | | MI | 7633 | 3548 | 11805 | 2554 | 12290 | 2155 | 12293 | 1845 | 11879 | 1394 | 12995 | 1038 | 5364 |
| 8-#10 | 1.10 | MA | 14906 | 3548 | 22818 | 2684 | 24525 | 2266 | 25073 | 1954 | 24985 | 1475 | 28156 | 1190 | 10556 |
| 3E | | MI | 7696 | 3548 | 12091 | 2535 | 12662 | 2149 | 12749 | 1841 | 12473 | 1382 | 13743 | 1087 | 5327 |
| 8-#10 | 1.10 | MA | 14725 | 3548 | 22213 | 2707 | 23739 | 2289 | 24106 | 1965 | 23654 | 1484 | 26606 | 1143 | 10568 |
| 4L-2S | | MI | 7827 | 3548 | 12464 | 2527 | 13140 | 2132 | 13332 | 1825 | 13266 | 1369 | 14814 | 1177 | 5300 |
| 8-#11 | 1.35 | MA | 15529 | 3613 | 24386 | 2699 | 26472 | 2273 | 27419 | 1941 | 28158 | 1442 | 32536 | 1251 | 12791 |
| 2L-4S | | MI | 7721 | 3613 | 12007 | 2574 | 12496 | 2167 | 12521 | 1847 | 12184 | 1377 | 13336 | 972 | 6447 |
| 8-#11 | 1.35 | MA | 15151 | 3613 | 23399 | 2714 | 25207 | 2287 | 25876 | 1967 | 26058 | 1466 | 29629 | 1157 | 12816 |
| 3E | | MI | 7791 | 3613 | 12353 | 2552 | 12944 | 2161 | 13071 | 1843 | 12900 | 1364 | 14217 | 1030 | 6399 |
| 8-#11 | 1.35 | MA | 14936 | 3613 | 22662 | 2742 | 24249 | 2314 | 24697 | 1979 | 24439 | 1477 | 27732 | 1099 | 12811 |
| 4L-2S | | MI | 7946 | 3613 | 12800 | 2544 | 13517 | 2141 | 13770 | 1825 | 13852 | 1350 | 15471 | 1140 | 6361 |
| 8-#14 | 1.95 | MA | 16281 | 3765 | 26128 | 2786 | 28660 | 2334 | 30068 | 1976 | 31749 | 1425 | 37498 | 1230 | 18177 |
| 2L-4S | | MI | 7942 | 3765 | 12447 | 2664 | 13020 | 2229 | 13144 | 1882 | 13038 | 1363 | 14404 | 845 | 8950 |
| 8-#14 | 1.95 | MA | 15755 | 3765 | 24716 | 2806 | 26849 | 2353 | 27859 | 2013 | 28743 | 1459 | 33337 | 1092 | 18183 |
| 3E | | MI | 8038 | 3765 | 12939 | 2633 | 13657 | 2222 | 13926 | 1878 | 14057 | 1346 | 15636 | 926 | 8897 |
| 8-#14 | 1.95 | MA | 15454 | 3765 | 23659 | 2846 | 25476 | 2392 | 26169 | 2030 | 26422 | 1473 | 30607 | 1008 | 18074 |
| 4L-2S | | MI | 8253 | 3765 | 13574 | 2622 | 14471 | 2195 | 14918 | 1854 | 15406 | 1328 | 17381 | 1084 | 8843 |
| 8-#18 | 3.46 | MA | 17242 | 4153 | 27972 | 3045 | 30934 | 2524 | 32801 | 2132 | 35444 | 1440 | 42595 | 926 | 31386 |
| 3E | | MI | 8631 | 4153 | 14349 | 2845 | 15392 | 2383 | 16012 | 1972 | 16883 | 1301 | 18936 | 638 | 14860 |
| 8-#18 | 3.46 | MA | 16735 | 4153 | 26116 | 3114 | 28522 | 2591 | 29836 | 2160 | 31580 | 1498 | 37766 | 775 | 29933 |
| 4L-2S | | MI | 8985 | 4153 | 15437 | 2830 | 16788 | 2340 | 17715 | 1935 | 19200 | 1277 | 21819 | 919 | 14806 |
| 10-#10 | 1.37 | MA | 15592 | 3619 | 24442 | 2716 | 26607 | 2287 | 27613 | 1952 | 28440 | 1449 | 32940 | 1257 | 13083 |
| 2L-5S | | MI | 7682 | 3619 | 11936 | 2605 | 12447 | 2204 | 12475 | 1880 | 12081 | 1389 | 13319 | 976 | 6598 |
| 10-#10 | 1.37 | MA | 15281 | 3619 | 23630 | 2728 | 25566 | 2298 | 26343 | 1974 | 26712 | 1469 | 30548 | 1182 | 13100 |
| 3L-4S | | MI | 7794 | 3619 | 12178 | 2597 | 12768 | 2186 | 12876 | 1864 | 12672 | 1388 | 14065 | 1027 | 6563 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

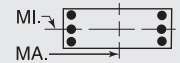



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.37 | MA | 15101 | 3619 | 23025 | 2751 | 24780 | 2320 | 25376 | 1984 | 25382 | 1478 | 28999 | 1135 | 13099 |
| 4L-3S | | MI | 7856 | 3619 | 12464 | 2579 | 13140 | 2181 | 13332 | 1860 | 13266 | 1376 | 14814 | 1076 | 6529 |
| 10-#10 | 1.37 | MA | 14841 | 3619 | 22507 | 2761 | 24110 | 2332 | 24536 | 2006 | 24204 | 1499 | 27411 | 1101 | 13049 |
| 5L-2S | | MI | 7986 | 3619 | 12837 | 2571 | 13618 | 2164 | 13915 | 1845 | 14059 | 1364 | 15885 | 1166 | 6501 |
| 10-#11 | 1.69 | MA | 15973 | 3699 | 25373 | 2753 | 27737 | 2312 | 28963 | 1964 | 30258 | 1435 | 35444 | 1242 | 15888 |
| 2L-5S | | MI | 7779 | 3699 | 12163 | 2636 | 12682 | 2225 | 12737 | 1888 | 12422 | 1370 | 13716 | 892 | 7914 |
| 10-#11 | 1.69 | MA | 15602 | 3699 | 24386 | 2768 | 26472 | 2325 | 27419 | 1991 | 28158 | 1459 | 32536 | 1148 | 15903 |
| 3L-4S | | MI | 7911 | 3699 | 12455 | 2628 | 13069 | 2205 | 13220 | 1870 | 13136 | 1370 | 14590 | 955 | 7877 |
| 10-#11 | 1.69 | MA | 15389 | 3699 | 23649 | 2796 | 25514 | 2353 | 26241 | 2003 | 26539 | 1470 | 30639 | 1090 | 15879 |
| 4L-3S | | MI | 7981 | 3699 | 12800 | 2606 | 13517 | 2199 | 13770 | 1867 | 13852 | 1357 | 15471 | 1013 | 7837 |
| 10-#11 | 1.69 | MA | 15077 | 3699 | 23024 | 2809 | 24697 | 2366 | 25217 | 2029 | 25102 | 1494 | 28699 | 1046 | 15772 |
| 5L-2S | | MI | 8134 | 3699 | 13248 | 2598 | 14091 | 2180 | 14470 | 1849 | 14804 | 1343 | 16725 | 1122 | 7800 |
| 10-#14 | 2.44 | MA | 16394 | 3890 | 26128 | 2884 | 28660 | 2409 | 30068 | 2047 | 31749 | 1449 | 37498 | 1078 | 22580 |
| 3L-4S | | MI | 8210 | 3890 | 13081 | 2741 | 13834 | 2285 | 14136 | 1916 | 14388 | 1353 | 16150 | 816 | 10944 |
| 10-#14 | 2.44 | MA | 16096 | 3890 | 25072 | 2924 | 27287 | 2447 | 28378 | 2064 | 29427 | 1463 | 34768 | 994 | 22447 |
| 4L-3S | | MI | 8305 | 3890 | 13574 | 2711 | 14471 | 2278 | 14918 | 1912 | 15406 | 1336 | 17381 | 897 | 10909 |
| 10-#14 | 2.44 | MA | 15656 | 3890 | 24181 | 2943 | 26114 | 2466 | 26909 | 2101 | 27367 | 1496 | 31982 | 929 | 21581 |
| 5L-2S | | MI | 8517 | 3890 | 14208 | 2700 | 15284 | 2251 | 15910 | 1888 | 16756 | 1318 | 19127 | 1055 | 10865 |
| 10-#18 | 4.33 | MA | 17841 | 4374 | 28588 | 3253 | 31691 | 2690 | 33702 | 2220 | 36839 | 1480 | 45049 | 750 | 37458 |
| 4L-3S | | MI | 9083 | 4374 | 15437 | 2984 | 16788 | 2483 | 17715 | 2032 | 19200 | 1284 | 21819 | 572 | 18248 |
| 10-#18 | 4.33 | MA | 17093 | 4374 | 27043 | 3287 | 29628 | 2721 | 31119 | 2283 | 33008 | 1502 | 40137 | 627 | 34788 |
| 5L-2S | | MI | 9431 | 4374 | 16526 | 2969 | 18183 | 2439 | 19417 | 1995 | 21516 | 1259 | 24702 | 854 | 18237 |
| 12-#10 | 1.65 | MA | 15960 | 3689 | 25254 | 2760 | 27648 | 2318 | 28883 | 1971 | 30168 | 1444 | 35333 | 1249 | 15629 |
| 2L-6S | | MI | 7763 | 3689 | 12062 | 2666 | 12606 | 2241 | 12661 | 1903 | 12340 | 1396 | 13707 | 909 | 7746 |
| 12-#10 | 1.65 | MA | 15653 | 3689 | 24442 | 2772 | 26607 | 2329 | 27613 | 1993 | 28440 | 1464 | 32940 | 1174 | 15640 |
| 3L-5S | | MI | 7843 | 3689 | 12309 | 2649 | 12925 | 2235 | 13058 | 1899 | 12874 | 1384 | 14390 | 965 | 7778 |
| 12-#10 | 1.65 | MA | 15475 | 3689 | 23837 | 2795 | 25821 | 2352 | 26646 | 2003 | 27110 | 1473 | 31391 | 1127 | 15626 |
| 4E | | MI | 7954 | 3689 | 12551 | 2641 | 13246 | 2218 | 13459 | 1883 | 13466 | 1383 | 15136 | 1016 | 7750 |
| 12-#10 | 1.65 | MA | 15218 | 3689 | 23319 | 2805 | 25151 | 2363 | 25806 | 2025 | 25931 | 1493 | 29803 | 1093 | 15567 |
| 5L-3S | | MI | 8015 | 3689 | 12837 | 2623 | 13618 | 2212 | 13915 | 1879 | 14059 | 1370 | 15885 | 1065 | 7721 |
| 12-#10 | 1.65 | MA | 15033 | 3689 | 22781 | 2811 | 24459 | 2384 | 24975 | 2036 | 24813 | 1513 | 28383 | 1043 | 15275 |
| 6L-2S | | MI | 8144 | 3689 | 13210 | 2615 | 14096 | 2195 | 14498 | 1864 | 14853 | 1358 | 16955 | 1155 | 7695 |
| 12-#11 | 2.03 | MA | 16050 | 3785 | 25373 | 2822 | 27737 | 2364 | 28963 | 2014 | 30258 | 1453 | 35444 | 1138 | 18983 |
| 3L-5S | | MI | 7970 | 3785 | 12610 | 2690 | 13255 | 2264 | 13436 | 1912 | 13374 | 1363 | 14970 | 874 | 9321 |
| 12-#11 | 2.03 | MA | 15839 | 3785 | 24636 | 2850 | 26780 | 2391 | 27784 | 2026 | 28639 | 1463 | 33547 | 1080 | 18945 |
| 4E | | MI | 8101 | 3785 | 12902 | 2682 | 13643 | 2244 | 13920 | 1894 | 14088 | 1363 | 15844 | 937 | 9296 |
| 12-#11 | 2.03 | MA | 15531 | 3785 | 24010 | 2863 | 25962 | 2405 | 26760 | 2053 | 27202 | 1487 | 31607 | 1036 | 18826 |
| 5L-3S | | MI | 8171 | 3785 | 13248 | 2660 | 14091 | 2238 | 14470 | 1890 | 14804 | 1350 | 16725 | 995 | 9262 |
| 12-#11 | 2.03 | MA | 15309 | 3785 | 23356 | 2869 | 25128 | 2430 | 25747 | 2065 | 25838 | 1511 | 29872 | 972 | 18170 |
| 6L-2S | | MI | 8322 | 3785 | 13695 | 2652 | 14665 | 2218 | 15170 | 1872 | 15756 | 1337 | 17979 | 1105 | 9229 |
| 12-#14 | 2.92 | MA | 16733 | 4014 | 26484 | 3002 | 29097 | 2503 | 30587 | 2098 | 32433 | 1453 | 38930 | 980 | 26822 |
| 4E | | MI | 8477 | 4014 | 13716 | 2819 | 14647 | 2341 | 15128 | 1950 | 15738 | 1343 | 17895 | 787 | 12927 |
| 12-#14 | 2.92 | MA | 16301 | 4014 | 25593 | 3021 | 27924 | 2522 | 29118 | 2135 | 30372 | 1486 | 36143 | 915 | 25894 |
| 5L-3S | | MI | 8571 | 4014 | 14208 | 2789 | 15284 | 2334 | 15910 | 1946 | 16756 | 1326 | 19127 | 868 | 12910 |
| 12-#14 | 2.92 | MA | 15989 | 4014 | 24656 | 3029 | 26737 | 2559 | 27665 | 2152 | 28417 | 1520 | 33650 | 821 | 24898 |
| 6L-2S | | MI | 8780 | 4014 | 14842 | 2778 | 16097 | 2307 | 16902 | 1922 | 18106 | 1308 | 20872 | 1027 | 12874 |
| 12-#18 | 5.19 | MA | 18205 | 4595 | 29515 | 3425 | 32797 | 2820 | 34985 | 2344 | 38268 | 1484 | 47420 | 602 | 42359 |
| 5L-3S | | MI | 9533 | 4595 | 16526 | 3122 | 18183 | 2582 | 19417 | 2093 | 21516 | 1266 | 24702 | 506 | 21625 |
| 12-#18 | 5.19 | MA | 17676 | 4595 | 27872 | 3439 | 30744 | 2887 | 32429 | 2372 | 34829 | 1541 | 43024 | 427 | 39166 |
| 6L-2S | | MI | 9875 | 4595 | 17615 | 3107 | 19579 | 2538 | 21120 | 2055 | 23833 | 1242 | 27585 | 788 | 21653 |
| 14-#10 | 1.92 | MA | 16023 | 3759 | 25254 | 2816 | 27648 | 2361 | 28883 | 2012 | 30168 | 1458 | 35333 | 1166 | 18175 |
| 3L-6S | | MI | 7924 | 3759 | 12435 | 2710 | 13084 | 2272 | 13244 | 1922 | 13134 | 1390 | 14777 | 898 | 8877 |
| 14-#10 | 1.92 | MA | 15846 | 3759 | 24649 | 2839 | 26862 | 2384 | 27916 | 2022 | 28838 | 1467 | 33784 | 1120 | 18152 |
| 4L-5S | | MI | 8003 | 3759 | 12682 | 2693 | 13403 | 2267 | 13642 | 1918 | 13667 | 1378 | 15460 | 954 | 8952 |
| 14-#10 | 1.92 | MA | 15592 | 3759 | 24131 | 2849 | 26192 | 2395 | 27076 | 2044 | 27659 | 1487 | 32195 | 1086 | 18085 |
| 5L-4S | | MI | 8113 | 3759 | 12923 | 2685 | 13724 | 2250 | 14042 | 1903 | 14259 | 1377 | 16206 | 1005 | 8931 |
| 14-#10 | 1.92 | MA | 15411 | 3759 | 23593 | 2855 | 25500 | 2415 | 26245 | 2055 | 26541 | 1507 | 30775 | 1035 | 17759 |
| 6L-3S | | MI | 8174 | 3759 | 13210 | 2667 | 14096 | 2244 | 14498 | 1898 | 14853 | 1365 | 16955 | 1054 | 8906 |

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

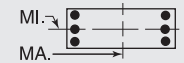
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 1.92 | MA | 15205 | 3759 | 23019 | 2873 | 24803 | 2421 | 25427 | 2074 | 25384 | 1516 | 29121 | 989 | 17318 |
| 7L-2S | | MI | 8302 | 3759 | 13583 | 2659 | 14574 | 2227 | 15081 | 1883 | 15646 | 1353 | 18026 | 1144 | 8882 |
| 14-#11 | 2.36 | MA | 16286 | 3871 | 25623 | 2904 | 28045 | 2430 | 29328 | 2050 | 30739 | 1456 | 36455 | 1071 | 22010 |
| 4L-5S | | MI | 8160 | 3871 | 13058 | 2744 | 13829 | 2303 | 14136 | 1935 | 14326 | 1356 | 16224 | 857 | 10720 |
| 14-#11 | 2.36 | MA | 15982 | 3871 | 24997 | 2917 | 27227 | 2443 | 28304 | 2076 | 29302 | 1480 | 34515 | 1027 | 21882 |
| 5L-4S | | MI | 8290 | 3871 | 13350 | 2736 | 14217 | 2283 | 14620 | 1917 | 15040 | 1356 | 17098 | 920 | 10707 |
| 14-#11 | 2.36 | MA | 15765 | 3871 | 24343 | 2923 | 26393 | 2469 | 27291 | 2088 | 27938 | 1504 | 32780 | 963 | 21194 |
| 6L-3S | | MI | 8359 | 3871 | 13695 | 2714 | 14665 | 2277 | 15170 | 1914 | 15756 | 1343 | 17979 | 978 | 10680 |
| 14-#11 | 2.36 | MA | 15520 | 3871 | 23644 | 2946 | 25545 | 2476 | 26306 | 2113 | 26528 | 1514 | 30753 | 906 | 20693 |
| 7L-2S | | MI | 8509 | 3871 | 14143 | 2706 | 15238 | 2257 | 15870 | 1896 | 16708 | 1330 | 19233 | 1088 | 10651 |
| 14-#14 | 3.41 | MA | 16940 | 4139 | 27005 | 3099 | 29735 | 2578 | 31327 | 2169 | 33378 | 1477 | 40305 | 901 | 30215 |
| 5L-4S | | MI | 8743 | 4139 | 14350 | 2897 | 15460 | 2397 | 16120 | 1984 | 17088 | 1333 | 19641 | 759 | 14901 |
| 14-#14 | 3.41 | MA | 16636 | 4139 | 26068 | 3107 | 28548 | 2614 | 29874 | 2186 | 31422 | 1510 | 37812 | 807 | 29252 |
| 6L-3S | | MI | 8836 | 4139 | 14842 | 2866 | 16097 | 2390 | 16902 | 1980 | 18106 | 1316 | 20872 | 839 | 14903 |
| 14-#14 | 3.41 | MA | 16291 | 4139 | 25066 | 3139 | 27332 | 2624 | 28475 | 2222 | 29398 | 1524 | 34895 | 725 | 27877 |
| 7L-2S | | MI | 9042 | 4139 | 15477 | 2856 | 16910 | 2362 | 17894 | 1956 | 19456 | 1298 | 22618 | 998 | 14876 |
| 14-#18 | 6.06 | MA | 18797 | 4816 | 30344 | 3577 | 33913 | 2986 | 36295 | 2432 | 40089 | 1523 | 50307 | 403 | 46673 |
| 6L-3S | | MI | 9982 | 4816 | 17615 | 3260 | 19579 | 2681 | 21120 | 2153 | 23833 | 1248 | 27585 | 441 | 24995 |
| 14-#18 | 6.06 | MA | 18208 | 4816 | 28586 | 3633 | 31779 | 3001 | 33858 | 2495 | 36741 | 1581 | 45141 | 254 | 43540 |
| 7L-2S | | MI | 10318 | 4816 | 18704 | 3245 | 20975 | 2638 | 22823 | 2116 | 26150 | 1224 | 30468 | 722 | 25058 |
| 16-#10 | 2.20 | MA | 16216 | 3829 | 25461 | 2883 | 27903 | 2415 | 29185 | 2042 | 30566 | 1461 | 36176 | 1112 | 20677 |
| 4L-6S | | MI | 8085 | 3829 | 12808 | 2754 | 13562 | 2304 | 13827 | 1941 | 13927 | 1385 | 15848 | 886 | 9985 |
| 16-#10 | 2.20 | MA | 15965 | 3829 | 24943 | 2893 | 27233 | 2426 | 28345 | 2063 | 29387 | 1482 | 34588 | 1078 | 20603 |
| 5E | | MI | 8163 | 3829 | 13055 | 2737 | 13881 | 2298 | 14225 | 1937 | 14461 | 1373 | 16531 | 943 | 10122 |
| 16-#10 | 2.20 | MA | 15786 | 3829 | 24405 | 2898 | 26541 | 2447 | 27515 | 2074 | 28269 | 1502 | 33168 | 1027 | 20246 |
| 6L-4S | | MI | 8272 | 3829 | 13296 | 2729 | 14202 | 2281 | 14625 | 1922 | 15052 | 1372 | 17277 | 994 | 10107 |
| 16-#10 | 2.20 | MA | 15582 | 3829 | 23831 | 2917 | 25844 | 2453 | 26697 | 2093 | 27112 | 1511 | 31514 | 982 | 19819 |
| 7L-3S | | MI | 8333 | 3829 | 13583 | 2711 | 14574 | 2275 | 15081 | 1917 | 15646 | 1359 | 18026 | 1043 | 10086 |
| 16-#10 | 2.20 | MA | 15363 | 3829 | 23331 | 2926 | 25151 | 2471 | 25840 | 2100 | 26021 | 1531 | 30073 | 942 | 19428 |
| 8L-2S | | MI | 8460 | 3829 | 13956 | 2703 | 15052 | 2258 | 15664 | 1902 | 16440 | 1347 | 19096 | 1133 | 10064 |
| 16-#11 | 2.70 | MA | 16430 | 3958 | 25984 | 2971 | 28492 | 2482 | 29847 | 2100 | 31402 | 1473 | 37422 | 1017 | 24939 |
| 5E | | MI | 8350 | 3958 | 13505 | 2798 | 14403 | 2341 | 14836 | 1959 | 15278 | 1349 | 17478 | 840 | 12016 |
| 16-#11 | 2.70 | MA | 16217 | 3958 | 25330 | 2977 | 27658 | 2507 | 28834 | 2112 | 30038 | 1497 | 35687 | 953 | 24222 |
| 6L-4S | | MI | 8479 | 3958 | 13797 | 2790 | 14790 | 2321 | 15320 | 1941 | 15992 | 1350 | 18352 | 903 | 12113 |
| 16-#11 | 2.70 | MA | 15974 | 3958 | 24631 | 3000 | 26810 | 2514 | 27850 | 2136 | 28628 | 1507 | 33661 | 897 | 23738 |
| 7L-3S | | MI | 8548 | 3958 | 14143 | 2768 | 15238 | 2316 | 15870 | 1937 | 16708 | 1336 | 19233 | 961 | 12093 |
| 16-#11 | 2.70 | MA | 15711 | 3958 | 24021 | 3010 | 25965 | 2537 | 26806 | 2143 | 27298 | 1531 | 31900 | 846 | 22930 |
| 8L-2S | | MI | 8696 | 3958 | 14590 | 2760 | 15812 | 2296 | 16570 | 1919 | 17660 | 1323 | 20487 | 1070 | 12068 |
| 16-#14 | 3.90 | MA | 17279 | 4263 | 27481 | 3185 | 30359 | 2670 | 32083 | 2220 | 34427 | 1500 | 41973 | 793 | 33601 |
| 6L-4S | | MI | 9008 | 4263 | 14985 | 2975 | 16273 | 2453 | 17112 | 2018 | 18438 | 1323 | 21386 | 730 | 16815 |
| 16-#14 | 3.90 | MA | 16936 | 4263 | 26479 | 3217 | 29143 | 2680 | 30684 | 2256 | 32403 | 1514 | 39056 | 711 | 32196 |
| 7L-3S | | MI | 9101 | 4263 | 15477 | 2944 | 16910 | 2446 | 17894 | 2014 | 19456 | 1306 | 22618 | 810 | 16891 |
| 16-#14 | 3.90 | MA | 16566 | 4263 | 25604 | 3232 | 27931 | 2712 | 29187 | 2265 | 30495 | 1548 | 36525 | 635 | 30902 |
| 8L-2S | | MI | 9304 | 4263 | 16111 | 2934 | 17724 | 2418 | 18886 | 1990 | 20806 | 1288 | 24363 | 969 | 16871 |
| 16-#18 | 6.93 | MA | 19322 | 5038 | 31058 | 3771 | 34948 | 3100 | 37724 | 2556 | 42001 | 1563 | 52424 | 229 | 50999 |
| 7L-3S | | MI | 10429 | 5038 | 18704 | 3399 | 20975 | 2781 | 22823 | 2213 | 26150 | 1231 | 30468 | 375 | 28360 |
| 18-#10 | 2.47 | MA | 16335 | 3900 | 25755 | 2937 | 28274 | 2458 | 29615 | 2082 | 31115 | 1476 | 36980 | 1070 | 23121 |
| 5L-6S | | MI | 8245 | 3900 | 13180 | 2798 | 14040 | 2336 | 14410 | 1961 | 14720 | 1379 | 16919 | 875 | 11116 |
| 18-#10 | 2.47 | MA | 16160 | 3900 | 25217 | 2942 | 27582 | 2478 | 28785 | 2093 | 29997 | 1496 | 35560 | 1020 | 22736 |
| 6L-5S | | MI | 8322 | 3900 | 13428 | 2781 | 14359 | 2330 | 14808 | 1956 | 15254 | 1367 | 17601 | 932 | 11290 |
| 18-#10 | 2.47 | MA | 15957 | 3900 | 24643 | 2961 | 26885 | 2484 | 27967 | 2113 | 28839 | 1505 | 33906 | 974 | 22322 |
| 7L-4S | | MI | 8431 | 3900 | 13669 | 2773 | 14680 | 2313 | 15208 | 1941 | 15846 | 1366 | 18348 | 983 | 11279 |
| 18-#10 | 2.47 | MA | 15742 | 3900 | 24143 | 2970 | 26192 | 2503 | 27110 | 2119 | 27749 | 1525 | 32465 | 934 | 21924 |
| 8L-3S | | MI | 8491 | 3900 | 13956 | 2754 | 15052 | 2307 | 15664 | 1937 | 16440 | 1354 | 19096 | 1032 | 11262 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis

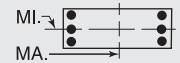



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.47 | MA | 15556 | 3900 | 23647 | 2978 | 25528 | 2512 | 26284 | 2137 | 26664 | 1545 | 31063 | 893 | 21284 |
| 9L-2S | | MI | 8617 | 3900 | 14328 | 2747 | 15530 | 2290 | 16248 | 1921 | 17233 | 1341 | 20167 | 1122 | 11243 |
| 18-#11 | 3.04 | MA | 16667 | 4044 | 26317 | 3031 | 28923 | 2546 | 30378 | 2135 | 32138 | 1490 | 38595 | 944 | 27254 |
| 6L-5S | | MI | 8539 | 4044 | 13953 | 2852 | 14976 | 2380 | 15536 | 1982 | 16231 | 1342 | 18732 | 822 | 13361 |
| 18-#11 | 3.04 | MA | 16425 | 4044 | 25618 | 3054 | 28075 | 2553 | 29393 | 2160 | 30728 | 1500 | 36569 | 887 | 26784 |
| 7L-4S | | MI | 8667 | 4044 | 14245 | 2844 | 15364 | 2360 | 16020 | 1964 | 16945 | 1343 | 19606 | 886 | 13516 |
| 18-#11 | 3.04 | MA | 16169 | 4044 | 25008 | 3064 | 27230 | 2576 | 28349 | 2167 | 29398 | 1524 | 34807 | 836 | 25961 |
| 8L-3S | | MI | 8736 | 4044 | 14590 | 2822 | 15812 | 2354 | 16570 | 1961 | 17660 | 1329 | 20487 | 943 | 13501 |
| 18-#11 | 3.04 | MA | 15945 | 4044 | 24347 | 3088 | 26421 | 2586 | 27343 | 2189 | 28087 | 1548 | 33088 | 786 | 25232 |
| 9L-2S | | MI | 8882 | 4044 | 15038 | 2814 | 16385 | 2334 | 17269 | 1943 | 18613 | 1316 | 21741 | 1053 | 13480 |
| 18-#14 | 4.38 | MA | 17576 | 4388 | 27891 | 3295 | 30954 | 2736 | 32892 | 2290 | 35409 | 1504 | 43217 | 697 | 36515 |
| 7L-4S | | MI | 9272 | 4388 | 15619 | 3053 | 17087 | 2509 | 18104 | 2052 | 19788 | 1313 | 23132 | 701 | 18698 |
| 18-#14 | 4.38 | MA | 17218 | 4388 | 27016 | 3310 | 29742 | 2768 | 31396 | 2299 | 33501 | 1538 | 40686 | 622 | 35196 |
| 8L-3S | | MI | 9364 | 4388 | 16111 | 3022 | 17724 | 2501 | 18886 | 2048 | 20806 | 1296 | 24363 | 781 | 18869 |
| 18-#14 | 4.38 | MA | 16900 | 4388 | 26075 | 3344 | 28582 | 2781 | 29953 | 2330 | 31620 | 1572 | 38209 | 548 | 33478 |
| 9L-2S | | MI | 9565 | 4388 | 16746 | 3011 | 18537 | 2474 | 19878 | 2024 | 22156 | 1278 | 26109 | 940 | 18862 |
| 20-#10 | 2.75 | MA | 16531 | 3970 | 26029 | 2986 | 28623 | 2510 | 30055 | 2112 | 31724 | 1491 | 37952 | 1012 | 25230 |
| 6E | | MI | 8405 | 3970 | 13553 | 2842 | 14518 | 2367 | 14993 | 1980 | 15514 | 1374 | 17989 | 864 | 12250 |
| 20-#10 | 2.75 | MA | 16329 | 3970 | 25455 | 3005 | 27926 | 2516 | 29237 | 2132 | 30567 | 1500 | 36298 | 966 | 24827 |
| 7L-5S | | MI | 8481 | 3970 | 13801 | 2824 | 14837 | 2361 | 15391 | 1975 | 16047 | 1361 | 18672 | 921 | 12434 |
| 20-#10 | 2.75 | MA | 16119 | 3970 | 24955 | 3014 | 27232 | 2535 | 28380 | 2138 | 29477 | 1520 | 34857 | 926 | 24421 |
| 8L-4S | | MI | 8589 | 3970 | 14042 | 2817 | 15158 | 2344 | 15791 | 1960 | 16639 | 1360 | 19418 | 972 | 12449 |
| 20-#10 | 2.75 | MA | 15936 | 3970 | 24459 | 3022 | 26569 | 2543 | 27554 | 2156 | 28392 | 1539 | 33456 | 886 | 23783 |
| 9L-3S | | MI | 8649 | 3970 | 14328 | 2798 | 15530 | 2338 | 16248 | 1956 | 17233 | 1348 | 20167 | 1021 | 12436 |
| 20-#10 | 2.75 | MA | 15714 | 3970 | 23887 | 3040 | 25904 | 2563 | 26727 | 2165 | 27213 | 1545 | 32022 | 852 | 23166 |
| 10L-2S | | MI | 8773 | 3970 | 14701 | 2791 | 16008 | 2321 | 16831 | 1940 | 18026 | 1336 | 21237 | 1110 | 12419 |
| 20-#11 | 3.38 | MA | 16873 | 4130 | 26605 | 3108 | 29340 | 2592 | 30937 | 2183 | 32828 | 1493 | 39476 | 878 | 29833 |
| 7L-5S | | MI | 8728 | 4130 | 14400 | 2906 | 15550 | 2419 | 16236 | 2006 | 17183 | 1335 | 19986 | 805 | 14711 |
| 20-#11 | 3.38 | MA | 16624 | 4130 | 25995 | 3118 | 28495 | 2614 | 29893 | 2190 | 31498 | 1517 | 37715 | 827 | 28992 |
| 8L-4S | | MI | 8855 | 4130 | 14692 | 2898 | 15938 | 2399 | 16719 | 1988 | 17897 | 1336 | 20860 | 868 | 14915 |
| 20-#11 | 3.38 | MA | 16404 | 4130 | 25334 | 3142 | 27686 | 2624 | 28886 | 2213 | 30187 | 1541 | 35996 | 776 | 28247 |
| 9L-3S | | MI | 8923 | 4130 | 15038 | 2876 | 16385 | 2393 | 17269 | 1984 | 18613 | 1322 | 21741 | 926 | 14906 |
| 20-#11 | 3.38 | MA | 16138 | 4130 | 24700 | 3149 | 26876 | 2649 | 27878 | 2222 | 28756 | 1548 | 34243 | 732 | 27240 |
| 10L-2S | | MI | 9068 | 4130 | 15485 | 2868 | 16959 | 2373 | 17969 | 1967 | 19565 | 1309 | 22995 | 1036 | 14889 |
| 20-#14 | 4.87 | MA | 17868 | 4512 | 28429 | 3388 | 31553 | 2824 | 33605 | 2333 | 36506 | 1528 | 44847 | 608 | 39490 |
| 8L-4S | | MI | 9536 | 4512 | 16253 | 3130 | 17900 | 2565 | 19096 | 2086 | 21137 | 1303 | 24877 | 672 | 20588 |
| 20-#14 | 4.87 | MA | 17555 | 4512 | 27487 | 3422 | 30393 | 2837 | 32161 | 2364 | 34625 | 1562 | 42370 | 534 | 37785 |
| 9L-3S | | MI | 9627 | 4512 | 16746 | 3100 | 18537 | 2557 | 19878 | 2082 | 22156 | 1286 | 26109 | 753 | 20843 |
| 22-#10 | 3.02 | MA | 16699 | 4040 | 26267 | 3049 | 28967 | 2547 | 30507 | 2151 | 32295 | 1494 | 38691 | 958 | 27333 |
| 7L-6S | | MI | 8564 | 4040 | 13926 | 2886 | 14996 | 2399 | 15577 | 1999 | 16307 | 1368 | 19060 | 853 | 13385 |
| 22-#10 | 3.02 | MA | 16494 | 4040 | 25767 | 3058 | 28273 | 2566 | 29650 | 2157 | 31205 | 1514 | 37250 | 918 | 26920 |
| 8L-5S | | MI | 8640 | 4040 | 14174 | 2868 | 15315 | 2393 | 15974 | 1995 | 16841 | 1356 | 19743 | 910 | 13560 |
| 22-#10 | 3.02 | MA | 16314 | 4040 | 25271 | 3066 | 27610 | 2575 | 28824 | 2176 | 30120 | 1534 | 35848 | 878 | 26283 |
| 9L-4S | | MI | 8747 | 4040 | 14415 | 2861 | 15636 | 2376 | 16374 | 1979 | 17432 | 1355 | 20489 | 961 | 13617 |
| 22-#10 | 3.02 | MA | 16093 | 4040 | 24699 | 3084 | 26945 | 2595 | 27997 | 2184 | 28940 | 1539 | 34415 | 844 | 25654 |
| 10L-3S | | MI | 8807 | 4040 | 14701 | 2842 | 16008 | 2370 | 16831 | 1975 | 18026 | 1342 | 21237 | 1010 | 13607 |
| 22-#10 | 3.02 | MA | 15889 | 4040 | 24196 | 3091 | 26275 | 2602 | 27192 | 2203 | 27831 | 1557 | 33024 | 802 | 24919 |
| 11L-2S | | MI | 8930 | 4040 | 15074 | 2835 | 16485 | 2353 | 17414 | 1959 | 18820 | 1330 | 22308 | 1099 | 13593 |
| 22-#11 | 3.71 | MA | 17077 | 4217 | 26982 | 3172 | 29760 | 2653 | 31436 | 2214 | 33598 | 1511 | 40623 | 817 | 32022 |
| 8L-5S | | MI | 8916 | 4217 | 14848 | 2960 | 16123 | 2457 | 16935 | 2029 | 18135 | 1328 | 21240 | 788 | 16064 |
| 22-#11 | 3.71 | MA | 16860 | 4217 | 26321 | 3196 | 28952 | 2663 | 30429 | 2236 | 32287 | 1535 | 38903 | 766 | 31262 |
| 9L-4S | | MI | 9043 | 4217 | 15140 | 2952 | 16511 | 2438 | 17419 | 2012 | 18849 | 1329 | 22114 | 851 | 16308 |
| 22-#11 | 3.71 | MA | 16595 | 4217 | 25687 | 3203 | 28141 | 2687 | 29422 | 2245 | 30856 | 1541 | 37151 | 723 | 30262 |
| 10L-3S | | MI | 9110 | 4217 | 15485 | 2930 | 16959 | 2432 | 17969 | 2008 | 19565 | 1315 | 22995 | 909 | 16308 |
| 22-#11 | 3.71 | MA | 16350 | 4217 | 25075 | 3212 | 27333 | 2697 | 28439 | 2269 | 29504 | 1562 | 35450 | 669 | 29201 |
| 11L-2S | | MI | 9254 | 4217 | 15933 | 2922 | 17533 | 2412 | 18669 | 1990 | 20517 | 1302 | 24249 | 1019 | 16295 |
| 22-#14 | 5.36 | MA | 18204 | 4637 | 28900 | 3500 | 32204 | 2893 | 34370 | 2398 | 37631 | 1552 | 46532 | 520 | 42092 |
| 9L-4S | | MI | 9799 | 4637 | 16888 | 3208 | 18713 | 2620 | 20088 | 2120 | 22487 | 1293 | 26623 | 643 | 22486 |

## RECTANGULAR TIED COLUMNS 22" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 24-#10 | 3.30 | MA | 16867 | 4110 | 26579 | 3102 | 29314 | 2598 | 30920 | 2176 | 32932 | 1509 | 39642 | 911 | 29418 |
| 8L-6S | | MI | 8723 | 4110 | 14299 | 2930 | 15474 | 2430 | 16160 | 2018 | 17100 | 1362 | 20130 | 842 | 14522 |
| 24-#10 | 3.30 | MA | 16690 | 4110 | 26083 | 3110 | 28651 | 2606 | 30094 | 2195 | 31847 | 1528 | 38240 | 870 | 28782 |
| 9L-5S | | MI | 8798 | 4110 | 14546 | 2912 | 15793 | 2424 | 16557 | 2014 | 17634 | 1350 | 20813 | 899 | 14689 |
| 24-#10 | 3.30 | MA | 16469 | 4110 | 25511 | 3128 | 27986 | 2626 | 29267 | 2203 | 30668 | 1534 | 36807 | 836 | 28143 |
| 10L-4S | | MI | 8904 | 4110 | 14788 | 2905 | 16114 | 2407 | 16958 | 1998 | 18226 | 1349 | 21559 | 950 | 14783 |
| 24-#10 | 3.30 | MA | 16269 | 4110 | 25008 | 3135 | 27316 | 2634 | 28461 | 2223 | 29559 | 1551 | 35417 | 794 | 27411 |
| 11L-3S | | MI | 8964 | 4110 | 15074 | 2886 | 16485 | 2401 | 17414 | 1994 | 18820 | 1337 | 22308 | 999 | 14776 |
| 24-#10 | 3.30 | MA | 16081 | 4110 | 24464 | 3155 | 26632 | 2652 | 27671 | 2243 | 28462 | 1570 | 33823 | 744 | 26609 |
| 12L-2S | | MI | 9086 | 4110 | 15447 | 2879 | 16963 | 2384 | 17997 | 1979 | 19613 | 1325 | 23379 | 1088 | 14764 |
| 24-#11 | 4.05 | MA | 17313 | 4303 | 27308 | 3250 | 30217 | 2702 | 31973 | 2260 | 34387 | 1528 | 41811 | 757 | 34277 |
| 9L-5S | | MI | 9104 | 4303 | 15295 | 3014 | 16697 | 2496 | 17635 | 2053 | 19087 | 1322 | 22494 | 771 | 17419 |
| 24-#11 | 4.05 | MA | 17050 | 4303 | 26674 | 3257 | 29406 | 2726 | 30965 | 2269 | 32956 | 1535 | 40058 | 713 | 33239 |
| 10L-4S | | MI | 9230 | 4303 | 15587 | 3006 | 17085 | 2476 | 18119 | 2035 | 19801 | 1322 | 23368 | 834 | 17700 |
| 24-#11 | 4.05 | MA | 16809 | 4303 | 26062 | 3266 | 28598 | 2735 | 29983 | 2293 | 31604 | 1555 | 38358 | 659 | 32211 |
| 11L-3S | | MI | 9297 | 4303 | 15933 | 2984 | 17533 | 2470 | 18669 | 2031 | 20517 | 1309 | 24249 | 891 | 17709 |

## RECTANGULAR TIED COLUMNS 22" x 44"

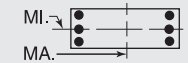
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#18 | 1.65 | MA | 17420 | 3865 | 27739 | 2860 | 30204 | 2402 | 31452 | 2042 | 32725 | 1494 | 38209 | 1292 | 16932 |
| 2E | | MI | 8433 | 3865 | 13788 | 2662 | 14530 | 2233 | 14828 | 1895 | 15039 | 1377 | 16543 | 1107 | 7897 |
| 6-#14 | 1.39 | MA | 17105 | 3796 | 26906 | 2835 | 29231 | 2386 | 30308 | 2036 | 31195 | 1510 | 36111 | 1309 | 14476 |
| 2L-3S | | MI | 8112 | 3796 | 12830 | 2665 | 13378 | 2260 | 13455 | 1926 | 13183 | 1421 | 14385 | 1012 | 6894 |
| 6-#14 | 1.39 | MA | 16532 | 3796 | 25416 | 2855 | 27321 | 2405 | 27977 | 2074 | 28024 | 1544 | 31720 | 1173 | 14508 |
| 3L-2S | | MI | 8331 | 3796 | 13465 | 2655 | 14192 | 2233 | 14447 | 1902 | 14533 | 1403 | 16131 | 1170 | 6834 |
| 6-#18 | 2.48 | MA | 18575 | 4087 | 30349 | 2998 | 33550 | 2501 | 35534 | 2102 | 38279 | 1476 | 45900 | 1268 | 25111 |
| 2L-3S | | MI | 8520 | 4087 | 13788 | 2816 | 14530 | 2377 | 14828 | 1992 | 15039 | 1383 | 16543 | 760 | 11490 |
| 6-#18 | 2.48 | MA | 17617 | 4087 | 27739 | 3033 | 30204 | 2534 | 31452 | 2166 | 32725 | 1534 | 38209 | 1020 | 25021 |
| 3L-2S | | MI | 8882 | 4087 | 14876 | 2801 | 15925 | 2333 | 16531 | 1955 | 17356 | 1359 | 19426 | 1041 | 11397 |
| 8-#10 | 1.05 | MA | 16649 | 3704 | 25756 | 2798 | 27872 | 2363 | 28702 | 2027 | 29044 | 1530 | 33158 | 1331 | 11082 |
| 2L-4S | | MI | 7975 | 3704 | 12327 | 2666 | 12825 | 2250 | 12817 | 1928 | 12359 | 1460 | 13496 | 1097 | 5385 |
| 8-#10 | 1.05 | MA | 16313 | 3704 | 24900 | 2810 | 26775 | 2374 | 27364 | 2049 | 27223 | 1550 | 30636 | 1256 | 11104 |
| 3E | | MI | 8038 | 3704 | 12614 | 2647 | 13196 | 2245 | 13273 | 1924 | 12953 | 1448 | 14245 | 1146 | 5349 |
| 8-#10 | 1.05 | MA | 16120 | 3704 | 24263 | 2834 | 25947 | 2397 | 26345 | 2059 | 25822 | 1559 | 29010 | 1210 | 11116 |
| 4L-2S | | MI | 8170 | 3704 | 12987 | 2639 | 13674 | 2228 | 13856 | 1909 | 13747 | 1436 | 15316 | 1235 | 5322 |
| 8-#11 | 1.29 | MA | 16975 | 3768 | 26556 | 2826 | 28831 | 2381 | 29841 | 2035 | 30574 | 1517 | 35261 | 1317 | 13465 |
| 2L-4S | | MI | 8063 | 3768 | 12532 | 2685 | 13030 | 2261 | 13043 | 1929 | 12662 | 1443 | 13833 | 1030 | 6474 |
| 8-#11 | 1.29 | MA | 16574 | 3768 | 25515 | 2841 | 27496 | 2395 | 28213 | 2061 | 28359 | 1542 | 32194 | 1224 | 13490 |
| 3E | | MI | 8134 | 3768 | 12877 | 2663 | 13478 | 2255 | 13593 | 1925 | 13378 | 1429 | 14715 | 1087 | 6426 |
| 8-#11 | 1.29 | MA | 16343 | 3768 | 24739 | 2869 | 26488 | 2422 | 26972 | 2074 | 26653 | 1552 | 30203 | 1166 | 13485 |
| 4L-2S | | MI | 8289 | 3768 | 13325 | 2655 | 14052 | 2235 | 14293 | 1908 | 14330 | 1416 | 15969 | 1197 | 6388 |
| 8-#14 | 1.86 | MA | 17773 | 3921 | 28396 | 2912 | 31141 | 2442 | 32638 | 2070 | 34366 | 1500 | 40501 | 1296 | 19149 |
| 2L-4S | | MI | 8284 | 3921 | 12973 | 2774 | 13554 | 2323 | 13665 | 1964 | 13515 | 1428 | 14899 | 902 | 8990 |
| 8-#14 | 1.86 | MA | 17215 | 3921 | 26906 | 2933 | 29231 | 2461 | 30308 | 2108 | 31195 | 1534 | 36111 | 1159 | 19155 |
| 3E | | MI | 8380 | 3921 | 13465 | 2743 | 14192 | 2316 | 14447 | 1960 | 14533 | 1411 | 16131 | 983 | 8932 |
| 8-#14 | 1.86 | MA | 16892 | 3921 | 25793 | 2974 | 27785 | 2500 | 28528 | 2125 | 28749 | 1549 | 33245 | 1076 | 19046 |
| 4L-2S | | MI | 8595 | 3921 | 14099 | 2732 | 15005 | 2289 | 15439 | 1936 | 15883 | 1393 | 17876 | 1142 | 8877 |
| 8-#18 | 3.31 | MA | 18793 | 4308 | 30349 | 3172 | 33550 | 2633 | 35534 | 2227 | 38279 | 1517 | 45900 | 995 | 33114 |
| 3E | | MI | 8974 | 4308 | 14876 | 2954 | 15925 | 2476 | 16531 | 2053 | 17356 | 1366 | 19426 | 694 | 14915 |
| 8-#18 | 3.31 | MA | 18249 | 4308 | 28392 | 3242 | 31008 | 2701 | 32407 | 2256 | 33983 | 1540 | 40828 | 845 | 31829 |
| 4L-2S | | MI | 9328 | 4308 | 15965 | 2939 | 17321 | 2432 | 18234 | 2015 | 19673 | 1341 | 22309 | 976 | 14855 |
| 10-#10 | 1.31 | MA | 17041 | 3774 | 26612 | 2842 | 28970 | 2394 | 30041 | 2046 | 30865 | 1524 | 35680 | 1323 | 13769 |
| 2L-5S | | MI | 8024 | 3774 | 12459 | 2717 | 12982 | 2299 | 12999 | 1963 | 12561 | 1456 | 13821 | 1035 | 6625 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

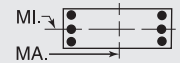



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 10-#10 | 1.31 | MA | 16710 | 3774 | 25756 | 2854 | 27872 | 2406 | 28702 | 2068 | 29044 | 1545 | 33158 | 1248 | 13786 |
| 3L-4S | | MI | 8136 | 3774 | 12700 | 2709 | 13303 | 2282 | 13400 | 1947 | 13153 | 1455 | 14567 | 1085 | 6587 |
| 10-#10 | 1.31 | MA | 16518 | 3774 | 25119 | 2878 | 27045 | 2429 | 27684 | 2079 | 27644 | 1554 | 31532 | 1202 | 13784 |
| 4L-3S | | MI | 8198 | 3774 | 12987 | 2691 | 13674 | 2276 | 13856 | 1943 | 13747 | 1442 | 15316 | 1135 | 6554 |
| 10-#10 | 1.31 | MA | 16243 | 3774 | 24571 | 2888 | 26339 | 2440 | 26800 | 2101 | 26403 | 1574 | 29863 | 1169 | 13735 |
| 5L-2S | | MI | 8329 | 3774 | 13360 | 2683 | 14152 | 2259 | 14439 | 1928 | 14540 | 1430 | 16386 | 1224 | 6526 |
| 10-#11 | 1.61 | MA | 17446 | 3854 | 27597 | 2880 | 30165 | 2420 | 31469 | 2058 | 32788 | 1510 | 38328 | 1308 | 16730 |
| 2L-5S | | MI | 8121 | 3854 | 12687 | 2747 | 13216 | 2320 | 13259 | 1970 | 12900 | 1435 | 14213 | 949 | 7950 |
| 10-#11 | 1.61 | MA | 17051 | 3854 | 26556 | 2895 | 28831 | 2434 | 29841 | 2085 | 30574 | 1535 | 35261 | 1214 | 16746 |
| 3L-4S | | MI | 8253 | 3854 | 12979 | 2739 | 13604 | 2300 | 13743 | 1953 | 13614 | 1436 | 15088 | 1012 | 7909 |
| 10-#11 | 1.61 | MA | 16823 | 3854 | 25780 | 2923 | 27822 | 2461 | 28600 | 2098 | 28867 | 1546 | 33270 | 1157 | 16722 |
| 4L-3S | | MI | 8324 | 3854 | 13325 | 2717 | 14052 | 2294 | 14293 | 1949 | 14330 | 1422 | 15969 | 1070 | 7867 |
| 10-#11 | 1.61 | MA | 16492 | 3854 | 25117 | 2936 | 26961 | 2475 | 27522 | 2124 | 27355 | 1570 | 31230 | 1114 | 16614 |
| 5L-2S | | MI | 8477 | 3854 | 13772 | 2709 | 14625 | 2274 | 14993 | 1931 | 15282 | 1409 | 17223 | 1180 | 7830 |
| 10-#14 | 2.32 | MA | 17891 | 4045 | 28396 | 3011 | 31141 | 2517 | 32638 | 2141 | 34366 | 1524 | 40501 | 1146 | 23795 |
| 3L-4S | | MI | 8552 | 4045 | 13607 | 2851 | 14368 | 2379 | 14657 | 1998 | 14865 | 1418 | 16645 | 873 | 10989 |
| 10-#14 | 2.32 | MA | 17573 | 4045 | 27283 | 3052 | 29695 | 2556 | 30859 | 2159 | 31920 | 1539 | 37636 | 1062 | 23662 |
| 4L-3S | | MI | 8647 | 4045 | 14099 | 2821 | 15005 | 2372 | 15439 | 1994 | 15883 | 1401 | 17876 | 954 | 10949 |
| 10-#14 | 2.32 | MA | 17106 | 4045 | 26339 | 3070 | 28460 | 2576 | 29312 | 2197 | 29750 | 1574 | 34705 | 999 | 22861 |
| 5L-2S | | MI | 8860 | 4045 | 14734 | 2810 | 15818 | 2345 | 16431 | 1970 | 17233 | 1383 | 19622 | 1113 | 10902 |
| 10-#18 | 4.13 | MA | 19422 | 4529 | 31003 | 3381 | 34354 | 2800 | 36489 | 2316 | 39537 | 1522 | 48519 | 820 | 39790 |
| 4L-3S | | MI | 9425 | 4529 | 15965 | 3092 | 17321 | 2575 | 18234 | 2113 | 19673 | 1348 | 22309 | 628 | 18314 |
| 10-#18 | 4.13 | MA | 18628 | 4529 | 29364 | 3415 | 32181 | 2832 | 33769 | 2381 | 35722 | 1581 | 43351 | 701 | 36847 |
| 5L-2S | | MI | 9774 | 4529 | 17054 | 3077 | 18717 | 2531 | 19937 | 2075 | 21989 | 1323 | 25192 | 910 | 18290 |
| 12-#10 | 1.57 | MA | 17430 | 3844 | 27467 | 2886 | 30067 | 2426 | 31379 | 2065 | 32687 | 1518 | 38201 | 1315 | 16452 |
| 2L-6S | | MI | 8105 | 3844 | 12584 | 2778 | 13140 | 2336 | 13185 | 1986 | 12821 | 1462 | 14208 | 967 | 7811 |
| 12-#10 | 1.57 | MA | 17104 | 3844 | 26612 | 2898 | 28970 | 2438 | 30041 | 2087 | 30865 | 1539 | 35680 | 1240 | 16463 |
| 3L-5S | | MI | 8185 | 3844 | 12832 | 2761 | 13460 | 2331 | 13582 | 1982 | 13354 | 1450 | 14891 | 1024 | 7808 |
| 12-#10 | 1.57 | MA | 16913 | 3844 | 25975 | 2922 | 28142 | 2460 | 29022 | 2098 | 29465 | 1548 | 34054 | 1194 | 16449 |
| 4E | | MI | 8296 | 3844 | 13073 | 2753 | 13781 | 2314 | 13983 | 1967 | 13946 | 1449 | 15637 | 1074 | 7778 |
| 12-#10 | 1.57 | MA | 16641 | 3844 | 25427 | 2932 | 27437 | 2472 | 28139 | 2120 | 28224 | 1569 | 32384 | 1161 | 16390 |
| 5L-3S | | MI | 8357 | 3844 | 13360 | 2735 | 14152 | 2308 | 14439 | 1962 | 14540 | 1437 | 16386 | 1124 | 7748 |
| 12-#10 | 1.57 | MA | 16446 | 3844 | 24860 | 2938 | 26704 | 2492 | 27265 | 2131 | 27048 | 1589 | 30892 | 1111 | 16141 |
| 6L-2S | | MI | 8487 | 3844 | 13732 | 2727 | 14630 | 2291 | 15022 | 1947 | 15333 | 1424 | 17457 | 1213 | 7721 |
| 12-#11 | 1.93 | MA | 17525 | 3941 | 27597 | 2948 | 30165 | 2472 | 31469 | 2108 | 32788 | 1528 | 38328 | 1205 | 19994 |
| 3L-5S | | MI | 8312 | 3941 | 13135 | 2801 | 13790 | 2358 | 13959 | 1994 | 13852 | 1429 | 15467 | 932 | 9361 |
| 12-#11 | 1.93 | MA | 17300 | 3941 | 26821 | 2977 | 29156 | 2500 | 30228 | 2121 | 31082 | 1539 | 36336 | 1147 | 19956 |
| 4E | | MI | 8443 | 3941 | 13426 | 2793 | 14177 | 2339 | 14443 | 1976 | 14566 | 1429 | 16342 | 995 | 9331 |
| 12-#11 | 1.93 | MA | 16973 | 3941 | 26158 | 2990 | 28296 | 2514 | 29150 | 2148 | 29570 | 1563 | 34297 | 1105 | 19837 |
| 5L-3S | | MI | 8513 | 3941 | 13772 | 2771 | 14625 | 2333 | 14993 | 1972 | 15282 | 1416 | 17223 | 1053 | 9295 |
| 12-#11 | 1.93 | MA | 16738 | 3941 | 25469 | 2996 | 27411 | 2539 | 28084 | 2160 | 28135 | 1588 | 32473 | 1042 | 19206 |
| 6L-2S | | MI | 8665 | 3941 | 14220 | 2763 | 15199 | 2313 | 15692 | 1955 | 16234 | 1402 | 18477 | 1163 | 9262 |
| 12-#14 | 2.79 | MA | 18248 | 4170 | 28773 | 3129 | 31605 | 2612 | 33189 | 2193 | 35091 | 1529 | 42026 | 1048 | 28280 |
| 4E | | MI | 8819 | 4170 | 14241 | 2929 | 15181 | 2435 | 15649 | 2032 | 16215 | 1408 | 18390 | 845 | 12979 |
| 12-#14 | 2.79 | MA | 17789 | 4170 | 27829 | 3148 | 30370 | 2631 | 31642 | 2231 | 32921 | 1564 | 39096 | 985 | 27416 |
| 5L-3S | | MI | 8913 | 4170 | 14734 | 2899 | 15818 | 2428 | 16431 | 2028 | 17233 | 1391 | 19622 | 925 | 12952 |
| 12-#14 | 2.79 | MA | 17458 | 4170 | 26841 | 3157 | 29111 | 2668 | 30113 | 2248 | 30862 | 1598 | 36475 | 893 | 26325 |
| 6L-2S | | MI | 9123 | 4170 | 15368 | 2888 | 16631 | 2400 | 17424 | 2004 | 18583 | 1373 | 21368 | 1084 | 12914 |
| 12-#18 | 4.96 | MA | 19807 | 4751 | 31974 | 3553 | 35527 | 2931 | 37851 | 2441 | 41276 | 1563 | 51041 | 676 | 44843 |
| 5L-3S | | MI | 9876 | 4751 | 17054 | 3231 | 18717 | 2675 | 19937 | 2173 | 21989 | 1330 | 25192 | 563 | 21695 |
| 12-#18 | 4.96 | MA | 19247 | 4751 | 30240 | 3567 | 33346 | 2997 | 35159 | 2471 | 37653 | 1622 | 46417 | 505 | 41619 |
| 6L-2S | | MI | 10218 | 4751 | 18143 | 3216 | 20113 | 2631 | 21639 | 2136 | 24306 | 1306 | 28075 | 844 | 21709 |
| 14-#10 | 1.84 | MA | 17495 | 3915 | 27467 | 2942 | 30067 | 2469 | 31379 | 2106 | 32687 | 1533 | 38201 | 1233 | 19135 |
| 3L-6S | | MI | 8266 | 3915 | 12957 | 2822 | 13618 | 2368 | 13768 | 2005 | 13614 | 1457 | 15279 | 956 | 8942 |
| 14-#10 | 1.84 | MA | 17307 | 3915 | 26831 | 2966 | 29239 | 2492 | 30361 | 2117 | 31286 | 1543 | 36575 | 1186 | 19112 |
| 4L-5S | | MI | 8345 | 3915 | 13205 | 2805 | 13938 | 2362 | 14165 | 2001 | 14148 | 1444 | 15962 | 1012 | 8985 |
| 14-#10 | 1.84 | MA | 17038 | 3915 | 26283 | 2976 | 28534 | 2503 | 29477 | 2139 | 30046 | 1563 | 34906 | 1153 | 19045 |
| 5L-4S | | MI | 8455 | 3915 | 13446 | 2797 | 14259 | 2345 | 14566 | 1986 | 14740 | 1443 | 16708 | 1063 | 8961 |

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

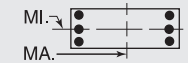
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 1.84 | MA | 16845 | 3915 | 25716 | 2981 | 27801 | 2524 | 28603 | 2150 | 28869 | 1584 | 33414 | 1104 | 18760 |
| 6L-3S | | MI | 8517 | 3915 | 13732 | 2779 | 14630 | 2339 | 15022 | 1982 | 15333 | 1431 | 17457 | 1112 | 8934 |
| 14-#10 | 1.84 | MA | 16627 | 3915 | 25112 | 3001 | 27068 | 2530 | 27737 | 2169 | 27652 | 1593 | 31678 | 1058 | 18279 |
| 7L-2S | | MI | 8645 | 3915 | 14105 | 2771 | 15108 | 2322 | 15605 | 1966 | 16127 | 1419 | 18527 | 1202 | 8909 |
| 14-#11 | 2.26 | MA | 17774 | 4027 | 27861 | 3031 | 30491 | 2539 | 31855 | 2145 | 33297 | 1532 | 39403 | 1138 | 23189 |
| 4L-5S | | MI | 8502 | 4027 | 13582 | 2855 | 14363 | 2397 | 14659 | 2018 | 14805 | 1422 | 16721 | 915 | 10765 |
| 14-#11 | 2.26 | MA | 17451 | 4027 | 27199 | 3044 | 29630 | 2552 | 30777 | 2171 | 31784 | 1556 | 37363 | 1095 | 23061 |
| 5L-4S | | MI | 8633 | 4027 | 13874 | 2847 | 14751 | 2377 | 15142 | 2000 | 15519 | 1422 | 17596 | 978 | 10745 |
| 14-#11 | 2.26 | MA | 17221 | 4027 | 26509 | 3050 | 28746 | 2577 | 29712 | 2184 | 30349 | 1581 | 35539 | 1032 | 22397 |
| 6L-3S | | MI | 8702 | 4027 | 14220 | 2825 | 15199 | 2371 | 15692 | 1996 | 16234 | 1409 | 18477 | 1036 | 10715 |
| 14-#11 | 2.26 | MA | 16960 | 4027 | 25773 | 3073 | 27852 | 2585 | 28667 | 2208 | 28864 | 1591 | 33413 | 976 | 21853 |
| 7L-2S | | MI | 8852 | 4027 | 14667 | 2817 | 15773 | 2352 | 16392 | 1978 | 17187 | 1395 | 19731 | 1145 | 10685 |
| 14-#14 | 3.25 | MA | 18466 | 4294 | 29319 | 3226 | 32281 | 2687 | 33973 | 2265 | 36092 | 1554 | 43486 | 971 | 31979 |
| 5L-4S | | MI | 9085 | 4294 | 14876 | 3007 | 15994 | 2491 | 16641 | 2066 | 17564 | 1398 | 20136 | 816 | 14955 |
| 14-#14 | 3.25 | MA | 18145 | 4294 | 28331 | 3235 | 31022 | 2724 | 32443 | 2282 | 34033 | 1588 | 40866 | 879 | 30916 |
| 6L-3S | | MI | 9179 | 4294 | 15368 | 2977 | 16631 | 2484 | 17424 | 2062 | 18583 | 1381 | 21368 | 896 | 14948 |
| 14-#14 | 3.25 | MA | 17775 | 4294 | 27276 | 3267 | 29741 | 2734 | 30957 | 2318 | 31902 | 1603 | 37804 | 797 | 29560 |
| 7L-2S | | MI | 9385 | 4294 | 16002 | 2966 | 17445 | 2456 | 18416 | 2038 | 19932 | 1363 | 23113 | 1055 | 14918 |
| 14-#18 | 5.79 | MA | 20436 | 4972 | 32851 | 3706 | 36692 | 3096 | 39241 | 2531 | 43207 | 1604 | 54107 | 480 | 49547 |
| 6L-3S | | MI | 10324 | 4972 | 18143 | 3369 | 20113 | 2774 | 21639 | 2234 | 24306 | 1313 | 28075 | 497 | 25068 |
| 14-#18 | 5.79 | MA | 19805 | 4972 | 30997 | 3762 | 34443 | 3112 | 36672 | 2595 | 39458 | 1628 | 48685 | 333 | 46378 |
| 7L-2S | | MI | 10661 | 4972 | 19232 | 3354 | 21508 | 2730 | 23342 | 2196 | 26623 | 1288 | 30958 | 778 | 25120 |
| 16-#10 | 2.10 | MA | 17698 | 3985 | 27687 | 3010 | 30337 | 2523 | 31700 | 2136 | 33107 | 1537 | 39097 | 1179 | 21774 |
| 4L-6S | | MI | 8427 | 3985 | 13330 | 2866 | 14096 | 2400 | 14351 | 2025 | 14408 | 1451 | 16349 | 945 | 10076 |
| 16-#10 | 2.10 | MA | 17432 | 3985 | 27139 | 3020 | 29631 | 2535 | 30816 | 2158 | 31867 | 1558 | 37428 | 1146 | 21700 |
| 5E | | MI | 8505 | 3985 | 13578 | 2849 | 14416 | 2394 | 14748 | 2020 | 14941 | 1439 | 17032 | 1001 | 10157 |
| 16-#10 | 2.10 | MA | 17243 | 3985 | 26572 | 3025 | 28899 | 2555 | 29942 | 2169 | 30690 | 1578 | 35935 | 1096 | 21383 |
| 6L-4S | | MI | 8615 | 3985 | 13819 | 2841 | 14737 | 2377 | 15149 | 2005 | 15533 | 1438 | 17779 | 1052 | 10139 |
| 16-#10 | 2.10 | MA | 17025 | 3985 | 25968 | 3044 | 28165 | 2561 | 29076 | 2188 | 29473 | 1587 | 34200 | 1051 | 20917 |
| 7L-3S | | MI | 8675 | 3985 | 14105 | 2823 | 15108 | 2371 | 15605 | 2001 | 16127 | 1426 | 18527 | 1101 | 10116 |
| 16-#10 | 2.10 | MA | 16792 | 3985 | 25441 | 3054 | 27435 | 2580 | 28173 | 2195 | 28326 | 1608 | 32686 | 1012 | 20558 |
| 8L-2S | | MI | 8802 | 3985 | 14478 | 2815 | 15586 | 2354 | 16188 | 1985 | 16920 | 1413 | 19598 | 1191 | 10093 |
| 16-#11 | 2.58 | MA | 17926 | 4113 | 28240 | 3098 | 30964 | 2591 | 32405 | 2195 | 33999 | 1549 | 40430 | 1086 | 26287 |
| 5E | | MI | 8692 | 4113 | 14030 | 2909 | 14937 | 2436 | 15358 | 2041 | 15757 | 1415 | 17975 | 897 | 12150 |
| 16-#11 | 2.58 | MA | 17700 | 4113 | 27550 | 3104 | 30080 | 2616 | 31339 | 2207 | 32564 | 1574 | 38606 | 1023 | 25592 |
| 6L-4S | | MI | 8822 | 4113 | 14321 | 2901 | 15325 | 2416 | 15842 | 2023 | 16471 | 1415 | 18850 | 960 | 12153 |
| 16-#11 | 2.58 | MA | 17441 | 4113 | 26814 | 3127 | 29187 | 2623 | 30295 | 2232 | 31079 | 1585 | 36480 | 967 | 25065 |
| 7L-3S | | MI | 8890 | 4113 | 14667 | 2879 | 15773 | 2410 | 16392 | 2020 | 17187 | 1402 | 19731 | 1018 | 12130 |
| 16-#11 | 2.58 | MA | 17161 | 4113 | 26172 | 3138 | 28297 | 2646 | 29195 | 2239 | 29680 | 1609 | 34629 | 917 | 24275 |
| 8L-2S | | MI | 9039 | 4113 | 15115 | 2871 | 16346 | 2390 | 17092 | 2002 | 18139 | 1388 | 20985 | 1128 | 12103 |
| 16-#14 | 3.72 | MA | 18825 | 4419 | 29821 | 3312 | 32932 | 2779 | 34774 | 2316 | 37204 | 1578 | 45256 | 865 | 35505 |
| 6L-4S | | MI | 9351 | 4419 | 15510 | 3085 | 16807 | 2547 | 17633 | 2100 | 18914 | 1388 | 21881 | 787 | 16926 |
| 16-#14 | 3.72 | MA | 18459 | 4419 | 28766 | 3345 | 31651 | 2789 | 33288 | 2352 | 35073 | 1593 | 42195 | 783 | 34117 |
| 7L-3S | | MI | 9443 | 4419 | 16002 | 3054 | 17445 | 2539 | 18416 | 2096 | 19932 | 1371 | 23113 | 868 | 16937 |
| 16-#14 | 3.72 | MA | 18066 | 4419 | 27844 | 3360 | 30375 | 2822 | 31711 | 2362 | 33064 | 1627 | 39534 | 710 | 32799 |
| 8L-2S | | MI | 9648 | 4419 | 16637 | 3044 | 18258 | 2512 | 19408 | 2072 | 21282 | 1353 | 24859 | 1026 | 16915 |
| 16-#18 | 6.61 | MA | 20987 | 5193 | 33607 | 3900 | 37789 | 3212 | 40754 | 2656 | 45013 | 1610 | 56375 | 308 | 54255 |
| 7L-3S | | MI | 10772 | 5193 | 19232 | 3507 | 21508 | 2873 | 23342 | 2294 | 26623 | 1295 | 30958 | 431 | 28436 |
| 18-#10 | 2.36 | MA | 17824 | 4055 | 27995 | 3064 | 30728 | 2567 | 32154 | 2177 | 33688 | 1552 | 39950 | 1138 | 24356 |
| 5L-6S | | MI | 8587 | 4055 | 13703 | 2910 | 14574 | 2431 | 14934 | 2044 | 15201 | 1445 | 17420 | 934 | 11181 |
| 18-#10 | 2.36 | MA | 17638 | 4055 | 27428 | 3069 | 29996 | 2587 | 31281 | 2188 | 32512 | 1573 | 38457 | 1088 | 24010 |
| 6L-5S | | MI | 8665 | 4055 | 13950 | 2893 | 14894 | 2425 | 15332 | 2040 | 15735 | 1433 | 18103 | 990 | 11326 |
| 18-#10 | 2.36 | MA | 17422 | 4055 | 26824 | 3088 | 29262 | 2593 | 30414 | 2208 | 31294 | 1582 | 36722 | 1043 | 23556 |
| 7L-4S | | MI | 8773 | 4055 | 14192 | 2885 | 15215 | 2408 | 15732 | 2024 | 16326 | 1432 | 18849 | 1041 | 11313 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis

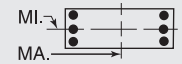


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.36 | MA | 17194 | 4055 | 26297 | 3097 | 28532 | 2612 | 29512 | 2214 | 30147 | 1602 | 35208 | 1004 | 23202 |
| 8L-3S | | MI | 8834 | 4055 | 14478 | 2866 | 15586 | 2402 | 16188 | 2020 | 16920 | 1420 | 19598 | 1090 | 11294 |
| 18-#10 | 2.36 | MA | 16997 | 4055 | 25773 | 3105 | 27834 | 2621 | 28643 | 2233 | 28996 | 1622 | 33739 | 963 | 22501 |
| 9L-2S | | MI | 8960 | 4055 | 14851 | 2859 | 16064 | 2385 | 16771 | 2004 | 17714 | 1408 | 20668 | 1180 | 11273 |
| 18-#11 | 2.90 | MA | 18177 | 4200 | 28591 | 3158 | 31414 | 2655 | 32967 | 2231 | 34779 | 1567 | 41673 | 1013 | 28792 |
| 6L-5S | | MI | 8881 | 4200 | 14477 | 2963 | 15511 | 2475 | 16058 | 2065 | 16709 | 1408 | 19229 | 880 | 13443 |
| 18-#11 | 2.90 | MA | 17918 | 4200 | 27855 | 3181 | 30521 | 2662 | 31923 | 2255 | 33294 | 1578 | 39546 | 957 | 28280 |
| 7L-4S | | MI | 9010 | 4200 | 14769 | 2955 | 15898 | 2455 | 16542 | 2047 | 17423 | 1408 | 20104 | 943 | 13557 |
| 18-#11 | 2.90 | MA | 17646 | 4200 | 27212 | 3192 | 29631 | 2685 | 30823 | 2263 | 31894 | 1602 | 37695 | 907 | 27472 |
| 8L-3S | | MI | 9078 | 4200 | 15115 | 2933 | 16346 | 2449 | 17092 | 2043 | 18139 | 1395 | 20985 | 1001 | 13540 |
| 18-#11 | 2.90 | MA | 17409 | 4200 | 26579 | 3202 | 28780 | 2695 | 29763 | 2285 | 30509 | 1626 | 35892 | 857 | 26692 |
| 9L-2S | | MI | 9226 | 4200 | 15562 | 2925 | 16920 | 2429 | 17792 | 2025 | 19091 | 1382 | 22239 | 1111 | 13517 |
| 18-#14 | 4.18 | MA | 19137 | 4543 | 30256 | 3423 | 33562 | 2845 | 35619 | 2386 | 38244 | 1583 | 46585 | 769 | 38675 |
| 7L-4S | | MI | 9615 | 4543 | 16145 | 3163 | 17621 | 2603 | 18626 | 2134 | 20264 | 1378 | 23627 | 758 | 18813 |
| 18-#14 | 4.18 | MA | 18766 | 4543 | 29335 | 3438 | 32285 | 2878 | 34042 | 2396 | 36235 | 1618 | 43925 | 696 | 37367 |
| 8L-3S | | MI | 9707 | 4543 | 16637 | 3132 | 18258 | 2595 | 19408 | 2130 | 21282 | 1361 | 24859 | 839 | 18921 |
| 18-#14 | 4.18 | MA | 18420 | 4543 | 28337 | 3472 | 31064 | 2892 | 32522 | 2428 | 34255 | 1652 | 41327 | 623 | 35524 |
| 9L-2S | | MI | 9909 | 4543 | 17271 | 3121 | 19071 | 2568 | 20400 | 2106 | 22632 | 1343 | 26604 | 997 | 18907 |
| 20-#10 | 2.62 | MA | 18032 | 4126 | 28284 | 3113 | 31093 | 2618 | 32619 | 2207 | 34333 | 1567 | 40979 | 1080 | 26639 |
| 6E | | MI | 8747 | 4126 | 14076 | 2954 | 15052 | 2463 | 15517 | 2063 | 15994 | 1440 | 18491 | 923 | 12315 |
| 20-#10 | 2.62 | MA | 17816 | 4126 | 27680 | 3132 | 30360 | 2624 | 31753 | 2227 | 33115 | 1576 | 39244 | 1035 | 26197 |
| 7L-5S | | MI | 8824 | 4126 | 14323 | 2936 | 15372 | 2457 | 15915 | 2059 | 16528 | 1428 | 19173 | 979 | 12493 |
| 20-#10 | 2.62 | MA | 17592 | 4126 | 27153 | 3141 | 29629 | 2643 | 30850 | 2233 | 31968 | 1597 | 37730 | 996 | 25833 |
| 8L-4S | | MI | 8932 | 4126 | 14564 | 2929 | 15693 | 2440 | 16315 | 2043 | 17120 | 1427 | 19920 | 1030 | 12484 |
| 20-#10 | 2.62 | MA | 17399 | 4126 | 26629 | 3149 | 28931 | 2652 | 29981 | 2252 | 30817 | 1616 | 36260 | 956 | 25137 |
| 9L-3S | | MI | 8992 | 4126 | 14851 | 2910 | 16064 | 2434 | 16771 | 2039 | 17714 | 1414 | 20668 | 1079 | 12468 |
| 20-#10 | 2.62 | MA | 17162 | 4126 | 26026 | 3167 | 28232 | 2673 | 29111 | 2260 | 29576 | 1622 | 34755 | 923 | 24545 |
| 10L-2S | | MI | 9117 | 4126 | 15224 | 2903 | 16542 | 2417 | 17354 | 2024 | 18507 | 1402 | 21739 | 1169 | 12451 |
| 20-#11 | 3.22 | MA | 18393 | 4286 | 28896 | 3235 | 31855 | 2701 | 33550 | 2279 | 35509 | 1571 | 42613 | 948 | 31497 |
| 7L-5S | | MI | 9070 | 4286 | 14925 | 3017 | 16084 | 2513 | 16758 | 2088 | 17661 | 1401 | 20483 | 863 | 14793 |
| 20-#11 | 3.22 | MA | 18128 | 4286 | 28253 | 3246 | 30965 | 2724 | 32451 | 2286 | 34109 | 1595 | 40762 | 898 | 30668 |
| 8L-4S | | MI | 9198 | 4286 | 15216 | 3009 | 16472 | 2494 | 17242 | 2070 | 18375 | 1401 | 21358 | 926 | 14959 |
| 20-#11 | 3.22 | MA | 17895 | 4286 | 27620 | 3255 | 30114 | 2734 | 31391 | 2309 | 32724 | 1619 | 38959 | 848 | 29893 |
| 9L-3S | | MI | 9266 | 4286 | 15562 | 2987 | 16920 | 2488 | 17792 | 2067 | 19091 | 1388 | 22239 | 984 | 14946 |
| 20-#11 | 3.22 | MA | 17612 | 4286 | 26886 | 3277 | 29261 | 2759 | 30330 | 2318 | 31211 | 1626 | 37118 | 805 | 28866 |
| 10L-2S | | MI | 9412 | 4286 | 16010 | 2979 | 17494 | 2468 | 18492 | 2049 | 20043 | 1375 | 23493 | 1093 | 14927 |
| 20-#14 | 4.65 | MA | 19446 | 4668 | 30825 | 3516 | 34196 | 2934 | 36373 | 2430 | 39406 | 1608 | 48315 | 682 | 41913 |
| 8L-4S | | MI | 9879 | 4668 | 16779 | 3240 | 18434 | 2658 | 19618 | 2168 | 21614 | 1368 | 25372 | 729 | 20702 |
| 20-#14 | 4.65 | MA | 19113 | 4668 | 29827 | 3550 | 32974 | 2948 | 34852 | 2462 | 37426 | 1642 | 45718 | 609 | 40069 |
| 9L-3S | | MI | 9970 | 4668 | 17271 | 3210 | 19071 | 2651 | 20400 | 2164 | 22632 | 1351 | 26604 | 810 | 20897 |
| 22-#10 | 2.89 | MA | 18208 | 4196 | 28536 | 3176 | 31457 | 2656 | 33091 | 2246 | 34937 | 1571 | 41766 | 1027 | 28841 |
| 7L-6S | | MI | 8906 | 4196 | 14449 | 2998 | 15530 | 2494 | 16100 | 2082 | 16788 | 1434 | 19561 | 911 | 13451 |
| 22-#10 | 2.89 | MA | 17989 | 4196 | 28009 | 3185 | 30727 | 2675 | 32189 | 2252 | 33789 | 1591 | 40252 | 988 | 28463 |
| 8L-5S | | MI | 8982 | 4196 | 14696 | 2980 | 15850 | 2488 | 16498 | 2078 | 17321 | 1422 | 20244 | 968 | 13631 |
| 22-#10 | 2.89 | MA | 17799 | 4196 | 27484 | 3193 | 30029 | 2684 | 31320 | 2271 | 32639 | 1610 | 38782 | 948 | 27772 |
| 9L-4S | | MI | 9090 | 4196 | 14937 | 2973 | 16171 | 2471 | 16898 | 2062 | 17913 | 1421 | 20990 | 1019 | 13653 |
| 22-#10 | 2.89 | MA | 17563 | 4196 | 26882 | 3211 | 29329 | 2704 | 30450 | 2280 | 31398 | 1617 | 37277 | 915 | 27168 |
| 10L-3S | | MI | 9149 | 4196 | 15224 | 2954 | 16542 | 2465 | 17354 | 2058 | 18507 | 1409 | 21739 | 1068 | 13641 |
| 22-#10 | 2.89 | MA | 17348 | 4196 | 26353 | 3219 | 28619 | 2711 | 29602 | 2300 | 30230 | 1635 | 35816 | 873 | 26375 |
| 11L-2S | | MI | 9273 | 4196 | 15597 | 2947 | 17020 | 2448 | 17938 | 2043 | 19300 | 1396 | 22810 | 1158 | 13625 |
| 22-#11 | 3.55 | MA | 18606 | 4372 | 29294 | 3300 | 32300 | 2762 | 34079 | 2310 | 36324 | 1588 | 43829 | 888 | 33865 |
| 8L-5S | | MI | 9258 | 4372 | 15372 | 3071 | 16658 | 2552 | 17458 | 2112 | 18613 | 1394 | 21737 | 845 | 16145 |
| 22-#11 | 3.55 | MA | 18378 | 4372 | 28661 | 3309 | 31448 | 2773 | 33019 | 2332 | 34939 | 1612 | 42026 | 838 | 33094 |
| 9L-4S | | MI | 9385 | 4372 | 15664 | 3063 | 17046 | 2532 | 17942 | 2094 | 19327 | 1394 | 22612 | 909 | 16358 |
| 22-#11 | 3.55 | MA | 18096 | 4372 | 27927 | 3331 | 30595 | 2797 | 31958 | 2342 | 33426 | 1619 | 40184 | 796 | 32053 |
| 10L-3S | | MI | 9453 | 4372 | 16010 | 3041 | 17494 | 2526 | 18492 | 2090 | 20043 | 1381 | 23493 | 966 | 16350 |
| 22-#11 | 3.55 | MA | 17837 | 4372 | 27282 | 3340 | 29738 | 2806 | 30924 | 2366 | 32002 | 1641 | 38398 | 743 | 31001 |
| 11L-2S | | MI | 9598 | 4372 | 16457 | 3033 | 18067 | 2507 | 19191 | 2072 | 20995 | 1368 | 24747 | 1076 | 16335 |

## RECTANGULAR TIED COLUMNS 22" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

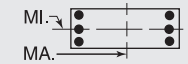
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 5.11 | MA | 19801 | 4792 | 31318 | 3628 | 34885 | 3004 | 37183 | 2495 | 40597 | 1632 | 50108 | 595 | 44613 |
| 9L-4S | | MI | 10142 | 4792 | 17413 | 3318 | 19247 | 2714 | 20610 | 2202 | 22964 | 1359 | 27118 | 700 | 22598 |
| 24-#10 | 3.15 | MA | 18384 | 4266 | 28865 | 3229 | 31824 | 2707 | 33528 | 2272 | 35611 | 1586 | 42774 | 981 | 31094 |
| 8L-6S | | MI | 9065 | 4266 | 14822 | 3042 | 16008 | 2526 | 16683 | 2101 | 17581 | 1429 | 20632 | 900 | 14588 |
| 24-#10 | 3.15 | MA | 18197 | 4266 | 28340 | 3237 | 31126 | 2715 | 32658 | 2290 | 34460 | 1605 | 41304 | 940 | 30407 |
| 9L-5S | | MI | 9141 | 4266 | 15069 | 3024 | 16328 | 2520 | 17081 | 2097 | 18115 | 1416 | 21315 | 957 | 14759 |
| 24-#10 | 3.15 | MA | 17962 | 4266 | 27738 | 3255 | 30426 | 2736 | 31788 | 2299 | 33219 | 1611 | 39798 | 907 | 29791 |
| 10L-4S | | MI | 9247 | 4266 | 15310 | 3017 | 16649 | 2503 | 17481 | 2082 | 18706 | 1415 | 22061 | 1008 | 14820 |
| 24-#10 | 3.15 | MA | 17750 | 4266 | 27209 | 3263 | 29716 | 2743 | 30941 | 2319 | 32051 | 1629 | 38338 | 866 | 29001 |
| 11L-3S | | MI | 9307 | 4266 | 15597 | 2998 | 17020 | 2497 | 17938 | 2077 | 19300 | 1403 | 22810 | 1057 | 14811 |
| 24-#10 | 3.15 | MA | 17549 | 4266 | 26635 | 3283 | 28997 | 2761 | 30110 | 2339 | 30898 | 1647 | 36666 | 816 | 28210 |
| 12L-2S | | MI | 9429 | 4266 | 15970 | 2991 | 17498 | 2480 | 18521 | 2062 | 20094 | 1391 | 23880 | 1147 | 14798 |
| 24-#11 | 3.87 | MA | 18858 | 4459 | 29702 | 3363 | 32783 | 2811 | 34647 | 2356 | 37153 | 1606 | 45092 | 828 | 36295 |
| 9L-5S | | MI | 9446 | 4459 | 15820 | 3125 | 17232 | 2591 | 18158 | 2135 | 19565 | 1387 | 22991 | 828 | 17501 |
| 24-#11 | 3.87 | MA | 18577 | 4459 | 28968 | 3385 | 31929 | 2836 | 33586 | 2365 | 35640 | 1612 | 43251 | 786 | 35240 |
| 10L-4S | | MI | 9572 | 4459 | 16111 | 3116 | 17619 | 2571 | 18641 | 2117 | 20279 | 1388 | 23866 | 891 | 17749 |
| 24-#11 | 3.87 | MA | 18322 | 4459 | 28323 | 3394 | 31073 | 2845 | 32552 | 2389 | 34217 | 1634 | 41465 | 733 | 34175 |
| 11L-3S | | MI | 9640 | 4459 | 16457 | 3095 | 18067 | 2565 | 19191 | 2114 | 20995 | 1374 | 24747 | 949 | 17752 |

## RECTANGULAR TIED COLUMNS 24" x 24"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#9 | 1.04 | MA | 5320 | 2203 | 8414 | 1590 | 8909 | 1343 | 9057 | 1151 | 9020 | 867 | 10157 | 754 | 3450 |
| 2L-3S | | MI | 5200 | 2203 | 8084 | 1597 | 8485 | 1357 | 8540 | 1164 | 8316 | 878 | 9183 | 684 | 3472 |
| 6-#10 | 1.32 | MA | 5430 | 2248 | 8683 | 1614 | 9240 | 1358 | 9455 | 1159 | 9559 | 860 | 10898 | 746 | 4297 |
| 2L-3S | | MI | 5280 | 2248 | 8266 | 1622 | 8706 | 1377 | 8803 | 1176 | 8672 | 874 | 9671 | 656 | 4327 |
| 6-#11 | 1.63 | MA | 5532 | 2296 | 8962 | 1630 | 9564 | 1369 | 9836 | 1162 | 10069 | 848 | 11505 | 723 | 5167 |
| 2L-3S | | MI | 5356 | 2296 | 8461 | 1639 | 8921 | 1390 | 9051 | 1182 | 9003 | 864 | 10060 | 614 | 5204 |
| 6-#14 | 2.34 | MA | 5794 | 2410 | 9612 | 1692 | 10373 | 1412 | 10812 | 1186 | 11393 | 833 | 13196 | 690 | 7225 |
| 2L-3S | | MI | 5549 | 2410 | 8900 | 1704 | 9460 | 1441 | 9698 | 1213 | 9877 | 854 | 11176 | 532 | 7264 |
| 6-#18 | 4.17 | MA | 6421 | 2701 | 11189 | 1854 | 12347 | 1525 | 13201 | 1251 | 14635 | 799 | 17167 | 590 | 12206 |
| 2L-3S | | MI | 6017 | 2701 | 9962 | 1873 | 10774 | 1574 | 11282 | 1293 | 12024 | 829 | 13800 | 308 | 12150 |
| 8-#8 | 1.10 | MA | 5348 | 2212 | 8465 | 1600 | 8986 | 1350 | 9156 | 1156 | 9157 | 869 | 10349 | 755 | 3625 |
| 2L-4S | | MI | 5204 | 2212 | 8002 | 1618 | 8389 | 1366 | 8425 | 1171 | 8182 | 887 | 9040 | 669 | 3663 |
| 8-#9 | 1.39 | MA | 5463 | 2258 | 8745 | 1625 | 9333 | 1367 | 9574 | 1166 | 9723 | 862 | 11131 | 747 | 4508 |
| 2L-4S | | MI | 5285 | 2258 | 8162 | 1647 | 8582 | 1387 | 8655 | 1184 | 8496 | 885 | 9482 | 638 | 4552 |
| 8-#10 | 1.76 | MA | 5609 | 2318 | 9099 | 1657 | 9774 | 1390 | 10107 | 1178 | 10446 | 855 | 12125 | 738 | 5624 |
| 2L-4S | | MI | 5388 | 2318 | 8364 | 1685 | 8827 | 1415 | 8948 | 1200 | 8898 | 882 | 10044 | 597 | 5668 |
| 8-#11 | 2.17 | MA | 5745 | 2382 | 9464 | 1684 | 10207 | 1407 | 10620 | 1186 | 11136 | 841 | 12950 | 710 | 6760 |
| 2L-4S | | MI | 5487 | 2382 | 8577 | 1716 | 9065 | 1436 | 9223 | 1211 | 9271 | 872 | 10495 | 540 | 6798 |
| 8-#14 | 3.13 | MA | 6092 | 2535 | 10324 | 1770 | 11286 | 1468 | 11926 | 1220 | 12908 | 823 | 15216 | 668 | 9472 |
| 2L-4S | | MI | 5737 | 2535 | 9063 | 1815 | 9662 | 1506 | 9939 | 1253 | 10256 | 864 | 11779 | 425 | 9200 |
| 8-#18 | 5.56 | MA | 6924 | 2922 | 12416 | 1992 | 13920 | 1625 | 15120 | 1311 | 17246 | 781 | 20534 | 537 | 16047 |
| 2L-4S | | MI | 6347 | 2922 | 10236 | 2065 | 11114 | 1686 | 11687 | 1361 | 12664 | 842 | 14790 | 113 | 14161 |
| 10-#10 | 2.20 | MA | 5786 | 2388 | 9516 | 1701 | 10309 | 1422 | 10759 | 1198 | 11333 | 849 | 13352 | 730 | 6942 |
| 2L-5S | | MI | 5444 | 2388 | 8513 | 1737 | 9006 | 1465 | 9155 | 1236 | 9128 | 879 | 10416 | 539 | 6824 |
| 10-#10 | 2.20 | MA | 5642 | 2388 | 9099 | 1710 | 9774 | 1440 | 10107 | 1214 | 10446 | 863 | 12125 | 641 | 6961 |
| 3L-4S | | MI | 5569 | 2388 | 8781 | 1729 | 9362 | 1446 | 9599 | 1220 | 9785 | 876 | 11271 | 589 | 6970 |
| 10-#11 | 2.71 | MA | 5956 | 2468 | 9965 | 1738 | 10850 | 1446 | 11404 | 1209 | 12203 | 835 | 14395 | 697 | 8344 |
| 2L-5S | | MI | 5554 | 2468 | 8755 | 1780 | 9277 | 1496 | 9469 | 1253 | 9543 | 867 | 10933 | 464 | 7997 |
| 10-#11 | 2.71 | MA | 5786 | 2468 | 9464 | 1747 | 10207 | 1467 | 10620 | 1229 | 11136 | 850 | 12950 | 588 | 8364 |
| 3L-4S | | MI | 5703 | 2468 | 9078 | 1770 | 9708 | 1475 | 10007 | 1234 | 10338 | 865 | 11940 | 527 | 8355 |
| 10-#14 | 3.91 | MA | 6388 | 2659 | 11036 | 1848 | 12199 | 1523 | 13039 | 1254 | 14424 | 814 | 17236 | 646 | 11709 |
| 2L-5S | | MI | 5832 | 2659 | 9313 | 1905 | 9960 | 1592 | 10285 | 1314 | 10638 | 855 | 12391 | 312 | 10721 |
| 10-#14 | 3.91 | MA | 6155 | 2659 | 10324 | 1860 | 11286 | 1553 | 11926 | 1281 | 12908 | 834 | 15216 | 487 | 11704 |
| 3L-4S | | MI | 6041 | 2659 | 9775 | 1892 | 10575 | 1562 | 11052 | 1287 | 11771 | 855 | 13799 | 402 | 11290 |
| 10-#18 | 6.94 | MA | 7046 | 3143 | 12416 | 2149 | 13920 | 1772 | 15120 | 1414 | 17246 | 794 | 20534 | 203 | 19651 |
| 3L-4S | | MI | 6864 | 3143 | 11463 | 2203 | 12687 | 1785 | 13606 | 1421 | 15275 | 825 | 18157 | 61 | 17807 |

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

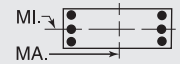
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.00 | MA | 6219 | 2379 | 9831 | 1714 | 10387 | 1447 | 10540 | 1241 | 10462 | 937 | 11747 | 815 | 3895 |
| 2E | | MI | 5726 | 2379 | 9082 | 1699 | 9558 | 1434 | 9675 | 1230 | 9575 | 928 | 10658 | 800 | 3583 |
| 4-#14 | 1.44 | MA | 6417 | 2455 | 10321 | 1752 | 10988 | 1473 | 11261 | 1255 | 11437 | 925 | 13029 | 795 | 5444 |
| 2E | | MI | 5902 | 2455 | 9523 | 1736 | 10096 | 1459 | 10321 | 1243 | 10448 | 915 | 11770 | 776 | 4990 |
| 4-#18 | 2.56 | MA | 6891 | 2649 | 11510 | 1854 | 12459 | 1544 | 13034 | 1293 | 13838 | 898 | 16072 | 736 | 9204 |
| 2E | | MI | 6322 | 2649 | 10587 | 1836 | 11410 | 1528 | 11902 | 1280 | 12590 | 887 | 14389 | 705 | 8387 |
| 6-#10 | 1.22 | MA | 6342 | 2417 | 10073 | 1751 | 10735 | 1476 | 10981 | 1262 | 11071 | 942 | 12597 | 818 | 4709 |
| 2L-3S | | MI | 5688 | 2417 | 8885 | 1745 | 9342 | 1482 | 9428 | 1268 | 9247 | 947 | 10273 | 720 | 4352 |
| 6-#10 | 1.22 | MA | 6174 | 2417 | 9612 | 1760 | 10145 | 1484 | 10261 | 1279 | 10091 | 957 | 11240 | 731 | 4738 |
| 3L-2S | | MI | 5838 | 2417 | 9302 | 1737 | 9877 | 1464 | 10080 | 1251 | 10134 | 933 | 11499 | 810 | 4322 |
| 6-#11 | 1.50 | MA | 6458 | 2465 | 10387 | 1768 | 11099 | 1486 | 11409 | 1265 | 11644 | 930 | 13383 | 805 | 5673 |
| 2L-3S | | MI | 5763 | 2465 | 9082 | 1762 | 9558 | 1494 | 9675 | 1273 | 9575 | 936 | 10658 | 677 | 5236 |
| 6-#11 | 1.50 | MA | 6260 | 2465 | 9831 | 1778 | 10387 | 1508 | 10540 | 1285 | 10462 | 947 | 11747 | 696 | 5710 |
| 3L-2S | | MI | 5940 | 2465 | 9584 | 1753 | 10200 | 1473 | 10459 | 1253 | 10642 | 921 | 12103 | 787 | 5198 |
| 6-#14 | 2.16 | MA | 6753 | 2580 | 11111 | 1830 | 12001 | 1529 | 12497 | 1289 | 13118 | 915 | 15326 | 778 | 7954 |
| 2L-3S | | MI | 5956 | 2580 | 9523 | 1826 | 10096 | 1545 | 10321 | 1303 | 10448 | 926 | 11770 | 595 | 7307 |
| 6-#14 | 2.16 | MA | 6477 | 2580 | 10321 | 1844 | 10988 | 1560 | 11261 | 1317 | 11437 | 938 | 13029 | 620 | 7993 |
| 3L-2S | | MI | 6202 | 2580 | 10235 | 1814 | 11009 | 1515 | 11434 | 1277 | 11963 | 905 | 13790 | 754 | 7263 |
| 6-#18 | 3.85 | MA | 7460 | 2870 | 12875 | 1992 | 14210 | 1643 | 15169 | 1354 | 16744 | 880 | 19926 | 694 | 13502 |
| 2L-3S | | MI | 6424 | 2870 | 10587 | 1993 | 11410 | 1676 | 11902 | 1383 | 12590 | 900 | 14389 | 371 | 12232 |
| 6-#18 | 3.85 | MA | 7004 | 2870 | 11510 | 2014 | 12459 | 1695 | 13034 | 1400 | 13838 | 916 | 16072 | 413 | 13446 |
| 3L-2S | | MI | 6829 | 2870 | 11815 | 1974 | 12983 | 1628 | 13821 | 1340 | 15201 | 870 | 17756 | 652 | 12259 |
| 8-#8 | 1.01 | MA | 6250 | 2381 | 9830 | 1738 | 10452 | 1468 | 10647 | 1259 | 10623 | 950 | 11981 | 826 | 3967 |
| 2L-4S | | MI | 5612 | 2381 | 8620 | 1743 | 9026 | 1472 | 9051 | 1263 | 8758 | 960 | 9644 | 733 | 3684 |
| 8-#8 | 1.01 | MA | 6143 | 2381 | 9540 | 1744 | 10080 | 1473 | 10193 | 1270 | 10005 | 960 | 11126 | 773 | 3983 |
| 3E | | MI | 5660 | 2381 | 8820 | 1730 | 9285 | 1468 | 9370 | 1260 | 9174 | 951 | 10178 | 765 | 3663 |
| 8-#8 | 1.01 | MA | 6087 | 2381 | 9320 | 1757 | 9794 | 1485 | 9842 | 1275 | 9548 | 970 | 10543 | 742 | 4004 |
| 4L-2S | | MI | 5756 | 2381 | 9083 | 1725 | 9623 | 1456 | 9781 | 1249 | 9734 | 942 | 10953 | 819 | 3646 |
| 8-#9 | 1.28 | MA | 6379 | 2428 | 10140 | 1763 | 10836 | 1485 | 11110 | 1268 | 11250 | 944 | 12848 | 819 | 4940 |
| 2L-4S | | MI | 5693 | 2428 | 8781 | 1771 | 9219 | 1493 | 9280 | 1276 | 9072 | 958 | 10085 | 702 | 4579 |
| 8-#9 | 1.28 | MA | 6246 | 2428 | 9775 | 1770 | 10368 | 1491 | 10539 | 1282 | 10473 | 956 | 11772 | 751 | 4961 |
| 3E | | MI | 5752 | 2428 | 9033 | 1756 | 9546 | 1488 | 9682 | 1271 | 9596 | 947 | 10760 | 742 | 4553 |
| 8-#9 | 1.28 | MA | 6177 | 2428 | 9498 | 1786 | 10008 | 1506 | 10097 | 1288 | 9897 | 968 | 11036 | 712 | 4984 |
| 4L-2S | | MI | 5871 | 2428 | 9363 | 1749 | 9969 | 1473 | 10199 | 1258 | 10299 | 936 | 11734 | 812 | 4532 |
| 8-#10 | 1.63 | MA | 6542 | 2488 | 10534 | 1795 | 11326 | 1508 | 11702 | 1281 | 12052 | 936 | 13954 | 810 | 6172 |
| 2L-4S | | MI | 5795 | 2488 | 8983 | 1809 | 9464 | 1520 | 9573 | 1292 | 9473 | 955 | 10646 | 661 | 5702 |
| 8-#10 | 1.63 | MA | 6377 | 2488 | 10073 | 1804 | 10735 | 1515 | 10981 | 1299 | 11071 | 951 | 12597 | 723 | 6197 |
| 3E | | MI | 5869 | 2488 | 9302 | 1789 | 9877 | 1513 | 10080 | 1287 | 10134 | 941 | 11499 | 713 | 5678 |
| 8-#10 | 1.63 | MA | 6291 | 2488 | 9722 | 1825 | 10281 | 1534 | 10423 | 1305 | 10344 | 966 | 11665 | 673 | 6217 |
| 4L-2S | | MI | 6016 | 2488 | 9719 | 1781 | 10411 | 1495 | 10732 | 1270 | 11021 | 928 | 12726 | 802 | 5651 |
| 8-#11 | 2.00 | MA | 6696 | 2552 | 10942 | 1822 | 11811 | 1525 | 12277 | 1288 | 12826 | 923 | 15019 | 796 | 7434 |
| 2L-4S | | MI | 5895 | 2552 | 9199 | 1839 | 9701 | 1540 | 9846 | 1302 | 9844 | 945 | 11093 | 603 | 6846 |
| 8-#11 | 2.00 | MA | 6501 | 2552 | 10387 | 1832 | 11099 | 1547 | 11409 | 1309 | 11644 | 940 | 13383 | 686 | 7463 |
| 3E | | MI | 5979 | 2552 | 9584 | 1816 | 10200 | 1533 | 10459 | 1296 | 10642 | 929 | 12103 | 664 | 6825 |
| 8-#11 | 2.00 | MA | 6403 | 2552 | 9962 | 1856 | 10549 | 1556 | 10733 | 1316 | 10764 | 957 | 12245 | 623 | 7472 |
| 4L-2S | | MI | 6153 | 2552 | 10085 | 1806 | 10843 | 1512 | 11243 | 1277 | 11709 | 914 | 13548 | 774 | 6794 |
| 8-#14 | 2.88 | MA | 7086 | 2704 | 11901 | 1908 | 13013 | 1585 | 13732 | 1323 | 14799 | 905 | 17622 | 762 | 10444 |
| 2L-4S | | MI | 6145 | 2704 | 9686 | 1936 | 10298 | 1610 | 10561 | 1344 | 10826 | 936 | 12374 | 488 | 9378 |
| 8-#14 | 2.88 | MA | 6817 | 2704 | 11111 | 1922 | 12001 | 1616 | 12497 | 1351 | 13118 | 928 | 15326 | 603 | 10462 |
| 3E | | MI | 6260 | 2704 | 10235 | 1904 | 11009 | 1601 | 11434 | 1337 | 11963 | 916 | 13790 | 573 | 9542 |
| 8-#14 | 2.88 | MA | 6682 | 2704 | 10505 | 1955 | 11216 | 1627 | 11532 | 1360 | 11863 | 951 | 13724 | 514 | 10284 |
| 4L-2S | | MI | 6500 | 2704 | 10947 | 1891 | 11922 | 1571 | 12548 | 1311 | 13479 | 895 | 15810 | 731 | 9514 |
| 8-#18 | 5.13 | MA | 8025 | 3092 | 14241 | 2130 | 15960 | 1742 | 17305 | 1414 | 19649 | 863 | 23781 | 653 | 17775 |
| 2L-4S | | MI | 6755 | 3092 | 10862 | 2185 | 11750 | 1788 | 12308 | 1450 | 13231 | 913 | 15379 | 175 | 14393 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

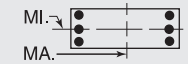



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 5.13 | MA | 7584 | 3092 | 12875 | 2152 | 14210 | 1794 | 15169 | 1460 | 16744 | 898 | 19926 | 371 | 17657 |
| 3E | | MI | 6940 | 3092 | 11815 | 2131 | 12983 | 1775 | 13821 | 1443 | 15201 | 883 | 17756 | 318 | 16017 |
| 8-#18 | 5.13 | MA | 7365 | 3092 | 11822 | 2209 | 12845 | 1810 | 13494 | 1471 | 14562 | 934 | 17221 | 221 | 15864 |
| 4L-2S | | MI | 7334 | 3092 | 13042 | 2112 | 14556 | 1727 | 15740 | 1401 | 17812 | 852 | 21123 | 600 | 16108 |
| 10-#10 | 2.04 | MA | 6740 | 2558 | 10994 | 1839 | 11917 | 1539 | 12422 | 1300 | 13032 | 931 | 15312 | 802 | 7628 |
| 2L-5S | | MI | 5851 | 2558 | 9133 | 1861 | 9642 | 1570 | 9780 | 1328 | 9702 | 952 | 11018 | 603 | 6931 |
| 10-#10 | 2.04 | MA | 6578 | 2558 | 10534 | 1848 | 11326 | 1547 | 11702 | 1318 | 12052 | 945 | 13954 | 715 | 7647 |
| 3L-4S | | MI | 5976 | 2558 | 9400 | 1853 | 9998 | 1552 | 10224 | 1311 | 10360 | 949 | 11873 | 653 | 7009 |
| 10-#10 | 2.04 | MA | 6494 | 2558 | 10183 | 1868 | 10872 | 1566 | 11143 | 1324 | 11324 | 960 | 13022 | 665 | 7655 |
| 4L-3S | | MI | 6049 | 2558 | 9719 | 1833 | 10411 | 1545 | 10732 | 1306 | 11021 | 936 | 12726 | 705 | 6994 |
| 10-#10 | 2.04 | MA | 6354 | 2558 | 9890 | 1877 | 10480 | 1573 | 10654 | 1342 | 10601 | 964 | 12084 | 617 | 7560 |
| 5L-2S | | MI | 6195 | 2558 | 10135 | 1825 | 10945 | 1527 | 11384 | 1289 | 11908 | 922 | 13953 | 794 | 6972 |
| 10-#11 | 2.50 | MA | 6933 | 2638 | 11497 | 1876 | 12523 | 1564 | 13146 | 1312 | 14007 | 916 | 16655 | 786 | 9186 |
| 2L-5S | | MI | 5961 | 2638 | 9376 | 1902 | 9913 | 1600 | 10092 | 1344 | 10116 | 939 | 11531 | 528 | 8120 |
| 10-#11 | 2.50 | MA | 6741 | 2638 | 10942 | 1886 | 11811 | 1586 | 12277 | 1333 | 12826 | 933 | 15019 | 677 | 9206 |
| 3L-4S | | MI | 6110 | 2638 | 9700 | 1893 | 10344 | 1579 | 10630 | 1325 | 10911 | 938 | 12538 | 590 | 8407 |
| 10-#11 | 2.50 | MA | 6644 | 2638 | 10518 | 1910 | 11261 | 1594 | 11601 | 1339 | 11945 | 950 | 13881 | 614 | 9197 |
| 4L-3S | | MI | 6194 | 2638 | 10085 | 1870 | 10843 | 1572 | 11243 | 1320 | 11709 | 922 | 13548 | 651 | 8404 |
| 10-#11 | 2.50 | MA | 6478 | 2638 | 10162 | 1920 | 10787 | 1617 | 11009 | 1360 | 11069 | 953 | 12741 | 552 | 8871 |
| 5L-2S | | MI | 6364 | 2638 | 10586 | 1860 | 11486 | 1550 | 12028 | 1300 | 12776 | 907 | 14993 | 761 | 8380 |
| 10-#14 | 3.61 | MA | 7418 | 2829 | 12691 | 1986 | 14026 | 1641 | 14968 | 1357 | 16480 | 895 | 19918 | 745 | 12924 |
| 2L-5S | | MI | 6239 | 2829 | 9936 | 2026 | 10596 | 1695 | 10907 | 1404 | 11208 | 927 | 12986 | 375 | 10873 |
| 10-#14 | 3.61 | MA | 7156 | 2829 | 11901 | 1999 | 13013 | 1672 | 13732 | 1385 | 14799 | 918 | 17622 | 586 | 12919 |
| 3L-4S | | MI | 6449 | 2829 | 10398 | 2014 | 11211 | 1666 | 11675 | 1378 | 12342 | 926 | 14394 | 465 | 11463 |
| 10-#14 | 3.61 | MA | 7022 | 2829 | 11295 | 2033 | 12228 | 1683 | 12768 | 1394 | 13544 | 941 | 16020 | 498 | 12609 |
| 4L-3S | | MI | 6563 | 2829 | 10947 | 1982 | 11922 | 1656 | 12548 | 1371 | 13479 | 906 | 15810 | 551 | 11760 |
| 10-#14 | 3.61 | MA | 6789 | 2829 | 10786 | 2047 | 11551 | 1714 | 11922 | 1422 | 12293 | 944 | 14420 | 408 | 11912 |
| 5L-2S | | MI | 6797 | 2829 | 11659 | 1969 | 12835 | 1627 | 13662 | 1345 | 14994 | 885 | 17830 | 709 | 11754 |
| 10-#18 | 6.41 | MA | 8160 | 3313 | 14241 | 2290 | 15960 | 1893 | 17305 | 1521 | 19649 | 881 | 23781 | 330 | 21866 |
| 3L-4S | | MI | 7272 | 3313 | 12089 | 2323 | 13323 | 1887 | 14227 | 1510 | 15842 | 895 | 18746 | 123 | 18030 |
| 10-#18 | 6.41 | MA | 7945 | 3313 | 13187 | 2347 | 14595 | 1910 | 15629 | 1531 | 17467 | 916 | 21076 | 180 | 19933 |
| 4L-3S | | MI | 7454 | 3313 | 13042 | 2269 | 14556 | 1875 | 15740 | 1503 | 17812 | 865 | 21123 | 266 | 19798 |
| 12-#10 | 2.44 | MA | 6938 | 2628 | 11455 | 1883 | 12507 | 1571 | 13143 | 1319 | 14012 | 925 | 16669 | 794 | 9078 |
| 2L-6S | | MI | 5943 | 2628 | 9289 | 1911 | 9822 | 1608 | 9991 | 1353 | 9997 | 960 | 11465 | 536 | 7944 |
| 12-#10 | 2.44 | MA | 6778 | 2628 | 10994 | 1892 | 11917 | 1578 | 12422 | 1337 | 13032 | 940 | 15312 | 707 | 9092 |
| 3L-5S | | MI | 6033 | 2628 | 9550 | 1905 | 10176 | 1601 | 10432 | 1347 | 10589 | 946 | 12244 | 595 | 8174 |
| 12-#10 | 2.44 | MA | 6695 | 2628 | 10644 | 1912 | 11462 | 1597 | 11864 | 1343 | 12304 | 955 | 14379 | 657 | 9089 |
| 4E | | MI | 6157 | 2628 | 9817 | 1897 | 10532 | 1583 | 10876 | 1331 | 11247 | 944 | 13099 | 646 | 8309 |
| 12-#10 | 2.44 | MA | 6557 | 2628 | 10350 | 1921 | 11071 | 1605 | 11375 | 1361 | 11581 | 958 | 13441 | 610 | 8938 |
| 5L-3S | | MI | 6229 | 2628 | 10135 | 1877 | 10945 | 1576 | 11384 | 1325 | 11908 | 930 | 13953 | 697 | 8304 |
| 12-#10 | 2.44 | MA | 6457 | 2628 | 10057 | 1927 | 10682 | 1624 | 10891 | 1367 | 10930 | 973 | 12590 | 551 | 8666 |
| 6L-2S | | MI | 6372 | 2628 | 10552 | 1869 | 11479 | 1558 | 12035 | 1309 | 12794 | 916 | 15180 | 786 | 8287 |
| 12-#11 | 3.00 | MA | 7168 | 2724 | 12053 | 1930 | 13235 | 1602 | 14014 | 1336 | 15189 | 909 | 18292 | 777 | 10932 |
| 2L-6S | | MI | 6071 | 2724 | 9544 | 1978 | 10127 | 1646 | 10343 | 1373 | 10466 | 948 | 12055 | 445 | 9377 |
| 12-#11 | 3.00 | MA | 6980 | 2724 | 11497 | 1940 | 12523 | 1625 | 13146 | 1356 | 14007 | 926 | 16655 | 667 | 10944 |
| 3L-5S | | MI | 6178 | 2724 | 9877 | 1956 | 10556 | 1639 | 10876 | 1368 | 11182 | 932 | 12976 | 515 | 9618 |
| 12-#11 | 3.00 | MA | 6884 | 2724 | 11073 | 1964 | 11973 | 1633 | 12470 | 1363 | 13127 | 943 | 15517 | 604 | 10919 |
| 4E | | MI | 6325 | 2724 | 10201 | 1947 | 10987 | 1618 | 11415 | 1349 | 11978 | 931 | 13983 | 577 | 9964 |
| 12-#11 | 3.00 | MA | 6720 | 2724 | 10717 | 1974 | 11499 | 1655 | 11877 | 1383 | 12251 | 946 | 14377 | 542 | 10535 |
| 5L-3S | | MI | 6407 | 2724 | 10586 | 1924 | 11486 | 1610 | 12028 | 1343 | 12776 | 915 | 14993 | 638 | 9976 |
| 12-#11 | 3.00 | MA | 6601 | 2724 | 10369 | 1982 | 11027 | 1664 | 11290 | 1390 | 11462 | 963 | 13338 | 470 | 10246 |
| 6L-2S | | MI | 6575 | 2724 | 11088 | 1914 | 12129 | 1589 | 12812 | 1324 | 13843 | 900 | 16438 | 748 | 9960 |
| 12-#14 | 4.33 | MA | 7492 | 2953 | 12691 | 2077 | 14026 | 1728 | 14968 | 1419 | 16480 | 908 | 19918 | 569 | 15371 |
| 3L-5S | | MI | 6545 | 2953 | 10648 | 2104 | 11509 | 1751 | 12021 | 1438 | 12724 | 917 | 15006 | 352 | 13014 |
| 12-#14 | 4.33 | MA | 7360 | 2953 | 12085 | 2111 | 13241 | 1739 | 14003 | 1428 | 15225 | 931 | 18316 | 481 | 14950 |
| 4E | | MI | 6751 | 2953 | 11110 | 2092 | 12124 | 1722 | 12789 | 1411 | 13857 | 917 | 16414 | 443 | 13564 |
| 12-#14 | 4.33 | MA | 7131 | 2953 | 11576 | 2125 | 12564 | 1770 | 13158 | 1456 | 13974 | 934 | 16716 | 391 | 14295 |
| 5L-3S | | MI | 6863 | 2953 | 11659 | 2059 | 12835 | 1712 | 13662 | 1405 | 14994 | 896 | 17830 | 528 | 13972 |


## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

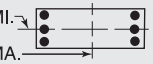



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 7.69 | MA | 8520 | 3534 | 14553 | 2485 | 16346 | 2009 | 17764 | 1592 | 20373 | 898 | 24930 | 138 | 24025 |
| 4E | | MI | 7785 | 3534 | 13316 | 2462 | 14896 | 1987 | 16146 | 1570 | 18453 | 878 | 22113 | 70 | 21690 |
| 14-#10 | 2.85 | MA | 6978 | 2698 | 11455 | 1936 | 12507 | 1610 | 13143 | 1356 | 14012 | 934 | 16669 | 700 | 10534 |
| 3L-6S | | MI | 6125 | 2698 | 9706 | 1955 | 10356 | 1640 | 10642 | 1372 | 10884 | 954 | 12691 | 528 | 9206 |
| 14-#10 | 2.85 | MA | 6895 | 2698 | 11105 | 1956 | 12053 | 1629 | 12584 | 1362 | 13284 | 949 | 15736 | 649 | 10520 |
| 4L-5S | | MI | 6214 | 2698 | 9966 | 1949 | 10711 | 1633 | 11083 | 1366 | 11476 | 941 | 13471 | 587 | 9423 |
| 14-#10 | 2.85 | MA | 6759 | 2698 | 10811 | 1965 | 11662 | 1636 | 12095 | 1380 | 12561 | 953 | 14799 | 602 | 10322 |
| 5L-4S | | MI | 6336 | 2698 | 10234 | 1940 | 11067 | 1615 | 11528 | 1350 | 12134 | 938 | 14326 | 638 | 9606 |
| 14-#10 | 2.85 | MA | 6661 | 2698 | 10518 | 1971 | 11272 | 1655 | 11611 | 1386 | 11910 | 968 | 13948 | 544 | 10064 |
| 6L-3S | | MI | 6408 | 2698 | 10552 | 1921 | 11479 | 1608 | 12035 | 1344 | 12794 | 924 | 15180 | 689 | 9610 |
| 14-#10 | 2.85 | MA | 6561 | 2698 | 10187 | 1987 | 10893 | 1662 | 11149 | 1404 | 11276 | 983 | 13066 | 504 | 9792 |
| 7L-2S | | MI | 6549 | 2698 | 10969 | 1913 | 12014 | 1590 | 12687 | 1328 | 13681 | 911 | 16407 | 778 | 9598 |
| 14-#11 | 3.50 | MA | 7218 | 2811 | 12053 | 1994 | 13235 | 1663 | 14014 | 1380 | 15189 | 919 | 18292 | 657 | 12674 |
| 3L-6S | | MI | 6288 | 2811 | 10045 | 2031 | 10769 | 1685 | 11127 | 1397 | 11533 | 941 | 13500 | 432 | 10897 |
| 14-#11 | 3.50 | MA | 7123 | 2811 | 11628 | 2018 | 12685 | 1672 | 13338 | 1386 | 14309 | 936 | 17154 | 595 | 12638 |
| 4L-5S | | MI | 6393 | 2811 | 10379 | 2010 | 11199 | 1678 | 11661 | 1391 | 12249 | 925 | 14421 | 502 | 11124 |
| 14-#11 | 3.50 | MA | 6961 | 2811 | 11272 | 2028 | 12211 | 1694 | 12746 | 1407 | 13433 | 939 | 16014 | 533 | 12206 |
| 5L-4S | | MI | 6538 | 2811 | 10703 | 2001 | 11630 | 1656 | 12199 | 1372 | 13044 | 924 | 15428 | 564 | 11518 |
| 14-#11 | 3.50 | MA | 6844 | 2811 | 10925 | 2036 | 11739 | 1703 | 12159 | 1413 | 12644 | 956 | 14974 | 460 | 11933 |
| 6L-3S | | MI | 6620 | 2811 | 11088 | 1978 | 12129 | 1649 | 12812 | 1367 | 13843 | 909 | 16438 | 625 | 11544 |
| 14-#14 | 5.05 | MA | 7696 | 3078 | 12875 | 2189 | 14254 | 1795 | 15239 | 1462 | 16905 | 921 | 20612 | 464 | 17304 |
| 4L-5S | | MI | 6848 | 3078 | 11360 | 2182 | 12422 | 1807 | 13135 | 1472 | 14239 | 907 | 17026 | 330 | 15163 |
| 14-#14 | 5.05 | MA | 7470 | 3078 | 12366 | 2203 | 13577 | 1826 | 14393 | 1490 | 15655 | 924 | 19012 | 374 | 16685 |
| 5L-4S | | MI | 7051 | 3078 | 11823 | 2169 | 13037 | 1778 | 13903 | 1445 | 15373 | 907 | 18434 | 421 | 15678 |
| 16-#10 | 3.26 | MA | 7094 | 2769 | 11565 | 2000 | 12643 | 1660 | 13305 | 1382 | 14265 | 944 | 17094 | 642 | 11949 |
| 4L-6S | | MI | 6307 | 2769 | 10122 | 1999 | 10890 | 1671 | 11294 | 1391 | 11771 | 949 | 13918 | 520 | 10472 |
| 16-#10 | 3.26 | MA | 6959 | 2769 | 11272 | 2009 | 12252 | 1668 | 12816 | 1399 | 13541 | 947 | 16156 | 594 | 11710 |
| 5E | | MI | 6394 | 2769 | 10383 | 1993 | 11245 | 1664 | 11735 | 1386 | 12363 | 935 | 14698 | 579 | 10677 |
| 16-#10 | 3.26 | MA | 6863 | 2769 | 10979 | 2015 | 11863 | 1687 | 12332 | 1405 | 12890 | 962 | 15305 | 536 | 11465 |
| 6L-4S | | MI | 6515 | 2769 | 10650 | 1984 | 11601 | 1646 | 12180 | 1369 | 13020 | 933 | 15553 | 630 | 10900 |
| 16-#10 | 3.26 | MA | 6764 | 2769 | 10648 | 2031 | 11484 | 1693 | 11869 | 1423 | 12256 | 977 | 14423 | 496 | 11173 |
| 7L-3S | | MI | 6586 | 2769 | 10969 | 1965 | 12014 | 1640 | 12687 | 1363 | 13681 | 919 | 16407 | 681 | 10914 |
| 16-#11 | 4.00 | MA | 7360 | 2897 | 12184 | 2072 | 13397 | 1711 | 14207 | 1410 | 15490 | 929 | 18790 | 585 | 14357 |
| 4L-6S | | MI | 6504 | 2897 | 10547 | 2085 | 11412 | 1724 | 11911 | 1420 | 12599 | 934 | 14945 | 419 | 12407 |
| 16-#11 | 4.00 | MA | 7200 | 2897 | 11828 | 2082 | 12923 | 1733 | 13615 | 1430 | 14614 | 933 | 17650 | 523 | 13883 |
| 5E | | MI | 6607 | 2897 | 10880 | 2064 | 11842 | 1716 | 12445 | 1415 | 13316 | 918 | 15866 | 489 | 12634 |
| 16-#11 | 4.00 | MA | 7086 | 2897 | 11480 | 2089 | 12451 | 1741 | 13027 | 1437 | 13825 | 950 | 16610 | 451 | 13624 |
| 6L-4S | | MI | 6751 | 2897 | 11204 | 2055 | 12273 | 1695 | 12983 | 1396 | 14111 | 917 | 16873 | 551 | 13070 |
| 16-#14 | 5.77 | MA | 7808 | 3202 | 13156 | 2281 | 14589 | 1882 | 15628 | 1524 | 17336 | 914 | 21308 | 357 | 19083 |
| 5E | | MI | 7150 | 3202 | 12072 | 2260 | 13335 | 1863 | 14249 | 1506 | 15755 | 897 | 19046 | 308 | 17318 |
| 18-#10 | 3.66 | MA | 7159 | 2839 | 11732 | 2053 | 12843 | 1700 | 13536 | 1418 | 14522 | 942 | 17513 | 586 | 13103 |
| 5L-6S | | MI | 6488 | 2839 | 10539 | 2042 | 11425 | 1703 | 11946 | 1410 | 12657 | 943 | 15145 | 513 | 11740 |
| 18-#10 | 3.66 | MA | 7065 | 2839 | 11439 | 2059 | 12454 | 1718 | 13052 | 1425 | 13871 | 957 | 16662 | 528 | 12869 |
| 6L-5S | | MI | 6573 | 2839 | 10800 | 2037 | 11779 | 1696 | 12387 | 1405 | 13250 | 929 | 15925 | 572 | 11935 |
| 18-#10 | 3.66 | MA | 6967 | 2839 | 11109 | 2075 | 12074 | 1725 | 12590 | 1442 | 13236 | 972 | 15781 | 489 | 12558 |
| 7L-4S | | MI | 6693 | 2839 | 11067 | 2028 | 12135 | 1678 | 12832 | 1388 | 13907 | 927 | 16780 | 622 | 12193 |
| 18-#11 | 4.50 | MA | 7439 | 2983 | 12383 | 2136 | 13635 | 1772 | 14483 | 1454 | 15796 | 926 | 19286 | 514 | 15564 |
| 5L-6S | | MI | 6720 | 2983 | 11048 | 2139 | 12055 | 1762 | 12695 | 1444 | 13666 | 927 | 16390 | 406 | 13892 |
| 18-#11 | 4.50 | MA | 7327 | 2983 | 12035 | 2143 | 13162 | 1780 | 13896 | 1461 | 15007 | 943 | 18246 | 441 | 15294 |
| 6L-5S | | MI | 6821 | 2983 | 11382 | 2118 | 12484 | 1755 | 13229 | 1438 | 14383 | 912 | 17311 | 476 | 14150 |
| 20-#10 | 4.07 | MA | 7266 | 2909 | 11900 | 2103 | 13044 | 1750 | 13772 | 1444 | 14851 | 951 | 18020 | 520 | 14275 |
| 6E | | MI | 6668 | 2909 | 10956 | 2086 | 11959 | 1734 | 12598 | 1429 | 13544 | 938 | 16372 | 505 | 13010 |
| 20-#10 | 4.07 | MA | 7168 | 2909 | 11569 | 2118 | 12665 | 1756 | 13310 | 1461 | 14217 | 966 | 17138 | 481 | 13947 |
| 7L-5S | | MI | 6751 | 2909 | 11217 | 2081 | 12313 | 1728 | 13039 | 1424 | 14136 | 924 | 17152 | 564 | 13196 |
| 20-#11 | 5.00 | MA | 7566 | 3070 | 12591 | 2197 | 13874 | 1819 | 14764 | 1484 | 16189 | 936 | 19883 | 432 | 16954 |
| 6E | | MI | 6934 | 3070 | 11549 | 2193 | 12698 | 1801 | 13479 | 1467 | 14733 | 920 | 17835 | 393 | 15383 |

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

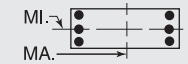
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.34 | MA | 7408 | 2625 | 11839 | 1890 | 12621 | 1591 | 12930 | 1358 | 13097 | 1007 | 14960 | 873 | 5930 |
| 2E | | MI | 6309 | 2625 | 10146 | 1857 | 10732 | 1563 | 10943 | 1333 | 11018 | 987 | 12365 | 839 | 5022 |
| 4-#18 | 2.38 | MA | 7938 | 2819 | 13154 | 1992 | 14249 | 1661 | 14892 | 1396 | 15753 | 980 | 18457 | 826 | 10068 |
| 2E | | MI | 6730 | 2819 | 11213 | 1956 | 12046 | 1631 | 12523 | 1369 | 13157 | 958 | 14978 | 767 | 8432 |
| 6-#10 | 1.13 | MA | 7323 | 2587 | 11560 | 1889 | 12336 | 1594 | 12614 | 1364 | 12684 | 1023 | 14401 | 889 | 5120 |
| 2L-3S | | MI | 6095 | 2587 | 9504 | 1869 | 9979 | 1587 | 10053 | 1360 | 9822 | 1020 | 10874 | 785 | 4376 |
| 6-#10 | 1.13 | MA | 7136 | 2587 | 11055 | 1899 | 11689 | 1602 | 11824 | 1383 | 11610 | 1039 | 12915 | 805 | 5150 |
| 3L-2S | | MI | 6245 | 2587 | 9921 | 1860 | 10513 | 1569 | 10705 | 1343 | 10709 | 1006 | 12101 | 874 | 4346 |
| 6-#11 | 1.39 | MA | 7453 | 2635 | 11908 | 1906 | 12739 | 1604 | 13088 | 1367 | 13319 | 1012 | 15272 | 877 | 6178 |
| 2L-3S | | MI | 6171 | 2635 | 9704 | 1884 | 10194 | 1598 | 10299 | 1364 | 10147 | 1009 | 11255 | 741 | 5266 |
| 6-#11 | 1.39 | MA | 7232 | 2635 | 11298 | 1917 | 11958 | 1613 | 12135 | 1389 | 12022 | 1030 | 13477 | 770 | 6215 |
| 3L-2S | | MI | 6348 | 2635 | 10205 | 1875 | 10837 | 1577 | 11083 | 1344 | 11214 | 993 | 12700 | 850 | 5227 |
| 6-#14 | 2.01 | MA | 7781 | 2750 | 12706 | 1968 | 13733 | 1647 | 14287 | 1391 | 14944 | 997 | 17517 | 859 | 8683 |
| 2L-3S | | MI | 6364 | 2750 | 10146 | 1948 | 10732 | 1648 | 10943 | 1394 | 11018 | 998 | 12365 | 658 | 7348 |
| 6-#14 | 2.01 | MA | 7473 | 2750 | 11839 | 1983 | 12621 | 1679 | 12930 | 1422 | 13097 | 1022 | 14960 | 702 | 8722 |
| 3L-2S | | MI | 6610 | 2750 | 10858 | 1935 | 11645 | 1619 | 12057 | 1367 | 12534 | 977 | 14385 | 817 | 7299 |
| 6-#18 | 3.57 | MA | 8570 | 3040 | 14658 | 2130 | 16177 | 1761 | 17243 | 1456 | 18953 | 962 | 22802 | 793 | 14798 |
| 2L-3S | | MI | 6831 | 3040 | 11213 | 2113 | 12046 | 1778 | 12523 | 1472 | 13157 | 971 | 14978 | 433 | 12309 |
| 6-#18 | 3.57 | MA | 8060 | 3040 | 13154 | 2154 | 14249 | 1815 | 14892 | 1506 | 15753 | 1002 | 18457 | 512 | 14742 |
| 3L-2S | | MI | 7238 | 3040 | 12440 | 2094 | 13619 | 1730 | 14442 | 1429 | 15768 | 941 | 18345 | 714 | 12312 |
| 8-#9 | 1.19 | MA | 7363 | 2598 | 11632 | 1901 | 12444 | 1603 | 12753 | 1371 | 12878 | 1025 | 14672 | 891 | 5372 |
| 2L-4S | | MI | 6100 | 2598 | 9399 | 1895 | 9855 | 1599 | 9906 | 1368 | 9648 | 1031 | 10688 | 766 | 4604 |
| 8-#9 | 1.19 | MA | 7215 | 2598 | 11233 | 1909 | 11932 | 1609 | 12128 | 1386 | 12027 | 1038 | 13495 | 825 | 5393 |
| 3E | | MI | 6159 | 2598 | 9651 | 1880 | 10182 | 1593 | 10308 | 1363 | 10172 | 1020 | 11363 | 806 | 4577 |
| 8-#9 | 1.19 | MA | 7137 | 2598 | 10930 | 1925 | 11539 | 1625 | 11645 | 1391 | 11398 | 1051 | 12698 | 786 | 5416 |
| 4L-2S | | MI | 6279 | 2598 | 9982 | 1873 | 10606 | 1579 | 10825 | 1350 | 10875 | 1009 | 12337 | 876 | 4555 |
| 8-#10 | 1.51 | MA | 7544 | 2657 | 12064 | 1933 | 12982 | 1625 | 13403 | 1384 | 13758 | 1018 | 15888 | 882 | 6721 |
| 2L-4S | | MI | 6203 | 2657 | 9603 | 1932 | 10100 | 1626 | 10198 | 1384 | 10048 | 1028 | 11247 | 725 | 5734 |
| 8-#10 | 1.51 | MA | 7360 | 2657 | 11560 | 1943 | 12336 | 1634 | 12614 | 1402 | 12684 | 1034 | 14401 | 797 | 6746 |
| 3E | | MI | 6276 | 2657 | 9921 | 1913 | 10513 | 1619 | 10705 | 1379 | 10709 | 1014 | 12101 | 777 | 5706 |
| 8-#10 | 1.51 | MA | 7263 | 2657 | 11177 | 1964 | 11839 | 1653 | 12004 | 1409 | 11890 | 1050 | 13391 | 747 | 6765 |
| 4L-2S | | MI | 6424 | 2657 | 10338 | 1904 | 11047 | 1601 | 11357 | 1362 | 11596 | 1001 | 13328 | 866 | 5678 |
| 8-#11 | 1.86 | MA | 7716 | 2721 | 12517 | 1960 | 13520 | 1643 | 14041 | 1391 | 14615 | 1005 | 17067 | 867 | 8108 |
| 2L-4S | | MI | 6302 | 2721 | 9820 | 1961 | 10338 | 1645 | 10470 | 1393 | 10416 | 1017 | 11690 | 667 | 6888 |
| 8-#11 | 1.86 | MA | 7499 | 2721 | 11908 | 1971 | 12739 | 1652 | 13088 | 1413 | 13319 | 1023 | 15272 | 761 | 8137 |
| 3E | | MI | 6386 | 2721 | 10205 | 1938 | 10837 | 1637 | 11083 | 1387 | 11214 | 1002 | 12700 | 728 | 6860 |
| 8-#11 | 1.86 | MA | 7387 | 2721 | 11444 | 1996 | 12138 | 1675 | 12349 | 1420 | 12356 | 1041 | 14039 | 699 | 8146 |
| 4L-2S | | MI | 6561 | 2721 | 10706 | 1929 | 11480 | 1616 | 11867 | 1368 | 12281 | 986 | 14145 | 837 | 6827 |
| 8-#14 | 2.68 | MA | 8151 | 2874 | 13574 | 2046 | 14846 | 1703 | 15644 | 1425 | 16790 | 987 | 20074 | 845 | 11416 |
| 2L-4S | | MI | 6552 | 2874 | 10309 | 2058 | 10934 | 1714 | 11184 | 1434 | 11397 | 1008 | 12969 | 551 | 9550 |
| 8-#14 | 2.68 | MA | 7851 | 2874 | 12706 | 2061 | 13733 | 1735 | 14287 | 1455 | 14944 | 1012 | 17517 | 689 | 11434 |
| 3E | | MI | 6668 | 2874 | 10858 | 2025 | 11645 | 1704 | 12057 | 1427 | 12534 | 988 | 14385 | 636 | 9587 |
| 8-#14 | 2.68 | MA | 7695 | 2874 | 12044 | 2096 | 12875 | 1748 | 13232 | 1466 | 13570 | 1037 | 15746 | 598 | 11356 |
| 4L-2S | | MI | 6909 | 2874 | 11570 | 2013 | 12558 | 1675 | 13171 | 1401 | 14049 | 967 | 16405 | 794 | 9555 |
| 8-#18 | 4.76 | MA | 9197 | 3261 | 16162 | 2268 | 18104 | 1860 | 19595 | 1516 | 22153 | 944 | 27147 | 761 | 19503 |
| 2L-4S | | MI | 7162 | 3261 | 11488 | 2305 | 12385 | 1890 | 12928 | 1539 | 13798 | 984 | 15968 | 238 | 14617 |
| 8-#18 | 4.76 | MA | 8705 | 3261 | 14658 | 2292 | 16177 | 1915 | 17243 | 1566 | 18953 | 984 | 22802 | 480 | 19385 |
| 3E | | MI | 7348 | 3261 | 12440 | 2251 | 13619 | 1877 | 14442 | 1532 | 15768 | 954 | 18345 | 380 | 16100 |
| 8-#18 | 4.76 | MA | 8451 | 3261 | 13504 | 2352 | 14681 | 1934 | 15406 | 1580 | 16561 | 1024 | 19767 | 323 | 17596 |
| 4L-2S | | MI | 7743 | 3261 | 13667 | 2232 | 15192 | 1829 | 16361 | 1490 | 18379 | 923 | 21712 | 662 | 16163 |
| 10-#10 | 1.89 | MA | 7763 | 2728 | 12569 | 1977 | 13629 | 1657 | 14192 | 1403 | 14831 | 1012 | 17375 | 874 | 8314 |
| 2L-5S | | MI | 6258 | 2728 | 9752 | 1984 | 10278 | 1675 | 10405 | 1420 | 10277 | 1025 | 11619 | 667 | 7035 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

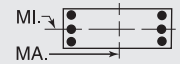



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.89 | MA | 7583 | 2728 | 12064 | 1987 | 12982 | 1665 | 13403 | 1421 | 13758 | 1028 | 15888 | 789 | 8333 |
| 3L-4S | | MI | 6384 | 2728 | 10019 | 1976 | 10634 | 1657 | 10849 | 1403 | 10935 | 1023 | 12474 | 718 | 7044 |
| 10-#10 | 1.89 | MA | 7487 | 2728 | 11682 | 2008 | 12486 | 1685 | 12793 | 1428 | 12963 | 1044 | 14878 | 739 | 8341 |
| 4L-3S | | MI | 6457 | 2728 | 10338 | 1957 | 11047 | 1650 | 11357 | 1398 | 11596 | 1009 | 13328 | 769 | 7025 |
| 10-#10 | 1.89 | MA | 7332 | 2728 | 11363 | 2017 | 12060 | 1693 | 12260 | 1447 | 12174 | 1049 | 13858 | 695 | 8307 |
| 5L-2S | | MI | 6603 | 2728 | 10755 | 1948 | 11582 | 1632 | 12009 | 1381 | 12482 | 995 | 14555 | 858 | 7001 |
| 10-#11 | 2.32 | MA | 7978 | 2808 | 13126 | 2014 | 14301 | 1681 | 14993 | 1415 | 15912 | 998 | 18862 | 858 | 10028 |
| 2L-5S | | MI | 6368 | 2808 | 9997 | 2024 | 10550 | 1704 | 10716 | 1435 | 10688 | 1012 | 12128 | 592 | 8238 |
| 10-#11 | 2.32 | MA | 7765 | 2808 | 12517 | 2025 | 13520 | 1691 | 14041 | 1436 | 14615 | 1016 | 17067 | 751 | 10048 |
| 3L-4S | | MI | 6518 | 2808 | 10321 | 2015 | 10981 | 1683 | 11254 | 1416 | 11483 | 1010 | 13136 | 654 | 8457 |
| 10-#11 | 2.32 | MA | 7654 | 2808 | 12053 | 2050 | 12919 | 1714 | 13302 | 1444 | 13653 | 1034 | 15834 | 689 | 10040 |
| 4L-3S | | MI | 6601 | 2808 | 10706 | 1992 | 11480 | 1676 | 11867 | 1411 | 12281 | 995 | 14145 | 715 | 8442 |
| 10-#11 | 2.32 | MA | 7470 | 2808 | 11665 | 2061 | 12402 | 1723 | 12655 | 1466 | 12696 | 1039 | 14593 | 631 | 9756 |
| 5L-2S | | MI | 6773 | 2808 | 11208 | 1983 | 12122 | 1655 | 12651 | 1391 | 13348 | 979 | 15590 | 824 | 8416 |
| 10-#14 | 3.35 | MA | 8519 | 2999 | 14442 | 2123 | 15958 | 1759 | 17002 | 1459 | 18637 | 977 | 22631 | 832 | 14139 |
| 2L-5S | | MI | 6647 | 2999 | 10559 | 2148 | 11232 | 1799 | 11530 | 1494 | 11779 | 999 | 13581 | 438 | 11019 |
| 10-#14 | 3.35 | MA | 8226 | 2999 | 13574 | 2139 | 14846 | 1791 | 15644 | 1489 | 16790 | 1002 | 20074 | 675 | 14134 |
| 3L-4S | | MI | 6856 | 2999 | 11021 | 2135 | 11847 | 1770 | 12298 | 1468 | 12912 | 998 | 14989 | 528 | 11630 |
| 10-#14 | 3.35 | MA | 8073 | 2999 | 12912 | 2174 | 13987 | 1804 | 14589 | 1500 | 15416 | 1027 | 18303 | 584 | 13951 |
| 4L-3S | | MI | 6970 | 2999 | 11570 | 2103 | 12558 | 1760 | 13171 | 1461 | 14049 | 978 | 16405 | 614 | 11814 |
| 10-#14 | 3.35 | MA | 7814 | 2999 | 12357 | 2189 | 13247 | 1836 | 13665 | 1530 | 14050 | 1032 | 16526 | 497 | 13116 |
| 5L-2S | | MI | 7206 | 2999 | 12282 | 2091 | 13471 | 1731 | 14285 | 1435 | 15565 | 957 | 18425 | 772 | 11798 |
| 10-#18 | 5.95 | MA | 9344 | 3483 | 16162 | 2431 | 18104 | 2014 | 19595 | 1626 | 22153 | 966 | 27147 | 447 | 24026 |
| 3L-4S | | MI | 7679 | 3483 | 12715 | 2443 | 13959 | 1990 | 14847 | 1599 | 16409 | 966 | 19334 | 185 | 18246 |
| 10-#18 | 5.95 | MA | 9096 | 3483 | 15008 | 2490 | 16609 | 2033 | 17758 | 1641 | 19760 | 1006 | 24112 | 291 | 22090 |
| 4L-3S | | MI | 7861 | 3483 | 13667 | 2389 | 15192 | 1977 | 16361 | 1592 | 18379 | 936 | 21712 | 328 | 19886 |
| 12-#10 | 2.27 | MA | 7982 | 2798 | 13074 | 2021 | 14276 | 1688 | 14981 | 1422 | 15905 | 1007 | 18861 | 866 | 9901 |
| 2L-6S | | MI | 6350 | 2798 | 9908 | 2034 | 10458 | 1714 | 10616 | 1444 | 10572 | 1033 | 12066 | 600 | 8038 |
| 12-#10 | 2.27 | MA | 7804 | 2798 | 12569 | 2031 | 13629 | 1697 | 14192 | 1440 | 14831 | 1022 | 17375 | 781 | 9915 |
| 3L-5S | | MI | 6440 | 2798 | 10169 | 2028 | 10813 | 1707 | 11057 | 1439 | 11164 | 1019 | 12846 | 659 | 8276 |
| 12-#10 | 2.27 | MA | 7709 | 2798 | 12187 | 2052 | 13133 | 1716 | 13582 | 1447 | 14037 | 1038 | 16365 | 732 | 9912 |
| 4E | | MI | 6564 | 2798 | 10436 | 2020 | 11169 | 1689 | 11501 | 1422 | 11822 | 1017 | 13701 | 710 | 8350 |
| 12-#10 | 2.27 | MA | 7557 | 2798 | 11867 | 2061 | 12707 | 1725 | 13049 | 1466 | 13248 | 1043 | 15345 | 687 | 9818 |
| 5L-3S | | MI | 6637 | 2798 | 10755 | 2001 | 11582 | 1682 | 12009 | 1417 | 12482 | 1003 | 14555 | 761 | 8337 |
| 12-#10 | 2.27 | MA | 7446 | 2798 | 11542 | 2066 | 12283 | 1744 | 12522 | 1473 | 12538 | 1059 | 14425 | 629 | 9493 |
| 6L-2S | | MI | 6780 | 2798 | 11172 | 1992 | 12116 | 1664 | 12660 | 1400 | 13369 | 989 | 15781 | 850 | 8318 |
| 12-#11 | 2.79 | MA | 8239 | 2894 | 13735 | 2068 | 15082 | 1720 | 15946 | 1438 | 17208 | 991 | 20658 | 848 | 11942 |
| 2L-6S | | MI | 6478 | 2894 | 10165 | 2100 | 10763 | 1751 | 10966 | 1464 | 11038 | 1020 | 12652 | 508 | 9489 |
| 12-#11 | 2.79 | MA | 8030 | 2894 | 13126 | 2079 | 14301 | 1729 | 14993 | 1460 | 15912 | 1009 | 18862 | 742 | 11955 |
| 3L-5S | | MI | 6585 | 2894 | 10499 | 2078 | 11192 | 1743 | 11500 | 1459 | 11755 | 1005 | 13573 | 579 | 9734 |
| 12-#11 | 2.79 | MA | 7920 | 2894 | 12663 | 2104 | 13700 | 1753 | 14255 | 1467 | 14949 | 1028 | 17629 | 680 | 11930 |
| 4E | | MI | 6732 | 2894 | 10823 | 2069 | 11623 | 1722 | 12038 | 1440 | 12550 | 1003 | 14581 | 641 | 10016 |
| 12-#11 | 2.79 | MA | 7738 | 2894 | 12275 | 2115 | 13183 | 1762 | 13608 | 1489 | 13993 | 1032 | 16388 | 621 | 11584 |
| 5L-3S | | MI | 6815 | 2894 | 11208 | 2046 | 12122 | 1715 | 12651 | 1434 | 13348 | 988 | 15590 | 702 | 10017 |
| 12-#11 | 2.79 | MA | 7606 | 2894 | 11887 | 2121 | 12668 | 1785 | 12967 | 1497 | 13132 | 1050 | 15263 | 550 | 11239 |
| 6L-2S | | MI | 6984 | 2894 | 11709 | 2037 | 12765 | 1694 | 13435 | 1415 | 14415 | 972 | 17035 | 811 | 9997 |
| 12-#14 | 4.02 | MA | 8598 | 3123 | 14442 | 2216 | 15958 | 1847 | 17002 | 1523 | 18637 | 992 | 22631 | 661 | 16829 |
| 3L-5S | | MI | 6952 | 3123 | 11271 | 2226 | 12145 | 1855 | 12644 | 1528 | 13294 | 989 | 15601 | 416 | 13157 |
| 12-#14 | 4.02 | MA | 8447 | 3123 | 13780 | 2251 | 15100 | 1860 | 15947 | 1533 | 17263 | 1017 | 20859 | 571 | 16528 |
| 4E | | MI | 7158 | 3123 | 11733 | 2213 | 12760 | 1825 | 13411 | 1502 | 14428 | 988 | 17009 | 506 | 13727 |
| 12-#14 | 4.02 | MA | 8193 | 3123 | 13225 | 2267 | 14360 | 1892 | 15023 | 1564 | 15896 | 1022 | 19082 | 483 | 15737 |
| 5L-3S | | MI | 7271 | 3123 | 12282 | 2181 | 13471 | 1816 | 14285 | 1495 | 15565 | 968 | 18425 | 591 | 14029 |
| 12-#14 | 4.02 | MA | 8008 | 3123 | 12679 | 2277 | 13624 | 1905 | 14107 | 1574 | 14665 | 1047 | 17465 | 379 | 14991 |
| 6L-2S | | MI | 7502 | 3123 | 12994 | 2169 | 14384 | 1787 | 15398 | 1469 | 17080 | 947 | 20445 | 750 | 14033 |
| 12-#18 | 7.14 | MA | 9734 | 3704 | 16511 | 2628 | 18536 | 2132 | 20109 | 1701 | 22960 | 988 | 28457 | 259 | 26607 |
| 4E | | MI | 8192 | 3704 | 13942 | 2581 | 15532 | 2089 | 16766 | 1660 | 19020 | 949 | 22701 | 133 | 21899 |
| 14-#10 | 2.65 | MA | 8024 | 2868 | 13074 | 2075 | 14276 | 1728 | 14981 | 1459 | 15905 | 1017 | 18861 | 774 | 11494 |
| 3L-6S | | MI | 6533 | 2868 | 10325 | 2078 | 10992 | 1745 | 11267 | 1464 | 11459 | 1028 | 13293 | 592 | 9299 |

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

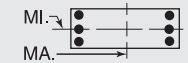
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.65 | MA | 7930 | 2868 | 12691 | 2095 | 13780 | 1748 | 14371 | 1467 | 15111 | 1033 | 17851 | 724 | 11480 |
| 4L-5S | | MI | 6621 | 2868 | 10586 | 2072 | 11347 | 1738 | 11708 | 1458 | 12051 | 1014 | 14073 | 651 | 9523 |
| 14-#10 | 2.65 | MA | 7780 | 2868 | 12372 | 2105 | 13354 | 1756 | 13839 | 1485 | 14322 | 1038 | 16832 | 679 | 11335 |
| 5L-4S | | MI | 6744 | 2868 | 10853 | 2064 | 11703 | 1720 | 12153 | 1442 | 12708 | 1011 | 14928 | 702 | 9649 |
| 14-#10 | 2.65 | MA | 7672 | 2868 | 12046 | 2110 | 12930 | 1776 | 13311 | 1492 | 13612 | 1053 | 15911 | 621 | 11026 |
| 6L-3S | | MI | 6815 | 2868 | 11172 | 2044 | 12116 | 1713 | 12660 | 1436 | 13369 | 998 | 15781 | 753 | 9645 |
| 14-#10 | 2.65 | MA | 7559 | 2868 | 11685 | 2127 | 12508 | 1782 | 12807 | 1510 | 12921 | 1069 | 14955 | 585 | 10791 |
| 7L-2S | | MI | 6957 | 2868 | 11588 | 2036 | 12650 | 1695 | 13312 | 1420 | 14256 | 984 | 17008 | 842 | 9631 |
| 14-#11 | 3.25 | MA | 8293 | 2980 | 13735 | 2133 | 15082 | 1768 | 15946 | 1483 | 17208 | 1002 | 20658 | 732 | 13854 |
| 3L-6S | | MI | 6695 | 2980 | 10667 | 2154 | 11406 | 1789 | 11750 | 1488 | 12105 | 1013 | 14097 | 495 | 11007 |
| 14-#11 | 3.25 | MA | 8184 | 2980 | 13272 | 2158 | 14481 | 1791 | 15207 | 1491 | 16246 | 1021 | 19424 | 670 | 13818 |
| 4L-5S | | MI | 6800 | 2980 | 11000 | 2132 | 11835 | 1782 | 12284 | 1482 | 12822 | 998 | 15018 | 565 | 11238 |
| 14-#11 | 3.25 | MA | 8004 | 2980 | 12884 | 2169 | 13964 | 1801 | 14561 | 1513 | 15289 | 1025 | 18184 | 612 | 13419 |
| 5L-4S | | MI | 6946 | 2980 | 11324 | 2123 | 12266 | 1761 | 12822 | 1463 | 13617 | 996 | 16026 | 628 | 11573 |
| 14-#11 | 3.25 | MA | 7876 | 2980 | 12496 | 2175 | 13449 | 1824 | 13920 | 1520 | 14428 | 1044 | 17058 | 540 | 13092 |
| 6L-3S | | MI | 7028 | 2980 | 11709 | 2100 | 12765 | 1753 | 13435 | 1458 | 14415 | 981 | 17035 | 689 | 11588 |
| 14-#11 | 3.25 | MA | 7744 | 2980 | 12059 | 2195 | 12948 | 1832 | 13309 | 1542 | 13589 | 1062 | 15892 | 492 | 12595 |
| 7L-2S | | MI | 7194 | 2980 | 12211 | 2091 | 13408 | 1732 | 14220 | 1438 | 15482 | 966 | 18481 | 798 | 11574 |
| 14-#14 | 4.69 | MA | 8819 | 3248 | 14648 | 2329 | 16212 | 1916 | 17304 | 1567 | 19109 | 1007 | 23416 | 557 | 19117 |
| 4L-5S | | MI | 7255 | 3248 | 11983 | 2303 | 13058 | 1911 | 13757 | 1562 | 14810 | 979 | 17621 | 393 | 15303 |
| 14-#14 | 4.69 | MA | 8569 | 3248 | 14093 | 2344 | 15472 | 1948 | 16380 | 1597 | 17743 | 1012 | 21639 | 470 | 18367 |
| 5L-4S | | MI | 7459 | 3248 | 12446 | 2291 | 13673 | 1881 | 14525 | 1536 | 15943 | 979 | 19029 | 484 | 15837 |
| 14-#14 | 4.69 | MA | 8389 | 3248 | 13546 | 2354 | 14736 | 1961 | 15464 | 1608 | 16512 | 1037 | 20022 | 365 | 17590 |
| 6L-3S | | MI | 7570 | 3248 | 12994 | 2259 | 14384 | 1872 | 15398 | 1529 | 17080 | 958 | 20445 | 569 | 16241 |
| 16-#10 | 3.02 | MA | 8150 | 2938 | 13196 | 2139 | 14427 | 1779 | 15160 | 1486 | 16184 | 1027 | 19338 | 716 | 13047 |
| 4L-6S | | MI | 6714 | 2938 | 10742 | 2122 | 11527 | 1777 | 11919 | 1483 | 12345 | 1022 | 14520 | 585 | 10564 |
| 16-#10 | 3.02 | MA | 8001 | 2938 | 12876 | 2149 | 14001 | 1788 | 14628 | 1504 | 15395 | 1032 | 18318 | 671 | 12857 |
| 5E | | MI | 6801 | 2938 | 11002 | 2116 | 11881 | 1770 | 12360 | 1477 | 12938 | 1008 | 15300 | 644 | 10775 |
| 16-#10 | 3.02 | MA | 7895 | 2938 | 12551 | 2154 | 13577 | 1807 | 14100 | 1511 | 14686 | 1048 | 17398 | 614 | 12562 |
| 6L-4S | | MI | 6923 | 2938 | 11270 | 2108 | 12237 | 1752 | 12805 | 1461 | 13595 | 1006 | 16155 | 694 | 10945 |
| 16-#10 | 3.02 | MA | 7784 | 2938 | 12190 | 2171 | 13155 | 1813 | 13596 | 1530 | 13995 | 1064 | 16441 | 577 | 12308 |
| 7L-3S | | MI | 6994 | 2938 | 11588 | 2088 | 12650 | 1745 | 13312 | 1455 | 14256 | 992 | 17008 | 745 | 10951 |
| 16-#10 | 3.02 | MA | 7657 | 2938 | 11873 | 2177 | 12717 | 1829 | 13101 | 1547 | 13259 | 1069 | 15393 | 511 | 11902 |
| 8L-2S | | MI | 7134 | 2938 | 12005 | 2080 | 13184 | 1727 | 13964 | 1439 | 15143 | 978 | 18235 | 835 | 10940 |
| 16-#11 | 3.71 | MA | 8447 | 3067 | 13881 | 2212 | 15262 | 1830 | 16160 | 1515 | 17542 | 1014 | 21219 | 661 | 15705 |
| 4L-6S | | MI | 6912 | 3067 | 11168 | 2208 | 12048 | 1828 | 12535 | 1511 | 13172 | 1006 | 15542 | 482 | 12529 |
| 16-#11 | 3.71 | MA | 8270 | 3067 | 13493 | 2223 | 14745 | 1840 | 15514 | 1536 | 16586 | 1018 | 19979 | 602 | 15260 |
| 5E | | MI | 7015 | 3067 | 11502 | 2186 | 12478 | 1821 | 13068 | 1506 | 13889 | 991 | 16463 | 552 | 12747 |
| 16-#11 | 3.71 | MA | 8144 | 3067 | 13106 | 2229 | 14230 | 1863 | 14873 | 1544 | 15725 | 1037 | 18853 | 531 | 14949 |
| 6L-4S | | MI | 7159 | 3067 | 11826 | 2177 | 12909 | 1799 | 13607 | 1487 | 14684 | 989 | 17471 | 615 | 13128 |
| 16-#11 | 3.71 | MA | 8013 | 3067 | 12668 | 2249 | 13729 | 1870 | 14262 | 1565 | 14885 | 1055 | 17687 | 482 | 14430 |
| 7L-3S | | MI | 7240 | 3067 | 12211 | 2154 | 13408 | 1792 | 14220 | 1481 | 15482 | 974 | 18481 | 676 | 13153 |
| 16-#14 | 5.36 | MA | 8943 | 3372 | 14960 | 2422 | 16585 | 2004 | 17737 | 1631 | 19589 | 1002 | 24196 | 456 | 21004 |
| 5E | | MI | 7557 | 3372 | 12695 | 2381 | 13971 | 1967 | 14871 | 1596 | 16325 | 969 | 19641 | 371 | 17455 |
| 16-#14 | 5.36 | MA | 8768 | 3372 | 14414 | 2432 | 15849 | 2017 | 16821 | 1642 | 18359 | 1027 | 22578 | 352 | 20197 |
| 6L-4S | | MI | 7758 | 3372 | 13158 | 2369 | 14586 | 1937 | 15639 | 1570 | 17459 | 969 | 21049 | 462 | 17958 |
| 18-#10 | 3.40 | MA | 8222 | 3009 | 13381 | 2193 | 14648 | 1819 | 15417 | 1523 | 16469 | 1026 | 19805 | 664 | 14383 |
| 5L-6S | | MI | 6895 | 3009 | 11159 | 2166 | 12061 | 1808 | 12571 | 1502 | 13232 | 1016 | 15747 | 577 | 11831 |
| 18-#10 | 3.40 | MA | 8118 | 3009 | 13055 | 2198 | 14224 | 1839 | 14889 | 1530 | 15760 | 1042 | 18885 | 606 | 14101 |
| 6L-5S | | MI | 6980 | 3009 | 11419 | 2160 | 12416 | 1801 | 13012 | 1496 | 13825 | 1003 | 16526 | 636 | 12032 |
| 18-#10 | 3.40 | MA | 8007 | 3009 | 12694 | 2214 | 13802 | 1845 | 14385 | 1549 | 15068 | 1058 | 17928 | 569 | 13828 |
| 7L-4S | | MI | 7101 | 3009 | 11687 | 2152 | 12772 | 1783 | 13457 | 1480 | 14482 | 1000 | 17381 | 686 | 12240 |
| 18-#10 | 3.40 | MA | 7883 | 3009 | 12377 | 2221 | 13364 | 1861 | 13890 | 1567 | 14332 | 1063 | 16879 | 503 | 13435 |
| 8L-3S | | MI | 7172 | 3009 | 12005 | 2132 | 13184 | 1776 | 13964 | 1474 | 15143 | 986 | 18235 | 737 | 12254 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

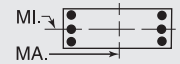
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 4.18 | MA | 8533 | 3153 | 14102 | 2277 | 15526 | 1878 | 16467 | 1560 | 17882 | 1011 | 21774 | 593 | 17106 |
| 5L-6S | | MI | 7127 | 3153 | 11669 | 2262 | 12691 | 1867 | 13319 | 1535 | 14239 | 999 | 16987 | 469 | 14054 |
| 18-#11 | 4.18 | MA | 8410 | 3153 | 13715 | 2283 | 15011 | 1902 | 15826 | 1567 | 17021 | 1030 | 20649 | 521 | 16809 |
| 6L-5S | | MI | 7228 | 3153 | 12003 | 2240 | 13121 | 1859 | 13853 | 1529 | 14956 | 984 | 17908 | 539 | 14261 |
| 18-#11 | 4.18 | MA | 8280 | 3153 | 13277 | 2303 | 14510 | 1909 | 15214 | 1589 | 16182 | 1048 | 19482 | 473 | 16269 |
| 7L-4S | | MI | 7371 | 3153 | 12327 | 2231 | 13552 | 1838 | 14391 | 1510 | 15751 | 982 | 18916 | 602 | 14681 |
| 18-#14 | 6.03 | MA | 9144 | 3497 | 15282 | 2510 | 16961 | 2073 | 18178 | 1676 | 20205 | 1017 | 25135 | 338 | 22810 |
| 6L-5S | | MI | 7858 | 3497 | 13407 | 2459 | 14884 | 2022 | 15985 | 1630 | 17841 | 959 | 21661 | 349 | 19614 |
| 20-#10 | 3.78 | MA | 8340 | 3079 | 13560 | 2242 | 14871 | 1870 | 15678 | 1550 | 16833 | 1037 | 20371 | 598 | 15643 |
| 6E | | MI | 7075 | 3079 | 11575 | 2210 | 12595 | 1840 | 13223 | 1521 | 14119 | 1011 | 16973 | 569 | 13100 |
| 20-#10 | 3.78 | MA | 8229 | 3079 | 13199 | 2258 | 14449 | 1876 | 15175 | 1568 | 16142 | 1053 | 19415 | 561 | 15352 |
| 7L-5S | | MI | 7159 | 3079 | 11836 | 2204 | 12950 | 1833 | 13664 | 1516 | 14711 | 997 | 17753 | 628 | 13292 |
| 20-#10 | 3.78 | MA | 8106 | 3079 | 12882 | 2265 | 14011 | 1892 | 14679 | 1586 | 15406 | 1057 | 18366 | 495 | 14970 |
| 8L-4S | | MI | 7279 | 3079 | 12103 | 2196 | 13306 | 1815 | 14108 | 1499 | 15369 | 994 | 18608 | 678 | 13533 |
| 20-#11 | 4.64 | MA | 8675 | 3239 | 14324 | 2337 | 15792 | 1940 | 16779 | 1591 | 18318 | 1023 | 22444 | 512 | 18672 |
| 6E | | MI | 7341 | 3239 | 12171 | 2316 | 13334 | 1905 | 14103 | 1558 | 15306 | 992 | 18432 | 456 | 15561 |
| 20-#11 | 4.64 | MA | 8545 | 3239 | 13887 | 2357 | 15291 | 1948 | 16167 | 1613 | 17478 | 1041 | 21278 | 463 | 18112 |
| 7L-5S | | MI | 7441 | 3239 | 12505 | 2294 | 13763 | 1898 | 14637 | 1553 | 16023 | 977 | 19354 | 526 | 15778 |
| 22-#10 | 4.16 | MA | 8450 | 3149 | 13703 | 2302 | 15096 | 1908 | 15964 | 1587 | 17216 | 1047 | 20901 | 553 | 16878 |
| 7L-6S | | MI | 7255 | 3149 | 11992 | 2254 | 13130 | 1871 | 13875 | 1540 | 15006 | 1005 | 18200 | 561 | 14371 |
| 22-#10 | 4.16 | MA | 8329 | 3149 | 13386 | 2309 | 14658 | 1924 | 15468 | 1605 | 16480 | 1052 | 19853 | 487 | 16507 |
| 8L-5S | | MI | 7337 | 3149 | 12253 | 2248 | 13484 | 1864 | 14315 | 1535 | 15598 | 991 | 18980 | 620 | 14555 |
| 22-#11 | 5.11 | MA | 8810 | 3326 | 14496 | 2411 | 16072 | 1987 | 17120 | 1636 | 18775 | 1034 | 23073 | 453 | 19958 |
| 7L-6S | | MI | 7555 | 3326 | 12672 | 2370 | 13977 | 1944 | 14887 | 1582 | 16373 | 986 | 19877 | 443 | 17053 |

## RECTANGULAR TIED COLUMNS 24" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.25 | MA | 8468 | 2795 | 13453 | 2028 | 14358 | 1709 | 14705 | 1460 | 14858 | 1088 | 16937 | 945 | 6416 |
| 2E | | MI | 6717 | 2795 | 10769 | 1979 | 11368 | 1667 | 11566 | 1424 | 11589 | 1059 | 12960 | 902 | 5052 |
| 4-#18 | 2.22 | MA | 9054 | 2989 | 14895 | 2129 | 16144 | 1779 | 16855 | 1498 | 17769 | 1061 | 20955 | 913 | 10932 |
| 2E | | MI | 7138 | 2989 | 11839 | 2076 | 12681 | 1733 | 13143 | 1458 | 13724 | 1029 | 15567 | 829 | 8477 |
| 6-#10 | 1.06 | MA | 8372 | 2757 | 13143 | 2027 | 14040 | 1711 | 14352 | 1467 | 14397 | 1105 | 16314 | 961 | 5532 |
| 2L-3S | | MI | 6502 | 2757 | 10124 | 1992 | 10615 | 1693 | 10678 | 1451 | 10397 | 1093 | 11476 | 849 | 4399 |
| 6-#10 | 1.06 | MA | 8167 | 2757 | 12595 | 2037 | 13337 | 1720 | 13494 | 1486 | 13230 | 1122 | 14698 | 878 | 5561 |
| 3L-2S | | MI | 6653 | 2757 | 10541 | 1984 | 11150 | 1674 | 11330 | 1435 | 11284 | 1079 | 12702 | 938 | 4369 |
| 6-#11 | 1.30 | MA | 8516 | 2805 | 13525 | 2044 | 14484 | 1721 | 14873 | 1470 | 15094 | 1093 | 17270 | 949 | 6684 |
| 2L-3S | | MI | 6578 | 2805 | 10325 | 2007 | 10830 | 1703 | 10922 | 1455 | 10720 | 1081 | 11853 | 804 | 5295 |
| 6-#11 | 1.30 | MA | 8272 | 2805 | 12862 | 2056 | 13634 | 1732 | 13835 | 1493 | 13683 | 1113 | 15316 | 844 | 6721 |
| 3L-2S | | MI | 6755 | 2805 | 10827 | 1997 | 11473 | 1682 | 11706 | 1435 | 11787 | 1066 | 13298 | 914 | 5255 |
| 6-#14 | 1.88 | MA | 8878 | 2919 | 14398 | 2106 | 15571 | 1765 | 16184 | 1494 | 16870 | 1078 | 19723 | 931 | 9412 |
| 2L-3S | | MI | 6771 | 2919 | 10769 | 2069 | 11368 | 1752 | 11566 | 1484 | 11589 | 1070 | 12960 | 721 | 7388 |
| 6-#14 | 1.88 | MA | 8538 | 2919 | 13453 | 2122 | 14358 | 1778 | 14705 | 1525 | 14858 | 1105 | 16937 | 778 | 9451 |
| 3L-2S | | MI | 7018 | 2919 | 11481 | 2057 | 12281 | 1723 | 12680 | 1458 | 13104 | 1049 | 14980 | 880 | 7335 |
| 6-#18 | 3.33 | MA | 9750 | 3210 | 16538 | 2268 | 18249 | 1878 | 19423 | 1559 | 21263 | 1044 | 25792 | 889 | 16094 |
| 2L-3S | | MI | 7238 | 3210 | 11839 | 2232 | 12681 | 1880 | 13143 | 1561 | 13724 | 1042 | 15567 | 495 | 12381 |
| 6-#18 | 3.33 | MA | 9186 | 3210 | 14895 | 2294 | 16144 | 1935 | 16855 | 1611 | 17769 | 1087 | 20955 | 607 | 16038 |
| 3L-2S | | MI | 7646 | 3210 | 13066 | 2214 | 14254 | 1832 | 15062 | 1519 | 16335 | 1012 | 18934 | 777 | 12363 |
| 8-#9 | 1.11 | MA | 8416 | 2767 | 13221 | 2039 | 14157 | 1720 | 14502 | 1473 | 14605 | 1107 | 16605 | 962 | 5804 |
| 2L-4S | | MI | 6507 | 2767 | 10018 | 2019 | 10491 | 1704 | 10531 | 1460 | 10224 | 1104 | 11291 | 831 | 4627 |
| 8-#9 | 1.11 | MA | 8253 | 2767 | 12786 | 2047 | 13600 | 1728 | 13822 | 1489 | 13681 | 1121 | 15326 | 898 | 5825 |
| 3E | | MI | 6567 | 2767 | 10270 | 2003 | 10819 | 1699 | 10933 | 1456 | 10747 | 1093 | 11966 | 871 | 4599 |
| 8-#9 | 1.11 | MA | 8166 | 2767 | 12459 | 2064 | 13175 | 1744 | 13300 | 1495 | 13000 | 1134 | 14468 | 859 | 5848 |
| 4L-2S | | MI | 6686 | 2767 | 10601 | 1997 | 11242 | 1684 | 11450 | 1442 | 11451 | 1082 | 12940 | 940 | 4578 |
| 8-#10 | 1.41 | MA | 8614 | 2827 | 13692 | 2071 | 14744 | 1743 | 15210 | 1486 | 15564 | 1099 | 17930 | 953 | 7270 |
| 2L-4S | | MI | 6610 | 2827 | 10222 | 2056 | 10737 | 1731 | 10823 | 1476 | 10623 | 1101 | 11849 | 790 | 5764 |
| 8-#10 | 1.41 | MA | 8412 | 2827 | 13143 | 2081 | 14040 | 1752 | 14352 | 1505 | 14397 | 1116 | 16314 | 870 | 7294 |
| 3E | | MI | 6684 | 2827 | 10541 | 2036 | 11150 | 1724 | 11330 | 1471 | 11284 | 1087 | 12702 | 841 | 5732 |

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

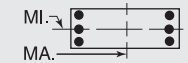
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#10 | 1.41 | MA | 8303 | 2827 | 12729 | 2103 | 13503 | 1772 | 13691 | 1513 | 13536 | 1133 | 15226 | 821 | 7314 |
| 4L-2S | | MI | 6832 | 2827 | 10957 | 2028 | 11684 | 1706 | 11982 | 1454 | 12171 | 1074 | 13929 | 930 | 5704 |
| 8-#11 | 1.73 | MA | 8806 | 2891 | 14188 | 2098 | 15334 | 1760 | 15910 | 1494 | 16505 | 1086 | 19224 | 939 | 8782 |
| 2L-4S | | MI | 6709 | 2891 | 10441 | 2084 | 10974 | 1749 | 11093 | 1484 | 10988 | 1089 | 12288 | 730 | 6927 |
| 8-#11 | 1.73 | MA | 8566 | 2891 | 13525 | 2110 | 14484 | 1770 | 14873 | 1516 | 15094 | 1106 | 17270 | 835 | 8811 |
| 3E | | MI | 6794 | 2891 | 10827 | 2060 | 11473 | 1742 | 11706 | 1478 | 11787 | 1074 | 13298 | 791 | 6894 |
| 8-#11 | 1.73 | MA | 8439 | 2891 | 13022 | 2135 | 13832 | 1794 | 14071 | 1525 | 14050 | 1125 | 15941 | 774 | 8820 |
| 4L-2S | | MI | 6969 | 2891 | 11328 | 2051 | 12116 | 1720 | 12491 | 1459 | 12854 | 1059 | 14743 | 901 | 6859 |
| 8-#14 | 2.50 | MA | 9284 | 3044 | 15344 | 2184 | 16783 | 1820 | 17663 | 1528 | 18882 | 1068 | 22509 | 917 | 12388 |
| 2L-4S | | MI | 6959 | 3044 | 10932 | 2179 | 11570 | 1817 | 11806 | 1524 | 11967 | 1080 | 13563 | 614 | 9624 |
| 8-#14 | 2.50 | MA | 8953 | 3044 | 14398 | 2200 | 15571 | 1834 | 16184 | 1559 | 16870 | 1095 | 19723 | 764 | 12406 |
| 3E | | MI | 7075 | 3044 | 11481 | 2147 | 12281 | 1808 | 12680 | 1518 | 13104 | 1060 | 14980 | 699 | 9632 |
| 8-#14 | 2.50 | MA | 8777 | 3044 | 13680 | 2236 | 14638 | 1868 | 15038 | 1571 | 15378 | 1122 | 17814 | 675 | 12328 |
| 4L-2S | | MI | 7317 | 3044 | 12193 | 2134 | 13194 | 1779 | 13793 | 1491 | 14620 | 1039 | 17000 | 857 | 9595 |
| 8-#18 | 4.44 | MA | 10439 | 3431 | 18180 | 2406 | 20354 | 1978 | 21991 | 1619 | 24757 | 1026 | 30630 | 864 | 21231 |
| 2L-4S | | MI | 7569 | 3431 | 12113 | 2425 | 13021 | 1993 | 13548 | 1628 | 14364 | 1055 | 16556 | 300 | 14835 |
| 8-#18 | 4.44 | MA | 9896 | 3431 | 16538 | 2432 | 18249 | 2035 | 19423 | 1671 | 21263 | 1069 | 25792 | 582 | 21113 |
| 3E | | MI | 7755 | 3431 | 13066 | 2371 | 14254 | 1980 | 15062 | 1621 | 16335 | 1025 | 18934 | 443 | 16179 |
| 8-#18 | 4.44 | MA | 9607 | 3431 | 15283 | 2494 | 16622 | 2056 | 17425 | 1689 | 18660 | 1113 | 22427 | 421 | 19357 |
| 4L-2S | | MI | 8152 | 3431 | 14293 | 2352 | 15827 | 1932 | 16981 | 1579 | 18946 | 994 | 22301 | 724 | 16219 |
| 10-#10 | 1.76 | MA | 8855 | 2897 | 14240 | 2115 | 15447 | 1774 | 16067 | 1505 | 16731 | 1094 | 19546 | 945 | 8999 |
| 2L-5S | | MI | 6666 | 2897 | 10372 | 2108 | 10915 | 1780 | 11030 | 1512 | 10852 | 1098 | 12221 | 731 | 7085 |
| 10-#10 | 1.76 | MA | 8656 | 2897 | 13692 | 2125 | 14744 | 1783 | 15210 | 1524 | 15564 | 1111 | 17930 | 863 | 9019 |
| 3L-4S | | MI | 6791 | 2897 | 10639 | 2100 | 11271 | 1762 | 11474 | 1495 | 11510 | 1096 | 13076 | 782 | 7078 |
| 10-#10 | 1.76 | MA | 8548 | 2897 | 13278 | 2147 | 14206 | 1804 | 14549 | 1532 | 14703 | 1127 | 16842 | 814 | 9027 |
| 4L-3S | | MI | 6864 | 2897 | 10957 | 2080 | 11684 | 1756 | 11982 | 1490 | 12171 | 1082 | 13929 | 833 | 7054 |
| 10-#10 | 1.76 | MA | 8379 | 2897 | 12932 | 2157 | 13745 | 1813 | 13972 | 1551 | 13848 | 1133 | 15741 | 771 | 8995 |
| 5L-2S | | MI | 7011 | 2897 | 11374 | 2072 | 12218 | 1738 | 12634 | 1473 | 13057 | 1068 | 15156 | 922 | 7030 |
| 10-#11 | 2.17 | MA | 9093 | 2977 | 14852 | 2152 | 16184 | 1799 | 16947 | 1517 | 17916 | 1079 | 21178 | 929 | 10871 |
| 2L-5S | | MI | 6776 | 2977 | 10619 | 2147 | 11186 | 1809 | 11340 | 1526 | 11260 | 1084 | 12726 | 655 | 8352 |
| 10-#11 | 2.17 | MA | 8858 | 2977 | 14188 | 2164 | 15334 | 1809 | 15910 | 1540 | 16505 | 1099 | 19224 | 825 | 10891 |
| 3L-4S | | MI | 6925 | 2977 | 10943 | 2137 | 11617 | 1788 | 11878 | 1507 | 12055 | 1082 | 13733 | 717 | 8500 |
| 10-#11 | 2.17 | MA | 8732 | 2977 | 13686 | 2189 | 14682 | 1833 | 15108 | 1548 | 15461 | 1118 | 17895 | 764 | 10882 |
| 4L-3S | | MI | 7009 | 2977 | 11328 | 2114 | 12116 | 1780 | 12491 | 1502 | 12854 | 1067 | 14743 | 778 | 8479 |
| 10-#11 | 2.17 | MA | 8530 | 2977 | 13266 | 2201 | 14122 | 1843 | 14408 | 1571 | 14423 | 1124 | 16554 | 709 | 10652 |
| 5L-2S | | MI | 7181 | 2977 | 11829 | 2105 | 12759 | 1759 | 13275 | 1482 | 13920 | 1052 | 16188 | 888 | 8450 |
| 10-#14 | 3.13 | MA | 9689 | 3168 | 16290 | 2261 | 17995 | 1876 | 19142 | 1562 | 20894 | 1058 | 25295 | 903 | 15354 |
| 2L-5S | | MI | 7054 | 3168 | 11182 | 2269 | 11868 | 1903 | 12152 | 1585 | 12349 | 1071 | 14175 | 501 | 11160 |
| 10-#14 | 3.13 | MA | 9365 | 3168 | 15344 | 2278 | 16783 | 1890 | 17663 | 1593 | 18882 | 1085 | 22509 | 750 | 15349 |
| 3L-4S | | MI | 7263 | 3168 | 11644 | 2257 | 12483 | 1873 | 12920 | 1558 | 13483 | 1070 | 15583 | 592 | 11792 |
| 10-#14 | 3.13 | MA | 9192 | 3168 | 14625 | 2314 | 15851 | 1924 | 16517 | 1605 | 17390 | 1112 | 20600 | 661 | 15247 |
| 4L-3S | | MI | 7378 | 3168 | 12193 | 2225 | 13194 | 1864 | 13793 | 1552 | 14620 | 1050 | 17000 | 677 | 11865 |
| 10-#14 | 3.13 | MA | 8907 | 3168 | 14024 | 2330 | 15049 | 1938 | 15515 | 1636 | 15907 | 1119 | 18678 | 578 | 14334 |
| 5L-2S | | MI | 7615 | 3168 | 12905 | 2212 | 14107 | 1834 | 14907 | 1525 | 16135 | 1029 | 19020 | 835 | 11840 |
| 10-#18 | 5.56 | MA | 10599 | 3652 | 18180 | 2571 | 20354 | 2134 | 21991 | 1732 | 24757 | 1052 | 30630 | 558 | 26186 |
| 3L-4S | | MI | 8086 | 3652 | 13340 | 2563 | 14594 | 2092 | 15467 | 1688 | 16976 | 1037 | 19923 | 247 | 18456 |
| 10-#18 | 5.56 | MA | 10316 | 3652 | 16925 | 2632 | 18727 | 2156 | 19993 | 1749 | 22154 | 1095 | 27264 | 396 | 24277 |
| 4L-3S | | MI | 8268 | 3652 | 14293 | 2509 | 15827 | 2079 | 16981 | 1682 | 18946 | 1007 | 22301 | 390 | 19969 |
| 10-#18 | 5.56 | MA | 9835 | 3652 | 15872 | 2658 | 17325 | 2213 | 18241 | 1801 | 19564 | 1103 | 23893 | 238 | 22658 |
| 5L-2S | | MI | 8656 | 3652 | 15520 | 2491 | 17400 | 2031 | 18900 | 1639 | 21557 | 976 | 25668 | 672 | 20059 |
| 12-#10 | 2.12 | MA | 9095 | 2968 | 14789 | 2159 | 16150 | 1806 | 16925 | 1524 | 17898 | 1088 | 21162 | 938 | 10724 |
| 2L-6S | | MI | 6757 | 2968 | 10528 | 2158 | 11095 | 1819 | 11241 | 1536 | 11147 | 1106 | 12667 | 664 | 8128 |
| 12-#10 | 2.12 | MA | 8899 | 2968 | 14240 | 2169 | 15447 | 1815 | 16067 | 1543 | 16731 | 1105 | 19546 | 855 | 10738 |
| 3L-5S | | MI | 6847 | 2968 | 10788 | 2152 | 11449 | 1812 | 11682 | 1531 | 11739 | 1092 | 13447 | 723 | 8374 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

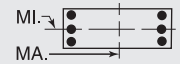



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 2.12 | MA | 8792 | 2968 | 13826 | 2190 | 14909 | 1835 | 15407 | 1551 | 15870 | 1122 | 18458 | 806 | 10735 |
| 4E | | MI | 6972 | 2968 | 11056 | 2144 | 11805 | 1794 | 12126 | 1514 | 12397 | 1090 | 14302 | 774 | 8385 |
| 12-#10 | 2.12 | MA | 8625 | 2968 | 13481 | 2201 | 14448 | 1844 | 14830 | 1570 | 15016 | 1127 | 17357 | 763 | 10693 |
| 5L-3S | | MI | 7044 | 2968 | 11374 | 2124 | 12218 | 1787 | 12634 | 1509 | 13057 | 1076 | 15156 | 825 | 8369 |
| 12-#10 | 2.12 | MA | 8504 | 2968 | 13122 | 2205 | 13990 | 1864 | 14259 | 1578 | 14248 | 1144 | 16368 | 706 | 10328 |
| 6L-2S | | MI | 7189 | 2968 | 11791 | 2116 | 12752 | 1769 | 13285 | 1492 | 13944 | 1063 | 16383 | 914 | 8349 |
| 12-#11 | 2.60 | MA | 9379 | 3064 | 15515 | 2206 | 17035 | 1838 | 17984 | 1541 | 19328 | 1072 | 23132 | 920 | 12953 |
| 2L-6S | | MI | 6885 | 3064 | 10787 | 2222 | 11399 | 1855 | 11590 | 1555 | 11610 | 1092 | 13250 | 572 | 9595 |
| 12-#11 | 2.60 | MA | 9148 | 3064 | 14852 | 2217 | 16184 | 1848 | 16947 | 1563 | 17916 | 1092 | 21178 | 816 | 12966 |
| 3L-5S | | MI | 6992 | 3064 | 11120 | 2201 | 11829 | 1848 | 12124 | 1550 | 12327 | 1077 | 14171 | 642 | 9846 |
| 12-#11 | 2.60 | MA | 9024 | 3064 | 14349 | 2243 | 15532 | 1872 | 16145 | 1572 | 16872 | 1111 | 19849 | 755 | 12940 |
| 4E | | MI | 7140 | 3064 | 11444 | 2191 | 12260 | 1826 | 12662 | 1531 | 13122 | 1076 | 15178 | 704 | 10066 |
| 12-#11 | 2.60 | MA | 8825 | 3064 | 13929 | 2255 | 14972 | 1882 | 15445 | 1594 | 15835 | 1117 | 18508 | 699 | 12644 |
| 5L-3S | | MI | 7223 | 3064 | 11829 | 2168 | 12759 | 1819 | 13275 | 1525 | 13920 | 1060 | 16188 | 765 | 10057 |
| 12-#11 | 2.60 | MA | 8680 | 3064 | 13501 | 2261 | 14414 | 1906 | 14751 | 1603 | 14902 | 1137 | 17297 | 628 | 12240 |
| 6L-2S | | MI | 7392 | 3064 | 12331 | 2159 | 13401 | 1798 | 14059 | 1506 | 14987 | 1045 | 17633 | 875 | 10034 |
| 12-#14 | 3.75 | MA | 9774 | 3293 | 16290 | 2355 | 17995 | 1946 | 19142 | 1627 | 20894 | 1075 | 25295 | 737 | 18287 |
| 3L-5S | | MI | 7359 | 3293 | 11894 | 2347 | 12781 | 1958 | 13266 | 1619 | 13865 | 1061 | 16195 | 479 | 13294 |
| 12-#14 | 3.75 | MA | 9603 | 3293 | 15571 | 2391 | 17063 | 1980 | 17996 | 1639 | 19402 | 1102 | 23386 | 648 | 18129 |
| 4E | | MI | 7566 | 3293 | 12356 | 2335 | 13396 | 1929 | 14034 | 1592 | 14998 | 1060 | 17603 | 569 | 13885 |
| 12-#14 | 3.75 | MA | 9324 | 3293 | 14970 | 2408 | 16261 | 1994 | 16994 | 1670 | 17919 | 1109 | 21464 | 565 | 17194 |
| 5L-3S | | MI | 7679 | 3293 | 12905 | 2302 | 14107 | 1920 | 14907 | 1586 | 16135 | 1040 | 19020 | 654 | 14084 |
| 12-#14 | 3.75 | MA | 9121 | 3293 | 14366 | 2417 | 15463 | 2028 | 16001 | 1682 | 16584 | 1136 | 19723 | 462 | 16485 |
| 6L-2S | | MI | 7911 | 3293 | 13617 | 2290 | 15020 | 1890 | 16021 | 1559 | 17651 | 1019 | 21040 | 813 | 14078 |
| 12-#18 | 6.67 | MA | 11018 | 3874 | 18567 | 2770 | 20832 | 2255 | 22561 | 1809 | 25648 | 1077 | 32102 | 372 | 29220 |
| 4E | | MI | 8600 | 3874 | 14567 | 2701 | 16167 | 2191 | 17386 | 1749 | 19587 | 1020 | 23290 | 195 | 22102 |
| 12-#18 | 6.67 | MA | 10549 | 3874 | 17514 | 2797 | 19430 | 2312 | 20809 | 1862 | 23058 | 1085 | 28730 | 213 | 27571 |
| 5L-3S | | MI | 8779 | 3874 | 15520 | 2647 | 17400 | 2178 | 18900 | 1742 | 21557 | 989 | 25668 | 338 | 23755 |
| 14-#10 | 2.47 | MA | 9140 | 3038 | 14789 | 2213 | 16150 | 1846 | 16925 | 1563 | 17898 | 1099 | 21162 | 847 | 12454 |
| 3L-6S | | MI | 6940 | 3038 | 10944 | 2202 | 11629 | 1850 | 11892 | 1555 | 12033 | 1101 | 13894 | 657 | 9388 |
| 14-#10 | 2.47 | MA | 9034 | 3038 | 14375 | 2234 | 15612 | 1867 | 16264 | 1570 | 17037 | 1116 | 20074 | 798 | 12440 |
| 4L-5S | | MI | 7028 | 3038 | 11205 | 2196 | 11983 | 1844 | 12333 | 1550 | 12626 | 1087 | 14674 | 716 | 9619 |
| 14-#10 | 2.47 | MA | 8869 | 3038 | 14029 | 2244 | 15151 | 1876 | 15688 | 1590 | 16183 | 1122 | 18974 | 755 | 12358 |
| 5L-4S | | MI | 7151 | 3038 | 11472 | 2187 | 12339 | 1825 | 12778 | 1533 | 13283 | 1084 | 15529 | 766 | 9689 |
| 14-#10 | 2.47 | MA | 8751 | 3038 | 13671 | 2249 | 14693 | 1896 | 15117 | 1597 | 15415 | 1139 | 17984 | 698 | 11995 |
| 6L-3S | | MI | 7223 | 3038 | 11791 | 2168 | 12752 | 1819 | 13285 | 1528 | 13944 | 1071 | 16383 | 817 | 9680 |
| 14-#10 | 2.47 | MA | 8625 | 3038 | 13279 | 2266 | 14228 | 1901 | 14572 | 1616 | 14667 | 1155 | 16823 | 648 | 11764 |
| 7L-2S | | MI | 7366 | 3038 | 12208 | 2160 | 13287 | 1801 | 13937 | 1511 | 14831 | 1057 | 17610 | 907 | 9663 |
| 14-#11 | 3.03 | MA | 9437 | 3150 | 15515 | 2271 | 17035 | 1887 | 17984 | 1587 | 19328 | 1085 | 23132 | 806 | 15033 |
| 3L-6S | | MI | 7102 | 3150 | 11288 | 2276 | 12042 | 1894 | 12374 | 1579 | 12677 | 1086 | 14695 | 559 | 11112 |
| 14-#11 | 3.03 | MA | 9314 | 3150 | 15012 | 2297 | 16382 | 1911 | 17183 | 1595 | 18283 | 1105 | 21803 | 745 | 14997 |
| 4L-5S | | MI | 7208 | 3150 | 11622 | 2255 | 12471 | 1886 | 12908 | 1573 | 13394 | 1070 | 15616 | 629 | 11348 |
| 14-#11 | 3.03 | MA | 9117 | 3150 | 14592 | 2309 | 15822 | 1921 | 16482 | 1618 | 17246 | 1110 | 20462 | 690 | 14643 |
| 5L-4S | | MI | 7354 | 3150 | 11946 | 2245 | 12902 | 1865 | 13446 | 1554 | 14189 | 1069 | 16623 | 691 | 11625 |
| 14-#11 | 3.03 | MA | 8976 | 3150 | 14165 | 2315 | 15265 | 1945 | 15788 | 1627 | 16313 | 1130 | 19252 | 619 | 14259 |
| 6L-3S | | MI | 7436 | 3150 | 12331 | 2222 | 13401 | 1858 | 14059 | 1549 | 14987 | 1053 | 17633 | 752 | 11630 |
| 14-#11 | 3.03 | MA | 8828 | 3150 | 13690 | 2335 | 14711 | 1952 | 15126 | 1649 | 15404 | 1149 | 17993 | 573 | 13788 |
| 7L-2S | | MI | 7603 | 3150 | 12832 | 2213 | 14044 | 1837 | 14843 | 1529 | 16054 | 1038 | 19078 | 862 | 11613 |
| 14-#14 | 4.38 | MA | 10012 | 3417 | 16517 | 2469 | 18275 | 2036 | 19475 | 1673 | 21414 | 1092 | 26172 | 634 | 20955 |
| 4L-5S | | MI | 7663 | 3417 | 12606 | 2425 | 13694 | 2014 | 14380 | 1653 | 15380 | 1051 | 18215 | 456 | 15437 |
| 14-#14 | 4.38 | MA | 9737 | 3417 | 15915 | 2485 | 17473 | 2050 | 18473 | 1704 | 19931 | 1099 | 24250 | 551 | 20063 |
| 5L-4S | | MI | 7867 | 3417 | 13068 | 2413 | 14309 | 1985 | 15148 | 1626 | 16514 | 1050 | 19623 | 547 | 15991 |
| 14-#14 | 4.38 | MA | 9540 | 3417 | 15312 | 2495 | 16675 | 2083 | 17480 | 1716 | 18596 | 1126 | 22509 | 448 | 19327 |
| 6L-3S | | MI | 7978 | 3417 | 13617 | 2380 | 15020 | 1976 | 16021 | 1620 | 17651 | 1030 | 21040 | 632 | 16298 |
| 14-#18 | 7.78 | MA | 11256 | 4095 | 19156 | 2935 | 21535 | 2411 | 23377 | 1922 | 26552 | 1068 | 33568 | 189 | 32499 |
| 5L-4S | | MI | 9110 | 4095 | 15795 | 2840 | 17740 | 2291 | 19305 | 1809 | 22198 | 1002 | 26657 | 142 | 25769 |
| 16-#10 | 2.82 | MA | 9276 | 3108 | 14923 | 2278 | 16316 | 1898 | 17122 | 1590 | 18204 | 1111 | 21691 | 790 | 14144 |
| 4L-6S | | MI | 7121 | 3108 | 11361 | 2246 | 12163 | 1882 | 12544 | 1575 | 12920 | 1095 | 15121 | 649 | 10652 |

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

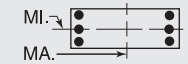



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.82 | MA | 9112 | 3108 | 14578 | 2288 | 15855 | 1907 | 16545 | 1609 | 17350 | 1116 | 20590 | 748 | 14014 |
| 5E | | MI | 7209 | 3108 | 11622 | 2240 | 12518 | 1875 | 12985 | 1569 | 13513 | 1081 | 15901 | 708 | 10870 |
| 16-#10 | 2.82 | MA | 8996 | 3108 | 14219 | 2293 | 15396 | 1927 | 15974 | 1617 | 16582 | 1133 | 19600 | 691 | 13666 |
| 6L-4S | | MI | 7331 | 3108 | 11889 | 2231 | 12874 | 1857 | 13430 | 1553 | 14170 | 1079 | 16756 | 758 | 10988 |
| 16-#10 | 2.82 | MA | 8871 | 3108 | 13828 | 2310 | 14931 | 1933 | 15430 | 1636 | 15834 | 1150 | 18439 | 640 | 13444 |
| 7L-3S | | MI | 7402 | 3108 | 12208 | 2212 | 13287 | 1850 | 13937 | 1547 | 14831 | 1065 | 17610 | 809 | 10987 |
| 16-#10 | 2.82 | MA | 8733 | 3108 | 13484 | 2317 | 14457 | 1949 | 14863 | 1642 | 15037 | 1155 | 17436 | 592 | 12987 |
| 8L-2S | | MI | 7543 | 3108 | 12624 | 2204 | 13821 | 1832 | 14589 | 1531 | 15718 | 1051 | 18837 | 899 | 10974 |
| 16-#11 | 3.47 | MA | 9602 | 3236 | 15675 | 2351 | 17233 | 1949 | 18220 | 1619 | 19695 | 1098 | 23757 | 736 | 17052 |
| 4L-6S | | MI | 7319 | 3236 | 11790 | 2330 | 12685 | 1932 | 13158 | 1602 | 13744 | 1079 | 16140 | 546 | 12633 |
| 16-#11 | 3.47 | MA | 9408 | 3236 | 15255 | 2363 | 16672 | 1960 | 17519 | 1641 | 18657 | 1103 | 22417 | 680 | 16649 |
| 5E | | MI | 7422 | 3236 | 12123 | 2309 | 13114 | 1925 | 13692 | 1597 | 14461 | 1063 | 17061 | 616 | 12855 |
| 16-#11 | 3.47 | MA | 9270 | 3236 | 14828 | 2369 | 16115 | 1984 | 16825 | 1650 | 17724 | 1123 | 21206 | 609 | 16282 |
| 6L-4S | | MI | 7567 | 3236 | 12447 | 2299 | 13545 | 1904 | 14230 | 1578 | 15256 | 1062 | 18068 | 678 | 13182 |
| 16-#11 | 3.47 | MA | 9123 | 3236 | 14353 | 2389 | 15561 | 1991 | 16163 | 1673 | 16815 | 1142 | 19947 | 564 | 15790 |
| 7L-3S | | MI | 7648 | 3236 | 12832 | 2276 | 14044 | 1897 | 14843 | 1572 | 16054 | 1046 | 19078 | 739 | 13199 |
| 16-#14 | 5.00 | MA | 10148 | 3542 | 16861 | 2563 | 18686 | 2105 | 19951 | 1738 | 21943 | 1089 | 27036 | 537 | 22939 |
| 5E | | MI | 7965 | 3542 | 13318 | 2503 | 14607 | 2070 | 15494 | 1686 | 16896 | 1041 | 20235 | 434 | 17588 |
| 16-#14 | 5.00 | MA | 9956 | 3542 | 16257 | 2573 | 17888 | 2139 | 18959 | 1750 | 20608 | 1116 | 25295 | 434 | 22175 |
| 6L-4S | | MI | 8166 | 3542 | 13781 | 2490 | 15222 | 2041 | 16261 | 1660 | 18029 | 1040 | 21644 | 525 | 18109 |
| 18-#10 | 3.17 | MA | 9354 | 3178 | 15126 | 2332 | 16558 | 1939 | 17403 | 1628 | 18517 | 1111 | 22206 | 740 | 15674 |
| 5L-6S | | MI | 7302 | 3178 | 11778 | 2289 | 12697 | 1913 | 13196 | 1594 | 13807 | 1089 | 16348 | 641 | 11918 |
| 18-#10 | 3.17 | MA | 9240 | 3178 | 14768 | 2337 | 16099 | 1959 | 16832 | 1636 | 17749 | 1127 | 21216 | 683 | 15340 |
| 6L-5S | | MI | 7388 | 3178 | 12039 | 2284 | 13052 | 1907 | 13637 | 1588 | 14399 | 1076 | 17128 | 700 | 12126 |
| 18-#10 | 3.17 | MA | 9116 | 3178 | 14376 | 2354 | 15634 | 1964 | 16287 | 1655 | 17001 | 1144 | 20055 | 633 | 15114 |
| 7L-4S | | MI | 7509 | 3178 | 12306 | 2275 | 13408 | 1889 | 14082 | 1572 | 15057 | 1073 | 17983 | 750 | 12285 |
| 18-#10 | 3.17 | MA | 8980 | 3178 | 14033 | 2361 | 15160 | 1981 | 15721 | 1661 | 16204 | 1150 | 19052 | 584 | 14656 |
| 8L-3S | | MI | 7580 | 3178 | 12624 | 2256 | 13821 | 1882 | 14589 | 1566 | 15718 | 1059 | 18837 | 801 | 12292 |
| 18-#11 | 3.90 | MA | 9697 | 3323 | 15919 | 2417 | 17523 | 1998 | 18557 | 1665 | 20068 | 1097 | 24371 | 671 | 18660 |
| 5L-6S | | MI | 7534 | 3323 | 12291 | 2384 | 13328 | 1971 | 13942 | 1626 | 14811 | 1072 | 17585 | 533 | 14157 |
| 18-#11 | 3.90 | MA | 9562 | 3323 | 15491 | 2423 | 16965 | 2022 | 17863 | 1674 | 19136 | 1116 | 23160 | 600 | 18309 |
| 6L-5S | | MI | 7636 | 3323 | 12625 | 2363 | 13757 | 1964 | 14476 | 1620 | 15528 | 1056 | 18506 | 603 | 14368 |
| 18-#11 | 3.90 | MA | 9416 | 3323 | 15016 | 2443 | 16411 | 2029 | 17200 | 1696 | 18227 | 1136 | 21902 | 554 | 17796 |
| 7L-4S | | MI | 7779 | 3323 | 12949 | 2353 | 14188 | 1943 | 15014 | 1601 | 16323 | 1055 | 19513 | 665 | 14737 |
| 18-#14 | 5.63 | MA | 10369 | 3666 | 17203 | 2651 | 19100 | 2195 | 20437 | 1784 | 22620 | 1106 | 28081 | 420 | 25031 |
| 6L-5S | | MI | 8266 | 3666 | 14030 | 2581 | 15520 | 2126 | 16608 | 1720 | 18411 | 1031 | 22255 | 412 | 19744 |
| 20-#10 | 3.53 | MA | 9483 | 3249 | 15316 | 2381 | 16802 | 1990 | 17690 | 1655 | 18916 | 1122 | 22832 | 675 | 17017 |
| 6E | | MI | 7482 | 3249 | 12195 | 2333 | 13232 | 1945 | 13848 | 1613 | 14694 | 1084 | 17575 | 633 | 13187 |
| 20-#10 | 3.53 | MA | 9359 | 3249 | 14925 | 2398 | 16338 | 1996 | 17145 | 1674 | 18168 | 1139 | 21671 | 625 | 16773 |
| 7L-5S | | MI | 7567 | 3249 | 12455 | 2327 | 13586 | 1938 | 14289 | 1607 | 15286 | 1070 | 18355 | 692 | 13384 |
| 20-#10 | 3.53 | MA | 9225 | 3249 | 14581 | 2405 | 15863 | 2012 | 16579 | 1680 | 17371 | 1144 | 20668 | 577 | 16327 |
| 8L-4S | | MI | 7687 | 3249 | 12723 | 2319 | 13942 | 1920 | 14733 | 1591 | 15944 | 1068 | 19210 | 742 | 13580 |
| 20-#11 | 4.33 | MA | 9853 | 3409 | 16154 | 2477 | 17815 | 2061 | 18900 | 1697 | 20547 | 1109 | 25114 | 590 | 20338 |
| 6E | | MI | 7749 | 3409 | 12792 | 2438 | 13970 | 2010 | 14727 | 1649 | 15878 | 1065 | 19030 | 520 | 15684 |
| 20-#11 | 4.33 | MA | 9708 | 3409 | 15679 | 2497 | 17262 | 2068 | 18238 | 1720 | 19638 | 1129 | 23856 | 545 | 19806 |
| 7L-5S | | MI | 7849 | 3409 | 13126 | 2416 | 14400 | 2002 | 15260 | 1644 | 16595 | 1050 | 19951 | 590 | 15884 |
| 22-#10 | 3.88 | MA | 9601 | 3319 | 15473 | 2442 | 17041 | 2027 | 18003 | 1693 | 19335 | 1133 | 23287 | 617 | 18435 |
| 7L-6S | | MI | 7662 | 3319 | 12611 | 2377 | 13766 | 1977 | 14500 | 1632 | 15581 | 1078 | 18802 | 625 | 14458 |
| 22-#10 | 3.88 | MA | 9469 | 3319 | 15130 | 2449 | 16566 | 2044 | 17437 | 1699 | 18539 | 1139 | 22284 | 569 | 18000 |
| 8L-5S | | MI | 7745 | 3319 | 12872 | 2371 | 14121 | 1970 | 14940 | 1627 | 16173 | 1064 | 19582 | 684 | 14646 |
| 22-#11 | 4.77 | MA | 9998 | 3495 | 16343 | 2551 | 18112 | 2107 | 19275 | 1743 | 21049 | 1122 | 25810 | 535 | 21819 |
| 7L-6S | | MI | 7963 | 3495 | 13294 | 2492 | 14613 | 2049 | 15511 | 1673 | 16945 | 1058 | 20475 | 507 | 17213 |
| 24-#10 | 4.23 | MA | 9712 | 3389 | 15679 | 2493 | 17269 | 2075 | 18294 | 1718 | 19706 | 1133 | 23900 | 561 | 19675 |
| 8L-6S | | MI | 7841 | 3389 | 13028 | 2421 | 14300 | 2008 | 15151 | 1651 | 16468 | 1073 | 20028 | 617 | 15730 |

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

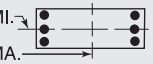
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.17 | MA | 9596 | 2965 | 15164 | 2166 | 16201 | 1826 | 16586 | 1563 | 16719 | 1170 | 19022 | 1016 | 6902 |
| 2E | | MI | 7125 | 2965 | 11392 | 2100 | 12004 | 1771 | 12188 | 1514 | 12159 | 1131 | 13554 | 965 | 5082 |
| 4-#18 | 2.08 | MA | 10239 | 3158 | 16733 | 2267 | 18143 | 1897 | 18925 | 1601 | 19885 | 1143 | 23392 | 985 | 11796 |
| 2E | | MI | 7546 | 3158 | 12464 | 2195 | 13317 | 1835 | 13763 | 1547 | 14291 | 1100 | 16155 | 891 | 8520 |
| 6-#11 | 1.22 | MA | 9648 | 2975 | 15239 | 2182 | 16333 | 1839 | 16763 | 1573 | 16970 | 1175 | 19376 | 1020 | 7189 |
| 2L-3S | | MI | 6985 | 2975 | 10947 | 2129 | 11467 | 1807 | 11546 | 1546 | 11292 | 1153 | 12450 | 868 | 5323 |
| 6-#11 | 1.22 | MA | 9381 | 2975 | 14522 | 2194 | 15414 | 1850 | 15642 | 1596 | 15444 | 1195 | 17263 | 918 | 7226 |
| 3L-2S | | MI | 7163 | 2975 | 11448 | 2120 | 12109 | 1786 | 12330 | 1526 | 12359 | 1138 | 13895 | 977 | 5283 |
| 6-#14 | 1.76 | MA | 10043 | 3089 | 16187 | 2244 | 17513 | 1882 | 18186 | 1597 | 18897 | 1160 | 22037 | 1002 | 10141 |
| 2L-3S | | MI | 7178 | 3089 | 11392 | 2191 | 12004 | 1856 | 12188 | 1574 | 12159 | 1142 | 13554 | 784 | 7425 |
| 6-#14 | 1.76 | MA | 9671 | 3089 | 15164 | 2261 | 16201 | 1897 | 16586 | 1629 | 16719 | 1188 | 19022 | 853 | 10180 |
| 3L-2S | | MI | 7426 | 3089 | 12104 | 2178 | 12917 | 1826 | 13302 | 1548 | 13675 | 1121 | 15574 | 943 | 7370 |
| 6-#18 | 3.13 | MA | 10999 | 3380 | 18513 | 2406 | 20425 | 1996 | 21709 | 1661 | 23673 | 1125 | 28638 | 960 | 17390 |
| 2L-3S | | MI | 7645 | 3380 | 12464 | 2352 | 13317 | 1983 | 13763 | 1650 | 14291 | 1113 | 16155 | 557 | 12449 |
| 6-#18 | 3.13 | MA | 10380 | 3380 | 16733 | 2434 | 18143 | 2020 | 18925 | 1716 | 19885 | 1172 | 23392 | 685 | 17334 |
| 3L-2S | | MI | 8055 | 3380 | 13691 | 2334 | 14890 | 1935 | 15682 | 1608 | 16902 | 1083 | 19522 | 839 | 12413 |
| 8-#9 | 1.04 | MA | 9537 | 2937 | 14906 | 2177 | 15975 | 1838 | 16356 | 1576 | 16433 | 1189 | 18647 | 1034 | 6236 |
| 2L-4S | | MI | 6915 | 2937 | 10636 | 2143 | 11128 | 1810 | 11157 | 1552 | 10800 | 1178 | 11894 | 895 | 4649 |
| 8-#9 | 1.04 | MA | 9359 | 2937 | 14437 | 2185 | 15374 | 1846 | 15623 | 1592 | 15436 | 1203 | 17265 | 971 | 6257 |
| 3E | | MI | 6974 | 2937 | 10888 | 2127 | 11455 | 1805 | 11559 | 1548 | 11323 | 1167 | 12568 | 935 | 4621 |
| 8-#9 | 1.04 | MA | 9262 | 2937 | 14084 | 2202 | 14916 | 1862 | 15060 | 1599 | 14702 | 1217 | 16347 | 933 | 6280 |
| 4L-2S | | MI | 7094 | 2937 | 11219 | 2121 | 11879 | 1790 | 12076 | 1534 | 12027 | 1155 | 13543 | 1005 | 4600 |
| 8-#10 | 1.32 | MA | 9753 | 2997 | 15415 | 2209 | 16610 | 1861 | 17123 | 1589 | 17471 | 1181 | 20080 | 1025 | 7818 |
| 2L-4S | | MI | 7017 | 2997 | 10841 | 2179 | 11373 | 1836 | 11448 | 1568 | 11198 | 1174 | 12450 | 854 | 5792 |
| 8-#10 | 1.32 | MA | 9532 | 2997 | 14823 | 2220 | 15850 | 1870 | 16196 | 1608 | 16211 | 1199 | 18334 | 944 | 7843 |
| 3E | | MI | 7091 | 2997 | 11160 | 2160 | 11786 | 1829 | 11955 | 1562 | 11859 | 1161 | 13304 | 905 | 5758 |
| 8-#10 | 1.32 | MA | 9411 | 2997 | 14377 | 2241 | 15271 | 1891 | 15484 | 1617 | 15283 | 1216 | 17170 | 895 | 7863 |
| 4L-2S | | MI | 7240 | 2997 | 11577 | 2151 | 12320 | 1811 | 12607 | 1546 | 12745 | 1147 | 14531 | 994 | 5730 |
| 8-#11 | 1.63 | MA | 9963 | 3061 | 15956 | 2236 | 17253 | 1878 | 17885 | 1596 | 18496 | 1168 | 21489 | 1011 | 9456 |
| 2L-4S | | MI | 7117 | 3061 | 11063 | 2206 | 11610 | 1853 | 11717 | 1574 | 11561 | 1162 | 12885 | 794 | 6964 |
| 8-#11 | 1.63 | MA | 9701 | 3061 | 15239 | 2248 | 16333 | 1889 | 16763 | 1619 | 16970 | 1188 | 19376 | 909 | 9484 |
| 3E | | MI | 7201 | 3061 | 11448 | 2183 | 12109 | 1846 | 12330 | 1569 | 12359 | 1146 | 13895 | 855 | 6926 |
| 8-#11 | 1.63 | MA | 9560 | 3061 | 14697 | 2274 | 15630 | 1913 | 15899 | 1629 | 15843 | 1209 | 17952 | 848 | 9494 |
| 4L-2S | | MI | 7376 | 3061 | 11949 | 2174 | 12752 | 1825 | 13114 | 1550 | 13426 | 1131 | 15340 | 964 | 6890 |
| 8-#14 | 2.34 | MA | 10487 | 3214 | 17210 | 2321 | 18825 | 1938 | 19787 | 1630 | 21074 | 1150 | 25052 | 989 | 13360 |
| 2L-4S | | MI | 7367 | 3214 | 11555 | 2301 | 12206 | 1921 | 12429 | 1615 | 12538 | 1152 | 14158 | 677 | 9683 |
| 8-#14 | 2.34 | MA | 10124 | 3214 | 16187 | 2339 | 17513 | 1953 | 18186 | 1663 | 18897 | 1178 | 22037 | 839 | 13378 |
| 3E | | MI | 7482 | 3214 | 12104 | 2268 | 12917 | 1912 | 13302 | 1608 | 13675 | 1132 | 15574 | 762 | 9675 |
| 8-#14 | 2.34 | MA | 9927 | 3214 | 15412 | 2376 | 16507 | 1988 | 16950 | 1676 | 17286 | 1207 | 19991 | 751 | 13300 |
| 4L-2S | | MI | 7725 | 3214 | 12816 | 2256 | 13830 | 1882 | 14416 | 1582 | 15190 | 1111 | 17594 | 921 | 9633 |
| 8-#18 | 4.17 | MA | 11753 | 3601 | 20294 | 2544 | 22708 | 2095 | 24494 | 1722 | 27462 | 1107 | 33883 | 936 | 22959 |
| 2L-4S | | MI | 7976 | 3601 | 12739 | 2545 | 13657 | 2095 | 14169 | 1717 | 14931 | 1126 | 17145 | 362 | 15048 |
| 8-#18 | 4.17 | MA | 11156 | 3601 | 18513 | 2572 | 20425 | 2119 | 21709 | 1776 | 23673 | 1154 | 28638 | 661 | 22841 |
| 3E | | MI | 8162 | 3601 | 13691 | 2491 | 14890 | 2082 | 15682 | 1710 | 16902 | 1096 | 19522 | 505 | 16254 |
| 8-#18 | 4.17 | MA | 10831 | 3601 | 17158 | 2635 | 18668 | 2178 | 19549 | 1796 | 20860 | 1200 | 25027 | 502 | 21146 |
| 4L-2S | | MI | 8561 | 3601 | 14919 | 2472 | 16463 | 2034 | 17601 | 1668 | 19513 | 1065 | 22889 | 786 | 16274 |
| 10-#10 | 1.65 | MA | 10015 | 3067 | 16008 | 2253 | 17369 | 1892 | 18049 | 1608 | 18732 | 1175 | 21825 | 1017 | 9685 |
| 2L-5S | | MI | 7073 | 3067 | 10991 | 2231 | 11551 | 1886 | 11655 | 1604 | 11427 | 1171 | 12822 | 795 | 7125 |
| 10-#10 | 1.65 | MA | 9798 | 3067 | 15415 | 2264 | 16610 | 1902 | 17123 | 1627 | 17471 | 1193 | 20080 | 936 | 9705 |
| 3L-4S | | MI | 7199 | 3067 | 11258 | 2223 | 11907 | 1868 | 12099 | 1587 | 12085 | 1169 | 13677 | 846 | 7109 |
| 10-#10 | 1.65 | MA | 9678 | 3067 | 14970 | 2285 | 16031 | 1922 | 16410 | 1636 | 16543 | 1211 | 18915 | 887 | 9713 |
| 4L-3S | | MI | 7272 | 3067 | 11577 | 2204 | 12320 | 1861 | 12607 | 1581 | 12745 | 1155 | 14531 | 897 | 7083 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

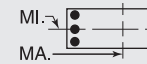
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.65 | MA | 9494 | 3067 | 14598 | 2296 | 15535 | 1932 | 15790 | 1656 | 15623 | 1217 | 17733 | 847 | 9681 |
| 5L-2S | | MI | 7419 | 3067 | 11993 | 2195 | 12855 | 1843 | 13259 | 1565 | 13632 | 1141 | 15758 | 986 | 7058 |
| 10-#11 | 2.03 | MA | 10277 | 3147 | 16673 | 2290 | 18172 | 1917 | 19007 | 1620 | 20022 | 1161 | 23602 | 1001 | 11713 |
| 2L-5S | | MI | 7183 | 3147 | 11240 | 2269 | 11822 | 1913 | 11963 | 1617 | 11833 | 1156 | 13323 | 719 | 8462 |
| 10-#11 | 2.03 | MA | 10019 | 3147 | 15956 | 2302 | 17253 | 1928 | 17885 | 1643 | 18496 | 1182 | 21489 | 899 | 11733 |
| 3L-4S | | MI | 7332 | 3147 | 11564 | 2260 | 12253 | 1892 | 12501 | 1598 | 12628 | 1155 | 14331 | 781 | 8541 |
| 10-#11 | 2.03 | MA | 9879 | 3147 | 15415 | 2328 | 16550 | 1952 | 17020 | 1652 | 17369 | 1202 | 20065 | 839 | 11724 |
| 4L-3S | | MI | 7416 | 3147 | 11949 | 2237 | 12752 | 1885 | 13114 | 1593 | 13426 | 1140 | 15340 | 842 | 8515 |
| 10-#11 | 2.03 | MA | 9659 | 3147 | 14963 | 2340 | 15946 | 1963 | 16266 | 1676 | 16251 | 1209 | 18624 | 786 | 11558 |
| 5L-2S | | MI | 7589 | 3147 | 12451 | 2228 | 13395 | 1864 | 13898 | 1573 | 14493 | 1124 | 16785 | 951 | 8484 |
| 10-#14 | 2.93 | MA | 10928 | 3338 | 18234 | 2399 | 20137 | 1994 | 21388 | 1664 | 23252 | 1140 | 28067 | 975 | 16569 |
| 2L-5S | | MI | 7461 | 3338 | 11804 | 2391 | 12504 | 2006 | 12775 | 1675 | 12920 | 1143 | 14770 | 564 | 11296 |
| 10-#14 | 2.93 | MA | 10573 | 3338 | 17210 | 2416 | 18825 | 2009 | 19787 | 1697 | 21074 | 1168 | 25052 | 825 | 16564 |
| 3L-4S | | MI | 7671 | 3338 | 12267 | 2379 | 13119 | 1977 | 13543 | 1649 | 14053 | 1142 | 16178 | 655 | 11890 |
| 10-#14 | 2.93 | MA | 10379 | 3338 | 16435 | 2453 | 17819 | 2044 | 18551 | 1710 | 19464 | 1197 | 23006 | 737 | 16462 |
| 4L-3S | | MI | 7785 | 3338 | 12816 | 2346 | 13830 | 1967 | 14416 | 1642 | 15190 | 1122 | 17594 | 740 | 11911 |
| 10-#14 | 2.93 | MA | 10069 | 3338 | 15788 | 2470 | 16955 | 2059 | 17471 | 1743 | 17864 | 1205 | 20940 | 659 | 15564 |
| 5L-2S | | MI | 8023 | 3338 | 13528 | 2334 | 14743 | 1938 | 15530 | 1616 | 16706 | 1101 | 19614 | 898 | 11882 |
| 10-#18 | 5.21 | MA | 11923 | 3822 | 20294 | 2710 | 22708 | 2218 | 24494 | 1837 | 27462 | 1136 | 33883 | 636 | 28346 |
| 3L-4S | | MI | 8494 | 3822 | 13966 | 2683 | 15230 | 2194 | 16088 | 1778 | 17542 | 1108 | 20512 | 310 | 18661 |
| 10-#18 | 5.21 | MA | 11606 | 3822 | 18939 | 2774 | 20950 | 2278 | 22334 | 1856 | 24648 | 1183 | 30272 | 477 | 26493 |
| 4L-3S | | MI | 8676 | 3822 | 14919 | 2629 | 16463 | 2181 | 17601 | 1771 | 19513 | 1078 | 22889 | 452 | 20049 |
| 10-#18 | 5.21 | MA | 11080 | 3822 | 17804 | 2802 | 19437 | 2301 | 20443 | 1911 | 21851 | 1194 | 26643 | 326 | 24907 |
| 5L-2S | | MI | 9065 | 3822 | 16146 | 2610 | 18036 | 2133 | 19521 | 1728 | 22124 | 1047 | 26256 | 734 | 20120 |
| 12-#10 | 1.98 | MA | 10276 | 3137 | 16600 | 2297 | 18129 | 1924 | 18976 | 1627 | 19992 | 1170 | 23571 | 1009 | 11547 |
| 2L-6S | | MI | 7165 | 3137 | 11147 | 2281 | 11731 | 1924 | 11866 | 1628 | 11722 | 1179 | 13269 | 729 | 8215 |
| 12-#10 | 1.98 | MA | 10062 | 3137 | 16008 | 2307 | 17369 | 1933 | 18049 | 1647 | 18732 | 1187 | 21825 | 928 | 11561 |
| 3L-5S | | MI | 7255 | 3137 | 11408 | 2275 | 12086 | 1917 | 12307 | 1623 | 12314 | 1166 | 14049 | 788 | 8424 |
| 12-#10 | 1.98 | MA | 9943 | 3137 | 15562 | 2329 | 16790 | 1954 | 17337 | 1655 | 17804 | 1205 | 20661 | 880 | 11558 |
| 4E | | MI | 7379 | 3137 | 11675 | 2267 | 12442 | 1899 | 12751 | 1606 | 12971 | 1163 | 14904 | 838 | 8420 |
| 12-#10 | 1.98 | MA | 9761 | 3137 | 15191 | 2340 | 16294 | 1963 | 16716 | 1675 | 16884 | 1211 | 19478 | 839 | 11515 |
| 5L-3S | | MI | 7452 | 3137 | 11993 | 2247 | 12855 | 1892 | 13259 | 1601 | 13632 | 1149 | 15758 | 889 | 8401 |
| 12-#10 | 1.98 | MA | 9630 | 3137 | 14800 | 2344 | 15801 | 1984 | 16102 | 1683 | 16057 | 1229 | 18419 | 782 | 11168 |
| 6L-2S | | MI | 7597 | 3137 | 12410 | 2239 | 13389 | 1874 | 13910 | 1584 | 14519 | 1136 | 16984 | 979 | 8378 |
| 12-#11 | 2.44 | MA | 10588 | 3234 | 17391 | 2344 | 19092 | 1955 | 20128 | 1643 | 21548 | 1154 | 25715 | 992 | 13964 |
| 2L-6S | | MI | 7292 | 3234 | 11408 | 2345 | 12035 | 1959 | 12213 | 1646 | 12183 | 1165 | 13847 | 635 | 9696 |
| 12-#11 | 2.44 | MA | 10335 | 3234 | 16673 | 2356 | 18172 | 1966 | 19007 | 1666 | 20022 | 1175 | 23602 | 890 | 13977 |
| 3L-5S | | MI | 7399 | 3234 | 11742 | 2323 | 12465 | 1952 | 12747 | 1641 | 12900 | 1150 | 14768 | 706 | 9954 |
| 12-#11 | 2.44 | MA | 10197 | 3234 | 16132 | 2382 | 17469 | 1991 | 18142 | 1676 | 18895 | 1195 | 22178 | 829 | 13951 |
| 4E | | MI | 7547 | 3234 | 12066 | 2314 | 12896 | 1931 | 13285 | 1622 | 13695 | 1148 | 15776 | 768 | 10112 |
| 12-#11 | 2.44 | MA | 9980 | 3234 | 15680 | 2394 | 16866 | 2002 | 17388 | 1699 | 17777 | 1202 | 20737 | 777 | 13715 |
| 5L-3S | | MI | 7630 | 3234 | 12451 | 2291 | 13395 | 1923 | 13898 | 1616 | 14493 | 1133 | 16785 | 829 | 10096 |
| 12-#11 | 2.44 | MA | 9823 | 3234 | 15212 | 2400 | 16266 | 2027 | 16640 | 1709 | 16772 | 1222 | 19441 | 706 | 13248 |
| 6L-2S | | MI | 7801 | 3234 | 12952 | 2281 | 14038 | 1902 | 14683 | 1597 | 15560 | 1117 | 18230 | 938 | 10071 |
| 12-#14 | 3.52 | MA | 11019 | 3463 | 18234 | 2494 | 20137 | 2065 | 21388 | 1731 | 23252 | 1158 | 28067 | 812 | 19745 |
| 3L-5S | | MI | 7766 | 3463 | 12517 | 2469 | 13417 | 2062 | 13889 | 1709 | 14435 | 1133 | 16790 | 542 | 13427 |
| 12-#14 | 3.52 | MA | 10828 | 3463 | 17459 | 2531 | 19131 | 2100 | 20151 | 1744 | 21641 | 1187 | 26021 | 724 | 19624 |
| 4E | | MI | 7973 | 3463 | 12979 | 2456 | 14032 | 2033 | 14656 | 1683 | 15569 | 1132 | 18198 | 632 | 14038 |
| 12-#14 | 3.52 | MA | 10523 | 3463 | 16811 | 2548 | 18267 | 2115 | 19071 | 1777 | 20042 | 1195 | 23955 | 645 | 18663 |
| 5L-3S | | MI | 8086 | 3463 | 13528 | 2424 | 14743 | 2023 | 15530 | 1676 | 16706 | 1112 | 19614 | 718 | 14137 |
| 12-#14 | 3.52 | MA | 10303 | 3463 | 16150 | 2557 | 17408 | 2149 | 18001 | 1789 | 18604 | 1224 | 22091 | 543 | 18006 |
| 6L-2S | | MI | 8320 | 3463 | 14240 | 2412 | 15656 | 1994 | 16643 | 1650 | 18221 | 1091 | 21634 | 876 | 14122 |
| 12-#18 | 6.25 | MA | 12372 | 4044 | 20719 | 2912 | 23232 | 2377 | 25118 | 1917 | 28436 | 1165 | 35517 | 453 | 31863 |
| 4E | | MI | 9007 | 4044 | 15193 | 2821 | 16803 | 2293 | 18007 | 1838 | 20153 | 1091 | 23879 | 257 | 22301 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

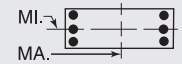


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 6.25 | MA | 11860 | 4044 | 19584 | 2940 | 21720 | 2401 | 23227 | 1972 | 25639 | 1176 | 31888 | 302 | 30258 |
| 5L-3S | | MI | 9187 | 4044 | 16146 | 2767 | 18036 | 2281 | 19521 | 1831 | 22124 | 1060 | 26256 | 400 | 23839 |
| 14-#10 | 2.32 | MA | 10324 | 3208 | 16600 | 2351 | 18129 | 1965 | 18976 | 1666 | 19992 | 1182 | 23571 | 920 | 13414 |
| 3L-6S | | MI | 7347 | 3208 | 11564 | 2325 | 12265 | 1956 | 12517 | 1647 | 12608 | 1174 | 14496 | 721 | 9474 |
| 14-#10 | 2.32 | MA | 10207 | 3208 | 16154 | 2373 | 17550 | 1985 | 18263 | 1674 | 19065 | 1199 | 22406 | 872 | 13400 |
| 4L-5S | | MI | 7436 | 3208 | 11824 | 2319 | 12620 | 1949 | 12958 | 1642 | 13201 | 1160 | 15276 | 780 | 9713 |
| 14-#10 | 2.32 | MA | 10027 | 3208 | 15783 | 2384 | 17054 | 1995 | 17643 | 1694 | 18144 | 1206 | 21224 | 831 | 13349 |
| 5L-4S | | MI | 7559 | 3208 | 12092 | 2311 | 12976 | 1931 | 13403 | 1625 | 13858 | 1157 | 16131 | 830 | 9726 |
| 14-#10 | 2.32 | MA | 9898 | 3208 | 15392 | 2388 | 16560 | 2016 | 17028 | 1702 | 17318 | 1223 | 20165 | 775 | 12971 |
| 6L-3S | | MI | 7631 | 3208 | 12410 | 2291 | 13389 | 1924 | 13910 | 1620 | 14519 | 1144 | 16984 | 881 | 9713 |
| 14-#10 | 2.32 | MA | 9760 | 3208 | 14970 | 2406 | 16053 | 2021 | 16442 | 1722 | 16513 | 1241 | 18919 | 726 | 12708 |
| 7L-2S | | MI | 7774 | 3208 | 12827 | 2283 | 13923 | 1906 | 14562 | 1603 | 15406 | 1130 | 18211 | 971 | 9694 |
| 14-#11 | 2.84 | MA | 10650 | 3320 | 17391 | 2410 | 19092 | 2005 | 20128 | 1690 | 21548 | 1168 | 25715 | 880 | 16212 |
| 3L-6S | | MI | 7509 | 3320 | 11910 | 2399 | 12678 | 1998 | 12998 | 1670 | 13250 | 1158 | 15292 | 622 | 11212 |
| 14-#11 | 2.84 | MA | 10513 | 3320 | 16849 | 2436 | 18388 | 2030 | 19264 | 1700 | 20421 | 1188 | 24291 | 820 | 16176 |
| 4L-5S | | MI | 7615 | 3320 | 12243 | 2377 | 13108 | 1991 | 13531 | 1664 | 13967 | 1143 | 16213 | 693 | 11454 |
| 14-#11 | 2.84 | MA | 10298 | 3320 | 16397 | 2448 | 17785 | 2041 | 18509 | 1723 | 19303 | 1195 | 22850 | 767 | 15879 |
| 5L-4S | | MI | 7761 | 3320 | 12567 | 2368 | 13539 | 1969 | 14070 | 1645 | 14762 | 1141 | 17221 | 755 | 11675 |
| 14-#11 | 2.84 | MA | 10145 | 3320 | 15929 | 2454 | 17185 | 2065 | 17762 | 1732 | 18299 | 1215 | 21554 | 697 | 15433 |
| 6L-3S | | MI | 7844 | 3320 | 12952 | 2345 | 14038 | 1962 | 14683 | 1640 | 15560 | 1126 | 18230 | 816 | 11671 |
| 14-#11 | 2.84 | MA | 9981 | 3320 | 15417 | 2475 | 16579 | 2072 | 17049 | 1756 | 17320 | 1236 | 20034 | 635 | 14998 |
| 7L-2S | | MI | 8012 | 3320 | 13454 | 2335 | 14681 | 1941 | 15467 | 1620 | 16627 | 1110 | 19676 | 925 | 11651 |
| 14-#14 | 4.10 | MA | 11273 | 3587 | 18482 | 2609 | 20443 | 2155 | 21752 | 1778 | 23819 | 1177 | 29036 | 710 | 22786 |
| 4L-5S | | MI | 8070 | 3587 | 13229 | 2547 | 14330 | 2118 | 15003 | 1743 | 15951 | 1123 | 18810 | 519 | 15568 |
| 14-#14 | 4.10 | MA | 10974 | 3587 | 17835 | 2626 | 19579 | 2170 | 20672 | 1811 | 22219 | 1186 | 26970 | 631 | 21772 |
| 5L-4S | | MI | 8275 | 3587 | 13691 | 2534 | 14945 | 2089 | 15770 | 1717 | 17084 | 1122 | 20218 | 610 | 16142 |
| 14-#14 | 4.10 | MA | 10759 | 3587 | 17173 | 2635 | 18720 | 2205 | 19602 | 1823 | 20781 | 1214 | 25106 | 529 | 21090 |
| 6L-3S | | MI | 8386 | 3587 | 14240 | 2502 | 15656 | 2079 | 16643 | 1710 | 18221 | 1102 | 21634 | 695 | 16354 |
| 14-#14 | 4.10 | MA | 10530 | 3587 | 16441 | 2664 | 17863 | 2215 | 18581 | 1856 | 19380 | 1242 | 23168 | 464 | 20011 |
| 7L-2S | | MI | 8616 | 3587 | 14952 | 2489 | 16569 | 2050 | 17757 | 1684 | 19737 | 1081 | 23654 | 854 | 16356 |
| 14-#18 | 7.29 | MA | 12632 | 4265 | 21364 | 3078 | 24002 | 2500 | 26012 | 2032 | 29427 | 1158 | 37133 | 277 | 35624 |
| 5L-4S | | MI | 9518 | 4265 | 16420 | 2960 | 18376 | 2393 | 19926 | 1898 | 22764 | 1073 | 27246 | 205 | 25962 |
| 16-#10 | 2.65 | MA | 10469 | 3278 | 16747 | 2417 | 18309 | 2017 | 19190 | 1693 | 20325 | 1194 | 24152 | 864 | 15241 |
| 4L-6S | | MI | 7529 | 3278 | 11981 | 2369 | 12800 | 1987 | 13169 | 1666 | 13495 | 1168 | 15723 | 713 | 10737 |
| 16-#10 | 2.65 | MA | 10291 | 3278 | 16375 | 2428 | 17813 | 2026 | 18569 | 1713 | 19405 | 1200 | 22969 | 823 | 15182 |
| 5E | | MI | 7616 | 3278 | 12241 | 2363 | 13154 | 1980 | 13610 | 1661 | 14088 | 1154 | 16502 | 772 | 10962 |
| 16-#10 | 2.65 | MA | 10165 | 3278 | 15985 | 2432 | 17320 | 2047 | 17955 | 1721 | 18578 | 1218 | 21910 | 767 | 14777 |
| 6L-4S | | MI | 7738 | 3278 | 12509 | 2355 | 13510 | 1962 | 14055 | 1644 | 14745 | 1152 | 17358 | 822 | 11029 |
| 16-#10 | 2.65 | MA | 10027 | 3278 | 15562 | 2450 | 16812 | 2052 | 17369 | 1741 | 17774 | 1235 | 20664 | 719 | 14524 |
| 7L-3S | | MI | 7810 | 3278 | 12827 | 2335 | 13923 | 1955 | 14562 | 1639 | 15406 | 1138 | 18211 | 873 | 11022 |
| 16-#10 | 2.65 | MA | 9877 | 3278 | 15193 | 2457 | 16301 | 2069 | 16750 | 1747 | 16916 | 1242 | 19588 | 672 | 14084 |
| 8L-2S | | MI | 7951 | 3278 | 13244 | 2327 | 14457 | 1937 | 15214 | 1622 | 16293 | 1124 | 19438 | 963 | 11007 |
| 16-#11 | 3.25 | MA | 10827 | 3406 | 17566 | 2490 | 19308 | 2068 | 20385 | 1723 | 21947 | 1181 | 26404 | 810 | 18400 |
| 4L-6S | | MI | 7726 | 3406 | 12411 | 2452 | 13321 | 2037 | 13782 | 1693 | 14317 | 1151 | 16737 | 609 | 12733 |
| 16-#11 | 3.25 | MA | 10615 | 3406 | 17114 | 2502 | 18705 | 2079 | 19631 | 1746 | 20829 | 1188 | 24963 | 757 | 18050 |
| 5E | | MI | 7830 | 3406 | 12745 | 2431 | 13751 | 2029 | 14316 | 1688 | 15033 | 1136 | 17658 | 680 | 12961 |
| 16-#11 | 3.25 | MA | 10465 | 3406 | 16647 | 2508 | 18105 | 2104 | 18884 | 1756 | 19825 | 1209 | 23667 | 687 | 17623 |
| 6L-4S | | MI | 7975 | 3406 | 13069 | 2422 | 14182 | 2008 | 14854 | 1669 | 15829 | 1134 | 18666 | 742 | 13235 |
| 16-#11 | 3.25 | MA | 10302 | 3406 | 16134 | 2529 | 17498 | 2111 | 18171 | 1779 | 18846 | 1229 | 22147 | 625 | 17167 |
| 7L-3S | | MI | 8056 | 3406 | 13454 | 2399 | 14681 | 2001 | 15467 | 1663 | 16627 | 1119 | 19676 | 803 | 13242 |
| 16-#11 | 3.25 | MA | 10122 | 3406 | 15685 | 2538 | 16877 | 2131 | 17432 | 1787 | 17804 | 1236 | 20835 | 566 | 16586 |
| 8L-2S | | MI | 8222 | 3406 | 13955 | 2389 | 15323 | 1980 | 16251 | 1644 | 17694 | 1104 | 21121 | 912 | 13228 |
| 16-#14 | 4.69 | MA | 11421 | 3712 | 18858 | 2704 | 20891 | 2226 | 22272 | 1844 | 24397 | 1176 | 29985 | 617 | 24888 |
| 5E | | MI | 8372 | 3712 | 13941 | 2624 | 15243 | 2174 | 16116 | 1777 | 17466 | 1113 | 20830 | 497 | 17716 |
| 16-#14 | 4.69 | MA | 11213 | 3712 | 18197 | 2713 | 20032 | 2261 | 21202 | 1857 | 22959 | 1204 | 28121 | 515 | 24182 |
| 6L-4S | | MI | 8574 | 3712 | 14404 | 2612 | 15858 | 2145 | 16884 | 1750 | 18600 | 1112 | 22238 | 588 | 18257 |
| 16-#14 | 4.69 | MA | 10985 | 3712 | 17464 | 2742 | 19175 | 2271 | 20181 | 1890 | 21558 | 1232 | 26183 | 450 | 23133 |
| 7L-3S | | MI | 8685 | 3712 | 14952 | 2580 | 16569 | 2135 | 17757 | 1744 | 19737 | 1092 | 23654 | 673 | 18567 |

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

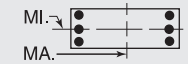



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.98 | MA | 10555 | 3348 | 16968 | 2472 | 18572 | 2058 | 19496 | 1732 | 20665 | 1194 | 24715 | 816 | 16976 |
| 5L-6S | | MI | 7710 | 3348 | 12397 | 2413 | 13334 | 2019 | 13821 | 1686 | 14382 | 1162 | 16949 | 705 | 12003 |
| 18-#10 | 2.98 | MA | 10430 | 3348 | 16577 | 2476 | 18079 | 2079 | 18881 | 1741 | 19839 | 1212 | 23656 | 759 | 16586 |
| 6L-5S | | MI | 7796 | 3348 | 12658 | 2407 | 13688 | 2012 | 14262 | 1680 | 14974 | 1149 | 17729 | 764 | 12217 |
| 18-#10 | 2.98 | MA | 10293 | 3348 | 16155 | 2493 | 17572 | 2084 | 18296 | 1760 | 19034 | 1230 | 22410 | 711 | 16342 |
| 7L-4S | | MI | 7917 | 3348 | 12925 | 2399 | 14044 | 1994 | 14707 | 1663 | 15632 | 1146 | 18584 | 814 | 12328 |
| 18-#10 | 2.98 | MA | 10145 | 3348 | 15785 | 2501 | 17061 | 2101 | 17676 | 1766 | 18177 | 1236 | 21334 | 664 | 15889 |
| 8L-3S | | MI | 7988 | 3348 | 13244 | 2379 | 14457 | 1987 | 15214 | 1658 | 16293 | 1133 | 19438 | 866 | 12328 |
| 18-#10 | 2.98 | MA | 10011 | 3348 | 15393 | 2520 | 16571 | 2107 | 17067 | 1782 | 17382 | 1253 | 20273 | 622 | 15506 |
| 9L-2S | | MI | 8128 | 3348 | 13661 | 2371 | 14992 | 1969 | 15866 | 1641 | 17179 | 1119 | 20665 | 955 | 12316 |
| 18-#11 | 3.66 | MA | 10930 | 3492 | 17831 | 2556 | 19624 | 2118 | 20752 | 1770 | 22355 | 1181 | 27076 | 748 | 20226 |
| 5L-6S | | MI | 7941 | 3492 | 12912 | 2506 | 13964 | 2075 | 14566 | 1717 | 15384 | 1144 | 18182 | 596 | 14256 |
| 18-#11 | 3.66 | MA | 10783 | 3492 | 17364 | 2562 | 19024 | 2143 | 20005 | 1779 | 21351 | 1202 | 25780 | 678 | 19816 |
| 6L-5S | | MI | 8044 | 3492 | 13246 | 2485 | 14393 | 2068 | 15100 | 1711 | 16100 | 1129 | 19104 | 667 | 14472 |
| 18-#11 | 3.66 | MA | 10621 | 3492 | 16851 | 2583 | 18418 | 2149 | 19292 | 1803 | 20372 | 1222 | 24260 | 616 | 19340 |
| 7L-4S | | MI | 8187 | 3492 | 13570 | 2476 | 14824 | 2047 | 15638 | 1692 | 16895 | 1127 | 20111 | 729 | 14792 |
| 18-#11 | 3.66 | MA | 10444 | 3492 | 16402 | 2591 | 17797 | 2170 | 18553 | 1810 | 19330 | 1229 | 22948 | 556 | 18775 |
| 8L-3S | | MI | 8268 | 3492 | 13955 | 2453 | 15323 | 2040 | 16251 | 1687 | 17694 | 1112 | 21121 | 790 | 14810 |
| 18-#14 | 5.27 | MA | 11663 | 3836 | 19220 | 2791 | 21344 | 2317 | 22803 | 1891 | 25136 | 1194 | 31136 | 501 | 27280 |
| 6L-5S | | MI | 8673 | 3836 | 14653 | 2702 | 16156 | 2230 | 17230 | 1811 | 18982 | 1103 | 22850 | 475 | 19871 |
| 18-#14 | 5.27 | MA | 11437 | 3836 | 18488 | 2820 | 20487 | 2327 | 21782 | 1924 | 23735 | 1223 | 29198 | 437 | 26259 |
| 7L-4S | | MI | 8873 | 3836 | 15116 | 2690 | 16771 | 2200 | 17998 | 1784 | 20115 | 1102 | 24258 | 565 | 20381 |
| 20-#10 | 3.31 | MA | 10694 | 3418 | 17169 | 2520 | 18839 | 2110 | 19808 | 1760 | 21100 | 1206 | 25401 | 751 | 18398 |
| 6E | | MI | 7890 | 3418 | 12814 | 2457 | 13868 | 2050 | 14473 | 1705 | 15269 | 1157 | 18176 | 697 | 13271 |
| 20-#10 | 3.31 | MA | 10558 | 3418 | 16747 | 2537 | 18331 | 2115 | 19222 | 1779 | 20295 | 1224 | 24155 | 703 | 18162 |
| 7L-5S | | MI | 7975 | 3418 | 13075 | 2451 | 14223 | 2043 | 14914 | 1699 | 15861 | 1143 | 18956 | 756 | 13474 |
| 20-#10 | 3.31 | MA | 10412 | 3418 | 16378 | 2545 | 17820 | 2132 | 18603 | 1785 | 19438 | 1230 | 23079 | 657 | 17696 |
| 8L-4S | | MI | 8095 | 3418 | 13342 | 2443 | 14579 | 2025 | 15358 | 1683 | 16519 | 1141 | 19811 | 806 | 13624 |
| 20-#10 | 3.31 | MA | 10282 | 3418 | 15986 | 2564 | 17330 | 2139 | 17994 | 1802 | 18642 | 1248 | 22018 | 614 | 17311 |
| 9L-3S | | MI | 8165 | 3418 | 13661 | 2423 | 14992 | 2019 | 15866 | 1677 | 17179 | 1127 | 20665 | 858 | 13633 |
| 20-#11 | 4.06 | MA | 11099 | 3579 | 18081 | 2616 | 19943 | 2182 | 21127 | 1803 | 22877 | 1195 | 27893 | 668 | 22012 |
| 6E | | MI | 8156 | 3579 | 13414 | 2560 | 14607 | 2114 | 15350 | 1740 | 16450 | 1137 | 19627 | 583 | 15782 |
| 20-#11 | 4.06 | MA | 10939 | 3579 | 17569 | 2637 | 19337 | 2188 | 20414 | 1826 | 21898 | 1215 | 26373 | 606 | 21517 |
| 7L-5S | | MI | 8257 | 3579 | 13748 | 2539 | 15036 | 2107 | 15884 | 1735 | 17167 | 1122 | 20549 | 654 | 15987 |
| 20-#11 | 4.06 | MA | 10764 | 3579 | 17120 | 2645 | 18716 | 2208 | 19675 | 1834 | 20856 | 1222 | 25061 | 546 | 20967 |
| 8L-4S | | MI | 8399 | 3579 | 14071 | 2530 | 15467 | 2086 | 16422 | 1716 | 17962 | 1120 | 21556 | 716 | 16347 |
| 20-#14 | 5.86 | MA | 11885 | 3961 | 19511 | 2898 | 21799 | 2383 | 23383 | 1958 | 25913 | 1213 | 32213 | 423 | 29389 |
| 7L-5S | | MI | 8973 | 3961 | 15365 | 2780 | 17069 | 2286 | 18344 | 1845 | 20497 | 1093 | 24870 | 453 | 22030 |
| 22-#10 | 3.64 | MA | 10821 | 3489 | 17340 | 2581 | 19091 | 2147 | 20149 | 1799 | 21555 | 1218 | 25901 | 695 | 19984 |
| 7L-6S | | MI | 8070 | 3489 | 13231 | 2501 | 14402 | 2082 | 15125 | 1724 | 16156 | 1151 | 19403 | 689 | 14541 |
| 22-#10 | 3.64 | MA | 10677 | 3489 | 16970 | 2589 | 18580 | 2164 | 19529 | 1804 | 20698 | 1225 | 24825 | 649 | 19505 |
| 8L-5S | | MI | 8153 | 3489 | 13491 | 2495 | 14757 | 2075 | 15565 | 1718 | 16748 | 1138 | 20183 | 748 | 14735 |
| 22-#10 | 3.64 | MA | 10550 | 3489 | 16578 | 2608 | 18090 | 2170 | 18920 | 1821 | 19903 | 1242 | 23764 | 606 | 19115 |
| 9L-4S | | MI | 8272 | 3489 | 13759 | 2487 | 15113 | 2057 | 16010 | 1702 | 17406 | 1135 | 21038 | 799 | 14920 |
| 22-#11 | 4.47 | MA | 11254 | 3665 | 18286 | 2691 | 20256 | 2227 | 21536 | 1850 | 23424 | 1208 | 28486 | 597 | 23697 |
| 7L-6S | | MI | 8370 | 3665 | 13915 | 2614 | 15249 | 2153 | 16134 | 1764 | 17517 | 1130 | 21072 | 570 | 17311 |
| 22-#11 | 4.47 | MA | 11083 | 3665 | 17837 | 2699 | 19636 | 2247 | 20796 | 1857 | 22382 | 1215 | 27174 | 537 | 23162 |
| 8L-5S | | MI | 8469 | 3665 | 14249 | 2593 | 15679 | 2146 | 16668 | 1758 | 18234 | 1115 | 21994 | 641 | 17506 |
| 24-#10 | 3.97 | MA | 10941 | 3559 | 17563 | 2633 | 19339 | 2195 | 20456 | 1823 | 21959 | 1219 | 26570 | 641 | 21317 |
| 8L-6S | | MI | 8249 | 3559 | 13648 | 2545 | 14937 | 2113 | 15776 | 1743 | 17042 | 1146 | 20630 | 681 | 15813 |
| 24-#10 | 3.97 | MA | 10818 | 3559 | 17171 | 2652 | 18849 | 2202 | 19847 | 1840 | 21163 | 1237 | 25509 | 598 | 20921 |
| 9L-5S | | MI | 8331 | 3559 | 13908 | 2539 | 15291 | 2107 | 16217 | 1738 | 17635 | 1132 | 21410 | 740 | 15999 |
| 24-#11 | 4.88 | MA | 11399 | 3751 | 18554 | 2753 | 20555 | 2286 | 21918 | 1881 | 23908 | 1208 | 29287 | 527 | 25359 |
| 8L-6S | | MI | 8583 | 3751 | 14417 | 2668 | 15892 | 2192 | 16918 | 1787 | 18584 | 1124 | 22517 | 557 | 18841 |

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

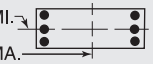
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.10 | MA | 10793 | 3134 | 16971 | 2304 | 18148 | 1944 | 18573 | 1665 | 18681 | 1251 | 21215 | 1088 | 7388 |
| 2E | | MI | 7532 | 3134 | 12014 | 2222 | 12641 | 1874 | 12811 | 1604 | 12730 | 1203 | 14149 | 1028 | 5110 |
| 4-#18 | 1.96 | MA | 11493 | 3328 | 18667 | 2405 | 20247 | 2014 | 21101 | 1703 | 22101 | 1224 | 25937 | 1056 | 12660 |
| 2E | | MI | 7954 | 3328 | 13090 | 2315 | 13953 | 1938 | 14384 | 1637 | 14857 | 1171 | 16744 | 954 | 8562 |
| 6-#11 | 1.15 | MA | 10848 | 3144 | 17050 | 2320 | 18288 | 1957 | 18760 | 1675 | 18946 | 1256 | 21590 | 1092 | 7695 |
| 2L-3S | | MI | 7393 | 3144 | 11568 | 2251 | 12103 | 1912 | 12169 | 1637 | 11864 | 1226 | 13048 | 931 | 5349 |
| 6-#11 | 1.15 | MA | 10558 | 3144 | 16279 | 2333 | 17299 | 1968 | 17554 | 1699 | 17305 | 1278 | 19318 | 992 | 7732 |
| 3L-2S | | MI | 7571 | 3144 | 12070 | 2242 | 12746 | 1890 | 12954 | 1617 | 12931 | 1210 | 14493 | 1041 | 5310 |
| 6-#14 | 1.65 | MA | 11278 | 3259 | 18072 | 2382 | 19560 | 2000 | 20295 | 1699 | 21024 | 1241 | 24459 | 1074 | 10870 |
| 2L-3S | | MI | 7585 | 3259 | 12014 | 2312 | 12641 | 1959 | 12811 | 1665 | 12730 | 1214 | 14149 | 848 | 7461 |
| 6-#14 | 1.65 | MA | 10872 | 3259 | 16971 | 2399 | 18148 | 2016 | 18573 | 1733 | 18681 | 1271 | 21215 | 927 | 10909 |
| 3L-2S | | MI | 7833 | 3259 | 12727 | 2300 | 13554 | 1930 | 13925 | 1638 | 14245 | 1193 | 16169 | 1006 | 7404 |
| 6-#18 | 2.94 | MA | 12318 | 3549 | 20586 | 2544 | 22707 | 2114 | 24101 | 1764 | 26184 | 1207 | 31590 | 1032 | 18686 |
| 2L-3S | | MI | 8052 | 3549 | 13090 | 2472 | 13953 | 2085 | 14384 | 1739 | 14857 | 1184 | 16744 | 620 | 12514 |
| 6-#18 | 2.94 | MA | 11643 | 3549 | 18667 | 2573 | 20247 | 2139 | 21101 | 1821 | 22101 | 1256 | 25937 | 763 | 18630 |
| 3L-2S | | MI | 8463 | 3549 | 14317 | 2454 | 15526 | 2037 | 16303 | 1697 | 17469 | 1154 | 20111 | 901 | 12462 |
| 8-#10 | 1.25 | MA | 10961 | 3166 | 17236 | 2347 | 18581 | 1978 | 19141 | 1691 | 19479 | 1263 | 22338 | 1096 | 8367 |
| 2L-4S | | MI | 7425 | 3166 | 11461 | 2303 | 12009 | 1942 | 12073 | 1660 | 11773 | 1247 | 13052 | 918 | 5818 |
| 8-#10 | 1.25 | MA | 10720 | 3166 | 16600 | 2358 | 17765 | 1988 | 18146 | 1711 | 18124 | 1281 | 20464 | 1017 | 8392 |
| 3E | | MI | 7498 | 3166 | 11779 | 2283 | 12422 | 1935 | 12580 | 1654 | 12434 | 1234 | 13905 | 969 | 5783 |
| 8-#10 | 1.25 | MA | 10587 | 3166 | 16122 | 2380 | 17144 | 2009 | 17383 | 1720 | 17130 | 1299 | 19222 | 969 | 8411 |
| 4L-2S | | MI | 7648 | 3166 | 12196 | 2275 | 12957 | 1917 | 13232 | 1638 | 13320 | 1220 | 15132 | 1058 | 5755 |
| 8-#11 | 1.53 | MA | 11190 | 3231 | 17821 | 2374 | 19276 | 1995 | 19966 | 1699 | 20587 | 1250 | 23862 | 1082 | 10130 |
| 2L-4S | | MI | 7524 | 3231 | 11684 | 2328 | 12247 | 1958 | 12341 | 1665 | 12133 | 1234 | 13483 | 858 | 6998 |
| 8-#11 | 1.53 | MA | 10904 | 3231 | 17050 | 2386 | 18288 | 2007 | 18760 | 1723 | 18946 | 1271 | 21590 | 982 | 10158 |
| 3E | | MI | 7609 | 3231 | 12070 | 2305 | 12746 | 1950 | 12954 | 1660 | 12931 | 1219 | 14493 | 918 | 6957 |
| 8-#11 | 1.53 | MA | 10748 | 3231 | 16469 | 2413 | 17534 | 2032 | 17833 | 1733 | 17737 | 1292 | 20071 | 922 | 10168 |
| 4L-2S | | MI | 7784 | 3231 | 12571 | 2296 | 13389 | 1929 | 13738 | 1641 | 13998 | 1204 | 15938 | 1028 | 6920 |
| 8-#14 | 2.21 | MA | 11759 | 3383 | 19173 | 2459 | 20971 | 2056 | 22017 | 1733 | 23367 | 1232 | 27704 | 1060 | 14332 |
| 2L-4S | | MI | 7774 | 3383 | 12178 | 2422 | 12842 | 2025 | 13051 | 1705 | 13109 | 1224 | 14753 | 740 | 9738 |
| 8-#14 | 2.21 | MA | 11363 | 3383 | 18072 | 2477 | 19560 | 2072 | 20295 | 1767 | 21024 | 1261 | 24459 | 914 | 14350 |
| 3E | | MI | 7890 | 3383 | 12727 | 2390 | 13554 | 2015 | 13925 | 1699 | 14245 | 1204 | 16169 | 825 | 9716 |
| 8-#14 | 2.21 | MA | 11146 | 3383 | 17241 | 2515 | 18481 | 2107 | 18968 | 1781 | 19295 | 1291 | 22276 | 827 | 14272 |
| 4L-2S | | MI | 8133 | 3383 | 13439 | 2378 | 14467 | 1986 | 15038 | 1672 | 15761 | 1183 | 18189 | 984 | 9671 |
| 8-#18 | 3.92 | MA | 13136 | 3771 | 22505 | 2682 | 25167 | 2213 | 27102 | 1824 | 30267 | 1189 | 37243 | 1007 | 24687 |
| 2L-4S | | MI | 8384 | 3771 | 13365 | 2665 | 14292 | 2197 | 14789 | 1806 | 15498 | 1197 | 17734 | 424 | 15255 |
| 8-#18 | 3.92 | MA | 12485 | 3771 | 20586 | 2712 | 22707 | 2239 | 24101 | 1881 | 26184 | 1238 | 31590 | 738 | 24569 |
| 3E | | MI | 8569 | 3771 | 14317 | 2611 | 15526 | 2184 | 16303 | 1800 | 17469 | 1166 | 20111 | 567 | 16326 |
| 8-#18 | 3.92 | MA | 12125 | 3771 | 19130 | 2776 | 20818 | 2300 | 21780 | 1903 | 23160 | 1287 | 27734 | 581 | 22960 |
| 4L-2S | | MI | 8970 | 3771 | 15544 | 2592 | 17099 | 2136 | 18222 | 1757 | 20080 | 1136 | 23478 | 849 | 16328 |
| 10-#10 | 1.56 | MA | 11244 | 3237 | 17872 | 2391 | 19396 | 2010 | 20137 | 1710 | 20833 | 1257 | 24213 | 1089 | 10371 |
| 2L-5S | | MI | 7480 | 3237 | 11610 | 2355 | 12188 | 1991 | 12280 | 1695 | 12002 | 1244 | 13423 | 860 | 7161 |
| 10-#10 | 1.56 | MA | 11007 | 3237 | 17236 | 2402 | 18581 | 2020 | 19141 | 1731 | 19479 | 1275 | 22338 | 1009 | 10390 |
| 3L-4S | | MI | 7606 | 3237 | 11878 | 2347 | 12544 | 1973 | 12724 | 1679 | 12660 | 1242 | 14278 | 910 | 7139 |
| 10-#10 | 1.56 | MA | 10876 | 3237 | 16758 | 2424 | 17960 | 2041 | 18378 | 1739 | 18484 | 1293 | 21097 | 961 | 10399 |
| 4L-3S | | MI | 7679 | 3237 | 12196 | 2327 | 12957 | 1966 | 13232 | 1673 | 13320 | 1228 | 15132 | 961 | 7111 |
| 10-#10 | 1.56 | MA | 10677 | 3237 | 16360 | 2435 | 17429 | 2051 | 17714 | 1760 | 17498 | 1300 | 19833 | 922 | 10367 |
| 5L-2S | | MI | 7826 | 3237 | 12613 | 2319 | 13491 | 1948 | 13884 | 1657 | 14207 | 1214 | 16359 | 1051 | 7085 |
| 10-#11 | 1.91 | MA | 11529 | 3317 | 18592 | 2428 | 20265 | 2034 | 21172 | 1722 | 22227 | 1243 | 26134 | 1073 | 12556 |
| 2L-5S | | MI | 7590 | 3317 | 11862 | 2391 | 12458 | 2018 | 12587 | 1708 | 12405 | 1229 | 13921 | 782 | 8569 |
| 10-#11 | 1.91 | MA | 11249 | 3317 | 17821 | 2440 | 19276 | 2046 | 19966 | 1746 | 20587 | 1264 | 23862 | 973 | 12576 |
| 3L-4S | | MI | 7740 | 3317 | 12186 | 2382 | 12889 | 1996 | 13125 | 1689 | 13200 | 1227 | 14928 | 845 | 8580 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

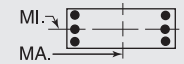
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.91 | MA | 11094 | 3317 | 17240 | 2467 | 18522 | 2071 | 19039 | 1756 | 19378 | 1285 | 22343 | 913 | 12567 |
| 4L-3S | | MI | 7824 | 3317 | 12571 | 2359 | 13389 | 1989 | 13738 | 1684 | 13998 | 1212 | 15938 | 905 | 8550 |
| 10-#11 | 1.91 | MA | 10856 | 3317 | 16756 | 2480 | 17876 | 2083 | 18230 | 1780 | 18180 | 1293 | 20802 | 862 | 12475 |
| 5L-2S | | MI | 7997 | 3317 | 13072 | 2350 | 14031 | 1968 | 14522 | 1664 | 15065 | 1197 | 17383 | 1015 | 8517 |
| 10-#14 | 2.76 | MA | 12236 | 3508 | 20274 | 2537 | 22383 | 2112 | 23739 | 1767 | 25710 | 1222 | 30948 | 1047 | 17784 |
| 2L-5S | | MI | 7868 | 3508 | 12427 | 2512 | 13140 | 2110 | 13398 | 1765 | 13491 | 1215 | 15365 | 627 | 11427 |
| 10-#14 | 2.76 | MA | 11850 | 3508 | 19173 | 2555 | 20971 | 2127 | 22017 | 1801 | 23367 | 1251 | 27704 | 900 | 17779 |
| 3L-4S | | MI | 8078 | 3508 | 12890 | 2500 | 13755 | 2081 | 14165 | 1739 | 14624 | 1214 | 16773 | 718 | 11951 |
| 10-#14 | 2.76 | MA | 11636 | 3508 | 18342 | 2593 | 19892 | 2163 | 20690 | 1815 | 21638 | 1281 | 25521 | 813 | 17677 |
| 4L-3S | | MI | 8193 | 3508 | 13439 | 2468 | 14467 | 2071 | 15038 | 1733 | 15761 | 1194 | 18189 | 803 | 11956 |
| 10-#14 | 2.76 | MA | 11300 | 3508 | 17648 | 2611 | 18967 | 2179 | 19532 | 1848 | 19922 | 1291 | 23310 | 738 | 16806 |
| 5L-2S | | MI | 8432 | 3508 | 14151 | 2455 | 15380 | 2042 | 16152 | 1706 | 17276 | 1173 | 20209 | 961 | 11923 |
| 10-#18 | 4.90 | MA | 13318 | 3992 | 22505 | 2850 | 25167 | 2338 | 27102 | 1941 | 30267 | 1221 | 37243 | 714 | 30506 |
| 3L-4S | | MI | 8901 | 3992 | 14592 | 2803 | 15866 | 2296 | 16708 | 1867 | 18109 | 1179 | 21101 | 372 | 18861 |
| 10-#18 | 4.90 | MA | 12965 | 3992 | 21049 | 2915 | 23278 | 2399 | 24781 | 1963 | 27243 | 1270 | 33387 | 557 | 28736 |
| 4L-3S | | MI | 9083 | 3992 | 15544 | 2749 | 17099 | 2284 | 18222 | 1860 | 20080 | 1149 | 23478 | 515 | 20126 |
| 10-#18 | 4.90 | MA | 12395 | 3992 | 19832 | 2944 | 21655 | 2425 | 22752 | 2020 | 24238 | 1283 | 29501 | 413 | 27031 |
| 5L-2S | | MI | 9474 | 3992 | 16771 | 2730 | 18672 | 2236 | 20141 | 1818 | 22691 | 1118 | 26845 | 796 | 20176 |
| 12-#10 | 1.87 | MA | 11526 | 3307 | 18509 | 2435 | 20212 | 2041 | 21132 | 1729 | 22187 | 1251 | 26088 | 1081 | 12370 |
| 2L-6S | | MI | 7572 | 3307 | 11766 | 2405 | 12368 | 2030 | 12491 | 1720 | 12296 | 1252 | 13870 | 793 | 8298 |
| 12-#10 | 1.87 | MA | 11293 | 3307 | 17872 | 2446 | 19396 | 2051 | 20137 | 1750 | 20833 | 1270 | 24213 | 1001 | 12384 |
| 3L-5S | | MI | 7662 | 3307 | 12027 | 2399 | 12722 | 2023 | 12931 | 1714 | 12889 | 1239 | 14650 | 852 | 8465 |
| 12-#10 | 1.87 | MA | 11163 | 3307 | 17394 | 2468 | 18776 | 2072 | 19373 | 1759 | 19838 | 1288 | 22971 | 953 | 12381 |
| 4E | | MI | 7787 | 3307 | 12294 | 2390 | 13078 | 2005 | 13376 | 1698 | 13546 | 1236 | 15505 | 902 | 8453 |
| 12-#10 | 1.87 | MA | 10966 | 3307 | 16996 | 2479 | 18245 | 2082 | 18709 | 1779 | 18852 | 1295 | 21708 | 914 | 12338 |
| 5L-3S | | MI | 7859 | 3307 | 12613 | 2371 | 13491 | 1998 | 13884 | 1692 | 14207 | 1222 | 16359 | 953 | 8431 |
| 12-#10 | 1.87 | MA | 10824 | 3307 | 16574 | 2483 | 17716 | 2103 | 18051 | 1788 | 17967 | 1313 | 20577 | 859 | 12015 |
| 6L-2S | | MI | 8005 | 3307 | 13030 | 2363 | 14025 | 1980 | 14535 | 1676 | 15094 | 1209 | 17586 | 1043 | 8407 |
| 12-#11 | 2.29 | MA | 11867 | 3403 | 19363 | 2482 | 21253 | 2073 | 22378 | 1746 | 23868 | 1236 | 28405 | 1063 | 14975 |
| 2L-6S | | MI | 7699 | 3403 | 12030 | 2467 | 12672 | 2064 | 12837 | 1737 | 12755 | 1237 | 14445 | 699 | 9794 |
| 12-#11 | 2.29 | MA | 11591 | 3403 | 18592 | 2494 | 20265 | 2084 | 21172 | 1770 | 22227 | 1257 | 26134 | 963 | 14988 |
| 3L-5S | | MI | 7807 | 3403 | 12363 | 2445 | 13101 | 2056 | 13371 | 1732 | 13472 | 1222 | 15366 | 769 | 10059 |
| 12-#11 | 2.29 | MA | 11438 | 3403 | 18011 | 2521 | 19511 | 2110 | 20245 | 1780 | 21019 | 1279 | 24615 | 903 | 14962 |
| 4E | | MI | 7955 | 3403 | 12687 | 2436 | 13532 | 2035 | 13909 | 1713 | 14267 | 1220 | 16373 | 832 | 10154 |
| 12-#11 | 2.29 | MA | 11203 | 3403 | 17527 | 2534 | 18865 | 2121 | 19436 | 1804 | 19820 | 1286 | 23074 | 853 | 14797 |
| 5L-3S | | MI | 8038 | 3403 | 13072 | 2413 | 14031 | 2028 | 14522 | 1707 | 15065 | 1205 | 17383 | 892 | 10133 |
| 12-#11 | 2.29 | MA | 11033 | 3403 | 17020 | 2539 | 18222 | 2147 | 18636 | 1814 | 18744 | 1307 | 21693 | 783 | 14263 |
| 6L-2S | | MI | 8209 | 3403 | 13574 | 2404 | 14674 | 2007 | 15306 | 1688 | 16132 | 1190 | 18828 | 1002 | 10106 |
| 12-#14 | 3.31 | MA | 12333 | 3632 | 20274 | 2633 | 22383 | 2183 | 23739 | 1835 | 25710 | 1241 | 30948 | 886 | 21203 |
| 3L-5S | | MI | 8173 | 3632 | 13140 | 2590 | 14053 | 2166 | 14511 | 1799 | 15006 | 1205 | 17385 | 605 | 13556 |
| 12-#14 | 3.31 | MA | 12122 | 3632 | 19443 | 2671 | 21304 | 2219 | 22412 | 1849 | 23981 | 1271 | 28765 | 799 | 21082 |
| 4E | | MI | 8381 | 3632 | 13602 | 2578 | 14668 | 2136 | 15279 | 1773 | 16139 | 1204 | 18793 | 696 | 14157 |
| 12-#14 | 3.31 | MA | 11792 | 3632 | 18749 | 2689 | 20378 | 2235 | 21255 | 1882 | 22266 | 1281 | 26555 | 724 | 20146 |
| 5L-3S | | MI | 8494 | 3632 | 14151 | 2546 | 15380 | 2127 | 16152 | 1766 | 17276 | 1184 | 20209 | 781 | 14189 |
| 12-#14 | 3.31 | MA | 11553 | 3632 | 18030 | 2697 | 19458 | 2271 | 20108 | 1896 | 20724 | 1311 | 24567 | 623 | 19478 |
| 6L-2S | | MI | 8729 | 3632 | 14863 | 2533 | 16293 | 2098 | 17266 | 1740 | 18792 | 1163 | 22229 | 939 | 14166 |
| 12-#18 | 5.88 | MA | 13796 | 4213 | 22968 | 3053 | 25738 | 2498 | 27781 | 2024 | 31325 | 1252 | 39040 | 532 | 34535 |
| 4E | | MI | 9415 | 4213 | 15819 | 2941 | 17439 | 2396 | 18627 | 1927 | 20720 | 1162 | 24468 | 319 | 22495 |
| 12-#18 | 5.88 | MA | 13241 | 4213 | 21751 | 3083 | 24115 | 2524 | 25752 | 2081 | 28321 | 1266 | 35154 | 388 | 32915 |
| 5L-3S | | MI | 9594 | 4213 | 16771 | 2887 | 18672 | 2383 | 20141 | 1920 | 22691 | 1131 | 26845 | 462 | 23919 |
| 14-#10 | 2.18 | MA | 11577 | 3377 | 18509 | 2490 | 20212 | 2083 | 21132 | 1769 | 22187 | 1264 | 26088 | 993 | 14375 |
| 3L-6S | | MI | 7754 | 3377 | 12183 | 2449 | 12902 | 2061 | 13142 | 1739 | 13183 | 1247 | 15097 | 785 | 9556 |
| 14-#10 | 2.18 | MA | 11448 | 3377 | 18031 | 2512 | 19592 | 2104 | 20369 | 1778 | 21192 | 1282 | 24846 | 945 | 14360 |
| 4L-5S | | MI | 7843 | 3377 | 12444 | 2443 | 13256 | 2054 | 13583 | 1734 | 13776 | 1233 | 15877 | 844 | 9764 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

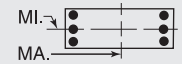


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.18 | MA | 11253 | 3377 | 17633 | 2523 | 19061 | 2114 | 19704 | 1798 | 20206 | 1289 | 23583 | 906 | 14310 |
| 5L-4S | | MI | 7967 | 3377 | 12711 | 2434 | 13612 | 2036 | 14028 | 1717 | 14433 | 1231 | 16732 | 894 | 9762 |
| 14-#10 | 2.18 | MA | 11114 | 3377 | 17210 | 2527 | 18531 | 2135 | 19046 | 1807 | 19321 | 1307 | 22452 | 851 | 13953 |
| 6L-3S | | MI | 8039 | 3377 | 13030 | 2415 | 14025 | 2029 | 14535 | 1712 | 15094 | 1217 | 17586 | 945 | 9745 |
| 14-#10 | 2.18 | MA | 10962 | 3377 | 16757 | 2545 | 17982 | 2140 | 18419 | 1827 | 18460 | 1326 | 21124 | 804 | 13657 |
| 7L-2S | | MI | 8183 | 3377 | 13446 | 2407 | 14560 | 2011 | 15187 | 1695 | 15981 | 1203 | 18813 | 1035 | 9725 |
| 14-#11 | 2.68 | MA | 11932 | 3490 | 19363 | 2548 | 21253 | 2123 | 22378 | 1793 | 23868 | 1250 | 28405 | 954 | 17392 |
| 3L-6S | | MI | 7917 | 3490 | 12531 | 2521 | 13315 | 2102 | 13621 | 1761 | 13822 | 1230 | 15890 | 686 | 11309 |
| 14-#11 | 2.68 | MA | 11780 | 3490 | 18782 | 2575 | 20499 | 2149 | 21451 | 1803 | 22660 | 1272 | 26887 | 894 | 17356 |
| 4L-5S | | MI | 8022 | 3490 | 12865 | 2499 | 13744 | 2095 | 14155 | 1755 | 14539 | 1215 | 16811 | 756 | 11558 |
| 14-#11 | 2.68 | MA | 11548 | 3490 | 18298 | 2588 | 19853 | 2160 | 20642 | 1827 | 21461 | 1279 | 25346 | 843 | 17126 |
| 5L-4S | | MI | 8169 | 3490 | 13189 | 2490 | 14175 | 2074 | 14693 | 1736 | 15334 | 1214 | 17818 | 818 | 11723 |
| 14-#11 | 2.68 | MA | 11382 | 3490 | 17791 | 2593 | 19211 | 2185 | 19842 | 1838 | 20385 | 1301 | 23965 | 774 | 16614 |
| 6L-3S | | MI | 8251 | 3490 | 13574 | 2467 | 14674 | 2067 | 15306 | 1731 | 16132 | 1198 | 18828 | 879 | 11710 |
| 14-#11 | 2.68 | MA | 11202 | 3490 | 17241 | 2615 | 18552 | 2192 | 19079 | 1862 | 19336 | 1322 | 22341 | 714 | 16224 |
| 7L-2S | | MI | 8420 | 3490 | 14075 | 2458 | 15317 | 2045 | 16090 | 1711 | 17199 | 1183 | 20273 | 989 | 11688 |
| 14-#14 | 3.86 | MA | 12604 | 3757 | 20544 | 2748 | 22716 | 2275 | 24135 | 1883 | 26325 | 1261 | 32009 | 785 | 24487 |
| 4L-5S | | MI | 8477 | 3757 | 13852 | 2668 | 14966 | 2222 | 15625 | 1833 | 16521 | 1195 | 19405 | 583 | 15695 |
| 14-#14 | 3.86 | MA | 12280 | 3757 | 19851 | 2766 | 21790 | 2291 | 22977 | 1916 | 24609 | 1271 | 29799 | 710 | 23494 |
| 5L-4S | | MI | 8682 | 3757 | 14314 | 2656 | 15581 | 2192 | 16393 | 1807 | 17655 | 1194 | 20813 | 673 | 16288 |
| 14-#14 | 3.86 | MA | 12047 | 3757 | 19132 | 2775 | 20869 | 2327 | 21830 | 1930 | 23067 | 1301 | 27812 | 609 | 22855 |
| 6L-3S | | MI | 8794 | 3757 | 14863 | 2623 | 16293 | 2183 | 17266 | 1800 | 18792 | 1174 | 22229 | 758 | 16408 |
| 14-#14 | 3.86 | MA | 11795 | 3757 | 18345 | 2805 | 19936 | 2336 | 20736 | 1964 | 21565 | 1331 | 25481 | 520 | 21653 |
| 7L-2S | | MI | 9025 | 3757 | 15575 | 2611 | 17206 | 2154 | 18380 | 1774 | 20307 | 1153 | 24249 | 917 | 16402 |
| 14-#18 | 6.86 | MA | 14078 | 4435 | 23669 | 3221 | 26574 | 2623 | 28753 | 2141 | 32404 | 1248 | 40806 | 364 | 38800 |
| 5L-4S | | MI | 9926 | 4435 | 17046 | 3080 | 19012 | 2495 | 20546 | 1987 | 23331 | 1144 | 27835 | 267 | 26151 |
| 16-#10 | 2.49 | MA | 11732 | 3448 | 18667 | 2556 | 20407 | 2135 | 21364 | 1797 | 22546 | 1277 | 26721 | 938 | 16339 |
| 4L-6S | | MI | 7936 | 3448 | 12600 | 2492 | 13436 | 2093 | 13794 | 1758 | 14070 | 1241 | 16324 | 777 | 10819 |
| 16-#10 | 2.49 | MA | 11539 | 3448 | 18269 | 2567 | 19876 | 2145 | 20699 | 1817 | 21560 | 1284 | 25458 | 899 | 16281 |
| 5E | | MI | 8023 | 3448 | 12861 | 2487 | 13791 | 2086 | 14235 | 1753 | 14662 | 1227 | 17104 | 836 | 11052 |
| 16-#10 | 2.49 | MA | 11402 | 3448 | 17846 | 2571 | 19347 | 2166 | 20042 | 1826 | 20675 | 1302 | 24327 | 843 | 15894 |
| 6L-4S | | MI | 8146 | 3448 | 13128 | 2478 | 14147 | 2068 | 14680 | 1736 | 15320 | 1225 | 17959 | 886 | 11067 |
| 16-#10 | 2.49 | MA | 11251 | 3448 | 17394 | 2589 | 18798 | 2171 | 19415 | 1846 | 19814 | 1320 | 22998 | 796 | 15609 |
| 7L-3S | | MI | 8218 | 3448 | 13446 | 2459 | 14560 | 2061 | 15187 | 1731 | 15981 | 1211 | 18813 | 938 | 11056 |
| 16-#10 | 2.49 | MA | 11089 | 3448 | 16998 | 2597 | 18251 | 2189 | 18743 | 1852 | 18896 | 1327 | 21849 | 751 | 15191 |
| 8L-2S | | MI | 8360 | 3448 | 13863 | 2451 | 15094 | 2043 | 15839 | 1714 | 16868 | 1197 | 20039 | 1027 | 11039 |
| 16-#11 | 3.06 | MA | 12121 | 3576 | 19553 | 2629 | 21488 | 2187 | 22657 | 1827 | 24301 | 1265 | 29159 | 884 | 19748 |
| 4L-6S | | MI | 8133 | 3576 | 13032 | 2575 | 13957 | 2141 | 14405 | 1784 | 14889 | 1224 | 17335 | 673 | 12829 |
| 16-#11 | 3.06 | MA | 11891 | 3576 | 19069 | 2642 | 20842 | 2199 | 21848 | 1851 | 23102 | 1272 | 27618 | 834 | 19461 |
| 5E | | MI | 8237 | 3576 | 13366 | 2553 | 14387 | 2134 | 14939 | 1779 | 15606 | 1208 | 18256 | 743 | 13063 |
| 16-#11 | 3.06 | MA | 11728 | 3576 | 18562 | 2647 | 20199 | 2224 | 21048 | 1861 | 22026 | 1294 | 26237 | 764 | 18970 |
| 6L-4S | | MI | 8382 | 3576 | 13690 | 2544 | 14818 | 2113 | 15477 | 1760 | 16401 | 1207 | 19263 | 805 | 13285 |
| 16-#11 | 3.06 | MA | 11549 | 3576 | 18012 | 2669 | 19540 | 2230 | 20285 | 1885 | 20977 | 1315 | 24613 | 705 | 18561 |
| 7L-3S | | MI | 8464 | 3576 | 14075 | 2521 | 15317 | 2105 | 16090 | 1754 | 17199 | 1191 | 20273 | 866 | 13283 |
| 16-#11 | 3.06 | MA | 11355 | 3576 | 17531 | 2678 | 18874 | 2251 | 19481 | 1892 | 19860 | 1323 | 23210 | 647 | 17901 |
| 8L-2S | | MI | 8631 | 3576 | 14577 | 2512 | 15960 | 2084 | 16874 | 1735 | 18266 | 1176 | 21718 | 976 | 13267 |
| 16-#14 | 4.41 | MA | 12764 | 3881 | 20952 | 2844 | 23202 | 2347 | 24699 | 1950 | 26952 | 1261 | 33043 | 696 | 26851 |
| 5E | | MI | 8780 | 3881 | 14564 | 2746 | 15879 | 2278 | 16739 | 1867 | 18037 | 1185 | 21425 | 560 | 17841 |
| 16-#14 | 4.41 | MA | 12538 | 3881 | 20233 | 2853 | 22281 | 2383 | 23552 | 1964 | 25410 | 1291 | 31056 | 595 | 26215 |
| 6L-4S | | MI | 8982 | 3881 | 15027 | 2733 | 16494 | 2248 | 17507 | 1841 | 19170 | 1184 | 22833 | 651 | 18401 |
| 16-#14 | 4.41 | MA | 12288 | 3881 | 19446 | 2883 | 21348 | 2392 | 22459 | 1998 | 23908 | 1321 | 28726 | 506 | 25019 |
| 7L-3S | | MI | 9093 | 3881 | 15575 | 2701 | 17206 | 2239 | 18380 | 1834 | 20307 | 1164 | 24249 | 736 | 18624 |
| 18-#10 | 2.80 | MA | 11824 | 3518 | 18905 | 2611 | 20692 | 2177 | 21694 | 1836 | 22914 | 1278 | 27332 | 891 | 18252 |
| 5L-6S | | MI | 8117 | 3518 | 13017 | 2536 | 13970 | 2124 | 14446 | 1777 | 14957 | 1236 | 17551 | 769 | 12084 |
| 18-#10 | 2.80 | MA | 11689 | 3518 | 18483 | 2615 | 20163 | 2198 | 21037 | 1845 | 22029 | 1296 | 26201 | 836 | 17839 |
| 6L-5S | | MI | 8203 | 3518 | 13277 | 2531 | 14325 | 2117 | 14887 | 1772 | 15549 | 1222 | 18331 | 828 | 12305 |
| 18-#10 | 2.80 | MA | 11539 | 3518 | 18030 | 2633 | 19614 | 2203 | 20410 | 1865 | 21168 | 1314 | 24873 | 788 | 17563 |
| 7L-4S | | MI | 8325 | 3518 | 13545 | 2522 | 14681 | 2099 | 15332 | 1755 | 16207 | 1219 | 19186 | 878 | 12369 |

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

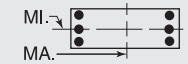



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.80 | MA | 11379 | 3518 | 17634 | 2640 | 19066 | 2220 | 19738 | 1871 | 20250 | 1321 | 23724 | 743 | 17133 |
| 8L-3S | | MI | 8396 | 3518 | 13863 | 2503 | 15094 | 2092 | 15839 | 1750 | 16868 | 1206 | 20039 | 930 | 12363 |
| 18-#10 | 2.80 | MA | 11233 | 3518 | 17214 | 2660 | 18542 | 2227 | 19085 | 1888 | 19399 | 1340 | 22595 | 701 | 16703 |
| 9L-2S | | MI | 8537 | 3518 | 14280 | 2494 | 15628 | 2074 | 16491 | 1733 | 17754 | 1192 | 21266 | 1019 | 12350 |
| 18-#11 | 3.44 | MA | 12232 | 3662 | 19841 | 2696 | 21830 | 2238 | 23054 | 1875 | 24743 | 1265 | 29890 | 824 | 21803 |
| 5L-6S | | MI | 8349 | 3662 | 13534 | 2629 | 14600 | 2180 | 15190 | 1808 | 15956 | 1217 | 18780 | 660 | 14352 |
| 18-#11 | 3.44 | MA | 12072 | 3662 | 19333 | 2701 | 21188 | 2263 | 22254 | 1885 | 23666 | 1287 | 28509 | 755 | 21330 |
| 6L-5S | | MI | 8451 | 3662 | 13868 | 2607 | 15030 | 2172 | 15723 | 1802 | 16673 | 1201 | 19701 | 730 | 14573 |
| 18-#11 | 3.44 | MA | 11895 | 3662 | 18783 | 2723 | 20529 | 2269 | 21491 | 1909 | 22618 | 1308 | 26885 | 695 | 20901 |
| 7L-4S | | MI | 8595 | 3662 | 14192 | 2598 | 15461 | 2151 | 16262 | 1783 | 17468 | 1200 | 20708 | 792 | 14844 |
| 18-#11 | 3.44 | MA | 11703 | 3662 | 18302 | 2732 | 19863 | 2290 | 20687 | 1916 | 21501 | 1316 | 25482 | 637 | 20258 |
| 8L-3S | | MI | 8676 | 3662 | 14577 | 2575 | 15960 | 2144 | 16874 | 1778 | 18266 | 1184 | 21718 | 853 | 14854 |
| 18-#14 | 4.96 | MA | 13025 | 4006 | 21334 | 2930 | 23693 | 2438 | 25275 | 1998 | 27753 | 1281 | 34301 | 581 | 29556 |
| 6L-5S | | MI | 9081 | 4006 | 15276 | 2824 | 16792 | 2333 | 17853 | 1901 | 19552 | 1175 | 23445 | 538 | 19994 |
| 18-#14 | 4.96 | MA | 12777 | 4006 | 20548 | 2961 | 22760 | 2448 | 24181 | 2032 | 26251 | 1311 | 31970 | 492 | 28388 |
| 7L-4S | | MI | 9281 | 4006 | 15739 | 2811 | 17407 | 2304 | 18620 | 1875 | 20686 | 1174 | 24853 | 629 | 20523 |
| 20-#10 | 3.11 | MA | 11975 | 3588 | 19119 | 2659 | 20979 | 2229 | 22032 | 1864 | 23384 | 1291 | 28076 | 828 | 19786 |
| 6E | | MI | 8297 | 3588 | 13433 | 2580 | 14505 | 2156 | 15098 | 1796 | 15844 | 1230 | 18778 | 761 | 13352 |
| 20-#10 | 3.11 | MA | 11825 | 3588 | 18666 | 2677 | 20430 | 2234 | 21405 | 1885 | 22522 | 1309 | 26748 | 780 | 19519 |
| 7L-5S | | MI | 8382 | 3588 | 13694 | 2574 | 14859 | 2149 | 15539 | 1791 | 16436 | 1216 | 19558 | 820 | 13562 |
| 20-#10 | 3.11 | MA | 11667 | 3588 | 18271 | 2684 | 19882 | 2252 | 20733 | 1890 | 21604 | 1316 | 25599 | 736 | 19077 |
| 8L-4S | | MI | 8503 | 3588 | 13961 | 2566 | 15215 | 2131 | 15983 | 1774 | 17094 | 1214 | 20413 | 871 | 13667 |
| 20-#10 | 3.11 | MA | 11526 | 3588 | 17850 | 2704 | 19358 | 2259 | 20080 | 1907 | 20753 | 1334 | 24470 | 693 | 18657 |
| 9L-3S | | MI | 8574 | 3588 | 14280 | 2547 | 15628 | 2124 | 16491 | 1769 | 17754 | 1200 | 21266 | 922 | 13669 |
| 20-#10 | 3.11 | MA | 11360 | 3588 | 17440 | 2710 | 18832 | 2278 | 19445 | 1925 | 19905 | 1352 | 23325 | 654 | 18086 |
| 10L-2S | | MI | 8713 | 3588 | 14697 | 2538 | 16162 | 2106 | 17143 | 1752 | 18641 | 1186 | 22493 | 1011 | 13658 |
| 20-#11 | 3.82 | MA | 12415 | 3748 | 20104 | 2755 | 22176 | 2302 | 23460 | 1908 | 25307 | 1280 | 30781 | 745 | 23693 |
| 6E | | MI | 8563 | 3748 | 14035 | 2683 | 15243 | 2219 | 15974 | 1831 | 17023 | 1210 | 20225 | 647 | 15878 |
| 20-#11 | 3.82 | MA | 12238 | 3748 | 19554 | 2777 | 21517 | 2308 | 22697 | 1932 | 24259 | 1301 | 29157 | 685 | 23245 |
| 7L-5S | | MI | 8664 | 3748 | 14369 | 2661 | 15672 | 2211 | 16508 | 1826 | 17740 | 1194 | 21146 | 717 | 16087 |
| 20-#11 | 3.82 | MA | 12050 | 3748 | 19073 | 2786 | 20852 | 2329 | 21893 | 1939 | 23142 | 1309 | 27754 | 628 | 22619 |
| 8L-4S | | MI | 8807 | 3748 | 14693 | 2652 | 16103 | 2190 | 17046 | 1807 | 18535 | 1193 | 22153 | 779 | 16401 |
| 20-#14 | 5.51 | MA | 13262 | 4130 | 21649 | 3038 | 24172 | 2504 | 25903 | 2066 | 28595 | 1301 | 35214 | 479 | 31762 |
| 7L-5S | | MI | 9381 | 4130 | 15988 | 2902 | 17705 | 2389 | 18967 | 1935 | 21068 | 1165 | 25465 | 516 | 22151 |
| 22-#10 | 3.42 | MA | 12110 | 3658 | 19303 | 2720 | 21246 | 2266 | 22400 | 1904 | 23876 | 1303 | 28623 | 773 | 21477 |
| 7L-6S | | MI | 8477 | 3658 | 13850 | 2624 | 15039 | 2187 | 15750 | 1816 | 16731 | 1224 | 20005 | 753 | 14621 |
| 22-#10 | 3.42 | MA | 11954 | 3658 | 18907 | 2728 | 20698 | 2283 | 21728 | 1909 | 22958 | 1310 | 27474 | 728 | 21023 |
| 8L-5S | | MI | 8561 | 3658 | 14111 | 2618 | 15393 | 2180 | 16190 | 1810 | 17323 | 1211 | 20784 | 812 | 14822 |
| 22-#10 | 3.42 | MA | 11816 | 3658 | 18487 | 2748 | 20173 | 2291 | 21076 | 1926 | 22107 | 1328 | 26344 | 686 | 20613 |
| 9L-4S | | MI | 8681 | 3658 | 14378 | 2610 | 15749 | 2162 | 16635 | 1794 | 17980 | 1208 | 21639 | 863 | 14964 |
| 22-#10 | 3.42 | MA | 11652 | 3658 | 18077 | 2753 | 19647 | 2310 | 20440 | 1944 | 21259 | 1346 | 25200 | 647 | 20037 |
| 10L-3S | | MI | 8751 | 3658 | 14697 | 2591 | 16162 | 2155 | 17143 | 1788 | 18641 | 1194 | 22493 | 914 | 14973 |
| 22-#11 | 4.21 | MA | 12580 | 3835 | 20326 | 2830 | 22506 | 2347 | 23903 | 1956 | 25900 | 1294 | 31429 | 676 | 25593 |
| 7L-6S | | MI | 8777 | 3835 | 14537 | 2737 | 15886 | 2257 | 16758 | 1855 | 18090 | 1203 | 21670 | 634 | 17406 |
| 22-#11 | 4.21 | MA | 12394 | 3835 | 19844 | 2839 | 21840 | 2367 | 23099 | 1963 | 24783 | 1302 | 30026 | 618 | 24981 |
| 8L-5S | | MI | 8877 | 3835 | 14870 | 2715 | 16315 | 2250 | 17292 | 1849 | 18807 | 1187 | 22591 | 704 | 17605 |
| 24-#10 | 3.74 | MA | 12239 | 3729 | 19543 | 2772 | 21514 | 2315 | 22723 | 1928 | 24312 | 1305 | 29349 | 720 | 22970 |
| 8L-6S | | MI | 8656 | 3729 | 14267 | 2668 | 15573 | 2219 | 16401 | 1835 | 17617 | 1219 | 21231 | 745 | 15893 |
| 24-#10 | 3.74 | MA | 12105 | 3729 | 19123 | 2792 | 20989 | 2322 | 22071 | 1945 | 23461 | 1323 | 28219 | 678 | 22570 |
| 9L-5S | | MI | 8739 | 3729 | 14528 | 2662 | 15928 | 2212 | 16842 | 1829 | 18210 | 1205 | 22011 | 804 | 16085 |
| 24-#10 | 3.74 | MA | 11941 | 3729 | 18713 | 2797 | 20463 | 2341 | 21435 | 1963 | 22613 | 1341 | 27075 | 639 | 21987 |
| 10L-4S | | MI | 8858 | 3729 | 14795 | 2654 | 16284 | 2194 | 17287 | 1813 | 18867 | 1202 | 22866 | 855 | 16260 |
| 24-#11 | 4.59 | MA | 12737 | 3921 | 20615 | 2893 | 22829 | 2406 | 24305 | 1986 | 26424 | 1295 | 32298 | 609 | 27346 |
| 8L-6S | | MI | 8991 | 3921 | 15038 | 2791 | 16529 | 2296 | 17542 | 1878 | 19157 | 1196 | 23115 | 621 | 18935 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

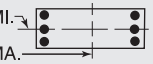
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.04 | MA | 12058 | 3304 | 18875 | 2442 | 20200 | 2062 | 20666 | 1768 | 20743 | 1333 | 23517 | 1159 | 7874 |
| 2E | | MI | 7940 | 3304 | 12637 | 2343 | 13277 | 1978 | 13433 | 1695 | 13301 | 1275 | 14743 | 1091 | 5138 |
| 4-#18 | 1.85 | MA | 12816 | 3498 | 20698 | 2543 | 22456 | 2132 | 23382 | 1806 | 24418 | 1306 | 28590 | 1128 | 13524 |
| 2E | | MI | 8361 | 3498 | 13716 | 2435 | 14588 | 2040 | 15004 | 1726 | 15424 | 1242 | 17333 | 1016 | 8604 |
| 6-#11 | 1.08 | MA | 12117 | 3314 | 18957 | 2458 | 20347 | 2074 | 20863 | 1778 | 21022 | 1338 | 23912 | 1163 | 8200 |
| 2L-3S | | MI | 7800 | 3314 | 12190 | 2374 | 12739 | 2016 | 12793 | 1728 | 12437 | 1298 | 13645 | 995 | 5375 |
| 6-#11 | 1.08 | MA | 11802 | 3314 | 18132 | 2471 | 19289 | 2086 | 19573 | 1802 | 19267 | 1360 | 21481 | 1065 | 8237 |
| 3L-2S | | MI | 7978 | 3314 | 12691 | 2364 | 13382 | 1995 | 13577 | 1708 | 13504 | 1283 | 15090 | 1105 | 5336 |
| 6-#14 | 1.56 | MA | 12581 | 3429 | 20054 | 2519 | 21712 | 2117 | 22510 | 1802 | 23251 | 1323 | 26990 | 1146 | 11599 |
| 2L-3S | | MI | 7993 | 3429 | 12637 | 2434 | 13277 | 2063 | 13433 | 1755 | 13301 | 1286 | 14743 | 911 | 7496 |
| 6-#14 | 1.56 | MA | 12142 | 3429 | 18875 | 2538 | 20200 | 2134 | 20666 | 1836 | 20743 | 1354 | 23517 | 1002 | 11638 |
| 3L-2S | | MI | 8241 | 3429 | 13350 | 2421 | 14190 | 2034 | 14547 | 1729 | 14816 | 1265 | 16764 | 1069 | 7437 |
| 6-#18 | 2.78 | MA | 13707 | 3719 | 22755 | 2682 | 25093 | 2231 | 26599 | 1866 | 28795 | 1288 | 34650 | 1103 | 19982 |
| 2L-3S | | MI | 8459 | 3719 | 13716 | 2592 | 14588 | 2187 | 15004 | 1828 | 15424 | 1255 | 17333 | 682 | 12574 |
| 6-#18 | 2.78 | MA | 12975 | 3719 | 20698 | 2713 | 22456 | 2258 | 23382 | 1925 | 24418 | 1340 | 28590 | 840 | 19926 |
| 3L-2S | | MI | 8871 | 3719 | 14943 | 2574 | 16161 | 2139 | 16923 | 1786 | 18035 | 1225 | 20700 | 963 | 12510 |
| 8-#10 | 1.18 | MA | 12236 | 3336 | 19153 | 2485 | 20656 | 2096 | 21266 | 1794 | 21586 | 1344 | 24705 | 1168 | 8916 |
| 2L-4S | | MI | 7832 | 3336 | 12080 | 2426 | 12646 | 2047 | 12698 | 1751 | 12348 | 1320 | 13653 | 982 | 5843 |
| 8-#10 | 1.18 | MA | 11977 | 3336 | 18473 | 2496 | 19784 | 2106 | 20202 | 1814 | 20139 | 1363 | 22701 | 1090 | 8940 |
| 3E | | MI | 7906 | 3336 | 12399 | 2407 | 13059 | 2040 | 13205 | 1746 | 13008 | 1307 | 14507 | 1033 | 5808 |
| 8-#10 | 1.18 | MA | 11832 | 3336 | 17963 | 2519 | 19122 | 2128 | 19388 | 1824 | 19020 | 1371 | 21382 | 1042 | 8960 |
| 4L-2S | | MI | 8055 | 3336 | 12815 | 2398 | 13593 | 2022 | 13857 | 1729 | 13895 | 1293 | 15734 | 1123 | 5779 |
| 8-#11 | 1.44 | MA | 12484 | 3400 | 19782 | 2512 | 21405 | 2113 | 22153 | 1801 | 22778 | 1331 | 26343 | 1154 | 10804 |
| 2L-4S | | MI | 7931 | 3400 | 12306 | 2451 | 12883 | 2062 | 12964 | 1756 | 12706 | 1307 | 14081 | 921 | 7031 |
| 8-#11 | 1.44 | MA | 12176 | 3400 | 18957 | 2525 | 20347 | 2125 | 20863 | 1826 | 21022 | 1353 | 23912 | 1055 | 10832 |
| 3E | | MI | 8016 | 3400 | 12691 | 2428 | 13382 | 2055 | 13577 | 1751 | 13504 | 1291 | 15090 | 982 | 6987 |
| 8-#11 | 1.44 | MA | 12005 | 3400 | 18337 | 2552 | 19542 | 2151 | 19873 | 1837 | 19732 | 1375 | 22299 | 996 | 10842 |
| 4L-2S | | MI | 8192 | 3400 | 13192 | 2418 | 14025 | 2034 | 14361 | 1732 | 14571 | 1276 | 16535 | 1092 | 6950 |
| 8-#14 | 2.08 | MA | 13099 | 3553 | 21233 | 2597 | 23223 | 2173 | 24353 | 1836 | 25760 | 1313 | 30464 | 1132 | 15304 |
| 2L-4S | | MI | 8181 | 3553 | 12801 | 2544 | 13479 | 2128 | 13674 | 1796 | 13679 | 1296 | 15347 | 803 | 9790 |
| 8-#14 | 2.08 | MA | 12671 | 3553 | 20054 | 2616 | 21712 | 2190 | 22510 | 1870 | 23251 | 1344 | 26990 | 988 | 15322 |
| 3E | | MI | 8297 | 3553 | 13350 | 2512 | 14190 | 2119 | 14547 | 1789 | 14816 | 1276 | 16764 | 888 | 9756 |
| 8-#14 | 2.08 | MA | 12432 | 3553 | 19166 | 2654 | 20559 | 2227 | 21092 | 1885 | 21405 | 1375 | 24670 | 902 | 15244 |
| 4L-2S | | MI | 8541 | 3553 | 14062 | 2499 | 15103 | 2090 | 15661 | 1763 | 16331 | 1255 | 18784 | 1047 | 9708 |
| 8-#18 | 3.70 | MA | 14589 | 3940 | 24812 | 2820 | 27730 | 2331 | 29816 | 1927 | 33172 | 1271 | 40711 | 1079 | 26415 |
| 2L-4S | | MI | 8791 | 3940 | 13990 | 2785 | 14928 | 2299 | 15409 | 1896 | 16065 | 1268 | 18323 | 487 | 15457 |
| 8-#18 | 3.70 | MA | 13883 | 3940 | 22755 | 2851 | 25093 | 2358 | 26599 | 1986 | 28795 | 1322 | 34650 | 815 | 26297 |
| 3E | | MI | 8976 | 3940 | 14943 | 2731 | 16161 | 2287 | 16923 | 1889 | 18035 | 1237 | 20700 | 629 | 16395 |
| 8-#18 | 3.70 | MA | 13487 | 3940 | 21199 | 2917 | 23074 | 2420 | 24117 | 2009 | 25561 | 1374 | 30551 | 660 | 24800 |
| 4L-2S | | MI | 9378 | 3940 | 16170 | 2712 | 17734 | 2239 | 18842 | 1846 | 20646 | 1207 | 24067 | 911 | 16381 |
| 10-#10 | 1.47 | MA | 12541 | 3406 | 19833 | 2529 | 21528 | 2127 | 22330 | 1813 | 23034 | 1339 | 26709 | 1160 | 11057 |
| 2L-5S | | MI | 7887 | 3406 | 12230 | 2478 | 12824 | 2096 | 12905 | 1787 | 12577 | 1317 | 14025 | 924 | 7194 |
| 10-#10 | 1.47 | MA | 12286 | 3406 | 19153 | 2540 | 20656 | 2138 | 21266 | 1834 | 21586 | 1357 | 24705 | 1082 | 11076 |
| 3L-4S | | MI | 8013 | 3406 | 12497 | 2470 | 13180 | 2078 | 13349 | 1771 | 13234 | 1315 | 14880 | 974 | 7168 |
| 10-#10 | 1.47 | MA | 12142 | 3406 | 18643 | 2563 | 19994 | 2159 | 20452 | 1843 | 20467 | 1365 | 23386 | 1034 | 11084 |
| 4L-3S | | MI | 8087 | 3406 | 12815 | 2451 | 13593 | 2072 | 13857 | 1765 | 13895 | 1301 | 15734 | 1025 | 7138 |
| 10-#10 | 1.47 | MA | 11928 | 3406 | 18215 | 2573 | 19428 | 2170 | 19743 | 1864 | 19474 | 1384 | 22042 | 997 | 11053 |
| 5L-2S | | MI | 8234 | 3406 | 13232 | 2442 | 14127 | 2053 | 14509 | 1749 | 14782 | 1287 | 16960 | 1115 | 7111 |
| 10-#11 | 1.81 | MA | 12850 | 3487 | 20607 | 2565 | 22462 | 2152 | 23444 | 1825 | 24534 | 1324 | 28774 | 1144 | 13398 |
| 2L-5S | | MI | 7997 | 3487 | 12483 | 2514 | 13095 | 2122 | 13210 | 1799 | 12977 | 1301 | 14518 | 846 | 8636 |
| 10-#11 | 1.81 | MA | 12547 | 3487 | 19782 | 2579 | 21405 | 2164 | 22153 | 1849 | 22778 | 1346 | 26343 | 1046 | 13418 |
| 3L-4S | | MI | 8147 | 3487 | 12807 | 2505 | 13526 | 2101 | 13748 | 1780 | 13773 | 1300 | 15526 | 908 | 8617 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

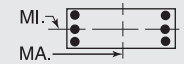
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.81 | MA | 12378 | 3487 | 19162 | 2606 | 20600 | 2190 | 21163 | 1860 | 21488 | 1369 | 24730 | 987 | 13409 |
| 4L-3S | | MI | 8231 | 3487 | 13192 | 2482 | 14025 | 2093 | 14361 | 1775 | 14571 | 1284 | 16535 | 969 | 8583 |
| 10-#11 | 1.81 | MA | 12121 | 3487 | 18646 | 2619 | 19910 | 2202 | 20301 | 1885 | 20208 | 1377 | 23089 | 938 | 13330 |
| 5L-2S | | MI | 8405 | 3487 | 13694 | 2472 | 14668 | 2072 | 15146 | 1755 | 15638 | 1269 | 17980 | 1079 | 8550 |
| 10-#14 | 2.60 | MA | 13614 | 3678 | 22412 | 2675 | 24735 | 2229 | 26197 | 1869 | 28269 | 1303 | 33937 | 1118 | 18999 |
| 2L-5S | | MI | 8275 | 3678 | 13050 | 2634 | 13777 | 2214 | 14020 | 1856 | 14061 | 1287 | 15959 | 690 | 11554 |
| 10-#14 | 2.60 | MA | 13195 | 3678 | 21233 | 2694 | 23223 | 2246 | 24353 | 1904 | 25760 | 1334 | 30464 | 974 | 18994 |
| 3L-4S | | MI | 8486 | 3678 | 13513 | 2622 | 14392 | 2184 | 14788 | 1829 | 15194 | 1286 | 17367 | 781 | 12008 |
| 10-#14 | 2.60 | MA | 12960 | 3678 | 20345 | 2732 | 22070 | 2283 | 22936 | 1919 | 23913 | 1365 | 28144 | 888 | 18892 |
| 4L-3S | | MI | 8600 | 3678 | 14062 | 2589 | 15103 | 2175 | 15661 | 1823 | 16331 | 1266 | 18784 | 866 | 12000 |
| 10-#14 | 2.60 | MA | 12598 | 3678 | 19605 | 2751 | 21083 | 2299 | 21700 | 1954 | 22081 | 1376 | 25789 | 816 | 18061 |
| 5L-2S | | MI | 8840 | 3678 | 14774 | 2577 | 16016 | 2145 | 16775 | 1797 | 17847 | 1245 | 20804 | 1024 | 11964 |
| 10-#18 | 4.63 | MA | 14781 | 4162 | 24812 | 2989 | 27730 | 2457 | 29816 | 2046 | 33172 | 1305 | 40711 | 791 | 32666 |
| 3L-4S | | MI | 9308 | 4162 | 15217 | 2923 | 16501 | 2399 | 17328 | 1956 | 18676 | 1250 | 21690 | 434 | 19056 |
| 10-#18 | 4.63 | MA | 14393 | 4162 | 23256 | 3055 | 25711 | 2520 | 27334 | 2069 | 29938 | 1356 | 36611 | 635 | 31007 |
| 4L-3S | | MI | 9490 | 4162 | 16170 | 2869 | 17734 | 2386 | 18842 | 1949 | 20646 | 1220 | 24067 | 577 | 20200 |
| 10-#18 | 4.63 | MA | 13778 | 4162 | 21957 | 3086 | 23978 | 2547 | 25166 | 2128 | 26727 | 1372 | 32468 | 497 | 29079 |
| 5L-2S | | MI | 9883 | 4162 | 17397 | 2850 | 19307 | 2338 | 20761 | 1907 | 23257 | 1189 | 27434 | 859 | 20232 |
| 12-#10 | 1.76 | MA | 12845 | 3477 | 20513 | 2573 | 22400 | 2159 | 23394 | 1832 | 24481 | 1333 | 28714 | 1152 | 13193 |
| 2L-6S | | MI | 7979 | 3477 | 12386 | 2528 | 13004 | 2135 | 13116 | 1812 | 12871 | 1325 | 14472 | 857 | 8378 |
| 12-#10 | 1.76 | MA | 12593 | 3477 | 19833 | 2584 | 21528 | 2169 | 22330 | 1853 | 23034 | 1352 | 26709 | 1074 | 13207 |
| 3L-5S | | MI | 8069 | 3477 | 12646 | 2522 | 13358 | 2128 | 13556 | 1806 | 13464 | 1312 | 15252 | 916 | 8502 |
| 12-#10 | 1.76 | MA | 12451 | 3477 | 19324 | 2607 | 20866 | 2191 | 21516 | 1862 | 21915 | 1359 | 25391 | 1026 | 13204 |
| 4E | | MI | 8194 | 3477 | 12914 | 2514 | 13714 | 2110 | 14001 | 1790 | 14121 | 1309 | 16107 | 966 | 8485 |
| 12-#10 | 1.76 | MA | 12239 | 3477 | 18896 | 2617 | 20300 | 2201 | 20807 | 1883 | 20921 | 1378 | 24046 | 989 | 13161 |
| 5L-3S | | MI | 8267 | 3477 | 13232 | 2494 | 14127 | 2103 | 14509 | 1784 | 14782 | 1296 | 16960 | 1017 | 8460 |
| 12-#10 | 1.76 | MA | 12086 | 3477 | 18444 | 2622 | 19731 | 2222 | 20106 | 1892 | 19978 | 1397 | 22843 | 935 | 12869 |
| 6L-2S | | MI | 8413 | 3477 | 13649 | 2486 | 14662 | 2085 | 15160 | 1768 | 15669 | 1282 | 18187 | 1107 | 8436 |
| 12-#11 | 2.17 | MA | 13214 | 3573 | 21432 | 2619 | 23520 | 2191 | 24734 | 1848 | 26289 | 1317 | 31205 | 1135 | 15986 |
| 2L-6S | | MI | 8106 | 3573 | 12651 | 2589 | 13308 | 2168 | 13461 | 1828 | 13328 | 1310 | 15042 | 762 | 9888 |
| 12-#11 | 2.17 | MA | 12915 | 3573 | 20607 | 2633 | 22462 | 2203 | 23444 | 1873 | 24534 | 1340 | 28774 | 1036 | 15998 |
| 3L-5S | | MI | 8214 | 3573 | 12985 | 2568 | 13738 | 2161 | 13994 | 1823 | 14044 | 1294 | 15963 | 833 | 10161 |
| 12-#11 | 2.17 | MA | 12748 | 3573 | 19987 | 2660 | 21657 | 2229 | 22454 | 1884 | 23243 | 1362 | 27160 | 977 | 15973 |
| 4E | | MI | 8362 | 3573 | 13309 | 2559 | 14169 | 2139 | 14533 | 1804 | 14839 | 1293 | 16971 | 895 | 10194 |
| 12-#11 | 2.17 | MA | 12495 | 3573 | 19471 | 2673 | 20968 | 2241 | 21591 | 1908 | 21964 | 1370 | 25520 | 929 | 15882 |
| 5L-3S | | MI | 8445 | 3573 | 13694 | 2535 | 14668 | 2132 | 15146 | 1798 | 15638 | 1277 | 17980 | 956 | 10169 |
| 12-#11 | 2.17 | MA | 12312 | 3573 | 18923 | 2678 | 20283 | 2266 | 20738 | 1919 | 20816 | 1392 | 24051 | 860 | 15284 |
| 6L-2S | | MI | 8617 | 3573 | 14195 | 2526 | 15310 | 2111 | 15930 | 1779 | 16705 | 1262 | 19426 | 1066 | 10140 |
| 12-#14 | 3.13 | MA | 13716 | 3802 | 22412 | 2771 | 24735 | 2302 | 26197 | 1938 | 28269 | 1324 | 33937 | 960 | 22661 |
| 3L-5S | | MI | 8581 | 3802 | 13763 | 2712 | 14690 | 2270 | 15134 | 1890 | 15576 | 1277 | 17979 | 668 | 13681 |
| 12-#14 | 3.13 | MA | 13484 | 3802 | 21524 | 2810 | 23582 | 2338 | 24780 | 1953 | 26422 | 1355 | 31617 | 874 | 22540 |
| 4E | | MI | 8788 | 3802 | 14225 | 2699 | 15305 | 2240 | 15901 | 1863 | 16710 | 1276 | 19387 | 759 | 14218 |
| 12-#14 | 3.13 | MA | 13128 | 3802 | 20784 | 2829 | 22594 | 2355 | 23544 | 1988 | 24590 | 1366 | 29263 | 802 | 21640 |
| 5L-3S | | MI | 8902 | 3802 | 14774 | 2667 | 16016 | 2231 | 16775 | 1857 | 17847 | 1256 | 20804 | 844 | 14234 |
| 12-#14 | 3.13 | MA | 12871 | 3802 | 20007 | 2837 | 21612 | 2392 | 22321 | 2003 | 22944 | 1397 | 27153 | 701 | 20891 |
| 6L-2S | | MI | 9138 | 3802 | 15486 | 2655 | 16929 | 2201 | 17889 | 1830 | 19362 | 1235 | 22824 | 1002 | 14209 |
| 12-#18 | 5.56 | MA | 15290 | 4383 | 25313 | 3194 | 28348 | 2619 | 30551 | 2130 | 34315 | 1338 | 42672 | 611 | 37235 |
| 4E | | MI | 9822 | 4383 | 16444 | 3061 | 18074 | 2498 | 19247 | 2016 | 21287 | 1233 | 25057 | 382 | 22685 |
| 12-#18 | 5.56 | MA | 14690 | 4383 | 24014 | 3225 | 26615 | 2646 | 28383 | 2189 | 31104 | 1355 | 38528 | 473 | 35390 |
| 5L-3S | | MI | 10002 | 4383 | 17397 | 3007 | 19307 | 2485 | 20761 | 2009 | 23257 | 1202 | 27434 | 525 | 23997 |
| 12-#18 | 5.56 | MA | 14254 | 4383 | 22679 | 3240 | 24890 | 2709 | 26236 | 2212 | 28217 | 1406 | 34795 | 292 | 32571 |
| 6L-2S | | MI | 10387 | 4383 | 18624 | 2989 | 20881 | 2437 | 22680 | 1967 | 25869 | 1172 | 30801 | 806 | 24070 |
| 14-#10 | 2.06 | MA | 12898 | 3547 | 20513 | 2628 | 22400 | 2201 | 23394 | 1872 | 24481 | 1346 | 28714 | 1066 | 15335 |
| 3L-6S | | MI | 8161 | 3547 | 12802 | 2572 | 13538 | 2166 | 13767 | 1831 | 13758 | 1320 | 15699 | 849 | 9636 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

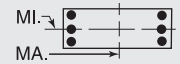



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#10 | 2.06 | MA | 12757 | 3547 | 20004 | 2650 | 21738 | 2222 | 22580 | 1881 | 23362 | 1354 | 27395 | 1019 | 15321 |
| 4L-5S | | MI | 8250 | 3547 | 13063 | 2566 | 13893 | 2160 | 14208 | 1825 | 14350 | 1306 | 16479 | 908 | 9805 |
| 14-#10 | 2.06 | MA | 12548 | 3547 | 19576 | 2661 | 21172 | 2233 | 21871 | 1902 | 22369 | 1373 | 26050 | 981 | 15270 |
| 5L-4S | | MI | 8374 | 3547 | 13330 | 2558 | 14249 | 2141 | 14653 | 1809 | 15008 | 1304 | 17334 | 958 | 9796 |
| 14-#10 | 2.06 | MA | 12398 | 3547 | 19124 | 2666 | 20603 | 2253 | 21170 | 1911 | 21426 | 1391 | 24847 | 927 | 14941 |
| 6L-3S | | MI | 8446 | 3547 | 13649 | 2538 | 14662 | 2135 | 15160 | 1803 | 15669 | 1290 | 18187 | 1010 | 9776 |
| 14-#10 | 2.06 | MA | 12233 | 3547 | 18641 | 2684 | 20017 | 2259 | 20499 | 1932 | 20449 | 1399 | 23437 | 880 | 14609 |
| 7L-2S | | MI | 8591 | 3547 | 14066 | 2530 | 15196 | 2117 | 15812 | 1787 | 16556 | 1276 | 19414 | 1099 | 9755 |
| 14-#11 | 2.53 | MA | 13282 | 3659 | 21432 | 2687 | 23520 | 2241 | 24734 | 1896 | 26289 | 1333 | 31205 | 1027 | 18571 |
| 3L-6S | | MI | 8324 | 3659 | 13153 | 2643 | 13951 | 2207 | 14245 | 1852 | 14394 | 1303 | 16487 | 749 | 11403 |
| 14-#11 | 2.53 | MA | 13117 | 3659 | 20812 | 2714 | 22715 | 2267 | 23744 | 1907 | 24999 | 1355 | 29591 | 968 | 18535 |
| 4L-5S | | MI | 8430 | 3659 | 13486 | 2622 | 14380 | 2199 | 14779 | 1846 | 15111 | 1287 | 17408 | 820 | 11658 |
| 14-#11 | 2.53 | MA | 12866 | 3659 | 20296 | 2727 | 22026 | 2279 | 22882 | 1932 | 23720 | 1363 | 27951 | 919 | 18383 |
| 5L-4S | | MI | 8577 | 3659 | 13810 | 2612 | 14811 | 2178 | 15317 | 1827 | 15906 | 1286 | 18416 | 882 | 11766 |
| 14-#11 | 2.53 | MA | 12687 | 3659 | 19749 | 2732 | 21341 | 2305 | 22028 | 1943 | 22571 | 1385 | 26482 | 851 | 17802 |
| 6L-3S | | MI | 8659 | 3659 | 14195 | 2589 | 15310 | 2171 | 15930 | 1822 | 16705 | 1271 | 19426 | 943 | 11749 |
| 14-#11 | 2.53 | MA | 12491 | 3659 | 19162 | 2754 | 20629 | 2311 | 21214 | 1967 | 21453 | 1407 | 24756 | 792 | 17424 |
| 7L-2S | | MI | 8829 | 3659 | 14697 | 2580 | 15953 | 2150 | 16714 | 1802 | 17771 | 1255 | 20871 | 1053 | 11725 |
| 14-#14 | 3.65 | MA | 14004 | 3927 | 22703 | 2888 | 25093 | 2394 | 26624 | 1987 | 28931 | 1345 | 35091 | 860 | 26188 |
| 4L-5S | | MI | 8884 | 3927 | 14475 | 2790 | 15603 | 2325 | 16248 | 1924 | 17092 | 1267 | 19999 | 646 | 15818 |
| 14-#14 | 3.65 | MA | 13654 | 3927 | 21963 | 2906 | 24106 | 2411 | 25388 | 2022 | 27099 | 1356 | 32736 | 788 | 25229 |
| 5L-4S | | MI | 9090 | 3927 | 14937 | 2777 | 16218 | 2296 | 17015 | 1897 | 18225 | 1266 | 21407 | 736 | 16425 |
| 14-#14 | 3.65 | MA | 13404 | 3927 | 21186 | 2914 | 23124 | 2448 | 24165 | 2037 | 25453 | 1387 | 30626 | 688 | 24511 |
| 6L-3S | | MI | 9202 | 3927 | 15486 | 2745 | 16929 | 2287 | 17889 | 1891 | 19362 | 1246 | 22824 | 821 | 16461 |
| 14-#14 | 3.65 | MA | 13128 | 3927 | 20346 | 2945 | 22115 | 2456 | 22998 | 2071 | 23851 | 1418 | 28145 | 602 | 23314 |
| 7L-2S | | MI | 9434 | 3927 | 16198 | 2732 | 17842 | 2257 | 19002 | 1864 | 20878 | 1225 | 24844 | 980 | 16447 |
| 14-#18 | 6.48 | MA | 15593 | 4604 | 26071 | 3363 | 29252 | 2746 | 31600 | 2249 | 35481 | 1337 | 44589 | 448 | 41691 |
| 5L-4S | | MI | 10334 | 4604 | 17671 | 3200 | 19647 | 2597 | 21166 | 2077 | 23898 | 1215 | 28424 | 329 | 26336 |
| 14-#18 | 6.48 | MA | 15174 | 4604 | 24736 | 3379 | 27528 | 2808 | 29453 | 2273 | 32594 | 1388 | 40855 | 267 | 38819 |
| 6L-3S | | MI | 10511 | 4604 | 18624 | 3146 | 20881 | 2585 | 22680 | 2070 | 25869 | 1184 | 30801 | 472 | 27790 |
| 16-#10 | 2.35 | MA | 13063 | 3617 | 20684 | 2694 | 22610 | 2254 | 23643 | 1900 | 24810 | 1348 | 29399 | 1011 | 17436 |
| 4L-6S | | MI | 8343 | 3617 | 13219 | 2616 | 14073 | 2198 | 14419 | 1850 | 14645 | 1314 | 16926 | 841 | 10898 |
| 16-#10 | 2.35 | MA | 12855 | 3617 | 20256 | 2705 | 22045 | 2264 | 22935 | 1921 | 23816 | 1367 | 28054 | 973 | 17378 |
| 5E | | MI | 8431 | 3617 | 13480 | 2610 | 14427 | 2191 | 14860 | 1845 | 15237 | 1301 | 17705 | 900 | 11103 |
| 16-#10 | 2.35 | MA | 12708 | 3617 | 19804 | 2710 | 21475 | 2285 | 22234 | 1931 | 22873 | 1386 | 26851 | 919 | 17018 |
| 6L-4S | | MI | 8554 | 3617 | 13747 | 2602 | 14783 | 2173 | 15305 | 1828 | 15895 | 1298 | 18560 | 950 | 11103 |
| 16-#10 | 2.35 | MA | 12544 | 3617 | 19322 | 2728 | 20889 | 2290 | 21563 | 1951 | 21897 | 1393 | 25441 | 873 | 16697 |
| 7L-3S | | MI | 8625 | 3617 | 14066 | 2582 | 15196 | 2166 | 15812 | 1823 | 16556 | 1284 | 19414 | 1002 | 11089 |
| 16-#10 | 2.35 | MA | 12364 | 3617 | 18900 | 2736 | 20305 | 2308 | 20841 | 1956 | 20977 | 1412 | 24219 | 829 | 16310 |
| 8L-2S | | MI | 8768 | 3617 | 14482 | 2574 | 15730 | 2148 | 16464 | 1806 | 17442 | 1271 | 20641 | 1091 | 11070 |
| 16-#11 | 2.89 | MA | 13483 | 3746 | 21637 | 2768 | 23773 | 2306 | 25034 | 1931 | 26755 | 1348 | 32022 | 958 | 21096 |
| 4L-6S | | MI | 8540 | 3746 | 13654 | 2697 | 14594 | 2245 | 15029 | 1875 | 15461 | 1296 | 17932 | 736 | 12922 |
| 16-#11 | 2.89 | MA | 13235 | 3746 | 21121 | 2781 | 23084 | 2318 | 24172 | 1955 | 25475 | 1356 | 30381 | 910 | 20884 |
| 5E | | MI | 8645 | 3746 | 13988 | 2676 | 15023 | 2238 | 15563 | 1870 | 16178 | 1281 | 18854 | 807 | 13162 |
| 16-#11 | 2.89 | MA | 13060 | 3746 | 20574 | 2786 | 22399 | 2344 | 23318 | 1966 | 24327 | 1378 | 28913 | 841 | 20325 |
| 6L-4S | | MI | 8790 | 3746 | 14312 | 2666 | 15454 | 2217 | 16101 | 1851 | 16973 | 1279 | 19861 | 869 | 13334 |
| 16-#11 | 2.89 | MA | 12865 | 3746 | 19987 | 2808 | 21687 | 2350 | 22505 | 1991 | 23209 | 1401 | 27187 | 783 | 19960 |
| 7L-3S | | MI | 8872 | 3746 | 14697 | 2643 | 15953 | 2210 | 16714 | 1845 | 17771 | 1264 | 20871 | 930 | 13324 |
| 16-#11 | 2.89 | MA | 12656 | 3746 | 19473 | 2818 | 20976 | 2371 | 21636 | 1997 | 22018 | 1409 | 25695 | 727 | 19228 |
| 8L-2S | | MI | 9039 | 3746 | 15198 | 2634 | 16596 | 2188 | 17498 | 1826 | 18838 | 1248 | 22316 | 1039 | 13305 |
| 16-#14 | 4.17 | MA | 14176 | 4051 | 23142 | 2984 | 25617 | 2467 | 27232 | 2056 | 29607 | 1346 | 36210 | 774 | 28826 |
| 5E | | MI | 9187 | 4051 | 15187 | 2867 | 16516 | 2381 | 17361 | 1958 | 18607 | 1257 | 22019 | 623 | 17962 |
| 16-#14 | 4.17 | MA | 13932 | 4051 | 22365 | 2992 | 24635 | 2503 | 26009 | 2070 | 27962 | 1377 | 34100 | 674 | 28135 |
| 6L-4S | | MI | 9390 | 4051 | 15649 | 2855 | 17131 | 2352 | 18129 | 1931 | 19741 | 1256 | 23427 | 714 | 18541 |
| 16-#14 | 4.17 | MA | 13659 | 4051 | 21525 | 3023 | 23626 | 2512 | 24842 | 2105 | 26360 | 1408 | 31619 | 588 | 26923 |
| 7L-3S | | MI | 9501 | 4051 | 16198 | 2823 | 17842 | 2342 | 19002 | 1925 | 20878 | 1236 | 24844 | 799 | 18679 |
| 16-#14 | 4.17 | MA | 13364 | 4051 | 20789 | 3036 | 22609 | 2542 | 23611 | 2115 | 24653 | 1419 | 29476 | 506 | 25736 |
| 8L-2S | | MI | 9730 | 4051 | 16911 | 2810 | 18755 | 2313 | 20116 | 1898 | 22393 | 1215 | 26864 | 958 | 18680 |
| 16-#18 | 7.41 | MA | 16084 | 4826 | 26793 | 3517 | 30165 | 2908 | 32670 | 2333 | 36971 | 1371 | 46916 | 243 | 45066 |
| 6L-4S | | MI | 10843 | 4826 | 18899 | 3338 | 21220 | 2697 | 23086 | 2137 | 26509 | 1197 | 31791 | 277 | 30004 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

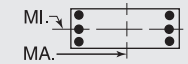
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.65 | MA | 13161 | 3688 | 20936 | 2749 | 22917 | 2296 | 23999 | 1940 | 25264 | 1361 | 30058 | 966 | 19486 |
| 5L-6S | | MI | 8524 | 3688 | 13636 | 2660 | 14607 | 2229 | 15071 | 1869 | 15532 | 1309 | 18152 | 833 | 12163 |
| 18-#10 | 2.65 | MA | 13017 | 3688 | 20485 | 2754 | 22347 | 2317 | 23298 | 1950 | 24321 | 1380 | 28855 | 912 | 19097 |
| 6L-5S | | MI | 8611 | 3688 | 13897 | 2654 | 14961 | 2223 | 15512 | 1864 | 16124 | 1295 | 18932 | 892 | 12391 |
| 18-#10 | 2.65 | MA | 12853 | 3688 | 20002 | 2772 | 21761 | 2322 | 22627 | 1970 | 23344 | 1388 | 27445 | 865 | 18788 |
| 7L-4S | | MI | 8733 | 3688 | 14164 | 2646 | 15317 | 2205 | 15956 | 1847 | 16782 | 1292 | 19787 | 943 | 12409 |
| 18-#10 | 2.65 | MA | 12678 | 3688 | 19580 | 2780 | 21177 | 2340 | 21905 | 1975 | 22424 | 1407 | 26223 | 821 | 18388 |
| 8L-3S | | MI | 8804 | 3688 | 14482 | 2626 | 15730 | 2198 | 16464 | 1842 | 17442 | 1279 | 20641 | 994 | 12398 |
| 18-#10 | 2.65 | MA | 12524 | 3688 | 19128 | 2799 | 20618 | 2347 | 21209 | 1993 | 21517 | 1425 | 25026 | 780 | 17908 |
| 9L-2S | | MI | 8945 | 3688 | 14899 | 2618 | 16265 | 2180 | 17116 | 1825 | 18329 | 1265 | 21868 | 1083 | 12382 |
| 18-#11 | 3.25 | MA | 13602 | 3832 | 21946 | 2835 | 24141 | 2357 | 25462 | 1979 | 27231 | 1349 | 32812 | 900 | 23391 |
| 5L-6S | | MI | 8756 | 3832 | 14155 | 2751 | 15236 | 2284 | 15813 | 1899 | 16528 | 1289 | 19377 | 723 | 14444 |
| 18-#11 | 3.25 | MA | 13430 | 3832 | 21399 | 2840 | 23456 | 2383 | 24609 | 1990 | 26083 | 1372 | 31344 | 832 | 22851 |
| 6L-5S | | MI | 8859 | 3832 | 14489 | 2730 | 15666 | 2277 | 16347 | 1893 | 17245 | 1274 | 20299 | 794 | 14671 |
| 18-#11 | 3.25 | MA | 13237 | 3832 | 20812 | 2862 | 22745 | 2388 | 23795 | 2014 | 24965 | 1394 | 29618 | 773 | 22478 |
| 7L-4S | | MI | 9003 | 3832 | 14813 | 2720 | 16097 | 2256 | 16885 | 1874 | 18040 | 1272 | 21306 | 856 | 14894 |
| 18-#11 | 3.25 | MA | 13031 | 3832 | 20298 | 2871 | 22034 | 2410 | 22926 | 2021 | 23774 | 1402 | 28125 | 718 | 21754 |
| 8L-3S | | MI | 9084 | 3832 | 15198 | 2697 | 16596 | 2248 | 17498 | 1869 | 18838 | 1257 | 22316 | 917 | 14896 |
| 18-#11 | 3.25 | MA | 12843 | 3832 | 19753 | 2896 | 21353 | 2418 | 22079 | 2042 | 22669 | 1424 | 26657 | 666 | 21101 |
| 9L-2S | | MI | 9250 | 3832 | 15700 | 2688 | 17239 | 2227 | 18282 | 1849 | 19905 | 1241 | 23761 | 1026 | 14881 |
| 18-#14 | 4.69 | MA | 14457 | 4175 | 23545 | 3070 | 26147 | 2559 | 27852 | 2104 | 30471 | 1367 | 37574 | 660 | 31764 |
| 6L-5S | | MI | 9488 | 4175 | 15899 | 2945 | 17429 | 2437 | 18475 | 1992 | 20123 | 1247 | 24039 | 601 | 20113 |
| 18-#14 | 4.69 | MA | 14186 | 4175 | 22704 | 3101 | 25138 | 2568 | 26686 | 2139 | 28868 | 1398 | 35092 | 574 | 30534 |
| 7L-4S | | MI | 9689 | 4175 | 16362 | 2933 | 18044 | 2408 | 19243 | 1965 | 21256 | 1246 | 25447 | 692 | 20661 |
| 18-#14 | 4.69 | MA | 13897 | 4175 | 21969 | 3114 | 24120 | 2598 | 25455 | 2149 | 27161 | 1409 | 32949 | 492 | 29321 |
| 8L-3S | | MI | 9799 | 4175 | 16911 | 2901 | 18755 | 2398 | 20116 | 1959 | 22393 | 1226 | 26864 | 777 | 20893 |
| 20-#10 | 2.94 | MA | 13324 | 3758 | 21165 | 2798 | 23219 | 2348 | 24362 | 1969 | 25768 | 1375 | 30859 | 904 | 21180 |
| 6E | | MI | 8705 | 3758 | 14053 | 2704 | 15141 | 2261 | 15723 | 1888 | 16419 | 1303 | 19379 | 825 | 13430 |
| 20-#10 | 2.94 | MA | 13161 | 3758 | 20682 | 2816 | 22633 | 2353 | 23691 | 1989 | 24792 | 1382 | 29450 | 857 | 20880 |
| 7L-5S | | MI | 8790 | 3758 | 14313 | 2698 | 15496 | 2254 | 16164 | 1883 | 17011 | 1289 | 20159 | 884 | 13647 |
| 20-#10 | 2.94 | MA | 12991 | 3758 | 20260 | 2824 | 22049 | 2371 | 22969 | 1994 | 23872 | 1401 | 28227 | 814 | 20469 |
| 8L-4S | | MI | 8911 | 3758 | 14581 | 2690 | 15852 | 2236 | 16608 | 1866 | 17668 | 1287 | 21014 | 935 | 13709 |
| 20-#10 | 2.94 | MA | 12838 | 3758 | 19808 | 2843 | 21490 | 2379 | 22273 | 2012 | 22964 | 1420 | 27030 | 772 | 19999 |
| 9L-3S | | MI | 8982 | 3758 | 14899 | 2670 | 16265 | 2229 | 17116 | 1861 | 18329 | 1273 | 21868 | 986 | 13704 |
| 20-#10 | 2.94 | MA | 12658 | 3758 | 19370 | 2849 | 20929 | 2398 | 21595 | 2030 | 21991 | 1426 | 25813 | 734 | 19438 |
| 10L-2S | | MI | 9122 | 3758 | 15316 | 2662 | 16799 | 2211 | 17767 | 1844 | 19216 | 1259 | 23095 | 1075 | 13692 |
| 20-#11 | 3.61 | MA | 13799 | 3918 | 22224 | 2894 | 24514 | 2421 | 25899 | 2013 | 27838 | 1365 | 33775 | 822 | 25381 |
| 6E | | MI | 8971 | 3918 | 14657 | 2805 | 15879 | 2323 | 16597 | 1922 | 17595 | 1282 | 20822 | 710 | 15970 |
| 20-#11 | 3.61 | MA | 13607 | 3918 | 21637 | 2916 | 23802 | 2427 | 25085 | 2038 | 26720 | 1387 | 32049 | 764 | 24990 |
| 7L-5S | | MI | 9072 | 3918 | 14991 | 2784 | 16309 | 2316 | 17131 | 1917 | 18312 | 1267 | 21744 | 781 | 16185 |
| 20-#11 | 3.61 | MA | 13403 | 3918 | 21123 | 2925 | 23092 | 2449 | 24217 | 2044 | 25529 | 1395 | 30556 | 708 | 24282 |
| 8L-4S | | MI | 9215 | 3918 | 15314 | 2774 | 16740 | 2294 | 17669 | 1898 | 19107 | 1265 | 22751 | 843 | 16453 |
| 20-#11 | 3.61 | MA | 13221 | 3918 | 20579 | 2950 | 22411 | 2457 | 23370 | 2065 | 24424 | 1417 | 29088 | 656 | 23622 |
| 9L-3S | | MI | 9296 | 3918 | 15700 | 2751 | 17239 | 2287 | 18282 | 1892 | 19905 | 1250 | 23761 | 904 | 16465 |
| 20-#14 | 5.21 | MA | 14709 | 4300 | 23883 | 3179 | 26649 | 2624 | 28530 | 2173 | 31377 | 1388 | 38566 | 561 | 34140 |
| 7L-5S | | MI | 9789 | 4300 | 16611 | 3023 | 18342 | 2493 | 19589 | 2026 | 21638 | 1237 | 26059 | 579 | 22270 |
| 20-#14 | 5.21 | MA | 14426 | 4300 | 23148 | 3192 | 25632 | 2654 | 27299 | 2183 | 29670 | 1400 | 36423 | 478 | 32906 |
| 8L-4S | | MI | 9988 | 4300 | 17074 | 3011 | 18957 | 2464 | 20357 | 1999 | 22771 | 1236 | 27468 | 669 | 22789 |
| 22-#10 | 3.23 | MA | 13467 | 3828 | 21362 | 2860 | 23505 | 2385 | 24754 | 2008 | 26239 | 1377 | 31454 | 849 | 22974 |
| 7L-6S | | MI | 8884 | 3828 | 14470 | 2748 | 15675 | 2292 | 16375 | 1907 | 17305 | 1297 | 20606 | 817 | 14699 |
| 22-#10 | 3.23 | MA | 13299 | 3828 | 20940 | 2868 | 22921 | 2403 | 24033 | 2013 | 25319 | 1395 | 30232 | 806 | 22551 |
| 8L-5S | | MI | 8969 | 3828 | 14730 | 2742 | 16030 | 2286 | 16815 | 1902 | 17898 | 1284 | 21386 | 876 | 14907 |
| 22-#10 | 3.23 | MA | 13150 | 3828 | 20488 | 2887 | 22362 | 2410 | 23337 | 2031 | 24412 | 1414 | 29034 | 764 | 22092 |
| 9L-4S | | MI | 9089 | 3828 | 14998 | 2734 | 16386 | 2268 | 17260 | 1885 | 18555 | 1281 | 22241 | 927 | 15007 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

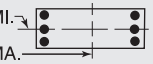
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 3.23 | MA | 12971 | 3828 | 20051 | 2893 | 21801 | 2430 | 22659 | 2049 | 23438 | 1420 | 27817 | 727 | 21522 |
| 10L-3S | | MI | 9159 | 3828 | 15316 | 2714 | 16799 | 2261 | 17767 | 1880 | 19216 | 1267 | 23095 | 978 | 15009 |
| 22-#11 | 3.97 | MA | 13974 | 4005 | 22462 | 2970 | 24860 | 2466 | 26376 | 2061 | 28476 | 1380 | 34480 | 754 | 27505 |
| 7L-6S | | MI | 9185 | 4005 | 15158 | 2859 | 16522 | 2362 | 17381 | 1946 | 18662 | 1275 | 22267 | 697 | 17497 |
| 22-#11 | 3.97 | MA | 13774 | 4005 | 21948 | 2979 | 24150 | 2487 | 25507 | 2068 | 27285 | 1388 | 32987 | 699 | 26813 |
| 8L-5S | | MI | 9285 | 4005 | 15492 | 2838 | 16952 | 2354 | 17915 | 1940 | 19379 | 1260 | 23189 | 768 | 17702 |
| 22-#11 | 3.97 | MA | 13597 | 4005 | 21404 | 3004 | 23469 | 2496 | 24660 | 2089 | 26180 | 1410 | 31519 | 647 | 26144 |
| 9L-4S | | MI | 9427 | 4005 | 15816 | 2828 | 17383 | 2333 | 18453 | 1921 | 20174 | 1258 | 24196 | 830 | 18010 |
| 22-#14 | 5.73 | MA | 14951 | 4424 | 24327 | 3269 | 27143 | 2710 | 29143 | 2217 | 32179 | 1390 | 39896 | 464 | 36491 |
| 8L-5S | | MI | 10088 | 4424 | 17323 | 3101 | 19255 | 2549 | 20703 | 2059 | 23154 | 1227 | 28079 | 556 | 24431 |
| 24-#10 | 3.53 | MA | 13606 | 3898 | 21621 | 2912 | 23793 | 2434 | 25097 | 2033 | 26767 | 1390 | 32236 | 798 | 24636 |
| 8L-6S | | MI | 9064 | 3898 | 14886 | 2792 | 16210 | 2324 | 17026 | 1927 | 18192 | 1292 | 21833 | 810 | 15971 |
| 24-#10 | 3.53 | MA | 13461 | 3898 | 21169 | 2931 | 23234 | 2442 | 24401 | 2050 | 25859 | 1409 | 31038 | 756 | 24186 |
| 9L-5S | | MI | 9147 | 3898 | 15147 | 2786 | 16564 | 2317 | 17467 | 1921 | 18785 | 1278 | 22613 | 869 | 16169 |
| 24-#10 | 3.53 | MA | 13283 | 3898 | 20731 | 2937 | 22673 | 2461 | 23723 | 2068 | 24886 | 1415 | 29822 | 719 | 23607 |
| 10L-4S | | MI | 9266 | 3898 | 15414 | 2777 | 16920 | 2299 | 17912 | 1905 | 19442 | 1276 | 23468 | 919 | 16304 |
| 24-#11 | 4.33 | MA | 14143 | 4091 | 22773 | 3033 | 25207 | 2526 | 26797 | 2091 | 29040 | 1381 | 35418 | 689 | 29346 |
| 8L-6S | | MI | 9398 | 4091 | 15660 | 2913 | 17165 | 2400 | 18166 | 1969 | 19729 | 1268 | 23712 | 684 | 19027 |
| 24-#11 | 4.33 | MA | 13971 | 4091 | 22229 | 3058 | 24527 | 2535 | 25951 | 2112 | 27935 | 1404 | 33950 | 637 | 28665 |
| 9L-5S | | MI | 9497 | 4091 | 15993 | 2891 | 17594 | 2393 | 18699 | 1964 | 20446 | 1253 | 24634 | 755 | 19222 |

## RECTANGULAR TIED COLUMNS 24" x 38"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.75 | MA | 14207 | 3667 | 22825 | 2681 | 24770 | 2250 | 25770 | 1909 | 26836 | 1388 | 31351 | 1200 | 14388 |
| 2E | | MI | 8769 | 3667 | 14341 | 2555 | 15224 | 2142 | 15624 | 1815 | 15991 | 1313 | 17922 | 1078 | 8644 |
| 6-#11 | 1.03 | MA | 13453 | 3484 | 20960 | 2595 | 22511 | 2192 | 23072 | 1880 | 23199 | 1420 | 26343 | 1235 | 8705 |
| 2L-3S | | MI | 8207 | 3484 | 12811 | 2496 | 13376 | 2120 | 13417 | 1819 | 13009 | 1371 | 14243 | 1058 | 5400 |
| 6-#11 | 1.03 | MA | 13115 | 3484 | 20081 | 2609 | 21384 | 2205 | 21697 | 1905 | 21329 | 1442 | 23753 | 1138 | 8742 |
| 3L-2S | | MI | 8386 | 3484 | 13313 | 2487 | 14018 | 2099 | 14201 | 1799 | 14076 | 1355 | 15688 | 1168 | 5362 |
| 6-#14 | 1.48 | MA | 13952 | 3598 | 22132 | 2657 | 23968 | 2235 | 24830 | 1904 | 25579 | 1405 | 29629 | 1217 | 12328 |
| 2L-3S | | MI | 8400 | 3598 | 13260 | 2555 | 13913 | 2167 | 14056 | 1845 | 13871 | 1357 | 15338 | 974 | 7529 |
| 6-#14 | 1.48 | MA | 13479 | 3598 | 20875 | 2677 | 22357 | 2253 | 22864 | 1940 | 22905 | 1437 | 25926 | 1076 | 12367 |
| 3L-2S | | MI | 8649 | 3598 | 13973 | 2543 | 14826 | 2137 | 15170 | 1819 | 15387 | 1337 | 17358 | 1132 | 7470 |
| 6-#18 | 2.63 | MA | 15164 | 3889 | 25020 | 2819 | 27585 | 2349 | 29203 | 1969 | 31507 | 1370 | 37819 | 1175 | 21278 |
| 2L-3S | | MI | 8866 | 3889 | 14341 | 2712 | 15224 | 2290 | 15624 | 1918 | 15991 | 1326 | 17922 | 744 | 12630 |
| 6-#18 | 2.63 | MA | 14375 | 3889 | 22825 | 2852 | 24770 | 2378 | 25770 | 2029 | 26836 | 1424 | 31351 | 916 | 21222 |
| 3L-2S | | MI | 9279 | 3889 | 15568 | 2694 | 16797 | 2241 | 17543 | 1875 | 18602 | 1296 | 21289 | 1026 | 12557 |
| 8-#10 | 1.11 | MA | 13580 | 3506 | 21166 | 2623 | 22837 | 2213 | 23497 | 1896 | 23795 | 1426 | 27180 | 1240 | 9464 |
| 2L-4S | | MI | 8239 | 3506 | 12699 | 2550 | 13282 | 2152 | 13323 | 1843 | 12923 | 1394 | 14255 | 1046 | 5867 |
| 8-#10 | 1.11 | MA | 13301 | 3506 | 20442 | 2634 | 21908 | 2224 | 22364 | 1917 | 22254 | 1445 | 25047 | 1162 | 9489 |
| 3E | | MI | 8313 | 3506 | 13018 | 2530 | 13695 | 2145 | 13830 | 1838 | 13583 | 1380 | 15108 | 1097 | 5831 |
| 8-#10 | 1.11 | MA | 13144 | 3506 | 19901 | 2657 | 21205 | 2246 | 21499 | 1927 | 21064 | 1453 | 23651 | 1115 | 9508 |
| 4L-2S | | MI | 8463 | 3506 | 13435 | 2522 | 14230 | 2127 | 14482 | 1821 | 14470 | 1366 | 16335 | 1187 | 5803 |
| 8-#11 | 1.37 | MA | 13848 | 3570 | 21839 | 2649 | 23638 | 2231 | 24447 | 1904 | 25070 | 1413 | 28933 | 1225 | 11478 |
| 2L-4S | | MI | 8339 | 3570 | 12927 | 2573 | 13519 | 2166 | 13588 | 1847 | 13278 | 1379 | 14678 | 985 | 7062 |
| 8-#11 | 1.37 | MA | 13515 | 3570 | 20960 | 2663 | 22511 | 2243 | 23072 | 1929 | 23199 | 1436 | 26343 | 1129 | 11506 |
| 3E | | MI | 8423 | 3570 | 13313 | 2550 | 14018 | 2159 | 14201 | 1842 | 14076 | 1364 | 15688 | 1045 | 7017 |
| 8-#11 | 1.37 | MA | 13330 | 3570 | 20301 | 2691 | 21655 | 2270 | 22019 | 1940 | 21752 | 1445 | 24635 | 1070 | 11516 |
| 4L-2S | | MI | 8600 | 3570 | 13814 | 2541 | 14661 | 2138 | 14985 | 1823 | 15143 | 1348 | 17133 | 1155 | 6979 |
| 8-#14 | 1.97 | MA | 14508 | 3723 | 23389 | 2735 | 25579 | 2291 | 26796 | 1938 | 28254 | 1395 | 33332 | 1203 | 16276 |
| 2L-4S | | MI | 8589 | 3723 | 13424 | 2665 | 14115 | 2232 | 14296 | 1886 | 14250 | 1368 | 15942 | 866 | 9836 |
| 8-#14 | 1.97 | MA | 14047 | 3723 | 22132 | 2754 | 23968 | 2308 | 24830 | 1974 | 25579 | 1427 | 29629 | 1062 | 16294 |
| 3E | | MI | 8704 | 3723 | 13973 | 2633 | 14826 | 2223 | 15170 | 1879 | 15387 | 1348 | 17358 | 952 | 9795 |
| 8-#14 | 1.97 | MA | 13787 | 3723 | 21188 | 2793 | 22742 | 2346 | 23322 | 1989 | 23614 | 1459 | 27172 | 976 | 16216 |
| 4L-2S | | MI | 8949 | 3723 | 14685 | 2621 | 15739 | 2193 | 16283 | 1853 | 16902 | 1327 | 19378 | 1110 | 9745 |
| 8-#18 | 3.51 | MA | 16111 | 4110 | 27216 | 2958 | 30399 | 2448 | 32637 | 2029 | 36178 | 1352 | 44287 | 1151 | 28143 |
| 2L-4S | | MI | 9198 | 4110 | 14616 | 2904 | 15564 | 2402 | 16029 | 1985 | 16632 | 1339 | 18912 | 549 | 15654 |

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

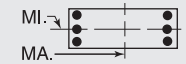
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.51 | MA | 15350 | 4110 | 25020 | 2990 | 27585 | 2477 | 29203 | 2090 | 31507 | 1406 | 37819 | 891 | 28025 |
| 3E | | MI | 9384 | 4110 | 15568 | 2851 | 16797 | 2389 | 17543 | 1978 | 18602 | 1308 | 21289 | 692 | 16462 |
| 8-#18 | 3.51 | MA | 14917 | 4110 | 23364 | 3058 | 25435 | 2541 | 26560 | 2115 | 28063 | 1460 | 33476 | 737 | 26664 |
| 4L-2S | | MI | 9787 | 4110 | 16795 | 2832 | 18370 | 2341 | 19462 | 1936 | 21213 | 1278 | 24656 | 973 | 16433 |
| 10-#10 | 1.39 | MA | 13907 | 3576 | 21890 | 2667 | 23765 | 2245 | 24629 | 1915 | 25336 | 1420 | 29314 | 1232 | 11743 |
| 2L-5S | | MI | 8295 | 3576 | 12849 | 2602 | 13461 | 2202 | 13530 | 1879 | 13152 | 1390 | 14626 | 988 | 7226 |
| 10-#10 | 1.39 | MA | 13632 | 3576 | 21166 | 2678 | 22837 | 2256 | 23497 | 1936 | 23795 | 1440 | 27180 | 1154 | 11762 |
| 3L-4S | | MI | 8421 | 3576 | 13116 | 2594 | 13817 | 2184 | 13974 | 1862 | 13809 | 1388 | 15481 | 1038 | 7196 |
| 10-#10 | 1.39 | MA | 13476 | 3576 | 20625 | 2701 | 22133 | 2278 | 22631 | 1946 | 22605 | 1448 | 25785 | 1107 | 11770 |
| 4L-3S | | MI | 8494 | 3576 | 13435 | 2574 | 14230 | 2177 | 14482 | 1857 | 14470 | 1374 | 16335 | 1089 | 7165 |
| 10-#10 | 1.39 | MA | 13247 | 3576 | 20167 | 2712 | 21533 | 2288 | 21879 | 1967 | 21550 | 1467 | 24359 | 1071 | 11738 |
| 5L-2S | | MI | 8642 | 3576 | 13852 | 2566 | 14764 | 2159 | 15134 | 1840 | 15357 | 1360 | 17562 | 1179 | 7137 |
| 10-#11 | 1.71 | MA | 14239 | 3656 | 22718 | 2703 | 24765 | 2269 | 25821 | 1927 | 26940 | 1406 | 31522 | 1216 | 14240 |
| 2L-5S | | MI | 8405 | 3656 | 13105 | 2636 | 13731 | 2226 | 13834 | 1890 | 13550 | 1374 | 15116 | 909 | 8679 |
| 10-#11 | 1.71 | MA | 13913 | 3656 | 21839 | 2717 | 23638 | 2282 | 24447 | 1952 | 25070 | 1429 | 28933 | 1119 | 14260 |
| 3L-4S | | MI | 8555 | 3656 | 13429 | 2627 | 14162 | 2205 | 14372 | 1871 | 14345 | 1372 | 16123 | 972 | 8653 |
| 10-#11 | 1.71 | MA | 13729 | 3656 | 21180 | 2745 | 22782 | 2308 | 23394 | 1964 | 23623 | 1438 | 27225 | 1060 | 14252 |
| 4L-3S | | MI | 8638 | 3656 | 13814 | 2604 | 14661 | 2198 | 14985 | 1866 | 15143 | 1357 | 17133 | 1032 | 8616 |
| 10-#11 | 1.71 | MA | 13454 | 3656 | 20629 | 2758 | 22050 | 2321 | 22477 | 1989 | 22338 | 1461 | 25484 | 1014 | 14173 |
| 5L-2S | | MI | 8813 | 3656 | 14315 | 2595 | 15304 | 2177 | 15769 | 1846 | 16210 | 1341 | 18578 | 1142 | 8581 |
| 10-#14 | 2.47 | MA | 15061 | 3847 | 24645 | 2813 | 27191 | 2347 | 28761 | 1972 | 30928 | 1385 | 37035 | 1190 | 20214 |
| 2L-5S | | MI | 8682 | 3847 | 13673 | 2756 | 14413 | 2317 | 14643 | 1946 | 14632 | 1359 | 16554 | 753 | 11678 |
| 10-#14 | 2.47 | MA | 14609 | 3847 | 23389 | 2832 | 25579 | 2364 | 26796 | 2008 | 28254 | 1417 | 33332 | 1048 | 20209 |
| 3L-4S | | MI | 8893 | 3847 | 14136 | 2743 | 15028 | 2288 | 15410 | 1920 | 15765 | 1358 | 17962 | 844 | 12062 |
| 10-#14 | 2.47 | MA | 14354 | 3847 | 22444 | 2871 | 24353 | 2402 | 25287 | 2023 | 26289 | 1449 | 30875 | 963 | 20107 |
| 4L-3S | | MI | 9007 | 3847 | 14685 | 2711 | 15739 | 2278 | 16283 | 1913 | 16902 | 1338 | 19378 | 929 | 12043 |
| 10-#14 | 2.47 | MA | 13965 | 3847 | 21659 | 2891 | 23304 | 2419 | 23974 | 2059 | 24340 | 1461 | 28377 | 893 | 19327 |
| 5L-2S | | MI | 9248 | 3847 | 15397 | 2698 | 16652 | 2249 | 17397 | 1887 | 18417 | 1317 | 21398 | 1088 | 12003 |
| 10-#18 | 4.39 | MA | 16314 | 4331 | 27216 | 3128 | 30399 | 2576 | 32637 | 2150 | 36178 | 1388 | 44287 | 867 | 34826 |
| 3L-4S | | MI | 9716 | 4331 | 15843 | 3043 | 17137 | 2501 | 17949 | 2045 | 19243 | 1321 | 22279 | 496 | 19248 |
| 10-#18 | 4.39 | MA | 15890 | 4331 | 25560 | 3196 | 28249 | 2640 | 29993 | 2175 | 32734 | 1442 | 39944 | 713 | 33302 |
| 4L-3S | | MI | 9898 | 4331 | 16795 | 2989 | 18370 | 2488 | 19462 | 2038 | 21213 | 1291 | 24656 | 639 | 20272 |
| 10-#18 | 4.39 | MA | 15230 | 4331 | 24179 | 3228 | 26405 | 2669 | 27687 | 2236 | 29316 | 1460 | 35544 | 580 | 31135 |
| 5L-2S | | MI | 10292 | 4331 | 18023 | 2970 | 19943 | 2440 | 21381 | 1996 | 23824 | 1260 | 28023 | 921 | 20288 |
| 12-#10 | 1.67 | MA | 14232 | 3646 | 22615 | 2711 | 24693 | 2276 | 25762 | 1935 | 26876 | 1415 | 31447 | 1224 | 14016 |
| 2L-6S | | MI | 8386 | 3646 | 13005 | 2652 | 13640 | 2240 | 13741 | 1904 | 13446 | 1399 | 15073 | 921 | 8456 |
| 12-#10 | 1.67 | MA | 13961 | 3646 | 21890 | 2722 | 23765 | 2287 | 24629 | 1956 | 25336 | 1434 | 29314 | 1147 | 14030 |
| 3L-5S | | MI | 8477 | 3646 | 13266 | 2646 | 13995 | 2233 | 14181 | 1898 | 14039 | 1385 | 15853 | 980 | 8537 |
| 12-#10 | 1.67 | MA | 13807 | 3646 | 21349 | 2745 | 23062 | 2309 | 23764 | 1965 | 24146 | 1442 | 27918 | 1099 | 14027 |
| 4E | | MI | 8602 | 3646 | 13533 | 2637 | 14351 | 2215 | 14626 | 1881 | 14696 | 1382 | 16708 | 1030 | 8515 |
| 12-#10 | 1.67 | MA | 13579 | 3646 | 20891 | 2756 | 22461 | 2320 | 23012 | 1987 | 23091 | 1461 | 26492 | 1063 | 13984 |
| 5L-3S | | MI | 8674 | 3646 | 13852 | 2618 | 14764 | 2208 | 15134 | 1876 | 15357 | 1369 | 17562 | 1082 | 8489 |
| 12-#10 | 1.67 | MA | 13416 | 3646 | 20411 | 2760 | 21851 | 2340 | 22268 | 1996 | 22089 | 1481 | 25217 | 1011 | 13728 |
| 6L-2S | | MI | 8821 | 3646 | 14268 | 2610 | 15298 | 2190 | 15785 | 1859 | 16244 | 1355 | 18789 | 1171 | 8464 |
| 12-#11 | 2.05 | MA | 14629 | 3743 | 23598 | 2757 | 25892 | 2308 | 27196 | 1951 | 28811 | 1399 | 34112 | 1206 | 16997 |
| 2L-6S | | MI | 8514 | 3743 | 13273 | 2712 | 13944 | 2272 | 14084 | 1919 | 13900 | 1382 | 15640 | 826 | 9979 |
| 12-#11 | 2.05 | MA | 14308 | 3743 | 22718 | 2771 | 24765 | 2321 | 25821 | 1976 | 26940 | 1422 | 31522 | 1109 | 17009 |
| 3L-5S | | MI | 8621 | 3743 | 13606 | 2690 | 14374 | 2265 | 14618 | 1914 | 14617 | 1367 | 16561 | 896 | 10246 |
| 12-#11 | 2.05 | MA | 14126 | 3743 | 22060 | 2799 | 23909 | 2347 | 24768 | 1987 | 25493 | 1431 | 29814 | 1051 | 16984 |
| 4E | | MI | 8770 | 3743 | 13930 | 2681 | 14805 | 2244 | 15156 | 1895 | 15412 | 1365 | 17568 | 959 | 10233 |
| 12-#11 | 2.05 | MA | 13854 | 3743 | 21508 | 2812 | 23177 | 2360 | 23852 | 2013 | 24208 | 1454 | 28074 | 1004 | 16893 |
| 5L-3S | | MI | 8853 | 3743 | 14315 | 2658 | 15304 | 2237 | 15769 | 1889 | 16210 | 1350 | 18578 | 1019 | 10205 |
| 12-#11 | 2.05 | MA | 13658 | 3743 | 20924 | 2817 | 22442 | 2385 | 22945 | 2024 | 22988 | 1477 | 26516 | 937 | 16312 |
| 6L-2S | | MI | 9025 | 3743 | 14817 | 2649 | 15947 | 2215 | 16553 | 1870 | 17277 | 1335 | 20023 | 1129 | 10174 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

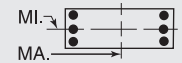



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 2.96 | MA | 15168 | 3972 | 24645 | 2910 | 27191 | 2420 | 28761 | 2042 | 30928 | 1407 | 37035 | 1034 | 24119 |
| 3L-5S | | MI | 8988 | 3972 | 14386 | 2833 | 15326 | 2373 | 15756 | 1980 | 16147 | 1349 | 18574 | 731 | 13802 |
| 12-#14 | 2.96 | MA | 14915 | 3972 | 23701 | 2949 | 25965 | 2457 | 27253 | 2057 | 28963 | 1439 | 34578 | 949 | 23998 |
| 4E | | MI | 9196 | 3972 | 14848 | 2821 | 15941 | 2344 | 16524 | 1954 | 17280 | 1348 | 19982 | 822 | 14277 |
| 12-#14 | 2.96 | MA | 14533 | 3972 | 22916 | 2968 | 24915 | 2475 | 25939 | 2093 | 27015 | 1451 | 32080 | 879 | 23147 |
| 5L-3S | | MI | 9309 | 3972 | 15397 | 2789 | 16652 | 2334 | 17397 | 1947 | 18417 | 1328 | 21398 | 907 | 14280 |
| 12-#14 | 2.96 | MA | 14258 | 3972 | 22081 | 2976 | 23872 | 2512 | 24640 | 2108 | 25266 | 1483 | 29843 | 781 | 22312 |
| 6L-2S | | MI | 9546 | 3972 | 16109 | 2776 | 17565 | 2305 | 18511 | 1921 | 19933 | 1307 | 23418 | 1065 | 14251 |
| 12-#18 | 5.26 | MA | 16852 | 4553 | 27755 | 3334 | 31063 | 2740 | 33426 | 2236 | 37405 | 1424 | 46412 | 688 | 39961 |
| 4E | | MI | 10230 | 4553 | 17070 | 3181 | 18710 | 2600 | 19868 | 2105 | 21854 | 1304 | 25646 | 444 | 22871 |
| 12-#18 | 5.26 | MA | 16209 | 4553 | 26374 | 3366 | 29220 | 2768 | 31120 | 2296 | 33987 | 1442 | 42012 | 556 | 37861 |
| 5L-3S | | MI | 10410 | 4553 | 18023 | 3127 | 19943 | 2588 | 21381 | 2099 | 23824 | 1273 | 28023 | 587 | 24072 |
| 12-#18 | 5.26 | MA | 15742 | 4553 | 24937 | 3381 | 27386 | 2832 | 28837 | 2321 | 30916 | 1496 | 38060 | 376 | 34991 |
| 6L-2S | | MI | 10796 | 4553 | 19250 | 3109 | 21516 | 2539 | 23301 | 2056 | 26435 | 1242 | 31390 | 868 | 24132 |
| 14-#10 | 1.95 | MA | 14288 | 3717 | 22615 | 2766 | 24693 | 2319 | 25762 | 1975 | 26876 | 1428 | 31447 | 1139 | 16295 |
| 3L-6S | | MI | 8569 | 3717 | 13422 | 2696 | 14175 | 2272 | 14392 | 1923 | 14333 | 1393 | 16300 | 913 | 9713 |
| 14-#10 | 1.95 | MA | 14135 | 3717 | 22073 | 2789 | 23990 | 2341 | 24897 | 1985 | 25687 | 1436 | 30052 | 1092 | 16281 |
| 4L-5S | | MI | 8658 | 3717 | 13682 | 2690 | 14529 | 2265 | 14833 | 1917 | 14925 | 1379 | 17080 | 972 | 9843 |
| 14-#10 | 1.95 | MA | 13910 | 3717 | 21615 | 2799 | 23389 | 2351 | 24144 | 2006 | 24632 | 1456 | 28626 | 1055 | 16230 |
| 5L-4S | | MI | 8782 | 3717 | 13950 | 2681 | 14885 | 2247 | 15278 | 1901 | 15583 | 1377 | 17935 | 1022 | 9828 |
| 14-#10 | 1.95 | MA | 13750 | 3717 | 21135 | 2804 | 22779 | 2372 | 23400 | 2016 | 23630 | 1475 | 27350 | 1003 | 15936 |
| 6L-3S | | MI | 8854 | 3717 | 14268 | 2662 | 15298 | 2240 | 15785 | 1895 | 16244 | 1363 | 18789 | 1074 | 9807 |
| 14-#10 | 1.95 | MA | 13571 | 3717 | 20622 | 2823 | 22156 | 2377 | 22680 | 2036 | 22594 | 1483 | 25859 | 956 | 15566 |
| 7L-2S | | MI | 8999 | 3717 | 14685 | 2654 | 15832 | 2222 | 16437 | 1879 | 17131 | 1349 | 20016 | 1163 | 9784 |
| 14-#11 | 2.39 | MA | 14701 | 3829 | 23598 | 2825 | 25892 | 2359 | 27196 | 1999 | 28811 | 1415 | 34112 | 1100 | 19750 |
| 3L-6S | | MI | 8731 | 3829 | 13774 | 2766 | 14587 | 2311 | 14868 | 1943 | 14967 | 1375 | 17085 | 813 | 11493 |
| 14-#11 | 2.39 | MA | 14521 | 3829 | 22939 | 2853 | 25036 | 2386 | 26143 | 2011 | 27364 | 1424 | 32404 | 1041 | 19714 |
| 4L-5S | | MI | 8837 | 3829 | 14108 | 2744 | 15017 | 2304 | 15402 | 1937 | 15684 | 1360 | 18006 | 883 | 11756 |
| 14-#11 | 2.39 | MA | 14252 | 3829 | 22387 | 2866 | 24304 | 2398 | 25227 | 2036 | 26079 | 1447 | 30664 | 995 | 19613 |
| 5L-4S | | MI | 8984 | 3829 | 14432 | 2735 | 15448 | 2283 | 15940 | 1918 | 16479 | 1358 | 19013 | 946 | 11808 |
| 14-#11 | 2.39 | MA | 14060 | 3829 | 21803 | 2871 | 23569 | 2424 | 24320 | 2047 | 24859 | 1470 | 29106 | 928 | 18997 |
| 6L-3S | | MI | 9067 | 3829 | 14817 | 2712 | 15947 | 2275 | 16553 | 1913 | 17277 | 1343 | 20023 | 1006 | 11787 |
| 14-#11 | 2.39 | MA | 13848 | 3829 | 21179 | 2893 | 22812 | 2430 | 23455 | 2073 | 23596 | 1479 | 27280 | 870 | 18579 |
| 7L-2S | | MI | 9237 | 3829 | 15318 | 2702 | 16590 | 2254 | 17337 | 1893 | 18344 | 1328 | 21468 | 1116 | 11761 |
| 14-#14 | 3.45 | MA | 15473 | 4096 | 24958 | 3027 | 27576 | 2513 | 29219 | 2091 | 31637 | 1429 | 38281 | 935 | 27889 |
| 4L-5S | | MI | 9292 | 4096 | 15098 | 2911 | 16239 | 2429 | 16870 | 2014 | 17662 | 1339 | 20594 | 709 | 15937 |
| 14-#14 | 3.45 | MA | 15097 | 4096 | 24172 | 3046 | 26526 | 2531 | 27905 | 2127 | 29689 | 1441 | 35782 | 865 | 26976 |
| 5L-4S | | MI | 9498 | 4096 | 15560 | 2899 | 16854 | 2400 | 17638 | 1988 | 18796 | 1338 | 22002 | 799 | 16486 |
| 14-#14 | 3.45 | MA | 14829 | 4096 | 23338 | 3054 | 25483 | 2568 | 26605 | 2142 | 27940 | 1473 | 33546 | 767 | 26174 |
| 6L-3S | | MI | 9610 | 4096 | 16109 | 2866 | 17565 | 2390 | 18511 | 1981 | 19933 | 1318 | 23418 | 885 | 16512 |
| 14-#14 | 3.45 | MA | 14530 | 4096 | 22444 | 3085 | 24398 | 2576 | 25366 | 2178 | 26237 | 1505 | 30918 | 683 | 24987 |
| 7L-2S | | MI | 9843 | 4096 | 16821 | 2854 | 18478 | 2361 | 19625 | 1955 | 21448 | 1297 | 25438 | 1043 | 16491 |
| 14-#18 | 6.14 | MA | 17177 | 4774 | 28569 | 3505 | 32034 | 2868 | 34553 | 2357 | 38658 | 1425 | 48480 | 531 | 44587 |
| 5L-4S | | MI | 10742 | 4774 | 18297 | 3319 | 20283 | 2700 | 21787 | 2166 | 24465 | 1286 | 29013 | 391 | 26517 |
| 14-#18 | 6.14 | MA | 16728 | 4774 | 27132 | 3520 | 30201 | 2932 | 32270 | 2382 | 35588 | 1478 | 44528 | 352 | 41660 |
| 6L-3S | | MI | 10919 | 4774 | 19250 | 3265 | 21516 | 2687 | 23301 | 2159 | 26435 | 1255 | 31390 | 534 | 27868 |
| 16-#10 | 2.23 | MA | 14462 | 3787 | 22797 | 2833 | 24918 | 2372 | 26029 | 2004 | 27228 | 1431 | 32185 | 1084 | 18533 |
| 4L-6S | | MI | 8750 | 3787 | 13839 | 2739 | 14709 | 2303 | 15044 | 1942 | 15220 | 1387 | 17527 | 905 | 10974 |
| 16-#10 | 2.23 | MA | 14240 | 3787 | 22339 | 2843 | 24318 | 2383 | 25277 | 2025 | 26173 | 1450 | 30759 | 1048 | 18475 |
| 5E | | MI | 8838 | 3787 | 14099 | 2734 | 15063 | 2296 | 15485 | 1936 | 15812 | 1374 | 18307 | 964 | 11145 |
| 16-#10 | 2.23 | MA | 14082 | 3787 | 21859 | 2848 | 23707 | 2403 | 24533 | 2035 | 25171 | 1469 | 29484 | 995 | 18147 |
| 6L-4S | | MI | 8961 | 3787 | 14367 | 2725 | 15419 | 2278 | 15930 | 1920 | 16470 | 1371 | 19162 | 1015 | 11138 |
| 16-#10 | 2.23 | MA | 13904 | 3787 | 21346 | 2867 | 23084 | 2409 | 23813 | 2055 | 24135 | 1478 | 27993 | 949 | 17791 |
| 7L-3S | | MI | 9033 | 3787 | 14685 | 2706 | 15832 | 2271 | 16437 | 1914 | 17131 | 1357 | 20016 | 1066 | 11121 |
| 16-#10 | 2.23 | MA | 13712 | 3787 | 20898 | 2875 | 22464 | 2427 | 23046 | 2060 | 23158 | 1497 | 26697 | 907 | 17439 |
| 8L-2S | | MI | 9177 | 3787 | 15102 | 2697 | 16367 | 2253 | 17089 | 1898 | 18017 | 1344 | 21242 | 1155 | 11101 |
| 16-#11 | 2.74 | MA | 14914 | 3915 | 23818 | 2906 | 26163 | 2425 | 27518 | 2034 | 29234 | 1417 | 34994 | 1032 | 22444 |
| 4L-6S | | MI | 8947 | 3915 | 14275 | 2820 | 15230 | 2350 | 15653 | 1966 | 16034 | 1368 | 18530 | 800 | 13012 |

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

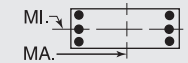
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.74 | MA | 14648 | 3915 | 23266 | 2920 | 25430 | 2437 | 26601 | 2060 | 27949 | 1440 | 33254 | 985 | 22316 |
| 5E | | MI | 9052 | 3915 | 14609 | 2798 | 15659 | 2342 | 16186 | 1961 | 16751 | 1353 | 19451 | 870 | 13259 |
| 16-#11 | 2.74 | MA | 14460 | 3915 | 22682 | 2925 | 24696 | 2463 | 25695 | 2071 | 26729 | 1463 | 31696 | 918 | 21686 |
| 6L-4S | | MI | 9198 | 3915 | 14933 | 2789 | 16091 | 2321 | 16725 | 1942 | 17546 | 1351 | 20458 | 933 | 13378 |
| 16-#11 | 2.74 | MA | 14249 | 3915 | 22058 | 2947 | 23939 | 2469 | 24830 | 2096 | 25467 | 1472 | 29870 | 861 | 21282 |
| 7L-3S | | MI | 9280 | 3915 | 15318 | 2766 | 16590 | 2314 | 17337 | 1936 | 18344 | 1336 | 21468 | 993 | 13364 |
| 16-#11 | 2.74 | MA | 14019 | 3915 | 21512 | 2957 | 23183 | 2491 | 23897 | 2102 | 24276 | 1495 | 28288 | 807 | 20567 |
| 8L-2S | | MI | 9448 | 3915 | 15820 | 2756 | 17232 | 2293 | 18122 | 1917 | 19411 | 1321 | 22913 | 1103 | 13342 |
| 16-#14 | 3.95 | MA | 15657 | 4221 | 25429 | 3124 | 28137 | 2587 | 29871 | 2161 | 32363 | 1431 | 39485 | 852 | 30814 |
| 5E | | MI | 9594 | 4221 | 15810 | 2989 | 17152 | 2485 | 17984 | 2048 | 19178 | 1329 | 22614 | 687 | 18080 |
| 16-#14 | 3.95 | MA | 15395 | 4221 | 24595 | 3132 | 27094 | 2624 | 28571 | 2176 | 30614 | 1463 | 37249 | 753 | 30040 |
| 6L-4S | | MI | 9798 | 4221 | 16272 | 2977 | 17767 | 2456 | 18752 | 2022 | 20311 | 1328 | 24022 | 777 | 18678 |
| 16-#14 | 3.95 | MA | 15099 | 4221 | 23700 | 3163 | 26009 | 2632 | 27331 | 2212 | 28911 | 1495 | 34621 | 669 | 28832 |
| 7L-3S | | MI | 9909 | 4221 | 16821 | 2944 | 18478 | 2446 | 19625 | 2015 | 21448 | 1308 | 25438 | 862 | 18732 |
| 16-#14 | 3.95 | MA | 14783 | 4221 | 22918 | 3177 | 24927 | 2663 | 26007 | 2221 | 27097 | 1507 | 32348 | 589 | 27655 |
| 8L-2S | | MI | 10140 | 4221 | 17534 | 2932 | 19391 | 2417 | 20739 | 1989 | 22964 | 1287 | 27458 | 1021 | 18725 |
| 16-#18 | 7.02 | MA | 17704 | 4995 | 29327 | 3658 | 33015 | 3031 | 35704 | 2442 | 40259 | 1461 | 50996 | 327 | 48329 |
| 6L-4S | | MI | 11251 | 4995 | 19524 | 3458 | 21856 | 2799 | 23706 | 2226 | 27076 | 1268 | 32380 | 339 | 30181 |
| 18-#10 | 2.51 | MA | 14567 | 3857 | 23064 | 2887 | 25246 | 2414 | 26409 | 2044 | 27714 | 1444 | 32893 | 1040 | 20720 |
| 5L-6S | | MI | 8931 | 3857 | 14255 | 2783 | 15243 | 2335 | 15696 | 1961 | 16107 | 1382 | 18754 | 897 | 12239 |
| 18-#10 | 2.51 | MA | 14412 | 3857 | 22583 | 2892 | 24636 | 2435 | 25665 | 2054 | 26712 | 1464 | 31617 | 987 | 20363 |
| 6L-5S | | MI | 9018 | 3857 | 14516 | 2777 | 15598 | 2328 | 16137 | 1956 | 16699 | 1368 | 19534 | 956 | 12443 |
| 18-#10 | 2.51 | MA | 14235 | 3857 | 22070 | 2911 | 24013 | 2441 | 24945 | 2074 | 25676 | 1472 | 30126 | 941 | 20017 |
| 7L-4S | | MI | 9140 | 3857 | 14783 | 2769 | 15954 | 2310 | 16581 | 1939 | 17357 | 1365 | 20389 | 1007 | 12444 |
| 18-#10 | 2.51 | MA | 14047 | 3857 | 21622 | 2919 | 23392 | 2459 | 24178 | 2079 | 24699 | 1491 | 28831 | 899 | 19654 |
| 8L-3S | | MI | 9212 | 3857 | 15102 | 2750 | 16367 | 2303 | 17089 | 1934 | 18017 | 1352 | 21242 | 1058 | 12431 |
| 18-#10 | 2.51 | MA | 13882 | 3857 | 21138 | 2938 | 22798 | 2467 | 23439 | 2097 | 23735 | 1511 | 27565 | 857 | 19122 |
| 9L-2S | | MI | 9354 | 3857 | 15519 | 2741 | 16901 | 2285 | 17741 | 1917 | 18904 | 1338 | 22469 | 1147 | 12415 |
| 18-#11 | 3.08 | MA | 15042 | 4002 | 24145 | 2974 | 26557 | 2476 | 27976 | 2083 | 29820 | 1433 | 35843 | 975 | 24989 |
| 5L-6S | | MI | 9163 | 4002 | 14777 | 2874 | 15873 | 2389 | 16437 | 1990 | 17101 | 1361 | 19975 | 787 | 14534 |
| 18-#11 | 3.08 | MA | 14857 | 4002 | 23561 | 2979 | 25823 | 2501 | 27070 | 2095 | 28599 | 1456 | 34286 | 909 | 24379 |
| 6L-5S | | MI | 9266 | 4002 | 15111 | 2852 | 16302 | 2381 | 16971 | 1984 | 17818 | 1346 | 20896 | 857 | 14767 |
| 18-#11 | 3.08 | MA | 14647 | 4002 | 22937 | 3001 | 25065 | 2508 | 26205 | 2120 | 27337 | 1465 | 32460 | 851 | 23989 |
| 7L-4S | | MI | 9411 | 4002 | 15435 | 2843 | 16733 | 2360 | 17509 | 1965 | 18613 | 1345 | 21903 | 920 | 14942 |
| 18-#11 | 3.08 | MA | 14423 | 4002 | 22391 | 3011 | 24310 | 2529 | 25272 | 2126 | 26146 | 1488 | 30877 | 797 | 23262 |
| 8L-3S | | MI | 9492 | 4002 | 15820 | 2820 | 17232 | 2353 | 18122 | 1960 | 19411 | 1329 | 22913 | 980 | 14937 |
| 18-#11 | 3.08 | MA | 14224 | 4002 | 21808 | 3035 | 23587 | 2539 | 24372 | 2147 | 24973 | 1511 | 29325 | 746 | 22627 |
| 9L-2S | | MI | 9659 | 4002 | 16321 | 2810 | 17875 | 2332 | 18906 | 1940 | 20478 | 1314 | 24358 | 1090 | 14920 |
| 18-#14 | 4.44 | MA | 15958 | 4345 | 25851 | 3209 | 28705 | 2680 | 30536 | 2210 | 33289 | 1453 | 40952 | 739 | 33911 |
| 6L-5S | | MI | 9896 | 4345 | 16522 | 3067 | 18065 | 2541 | 19098 | 2082 | 20693 | 1319 | 24634 | 664 | 20230 |
| 18-#14 | 4.44 | MA | 15663 | 4345 | 24957 | 3241 | 27621 | 2688 | 29297 | 2246 | 31586 | 1485 | 38324 | 655 | 32676 |
| 7L-4S | | MI | 10098 | 4345 | 16985 | 3054 | 18680 | 2511 | 19865 | 2056 | 21827 | 1318 | 26042 | 755 | 20796 |
| 18-#14 | 4.44 | MA | 15354 | 4345 | 24175 | 3254 | 26538 | 2719 | 27973 | 2255 | 29772 | 1497 | 36051 | 575 | 31477 |
| 8L-3S | | MI | 10208 | 4345 | 17534 | 3022 | 19391 | 2502 | 20739 | 2049 | 22964 | 1298 | 27458 | 840 | 20949 |
| 20-#10 | 2.79 | MA | 14741 | 3927 | 23308 | 2936 | 25564 | 2467 | 26798 | 2073 | 28253 | 1458 | 33751 | 980 | 22581 |
| 6E | | MI | 9112 | 3927 | 14672 | 2827 | 15778 | 2366 | 16348 | 1980 | 16993 | 1376 | 19981 | 889 | 13506 |
| 20-#10 | 2.79 | MA | 14565 | 3927 | 22794 | 2955 | 24941 | 2472 | 26078 | 2093 | 27217 | 1466 | 32260 | 933 | 22246 |
| 7L-5S | | MI | 9198 | 3927 | 14933 | 2821 | 16132 | 2359 | 16789 | 1975 | 17586 | 1362 | 20761 | 948 | 13730 |
| 20-#10 | 2.79 | MA | 14380 | 3927 | 22346 | 2963 | 24320 | 2490 | 25311 | 2099 | 26239 | 1486 | 30965 | 891 | 21871 |
| 8L-4S | | MI | 9319 | 3927 | 15200 | 2813 | 16488 | 2341 | 17233 | 1958 | 18243 | 1360 | 21616 | 999 | 13749 |
| 20-#10 | 2.79 | MA | 14218 | 3927 | 21862 | 2982 | 23727 | 2498 | 24572 | 2116 | 25276 | 1505 | 29699 | 850 | 21350 |
| 9L-3S | | MI | 9390 | 3927 | 15519 | 2794 | 16901 | 2335 | 17741 | 1953 | 18904 | 1346 | 22469 | 1050 | 13739 |
| 20-#10 | 2.79 | MA | 14024 | 3927 | 21397 | 2988 | 23131 | 2518 | 23852 | 2135 | 24231 | 1511 | 28410 | 814 | 20802 |
| 10L-2S | | MI | 9530 | 3927 | 15935 | 2785 | 17435 | 2316 | 18392 | 1936 | 19791 | 1332 | 23696 | 1139 | 13725 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

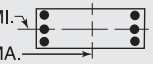



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.42 | MA | 15252 | 4088 | 24440 | 3033 | 26950 | 2540 | 28444 | 2118 | 30470 | 1449 | 36876 | 899 | 27076 |
| 6E | | MI | 9378 | 4088 | 15278 | 2927 | 16516 | 2427 | 17221 | 2013 | 18168 | 1355 | 21420 | 774 | 16059 |
| 20-#11 | 3.42 | MA | 15043 | 4088 | 23816 | 3055 | 26192 | 2546 | 27579 | 2143 | 29207 | 1458 | 35049 | 841 | 26697 |
| 7L-5S | | MI | 9480 | 4088 | 15612 | 2906 | 16945 | 2420 | 17755 | 2008 | 18885 | 1339 | 22341 | 844 | 16280 |
| 20-#11 | 3.42 | MA | 14826 | 4088 | 23270 | 3065 | 25437 | 2568 | 26646 | 2149 | 28017 | 1481 | 33467 | 788 | 25958 |
| 8L-4S | | MI | 9623 | 4088 | 15936 | 2897 | 17376 | 2399 | 18293 | 1989 | 19680 | 1338 | 23348 | 907 | 16503 |
| 20-#11 | 3.42 | MA | 14630 | 4088 | 22687 | 3089 | 24714 | 2577 | 25746 | 2171 | 26843 | 1504 | 31915 | 736 | 25313 |
| 9L-3S | | MI | 9704 | 4088 | 16321 | 2874 | 17875 | 2391 | 18906 | 1983 | 20478 | 1322 | 24358 | 967 | 16508 |
| 20-#11 | 3.42 | MA | 14399 | 4088 | 22121 | 3096 | 23988 | 2601 | 24870 | 2193 | 25589 | 1511 | 30340 | 689 | 24432 |
| 10L-2S | | MI | 9869 | 4088 | 16822 | 2864 | 18518 | 2370 | 19690 | 1964 | 21545 | 1307 | 25803 | 1077 | 16495 |
| 20-#14 | 4.93 | MA | 16224 | 4470 | 26214 | 3319 | 29232 | 2744 | 31262 | 2280 | 34260 | 1475 | 42027 | 641 | 36520 |
| 7L-5S | | MI | 10196 | 4470 | 17234 | 3145 | 18978 | 2597 | 20212 | 2116 | 22209 | 1309 | 26654 | 642 | 22385 |
| 20-#14 | 4.93 | MA | 15920 | 4470 | 25432 | 3332 | 28150 | 2775 | 29938 | 2289 | 32446 | 1487 | 39754 | 561 | 35299 |
| 8L-4S | | MI | 10396 | 4470 | 17697 | 3132 | 19593 | 2567 | 20979 | 2089 | 23342 | 1308 | 28062 | 732 | 22922 |
| 22-#10 | 3.06 | MA | 14893 | 3998 | 23518 | 2998 | 25870 | 2504 | 27210 | 2112 | 28757 | 1461 | 34393 | 925 | 24476 |
| 7L-6S | | MI | 9292 | 3998 | 15089 | 2871 | 16312 | 2398 | 16999 | 1999 | 17880 | 1370 | 21207 | 882 | 14775 |
| 22-#10 | 3.06 | MA | 14713 | 3998 | 23070 | 3007 | 25249 | 2522 | 26444 | 2118 | 27780 | 1480 | 33098 | 883 | 24091 |
| 8L-5S | | MI | 9377 | 3998 | 15350 | 2865 | 16666 | 2391 | 17440 | 1994 | 18473 | 1357 | 21987 | 941 | 14989 |
| 22-#10 | 3.06 | MA | 14552 | 3998 | 22586 | 3026 | 24655 | 2530 | 25704 | 2136 | 26817 | 1499 | 31833 | 842 | 23580 |
| 9L-4S | | MI | 9497 | 3998 | 15617 | 2857 | 17022 | 2373 | 17885 | 1977 | 19130 | 1354 | 22842 | 991 | 15048 |
| 22-#10 | 3.06 | MA | 14359 | 3998 | 22121 | 3032 | 24059 | 2550 | 24985 | 2154 | 25772 | 1505 | 30544 | 806 | 23022 |
| 10L-3S | | MI | 9568 | 3998 | 15935 | 2838 | 17435 | 2366 | 18392 | 1972 | 19791 | 1341 | 23696 | 1042 | 15045 |
| 22-#10 | 3.06 | MA | 14179 | 3998 | 21672 | 3039 | 23468 | 2557 | 24242 | 2162 | 24778 | 1522 | 29293 | 761 | 22378 |
| 11L-2S | | MI | 9707 | 3998 | 16352 | 2829 | 17970 | 2348 | 19044 | 1955 | 20678 | 1327 | 24923 | 1131 | 15034 |
| 22-#11 | 3.76 | MA | 15437 | 4174 | 24695 | 3109 | 27319 | 2585 | 28954 | 2167 | 31078 | 1451 | 37639 | 832 | 29408 |
| 7L-6S | | MI | 9592 | 4174 | 15780 | 2981 | 17158 | 2466 | 18005 | 2037 | 19235 | 1348 | 22865 | 761 | 17586 |
| 22-#11 | 3.76 | MA | 15223 | 4174 | 24149 | 3119 | 26564 | 2607 | 28021 | 2173 | 29887 | 1474 | 36057 | 778 | 28657 |
| 8L-5S | | MI | 9693 | 4174 | 16113 | 2960 | 17588 | 2459 | 18539 | 2031 | 19951 | 1332 | 23786 | 831 | 17796 |
| 22-#11 | 3.76 | MA | 15032 | 4174 | 23566 | 3143 | 25840 | 2616 | 27121 | 2194 | 28714 | 1497 | 34505 | 726 | 27999 |
| 9L-4S | | MI | 9835 | 4174 | 16437 | 2951 | 18019 | 2438 | 19077 | 2012 | 20746 | 1331 | 24793 | 894 | 18062 |
| 22-#11 | 3.76 | MA | 14802 | 4174 | 23000 | 3150 | 25115 | 2640 | 26245 | 2216 | 27460 | 1505 | 32930 | 680 | 27124 |
| 10L-3S | | MI | 9916 | 4174 | 16822 | 2928 | 18518 | 2430 | 19690 | 2007 | 21545 | 1315 | 25803 | 954 | 18076 |
| 22-#14 | 5.43 | MA | 16483 | 4594 | 26689 | 3410 | 29761 | 2831 | 31904 | 2323 | 35120 | 1478 | 43457 | 548 | 39121 |
| 8L-5S | | MI | 10496 | 4594 | 17946 | 3222 | 19891 | 2653 | 21325 | 2150 | 23724 | 1299 | 28674 | 620 | 24545 |
| 24-#10 | 3.34 | MA | 15041 | 4068 | 23794 | 3051 | 26177 | 2553 | 27576 | 2137 | 29321 | 1474 | 35232 | 876 | 26312 |
| 8L-6S | | MI | 9471 | 4068 | 15506 | 2915 | 16846 | 2429 | 17651 | 2018 | 18767 | 1365 | 22434 | 874 | 16046 |
| 24-#10 | 3.34 | MA | 14885 | 4068 | 23311 | 3070 | 25583 | 2561 | 26837 | 2155 | 28358 | 1494 | 33966 | 834 | 25811 |
| 9L-5S | | MI | 9555 | 4068 | 15766 | 2909 | 17201 | 2423 | 18092 | 2013 | 19359 | 1351 | 23214 | 933 | 16251 |
| 24-#10 | 3.34 | MA | 14693 | 4068 | 22845 | 3076 | 24988 | 2581 | 26117 | 2173 | 27313 | 1499 | 32677 | 798 | 25241 |
| 10L-4S | | MI | 9675 | 4068 | 16034 | 2901 | 17557 | 2404 | 18537 | 1996 | 20017 | 1349 | 24069 | 983 | 16346 |
| 24-#10 | 3.34 | MA | 14515 | 4068 | 22396 | 3083 | 24397 | 2589 | 25375 | 2181 | 26319 | 1516 | 31427 | 754 | 24601 |
| 11L-3S | | MI | 9745 | 4068 | 16352 | 2881 | 17970 | 2398 | 19044 | 1991 | 20678 | 1335 | 24923 | 1034 | 16350 |
| 24-#11 | 4.11 | MA | 15618 | 4261 | 25028 | 3173 | 27691 | 2646 | 29396 | 2196 | 31758 | 1467 | 38647 | 768 | 31358 |
| 8L-6S | | MI | 9806 | 4261 | 16281 | 3035 | 17801 | 2505 | 18789 | 2060 | 20301 | 1341 | 24310 | 748 | 19116 |
| 24-#11 | 4.11 | MA | 15433 | 4261 | 24445 | 3197 | 26967 | 2655 | 28496 | 2218 | 30584 | 1490 | 37095 | 717 | 30685 |
| 9L-5S | | MI | 9905 | 4261 | 16615 | 3014 | 18231 | 2497 | 19323 | 2055 | 21018 | 1325 | 25231 | 818 | 19316 |
| 24-#11 | 4.11 | MA | 15204 | 4261 | 23879 | 3204 | 26242 | 2679 | 27619 | 2240 | 29330 | 1498 | 35520 | 670 | 29816 |
| 10L-4S | | MI | 10047 | 4261 | 16939 | 3005 | 18662 | 2476 | 19861 | 2036 | 21813 | 1324 | 26238 | 880 | 19619 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

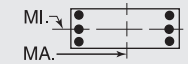
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.67 | MA | 15667 | 3837 | 25049 | 2819 | 27189 | 2367 | 28264 | 2011 | 29353 | 1469 | 34220 | 1271 | 15252 |
| 2E | | MI | 9177 | 3837 | 14967 | 2675 | 15860 | 2244 | 16245 | 1904 | 16558 | 1384 | 18511 | 1140 | 8684 |
| 6-#14 | 1.41 | MA | 15392 | 3768 | 24307 | 2795 | 26330 | 2353 | 27256 | 2007 | 28008 | 1486 | 32377 | 1289 | 13057 |
| 2L-3S | | MI | 8807 | 3768 | 13883 | 2677 | 14549 | 2270 | 14678 | 1936 | 14442 | 1429 | 15933 | 1037 | 7561 |
| 6-#14 | 1.41 | MA | 14885 | 3768 | 22972 | 2815 | 24619 | 2371 | 25169 | 2043 | 25168 | 1519 | 28444 | 1149 | 13096 |
| 3L-2S | | MI | 9056 | 3768 | 14596 | 2664 | 15462 | 2241 | 15792 | 1909 | 15957 | 1409 | 17953 | 1195 | 7501 |
| 6-#18 | 2.50 | MA | 16690 | 4058 | 27383 | 2957 | 30181 | 2466 | 31913 | 2071 | 34319 | 1452 | 41096 | 1247 | 22574 |
| 2L-3S | | MI | 9273 | 4058 | 14967 | 2832 | 15860 | 2392 | 16245 | 2007 | 16558 | 1397 | 18511 | 806 | 12684 |
| 6-#18 | 2.50 | MA | 15844 | 4058 | 25049 | 2991 | 27189 | 2496 | 28264 | 2134 | 29353 | 1507 | 34220 | 991 | 22518 |
| 3L-2S | | MI | 9687 | 4058 | 16194 | 2814 | 17433 | 2344 | 18164 | 1964 | 19169 | 1367 | 21878 | 1088 | 12603 |
| 8-#10 | 1.06 | MA | 14992 | 3676 | 23276 | 2761 | 25122 | 2331 | 25834 | 1999 | 26103 | 1507 | 29764 | 1311 | 10013 |
| 2L-4S | | MI | 8647 | 3676 | 13319 | 2673 | 13919 | 2257 | 13948 | 1935 | 13497 | 1467 | 14856 | 1110 | 5890 |
| 8-#10 | 1.06 | MA | 14694 | 3676 | 22508 | 2773 | 24137 | 2342 | 24632 | 2020 | 24469 | 1527 | 27501 | 1235 | 10038 |
| 3E | | MI | 8721 | 3676 | 13637 | 2654 | 14332 | 2251 | 14455 | 1930 | 14158 | 1453 | 15710 | 1161 | 5854 |
| 8-#10 | 1.06 | MA | 14524 | 3676 | 21935 | 2796 | 23393 | 2364 | 23716 | 2030 | 23209 | 1536 | 26028 | 1188 | 10057 |
| 4L-2S | | MI | 8870 | 3676 | 14054 | 2645 | 14866 | 2233 | 15107 | 1913 | 15045 | 1439 | 16937 | 1251 | 5826 |
| 8-#11 | 1.30 | MA | 15279 | 3740 | 23994 | 2787 | 25976 | 2348 | 26846 | 2006 | 27462 | 1494 | 31631 | 1297 | 12152 |
| 2L-4S | | MI | 8746 | 3740 | 13549 | 2695 | 14156 | 2271 | 14211 | 1938 | 13850 | 1451 | 15276 | 1048 | 7092 |
| 8-#11 | 1.30 | MA | 14923 | 3740 | 23061 | 2801 | 24780 | 2361 | 25387 | 2032 | 25477 | 1518 | 28882 | 1202 | 12180 |
| 3E | | MI | 8831 | 3740 | 13934 | 2672 | 14655 | 2263 | 14824 | 1933 | 14649 | 1436 | 16285 | 1109 | 7045 |
| 8-#11 | 1.30 | MA | 14723 | 3740 | 22363 | 2829 | 23873 | 2388 | 24271 | 2044 | 23943 | 1527 | 27079 | 1143 | 12190 |
| 4L-2S | | MI | 9007 | 3740 | 14435 | 2663 | 15297 | 2242 | 15609 | 1914 | 15715 | 1421 | 17730 | 1219 | 7007 |
| 8-#14 | 1.88 | MA | 15986 | 3893 | 25641 | 2873 | 28041 | 2409 | 29344 | 2041 | 30848 | 1476 | 36309 | 1275 | 17248 |
| 2L-4S | | MI | 8996 | 3893 | 14047 | 2787 | 14751 | 2336 | 14919 | 1976 | 14820 | 1440 | 16536 | 929 | 9880 |
| 8-#14 | 1.88 | MA | 15491 | 3893 | 24307 | 2893 | 26330 | 2427 | 27256 | 2077 | 28008 | 1509 | 32377 | 1135 | 17266 |
| 3E | | MI | 9112 | 3893 | 14596 | 2755 | 15462 | 2326 | 15792 | 1970 | 15957 | 1419 | 17953 | 1015 | 9832 |
| 8-#14 | 1.88 | MA | 15210 | 3893 | 23306 | 2933 | 25030 | 2465 | 25658 | 2093 | 25811 | 1522 | 29783 | 1051 | 17188 |
| 4L-2S | | MI | 9357 | 3893 | 15308 | 2742 | 16375 | 2297 | 16906 | 1943 | 17472 | 1399 | 19973 | 1173 | 9780 |
| 8-#18 | 3.33 | MA | 17703 | 4280 | 29716 | 3096 | 33172 | 2566 | 35563 | 2132 | 39285 | 1434 | 47971 | 1222 | 29871 |
| 2L-4S | | MI | 9606 | 4280 | 15241 | 3024 | 16199 | 2504 | 16650 | 2074 | 17198 | 1410 | 19501 | 611 | 15847 |
| 8-#18 | 3.33 | MA | 16886 | 4280 | 27383 | 3129 | 30181 | 2596 | 31913 | 2194 | 34319 | 1489 | 41096 | 967 | 29753 |
| 3E | | MI | 9791 | 4280 | 16194 | 2970 | 17433 | 2491 | 18164 | 2067 | 19169 | 1379 | 21878 | 754 | 16526 |
| 8-#18 | 3.33 | MA | 16416 | 4280 | 25626 | 3198 | 27900 | 2661 | 29108 | 2221 | 30665 | 1545 | 36510 | 814 | 28553 |
| 4L-2S | | MI | 10195 | 4280 | 17421 | 2952 | 19006 | 2443 | 20083 | 2025 | 21780 | 1349 | 25245 | 1036 | 16484 |
| 10-#10 | 1.32 | MA | 15340 | 3746 | 24044 | 2805 | 26107 | 2363 | 27035 | 2018 | 27738 | 1502 | 32027 | 1303 | 12428 |
| 2L-5S | | MI | 8702 | 3746 | 13468 | 2725 | 14097 | 2307 | 14155 | 1971 | 13727 | 1464 | 15228 | 1052 | 7256 |
| 10-#10 | 1.32 | MA | 15046 | 3746 | 23276 | 2816 | 25122 | 2374 | 25834 | 2039 | 26103 | 1522 | 29764 | 1227 | 12448 |
| 3L-4S | | MI | 8828 | 3746 | 13736 | 2717 | 14453 | 2289 | 14599 | 1954 | 14384 | 1461 | 16083 | 1102 | 7223 |
| 10-#10 | 1.32 | MA | 14878 | 3746 | 22703 | 2840 | 24377 | 2396 | 24917 | 2050 | 24844 | 1530 | 28291 | 1180 | 12456 |
| 4L-3S | | MI | 8901 | 3746 | 14054 | 2698 | 14866 | 2282 | 15107 | 1949 | 15045 | 1447 | 16937 | 1154 | 7190 |
| 10-#10 | 1.32 | MA | 14634 | 3746 | 22215 | 2850 | 23742 | 2407 | 24121 | 2071 | 23727 | 1550 | 26784 | 1145 | 12424 |
| 5L-2S | | MI | 9050 | 3746 | 14471 | 2689 | 15400 | 2264 | 15758 | 1932 | 15932 | 1434 | 18163 | 1243 | 7162 |
| 10-#11 | 1.63 | MA | 15697 | 3826 | 24927 | 2841 | 27172 | 2387 | 28305 | 2030 | 29447 | 1487 | 34379 | 1287 | 15083 |
| 2L-5S | | MI | 8812 | 3826 | 13726 | 2759 | 14367 | 2331 | 14457 | 1981 | 14122 | 1446 | 15713 | 973 | 8719 |
| 10-#11 | 1.63 | MA | 15348 | 3826 | 23994 | 2855 | 25976 | 2400 | 26846 | 2055 | 27462 | 1511 | 31631 | 1192 | 15103 |
| 3L-4S | | MI | 8962 | 3826 | 14050 | 2749 | 14798 | 2309 | 14996 | 1962 | 14917 | 1445 | 16721 | 1035 | 8687 |
| 10-#11 | 1.63 | MA | 15149 | 3826 | 23296 | 2883 | 25069 | 2427 | 25730 | 2067 | 25929 | 1521 | 29828 | 1134 | 15094 |
| 4L-3S | | MI | 9046 | 3826 | 14435 | 2726 | 15297 | 2302 | 15609 | 1957 | 15715 | 1429 | 17730 | 1096 | 8648 |
| 10-#11 | 1.63 | MA | 14855 | 3826 | 22707 | 2896 | 24294 | 2440 | 24760 | 2093 | 24568 | 1544 | 27988 | 1089 | 15015 |
| 5L-2S | | MI | 9220 | 3826 | 14937 | 2717 | 15940 | 2281 | 16393 | 1937 | 16782 | 1414 | 19176 | 1206 | 8612 |
| 10-#14 | 2.34 | MA | 16576 | 4017 | 26976 | 2951 | 29752 | 2464 | 31431 | 2075 | 33688 | 1466 | 40241 | 1261 | 21429 |
| 2L-5S | | MI | 9090 | 4017 | 14296 | 2877 | 15049 | 2421 | 15265 | 2037 | 15202 | 1431 | 17148 | 817 | 11799 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

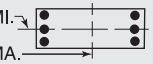



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.34 | MA | 16092 | 4017 | 25641 | 2971 | 28041 | 2483 | 29344 | 2111 | 30848 | 1499 | 36309 | 1122 | 21424 |
| 3L-4S | | MI | 9300 | 4017 | 14759 | 2865 | 15664 | 2392 | 16033 | 2010 | 16336 | 1430 | 18556 | 907 | 12113 |
| 10-#14 | 2.34 | MA | 15815 | 4017 | 24641 | 3010 | 26741 | 2521 | 27745 | 2127 | 28651 | 1512 | 33715 | 1037 | 21322 |
| 4L-3S | | MI | 9415 | 4017 | 15308 | 2832 | 16375 | 2382 | 16906 | 2004 | 17472 | 1410 | 19973 | 992 | 12084 |
| 10-#14 | 2.34 | MA | 15400 | 4017 | 23803 | 3029 | 25630 | 2539 | 26354 | 2164 | 26700 | 1545 | 31073 | 970 | 20604 |
| 5L-2S | | MI | 9656 | 4017 | 16020 | 2820 | 17288 | 2353 | 18020 | 1977 | 18988 | 1389 | 21993 | 1151 | 12042 |
| 10-#18 | 4.17 | MA | 17916 | 4501 | 29716 | 3267 | 33172 | 2695 | 35563 | 2254 | 39285 | 1472 | 47971 | 942 | 36986 |
| 3L-4S | | MI | 10123 | 4501 | 16469 | 3163 | 17773 | 2603 | 18569 | 2134 | 19809 | 1392 | 22868 | 559 | 19435 |
| 10-#18 | 4.17 | MA | 17456 | 4501 | 27960 | 3336 | 30892 | 2760 | 32758 | 2281 | 35630 | 1527 | 43385 | 790 | 35623 |
| 4L-3S | | MI | 10305 | 4501 | 17421 | 3109 | 19006 | 2591 | 20083 | 2127 | 21780 | 1362 | 25245 | 702 | 20341 |
| 10-#18 | 4.17 | MA | 16751 | 4501 | 26497 | 3369 | 28938 | 2791 | 30314 | 2343 | 32006 | 1547 | 38729 | 662 | 33195 |
| 5L-2S | | MI | 10701 | 4501 | 18648 | 3090 | 20579 | 2542 | 22002 | 2085 | 24391 | 1331 | 28612 | 983 | 20343 |
| 12-#10 | 1.59 | MA | 15687 | 3816 | 24812 | 2849 | 27091 | 2394 | 28236 | 2037 | 29372 | 1496 | 34290 | 1296 | 14839 |
| 2L-6S | | MI | 8794 | 3816 | 13624 | 2775 | 14277 | 2345 | 14366 | 1995 | 14021 | 1472 | 15675 | 985 | 8549 |
| 12-#10 | 1.59 | MA | 15397 | 3816 | 24044 | 2860 | 26107 | 2405 | 27035 | 2059 | 27738 | 1516 | 32027 | 1219 | 14853 |
| 3L-5S | | MI | 8884 | 3816 | 13885 | 2769 | 14631 | 2339 | 14806 | 1990 | 14613 | 1458 | 16455 | 1044 | 8570 |
| 12-#10 | 1.59 | MA | 15231 | 3816 | 23471 | 2883 | 25362 | 2427 | 26118 | 2069 | 26478 | 1525 | 30554 | 1172 | 14850 |
| 4E | | MI | 9009 | 3816 | 14152 | 2761 | 14987 | 2321 | 15251 | 1973 | 15271 | 1455 | 17310 | 1094 | 8545 |
| 12-#10 | 1.59 | MA | 14988 | 3816 | 22983 | 2894 | 24726 | 2438 | 25322 | 2090 | 25361 | 1544 | 29047 | 1137 | 14807 |
| 5L-3S | | MI | 9082 | 3816 | 14471 | 2741 | 15400 | 2314 | 15758 | 1968 | 15932 | 1442 | 18163 | 1146 | 8517 |
| 12-#10 | 1.59 | MA | 14814 | 3816 | 22474 | 2899 | 24075 | 2459 | 24535 | 2100 | 24301 | 1564 | 27699 | 1086 | 14593 |
| 6L-2S | | MI | 9229 | 3816 | 14888 | 2733 | 15935 | 2296 | 16410 | 1951 | 16819 | 1428 | 19390 | 1235 | 8491 |
| 12-#11 | 1.95 | MA | 16113 | 3912 | 25860 | 2895 | 28368 | 2426 | 29764 | 2053 | 31432 | 1481 | 37128 | 1278 | 18008 |
| 2L-6S | | MI | 8921 | 3912 | 13894 | 2834 | 14581 | 2377 | 14708 | 2010 | 14472 | 1455 | 16237 | 890 | 10067 |
| 12-#11 | 1.95 | MA | 15769 | 3912 | 24927 | 2909 | 27172 | 2439 | 28305 | 2079 | 29447 | 1504 | 34379 | 1182 | 18020 |
| 3L-5S | | MI | 9029 | 3912 | 14228 | 2813 | 15010 | 2369 | 15242 | 2005 | 15189 | 1439 | 17158 | 960 | 10291 |
| 12-#11 | 1.95 | MA | 15573 | 3912 | 24229 | 2937 | 26265 | 2466 | 27189 | 2091 | 27914 | 1514 | 32577 | 1124 | 17995 |
| 4E | | MI | 9177 | 3912 | 14552 | 2803 | 15441 | 2348 | 15780 | 1985 | 15984 | 1438 | 18166 | 1022 | 10271 |
| 12-#11 | 1.95 | MA | 15282 | 3912 | 23640 | 2950 | 25490 | 2479 | 26219 | 2117 | 26553 | 1537 | 30737 | 1079 | 17903 |
| 5L-3S | | MI | 9260 | 3912 | 14937 | 2780 | 15940 | 2341 | 16393 | 1980 | 16782 | 1422 | 19176 | 1083 | 10240 |
| 12-#11 | 1.95 | MA | 15073 | 3912 | 23021 | 2956 | 24706 | 2504 | 25259 | 2128 | 25261 | 1561 | 29090 | 1014 | 17347 |
| 6L-2S | | MI | 9433 | 3912 | 15438 | 2771 | 16583 | 2320 | 17177 | 1961 | 17849 | 1407 | 20621 | 1193 | 10208 |
| 12-#14 | 2.81 | MA | 16688 | 4141 | 26976 | 3048 | 29752 | 2538 | 31431 | 2145 | 33688 | 1489 | 40241 | 1108 | 25577 |
| 3L-5S | | MI | 9395 | 4141 | 15008 | 2955 | 15962 | 2477 | 16379 | 2071 | 16718 | 1421 | 19168 | 794 | 13921 |
| 12-#14 | 2.81 | MA | 16415 | 4141 | 25975 | 3088 | 28452 | 2576 | 29832 | 2161 | 31491 | 1503 | 37648 | 1023 | 25456 |
| 4E | | MI | 9603 | 4141 | 15471 | 2943 | 16577 | 2447 | 17147 | 2044 | 17851 | 1420 | 20577 | 885 | 14332 |
| 12-#14 | 2.81 | MA | 16007 | 4141 | 25137 | 3107 | 27341 | 2595 | 28441 | 2198 | 29540 | 1535 | 35005 | 956 | 24665 |
| 5L-3S | | MI | 9717 | 4141 | 16020 | 2910 | 17288 | 2438 | 18020 | 2038 | 18988 | 1400 | 21993 | 970 | 14324 |
| 12-#14 | 2.81 | MA | 15712 | 4141 | 24251 | 3115 | 26226 | 2631 | 27065 | 2214 | 27688 | 1568 | 32640 | 860 | 23740 |
| 6L-2S | | MI | 9955 | 4141 | 16732 | 2898 | 18201 | 2409 | 19134 | 2011 | 20503 | 1379 | 24013 | 1128 | 14292 |
| 12-#18 | 5.00 | MA | 18484 | 4722 | 30293 | 3474 | 33883 | 2860 | 36408 | 2341 | 40596 | 1509 | 50261 | 765 | 42714 |
| 4E | | MI | 10637 | 4722 | 17696 | 3301 | 19346 | 2703 | 20488 | 2195 | 22421 | 1375 | 26235 | 506 | 23053 |
| 12-#18 | 5.00 | MA | 17796 | 4722 | 28830 | 3508 | 31930 | 2890 | 33963 | 2403 | 36971 | 1530 | 45605 | 637 | 40346 |
| 5L-3S | | MI | 10817 | 4722 | 18648 | 3247 | 20579 | 2690 | 22002 | 2188 | 24391 | 1344 | 28612 | 649 | 24146 |
| 12-#18 | 5.00 | MA | 17297 | 4722 | 27290 | 3522 | 29987 | 2955 | 31544 | 2430 | 33716 | 1585 | 41435 | 459 | 37441 |
| 6L-2S | | MI | 11205 | 4722 | 19875 | 3228 | 22152 | 2642 | 23921 | 2145 | 27002 | 1313 | 31979 | 931 | 24188 |
| 14-#10 | 1.85 | MA | 15746 | 3886 | 24812 | 2904 | 27091 | 2437 | 28236 | 2078 | 29372 | 1510 | 34290 | 1212 | 17255 |
| 3L-6S | | MI | 8976 | 3886 | 14041 | 2819 | 14811 | 2377 | 15017 | 2014 | 14908 | 1466 | 16902 | 977 | 9788 |
| 14-#10 | 1.85 | MA | 15581 | 3886 | 24239 | 2927 | 26347 | 2459 | 27320 | 2088 | 28112 | 1519 | 32817 | 1165 | 17241 |
| 4L-5S | | MI | 9065 | 3886 | 14302 | 2813 | 15166 | 2370 | 15458 | 2009 | 15500 | 1452 | 17681 | 1036 | 9878 |
| 14-#10 | 1.85 | MA | 15341 | 3886 | 23751 | 2938 | 25711 | 2470 | 26523 | 2109 | 26995 | 1539 | 31310 | 1130 | 17190 |
| 5L-4S | | MI | 9189 | 3886 | 14569 | 2805 | 15522 | 2352 | 15903 | 1992 | 16158 | 1450 | 18537 | 1087 | 9860 |
| 14-#10 | 1.85 | MA | 15170 | 3886 | 23242 | 2943 | 25060 | 2490 | 25736 | 2120 | 25935 | 1558 | 29962 | 1078 | 16936 |
| 6L-3S | | MI | 9262 | 3886 | 14888 | 2785 | 15935 | 2345 | 16410 | 1987 | 16819 | 1436 | 19390 | 1138 | 9837 |
| 14-#10 | 1.85 | MA | 14978 | 3886 | 22699 | 2962 | 24400 | 2496 | 24967 | 2139 | 24839 | 1567 | 28389 | 1032 | 16527 |
| 7L-2S | | MI | 9407 | 3886 | 15304 | 2777 | 16469 | 2327 | 17062 | 1970 | 17705 | 1422 | 20617 | 1227 | 9813 |
| 14-#11 | 2.27 | MA | 16189 | 3999 | 25860 | 2963 | 28368 | 2478 | 29764 | 2103 | 31432 | 1497 | 37128 | 1173 | 20930 |
| 3L-6S | | MI | 9138 | 3999 | 14396 | 2888 | 15224 | 2415 | 15492 | 2034 | 15539 | 1448 | 17682 | 877 | 11581 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

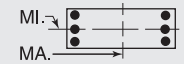
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.27 | MA | 15994 | 3999 | 25162 | 2991 | 27461 | 2504 | 28648 | 2114 | 29899 | 1507 | 35326 | 1115 | 20894 |
| 4L-5S | | MI | 9244 | 3999 | 14729 | 2866 | 15653 | 2408 | 16026 | 2028 | 16256 | 1432 | 18603 | 947 | 11851 |
| 14-#11 | 2.27 | MA | 15707 | 3999 | 24573 | 3004 | 26686 | 2517 | 27678 | 2140 | 28538 | 1530 | 33485 | 1070 | 20792 |
| 5L-4S | | MI | 9392 | 3999 | 15053 | 2857 | 16084 | 2387 | 16564 | 2009 | 17051 | 1431 | 19611 | 1009 | 11848 |
| 14-#11 | 2.27 | MA | 15502 | 3999 | 23954 | 3010 | 25902 | 2543 | 26718 | 2152 | 27246 | 1554 | 31839 | 1004 | 20198 |
| 6L-3S | | MI | 9474 | 3999 | 15438 | 2834 | 16583 | 2380 | 17177 | 2004 | 17849 | 1415 | 20621 | 1070 | 11824 |
| 14-#11 | 2.27 | MA | 15274 | 3999 | 23292 | 3032 | 25099 | 2549 | 25793 | 2177 | 25910 | 1563 | 29913 | 947 | 19738 |
| 7L-2S | | MI | 9645 | 3999 | 15940 | 2825 | 17226 | 2358 | 17961 | 1984 | 18916 | 1400 | 22066 | 1180 | 11796 |
| 14-#14 | 3.28 | MA | 17010 | 4266 | 27310 | 3166 | 30163 | 2632 | 31919 | 2195 | 34331 | 1493 | 41580 | 1009 | 29590 |
| 4L-5S | | MI | 9699 | 4266 | 15721 | 3033 | 16875 | 2533 | 17493 | 2104 | 18233 | 1411 | 21189 | 772 | 16054 |
| 14-#14 | 3.28 | MA | 16608 | 4266 | 26472 | 3185 | 29052 | 2650 | 30528 | 2232 | 32380 | 1526 | 38937 | 942 | 28736 |
| 5L-4S | | MI | 9905 | 4266 | 16183 | 3020 | 17490 | 2503 | 18260 | 2078 | 19366 | 1410 | 22597 | 863 | 16545 |
| 14-#14 | 3.28 | MA | 16322 | 4266 | 25586 | 3193 | 27937 | 2687 | 29152 | 2248 | 30527 | 1559 | 36572 | 846 | 27845 |
| 6L-3S | | MI | 10017 | 4266 | 16732 | 2988 | 18201 | 2494 | 19134 | 2072 | 20503 | 1390 | 24013 | 948 | 16558 |
| 14-#14 | 3.28 | MA | 16000 | 4266 | 24638 | 3225 | 26786 | 2696 | 27838 | 2284 | 28610 | 1572 | 33800 | 763 | 26669 |
| 7L-2S | | MI | 10252 | 4266 | 17444 | 2976 | 19114 | 2465 | 20247 | 2045 | 22019 | 1369 | 26033 | 1106 | 16534 |
| 14-#18 | 5.83 | MA | 18831 | 4944 | 31164 | 3646 | 34921 | 2989 | 37613 | 2464 | 41937 | 1512 | 52480 | 613 | 47497 |
| 5L-4S | | MI | 11149 | 4944 | 18923 | 3439 | 20919 | 2802 | 22407 | 2255 | 25032 | 1357 | 29602 | 454 | 26695 |
| 14-#18 | 5.83 | MA | 18351 | 4944 | 29624 | 3660 | 32979 | 3055 | 35193 | 2490 | 38682 | 1567 | 48310 | 435 | 44530 |
| 6L-3S | | MI | 11327 | 4944 | 19875 | 3385 | 22152 | 2789 | 23921 | 2248 | 27002 | 1326 | 31979 | 597 | 27944 |
| 16-#10 | 2.12 | MA | 15930 | 3957 | 25007 | 2971 | 27331 | 2490 | 28521 | 2107 | 29747 | 1513 | 35080 | 1157 | 19630 |
| 4L-6S | | MI | 9158 | 3957 | 14458 | 2863 | 15345 | 2409 | 15669 | 2034 | 15795 | 1460 | 18128 | 969 | 11049 |
| 16-#10 | 2.12 | MA | 15692 | 3957 | 24519 | 2982 | 26696 | 2501 | 27725 | 2128 | 28630 | 1533 | 33573 | 1122 | 19572 |
| 5E | | MI | 9246 | 3957 | 14719 | 2857 | 15700 | 2402 | 16110 | 2028 | 16387 | 1447 | 18908 | 1028 | 11183 |
| 16-#10 | 2.12 | MA | 15524 | 3957 | 24010 | 2987 | 26044 | 2522 | 26937 | 2139 | 27570 | 1553 | 32225 | 1070 | 19283 |
| 6L-4S | | MI | 9369 | 3957 | 14986 | 2849 | 16056 | 2384 | 16555 | 2012 | 17045 | 1444 | 19763 | 1079 | 11171 |
| 16-#10 | 2.12 | MA | 15333 | 3957 | 23467 | 3006 | 25385 | 2528 | 26168 | 2159 | 26473 | 1561 | 30652 | 1024 | 18888 |
| 7L-3S | | MI | 9441 | 3957 | 15304 | 2829 | 16469 | 2377 | 17062 | 2006 | 17705 | 1430 | 20617 | 1130 | 11152 |
| 16-#10 | 2.12 | MA | 15127 | 3957 | 22992 | 3014 | 24728 | 2546 | 25357 | 2164 | 25439 | 1581 | 29284 | 983 | 18579 |
| 8L-2S | | MI | 9585 | 3957 | 15721 | 2821 | 17003 | 2359 | 17714 | 1990 | 18592 | 1417 | 21844 | 1219 | 11131 |
| 16-#11 | 2.60 | MA | 16413 | 4085 | 26094 | 3045 | 28657 | 2543 | 30107 | 2138 | 31884 | 1500 | 38074 | 1105 | 23792 |
| 4L-6S | | MI | 9354 | 4085 | 14897 | 2942 | 15866 | 2454 | 16276 | 2057 | 16606 | 1441 | 19127 | 864 | 13099 |
| 16-#11 | 2.60 | MA | 16129 | 4085 | 25506 | 3058 | 27882 | 2556 | 29137 | 2164 | 30523 | 1523 | 36234 | 1060 | 23682 |
| 5E | | MI | 9459 | 4085 | 15231 | 2920 | 16296 | 2447 | 16810 | 2052 | 17323 | 1425 | 20049 | 934 | 13353 |
| 16-#11 | 2.60 | MA | 15928 | 4085 | 24887 | 3064 | 27098 | 2581 | 28177 | 2175 | 29232 | 1547 | 34588 | 995 | 23054 |
| 6L-4S | | MI | 9606 | 4085 | 15555 | 2911 | 16727 | 2426 | 17348 | 2033 | 18118 | 1424 | 21056 | 996 | 13420 |
| 16-#11 | 2.60 | MA | 15701 | 4085 | 24225 | 3086 | 26295 | 2588 | 27253 | 2200 | 27895 | 1557 | 32661 | 937 | 22610 |
| 7L-3S | | MI | 9688 | 4085 | 15940 | 2888 | 17226 | 2418 | 17961 | 2027 | 18916 | 1409 | 22066 | 1057 | 13403 |
| 16-#11 | 2.60 | MA | 15454 | 4085 | 23647 | 3097 | 25495 | 2610 | 26264 | 2207 | 26635 | 1580 | 30990 | 885 | 21918 |
| 8L-2S | | MI | 9856 | 4085 | 16441 | 2879 | 17869 | 2397 | 18745 | 2008 | 19983 | 1393 | 23511 | 1167 | 13379 |
| 16-#14 | 3.75 | MA | 17206 | 4390 | 27807 | 3263 | 30762 | 2706 | 32615 | 2265 | 35220 | 1516 | 42869 | 928 | 32814 |
| 5E | | MI | 10002 | 4390 | 16433 | 3111 | 17788 | 2589 | 18607 | 2138 | 19748 | 1401 | 23209 | 750 | 18196 |
| 16-#14 | 3.75 | MA | 16927 | 4390 | 26920 | 3271 | 29648 | 2743 | 31239 | 2282 | 33367 | 1549 | 40505 | 832 | 31954 |
| 6L-4S | | MI | 10206 | 4390 | 16895 | 3098 | 18403 | 2559 | 19374 | 2112 | 20882 | 1400 | 24617 | 840 | 18754 |
| 16-#14 | 3.75 | MA | 16607 | 4390 | 25972 | 3303 | 28497 | 2752 | 29926 | 2318 | 31450 | 1562 | 37732 | 749 | 30752 |
| 7L-3S | | MI | 10317 | 4390 | 17444 | 3066 | 19114 | 2550 | 20247 | 2105 | 22019 | 1380 | 26033 | 925 | 18784 |
| 16-#14 | 3.75 | MA | 16259 | 4390 | 25144 | 3317 | 27350 | 2784 | 28509 | 2327 | 29643 | 1595 | 35330 | 671 | 29589 |
| 8L-2S | | MI | 10549 | 4390 | 18156 | 3053 | 20027 | 2520 | 21361 | 2079 | 23534 | 1359 | 28053 | 1084 | 18771 |
| 16-#18 | 6.67 | MA | 19394 | 5165 | 31958 | 3798 | 35971 | 3154 | 38843 | 2551 | 43647 | 1550 | 55186 | 410 | 51620 |
| 6L-4S | | MI | 11659 | 5165 | 20150 | 3578 | 22492 | 2901 | 24326 | 2315 | 27643 | 1339 | 32969 | 401 | 30355 |
| 18-#10 | 2.38 | MA | 16042 | 4027 | 25288 | 3026 | 27680 | 2533 | 28926 | 2148 | 30264 | 1527 | 35836 | 1114 | 21955 |
| 5L-6S | | MI | 9339 | 4027 | 14875 | 2907 | 15880 | 2440 | 16321 | 2053 | 16682 | 1455 | 19355 | 961 | 12313 |
| 18-#10 | 2.38 | MA | 15876 | 4027 | 24779 | 3031 | 27029 | 2553 | 28139 | 2158 | 29204 | 1547 | 34488 | 1063 | 21634 |
| 6L-5S | | MI | 9426 | 4027 | 15135 | 2901 | 16234 | 2433 | 16762 | 2047 | 17274 | 1441 | 20135 | 1020 | 12484 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

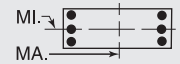



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.38 | MA | 15686 | 4027 | 24235 | 3049 | 26369 | 2559 | 27370 | 2178 | 28107 | 1556 | 32915 | 1017 | 21251 |
| 7L-4S | | MI | 9548 | 4027 | 15403 | 2893 | 16590 | 2415 | 17206 | 2031 | 17931 | 1439 | 20990 | 1071 | 12479 |
| 18-#10 | 2.38 | MA | 15484 | 4027 | 23760 | 3058 | 25712 | 2578 | 26558 | 2184 | 27074 | 1576 | 31547 | 976 | 20931 |
| 8L-3S | | MI | 9620 | 4027 | 15721 | 2873 | 17003 | 2408 | 17714 | 2025 | 18592 | 1425 | 21844 | 1122 | 12464 |
| 18-#10 | 2.38 | MA | 15309 | 4027 | 23245 | 3077 | 25084 | 2586 | 25775 | 2202 | 26054 | 1595 | 30214 | 935 | 20344 |
| 9L-2S | | MI | 9762 | 4027 | 16138 | 2865 | 17537 | 2390 | 18366 | 2009 | 19479 | 1411 | 23071 | 1211 | 12446 |
| 18-#11 | 2.92 | MA | 16549 | 4171 | 26439 | 3112 | 29078 | 2595 | 30596 | 2187 | 32509 | 1516 | 38983 | 1050 | 26572 |
| 5L-6S | | MI | 9570 | 4171 | 15398 | 2996 | 16509 | 2493 | 17060 | 2081 | 17673 | 1434 | 20572 | 851 | 14621 |
| 18-#11 | 2.92 | MA | 16352 | 4171 | 25820 | 3118 | 28294 | 2620 | 29636 | 2199 | 31217 | 1540 | 37336 | 985 | 25914 |
| 6L-5S | | MI | 9674 | 4171 | 15732 | 2974 | 16939 | 2486 | 17594 | 2075 | 18390 | 1419 | 21494 | 921 | 14861 |
| 18-#11 | 2.92 | MA | 16126 | 4171 | 25158 | 3140 | 27491 | 2627 | 28712 | 2224 | 29880 | 1550 | 35410 | 928 | 25484 |
| 7L-4S | | MI | 9819 | 4171 | 16056 | 2965 | 17370 | 2464 | 18132 | 2056 | 19185 | 1417 | 22501 | 983 | 14989 |
| 18-#11 | 2.92 | MA | 15885 | 4171 | 24580 | 3151 | 26691 | 2649 | 27723 | 2230 | 28620 | 1573 | 33738 | 876 | 24781 |
| 8L-3S | | MI | 9900 | 4171 | 16441 | 2942 | 17869 | 2457 | 18745 | 2051 | 19983 | 1402 | 23511 | 1044 | 14978 |
| 18-#11 | 2.92 | MA | 15674 | 4171 | 23958 | 3174 | 25925 | 2658 | 26770 | 2252 | 27378 | 1597 | 32103 | 825 | 24114 |
| 9L-2S | | MI | 10067 | 4171 | 16942 | 2933 | 18511 | 2436 | 19529 | 2031 | 21050 | 1386 | 24956 | 1154 | 14958 |
| 18-#14 | 4.22 | MA | 17527 | 4515 | 28255 | 3349 | 31359 | 2799 | 33326 | 2316 | 36207 | 1539 | 44437 | 818 | 36067 |
| 6L-5S | | MI | 10303 | 4515 | 17145 | 3188 | 18701 | 2644 | 19720 | 2172 | 21264 | 1391 | 25229 | 727 | 20344 |
| 18-#14 | 4.22 | MA | 17209 | 4515 | 27307 | 3380 | 30208 | 2808 | 32013 | 2352 | 34290 | 1552 | 41664 | 735 | 34835 |
| 7L-4S | | MI | 10506 | 4515 | 17608 | 3176 | 19316 | 2615 | 20488 | 2146 | 22397 | 1390 | 26637 | 818 | 20928 |
| 18-#14 | 4.22 | MA | 16879 | 4515 | 26478 | 3395 | 29061 | 2839 | 30596 | 2361 | 32483 | 1585 | 39262 | 657 | 33660 |
| 8L-3S | | MI | 10616 | 4515 | 18156 | 3144 | 20027 | 2606 | 21361 | 2139 | 23534 | 1370 | 28053 | 903 | 21003 |
| 18-#14 | 4.22 | MA | 16573 | 4515 | 25593 | 3429 | 27963 | 2853 | 29230 | 2392 | 30701 | 1618 | 36906 | 583 | 32019 |
| 9L-2S | | MI | 10844 | 4515 | 18869 | 3131 | 20940 | 2576 | 22475 | 2113 | 25050 | 1349 | 30073 | 1061 | 21003 |
| 20-#10 | 2.65 | MA | 16226 | 4097 | 25547 | 3075 | 28014 | 2585 | 29340 | 2177 | 30839 | 1542 | 36751 | 1055 | 23988 |
| 6E | | MI | 9519 | 4097 | 15291 | 2951 | 16414 | 2472 | 16973 | 2072 | 17568 | 1449 | 20582 | 954 | 13580 |
| 20-#10 | 2.65 | MA | 16037 | 4097 | 25003 | 3093 | 27354 | 2591 | 28571 | 2197 | 29742 | 1550 | 35178 | 1009 | 23616 |
| 7L-5S | | MI | 9605 | 4097 | 15552 | 2945 | 16768 | 2465 | 17414 | 2067 | 18161 | 1435 | 21362 | 1013 | 13782 |
| 20-#10 | 2.65 | MA | 15839 | 4097 | 24529 | 3102 | 26697 | 2609 | 27759 | 2203 | 28708 | 1570 | 33810 | 968 | 23285 |
| 8L-4S | | MI | 9727 | 4097 | 15819 | 2937 | 17124 | 2447 | 17858 | 2050 | 18818 | 1433 | 22217 | 1063 | 13785 |
| 20-#10 | 2.65 | MA | 15667 | 4097 | 24013 | 3121 | 26068 | 2617 | 26976 | 2221 | 27689 | 1590 | 32477 | 927 | 22710 |
| 9L-3S | | MI | 9798 | 4097 | 16138 | 2917 | 17537 | 2440 | 18366 | 2045 | 19479 | 1419 | 23071 | 1114 | 13774 |
| 20-#10 | 2.65 | MA | 15459 | 4097 | 23520 | 3128 | 25438 | 2638 | 26193 | 2229 | 26571 | 1595 | 31115 | 892 | 22180 |
| 10L-2S | | MI | 9939 | 4097 | 16555 | 2909 | 18072 | 2422 | 19017 | 2028 | 20366 | 1405 | 24298 | 1203 | 13758 |
| 20-#11 | 3.25 | MA | 16773 | 4258 | 26753 | 3172 | 29490 | 2659 | 31095 | 2223 | 33202 | 1533 | 40085 | 976 | 28777 |
| 6E | | MI | 9785 | 4258 | 15900 | 3050 | 17152 | 2532 | 17845 | 2104 | 18740 | 1427 | 22017 | 837 | 16145 |
| 20-#11 | 3.25 | MA | 16549 | 4258 | 26091 | 3194 | 28687 | 2665 | 30171 | 2247 | 31865 | 1543 | 38159 | 918 | 28360 |
| 7L-5S | | MI | 9887 | 4258 | 16233 | 3028 | 17581 | 2524 | 18378 | 2099 | 19457 | 1412 | 22939 | 908 | 16373 |
| 20-#11 | 3.25 | MA | 16316 | 4258 | 25513 | 3205 | 27887 | 2688 | 29182 | 2254 | 30605 | 1566 | 36487 | 866 | 27646 |
| 8L-4S | | MI | 10031 | 4258 | 16557 | 3019 | 18012 | 2503 | 18916 | 2080 | 20252 | 1410 | 23946 | 970 | 16552 |
| 20-#11 | 3.25 | MA | 16106 | 4258 | 24891 | 3228 | 27121 | 2697 | 28229 | 2276 | 29363 | 1590 | 34851 | 815 | 26984 |
| 9L-3S | | MI | 10112 | 4258 | 16942 | 2996 | 18511 | 2496 | 19529 | 2074 | 21050 | 1395 | 24956 | 1031 | 16550 |
| 20-#11 | 3.25 | MA | 15858 | 4258 | 24291 | 3236 | 26353 | 2721 | 27301 | 2298 | 28021 | 1597 | 33187 | 770 | 26058 |
| 10L-2S | | MI | 10278 | 4258 | 17444 | 2987 | 19154 | 2475 | 20314 | 2055 | 22117 | 1379 | 26401 | 1141 | 16534 |
| 20-#14 | 4.69 | MA | 17808 | 4639 | 28642 | 3458 | 31919 | 2864 | 34100 | 2386 | 37130 | 1542 | 45596 | 721 | 38918 |
| 7L-5S | | MI | 10604 | 4639 | 17857 | 3266 | 19614 | 2700 | 20834 | 2206 | 22779 | 1381 | 27249 | 705 | 22498 |
| 20-#14 | 4.69 | MA | 17483 | 4639 | 27813 | 3472 | 30772 | 2895 | 32684 | 2395 | 35322 | 1575 | 43194 | 644 | 37719 |
| 8L-4S | | MI | 10804 | 4639 | 18320 | 3254 | 20229 | 2671 | 21602 | 2180 | 23913 | 1380 | 28657 | 796 | 23052 |
| 20-#14 | 4.69 | MA | 17189 | 4639 | 26928 | 3507 | 29674 | 2909 | 31317 | 2426 | 33541 | 1608 | 40838 | 569 | 36090 |
| 9L-3S | | MI | 10914 | 4639 | 18869 | 3221 | 20940 | 2661 | 22475 | 2173 | 25050 | 1360 | 30073 | 881 | 23218 |
| 22-#10 | 2.91 | MA | 16386 | 4167 | 25771 | 3137 | 28339 | 2622 | 29772 | 2216 | 31376 | 1545 | 37441 | 1001 | 25983 |
| 7L-6S | | MI | 9699 | 4167 | 15708 | 2995 | 16948 | 2503 | 17624 | 2091 | 18455 | 1444 | 21809 | 946 | 14849 |
| 22-#10 | 2.91 | MA | 16192 | 4167 | 25297 | 3146 | 27682 | 2641 | 28960 | 2222 | 30342 | 1564 | 36073 | 960 | 25641 |
| 8L-5S | | MI | 9785 | 4167 | 15969 | 2989 | 17303 | 2496 | 18065 | 2086 | 19048 | 1430 | 22589 | 1005 | 15069 |
| 22-#10 | 2.91 | MA | 16023 | 4167 | 24781 | 3165 | 27053 | 2649 | 28178 | 2240 | 29323 | 1584 | 34740 | 919 | 25077 |
| 9L-4S | | MI | 9905 | 4167 | 16236 | 2981 | 17659 | 2478 | 18510 | 2069 | 19705 | 1427 | 23444 | 1055 | 15089 |
| 22-#10 | 2.91 | MA | 15816 | 4167 | 24288 | 3171 | 26423 | 2669 | 27394 | 2248 | 28206 | 1590 | 33378 | 884 | 24534 |
| 10L-3S | | MI | 9976 | 4167 | 16555 | 2961 | 18072 | 2471 | 19017 | 2064 | 20366 | 1414 | 24298 | 1106 | 15081 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 2.91 | MA | 15624 | 4167 | 23812 | 3179 | 25792 | 2677 | 26631 | 2267 | 27154 | 1607 | 32058 | 841 | 23861 |
| 11L-2S | | MI | 10116 | 4167 | 16972 | 2953 | 18606 | 2453 | 19669 | 2047 | 21253 | 1400 | 25524 | 1196 | 15068 |
| 22-#11 | 3.57 | MA | 16969 | 4344 | 27024 | 3248 | 29883 | 2704 | 31630 | 2271 | 33850 | 1536 | 40908 | 909 | 31238 |
| 7L-6S | | MI | 10000 | 4344 | 16401 | 3104 | 17795 | 2570 | 18629 | 2128 | 19807 | 1420 | 23462 | 824 | 17673 |
| 22-#11 | 3.57 | MA | 16740 | 4344 | 26446 | 3258 | 29083 | 2726 | 30641 | 2277 | 32590 | 1559 | 39236 | 856 | 30513 |
| 8L-5S | | MI | 10100 | 4344 | 16735 | 3082 | 18224 | 2563 | 19162 | 2122 | 20524 | 1405 | 24384 | 895 | 17889 |
| 22-#11 | 3.57 | MA | 16536 | 4344 | 25824 | 3282 | 28317 | 2736 | 29688 | 2299 | 31348 | 1583 | 37600 | 805 | 29854 |
| 9L-4S | | MI | 10243 | 4344 | 17059 | 3073 | 18655 | 2542 | 19701 | 2103 | 21319 | 1403 | 25391 | 957 | 18112 |
| 22-#11 | 3.57 | MA | 16288 | 4344 | 25224 | 3290 | 27549 | 2760 | 28760 | 2322 | 30006 | 1590 | 35936 | 760 | 28915 |
| 10L-3S | | MI | 10324 | 4344 | 17444 | 3050 | 19154 | 2535 | 20314 | 2098 | 22117 | 1388 | 26401 | 1018 | 18119 |
| 22-#14 | 5.16 | MA | 18084 | 4764 | 29147 | 3550 | 32483 | 2951 | 34771 | 2429 | 38162 | 1565 | 47126 | 630 | 41778 |
| 8L-5S | | MI | 10904 | 4764 | 18569 | 3344 | 20527 | 2756 | 21948 | 2240 | 24295 | 1371 | 29269 | 683 | 24657 |
| 22-#14 | 5.16 | MA | 17800 | 4764 | 28263 | 3585 | 31385 | 2964 | 33404 | 2459 | 36380 | 1598 | 44770 | 555 | 40161 |
| 9L-4S | | MI | 11102 | 4764 | 19032 | 3332 | 21142 | 2727 | 22716 | 2214 | 25428 | 1370 | 30677 | 773 | 25184 |
| 24-#10 | 3.17 | MA | 16544 | 4238 | 26065 | 3190 | 28666 | 2672 | 30162 | 2241 | 31977 | 1559 | 38336 | 952 | 27999 |
| 8L-6S | | MI | 9879 | 4238 | 16125 | 3039 | 17483 | 2535 | 18276 | 2110 | 19342 | 1438 | 23036 | 938 | 16119 |
| 24-#10 | 3.17 | MA | 16377 | 4238 | 25549 | 3209 | 28038 | 2681 | 29379 | 2259 | 30957 | 1579 | 37003 | 911 | 27445 |
| 9L-5S | | MI | 9963 | 4238 | 16386 | 3033 | 17837 | 2528 | 18717 | 2105 | 19934 | 1424 | 23816 | 997 | 16330 |
| 24-#10 | 3.17 | MA | 16171 | 4238 | 25056 | 3215 | 27407 | 2701 | 28595 | 2267 | 29840 | 1584 | 35641 | 876 | 26889 |
| 10L-4S | | MI | 10083 | 4238 | 16653 | 3024 | 18193 | 2510 | 19162 | 2088 | 20592 | 1422 | 24671 | 1047 | 16388 |
| 24-#10 | 3.17 | MA | 15981 | 4238 | 24580 | 3223 | 26777 | 2708 | 27832 | 2286 | 28789 | 1601 | 34321 | 833 | 26219 |
| 11L-3S | | MI | 10153 | 4238 | 16972 | 3005 | 18606 | 2503 | 19669 | 2083 | 21253 | 1408 | 25524 | 1098 | 16386 |
| 24-#11 | 3.90 | MA | 17161 | 4430 | 27379 | 3312 | 30279 | 2765 | 32100 | 2301 | 34575 | 1552 | 41984 | 847 | 33383 |
| 8L-6S | | MI | 10213 | 4430 | 16903 | 3158 | 18437 | 2609 | 19413 | 2151 | 20874 | 1413 | 24907 | 811 | 19202 |
| 24-#11 | 3.90 | MA | 16962 | 4430 | 26757 | 3336 | 29513 | 2775 | 31147 | 2323 | 33333 | 1576 | 40349 | 796 | 32724 |
| 9L-5S | | MI | 10313 | 4430 | 17236 | 3136 | 18867 | 2602 | 19947 | 2146 | 21591 | 1398 | 25829 | 882 | 19408 |
| 24-#11 | 3.90 | MA | 16716 | 4430 | 26157 | 3344 | 28745 | 2799 | 30219 | 2345 | 31991 | 1583 | 38685 | 751 | 31772 |
| 10L-4S | | MI | 10455 | 4430 | 17560 | 3127 | 19298 | 2581 | 20485 | 2127 | 22386 | 1396 | 26836 | 944 | 19671 |
| 24-#14 | 5.63 | MA | 18406 | 4888 | 29597 | 3663 | 33096 | 3020 | 35492 | 2493 | 39220 | 1588 | 48702 | 542 | 44232 |
| 9L-5S | | MI | 11203 | 4888 | 19282 | 3422 | 21440 | 2812 | 23062 | 2274 | 25810 | 1361 | 31289 | 660 | 26819 |

## RECTANGULAR TIED COLUMNS 24" x 42"

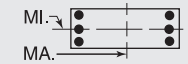
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.59 | MA | 17195 | 4007 | 27369 | 2957 | 29712 | 2485 | 30863 | 2114 | 31971 | 1551 | 37198 | 1343 | 16116 |
| 2E | | MI | 9584 | 4007 | 15593 | 2795 | 16495 | 2347 | 16865 | 1993 | 17125 | 1455 | 19100 | 1203 | 8722 |
| 6-#14 | 1.34 | MA | 16900 | 3938 | 26578 | 2933 | 28796 | 2470 | 29789 | 2109 | 30537 | 1568 | 35232 | 1360 | 13786 |
| 2L-3S | | MI | 9215 | 3938 | 14506 | 2798 | 15185 | 2374 | 15301 | 2026 | 15012 | 1501 | 16527 | 1100 | 7593 |
| 6-#14 | 1.34 | MA | 16359 | 3938 | 25165 | 2953 | 26985 | 2489 | 27580 | 2146 | 27531 | 1602 | 31071 | 1223 | 13825 |
| 3L-2S | | MI | 9464 | 3938 | 15218 | 2786 | 16098 | 2345 | 16415 | 2000 | 16528 | 1481 | 18547 | 1258 | 7533 |
| 6-#18 | 2.38 | MA | 18286 | 4228 | 29841 | 3095 | 32881 | 2584 | 34729 | 2174 | 37231 | 1533 | 44481 | 1318 | 23870 |
| 2L-3S | | MI | 9681 | 4228 | 15593 | 2952 | 16495 | 2494 | 16865 | 2096 | 17125 | 1468 | 19100 | 869 | 12736 |
| 6-#18 | 2.38 | MA | 17381 | 4228 | 27369 | 3130 | 29712 | 2615 | 30863 | 2237 | 31971 | 1590 | 37198 | 1067 | 23814 |
| 3L-2S | | MI | 10095 | 4228 | 16820 | 2933 | 18068 | 2446 | 18784 | 2054 | 19736 | 1437 | 22467 | 1150 | 12649 |
| 8-#10 | 1.01 | MA | 16472 | 3845 | 25483 | 2899 | 27512 | 2449 | 28276 | 2101 | 28512 | 1589 | 32455 | 1383 | 10562 |
| 2L-4S | | MI | 9054 | 3845 | 13938 | 2797 | 14555 | 2363 | 14572 | 2027 | 14072 | 1540 | 15457 | 1174 | 5912 |
| 8-#10 | 1.01 | MA | 16154 | 3845 | 24671 | 2911 | 26471 | 2460 | 27006 | 2123 | 26785 | 1609 | 30063 | 1307 | 10586 |
| 3E | | MI | 9128 | 3845 | 14257 | 2777 | 14968 | 2356 | 15080 | 2021 | 14733 | 1526 | 16311 | 1226 | 5876 |
| 8-#10 | 1.01 | MA | 15973 | 3845 | 24066 | 2934 | 25685 | 2482 | 26039 | 2134 | 25455 | 1618 | 28514 | 1261 | 10606 |
| 4L-2S | | MI | 9278 | 3845 | 14673 | 2769 | 15503 | 2338 | 15732 | 2005 | 15620 | 1512 | 17538 | 1315 | 5848 |
| 8-#11 | 1.24 | MA | 16779 | 3910 | 26244 | 2925 | 28419 | 2466 | 29351 | 2109 | 29955 | 1576 | 34437 | 1369 | 12826 |
| 2L-4S | | MI | 9153 | 3910 | 14170 | 2818 | 14792 | 2375 | 14835 | 2029 | 14423 | 1524 | 15873 | 1112 | 7121 |
| 8-#11 | 1.24 | MA | 16399 | 3910 | 25257 | 2940 | 27153 | 2479 | 27807 | 2135 | 27855 | 1600 | 31529 | 1274 | 12854 |
| 3E | | MI | 9238 | 3910 | 14555 | 2795 | 15291 | 2368 | 15448 | 2024 | 15221 | 1509 | 16883 | 1172 | 7073 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.24 | MA | 16184 | 3910 | 24520 | 2968 | 26196 | 2506 | 26629 | 2147 | 26235 | 1610 | 29632 | 1217 | 12864 |
| 4L-2S | | MI | 9415 | 3910 | 15057 | 2785 | 15934 | 2347 | 16232 | 2005 | 16288 | 1493 | 18328 | 1282 | 7035 |
| 8-#14 | 1.79 | MA | 17532 | 4062 | 27990 | 3011 | 30607 | 2526 | 31998 | 2143 | 33542 | 1558 | 39394 | 1347 | 18220 |
| 2L-4S | | MI | 9403 | 4062 | 14670 | 2908 | 15387 | 2439 | 15542 | 2067 | 15391 | 1512 | 17131 | 993 | 9922 |
| 8-#14 | 1.79 | MA | 17004 | 4062 | 26578 | 3031 | 28796 | 2545 | 29789 | 2180 | 30537 | 1592 | 35232 | 1209 | 18238 |
| 3E | | MI | 9519 | 4062 | 15218 | 2876 | 16098 | 2430 | 16415 | 2060 | 16528 | 1491 | 18547 | 1078 | 9869 |
| 8-#14 | 1.79 | MA | 16702 | 4062 | 25521 | 3071 | 27423 | 2583 | 28100 | 2197 | 28215 | 1606 | 32503 | 1125 | 18160 |
| 4L-2S | | MI | 9765 | 4062 | 15931 | 2864 | 17011 | 2401 | 17529 | 2034 | 18043 | 1471 | 20567 | 1236 | 9815 |
| 8-#18 | 3.17 | MA | 19364 | 4450 | 32313 | 3234 | 36050 | 2683 | 38595 | 2234 | 42491 | 1516 | 51764 | 1294 | 31599 |
| 2L-4S | | MI | 10013 | 4450 | 15867 | 3144 | 16835 | 2606 | 17270 | 2163 | 17765 | 1481 | 20089 | 673 | 16036 |
| 8-#18 | 3.17 | MA | 18490 | 4450 | 29841 | 3268 | 32881 | 2715 | 34729 | 2298 | 37231 | 1573 | 44481 | 1042 | 31481 |
| 3E | | MI | 10198 | 4450 | 16820 | 3090 | 18068 | 2594 | 18784 | 2156 | 19736 | 1450 | 22467 | 816 | 16588 |
| 8-#18 | 3.17 | MA | 17983 | 4450 | 27985 | 3338 | 30470 | 2781 | 31763 | 2326 | 33367 | 1630 | 39652 | 891 | 30464 |
| 4L-2S | | MI | 10604 | 4450 | 18047 | 3072 | 19641 | 2545 | 20703 | 2114 | 22347 | 1420 | 25834 | 1098 | 16534 |
| 10-#10 | 1.26 | MA | 16842 | 3916 | 26295 | 2942 | 28553 | 2480 | 29546 | 2120 | 30240 | 1583 | 34848 | 1375 | 13114 |
| 2L-5S | | MI | 9109 | 3916 | 14088 | 2849 | 14734 | 2412 | 14780 | 2063 | 14302 | 1537 | 15829 | 1116 | 7284 |
| 10-#10 | 1.26 | MA | 16529 | 3916 | 25483 | 2955 | 27512 | 2491 | 28276 | 2142 | 28512 | 1604 | 32455 | 1300 | 13134 |
| 3L-4S | | MI | 9236 | 3916 | 14355 | 2840 | 15090 | 2394 | 15224 | 2046 | 14959 | 1534 | 16684 | 1166 | 7248 |
| 10-#10 | 1.26 | MA | 16349 | 3916 | 24878 | 2978 | 26726 | 2514 | 27309 | 2153 | 27182 | 1613 | 30906 | 1253 | 13142 |
| 4L-3S | | MI | 9309 | 3916 | 14673 | 2821 | 15503 | 2388 | 15732 | 2041 | 15620 | 1520 | 17538 | 1218 | 7215 |
| 10-#10 | 1.26 | MA | 16089 | 3916 | 24360 | 2988 | 26055 | 2525 | 26469 | 2175 | 26004 | 1633 | 29318 | 1219 | 13110 |
| 5L-2S | | MI | 9458 | 3916 | 15090 | 2813 | 16037 | 2369 | 16383 | 2024 | 16507 | 1507 | 18765 | 1307 | 7187 |
| 10-#11 | 1.55 | MA | 17224 | 3996 | 27231 | 2979 | 29684 | 2505 | 30894 | 2132 | 32055 | 1569 | 37345 | 1359 | 15925 |
| 2L-5S | | MI | 9219 | 3996 | 14348 | 2881 | 15004 | 2435 | 15081 | 2072 | 14695 | 1519 | 16311 | 1036 | 8757 |
| 10-#11 | 1.55 | MA | 16850 | 3996 | 26244 | 2994 | 28419 | 2518 | 29351 | 2158 | 29955 | 1593 | 34437 | 1265 | 15945 |
| 3L-4S | | MI | 9369 | 3996 | 14672 | 2872 | 15435 | 2414 | 15619 | 2053 | 15490 | 1517 | 17318 | 1099 | 8720 |
| 10-#11 | 1.55 | MA | 16637 | 3996 | 25507 | 3022 | 27461 | 2545 | 28172 | 2171 | 28335 | 1603 | 32540 | 1207 | 15936 |
| 4L-3S | | MI | 9453 | 3996 | 15057 | 2849 | 15934 | 2407 | 16232 | 2048 | 16288 | 1502 | 18328 | 1159 | 8679 |
| 10-#11 | 1.55 | MA | 16324 | 3996 | 24882 | 3035 | 26643 | 2559 | 27148 | 2197 | 26898 | 1627 | 30600 | 1163 | 15858 |
| 5L-2S | | MI | 9628 | 3996 | 15558 | 2839 | 16577 | 2385 | 17016 | 2028 | 17355 | 1486 | 19773 | 1269 | 8643 |
| 10-#14 | 2.23 | MA | 18160 | 4187 | 29403 | 3089 | 32417 | 2582 | 34207 | 2177 | 36548 | 1548 | 43555 | 1333 | 22644 |
| 2L-5S | | MI | 9497 | 4187 | 14919 | 2999 | 15685 | 2525 | 15888 | 2127 | 15773 | 1503 | 17743 | 880 | 11916 |
| 10-#14 | 2.23 | MA | 17643 | 4187 | 27990 | 3109 | 30607 | 2601 | 31998 | 2214 | 33542 | 1582 | 39394 | 1195 | 22639 |
| 3L-4S | | MI | 9708 | 4187 | 15382 | 2986 | 16300 | 2495 | 16655 | 2101 | 16906 | 1502 | 19151 | 970 | 12159 |
| 10-#14 | 2.23 | MA | 17345 | 4187 | 26933 | 3149 | 29234 | 2639 | 30309 | 2231 | 31221 | 1596 | 36664 | 1111 | 22537 |
| 4L-3S | | MI | 9822 | 4187 | 15931 | 2954 | 17011 | 2486 | 17529 | 2094 | 18043 | 1481 | 20567 | 1055 | 12124 |
| 10-#14 | 2.23 | MA | 16903 | 4187 | 26042 | 3168 | 28061 | 2658 | 28840 | 2268 | 29160 | 1630 | 33878 | 1046 | 21892 |
| 5L-2S | | MI | 10064 | 4187 | 16643 | 2942 | 17924 | 2456 | 18642 | 2068 | 19558 | 1461 | 22588 | 1214 | 12080 |
| 10-#18 | 3.97 | MA | 19588 | 4671 | 32313 | 3406 | 36050 | 2814 | 38595 | 2358 | 42491 | 1555 | 51764 | 1018 | 39146 |
| 3L-4S | | MI | 10530 | 4671 | 17094 | 3283 | 18408 | 2706 | 19189 | 2224 | 20376 | 1463 | 23456 | 621 | 19618 |
| 10-#18 | 3.97 | MA | 19091 | 4671 | 30457 | 3476 | 33639 | 2880 | 35629 | 2386 | 38627 | 1612 | 46935 | 866 | 37968 |
| 4L-3S | | MI | 10713 | 4671 | 18047 | 3229 | 19641 | 2693 | 20703 | 2217 | 22347 | 1433 | 25834 | 764 | 20408 |
| 10-#18 | 3.97 | MA | 18339 | 4671 | 28912 | 3510 | 31576 | 2912 | 33047 | 2449 | 34796 | 1634 | 42023 | 743 | 35269 |
| 5L-2S | | MI | 11110 | 4671 | 19274 | 3210 | 21215 | 2645 | 22622 | 2174 | 24958 | 1402 | 29201 | 1045 | 20397 |
| 12-#10 | 1.51 | MA | 17211 | 3986 | 27107 | 2986 | 29594 | 2512 | 30816 | 2140 | 31968 | 1578 | 37240 | 1367 | 15662 |
| 2L-6S | | MI | 9201 | 3986 | 14244 | 2899 | 14913 | 2451 | 14990 | 2087 | 14596 | 1545 | 16276 | 1049 | 8618 |
| 12-#10 | 1.51 | MA | 16902 | 3986 | 26295 | 2999 | 28553 | 2523 | 29546 | 2161 | 30240 | 1598 | 34848 | 1292 | 15676 |
| 3L-5S | | MI | 9291 | 3986 | 14504 | 2893 | 15268 | 2444 | 15431 | 2082 | 15188 | 1531 | 17056 | 1108 | 8601 |
| 12-#10 | 1.51 | MA | 16723 | 3986 | 25690 | 3022 | 27767 | 2546 | 28579 | 2172 | 28910 | 1607 | 33298 | 1245 | 15673 |
| 4E | | MI | 9416 | 3986 | 14772 | 2884 | 15624 | 2426 | 15876 | 2065 | 15846 | 1528 | 17911 | 1159 | 8573 |
| 12-#10 | 1.51 | MA | 16466 | 3986 | 25172 | 3032 | 27096 | 2557 | 27739 | 2194 | 27731 | 1627 | 31710 | 1211 | 15630 |
| 5L-3S | | MI | 9489 | 3986 | 15090 | 2865 | 16037 | 2419 | 16383 | 2060 | 16507 | 1515 | 18765 | 1210 | 8544 |
| 12-#10 | 1.51 | MA | 16280 | 3986 | 24634 | 3038 | 26405 | 2577 | 26908 | 2204 | 26613 | 1647 | 30290 | 1161 | 15464 |
| 6L-2S | | MI | 9636 | 3986 | 15507 | 2857 | 16571 | 2401 | 17035 | 2043 | 17394 | 1501 | 19992 | 1299 | 8518 |
| 12-#11 | 1.86 | MA | 17666 | 4082 | 28218 | 3033 | 30949 | 2543 | 32438 | 2156 | 34155 | 1562 | 40252 | 1350 | 19019 |
| 2L-6S | | MI | 9328 | 4082 | 14516 | 2956 | 15217 | 2481 | 15331 | 2101 | 15045 | 1527 | 16835 | 953 | 10152 |
| 12-#11 | 1.86 | MA | 17299 | 4082 | 27231 | 3048 | 29684 | 2557 | 30894 | 2182 | 32055 | 1586 | 37345 | 1255 | 19031 |
| 3L-5S | | MI | 9436 | 4082 | 14849 | 2935 | 15647 | 2474 | 15865 | 2096 | 15762 | 1512 | 17756 | 1023 | 10332 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

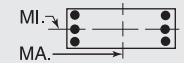
$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.86 | MA | 17088 | 4082 | 26494 | 3076 | 28726 | 2584 | 29716 | 2194 | 30435 | 1596 | 35448 | 1197 | 19006 |
| 4E | | MI | 9585 | 4082 | 15173 | 2926 | 16078 | 2453 | 16403 | 2076 | 16557 | 1510 | 18763 | 1086 | 10307 |
| 12-#11 | 1.86 | MA | 16779 | 4082 | 25869 | 3089 | 27908 | 2597 | 28692 | 2220 | 28998 | 1620 | 33508 | 1154 | 18914 |
| 5L-3S | | MI | 9668 | 4082 | 15558 | 2903 | 16577 | 2445 | 17016 | 2071 | 17355 | 1495 | 19773 | 1146 | 10273 |
| 12-#11 | 1.86 | MA | 16556 | 4082 | 25214 | 3095 | 27074 | 2622 | 27679 | 2233 | 27635 | 1644 | 31772 | 1090 | 18388 |
| 6L-2S | | MI | 9841 | 4082 | 16060 | 2893 | 17219 | 2424 | 17801 | 2052 | 18422 | 1479 | 21218 | 1256 | 10240 |
| 12-#14 | 2.68 | MA | 18277 | 4311 | 29403 | 3187 | 32417 | 2657 | 34207 | 2248 | 36548 | 1572 | 43555 | 1181 | 27035 |
| 3L-5S | | MI | 9802 | 4311 | 15631 | 3076 | 16598 | 2581 | 17001 | 2161 | 17288 | 1493 | 19763 | 857 | 14036 |
| 12-#14 | 2.68 | MA | 17983 | 4311 | 28346 | 3227 | 31044 | 2695 | 32518 | 2265 | 34226 | 1586 | 40825 | 1097 | 26914 |
| 4E | | MI | 10011 | 4311 | 16094 | 3064 | 17213 | 2551 | 17769 | 2135 | 18421 | 1492 | 21171 | 948 | 14385 |
| 12-#14 | 2.68 | MA | 17548 | 4311 | 27455 | 3246 | 29871 | 2714 | 31049 | 2302 | 32166 | 1620 | 38039 | 1032 | 26195 |
| 5L-3S | | MI | 10124 | 4311 | 16643 | 3032 | 17924 | 2542 | 18642 | 2128 | 19558 | 1472 | 22588 | 1033 | 14368 |
| 12-#14 | 2.68 | MA | 17235 | 4311 | 26518 | 3254 | 28684 | 2751 | 29595 | 2319 | 30210 | 1653 | 35546 | 938 | 25177 |
| 6L-2S | | MI | 10363 | 4311 | 17355 | 3019 | 18837 | 2512 | 19756 | 2102 | 21074 | 1451 | 24608 | 1191 | 14332 |
| 12-#18 | 4.76 | MA | 20185 | 4892 | 32929 | 3614 | 36808 | 2980 | 39495 | 2446 | 43887 | 1594 | 54218 | 842 | 45491 |
| 4E | | MI | 11045 | 4892 | 18321 | 3421 | 19981 | 2805 | 21108 | 2284 | 22987 | 1446 | 26823 | 568 | 23232 |
| 12-#18 | 4.76 | MA | 19452 | 4892 | 31384 | 3648 | 34745 | 3011 | 36912 | 2510 | 40056 | 1616 | 49306 | 718 | 42845 |
| 5L-3S | | MI | 11225 | 4892 | 19274 | 3367 | 21215 | 2792 | 22622 | 2277 | 24958 | 1415 | 29201 | 711 | 24217 |
| 12-#18 | 4.76 | MA | 18922 | 4892 | 29741 | 3662 | 32692 | 3077 | 34357 | 2538 | 36617 | 1673 | 44910 | 543 | 39918 |
| 6L-2S | | MI | 11615 | 4892 | 20501 | 3348 | 22788 | 2744 | 24541 | 2235 | 27569 | 1384 | 32568 | 993 | 24245 |
| 14-#10 | 1.76 | MA | 17272 | 4056 | 27107 | 3042 | 29594 | 2555 | 30816 | 2181 | 31968 | 1592 | 37240 | 1284 | 18215 |
| 3L-6S | | MI | 9383 | 4056 | 14661 | 2942 | 15448 | 2482 | 15642 | 2106 | 15483 | 1539 | 17503 | 1041 | 9861 |
| 14-#10 | 1.76 | MA | 17095 | 4056 | 26502 | 3066 | 28808 | 2577 | 29849 | 2191 | 30638 | 1601 | 35691 | 1237 | 18201 |
| 4L-5S | | MI | 9473 | 4056 | 14921 | 2937 | 15802 | 2475 | 16083 | 2101 | 16075 | 1525 | 18283 | 1100 | 9912 |
| 14-#10 | 1.76 | MA | 16840 | 4056 | 25984 | 3076 | 28137 | 2588 | 29009 | 2213 | 29459 | 1622 | 34102 | 1203 | 18150 |
| 5L-4S | | MI | 9597 | 4056 | 15189 | 2928 | 16158 | 2457 | 16528 | 2084 | 16733 | 1523 | 19138 | 1151 | 9891 |
| 14-#10 | 1.76 | MA | 16658 | 4056 | 25446 | 3081 | 27446 | 2609 | 28178 | 2223 | 28341 | 1642 | 32682 | 1153 | 17942 |
| 6L-3S | | MI | 9669 | 4056 | 15507 | 2909 | 16571 | 2451 | 17035 | 2079 | 17394 | 1509 | 19992 | 1202 | 9866 |
| 14-#10 | 1.76 | MA | 16453 | 4056 | 24872 | 3100 | 26749 | 2615 | 27360 | 2243 | 27184 | 1651 | 31028 | 1107 | 17493 |
| 7L-2S | | MI | 9815 | 4056 | 15924 | 2901 | 17105 | 2433 | 17687 | 2062 | 18280 | 1495 | 21219 | 1291 | 9842 |
| 14-#11 | 2.17 | MA | 17745 | 4168 | 28218 | 3101 | 30949 | 2596 | 32438 | 2206 | 34155 | 1579 | 40252 | 1246 | 22109 |
| 3L-6S | | MI | 9545 | 4168 | 15017 | 3010 | 15860 | 2520 | 16116 | 2125 | 16112 | 1520 | 18280 | 940 | 11666 |
| 14-#11 | 2.17 | MA | 17535 | 4168 | 27481 | 3130 | 29991 | 2623 | 31259 | 2218 | 32535 | 1590 | 38355 | 1188 | 22073 |
| 4L-5S | | MI | 9652 | 4168 | 15351 | 2989 | 16289 | 2512 | 16649 | 2119 | 16829 | 1505 | 19201 | 1010 | 11902 |
| 14-#11 | 2.17 | MA | 17230 | 4168 | 26855 | 3143 | 29173 | 2636 | 30235 | 2244 | 31098 | 1614 | 36415 | 1144 | 21972 |
| 5L-4S | | MI | 9799 | 4168 | 15675 | 2980 | 16720 | 2491 | 17188 | 2100 | 17624 | 1503 | 20208 | 1073 | 11886 |
| 14-#11 | 2.17 | MA | 17012 | 4168 | 26201 | 3149 | 28339 | 2661 | 29222 | 2256 | 29735 | 1638 | 34680 | 1080 | 21406 |
| 6L-3S | | MI | 9882 | 4168 | 16060 | 2956 | 17219 | 2484 | 17801 | 2095 | 18422 | 1488 | 21218 | 1133 | 11860 |
| 14-#11 | 2.17 | MA | 16767 | 4168 | 25502 | 3171 | 27491 | 2668 | 28238 | 2281 | 28324 | 1648 | 32654 | 1023 | 20902 |
| 7L-2S | | MI | 10053 | 4168 | 16561 | 2947 | 17862 | 2463 | 18585 | 2075 | 19489 | 1473 | 22663 | 1243 | 11831 |
| 14-#14 | 3.13 | MA | 18616 | 4436 | 29758 | 3305 | 32855 | 2751 | 34726 | 2299 | 37231 | 1576 | 44987 | 1084 | 31291 |
| 4L-5S | | MI | 10106 | 4436 | 16344 | 3154 | 17511 | 2636 | 18115 | 2195 | 18804 | 1483 | 21783 | 835 | 16168 |
| 14-#14 | 3.13 | MA | 18188 | 4436 | 28867 | 3324 | 31682 | 2770 | 33257 | 2336 | 35171 | 1610 | 42200 | 1018 | 30506 |
| 5L-4S | | MI | 10313 | 4436 | 16806 | 3142 | 18126 | 2607 | 18883 | 2168 | 19937 | 1482 | 23191 | 926 | 16602 |
| 14-#14 | 3.13 | MA | 17883 | 4436 | 27930 | 3332 | 30495 | 2806 | 31804 | 2353 | 33215 | 1643 | 39707 | 924 | 29523 |
| 6L-3S | | MI | 10425 | 4436 | 17355 | 3110 | 18837 | 2598 | 19756 | 2162 | 21074 | 1462 | 24608 | 1011 | 16604 |
| 14-#14 | 3.13 | MA | 17538 | 4436 | 26928 | 3364 | 29279 | 2816 | 30405 | 2389 | 31191 | 1657 | 36790 | 842 | 28368 |
| 7L-2S | | MI | 10661 | 4436 | 18067 | 3097 | 19750 | 2568 | 20870 | 2136 | 22589 | 1441 | 26628 | 1169 | 16577 |
| 14-#18 | 5.56 | MA | 20553 | 5113 | 33856 | 3787 | 37914 | 3110 | 40778 | 2570 | 45316 | 1599 | 56589 | 694 | 50420 |
| 5L-4S | | MI | 11557 | 5113 | 19548 | 3559 | 21554 | 2904 | 23027 | 2344 | 25598 | 1428 | 30190 | 516 | 26869 |
| 14-#18 | 5.56 | MA | 20043 | 5113 | 32213 | 3800 | 35861 | 3177 | 38223 | 2598 | 41877 | 1656 | 52193 | 519 | 47429 |
| 6L-3S | | MI | 11735 | 5113 | 20501 | 3505 | 22788 | 2891 | 24541 | 2337 | 27569 | 1397 | 32568 | 659 | 28019 |
| 14-#18 | 5.56 | MA | 19454 | 5113 | 30454 | 3856 | 33727 | 3192 | 35785 | 2662 | 38529 | 1713 | 47027 | 370 | 44526 |
| 7L-2S | | MI | 12118 | 5113 | 21728 | 3487 | 24361 | 2843 | 26460 | 2295 | 30180 | 1367 | 35935 | 940 | 28082 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

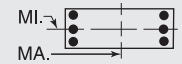


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#10 | 2.02 | MA | 17465 | 4126 | 27314 | 3110 | 29849 | 2609 | 31118 | 2210 | 32366 | 1596 | 38083 | 1230 | 20728 |
| 4L-6S | | MI | 9565 | 4126 | 15077 | 2986 | 15982 | 2514 | 16294 | 2125 | 16370 | 1533 | 18730 | 1033 | 11121 |
| 16-#10 | 2.02 | MA | 17213 | 4126 | 26796 | 3120 | 29178 | 2620 | 30278 | 2232 | 31187 | 1616 | 36495 | 1196 | 20670 |
| 5E | | MI | 9653 | 4126 | 15338 | 2981 | 16336 | 2507 | 16735 | 2120 | 16962 | 1520 | 19510 | 1092 | 11219 |
| 16-#10 | 2.02 | MA | 17034 | 4126 | 26258 | 3125 | 28487 | 2640 | 29448 | 2243 | 30069 | 1636 | 35075 | 1145 | 20425 |
| 6L-4S | | MI | 9777 | 4126 | 15605 | 2972 | 16692 | 2489 | 17180 | 2103 | 17620 | 1517 | 20365 | 1143 | 11204 |
| 16-#10 | 2.02 | MA | 16830 | 4126 | 25684 | 3144 | 27790 | 2646 | 28630 | 2262 | 28912 | 1645 | 33421 | 1100 | 19989 |
| 7L-3S | | MI | 9849 | 4126 | 15924 | 2953 | 17105 | 2482 | 17687 | 2098 | 18280 | 1504 | 21219 | 1194 | 11183 |
| 16-#10 | 2.02 | MA | 16610 | 4126 | 25184 | 3153 | 27096 | 2665 | 27773 | 2268 | 27821 | 1665 | 31980 | 1060 | 19663 |
| 8L-2S | | MI | 9993 | 4126 | 16341 | 2944 | 17640 | 2464 | 18339 | 2081 | 19167 | 1490 | 22445 | 1283 | 11161 |
| 16-#11 | 2.48 | MA | 17981 | 4255 | 28468 | 3184 | 31256 | 2661 | 32803 | 2241 | 34635 | 1583 | 41263 | 1178 | 25139 |
| 4L-6S | | MI | 9762 | 4255 | 15518 | 3064 | 16503 | 2559 | 16900 | 2148 | 17179 | 1513 | 19725 | 927 | 13184 |
| 16-#11 | 2.48 | MA | 17679 | 4255 | 27842 | 3197 | 30439 | 2675 | 31779 | 2267 | 33198 | 1607 | 39323 | 1135 | 25029 |
| 5E | | MI | 9867 | 4255 | 15852 | 3043 | 16932 | 2551 | 17434 | 2143 | 17895 | 1498 | 20646 | 997 | 13445 |
| 16-#11 | 2.48 | MA | 17465 | 4255 | 27188 | 3203 | 29605 | 2700 | 30766 | 2280 | 31835 | 1631 | 37588 | 1071 | 24429 |
| 6L-4S | | MI | 10013 | 4255 | 16176 | 3033 | 17363 | 2530 | 17972 | 2124 | 18690 | 1496 | 21653 | 1060 | 13461 |
| 16-#11 | 2.48 | MA | 17221 | 4255 | 26489 | 3225 | 28756 | 2707 | 29781 | 2304 | 30424 | 1641 | 35561 | 1014 | 23942 |
| 7L-3S | | MI | 10095 | 4255 | 16561 | 3010 | 17862 | 2523 | 18585 | 2118 | 19489 | 1481 | 22663 | 1120 | 13440 |
| 16-#11 | 2.48 | MA | 16958 | 4255 | 25879 | 3236 | 27911 | 2729 | 28737 | 2311 | 29094 | 1665 | 33800 | 963 | 23280 |
| 8L-2S | | MI | 10265 | 4255 | 17063 | 3001 | 18505 | 2502 | 19369 | 2099 | 20556 | 1466 | 24108 | 1230 | 13415 |
| 16-#14 | 3.57 | MA | 18824 | 4560 | 30280 | 3401 | 33493 | 2826 | 35466 | 2370 | 38177 | 1600 | 46362 | 1005 | 34825 |
| 5E | | MI | 10409 | 4560 | 17056 | 3232 | 18424 | 2692 | 19229 | 2229 | 20319 | 1473 | 23803 | 813 | 18308 |
| 16-#14 | 3.57 | MA | 18526 | 4560 | 29342 | 3410 | 32306 | 2862 | 34013 | 2387 | 36221 | 1634 | 43869 | 910 | 33875 |
| 6L-4S | | MI | 10614 | 4560 | 17518 | 3220 | 19039 | 2663 | 19997 | 2202 | 21452 | 1472 | 25211 | 903 | 18813 |
| 16-#14 | 3.57 | MA | 18183 | 4560 | 28341 | 3442 | 31090 | 2872 | 32614 | 2423 | 34197 | 1647 | 40952 | 828 | 32689 |
| 7L-3S | | MI | 10725 | 4560 | 18067 | 3187 | 19750 | 2653 | 20870 | 2196 | 22589 | 1452 | 26628 | 988 | 18835 |
| 16-#14 | 3.57 | MA | 17813 | 4560 | 27465 | 3457 | 29878 | 2904 | 31117 | 2432 | 32289 | 1681 | 38420 | 752 | 31427 |
| 8L-2S | | MI | 10957 | 4560 | 18779 | 3175 | 20663 | 2624 | 21984 | 2169 | 24105 | 1431 | 28648 | 1147 | 18815 |
| 16-#18 | 6.35 | MA | 21152 | 5335 | 34685 | 3939 | 39030 | 3276 | 42089 | 2658 | 47137 | 1638 | 59476 | 494 | 54940 |
| 6L-4S | | MI | 12067 | 5335 | 20775 | 3698 | 23127 | 3004 | 24946 | 2404 | 28209 | 1410 | 33557 | 464 | 30526 |
| 16-#18 | 6.35 | MA | 20569 | 5335 | 32926 | 3994 | 36896 | 3291 | 39651 | 2722 | 43789 | 1695 | 54310 | 345 | 51989 |
| 7L-3S | | MI | 12243 | 5335 | 21728 | 3644 | 24361 | 2991 | 26460 | 2398 | 30180 | 1380 | 35935 | 606 | 31816 |
| 18-#10 | 2.27 | MA | 17584 | 4197 | 27608 | 3164 | 30219 | 2651 | 31548 | 2251 | 32915 | 1610 | 38887 | 1188 | 23189 |
| 5L-6S | | MI | 9746 | 4197 | 15494 | 3030 | 16516 | 2545 | 16946 | 2145 | 17256 | 1528 | 19957 | 1026 | 12385 |
| 18-#10 | 2.27 | MA | 17408 | 4197 | 27070 | 3169 | 29528 | 2672 | 30718 | 2262 | 31797 | 1631 | 37467 | 1137 | 22911 |
| 6L-5S | | MI | 9833 | 4197 | 15755 | 3024 | 16871 | 2539 | 17387 | 2139 | 17849 | 1514 | 20737 | 1085 | 12524 |
| 18-#10 | 2.27 | MA | 17205 | 4197 | 26496 | 3188 | 28831 | 2678 | 29900 | 2281 | 30639 | 1639 | 35813 | 1092 | 22489 |
| 7L-4S | | MI | 9956 | 4197 | 16022 | 3016 | 17227 | 2520 | 17831 | 2123 | 18506 | 1512 | 21592 | 1135 | 12514 |
| 18-#10 | 2.27 | MA | 16989 | 4197 | 25996 | 3197 | 28137 | 2697 | 29043 | 2288 | 29549 | 1660 | 34372 | 1052 | 22171 |
| 8L-3S | | MI | 10027 | 4197 | 16341 | 2997 | 17640 | 2514 | 18339 | 2117 | 19167 | 1498 | 22445 | 1186 | 12497 |
| 18-#10 | 2.27 | MA | 16803 | 4197 | 25500 | 3205 | 27474 | 2705 | 28217 | 2306 | 28464 | 1679 | 32970 | 1011 | 21574 |
| 9L-2S | | MI | 10170 | 4197 | 16757 | 2988 | 18174 | 2496 | 18991 | 2101 | 20054 | 1484 | 23672 | 1275 | 12477 |
| 18-#11 | 2.79 | MA | 18125 | 4341 | 28829 | 3250 | 31704 | 2714 | 33322 | 2291 | 35298 | 1600 | 42231 | 1125 | 28088 |
| 5L-6S | | MI | 9977 | 4341 | 16020 | 3118 | 17145 | 2597 | 17684 | 2172 | 18245 | 1506 | 21170 | 914 | 14705 |
| 18-#11 | 2.79 | MA | 17915 | 4341 | 28175 | 3257 | 30870 | 2739 | 32309 | 2303 | 33935 | 1624 | 40495 | 1061 | 27455 |
| 6L-5S | | MI | 10081 | 4341 | 16354 | 3097 | 17575 | 2590 | 18218 | 2166 | 18962 | 1491 | 22091 | 984 | 14952 |
| 18-#11 | 2.79 | MA | 17673 | 4341 | 27476 | 3279 | 30021 | 2746 | 31325 | 2328 | 32524 | 1634 | 38469 | 1004 | 26983 |
| 7L-4S | | MI | 10227 | 4341 | 16677 | 3087 | 18006 | 2569 | 18756 | 2147 | 19757 | 1489 | 23098 | 1047 | 15032 |
| 18-#11 | 2.79 | MA | 17416 | 4341 | 26866 | 3290 | 29176 | 2768 | 30280 | 2335 | 31194 | 1658 | 36708 | 953 | 26311 |
| 8L-3S | | MI | 10308 | 4341 | 17063 | 3064 | 18505 | 2561 | 19369 | 2142 | 20556 | 1474 | 24108 | 1107 | 15017 |
| 18-#11 | 2.79 | MA | 17192 | 4341 | 26205 | 3314 | 28368 | 2778 | 29274 | 2357 | 29883 | 1682 | 34988 | 903 | 25578 |
| 9L-2S | | MI | 10476 | 4341 | 17564 | 3055 | 19148 | 2540 | 20153 | 2122 | 21622 | 1459 | 25553 | 1217 | 14996 |
| 18-#14 | 4.02 | MA | 19165 | 4685 | 30755 | 3488 | 34116 | 2918 | 36222 | 2421 | 39226 | 1624 | 48030 | 896 | 38230 |
| 6L-5S | | MI | 10711 | 4685 | 17768 | 3310 | 19337 | 2748 | 20343 | 2263 | 21834 | 1463 | 25823 | 790 | 20455 |
| 18-#14 | 4.02 | MA | 18824 | 4685 | 29753 | 3520 | 32901 | 2928 | 34823 | 2457 | 37202 | 1638 | 45113 | 814 | 37010 |
| 7L-4S | | MI | 10914 | 4685 | 18231 | 3297 | 19952 | 2719 | 21110 | 2236 | 22968 | 1462 | 27231 | 881 | 21022 |
| 18-#14 | 4.02 | MA | 18464 | 4685 | 28878 | 3535 | 31689 | 2960 | 33326 | 2466 | 35294 | 1671 | 42582 | 738 | 35758 |
| 8L-3S | | MI | 11024 | 4685 | 18779 | 3265 | 20663 | 2709 | 21984 | 2230 | 24105 | 1442 | 28648 | 966 | 21056 |
| 18-#14 | 4.02 | MA | 18146 | 4685 | 27937 | 3569 | 30529 | 2973 | 31883 | 2498 | 33413 | 1705 | 40105 | 665 | 34163 |
| 9L-2S | | MI | 11254 | 4685 | 19492 | 3253 | 21576 | 2680 | 23098 | 2203 | 25620 | 1421 | 30668 | 1125 | 21049 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

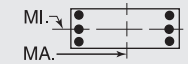
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 7.14 | MA | 21673 | 5556 | 35398 | 4133 | 40065 | 3390 | 43517 | 2782 | 49049 | 1677 | 61593 | 321 | 59452 |
| 7L-4S | | MI | 12575 | 5556 | 22003 | 3836 | 24701 | 3103 | 26866 | 2465 | 30820 | 1393 | 36924 | 411 | 34198 |
| 20-#10 | 2.52 | MA | 17780 | 4267 | 27882 | 3213 | 30568 | 2703 | 31988 | 2281 | 33524 | 1625 | 39859 | 1130 | 25401 |
| 6E | | MI | 9927 | 4267 | 15911 | 3074 | 17050 | 2577 | 17598 | 2164 | 18143 | 1522 | 21184 | 1018 | 13652 |
| 20-#10 | 2.52 | MA | 17577 | 4267 | 27308 | 3232 | 29872 | 2709 | 31170 | 2300 | 32367 | 1634 | 38205 | 1084 | 24990 |
| 7L-5S | | MI | 10013 | 4267 | 16171 | 3068 | 17405 | 2570 | 18039 | 2158 | 18736 | 1509 | 21963 | 1077 | 13824 |
| 20-#10 | 2.52 | MA | 17366 | 4267 | 26808 | 3241 | 29178 | 2728 | 30313 | 2307 | 31277 | 1654 | 36765 | 1044 | 24681 |
| 8L-4S | | MI | 10135 | 4267 | 16439 | 3060 | 17761 | 2552 | 18483 | 2142 | 19393 | 1506 | 22818 | 1127 | 13821 |
| 20-#10 | 2.52 | MA | 17183 | 4267 | 26312 | 3249 | 28515 | 2737 | 29487 | 2325 | 30192 | 1674 | 35363 | 1003 | 24076 |
| 9L-3S | | MI | 10206 | 4267 | 16757 | 3041 | 18174 | 2545 | 18991 | 2136 | 20054 | 1492 | 23672 | 1178 | 13807 |
| 20-#10 | 2.52 | MA | 16961 | 4267 | 25740 | 3267 | 27850 | 2757 | 28660 | 2333 | 29013 | 1679 | 33930 | 969 | 23563 |
| 10L-2S | | MI | 10348 | 4267 | 17174 | 3032 | 18708 | 2527 | 19642 | 2120 | 20941 | 1479 | 24899 | 1268 | 13790 |
| 20-#11 | 3.10 | MA | 18363 | 4427 | 29162 | 3311 | 32135 | 2777 | 33853 | 2327 | 36035 | 1617 | 43403 | 1051 | 30486 |
| 6E | | MI | 10193 | 4427 | 16521 | 3172 | 17788 | 2636 | 18468 | 2195 | 19312 | 1499 | 22615 | 901 | 16230 |
| 20-#11 | 3.10 | MA | 18122 | 4427 | 28463 | 3333 | 31287 | 2784 | 32868 | 2351 | 34624 | 1627 | 41377 | 995 | 30028 |
| 7L-5S | | MI | 10295 | 4427 | 16855 | 3151 | 18218 | 2629 | 19002 | 2190 | 20029 | 1484 | 23536 | 971 | 16463 |
| 20-#11 | 3.10 | MA | 17871 | 4427 | 27853 | 3344 | 30441 | 2807 | 31824 | 2358 | 33294 | 1651 | 39615 | 944 | 29345 |
| 8L-4S | | MI | 10439 | 4427 | 17179 | 3141 | 18649 | 2608 | 19540 | 2171 | 20824 | 1482 | 24543 | 1034 | 16600 |
| 20-#11 | 3.10 | MA | 17651 | 4427 | 27192 | 3368 | 29633 | 2817 | 30817 | 2381 | 31983 | 1675 | 37896 | 893 | 28614 |
| 9L-3S | | MI | 10520 | 4427 | 17564 | 3118 | 19148 | 2600 | 20153 | 2165 | 21622 | 1467 | 25553 | 1094 | 16591 |
| 20-#11 | 3.10 | MA | 17385 | 4427 | 26558 | 3375 | 28822 | 2841 | 29810 | 2390 | 30553 | 1682 | 36143 | 849 | 27698 |
| 10L-2S | | MI | 10686 | 4427 | 18065 | 3109 | 19791 | 2579 | 20937 | 2146 | 22689 | 1452 | 26998 | 1204 | 16573 |
| 20-#14 | 4.46 | MA | 19460 | 4809 | 31165 | 3598 | 34711 | 2983 | 37032 | 2491 | 40208 | 1628 | 49274 | 800 | 41332 |
| 7L-5S | | MI | 11012 | 4809 | 18480 | 3388 | 20250 | 2804 | 21457 | 2297 | 23350 | 1453 | 27843 | 768 | 22608 |
| 20-#14 | 4.46 | MA | 19115 | 4809 | 30290 | 3613 | 33500 | 3015 | 35535 | 2500 | 38300 | 1661 | 46743 | 725 | 40089 |
| 8L-4S | | MI | 11212 | 4809 | 18943 | 3375 | 20865 | 2775 | 22224 | 2270 | 24483 | 1452 | 29251 | 859 | 23180 |
| 20-#14 | 4.46 | MA | 18801 | 4809 | 29349 | 3647 | 32340 | 3029 | 34092 | 2532 | 36419 | 1695 | 44266 | 651 | 38472 |
| 9L-3S | | MI | 11322 | 4809 | 19492 | 3343 | 21576 | 2765 | 23098 | 2264 | 25620 | 1432 | 30668 | 944 | 23273 |
| 22-#10 | 2.77 | MA | 17949 | 4337 | 28120 | 3276 | 30913 | 2741 | 32440 | 2320 | 34095 | 1628 | 40598 | 1076 | 27493 |
| 7L-6S | | MI | 10107 | 4337 | 16328 | 3118 | 17585 | 2608 | 18249 | 2183 | 19030 | 1517 | 22410 | 1010 | 14920 |
| 22-#10 | 2.77 | MA | 17741 | 4337 | 27620 | 3285 | 30219 | 2760 | 31583 | 2326 | 33005 | 1648 | 39157 | 1036 | 27191 |
| 8L-5S | | MI | 10192 | 4337 | 16588 | 3112 | 17939 | 2602 | 18690 | 2178 | 19622 | 1503 | 23190 | 1069 | 15122 |
| 22-#10 | 2.77 | MA | 17561 | 4337 | 27124 | 3293 | 29556 | 2768 | 30757 | 2344 | 31920 | 1668 | 37755 | 996 | 26577 |
| 9L-4S | | MI | 10313 | 4337 | 16856 | 3104 | 18295 | 2584 | 19135 | 2161 | 20280 | 1500 | 24045 | 1119 | 15126 |
| 22-#10 | 2.77 | MA | 17340 | 4337 | 26552 | 3311 | 28891 | 2789 | 29930 | 2352 | 30741 | 1674 | 36322 | 962 | 26061 |
| 10L-3S | | MI | 10384 | 4337 | 17174 | 3084 | 18708 | 2577 | 19642 | 2156 | 20941 | 1487 | 24899 | 1170 | 15116 |
| 22-#10 | 2.77 | MA | 17136 | 4337 | 26049 | 3318 | 28220 | 2796 | 29125 | 2372 | 29631 | 1691 | 34932 | 919 | 25329 |
| 11L-2S | | MI | 10524 | 4337 | 17591 | 3076 | 19242 | 2559 | 20294 | 2139 | 21828 | 1473 | 26126 | 1260 | 15101 |
| 22-#11 | 3.40 | MA | 18569 | 4514 | 29450 | 3387 | 32552 | 2823 | 34411 | 2375 | 36724 | 1620 | 44284 | 985 | 33074 |
| 7L-6S | | MI | 10407 | 4514 | 17023 | 3226 | 18431 | 2675 | 19252 | 2219 | 20379 | 1492 | 24060 | 888 | 17757 |
| 22-#11 | 3.40 | MA | 18325 | 4514 | 28840 | 3398 | 31707 | 2846 | 33367 | 2382 | 35394 | 1644 | 42523 | 934 | 32381 |
| 8L-5S | | MI | 10508 | 4514 | 17356 | 3205 | 18860 | 2667 | 19786 | 2213 | 21096 | 1477 | 24981 | 958 | 17979 |
| 22-#11 | 3.40 | MA | 18107 | 4514 | 28179 | 3421 | 30898 | 2856 | 32361 | 2404 | 34083 | 1668 | 40804 | 884 | 31651 |
| 9L-4S | | MI | 10651 | 4514 | 17680 | 3195 | 19292 | 2646 | 20324 | 2194 | 21891 | 1476 | 25988 | 1021 | 18161 |
| 22-#11 | 3.40 | MA | 17842 | 4514 | 27545 | 3429 | 30087 | 2880 | 31353 | 2413 | 32653 | 1675 | 39051 | 840 | 30721 |
| 10L-3S | | MI | 10732 | 4514 | 18065 | 3172 | 19791 | 2639 | 20937 | 2189 | 22689 | 1460 | 26998 | 1081 | 18162 |
| 22-#11 | 3.40 | MA | 17597 | 4514 | 26933 | 3438 | 29279 | 2889 | 30371 | 2437 | 31300 | 1696 | 37351 | 786 | 29781 |
| 11L-2S | | MI | 10896 | 4514 | 18567 | 3163 | 20433 | 2618 | 21721 | 2169 | 23756 | 1445 | 28443 | 1191 | 18148 |
| 22-#14 | 4.91 | MA | 19753 | 4934 | 31703 | 3690 | 35310 | 3071 | 37744 | 2534 | 41305 | 1651 | 50904 | 711 | 44419 |
| 8L-5S | | MI | 11312 | 4934 | 19192 | 3466 | 21163 | 2860 | 22570 | 2331 | 24865 | 1443 | 29863 | 746 | 24766 |
| 22-#14 | 4.91 | MA | 19450 | 4934 | 30762 | 3725 | 34151 | 3085 | 36301 | 2566 | 39424 | 1685 | 48427 | 637 | 42702 |
| 9L-4S | | MI | 11511 | 4934 | 19655 | 3453 | 21778 | 2831 | 23338 | 2304 | 25999 | 1442 | 31271 | 836 | 25310 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#10 | 3.02 | MA | 18115 | 4407 | 28432 | 3329 | 31260 | 2791 | 32853 | 2345 | 34733 | 1643 | 41549 | 1029 | 29697 |
| 8L-6S | | MI | 10287 | 4407 | 16744 | 3162 | 18119 | 2640 | 18901 | 2202 | 19917 | 1511 | 23637 | 1002 | 16191 |
| 24-#10 | 3.02 | MA | 17938 | 4407 | 27936 | 3337 | 30597 | 2800 | 32027 | 2364 | 33648 | 1662 | 40148 | 988 | 29077 |
| 9L-5S | | MI | 10371 | 4407 | 17005 | 3156 | 18474 | 2633 | 19342 | 2197 | 20509 | 1497 | 24417 | 1061 | 16409 |
| 24-#10 | 3.02 | MA | 17717 | 4407 | 27364 | 3354 | 29932 | 2820 | 31200 | 2372 | 32468 | 1668 | 38714 | 954 | 28550 |
| 10L-4S | | MI | 10491 | 4407 | 17272 | 3148 | 18829 | 2615 | 19787 | 2180 | 21167 | 1495 | 25272 | 1111 | 16428 |
| 24-#10 | 3.02 | MA | 17516 | 4407 | 26861 | 3362 | 29261 | 2827 | 30394 | 2391 | 31359 | 1686 | 37324 | 912 | 27822 |
| 11L-3S | | MI | 10562 | 4407 | 17591 | 3128 | 19242 | 2608 | 20294 | 2175 | 21828 | 1481 | 26126 | 1162 | 16422 |
| 24-#10 | 3.02 | MA | 17328 | 4407 | 26317 | 3382 | 28578 | 2846 | 29604 | 2411 | 30262 | 1704 | 35730 | 861 | 27090 |
| 12L-2S | | MI | 10701 | 4407 | 18008 | 3120 | 19777 | 2590 | 20946 | 2158 | 22714 | 1467 | 27353 | 1252 | 16410 |
| 24-#11 | 3.71 | MA | 18773 | 4600 | 29827 | 3452 | 32972 | 2884 | 34911 | 2405 | 37494 | 1637 | 45431 | 925 | 35418 |
| 8L-6S | | MI | 10621 | 4600 | 17524 | 3280 | 19074 | 2713 | 20036 | 2242 | 21446 | 1486 | 25505 | 875 | 19286 |
| 24-#11 | 3.71 | MA | 18561 | 4600 | 29166 | 3475 | 32163 | 2894 | 33904 | 2428 | 36183 | 1661 | 43711 | 874 | 34687 |
| 9L-5S | | MI | 10721 | 4600 | 17858 | 3259 | 19503 | 2706 | 20570 | 2237 | 22163 | 1470 | 26426 | 945 | 19497 |
| 24-#11 | 3.71 | MA | 18297 | 4600 | 28532 | 3483 | 31353 | 2919 | 32897 | 2437 | 34753 | 1668 | 41959 | 830 | 33744 |
| 10L-4S | | MI | 10863 | 4600 | 18182 | 3249 | 19934 | 2685 | 21108 | 2218 | 22958 | 1469 | 27433 | 1008 | 19722 |
| 24-#11 | 3.71 | MA | 18055 | 4600 | 27920 | 3492 | 30545 | 2928 | 31914 | 2460 | 33400 | 1689 | 40259 | 776 | 32791 |
| 11L-3S | | MI | 10943 | 4600 | 18567 | 3226 | 20433 | 2678 | 21721 | 2212 | 23756 | 1453 | 28443 | 1068 | 19731 |
| 24-#14 | 5.36 | MA | 20095 | 5058 | 32174 | 3803 | 35961 | 3141 | 38509 | 2599 | 42430 | 1675 | 52589 | 623 | 47011 |
| 9L-5S | | MI | 11611 | 5058 | 19905 | 3543 | 22076 | 2916 | 23684 | 2365 | 26381 | 1433 | 31883 | 723 | 26928 |

## RECTANGULAR TIED COLUMNS 24" x 44"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.52 | MA | 18792 | 4177 | 29786 | 3095 | 32341 | 2602 | 33568 | 2216 | 34690 | 1633 | 40284 | 1414 | 16980 |
| 2E | | MI | 9992 | 4177 | 16218 | 2915 | 17131 | 2449 | 17485 | 2083 | 17691 | 1526 | 19689 | 1265 | 8761 |
| 6-#14 | 1.28 | MA | 18476 | 4107 | 28945 | 3071 | 31367 | 2588 | 32427 | 2212 | 33166 | 1650 | 38196 | 1432 | 14515 |
| 2L-3S | | MI | 9622 | 4107 | 15129 | 2920 | 15821 | 2478 | 15924 | 2117 | 15583 | 1573 | 17122 | 1163 | 7623 |
| 6-#14 | 1.28 | MA | 17901 | 4107 | 27455 | 3092 | 29457 | 2607 | 30097 | 2249 | 29995 | 1684 | 33806 | 1296 | 14554 |
| 3L-2S | | MI | 9872 | 4107 | 15841 | 2907 | 16734 | 2448 | 17037 | 2090 | 17098 | 1553 | 19142 | 1322 | 7563 |
| 6-#18 | 2.27 | MA | 19950 | 4398 | 32396 | 3233 | 35687 | 2702 | 37651 | 2277 | 40244 | 1615 | 47975 | 1390 | 25166 |
| 2L-3S | | MI | 10088 | 4398 | 16218 | 3072 | 17131 | 2596 | 17485 | 2185 | 17691 | 1539 | 19689 | 931 | 12786 |
| 6-#18 | 2.27 | MA | 18986 | 4398 | 29786 | 3268 | 32341 | 2734 | 33568 | 2341 | 34690 | 1673 | 40284 | 1142 | 25110 |
| 3L-2S | | MI | 10503 | 4398 | 17445 | 3053 | 18704 | 2548 | 19404 | 2143 | 20302 | 1508 | 23056 | 1213 | 12693 |
| 8-#11 | 1.18 | MA | 18346 | 4079 | 28591 | 3063 | 30966 | 2584 | 31962 | 2211 | 32548 | 1658 | 37351 | 1440 | 13500 |
| 2L-4S | | MI | 9561 | 4079 | 14792 | 2940 | 15428 | 2479 | 15459 | 2120 | 14995 | 1596 | 16471 | 1175 | 7148 |
| 8-#11 | 1.18 | MA | 17943 | 4079 | 27551 | 3078 | 29632 | 2597 | 30334 | 2238 | 30333 | 1682 | 34285 | 1347 | 13528 |
| 3E | | MI | 9645 | 4079 | 15177 | 2917 | 15927 | 2472 | 16072 | 2115 | 15793 | 1581 | 17480 | 1236 | 7100 |
| 8-#11 | 1.18 | MA | 17713 | 4079 | 26774 | 3106 | 28623 | 2625 | 29093 | 2251 | 28627 | 1693 | 32293 | 1290 | 13537 |
| 4L-2S | | MI | 9823 | 4079 | 15678 | 2908 | 16570 | 2451 | 16856 | 2096 | 16860 | 1566 | 18925 | 1346 | 7062 |
| 8-#14 | 1.70 | MA | 19147 | 4232 | 30436 | 3149 | 33278 | 2644 | 34758 | 2246 | 36337 | 1640 | 42587 | 1418 | 19192 |
| 2L-4S | | MI | 9811 | 4232 | 15293 | 3030 | 16023 | 2543 | 16164 | 2157 | 15961 | 1584 | 17726 | 1056 | 9962 |
| 8-#14 | 1.70 | MA | 18585 | 4232 | 28945 | 3170 | 31367 | 2663 | 32427 | 2283 | 33166 | 1674 | 38196 | 1282 | 19210 |
| 3E | | MI | 9926 | 4232 | 15841 | 2998 | 16734 | 2534 | 17037 | 2151 | 17098 | 1563 | 19142 | 1141 | 9904 |
| 8-#14 | 1.70 | MA | 18261 | 4232 | 27832 | 3210 | 29921 | 2702 | 30648 | 2301 | 30720 | 1689 | 35330 | 1199 | 19132 |
| 4L-2S | | MI | 10173 | 4232 | 16554 | 2985 | 17647 | 2504 | 18151 | 2124 | 18614 | 1543 | 21162 | 1299 | 9849 |
| 8-#18 | 3.03 | MA | 21095 | 4619 | 35007 | 3371 | 39033 | 2801 | 41733 | 2337 | 45799 | 1597 | 55665 | 1365 | 33327 |
| 2L-4S | | MI | 10420 | 4619 | 16493 | 3264 | 17471 | 2709 | 17890 | 2252 | 18332 | 1552 | 20678 | 736 | 16221 |
| 8-#18 | 3.03 | MA | 20163 | 4619 | 32396 | 3407 | 35687 | 2833 | 37651 | 2401 | 40244 | 1656 | 47975 | 1117 | 33209 |
| 3E | | MI | 10605 | 4619 | 17445 | 3210 | 18704 | 2696 | 19404 | 2245 | 20302 | 1521 | 23056 | 879 | 16643 |
| 8-#18 | 3.03 | MA | 19619 | 4619 | 30440 | 3477 | 33145 | 2901 | 34524 | 2431 | 35948 | 1679 | 42903 | 967 | 32398 |
| 4L-2S | | MI | 11012 | 4619 | 18672 | 3192 | 20277 | 2648 | 21323 | 2203 | 22914 | 1491 | 26423 | 1160 | 16583 |
| 10-#10 | 1.20 | MA | 18412 | 4085 | 28642 | 3080 | 31104 | 2598 | 32163 | 2223 | 32843 | 1665 | 37777 | 1447 | 13800 |
| 2L-5S | | MI | 9517 | 4085 | 14707 | 2972 | 15370 | 2518 | 15405 | 2154 | 14876 | 1610 | 16431 | 1180 | 7310 |
| 10-#10 | 1.20 | MA | 18080 | 4085 | 27786 | 3093 | 30007 | 2609 | 30825 | 2245 | 31022 | 1686 | 35255 | 1372 | 13819 |
| 3L-4S | | MI | 9643 | 4085 | 14974 | 2964 | 15726 | 2500 | 15849 | 2138 | 15534 | 1607 | 17286 | 1231 | 7273 |
| 10-#10 | 1.20 | MA | 17887 | 4085 | 27149 | 3116 | 29180 | 2632 | 29806 | 2256 | 29622 | 1695 | 33629 | 1326 | 13828 |
| 4L-3S | | MI | 9716 | 4085 | 15293 | 2944 | 16139 | 2493 | 16357 | 2132 | 16195 | 1593 | 18139 | 1282 | 7240 |

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

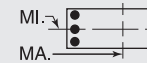
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 1.20 | MA | 17612 | 4085 | 26601 | 3126 | 28474 | 2644 | 28922 | 2278 | 28381 | 1716 | 31960 | 1293 | 13796 |
| 5L-2S | | MI | 9865 | 4085 | 15710 | 2936 | 16673 | 2475 | 17008 | 2116 | 17082 | 1580 | 19366 | 1371 | 7212 |
| 10-#11 | 1.48 | MA | 18818 | 4166 | 29632 | 3117 | 32301 | 2622 | 33590 | 2235 | 34762 | 1651 | 40418 | 1431 | 16768 |
| 2L-5S | | MI | 9627 | 4166 | 14969 | 3003 | 15640 | 2539 | 15705 | 2163 | 15267 | 1591 | 16908 | 1100 | 8792 |
| 10-#11 | 1.48 | MA | 18421 | 4166 | 28591 | 3132 | 30966 | 2636 | 31962 | 2261 | 32548 | 1675 | 37351 | 1337 | 16788 |
| 3L-4S | | MI | 9777 | 4166 | 15293 | 2994 | 16071 | 2518 | 16243 | 2144 | 16062 | 1589 | 17916 | 1162 | 8751 |
| 10-#11 | 1.48 | MA | 18193 | 4166 | 27815 | 3160 | 29958 | 2664 | 30721 | 2274 | 30842 | 1686 | 35360 | 1280 | 16779 |
| 4L-3S | | MI | 9861 | 4166 | 15678 | 2971 | 16570 | 2511 | 16856 | 2139 | 16860 | 1574 | 18925 | 1223 | 8709 |
| 10-#11 | 1.48 | MA | 17862 | 4166 | 27153 | 3173 | 29097 | 2677 | 29643 | 2301 | 29329 | 1710 | 33320 | 1238 | 16700 |
| 5L-2S | | MI | 10036 | 4166 | 16180 | 2962 | 17213 | 2490 | 17640 | 2119 | 17927 | 1559 | 20371 | 1333 | 8673 |
| 10-#14 | 2.13 | MA | 19812 | 4356 | 31926 | 3227 | 35188 | 2700 | 37088 | 2280 | 39508 | 1630 | 46977 | 1405 | 23859 |
| 2L-5S | | MI | 9904 | 4356 | 15542 | 3120 | 16321 | 2628 | 16510 | 2217 | 16343 | 1574 | 18338 | 943 | 12030 |
| 10-#14 | 2.13 | MA | 19262 | 4356 | 30436 | 3247 | 33278 | 2719 | 34758 | 2317 | 36337 | 1664 | 42587 | 1268 | 23854 |
| 3L-4S | | MI | 10115 | 4356 | 16005 | 3108 | 16936 | 2599 | 17278 | 2191 | 17477 | 1574 | 19746 | 1033 | 12204 |
| 10-#14 | 2.13 | MA | 18943 | 4356 | 29323 | 3288 | 31831 | 2758 | 32978 | 2335 | 33891 | 1679 | 39721 | 1185 | 23752 |
| 4L-3S | | MI | 10230 | 4356 | 16554 | 3076 | 17647 | 2590 | 18151 | 2184 | 18614 | 1553 | 21162 | 1119 | 12164 |
| 10-#14 | 2.13 | MA | 18475 | 4356 | 28378 | 3307 | 30596 | 2777 | 31431 | 2373 | 31721 | 1713 | 36791 | 1122 | 23191 |
| 5L-2S | | MI | 10472 | 4356 | 17266 | 3063 | 18560 | 2560 | 19265 | 2158 | 20129 | 1533 | 23182 | 1277 | 12117 |
| 10-#18 | 3.79 | MA | 21327 | 4841 | 35007 | 3545 | 39033 | 2933 | 41733 | 2462 | 45799 | 1638 | 55665 | 1093 | 41306 |
| 3L-4S | | MI | 10938 | 4841 | 17720 | 3403 | 19044 | 2808 | 19810 | 2313 | 20943 | 1534 | 24045 | 683 | 19798 |
| 10-#18 | 3.79 | MA | 20794 | 4841 | 33050 | 3616 | 36492 | 3000 | 38606 | 2491 | 41502 | 1661 | 50594 | 942 | 40335 |
| 4L-3S | | MI | 11120 | 4841 | 18672 | 3349 | 20277 | 2795 | 21323 | 2306 | 22914 | 1504 | 26423 | 826 | 20474 |
| 10-#18 | 3.79 | MA | 19996 | 4841 | 31411 | 3649 | 34318 | 3032 | 35885 | 2556 | 37687 | 1720 | 45426 | 822 | 37356 |
| 5L-2S | | MI | 11519 | 4841 | 19899 | 3330 | 21850 | 2747 | 23242 | 2263 | 25525 | 1473 | 29790 | 1108 | 20450 |
| 12-#10 | 1.44 | MA | 18803 | 4156 | 29498 | 3124 | 32202 | 2629 | 33502 | 2242 | 34665 | 1659 | 40299 | 1439 | 16485 |
| 2L-6S | | MI | 9608 | 4156 | 14863 | 3022 | 15550 | 2556 | 15615 | 2179 | 15171 | 1618 | 16878 | 1113 | 8654 |
| 12-#10 | 1.44 | MA | 18474 | 4156 | 28642 | 3137 | 31104 | 2641 | 32163 | 2264 | 32843 | 1680 | 37777 | 1364 | 16499 |
| 3L-5S | | MI | 9699 | 4156 | 15124 | 3016 | 15904 | 2549 | 16056 | 2174 | 15763 | 1604 | 17658 | 1172 | 8631 |
| 12-#10 | 1.44 | MA | 18283 | 4156 | 28005 | 3160 | 30277 | 2664 | 31145 | 2275 | 31443 | 1689 | 36151 | 1318 | 16496 |
| 4E | | MI | 9824 | 4156 | 15391 | 3008 | 16260 | 2531 | 16501 | 2157 | 16421 | 1602 | 18513 | 1223 | 8601 |
| 12-#10 | 1.44 | MA | 18011 | 4156 | 27457 | 3170 | 29571 | 2675 | 30261 | 2297 | 30202 | 1710 | 34482 | 1285 | 16453 |
| 5L-3S | | MI | 9897 | 4156 | 15710 | 2988 | 16673 | 2524 | 17008 | 2152 | 17082 | 1588 | 19366 | 1274 | 8571 |
| 12-#10 | 1.44 | MA | 17815 | 4156 | 26891 | 3176 | 28839 | 2695 | 29387 | 2308 | 29026 | 1730 | 32989 | 1235 | 16340 |
| 6L-2S | | MI | 10044 | 4156 | 16126 | 2980 | 17208 | 2506 | 17660 | 2135 | 17968 | 1574 | 20593 | 1363 | 8544 |
| 12-#11 | 1.77 | MA | 19287 | 4252 | 30673 | 3171 | 33635 | 2661 | 35217 | 2258 | 36977 | 1644 | 43485 | 1421 | 20029 |
| 2L-6S | | MI | 9735 | 4252 | 15137 | 3079 | 15853 | 2585 | 15955 | 2192 | 15617 | 1599 | 17432 | 1017 | 10256 |
| 12-#11 | 1.77 | MA | 18897 | 4252 | 29632 | 3186 | 32301 | 2675 | 33590 | 2285 | 34762 | 1668 | 40418 | 1328 | 20042 |
| 3L-5S | | MI | 9843 | 4252 | 15471 | 3057 | 16283 | 2578 | 16489 | 2187 | 16334 | 1584 | 18353 | 1087 | 10372 |
| 12-#11 | 1.77 | MA | 18670 | 4252 | 28856 | 3214 | 31292 | 2702 | 32348 | 2298 | 33056 | 1679 | 38427 | 1270 | 20017 |
| 4E | | MI | 9992 | 4252 | 15795 | 3048 | 16714 | 2557 | 17027 | 2167 | 17129 | 1582 | 19361 | 1149 | 10342 |
| 12-#11 | 1.77 | MA | 18343 | 4252 | 28194 | 3227 | 30431 | 2716 | 31270 | 2324 | 31544 | 1704 | 36387 | 1228 | 19925 |
| 5L-3S | | MI | 10075 | 4252 | 16180 | 3025 | 17213 | 2550 | 17640 | 2162 | 17927 | 1567 | 20371 | 1210 | 10306 |
| 12-#11 | 1.77 | MA | 18107 | 4252 | 27504 | 3233 | 29547 | 2741 | 30205 | 2337 | 30109 | 1728 | 34563 | 1165 | 19434 |
| 6L-2S | | MI | 10249 | 4252 | 16681 | 3016 | 17856 | 2528 | 18424 | 2143 | 18994 | 1552 | 21816 | 1320 | 10272 |
| 12-#14 | 2.56 | MA | 19934 | 4481 | 31926 | 3325 | 35188 | 2775 | 37088 | 2351 | 39508 | 1654 | 46977 | 1255 | 28493 |
| 3L-5S | | MI | 10209 | 4481 | 16254 | 3198 | 17234 | 2684 | 17624 | 2251 | 17859 | 1565 | 20358 | 920 | 14149 |
| 12-#14 | 2.56 | MA | 19619 | 4481 | 30813 | 3366 | 33742 | 2814 | 35309 | 2369 | 37062 | 1669 | 44111 | 1171 | 28372 |
| 4E | | MI | 10418 | 4481 | 16717 | 3186 | 17849 | 2655 | 18392 | 2225 | 18992 | 1564 | 21766 | 1011 | 14437 |
| 12-#14 | 2.56 | MA | 19158 | 4481 | 29869 | 3384 | 32507 | 2833 | 33762 | 2407 | 34892 | 1704 | 41181 | 1108 | 27735 |
| 5L-3S | | MI | 10532 | 4481 | 17266 | 3153 | 18560 | 2645 | 19265 | 2218 | 20129 | 1543 | 23182 | 1096 | 14410 |
| 12-#14 | 2.56 | MA | 18826 | 4481 | 28881 | 3393 | 31248 | 2869 | 32232 | 2424 | 32833 | 1738 | 38560 | 1015 | 26620 |
| 6L-2S | | MI | 10771 | 4481 | 17978 | 3141 | 19473 | 2616 | 20379 | 2192 | 21644 | 1523 | 25202 | 1255 | 14372 |
| 12-#18 | 4.55 | MA | 21955 | 5062 | 35660 | 3754 | 39838 | 3099 | 42689 | 2551 | 47056 | 1644 | 58284 | 918 | 48292 |
| 4E | | MI | 11452 | 5062 | 18947 | 3541 | 20617 | 2907 | 21729 | 2373 | 23554 | 1517 | 27412 | 631 | 23407 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

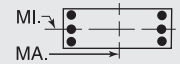


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 4.55 | MA | 21177 | 5062 | 34021 | 3788 | 37664 | 3132 | 39968 | 2616 | 43241 | 1702 | 53116 | 798 | 45357 |
| 5L-3S | | MI | 11632 | 5062 | 19899 | 3487 | 21850 | 2894 | 23242 | 2366 | 25525 | 1486 | 29790 | 774 | 24287 |
| 12-#18 | 4.55 | MA | 20614 | 5062 | 32288 | 3802 | 35484 | 3197 | 37276 | 2645 | 39618 | 1761 | 48492 | 627 | 42424 |
| 6L-2S | | MI | 12024 | 5062 | 21127 | 3468 | 23423 | 2846 | 25162 | 2324 | 28136 | 1455 | 33157 | 1055 | 24301 |
| 14-#10 | 1.68 | MA | 18867 | 4226 | 29498 | 3181 | 32202 | 2672 | 33502 | 2283 | 34665 | 1674 | 40299 | 1356 | 19175 |
| 3L-6S | | MI | 9790 | 4226 | 15280 | 3066 | 16084 | 2588 | 16267 | 2198 | 16058 | 1612 | 18105 | 1105 | 9955 |
| 14-#10 | 1.68 | MA | 18677 | 4226 | 28861 | 3204 | 31374 | 2695 | 32483 | 2294 | 33264 | 1684 | 38673 | 1310 | 19161 |
| 4L-5S | | MI | 9880 | 4226 | 15541 | 3060 | 16439 | 2581 | 16708 | 2193 | 16650 | 1598 | 18884 | 1164 | 9945 |
| 14-#10 | 1.68 | MA | 18407 | 4226 | 28313 | 3214 | 30669 | 2707 | 31600 | 2316 | 32024 | 1704 | 37003 | 1277 | 19110 |
| 5L-4S | | MI | 10004 | 4226 | 15808 | 3052 | 16795 | 2563 | 17153 | 2176 | 17308 | 1596 | 19739 | 1215 | 9921 |
| 14-#10 | 1.68 | MA | 18215 | 4226 | 27747 | 3220 | 29936 | 2727 | 30726 | 2327 | 30847 | 1725 | 35511 | 1227 | 18954 |
| 6L-3S | | MI | 10077 | 4226 | 16126 | 3032 | 17208 | 2556 | 17660 | 2171 | 17968 | 1582 | 20593 | 1266 | 9895 |
| 14-#10 | 1.68 | MA | 17996 | 4226 | 27142 | 3239 | 29203 | 2733 | 29859 | 2347 | 29630 | 1734 | 33776 | 1182 | 18462 |
| 7L-2S | | MI | 10223 | 4226 | 16543 | 3024 | 17742 | 2538 | 18312 | 2154 | 18855 | 1568 | 21820 | 1355 | 9870 |
| 14-#11 | 2.07 | MA | 19369 | 4338 | 30673 | 3240 | 33635 | 2713 | 35217 | 2308 | 36977 | 1661 | 43485 | 1318 | 23288 |
| 3L-6S | | MI | 9952 | 4338 | 15639 | 3133 | 16496 | 2624 | 16739 | 2216 | 16684 | 1592 | 18877 | 1004 | 11748 |
| 14-#11 | 2.07 | MA | 19145 | 4338 | 29897 | 3268 | 32626 | 2741 | 33976 | 2321 | 35271 | 1672 | 41493 | 1261 | 23252 |
| 4L-5S | | MI | 10059 | 4338 | 15972 | 3111 | 16926 | 2617 | 17273 | 2210 | 17401 | 1577 | 19799 | 1074 | 11944 |
| 14-#11 | 2.07 | MA | 18821 | 4338 | 29235 | 3281 | 31766 | 2755 | 32898 | 2348 | 33759 | 1697 | 39454 | 1218 | 23151 |
| 5L-4S | | MI | 10207 | 4338 | 16296 | 3102 | 17357 | 2596 | 17811 | 2191 | 18196 | 1576 | 20806 | 1136 | 11924 |
| 14-#11 | 2.07 | MA | 18590 | 4338 | 28545 | 3287 | 30882 | 2780 | 31832 | 2360 | 32323 | 1721 | 37630 | 1156 | 22620 |
| 6L-3S | | MI | 10290 | 4338 | 16681 | 3079 | 17856 | 2588 | 18424 | 2186 | 18994 | 1560 | 21816 | 1197 | 11895 |
| 14-#11 | 2.07 | MA | 18328 | 4338 | 27809 | 3310 | 29988 | 2787 | 30788 | 2385 | 30838 | 1732 | 35503 | 1099 | 22071 |
| 7L-2S | | MI | 10461 | 4338 | 17183 | 3070 | 18498 | 2567 | 19208 | 2166 | 20061 | 1545 | 23261 | 1307 | 11865 |
| 14-#14 | 2.98 | MA | 20290 | 4605 | 32303 | 3444 | 35652 | 2870 | 37639 | 2403 | 40233 | 1659 | 48502 | 1157 | 32992 |
| 4L-5S | | MI | 10514 | 4605 | 16967 | 3276 | 18147 | 2740 | 18738 | 2285 | 19374 | 1555 | 22378 | 898 | 16279 |
| 14-#14 | 2.98 | MA | 19837 | 4605 | 31359 | 3462 | 34417 | 2889 | 36093 | 2440 | 38063 | 1694 | 45572 | 1094 | 32288 |
| 5L-4S | | MI | 10720 | 4605 | 17429 | 3263 | 18762 | 2711 | 19505 | 2259 | 20507 | 1554 | 23786 | 989 | 16656 |
| 14-#14 | 2.98 | MA | 19513 | 4605 | 30371 | 3471 | 33158 | 2925 | 34563 | 2458 | 36004 | 1728 | 42951 | 1002 | 31209 |
| 6L-3S | | MI | 10833 | 4605 | 17978 | 3231 | 19473 | 2701 | 20379 | 2252 | 21644 | 1533 | 25202 | 1074 | 16649 |
| 14-#14 | 2.98 | MA | 19144 | 4605 | 29315 | 3504 | 31877 | 2935 | 33077 | 2494 | 33873 | 1743 | 39890 | 920 | 30083 |
| 7L-2S | | MI | 11069 | 4605 | 18690 | 3219 | 20386 | 2672 | 21492 | 2226 | 23160 | 1513 | 27222 | 1232 | 16619 |
| 14-#18 | 5.30 | MA | 22345 | 5283 | 36631 | 3926 | 41011 | 3231 | 44050 | 2676 | 48795 | 1685 | 60807 | 774 | 53358 |
| 5L-4S | | MI | 11965 | 5283 | 20174 | 3679 | 22190 | 3007 | 23648 | 2433 | 26165 | 1499 | 30779 | 578 | 27040 |
| 14-#18 | 5.30 | MA | 21803 | 5283 | 34898 | 3940 | 38830 | 3297 | 41358 | 2705 | 45172 | 1743 | 56182 | 602 | 50356 |
| 6L-3S | | MI | 12143 | 5283 | 21127 | 3625 | 23423 | 2994 | 25162 | 2426 | 28136 | 1468 | 33157 | 721 | 28092 |
| 14-#18 | 5.30 | MA | 21173 | 5283 | 33044 | 3997 | 36580 | 3313 | 38789 | 2770 | 41423 | 1767 | 50760 | 454 | 47438 |
| 7L-2S | | MI | 12527 | 5283 | 22354 | 3607 | 24996 | 2946 | 27081 | 2384 | 30747 | 1438 | 36524 | 1003 | 28144 |
| 16-#10 | 1.92 | MA | 19070 | 4296 | 29717 | 3248 | 32471 | 2727 | 33822 | 2313 | 35085 | 1678 | 41194 | 1302 | 21825 |
| 4L-6S | | MI | 9972 | 4296 | 15697 | 3110 | 16618 | 2619 | 16919 | 2217 | 16945 | 1607 | 19331 | 1098 | 11191 |
| 16-#10 | 1.92 | MA | 18802 | 4296 | 29169 | 3258 | 31766 | 2738 | 32938 | 2335 | 33845 | 1699 | 39525 | 1269 | 21767 |
| 5E | | MI | 10061 | 4296 | 15957 | 3104 | 16973 | 2612 | 17360 | 2212 | 17537 | 1593 | 20111 | 1157 | 11254 |
| 16-#10 | 1.92 | MA | 18612 | 4296 | 28602 | 3264 | 31033 | 2758 | 32065 | 2346 | 32668 | 1719 | 38033 | 1220 | 21572 |
| 6L-4S | | MI | 10184 | 4296 | 16225 | 3096 | 17329 | 2594 | 17805 | 2195 | 18194 | 1590 | 20966 | 1207 | 11236 |
| 16-#10 | 1.92 | MA | 18395 | 4296 | 27998 | 3283 | 30300 | 2765 | 31198 | 2366 | 31451 | 1729 | 36298 | 1174 | 21095 |
| 7L-3S | | MI | 10256 | 4296 | 16543 | 3076 | 17742 | 2587 | 18312 | 2190 | 18855 | 1577 | 21820 | 1258 | 11213 |
| 16-#10 | 1.92 | MA | 18161 | 4296 | 27471 | 3292 | 29570 | 2784 | 30296 | 2372 | 30304 | 1749 | 34784 | 1135 | 20744 |
| 8L-2S | | MI | 10401 | 4296 | 16960 | 3068 | 18276 | 2569 | 18964 | 2173 | 19742 | 1563 | 23047 | 1347 | 11191 |
| 16-#11 | 2.36 | MA | 19617 | 4425 | 30938 | 3322 | 33961 | 2780 | 35604 | 2345 | 37486 | 1665 | 44560 | 1251 | 26487 |
| 4L-6S | | MI | 10169 | 4425 | 16140 | 3187 | 17139 | 2663 | 17523 | 2239 | 17751 | 1586 | 20322 | 991 | 13266 |
| 16-#11 | 2.36 | MA | 19297 | 4425 | 30275 | 3335 | 33100 | 2793 | 34526 | 2371 | 35973 | 1690 | 42520 | 1209 | 26377 |
| 5E | | MI | 10274 | 4425 | 16474 | 3165 | 17568 | 2656 | 18057 | 2234 | 18468 | 1570 | 21244 | 1061 | 13513 |
| 16-#11 | 2.36 | MA | 19070 | 4425 | 29586 | 3341 | 32216 | 2818 | 33460 | 2384 | 34538 | 1714 | 40696 | 1146 | 25809 |
| 6L-4S | | MI | 10421 | 4425 | 16798 | 3156 | 17999 | 2634 | 18595 | 2215 | 19263 | 1569 | 22251 | 1123 | 13501 |
| 16-#11 | 2.36 | MA | 18810 | 4425 | 28850 | 3364 | 31322 | 2826 | 32416 | 2408 | 33053 | 1725 | 38570 | 1090 | 25278 |
| 7L-3S | | MI | 10503 | 4425 | 17183 | 3133 | 18498 | 2627 | 19208 | 2209 | 20061 | 1553 | 23261 | 1184 | 13478 |
| 16-#11 | 2.36 | MA | 18530 | 4425 | 28207 | 3375 | 30432 | 2849 | 31316 | 2416 | 31654 | 1749 | 36719 | 1040 | 24652 |
| 8L-2S | | MI | 10673 | 4425 | 17684 | 3124 | 19141 | 2606 | 19992 | 2190 | 21128 | 1538 | 24706 | 1294 | 13451 |

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

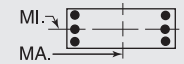
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.41 | MA | 20510 | 4730 | 32849 | 3540 | 36327 | 2945 | 38423 | 2474 | 41234 | 1684 | 49962 | 1080 | 36849 |
| 5E | | MI | 10817 | 4730 | 17679 | 3354 | 19060 | 2796 | 19852 | 2319 | 20889 | 1545 | 24398 | 876 | 18418 |
| 16-#14 | 3.41 | MA | 20195 | 4730 | 31861 | 3549 | 35068 | 2981 | 36894 | 2492 | 39175 | 1718 | 47341 | 988 | 35803 |
| 6L-4S | | MI | 11021 | 4730 | 18141 | 3341 | 19675 | 2767 | 20619 | 2293 | 22023 | 1544 | 25806 | 966 | 18870 |
| 16-#14 | 3.41 | MA | 19828 | 4730 | 30805 | 3582 | 33788 | 2991 | 35408 | 2527 | 37044 | 1733 | 44280 | 906 | 34642 |
| 7L-3S | | MI | 11133 | 4730 | 18690 | 3309 | 20386 | 2757 | 21492 | 2286 | 23160 | 1524 | 27222 | 1052 | 18881 |
| 16-#14 | 3.41 | MA | 19434 | 4730 | 29884 | 3597 | 32511 | 3024 | 33831 | 2538 | 35035 | 1767 | 41619 | 832 | 33277 |
| 8L-2S | | MI | 11366 | 4730 | 19402 | 3296 | 21299 | 2728 | 22606 | 2260 | 24675 | 1503 | 29242 | 1210 | 18859 |
| 16-#18 | 6.06 | MA | 22980 | 5505 | 37508 | 4079 | 42176 | 3396 | 45440 | 2766 | 50727 | 1726 | 63873 | 578 | 58288 |
| 6L-4S | | MI | 12475 | 5505 | 21401 | 3818 | 23763 | 3106 | 25567 | 2494 | 28776 | 1481 | 34146 | 526 | 30694 |
| 16-#18 | 6.06 | MA | 22355 | 5505 | 35654 | 4135 | 39926 | 3412 | 42871 | 2830 | 46978 | 1749 | 58451 | 430 | 55320 |
| 7L-3S | | MI | 12651 | 5505 | 22354 | 3764 | 24996 | 3093 | 27081 | 2487 | 30747 | 1451 | 36524 | 669 | 31892 |
| 18-#10 | 2.16 | MA | 19195 | 4366 | 30025 | 3302 | 32863 | 2770 | 34277 | 2355 | 35666 | 1693 | 42047 | 1262 | 24424 |
| 5L-6S | | MI | 10153 | 4366 | 16113 | 3154 | 17153 | 2651 | 17571 | 2236 | 17831 | 1601 | 20558 | 1090 | 12455 |
| 18-#10 | 2.16 | MA | 19008 | 4366 | 29458 | 3308 | 32131 | 2790 | 33403 | 2365 | 34490 | 1714 | 40555 | 1212 | 24195 |
| 6L-5S | | MI | 10241 | 4366 | 16374 | 3148 | 17507 | 2644 | 18012 | 2231 | 18424 | 1587 | 21338 | 1149 | 12560 |
| 18-#10 | 2.16 | MA | 18791 | 4366 | 28854 | 3327 | 31397 | 2796 | 32537 | 2385 | 33272 | 1723 | 38819 | 1167 | 23731 |
| 7L-4S | | MI | 10364 | 4366 | 16641 | 3140 | 17863 | 2626 | 18456 | 2214 | 19081 | 1585 | 22193 | 1199 | 12547 |
| 18-#10 | 2.16 | MA | 18562 | 4366 | 28327 | 3336 | 30667 | 2815 | 31634 | 2391 | 32125 | 1744 | 37306 | 1128 | 23389 |
| 8L-3S | | MI | 10435 | 4366 | 16960 | 3120 | 18276 | 2619 | 18964 | 2209 | 19742 | 1571 | 23047 | 1250 | 12528 |
| 18-#10 | 2.16 | MA | 18366 | 4366 | 27803 | 3344 | 29969 | 2824 | 30765 | 2410 | 30974 | 1763 | 35836 | 1087 | 22809 |
| 9L-2S | | MI | 10579 | 4366 | 17377 | 3112 | 18810 | 2601 | 19616 | 2192 | 20629 | 1557 | 24274 | 1340 | 12508 |
| 18-#11 | 2.66 | MA | 19770 | 4511 | 31316 | 3389 | 34434 | 2832 | 36154 | 2395 | 38188 | 1683 | 45587 | 1199 | 29604 |
| 5L-6S | | MI | 10385 | 4511 | 16641 | 3241 | 17782 | 2702 | 18308 | 2263 | 18818 | 1579 | 21767 | 978 | 14788 |
| 18-#11 | 2.66 | MA | 19547 | 4511 | 30627 | 3395 | 33550 | 2857 | 35088 | 2407 | 36753 | 1707 | 43763 | 1137 | 29003 |
| 6L-5S | | MI | 10489 | 4511 | 16975 | 3219 | 18211 | 2694 | 18841 | 2257 | 19535 | 1563 | 22689 | 1048 | 15041 |
| 18-#11 | 2.66 | MA | 19288 | 4511 | 29891 | 3418 | 32657 | 2864 | 34043 | 2432 | 35268 | 1718 | 41637 | 1080 | 28488 |
| 7L-4S | | MI | 10634 | 4511 | 17299 | 3210 | 18642 | 2673 | 19379 | 2238 | 20330 | 1562 | 23696 | 1110 | 15074 |
| 18-#11 | 2.66 | MA | 19015 | 4511 | 29248 | 3429 | 31767 | 2887 | 32944 | 2439 | 33868 | 1743 | 39786 | 1031 | 27853 |
| 8L-3S | | MI | 10716 | 4511 | 17684 | 3187 | 19141 | 2666 | 19992 | 2233 | 21128 | 1546 | 24706 | 1171 | 15056 |
| 18-#11 | 2.66 | MA | 18778 | 4511 | 28615 | 3439 | 30915 | 2898 | 31884 | 2462 | 32483 | 1767 | 37983 | 980 | 27050 |
| 9L-2S | | MI | 10884 | 4511 | 18185 | 3177 | 19784 | 2645 | 20777 | 2213 | 22195 | 1531 | 26151 | 1281 | 15033 |
| 18-#14 | 3.84 | MA | 20871 | 4854 | 33351 | 3627 | 36979 | 3037 | 39224 | 2526 | 42346 | 1708 | 51732 | 974 | 40401 |
| 6L-5S | | MI | 11118 | 4854 | 18391 | 3431 | 19973 | 2852 | 20965 | 2353 | 22405 | 1535 | 26418 | 854 | 20564 |
| 18-#14 | 3.84 | MA | 20507 | 4854 | 32296 | 3659 | 35698 | 3047 | 37738 | 2561 | 40215 | 1723 | 48671 | 892 | 39202 |
| 7L-4S | | MI | 11321 | 4854 | 18853 | 3419 | 20588 | 2822 | 21733 | 2327 | 23538 | 1534 | 27826 | 944 | 21081 |
| 18-#14 | 3.84 | MA | 20125 | 4854 | 31374 | 3675 | 34422 | 3079 | 36162 | 2572 | 38206 | 1757 | 46010 | 819 | 37847 |
| 8L-3S | | MI | 11432 | 4854 | 19402 | 3387 | 21299 | 2813 | 22606 | 2320 | 24675 | 1514 | 29242 | 1029 | 21108 |
| 18-#14 | 3.84 | MA | 19788 | 4854 | 30377 | 3709 | 33200 | 3094 | 34641 | 2603 | 36227 | 1792 | 43412 | 745 | 36252 |
| 9L-2S | | MI | 11663 | 4854 | 20115 | 3374 | 22212 | 2784 | 23720 | 2294 | 26191 | 1493 | 31262 | 1188 | 21094 |
| 18-#18 | 6.82 | MA | 23526 | 5726 | 38265 | 4274 | 43273 | 3511 | 46954 | 2891 | 52532 | 1731 | 66141 | 405 | 63201 |
| 7L-4S | | MI | 12984 | 5726 | 22628 | 3956 | 25336 | 3205 | 27486 | 2554 | 31387 | 1464 | 37513 | 473 | 34363 |
| 20-#10 | 2.41 | MA | 19402 | 4437 | 30314 | 3352 | 33228 | 2821 | 34742 | 2385 | 36311 | 1708 | 43076 | 1204 | 26820 |
| 6E | | MI | 10334 | 4437 | 16530 | 3198 | 17687 | 2682 | 18223 | 2256 | 18718 | 1595 | 21785 | 1082 | 13722 |
| 20-#10 | 2.41 | MA | 19186 | 4437 | 29710 | 3371 | 32494 | 2828 | 33875 | 2404 | 35093 | 1717 | 41341 | 1159 | 26368 |
| 7L-5S | | MI | 10421 | 4437 | 16791 | 3192 | 18041 | 2675 | 18664 | 2250 | 19310 | 1582 | 22565 | 1141 | 13864 |
| 20-#10 | 2.41 | MA | 18962 | 4437 | 29183 | 3380 | 31764 | 2847 | 32973 | 2410 | 33946 | 1738 | 39827 | 1120 | 26035 |
| 8L-4S | | MI | 10543 | 4437 | 17058 | 3184 | 18397 | 2657 | 19108 | 2234 | 19968 | 1579 | 23420 | 1191 | 13855 |
| 20-#10 | 2.41 | MA | 18768 | 4437 | 28659 | 3388 | 31066 | 2856 | 32104 | 2429 | 32795 | 1757 | 38358 | 1079 | 25445 |
| 9L-3S | | MI | 10614 | 4437 | 17377 | 3164 | 18810 | 2651 | 19616 | 2228 | 20629 | 1565 | 24274 | 1242 | 13840 |
| 20-#10 | 2.41 | MA | 18531 | 4437 | 28056 | 3406 | 30367 | 2876 | 31234 | 2438 | 31554 | 1763 | 36852 | 1046 | 24895 |
| 10L-2S | | MI | 10756 | 4437 | 17793 | 3156 | 19345 | 2632 | 20267 | 2212 | 21516 | 1552 | 25500 | 1332 | 13822 |
| 20-#11 | 2.95 | MA | 20021 | 4597 | 31668 | 3449 | 34885 | 2896 | 36716 | 2431 | 38968 | 1700 | 46830 | 1127 | 32201 |
| 6E | | MI | 10600 | 4597 | 17143 | 3295 | 18425 | 2740 | 19092 | 2286 | 19885 | 1572 | 23212 | 965 | 16312 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

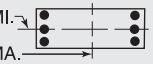



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.95 | MA | 19764 | 4597 | 30931 | 3472 | 33991 | 2903 | 35671 | 2455 | 37483 | 1711 | 44703 | 1071 | 31700 |
| 7L-5S | | MI | 10703 | 4597 | 17476 | 3273 | 18854 | 2733 | 19626 | 2281 | 20602 | 1556 | 24134 | 1035 | 16552 |
| 20-#11 | 2.95 | MA | 19497 | 4597 | 30289 | 3483 | 33101 | 2926 | 34572 | 2463 | 36083 | 1736 | 42852 | 1021 | 31052 |
| 8L-4S | | MI | 10847 | 4597 | 17800 | 3264 | 19285 | 2712 | 20164 | 2262 | 21397 | 1555 | 25141 | 1097 | 16644 |
| 20-#11 | 2.95 | MA | 19264 | 4597 | 29656 | 3493 | 32250 | 2936 | 33512 | 2485 | 34698 | 1760 | 41049 | 971 | 30253 |
| 9L-3S | | MI | 10928 | 4597 | 18185 | 3241 | 19784 | 2705 | 20777 | 2256 | 22195 | 1540 | 26151 | 1158 | 16631 |
| 20-#11 | 2.95 | MA | 18980 | 4597 | 28922 | 3514 | 31396 | 2961 | 32451 | 2495 | 33185 | 1767 | 39208 | 928 | 29352 |
| 10L-2S | | MI | 11095 | 4597 | 18687 | 3231 | 20427 | 2683 | 21561 | 2237 | 23262 | 1524 | 27596 | 1268 | 16612 |
| 20-#14 | 4.26 | MA | 21181 | 4979 | 33786 | 3737 | 37608 | 3103 | 40069 | 2595 | 43386 | 1713 | 53061 | 878 | 43761 |
| 7L-5S | | MI | 11419 | 4979 | 19103 | 3509 | 20886 | 2908 | 22079 | 2387 | 23920 | 1525 | 28438 | 831 | 22716 |
| 20-#14 | 4.26 | MA | 20815 | 4979 | 32864 | 3752 | 36332 | 3135 | 38492 | 2605 | 41377 | 1748 | 50401 | 805 | 42417 |
| 8L-4S | | MI | 11621 | 4979 | 19566 | 3497 | 21501 | 2878 | 22847 | 2361 | 25054 | 1524 | 29846 | 922 | 23290 |
| 20-#14 | 4.26 | MA | 20481 | 4979 | 31867 | 3787 | 35111 | 3150 | 36972 | 2637 | 39397 | 1782 | 47803 | 732 | 40799 |
| 9L-3S | | MI | 11731 | 4979 | 20115 | 3465 | 22212 | 2869 | 23720 | 2354 | 26191 | 1504 | 31262 | 1007 | 23327 |
| 22-#10 | 2.65 | MA | 19579 | 4507 | 30566 | 3415 | 33592 | 2859 | 35214 | 2423 | 36915 | 1712 | 43863 | 1151 | 29008 |
| 7L-6S | | MI | 10514 | 4507 | 16947 | 3242 | 18221 | 2714 | 18874 | 2275 | 19605 | 1590 | 23012 | 1074 | 14990 |
| 22-#10 | 2.65 | MA | 19359 | 4507 | 30039 | 3424 | 32862 | 2878 | 34312 | 2430 | 35768 | 1732 | 42349 | 1112 | 28683 |
| 8L-5S | | MI | 10600 | 4507 | 17208 | 3236 | 18576 | 2707 | 19315 | 2269 | 20197 | 1576 | 23792 | 1133 | 15163 |
| 22-#10 | 2.65 | MA | 19168 | 4507 | 29515 | 3431 | 32163 | 2887 | 33442 | 2448 | 34617 | 1751 | 40879 | 1072 | 28082 |
| 9L-4S | | MI | 10721 | 4507 | 17475 | 3227 | 18932 | 2689 | 19760 | 2253 | 20855 | 1573 | 24647 | 1183 | 15162 |
| 22-#10 | 2.65 | MA | 18932 | 4507 | 28912 | 3449 | 31464 | 2908 | 32572 | 2457 | 33376 | 1758 | 39374 | 1039 | 27533 |
| 10L-3S | | MI | 10792 | 4507 | 17793 | 3208 | 19345 | 2682 | 20267 | 2247 | 21516 | 1560 | 25500 | 1234 | 15150 |
| 22-#10 | 2.65 | MA | 18717 | 4507 | 28383 | 3457 | 30754 | 2915 | 31725 | 2477 | 32208 | 1776 | 37914 | 997 | 26808 |
| 11L-2S | | MI | 10933 | 4507 | 18210 | 3200 | 19879 | 2664 | 20919 | 2231 | 22402 | 1546 | 26727 | 1324 | 15134 |
| 22-#11 | 3.25 | MA | 20237 | 4683 | 31972 | 3526 | 35325 | 2942 | 37299 | 2479 | 39697 | 1704 | 47770 | 1061 | 34914 |
| 7L-6S | | MI | 10814 | 4683 | 17644 | 3348 | 19067 | 2779 | 19876 | 2310 | 20952 | 1565 | 24657 | 952 | 17839 |
| 22-#11 | 3.25 | MA | 19976 | 4683 | 31330 | 3537 | 34435 | 2965 | 36200 | 2486 | 38298 | 1729 | 45919 | 1011 | 34250 |
| 8L-5S | | MI | 10916 | 4683 | 17978 | 3327 | 19497 | 2772 | 20410 | 2304 | 21669 | 1550 | 25579 | 1022 | 18067 |
| 22-#11 | 3.25 | MA | 19747 | 4683 | 30697 | 3547 | 33584 | 2975 | 35140 | 2509 | 36913 | 1753 | 44116 | 961 | 33456 |
| 9L-4S | | MI | 11060 | 4683 | 18302 | 3318 | 19928 | 2751 | 20948 | 2285 | 22464 | 1548 | 26586 | 1084 | 18211 |
| 22-#11 | 3.25 | MA | 19465 | 4683 | 29963 | 3568 | 32731 | 3000 | 34079 | 2518 | 35400 | 1760 | 42275 | 919 | 32541 |
| 10L-3S | | MI | 11140 | 4683 | 18687 | 3295 | 20427 | 2743 | 21561 | 2280 | 23262 | 1533 | 27596 | 1145 | 18203 |
| 22-#11 | 3.25 | MA | 19205 | 4683 | 29318 | 3578 | 31874 | 3009 | 33045 | 2542 | 33976 | 1781 | 40489 | 866 | 31620 |
| 11L-2S | | MI | 11305 | 4683 | 19188 | 3285 | 21070 | 2722 | 22345 | 2260 | 24329 | 1517 | 29041 | 1255 | 18188 |
| 22-#14 | 4.69 | MA | 21491 | 5103 | 34355 | 3830 | 38242 | 3191 | 40823 | 2639 | 44548 | 1738 | 54791 | 791 | 46987 |
| 8L-5S | | MI | 11719 | 5103 | 19815 | 3587 | 21799 | 2964 | 23193 | 2421 | 25436 | 1515 | 30458 | 809 | 24873 |
| 22-#14 | 4.69 | MA | 21169 | 5103 | 33357 | 3864 | 37021 | 3205 | 39303 | 2671 | 42568 | 1772 | 52193 | 718 | 45346 |
| 9L-4S | | MI | 11919 | 5103 | 20278 | 3575 | 22414 | 2934 | 23961 | 2395 | 26569 | 1514 | 31866 | 899 | 25434 |
| 24-#10 | 2.89 | MA | 19754 | 4577 | 30895 | 3468 | 33959 | 2910 | 35650 | 2449 | 37589 | 1727 | 44871 | 1104 | 31332 |
| 8L-6S | | MI | 10694 | 4577 | 17364 | 3286 | 18755 | 2745 | 19526 | 2294 | 20492 | 1584 | 24239 | 1066 | 16261 |
| 24-#10 | 2.89 | MA | 19566 | 4577 | 30371 | 3475 | 33261 | 2919 | 34781 | 2468 | 36438 | 1746 | 43401 | 1064 | 30718 |
| 9L-5S | | MI | 10779 | 4577 | 17624 | 3280 | 19110 | 2738 | 19967 | 2288 | 21084 | 1570 | 25019 | 1125 | 16461 |
| 24-#10 | 2.89 | MA | 19331 | 4577 | 29768 | 3493 | 32561 | 2939 | 33911 | 2476 | 35197 | 1752 | 41896 | 1031 | 30171 |
| 10L-4S | | MI | 10899 | 4577 | 17892 | 3271 | 19466 | 2720 | 20412 | 2272 | 21742 | 1568 | 25874 | 1175 | 16466 |
| 24-#10 | 2.89 | MA | 19118 | 4577 | 29239 | 3501 | 31851 | 2946 | 33063 | 2496 | 34029 | 1770 | 40435 | 990 | 29437 |
| 11L-3S | | MI | 10970 | 4577 | 18210 | 3252 | 19879 | 2714 | 20919 | 2266 | 22402 | 1554 | 26727 | 1227 | 16457 |
| 24-#10 | 2.89 | MA | 18918 | 4577 | 28666 | 3521 | 31131 | 2965 | 32232 | 2516 | 32876 | 1789 | 38764 | 940 | 28723 |
| 12L-2S | | MI | 11110 | 4577 | 18627 | 3244 | 20413 | 2696 | 21571 | 2250 | 23289 | 1540 | 27954 | 1316 | 16444 |
| 24-#11 | 3.55 | MA | 20453 | 4770 | 32371 | 3591 | 35770 | 3003 | 37827 | 2510 | 40513 | 1722 | 48986 | 1002 | 37448 |
| 8L-6S | | MI | 11028 | 4770 | 18146 | 3402 | 19710 | 2818 | 20660 | 2333 | 22019 | 1558 | 26103 | 939 | 19368 |
| 24-#11 | 3.55 | MA | 20227 | 4770 | 31737 | 3601 | 34918 | 3014 | 36768 | 2532 | 39127 | 1746 | 47183 | 952 | 36659 |
| 9L-5S | | MI | 11129 | 4770 | 18479 | 3381 | 20140 | 2811 | 21194 | 2328 | 22736 | 1543 | 27024 | 1009 | 19585 |
| 24-#11 | 3.55 | MA | 19946 | 4770 | 31003 | 3622 | 34065 | 3039 | 35707 | 2542 | 37615 | 1753 | 45341 | 909 | 35730 |
| 10L-4S | | MI | 11271 | 4770 | 18803 | 3372 | 20571 | 2789 | 21732 | 2309 | 23531 | 1541 | 28031 | 1071 | 19771 |
| 24-#11 | 3.55 | MA | 19690 | 4770 | 30359 | 3631 | 33208 | 3048 | 34673 | 2566 | 36191 | 1774 | 43555 | 857 | 34795 |
| 11L-3S | | MI | 11352 | 4770 | 19188 | 3349 | 21070 | 2782 | 22345 | 2303 | 24329 | 1526 | 29041 | 1132 | 19774 |
| 24-#14 | 5.11 | MA | 21852 | 5228 | 34847 | 3942 | 38932 | 3261 | 41633 | 2705 | 45739 | 1762 | 56584 | 704 | 49893 |
| 9L-5S | | MI | 12019 | 5228 | 20527 | 3665 | 22712 | 3019 | 24307 | 2455 | 26951 | 1505 | 32478 | 787 | 27034 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

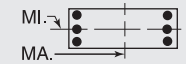
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.45 | MA | 20457 | 4346 | 32299 | 3233 | 35074 | 2720 | 36380 | 2319 | 37509 | 1714 | 43479 | 1486 | 17844 |
| 2E | | MI | 10400 | 4346 | 16844 | 3035 | 17767 | 2551 | 18106 | 2172 | 18258 | 1597 | 20277 | 1327 | 8798 |
| 6-#14 | 1.22 | MA | 20121 | 4277 | 31410 | 3209 | 34043 | 2706 | 35172 | 2314 | 35896 | 1731 | 41268 | 1504 | 15244 |
| 2L-3S | | MI | 10029 | 4277 | 15752 | 3041 | 16457 | 2581 | 16546 | 2207 | 16153 | 1645 | 17717 | 1226 | 7653 |
| 6-#14 | 1.22 | MA | 19512 | 4277 | 29842 | 3230 | 32033 | 2725 | 32719 | 2353 | 32559 | 1766 | 36649 | 1369 | 15283 |
| 3L-2S | | MI | 10279 | 4277 | 16464 | 3029 | 17370 | 2552 | 17660 | 2181 | 17669 | 1625 | 19737 | 1385 | 7593 |
| 6-#18 | 2.17 | MA | 21682 | 4568 | 35048 | 3371 | 38598 | 2819 | 40679 | 2379 | 43358 | 1696 | 51577 | 1461 | 26462 |
| 2L-3S | | MI | 10495 | 4568 | 16844 | 3192 | 17767 | 2699 | 18106 | 2274 | 18258 | 1610 | 20277 | 993 | 12834 |
| 6-#18 | 2.17 | MA | 20659 | 4568 | 32299 | 3407 | 35074 | 2852 | 36380 | 2445 | 37509 | 1756 | 43479 | 1216 | 26406 |
| 3L-2S | | MI | 10911 | 4568 | 18071 | 3173 | 19340 | 2651 | 20025 | 2232 | 20869 | 1579 | 23644 | 1275 | 12737 |
| 8-#11 | 1.13 | MA | 19982 | 4249 | 31035 | 3201 | 33619 | 2701 | 34679 | 2314 | 35241 | 1739 | 40374 | 1512 | 14173 |
| 2L-4S | | MI | 9968 | 4249 | 15413 | 3062 | 16065 | 2584 | 16082 | 2211 | 15568 | 1669 | 17068 | 1239 | 7174 |
| 8-#11 | 1.13 | MA | 19555 | 4249 | 29940 | 3216 | 32215 | 2715 | 32967 | 2341 | 32912 | 1764 | 37149 | 1420 | 14202 |
| 3E | | MI | 10053 | 4249 | 15798 | 3039 | 16564 | 2577 | 16695 | 2206 | 16366 | 1653 | 18078 | 1299 | 7126 |
| 8-#11 | 1.13 | MA | 19310 | 4249 | 29125 | 3245 | 31156 | 2743 | 31663 | 2354 | 31119 | 1775 | 35063 | 1362 | 14211 |
| 4L-2S | | MI | 10230 | 4249 | 16300 | 3030 | 17206 | 2555 | 17479 | 2187 | 17433 | 1638 | 19523 | 1409 | 7089 |
| 8-#14 | 1.63 | MA | 20830 | 4402 | 32978 | 3287 | 36053 | 2761 | 37624 | 2348 | 39232 | 1721 | 45888 | 1490 | 20164 |
| 2L-4S | | MI | 10218 | 4402 | 15915 | 3152 | 16659 | 2647 | 16787 | 2247 | 16532 | 1656 | 18320 | 1119 | 10000 |
| 8-#14 | 1.63 | MA | 20234 | 4402 | 31410 | 3308 | 34043 | 2781 | 35172 | 2386 | 35896 | 1756 | 41268 | 1355 | 20182 |
| 3E | | MI | 10334 | 4402 | 16464 | 3119 | 17370 | 2637 | 17660 | 2241 | 17669 | 1635 | 19737 | 1204 | 9939 |
| 8-#14 | 1.63 | MA | 19888 | 4402 | 30240 | 3349 | 32524 | 2821 | 33301 | 2405 | 33325 | 1772 | 38266 | 1272 | 20104 |
| 4L-2S | | MI | 10580 | 4402 | 17177 | 3107 | 18283 | 2608 | 18774 | 2215 | 19184 | 1615 | 21757 | 1362 | 9883 |
| 8-#18 | 2.90 | MA | 22894 | 4789 | 37797 | 3509 | 42121 | 2919 | 44977 | 2439 | 49206 | 1679 | 59675 | 1437 | 35055 |
| 2L-4S | | MI | 10828 | 4789 | 17118 | 3384 | 18106 | 2811 | 18511 | 2342 | 18899 | 1623 | 21267 | 798 | 16402 |
| 8-#18 | 2.90 | MA | 21905 | 4789 | 35048 | 3545 | 38598 | 2952 | 40679 | 2505 | 43358 | 1739 | 51577 | 1192 | 34937 |
| 3E | | MI | 11013 | 4789 | 18071 | 3330 | 19340 | 2798 | 20025 | 2335 | 20869 | 1592 | 23644 | 941 | 16698 |
| 8-#18 | 2.90 | MA | 21323 | 4789 | 32991 | 3617 | 35925 | 3020 | 37391 | 2535 | 38840 | 1763 | 46263 | 1042 | 34330 |
| 4L-2S | | MI | 11420 | 4789 | 19298 | 3312 | 20913 | 2750 | 21944 | 2292 | 23480 | 1562 | 27011 | 1222 | 16632 |
| 10-#10 | 1.15 | MA | 20051 | 4255 | 31085 | 3218 | 33760 | 2715 | 34887 | 2326 | 35547 | 1747 | 40815 | 1518 | 14486 |
| 2L-5S | | MI | 9924 | 4255 | 15326 | 3096 | 16006 | 2623 | 16030 | 2246 | 15451 | 1683 | 17032 | 1244 | 7336 |
| 10-#10 | 1.15 | MA | 19698 | 4255 | 30185 | 3231 | 32607 | 2727 | 33479 | 2348 | 33632 | 1768 | 38163 | 1444 | 14505 |
| 3L-4S | | MI | 10050 | 4255 | 15594 | 3087 | 16362 | 2605 | 16474 | 2230 | 16109 | 1680 | 17887 | 1295 | 7297 |
| 10-#10 | 1.15 | MA | 19494 | 4255 | 29517 | 3255 | 31738 | 2750 | 32410 | 2359 | 32161 | 1777 | 36461 | 1398 | 14513 |
| 4L-3S | | MI | 10124 | 4255 | 15912 | 3068 | 16775 | 2598 | 16982 | 2224 | 16770 | 1667 | 18741 | 1346 | 7263 |
| 10-#10 | 1.15 | MA | 19203 | 4255 | 28939 | 3265 | 30998 | 2762 | 31482 | 2381 | 30859 | 1798 | 34710 | 1366 | 14482 |
| 5L-2S | | MI | 10273 | 4255 | 16329 | 3060 | 17310 | 2580 | 17633 | 2208 | 17656 | 1653 | 19968 | 1435 | 7236 |
| 10-#11 | 1.41 | MA | 20481 | 4335 | 32130 | 3255 | 35022 | 2740 | 36391 | 2337 | 37571 | 1732 | 43600 | 1502 | 17610 |
| 2L-5S | | MI | 10034 | 4335 | 15591 | 3126 | 16276 | 2644 | 16328 | 2254 | 15839 | 1663 | 17506 | 1163 | 8826 |
| 10-#11 | 1.41 | MA | 20060 | 4335 | 31035 | 3270 | 33619 | 2754 | 34679 | 2364 | 35241 | 1757 | 40374 | 1410 | 17630 |
| 3L-4S | | MI | 10184 | 4335 | 15915 | 3116 | 16707 | 2623 | 16866 | 2235 | 16634 | 1662 | 18513 | 1226 | 8782 |
| 10-#11 | 1.41 | MA | 19817 | 4335 | 30220 | 3299 | 32559 | 2782 | 33375 | 2377 | 33449 | 1768 | 38289 | 1353 | 17621 |
| 4L-3S | | MI | 10268 | 4335 | 16300 | 3093 | 17206 | 2615 | 17479 | 2230 | 17433 | 1646 | 19523 | 1286 | 8739 |
| 10-#11 | 1.41 | MA | 19467 | 4335 | 29521 | 3311 | 31656 | 2796 | 32243 | 2404 | 31860 | 1793 | 36149 | 1312 | 17542 |
| 5L-2S | | MI | 10444 | 4335 | 16801 | 3084 | 17849 | 2594 | 18264 | 2210 | 18500 | 1631 | 20968 | 1396 | 8702 |
| 10-#14 | 2.04 | MA | 21533 | 4526 | 34546 | 3365 | 38064 | 2817 | 40076 | 2382 | 42569 | 1711 | 50508 | 1476 | 25074 |
| 2L-5S | | MI | 10311 | 4526 | 16165 | 3242 | 16957 | 2732 | 17133 | 2308 | 16914 | 1646 | 18932 | 1006 | 12142 |
| 10-#14 | 2.04 | MA | 20950 | 4526 | 32978 | 3386 | 36053 | 2837 | 37624 | 2420 | 39232 | 1747 | 45888 | 1341 | 25069 |
| 3L-4S | | MI | 10523 | 4526 | 16628 | 3229 | 17572 | 2703 | 17900 | 2281 | 18047 | 1646 | 20340 | 1096 | 12247 |
| 10-#14 | 2.04 | MA | 20609 | 4526 | 31808 | 3427 | 34534 | 2877 | 35754 | 2439 | 36661 | 1762 | 42886 | 1259 | 24967 |
| 4L-3S | | MI | 10637 | 4526 | 17177 | 3197 | 18283 | 2693 | 18774 | 2275 | 19184 | 1625 | 21757 | 1182 | 12202 |
| 10-#14 | 2.04 | MA | 20114 | 4526 | 30811 | 3445 | 33237 | 2896 | 34129 | 2477 | 34382 | 1797 | 39812 | 1197 | 24501 |
| 5L-2S | | MI | 10880 | 4526 | 17889 | 3185 | 19196 | 2664 | 19887 | 2248 | 20700 | 1605 | 23777 | 1340 | 12154 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

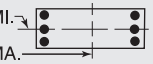


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.62 | MA | 23136 | 5010 | 37797 | 3684 | 42121 | 3051 | 44977 | 2565 | 49206 | 1721 | 59675 | 1167 | 43466 |
| 3L-4S | | MI | 11345 | 5010 | 18345 | 3523 | 19680 | 2910 | 20430 | 2402 | 21510 | 1605 | 24634 | 745 | 19974 |
| 10-#18 | 3.62 | MA | 22566 | 5010 | 35740 | 3755 | 39449 | 3120 | 41690 | 2596 | 44688 | 1746 | 54361 | 1018 | 42726 |
| 4L-3S | | MI | 11527 | 5010 | 19298 | 3469 | 20913 | 2897 | 21944 | 2395 | 23480 | 1575 | 27011 | 888 | 20537 |
| 10-#18 | 3.62 | MA | 21722 | 5010 | 34006 | 3789 | 37165 | 3153 | 38831 | 2661 | 40678 | 1806 | 48937 | 902 | 39457 |
| 5L-2S | | MI | 11927 | 5010 | 20525 | 3450 | 22486 | 2849 | 23863 | 2353 | 26091 | 1544 | 30378 | 1170 | 20502 |
| 12-#10 | 1.38 | MA | 20463 | 4325 | 31985 | 3262 | 34914 | 2747 | 36294 | 2345 | 37462 | 1741 | 43466 | 1510 | 17308 |
| 2L-6S | | MI | 10015 | 4325 | 15482 | 3146 | 16186 | 2661 | 16240 | 2271 | 15746 | 1691 | 17479 | 1177 | 8687 |
| 12-#10 | 1.38 | MA | 20115 | 4325 | 31085 | 3275 | 33760 | 2759 | 34887 | 2367 | 35547 | 1762 | 40815 | 1437 | 17322 |
| 3L-5S | | MI | 10106 | 4325 | 15743 | 3140 | 16541 | 2655 | 16681 | 2265 | 16338 | 1677 | 18259 | 1236 | 8660 |
| 12-#10 | 1.38 | MA | 19912 | 4325 | 30417 | 3299 | 32892 | 2782 | 33817 | 2378 | 34076 | 1772 | 39112 | 1390 | 17319 |
| 4E | | MI | 10231 | 4325 | 16010 | 3131 | 16897 | 2637 | 17126 | 2249 | 16996 | 1675 | 19114 | 1287 | 8628 |
| 12-#10 | 1.38 | MA | 19624 | 4325 | 29839 | 3309 | 32151 | 2794 | 32889 | 2400 | 32774 | 1793 | 37362 | 1358 | 17276 |
| 5L-3S | | MI | 10304 | 4325 | 16329 | 3112 | 17310 | 2630 | 17633 | 2243 | 17656 | 1661 | 19968 | 1338 | 8597 |
| 12-#10 | 1.38 | MA | 19417 | 4325 | 29244 | 3314 | 31378 | 2814 | 31973 | 2412 | 31539 | 1813 | 35797 | 1309 | 17167 |
| 6L-2S | | MI | 10452 | 4325 | 16746 | 3104 | 17844 | 2612 | 18285 | 2227 | 18543 | 1647 | 21195 | 1427 | 8570 |
| 12-#11 | 1.70 | MA | 20977 | 4422 | 33225 | 3309 | 36426 | 2779 | 38103 | 2361 | 39900 | 1725 | 46825 | 1493 | 21040 |
| 2L-6S | | MI | 10143 | 4422 | 15759 | 3201 | 16490 | 2690 | 16579 | 2283 | 16189 | 1672 | 18030 | 1080 | 10337 |
| 12-#11 | 1.70 | MA | 20562 | 4422 | 32130 | 3324 | 35022 | 2793 | 36391 | 2388 | 37571 | 1750 | 43600 | 1401 | 21053 |
| 3L-5S | | MI | 10250 | 4422 | 16092 | 3180 | 16919 | 2682 | 17112 | 2278 | 16906 | 1656 | 18951 | 1150 | 10409 |
| 12-#11 | 1.70 | MA | 20321 | 4422 | 31315 | 3353 | 33963 | 2821 | 35087 | 2401 | 35778 | 1762 | 41514 | 1343 | 21028 |
| 4E | | MI | 10400 | 4422 | 16416 | 3170 | 17350 | 2661 | 17651 | 2258 | 17701 | 1655 | 19958 | 1213 | 10376 |
| 12-#11 | 1.70 | MA | 19975 | 4422 | 30616 | 3365 | 33059 | 2835 | 33955 | 2428 | 34190 | 1787 | 39375 | 1302 | 20936 |
| 5L-3S | | MI | 10483 | 4422 | 16801 | 3147 | 17849 | 2654 | 18264 | 2253 | 18500 | 1640 | 20968 | 1273 | 10338 |
| 12-#11 | 1.70 | MA | 19726 | 4422 | 29891 | 3372 | 32125 | 2859 | 32836 | 2441 | 32683 | 1811 | 37462 | 1240 | 20488 |
| 6L-2S | | MI | 10657 | 4422 | 17303 | 3138 | 18492 | 2633 | 19048 | 2234 | 19566 | 1624 | 22413 | 1383 | 10304 |
| 12-#14 | 2.45 | MA | 21660 | 4651 | 34546 | 3463 | 38064 | 2893 | 40076 | 2454 | 42569 | 1737 | 50508 | 1328 | 29951 |
| 3L-5S | | MI | 10617 | 4651 | 16877 | 3320 | 17870 | 2788 | 18247 | 2342 | 18429 | 1636 | 20952 | 984 | 14259 |
| 12-#14 | 2.45 | MA | 21324 | 4651 | 33376 | 3505 | 36544 | 2932 | 38206 | 2473 | 39998 | 1752 | 47506 | 1245 | 29830 |
| 4E | | MI | 10826 | 4651 | 17340 | 3307 | 18485 | 2759 | 19014 | 2315 | 19563 | 1636 | 22360 | 1074 | 14482 |
| 12-#14 | 2.45 | MA | 20837 | 4651 | 32379 | 3523 | 35247 | 2952 | 36582 | 2511 | 37719 | 1787 | 44432 | 1183 | 29287 |
| 5L-3S | | MI | 10939 | 4651 | 17889 | 3275 | 19196 | 2749 | 19887 | 2309 | 20700 | 1615 | 23777 | 1159 | 14452 |
| 12-#14 | 2.45 | MA | 20486 | 4651 | 31340 | 3532 | 33916 | 2988 | 34975 | 2529 | 35556 | 1822 | 41683 | 1092 | 28071 |
| 6L-2S | | MI | 11179 | 4651 | 18601 | 3262 | 20109 | 2720 | 21001 | 2282 | 22215 | 1595 | 25797 | 1318 | 14411 |
| 12-#18 | 4.35 | MA | 23794 | 5232 | 38488 | 3893 | 42973 | 3219 | 45988 | 2656 | 50537 | 1728 | 62459 | 993 | 51117 |
| 4E | | MI | 11860 | 5232 | 19573 | 3661 | 21253 | 3010 | 22349 | 2462 | 24121 | 1588 | 28001 | 693 | 23579 |
| 12-#18 | 4.35 | MA | 22970 | 5232 | 36755 | 3927 | 40689 | 3252 | 43129 | 2722 | 46527 | 1788 | 57035 | 877 | 47883 |
| 5L-3S | | MI | 12040 | 5232 | 20525 | 3607 | 22486 | 2997 | 23863 | 2455 | 26091 | 1557 | 30378 | 836 | 24355 |
| 12-#18 | 4.35 | MA | 22375 | 5232 | 34931 | 3942 | 38380 | 3317 | 40301 | 2752 | 42720 | 1848 | 52183 | 709 | 44956 |
| 6L-2S | | MI | 12433 | 5232 | 21752 | 3588 | 24059 | 2949 | 25782 | 2413 | 28702 | 1526 | 33745 | 1117 | 24357 |
| 14-#10 | 1.61 | MA | 20529 | 4396 | 31985 | 3319 | 34914 | 2790 | 36294 | 2386 | 37462 | 1756 | 43466 | 1429 | 20135 |
| 3L-6S | | MI | 10198 | 4396 | 15899 | 3189 | 16720 | 2693 | 16892 | 2290 | 16633 | 1685 | 18706 | 1170 | 9995 |
| 14-#10 | 1.61 | MA | 20328 | 4396 | 31317 | 3342 | 34045 | 2813 | 35224 | 2397 | 35991 | 1766 | 41763 | 1383 | 20121 |
| 4L-5S | | MI | 10287 | 4396 | 16160 | 3184 | 17075 | 2686 | 17333 | 2285 | 17225 | 1672 | 19486 | 1229 | 9976 |
| 14-#10 | 1.61 | MA | 20043 | 4396 | 30739 | 3353 | 33305 | 2825 | 34297 | 2420 | 34689 | 1787 | 40013 | 1351 | 20070 |
| 5L-4S | | MI | 10412 | 4396 | 16427 | 3175 | 17431 | 2668 | 17778 | 2268 | 17882 | 1669 | 20341 | 1279 | 9950 |
| 14-#10 | 1.61 | MA | 19839 | 4396 | 30143 | 3358 | 32532 | 2845 | 33380 | 2431 | 33454 | 1808 | 38448 | 1302 | 19955 |
| 6L-3S | | MI | 10484 | 4396 | 16746 | 3156 | 17844 | 2661 | 18285 | 2263 | 18543 | 1655 | 21195 | 1330 | 9923 |
| 14-#10 | 1.61 | MA | 19606 | 4396 | 29509 | 3378 | 31761 | 2852 | 32465 | 2450 | 32176 | 1817 | 36632 | 1257 | 19435 |
| 7L-2S | | MI | 10631 | 4396 | 17162 | 3147 | 18378 | 2643 | 18937 | 2246 | 19430 | 1642 | 22421 | 1419 | 9897 |
| 14-#11 | 1.98 | MA | 21062 | 4508 | 33225 | 3378 | 36426 | 2831 | 38103 | 2411 | 39900 | 1743 | 46825 | 1391 | 24468 |
| 3L-6S | | MI | 10360 | 4508 | 16260 | 3255 | 17132 | 2729 | 17363 | 2307 | 17256 | 1665 | 19475 | 1067 | 11829 |
| 14-#11 | 1.98 | MA | 20823 | 4508 | 32410 | 3407 | 35366 | 2859 | 36799 | 2424 | 38108 | 1755 | 44740 | 1334 | 24432 |
| 4L-5S | | MI | 10466 | 4508 | 16594 | 3234 | 17562 | 2721 | 17897 | 2301 | 17973 | 1650 | 20396 | 1137 | 11985 |
| 14-#11 | 1.98 | MA | 20480 | 4508 | 31710 | 3419 | 34463 | 2873 | 35667 | 2451 | 36519 | 1780 | 42601 | 1293 | 24330 |
| 5L-4S | | MI | 10614 | 4508 | 16918 | 3224 | 17993 | 2700 | 18435 | 2282 | 18768 | 1648 | 21403 | 1200 | 11961 |
| 14-#11 | 1.98 | MA | 20236 | 4508 | 30986 | 3426 | 33529 | 2898 | 34549 | 2464 | 35013 | 1805 | 40688 | 1231 | 23840 |
| 6L-3S | | MI | 10697 | 4508 | 17303 | 3201 | 18492 | 2693 | 19048 | 2277 | 19566 | 1633 | 22413 | 1260 | 11929 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

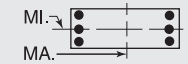
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.98 | MA | 19958 | 4508 | 30212 | 3449 | 32590 | 2906 | 33444 | 2488 | 33454 | 1816 | 38462 | 1175 | 23244 |
| 7L-2S | | MI | 10869 | 4508 | 17804 | 3192 | 19135 | 2672 | 19832 | 2257 | 20633 | 1617 | 23858 | 1370 | 11898 |
| 14-#14 | 2.85 | MA | 22033 | 4775 | 34944 | 3582 | 38554 | 2988 | 40658 | 2506 | 43335 | 1742 | 52126 | 1231 | 34693 |
| 4L-5S | | MI | 10921 | 4775 | 17589 | 3397 | 18783 | 2844 | 19360 | 2376 | 19945 | 1627 | 22972 | 961 | 16388 |
| 14-#14 | 2.85 | MA | 21553 | 4775 | 33947 | 3601 | 37257 | 3008 | 39034 | 2545 | 41055 | 1777 | 49052 | 1169 | 34081 |
| 5L-4S | | MI | 11128 | 4775 | 18052 | 3385 | 19398 | 2814 | 20128 | 2349 | 21078 | 1626 | 24380 | 1052 | 16709 |
| 14-#14 | 2.85 | MA | 21211 | 4775 | 32908 | 3610 | 35926 | 3044 | 37428 | 2563 | 38893 | 1813 | 46303 | 1079 | 32903 |
| 6L-3S | | MI | 11241 | 4775 | 18601 | 3353 | 20109 | 2805 | 21001 | 2343 | 22215 | 1605 | 25797 | 1137 | 16693 |
| 14-#14 | 2.85 | MA | 20818 | 4775 | 31799 | 3643 | 34580 | 3054 | 35855 | 2598 | 36655 | 1828 | 43097 | 997 | 31813 |
| 7L-2S | | MI | 11478 | 4775 | 19313 | 3340 | 21022 | 2776 | 22115 | 2316 | 23730 | 1585 | 27817 | 1295 | 16660 |
| 14-#18 | 5.07 | MA | 24205 | 5453 | 39503 | 4065 | 44213 | 3351 | 47428 | 2782 | 52375 | 1770 | 65133 | 853 | 56308 |
| 5L-4S | | MI | 12372 | 5453 | 20800 | 3799 | 22826 | 3109 | 24268 | 2523 | 26732 | 1570 | 31368 | 641 | 27209 |
| 14-#18 | 5.07 | MA | 23632 | 5453 | 37680 | 4080 | 41904 | 3417 | 44599 | 2812 | 48569 | 1830 | 60281 | 685 | 53310 |
| 6L-3S | | MI | 12550 | 5453 | 21752 | 3745 | 24059 | 3096 | 25782 | 2516 | 28702 | 1539 | 33745 | 783 | 28163 |
| 14-#18 | 5.07 | MA | 22960 | 5453 | 35730 | 4138 | 39538 | 3433 | 41877 | 2876 | 44629 | 1855 | 54602 | 538 | 50373 |
| 7L-2S | | MI | 12936 | 5453 | 22979 | 3727 | 25632 | 3048 | 27701 | 2473 | 31314 | 1509 | 37112 | 1065 | 28205 |
| 16-#10 | 1.84 | MA | 20742 | 4466 | 32216 | 3386 | 35199 | 2845 | 36632 | 2416 | 37906 | 1760 | 44414 | 1375 | 22922 |
| 4L-6S | | MI | 10379 | 4466 | 16316 | 3233 | 17255 | 2725 | 17544 | 2309 | 17519 | 1680 | 19933 | 1162 | 11290 |
| 16-#10 | 1.84 | MA | 20459 | 4466 | 31638 | 3396 | 34458 | 2857 | 35704 | 2439 | 36603 | 1781 | 42664 | 1343 | 22864 |
| 5E | | MI | 10468 | 4466 | 16577 | 3227 | 17609 | 2718 | 17985 | 2304 | 18112 | 1666 | 20713 | 1221 | 11288 |
| 16-#10 | 1.84 | MA | 20259 | 4466 | 31043 | 3402 | 33685 | 2877 | 34787 | 2450 | 35368 | 1802 | 41099 | 1294 | 22726 |
| 6L-4S | | MI | 10592 | 4466 | 16844 | 3219 | 17965 | 2700 | 18430 | 2287 | 18769 | 1663 | 21568 | 1271 | 11267 |
| 16-#10 | 1.84 | MA | 20027 | 4466 | 30409 | 3421 | 32915 | 2883 | 33872 | 2469 | 34091 | 1812 | 39283 | 1249 | 22205 |
| 7L-3S | | MI | 10664 | 4466 | 17162 | 3200 | 18378 | 2693 | 18937 | 2282 | 19430 | 1650 | 22421 | 1322 | 11243 |
| 16-#10 | 1.84 | MA | 19780 | 4466 | 29856 | 3431 | 32148 | 2902 | 32924 | 2476 | 32887 | 1833 | 37696 | 1211 | 21827 |
| 8L-2S | | MI | 10809 | 4466 | 17579 | 3191 | 18913 | 2675 | 19589 | 2265 | 20317 | 1636 | 23648 | 1412 | 11219 |
| 16-#11 | 2.26 | MA | 21321 | 4594 | 33504 | 3461 | 36770 | 2898 | 38511 | 2448 | 40437 | 1748 | 47965 | 1324 | 27835 |
| 4L-6S | | MI | 10576 | 4594 | 16761 | 3309 | 17775 | 2767 | 18147 | 2330 | 18323 | 1658 | 20920 | 1054 | 13346 |
| 16-#11 | 2.26 | MA | 20983 | 4594 | 32805 | 3473 | 35866 | 2912 | 37380 | 2475 | 38849 | 1773 | 45826 | 1283 | 27725 |
| 5E | | MI | 10682 | 4594 | 17095 | 3287 | 18205 | 2760 | 18681 | 2325 | 19040 | 1643 | 21841 | 1124 | 13556 |
| 16-#11 | 2.26 | MA | 20743 | 4594 | 32080 | 3480 | 34932 | 2937 | 36261 | 2488 | 37342 | 1798 | 43913 | 1221 | 27197 |
| 6L-4S | | MI | 10828 | 4594 | 17419 | 3278 | 18636 | 2739 | 19219 | 2306 | 19835 | 1641 | 22848 | 1187 | 13540 |
| 16-#11 | 2.26 | MA | 20466 | 4594 | 31307 | 3503 | 33993 | 2944 | 35156 | 2512 | 35783 | 1809 | 41687 | 1165 | 26619 |
| 7L-3S | | MI | 10911 | 4594 | 17804 | 3255 | 19135 | 2731 | 19832 | 2300 | 20633 | 1626 | 23858 | 1247 | 13514 |
| 16-#11 | 2.26 | MA | 20170 | 4594 | 30632 | 3514 | 33058 | 2968 | 34001 | 2520 | 34314 | 1834 | 39747 | 1117 | 26032 |
| 8L-2S | | MI | 11081 | 4594 | 18306 | 3246 | 19778 | 2710 | 20616 | 2281 | 21700 | 1610 | 25303 | 1357 | 13486 |
| 16-#14 | 3.26 | MA | 22265 | 4900 | 35515 | 3679 | 39267 | 3064 | 41486 | 2579 | 44392 | 1767 | 53672 | 1156 | 38883 |
| 5E | | MI | 11224 | 4900 | 18302 | 3475 | 19696 | 2900 | 20474 | 2410 | 21460 | 1617 | 24992 | 939 | 18526 |
| 16-#14 | 3.26 | MA | 21931 | 4900 | 34476 | 3688 | 37936 | 3100 | 39880 | 2597 | 42229 | 1803 | 50923 | 1065 | 37739 |
| 6L-4S | | MI | 11429 | 4900 | 18764 | 3463 | 20311 | 2870 | 21242 | 2383 | 22593 | 1616 | 26401 | 1030 | 18926 |
| 16-#14 | 3.26 | MA | 21541 | 4900 | 33367 | 3721 | 36590 | 3110 | 38308 | 2632 | 39992 | 1818 | 47717 | 984 | 36611 |
| 7L-3S | | MI | 11541 | 4900 | 19313 | 3430 | 21022 | 2861 | 22115 | 2377 | 23730 | 1595 | 27817 | 1115 | 18927 |
| 16-#14 | 3.26 | MA | 21123 | 4900 | 32399 | 3736 | 35249 | 3143 | 36651 | 2642 | 37883 | 1853 | 44927 | 912 | 35140 |
| 8L-2S | | MI | 11775 | 4900 | 20025 | 3418 | 21935 | 2831 | 23229 | 2350 | 25246 | 1575 | 29837 | 1273 | 18902 |
| 16-#18 | 5.80 | MA | 24876 | 5674 | 40428 | 4219 | 45427 | 3516 | 48898 | 2873 | 54417 | 1813 | 68379 | 660 | 61663 |
| 6L-4S | | MI | 12883 | 5674 | 22027 | 3937 | 24399 | 3208 | 26187 | 2583 | 29343 | 1552 | 34735 | 588 | 30859 |
| 16-#18 | 5.80 | MA | 24210 | 5674 | 38479 | 4276 | 43062 | 3533 | 46176 | 2936 | 50478 | 1837 | 62700 | 513 | 58690 |
| 7L-3S | | MI | 13059 | 5674 | 22979 | 3884 | 25632 | 3195 | 27701 | 2576 | 31314 | 1522 | 37112 | 731 | 31965 |
| 16-#18 | 5.80 | MA | 23498 | 5674 | 36775 | 4302 | 40703 | 3590 | 43263 | 2953 | 46764 | 1897 | 57772 | 379 | 54731 |
| 8L-2S | | MI | 13439 | 5674 | 24206 | 3865 | 27205 | 3147 | 29620 | 2534 | 33925 | 1491 | 40479 | 1012 | 32031 |
| 18-#10 | 2.07 | MA | 20874 | 4536 | 32538 | 3440 | 35612 | 2888 | 37111 | 2458 | 38518 | 1776 | 45315 | 1335 | 25658 |
| 5L-6S | | MI | 10561 | 4536 | 16733 | 3277 | 17789 | 2756 | 18196 | 2328 | 18406 | 1674 | 21160 | 1154 | 12524 |
| 18-#10 | 2.07 | MA | 20677 | 4536 | 31943 | 3446 | 34839 | 2908 | 36194 | 2469 | 37283 | 1797 | 43750 | 1286 | 25484 |
| 6L-5S | | MI | 10648 | 4536 | 16993 | 3271 | 18144 | 2749 | 18637 | 2323 | 18999 | 1660 | 21940 | 1213 | 12596 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

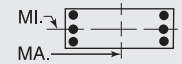



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.07 | MA | 20446 | 4536 | 31308 | 3465 | 34068 | 2915 | 35279 | 2488 | 36005 | 1806 | 41934 | 1241 | 24977 |
| 7L-4S | | MI | 10771 | 4536 | 17261 | 3263 | 18500 | 2731 | 19081 | 2306 | 19656 | 1658 | 22795 | 1263 | 12580 |
| 18-#10 | 2.07 | MA | 20204 | 4536 | 30755 | 3475 | 33302 | 2934 | 34332 | 2495 | 34802 | 1827 | 40347 | 1203 | 24609 |
| 8L-3S | | MI | 10843 | 4536 | 17579 | 3244 | 18913 | 2724 | 19589 | 2301 | 20317 | 1644 | 23648 | 1314 | 12559 |
| 18-#10 | 2.07 | MA | 19996 | 4536 | 30202 | 3482 | 32569 | 2943 | 33419 | 2514 | 33585 | 1846 | 38810 | 1163 | 24051 |
| 9L-2S | | MI | 10987 | 4536 | 17996 | 3235 | 19447 | 2706 | 20241 | 2284 | 21204 | 1630 | 24875 | 1404 | 12538 |
| 18-#11 | 2.54 | MA | 21482 | 4681 | 33900 | 3527 | 37270 | 2951 | 39092 | 2498 | 41179 | 1766 | 49052 | 1273 | 31121 |
| 5L-6S | | MI | 10792 | 4681 | 17263 | 3363 | 18418 | 2806 | 18931 | 2354 | 19390 | 1651 | 22365 | 1041 | 14868 |
| 18-#11 | 2.54 | MA | 21247 | 4681 | 33175 | 3534 | 36336 | 2975 | 37973 | 2511 | 39672 | 1791 | 47139 | 1212 | 30558 |
| 6L-5S | | MI | 10896 | 4681 | 17597 | 3341 | 18848 | 2799 | 19465 | 2348 | 20107 | 1636 | 23286 | 1111 | 15124 |
| 18-#11 | 2.54 | MA | 20972 | 4681 | 32402 | 3557 | 35397 | 2983 | 36868 | 2535 | 38113 | 1802 | 44913 | 1156 | 29996 |
| 7L-4S | | MI | 11042 | 4681 | 17920 | 3332 | 19279 | 2778 | 20003 | 2329 | 20902 | 1634 | 24293 | 1174 | 15114 |
| 18-#11 | 2.54 | MA | 20682 | 4681 | 31727 | 3568 | 34462 | 3006 | 35713 | 2543 | 36643 | 1827 | 42972 | 1107 | 29396 |
| 8L-3S | | MI | 11124 | 4681 | 18306 | 3309 | 19778 | 2770 | 20616 | 2324 | 21700 | 1619 | 25303 | 1234 | 15094 |
| 18-#11 | 2.54 | MA | 20432 | 4681 | 31058 | 3578 | 33568 | 3017 | 34600 | 2566 | 35177 | 1851 | 41086 | 1057 | 28531 |
| 9L-2S | | MI | 11293 | 4681 | 18807 | 3300 | 20420 | 2749 | 21400 | 2304 | 22767 | 1604 | 26748 | 1344 | 15070 |
| 18-#14 | 3.67 | MA | 22646 | 5024 | 36044 | 3766 | 39946 | 3156 | 42332 | 2631 | 45566 | 1793 | 55543 | 1051 | 42580 |
| 6L-5S | | MI | 11526 | 5024 | 19014 | 3553 | 20609 | 2955 | 21588 | 2443 | 22975 | 1607 | 27013 | 917 | 20671 |
| 18-#14 | 3.67 | MA | 22258 | 5024 | 34935 | 3799 | 38600 | 3166 | 40760 | 2666 | 43328 | 1808 | 52337 | 970 | 41409 |
| 7L-4S | | MI | 11729 | 5024 | 19476 | 3541 | 21224 | 2926 | 22356 | 2417 | 24109 | 1606 | 28421 | 1007 | 21139 |
| 18-#14 | 3.67 | MA | 21853 | 5024 | 33967 | 3814 | 37259 | 3199 | 39103 | 2676 | 41219 | 1843 | 49547 | 898 | 39949 |
| 8L-3S | | MI | 11840 | 5024 | 20025 | 3508 | 21935 | 2917 | 23229 | 2411 | 25246 | 1586 | 29837 | 1092 | 21159 |
| 18-#14 | 3.67 | MA | 21498 | 5024 | 33013 | 3828 | 35976 | 3214 | 37506 | 2709 | 39134 | 1878 | 46829 | 825 | 38361 |
| 9L-2S | | MI | 12072 | 5024 | 20737 | 3496 | 22848 | 2887 | 24343 | 2384 | 26761 | 1565 | 31857 | 1251 | 21139 |
| 18-#18 | 6.52 | MA | 25447 | 5896 | 41227 | 4414 | 46585 | 3632 | 50474 | 2997 | 56327 | 1820 | 70798 | 489 | 66990 |
| 7L-4S | | MI | 13392 | 5896 | 23254 | 4076 | 25972 | 3307 | 28106 | 2643 | 31954 | 1535 | 38102 | 536 | 34525 |
| 18-#18 | 6.52 | MA | 24783 | 5896 | 39524 | 4440 | 44227 | 3689 | 47562 | 3014 | 52613 | 1880 | 65870 | 354 | 63069 |
| 8L-3S | | MI | 13567 | 5896 | 24206 | 4022 | 27205 | 3295 | 29620 | 2636 | 33925 | 1504 | 40479 | 678 | 35764 |
| 20-#10 | 2.30 | MA | 21092 | 4606 | 32843 | 3490 | 35992 | 2940 | 37602 | 2488 | 39198 | 1791 | 46402 | 1278 | 28245 |
| 6E | | MI | 10741 | 4606 | 17150 | 3321 | 18323 | 2788 | 18848 | 2347 | 19293 | 1668 | 22387 | 1146 | 13790 |
| 20-#10 | 2.30 | MA | 20863 | 4606 | 32208 | 3509 | 35222 | 2946 | 36686 | 2507 | 37920 | 1801 | 44585 | 1233 | 27751 |
| 7L-5S | | MI | 10828 | 4606 | 17410 | 3315 | 18678 | 2781 | 19288 | 2342 | 19885 | 1655 | 23166 | 1205 | 13901 |
| 20-#10 | 2.30 | MA | 20625 | 4606 | 31655 | 3519 | 34455 | 2965 | 35739 | 2514 | 36716 | 1822 | 42999 | 1195 | 27392 |
| 8L-4S | | MI | 10950 | 4606 | 17678 | 3307 | 19034 | 2763 | 19733 | 2325 | 20543 | 1652 | 24021 | 1255 | 13889 |
| 20-#10 | 2.30 | MA | 20421 | 4606 | 31102 | 3526 | 33722 | 2974 | 34826 | 2533 | 35499 | 1840 | 41461 | 1155 | 26822 |
| 9L-3S | | MI | 11022 | 4606 | 17996 | 3288 | 19447 | 2756 | 20241 | 2320 | 21204 | 1638 | 24875 | 1306 | 13872 |
| 20-#10 | 2.30 | MA | 20169 | 4606 | 30469 | 3544 | 32988 | 2995 | 33913 | 2542 | 34196 | 1847 | 39884 | 1123 | 26232 |
| 10L-2S | | MI | 11164 | 4606 | 18413 | 3279 | 19981 | 2738 | 20892 | 2303 | 22091 | 1625 | 26102 | 1396 | 13853 |
| 20-#11 | 2.83 | MA | 21748 | 4767 | 34270 | 3588 | 37739 | 3014 | 39685 | 2535 | 42001 | 1784 | 50365 | 1202 | 33923 |
| 6E | | MI | 11007 | 4767 | 17764 | 3417 | 19061 | 2845 | 19715 | 2377 | 20457 | 1644 | 23810 | 1028 | 16392 |
| 20-#11 | 2.83 | MA | 21474 | 4767 | 33496 | 3611 | 36800 | 3022 | 38581 | 2559 | 40442 | 1795 | 48138 | 1146 | 33376 |
| 7L-5S | | MI | 11110 | 4767 | 18098 | 3395 | 19490 | 2837 | 20249 | 2372 | 21174 | 1629 | 24731 | 1098 | 16639 |
| 20-#11 | 2.83 | MA | 21191 | 4767 | 32822 | 3622 | 35865 | 3045 | 37425 | 2567 | 38973 | 1820 | 46198 | 1098 | 32761 |
| 8L-4S | | MI | 11255 | 4767 | 18422 | 3386 | 19921 | 2816 | 20787 | 2353 | 21969 | 1627 | 25738 | 1161 | 16686 |
| 20-#11 | 2.83 | MA | 20945 | 4767 | 32153 | 3632 | 34972 | 3056 | 36312 | 2590 | 37507 | 1844 | 44311 | 1048 | 31900 |
| 9L-3S | | MI | 11336 | 4767 | 18807 | 3363 | 20420 | 2809 | 21400 | 2347 | 22767 | 1612 | 26748 | 1221 | 16671 |
| 20-#11 | 2.83 | MA | 20644 | 4767 | 31382 | 3654 | 34076 | 3081 | 35198 | 2600 | 35918 | 1851 | 42382 | 1006 | 31021 |
| 10L-2S | | MI | 11504 | 4767 | 19308 | 3354 | 21063 | 2788 | 22184 | 2328 | 23834 | 1597 | 28193 | 1331 | 16650 |
| 20-#14 | 4.08 | MA | 22970 | 5149 | 36503 | 3877 | 40610 | 3222 | 43212 | 2700 | 46665 | 1798 | 56957 | 956 | 46207 |
| 7L-5S | | MI | 11827 | 5149 | 19726 | 3631 | 21522 | 3011 | 22702 | 2477 | 24491 | 1597 | 29033 | 894 | 22822 |
| 20-#14 | 4.08 | MA | 22577 | 5149 | 35535 | 3892 | 39269 | 3255 | 41555 | 2710 | 44556 | 1833 | 54167 | 884 | 44759 |
| 8L-4S | | MI | 12029 | 5149 | 20189 | 3618 | 22137 | 2982 | 23469 | 2451 | 25624 | 1596 | 30441 | 985 | 23349 |
| 20-#14 | 4.08 | MA | 22230 | 5149 | 34581 | 3906 | 37986 | 3270 | 39959 | 2743 | 42471 | 1868 | 51449 | 812 | 43146 |
| 9L-3S | | MI | 12139 | 5149 | 20737 | 3586 | 22848 | 2973 | 24343 | 2444 | 26761 | 1576 | 31857 | 1070 | 23380 |
| 20-#14 | 4.08 | MA | 21803 | 5149 | 33476 | 3937 | 36701 | 3305 | 38360 | 2757 | 40191 | 1878 | 48673 | 750 | 41463 |
| 10L-2S | | MI | 12368 | 5149 | 21450 | 3574 | 23761 | 2943 | 25456 | 2418 | 28277 | 1555 | 33877 | 1228 | 23373 |
| 20-#18 | 7.25 | MA | 26027 | 6117 | 42272 | 4579 | 47751 | 3788 | 51860 | 3074 | 58461 | 1862 | 73968 | 330 | 71407 |
| 8L-4S | | MI | 13899 | 6117 | 24481 | 4214 | 27545 | 3407 | 30025 | 2703 | 34565 | 1517 | 41469 | 483 | 38205 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



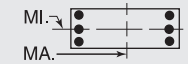

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 2.53 | MA | 21278 | 4677 | 33108 | 3553 | 36375 | 2978 | 38094 | 2527 | 39835 | 1795 | 47236 | 1226 | 30527 |
| 7L-6S | | MI | 10922 | 4677 | 17566 | 3365 | 18858 | 2819 | 19499 | 2367 | 20180 | 1663 | 23613 | 1138 | 15059 |
| 22-#10 | 2.53 | MA | 21044 | 4677 | 32555 | 3562 | 35609 | 2997 | 37146 | 2533 | 38631 | 1816 | 45650 | 1187 | 30177 |
| 8L-5S | | MI | 11008 | 4677 | 17827 | 3359 | 19212 | 2812 | 19940 | 2361 | 20772 | 1649 | 24393 | 1197 | 15204 |
| 22-#10 | 2.53 | MA | 20843 | 4677 | 32002 | 3570 | 34876 | 3006 | 36234 | 2552 | 37414 | 1835 | 44112 | 1147 | 29594 |
| 9L-4S | | MI | 11129 | 4677 | 18094 | 3351 | 19568 | 2794 | 20385 | 2345 | 21430 | 1647 | 25248 | 1247 | 15197 |
| 22-#10 | 2.53 | MA | 20593 | 4677 | 31369 | 3588 | 34142 | 3027 | 35320 | 2561 | 36111 | 1841 | 42535 | 1115 | 29006 |
| 10L-3S | | MI | 11200 | 4677 | 18413 | 3331 | 19981 | 2787 | 20892 | 2339 | 22091 | 1633 | 26102 | 1299 | 15183 |
| 22-#10 | 2.53 | MA | 20365 | 4677 | 30813 | 3596 | 33392 | 3034 | 34431 | 2581 | 34885 | 1860 | 41004 | 1075 | 28298 |
| 11L-2S | | MI | 11342 | 4677 | 18830 | 3323 | 20515 | 2769 | 21544 | 2323 | 22977 | 1619 | 27329 | 1388 | 15166 |
| 22-#11 | 3.11 | MA | 21974 | 4853 | 34591 | 3665 | 38204 | 3061 | 40293 | 2582 | 42772 | 1788 | 51364 | 1137 | 36758 |
| 7L-6S | | MI | 11222 | 4853 | 18266 | 3471 | 19704 | 2883 | 20499 | 2401 | 21524 | 1637 | 25255 | 1015 | 17919 |
| 22-#11 | 3.11 | MA | 21697 | 4853 | 33917 | 3676 | 37269 | 3084 | 39138 | 2590 | 41303 | 1813 | 49423 | 1088 | 36125 |
| 8L-5S | | MI | 11324 | 4853 | 18599 | 3449 | 20133 | 2876 | 21033 | 2395 | 22241 | 1622 | 26176 | 1085 | 18153 |
| 22-#11 | 3.11 | MA | 21455 | 4853 | 33248 | 3686 | 36375 | 3094 | 38025 | 2613 | 39836 | 1837 | 47537 | 1038 | 35270 |
| 9L-4S | | MI | 11468 | 4853 | 18923 | 3440 | 20564 | 2855 | 21571 | 2376 | 23036 | 1620 | 27183 | 1148 | 18255 |
| 22-#11 | 3.11 | MA | 21155 | 4853 | 32476 | 3707 | 35479 | 3119 | 36911 | 2623 | 38247 | 1844 | 45607 | 997 | 34375 |
| 10L-3S | | MI | 11548 | 4853 | 19308 | 3417 | 21063 | 2848 | 22184 | 2371 | 23834 | 1605 | 28193 | 1208 | 18244 |
| 22-#11 | 3.11 | MA | 20881 | 4853 | 31799 | 3717 | 34574 | 3128 | 35825 | 2647 | 36752 | 1866 | 43735 | 945 | 33391 |
| 11L-2S | | MI | 11714 | 4853 | 19810 | 3408 | 21706 | 2827 | 22969 | 2351 | 24901 | 1590 | 29638 | 1318 | 18227 |
| 22-#14 | 4.48 | MA | 23298 | 5273 | 37103 | 3970 | 41279 | 3311 | 44008 | 2744 | 47892 | 1823 | 58787 | 870 | 49568 |
| 8L-5S | | MI | 12127 | 5273 | 20438 | 3709 | 22435 | 3067 | 23816 | 2511 | 26006 | 1587 | 31053 | 872 | 24978 |
| 22-#14 | 4.48 | MA | 22956 | 5273 | 36149 | 3984 | 39997 | 3326 | 42411 | 2777 | 45807 | 1858 | 56069 | 798 | 47931 |
| 9L-4S | | MI | 12327 | 5273 | 20901 | 3696 | 23050 | 3038 | 24583 | 2485 | 27140 | 1586 | 32461 | 963 | 25556 |
| 22-#14 | 4.48 | MA | 22532 | 5273 | 35044 | 4015 | 38711 | 3361 | 40812 | 2791 | 43527 | 1868 | 53293 | 736 | 46227 |
| 10L-3S | | MI | 12437 | 5273 | 21450 | 3664 | 23761 | 3028 | 25456 | 2478 | 28277 | 1566 | 33877 | 1048 | 25597 |
| 24-#10 | 2.76 | MA | 21461 | 4747 | 33455 | 3606 | 36762 | 3029 | 38553 | 2552 | 40546 | 1810 | 48301 | 1180 | 32963 |
| 8L-6S | | MI | 11102 | 4747 | 17983 | 3409 | 19392 | 2851 | 20151 | 2386 | 21067 | 1657 | 24840 | 1130 | 16329 |
| 24-#10 | 2.76 | MA | 21263 | 4747 | 32901 | 3614 | 36030 | 3038 | 37641 | 2572 | 39329 | 1829 | 46763 | 1140 | 32366 |
| 9L-5S | | MI | 11187 | 4747 | 18244 | 3403 | 19746 | 2844 | 20592 | 2380 | 21659 | 1643 | 25620 | 1189 | 16503 |
| 24-#10 | 2.76 | MA | 21014 | 4747 | 32269 | 3632 | 35295 | 3058 | 36728 | 2580 | 38026 | 1836 | 45186 | 1107 | 31781 |
| 10L-4S | | MI | 11307 | 4747 | 18511 | 3395 | 20102 | 2826 | 21037 | 2364 | 22317 | 1641 | 26475 | 1239 | 16503 |
| 24-#10 | 2.76 | MA | 20789 | 4747 | 31713 | 3640 | 34545 | 3065 | 35838 | 2600 | 36800 | 1854 | 43655 | 1067 | 31062 |
| 11L-3S | | MI | 11378 | 4747 | 18830 | 3375 | 20515 | 2819 | 21544 | 2358 | 22977 | 1627 | 27329 | 1291 | 16492 |
| 24-#10 | 2.76 | MA | 20576 | 4747 | 31111 | 3660 | 33790 | 3084 | 34961 | 2621 | 35589 | 1873 | 41906 | 1017 | 30351 |
| 12L-2S | | MI | 11518 | 4747 | 19246 | 3367 | 21050 | 2801 | 22196 | 2342 | 23864 | 1614 | 28556 | 1380 | 16477 |
| 24-#11 | 3.39 | MA | 22200 | 4939 | 35011 | 3730 | 38672 | 3122 | 40850 | 2614 | 43632 | 1806 | 52649 | 1079 | 39489 |
| 8L-6S | | MI | 11436 | 4939 | 18767 | 3525 | 20346 | 2922 | 21284 | 2424 | 22591 | 1630 | 26700 | 1002 | 19448 |
| 24-#11 | 3.39 | MA | 21962 | 4939 | 34342 | 3740 | 37779 | 3133 | 39737 | 2637 | 42166 | 1830 | 50763 | 1029 | 38639 |
| 9L-5S | | MI | 11537 | 4939 | 19101 | 3503 | 20776 | 2915 | 21817 | 2419 | 23308 | 1615 | 27621 | 1072 | 19671 |
| 24-#11 | 3.39 | MA | 21663 | 4939 | 33571 | 3761 | 36883 | 3158 | 38623 | 2647 | 40577 | 1837 | 48833 | 987 | 37730 |
| 10L-4S | | MI | 11680 | 4939 | 19425 | 3494 | 21207 | 2894 | 22356 | 2400 | 24103 | 1614 | 28628 | 1135 | 19819 |
| 24-#11 | 3.39 | MA | 21393 | 4939 | 32894 | 3771 | 35977 | 3167 | 37537 | 2671 | 39082 | 1859 | 46960 | 936 | 36750 |
| 11L-3S | | MI | 11760 | 4939 | 19810 | 3471 | 21706 | 2886 | 22969 | 2394 | 24901 | 1598 | 29638 | 1195 | 19816 |
| 24-#11 | 3.39 | MA | 21139 | 4939 | 32160 | 3795 | 35056 | 3189 | 36473 | 2696 | 37605 | 1882 | 44815 | 874 | 35628 |
| 12L-2S | | MI | 11924 | 4939 | 20311 | 3462 | 22349 | 2865 | 23753 | 2375 | 25968 | 1583 | 31083 | 1305 | 19802 |
| 24-#14 | 4.89 | MA | 23677 | 5398 | 37717 | 4062 | 42007 | 3381 | 44863 | 2811 | 49144 | 1848 | 60688 | 784 | 52717 |
| 9L-5S | | MI | 12427 | 5398 | 21150 | 3786 | 23348 | 3123 | 24929 | 2545 | 27522 | 1577 | 33073 | 850 | 27139 |
| 24-#14 | 4.89 | MA | 23255 | 5398 | 36612 | 4093 | 40721 | 3417 | 43265 | 2824 | 46864 | 1858 | 57913 | 723 | 50991 |
| 10L-4S | | MI | 12625 | 5398 | 21613 | 3774 | 23963 | 3094 | 25697 | 2519 | 28655 | 1576 | 34481 | 940 | 27690 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

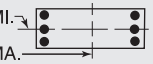



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.39 | MA | 22191 | 4516 | 34909 | 3371 | 37912 | 2838 | 39297 | 2421 | 40429 | 1796 | 46781 | 1558 | 18708 |
| 2E | | MI | 10807 | 4516 | 17469 | 3155 | 18402 | 2654 | 18726 | 2261 | 18825 | 1668 | 20866 | 1390 | 8835 |
| 6-#14 | 1.17 | MA | 21833 | 4447 | 33971 | 3347 | 36824 | 2823 | 38022 | 2417 | 38726 | 1813 | 44449 | 1575 | 15973 |
| 2L-3S | | MI | 10437 | 4447 | 16375 | 3163 | 17094 | 2685 | 17169 | 2297 | 16724 | 1717 | 18311 | 1289 | 7681 |
| 6-#14 | 1.17 | MA | 21190 | 4447 | 32325 | 3368 | 34714 | 2843 | 35448 | 2456 | 35224 | 1849 | 39600 | 1442 | 16012 |
| 3L-2S | | MI | 10687 | 4447 | 17087 | 3151 | 18007 | 2656 | 18282 | 2271 | 18239 | 1697 | 20331 | 1448 | 7622 |
| 6-#18 | 2.08 | MA | 23483 | 4737 | 37796 | 3509 | 41613 | 2937 | 43812 | 2482 | 46572 | 1778 | 55287 | 1533 | 27758 |
| 2L-3S | | MI | 10902 | 4737 | 17469 | 3312 | 18402 | 2801 | 18726 | 2363 | 18825 | 1681 | 20866 | 1056 | 12882 |
| 6-#18 | 2.08 | MA | 22401 | 4737 | 34909 | 3546 | 37912 | 2971 | 39297 | 2548 | 40429 | 1839 | 46781 | 1290 | 27702 |
| 3L-2S | | MI | 11319 | 4737 | 18697 | 3293 | 19975 | 2753 | 20645 | 2321 | 21436 | 1650 | 24233 | 1337 | 12780 |
| 8-#11 | 1.08 | MA | 21686 | 4419 | 33575 | 3339 | 36376 | 2819 | 37502 | 2416 | 38035 | 1821 | 43505 | 1583 | 14847 |
| 2L-4S | | MI | 10375 | 4419 | 16035 | 3185 | 16701 | 2688 | 16706 | 2302 | 16140 | 1741 | 17666 | 1302 | 7200 |
| 8-#11 | 1.08 | MA | 21236 | 4419 | 32427 | 3354 | 34903 | 2833 | 35705 | 2444 | 35591 | 1846 | 40121 | 1492 | 14876 |
| 3E | | MI | 10460 | 4419 | 16420 | 3162 | 17200 | 2681 | 17319 | 2297 | 16938 | 1726 | 18675 | 1363 | 7152 |
| 8-#11 | 1.08 | MA | 20975 | 4419 | 31573 | 3383 | 33793 | 2861 | 34339 | 2457 | 33712 | 1858 | 37941 | 1435 | 14885 |
| 4L-2S | | MI | 10638 | 4419 | 16921 | 3152 | 17843 | 2660 | 18103 | 2278 | 18005 | 1710 | 20121 | 1473 | 7115 |
| 8-#14 | 1.56 | MA | 22581 | 4571 | 35616 | 3425 | 38934 | 2879 | 40596 | 2451 | 42228 | 1803 | 49298 | 1562 | 21136 |
| 2L-4S | | MI | 10625 | 4571 | 16538 | 3273 | 17296 | 2750 | 17409 | 2338 | 17102 | 1728 | 18915 | 1182 | 10037 |
| 8-#14 | 1.56 | MA | 21951 | 4571 | 33971 | 3446 | 36824 | 2899 | 38022 | 2489 | 38726 | 1839 | 44449 | 1428 | 21154 |
| 3E | | MI | 10741 | 4571 | 17087 | 3241 | 18007 | 2741 | 18282 | 2331 | 18239 | 1707 | 20331 | 1267 | 9973 |
| 8-#14 | 1.56 | MA | 21584 | 4571 | 32745 | 3488 | 35231 | 2939 | 36061 | 2508 | 36031 | 1855 | 41311 | 1346 | 21076 |
| 4L-2S | | MI | 10988 | 4571 | 17799 | 3228 | 18920 | 2712 | 19396 | 2305 | 19755 | 1687 | 22351 | 1425 | 9916 |
| 8-#18 | 2.78 | MA | 24762 | 4959 | 40683 | 3647 | 45314 | 3036 | 48327 | 2542 | 52714 | 1760 | 63793 | 1509 | 36783 |
| 2L-4S | | MI | 11235 | 4959 | 17744 | 3504 | 18742 | 2913 | 19131 | 2431 | 19466 | 1694 | 21856 | 860 | 16580 |
| 8-#18 | 2.78 | MA | 23715 | 4959 | 37796 | 3684 | 41613 | 3070 | 43812 | 2609 | 46572 | 1822 | 55287 | 1266 | 36665 |
| 3E | | MI | 11420 | 4959 | 18697 | 3450 | 19975 | 2900 | 20645 | 2424 | 21436 | 1663 | 24233 | 1003 | 16752 |
| 8-#18 | 2.78 | MA | 23095 | 4959 | 35639 | 3756 | 38810 | 3140 | 40364 | 2640 | 41832 | 1848 | 49731 | 1117 | 36058 |
| 4L-2S | | MI | 11828 | 4959 | 19924 | 3432 | 21548 | 2852 | 22564 | 2382 | 24047 | 1633 | 27600 | 1285 | 16680 |
| 10-#10 | 1.10 | MA | 21757 | 4425 | 33625 | 3356 | 36521 | 2833 | 37716 | 2428 | 38351 | 1828 | 43961 | 1590 | 15172 |
| 2L-5S | | MI | 10331 | 4425 | 15946 | 3219 | 16643 | 2728 | 16655 | 2338 | 16026 | 1756 | 17634 | 1308 | 7360 |
| 10-#10 | 1.10 | MA | 21385 | 4425 | 32681 | 3369 | 35312 | 2845 | 36240 | 2451 | 36343 | 1850 | 41180 | 1517 | 15191 |
| 3L-4S | | MI | 10458 | 4425 | 16213 | 3211 | 16999 | 2710 | 17099 | 2321 | 16684 | 1753 | 18489 | 1359 | 7321 |
| 10-#10 | 1.10 | MA | 21168 | 4425 | 31981 | 3393 | 34401 | 2868 | 35119 | 2462 | 34802 | 1859 | 39401 | 1471 | 15199 |
| 4L-3S | | MI | 10531 | 4425 | 16532 | 3191 | 17412 | 2703 | 17607 | 2316 | 17345 | 1740 | 19342 | 1410 | 7287 |
| 10-#10 | 1.10 | MA | 20862 | 4425 | 31373 | 3403 | 33626 | 2880 | 34148 | 2485 | 33438 | 1881 | 37569 | 1439 | 15167 |
| 5L-2S | | MI | 10680 | 4425 | 16948 | 3183 | 17946 | 2685 | 18258 | 2299 | 18231 | 1726 | 20569 | 1499 | 7259 |
| 10-#11 | 1.35 | MA | 22212 | 4505 | 34724 | 3393 | 37849 | 2858 | 39298 | 2440 | 40480 | 1814 | 46890 | 1574 | 18452 |
| 2L-5S | | MI | 10441 | 4505 | 16212 | 3248 | 16913 | 2748 | 16952 | 2345 | 16412 | 1736 | 18103 | 1227 | 8859 |
| 10-#11 | 1.35 | MA | 21768 | 4505 | 33575 | 3408 | 36376 | 2872 | 37502 | 2467 | 38035 | 1839 | 43505 | 1483 | 18472 |
| 3L-4S | | MI | 10592 | 4505 | 16536 | 3239 | 17344 | 2727 | 17490 | 2326 | 17207 | 1734 | 19111 | 1289 | 8812 |
| 10-#11 | 1.35 | MA | 21509 | 4505 | 32721 | 3437 | 35266 | 2900 | 36135 | 2481 | 36156 | 1851 | 41326 | 1426 | 18464 |
| 4L-3S | | MI | 10676 | 4505 | 16921 | 3216 | 17843 | 2720 | 18103 | 2321 | 18005 | 1719 | 20121 | 1350 | 8768 |
| 10-#11 | 1.35 | MA | 21140 | 4505 | 31985 | 3450 | 34319 | 2914 | 34950 | 2508 | 34492 | 1876 | 39087 | 1385 | 18385 |
| 5L-2S | | MI | 10851 | 4505 | 17423 | 3206 | 18486 | 2698 | 18887 | 2301 | 19072 | 1704 | 21566 | 1460 | 8731 |
| 10-#14 | 1.95 | MA | 23323 | 4696 | 37262 | 3502 | 41044 | 2935 | 43170 | 2485 | 45730 | 1793 | 54147 | 1548 | 26289 |
| 2L-5S | | MI | 10719 | 4696 | 16788 | 3363 | 17593 | 2836 | 17755 | 2398 | 17484 | 1718 | 19527 | 1069 | 12252 |
| 10-#14 | 1.95 | MA | 22705 | 4696 | 35616 | 3524 | 38934 | 2955 | 40596 | 2523 | 42228 | 1829 | 49298 | 1414 | 26284 |
| 3L-4S | | MI | 10930 | 4696 | 17251 | 3351 | 18209 | 2806 | 18523 | 2372 | 18618 | 1718 | 20935 | 1160 | 12289 |
| 10-#14 | 1.95 | MA | 22343 | 4696 | 34391 | 3565 | 37341 | 2995 | 38635 | 2542 | 39533 | 1845 | 46160 | 1332 | 26182 |
| 4L-3S | | MI | 11045 | 4696 | 17799 | 3319 | 18920 | 2797 | 19396 | 2365 | 19755 | 1697 | 22351 | 1245 | 12240 |
| 10-#14 | 1.95 | MA | 21821 | 4696 | 33340 | 3584 | 35982 | 3015 | 36933 | 2581 | 37144 | 1881 | 42942 | 1272 | 25821 |
| 5L-2S | | MI | 11288 | 4696 | 18512 | 3306 | 19833 | 2767 | 20510 | 2339 | 21270 | 1677 | 24371 | 1403 | 12190 |
| 10-#18 | 3.47 | MA | 25014 | 5180 | 40683 | 3822 | 45314 | 3170 | 48327 | 2669 | 52714 | 1804 | 63793 | 1242 | 45626 |
| 3L-4S | | MI | 11752 | 5180 | 18971 | 3642 | 20315 | 3012 | 21050 | 2491 | 22077 | 1676 | 25223 | 808 | 20148 |
| 10-#18 | 3.47 | MA | 24406 | 5180 | 38526 | 3894 | 42511 | 3239 | 44879 | 2700 | 47975 | 1830 | 58237 | 1093 | 45004 |
| 4L-3S | | MI | 11935 | 5180 | 19924 | 3588 | 21548 | 3000 | 22564 | 2484 | 24047 | 1646 | 27600 | 951 | 20599 |
| 10-#18 | 3.47 | MA | 23515 | 5180 | 36698 | 3928 | 40118 | 3273 | 41882 | 2767 | 43770 | 1891 | 52557 | 980 | 41570 |
| 5L-2S | | MI | 12336 | 5180 | 21151 | 3570 | 23122 | 2952 | 24483 | 2442 | 26658 | 1615 | 30967 | 1232 | 20554 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

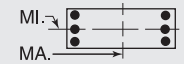
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.32 | MA | 22191 | 4495 | 34569 | 3400 | 37731 | 2865 | 39192 | 2447 | 40359 | 1823 | 46741 | 1582 | 18130 |
| 2L-6S | | MI | 10423 | 4495 | 16102 | 3269 | 16823 | 2767 | 16865 | 2363 | 16321 | 1764 | 18081 | 1242 | 8718 |
| 12-#10 | 1.32 | MA | 21824 | 4495 | 33625 | 3413 | 36521 | 2877 | 37716 | 2470 | 38351 | 1844 | 43961 | 1509 | 18145 |
| 3L-5S | | MI | 10513 | 4495 | 16362 | 3263 | 17177 | 2760 | 17306 | 2357 | 16913 | 1750 | 18861 | 1301 | 8687 |
| 12-#10 | 1.32 | MA | 21608 | 4495 | 32925 | 3437 | 35611 | 2900 | 36595 | 2481 | 36810 | 1854 | 42181 | 1463 | 18141 |
| 4E | | MI | 10639 | 4495 | 16630 | 3255 | 17533 | 2742 | 17751 | 2341 | 17571 | 1748 | 19716 | 1351 | 8654 |
| 12-#10 | 1.32 | MA | 21305 | 4495 | 32317 | 3447 | 34836 | 2912 | 35624 | 2504 | 35446 | 1875 | 40350 | 1432 | 18099 |
| 5L-3S | | MI | 10712 | 4495 | 16948 | 3235 | 17946 | 2735 | 18258 | 2335 | 18231 | 1734 | 20569 | 1402 | 8622 |
| 12-#10 | 1.32 | MA | 21087 | 4495 | 31693 | 3453 | 34022 | 2932 | 34664 | 2515 | 34153 | 1896 | 38713 | 1383 | 17990 |
| 6L-2S | | MI | 10860 | 4495 | 17365 | 3227 | 18480 | 2717 | 18910 | 2319 | 19118 | 1720 | 21796 | 1491 | 8595 |
| 12-#11 | 1.63 | MA | 22734 | 4591 | 35873 | 3447 | 39321 | 2896 | 41095 | 2464 | 42924 | 1807 | 50274 | 1564 | 22051 |
| 2L-6S | | MI | 10550 | 4591 | 16380 | 3323 | 17126 | 2794 | 17202 | 2374 | 16762 | 1744 | 18627 | 1144 | 10415 |
| 12-#11 | 1.63 | MA | 22297 | 4591 | 34724 | 3462 | 37849 | 2911 | 39298 | 2491 | 40480 | 1832 | 46890 | 1473 | 22064 |
| 3L-5S | | MI | 10658 | 4591 | 16714 | 3302 | 17555 | 2787 | 17736 | 2369 | 17479 | 1729 | 19548 | 1214 | 10446 |
| 12-#11 | 1.63 | MA | 22041 | 4591 | 33870 | 3491 | 36738 | 2939 | 37932 | 2504 | 38601 | 1844 | 44710 | 1416 | 22038 |
| 4E | | MI | 10807 | 4591 | 17038 | 3293 | 17986 | 2766 | 18274 | 2349 | 18274 | 1727 | 20556 | 1276 | 10409 |
| 12-#11 | 1.63 | MA | 21676 | 4591 | 33134 | 3504 | 35792 | 2953 | 36746 | 2531 | 36936 | 1869 | 42471 | 1376 | 21947 |
| 5L-3S | | MI | 10890 | 4591 | 17423 | 3270 | 18486 | 2758 | 18887 | 2344 | 19072 | 1712 | 21566 | 1337 | 10370 |
| 12-#11 | 1.63 | MA | 21413 | 4591 | 32374 | 3510 | 34808 | 2978 | 35574 | 2545 | 35358 | 1895 | 40470 | 1315 | 21546 |
| 6L-2S | | MI | 11065 | 4591 | 17924 | 3260 | 19128 | 2737 | 19671 | 2325 | 20139 | 1697 | 23011 | 1447 | 10335 |
| 12-#14 | 2.34 | MA | 23454 | 4820 | 37262 | 3602 | 41044 | 3011 | 43170 | 2557 | 45730 | 1819 | 54147 | 1401 | 31409 |
| 3L-5S | | MI | 11024 | 4820 | 17500 | 3441 | 18506 | 2892 | 18869 | 2432 | 19000 | 1708 | 21547 | 1047 | 14367 |
| 12-#14 | 2.34 | MA | 23097 | 4820 | 36037 | 3643 | 39451 | 3051 | 41209 | 2576 | 43035 | 1835 | 51009 | 1318 | 31288 |
| 4E | | MI | 11233 | 4820 | 17963 | 3429 | 19122 | 2862 | 19637 | 2406 | 20133 | 1708 | 22955 | 1137 | 14528 |
| 12-#14 | 2.34 | MA | 22583 | 4820 | 34986 | 3661 | 38092 | 3071 | 39507 | 2615 | 40646 | 1871 | 47791 | 1258 | 30848 |
| 5L-3S | | MI | 11347 | 4820 | 18512 | 3396 | 19833 | 2853 | 20510 | 2399 | 21270 | 1687 | 24371 | 1222 | 14493 |
| 12-#14 | 2.34 | MA | 22213 | 4820 | 33896 | 3671 | 36689 | 3107 | 37824 | 2633 | 38380 | 1907 | 44915 | 1169 | 29529 |
| 6L-2S | | MI | 11588 | 4820 | 19224 | 3384 | 20746 | 2823 | 21624 | 2373 | 22785 | 1667 | 26391 | 1381 | 14450 |
| 12-#18 | 4.17 | MA | 25701 | 5401 | 41413 | 4033 | 46212 | 3338 | 49394 | 2761 | 54118 | 1812 | 66742 | 1069 | 53958 |
| 4E | | MI | 12267 | 5401 | 20198 | 3781 | 21888 | 3112 | 22969 | 2551 | 24688 | 1659 | 28590 | 755 | 23748 |
| 12-#18 | 4.17 | MA | 24832 | 5401 | 39585 | 4066 | 43819 | 3372 | 46396 | 2827 | 49913 | 1873 | 61063 | 955 | 50421 |
| 5L-3S | | MI | 12447 | 5401 | 21151 | 3727 | 23122 | 3099 | 24483 | 2544 | 26658 | 1628 | 30967 | 898 | 24421 |
| 12-#18 | 4.17 | MA | 24204 | 5401 | 37671 | 4082 | 41382 | 3437 | 43432 | 2859 | 45923 | 1935 | 55983 | 791 | 47516 |
| 6L-2S | | MI | 12841 | 5401 | 22378 | 3708 | 24695 | 3051 | 26402 | 2502 | 29269 | 1597 | 34334 | 1180 | 24411 |
| 14-#10 | 1.54 | MA | 22260 | 4565 | 34569 | 3457 | 37731 | 2908 | 39192 | 2489 | 40359 | 1838 | 46741 | 1501 | 21095 |
| 3L-6S | | MI | 10605 | 4565 | 16519 | 3313 | 17357 | 2798 | 17517 | 2382 | 17207 | 1758 | 19307 | 1234 | 10029 |
| 14-#10 | 1.54 | MA | 22046 | 4565 | 33869 | 3481 | 36821 | 2931 | 38071 | 2500 | 38818 | 1848 | 44962 | 1455 | 21081 |
| 4L-5S | | MI | 10695 | 4565 | 16779 | 3307 | 17711 | 2791 | 17958 | 2376 | 17800 | 1745 | 20087 | 1293 | 10007 |
| 14-#10 | 1.54 | MA | 21746 | 4565 | 33261 | 3491 | 36046 | 2943 | 37100 | 2523 | 37454 | 1869 | 43130 | 1424 | 21030 |
| 5L-4S | | MI | 10819 | 4565 | 17047 | 3299 | 18067 | 2773 | 18403 | 2360 | 18457 | 1742 | 20942 | 1343 | 9978 |
| 14-#10 | 1.54 | MA | 21531 | 4565 | 32637 | 3497 | 35232 | 2963 | 36140 | 2534 | 36161 | 1891 | 41494 | 1376 | 20915 |
| 6L-3S | | MI | 10892 | 4565 | 17365 | 3279 | 18480 | 2767 | 18910 | 2354 | 19118 | 1728 | 21796 | 1394 | 9950 |
| 14-#10 | 1.54 | MA | 21285 | 4565 | 31972 | 3516 | 34425 | 2970 | 35176 | 2553 | 34823 | 1901 | 39596 | 1331 | 20412 |
| 7L-2S | | MI | 11039 | 4565 | 17782 | 3271 | 19015 | 2748 | 19562 | 2338 | 20005 | 1715 | 23023 | 1484 | 9924 |
| 14-#11 | 1.90 | MA | 22823 | 4678 | 35873 | 3516 | 39321 | 2949 | 41095 | 2514 | 42924 | 1826 | 50274 | 1463 | 25647 |
| 3L-6S | | MI | 10767 | 4678 | 16881 | 3377 | 17769 | 2833 | 17986 | 2398 | 17829 | 1737 | 20072 | 1131 | 11936 |
| 14-#11 | 1.90 | MA | 22569 | 4678 | 35019 | 3545 | 38211 | 2977 | 39728 | 2528 | 41045 | 1837 | 48094 | 1407 | 25611 |
| 4L-5S | | MI | 10874 | 4678 | 17215 | 3356 | 18198 | 2826 | 18520 | 2392 | 18546 | 1722 | 20994 | 1201 | 12025 |
| 14-#11 | 1.90 | MA | 22208 | 4678 | 34283 | 3557 | 37265 | 2992 | 38543 | 2555 | 39381 | 1862 | 45856 | 1366 | 25510 |
| 5L-4S | | MI | 11022 | 4678 | 17539 | 3347 | 18629 | 2804 | 19058 | 2373 | 19341 | 1720 | 22001 | 1263 | 11996 |
| 14-#11 | 1.90 | MA | 21950 | 4678 | 33523 | 3564 | 36280 | 3016 | 37371 | 2568 | 37802 | 1888 | 43854 | 1306 | 25066 |
| 6L-3S | | MI | 11105 | 4678 | 17924 | 3324 | 19128 | 2797 | 19671 | 2368 | 20139 | 1705 | 23011 | 1324 | 11963 |
| 14-#11 | 1.90 | MA | 21656 | 4678 | 32712 | 3588 | 35296 | 3024 | 36206 | 2592 | 36169 | 1899 | 41528 | 1250 | 24421 |
| 7L-2S | | MI | 11277 | 4678 | 18426 | 3314 | 19771 | 2776 | 20455 | 2348 | 21206 | 1690 | 24456 | 1434 | 11931 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

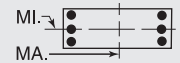


$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.73 | MA | 23845 | 4945 | 37682 | 3721 | 41561 | 3107 | 43783 | 2610 | 46537 | 1825 | 55858 | 1304 | 36394 |
| 4L-5S | | MI | 11328 | 4945 | 18212 | 3519 | 19419 | 2947 | 19983 | 2466 | 20515 | 1698 | 23567 | 1024 | 16495 |
| 14-#14 | 2.73 | MA | 23338 | 4945 | 36632 | 3739 | 40202 | 3127 | 42081 | 2649 | 44148 | 1861 | 52640 | 1244 | 35885 |
| 5L-4S | | MI | 11536 | 4945 | 18675 | 3507 | 20035 | 2918 | 20751 | 2440 | 21649 | 1698 | 24975 | 1115 | 16760 |
| 14-#14 | 2.73 | MA | 22977 | 4945 | 35542 | 3749 | 38799 | 3163 | 40398 | 2667 | 41882 | 1897 | 49764 | 1155 | 34603 |
| 6L-3S | | MI | 11648 | 4945 | 19224 | 3474 | 20746 | 2909 | 21624 | 2433 | 22785 | 1677 | 26391 | 1200 | 16736 |
| 14-#14 | 2.73 | MA | 22561 | 4945 | 34379 | 3782 | 37387 | 3174 | 38740 | 2702 | 39538 | 1913 | 46414 | 1074 | 33559 |
| 7L-2S | | MI | 11886 | 4945 | 19936 | 3462 | 21659 | 2879 | 22738 | 2407 | 24301 | 1657 | 28412 | 1358 | 16701 |
| 14-#18 | 4.86 | MA | 26134 | 5623 | 42472 | 4204 | 47520 | 3472 | 50911 | 2888 | 56056 | 1856 | 69568 | 931 | 59272 |
| 5L-4S | | MI | 12780 | 5623 | 21425 | 3919 | 23461 | 3211 | 24888 | 2612 | 27299 | 1641 | 31957 | 703 | 27374 |
| 14-#18 | 4.86 | MA | 25529 | 5623 | 40558 | 4220 | 45083 | 3536 | 47947 | 2919 | 52065 | 1917 | 64488 | 766 | 56290 |
| 6L-3S | | MI | 12958 | 5623 | 22378 | 3865 | 24695 | 3198 | 26402 | 2605 | 29269 | 1610 | 34334 | 846 | 28232 |
| 14-#18 | 4.86 | MA | 24816 | 5623 | 38512 | 4278 | 42601 | 3554 | 45071 | 2982 | 47936 | 1943 | 58552 | 620 | 53136 |
| 7L-2S | | MI | 13346 | 5623 | 23605 | 3847 | 26268 | 3150 | 28321 | 2562 | 31880 | 1580 | 37701 | 1127 | 28258 |
| 16-#10 | 1.76 | MA | 22482 | 4636 | 34813 | 3525 | 38031 | 2963 | 39547 | 2519 | 40826 | 1843 | 47742 | 1447 | 24020 |
| 4L-6S | | MI | 10787 | 4636 | 16935 | 3357 | 17891 | 2830 | 18169 | 2401 | 18094 | 1753 | 20534 | 1226 | 11336 |
| 16-#10 | 1.76 | MA | 22185 | 4636 | 34204 | 3535 | 37256 | 2975 | 38576 | 2542 | 39462 | 1864 | 45911 | 1416 | 23962 |
| 5E | | MI | 10875 | 4636 | 17196 | 3351 | 18246 | 2823 | 18610 | 2396 | 18687 | 1739 | 21314 | 1285 | 11320 |
| 16-#10 | 1.76 | MA | 21973 | 4636 | 33581 | 3541 | 36442 | 2995 | 37616 | 2553 | 38169 | 1885 | 44274 | 1368 | 23842 |
| 6L-4S | | MI | 10999 | 4636 | 17463 | 3343 | 18602 | 2805 | 19055 | 2379 | 19344 | 1736 | 22169 | 1335 | 11297 |
| 16-#10 | 1.76 | MA | 21728 | 4636 | 32916 | 3560 | 35634 | 3001 | 36652 | 2572 | 36831 | 1895 | 42377 | 1323 | 23318 |
| 7L-3S | | MI | 11072 | 4636 | 17782 | 3323 | 19015 | 2798 | 19562 | 2374 | 20005 | 1723 | 23023 | 1386 | 11272 |
| 16-#10 | 1.76 | MA | 21468 | 4636 | 32336 | 3569 | 34831 | 3021 | 35659 | 2579 | 35570 | 1916 | 40717 | 1286 | 22914 |
| 8L-2S | | MI | 11217 | 4636 | 18199 | 3315 | 19549 | 2780 | 20214 | 2357 | 20892 | 1709 | 24250 | 1476 | 11248 |
| 16-#11 | 2.17 | MA | 23094 | 4764 | 36168 | 3599 | 39684 | 3016 | 41525 | 2551 | 43489 | 1830 | 51479 | 1397 | 29183 |
| 4L-6S | | MI | 10983 | 4764 | 17383 | 3431 | 18412 | 2872 | 18771 | 2421 | 18896 | 1730 | 21517 | 1118 | 13425 |
| 16-#11 | 2.17 | MA | 22737 | 4764 | 35431 | 3611 | 38737 | 3030 | 40339 | 2578 | 41825 | 1856 | 49240 | 1357 | 29073 |
| 5E | | MI | 11089 | 4764 | 17717 | 3410 | 18841 | 2864 | 19304 | 2416 | 19613 | 1715 | 22439 | 1188 | 13598 |
| 16-#11 | 2.17 | MA | 22484 | 4764 | 34671 | 3618 | 37753 | 3055 | 39167 | 2592 | 40247 | 1881 | 47239 | 1296 | 28590 |
| 6L-4S | | MI | 11236 | 4764 | 18041 | 3401 | 19272 | 2843 | 19842 | 2396 | 20408 | 1714 | 23446 | 1250 | 13577 |
| 16-#11 | 2.17 | MA | 22191 | 4764 | 33860 | 3642 | 36769 | 3063 | 38003 | 2616 | 38613 | 1893 | 44913 | 1241 | 27964 |
| 7L-3S | | MI | 11318 | 4764 | 18426 | 3378 | 19771 | 2836 | 20455 | 2391 | 21206 | 1698 | 24456 | 1311 | 13550 |
| 16-#11 | 2.17 | MA | 21878 | 4764 | 33154 | 3653 | 35789 | 3086 | 36792 | 2624 | 37075 | 1918 | 42883 | 1193 | 27419 |
| 8L-2S | | MI | 11489 | 4764 | 18927 | 3368 | 20414 | 2815 | 21240 | 2372 | 22273 | 1683 | 25901 | 1421 | 13521 |
| 16-#14 | 3.13 | MA | 24088 | 5069 | 38278 | 3817 | 42312 | 3183 | 44655 | 2683 | 47650 | 1851 | 57489 | 1231 | 40929 |
| 5E | | MI | 11631 | 5069 | 18925 | 3597 | 20332 | 3003 | 21097 | 2500 | 22031 | 1689 | 25587 | 1002 | 18631 |
| 16-#14 | 3.13 | MA | 23736 | 5069 | 37188 | 3827 | 40909 | 3219 | 42972 | 2701 | 45384 | 1887 | 54613 | 1141 | 39683 |
| 6L-4S | | MI | 11837 | 5069 | 19387 | 3584 | 20948 | 2974 | 21864 | 2474 | 23164 | 1688 | 26995 | 1093 | 18980 |
| 16-#14 | 3.13 | MA | 23322 | 5069 | 36025 | 3860 | 39497 | 3229 | 41314 | 2736 | 43040 | 1903 | 51263 | 1061 | 38595 |
| 7L-3S | | MI | 11949 | 5069 | 19936 | 3552 | 21659 | 2964 | 22738 | 2467 | 24301 | 1667 | 28412 | 1178 | 18972 |
| 16-#14 | 3.13 | MA | 22881 | 5069 | 35010 | 3876 | 38091 | 3263 | 39577 | 2747 | 40830 | 1939 | 48344 | 990 | 37015 |
| 8L-2S | | MI | 12184 | 5069 | 20648 | 3540 | 22572 | 2935 | 23851 | 2441 | 25816 | 1647 | 30432 | 1336 | 18945 |
| 16-#18 | 5.56 | MA | 26840 | 5844 | 43445 | 4358 | 48784 | 3636 | 52462 | 2979 | 58208 | 1899 | 72994 | 742 | 65064 |
| 6L-4S | | MI | 13291 | 5844 | 22652 | 4057 | 25034 | 3310 | 26807 | 2672 | 29910 | 1623 | 35324 | 650 | 31021 |
| 16-#18 | 5.56 | MA | 26134 | 5844 | 41399 | 4416 | 46302 | 3653 | 49586 | 3042 | 54079 | 1925 | 67058 | 596 | 61944 |
| 7L-3S | | MI | 13467 | 5844 | 23605 | 4003 | 26268 | 3298 | 28321 | 2665 | 31880 | 1593 | 37701 | 793 | 32038 |
| 16-#18 | 5.56 | MA | 25381 | 5844 | 39613 | 4443 | 43828 | 3711 | 46531 | 3060 | 50186 | 1986 | 61901 | 464 | 57847 |
| 8L-2S | | MI | 13849 | 5844 | 24832 | 3985 | 27841 | 3250 | 30240 | 2623 | 34491 | 1562 | 41068 | 1075 | 32094 |
| 18-#10 | 1.98 | MA | 22621 | 4706 | 35148 | 3579 | 38465 | 3006 | 40052 | 2561 | 41470 | 1858 | 48691 | 1408 | 26893 |
| 5L-6S | | MI | 10968 | 4706 | 17352 | 3401 | 18425 | 2861 | 18821 | 2420 | 18981 | 1747 | 21761 | 1218 | 12625 |
| 18-#10 | 1.98 | MA | 22413 | 4706 | 34524 | 3584 | 37651 | 3026 | 39092 | 2573 | 40177 | 1879 | 47055 | 1360 | 26769 |
| 6L-5S | | MI | 11056 | 4706 | 17613 | 3395 | 18780 | 2855 | 19262 | 2415 | 19573 | 1733 | 22541 | 1277 | 12630 |
| 18-#10 | 1.98 | MA | 22169 | 4706 | 33859 | 3604 | 36844 | 3033 | 38127 | 2592 | 38839 | 1889 | 45157 | 1315 | 26227 |
| 7L-4S | | MI | 11179 | 4706 | 17880 | 3387 | 19136 | 2836 | 19706 | 2398 | 20231 | 1731 | 23396 | 1327 | 12611 |
| 18-#10 | 1.98 | MA | 21913 | 4706 | 33280 | 3613 | 36041 | 3052 | 37135 | 2599 | 37579 | 1911 | 43498 | 1278 | 25832 |
| 8L-3S | | MI | 11251 | 4706 | 18199 | 3367 | 19549 | 2830 | 20214 | 2393 | 20892 | 1717 | 24250 | 1378 | 12590 |
| 18-#10 | 1.98 | MA | 21695 | 4706 | 32698 | 3621 | 35274 | 3062 | 36179 | 2618 | 36296 | 1929 | 41892 | 1238 | 25300 |
| 9L-2S | | MI | 11395 | 4706 | 18615 | 3359 | 20083 | 2812 | 20866 | 2376 | 21779 | 1703 | 25477 | 1468 | 12567 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

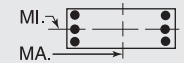
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.44 | MA | 23263 | 4850 | 36580 | 3665 | 40210 | 3069 | 42136 | 2602 | 44269 | 1849 | 52625 | 1347 | 32637 |
| 5L-6S | | MI | 11199 | 4850 | 17884 | 3485 | 19054 | 2910 | 19555 | 2445 | 19963 | 1724 | 22962 | 1105 | 14946 |
| 18-#11 | 2.44 | MA | 23015 | 4850 | 35820 | 3672 | 39226 | 3094 | 40964 | 2615 | 42691 | 1874 | 50623 | 1287 | 32118 |
| 6L-5S | | MI | 11304 | 4850 | 18218 | 3464 | 19484 | 2903 | 20089 | 2439 | 20680 | 1708 | 23884 | 1175 | 15168 |
| 18-#11 | 2.44 | MA | 22723 | 4850 | 35009 | 3696 | 38242 | 3102 | 39799 | 2639 | 41058 | 1886 | 48297 | 1231 | 31509 |
| 7L-4S | | MI | 11450 | 4850 | 18542 | 3455 | 19915 | 2882 | 20627 | 2420 | 21475 | 1707 | 24891 | 1237 | 15154 |
| 18-#11 | 2.44 | MA | 22417 | 4850 | 34302 | 3707 | 37262 | 3125 | 38589 | 2647 | 39519 | 1911 | 46267 | 1183 | 30949 |
| 8L-3S | | MI | 11532 | 4850 | 18927 | 3431 | 20414 | 2875 | 21240 | 2415 | 22273 | 1691 | 25901 | 1298 | 15131 |
| 18-#11 | 2.44 | MA | 22153 | 4850 | 33598 | 3717 | 36326 | 3136 | 37422 | 2670 | 37972 | 1934 | 44298 | 1134 | 30020 |
| 9L-2S | | MI | 11701 | 4850 | 19428 | 3422 | 21057 | 2853 | 22024 | 2395 | 23340 | 1676 | 27346 | 1408 | 15106 |
| 18-#14 | 3.52 | MA | 24489 | 5194 | 38834 | 3904 | 43019 | 3274 | 45546 | 2735 | 48886 | 1877 | 59462 | 1128 | 44762 |
| 6L-5S | | MI | 11933 | 5194 | 19637 | 3675 | 21245 | 3059 | 22211 | 2534 | 23546 | 1679 | 27607 | 980 | 20776 |
| 18-#14 | 3.52 | MA | 24078 | 5194 | 37671 | 3938 | 41607 | 3285 | 43887 | 2770 | 46542 | 1893 | 56112 | 1047 | 43632 |
| 7L-4S | | MI | 12137 | 5194 | 20099 | 3662 | 21861 | 3030 | 22978 | 2507 | 24679 | 1678 | 29015 | 1070 | 21196 |
| 18-#14 | 3.52 | MA | 23649 | 5194 | 36656 | 3954 | 40201 | 3319 | 42151 | 2781 | 44332 | 1929 | 53193 | 977 | 42063 |
| 8L-3S | | MI | 12248 | 5194 | 20648 | 3630 | 22572 | 3020 | 23851 | 2501 | 25816 | 1657 | 30432 | 1156 | 21204 |
| 18-#14 | 3.52 | MA | 23275 | 5194 | 35651 | 3968 | 38857 | 3334 | 40477 | 2814 | 42131 | 1963 | 50354 | 905 | 40490 |
| 9L-2S | | MI | 12480 | 5194 | 21360 | 3617 | 23485 | 2991 | 24965 | 2475 | 27332 | 1637 | 32452 | 1314 | 21184 |
| 18-#18 | 6.25 | MA | 27438 | 6065 | 44286 | 4555 | 50003 | 3753 | 54101 | 3103 | 60222 | 1907 | 75564 | 571 | 70752 |
| 7L-4S | | MI | 13800 | 6065 | 23879 | 4196 | 26608 | 3410 | 28727 | 2732 | 32521 | 1606 | 38691 | 598 | 34684 |
| 18-#18 | 6.25 | MA | 26737 | 6065 | 42500 | 4581 | 47529 | 3810 | 51046 | 3120 | 56329 | 1969 | 70406 | 440 | 66606 |
| 8L-3S | | MI | 13975 | 6065 | 24832 | 4142 | 27841 | 3397 | 30240 | 2725 | 34491 | 1575 | 41068 | 741 | 35839 |
| 20-#10 | 2.20 | MA | 22851 | 4776 | 35468 | 3628 | 38861 | 3058 | 40568 | 2592 | 42185 | 1874 | 49835 | 1352 | 29675 |
| 6E | | MI | 11149 | 4776 | 17769 | 3445 | 18960 | 2893 | 19473 | 2439 | 19868 | 1741 | 22988 | 1210 | 13857 |
| 20-#10 | 2.20 | MA | 22608 | 4776 | 34803 | 3648 | 38054 | 3065 | 39603 | 2611 | 40847 | 1884 | 47938 | 1308 | 29137 |
| 7L-5S | | MI | 11236 | 4776 | 18030 | 3439 | 19314 | 2886 | 19913 | 2434 | 20460 | 1728 | 23768 | 1269 | 13937 |
| 20-#10 | 2.20 | MA | 22357 | 4776 | 34224 | 3657 | 37251 | 3084 | 38611 | 2618 | 39587 | 1905 | 46278 | 1270 | 28753 |
| 8L-4S | | MI | 11358 | 4776 | 18297 | 3431 | 19670 | 2868 | 20358 | 2417 | 21118 | 1725 | 24623 | 1319 | 13923 |
| 20-#10 | 2.20 | MA | 22141 | 4776 | 33641 | 3665 | 36483 | 3093 | 37655 | 2637 | 38304 | 1924 | 44673 | 1230 | 28207 |
| 9L-3S | | MI | 11430 | 4776 | 18615 | 3411 | 20083 | 2861 | 20866 | 2412 | 21779 | 1712 | 25477 | 1371 | 13904 |
| 20-#10 | 2.20 | MA | 21876 | 4776 | 32978 | 3683 | 35715 | 3114 | 36698 | 2646 | 36939 | 1930 | 43023 | 1199 | 27576 |
| 10L-2S | | MI | 11573 | 4776 | 19032 | 3403 | 20618 | 2843 | 21517 | 2395 | 22665 | 1698 | 26703 | 1460 | 13884 |
| 20-#11 | 2.71 | MA | 23543 | 4937 | 36969 | 3726 | 40698 | 3133 | 42760 | 2639 | 45135 | 1867 | 54008 | 1277 | 35650 |
| 6E | | MI | 11415 | 4937 | 18386 | 3539 | 19697 | 2949 | 20339 | 2468 | 21030 | 1717 | 24407 | 1092 | 16471 |
| 20-#11 | 2.71 | MA | 23253 | 4937 | 36158 | 3750 | 39714 | 3140 | 41596 | 2663 | 43502 | 1879 | 51682 | 1221 | 35057 |
| 7L-5S | | MI | 11518 | 4937 | 18719 | 3518 | 20127 | 2942 | 20873 | 2463 | 21746 | 1701 | 25329 | 1162 | 16724 |
| 20-#11 | 2.71 | MA | 22953 | 4937 | 35451 | 3761 | 38735 | 3164 | 40385 | 2671 | 41963 | 1904 | 49652 | 1174 | 34479 |
| 8L-4S | | MI | 11663 | 4937 | 19043 | 3508 | 20558 | 2921 | 21411 | 2444 | 22541 | 1700 | 26336 | 1224 | 16727 |
| 20-#11 | 2.71 | MA | 22694 | 4937 | 34747 | 3770 | 37798 | 3175 | 39219 | 2694 | 40416 | 1928 | 47682 | 1124 | 33556 |
| 9L-3S | | MI | 11744 | 4937 | 19428 | 3485 | 21057 | 2913 | 22024 | 2438 | 23340 | 1684 | 27346 | 1285 | 16709 |
| 20-#11 | 2.71 | MA | 22375 | 4937 | 33938 | 3793 | 36860 | 3200 | 38052 | 2704 | 38751 | 1935 | 45664 | 1084 | 32704 |
| 10L-2S | | MI | 11912 | 4937 | 19930 | 3476 | 21699 | 2892 | 22808 | 2419 | 24407 | 1669 | 28791 | 1395 | 16687 |
| 20-#14 | 3.91 | MA | 24828 | 5318 | 39316 | 4016 | 43717 | 3341 | 46461 | 2804 | 50044 | 1883 | 60961 | 1033 | 48668 |
| 7L-5S | | MI | 12235 | 5318 | 20349 | 3752 | 22158 | 3115 | 23324 | 2568 | 25061 | 1669 | 29627 | 957 | 22926 |
| 20-#14 | 3.91 | MA | 24412 | 5318 | 38302 | 4032 | 42311 | 3375 | 44725 | 2815 | 47834 | 1919 | 58042 | 963 | 47112 |
| 8L-4S | | MI | 12437 | 5318 | 20812 | 3740 | 22774 | 3086 | 24092 | 2541 | 26195 | 1668 | 31035 | 1048 | 23408 |
| 20-#14 | 3.91 | MA | 24046 | 5318 | 37297 | 4045 | 40967 | 3390 | 43051 | 2848 | 45633 | 1953 | 55203 | 891 | 45513 |
| 9L-3S | | MI | 12547 | 5318 | 21360 | 3708 | 23485 | 3076 | 24965 | 2535 | 27332 | 1648 | 32452 | 1133 | 23431 |
| 20-#14 | 3.91 | MA | 23594 | 5318 | 36138 | 4077 | 39620 | 3426 | 41376 | 2862 | 43243 | 1963 | 52300 | 831 | 43842 |
| 10L-2S | | MI | 12777 | 5318 | 22073 | 3695 | 24398 | 3047 | 26079 | 2508 | 28847 | 1627 | 34472 | 1292 | 23418 |
| 20-#18 | 6.94 | MA | 28048 | 6287 | 45387 | 4720 | 51230 | 3910 | 55561 | 3181 | 62472 | 1951 | 78912 | 415 | 75365 |
| 8L-4S | | MI | 14307 | 6287 | 25107 | 4334 | 28181 | 3509 | 30646 | 2793 | 35132 | 1588 | 42058 | 545 | 38362 |
| 22-#10 | 2.43 | MA | 23045 | 4846 | 35747 | 3692 | 39264 | 3096 | 41079 | 2630 | 42855 | 1878 | 50718 | 1300 | 32050 |
| 7L-6S | | MI | 11329 | 4846 | 18186 | 3489 | 19494 | 2924 | 20124 | 2458 | 20755 | 1736 | 24215 | 1202 | 15125 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

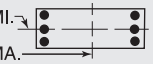



$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#10 | 2.43 | MA | 22798 | 4846 | 35168 | 3701 | 38461 | 3116 | 40087 | 2637 | 41595 | 1899 | 49059 | 1263 | 31674 |
| 8L-5S | | MI | 11415 | 4846 | 18446 | 3483 | 19849 | 2918 | 20565 | 2453 | 21347 | 1722 | 24995 | 1261 | 15242 |
| 22-#10 | 2.43 | MA | 22586 | 4846 | 34585 | 3709 | 37693 | 3125 | 39131 | 2656 | 40312 | 1918 | 47453 | 1223 | 31114 |
| 9L-4S | | MI | 11537 | 4846 | 18714 | 3474 | 20205 | 2900 | 21010 | 2436 | 22005 | 1720 | 25850 | 1311 | 15231 |
| 22-#10 | 2.43 | MA | 22321 | 4846 | 33922 | 3727 | 36924 | 3146 | 38174 | 2665 | 38947 | 1925 | 45804 | 1191 | 30486 |
| 10L-3S | | MI | 11608 | 4846 | 19032 | 3455 | 20618 | 2893 | 21517 | 2431 | 22665 | 1706 | 26703 | 1363 | 15216 |
| 22-#10 | 2.43 | MA | 22082 | 4846 | 33340 | 3735 | 36135 | 3153 | 37243 | 2686 | 37663 | 1944 | 44203 | 1151 | 29799 |
| 11L-2S | | MI | 11750 | 4846 | 19449 | 3447 | 21152 | 2875 | 22169 | 2414 | 23552 | 1692 | 27930 | 1452 | 15198 |
| 22-#11 | 2.98 | MA | 23779 | 5023 | 37307 | 3804 | 41187 | 3179 | 43392 | 2686 | 45947 | 1872 | 55066 | 1212 | 38607 |
| 7L-6S | | MI | 11629 | 5023 | 18887 | 3593 | 20340 | 2988 | 21123 | 2492 | 22096 | 1710 | 25852 | 1079 | 17998 |
| 22-#11 | 2.98 | MA | 23486 | 5023 | 36600 | 3815 | 40207 | 3203 | 42182 | 2694 | 44408 | 1897 | 53036 | 1164 | 38009 |
| 8L-5S | | MI | 11731 | 5023 | 19221 | 3572 | 20769 | 2981 | 21657 | 2486 | 22813 | 1694 | 26774 | 1149 | 18238 |
| 22-#11 | 2.98 | MA | 23231 | 5023 | 35895 | 3824 | 39271 | 3213 | 41016 | 2717 | 42861 | 1921 | 51067 | 1115 | 37092 |
| 9L-4S | | MI | 11875 | 5023 | 19545 | 3562 | 21200 | 2959 | 22195 | 2467 | 23608 | 1693 | 27781 | 1211 | 18298 |
| 22-#11 | 2.98 | MA | 22914 | 5023 | 35087 | 3847 | 38332 | 3239 | 39848 | 2728 | 41196 | 1928 | 49048 | 1075 | 36224 |
| 10L-3S | | MI | 11956 | 5023 | 19930 | 3539 | 21699 | 2952 | 22808 | 2462 | 24407 | 1678 | 28791 | 1272 | 18284 |
| 22-#11 | 2.98 | MA | 22625 | 5023 | 34377 | 3856 | 37378 | 3247 | 38711 | 2752 | 39629 | 1951 | 47090 | 1024 | 35170 |
| 11L-2S | | MI | 12123 | 5023 | 20431 | 3530 | 22342 | 2931 | 23592 | 2442 | 25473 | 1662 | 30236 | 1382 | 18265 |
| 22-#14 | 4.30 | MA | 25169 | 5443 | 39948 | 4109 | 44421 | 3430 | 47299 | 2849 | 51336 | 1909 | 62891 | 949 | 52161 |
| 8L-5S | | MI | 12535 | 5443 | 21061 | 3830 | 23071 | 3171 | 24438 | 2602 | 26577 | 1659 | 31647 | 935 | 25081 |
| 22-#14 | 4.30 | MA | 24811 | 5443 | 38943 | 4123 | 43077 | 3446 | 45625 | 2882 | 49135 | 1943 | 60052 | 877 | 50536 |
| 9L-4S | | MI | 12735 | 5443 | 21524 | 3818 | 23687 | 3142 | 25206 | 2575 | 27710 | 1658 | 33055 | 1026 | 25618 |
| 22-#14 | 4.30 | MA | 24362 | 5443 | 37783 | 4155 | 41730 | 3482 | 43950 | 2896 | 46746 | 1954 | 57149 | 817 | 48843 |
| 10L-3S | | MI | 12845 | 5443 | 22073 | 3785 | 24398 | 3132 | 26079 | 2569 | 28847 | 1638 | 34472 | 1111 | 25651 |
| 24-#10 | 2.65 | MA | 23237 | 4917 | 36111 | 3745 | 39671 | 3147 | 41563 | 2656 | 43603 | 1894 | 51839 | 1255 | 34597 |
| 8L-6S | | MI | 11509 | 4917 | 18602 | 3533 | 20028 | 2956 | 20776 | 2478 | 21642 | 1730 | 25442 | 1194 | 16396 |
| 24-#10 | 2.65 | MA | 23028 | 4917 | 35529 | 3753 | 38903 | 3156 | 40607 | 2675 | 42320 | 1912 | 50234 | 1215 | 34021 |
| 9L-5S | | MI | 11594 | 4917 | 18863 | 3527 | 20383 | 2949 | 21217 | 2472 | 22234 | 1717 | 26222 | 1253 | 16544 |
| 24-#10 | 2.65 | MA | 22764 | 4917 | 34866 | 3771 | 38134 | 3177 | 39650 | 2684 | 40955 | 1919 | 48584 | 1183 | 33396 |
| 10L-4S | | MI | 11715 | 4917 | 19130 | 3518 | 20739 | 2931 | 21662 | 2456 | 22891 | 1714 | 27077 | 1304 | 16538 |
| 24-#10 | 2.65 | MA | 22528 | 4917 | 34284 | 3779 | 37345 | 3184 | 38719 | 2705 | 39672 | 1938 | 46984 | 1144 | 32698 |
| 11L-3S | | MI | 11786 | 4917 | 19449 | 3499 | 21152 | 2924 | 22169 | 2450 | 23552 | 1700 | 27930 | 1355 | 16526 |
| 24-#10 | 2.65 | MA | 22303 | 4917 | 33653 | 3799 | 36553 | 3203 | 37795 | 2725 | 38404 | 1957 | 45156 | 1094 | 31938 |
| 12L-2S | | MI | 11927 | 4917 | 19866 | 3491 | 21686 | 2906 | 22821 | 2433 | 24439 | 1687 | 29157 | 1444 | 16510 |
| 24-#11 | 3.25 | MA | 24016 | 5109 | 37749 | 3869 | 41680 | 3241 | 43978 | 2718 | 46852 | 1890 | 56421 | 1155 | 41539 |
| 8L-6S | | MI | 11843 | 5109 | 19389 | 3647 | 20983 | 3027 | 21907 | 2515 | 23163 | 1703 | 27298 | 1066 | 19527 |
| 24-#11 | 3.25 | MA | 23765 | 5109 | 37044 | 3878 | 40743 | 3252 | 42812 | 2741 | 45305 | 1914 | 54451 | 1105 | 40627 |
| 9L-5S | | MI | 11944 | 5109 | 19722 | 3626 | 21412 | 3019 | 22441 | 2510 | 23880 | 1688 | 28219 | 1136 | 19756 |
| 24-#11 | 3.25 | MA | 23449 | 5109 | 36236 | 3900 | 39805 | 3278 | 41645 | 2751 | 43640 | 1921 | 52433 | 1065 | 39743 |
| 10L-4S | | MI | 12088 | 5109 | 20046 | 3616 | 21843 | 2998 | 22979 | 2491 | 24675 | 1686 | 29226 | 1198 | 19866 |
| 24-#11 | 3.25 | MA | 23164 | 5109 | 35526 | 3910 | 38851 | 3286 | 40508 | 2776 | 42073 | 1944 | 50474 | 1014 | 38694 |
| 11L-3S | | MI | 12168 | 5109 | 20431 | 3593 | 22342 | 2991 | 23592 | 2485 | 25473 | 1671 | 30236 | 1259 | 19857 |
| 24-#11 | 3.25 | MA | 22895 | 5109 | 34757 | 3935 | 37885 | 3309 | 39393 | 2801 | 40526 | 1967 | 48233 | 953 | 37582 |
| 12L-2S | | MI | 12333 | 5109 | 20933 | 3584 | 22985 | 2970 | 24376 | 2466 | 26540 | 1655 | 31681 | 1369 | 19841 |
| 24-#14 | 4.69 | MA | 25571 | 5567 | 40589 | 4201 | 45187 | 3501 | 48199 | 2916 | 52637 | 1933 | 64901 | 863 | 55559 |
| 9L-5S | | MI | 12835 | 5567 | 21773 | 3908 | 23984 | 3227 | 25552 | 2636 | 28092 | 1649 | 33667 | 913 | 27241 |
| 24-#14 | 4.69 | MA | 25124 | 5567 | 39429 | 4233 | 43839 | 3538 | 46524 | 2930 | 50248 | 1944 | 61998 | 803 | 53844 |
| 10L-4S | | MI | 13033 | 5567 | 22236 | 3896 | 24600 | 3197 | 26320 | 2609 | 29226 | 1648 | 35075 | 1003 | 27809 |

## RECTANGULAR TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.63 | MA | 4576 | 1868 | 7077 | 1483 | 8143 | 1197 | 8629 | 975 | 9117 | 641 | 10930 | 565 | 6270 |
| 2L-3S | | MI | 4071 | 1868 | 6419 | 1479 | 7321 | 1191 | 7653 | 980 | 7832 | 646 | 9267 | 474 | 6264 |
| 6-#14 | 2.34 | MA | 4921 | 2018 | 7941 | 1569 | 9155 | 1253 | 9818 | 1003 | 10672 | 612 | 12904 | 508 | 8786 |
| 2L-3S | | MI | 4220 | 2018 | 7006 | 1562 | 7998 | 1246 | 8443 | 1011 | 8864 | 620 | 10574 | 376 | 8694 |
| 6-#18 | 4.17 | MA | 5697 | 2400 | 9962 | 1783 | 11566 | 1394 | 12654 | 1071 | 14391 | 533 | 17563 | 346 | 14854 |
| 2L-3S | | MI | 4568 | 2400 | 8374 | 1769 | 9610 | 1380 | 10331 | 1084 | 11333 | 547 | 13663 | 112 | 13290 |
| 8-#11 | 2.17 | MA | 4861 | 1981 | 7736 | 1554 | 8965 | 1247 | 9606 | 1004 | 10402 | 627 | 12593 | 533 | 8232 |
| 2L-4S | | MI | 3995 | 1981 | 6578 | 1546 | 7482 | 1247 | 7848 | 1004 | 8128 | 637 | 9833 | 358 | 7728 |
| 8-#14 | 3.13 | MA | 5309 | 2182 | 8877 | 1671 | 10312 | 1325 | 11192 | 1044 | 12481 | 591 | 15233 | 458 | 11548 |
| 2L-4S | | MI | 4112 | 2182 | 7230 | 1657 | 8225 | 1325 | 8718 | 1044 | 9281 | 606 | 11363 | 208 | 10208 |
| 8-#18 | 5.56 | MA | 6302 | 2691 | 11551 | 1962 | 13521 | 1516 | 14978 | 1138 | 17450 | 488 | 21463 | 245 | 19560 |
| 2L-4S | | MI | 4395 | 2691 | 8753 | 1935 | 9992 | 1516 | 10795 | 1138 | 12038 | 515 | 14972 | -191 | 14345 |
| 10-#11 | 2.71 | MA | 5140 | 2095 | 8395 | 1625 | 9787 | 1297 | 10582 | 1033 | 11687 | 613 | 14256 | 501 | 10180 |
| 2L-5S | | MI | 3956 | 2095 | 6728 | 1623 | 7708 | 1292 | 8117 | 1038 | 8450 | 618 | 10336 | 282 | 9091 |
| 10-#11 | 2.71 | MA | 4652 | 2095 | 7736 | 1621 | 8965 | 1292 | 9606 | 1038 | 10402 | 618 | 12593 | 410 | 10115 |
| 3L-4S | | MI | 4289 | 2095 | 7236 | 1617 | 8304 | 1297 | 8825 | 1033 | 9413 | 623 | 11496 | 326 | 9534 |
| 10-#14 | 3.91 | MA | 5686 | 2345 | 9813 | 1773 | 11469 | 1396 | 12566 | 1084 | 14290 | 569 | 17563 | 409 | 14295 |
| 2L-5S | | MI | 4075 | 2345 | 7441 | 1767 | 8542 | 1389 | 9096 | 1092 | 9734 | 576 | 12068 | 95 | 11683 |
| 10-#14 | 3.91 | MA | 5029 | 2345 | 8877 | 1766 | 10312 | 1389 | 11192 | 1092 | 12481 | 576 | 15233 | 278 | 14005 |
| 3L-4S | | MI | 4533 | 2345 | 8165 | 1759 | 9382 | 1396 | 10093 | 1084 | 11089 | 584 | 13693 | 159 | 12787 |
| 10-#18 | 6.94 | MA | 5846 | 2981 | 11551 | 2127 | 13521 | 1626 | 14978 | 1218 | 17450 | 456 | 21463 | -89 | 20982 |
| 3L-4S | | MI | 5056 | 2981 | 10341 | 2114 | 11948 | 1639 | 13118 | 1205 | 15097 | 469 | 18872 | -292 | 17688 |

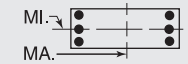
## RECTANGULAR TIED COLUMNS 24" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.00 | MA | 5000 | 1882 | 7387 | 1532 | 8493 | 1247 | 8889 | 1032 | 9085 | 722 | 10775 | 665 | 4710 |
| 2E | | MI | 4590 | 1882 | 6844 | 1518 | 7794 | 1233 | 8128 | 1020 | 8270 | 712 | 9763 | 651 | 4313 |
| 4-#14 | 1.44 | MA | 5270 | 1982 | 8041 | 1586 | 9260 | 1283 | 9785 | 1051 | 10254 | 704 | 12269 | 630 | 6604 |
| 2E | | MI | 4828 | 1982 | 7433 | 1572 | 8472 | 1268 | 8918 | 1036 | 9301 | 691 | 11067 | 612 | 6027 |
| 4-#18 | 2.56 | MA | 5893 | 2236 | 9625 | 1728 | 11098 | 1376 | 11937 | 1096 | 13069 | 654 | 15829 | 530 | 11195 |
| 2E | | MI | 5376 | 2236 | 8807 | 1707 | 10084 | 1356 | 10804 | 1077 | 11767 | 634 | 14151 | 500 | 10163 |
| 6-#11 | 1.50 | MA | 5331 | 1995 | 8117 | 1603 | 9415 | 1298 | 9984 | 1062 | 10527 | 710 | 12654 | 637 | 6902 |
| 2L-3S | | MI | 4378 | 1995 | 6844 | 1585 | 7794 | 1279 | 8128 | 1054 | 8270 | 703 | 9763 | 529 | 6304 |
| 6-#11 | 1.50 | MA | 4769 | 1995 | 7387 | 1599 | 8493 | 1293 | 8889 | 1068 | 9085 | 715 | 10775 | 546 | 6896 |
| 3L-2S | | MI | 4885 | 1995 | 7502 | 1589 | 8616 | 1284 | 9104 | 1049 | 9555 | 698 | 11426 | 620 | 6299 |
| 6-#14 | 2.16 | MA | 5723 | 2146 | 9079 | 1688 | 10562 | 1357 | 11330 | 1093 | 12288 | 685 | 14909 | 586 | 9697 |
| 2L-3S | | MI | 4527 | 2146 | 7433 | 1667 | 8472 | 1332 | 8918 | 1084 | 9301 | 676 | 11067 | 431 | 8756 |
| 6-#14 | 2.16 | MA | 4942 | 2146 | 8041 | 1683 | 9260 | 1349 | 9785 | 1101 | 10254 | 692 | 12269 | 455 | 9605 |
| 3L-2S | | MI | 5232 | 2146 | 8369 | 1674 | 9629 | 1340 | 10292 | 1077 | 11110 | 669 | 13397 | 562 | 8824 |
| 6-#18 | 3.85 | MA | 6622 | 2527 | 11419 | 1910 | 13310 | 1503 | 14564 | 1167 | 16527 | 614 | 20277 | 440 | 16474 |
| 2L-3S | | MI | 4877 | 2527 | 8807 | 1873 | 10084 | 1466 | 10804 | 1157 | 11767 | 602 | 14151 | 166 | 13586 |
| 6-#18 | 3.85 | MA | 5356 | 2527 | 9625 | 1897 | 11098 | 1489 | 11937 | 1180 | 13069 | 627 | 15829 | 207 | 15072 |
| 3L-2S | | MI | 6017 | 2527 | 10395 | 1886 | 12040 | 1479 | 13128 | 1144 | 14826 | 589 | 18051 | 399 | 14911 |
| 8-#11 | 2.00 | MA | 5653 | 2108 | 8846 | 1674 | 10338 | 1350 | 11080 | 1093 | 11968 | 698 | 14532 | 609 | 9075 |
| 2L-4S | | MI | 4301 | 2108 | 7003 | 1652 | 7955 | 1334 | 8324 | 1078 | 8567 | 694 | 10328 | 413 | 7871 |
| 8-#11 | 2.00 | MA | 5101 | 2108 | 8117 | 1670 | 9415 | 1345 | 9984 | 1098 | 10527 | 703 | 12654 | 518 | 9036 |
| 3E | | MI | 4674 | 2108 | 7502 | 1656 | 8616 | 1329 | 9104 | 1083 | 9555 | 689 | 11426 | 497 | 8240 |
| 8-#11 | 2.00 | MA | 4691 | 2108 | 7565 | 1667 | 8674 | 1350 | 9109 | 1093 | 9418 | 709 | 11418 | 432 | 8625 |
| 4L-2S | | MI | 5172 | 2108 | 8161 | 1660 | 9438 | 1334 | 10081 | 1078 | 10840 | 684 | 13089 | 588 | 8266 |
| 8-#14 | 2.88 | MA | 6163 | 2309 | 10117 | 1790 | 11863 | 1430 | 12876 | 1136 | 14322 | 666 | 17548 | 542 | 12763 |
| 2L-4S | | MI | 4417 | 2309 | 7657 | 1762 | 8699 | 1411 | 9193 | 1117 | 9718 | 662 | 11856 | 263 | 10380 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

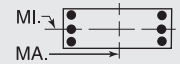



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.88 | MA | 5399 | 2309 | 9079 | 1785 | 10562 | 1423 | 11330 | 1143 | 12288 | 673 | 14909 | 411 | 12613 |
| 3E | | MI | 4933 | 2309 | 8369 | 1769 | 9629 | 1404 | 10292 | 1125 | 11110 | 655 | 13397 | 382 | 11468 |
| 8-#14 | 2.88 | MA | 4831 | 2309 | 8293 | 1779 | 9516 | 1430 | 10094 | 1136 | 10723 | 681 | 13169 | 288 | 11406 |
| 4L-2S | | MI | 5623 | 2309 | 9305 | 1776 | 10786 | 1411 | 11666 | 1117 | 12918 | 647 | 15726 | 513 | 11591 |
| 8-#18 | 5.13 | MA | 7311 | 2818 | 13213 | 2092 | 15522 | 1629 | 17192 | 1238 | 19985 | 574 | 24725 | 351 | 21720 |
| 2L-4S | | MI | 4698 | 2818 | 9186 | 2039 | 10467 | 1602 | 11268 | 1210 | 12473 | 570 | 15460 | -137 | 15011 |
| 8-#18 | 5.13 | MA | 6095 | 2818 | 11419 | 2079 | 13310 | 1616 | 14564 | 1252 | 16527 | 587 | 20277 | 117 | 19804 |
| 3E | | MI | 5531 | 2818 | 10395 | 2052 | 12040 | 1589 | 13128 | 1224 | 14826 | 557 | 18051 | 65 | 17806 |
| 8-#18 | 5.13 | MA | 5177 | 2818 | 10053 | 2066 | 11531 | 1629 | 12463 | 1238 | 13866 | 601 | 17334 | -93 | 16972 |
| 4L-2S | | MI | 6627 | 2818 | 11984 | 2065 | 13996 | 1602 | 15452 | 1210 | 17885 | 544 | 21952 | 299 | 19623 |
| 10-#11 | 2.50 | MA | 5968 | 2222 | 9576 | 1744 | 11260 | 1401 | 12175 | 1123 | 13410 | 686 | 16411 | 581 | 11233 |
| 2L-5S | | MI | 4261 | 2222 | 7154 | 1729 | 8181 | 1379 | 8592 | 1112 | 8889 | 675 | 10831 | 337 | 9234 |
| 10-#11 | 2.50 | MA | 5425 | 2222 | 8846 | 1741 | 10338 | 1396 | 11080 | 1128 | 11968 | 691 | 14532 | 490 | 11168 |
| 3L-4S | | MI | 4596 | 2222 | 7662 | 1723 | 8777 | 1385 | 9300 | 1107 | 9852 | 680 | 11991 | 381 | 9674 |
| 10-#11 | 2.50 | MA | 5023 | 2222 | 8295 | 1738 | 9597 | 1401 | 10204 | 1123 | 10859 | 696 | 13296 | 403 | 10630 |
| 4L-3S | | MI | 4962 | 2222 | 8161 | 1727 | 9438 | 1379 | 10081 | 1112 | 10840 | 675 | 13089 | 465 | 10166 |
| 10-#11 | 2.50 | MA | 4655 | 2222 | 7735 | 1745 | 8927 | 1396 | 9410 | 1128 | 9780 | 691 | 11986 | 360 | 10112 |
| 5L-2S | | MI | 5453 | 2222 | 8820 | 1731 | 10260 | 1385 | 11057 | 1107 | 12125 | 670 | 14752 | 556 | 10218 |
| 10-#14 | 3.61 | MA | 6593 | 2473 | 11155 | 1893 | 13165 | 1503 | 14422 | 1178 | 16356 | 647 | 20188 | 498 | 15814 |
| 2L-5S | | MI | 4362 | 2473 | 7869 | 1872 | 9016 | 1475 | 9571 | 1165 | 10171 | 633 | 12561 | 150 | 11943 |
| 10-#14 | 3.61 | MA | 5844 | 2473 | 10117 | 1887 | 11863 | 1496 | 12876 | 1186 | 14322 | 654 | 17548 | 367 | 15614 |
| 3L-4S | | MI | 4823 | 2473 | 8593 | 1864 | 9855 | 1483 | 10567 | 1158 | 11527 | 640 | 14186 | 213 | 12954 |
| 10-#14 | 3.61 | MA | 5288 | 2473 | 9331 | 1882 | 10817 | 1503 | 11640 | 1178 | 12757 | 662 | 15808 | 244 | 14273 |
| 4L-3S | | MI | 5342 | 2473 | 9305 | 1872 | 10786 | 1475 | 11666 | 1165 | 12918 | 633 | 15726 | 332 | 14172 |
| 10-#14 | 3.61 | MA | 4782 | 2473 | 8532 | 1891 | 9873 | 1496 | 10520 | 1186 | 11233 | 654 | 13968 | 182 | 13155 |
| 5L-2S | | MI | 6007 | 2473 | 10241 | 1879 | 11942 | 1483 | 13040 | 1158 | 14727 | 625 | 18056 | 464 | 14343 |
| 10-#18 | 6.41 | MA | 6807 | 3109 | 13213 | 2260 | 15522 | 1742 | 17192 | 1323 | 19985 | 548 | 24725 | 28 | 24604 |
| 3L-4S | | MI | 5362 | 3109 | 10774 | 2218 | 12423 | 1725 | 13592 | 1277 | 15532 | 525 | 19360 | -238 | 18399 |
| 10-#18 | 6.41 | MA | 5926 | 3109 | 11847 | 2247 | 13743 | 1756 | 15090 | 1309 | 17324 | 561 | 21782 | -182 | 20905 |
| 4L-3S | | MI | 6163 | 3109 | 11984 | 2231 | 13996 | 1712 | 15452 | 1291 | 17885 | 512 | 21952 | -35 | 21766 |
| 12-#11 | 3.00 | MA | 6277 | 2335 | 10306 | 1815 | 12183 | 1453 | 13271 | 1154 | 14851 | 674 | 18289 | 553 | 13384 |
| 2L-6S | | MI | 4239 | 2335 | 7359 | 1795 | 8413 | 1435 | 8871 | 1136 | 9279 | 666 | 11415 | 243 | 10345 |
| 12-#11 | 3.00 | MA | 5742 | 2335 | 9576 | 1812 | 11260 | 1448 | 12175 | 1159 | 13410 | 679 | 16411 | 462 | 13294 |
| 3L-5S | | MI | 4555 | 2335 | 7812 | 1800 | 9003 | 1430 | 9568 | 1141 | 10174 | 661 | 12494 | 306 | 11076 |
| 12-#11 | 3.00 | MA | 5346 | 2335 | 9025 | 1809 | 10519 | 1453 | 11300 | 1154 | 12301 | 684 | 15175 | 375 | 12651 |
| 4E | | MI | 4884 | 2335 | 8320 | 1793 | 9599 | 1435 | 10276 | 1136 | 11136 | 666 | 13654 | 349 | 11493 |
| 12-#11 | 3.00 | MA | 4985 | 2335 | 8465 | 1816 | 9850 | 1448 | 10506 | 1159 | 11221 | 679 | 13865 | 332 | 12167 |
| 5L-3S | | MI | 5245 | 2335 | 8820 | 1798 | 10260 | 1430 | 11057 | 1141 | 12125 | 661 | 14752 | 434 | 12086 |
| 12-#11 | 3.00 | MA | 4639 | 2335 | 7965 | 1813 | 9188 | 1453 | 9723 | 1154 | 10217 | 684 | 12644 | 270 | 11347 |
| 6L-2S | | MI | 5729 | 2335 | 9479 | 1802 | 11082 | 1435 | 12033 | 1136 | 13410 | 656 | 16415 | 525 | 12161 |
| 12-#14 | 4.33 | MA | 6292 | 2636 | 11155 | 1989 | 13165 | 1569 | 14422 | 1228 | 16356 | 635 | 20188 | 323 | 18555 |
| 3L-5S | | MI | 4787 | 2636 | 8805 | 1975 | 10173 | 1547 | 10945 | 1206 | 11980 | 611 | 14891 | 100 | 14458 |
| 12-#14 | 4.33 | MA | 5756 | 2636 | 10369 | 1984 | 12119 | 1577 | 13186 | 1221 | 14791 | 643 | 18448 | 201 | 17160 |
| 4E | | MI | 5237 | 2636 | 9529 | 1967 | 11012 | 1554 | 11941 | 1198 | 13335 | 619 | 16515 | 164 | 15547 |
| 12-#14 | 4.33 | MA | 5263 | 2636 | 9570 | 1993 | 11175 | 1569 | 12065 | 1228 | 13267 | 635 | 16607 | 138 | 15964 |
| 5L-3S | | MI | 5724 | 2636 | 10241 | 1974 | 11942 | 1547 | 13040 | 1206 | 14727 | 611 | 18056 | 283 | 16727 |
| 12-#18 | 7.69 | MA | 6651 | 3400 | 13641 | 2429 | 15955 | 1882 | 17717 | 1381 | 20783 | 521 | 26230 | -272 | 24700 |
| 4E | | MI | 6005 | 3400 | 12363 | 2397 | 14379 | 1848 | 15916 | 1344 | 18591 | 480 | 23261 | -338 | 21663 |
| 14-#11 | 3.50 | MA | 6054 | 2449 | 10306 | 1883 | 12183 | 1499 | 13271 | 1189 | 14851 | 667 | 18289 | 434 | 15416 |
| 3L-6S | | MI | 4532 | 2449 | 8017 | 1866 | 9235 | 1485 | 9847 | 1165 | 10564 | 653 | 13078 | 211 | 12156 |
| 14-#11 | 3.50 | MA | 5664 | 2449 | 9754 | 1880 | 11442 | 1505 | 12395 | 1184 | 13742 | 672 | 17053 | 347 | 14684 |
| 4L-5S | | MI | 4843 | 2449 | 8471 | 1870 | 9825 | 1480 | 10545 | 1170 | 11459 | 647 | 14157 | 274 | 12849 |
| 14-#11 | 3.50 | MA | 5308 | 2449 | 9194 | 1887 | 10772 | 1499 | 11601 | 1189 | 12663 | 667 | 15743 | 304 | 14171 |
| 5L-4S | | MI | 5168 | 2449 | 8979 | 1864 | 10421 | 1485 | 11252 | 1165 | 12421 | 653 | 15317 | 318 | 13323 |
| 14-#11 | 3.50 | MA | 4967 | 2449 | 8695 | 1884 | 10111 | 1505 | 10818 | 1184 | 11659 | 672 | 14522 | 242 | 13363 |
| 6L-3S | | MI | 5523 | 2449 | 9479 | 1869 | 11082 | 1480 | 12033 | 1170 | 13410 | 647 | 16415 | 402 | 14001 |
| 14-#14 | 5.05 | MA | 6189 | 2800 | 11407 | 2086 | 13420 | 1650 | 14732 | 1263 | 16825 | 624 | 21088 | 157 | 20062 |
| 4L-5S | | MI | 5184 | 2800 | 9741 | 2077 | 11330 | 1618 | 12319 | 1246 | 13788 | 589 | 17220 | 51 | 16992 |

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 5.05 | MA | 5709 | 2800 | 10608 | 2095 | 12476 | 1643 | 13611 | 1271 | 15302 | 616 | 19247 | 94 | 18792 |
| 5L-4S | | MI | 5621 | 2800 | 10465 | 2069 | 12169 | 1626 | 13315 | 1239 | 15144 | 597 | 18845 | 115 | 18155 |
| 16-#11 | 4.00 | MA | 5976 | 2562 | 10484 | 1951 | 12364 | 1556 | 13491 | 1214 | 15184 | 660 | 18932 | 319 | 16726 |
| 4L-6S | | MI | 4820 | 2562 | 8676 | 1937 | 10057 | 1536 | 10823 | 1194 | 11849 | 639 | 14741 | 180 | 13977 |
| 16-#11 | 4.00 | MA | 5626 | 2562 | 9924 | 1958 | 11695 | 1551 | 12697 | 1219 | 14104 | 655 | 17622 | 276 | 16159 |
| 5E | | MI | 5127 | 2562 | 9130 | 1941 | 10647 | 1531 | 11521 | 1199 | 12743 | 633 | 15820 | 242 | 14633 |
| 16-#11 | 4.00 | MA | 5290 | 2562 | 9425 | 1954 | 11033 | 1556 | 11914 | 1214 | 13100 | 660 | 16401 | 214 | 15389 |
| 6L-4S | | MI | 5446 | 2562 | 9638 | 1935 | 11243 | 1536 | 12229 | 1194 | 13706 | 639 | 16980 | 286 | 15162 |
| 16-#14 | 5.77 | MA | 6144 | 2963 | 11646 | 2198 | 13778 | 1716 | 15157 | 1313 | 17336 | 597 | 21886 | 50 | 21635 |
| 5E | | MI | 5571 | 2963 | 10676 | 2179 | 12487 | 1690 | 13693 | 1286 | 15597 | 567 | 19550 | 2 | 19541 |
| 18-#11 | 4.50 | MA | 5963 | 2676 | 10654 | 2029 | 12617 | 1603 | 13792 | 1250 | 15546 | 643 | 19500 | 248 | 18156 |
| 5L-6S | | MI | 5123 | 2676 | 9335 | 2008 | 10879 | 1586 | 11799 | 1223 | 13134 | 625 | 16404 | 148 | 15804 |
| 18-#11 | 4.50 | MA | 5608 | 2675 | 10154 | 2025 | 11956 | 1608 | 13009 | 1245 | 14542 | 648 | 18279 | 185 | 17422 |
| 6L-5S | | MI | 5424 | 2675 | 9789 | 2012 | 11469 | 1581 | 12497 | 1228 | 14028 | 620 | 17483 | 211 | 16428 |
| 20-#11 | 5.00 | MA | 5946 | 2789 | 10884 | 2096 | 12878 | 1659 | 14105 | 1275 | 15983 | 636 | 20157 | 157 | 19461 |
| 6E | | MI | 5402 | 2789 | 9994 | 2079 | 11701 | 1637 | 12776 | 1252 | 14419 | 611 | 18067 | 116 | 17606 |

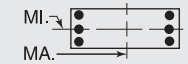
## RECTANGULAR TIED COLUMNS 24" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.34 | MA | 6071 | 2109 | 9136 | 1705 | 10597 | 1384 | 11206 | 1137 | 11722 | 773 | 14055 | 701 | 7211 |
| 2E | | MI | 5137 | 2109 | 7861 | 1677 | 8945 | 1355 | 9393 | 1110 | 9738 | 747 | 11560 | 666 | 6058 |
| 4-#18 | 2.38 | MA | 6776 | 2364 | 10887 | 1848 | 12663 | 1480 | 13624 | 1187 | 14884 | 727 | 18090 | 610 | 12275 |
| 2E | | MI | 5687 | 2364 | 9240 | 1811 | 10559 | 1441 | 11278 | 1149 | 12202 | 690 | 14640 | 554 | 10210 |
| 6-#11 | 1.39 | MA | 6138 | 2122 | 9216 | 1722 | 10740 | 1397 | 11420 | 1149 | 12015 | 779 | 14468 | 708 | 7533 |
| 2L-3S | | MI | 4685 | 2122 | 7269 | 1691 | 8267 | 1366 | 8603 | 1128 | 8709 | 760 | 10258 | 584 | 6342 |
| 6-#11 | 1.39 | MA | 5519 | 2122 | 8415 | 1720 | 9725 | 1393 | 10205 | 1154 | 10416 | 784 | 12374 | 617 | 7528 |
| 3L-2S | | MI | 5194 | 2122 | 7928 | 1695 | 9089 | 1371 | 9579 | 1123 | 9994 | 755 | 11921 | 675 | 6327 |
| 6-#14 | 2.01 | MA | 6579 | 2273 | 10276 | 1808 | 12043 | 1459 | 12924 | 1182 | 13982 | 756 | 17006 | 662 | 10608 |
| 2L-3S | | MI | 4834 | 2273 | 7861 | 1772 | 8945 | 1419 | 9393 | 1158 | 9738 | 733 | 11560 | 485 | 8813 |
| 6-#14 | 2.01 | MA | 5717 | 2273 | 9136 | 1803 | 10597 | 1452 | 11206 | 1189 | 11722 | 763 | 14055 | 530 | 10516 |
| 3L-2S | | MI | 5542 | 2273 | 8797 | 1779 | 10102 | 1426 | 10767 | 1150 | 11547 | 725 | 13890 | 617 | 8860 |
| 6-#18 | 3.57 | MA | 7598 | 2654 | 12863 | 2029 | 15132 | 1610 | 16557 | 1261 | 18743 | 692 | 23089 | 530 | 18094 |
| 2L-3S | | MI | 5185 | 2654 | 9240 | 1977 | 10559 | 1551 | 11278 | 1229 | 12202 | 658 | 14640 | 220 | 13874 |
| 6-#18 | 3.57 | MA | 6171 | 2654 | 10887 | 2019 | 12663 | 1597 | 13624 | 1274 | 14884 | 705 | 18090 | 296 | 16905 |
| 3L-2S | | MI | 6336 | 2654 | 10828 | 1990 | 12515 | 1564 | 13602 | 1216 | 15261 | 645 | 18540 | 453 | 14966 |
| 8-#11 | 1.86 | MA | 6498 | 2236 | 10016 | 1793 | 11755 | 1449 | 12635 | 1181 | 13613 | 768 | 16563 | 683 | 9917 |
| 2L-4S | | MI | 4607 | 2236 | 7428 | 1758 | 8428 | 1421 | 8799 | 1152 | 9005 | 751 | 10823 | 468 | 8009 |
| 8-#11 | 1.86 | MA | 5889 | 2236 | 9216 | 1790 | 10740 | 1445 | 11420 | 1186 | 12015 | 773 | 14468 | 592 | 9879 |
| 3E | | MI | 4981 | 2236 | 7928 | 1762 | 9089 | 1416 | 9579 | 1157 | 9994 | 746 | 11921 | 552 | 8284 |
| 8-#11 | 1.86 | MA | 5440 | 2236 | 8613 | 1788 | 9926 | 1451 | 10449 | 1181 | 10784 | 779 | 13094 | 504 | 9539 |
| 4L-2S | | MI | 5482 | 2236 | 8586 | 1766 | 9911 | 1421 | 10556 | 1152 | 11279 | 741 | 13584 | 643 | 8298 |
| 8-#14 | 2.68 | MA | 7071 | 2436 | 11416 | 1910 | 13489 | 1534 | 14642 | 1226 | 16243 | 739 | 19957 | 623 | 13978 |
| 2L-4S | | MI | 4723 | 2436 | 8085 | 1867 | 9172 | 1498 | 9668 | 1191 | 10155 | 719 | 12349 | 317 | 10545 |
| 8-#14 | 2.68 | MA | 6228 | 2436 | 10276 | 1906 | 12043 | 1527 | 12924 | 1234 | 13982 | 747 | 17006 | 491 | 13828 |
| 3E | | MI | 5242 | 2436 | 8797 | 1874 | 10102 | 1490 | 10767 | 1198 | 11547 | 711 | 13890 | 436 | 11533 |
| 8-#14 | 2.68 | MA | 5604 | 2436 | 9415 | 1901 | 10882 | 1534 | 11551 | 1226 | 12243 | 754 | 15067 | 365 | 12624 |
| 4L-2S | | MI | 5937 | 2436 | 9733 | 1882 | 11259 | 1498 | 12141 | 1191 | 13355 | 704 | 16219 | 568 | 11634 |
| 8-#18 | 4.76 | MA | 8379 | 2945 | 14839 | 2211 | 17601 | 1739 | 19489 | 1336 | 22602 | 657 | 28087 | 450 | 23880 |
| 2L-4S | | MI | 5002 | 2945 | 9619 | 2143 | 10942 | 1687 | 11742 | 1283 | 12908 | 626 | 15949 | -84 | 15675 |
| 8-#18 | 4.76 | MA | 7028 | 2945 | 12863 | 2201 | 15132 | 1726 | 16557 | 1349 | 18743 | 670 | 23089 | 216 | 22143 |
| 3E | | MI | 5844 | 2945 | 10828 | 2156 | 12515 | 1674 | 13602 | 1296 | 15261 | 613 | 18540 | 119 | 18084 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

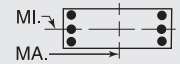



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 4.76 | MA | 6014 | 2945 | 11365 | 2190 | 13147 | 1739 | 14212 | 1336 | 15773 | 683 | 19792 | 0 | 19790 |
| 4L-2S | | MI | 6951 | 2945 | 12417 | 2169 | 14471 | 1687 | 15925 | 1283 | 18320 | 600 | 22440 | 353 | 19686 |
| 10-#11 | 2.32 | MA | 6850 | 2349 | 10817 | 1864 | 12771 | 1501 | 13850 | 1212 | 15212 | 758 | 18658 | 658 | 12286 |
| 2L-5S | | MI | 4566 | 2349 | 7579 | 1835 | 8654 | 1466 | 9067 | 1186 | 9327 | 732 | 11327 | 392 | 9356 |
| 10-#11 | 2.32 | MA | 6251 | 2349 | 10016 | 1861 | 11755 | 1497 | 12635 | 1218 | 13613 | 763 | 16563 | 567 | 12221 |
| 3L-4S | | MI | 4903 | 2349 | 8087 | 1828 | 9250 | 1472 | 9775 | 1181 | 10290 | 737 | 12486 | 436 | 9810 |
| 10-#11 | 2.32 | MA | 5809 | 2349 | 9413 | 1859 | 10941 | 1502 | 11664 | 1212 | 12383 | 768 | 15189 | 478 | 11744 |
| 4L-3S | | MI | 5272 | 2349 | 8586 | 1833 | 9911 | 1466 | 10556 | 1186 | 11279 | 732 | 13584 | 520 | 10215 |
| 10-#11 | 2.32 | MA | 5407 | 2349 | 8801 | 1867 | 10207 | 1498 | 10783 | 1218 | 11186 | 763 | 13728 | 436 | 11129 |
| 5L-2S | | MI | 5765 | 2349 | 9245 | 1837 | 10733 | 1472 | 11532 | 1181 | 12564 | 727 | 15247 | 611 | 10255 |
| 10-#14 | 3.35 | MA | 7551 | 2600 | 12556 | 2012 | 14935 | 1609 | 16359 | 1270 | 18503 | 722 | 22908 | 583 | 17333 |
| 2L-5S | | MI | 4665 | 2600 | 8297 | 1978 | 9490 | 1562 | 10046 | 1239 | 10608 | 689 | 13054 | 204 | 12196 |
| 10-#14 | 3.35 | MA | 6724 | 2600 | 11416 | 2008 | 13489 | 1601 | 14642 | 1278 | 16243 | 730 | 19957 | 452 | 17133 |
| 3L-4S | | MI | 5131 | 2600 | 9021 | 1970 | 10329 | 1569 | 11042 | 1231 | 11964 | 697 | 14679 | 268 | 13116 |
| 10-#14 | 3.35 | MA | 6114 | 2600 | 10556 | 2003 | 12328 | 1609 | 13269 | 1270 | 14503 | 737 | 18017 | 326 | 15781 |
| 4L-3S | | MI | 5640 | 2600 | 9733 | 1977 | 11259 | 1562 | 12141 | 1239 | 13355 | 689 | 16219 | 387 | 14243 |
| 10-#14 | 3.35 | MA | 5558 | 2600 | 9682 | 2014 | 11279 | 1602 | 12023 | 1278 | 12811 | 730 | 15960 | 264 | 14664 |
| 5L-2S | | MI | 6322 | 2600 | 10668 | 1984 | 12416 | 1569 | 13515 | 1231 | 15164 | 682 | 18549 | 518 | 14390 |
| 10-#18 | 5.95 | MA | 7827 | 3236 | 14839 | 2382 | 17601 | 1856 | 19489 | 1424 | 22602 | 635 | 28087 | 136 | 27449 |
| 3L-4S | | MI | 5668 | 3236 | 11208 | 2322 | 12898 | 1810 | 14066 | 1350 | 15966 | 581 | 19849 | -184 | 19106 |
| 10-#18 | 5.95 | MA | 6853 | 3236 | 13340 | 2372 | 15616 | 1869 | 17144 | 1411 | 19632 | 648 | 24790 | -81 | 24331 |
| 4L-3S | | MI | 6479 | 3236 | 12417 | 2335 | 14471 | 1797 | 15925 | 1363 | 18320 | 568 | 22440 | 19 | 22362 |
| 12-#11 | 2.79 | MA | 7195 | 2463 | 11617 | 1935 | 13786 | 1553 | 15065 | 1244 | 16810 | 747 | 20752 | 633 | 14647 |
| 2L-6S | | MI | 4543 | 2463 | 7784 | 1901 | 8886 | 1522 | 9346 | 1210 | 9718 | 723 | 11910 | 298 | 10529 |
| 12-#11 | 2.79 | MA | 6605 | 2463 | 10817 | 1932 | 12771 | 1548 | 13850 | 1249 | 15212 | 752 | 18658 | 542 | 14557 |
| 3L-5S | | MI | 4861 | 2463 | 8237 | 1905 | 9476 | 1517 | 10043 | 1215 | 10612 | 718 | 12989 | 361 | 11205 |
| 12-#11 | 2.79 | MA | 6170 | 2463 | 10214 | 1930 | 11957 | 1554 | 12879 | 1244 | 13981 | 758 | 17283 | 453 | 13965 |
| 4E | | MI | 5193 | 2463 | 8745 | 1899 | 10072 | 1522 | 10751 | 1210 | 11575 | 723 | 14149 | 404 | 11626 |
| 12-#11 | 2.79 | MA | 5774 | 2463 | 9602 | 1938 | 11222 | 1550 | 11998 | 1249 | 12785 | 752 | 15822 | 411 | 13388 |
| 5L-3S | | MI | 5556 | 2463 | 9245 | 1904 | 10733 | 1517 | 11532 | 1215 | 12564 | 718 | 15247 | 488 | 12138 |
| 12-#11 | 2.79 | MA | 5394 | 2463 | 9057 | 1935 | 10497 | 1556 | 11130 | 1244 | 11672 | 758 | 14459 | 349 | 12562 |
| 6L-2S | | MI | 6043 | 2463 | 9904 | 1908 | 11555 | 1522 | 12508 | 1210 | 13848 | 713 | 16910 | 580 | 12201 |
| 12-#14 | 4.02 | MA | 7209 | 2764 | 12556 | 2110 | 14935 | 1676 | 16359 | 1322 | 18503 | 713 | 22908 | 413 | 20434 |
| 3L-5S | | MI | 5093 | 2764 | 9233 | 2080 | 10647 | 1633 | 11420 | 1279 | 12417 | 668 | 15383 | 155 | 14706 |
| 12-#14 | 4.02 | MA | 6611 | 2764 | 11696 | 2106 | 13774 | 1684 | 14986 | 1315 | 16764 | 721 | 20968 | 287 | 18959 |
| 4E | | MI | 5547 | 2764 | 9957 | 2072 | 11486 | 1641 | 12416 | 1272 | 13772 | 675 | 17008 | 219 | 15706 |
| 12-#14 | 4.02 | MA | 6067 | 2764 | 10822 | 2116 | 12725 | 1676 | 13741 | 1322 | 15071 | 713 | 18910 | 225 | 17764 |
| 5L-3S | | MI | 6040 | 2764 | 10668 | 2079 | 12416 | 1633 | 13515 | 1279 | 15164 | 668 | 18549 | 338 | 16941 |
| 12-#14 | 4.02 | MA | 5544 | 2764 | 10043 | 2112 | 11688 | 1684 | 12514 | 1315 | 13497 | 721 | 16991 | 135 | 16497 |
| 6L-2S | | MI | 6695 | 2764 | 11604 | 2086 | 13573 | 1641 | 14889 | 1272 | 16973 | 660 | 20879 | 469 | 17135 |
| 12-#18 | 7.14 | MA | 7663 | 3527 | 15316 | 2553 | 18085 | 1999 | 20077 | 1485 | 23491 | 613 | 29789 | -161 | 28734 |
| 4E | | MI | 6314 | 3527 | 12796 | 2501 | 14853 | 1933 | 16389 | 1417 | 19025 | 536 | 23749 | -284 | 22413 |
| 14-#11 | 3.25 | MA | 6952 | 2576 | 11617 | 2003 | 13786 | 1600 | 15065 | 1281 | 16810 | 742 | 20752 | 517 | 16890 |
| 3L-6S | | MI | 4837 | 2576 | 8443 | 1972 | 9708 | 1572 | 10322 | 1239 | 11003 | 709 | 13573 | 266 | 12338 |
| 14-#11 | 3.25 | MA | 6524 | 2576 | 11014 | 2001 | 12972 | 1606 | 14094 | 1275 | 15580 | 747 | 19378 | 428 | 16198 |
| 4L-5S | | MI | 5151 | 2576 | 8896 | 1976 | 10298 | 1567 | 11020 | 1244 | 11897 | 704 | 14652 | 329 | 13060 |
| 14-#11 | 3.25 | MA | 6135 | 2576 | 10403 | 2009 | 12238 | 1602 | 13213 | 1281 | 14383 | 742 | 17917 | 385 | 15654 |
| 5L-4S | | MI | 5478 | 2576 | 9404 | 1970 | 10894 | 1572 | 11727 | 1239 | 12860 | 709 | 15812 | 373 | 13454 |
| 14-#11 | 3.25 | MA | 5761 | 2576 | 9857 | 2006 | 11512 | 1608 | 12345 | 1275 | 13270 | 747 | 16553 | 323 | 14781 |
| 6L-3S | | MI | 5836 | 2576 | 9904 | 1974 | 11555 | 1567 | 12508 | 1244 | 13848 | 704 | 16910 | 457 | 14057 |
| 14-#11 | 3.25 | MA | 5394 | 2576 | 9326 | 2004 | 10810 | 1603 | 11503 | 1281 | 12179 | 752 | 15157 | 240 | 13937 |
| 7L-2S | | MI | 6316 | 2576 | 10563 | 1979 | 12377 | 1572 | 13484 | 1239 | 15133 | 699 | 18573 | 548 | 14140 |
| 14-#14 | 4.69 | MA | 7126 | 2927 | 12836 | 2208 | 15220 | 1759 | 16704 | 1359 | 19024 | 704 | 23919 | 248 | 22153 |
| 4L-5S | | MI | 5492 | 2927 | 10168 | 2182 | 11804 | 1705 | 12794 | 1320 | 14226 | 646 | 17713 | 106 | 17234 |
| 14-#14 | 4.69 | MA | 6597 | 2927 | 11962 | 2219 | 14171 | 1751 | 15459 | 1367 | 17331 | 696 | 21861 | 186 | 20882 |
| 5L-4S | | MI | 5935 | 2927 | 10892 | 2174 | 12643 | 1712 | 13790 | 1312 | 15581 | 653 | 19338 | 170 | 18311 |
| 14-#14 | 4.69 | MA | 6084 | 2927 | 11183 | 2214 | 13134 | 1759 | 14232 | 1359 | 15757 | 704 | 19942 | 96 | 19574 |
| 6L-3S | | MI | 6415 | 2927 | 11604 | 2181 | 13573 | 1705 | 14889 | 1320 | 16973 | 646 | 20879 | 288 | 19457 |

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 3.71 | MA | 6872 | 2689 | 11815 | 2072 | 13987 | 1658 | 15309 | 1307 | 17179 | 736 | 21473 | 403 | 18441 |
| 4L-6S | | MI | 5126 | 2689 | 9101 | 2043 | 10530 | 1623 | 11298 | 1268 | 12287 | 696 | 15236 | 235 | 14156 |
| 16-#11 | 3.71 | MA | 6488 | 2689 | 11203 | 2079 | 13253 | 1654 | 14428 | 1312 | 15982 | 731 | 20012 | 360 | 17927 |
| 5E | | MI | 5435 | 2689 | 9555 | 2047 | 11120 | 1618 | 11996 | 1273 | 13182 | 690 | 16315 | 297 | 14840 |
| 16-#11 | 3.71 | MA | 6120 | 2689 | 10658 | 2077 | 12527 | 1659 | 13560 | 1307 | 14869 | 736 | 18648 | 298 | 17009 |
| 6L-4S | | MI | 5758 | 2689 | 10063 | 2041 | 11716 | 1623 | 12704 | 1268 | 14145 | 696 | 17475 | 341 | 15292 |
| 16-#11 | 3.71 | MA | 5760 | 2689 | 10126 | 2075 | 11825 | 1655 | 12718 | 1312 | 13778 | 742 | 17251 | 215 | 16133 |
| 7L-3S | | MI | 6111 | 2689 | 10563 | 2045 | 12377 | 1618 | 13484 | 1273 | 15133 | 690 | 18573 | 425 | 15973 |
| 16-#14 | 5.36 | MA | 7083 | 3091 | 13102 | 2321 | 15617 | 1826 | 17177 | 1411 | 19592 | 680 | 24812 | 147 | 24015 |
| 5E | | MI | 5881 | 3091 | 11104 | 2284 | 12960 | 1776 | 14168 | 1360 | 16034 | 624 | 20043 | 57 | 19779 |
| 16-#14 | 5.36 | MA | 6584 | 3091 | 12323 | 2316 | 14580 | 1833 | 15949 | 1403 | 18018 | 687 | 22892 | 57 | 22665 |
| 6L-4S | | MI | 6314 | 3091 | 11828 | 2276 | 13800 | 1784 | 15164 | 1353 | 17390 | 631 | 21668 | 120 | 20928 |
| 18-#11 | 4.18 | MA | 6836 | 2803 | 12004 | 2150 | 14268 | 1705 | 15643 | 1344 | 17580 | 721 | 22107 | 335 | 20129 |
| 5L-6S | | MI | 5432 | 2803 | 9760 | 2114 | 11352 | 1673 | 12274 | 1297 | 13572 | 682 | 16899 | 203 | 15981 |
| 18-#11 | 4.18 | MA | 6474 | 2803 | 11458 | 2148 | 13543 | 1711 | 14775 | 1338 | 16467 | 726 | 20743 | 273 | 19245 |
| 6L-5S | | MI | 5736 | 2803 | 10214 | 2118 | 11942 | 1668 | 12972 | 1302 | 14467 | 676 | 17978 | 266 | 16632 |
| 18-#11 | 4.18 | MA | 6118 | 2803 | 10927 | 2145 | 12840 | 1707 | 13933 | 1344 | 15376 | 731 | 19346 | 190 | 18338 |
| 7L-4S | | MI | 6034 | 2803 | 10722 | 2112 | 12538 | 1673 | 13680 | 1297 | 15429 | 682 | 19138 | 309 | 17137 |
| 18-#14 | 6.03 | MA | 7072 | 3254 | 13463 | 2419 | 16026 | 1908 | 17667 | 1448 | 20278 | 670 | 25843 | 18 | 25769 |
| 6L-5S | | MI | 6263 | 3254 | 12040 | 2386 | 14117 | 1848 | 15542 | 1400 | 17843 | 602 | 22372 | 7 | 22337 |
| 20-#11 | 4.64 | MA | 6822 | 2916 | 12259 | 2219 | 14558 | 1763 | 15990 | 1370 | 18066 | 715 | 22837 | 248 | 21488 |
| 6E | | MI | 5712 | 2916 | 10419 | 2185 | 12174 | 1724 | 13251 | 1326 | 14857 | 668 | 18562 | 171 | 17813 |
| 20-#11 | 4.64 | MA | 6471 | 2916 | 11728 | 2216 | 13856 | 1759 | 15148 | 1375 | 16975 | 720 | 21441 | 165 | 20551 |
| 7L-5S | | MI | 6010 | 2916 | 10873 | 2189 | 12764 | 1719 | 13949 | 1331 | 15752 | 663 | 19641 | 234 | 18432 |
| 22-#11 | 5.11 | MA | 6820 | 3030 | 12528 | 2287 | 14871 | 1811 | 16363 | 1407 | 18574 | 710 | 23535 | 139 | 22744 |
| 7L-6S | | MI | 5987 | 3030 | 11078 | 2256 | 12996 | 1774 | 14227 | 1355 | 16142 | 654 | 20225 | 140 | 19647 |

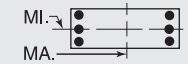
## RECTANGULAR TIED COLUMNS 24" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.25 | MA | 6925 | 2237 | 10290 | 1825 | 11979 | 1483 | 12708 | 1224 | 13268 | 841 | 15933 | 771 | 7819 |
| 2E | | MI | 5445 | 2237 | 8289 | 1782 | 9419 | 1441 | 9867 | 1183 | 10175 | 804 | 12053 | 721 | 6087 |
| 4-#18 | 2.22 | MA | 7712 | 2491 | 12209 | 1967 | 14304 | 1583 | 15393 | 1276 | 16778 | 799 | 20444 | 688 | 13355 |
| 2E | | MI | 5998 | 2491 | 9673 | 1915 | 11034 | 1527 | 11752 | 1222 | 12636 | 746 | 15128 | 608 | 10253 |
| 6-#11 | 1.30 | MA | 6997 | 2250 | 10374 | 1841 | 12131 | 1496 | 12936 | 1236 | 13580 | 847 | 16374 | 778 | 8165 |
| 2L-3S | | MI | 4991 | 2250 | 7694 | 1797 | 8740 | 1453 | 9078 | 1202 | 9148 | 817 | 10753 | 639 | 6376 |
| 6-#11 | 1.30 | MA | 6320 | 2250 | 9503 | 1840 | 11026 | 1492 | 11601 | 1241 | 11824 | 852 | 14062 | 687 | 8160 |
| 3L-2S | | MI | 5502 | 2250 | 8353 | 1801 | 9562 | 1458 | 10054 | 1197 | 10432 | 811 | 12416 | 730 | 6355 |
| 6-#14 | 1.88 | MA | 7488 | 2400 | 11533 | 1927 | 13555 | 1557 | 14598 | 1270 | 15755 | 826 | 19196 | 735 | 11520 |
| 2L-3S | | MI | 5141 | 2400 | 8289 | 1877 | 9419 | 1505 | 9867 | 1231 | 10175 | 789 | 12053 | 540 | 8865 |
| 6-#14 | 1.88 | MA | 6544 | 2400 | 10290 | 1924 | 11979 | 1551 | 12708 | 1277 | 13268 | 833 | 15933 | 604 | 11428 |
| 3L-2S | | MI | 5852 | 2400 | 9225 | 1884 | 10576 | 1513 | 11241 | 1224 | 11984 | 782 | 14383 | 671 | 8895 |
| 6-#18 | 3.33 | MA | 8625 | 2782 | 14367 | 2149 | 17031 | 1716 | 18631 | 1354 | 21039 | 768 | 25996 | 615 | 19714 |
| 2L-3S | | MI | 5494 | 2782 | 9673 | 2081 | 11034 | 1636 | 11752 | 1302 | 12636 | 714 | 15128 | 274 | 14156 |
| 6-#18 | 3.33 | MA | 7059 | 2782 | 12209 | 2140 | 14304 | 1702 | 15393 | 1367 | 16778 | 781 | 20444 | 382 | 18787 |
| 3L-2S | | MI | 6653 | 2782 | 11262 | 2094 | 12990 | 1650 | 14075 | 1289 | 15695 | 700 | 19028 | 507 | 15020 |
| 8-#11 | 1.73 | MA | 7395 | 2363 | 11246 | 1912 | 13236 | 1547 | 14270 | 1268 | 15336 | 838 | 18685 | 755 | 10759 |
| 2L-4S | | MI | 4913 | 2363 | 7853 | 1863 | 8901 | 1508 | 9274 | 1226 | 9444 | 808 | 11319 | 523 | 8142 |
| 8-#11 | 1.73 | MA | 6730 | 2363 | 10374 | 1910 | 12131 | 1544 | 12936 | 1273 | 13580 | 843 | 16374 | 664 | 10721 |
| 3E | | MI | 5289 | 2363 | 8353 | 1868 | 9562 | 1503 | 10054 | 1231 | 10432 | 803 | 12416 | 607 | 8324 |
| 8-#11 | 1.73 | MA | 6240 | 2363 | 9720 | 1909 | 11248 | 1550 | 11869 | 1268 | 12186 | 838 | 14860 | 574 | 10470 |
| 4L-2S | | MI | 5792 | 2363 | 9011 | 1872 | 10384 | 1508 | 11031 | 1226 | 11717 | 798 | 14079 | 698 | 8329 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

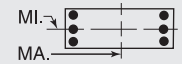



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.50 | MA | 8033 | 2564 | 12775 | 2029 | 15131 | 1632 | 16488 | 1316 | 18242 | 811 | 22458 | 700 | 15193 |
| 2L-4S | | MI | 5028 | 2564 | 8513 | 1973 | 9646 | 1584 | 10142 | 1264 | 10593 | 775 | 12842 | 372 | 10706 |
| 8-#14 | 2.50 | MA | 7109 | 2564 | 11533 | 2026 | 13555 | 1626 | 14598 | 1323 | 15755 | 819 | 19196 | 569 | 15043 |
| 3E | | MI | 5551 | 2564 | 9225 | 1980 | 10576 | 1577 | 11241 | 1272 | 11984 | 768 | 14383 | 491 | 11593 |
| 8-#14 | 2.50 | MA | 6429 | 2564 | 10598 | 2023 | 12293 | 1635 | 13087 | 1316 | 13840 | 826 | 17056 | 440 | 13862 |
| 4L-2S | | MI | 6249 | 2564 | 10161 | 1987 | 11733 | 1584 | 12615 | 1264 | 13793 | 760 | 16712 | 622 | 11675 |
| 8-#18 | 4.44 | MA | 9504 | 3073 | 16524 | 2330 | 19758 | 1848 | 21869 | 1431 | 25299 | 737 | 31547 | 543 | 26040 |
| 2L-4S | | MI | 5306 | 3073 | 10052 | 2246 | 11416 | 1773 | 12216 | 1356 | 13342 | 682 | 16437 | -30 | 16339 |
| 8-#18 | 4.44 | MA | 7986 | 3073 | 14367 | 2322 | 17031 | 1835 | 18631 | 1445 | 21039 | 750 | 25996 | 309 | 24534 |
| 3E | | MI | 6156 | 3073 | 11262 | 2260 | 12990 | 1759 | 14075 | 1369 | 15695 | 669 | 19028 | 173 | 18356 |
| 8-#18 | 4.44 | MA | 6866 | 3073 | 12736 | 2314 | 14840 | 1848 | 16043 | 1431 | 17760 | 763 | 22344 | 88 | 21763 |
| 4L-2S | | MI | 7274 | 3073 | 12850 | 2273 | 14946 | 1773 | 16399 | 1356 | 18754 | 655 | 22929 | 407 | 19746 |
| 10-#11 | 2.17 | MA | 7784 | 2476 | 12117 | 1983 | 14342 | 1599 | 15605 | 1301 | 17092 | 828 | 20997 | 733 | 13339 |
| 2L-5S | | MI | 4871 | 2476 | 8004 | 1940 | 9127 | 1554 | 9542 | 1260 | 9766 | 789 | 11822 | 447 | 9472 |
| 10-#11 | 2.17 | MA | 7129 | 2476 | 11246 | 1981 | 13236 | 1596 | 14270 | 1306 | 15336 | 833 | 18685 | 642 | 13274 |
| 3L-4S | | MI | 5210 | 2476 | 8512 | 1934 | 9723 | 1559 | 10250 | 1255 | 10729 | 794 | 12982 | 491 | 9940 |
| 10-#11 | 2.17 | MA | 6648 | 2476 | 10591 | 1980 | 12353 | 1602 | 13204 | 1301 | 13942 | 828 | 17172 | 551 | 12874 |
| 4L-3S | | MI | 5581 | 2476 | 9011 | 1939 | 10384 | 1554 | 11031 | 1260 | 11717 | 789 | 14079 | 575 | 10260 |
| 10-#11 | 2.17 | MA | 6210 | 2476 | 9928 | 1988 | 11556 | 1599 | 12236 | 1306 | 12670 | 833 | 15560 | 509 | 12155 |
| 5L-2S | | MI | 6077 | 2476 | 9670 | 1943 | 11206 | 1559 | 12007 | 1255 | 13002 | 784 | 15742 | 666 | 10290 |
| 10-#14 | 3.13 | MA | 8564 | 2727 | 14018 | 2131 | 16707 | 1707 | 18378 | 1361 | 20729 | 796 | 25721 | 665 | 18851 |
| 2L-5S | | MI | 4969 | 2727 | 8725 | 2083 | 9963 | 1648 | 10520 | 1312 | 11046 | 746 | 13547 | 259 | 12443 |
| 10-#14 | 3.13 | MA | 7658 | 2727 | 12775 | 2128 | 15131 | 1701 | 16488 | 1369 | 18242 | 804 | 22458 | 533 | 18652 |
| 3L-4S | | MI | 5438 | 2727 | 9449 | 2075 | 10803 | 1656 | 11516 | 1305 | 12401 | 753 | 15172 | 323 | 13273 |
| 10-#14 | 3.13 | MA | 6992 | 2727 | 11840 | 2125 | 13869 | 1710 | 14978 | 1361 | 16327 | 811 | 20319 | 405 | 17310 |
| 4L-3S | | MI | 5951 | 2727 | 10161 | 2082 | 11733 | 1648 | 12615 | 1312 | 13793 | 746 | 16712 | 442 | 14309 |
| 10-#14 | 3.13 | MA | 6387 | 2727 | 10892 | 2137 | 12730 | 1704 | 13607 | 1369 | 14466 | 804 | 18043 | 344 | 16208 |
| 5L-2S | | MI | 6637 | 2727 | 11096 | 2089 | 12890 | 1656 | 13990 | 1305 | 15601 | 738 | 19042 | 573 | 14435 |
| 10-#18 | 5.56 | MA | 8903 | 3363 | 16524 | 2504 | 19758 | 1967 | 21869 | 1522 | 25299 | 719 | 31547 | 237 | 30348 |
| 3L-4S | | MI | 5975 | 3363 | 11641 | 2425 | 13372 | 1896 | 14539 | 1422 | 16401 | 637 | 20337 | -130 | 19809 |
| 10-#18 | 5.56 | MA | 7835 | 3363 | 14894 | 2495 | 17567 | 1980 | 19281 | 1509 | 22020 | 732 | 27895 | 15 | 27790 |
| 4L-3S | | MI | 6795 | 3363 | 12850 | 2439 | 14946 | 1882 | 16399 | 1436 | 18754 | 623 | 22929 | 73 | 22626 |
| 10-#18 | 5.56 | MA | 6849 | 3363 | 13238 | 2513 | 15589 | 1967 | 16933 | 1522 | 18830 | 719 | 24023 | -95 | 23629 |
| 5L-2S | | MI | 7877 | 3363 | 14438 | 2452 | 16902 | 1896 | 18722 | 1422 | 21813 | 610 | 26829 | 307 | 24449 |
| 12-#11 | 2.60 | MA | 8166 | 2590 | 12988 | 2054 | 15447 | 1651 | 16940 | 1333 | 18848 | 819 | 23308 | 710 | 15911 |
| 2L-6S | | MI | 4847 | 2590 | 8209 | 2007 | 9359 | 1609 | 9821 | 1284 | 10156 | 780 | 12405 | 353 | 10708 |
| 12-#11 | 2.60 | MA | 7520 | 2590 | 12117 | 2052 | 14342 | 1647 | 15605 | 1338 | 17092 | 824 | 20997 | 619 | 15821 |
| 3L-5S | | MI | 5167 | 2590 | 8662 | 2011 | 9949 | 1604 | 10518 | 1289 | 11051 | 775 | 13485 | 416 | 11321 |
| 12-#11 | 2.60 | MA | 7046 | 2590 | 11463 | 2050 | 13458 | 1654 | 14539 | 1333 | 15698 | 819 | 19483 | 529 | 15295 |
| 4E | | MI | 5501 | 2590 | 9171 | 2005 | 10545 | 1609 | 11226 | 1284 | 12013 | 780 | 14645 | 459 | 11754 |
| 12-#11 | 2.60 | MA | 6616 | 2590 | 10799 | 2059 | 12662 | 1651 | 13571 | 1338 | 14426 | 824 | 17871 | 487 | 14619 |
| 5L-3S | | MI | 5867 | 2590 | 9670 | 2009 | 11206 | 1604 | 12007 | 1289 | 13002 | 775 | 15742 | 543 | 12188 |
| 12-#11 | 2.60 | MA | 6202 | 2590 | 10208 | 2057 | 11874 | 1657 | 12618 | 1333 | 13203 | 829 | 16259 | 410 | 13798 |
| 6L-2S | | MI | 6356 | 2590 | 10329 | 2014 | 12028 | 1609 | 12983 | 1284 | 14287 | 770 | 17405 | 635 | 12239 |
| 12-#14 | 3.75 | MA | 8195 | 2891 | 14018 | 2230 | 16707 | 1776 | 18378 | 1415 | 20729 | 789 | 25721 | 498 | 22257 |
| 3L-5S | | MI | 5399 | 2891 | 9661 | 2185 | 11120 | 1720 | 11894 | 1353 | 12854 | 724 | 15876 | 210 | 14947 |
| 12-#14 | 3.75 | MA | 7542 | 2891 | 13083 | 2227 | 15444 | 1784 | 16868 | 1407 | 18814 | 797 | 23582 | 370 | 20778 |
| 4E | | MI | 5858 | 2891 | 10385 | 2177 | 11960 | 1727 | 12890 | 1345 | 14210 | 732 | 17501 | 273 | 15860 |
| 12-#14 | 3.75 | MA | 6949 | 2891 | 12134 | 2239 | 14306 | 1778 | 15498 | 1415 | 16953 | 789 | 21306 | 309 | 19600 |
| 5L-3S | | MI | 6355 | 2891 | 11096 | 2184 | 12890 | 1720 | 13990 | 1353 | 15601 | 724 | 19042 | 392 | 17018 |
| 12-#14 | 3.75 | MA | 6379 | 2891 | 11289 | 2236 | 13181 | 1787 | 14147 | 1407 | 15221 | 797 | 19181 | 219 | 18236 |
| 6L-2S | | MI | 7016 | 2891 | 12032 | 2191 | 14047 | 1727 | 15364 | 1345 | 17410 | 717 | 21371 | 524 | 17183 |
| 12-#18 | 6.67 | MA | 8733 | 3654 | 17051 | 2677 | 20294 | 2112 | 22519 | 1587 | 26281 | 701 | 33446 | -57 | 33002 |
| 4E | | MI | 6623 | 3654 | 13229 | 2604 | 15328 | 2019 | 16863 | 1489 | 19460 | 591 | 24238 | -230 | 23158 |
| 12-#18 | 6.67 | MA | 7785 | 3654 | 15395 | 2695 | 18316 | 2099 | 20171 | 1600 | 23090 | 688 | 29575 | -168 | 28647 |
| 5L-3S | | MI | 7416 | 3654 | 14438 | 2618 | 16902 | 2005 | 18722 | 1503 | 21813 | 578 | 26829 | -27 | 26666 |
| 14-#11 | 3.03 | MA | 7904 | 2703 | 12988 | 2123 | 15447 | 1699 | 16940 | 1371 | 18848 | 815 | 23308 | 596 | 18364 |
| 3L-6S | | MI | 5142 | 2703 | 8868 | 2078 | 10181 | 1660 | 10797 | 1313 | 11441 | 766 | 14068 | 321 | 12514 |

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

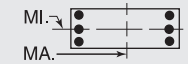
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 3.03 | MA | 7437 | 2703 | 12334 | 2121 | 14563 | 1706 | 15873 | 1366 | 17454 | 810 | 21795 | 506 | 17730 |
| 4L-5S | | MI | 5458 | 2703 | 9321 | 2082 | 10771 | 1654 | 11495 | 1318 | 12336 | 761 | 15148 | 384 | 13177 |
| 14-#11 | 3.03 | MA | 7014 | 2703 | 11671 | 2130 | 13767 | 1702 | 14906 | 1371 | 16182 | 815 | 20183 | 464 | 17090 |
| 5L-4S | | MI | 5787 | 2703 | 9829 | 2076 | 11367 | 1660 | 12202 | 1313 | 13298 | 766 | 16308 | 428 | 13581 |
| 14-#11 | 3.03 | MA | 6607 | 2703 | 11079 | 2128 | 12980 | 1709 | 13952 | 1366 | 14959 | 820 | 18570 | 388 | 16220 |
| 6L-3S | | MI | 6148 | 2703 | 10329 | 2080 | 12028 | 1654 | 12983 | 1318 | 14287 | 761 | 17405 | 512 | 14110 |
| 14-#11 | 3.03 | MA | 6208 | 2703 | 10504 | 2126 | 12219 | 1706 | 13027 | 1371 | 13718 | 815 | 17140 | 317 | 15373 |
| 7L-2S | | MI | 6631 | 2703 | 10988 | 2084 | 12850 | 1660 | 13960 | 1313 | 15572 | 756 | 19068 | 603 | 14181 |
| 14-#14 | 4.38 | MA | 8080 | 3054 | 14325 | 2329 | 17020 | 1859 | 18758 | 1453 | 21301 | 782 | 26844 | 335 | 24264 |
| 4L-5S | | MI | 5800 | 3054 | 10596 | 2287 | 12277 | 1791 | 13268 | 1393 | 14663 | 702 | 18206 | 160 | 17471 |
| 14-#14 | 4.38 | MA | 7498 | 3054 | 13377 | 2341 | 15882 | 1853 | 17388 | 1461 | 19440 | 774 | 24569 | 273 | 23009 |
| 5L-4S | | MI | 6248 | 3054 | 11320 | 2279 | 13117 | 1799 | 14265 | 1386 | 16018 | 710 | 19831 | 224 | 18463 |
| 14-#14 | 4.38 | MA | 6940 | 3054 | 12531 | 2338 | 14756 | 1862 | 16038 | 1453 | 17708 | 782 | 22444 | 184 | 21678 |
| 6L-3S | | MI | 6733 | 3054 | 12032 | 2286 | 14047 | 1791 | 15364 | 1393 | 17410 | 702 | 21371 | 343 | 19662 |
| 14-#18 | 7.78 | MA | 8691 | 3945 | 17553 | 2877 | 21042 | 2231 | 23409 | 1678 | 27351 | 657 | 35126 | -240 | 33488 |
| 5L-4S | | MI | 7256 | 3945 | 14817 | 2783 | 17284 | 2142 | 19187 | 1556 | 22519 | 546 | 28138 | -331 | 26394 |
| 16-#11 | 3.47 | MA | 7822 | 2817 | 13206 | 2192 | 15668 | 1758 | 17208 | 1398 | 19210 | 800 | 24106 | 484 | 20175 |
| 4L-6S | | MI | 5432 | 2817 | 9526 | 2149 | 11003 | 1710 | 11773 | 1342 | 12726 | 752 | 15731 | 290 | 14329 |
| 16-#11 | 3.47 | MA | 7404 | 2817 | 12542 | 2201 | 14872 | 1754 | 16241 | 1403 | 17938 | 806 | 22494 | 441 | 19568 |
| 5E | | MI | 5744 | 2817 | 9980 | 2153 | 11593 | 1705 | 12471 | 1347 | 13620 | 747 | 16811 | 352 | 15038 |
| 16-#11 | 3.47 | MA | 7003 | 2817 | 11951 | 2199 | 14085 | 1761 | 15287 | 1398 | 16715 | 811 | 20882 | 365 | 18652 |
| 6L-4S | | MI | 6069 | 2817 | 10488 | 2147 | 12189 | 1710 | 13179 | 1342 | 14583 | 752 | 17970 | 396 | 15417 |
| 16-#11 | 3.47 | MA | 6611 | 2817 | 11375 | 2197 | 13324 | 1757 | 14362 | 1403 | 15474 | 806 | 19452 | 295 | 17773 |
| 7L-3S | | MI | 6425 | 2817 | 10988 | 2151 | 12850 | 1705 | 13960 | 1347 | 15572 | 747 | 19068 | 480 | 16029 |
| 16-#14 | 5.00 | MA | 8037 | 3218 | 14619 | 2443 | 17457 | 1928 | 19278 | 1506 | 21927 | 760 | 27832 | 238 | 26434 |
| 5E | | MI | 6191 | 3218 | 11532 | 2389 | 13434 | 1863 | 14642 | 1433 | 16471 | 680 | 20536 | 111 | 20011 |
| 16-#14 | 5.00 | MA | 7489 | 3218 | 13774 | 2440 | 16332 | 1937 | 17928 | 1499 | 20195 | 767 | 25707 | 149 | 25063 |
| 6L-4S | | MI | 6629 | 3218 | 12256 | 2382 | 14274 | 1870 | 15639 | 1426 | 17827 | 688 | 22161 | 175 | 21078 |
| 18-#11 | 3.90 | MA | 7788 | 2930 | 13413 | 2272 | 15977 | 1806 | 17575 | 1436 | 19694 | 796 | 24806 | 419 | 22052 |
| 5L-6S | | MI | 5718 | 2930 | 10185 | 2220 | 11825 | 1760 | 12749 | 1371 | 14011 | 739 | 17394 | 258 | 16152 |
| 18-#11 | 3.90 | MA | 7393 | 2930 | 12822 | 2270 | 15190 | 1813 | 16622 | 1431 | 18471 | 801 | 23193 | 343 | 21091 |
| 6L-5S | | MI | 6026 | 2930 | 10639 | 2224 | 12415 | 1755 | 13447 | 1376 | 14905 | 733 | 18474 | 321 | 16830 |
| 18-#11 | 3.90 | MA | 7006 | 2930 | 12246 | 2268 | 14429 | 1809 | 15697 | 1436 | 17230 | 796 | 21763 | 272 | 20182 |
| 7L-4S | | MI | 6347 | 2930 | 11147 | 2218 | 13011 | 1760 | 14155 | 1371 | 15868 | 739 | 19633 | 364 | 17261 |
| 18-#14 | 5.63 | MA | 8072 | 3382 | 15016 | 2542 | 17908 | 2012 | 19818 | 1545 | 22682 | 752 | 28970 | 113 | 28460 |
| 6L-5S | | MI | 6575 | 3382 | 12468 | 2492 | 14591 | 1934 | 16017 | 1474 | 18280 | 659 | 22865 | 62 | 22565 |
| 20-#11 | 4.33 | MA | 7777 | 3043 | 13694 | 2341 | 16295 | 1865 | 17957 | 1463 | 20227 | 792 | 25505 | 320 | 23537 |
| 6E | | MI | 6022 | 3043 | 10844 | 2291 | 12647 | 1811 | 13726 | 1400 | 15296 | 725 | 19057 | 226 | 17981 |
| 20-#11 | 4.33 | MA | 7396 | 3043 | 13118 | 2339 | 15534 | 1861 | 17032 | 1468 | 18986 | 787 | 24075 | 249 | 22597 |
| 7L-5S | | MI | 6324 | 3043 | 11298 | 2295 | 13237 | 1806 | 14424 | 1405 | 16190 | 719 | 20137 | 289 | 18627 |
| 22-#11 | 4.77 | MA | 7780 | 3157 | 13989 | 2410 | 16639 | 1913 | 18366 | 1501 | 20742 | 778 | 26387 | 227 | 25019 |
| 7L-6S | | MI | 6299 | 3157 | 11503 | 2362 | 13469 | 1861 | 14702 | 1429 | 16580 | 711 | 20720 | 194 | 19817 |

## RECTANGULAR TIED COLUMNS 24" x 32"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.17 | MA | 7831 | 2364 | 11505 | 1944 | 13437 | 1581 | 14289 | 1310 | 14891 | 908 | 17901 | 839 | 8426 |
| 2E | | MI | 5752 | 2364 | 8717 | 1887 | 9893 | 1528 | 10342 | 1257 | 10613 | 860 | 12546 | 775 | 6115 |
| 4-#18 | 2.08 | MA | 8701 | 2618 | 13591 | 2086 | 15986 | 1683 | 17242 | 1365 | 18750 | 870 | 22891 | 763 | 14435 |
| 2E | | MI | 6308 | 2618 | 10106 | 2019 | 11509 | 1612 | 12225 | 1294 | 13071 | 801 | 15617 | 661 | 10296 |
| 6-#11 | 1.22 | MA | 7907 | 2377 | 11592 | 1961 | 13598 | 1594 | 14511 | 1320 | 15222 | 914 | 18370 | 846 | 8797 |
| 2L-3S | | MI | 5298 | 2377 | 8119 | 1903 | 9213 | 1540 | 9553 | 1276 | 9586 | 873 | 11248 | 694 | 6408 |
| 6-#11 | 1.22 | MA | 7173 | 2377 | 10650 | 1960 | 12403 | 1591 | 13063 | 1326 | 13309 | 919 | 15841 | 755 | 8791 |
| 3L-2S | | MI | 5810 | 2377 | 8778 | 1907 | 10035 | 1545 | 10529 | 1271 | 10871 | 868 | 12911 | 785 | 6382 |
| 6-#14 | 1.76 | MA | 8449 | 2527 | 12849 | 2046 | 15142 | 1656 | 16352 | 1357 | 17605 | 895 | 21476 | 808 | 12431 |
| 2L-3S | | MI | 5448 | 2527 | 8717 | 1983 | 9893 | 1592 | 10342 | 1305 | 10613 | 846 | 12546 | 595 | 8915 |

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

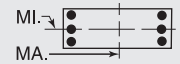
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.76 | MA | 7423 | 2527 | 11505 | 2044 | 13437 | 1651 | 14289 | 1365 | 14891 | 903 | 17901 | 676 | 12339 |
| 3L-2S | | MI | 6162 | 2527 | 9653 | 1990 | 11050 | 1599 | 11716 | 1297 | 12421 | 838 | 14876 | 726 | 8929 |
| 6-#18 | 3.13 | MA | 9707 | 2909 | 15930 | 2268 | 18953 | 1816 | 20787 | 1445 | 23414 | 842 | 28997 | 698 | 21334 |
| 2L-3S | | MI | 5802 | 2909 | 10106 | 2184 | 11509 | 1722 | 12225 | 1374 | 13071 | 769 | 15617 | 328 | 14430 |
| 6-#18 | 3.13 | MA | 8000 | 2909 | 13591 | 2261 | 15986 | 1804 | 17242 | 1458 | 18750 | 855 | 22891 | 464 | 20715 |
| 3L-2S | | MI | 6970 | 2909 | 11695 | 2198 | 13465 | 1735 | 14549 | 1361 | 16130 | 756 | 19517 | 561 | 15072 |
| 8-#11 | 1.63 | MA | 8344 | 2490 | 12535 | 2032 | 14793 | 1646 | 15959 | 1353 | 17136 | 906 | 20898 | 826 | 11602 |
| 2L-4S | | MI | 5219 | 2490 | 8278 | 1969 | 9374 | 1595 | 9749 | 1300 | 9882 | 865 | 11814 | 578 | 8271 |
| 8-#11 | 1.63 | MA | 7622 | 2490 | 11592 | 2030 | 13598 | 1643 | 14511 | 1359 | 15222 | 911 | 18370 | 735 | 11563 |
| 3E | | MI | 5597 | 2490 | 8778 | 1974 | 10035 | 1590 | 10529 | 1305 | 10871 | 860 | 12911 | 662 | 8363 |
| 8-#11 | 1.63 | MA | 7092 | 2490 | 10887 | 2029 | 12644 | 1650 | 13355 | 1354 | 13703 | 906 | 16714 | 644 | 11400 |
| 4L-2S | | MI | 6102 | 2490 | 9437 | 1978 | 10857 | 1595 | 11506 | 1300 | 12156 | 854 | 14574 | 753 | 8360 |
| 8-#14 | 2.34 | MA | 9048 | 2691 | 14194 | 2149 | 16848 | 1730 | 18415 | 1404 | 20319 | 882 | 25052 | 776 | 16408 |
| 2L-4S | | MI | 5334 | 2691 | 8941 | 2078 | 10120 | 1671 | 10617 | 1338 | 11030 | 832 | 13335 | 426 | 10861 |
| 8-#14 | 2.34 | MA | 8043 | 2691 | 12849 | 2146 | 15142 | 1725 | 16352 | 1412 | 17605 | 890 | 21476 | 644 | 16258 |
| 3E | | MI | 5859 | 2691 | 9653 | 2085 | 11050 | 1663 | 11716 | 1345 | 12421 | 824 | 14876 | 545 | 11649 |
| 8-#14 | 2.34 | MA | 7306 | 2691 | 11840 | 2144 | 13780 | 1735 | 14704 | 1404 | 15450 | 882 | 19136 | 514 | 15118 |
| 4L-2S | | MI | 6561 | 2691 | 10588 | 2092 | 12207 | 1671 | 13090 | 1338 | 14230 | 817 | 17205 | 677 | 11714 |
| 8-#18 | 4.17 | MA | 10677 | 3200 | 18269 | 2450 | 21920 | 1949 | 24331 | 1525 | 28077 | 814 | 35102 | 632 | 28200 |
| 2L-4S | | MI | 5610 | 3200 | 10485 | 2350 | 11891 | 1858 | 12689 | 1428 | 13777 | 738 | 16926 | 24 | 16798 |
| 8-#18 | 4.17 | MA | 9019 | 3200 | 15930 | 2443 | 18953 | 1937 | 20787 | 1539 | 23414 | 828 | 28997 | 398 | 26973 |
| 3E | | MI | 6468 | 3200 | 11695 | 2363 | 13465 | 1845 | 14549 | 1441 | 16130 | 724 | 19517 | 227 | 18622 |
| 8-#18 | 4.17 | MA | 7803 | 3200 | 14168 | 2437 | 16574 | 1952 | 17954 | 1525 | 19824 | 841 | 24989 | 172 | 23759 |
| 4L-2S | | MI | 7595 | 3200 | 13283 | 2377 | 15421 | 1858 | 16872 | 1428 | 19189 | 711 | 23417 | 461 | 19805 |
| 10-#11 | 2.03 | MA | 8772 | 2604 | 13477 | 2102 | 15988 | 1697 | 17406 | 1386 | 19049 | 898 | 23427 | 806 | 14392 |
| 2L-5S | | MI | 5177 | 2604 | 8429 | 2046 | 9600 | 1641 | 10017 | 1334 | 10204 | 846 | 12317 | 502 | 9584 |
| 10-#11 | 2.03 | MA | 8060 | 2604 | 12535 | 2101 | 14793 | 1695 | 15959 | 1391 | 17136 | 903 | 20898 | 715 | 14327 |
| 3L-4S | | MI | 5517 | 2604 | 8937 | 2040 | 10196 | 1646 | 10725 | 1329 | 11167 | 851 | 13477 | 546 | 10067 |
| 10-#11 | 2.03 | MA | 7538 | 2604 | 11829 | 2100 | 13839 | 1702 | 14803 | 1387 | 15617 | 898 | 19243 | 623 | 14021 |
| 4L-3S | | MI | 5889 | 2604 | 9437 | 2044 | 10857 | 1641 | 11506 | 1334 | 12156 | 846 | 14574 | 630 | 10303 |
| 10-#11 | 2.03 | MA | 7065 | 2604 | 11113 | 2109 | 12981 | 1699 | 13756 | 1392 | 14231 | 903 | 17482 | 581 | 13192 |
| 5L-2S | | MI | 6388 | 2604 | 10095 | 2049 | 11679 | 1646 | 12482 | 1329 | 13441 | 841 | 16237 | 721 | 10325 |
| 10-#14 | 2.93 | MA | 9632 | 2855 | 15539 | 2251 | 18553 | 1805 | 20478 | 1451 | 23033 | 869 | 28628 | 744 | 20370 |
| 2L-5S | | MI | 5274 | 2855 | 9153 | 2188 | 10437 | 1735 | 10995 | 1386 | 11483 | 802 | 14040 | 314 | 12683 |
| 10-#14 | 2.93 | MA | 8646 | 2855 | 14194 | 2248 | 16848 | 1800 | 18415 | 1459 | 20319 | 876 | 25052 | 612 | 20171 |
| 3L-4S | | MI | 5745 | 2855 | 9877 | 2180 | 11276 | 1742 | 11991 | 1378 | 12838 | 810 | 15665 | 377 | 13425 |
| 10-#14 | 2.93 | MA | 7924 | 2855 | 13185 | 2246 | 15485 | 1810 | 16767 | 1451 | 18164 | 869 | 22712 | 482 | 18857 |
| 4L-3S | | MI | 6261 | 2855 | 10588 | 2187 | 12207 | 1735 | 13090 | 1386 | 14230 | 802 | 17205 | 496 | 14371 |
| 10-#14 | 2.93 | MA | 7268 | 2855 | 12162 | 2259 | 14257 | 1805 | 15272 | 1459 | 16199 | 876 | 20218 | 421 | 17787 |
| 5L-2S | | MI | 6951 | 2855 | 11524 | 2194 | 13364 | 1742 | 14464 | 1378 | 16038 | 795 | 19535 | 628 | 14478 |
| 10-#18 | 5.21 | MA | 10036 | 3491 | 18269 | 2625 | 21920 | 2070 | 24331 | 1619 | 28077 | 800 | 35102 | 333 | 33298 |
| 3L-4S | | MI | 6282 | 3491 | 12074 | 2529 | 13847 | 1981 | 15013 | 1495 | 16836 | 692 | 20826 | -76 | 20509 |
| 10-#18 | 5.21 | MA | 8873 | 3491 | 16507 | 2618 | 19540 | 2085 | 21498 | 1606 | 24488 | 813 | 31095 | 106 | 30308 |
| 4L-3S | | MI | 7110 | 3491 | 13283 | 2542 | 15421 | 1968 | 16872 | 1508 | 19189 | 679 | 23417 | 127 | 22884 |
| 10-#18 | 5.21 | MA | 7800 | 3491 | 14718 | 2638 | 17393 | 2073 | 18929 | 1619 | 20997 | 800 | 26837 | -3 | 26823 |
| 5L-2S | | MI | 8203 | 3491 | 14871 | 2556 | 17377 | 1981 | 19196 | 1495 | 22248 | 666 | 27318 | 360 | 24514 |
| 12-#11 | 2.44 | MA | 9190 | 2717 | 14419 | 2173 | 17183 | 1749 | 18854 | 1419 | 20963 | 890 | 25956 | 785 | 17174 |
| 2L-6S | | MI | 5151 | 2717 | 8634 | 2113 | 9832 | 1696 | 10296 | 1358 | 10595 | 837 | 12901 | 408 | 10881 |
| 12-#11 | 2.44 | MA | 8489 | 2717 | 13477 | 2172 | 15988 | 1746 | 17406 | 1424 | 19049 | 895 | 23427 | 694 | 17084 |
| 3L-5S | | MI | 5474 | 2717 | 9088 | 2117 | 10422 | 1691 | 10993 | 1363 | 11489 | 832 | 13980 | 471 | 11432 |
| 12-#11 | 2.44 | MA | 7975 | 2717 | 12771 | 2171 | 15034 | 1754 | 16251 | 1420 | 17531 | 890 | 21772 | 603 | 16643 |
| 4E | | MI | 5809 | 2717 | 9596 | 2111 | 11018 | 1696 | 11701 | 1358 | 12452 | 837 | 15140 | 514 | 11879 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis

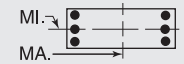



$f'_c$ = 6,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.44 | MA | 7509 | 2717 | 12056 | 2180 | 14176 | 1751 | 15204 | 1425 | 16145 | 895 | 20011 | 561 | 15860 |
| 5L-3S | | MI | 6177 | 2717 | 10095 | 2115 | 11679 | 1691 | 12482 | 1363 | 13441 | 832 | 16237 | 598 | 12235 |
| 12-#11 | 2.44 | MA | 7062 | 2717 | 11419 | 2179 | 13328 | 1758 | 14172 | 1421 | 14812 | 900 | 18246 | 485 | 15054 |
| 6L-2S | | MI | 6669 | 2717 | 10754 | 2120 | 12501 | 1696 | 13458 | 1358 | 14725 | 827 | 17900 | 690 | 12277 |
| 12-#14 | 3.52 | MA | 9234 | 3018 | 15539 | 2351 | 18553 | 1875 | 20478 | 1506 | 23033 | 863 | 28628 | 580 | 24079 |
| 3L-5S | | MI | 5684 | 3018 | 10088 | 2290 | 11594 | 1806 | 12369 | 1426 | 13291 | 781 | 16369 | 264 | 15183 |
| 12-#14 | 3.52 | MA | 8527 | 3018 | 14530 | 2348 | 17190 | 1885 | 18830 | 1499 | 20878 | 856 | 26287 | 450 | 22618 |
| 4E | | MI | 6147 | 3018 | 10812 | 2282 | 12433 | 1814 | 13365 | 1419 | 14647 | 788 | 17994 | 328 | 16010 |
| 12-#14 | 3.52 | MA | 7884 | 3018 | 13506 | 2361 | 15962 | 1880 | 17335 | 1506 | 18913 | 863 | 23794 | 389 | 21470 |
| 5L-3S | | MI | 6655 | 3018 | 11524 | 2289 | 13364 | 1806 | 14464 | 1426 | 16038 | 781 | 19535 | 447 | 17086 |
| 12-#14 | 3.52 | MA | 7267 | 3018 | 12595 | 2359 | 14749 | 1890 | 15861 | 1499 | 17023 | 871 | 21299 | 279 | 19902 |
| 6L-2S | | MI | 7336 | 3018 | 12460 | 2296 | 14520 | 1814 | 15838 | 1419 | 17847 | 773 | 21864 | 578 | 17231 |
| 12-#18 | 6.25 | MA | 9860 | 3781 | 18846 | 2800 | 22507 | 2218 | 25043 | 1686 | 29151 | 786 | 37200 | 41 | 36890 |
| 4E | | MI | 6933 | 3781 | 13662 | 2708 | 15803 | 2104 | 17337 | 1562 | 19895 | 647 | 24726 | -177 | 23897 |
| 12-#18 | 6.25 | MA | 8828 | 3781 | 17057 | 2820 | 20360 | 2206 | 22474 | 1699 | 25660 | 772 | 32942 | -69 | 32518 |
| 5L-3S | | MI | 7735 | 3781 | 14871 | 2721 | 17377 | 2091 | 19196 | 1575 | 22248 | 634 | 27318 | 26 | 27200 |
| 14-#11 | 2.84 | MA | 8909 | 2831 | 14419 | 2243 | 17183 | 1798 | 18854 | 1457 | 20963 | 887 | 25956 | 674 | 19839 |
| 3L-6S | | MI | 5447 | 2831 | 9293 | 2184 | 10654 | 1747 | 11272 | 1387 | 11880 | 823 | 14564 | 376 | 12684 |
| 14-#11 | 2.84 | MA | 8404 | 2831 | 13714 | 2242 | 16230 | 1806 | 17699 | 1453 | 19444 | 882 | 24301 | 583 | 19278 |
| 4L-5S | | MI | 5765 | 2831 | 9746 | 2188 | 11244 | 1742 | 11970 | 1392 | 12774 | 818 | 15643 | 439 | 13287 |
| 14-#11 | 2.84 | MA | 7945 | 2831 | 12998 | 2251 | 15371 | 1803 | 16651 | 1458 | 18058 | 887 | 22540 | 540 | 18536 |
| 5L-4S | | MI | 6097 | 2831 | 10254 | 2182 | 11840 | 1747 | 12678 | 1387 | 13737 | 823 | 16803 | 483 | 13704 |
| 14-#11 | 2.84 | MA | 7505 | 2831 | 12361 | 2250 | 14523 | 1810 | 15619 | 1454 | 16726 | 892 | 20775 | 464 | 17680 |
| 6L-3S | | MI | 6459 | 2831 | 10754 | 2186 | 12501 | 1742 | 13458 | 1392 | 14725 | 818 | 17900 | 567 | 14161 |
| 14-#11 | 2.84 | MA | 7074 | 2831 | 11741 | 2249 | 13703 | 1807 | 14618 | 1459 | 15374 | 887 | 19213 | 393 | 16839 |
| 7L-2S | | MI | 6946 | 2831 | 11413 | 2190 | 13323 | 1747 | 14435 | 1387 | 16010 | 813 | 19563 | 658 | 14221 |
| 14-#14 | 4.10 | MA | 9116 | 3182 | 15874 | 2451 | 18896 | 1960 | 20893 | 1546 | 23592 | 843 | 29863 | 418 | 26396 |
| 4L-5S | | MI | 6108 | 3182 | 11024 | 2392 | 12751 | 1878 | 13743 | 1467 | 15100 | 759 | 18699 | 215 | 17702 |
| 14-#14 | 4.10 | MA | 8486 | 3182 | 14851 | 2463 | 17668 | 1955 | 19398 | 1553 | 21627 | 850 | 27370 | 357 | 25172 |
| 5L-4S | | MI | 6560 | 3182 | 11748 | 2385 | 13590 | 1885 | 14739 | 1459 | 16456 | 766 | 20324 | 279 | 18610 |
| 14-#14 | 4.10 | MA | 7881 | 3182 | 13940 | 2461 | 16454 | 1965 | 17924 | 1546 | 19737 | 858 | 24875 | 248 | 23669 |
| 6L-3S | | MI | 7050 | 3182 | 12460 | 2392 | 14520 | 1878 | 15838 | 1467 | 17847 | 759 | 21864 | 398 | 19795 |
| 14-#14 | 4.10 | MA | 7289 | 3182 | 13052 | 2458 | 15281 | 1960 | 16494 | 1553 | 17819 | 850 | 22664 | 145 | 21839 |
| 7L-2S | | MI | 7703 | 3182 | 13396 | 2399 | 15677 | 1885 | 17212 | 1459 | 19656 | 751 | 24194 | 529 | 19974 |
| 14-#18 | 7.29 | MA | 9823 | 4072 | 19397 | 3002 | 23327 | 2339 | 26018 | 1780 | 30323 | 745 | 39048 | -134 | 38023 |
| 5L-4S | | MI | 7568 | 4072 | 15250 | 2887 | 17759 | 2227 | 19660 | 1629 | 22953 | 602 | 28627 | -277 | 27172 |
| 16-#11 | 3.25 | MA | 8825 | 2944 | 14656 | 2313 | 17425 | 1858 | 19147 | 1485 | 21358 | 873 | 26830 | 562 | 21925 |
| 4L-6S | | MI | 5738 | 2944 | 9952 | 2255 | 11476 | 1797 | 12248 | 1416 | 13164 | 809 | 16227 | 345 | 14497 |
| 16-#11 | 3.25 | MA | 8373 | 2944 | 13940 | 2322 | 16566 | 1855 | 18099 | 1491 | 19972 | 879 | 25069 | 520 | 21220 |
| 5E | | MI | 6053 | 2944 | 10405 | 2259 | 12066 | 1792 | 12946 | 1421 | 14059 | 804 | 17306 | 407 | 15148 |
| 16-#11 | 3.25 | MA | 7939 | 2944 | 13304 | 2321 | 15718 | 1862 | 17067 | 1486 | 18639 | 884 | 23304 | 444 | 20315 |
| 6L-4S | | MI | 6380 | 2944 | 10913 | 2253 | 12662 | 1797 | 13654 | 1416 | 15022 | 809 | 18466 | 451 | 15538 |
| 16-#11 | 3.25 | MA | 7514 | 2944 | 12683 | 2320 | 14898 | 1859 | 16066 | 1492 | 17287 | 879 | 21741 | 373 | 19444 |
| 7L-3S | | MI | 6738 | 2944 | 11413 | 2257 | 13323 | 1792 | 14435 | 1421 | 16010 | 804 | 19563 | 535 | 16082 |
| 16-#11 | 3.25 | MA | 7095 | 2944 | 12073 | 2319 | 14094 | 1856 | 15062 | 1487 | 15983 | 884 | 20098 | 323 | 18359 |
| 8L-2S | | MI | 7219 | 2944 | 12072 | 2261 | 14145 | 1797 | 15411 | 1416 | 17295 | 799 | 21226 | 626 | 16160 |
| 16-#14 | 4.69 | MA | 9076 | 3345 | 16196 | 2565 | 19373 | 2029 | 21461 | 1600 | 24341 | 837 | 30946 | 325 | 28890 |
| 5E | | MI | 6502 | 3345 | 11960 | 2495 | 13908 | 1949 | 15117 | 1507 | 16909 | 737 | 21029 | 166 | 20238 |
| 16-#14 | 4.69 | MA | 8482 | 3345 | 15284 | 2563 | 18159 | 2039 | 19987 | 1593 | 22451 | 845 | 28451 | 216 | 27447 |
| 6L-4S | | MI | 6944 | 3345 | 12684 | 2487 | 14747 | 1957 | 16113 | 1500 | 18264 | 744 | 22653 | 229 | 21223 |
| 16-#14 | 4.69 | MA | 7901 | 3345 | 14396 | 2561 | 16986 | 2034 | 18557 | 1600 | 20533 | 837 | 26240 | 113 | 25579 |
| 7L-3S | | MI | 7424 | 3345 | 13396 | 2494 | 15677 | 1949 | 17212 | 1507 | 19656 | 737 | 24194 | 348 | 22390 |
| 18-#11 | 3.66 | MA | 8794 | 3057 | 14883 | 2393 | 17761 | 1907 | 19547 | 1524 | 21885 | 870 | 27598 | 500 | 23909 |
| 5L-6S | | MI | 6025 | 3057 | 10610 | 2326 | 12298 | 1848 | 13225 | 1445 | 14449 | 795 | 17890 | 313 | 16318 |
| 18-#11 | 3.66 | MA | 8366 | 3057 | 14246 | 2392 | 16913 | 1914 | 18515 | 1519 | 20553 | 876 | 25833 | 424 | 22958 |
| 6L-5S | | MI | 6336 | 3057 | 11064 | 2330 | 12888 | 1842 | 13922 | 1450 | 15344 | 790 | 18969 | 376 | 17014 |
| 18-#11 | 3.66 | MA | 7948 | 3057 | 13626 | 2391 | 16093 | 1911 | 17514 | 1525 | 19201 | 870 | 24270 | 352 | 22056 |
| 7L-4S | | MI | 6659 | 3057 | 11572 | 2324 | 13484 | 1848 | 14630 | 1445 | 16307 | 795 | 20129 | 419 | 17381 |

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 3.66 | MA | 7534 | 3057 | 13015 | 2389 | 15289 | 1908 | 16510 | 1520 | 17897 | 876 | 22627 | 303 | 21003 |
| 8L-3S | | MI | 7013 | 3057 | 12072 | 2328 | 14145 | 1842 | 15411 | 1450 | 17295 | 790 | 21226 | 503 | 18001 |
| 18-#14 | 5.27 | MA | 9126 | 3509 | 16629 | 2665 | 19865 | 2114 | 22050 | 1640 | 25165 | 832 | 32027 | 184 | 31200 |
| 6L-5S | | MI | 6887 | 3509 | 12896 | 2597 | 15065 | 2021 | 16491 | 1547 | 18717 | 715 | 23358 | 117 | 22788 |
| 18-#14 | 5.27 | MA | 8501 | 3509 | 15741 | 2663 | 18691 | 2109 | 20620 | 1647 | 23247 | 824 | 29816 | 81 | 29329 |
| 7L-4S | | MI | 7320 | 3509 | 13620 | 2589 | 15904 | 2028 | 17487 | 1540 | 20073 | 723 | 24983 | 180 | 23847 |
| 20-#11 | 4.06 | MA | 8787 | 3171 | 15188 | 2463 | 18108 | 1966 | 19963 | 1552 | 22466 | 867 | 28362 | 403 | 25608 |
| 6E | | MI | 6308 | 3171 | 11269 | 2397 | 13120 | 1898 | 14201 | 1474 | 15734 | 782 | 19552 | 281 | 18145 |
| 20-#11 | 4.06 | MA | 8374 | 3171 | 14568 | 2461 | 17288 | 1963 | 18962 | 1558 | 21114 | 862 | 26799 | 332 | 24676 |
| 7L-5S | | MI | 6615 | 3171 | 11723 | 2401 | 13710 | 1893 | 14899 | 1479 | 16629 | 776 | 20632 | 344 | 18817 |
| 20-#11 | 4.06 | MA | 7966 | 3171 | 13957 | 2460 | 16484 | 1960 | 17958 | 1553 | 19811 | 867 | 25156 | 282 | 23646 |
| 8L-4S | | MI | 6935 | 3171 | 12231 | 2395 | 14306 | 1898 | 15606 | 1474 | 17591 | 782 | 21792 | 388 | 19230 |
| 20-#14 | 5.86 | MA | 9147 | 3672 | 17086 | 2765 | 20397 | 2184 | 22683 | 1695 | 25961 | 811 | 33392 | 50 | 33089 |
| 7L-5S | | MI | 7266 | 3672 | 13831 | 2699 | 16222 | 2093 | 17865 | 1588 | 20526 | 693 | 25688 | 67 | 25351 |
| 22-#11 | 4.47 | MA | 8794 | 3284 | 15510 | 2532 | 18483 | 2015 | 20409 | 1591 | 23028 | 854 | 29328 | 311 | 27302 |
| 7L-6S | | MI | 6611 | 3284 | 11928 | 2467 | 13942 | 1948 | 15177 | 1503 | 17019 | 768 | 21215 | 249 | 19979 |
| 22-#11 | 4.47 | MA | 8392 | 3284 | 14900 | 2531 | 17679 | 2012 | 19406 | 1586 | 21724 | 859 | 27685 | 262 | 26254 |
| 8L-5S | | MI | 6910 | 3284 | 12382 | 2472 | 14532 | 1943 | 15875 | 1508 | 17914 | 762 | 22295 | 312 | 20620 |
| 24-#11 | 4.88 | MA | 8811 | 3398 | 15842 | 2602 | 18874 | 2064 | 20854 | 1619 | 23638 | 851 | 30214 | 242 | 28868 |
| 8L-6S | | MI | 6885 | 3398 | 12587 | 2538 | 14764 | 1999 | 16153 | 1532 | 18304 | 754 | 22878 | 218 | 21818 |

## RECTANGULAR TIED COLUMNS 24" x 34"

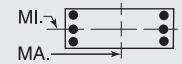
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.10 | MA | 8789 | 2491 | 12779 | 2063 | 14970 | 1679 | 15925 | 1394 | 16591 | 975 | 19959 | 907 | 9034 |
| 2E | | MI | 6060 | 2491 | 9145 | 1993 | 10367 | 1614 | 10816 | 1330 | 11050 | 917 | 13039 | 830 | 6143 |
| 4-#18 | 1.96 | MA | 9744 | 2746 | 15032 | 2206 | 17724 | 1781 | 19172 | 1453 | 20800 | 940 | 25430 | 837 | 15515 |
| 2E | | MI | 6618 | 2746 | 10539 | 2122 | 11984 | 1697 | 12699 | 1367 | 13505 | 857 | 16105 | 715 | 10337 |
| 6-#11 | 1.15 | MA | 8870 | 2504 | 12870 | 2080 | 15139 | 1692 | 16153 | 1403 | 16942 | 981 | 20456 | 914 | 9429 |
| 2L-3S | | MI | 5604 | 2504 | 8544 | 2009 | 9686 | 1627 | 10028 | 1350 | 10025 | 930 | 11743 | 748 | 6438 |
| 6-#11 | 1.15 | MA | 8077 | 2504 | 11857 | 2079 | 13854 | 1690 | 14596 | 1410 | 14871 | 986 | 17709 | 823 | 9423 |
| 3L-2S | | MI | 6117 | 2504 | 9203 | 2013 | 10508 | 1632 | 11004 | 1345 | 11309 | 925 | 13406 | 840 | 6408 |
| 6-#14 | 1.65 | MA | 9463 | 2655 | 14225 | 2166 | 16805 | 1754 | 18148 | 1441 | 19532 | 964 | 23848 | 878 | 13342 |
| 2L-3S | | MI | 5755 | 2655 | 9145 | 2088 | 10367 | 1678 | 10816 | 1378 | 11050 | 902 | 13039 | 649 | 8961 |
| 6-#14 | 1.65 | MA | 8354 | 2655 | 12779 | 2164 | 14970 | 1750 | 15925 | 1450 | 16591 | 971 | 19959 | 747 | 13250 |
| 3L-2S | | MI | 6471 | 2655 | 10080 | 2095 | 11523 | 1686 | 12190 | 1371 | 12858 | 895 | 15368 | 781 | 8962 |
| 6-#18 | 2.94 | MA | 10842 | 3036 | 17553 | 2387 | 20921 | 1914 | 23023 | 1535 | 25867 | 915 | 32091 | 777 | 22954 |
| 2L-3S | | MI | 6111 | 3036 | 10539 | 2288 | 11984 | 1807 | 12699 | 1447 | 13505 | 825 | 16105 | 381 | 14699 |
| 6-#18 | 2.94 | MA | 8994 | 3036 | 15032 | 2382 | 17724 | 1905 | 19172 | 1548 | 20800 | 928 | 25430 | 543 | 22384 |
| 3L-2S | | MI | 7286 | 3036 | 12128 | 2301 | 13940 | 1820 | 15022 | 1434 | 16564 | 812 | 20005 | 615 | 15123 |
| 8-#11 | 1.53 | MA | 9346 | 2618 | 13883 | 2151 | 16424 | 1744 | 17709 | 1436 | 19013 | 974 | 23202 | 896 | 12444 |
| 2L-4S | | MI | 5525 | 2618 | 8703 | 2075 | 9847 | 1683 | 10224 | 1374 | 10321 | 922 | 12309 | 633 | 8353 |
| 8-#11 | 1.53 | MA | 8565 | 2618 | 12870 | 2150 | 15139 | 1741 | 16153 | 1443 | 16942 | 979 | 20456 | 805 | 12406 |
| 3E | | MI | 5904 | 2618 | 9203 | 2079 | 10508 | 1677 | 11004 | 1379 | 11309 | 916 | 13406 | 717 | 8400 |
| 8-#11 | 1.53 | MA | 7995 | 2618 | 12113 | 2150 | 14116 | 1750 | 14913 | 1439 | 15298 | 974 | 18654 | 713 | 12243 |
| 4L-2S | | MI | 6411 | 2618 | 9862 | 2084 | 11330 | 1683 | 11981 | 1374 | 12594 | 911 | 15069 | 808 | 8389 |
| 8-#14 | 2.21 | MA | 10116 | 2818 | 15672 | 2268 | 18640 | 1829 | 20371 | 1489 | 22473 | 952 | 27737 | 849 | 17623 |
| 2L-4S | | MI | 5640 | 2818 | 9369 | 2183 | 10593 | 1757 | 11091 | 1411 | 11467 | 888 | 13828 | 481 | 11012 |
| 8-#14 | 2.21 | MA | 9029 | 2818 | 14225 | 2266 | 16805 | 1825 | 18148 | 1497 | 19532 | 960 | 23848 | 718 | 17473 |
| 3E | | MI | 6168 | 2818 | 10080 | 2190 | 11523 | 1750 | 12190 | 1419 | 12858 | 881 | 15368 | 600 | 11703 |
| 8-#14 | 2.21 | MA | 8235 | 2818 | 13142 | 2265 | 15342 | 1835 | 16375 | 1490 | 17197 | 952 | 21301 | 587 | 16393 |
| 4L-2S | | MI | 6872 | 2818 | 11016 | 2197 | 12680 | 1757 | 13565 | 1411 | 14667 | 873 | 17698 | 731 | 11753 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

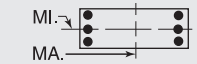



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.92 | MA | 11902 | 3327 | 20074 | 2569 | 24118 | 2047 | 26875 | 1618 | 30934 | 890 | 38752 | 717 | 30360 |
| 2L-4S | | MI | 5915 | 3327 | 10919 | 2454 | 12366 | 1943 | 13163 | 1501 | 14211 | 793 | 17414 | 78 | 16999 |
| 8-#18 | 3.92 | MA | 10106 | 3327 | 17553 | 2564 | 20921 | 2038 | 23023 | 1631 | 25867 | 904 | 32091 | 484 | 29459 |
| 3E | | MI | 6779 | 3327 | 12128 | 2467 | 13940 | 1930 | 15022 | 1514 | 16564 | 780 | 20005 | 281 | 18883 |
| 8-#18 | 3.92 | MA | 8792 | 3327 | 15659 | 2559 | 18363 | 2054 | 19946 | 1618 | 21845 | 890 | 27727 | 254 | 25778 |
| 4L-2S | | MI | 7916 | 3327 | 13716 | 2480 | 15896 | 1943 | 17346 | 1501 | 19623 | 767 | 23906 | 515 | 19862 |
| 10-#11 | 1.91 | MA | 9812 | 2731 | 14897 | 2222 | 17709 | 1796 | 19266 | 1469 | 21085 | 967 | 25949 | 877 | 15445 |
| 2L-5S | | MI | 5482 | 2731 | 8854 | 2152 | 10073 | 1728 | 10492 | 1408 | 10643 | 903 | 12812 | 557 | 9692 |
| 10-#11 | 1.91 | MA | 9042 | 2731 | 13883 | 2221 | 16424 | 1793 | 17709 | 1476 | 19013 | 972 | 23202 | 786 | 15380 |
| 3L-4S | | MI | 5824 | 2731 | 9362 | 2146 | 10669 | 1733 | 11200 | 1403 | 11606 | 908 | 13972 | 601 | 10190 |
| 10-#11 | 1.91 | MA | 8481 | 2731 | 13126 | 2221 | 15401 | 1801 | 16470 | 1472 | 17369 | 967 | 21401 | 695 | 15183 |
| 4L-3S | | MI | 6198 | 2731 | 9862 | 2150 | 11330 | 1728 | 11981 | 1408 | 12594 | 903 | 15069 | 685 | 10344 |
| 10-#11 | 1.91 | MA | 7971 | 2731 | 12359 | 2230 | 14480 | 1799 | 15346 | 1478 | 15869 | 972 | 19495 | 652 | 14238 |
| 5L-2S | | MI | 6698 | 2731 | 10520 | 2155 | 12152 | 1733 | 12957 | 1403 | 13879 | 897 | 16732 | 776 | 10357 |
| 10-#14 | 2.76 | MA | 10752 | 2982 | 17119 | 2370 | 20475 | 1903 | 22594 | 1536 | 25415 | 941 | 31627 | 820 | 21889 |
| 2L-5S | | MI | 5578 | 2982 | 9580 | 2293 | 10911 | 1821 | 11469 | 1459 | 11920 | 859 | 14533 | 368 | 12918 |
| 10-#14 | 2.76 | MA | 9686 | 2982 | 15672 | 2369 | 18640 | 1899 | 20371 | 1544 | 22473 | 948 | 27737 | 689 | 21689 |
| 3L-4S | | MI | 6052 | 2982 | 10304 | 2285 | 11750 | 1829 | 12466 | 1452 | 13276 | 866 | 16158 | 432 | 13573 |
| 10-#14 | 2.76 | MA | 8908 | 2982 | 14589 | 2367 | 17177 | 1910 | 18598 | 1538 | 20139 | 941 | 25191 | 558 | 20424 |
| 4L-3S | | MI | 6571 | 2982 | 11016 | 2292 | 12680 | 1821 | 13565 | 1459 | 14667 | 859 | 17698 | 551 | 14430 |
| 10-#14 | 2.76 | MA | 8201 | 2982 | 13491 | 2380 | 15859 | 1906 | 16990 | 1546 | 18009 | 948 | 22484 | 496 | 19283 |
| 5L-2S | | MI | 7264 | 2982 | 11952 | 2299 | 13837 | 1829 | 14939 | 1452 | 16476 | 851 | 20028 | 682 | 14521 |
| 10-#18 | 4.90 | MA | 11183 | 3618 | 20074 | 2746 | 24118 | 2171 | 26875 | 1714 | 30934 | 879 | 38752 | 424 | 36298 |
| 3L-4S | | MI | 6589 | 3618 | 12507 | 2633 | 14322 | 2066 | 15487 | 1567 | 17270 | 748 | 21314 | -22 | 21220 |
| 10-#18 | 4.90 | MA | 9906 | 3618 | 18180 | 2741 | 21560 | 2187 | 23797 | 1700 | 26911 | 866 | 34388 | 194 | 32851 |
| 4L-3S | | MI | 7425 | 3618 | 13716 | 2646 | 15896 | 2053 | 17346 | 1581 | 19623 | 735 | 23906 | 181 | 23137 |
| 10-#18 | 4.90 | MA | 8747 | 3618 | 16258 | 2762 | 19254 | 2177 | 21006 | 1714 | 23242 | 879 | 29743 | 85 | 29278 |
| 5L-2S | | MI | 8527 | 3618 | 15304 | 2659 | 17851 | 2066 | 19670 | 1567 | 22682 | 722 | 27806 | 414 | 24576 |
| 12-#11 | 2.29 | MA | 10268 | 2844 | 15910 | 2293 | 18994 | 1847 | 20823 | 1502 | 23156 | 960 | 28695 | 859 | 18438 |
| 2L-6S | | MI | 5455 | 2844 | 9059 | 2219 | 10305 | 1783 | 10771 | 1432 | 11033 | 894 | 13396 | 463 | 11049 |
| 12-#11 | 2.29 | MA | 9509 | 2844 | 14897 | 2292 | 17709 | 1845 | 19266 | 1508 | 21085 | 965 | 25949 | 768 | 18348 |
| 3L-5S | | MI | 5780 | 2844 | 9513 | 2223 | 10895 | 1778 | 11468 | 1437 | 11928 | 889 | 14475 | 526 | 11539 |
| 12-#11 | 2.29 | MA | 8957 | 2844 | 14139 | 2291 | 16686 | 1853 | 18026 | 1505 | 19441 | 960 | 24148 | 677 | 18006 |
| 4E | | MI | 6117 | 2844 | 10021 | 2217 | 11491 | 1783 | 12176 | 1432 | 12890 | 894 | 15635 | 569 | 12000 |
| 12-#11 | 2.29 | MA | 8455 | 2844 | 13372 | 2301 | 15765 | 1851 | 16903 | 1511 | 17941 | 965 | 22241 | 633 | 17110 |
| 5L-3S | | MI | 6487 | 2844 | 10520 | 2221 | 12152 | 1778 | 12957 | 1437 | 13879 | 889 | 16732 | 653 | 12280 |
| 12-#11 | 2.29 | MA | 7974 | 2844 | 12690 | 2300 | 14856 | 1859 | 15796 | 1507 | 16498 | 970 | 20324 | 558 | 16331 |
| 6L-2S | | MI | 6981 | 2844 | 11179 | 2225 | 12974 | 1783 | 13933 | 1432 | 15164 | 884 | 18395 | 745 | 12313 |
| 12-#14 | 3.31 | MA | 10327 | 3145 | 17119 | 2471 | 20475 | 1974 | 22594 | 1592 | 25415 | 936 | 31627 | 660 | 25902 |
| 3L-5S | | MI | 5989 | 3145 | 10516 | 2395 | 12068 | 1893 | 12843 | 1500 | 13729 | 837 | 16862 | 319 | 15413 |
| 12-#14 | 3.31 | MA | 9564 | 3145 | 16036 | 2469 | 19012 | 1985 | 20821 | 1585 | 23080 | 929 | 29080 | 529 | 24477 |
| 4E | | MI | 6456 | 3145 | 11240 | 2387 | 12907 | 1900 | 13840 | 1492 | 15084 | 844 | 18487 | 383 | 16155 |
| 12-#14 | 3.31 | MA | 8872 | 3145 | 14938 | 2483 | 17694 | 1981 | 19213 | 1594 | 20950 | 936 | 26373 | 467 | 23375 |
| 5L-3S | | MI | 6967 | 3145 | 11952 | 2395 | 13837 | 1893 | 14939 | 1500 | 16476 | 837 | 20028 | 502 | 17150 |
| 12-#14 | 3.31 | MA | 8207 | 3145 | 13961 | 2481 | 16392 | 1992 | 17629 | 1587 | 18902 | 944 | 23659 | 358 | 21591 |
| 6L-2S | | MI | 7649 | 3145 | 12888 | 2402 | 14994 | 1900 | 16313 | 1492 | 18284 | 830 | 22357 | 633 | 17277 |
| 12-#18 | 5.88 | MA | 11043 | 3909 | 20701 | 2923 | 24758 | 2320 | 27649 | 1783 | 31978 | 841 | 41049 | 134 | 39958 |
| 4E | | MI | 7242 | 3909 | 14095 | 2812 | 16278 | 2189 | 17810 | 1634 | 20329 | 703 | 25215 | -123 | 24631 |
| 12-#18 | 5.88 | MA | 9926 | 3909 | 18779 | 2944 | 22451 | 2310 | 24857 | 1796 | 28308 | 854 | 36404 | 25 | 36259 |
| 5L-3S | | MI | 8053 | 3909 | 15304 | 2825 | 17851 | 2176 | 19670 | 1648 | 22682 | 690 | 27806 | 80 | 27446 |
| 14-#11 | 2.68 | MA | 9968 | 2958 | 15910 | 2363 | 18994 | 1897 | 20823 | 1541 | 23156 | 958 | 28695 | 749 | 21313 |
| 3L-6S | | MI | 5752 | 2958 | 9718 | 2290 | 11127 | 1834 | 11747 | 1461 | 12318 | 880 | 15059 | 431 | 12850 |
| 14-#11 | 2.68 | MA | 9423 | 2958 | 15153 | 2362 | 17971 | 1905 | 19583 | 1537 | 21512 | 952 | 26894 | 658 | 20843 |
| 4L-5S | | MI | 6073 | 2958 | 10171 | 2294 | 11717 | 1829 | 12445 | 1466 | 13213 | 875 | 16138 | 494 | 13394 |
| 14-#11 | 2.68 | MA | 8929 | 2958 | 14386 | 2372 | 17050 | 1903 | 18460 | 1544 | 20012 | 958 | 24988 | 615 | 19992 |
| 5L-4S | | MI | 6406 | 2958 | 10680 | 2288 | 12313 | 1834 | 13153 | 1461 | 14175 | 880 | 17298 | 538 | 13823 |
| 14-#11 | 2.68 | MA | 8455 | 2958 | 13703 | 2371 | 16141 | 1911 | 17353 | 1540 | 18569 | 963 | 23071 | 539 | 19160 |
| 6L-3S | | MI | 6771 | 2958 | 11179 | 2292 | 12974 | 1829 | 13933 | 1466 | 15164 | 875 | 18395 | 622 | 14209 |


## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

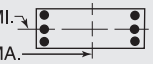



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.68 | MA | 7991 | 2958 | 13038 | 2371 | 15262 | 1909 | 16280 | 1546 | 17106 | 958 | 21371 | 468 | 18264 |
| 7L-2S | | MI | 7259 | 2958 | 11838 | 2296 | 13796 | 1834 | 14910 | 1461 | 16449 | 870 | 20058 | 713 | 14260 |
| 14-#14 | 3.86 | MA | 10206 | 3309 | 17483 | 2571 | 20847 | 2060 | 23044 | 1633 | 26021 | 917 | 32969 | 500 | 28548 |
| 4L-5S | | MI | 6416 | 3309 | 11452 | 2498 | 13225 | 1964 | 14218 | 1540 | 15537 | 815 | 19192 | 270 | 17927 |
| 14-#14 | 3.86 | MA | 9527 | 3309 | 16385 | 2585 | 19529 | 2056 | 21436 | 1641 | 23891 | 925 | 30262 | 438 | 27370 |
| 5L-4S | | MI | 6872 | 3309 | 12176 | 2490 | 14064 | 1972 | 15214 | 1533 | 16893 | 823 | 20817 | 333 | 18753 |
| 14-#14 | 3.86 | MA | 8875 | 3309 | 15408 | 2583 | 18227 | 2067 | 19852 | 1634 | 21843 | 932 | 27549 | 329 | 25654 |
| 6L-3S | | MI | 7367 | 3309 | 12888 | 2497 | 14994 | 1964 | 16313 | 1540 | 18284 | 815 | 22357 | 452 | 19863 |
| 14-#14 | 3.86 | MA | 8237 | 3309 | 14456 | 2582 | 16969 | 2063 | 18315 | 1643 | 19765 | 925 | 25145 | 226 | 23773 |
| 7L-2S | | MI | 8025 | 3309 | 13823 | 2504 | 16151 | 1972 | 17687 | 1533 | 20093 | 808 | 24687 | 584 | 20023 |
| 14-#18 | 6.86 | MA | 11011 | 4200 | 21300 | 3126 | 25648 | 2443 | 28708 | 1879 | 33375 | 829 | 43065 | -34 | 42776 |
| 5L-4S | | MI | 7880 | 4200 | 15683 | 2991 | 18234 | 2312 | 20134 | 1701 | 23388 | 658 | 29115 | -223 | 27945 |
| 16-#11 | 3.06 | MA | 9881 | 3071 | 16166 | 2433 | 19256 | 1957 | 21140 | 1570 | 23583 | 945 | 29641 | 640 | 23692 |
| 4L-6S | | MI | 6045 | 3071 | 10377 | 2361 | 11949 | 1884 | 12723 | 1490 | 13603 | 866 | 16722 | 400 | 14660 |
| 16-#11 | 3.06 | MA | 9395 | 3071 | 15399 | 2443 | 18335 | 1955 | 20016 | 1577 | 22083 | 950 | 27734 | 596 | 22881 |
| 5E | | MI | 6361 | 3071 | 10830 | 2365 | 12539 | 1879 | 13421 | 1495 | 14498 | 861 | 17801 | 462 | 15255 |
| 16-#11 | 3.06 | MA | 8928 | 3071 | 14716 | 2442 | 17426 | 1963 | 18910 | 1573 | 20641 | 956 | 25818 | 521 | 21999 |
| 6L-4S | | MI | 6690 | 3071 | 11338 | 2359 | 13135 | 1884 | 14129 | 1490 | 15460 | 866 | 18961 | 506 | 15656 |
| 16-#11 | 3.06 | MA | 8471 | 3071 | 14052 | 2442 | 16547 | 1961 | 17836 | 1579 | 19178 | 950 | 24118 | 449 | 21134 |
| 7L-3S | | MI | 7050 | 3071 | 11838 | 2363 | 13796 | 1879 | 14910 | 1495 | 16449 | 861 | 20058 | 590 | 16134 |
| 16-#11 | 3.06 | MA | 8019 | 3071 | 13397 | 2441 | 15686 | 1958 | 16761 | 1575 | 17766 | 956 | 22338 | 399 | 19917 |
| 8L-2S | | MI | 7534 | 3071 | 12497 | 2367 | 14618 | 1884 | 15886 | 1490 | 17734 | 856 | 21721 | 681 | 16201 |
| 16-#14 | 4.41 | MA | 10169 | 3473 | 17832 | 2687 | 21364 | 2131 | 23659 | 1688 | 26833 | 913 | 34152 | 409 | 31381 |
| 5E | | MI | 6812 | 3473 | 12388 | 2600 | 14382 | 2036 | 15592 | 1580 | 17346 | 793 | 21521 | 220 | 20459 |
| 16-#14 | 4.41 | MA | 9529 | 3473 | 16855 | 2686 | 20062 | 2141 | 22075 | 1682 | 24784 | 921 | 31438 | 300 | 29728 |
| 6L-4S | | MI | 7258 | 3473 | 13112 | 2592 | 15221 | 2043 | 16588 | 1573 | 18701 | 801 | 23146 | 284 | 21365 |
| 16-#14 | 4.41 | MA | 8902 | 3473 | 15903 | 2684 | 18804 | 2137 | 20538 | 1690 | 22706 | 913 | 29034 | 197 | 27809 |
| 7L-3S | | MI | 7742 | 3473 | 13823 | 2599 | 16151 | 2036 | 17687 | 1580 | 20093 | 793 | 24687 | 403 | 22571 |
| 18-#11 | 3.44 | MA | 9852 | 3185 | 16412 | 2514 | 19620 | 2007 | 21573 | 1610 | 24155 | 943 | 30481 | 578 | 25776 |
| 5L-6S | | MI | 6333 | 3185 | 11035 | 2432 | 12771 | 1935 | 13700 | 1519 | 14888 | 852 | 18385 | 368 | 16479 |
| 18-#11 | 3.44 | MA | 9392 | 3185 | 15730 | 2513 | 18711 | 2015 | 20467 | 1606 | 22712 | 948 | 28564 | 502 | 24846 |
| 6L-5S | | MI | 6645 | 3185 | 11489 | 2436 | 13361 | 1929 | 14397 | 1524 | 15782 | 847 | 19464 | 431 | 17120 |
| 18-#11 | 3.44 | MA | 8942 | 3185 | 15065 | 2512 | 17832 | 2012 | 19393 | 1612 | 21249 | 943 | 26864 | 431 | 23961 |
| 7L-4S | | MI | 6971 | 3185 | 11997 | 2430 | 13957 | 1935 | 15105 | 1519 | 16745 | 852 | 20624 | 474 | 17498 |
| 18-#11 | 3.44 | MA | 8496 | 3185 | 14410 | 2512 | 16971 | 2010 | 18318 | 1608 | 19838 | 948 | 25085 | 380 | 22767 |
| 8L-3S | | MI | 7327 | 3185 | 12497 | 2434 | 14618 | 1929 | 15886 | 1524 | 17734 | 847 | 21721 | 558 | 18055 |
| 18-#14 | 4.96 | MA | 10171 | 3636 | 18302 | 2788 | 21897 | 2216 | 24298 | 1729 | 27726 | 909 | 35327 | 271 | 33813 |
| 6L-5S | | MI | 7199 | 3636 | 13323 | 2702 | 15538 | 2108 | 16966 | 1621 | 19154 | 772 | 23851 | 171 | 23006 |
| 18-#14 | 4.96 | MA | 9555 | 3636 | 17350 | 2786 | 20639 | 2212 | 22762 | 1738 | 25648 | 902 | 32923 | 168 | 31856 |
| 7L-4S | | MI | 7636 | 3636 | 14047 | 2694 | 16378 | 2115 | 17962 | 1613 | 20510 | 779 | 25476 | 235 | 23987 |
| 20-#11 | 3.82 | MA | 9849 | 3298 | 16743 | 2584 | 19996 | 2067 | 22023 | 1638 | 24783 | 941 | 31311 | 484 | 27701 |
| 6E | | MI | 6617 | 3298 | 11694 | 2502 | 13593 | 1985 | 14676 | 1548 | 16173 | 838 | 20048 | 336 | 18304 |
| 20-#11 | 3.82 | MA | 9405 | 3298 | 16078 | 2583 | 19117 | 2064 | 20950 | 1645 | 23320 | 936 | 29611 | 412 | 26785 |
| 7L-5S | | MI | 6926 | 3298 | 12148 | 2507 | 14183 | 1980 | 15374 | 1553 | 17067 | 833 | 21127 | 399 | 18990 |
| 20-#11 | 3.82 | MA | 8966 | 3298 | 15424 | 2583 | 18256 | 2062 | 19874 | 1641 | 21909 | 941 | 27832 | 362 | 25623 |
| 8L-4S | | MI | 7248 | 3298 | 12656 | 2500 | 14780 | 1985 | 16081 | 1548 | 18030 | 838 | 22287 | 443 | 19346 |
| 20-#14 | 5.51 | MA | 10197 | 3800 | 18797 | 2888 | 22474 | 2287 | 24985 | 1785 | 28589 | 890 | 36813 | 139 | 35912 |
| 7L-5S | | MI | 7580 | 3800 | 14259 | 2804 | 16695 | 2179 | 18340 | 1661 | 20963 | 750 | 26181 | 122 | 25566 |
| 22-#11 | 4.21 | MA | 9862 | 3411 | 17091 | 2654 | 20402 | 2116 | 22507 | 1678 | 25392 | 929 | 32357 | 394 | 29615 |
| 7L-6S | | MI | 6922 | 3411 | 12353 | 2573 | 14415 | 2035 | 15652 | 1577 | 17457 | 825 | 21711 | 304 | 20136 |
| 22-#11 | 4.21 | MA | 9428 | 3411 | 16437 | 2654 | 19541 | 2114 | 21431 | 1674 | 23980 | 934 | 30578 | 343 | 28484 |
| 8L-5S | | MI | 7224 | 3411 | 12807 | 2577 | 15005 | 2030 | 16350 | 1582 | 18352 | 819 | 22790 | 367 | 20804 |
| 24-#11 | 4.59 | MA | 9885 | 3525 | 17450 | 2724 | 20826 | 2166 | 22988 | 1707 | 26052 | 927 | 33325 | 325 | 31349 |
| 8L-6S | | MI | 7198 | 3525 | 13012 | 2644 | 15237 | 2086 | 16628 | 1606 | 18742 | 811 | 23374 | 273 | 21974 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis



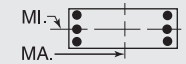

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.04 | MA | 9798 | 2618 | 14112 | 2183 | 16578 | 1777 | 17634 | 1477 | 18368 | 1042 | 22107 | 974 | 9641 |
| 2E | | MI | 6367 | 2618 | 9573 | 2098 | 10840 | 1701 | 11291 | 1404 | 11487 | 973 | 13532 | 885 | 6170 |
| 4-#18 | 1.85 | MA | 10839 | 2873 | 16533 | 2325 | 19537 | 1880 | 21170 | 1539 | 22928 | 1009 | 28060 | 909 | 16595 |
| 2E | | MI | 6927 | 2873 | 10973 | 2226 | 12458 | 1783 | 13173 | 1439 | 13940 | 913 | 16593 | 769 | 10377 |
| 6-#11 | 1.08 | MA | 9884 | 2632 | 14208 | 2199 | 16756 | 1790 | 17874 | 1487 | 18739 | 1048 | 22632 | 981 | 10061 |
| 2L-3S | | MI | 5910 | 2632 | 8969 | 2114 | 10159 | 1714 | 10503 | 1424 | 10463 | 987 | 12238 | 803 | 6467 |
| 6-#11 | 1.08 | MA | 9032 | 2632 | 13124 | 2199 | 15381 | 1788 | 16208 | 1494 | 16509 | 1053 | 19667 | 890 | 10055 |
| 3L-2S | | MI | 6425 | 2632 | 9628 | 2119 | 10981 | 1719 | 11479 | 1419 | 11748 | 982 | 13901 | 895 | 6433 |
| 6-#14 | 1.56 | MA | 10528 | 2782 | 15661 | 2285 | 18543 | 1852 | 20014 | 1525 | 21537 | 1032 | 26310 | 948 | 14253 |
| 2L-3S | | MI | 6061 | 2782 | 9573 | 2193 | 10840 | 1765 | 11291 | 1452 | 11487 | 959 | 13532 | 704 | 9004 |
| 6-#14 | 1.56 | MA | 9336 | 2782 | 14112 | 2284 | 16578 | 1849 | 17634 | 1534 | 18368 | 1039 | 22107 | 817 | 14161 |
| 3L-2S | | MI | 6780 | 2782 | 10508 | 2200 | 11997 | 1772 | 12665 | 1444 | 13296 | 951 | 15861 | 835 | 8994 |
| 6-#18 | 2.78 | MA | 12032 | 3164 | 19236 | 2507 | 22965 | 2013 | 25323 | 1623 | 28399 | 987 | 35278 | 854 | 24574 |
| 2L-3S | | MI | 6400 | 3164 | 10973 | 2392 | 12458 | 1893 | 13173 | 1519 | 13940 | 881 | 16593 | 435 | 14946 |
| 6-#18 | 2.78 | MA | 10040 | 3164 | 16533 | 2503 | 19537 | 2004 | 21170 | 1637 | 22928 | 1000 | 28060 | 621 | 24004 |
| 3L-2S | | MI | 7596 | 3164 | 12561 | 2405 | 14414 | 1906 | 15496 | 1506 | 16999 | 868 | 20494 | 669 | 15173 |
| 8-#11 | 1.44 | MA | 10399 | 2745 | 15292 | 2270 | 18131 | 1842 | 19539 | 1520 | 20968 | 1042 | 25596 | 964 | 13287 |
| 2L-4S | | MI | 5831 | 2745 | 9128 | 2181 | 10320 | 1770 | 10699 | 1448 | 10759 | 978 | 12804 | 688 | 8402 |
| 8-#11 | 1.44 | MA | 9561 | 2745 | 14208 | 2270 | 16756 | 1840 | 17874 | 1527 | 18739 | 1047 | 22632 | 873 | 13248 |
| 3E | | MI | 6211 | 2745 | 9628 | 2185 | 10981 | 1765 | 11479 | 1453 | 11748 | 973 | 13901 | 772 | 8434 |
| 8-#11 | 1.44 | MA | 8949 | 2745 | 13399 | 2270 | 15663 | 1849 | 16550 | 1524 | 16970 | 1042 | 20684 | 782 | 13085 |
| 4L-2S | | MI | 6719 | 2745 | 10287 | 2190 | 11803 | 1770 | 12456 | 1448 | 13033 | 968 | 15564 | 863 | 8418 |
| 8-#14 | 2.08 | MA | 11237 | 2946 | 17210 | 2387 | 20507 | 1927 | 22394 | 1572 | 24706 | 1021 | 30514 | 922 | 18838 |
| 2L-4S | | MI | 5946 | 2946 | 9797 | 2288 | 11067 | 1844 | 11566 | 1485 | 11904 | 945 | 14321 | 536 | 11158 |
| 8-#14 | 2.08 | MA | 10068 | 2946 | 15661 | 2386 | 18543 | 1924 | 20014 | 1581 | 21537 | 1029 | 26310 | 790 | 18688 |
| 3E | | MI | 6476 | 2946 | 10508 | 2295 | 11997 | 1836 | 12665 | 1492 | 13296 | 937 | 15861 | 655 | 11753 |
| 8-#14 | 2.08 | MA | 9215 | 2946 | 14504 | 2386 | 16979 | 1935 | 18119 | 1576 | 19022 | 1021 | 23553 | 659 | 17685 |
| 4L-2S | | MI | 7183 | 2946 | 11444 | 2302 | 13154 | 1844 | 14039 | 1485 | 15104 | 930 | 18191 | 786 | 11790 |
| 8-#18 | 3.70 | MA | 13182 | 3454 | 21939 | 2688 | 26392 | 2146 | 29476 | 1708 | 33869 | 965 | 42496 | 800 | 32520 |
| 2L-4S | | MI | 6220 | 3454 | 11352 | 2558 | 12841 | 2029 | 13637 | 1573 | 14646 | 849 | 17903 | 132 | 17194 |
| 8-#18 | 3.70 | MA | 11246 | 3454 | 19236 | 2685 | 22965 | 2137 | 25323 | 1721 | 28399 | 978 | 35278 | 566 | 31810 |
| 3E | | MI | 7091 | 3454 | 12561 | 2571 | 14414 | 2016 | 15496 | 1586 | 16999 | 836 | 20494 | 335 | 19138 |
| 8-#18 | 3.70 | MA | 9835 | 3454 | 17210 | 2681 | 20228 | 2156 | 22007 | 1708 | 24056 | 965 | 30556 | 333 | 27821 |
| 4L-2S | | MI | 8235 | 3454 | 14149 | 2584 | 16370 | 2029 | 17820 | 1573 | 20058 | 822 | 24394 | 569 | 19918 |
| 10-#11 | 1.81 | MA | 10904 | 2858 | 16376 | 2341 | 19506 | 1894 | 21205 | 1553 | 23197 | 1035 | 28561 | 948 | 16498 |
| 2L-5S | | MI | 5787 | 2858 | 9279 | 2258 | 10546 | 1815 | 10967 | 1482 | 11081 | 959 | 13307 | 612 | 9796 |
| 10-#11 | 1.81 | MA | 10077 | 2858 | 15292 | 2341 | 18131 | 1892 | 19539 | 1560 | 20968 | 1040 | 25596 | 857 | 16433 |
| 3L-4S | | MI | 6131 | 2858 | 9787 | 2252 | 11142 | 1820 | 11675 | 1477 | 12044 | 965 | 14467 | 656 | 10309 |
| 10-#11 | 1.81 | MA | 9475 | 2858 | 14483 | 2341 | 17038 | 1901 | 18215 | 1556 | 19199 | 1035 | 23649 | 765 | 16236 |
| 4L-3S | | MI | 6506 | 2858 | 10287 | 2256 | 11803 | 1815 | 12456 | 1482 | 13033 | 959 | 15564 | 740 | 10384 |
| 10-#11 | 1.81 | MA | 8930 | 2858 | 13664 | 2351 | 16055 | 1899 | 17016 | 1563 | 17584 | 1040 | 21597 | 721 | 15292 |
| 5L-2S | | MI | 7008 | 2858 | 10946 | 2260 | 12625 | 1820 | 13432 | 1477 | 14318 | 954 | 17227 | 831 | 10389 |
| 10-#14 | 2.60 | MA | 11927 | 3109 | 18760 | 2489 | 22472 | 2002 | 24774 | 1619 | 27875 | 1011 | 34717 | 895 | 23408 |
| 2L-5S | | MI | 5883 | 3109 | 10008 | 2398 | 11385 | 1908 | 11944 | 1533 | 12357 | 915 | 15026 | 423 | 13125 |
| 10-#14 | 2.60 | MA | 10779 | 3109 | 17210 | 2489 | 20507 | 1998 | 22394 | 1629 | 24706 | 1019 | 30514 | 764 | 23208 |
| 3L-4S | | MI | 6359 | 3109 | 10732 | 2390 | 12224 | 1915 | 12940 | 1525 | 13713 | 923 | 16650 | 486 | 13716 |
| 10-#14 | 2.60 | MA | 9944 | 3109 | 16053 | 2488 | 18943 | 2010 | 20499 | 1623 | 22191 | 1011 | 27757 | 633 | 22008 |
| 4L-3S | | MI | 6881 | 3109 | 11444 | 2397 | 13154 | 1908 | 14039 | 1533 | 15104 | 915 | 18191 | 605 | 14487 |
| 10-#14 | 2.60 | MA | 9187 | 3109 | 14880 | 2502 | 17536 | 2007 | 18782 | 1633 | 19896 | 1019 | 24840 | 570 | 20727 |
| 5L-2S | | MI | 7577 | 3109 | 12380 | 2404 | 14311 | 1915 | 15413 | 1525 | 16913 | 908 | 20521 | 737 | 14563 |
| 10-#18 | 4.63 | MA | 12414 | 3745 | 21939 | 2867 | 26392 | 2270 | 29476 | 1805 | 33869 | 956 | 42496 | 512 | 39344 |
| 3L-4S | | MI | 6896 | 3745 | 12940 | 2737 | 14797 | 2152 | 15960 | 1640 | 17705 | 804 | 21803 | 32 | 21628 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

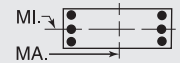



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 4.63 | MA | 11041 | 3745 | 19912 | 2863 | 23655 | 2289 | 26160 | 1793 | 29527 | 943 | 37774 | 278 | 35419 |
| 4L-3S | | MI | 7740 | 3745 | 14149 | 2750 | 16370 | 2139 | 17820 | 1653 | 20058 | 791 | 24394 | 235 | 23385 |
| 10-#18 | 4.63 | MA | 9796 | 3745 | 17858 | 2886 | 21190 | 2280 | 23151 | 1806 | 25565 | 956 | 32741 | 170 | 31745 |
| 5L-2S | | MI | 8851 | 3745 | 15737 | 2763 | 18326 | 2152 | 20143 | 1640 | 23117 | 777 | 28295 | 468 | 24637 |
| 12-#11 | 2.17 | MA | 11398 | 2972 | 17460 | 2412 | 20881 | 1946 | 22871 | 1585 | 25426 | 1029 | 31525 | 931 | 19702 |
| 2L-6S | | MI | 5760 | 2972 | 9484 | 2325 | 10778 | 1871 | 11246 | 1506 | 11472 | 951 | 13891 | 518 | 11213 |
| 12-#11 | 2.17 | MA | 10583 | 2972 | 16376 | 2412 | 19506 | 1944 | 21205 | 1593 | 23197 | 1034 | 28561 | 840 | 19612 |
| 3L-5S | | MI | 6086 | 2972 | 9938 | 2329 | 11368 | 1865 | 11943 | 1511 | 12366 | 946 | 14970 | 581 | 11643 |
| 12-#11 | 2.17 | MA | 9990 | 2972 | 15567 | 2412 | 18413 | 1953 | 19881 | 1589 | 21428 | 1029 | 26614 | 749 | 19384 |
| 4E | | MI | 6425 | 2972 | 10446 | 2323 | 11964 | 1871 | 12651 | 1506 | 13329 | 951 | 16130 | 624 | 12118 |
| 12-#11 | 2.17 | MA | 9453 | 2972 | 14748 | 2422 | 17430 | 1951 | 18682 | 1596 | 19814 | 1034 | 24562 | 704 | 18370 |
| 5L-3S | | MI | 6796 | 2972 | 10946 | 2327 | 12625 | 1865 | 13432 | 1511 | 14318 | 946 | 17227 | 708 | 12323 |
| 12-#11 | 2.17 | MA | 8937 | 2972 | 14020 | 2422 | 16460 | 1959 | 17501 | 1593 | 18261 | 1039 | 22492 | 629 | 17626 |
| 6L-2S | | MI | 7292 | 2972 | 11604 | 2331 | 13447 | 1871 | 14408 | 1506 | 15603 | 940 | 18890 | 800 | 12348 |
| 12-#14 | 3.13 | MA | 11474 | 3273 | 18760 | 2591 | 22472 | 2073 | 24774 | 1676 | 27875 | 1008 | 34717 | 738 | 27724 |
| 3L-5S | | MI | 6295 | 3273 | 10944 | 2501 | 12541 | 1979 | 13318 | 1573 | 14166 | 894 | 17355 | 374 | 15637 |
| 12-#14 | 3.13 | MA | 10655 | 3273 | 17602 | 2590 | 20908 | 2085 | 22879 | 1671 | 25360 | 1001 | 31960 | 606 | 26354 |
| 4E | | MI | 6765 | 3273 | 11668 | 2493 | 13381 | 1987 | 14314 | 1566 | 15521 | 901 | 18980 | 437 | 16296 |
| 12-#14 | 3.13 | MA | 9912 | 3273 | 16430 | 2604 | 19501 | 2082 | 21162 | 1680 | 23065 | 1008 | 29043 | 543 | 25139 |
| 5L-3S | | MI | 7278 | 3273 | 12380 | 2500 | 14311 | 1979 | 15413 | 1573 | 16913 | 894 | 20521 | 556 | 17210 |
| 12-#14 | 3.13 | MA | 9200 | 3273 | 15387 | 2603 | 18111 | 2093 | 19471 | 1674 | 20858 | 1016 | 26110 | 434 | 23304 |
| 6L-2S | | MI | 7964 | 3273 | 13316 | 2507 | 15468 | 1987 | 16787 | 1566 | 18721 | 886 | 22850 | 688 | 17322 |
| 12-#18 | 5.56 | MA | 12282 | 4036 | 22615 | 3045 | 27083 | 2422 | 30312 | 1877 | 34997 | 920 | 44992 | 223 | 43051 |
| 4E | | MI | 7552 | 4036 | 14528 | 2916 | 16753 | 2275 | 18284 | 1707 | 20764 | 759 | 25703 | -69 | 25361 |
| 12-#18 | 5.56 | MA | 11078 | 4036 | 20561 | 3068 | 24617 | 2413 | 27304 | 1891 | 31036 | 934 | 39959 | 116 | 39253 |
| 5L-3S | | MI | 8371 | 4036 | 15737 | 2929 | 18326 | 2261 | 20143 | 1720 | 23117 | 745 | 28295 | 134 | 27688 |
| 12-#18 | 5.56 | MA | 9906 | 4036 | 18732 | 3064 | 22181 | 2432 | 24340 | 1878 | 27226 | 947 | 34923 | -79 | 34519 |
| 6L-2S | | MI | 9453 | 4036 | 17326 | 2942 | 20282 | 2275 | 22467 | 1707 | 26176 | 732 | 32195 | 368 | 29339 |
| 14-#11 | 2.53 | MA | 11079 | 3085 | 17460 | 2483 | 20881 | 1996 | 22871 | 1625 | 25426 | 1028 | 31525 | 823 | 22787 |
| 3L-6S | | MI | 6058 | 3085 | 10143 | 2396 | 11600 | 1921 | 12222 | 1535 | 12757 | 937 | 15554 | 486 | 13011 |
| 14-#11 | 2.53 | MA | 10495 | 3085 | 16651 | 2483 | 19788 | 2004 | 21547 | 1622 | 23657 | 1022 | 29578 | 732 | 22423 |
| 4L-5S | | MI | 6380 | 3085 | 10597 | 2400 | 12190 | 1916 | 12920 | 1540 | 13651 | 932 | 16633 | 549 | 13497 |
| 14-#11 | 2.53 | MA | 9966 | 3085 | 15833 | 2493 | 18805 | 2003 | 20347 | 1629 | 22043 | 1028 | 27526 | 688 | 21457 |
| 5L-4S | | MI | 6715 | 3085 | 11105 | 2394 | 12786 | 1921 | 13628 | 1535 | 14614 | 937 | 17793 | 593 | 13939 |
| 14-#11 | 2.53 | MA | 9458 | 3085 | 15105 | 2493 | 17835 | 2011 | 19166 | 1626 | 20490 | 1033 | 25457 | 612 | 20660 |
| 6L-3S | | MI | 7081 | 3085 | 11604 | 2398 | 13447 | 1916 | 14408 | 1540 | 15603 | 932 | 18890 | 677 | 14255 |
| 14-#11 | 2.53 | MA | 8961 | 3085 | 14396 | 2492 | 16897 | 2010 | 18021 | 1633 | 18916 | 1028 | 23620 | 541 | 19656 |
| 7L-2S | | MI | 7572 | 3085 | 12263 | 2402 | 14269 | 1921 | 15385 | 1535 | 16887 | 927 | 20553 | 768 | 14298 |
| 14-#14 | 3.65 | MA | 11350 | 3436 | 19151 | 2692 | 22873 | 2160 | 25259 | 1718 | 28529 | 991 | 36163 | 580 | 30718 |
| 4L-5S | | MI | 6700 | 3436 | 11880 | 2603 | 13698 | 2051 | 14692 | 1614 | 15974 | 872 | 19685 | 324 | 18148 |
| 14-#14 | 3.65 | MA | 10621 | 3436 | 17979 | 2706 | 21466 | 2157 | 23542 | 1727 | 26234 | 998 | 33247 | 517 | 29561 |
| 5L-4S | | MI | 7184 | 3436 | 12604 | 2595 | 14538 | 2058 | 15688 | 1606 | 17330 | 879 | 21310 | 388 | 18893 |
| 14-#14 | 3.65 | MA | 9922 | 3436 | 16936 | 2705 | 20076 | 2168 | 21851 | 1722 | 24027 | 1006 | 30313 | 408 | 27663 |
| 6L-3S | | MI | 7683 | 3436 | 13316 | 2602 | 15468 | 2051 | 16787 | 1614 | 18721 | 872 | 22850 | 507 | 19927 |
| 14-#14 | 3.65 | MA | 9237 | 3436 | 15920 | 2705 | 18732 | 2165 | 20210 | 1731 | 21788 | 998 | 27712 | 305 | 25740 |
| 7L-2S | | MI | 8345 | 3436 | 14251 | 2609 | 16625 | 2058 | 18162 | 1606 | 20530 | 864 | 25180 | 638 | 20071 |
| 14-#18 | 6.48 | MA | 12254 | 4327 | 23263 | 3249 | 28045 | 2546 | 31457 | 1975 | 36506 | 912 | 47177 | 61 | 46789 |
| 5L-4S | | MI | 8192 | 4327 | 16117 | 3095 | 18709 | 2398 | 20607 | 1774 | 23823 | 713 | 29604 | -169 | 28711 |
| 14-#18 | 6.48 | MA | 11124 | 4327 | 21434 | 3246 | 25609 | 2565 | 28492 | 1962 | 32696 | 925 | 42141 | -134 | 41265 |
| 6L-3S | | MI | 8988 | 4327 | 17326 | 3108 | 20282 | 2384 | 22467 | 1787 | 26176 | 700 | 32195 | 34 | 32035 |
| 16-#11 | 2.89 | MA | 10990 | 3199 | 17735 | 2553 | 21163 | 2056 | 23212 | 1655 | 25887 | 1016 | 32543 | 715 | 25474 |
| 4L-6S | | MI | 6351 | 3199 | 10802 | 2467 | 12422 | 1971 | 13198 | 1564 | 14041 | 923 | 17217 | 454 | 14819 |
| 16-#11 | 2.89 | MA | 10469 | 3199 | 16917 | 2564 | 20180 | 2055 | 22013 | 1662 | 24272 | 1021 | 30491 | 671 | 24551 |
| 5E | | MI | 6669 | 3199 | 11255 | 2471 | 13012 | 1966 | 13896 | 1569 | 14936 | 918 | 18296 | 517 | 15358 |
| 16-#11 | 2.89 | MA | 9969 | 3199 | 16189 | 2563 | 19210 | 2063 | 20832 | 1659 | 22720 | 1026 | 28421 | 595 | 23703 |
| 6L-4S | | MI | 7000 | 3199 | 11763 | 2465 | 13609 | 1971 | 14604 | 1564 | 15899 | 923 | 19456 | 561 | 15771 |
| 16-#11 | 2.89 | MA | 9479 | 3199 | 15480 | 2563 | 18272 | 2061 | 19687 | 1666 | 21145 | 1021 | 26585 | 524 | 22731 |
| 7L-3S | | MI | 7363 | 3199 | 12263 | 2469 | 14269 | 1966 | 15385 | 1569 | 16887 | 918 | 20553 | 645 | 16183 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

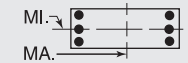
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.89 | MA | 8995 | 3199 | 14782 | 2563 | 17353 | 2060 | 18539 | 1663 | 19626 | 1026 | 24669 | 473 | 21499 |
| 8L-2S | | MI | 7848 | 3199 | 12922 | 2473 | 15091 | 1971 | 16361 | 1564 | 18172 | 913 | 22216 | 736 | 16241 |
| 16-#14 | 4.17 | MA | 11316 | 3600 | 19528 | 2809 | 23430 | 2231 | 25922 | 1775 | 29403 | 988 | 37450 | 491 | 33906 |
| 5E | | MI | 7122 | 3600 | 12816 | 2705 | 14855 | 2123 | 16066 | 1654 | 17783 | 850 | 22014 | 275 | 20676 |
| 16-#14 | 4.17 | MA | 10630 | 3600 | 18485 | 2808 | 22040 | 2243 | 24231 | 1769 | 27196 | 995 | 34517 | 382 | 32034 |
| 6L-4S | | MI | 7572 | 3600 | 13540 | 2697 | 15695 | 2130 | 17062 | 1647 | 19139 | 857 | 23639 | 339 | 21503 |
| 16-#14 | 4.17 | MA | 9957 | 3600 | 17469 | 2807 | 20697 | 2240 | 22590 | 1779 | 24957 | 988 | 31915 | 279 | 30074 |
| 7L-3S | | MI | 8060 | 3600 | 14251 | 2704 | 16625 | 2123 | 18162 | 1654 | 20530 | 850 | 25180 | 458 | 22640 |
| 16-#14 | 4.17 | MA | 9292 | 3600 | 16469 | 2806 | 19380 | 2237 | 20946 | 1773 | 22798 | 995 | 29193 | 206 | 28087 |
| 8L-2S | | MI | 8711 | 3600 | 15187 | 2711 | 17782 | 2130 | 19536 | 1647 | 22339 | 842 | 27509 | 589 | 22813 |
| 16-#18 | 7.41 | MA | 12305 | 4618 | 24137 | 3428 | 29037 | 2698 | 32645 | 2046 | 38167 | 903 | 49359 | -188 | 47867 |
| 6L-4S | | MI | 8820 | 4618 | 17705 | 3274 | 20665 | 2521 | 22931 | 1841 | 26882 | 668 | 33504 | -269 | 31958 |
| 18-#11 | 3.25 | MA | 10964 | 3312 | 18001 | 2634 | 21555 | 2106 | 23679 | 1695 | 26501 | 1015 | 33455 | 654 | 27652 |
| 5L-6S | | MI | 6640 | 3312 | 11460 | 2537 | 13244 | 2022 | 14175 | 1593 | 15326 | 909 | 18880 | 423 | 16636 |
| 18-#11 | 3.25 | MA | 10471 | 3312 | 17273 | 2634 | 20585 | 2115 | 22498 | 1692 | 24949 | 1020 | 31386 | 579 | 26755 |
| 6L-5S | | MI | 6955 | 3312 | 11914 | 2542 | 13834 | 2017 | 14872 | 1598 | 16221 | 904 | 19959 | 485 | 17223 |
| 18-#11 | 3.25 | MA | 9988 | 3312 | 16564 | 2634 | 19647 | 2113 | 21352 | 1699 | 23374 | 1015 | 29549 | 507 | 25813 |
| 7L-4S | | MI | 7282 | 3312 | 12422 | 2535 | 14431 | 2022 | 15580 | 1593 | 17184 | 909 | 21119 | 529 | 17612 |
| 18-#11 | 3.25 | MA | 9511 | 3312 | 15866 | 2634 | 18728 | 2112 | 20205 | 1695 | 21855 | 1020 | 27634 | 456 | 24555 |
| 8L-3S | | MI | 7640 | 3312 | 12922 | 2540 | 15091 | 2017 | 16361 | 1598 | 18172 | 904 | 22216 | 613 | 18106 |
| 18-#11 | 3.25 | MA | 9037 | 3312 | 15095 | 2644 | 17781 | 2120 | 19075 | 1703 | 20351 | 1025 | 25758 | 397 | 23306 |
| 9L-2S | | MI | 8121 | 3312 | 13581 | 2544 | 15913 | 2022 | 17337 | 1593 | 19457 | 899 | 23879 | 704 | 18180 |
| 18-#14 | 4.69 | MA | 11324 | 3763 | 20034 | 2910 | 24005 | 2318 | 26611 | 1817 | 30365 | 985 | 38720 | 355 | 36415 |
| 6L-5S | | MI | 7511 | 3763 | 13751 | 2807 | 16012 | 2194 | 17440 | 1694 | 19592 | 828 | 24344 | 226 | 23219 |
| 18-#14 | 4.69 | MA | 10663 | 3763 | 19018 | 2909 | 22662 | 2315 | 24970 | 1826 | 28126 | 978 | 36118 | 252 | 34418 |
| 7L-4S | | MI | 7952 | 3763 | 14475 | 2799 | 16851 | 2202 | 18437 | 1687 | 20947 | 836 | 25969 | 289 | 24123 |
| 18-#14 | 4.69 | MA | 10010 | 3763 | 18018 | 2908 | 21345 | 2311 | 23326 | 1820 | 25967 | 985 | 33396 | 180 | 32406 |
| 8L-3S | | MI | 8432 | 3763 | 15187 | 2806 | 17782 | 2194 | 19536 | 1694 | 22339 | 828 | 27509 | 408 | 25309 |
| 20-#11 | 3.61 | MA | 10965 | 3425 | 18357 | 2705 | 21960 | 2167 | 24163 | 1724 | 27178 | 1014 | 34351 | 562 | 29814 |
| 6E | | MI | 6925 | 3425 | 12119 | 2608 | 14066 | 2072 | 15151 | 1622 | 16611 | 895 | 20543 | 391 | 18460 |
| 20-#11 | 3.61 | MA | 10489 | 3425 | 17648 | 2705 | 21022 | 2165 | 23018 | 1732 | 25604 | 1009 | 32514 | 491 | 28901 |
| 7L-5S | | MI | 7236 | 3425 | 12573 | 2613 | 14656 | 2067 | 15849 | 1627 | 17506 | 890 | 21622 | 454 | 19093 |
| 20-#11 | 3.61 | MA | 10018 | 3425 | 16950 | 2705 | 20103 | 2164 | 21870 | 1728 | 24085 | 1014 | 30598 | 439 | 27616 |
| 8L-4S | | MI | 7560 | 3425 | 13081 | 2606 | 15253 | 2072 | 16556 | 1622 | 18468 | 895 | 22782 | 498 | 19459 |
| 20-#11 | 3.61 | MA | 9551 | 3425 | 16179 | 2715 | 19156 | 2172 | 20741 | 1735 | 22580 | 1019 | 28722 | 380 | 26348 |
| 9L-3S | | MI | 7915 | 3425 | 13581 | 2611 | 15913 | 2067 | 17337 | 1627 | 19457 | 890 | 23879 | 582 | 20027 |
| 20-#14 | 5.21 | MA | 11357 | 3927 | 20567 | 3011 | 24626 | 2389 | 27351 | 1873 | 31295 | 967 | 40322 | 226 | 38771 |
| 7L-5S | | MI | 7894 | 3927 | 14687 | 2909 | 17169 | 2266 | 18815 | 1735 | 21400 | 806 | 26674 | 177 | 25776 |
| 20-#14 | 5.21 | MA | 10714 | 3927 | 19567 | 3010 | 23310 | 2386 | 25707 | 1868 | 29136 | 975 | 37599 | 153 | 36733 |
| 8L-4S | | MI | 8327 | 3927 | 15411 | 2902 | 18008 | 2273 | 19811 | 1727 | 22756 | 814 | 28299 | 240 | 26752 |
| 22-#11 | 3.97 | MA | 10983 | 3539 | 18732 | 2776 | 22397 | 2217 | 24684 | 1764 | 27833 | 1002 | 35478 | 474 | 31959 |
| 7L-6S | | MI | 7207 | 3539 | 12778 | 2679 | 14888 | 2123 | 16127 | 1651 | 17896 | 881 | 22206 | 359 | 20290 |
| 22-#11 | 3.97 | MA | 10518 | 3539 | 18034 | 2776 | 21478 | 2215 | 23536 | 1761 | 26314 | 1007 | 33563 | 423 | 30683 |
| 8L-5S | | MI | 7515 | 3539 | 13232 | 2683 | 15478 | 2117 | 16825 | 1656 | 18791 | 876 | 23285 | 422 | 20965 |
| 22-#11 | 3.97 | MA | 10057 | 3539 | 17264 | 2786 | 20531 | 2224 | 22407 | 1768 | 24810 | 1013 | 31687 | 364 | 29396 |
| 9L-4S | | MI | 7836 | 3539 | 13740 | 2677 | 16075 | 2123 | 17533 | 1651 | 19753 | 881 | 24445 | 466 | 21313 |
| 22-#14 | 5.73 | MA | 11407 | 4091 | 21116 | 3113 | 25274 | 2461 | 28087 | 1915 | 32305 | 965 | 41803 | 127 | 41068 |
| 8L-5S | | MI | 8271 | 4091 | 15623 | 3012 | 18326 | 2337 | 20189 | 1775 | 23209 | 785 | 29003 | 127 | 28343 |
| 24-#11 | 4.33 | MA | 11011 | 3652 | 19118 | 2847 | 22852 | 2267 | 25202 | 1794 | 28543 | 1001 | 36527 | 406 | 33755 |
| 8L-6S | | MI | 7510 | 3652 | 13437 | 2750 | 15710 | 2173 | 17103 | 1680 | 19181 | 868 | 23869 | 328 | 22126 |
| 24-#11 | 4.33 | MA | 10555 | 3652 | 18348 | 2857 | 21905 | 2276 | 24072 | 1801 | 27039 | 1006 | 34651 | 347 | 32448 |
| 9L-5S | | MI | 7811 | 3652 | 13891 | 2754 | 16300 | 2168 | 17801 | 1685 | 20075 | 862 | 24948 | 390 | 22789 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

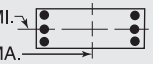



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.75 | MA | 11986 | 3000 | 18094 | 2444 | 21425 | 1978 | 23204 | 1623 | 25134 | 1078 | 30781 | 980 | 17675 |
| 2E | | MI | 7236 | 3000 | 11406 | 2330 | 12933 | 1868 | 13646 | 1512 | 14374 | 969 | 17082 | 823 | 10416 |
| 6-#11 | 1.03 | MA | 10949 | 2759 | 15605 | 2319 | 18448 | 1888 | 19674 | 1570 | 20612 | 1114 | 24898 | 1048 | 10692 |
| 2L-3S | | MI | 6216 | 2759 | 9394 | 2220 | 10632 | 1801 | 10978 | 1498 | 10902 | 1044 | 12733 | 858 | 6494 |
| 6-#11 | 1.03 | MA | 10039 | 2759 | 14450 | 2319 | 16983 | 1887 | 17900 | 1578 | 18225 | 1119 | 21715 | 957 | 10687 |
| 3L-2S | | MI | 6732 | 2759 | 10053 | 2225 | 11454 | 1806 | 11954 | 1493 | 12186 | 1039 | 14396 | 950 | 6458 |
| 6-#14 | 1.48 | MA | 11646 | 2909 | 17157 | 2404 | 20356 | 1950 | 21959 | 1608 | 23619 | 1099 | 28863 | 1017 | 15165 |
| 2L-3S | | MI | 6368 | 2909 | 10000 | 2298 | 11314 | 1851 | 11766 | 1525 | 11924 | 1015 | 14025 | 759 | 9045 |
| 6-#14 | 1.48 | MA | 10370 | 2909 | 15505 | 2404 | 18261 | 1948 | 19422 | 1618 | 20222 | 1107 | 24345 | 886 | 15073 |
| 3L-2S | | MI | 7089 | 2909 | 10936 | 2305 | 12471 | 1859 | 13140 | 1518 | 13733 | 1008 | 16354 | 890 | 9026 |
| 6-#18 | 2.63 | MA | 13275 | 3291 | 20978 | 2626 | 25083 | 2111 | 27636 | 1707 | 31009 | 1058 | 38556 | 930 | 26194 |
| 2L-3S | | MI | 6707 | 3291 | 11406 | 2496 | 12933 | 1978 | 13646 | 1592 | 14374 | 937 | 17082 | 489 | 15029 |
| 6-#18 | 2.63 | MA | 11139 | 3291 | 18094 | 2624 | 21425 | 2104 | 23204 | 1722 | 25134 | 1071 | 30781 | 696 | 25624 |
| 3L-2S | | MI | 7908 | 3291 | 12994 | 2509 | 14889 | 1991 | 15970 | 1579 | 17433 | 923 | 20982 | 723 | 15221 |
| 8-#11 | 1.37 | MA | 11505 | 2872 | 16760 | 2390 | 19913 | 1940 | 21449 | 1603 | 22999 | 1109 | 28081 | 1032 | 14129 |
| 2L-4S | | MI | 6137 | 2872 | 9553 | 2287 | 10793 | 1857 | 11174 | 1522 | 11198 | 1035 | 13299 | 743 | 8447 |
| 8-#11 | 1.37 | MA | 10608 | 2872 | 15605 | 2390 | 18448 | 1939 | 19674 | 1611 | 20612 | 1114 | 24898 | 941 | 14091 |
| 3E | | MI | 6518 | 2872 | 10053 | 2291 | 11454 | 1852 | 11954 | 1527 | 12186 | 1030 | 14396 | 827 | 8467 |
| 8-#11 | 1.37 | MA | 9956 | 2872 | 14745 | 2390 | 17286 | 1948 | 18266 | 1608 | 18718 | 1109 | 22804 | 850 | 13928 |
| 4L-2S | | MI | 7028 | 2872 | 10712 | 2295 | 12276 | 1857 | 12931 | 1522 | 13471 | 1025 | 16059 | 918 | 8446 |
| 8-#14 | 1.97 | MA | 12410 | 3073 | 18808 | 2507 | 22450 | 2025 | 24496 | 1655 | 27015 | 1090 | 33381 | 993 | 20053 |
| 2L-4S | | MI | 6252 | 3073 | 10224 | 2393 | 11541 | 1930 | 12041 | 1558 | 12341 | 1001 | 14814 | 590 | 11301 |
| 8-#14 | 1.97 | MA | 11158 | 3073 | 17157 | 2506 | 20356 | 2022 | 21959 | 1666 | 23619 | 1098 | 28863 | 861 | 19903 |
| 3E | | MI | 6784 | 3073 | 10936 | 2400 | 12471 | 1923 | 13140 | 1566 | 13733 | 994 | 16354 | 709 | 11801 |
| 8-#14 | 1.97 | MA | 10248 | 3073 | 15925 | 2506 | 18691 | 2035 | 19942 | 1661 | 20923 | 1090 | 25895 | 730 | 18994 |
| 4L-2S | | MI | 7493 | 3073 | 11872 | 2407 | 13628 | 1930 | 14514 | 1558 | 15542 | 986 | 18684 | 841 | 11825 |
| 8-#18 | 3.51 | MA | 14517 | 3582 | 23863 | 2808 | 28742 | 2244 | 32068 | 1791 | 36884 | 1038 | 46332 | 880 | 34680 |
| 2L-4S | | MI | 6525 | 3582 | 11785 | 2662 | 13316 | 2114 | 14110 | 1646 | 15080 | 905 | 18391 | 186 | 17385 |
| 8-#18 | 3.51 | MA | 12440 | 3582 | 20978 | 2805 | 25083 | 2237 | 27636 | 1806 | 31009 | 1051 | 38556 | 646 | 33970 |
| 3E | | MI | 7402 | 3582 | 12994 | 2675 | 14889 | 2101 | 15970 | 1659 | 17433 | 891 | 20982 | 389 | 19387 |
| 8-#18 | 3.51 | MA | 10930 | 3582 | 18820 | 2803 | 22168 | 2257 | 24103 | 1795 | 26346 | 1038 | 33462 | 413 | 29887 |
| 4L-2S | | MI | 8553 | 3582 | 14582 | 2688 | 16845 | 2114 | 18293 | 1646 | 20492 | 878 | 24883 | 622 | 19973 |
| 10-#11 | 1.71 | MA | 12048 | 2986 | 17915 | 2460 | 21378 | 1992 | 23223 | 1636 | 25387 | 1103 | 31263 | 1017 | 17551 |
| 2L-5S | | MI | 6093 | 2986 | 9704 | 2364 | 11019 | 1902 | 11442 | 1556 | 11520 | 1016 | 13802 | 667 | 9896 |
| 10-#11 | 1.71 | MA | 11164 | 2986 | 16760 | 2461 | 19913 | 1991 | 21449 | 1644 | 22999 | 1108 | 28081 | 926 | 17486 |
| 3L-4S | | MI | 6437 | 2986 | 10212 | 2358 | 11615 | 1907 | 12150 | 1551 | 12483 | 1021 | 14962 | 711 | 10374 |
| 10-#11 | 1.71 | MA | 10521 | 2986 | 15900 | 2461 | 18750 | 2000 | 20040 | 1641 | 21105 | 1103 | 25987 | 835 | 17289 |
| 4L-3S | | MI | 6814 | 2986 | 10712 | 2362 | 12276 | 1902 | 12931 | 1556 | 13471 | 1016 | 16059 | 795 | 10421 |
| 10-#11 | 1.71 | MA | 9939 | 2986 | 15029 | 2471 | 17706 | 1999 | 18765 | 1649 | 19376 | 1108 | 23789 | 790 | 16356 |
| 5L-2S | | MI | 7318 | 2986 | 11371 | 2366 | 13098 | 1907 | 13907 | 1551 | 14756 | 1011 | 17722 | 886 | 10419 |
| 10-#14 | 2.47 | MA | 13154 | 3236 | 20459 | 2609 | 24544 | 2100 | 27034 | 1703 | 30412 | 1081 | 37899 | 969 | 24926 |
| 2L-5S | | MI | 6187 | 3236 | 10436 | 2503 | 11858 | 1994 | 12418 | 1606 | 12794 | 972 | 15518 | 477 | 13253 |
| 10-#14 | 2.47 | MA | 11925 | 3236 | 18808 | 2609 | 22450 | 2097 | 24496 | 1713 | 27015 | 1088 | 33381 | 837 | 24727 |
| 3L-4S | | MI | 6666 | 3236 | 11160 | 2496 | 12698 | 2002 | 13415 | 1599 | 14150 | 979 | 17143 | 541 | 13857 |
| 10-#14 | 2.47 | MA | 11033 | 3236 | 17577 | 2608 | 20785 | 2110 | 22480 | 1708 | 24320 | 1081 | 30413 | 706 | 23610 |
| 4L-3S | | MI | 7190 | 3236 | 11872 | 2503 | 13628 | 1994 | 14514 | 1606 | 15542 | 972 | 18684 | 660 | 14540 |
| 10-#14 | 2.47 | MA | 10224 | 3236 | 16329 | 2623 | 19289 | 2107 | 20653 | 1719 | 21860 | 1088 | 27286 | 642 | 22182 |
| 5L-2S | | MI | 7889 | 3236 | 12808 | 2510 | 14785 | 2002 | 15888 | 1599 | 17350 | 964 | 21014 | 791 | 14603 |
| 10-#18 | 4.39 | MA | 13699 | 3873 | 23863 | 2987 | 28742 | 2370 | 32068 | 1891 | 36884 | 1031 | 46332 | 596 | 42321 |
| 3L-4S | | MI | 7204 | 3873 | 13373 | 2841 | 15272 | 2237 | 16434 | 1713 | 18139 | 860 | 22291 | 85 | 21815 |
| 10-#18 | 4.39 | MA | 12230 | 3873 | 21705 | 2985 | 25826 | 2390 | 28535 | 1880 | 32221 | 1018 | 41238 | 363 | 38010 |
| 4L-3S | | MI | 8054 | 3873 | 14582 | 2854 | 16845 | 2224 | 18293 | 1726 | 20492 | 846 | 24883 | 288 | 23628 |
| 10-#18 | 4.39 | MA | 10899 | 3873 | 19517 | 3009 | 23201 | 2383 | 25332 | 1895 | 27966 | 1031 | 35831 | 253 | 34253 |
| 5L-2S | | MI | 9173 | 3873 | 16171 | 2867 | 18801 | 2237 | 20617 | 1713 | 23551 | 833 | 28783 | 522 | 24697 |
| 12-#11 | 2.05 | MA | 12580 | 3099 | 19070 | 2531 | 22842 | 2044 | 24998 | 1669 | 27774 | 1097 | 34446 | 1002 | 20965 |
| 2L-6S | | MI | 6065 | 3099 | 9909 | 2431 | 11251 | 1958 | 11721 | 1580 | 11910 | 1008 | 14386 | 573 | 11372 |

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

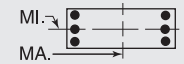
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.05 | MA | 11708 | 3099 | 17915 | 2532 | 21378 | 2043 | 23223 | 1676 | 25387 | 1103 | 31263 | 911 | 20875 |
| 3L-5S | | MI | 6392 | 3099 | 10363 | 2435 | 11841 | 1952 | 12419 | 1585 | 12805 | 1002 | 15465 | 636 | 11743 |
| 12-#11 | 2.05 | MA | 11075 | 3099 | 17055 | 2532 | 20215 | 2052 | 21815 | 1674 | 23493 | 1097 | 29170 | 820 | 20650 |
| 4E | | MI | 6733 | 3099 | 10871 | 2429 | 12438 | 1958 | 13126 | 1580 | 13768 | 1008 | 16625 | 679 | 12232 |
| 12-#11 | 2.05 | MA | 10502 | 3099 | 16184 | 2542 | 19170 | 2051 | 20540 | 1681 | 21764 | 1103 | 26972 | 775 | 19639 |
| 5L-3S | | MI | 7105 | 3099 | 11371 | 2433 | 13098 | 1952 | 13907 | 1585 | 14756 | 1002 | 17722 | 763 | 12364 |
| 12-#11 | 2.05 | MA | 9952 | 3099 | 15411 | 2543 | 18139 | 2060 | 19284 | 1679 | 20101 | 1108 | 24750 | 699 | 18940 |
| 6L-2S | | MI | 7603 | 3099 | 12029 | 2437 | 13920 | 1958 | 14883 | 1580 | 16041 | 997 | 19385 | 855 | 12383 |
| 12-#14 | 2.96 | MA | 12674 | 3400 | 20459 | 2711 | 24544 | 2172 | 27034 | 1760 | 30412 | 1079 | 37899 | 813 | 29547 |
| 3L-5S | | MI | 6601 | 3400 | 11372 | 2606 | 13015 | 2066 | 13793 | 1647 | 14603 | 950 | 17848 | 428 | 15857 |
| 12-#14 | 2.96 | MA | 11798 | 3400 | 19228 | 2711 | 22880 | 2185 | 25017 | 1756 | 27717 | 1072 | 34931 | 682 | 28249 |
| 4E | | MI | 7073 | 3400 | 12096 | 2598 | 13854 | 2073 | 14789 | 1639 | 15959 | 957 | 19473 | 492 | 16434 |
| 12-#14 | 2.96 | MA | 11005 | 3400 | 17981 | 2725 | 21383 | 2182 | 23190 | 1766 | 25257 | 1079 | 31804 | 618 | 26891 |
| 5L-3S | | MI | 7589 | 3400 | 12808 | 2605 | 14785 | 2066 | 15888 | 1647 | 17350 | 950 | 21014 | 611 | 17268 |
| 12-#14 | 2.96 | MA | 10244 | 3400 | 16872 | 2725 | 19905 | 2195 | 21392 | 1761 | 22891 | 1087 | 28651 | 509 | 25038 |
| 6L-2S | | MI | 8278 | 3400 | 13743 | 2612 | 15942 | 2073 | 17262 | 1639 | 19159 | 943 | 23343 | 742 | 17365 |
| 12-#18 | 5.26 | MA | 13494 | 4163 | 24589 | 3167 | 29484 | 2523 | 32967 | 1964 | 38096 | 998 | 49014 | 313 | 46168 |
| 4E | | MI | 7862 | 4163 | 14961 | 3020 | 17227 | 2360 | 18757 | 1779 | 21198 | 814 | 26192 | -15 | 26117 |
| 12-#18 | 5.26 | MA | 12198 | 4163 | 22402 | 3191 | 26859 | 2516 | 29763 | 1979 | 33841 | 1012 | 43607 | 203 | 42288 |
| 5L-3S | | MI | 8688 | 4163 | 16171 | 3033 | 18801 | 2347 | 20617 | 1793 | 23551 | 801 | 28783 | 188 | 27925 |
| 12-#18 | 5.26 | MA | 10954 | 4163 | 20456 | 3188 | 24266 | 2536 | 26608 | 1968 | 29750 | 1025 | 38181 | 8 | 38143 |
| 6L-2S | | MI | 9778 | 4163 | 17759 | 3046 | 20757 | 2360 | 22941 | 1779 | 26610 | 788 | 32683 | 422 | 29404 |
| 14-#11 | 2.39 | MA | 12242 | 3212 | 19070 | 2602 | 22842 | 2094 | 24998 | 1709 | 27774 | 1097 | 34446 | 895 | 24261 |
| 3L-6S | | MI | 6363 | 3212 | 10568 | 2502 | 12073 | 2008 | 12697 | 1609 | 13195 | 994 | 16049 | 541 | 13168 |
| 14-#11 | 2.39 | MA | 11619 | 3212 | 18210 | 2603 | 21680 | 2104 | 23589 | 1707 | 25880 | 1092 | 32353 | 804 | 24011 |
| 4L-5S | | MI | 6687 | 3212 | 11022 | 2506 | 12663 | 2003 | 13395 | 1614 | 14090 | 989 | 17128 | 604 | 13597 |
| 14-#11 | 2.39 | MA | 11054 | 3212 | 17339 | 2613 | 20635 | 2102 | 22314 | 1714 | 24151 | 1097 | 30155 | 759 | 22931 |
| 5L-4S | | MI | 7023 | 3212 | 11530 | 2500 | 13260 | 2008 | 14103 | 1609 | 15052 | 994 | 18288 | 648 | 14052 |
| 14-#11 | 2.39 | MA | 10512 | 3212 | 16566 | 2613 | 19604 | 2112 | 21059 | 1712 | 22488 | 1102 | 27933 | 684 | 22179 |
| 6L-3S | | MI | 7392 | 3212 | 12029 | 2504 | 13920 | 2003 | 14883 | 1614 | 16041 | 989 | 19385 | 732 | 14300 |
| 14-#11 | 2.39 | MA | 9982 | 3212 | 15812 | 2614 | 18607 | 2110 | 19842 | 1719 | 20803 | 1097 | 25959 | 613 | 21061 |
| 7L-2S | | MI | 7884 | 3212 | 12688 | 2508 | 14742 | 2008 | 15860 | 1609 | 17326 | 983 | 21048 | 823 | 14335 |
| 14-#14 | 3.45 | MA | 12547 | 3564 | 20879 | 2813 | 24974 | 2259 | 27554 | 1803 | 31114 | 1063 | 39449 | 658 | 32907 |
| 4L-5S | | MI | 7007 | 3564 | 12308 | 2708 | 14172 | 2138 | 15167 | 1687 | 16412 | 928 | 20178 | 379 | 18364 |
| 14-#14 | 3.45 | MA | 11769 | 3564 | 19632 | 2827 | 23477 | 2257 | 25728 | 1813 | 28654 | 1070 | 36322 | 594 | 31611 |
| 5L-4S | | MI | 7472 | 3564 | 13032 | 2700 | 15011 | 2145 | 16163 | 1680 | 17767 | 936 | 21803 | 443 | 19029 |
| 14-#14 | 3.45 | MA | 11022 | 3564 | 18523 | 2827 | 22000 | 2269 | 23929 | 1809 | 26288 | 1078 | 33169 | 485 | 29694 |
| 6L-3S | | MI | 7981 | 3564 | 13743 | 2707 | 15942 | 2138 | 17262 | 1687 | 19159 | 928 | 23343 | 562 | 19989 |
| 14-#14 | 3.45 | MA | 10290 | 3564 | 17444 | 2827 | 20571 | 2267 | 22184 | 1819 | 23889 | 1070 | 30369 | 382 | 27740 |
| 7L-2S | | MI | 8661 | 3564 | 14679 | 2714 | 17098 | 2145 | 18636 | 1680 | 20967 | 921 | 25673 | 693 | 20118 |
| 14-#18 | 6.14 | MA | 13553 | 4454 | 25286 | 3372 | 30517 | 2649 | 34195 | 2063 | 39716 | 992 | 51382 | 153 | 50352 |
| 5L-4S | | MI | 8505 | 4454 | 16550 | 3199 | 19183 | 2483 | 21081 | 1846 | 24257 | 769 | 30092 | -115 | 29472 |
| 14-#18 | 6.14 | MA | 12341 | 4454 | 23340 | 3370 | 27924 | 2669 | 31040 | 2052 | 35624 | 1005 | 45957 | -42 | 45660 |
| 6L-3S | | MI | 9308 | 4454 | 17759 | 3212 | 20757 | 2470 | 22941 | 1860 | 26610 | 756 | 32683 | 88 | 32267 |
| 16-#11 | 2.74 | MA | 12152 | 3326 | 19365 | 2674 | 23145 | 2155 | 25364 | 1740 | 28267 | 1086 | 35535 | 789 | 27273 |
| 4L-6S | | MI | 6657 | 3326 | 11227 | 2572 | 12895 | 2058 | 13673 | 1638 | 14480 | 980 | 17712 | 509 | 14974 |
| 16-#11 | 2.74 | MA | 11596 | 3326 | 18494 | 2684 | 22100 | 2154 | 24089 | 1747 | 26538 | 1091 | 33338 | 744 | 26231 |
| 5E | | MI | 6977 | 3326 | 11680 | 2577 | 13485 | 2053 | 14371 | 1643 | 15375 | 975 | 18791 | 572 | 15458 |
| 16-#11 | 2.74 | MA | 11062 | 3326 | 17721 | 2684 | 21069 | 2163 | 22834 | 1744 | 24876 | 1097 | 31116 | 669 | 25427 |
| 6L-4S | | MI | 7310 | 3326 | 12188 | 2571 | 14082 | 2058 | 15079 | 1638 | 16337 | 980 | 19951 | 616 | 15883 |
| 16-#11 | 2.74 | MA | 10539 | 3326 | 16967 | 2685 | 20072 | 2162 | 21616 | 1752 | 23190 | 1091 | 29142 | 598 | 24343 |
| 7L-3S | | MI | 7674 | 3326 | 12688 | 2575 | 14742 | 2053 | 15860 | 1643 | 17326 | 975 | 21048 | 700 | 16230 |
| 16-#11 | 2.74 | MA | 10022 | 3326 | 16226 | 2685 | 19095 | 2161 | 20397 | 1749 | 21563 | 1097 | 27090 | 546 | 23102 |
| 8L-2S | | MI | 8162 | 3326 | 13347 | 2579 | 15564 | 2058 | 16836 | 1638 | 18611 | 970 | 22711 | 791 | 16281 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

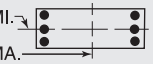


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.95 | MA | 12516 | 3727 | 21283 | 2930 | 25572 | 2332 | 28265 | 1861 | 32050 | 1061 | 40840 | 570 | 36341 |
| 5E | | MI | 7432 | 3727 | 13243 | 2810 | 15329 | 2209 | 16541 | 1727 | 18220 | 906 | 22507 | 330 | 20888 |
| 16-#14 | 3.95 | MA | 11783 | 3727 | 20175 | 2930 | 24094 | 2344 | 26466 | 1856 | 29685 | 1069 | 37686 | 461 | 34362 |
| 6L-4S | | MI | 7885 | 3727 | 13967 | 2802 | 16168 | 2217 | 17537 | 1720 | 19576 | 914 | 24132 | 393 | 21637 |
| 16-#14 | 3.95 | MA | 11065 | 3727 | 19095 | 2929 | 22666 | 2342 | 24722 | 1866 | 27286 | 1061 | 34887 | 358 | 32372 |
| 7L-3S | | MI | 8378 | 3727 | 14679 | 2809 | 17098 | 2209 | 18636 | 1727 | 20967 | 906 | 25673 | 512 | 22705 |
| 16-#14 | 3.95 | MA | 10354 | 3727 | 18032 | 2929 | 21266 | 2339 | 22974 | 1862 | 24971 | 1069 | 31968 | 284 | 30335 |
| 8L-2S | | MI | 9033 | 3727 | 15615 | 2816 | 18255 | 2217 | 20010 | 1720 | 22776 | 899 | 28002 | 644 | 22863 |
| 16-#18 | 7.02 | MA | 13614 | 4745 | 26225 | 3552 | 31583 | 2802 | 35472 | 2137 | 41499 | 985 | 53732 | -92 | 52942 |
| 6L-4S | | MI | 9134 | 4745 | 18138 | 3378 | 21139 | 2606 | 23405 | 1913 | 27316 | 724 | 33992 | -216 | 32754 |
| 18-#11 | 3.08 | MA | 12129 | 3439 | 19649 | 2755 | 23565 | 2206 | 25864 | 1780 | 28926 | 1086 | 36521 | 729 | 29537 |
| 5L-6S | | MI | 6947 | 3439 | 11886 | 2643 | 13717 | 2109 | 14650 | 1667 | 15765 | 966 | 19375 | 478 | 16789 |
| 18-#11 | 3.08 | MA | 11602 | 3439 | 18876 | 2755 | 22533 | 2215 | 24608 | 1777 | 27263 | 1091 | 34299 | 653 | 28683 |
| 6L-5S | | MI | 7264 | 3439 | 12339 | 2648 | 14307 | 2104 | 15347 | 1672 | 16659 | 961 | 20454 | 540 | 17323 |
| 18-#11 | 3.08 | MA | 11087 | 3439 | 18122 | 2755 | 21537 | 2214 | 23391 | 1785 | 25577 | 1086 | 32324 | 582 | 27631 |
| 7L-4S | | MI | 7593 | 3439 | 12847 | 2641 | 14904 | 2109 | 16055 | 1667 | 17622 | 966 | 21614 | 584 | 17723 |
| 18-#11 | 3.08 | MA | 10577 | 3439 | 17381 | 2756 | 20560 | 2213 | 22171 | 1782 | 23950 | 1091 | 30272 | 530 | 26364 |
| 8L-3S | | MI | 7953 | 3439 | 13347 | 2646 | 15564 | 2104 | 16836 | 1672 | 18611 | 961 | 22711 | 668 | 18156 |
| 18-#11 | 3.08 | MA | 10071 | 3439 | 16562 | 2766 | 19554 | 2222 | 20971 | 1790 | 22339 | 1096 | 28257 | 471 | 25101 |
| 9L-2S | | MI | 8436 | 3439 | 14006 | 2650 | 16386 | 2109 | 17812 | 1667 | 19896 | 956 | 24374 | 759 | 18221 |
| 18-#14 | 4.44 | MA | 12530 | 3891 | 21826 | 3032 | 26188 | 2419 | 29003 | 1903 | 33081 | 1060 | 42204 | 437 | 39040 |
| 6L-5S | | MI | 7823 | 3891 | 14179 | 2912 | 16486 | 2281 | 17915 | 1768 | 20029 | 885 | 24837 | 280 | 23428 |
| 18-#14 | 4.44 | MA | 11824 | 3891 | 20746 | 3032 | 24760 | 2417 | 27259 | 1914 | 30683 | 1052 | 39405 | 334 | 37014 |
| 7L-4S | | MI | 8268 | 3891 | 14903 | 2905 | 17325 | 2288 | 18911 | 1760 | 21384 | 892 | 26462 | 344 | 24256 |
| 18-#14 | 4.44 | MA | 11126 | 3891 | 19683 | 3031 | 23360 | 2414 | 25511 | 1909 | 28368 | 1060 | 36486 | 260 | 34953 |
| 8L-3S | | MI | 8751 | 3891 | 15615 | 2912 | 18255 | 2281 | 20010 | 1768 | 22776 | 885 | 28002 | 463 | 25417 |
| 20-#11 | 3.42 | MA | 12134 | 3553 | 20031 | 2826 | 23998 | 2267 | 26383 | 1810 | 29650 | 1085 | 37481 | 638 | 31946 |
| 6E | | MI | 7234 | 3553 | 12544 | 2714 | 14539 | 2159 | 15626 | 1696 | 17050 | 952 | 21038 | 446 | 18611 |
| 20-#11 | 3.42 | MA | 11626 | 3553 | 19277 | 2826 | 23002 | 2266 | 25165 | 1818 | 27965 | 1080 | 35507 | 567 | 30925 |
| 7L-5S | | MI | 7547 | 3553 | 12998 | 2718 | 15129 | 2154 | 16324 | 1701 | 17944 | 947 | 22117 | 509 | 19192 |
| 20-#11 | 3.42 | MA | 11123 | 3553 | 18536 | 2827 | 22025 | 2265 | 23946 | 1815 | 26338 | 1085 | 33455 | 515 | 29632 |
| 8L-4S | | MI | 7872 | 3553 | 13506 | 2712 | 15726 | 2159 | 17032 | 1696 | 18907 | 952 | 23277 | 553 | 19569 |
| 20-#11 | 3.42 | MA | 10624 | 3553 | 17717 | 2837 | 21019 | 2274 | 22746 | 1823 | 24727 | 1091 | 31440 | 456 | 28350 |
| 9L-3S | | MI | 8229 | 3553 | 14006 | 2716 | 16386 | 2154 | 17812 | 1701 | 19896 | 947 | 24374 | 637 | 20079 |
| 20-#11 | 3.42 | MA | 10126 | 3553 | 16978 | 2837 | 20049 | 2273 | 21540 | 1820 | 23070 | 1085 | 29485 | 390 | 27029 |
| 10L-2S | | MI | 8708 | 3553 | 14665 | 2721 | 17208 | 2159 | 18789 | 1696 | 21180 | 942 | 26037 | 728 | 20158 |
| 20-#14 | 4.93 | MA | 12570 | 4054 | 22398 | 3134 | 26854 | 2491 | 29796 | 1961 | 34079 | 1043 | 43923 | 310 | 41665 |
| 7L-5S | | MI | 8207 | 4054 | 15115 | 3015 | 17643 | 2352 | 19289 | 1808 | 21837 | 863 | 27166 | 231 | 25981 |
| 20-#14 | 4.93 | MA | 11883 | 4054 | 21334 | 3134 | 25454 | 2489 | 28048 | 1956 | 31765 | 1050 | 41004 | 236 | 39579 |
| 8L-4S | | MI | 8644 | 4054 | 15839 | 3007 | 18482 | 2360 | 20285 | 1801 | 23193 | 870 | 28791 | 295 | 26884 |
| 22-#11 | 3.76 | MA | 12157 | 3666 | 20432 | 2897 | 24466 | 2318 | 26940 | 1851 | 30352 | 1075 | 38690 | 552 | 34224 |
| 7L-6S | | MI | 7517 | 3666 | 13203 | 2785 | 15361 | 2210 | 16602 | 1725 | 18335 | 938 | 22701 | 414 | 20440 |
| 22-#11 | 3.76 | MA | 11661 | 3666 | 19691 | 2897 | 23490 | 2317 | 25720 | 1848 | 28725 | 1080 | 36638 | 500 | 32905 |
| 8L-5S | | MI | 7826 | 3666 | 13657 | 2789 | 15951 | 2205 | 17300 | 1730 | 19229 | 933 | 23780 | 477 | 21065 |
| 22-#11 | 3.76 | MA | 11168 | 3666 | 18872 | 2908 | 22483 | 2326 | 24520 | 1856 | 27114 | 1085 | 34623 | 441 | 31604 |
| 9L-4S | | MI | 8149 | 3666 | 14165 | 2783 | 16548 | 2210 | 18008 | 1725 | 20192 | 938 | 24940 | 521 | 21422 |
| 22-#11 | 3.76 | MA | 10677 | 3666 | 18133 | 2908 | 21513 | 2324 | 23314 | 1853 | 25458 | 1080 | 32668 | 375 | 30271 |
| 10L-3S | | MI | 8502 | 3666 | 14665 | 2787 | 17208 | 2205 | 18789 | 1730 | 21180 | 933 | 26037 | 605 | 21999 |
| 22-#14 | 5.43 | MA | 12629 | 4218 | 22986 | 3236 | 27549 | 2564 | 30585 | 2004 | 35162 | 1041 | 45521 | 212 | 44213 |
| 8L-5S | | MI | 8586 | 4218 | 16051 | 3117 | 18800 | 2424 | 20663 | 1849 | 23646 | 841 | 29496 | 182 | 28546 |
| 24-#11 | 4.11 | MA | 12191 | 3779 | 20846 | 2968 | 24955 | 2368 | 27495 | 1881 | 31112 | 1074 | 39821 | 484 | 36183 |
| 8L-6S | | MI | 7797 | 3779 | 13862 | 2856 | 16183 | 2260 | 17578 | 1754 | 19619 | 924 | 24364 | 383 | 22274 |
| 24-#11 | 4.11 | MA | 11704 | 3779 | 20027 | 2979 | 23948 | 2378 | 26295 | 1889 | 29501 | 1079 | 37806 | 426 | 34863 |
| 9L-5S | | MI | 8103 | 3779 | 14316 | 2860 | 16773 | 2255 | 18276 | 1759 | 20514 | 919 | 25443 | 445 | 22940 |
| 24-#11 | 4.11 | MA | 11220 | 3779 | 19288 | 2979 | 22978 | 2376 | 25089 | 1886 | 27845 | 1074 | 35851 | 360 | 33516 |
| 10L-4S | | MI | 8423 | 3779 | 14824 | 2854 | 17370 | 2260 | 18984 | 1754 | 21477 | 924 | 26603 | 489 | 23280 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

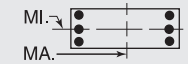
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.67 | MA | 13185 | 3127 | 19714 | 2564 | 23388 | 2076 | 25316 | 1706 | 27417 | 1146 | 33592 | 1050 | 18755 |
| 2E | | MI | 7545 | 3127 | 11839 | 2434 | 13408 | 1954 | 14120 | 1584 | 14809 | 1024 | 17570 | 877 | 10454 |
| 6-#14 | 1.41 | MA | 12815 | 3037 | 18712 | 2524 | 22244 | 2048 | 23984 | 1691 | 25778 | 1166 | 31506 | 1085 | 16076 |
| 2L-3S | | MI | 6674 | 3037 | 10428 | 2403 | 11788 | 1938 | 12240 | 1599 | 12362 | 1072 | 14518 | 813 | 9085 |
| 6-#14 | 1.41 | MA | 11455 | 3037 | 16958 | 2524 | 20020 | 2047 | 21290 | 1702 | 22153 | 1174 | 26673 | 954 | 15984 |
| 3L-2S | | MI | 7397 | 3037 | 11364 | 2410 | 12945 | 1945 | 13614 | 1591 | 14170 | 1064 | 16847 | 945 | 9056 |
| 6-#18 | 2.50 | MA | 14571 | 3418 | 22780 | 2745 | 27277 | 2209 | 30027 | 1790 | 33696 | 1128 | 41926 | 1004 | 27814 |
| 2L-3S | | MI | 7015 | 3418 | 11839 | 2600 | 13408 | 2063 | 14120 | 1664 | 14809 | 992 | 17570 | 543 | 15107 |
| 6-#18 | 2.50 | MA | 12291 | 3418 | 19714 | 2744 | 23388 | 2204 | 25316 | 1807 | 27417 | 1141 | 33592 | 771 | 27244 |
| 3L-2S | | MI | 8219 | 3418 | 13427 | 2613 | 15364 | 2077 | 16443 | 1651 | 17868 | 979 | 21471 | 777 | 15269 |
| 8-#11 | 1.30 | MA | 12662 | 3000 | 18288 | 2509 | 21770 | 2038 | 23438 | 1687 | 25091 | 1174 | 30655 | 1100 | 14971 |
| 2L-4S | | MI | 6442 | 3000 | 9978 | 2393 | 11266 | 1944 | 11649 | 1596 | 11636 | 1092 | 13794 | 798 | 8490 |
| 8-#11 | 1.30 | MA | 11706 | 3000 | 17062 | 2510 | 20215 | 2038 | 21554 | 1695 | 22549 | 1180 | 27254 | 1009 | 14933 |
| 3E | | MI | 6825 | 3000 | 10478 | 2397 | 11927 | 1939 | 12429 | 1601 | 12625 | 1087 | 14891 | 882 | 8498 |
| 8-#11 | 1.30 | MA | 11013 | 3000 | 16150 | 2510 | 18983 | 2047 | 20061 | 1693 | 20534 | 1175 | 25013 | 918 | 14770 |
| 4L-2S | | MI | 7336 | 3000 | 11137 | 2401 | 12749 | 1944 | 13406 | 1596 | 13910 | 1082 | 16554 | 973 | 8473 |
| 8-#14 | 1.88 | MA | 13635 | 3200 | 20466 | 2626 | 24468 | 2123 | 26678 | 1739 | 29402 | 1158 | 36339 | 1063 | 21268 |
| 2L-4S | | MI | 6557 | 3200 | 10652 | 2499 | 12014 | 2017 | 12515 | 1632 | 12779 | 1058 | 15307 | 645 | 11440 |
| 8-#14 | 1.88 | MA | 12301 | 3200 | 18712 | 2626 | 22244 | 2121 | 23984 | 1750 | 25778 | 1166 | 31506 | 932 | 21118 |
| 3E | | MI | 7091 | 3200 | 11364 | 2506 | 12945 | 2009 | 13614 | 1639 | 14170 | 1050 | 16847 | 764 | 11847 |
| 8-#14 | 1.88 | MA | 11332 | 3200 | 17406 | 2627 | 20479 | 2135 | 21845 | 1746 | 22902 | 1158 | 28327 | 800 | 20320 |
| 4L-2S | | MI | 7803 | 3200 | 12300 | 2513 | 14101 | 2017 | 14988 | 1632 | 15979 | 1043 | 19177 | 895 | 11860 |
| 8-#18 | 3.33 | MA | 15905 | 3709 | 25847 | 2927 | 31166 | 2342 | 34739 | 1874 | 39976 | 1110 | 50261 | 958 | 36840 |
| 2L-4S | | MI | 6830 | 3709 | 12218 | 2765 | 13790 | 2200 | 14584 | 1718 | 15515 | 960 | 18880 | 240 | 17571 |
| 8-#18 | 3.33 | MA | 13687 | 3709 | 22780 | 2926 | 27277 | 2337 | 30027 | 1891 | 33696 | 1124 | 41926 | 725 | 36130 |
| 3E | | MI | 7713 | 3709 | 13427 | 2779 | 15364 | 2186 | 16443 | 1731 | 17868 | 947 | 21471 | 443 | 19633 |
| 8-#18 | 3.33 | MA | 12077 | 3709 | 20490 | 2925 | 24183 | 2358 | 26278 | 1882 | 28713 | 1110 | 36458 | 491 | 31974 |
| 4L-2S | | MI | 8871 | 3709 | 15015 | 2792 | 17320 | 2200 | 18767 | 1718 | 20927 | 934 | 25371 | 676 | 20027 |
| 10-#11 | 1.63 | MA | 13244 | 3113 | 19514 | 2580 | 23324 | 2090 | 25321 | 1719 | 27632 | 1169 | 34056 | 1086 | 18604 |
| 2L-5S | | MI | 6398 | 3113 | 10129 | 2470 | 11492 | 1989 | 11917 | 1630 | 11959 | 1073 | 14297 | 722 | 9994 |
| 10-#11 | 1.63 | MA | 12302 | 3113 | 18288 | 2580 | 21770 | 2089 | 23438 | 1728 | 25091 | 1175 | 30655 | 995 | 18539 |
| 3L-4S | | MI | 6744 | 3113 | 10637 | 2464 | 12089 | 1994 | 12625 | 1625 | 12921 | 1078 | 15457 | 766 | 10422 |
| 10-#11 | 1.63 | MA | 11619 | 3113 | 17376 | 2581 | 20538 | 2099 | 21945 | 1725 | 23075 | 1170 | 28415 | 904 | 18342 |
| 4L-3S | | MI | 7122 | 3113 | 11137 | 2468 | 12749 | 1989 | 13406 | 1630 | 13910 | 1073 | 16554 | 850 | 10458 |
| 10-#11 | 1.63 | MA | 11000 | 3113 | 16454 | 2592 | 19431 | 2098 | 20594 | 1734 | 21236 | 1175 | 26071 | 858 | 17429 |
| 5L-2S | | MI | 7627 | 3113 | 11796 | 2472 | 13571 | 1994 | 14382 | 1625 | 15195 | 1068 | 18217 | 941 | 10450 |
| 10-#14 | 2.34 | MA | 14434 | 3364 | 22219 | 2728 | 26692 | 2198 | 29373 | 1786 | 33027 | 1150 | 41171 | 1041 | 26445 |
| 2L-5S | | MI | 6492 | 3364 | 10864 | 2609 | 12332 | 2081 | 12893 | 1680 | 13232 | 1028 | 16011 | 532 | 13377 |
| 10-#14 | 2.34 | MA | 13123 | 3364 | 20466 | 2728 | 24468 | 2196 | 26678 | 1797 | 29402 | 1158 | 36339 | 910 | 26246 |
| 3L-4S | | MI | 6973 | 3364 | 11588 | 2601 | 13171 | 2088 | 13889 | 1672 | 14587 | 1036 | 17636 | 596 | 13993 |
| 10-#14 | 2.34 | MA | 12174 | 3364 | 19160 | 2729 | 22703 | 2209 | 24540 | 1793 | 26526 | 1150 | 33159 | 778 | 25229 |
| 4L-3S | | MI | 7499 | 3364 | 12300 | 2608 | 14101 | 2081 | 14988 | 1680 | 15979 | 1028 | 19177 | 715 | 14591 |
| 10-#14 | 2.34 | MA | 11313 | 3364 | 17838 | 2744 | 21117 | 2208 | 22604 | 1804 | 23901 | 1158 | 29823 | 713 | 23647 |
| 5L-2S | | MI | 8201 | 3364 | 13235 | 2615 | 15258 | 2088 | 16363 | 1672 | 17787 | 1021 | 21506 | 846 | 14643 |
| 10-#18 | 4.17 | MA | 15039 | 4000 | 25847 | 3108 | 31166 | 2470 | 34739 | 1976 | 39976 | 1106 | 50261 | 679 | 45021 |
| 3L-4S | | MI | 7512 | 4000 | 13806 | 2944 | 15746 | 2323 | 16907 | 1785 | 18574 | 915 | 22780 | 139 | 21997 |
| 10-#18 | 4.17 | MA | 13473 | 4000 | 23557 | 3106 | 28071 | 2491 | 30989 | 1966 | 34992 | 1093 | 44792 | 445 | 40624 |
| 4L-3S | | MI | 8367 | 4000 | 15015 | 2958 | 17320 | 2309 | 18767 | 1798 | 20927 | 902 | 25371 | 342 | 23866 |
| 10-#18 | 4.17 | MA | 12054 | 4000 | 21237 | 3132 | 25287 | 2485 | 27591 | 1983 | 30444 | 1106 | 39012 | 333 | 36800 |
| 5L-2S | | MI | 9494 | 4000 | 16604 | 2971 | 19276 | 2323 | 21091 | 1785 | 23986 | 889 | 29271 | 576 | 24756 |
| 12-#11 | 1.95 | MA | 13815 | 3226 | 20739 | 2651 | 24879 | 2142 | 27205 | 1752 | 30173 | 1164 | 37457 | 1072 | 22229 |
| 2L-6S | | MI | 6370 | 3226 | 10334 | 2537 | 11724 | 2045 | 12196 | 1654 | 12349 | 1064 | 14881 | 628 | 11528 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

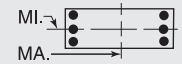



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.95 | MA | 12885 | 3226 | 19514 | 2651 | 23324 | 2141 | 25321 | 1760 | 27632 | 1170 | 34056 | 981 | 22139 |
| 3L-5S | | MI | 6698 | 3226 | 10788 | 2541 | 12314 | 2040 | 12894 | 1659 | 13243 | 1059 | 15960 | 691 | 11840 |
| 12-#11 | 1.95 | MA | 12213 | 3226 | 18602 | 2652 | 22092 | 2151 | 23828 | 1758 | 25617 | 1165 | 31816 | 890 | 21914 |
| 4E | | MI | 7040 | 3226 | 11296 | 2535 | 12911 | 2045 | 13601 | 1654 | 14206 | 1064 | 17120 | 734 | 12344 |
| 12-#11 | 1.95 | MA | 11603 | 3226 | 17680 | 2663 | 20986 | 2150 | 22477 | 1766 | 23778 | 1170 | 29472 | 844 | 20916 |
| 5L-3S | | MI | 7414 | 3226 | 11796 | 2539 | 13571 | 2040 | 14382 | 1659 | 15195 | 1059 | 18217 | 818 | 12404 |
| 12-#11 | 1.95 | MA | 11019 | 3226 | 16861 | 2663 | 19893 | 2160 | 21148 | 1764 | 22009 | 1175 | 27098 | 769 | 20195 |
| 6L-2S | | MI | 7914 | 3226 | 12454 | 2543 | 14393 | 2045 | 15358 | 1654 | 16480 | 1054 | 19880 | 909 | 12416 |
| 12-#14 | 2.81 | MA | 13926 | 3527 | 22219 | 2831 | 26692 | 2271 | 29373 | 1845 | 33027 | 1150 | 41171 | 888 | 31369 |
| 3L-5S | | MI | 6907 | 3527 | 11800 | 2711 | 13489 | 2153 | 14267 | 1720 | 15040 | 1006 | 18341 | 483 | 16000 |
| 12-#14 | 2.81 | MA | 12994 | 3527 | 20913 | 2831 | 24927 | 2284 | 27234 | 1841 | 30151 | 1142 | 37992 | 756 | 30162 |
| 4E | | MI | 7381 | 3527 | 12524 | 2703 | 14328 | 2160 | 15263 | 1713 | 16396 | 1014 | 19966 | 546 | 16569 |
| 12-#14 | 2.81 | MA | 12150 | 3527 | 19592 | 2846 | 23341 | 2282 | 25298 | 1852 | 27526 | 1150 | 34655 | 691 | 28654 |
| 5L-3S | | MI | 7900 | 3527 | 13235 | 2710 | 15258 | 2153 | 16363 | 1720 | 17787 | 1006 | 21506 | 665 | 17324 |
| 12-#14 | 2.81 | MA | 11341 | 3527 | 18417 | 2847 | 21775 | 2296 | 23392 | 1848 | 25002 | 1157 | 31282 | 583 | 26794 |
| 6L-2S | | MI | 8592 | 3527 | 14171 | 2717 | 16415 | 2160 | 17737 | 1713 | 19596 | 999 | 23836 | 797 | 17408 |
| 12-#18 | 5.00 | MA | 14828 | 4291 | 26623 | 3288 | 31960 | 2624 | 35700 | 2050 | 41272 | 1075 | 53126 | 399 | 49308 |
| 4E | | MI | 8173 | 4291 | 15394 | 3123 | 17702 | 2446 | 19231 | 1852 | 21633 | 870 | 26680 | 39 | 26456 |
| 12-#18 | 5.00 | MA | 13447 | 4291 | 24303 | 3313 | 29176 | 2618 | 32303 | 2067 | 36724 | 1088 | 47346 | 287 | 45364 |
| 5L-3S | | MI | 9005 | 4291 | 16604 | 3137 | 19276 | 2432 | 21091 | 1865 | 23986 | 857 | 29271 | 242 | 28157 |
| 12-#18 | 5.00 | MA | 12121 | 4291 | 22240 | 3312 | 26427 | 2639 | 28957 | 2058 | 32351 | 1101 | 41530 | 93 | 41086 |
| 6L-2S | | MI | 10103 | 4291 | 18192 | 3150 | 21232 | 2446 | 23414 | 1852 | 27045 | 844 | 33172 | 476 | 29467 |
| 14-#11 | 2.27 | MA | 13458 | 3340 | 20739 | 2722 | 24879 | 2193 | 27205 | 1793 | 30173 | 1164 | 37457 | 967 | 25735 |
| 3L-6S | | MI | 6669 | 3340 | 10993 | 2607 | 12546 | 2095 | 13172 | 1683 | 13634 | 1051 | 16544 | 596 | 13322 |
| 14-#11 | 2.27 | MA | 12795 | 3340 | 19828 | 2723 | 23647 | 2203 | 25712 | 1791 | 28158 | 1159 | 35217 | 876 | 25485 |
| 4L-5S | | MI | 6994 | 3340 | 11447 | 2612 | 13136 | 2090 | 13870 | 1688 | 14528 | 1045 | 17623 | 659 | 13694 |
| 14-#11 | 2.27 | MA | 12194 | 3340 | 18906 | 2734 | 22540 | 2202 | 24361 | 1799 | 26319 | 1165 | 32874 | 830 | 24414 |
| 5L-4S | | MI | 7332 | 3340 | 11955 | 2606 | 13733 | 2095 | 14578 | 1683 | 15491 | 1051 | 18783 | 703 | 14163 |
| 14-#11 | 2.27 | MA | 11619 | 3340 | 18087 | 2734 | 21448 | 2211 | 23031 | 1797 | 24550 | 1170 | 30499 | 755 | 23715 |
| 6L-3S | | MI | 7702 | 3340 | 12454 | 2610 | 14393 | 2090 | 15358 | 1688 | 16480 | 1045 | 19880 | 787 | 14343 |
| 14-#11 | 2.27 | MA | 11055 | 3340 | 17289 | 2735 | 20393 | 2211 | 21742 | 1805 | 22757 | 1165 | 28387 | 684 | 22480 |
| 7L-2S | | MI | 8196 | 3340 | 13113 | 2614 | 15215 | 2095 | 16335 | 1683 | 17764 | 1040 | 21543 | 878 | 14371 |
| 14-#14 | 3.28 | MA | 13797 | 3691 | 22667 | 2933 | 27151 | 2359 | 29928 | 1888 | 33776 | 1134 | 42825 | 734 | 35114 |
| 4L-5S | | MI | 7314 | 3691 | 12735 | 2813 | 14646 | 2224 | 15641 | 1761 | 16849 | 985 | 20671 | 434 | 18575 |
| 14-#14 | 3.28 | MA | 12968 | 3691 | 21345 | 2948 | 25565 | 2357 | 27992 | 1899 | 31151 | 1142 | 39488 | 669 | 33672 |
| 5L-4S | | MI | 7782 | 3691 | 13459 | 2805 | 15485 | 2232 | 16638 | 1753 | 18204 | 992 | 22296 | 497 | 19162 |
| 14-#14 | 3.28 | MA | 12174 | 3691 | 20171 | 2949 | 23999 | 2370 | 26086 | 1895 | 28626 | 1149 | 36114 | 561 | 31748 |
| 6L-3S | | MI | 8293 | 3691 | 14171 | 2812 | 16415 | 2224 | 17737 | 1761 | 19596 | 985 | 23836 | 616 | 20049 |
| 14-#14 | 3.28 | MA | 11395 | 3691 | 19027 | 2949 | 22486 | 2369 | 24238 | 1906 | 26067 | 1142 | 33117 | 458 | 29851 |
| 7L-2S | | MI | 8977 | 3691 | 15107 | 2819 | 17572 | 2232 | 19111 | 1753 | 21404 | 977 | 26166 | 748 | 20164 |
| 14-#18 | 5.83 | MA | 14804 | 4581 | 27369 | 3495 | 33065 | 2751 | 37014 | 2152 | 43004 | 1070 | 55680 | 241 | 53957 |
| 5L-4S | | MI | 8817 | 4581 | 16983 | 3302 | 19658 | 2568 | 21555 | 1919 | 24692 | 825 | 30581 | -61 | 30228 |
| 14-#18 | 5.83 | MA | 13511 | 4581 | 25306 | 3494 | 30315 | 2772 | 33668 | 2142 | 38630 | 1083 | 49864 | 47 | 49628 |
| 6L-3S | | MI | 9628 | 4581 | 18192 | 3316 | 21232 | 2555 | 23414 | 1932 | 27045 | 812 | 33172 | 142 | 32494 |
| 16-#11 | 2.60 | MA | 13367 | 3453 | 21054 | 2794 | 25202 | 2255 | 27595 | 1824 | 30699 | 1154 | 38619 | 862 | 29056 |
| 4L-6S | | MI | 6964 | 3453 | 11652 | 2678 | 13368 | 2146 | 14148 | 1712 | 14918 | 1037 | 18207 | 564 | 15125 |
| 16-#11 | 2.60 | MA | 12775 | 3453 | 20132 | 2805 | 24095 | 2254 | 26244 | 1832 | 28860 | 1160 | 36275 | 816 | 27919 |
| 5E | | MI | 7285 | 3453 | 12106 | 2683 | 13958 | 2140 | 14846 | 1717 | 15813 | 1032 | 19286 | 627 | 15554 |
| 16-#11 | 2.60 | MA | 12207 | 3453 | 19312 | 2805 | 23003 | 2263 | 24915 | 1830 | 27091 | 1165 | 33900 | 741 | 27168 |
| 6L-4S | | MI | 7620 | 3453 | 12614 | 2676 | 14555 | 2146 | 15554 | 1712 | 16776 | 1037 | 20446 | 671 | 15993 |
| 16-#11 | 2.60 | MA | 11652 | 3453 | 18515 | 2806 | 21947 | 2263 | 23625 | 1838 | 25298 | 1160 | 31789 | 670 | 25968 |
| 7L-3S | | MI | 7985 | 3453 | 13113 | 2681 | 15215 | 2140 | 16335 | 1717 | 17764 | 1032 | 21543 | 755 | 16276 |
| 16-#11 | 2.60 | MA | 11102 | 3453 | 17730 | 2806 | 20913 | 2262 | 22334 | 1836 | 23568 | 1166 | 29600 | 617 | 24726 |
| 8L-2S | | MI | 8475 | 3453 | 13772 | 2685 | 16037 | 2146 | 17311 | 1712 | 19049 | 1026 | 23206 | 846 | 16319 |
| 16-#14 | 3.75 | MA | 13770 | 3854 | 23099 | 3051 | 27788 | 2432 | 30687 | 1947 | 34776 | 1134 | 44321 | 647 | 38700 |
| 5E | | MI | 7741 | 3854 | 13671 | 2915 | 15803 | 2296 | 17015 | 1801 | 18657 | 963 | 23000 | 384 | 21096 |
| 16-#14 | 3.75 | MA | 12989 | 3854 | 21924 | 3051 | 26223 | 2445 | 28781 | 1943 | 32251 | 1141 | 40947 | 539 | 36713 |
| 6L-4S | | MI | 8198 | 3854 | 14395 | 2907 | 16642 | 2303 | 18012 | 1794 | 20013 | 970 | 24625 | 448 | 21769 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

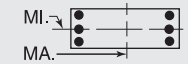
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.75 | MA | 12225 | 3854 | 20781 | 3051 | 24710 | 2443 | 26933 | 1954 | 29692 | 1134 | 37949 | 436 | 34702 |
| 7L-3S | | MI | 8694 | 3854 | 15107 | 2915 | 17572 | 2296 | 19111 | 1801 | 21404 | 963 | 26166 | 567 | 22768 |
| 16-#14 | 3.75 | MA | 11469 | 3854 | 19655 | 3052 | 23227 | 2442 | 25081 | 1950 | 27222 | 1141 | 34834 | 361 | 32624 |
| 8L-2S | | MI | 9354 | 3854 | 16043 | 2922 | 18729 | 2303 | 20485 | 1794 | 23213 | 955 | 28495 | 698 | 22911 |
| 16-#18 | 6.67 | MA | 14978 | 4872 | 28372 | 3676 | 34204 | 2905 | 38379 | 2226 | 44910 | 1066 | 58198 | 1 | 58192 |
| 6L-4S | | MI | 9449 | 4872 | 18571 | 3481 | 21614 | 2691 | 23878 | 1986 | 27751 | 780 | 34481 | -162 | 33544 |
| 18-#11 | 2.92 | MA | 13346 | 3567 | 21358 | 2875 | 25650 | 2306 | 28128 | 1865 | 31401 | 1155 | 39676 | 802 | 31432 |
| 5L-6S | | MI | 7255 | 3567 | 12311 | 2749 | 14190 | 2196 | 15125 | 1741 | 16203 | 1023 | 19870 | 533 | 16938 |
| 18-#11 | 2.92 | MA | 12786 | 3567 | 20538 | 2876 | 24557 | 2315 | 26798 | 1863 | 29632 | 1160 | 37302 | 727 | 30630 |
| 6L-5S | | MI | 7573 | 3567 | 12764 | 2753 | 14780 | 2191 | 15822 | 1746 | 17098 | 1018 | 20949 | 595 | 17419 |
| 18-#11 | 2.92 | MA | 12238 | 3567 | 19741 | 2877 | 23502 | 2314 | 25509 | 1871 | 27839 | 1155 | 35190 | 656 | 29463 |
| 7L-4S | | MI | 7903 | 3567 | 13272 | 2747 | 15377 | 2196 | 16530 | 1741 | 18061 | 1023 | 22109 | 639 | 17831 |
| 18-#11 | 2.92 | MA | 11696 | 3567 | 18956 | 2877 | 22468 | 2314 | 24217 | 1869 | 26109 | 1160 | 33001 | 603 | 28195 |
| 8L-3S | | MI | 8265 | 3567 | 13772 | 2751 | 16037 | 2191 | 17311 | 1746 | 19049 | 1018 | 23206 | 723 | 18204 |
| 18-#11 | 2.92 | MA | 11158 | 3567 | 18089 | 2888 | 21402 | 2323 | 22946 | 1877 | 24396 | 1166 | 30847 | 544 | 26924 |
| 9L-2S | | MI | 8751 | 3567 | 14431 | 2756 | 16859 | 2196 | 18287 | 1741 | 20334 | 1013 | 24869 | 814 | 18262 |
| 18-#14 | 4.22 | MA | 13790 | 4018 | 23678 | 3153 | 28447 | 2520 | 31475 | 1990 | 35876 | 1133 | 45780 | 517 | 41688 |
| 6L-5S | | MI | 8134 | 4018 | 14607 | 3018 | 16960 | 2367 | 18390 | 1841 | 20466 | 941 | 25330 | 335 | 23633 |
| 18-#14 | 4.22 | MA | 13038 | 4018 | 22534 | 3154 | 26934 | 2518 | 29627 | 2001 | 33316 | 1125 | 42782 | 414 | 39642 |
| 7L-4S | | MI | 8583 | 4018 | 15331 | 3010 | 17799 | 2375 | 19386 | 1834 | 21822 | 949 | 26955 | 399 | 24386 |
| 18-#14 | 4.22 | MA | 12295 | 4018 | 21408 | 3154 | 25451 | 2516 | 27775 | 1997 | 30846 | 1133 | 39666 | 339 | 37542 |
| 8L-3S | | MI | 9070 | 4018 | 16043 | 3017 | 18729 | 2367 | 20485 | 1841 | 23213 | 941 | 28495 | 518 | 25483 |
| 18-#14 | 4.22 | MA | 11556 | 4018 | 20165 | 3169 | 23923 | 2530 | 25953 | 2008 | 28400 | 1140 | 36607 | 254 | 35237 |
| 9L-2S | | MI | 9720 | 4018 | 16978 | 3024 | 19886 | 2375 | 21859 | 1834 | 25022 | 934 | 30825 | 649 | 25652 |
| 20-#11 | 3.25 | MA | 13356 | 3680 | 21764 | 2947 | 26112 | 2367 | 28682 | 1896 | 32173 | 1155 | 40703 | 713 | 34098 |
| 6E | | MI | 7542 | 3680 | 12969 | 2820 | 15012 | 2246 | 16101 | 1770 | 17488 | 1009 | 21533 | 501 | 18759 |
| 20-#11 | 3.25 | MA | 12815 | 3680 | 20967 | 2948 | 25057 | 2366 | 27392 | 1904 | 30381 | 1150 | 38591 | 642 | 32963 |
| 7L-5S | | MI | 7857 | 3680 | 13423 | 2824 | 15602 | 2241 | 16799 | 1775 | 18383 | 1004 | 22612 | 564 | 19289 |
| 20-#11 | 3.25 | MA | 12280 | 3680 | 20181 | 2948 | 24023 | 2365 | 26101 | 1902 | 28650 | 1155 | 36403 | 589 | 31670 |
| 8L-4S | | MI | 8184 | 3680 | 13931 | 2818 | 16199 | 2246 | 17507 | 1770 | 19345 | 1009 | 23772 | 607 | 19677 |
| 20-#11 | 3.25 | MA | 11749 | 3680 | 19315 | 2959 | 22957 | 2375 | 24830 | 1910 | 26937 | 1161 | 34248 | 531 | 30381 |
| 9L-3S | | MI | 8543 | 3680 | 14431 | 2822 | 16859 | 2241 | 18287 | 1775 | 20334 | 1004 | 24869 | 692 | 20129 |
| 20-#11 | 3.25 | MA | 11220 | 3680 | 18532 | 2960 | 21930 | 2374 | 23553 | 1908 | 25175 | 1156 | 32019 | 450 | 28974 |
| 10L-2S | | MI | 9023 | 3680 | 15090 | 2827 | 17681 | 2246 | 19264 | 1770 | 21619 | 999 | 26532 | 783 | 20200 |
| 20-#14 | 4.69 | MA | 13837 | 4182 | 24288 | 3256 | 29158 | 2593 | 32321 | 2049 | 36941 | 1117 | 47615 | 392 | 44592 |
| 7L-5S | | MI | 8520 | 4182 | 15543 | 3120 | 18116 | 2439 | 19764 | 1882 | 22275 | 919 | 27659 | 286 | 26183 |
| 20-#14 | 4.69 | MA | 13106 | 4182 | 23162 | 3256 | 27675 | 2591 | 30469 | 2045 | 34471 | 1125 | 44499 | 317 | 42467 |
| 8L-4S | | MI | 8961 | 4182 | 16267 | 3112 | 18956 | 2446 | 20760 | 1874 | 23630 | 927 | 29284 | 349 | 27013 |
| 20-#14 | 4.69 | MA | 12379 | 4182 | 21919 | 3271 | 26147 | 2604 | 28647 | 2056 | 32025 | 1132 | 41439 | 232 | 40205 |
| 9L-3S | | MI | 9440 | 4182 | 16978 | 3119 | 19886 | 2439 | 21859 | 1882 | 25022 | 919 | 30825 | 468 | 28195 |
| 22-#11 | 3.57 | MA | 13384 | 3793 | 22192 | 3018 | 26611 | 2418 | 29276 | 1937 | 32922 | 1145 | 41992 | 628 | 36469 |
| 7L-6S | | MI | 7826 | 3793 | 13628 | 2891 | 15835 | 2297 | 17077 | 1799 | 18773 | 995 | 23196 | 469 | 20586 |
| 22-#11 | 3.57 | MA | 12856 | 3793 | 21407 | 3019 | 25577 | 2417 | 27984 | 1935 | 31192 | 1150 | 39804 | 575 | 35149 |
| 8L-5S | | MI | 8137 | 3793 | 14082 | 2895 | 16424 | 2292 | 17775 | 1804 | 19668 | 990 | 24275 | 532 | 21162 |
| 22-#11 | 3.57 | MA | 12332 | 3793 | 20541 | 3030 | 24512 | 2427 | 26713 | 1943 | 29478 | 1156 | 37649 | 517 | 33842 |
| 9L-4S | | MI | 8462 | 3793 | 14590 | 2889 | 17021 | 2297 | 18483 | 1799 | 20630 | 995 | 25435 | 576 | 21529 |
| 22-#11 | 3.57 | MA | 11809 | 3793 | 19758 | 3031 | 23485 | 2426 | 25436 | 1941 | 27716 | 1151 | 35421 | 436 | 32460 |
| 10L-3S | | MI | 8817 | 3793 | 15090 | 2893 | 17681 | 2292 | 19264 | 1804 | 21619 | 990 | 26532 | 660 | 22051 |
| 22-#14 | 5.16 | MA | 13904 | 4345 | 24915 | 3358 | 29899 | 2666 | 33164 | 2092 | 38096 | 1117 | 49332 | 295 | 47401 |
| 8L-5S | | MI | 8901 | 4345 | 16478 | 3222 | 19273 | 2510 | 21138 | 1922 | 24083 | 898 | 29989 | 237 | 28745 |
| 22-#14 | 5.16 | MA | 13188 | 4345 | 23673 | 3374 | 28371 | 2679 | 31342 | 2103 | 35650 | 1124 | 46272 | 210 | 45160 |
| 9L-4S | | MI | 9334 | 4345 | 17202 | 3214 | 20113 | 2518 | 22134 | 1915 | 25439 | 905 | 31614 | 300 | 29647 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

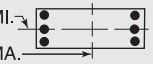
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 3.90 | MA | 13424 | 3907 | 22633 | 3090 | 27132 | 2469 | 29868 | 1967 | 33733 | 1145 | 43205 | 561 | 38634 |
| 8L-6S | | MI | 8107 | 3907 | 14287 | 2962 | 16657 | 2347 | 18054 | 1828 | 20058 | 981 | 24859 | 438 | 22419 |
| 24-#11 | 3.90 | MA | 12906 | 3907 | 21766 | 3101 | 26066 | 2479 | 28597 | 1976 | 32019 | 1150 | 41050 | 503 | 37308 |
| 9L-5S | | MI | 8416 | 3907 | 14741 | 2966 | 17246 | 2342 | 18751 | 1833 | 20952 | 976 | 25938 | 500 | 23037 |
| 24-#11 | 3.90 | MA | 12390 | 3907 | 20984 | 3101 | 25039 | 2478 | 27320 | 1973 | 30258 | 1145 | 38822 | 422 | 35945 |
| 10L-4S | | MI | 8737 | 3907 | 15249 | 2960 | 17843 | 2347 | 19459 | 1828 | 21915 | 981 | 27098 | 544 | 23386 |
| 24-#14 | 5.63 | MA | 13985 | 4509 | 25426 | 3476 | 30595 | 2754 | 34036 | 2150 | 39275 | 1116 | 51104 | 188 | 50085 |
| 9L-5S | | MI | 9276 | 4509 | 17414 | 3324 | 20430 | 2582 | 22512 | 1963 | 25892 | 876 | 32319 | 187 | 31318 |

## RECTANGULAR TIED COLUMNS 24" x 42"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.59 | MA | 14437 | 3255 | 21394 | 2683 | 25427 | 2174 | 27508 | 1789 | 29777 | 1214 | 36494 | 1120 | 19835 |
| 2E | | MI | 7853 | 3255 | 12272 | 2538 | 13883 | 2039 | 14593 | 1657 | 15244 | 1080 | 18059 | 931 | 10492 |
| 6-#14 | 1.34 | MA | 14036 | 3164 | 20327 | 2643 | 24207 | 2146 | 26088 | 1775 | 27996 | 1232 | 34239 | 1153 | 16987 |
| 2L-3S | | MI | 6981 | 3164 | 10856 | 2509 | 12261 | 2024 | 12715 | 1672 | 12799 | 1128 | 15011 | 868 | 9121 |
| 6-#14 | 1.34 | MA | 12592 | 3164 | 18471 | 2644 | 21853 | 2145 | 23237 | 1787 | 24149 | 1240 | 29091 | 1021 | 16895 |
| 3L-2S | | MI | 7705 | 3164 | 11792 | 2516 | 13418 | 2032 | 14089 | 1665 | 14607 | 1121 | 17340 | 999 | 9086 |
| 6-#18 | 2.38 | MA | 15919 | 3546 | 24642 | 2865 | 29546 | 2307 | 32499 | 1874 | 36461 | 1198 | 45387 | 1077 | 29434 |
| 2L-3S | | MI | 7322 | 3546 | 12272 | 2703 | 13883 | 2149 | 14593 | 1737 | 15244 | 1048 | 18059 | 597 | 15180 |
| 6-#18 | 2.38 | MA | 13494 | 3546 | 21394 | 2864 | 25427 | 2303 | 27508 | 1892 | 29777 | 1211 | 36494 | 844 | 28864 |
| 3L-2S | | MI | 8530 | 3546 | 13860 | 2717 | 15839 | 2162 | 16917 | 1724 | 18302 | 1035 | 21959 | 831 | 15315 |
| 8-#11 | 1.24 | MA | 13870 | 3127 | 19875 | 2628 | 23702 | 2136 | 25506 | 1770 | 27231 | 1239 | 33319 | 1167 | 15814 |
| 2L-4S | | MI | 6748 | 3127 | 10403 | 2499 | 11740 | 2031 | 12124 | 1670 | 12075 | 1149 | 14289 | 853 | 8529 |
| 8-#11 | 1.24 | MA | 12856 | 3127 | 18578 | 2629 | 22058 | 2136 | 23514 | 1779 | 24543 | 1245 | 29699 | 1075 | 15775 |
| 3E | | MI | 7132 | 3127 | 10903 | 2503 | 12400 | 2026 | 12904 | 1675 | 13064 | 1144 | 15387 | 937 | 8528 |
| 8-#11 | 1.24 | MA | 12121 | 3127 | 17616 | 2630 | 20756 | 2146 | 21936 | 1777 | 22413 | 1240 | 27312 | 984 | 15612 |
| 4L-2S | | MI | 7644 | 3127 | 11562 | 2507 | 13222 | 2031 | 13881 | 1670 | 14348 | 1139 | 17050 | 1028 | 8500 |
| 8-#14 | 1.79 | MA | 14912 | 3327 | 22183 | 2745 | 26561 | 2221 | 28939 | 1822 | 31843 | 1225 | 39386 | 1132 | 22483 |
| 2L-4S | | MI | 6863 | 3327 | 11080 | 2604 | 12488 | 2103 | 12990 | 1705 | 13216 | 1114 | 15800 | 700 | 11576 |
| 8-#14 | 1.79 | MA | 13495 | 3327 | 20327 | 2746 | 24207 | 2220 | 26088 | 1834 | 27996 | 1233 | 34239 | 1001 | 22333 |
| 3E | | MI | 7399 | 3327 | 11792 | 2611 | 13418 | 2096 | 14089 | 1713 | 14607 | 1107 | 17340 | 819 | 11891 |
| 8-#14 | 1.79 | MA | 12467 | 3327 | 18947 | 2747 | 22342 | 2234 | 23828 | 1831 | 24945 | 1225 | 30848 | 869 | 21661 |
| 4L-2S | | MI | 8113 | 3327 | 12728 | 2618 | 14575 | 2103 | 15463 | 1705 | 16416 | 1099 | 19670 | 950 | 11894 |
| 8-#18 | 3.17 | MA | 17348 | 3836 | 27890 | 3046 | 33665 | 2440 | 37489 | 1958 | 43146 | 1182 | 54281 | 1035 | 39000 |
| 2L-4S | | MI | 7136 | 3836 | 12651 | 2869 | 14265 | 2285 | 15057 | 1791 | 15949 | 1016 | 19368 | 294 | 17753 |
| 8-#18 | 3.17 | MA | 14988 | 3836 | 24642 | 3046 | 29546 | 2436 | 32499 | 1976 | 36461 | 1195 | 45387 | 801 | 38290 |
| 3E | | MI | 8023 | 3836 | 13860 | 2882 | 15839 | 2272 | 16917 | 1804 | 18302 | 1003 | 21959 | 497 | 19837 |
| 8-#18 | 3.17 | MA | 13277 | 3836 | 22220 | 3046 | 26273 | 2458 | 28532 | 1968 | 31157 | 1182 | 39544 | 568 | 34083 |
| 4L-2S | | MI | 9188 | 3836 | 15448 | 2896 | 17795 | 2285 | 19241 | 1791 | 21361 | 990 | 25860 | 730 | 20079 |
| 10-#11 | 1.55 | MA | 14492 | 3240 | 21172 | 2699 | 25347 | 2188 | 27498 | 1803 | 29919 | 1233 | 36939 | 1154 | 19657 |
| 2L-5S | | MI | 6704 | 3240 | 10554 | 2576 | 11965 | 2076 | 12392 | 1704 | 12397 | 1130 | 14792 | 777 | 10089 |
| 10-#11 | 1.55 | MA | 13492 | 3240 | 19875 | 2700 | 23702 | 2188 | 25506 | 1811 | 27231 | 1239 | 33319 | 1063 | 19592 |
| 3L-4S | | MI | 7050 | 3240 | 11062 | 2570 | 12562 | 2081 | 13100 | 1699 | 13360 | 1135 | 15952 | 821 | 10467 |
| 10-#11 | 1.55 | MA | 12768 | 3240 | 18912 | 2701 | 22400 | 2198 | 23928 | 1810 | 25102 | 1235 | 30932 | 972 | 19395 |
| 4L-3S | | MI | 7430 | 3240 | 11562 | 2574 | 13222 | 2076 | 13881 | 1704 | 14348 | 1130 | 17050 | 905 | 10493 |
| 10-#11 | 1.55 | MA | 12113 | 3240 | 17939 | 2712 | 21232 | 2198 | 22502 | 1818 | 23159 | 1241 | 28443 | 925 | 18509 |
| 5L-2S | | MI | 7936 | 3240 | 12221 | 2578 | 14044 | 2081 | 14857 | 1699 | 15633 | 1125 | 18713 | 996 | 10479 |
| 10-#14 | 2.23 | MA | 15766 | 3491 | 24038 | 2847 | 28914 | 2296 | 31791 | 1870 | 35690 | 1217 | 44534 | 1112 | 27964 |
| 2L-5S | | MI | 6797 | 3491 | 11292 | 2714 | 12806 | 2168 | 13368 | 1753 | 13669 | 1085 | 16504 | 587 | 13498 |
| 10-#14 | 2.23 | MA | 14373 | 3491 | 22183 | 2848 | 26561 | 2295 | 28939 | 1881 | 31843 | 1225 | 39386 | 981 | 27764 |
| 3L-4S | | MI | 7280 | 3491 | 12016 | 2706 | 13645 | 2175 | 14364 | 1746 | 15024 | 1092 | 18129 | 650 | 14127 |
| 10-#14 | 2.23 | MA | 13366 | 3491 | 20803 | 2849 | 24695 | 2309 | 26679 | 1878 | 28792 | 1218 | 35996 | 849 | 26864 |
| 4L-3S | | MI | 7808 | 3491 | 12728 | 2713 | 14575 | 2168 | 15463 | 1753 | 16416 | 1085 | 19670 | 769 | 14641 |
| 10-#14 | 2.23 | MA | 12454 | 3491 | 19407 | 2865 | 23020 | 2308 | 24634 | 1890 | 26008 | 1226 | 32449 | 784 | 25122 |
| 5L-2S | | MI | 8512 | 3491 | 13663 | 2720 | 15732 | 2175 | 16837 | 1746 | 18225 | 1077 | 21999 | 901 | 14682 |
| 10-#18 | 3.97 | MA | 16432 | 4127 | 27890 | 3228 | 33665 | 2569 | 37489 | 2060 | 43146 | 1179 | 54281 | 759 | 47721 |
| 3L-4S | | MI | 7819 | 4127 | 14239 | 3048 | 16221 | 2408 | 17381 | 1858 | 19008 | 971 | 23268 | 193 | 22175 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

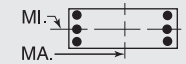
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.97 | MA | 14769 | 4127 | 25468 | 3228 | 30392 | 2591 | 33523 | 2052 | 37841 | 1166 | 48437 | 525 | 43260 |
| 4L-3S | | MI | 8681 | 4127 | 15448 | 3061 | 17795 | 2395 | 19241 | 1871 | 21361 | 958 | 25860 | 396 | 24100 |
| 10-#18 | 3.97 | MA | 13262 | 4127 | 23016 | 3254 | 27449 | 2587 | 29931 | 2071 | 33000 | 1179 | 42284 | 412 | 39385 |
| 5L-2S | | MI | 9815 | 4127 | 17037 | 3075 | 19751 | 2408 | 21564 | 1858 | 24420 | 944 | 29760 | 630 | 24814 |
| 12-#11 | 1.86 | MA | 15102 | 3354 | 22469 | 2770 | 26991 | 2240 | 29491 | 1836 | 32607 | 1228 | 40559 | 1141 | 23492 |
| 2L-6S | | MI | 6675 | 3354 | 10759 | 2642 | 12197 | 2132 | 12671 | 1728 | 12787 | 1121 | 15376 | 683 | 11665 |
| 12-#11 | 1.86 | MA | 14115 | 3354 | 21172 | 2771 | 25347 | 2240 | 27498 | 1844 | 29919 | 1234 | 36939 | 1050 | 23402 |
| 3L-5S | | MI | 7005 | 3354 | 11213 | 2647 | 12787 | 2127 | 13369 | 1733 | 13682 | 1116 | 16455 | 745 | 11934 |
| 12-#11 | 1.86 | MA | 13401 | 3354 | 20209 | 2772 | 24045 | 2250 | 25921 | 1843 | 27790 | 1230 | 34552 | 959 | 23177 |
| 4E | | MI | 7348 | 3354 | 11721 | 2641 | 13384 | 2132 | 14076 | 1728 | 14645 | 1121 | 17615 | 789 | 12394 |
| 12-#11 | 1.86 | MA | 12756 | 3354 | 19235 | 2783 | 22876 | 2249 | 24494 | 1851 | 25847 | 1236 | 32063 | 913 | 22202 |
| 5L-3S | | MI | 7723 | 3354 | 12221 | 2645 | 14044 | 2127 | 14857 | 1733 | 15633 | 1116 | 18713 | 873 | 12443 |
| 12-#11 | 1.86 | MA | 12137 | 3354 | 18370 | 2784 | 21723 | 2259 | 23090 | 1850 | 23980 | 1242 | 29535 | 837 | 21417 |
| 6L-2S | | MI | 8224 | 3354 | 12880 | 2649 | 14866 | 2132 | 15833 | 1728 | 16918 | 1111 | 20376 | 964 | 12447 |
| 12-#14 | 2.68 | MA | 15231 | 3655 | 24038 | 2951 | 28914 | 2370 | 31791 | 1929 | 35690 | 1218 | 44534 | 961 | 33192 |
| 3L-5S | | MI | 7213 | 3655 | 12228 | 2816 | 13963 | 2239 | 14742 | 1794 | 15478 | 1063 | 18834 | 537 | 16120 |
| 12-#14 | 2.68 | MA | 14242 | 3655 | 22659 | 2951 | 27049 | 2384 | 29530 | 1926 | 32639 | 1211 | 41144 | 829 | 32091 |
| 4E | | MI | 7689 | 3655 | 12952 | 2808 | 14802 | 2247 | 15738 | 1786 | 16833 | 1070 | 20459 | 601 | 16700 |
| 12-#14 | 2.68 | MA | 13347 | 3655 | 21262 | 2967 | 25373 | 2382 | 27485 | 1937 | 29855 | 1218 | 37597 | 763 | 30427 |
| 5L-3S | | MI | 8210 | 3655 | 13663 | 2815 | 15732 | 2239 | 16837 | 1794 | 18225 | 1063 | 21999 | 720 | 17378 |
| 12-#14 | 2.68 | MA | 12489 | 3655 | 20022 | 2968 | 23719 | 2396 | 25472 | 1934 | 27177 | 1226 | 34003 | 655 | 28571 |
| 6L-2S | | MI | 8905 | 3655 | 14599 | 2822 | 16889 | 2247 | 18211 | 1786 | 20033 | 1056 | 24329 | 851 | 17450 |
| 12-#18 | 4.76 | MA | 16217 | 4418 | 28716 | 3409 | 34512 | 2724 | 38513 | 2137 | 44526 | 1150 | 57331 | 483 | 52471 |
| 4E | | MI | 8483 | 4418 | 15828 | 3227 | 18177 | 2531 | 19705 | 1925 | 22067 | 926 | 27169 | 93 | 26631 |
| 12-#18 | 4.76 | MA | 14749 | 4418 | 26264 | 3436 | 31568 | 2720 | 34921 | 2155 | 39685 | 1163 | 51178 | 369 | 48480 |
| 5L-3S | | MI | 9321 | 4418 | 17037 | 3240 | 19751 | 2518 | 21564 | 1938 | 24420 | 913 | 29760 | 296 | 28386 |
| 12-#18 | 4.76 | MA | 13341 | 4418 | 24084 | 3435 | 28663 | 2742 | 31385 | 2147 | 35029 | 1176 | 44970 | 176 | 44080 |
| 6L-2S | | MI | 10427 | 4418 | 18625 | 3254 | 21707 | 2531 | 23888 | 1925 | 27479 | 899 | 33660 | 530 | 29528 |
| 14-#11 | 2.17 | MA | 14726 | 3467 | 22469 | 2842 | 26991 | 2292 | 29491 | 1877 | 32607 | 1229 | 40559 | 1037 | 27210 |
| 3L-6S | | MI | 6975 | 3467 | 11418 | 2713 | 13019 | 2182 | 13647 | 1757 | 14072 | 1107 | 17039 | 651 | 13471 |
| 14-#11 | 2.17 | MA | 14023 | 3467 | 21506 | 2843 | 25690 | 2302 | 27913 | 1875 | 30478 | 1225 | 38172 | 946 | 26959 |
| 4L-5S | | MI | 7301 | 3467 | 11872 | 2718 | 13609 | 2177 | 14345 | 1762 | 14967 | 1102 | 18118 | 714 | 13788 |
| 14-#11 | 2.17 | MA | 13387 | 3467 | 20532 | 2854 | 24521 | 2301 | 26487 | 1884 | 28535 | 1231 | 35683 | 900 | 25905 |
| 5L-4S | | MI | 7640 | 3467 | 12380 | 2711 | 14206 | 2182 | 15053 | 1757 | 15929 | 1107 | 19278 | 758 | 14271 |
| 14-#11 | 2.17 | MA | 12777 | 3467 | 19667 | 2855 | 23368 | 2311 | 25083 | 1882 | 26668 | 1237 | 33155 | 825 | 25147 |
| 6L-3S | | MI | 8011 | 3467 | 12880 | 2716 | 14866 | 2177 | 15833 | 1762 | 16918 | 1102 | 20376 | 842 | 14384 |
| 14-#11 | 2.17 | MA | 12179 | 3467 | 18825 | 2856 | 22253 | 2311 | 23722 | 1891 | 24775 | 1232 | 30906 | 754 | 23912 |
| 7L-2S | | MI | 8508 | 3467 | 13538 | 2720 | 15688 | 2182 | 16810 | 1757 | 18203 | 1097 | 22039 | 933 | 14407 |
| 14-#14 | 3.13 | MA | 15099 | 3818 | 24514 | 3054 | 29402 | 2458 | 32382 | 1973 | 36486 | 1203 | 46292 | 809 | 37337 |
| 4L-5S | | MI | 7622 | 3818 | 13163 | 2918 | 15119 | 2311 | 16116 | 1834 | 17286 | 1041 | 21164 | 488 | 18752 |
| 14-#14 | 3.13 | MA | 14221 | 3818 | 23118 | 3069 | 27727 | 2457 | 30337 | 1985 | 33702 | 1211 | 42744 | 743 | 35743 |
| 5L-4S | | MI | 8091 | 3818 | 13887 | 2910 | 15959 | 2318 | 17112 | 1827 | 18642 | 1049 | 22788 | 552 | 19292 |
| 14-#14 | 3.13 | MA | 13378 | 3818 | 21878 | 3070 | 26073 | 2471 | 28324 | 1982 | 31024 | 1219 | 39151 | 635 | 33822 |
| 6L-3S | | MI | 8605 | 3818 | 14599 | 2917 | 16889 | 2311 | 18211 | 1834 | 20033 | 1041 | 24329 | 671 | 20107 |
| 14-#14 | 3.13 | MA | 12552 | 3818 | 20670 | 3071 | 24475 | 2470 | 26372 | 1993 | 28310 | 1212 | 35955 | 532 | 31918 |
| 7L-2S | | MI | 9291 | 3818 | 15535 | 2925 | 18046 | 2318 | 19585 | 1827 | 21842 | 1034 | 26659 | 802 | 20208 |
| 14-#18 | 5.56 | MA | 16198 | 4709 | 29512 | 3617 | 35688 | 2853 | 39912 | 2239 | 46370 | 1147 | 60071 | 327 | 57602 |
| 5L-4S | | MI | 9130 | 4709 | 17416 | 3406 | 20133 | 2654 | 22028 | 1991 | 25126 | 881 | 31069 | -7 | 31027 |
| 14-#18 | 5.56 | MA | 14824 | 4709 | 27332 | 3617 | 32782 | 2875 | 36375 | 2231 | 41714 | 1160 | 53863 | 133 | 53156 |
| 6L-3S | | MI | 9947 | 4709 | 18625 | 3419 | 21707 | 2641 | 23888 | 2005 | 27479 | 867 | 33660 | 196 | 32718 |
| 14-#18 | 5.56 | MA | 13477 | 4709 | 25209 | 3617 | 29973 | 2871 | 32945 | 2250 | 36993 | 1147 | 48352 | -49 | 48037 |
| 7L-2S | | MI | 11028 | 4709 | 20213 | 3433 | 23663 | 2654 | 26211 | 1991 | 30538 | 854 | 37561 | 429 | 34229 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

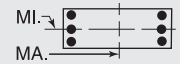


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.48 | MA | 14633 | 3580 | 22803 | 2914 | 27334 | 2354 | 29906 | 1908 | 33166 | 1220 | 41792 | 933 | 30741 |
| 4L-6S | | MI | 7270 | 3580 | 12077 | 2784 | 13841 | 2233 | 14623 | 1786 | 15357 | 1094 | 18702 | 619 | 15273 |
| 16-#11 | 2.48 | MA | 14006 | 3580 | 21829 | 2925 | 26165 | 2353 | 28479 | 1917 | 31223 | 1226 | 39303 | 887 | 29617 |
| 5E | | MI | 7593 | 3580 | 12531 | 2788 | 14431 | 2228 | 15321 | 1791 | 16252 | 1088 | 19781 | 682 | 15648 |
| 16-#11 | 2.48 | MA | 13405 | 3580 | 20964 | 2926 | 25012 | 2363 | 27075 | 1915 | 29356 | 1232 | 36775 | 812 | 28883 |
| 6L-4S | | MI | 7929 | 3580 | 13039 | 2782 | 15028 | 2233 | 16029 | 1786 | 17214 | 1094 | 20941 | 726 | 16099 |
| 16-#11 | 2.48 | MA | 12816 | 3580 | 20122 | 2927 | 23898 | 2363 | 25714 | 1924 | 27463 | 1227 | 34526 | 741 | 27607 |
| 7L-3S | | MI | 8296 | 3580 | 13538 | 2786 | 15688 | 2228 | 16810 | 1791 | 18203 | 1088 | 22039 | 810 | 16320 |
| 16-#11 | 2.48 | MA | 12233 | 3580 | 19294 | 2928 | 22806 | 2362 | 24350 | 1922 | 25636 | 1233 | 32201 | 688 | 26415 |
| 8L-2S | | MI | 8788 | 3580 | 14197 | 2791 | 16510 | 2233 | 17786 | 1786 | 19488 | 1083 | 23702 | 901 | 16356 |
| 16-#14 | 3.57 | MA | 15076 | 3982 | 24974 | 3172 | 30081 | 2532 | 33188 | 2032 | 37549 | 1203 | 47892 | 723 | 41070 |
| 5E | | MI | 8024 | 3982 | 14099 | 3021 | 16276 | 2382 | 17490 | 1874 | 19095 | 1019 | 23493 | 439 | 21301 |
| 16-#14 | 3.57 | MA | 14248 | 3982 | 23734 | 3172 | 28427 | 2546 | 31175 | 2029 | 34871 | 1211 | 44298 | 615 | 39085 |
| 6L-4S | | MI | 8487 | 3982 | 14823 | 3013 | 17116 | 2390 | 18486 | 1867 | 20450 | 1027 | 25118 | 503 | 21897 |
| 16-#14 | 3.57 | MA | 13437 | 3982 | 22526 | 3173 | 26829 | 2545 | 29223 | 2041 | 32157 | 1204 | 41102 | 512 | 37144 |
| 7L-3S | | MI | 9010 | 3982 | 15535 | 3020 | 18046 | 2382 | 19585 | 1874 | 21842 | 1019 | 26659 | 622 | 22829 |
| 16-#14 | 3.57 | MA | 12635 | 3982 | 21337 | 3174 | 25263 | 2543 | 27267 | 2038 | 29537 | 1212 | 37790 | 436 | 34904 |
| 8L-2S | | MI | 9674 | 3982 | 16471 | 3027 | 19203 | 2390 | 20960 | 1867 | 23650 | 1012 | 28988 | 753 | 22958 |
| 16-#18 | 6.35 | MA | 16273 | 4999 | 30580 | 3799 | 36901 | 3008 | 41365 | 2315 | 48399 | 1144 | 62757 | 91 | 62254 |
| 6L-4S | | MI | 9764 | 4999 | 19004 | 3585 | 22089 | 2777 | 24352 | 2058 | 28185 | 835 | 34969 | -108 | 34327 |
| 16-#18 | 6.35 | MA | 14958 | 4999 | 28456 | 3799 | 34093 | 3004 | 37935 | 2334 | 43678 | 1131 | 57245 | -92 | 56525 |
| 7L-3S | | MI | 10561 | 4999 | 20213 | 3598 | 23663 | 2764 | 26211 | 2072 | 30538 | 822 | 37561 | 95 | 37087 |
| 18-#11 | 2.79 | MA | 14615 | 3694 | 23125 | 2996 | 27810 | 2405 | 30471 | 1950 | 33911 | 1220 | 42922 | 874 | 33335 |
| 5L-6S | | MI | 7562 | 3694 | 12736 | 2855 | 14664 | 2283 | 15600 | 1815 | 16642 | 1080 | 20365 | 588 | 17084 |
| 18-#11 | 2.79 | MA | 14022 | 3694 | 22261 | 2997 | 26657 | 2415 | 29068 | 1948 | 32044 | 1226 | 40395 | 799 | 32595 |
| 6L-5S | | MI | 7881 | 3694 | 13189 | 2859 | 15253 | 2278 | 16297 | 1820 | 17536 | 1075 | 21444 | 650 | 17513 |
| 18-#11 | 2.79 | MA | 13441 | 3694 | 21419 | 2998 | 25543 | 2415 | 27706 | 1957 | 30151 | 1222 | 38145 | 728 | 31308 |
| 7L-4S | | MI | 8214 | 3694 | 13697 | 2853 | 15850 | 2283 | 17005 | 1815 | 18499 | 1080 | 22604 | 694 | 17937 |
| 18-#11 | 2.79 | MA | 12867 | 3694 | 20590 | 2999 | 24451 | 2414 | 26343 | 1955 | 28324 | 1228 | 35820 | 675 | 30047 |
| 8L-3S | | MI | 8577 | 3694 | 14197 | 2857 | 16510 | 2278 | 17786 | 1820 | 19488 | 1075 | 23702 | 778 | 18251 |
| 18-#11 | 2.79 | MA | 12296 | 3694 | 19675 | 3010 | 23326 | 2424 | 25001 | 1964 | 26515 | 1234 | 33526 | 616 | 28775 |
| 9L-2S | | MI | 9065 | 3694 | 14856 | 2862 | 17332 | 2283 | 18762 | 1815 | 20773 | 1069 | 25365 | 869 | 18301 |
| 18-#14 | 4.02 | MA | 15102 | 4145 | 25589 | 3275 | 30780 | 2621 | 34026 | 2076 | 38718 | 1204 | 49446 | 594 | 44358 |
| 6L-5S | | MI | 8445 | 4145 | 15035 | 3123 | 17433 | 2454 | 18864 | 1915 | 20903 | 998 | 25823 | 390 | 23834 |
| 18-#14 | 4.02 | MA | 14305 | 4145 | 24382 | 3275 | 29183 | 2619 | 32074 | 2088 | 36004 | 1197 | 46250 | 492 | 42303 |
| 7L-4S | | MI | 8897 | 4145 | 15759 | 3115 | 18273 | 2461 | 19860 | 1907 | 22259 | 1005 | 27448 | 453 | 24514 |
| 18-#14 | 4.02 | MA | 13516 | 4145 | 23193 | 3276 | 27617 | 2618 | 30119 | 2085 | 33384 | 1204 | 42938 | 416 | 40171 |
| 8L-3S | | MI | 9388 | 4145 | 16471 | 3122 | 19203 | 2454 | 20960 | 1915 | 23650 | 998 | 28988 | 572 | 25547 |
| 18-#14 | 4.02 | MA | 12732 | 4145 | 21881 | 3292 | 26003 | 2632 | 28194 | 2097 | 30790 | 1212 | 39676 | 331 | 37641 |
| 9L-2S | | MI | 10042 | 4145 | 17406 | 3129 | 20360 | 2461 | 22334 | 1907 | 25459 | 990 | 31318 | 704 | 25702 |
| 18-#18 | 7.14 | MA | 16537 | 5290 | 31704 | 3980 | 38212 | 3137 | 42926 | 2418 | 50363 | 1115 | 66138 | -134 | 64896 |
| 7L-4S | | MI | 10387 | 5290 | 20592 | 3764 | 24045 | 2900 | 26676 | 2125 | 31244 | 790 | 38870 | -208 | 37583 |
| 20-#11 | 3.10 | MA | 14630 | 3807 | 23557 | 3068 | 28301 | 2467 | 31060 | 1981 | 34732 | 1221 | 44015 | 787 | 36269 |
| 6E | | MI | 7850 | 3807 | 13395 | 2926 | 15486 | 2334 | 16576 | 1844 | 17927 | 1066 | 22028 | 556 | 18903 |
| 20-#11 | 3.10 | MA | 14057 | 3807 | 22716 | 3068 | 27187 | 2466 | 29699 | 1990 | 32839 | 1217 | 41765 | 716 | 35015 |
| 7L-5S | | MI | 8166 | 3807 | 13848 | 2930 | 16075 | 2328 | 17274 | 1849 | 18821 | 1061 | 23107 | 619 | 19383 |
| 20-#11 | 3.10 | MA | 13490 | 3807 | 21887 | 3069 | 26095 | 2466 | 28335 | 1988 | 31012 | 1223 | 39440 | 662 | 33729 |
| 8L-4S | | MI | 8496 | 3807 | 14356 | 2924 | 16672 | 2334 | 17982 | 1844 | 19784 | 1066 | 24267 | 662 | 19782 |
| 20-#11 | 3.10 | MA | 12927 | 3807 | 20972 | 3081 | 24971 | 2476 | 26993 | 1997 | 29203 | 1229 | 37146 | 604 | 32439 |
| 9L-3S | | MI | 8856 | 3807 | 14856 | 2928 | 17332 | 2328 | 18762 | 1849 | 20773 | 1061 | 25365 | 747 | 20178 |
| 20-#11 | 3.10 | MA | 12366 | 3807 | 20146 | 3082 | 23886 | 2476 | 25645 | 1995 | 27343 | 1225 | 34773 | 523 | 30898 |
| 10L-2S | | MI | 9339 | 3807 | 15515 | 2932 | 18154 | 2334 | 19739 | 1844 | 22057 | 1056 | 27028 | 838 | 20241 |
| 20-#14 | 4.46 | MA | 15157 | 4309 | 26238 | 3378 | 31536 | 2694 | 34926 | 2135 | 39851 | 1189 | 51398 | 472 | 47551 |
| 7L-5S | | MI | 8833 | 4309 | 15971 | 3225 | 18590 | 2525 | 20238 | 1955 | 22712 | 976 | 28152 | 340 | 26381 |
| 20-#14 | 4.46 | MA | 14381 | 4309 | 25049 | 3379 | 29970 | 2693 | 32970 | 2132 | 37231 | 1197 | 48085 | 396 | 45396 |
| 8L-4S | | MI | 9277 | 4309 | 16695 | 3217 | 19429 | 2533 | 21235 | 1948 | 24067 | 983 | 29777 | 404 | 27140 |
| 20-#14 | 4.46 | MA | 13610 | 4309 | 23737 | 3394 | 28357 | 2707 | 31046 | 2144 | 34637 | 1205 | 44824 | 311 | 42910 |
| 9L-3S | | MI | 9760 | 4309 | 17406 | 3224 | 20360 | 2525 | 22334 | 1955 | 25459 | 976 | 31318 | 523 | 28262 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.40 | MA | 14663 | 3921 | 24012 | 3139 | 28832 | 2518 | 31691 | 2022 | 35527 | 1212 | 45385 | 703 | 38728 |
| 7L-6S | | MI | 8135 | 3921 | 14053 | 2997 | 16308 | 2384 | 17552 | 1873 | 19212 | 1052 | 23691 | 524 | 20729 |
| 22-#11 | 3.40 | MA | 14104 | 3921 | 23184 | 3140 | 27740 | 2518 | 30327 | 2021 | 33700 | 1218 | 43060 | 649 | 37415 |
| 8L-5S | | MI | 8448 | 3921 | 14507 | 3001 | 16897 | 2379 | 18250 | 1878 | 20106 | 1047 | 24770 | 587 | 21256 |
| 22-#11 | 3.40 | MA | 13548 | 3921 | 22269 | 3152 | 26615 | 2528 | 28986 | 2029 | 31891 | 1224 | 40766 | 591 | 36108 |
| 9L-4S | | MI | 8774 | 3921 | 15015 | 2995 | 17494 | 2384 | 18958 | 1873 | 21069 | 1052 | 25930 | 631 | 21634 |
| 22-#11 | 3.40 | MA | 12994 | 3921 | 21443 | 3152 | 25531 | 2527 | 27638 | 2028 | 30031 | 1220 | 38393 | 511 | 34592 |
| 10L-3S | | MI | 9131 | 3921 | 15515 | 2999 | 18154 | 2379 | 19739 | 1878 | 22057 | 1047 | 27028 | 715 | 22102 |
| 22-#11 | 3.40 | MA | 12399 | 3921 | 20624 | 3153 | 24419 | 2537 | 26304 | 2036 | 28230 | 1226 | 36108 | 454 | 32983 |
| 11L-2S | | MI | 9610 | 3921 | 16174 | 3003 | 18977 | 2384 | 20715 | 1873 | 23342 | 1042 | 28690 | 806 | 22178 |
| 22-#14 | 4.91 | MA | 15232 | 4472 | 26905 | 3481 | 32324 | 2768 | 35821 | 2180 | 41078 | 1189 | 53233 | 375 | 50629 |
| 8L-5S | | MI | 9215 | 4472 | 16906 | 3327 | 19747 | 2597 | 21612 | 1996 | 24520 | 954 | 30482 | 291 | 28941 |
| 22-#14 | 4.91 | MA | 14473 | 4472 | 25592 | 3497 | 30710 | 2782 | 33897 | 2191 | 38484 | 1197 | 49972 | 291 | 48186 |
| 9L-4S | | MI | 9652 | 4472 | 17630 | 3319 | 20586 | 2604 | 22609 | 1988 | 25876 | 961 | 32107 | 355 | 29773 |
| 24-#11 | 3.71 | MA | 14709 | 4034 | 24480 | 3211 | 29385 | 2570 | 32320 | 2054 | 36388 | 1213 | 46680 | 637 | 41106 |
| 8L-6S | | MI | 8417 | 4034 | 14712 | 3068 | 17130 | 2434 | 18529 | 1902 | 20496 | 1038 | 25354 | 493 | 22561 |
| 24-#11 | 3.71 | MA | 14160 | 4034 | 23565 | 3222 | 28260 | 2580 | 30978 | 2062 | 34580 | 1219 | 44386 | 578 | 39782 |
| 9L-5S | | MI | 8727 | 4034 | 15166 | 3072 | 17719 | 2429 | 19226 | 1907 | 21391 | 1033 | 26433 | 555 | 23132 |
| 24-#11 | 3.71 | MA | 13608 | 4034 | 22740 | 3223 | 27176 | 2579 | 29630 | 2061 | 32719 | 1214 | 42013 | 498 | 38289 |
| 10L-4S | | MI | 9050 | 4034 | 15674 | 3066 | 18316 | 2434 | 19934 | 1902 | 22354 | 1038 | 27593 | 599 | 23490 |
| 24-#11 | 3.71 | MA | 13021 | 4034 | 21920 | 3224 | 26063 | 2589 | 28297 | 2069 | 30918 | 1220 | 39728 | 442 | 36667 |
| 11L-3S | | MI | 9404 | 4034 | 16174 | 3070 | 18977 | 2429 | 20715 | 1907 | 23342 | 1033 | 28690 | 683 | 24024 |
| 24-#14 | 5.36 | MA | 15323 | 4636 | 27448 | 3599 | 33064 | 2856 | 36749 | 2239 | 42331 | 1190 | 55120 | 271 | 53468 |
| 9L-5S | | MI | 9592 | 4636 | 17842 | 3429 | 20904 | 2668 | 22987 | 2036 | 26329 | 932 | 32812 | 242 | 31511 |

## RECTANGULAR TIED COLUMNS 24" x 44"

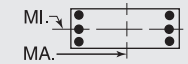
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.52 | MA | 15740 | 3382 | 23134 | 2802 | 27541 | 2272 | 29780 | 1873 | 32214 | 1281 | 39486 | 1188 | 20915 |
| 2E | | MI | 8162 | 3382 | 12705 | 2641 | 14358 | 2124 | 15067 | 1729 | 15678 | 1136 | 18547 | 985 | 10529 |
| 6-#14 | 1.28 | MA | 15309 | 3291 | 22001 | 2762 | 26245 | 2245 | 28272 | 1858 | 30260 | 1296 | 37061 | 1219 | 17898 |
| 2L-3S | | MI | 7287 | 3291 | 11284 | 2614 | 12735 | 2111 | 13189 | 1746 | 13236 | 1185 | 15504 | 922 | 9156 |
| 6-#14 | 1.28 | MA | 13780 | 3291 | 20043 | 2764 | 23762 | 2244 | 25263 | 1871 | 26201 | 1305 | 31598 | 1088 | 17806 |
| 3L-2S | | MI | 8013 | 3291 | 12220 | 2621 | 13892 | 2118 | 14563 | 1738 | 15045 | 1177 | 17833 | 1054 | 9116 |
| 6-#18 | 2.27 | MA | 17321 | 3673 | 26564 | 2984 | 31891 | 2405 | 35049 | 1957 | 39304 | 1267 | 48939 | 1149 | 31054 |
| 2L-3S | | MI | 7629 | 3673 | 12705 | 2807 | 14358 | 2234 | 15067 | 1810 | 15678 | 1104 | 18547 | 651 | 15250 |
| 6-#18 | 2.27 | MA | 14749 | 3673 | 23134 | 2985 | 27541 | 2402 | 29780 | 1977 | 32214 | 1280 | 39486 | 915 | 30484 |
| 3L-2S | | MI | 8841 | 3673 | 14293 | 2820 | 16314 | 2247 | 17391 | 1796 | 18737 | 1091 | 22448 | 884 | 15358 |
| 8-#11 | 1.18 | MA | 15130 | 3254 | 21522 | 2748 | 25710 | 2235 | 27654 | 1853 | 29447 | 1303 | 36073 | 1233 | 16656 |
| 2L-4S | | MI | 7054 | 3254 | 10828 | 2605 | 12213 | 2118 | 12599 | 1744 | 12513 | 1206 | 14784 | 908 | 8567 |
| 8-#11 | 1.18 | MA | 14057 | 3254 | 20155 | 2749 | 23975 | 2235 | 25552 | 1862 | 26613 | 1309 | 32234 | 1142 | 16618 |
| 3E | | MI | 7439 | 3254 | 11328 | 2609 | 12873 | 2113 | 13379 | 1749 | 13502 | 1201 | 15882 | 992 | 8557 |
| 8-#11 | 1.18 | MA | 13281 | 3254 | 19141 | 2750 | 22604 | 2245 | 23890 | 1861 | 24369 | 1305 | 29700 | 1051 | 16455 |
| 4L-2S | | MI | 7951 | 3254 | 11987 | 2613 | 13695 | 2118 | 14356 | 1744 | 14787 | 1196 | 17545 | 1083 | 8526 |
| 8-#14 | 1.70 | MA | 16242 | 3455 | 23959 | 2865 | 28729 | 2319 | 31280 | 1906 | 34319 | 1289 | 42524 | 1201 | 23698 |
| 2L-4S | | MI | 7169 | 3455 | 11508 | 2709 | 12962 | 2190 | 13464 | 1779 | 13653 | 1171 | 16293 | 754 | 11709 |
| 8-#14 | 1.70 | MA | 14740 | 3455 | 22001 | 2866 | 26245 | 2319 | 28272 | 1918 | 30260 | 1298 | 37061 | 1070 | 23548 |
| 3E | | MI | 7706 | 3455 | 12220 | 2716 | 13892 | 2183 | 14563 | 1786 | 15045 | 1163 | 17833 | 873 | 11933 |
| 8-#14 | 1.70 | MA | 13655 | 3455 | 20547 | 2867 | 24280 | 2333 | 25889 | 1915 | 27044 | 1291 | 33459 | 938 | 23019 |
| 4L-2S | | MI | 8422 | 3455 | 13155 | 2723 | 15049 | 2190 | 15938 | 1779 | 16853 | 1156 | 20163 | 1005 | 11928 |
| 8-#18 | 3.03 | MA | 18844 | 3964 | 29993 | 3166 | 36240 | 2538 | 40319 | 2041 | 46394 | 1253 | 58392 | 1110 | 41160 |
| 2L-4S | | MI | 7441 | 3964 | 13084 | 2973 | 14740 | 2370 | 15531 | 1863 | 16384 | 1072 | 19857 | 348 | 17931 |
| 8-#18 | 3.03 | MA | 16340 | 3964 | 26564 | 3166 | 31891 | 2535 | 35049 | 2061 | 39304 | 1266 | 48939 | 876 | 40450 |
| 3E | | MI | 8333 | 3964 | 14293 | 2986 | 16314 | 2357 | 17391 | 1876 | 18737 | 1059 | 22448 | 550 | 19917 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

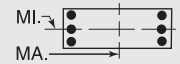



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.03 | MA | 14529 | 3964 | 24010 | 3167 | 28439 | 2559 | 30866 | 2054 | 33678 | 1253 | 42721 | 643 | 36213 |
| 4L-2S | | MI | 9504 | 3964 | 15882 | 2999 | 18270 | 2370 | 19714 | 1863 | 21796 | 1045 | 26348 | 784 | 20130 |
| 10-#11 | 1.48 | MA | 15792 | 3368 | 22890 | 2818 | 27444 | 2287 | 29755 | 1886 | 32282 | 1297 | 39911 | 1221 | 20710 |
| 2L-5S | | MI | 7009 | 3368 | 10979 | 2682 | 12438 | 2163 | 12867 | 1778 | 12836 | 1187 | 15288 | 832 | 10181 |
| 10-#11 | 1.48 | MA | 14733 | 3368 | 21522 | 2820 | 25710 | 2286 | 27654 | 1895 | 29447 | 1304 | 36073 | 1130 | 20645 |
| 3L-4S | | MI | 7357 | 3368 | 11487 | 2676 | 13035 | 2169 | 13575 | 1773 | 13798 | 1192 | 16447 | 876 | 10509 |
| 10-#11 | 1.48 | MA | 13969 | 3368 | 20508 | 2821 | 24338 | 2297 | 25992 | 1894 | 27204 | 1300 | 33539 | 1039 | 20448 |
| 4L-3S | | MI | 7737 | 3368 | 11987 | 2680 | 13695 | 2163 | 14356 | 1778 | 14787 | 1187 | 17545 | 960 | 10525 |
| 10-#11 | 1.48 | MA | 13277 | 3368 | 19483 | 2832 | 23108 | 2297 | 24489 | 1903 | 25159 | 1307 | 30904 | 992 | 19599 |
| 5L-2S | | MI | 8245 | 3368 | 12646 | 2684 | 14517 | 2169 | 15332 | 1773 | 16072 | 1182 | 19208 | 1051 | 10508 |
| 10-#14 | 2.13 | MA | 17151 | 3618 | 25917 | 2967 | 31212 | 2394 | 34289 | 1953 | 38378 | 1281 | 47987 | 1182 | 29483 |
| 2L-5S | | MI | 7102 | 3618 | 11720 | 2819 | 13279 | 2254 | 13842 | 1827 | 14106 | 1141 | 16997 | 641 | 13614 |
| 10-#14 | 2.13 | MA | 15675 | 3618 | 23959 | 2968 | 28729 | 2394 | 31280 | 1965 | 34319 | 1290 | 42524 | 1051 | 29283 |
| 3L-4S | | MI | 7587 | 3618 | 12444 | 2811 | 14119 | 2262 | 14838 | 1819 | 15462 | 1149 | 18622 | 705 | 14257 |
| 10-#14 | 2.13 | MA | 14610 | 3618 | 22505 | 2969 | 26763 | 2408 | 28898 | 1963 | 31103 | 1284 | 38923 | 920 | 28516 |
| 4L-3S | | MI | 8117 | 3618 | 13155 | 2818 | 15049 | 2254 | 15938 | 1827 | 16853 | 1141 | 20163 | 824 | 14688 |
| 10-#14 | 2.13 | MA | 13646 | 3618 | 21035 | 2986 | 24998 | 2407 | 26743 | 1975 | 28170 | 1292 | 35165 | 853 | 26607 |
| 5L-2S | | MI | 8823 | 3618 | 14091 | 2825 | 16206 | 2262 | 17312 | 1819 | 18662 | 1134 | 22492 | 955 | 14719 |
| 10-#18 | 3.79 | MA | 17879 | 4254 | 29993 | 3348 | 36240 | 2668 | 40319 | 2145 | 46394 | 1251 | 58392 | 837 | 50421 |
| 3L-4S | | MI | 8127 | 4254 | 14672 | 3152 | 16696 | 2493 | 17855 | 1930 | 19443 | 1027 | 23757 | 247 | 22350 |
| 10-#18 | 3.79 | MA | 16117 | 4254 | 27440 | 3349 | 32788 | 2692 | 36136 | 2138 | 40768 | 1238 | 52174 | 604 | 45917 |
| 4L-3S | | MI | 8994 | 4254 | 15882 | 3165 | 18270 | 2480 | 19714 | 1943 | 21796 | 1013 | 26348 | 450 | 24331 |
| 10-#18 | 3.79 | MA | 14522 | 4254 | 24855 | 3376 | 29686 | 2689 | 32350 | 2158 | 35633 | 1251 | 45647 | 488 | 42008 |
| 5L-2S | | MI | 10134 | 4254 | 17470 | 3178 | 20225 | 2493 | 22038 | 1930 | 24855 | 1000 | 30248 | 684 | 24870 |
| 12-#11 | 1.77 | MA | 16441 | 3481 | 24258 | 2889 | 29178 | 2338 | 31856 | 1919 | 35117 | 1292 | 43750 | 1210 | 24756 |
| 2L-6S | | MI | 6980 | 3481 | 11184 | 2748 | 12670 | 2219 | 13146 | 1802 | 13226 | 1178 | 15871 | 738 | 11755 |
| 12-#11 | 1.77 | MA | 15396 | 3481 | 22890 | 2891 | 27444 | 2338 | 29755 | 1928 | 32282 | 1299 | 39911 | 1118 | 24666 |
| 3L-5S | | MI | 7311 | 3481 | 11638 | 2753 | 13260 | 2214 | 13844 | 1807 | 14120 | 1173 | 16951 | 800 | 12025 |
| 12-#11 | 1.77 | MA | 14642 | 3481 | 21876 | 2892 | 26073 | 2349 | 28093 | 1927 | 30039 | 1295 | 37378 | 1027 | 24441 |
| 4E | | MI | 7655 | 3481 | 12146 | 2746 | 13857 | 2219 | 14551 | 1802 | 15083 | 1178 | 18110 | 844 | 12441 |
| 12-#11 | 1.77 | MA | 13960 | 3481 | 20850 | 2903 | 24842 | 2349 | 26591 | 1936 | 27994 | 1302 | 34742 | 981 | 23497 |
| 5L-3S | | MI | 8031 | 3481 | 12646 | 2751 | 14517 | 2214 | 15332 | 1807 | 16072 | 1173 | 19208 | 928 | 12480 |
| 12-#11 | 1.77 | MA | 13306 | 3481 | 19940 | 2905 | 23628 | 2359 | 25112 | 1935 | 26027 | 1308 | 32062 | 906 | 22645 |
| 6L-2S | | MI | 8534 | 3481 | 13305 | 2755 | 15339 | 2219 | 16308 | 1802 | 17357 | 1168 | 20871 | 1019 | 12479 |
| 12-#14 | 2.56 | MA | 16589 | 3782 | 25917 | 3070 | 31212 | 2468 | 34289 | 2013 | 38378 | 1283 | 47987 | 1032 | 35014 |
| 3L-5S | | MI | 7519 | 3782 | 12655 | 2921 | 14436 | 2326 | 15216 | 1867 | 15915 | 1119 | 19327 | 592 | 16236 |
| 12-#14 | 2.56 | MA | 15543 | 3782 | 24463 | 3072 | 29246 | 2483 | 31906 | 2010 | 35162 | 1276 | 44386 | 901 | 34037 |
| 4E | | MI | 7997 | 3782 | 13379 | 2913 | 15276 | 2333 | 16213 | 1860 | 17270 | 1127 | 20952 | 656 | 16829 |
| 12-#14 | 2.56 | MA | 14596 | 3782 | 22993 | 3088 | 27481 | 2482 | 29752 | 2023 | 32229 | 1285 | 40628 | 834 | 32210 |
| 5L-3S | | MI | 8520 | 3782 | 14091 | 2920 | 16206 | 2326 | 17312 | 1867 | 18662 | 1119 | 22492 | 775 | 17429 |
| 12-#14 | 2.56 | MA | 13689 | 3782 | 21687 | 3089 | 25740 | 2496 | 27632 | 2020 | 29409 | 1294 | 36814 | 726 | 30369 |
| 6L-2S | | MI | 9217 | 3782 | 15027 | 2927 | 17363 | 2333 | 18686 | 1860 | 20470 | 1112 | 24822 | 906 | 17492 |
| 12-#18 | 4.55 | MA | 17659 | 4545 | 30869 | 3530 | 37138 | 2825 | 41406 | 2223 | 47858 | 1224 | 61627 | 564 | 55656 |
| 4E | | MI | 8793 | 4545 | 16261 | 3331 | 18652 | 2616 | 20178 | 1997 | 22502 | 982 | 27657 | 147 | 26803 |
| 12-#18 | 4.55 | MA | 16105 | 4545 | 28284 | 3558 | 34036 | 2822 | 37620 | 2242 | 42723 | 1237 | 55100 | 449 | 51633 |
| 5L-3S | | MI | 9637 | 4545 | 17470 | 3344 | 20225 | 2603 | 22038 | 2010 | 24855 | 968 | 30248 | 350 | 28611 |
| 12-#18 | 4.55 | MA | 14613 | 4545 | 25987 | 3558 | 30974 | 2845 | 33892 | 2235 | 37785 | 1250 | 48501 | 256 | 47343 |
| 6L-2S | | MI | 10750 | 4545 | 19058 | 3357 | 22181 | 2616 | 24361 | 1997 | 27914 | 955 | 34149 | 583 | 29589 |
| 14-#11 | 2.07 | MA | 16046 | 3594 | 24258 | 2961 | 29178 | 2390 | 31856 | 1961 | 35117 | 1294 | 43750 | 1107 | 28684 |
| 3L-6S | | MI | 7280 | 3594 | 11843 | 2819 | 13492 | 2269 | 14122 | 1831 | 14511 | 1164 | 17534 | 706 | 13618 |
| 14-#11 | 2.07 | MA | 15303 | 3594 | 23243 | 2963 | 27807 | 2401 | 30194 | 1960 | 32874 | 1290 | 41217 | 1016 | 28433 |
| 4L-5S | | MI | 7608 | 3594 | 12297 | 2823 | 14082 | 2264 | 14820 | 1836 | 15405 | 1159 | 18613 | 769 | 13879 |
| 14-#11 | 2.07 | MA | 14630 | 3594 | 22218 | 2974 | 26577 | 2401 | 28692 | 1969 | 30829 | 1296 | 38581 | 969 | 27405 |
| 5L-4S | | MI | 7948 | 3594 | 12805 | 2817 | 14679 | 2269 | 15528 | 1831 | 16368 | 1164 | 19773 | 813 | 14367 |
| 14-#11 | 2.07 | MA | 13986 | 3594 | 21307 | 2975 | 25362 | 2411 | 27214 | 1967 | 28862 | 1303 | 35901 | 894 | 26583 |
| 6L-3S | | MI | 8321 | 3594 | 13305 | 2822 | 15339 | 2264 | 16308 | 1836 | 17357 | 1159 | 20871 | 897 | 14424 |
| 14-#11 | 2.07 | MA | 13355 | 3594 | 20421 | 2977 | 24189 | 2411 | 25781 | 1977 | 26869 | 1299 | 33513 | 823 | 25357 |
| 7L-2S | | MI | 8818 | 3594 | 13963 | 2826 | 16161 | 2269 | 17285 | 1831 | 18641 | 1154 | 22534 | 988 | 14441 |

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

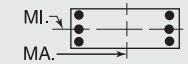
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.98 | MA | 16455 | 3945 | 26421 | 3174 | 31729 | 2558 | 34915 | 2058 | 39221 | 1269 | 49849 | 883 | 39578 |
| 4L-5S | | MI | 7929 | 3945 | 13591 | 3024 | 15593 | 2397 | 16591 | 1908 | 17723 | 1098 | 21656 | 543 | 18868 |
| 14-#14 | 2.98 | MA | 15525 | 3945 | 24951 | 3190 | 29965 | 2557 | 32760 | 2070 | 36288 | 1277 | 46091 | 816 | 37825 |
| 5L-4S | | MI | 8401 | 3945 | 14315 | 3016 | 16432 | 2405 | 17587 | 1900 | 19079 | 1105 | 23281 | 606 | 19419 |
| 14-#14 | 2.98 | MA | 14634 | 3945 | 23645 | 3191 | 28223 | 2571 | 30640 | 2068 | 33468 | 1286 | 42277 | 708 | 35918 |
| 6L-3S | | MI | 8917 | 3945 | 15027 | 3023 | 17363 | 2397 | 18686 | 1908 | 20470 | 1098 | 24822 | 725 | 20162 |
| 14-#14 | 2.98 | MA | 13761 | 3945 | 22373 | 3193 | 26540 | 2571 | 28584 | 2080 | 30609 | 1280 | 38882 | 605 | 34015 |
| 7L-2S | | MI | 9606 | 3945 | 15963 | 3030 | 18519 | 2405 | 20060 | 1900 | 22279 | 1090 | 27152 | 857 | 20252 |
| 14-#18 | 5.30 | MA | 17646 | 4836 | 31714 | 3739 | 38386 | 2955 | 42889 | 2326 | 49813 | 1223 | 64553 | 410 | 61286 |
| 5L-4S | | MI | 9442 | 4836 | 17849 | 3510 | 20608 | 2739 | 22502 | 2064 | 25561 | 936 | 31558 | 46 | 31282 |
| 14-#18 | 5.30 | MA | 16191 | 4836 | 29417 | 3740 | 35323 | 2978 | 39162 | 2320 | 44875 | 1236 | 57954 | 217 | 56736 |
| 6L-3S | | MI | 10265 | 4836 | 19058 | 3523 | 22181 | 2726 | 24361 | 2077 | 27914 | 923 | 34149 | 249 | 32938 |
| 14-#18 | 5.30 | MA | 14765 | 4836 | 27180 | 3741 | 32364 | 2975 | 35547 | 2339 | 39869 | 1223 | 52090 | 35 | 51956 |
| 7L-2S | | MI | 11354 | 4836 | 20646 | 3536 | 24137 | 2739 | 26685 | 2064 | 30973 | 910 | 38049 | 483 | 34294 |
| 16-#11 | 2.36 | MA | 15952 | 3708 | 24611 | 3034 | 29542 | 2452 | 32296 | 1993 | 35709 | 1285 | 45055 | 1004 | 32426 |
| 4L-6S | | MI | 7577 | 3708 | 12502 | 2890 | 14315 | 2320 | 15098 | 1860 | 15796 | 1150 | 19197 | 674 | 15418 |
| 16-#11 | 2.36 | MA | 15289 | 3708 | 23585 | 3045 | 28311 | 2452 | 30793 | 2002 | 33664 | 1291 | 42420 | 957 | 31322 |
| 5E | | MI | 7901 | 3708 | 12956 | 2894 | 14904 | 2315 | 15796 | 1865 | 16690 | 1145 | 20276 | 737 | 15739 |
| 16-#11 | 2.36 | MA | 14654 | 3708 | 22675 | 3046 | 27097 | 2463 | 29315 | 2000 | 31697 | 1298 | 39739 | 882 | 30526 |
| 6L-4S | | MI | 8238 | 3708 | 13464 | 2888 | 15501 | 2320 | 16504 | 1860 | 17653 | 1150 | 21436 | 781 | 16204 |
| 16-#11 | 2.36 | MA | 14031 | 3708 | 21789 | 3048 | 25924 | 2463 | 27882 | 2009 | 29704 | 1294 | 37352 | 811 | 29259 |
| 7L-3S | | MI | 8607 | 3708 | 13963 | 2892 | 16161 | 2315 | 17285 | 1865 | 18641 | 1145 | 22534 | 865 | 16363 |
| 16-#11 | 2.36 | MA | 13416 | 3708 | 20917 | 3049 | 24775 | 2463 | 26446 | 2008 | 27781 | 1301 | 34891 | 757 | 28083 |
| 8L-2S | | MI | 9100 | 3708 | 14622 | 2897 | 16983 | 2320 | 18261 | 1860 | 19926 | 1140 | 24197 | 956 | 16393 |
| 16-#14 | 3.41 | MA | 16436 | 4109 | 26909 | 3292 | 32448 | 2632 | 35769 | 2117 | 40347 | 1270 | 51554 | 797 | 43450 |
| 5E | | MI | 8332 | 4109 | 14527 | 3126 | 16750 | 2469 | 17965 | 1948 | 19532 | 1076 | 23986 | 494 | 21501 |
| 16-#14 | 3.41 | MA | 15560 | 4109 | 25603 | 3294 | 30706 | 2646 | 33649 | 2115 | 37527 | 1279 | 47740 | 689 | 41479 |
| 6L-4S | | MI | 8798 | 4109 | 15251 | 3118 | 17589 | 2476 | 18961 | 1941 | 20887 | 1083 | 25611 | 557 | 22023 |
| 16-#14 | 3.41 | MA | 14702 | 4109 | 24331 | 3295 | 29023 | 2645 | 31593 | 2127 | 34668 | 1272 | 44345 | 587 | 39540 |
| 7L-3S | | MI | 9308 | 4109 | 15963 | 3125 | 18519 | 2469 | 20060 | 1948 | 22279 | 1076 | 27152 | 676 | 22888 |
| 16-#14 | 3.41 | MA | 13853 | 4109 | 23080 | 3296 | 27375 | 2645 | 29533 | 2125 | 31909 | 1281 | 40836 | 510 | 37099 |
| 8L-2S | | MI | 9989 | 4109 | 16898 | 3132 | 19676 | 2476 | 21434 | 1941 | 24088 | 1068 | 29481 | 808 | 23005 |
| 16-#18 | 6.06 | MA | 17732 | 5127 | 32847 | 3922 | 39673 | 3111 | 44431 | 2404 | 51965 | 1222 | 67407 | 178 | 66368 |
| 6L-4S | | MI | 10078 | 5127 | 19437 | 3689 | 22564 | 2862 | 24826 | 2131 | 28620 | 891 | 35458 | -54 | 35121 |
| 16-#18 | 6.06 | MA | 16339 | 5127 | 30610 | 3922 | 36714 | 3108 | 40817 | 2424 | 46959 | 1209 | 61543 | -4 | 61506 |
| 7L-3S | | MI | 10882 | 5127 | 20646 | 3702 | 24137 | 2849 | 26685 | 2144 | 30973 | 878 | 38049 | 149 | 37303 |
| 18-#11 | 2.66 | MA | 15937 | 3821 | 24953 | 3116 | 30045 | 2504 | 32895 | 2034 | 36499 | 1286 | 46259 | 946 | 35247 |
| 5L-6S | | MI | 7869 | 3821 | 13161 | 2961 | 15137 | 2370 | 16075 | 1889 | 17080 | 1137 | 20860 | 643 | 17227 |
| 18-#11 | 2.66 | MA | 15310 | 3821 | 24043 | 3117 | 28831 | 2515 | 31416 | 2033 | 34532 | 1293 | 43578 | 871 | 34474 |
| 6L-5S | | MI | 8190 | 3821 | 13614 | 2965 | 15726 | 2365 | 16772 | 1894 | 17975 | 1131 | 21939 | 705 | 17605 |
| 18-#11 | 2.66 | MA | 14696 | 3821 | 23157 | 3118 | 27658 | 2515 | 29983 | 2042 | 32539 | 1289 | 41191 | 800 | 33167 |
| 7L-4S | | MI | 8524 | 3821 | 14123 | 2959 | 16323 | 2370 | 17480 | 1889 | 18938 | 1137 | 23099 | 749 | 18041 |
| 18-#11 | 2.66 | MA | 14089 | 3821 | 22285 | 3120 | 26509 | 2514 | 28548 | 2041 | 30616 | 1296 | 38729 | 746 | 31964 |
| 8L-3S | | MI | 8889 | 3821 | 14622 | 2963 | 16983 | 2365 | 18261 | 1894 | 19926 | 1131 | 24197 | 833 | 18296 |
| 18-#11 | 2.66 | MA | 13486 | 3821 | 21321 | 3131 | 25325 | 2525 | 27135 | 2050 | 28711 | 1302 | 36295 | 687 | 30539 |
| 9L-2S | | MI | 9378 | 3821 | 15281 | 2967 | 17806 | 2370 | 19237 | 1889 | 21211 | 1126 | 25860 | 924 | 18340 |
| 18-#14 | 3.84 | MA | 16468 | 4273 | 27561 | 3396 | 33189 | 2721 | 36657 | 2162 | 41586 | 1271 | 53203 | 671 | 47050 |
| 6L-5S | | MI | 8756 | 4273 | 15463 | 3228 | 17907 | 2540 | 19339 | 1988 | 21340 | 1054 | 26316 | 444 | 24031 |
| 18-#14 | 3.84 | MA | 15624 | 4273 | 26289 | 3397 | 31507 | 2720 | 34601 | 2175 | 38727 | 1265 | 49808 | 568 | 45075 |
| 7L-4S | | MI | 9211 | 4273 | 16187 | 3220 | 18746 | 2548 | 20335 | 1981 | 22696 | 1062 | 27941 | 508 | 24638 |
| 18-#14 | 3.84 | MA | 14790 | 4273 | 25038 | 3398 | 29858 | 2720 | 32542 | 2172 | 35968 | 1274 | 46299 | 491 | 42686 |
| 8L-3S | | MI | 9705 | 4273 | 16898 | 3227 | 19676 | 2540 | 21434 | 1988 | 24088 | 1054 | 29481 | 627 | 25609 |
| 18-#14 | 3.84 | MA | 13960 | 4273 | 23656 | 3415 | 28159 | 2734 | 30515 | 2185 | 33236 | 1282 | 42836 | 407 | 40078 |
| 9L-2S | | MI | 10363 | 4273 | 17834 | 3234 | 20833 | 2548 | 22808 | 1981 | 25896 | 1047 | 31811 | 758 | 25751 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

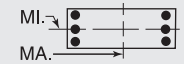
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 6.82 | MA | 18023 | 5418 | 34040 | 4104 | 41064 | 3241 | 46086 | 2508 | 54049 | 1194 | 70996 | -44 | 70565 |
| 7L-4S | | MI | 10703 | 5418 | 21026 | 3868 | 24520 | 2985 | 27149 | 2198 | 31679 | 846 | 39358 | -154 | 38392 |
| 20-#11 | 2.95 | MA | 15956 | 3935 | 25410 | 3188 | 30566 | 2566 | 33518 | 2066 | 37367 | 1288 | 47417 | 859 | 38426 |
| 6E | | MI | 8158 | 3935 | 13820 | 3032 | 15959 | 2421 | 17051 | 1918 | 18365 | 1123 | 22523 | 611 | 19045 |
| 20-#11 | 2.95 | MA | 15350 | 3935 | 24524 | 3189 | 29393 | 2566 | 32085 | 2075 | 35374 | 1284 | 45030 | 788 | 37081 |
| 7L-5S | | MI | 8476 | 3935 | 14273 | 3036 | 16548 | 2415 | 17749 | 1923 | 19260 | 1118 | 23602 | 674 | 19474 |
| 20-#11 | 2.95 | MA | 14751 | 3935 | 23652 | 3191 | 28244 | 2566 | 30649 | 2074 | 33451 | 1290 | 42568 | 734 | 35808 |
| 8L-4S | | MI | 8807 | 3935 | 14781 | 3030 | 17145 | 2421 | 18457 | 1918 | 20222 | 1123 | 24762 | 717 | 19885 |
| 20-#11 | 2.95 | MA | 14156 | 3935 | 22689 | 3202 | 27059 | 2577 | 29236 | 2083 | 31546 | 1297 | 40133 | 676 | 34454 |
| 9L-3S | | MI | 9168 | 3935 | 15281 | 3034 | 17806 | 2415 | 19237 | 1923 | 21211 | 1118 | 25860 | 802 | 20225 |
| 20-#11 | 2.95 | MA | 13559 | 3935 | 21820 | 3203 | 25918 | 2577 | 27817 | 2082 | 29588 | 1293 | 37617 | 596 | 32844 |
| 10L-2S | | MI | 9653 | 3935 | 15940 | 3038 | 18628 | 2421 | 20214 | 1918 | 22496 | 1112 | 27523 | 893 | 20282 |
| 20-#14 | 4.26 | MA | 16531 | 4436 | 28247 | 3499 | 33990 | 2795 | 37610 | 2222 | 42785 | 1257 | 55272 | 550 | 50541 |
| 7L-5S | | MI | 9146 | 4436 | 16398 | 3330 | 19064 | 2612 | 20713 | 2029 | 23149 | 1032 | 28645 | 395 | 26576 |
| 20-#14 | 4.26 | MA | 15710 | 4436 | 26996 | 3501 | 32341 | 2795 | 35550 | 2220 | 40027 | 1266 | 51762 | 473 | 48280 |
| 8L-4S | | MI | 9593 | 4436 | 17122 | 3322 | 19903 | 2619 | 21709 | 2021 | 24505 | 1040 | 30270 | 459 | 27263 |
| 20-#14 | 4.26 | MA | 14893 | 4436 | 25614 | 3517 | 30642 | 2809 | 33524 | 2232 | 37295 | 1275 | 48299 | 388 | 45648 |
| 9L-3S | | MI | 10079 | 4436 | 17834 | 3329 | 20833 | 2612 | 22808 | 2029 | 25896 | 1032 | 31811 | 578 | 28326 |
| 22-#11 | 3.25 | MA | 15995 | 4048 | 25892 | 3260 | 31127 | 2618 | 34186 | 2108 | 38209 | 1279 | 48868 | 776 | 41000 |
| 7L-6S | | MI | 8444 | 4048 | 14478 | 3103 | 16781 | 2471 | 18027 | 1947 | 19650 | 1109 | 24186 | 579 | 20869 |
| 22-#11 | 3.25 | MA | 15404 | 4048 | 25020 | 3261 | 29978 | 2618 | 32750 | 2107 | 36286 | 1285 | 46407 | 722 | 39702 |
| 8L-5S | | MI | 8759 | 4048 | 14932 | 3107 | 17370 | 2466 | 18725 | 1952 | 20545 | 1104 | 25265 | 642 | 21347 |
| 22-#11 | 3.25 | MA | 14816 | 4048 | 24057 | 3273 | 28794 | 2629 | 31338 | 2116 | 34381 | 1292 | 43972 | 664 | 38372 |
| 9L-4S | | MI | 9086 | 4048 | 15440 | 3101 | 17967 | 2471 | 19433 | 1947 | 21507 | 1109 | 26425 | 686 | 21736 |
| 22-#11 | 3.25 | MA | 14222 | 4048 | 23188 | 3274 | 27653 | 2629 | 29919 | 2114 | 32423 | 1288 | 41455 | 584 | 36746 |
| 10L-3S | | MI | 9445 | 4048 | 15940 | 3105 | 18628 | 2466 | 20214 | 1952 | 22496 | 1104 | 27523 | 770 | 22152 |
| 22-#11 | 3.25 | MA | 13593 | 4048 | 22325 | 3275 | 26482 | 2639 | 28515 | 2124 | 30527 | 1295 | 39036 | 527 | 35112 |
| 11L-2S | | MI | 9926 | 4048 | 16599 | 3109 | 19450 | 2471 | 21190 | 1947 | 23781 | 1098 | 29186 | 861 | 22220 |
| 22-#14 | 4.69 | MA | 16614 | 4600 | 28954 | 3603 | 34825 | 2869 | 38559 | 2267 | 44086 | 1259 | 57225 | 454 | 53881 |
| 8L-5S | | MI | 9529 | 4600 | 17334 | 3432 | 20221 | 2683 | 22087 | 2069 | 24958 | 1011 | 30975 | 346 | 29133 |
| 22-#14 | 4.69 | MA | 15811 | 4600 | 27572 | 3619 | 33126 | 2884 | 36532 | 2279 | 41354 | 1267 | 53762 | 370 | 51224 |
| 9L-4S | | MI | 9969 | 4600 | 18058 | 3425 | 21060 | 2691 | 23083 | 2062 | 26313 | 1018 | 32600 | 409 | 29896 |
| 24-#11 | 3.55 | MA | 16047 | 4161 | 26387 | 3332 | 31713 | 2670 | 34851 | 2140 | 39121 | 1280 | 50246 | 711 | 43600 |
| 8L-6S | | MI | 8727 | 4161 | 15137 | 3174 | 17603 | 2521 | 19004 | 1976 | 20935 | 1095 | 25849 | 548 | 22700 |
| 24-#11 | 3.55 | MA | 15467 | 4161 | 25424 | 3344 | 30528 | 2680 | 33439 | 2149 | 37216 | 1287 | 47811 | 652 | 42283 |
| 9L-5S | | MI | 9039 | 4161 | 15591 | 3178 | 18193 | 2516 | 19701 | 1981 | 21830 | 1090 | 26928 | 610 | 23223 |
| 24-#11 | 3.55 | MA | 14875 | 4161 | 24555 | 3345 | 29387 | 2680 | 32020 | 2147 | 35258 | 1283 | 45294 | 572 | 40652 |
| 10L-4S | | MI | 9363 | 4161 | 16099 | 3172 | 18789 | 2521 | 20409 | 1976 | 22792 | 1095 | 28088 | 654 | 23592 |
| 24-#11 | 3.55 | MA | 14253 | 4161 | 23693 | 3346 | 28216 | 2691 | 30616 | 2156 | 33362 | 1289 | 42875 | 515 | 39005 |
| 11L-3S | | MI | 9719 | 4161 | 16599 | 3176 | 19450 | 2516 | 21190 | 1981 | 23781 | 1090 | 29186 | 738 | 24075 |
| 24-#14 | 5.11 | MA | 16713 | 4763 | 29530 | 3721 | 35609 | 2958 | 39541 | 2327 | 45413 | 1260 | 59226 | 351 | 56807 |
| 9L-5S | | MI | 9908 | 4763 | 18270 | 3535 | 21378 | 2755 | 23461 | 2110 | 26766 | 989 | 33304 | 297 | 31700 |

## RECTANGULAR TIED COLUMNS 24" x 46"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.45 | MA | 17095 | 3509 | 24933 | 2922 | 29730 | 2371 | 32130 | 1956 | 34709 | 1347 | 42568 | 1256 | 21995 |
| 2E | | MI | 8470 | 3509 | 13138 | 2745 | 14832 | 2210 | 15541 | 1802 | 16113 | 1192 | 19036 | 1039 | 10565 |
| 6-#14 | 1.22 | MA | 16633 | 3419 | 23735 | 2882 | 28359 | 2343 | 30534 | 1942 | 32600 | 1360 | 39974 | 1286 | 18810 |
| 2L-3S | | MI | 7594 | 3419 | 11712 | 2719 | 13209 | 2198 | 13664 | 1819 | 13673 | 1241 | 15996 | 977 | 9189 |
| 6-#14 | 1.22 | MA | 15019 | 3419 | 21675 | 2883 | 25746 | 2343 | 27369 | 1955 | 28329 | 1370 | 34195 | 1155 | 18718 |
| 3L-2S | | MI | 8321 | 3419 | 12647 | 2726 | 14366 | 2205 | 15038 | 1812 | 15482 | 1234 | 18326 | 1108 | 9145 |
| 6-#18 | 2.17 | MA | 18775 | 3800 | 28545 | 3103 | 34310 | 2504 | 37679 | 2040 | 42196 | 1334 | 52582 | 1220 | 32674 |
| 2L-3S | | MI | 7935 | 3800 | 13138 | 2911 | 14832 | 2319 | 15541 | 1882 | 16113 | 1160 | 19036 | 705 | 15317 |
| 6-#18 | 2.17 | MA | 16056 | 3800 | 24933 | 3105 | 29730 | 2501 | 32130 | 2061 | 34709 | 1348 | 42568 | 986 | 32104 |
| 3L-2S | | MI | 9152 | 3800 | 14726 | 2924 | 16788 | 2333 | 17864 | 1869 | 19172 | 1146 | 22936 | 938 | 15401 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

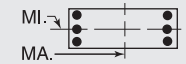
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.13 | MA | 16442 | 3381 | 23229 | 2867 | 27792 | 2333 | 29881 | 1937 | 31741 | 1367 | 38916 | 1299 | 17499 |
| 2L-4S | | MI | 7360 | 3381 | 11254 | 2711 | 12686 | 2205 | 13074 | 1818 | 12952 | 1263 | 15280 | 963 | 8602 |
| 8-#11 | 1.13 | MA | 15310 | 3381 | 21791 | 2868 | 25968 | 2333 | 27670 | 1946 | 28759 | 1374 | 34858 | 1208 | 17460 |
| 3E | | MI | 7745 | 3381 | 11753 | 2715 | 13346 | 2200 | 13854 | 1823 | 13941 | 1258 | 16377 | 1047 | 8585 |
| 8-#11 | 1.13 | MA | 14492 | 3381 | 20725 | 2870 | 24527 | 2344 | 25924 | 1945 | 26402 | 1371 | 32178 | 1116 | 17297 |
| 4L-2S | | MI | 8259 | 3381 | 12412 | 2719 | 14168 | 2205 | 14831 | 1818 | 15225 | 1252 | 18040 | 1138 | 8552 |
| 8-#14 | 1.63 | MA | 17623 | 3582 | 25796 | 2984 | 30972 | 2418 | 33700 | 1989 | 36871 | 1353 | 45752 | 1269 | 24913 |
| 2L-4S | | MI | 7475 | 3582 | 11936 | 2814 | 13435 | 2277 | 13939 | 1852 | 14090 | 1227 | 16785 | 809 | 11840 |
| 8-#14 | 1.63 | MA | 16038 | 3582 | 23735 | 2986 | 28359 | 2418 | 30534 | 2002 | 32600 | 1362 | 39974 | 1138 | 24763 |
| 3E | | MI | 8014 | 3582 | 12647 | 2821 | 14366 | 2269 | 15038 | 1860 | 15482 | 1220 | 18326 | 928 | 11974 |
| 8-#14 | 1.63 | MA | 14893 | 3582 | 22207 | 2987 | 26293 | 2432 | 28030 | 2000 | 29220 | 1357 | 36160 | 1006 | 24261 |
| 4L-2S | | MI | 8731 | 3582 | 13583 | 2828 | 15522 | 2277 | 16412 | 1852 | 17290 | 1212 | 20656 | 1059 | 11960 |
| 8-#18 | 2.90 | MA | 20394 | 4091 | 32156 | 3285 | 38890 | 2637 | 43228 | 2125 | 49682 | 1321 | 62595 | 1184 | 43320 |
| 2L-4S | | MI | 7723 | 4091 | 13517 | 3077 | 15215 | 2456 | 16005 | 1936 | 16819 | 1128 | 20345 | 401 | 18105 |
| 8-#18 | 2.90 | MA | 17746 | 4091 | 28545 | 3287 | 34310 | 2634 | 37679 | 2145 | 42196 | 1335 | 52582 | 950 | 42610 |
| 3E | | MI | 8643 | 4091 | 14726 | 3090 | 16788 | 2442 | 17864 | 1949 | 19172 | 1114 | 22936 | 604 | 19992 |
| 8-#18 | 2.90 | MA | 15834 | 4091 | 25859 | 3288 | 30680 | 2659 | 33280 | 2140 | 36258 | 1322 | 45987 | 717 | 38364 |
| 4L-2S | | MI | 9819 | 4091 | 16315 | 3103 | 18744 | 2456 | 20188 | 1936 | 22230 | 1101 | 26837 | 838 | 20181 |
| 10-#11 | 1.41 | MA | 17144 | 3495 | 24668 | 2938 | 29617 | 2385 | 32091 | 1970 | 34723 | 1362 | 42974 | 1288 | 21763 |
| 2L-5S | | MI | 7315 | 3495 | 11404 | 2788 | 12911 | 2251 | 13342 | 1852 | 13274 | 1244 | 15783 | 887 | 10270 |
| 10-#11 | 1.41 | MA | 16026 | 3495 | 23229 | 2939 | 27792 | 2385 | 29881 | 1979 | 31741 | 1369 | 38916 | 1197 | 21698 |
| 3L-4S | | MI | 7663 | 3495 | 11912 | 2781 | 13508 | 2256 | 14050 | 1847 | 14237 | 1249 | 16943 | 931 | 10549 |
| 10-#11 | 1.41 | MA | 15220 | 3495 | 22164 | 2941 | 26351 | 2396 | 28134 | 1978 | 29383 | 1365 | 36235 | 1106 | 21501 |
| 4L-3S | | MI | 8044 | 3495 | 12412 | 2786 | 14168 | 2251 | 14831 | 1852 | 15225 | 1244 | 18040 | 1015 | 10557 |
| 10-#11 | 1.41 | MA | 14492 | 3495 | 21086 | 2953 | 25059 | 2396 | 26556 | 1988 | 27235 | 1372 | 33454 | 1059 | 20696 |
| 5L-2S | | MI | 8553 | 3495 | 13071 | 2790 | 14990 | 2256 | 15807 | 1847 | 16510 | 1239 | 19703 | 1106 | 10536 |
| 10-#14 | 2.04 | MA | 18589 | 3746 | 27856 | 3086 | 33585 | 2492 | 36866 | 2036 | 41142 | 1346 | 51531 | 1252 | 31001 |
| 2L-5S | | MI | 7407 | 3746 | 12147 | 2924 | 13753 | 2341 | 14317 | 1900 | 14543 | 1198 | 17490 | 696 | 13728 |
| 10-#14 | 2.04 | MA | 17030 | 3746 | 25796 | 3088 | 30972 | 2492 | 33700 | 2049 | 36871 | 1355 | 45752 | 1120 | 30802 |
| 3L-4S | | MI | 7894 | 3746 | 12871 | 2916 | 14592 | 2348 | 15313 | 1893 | 15899 | 1205 | 19115 | 760 | 14385 |
| 10-#14 | 2.04 | MA | 15906 | 3746 | 24268 | 3090 | 28906 | 2507 | 31196 | 2047 | 33491 | 1349 | 41939 | 989 | 30183 |
| 4L-3S | | MI | 8426 | 3746 | 13583 | 2923 | 15522 | 2341 | 16412 | 1900 | 17290 | 1198 | 20656 | 879 | 14734 |
| 10-#14 | 2.04 | MA | 14890 | 3746 | 22722 | 3106 | 27052 | 2507 | 28932 | 2060 | 30409 | 1359 | 37971 | 922 | 28102 |
| 5L-2S | | MI | 9134 | 3746 | 14519 | 2930 | 16679 | 2348 | 17786 | 1893 | 19099 | 1190 | 22985 | 1010 | 14755 |
| 10-#18 | 3.62 | MA | 19380 | 4382 | 32156 | 3468 | 38890 | 2767 | 43228 | 2230 | 49682 | 1321 | 62595 | 914 | 53121 |
| 3L-4S | | MI | 8435 | 4382 | 15105 | 3256 | 17171 | 2579 | 18328 | 2003 | 19877 | 1082 | 24245 | 301 | 22521 |
| 10-#18 | 3.62 | MA | 17519 | 4382 | 29471 | 3470 | 35260 | 2792 | 38829 | 2224 | 43744 | 1308 | 56001 | 680 | 48595 |
| 4L-3S | | MI | 9307 | 4382 | 16315 | 3269 | 18744 | 2565 | 20188 | 2016 | 22230 | 1069 | 26837 | 504 | 24557 |
| 10-#18 | 3.62 | MA | 15834 | 4382 | 26753 | 3498 | 31999 | 2790 | 34848 | 2245 | 38325 | 1322 | 49100 | 564 | 44667 |
| 5L-2S | | MI | 10453 | 4382 | 17903 | 3282 | 20700 | 2579 | 22511 | 2003 | 25289 | 1056 | 30737 | 738 | 24925 |
| 12-#11 | 1.70 | MA | 17832 | 3608 | 26106 | 3009 | 31441 | 2437 | 34301 | 2002 | 37705 | 1356 | 47031 | 1277 | 26020 |
| 2L-6S | | MI | 7285 | 3608 | 11609 | 2854 | 13144 | 2306 | 13621 | 1876 | 13664 | 1235 | 16366 | 793 | 11841 |
| 12-#11 | 1.70 | MA | 16728 | 3608 | 24668 | 3010 | 29617 | 2437 | 32091 | 2012 | 34723 | 1363 | 42974 | 1186 | 25930 |
| 3L-5S | | MI | 7617 | 3608 | 12063 | 2858 | 13733 | 2301 | 14319 | 1881 | 14559 | 1230 | 17446 | 855 | 12115 |
| 12-#11 | 1.70 | MA | 15934 | 3608 | 23602 | 3012 | 28176 | 2447 | 30344 | 2011 | 32365 | 1360 | 40293 | 1095 | 25704 |
| 4E | | MI | 7962 | 3608 | 12571 | 2852 | 14330 | 2306 | 15026 | 1876 | 15522 | 1235 | 18606 | 899 | 12486 |
| 12-#11 | 1.70 | MA | 15216 | 3608 | 22525 | 3023 | 26883 | 2448 | 28766 | 2020 | 30217 | 1367 | 37512 | 1048 | 24799 |
| 5L-3S | | MI | 8339 | 3608 | 13071 | 2857 | 14990 | 2301 | 15807 | 1881 | 16510 | 1230 | 19703 | 983 | 12516 |
| 12-#11 | 1.70 | MA | 14527 | 3608 | 21569 | 3025 | 25608 | 2458 | 27214 | 2020 | 28151 | 1374 | 34678 | 973 | 23879 |
| 6L-2S | | MI | 8843 | 3608 | 13730 | 2861 | 15812 | 2306 | 16783 | 1876 | 17795 | 1225 | 21366 | 1074 | 12509 |
| 12-#14 | 2.45 | MA | 17998 | 3909 | 27856 | 3190 | 33585 | 2567 | 36866 | 2097 | 41142 | 1347 | 51531 | 1103 | 36837 |
| 3L-5S | | MI | 7825 | 3909 | 13083 | 3026 | 14910 | 2412 | 15691 | 1941 | 16352 | 1176 | 19820 | 647 | 16349 |
| 12-#14 | 2.45 | MA | 16895 | 3909 | 26328 | 3192 | 31519 | 2582 | 34361 | 2095 | 37762 | 1342 | 47717 | 972 | 35999 |
| 4E | | MI | 8305 | 3909 | 13807 | 3019 | 15749 | 2420 | 16687 | 1933 | 17707 | 1183 | 21445 | 710 | 16955 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

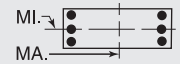



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 2.45 | MA | 15897 | 3909 | 24783 | 3208 | 29665 | 2582 | 32098 | 2108 | 34680 | 1351 | 43749 | 905 | 34003 |
| 5L-3S | | MI | 8830 | 3909 | 14519 | 3026 | 16679 | 2412 | 17786 | 1941 | 19099 | 1176 | 22985 | 829 | 17479 |
| 12-#14 | 2.45 | MA | 14940 | 3909 | 23411 | 3210 | 27835 | 2597 | 29870 | 2106 | 31717 | 1361 | 39714 | 797 | 32186 |
| 6L-2S | | MI | 9529 | 3909 | 15455 | 3033 | 17836 | 2420 | 19160 | 1933 | 20908 | 1168 | 25315 | 961 | 17532 |
| 12-#18 | 4.35 | MA | 19154 | 4673 | 33082 | 3651 | 39840 | 2925 | 44378 | 2308 | 51231 | 1295 | 66014 | 644 | 58863 |
| 4E | | MI | 9102 | 4673 | 16694 | 3435 | 19127 | 2702 | 20652 | 2070 | 22936 | 1037 | 28146 | 201 | 26972 |
| 12-#18 | 4.35 | MA | 17513 | 4673 | 30365 | 3679 | 36579 | 2923 | 40397 | 2329 | 45812 | 1309 | 59113 | 528 | 54824 |
| 5L-3S | | MI | 9952 | 4673 | 17903 | 3448 | 20700 | 2688 | 22511 | 2083 | 25289 | 1024 | 30737 | 404 | 28832 |
| 12-#18 | 4.35 | MA | 15938 | 4673 | 27951 | 3681 | 33360 | 2947 | 36479 | 2323 | 40600 | 1323 | 52122 | 335 | 50448 |
| 6L-2S | | MI | 11072 | 4673 | 19491 | 3461 | 22656 | 2702 | 24835 | 2070 | 28348 | 1011 | 34637 | 637 | 29649 |
| 14-#11 | 1.98 | MA | 17418 | 3722 | 26106 | 3081 | 31441 | 2489 | 34301 | 2045 | 37705 | 1358 | 47031 | 1176 | 30158 |
| 3L-6S | | MI | 7586 | 3722 | 12268 | 2925 | 13966 | 2357 | 14597 | 1905 | 14949 | 1221 | 18029 | 761 | 13711 |
| 14-#11 | 1.98 | MA | 16634 | 3722 | 25041 | 3083 | 30000 | 2499 | 32555 | 2044 | 35347 | 1355 | 44351 | 1085 | 29907 |
| 4L-5S | | MI | 7915 | 3722 | 12722 | 2929 | 14555 | 2351 | 15295 | 1910 | 15844 | 1216 | 19109 | 824 | 13968 |
| 14-#11 | 1.98 | MA | 15926 | 3722 | 23963 | 3094 | 28707 | 2500 | 30977 | 2053 | 33199 | 1362 | 41570 | 1037 | 28913 |
| 5L-4S | | MI | 8256 | 3722 | 13230 | 2923 | 15152 | 2357 | 16003 | 1905 | 16806 | 1221 | 20269 | 867 | 14415 |
| 14-#11 | 1.98 | MA | 15247 | 3722 | 23007 | 3096 | 27432 | 2510 | 29424 | 2052 | 31133 | 1369 | 38736 | 962 | 28024 |
| 6L-3S | | MI | 8630 | 3722 | 13730 | 2927 | 15812 | 2351 | 16783 | 1910 | 17795 | 1216 | 21366 | 952 | 14463 |
| 14-#11 | 1.98 | MA | 14582 | 3722 | 22077 | 3097 | 26201 | 2511 | 27919 | 2062 | 29040 | 1366 | 36211 | 892 | 26814 |
| 7L-2S | | MI | 9129 | 3722 | 14389 | 2932 | 16635 | 2357 | 17760 | 1905 | 19080 | 1211 | 23029 | 1043 | 14474 |
| 14-#14 | 2.85 | MA | 17862 | 4073 | 28388 | 3294 | 34132 | 2657 | 37527 | 2142 | 42033 | 1334 | 53496 | 955 | 41834 |
| 4L-5S | | MI | 8236 | 4073 | 14019 | 3129 | 16067 | 2484 | 17065 | 1981 | 18161 | 1154 | 22149 | 597 | 18981 |
| 14-#14 | 2.85 | MA | 16882 | 4073 | 26843 | 3311 | 32277 | 2657 | 35263 | 2155 | 38951 | 1344 | 49528 | 888 | 39916 |
| 5L-4S | | MI | 8710 | 4073 | 14743 | 3121 | 16906 | 2491 | 18061 | 1974 | 19516 | 1162 | 23774 | 661 | 19543 |
| 14-#14 | 2.85 | MA | 15943 | 4073 | 25471 | 3312 | 30448 | 2671 | 33036 | 2153 | 35988 | 1353 | 45493 | 780 | 38034 |
| 6L-3S | | MI | 9228 | 4073 | 15455 | 3128 | 17836 | 2484 | 19160 | 1981 | 20908 | 1154 | 25315 | 780 | 20216 |
| 14-#14 | 2.85 | MA | 15022 | 4073 | 24136 | 3314 | 28680 | 2671 | 30877 | 2166 | 32984 | 1348 | 41900 | 677 | 36065 |
| 7L-2S | | MI | 9919 | 4073 | 16390 | 3135 | 18993 | 2491 | 20535 | 1974 | 22716 | 1147 | 27644 | 911 | 20296 |
| 14-#18 | 5.07 | MA | 19148 | 4963 | 33976 | 3861 | 41159 | 3056 | 45946 | 2413 | 53298 | 1296 | 69126 | 491 | 65008 |
| 5L-4S | | MI | 9754 | 4963 | 18282 | 3614 | 21083 | 2825 | 22976 | 2136 | 25995 | 992 | 32046 | 100 | 31449 |
| 14-#18 | 5.07 | MA | 17612 | 4963 | 31562 | 3863 | 37940 | 3080 | 42028 | 2408 | 48087 | 1309 | 62136 | 299 | 60366 |
| 6L-3S | | MI | 10583 | 4963 | 19491 | 3627 | 22656 | 2811 | 24835 | 2150 | 28348 | 979 | 34637 | 303 | 33154 |
| 14-#18 | 5.07 | MA | 16105 | 4963 | 29212 | 3864 | 34831 | 3078 | 38229 | 2428 | 42803 | 1297 | 55919 | 117 | 55183 |
| 7L-2S | | MI | 11679 | 4963 | 21080 | 3640 | 24612 | 2825 | 27159 | 2136 | 31407 | 966 | 38538 | 537 | 34357 |
| 16-#11 | 2.26 | MA | 17323 | 3835 | 26479 | 3153 | 31824 | 2551 | 34765 | 2077 | 38329 | 1350 | 48409 | 1074 | 34110 |
| 4L-6S | | MI | 7883 | 3835 | 12927 | 2996 | 14788 | 2407 | 15573 | 1934 | 16234 | 1207 | 19692 | 729 | 15559 |
| 16-#11 | 2.26 | MA | 16624 | 3835 | 25402 | 3165 | 30532 | 2552 | 33187 | 2086 | 36180 | 1357 | 45627 | 1027 | 33037 |
| 5E | | MI | 8208 | 3835 | 13381 | 3000 | 15377 | 2402 | 16271 | 1939 | 17129 | 1202 | 20772 | 792 | 15828 |
| 16-#11 | 2.26 | MA | 15954 | 3835 | 24446 | 3167 | 29257 | 2562 | 31634 | 2085 | 34115 | 1364 | 42794 | 952 | 32175 |
| 6L-4S | | MI | 8547 | 3835 | 13889 | 2994 | 15974 | 2407 | 16979 | 1934 | 18091 | 1207 | 21931 | 836 | 16306 |
| 16-#11 | 2.26 | MA | 15299 | 3835 | 23516 | 3168 | 28025 | 2562 | 30129 | 2095 | 32022 | 1361 | 40268 | 881 | 30923 |
| 7L-3S | | MI | 8917 | 3835 | 14389 | 2998 | 16635 | 2402 | 17760 | 1939 | 19080 | 1202 | 23029 | 920 | 16404 |
| 16-#11 | 2.26 | MA | 14650 | 3835 | 22600 | 3170 | 26818 | 2563 | 28622 | 2094 | 30002 | 1368 | 37670 | 826 | 29770 |
| 8L-2S | | MI | 9412 | 3835 | 15047 | 3002 | 17457 | 2407 | 18736 | 1934 | 20365 | 1197 | 24692 | 1011 | 16429 |
| 16-#14 | 3.26 | MA | 17847 | 4236 | 28903 | 3413 | 34890 | 2731 | 38429 | 2203 | 43222 | 1336 | 55307 | 871 | 45840 |
| 5E | | MI | 8640 | 4236 | 14955 | 3231 | 17224 | 2555 | 18439 | 2022 | 19969 | 1132 | 24479 | 548 | 21621 |
| 16-#14 | 3.26 | MA | 16924 | 4236 | 27531 | 3415 | 33061 | 2746 | 36202 | 2201 | 40259 | 1346 | 51272 | 763 | 43893 |
| 6L-4S | | MI | 9108 | 4236 | 15679 | 3223 | 18063 | 2563 | 19435 | 2014 | 21325 | 1140 | 26104 | 612 | 22146 |
| 16-#14 | 3.26 | MA | 16019 | 4236 | 26196 | 3416 | 31293 | 2746 | 34042 | 2214 | 37255 | 1340 | 47678 | 660 | 41966 |
| 7L-3S | | MI | 9620 | 4236 | 16390 | 3230 | 18993 | 2555 | 20535 | 2022 | 22716 | 1132 | 27644 | 731 | 22945 |
| 16-#14 | 3.26 | MA | 15123 | 4236 | 24882 | 3418 | 29562 | 2746 | 31879 | 2212 | 34357 | 1350 | 43972 | 583 | 39318 |
| 8L-2S | | MI | 10304 | 4236 | 17326 | 3237 | 20150 | 2563 | 21909 | 2014 | 24525 | 1125 | 29974 | 862 | 23051 |
| 16-#18 | 5.80 | MA | 19245 | 5254 | 35174 | 4044 | 42521 | 3213 | 47577 | 2492 | 55573 | 1296 | 72149 | 262 | 70533 |
| 6L-4S | | MI | 10392 | 5254 | 19870 | 3793 | 23039 | 2948 | 25299 | 2203 | 29054 | 947 | 35946 | 0 | 35946 |
| 16-#18 | 5.80 | MA | 17773 | 5254 | 32823 | 4046 | 39411 | 3211 | 43778 | 2513 | 50290 | 1283 | 65932 | 80 | 65465 |
| 7L-3S | | MI | 11203 | 5254 | 21080 | 3806 | 24612 | 2934 | 27159 | 2217 | 31407 | 934 | 38538 | 203 | 37515 |
| 16-#18 | 5.80 | MA | 16315 | 5254 | 30510 | 4047 | 36363 | 3209 | 39971 | 2507 | 45191 | 1297 | 59488 | -55 | 59107 |
| 8L-2S | | MI | 12276 | 5254 | 22668 | 3819 | 26568 | 2948 | 29482 | 2203 | 34466 | 920 | 42438 | 437 | 39054 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

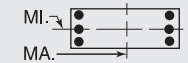
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.54 | MA | 17311 | 3948 | 26840 | 3236 | 32356 | 2603 | 35397 | 2119 | 39162 | 1352 | 49685 | 1016 | 37168 |
| 5L-6S | | MI | 8176 | 3948 | 13586 | 3067 | 15610 | 2457 | 16550 | 1963 | 17519 | 1193 | 21355 | 698 | 17367 |
| 18-#11 | 2.54 | MA | 16650 | 3948 | 25884 | 3238 | 31081 | 2614 | 33845 | 2118 | 37097 | 1359 | 46851 | 941 | 36331 |
| 6L-5S | | MI | 8499 | 3948 | 14040 | 3071 | 16199 | 2452 | 17248 | 1968 | 18414 | 1188 | 22435 | 760 | 17694 |
| 18-#11 | 2.54 | MA | 16003 | 3948 | 24954 | 3239 | 29849 | 2614 | 32340 | 2128 | 35004 | 1356 | 44326 | 870 | 35038 |
| 7L-4S | | MI | 8834 | 3948 | 14548 | 3065 | 16796 | 2457 | 17955 | 1963 | 19376 | 1193 | 23594 | 804 | 18142 |
| 18-#11 | 2.54 | MA | 15363 | 3948 | 24039 | 3241 | 28643 | 2615 | 30832 | 2127 | 32984 | 1363 | 41728 | 816 | 33858 |
| 8L-3S | | MI | 9200 | 3948 | 15047 | 3069 | 17457 | 2452 | 18736 | 1968 | 20365 | 1188 | 24692 | 888 | 18340 |
| 18-#11 | 2.54 | MA | 14727 | 3948 | 23027 | 3252 | 27399 | 2625 | 29349 | 2136 | 30984 | 1370 | 39153 | 757 | 32315 |
| 9L-2S | | MI | 9691 | 3948 | 15706 | 3073 | 18279 | 2457 | 19712 | 1963 | 21650 | 1183 | 26355 | 979 | 18378 |
| 18-#14 | 3.67 | MA | 17886 | 4400 | 29592 | 3517 | 35674 | 2821 | 39367 | 2248 | 44530 | 1338 | 57050 | 745 | 49762 |
| 6L-5S | | MI | 9067 | 4400 | 15890 | 3333 | 18381 | 2627 | 19813 | 2062 | 21778 | 1111 | 26809 | 499 | 24225 |
| 18-#14 | 3.67 | MA | 16996 | 4400 | 28257 | 3518 | 33906 | 2821 | 37208 | 2261 | 41526 | 1333 | 53457 | 643 | 47800 |
| 7L-4S | | MI | 9525 | 4400 | 16614 | 3325 | 19220 | 2634 | 20810 | 2054 | 23133 | 1118 | 28434 | 563 | 24761 |
| 18-#14 | 3.67 | MA | 16116 | 4400 | 26942 | 3520 | 32175 | 2821 | 35044 | 2259 | 38628 | 1342 | 49751 | 566 | 45205 |
| 8L-3S | | MI | 10022 | 4400 | 17326 | 3332 | 20150 | 2627 | 21909 | 2062 | 24525 | 1111 | 29974 | 682 | 25669 |
| 18-#14 | 3.67 | MA | 15240 | 4400 | 25491 | 3537 | 30390 | 2836 | 32916 | 2272 | 35759 | 1352 | 46086 | 481 | 42545 |
| 9L-2S | | MI | 10684 | 4400 | 18262 | 3339 | 21307 | 2634 | 23283 | 2054 | 26333 | 1103 | 32304 | 813 | 25799 |
| 18-#18 | 6.52 | MA | 19405 | 5545 | 36435 | 4227 | 43991 | 3344 | 49327 | 2597 | 57776 | 1270 | 75945 | 44 | 75745 |
| 7L-4S | | MI | 11020 | 5545 | 21459 | 3972 | 24995 | 3071 | 27623 | 2270 | 32113 | 902 | 39847 | -100 | 39196 |
| 18-#18 | 6.52 | MA | 17979 | 5545 | 34121 | 4229 | 40943 | 3342 | 45520 | 2591 | 52678 | 1284 | 69502 | -91 | 68705 |
| 8L-3S | | MI | 11813 | 5545 | 22668 | 3985 | 26568 | 3057 | 29482 | 2284 | 34466 | 888 | 42438 | 103 | 41907 |
| 20-#11 | 2.83 | MA | 17335 | 4062 | 27323 | 3308 | 32905 | 2666 | 36055 | 2151 | 40079 | 1354 | 50909 | 930 | 40491 |
| 6E | | MI | 8466 | 4062 | 14245 | 3138 | 16432 | 2508 | 17526 | 1992 | 18804 | 1180 | 23018 | 666 | 19183 |
| 20-#11 | 2.83 | MA | 16696 | 4062 | 26393 | 3310 | 31674 | 2666 | 34550 | 2160 | 37986 | 1350 | 48384 | 860 | 39159 |
| 7L-5S | | MI | 8785 | 4062 | 14698 | 3142 | 17021 | 2503 | 18224 | 1997 | 19698 | 1174 | 24098 | 729 | 19564 |
| 20-#11 | 2.83 | MA | 16065 | 4062 | 25477 | 3311 | 30467 | 2666 | 33042 | 2159 | 35966 | 1357 | 45786 | 805 | 37952 |
| 8L-4S | | MI | 9117 | 4062 | 15206 | 3136 | 17618 | 2508 | 18932 | 1992 | 20661 | 1180 | 25257 | 772 | 19986 |
| 20-#11 | 2.83 | MA | 15437 | 4062 | 24466 | 3323 | 29224 | 2677 | 31559 | 2169 | 33966 | 1365 | 43211 | 747 | 36438 |
| 9L-3S | | MI | 9481 | 4062 | 15706 | 3140 | 18279 | 2503 | 19712 | 1997 | 21650 | 1174 | 26355 | 857 | 20271 |
| 20-#11 | 2.83 | MA | 14800 | 4062 | 23554 | 3325 | 28025 | 2677 | 30069 | 2168 | 31910 | 1361 | 40550 | 667 | 34813 |
| 10L-2S | | MI | 9967 | 4062 | 16365 | 3144 | 19101 | 2508 | 20689 | 1992 | 22935 | 1169 | 28018 | 948 | 20321 |
| 20-#14 | 4.08 | MA | 17957 | 4563 | 30317 | 3621 | 36519 | 2896 | 40373 | 2308 | 45797 | 1325 | 59236 | 626 | 53644 |
| 7L-5S | | MI | 9458 | 4563 | 16826 | 3435 | 19538 | 2698 | 21188 | 2102 | 23586 | 1089 | 29138 | 450 | 26767 |
| 20-#14 | 4.08 | MA | 17090 | 4563 | 29003 | 3622 | 34788 | 2896 | 38210 | 2306 | 42899 | 1335 | 55529 | 549 | 51099 |
| 8L-4S | | MI | 9908 | 4563 | 17550 | 3427 | 20377 | 2706 | 22184 | 2095 | 24942 | 1096 | 30763 | 513 | 27385 |
| 20-#14 | 4.08 | MA | 16229 | 4563 | 27551 | 3639 | 33003 | 2910 | 36082 | 2319 | 40029 | 1344 | 51865 | 464 | 48417 |
| 9L-3S | | MI | 10398 | 4563 | 18262 | 3435 | 21307 | 2698 | 23283 | 2102 | 26333 | 1089 | 32304 | 632 | 28389 |
| 20-#14 | 4.08 | MA | 15343 | 4563 | 26242 | 3641 | 31283 | 2910 | 33943 | 2318 | 37079 | 1339 | 48076 | 349 | 45688 |
| 10L-2S | | MI | 11051 | 4563 | 19198 | 3442 | 22464 | 2706 | 24657 | 2095 | 28142 | 1081 | 34633 | 764 | 28541 |
| 20-#18 | 7.25 | MA | 19774 | 5836 | 37733 | 4411 | 45524 | 3475 | 51069 | 2675 | 60164 | 1271 | 79515 | -127 | 78178 |
| 8L-4S | | MI | 11638 | 5836 | 23047 | 4151 | 26951 | 3194 | 29946 | 2337 | 35172 | 856 | 43747 | -201 | 42426 |
| 22-#11 | 3.11 | MA | 17380 | 4175 | 27831 | 3381 | 33498 | 2718 | 36760 | 2193 | 40968 | 1345 | 52442 | 849 | 43286 |
| 7L-6S | | MI | 8753 | 4175 | 14904 | 3209 | 17254 | 2558 | 18502 | 2021 | 20089 | 1166 | 24681 | 634 | 21006 |
| 22-#11 | 3.11 | MA | 16756 | 4175 | 26916 | 3382 | 32291 | 2718 | 35252 | 2192 | 38948 | 1352 | 49843 | 794 | 42051 |
| 8L-5S | | MI | 9069 | 4175 | 15357 | 3213 | 17844 | 2553 | 19200 | 2026 | 20983 | 1161 | 25761 | 697 | 21437 |
| 22-#11 | 3.11 | MA | 16136 | 4175 | 25904 | 3394 | 31048 | 2729 | 33769 | 2202 | 36948 | 1359 | 47269 | 736 | 40565 |
| 9L-4S | | MI | 9398 | 4175 | 15865 | 3207 | 18440 | 2558 | 19908 | 2021 | 21946 | 1166 | 26920 | 741 | 21836 |
| 22-#11 | 3.11 | MA | 15502 | 4175 | 24992 | 3396 | 29850 | 2729 | 32279 | 2201 | 34892 | 1356 | 44608 | 656 | 38924 |
| 10L-3S | | MI | 9758 | 4175 | 16365 | 3211 | 19101 | 2553 | 20689 | 2026 | 22935 | 1161 | 28018 | 825 | 22200 |
| 22-#11 | 3.11 | MA | 14839 | 4175 | 24087 | 3397 | 28620 | 2740 | 30805 | 2210 | 32900 | 1363 | 42054 | 599 | 37269 |
| 11L-2S | | MI | 10241 | 4175 | 17024 | 3215 | 19923 | 2558 | 21665 | 2021 | 24219 | 1155 | 29681 | 916 | 22261 |
| 22-#14 | 4.48 | MA | 18049 | 4727 | 31063 | 3725 | 37400 | 2970 | 41375 | 2354 | 47170 | 1327 | 61308 | 532 | 57000 |
| 8L-5S | | MI | 9843 | 4727 | 17762 | 3538 | 20694 | 2770 | 22562 | 2143 | 25395 | 1067 | 31468 | 400 | 29322 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

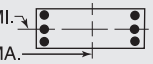
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 4.48 | MA | 17201 | 4727 | 29611 | 3741 | 35616 | 2985 | 39247 | 2367 | 44300 | 1337 | 57643 | 447 | 54295 |
| 9L-4S | | MI | 10286 | 4727 | 18486 | 3530 | 21534 | 2777 | 23558 | 2135 | 26750 | 1074 | 33093 | 464 | 30017 |
| 22-#14 | 4.48 | MA | 16319 | 4727 | 28302 | 3743 | 33896 | 2985 | 37109 | 2365 | 41349 | 1331 | 53855 | 332 | 51550 |
| 10L-3S | | MI | 10768 | 4727 | 19198 | 3537 | 22464 | 2770 | 24657 | 2143 | 28142 | 1067 | 34633 | 583 | 31105 |
| 24-#11 | 3.39 | MA | 17438 | 4289 | 28354 | 3453 | 34116 | 2770 | 37463 | 2225 | 41930 | 1347 | 53901 | 784 | 46114 |
| 8L-6S | | MI | 9036 | 4289 | 15562 | 3280 | 18076 | 2609 | 19479 | 2050 | 21373 | 1152 | 26344 | 603 | 22836 |
| 24-#11 | 3.39 | MA | 16825 | 4289 | 27343 | 3465 | 32872 | 2781 | 35979 | 2235 | 39930 | 1354 | 51326 | 725 | 44695 |
| 9L-5S | | MI | 9350 | 4289 | 16016 | 3284 | 18666 | 2603 | 20176 | 2055 | 22268 | 1147 | 27424 | 665 | 23313 |
| 24-#11 | 3.39 | MA | 16194 | 4289 | 26431 | 3467 | 31674 | 2781 | 34489 | 2234 | 37874 | 1351 | 48665 | 645 | 43038 |
| 10L-4S | | MI | 9676 | 4289 | 16524 | 3278 | 19262 | 2609 | 20884 | 2050 | 23231 | 1152 | 28583 | 709 | 23692 |
| 24-#11 | 3.39 | MA | 15538 | 4289 | 25525 | 3468 | 30445 | 2792 | 33015 | 2243 | 35882 | 1358 | 46112 | 588 | 41371 |
| 11L-3S | | MI | 10033 | 4289 | 17024 | 3282 | 19923 | 2603 | 21665 | 2055 | 24219 | 1147 | 29681 | 793 | 24125 |
| 24-#11 | 3.39 | MA | 14891 | 4289 | 24625 | 3469 | 29250 | 2792 | 31534 | 2242 | 33900 | 1365 | 43557 | 530 | 39598 |
| 12L-2S | | MI | 10512 | 4289 | 17683 | 3286 | 20745 | 2609 | 22641 | 2050 | 25504 | 1141 | 31344 | 884 | 24198 |
| 24-#14 | 4.89 | MA | 18157 | 4891 | 31672 | 3843 | 38229 | 3060 | 42413 | 2414 | 48571 | 1329 | 63422 | 430 | 60178 |
| 9L-5S | | MI | 10223 | 4891 | 18698 | 3640 | 21851 | 2841 | 23936 | 2183 | 27203 | 1045 | 33797 | 351 | 31887 |
| 24-#14 | 4.89 | MA | 17279 | 4891 | 30363 | 3845 | 36509 | 3060 | 40274 | 2412 | 45620 | 1324 | 59634 | 315 | 57418 |
| 10L-4S | | MI | 10659 | 4891 | 19422 | 3632 | 22691 | 2849 | 24932 | 2176 | 28559 | 1053 | 35422 | 415 | 32655 |

## RECTANGULAR TIED COLUMNS 24" x 48"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.39 | MA | 18502 | 3637 | 26792 | 3041 | 31994 | 2469 | 34560 | 2039 | 37242 | 1411 | 45740 | 1323 | 23075 |
| 2E | | MI | 8778 | 3637 | 13571 | 2849 | 15307 | 2295 | 16014 | 1874 | 16547 | 1247 | 19524 | 1093 | 10600 |
| 6-#14 | 1.17 | MA | 18009 | 3546 | 25529 | 3001 | 30548 | 2441 | 32877 | 2025 | 35017 | 1425 | 42976 | 1352 | 19721 |
| 2L-3S | | MI | 7900 | 3546 | 12140 | 2824 | 13682 | 2284 | 14139 | 1893 | 14110 | 1298 | 16489 | 1032 | 9222 |
| 6-#14 | 1.17 | MA | 16310 | 3546 | 23367 | 3003 | 27805 | 2441 | 29554 | 2038 | 30535 | 1435 | 36881 | 1221 | 19629 |
| 3L-2S | | MI | 8628 | 3546 | 13075 | 2831 | 14839 | 2291 | 15513 | 1885 | 15919 | 1290 | 18819 | 1163 | 9173 |
| 6-#18 | 2.08 | MA | 20282 | 3927 | 30586 | 3223 | 36805 | 2602 | 40388 | 2124 | 45105 | 1398 | 56314 | 1290 | 34294 |
| 2L-3S | | MI | 8242 | 3927 | 13571 | 3015 | 15307 | 2405 | 16014 | 1955 | 16547 | 1215 | 19524 | 759 | 15380 |
| 6-#18 | 2.08 | MA | 17415 | 3927 | 26792 | 3225 | 31994 | 2600 | 34560 | 2146 | 37242 | 1413 | 45740 | 1056 | 33724 |
| 3L-2S | | MI | 9462 | 3927 | 15160 | 3028 | 17263 | 2418 | 18338 | 1941 | 19606 | 1202 | 23425 | 992 | 15443 |
| 8-#11 | 1.08 | MA | 17805 | 3509 | 24996 | 2986 | 29950 | 2431 | 32187 | 2020 | 34111 | 1431 | 41849 | 1364 | 18341 |
| 2L-4S | | MI | 7666 | 3509 | 11679 | 2816 | 13159 | 2292 | 13549 | 1892 | 13390 | 1320 | 15775 | 1018 | 8635 |
| 8-#11 | 1.08 | MA | 16613 | 3509 | 23486 | 2988 | 28036 | 2432 | 29868 | 2030 | 30982 | 1438 | 37572 | 1273 | 18303 |
| 3E | | MI | 8052 | 3509 | 12178 | 2821 | 13819 | 2287 | 14330 | 1897 | 14379 | 1314 | 16872 | 1102 | 8612 |
| 8-#11 | 1.08 | MA | 15755 | 3509 | 22369 | 2990 | 26525 | 2443 | 28037 | 2029 | 28510 | 1436 | 34745 | 1182 | 18140 |
| 4L-2S | | MI | 8566 | 3509 | 12837 | 2825 | 14641 | 2292 | 15306 | 1892 | 15664 | 1309 | 18535 | 1193 | 8577 |
| 8-#14 | 1.56 | MA | 19056 | 3709 | 27692 | 3103 | 33291 | 2516 | 36199 | 2072 | 39500 | 1417 | 49070 | 1336 | 26128 |
| 2L-4S | | MI | 7781 | 3709 | 12364 | 2919 | 13909 | 2363 | 14414 | 1926 | 14527 | 1283 | 17278 | 863 | 11954 |
| 8-#14 | 1.56 | MA | 17387 | 3709 | 25529 | 3105 | 30548 | 2516 | 32877 | 2086 | 35017 | 1427 | 42976 | 1205 | 25978 |
| 3E | | MI | 8321 | 3709 | 13075 | 2926 | 14839 | 2356 | 15513 | 1933 | 15919 | 1276 | 18819 | 982 | 12013 |
| 8-#14 | 1.56 | MA | 16183 | 3709 | 23927 | 3107 | 28381 | 2531 | 30251 | 2084 | 31473 | 1422 | 38950 | 1074 | 25476 |
| 4L-2S | | MI | 9040 | 3709 | 14011 | 2933 | 15996 | 2363 | 16887 | 1926 | 17728 | 1269 | 21149 | 1114 | 11992 |
| 8-#18 | 2.78 | MA | 21997 | 4218 | 34379 | 3404 | 41615 | 2735 | 46217 | 2208 | 52968 | 1385 | 66888 | 1257 | 45480 |
| 2L-4S | | MI | 8028 | 4218 | 13950 | 3180 | 15690 | 2541 | 16478 | 2008 | 17253 | 1183 | 20833 | 455 | 18276 |
| 8-#18 | 2.78 | MA | 19204 | 4218 | 30586 | 3407 | 36805 | 2733 | 40388 | 2230 | 45105 | 1400 | 56314 | 1023 | 44770 |
| 3E | | MI | 8931 | 4218 | 15160 | 3194 | 17263 | 2528 | 18338 | 2022 | 19606 | 1170 | 23425 | 658 | 20065 |
| 8-#18 | 2.78 | MA | 17190 | 4218 | 27768 | 3409 | 32996 | 2759 | 35772 | 2225 | 38875 | 1389 | 49344 | 789 | 40534 |
| 4L-2S | | MI | 10127 | 4218 | 16748 | 3207 | 19219 | 2541 | 20661 | 2008 | 22665 | 1157 | 27325 | 892 | 20230 |
| 10-#11 | 1.35 | MA | 18547 | 3622 | 26505 | 3057 | 31864 | 2483 | 34506 | 2053 | 37239 | 1426 | 46126 | 1355 | 22816 |
| 2L-5S | | MI | 7620 | 3622 | 11829 | 2893 | 13384 | 2338 | 13817 | 1926 | 13713 | 1301 | 16278 | 942 | 10358 |
| 10-#11 | 1.35 | MA | 17370 | 3622 | 24996 | 3059 | 29950 | 2483 | 32187 | 2063 | 34111 | 1433 | 41849 | 1263 | 22751 |
| 3L-4S | | MI | 7970 | 3622 | 12337 | 2887 | 13981 | 2343 | 14525 | 1921 | 14675 | 1306 | 17438 | 986 | 10588 |
| 10-#11 | 1.35 | MA | 16524 | 3622 | 23879 | 3061 | 28440 | 2494 | 30356 | 2062 | 31639 | 1430 | 39021 | 1172 | 22554 |
| 4L-3S | | MI | 8352 | 3622 | 12837 | 2892 | 14641 | 2338 | 15306 | 1926 | 15664 | 1301 | 18535 | 1070 | 10588 |
| 10-#11 | 1.35 | MA | 15758 | 3622 | 22750 | 3073 | 27085 | 2495 | 28703 | 2072 | 29387 | 1438 | 36094 | 1125 | 21801 |
| 5L-2S | | MI | 8862 | 3622 | 13496 | 2896 | 15464 | 2343 | 16282 | 1921 | 16949 | 1295 | 20198 | 1161 | 10564 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



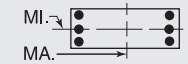

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.95 | MA | 20078 | 3873 | 29854 | 3205 | 36033 | 2591 | 39522 | 2120 | 43983 | 1410 | 55164 | 1321 | 32520 |
| 2L-5S | | MI | 7713 | 3873 | 12575 | 3029 | 14227 | 2427 | 14791 | 1974 | 14981 | 1254 | 17983 | 750 | 13838 |
| 10-#14 | 1.95 | MA | 18436 | 3873 | 27692 | 3208 | 33291 | 2591 | 36199 | 2133 | 39500 | 1420 | 49070 | 1189 | 32321 |
| 3L-4S | | MI | 8201 | 3873 | 13299 | 3022 | 15066 | 2435 | 15788 | 1966 | 16336 | 1262 | 19608 | 814 | 14510 |
| 10-#14 | 1.95 | MA | 17254 | 3873 | 26090 | 3210 | 31124 | 2606 | 33573 | 2132 | 35956 | 1415 | 45045 | 1058 | 31768 |
| 4L-3S | | MI | 8734 | 3873 | 14011 | 3029 | 15996 | 2427 | 16887 | 1974 | 17728 | 1254 | 21149 | 933 | 14778 |
| 10-#14 | 1.95 | MA | 16185 | 3873 | 24470 | 3227 | 29180 | 2607 | 31201 | 2145 | 32725 | 1425 | 40866 | 990 | 29606 |
| 5L-2S | | MI | 9444 | 3873 | 14947 | 3036 | 17153 | 2435 | 18261 | 1966 | 19536 | 1247 | 23478 | 1065 | 14791 |
| 10-#18 | 3.47 | MA | 20933 | 4509 | 34379 | 3588 | 41615 | 2866 | 46217 | 2314 | 52968 | 1387 | 66888 | 990 | 55821 |
| 3L-4S | | MI | 8742 | 4509 | 15539 | 3359 | 17646 | 2664 | 18802 | 2075 | 20312 | 1138 | 24734 | 355 | 22689 |
| 10-#18 | 3.47 | MA | 18973 | 4509 | 31562 | 3591 | 37806 | 2892 | 41601 | 2309 | 46738 | 1375 | 59918 | 756 | 51294 |
| 4L-3S | | MI | 9619 | 4509 | 16748 | 3373 | 19219 | 2651 | 20661 | 2088 | 22665 | 1125 | 27325 | 558 | 24728 |
| 10-#18 | 3.47 | MA | 17199 | 4509 | 28712 | 3619 | 34386 | 2891 | 37426 | 2331 | 41055 | 1390 | 52643 | 638 | 47361 |
| 5L-2S | | MI | 10771 | 4509 | 18336 | 3386 | 21175 | 2664 | 22985 | 2075 | 25724 | 1112 | 31225 | 792 | 24980 |
| 12-#11 | 1.63 | MA | 19275 | 3736 | 28014 | 3128 | 33779 | 2535 | 36825 | 2086 | 40368 | 1420 | 50402 | 1345 | 27283 |
| 2L-6S | | MI | 7590 | 3736 | 12035 | 2960 | 13617 | 2393 | 14096 | 1950 | 14103 | 1292 | 16862 | 848 | 11926 |
| 12-#11 | 1.63 | MA | 18113 | 3736 | 26505 | 3130 | 31864 | 2535 | 34506 | 2096 | 37239 | 1428 | 46126 | 1254 | 27193 |
| 3L-5S | | MI | 7923 | 3736 | 12488 | 2964 | 14206 | 2388 | 14794 | 1955 | 14997 | 1287 | 17941 | 910 | 12202 |
| 12-#11 | 1.63 | MA | 17277 | 3736 | 25388 | 3131 | 30354 | 2546 | 32675 | 2095 | 34768 | 1425 | 43298 | 1163 | 26968 |
| 4E | | MI | 8269 | 3736 | 12996 | 2958 | 14803 | 2393 | 15501 | 1950 | 15960 | 1292 | 19101 | 954 | 12528 |
| 12-#11 | 1.63 | MA | 16523 | 3736 | 24259 | 3144 | 28999 | 2547 | 31022 | 2105 | 32516 | 1433 | 40371 | 1115 | 26110 |
| 5L-3S | | MI | 8647 | 3736 | 13496 | 2962 | 15464 | 2388 | 16282 | 1955 | 16949 | 1287 | 20198 | 1038 | 12551 |
| 12-#11 | 1.63 | MA | 15799 | 3736 | 23258 | 3145 | 27663 | 2558 | 29395 | 2104 | 30352 | 1440 | 37384 | 1040 | 25117 |
| 6L-2S | | MI | 9152 | 3736 | 14155 | 2967 | 16286 | 2393 | 17258 | 1950 | 18234 | 1282 | 21861 | 1129 | 12539 |
| 12-#14 | 2.34 | MA | 19460 | 4036 | 29854 | 3310 | 36033 | 2666 | 39522 | 2181 | 43983 | 1412 | 55164 | 1174 | 38659 |
| 3L-5S | | MI | 8131 | 4037 | 13511 | 3132 | 15384 | 2499 | 16166 | 2014 | 16789 | 1232 | 20313 | 701 | 16459 |
| 12-#14 | 2.34 | MA | 18299 | 4036 | 28252 | 3312 | 33867 | 2681 | 36896 | 2179 | 40438 | 1407 | 51139 | 1042 | 37976 |
| 4E | | MI | 8613 | 4037 | 14235 | 3124 | 16223 | 2506 | 17162 | 2007 | 18145 | 1240 | 21938 | 765 | 17078 |
| 12-#14 | 2.34 | MA | 17250 | 4037 | 26632 | 3329 | 31923 | 2681 | 34523 | 2193 | 37207 | 1417 | 46961 | 974 | 35805 |
| 5L-3S | | MI | 9139 | 4037 | 14947 | 3131 | 17153 | 2499 | 18261 | 2014 | 19536 | 1232 | 23478 | 884 | 17528 |
| 12-#14 | 2.34 | MA | 16243 | 4037 | 25195 | 3331 | 30005 | 2697 | 32189 | 2191 | 34102 | 1428 | 42705 | 866 | 34023 |
| 6L-2S | | MI | 9841 | 4036 | 15883 | 3138 | 18310 | 2506 | 19635 | 2007 | 21345 | 1225 | 25808 | 1015 | 17572 |
| 12-#18 | 4.17 | MA | 20703 | 4800 | 35355 | 3772 | 42617 | 3025 | 47429 | 2394 | 54601 | 1362 | 70492 | 723 | 62090 |
| 4E | | MI | 9412 | 4800 | 17127 | 3538 | 19602 | 2787 | 21126 | 2142 | 23371 | 1093 | 28634 | 255 | 27137 |
| 12-#18 | 4.17 | MA | 18975 | 4800 | 32505 | 3801 | 39197 | 3024 | 43254 | 2416 | 48918 | 1377 | 63217 | 604 | 58051 |
| 5L-3S | | MI | 10267 | 4800 | 18336 | 3552 | 21175 | 2774 | 22985 | 2155 | 25724 | 1080 | 31225 | 458 | 29050 |
| 12-#18 | 4.17 | MA | 17316 | 4800 | 29974 | 3803 | 35822 | 3049 | 39146 | 2411 | 43453 | 1392 | 55834 | 412 | 53391 |
| 6L-2S | | MI | 11393 | 4800 | 19924 | 3565 | 23131 | 2787 | 25309 | 2142 | 28783 | 1066 | 35126 | 691 | 29707 |
| 14-#11 | 1.90 | MA | 18842 | 3849 | 28014 | 3201 | 33779 | 2587 | 36825 | 2128 | 40368 | 1423 | 50402 | 1244 | 31632 |
| 3L-6S | | MI | 7892 | 3849 | 12693 | 3031 | 14439 | 2444 | 15072 | 1979 | 15388 | 1278 | 18525 | 816 | 13795 |
| 14-#11 | 1.90 | MA | 18018 | 3849 | 26897 | 3202 | 32268 | 2598 | 34994 | 2128 | 37897 | 1420 | 47575 | 1153 | 31382 |
| 4L-5S | | MI | 8221 | 3849 | 13147 | 3035 | 15028 | 2438 | 15770 | 1984 | 16282 | 1273 | 19604 | 879 | 14055 |
| 14-#11 | 1.90 | MA | 17273 | 3849 | 25769 | 3214 | 30914 | 2599 | 33341 | 2138 | 35645 | 1428 | 44648 | 1105 | 30430 |
| 5L-4S | | MI | 8564 | 3849 | 13655 | 3029 | 15625 | 2444 | 16478 | 1979 | 17245 | 1278 | 20764 | 922 | 14461 |
| 14-#11 | 1.90 | MA | 16560 | 3849 | 24767 | 3216 | 29577 | 2610 | 31714 | 2137 | 33481 | 1435 | 41661 | 1030 | 29470 |
| 6L-3S | | MI | 8939 | 3849 | 14155 | 3033 | 16286 | 2438 | 17258 | 1984 | 18234 | 1273 | 21861 | 1007 | 14501 |
| 14-#11 | 1.90 | MA | 15861 | 3849 | 23793 | 3218 | 28287 | 2610 | 30137 | 2147 | 31287 | 1432 | 38998 | 960 | 28284 |
| 7L-2S | | MI | 9439 | 3849 | 14814 | 3037 | 17108 | 2444 | 18235 | 1979 | 19518 | 1268 | 23524 | 1098 | 14506 |
| 14-#14 | 2.73 | MA | 19322 | 4200 | 30415 | 3414 | 36609 | 2756 | 40219 | 2227 | 44921 | 1400 | 57234 | 1027 | 44107 |
| 4L-5S | | MI | 8543 | 4200 | 14447 | 3234 | 16540 | 2570 | 17540 | 2055 | 18598 | 1211 | 22642 | 652 | 19091 |
| 14-#14 | 2.73 | MA | 18291 | 4200 | 28795 | 3431 | 34666 | 2756 | 37846 | 2240 | 41690 | 1410 | 53055 | 959 | 42017 |
| 5L-4S | | MI | 9019 | 4200 | 15171 | 3226 | 17380 | 2578 | 18536 | 2047 | 19953 | 1218 | 24267 | 716 | 19665 |
| 14-#14 | 2.73 | MA | 17303 | 4200 | 27357 | 3433 | 32748 | 2771 | 35511 | 2239 | 38585 | 1420 | 48799 | 851 | 40169 |
| 6L-3S | | MI | 9539 | 4200 | 15883 | 3233 | 18310 | 2570 | 19635 | 2055 | 21345 | 1211 | 25808 | 835 | 20268 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

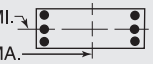



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.73 | MA | 16334 | 4200 | 25959 | 3435 | 30896 | 2772 | 33248 | 2252 | 35437 | 1415 | 45007 | 748 | 38044 |
| 7L-2S | | MI | 10232 | 4200 | 16818 | 3240 | 19467 | 2578 | 21009 | 2047 | 23153 | 1203 | 28137 | 966 | 20338 |
| 14-#18 | 4.86 | MA | 20704 | 5091 | 36298 | 3983 | 44008 | 3157 | 49082 | 2500 | 56781 | 1364 | 73791 | 571 | 68767 |
| 5L-4S | | MI | 10066 | 5091 | 18715 | 3718 | 21557 | 2910 | 23449 | 2209 | 26430 | 1048 | 32535 | 154 | 31612 |
| 14-#18 | 4.86 | MA | 19085 | 5091 | 33767 | 3985 | 40633 | 3182 | 44974 | 2495 | 51316 | 1379 | 66408 | 378 | 64244 |
| 6L-3S | | MI | 10900 | 5091 | 19924 | 3731 | 23131 | 2897 | 25309 | 2222 | 28783 | 1035 | 35126 | 357 | 33367 |
| 14-#18 | 4.86 | MA | 17497 | 5091 | 31303 | 3987 | 37372 | 3181 | 40990 | 2517 | 45776 | 1368 | 59839 | 197 | 58432 |
| 7L-2S | | MI | 12003 | 5091 | 21513 | 3744 | 25087 | 2910 | 27632 | 2209 | 31842 | 1021 | 39026 | 591 | 34419 |
| 16-#11 | 2.17 | MA | 18746 | 3962 | 28407 | 3273 | 34182 | 2650 | 37313 | 2161 | 41026 | 1415 | 51852 | 1143 | 35795 |
| 4L-6S | | MI | 8189 | 3962 | 13352 | 3102 | 15261 | 2494 | 16048 | 2008 | 16673 | 1264 | 20188 | 784 | 15669 |
| 16-#11 | 2.17 | MA | 18011 | 3962 | 27278 | 3285 | 32828 | 2651 | 35660 | 2171 | 38774 | 1422 | 48924 | 1095 | 34759 |
| 5E | | MI | 8516 | 3962 | 13806 | 3106 | 15850 | 2489 | 16746 | 2013 | 17567 | 1259 | 21267 | 847 | 15915 |
| 16-#11 | 2.17 | MA | 17307 | 3962 | 26277 | 3287 | 31492 | 2662 | 34033 | 2170 | 36610 | 1430 | 45937 | 1020 | 33829 |
| 6L-4S | | MI | 8855 | 3962 | 14314 | 3100 | 16447 | 2494 | 17454 | 2008 | 18530 | 1264 | 22427 | 891 | 16388 |
| 16-#11 | 2.17 | MA | 16618 | 3962 | 25302 | 3289 | 30201 | 2662 | 32456 | 2180 | 34416 | 1427 | 43274 | 950 | 32600 |
| 7L-3S | | MI | 9227 | 3962 | 14814 | 3104 | 17108 | 2489 | 18235 | 2013 | 19518 | 1259 | 23524 | 975 | 16445 |
| 16-#11 | 2.17 | MA | 15936 | 3962 | 24343 | 3290 | 28937 | 2663 | 30877 | 2179 | 32300 | 1435 | 40539 | 895 | 31414 |
| 8L-2S | | MI | 9723 | 3962 | 15472 | 3108 | 17930 | 2494 | 19211 | 2008 | 20803 | 1254 | 25187 | 1066 | 16465 |
| 16-#14 | 3.13 | MA | 19312 | 4364 | 30957 | 3533 | 37408 | 2831 | 41169 | 2288 | 46173 | 1403 | 59150 | 943 | 48240 |
| 5E | | MI | 8948 | 4364 | 15383 | 3336 | 17697 | 2642 | 18914 | 2095 | 20406 | 1189 | 24972 | 603 | 21732 |
| 16-#14 | 3.13 | MA | 18340 | 4364 | 29520 | 3535 | 35490 | 2846 | 38834 | 2286 | 43067 | 1413 | 54894 | 835 | 46327 |
| 6L-4S | | MI | 9418 | 4364 | 16107 | 3328 | 18537 | 2649 | 19910 | 2088 | 21762 | 1196 | 26597 | 666 | 22267 |
| 16-#14 | 3.13 | MA | 17388 | 4364 | 28121 | 3537 | 33638 | 2847 | 36571 | 2300 | 39919 | 1408 | 51101 | 733 | 44255 |
| 7L-3S | | MI | 9932 | 4364 | 16818 | 3335 | 19467 | 2642 | 21009 | 2095 | 23153 | 1189 | 28137 | 785 | 23000 |
| 16-#14 | 3.13 | MA | 16445 | 4364 | 26744 | 3539 | 31824 | 2847 | 34304 | 2298 | 36882 | 1418 | 47198 | 654 | 41559 |
| 8L-2S | | MI | 10619 | 4364 | 17754 | 3342 | 20624 | 2649 | 22383 | 2088 | 24962 | 1181 | 30467 | 917 | 23095 |
| 16-#18 | 5.56 | MA | 20811 | 5381 | 37560 | 4167 | 45443 | 3315 | 50802 | 2579 | 59179 | 1366 | 76982 | 345 | 74748 |
| 6L-4S | | MI | 10706 | 5381 | 20304 | 3897 | 23513 | 3033 | 25773 | 2276 | 29489 | 1003 | 36435 | 54 | 36108 |
| 16-#18 | 5.56 | MA | 19260 | 5381 | 35097 | 4169 | 42183 | 3314 | 46818 | 2601 | 53639 | 1354 | 70412 | 163 | 69250 |
| 7L-3S | | MI | 11522 | 5381 | 21513 | 3910 | 25087 | 3020 | 27632 | 2289 | 31842 | 989 | 39026 | 257 | 37724 |
| 16-#18 | 5.56 | MA | 17724 | 5381 | 32671 | 4171 | 38988 | 3312 | 42827 | 2597 | 48293 | 1369 | 63618 | 27 | 63443 |
| 8L-2S | | MI | 12603 | 5381 | 23101 | 3923 | 27043 | 3033 | 29956 | 2276 | 34901 | 976 | 42926 | 490 | 39119 |
| 18-#11 | 2.44 | MA | 18737 | 4076 | 28787 | 3356 | 34742 | 2702 | 37979 | 2203 | 41903 | 1417 | 53201 | 1086 | 39096 |
| 5L-6S | | MI | 8483 | 4076 | 14011 | 3173 | 16083 | 2544 | 17025 | 2037 | 17957 | 1250 | 21851 | 753 | 17504 |
| 18-#11 | 2.44 | MA | 18042 | 4076 | 27786 | 3358 | 33406 | 2713 | 36352 | 2203 | 39739 | 1425 | 50214 | 1011 | 38193 |
| 6L-5S | | MI | 8807 | 4076 | 14465 | 3177 | 16673 | 2539 | 17723 | 2042 | 18852 | 1245 | 22930 | 815 | 17781 |
| 18-#11 | 2.44 | MA | 17362 | 4076 | 26811 | 3360 | 32116 | 2714 | 34775 | 2213 | 37545 | 1422 | 47551 | 940 | 36923 |
| 7L-4S | | MI | 9143 | 4076 | 14973 | 3171 | 17269 | 2544 | 18430 | 2037 | 19815 | 1250 | 24090 | 859 | 18242 |
| 18-#11 | 2.44 | MA | 16689 | 4076 | 25852 | 3361 | 30852 | 2715 | 33196 | 2212 | 35429 | 1429 | 44816 | 885 | 35763 |
| 8L-3S | | MI | 9511 | 4076 | 15472 | 3175 | 17930 | 2539 | 19211 | 2042 | 20803 | 1245 | 25187 | 943 | 18383 |
| 18-#11 | 2.44 | MA | 16020 | 4076 | 24793 | 3373 | 29549 | 2726 | 31642 | 2222 | 33334 | 1437 | 42101 | 827 | 34107 |
| 9L-2S | | MI | 10003 | 4076 | 16131 | 3179 | 18752 | 2544 | 20187 | 2037 | 22088 | 1240 | 26850 | 1034 | 18415 |
| 18-#14 | 3.52 | MA | 19357 | 4527 | 31682 | 3638 | 38233 | 2921 | 42157 | 2334 | 47550 | 1405 | 60988 | 819 | 52495 |
| 6L-5S | | MI | 9348 | 4527 | 16318 | 3438 | 18854 | 2713 | 20288 | 2135 | 22215 | 1167 | 27301 | 554 | 24378 |
| 18-#14 | 3.52 | MA | 18421 | 4527 | 30284 | 3640 | 36381 | 2921 | 39894 | 2347 | 44402 | 1400 | 57196 | 717 | 50474 |
| 7L-4S | | MI | 9813 | 4527 | 17042 | 3430 | 19694 | 2721 | 21284 | 2128 | 23570 | 1175 | 28926 | 617 | 24881 |
| 18-#14 | 3.52 | MA | 17494 | 4527 | 28907 | 3642 | 34566 | 2922 | 37626 | 2346 | 41365 | 1410 | 53292 | 639 | 47747 |
| 8L-3S | | MI | 10321 | 4527 | 17754 | 3437 | 20624 | 2713 | 22383 | 2135 | 24962 | 1167 | 30467 | 736 | 25727 |
| 18-#14 | 3.52 | MA | 16573 | 4527 | 27386 | 3659 | 32697 | 2937 | 35396 | 2359 | 38358 | 1420 | 49426 | 554 | 45044 |
| 9L-2S | | MI | 11004 | 4527 | 18690 | 3445 | 21781 | 2721 | 23757 | 2128 | 26771 | 1160 | 32797 | 868 | 25846 |
| 18-#18 | 6.25 | MA | 20985 | 5672 | 38890 | 4351 | 46993 | 3447 | 52647 | 2686 | 61502 | 1341 | 80986 | 130 | 80083 |
| 7L-4S | | MI | 11336 | 5672 | 21892 | 4076 | 25469 | 3156 | 28096 | 2343 | 32548 | 957 | 40335 | -46 | 40024 |
| 18-#18 | 6.25 | MA | 19482 | 5672 | 36465 | 4353 | 43798 | 3445 | 48655 | 2681 | 56156 | 1356 | 74192 | -7 | 74129 |
| 8L-3S | | MI | 12135 | 5672 | 23101 | 4089 | 27043 | 3143 | 29956 | 2356 | 34901 | 944 | 42926 | 157 | 42113 |
| 20-#11 | 2.71 | MA | 18766 | 4189 | 29295 | 3429 | 35320 | 2765 | 38671 | 2236 | 42867 | 1420 | 54491 | 1001 | 42562 |
| 6E | | MI | 8774 | 4189 | 14670 | 3244 | 16905 | 2595 | 18001 | 2066 | 19242 | 1236 | 23513 | 721 | 19319 |
| 20-#11 | 2.71 | MA | 18094 | 4189 | 28321 | 3431 | 34030 | 2766 | 37094 | 2246 | 40674 | 1417 | 51828 | 930 | 41251 |
| 7L-5S | | MI | 9094 | 4189 | 15123 | 3248 | 17495 | 2590 | 18699 | 2071 | 20137 | 1231 | 24593 | 784 | 19651 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



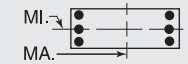

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.71 | MA | 17430 | 4189 | 27362 | 3432 | 32766 | 2766 | 35515 | 2245 | 38558 | 1424 | 49093 | 875 | 40073 |
| 8L-4S | | MI | 9428 | 4189 | 15632 | 3242 | 18091 | 2595 | 19407 | 2066 | 21100 | 1236 | 25753 | 827 | 20085 |
| 20-#11 | 2.71 | MA | 16770 | 4189 | 26302 | 3444 | 31463 | 2777 | 33961 | 2255 | 36463 | 1432 | 46378 | 817 | 38438 |
| 9L-3S | | MI | 9792 | 4189 | 16131 | 3246 | 18752 | 2590 | 20187 | 2071 | 22088 | 1231 | 26850 | 912 | 20316 |
| 20-#11 | 2.71 | MA | 16092 | 4189 | 25347 | 3446 | 30208 | 2778 | 32400 | 2254 | 34308 | 1429 | 43573 | 737 | 36804 |
| 10L-2S | | MI | 10281 | 4189 | 16790 | 3250 | 19574 | 2595 | 21164 | 2066 | 23373 | 1226 | 28513 | 1003 | 20360 |
| 20-#14 | 3.91 | MA | 19436 | 4691 | 32446 | 3742 | 39124 | 2996 | 43216 | 2394 | 48885 | 1393 | 63290 | 702 | 56698 |
| 7L-5S | | MI | 9770 | 4691 | 17254 | 3541 | 20011 | 2785 | 21662 | 2176 | 24024 | 1145 | 29631 | 504 | 26955 |
| 20-#14 | 3.91 | MA | 18524 | 4691 | 31069 | 3744 | 37309 | 2997 | 40949 | 2393 | 45848 | 1403 | 59387 | 623 | 53942 |
| 8L-4S | | MI | 10223 | 4691 | 17978 | 3533 | 20851 | 2792 | 22658 | 2168 | 25379 | 1153 | 31256 | 568 | 27504 |
| 20-#14 | 3.91 | MA | 17617 | 4691 | 29548 | 3761 | 35439 | 3012 | 38719 | 2407 | 42841 | 1413 | 55520 | 539 | 51217 |
| 9L-3S | | MI | 10716 | 4691 | 18690 | 3540 | 21781 | 2785 | 23757 | 2176 | 26771 | 1145 | 32797 | 687 | 28449 |
| 20-#14 | 3.91 | MA | 16673 | 4691 | 28177 | 3763 | 33637 | 3012 | 36478 | 2405 | 39748 | 1408 | 51524 | 423 | 48432 |
| 10L-2S | | MI | 11372 | 4691 | 19626 | 3547 | 22938 | 2792 | 25132 | 2168 | 28579 | 1138 | 35126 | 818 | 28590 |
| 20-#18 | 6.94 | MA | 21205 | 5963 | 40258 | 4534 | 48609 | 3578 | 54484 | 2765 | 64019 | 1343 | 84766 | -40 | 84318 |
| 8L-4S | | MI | 11956 | 5963 | 23480 | 4255 | 27425 | 3279 | 30420 | 2410 | 35607 | 912 | 44236 | -147 | 43253 |
| 22-#11 | 2.98 | MA | 18816 | 4303 | 29830 | 3501 | 35944 | 2818 | 39414 | 2278 | 43803 | 1412 | 56105 | 920 | 45584 |
| 7L-6S | | MI | 9061 | 4303 | 15329 | 3315 | 17727 | 2645 | 18977 | 2095 | 20527 | 1223 | 25176 | 689 | 21141 |
| 22-#11 | 2.98 | MA | 18160 | 4303 | 28871 | 3503 | 34680 | 2818 | 37834 | 2278 | 41687 | 1419 | 53370 | 865 | 44380 |
| 8L-5S | | MI | 9379 | 4303 | 15782 | 3319 | 18317 | 2640 | 19675 | 2100 | 21422 | 1217 | 26256 | 752 | 21524 |
| 22-#11 | 2.98 | MA | 17508 | 4303 | 27811 | 3515 | 33377 | 2829 | 36280 | 2288 | 39591 | 1427 | 50655 | 807 | 42773 |
| 9L-4S | | MI | 9710 | 4303 | 16290 | 3313 | 18913 | 2645 | 20383 | 2095 | 22384 | 1223 | 27416 | 796 | 21935 |
| 22-#11 | 2.98 | MA | 16834 | 4303 | 26856 | 3517 | 32122 | 2830 | 34719 | 2287 | 37437 | 1424 | 47849 | 727 | 41123 |
| 10L-3S | | MI | 10071 | 4303 | 16790 | 3317 | 19574 | 2640 | 21164 | 2100 | 23373 | 1217 | 28513 | 880 | 22246 |
| 22-#11 | 2.98 | MA | 16136 | 4303 | 25908 | 3519 | 30834 | 2841 | 33175 | 2297 | 35351 | 1431 | 45161 | 669 | 39454 |
| 11L-2S | | MI | 10556 | 4303 | 17449 | 3321 | 20396 | 2645 | 22140 | 2095 | 24658 | 1212 | 30176 | 971 | 22302 |
| 22-#14 | 4.30 | MA | 19536 | 4854 | 33232 | 3846 | 40052 | 3071 | 44272 | 2440 | 50331 | 1395 | 65481 | 607 | 60143 |
| 8L-5S | | MI | 10157 | 4854 | 18190 | 3643 | 21168 | 2856 | 23036 | 2216 | 25832 | 1123 | 31961 | 455 | 29507 |
| 22-#14 | 4.30 | MA | 18643 | 4854 | 31711 | 3863 | 38182 | 3087 | 42041 | 2454 | 47323 | 1406 | 61615 | 523 | 57396 |
| 9L-4S | | MI | 10603 | 4854 | 18914 | 3635 | 22007 | 2864 | 24032 | 2209 | 27188 | 1131 | 33586 | 519 | 30135 |
| 22-#14 | 4.30 | MA | 17704 | 4854 | 30339 | 3865 | 36380 | 3087 | 39801 | 2453 | 44231 | 1401 | 57618 | 408 | 54597 |
| 10L-3S | | MI | 11088 | 4854 | 19626 | 3642 | 22938 | 2856 | 25132 | 2216 | 28579 | 1123 | 35126 | 638 | 31168 |
| 24-#11 | 3.25 | MA | 18880 | 4416 | 30380 | 3574 | 36594 | 2870 | 40153 | 2311 | 44815 | 1414 | 57646 | 856 | 48691 |
| 8L-6S | | MI | 9346 | 4416 | 15987 | 3385 | 18549 | 2696 | 19954 | 2124 | 21812 | 1209 | 26839 | 658 | 22969 |
| 24-#11 | 3.25 | MA | 18236 | 4416 | 29321 | 3586 | 35291 | 2881 | 38599 | 2320 | 42720 | 1421 | 54932 | 797 | 47112 |
| 9L-5S | | MI | 9661 | 4416 | 16441 | 3390 | 19139 | 2691 | 20651 | 2129 | 22707 | 1204 | 27919 | 720 | 23400 |
| 24-#11 | 3.25 | MA | 17565 | 4416 | 28366 | 3588 | 34036 | 2882 | 37038 | 2320 | 40566 | 1419 | 52126 | 718 | 45445 |
| 10L-4S | | MI | 9989 | 4416 | 16949 | 3383 | 19735 | 2696 | 21359 | 2124 | 23669 | 1209 | 29079 | 764 | 23790 |
| 24-#11 | 3.25 | MA | 16875 | 4416 | 27417 | 3590 | 32748 | 2893 | 35494 | 2330 | 38479 | 1426 | 49438 | 660 | 43765 |
| 11L-3S | | MI | 10347 | 4416 | 17449 | 3388 | 20396 | 2691 | 22140 | 2129 | 24658 | 1204 | 30176 | 848 | 24173 |
| 24-#11 | 3.25 | MA | 16194 | 4416 | 26474 | 3591 | 31497 | 2893 | 33942 | 2329 | 36343 | 1423 | 46745 | 602 | 41995 |
| 12L-2S | | MI | 10828 | 4416 | 18108 | 3392 | 21218 | 2696 | 23116 | 2124 | 25943 | 1198 | 31839 | 939 | 24240 |
| 24-#14 | 4.69 | MA | 19654 | 5018 | 33873 | 3965 | 40924 | 3161 | 45364 | 2501 | 51806 | 1398 | 67709 | 507 | 63581 |
| 9L-5S | | MI | 10538 | 5018 | 19126 | 3745 | 22325 | 2928 | 24410 | 2257 | 27641 | 1102 | 34290 | 406 | 32070 |
| 24-#14 | 4.69 | MA | 18719 | 5018 | 32502 | 3967 | 39122 | 3162 | 43123 | 2500 | 48714 | 1393 | 63712 | 392 | 60767 |
| 10L-4S | | MI | 10978 | 5018 | 19850 | 3737 | 23164 | 2935 | 25407 | 2249 | 28996 | 1109 | 35915 | 469 | 32773 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

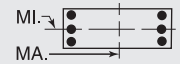
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.38 | MA | 5693 | 2133 | 8611 | 1718 | 9969 | 1394 | 10543 | 1143 | 11044 | 772 | 13239 | 697 | 6931 |
| 2L-3S | | MI | 5129 | 2133 | 7881 | 1715 | 9047 | 1388 | 9447 | 1149 | 9602 | 778 | 11360 | 606 | 6936 |
| 6-#14 | 2.00 | MA | 6088 | 2283 | 9576 | 1803 | 11116 | 1451 | 11888 | 1174 | 12804 | 747 | 15491 | 646 | 9736 |
| 2L-3S | | MI | 5303 | 2283 | 8538 | 1798 | 9815 | 1444 | 10342 | 1181 | 10770 | 754 | 12852 | 514 | 9667 |
| 6-#18 | 3.55 | MA | 6997 | 2665 | 11922 | 2024 | 13866 | 1596 | 15121 | 1247 | 17039 | 675 | 20855 | 499 | 16531 |
| 2L-3S | | MI | 5719 | 2665 | 10128 | 2011 | 11654 | 1583 | 12494 | 1260 | 13581 | 688 | 16407 | 266 | 15410 |
| 8-#11 | 1.85 | MA | 6018 | 2246 | 9340 | 1789 | 10892 | 1445 | 11638 | 1174 | 12485 | 760 | 15117 | 669 | 9109 |
| 2L-4S | | MI | 5051 | 2246 | 8059 | 1783 | 9228 | 1445 | 9667 | 1174 | 9934 | 771 | 12003 | 492 | 8784 |
| 8-#14 | 2.66 | MA | 6532 | 2447 | 10614 | 1906 | 12418 | 1525 | 13434 | 1216 | 14838 | 728 | 18131 | 602 | 12806 |
| 2L-4S | | MI | 5190 | 2447 | 8790 | 1895 | 10070 | 1525 | 10652 | 1216 | 11238 | 743 | 13751 | 348 | 11597 |
| 8-#18 | 4.73 | MA | 7693 | 2956 | 13716 | 2205 | 16078 | 1723 | 17749 | 1318 | 20498 | 635 | 25303 | 410 | 21783 |
| 2L-4S | | MI | 5534 | 2956 | 10556 | 2179 | 12087 | 1723 | 13019 | 1318 | 14379 | 662 | 17911 | -34 | 17774 |
| 10-#11 | 2.31 | MA | 6335 | 2360 | 10070 | 1860 | 11814 | 1497 | 12734 | 1204 | 13927 | 748 | 16995 | 641 | 11271 |
| 2L-5S | | MI | 5014 | 2360 | 8229 | 1861 | 9481 | 1492 | 9968 | 1209 | 10296 | 753 | 12571 | 420 | 10251 |
| 10-#11 | 2.31 | MA | 5789 | 2360 | 9340 | 1857 | 10892 | 1492 | 11638 | 1209 | 12485 | 753 | 15117 | 550 | 11219 |
| 3L-4S | | MI | 5383 | 2360 | 8789 | 1854 | 10151 | 1497 | 10762 | 1204 | 11376 | 759 | 13881 | 464 | 10786 |
| 10-#14 | 3.33 | MA | 6964 | 2611 | 11652 | 2008 | 13719 | 1598 | 14979 | 1259 | 16872 | 709 | 20770 | 558 | 15862 |
| 2L-5S | | MI | 5139 | 2611 | 9029 | 2006 | 10428 | 1591 | 11077 | 1266 | 11749 | 716 | 14550 | 241 | 13450 |
| 10-#14 | 3.33 | MA | 6210 | 2611 | 10614 | 2002 | 12418 | 1591 | 13434 | 1266 | 14838 | 716 | 18131 | 427 | 15691 |
| 3L-4S | | MI | 5649 | 2611 | 9828 | 1997 | 11372 | 1598 | 12198 | 1259 | 13273 | 724 | 16391 | 304 | 14460 |
| 10-#18 | 5.92 | MA | 7180 | 3247 | 13716 | 2374 | 16078 | 1836 | 17749 | 1402 | 20498 | 609 | 25303 | 87 | 24919 |
| 3L-4S | | MI | 6287 | 3247 | 12350 | 2361 | 14299 | 1849 | 15647 | 1389 | 17837 | 622 | 22359 | -123 | 21763 |

## RECTANGULAR TIED COLUMNS 26" x 28"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.24 | MA | 6491 | 2258 | 9707 | 1830 | 11239 | 1487 | 11854 | 1225 | 12322 | 840 | 14735 | 766 | 7242 |
| 2E | | MI | 5993 | 2258 | 9035 | 1816 | 10370 | 1473 | 10900 | 1211 | 11285 | 828 | 13434 | 749 | 6665 |
| 4-#18 | 2.20 | MA | 7200 | 2512 | 11465 | 1971 | 13306 | 1582 | 14271 | 1273 | 15481 | 793 | 18764 | 674 | 12323 |
| 2E | | MI | 6624 | 2512 | 10631 | 1956 | 12210 | 1563 | 13050 | 1255 | 14094 | 776 | 16984 | 648 | 11290 |
| 6-#11 | 1.29 | MA | 6558 | 2271 | 9783 | 1848 | 11381 | 1501 | 12068 | 1237 | 12616 | 846 | 15150 | 774 | 7563 |
| 2L-3S | | MI | 5489 | 2271 | 8375 | 1831 | 9601 | 1484 | 10005 | 1229 | 10119 | 840 | 11945 | 667 | 6973 |
| 6-#11 | 1.29 | MA | 5936 | 2271 | 8983 | 1845 | 10366 | 1496 | 10853 | 1242 | 11018 | 852 | 13056 | 682 | 7568 |
| 3L-2S | | MI | 6055 | 2271 | 9105 | 1834 | 10523 | 1489 | 11101 | 1224 | 11561 | 835 | 13823 | 758 | 6959 |
| 6-#14 | 1.85 | MA | 7002 | 2421 | 10847 | 1933 | 12685 | 1562 | 13571 | 1269 | 14583 | 823 | 17686 | 727 | 10647 |
| 2L-3S | | MI | 5664 | 2421 | 9035 | 1913 | 10370 | 1539 | 10900 | 1261 | 11285 | 816 | 13434 | 574 | 9724 |
| 6-#14 | 1.85 | MA | 6136 | 2421 | 9707 | 1928 | 11239 | 1555 | 11854 | 1277 | 12322 | 831 | 14735 | 595 | 10578 |
| 3L-2S | | MI | 6453 | 2421 | 10073 | 1919 | 11671 | 1546 | 12446 | 1254 | 13319 | 809 | 16074 | 706 | 9772 |
| 6-#18 | 3.30 | MA | 8028 | 2803 | 13441 | 2153 | 15775 | 1712 | 17203 | 1348 | 19340 | 758 | 23763 | 594 | 18151 |
| 2L-3S | | MI | 6060 | 2803 | 10631 | 2124 | 12210 | 1676 | 13050 | 1339 | 14094 | 749 | 16984 | 325 | 15739 |
| 6-#18 | 3.30 | MA | 6591 | 2803 | 11465 | 2142 | 13306 | 1698 | 14271 | 1361 | 15481 | 772 | 18764 | 361 | 17287 |
| 3L-2S | | MI | 7367 | 2803 | 12425 | 2137 | 14422 | 1690 | 15678 | 1326 | 17552 | 736 | 21433 | 559 | 16586 |
| 8-#11 | 1.71 | MA | 6920 | 2384 | 10584 | 1919 | 12397 | 1553 | 13283 | 1269 | 14215 | 836 | 17245 | 748 | 9951 |
| 2L-4S | | MI | 5410 | 2384 | 8553 | 1899 | 9782 | 1540 | 10225 | 1255 | 10451 | 833 | 12588 | 552 | 8938 |
| 8-#11 | 1.71 | MA | 6309 | 2384 | 9783 | 1916 | 11381 | 1548 | 12068 | 1274 | 12616 | 841 | 15150 | 657 | 9925 |
| 3E | | MI | 5824 | 2384 | 9105 | 1902 | 10523 | 1535 | 11101 | 1260 | 11561 | 828 | 13823 | 638 | 9126 |
| 8-#11 | 1.71 | MA | 5857 | 2384 | 9180 | 1914 | 10567 | 1554 | 11097 | 1269 | 11386 | 846 | 13776 | 569 | 9716 |
| 4L-2S | | MI | 6382 | 2384 | 9834 | 1905 | 11446 | 1540 | 12196 | 1255 | 13002 | 823 | 15702 | 729 | 9141 |
| 8-#14 | 2.47 | MA | 7498 | 2585 | 11987 | 2035 | 14131 | 1637 | 15289 | 1314 | 16843 | 806 | 20636 | 687 | 14021 |
| 2L-4S | | MI | 5550 | 2585 | 9287 | 2010 | 10625 | 1619 | 11210 | 1297 | 11754 | 804 | 14334 | 408 | 11781 |
| 8-#14 | 2.47 | MA | 6649 | 2585 | 10847 | 2031 | 12685 | 1630 | 13571 | 1321 | 14583 | 814 | 17686 | 556 | 13898 |
| 3E | | MI | 6125 | 2585 | 10073 | 2015 | 11671 | 1612 | 12446 | 1304 | 13319 | 797 | 16074 | 530 | 12748 |
| 8-#14 | 2.47 | MA | 6021 | 2585 | 9987 | 2026 | 11524 | 1637 | 12198 | 1314 | 12843 | 821 | 15746 | 430 | 12835 |
| 4L-2S | | MI | 6899 | 2585 | 11111 | 2021 | 12973 | 1619 | 13992 | 1297 | 15353 | 789 | 18713 | 662 | 12849 |
| 8-#18 | 4.40 | MA | 8822 | 3094 | 15416 | 2335 | 18244 | 1841 | 20136 | 1422 | 23199 | 723 | 28762 | 514 | 23943 |
| 2L-4S | | MI | 5892 | 3094 | 11059 | 2293 | 12643 | 1816 | 13576 | 1397 | 14891 | 723 | 18489 | 25 | 18346 |
| 8-#18 | 4.40 | MA | 7456 | 3094 | 13441 | 2324 | 15775 | 1828 | 17203 | 1436 | 19340 | 737 | 23763 | 280 | 22512 |
| 3E | | MI | 6831 | 3094 | 12425 | 2306 | 14422 | 1803 | 15678 | 1411 | 17552 | 710 | 21433 | 235 | 20449 |

## RECTANGULAR TIED COLUMNS 26" x 28"

Short columns – no sidesway
Bending on major or minor axis



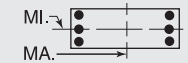

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 4.40 | MA | 6430 | 3094 | 11943 | 2314 | 13791 | 1841 | 14859 | 1422 | 16371 | 750 | 20466 | 64 | 20072 |
| 4L-2S | | MI | 8074 | 3094 | 14219 | 2319 | 16634 | 1816 | 18305 | 1397 | 21010 | 696 | 25881 | 469 | 21846 |
| 10-#11 | 2.14 | MA | 7275 | 2498 | 11384 | 1990 | 13412 | 1605 | 14498 | 1300 | 15813 | 825 | 19340 | 723 | 12324 |
| 2L-5S | | MI | 5372 | 2498 | 8723 | 1977 | 10035 | 1587 | 10526 | 1290 | 10813 | 816 | 13156 | 481 | 10384 |
| 10-#11 | 2.14 | MA | 6672 | 2498 | 10584 | 1987 | 12397 | 1600 | 13283 | 1305 | 14215 | 830 | 17245 | 632 | 12272 |
| 3L-4S | | MI | 5744 | 2498 | 9283 | 1970 | 10705 | 1592 | 11321 | 1285 | 11893 | 821 | 14466 | 524 | 10936 |
| 10-#11 | 2.14 | MA | 6228 | 2498 | 9981 | 1985 | 11583 | 1606 | 12312 | 1300 | 12984 | 836 | 15871 | 544 | 11916 |
| 4L-3S | | MI | 6152 | 2498 | 9834 | 1973 | 11446 | 1587 | 12196 | 1290 | 13002 | 816 | 15702 | 610 | 11268 |
| 10-#11 | 2.14 | MA | 5822 | 2498 | 9369 | 1993 | 10848 | 1601 | 11431 | 1305 | 11788 | 830 | 14410 | 501 | 11279 |
| 5L-2S | | MI | 6701 | 2498 | 10564 | 1976 | 12368 | 1592 | 13292 | 1285 | 14444 | 811 | 17580 | 701 | 11308 |
| 10-#14 | 3.09 | MA | 7982 | 2748 | 13128 | 2137 | 15577 | 1712 | 17007 | 1358 | 19103 | 790 | 23587 | 648 | 17381 |
| 2L-5S | | MI | 5496 | 2748 | 9526 | 2121 | 10983 | 1685 | 11635 | 1347 | 12264 | 778 | 15133 | 301 | 13736 |
| 10-#14 | 3.09 | MA | 7149 | 2748 | 11987 | 2133 | 14131 | 1704 | 15289 | 1365 | 16843 | 797 | 20636 | 517 | 17209 |
| 3L-4S | | MI | 6011 | 2748 | 10325 | 2112 | 11927 | 1693 | 12756 | 1339 | 13788 | 785 | 16973 | 364 | 14640 |
| 10-#14 | 3.09 | MA | 6533 | 2748 | 11127 | 2129 | 12970 | 1712 | 13916 | 1358 | 15103 | 805 | 18697 | 391 | 15987 |
| 4L-3S | | MI | 6575 | 2748 | 11111 | 2117 | 12973 | 1685 | 13992 | 1347 | 15353 | 778 | 18713 | 487 | 15762 |
| 10-#14 | 3.09 | MA | 5973 | 2748 | 10253 | 2139 | 11921 | 1704 | 12671 | 1365 | 13411 | 797 | 16639 | 329 | 14995 |
| 5L-2S | | MI | 7335 | 2748 | 12149 | 2123 | 14274 | 1693 | 15537 | 1339 | 17387 | 770 | 21353 | 618 | 15908 |
| 10-#18 | 5.49 | MA | 8260 | 3385 | 15416 | 2506 | 18244 | 1957 | 20136 | 1510 | 23199 | 701 | 28762 | 200 | 27806 |
| 3L-4S | | MI | 6648 | 3385 | 12853 | 2475 | 14855 | 1943 | 16204 | 1468 | 18350 | 683 | 22937 | -64 | 22616 |
| 10-#18 | 5.49 | MA | 7273 | 3385 | 13918 | 2495 | 16260 | 1971 | 17791 | 1497 | 20230 | 715 | 25464 | -16 | 25361 |
| 4L-3S | | MI | 7553 | 3385 | 14219 | 2488 | 16634 | 1930 | 18305 | 1482 | 21010 | 670 | 25881 | 146 | 25227 |
| 12-#11 | 2.57 | MA | 7623 | 2611 | 12185 | 2060 | 14427 | 1656 | 15713 | 1332 | 17412 | 815 | 21434 | 698 | 14688 |
| 2L-6S | | MI | 5353 | 2611 | 8953 | 2044 | 10296 | 1644 | 10839 | 1315 | 11251 | 809 | 13813 | 390 | 11766 |
| 12-#11 | 2.57 | MA | 7029 | 2611 | 11384 | 2058 | 13412 | 1652 | 14498 | 1337 | 15813 | 820 | 19340 | 607 | 14613 |
| 3L-5S | | MI | 5705 | 2611 | 9453 | 2048 | 10958 | 1638 | 11622 | 1321 | 12255 | 804 | 15035 | 452 | 12436 |
| 12-#11 | 2.57 | MA | 6591 | 2611 | 10782 | 2056 | 12598 | 1658 | 13527 | 1332 | 14583 | 825 | 17965 | 519 | 14133 |
| 4E | | MI | 6071 | 2611 | 10013 | 2040 | 11627 | 1644 | 12416 | 1315 | 13334 | 809 | 16345 | 496 | 12951 |
| 12-#11 | 2.57 | MA | 6192 | 2611 | 10170 | 2063 | 11864 | 1653 | 12646 | 1337 | 13386 | 820 | 16504 | 476 | 13537 |
| 5L-3S | | MI | 6473 | 2611 | 10564 | 2044 | 12368 | 1638 | 13292 | 1321 | 14444 | 804 | 17580 | 582 | 13402 |
| 12-#11 | 2.57 | MA | 5809 | 2611 | 9625 | 2061 | 11138 | 1659 | 11778 | 1332 | 12273 | 825 | 15141 | 414 | 12798 |
| 6L-2S | | MI | 7015 | 2611 | 11294 | 2047 | 13291 | 1644 | 14387 | 1315 | 15885 | 798 | 19459 | 673 | 13464 |
| 12-#14 | 3.71 | MA | 7637 | 2912 | 13128 | 2235 | 15577 | 1779 | 17007 | 1410 | 19103 | 780 | 23587 | 478 | 20516 |
| 3L-5S | | MI | 5956 | 2912 | 10564 | 2223 | 12284 | 1759 | 13181 | 1389 | 14298 | 759 | 17772 | 257 | 16533 |
| 12-#14 | 3.71 | MA | 7033 | 2912 | 12267 | 2231 | 14416 | 1787 | 15634 | 1402 | 17364 | 788 | 21648 | 352 | 19160 |
| 4E | | MI | 6461 | 2912 | 11363 | 2214 | 13228 | 1766 | 14301 | 1382 | 15822 | 766 | 19613 | 320 | 17519 |
| 12-#14 | 3.71 | MA | 6484 | 2912 | 11393 | 2241 | 13367 | 1779 | 14389 | 1410 | 15671 | 780 | 19590 | 290 | 18088 |
| 5L-3S | | MI | 7015 | 2912 | 12149 | 2220 | 14274 | 1759 | 15537 | 1389 | 17387 | 759 | 21353 | 443 | 18770 |
| 12-#14 | 3.71 | MA | 5956 | 2912 | 10614 | 2237 | 12330 | 1787 | 13161 | 1402 | 14097 | 788 | 17670 | 200 | 16876 |
| 6L-2S | | MI | 7762 | 2912 | 13187 | 2225 | 15576 | 1766 | 17083 | 1382 | 19422 | 751 | 23992 | 574 | 18957 |
| 12-#18 | 6.59 | MA | 8088 | 3675 | 15894 | 2677 | 18729 | 2100 | 20723 | 1572 | 24088 | 680 | 30463 | -97 | 29820 |
| 4E | | MI | 7380 | 3675 | 14647 | 2657 | 17067 | 2069 | 18831 | 1540 | 21808 | 644 | 27385 | -154 | 26520 |
| 14-#11 | 3.00 | MA | 7378 | 2724 | 12185 | 2129 | 14427 | 1704 | 15713 | 1368 | 17412 | 809 | 21434 | 582 | 16950 |
| 3L-6S | | MI | 5684 | 2724 | 9683 | 2115 | 11219 | 1695 | 11935 | 1346 | 12693 | 797 | 15692 | 362 | 13776 |
| 14-#11 | 3.00 | MA | 6947 | 2724 | 11582 | 2126 | 13613 | 1710 | 14742 | 1363 | 16182 | 814 | 20060 | 493 | 16363 |
| 4L-5S | | MI | 6031 | 2724 | 10182 | 2118 | 11880 | 1690 | 12717 | 1351 | 13696 | 792 | 16913 | 424 | 14496 |
| 14-#11 | 3.00 | MA | 6554 | 2724 | 10970 | 2134 | 12879 | 1705 | 13861 | 1368 | 14985 | 809 | 18599 | 451 | 15802 |
| 5L-4S | | MI | 6392 | 2724 | 10742 | 2111 | 12550 | 1695 | 13512 | 1346 | 14776 | 797 | 18223 | 467 | 14978 |
| 14-#11 | 3.00 | MA | 6177 | 2724 | 10425 | 2132 | 12153 | 1711 | 12993 | 1363 | 13872 | 814 | 17235 | 389 | 15013 |
| 6L-3S | | MI | 6789 | 2724 | 11294 | 2115 | 13291 | 1690 | 14387 | 1351 | 15885 | 792 | 19459 | 554 | 15532 |
| 14-#11 | 3.00 | MA | 5807 | 2724 | 9894 | 2129 | 11451 | 1707 | 12151 | 1368 | 12781 | 820 | 15839 | 305 | 14249 |
| 7L-2S | | MI | 7324 | 2724 | 12023 | 2118 | 14213 | 1695 | 15483 | 1346 | 17327 | 786 | 21337 | 645 | 15614 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

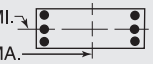
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 4.33 | MA | 7523 | 3076 | 13407 | 2333 | 15862 | 1861 | 17352 | 1447 | 19624 | 771 | 24598 | 313 | 22350 |
| 4L-5S | | MI | 6434 | 3076 | 11602 | 2326 | 13586 | 1832 | 14727 | 1432 | 16332 | 740 | 20412 | 214 | 19350 |
| 14-#14 | 4.33 | MA | 6984 | 3076 | 12534 | 2344 | 14813 | 1854 | 16106 | 1454 | 17931 | 764 | 22540 | 251 | 21199 |
| 5L-4S | | MI | 6926 | 3076 | 12401 | 2316 | 14530 | 1839 | 15847 | 1424 | 17856 | 747 | 22253 | 276 | 20414 |
| 14-#14 | 4.33 | MA | 6466 | 3076 | 11754 | 2339 | 13776 | 1862 | 14879 | 1447 | 16358 | 771 | 20621 | 161 | 19990 |
| 6L-3S | | MI | 7461 | 3076 | 13187 | 2322 | 15576 | 1832 | 17083 | 1432 | 19422 | 740 | 23992 | 399 | 21774 |
| 16-#11 | 3.43 | MA | 7297 | 2838 | 12383 | 2197 | 14629 | 1762 | 15957 | 1395 | 17780 | 804 | 22155 | 468 | 18604 |
| 4L-6S | | MI | 6010 | 2838 | 10413 | 2186 | 12141 | 1747 | 13030 | 1376 | 14134 | 785 | 17570 | 334 | 15794 |
| 16-#11 | 3.43 | MA | 6910 | 2838 | 11771 | 2205 | 13894 | 1757 | 15076 | 1400 | 16583 | 799 | 20694 | 426 | 18073 |
| 5E | | MI | 6352 | 2838 | 10912 | 2189 | 12803 | 1742 | 13813 | 1381 | 15138 | 779 | 18792 | 396 | 16562 |
| 16-#11 | 3.43 | MA | 6538 | 2838 | 11226 | 2203 | 13168 | 1763 | 14208 | 1395 | 15470 | 804 | 19330 | 364 | 17238 |
| 6L-4S | | MI | 6708 | 2838 | 11472 | 2182 | 13472 | 1747 | 14607 | 1376 | 16217 | 785 | 20102 | 439 | 17016 |
| 16-#11 | 3.43 | MA | 6174 | 2838 | 10694 | 2200 | 12466 | 1758 | 13366 | 1400 | 14379 | 809 | 17933 | 280 | 16441 |
| 7L-3S | | MI | 7099 | 2838 | 12023 | 2185 | 14213 | 1742 | 15483 | 1381 | 17327 | 779 | 21337 | 526 | 17658 |
| 16-#14 | 4.95 | MA | 7508 | 3239 | 13674 | 2446 | 16259 | 1929 | 17824 | 1498 | 20192 | 747 | 25491 | 212 | 24327 |
| 5E | | MI | 6875 | 3239 | 12640 | 2428 | 14887 | 1905 | 16272 | 1474 | 18367 | 721 | 23051 | 170 | 22182 |
| 16-#14 | 4.95 | MA | 7002 | 3239 | 12894 | 2442 | 15222 | 1936 | 16597 | 1491 | 18618 | 754 | 23572 | 122 | 23075 |
| 6L-4S | | MI | 7355 | 3239 | 13439 | 2419 | 15831 | 1913 | 17393 | 1467 | 19890 | 728 | 24892 | 233 | 23322 |
| 18-#11 | 3.86 | MA | 7260 | 2951 | 12572 | 2276 | 14910 | 1809 | 16291 | 1431 | 18182 | 788 | 22789 | 400 | 20350 |
| 5L-6S | | MI | 6330 | 2951 | 11142 | 2257 | 13064 | 1798 | 14126 | 1406 | 15576 | 773 | 19449 | 306 | 17821 |
| 18-#11 | 3.86 | MA | 6893 | 2951 | 12026 | 2274 | 14184 | 1815 | 15423 | 1426 | 17069 | 793 | 21425 | 338 | 19470 |
| 6L-5S | | MI | 6668 | 2951 | 11642 | 2260 | 13725 | 1793 | 14908 | 1412 | 16579 | 767 | 20670 | 368 | 18623 |
| 18-#11 | 3.86 | MA | 6535 | 2951 | 11495 | 2271 | 13482 | 1810 | 14581 | 1431 | 15978 | 799 | 20028 | 255 | 18642 |
| 7L-4S | | MI | 7020 | 2951 | 12202 | 2253 | 14395 | 1798 | 15703 | 1406 | 17659 | 773 | 21980 | 411 | 19063 |
| 18-#14 | 5.56 | MA | 7493 | 3403 | 14035 | 2544 | 16668 | 2011 | 18315 | 1535 | 20878 | 738 | 26523 | 83 | 26172 |
| 6L-5S | | MI | 7306 | 3403 | 13678 | 2530 | 16189 | 1979 | 17818 | 1517 | 20401 | 702 | 25691 | 126 | 25029 |
| 20-#11 | 4.29 | MA | 7244 | 3065 | 12827 | 2345 | 15199 | 1867 | 16638 | 1458 | 18667 | 783 | 23519 | 313 | 21709 |
| 6E | | MI | 6647 | 3065 | 11872 | 2328 | 13986 | 1850 | 15221 | 1437 | 17017 | 760 | 21327 | 278 | 19855 |
| 20-#11 | 4.29 | MA | 6890 | 3065 | 12295 | 2342 | 14497 | 1862 | 15796 | 1463 | 17577 | 788 | 22123 | 230 | 20849 |
| 7L-5S | | MI | 6980 | 3065 | 12371 | 2331 | 14648 | 1845 | 16004 | 1442 | 18021 | 755 | 22548 | 340 | 20622 |
| 22-#11 | 4.71 | MA | 7240 | 3178 | 13096 | 2413 | 15512 | 1914 | 17011 | 1495 | 19175 | 777 | 24217 | 205 | 23064 |
| 7L-6S | | MI | 6987 | 3178 | 12602 | 2399 | 14909 | 1902 | 16317 | 1467 | 18459 | 748 | 23206 | 249 | 21895 |

## RECTANGULAR TIED COLUMNS 26" x 30"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.15 | MA | 7407 | 2396 | 10941 | 1960 | 12715 | 1594 | 13451 | 1318 | 13959 | 913 | 16717 | 841 | 7850 |
| 2E | | MI | 6354 | 2396 | 9532 | 1931 | 10924 | 1567 | 11458 | 1292 | 11800 | 889 | 14017 | 809 | 6694 |
| 4-#18 | 2.05 | MA | 8199 | 2650 | 12867 | 2101 | 15042 | 1693 | 16136 | 1369 | 17466 | 871 | 21223 | 757 | 13403 |
| 2E | | MI | 6988 | 2650 | 11134 | 2069 | 12766 | 1657 | 13607 | 1334 | 14607 | 837 | 17562 | 707 | 11333 |
| 6-#11 | 1.20 | MA | 7478 | 2409 | 11021 | 1977 | 12866 | 1607 | 13680 | 1330 | 14273 | 920 | 17160 | 848 | 8194 |
| 2L-3S | | MI | 5849 | 2409 | 8869 | 1947 | 10155 | 1579 | 10563 | 1310 | 10636 | 902 | 12530 | 727 | 7008 |
| 6-#11 | 1.20 | MA | 6799 | 2409 | 10149 | 1975 | 11761 | 1604 | 12345 | 1336 | 12517 | 925 | 14849 | 757 | 8200 |
| 3L-2S | | MI | 6417 | 2409 | 9599 | 1950 | 11077 | 1584 | 11659 | 1305 | 12077 | 897 | 14408 | 818 | 6987 |
| 6-#14 | 1.73 | MA | 7973 | 2559 | 12183 | 2062 | 14291 | 1668 | 15342 | 1364 | 16446 | 898 | 19979 | 806 | 11558 |
| 2L-3S | | MI | 6024 | 2559 | 9532 | 2028 | 10924 | 1633 | 11458 | 1342 | 11800 | 878 | 14017 | 634 | 9777 |
| 6-#14 | 1.73 | MA | 7024 | 2559 | 10941 | 2059 | 12715 | 1662 | 13451 | 1372 | 13959 | 906 | 16717 | 674 | 11490 |
| 3L-2S | | MI | 6816 | 2559 | 10570 | 2034 | 12226 | 1641 | 13004 | 1334 | 13835 | 870 | 16656 | 765 | 9806 |
| 6-#18 | 3.08 | MA | 9119 | 2941 | 15024 | 2282 | 17769 | 1826 | 19374 | 1447 | 21727 | 840 | 26774 | 685 | 19771 |
| 2L-3S | | MI | 6421 | 2941 | 11134 | 2238 | 12766 | 1770 | 13607 | 1419 | 14607 | 810 | 17562 | 384 | 16060 |
| 6-#18 | 3.08 | MA | 7541 | 2941 | 12867 | 2274 | 15042 | 1812 | 16136 | 1460 | 17466 | 853 | 21223 | 451 | 19215 |
| 3L-2S | | MI | 7737 | 2941 | 12928 | 2251 | 14978 | 1783 | 16235 | 1406 | 18065 | 797 | 22010 | 618 | 16640 |
| 8-#11 | 1.60 | MA | 7880 | 2522 | 11892 | 2048 | 13971 | 1659 | 15015 | 1363 | 16028 | 910 | 19472 | 826 | 10793 |
| 2L-4S | | MI | 5769 | 2522 | 9047 | 2015 | 10336 | 1636 | 10783 | 1336 | 10968 | 895 | 13173 | 612 | 9086 |
| 8-#11 | 1.60 | MA | 7211 | 2522 | 11021 | 2046 | 12866 | 1655 | 13680 | 1368 | 14273 | 916 | 17160 | 735 | 10768 |
| 3E | | MI | 6185 | 2522 | 9599 | 2018 | 11077 | 1631 | 11659 | 1341 | 12077 | 890 | 14408 | 699 | 9167 |

## RECTANGULAR TIED COLUMNS 26" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

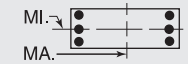
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.60 | MA | 6718 | 2522 | 10366 | 2044 | 11982 | 1662 | 12613 | 1363 | 12879 | 910 | 15647 | 644 | 10637 |
| 4L-2S | | MI | 6745 | 2522 | 10328 | 2021 | 12000 | 1636 | 12754 | 1336 | 13519 | 885 | 16287 | 790 | 9172 |
| 8-#14 | 2.31 | MA | 8523 | 2723 | 13426 | 2164 | 15867 | 1743 | 17232 | 1410 | 18933 | 884 | 23242 | 770 | 15236 |
| 2L-4S | | MI | 5909 | 2723 | 9784 | 2125 | 11180 | 1714 | 11768 | 1377 | 12269 | 866 | 14916 | 468 | 11959 |
| 8-#14 | 2.31 | MA | 7593 | 2723 | 12183 | 2161 | 14291 | 1737 | 15342 | 1417 | 16446 | 891 | 19979 | 639 | 15113 |
| 3E | | MI | 6488 | 2723 | 10570 | 2130 | 12226 | 1707 | 13004 | 1384 | 13835 | 859 | 16656 | 590 | 12808 |
| 8-#14 | 2.31 | MA | 6908 | 2723 | 11248 | 2158 | 13029 | 1746 | 13831 | 1410 | 14532 | 899 | 17840 | 511 | 14094 |
| 4L-2S | | MI | 7265 | 2723 | 11608 | 2136 | 13527 | 1714 | 14549 | 1377 | 15869 | 851 | 19296 | 722 | 12890 |
| 8-#18 | 4.10 | MA | 10008 | 3232 | 17182 | 2464 | 20495 | 1958 | 22612 | 1525 | 25987 | 808 | 32325 | 612 | 26103 |
| 2L-4S | | MI | 6250 | 3232 | 11562 | 2407 | 13199 | 1910 | 14133 | 1477 | 15404 | 784 | 19067 | 84 | 18582 |
| 8-#18 | 4.10 | MA | 8474 | 3232 | 15024 | 2456 | 17769 | 1945 | 19374 | 1538 | 21727 | 822 | 26774 | 379 | 24947 |
| 3E | | MI | 7198 | 3232 | 12928 | 2420 | 14978 | 1897 | 16235 | 1490 | 18065 | 771 | 22010 | 295 | 20759 |
| 8-#18 | 4.10 | MA | 7343 | 3232 | 13394 | 2447 | 15578 | 1958 | 16786 | 1525 | 18448 | 835 | 23122 | 157 | 22070 |
| 4L-2S | | MI | 8452 | 3232 | 14722 | 2433 | 17190 | 1910 | 18862 | 1477 | 21523 | 757 | 26458 | 528 | 21906 |
| 10-#11 | 2.00 | MA | 8272 | 2636 | 12764 | 2119 | 15076 | 1711 | 16349 | 1396 | 17784 | 901 | 21783 | 803 | 13377 |
| 2L-5S | | MI | 5730 | 2636 | 9217 | 2093 | 10589 | 1682 | 11085 | 1371 | 11330 | 878 | 13741 | 541 | 10511 |
| 10-#11 | 2.00 | MA | 7613 | 2636 | 11892 | 2117 | 13971 | 1707 | 15015 | 1401 | 16028 | 906 | 19472 | 712 | 13325 |
| 3L-4S | | MI | 6104 | 2636 | 9777 | 2085 | 11259 | 1687 | 11879 | 1366 | 12410 | 883 | 15051 | 584 | 11081 |
| 10-#11 | 2.00 | MA | 7128 | 2636 | 11238 | 2115 | 13087 | 1714 | 13948 | 1396 | 14634 | 901 | 17958 | 622 | 13063 |
| 4L-3S | | MI | 6514 | 2636 | 10328 | 2089 | 12000 | 1682 | 12754 | 1371 | 13519 | 878 | 16287 | 670 | 11313 |
| 10-#11 | 2.00 | MA | 6687 | 2636 | 10574 | 2124 | 12291 | 1710 | 12981 | 1401 | 13363 | 906 | 16346 | 580 | 12318 |
| 5L-2S | | MI | 7067 | 2636 | 11058 | 2092 | 12922 | 1687 | 13850 | 1366 | 14961 | 873 | 18165 | 761 | 11343 |
| 10-#14 | 2.88 | MA | 9058 | 2886 | 14668 | 2266 | 17442 | 1818 | 19122 | 1456 | 21420 | 869 | 26505 | 735 | 18899 |
| 2L-5S | | MI | 5853 | 2886 | 10023 | 2236 | 11537 | 1780 | 12193 | 1427 | 12780 | 840 | 15715 | 361 | 14015 |
| 10-#14 | 2.88 | MA | 8146 | 2886 | 13426 | 2263 | 15867 | 1812 | 17232 | 1463 | 18933 | 876 | 23242 | 604 | 18728 |
| 3L-4S | | MI | 6372 | 2886 | 10822 | 2227 | 12481 | 1787 | 13313 | 1420 | 14303 | 847 | 17556 | 424 | 14814 |
| 10-#14 | 2.88 | MA | 7474 | 2886 | 12491 | 2260 | 14604 | 1821 | 15722 | 1456 | 17019 | 884 | 21103 | 475 | 17536 |
| 4L-3S | | MI | 6940 | 2886 | 11608 | 2233 | 13527 | 1780 | 14549 | 1427 | 15869 | 840 | 19296 | 546 | 15828 |
| 10-#14 | 2.88 | MA | 6864 | 2886 | 11542 | 2272 | 13466 | 1815 | 14351 | 1463 | 15157 | 876 | 18827 | 414 | 16577 |
| 5L-2S | | MI | 7704 | 2886 | 12646 | 2238 | 14829 | 1787 | 16095 | 1420 | 17903 | 832 | 21935 | 678 | 15953 |
| 10-#18 | 5.13 | MA | 9402 | 3522 | 17182 | 2637 | 20495 | 2077 | 22612 | 1616 | 25987 | 791 | 32325 | 306 | 30749 |
| 3L-4S | | MI | 7010 | 3522 | 13356 | 2589 | 15411 | 2036 | 16760 | 1548 | 18862 | 744 | 23515 | -5 | 23488 |
| 10-#18 | 5.13 | MA | 8319 | 3522 | 15552 | 2629 | 18305 | 2090 | 20024 | 1603 | 22708 | 804 | 28673 | 85 | 28087 |
| 4L-3S | | MI | 7924 | 3522 | 14722 | 2602 | 17190 | 2023 | 18862 | 1561 | 21523 | 731 | 26458 | 205 | 25528 |
| 10-#18 | 5.13 | MA | 7320 | 3522 | 13896 | 2647 | 16327 | 2077 | 17676 | 1616 | 19518 | 791 | 24802 | -26 | 24697 |
| 5L-2S | | MI | 9139 | 3522 | 16516 | 2615 | 19402 | 2036 | 21490 | 1548 | 24981 | 718 | 30906 | 439 | 27149 |
| 12-#11 | 2.40 | MA | 8657 | 2749 | 13635 | 2190 | 16181 | 1763 | 17684 | 1428 | 19540 | 892 | 24095 | 781 | 15952 |
| 2L-6S | | MI | 5710 | 2749 | 9447 | 2160 | 10850 | 1739 | 11397 | 1396 | 11768 | 871 | 14398 | 450 | 11965 |
| 12-#11 | 2.40 | MA | 8007 | 2749 | 12764 | 2188 | 15076 | 1759 | 16349 | 1433 | 17784 | 897 | 21783 | 689 | 15877 |
| 3L-5S | | MI | 6064 | 2749 | 9947 | 2163 | 11512 | 1734 | 12180 | 1402 | 12772 | 866 | 15619 | 513 | 12562 |
| 12-#11 | 2.40 | MA | 7529 | 2749 | 12109 | 2186 | 14193 | 1766 | 15283 | 1428 | 16390 | 892 | 20270 | 599 | 15480 |
| 4E | | MI | 6433 | 2749 | 10507 | 2156 | 12181 | 1739 | 12974 | 1396 | 13851 | 871 | 16930 | 556 | 13093 |
| 12-#11 | 2.40 | MA | 7095 | 2749 | 11446 | 2195 | 13396 | 1762 | 14315 | 1433 | 15119 | 897 | 18658 | 557 | 14779 |
| 5L-3S | | MI | 6837 | 2749 | 11058 | 2160 | 12922 | 1734 | 13850 | 1402 | 14961 | 866 | 18165 | 642 | 13452 |
| 12-#11 | 2.40 | MA | 6679 | 2749 | 10855 | 2193 | 12609 | 1769 | 13362 | 1428 | 13896 | 902 | 17045 | 481 | 14058 |
| 6L-2S | | MI | 7382 | 2749 | 11788 | 2163 | 13845 | 1739 | 14945 | 1396 | 16402 | 861 | 20044 | 733 | 13503 |
| 12-#14 | 3.46 | MA | 8686 | 3050 | 14668 | 2365 | 17442 | 1887 | 19122 | 1509 | 21420 | 862 | 26505 | 568 | 22339 |
| 3L-5S | | MI | 6315 | 3050 | 11061 | 2339 | 12839 | 1853 | 13739 | 1470 | 14814 | 821 | 18355 | 317 | 16806 |
| 12-#14 | 3.46 | MA | 8027 | 3050 | 13733 | 2362 | 16180 | 1896 | 17612 | 1502 | 19506 | 869 | 24365 | 440 | 20999 |
| 4E | | MI | 6824 | 3050 | 11860 | 2329 | 13783 | 1861 | 14859 | 1462 | 16338 | 828 | 20196 | 380 | 17689 |
| 12-#14 | 3.46 | MA | 7428 | 3050 | 12785 | 2374 | 15042 | 1889 | 16242 | 1509 | 17644 | 862 | 22090 | 379 | 19961 |
| 5L-3S | | MI | 7382 | 3050 | 12646 | 2335 | 14829 | 1853 | 16095 | 1470 | 17903 | 821 | 21935 | 503 | 18841 |
| 12-#14 | 3.46 | MA | 6853 | 3050 | 11939 | 2371 | 13916 | 1898 | 14891 | 1502 | 15912 | 869 | 19965 | 289 | 18546 |
| 6L-2S | | MI | 8134 | 3050 | 13684 | 2340 | 16131 | 1861 | 17641 | 1462 | 19937 | 813 | 24575 | 634 | 19006 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 30"

Short columns – no sidesway
Bending on major or minor axis

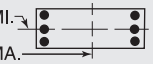



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 6.15 | MA | 9223 | 3813 | 17709 | 2811 | 21031 | 2222 | 23262 | 1680 | 26969 | 773 | 34224 | 12 | 34137 |
| 4E | | MI | 7745 | 3813 | 15150 | 2770 | 17623 | 2163 | 19388 | 1619 | 22321 | 705 | 27963 | -95 | 27419 |
| 12-#18 | 6.15 | MA | 8261 | 3813 | 16053 | 2829 | 19053 | 2209 | 20914 | 1694 | 23778 | 760 | 30353 | -98 | 29820 |
| 5L-3S | | MI | 8630 | 3813 | 16516 | 2783 | 19402 | 2150 | 21490 | 1632 | 24981 | 691 | 30906 | 116 | 30353 |
| 14-#11 | 2.80 | MA | 8393 | 2862 | 13635 | 2259 | 16181 | 1811 | 17684 | 1466 | 19540 | 888 | 24095 | 667 | 18424 |
| 3L-6S | | MI | 6043 | 2862 | 10177 | 2231 | 11773 | 1791 | 12493 | 1427 | 13209 | 859 | 16277 | 422 | 13972 |
| 14-#11 | 2.80 | MA | 7923 | 2862 | 12981 | 2257 | 15298 | 1818 | 16618 | 1461 | 18146 | 883 | 22581 | 577 | 17911 |
| 4L-5S | | MI | 6392 | 2862 | 10676 | 2234 | 12434 | 1785 | 13276 | 1432 | 14213 | 854 | 17498 | 484 | 14621 |
| 14-#11 | 2.80 | MA | 7495 | 2862 | 12317 | 2266 | 14501 | 1814 | 15650 | 1466 | 16875 | 888 | 20969 | 534 | 17249 |
| 5L-4S | | MI | 6756 | 2862 | 11236 | 2227 | 13104 | 1791 | 14070 | 1427 | 15293 | 859 | 18808 | 528 | 15119 |
| 14-#11 | 2.80 | MA | 7085 | 2862 | 11726 | 2264 | 13714 | 1821 | 14697 | 1461 | 15652 | 893 | 19357 | 458 | 16476 |
| 6L-3S | | MI | 7155 | 2862 | 11788 | 2230 | 13845 | 1785 | 14945 | 1432 | 16402 | 854 | 20044 | 614 | 15585 |
| 14-#11 | 2.80 | MA | 6683 | 2862 | 11150 | 2262 | 12953 | 1817 | 13772 | 1466 | 14411 | 888 | 17927 | 388 | 15720 |
| 7L-2S | | MI | 7693 | 2862 | 12517 | 2234 | 14767 | 1791 | 16041 | 1427 | 17844 | 849 | 21922 | 705 | 15655 |
| 14-#14 | 4.04 | MA | 8568 | 3214 | 14976 | 2464 | 17756 | 1970 | 19502 | 1548 | 21993 | 854 | 27628 | 405 | 24480 |
| 4L-5S | | MI | 6767 | 3214 | 12099 | 2441 | 14140 | 1927 | 15284 | 1512 | 16848 | 802 | 20994 | 273 | 19617 |
| 14-#14 | 4.04 | MA | 7981 | 3214 | 14027 | 2476 | 16617 | 1964 | 18132 | 1555 | 20131 | 847 | 25353 | 343 | 23363 |
| 5L-4S | | MI | 7268 | 3214 | 12898 | 2431 | 15085 | 1934 | 16405 | 1505 | 18372 | 809 | 22835 | 336 | 20581 |
| 14-#14 | 4.04 | MA | 7416 | 3214 | 13182 | 2473 | 15492 | 1973 | 16781 | 1548 | 18399 | 854 | 23228 | 254 | 22011 |
| 6L-3S | | MI | 7817 | 3214 | 13684 | 2437 | 16131 | 1927 | 17641 | 1512 | 19937 | 802 | 24575 | 459 | 21849 |
| 14-#18 | 7.18 | MA | 9172 | 4104 | 18211 | 3011 | 21780 | 2341 | 24152 | 1771 | 28039 | 728 | 35904 | -171 | 34763 |
| 5L-4S | | MI | 8462 | 4104 | 16944 | 2952 | 19835 | 2290 | 22015 | 1690 | 25779 | 665 | 32411 | -184 | 31248 |
| 16-#11 | 3.20 | MA | 8310 | 2976 | 13852 | 2328 | 16403 | 1870 | 17952 | 1493 | 19902 | 873 | 24893 | 554 | 20353 |
| 4L-6S | | MI | 6370 | 2976 | 10907 | 2302 | 12695 | 1842 | 13588 | 1457 | 14651 | 847 | 18155 | 394 | 15987 |
| 16-#11 | 3.20 | MA | 7888 | 2976 | 13189 | 2337 | 15607 | 1866 | 16985 | 1498 | 18631 | 878 | 23281 | 512 | 19725 |
| 5E | | MI | 6715 | 2976 | 11406 | 2305 | 13357 | 1837 | 14371 | 1462 | 15655 | 842 | 19376 | 456 | 16686 |
| 16-#11 | 3.20 | MA | 7484 | 2976 | 12598 | 2335 | 14820 | 1873 | 16032 | 1493 | 17408 | 884 | 21668 | 436 | 18903 |
| 6L-4S | | MI | 7074 | 2976 | 11966 | 2298 | 14026 | 1842 | 15165 | 1457 | 16734 | 847 | 20686 | 499 | 17155 |
| 16-#11 | 3.20 | MA | 7087 | 2976 | 12022 | 2333 | 14058 | 1869 | 15106 | 1498 | 16167 | 878 | 20239 | 365 | 18115 |
| 7L-3S | | MI | 7467 | 2976 | 12517 | 2301 | 14767 | 1837 | 16041 | 1462 | 17844 | 842 | 21922 | 586 | 17714 |
| 16-#14 | 4.62 | MA | 8522 | 3377 | 15270 | 2578 | 18193 | 2039 | 20022 | 1601 | 22618 | 832 | 28616 | 308 | 26781 |
| 5E | | MI | 7240 | 3377 | 13137 | 2543 | 15442 | 2000 | 16830 | 1555 | 18882 | 783 | 23634 | 230 | 22445 |
| 16-#14 | 4.62 | MA | 7968 | 3377 | 14424 | 2575 | 17068 | 2048 | 18672 | 1593 | 20886 | 840 | 26491 | 219 | 25489 |
| 6L-4S | | MI | 7726 | 3377 | 13936 | 2534 | 16386 | 2008 | 17951 | 1547 | 20406 | 790 | 25475 | 292 | 23487 |
| 18-#11 | 3.60 | MA | 8275 | 3089 | 14060 | 2407 | 16712 | 1918 | 18320 | 1531 | 20387 | 869 | 25593 | 489 | 22207 |
| 5L-6S | | MI | 6692 | 3089 | 11636 | 2373 | 13618 | 1894 | 14684 | 1487 | 16092 | 835 | 20034 | 366 | 18011 |
| 18-#11 | 3.60 | MA | 7876 | 3089 | 13469 | 2406 | 15925 | 1925 | 17366 | 1526 | 19164 | 874 | 23980 | 413 | 21338 |
| 6L-5S | | MI | 7032 | 3089 | 12136 | 2376 | 14279 | 1889 | 15467 | 1493 | 17096 | 830 | 21255 | 428 | 18757 |
| 18-#11 | 3.60 | MA | 7485 | 3089 | 12893 | 2404 | 15164 | 1921 | 16441 | 1531 | 17923 | 869 | 22550 | 343 | 20518 |
| 7L-4S | | MI | 7387 | 3089 | 12696 | 2369 | 14949 | 1894 | 16261 | 1487 | 18176 | 835 | 22565 | 471 | 19199 |
| 18-#14 | 5.19 | MA | 8556 | 3541 | 15667 | 2677 | 18643 | 2123 | 20562 | 1639 | 23373 | 825 | 29754 | 183 | 28912 |
| 6L-5S | | MI | 7674 | 3541 | 14175 | 2645 | 16743 | 2073 | 18376 | 1597 | 20916 | 764 | 26273 | 186 | 25287 |
| 20-#11 | 4.00 | MA | 8262 | 3203 | 14340 | 2477 | 17030 | 1976 | 18701 | 1558 | 20920 | 865 | 26291 | 391 | 23781 |
| 6E | | MI | 7010 | 3203 | 12366 | 2444 | 14540 | 1945 | 15779 | 1518 | 17534 | 823 | 21912 | 338 | 20043 |
| 20-#11 | 4.00 | MA | 7877 | 3203 | 13765 | 2475 | 16269 | 1973 | 17776 | 1563 | 19679 | 860 | 24862 | 320 | 22929 |
| 7L-5S | | MI | 7346 | 3203 | 12865 | 2447 | 15202 | 1940 | 16562 | 1523 | 18538 | 818 | 23133 | 400 | 20831 |
| 22-#11 | 4.40 | MA | 8263 | 3316 | 14636 | 2546 | 17374 | 2025 | 19111 | 1596 | 21435 | 851 | 27173 | 297 | 25347 |
| 7L-6S | | MI | 7323 | 3316 | 13096 | 2515 | 15463 | 1997 | 16875 | 1548 | 18975 | 811 | 23791 | 310 | 22080 |

## RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

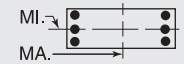
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.08 | MA | 8379 | 2534 | 12239 | 2089 | 14273 | 1700 | 15136 | 1411 | 15679 | 986 | 18796 | 915 | 8457 |
| 2E | | MI | 6715 | 2534 | 10029 | 2047 | 11479 | 1662 | 12016 | 1372 | 12316 | 951 | 14599 | 869 | 6723 |
| 4-#18 | 1.92 | MA | 9255 | 2788 | 14333 | 2230 | 16824 | 1801 | 18089 | 1465 | 19536 | 947 | 23781 | 838 | 14483 |
| 2E | | MI | 7352 | 2788 | 11637 | 2183 | 13322 | 1750 | 14164 | 1414 | 15119 | 898 | 18140 | 766 | 11376 |
| 6-#11 | 1.13 | MA | 8455 | 2547 | 12323 | 2106 | 14432 | 1714 | 15358 | 1422 | 16012 | 992 | 19268 | 922 | 8826 |
| 2L-3S | | MI | 6208 | 2547 | 9363 | 2063 | 10709 | 1674 | 11122 | 1391 | 11153 | 964 | 13115 | 787 | 7040 |
| 6-#11 | 1.13 | MA | 7718 | 2547 | 11380 | 2105 | 13237 | 1711 | 13910 | 1428 | 14099 | 998 | 16739 | 831 | 8832 |
| 3L-2S | | MI | 6778 | 2547 | 10092 | 2066 | 11631 | 1679 | 12217 | 1386 | 12594 | 959 | 14993 | 878 | 7013 |
| 6-#14 | 1.62 | MA | 9001 | 2697 | 13584 | 2191 | 15978 | 1775 | 17199 | 1458 | 18393 | 973 | 22372 | 883 | 12469 |
| 2L-3S | | MI | 6384 | 2697 | 10029 | 2143 | 11479 | 1728 | 12016 | 1422 | 12316 | 940 | 14599 | 694 | 9826 |
| 6-#14 | 1.62 | MA | 7969 | 2697 | 12239 | 2189 | 14273 | 1770 | 15136 | 1466 | 15679 | 980 | 18796 | 751 | 12401 |
| 3L-2S | | MI | 7179 | 2697 | 11067 | 2149 | 12781 | 1736 | 13561 | 1415 | 14350 | 932 | 17239 | 825 | 9840 |
| 6-#18 | 2.88 | MA | 10268 | 3079 | 16673 | 2412 | 19791 | 1934 | 21633 | 1545 | 24199 | 919 | 29887 | 772 | 21391 |
| 2L-3S | | MI | 6782 | 3079 | 11637 | 2352 | 13322 | 1864 | 14164 | 1498 | 15119 | 871 | 18140 | 443 | 16373 |
| 6-#18 | 2.88 | MA | 8549 | 3079 | 14333 | 2405 | 16824 | 1923 | 18089 | 1559 | 19536 | 932 | 23781 | 538 | 20902 |
| 3L-2S | | MI | 8105 | 3079 | 13431 | 2365 | 15534 | 1877 | 16792 | 1485 | 18577 | 858 | 22588 | 677 | 16692 |
| 8-#11 | 1.50 | MA | 8895 | 2660 | 13265 | 2177 | 15627 | 1765 | 16806 | 1455 | 17926 | 984 | 21797 | 902 | 11636 |
| 2L-4S | | MI | 6128 | 2660 | 9541 | 2130 | 10890 | 1731 | 11341 | 1417 | 11485 | 957 | 13757 | 672 | 9143 |
| 8-#11 | 1.50 | MA | 8169 | 2660 | 12323 | 2176 | 14432 | 1762 | 15358 | 1460 | 16012 | 989 | 19268 | 811 | 11610 |
| 3E | | MI | 6546 | 2660 | 10092 | 2134 | 11631 | 1726 | 12217 | 1422 | 12594 | 952 | 14993 | 759 | 9205 |
| 8-#11 | 1.50 | MA | 7636 | 2660 | 11617 | 2175 | 13479 | 1770 | 14203 | 1456 | 14494 | 984 | 17613 | 719 | 11479 |
| 4L-2S | | MI | 7108 | 2660 | 10822 | 2137 | 12554 | 1731 | 13313 | 1417 | 14036 | 947 | 16872 | 850 | 9202 |
| 8-#14 | 2.16 | MA | 9604 | 2861 | 14929 | 2293 | 17683 | 1850 | 19262 | 1506 | 21107 | 960 | 25948 | 851 | 16451 |
| 2L-4S | | MI | 6268 | 2861 | 10281 | 2240 | 11735 | 1809 | 12325 | 1457 | 12785 | 928 | 15499 | 527 | 12132 |
| 8-#14 | 2.16 | MA | 8593 | 2861 | 13584 | 2291 | 15978 | 1845 | 17199 | 1513 | 18393 | 967 | 22372 | 720 | 16328 |
| 3E | | MI | 6850 | 2861 | 11067 | 2245 | 12781 | 1801 | 13561 | 1465 | 14350 | 921 | 17239 | 650 | 12864 |
| 8-#14 | 2.16 | MA | 7851 | 2861 | 12575 | 2289 | 14615 | 1855 | 15551 | 1506 | 16239 | 960 | 20032 | 589 | 15372 |
| 4L-2S | | MI | 7631 | 2861 | 12105 | 2251 | 14082 | 1809 | 15107 | 1457 | 16384 | 913 | 19878 | 781 | 12929 |
| 8-#18 | 3.85 | MA | 11246 | 3370 | 19012 | 2593 | 22757 | 2067 | 25177 | 1626 | 28862 | 891 | 35992 | 706 | 28263 |
| 2L-4S | | MI | 6608 | 3370 | 12065 | 2521 | 13756 | 2003 | 14690 | 1556 | 15917 | 845 | 19645 | 143 | 18811 |
| 8-#18 | 3.85 | MA | 9574 | 3370 | 16673 | 2587 | 19791 | 2056 | 21633 | 1639 | 24199 | 905 | 29887 | 473 | 27434 |
| 3E | | MI | 7565 | 3370 | 13431 | 2534 | 15534 | 1990 | 16792 | 1569 | 18577 | 832 | 22588 | 354 | 21062 |
| 8-#18 | 3.85 | MA | 8346 | 3370 | 14910 | 2580 | 17411 | 2070 | 18800 | 1626 | 20610 | 918 | 25879 | 247 | 24094 |
| 4L-2S | | MI | 8829 | 3370 | 15225 | 2547 | 17746 | 2003 | 19419 | 1556 | 22036 | 819 | 27036 | 587 | 21965 |
| 10-#11 | 1.87 | MA | 9326 | 2773 | 14207 | 2248 | 16822 | 1817 | 18254 | 1488 | 19840 | 976 | 24326 | 881 | 14430 |
| 2L-5S | | MI | 6089 | 2773 | 9711 | 2208 | 11143 | 1777 | 11643 | 1452 | 11847 | 940 | 14326 | 601 | 10633 |
| 10-#11 | 1.87 | MA | 8610 | 2773 | 13265 | 2247 | 15627 | 1814 | 16806 | 1493 | 17926 | 981 | 21797 | 790 | 14378 |
| 3L-4S | | MI | 6465 | 2773 | 10271 | 2201 | 11813 | 1783 | 12437 | 1447 | 12926 | 945 | 15636 | 644 | 11222 |
| 10-#11 | 1.87 | MA | 8085 | 2773 | 12559 | 2246 | 14674 | 1822 | 15651 | 1489 | 16407 | 976 | 20142 | 699 | 14215 |
| 4L-3S | | MI | 6877 | 2773 | 10822 | 2204 | 12554 | 1777 | 13313 | 1452 | 14036 | 940 | 16872 | 731 | 11356 |
| 10-#11 | 1.87 | MA | 7608 | 2773 | 11844 | 2255 | 13815 | 1819 | 14603 | 1494 | 15021 | 981 | 18381 | 657 | 13367 |
| 5L-2S | | MI | 7431 | 2773 | 11552 | 2208 | 13476 | 1783 | 14408 | 1447 | 15477 | 935 | 18750 | 822 | 11378 |
| 10-#14 | 2.70 | MA | 10193 | 3024 | 16273 | 2396 | 19389 | 1924 | 21325 | 1553 | 23821 | 947 | 29524 | 819 | 20418 |
| 2L-5S | | MI | 6211 | 3024 | 10520 | 2351 | 12092 | 1875 | 12751 | 1507 | 13295 | 902 | 16297 | 421 | 14287 |
| 10-#14 | 2.70 | MA | 9200 | 3024 | 14929 | 2393 | 17683 | 1919 | 19262 | 1560 | 21107 | 954 | 25948 | 688 | 20247 |
| 3L-4S | | MI | 6732 | 3024 | 11319 | 2342 | 13036 | 1882 | 13871 | 1500 | 14819 | 909 | 18138 | 484 | 14982 |
| 10-#14 | 2.70 | MA | 8472 | 3024 | 13919 | 2391 | 16321 | 1929 | 17614 | 1553 | 18953 | 947 | 23607 | 557 | 19104 |
| 4L-3S | | MI | 7304 | 3024 | 12105 | 2348 | 14082 | 1875 | 15107 | 1507 | 16384 | 902 | 19878 | 606 | 15890 |
| 10-#14 | 2.70 | MA | 7811 | 3024 | 12896 | 2404 | 15092 | 1924 | 16119 | 1560 | 16987 | 954 | 21114 | 496 | 18074 |
| 5L-2S | | MI | 8073 | 3024 | 13143 | 2353 | 15384 | 1882 | 16653 | 1500 | 18418 | 894 | 22518 | 738 | 15997 |
| 10-#18 | 4.81 | MA | 10604 | 3660 | 19012 | 2768 | 22757 | 2189 | 25177 | 1719 | 28862 | 877 | 35992 | 407 | 33745 |
| 3L-4S | | MI | 7372 | 3660 | 13859 | 2702 | 15968 | 2130 | 17317 | 1627 | 19375 | 805 | 24093 | 54 | 23769 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis

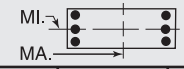


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 4.81 | MA | 9425 | 3660 | 17250 | 2762 | 20378 | 2203 | 22345 | 1706 | 25273 | 890 | 31985 | 181 | 30633 |
| 4L-3S | | MI | 8295 | 3660 | 15225 | 2715 | 17746 | 2117 | 19419 | 1641 | 22036 | 792 | 27036 | 264 | 25822 |
| 10-#18 | 4.81 | MA | 8338 | 3660 | 15461 | 2782 | 18231 | 2191 | 19775 | 1719 | 21782 | 877 | 27727 | 71 | 27358 |
| 5L-2S | | MI | 9521 | 3660 | 17019 | 2728 | 19958 | 2130 | 22046 | 1627 | 25494 | 779 | 31484 | 498 | 27214 |
| 12-#11 | 2.25 | MA | 9748 | 2887 | 15150 | 2319 | 18017 | 1869 | 19702 | 1520 | 21753 | 968 | 26855 | 861 | 17215 |
| 2L-6S | | MI | 6068 | 2887 | 9941 | 2276 | 11404 | 1834 | 11955 | 1477 | 12285 | 933 | 14983 | 510 | 12158 |
| 12-#11 | 2.25 | MA | 9042 | 2887 | 14207 | 2318 | 16822 | 1866 | 18254 | 1526 | 19840 | 973 | 24326 | 770 | 17140 |
| 3L-5S | | MI | 6424 | 2887 | 10441 | 2279 | 12066 | 1829 | 12738 | 1482 | 13288 | 928 | 16204 | 573 | 12683 |
| 12-#11 | 2.25 | MA | 8525 | 2887 | 13502 | 2317 | 15869 | 1874 | 17098 | 1521 | 18321 | 968 | 22671 | 679 | 16844 |
| 4E | | MI | 6795 | 2887 | 11001 | 2272 | 12735 | 1834 | 13532 | 1477 | 14368 | 933 | 17514 | 616 | 13232 |
| 12-#11 | 2.25 | MA | 8055 | 2887 | 12786 | 2326 | 15010 | 1871 | 16051 | 1527 | 16935 | 973 | 20910 | 636 | 16032 |
| 5L-3S | | MI | 7201 | 2887 | 11552 | 2275 | 13476 | 1829 | 14408 | 1482 | 15477 | 928 | 18750 | 702 | 13499 |
| 12-#11 | 2.25 | MA | 7605 | 2887 | 12150 | 2325 | 14162 | 1878 | 15019 | 1522 | 15602 | 978 | 19145 | 560 | 15339 |
| 6L-2S | | MI | 7749 | 2887 | 12282 | 2279 | 14399 | 1834 | 15504 | 1477 | 16919 | 923 | 20629 | 794 | 13540 |
| 12-#14 | 3.25 | MA | 9793 | 3188 | 16273 | 2496 | 19389 | 1994 | 21325 | 1607 | 23821 | 941 | 29524 | 656 | 24161 |
| 3L-5S | | MI | 6674 | 3188 | 11558 | 2454 | 13394 | 1948 | 14296 | 1550 | 15329 | 883 | 18937 | 377 | 17073 |
| 12-#14 | 3.25 | MA | 9079 | 3188 | 15264 | 2493 | 18026 | 2004 | 19677 | 1600 | 21667 | 934 | 27183 | 525 | 22859 |
| 4E | | MI | 7187 | 3188 | 12357 | 2444 | 14338 | 1956 | 15417 | 1543 | 16853 | 890 | 20778 | 440 | 17855 |
| 12-#14 | 3.25 | MA | 8430 | 3188 | 14241 | 2506 | 16798 | 1999 | 18182 | 1607 | 19701 | 941 | 24690 | 464 | 21870 |
| 5L-3S | | MI | 7749 | 3188 | 13143 | 2450 | 15384 | 1948 | 16653 | 1550 | 18418 | 883 | 22518 | 562 | 18908 |
| 12-#14 | 3.25 | MA | 7808 | 3188 | 13330 | 2504 | 15584 | 2009 | 16708 | 1600 | 17811 | 949 | 22195 | 355 | 20241 |
| 6L-2S | | MI | 8506 | 3188 | 14181 | 2455 | 16685 | 1956 | 18198 | 1543 | 20453 | 875 | 25157 | 694 | 19053 |
| 12-#18 | 5.77 | MA | 10419 | 3951 | 19589 | 2944 | 23345 | 2336 | 25889 | 1786 | 29936 | 863 | 38090 | 115 | 37206 |
| 4E | | MI | 8110 | 3951 | 15653 | 2884 | 18180 | 2257 | 19945 | 1699 | 22833 | 766 | 28541 | -36 | 28317 |
| 12-#18 | 5.77 | MA | 9372 | 3951 | 17800 | 2964 | 21198 | 2324 | 23320 | 1800 | 26445 | 849 | 33832 | 6 | 33801 |
| 5L-3S | | MI | 9005 | 3951 | 17019 | 2897 | 19958 | 2243 | 22046 | 1712 | 25494 | 752 | 31484 | 175 | 30639 |
| 14-#11 | 2.63 | MA | 9465 | 3000 | 15150 | 2389 | 18017 | 1918 | 19702 | 1559 | 21753 | 965 | 26855 | 749 | 19898 |
| 3L-6S | | MI | 6402 | 3000 | 10671 | 2347 | 12327 | 1886 | 13051 | 1508 | 13726 | 921 | 16861 | 482 | 14161 |
| 14-#11 | 2.63 | MA | 8956 | 3000 | 14444 | 2388 | 17064 | 1926 | 18546 | 1554 | 20234 | 960 | 25199 | 658 | 19476 |
| 4L-5S | | MI | 6753 | 3000 | 11170 | 2350 | 12988 | 1881 | 13834 | 1513 | 14730 | 916 | 18083 | 545 | 14741 |
| 14-#11 | 2.63 | MA | 8494 | 3000 | 13729 | 2397 | 16205 | 1923 | 17499 | 1560 | 18848 | 965 | 23438 | 616 | 18706 |
| 5L-4S | | MI | 7119 | 3000 | 11730 | 2343 | 13658 | 1886 | 14628 | 1508 | 15810 | 921 | 19393 | 588 | 15255 |
| 14-#11 | 2.63 | MA | 8050 | 3000 | 13092 | 2396 | 15357 | 1930 | 16467 | 1555 | 17516 | 970 | 21674 | 540 | 17960 |
| 6L-3S | | MI | 7520 | 3000 | 12282 | 2346 | 14399 | 1881 | 15504 | 1513 | 16919 | 916 | 20629 | 674 | 15635 |
| 14-#11 | 2.63 | MA | 7615 | 3000 | 12472 | 2394 | 14537 | 1927 | 15465 | 1561 | 16164 | 965 | 20111 | 469 | 17145 |
| 7L-2S | | MI | 8062 | 3000 | 13011 | 2350 | 15321 | 1886 | 16599 | 1508 | 18360 | 911 | 22507 | 765 | 15695 |
| 14-#14 | 3.79 | MA | 9672 | 3351 | 16609 | 2595 | 19731 | 2079 | 21740 | 1647 | 24381 | 921 | 30759 | 493 | 26632 |
| 4L-5S | | MI | 7128 | 3351 | 12596 | 2556 | 14695 | 2021 | 15842 | 1593 | 17363 | 863 | 21577 | 333 | 19878 |
| 14-#14 | 3.79 | MA | 9035 | 3351 | 15586 | 2608 | 18503 | 2074 | 20245 | 1654 | 22415 | 928 | 28265 | 433 | 25564 |
| 5L-4S | | MI | 7633 | 3351 | 13395 | 2547 | 15639 | 2029 | 16963 | 1585 | 18887 | 871 | 23418 | 396 | 20744 |
| 14-#14 | 3.79 | MA | 8424 | 3351 | 14674 | 2606 | 17290 | 2084 | 18771 | 1647 | 20525 | 936 | 25771 | 323 | 24002 |
| 6L-3S | | MI | 8186 | 3351 | 14181 | 2552 | 16685 | 2021 | 18198 | 1593 | 20453 | 863 | 25157 | 519 | 21921 |
| 14-#14 | 3.79 | MA | 7826 | 3351 | 13786 | 2603 | 16116 | 2079 | 17341 | 1654 | 18607 | 928 | 23560 | 221 | 22285 |
| 7L-2S | | MI | 8932 | 3351 | 15219 | 2558 | 17987 | 2029 | 19744 | 1585 | 22487 | 856 | 27797 | 650 | 22100 |
| 14-#18 | 6.73 | MA | 10372 | 4242 | 20139 | 3145 | 24165 | 2457 | 26864 | 1880 | 31109 | 822 | 39938 | -60 | 39491 |
| 5L-4S | | MI | 8830 | 4242 | 17447 | 3066 | 20392 | 2383 | 22572 | 1770 | 26292 | 726 | 32989 | -125 | 32188 |
| 16-#11 | 3.00 | MA | 9380 | 3114 | 15386 | 2458 | 18259 | 1977 | 19994 | 1587 | 22148 | 952 | 27728 | 638 | 22119 |
| 4L-6S | | MI | 6730 | 3114 | 11400 | 2418 | 13249 | 1937 | 14146 | 1538 | 15168 | 909 | 18740 | 454 | 16175 |
| 16-#11 | 3.00 | MA | 8924 | 3114 | 14671 | 2468 | 17400 | 1974 | 18947 | 1593 | 20762 | 957 | 25967 | 596 | 21388 |
| 5E | | MI | 7077 | 3114 | 11900 | 2421 | 13911 | 1932 | 14929 | 1543 | 16172 | 904 | 19961 | 516 | 16806 |
| 16-#11 | 3.00 | MA | 8486 | 3114 | 14034 | 2466 | 16552 | 1982 | 17915 | 1588 | 19429 | 962 | 24203 | 520 | 20591 |
| 6L-4S | | MI | 7438 | 3114 | 12460 | 2414 | 14580 | 1937 | 15723 | 1538 | 17251 | 909 | 21271 | 560 | 17289 |
| 16-#11 | 3.00 | MA | 8058 | 3114 | 13414 | 2465 | 15732 | 1979 | 16913 | 1594 | 18078 | 957 | 22640 | 448 | 19805 |
| 7L-3S | | MI | 7835 | 3114 | 13011 | 2417 | 15321 | 1932 | 16599 | 1543 | 18360 | 904 | 22507 | 646 | 17767 |
| 16-#11 | 3.00 | MA | 7634 | 3114 | 12803 | 2464 | 14928 | 1976 | 15910 | 1589 | 16774 | 962 | 20997 | 399 | 18699 |
| 8L-2S | | MI | 8370 | 3114 | 13741 | 2420 | 16244 | 1937 | 17695 | 1538 | 19802 | 899 | 24385 | 737 | 17845 |
| 16-#14 | 4.33 | MA | 9629 | 3515 | 16930 | 2710 | 20208 | 2149 | 22308 | 1702 | 25129 | 915 | 31841 | 401 | 29274 |
| 5E | | MI | 7605 | 3515 | 13634 | 2658 | 15997 | 2095 | 17388 | 1635 | 19398 | 844 | 24216 | 289 | 22701 |

## RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 4.33 | MA | 9029 | 3515 | 16019 | 2708 | 18995 | 2159 | 20834 | 1694 | 23239 | 923 | 29347 | 291 | 27774 |
| 6L-4S | | MI | 8095 | 3515 | 14433 | 2649 | 16941 | 2102 | 18508 | 1628 | 20921 | 852 | 26057 | 352 | 23648 |
| 16-#14 | 4.33 | MA | 8441 | 3515 | 15131 | 2706 | 17821 | 2154 | 19404 | 1702 | 21321 | 915 | 27136 | 189 | 26017 |
| 7L-3S | | MI | 8629 | 3515 | 15219 | 2654 | 17987 | 2095 | 19744 | 1635 | 22487 | 844 | 27797 | 475 | 24930 |
| 18-#11 | 3.37 | MA | 9347 | 3227 | 15613 | 2539 | 18596 | 2026 | 20394 | 1626 | 22675 | 949 | 28496 | 575 | 24075 |
| 5L-6S | | MI | 7053 | 3227 | 12130 | 2489 | 14172 | 1989 | 15242 | 1568 | 16609 | 897 | 20618 | 426 | 18196 |
| 18-#11 | 3.37 | MA | 8916 | 3227 | 14977 | 2537 | 17747 | 2034 | 19362 | 1621 | 21343 | 954 | 26732 | 499 | 23229 |
| 6L-5S | | MI | 7396 | 3227 | 12630 | 2492 | 14833 | 1984 | 16025 | 1574 | 17613 | 892 | 21840 | 488 | 18876 |
| 18-#11 | 3.37 | MA | 8493 | 3227 | 14356 | 2536 | 16927 | 2031 | 18361 | 1627 | 19991 | 949 | 25169 | 428 | 22428 |
| 7L-4S | | MI | 7753 | 3227 | 13190 | 2485 | 15503 | 1989 | 16819 | 1568 | 18693 | 897 | 23150 | 531 | 19332 |
| 18-#11 | 3.37 | MA | 8075 | 3227 | 13745 | 2535 | 16123 | 2028 | 17357 | 1622 | 18687 | 954 | 23526 | 378 | 21338 |
| 8L-3S | | MI | 8145 | 3227 | 13741 | 2488 | 16244 | 1984 | 17695 | 1574 | 19802 | 892 | 24385 | 618 | 19896 |
| 18-#14 | 4.87 | MA | 9622 | 3679 | 17364 | 2810 | 20700 | 2233 | 22897 | 1741 | 25953 | 910 | 32922 | 259 | 31557 |
| 6L-5S | | MI | 8041 | 3679 | 14672 | 2760 | 17298 | 2168 | 18934 | 1678 | 21432 | 825 | 26856 | 246 | 25539 |
| 18-#14 | 4.87 | MA | 9044 | 3679 | 16476 | 2808 | 19527 | 2228 | 21467 | 1749 | 24035 | 902 | 30712 | 157 | 29761 |
| 7L-4S | | MI | 8522 | 3679 | 15471 | 2751 | 18242 | 2176 | 20054 | 1670 | 22956 | 833 | 28697 | 308 | 26562 |
| 20-#11 | 3.75 | MA | 9339 | 3341 | 15919 | 2608 | 18942 | 2086 | 20810 | 1654 | 23256 | 946 | 29260 | 479 | 25875 |
| 6E | | MI | 7372 | 3341 | 12860 | 2559 | 15094 | 2041 | 16337 | 1599 | 18051 | 885 | 22497 | 398 | 20225 |
| 20-#11 | 3.75 | MA | 8922 | 3341 | 15299 | 2607 | 18122 | 2083 | 19809 | 1660 | 21905 | 940 | 27698 | 407 | 25042 |
| 7L-5S | | MI | 7711 | 3341 | 13359 | 2563 | 15756 | 2035 | 17120 | 1604 | 19055 | 880 | 23718 | 460 | 20950 |
| 20-#11 | 3.75 | MA | 8510 | 3341 | 14688 | 2606 | 17318 | 2080 | 18805 | 1655 | 20601 | 946 | 26055 | 358 | 23984 |
| 8L-4S | | MI | 8064 | 3341 | 13919 | 2556 | 16425 | 2041 | 17914 | 1599 | 20134 | 885 | 25028 | 503 | 21382 |
| 20-#14 | 5.41 | MA | 9696 | 3842 | 17820 | 2910 | 21232 | 2303 | 23530 | 1796 | 26750 | 889 | 34288 | 125 | 33514 |
| 7L-5S | | MI | 8470 | 3842 | 15710 | 2863 | 18600 | 2241 | 20479 | 1720 | 23466 | 806 | 29495 | 202 | 28390 |
| 22-#11 | 4.13 | MA | 9344 | 3454 | 16241 | 2678 | 19318 | 2135 | 21257 | 1692 | 23818 | 932 | 30227 | 387 | 27664 |
| 7L-6S | | MI | 7687 | 3454 | 13590 | 2630 | 16017 | 2092 | 17433 | 1629 | 19492 | 873 | 24375 | 370 | 22260 |
| 22-#11 | 4.13 | MA | 8937 | 3454 | 15630 | 2677 | 18514 | 2132 | 20253 | 1688 | 22514 | 937 | 28583 | 338 | 26634 |
| 8L-5S | | MI | 8022 | 3454 | 14089 | 2634 | 16678 | 2087 | 18216 | 1634 | 20496 | 868 | 25597 | 432 | 23027 |
| 24-#11 | 4.50 | MA | 9360 | 3567 | 16572 | 2748 | 19709 | 2184 | 21701 | 1721 | 24428 | 929 | 31112 | 317 | 29290 |
| 8L-6S | | MI | 8030 | 3567 | 14319 | 2701 | 16939 | 2144 | 18529 | 1659 | 20934 | 861 | 26254 | 342 | 24301 |

## RECTANGULAR TIED COLUMNS 26" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.02 | MA | 9406 | 2672 | 13602 | 2218 | 15912 | 1806 | 16881 | 1502 | 17483 | 1058 | 20974 | 988 | 9065 |
| 2E | | MI | 7076 | 2672 | 10526 | 2162 | 12034 | 1757 | 12573 | 1453 | 12831 | 1013 | 15181 | 929 | 6750 |
| 4-#18 | 1.81 | MA | 10368 | 2926 | 15865 | 2359 | 18668 | 1908 | 20128 | 1560 | 21689 | 1022 | 26439 | 917 | 15563 |
| 2E | | MI | 7716 | 2926 | 12140 | 2297 | 13878 | 1844 | 14721 | 1493 | 15632 | 959 | 18718 | 825 | 11417 |
| 6-#11 | 1.06 | MA | 9488 | 2685 | 13689 | 2236 | 16080 | 1820 | 17109 | 1512 | 17836 | 1065 | 21474 | 995 | 9458 |
| 2L-3S | | MI | 6568 | 2685 | 9857 | 2179 | 11263 | 1770 | 11680 | 1472 | 11670 | 1026 | 13699 | 847 | 7070 |
| 6-#11 | 1.06 | MA | 8692 | 2685 | 12676 | 2235 | 14795 | 1818 | 15553 | 1519 | 15765 | 1070 | 18727 | 904 | 9463 |
| 3L-2S | | MI | 7139 | 2685 | 10586 | 2182 | 12185 | 1775 | 12775 | 1467 | 13111 | 1021 | 15578 | 938 | 7039 |
| 6-#14 | 1.53 | MA | 10085 | 2835 | 15049 | 2321 | 17747 | 1881 | 19104 | 1549 | 20424 | 1047 | 24863 | 959 | 13381 |
| 2L-3S | | MI | 6744 | 2835 | 10526 | 2258 | 12034 | 1823 | 12573 | 1503 | 12831 | 1001 | 15181 | 753 | 9872 |
| 6-#14 | 1.53 | MA | 8970 | 2835 | 13602 | 2319 | 15912 | 1877 | 16881 | 1558 | 17483 | 1054 | 20974 | 827 | 13312 |
| 3L-2S | | MI | 7542 | 2835 | 11564 | 2264 | 13335 | 1830 | 14119 | 1495 | 14866 | 994 | 17821 | 885 | 9873 |
| 6-#18 | 2.71 | MA | 11475 | 3217 | 18386 | 2541 | 21865 | 2041 | 23979 | 1642 | 26756 | 997 | 33100 | 857 | 23011 |
| 2L-3S | | MI | 7143 | 3217 | 12140 | 2466 | 13878 | 1957 | 14721 | 1578 | 15632 | 933 | 18718 | 502 | 16477 |
| 6-#18 | 2.71 | MA | 9614 | 3217 | 15865 | 2536 | 18668 | 2031 | 20128 | 1656 | 21689 | 1011 | 26439 | 623 | 22522 |
| 3L-2S | | MI | 8472 | 3217 | 13934 | 2479 | 16090 | 1970 | 17348 | 1565 | 19090 | 919 | 23166 | 736 | 16743 |
| 8-#11 | 1.41 | MA | 9967 | 2798 | 14703 | 2307 | 17365 | 1872 | 18666 | 1545 | 19907 | 1058 | 24220 | 977 | 12478 |
| 2L-4S | | MI | 6487 | 2798 | 10035 | 2246 | 11444 | 1826 | 11900 | 1498 | 12002 | 1020 | 14342 | 732 | 9196 |
| 8-#11 | 1.41 | MA | 9183 | 2798 | 13689 | 2306 | 16080 | 1869 | 17109 | 1551 | 17836 | 1063 | 21474 | 885 | 12452 |
| 3E | | MI | 6907 | 2798 | 10586 | 2249 | 12185 | 1821 | 12775 | 1503 | 13111 | 1014 | 15578 | 819 | 9242 |
| 8-#11 | 1.41 | MA | 8610 | 2798 | 12932 | 2305 | 15056 | 1878 | 15870 | 1548 | 16192 | 1058 | 19672 | 794 | 12322 |
| 4L-2S | | MI | 7470 | 2798 | 11316 | 2253 | 13108 | 1826 | 13871 | 1498 | 14553 | 1009 | 17456 | 910 | 9231 |

## RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

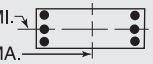
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.04 | MA | 10743 | 2999 | 16496 | 2423 | 19582 | 1956 | 21327 | 1597 | 23366 | 1035 | 28752 | 930 | 17666 |
| 2L-4S | | MI | 6627 | 2999 | 10778 | 2355 | 12289 | 1904 | 12883 | 1538 | 13300 | 990 | 16081 | 587 | 12300 |
| 8-#14 | 2.04 | MA | 9650 | 2999 | 15049 | 2421 | 17747 | 1952 | 19104 | 1605 | 20424 | 1043 | 24863 | 798 | 17543 |
| 3E | | MI | 7212 | 2999 | 11564 | 2361 | 13335 | 1896 | 14119 | 1545 | 14866 | 982 | 17821 | 710 | 12918 |
| 8-#14 | 2.04 | MA | 8850 | 2999 | 13966 | 2420 | 16283 | 1963 | 17331 | 1599 | 18090 | 1035 | 22316 | 667 | 16669 |
| 4L-2S | | MI | 7996 | 2999 | 12602 | 2366 | 14637 | 1904 | 15665 | 1538 | 16900 | 975 | 20461 | 841 | 12968 |
| 8-#18 | 3.62 | MA | 12544 | 3508 | 20907 | 2723 | 25063 | 2174 | 27830 | 1725 | 31823 | 973 | 39761 | 797 | 30423 |
| 2L-4S | | MI | 6967 | 3508 | 12568 | 2634 | 14312 | 2097 | 15247 | 1636 | 16429 | 906 | 20222 | 202 | 19034 |
| 8-#18 | 3.62 | MA | 10733 | 3508 | 18386 | 2718 | 21865 | 2164 | 23979 | 1738 | 26756 | 986 | 33100 | 563 | 29798 |
| 3E | | MI | 7931 | 3508 | 13934 | 2647 | 16090 | 2084 | 17348 | 1649 | 19090 | 893 | 23166 | 413 | 21358 |
| 8-#18 | 3.62 | MA | 9407 | 3508 | 16491 | 2713 | 19307 | 2180 | 20902 | 1725 | 22734 | 973 | 28736 | 333 | 26143 |
| 4L-2S | | MI | 9205 | 3508 | 15728 | 2660 | 18302 | 2097 | 19976 | 1636 | 22548 | 880 | 27614 | 646 | 22022 |
| 10-#11 | 1.76 | MA | 10436 | 2911 | 15716 | 2377 | 18650 | 1924 | 20223 | 1578 | 21979 | 1050 | 26967 | 958 | 15483 |
| 2L-5S | | MI | 6447 | 2911 | 10205 | 2324 | 11697 | 1873 | 12201 | 1533 | 12364 | 1002 | 14911 | 661 | 10750 |
| 10-#11 | 1.76 | MA | 9663 | 2911 | 14703 | 2377 | 17365 | 1921 | 18666 | 1584 | 19907 | 1056 | 24220 | 867 | 15431 |
| 3L-4S | | MI | 6825 | 2911 | 10765 | 2317 | 12367 | 1878 | 12995 | 1528 | 13443 | 1007 | 16221 | 704 | 11322 |
| 10-#11 | 1.76 | MA | 9098 | 2911 | 13945 | 2376 | 16341 | 1929 | 17426 | 1580 | 18263 | 1050 | 22419 | 776 | 15268 |
| 4L-3S | | MI | 7239 | 2911 | 11316 | 2320 | 13108 | 1873 | 13871 | 1533 | 14553 | 1002 | 17456 | 791 | 11397 |
| 10-#11 | 1.76 | MA | 8585 | 2911 | 13178 | 2386 | 15421 | 1927 | 16303 | 1587 | 16763 | 1056 | 20513 | 732 | 14425 |
| 5L-2S | | MI | 7795 | 2911 | 12046 | 2324 | 14030 | 1878 | 14966 | 1528 | 15994 | 997 | 19335 | 882 | 11410 |
| 10-#14 | 2.55 | MA | 11385 | 3162 | 17943 | 2525 | 21417 | 2031 | 23551 | 1644 | 26307 | 1024 | 32642 | 901 | 21937 |
| 2L-5S | | MI | 6569 | 3162 | 11017 | 2467 | 12647 | 1969 | 13308 | 1588 | 13811 | 963 | 16880 | 481 | 14440 |
| 10-#14 | 2.55 | MA | 10311 | 3162 | 16496 | 2523 | 19582 | 2027 | 21327 | 1653 | 23366 | 1031 | 28752 | 769 | 21766 |
| 3L-4S | | MI | 7093 | 3162 | 11816 | 2457 | 13591 | 1977 | 14429 | 1580 | 15334 | 971 | 18721 | 543 | 15146 |
| 10-#14 | 2.55 | MA | 9527 | 3162 | 15413 | 2522 | 18118 | 2038 | 19554 | 1646 | 21031 | 1024 | 26206 | 638 | 20692 |
| 4L-3S | | MI | 7668 | 3162 | 12602 | 2463 | 14637 | 1969 | 15665 | 1588 | 16900 | 963 | 20461 | 666 | 15949 |
| 10-#14 | 2.55 | MA | 8815 | 3162 | 14315 | 2535 | 16801 | 2034 | 17946 | 1654 | 18901 | 1031 | 23499 | 577 | 19523 |
| 5L-2S | | MI | 8440 | 3162 | 13640 | 2468 | 15938 | 1977 | 17211 | 1580 | 18934 | 956 | 23100 | 797 | 16040 |
| 10-#18 | 4.52 | MA | 11817 | 3798 | 20907 | 2899 | 25063 | 2297 | 27830 | 1821 | 31823 | 961 | 39761 | 504 | 36792 |
| 3L-4S | | MI | 7734 | 3798 | 14362 | 2816 | 16524 | 2223 | 17874 | 1707 | 19888 | 866 | 24670 | 113 | 23987 |
| 10-#18 | 4.52 | MA | 10527 | 3798 | 19012 | 2894 | 22504 | 2313 | 24753 | 1808 | 27800 | 948 | 35397 | 274 | 33205 |
| 4L-3S | | MI | 8666 | 3798 | 15728 | 2829 | 18302 | 2210 | 19976 | 1720 | 22548 | 853 | 27614 | 323 | 26110 |
| 10-#18 | 4.52 | MA | 9355 | 3798 | 17091 | 2916 | 20198 | 2303 | 21962 | 1821 | 24131 | 961 | 30752 | 165 | 29836 |
| 5L-2S | | MI | 9902 | 3798 | 17522 | 2842 | 20514 | 2223 | 22603 | 1707 | 26007 | 840 | 32062 | 557 | 27276 |
| 12-#11 | 2.12 | MA | 10896 | 3025 | 16729 | 2448 | 19935 | 1975 | 21780 | 1611 | 24050 | 1043 | 29713 | 940 | 18479 |
| 2L-6S | | MI | 6426 | 3025 | 10435 | 2392 | 11958 | 1930 | 12514 | 1558 | 12802 | 995 | 15568 | 571 | 12346 |
| 12-#11 | 2.12 | MA | 10133 | 3025 | 15716 | 2448 | 18650 | 1973 | 20223 | 1617 | 21979 | 1048 | 26967 | 848 | 18404 |
| 3L-5S | | MI | 6784 | 3025 | 10935 | 2395 | 12620 | 1924 | 13296 | 1563 | 13805 | 990 | 16789 | 633 | 12799 |
| 12-#11 | 2.12 | MA | 9577 | 3025 | 14959 | 2447 | 17626 | 1981 | 18983 | 1613 | 20335 | 1043 | 25166 | 757 | 18212 |
| 4E | | MI | 7156 | 3025 | 11495 | 2388 | 13289 | 1930 | 14091 | 1558 | 14885 | 995 | 18099 | 676 | 13366 |
| 12-#11 | 2.12 | MA | 9072 | 3025 | 14192 | 2457 | 16706 | 1979 | 17860 | 1620 | 18835 | 1048 | 23259 | 714 | 17295 |
| 5L-3S | | MI | 7565 | 3025 | 12046 | 2391 | 14030 | 1924 | 14966 | 1563 | 15994 | 990 | 19335 | 763 | 13544 |
| 12-#11 | 2.12 | MA | 8587 | 3025 | 13509 | 2456 | 15797 | 1987 | 16753 | 1616 | 17392 | 1054 | 21342 | 638 | 16641 |
| 6L-2S | | MI | 8115 | 3025 | 12776 | 2394 | 14953 | 1930 | 16062 | 1558 | 17436 | 985 | 21213 | 854 | 13577 |
| 12-#14 | 3.05 | MA | 10957 | 3326 | 17943 | 2626 | 21417 | 2102 | 23551 | 1700 | 26307 | 1020 | 32642 | 741 | 25984 |
| 3L-5S | | MI | 7034 | 3326 | 12055 | 2569 | 13948 | 2043 | 14854 | 1630 | 15845 | 944 | 19520 | 437 | 17332 |
| 12-#14 | 3.05 | MA | 10188 | 3326 | 16860 | 2624 | 19953 | 2112 | 21777 | 1693 | 23972 | 1012 | 30095 | 609 | 24739 |
| 4E | | MI | 7550 | 3326 | 12854 | 2559 | 14893 | 2050 | 15975 | 1623 | 17369 | 952 | 21361 | 500 | 18016 |
| 12-#14 | 3.05 | MA | 9489 | 3326 | 15762 | 2638 | 18636 | 2108 | 20170 | 1702 | 21842 | 1020 | 27388 | 548 | 23632 |
| 5L-3S | | MI | 8115 | 3326 | 13640 | 2565 | 15938 | 2043 | 17211 | 1630 | 18934 | 944 | 23100 | 622 | 18972 |
| 12-#14 | 3.05 | MA | 8818 | 3326 | 14785 | 2636 | 17334 | 2119 | 18586 | 1695 | 19794 | 1027 | 24674 | 438 | 21961 |
| 6L-2S | | MI | 8876 | 3326 | 14678 | 2571 | 17240 | 2050 | 18756 | 1623 | 20968 | 937 | 25740 | 754 | 19099 |
| 12-#18 | 5.43 | MA | 11675 | 4089 | 21533 | 3076 | 25702 | 2446 | 28604 | 1890 | 32867 | 923 | 42058 | 214 | 40301 |
| 4E | | MI | 8476 | 4089 | 16156 | 2998 | 18736 | 2350 | 20502 | 1778 | 23346 | 827 | 29119 | 24 | 28972 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

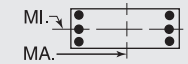
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 5.43 | MA | 10542 | 4089 | 19612 | 3098 | 23395 | 2436 | 25813 | 1904 | 29197 | 937 | 37413 | 105 | 36803 |
| 5L-3S | | MI | 9379 | 4089 | 17522 | 3011 | 20514 | 2337 | 22603 | 1791 | 26007 | 814 | 32062 | 234 | 30919 |
| 14-#11 | 2.47 | MA | 10595 | 3138 | 16729 | 2519 | 19935 | 2025 | 21780 | 1650 | 24050 | 1041 | 29713 | 830 | 21372 |
| 3L-6S | | MI | 6760 | 3138 | 11165 | 2463 | 12881 | 1981 | 13609 | 1589 | 14243 | 983 | 17446 | 542 | 14346 |
| 14-#11 | 2.47 | MA | 10046 | 3138 | 15972 | 2518 | 18911 | 2033 | 20540 | 1646 | 22406 | 1036 | 27912 | 739 | 21058 |
| 4L-5S | | MI | 7114 | 3138 | 11664 | 2466 | 13542 | 1976 | 14392 | 1594 | 15247 | 978 | 18668 | 605 | 14857 |
| 14-#11 | 2.47 | MA | 9548 | 3138 | 15205 | 2528 | 17991 | 2031 | 19417 | 1653 | 20906 | 1041 | 26006 | 696 | 20174 |
| 5L-4S | | MI | 7482 | 3138 | 12224 | 2459 | 14212 | 1981 | 15186 | 1589 | 16326 | 983 | 19978 | 648 | 15387 |
| 14-#11 | 2.47 | MA | 9071 | 3138 | 14522 | 2527 | 17082 | 2039 | 18310 | 1649 | 19463 | 1046 | 24089 | 620 | 19466 |
| 6L-3S | | MI | 7885 | 3138 | 12776 | 2462 | 14953 | 1976 | 16062 | 1594 | 17436 | 978 | 21213 | 734 | 15683 |
| 14-#11 | 2.47 | MA | 8603 | 3138 | 13858 | 2526 | 16203 | 2037 | 17237 | 1655 | 18000 | 1041 | 22389 | 549 | 18542 |
| 7L-2S | | MI | 8429 | 3138 | 13505 | 2465 | 15875 | 1981 | 17157 | 1589 | 18877 | 973 | 23092 | 826 | 15734 |
| 14-#14 | 3.56 | MA | 10834 | 3489 | 18307 | 2726 | 21788 | 2187 | 24001 | 1741 | 26914 | 1001 | 33984 | 580 | 28804 |
| 4L-5S | | MI | 7489 | 3489 | 13093 | 2671 | 15250 | 2116 | 16400 | 1673 | 17879 | 925 | 22159 | 393 | 20133 |
| 14-#14 | 3.56 | MA | 10148 | 3489 | 17209 | 2740 | 20471 | 2183 | 22393 | 1749 | 24784 | 1008 | 31277 | 519 | 27753 |
| 5L-4S | | MI | 7997 | 3489 | 13892 | 2662 | 16194 | 2124 | 17520 | 1666 | 19403 | 933 | 24000 | 456 | 20902 |
| 14-#14 | 3.56 | MA | 9490 | 3489 | 16232 | 2738 | 19169 | 2194 | 20809 | 1743 | 22735 | 1016 | 28564 | 409 | 26017 |
| 6L-3S | | MI | 8554 | 3489 | 14678 | 2667 | 17240 | 2116 | 18756 | 1673 | 20968 | 925 | 25740 | 578 | 21989 |
| 14-#14 | 3.56 | MA | 8845 | 3489 | 15280 | 2737 | 17910 | 2190 | 19272 | 1751 | 20657 | 1008 | 26160 | 306 | 24263 |
| 7L-2S | | MI | 9304 | 3489 | 15716 | 2673 | 18542 | 2124 | 20302 | 1666 | 23002 | 918 | 28379 | 710 | 22149 |
| 14-#18 | 6.33 | MA | 11633 | 4380 | 22133 | 3279 | 26592 | 2569 | 29664 | 1986 | 34264 | 912 | 44074 | 45 | 43800 |
| 5L-4S | | MI | 9199 | 4380 | 17950 | 3180 | 20948 | 2477 | 23129 | 1849 | 26804 | 787 | 33567 | -66 | 33121 |
| 16-#11 | 2.82 | MA | 10508 | 3252 | 16985 | 2589 | 20196 | 2085 | 22097 | 1679 | 24477 | 1029 | 30659 | 720 | 23903 |
| 4L-6S | | MI | 7090 | 3252 | 11894 | 2534 | 13803 | 2033 | 14705 | 1619 | 15685 | 971 | 19325 | 514 | 16356 |
| 16-#11 | 2.82 | MA | 10017 | 3252 | 16218 | 2598 | 19276 | 2083 | 20973 | 1685 | 22977 | 1034 | 28752 | 677 | 23060 |
| 5E | | MI | 7439 | 3252 | 12394 | 2537 | 14465 | 2028 | 15487 | 1624 | 16688 | 966 | 20546 | 577 | 16921 |
| 16-#11 | 2.82 | MA | 9546 | 3252 | 15536 | 2598 | 18367 | 2091 | 19867 | 1682 | 21535 | 1039 | 26836 | 601 | 22300 |
| 6L-4S | | MI | 7803 | 3252 | 12954 | 2530 | 15134 | 2033 | 16282 | 1619 | 17768 | 971 | 21856 | 620 | 17419 |
| 16-#11 | 2.82 | MA | 9084 | 3252 | 14871 | 2597 | 17488 | 2089 | 18793 | 1688 | 20072 | 1034 | 25136 | 530 | 21407 |
| 7L-3S | | MI | 8201 | 3252 | 13505 | 2533 | 15875 | 2028 | 17157 | 1624 | 18877 | 966 | 23092 | 706 | 17818 |
| 16-#11 | 2.82 | MA | 8629 | 3252 | 14216 | 2597 | 16626 | 2086 | 17718 | 1684 | 18660 | 1039 | 23356 | 480 | 20289 |
| 8L-2S | | MI | 8739 | 3252 | 14235 | 2536 | 16798 | 2033 | 18253 | 1619 | 20319 | 961 | 24970 | 797 | 17886 |
| 16-#14 | 4.07 | MA | 10794 | 3653 | 18656 | 2842 | 22306 | 2258 | 24616 | 1797 | 27725 | 997 | 35167 | 490 | 31804 |
| 5E | | MI | 7937 | 3653 | 14131 | 2773 | 16551 | 2189 | 17946 | 1716 | 19913 | 906 | 24799 | 349 | 22951 |
| 16-#14 | 4.07 | MA | 10147 | 3653 | 17678 | 2840 | 21004 | 2269 | 23032 | 1790 | 25677 | 1004 | 32453 | 380 | 30085 |
| 6L-4S | | MI | 8438 | 3653 | 14930 | 2764 | 17496 | 2197 | 19066 | 1708 | 21437 | 914 | 26640 | 412 | 23804 |
| 16-#14 | 4.07 | MA | 9513 | 3653 | 16727 | 2839 | 19745 | 2265 | 21495 | 1798 | 23599 | 997 | 30049 | 277 | 28291 |
| 7L-3S | | MI | 8987 | 3653 | 15716 | 2770 | 18542 | 2189 | 20302 | 1716 | 23002 | 906 | 28379 | 535 | 25001 |
| 18-#11 | 3.18 | MA | 10477 | 3365 | 17231 | 2669 | 20561 | 2135 | 22530 | 1718 | 25049 | 1027 | 31499 | 659 | 25953 |
| 5L-6S | | MI | 7415 | 3365 | 12624 | 2604 | 14726 | 2084 | 15800 | 1649 | 17126 | 959 | 21203 | 486 | 18375 |
| 18-#11 | 3.18 | MA | 10013 | 3365 | 16549 | 2669 | 19652 | 2143 | 21424 | 1714 | 23606 | 1032 | 29582 | 583 | 25142 |
| 6L-5S | | MI | 7760 | 3365 | 13124 | 2608 | 15387 | 2079 | 16583 | 1654 | 18130 | 954 | 22425 | 548 | 18990 |
| 18-#11 | 3.18 | MA | 9558 | 3365 | 15884 | 2668 | 18773 | 2140 | 20350 | 1721 | 22143 | 1027 | 27882 | 512 | 24279 |
| 7L-4S | | MI | 8119 | 3365 | 13684 | 2601 | 16057 | 2084 | 17377 | 1649 | 19209 | 959 | 23735 | 592 | 19461 |
| 18-#11 | 3.18 | MA | 9108 | 3365 | 15230 | 2667 | 17911 | 2138 | 19274 | 1717 | 20732 | 1032 | 26103 | 461 | 23133 |
| 8L-3S | | MI | 8513 | 3365 | 14235 | 2604 | 16798 | 2079 | 18253 | 1654 | 20319 | 954 | 24970 | 678 | 19950 |
| 18-#14 | 4.58 | MA | 10793 | 3816 | 19125 | 2943 | 22839 | 2344 | 25255 | 1837 | 28618 | 992 | 36342 | 351 | 34163 |
| 6L-5S | | MI | 8408 | 3816 | 15169 | 2876 | 17853 | 2263 | 19491 | 1758 | 21947 | 887 | 27438 | 305 | 25785 |
| 18-#14 | 4.58 | MA | 10170 | 3816 | 18173 | 2941 | 21580 | 2340 | 23718 | 1846 | 26540 | 985 | 33938 | 249 | 32331 |
| 7L-4S | | MI | 8893 | 3816 | 15968 | 2866 | 18797 | 2270 | 20612 | 1751 | 23471 | 895 | 29279 | 368 | 26716 |
| 20-#11 | 3.53 | MA | 10473 | 3478 | 17562 | 2740 | 20937 | 2195 | 22980 | 1747 | 25677 | 1025 | 32329 | 564 | 27992 |
| 6E | | MI | 7735 | 3478 | 13354 | 2675 | 15648 | 2136 | 16896 | 1680 | 18568 | 947 | 23082 | 458 | 20402 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

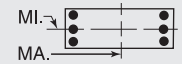
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.53 | MA | 10024 | 3478 | 16897 | 2739 | 20058 | 2192 | 21907 | 1754 | 24214 | 1020 | 30629 | 493 | 27157 |
| 7L-5S | | MI | 8076 | 3478 | 13853 | 2679 | 16310 | 2131 | 17678 | 1685 | 19571 | 942 | 24303 | 520 | 21064 |
| 20-#11 | 3.53 | MA | 9580 | 3478 | 16243 | 2738 | 19196 | 2190 | 20831 | 1750 | 22803 | 1025 | 28850 | 443 | 25984 |
| 8L-4S | | MI | 8432 | 3478 | 14413 | 2671 | 16979 | 2136 | 18473 | 1680 | 20651 | 947 | 25613 | 563 | 21510 |
| 20-#14 | 5.09 | MA | 10815 | 3980 | 19620 | 3043 | 23415 | 2414 | 25941 | 1893 | 29481 | 973 | 37828 | 220 | 36380 |
| 7L-5S | | MI | 8839 | 3980 | 16207 | 2978 | 19154 | 2336 | 21037 | 1801 | 23981 | 868 | 30078 | 262 | 28632 |
| 22-#11 | 3.88 | MA | 10483 | 3592 | 17911 | 2810 | 21343 | 2244 | 23464 | 1786 | 26286 | 1012 | 33375 | 475 | 30013 |
| 7L-6S | | MI | 8051 | 3592 | 14084 | 2746 | 16571 | 2187 | 17991 | 1710 | 20009 | 935 | 24960 | 430 | 22435 |
| 22-#11 | 3.88 | MA | 10045 | 3592 | 17256 | 2809 | 20481 | 2242 | 22388 | 1783 | 24874 | 1018 | 31596 | 424 | 28840 |
| 8L-5S | | MI | 8389 | 3592 | 14583 | 2749 | 17232 | 2182 | 18774 | 1715 | 21013 | 930 | 26182 | 492 | 23141 |
| 24-#11 | 4.24 | MA | 10504 | 3705 | 18269 | 2880 | 21766 | 2294 | 23945 | 1815 | 26946 | 1010 | 34343 | 406 | 31701 |
| 8L-6S | | MI | 8364 | 3705 | 14813 | 2817 | 17493 | 2239 | 19087 | 1740 | 21451 | 923 | 26839 | 402 | 24474 |

## RECTANGULAR TIED COLUMNS 26" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.71 | MA | 11538 | 3064 | 17460 | 2488 | 20594 | 2014 | 22243 | 1653 | 23927 | 1097 | 29195 | 994 | 16643 |
| 2E | | MI | 8079 | 3064 | 12643 | 2411 | 14434 | 1937 | 15278 | 1573 | 16145 | 1020 | 19295 | 884 | 11457 |
| 6-#11 | 1.00 | MA | 10577 | 2822 | 15121 | 2365 | 17809 | 1926 | 18947 | 1603 | 19743 | 1137 | 23777 | 1067 | 10090 |
| 2L-3S | | MI | 6927 | 2822 | 10351 | 2294 | 11817 | 1865 | 12238 | 1553 | 12187 | 1089 | 14284 | 907 | 7098 |
| 6-#11 | 1.00 | MA | 9722 | 2822 | 14037 | 2365 | 16434 | 1925 | 17281 | 1610 | 17514 | 1142 | 20812 | 976 | 10095 |
| 3L-2S | | MI | 7499 | 2822 | 11080 | 2298 | 12739 | 1870 | 13333 | 1548 | 13628 | 1083 | 16163 | 998 | 7065 |
| 6-#14 | 1.44 | MA | 11225 | 2973 | 16579 | 2450 | 19597 | 1988 | 21087 | 1640 | 22539 | 1120 | 27452 | 1034 | 14292 |
| 2L-3S | | MI | 7104 | 2973 | 11023 | 2373 | 12589 | 1917 | 13131 | 1583 | 13347 | 1063 | 15764 | 813 | 9915 |
| 6-#14 | 1.44 | MA | 10027 | 2973 | 15030 | 2449 | 17632 | 1984 | 18706 | 1649 | 19370 | 1128 | 23249 | 902 | 14223 |
| 3L-2S | | MI | 7904 | 2973 | 12061 | 2379 | 13890 | 1925 | 14677 | 1576 | 15381 | 1056 | 18404 | 945 | 9905 |
| 6-#18 | 2.56 | MA | 12741 | 3355 | 20163 | 2670 | 24021 | 2147 | 26395 | 1738 | 29398 | 1075 | 36413 | 939 | 24631 |
| 2L-3S | | MI | 7504 | 3355 | 12643 | 2579 | 14434 | 2051 | 15278 | 1657 | 16145 | 994 | 19295 | 561 | 16566 |
| 6-#18 | 2.56 | MA | 10736 | 3355 | 17460 | 2667 | 20594 | 2139 | 22243 | 1751 | 23927 | 1088 | 29195 | 706 | 24142 |
| 3L-2S | | MI | 8839 | 3355 | 14437 | 2592 | 16646 | 2064 | 17905 | 1644 | 19603 | 980 | 23744 | 795 | 16793 |
| 8-#11 | 1.33 | MA | 11096 | 2936 | 16205 | 2436 | 19183 | 1978 | 20612 | 1635 | 21972 | 1130 | 26741 | 1050 | 13321 |
| 2L-4S | | MI | 6847 | 2936 | 10529 | 2362 | 11998 | 1922 | 12458 | 1578 | 12519 | 1082 | 14927 | 792 | 9245 |
| 8-#11 | 1.33 | MA | 10253 | 2936 | 15121 | 2436 | 17809 | 1976 | 18947 | 1642 | 19743 | 1136 | 23777 | 959 | 13295 |
| 3E | | MI | 7267 | 2936 | 11080 | 2365 | 12739 | 1916 | 13333 | 1584 | 13628 | 1077 | 16163 | 879 | 9277 |
| 8-#11 | 1.33 | MA | 9639 | 2936 | 14312 | 2435 | 16716 | 1985 | 17623 | 1639 | 17974 | 1130 | 21829 | 868 | 13164 |
| 4L-2S | | MI | 7832 | 2936 | 11810 | 2369 | 13662 | 1922 | 14429 | 1578 | 15070 | 1071 | 18041 | 970 | 9260 |
| 8-#14 | 1.92 | MA | 11939 | 3137 | 18128 | 2552 | 21561 | 2062 | 23467 | 1687 | 25708 | 1110 | 31655 | 1007 | 18881 |
| 2L-4S | | MI | 6986 | 3137 | 11275 | 2470 | 12844 | 1998 | 13441 | 1618 | 13816 | 1052 | 16664 | 647 | 12463 |
| 8-#14 | 1.92 | MA | 10763 | 3137 | 16579 | 2551 | 19597 | 2059 | 21087 | 1697 | 22539 | 1117 | 27452 | 876 | 18758 |
| 3E | | MI | 7573 | 3137 | 12061 | 2476 | 13890 | 1991 | 14677 | 1626 | 15381 | 1044 | 18404 | 769 | 12968 |
| 8-#14 | 1.92 | MA | 9905 | 3137 | 15422 | 2550 | 18033 | 2071 | 19192 | 1691 | 20024 | 1110 | 24695 | 744 | 17984 |
| 4L-2S | | MI | 8361 | 3137 | 13099 | 2481 | 15192 | 1998 | 16223 | 1618 | 17415 | 1037 | 21043 | 901 | 13005 |
| 8-#18 | 3.42 | MA | 13901 | 3645 | 22866 | 2852 | 27449 | 2280 | 30548 | 1822 | 34868 | 1053 | 43631 | 885 | 32583 |
| 2L-4S | | MI | 7297 | 3645 | 13071 | 2748 | 14868 | 2190 | 15804 | 1715 | 16942 | 967 | 20800 | 261 | 19251 |
| 8-#18 | 3.42 | MA | 11949 | 3645 | 20163 | 2848 | 24021 | 2272 | 26395 | 1835 | 29398 | 1066 | 36413 | 651 | 31958 |
| 3E | | MI | 8272 | 3645 | 14437 | 2761 | 16646 | 2177 | 17905 | 1728 | 19603 | 954 | 23744 | 472 | 21648 |
| 8-#18 | 3.42 | MA | 10524 | 3645 | 18137 | 2845 | 21284 | 2290 | 23079 | 1823 | 25055 | 1053 | 31692 | 418 | 28216 |
| 4L-2S | | MI | 9577 | 3645 | 16231 | 2774 | 18858 | 2190 | 20533 | 1715 | 23061 | 941 | 28192 | 705 | 22078 |
| 10-#11 | 1.67 | MA | 11604 | 3049 | 17289 | 2507 | 20558 | 2030 | 22278 | 1668 | 24201 | 1124 | 29706 | 1034 | 16536 |
| 2L-5S | | MI | 6806 | 3049 | 10699 | 2440 | 12251 | 1968 | 12759 | 1614 | 12881 | 1065 | 15496 | 721 | 10863 |
| 10-#11 | 1.67 | MA | 10773 | 3049 | 16205 | 2506 | 19183 | 2028 | 20612 | 1675 | 21972 | 1129 | 26741 | 943 | 16484 |
| 3L-4S | | MI | 7185 | 3049 | 11259 | 2433 | 12921 | 1973 | 13553 | 1609 | 13960 | 1070 | 16806 | 764 | 11376 |
| 10-#11 | 1.67 | MA | 10167 | 3049 | 15396 | 2506 | 18091 | 2037 | 19288 | 1672 | 20203 | 1124 | 24794 | 851 | 16321 |
| 4L-3S | | MI | 7600 | 3049 | 11810 | 2436 | 13662 | 1968 | 14429 | 1614 | 15070 | 1065 | 18041 | 851 | 11437 |
| 10-#11 | 1.67 | MA | 9618 | 3049 | 14577 | 2516 | 17108 | 2035 | 18089 | 1679 | 18589 | 1129 | 22742 | 807 | 15493 |
| 5L-2S | | MI | 8159 | 3049 | 12540 | 2439 | 14584 | 1973 | 15524 | 1609 | 16511 | 1059 | 19920 | 942 | 11442 |

## RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

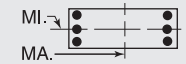
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.40 | MA | 12635 | 3300 | 19677 | 2654 | 23526 | 2137 | 25847 | 1735 | 28877 | 1100 | 35859 | 981 | 23456 |
| 2L-5S | | MI | 6927 | 3300 | 11514 | 2582 | 13202 | 2064 | 13866 | 1668 | 14326 | 1025 | 17462 | 540 | 14585 |
| 10-#14 | 2.40 | MA | 11480 | 3300 | 18128 | 2653 | 21561 | 2134 | 23467 | 1744 | 25708 | 1107 | 31655 | 850 | 23284 |
| 3L-4S | | MI | 7454 | 3300 | 12313 | 2572 | 14146 | 2072 | 14987 | 1661 | 15850 | 1033 | 19303 | 603 | 15306 |
| 10-#14 | 2.40 | MA | 10639 | 3300 | 16971 | 2653 | 19997 | 2146 | 21572 | 1738 | 23193 | 1100 | 28898 | 718 | 22299 |
| 4L-3S | | MI | 8031 | 3300 | 13099 | 2578 | 15192 | 2064 | 16223 | 1668 | 17415 | 1025 | 21043 | 726 | 16005 |
| 10-#14 | 2.40 | MA | 9875 | 3300 | 15798 | 2667 | 18590 | 2143 | 19854 | 1748 | 20898 | 1107 | 25982 | 655 | 20982 |
| 5L-2S | | MI | 8807 | 3300 | 14137 | 2583 | 16493 | 2072 | 17768 | 1661 | 19449 | 1018 | 23683 | 857 | 16081 |
| 10-#18 | 4.27 | MA | 13125 | 3936 | 22866 | 3030 | 27449 | 2405 | 30548 | 1920 | 34868 | 1044 | 43631 | 596 | 39776 |
| 3L-4S | | MI | 8096 | 3936 | 14865 | 2930 | 17080 | 2317 | 18431 | 1786 | 20400 | 928 | 25248 | 172 | 24199 |
| 10-#18 | 4.27 | MA | 11738 | 3936 | 20840 | 3026 | 24712 | 2423 | 27232 | 1907 | 30526 | 1030 | 38910 | 363 | 35802 |
| 4L-3S | | MI | 9035 | 3936 | 16231 | 2943 | 18858 | 2304 | 20533 | 1800 | 23061 | 914 | 28192 | 382 | 26392 |
| 10-#18 | 4.27 | MA | 10480 | 3936 | 18785 | 3049 | 22246 | 2415 | 24223 | 1921 | 26564 | 1044 | 33877 | 255 | 32357 |
| 5L-2S | | MI | 10282 | 3936 | 18025 | 2956 | 21070 | 2317 | 23160 | 1786 | 26519 | 901 | 32640 | 616 | 27337 |
| 12-#11 | 2.00 | MA | 12102 | 3163 | 18373 | 2578 | 21933 | 2082 | 23944 | 1701 | 26431 | 1118 | 32670 | 1017 | 19743 |
| 2L-6S | | MI | 6784 | 3163 | 10929 | 2508 | 12512 | 2025 | 13072 | 1639 | 13318 | 1058 | 16153 | 631 | 12528 |
| 12-#11 | 2.00 | MA | 11281 | 3163 | 17289 | 2577 | 20558 | 2080 | 22278 | 1708 | 24201 | 1123 | 29706 | 926 | 19668 |
| 3L-5S | | MI | 7143 | 3163 | 11429 | 2511 | 13174 | 2020 | 13855 | 1644 | 14322 | 1052 | 17374 | 693 | 12911 |
| 12-#11 | 2.00 | MA | 10685 | 3163 | 16480 | 2577 | 19466 | 2089 | 20954 | 1705 | 22432 | 1118 | 27758 | 835 | 19476 |
| 4E | | MI | 7518 | 3163 | 11988 | 2504 | 13843 | 2025 | 14649 | 1639 | 15402 | 1058 | 18684 | 736 | 13496 |
| 12-#11 | 2.00 | MA | 10144 | 3163 | 15661 | 2587 | 18483 | 2087 | 19755 | 1712 | 20818 | 1123 | 25706 | 790 | 18567 |
| 5L-3S | | MI | 7928 | 3163 | 12540 | 2507 | 14584 | 2020 | 15524 | 1644 | 16511 | 1052 | 19920 | 823 | 13587 |
| 12-#11 | 2.00 | MA | 9625 | 3163 | 14933 | 2587 | 17513 | 2096 | 18574 | 1709 | 19265 | 1128 | 23637 | 715 | 17963 |
| 6L-2S | | MI | 8480 | 3163 | 13269 | 2510 | 15507 | 2025 | 16620 | 1639 | 17953 | 1047 | 21798 | 914 | 13612 |
| 12-#14 | 2.88 | MA | 12180 | 3464 | 19677 | 2756 | 23526 | 2209 | 25847 | 1791 | 28877 | 1097 | 35859 | 823 | 27806 |
| 3L-5S | | MI | 7393 | 3464 | 12552 | 2684 | 14503 | 2138 | 15412 | 1711 | 16360 | 1006 | 20102 | 497 | 17502 |
| 12-#14 | 2.88 | MA | 11354 | 3464 | 18520 | 2755 | 21962 | 2221 | 23952 | 1786 | 26362 | 1089 | 33102 | 692 | 26638 |
| 4E | | MI | 7912 | 3464 | 13351 | 2675 | 15447 | 2145 | 16532 | 1703 | 17884 | 1014 | 21943 | 559 | 18172 |
| 12-#14 | 2.88 | MA | 10605 | 3464 | 17347 | 2769 | 20555 | 2217 | 22235 | 1795 | 24067 | 1097 | 30185 | 629 | 25389 |
| 5L-3S | | MI | 8480 | 3464 | 14137 | 2680 | 16493 | 2138 | 17768 | 1711 | 19449 | 1006 | 23683 | 682 | 19033 |
| 12-#14 | 2.88 | MA | 9886 | 3464 | 16304 | 2768 | 19165 | 2229 | 20543 | 1790 | 21860 | 1104 | 27252 | 520 | 23705 |
| 6L-2S | | MI | 9245 | 3464 | 15175 | 2686 | 17795 | 2145 | 19314 | 1703 | 21483 | 999 | 26322 | 813 | 19144 |
| 12-#18 | 5.13 | MA | 12991 | 4227 | 23542 | 3208 | 28140 | 2556 | 31384 | 1991 | 35996 | 1008 | 46128 | 308 | 43423 |
| 4E | | MI | 8841 | 4227 | 16659 | 3112 | 19292 | 2444 | 21058 | 1857 | 23859 | 888 | 29696 | 83 | 29180 |
| 12-#18 | 5.13 | MA | 11692 | 4227 | 21488 | 3231 | 25674 | 2548 | 28376 | 2005 | 32035 | 1022 | 41094 | 201 | 39850 |
| 5L-3S | | MI | 9753 | 4227 | 18025 | 3125 | 21070 | 2430 | 23160 | 1871 | 26519 | 875 | 32640 | 293 | 31193 |
| 12-#18 | 5.13 | MA | 10515 | 4227 | 19659 | 3228 | 23238 | 2566 | 25412 | 1992 | 28225 | 1035 | 36059 | 6 | 36033 |
| 6L-2S | | MI | 10966 | 4227 | 19819 | 3138 | 23282 | 2444 | 25788 | 1857 | 29978 | 861 | 37088 | 527 | 32579 |
| 14-#11 | 2.33 | MA | 11781 | 3276 | 18373 | 2648 | 21933 | 2132 | 23944 | 1741 | 26431 | 1117 | 32670 | 909 | 22846 |
| 3L-6S | | MI | 7119 | 3276 | 11659 | 2579 | 13435 | 2076 | 14167 | 1670 | 14760 | 1046 | 18031 | 603 | 14526 |
| 14-#11 | 2.33 | MA | 11193 | 3276 | 17564 | 2648 | 20840 | 2141 | 22620 | 1738 | 24662 | 1111 | 30723 | 818 | 22630 |
| 4L-5S | | MI | 7475 | 3276 | 12158 | 2582 | 14096 | 2071 | 14950 | 1675 | 15764 | 1040 | 19252 | 665 | 14968 |
| 14-#11 | 2.33 | MA | 10660 | 3276 | 16746 | 2658 | 19858 | 2139 | 21420 | 1745 | 23047 | 1117 | 28671 | 774 | 21651 |
| 5L-4S | | MI | 7845 | 3276 | 12718 | 2575 | 14766 | 2076 | 15744 | 1670 | 16843 | 1046 | 20563 | 708 | 15515 |
| 14-#11 | 2.33 | MA | 10148 | 3276 | 16018 | 2658 | 18888 | 2148 | 20239 | 1742 | 21495 | 1122 | 26602 | 698 | 20991 |
| 6L-3S | | MI | 8250 | 3276 | 13269 | 2578 | 15507 | 2071 | 16620 | 1675 | 17953 | 1040 | 21798 | 795 | 15730 |
| 14-#11 | 2.33 | MA | 9647 | 3276 | 15309 | 2658 | 17950 | 2146 | 19094 | 1749 | 19920 | 1117 | 24765 | 627 | 19954 |
| 7L-2S | | MI | 8796 | 3276 | 13999 | 2581 | 16429 | 2076 | 17715 | 1670 | 19394 | 1035 | 23677 | 886 | 15772 |
| 14-#14 | 3.37 | MA | 12054 | 3627 | 20069 | 2857 | 23927 | 2295 | 26332 | 1833 | 29531 | 1079 | 37305 | 665 | 30996 |
| 4L-5S | | MI | 7850 | 3627 | 13590 | 2786 | 15805 | 2211 | 16958 | 1753 | 18394 | 987 | 22742 | 453 | 20382 |
| 14-#14 | 3.37 | MA | 11318 | 3627 | 18896 | 2871 | 22520 | 2292 | 24615 | 1843 | 27236 | 1087 | 34388 | 603 | 29807 |
| 5L-4S | | MI | 8361 | 3627 | 14389 | 2777 | 16749 | 2218 | 18078 | 1746 | 19918 | 995 | 24583 | 515 | 21057 |
| 14-#14 | 3.37 | MA | 10612 | 3627 | 17853 | 2870 | 21130 | 2304 | 22924 | 1837 | 25029 | 1094 | 31455 | 494 | 28057 |
| 6L-3S | | MI | 8922 | 3627 | 15175 | 2782 | 17795 | 2211 | 19314 | 1753 | 21483 | 987 | 26322 | 638 | 22054 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis

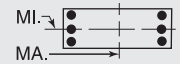


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 3.37 | MA | 9920 | 3627 | 16838 | 2869 | 19786 | 2301 | 21283 | 1846 | 22791 | 1087 | 28853 | 391 | 26344 |
| 7L-2S | | MI | 9676 | 3627 | 16213 | 2788 | 19096 | 2218 | 20860 | 1746 | 23518 | 980 | 28962 | 770 | 22197 |
| 14-#18 | 5.98 | MA | 12954 | 4518 | 24191 | 3413 | 29102 | 2681 | 32529 | 2089 | 37505 | 999 | 48312 | 146 | 47373 |
| 5L-4S | | MI | 9567 | 4518 | 18453 | 3293 | 21504 | 2570 | 23686 | 1929 | 27317 | 848 | 34144 | -7 | 34096 |
| 14-#18 | 5.98 | MA | 11807 | 4518 | 22362 | 3409 | 26666 | 2699 | 29564 | 2076 | 33695 | 1013 | 43276 | -49 | 42961 |
| 6L-3S | | MI | 10454 | 4518 | 19819 | 3306 | 23282 | 2557 | 25788 | 1942 | 29978 | 835 | 37088 | 203 | 36042 |
| 16-#11 | 2.67 | MA | 11692 | 3390 | 18648 | 2719 | 22215 | 2193 | 24285 | 1771 | 26891 | 1105 | 33688 | 801 | 25703 |
| 4L-6S | | MI | 7450 | 3390 | 12388 | 2649 | 14357 | 2128 | 15263 | 1700 | 16201 | 1033 | 19910 | 574 | 16533 |
| 16-#11 | 2.67 | MA | 11166 | 3390 | 17830 | 2729 | 21233 | 2191 | 23086 | 1778 | 25276 | 1110 | 31636 | 757 | 24742 |
| 5E | | MI | 7801 | 3390 | 12888 | 2653 | 15019 | 2123 | 16046 | 1705 | 17205 | 1028 | 21131 | 637 | 17032 |
| 16-#11 | 2.67 | MA | 10662 | 3390 | 17102 | 2729 | 20262 | 2199 | 21905 | 1774 | 23724 | 1115 | 29566 | 681 | 24029 |
| 6L-4S | | MI | 8167 | 3390 | 13448 | 2646 | 15688 | 2128 | 16840 | 1700 | 18285 | 1033 | 22441 | 680 | 17546 |
| 16-#11 | 2.67 | MA | 10168 | 3390 | 16393 | 2729 | 19325 | 2198 | 20760 | 1782 | 22149 | 1110 | 27729 | 610 | 23025 |
| 7L-3S | | MI | 8567 | 3390 | 13999 | 2649 | 16429 | 2123 | 17715 | 1705 | 19394 | 1028 | 23677 | 766 | 17868 |
| 16-#11 | 2.67 | MA | 9679 | 3390 | 15695 | 2729 | 18406 | 2196 | 19612 | 1778 | 20630 | 1115 | 25814 | 559 | 21901 |
| 8L-2S | | MI | 9108 | 3390 | 14729 | 2652 | 17352 | 2128 | 18811 | 1700 | 20836 | 1023 | 25555 | 858 | 17926 |
| 16-#14 | 3.85 | MA | 12017 | 3791 | 20446 | 2973 | 24484 | 2367 | 26995 | 1890 | 30405 | 1076 | 38592 | 576 | 34235 |
| 5E | | MI | 8300 | 3791 | 14628 | 2888 | 17106 | 2284 | 18503 | 1796 | 20429 | 968 | 25381 | 409 | 23196 |
| 16-#14 | 3.85 | MA | 11323 | 3791 | 19403 | 2973 | 23094 | 2379 | 25304 | 1884 | 28198 | 1084 | 35658 | 467 | 32420 |
| 6L-4S | | MI | 8804 | 3791 | 15427 | 2879 | 18050 | 2292 | 19624 | 1789 | 21952 | 976 | 27222 | 472 | 23956 |
| 16-#14 | 3.85 | MA | 10644 | 3791 | 18387 | 2972 | 21751 | 2375 | 23663 | 1894 | 25960 | 1076 | 33057 | 364 | 30601 |
| 7L-3S | | MI | 9356 | 3791 | 16213 | 2885 | 19096 | 2284 | 20860 | 1796 | 23518 | 968 | 28962 | 594 | 25070 |
| 16-#14 | 3.85 | MA | 9972 | 3791 | 17386 | 2971 | 20434 | 2372 | 22019 | 1888 | 23801 | 1084 | 30334 | 292 | 28736 |
| 8L-2S | | MI | 10101 | 3791 | 17251 | 2890 | 20398 | 2292 | 22405 | 1789 | 25552 | 961 | 31601 | 726 | 25243 |
| 16-#18 | 6.84 | MA | 12995 | 4809 | 25064 | 3591 | 30094 | 2832 | 33717 | 2160 | 39166 | 990 | 50494 | -103 | 49687 |
| 6L-4S | | MI | 10278 | 4809 | 20247 | 3475 | 23716 | 2697 | 26313 | 2000 | 30775 | 809 | 38592 | -96 | 37900 |
| 18-#11 | 3.00 | MA | 11665 | 3503 | 18914 | 2800 | 22608 | 2243 | 24752 | 1811 | 27506 | 1104 | 34600 | 740 | 27841 |
| 5L-6S | | MI | 7776 | 3503 | 13118 | 2720 | 15280 | 2180 | 16358 | 1730 | 17643 | 1021 | 21788 | 546 | 18550 |
| 18-#11 | 3.00 | MA | 11167 | 3503 | 18186 | 2800 | 21637 | 2251 | 23571 | 1807 | 25953 | 1109 | 32531 | 665 | 27075 |
| 6L-5S | | MI | 8123 | 3503 | 13618 | 2724 | 15941 | 2174 | 17141 | 1735 | 18647 | 1016 | 23009 | 609 | 19101 |
| 18-#11 | 3.00 | MA | 10679 | 3503 | 17477 | 2800 | 20700 | 2250 | 22425 | 1814 | 24379 | 1104 | 30694 | 593 | 26103 |
| 7L-4S | | MI | 8485 | 3503 | 14178 | 2716 | 16611 | 2180 | 17935 | 1730 | 19726 | 1021 | 24319 | 652 | 19586 |
| 18-#11 | 3.00 | MA | 10198 | 3503 | 16779 | 2799 | 19780 | 2248 | 21278 | 1811 | 22860 | 1109 | 28778 | 542 | 24952 |
| 8L-3S | | MI | 8881 | 3503 | 14729 | 2720 | 17352 | 2174 | 18811 | 1735 | 20836 | 1016 | 25555 | 738 | 20002 |
| 18-#11 | 3.00 | MA | 9719 | 3503 | 16008 | 2810 | 18833 | 2256 | 20148 | 1818 | 21355 | 1114 | 26903 | 483 | 23803 |
| 9L-2S | | MI | 9416 | 3503 | 15459 | 2723 | 18274 | 2180 | 19907 | 1730 | 22277 | 1011 | 27434 | 829 | 20075 |
| 18-#14 | 4.33 | MA | 12021 | 3954 | 20952 | 3075 | 25059 | 2453 | 27684 | 1932 | 31367 | 1074 | 39862 | 441 | 36795 |
| 6L-5S | | MI | 8775 | 3954 | 15666 | 2991 | 18408 | 2358 | 20049 | 1839 | 22463 | 949 | 28021 | 365 | 26026 |
| 18-#14 | 4.33 | MA | 11353 | 3954 | 19936 | 3074 | 23716 | 2450 | 26043 | 1941 | 29129 | 1066 | 37260 | 338 | 34937 |
| 7L-4S | | MI | 9265 | 3954 | 16465 | 2981 | 19352 | 2365 | 21170 | 1831 | 23986 | 957 | 29862 | 428 | 26866 |
| 18-#14 | 4.33 | MA | 10692 | 3954 | 18936 | 3073 | 22399 | 2447 | 24399 | 1936 | 26969 | 1074 | 34538 | 265 | 33046 |
| 8L-3S | | MI | 9798 | 3954 | 17251 | 2987 | 20398 | 2358 | 22405 | 1839 | 25552 | 949 | 31601 | 551 | 28082 |
| 20-#11 | 3.33 | MA | 11665 | 3616 | 19270 | 2871 | 23012 | 2303 | 25236 | 1840 | 28182 | 1103 | 35495 | 648 | 30129 |
| 6E | | MI | 8097 | 3616 | 13848 | 2791 | 16202 | 2231 | 17454 | 1761 | 19085 | 1009 | 23667 | 518 | 20574 |
| 20-#11 | 3.33 | MA | 11183 | 3616 | 18561 | 2871 | 22074 | 2301 | 24091 | 1847 | 26608 | 1098 | 33659 | 577 | 29186 |
| 7L-5S | | MI | 8441 | 3616 | 14347 | 2794 | 16864 | 2226 | 18237 | 1766 | 20088 | 1004 | 24888 | 580 | 21175 |
| 20-#11 | 3.33 | MA | 10708 | 3616 | 17863 | 2870 | 21155 | 2300 | 22943 | 1844 | 25089 | 1103 | 31743 | 525 | 28008 |
| 8L-4S | | MI | 8798 | 3616 | 14907 | 2787 | 17533 | 2231 | 19031 | 1761 | 21168 | 1009 | 26198 | 624 | 21634 |
| 20-#11 | 3.33 | MA | 10236 | 3616 | 17092 | 2881 | 20208 | 2308 | 21814 | 1851 | 23585 | 1108 | 29867 | 466 | 26840 |
| 9L-3S | | MI | 9191 | 3616 | 15459 | 2791 | 18274 | 2226 | 19907 | 1766 | 22277 | 1004 | 27434 | 710 | 22133 |
| 20-#14 | 4.81 | MA | 12051 | 4118 | 21485 | 3176 | 25680 | 2525 | 28423 | 1988 | 32298 | 1056 | 41463 | 312 | 39283 |
| 7L-5S | | MI | 9208 | 4118 | 16704 | 3093 | 19709 | 2431 | 21595 | 1881 | 24497 | 930 | 30660 | 321 | 28869 |
| 20-#14 | 4.81 | MA | 11400 | 4118 | 20485 | 3175 | 24364 | 2522 | 26779 | 1983 | 30138 | 1063 | 38741 | 239 | 37365 |
| 8L-4S | | MI | 9689 | 4118 | 17503 | 3084 | 20653 | 2438 | 22715 | 1874 | 26021 | 937 | 32501 | 384 | 29787 |
| 22-#11 | 3.67 | MA | 11680 | 3730 | 19645 | 2941 | 23449 | 2353 | 25757 | 1880 | 28837 | 1091 | 36623 | 560 | 32275 |
| 7L-6S | | MI | 8415 | 3730 | 14577 | 2862 | 17125 | 2283 | 18549 | 1791 | 20526 | 997 | 25545 | 490 | 22606 |

## RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.67 | MA | 11211 | 3730 | 18947 | 2941 | 22530 | 2352 | 24609 | 1877 | 27318 | 1096 | 34708 | 509 | 31070 |
| 8L-5S | | MI | 8755 | 3730 | 15077 | 2865 | 17786 | 2278 | 19332 | 1796 | 21530 | 992 | 26766 | 552 | 23252 |
| 22-#11 | 3.67 | MA | 10744 | 3730 | 18176 | 2951 | 21583 | 2360 | 23480 | 1884 | 25814 | 1102 | 32832 | 450 | 29882 |
| 9L-4S | | MI | 9109 | 3730 | 15637 | 2858 | 18456 | 2283 | 20126 | 1791 | 22609 | 997 | 28076 | 595 | 23688 |
| 22-#14 | 5.29 | MA | 12097 | 4281 | 22034 | 3278 | 26328 | 2597 | 29160 | 2030 | 33307 | 1053 | 42944 | 212 | 41692 |
| 8L-5S | | MI | 9634 | 4281 | 17742 | 3195 | 21011 | 2504 | 23140 | 1924 | 26531 | 911 | 33300 | 278 | 31724 |
| 24-#11 | 4.00 | MA | 11707 | 3843 | 20031 | 3012 | 23905 | 2403 | 26275 | 1910 | 29547 | 1090 | 37672 | 492 | 34136 |
| 8L-6S | | MI | 8729 | 3843 | 15307 | 2933 | 18047 | 2334 | 19645 | 1821 | 21968 | 985 | 27424 | 462 | 24643 |
| 24-#11 | 4.00 | MA | 11246 | 3843 | 19261 | 3022 | 22958 | 2412 | 25145 | 1917 | 28043 | 1095 | 35796 | 433 | 32928 |
| 9L-5S | | MI | 9066 | 3843 | 15807 | 2936 | 18709 | 2329 | 20428 | 1827 | 22971 | 980 | 28645 | 524 | 25332 |

## RECTANGULAR TIED COLUMNS 26" x 38"

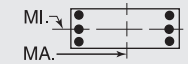
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.62 | MA | 12764 | 3202 | 19121 | 2618 | 22601 | 2120 | 24399 | 1744 | 26249 | 1171 | 32050 | 1070 | 17723 |
| 2E | | MI | 8442 | 3202 | 13146 | 2524 | 14991 | 2031 | 15835 | 1652 | 16657 | 1081 | 19873 | 943 | 11496 |
| 6-#14 | 1.37 | MA | 12422 | 3111 | 18174 | 2579 | 21528 | 2094 | 23155 | 1730 | 24738 | 1193 | 30139 | 1108 | 15203 |
| 2L-3S | | MI | 7464 | 3111 | 11520 | 2489 | 13143 | 2012 | 13689 | 1664 | 13862 | 1125 | 16346 | 873 | 9957 |
| 6-#14 | 1.37 | MA | 11140 | 3111 | 16522 | 2579 | 19434 | 2091 | 20618 | 1740 | 21341 | 1201 | 25621 | 976 | 15135 |
| 3L-2S | | MI | 8266 | 3111 | 12558 | 2494 | 14445 | 2020 | 15235 | 1656 | 15897 | 1118 | 18986 | 1004 | 9937 |
| 6-#18 | 2.43 | MA | 14064 | 3493 | 22005 | 2799 | 26259 | 2253 | 28831 | 1828 | 32124 | 1151 | 39826 | 1020 | 26251 |
| 2L-3S | | MI | 7865 | 3493 | 13146 | 2693 | 14991 | 2144 | 15835 | 1737 | 16657 | 1055 | 19873 | 620 | 16649 |
| 6-#18 | 2.43 | MA | 11914 | 3493 | 19121 | 2797 | 22601 | 2247 | 24399 | 1843 | 26249 | 1164 | 32050 | 787 | 25762 |
| 3L-2S | | MI | 9205 | 3493 | 14940 | 2706 | 17203 | 2157 | 18462 | 1723 | 20115 | 1041 | 24321 | 854 | 16841 |
| 8-#11 | 1.26 | MA | 12280 | 3074 | 17772 | 2565 | 21084 | 2084 | 22645 | 1726 | 24120 | 1203 | 29360 | 1124 | 14163 |
| 2L-4S | | MI | 7206 | 3074 | 11023 | 2478 | 12552 | 2017 | 13016 | 1659 | 13036 | 1144 | 15512 | 853 | 9290 |
| 8-#11 | 1.26 | MA | 11379 | 3074 | 16617 | 2565 | 19619 | 2083 | 20870 | 1733 | 21733 | 1208 | 26177 | 1032 | 14137 |
| 3E | | MI | 7627 | 3074 | 11574 | 2481 | 13293 | 2012 | 13892 | 1665 | 14145 | 1139 | 16748 | 939 | 9309 |
| 8-#11 | 1.26 | MA | 10723 | 3074 | 15757 | 2566 | 18457 | 2092 | 19462 | 1731 | 19839 | 1203 | 24083 | 941 | 14007 |
| 4L-2S | | MI | 8194 | 3074 | 12304 | 2484 | 14216 | 2017 | 14987 | 1659 | 15586 | 1134 | 18626 | 1030 | 9288 |
| 8-#14 | 1.82 | MA | 13191 | 3274 | 19825 | 2681 | 23623 | 2169 | 25692 | 1777 | 28135 | 1184 | 34657 | 1084 | 20096 |
| 2L-4S | | MI | 7345 | 3274 | 11772 | 2585 | 13399 | 2093 | 13999 | 1699 | 14331 | 1114 | 17246 | 707 | 12621 |
| 8-#14 | 1.82 | MA | 11933 | 3274 | 18174 | 2681 | 21528 | 2166 | 23155 | 1788 | 24738 | 1191 | 30139 | 952 | 19973 |
| 3E | | MI | 7935 | 3274 | 12558 | 2591 | 14445 | 2086 | 15235 | 1706 | 15897 | 1106 | 18986 | 829 | 13016 |
| 8-#14 | 1.82 | MA | 11017 | 3274 | 16942 | 2681 | 19864 | 2179 | 21138 | 1783 | 22042 | 1184 | 27171 | 821 | 19318 |
| 4L-2S | | MI | 8725 | 3274 | 13596 | 2596 | 15746 | 2093 | 16780 | 1699 | 17931 | 1099 | 21626 | 961 | 13040 |
| 8-#18 | 3.24 | MA | 15317 | 3783 | 24890 | 2981 | 29917 | 2386 | 33263 | 1912 | 37999 | 1131 | 47601 | 970 | 34743 |
| 2L-4S | | MI | 7655 | 3783 | 13574 | 2862 | 15424 | 2284 | 16360 | 1795 | 17455 | 1028 | 21378 | 320 | 19463 |
| 8-#18 | 3.24 | MA | 13223 | 3783 | 22005 | 2979 | 26259 | 2380 | 28831 | 1928 | 32124 | 1144 | 39826 | 736 | 34118 |
| 3E | | MI | 8636 | 3783 | 14940 | 2875 | 17203 | 2271 | 18462 | 1808 | 20115 | 1015 | 24321 | 531 | 21826 |
| 8-#18 | 3.24 | MA | 11699 | 3783 | 19847 | 2976 | 23343 | 2400 | 25298 | 1916 | 27461 | 1131 | 34731 | 503 | 30314 |
| 4L-2S | | MI | 9946 | 3783 | 16734 | 2888 | 19415 | 2284 | 21090 | 1795 | 23574 | 1002 | 28769 | 764 | 22133 |
| 10-#11 | 1.58 | MA | 12827 | 3187 | 18927 | 2636 | 22549 | 2136 | 24419 | 1759 | 26508 | 1197 | 32543 | 1108 | 17589 |
| 2L-5S | | MI | 7165 | 3187 | 11193 | 2556 | 12805 | 2063 | 13317 | 1695 | 13398 | 1127 | 16080 | 781 | 10973 |
| 10-#11 | 1.58 | MA | 11938 | 3187 | 17772 | 2636 | 21084 | 2135 | 22645 | 1766 | 24120 | 1202 | 29360 | 1017 | 17537 |
| 3L-4S | | MI | 7545 | 3187 | 11753 | 2549 | 13475 | 2069 | 14111 | 1690 | 14477 | 1132 | 17390 | 824 | 11427 |
| 10-#11 | 1.58 | MA | 11292 | 3187 | 16912 | 2636 | 19921 | 2144 | 21236 | 1764 | 22226 | 1197 | 27266 | 926 | 17374 |
| 4L-3S | | MI | 7962 | 3187 | 12304 | 2552 | 14216 | 2063 | 14987 | 1695 | 15586 | 1127 | 18626 | 911 | 11474 |
| 10-#11 | 1.58 | MA | 10707 | 3187 | 16041 | 2647 | 18877 | 2143 | 19961 | 1771 | 20497 | 1202 | 25068 | 881 | 16571 |
| 5L-2S | | MI | 8522 | 3187 | 13034 | 2555 | 15138 | 2069 | 16083 | 1690 | 17028 | 1122 | 20505 | 1002 | 11472 |
| 10-#14 | 2.28 | MA | 13942 | 3438 | 21476 | 2784 | 25717 | 2244 | 28229 | 1825 | 31531 | 1175 | 39175 | 1060 | 24974 |
| 2L-5S | | MI | 7285 | 3438 | 12011 | 2697 | 13756 | 2159 | 14424 | 1749 | 14842 | 1087 | 18045 | 600 | 14724 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis

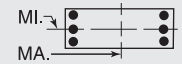



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.28 | MA | 12705 | 3438 | 19825 | 2783 | 23623 | 2241 | 25692 | 1835 | 28135 | 1182 | 34657 | 928 | 24803 |
| 3L-4S | | MI | 7815 | 3438 | 12810 | 2688 | 14700 | 2166 | 15544 | 1741 | 16365 | 1094 | 19886 | 663 | 15461 |
| 10-#14 | 2.28 | MA | 11806 | 3438 | 18593 | 2783 | 21958 | 2254 | 23675 | 1830 | 25439 | 1175 | 31689 | 797 | 23925 |
| 4L-3S | | MI | 8395 | 3438 | 13596 | 2693 | 15746 | 2159 | 16780 | 1749 | 17931 | 1087 | 21626 | 785 | 16059 |
| 10-#14 | 2.28 | MA | 10991 | 3438 | 17346 | 2798 | 20461 | 2251 | 21849 | 1841 | 22979 | 1182 | 28562 | 733 | 22453 |
| 5L-2S | | MI | 9173 | 3438 | 14634 | 2699 | 17048 | 2166 | 18326 | 1741 | 19965 | 1080 | 24265 | 917 | 16122 |
| 10-#18 | 4.05 | MA | 14491 | 4074 | 24890 | 3161 | 29917 | 2513 | 33263 | 2012 | 37999 | 1125 | 47601 | 686 | 42476 |
| 3L-4S | | MI | 8458 | 4074 | 15368 | 3044 | 17636 | 2411 | 18988 | 1866 | 20913 | 989 | 25826 | 231 | 24405 |
| 10-#18 | 4.05 | MA | 13008 | 4074 | 22732 | 3158 | 27002 | 2533 | 29730 | 2001 | 33336 | 1111 | 42507 | 453 | 38424 |
| 4L-3S | | MI | 9405 | 4074 | 16734 | 3057 | 19415 | 2397 | 21090 | 1879 | 23574 | 975 | 28769 | 441 | 26668 |
| 10-#18 | 4.05 | MA | 11662 | 4074 | 20544 | 3182 | 24377 | 2526 | 26527 | 2016 | 29081 | 1125 | 37100 | 343 | 34920 |
| 5L-2S | | MI | 10660 | 4074 | 18528 | 3070 | 21627 | 2411 | 23717 | 1866 | 27032 | 962 | 33217 | 675 | 27397 |
| 12-#11 | 1.89 | MA | 13364 | 3301 | 20082 | 2707 | 24013 | 2188 | 26194 | 1791 | 28895 | 1192 | 35725 | 1093 | 21006 |
| 2L-6S | | MI | 7142 | 3301 | 11423 | 2623 | 13066 | 2120 | 13630 | 1720 | 13835 | 1120 | 16738 | 691 | 12698 |
| 12-#11 | 1.89 | MA | 12486 | 3301 | 18927 | 2707 | 22549 | 2187 | 24419 | 1799 | 26508 | 1197 | 32543 | 1002 | 20931 |
| 3L-5S | | MI | 7503 | 3301 | 11922 | 2627 | 13728 | 2115 | 14413 | 1725 | 14839 | 1115 | 17959 | 753 | 13020 |
| 12-#11 | 1.89 | MA | 11849 | 3301 | 18067 | 2707 | 21386 | 2196 | 23011 | 1796 | 24613 | 1192 | 30449 | 911 | 20740 |
| 4E | | MI | 7879 | 3301 | 12482 | 2620 | 14397 | 2120 | 15207 | 1720 | 15919 | 1120 | 19269 | 796 | 13557 |
| 12-#11 | 1.89 | MA | 11272 | 3301 | 17196 | 2718 | 20342 | 2195 | 21736 | 1804 | 22885 | 1197 | 28251 | 866 | 19849 |
| 5L-3S | | MI | 8290 | 3301 | 13034 | 2623 | 15138 | 2115 | 16083 | 1725 | 17028 | 1115 | 20505 | 883 | 13628 |
| 12-#11 | 1.89 | MA | 10719 | 3301 | 16422 | 2718 | 19310 | 2204 | 20480 | 1801 | 21222 | 1202 | 26029 | 790 | 19186 |
| 6L-2S | | MI | 8845 | 3301 | 13763 | 2626 | 16061 | 2120 | 17178 | 1720 | 18469 | 1109 | 22383 | 974 | 13647 |
| 12-#14 | 2.73 | MA | 13459 | 3602 | 21476 | 2886 | 25717 | 2316 | 28229 | 1883 | 31531 | 1173 | 39175 | 904 | 29629 |
| 3L-5S | | MI | 7753 | 3602 | 13049 | 2799 | 15058 | 2232 | 15970 | 1791 | 16876 | 1068 | 20685 | 556 | 17640 |
| 12-#14 | 2.73 | MA | 12577 | 3602 | 20245 | 2885 | 24052 | 2328 | 26212 | 1878 | 28836 | 1166 | 36207 | 773 | 28556 |
| 4E | | MI | 8274 | 3602 | 13848 | 2790 | 16002 | 2240 | 17090 | 1784 | 18400 | 1075 | 22525 | 619 | 18325 |
| 12-#14 | 2.73 | MA | 11777 | 3602 | 18998 | 2900 | 22556 | 2326 | 24386 | 1888 | 26376 | 1173 | 33080 | 709 | 27157 |
| 5L-3S | | MI | 8846 | 3602 | 14634 | 2795 | 17048 | 2232 | 18326 | 1791 | 19965 | 1068 | 24265 | 742 | 19091 |
| 12-#14 | 2.73 | MA | 11009 | 3602 | 17889 | 2900 | 21078 | 2338 | 22587 | 1883 | 24010 | 1181 | 29927 | 600 | 25472 |
| 6L-2S | | MI | 9613 | 3602 | 15672 | 2801 | 18350 | 2240 | 19872 | 1784 | 21999 | 1061 | 26905 | 873 | 19188 |
| 12-#18 | 4.86 | MA | 14279 | 4365 | 25616 | 3340 | 30660 | 2666 | 34161 | 2085 | 39211 | 1091 | 50283 | 403 | 46570 |
| 4E | | MI | 9206 | 4365 | 17162 | 3225 | 19848 | 2537 | 21615 | 1937 | 24371 | 949 | 30274 | 142 | 29383 |
| 12-#18 | 4.86 | MA | 12967 | 4365 | 23429 | 3364 | 28035 | 2659 | 30958 | 2100 | 34956 | 1105 | 44876 | 293 | 42940 |
| 5L-3S | | MI | 10126 | 4365 | 18528 | 3238 | 21627 | 2524 | 23717 | 1950 | 27032 | 936 | 33217 | 352 | 31462 |
| 12-#18 | 4.86 | MA | 11709 | 4365 | 21483 | 3362 | 25442 | 2679 | 27803 | 2089 | 30865 | 1118 | 39450 | 99 | 38998 |
| 6L-2S | | MI | 11349 | 4365 | 20322 | 3251 | 23839 | 2537 | 26344 | 1937 | 30490 | 922 | 37665 | 586 | 32644 |
| 14-#11 | 2.21 | MA | 13024 | 3414 | 20082 | 2778 | 24013 | 2239 | 26194 | 1832 | 28895 | 1191 | 35725 | 987 | 24321 |
| 3L-6S | | MI | 7478 | 3414 | 12153 | 2694 | 13989 | 2172 | 14725 | 1750 | 15277 | 1108 | 18616 | 663 | 14701 |
| 14-#11 | 2.21 | MA | 12396 | 3414 | 19222 | 2778 | 22851 | 2248 | 24785 | 1829 | 27001 | 1186 | 33632 | 895 | 24104 |
| 4L-5S | | MI | 7835 | 3414 | 12652 | 2698 | 14650 | 2167 | 15508 | 1756 | 16281 | 1103 | 19837 | 725 | 15076 |
| 14-#11 | 2.21 | MA | 11827 | 3414 | 18351 | 2789 | 21806 | 2247 | 23510 | 1837 | 25272 | 1191 | 31434 | 851 | 23138 |
| 5L-4S | | MI | 8207 | 3414 | 13212 | 2691 | 15320 | 2172 | 16302 | 1750 | 17360 | 1108 | 21147 | 768 | 15641 |
| 14-#11 | 2.21 | MA | 11281 | 3414 | 17577 | 2789 | 20775 | 2256 | 22255 | 1834 | 23609 | 1196 | 29212 | 775 | 22499 |
| 6L-3S | | MI | 8614 | 3414 | 13763 | 2694 | 16061 | 2167 | 17178 | 1756 | 18469 | 1103 | 22383 | 855 | 15774 |
| 14-#11 | 2.21 | MA | 10747 | 3414 | 16824 | 2789 | 19778 | 2255 | 21038 | 1842 | 21923 | 1191 | 27238 | 704 | 21380 |
| 7L-2S | | MI | 9162 | 3414 | 14493 | 2697 | 16983 | 2172 | 18274 | 1750 | 19911 | 1097 | 24262 | 946 | 15809 |
| 14-#14 | 3.19 | MA | 13330 | 3765 | 21896 | 2988 | 26147 | 2403 | 28750 | 1925 | 32233 | 1157 | 40724 | 749 | 33207 |
| 4L-5S | | MI | 8211 | 3765 | 14087 | 2901 | 16359 | 2306 | 17515 | 1834 | 18910 | 1049 | 23324 | 513 | 20567 |
| 14-#14 | 3.19 | MA | 12545 | 3765 | 20649 | 3002 | 24650 | 2401 | 26923 | 1936 | 29773 | 1164 | 37598 | 685 | 31873 |
| 5L-4S | | MI | 8725 | 3765 | 14886 | 2892 | 17304 | 2313 | 18636 | 1826 | 20434 | 1056 | 25165 | 575 | 21207 |
| 14-#14 | 3.19 | MA | 11791 | 3765 | 19540 | 3002 | 23172 | 2413 | 25124 | 1931 | 27407 | 1172 | 34444 | 576 | 30120 |
| 6L-3S | | MI | 9289 | 3765 | 15672 | 2898 | 18350 | 2306 | 19872 | 1834 | 21999 | 1049 | 26905 | 698 | 22116 |
| 14-#14 | 3.19 | MA | 11052 | 3765 | 18460 | 3002 | 21744 | 2411 | 23380 | 1941 | 25008 | 1164 | 31645 | 473 | 28395 |
| 7L-2S | | MI | 10047 | 3765 | 16710 | 2903 | 19651 | 2313 | 21417 | 1826 | 24033 | 1042 | 29544 | 829 | 22244 |
| 14-#18 | 5.67 | MA | 14240 | 4656 | 26313 | 3546 | 31693 | 2792 | 35390 | 2185 | 40831 | 1085 | 52652 | 243 | 50990 |
| 5L-4S | | MI | 9935 | 4656 | 18956 | 3407 | 22060 | 2664 | 24243 | 2008 | 27830 | 909 | 34722 | 52 | 34387 |
| 14-#18 | 5.67 | MA | 13012 | 4656 | 24367 | 3543 | 29100 | 2812 | 32235 | 2174 | 36740 | 1098 | 47226 | 48 | 46992 |
| 6L-3S | | MI | 10830 | 4656 | 20322 | 3420 | 23839 | 2651 | 26344 | 2021 | 30490 | 896 | 37665 | 263 | 36305 |

## RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis



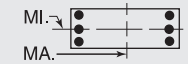

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.53 | MA | 12934 | 3527 | 20377 | 2849 | 24316 | 2300 | 26560 | 1862 | 29388 | 1181 | 36814 | 880 | 27468 |
| 4L-6S | | MI | 7810 | 3527 | 12882 | 2765 | 14911 | 2223 | 15821 | 1781 | 16718 | 1096 | 20495 | 635 | 16706 |
| 16-#11 | 2.53 | MA | 12372 | 3527 | 19506 | 2860 | 23271 | 2299 | 25285 | 1870 | 27659 | 1186 | 34617 | 835 | 26434 |
| 5E | | MI | 8163 | 3527 | 13382 | 2768 | 15573 | 2218 | 16604 | 1786 | 17722 | 1090 | 21716 | 697 | 17139 |
| 16-#11 | 2.53 | MA | 11834 | 3527 | 18732 | 2860 | 22240 | 2308 | 24030 | 1867 | 25997 | 1191 | 32395 | 760 | 25779 |
| 6L-4S | | MI | 8530 | 3527 | 13942 | 2761 | 16242 | 2223 | 17398 | 1781 | 18802 | 1096 | 23026 | 740 | 17670 |
| 16-#11 | 2.53 | MA | 11307 | 3527 | 17979 | 2860 | 21243 | 2307 | 22812 | 1875 | 24311 | 1186 | 30421 | 689 | 24658 |
| 7L-3S | | MI | 8933 | 3527 | 14493 | 2765 | 16983 | 2218 | 18274 | 1786 | 19911 | 1090 | 24262 | 827 | 17915 |
| 16-#11 | 2.53 | MA | 10786 | 3527 | 17238 | 2860 | 20267 | 2305 | 21592 | 1872 | 22684 | 1191 | 28369 | 637 | 23575 |
| 8L-2S | | MI | 9476 | 3527 | 15223 | 2768 | 17906 | 2223 | 19369 | 1781 | 21353 | 1085 | 26140 | 918 | 17965 |
| 16-#14 | 3.64 | MA | 13297 | 3929 | 22300 | 3105 | 26744 | 2476 | 29460 | 1983 | 33169 | 1155 | 42116 | 661 | 36599 |
| 5E | | MI | 8663 | 3929 | 15125 | 3004 | 17661 | 2379 | 19061 | 1876 | 20944 | 1030 | 25964 | 469 | 23436 |
| 16-#14 | 3.64 | MA | 12556 | 3929 | 21192 | 3104 | 25267 | 2488 | 27662 | 1978 | 30804 | 1163 | 38962 | 552 | 34780 |
| 6L-4S | | MI | 9170 | 3929 | 15924 | 2994 | 18605 | 2386 | 20182 | 1869 | 22468 | 1037 | 27805 | 531 | 24104 |
| 16-#14 | 3.64 | MA | 11831 | 3929 | 20112 | 3104 | 23838 | 2486 | 25917 | 1989 | 28405 | 1155 | 36163 | 449 | 33015 |
| 7L-3S | | MI | 9725 | 3929 | 16710 | 3000 | 19651 | 2379 | 21417 | 1876 | 24033 | 1030 | 29544 | 654 | 25135 |
| 16-#14 | 3.64 | MA | 11113 | 3929 | 19049 | 3104 | 22439 | 2483 | 24169 | 1984 | 26090 | 1163 | 33244 | 375 | 31043 |
| 8L-2S | | MI | 10474 | 3929 | 17748 | 3005 | 20953 | 2386 | 22963 | 1869 | 26067 | 1022 | 32184 | 786 | 25293 |
| 16-#18 | 6.48 | MA | 14386 | 4946 | 27252 | 3725 | 32758 | 2945 | 36667 | 2258 | 42615 | 1078 | 55001 | -2 | 54987 |
| 6L-4S | | MI | 10649 | 4946 | 20750 | 3589 | 24272 | 2790 | 26870 | 2079 | 31288 | 870 | 39170 | -37 | 38880 |
| 18-#11 | 2.84 | MA | 12909 | 3641 | 20661 | 2931 | 24736 | 2350 | 27059 | 1903 | 30047 | 1180 | 37800 | 820 | 29738 |
| 5L-6S | | MI | 8137 | 3641 | 13612 | 2836 | 15834 | 2275 | 16916 | 1811 | 18160 | 1084 | 22373 | 606 | 18720 |
| 18-#11 | 2.84 | MA | 12378 | 3641 | 19887 | 2931 | 23705 | 2360 | 25804 | 1900 | 28384 | 1185 | 35578 | 745 | 29029 |
| 6L-5S | | MI | 8486 | 3641 | 14112 | 2839 | 16495 | 2270 | 17699 | 1816 | 19164 | 1078 | 23594 | 669 | 19208 |
| 18-#11 | 2.84 | MA | 11858 | 3641 | 19134 | 2931 | 22708 | 2358 | 24587 | 1908 | 26698 | 1180 | 33604 | 674 | 27941 |
| 7L-4S | | MI | 8849 | 3641 | 14672 | 2832 | 17165 | 2275 | 18493 | 1811 | 20243 | 1084 | 24904 | 712 | 19708 |
| 18-#11 | 2.84 | MA | 11343 | 3641 | 18392 | 2931 | 21731 | 2357 | 23367 | 1905 | 25071 | 1185 | 31552 | 621 | 26830 |
| 8L-3S | | MI | 9248 | 3641 | 15223 | 2836 | 17906 | 2270 | 19369 | 1816 | 21353 | 1078 | 26140 | 798 | 20052 |
| 18-#11 | 2.84 | MA | 10833 | 3641 | 17574 | 2942 | 20725 | 2366 | 22167 | 1913 | 23460 | 1190 | 29536 | 563 | 25641 |
| 9L-2S | | MI | 9786 | 3641 | 15953 | 2839 | 18828 | 2275 | 20465 | 1811 | 22794 | 1073 | 28018 | 890 | 20117 |
| 18-#14 | 4.10 | MA | 13308 | 4092 | 22843 | 3207 | 27361 | 2563 | 30199 | 2026 | 34201 | 1153 | 43480 | 528 | 39451 |
| 6L-5S | | MI | 9107 | 4092 | 16163 | 3106 | 18962 | 2452 | 20607 | 1919 | 22978 | 1011 | 28603 | 425 | 26262 |
| 18-#14 | 4.10 | MA | 12594 | 4092 | 21763 | 3206 | 25933 | 2560 | 28455 | 2036 | 31802 | 1146 | 40680 | 425 | 37579 |
| 7L-4S | | MI | 9607 | 4092 | 16962 | 3096 | 19907 | 2460 | 21727 | 1912 | 24502 | 1018 | 30444 | 488 | 27013 |
| 18-#14 | 4.10 | MA | 11888 | 4092 | 20700 | 3206 | 24533 | 2558 | 26707 | 2031 | 29487 | 1153 | 37762 | 351 | 35652 |
| 8L-3S | | MI | 10156 | 4092 | 17748 | 3102 | 20953 | 2452 | 22963 | 1919 | 26067 | 1011 | 32184 | 610 | 28151 |
| 20-#11 | 3.16 | MA | 12913 | 3754 | 21042 | 3002 | 25169 | 2411 | 27579 | 1933 | 30771 | 1180 | 38761 | 729 | 32288 |
| 6E | | MI | 8460 | 3754 | 14342 | 2907 | 16756 | 2326 | 18012 | 1842 | 19601 | 1072 | 24251 | 578 | 20743 |
| 20-#11 | 3.16 | MA | 12400 | 3754 | 20289 | 3002 | 24173 | 2410 | 26361 | 1941 | 29085 | 1175 | 36786 | 658 | 31231 |
| 7L-5S | | MI | 8805 | 3754 | 14841 | 2910 | 17418 | 2321 | 18795 | 1847 | 20605 | 1066 | 25473 | 641 | 21282 |
| 20-#11 | 3.16 | MA | 11892 | 3754 | 19547 | 3002 | 23196 | 2409 | 25142 | 1938 | 27459 | 1180 | 34734 | 606 | 30056 |
| 8L-4S | | MI | 9165 | 3754 | 15401 | 2903 | 18087 | 2326 | 19589 | 1842 | 21685 | 1072 | 26783 | 684 | 21755 |
| 20-#11 | 3.16 | MA | 11388 | 3754 | 18729 | 3013 | 22190 | 2418 | 23941 | 1945 | 25848 | 1185 | 32719 | 547 | 28884 |
| 9L-3S | | MI | 9559 | 3754 | 15953 | 2906 | 18828 | 2321 | 20465 | 1847 | 22794 | 1066 | 28018 | 770 | 22185 |
| 20-#11 | 3.16 | MA | 10886 | 3754 | 17990 | 3013 | 21220 | 2417 | 22736 | 1943 | 24191 | 1180 | 30764 | 481 | 27566 |
| 10L-2S | | MI | 10092 | 3754 | 16682 | 2910 | 19751 | 2326 | 21560 | 1842 | 24236 | 1061 | 29897 | 861 | 22264 |
| 20-#14 | 4.55 | MA | 13344 | 4256 | 23415 | 3309 | 28027 | 2635 | 30992 | 2083 | 35198 | 1137 | 45198 | 401 | 42222 |
| 7L-5S | | MI | 9576 | 4256 | 17201 | 3208 | 20264 | 2526 | 22153 | 1962 | 25012 | 992 | 31243 | 381 | 29101 |
| 20-#14 | 4.55 | MA | 12650 | 4256 | 22351 | 3308 | 26627 | 2633 | 29244 | 2079 | 32884 | 1144 | 42279 | 327 | 40269 |
| 8L-4S | | MI | 10061 | 4256 | 18000 | 3199 | 21208 | 2533 | 23273 | 1954 | 26536 | 999 | 33084 | 444 | 29932 |
| 22-#11 | 3.47 | MA | 12934 | 3868 | 21444 | 3073 | 25638 | 2462 | 28136 | 1973 | 31473 | 1169 | 39969 | 643 | 34526 |
| 7L-6S | | MI | 8779 | 3868 | 15071 | 2978 | 17679 | 2378 | 19107 | 1872 | 21043 | 1059 | 26130 | 550 | 22772 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

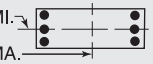
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.47 | MA | 12433 | 3868 | 20702 | 3073 | 24661 | 2461 | 26916 | 1971 | 29846 | 1174 | 37917 | 591 | 33323 |
| 8L-5S | | MI | 9121 | 3868 | 15571 | 2981 | 18340 | 2373 | 19890 | 1877 | 22047 | 1054 | 27351 | 613 | 23359 |
| 22-#11 | 3.47 | MA | 11935 | 3868 | 19884 | 3084 | 23655 | 2470 | 25716 | 1978 | 28235 | 1179 | 35902 | 532 | 32132 |
| 9L-4S | | MI | 9477 | 3868 | 16131 | 2974 | 19010 | 2378 | 20684 | 1872 | 23126 | 1059 | 28661 | 656 | 23808 |
| 22-#11 | 3.47 | MA | 11439 | 3868 | 19145 | 3084 | 22685 | 2469 | 24510 | 1976 | 26578 | 1174 | 33947 | 466 | 30838 |
| 10L-3S | | MI | 9867 | 3868 | 16682 | 2977 | 19751 | 2373 | 21560 | 1877 | 24236 | 1054 | 29897 | 742 | 24316 |
| 22-#14 | 5.01 | MA | 13399 | 4419 | 24003 | 3411 | 28722 | 2708 | 31781 | 2126 | 36281 | 1135 | 46797 | 303 | 44895 |
| 8L-5S | | MI | 10005 | 4419 | 18239 | 3310 | 21566 | 2599 | 23698 | 2004 | 27046 | 973 | 33882 | 337 | 31953 |
| 24-#11 | 3.79 | MA | 12966 | 3981 | 21857 | 3144 | 26126 | 2513 | 28691 | 2004 | 32233 | 1169 | 41100 | 576 | 36596 |
| 8L-6S | | MI | 9094 | 3981 | 15801 | 3049 | 18601 | 2430 | 20203 | 1902 | 22484 | 1047 | 28008 | 522 | 24807 |
| 24-#11 | 3.79 | MA | 12474 | 3981 | 21039 | 3154 | 25119 | 2522 | 27491 | 2011 | 30622 | 1174 | 39085 | 517 | 35385 |
| 9L-5S | | MI | 9433 | 3981 | 16301 | 3052 | 19263 | 2424 | 20986 | 1907 | 23488 | 1042 | 29230 | 584 | 25439 |
| 24-#11 | 3.79 | MA | 11985 | 3981 | 20300 | 3155 | 24149 | 2521 | 26285 | 2009 | 28966 | 1169 | 37130 | 451 | 34115 |
| 10L-4S | | MI | 9785 | 3981 | 16861 | 3045 | 19932 | 2430 | 21780 | 1902 | 24568 | 1047 | 30540 | 628 | 25867 |

## RECTANGULAR TIED COLUMNS 26" x 40"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.54 | MA | 14047 | 3340 | 20846 | 2747 | 24689 | 2227 | 26641 | 1834 | 28655 | 1244 | 35003 | 1146 | 18803 |
| 2E | | MI | 8804 | 3340 | 13649 | 2638 | 15547 | 2124 | 16391 | 1732 | 17170 | 1142 | 20451 | 1002 | 11534 |
| 6-#14 | 1.30 | MA | 13674 | 3249 | 19833 | 2708 | 23541 | 2200 | 25309 | 1820 | 27020 | 1266 | 32923 | 1181 | 16114 |
| 2L-3S | | MI | 7824 | 3249 | 12017 | 2604 | 13698 | 2107 | 14247 | 1744 | 14378 | 1187 | 16929 | 933 | 9996 |
| 6-#14 | 1.30 | MA | 12308 | 3249 | 18079 | 2709 | 21317 | 2199 | 22615 | 1832 | 23395 | 1273 | 28091 | 1050 | 16046 |
| 3L-2S | | MI | 8628 | 3249 | 13055 | 2609 | 15000 | 2114 | 15792 | 1737 | 16412 | 1179 | 19569 | 1064 | 9968 |
| 6-#18 | 2.31 | MA | 15444 | 3630 | 23912 | 2929 | 28578 | 2360 | 31352 | 1918 | 34934 | 1227 | 43337 | 1099 | 27871 |
| 2L-3S | | MI | 8225 | 3630 | 13649 | 2807 | 15547 | 2238 | 16391 | 1816 | 17170 | 1116 | 20451 | 679 | 16727 |
| 6-#18 | 2.31 | MA | 13149 | 3630 | 20846 | 2927 | 24689 | 2354 | 26641 | 1935 | 28655 | 1240 | 35003 | 866 | 27382 |
| 3L-2S | | MI | 9571 | 3630 | 15443 | 2820 | 17759 | 2251 | 19019 | 1803 | 20628 | 1103 | 24899 | 913 | 16889 |
| 8-#11 | 1.20 | MA | 13520 | 3212 | 19403 | 2694 | 23066 | 2191 | 24763 | 1816 | 26334 | 1274 | 32076 | 1196 | 15005 |
| 2L-4S | | MI | 7565 | 3212 | 11517 | 2594 | 13106 | 2112 | 13574 | 1740 | 13552 | 1206 | 16097 | 913 | 9332 |
| 8-#11 | 1.20 | MA | 12560 | 3212 | 18177 | 2695 | 21511 | 2190 | 22880 | 1824 | 23793 | 1279 | 28674 | 1105 | 14980 |
| 3E | | MI | 7988 | 3212 | 12068 | 2597 | 13847 | 2107 | 14450 | 1746 | 14662 | 1201 | 17333 | 999 | 9340 |
| 8-#11 | 1.20 | MA | 11864 | 3212 | 17266 | 2696 | 20279 | 2200 | 21386 | 1822 | 21778 | 1275 | 26434 | 1014 | 14849 |
| 4L-2S | | MI | 8555 | 3212 | 12798 | 2600 | 14770 | 2112 | 15545 | 1740 | 16103 | 1196 | 19211 | 1090 | 9316 |
| 8-#14 | 1.73 | MA | 14500 | 3412 | 21586 | 2811 | 25765 | 2275 | 28003 | 1868 | 30644 | 1258 | 37756 | 1159 | 21311 |
| 2L-4S | | MI | 7704 | 3412 | 12269 | 2700 | 13954 | 2188 | 14556 | 1779 | 14847 | 1175 | 17829 | 766 | 12776 |
| 8-#14 | 1.73 | MA | 13159 | 3412 | 19833 | 2811 | 23541 | 2273 | 25309 | 1879 | 27020 | 1265 | 32923 | 1028 | 21188 |
| 3E | | MI | 8296 | 3412 | 13055 | 2706 | 15000 | 2180 | 15792 | 1787 | 16412 | 1168 | 19569 | 889 | 13062 |
| 8-#14 | 1.73 | MA | 12184 | 3412 | 18527 | 2811 | 21776 | 2286 | 23170 | 1875 | 24144 | 1258 | 29744 | 896 | 20668 |
| 4L-2S | | MI | 9088 | 3412 | 14093 | 2712 | 16301 | 2188 | 17338 | 1779 | 18446 | 1160 | 22208 | 1020 | 13075 |
| 8-#18 | 3.08 | MA | 16791 | 3921 | 26978 | 3110 | 32467 | 2493 | 36063 | 2003 | 41214 | 1209 | 51671 | 1053 | 36903 |
| 2L-4S | | MI | 8014 | 3921 | 14077 | 2976 | 15980 | 2378 | 16917 | 1874 | 17967 | 1089 | 21956 | 379 | 19670 |
| 8-#18 | 3.08 | MA | 14555 | 3921 | 23912 | 3109 | 28578 | 2487 | 31352 | 2020 | 34934 | 1222 | 43337 | 820 | 36278 |
| 3E | | MI | 8999 | 3921 | 15443 | 2989 | 17759 | 2364 | 19019 | 1887 | 20628 | 1076 | 24899 | 590 | 21914 |
| 8-#18 | 3.08 | MA | 12930 | 3921 | 21622 | 3108 | 25484 | 2509 | 27602 | 2010 | 29951 | 1209 | 37868 | 586 | 32434 |
| 4L-2S | | MI | 10316 | 3921 | 17237 | 3002 | 19971 | 2378 | 21646 | 1874 | 24086 | 1063 | 29347 | 823 | 22187 |
| 10-#11 | 1.50 | MA | 14107 | 3325 | 20629 | 2765 | 24620 | 2243 | 26647 | 1849 | 28876 | 1269 | 35477 | 1182 | 18642 |
| 2L-5S | | MI | 7523 | 3325 | 11687 | 2672 | 13359 | 2159 | 13875 | 1776 | 13914 | 1189 | 16665 | 841 | 11079 |
| 10-#11 | 1.50 | MA | 13159 | 3325 | 19403 | 2766 | 23066 | 2242 | 24763 | 1857 | 26334 | 1274 | 32076 | 1091 | 18590 |
| 3L-4S | | MI | 7905 | 3325 | 12247 | 2665 | 14028 | 2164 | 14670 | 1771 | 14994 | 1194 | 17975 | 885 | 11475 |
| 10-#11 | 1.50 | MA | 12473 | 3325 | 18492 | 2766 | 21834 | 2251 | 23270 | 1855 | 24319 | 1269 | 29835 | 1000 | 18427 |
| 4L-3S | | MI | 8323 | 3325 | 12798 | 2668 | 14770 | 2159 | 15545 | 1776 | 16103 | 1189 | 19211 | 971 | 11511 |
| 10-#11 | 1.50 | MA | 11851 | 3325 | 17569 | 2777 | 20727 | 2251 | 21919 | 1863 | 22480 | 1275 | 27492 | 954 | 17657 |
| 5L-2S | | MI | 8885 | 3325 | 13528 | 2671 | 15692 | 2164 | 16641 | 1771 | 17545 | 1184 | 21089 | 1062 | 11503 |
| 10-#14 | 2.16 | MA | 15306 | 3576 | 23340 | 2913 | 27989 | 2350 | 30698 | 1915 | 34269 | 1249 | 42588 | 1137 | 26493 |
| 2L-5S | | MI | 7643 | 3576 | 12508 | 2812 | 14311 | 2254 | 14982 | 1829 | 15357 | 1149 | 18627 | 660 | 14859 |
| 10-#14 | 2.16 | MA | 13987 | 3576 | 21586 | 2913 | 25765 | 2348 | 28003 | 1926 | 30644 | 1257 | 37756 | 1006 | 26322 |
| 3L-4S | | MI | 8175 | 3576 | 13307 | 2803 | 15255 | 2261 | 16102 | 1822 | 16881 | 1156 | 20468 | 723 | 15613 |

## RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

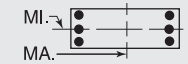
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.16 | MA | 13030 | 3576 | 20281 | 2914 | 24000 | 2361 | 25865 | 1922 | 27768 | 1249 | 34577 | 874 | 25568 |
| 4L-3S | | MI | 8757 | 3576 | 14093 | 2808 | 16301 | 2254 | 17338 | 1829 | 18446 | 1149 | 22208 | 845 | 16110 |
| 10-#14 | 2.16 | MA | 12163 | 3576 | 18959 | 2929 | 22414 | 2360 | 23929 | 1933 | 25143 | 1257 | 31240 | 809 | 23935 |
| 5L-2S | | MI | 9539 | 3576 | 15131 | 2814 | 17603 | 2261 | 18884 | 1822 | 20480 | 1141 | 24848 | 977 | 16162 |
| 10-#18 | 3.85 | MA | 15916 | 4212 | 26978 | 3291 | 32467 | 2620 | 36063 | 2104 | 41214 | 1204 | 51671 | 774 | 45176 |
| 3L-4S | | MI | 8820 | 4212 | 15871 | 3157 | 18192 | 2504 | 19545 | 1945 | 21426 | 1050 | 26404 | 290 | 24607 |
| 10-#18 | 3.85 | MA | 14334 | 4212 | 24688 | 3290 | 29372 | 2642 | 32313 | 2094 | 36230 | 1191 | 46202 | 540 | 41069 |
| 4L-3S | | MI | 9773 | 4212 | 17237 | 3170 | 19971 | 2491 | 21646 | 1959 | 24086 | 1036 | 29347 | 500 | 26939 |
| 10-#18 | 3.85 | MA | 12901 | 4212 | 22369 | 3315 | 26588 | 2636 | 28916 | 2111 | 31683 | 1204 | 40423 | 428 | 37525 |
| 5L-2S | | MI | 11037 | 4212 | 19031 | 3183 | 22183 | 2504 | 24274 | 1945 | 27545 | 1023 | 33795 | 734 | 27456 |
| 12-#11 | 1.80 | MA | 14682 | 3439 | 21855 | 2836 | 26175 | 2295 | 28530 | 1882 | 31417 | 1264 | 38878 | 1168 | 22270 |
| 2L-6S | | MI | 7500 | 3439 | 11917 | 2739 | 13620 | 2215 | 14188 | 1801 | 14352 | 1182 | 17322 | 751 | 12802 |
| 12-#11 | 1.80 | MA | 13747 | 3439 | 20629 | 2837 | 24620 | 2294 | 26647 | 1890 | 28876 | 1269 | 35477 | 1077 | 22195 |
| 3L-5S | | MI | 7862 | 3439 | 12416 | 2743 | 14282 | 2210 | 14971 | 1806 | 15356 | 1177 | 18544 | 813 | 13125 |
| 12-#11 | 1.80 | MA | 13070 | 3439 | 19718 | 2837 | 23388 | 2303 | 25153 | 1888 | 26860 | 1264 | 33237 | 986 | 22003 |
| 4E | | MI | 8240 | 3439 | 12976 | 2735 | 14951 | 2215 | 15765 | 1801 | 16435 | 1182 | 19854 | 856 | 13609 |
| 12-#11 | 1.80 | MA | 12457 | 3439 | 18795 | 2848 | 22282 | 2303 | 23803 | 1896 | 25021 | 1270 | 30893 | 940 | 21140 |
| 5L-3S | | MI | 8653 | 3439 | 13528 | 2739 | 15692 | 2210 | 16641 | 1806 | 17545 | 1177 | 21089 | 943 | 13668 |
| 12-#11 | 1.80 | MA | 11868 | 3439 | 17976 | 2849 | 21189 | 2312 | 22473 | 1894 | 23253 | 1275 | 28519 | 865 | 20413 |
| 6L-2S | | MI | 9209 | 3439 | 14257 | 2742 | 16615 | 2215 | 17736 | 1801 | 18986 | 1172 | 22968 | 1034 | 13679 |
| 12-#14 | 2.60 | MA | 14796 | 3739 | 23340 | 3015 | 27989 | 2423 | 30698 | 1974 | 34269 | 1249 | 42588 | 983 | 31451 |
| 3L-5S | | MI | 8112 | 3739 | 13546 | 2914 | 15613 | 2327 | 16527 | 1872 | 17391 | 1130 | 21267 | 616 | 17774 |
| 12-#14 | 2.60 | MA | 13856 | 3739 | 22034 | 3016 | 26224 | 2436 | 28559 | 1970 | 31393 | 1241 | 39409 | 852 | 30492 |
| 4E | | MI | 8636 | 3739 | 14345 | 2905 | 16557 | 2334 | 17648 | 1864 | 18915 | 1137 | 23108 | 679 | 18474 |
| 12-#14 | 2.60 | MA | 13005 | 3739 | 20713 | 3031 | 24638 | 2434 | 26623 | 1981 | 28768 | 1249 | 36073 | 787 | 28936 |
| 5L-3S | | MI | 9210 | 3739 | 15131 | 2910 | 17603 | 2327 | 18884 | 1872 | 20480 | 1130 | 24848 | 801 | 19147 |
| 12-#14 | 2.60 | MA | 12189 | 3739 | 19538 | 3031 | 23072 | 2448 | 24717 | 1977 | 26244 | 1256 | 32699 | 679 | 27262 |
| 6L-2S | | MI | 9981 | 3739 | 16169 | 2916 | 18904 | 2334 | 20430 | 1864 | 22514 | 1122 | 27487 | 933 | 19231 |
| 12-#18 | 4.62 | MA | 15699 | 4503 | 27755 | 3471 | 33261 | 2775 | 37025 | 2178 | 42510 | 1173 | 54537 | 494 | 49741 |
| 4E | | MI | 9571 | 4503 | 17665 | 3339 | 20404 | 2631 | 22172 | 2016 | 24884 | 1010 | 30852 | 201 | 29581 |
| 12-#18 | 4.62 | MA | 14301 | 4503 | 25435 | 3497 | 30477 | 2769 | 33627 | 2195 | 37962 | 1186 | 48757 | 382 | 46073 |
| 5L-3S | | MI | 10498 | 4503 | 19031 | 3352 | 22183 | 2618 | 24274 | 2030 | 27545 | 997 | 33795 | 411 | 31727 |
| 12-#18 | 4.62 | MA | 12960 | 4503 | 23372 | 3495 | 27728 | 2790 | 30281 | 2186 | 33589 | 1200 | 42940 | 188 | 42210 |
| 6L-2S | | MI | 11730 | 4503 | 20825 | 3365 | 24395 | 2631 | 26901 | 2016 | 31003 | 983 | 38243 | 645 | 32707 |
| 14-#11 | 2.10 | MA | 14324 | 3552 | 21855 | 2908 | 26175 | 2346 | 28530 | 1923 | 31417 | 1264 | 38878 | 1063 | 25795 |
| 3L-6S | | MI | 7837 | 3552 | 12647 | 2810 | 14543 | 2267 | 15284 | 1831 | 15794 | 1170 | 19201 | 723 | 14871 |
| 14-#11 | 2.10 | MA | 13656 | 3552 | 20943 | 2908 | 24943 | 2355 | 27037 | 1921 | 29401 | 1259 | 36638 | 972 | 25578 |
| 4L-5S | | MI | 8196 | 3552 | 13146 | 2813 | 15204 | 2262 | 16066 | 1837 | 16797 | 1165 | 20422 | 785 | 15181 |
| 14-#11 | 2.10 | MA | 13051 | 3552 | 20021 | 2919 | 23836 | 2354 | 25686 | 1929 | 27562 | 1264 | 34295 | 926 | 24633 |
| 5L-4S | | MI | 8569 | 3552 | 13706 | 2806 | 15874 | 2267 | 16861 | 1831 | 17877 | 1170 | 21732 | 828 | 15738 |
| 14-#11 | 2.10 | MA | 12471 | 3552 | 19202 | 2920 | 22744 | 2364 | 24356 | 1927 | 25794 | 1270 | 31920 | 851 | 23933 |
| 6L-3S | | MI | 8978 | 3552 | 14257 | 2810 | 16615 | 2262 | 17736 | 1837 | 18986 | 1165 | 22968 | 915 | 15817 |
| 14-#11 | 2.10 | MA | 11903 | 3552 | 18404 | 2920 | 21689 | 2363 | 23067 | 1935 | 24001 | 1265 | 29808 | 780 | 22821 |
| 7L-2S | | MI | 9528 | 3552 | 14987 | 2813 | 17537 | 2267 | 18832 | 1831 | 20428 | 1160 | 24846 | 1006 | 15845 |
| 14-#14 | 3.03 | MA | 14665 | 3903 | 23788 | 3118 | 28448 | 2511 | 31253 | 2017 | 35018 | 1233 | 44242 | 830 | 35436 |
| 4L-5S | | MI | 8572 | 3903 | 14584 | 3016 | 16914 | 2400 | 18073 | 1914 | 19425 | 1111 | 23907 | 572 | 20700 |
| 14-#14 | 3.03 | MA | 13828 | 3903 | 22466 | 3133 | 26862 | 2509 | 29317 | 2028 | 32393 | 1241 | 40905 | 765 | 33949 |
| 5L-4S | | MI | 9089 | 3903 | 15383 | 3007 | 17858 | 2408 | 19194 | 1907 | 20949 | 1118 | 25748 | 635 | 21354 |
| 14-#14 | 3.03 | MA | 13026 | 3903 | 21292 | 3134 | 25296 | 2522 | 27412 | 2024 | 29868 | 1248 | 37532 | 657 | 32206 |
| 6L-3S | | MI | 9655 | 3903 | 16169 | 3013 | 18904 | 2400 | 20430 | 1914 | 22514 | 1111 | 27487 | 758 | 22175 |
| 14-#14 | 3.03 | MA | 12241 | 3903 | 20148 | 3134 | 23783 | 2521 | 25563 | 2035 | 27309 | 1241 | 34534 | 554 | 30480 |
| 7L-2S | | MI | 10417 | 3903 | 17207 | 3018 | 20206 | 2408 | 21975 | 1907 | 24549 | 1103 | 30127 | 889 | 22290 |
| 14-#18 | 5.38 | MA | 15666 | 4794 | 28501 | 3678 | 34366 | 2902 | 38338 | 2280 | 44242 | 1169 | 57091 | 336 | 54650 |
| 5L-4S | | MI | 10303 | 4794 | 19459 | 3521 | 22616 | 2757 | 24799 | 2088 | 28342 | 970 | 35300 | 111 | 34582 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis

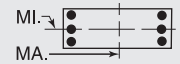


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 5.38 | MA | 14356 | 4794 | 26438 | 3677 | 31616 | 2923 | 34992 | 2270 | 39868 | 1182 | 51274 | 142 | 50544 |
| 6L-3S | | MI | 11206 | 4794 | 20825 | 3534 | 24395 | 2744 | 26901 | 2101 | 31003 | 957 | 38243 | 322 | 36563 |
| 16-#11 | 2.40 | MA | 14232 | 3665 | 22169 | 2979 | 26498 | 2407 | 28920 | 1954 | 31943 | 1254 | 40039 | 958 | 29153 |
| 4L-6S | | MI | 8170 | 3665 | 13376 | 2881 | 15465 | 2319 | 16379 | 1862 | 17235 | 1158 | 21079 | 695 | 16874 |
| 16-#11 | 2.40 | MA | 13635 | 3665 | 21247 | 2990 | 25391 | 2406 | 27570 | 1962 | 30104 | 1259 | 37696 | 912 | 28136 |
| 5E | | MI | 8525 | 3665 | 13876 | 2884 | 16127 | 2313 | 17162 | 1867 | 18239 | 1153 | 22301 | 757 | 17244 |
| 16-#11 | 2.40 | MA | 13063 | 3665 | 20428 | 2991 | 24299 | 2416 | 26240 | 1960 | 28335 | 1265 | 35321 | 837 | 27458 |
| 6L-4S | | MI | 8894 | 3665 | 14436 | 2877 | 16796 | 2319 | 17956 | 1862 | 19319 | 1158 | 23611 | 800 | 17790 |
| 16-#11 | 2.40 | MA | 12503 | 3665 | 19630 | 2991 | 23243 | 2415 | 24951 | 1968 | 26542 | 1260 | 33209 | 766 | 26305 |
| 7L-3S | | MI | 9298 | 3665 | 14987 | 2880 | 17537 | 2313 | 18832 | 1867 | 20428 | 1153 | 24846 | 887 | 17961 |
| 16-#11 | 2.40 | MA | 11949 | 3665 | 18845 | 2992 | 22209 | 2414 | 23659 | 1966 | 24812 | 1265 | 31021 | 713 | 25235 |
| 8L-2S | | MI | 9843 | 3665 | 15717 | 2884 | 18460 | 2319 | 19927 | 1862 | 21869 | 1148 | 26725 | 978 | 18004 |
| 16-#14 | 3.46 | MA | 14635 | 4067 | 24220 | 3235 | 29086 | 2584 | 32012 | 2076 | 36018 | 1233 | 45738 | 743 | 38973 |
| 5E | | MI | 9025 | 4067 | 15622 | 3119 | 18216 | 2474 | 19619 | 1957 | 21460 | 1092 | 26546 | 529 | 23634 |
| 16-#14 | 3.46 | MA | 13847 | 4067 | 23045 | 3236 | 27520 | 2597 | 30106 | 2072 | 33493 | 1240 | 42364 | 634 | 37163 |
| 6L-4S | | MI | 9535 | 4067 | 16421 | 3109 | 19160 | 2481 | 20739 | 1949 | 22983 | 1099 | 28387 | 591 | 24249 |
| 16-#14 | 3.46 | MA | 13074 | 4067 | 21902 | 3236 | 26007 | 2595 | 28258 | 2083 | 30933 | 1233 | 39367 | 532 | 35397 |
| 7L-3S | | MI | 10094 | 4067 | 17207 | 3115 | 20206 | 2474 | 21975 | 1957 | 24549 | 1092 | 30127 | 714 | 25198 |
| 16-#14 | 3.46 | MA | 12310 | 4067 | 20776 | 3237 | 24524 | 2594 | 26406 | 2079 | 28463 | 1240 | 36251 | 457 | 33291 |
| 8L-2S | | MI | 10846 | 4067 | 18245 | 3120 | 21507 | 2481 | 23521 | 1949 | 26583 | 1084 | 32766 | 845 | 25341 |
| 16-#18 | 6.15 | MA | 15836 | 5084 | 29504 | 3859 | 35505 | 3056 | 39704 | 2354 | 46148 | 1164 | 59608 | 96 | 59093 |
| 6L-4S | | MI | 11020 | 5084 | 21253 | 3702 | 24828 | 2884 | 27427 | 2159 | 31800 | 931 | 39748 | 22 | 39604 |
| 18-#11 | 2.70 | MA | 14210 | 3779 | 22473 | 3061 | 26946 | 2458 | 29453 | 1995 | 32645 | 1254 | 41097 | 898 | 31645 |
| 5L-6S | | MI | 8498 | 3779 | 14106 | 2952 | 16388 | 2370 | 17475 | 1892 | 18677 | 1146 | 22958 | 667 | 18886 |
| 18-#11 | 2.70 | MA | 13645 | 3779 | 21654 | 3061 | 25853 | 2468 | 28123 | 1992 | 30876 | 1260 | 38723 | 823 | 30988 |
| 6L-5S | | MI | 8849 | 3779 | 14606 | 2955 | 17049 | 2365 | 18257 | 1897 | 19680 | 1141 | 24179 | 729 | 19312 |
| 18-#11 | 2.70 | MA | 13092 | 3779 | 20856 | 3062 | 24798 | 2467 | 26834 | 2001 | 29083 | 1255 | 36611 | 752 | 29794 |
| 7L-4S | | MI | 9214 | 3779 | 15165 | 2948 | 17719 | 2370 | 19052 | 1892 | 20760 | 1146 | 25489 | 772 | 19828 |
| 18-#11 | 2.70 | MA | 12546 | 3779 | 20071 | 3063 | 23764 | 2466 | 25542 | 1998 | 27353 | 1260 | 34422 | 699 | 28696 |
| 8L-3S | | MI | 9614 | 3779 | 15717 | 2951 | 18460 | 2365 | 19927 | 1897 | 21869 | 1141 | 26725 | 859 | 20100 |
| 18-#11 | 2.70 | MA | 12002 | 3779 | 19204 | 3074 | 22698 | 2476 | 24272 | 2007 | 25640 | 1265 | 32267 | 641 | 27465 |
| 9L-2S | | MI | 10154 | 3779 | 16446 | 2955 | 19382 | 2370 | 21023 | 1892 | 23311 | 1135 | 28603 | 950 | 20157 |
| 18-#14 | 3.89 | MA | 14652 | 4230 | 24799 | 3338 | 29744 | 2672 | 32800 | 2119 | 37118 | 1232 | 47197 | 612 | 42131 |
| 6L-5S | | MI | 9471 | 4230 | 16660 | 3221 | 19517 | 2547 | 21165 | 1999 | 23494 | 1073 | 29186 | 485 | 26493 |
| 18-#14 | 3.89 | MA | 13892 | 4230 | 23655 | 3338 | 28231 | 2670 | 30952 | 2130 | 34558 | 1225 | 44199 | 510 | 40325 |
| 7L-4S | | MI | 9974 | 4230 | 17459 | 3212 | 20461 | 2554 | 22285 | 1992 | 25017 | 1080 | 31027 | 547 | 27156 |
| 18-#14 | 3.89 | MA | 13141 | 4230 | 22529 | 3339 | 26748 | 2668 | 29100 | 2126 | 32088 | 1232 | 41084 | 435 | 38270 |
| 8L-3S | | MI | 10526 | 4230 | 18245 | 3217 | 21507 | 2547 | 23521 | 1999 | 26583 | 1073 | 32766 | 670 | 28217 |
| 18-#14 | 3.89 | MA | 12394 | 4230 | 21286 | 3354 | 25220 | 2682 | 27278 | 2137 | 29642 | 1240 | 38024 | 350 | 35916 |
| 9L-2S | | MI | 11270 | 4230 | 19283 | 3223 | 22809 | 2554 | 25067 | 1992 | 28617 | 1065 | 35406 | 802 | 28386 |
| 20-#11 | 3.00 | MA | 14219 | 3892 | 22880 | 3132 | 27408 | 2520 | 30007 | 2025 | 33417 | 1254 | 42124 | 809 | 34466 |
| 6E | | MI | 8822 | 3892 | 14836 | 3023 | 17310 | 2422 | 18570 | 1923 | 20118 | 1134 | 24836 | 638 | 20907 |
| 20-#11 | 3.00 | MA | 13673 | 3892 | 22082 | 3133 | 26353 | 2519 | 28718 | 2033 | 31624 | 1249 | 40012 | 738 | 33290 |
| 7L-5S | | MI | 9169 | 3892 | 15335 | 3026 | 17972 | 2417 | 19353 | 1928 | 21122 | 1129 | 26058 | 701 | 21386 |
| 20-#11 | 3.00 | MA | 13133 | 3892 | 21297 | 3134 | 25319 | 2518 | 27426 | 2031 | 29894 | 1255 | 37824 | 686 | 32163 |
| 8L-4S | | MI | 9531 | 3892 | 15895 | 3019 | 18641 | 2422 | 20147 | 1923 | 22202 | 1134 | 27368 | 744 | 21873 |
| 20-#11 | 3.00 | MA | 12597 | 3892 | 20430 | 3145 | 24253 | 2528 | 26155 | 2039 | 28181 | 1260 | 35669 | 627 | 30958 |
| 9L-3S | | MI | 9927 | 3892 | 16446 | 3022 | 19382 | 2417 | 21023 | 1928 | 23311 | 1129 | 28603 | 830 | 22235 |
| 20-#11 | 3.00 | MA | 12063 | 3892 | 19648 | 3145 | 23226 | 2527 | 24878 | 2037 | 26419 | 1255 | 33440 | 547 | 29504 |
| 10L-2S | | MI | 10462 | 3892 | 17176 | 3025 | 20305 | 2422 | 22118 | 1923 | 24752 | 1123 | 30482 | 922 | 22306 |
| 20-#14 | 4.33 | MA | 14696 | 4394 | 25409 | 3441 | 30455 | 2745 | 33646 | 2178 | 38183 | 1217 | 49032 | 488 | 45195 |
| 7L-5S | | MI | 9945 | 4394 | 17698 | 3323 | 20819 | 2620 | 22710 | 2042 | 25528 | 1054 | 31825 | 441 | 29329 |
| 20-#14 | 4.33 | MA | 13956 | 4394 | 24283 | 3441 | 28972 | 2743 | 31794 | 2174 | 35713 | 1224 | 45916 | 413 | 43218 |
| 8L-4S | | MI | 10434 | 4394 | 18497 | 3314 | 21763 | 2628 | 23831 | 2035 | 27052 | 1061 | 33666 | 504 | 30073 |
| 20-#14 | 4.33 | MA | 13221 | 4394 | 23040 | 3456 | 27444 | 2756 | 29972 | 2185 | 33267 | 1232 | 42857 | 328 | 40876 |
| 9L-3S | | MI | 10966 | 4394 | 19283 | 3319 | 22809 | 2620 | 25067 | 2042 | 28617 | 1054 | 35406 | 626 | 31233 |

## RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

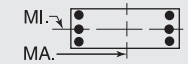
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.30 | MA | 14245 | 4006 | 23308 | 3204 | 27907 | 2571 | 30601 | 2066 | 34166 | 1244 | 43413 | 724 | 36791 |
| 7L-6S | | MI | 9142 | 4006 | 15565 | 3094 | 18233 | 2473 | 19666 | 1953 | 21560 | 1122 | 26715 | 610 | 22934 |
| 22-#11 | 3.30 | MA | 13712 | 4006 | 22523 | 3204 | 26873 | 2570 | 29309 | 2064 | 32435 | 1250 | 41225 | 672 | 35600 |
| 8L-5S | | MI | 9486 | 4006 | 16065 | 3097 | 18894 | 2468 | 20448 | 1958 | 22564 | 1116 | 27936 | 673 | 23463 |
| 22-#11 | 3.30 | MA | 13183 | 4006 | 21656 | 3215 | 25808 | 2579 | 28039 | 2072 | 30722 | 1255 | 39070 | 613 | 34413 |
| 9L-4S | | MI | 9844 | 4006 | 16625 | 3090 | 19564 | 2473 | 21243 | 1953 | 23643 | 1122 | 29246 | 716 | 23926 |
| 22-#11 | 3.30 | MA | 12655 | 4006 | 20874 | 3216 | 24780 | 2579 | 26762 | 2070 | 28960 | 1250 | 36841 | 533 | 32984 |
| 10L-3S | | MI | 10237 | 4006 | 17176 | 3093 | 20305 | 2468 | 22118 | 1958 | 24752 | 1116 | 30482 | 802 | 24368 |
| 22-#14 | 4.76 | MA | 14759 | 4557 | 26036 | 3543 | 31196 | 2818 | 34489 | 2221 | 39338 | 1216 | 50749 | 391 | 48143 |
| 8L-5S | | MI | 10375 | 4557 | 18736 | 3425 | 22120 | 2694 | 24256 | 2085 | 27562 | 1035 | 34465 | 397 | 32177 |
| 22-#14 | 4.76 | MA | 14035 | 4557 | 24793 | 3558 | 29668 | 2831 | 32667 | 2232 | 36892 | 1224 | 47689 | 306 | 45843 |
| 9L-4S | | MI | 10856 | 4557 | 19535 | 3416 | 23064 | 2701 | 25377 | 2077 | 29086 | 1042 | 36306 | 460 | 32999 |
| 24-#11 | 3.60 | MA | 14283 | 4119 | 23749 | 3275 | 28428 | 2622 | 31193 | 2097 | 34976 | 1245 | 44626 | 658 | 39079 |
| 8L-6S | | MI | 9458 | 4119 | 16295 | 3165 | 19155 | 2525 | 20761 | 1983 | 23001 | 1110 | 28593 | 582 | 24968 |
| 24-#11 | 3.60 | MA | 13760 | 4119 | 22882 | 3286 | 27362 | 2631 | 29922 | 2105 | 33263 | 1250 | 42471 | 599 | 37873 |
| 9L-5S | | MI | 9799 | 4119 | 16795 | 3168 | 19817 | 2520 | 21544 | 1988 | 24005 | 1104 | 29815 | 645 | 25543 |
| 24-#11 | 3.60 | MA | 13239 | 4119 | 22100 | 3287 | 26335 | 2631 | 28645 | 2103 | 31501 | 1245 | 40243 | 519 | 36468 |
| 10L-4S | | MI | 10154 | 4119 | 17355 | 3161 | 20486 | 2525 | 22338 | 1983 | 25085 | 1110 | 31125 | 688 | 25984 |
| 24-#14 | 5.19 | MA | 14836 | 4721 | 26547 | 3661 | 31892 | 2906 | 35361 | 2280 | 40517 | 1215 | 52522 | 284 | 50816 |
| 9L-5S | | MI | 10799 | 4721 | 19774 | 3528 | 23422 | 2767 | 25802 | 2127 | 29596 | 1016 | 37104 | 353 | 35037 |

## RECTANGULAR TIED COLUMNS 26" x 42"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.47 | MA | 15386 | 3478 | 22636 | 2876 | 26859 | 2333 | 28969 | 1924 | 31144 | 1318 | 38053 | 1220 | 19883 |
| 2E | | MI | 9166 | 3478 | 14152 | 2752 | 16103 | 2218 | 16948 | 1811 | 17683 | 1203 | 21029 | 1061 | 11572 |
| 6-#14 | 1.24 | MA | 14983 | 3387 | 21557 | 2838 | 25636 | 2307 | 27549 | 1911 | 29367 | 1337 | 35805 | 1254 | 17026 |
| 2L-3S | | MI | 8183 | 3387 | 12514 | 2719 | 14253 | 2202 | 14804 | 1825 | 14893 | 1249 | 17511 | 993 | 10032 |
| 6-#14 | 1.24 | MA | 13532 | 3387 | 19701 | 2839 | 23282 | 2305 | 24698 | 1923 | 25520 | 1345 | 30657 | 1122 | 16957 |
| 3L-2S | | MI | 8990 | 3387 | 13552 | 2724 | 15554 | 2209 | 16350 | 1817 | 16928 | 1241 | 20151 | 1124 | 9998 |
| 6-#18 | 2.20 | MA | 16881 | 3768 | 25884 | 3058 | 30979 | 2466 | 33959 | 2009 | 37828 | 1302 | 46946 | 1178 | 29491 |
| 2L-3S | | MI | 8586 | 3768 | 14152 | 2921 | 16103 | 2331 | 16948 | 1896 | 17683 | 1177 | 21029 | 738 | 16800 |
| 6-#18 | 2.20 | MA | 14440 | 3768 | 22636 | 3058 | 26859 | 2462 | 28969 | 2027 | 31144 | 1315 | 38053 | 944 | 29002 |
| 3L-2S | | MI | 9936 | 3768 | 15946 | 2934 | 18315 | 2345 | 19576 | 1882 | 21141 | 1164 | 25477 | 972 | 16935 |
| 8-#11 | 1.14 | MA | 14816 | 3350 | 21099 | 2824 | 25129 | 2297 | 26967 | 1906 | 28604 | 1343 | 34889 | 1268 | 15848 |
| 2L-4S | | MI | 7924 | 3350 | 12011 | 2710 | 13660 | 2208 | 14132 | 1821 | 14069 | 1268 | 16682 | 973 | 9372 |
| 8-#11 | 1.14 | MA | 13797 | 3350 | 19802 | 2825 | 23485 | 2297 | 24975 | 1915 | 25916 | 1349 | 31269 | 1177 | 15822 |
| 3E | | MI | 8348 | 3350 | 12562 | 2713 | 14401 | 2202 | 15008 | 1826 | 15179 | 1263 | 17917 | 1059 | 9370 |
| 8-#11 | 1.14 | MA | 13060 | 3350 | 18840 | 2825 | 22183 | 2307 | 23397 | 1913 | 23787 | 1345 | 28882 | 1086 | 15691 |
| 4L-2S | | MI | 8917 | 3350 | 13292 | 2716 | 15324 | 2208 | 16103 | 1821 | 16620 | 1258 | 19796 | 1150 | 9342 |
| 8-#14 | 1.65 | MA | 15866 | 3550 | 23413 | 2940 | 27989 | 2381 | 30401 | 1958 | 33214 | 1329 | 40953 | 1233 | 22526 |
| 2L-4S | | MI | 8063 | 3550 | 12766 | 2816 | 14508 | 2282 | 15114 | 1860 | 15362 | 1237 | 18411 | 826 | 12927 |
| 8-#14 | 1.65 | MA | 14440 | 3550 | 21557 | 2941 | 25636 | 2380 | 27549 | 1970 | 29367 | 1337 | 35805 | 1102 | 22403 |
| 3E | | MI | 8657 | 3550 | 13552 | 2821 | 15554 | 2275 | 16350 | 1867 | 16928 | 1230 | 20151 | 949 | 13106 |
| 8-#14 | 1.65 | MA | 13407 | 3550 | 20177 | 2942 | 23770 | 2394 | 25289 | 1967 | 26316 | 1330 | 32415 | 971 | 21976 |
| 4L-2S | | MI | 9451 | 3550 | 14590 | 2827 | 16856 | 2282 | 17896 | 1860 | 18962 | 1222 | 22791 | 1080 | 13109 |
| 8-#18 | 2.93 | MA | 18323 | 4059 | 29132 | 3240 | 35098 | 2599 | 38950 | 2093 | 44513 | 1286 | 55840 | 1135 | 39063 |
| 2L-4S | | MI | 8372 | 4059 | 14580 | 3089 | 16536 | 2471 | 17474 | 1954 | 18480 | 1150 | 22533 | 439 | 19872 |
| 8-#18 | 2.93 | MA | 15943 | 4059 | 25884 | 3239 | 30979 | 2595 | 33959 | 2111 | 37828 | 1299 | 46946 | 902 | 38438 |
| 3E | | MI | 9362 | 4059 | 15946 | 3102 | 18315 | 2458 | 19576 | 1967 | 21141 | 1137 | 25477 | 649 | 21997 |
| 8-#18 | 2.93 | MA | 14218 | 4059 | 23462 | 3239 | 27706 | 2617 | 29993 | 2103 | 32524 | 1286 | 41103 | 668 | 34576 |
| 4L-2S | | MI | 10684 | 4059 | 17740 | 3115 | 20527 | 2471 | 22203 | 1954 | 24599 | 1124 | 29925 | 882 | 22239 |
| 10-#11 | 1.43 | MA | 15442 | 3463 | 22396 | 2895 | 26774 | 2349 | 28960 | 1939 | 31292 | 1338 | 38509 | 1255 | 19695 |
| 2L-5S | | MI | 7882 | 3463 | 12181 | 2788 | 13913 | 2254 | 14434 | 1857 | 14431 | 1251 | 17250 | 902 | 11183 |
| 10-#11 | 1.43 | MA | 14437 | 3463 | 21099 | 2895 | 25129 | 2349 | 26967 | 1948 | 28604 | 1344 | 34889 | 1164 | 19643 |
| 3L-4S | | MI | 8265 | 3463 | 12741 | 2780 | 14582 | 2259 | 15228 | 1852 | 15511 | 1256 | 18560 | 945 | 11520 |
| 10-#11 | 1.43 | MA | 13709 | 3463 | 20136 | 2896 | 23827 | 2359 | 25390 | 1946 | 26475 | 1340 | 32502 | 1073 | 19480 |
| 4L-3S | | MI | 8684 | 3463 | 13292 | 2784 | 15324 | 2254 | 16103 | 1857 | 16620 | 1251 | 19796 | 1031 | 11546 |

## RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

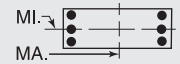
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.43 | MA | 13050 | 3463 | 19163 | 2908 | 22659 | 2358 | 23963 | 1955 | 24532 | 1346 | 30013 | 1027 | 18752 |
| 5L-2S | | MI | 9247 | 3463 | 14022 | 2787 | 16246 | 2259 | 17199 | 1852 | 18062 | 1246 | 21674 | 1122 | 11532 |
| 10-#14 | 2.06 | MA | 16727 | 3714 | 25268 | 3042 | 30343 | 2456 | 33252 | 2006 | 37061 | 1322 | 46100 | 1213 | 28012 |
| 2L-5S | | MI | 8001 | 3714 | 13005 | 2927 | 14866 | 2348 | 15539 | 1910 | 15873 | 1211 | 19210 | 720 | 14989 |
| 10-#14 | 2.06 | MA | 15325 | 3714 | 23413 | 3043 | 27989 | 2455 | 30401 | 2017 | 33214 | 1330 | 40953 | 1082 | 27841 |
| 3L-4S | | MI | 8535 | 3714 | 13804 | 2918 | 15810 | 2356 | 16660 | 1902 | 17396 | 1218 | 21051 | 782 | 15761 |
| 10-#14 | 2.06 | MA | 14310 | 3714 | 22033 | 3044 | 26124 | 2469 | 28140 | 2014 | 30163 | 1323 | 37562 | 950 | 27228 |
| 4L-3S | | MI | 9120 | 3714 | 14590 | 2923 | 16856 | 2348 | 17896 | 1910 | 18962 | 1211 | 22791 | 905 | 16159 |
| 10-#14 | 2.06 | MA | 13391 | 3714 | 20636 | 3060 | 24449 | 2468 | 26095 | 2026 | 27379 | 1330 | 34015 | 885 | 25427 |
| 5L-2S | | MI | 9904 | 3714 | 15628 | 2929 | 18157 | 2356 | 19442 | 1902 | 20996 | 1203 | 25430 | 1036 | 16201 |
| 10-#18 | 3.66 | MA | 17399 | 4350 | 29132 | 3421 | 35098 | 2728 | 38950 | 2196 | 44513 | 1283 | 55840 | 859 | 47876 |
| 3L-4S | | MI | 9181 | 4350 | 16374 | 3271 | 18748 | 2598 | 20101 | 2025 | 21938 | 1111 | 26981 | 349 | 24805 |
| 10-#18 | 3.66 | MA | 15719 | 4350 | 26710 | 3421 | 31825 | 2750 | 34983 | 2187 | 39209 | 1270 | 49996 | 626 | 43737 |
| 4L-3S | | MI | 10141 | 4350 | 17740 | 3284 | 20527 | 2584 | 22203 | 2038 | 24599 | 1097 | 29925 | 559 | 27178 |
| 10-#18 | 3.66 | MA | 14196 | 4350 | 24257 | 3447 | 28882 | 2746 | 31392 | 2206 | 34368 | 1283 | 43843 | 512 | 40169 |
| 5L-2S | | MI | 11413 | 4350 | 19534 | 3297 | 22739 | 2598 | 24831 | 2025 | 28057 | 1084 | 34373 | 793 | 27514 |
| 12-#11 | 1.71 | MA | 16057 | 3576 | 23693 | 2965 | 28418 | 2401 | 30952 | 1972 | 33980 | 1333 | 42129 | 1243 | 23533 |
| 2L-6S | | MI | 7858 | 3576 | 12411 | 2855 | 14174 | 2311 | 14746 | 1882 | 14869 | 1244 | 17907 | 811 | 12902 |
| 12-#11 | 1.71 | MA | 15064 | 3576 | 22396 | 2966 | 26774 | 2401 | 28960 | 1981 | 31292 | 1339 | 38509 | 1151 | 23458 |
| 3L-5S | | MI | 8222 | 3576 | 12910 | 2858 | 14836 | 2306 | 15529 | 1887 | 15873 | 1239 | 19129 | 873 | 13228 |
| 12-#11 | 1.71 | MA | 14346 | 3576 | 21433 | 2967 | 25472 | 2411 | 27382 | 1979 | 29163 | 1335 | 36122 | 1060 | 23267 |
| 4E | | MI | 8600 | 3576 | 13470 | 2851 | 15505 | 2311 | 16323 | 1882 | 16952 | 1244 | 20439 | 917 | 13658 |
| 12-#11 | 1.71 | MA | 13697 | 3576 | 20459 | 2979 | 24303 | 2410 | 25956 | 1988 | 27221 | 1341 | 33633 | 1014 | 22440 |
| 5L-3S | | MI | 9015 | 3576 | 14022 | 2855 | 16246 | 2306 | 17199 | 1887 | 18062 | 1239 | 21674 | 1003 | 13706 |
| 12-#11 | 1.71 | MA | 13073 | 3576 | 19595 | 2979 | 23150 | 2420 | 24552 | 1986 | 25353 | 1347 | 31105 | 939 | 21645 |
| 6L-2S | | MI | 9572 | 3576 | 14751 | 2858 | 17169 | 2311 | 18294 | 1882 | 19503 | 1234 | 23553 | 1094 | 13711 |
| 12-#14 | 2.47 | MA | 16189 | 3877 | 25268 | 3145 | 30343 | 2530 | 33252 | 2065 | 37061 | 1322 | 46100 | 1062 | 33274 |
| 3L-5S | | MI | 8472 | 3877 | 14043 | 3029 | 16167 | 2422 | 17085 | 1952 | 17907 | 1192 | 21850 | 676 | 17903 |
| 12-#14 | 2.47 | MA | 15192 | 3877 | 23889 | 3146 | 28478 | 2544 | 30992 | 2062 | 34010 | 1315 | 42710 | 930 | 32445 |
| 4E | | MI | 8998 | 3877 | 14842 | 3020 | 17112 | 2429 | 18206 | 1945 | 19431 | 1199 | 23690 | 739 | 18619 |
| 12-#14 | 2.47 | MA | 14290 | 3877 | 22492 | 3162 | 26802 | 2543 | 28946 | 2073 | 31226 | 1323 | 39163 | 864 | 30726 |
| 5L-3S | | MI | 9574 | 3877 | 15628 | 3026 | 18157 | 2422 | 19442 | 1952 | 20996 | 1192 | 25430 | 861 | 19200 |
| 12-#14 | 2.47 | MA | 13424 | 3877 | 21252 | 3163 | 25148 | 2556 | 26933 | 2070 | 28548 | 1331 | 35569 | 756 | 29073 |
| 6L-2S | | MI | 10348 | 3877 | 16666 | 3031 | 19459 | 2429 | 20987 | 1945 | 23030 | 1184 | 28070 | 993 | 19273 |
| 12-#18 | 4.40 | MA | 17176 | 4641 | 29958 | 3603 | 35944 | 2883 | 39974 | 2272 | 45893 | 1254 | 58890 | 583 | 52935 |
| 4E | | MI | 9936 | 4641 | 18168 | 3453 | 20960 | 2724 | 22729 | 2096 | 25397 | 1071 | 31429 | 260 | 29775 |
| 12-#18 | 4.40 | MA | 15692 | 4641 | 27505 | 3629 | 33001 | 2879 | 36382 | 2290 | 41052 | 1267 | 52737 | 470 | 49246 |
| 5L-3S | | MI | 10870 | 4641 | 19534 | 3466 | 22739 | 2711 | 24831 | 2109 | 28057 | 1058 | 34373 | 470 | 31986 |
| 12-#18 | 4.40 | MA | 14268 | 4641 | 25325 | 3629 | 30095 | 2901 | 32845 | 2282 | 36397 | 1280 | 46529 | 276 | 45295 |
| 6L-2S | | MI | 12110 | 4641 | 21328 | 3479 | 24951 | 2724 | 27458 | 2096 | 31516 | 1045 | 38821 | 704 | 32768 |
| 14-#11 | 2.00 | MA | 15680 | 3690 | 23693 | 3037 | 28418 | 2452 | 30952 | 2014 | 33980 | 1334 | 42129 | 1139 | 27269 |
| 3L-6S | | MI | 8196 | 3690 | 13141 | 2926 | 15097 | 2362 | 15842 | 1912 | 16311 | 1232 | 19786 | 783 | 14974 |
| 14-#11 | 2.00 | MA | 14971 | 3690 | 22730 | 3038 | 27117 | 2462 | 29375 | 2012 | 31851 | 1330 | 39742 | 1048 | 27053 |
| 4L-5S | | MI | 8556 | 3690 | 13640 | 2929 | 15758 | 2357 | 16625 | 1918 | 17314 | 1227 | 21007 | 845 | 15283 |
| 14-#11 | 2.00 | MA | 14331 | 3690 | 21756 | 3049 | 25948 | 2462 | 27948 | 2021 | 29909 | 1336 | 37252 | 1001 | 26138 |
| 5L-4S | | MI | 8931 | 3690 | 14200 | 2922 | 16427 | 2362 | 17419 | 1912 | 18394 | 1232 | 22317 | 888 | 15791 |
| 14-#11 | 2.00 | MA | 13716 | 3690 | 20891 | 3050 | 24795 | 2472 | 26544 | 2019 | 28041 | 1342 | 34725 | 926 | 25373 |
| 6L-3S | | MI | 9341 | 3690 | 14751 | 2925 | 17169 | 2357 | 18294 | 1918 | 19503 | 1227 | 23553 | 975 | 15858 |
| 14-#11 | 2.00 | MA | 13114 | 3690 | 20049 | 3051 | 23680 | 2472 | 25183 | 2028 | 26148 | 1337 | 32475 | 855 | 24276 |
| 7L-2S | | MI | 9893 | 3690 | 15481 | 2929 | 18091 | 2362 | 19390 | 1912 | 20945 | 1222 | 25431 | 1066 | 15881 |
| 14-#14 | 2.88 | MA | 16056 | 4041 | 25744 | 3248 | 30831 | 2618 | 33843 | 2109 | 37857 | 1308 | 47858 | 910 | 37683 |
| 4L-5S | | MI | 8933 | 4041 | 15081 | 3132 | 17469 | 2495 | 18631 | 1995 | 19941 | 1173 | 24489 | 632 | 20829 |
| 14-#14 | 2.88 | MA | 15169 | 4041 | 24348 | 3264 | 29156 | 2617 | 31798 | 2121 | 35073 | 1315 | 44311 | 844 | 36037 |
| 5L-4S | | MI | 9452 | 4041 | 15880 | 3122 | 18413 | 2502 | 19751 | 1987 | 21465 | 1180 | 26330 | 695 | 21497 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis



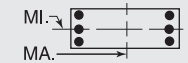

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.88 | MA | 14318 | 4041 | 23108 | 3265 | 27502 | 2631 | 29785 | 2118 | 32395 | 1323 | 40717 | 736 | 34315 |
| 6L-3S | | MI | 10021 | 4041 | 16666 | 3128 | 19459 | 2495 | 20987 | 1995 | 23030 | 1173 | 28070 | 817 | 22233 |
| 14-#14 | 2.88 | MA | 13485 | 4041 | 21900 | 3266 | 25904 | 2630 | 27833 | 2129 | 29681 | 1316 | 37521 | 633 | 32596 |
| 7L-2S | | MI | 10786 | 4041 | 17704 | 3133 | 20761 | 2502 | 22533 | 1987 | 25064 | 1165 | 30709 | 949 | 22335 |
| 14-#18 | 5.13 | MA | 17149 | 4931 | 30753 | 3811 | 37120 | 3012 | 41372 | 2374 | 47737 | 1251 | 61630 | 427 | 58352 |
| 5L-4S | | MI | 10671 | 4931 | 19962 | 3634 | 23172 | 2851 | 25356 | 2167 | 28855 | 1031 | 35878 | 170 | 34772 |
| 14-#18 | 5.13 | MA | 15759 | 4931 | 28573 | 3810 | 34214 | 3034 | 37836 | 2366 | 43081 | 1264 | 55422 | 234 | 54346 |
| 6L-3S | | MI | 11581 | 4931 | 21328 | 3647 | 24951 | 2838 | 27458 | 2180 | 31516 | 1018 | 38821 | 381 | 36816 |
| 14-#18 | 5.13 | MA | 14396 | 4931 | 26450 | 3810 | 31406 | 3030 | 34405 | 2385 | 38361 | 1251 | 49911 | 51 | 49651 |
| 7L-2S | | MI | 12794 | 4931 | 23122 | 3660 | 27163 | 2851 | 30085 | 2167 | 34974 | 1005 | 43269 | 614 | 38009 |
| 16-#11 | 2.29 | MA | 15586 | 3803 | 24027 | 3109 | 28761 | 2514 | 31367 | 2045 | 34539 | 1324 | 43362 | 1035 | 30838 |
| 4L-6S | | MI | 8530 | 3803 | 13870 | 2997 | 16019 | 2414 | 16937 | 1943 | 17752 | 1220 | 21664 | 755 | 17039 |
| 16-#11 | 2.29 | MA | 14954 | 3803 | 23053 | 3120 | 27592 | 2514 | 29940 | 2053 | 32597 | 1331 | 40872 | 989 | 29846 |
| 5E | | MI | 8886 | 3803 | 14370 | 3000 | 16681 | 2409 | 17720 | 1948 | 18756 | 1215 | 22886 | 817 | 17345 |
| 16-#11 | 2.29 | MA | 14348 | 3803 | 22188 | 3121 | 26439 | 2524 | 28536 | 2052 | 30729 | 1337 | 38345 | 913 | 29106 |
| 6L-4S | | MI | 9257 | 3803 | 14930 | 2993 | 17350 | 2414 | 18514 | 1943 | 19835 | 1220 | 24196 | 860 | 17908 |
| 16-#11 | 2.29 | MA | 13754 | 3803 | 21346 | 3122 | 25325 | 2523 | 27175 | 2060 | 28836 | 1332 | 36095 | 843 | 27965 |
| 7L-3S | | MI | 9663 | 3803 | 15481 | 2996 | 18091 | 2409 | 19390 | 1948 | 20945 | 1215 | 25431 | 947 | 18005 |
| 16-#11 | 2.29 | MA | 13167 | 3803 | 20518 | 3123 | 24233 | 2523 | 25812 | 2059 | 27009 | 1338 | 33770 | 789 | 26916 |
| 8L-2S | | MI | 10210 | 3803 | 16211 | 3000 | 19014 | 2414 | 20485 | 1943 | 22386 | 1210 | 27310 | 1038 | 18041 |
| 16-#14 | 3.30 | MA | 16030 | 4205 | 26204 | 3366 | 31509 | 2692 | 34649 | 2168 | 38920 | 1308 | 49459 | 824 | 41359 |
| 5E | | MI | 9387 | 4205 | 16119 | 3234 | 18770 | 2568 | 20177 | 2037 | 21975 | 1154 | 27129 | 588 | 23763 |
| 16-#14 | 3.30 | MA | 15194 | 4205 | 24964 | 3367 | 29856 | 2706 | 32636 | 2165 | 36242 | 1316 | 45865 | 716 | 39569 |
| 6L-4S | | MI | 9900 | 4205 | 16918 | 3224 | 19715 | 2576 | 21297 | 2030 | 23499 | 1161 | 28970 | 651 | 24390 |
| 16-#14 | 3.30 | MA | 14375 | 4205 | 23756 | 3368 | 28258 | 2705 | 30684 | 2177 | 33528 | 1309 | 42669 | 613 | 37812 |
| 7L-3S | | MI | 10461 | 4205 | 17704 | 3230 | 20761 | 2568 | 22533 | 2037 | 25064 | 1154 | 30709 | 774 | 25259 |
| 16-#14 | 3.30 | MA | 13564 | 4205 | 22567 | 3369 | 26692 | 2704 | 28728 | 2174 | 30908 | 1316 | 39356 | 537 | 35503 |
| 8L-2S | | MI | 11217 | 4205 | 18742 | 3236 | 22062 | 2576 | 24079 | 2030 | 27098 | 1146 | 33349 | 905 | 25388 |
| 16-#18 | 5.86 | MA | 17215 | 5222 | 31821 | 3992 | 38333 | 3167 | 42826 | 2450 | 49766 | 1248 | 64316 | 191 | 63233 |
| 6L-4S | | MI | 11390 | 5222 | 21757 | 3816 | 25384 | 2977 | 27984 | 2238 | 32313 | 992 | 40326 | 81 | 39792 |
| 16-#18 | 5.86 | MA | 15883 | 5222 | 29698 | 3992 | 35525 | 3163 | 39396 | 2469 | 45045 | 1235 | 58804 | 9 | 58769 |
| 7L-3S | | MI | 12279 | 5222 | 23122 | 3829 | 27163 | 2964 | 30085 | 2251 | 34974 | 978 | 43269 | 291 | 41687 |
| 18-#11 | 2.57 | MA | 15568 | 3917 | 24349 | 3191 | 29237 | 2566 | 31933 | 2086 | 35285 | 1325 | 44492 | 976 | 33561 |
| 5L-6S | | MI | 8859 | 3917 | 14600 | 3068 | 16942 | 2465 | 18033 | 1973 | 19194 | 1208 | 23543 | 727 | 19049 |
| 18-#11 | 2.57 | MA | 14969 | 3917 | 23485 | 3192 | 28084 | 2576 | 30529 | 2085 | 33417 | 1331 | 41965 | 901 | 32844 |
| 6L-5S | | MI | 9211 | 3917 | 15099 | 3071 | 17603 | 2460 | 18816 | 1978 | 20197 | 1203 | 24764 | 789 | 19414 |
| 18-#11 | 2.57 | MA | 14383 | 3917 | 22643 | 3193 | 26970 | 2575 | 29168 | 2093 | 31524 | 1327 | 39715 | 830 | 31662 |
| 7L-4S | | MI | 9578 | 3917 | 15659 | 3064 | 18273 | 2465 | 19610 | 1973 | 21277 | 1208 | 26074 | 832 | 19944 |
| 18-#11 | 2.57 | MA | 13804 | 3917 | 21814 | 3194 | 25878 | 2575 | 27804 | 2092 | 29697 | 1333 | 37390 | 776 | 30584 |
| 8L-3S | | MI | 9980 | 3917 | 16211 | 3067 | 19014 | 2460 | 20485 | 1978 | 22386 | 1203 | 27310 | 919 | 20146 |
| 18-#11 | 2.57 | MA | 13228 | 3917 | 20899 | 3205 | 24753 | 2585 | 26462 | 2100 | 27889 | 1339 | 35096 | 718 | 29238 |
| 9L-2S | | MI | 10523 | 3917 | 16940 | 3070 | 19936 | 2465 | 21581 | 1973 | 23828 | 1198 | 29188 | 1010 | 20196 |
| 18-#14 | 3.71 | MA | 16054 | 4368 | 26819 | 3469 | 32209 | 2781 | 35487 | 2212 | 40089 | 1308 | 51012 | 695 | 44834 |
| 6L-5S | | MI | 9835 | 4368 | 17157 | 3336 | 20072 | 2642 | 21722 | 2080 | 24009 | 1135 | 29768 | 545 | 26704 |
| 18-#14 | 3.71 | MA | 15247 | 4368 | 25612 | 3470 | 30611 | 2780 | 33536 | 2224 | 37375 | 1301 | 47816 | 593 | 43038 |
| 7L-4S | | MI | 10341 | 4368 | 17956 | 3327 | 21016 | 2649 | 22843 | 2072 | 25533 | 1142 | 31609 | 607 | 27296 |
| 18-#14 | 3.71 | MA | 14450 | 4368 | 24423 | 3471 | 29046 | 2778 | 31580 | 2221 | 34755 | 1309 | 44504 | 517 | 40781 |
| 8L-3S | | MI | 10896 | 4368 | 18742 | 3332 | 22062 | 2642 | 24079 | 2080 | 27098 | 1135 | 33349 | 730 | 28281 |
| 18-#14 | 3.71 | MA | 13658 | 4368 | 23111 | 3487 | 27432 | 2792 | 29656 | 2233 | 32161 | 1317 | 41243 | 432 | 38374 |
| 9L-2S | | MI | 11643 | 4368 | 19780 | 3338 | 23364 | 2649 | 25624 | 2072 | 29132 | 1127 | 35988 | 861 | 28436 |
| 18-#18 | 6.59 | MA | 17473 | 5513 | 32946 | 4174 | 39644 | 3296 | 44386 | 2553 | 51730 | 1219 | 67697 | -34 | 67389 |
| 7L-4S | | MI | 12097 | 5513 | 23551 | 3998 | 27596 | 3104 | 30611 | 2309 | 35771 | 952 | 44774 | -8 | 44703 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

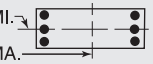
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.86 | MA | 15581 | 4030 | 24781 | 3263 | 29728 | 2628 | 32521 | 2117 | 36105 | 1326 | 45585 | 888 | 36586 |
| 6E | | MI | 9184 | 4030 | 15330 | 3139 | 17864 | 2517 | 19128 | 2003 | 20635 | 1196 | 25421 | 699 | 21067 |
| 20-#11 | 2.86 | MA | 15002 | 4030 | 23940 | 3264 | 28614 | 2627 | 31160 | 2126 | 34212 | 1322 | 43335 | 817 | 35364 |
| 7L-5S | | MI | 9533 | 4030 | 15829 | 3142 | 18526 | 2512 | 19911 | 2009 | 21639 | 1191 | 26642 | 761 | 21487 |
| 20-#11 | 2.86 | MA | 14430 | 4030 | 23111 | 3265 | 27522 | 2627 | 29796 | 2124 | 32385 | 1328 | 41010 | 764 | 34257 |
| 8L-4S | | MI | 9896 | 4030 | 16389 | 3135 | 19195 | 2517 | 20705 | 2003 | 22718 | 1196 | 27953 | 804 | 21989 |
| 20-#11 | 2.86 | MA | 13862 | 4030 | 22196 | 3276 | 26397 | 2637 | 28455 | 2133 | 30577 | 1334 | 38716 | 705 | 32939 |
| 9L-3S | | MI | 10294 | 4030 | 16940 | 3138 | 19936 | 2512 | 21581 | 2009 | 23828 | 1191 | 29188 | 891 | 22284 |
| 20-#11 | 2.86 | MA | 13296 | 4030 | 21370 | 3277 | 25313 | 2636 | 27107 | 2131 | 28717 | 1330 | 36343 | 625 | 31467 |
| 10L-2S | | MI | 10832 | 4030 | 17670 | 3141 | 20859 | 2517 | 22677 | 2003 | 25269 | 1186 | 31067 | 982 | 22347 |
| 20-#14 | 4.12 | MA | 16105 | 4532 | 27468 | 3572 | 32965 | 2854 | 36387 | 2272 | 41222 | 1294 | 52964 | 573 | 48273 |
| 7L-5S | | MI | 10277 | 4532 | 18195 | 3438 | 21373 | 2715 | 23268 | 2122 | 26043 | 1116 | 32408 | 501 | 29552 |
| 20-#14 | 4.12 | MA | 15320 | 4532 | 26279 | 3573 | 31399 | 2853 | 34431 | 2268 | 38602 | 1302 | 49652 | 497 | 46066 |
| 8L-4S | | MI | 10777 | 4532 | 18994 | 3429 | 22318 | 2722 | 24389 | 2115 | 27567 | 1123 | 34249 | 563 | 30212 |
| 20-#14 | 4.12 | MA | 14540 | 4532 | 24967 | 3589 | 29786 | 2867 | 32507 | 2280 | 36008 | 1309 | 46390 | 412 | 43634 |
| 9L-3S | | MI | 11325 | 4532 | 19780 | 3434 | 23364 | 2715 | 25624 | 2122 | 29132 | 1116 | 35988 | 686 | 31299 |
| 22-#11 | 3.14 | MA | 15613 | 4143 | 25236 | 3335 | 30259 | 2679 | 33153 | 2159 | 36900 | 1317 | 46955 | 804 | 39071 |
| 7L-6S | | MI | 9505 | 4143 | 16059 | 3210 | 18787 | 2569 | 20224 | 2034 | 22077 | 1184 | 27300 | 670 | 23093 |
| 22-#11 | 3.14 | MA | 15048 | 4143 | 24408 | 3336 | 29167 | 2679 | 31789 | 2157 | 35074 | 1323 | 44630 | 751 | 37936 |
| 8L-5S | | MI | 9851 | 4143 | 16559 | 3213 | 19448 | 2563 | 21007 | 2039 | 23080 | 1179 | 28521 | 733 | 23564 |
| 22-#11 | 3.14 | MA | 14486 | 4143 | 23493 | 3347 | 28042 | 2689 | 30447 | 2166 | 33265 | 1329 | 42336 | 692 | 36644 |
| 9L-4S | | MI | 10211 | 4143 | 17119 | 3206 | 20118 | 2569 | 21801 | 2034 | 24160 | 1184 | 29831 | 776 | 24040 |
| 22-#11 | 3.14 | MA | 13927 | 4143 | 22667 | 3348 | 26958 | 2688 | 29099 | 2164 | 31405 | 1324 | 39963 | 612 | 35154 |
| 10L-3S | | MI | 10605 | 4143 | 17670 | 3209 | 20859 | 2563 | 22677 | 2039 | 25269 | 1179 | 31067 | 862 | 24419 |
| 22-#11 | 3.14 | MA | 13331 | 4143 | 21848 | 3349 | 25846 | 2698 | 27766 | 2173 | 29603 | 1331 | 37678 | 556 | 33655 |
| 11L-2S | | MI | 11138 | 4143 | 18400 | 3212 | 21781 | 2569 | 23772 | 2034 | 26711 | 1173 | 32945 | 954 | 24495 |
| 22-#14 | 4.53 | MA | 16176 | 4695 | 28135 | 3675 | 33753 | 2928 | 37283 | 2316 | 42449 | 1294 | 54799 | 477 | 51359 |
| 8L-5S | | MI | 10745 | 4695 | 19233 | 3541 | 22675 | 2788 | 24814 | 2165 | 28077 | 1096 | 35047 | 457 | 32397 |
| 22-#14 | 4.53 | MA | 15408 | 4695 | 26822 | 3691 | 32139 | 2942 | 35358 | 2328 | 39855 | 1302 | 51538 | 392 | 48901 |
| 9L-4S | | MI | 11229 | 4695 | 20032 | 3531 | 23619 | 2796 | 25934 | 2158 | 29601 | 1104 | 36888 | 520 | 33137 |
| 24-#11 | 3.43 | MA | 15657 | 4257 | 25704 | 3407 | 30812 | 2731 | 33781 | 2190 | 37762 | 1318 | 48250 | 738 | 41620 |
| 8L-6S | | MI | 9823 | 4257 | 16789 | 3280 | 19709 | 2620 | 21319 | 2064 | 23518 | 1172 | 29178 | 642 | 25125 |
| 24-#11 | 3.43 | MA | 15102 | 4257 | 24789 | 3418 | 29687 | 2740 | 32440 | 2199 | 35953 | 1324 | 45956 | 680 | 40354 |
| 9L-5S | | MI | 10165 | 4257 | 17289 | 3284 | 20371 | 2615 | 22102 | 2069 | 24522 | 1167 | 30399 | 705 | 25644 |
| 24-#11 | 3.43 | MA | 14549 | 4257 | 23964 | 3419 | 28603 | 2740 | 31092 | 2197 | 34093 | 1319 | 43583 | 599 | 38846 |
| 10L-4S | | MI | 10522 | 4257 | 17849 | 3277 | 21040 | 2620 | 22896 | 2064 | 25601 | 1172 | 31709 | 748 | 26098 |
| 24-#11 | 3.43 | MA | 13956 | 4257 | 23144 | 3420 | 27490 | 2750 | 29758 | 2206 | 32291 | 1325 | 41298 | 543 | 37334 |
| 11L-3S | | MI | 10913 | 4257 | 18400 | 3280 | 21781 | 2615 | 23772 | 2069 | 26711 | 1167 | 32945 | 834 | 26551 |
| 24-#14 | 4.95 | MA | 16262 | 4859 | 28678 | 3793 | 34493 | 3017 | 38210 | 2375 | 43702 | 1294 | 56686 | 372 | 54174 |
| 9L-5S | | MI | 11171 | 4859 | 20271 | 3643 | 23977 | 2862 | 26359 | 2208 | 30112 | 1077 | 37687 | 413 | 35254 |

## RECTANGULAR TIED COLUMNS 26" x 44"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.40 | MA | 16781 | 3615 | 24490 | 3006 | 29111 | 2440 | 31383 | 2015 | 33716 | 1390 | 41201 | 1294 | 20963 |
| 2E | | MI | 9528 | 3615 | 14655 | 2866 | 16659 | 2312 | 17505 | 1891 | 18195 | 1264 | 21606 | 1120 | 11609 |
| 6-#14 | 1.18 | MA | 16347 | 3525 | 23345 | 2967 | 27812 | 2413 | 29875 | 2001 | 31767 | 1406 | 38784 | 1326 | 17937 |
| 2L-3S | | MI | 8543 | 3525 | 13011 | 2834 | 14808 | 2296 | 15362 | 1905 | 15409 | 1311 | 18094 | 1052 | 10067 |
| 6-#14 | 1.18 | MA | 14812 | 3525 | 21387 | 2968 | 25328 | 2412 | 26867 | 2014 | 27708 | 1415 | 33321 | 1194 | 17868 |
| 3L-2S | | MI | 9351 | 3525 | 14049 | 2840 | 16109 | 2304 | 16908 | 1898 | 17443 | 1303 | 20734 | 1184 | 10027 |
| 6-#18 | 2.10 | MA | 18375 | 3906 | 27920 | 3187 | 33461 | 2573 | 36653 | 2099 | 40806 | 1376 | 50654 | 1255 | 31111 |
| 2L-3S | | MI | 8946 | 3906 | 14655 | 3034 | 16659 | 2425 | 17505 | 1975 | 18195 | 1238 | 21606 | 797 | 16870 |
| 6-#18 | 2.10 | MA | 15787 | 3906 | 24490 | 3188 | 29111 | 2569 | 31383 | 2119 | 33716 | 1389 | 41201 | 1021 | 30622 |
| 3L-2S | | MI | 10300 | 3906 | 16449 | 3047 | 18871 | 2438 | 20133 | 1962 | 21653 | 1225 | 26054 | 1031 | 16978 |
| 8-#11 | 1.09 | MA | 16167 | 3488 | 22860 | 2953 | 27274 | 2404 | 29258 | 1997 | 30956 | 1413 | 37799 | 1339 | 16690 |
| 2L-4S | | MI | 8283 | 3488 | 12505 | 2825 | 14214 | 2303 | 14690 | 1902 | 14586 | 1331 | 17267 | 1033 | 9409 |
| 8-#11 | 1.09 | MA | 15090 | 3488 | 21492 | 2954 | 25539 | 2404 | 27156 | 2006 | 28121 | 1419 | 33960 | 1248 | 16664 |
| 3E | | MI | 8707 | 3488 | 13056 | 2829 | 14955 | 2298 | 15566 | 1907 | 15695 | 1325 | 18502 | 1120 | 9399 |

## RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

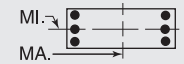
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.09 | MA | 14311 | 3488 | 20478 | 2955 | 24168 | 2414 | 25494 | 2005 | 25878 | 1416 | 31427 | 1157 | 16534 |
| 4L-2S | | MI | 9278 | 3488 | 13786 | 2832 | 15878 | 2303 | 16662 | 1902 | 17137 | 1320 | 20381 | 1211 | 9369 |
| 8-#14 | 1.57 | MA | 17287 | 3688 | 25303 | 3069 | 30295 | 2488 | 32884 | 2049 | 35826 | 1399 | 44247 | 1307 | 23741 |
| 2L-4S | | MI | 8423 | 3688 | 13263 | 2931 | 15063 | 2377 | 15672 | 1940 | 15878 | 1299 | 18994 | 886 | 13055 |
| 8-#14 | 1.57 | MA | 15778 | 3688 | 23345 | 3070 | 27812 | 2487 | 29875 | 2061 | 31767 | 1407 | 38784 | 1176 | 23618 |
| 3E | | MI | 9017 | 3688 | 14049 | 2936 | 16109 | 2370 | 16908 | 1948 | 17443 | 1292 | 20734 | 1009 | 13148 |
| 8-#14 | 1.57 | MA | 14685 | 3688 | 21891 | 3072 | 25846 | 2502 | 27493 | 2058 | 28551 | 1401 | 35182 | 1044 | 23191 |
| 4L-2S | | MI | 9814 | 3688 | 15087 | 2942 | 17411 | 2377 | 18454 | 1940 | 19477 | 1284 | 23373 | 1140 | 13143 |
| 8-#18 | 2.80 | MA | 19913 | 4197 | 31350 | 3369 | 37810 | 2706 | 41922 | 2183 | 47896 | 1362 | 60107 | 1215 | 41223 |
| 2L-4S | | MI | 8731 | 4197 | 15083 | 3203 | 17092 | 2565 | 18031 | 2033 | 18993 | 1212 | 23111 | 498 | 20069 |
| 8-#18 | 2.80 | MA | 17389 | 4197 | 27920 | 3370 | 33461 | 2702 | 36653 | 2203 | 40806 | 1375 | 50654 | 982 | 40598 |
| 3E | | MI | 9724 | 4197 | 16449 | 3216 | 18871 | 2551 | 20133 | 2046 | 21653 | 1198 | 26054 | 708 | 22077 |
| 8-#18 | 2.80 | MA | 15562 | 4197 | 25366 | 3370 | 30009 | 2726 | 32470 | 2196 | 35181 | 1362 | 44436 | 748 | 36740 |
| 4L-2S | | MI | 11052 | 4197 | 18243 | 3229 | 21083 | 2565 | 22760 | 2033 | 25112 | 1185 | 30503 | 942 | 22290 |
| 10-#11 | 1.36 | MA | 16834 | 3601 | 24228 | 3024 | 29008 | 2455 | 31359 | 2030 | 33791 | 1408 | 41638 | 1328 | 20748 |
| 2L-5S | | MI | 8241 | 3601 | 12675 | 2903 | 14467 | 2349 | 14992 | 1938 | 14948 | 1313 | 17835 | 962 | 11283 |
| 10-#11 | 1.36 | MA | 15770 | 3601 | 22860 | 3025 | 27274 | 2455 | 29258 | 2039 | 30956 | 1414 | 37799 | 1237 | 20696 |
| 3L-4S | | MI | 8625 | 3601 | 13235 | 2896 | 15136 | 2354 | 15786 | 1933 | 16028 | 1319 | 19145 | 1005 | 11562 |
| 10-#11 | 1.36 | MA | 15001 | 3601 | 21846 | 3026 | 25903 | 2466 | 27596 | 2037 | 28713 | 1411 | 35265 | 1146 | 20533 |
| 4L-3S | | MI | 9045 | 3601 | 13786 | 2900 | 15878 | 2349 | 16662 | 1938 | 17137 | 1313 | 20381 | 1091 | 11578 |
| 10-#11 | 1.36 | MA | 14306 | 3601 | 20820 | 3038 | 24672 | 2466 | 26093 | 2047 | 26668 | 1417 | 32630 | 1099 | 19856 |
| 5L-2S | | MI | 9609 | 3601 | 14516 | 2903 | 16800 | 2354 | 17757 | 1933 | 18579 | 1308 | 22259 | 1183 | 11561 |
| 10-#14 | 1.97 | MA | 18204 | 3852 | 27261 | 3171 | 32778 | 2563 | 35892 | 2096 | 39885 | 1391 | 49710 | 1289 | 29531 |
| 2L-5S | | MI | 8360 | 3852 | 13502 | 3042 | 15421 | 2443 | 16097 | 1990 | 16388 | 1273 | 19792 | 779 | 15116 |
| 10-#14 | 1.97 | MA | 16719 | 3852 | 25303 | 3173 | 30295 | 2562 | 32884 | 2108 | 35826 | 1400 | 44247 | 1157 | 29359 |
| 3L-4S | | MI | 8896 | 3852 | 14301 | 3033 | 16365 | 2451 | 17218 | 1983 | 17912 | 1280 | 21633 | 842 | 15906 |
| 10-#14 | 1.97 | MA | 15647 | 3852 | 23849 | 3174 | 28329 | 2576 | 30502 | 2106 | 32610 | 1394 | 40645 | 1026 | 28881 |
| 4L-3S | | MI | 9482 | 3852 | 15087 | 3038 | 17411 | 2443 | 18454 | 1990 | 19477 | 1273 | 23373 | 965 | 16207 |
| 10-#14 | 1.97 | MA | 14675 | 3852 | 22379 | 3190 | 26564 | 2576 | 28347 | 2118 | 29677 | 1402 | 36888 | 959 | 26930 |
| 5L-2S | | MI | 10269 | 3852 | 16125 | 3044 | 18712 | 2451 | 19999 | 1983 | 21511 | 1265 | 26013 | 1096 | 16238 |
| 10-#18 | 3.50 | MA | 18940 | 4488 | 31350 | 3551 | 37810 | 2835 | 41922 | 2287 | 47896 | 1361 | 60107 | 943 | 50576 |
| 3L-4S | | MI | 9543 | 4488 | 16877 | 3385 | 19304 | 2691 | 20658 | 2104 | 22451 | 1172 | 27559 | 408 | 24998 |
| 10-#18 | 3.50 | MA | 17160 | 4488 | 28796 | 3552 | 34359 | 2859 | 37739 | 2280 | 42271 | 1347 | 53889 | 709 | 46428 |
| 4L-3S | | MI | 10483 | 4488 | 18243 | 3398 | 21083 | 2678 | 22760 | 2117 | 25112 | 1159 | 30503 | 618 | 27265 |
| 10-#18 | 3.50 | MA | 15549 | 4488 | 26211 | 3579 | 31256 | 2856 | 33953 | 2300 | 37136 | 1361 | 47362 | 594 | 42852 |
| 5L-2S | | MI | 11786 | 4488 | 20037 | 3411 | 23295 | 2691 | 25387 | 2104 | 28570 | 1145 | 34951 | 852 | 27570 |
| 12-#11 | 1.64 | MA | 17488 | 3714 | 25595 | 3095 | 30743 | 2507 | 33460 | 2062 | 36626 | 1403 | 45477 | 1316 | 24797 |
| 2L-6S | | MI | 8216 | 3714 | 12905 | 2971 | 14728 | 2406 | 15304 | 1963 | 15386 | 1306 | 18492 | 871 | 12998 |
| 12-#11 | 1.64 | MA | 16437 | 3714 | 24228 | 3096 | 29008 | 2507 | 31359 | 2072 | 33791 | 1409 | 41638 | 1225 | 24722 |
| 3L-5S | | MI | 8581 | 3714 | 13404 | 2974 | 15390 | 2401 | 16087 | 1968 | 16390 | 1301 | 19713 | 934 | 13327 |
| 12-#11 | 1.64 | MA | 15678 | 3714 | 23213 | 3097 | 27637 | 2518 | 29697 | 2070 | 31548 | 1405 | 39104 | 1134 | 24530 |
| 4E | | MI | 8961 | 3714 | 13964 | 2967 | 16059 | 2406 | 16881 | 1963 | 17469 | 1306 | 21024 | 977 | 13705 |
| 12-#11 | 1.64 | MA | 14992 | 3714 | 22188 | 3109 | 26406 | 2518 | 28195 | 2079 | 29503 | 1412 | 36469 | 1087 | 23748 |
| 5L-3S | | MI | 9377 | 3714 | 14516 | 2970 | 16800 | 2401 | 17757 | 1968 | 18579 | 1301 | 22259 | 1063 | 13743 |
| 12-#11 | 1.64 | MA | 14334 | 3714 | 21278 | 3110 | 25192 | 2528 | 26716 | 2078 | 27536 | 1419 | 33788 | 1012 | 22884 |
| 6L-2S | | MI | 9936 | 3714 | 15245 | 2974 | 17723 | 2406 | 18853 | 1963 | 20020 | 1296 | 24138 | 1154 | 13742 |
| 12-#14 | 2.36 | MA | 17639 | 4015 | 27261 | 3275 | 32778 | 2637 | 35892 | 2156 | 39885 | 1393 | 49710 | 1139 | 35096 |
| 3L-5S | | MI | 8831 | 4015 | 14540 | 3145 | 16722 | 2516 | 17643 | 2033 | 18422 | 1253 | 22432 | 736 | 18029 |
| 12-#14 | 2.36 | MA | 16585 | 4015 | 25807 | 3276 | 30813 | 2651 | 33510 | 2153 | 36669 | 1386 | 46108 | 1007 | 34416 |
| 4E | | MI | 9360 | 4015 | 15339 | 3135 | 17666 | 2524 | 18763 | 2025 | 19946 | 1261 | 24273 | 798 | 18762 |
| 12-#14 | 2.36 | MA | 15631 | 4015 | 24337 | 3292 | 29048 | 2651 | 31356 | 2166 | 33736 | 1395 | 42351 | 941 | 32526 |
| 5L-3S | | MI | 9938 | 4015 | 16125 | 3141 | 18712 | 2516 | 19999 | 2033 | 21511 | 1253 | 26013 | 921 | 19252 |
| 12-#14 | 2.36 | MA | 14716 | 4015 | 23031 | 3294 | 27306 | 2665 | 29235 | 2163 | 30916 | 1403 | 38536 | 832 | 30906 |
| 6L-2S | | MI | 10715 | 4015 | 17163 | 3146 | 20014 | 2524 | 21545 | 2025 | 23545 | 1246 | 28652 | 1052 | 19314 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis

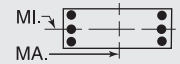



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 4.20 | MA | 18712 | 4779 | 32226 | 3734 | 38708 | 2992 | 43009 | 2365 | 49361 | 1333 | 63342 | 670 | 56153 |
| 4E | | MI | 10301 | 4779 | 18671 | 3566 | 21516 | 2818 | 23286 | 2175 | 25909 | 1132 | 32007 | 319 | 29964 |
| 12-#18 | 4.20 | MA | 17141 | 4779 | 29641 | 3761 | 35606 | 2989 | 39223 | 2384 | 44226 | 1346 | 56815 | 555 | 52460 |
| 5L-3S | | MI | 11241 | 4779 | 20037 | 3579 | 23295 | 2805 | 25387 | 2189 | 28570 | 1119 | 34951 | 529 | 32241 |
| 12-#18 | 4.20 | MA | 15633 | 4779 | 27344 | 3761 | 32544 | 3012 | 35495 | 2377 | 39288 | 1360 | 50216 | 361 | 48385 |
| 6L-2S | | MI | 12489 | 4779 | 21831 | 3592 | 25507 | 2818 | 28015 | 2175 | 32028 | 1106 | 39399 | 763 | 32829 |
| 14-#11 | 1.91 | MA | 17092 | 3828 | 25595 | 3167 | 30743 | 2559 | 33460 | 2104 | 36626 | 1404 | 45477 | 1213 | 28743 |
| 3L-6S | | MI | 8555 | 3828 | 13635 | 3042 | 15651 | 2458 | 16400 | 1993 | 16827 | 1294 | 20371 | 843 | 15071 |
| 14-#11 | 1.91 | MA | 16343 | 3828 | 24581 | 3168 | 29372 | 2569 | 31798 | 2103 | 34383 | 1400 | 42943 | 1122 | 28527 |
| 4L-5S | | MI | 8917 | 3828 | 14134 | 3045 | 16312 | 2452 | 17183 | 1998 | 17831 | 1289 | 21592 | 905 | 15382 |
| 14-#11 | 1.91 | MA | 15666 | 3828 | 23556 | 3180 | 28141 | 2569 | 30296 | 2112 | 32338 | 1407 | 40308 | 1076 | 27652 |
| 5L-4S | | MI | 9292 | 3828 | 14694 | 3038 | 16981 | 2458 | 17977 | 1993 | 18911 | 1294 | 22902 | 949 | 15841 |
| 14-#11 | 1.91 | MA | 15017 | 3828 | 22645 | 3181 | 26927 | 2580 | 28818 | 2111 | 30371 | 1413 | 37627 | 1001 | 26819 |
| 6L-3S | | MI | 9704 | 3828 | 15245 | 3041 | 17723 | 2452 | 18853 | 1998 | 20020 | 1289 | 24138 | 1035 | 15899 |
| 14-#11 | 1.91 | MA | 14382 | 3828 | 21759 | 3182 | 25754 | 2580 | 27385 | 2120 | 28378 | 1410 | 35240 | 930 | 25744 |
| 7L-2S | | MI | 10258 | 3828 | 15975 | 3045 | 18645 | 2458 | 19948 | 1993 | 21462 | 1284 | 26016 | 1126 | 15915 |
| 14-#14 | 2.75 | MA | 17503 | 4179 | 27765 | 3378 | 33296 | 2726 | 36519 | 2201 | 40728 | 1379 | 51571 | 989 | 39948 |
| 4L-5S | | MI | 9294 | 4179 | 15578 | 3247 | 18024 | 2590 | 19189 | 2075 | 20456 | 1234 | 25072 | 692 | 20954 |
| 14-#14 | 2.75 | MA | 16566 | 4179 | 26295 | 3395 | 31531 | 2725 | 34364 | 2213 | 37795 | 1387 | 47814 | 922 | 38135 |
| 5L-4S | | MI | 9816 | 4179 | 16377 | 3237 | 18968 | 2597 | 20309 | 2068 | 21980 | 1242 | 26913 | 755 | 21637 |
| 14-#14 | 2.75 | MA | 15667 | 4179 | 24989 | 3396 | 29789 | 2740 | 32244 | 2210 | 34975 | 1396 | 43999 | 814 | 36445 |
| 6L-3S | | MI | 10387 | 4179 | 17163 | 3243 | 20014 | 2590 | 21545 | 2075 | 23545 | 1234 | 28652 | 877 | 22288 |
| 14-#14 | 2.75 | MA | 14786 | 4179 | 23717 | 3397 | 28107 | 2739 | 30188 | 2223 | 32116 | 1390 | 40605 | 712 | 34581 |
| 7L-2S | | MI | 11154 | 4179 | 18201 | 3248 | 21315 | 2597 | 23091 | 2068 | 25580 | 1227 | 31292 | 1009 | 22379 |
| 14-#18 | 4.90 | MA | 18692 | 5069 | 33070 | 3943 | 39956 | 3122 | 44493 | 2468 | 51316 | 1332 | 66268 | 516 | 62096 |
| 5L-4S | | MI | 11039 | 5069 | 20466 | 3748 | 23728 | 2944 | 25913 | 2247 | 29368 | 1092 | 36455 | 229 | 34959 |
| 14-#18 | 4.90 | MA | 17219 | 5069 | 30773 | 3943 | 36893 | 3145 | 40765 | 2462 | 46378 | 1345 | 59669 | 322 | 58017 |
| 6L-3S | | MI | 11956 | 5069 | 21831 | 3761 | 25507 | 2931 | 28015 | 2260 | 32028 | 1079 | 39399 | 440 | 37066 |
| 14-#18 | 4.90 | MA | 15775 | 5069 | 28537 | 3944 | 33934 | 3142 | 37150 | 2481 | 41372 | 1332 | 53805 | 140 | 52889 |
| 7L-2S | | MI | 13177 | 5069 | 23625 | 3774 | 27719 | 2944 | 30642 | 2247 | 35486 | 1066 | 43847 | 673 | 38074 |
| 16-#11 | 2.18 | MA | 16997 | 3941 | 25949 | 3239 | 31106 | 2621 | 33900 | 2136 | 37218 | 1395 | 46782 | 1111 | 32523 |
| 4L-6S | | MI | 8890 | 3941 | 14364 | 3113 | 16573 | 2509 | 17495 | 2024 | 18269 | 1282 | 22249 | 815 | 17148 |
| 16-#11 | 2.18 | MA | 16329 | 3941 | 24923 | 3250 | 29875 | 2621 | 32397 | 2145 | 35173 | 1402 | 44146 | 1064 | 31565 |
| 5E | | MI | 9247 | 3941 | 14864 | 3116 | 17235 | 2504 | 18278 | 2029 | 19273 | 1277 | 23470 | 877 | 17444 |
| 16-#11 | 2.18 | MA | 15689 | 3941 | 24013 | 3252 | 28661 | 2632 | 30919 | 2144 | 33206 | 1408 | 41466 | 989 | 30759 |
| 6L-4S | | MI | 9619 | 3941 | 15424 | 3109 | 17904 | 2509 | 19072 | 2024 | 20352 | 1282 | 24780 | 920 | 17972 |
| 16-#11 | 2.18 | MA | 15061 | 3941 | 23127 | 3253 | 27488 | 2632 | 29486 | 2153 | 31213 | 1404 | 39079 | 918 | 29640 |
| 7L-3S | | MI | 10027 | 3941 | 15975 | 3112 | 18645 | 2504 | 19948 | 2029 | 21462 | 1277 | 26016 | 1007 | 18047 |
| 16-#11 | 2.18 | MA | 14441 | 3941 | 22255 | 3254 | 26339 | 2632 | 28050 | 2152 | 29290 | 1411 | 36617 | 864 | 28600 |
| 8L-2S | | MI | 10576 | 3941 | 16705 | 3115 | 19568 | 2509 | 21044 | 2024 | 22903 | 1272 | 27895 | 1098 | 18078 |
| 16-#14 | 3.15 | MA | 17482 | 4342 | 28253 | 3497 | 34014 | 2800 | 37373 | 2260 | 41854 | 1380 | 53277 | 904 | 43755 |
| 5E | | MI | 9749 | 4342 | 16616 | 3349 | 19325 | 2663 | 20734 | 2118 | 22490 | 1215 | 27711 | 648 | 23888 |
| 16-#14 | 3.15 | MA | 16598 | 4342 | 26947 | 3498 | 32272 | 2814 | 35252 | 2258 | 39034 | 1389 | 49463 | 795 | 41996 |
| 6L-4S | | MI | 10265 | 4342 | 17415 | 3340 | 20269 | 2671 | 21855 | 2110 | 24014 | 1223 | 29552 | 711 | 24529 |
| 16-#14 | 3.15 | MA | 15732 | 4342 | 25675 | 3499 | 30590 | 2814 | 33197 | 2270 | 36174 | 1382 | 46068 | 693 | 40184 |
| 7L-3S | | MI | 10829 | 4342 | 18201 | 3345 | 21315 | 2663 | 23091 | 2118 | 25580 | 1215 | 31292 | 833 | 25318 |
| 16-#14 | 3.15 | MA | 14875 | 4342 | 24424 | 3501 | 28941 | 2813 | 31137 | 2268 | 33416 | 1391 | 42559 | 616 | 37740 |
| 8L-2S | | MI | 11588 | 4342 | 19239 | 3351 | 22617 | 2671 | 24636 | 2110 | 27614 | 1208 | 33931 | 965 | 25435 |
| 16-#18 | 5.59 | MA | 18768 | 5360 | 34203 | 4125 | 41243 | 3278 | 46035 | 2546 | 53468 | 1331 | 69122 | 283 | 67624 |
| 6L-4S | | MI | 11761 | 5360 | 22260 | 3930 | 25940 | 3071 | 28541 | 2318 | 32826 | 1053 | 40903 | 140 | 39976 |
| 16-#18 | 5.59 | MA | 17357 | 5360 | 31966 | 4126 | 38284 | 3275 | 42420 | 2566 | 48462 | 1318 | 63258 | 101 | 62619 |
| 7L-3S | | MI | 12657 | 5360 | 23625 | 3943 | 27719 | 3058 | 30642 | 2331 | 35486 | 1040 | 43847 | 350 | 41931 |
| 18-#11 | 2.45 | MA | 16982 | 4055 | 26291 | 3321 | 31610 | 2673 | 34499 | 2178 | 38008 | 1396 | 47985 | 1052 | 35486 |
| 5L-6S | | MI | 9220 | 4055 | 15094 | 3184 | 17496 | 2561 | 18591 | 2054 | 19710 | 1270 | 24128 | 787 | 19208 |
| 18-#11 | 2.45 | MA | 16349 | 4055 | 25380 | 3323 | 30395 | 2683 | 33020 | 2177 | 36041 | 1403 | 45305 | 977 | 34705 |
| 6L-5S | | MI | 9574 | 4055 | 15593 | 3187 | 18157 | 2556 | 19374 | 2059 | 20714 | 1265 | 25349 | 849 | 19512 |
| 18-#11 | 2.45 | MA | 15730 | 4055 | 24494 | 3324 | 29223 | 2683 | 31587 | 2186 | 34048 | 1399 | 42917 | 906 | 33543 |
| 7L-4S | | MI | 9942 | 4055 | 16153 | 3180 | 18826 | 2561 | 20168 | 2054 | 21794 | 1270 | 26659 | 892 | 20059 |

## RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis

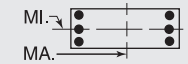



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.45 | MA | 15118 | 4055 | 23622 | 3325 | 28074 | 2683 | 30152 | 2184 | 32125 | 1406 | 40456 | 852 | 32493 |
| 8L-3S | | MI | 10346 | 4055 | 16705 | 3183 | 19568 | 2556 | 21044 | 2059 | 22903 | 1265 | 27895 | 979 | 20191 |
| 18-#11 | 2.45 | MA | 14510 | 4055 | 22659 | 3337 | 26889 | 2694 | 28739 | 2194 | 30220 | 1412 | 38021 | 794 | 31027 |
| 9L-2S | | MI | 10890 | 4055 | 17434 | 3186 | 20490 | 2561 | 22139 | 2054 | 24345 | 1260 | 29773 | 1070 | 20235 |
| 18-#14 | 3.54 | MA | 17512 | 4506 | 28905 | 3600 | 34756 | 2889 | 38261 | 2305 | 43093 | 1381 | 54926 | 777 | 47559 |
| 6L-5S | | MI | 10199 | 4506 | 17654 | 3451 | 20627 | 2736 | 22280 | 2160 | 24525 | 1196 | 30351 | 604 | 26829 |
| 18-#14 | 3.54 | MA | 16660 | 4506 | 27633 | 3602 | 33073 | 2889 | 36205 | 2318 | 40233 | 1375 | 51531 | 675 | 45783 |
| 7L-4S | | MI | 10707 | 4506 | 18453 | 3442 | 21571 | 2744 | 23401 | 2153 | 26048 | 1204 | 32192 | 667 | 27433 |
| 18-#14 | 3.54 | MA | 15816 | 4506 | 26382 | 3603 | 31424 | 2888 | 34146 | 2315 | 37475 | 1383 | 48022 | 598 | 43318 |
| 8L-3S | | MI | 11265 | 4506 | 19239 | 3447 | 22617 | 2736 | 24636 | 2160 | 27614 | 1196 | 33931 | 790 | 28343 |
| 18-#14 | 3.54 | MA | 14978 | 4506 | 25000 | 3619 | 29725 | 2902 | 32119 | 2328 | 34743 | 1392 | 44559 | 513 | 40865 |
| 9L-2S | | MI | 12016 | 4506 | 20277 | 3453 | 23918 | 2744 | 26182 | 2153 | 29648 | 1189 | 36571 | 921 | 28485 |
| 18-#18 | 6.29 | MA | 18905 | 5651 | 35396 | 4307 | 42634 | 3408 | 47690 | 2650 | 55552 | 1303 | 72711 | 62 | 72364 |
| 7L-4S | | MI | 12470 | 5651 | 24054 | 4112 | 28152 | 3198 | 31168 | 2389 | 36284 | 1013 | 45351 | 51 | 45012 |
| 20-#11 | 2.73 | MA | 17000 | 4168 | 26748 | 3393 | 32130 | 2735 | 35122 | 2210 | 38876 | 1398 | 49143 | 966 | 38655 |
| 6E | | MI | 9545 | 4168 | 15824 | 3254 | 18418 | 2612 | 19686 | 2084 | 21152 | 1258 | 26006 | 759 | 21224 |
| 20-#11 | 2.73 | MA | 16388 | 4168 | 25862 | 3395 | 30957 | 2735 | 33689 | 2219 | 36883 | 1394 | 46756 | 895 | 37451 |
| 7L-5S | | MI | 9896 | 4168 | 16323 | 3258 | 19080 | 2607 | 20469 | 2090 | 22156 | 1253 | 27227 | 821 | 21585 |
| 20-#11 | 2.73 | MA | 15784 | 4168 | 24990 | 3396 | 29808 | 2735 | 32253 | 2217 | 34960 | 1401 | 44295 | 841 | 36373 |
| 8L-4S | | MI | 10261 | 4168 | 16883 | 3251 | 19749 | 2612 | 21263 | 2084 | 23235 | 1258 | 28537 | 864 | 22102 |
| 20-#11 | 2.73 | MA | 15183 | 4168 | 24027 | 3407 | 28624 | 2746 | 30841 | 2226 | 33055 | 1407 | 41860 | 782 | 34936 |
| 9L-3S | | MI | 10661 | 4168 | 17434 | 3254 | 20490 | 2607 | 22139 | 2090 | 24345 | 1253 | 29773 | 951 | 22331 |
| 20-#11 | 2.73 | MA | 14585 | 4168 | 23158 | 3409 | 27483 | 2746 | 29421 | 2225 | 31097 | 1403 | 39343 | 702 | 33453 |
| 10L-2S | | MI | 11201 | 4168 | 18164 | 3257 | 21413 | 2612 | 23235 | 2084 | 25786 | 1248 | 31652 | 1042 | 22388 |
| 20-#14 | 3.93 | MA | 17571 | 4670 | 29591 | 3704 | 35556 | 2963 | 39214 | 2365 | 44292 | 1367 | 56994 | 656 | 51317 |
| 7L-5S | | MI | 10642 | 4670 | 18692 | 3553 | 21928 | 2810 | 23826 | 2203 | 26559 | 1177 | 32990 | 561 | 29771 |
| 20-#14 | 3.93 | MA | 16741 | 4670 | 28340 | 3705 | 33908 | 2963 | 37154 | 2363 | 41534 | 1376 | 53485 | 579 | 48903 |
| 8L-4S | | MI | 11145 | 4670 | 19491 | 3544 | 22872 | 2817 | 24946 | 2195 | 28083 | 1185 | 34831 | 623 | 30348 |
| 20-#14 | 3.93 | MA | 15916 | 4670 | 26958 | 3721 | 32209 | 2977 | 35128 | 2375 | 38802 | 1385 | 50022 | 494 | 46426 |
| 9L-3S | | MI | 11696 | 4670 | 20277 | 3550 | 23918 | 2810 | 26182 | 2203 | 29648 | 1177 | 36571 | 746 | 31364 |
| 22-#11 | 3.00 | MA | 17038 | 4281 | 27230 | 3466 | 32692 | 2787 | 35790 | 2251 | 39718 | 1389 | 50595 | 883 | 41365 |
| 7L-6S | | MI | 9868 | 4281 | 16553 | 3325 | 19341 | 2664 | 20782 | 2115 | 22593 | 1246 | 27885 | 731 | 23248 |
| 22-#11 | 3.00 | MA | 16440 | 4281 | 26357 | 3467 | 31542 | 2787 | 34354 | 2250 | 37795 | 1395 | 48133 | 829 | 40259 |
| 8L-5S | | MI | 10215 | 4281 | 17053 | 3329 | 20002 | 2659 | 21565 | 2120 | 23597 | 1241 | 29106 | 793 | 23662 |
| 22-#11 | 3.00 | MA | 15847 | 4281 | 25394 | 3478 | 30358 | 2797 | 32942 | 2259 | 35890 | 1402 | 45699 | 771 | 38849 |
| 9L-4S | | MI | 10577 | 4281 | 17613 | 3322 | 20672 | 2664 | 22359 | 2115 | 24677 | 1246 | 30416 | 836 | 24153 |
| 22-#11 | 3.00 | MA | 15251 | 4281 | 24525 | 3480 | 29217 | 2797 | 31523 | 2258 | 33932 | 1398 | 43182 | 690 | 37349 |
| 10L-3S | | MI | 10973 | 4281 | 18164 | 3325 | 21413 | 2659 | 23235 | 2120 | 25786 | 1241 | 31652 | 923 | 24468 |
| 22-#11 | 3.00 | MA | 14617 | 4281 | 23663 | 3481 | 28046 | 2808 | 30119 | 2267 | 32036 | 1405 | 40763 | 634 | 35834 |
| 11L-2S | | MI | 11509 | 4281 | 18894 | 3328 | 22335 | 2664 | 24330 | 2115 | 27228 | 1236 | 33530 | 1014 | 24537 |
| 22-#14 | 4.33 | MA | 17651 | 4833 | 30298 | 3807 | 36391 | 3038 | 40163 | 2410 | 45593 | 1369 | 58948 | 561 | 54495 |
| 8L-5S | | MI | 11114 | 4833 | 19730 | 3656 | 23230 | 2883 | 25372 | 2245 | 28593 | 1158 | 35630 | 517 | 32614 |
| 22-#14 | 4.33 | MA | 16838 | 4833 | 28916 | 3824 | 34692 | 3052 | 38136 | 2422 | 42861 | 1377 | 55485 | 476 | 51993 |
| 9L-4S | | MI | 11602 | 4833 | 20529 | 3646 | 24174 | 2891 | 26492 | 2238 | 30117 | 1166 | 37471 | 579 | 33271 |
| 24-#11 | 3.27 | MA | 17088 | 4395 | 27725 | 3538 | 33277 | 2839 | 36456 | 2283 | 40630 | 1390 | 51972 | 817 | 44149 |
| 8L-6S | | MI | 10187 | 4395 | 17283 | 3396 | 20263 | 2716 | 21877 | 2145 | 24035 | 1234 | 29763 | 702 | 25279 |
| 24-#11 | 3.27 | MA | 16501 | 4395 | 26762 | 3549 | 32093 | 2849 | 35043 | 2292 | 38725 | 1397 | 49537 | 759 | 42766 |
| 9L-5S | | MI | 10531 | 4395 | 17783 | 3400 | 20925 | 2710 | 22660 | 2150 | 25039 | 1229 | 30984 | 765 | 25742 |
| 24-#11 | 3.27 | MA | 15908 | 4395 | 25893 | 3550 | 30951 | 2849 | 33624 | 2291 | 36767 | 1393 | 47021 | 679 | 41248 |
| 10L-4S | | MI | 10889 | 4395 | 18342 | 3392 | 21594 | 2716 | 23454 | 2145 | 26118 | 1234 | 32294 | 808 | 26209 |
| 24-#11 | 3.27 | MA | 15280 | 4395 | 25031 | 3552 | 29781 | 2860 | 32220 | 2300 | 34871 | 1400 | 44601 | 622 | 39721 |
| 11L-3S | | MI | 11282 | 4395 | 18894 | 3396 | 22335 | 2710 | 24330 | 2150 | 27228 | 1229 | 33530 | 894 | 26602 |
| 24-#14 | 4.72 | MA | 17746 | 4997 | 30874 | 3926 | 37175 | 3127 | 41145 | 2470 | 46920 | 1370 | 60948 | 457 | 57567 |
| 9L-5S | | MI | 11542 | 4997 | 20768 | 3758 | 24531 | 2956 | 26917 | 2288 | 30627 | 1139 | 38269 | 473 | 35468 |

## RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis

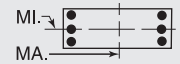



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.34 | MA | 18233 | 3753 | 26409 | 3135 | 31444 | 2546 | 33883 | 2105 | 36354 | 1462 | 44447 | 1367 | 22043 |
| 2E | | MI | 9889 | 3753 | 15158 | 2979 | 17215 | 2405 | 18062 | 1970 | 18708 | 1325 | 22184 | 1179 | 11645 |
| 6-#14 | 1.13 | MA | 17767 | 3662 | 25198 | 3096 | 30069 | 2519 | 32288 | 2091 | 34249 | 1476 | 41860 | 1397 | 18848 |
| 2L-3S | | MI | 8902 | 3662 | 13509 | 2949 | 15362 | 2391 | 15920 | 1986 | 15924 | 1372 | 18676 | 1112 | 10101 |
| 6-#14 | 1.13 | MA | 16147 | 3662 | 23138 | 3098 | 27456 | 2519 | 29122 | 2104 | 29978 | 1485 | 36081 | 1266 | 18780 |
| 3L-2S | | MI | 9712 | 3662 | 14547 | 2955 | 16664 | 2399 | 17466 | 1978 | 17958 | 1365 | 21316 | 1244 | 10056 |
| 6-#18 | 2.01 | MA | 19926 | 4044 | 30021 | 3317 | 36024 | 2679 | 39432 | 2189 | 43840 | 1449 | 54460 | 1331 | 32731 |
| 2L-3S | | MI | 9307 | 4044 | 15158 | 3148 | 17215 | 2518 | 18062 | 2055 | 18708 | 1299 | 22184 | 856 | 16937 |
| 6-#18 | 2.01 | MA | 17190 | 4044 | 26409 | 3318 | 31444 | 2677 | 33883 | 2210 | 36354 | 1462 | 44447 | 1097 | 32242 |
| 3L-2S | | MI | 10665 | 4044 | 16952 | 3161 | 19427 | 2532 | 20689 | 2041 | 22166 | 1286 | 26632 | 1090 | 17021 |
| 8-#11 | 1.04 | MA | 17575 | 3625 | 24685 | 3082 | 29500 | 2510 | 31634 | 2087 | 33392 | 1482 | 40806 | 1411 | 17533 |
| 2L-4S | | MI | 8642 | 3625 | 12999 | 2941 | 14768 | 2398 | 15248 | 1983 | 15103 | 1393 | 17851 | 1093 | 9445 |
| 8-#11 | 1.04 | MA | 16438 | 3625 | 23247 | 3084 | 27676 | 2510 | 29424 | 2097 | 30410 | 1489 | 36749 | 1319 | 17507 |
| 3E | | MI | 9067 | 3625 | 13550 | 2944 | 15509 | 2393 | 16124 | 1988 | 16212 | 1388 | 19087 | 1180 | 9427 |
| 8-#11 | 1.04 | MA | 15617 | 3625 | 22181 | 3085 | 26235 | 2521 | 27677 | 2096 | 28053 | 1486 | 34068 | 1228 | 17376 |
| 4L-2S | | MI | 9639 | 3625 | 14280 | 2948 | 16432 | 2398 | 17220 | 1983 | 17654 | 1382 | 20966 | 1271 | 9394 |
| 8-#14 | 1.51 | MA | 18765 | 3826 | 27259 | 3198 | 32682 | 2594 | 35453 | 2139 | 38520 | 1468 | 47639 | 1380 | 24956 |
| 2L-4S | | MI | 8782 | 3826 | 13760 | 3046 | 15618 | 2472 | 16230 | 2021 | 16393 | 1361 | 19576 | 946 | 13114 |
| 8-#14 | 1.51 | MA | 17171 | 3826 | 25198 | 3200 | 30069 | 2594 | 32288 | 2152 | 34249 | 1478 | 41860 | 1249 | 24833 |
| 3E | | MI | 9378 | 3826 | 14547 | 3051 | 16664 | 2464 | 17466 | 2028 | 17958 | 1353 | 21316 | 1068 | 13189 |
| 8-#14 | 1.51 | MA | 16020 | 3826 | 23670 | 3202 | 28003 | 2609 | 29783 | 2150 | 30869 | 1472 | 38047 | 1118 | 24406 |
| 4L-2S | | MI | 10177 | 3826 | 15585 | 3057 | 17965 | 2472 | 19011 | 2021 | 19993 | 1346 | 23956 | 1200 | 13175 |
| 8-#18 | 2.68 | MA | 21560 | 4335 | 33632 | 3498 | 40604 | 2812 | 44981 | 2274 | 51327 | 1435 | 64473 | 1295 | 43383 |
| 2L-4S | | MI | 9089 | 4335 | 15586 | 3317 | 17648 | 2658 | 18588 | 2113 | 19506 | 1273 | 23689 | 557 | 20263 |
| 8-#18 | 2.68 | MA | 18891 | 4335 | 30021 | 3500 | 36024 | 2810 | 39432 | 2294 | 43840 | 1449 | 54460 | 1061 | 42758 |
| 3E | | MI | 10087 | 4335 | 16952 | 3330 | 19427 | 2645 | 20689 | 2126 | 22166 | 1259 | 26632 | 767 | 22152 |
| 8-#18 | 2.68 | MA | 16963 | 4335 | 27335 | 3501 | 32394 | 2834 | 35032 | 2289 | 37903 | 1436 | 47866 | 827 | 38926 |
| 4L-2S | | MI | 11419 | 4335 | 18746 | 3343 | 21639 | 2658 | 23317 | 2113 | 25624 | 1246 | 31080 | 1001 | 22341 |
| 10-#11 | 1.30 | MA | 18282 | 3739 | 26124 | 3153 | 31325 | 2562 | 33844 | 2120 | 36374 | 1477 | 44864 | 1400 | 21801 |
| 2L-5S | | MI | 8599 | 3739 | 13169 | 3019 | 15021 | 2445 | 15550 | 2019 | 15465 | 1376 | 18420 | 1022 | 11381 |
| 10-#11 | 1.30 | MA | 17159 | 3739 | 24685 | 3155 | 29500 | 2562 | 31634 | 2129 | 33392 | 1484 | 40806 | 1309 | 21749 |
| 3L-4S | | MI | 8984 | 3739 | 13729 | 3012 | 15690 | 2450 | 16344 | 2014 | 16545 | 1381 | 19730 | 1065 | 11602 |
| 10-#11 | 1.30 | MA | 16349 | 3739 | 23620 | 3156 | 28059 | 2573 | 29888 | 2129 | 31035 | 1481 | 38126 | 1218 | 21586 |
| 4L-3S | | MI | 9405 | 3739 | 14280 | 3015 | 16432 | 2445 | 17220 | 2019 | 17654 | 1376 | 20966 | 1152 | 11610 |
| 10-#11 | 1.30 | MA | 15616 | 3739 | 22543 | 3168 | 26767 | 2573 | 28310 | 2138 | 28886 | 1488 | 35345 | 1170 | 20968 |
| 5L-2S | | MI | 9971 | 3739 | 15010 | 3019 | 17354 | 2450 | 18315 | 2014 | 19095 | 1370 | 22844 | 1243 | 11589 |
| 10-#14 | 1.88 | MA | 19738 | 3990 | 29319 | 3301 | 35295 | 2669 | 38619 | 2186 | 42791 | 1461 | 53417 | 1363 | 31049 |
| 2L-5S | | MI | 8718 | 3990 | 13999 | 3157 | 15975 | 2538 | 16655 | 2071 | 16904 | 1334 | 20375 | 839 | 15239 |
| 10-#14 | 1.88 | MA | 18170 | 3990 | 27259 | 3302 | 32682 | 2669 | 35453 | 2199 | 38520 | 1470 | 47639 | 1232 | 30878 |
| 3L-4S | | MI | 9256 | 3990 | 14798 | 3148 | 16919 | 2545 | 17775 | 2063 | 18427 | 1342 | 22216 | 902 | 16048 |
| 10-#14 | 1.88 | MA | 17039 | 3990 | 25731 | 3304 | 30616 | 2684 | 32949 | 2197 | 35140 | 1465 | 43825 | 1100 | 30400 |
| 4L-3S | | MI | 9844 | 3990 | 15585 | 3154 | 17965 | 2538 | 19011 | 2071 | 19993 | 1334 | 23956 | 1025 | 16252 |
| 10-#14 | 1.88 | MA | 16015 | 3990 | 24185 | 3321 | 28762 | 2684 | 30685 | 2210 | 32058 | 1474 | 39857 | 1033 | 28442 |
| 5L-2S | | MI | 10633 | 3990 | 16623 | 3159 | 19267 | 2545 | 20557 | 2063 | 22027 | 1327 | 26595 | 1156 | 16274 |
| 10-#18 | 3.34 | MA | 20538 | 4626 | 33632 | 3681 | 40604 | 2943 | 44981 | 2379 | 51327 | 1436 | 64473 | 1025 | 53276 |
| 3L-4S | | MI | 9869 | 4626 | 17380 | 3498 | 19861 | 2785 | 21215 | 2184 | 22964 | 1233 | 28137 | 467 | 25188 |
| 10-#18 | 3.34 | MA | 18659 | 4626 | 30947 | 3683 | 36974 | 2967 | 40581 | 2373 | 45389 | 1423 | 57879 | 791 | 49141 |
| 4L-3S | | MI | 10848 | 4626 | 18746 | 3511 | 21639 | 2772 | 23317 | 2197 | 25624 | 1220 | 31080 | 678 | 27348 |
| 10-#18 | 3.34 | MA | 16958 | 4626 | 28229 | 3711 | 33713 | 2965 | 36601 | 2394 | 39970 | 1437 | 50979 | 674 | 45574 |
| 5L-2S | | MI | 12156 | 4626 | 20540 | 3524 | 23851 | 2785 | 25944 | 2184 | 29083 | 1206 | 35528 | 911 | 27625 |
| 12-#11 | 1.57 | MA | 18976 | 3852 | 27562 | 3224 | 33149 | 2614 | 36054 | 2153 | 39356 | 1472 | 48922 | 1389 | 26061 |
| 2L-6S | | MI | 8574 | 3852 | 13399 | 3087 | 15282 | 2501 | 15863 | 2044 | 15903 | 1369 | 19077 | 931 | 13091 |
| 12-#11 | 1.57 | MA | 17866 | 3852 | 26124 | 3225 | 31325 | 2614 | 33844 | 2162 | 36374 | 1479 | 44864 | 1298 | 25986 |
| 3L-5S | | MI | 8941 | 3852 | 13898 | 3090 | 15944 | 2496 | 16645 | 2049 | 16906 | 1363 | 20298 | 994 | 13425 |
| 12-#11 | 1.57 | MA | 17066 | 3852 | 25058 | 3227 | 29884 | 2625 | 32098 | 2161 | 34016 | 1476 | 42184 | 1207 | 25794 |
| 4E | | MI | 9321 | 3852 | 14458 | 3083 | 16613 | 2501 | 17440 | 2044 | 17986 | 1369 | 21608 | 1037 | 13749 |

## RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis



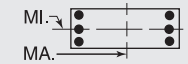

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.57 | MA | 16344 | 3852 | 23981 | 3239 | 28591 | 2625 | 30520 | 2171 | 31868 | 1483 | 39402 | 1160 | 25065 |
| 5L-3S | | MI | 9738 | 3852 | 15010 | 3086 | 17354 | 2496 | 18315 | 2049 | 19095 | 1363 | 22844 | 1123 | 13779 |
| 12-#11 | 1.57 | MA | 15651 | 3852 | 23025 | 3240 | 27316 | 2636 | 28967 | 2170 | 29803 | 1490 | 36569 | 1085 | 24128 |
| 6L-2S | | MI | 10299 | 3852 | 15739 | 3089 | 18277 | 2501 | 19411 | 2044 | 20537 | 1358 | 24723 | 1215 | 13773 |
| 12-#14 | 2.26 | MA | 19146 | 4153 | 29319 | 3405 | 35295 | 2744 | 38619 | 2247 | 42791 | 1463 | 53417 | 1215 | 36919 |
| 3L-5S | | MI | 9191 | 4153 | 15037 | 3260 | 17277 | 2611 | 18201 | 2113 | 18938 | 1315 | 23015 | 795 | 18152 |
| 12-#14 | 2.26 | MA | 18034 | 4153 | 27791 | 3406 | 33229 | 2758 | 36115 | 2245 | 39411 | 1457 | 49604 | 1083 | 36396 |
| 4E | | MI | 9721 | 4153 | 15836 | 3250 | 18221 | 2619 | 19321 | 2106 | 20461 | 1323 | 24855 | 858 | 18901 |
| 12-#14 | 2.26 | MA | 17028 | 4153 | 26246 | 3423 | 31375 | 2758 | 33851 | 2258 | 36329 | 1467 | 45636 | 1016 | 34336 |
| 5L-3S | | MI | 10302 | 4153 | 16623 | 3256 | 19267 | 2611 | 20557 | 2113 | 22027 | 1315 | 26595 | 981 | 19302 |
| 12-#14 | 2.26 | MA | 16064 | 4153 | 24874 | 3425 | 29545 | 2773 | 31624 | 2256 | 33366 | 1476 | 41601 | 908 | 32759 |
| 6L-2S | | MI | 11081 | 4153 | 17660 | 3261 | 20569 | 2619 | 22103 | 2106 | 24061 | 1308 | 29235 | 1112 | 19355 |
| 12-#18 | 4.01 | MA | 20306 | 4916 | 34558 | 3865 | 41554 | 3100 | 46130 | 2457 | 52875 | 1410 | 67892 | 755 | 59393 |
| 4E | | MI | 10665 | 4916 | 19175 | 3680 | 22073 | 2911 | 23843 | 2255 | 26422 | 1193 | 32585 | 378 | 30150 |
| 12-#18 | 4.01 | MA | 18647 | 4916 | 31841 | 3893 | 38293 | 3098 | 42150 | 2478 | 47456 | 1423 | 60992 | 638 | 55712 |
| 5L-3S | | MI | 11611 | 4916 | 20540 | 3693 | 23851 | 2898 | 25944 | 2268 | 29083 | 1180 | 35528 | 588 | 32492 |
| 12-#18 | 4.01 | MA | 17054 | 4916 | 29427 | 3894 | 35074 | 3122 | 38232 | 2472 | 42245 | 1437 | 54001 | 445 | 51273 |
| 6L-2S | | MI | 12867 | 4916 | 22334 | 3706 | 26063 | 2911 | 28572 | 2255 | 32541 | 1167 | 39976 | 822 | 32889 |
| 14-#11 | 1.83 | MA | 18560 | 3966 | 27562 | 3296 | 33149 | 2666 | 36054 | 2195 | 39356 | 1474 | 48922 | 1287 | 30217 |
| 3L-6S | | MI | 8914 | 3966 | 14129 | 3158 | 16205 | 2553 | 16958 | 2074 | 17344 | 1357 | 20955 | 903 | 15164 |
| 14-#11 | 1.83 | MA | 17771 | 3966 | 26497 | 3298 | 31708 | 2676 | 34308 | 2194 | 36998 | 1471 | 46241 | 1196 | 30001 |
| 4L-5S | | MI | 9277 | 3966 | 14628 | 3161 | 16866 | 2548 | 17741 | 2079 | 18348 | 1351 | 22177 | 966 | 15478 |
| 14-#11 | 1.83 | MA | 17058 | 3966 | 25420 | 3310 | 30415 | 2677 | 32730 | 2204 | 34850 | 1478 | 43460 | 1149 | 29175 |
| 5L-4S | | MI | 9654 | 3966 | 15188 | 3154 | 17535 | 2553 | 18535 | 2074 | 19428 | 1357 | 23487 | 1009 | 15889 |
| 14-#11 | 1.83 | MA | 16374 | 3966 | 24464 | 3311 | 29140 | 2687 | 31177 | 2203 | 32784 | 1485 | 40626 | 1074 | 28270 |
| 6L-3S | | MI | 10067 | 3966 | 15739 | 3157 | 18277 | 2548 | 19411 | 2079 | 20537 | 1351 | 24723 | 1095 | 15938 |
| 14-#11 | 1.83 | MA | 15705 | 3966 | 23533 | 3313 | 27909 | 2688 | 29673 | 2212 | 30691 | 1481 | 38101 | 1003 | 27225 |
| 7L-2S | | MI | 10622 | 3966 | 16469 | 3160 | 19199 | 2553 | 20506 | 2074 | 21978 | 1346 | 26601 | 1186 | 15948 |
| 14-#14 | 2.63 | MA | 19008 | 4317 | 29851 | 3509 | 35842 | 2833 | 39280 | 2292 | 43682 | 1450 | 55383 | 1066 | 42229 |
| 4L-5S | | MI | 9655 | 4317 | 16075 | 3362 | 18578 | 2684 | 19746 | 2156 | 20972 | 1296 | 25654 | 752 | 21076 |
| 14-#14 | 2.63 | MA | 18019 | 4317 | 28306 | 3525 | 33987 | 2833 | 37017 | 2305 | 40600 | 1459 | 51415 | 999 | 40243 |
| 5L-4S | | MI | 10178 | 4317 | 16874 | 3353 | 19523 | 2692 | 20867 | 2148 | 22496 | 1304 | 27495 | 814 | 21775 |
| 14-#14 | 2.63 | MA | 17071 | 4317 | 26934 | 3527 | 32158 | 2848 | 34789 | 2303 | 37637 | 1468 | 47379 | 891 | 38596 |
| 6L-3S | | MI | 10752 | 4317 | 17660 | 3358 | 20569 | 2684 | 22103 | 2156 | 24061 | 1296 | 29235 | 937 | 22342 |
| 14-#14 | 2.63 | MA | 16142 | 4317 | 25599 | 3529 | 30390 | 2848 | 32630 | 2316 | 34633 | 1463 | 43786 | 789 | 36573 |
| 7L-2S | | MI | 11522 | 4317 | 18698 | 3364 | 21870 | 2692 | 23649 | 2148 | 26095 | 1289 | 31874 | 1068 | 22422 |
| 14-#18 | 4.68 | MA | 20292 | 5207 | 35452 | 4074 | 42873 | 3231 | 47699 | 2562 | 54943 | 1410 | 71005 | 602 | 65878 |
| 5L-4S | | MI | 11406 | 5207 | 20969 | 3862 | 24285 | 3038 | 26470 | 2326 | 29880 | 1154 | 37033 | 288 | 35142 |
| 14-#18 | 4.68 | MA | 18737 | 5207 | 33038 | 4076 | 39654 | 3255 | 43781 | 2557 | 49731 | 1424 | 64014 | 409 | 61576 |
| 6L-3S | | MI | 12329 | 5207 | 22334 | 3875 | 26063 | 3025 | 28572 | 2339 | 32541 | 1140 | 39976 | 499 | 37311 |
| 14-#18 | 4.68 | MA | 17212 | 5207 | 30688 | 4077 | 36545 | 3253 | 39982 | 2577 | 44448 | 1411 | 57798 | 227 | 56167 |
| 7L-2S | | MI | 13559 | 5207 | 24128 | 3888 | 28275 | 3038 | 31199 | 2326 | 35999 | 1127 | 44424 | 732 | 38137 |
| 16-#11 | 2.09 | MA | 18465 | 4079 | 27935 | 3369 | 33532 | 2728 | 36518 | 2227 | 39980 | 1465 | 50299 | 1186 | 34208 |
| 4L-6S | | MI | 9249 | 4079 | 14858 | 3229 | 17127 | 2604 | 18054 | 2105 | 18786 | 1344 | 22834 | 875 | 17242 |
| 16-#11 | 2.09 | MA | 17760 | 4079 | 26858 | 3381 | 32240 | 2729 | 34940 | 2237 | 37832 | 1473 | 47518 | 1138 | 33293 |
| 5E | | MI | 9608 | 4079 | 15358 | 3232 | 17789 | 2599 | 18836 | 2110 | 19790 | 1339 | 24055 | 937 | 17540 |
| 16-#11 | 2.09 | MA | 17086 | 4079 | 25902 | 3382 | 30964 | 2739 | 33388 | 2236 | 35766 | 1480 | 44684 | 1063 | 32418 |
| 6L-4S | | MI | 9982 | 4079 | 15918 | 3225 | 18458 | 2604 | 19631 | 2105 | 20869 | 1344 | 25365 | 981 | 18023 |
| 16-#11 | 2.09 | MA | 16425 | 4079 | 24972 | 3383 | 29733 | 2740 | 31883 | 2245 | 33673 | 1476 | 42159 | 993 | 31328 |
| 7L-3S | | MI | 10391 | 4079 | 16469 | 3228 | 19199 | 2599 | 20506 | 2110 | 21978 | 1339 | 26601 | 1067 | 18089 |
| 16-#11 | 2.09 | MA | 15771 | 4079 | 24056 | 3385 | 28526 | 2740 | 30375 | 2244 | 31653 | 1483 | 39561 | 938 | 30204 |
| 8L-2S | | MI | 10941 | 4079 | 17199 | 3231 | 20122 | 2604 | 21602 | 2105 | 23420 | 1334 | 28479 | 1158 | 18114 |
| 16-#14 | 3.01 | MA | 18991 | 4480 | 30366 | 3627 | 36600 | 2908 | 40182 | 2352 | 44871 | 1452 | 57193 | 982 | 46161 |
| 5E | | MI | 10112 | 4480 | 17113 | 3464 | 19880 | 2758 | 21292 | 2198 | 23006 | 1277 | 28294 | 708 | 24010 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis

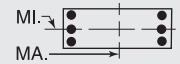



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.01 | MA | 18058 | 4480 | 28994 | 3629 | 34771 | 2923 | 37955 | 2351 | 41908 | 1461 | 53158 | 874 | 44446 |
| 6L-4S | | MI | 10629 | 4480 | 17912 | 3455 | 20824 | 2765 | 22413 | 2191 | 24530 | 1285 | 30135 | 771 | 24665 |
| 16-#14 | 3.01 | MA | 17145 | 4480 | 27659 | 3631 | 33003 | 2923 | 35795 | 2364 | 38904 | 1455 | 49565 | 772 | 42475 |
| 7L-3S | | MI | 11196 | 4480 | 18698 | 3460 | 21870 | 2758 | 23649 | 2198 | 26095 | 1277 | 31874 | 893 | 25375 |
| 16-#14 | 3.01 | MA | 16241 | 4480 | 26345 | 3632 | 31272 | 2923 | 33632 | 2362 | 36006 | 1465 | 45859 | 694 | 40001 |
| 8L-2S | | MI | 11958 | 4480 | 19736 | 3466 | 23172 | 2765 | 25194 | 2191 | 28129 | 1270 | 34514 | 1025 | 25481 |
| 16-#18 | 5.35 | MA | 20379 | 5498 | 36650 | 4257 | 44235 | 3388 | 49330 | 2641 | 57218 | 1411 | 74027 | 373 | 71882 |
| 6L-4S | | MI | 12131 | 5498 | 22763 | 4044 | 26497 | 3165 | 29097 | 2397 | 33338 | 1114 | 41481 | 199 | 40157 |
| 16-#18 | 5.35 | MA | 18889 | 5498 | 34299 | 4259 | 41125 | 3386 | 45530 | 2662 | 51935 | 1398 | 67811 | 191 | 66432 |
| 7L-3S | | MI | 13033 | 5498 | 24128 | 4057 | 28275 | 3151 | 31199 | 2410 | 35999 | 1101 | 44424 | 409 | 42171 |
| 16-#18 | 5.35 | MA | 17413 | 5498 | 31986 | 4260 | 38077 | 3384 | 41724 | 2656 | 46836 | 1412 | 61367 | 56 | 61010 |
| 8L-2S | | MI | 14238 | 5498 | 25922 | 4070 | 30487 | 3165 | 33827 | 2397 | 39457 | 1087 | 48873 | 643 | 43374 |
| 18-#11 | 2.35 | MA | 18452 | 4192 | 28297 | 3451 | 34064 | 2781 | 37150 | 2269 | 40814 | 1467 | 51575 | 1128 | 37420 |
| 5L-6S | | MI | 9580 | 4192 | 15588 | 3299 | 18050 | 2656 | 19149 | 2135 | 20227 | 1332 | 24712 | 847 | 19323 |
| 18-#11 | 2.35 | MA | 17786 | 4192 | 27341 | 3453 | 32789 | 2791 | 35598 | 2269 | 38748 | 1474 | 48742 | 1053 | 36572 |
| 6L-5S | | MI | 9936 | 4192 | 16087 | 3303 | 18711 | 2651 | 19932 | 2140 | 21231 | 1327 | 25934 | 909 | 19608 |
| 18-#11 | 2.35 | MA | 17133 | 4192 | 26410 | 3454 | 31557 | 2791 | 34093 | 2278 | 36655 | 1471 | 46217 | 982 | 35437 |
| 7L-4S | | MI | 10306 | 4192 | 16647 | 3296 | 19380 | 2656 | 20726 | 2135 | 22311 | 1332 | 27244 | 952 | 20154 |
| 18-#11 | 2.35 | MA | 16488 | 4192 | 25495 | 3456 | 30351 | 2792 | 32585 | 2277 | 34635 | 1478 | 43618 | 928 | 34339 |
| 8L-3S | | MI | 10711 | 4192 | 17199 | 3299 | 20122 | 2651 | 21602 | 2140 | 23420 | 1327 | 28479 | 1039 | 20235 |
| 18-#11 | 2.35 | MA | 15847 | 4192 | 24483 | 3468 | 29107 | 2802 | 31102 | 2287 | 32635 | 1485 | 41044 | 869 | 32834 |
| 9L-2S | | MI | 11257 | 4192 | 17928 | 3302 | 21044 | 2656 | 22697 | 2135 | 24861 | 1322 | 30358 | 1130 | 20273 |
| 18-#14 | 3.39 | MA | 19027 | 4644 | 31055 | 3731 | 37384 | 2998 | 41120 | 2398 | 46179 | 1454 | 58937 | 857 | 50306 |
| 6L-5S | | MI | 10562 | 4644 | 18151 | 3566 | 21181 | 2831 | 22838 | 2241 | 25040 | 1258 | 30933 | 664 | 26951 |
| 18-#14 | 3.39 | MA | 18128 | 4644 | 29719 | 3733 | 35616 | 2997 | 38961 | 2411 | 43175 | 1448 | 55344 | 755 | 48386 |
| 7L-4S | | MI | 11073 | 4644 | 18950 | 3557 | 22126 | 2839 | 23958 | 2233 | 26564 | 1266 | 32774 | 727 | 27568 |
| 18-#14 | 3.39 | MA | 17239 | 4644 | 28405 | 3735 | 33885 | 2997 | 36798 | 2409 | 40277 | 1457 | 51637 | 677 | 45879 |
| 8L-3S | | MI | 11634 | 4644 | 19736 | 3563 | 23172 | 2831 | 25194 | 2241 | 28129 | 1258 | 34514 | 849 | 28403 |
| 18-#14 | 3.39 | MA | 16354 | 4644 | 26954 | 3751 | 32100 | 3012 | 34669 | 2422 | 37407 | 1467 | 47973 | 593 | 43389 |
| 9L-2S | | MI | 12387 | 4644 | 20774 | 3568 | 24473 | 2839 | 26740 | 2233 | 30163 | 1251 | 37153 | 981 | 28532 |
| 18-#18 | 6.02 | MA | 20529 | 5789 | 37911 | 4441 | 45705 | 3519 | 51079 | 2746 | 59421 | 1385 | 77824 | 155 | 76712 |
| 7L-4S | | MI | 12842 | 5789 | 24557 | 4225 | 28709 | 3291 | 31725 | 2468 | 36797 | 1074 | 45929 | 110 | 45191 |
| 18-#18 | 6.02 | MA | 19084 | 5789 | 35597 | 4442 | 42657 | 3517 | 47273 | 2740 | 54322 | 1398 | 71380 | 20 | 71250 |
| 8L-3S | | MI | 13726 | 5789 | 25922 | 4238 | 30487 | 3278 | 33827 | 2482 | 39457 | 1061 | 48873 | 320 | 47066 |
| 20-#11 | 2.61 | MA | 18475 | 4306 | 28779 | 3524 | 34613 | 2843 | 37808 | 2301 | 41730 | 1469 | 52799 | 1042 | 40729 |
| 6E | | MI | 9907 | 4306 | 16318 | 3370 | 18972 | 2708 | 20245 | 2165 | 21669 | 1320 | 26591 | 819 | 21378 |
| 20-#11 | 2.61 | MA | 17831 | 4306 | 27849 | 3525 | 33382 | 2843 | 36303 | 2311 | 39637 | 1466 | 50274 | 971 | 39552 |
| 7L-5S | | MI | 10259 | 4306 | 16817 | 3374 | 19634 | 2702 | 21027 | 2171 | 22673 | 1315 | 27812 | 881 | 21681 |
| 20-#11 | 2.61 | MA | 17193 | 4306 | 26933 | 3527 | 32175 | 2844 | 34796 | 2310 | 37617 | 1473 | 47676 | 917 | 38479 |
| 8L-4S | | MI | 10626 | 4306 | 17377 | 3366 | 20303 | 2708 | 21822 | 2165 | 23752 | 1320 | 29122 | 924 | 22213 |
| 20-#11 | 2.61 | MA | 16560 | 4306 | 25922 | 3539 | 30931 | 2854 | 33312 | 2319 | 35617 | 1480 | 45101 | 858 | 36950 |
| 9L-3S | | MI | 11028 | 4306 | 17928 | 3370 | 21044 | 2702 | 22697 | 2171 | 24861 | 1315 | 30358 | 1011 | 22377 |
| 20-#11 | 2.61 | MA | 15921 | 4306 | 25010 | 3540 | 29733 | 2855 | 31822 | 2318 | 33561 | 1477 | 42440 | 778 | 35463 |
| 10L-2S | | MI | 11569 | 4306 | 18658 | 3373 | 21967 | 2708 | 23793 | 2165 | 26303 | 1310 | 32236 | 1102 | 22427 |
| 20-#14 | 3.76 | MA | 19095 | 4807 | 31780 | 3835 | 38229 | 3072 | 42126 | 2458 | 47446 | 1441 | 61122 | 738 | 54304 |
| 7L-5S | | MI | 11007 | 4807 | 19189 | 3669 | 22483 | 2904 | 24384 | 2283 | 27074 | 1239 | 33573 | 620 | 29897 |
| 20-#14 | 3.76 | MA | 18219 | 4807 | 30466 | 3837 | 36498 | 3072 | 39963 | 2456 | 44548 | 1450 | 57416 | 660 | 51764 |
| 8L-4S | | MI | 11512 | 4807 | 19988 | 3659 | 23427 | 2912 | 25504 | 2276 | 28598 | 1247 | 35414 | 683 | 30481 |
| 20-#14 | 3.76 | MA | 17348 | 4807 | 29014 | 3854 | 34713 | 3087 | 37835 | 2469 | 41678 | 1459 | 53751 | 576 | 49251 |
| 9L-3S | | MI | 12066 | 4807 | 20774 | 3665 | 24473 | 2904 | 26740 | 2283 | 30163 | 1239 | 37153 | 806 | 31426 |
| 20-#14 | 3.76 | MA | 16459 | 4807 | 27705 | 3855 | 32994 | 3087 | 35697 | 2467 | 38728 | 1454 | 49963 | 460 | 46677 |
| 10L-2S | | MI | 12813 | 4807 | 21812 | 3670 | 25775 | 2912 | 28286 | 2276 | 32197 | 1232 | 39793 | 937 | 31579 |
| 20-#18 | 6.69 | MA | 20723 | 6080 | 39208 | 4624 | 47238 | 3650 | 52822 | 2824 | 61809 | 1385 | 81393 | -16 | 81224 |
| 8L-4S | | MI | 13543 | 6080 | 26351 | 4407 | 30921 | 3418 | 34352 | 2540 | 40255 | 1035 | 50377 | 20 | 50239 |
| 22-#11 | 2.87 | MA | 18519 | 4419 | 29287 | 3596 | 35206 | 2895 | 38513 | 2344 | 42619 | 1461 | 54332 | 961 | 43673 |
| 7L-6S | | MI | 10230 | 4419 | 17047 | 3441 | 19895 | 2759 | 21340 | 2196 | 23110 | 1308 | 28469 | 791 | 23401 |
| 22-#11 | 2.87 | MA | 17889 | 4419 | 28372 | 3598 | 33999 | 2895 | 37006 | 2343 | 40599 | 1468 | 51734 | 906 | 42602 |
| 8L-5S | | MI | 10579 | 4419 | 17547 | 3444 | 20556 | 2754 | 22123 | 2201 | 24114 | 1303 | 29691 | 853 | 23758 |

## RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.87 | MA | 17263 | 4419 | 27360 | 3609 | 32756 | 2906 | 35523 | 2352 | 38599 | 1475 | 49159 | 848 | 41071 |
| 9L-4S | | MI | 10943 | 4419 | 18107 | 3437 | 21225 | 2759 | 22917 | 2196 | 25194 | 1308 | 31001 | 896 | 24263 |
| 22-#11 | 2.87 | MA | 16627 | 4419 | 26448 | 3611 | 31558 | 2906 | 34033 | 2351 | 36543 | 1472 | 46498 | 768 | 39567 |
| 10L-3S | | MI | 11341 | 4419 | 18658 | 3441 | 21967 | 2754 | 23793 | 2201 | 26303 | 1303 | 32236 | 983 | 24516 |
| 22-#11 | 2.87 | MA | 15958 | 4419 | 25543 | 3612 | 30328 | 2917 | 32559 | 2361 | 34551 | 1479 | 43944 | 710 | 38042 |
| 11L-2S | | MI | 11878 | 4419 | 19388 | 3444 | 22889 | 2759 | 24888 | 2196 | 27745 | 1298 | 34115 | 1074 | 24578 |
| 22-#14 | 4.14 | MA | 19183 | 4971 | 32526 | 3939 | 39110 | 3147 | 43129 | 2504 | 48819 | 1442 | 63195 | 643 | 57656 |
| 8L-5S | | MI | 11446 | 4971 | 20227 | 3771 | 23785 | 2978 | 25929 | 2326 | 29108 | 1220 | 36212 | 577 | 32826 |
| 22-#14 | 4.14 | MA | 18325 | 4971 | 31074 | 3956 | 37326 | 3162 | 41000 | 2517 | 45949 | 1452 | 59530 | 559 | 55119 |
| 9L-4S | | MI | 11946 | 4971 | 21026 | 3761 | 24729 | 2985 | 27050 | 2318 | 30632 | 1228 | 38053 | 639 | 33404 |
| 22-#14 | 4.14 | MA | 17440 | 4971 | 29765 | 3957 | 35606 | 3162 | 38862 | 2515 | 42998 | 1446 | 55741 | 443 | 52529 |
| 10L-3S | | MI | 12495 | 4971 | 21812 | 3767 | 25775 | 2978 | 28286 | 2326 | 32197 | 1220 | 39793 | 762 | 34446 |
| 24-#11 | 3.13 | MA | 18575 | 4533 | 29810 | 3668 | 35824 | 2947 | 39216 | 2376 | 43581 | 1463 | 55791 | 896 | 46700 |
| 8L-6S | | MI | 10550 | 4533 | 17777 | 3512 | 20817 | 2811 | 22436 | 2226 | 24552 | 1296 | 30348 | 763 | 25430 |
| 24-#11 | 3.13 | MA | 17957 | 4533 | 28799 | 3680 | 34580 | 2958 | 37733 | 2385 | 41581 | 1470 | 53217 | 837 | 45196 |
| 9L-5S | | MI | 10896 | 4533 | 18276 | 3515 | 21479 | 2806 | 23218 | 2231 | 25556 | 1291 | 31569 | 825 | 25838 |
| 24-#11 | 3.13 | MA | 17323 | 4533 | 27887 | 3682 | 33382 | 2958 | 36243 | 2384 | 39525 | 1467 | 50556 | 757 | 43674 |
| 10L-4S | | MI | 11256 | 4533 | 18836 | 3508 | 22148 | 2811 | 24013 | 2226 | 26635 | 1296 | 32879 | 868 | 26319 |
| 24-#11 | 3.13 | MA | 16661 | 4533 | 26981 | 3683 | 32153 | 2969 | 34769 | 2394 | 37533 | 1474 | 48002 | 700 | 42138 |
| 11L-3S | | MI | 11651 | 4533 | 19388 | 3511 | 22889 | 2806 | 24888 | 2231 | 27745 | 1291 | 34115 | 955 | 26652 |
| 24-#11 | 3.13 | MA | 16008 | 4533 | 26081 | 3685 | 30958 | 2969 | 33287 | 2393 | 35551 | 1481 | 45448 | 642 | 40445 |
| 12L-2S | | MI | 12184 | 4533 | 20117 | 3515 | 23812 | 2811 | 25984 | 2226 | 29186 | 1286 | 35993 | 1046 | 26725 |
| 24-#14 | 4.52 | MA | 19287 | 5135 | 33135 | 4058 | 39939 | 3237 | 44166 | 2564 | 50220 | 1444 | 65309 | 542 | 60993 |
| 9L-5S | | MI | 11913 | 5135 | 21265 | 3873 | 25086 | 3051 | 27475 | 2368 | 31143 | 1201 | 38852 | 533 | 35677 |
| 24-#14 | 4.52 | MA | 18406 | 5135 | 31825 | 4060 | 38219 | 3237 | 42028 | 2562 | 47269 | 1439 | 61520 | 426 | 58387 |
| 10L-4S | | MI | 12397 | 5135 | 22064 | 3864 | 26030 | 3059 | 28596 | 2361 | 32666 | 1209 | 40693 | 595 | 36334 |

## RECTANGULAR TIED COLUMNS 26" x 48"

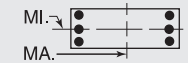
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.28 | MA | 19740 | 3891 | 28393 | 3264 | 33858 | 2652 | 36469 | 2195 | 39035 | 1531 | 47790 | 1439 | 23123 |
| 2E | | MI | 10251 | 3891 | 15661 | 3093 | 17771 | 2499 | 18619 | 2050 | 19221 | 1386 | 22762 | 1238 | 11680 |
| 6-#14 | 1.08 | MA | 19243 | 3800 | 27116 | 3226 | 32408 | 2626 | 34786 | 2182 | 36815 | 1545 | 45033 | 1469 | 19759 |
| 2L-3S | | MI | 9262 | 3800 | 14006 | 3064 | 15917 | 2486 | 16478 | 2066 | 16440 | 1434 | 19259 | 1172 | 10133 |
| 6-#14 | 1.08 | MA | 17537 | 3800 | 24954 | 3228 | 29666 | 2626 | 31463 | 2195 | 32332 | 1555 | 38939 | 1337 | 19691 |
| 3L-2S | | MI | 10073 | 3800 | 15044 | 3070 | 17219 | 2493 | 18023 | 2059 | 18474 | 1427 | 21899 | 1303 | 10084 |
| 6-#18 | 1.92 | MA | 21534 | 4182 | 32186 | 3446 | 38669 | 2785 | 42297 | 2280 | 46898 | 1518 | 58364 | 1406 | 34351 |
| 2L-3S | | MI | 9667 | 4182 | 15661 | 3262 | 17771 | 2612 | 18619 | 2134 | 19221 | 1360 | 22762 | 915 | 17000 |
| 6-#18 | 1.92 | MA | 18650 | 4182 | 28393 | 3448 | 33858 | 2784 | 36469 | 2302 | 39035 | 1533 | 47790 | 1172 | 33862 |
| 3L-2S | | MI | 11029 | 4182 | 17455 | 3275 | 19983 | 2625 | 21246 | 2121 | 22679 | 1347 | 27210 | 1149 | 17063 |
| 8-#11 | 1.00 | MA | 19038 | 3763 | 26575 | 3211 | 31808 | 2616 | 34096 | 2177 | 35910 | 1552 | 43911 | 1481 | 18375 |
| 2L-4S | | MI | 9000 | 3763 | 13493 | 3057 | 15322 | 2493 | 15807 | 2064 | 15620 | 1455 | 18436 | 1153 | 9478 |
| 8-#11 | 1.00 | MA | 17842 | 3763 | 25066 | 3213 | 29894 | 2617 | 31777 | 2187 | 32781 | 1559 | 39634 | 1390 | 18349 |
| 3E | | MI | 9427 | 3763 | 14044 | 3060 | 16063 | 2488 | 16682 | 2069 | 16729 | 1450 | 19672 | 1240 | 9454 |
| 8-#11 | 1.00 | MA | 16979 | 3763 | 23949 | 3215 | 28383 | 2628 | 29946 | 2187 | 30310 | 1556 | 36806 | 1299 | 18219 |
| 4L-2S | | MI | 9999 | 3763 | 14774 | 3064 | 16986 | 2493 | 17778 | 2064 | 18171 | 1445 | 21550 | 1331 | 9420 |
| 8-#14 | 1.44 | MA | 20298 | 3964 | 29279 | 3328 | 35151 | 2701 | 38108 | 2229 | 41297 | 1538 | 51128 | 1453 | 26171 |
| 2L-4S | | MI | 9141 | 3964 | 14257 | 3161 | 16173 | 2567 | 16787 | 2101 | 16909 | 1423 | 20159 | 1006 | 13169 |
| 8-#14 | 1.44 | MA | 18620 | 3964 | 27116 | 3330 | 32408 | 2701 | 34786 | 2243 | 36815 | 1548 | 45033 | 1322 | 26048 |
| 3E | | MI | 9739 | 3964 | 15044 | 3167 | 17219 | 2559 | 18023 | 2109 | 18474 | 1415 | 21899 | 1128 | 13228 |
| 8-#14 | 1.44 | MA | 17409 | 3964 | 25514 | 3332 | 30242 | 2716 | 32160 | 2241 | 33270 | 1543 | 41008 | 1190 | 25621 |
| 4L-2S | | MI | 10539 | 3964 | 16082 | 3172 | 18520 | 2567 | 19569 | 2101 | 20508 | 1408 | 24538 | 1260 | 13207 |
| 8-#18 | 2.56 | MA | 23265 | 4473 | 35979 | 3628 | 43480 | 2918 | 48125 | 2364 | 54761 | 1505 | 68937 | 1373 | 45543 |
| 2L-4S | | MI | 9448 | 4473 | 16089 | 3430 | 18205 | 2752 | 19145 | 2192 | 20018 | 1334 | 24267 | 616 | 20452 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

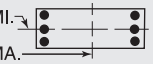



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 2.56 | MA | 20450 | 4473 | 32186 | 3630 | 38669 | 2917 | 42297 | 2386 | 46898 | 1520 | 58364 | 1139 | 44918 |
| 3E | | MI | 10449 | 4473 | 17455 | 3443 | 19983 | 2739 | 21246 | 2205 | 22679 | 1320 | 27210 | 826 | 22225 |
| 8-#18 | 2.56 | MA | 18420 | 4473 | 29369 | 3632 | 34860 | 2942 | 37681 | 2381 | 40668 | 1508 | 51394 | 905 | 41132 |
| 4L-2S | | MI | 11785 | 4473 | 19249 | 3456 | 22195 | 2752 | 23874 | 2192 | 26137 | 1307 | 31658 | 1060 | 22390 |
| 10-#11 | 1.25 | MA | 19785 | 3877 | 28085 | 3282 | 33722 | 2668 | 36415 | 2210 | 39039 | 1547 | 48187 | 1471 | 22854 |
| 2L-5S | | MI | 8958 | 3877 | 13663 | 3135 | 15575 | 2540 | 16108 | 2100 | 15982 | 1438 | 19005 | 1082 | 11476 |
| 10-#11 | 1.25 | MA | 18603 | 3877 | 26575 | 3284 | 31808 | 2669 | 34096 | 2220 | 35910 | 1554 | 43911 | 1380 | 22802 |
| 3L-4S | | MI | 9344 | 3877 | 14223 | 3128 | 16244 | 2545 | 16902 | 2094 | 17061 | 1443 | 20315 | 1125 | 11641 |
| 10-#11 | 1.25 | MA | 17752 | 3877 | 25459 | 3286 | 30297 | 2680 | 32265 | 2220 | 33439 | 1551 | 41083 | 1289 | 22639 |
| 4L-3S | | MI | 9766 | 3877 | 14774 | 3131 | 16986 | 2540 | 17778 | 2100 | 18171 | 1438 | 21550 | 1212 | 11641 |
| 10-#11 | 1.25 | MA | 16982 | 3877 | 24330 | 3298 | 28943 | 2680 | 30612 | 2229 | 31187 | 1559 | 38156 | 1242 | 22088 |
| 5L-2S | | MI | 10333 | 3877 | 15504 | 3134 | 17908 | 2545 | 18873 | 2094 | 19612 | 1433 | 23429 | 1303 | 11617 |
| 10-#14 | 1.80 | MA | 21329 | 4128 | 31441 | 3430 | 37893 | 2775 | 41431 | 2277 | 45780 | 1530 | 57222 | 1437 | 32568 |
| 2L-5S | | MI | 9077 | 4128 | 14496 | 3273 | 16530 | 2632 | 17213 | 2151 | 17419 | 1396 | 20957 | 899 | 15360 |
| 10-#14 | 1.80 | MA | 19676 | 4128 | 29279 | 3432 | 35151 | 2776 | 38108 | 2290 | 41297 | 1540 | 51128 | 1306 | 32397 |
| 3L-4S | | MI | 9616 | 4128 | 15295 | 3263 | 17474 | 2640 | 18333 | 2144 | 18943 | 1404 | 22798 | 962 | 16186 |
| 10-#14 | 1.80 | MA | 18486 | 4128 | 27677 | 3434 | 32984 | 2791 | 35483 | 2289 | 37753 | 1535 | 47102 | 1174 | 31919 |
| 4L-3S | | MI | 10206 | 4128 | 16082 | 3269 | 18520 | 2632 | 19569 | 2151 | 20508 | 1396 | 24538 | 1084 | 16297 |
| 10-#14 | 1.80 | MA | 17410 | 4128 | 26057 | 3451 | 31040 | 2791 | 33110 | 2302 | 34522 | 1546 | 42924 | 1106 | 29965 |
| 5L-2S | | MI | 10997 | 4128 | 17120 | 3274 | 19822 | 2640 | 21115 | 2144 | 22542 | 1389 | 27178 | 1216 | 16309 |
| 10-#18 | 3.21 | MA | 22194 | 4764 | 35979 | 3811 | 43480 | 3050 | 48125 | 2470 | 54761 | 1507 | 68937 | 1105 | 55976 |
| 3L-4S | | MI | 10230 | 4764 | 17883 | 3612 | 20417 | 2878 | 21772 | 2263 | 23476 | 1294 | 28715 | 526 | 25373 |
| 10-#18 | 3.21 | MA | 20214 | 4764 | 33162 | 3814 | 39671 | 3075 | 43509 | 2465 | 48531 | 1495 | 61967 | 872 | 51874 |
| 4L-3S | | MI | 11213 | 4764 | 19249 | 3625 | 22195 | 2865 | 23874 | 2276 | 26137 | 1281 | 31658 | 737 | 27428 |
| 10-#18 | 3.21 | MA | 18423 | 4764 | 30312 | 3842 | 36251 | 3074 | 39335 | 2487 | 42848 | 1510 | 54693 | 754 | 48332 |
| 5L-2S | | MI | 12525 | 4764 | 21043 | 3638 | 24407 | 2878 | 26501 | 2263 | 29595 | 1267 | 36106 | 970 | 27680 |
| 12-#11 | 1.50 | MA | 20519 | 3990 | 29594 | 3353 | 35636 | 2720 | 38734 | 2243 | 42168 | 1541 | 52464 | 1462 | 27324 |
| 2L-6S | | MI | 8933 | 3990 | 13893 | 3203 | 15836 | 2597 | 16421 | 2125 | 16420 | 1431 | 19662 | 992 | 13181 |
| 12-#11 | 1.50 | MA | 19350 | 3990 | 28085 | 3355 | 33722 | 2721 | 36415 | 2253 | 39039 | 1549 | 48187 | 1371 | 27249 |
| 3L-5S | | MI | 9300 | 3990 | 14392 | 3206 | 16498 | 2591 | 17204 | 2130 | 17423 | 1426 | 20883 | 1054 | 13519 |
| 12-#11 | 1.50 | MA | 18510 | 3990 | 26968 | 3357 | 32212 | 2732 | 34585 | 2252 | 36568 | 1546 | 45360 | 1279 | 27058 |
| 4E | | MI | 9682 | 3990 | 14952 | 3199 | 17167 | 2597 | 17998 | 2125 | 18503 | 1431 | 22193 | 1097 | 13792 |
| 12-#11 | 1.50 | MA | 17751 | 3990 | 25839 | 3369 | 30857 | 2732 | 32931 | 2262 | 34316 | 1554 | 42433 | 1232 | 26391 |
| 5L-3S | | MI | 10100 | 3990 | 15504 | 3202 | 17908 | 2591 | 18873 | 2130 | 19612 | 1426 | 23429 | 1184 | 13814 |
| 12-#11 | 1.50 | MA | 17023 | 3990 | 24838 | 3371 | 29521 | 2743 | 31304 | 2262 | 32152 | 1561 | 39446 | 1157 | 25378 |
| 6L-2S | | MI | 10662 | 3990 | 16233 | 3205 | 18831 | 2597 | 19969 | 2125 | 21054 | 1421 | 25307 | 1275 | 13803 |
| 12-#14 | 2.16 | MA | 20709 | 4291 | 31441 | 3534 | 37893 | 2850 | 41431 | 2338 | 45780 | 1533 | 57222 | 1290 | 38741 |
| 3L-5S | | MI | 9550 | 4291 | 15534 | 3375 | 17832 | 2706 | 18758 | 2194 | 19453 | 1377 | 23597 | 855 | 18271 |
| 12-#14 | 2.16 | MA | 19539 | 4291 | 29839 | 3536 | 35727 | 2866 | 38805 | 2336 | 42236 | 1528 | 53197 | 1159 | 38218 |
| 4E | | MI | 10082 | 4291 | 16333 | 3365 | 18776 | 2713 | 19879 | 2186 | 20977 | 1385 | 25438 | 918 | 19038 |
| 12-#14 | 2.16 | MA | 18481 | 4291 | 28219 | 3553 | 33783 | 2866 | 36432 | 2350 | 39005 | 1538 | 49018 | 1091 | 36156 |
| 5L-3S | | MI | 10665 | 4291 | 17120 | 3371 | 19822 | 2706 | 21115 | 2194 | 22542 | 1377 | 27178 | 1041 | 19350 |
| 12-#14 | 2.16 | MA | 17467 | 4291 | 26782 | 3555 | 31865 | 2881 | 34098 | 2348 | 35899 | 1548 | 44762 | 983 | 34633 |
| 6L-2S | | MI | 11447 | 4291 | 18158 | 3377 | 21123 | 2713 | 22661 | 2186 | 24576 | 1370 | 29817 | 1172 | 19394 |
| 12-#18 | 3.85 | MA | 21957 | 5054 | 36955 | 3995 | 44482 | 3208 | 49337 | 2550 | 56394 | 1482 | 72541 | 838 | 62654 |
| 4E | | MI | 11029 | 5054 | 19678 | 3794 | 22629 | 3005 | 24399 | 2334 | 26935 | 1254 | 33163 | 437 | 30333 |
| 12-#18 | 3.85 | MA | 20209 | 5054 | 34105 | 4024 | 41062 | 3207 | 45163 | 2572 | 50711 | 1497 | 65266 | 720 | 59002 |
| 5L-3S | | MI | 11981 | 5054 | 21043 | 3807 | 24407 | 2992 | 26501 | 2348 | 29595 | 1241 | 36106 | 647 | 32618 |
| 12-#18 | 3.85 | MA | 18532 | 5054 | 31574 | 4026 | 37686 | 3232 | 41054 | 2567 | 45246 | 1512 | 57884 | 528 | 54189 |
| 6L-2S | | MI | 13244 | 5054 | 22837 | 3820 | 26619 | 3005 | 29129 | 2334 | 33054 | 1228 | 40554 | 881 | 32947 |
| 14-#11 | 1.75 | MA | 20085 | 4104 | 29594 | 3426 | 35636 | 2772 | 38734 | 2286 | 42168 | 1544 | 52464 | 1361 | 31692 |
| 3L-6S | | MI | 9273 | 4104 | 14622 | 3274 | 16758 | 2648 | 17516 | 2155 | 17861 | 1419 | 21540 | 963 | 15255 |
| 14-#11 | 1.75 | MA | 19255 | 4104 | 28477 | 3428 | 34126 | 2783 | 36904 | 2285 | 39697 | 1541 | 49637 | 1270 | 31475 |
| 4L-5S | | MI | 9637 | 4104 | 15122 | 3277 | 17420 | 2643 | 18299 | 2160 | 18865 | 1414 | 22762 | 1026 | 15573 |
| 14-#11 | 1.75 | MA | 18505 | 4104 | 27348 | 3440 | 32771 | 2784 | 35250 | 2295 | 37445 | 1548 | 46709 | 1222 | 30705 |
| 5L-4S | | MI | 10015 | 4104 | 15682 | 3270 | 18089 | 2648 | 19093 | 2155 | 19944 | 1419 | 24072 | 1069 | 15935 |
| 14-#11 | 1.75 | MA | 17787 | 4104 | 26347 | 3441 | 31435 | 2795 | 33623 | 2295 | 35281 | 1556 | 43722 | 1147 | 29727 |
| 6L-3S | | MI | 10429 | 4104 | 16233 | 3273 | 18831 | 2643 | 19969 | 2160 | 21054 | 1414 | 25307 | 1155 | 15975 |

## RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

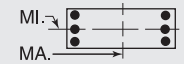
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.75 | MA | 17083 | 4104 | 25373 | 3443 | 30145 | 2796 | 32046 | 2304 | 33087 | 1553 | 41059 | 1076 | 28719 |
| 7L-2S | | MI | 10986 | 4104 | 16963 | 3276 | 19753 | 2648 | 21064 | 2155 | 22495 | 1408 | 27186 | 1247 | 15980 |
| 14-#14 | 2.52 | MA | 20569 | 4455 | 32002 | 3639 | 38469 | 2941 | 42128 | 2384 | 46719 | 1521 | 59291 | 1143 | 44521 |
| 4L-5S | | MI | 10015 | 4455 | 16572 | 3477 | 19133 | 2779 | 20304 | 2236 | 21487 | 1358 | 26237 | 811 | 21195 |
| 14-#14 | 2.52 | MA | 19529 | 4455 | 30382 | 3656 | 36526 | 2941 | 39755 | 2397 | 43488 | 1531 | 55113 | 1075 | 42361 |
| 5L-4S | | MI | 10541 | 4455 | 17371 | 3468 | 20077 | 2787 | 21425 | 2229 | 23011 | 1366 | 28078 | 874 | 21910 |
| 14-#14 | 2.52 | MA | 18532 | 4455 | 28944 | 3658 | 34608 | 2956 | 37420 | 2396 | 40382 | 1541 | 50857 | 967 | 40768 |
| 6L-3S | | MI | 11117 | 4455 | 18158 | 3473 | 21123 | 2779 | 22661 | 2236 | 24576 | 1358 | 29817 | 997 | 22394 |
| 14-#14 | 2.52 | MA | 17555 | 4455 | 27545 | 3660 | 32756 | 2957 | 35157 | 2409 | 37234 | 1536 | 47065 | 865 | 38580 |
| 7L-2S | | MI | 11890 | 4455 | 19196 | 3479 | 22425 | 2787 | 24206 | 2229 | 26611 | 1351 | 32457 | 1128 | 22464 |
| 14-#18 | 4.49 | MA | 21949 | 5345 | 37899 | 4206 | 45872 | 3340 | 50991 | 2656 | 58574 | 1484 | 75840 | 687 | 69700 |
| 5L-4S | | MI | 11773 | 5345 | 21472 | 3976 | 24841 | 3132 | 27027 | 2405 | 30393 | 1215 | 37611 | 347 | 35322 |
| 14-#18 | 4.49 | MA | 20312 | 5345 | 35368 | 4208 | 42497 | 3365 | 46882 | 2651 | 53109 | 1499 | 68457 | 494 | 65026 |
| 6L-3S | | MI | 12702 | 5345 | 22837 | 3989 | 26619 | 3118 | 29129 | 2419 | 33054 | 1201 | 40554 | 558 | 37553 |
| 14-#18 | 4.49 | MA | 18705 | 5345 | 32904 | 4210 | 39237 | 3364 | 42899 | 2673 | 47569 | 1487 | 61888 | 312 | 59484 |
| 7L-2S | | MI | 13939 | 5345 | 24631 | 4002 | 28831 | 3132 | 31756 | 2405 | 36512 | 1188 | 45002 | 791 | 38199 |
| 16-#11 | 2.00 | MA | 19988 | 4217 | 29987 | 3498 | 36040 | 2835 | 39223 | 2318 | 42825 | 1536 | 53914 | 1260 | 35892 |
| 4L-6S | | MI | 9609 | 4217 | 15352 | 3344 | 17681 | 2700 | 18612 | 2186 | 19303 | 1407 | 23419 | 935 | 17333 |
| 16-#11 | 2.00 | MA | 19248 | 4217 | 28858 | 3511 | 34686 | 2836 | 37569 | 2328 | 40574 | 1543 | 50986 | 1212 | 35030 |
| 5E | | MI | 9969 | 4217 | 15852 | 3348 | 18343 | 2695 | 19395 | 2191 | 20306 | 1402 | 24640 | 998 | 17634 |
| 16-#11 | 2.00 | MA | 18538 | 4217 | 27856 | 3512 | 33349 | 2847 | 35942 | 2327 | 38409 | 1551 | 47999 | 1137 | 34083 |
| 6L-4S | | MI | 10344 | 4217 | 16412 | 3341 | 19012 | 2700 | 20189 | 2186 | 21386 | 1407 | 25950 | 1041 | 18073 |
| 16-#11 | 2.00 | MA | 17844 | 4217 | 26882 | 3514 | 32059 | 2847 | 34366 | 2337 | 36216 | 1548 | 45336 | 1067 | 33029 |
| 7L-3S | | MI | 10754 | 4217 | 16963 | 3344 | 19753 | 2695 | 21064 | 2191 | 22495 | 1402 | 27186 | 1127 | 18129 |
| 16-#11 | 2.00 | MA | 17157 | 4217 | 25923 | 3516 | 30795 | 2848 | 32786 | 2337 | 34100 | 1556 | 42601 | 1012 | 31818 |
| 8L-2S | | MI | 11306 | 4217 | 17693 | 3347 | 20676 | 2700 | 22160 | 2186 | 23937 | 1396 | 29064 | 1218 | 18149 |
| 16-#14 | 2.88 | MA | 20556 | 4618 | 32544 | 3758 | 39268 | 3016 | 43078 | 2444 | 47970 | 1523 | 61207 | 1060 | 48578 |
| 5E | | MI | 10473 | 4618 | 17610 | 3579 | 20435 | 2853 | 21850 | 2279 | 23521 | 1339 | 28876 | 768 | 24128 |
| 16-#14 | 2.88 | MA | 19575 | 4618 | 31107 | 3760 | 37350 | 3031 | 40743 | 2443 | 44865 | 1533 | 56951 | 951 | 46916 |
| 6L-4S | | MI | 10993 | 4618 | 18409 | 3570 | 21379 | 2860 | 22970 | 2271 | 25045 | 1347 | 30717 | 830 | 24798 |
| 16-#14 | 2.88 | MA | 18614 | 4618 | 29708 | 3762 | 35498 | 3031 | 38480 | 2457 | 41717 | 1528 | 53159 | 849 | 44782 |
| 7L-3S | | MI | 11562 | 4618 | 19196 | 3575 | 22425 | 2853 | 24206 | 2279 | 26611 | 1339 | 32457 | 953 | 25430 |
| 16-#14 | 2.88 | MA | 17663 | 4618 | 28331 | 3764 | 33684 | 3032 | 36213 | 2455 | 38680 | 1538 | 49256 | 771 | 42287 |
| 8L-2S | | MI | 12327 | 4618 | 20234 | 3581 | 23726 | 2860 | 25752 | 2271 | 28645 | 1332 | 35096 | 1084 | 25525 |
| 16-#18 | 5.13 | MA | 22048 | 5636 | 39161 | 4390 | 47308 | 3498 | 52711 | 2735 | 60972 | 1486 | 79031 | 461 | 75880 |
| 6L-4S | | MI | 12500 | 5636 | 23266 | 4157 | 27053 | 3258 | 29654 | 2477 | 33851 | 1175 | 42059 | 258 | 40335 |
| 16-#18 | 5.13 | MA | 20478 | 5636 | 36697 | 4392 | 44047 | 3497 | 48727 | 2757 | 55432 | 1474 | 72462 | 279 | 70285 |
| 7L-3S | | MI | 13409 | 5636 | 24631 | 4170 | 28831 | 3245 | 31756 | 2490 | 36512 | 1162 | 45002 | 468 | 42408 |
| 16-#18 | 5.13 | MA | 18922 | 5636 | 34272 | 4394 | 40852 | 3496 | 44736 | 2753 | 50086 | 1489 | 65668 | 142 | 64708 |
| 8L-2S | | MI | 14622 | 5636 | 26425 | 4183 | 31043 | 3258 | 34383 | 2477 | 39970 | 1148 | 49450 | 702 | 43439 |
| 18-#11 | 2.25 | MA | 19979 | 4330 | 30367 | 3581 | 36600 | 2888 | 39888 | 2361 | 43702 | 1538 | 55263 | 1202 | 39363 |
| 5L-6S | | MI | 9941 | 4330 | 16082 | 3415 | 18604 | 2751 | 19707 | 2216 | 20744 | 1395 | 25297 | 907 | 19414 |
| 18-#11 | 2.25 | MA | 19278 | 4330 | 29366 | 3583 | 35264 | 2899 | 38261 | 2360 | 41538 | 1546 | 52276 | 1128 | 38444 |
| 6L-5S | | MI | 10298 | 4330 | 16581 | 3419 | 19265 | 2746 | 20490 | 2221 | 21748 | 1389 | 26519 | 970 | 19702 |
| 18-#11 | 2.25 | MA | 18592 | 4330 | 28391 | 3585 | 33973 | 2899 | 36685 | 2370 | 39345 | 1543 | 49613 | 1057 | 37345 |
| 7L-4S | | MI | 10669 | 4330 | 17141 | 3411 | 19934 | 2751 | 21284 | 2216 | 22827 | 1395 | 27829 | 1013 | 20206 |
| 18-#11 | 2.25 | MA | 17914 | 4330 | 27432 | 3587 | 32709 | 2900 | 35105 | 2370 | 37228 | 1550 | 46878 | 1002 | 36161 |
| 8L-3S | | MI | 11076 | 4330 | 17693 | 3415 | 20676 | 2746 | 22160 | 2221 | 23937 | 1389 | 29064 | 1099 | 20278 |
| 18-#11 | 2.25 | MA | 17240 | 4330 | 26373 | 3599 | 31407 | 2911 | 33551 | 2379 | 35133 | 1558 | 44163 | 944 | 34657 |
| 9L-2S | | MI | 11623 | 4330 | 18422 | 3418 | 21598 | 2751 | 23255 | 2216 | 25378 | 1384 | 30943 | 1190 | 20310 |
| 18-#14 | 3.25 | MA | 20600 | 4782 | 33269 | 3862 | 40093 | 3106 | 44066 | 2490 | 49348 | 1526 | 63046 | 936 | 53074 |
| 6L-5S | | MI | 10925 | 4782 | 18648 | 3681 | 21736 | 2926 | 23396 | 2321 | 25556 | 1320 | 31516 | 724 | 27069 |
| 18-#14 | 3.25 | MA | 19653 | 4782 | 31870 | 3864 | 38241 | 3106 | 41803 | 2504 | 46200 | 1521 | 59254 | 834 | 50993 |
| 7L-4S | | MI | 11439 | 4782 | 19447 | 3672 | 22680 | 2933 | 24516 | 2314 | 27079 | 1327 | 33357 | 787 | 27699 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

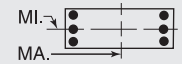


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 3.25 | MA | 18717 | 4782 | 30493 | 3866 | 36427 | 3106 | 39536 | 2503 | 43162 | 1531 | 55350 | 755 | 48465 |
| 8L-3S | | MI | 12002 | 4782 | 20234 | 3678 | 23726 | 2926 | 25752 | 2321 | 28645 | 1320 | 35096 | 909 | 28461 |
| 18-#14 | 3.25 | MA | 17787 | 4782 | 28972 | 3883 | 34557 | 3122 | 37305 | 2516 | 40155 | 1541 | 51484 | 671 | 45946 |
| 9L-2S | | MI | 12758 | 4782 | 21271 | 3683 | 25028 | 2933 | 27298 | 2314 | 30679 | 1313 | 37736 | 1041 | 28580 |
| 18-#18 | 5.77 | MA | 22212 | 5927 | 40490 | 4574 | 48858 | 3630 | 54555 | 2842 | 63295 | 1461 | 83036 | 246 | 81101 |
| 7L-4S | | MI | 13215 | 5927 | 25060 | 4339 | 29265 | 3385 | 32282 | 2548 | 37309 | 1135 | 46507 | 169 | 45366 |
| 18-#18 | 5.77 | MA | 20689 | 5927 | 38065 | 4576 | 45663 | 3629 | 50564 | 2837 | 57949 | 1476 | 76241 | 109 | 75486 |
| 8L-3S | | MI | 14105 | 5927 | 26425 | 4352 | 31043 | 3371 | 34383 | 2561 | 39970 | 1122 | 49450 | 379 | 47298 |
| 20-#11 | 2.50 | MA | 20007 | 4444 | 30875 | 3654 | 37178 | 2951 | 40580 | 2393 | 44667 | 1540 | 56553 | 1118 | 42810 |
| 6E | | MI | 10269 | 4444 | 16812 | 3486 | 19526 | 2803 | 20803 | 2246 | 22186 | 1383 | 27176 | 879 | 21499 |
| 20-#11 | 2.50 | MA | 19329 | 4444 | 29901 | 3656 | 35888 | 2951 | 39004 | 2403 | 42473 | 1538 | 53890 | 1047 | 41667 |
| 7L-5S | | MI | 10622 | 4444 | 17311 | 3489 | 20188 | 2798 | 21586 | 2251 | 23189 | 1377 | 28397 | 941 | 21774 |
| 20-#11 | 2.50 | MA | 18659 | 4444 | 28942 | 3657 | 34624 | 2952 | 37424 | 2402 | 40357 | 1545 | 51155 | 992 | 40509 |
| 8L-4S | | MI | 10990 | 4444 | 17871 | 3482 | 20857 | 2803 | 22380 | 2246 | 24269 | 1383 | 29707 | 985 | 22322 |
| 20-#11 | 2.50 | MA | 17993 | 4444 | 27882 | 3670 | 33321 | 2963 | 35870 | 2412 | 38262 | 1553 | 48440 | 934 | 38981 |
| 9L-3S | | MI | 11393 | 4444 | 18422 | 3486 | 21598 | 2798 | 23255 | 2251 | 25378 | 1377 | 30943 | 1071 | 22422 |
| 20-#11 | 2.50 | MA | 17314 | 4444 | 26927 | 3671 | 32066 | 2963 | 34309 | 2412 | 36107 | 1550 | 45635 | 854 | 37496 |
| 10L-2S | | MI | 11937 | 4444 | 19152 | 3489 | 22521 | 2803 | 24351 | 2246 | 26820 | 1372 | 32821 | 1162 | 22466 |
| 20-#14 | 3.61 | MA | 20675 | 4945 | 34033 | 3966 | 40984 | 3181 | 45125 | 2551 | 50682 | 1513 | 65348 | 818 | 57210 |
| 7L-5S | | MI | 11371 | 4945 | 19686 | 3784 | 23038 | 2999 | 24941 | 2364 | 27590 | 1301 | 34155 | 680 | 30016 |
| 20-#14 | 3.61 | MA | 19753 | 4945 | 32656 | 3968 | 39169 | 3181 | 42858 | 2550 | 47645 | 1524 | 61445 | 740 | 54650 |
| 8L-4S | | MI | 11879 | 4945 | 20485 | 3774 | 23982 | 3007 | 26062 | 2356 | 29114 | 1308 | 35996 | 743 | 30612 |
| 20-#14 | 3.61 | MA | 18837 | 4945 | 31135 | 3985 | 37299 | 3197 | 40628 | 2563 | 44638 | 1534 | 57578 | 655 | 52109 |
| 9L-3S | | MI | 12436 | 4945 | 21271 | 3780 | 25028 | 2999 | 27298 | 2364 | 30679 | 1301 | 37736 | 865 | 31487 |
| 20-#14 | 3.61 | MA | 17890 | 4945 | 29763 | 3988 | 35497 | 3197 | 38387 | 2562 | 41546 | 1529 | 53581 | 540 | 49491 |
| 10L-2S | | MI | 13185 | 4945 | 22309 | 3785 | 26329 | 3007 | 28843 | 2356 | 32713 | 1294 | 40375 | 997 | 31628 |
| 20-#18 | 6.41 | MA | 22420 | 6218 | 41858 | 4758 | 50474 | 3762 | 56392 | 2921 | 65812 | 1463 | 86815 | 76 | 86278 |
| 8L-4S | | MI | 13918 | 6218 | 26854 | 4521 | 31477 | 3511 | 34909 | 2619 | 40768 | 1096 | 50955 | 79 | 50413 |
| 22-#11 | 2.75 | MA | 20056 | 4557 | 31410 | 3727 | 37802 | 3003 | 41323 | 2436 | 45602 | 1533 | 58167 | 1037 | 45994 |
| 7L-6S | | MI | 10593 | 4557 | 17541 | 3557 | 20449 | 2855 | 21898 | 2277 | 23627 | 1370 | 29054 | 851 | 23550 |
| 22-#11 | 2.75 | MA | 19394 | 4557 | 30451 | 3728 | 36538 | 3004 | 39743 | 2435 | 43486 | 1540 | 55431 | 982 | 44860 |
| 8L-5S | | MI | 10943 | 4557 | 18041 | 3560 | 21110 | 2849 | 22681 | 2282 | 24631 | 1365 | 30276 | 913 | 23851 |
| 22-#11 | 2.75 | MA | 18736 | 4557 | 29391 | 3740 | 35235 | 3015 | 38189 | 2445 | 41391 | 1548 | 52717 | 924 | 43310 |
| 9L-4S | | MI | 11308 | 4557 | 18601 | 3553 | 21779 | 2855 | 23475 | 2277 | 25711 | 1370 | 31586 | 956 | 24371 |
| 22-#11 | 2.75 | MA | 18059 | 4557 | 28436 | 3742 | 33980 | 3015 | 36628 | 2444 | 39236 | 1545 | 49911 | 844 | 41807 |
| 10L-3S | | MI | 11708 | 4557 | 19152 | 3556 | 22521 | 2849 | 24351 | 2282 | 26820 | 1365 | 32821 | 1043 | 24563 |
| 22-#11 | 2.75 | MA | 17356 | 4557 | 27488 | 3744 | 32692 | 3026 | 35084 | 2454 | 37150 | 1552 | 47223 | 786 | 40240 |
| 11L-2S | | MI | 12247 | 4557 | 19882 | 3560 | 23443 | 2855 | 25447 | 2277 | 28261 | 1360 | 34700 | 1134 | 24619 |
| 22-#14 | 3.97 | MA | 20772 | 5109 | 34818 | 4071 | 41912 | 3256 | 46181 | 2597 | 52128 | 1516 | 67539 | 724 | 60842 |
| 8L-5S | | MI | 11812 | 5109 | 20724 | 3886 | 24339 | 3073 | 26487 | 2406 | 29624 | 1282 | 36795 | 636 | 32968 |
| 22-#14 | 3.97 | MA | 19869 | 5109 | 33297 | 4088 | 40042 | 3271 | 43951 | 2611 | 49121 | 1526 | 63672 | 640 | 58278 |
| 9L-4S | | MI | 12315 | 5109 | 21523 | 3877 | 25283 | 3080 | 27608 | 2399 | 31148 | 1289 | 38636 | 699 | 33533 |
| 22-#14 | 3.97 | MA | 18927 | 5109 | 31926 | 4090 | 38240 | 3272 | 41710 | 2609 | 46028 | 1521 | 59676 | 524 | 55646 |
| 10L-3S | | MI | 12866 | 5109 | 22309 | 3882 | 26329 | 3073 | 28843 | 2406 | 32713 | 1282 | 40375 | 822 | 34509 |
| 24-#11 | 3.00 | MA | 20119 | 4671 | 31960 | 3799 | 38452 | 3055 | 42062 | 2468 | 46615 | 1535 | 59708 | 973 | 49216 |
| 8L-6S | | MI | 10914 | 4671 | 18271 | 3628 | 21371 | 2906 | 22994 | 2307 | 25069 | 1358 | 30933 | 823 | 25578 |
| 24-#11 | 3.00 | MA | 19468 | 4671 | 30901 | 3811 | 37149 | 3066 | 40509 | 2478 | 44520 | 1542 | 56994 | 914 | 47643 |
| 9L-5S | | MI | 11261 | 4671 | 18770 | 3631 | 22033 | 2901 | 23777 | 2312 | 26072 | 1353 | 32154 | 885 | 25932 |
| 24-#11 | 3.00 | MA | 18794 | 4671 | 29945 | 3813 | 35894 | 3067 | 38947 | 2477 | 42365 | 1540 | 54188 | 834 | 46123 |
| 10L-4S | | MI | 11623 | 4671 | 19330 | 3624 | 22702 | 2906 | 24571 | 2307 | 27152 | 1358 | 33464 | 928 | 26426 |
| 24-#11 | 3.00 | MA | 18098 | 4671 | 28997 | 3815 | 34606 | 3078 | 37403 | 2487 | 40279 | 1547 | 51500 | 777 | 44577 |
| 11L-3S | | MI | 12020 | 4671 | 19882 | 3627 | 23443 | 2901 | 25447 | 2312 | 28261 | 1353 | 34700 | 1015 | 26701 |
| 24-#11 | 3.00 | MA | 17411 | 4671 | 28054 | 3816 | 33355 | 3079 | 35851 | 2487 | 38142 | 1544 | 48807 | 719 | 42756 |
| 12L-2S | | MI | 12555 | 4671 | 20611 | 3631 | 24366 | 2906 | 26542 | 2307 | 29703 | 1348 | 36578 | 1106 | 26767 |
| 24-#14 | 4.33 | MA | 20885 | 5272 | 35460 | 4190 | 42784 | 3346 | 47273 | 2658 | 53604 | 1519 | 69767 | 624 | 64452 |
| 9L-5S | | MI | 12283 | 5272 | 21762 | 3988 | 25641 | 3146 | 28033 | 2449 | 31658 | 1263 | 39434 | 592 | 35884 |
| 24-#14 | 4.33 | MA | 19948 | 5272 | 34088 | 4192 | 40982 | 3346 | 45032 | 2657 | 50511 | 1514 | 65770 | 509 | 61806 |
| 10L-4S | | MI | 12771 | 5272 | 22561 | 3979 | 26585 | 3153 | 29153 | 2441 | 33182 | 1270 | 41275 | 655 | 36462 |

## RECTANGULAR TIED COLUMNS 28" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.19 | MA | 6977 | 2419 | 10351 | 1974 | 12022 | 1604 | 12716 | 1325 | 13218 | 914 | 15832 | 839 | 7591 |
| 2L-3S | | MI | 6354 | 2419 | 9551 | 1971 | 11007 | 1600 | 11501 | 1330 | 11619 | 919 | 13738 | 748 | 7605 |
| 6-#14 | 1.72 | MA | 7424 | 2570 | 11418 | 2058 | 13327 | 1665 | 14219 | 1357 | 15183 | 890 | 18365 | 792 | 10683 |
| 2L-3S | | MI | 6554 | 2570 | 10278 | 2053 | 11881 | 1658 | 12501 | 1364 | 12922 | 898 | 15414 | 660 | 10635 |
| 6-#18 | 3.06 | MA | 8458 | 2952 | 14019 | 2277 | 16419 | 1813 | 17850 | 1434 | 19937 | 825 | 24437 | 658 | 18206 |
| 2L-3S | | MI | 7010 | 2952 | 12043 | 2266 | 13950 | 1800 | 14918 | 1447 | 16078 | 838 | 19439 | 425 | 17659 |
| 8-#11 | 1.59 | MA | 7342 | 2533 | 11152 | 2044 | 13038 | 1656 | 13931 | 1357 | 14816 | 903 | 17927 | 814 | 9983 |
| 2L-4S | | MI | 6273 | 2533 | 9748 | 2040 | 11208 | 1658 | 11745 | 1357 | 11987 | 914 | 14458 | 634 | 9865 |
| 8-#14 | 2.30 | MA | 7924 | 2733 | 12559 | 2160 | 14773 | 1740 | 15937 | 1401 | 17443 | 874 | 21316 | 752 | 14064 |
| 2L-4S | | MI | 6438 | 2733 | 10558 | 2151 | 12166 | 1740 | 12846 | 1401 | 13443 | 888 | 16426 | 495 | 13039 |
| 8-#18 | 4.08 | MA | 9263 | 3242 | 15994 | 2458 | 18888 | 1943 | 20782 | 1509 | 23796 | 790 | 29436 | 578 | 24006 |
| 2L-4S | | MI | 6846 | 3242 | 12521 | 2437 | 14435 | 1943 | 15505 | 1509 | 16968 | 816 | 21140 | 128 | 20342 |
| 10-#11 | 1.99 | MA | 7699 | 2646 | 11952 | 2115 | 14053 | 1708 | 15146 | 1388 | 16415 | 893 | 20022 | 789 | 12361 |
| 2L-5S | | MI | 6238 | 2646 | 9937 | 2118 | 11489 | 1705 | 12079 | 1393 | 12389 | 898 | 15092 | 566 | 11423 |
| 10-#11 | 1.99 | MA | 7093 | 2646 | 11152 | 2113 | 13038 | 1704 | 13931 | 1393 | 14816 | 898 | 17927 | 697 | 12321 |
| 3L-4S | | MI | 6646 | 2646 | 10549 | 2110 | 12224 | 1709 | 12960 | 1388 | 13586 | 903 | 16553 | 609 | 12082 |
| 10-#14 | 2.87 | MA | 8411 | 2897 | 13699 | 2262 | 16219 | 1815 | 17655 | 1445 | 19703 | 857 | 24267 | 713 | 17427 |
| 2L-5S | | MI | 6388 | 2897 | 10824 | 2264 | 12563 | 1807 | 13318 | 1453 | 14011 | 864 | 17318 | 394 | 15316 |
| 10-#14 | 2.87 | MA | 7572 | 2897 | 12559 | 2258 | 14773 | 1807 | 15937 | 1453 | 17443 | 864 | 21316 | 582 | 17280 |
| 3L-4S | | MI | 6952 | 2897 | 11698 | 2254 | 13612 | 1815 | 14564 | 1445 | 15703 | 872 | 19376 | 456 | 16186 |
| 10-#18 | 5.10 | MA | 8693 | 3533 | 15994 | 2630 | 18888 | 2059 | 20782 | 1597 | 23796 | 768 | 29436 | 264 | 28154 |
| 3L-4S | | MI | 7694 | 3533 | 14496 | 2619 | 16904 | 2072 | 18438 | 1584 | 20827 | 781 | 26139 | 48 | 25830 |

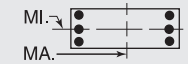
## RECTANGULAR TIED COLUMNS 28" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.07 | MA | 7888 | 2555 | 11591 | 2095 | 13451 | 1705 | 14195 | 1413 | 14650 | 986 | 17500 | 911 | 7880 |
| 2E | | MI | 7329 | 2555 | 10850 | 2081 | 12523 | 1693 | 13149 | 1400 | 13522 | 974 | 16094 | 896 | 7302 |
| 4-#18 | 1.90 | MA | 8684 | 2809 | 13525 | 2234 | 15780 | 1803 | 16879 | 1463 | 18154 | 942 | 22001 | 827 | 13450 |
| 2E | | MI | 8046 | 2809 | 12621 | 2219 | 14594 | 1785 | 15564 | 1446 | 16675 | 926 | 20113 | 803 | 12413 |
| 6-#11 | 1.11 | MA | 7960 | 2568 | 11667 | 2113 | 13600 | 1719 | 14424 | 1425 | 14965 | 993 | 17947 | 919 | 8223 |
| 2L-3S | | MI | 6771 | 2568 | 10118 | 2097 | 11648 | 1703 | 12149 | 1418 | 12221 | 987 | 14420 | 813 | 7640 |
| 6-#11 | 1.11 | MA | 7278 | 2568 | 10796 | 2111 | 12495 | 1715 | 13089 | 1431 | 13209 | 998 | 15635 | 828 | 8237 |
| 3L-2S | | MI | 7396 | 2568 | 10919 | 2099 | 12664 | 1708 | 13364 | 1413 | 13819 | 982 | 16514 | 904 | 7619 |
| 6-#14 | 1.61 | MA | 8457 | 2718 | 12834 | 2197 | 15027 | 1780 | 16086 | 1458 | 17137 | 971 | 20763 | 876 | 11594 |
| 2L-3S | | MI | 6972 | 2718 | 10850 | 2179 | 12523 | 1760 | 13149 | 1451 | 13522 | 965 | 16094 | 725 | 10688 |
| 6-#14 | 1.61 | MA | 7504 | 2718 | 11591 | 2194 | 13451 | 1773 | 14195 | 1466 | 14650 | 978 | 17500 | 744 | 11547 |
| 3L-2S | | MI | 7846 | 2718 | 11990 | 2183 | 13969 | 1768 | 14866 | 1444 | 15783 | 957 | 19045 | 857 | 10718 |
| 6-#18 | 2.86 | MA | 9611 | 3100 | 15682 | 2416 | 18506 | 1936 | 20117 | 1540 | 22415 | 911 | 27553 | 754 | 19826 |
| 2L-3S | | MI | 7430 | 3100 | 12621 | 2390 | 14594 | 1902 | 15564 | 1534 | 16675 | 904 | 20113 | 489 | 17898 |
| 6-#18 | 2.86 | MA | 8023 | 3100 | 13525 | 2407 | 15780 | 1922 | 16879 | 1554 | 18154 | 925 | 22001 | 520 | 19406 |
| 3L-2S | | MI | 8885 | 3100 | 14597 | 2400 | 17063 | 1915 | 18497 | 1521 | 20534 | 891 | 25112 | 723 | 18260 |
| 8-#11 | 1.49 | MA | 8363 | 2681 | 12539 | 2184 | 14706 | 1771 | 15759 | 1458 | 16721 | 983 | 20258 | 896 | 10825 |
| 2L-4S | | MI | 6690 | 2681 | 10316 | 2165 | 11850 | 1761 | 12393 | 1444 | 12589 | 981 | 15140 | 699 | 9928 |
| 8-#11 | 1.49 | MA | 7692 | 2681 | 11667 | 2182 | 13600 | 1767 | 14424 | 1463 | 14965 | 988 | 17947 | 805 | 10811 |
| 3E | | MI | 7146 | 2681 | 10919 | 2168 | 12664 | 1755 | 13364 | 1450 | 13819 | 976 | 16514 | 788 | 10009 |
| 8-#11 | 1.49 | MA | 7197 | 2681 | 11013 | 2180 | 12717 | 1774 | 13358 | 1458 | 13571 | 983 | 16433 | 715 | 10707 |
| 4L-2S | | MI | 7763 | 2681 | 11720 | 2170 | 13679 | 1760 | 14579 | 1444 | 15418 | 971 | 18609 | 879 | 10014 |
| 8-#14 | 2.14 | MA | 9011 | 2882 | 14076 | 2299 | 16602 | 1854 | 17976 | 1504 | 19624 | 956 | 24026 | 840 | 15279 |
| 2L-4S | | MI | 6854 | 2882 | 11129 | 2276 | 12808 | 1843 | 13493 | 1488 | 14043 | 956 | 17105 | 560 | 13236 |
| 8-#14 | 2.14 | MA | 8076 | 2882 | 12834 | 2296 | 15027 | 1848 | 16086 | 1512 | 17137 | 964 | 20763 | 709 | 15178 |
| 3E | | MI | 7490 | 2882 | 11990 | 2281 | 13969 | 1835 | 14866 | 1496 | 15783 | 948 | 19045 | 686 | 14023 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis

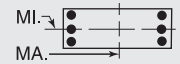



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.14 | MA | 7386 | 2882 | 11899 | 2293 | 13764 | 1857 | 14575 | 1504 | 15223 | 971 | 18624 | 581 | 14318 |
| 4L-2S | | MI | 8348 | 2882 | 13130 | 2285 | 15415 | 1843 | 16584 | 1488 | 18043 | 941 | 21995 | 817 | 14105 |
| 8-#18 | 3.81 | MA | 10507 | 3391 | 17840 | 2598 | 21233 | 2068 | 23355 | 1618 | 26675 | 880 | 33104 | 682 | 26166 |
| 2L-4S | | MI | 7228 | 3391 | 13099 | 2561 | 15079 | 2045 | 16152 | 1595 | 17565 | 883 | 21815 | 192 | 20603 |
| 8-#18 | 3.81 | MA | 8961 | 3391 | 15682 | 2589 | 18506 | 2054 | 20117 | 1631 | 22415 | 893 | 27553 | 448 | 25350 |
| 3E | | MI | 8309 | 3391 | 14597 | 2572 | 17063 | 2031 | 18497 | 1608 | 20534 | 869 | 25112 | 409 | 23222 |
| 8-#18 | 3.81 | MA | 7820 | 3391 | 14052 | 2581 | 16316 | 2068 | 17529 | 1618 | 19136 | 907 | 23901 | 226 | 22366 |
| 4L-2S | | MI | 9702 | 3391 | 16572 | 2582 | 19532 | 2045 | 21429 | 1595 | 24393 | 856 | 30110 | 642 | 24066 |
| 10-#11 | 1.86 | MA | 8758 | 2795 | 13410 | 2255 | 15811 | 1823 | 17094 | 1490 | 18477 | 974 | 22570 | 874 | 13414 |
| 2L-5S | | MI | 6654 | 2795 | 10505 | 2244 | 12131 | 1808 | 12727 | 1481 | 12991 | 966 | 15774 | 632 | 11561 |
| 10-#11 | 1.86 | MA | 8096 | 2795 | 12539 | 2253 | 14706 | 1819 | 15759 | 1496 | 16721 | 979 | 20258 | 783 | 13374 |
| 3L-4S | | MI | 7064 | 2795 | 11117 | 2236 | 12865 | 1813 | 13608 | 1476 | 14188 | 971 | 17235 | 674 | 12242 |
| 10-#11 | 1.86 | MA | 7609 | 2795 | 11884 | 2251 | 13822 | 1826 | 14692 | 1490 | 15327 | 974 | 18745 | 692 | 13238 |
| 4L-3S | | MI | 7514 | 2795 | 11720 | 2239 | 13679 | 1807 | 14579 | 1481 | 15418 | 966 | 18609 | 763 | 12366 |
| 10-#11 | 1.86 | MA | 7165 | 2795 | 11221 | 2260 | 13026 | 1822 | 13725 | 1496 | 14055 | 979 | 17133 | 650 | 12473 |
| 5L-2S | | MI | 8122 | 2795 | 12520 | 2241 | 14694 | 1812 | 15794 | 1476 | 17017 | 960 | 20704 | 854 | 12396 |
| 10-#14 | 2.68 | MA | 9551 | 3046 | 15319 | 2401 | 18178 | 1929 | 19866 | 1550 | 22111 | 941 | 27289 | 805 | 18946 |
| 2L-5S | | MI | 6803 | 3046 | 11396 | 2389 | 13205 | 1910 | 13966 | 1540 | 14611 | 931 | 17998 | 459 | 15573 |
| 10-#14 | 2.68 | MA | 8632 | 3046 | 14076 | 2398 | 16602 | 1923 | 17976 | 1558 | 19624 | 949 | 24026 | 674 | 18799 |
| 3L-4S | | MI | 7371 | 3046 | 12269 | 2379 | 14254 | 1918 | 15211 | 1533 | 16304 | 939 | 20056 | 521 | 16378 |
| 10-#14 | 2.68 | MA | 7956 | 3046 | 13141 | 2395 | 15340 | 1932 | 16465 | 1550 | 17710 | 956 | 21886 | 545 | 17754 |
| 4L-3S | | MI | 7995 | 3046 | 13130 | 2383 | 15415 | 1910 | 16584 | 1540 | 18043 | 931 | 21995 | 647 | 17347 |
| 10-#14 | 2.68 | MA | 7340 | 3046 | 12193 | 2407 | 14201 | 1926 | 15095 | 1558 | 15848 | 949 | 19611 | 484 | 16836 |
| 5L-2S | | MI | 8839 | 3046 | 14270 | 2387 | 16861 | 1918 | 18302 | 1533 | 20303 | 924 | 24946 | 778 | 17472 |
| 10-#18 | 4.76 | MA | 9899 | 3682 | 17840 | 2771 | 21233 | 2187 | 23355 | 1709 | 26675 | 862 | 33104 | 376 | 31139 |
| 3L-4S | | MI | 8115 | 3682 | 15074 | 2743 | 17547 | 2174 | 19084 | 1670 | 21424 | 848 | 26813 | 112 | 26084 |
| 10-#18 | 4.76 | MA | 8804 | 3682 | 16209 | 2763 | 19042 | 2200 | 20767 | 1696 | 23397 | 876 | 29452 | 154 | 28375 |
| 4L-3S | | MI | 9125 | 3682 | 16572 | 2753 | 19532 | 2161 | 21429 | 1683 | 24393 | 834 | 30110 | 329 | 28494 |
| 10-#18 | 4.76 | MA | 7793 | 3682 | 14554 | 2781 | 17064 | 2187 | 18420 | 1709 | 20206 | 862 | 25580 | 43 | 25370 |
| 5L-2S | | MI | 10473 | 3682 | 18548 | 2764 | 22001 | 2174 | 24361 | 1670 | 28252 | 821 | 35109 | 562 | 29849 |
| 12-#11 | 2.23 | MA | 9146 | 2908 | 14282 | 2325 | 16916 | 1874 | 18428 | 1523 | 20233 | 965 | 24881 | 851 | 15991 |
| 2L-6S | | MI | 6639 | 2908 | 10760 | 2313 | 12420 | 1866 | 13074 | 1508 | 13476 | 960 | 16505 | 544 | 13247 |
| 12-#11 | 2.23 | MA | 8492 | 2908 | 13410 | 2324 | 15811 | 1871 | 17094 | 1528 | 18477 | 970 | 22570 | 760 | 15929 |
| 3L-5S | | MI | 7027 | 2908 | 11305 | 2315 | 13146 | 1860 | 13942 | 1513 | 14589 | 955 | 17868 | 607 | 13815 |
| 12-#11 | 2.23 | MA | 8012 | 2908 | 12756 | 2322 | 14927 | 1878 | 16027 | 1523 | 17083 | 965 | 21056 | 670 | 15658 |
| 4E | | MI | 7431 | 2908 | 11917 | 2307 | 13880 | 1865 | 14823 | 1508 | 15786 | 960 | 19329 | 649 | 14453 |
| 12-#11 | 2.23 | MA | 7575 | 2908 | 12092 | 2331 | 14131 | 1874 | 15060 | 1528 | 15811 | 970 | 19444 | 628 | 14932 |
| 5L-3S | | MI | 7874 | 2908 | 12520 | 2310 | 14694 | 1859 | 15794 | 1513 | 17017 | 955 | 20704 | 738 | 14715 |
| 12-#11 | 2.23 | MA | 7155 | 2908 | 11501 | 2329 | 13344 | 1881 | 14106 | 1523 | 14589 | 975 | 17832 | 551 | 14309 |
| 6L-2S | | MI | 8475 | 2908 | 13321 | 2312 | 15710 | 1863 | 17009 | 1508 | 18615 | 950 | 22798 | 829 | 14766 |
| 12-#14 | 3.21 | MA | 10079 | 3209 | 16561 | 2504 | 19754 | 2004 | 21757 | 1596 | 24598 | 927 | 30552 | 770 | 22602 |
| 2L-6S | | MI | 6782 | 3209 | 11757 | 2487 | 13614 | 1993 | 14456 | 1577 | 15297 | 922 | 19029 | 330 | 17411 |
| 12-#14 | 3.21 | MA | 9176 | 3209 | 15319 | 2500 | 18178 | 1998 | 19866 | 1603 | 22111 | 934 | 27289 | 638 | 22415 |
| 3L-5S | | MI | 7318 | 3209 | 12536 | 2492 | 14651 | 1985 | 15684 | 1584 | 16871 | 915 | 20949 | 420 | 18709 |
| 12-#14 | 3.21 | MA | 8512 | 3209 | 14384 | 2497 | 16916 | 2007 | 18356 | 1596 | 20197 | 942 | 25149 | 510 | 21212 |
| 4E | | MI | 7877 | 3209 | 13410 | 2481 | 15700 | 1992 | 16929 | 1577 | 18564 | 922 | 23007 | 482 | 19542 |
| 12-#14 | 3.21 | MA | 7908 | 3209 | 13435 | 2509 | 15777 | 2001 | 16986 | 1603 | 18335 | 934 | 22874 | 449 | 20311 |
| 5L-3S | | MI | 8490 | 3209 | 14270 | 2485 | 16861 | 1985 | 18302 | 1584 | 20303 | 915 | 24946 | 608 | 20663 |
| 12-#14 | 3.21 | MA | 7328 | 3209 | 12590 | 2506 | 14652 | 2009 | 15635 | 1596 | 16603 | 942 | 20749 | 359 | 18845 |
| 6L-2S | | MI | 9320 | 3209 | 15410 | 2490 | 18308 | 1992 | 20020 | 1577 | 22564 | 907 | 27897 | 739 | 20828 |
| 12-#18 | 5.71 | MA | 9713 | 3972 | 18367 | 2944 | 21769 | 2332 | 24005 | 1774 | 27657 | 845 | 35003 | 82 | 34417 |
| 4E | | MI | 8939 | 3972 | 17050 | 2925 | 20016 | 2304 | 22017 | 1745 | 25283 | 813 | 31812 | 32 | 31599 |
| 12-#18 | 5.71 | MA | 8738 | 3972 | 16711 | 2962 | 19791 | 2319 | 21658 | 1787 | 24466 | 831 | 31132 | -29 | 30977 |
| 5L-3S | | MI | 9916 | 3972 | 18548 | 2935 | 22001 | 2291 | 24361 | 1758 | 28252 | 799 | 35109 | 248 | 33823 |
| 14-#11 | 2.60 | MA | 9527 | 3022 | 15153 | 2396 | 18021 | 1926 | 19763 | 1555 | 21989 | 955 | 27193 | 828 | 18563 |
| 2L-7S | | MI | 6635 | 3022 | 11029 | 2381 | 12733 | 1914 | 13447 | 1544 | 13984 | 955 | 17203 | 436 | 14807 |
| 14-#11 | 2.60 | MA | 8881 | 3022 | 14282 | 2395 | 16916 | 1923 | 18428 | 1561 | 20233 | 961 | 24881 | 737 | 18480 |
| 3L-6S | | MI | 7010 | 3022 | 11561 | 2383 | 13435 | 1918 | 14289 | 1539 | 15075 | 950 | 18599 | 519 | 15454 |

## RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

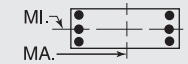
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.60 | MA | 8408 | 3022 | 13627 | 2393 | 16032 | 1929 | 17362 | 1555 | 18839 | 955 | 23368 | 647 | 18086 |
| 4L-5S | | MI | 7392 | 3022 | 12106 | 2386 | 14161 | 1912 | 15157 | 1544 | 16188 | 944 | 19963 | 581 | 16077 |
| 14-#11 | 2.60 | MA | 7977 | 3022 | 12964 | 2401 | 15236 | 1926 | 16394 | 1561 | 17567 | 961 | 21756 | 605 | 17400 |
| 5L-4S | | MI | 7791 | 3022 | 12718 | 2378 | 14896 | 1917 | 16038 | 1539 | 17385 | 950 | 21424 | 624 | 16677 |
| 14-#11 | 2.60 | MA | 7563 | 3022 | 12373 | 2400 | 14449 | 1932 | 15441 | 1555 | 16345 | 966 | 20143 | 529 | 16723 |
| 6L-3S | | MI | 8228 | 3022 | 13321 | 2380 | 15710 | 1911 | 17009 | 1544 | 18615 | 944 | 22798 | 712 | 17059 |
| 14-#11 | 2.60 | MA | 7158 | 3022 | 11797 | 2398 | 13688 | 1929 | 14516 | 1561 | 15104 | 961 | 18714 | 458 | 15990 |
| 7L-2S | | MI | 8822 | 3022 | 14121 | 2383 | 16725 | 1915 | 18224 | 1539 | 20214 | 939 | 24893 | 804 | 17130 |
| 14-#14 | 3.75 | MA | 9709 | 3373 | 16561 | 2603 | 19754 | 2073 | 21757 | 1649 | 24598 | 919 | 30552 | 603 | 26026 |
| 3L-6S | | MI | 7295 | 3373 | 12897 | 2589 | 15060 | 2067 | 16174 | 1621 | 17558 | 905 | 21980 | 291 | 20572 |
| 14-#14 | 3.75 | MA | 9056 | 3373 | 15626 | 2599 | 18491 | 2081 | 20246 | 1642 | 22684 | 927 | 28412 | 475 | 24689 |
| 4L-5S | | MI | 7823 | 3373 | 13676 | 2594 | 16097 | 2060 | 17402 | 1629 | 19132 | 898 | 23899 | 381 | 21808 |
| 14-#14 | 3.75 | MA | 8463 | 3373 | 14678 | 2611 | 17353 | 2075 | 18876 | 1649 | 20822 | 919 | 26137 | 414 | 23706 |
| 5L-4S | | MI | 8372 | 3373 | 14550 | 2583 | 17146 | 2067 | 18647 | 1621 | 20824 | 905 | 25957 | 443 | 22724 |
| 14-#14 | 3.75 | MA | 7893 | 3373 | 13832 | 2608 | 16228 | 2084 | 17525 | 1642 | 19090 | 927 | 24012 | 324 | 22305 |
| 6L-3S | | MI | 8975 | 3373 | 15410 | 2587 | 18308 | 2060 | 20020 | 1629 | 22564 | 898 | 27897 | 568 | 23976 |
| 14-#18 | 6.67 | MA | 9653 | 4263 | 18869 | 3144 | 22518 | 2451 | 24896 | 1865 | 28727 | 800 | 36683 | -101 | 36018 |
| 5L-4S | | MI | 9740 | 4263 | 19026 | 3106 | 22485 | 2433 | 24949 | 1819 | 29142 | 777 | 36810 | -48 | 36420 |
| 16-#11 | 2.97 | MA | 9264 | 3135 | 15153 | 2465 | 18021 | 1975 | 19763 | 1593 | 21989 | 951 | 27193 | 715 | 21027 |
| 3L-7S | | MI | 7004 | 3135 | 11830 | 2452 | 13749 | 1965 | 14662 | 1576 | 15583 | 944 | 19297 | 411 | 17029 |
| 16-#11 | 2.97 | MA | 8797 | 3135 | 14499 | 2464 | 17138 | 1981 | 18697 | 1588 | 20595 | 946 | 25679 | 625 | 20525 |
| 4L-6S | | MI | 7374 | 3135 | 12361 | 2454 | 14451 | 1970 | 15504 | 1571 | 16673 | 939 | 20694 | 494 | 17672 |
| 16-#11 | 2.97 | MA | 8372 | 3135 | 13835 | 2472 | 16341 | 1978 | 17729 | 1593 | 19323 | 951 | 24068 | 582 | 19875 |
| 5E | | MI | 7752 | 3135 | 12907 | 2457 | 15177 | 1964 | 16372 | 1576 | 17787 | 934 | 22058 | 556 | 18347 |
| 16-#11 | 2.97 | MA | 7964 | 3135 | 13244 | 2471 | 15554 | 1984 | 16776 | 1588 | 18100 | 957 | 22455 | 506 | 19146 |
| 6L-4S | | MI | 8145 | 3135 | 13518 | 2449 | 15911 | 1969 | 17253 | 1571 | 18983 | 939 | 23519 | 599 | 18913 |
| 16-#11 | 2.97 | MA | 7565 | 3135 | 12668 | 2469 | 14793 | 1981 | 15851 | 1593 | 16860 | 951 | 21025 | 436 | 18442 |
| 7L-3S | | MI | 8577 | 3135 | 14121 | 2451 | 16725 | 1963 | 18224 | 1576 | 20214 | 934 | 24893 | 687 | 19399 |
| 16-#14 | 4.29 | MA | 9591 | 3536 | 16869 | 2702 | 20067 | 2156 | 22136 | 1688 | 25171 | 912 | 31675 | 440 | 28180 |
| 4L-6S | | MI | 7799 | 3536 | 14037 | 2692 | 16506 | 2142 | 17892 | 1666 | 19818 | 889 | 24931 | 252 | 23746 |
| 16-#14 | 4.29 | MA | 9007 | 3536 | 15920 | 2713 | 18929 | 2150 | 20766 | 1695 | 23309 | 905 | 29400 | 378 | 27118 |
| 5E | | MI | 8318 | 3536 | 14816 | 2696 | 17543 | 2135 | 19119 | 1673 | 21392 | 881 | 26850 | 342 | 24924 |
| 16-#14 | 4.29 | MA | 8447 | 3536 | 15075 | 2710 | 17803 | 2159 | 19416 | 1688 | 21577 | 912 | 27275 | 289 | 25777 |
| 6L-4S | | MI | 8859 | 3536 | 15690 | 2685 | 18592 | 2142 | 20365 | 1666 | 23084 | 889 | 28908 | 404 | 25921 |
| 18-#11 | 3.34 | MA | 9180 | 3248 | 15370 | 2535 | 18243 | 2033 | 20031 | 1620 | 22351 | 937 | 27991 | 602 | 22974 |
| 4L-7S | | MI | 7368 | 3248 | 12630 | 2523 | 14764 | 2017 | 15877 | 1607 | 17181 | 934 | 21392 | 386 | 19221 |
| 18-#11 | 3.34 | MA | 8761 | 3248 | 14707 | 2543 | 17446 | 2029 | 19064 | 1626 | 21079 | 942 | 26379 | 560 | 22356 |
| 5L-6S | | MI | 7733 | 3248 | 13162 | 2525 | 15466 | 2022 | 16719 | 1602 | 18272 | 928 | 22789 | 469 | 19897 |
| 18-#11 | 3.34 | MA | 8358 | 3248 | 14116 | 2541 | 16659 | 2036 | 18111 | 1620 | 19856 | 947 | 24767 | 484 | 21577 |
| 6L-5S | | MI | 8106 | 3248 | 13707 | 2528 | 16192 | 2016 | 17587 | 1607 | 19385 | 923 | 24153 | 531 | 20622 |
| 18-#11 | 3.34 | MA | 7964 | 3248 | 13540 | 2540 | 15898 | 2033 | 17185 | 1626 | 18616 | 942 | 23337 | 413 | 20845 |
| 7L-4S | | MI | 8494 | 3248 | 14319 | 2520 | 16926 | 2020 | 18468 | 1602 | 20582 | 928 | 25613 | 574 | 21158 |
| 18-#14 | 4.82 | MA | 9543 | 3700 | 17162 | 2816 | 20504 | 2225 | 22656 | 1741 | 25796 | 890 | 32663 | 343 | 30545 |
| 5L-6S | | MI | 8336 | 3700 | 15177 | 2794 | 17952 | 2217 | 19610 | 1710 | 22078 | 872 | 27882 | 213 | 26931 |
| 18-#14 | 4.82 | MA | 8992 | 3700 | 16317 | 2812 | 19379 | 2234 | 21306 | 1734 | 24064 | 897 | 30537 | 254 | 29260 |
| 6L-5S | | MI | 8842 | 3700 | 15956 | 2798 | 18989 | 2209 | 20837 | 1717 | 23652 | 865 | 29801 | 302 | 28055 |
| 20-#11 | 3.71 | MA | 9144 | 3362 | 15578 | 2614 | 18552 | 2081 | 20399 | 1658 | 22835 | 933 | 28691 | 537 | 24842 |
| 5L-7S | | MI | 7726 | 3362 | 13431 | 2594 | 15779 | 2069 | 17092 | 1639 | 18780 | 923 | 23487 | 360 | 21421 |
| 20-#11 | 3.71 | MA | 8747 | 3362 | 14987 | 2612 | 17765 | 2088 | 19445 | 1653 | 21612 | 938 | 27078 | 461 | 24016 |
| 6E | | MI | 8087 | 3362 | 13962 | 2596 | 16481 | 2074 | 17934 | 1634 | 19871 | 918 | 24883 | 444 | 22131 |
| 20-#11 | 3.71 | MA | 8358 | 3362 | 14411 | 2611 | 17003 | 2084 | 18520 | 1658 | 20372 | 933 | 25648 | 390 | 23251 |
| 7L-5S | | MI | 8455 | 3362 | 14508 | 2599 | 17207 | 2068 | 18802 | 1639 | 20984 | 913 | 26247 | 506 | 22901 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

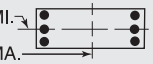
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 5.36 | MA | 9576 | 3863 | 17560 | 2915 | 20955 | 2309 | 23196 | 1779 | 26551 | 883 | 33800 | 218 | 32749 |
| 6E | | MI | 8822 | 3863 | 16317 | 2896 | 19398 | 2292 | 21328 | 1754 | 24339 | 855 | 30832 | 173 | 30048 |
| 22-#11 | 4.09 | MA | 9130 | 3475 | 15859 | 2683 | 18870 | 2140 | 20780 | 1685 | 23368 | 929 | 29390 | 438 | 26462 |
| 6L-7S | | MI | 8080 | 3475 | 14232 | 2665 | 16795 | 2121 | 18307 | 1670 | 20378 | 912 | 25581 | 335 | 23628 |
| 22-#11 | 4.09 | MA | 8746 | 3475 | 15283 | 2681 | 18109 | 2136 | 19855 | 1691 | 22128 | 924 | 27960 | 368 | 25665 |
| 7L-6S | | MI | 8436 | 3475 | 14763 | 2667 | 17497 | 2126 | 19149 | 1665 | 21469 | 907 | 26978 | 419 | 24371 |
| 24-#11 | 4.46 | MA | 9129 | 3589 | 16154 | 2752 | 19214 | 2188 | 21190 | 1723 | 23883 | 914 | 30271 | 345 | 28085 |
| 7E | | MI | 8429 | 3589 | 15032 | 2735 | 17810 | 2173 | 19522 | 1702 | 21977 | 902 | 27676 | 310 | 25842 |

## RECTANGULAR TIED COLUMNS 28" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.00 | MA | 8926 | 2703 | 12974 | 2234 | 15108 | 1819 | 15983 | 1513 | 16468 | 1064 | 19692 | 990 | 8488 |
| 2E | | MI | 7747 | 2703 | 11421 | 2206 | 13165 | 1796 | 13796 | 1487 | 14123 | 1041 | 16773 | 961 | 7330 |
| 4-#18 | 1.79 | MA | 9807 | 2958 | 15076 | 2373 | 17662 | 1920 | 18935 | 1565 | 20321 | 1024 | 24671 | 912 | 14530 |
| 2E | | MI | 8468 | 2958 | 13199 | 2342 | 15238 | 1887 | 16211 | 1532 | 17273 | 993 | 20788 | 867 | 12456 |
| 6-#11 | 1.04 | MA | 9003 | 2716 | 13053 | 2252 | 15266 | 1833 | 16205 | 1524 | 16803 | 1071 | 20167 | 998 | 8855 |
| 2L-3S | | MI | 7188 | 2716 | 10686 | 2223 | 12289 | 1807 | 12797 | 1506 | 12822 | 1054 | 15102 | 878 | 7671 |
| 6-#11 | 1.04 | MA | 8263 | 2716 | 12111 | 2251 | 14071 | 1830 | 14757 | 1529 | 14889 | 1076 | 17638 | 907 | 8869 |
| 3L-2S | | MI | 7815 | 2716 | 11487 | 2225 | 13305 | 1811 | 14012 | 1501 | 14421 | 1049 | 17196 | 970 | 7645 |
| 6-#14 | 1.51 | MA | 9551 | 2867 | 14318 | 2336 | 16814 | 1894 | 18046 | 1560 | 19182 | 1051 | 23268 | 958 | 12505 |
| 2L-3S | | MI | 7389 | 2867 | 11421 | 2304 | 13165 | 1863 | 13796 | 1539 | 14123 | 1032 | 16773 | 790 | 10737 |
| 6-#14 | 1.51 | MA | 8516 | 2867 | 12974 | 2334 | 15108 | 1889 | 15983 | 1567 | 16468 | 1058 | 19692 | 827 | 12458 |
| 3L-2S | | MI | 8267 | 2867 | 12561 | 2308 | 14611 | 1871 | 15514 | 1531 | 16383 | 1025 | 19724 | 922 | 10752 |
| 6-#18 | 2.68 | MA | 10828 | 3249 | 17415 | 2555 | 20628 | 2052 | 22479 | 1646 | 24984 | 996 | 30777 | 847 | 21446 |
| 2L-3S | | MI | 7849 | 3249 | 13199 | 2513 | 15238 | 2003 | 16211 | 1620 | 17273 | 971 | 20788 | 553 | 18001 |
| 6-#18 | 2.68 | MA | 9098 | 3249 | 15076 | 2549 | 17662 | 2041 | 18935 | 1659 | 20321 | 1010 | 24671 | 613 | 21026 |
| 3L-2S | | MI | 9312 | 3249 | 15175 | 2524 | 17707 | 2017 | 19143 | 1607 | 21131 | 958 | 25786 | 787 | 18312 |
| 8-#11 | 1.39 | MA | 9445 | 2830 | 13995 | 2323 | 16461 | 1885 | 17653 | 1557 | 18716 | 1063 | 22696 | 977 | 11668 |
| 2L-4S | | MI | 7107 | 2830 | 10884 | 2291 | 12491 | 1865 | 13041 | 1532 | 13191 | 1049 | 15822 | 765 | 9986 |
| 8-#11 | 1.39 | MA | 8716 | 2830 | 13053 | 2322 | 15266 | 1882 | 16205 | 1562 | 16803 | 1068 | 20167 | 886 | 11653 |
| 3E | | MI | 7565 | 2830 | 11487 | 2294 | 13305 | 1859 | 14012 | 1538 | 14421 | 1044 | 17196 | 853 | 10048 |
| 8-#11 | 1.39 | MA | 8181 | 2830 | 12347 | 2321 | 14313 | 1890 | 15050 | 1558 | 15284 | 1063 | 18511 | 795 | 11550 |
| 4L-2S | | MI | 8184 | 2830 | 12287 | 2296 | 14320 | 1863 | 15227 | 1532 | 16020 | 1038 | 19291 | 944 | 10044 |
| 8-#14 | 2.01 | MA | 10159 | 3030 | 15663 | 2438 | 18519 | 1969 | 20109 | 1607 | 21896 | 1038 | 26844 | 926 | 16494 |
| 2L-4S | | MI | 7271 | 3030 | 11701 | 2402 | 13450 | 1946 | 14141 | 1576 | 14643 | 1023 | 17785 | 625 | 13426 |
| 8-#14 | 2.01 | MA | 9142 | 3030 | 14318 | 2436 | 16814 | 1964 | 18046 | 1614 | 19182 | 1045 | 23268 | 795 | 16393 |
| 3E | | MI | 7910 | 3030 | 12561 | 2406 | 14611 | 1938 | 15514 | 1583 | 16383 | 1015 | 19724 | 751 | 14079 |
| 8-#14 | 2.01 | MA | 8396 | 3030 | 13309 | 2434 | 15451 | 1974 | 16398 | 1607 | 17027 | 1038 | 20927 | 664 | 15617 |
| 4L-2S | | MI | 8772 | 3030 | 13701 | 2410 | 16057 | 1946 | 17232 | 1576 | 18643 | 1008 | 22675 | 882 | 14144 |
| 8-#18 | 3.57 | MA | 11814 | 3539 | 19755 | 2737 | 23595 | 2185 | 26023 | 1726 | 29648 | 969 | 36882 | 781 | 28326 |
| 2L-4S | | MI | 7643 | 3539 | 13677 | 2685 | 15722 | 2146 | 16799 | 1682 | 18162 | 949 | 22489 | 257 | 20856 |
| 8-#18 | 3.57 | MA | 10129 | 3539 | 17415 | 2730 | 20628 | 2174 | 22479 | 1739 | 24984 | 982 | 30777 | 547 | 27772 |
| 3E | | MI | 8703 | 3539 | 15175 | 2695 | 17707 | 2133 | 19143 | 1695 | 21131 | 936 | 25786 | 473 | 23564 |
| 8-#18 | 3.57 | MA | 8890 | 3539 | 15653 | 2724 | 18249 | 2188 | 19646 | 1726 | 21395 | 995 | 26769 | 321 | 24417 |
| 4L-2S | | MI | 10131 | 3539 | 17150 | 2706 | 20176 | 2146 | 22076 | 1682 | 24990 | 923 | 30785 | 707 | 24125 |
| 10-#11 | 1.74 | MA | 9879 | 2943 | 14938 | 2394 | 17657 | 1937 | 19101 | 1589 | 20630 | 1054 | 25224 | 957 | 14467 |
| 2L-5S | | MI | 7070 | 2943 | 11073 | 2370 | 12772 | 1912 | 13375 | 1569 | 13592 | 1033 | 16456 | 697 | 11693 |
| 10-#11 | 1.74 | MA | 9159 | 2943 | 13995 | 2393 | 16461 | 1934 | 17653 | 1595 | 18716 | 1060 | 22696 | 866 | 14427 |
| 3L-4S | | MI | 7482 | 2943 | 11685 | 2362 | 13506 | 1916 | 14256 | 1564 | 14789 | 1038 | 17917 | 740 | 12317 |
| 10-#11 | 1.74 | MA | 8632 | 2943 | 13290 | 2391 | 15508 | 1942 | 16498 | 1590 | 17197 | 1054 | 21040 | 775 | 14291 |
| 4L-3S | | MI | 7934 | 2943 | 12287 | 2364 | 14320 | 1911 | 15227 | 1569 | 16020 | 1033 | 19291 | 828 | 12409 |
| 10-#11 | 1.74 | MA | 8152 | 2943 | 12574 | 2401 | 14649 | 1939 | 15450 | 1596 | 15811 | 1060 | 19279 | 732 | 13534 |
| 5L-2S | | MI | 8545 | 2943 | 13088 | 2367 | 15335 | 1915 | 16442 | 1564 | 17618 | 1028 | 21386 | 919 | 12431 |
| 10-#14 | 2.51 | MA | 10752 | 3194 | 17008 | 2541 | 20224 | 2044 | 22172 | 1654 | 24610 | 1025 | 30419 | 894 | 20465 |
| 2L-5S | | MI | 7218 | 3194 | 11967 | 2514 | 13847 | 2013 | 14613 | 1628 | 15211 | 999 | 18677 | 524 | 15742 |

## RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis



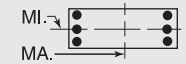

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.51 | MA | 9753 | 3194 | 15663 | 2538 | 18519 | 2039 | 20109 | 1661 | 21896 | 1032 | 26844 | 763 | 20318 |
| 3L-4S | | MI | 7790 | 3194 | 12841 | 2504 | 14896 | 2021 | 15859 | 1620 | 16904 | 1006 | 20735 | 586 | 16564 |
| 10-#14 | 2.51 | MA | 9020 | 3194 | 14654 | 2536 | 17156 | 2049 | 18461 | 1654 | 19741 | 1025 | 24503 | 632 | 19343 |
| 4L-3S | | MI | 8418 | 3194 | 13701 | 2508 | 16057 | 2013 | 17232 | 1628 | 18643 | 999 | 22675 | 712 | 17409 |
| 10-#14 | 2.51 | MA | 8354 | 3194 | 13631 | 2549 | 15928 | 2044 | 16965 | 1661 | 17776 | 1032 | 22010 | 572 | 18287 |
| 5L-2S | | MI | 9266 | 3194 | 14841 | 2512 | 17504 | 2020 | 18950 | 1620 | 20904 | 991 | 25625 | 843 | 17516 |
| 10-#18 | 4.46 | MA | 11129 | 3830 | 19755 | 2912 | 23595 | 2307 | 26023 | 1820 | 29648 | 954 | 36882 | 482 | 34179 |
| 3L-4S | | MI | 8535 | 3830 | 15652 | 2866 | 18191 | 2276 | 19731 | 1756 | 22021 | 914 | 27488 | 176 | 26331 |
| 10-#18 | 4.46 | MA | 9922 | 3830 | 17992 | 2905 | 21216 | 2321 | 23191 | 1806 | 26058 | 967 | 32875 | 256 | 30947 |
| 4L-3S | | MI | 9555 | 3830 | 17150 | 2877 | 20176 | 2263 | 22076 | 1770 | 24990 | 901 | 30785 | 393 | 28826 |
| 10-#18 | 4.46 | MA | 8826 | 3830 | 16203 | 2925 | 19069 | 2309 | 20621 | 1820 | 22567 | 954 | 28617 | 146 | 27851 |
| 5L-2S | | MI | 10917 | 3830 | 19126 | 2887 | 22645 | 2276 | 25008 | 1756 | 28849 | 887 | 35783 | 626 | 29914 |
| 12-#11 | 2.09 | MA | 10304 | 3057 | 15880 | 2465 | 18852 | 1989 | 20549 | 1622 | 22543 | 1046 | 27753 | 937 | 17255 |
| 2L-6S | | MI | 7054 | 3057 | 11328 | 2438 | 13061 | 1970 | 13722 | 1595 | 14078 | 1028 | 17187 | 610 | 13461 |
| 12-#11 | 2.09 | MA | 9594 | 3057 | 14938 | 2463 | 17657 | 1986 | 19101 | 1628 | 20630 | 1051 | 25224 | 845 | 17193 |
| 3L-5S | | MI | 7444 | 3057 | 11873 | 2441 | 13787 | 1964 | 14590 | 1601 | 15191 | 1023 | 18550 | 672 | 13946 |
| 12-#11 | 2.09 | MA | 9074 | 3057 | 14232 | 2462 | 16703 | 1994 | 17946 | 1623 | 19111 | 1046 | 23569 | 754 | 17030 |
| 4E | | MI | 7850 | 3057 | 12485 | 2433 | 14521 | 1968 | 15471 | 1595 | 16388 | 1028 | 20011 | 714 | 14605 |
| 12-#11 | 2.09 | MA | 8601 | 3057 | 13517 | 2472 | 15845 | 1991 | 16898 | 1629 | 17725 | 1051 | 21808 | 712 | 16197 |
| 5L-3S | | MI | 8296 | 3057 | 13088 | 2435 | 15335 | 1962 | 16442 | 1601 | 17618 | 1023 | 21386 | 803 | 14762 |
| 12-#11 | 2.09 | MA | 8147 | 3057 | 12880 | 2470 | 14996 | 1998 | 15866 | 1624 | 16392 | 1057 | 20044 | 636 | 15615 |
| 6L-2S | | MI | 8900 | 3057 | 13888 | 2438 | 16351 | 1967 | 17657 | 1595 | 19217 | 1017 | 23480 | 894 | 14804 |
| 12-#14 | 3.01 | MA | 11333 | 3358 | 18352 | 2643 | 21930 | 2119 | 24235 | 1701 | 27324 | 1012 | 33995 | 862 | 24425 |
| 2L-6S | | MI | 7195 | 3358 | 12328 | 2612 | 14256 | 2095 | 15104 | 1664 | 15898 | 989 | 19709 | 395 | 17667 |
| 12-#14 | 3.01 | MA | 10350 | 3358 | 17008 | 2641 | 20224 | 2114 | 22172 | 1709 | 24610 | 1019 | 30419 | 731 | 24237 |
| 3L-5S | | MI | 7735 | 3358 | 13107 | 2617 | 15293 | 2088 | 16331 | 1672 | 17471 | 982 | 21628 | 485 | 18956 |
| 12-#14 | 3.01 | MA | 9630 | 3358 | 15999 | 2638 | 18861 | 2123 | 20524 | 1701 | 22455 | 1012 | 28079 | 600 | 23092 |
| 4E | | MI | 8298 | 3358 | 13981 | 2606 | 16342 | 2095 | 17577 | 1664 | 19164 | 989 | 23686 | 547 | 19725 |
| 12-#14 | 3.01 | MA | 8976 | 3358 | 14975 | 2651 | 17633 | 2118 | 19028 | 1709 | 20490 | 1019 | 25585 | 540 | 22097 |
| 5L-3S | | MI | 8915 | 3358 | 14841 | 2610 | 17504 | 2088 | 18950 | 1672 | 20904 | 982 | 25625 | 673 | 20731 |
| 12-#14 | 3.01 | MA | 8348 | 3358 | 14064 | 2648 | 16420 | 2128 | 17555 | 1701 | 18600 | 1027 | 23091 | 430 | 20569 |
| 6L-2S | | MI | 9750 | 3358 | 15982 | 2615 | 18950 | 2095 | 20667 | 1664 | 23164 | 974 | 28576 | 804 | 20876 |
| 12-#18 | 5.36 | MA | 10977 | 4121 | 20332 | 3087 | 24183 | 2454 | 26735 | 1887 | 30722 | 940 | 38980 | 190 | 37511 |
| 4E | | MI | 9364 | 4121 | 17628 | 3048 | 20660 | 2406 | 22663 | 1831 | 25880 | 879 | 32486 | 96 | 31840 |
| 12-#18 | 5.36 | MA | 9916 | 4121 | 18543 | 3107 | 22036 | 2442 | 24166 | 1900 | 27231 | 926 | 34722 | 80 | 34282 |
| 5L-3S | | MI | 10352 | 4121 | 19126 | 3059 | 22645 | 2392 | 25008 | 1844 | 28849 | 866 | 35783 | 313 | 34145 |
| 14-#11 | 2.44 | MA | 10722 | 3170 | 16822 | 2536 | 20047 | 2041 | 21997 | 1655 | 24457 | 1038 | 30282 | 916 | 20037 |
| 2L-7S | | MI | 7049 | 3170 | 11597 | 2507 | 13374 | 2017 | 14095 | 1632 | 14586 | 1022 | 17885 | 501 | 15000 |
| 14-#11 | 2.44 | MA | 10020 | 3170 | 15880 | 2534 | 18852 | 2038 | 20549 | 1661 | 22543 | 1043 | 27753 | 825 | 19954 |
| 3L-6S | | MI | 7426 | 3170 | 12129 | 2509 | 14077 | 2022 | 14937 | 1627 | 15676 | 1017 | 19281 | 585 | 15665 |
| 14-#11 | 2.44 | MA | 9507 | 3170 | 15174 | 2533 | 17898 | 2045 | 19394 | 1656 | 21024 | 1038 | 26098 | 734 | 19667 |
| 4L-5S | | MI | 7811 | 3170 | 12674 | 2512 | 14802 | 2016 | 15805 | 1632 | 16790 | 1012 | 20645 | 647 | 16207 |
| 14-#11 | 2.44 | MA | 9041 | 3170 | 14459 | 2542 | 17040 | 2042 | 18346 | 1662 | 19639 | 1043 | 24337 | 692 | 18869 |
| 5L-4S | | MI | 8212 | 3170 | 13286 | 2504 | 15537 | 2020 | 16686 | 1627 | 17986 | 1017 | 22106 | 689 | 16827 |
| 14-#11 | 2.44 | MA | 8594 | 3170 | 13822 | 2541 | 16192 | 2050 | 17314 | 1657 | 18306 | 1048 | 22572 | 616 | 18231 |
| 6L-3S | | MI | 8652 | 3170 | 13888 | 2506 | 16351 | 2014 | 17657 | 1632 | 19217 | 1012 | 23480 | 778 | 17109 |
| 14-#11 | 2.44 | MA | 8156 | 3170 | 13202 | 2540 | 15371 | 2047 | 16312 | 1663 | 16954 | 1043 | 21010 | 544 | 17391 |
| 7L-2S | | MI | 9249 | 3170 | 14689 | 2509 | 17366 | 2019 | 18872 | 1627 | 20815 | 1007 | 25575 | 869 | 17169 |
| 14-#14 | 3.52 | MA | 10935 | 3521 | 18352 | 2743 | 21930 | 2188 | 24235 | 1756 | 27324 | 1006 | 33995 | 699 | 28153 |
| 3L-6S | | MI | 7711 | 3521 | 13468 | 2715 | 15702 | 2170 | 16822 | 1709 | 18158 | 973 | 22660 | 356 | 20823 |
| 14-#14 | 3.52 | MA | 10227 | 3521 | 17343 | 2740 | 20567 | 2198 | 22587 | 1748 | 25169 | 999 | 31655 | 569 | 26860 |
| 4L-5S | | MI | 8242 | 3521 | 14247 | 2719 | 16739 | 2163 | 18049 | 1716 | 19732 | 965 | 24579 | 446 | 22100 |
| 14-#14 | 3.52 | MA | 9585 | 3521 | 16320 | 2753 | 19339 | 2193 | 21092 | 1756 | 23204 | 1006 | 29161 | 508 | 25917 |
| 5L-4S | | MI | 8795 | 3521 | 15121 | 2708 | 17788 | 2170 | 19294 | 1709 | 21424 | 973 | 26637 | 508 | 22904 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis

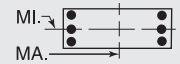



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 3.52 | MA | 8968 | 3521 | 15409 | 2751 | 18125 | 2203 | 19618 | 1748 | 21314 | 1014 | 26667 | 398 | 24323 |
| 6L-3S | | MI | 9403 | 3521 | 15982 | 2713 | 18950 | 2163 | 20667 | 1716 | 23164 | 965 | 28576 | 633 | 24047 |
| 14-#14 | 3.52 | MA | 8364 | 3521 | 14521 | 2748 | 16952 | 2198 | 18188 | 1756 | 19396 | 1006 | 24456 | 296 | 22777 |
| 7L-2S | | MI | 10226 | 3521 | 17122 | 2717 | 20396 | 2170 | 22385 | 1709 | 25424 | 958 | 31527 | 765 | 24227 |
| 14-#18 | 6.25 | MA | 10923 | 4412 | 20882 | 3289 | 25002 | 2575 | 27710 | 1980 | 31894 | 899 | 40828 | 15 | 40744 |
| 5L-4S | | MI | 10170 | 4412 | 19604 | 3230 | 23129 | 2535 | 25595 | 1906 | 29739 | 844 | 37485 | 16 | 37376 |
| 16-#11 | 2.79 | MA | 10440 | 3283 | 16822 | 2605 | 20047 | 2090 | 21997 | 1694 | 24457 | 1035 | 30282 | 805 | 22712 |
| 3L-7S | | MI | 7420 | 3283 | 12398 | 2578 | 14390 | 2069 | 15310 | 1664 | 16184 | 1012 | 19979 | 476 | 17242 |
| 16-#11 | 2.79 | MA | 9934 | 3283 | 16117 | 2604 | 19093 | 2097 | 20841 | 1689 | 22938 | 1030 | 28627 | 714 | 22307 |
| 4L-6S | | MI | 7792 | 3283 | 12929 | 2580 | 15092 | 2073 | 16152 | 1658 | 17275 | 1007 | 21376 | 559 | 17879 |
| 16-#11 | 2.79 | MA | 9474 | 3283 | 15401 | 2613 | 18235 | 2094 | 19794 | 1695 | 21552 | 1035 | 26866 | 671 | 21548 |
| 5E | | MI | 8172 | 3283 | 13474 | 2583 | 15818 | 2068 | 17020 | 1664 | 18388 | 1001 | 22740 | 622 | 18475 |
| 16-#11 | 2.79 | MA | 9033 | 3283 | 14765 | 2612 | 17387 | 2102 | 18762 | 1690 | 20219 | 1040 | 25101 | 595 | 20856 |
| 6L-4S | | MI | 8568 | 3283 | 14086 | 2575 | 16552 | 2072 | 17901 | 1658 | 19585 | 1007 | 24201 | 664 | 19060 |
| 16-#11 | 2.79 | MA | 8601 | 3283 | 14144 | 2611 | 16567 | 2099 | 17760 | 1696 | 18868 | 1035 | 23539 | 524 | 20047 |
| 7L-3S | | MI | 9003 | 3283 | 14689 | 2577 | 17366 | 2066 | 18872 | 1664 | 20815 | 1001 | 25575 | 753 | 19452 |
| 16-#11 | 2.79 | MA | 8174 | 3283 | 13533 | 2610 | 15763 | 2096 | 16757 | 1691 | 17564 | 1040 | 21895 | 474 | 19058 |
| 8L-2S | | MI | 9593 | 3283 | 15490 | 2579 | 18381 | 2071 | 20087 | 1658 | 22414 | 996 | 27670 | 844 | 19530 |
| 16-#14 | 4.02 | MA | 10814 | 3685 | 18688 | 2843 | 22272 | 2273 | 24650 | 1795 | 27883 | 986 | 35231 | 537 | 30643 |
| 4L-6S | | MI | 8217 | 3685 | 14608 | 2817 | 17148 | 2245 | 18539 | 1753 | 20418 | 956 | 25610 | 317 | 23993 |
| 16-#14 | 4.02 | MA | 10182 | 3685 | 17665 | 2855 | 21044 | 2268 | 23155 | 1803 | 25918 | 993 | 32737 | 476 | 29647 |
| 5E | | MI | 8740 | 3685 | 15388 | 2821 | 18185 | 2238 | 19767 | 1761 | 21992 | 948 | 27530 | 406 | 25211 |
| 16-#14 | 4.02 | MA | 9575 | 3685 | 16754 | 2853 | 19830 | 2278 | 21681 | 1795 | 24028 | 1001 | 30242 | 366 | 28090 |
| 6L-4S | | MI | 9284 | 3685 | 16261 | 2810 | 19234 | 2245 | 21012 | 1753 | 23685 | 956 | 29588 | 468 | 26097 |
| 16-#14 | 4.02 | MA | 8981 | 3685 | 15866 | 2851 | 18657 | 2273 | 20251 | 1803 | 22110 | 993 | 28032 | 264 | 26444 |
| 7L-3S | | MI | 9883 | 3685 | 17122 | 2815 | 20396 | 2237 | 22385 | 1761 | 25424 | 948 | 31527 | 594 | 27360 |
| 18-#11 | 3.13 | MA | 10354 | 3397 | 17059 | 2675 | 20288 | 2149 | 22289 | 1722 | 24851 | 1022 | 31156 | 693 | 24957 |
| 4L-7S | | MI | 7785 | 3397 | 13198 | 2649 | 15405 | 2121 | 16525 | 1695 | 17783 | 1001 | 22074 | 451 | 19491 |
| 18-#11 | 3.13 | MA | 9900 | 3397 | 16344 | 2684 | 19430 | 2146 | 21242 | 1727 | 23466 | 1027 | 29395 | 651 | 24234 |
| 5L-6S | | MI | 8153 | 3397 | 13730 | 2651 | 16107 | 2125 | 17367 | 1690 | 18874 | 996 | 23471 | 534 | 20102 |
| 18-#11 | 3.13 | MA | 9465 | 3397 | 15707 | 2683 | 18582 | 2154 | 20210 | 1723 | 22133 | 1032 | 27630 | 575 | 23491 |
| 6L-5S | | MI | 8528 | 3397 | 14275 | 2653 | 16833 | 2119 | 18235 | 1695 | 19987 | 991 | 24835 | 596 | 20750 |
| 18-#11 | 3.13 | MA | 9039 | 3397 | 15087 | 2682 | 17762 | 2151 | 19208 | 1729 | 20781 | 1027 | 26067 | 503 | 22710 |
| 7L-4S | | MI | 8919 | 3397 | 14887 | 2646 | 17567 | 2124 | 19116 | 1690 | 21184 | 996 | 26295 | 639 | 21304 |
| 18-#11 | 3.13 | MA | 8617 | 3397 | 14476 | 2681 | 16958 | 2148 | 18205 | 1724 | 19477 | 1032 | 24424 | 454 | 21662 |
| 8L-3S | | MI | 9349 | 3397 | 15490 | 2648 | 18381 | 2118 | 20087 | 1695 | 22414 | 991 | 27670 | 728 | 21792 |
| 18-#14 | 4.52 | MA | 10769 | 3848 | 19009 | 2958 | 22749 | 2343 | 25218 | 1850 | 28632 | 980 | 36313 | 444 | 33365 |
| 5L-6S | | MI | 8714 | 3848 | 15748 | 2919 | 18594 | 2320 | 20257 | 1797 | 22678 | 939 | 28561 | 278 | 27173 |
| 18-#14 | 4.52 | MA | 10172 | 3848 | 18098 | 2955 | 21536 | 2353 | 23744 | 1843 | 26742 | 987 | 33818 | 334 | 31867 |
| 6L-5S | | MI | 9269 | 3848 | 16528 | 2923 | 19631 | 2312 | 21485 | 1805 | 24252 | 932 | 30480 | 367 | 28337 |
| 18-#14 | 4.52 | MA | 9587 | 3848 | 17210 | 2953 | 20362 | 2348 | 22314 | 1850 | 24824 | 980 | 31608 | 232 | 30180 |
| 7L-4S | | MI | 9798 | 3848 | 17402 | 2913 | 20680 | 2320 | 22730 | 1797 | 25945 | 939 | 32538 | 429 | 29303 |
| 20-#11 | 3.48 | MA | 10320 | 3510 | 17286 | 2755 | 20625 | 2198 | 22690 | 1760 | 25379 | 1019 | 31924 | 630 | 26925 |
| 5L-7S | | MI | 8145 | 3510 | 13999 | 2719 | 16420 | 2173 | 17740 | 1727 | 19381 | 991 | 24169 | 426 | 21696 |
| 20-#11 | 3.48 | MA | 9890 | 3510 | 16649 | 2754 | 19777 | 2206 | 21658 | 1756 | 24047 | 1024 | 30159 | 555 | 26133 |
| 6E | | MI | 8508 | 3510 | 14530 | 2722 | 17123 | 2177 | 18582 | 1722 | 20472 | 985 | 25565 | 509 | 22332 |
| 20-#11 | 3.48 | MA | 9469 | 3510 | 16029 | 2753 | 18957 | 2203 | 20656 | 1761 | 22695 | 1019 | 28596 | 483 | 25379 |
| 7L-5S | | MI | 8879 | 3510 | 15076 | 2724 | 17848 | 2171 | 19450 | 1727 | 21585 | 980 | 26929 | 571 | 23028 |
| 20-#11 | 3.48 | MA | 9053 | 3510 | 15418 | 2752 | 18153 | 2200 | 19653 | 1757 | 21391 | 1024 | 26953 | 434 | 24303 |
| 8L-4S | | MI | 9266 | 3510 | 15687 | 2716 | 18583 | 2176 | 20331 | 1722 | 22782 | 985 | 28390 | 614 | 23555 |
| 20-#14 | 5.02 | MA | 10759 | 4012 | 19443 | 3057 | 23241 | 2428 | 25807 | 1890 | 29456 | 974 | 37394 | 302 | 35654 |
| 6E | | MI | 9246 | 4012 | 16889 | 3021 | 20040 | 2395 | 21975 | 1842 | 24939 | 922 | 31512 | 238 | 30364 |
| 20-#14 | 5.02 | MA | 10184 | 4012 | 18555 | 3055 | 22068 | 2423 | 24377 | 1897 | 27538 | 967 | 35183 | 200 | 33927 |
| 7L-5S | | MI | 9748 | 4012 | 17668 | 3025 | 21077 | 2387 | 23203 | 1849 | 26513 | 915 | 33431 | 328 | 31477 |
| 22-#11 | 3.83 | MA | 10310 | 3624 | 17592 | 2825 | 20972 | 2257 | 23105 | 1789 | 25960 | 1016 | 32688 | 534 | 28782 |
| 6L-7S | | MI | 8500 | 3624 | 14799 | 2790 | 17436 | 2225 | 18955 | 1758 | 20980 | 980 | 26263 | 401 | 23899 |

## RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

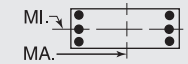
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.83 | MA | 9894 | 3624 | 16971 | 2824 | 20152 | 2254 | 22104 | 1794 | 24608 | 1011 | 31125 | 463 | 28015 |
| 7L-6S | | MI | 8859 | 3624 | 15331 | 2793 | 18138 | 2229 | 19797 | 1753 | 22071 | 975 | 27660 | 484 | 24569 |
| 22-#11 | 3.83 | MA | 9483 | 3624 | 16360 | 2822 | 19348 | 2252 | 21100 | 1790 | 23304 | 1016 | 29482 | 413 | 26950 |
| 8L-5S | | MI | 9226 | 3624 | 15876 | 2795 | 18864 | 2223 | 20665 | 1758 | 23184 | 970 | 29024 | 546 | 25311 |
| 22-#14 | 5.52 | MA | 10834 | 4175 | 19900 | 3157 | 23773 | 2497 | 26440 | 1944 | 30252 | 954 | 38759 | 168 | 37682 |
| 7L-6S | | MI | 9727 | 4175 | 18029 | 3123 | 21486 | 2469 | 23693 | 1886 | 27199 | 906 | 34463 | 199 | 33523 |
| 24-#11 | 4.18 | MA | 10314 | 3737 | 17914 | 2895 | 21347 | 2306 | 23552 | 1827 | 26522 | 1002 | 33654 | 442 | 30638 |
| 7E | | MI | 8850 | 3737 | 15600 | 2861 | 18451 | 2276 | 20170 | 1790 | 22579 | 969 | 28358 | 376 | 26109 |
| 24-#11 | 4.18 | MA | 9908 | 3737 | 17303 | 2893 | 20543 | 2303 | 22548 | 1822 | 25218 | 1008 | 32011 | 393 | 29601 |
| 8L-6S | | MI | 9206 | 3737 | 16131 | 2864 | 19153 | 2281 | 21012 | 1785 | 23669 | 964 | 29755 | 459 | 26813 |
| **RECTANGULAR TIED COLUMNS 28" x 34"** | | | | | | | | | | | | | | | |
| 4-#18 | 1.68 | MA | 10991 | 3106 | 16697 | 2513 | 19612 | 2034 | 21084 | 1667 | 22578 | 1105 | 27448 | 996 | 15610 |
| 2E | | MI | 8889 | 3106 | 13777 | 2466 | 15881 | 1989 | 16858 | 1619 | 17870 | 1059 | 21462 | 931 | 12497 |
| 6-#14 | 1.42 | MA | 10706 | 3015 | 15873 | 2475 | 18688 | 2009 | 20061 | 1658 | 21317 | 1130 | 25878 | 1039 | 13417 |
| 2L-3S | | MI | 7807 | 3015 | 11992 | 2429 | 13807 | 1966 | 14444 | 1626 | 14723 | 1099 | 17453 | 855 | 10783 |
| 6-#14 | 1.42 | MA | 9587 | 3015 | 14426 | 2474 | 16853 | 2005 | 17838 | 1666 | 18375 | 1137 | 21989 | 908 | 13369 |
| 3L-2S | | MI | 8687 | 3015 | 13132 | 2433 | 15254 | 1974 | 16161 | 1619 | 16983 | 1092 | 20404 | 986 | 10785 |
| 6-#18 | 2.52 | MA | 12107 | 3397 | 19218 | 2694 | 22809 | 2167 | 24935 | 1750 | 27645 | 1080 | 34109 | 936 | 23066 |
| 2L-3S | | MI | 8268 | 3397 | 13777 | 2637 | 15881 | 2105 | 16858 | 1707 | 17870 | 1037 | 21462 | 617 | 18097 |
| 6-#18 | 2.52 | MA | 10233 | 3397 | 16697 | 2689 | 19612 | 2157 | 21084 | 1763 | 22578 | 1093 | 27448 | 703 | 22646 |
| 3L-2S | | MI | 9738 | 3397 | 15753 | 2648 | 18350 | 2118 | 19790 | 1693 | 21729 | 1024 | 26461 | 851 | 18363 |
| 8-#11 | 1.31 | MA | 10588 | 2978 | 15522 | 2462 | 18305 | 2000 | 19623 | 1654 | 20801 | 1141 | 25238 | 1057 | 12510 |
| 2L-4S | | MI | 7523 | 2978 | 11452 | 2417 | 13132 | 1968 | 13689 | 1620 | 13792 | 1116 | 16504 | 830 | 10038 |
| 8-#11 | 1.31 | MA | 9800 | 2978 | 14509 | 2461 | 17020 | 1998 | 18066 | 1660 | 18730 | 1146 | 22492 | 966 | 12496 |
| 3E | | MI | 7983 | 2978 | 12055 | 2419 | 13946 | 1962 | 14660 | 1625 | 15023 | 1111 | 17878 | 919 | 10084 |
| 8-#11 | 1.31 | MA | 9224 | 2978 | 13751 | 2461 | 15997 | 2006 | 16827 | 1656 | 17086 | 1141 | 20690 | 875 | 12392 |
| 4L-2S | | MI | 8604 | 2978 | 12855 | 2422 | 14961 | 1967 | 15875 | 1620 | 16621 | 1106 | 19973 | 1010 | 10074 |
| 8-#14 | 1.89 | MA | 11369 | 3179 | 17320 | 2578 | 20523 | 2083 | 22284 | 1705 | 24258 | 1118 | 29767 | 1010 | 17709 |
| 2L-4S | | MI | 7688 | 3179 | 12272 | 2527 | 14092 | 2049 | 14788 | 1663 | 15244 | 1090 | 18464 | 690 | 13612 |
| 8-#14 | 1.89 | MA | 10270 | 3179 | 15873 | 2576 | 18688 | 2079 | 20061 | 1713 | 21317 | 1126 | 25878 | 879 | 17608 |
| 3E | | MI | 8330 | 3179 | 13132 | 2531 | 15254 | 2041 | 16161 | 1671 | 16983 | 1082 | 20404 | 816 | 14133 |
| 8-#14 | 1.89 | MA | 9465 | 3179 | 14790 | 2575 | 17225 | 2090 | 18288 | 1707 | 18982 | 1118 | 23331 | 747 | 16936 |
| 4L-2S | | MI | 9195 | 3179 | 14273 | 2535 | 16700 | 2049 | 17879 | 1663 | 19243 | 1075 | 23354 | 947 | 14183 |
| 8-#18 | 3.36 | MA | 13184 | 3688 | 21739 | 2876 | 26007 | 2300 | 28786 | 1832 | 32712 | 1055 | 40770 | 877 | 30486 |
| 2L-4S | | MI | 8059 | 3688 | 14254 | 2808 | 16366 | 2248 | 17445 | 1768 | 18759 | 1015 | 23164 | 321 | 21102 |
| 8-#18 | 3.36 | MA | 11359 | 3688 | 19218 | 2871 | 22809 | 2290 | 24935 | 1846 | 27645 | 1068 | 34109 | 643 | 29932 |
| 3E | | MI | 9126 | 3688 | 15753 | 2819 | 18350 | 2235 | 19790 | 1781 | 21729 | 1002 | 26461 | 537 | 23794 |
| 8-#18 | 3.36 | MA | 10022 | 3688 | 17324 | 2866 | 20251 | 2307 | 21858 | 1832 | 23623 | 1055 | 29745 | 413 | 26495 |
| 4L-2S | | MI | 10561 | 3688 | 17728 | 2829 | 20819 | 2248 | 22722 | 1768 | 25588 | 989 | 31459 | 771 | 24182 |
| 10-#11 | 1.64 | MA | 11060 | 3092 | 16535 | 2533 | 19590 | 2052 | 21180 | 1687 | 22873 | 1134 | 27985 | 1039 | 15520 |
| 2L-5S | | MI | 7486 | 3092 | 11641 | 2496 | 13413 | 2015 | 14023 | 1657 | 14194 | 1101 | 17138 | 762 | 11820 |
| 10-#11 | 1.64 | MA | 10283 | 3092 | 15522 | 2532 | 18305 | 2049 | 19623 | 1693 | 20801 | 1139 | 25238 | 948 | 15480 |
| 3L-4S | | MI | 7900 | 3092 | 12252 | 2488 | 14147 | 2020 | 14904 | 1652 | 15391 | 1106 | 18599 | 805 | 12375 |
| 10-#11 | 1.64 | MA | 9715 | 3092 | 14765 | 2532 | 17282 | 2057 | 18383 | 1689 | 19157 | 1134 | 23437 | 857 | 15344 |
| 4L-3S | | MI | 8353 | 3092 | 12855 | 2490 | 14961 | 2014 | 15875 | 1657 | 16621 | 1101 | 19973 | 893 | 12450 |
| 10-#11 | 1.64 | MA | 9199 | 3092 | 13998 | 2541 | 16361 | 2055 | 17260 | 1696 | 17657 | 1139 | 21531 | 813 | 14605 |
| 5L-2S | | MI | 8967 | 3092 | 13656 | 2493 | 15977 | 2018 | 17090 | 1652 | 18220 | 1095 | 22068 | 985 | 12463 |
| 10-#14 | 2.36 | MA | 12016 | 3343 | 18767 | 2680 | 22358 | 2158 | 24507 | 1752 | 27199 | 1107 | 33657 | 981 | 21983 |
| 2L-5S | | MI | 7634 | 3343 | 12538 | 2639 | 14489 | 2116 | 15261 | 1715 | 15811 | 1066 | 19357 | 589 | 15904 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis

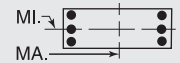



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.36 | MA | 10935 | 3343 | 17320 | 2678 | 20523 | 2154 | 22284 | 1761 | 24258 | 1114 | 29767 | 850 | 21837 |
| 3L-4S | | MI | 8209 | 3343 | 13412 | 2629 | 15538 | 2123 | 16506 | 1707 | 17504 | 1073 | 21415 | 651 | 16745 |
| 10-#14 | 2.36 | MA | 10146 | 3343 | 16237 | 2677 | 19060 | 2165 | 20511 | 1754 | 21923 | 1107 | 27221 | 718 | 20952 |
| 4L-3S | | MI | 8840 | 3343 | 14273 | 2633 | 16700 | 2116 | 17879 | 1715 | 19243 | 1066 | 23354 | 777 | 17468 |
| 10-#14 | 2.36 | MA | 9428 | 3343 | 15139 | 2690 | 17742 | 2161 | 18903 | 1763 | 19793 | 1114 | 24514 | 657 | 19750 |
| 5L-2S | | MI | 9692 | 3343 | 15413 | 2637 | 18146 | 2123 | 19597 | 1707 | 21504 | 1058 | 26305 | 908 | 17559 |
| 10-#18 | 4.20 | MA | 12450 | 3979 | 21739 | 3053 | 26007 | 2423 | 28786 | 1928 | 32712 | 1044 | 40770 | 583 | 37218 |
| 3L-4S | | MI | 8956 | 3979 | 16230 | 2990 | 18835 | 2378 | 20378 | 1843 | 22618 | 980 | 28162 | 241 | 26570 |
| 10-#18 | 4.20 | MA | 11147 | 3979 | 19845 | 3048 | 23449 | 2440 | 25709 | 1915 | 28689 | 1030 | 36406 | 353 | 33546 |
| 4L-3S | | MI | 9985 | 3979 | 17728 | 3001 | 20819 | 2364 | 22722 | 1856 | 25588 | 967 | 31459 | 457 | 29150 |
| 10-#18 | 4.20 | MA | 9964 | 3979 | 17923 | 3069 | 21142 | 2430 | 22917 | 1928 | 25020 | 1044 | 31761 | 245 | 30379 |
| 5L-2S | | MI | 11358 | 3979 | 19704 | 3011 | 23288 | 2378 | 25655 | 1843 | 29447 | 954 | 36458 | 691 | 29976 |
| 12-#11 | 1.97 | MA | 11523 | 3205 | 17548 | 2604 | 20875 | 2104 | 22737 | 1720 | 24944 | 1127 | 30731 | 1020 | 18519 |
| 2L-6S | | MI | 7469 | 3205 | 11896 | 2564 | 13702 | 2073 | 14370 | 1683 | 14679 | 1095 | 17869 | 675 | 13668 |
| 12-#11 | 1.97 | MA | 10756 | 3205 | 16535 | 2603 | 19590 | 2101 | 21180 | 1726 | 22873 | 1132 | 27985 | 929 | 18456 |
| 3L-5S | | MI | 7861 | 3205 | 12441 | 2567 | 14428 | 2067 | 15238 | 1688 | 15793 | 1090 | 19232 | 737 | 14071 |
| 12-#11 | 1.97 | MA | 10196 | 3205 | 15778 | 2603 | 18567 | 2109 | 19940 | 1722 | 21229 | 1127 | 26184 | 838 | 18293 |
| 4E | | MI | 8269 | 3205 | 13053 | 2559 | 15163 | 2072 | 16119 | 1683 | 16989 | 1095 | 20693 | 780 | 14707 |
| 12-#11 | 1.97 | MA | 9688 | 3205 | 15011 | 2612 | 17646 | 2107 | 18817 | 1728 | 19729 | 1132 | 24277 | 795 | 17471 |
| 5L-3S | | MI | 8717 | 3205 | 13656 | 2561 | 15977 | 2066 | 17090 | 1688 | 18220 | 1090 | 22068 | 868 | 14807 |
| 12-#11 | 1.97 | MA | 9200 | 3205 | 14328 | 2612 | 16737 | 2115 | 17710 | 1725 | 18286 | 1137 | 22360 | 719 | 16927 |
| 6L-2S | | MI | 9324 | 3205 | 14456 | 2564 | 16992 | 2070 | 18305 | 1683 | 19818 | 1085 | 24162 | 959 | 14840 |
| 12-#14 | 2.84 | MA | 12649 | 3506 | 20214 | 2782 | 24193 | 2233 | 26730 | 1800 | 30141 | 1095 | 37546 | 952 | 26247 |
| 2L-6S | | MI | 7609 | 3506 | 12899 | 2737 | 14898 | 2198 | 15751 | 1752 | 16498 | 1056 | 20388 | 460 | 17915 |
| 12-#14 | 2.84 | MA | 11586 | 3506 | 18767 | 2781 | 22358 | 2229 | 24507 | 1808 | 27199 | 1103 | 33657 | 821 | 26060 |
| 3L-5S | | MI | 8153 | 3506 | 13678 | 2742 | 15935 | 2191 | 16979 | 1759 | 18072 | 1049 | 22308 | 550 | 19116 |
| 12-#14 | 2.84 | MA | 10810 | 3506 | 17683 | 2779 | 20895 | 2240 | 22734 | 1802 | 24865 | 1095 | 31110 | 690 | 24992 |
| 4E | | MI | 8718 | 3506 | 14552 | 2731 | 16984 | 2198 | 18224 | 1752 | 19764 | 1056 | 24366 | 612 | 19902 |
| 12-#14 | 2.84 | MA | 10106 | 3506 | 16585 | 2792 | 19577 | 2236 | 21126 | 1810 | 22735 | 1103 | 28403 | 628 | 23856 |
| 5L-3S | | MI | 9339 | 3506 | 15413 | 2735 | 18146 | 2191 | 19597 | 1759 | 21504 | 1049 | 26305 | 737 | 20795 |
| 12-#14 | 2.84 | MA | 9430 | 3506 | 15608 | 2791 | 18276 | 2247 | 19542 | 1803 | 20686 | 1110 | 25689 | 519 | 22319 |
| 6L-2S | | MI | 10179 | 3506 | 16553 | 2740 | 19592 | 2198 | 21315 | 1752 | 23764 | 1042 | 29256 | 869 | 20922 |
| 12-#18 | 5.04 | MA | 12242 | 4269 | 22366 | 3230 | 26646 | 2573 | 29560 | 1998 | 33756 | 1006 | 43067 | 293 | 40634 |
| 4E | | MI | 9789 | 4269 | 18206 | 3172 | 21304 | 2507 | 23310 | 1918 | 26477 | 945 | 33161 | 160 | 32074 |
| 12-#18 | 5.04 | MA | 11088 | 4269 | 20444 | 3251 | 24339 | 2563 | 26769 | 2011 | 30086 | 1019 | 38422 | 185 | 37333 |
| 5L-3S | | MI | 10787 | 4269 | 19704 | 3182 | 23288 | 2494 | 25655 | 1931 | 29447 | 932 | 36458 | 377 | 34461 |
| 14-#11 | 2.29 | MA | 11979 | 3319 | 18561 | 2675 | 22160 | 2155 | 24293 | 1752 | 27015 | 1120 | 33478 | 1002 | 21511 |
| 2L-7S | | MI | 7464 | 3319 | 12165 | 2633 | 14016 | 2121 | 14743 | 1720 | 15187 | 1090 | 18567 | 567 | 15186 |
| 14-#11 | 2.29 | MA | 11221 | 3319 | 17548 | 2674 | 20875 | 2153 | 22737 | 1759 | 24944 | 1125 | 30731 | 911 | 21428 |
| 3L-6S | | MI | 7843 | 3319 | 12696 | 2635 | 14718 | 2125 | 15585 | 1715 | 16278 | 1085 | 19963 | 650 | 15869 |
| 14-#11 | 2.29 | MA | 10668 | 3319 | 16791 | 2673 | 19852 | 2161 | 21497 | 1755 | 23300 | 1120 | 28930 | 820 | 21241 |
| 4L-5S | | MI | 8230 | 3319 | 13242 | 2637 | 15444 | 2119 | 16453 | 1720 | 17391 | 1080 | 21327 | 712 | 16332 |
| 14-#11 | 2.29 | MA | 10167 | 3319 | 16024 | 2683 | 18931 | 2159 | 20373 | 1761 | 21800 | 1125 | 27024 | 776 | 20347 |
| 5L-4S | | MI | 8633 | 3319 | 13853 | 2630 | 16178 | 2124 | 17334 | 1715 | 18588 | 1085 | 22788 | 755 | 16972 |
| 14-#11 | 2.29 | MA | 9686 | 3319 | 15342 | 2683 | 18022 | 2167 | 19267 | 1757 | 20357 | 1130 | 25107 | 701 | 19760 |
| 6L-3S | | MI | 9075 | 3319 | 14456 | 2632 | 16992 | 2118 | 18305 | 1720 | 19818 | 1080 | 24162 | 843 | 17158 |
| 14-#11 | 2.29 | MA | 9215 | 3319 | 14677 | 2682 | 17143 | 2165 | 18193 | 1764 | 18894 | 1125 | 23407 | 629 | 18807 |
| 7L-2S | | MI | 9675 | 3319 | 15257 | 2634 | 18007 | 2122 | 19520 | 1715 | 21417 | 1074 | 26257 | 934 | 17208 |
| 14-#14 | 3.31 | MA | 12223 | 3670 | 20214 | 2883 | 24193 | 2304 | 26730 | 1856 | 30141 | 1091 | 37546 | 792 | 30279 |
| 3L-6S | | MI | 8127 | 3670 | 14039 | 2840 | 16344 | 2273 | 17469 | 1796 | 18758 | 1040 | 23339 | 421 | 21067 |
| 14-#14 | 3.31 | MA | 11460 | 3670 | 19130 | 2881 | 22730 | 2315 | 24957 | 1849 | 27806 | 1084 | 34999 | 661 | 29052 |
| 4L-5S | | MI | 8661 | 3670 | 14819 | 2844 | 17381 | 2266 | 18697 | 1804 | 20332 | 1032 | 25258 | 511 | 22339 |
| 14-#14 | 3.31 | MA | 10768 | 3670 | 18032 | 2895 | 21412 | 2311 | 23349 | 1857 | 25676 | 1091 | 32292 | 599 | 27974 |
| 5L-4S | | MI | 9218 | 3670 | 15692 | 2833 | 18430 | 2273 | 19942 | 1796 | 22024 | 1040 | 27316 | 573 | 23078 |
| 14-#14 | 3.31 | MA | 10104 | 3670 | 17055 | 2893 | 20111 | 2322 | 21765 | 1851 | 23628 | 1099 | 29579 | 490 | 26368 |
| 6L-3S | | MI | 9830 | 3670 | 16553 | 2838 | 19592 | 2266 | 21315 | 1804 | 23764 | 1032 | 29256 | 698 | 24115 |
| 14-#14 | 3.31 | MA | 9454 | 3670 | 16103 | 2892 | 18852 | 2318 | 20228 | 1859 | 21550 | 1091 | 27175 | 387 | 24801 |
| 7L-2S | | MI | 10658 | 3670 | 17693 | 2842 | 21038 | 2273 | 23033 | 1796 | 26024 | 1025 | 32206 | 830 | 24276 |

## RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

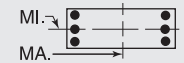
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 5.88 | MA | 12256 | 4560 | 22965 | 3433 | 27537 | 2696 | 30620 | 2094 | 35153 | 994 | 45083 | 125 | 44318 |
| 5L-4S | | MI | 10599 | 4560 | 20182 | 3354 | 23773 | 2637 | 26242 | 1992 | 30336 | 910 | 38159 | 80 | 37605 |
| 16-#11 | 2.62 | MA | 11678 | 3432 | 18561 | 2745 | 22160 | 2205 | 24293 | 1792 | 27015 | 1118 | 33478 | 892 | 24397 |
| 3L-7S | | MI | 7835 | 3432 | 12965 | 2703 | 15031 | 2172 | 15958 | 1752 | 16786 | 1079 | 20661 | 541 | 17426 |
| 16-#11 | 2.62 | MA | 11133 | 3432 | 17804 | 2744 | 21137 | 2213 | 23054 | 1788 | 25371 | 1112 | 31677 | 801 | 24107 |
| 4L-6S | | MI | 8210 | 3432 | 13497 | 2706 | 15733 | 2177 | 16800 | 1746 | 17877 | 1074 | 22058 | 625 | 18080 |
| 16-#11 | 2.62 | MA | 10638 | 3432 | 17037 | 2754 | 20216 | 2211 | 21930 | 1794 | 23871 | 1118 | 29770 | 758 | 23232 |
| 5E | | MI | 8592 | 3432 | 14042 | 2708 | 16459 | 2171 | 17668 | 1752 | 18990 | 1069 | 23422 | 687 | 18599 |
| 16-#11 | 2.62 | MA | 10163 | 3432 | 16355 | 2753 | 19307 | 2219 | 20824 | 1790 | 22429 | 1123 | 27854 | 682 | 22589 |
| 6L-4S | | MI | 8991 | 3432 | 14654 | 2700 | 17193 | 2175 | 18549 | 1746 | 20186 | 1074 | 24883 | 729 | 19204 |
| 16-#11 | 2.62 | MA | 9698 | 3432 | 15690 | 2753 | 18428 | 2217 | 19750 | 1797 | 20966 | 1118 | 26154 | 611 | 21669 |
| 7L-3S | | MI | 9428 | 3432 | 15257 | 2703 | 18007 | 2170 | 19520 | 1752 | 21417 | 1069 | 26257 | 818 | 19503 |
| 16-#11 | 2.62 | MA | 9239 | 3432 | 15036 | 2752 | 17566 | 2214 | 18675 | 1793 | 19554 | 1123 | 24374 | 560 | 20679 |
| 8L-2S | | MI | 10021 | 3432 | 16057 | 2705 | 19023 | 2174 | 20735 | 1746 | 23015 | 1064 | 28352 | 909 | 19571 |
| 16-#14 | 3.78 | MA | 12099 | 3833 | 20577 | 2984 | 24565 | 2390 | 27180 | 1896 | 30747 | 1072 | 38889 | 632 | 33128 |
| 4L-6S | | MI | 8634 | 3833 | 15180 | 2942 | 17790 | 2348 | 19187 | 1840 | 21018 | 1023 | 26290 | 382 | 24232 |
| 16-#14 | 3.78 | MA | 11418 | 3833 | 19479 | 2997 | 23247 | 2385 | 25572 | 1905 | 28617 | 1080 | 36182 | 570 | 32101 |
| 5E | | MI | 9161 | 3833 | 15959 | 2946 | 18827 | 2340 | 20414 | 1848 | 22592 | 1016 | 28209 | 471 | 25492 |
| 16-#14 | 3.78 | MA | 10765 | 3833 | 18502 | 2995 | 21946 | 2396 | 23988 | 1898 | 26569 | 1087 | 33468 | 461 | 30429 |
| 6L-4S | | MI | 9710 | 3833 | 16833 | 2936 | 19876 | 2348 | 21660 | 1840 | 24285 | 1023 | 30267 | 533 | 26269 |
| 16-#14 | 3.78 | MA | 10125 | 3833 | 17550 | 2994 | 20687 | 2392 | 22452 | 1907 | 24491 | 1080 | 31064 | 358 | 28819 |
| 7L-3S | | MI | 10313 | 3833 | 17693 | 2940 | 21038 | 2340 | 23033 | 1848 | 26024 | 1016 | 32206 | 659 | 27431 |
| 18-#11 | 2.95 | MA | 11590 | 3545 | 18817 | 2815 | 22422 | 2265 | 24610 | 1821 | 27443 | 1105 | 34423 | 783 | 26959 |
| 4L-7S | | MI | 8202 | 3545 | 13766 | 2774 | 16046 | 2224 | 17173 | 1783 | 18384 | 1069 | 22756 | 516 | 19673 |
| 18-#11 | 2.95 | MA | 11102 | 3545 | 18050 | 2825 | 21501 | 2263 | 23487 | 1827 | 25943 | 1110 | 32517 | 739 | 26123 |
| 5L-6S | | MI | 8572 | 3545 | 14298 | 2777 | 16748 | 2229 | 18015 | 1778 | 19475 | 1064 | 24153 | 600 | 20300 |
| 18-#11 | 2.95 | MA | 10633 | 3545 | 17368 | 2824 | 20592 | 2271 | 22380 | 1823 | 24500 | 1116 | 30600 | 664 | 25427 |
| 6L-5S | | MI | 8950 | 3545 | 14843 | 2779 | 17474 | 2223 | 18883 | 1783 | 20588 | 1058 | 25517 | 662 | 20873 |
| 18-#11 | 2.95 | MA | 10174 | 3545 | 16703 | 2824 | 19713 | 2268 | 21307 | 1830 | 23037 | 1110 | 28900 | 592 | 24537 |
| 7L-4S | | MI | 9344 | 3545 | 15455 | 2771 | 18209 | 2227 | 19764 | 1778 | 21785 | 1064 | 26977 | 704 | 21445 |
| 18-#11 | 2.95 | MA | 9721 | 3545 | 16049 | 2823 | 18851 | 2266 | 20231 | 1826 | 21626 | 1116 | 27121 | 542 | 23517 |
| 8L-3S | | MI | 9776 | 3545 | 16057 | 2774 | 19023 | 2221 | 20735 | 1783 | 23015 | 1058 | 28352 | 793 | 21845 |
| 18-#14 | 4.25 | MA | 12057 | 3997 | 20926 | 3099 | 25082 | 2460 | 27795 | 1952 | 31559 | 1068 | 40071 | 541 | 36225 |
| 5L-6S | | MI | 9134 | 3997 | 16320 | 3044 | 19236 | 2423 | 20905 | 1885 | 23279 | 1006 | 29241 | 342 | 27409 |
| 18-#14 | 4.25 | MA | 11414 | 3997 | 19949 | 3098 | 23781 | 2471 | 26212 | 1946 | 29510 | 1076 | 37357 | 432 | 34502 |
| 6L-5S | | MI | 9653 | 3997 | 17099 | 3048 | 20273 | 2415 | 22132 | 1892 | 24853 | 999 | 31160 | 432 | 28613 |
| 18-#14 | 4.25 | MA | 10785 | 3997 | 18997 | 3096 | 22522 | 2467 | 24675 | 1954 | 27432 | 1068 | 34953 | 329 | 32792 |
| 7L-4S | | MI | 10194 | 3997 | 17973 | 3038 | 21322 | 2423 | 23378 | 1885 | 26545 | 1006 | 33218 | 494 | 29472 |
| 20-#11 | 3.28 | MA | 11559 | 3659 | 19064 | 2896 | 22786 | 2315 | 25044 | 1860 | 28014 | 1103 | 35263 | 721 | 29019 |
| 5L-7S | | MI | 8563 | 3659 | 14567 | 2845 | 17062 | 2276 | 18388 | 1815 | 19983 | 1058 | 24851 | 491 | 21925 |
| 20-#11 | 3.28 | MA | 11096 | 3659 | 18381 | 2895 | 21877 | 2323 | 23937 | 1856 | 26571 | 1108 | 33347 | 645 | 28272 |
| 6E | | MI | 8929 | 3659 | 15098 | 2848 | 17764 | 2281 | 19230 | 1809 | 21074 | 1053 | 26247 | 575 | 22528 |
| 20-#11 | 3.28 | MA | 10643 | 3659 | 17717 | 2895 | 20998 | 2320 | 22864 | 1862 | 25108 | 1103 | 31647 | 574 | 27412 |
| 7L-5S | | MI | 9303 | 3659 | 15643 | 2850 | 18490 | 2275 | 20098 | 1815 | 22187 | 1048 | 27611 | 637 | 23151 |
| 20-#11 | 3.28 | MA | 10195 | 3659 | 17062 | 2894 | 20136 | 2318 | 21788 | 1858 | 23697 | 1108 | 29868 | 524 | 26332 |
| 8L-4S | | MI | 9692 | 3659 | 16255 | 2842 | 19224 | 2279 | 20979 | 1809 | 23384 | 1053 | 29072 | 679 | 23695 |
| 20-#14 | 4.73 | MA | 12053 | 4160 | 21396 | 3200 | 25616 | 2546 | 28435 | 1993 | 32452 | 1064 | 41247 | 403 | 38584 |
| 6E | | MI | 9670 | 4160 | 17460 | 3146 | 20682 | 2498 | 22623 | 1929 | 25539 | 990 | 32191 | 303 | 30596 |
| 20-#14 | 4.73 | MA | 11433 | 4160 | 20444 | 3198 | 24357 | 2542 | 26898 | 2001 | 30374 | 1057 | 38843 | 300 | 36834 |
| 7L-5S | | MI | 10177 | 4160 | 18239 | 3151 | 21719 | 2490 | 23850 | 1937 | 27113 | 982 | 34111 | 393 | 31749 |
| 22-#11 | 3.61 | MA | 11552 | 3772 | 19394 | 2966 | 23162 | 2374 | 25494 | 1889 | 28643 | 1101 | 36093 | 627 | 31125 |
| 6L-7S | | MI | 8919 | 3772 | 15367 | 2916 | 18077 | 2328 | 19603 | 1846 | 21581 | 1048 | 26945 | 466 | 24164 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

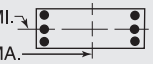
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.61 | MA | 11105 | 3772 | 18730 | 2965 | 22283 | 2372 | 24421 | 1895 | 27180 | 1096 | 34393 | 556 | 30291 |
| 7L-6S | | MI | 9281 | 3772 | 15899 | 2919 | 18779 | 2332 | 20445 | 1841 | 22672 | 1042 | 28342 | 549 | 24763 |
| 22-#11 | 3.61 | MA | 10663 | 3772 | 18075 | 2965 | 21421 | 2370 | 23345 | 1891 | 25768 | 1101 | 32614 | 505 | 29184 |
| 8L-5S | | MI | 9651 | 3772 | 16444 | 2921 | 19505 | 2327 | 21313 | 1846 | 23786 | 1037 | 29706 | 611 | 25434 |
| 22-#14 | 5.20 | MA | 12072 | 4324 | 21891 | 3301 | 26192 | 2617 | 29121 | 2049 | 33315 | 1045 | 42732 | 271 | 40885 |
| 7L-6S | | MI | 10154 | 4324 | 18600 | 3248 | 22128 | 2572 | 24340 | 1973 | 27799 | 973 | 35142 | 264 | 33792 |
| 24-#11 | 3.93 | MA | 11561 | 3886 | 19743 | 3036 | 23568 | 2424 | 25977 | 1928 | 29251 | 1089 | 37140 | 537 | 33175 |
| 7E | | MI | 9272 | 3886 | 16168 | 2987 | 19092 | 2380 | 20818 | 1878 | 23180 | 1037 | 29040 | 441 | 26370 |
| 24-#11 | 3.93 | MA | 11124 | 3886 | 19088 | 3036 | 22706 | 2422 | 24902 | 1924 | 27840 | 1094 | 35361 | 487 | 32040 |
| 8L-6S | | MI | 9630 | 3886 | 16699 | 2989 | 19794 | 2384 | 21660 | 1872 | 24271 | 1032 | 30437 | 524 | 27004 |

## RECTANGULAR TIED COLUMNS 28" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.59 | MA | 12236 | 3255 | 18388 | 2652 | 21651 | 2149 | 23315 | 1768 | 24926 | 1185 | 30331 | 1079 | 16690 |
| 2E | | MI | 9310 | 3255 | 14355 | 2590 | 16525 | 2091 | 17504 | 1705 | 18467 | 1125 | 22137 | 995 | 12537 |
| 6-#14 | 1.34 | MA | 11921 | 3164 | 17497 | 2615 | 20651 | 2123 | 22159 | 1755 | 23542 | 1209 | 28594 | 1119 | 14328 |
| 2L-3S | | MI | 8224 | 3164 | 12563 | 2554 | 14450 | 2069 | 15091 | 1714 | 15323 | 1166 | 18132 | 920 | 10827 |
| 6-#14 | 1.34 | MA | 10718 | 3164 | 15948 | 2614 | 18686 | 2120 | 19779 | 1764 | 20373 | 1216 | 24390 | 988 | 14280 |
| 3L-2S | | MI | 9107 | 3164 | 13704 | 2558 | 15896 | 2077 | 16809 | 1706 | 17583 | 1159 | 21083 | 1051 | 10817 |
| 6-#18 | 2.38 | MA | 13447 | 3546 | 21090 | 2834 | 25078 | 2282 | 27467 | 1852 | 30397 | 1162 | 37549 | 1024 | 24686 |
| 2L-3S | | MI | 8687 | 3546 | 14355 | 2761 | 16525 | 2207 | 17504 | 1793 | 18467 | 1104 | 22137 | 682 | 18186 |
| 6-#18 | 2.38 | MA | 11430 | 3546 | 18388 | 2830 | 21651 | 2273 | 23315 | 1865 | 24926 | 1176 | 30331 | 791 | 24266 |
| 3L-2S | | MI | 10163 | 3546 | 16330 | 2771 | 18994 | 2220 | 20437 | 1780 | 22326 | 1090 | 27135 | 915 | 18413 |
| 8-#11 | 1.24 | MA | 11791 | 3127 | 17118 | 2601 | 20236 | 2114 | 21686 | 1751 | 22976 | 1219 | 27886 | 1136 | 13353 |
| 2L-4S | | MI | 7940 | 3127 | 12020 | 2543 | 13773 | 2071 | 14336 | 1708 | 14394 | 1184 | 17186 | 895 | 10087 |
| 8-#11 | 1.24 | MA | 10945 | 3127 | 16034 | 2601 | 18861 | 2113 | 20020 | 1758 | 20747 | 1225 | 24922 | 1045 | 13338 |
| 3E | | MI | 8401 | 3127 | 12622 | 2545 | 14587 | 2066 | 15307 | 1713 | 15624 | 1179 | 18560 | 984 | 10119 |
| 8-#11 | 1.24 | MA | 10328 | 3127 | 15225 | 2601 | 17768 | 2121 | 18696 | 1755 | 18978 | 1219 | 22974 | 954 | 13234 |
| 4L-2S | | MI | 9023 | 3127 | 13423 | 2548 | 15602 | 2070 | 16522 | 1708 | 17223 | 1174 | 20655 | 1075 | 10103 |
| 8-#14 | 1.79 | MA | 12640 | 3327 | 19046 | 2717 | 22615 | 2198 | 24540 | 1802 | 26711 | 1198 | 32797 | 1093 | 18924 |
| 2L-4S | | MI | 8105 | 3327 | 12843 | 2652 | 14734 | 2152 | 15436 | 1751 | 15844 | 1157 | 19144 | 755 | 13792 |
| 8-#14 | 1.79 | MA | 11458 | 3327 | 17497 | 2716 | 20651 | 2195 | 22159 | 1812 | 23542 | 1206 | 28594 | 961 | 18823 |
| 3E | | MI | 8749 | 3327 | 13704 | 2656 | 15896 | 2144 | 16809 | 1758 | 17583 | 1150 | 21083 | 881 | 14183 |
| 8-#14 | 1.79 | MA | 10595 | 3327 | 16339 | 2715 | 19087 | 2207 | 20264 | 1806 | 21027 | 1198 | 25837 | 830 | 18273 |
| 4L-2S | | MI | 9618 | 3327 | 14844 | 2660 | 17342 | 2151 | 18527 | 1751 | 19843 | 1142 | 24034 | 1012 | 14220 |
| 8-#18 | 3.17 | MA | 14617 | 3836 | 23793 | 3015 | 28506 | 2415 | 31620 | 1936 | 35867 | 1140 | 44766 | 970 | 32646 |
| 2L-4S | | MI | 8475 | 3836 | 14832 | 2932 | 17010 | 2350 | 18092 | 1854 | 19356 | 1082 | 23838 | 385 | 21342 |
| 8-#18 | 3.17 | MA | 12651 | 3836 | 21090 | 3012 | 25078 | 2406 | 27467 | 1950 | 30397 | 1154 | 37549 | 736 | 32092 |
| 3E | | MI | 9548 | 3836 | 16330 | 2943 | 18994 | 2337 | 20437 | 1868 | 22326 | 1069 | 27135 | 601 | 23893 |
| 8-#18 | 3.17 | MA | 11214 | 3836 | 19064 | 3008 | 22341 | 2425 | 24151 | 1937 | 26054 | 1140 | 32827 | 502 | 28598 |
| 4L-2S | | MI | 10991 | 3836 | 18306 | 2953 | 21463 | 2350 | 23369 | 1854 | 26185 | 1055 | 32134 | 835 | 24238 |
| 10-#11 | 1.55 | MA | 12302 | 3240 | 18202 | 2672 | 21611 | 2166 | 23351 | 1784 | 25206 | 1213 | 30851 | 1120 | 16573 |
| 2L-5S | | MI | 7902 | 3240 | 12208 | 2621 | 14054 | 2119 | 14671 | 1745 | 14796 | 1168 | 17820 | 828 | 11943 |
| 10-#11 | 1.55 | MA | 11467 | 3240 | 17118 | 2672 | 20236 | 2164 | 21686 | 1791 | 22976 | 1218 | 27886 | 1028 | 16533 |
| 3L-4S | | MI | 8317 | 3240 | 12820 | 2614 | 14789 | 2123 | 15551 | 1740 | 15992 | 1173 | 19281 | 870 | 12429 |
| 10-#11 | 1.55 | MA | 10859 | 3240 | 16309 | 2672 | 19143 | 2173 | 20361 | 1788 | 21207 | 1213 | 25939 | 937 | 16397 |
| 4L-3S | | MI | 8773 | 3240 | 13423 | 2616 | 15602 | 2117 | 16522 | 1745 | 17223 | 1168 | 20655 | 959 | 12490 |
| 10-#11 | 1.55 | MA | 10307 | 3240 | 15490 | 2682 | 18161 | 2171 | 19162 | 1795 | 19593 | 1218 | 23887 | 893 | 15685 |
| 5L-2S | | MI | 9388 | 3240 | 14224 | 2618 | 16618 | 2122 | 17737 | 1740 | 18821 | 1163 | 22750 | 1050 | 12495 |
| 10-#14 | 2.23 | MA | 13341 | 3491 | 20595 | 2819 | 24580 | 2273 | 26920 | 1850 | 29880 | 1188 | 37001 | 1067 | 23502 |
| 2L-5S | | MI | 8049 | 3491 | 13109 | 2765 | 15131 | 2219 | 15908 | 1802 | 16411 | 1133 | 20036 | 654 | 16060 |
| 10-#14 | 2.23 | MA | 12179 | 3491 | 19046 | 2818 | 22615 | 2270 | 24540 | 1859 | 26711 | 1196 | 32797 | 935 | 23355 |
| 3L-4S | | MI | 8627 | 3491 | 13983 | 2754 | 16180 | 2226 | 17154 | 1795 | 18104 | 1140 | 22094 | 716 | 16921 |
| 10-#14 | 2.23 | MA | 11332 | 3491 | 17889 | 2817 | 21052 | 2281 | 22644 | 1854 | 24196 | 1188 | 30040 | 804 | 22580 |
| 4L-3S | | MI | 9261 | 3491 | 14844 | 2758 | 17342 | 2219 | 18527 | 1802 | 19843 | 1133 | 24034 | 842 | 17524 |
| 10-#14 | 2.23 | MA | 10563 | 3491 | 16716 | 2832 | 19644 | 2278 | 20927 | 1863 | 21901 | 1196 | 27123 | 741 | 21225 |
| 5L-2S | | MI | 10117 | 3491 | 15984 | 2763 | 18788 | 2226 | 20245 | 1795 | 22104 | 1125 | 26984 | 973 | 17600 |

## RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

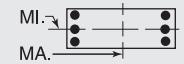
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.97 | MA | 13834 | 4127 | 23793 | 3193 | 28506 | 2539 | 31620 | 2034 | 35867 | 1131 | 44766 | 681 | 39918 |
| 3L-4S | | MI | 9377 | 4127 | 16808 | 3114 | 19479 | 2479 | 21024 | 1929 | 23215 | 1047 | 28837 | 305 | 26804 |
| 10-#18 | 3.97 | MA | 12435 | 4127 | 21767 | 3190 | 25769 | 2558 | 28304 | 2021 | 31525 | 1118 | 40045 | 448 | 36172 |
| 4L-3S | | MI | 10415 | 4127 | 18306 | 3124 | 21463 | 2466 | 23369 | 1942 | 26185 | 1034 | 32134 | 521 | 29468 |
| 10-#18 | 3.97 | MA | 11164 | 4127 | 19712 | 3213 | 23303 | 2549 | 25295 | 2035 | 27563 | 1131 | 35012 | 340 | 32952 |
| 5L-2S | | MI | 11798 | 4127 | 20282 | 3135 | 23932 | 2479 | 26301 | 1929 | 30044 | 1020 | 37132 | 755 | 30037 |
| 12-#11 | 1.86 | MA | 12804 | 3354 | 19286 | 2743 | 22986 | 2218 | 25017 | 1817 | 27435 | 1207 | 33815 | 1103 | 19782 |
| 2L-6S | | MI | 7885 | 3354 | 12464 | 2690 | 14344 | 2177 | 15018 | 1771 | 15281 | 1163 | 18551 | 740 | 13817 |
| 12-#11 | 1.86 | MA | 11979 | 3354 | 18202 | 2743 | 21611 | 2216 | 23351 | 1824 | 25206 | 1212 | 30851 | 1012 | 19720 |
| 3L-5S | | MI | 8279 | 3354 | 13009 | 2692 | 15069 | 2171 | 15886 | 1776 | 16394 | 1158 | 19914 | 802 | 14193 |
| 12-#11 | 1.86 | MA | 11379 | 3354 | 17393 | 2743 | 20518 | 2225 | 22027 | 1821 | 23437 | 1207 | 28903 | 921 | 19557 |
| 4E | | MI | 8688 | 3354 | 13621 | 2684 | 15804 | 2175 | 16767 | 1771 | 17591 | 1163 | 21375 | 845 | 14765 |
| 12-#11 | 1.86 | MA | 10835 | 3354 | 16574 | 2753 | 19536 | 2223 | 20828 | 1828 | 21822 | 1212 | 26851 | 876 | 18756 |
| 5L-3S | | MI | 9138 | 3354 | 14224 | 2687 | 16618 | 2169 | 17737 | 1776 | 18821 | 1158 | 22750 | 934 | 14850 |
| 12-#11 | 1.86 | MA | 10312 | 3354 | 15846 | 2753 | 18565 | 2232 | 19647 | 1824 | 20270 | 1217 | 24782 | 801 | 18151 |
| 6L-2S | | MI | 9747 | 3354 | 15024 | 2689 | 17633 | 2174 | 18952 | 1771 | 20420 | 1152 | 24844 | 1025 | 14876 |
| 12-#14 | 2.68 | MA | 14028 | 3655 | 22144 | 2921 | 26545 | 2348 | 29300 | 1897 | 33049 | 1178 | 41204 | 1040 | 28070 |
| 2L-6S | | MI | 8024 | 3655 | 13470 | 2862 | 15540 | 2301 | 16399 | 1839 | 17098 | 1124 | 21068 | 525 | 18156 |
| 12-#14 | 2.68 | MA | 12884 | 3655 | 20595 | 2921 | 24580 | 2344 | 26920 | 1906 | 29880 | 1185 | 37001 | 909 | 27882 |
| 3L-5S | | MI | 8570 | 3655 | 14250 | 2867 | 16577 | 2294 | 17626 | 1847 | 18672 | 1116 | 22987 | 615 | 19270 |
| 12-#14 | 2.68 | MA | 12051 | 3655 | 19438 | 2920 | 23016 | 2356 | 25025 | 1901 | 27365 | 1178 | 34243 | 777 | 26912 |
| 4E | | MI | 9139 | 3655 | 15123 | 2856 | 17626 | 2301 | 18872 | 1839 | 20364 | 1124 | 25045 | 677 | 20074 |
| 12-#14 | 2.68 | MA | 11296 | 3655 | 18265 | 2934 | 21609 | 2353 | 23307 | 1910 | 25070 | 1185 | 31327 | 715 | 25628 |
| 5L-3S | | MI | 9763 | 3655 | 15984 | 2860 | 18788 | 2294 | 20245 | 1847 | 22104 | 1116 | 26984 | 802 | 20855 |
| 12-#14 | 2.68 | MA | 10572 | 3655 | 17222 | 2933 | 20219 | 2365 | 21616 | 1905 | 22863 | 1193 | 28393 | 606 | 24093 |
| 6L-2S | | MI | 10607 | 3655 | 17124 | 2865 | 20234 | 2301 | 21962 | 1839 | 24364 | 1109 | 29935 | 934 | 20967 |
| 12-#18 | 4.76 | MA | 13621 | 4418 | 24470 | 3372 | 29197 | 2691 | 32457 | 2105 | 36995 | 1096 | 47263 | 393 | 43783 |
| 4E | | MI | 10213 | 4418 | 18784 | 3296 | 21948 | 2609 | 23956 | 2004 | 27074 | 1012 | 33835 | 225 | 32302 |
| 12-#18 | 4.76 | MA | 12382 | 4418 | 22415 | 3395 | 26731 | 2682 | 29448 | 2119 | 33033 | 1109 | 42230 | 286 | 40431 |
| 5L-3S | | MI | 11220 | 4418 | 20282 | 3306 | 23932 | 2596 | 26301 | 2017 | 30044 | 999 | 37132 | 441 | 34771 |
| 12-#18 | 4.76 | MA | 11193 | 4418 | 20586 | 3391 | 24295 | 2701 | 26484 | 2106 | 29224 | 1123 | 37194 | 91 | 36961 |
| 6L-2S | | MI | 12568 | 4418 | 22258 | 3317 | 26401 | 2609 | 29234 | 2004 | 33903 | 985 | 42131 | 675 | 35819 |
| 14-#11 | 2.17 | MA | 13298 | 3467 | 20370 | 2814 | 24361 | 2270 | 26683 | 1850 | 29664 | 1200 | 36780 | 1086 | 22985 |
| 2L-7S | | MI | 7878 | 3467 | 12733 | 2758 | 14657 | 2224 | 15391 | 1808 | 15789 | 1157 | 19249 | 632 | 15367 |
| 14-#11 | 2.17 | MA | 12482 | 3467 | 19286 | 2814 | 22986 | 2268 | 25017 | 1857 | 27435 | 1205 | 33815 | 995 | 22903 |
| 3L-6S | | MI | 8259 | 3467 | 13264 | 2761 | 15359 | 2228 | 16233 | 1803 | 16880 | 1152 | 20645 | 715 | 16068 |
| 14-#11 | 2.17 | MA | 11890 | 3467 | 18477 | 2814 | 21893 | 2277 | 23693 | 1853 | 25666 | 1200 | 31868 | 904 | 22715 |
| 4L-5S | | MI | 8648 | 3467 | 13809 | 2763 | 16085 | 2223 | 17101 | 1808 | 17993 | 1147 | 22009 | 777 | 16452 |
| 14-#11 | 2.17 | MA | 11353 | 3467 | 17658 | 2824 | 20910 | 2275 | 22493 | 1861 | 24051 | 1205 | 29816 | 860 | 21836 |
| 5L-4S | | MI | 9053 | 3467 | 14421 | 2755 | 16819 | 2227 | 17982 | 1803 | 19189 | 1152 | 23470 | 820 | 17097 |
| 14-#11 | 2.17 | MA | 10838 | 3467 | 16930 | 2824 | 19940 | 2284 | 21312 | 1857 | 22499 | 1211 | 27747 | 784 | 21255 |
| 6L-3S | | MI | 9498 | 3467 | 15024 | 2758 | 17633 | 2221 | 18952 | 1808 | 20420 | 1147 | 24844 | 908 | 17204 |
| 14-#11 | 2.17 | MA | 10333 | 3467 | 16222 | 2823 | 19002 | 2282 | 20167 | 1864 | 20924 | 1205 | 25910 | 713 | 20239 |
| 7L-2S | | MI | 10100 | 3467 | 15825 | 2760 | 18648 | 2226 | 20168 | 1803 | 22018 | 1142 | 26939 | 1000 | 17246 |
| 14-#14 | 3.13 | MA | 13574 | 3818 | 22144 | 3023 | 26545 | 2419 | 29300 | 1954 | 33049 | 1175 | 41204 | 882 | 32405 |
| 3L-6S | | MI | 8542 | 3818 | 14611 | 2965 | 16986 | 2376 | 18117 | 1884 | 19358 | 1107 | 24019 | 486 | 21304 |
| 14-#14 | 3.13 | MA | 12756 | 3818 | 20987 | 3022 | 24981 | 2431 | 27405 | 1948 | 30534 | 1168 | 38447 | 751 | 31264 |
| 4L-5S | | MI | 9081 | 3818 | 15390 | 2969 | 18023 | 2369 | 19344 | 1891 | 20932 | 1099 | 25938 | 576 | 22492 |
| 14-#14 | 3.13 | MA | 12014 | 3818 | 19814 | 3036 | 23574 | 2428 | 25688 | 1958 | 28239 | 1175 | 35530 | 688 | 30042 |
| 5L-4S | | MI | 9641 | 3818 | 16264 | 2958 | 19072 | 2376 | 20589 | 1884 | 22625 | 1107 | 27996 | 638 | 23247 |
| 14-#14 | 3.13 | MA | 11301 | 3818 | 18771 | 3035 | 22184 | 2439 | 23996 | 1952 | 26032 | 1183 | 32597 | 579 | 28437 |
| 6L-3S | | MI | 10256 | 3818 | 17124 | 2963 | 20234 | 2368 | 21962 | 1891 | 24364 | 1099 | 29935 | 763 | 24180 |
| 14-#14 | 3.13 | MA | 10604 | 3818 | 17755 | 3034 | 20841 | 2436 | 22356 | 1962 | 23793 | 1175 | 29995 | 476 | 26862 |
| 7L-2S | | MI | 11089 | 3818 | 18264 | 2967 | 21680 | 2376 | 23680 | 1884 | 26624 | 1092 | 32886 | 895 | 24323 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis

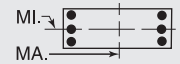


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 5.56 | MA | 13655 | 4709 | 25118 | 3576 | 30159 | 2815 | 33601 | 2203 | 38504 | 1087 | 49448 | 231 | 47941 |
| 5L-4S | | MI | 11027 | 4709 | 20760 | 3477 | 24417 | 2739 | 26889 | 2079 | 30933 | 977 | 38834 | 144 | 37829 |
| 14-#18 | 5.56 | MA | 12492 | 4709 | 23289 | 3573 | 27723 | 2834 | 30636 | 2190 | 34694 | 1100 | 44412 | 36 | 44245 |
| 6L-3S | | MI | 12007 | 4709 | 22258 | 3488 | 26401 | 2725 | 29234 | 2092 | 33903 | 963 | 42131 | 361 | 40122 |
| 16-#11 | 2.48 | MA | 12977 | 3580 | 20370 | 2885 | 24361 | 2320 | 26683 | 1890 | 29664 | 1199 | 36780 | 978 | 26082 |
| 3L-7S | | MI | 8251 | 3580 | 13533 | 2829 | 15672 | 2276 | 16606 | 1839 | 17387 | 1147 | 21343 | 607 | 17604 |
| 16-#11 | 2.48 | MA | 12393 | 3580 | 19561 | 2885 | 23268 | 2329 | 25358 | 1886 | 27895 | 1194 | 34832 | 887 | 25872 |
| 4L-6S | | MI | 8628 | 3580 | 14065 | 2832 | 16374 | 2280 | 17448 | 1834 | 18478 | 1142 | 22740 | 690 | 18276 |
| 16-#11 | 2.48 | MA | 11863 | 3580 | 18743 | 2895 | 22285 | 2327 | 24159 | 1893 | 26281 | 1199 | 32780 | 843 | 24926 |
| 5E | | MI | 9012 | 3580 | 14610 | 2834 | 17100 | 2274 | 18316 | 1839 | 19591 | 1136 | 24104 | 752 | 18719 |
| 16-#11 | 2.48 | MA | 11354 | 3580 | 18015 | 2895 | 21315 | 2336 | 22978 | 1890 | 24728 | 1204 | 30711 | 767 | 24343 |
| 6L-4S | | MI | 9413 | 3580 | 15222 | 2826 | 17834 | 2279 | 19197 | 1834 | 20788 | 1142 | 25565 | 795 | 19343 |
| 16-#11 | 2.48 | MA | 10856 | 3580 | 17306 | 2894 | 20377 | 2334 | 21833 | 1897 | 23154 | 1199 | 28874 | 696 | 23307 |
| 7L-3S | | MI | 9852 | 3580 | 15825 | 2829 | 18648 | 2273 | 20168 | 1839 | 22018 | 1136 | 26939 | 883 | 19552 |
| 16-#11 | 2.48 | MA | 10364 | 3580 | 16608 | 2894 | 19458 | 2332 | 20685 | 1894 | 21635 | 1204 | 26959 | 645 | 22324 |
| 8L-2S | | MI | 10448 | 3580 | 16625 | 2831 | 19664 | 2278 | 21383 | 1834 | 23617 | 1131 | 29034 | 974 | 19611 |
| 16-#14 | 3.57 | MA | 13447 | 3982 | 22536 | 3124 | 26946 | 2506 | 29785 | 1996 | 33703 | 1157 | 42650 | 725 | 35633 |
| 4L-6S | | MI | 9052 | 3982 | 15751 | 3067 | 18432 | 2451 | 19835 | 1928 | 21618 | 1090 | 26969 | 447 | 24466 |
| 16-#14 | 3.57 | MA | 12717 | 3982 | 21363 | 3138 | 25538 | 2503 | 28068 | 2005 | 31408 | 1165 | 39733 | 662 | 34467 |
| 5E | | MI | 9582 | 3982 | 16530 | 3071 | 19469 | 2443 | 21062 | 1935 | 23192 | 1083 | 28889 | 536 | 25723 |
| 16-#14 | 3.57 | MA | 12017 | 3982 | 20320 | 3137 | 24149 | 2514 | 26377 | 2000 | 29201 | 1172 | 36800 | 553 | 32794 |
| 6L-4S | | MI | 10135 | 3982 | 17404 | 3061 | 20518 | 2451 | 22307 | 1928 | 24885 | 1090 | 30947 | 598 | 26436 |
| 16-#14 | 3.57 | MA | 11331 | 3982 | 19305 | 3137 | 22805 | 2511 | 24736 | 2009 | 26962 | 1165 | 34198 | 450 | 31176 |
| 7L-3S | | MI | 10741 | 3982 | 18264 | 3065 | 21680 | 2443 | 23680 | 1935 | 26624 | 1083 | 32886 | 724 | 27500 |
| 16-#14 | 3.57 | MA | 10652 | 3982 | 18304 | 3136 | 21488 | 2508 | 23092 | 2003 | 24803 | 1172 | 31476 | 377 | 29367 |
| 8L-2S | | MI | 11564 | 3982 | 19405 | 3069 | 23126 | 2451 | 25398 | 1928 | 28885 | 1075 | 35837 | 855 | 27673 |
| 16-#18 | 6.35 | MA | 13687 | 4999 | 25992 | 3754 | 31150 | 2967 | 34789 | 2275 | 40165 | 1078 | 51630 | -19 | 51487 |
| 6L-4S | | MI | 11823 | 4999 | 22736 | 3659 | 26886 | 2868 | 29821 | 2153 | 34792 | 942 | 43832 | 64 | 43378 |
| 18-#11 | 2.79 | MA | 12887 | 3694 | 20645 | 2955 | 24643 | 2381 | 27024 | 1919 | 30124 | 1188 | 37797 | 870 | 28978 |
| 4L-7S | | MI | 8619 | 3694 | 14334 | 2900 | 16687 | 2328 | 17821 | 1871 | 18986 | 1136 | 23438 | 582 | 19849 |
| 18-#11 | 2.79 | MA | 12364 | 3694 | 19827 | 2966 | 23660 | 2379 | 25825 | 1926 | 28510 | 1193 | 35745 | 826 | 28022 |
| 5L-6S | | MI | 8991 | 3694 | 14865 | 2903 | 17390 | 2332 | 18663 | 1866 | 20077 | 1131 | 24835 | 665 | 20493 |
| 18-#11 | 2.79 | MA | 11862 | 3694 | 19099 | 2965 | 22690 | 2387 | 24644 | 1923 | 26957 | 1198 | 33676 | 751 | 27385 |
| 6L-5S | | MI | 9371 | 3694 | 15411 | 2905 | 18115 | 2326 | 19531 | 1871 | 21190 | 1126 | 26199 | 727 | 20992 |
| 18-#11 | 2.79 | MA | 11371 | 3694 | 18390 | 2965 | 21752 | 2386 | 23498 | 1930 | 25383 | 1193 | 31839 | 679 | 26380 |
| 7L-4S | | MI | 9767 | 3694 | 16022 | 2897 | 18850 | 2331 | 20412 | 1866 | 22387 | 1131 | 27659 | 770 | 21583 |
| 18-#11 | 2.79 | MA | 10885 | 3694 | 17692 | 2965 | 20833 | 2384 | 22351 | 1927 | 23864 | 1198 | 29923 | 628 | 25368 |
| 8L-3S | | MI | 10202 | 3694 | 16625 | 2899 | 19664 | 2325 | 21383 | 1871 | 23617 | 1126 | 29034 | 858 | 21897 |
| 18-#11 | 2.79 | MA | 10403 | 3694 | 16921 | 2975 | 19886 | 2393 | 21221 | 1934 | 22360 | 1203 | 28048 | 569 | 24285 |
| 9L-2S | | MI | 10792 | 3694 | 17426 | 2902 | 20679 | 2329 | 22598 | 1866 | 25216 | 1121 | 31129 | 949 | 21971 |
| 18-#14 | 4.02 | MA | 13408 | 4145 | 22913 | 3240 | 27503 | 2577 | 30448 | 2052 | 34577 | 1155 | 43937 | 636 | 38900 |
| 5L-6S | | MI | 9553 | 4145 | 16891 | 3169 | 19878 | 2526 | 21552 | 1972 | 23879 | 1073 | 29920 | 407 | 27639 |
| 18-#14 | 4.02 | MA | 12719 | 4145 | 21870 | 3240 | 26113 | 2589 | 28757 | 2047 | 32370 | 1162 | 41003 | 526 | 37162 |
| 6L-5S | | MI | 10076 | 4145 | 17670 | 3173 | 20915 | 2518 | 22780 | 1980 | 25453 | 1066 | 31839 | 497 | 28883 |
| 18-#14 | 4.02 | MA | 12044 | 4145 | 20854 | 3239 | 24770 | 2586 | 27116 | 2056 | 30131 | 1155 | 38402 | 424 | 35501 |
| 7L-4S | | MI | 10621 | 4145 | 18544 | 3163 | 21964 | 2526 | 24025 | 1972 | 27145 | 1073 | 33897 | 559 | 29637 |
| 18-#14 | 4.02 | MA | 11376 | 4145 | 19853 | 3238 | 23453 | 2583 | 25472 | 2051 | 27972 | 1162 | 35679 | 351 | 33669 |
| 8L-3S | | MI | 11220 | 4145 | 19405 | 3167 | 23126 | 2518 | 25398 | 1980 | 28885 | 1066 | 35837 | 685 | 30816 |
| 20-#11 | 3.10 | MA | 12859 | 3807 | 20911 | 3036 | 25035 | 2431 | 27490 | 1959 | 30739 | 1186 | 38709 | 809 | 31124 |
| 5L-7S | | MI | 8981 | 3807 | 15134 | 2971 | 17703 | 2380 | 19036 | 1902 | 20584 | 1126 | 25533 | 556 | 22100 |
| 20-#11 | 3.10 | MA | 12363 | 3807 | 20183 | 3036 | 24065 | 2439 | 26310 | 1956 | 29187 | 1192 | 36640 | 734 | 30434 |
| 6E | | MI | 9350 | 3807 | 15666 | 2973 | 18405 | 2384 | 19878 | 1897 | 21675 | 1121 | 26929 | 640 | 22718 |
| 20-#11 | 3.10 | MA | 11877 | 3807 | 19474 | 3036 | 23127 | 2438 | 25164 | 1963 | 27612 | 1186 | 34803 | 663 | 29460 |
| 7L-5S | | MI | 9726 | 3807 | 16211 | 2976 | 19131 | 2378 | 20746 | 1902 | 22789 | 1115 | 28293 | 702 | 23270 |
| 20-#11 | 3.10 | MA | 11398 | 3807 | 18776 | 3036 | 22208 | 2436 | 24016 | 1960 | 26093 | 1192 | 32888 | 611 | 28418 |
| 8L-4S | | MI | 10117 | 3807 | 16823 | 2968 | 19865 | 2383 | 21627 | 1897 | 23985 | 1121 | 29754 | 744 | 23831 |
| 20-#11 | 3.10 | MA | 10921 | 3807 | 18005 | 3046 | 21261 | 2445 | 22887 | 1967 | 24589 | 1197 | 31012 | 552 | 27316 |
| 9L-3S | | MI | 10548 | 3807 | 17426 | 2970 | 20679 | 2377 | 22598 | 1902 | 25216 | 1115 | 31129 | 833 | 24239 |

## RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 4.46 | MA | 13410 | 4309 | 23419 | 3342 | 28078 | 2664 | 31137 | 2094 | 35539 | 1152 | 45207 | 500 | 41540 |
| 6E | | MI | 10047 | 4309 | 18031 | 3271 | 21324 | 2600 | 23270 | 2017 | 26139 | 1057 | 32871 | 368 | 30823 |
| 20-#14 | 4.46 | MA | 12745 | 4309 | 22403 | 3341 | 26735 | 2661 | 29496 | 2104 | 33300 | 1144 | 42605 | 397 | 39779 |
| 7L-5S | | MI | 10605 | 4309 | 18811 | 3276 | 22362 | 2593 | 24498 | 2024 | 27713 | 1049 | 34790 | 458 | 32014 |
| 20-#14 | 4.46 | MA | 12088 | 4309 | 21403 | 3340 | 25418 | 2658 | 27852 | 2098 | 31141 | 1152 | 39883 | 324 | 37980 |
| 8L-4S | | MI | 11135 | 4309 | 19684 | 3265 | 23410 | 2600 | 25743 | 2017 | 29405 | 1057 | 36848 | 520 | 32849 |
| 22-#11 | 3.40 | MA | 12857 | 3921 | 21267 | 3107 | 25440 | 2491 | 27975 | 1989 | 31416 | 1185 | 39605 | 717 | 33490 |
| 6L-7S | | MI | 9339 | 3921 | 15935 | 3042 | 18718 | 2431 | 20251 | 1934 | 22183 | 1115 | 27628 | 531 | 24355 |
| 22-#11 | 3.40 | MA | 12377 | 3921 | 20558 | 3107 | 24502 | 2490 | 26830 | 1996 | 29841 | 1180 | 37768 | 646 | 32545 |
| 7L-6S | | MI | 9704 | 3921 | 16466 | 3044 | 19420 | 2436 | 21093 | 1929 | 23274 | 1110 | 29024 | 615 | 24951 |
| 22-#11 | 3.40 | MA | 11903 | 3921 | 19860 | 3107 | 23583 | 2488 | 25682 | 1993 | 28322 | 1185 | 35852 | 595 | 31443 |
| 8L-5S | | MI | 10076 | 3921 | 17012 | 3047 | 20146 | 2430 | 21961 | 1934 | 24387 | 1105 | 30388 | 677 | 25552 |
| 22-#11 | 3.40 | MA | 11432 | 3921 | 19089 | 3117 | 22636 | 2496 | 24553 | 2000 | 26818 | 1190 | 33977 | 535 | 30352 |
| 9L-4S | | MI | 10463 | 3921 | 17624 | 3039 | 20880 | 2435 | 22842 | 1929 | 25584 | 1110 | 31849 | 719 | 26087 |
| 22-#14 | 4.91 | MA | 13435 | 4472 | 23952 | 3443 | 28699 | 2736 | 31876 | 2151 | 36469 | 1134 | 46808 | 371 | 44127 |
| 7L-6S | | MI | 10580 | 4472 | 19171 | 3374 | 22771 | 2675 | 24988 | 2061 | 28399 | 1040 | 35822 | 329 | 34016 |
| 22-#14 | 4.91 | MA | 12788 | 4472 | 22952 | 3442 | 27382 | 2732 | 30232 | 2146 | 34310 | 1142 | 44086 | 298 | 42299 |
| 8L-5S | | MI | 11082 | 4472 | 19951 | 3378 | 23808 | 2668 | 26215 | 2068 | 29973 | 1033 | 37741 | 419 | 35157 |
| 24-#11 | 3.71 | MA | 12870 | 4034 | 21642 | 3178 | 25877 | 2541 | 28495 | 2029 | 32071 | 1174 | 40732 | 629 | 35635 |
| 7E | | MI | 9693 | 4034 | 16736 | 3113 | 19733 | 2483 | 21466 | 1966 | 23782 | 1105 | 29722 | 506 | 26616 |
| 24-#11 | 3.71 | MA | 12402 | 4034 | 20944 | 3178 | 24958 | 2540 | 27348 | 2025 | 30552 | 1179 | 38817 | 578 | 34505 |
| 8L-6S | | MI | 10054 | 4034 | 17267 | 3115 | 20436 | 2488 | 22308 | 1960 | 24873 | 1099 | 31119 | 590 | 27190 |
| 24-#11 | 3.71 | MA | 11937 | 4034 | 20174 | 3188 | 24011 | 2548 | 26218 | 2032 | 29047 | 1184 | 36941 | 519 | 33394 |
| 9L-5S | | MI | 10422 | 4034 | 17812 | 3118 | 21161 | 2482 | 23176 | 1966 | 25986 | 1094 | 32483 | 652 | 27837 |
| 24-#14 | 5.36 | MA | 13478 | 4636 | 24501 | 3545 | 29347 | 2807 | 32613 | 2193 | 37479 | 1131 | 48289 | 272 | 46627 |
| 8L-6S | | MI | 11058 | 4636 | 20312 | 3476 | 24217 | 2750 | 26706 | 2105 | 30660 | 1023 | 38772 | 290 | 37217 |

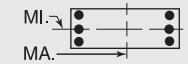
## RECTANGULAR TIED COLUMNS 28" x 38"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.50 | MA | 13541 | 3403 | 20148 | 2791 | 23777 | 2263 | 25594 | 1865 | 27364 | 1264 | 33319 | 1160 | 17770 |
| 2E | | MI | 9730 | 3403 | 14933 | 2713 | 17169 | 2192 | 18151 | 1791 | 19064 | 1192 | 22811 | 1060 | 12576 |
| 6-#14 | 1.27 | MA | 13197 | 3312 | 19191 | 2754 | 22701 | 2238 | 24350 | 1852 | 25857 | 1287 | 31415 | 1198 | 15239 |
| 2L-3S | | MI | 8642 | 3312 | 13135 | 2679 | 15092 | 2172 | 15739 | 1801 | 15923 | 1234 | 18812 | 985 | 10868 |
| 6-#14 | 1.27 | MA | 11910 | 3312 | 17539 | 2754 | 20607 | 2235 | 21813 | 1863 | 22460 | 1294 | 26897 | 1067 | 15192 |
| 3L-2S | | MI | 9527 | 3312 | 14275 | 2683 | 16538 | 2180 | 17456 | 1794 | 18183 | 1226 | 21762 | 1116 | 10848 |
| 6-#18 | 2.26 | MA | 14850 | 3694 | 23032 | 2973 | 27435 | 2396 | 30026 | 1949 | 33239 | 1244 | 41095 | 1110 | 26306 |
| 2L-3S | | MI | 9105 | 3694 | 14933 | 2885 | 17169 | 2309 | 18151 | 1879 | 19064 | 1170 | 22811 | 746 | 18269 |
| 6-#18 | 2.26 | MA | 12687 | 3694 | 20148 | 2970 | 23777 | 2389 | 25594 | 1965 | 27364 | 1257 | 33319 | 877 | 25886 |
| 3L-2S | | MI | 10588 | 3694 | 16908 | 2895 | 19638 | 2322 | 21083 | 1866 | 22923 | 1157 | 27809 | 979 | 18461 |
| 8-#11 | 1.17 | MA | 13054 | 3275 | 18783 | 2741 | 22255 | 2229 | 23841 | 1848 | 25241 | 1297 | 30639 | 1215 | 14195 |
| 2L-4S | | MI | 8356 | 3275 | 12587 | 2668 | 14414 | 2175 | 14984 | 1796 | 14995 | 1251 | 17868 | 961 | 10132 |
| 8-#11 | 1.17 | MA | 12149 | 3275 | 17628 | 2741 | 20790 | 2228 | 22066 | 1856 | 22854 | 1302 | 27456 | 1124 | 14181 |
| 3E | | MI | 8819 | 3275 | 13190 | 2671 | 15228 | 2169 | 15955 | 1801 | 16226 | 1246 | 19242 | 1049 | 10152 |
| 8-#11 | 1.17 | MA | 11491 | 3275 | 16768 | 2741 | 19628 | 2237 | 20657 | 1853 | 20960 | 1297 | 25362 | 1032 | 14077 |
| 4L-2S | | MI | 9443 | 3275 | 13991 | 2673 | 16244 | 2174 | 17170 | 1796 | 17824 | 1241 | 21337 | 1140 | 10131 |
| 8-#14 | 1.69 | MA | 13972 | 3476 | 20842 | 2856 | 24795 | 2313 | 26888 | 1900 | 29254 | 1278 | 35933 | 1174 | 20139 |
| 2L-4S | | MI | 8521 | 3476 | 13414 | 2777 | 15376 | 2254 | 16083 | 1838 | 16444 | 1224 | 19823 | 820 | 13967 |
| 8-#14 | 1.69 | MA | 12707 | 3476 | 19191 | 2856 | 22701 | 2310 | 24350 | 1910 | 25857 | 1285 | 31415 | 1043 | 20038 |
| 3E | | MI | 9168 | 3476 | 14275 | 2781 | 16538 | 2247 | 17456 | 1845 | 18183 | 1217 | 21762 | 946 | 14231 |
| 8-#14 | 1.69 | MA | 11785 | 3476 | 17959 | 2856 | 21037 | 2323 | 22334 | 1905 | 23161 | 1278 | 28447 | 912 | 19629 |
| 4L-2S | | MI | 10040 | 3476 | 15415 | 2785 | 17984 | 2254 | 19174 | 1838 | 20444 | 1209 | 24713 | 1077 | 14255 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis

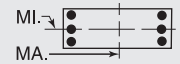



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.01 | MA | 16114 | 3985 | 25917 | 3155 | 31093 | 2529 | 34458 | 2033 | 39114 | 1224 | 48870 | 1060 | 34806 |
| 2L-4S | | MI | 8891 | 3985 | 15410 | 3056 | 17653 | 2452 | 18739 | 1941 | 19954 | 1148 | 24512 | 449 | 21575 |
| 8-#18 | 3.01 | MA | 14005 | 3985 | 23032 | 3152 | 27435 | 2522 | 30026 | 2049 | 33239 | 1238 | 41095 | 826 | 34252 |
| 3E | | MI | 9969 | 3985 | 16908 | 3066 | 19638 | 2438 | 21083 | 1954 | 22923 | 1135 | 27809 | 666 | 23986 |
| 8-#18 | 3.01 | MA | 12468 | 3985 | 20874 | 3150 | 24519 | 2542 | 26493 | 2038 | 28576 | 1224 | 36001 | 593 | 30726 |
| 4L-2S | | MI | 11420 | 3985 | 18884 | 3077 | 22107 | 2452 | 24016 | 1941 | 26782 | 1122 | 32808 | 899 | 24293 |
| 10-#11 | 1.47 | MA | 13605 | 3389 | 19938 | 2811 | 23720 | 2281 | 25615 | 1881 | 27629 | 1292 | 33822 | 1199 | 17626 |
| 2L-5S | | MI | 8318 | 3389 | 12776 | 2747 | 14695 | 2222 | 15319 | 1833 | 15397 | 1236 | 18502 | 893 | 12062 |
| 10-#11 | 1.47 | MA | 12711 | 3389 | 18783 | 2812 | 22255 | 2280 | 23841 | 1889 | 25241 | 1297 | 30639 | 1108 | 17586 |
| 3L-4S | | MI | 8735 | 3389 | 13388 | 2739 | 15430 | 2227 | 16199 | 1828 | 16594 | 1241 | 19963 | 936 | 12480 |
| 10-#11 | 1.47 | MA | 12062 | 3389 | 17923 | 2812 | 21093 | 2289 | 22432 | 1886 | 23347 | 1292 | 28545 | 1017 | 17450 |
| 4L-3S | | MI | 9192 | 3389 | 13991 | 2742 | 16244 | 2221 | 17170 | 1833 | 17824 | 1236 | 21337 | 1024 | 12527 |
| 10-#11 | 1.47 | MA | 11474 | 3389 | 17053 | 2823 | 20048 | 2287 | 21157 | 1894 | 21618 | 1297 | 26348 | 972 | 16776 |
| 5L-2S | | MI | 9809 | 3389 | 14791 | 2744 | 17259 | 2225 | 18385 | 1828 | 19423 | 1231 | 23432 | 1115 | 12525 |
| 10-#14 | 2.11 | MA | 14728 | 3640 | 22493 | 2958 | 26890 | 2387 | 29425 | 1947 | 32650 | 1269 | 40450 | 1150 | 25021 |
| 2L-5S | | MI | 8465 | 3640 | 13681 | 2890 | 15773 | 2322 | 16556 | 1890 | 17012 | 1200 | 20716 | 719 | 16210 |
| 10-#14 | 2.11 | MA | 13484 | 3640 | 20842 | 2958 | 24795 | 2385 | 26888 | 1957 | 29254 | 1276 | 35933 | 1019 | 24874 |
| 3L-4S | | MI | 9046 | 3640 | 14555 | 2879 | 16822 | 2329 | 17801 | 1882 | 18704 | 1208 | 22774 | 781 | 17092 |
| 10-#14 | 2.11 | MA | 12579 | 3640 | 19610 | 2958 | 23131 | 2397 | 24871 | 1953 | 26558 | 1269 | 32965 | 887 | 24228 |
| 4L-3S | | MI | 9682 | 3640 | 15415 | 2883 | 17984 | 2322 | 19174 | 1890 | 20444 | 1200 | 24713 | 907 | 17578 |
| 10-#14 | 2.11 | MA | 11758 | 3640 | 18363 | 2973 | 21634 | 2395 | 23044 | 1963 | 24098 | 1276 | 29838 | 824 | 22712 |
| 5L-2S | | MI | 10542 | 3640 | 16555 | 2888 | 19430 | 2329 | 20892 | 1882 | 22704 | 1193 | 27664 | 1038 | 17641 |
| 10-#18 | 3.76 | MA | 15282 | 4276 | 25917 | 3334 | 31093 | 2655 | 34458 | 2133 | 39114 | 1218 | 48870 | 776 | 42618 |
| 3L-4S | | MI | 9755 | 4276 | 17386 | 3237 | 20122 | 2581 | 21671 | 2016 | 23813 | 1113 | 29511 | 369 | 27032 |
| 10-#18 | 3.76 | MA | 13784 | 4276 | 23759 | 3332 | 28177 | 2675 | 30925 | 2122 | 34451 | 1204 | 43776 | 543 | 38823 |
| 4L-3S | | MI | 10843 | 4276 | 18884 | 3248 | 22107 | 2568 | 24016 | 2029 | 26782 | 1100 | 32808 | 585 | 29692 |
| 10-#18 | 3.76 | MA | 12426 | 4276 | 21572 | 3356 | 25552 | 2668 | 27721 | 2137 | 30197 | 1218 | 38369 | 433 | 35569 |
| 5L-2S | | MI | 12236 | 4276 | 20860 | 3258 | 24576 | 2581 | 26948 | 2016 | 30641 | 1087 | 37807 | 819 | 30097 |
| 12-#11 | 1.76 | MA | 14145 | 3502 | 21093 | 2882 | 25185 | 2333 | 27390 | 1914 | 30016 | 1286 | 37005 | 1184 | 21046 |
| 2L-6S | | MI | 8300 | 3502 | 13031 | 2816 | 14985 | 2280 | 15666 | 1859 | 15883 | 1230 | 19233 | 806 | 13932 |
| 12-#11 | 1.76 | MA | 13263 | 3502 | 19938 | 2883 | 23720 | 2331 | 25615 | 1922 | 27629 | 1291 | 33822 | 1093 | 20984 |
| 3L-5S | | MI | 8696 | 3502 | 13577 | 2818 | 15711 | 2274 | 16534 | 1864 | 16996 | 1225 | 20596 | 868 | 14311 |
| 12-#11 | 1.76 | MA | 12622 | 3502 | 19078 | 2883 | 22557 | 2341 | 24207 | 1919 | 25734 | 1286 | 31728 | 1002 | 20820 |
| 4E | | MI | 9107 | 3502 | 14189 | 2810 | 16445 | 2279 | 17414 | 1859 | 18192 | 1230 | 22057 | 910 | 14821 |
| 12-#11 | 1.76 | MA | 12042 | 3502 | 18208 | 2893 | 21513 | 2339 | 22932 | 1927 | 24005 | 1291 | 29530 | 957 | 20050 |
| 5L-3S | | MI | 9559 | 3502 | 14791 | 2813 | 17259 | 2273 | 18385 | 1864 | 19423 | 1225 | 23432 | 999 | 14892 |
| 12-#11 | 1.76 | MA | 11485 | 3502 | 17434 | 2894 | 20481 | 2348 | 21676 | 1924 | 22343 | 1296 | 27309 | 882 | 19381 |
| 6L-2S | | MI | 10169 | 3502 | 15592 | 2815 | 18274 | 2277 | 19600 | 1859 | 21021 | 1220 | 25526 | 1090 | 14910 |
| 12-#14 | 2.54 | MA | 15469 | 3803 | 24145 | 3061 | 28984 | 2462 | 31962 | 1994 | 36047 | 1260 | 44968 | 1126 | 29892 |
| 2L-6S | | MI | 8438 | 3803 | 14042 | 2987 | 16182 | 2404 | 17046 | 1927 | 17698 | 1191 | 21747 | 590 | 18392 |
| 12-#14 | 2.54 | MA | 14243 | 3803 | 22493 | 3060 | 26890 | 2460 | 29425 | 2005 | 32650 | 1267 | 40450 | 995 | 29705 |
| 3L-5S | | MI | 8987 | 3803 | 14821 | 2992 | 17219 | 2397 | 18274 | 1934 | 19272 | 1183 | 23667 | 680 | 19419 |
| 12-#14 | 2.54 | MA | 13354 | 3803 | 21262 | 3060 | 25225 | 2472 | 27408 | 2000 | 29955 | 1260 | 37482 | 863 | 28852 |
| 4E | | MI | 9559 | 3803 | 15695 | 2981 | 18268 | 2404 | 19519 | 1927 | 20964 | 1191 | 25725 | 742 | 20243 |
| 12-#14 | 2.54 | MA | 12548 | 3803 | 20015 | 3075 | 23729 | 2470 | 25581 | 2010 | 27495 | 1267 | 34356 | 800 | 27411 |
| 5L-3S | | MI | 10186 | 3803 | 16555 | 2986 | 19430 | 2397 | 20892 | 1934 | 22704 | 1183 | 27664 | 867 | 20913 |
| 12-#14 | 2.54 | MA | 11774 | 3803 | 18906 | 3075 | 22251 | 2482 | 23783 | 2006 | 25129 | 1275 | 31202 | 691 | 25891 |
| 6L-2S | | MI | 11034 | 3803 | 17695 | 2990 | 20876 | 2404 | 22610 | 1927 | 24964 | 1176 | 30615 | 999 | 21010 |
| 12-#18 | 4.51 | MA | 15063 | 4566 | 26643 | 3513 | 31835 | 2808 | 35356 | 2206 | 40326 | 1185 | 51552 | 493 | 46958 |
| 4E | | MI | 10638 | 4566 | 19362 | 3419 | 22591 | 2711 | 24603 | 2090 | 27672 | 1078 | 34510 | 289 | 32525 |
| 12-#18 | 4.51 | MA | 13738 | 4566 | 24456 | 3537 | 29211 | 2801 | 32153 | 2222 | 36072 | 1198 | 46145 | 383 | 43574 |
| 5L-3S | | MI | 11653 | 4566 | 20860 | 3430 | 24576 | 2698 | 26948 | 2104 | 30641 | 1065 | 37807 | 505 | 35074 |
| 12-#18 | 4.51 | MA | 12466 | 4566 | 22510 | 3535 | 26618 | 2821 | 28998 | 2210 | 31980 | 1211 | 40719 | 189 | 40009 |
| 6L-2S | | MI | 13012 | 4566 | 22836 | 3440 | 27045 | 2711 | 29880 | 2090 | 34500 | 1052 | 42805 | 739 | 35884 |
| 14-#11 | 2.05 | MA | 14677 | 3616 | 22248 | 2953 | 26649 | 2384 | 29164 | 1947 | 32403 | 1280 | 40187 | 1169 | 24459 |
| 2L-7S | | MI | 8293 | 3616 | 13300 | 2884 | 15298 | 2327 | 16038 | 1896 | 16390 | 1225 | 19931 | 697 | 15542 |
| 14-#11 | 2.05 | MA | 13805 | 3616 | 21093 | 2953 | 25185 | 2383 | 27390 | 1955 | 30016 | 1286 | 37005 | 1078 | 24377 |
| 3L-6S | | MI | 8676 | 3616 | 13832 | 2887 | 16000 | 2332 | 16881 | 1891 | 17481 | 1220 | 21327 | 781 | 16208 |

## RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

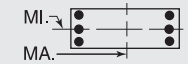
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.05 | MA | 13172 | 3616 | 20233 | 2954 | 24022 | 2392 | 25981 | 1952 | 28122 | 1280 | 34911 | 987 | 24189 |
| 4L-5S | | MI | 9067 | 3616 | 14377 | 2889 | 16726 | 2326 | 17749 | 1896 | 18594 | 1215 | 22691 | 843 | 16569 |
| 14-#11 | 2.05 | MA | 12600 | 3616 | 19363 | 2964 | 22977 | 2391 | 24706 | 1960 | 26393 | 1286 | 32713 | 942 | 23335 |
| 5L-4S | | MI | 9473 | 3616 | 14989 | 2881 | 17460 | 2331 | 18629 | 1891 | 19791 | 1220 | 24152 | 885 | 17156 |
| 14-#11 | 2.05 | MA | 12050 | 3616 | 18589 | 2964 | 21946 | 2400 | 23451 | 1957 | 24730 | 1291 | 30491 | 866 | 22692 |
| 6L-3S | | MI | 9920 | 3616 | 15592 | 2884 | 18274 | 2325 | 19600 | 1896 | 21021 | 1215 | 25526 | 974 | 17248 |
| 14-#11 | 2.05 | MA | 11512 | 3616 | 17836 | 2965 | 20950 | 2399 | 22233 | 1965 | 23044 | 1286 | 28517 | 795 | 21687 |
| 7L-2S | | MI | 10524 | 3616 | 16393 | 2886 | 19290 | 2329 | 20815 | 1891 | 22620 | 1209 | 27621 | 1065 | 17283 |
| 14-#14 | 2.96 | MA | 14987 | 3967 | 24145 | 3163 | 28984 | 2535 | 31962 | 2052 | 36047 | 1258 | 44968 | 971 | 34531 |
| 3L-6S | | MI | 8958 | 3967 | 15182 | 3090 | 17628 | 2479 | 18764 | 1971 | 19958 | 1174 | 24698 | 551 | 21536 |
| 14-#14 | 2.96 | MA | 14112 | 3967 | 22913 | 3162 | 27320 | 2547 | 29945 | 2047 | 33352 | 1251 | 42000 | 839 | 33496 |
| 4L-5S | | MI | 9500 | 3967 | 15961 | 3094 | 18665 | 2471 | 19992 | 1978 | 21532 | 1167 | 26617 | 640 | 22640 |
| 14-#14 | 2.96 | MA | 13320 | 3967 | 21666 | 3177 | 25823 | 2545 | 28119 | 2058 | 30892 | 1258 | 38874 | 776 | 32122 |
| 5L-4S | | MI | 10063 | 3967 | 16835 | 3083 | 19714 | 2479 | 21237 | 1971 | 23225 | 1174 | 28675 | 702 | 23412 |
| 14-#14 | 2.96 | MA | 12560 | 3967 | 20557 | 3177 | 24345 | 2557 | 26320 | 2053 | 28526 | 1266 | 35720 | 667 | 30531 |
| 6L-3S | | MI | 10682 | 3967 | 17695 | 3088 | 20876 | 2471 | 22610 | 1978 | 24964 | 1167 | 30615 | 828 | 24242 |
| 14-#14 | 2.96 | MA | 11815 | 3967 | 19477 | 3177 | 22917 | 2555 | 24576 | 2063 | 26127 | 1258 | 32921 | 564 | 28958 |
| 7L-2S | | MI | 11518 | 3967 | 18836 | 3092 | 22322 | 2479 | 24328 | 1971 | 27225 | 1159 | 33565 | 960 | 24370 |
| 14-#18 | 5.26 | MA | 15017 | 4857 | 27341 | 3719 | 32869 | 2934 | 36585 | 2306 | 41946 | 1178 | 53921 | 333 | 51610 |
| 5L-4S | | MI | 11455 | 4857 | 21338 | 3601 | 25060 | 2840 | 27535 | 2165 | 31530 | 1043 | 39508 | 209 | 38048 |
| 14-#18 | 5.26 | MA | 13775 | 4857 | 25394 | 3717 | 30276 | 2954 | 33430 | 2295 | 37855 | 1191 | 48495 | 138 | 47981 |
| 6L-3S | | MI | 12444 | 4857 | 22836 | 3611 | 27045 | 2827 | 29880 | 2178 | 34500 | 1030 | 42805 | 425 | 40418 |
| 16-#11 | 2.35 | MA | 14338 | 3729 | 22248 | 3024 | 26649 | 2435 | 29164 | 1987 | 32403 | 1280 | 40187 | 1062 | 27766 |
| 3L-7S | | MI | 8667 | 3729 | 14101 | 2955 | 16313 | 2379 | 17253 | 1927 | 17989 | 1214 | 22025 | 672 | 17777 |
| 16-#11 | 2.35 | MA | 13714 | 3729 | 21388 | 3025 | 25487 | 2444 | 27756 | 1985 | 30509 | 1275 | 38094 | 971 | 27557 |
| 4L-6S | | MI | 9046 | 3729 | 14633 | 2957 | 17015 | 2384 | 18096 | 1922 | 19080 | 1209 | 23422 | 755 | 18467 |
| 16-#11 | 2.35 | MA | 13148 | 3729 | 20518 | 3035 | 24442 | 2443 | 26481 | 1992 | 28780 | 1280 | 35896 | 926 | 26629 |
| 5E | | MI | 9432 | 3729 | 15178 | 2960 | 17741 | 2378 | 18964 | 1927 | 20193 | 1204 | 24786 | 817 | 18835 |
| 16-#11 | 2.35 | MA | 12606 | 3729 | 19744 | 3035 | 23411 | 2452 | 25225 | 1990 | 27117 | 1285 | 33674 | 851 | 26008 |
| 6L-4S | | MI | 9834 | 3729 | 15790 | 2952 | 18476 | 2382 | 19844 | 1922 | 21390 | 1209 | 26247 | 860 | 19479 |
| 16-#11 | 2.35 | MA | 12075 | 3729 | 18991 | 3036 | 22414 | 2451 | 24008 | 1997 | 25432 | 1280 | 31700 | 780 | 24959 |
| 7L-3S | | MI | 10276 | 3729 | 16393 | 2954 | 19290 | 2377 | 20815 | 1927 | 22620 | 1204 | 27621 | 949 | 19600 |
| 16-#11 | 2.35 | MA | 11550 | 3729 | 18249 | 3036 | 21438 | 2450 | 22788 | 1995 | 23805 | 1285 | 29648 | 728 | 23993 |
| 8L-2S | | MI | 10875 | 3729 | 17193 | 2957 | 20305 | 2381 | 22030 | 1922 | 24219 | 1199 | 29716 | 1040 | 19650 |
| 16-#14 | 3.38 | MA | 14857 | 4130 | 24564 | 3265 | 29414 | 2622 | 32483 | 2095 | 36748 | 1241 | 46518 | 815 | 38158 |
| 4L-6S | | MI | 9469 | 4130 | 16322 | 3192 | 19074 | 2554 | 20482 | 2015 | 22219 | 1157 | 27649 | 512 | 24694 |
| 16-#14 | 3.38 | MA | 14077 | 4130 | 23317 | 3279 | 27917 | 2619 | 30656 | 2105 | 34288 | 1249 | 43391 | 751 | 36844 |
| 5E | | MI | 10003 | 4130 | 17101 | 3196 | 20111 | 2546 | 21709 | 2023 | 23792 | 1150 | 29568 | 601 | 25870 |
| 16-#14 | 3.38 | MA | 13330 | 4130 | 22208 | 3279 | 26439 | 2632 | 28857 | 2100 | 31923 | 1256 | 40238 | 643 | 35184 |
| 6L-4S | | MI | 10559 | 4130 | 17975 | 3186 | 21160 | 2554 | 22955 | 2015 | 25485 | 1157 | 31626 | 663 | 26598 |
| 16-#14 | 3.38 | MA | 12597 | 4130 | 21129 | 3279 | 25011 | 2629 | 27113 | 2111 | 29524 | 1249 | 37438 | 540 | 33569 |
| 7L-3S | | MI | 11169 | 4130 | 18836 | 3190 | 22322 | 2546 | 24328 | 2023 | 27225 | 1150 | 33565 | 789 | 27565 |
| 16-#14 | 3.38 | MA | 11873 | 4130 | 20066 | 3279 | 23611 | 2627 | 25365 | 2106 | 27209 | 1256 | 34520 | 466 | 31605 |
| 8L-2S | | MI | 11996 | 4130 | 19976 | 3194 | 23768 | 2554 | 26046 | 2015 | 29485 | 1142 | 36516 | 920 | 27723 |
| 16-#18 | 6.02 | MA | 15159 | 5148 | 28279 | 3899 | 33934 | 3087 | 37862 | 2379 | 43730 | 1171 | 56270 | 88 | 55816 |
| 6L-4S | | MI | 12255 | 5148 | 23313 | 3783 | 27529 | 2970 | 30468 | 2240 | 35389 | 1008 | 44507 | 128 | 43593 |
| 18-#11 | 2.64 | MA | 14246 | 3842 | 22543 | 3095 | 26952 | 2496 | 29530 | 2018 | 32896 | 1269 | 41276 | 956 | 30924 |
| 4L-7S | | MI | 9036 | 3842 | 14902 | 3026 | 17329 | 2431 | 18468 | 1959 | 19587 | 1204 | 24120 | 647 | 20020 |
| 18-#11 | 2.64 | MA | 13688 | 3842 | 21673 | 3106 | 25907 | 2495 | 28255 | 2025 | 31167 | 1274 | 39079 | 911 | 29931 |
| 5L-6S | | MI | 9410 | 3842 | 15433 | 3028 | 18031 | 2436 | 19311 | 1954 | 20678 | 1199 | 25517 | 730 | 20681 |
| 18-#11 | 2.64 | MA | 13153 | 3842 | 20899 | 3106 | 24876 | 2504 | 27000 | 2023 | 29505 | 1280 | 36857 | 836 | 29329 |
| 6L-5S | | MI | 9792 | 3842 | 15978 | 3031 | 18757 | 2430 | 20179 | 1959 | 21792 | 1193 | 26881 | 792 | 21107 |
| 18-#11 | 2.64 | MA | 12628 | 3842 | 20146 | 3106 | 23879 | 2503 | 25783 | 2030 | 27819 | 1274 | 34883 | 765 | 28239 |
| 7L-4S | | MI | 10190 | 3842 | 16590 | 3023 | 19491 | 2434 | 21059 | 1954 | 22988 | 1199 | 28341 | 835 | 21717 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis

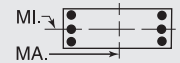



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.64 | MA | 12110 | 3842 | 19404 | 3107 | 22902 | 2502 | 24563 | 2028 | 26192 | 1280 | 32831 | 713 | 27242 |
| 8L-3S | | MI | 10628 | 3842 | 17193 | 3025 | 20305 | 2428 | 22030 | 1959 | 24219 | 1193 | 29716 | 923 | 21947 |
| 18-#11 | 2.64 | MA | 11595 | 3842 | 18586 | 3117 | 21896 | 2511 | 23363 | 2035 | 24581 | 1285 | 30815 | 654 | 26096 |
| 9L-2S | | MI | 11220 | 3842 | 17994 | 3028 | 21320 | 2433 | 23245 | 1954 | 25817 | 1188 | 31811 | 1015 | 22012 |
| 18-#14 | 3.81 | MA | 14822 | 4294 | 24969 | 3382 | 30011 | 2694 | 33193 | 2152 | 37685 | 1240 | 47909 | 727 | 41575 |
| 5L-6S | | MI | 9973 | 4294 | 17462 | 3294 | 20521 | 2629 | 22200 | 2060 | 24479 | 1141 | 30600 | 472 | 27864 |
| 18-#14 | 3.81 | MA | 14085 | 4294 | 23860 | 3381 | 28534 | 2707 | 31395 | 2148 | 35320 | 1247 | 44756 | 618 | 39848 |
| 6L-5S | | MI | 10499 | 4294 | 18242 | 3298 | 21558 | 2621 | 23427 | 2067 | 26053 | 1133 | 32519 | 562 | 29108 |
| 18-#14 | 3.81 | MA | 13364 | 4294 | 22780 | 3381 | 27105 | 2704 | 29650 | 2158 | 32921 | 1240 | 41956 | 516 | 38191 |
| 7L-4S | | MI | 11048 | 4294 | 19115 | 3288 | 22606 | 2628 | 24673 | 2060 | 27745 | 1141 | 34577 | 624 | 29797 |
| 18-#14 | 3.81 | MA | 12652 | 4294 | 21717 | 3381 | 25706 | 2702 | 27902 | 2153 | 30606 | 1247 | 39037 | 442 | 36278 |
| 8L-3S | | MI | 11650 | 4294 | 19976 | 3292 | 23768 | 2621 | 26046 | 2067 | 29485 | 1133 | 36516 | 750 | 30885 |
| 20-#11 | 2.93 | MA | 14220 | 3956 | 22828 | 3177 | 27372 | 2547 | 30030 | 2058 | 33555 | 1269 | 42262 | 896 | 33238 |
| 5L-7S | | MI | 9399 | 3956 | 15702 | 3097 | 18344 | 2483 | 19683 | 1990 | 21186 | 1193 | 26215 | 622 | 22269 |
| 20-#11 | 2.93 | MA | 13691 | 3956 | 22054 | 3177 | 26340 | 2556 | 28775 | 2055 | 31892 | 1274 | 40040 | 820 | 32617 |
| 6E | | MI | 9770 | 3956 | 16234 | 3099 | 19046 | 2488 | 20526 | 1985 | 22277 | 1188 | 27611 | 705 | 22904 |
| 20-#11 | 2.93 | MA | 13173 | 3956 | 21301 | 3177 | 25344 | 2555 | 27557 | 2063 | 30206 | 1269 | 38065 | 749 | 31524 |
| 7L-5S | | MI | 10148 | 3956 | 16779 | 3102 | 19772 | 2482 | 21394 | 1990 | 23390 | 1183 | 28975 | 767 | 23385 |
| 20-#11 | 2.93 | MA | 12661 | 3956 | 20559 | 3178 | 24367 | 2553 | 26337 | 2060 | 28579 | 1274 | 36013 | 697 | 30498 |
| 8L-4S | | MI | 10542 | 3956 | 17391 | 3094 | 20506 | 2486 | 22274 | 1985 | 24587 | 1188 | 30436 | 810 | 23964 |
| 20-#11 | 2.93 | MA | 12153 | 3956 | 19741 | 3188 | 23361 | 2563 | 25137 | 2068 | 26968 | 1279 | 33998 | 638 | 29378 |
| 9L-3S | | MI | 10975 | 3956 | 17994 | 3096 | 21320 | 2480 | 23245 | 1990 | 25817 | 1183 | 31811 | 898 | 24291 |
| 20-#11 | 2.93 | MA | 11647 | 3956 | 19002 | 3188 | 22391 | 2561 | 23932 | 2065 | 25312 | 1274 | 32043 | 572 | 28040 |
| 10L-2S | | MI | 11562 | 3956 | 18794 | 3099 | 22335 | 2485 | 24460 | 1985 | 27416 | 1178 | 33905 | 989 | 24370 |
| 20-#14 | 4.23 | MA | 14829 | 4457 | 25511 | 3484 | 30628 | 2781 | 33932 | 2195 | 38716 | 1238 | 49274 | 594 | 44522 |
| 6E | | MI | 10469 | 4457 | 18602 | 3396 | 21967 | 2703 | 23918 | 2104 | 26739 | 1124 | 33550 | 433 | 31044 |
| 20-#14 | 4.23 | MA | 14119 | 4457 | 24431 | 3483 | 29200 | 2779 | 32187 | 2205 | 36317 | 1231 | 46474 | 492 | 42823 |
| 7L-5S | | MI | 10989 | 4457 | 19382 | 3401 | 23004 | 2696 | 25145 | 2111 | 28313 | 1116 | 35470 | 523 | 32274 |
| 20-#14 | 4.23 | MA | 13417 | 4457 | 23368 | 3483 | 27800 | 2777 | 30439 | 2201 | 34003 | 1238 | 43555 | 418 | 40941 |
| 8L-4S | | MI | 11530 | 4457 | 20256 | 3390 | 24052 | 2703 | 26390 | 2104 | 30006 | 1124 | 37527 | 585 | 33007 |
| 22-#11 | 3.23 | MA | 14223 | 4069 | 23209 | 3248 | 27805 | 2608 | 30549 | 2088 | 34279 | 1268 | 43223 | 805 | 35878 |
| 6L-7S | | MI | 9759 | 4069 | 16503 | 3168 | 19359 | 2535 | 20899 | 2022 | 22785 | 1183 | 28310 | 597 | 24523 |
| 22-#11 | 3.23 | MA | 13711 | 4069 | 22456 | 3248 | 26809 | 2607 | 29332 | 2096 | 32594 | 1263 | 41248 | 734 | 34815 |
| 7L-6S | | MI | 10125 | 4069 | 17034 | 3170 | 20061 | 2539 | 21741 | 2017 | 23876 | 1177 | 29706 | 680 | 25134 |
| 22-#11 | 3.23 | MA | 13205 | 4069 | 21714 | 3248 | 25832 | 2605 | 28112 | 2093 | 30967 | 1268 | 39196 | 682 | 33759 |
| 8L-5S | | MI | 10500 | 4069 | 17580 | 3173 | 20787 | 2534 | 22609 | 2022 | 24989 | 1172 | 31070 | 742 | 25666 |
| 22-#11 | 3.23 | MA | 12703 | 4069 | 20895 | 3259 | 24826 | 2614 | 26912 | 2101 | 29356 | 1274 | 37181 | 623 | 32644 |
| 9L-4S | | MI | 10890 | 4069 | 18191 | 3165 | 21522 | 2538 | 23490 | 2017 | 26185 | 1177 | 32531 | 785 | 26218 |
| 22-#11 | 3.23 | MA | 12202 | 4069 | 20157 | 3259 | 23856 | 2613 | 25706 | 2098 | 27699 | 1268 | 35226 | 557 | 31308 |
| 10L-3S | | MI | 11318 | 4069 | 18794 | 3167 | 22335 | 2532 | 24460 | 2022 | 27416 | 1172 | 33905 | 873 | 26632 |
| 22-#14 | 4.65 | MA | 14862 | 4621 | 26083 | 3586 | 31294 | 2854 | 34725 | 2253 | 39714 | 1222 | 50992 | 468 | 47406 |
| 7L-6S | | MI | 11005 | 4621 | 19743 | 3499 | 23413 | 2778 | 25636 | 2148 | 28999 | 1107 | 36501 | 394 | 34234 |
| 22-#14 | 4.65 | MA | 14170 | 4621 | 25020 | 3585 | 29894 | 2851 | 32977 | 2248 | 37400 | 1229 | 48073 | 394 | 45559 |
| 8L-5S | | MI | 11512 | 4621 | 20522 | 3503 | 24450 | 2771 | 26863 | 2156 | 30573 | 1100 | 38420 | 484 | 35413 |
| 24-#11 | 3.52 | MA | 14241 | 4183 | 23611 | 3319 | 28273 | 2658 | 31106 | 2129 | 34981 | 1258 | 44431 | 719 | 38111 |
| 7E | | MI | 10114 | 4183 | 17303 | 3239 | 20375 | 2587 | 22114 | 2053 | 24383 | 1172 | 30404 | 571 | 26782 |
| 24-#11 | 3.52 | MA | 13741 | 4183 | 22869 | 3319 | 27297 | 2657 | 29887 | 2126 | 33354 | 1263 | 42379 | 667 | 36995 |
| 8L-6S | | MI | 10477 | 4183 | 17835 | 3241 | 21077 | 2591 | 22956 | 2048 | 25474 | 1167 | 31801 | 655 | 27371 |
| 24-#11 | 3.52 | MA | 13245 | 4183 | 22050 | 3330 | 26290 | 2666 | 28687 | 2134 | 31743 | 1268 | 40364 | 608 | 35891 |
| 9L-5S | | MI | 10848 | 4183 | 18380 | 3243 | 21803 | 2585 | 23824 | 2053 | 26587 | 1162 | 33165 | 717 | 27952 |
| 24-#11 | 3.52 | MA | 12750 | 4183 | 21312 | 3330 | 25320 | 2665 | 27481 | 2131 | 30087 | 1263 | 38409 | 542 | 34579 |
| 10L-4S | | MI | 11234 | 4183 | 18992 | 3235 | 22537 | 2590 | 24705 | 2048 | 27784 | 1167 | 34626 | 760 | 28479 |
| 24-#14 | 5.08 | MA | 14912 | 4785 | 26671 | 3688 | 31989 | 2926 | 35514 | 2296 | 40796 | 1220 | 52591 | 370 | 50184 |
| 8L-6S | | MI | 11486 | 4785 | 20883 | 3601 | 24859 | 2853 | 27353 | 2193 | 31260 | 1091 | 39452 | 355 | 37433 |

## RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

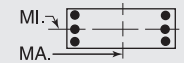
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.43 | MA | 14907 | 3552 | 21978 | 2930 | 25990 | 2378 | 27965 | 1962 | 29893 | 1343 | 36413 | 1241 | 18850 |
| 2E | | MI | 10150 | 3552 | 15511 | 2837 | 17813 | 2294 | 18798 | 1878 | 19661 | 1258 | 23485 | 1124 | 12614 |
| 6-#14 | 1.21 | MA | 14532 | 3461 | 20954 | 2893 | 24839 | 2352 | 26634 | 1950 | 28262 | 1365 | 34341 | 1277 | 16150 |
| 2L-3S | | MI | 9059 | 3461 | 13706 | 2804 | 15734 | 2275 | 16386 | 1888 | 16523 | 1301 | 19491 | 1050 | 10907 |
| 6-#14 | 1.21 | MA | 13161 | 3461 | 19200 | 2893 | 22615 | 2351 | 23940 | 1961 | 24637 | 1372 | 29508 | 1145 | 16103 |
| 3L-2S | | MI | 9946 | 3461 | 14846 | 2808 | 17180 | 2282 | 18104 | 1881 | 18783 | 1293 | 22442 | 1181 | 10879 |
| 6-#18 | 2.14 | MA | 16315 | 3843 | 25044 | 3112 | 29879 | 2511 | 32676 | 2046 | 36172 | 1325 | 44747 | 1195 | 27926 |
| 2L-3S | | MI | 9524 | 3843 | 15511 | 3008 | 17813 | 2410 | 18798 | 1966 | 19661 | 1236 | 23485 | 810 | 18347 |
| 6-#18 | 2.14 | MA | 14006 | 3843 | 21978 | 3111 | 25990 | 2505 | 27965 | 2063 | 29893 | 1338 | 36413 | 961 | 27506 |
| 3L-2S | | MI | 11012 | 3843 | 17486 | 3019 | 20282 | 2424 | 21730 | 1953 | 23520 | 1223 | 28484 | 1044 | 18509 |
| 8-#11 | 1.11 | MA | 14377 | 3424 | 20518 | 2880 | 24362 | 2343 | 26088 | 1946 | 27578 | 1374 | 33496 | 1292 | 15037 |
| 2L-4S | | MI | 8773 | 3424 | 13155 | 2794 | 15056 | 2278 | 15632 | 1884 | 15597 | 1319 | 18550 | 1026 | 10174 |
| 8-#11 | 1.11 | MA | 13414 | 3424 | 19293 | 2880 | 22807 | 2343 | 24205 | 1954 | 25037 | 1379 | 30095 | 1201 | 15023 |
| 3E | | MI | 9236 | 3424 | 13758 | 2797 | 15869 | 2273 | 16603 | 1889 | 16827 | 1314 | 19924 | 1114 | 10183 |
| 8-#11 | 1.11 | MA | 12714 | 3424 | 18381 | 2881 | 21575 | 2352 | 22712 | 1952 | 23022 | 1374 | 27855 | 1110 | 14919 |
| 4L-2S | | MI | 9862 | 3424 | 14559 | 2799 | 16885 | 2277 | 17818 | 1884 | 18426 | 1309 | 22019 | 1206 | 10158 |
| 8-#14 | 1.61 | MA | 15364 | 3625 | 22707 | 2995 | 27063 | 2427 | 29328 | 1997 | 31886 | 1357 | 39173 | 1255 | 21354 |
| 2L-4S | | MI | 8938 | 3625 | 13986 | 2902 | 16018 | 2357 | 16731 | 1925 | 17044 | 1291 | 20503 | 885 | 14138 |
| 8-#14 | 1.61 | MA | 14016 | 3625 | 20954 | 2996 | 24839 | 2425 | 26634 | 2008 | 28262 | 1364 | 34341 | 1123 | 21253 |
| 3E | | MI | 9587 | 3625 | 14846 | 2906 | 17180 | 2350 | 18104 | 1933 | 18783 | 1284 | 22442 | 1011 | 14277 |
| 8-#14 | 1.61 | MA | 13036 | 3625 | 19648 | 2996 | 23074 | 2438 | 24495 | 2004 | 25385 | 1357 | 31162 | 992 | 20888 |
| 4L-2S | | MI | 10461 | 3625 | 15986 | 2910 | 18626 | 2357 | 19822 | 1925 | 21044 | 1277 | 25393 | 1142 | 14290 |
| 8-#18 | 2.86 | MA | 17673 | 4133 | 28110 | 3294 | 33768 | 2644 | 37388 | 2131 | 42452 | 1307 | 53081 | 1149 | 36966 |
| 2L-4S | | MI | 9307 | 4133 | 15988 | 3179 | 18297 | 2553 | 19385 | 2027 | 20551 | 1215 | 25187 | 513 | 21803 |
| 8-#18 | 2.86 | MA | 15421 | 4133 | 25044 | 3293 | 29879 | 2638 | 32676 | 2148 | 36172 | 1321 | 44747 | 915 | 36412 |
| 3E | | MI | 10391 | 4133 | 17486 | 3190 | 20282 | 2540 | 21730 | 2041 | 23520 | 1201 | 28484 | 730 | 24074 |
| 8-#18 | 2.86 | MA | 13783 | 4133 | 22754 | 3291 | 26785 | 2659 | 28927 | 2138 | 31189 | 1307 | 39279 | 681 | 32877 |
| 4L-2S | | MI | 11847 | 4133 | 19462 | 3200 | 22751 | 2553 | 24662 | 2027 | 27379 | 1188 | 33482 | 963 | 24347 |
| 10-#11 | 1.39 | MA | 14968 | 3537 | 21744 | 2951 | 25916 | 2395 | 27972 | 1979 | 30119 | 1368 | 36898 | 1278 | 18679 |
| 2L-5S | | MI | 8735 | 3537 | 13344 | 2873 | 15337 | 2326 | 15967 | 1921 | 15999 | 1303 | 19184 | 958 | 12178 |
| 10-#11 | 1.39 | MA | 14016 | 3537 | 20518 | 2951 | 24362 | 2395 | 26088 | 1987 | 27578 | 1374 | 33496 | 1187 | 18639 |
| 3L-4S | | MI | 9152 | 3537 | 13956 | 2865 | 16071 | 2330 | 16847 | 1915 | 17195 | 1308 | 20645 | 1001 | 12528 |
| 10-#11 | 1.39 | MA | 13326 | 3537 | 19607 | 2952 | 23130 | 2404 | 24595 | 1985 | 25563 | 1369 | 31256 | 1096 | 18503 |
| 4L-3S | | MI | 9611 | 3537 | 14559 | 2868 | 16885 | 2324 | 17818 | 1921 | 18426 | 1303 | 22019 | 1089 | 12564 |
| 10-#11 | 1.39 | MA | 12701 | 3537 | 18685 | 2963 | 22023 | 2403 | 23244 | 1993 | 23724 | 1374 | 28913 | 1051 | 17875 |
| 5L-2S | | MI | 10230 | 3537 | 15359 | 2870 | 17900 | 2329 | 19033 | 1915 | 20024 | 1298 | 24114 | 1180 | 12556 |
| 10-#14 | 2.01 | MA | 16176 | 3788 | 24461 | 3098 | 29287 | 2502 | 32023 | 2044 | 35511 | 1349 | 44006 | 1233 | 26540 |
| 2L-5S | | MI | 8881 | 3788 | 14252 | 3015 | 16415 | 2425 | 17204 | 1977 | 17612 | 1267 | 21395 | 784 | 16356 |
| 10-#14 | 2.01 | MA | 14849 | 3788 | 22707 | 3098 | 27063 | 2500 | 29328 | 2055 | 31886 | 1356 | 39173 | 1101 | 26393 |
| 3L-4S | | MI | 9464 | 3788 | 15126 | 3004 | 17464 | 2432 | 18449 | 1970 | 19304 | 1275 | 23453 | 846 | 17260 |
| 10-#14 | 2.01 | MA | 13886 | 3788 | 21402 | 3098 | 25298 | 2513 | 27190 | 2052 | 29010 | 1349 | 35994 | 970 | 25894 |
| 4L-3S | | MI | 10103 | 3788 | 15986 | 3008 | 18626 | 2425 | 19822 | 1977 | 21044 | 1267 | 25393 | 971 | 17629 |
| 10-#14 | 2.01 | MA | 13014 | 3788 | 20080 | 3114 | 23712 | 2512 | 25254 | 2063 | 26385 | 1356 | 32657 | 905 | 24210 |
| 5L-2S | | MI | 10965 | 3788 | 17127 | 3013 | 20072 | 2432 | 21540 | 1970 | 23304 | 1260 | 28343 | 1103 | 17681 |
| 10-#18 | 3.57 | MA | 16791 | 4424 | 28110 | 3474 | 33768 | 2771 | 37388 | 2232 | 42452 | 1303 | 53081 | 869 | 45318 |
| 3L-4S | | MI | 10174 | 4424 | 17964 | 3361 | 20766 | 2683 | 22317 | 2102 | 24410 | 1180 | 30185 | 433 | 27255 |
| 10-#18 | 3.57 | MA | 15195 | 4424 | 25820 | 3473 | 30673 | 2792 | 33638 | 2222 | 37468 | 1289 | 47613 | 635 | 41499 |
| 4L-3S | | MI | 11235 | 4424 | 19462 | 3372 | 22751 | 2670 | 24662 | 2115 | 27379 | 1166 | 33482 | 650 | 29787 |
| 10-#18 | 3.57 | MA | 13748 | 4424 | 23500 | 3498 | 27889 | 2787 | 30240 | 2239 | 32921 | 1303 | 41833 | 524 | 38229 |
| 5L-2S | | MI | 12663 | 4424 | 21438 | 3382 | 25220 | 2683 | 27595 | 2102 | 31238 | 1153 | 38481 | 883 | 30156 |
| 12-#11 | 1.67 | MA | 15547 | 3651 | 22970 | 3022 | 27471 | 2447 | 29855 | 2011 | 32661 | 1363 | 40299 | 1264 | 22309 |
| 2L-6S | | MI | 8716 | 3651 | 13599 | 2941 | 15626 | 2384 | 16314 | 1947 | 16484 | 1298 | 19915 | 871 | 14042 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis

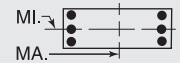


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.67 | MA | 14607 | 3651 | 21744 | 3022 | 25916 | 2446 | 27972 | 2020 | 30119 | 1369 | 36898 | 1173 | 22247 |
| 3L-5S | | MI | 9113 | 3651 | 14145 | 2944 | 16352 | 2378 | 17182 | 1952 | 17597 | 1293 | 21279 | 933 | 14425 |
| 12-#11 | 1.67 | MA | 13926 | 3651 | 20833 | 3023 | 24684 | 2456 | 26479 | 2017 | 28104 | 1364 | 34658 | 1082 | 22084 |
| 4E | | MI | 9526 | 3651 | 14756 | 2936 | 17086 | 2382 | 18062 | 1947 | 18794 | 1298 | 22739 | 976 | 14873 |
| 12-#11 | 1.67 | MA | 13309 | 3651 | 19911 | 3034 | 23578 | 2455 | 25128 | 2026 | 26265 | 1369 | 32314 | 1037 | 21354 |
| 5L-3S | | MI | 9979 | 3651 | 15359 | 2938 | 17900 | 2376 | 19033 | 1952 | 20024 | 1293 | 24114 | 1064 | 14931 |
| 12-#11 | 1.67 | MA | 12718 | 3651 | 19091 | 3034 | 22485 | 2465 | 23798 | 2023 | 24497 | 1375 | 29939 | 961 | 20617 |
| 6L-2S | | MI | 10591 | 3651 | 16160 | 2941 | 18915 | 2381 | 20248 | 1947 | 21623 | 1288 | 26208 | 1155 | 14943 |
| 12-#14 | 2.41 | MA | 16971 | 3952 | 26215 | 3200 | 31511 | 2577 | 34717 | 2092 | 39136 | 1341 | 48838 | 1211 | 31715 |
| 2L-6S | | MI | 8853 | 3952 | 14613 | 3113 | 16824 | 2507 | 17694 | 2014 | 18298 | 1258 | 22427 | 655 | 18622 |
| 12-#14 | 2.41 | MA | 15663 | 3952 | 24461 | 3200 | 29287 | 2575 | 32023 | 2103 | 35511 | 1348 | 44006 | 1079 | 31527 |
| 3L-5S | | MI | 9405 | 3952 | 15392 | 3117 | 17861 | 2500 | 18921 | 2021 | 19872 | 1251 | 24346 | 745 | 19564 |
| 12-#14 | 2.41 | MA | 14717 | 3952 | 23155 | 3200 | 27522 | 2588 | 29884 | 2099 | 32635 | 1341 | 40827 | 948 | 30810 |
| 4E | | MI | 9979 | 3952 | 16266 | 3106 | 18910 | 2507 | 20167 | 2014 | 21564 | 1258 | 26404 | 807 | 20407 |
| 12-#14 | 2.41 | MA | 13860 | 3952 | 21834 | 3216 | 25936 | 2586 | 27948 | 2110 | 30010 | 1348 | 37490 | 883 | 29205 |
| 5L-3S | | MI | 10609 | 3952 | 17127 | 3111 | 20072 | 2499 | 21540 | 2021 | 23304 | 1251 | 28343 | 932 | 20969 |
| 12-#14 | 2.41 | MA | 13037 | 3952 | 20659 | 3216 | 24370 | 2599 | 26042 | 2106 | 27485 | 1356 | 34116 | 774 | 27713 |
| 6L-2S | | MI | 11460 | 3952 | 18267 | 3115 | 21518 | 2507 | 23258 | 2014 | 25564 | 1243 | 31294 | 1064 | 21053 |
| 12-#18 | 4.29 | MA | 16568 | 4715 | 28886 | 3655 | 34562 | 2925 | 38349 | 2307 | 43748 | 1272 | 55947 | 589 | 50159 |
| 4E | | MI | 11062 | 4715 | 19940 | 3543 | 23235 | 2813 | 25250 | 2177 | 28269 | 1145 | 35184 | 353 | 32743 |
| 12-#18 | 4.29 | MA | 15156 | 4715 | 26567 | 3680 | 31778 | 2920 | 34952 | 2324 | 39200 | 1285 | 50167 | 478 | 46762 |
| 5L-3S | | MI | 12085 | 4715 | 21438 | 3553 | 25220 | 2799 | 27595 | 2190 | 31238 | 1131 | 38481 | 569 | 35372 |
| 12-#18 | 4.29 | MA | 13801 | 4715 | 24503 | 3679 | 29029 | 2941 | 31606 | 2314 | 34827 | 1298 | 44351 | 284 | 43115 |
| 6L-2S | | MI | 13454 | 4715 | 23414 | 3564 | 27688 | 2813 | 30527 | 2177 | 35097 | 1118 | 43480 | 803 | 35947 |
| 14-#11 | 1.95 | MA | 16118 | 3764 | 24196 | 3092 | 29026 | 2499 | 31739 | 2044 | 35202 | 1358 | 43700 | 1251 | 25934 |
| 2L-7S | | MI | 8708 | 3764 | 13868 | 3010 | 15939 | 2431 | 16686 | 1984 | 16992 | 1292 | 20613 | 762 | 15712 |
| 14-#11 | 1.95 | MA | 15188 | 3764 | 22970 | 3093 | 27471 | 2498 | 29855 | 2052 | 32661 | 1364 | 40299 | 1159 | 25851 |
| 3L-6S | | MI | 9092 | 3764 | 14400 | 3012 | 16641 | 2435 | 17529 | 1979 | 18083 | 1287 | 22009 | 846 | 16319 |
| 14-#11 | 1.95 | MA | 14515 | 3764 | 22059 | 3094 | 26239 | 2508 | 28362 | 2050 | 30645 | 1359 | 38059 | 1068 | 25663 |
| 4L-5S | | MI | 9485 | 3764 | 14945 | 3015 | 17367 | 2430 | 18397 | 1984 | 19196 | 1282 | 23373 | 908 | 16682 |
| 14-#11 | 1.95 | MA | 13907 | 3764 | 21137 | 3105 | 25132 | 2507 | 27011 | 2058 | 28806 | 1364 | 35715 | 1023 | 24844 |
| 5L-4S | | MI | 9893 | 3764 | 15557 | 3007 | 18101 | 2434 | 19277 | 1979 | 20393 | 1287 | 24834 | 951 | 17212 |
| 14-#11 | 1.95 | MA | 13323 | 3764 | 20317 | 3105 | 24040 | 2517 | 25682 | 2056 | 27038 | 1369 | 33341 | 947 | 24135 |
| 6L-3S | | MI | 10342 | 3764 | 16160 | 3009 | 18915 | 2428 | 20248 | 1984 | 21623 | 1282 | 26208 | 1039 | 17291 |
| 14-#11 | 1.95 | MA | 12751 | 3764 | 19520 | 3106 | 22985 | 2516 | 24393 | 2064 | 25245 | 1365 | 31229 | 876 | 23149 |
| 7L-2S | | MI | 10948 | 3764 | 16960 | 3012 | 19931 | 2433 | 21463 | 1979 | 23222 | 1277 | 28303 | 1130 | 17319 |
| 14-#14 | 2.81 | MA | 16462 | 4115 | 26215 | 3302 | 31511 | 2650 | 34717 | 2150 | 39136 | 1340 | 48838 | 1057 | 36658 |
| 3L-6S | | MI | 9374 | 4115 | 15753 | 3215 | 18270 | 2582 | 19412 | 2058 | 20558 | 1241 | 25378 | 616 | 21762 |
| 14-#14 | 2.81 | MA | 15531 | 4115 | 24909 | 3303 | 29746 | 2663 | 32578 | 2146 | 36260 | 1333 | 45659 | 926 | 35747 |
| 4L-5S | | MI | 9919 | 4115 | 16532 | 3219 | 19308 | 2574 | 20639 | 2066 | 22132 | 1234 | 27297 | 705 | 22783 |
| 14-#14 | 2.81 | MA | 14688 | 4115 | 23587 | 3318 | 28160 | 2661 | 30643 | 2157 | 33635 | 1340 | 42323 | 861 | 34214 |
| 5L-4S | | MI | 10485 | 4115 | 17406 | 3209 | 20356 | 2582 | 21884 | 2058 | 23825 | 1241 | 29355 | 767 | 23574 |
| 14-#14 | 2.81 | MA | 13879 | 4115 | 22413 | 3318 | 26594 | 2674 | 28737 | 2153 | 31110 | 1348 | 38949 | 752 | 32649 |
| 6L-3S | | MI | 11107 | 4115 | 18267 | 3213 | 21518 | 2574 | 23258 | 2066 | 25564 | 1234 | 31294 | 893 | 24302 |
| 14-#14 | 2.81 | MA | 13087 | 4115 | 21269 | 3319 | 25081 | 2673 | 26888 | 2165 | 28551 | 1340 | 35951 | 650 | 31050 |
| 7L-2S | | MI | 11947 | 4115 | 19407 | 3217 | 22964 | 2582 | 24975 | 2058 | 27825 | 1226 | 34245 | 1025 | 24416 |
| 14-#18 | 5.00 | MA | 16528 | 5006 | 29633 | 3862 | 35667 | 3053 | 39663 | 2408 | 45480 | 1267 | 58501 | 431 | 55324 |
| 5L-4S | | MI | 11883 | 5006 | 21916 | 3725 | 25704 | 2942 | 28182 | 2252 | 32128 | 1110 | 40182 | 273 | 38262 |
| 14-#18 | 5.00 | MA | 15204 | 5006 | 27570 | 3860 | 32917 | 3074 | 36317 | 2398 | 41107 | 1280 | 52685 | 238 | 51618 |
| 6L-3S | | MI | 12880 | 5006 | 23414 | 3735 | 27688 | 2929 | 30527 | 2265 | 35097 | 1096 | 43480 | 489 | 40709 |
| 16-#11 | 2.23 | MA | 15760 | 3877 | 24196 | 3164 | 29026 | 2550 | 31739 | 2085 | 35202 | 1358 | 43700 | 1145 | 29451 |
| 3L-7S | | MI | 9083 | 3877 | 14669 | 3081 | 16954 | 2483 | 17901 | 2015 | 18590 | 1282 | 22707 | 737 | 17945 |
| 16-#11 | 2.23 | MA | 15095 | 3877 | 23285 | 3165 | 27794 | 2560 | 30246 | 2083 | 33186 | 1353 | 41460 | 1054 | 29242 |
| 4L-6S | | MI | 9463 | 3877 | 15200 | 3083 | 17657 | 2487 | 18744 | 2010 | 19681 | 1277 | 24104 | 821 | 18601 |
| 16-#11 | 2.23 | MA | 14494 | 3877 | 22362 | 3175 | 26687 | 2559 | 28895 | 2091 | 31347 | 1359 | 39117 | 1009 | 28343 |
| 5E | | MI | 9851 | 3877 | 15746 | 3086 | 18382 | 2481 | 19612 | 2015 | 20795 | 1272 | 25468 | 883 | 18947 |
| 16-#11 | 2.23 | MA | 13918 | 3877 | 21543 | 3176 | 25595 | 2568 | 27565 | 2089 | 29579 | 1364 | 36742 | 933 | 27659 |
| 6L-4S | | MI | 10256 | 3877 | 16357 | 3078 | 19117 | 2486 | 20492 | 2010 | 21991 | 1277 | 26929 | 925 | 19547 |

## RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

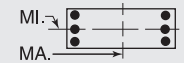
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.23 | MA | 13353 | 3877 | 20746 | 3177 | 24539 | 2568 | 26276 | 2097 | 27786 | 1359 | 34630 | 863 | 26627 |
| 7L-3S | | MI | 10699 | 3877 | 16960 | 3080 | 19931 | 2480 | 21463 | 2015 | 23222 | 1272 | 28303 | 1014 | 19645 |
| 16-#11 | 2.23 | MA | 12796 | 3877 | 19961 | 3177 | 23505 | 2567 | 24984 | 2095 | 26056 | 1365 | 32442 | 810 | 25685 |
| 8L-2S | | MI | 11300 | 3877 | 17761 | 3083 | 20946 | 2484 | 22678 | 2010 | 24820 | 1266 | 30398 | 1105 | 19689 |
| 16-#14 | 3.21 | MA | 16329 | 4279 | 26662 | 3405 | 31970 | 2738 | 35273 | 2194 | 39885 | 1325 | 50492 | 904 | 40702 |
| 4L-6S | | MI | 9887 | 4279 | 16893 | 3317 | 19717 | 2657 | 21130 | 2103 | 22819 | 1225 | 28328 | 576 | 24916 |
| 16-#14 | 3.21 | MA | 15499 | 4279 | 25341 | 3420 | 30384 | 2736 | 33337 | 2205 | 37260 | 1332 | 47155 | 839 | 39234 |
| 5E | | MI | 10424 | 4279 | 17673 | 3321 | 20754 | 2649 | 22357 | 2110 | 24393 | 1217 | 30248 | 666 | 26012 |
| 16-#14 | 3.21 | MA | 14704 | 4279 | 24166 | 3421 | 28818 | 2749 | 31431 | 2201 | 34735 | 1339 | 43782 | 730 | 37598 |
| 6L-4S | | MI | 10983 | 4279 | 18546 | 3311 | 21802 | 2657 | 23602 | 2103 | 26085 | 1225 | 32305 | 728 | 26757 |
| 16-#14 | 3.21 | MA | 13924 | 4279 | 23023 | 3421 | 27305 | 2747 | 29583 | 2212 | 32175 | 1332 | 40784 | 628 | 35997 |
| 7L-3S | | MI | 11596 | 4279 | 19407 | 3315 | 22964 | 2649 | 24975 | 2110 | 27825 | 1217 | 34245 | 854 | 27628 |
| 16-#14 | 3.21 | MA | 13154 | 4279 | 21897 | 3421 | 25822 | 2746 | 27731 | 2208 | 29705 | 1339 | 37669 | 553 | 33830 |
| 8L-2S | | MI | 12427 | 4279 | 20547 | 3319 | 24410 | 2656 | 26693 | 2103 | 30085 | 1210 | 37196 | 985 | 27771 |
| 16-#18 | 5.71 | MA | 16575 | 5297 | 30636 | 4042 | 36806 | 3207 | 41028 | 2483 | 47386 | 1263 | 61019 | 192 | 60144 |
| 6L-4S | | MI | 12686 | 5297 | 23891 | 3906 | 28173 | 3072 | 31114 | 2326 | 35987 | 1075 | 45181 | 193 | 43804 |
| 18-#11 | 2.51 | MA | 15667 | 3991 | 24510 | 3235 | 29348 | 2612 | 32129 | 2116 | 35728 | 1348 | 44861 | 1040 | 32819 |
| 4L-7S | | MI | 9453 | 3991 | 15469 | 3152 | 17970 | 2535 | 19116 | 2047 | 20189 | 1271 | 24802 | 712 | 20186 |
| 18-#11 | 2.51 | MA | 15073 | 3991 | 23588 | 3246 | 28242 | 2611 | 30778 | 2124 | 33889 | 1354 | 42518 | 995 | 31849 |
| 5L-6S | | MI | 9829 | 3991 | 16001 | 3154 | 18672 | 2539 | 19959 | 2042 | 21280 | 1266 | 26199 | 796 | 20865 |
| 18-#11 | 2.51 | MA | 14504 | 3991 | 22769 | 3247 | 27149 | 2620 | 29449 | 2122 | 32120 | 1359 | 40143 | 920 | 31187 |
| 6L-5S | | MI | 10213 | 3991 | 16546 | 3157 | 19398 | 2533 | 20827 | 2047 | 22393 | 1261 | 27563 | 858 | 21219 |
| 18-#11 | 2.51 | MA | 13946 | 3991 | 21972 | 3248 | 26094 | 2620 | 28160 | 2130 | 30327 | 1354 | 38032 | 849 | 30112 |
| 7L-4S | | MI | 10613 | 3991 | 17158 | 3149 | 20132 | 2538 | 21707 | 2042 | 23590 | 1266 | 29023 | 900 | 21848 |
| 18-#11 | 2.51 | MA | 13395 | 3991 | 21186 | 3248 | 25060 | 2619 | 26868 | 2128 | 28597 | 1360 | 35843 | 796 | 29140 |
| 8L-3S | | MI | 11052 | 3991 | 17761 | 3151 | 20946 | 2532 | 22678 | 2047 | 24820 | 1261 | 30398 | 989 | 21995 |
| 18-#11 | 2.51 | MA | 12848 | 3991 | 20320 | 3259 | 23994 | 2628 | 25597 | 2136 | 26884 | 1365 | 33688 | 737 | 27878 |
| 9L-2S | | MI | 11648 | 3991 | 18561 | 3153 | 21961 | 2536 | 23893 | 2042 | 26419 | 1256 | 32493 | 1080 | 22052 |
| 18-#14 | 3.62 | MA | 16297 | 4442 | 27094 | 3522 | 32608 | 2811 | 36031 | 2252 | 40884 | 1324 | 51988 | 817 | 44262 |
| 5L-6S | | MI | 10392 | 4442 | 18034 | 3419 | 21163 | 2731 | 22847 | 2147 | 25079 | 1208 | 31279 | 537 | 28083 |
| 18-#14 | 3.62 | MA | 15514 | 4442 | 25920 | 3523 | 31042 | 2824 | 34125 | 2248 | 38360 | 1331 | 48614 | 708 | 42559 |
| 6L-5S | | MI | 10922 | 4442 | 18813 | 3424 | 22200 | 2724 | 24075 | 2154 | 26653 | 1200 | 33198 | 627 | 29249 |
| 18-#14 | 3.62 | MA | 14747 | 4442 | 24776 | 3523 | 29529 | 2822 | 32277 | 2259 | 35800 | 1324 | 45617 | 606 | 40917 |
| 7L-4S | | MI | 11474 | 4442 | 19687 | 3413 | 23248 | 2731 | 25320 | 2147 | 28345 | 1208 | 35256 | 689 | 29954 |
| 18-#14 | 3.62 | MA | 13988 | 4442 | 23650 | 3523 | 28046 | 2820 | 30425 | 2255 | 33330 | 1331 | 42501 | 531 | 38800 |
| 8L-3S | | MI | 12080 | 4442 | 20547 | 3417 | 24410 | 2724 | 26693 | 2154 | 30085 | 1200 | 37196 | 815 | 30951 |
| 18-#14 | 3.62 | MA | 13234 | 4442 | 22407 | 3539 | 26518 | 2834 | 28603 | 2267 | 30884 | 1339 | 39441 | 446 | 36575 |
| 9L-2S | | MI | 12901 | 4442 | 21687 | 3422 | 25856 | 2731 | 28411 | 2147 | 32345 | 1193 | 40146 | 946 | 31120 |
| 20-#11 | 2.79 | MA | 15643 | 4104 | 24814 | 3317 | 29796 | 2663 | 32662 | 2157 | 36430 | 1349 | 45919 | 981 | 35363 |
| 5L-7S | | MI | 9818 | 4104 | 16270 | 3223 | 18985 | 2587 | 20331 | 2078 | 21788 | 1261 | 26897 | 687 | 22433 |
| 20-#11 | 2.79 | MA | 15081 | 4104 | 23995 | 3318 | 28704 | 2672 | 31332 | 2155 | 34661 | 1354 | 43545 | 906 | 34720 |
| 6E | | MI | 10190 | 4104 | 16802 | 3225 | 19687 | 2591 | 21174 | 2073 | 22879 | 1256 | 28293 | 770 | 23085 |
| 20-#11 | 2.79 | MA | 14530 | 4104 | 23197 | 3318 | 27649 | 2671 | 30043 | 2163 | 32868 | 1349 | 41433 | 835 | 33604 |
| 7L-5S | | MI | 10570 | 4104 | 17347 | 3227 | 20413 | 2585 | 22042 | 2078 | 23992 | 1250 | 29657 | 832 | 23496 |
| 20-#11 | 2.79 | MA | 13986 | 4104 | 22412 | 3319 | 26614 | 2671 | 28751 | 2161 | 31138 | 1354 | 39244 | 782 | 32601 |
| 8L-4S | | MI | 10966 | 4104 | 17959 | 3219 | 21147 | 2590 | 22922 | 2073 | 25188 | 1256 | 31118 | 875 | 24093 |
| 20-#11 | 2.79 | MA | 13445 | 4104 | 21545 | 3330 | 25549 | 2680 | 27480 | 2169 | 29425 | 1360 | 37089 | 723 | 31366 |
| 9L-3S | | MI | 11401 | 4104 | 18561 | 3222 | 21961 | 2584 | 23893 | 2078 | 26419 | 1250 | 32493 | 964 | 24341 |
| 20-#11 | 2.79 | MA | 12907 | 4104 | 20763 | 3331 | 24522 | 2679 | 26203 | 2167 | 27663 | 1355 | 34861 | 643 | 30015 |
| 10L-2S | | MI | 11991 | 4104 | 19362 | 3224 | 22977 | 2588 | 25108 | 2073 | 28017 | 1245 | 34587 | 1055 | 24412 |
| 20-#14 | 4.02 | MA | 16311 | 4606 | 27673 | 3625 | 33266 | 2899 | 36820 | 2296 | 41985 | 1323 | 53447 | 686 | 47529 |
| 6E | | MI | 10890 | 4606 | 19174 | 3521 | 22609 | 2806 | 24565 | 2191 | 27339 | 1191 | 34230 | 498 | 31260 |
| 20-#14 | 4.02 | MA | 15555 | 4606 | 26530 | 3625 | 31753 | 2897 | 34971 | 2307 | 39425 | 1316 | 50449 | 584 | 45846 |
| 7L-5S | | MI | 11413 | 4606 | 19953 | 3526 | 23646 | 2799 | 25793 | 2199 | 28913 | 1184 | 36149 | 588 | 32493 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

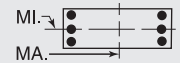
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 4.02 | MA | 14808 | 4606 | 25404 | 3626 | 30270 | 2895 | 33119 | 2303 | 36955 | 1323 | 47334 | 509 | 43779 |
| 8L-4S | | MI | 11958 | 4606 | 20827 | 3515 | 24695 | 2806 | 27038 | 2191 | 30606 | 1191 | 38207 | 650 | 33162 |
| 20-#14 | 4.02 | MA | 14065 | 4606 | 24161 | 3641 | 28742 | 2908 | 31297 | 2314 | 34509 | 1331 | 44274 | 424 | 41527 |
| 9L-3S | | MI | 12557 | 4606 | 21687 | 3519 | 25856 | 2799 | 28411 | 2199 | 32345 | 1184 | 40146 | 776 | 34270 |
| 22-#11 | 3.06 | MA | 15650 | 4218 | 25221 | 3389 | 30259 | 2724 | 33216 | 2188 | 37202 | 1349 | 46946 | 892 | 38257 |
| 6L-7S | | MI | 10178 | 4218 | 17071 | 3293 | 20000 | 2638 | 21546 | 2110 | 23386 | 1250 | 28992 | 662 | 24686 |
| 22-#11 | 3.06 | MA | 15106 | 4218 | 24423 | 3389 | 29203 | 2723 | 31927 | 2196 | 35409 | 1344 | 44834 | 821 | 37100 |
| 7L-6S | | MI | 10547 | 4218 | 17602 | 3296 | 20703 | 2643 | 22389 | 2105 | 24477 | 1245 | 30388 | 745 | 25314 |
| 22-#11 | 3.06 | MA | 14568 | 4218 | 23638 | 3390 | 28169 | 2722 | 30635 | 2194 | 33679 | 1349 | 42646 | 768 | 36068 |
| 8L-5S | | MI | 10924 | 4218 | 18147 | 3298 | 21428 | 2637 | 23257 | 2110 | 25590 | 1240 | 31752 | 807 | 25778 |
| 22-#11 | 3.06 | MA | 14034 | 4218 | 22771 | 3401 | 27103 | 2732 | 29364 | 2202 | 31966 | 1355 | 40491 | 709 | 34860 |
| 9L-4S | | MI | 11316 | 4218 | 18759 | 3290 | 22163 | 2641 | 24137 | 2105 | 26787 | 1245 | 33213 | 850 | 26346 |
| 22-#11 | 3.06 | MA | 13501 | 4218 | 21989 | 3401 | 26076 | 2731 | 28087 | 2200 | 30204 | 1350 | 38262 | 629 | 33490 |
| 10L-3S | | MI | 11746 | 4218 | 19362 | 3293 | 22977 | 2636 | 25108 | 2110 | 28017 | 1240 | 34587 | 938 | 26685 |
| 22-#14 | 4.42 | MA | 16351 | 4769 | 28283 | 3728 | 33977 | 2972 | 37666 | 2354 | 43050 | 1308 | 55282 | 562 | 50784 |
| 7L-6S | | MI | 11381 | 4769 | 20314 | 3624 | 24055 | 2881 | 26283 | 2236 | 29600 | 1174 | 37181 | 459 | 34448 |
| 22-#14 | 4.42 | MA | 15614 | 4769 | 27157 | 3728 | 32494 | 2970 | 35814 | 2350 | 40580 | 1315 | 52166 | 487 | 48765 |
| 8L-5S | | MI | 11942 | 4769 | 21093 | 3628 | 25092 | 2874 | 27510 | 2243 | 31174 | 1167 | 39100 | 549 | 35664 |
| 22-#14 | 4.42 | MA | 14882 | 4769 | 25914 | 3743 | 30966 | 2983 | 33992 | 2361 | 38134 | 1323 | 49107 | 402 | 46486 |
| 9L-4S | | MI | 12471 | 4769 | 21967 | 3617 | 26141 | 2881 | 28756 | 2236 | 32866 | 1174 | 41158 | 611 | 36380 |
| 24-#11 | 3.34 | MA | 15674 | 4331 | 25649 | 3460 | 30758 | 2775 | 33810 | 2229 | 37951 | 1339 | 48235 | 807 | 40602 |
| 7E | | MI | 10535 | 4331 | 17871 | 3364 | 21016 | 2690 | 22761 | 2141 | 24985 | 1240 | 31086 | 637 | 26944 |
| 24-#11 | 3.34 | MA | 15142 | 4331 | 24864 | 3461 | 29724 | 2774 | 32518 | 2227 | 36220 | 1344 | 46047 | 754 | 39541 |
| 8L-6S | | MI | 10900 | 4331 | 18403 | 3367 | 21718 | 2695 | 23604 | 2136 | 26076 | 1234 | 32483 | 720 | 27548 |
| 24-#11 | 3.34 | MA | 14614 | 4331 | 23997 | 3472 | 28658 | 2784 | 31247 | 2235 | 34507 | 1350 | 43892 | 695 | 38357 |
| 9L-5S | | MI | 11273 | 4331 | 18948 | 3369 | 22444 | 2689 | 24472 | 2141 | 27189 | 1229 | 33847 | 782 | 28063 |
| 24-#11 | 3.34 | MA | 14088 | 4331 | 23215 | 3472 | 27631 | 2783 | 29970 | 2233 | 32745 | 1345 | 41663 | 615 | 36968 |
| 10L-4S | | MI | 11661 | 4331 | 19560 | 3361 | 23178 | 2693 | 25352 | 2136 | 28386 | 1234 | 35308 | 825 | 28606 |
| 24-#14 | 4.82 | MA | 16409 | 4933 | 28911 | 3830 | 34718 | 3045 | 38508 | 2398 | 44205 | 1307 | 56999 | 465 | 53757 |
| 8L-6S | | MI | 11914 | 4933 | 21454 | 3726 | 25501 | 2956 | 28001 | 2280 | 31860 | 1158 | 40131 | 420 | 37643 |
| 24-#14 | 4.82 | MA | 15688 | 4933 | 27668 | 3845 | 33190 | 3058 | 36686 | 2409 | 41759 | 1315 | 53939 | 380 | 51451 |
| 9L-5S | | MI | 12417 | 4933 | 22233 | 3730 | 26538 | 2948 | 29228 | 2287 | 33434 | 1150 | 42051 | 509 | 38812 |

## RECTANGULAR TIED COLUMNS 28" x 42"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.36 | MA | 16334 | 3700 | 23877 | 3070 | 28292 | 2492 | 30429 | 2059 | 32511 | 1421 | 39612 | 1320 | 19930 |
| 2E | | MI | 10570 | 3700 | 16089 | 2961 | 18456 | 2396 | 19444 | 1964 | 20258 | 1325 | 24160 | 1188 | 12652 |
| 6-#14 | 1.15 | MA | 15928 | 3609 | 22787 | 3032 | 27065 | 2467 | 29010 | 2047 | 30739 | 1441 | 37371 | 1355 | 17062 |
| 2L-3S | | MI | 9476 | 3609 | 14277 | 2929 | 16376 | 2378 | 17034 | 1976 | 17123 | 1368 | 20171 | 1115 | 10944 |
| 6-#14 | 1.15 | MA | 14472 | 3609 | 20931 | 3033 | 24711 | 2466 | 26159 | 2059 | 26891 | 1449 | 32223 | 1223 | 17014 |
| 3L-2S | | MI | 10365 | 3609 | 15417 | 2933 | 17822 | 2385 | 18752 | 1968 | 19384 | 1360 | 23121 | 1246 | 10909 |
| 6-#18 | 2.04 | MA | 17840 | 3991 | 27125 | 3251 | 32411 | 2625 | 35420 | 2144 | 39196 | 1405 | 48505 | 1278 | 29546 |
| 2L-3S | | MI | 9942 | 3991 | 16089 | 3132 | 18456 | 2512 | 19444 | 2052 | 20258 | 1303 | 24160 | 874 | 18420 |
| 6-#18 | 2.04 | MA | 15384 | 3991 | 23877 | 3251 | 28292 | 2621 | 30429 | 2162 | 32511 | 1419 | 39612 | 1044 | 29126 |
| 3L-2S | | MI | 11435 | 3991 | 18064 | 3142 | 20925 | 2525 | 22377 | 2039 | 24117 | 1290 | 29158 | 1108 | 18555 |
| 8-#11 | 1.06 | MA | 15760 | 3572 | 22323 | 3019 | 26556 | 2458 | 28429 | 2043 | 29977 | 1448 | 36459 | 1369 | 15880 |
| 2L-4S | | MI | 9189 | 3572 | 13723 | 2920 | 15697 | 2382 | 16280 | 1972 | 16198 | 1387 | 19232 | 1091 | 10214 |
| 8-#11 | 1.06 | MA | 14738 | 3572 | 21027 | 3020 | 24912 | 2458 | 26436 | 2052 | 27289 | 1454 | 32839 | 1278 | 15865 |
| 3E | | MI | 9654 | 3572 | 14326 | 2922 | 16511 | 2376 | 17251 | 1977 | 17429 | 1381 | 20606 | 1180 | 10212 |
| 8-#11 | 1.06 | MA | 13997 | 3572 | 20064 | 3021 | 23610 | 2468 | 24859 | 2050 | 25160 | 1450 | 30452 | 1187 | 15762 |
| 4L-2S | | MI | 10280 | 3572 | 15126 | 2925 | 17526 | 2381 | 18466 | 1972 | 19027 | 1376 | 22701 | 1271 | 10185 |
| 8-#14 | 1.53 | MA | 16817 | 3773 | 24642 | 3135 | 29418 | 2542 | 31862 | 2094 | 34586 | 1434 | 42519 | 1335 | 22569 |
| 2L-4S | | MI | 9354 | 3773 | 14557 | 3027 | 16660 | 2460 | 17378 | 2013 | 17644 | 1359 | 21182 | 950 | 14207 |
| 8-#14 | 1.53 | MA | 15385 | 3773 | 22787 | 3135 | 27065 | 2540 | 29010 | 2106 | 30739 | 1442 | 37371 | 1203 | 22468 |
| 3E | | MI | 10005 | 3773 | 15417 | 3031 | 17822 | 2453 | 18752 | 2020 | 19384 | 1351 | 23121 | 1076 | 14321 |
| 8-#14 | 1.53 | MA | 14346 | 3773 | 21407 | 3136 | 25199 | 2554 | 26750 | 2103 | 27688 | 1435 | 33981 | 1072 | 22103 |
| 4L-2S | | MI | 10882 | 3773 | 16558 | 3036 | 19268 | 2460 | 20469 | 2013 | 21644 | 1344 | 26072 | 1207 | 14324 |

## RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

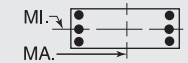
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 2.72 | MA | 19294 | 4282 | 30373 | 3433 | 36530 | 2758 | 40410 | 2228 | 45880 | 1389 | 57399 | 1236 | 39126 |
| 2L-4S | | MI | 9723 | 4282 | 16566 | 3303 | 18941 | 2655 | 20032 | 2114 | 21148 | 1281 | 25861 | 578 | 22026 |
| 8-#18 | 2.72 | MA | 16898 | 4282 | 27125 | 3433 | 32411 | 2754 | 35420 | 2246 | 39196 | 1403 | 48505 | 1002 | 38572 |
| 3E | | MI | 10812 | 4282 | 18064 | 3314 | 20925 | 2642 | 22377 | 2127 | 24117 | 1268 | 29158 | 794 | 24157 |
| 8-#18 | 2.72 | MA | 15159 | 4282 | 24703 | 3432 | 29138 | 2776 | 31454 | 2238 | 33891 | 1389 | 42662 | 768 | 35052 |
| 4L-2S | | MI | 12274 | 4282 | 20040 | 3324 | 23394 | 2655 | 25309 | 2114 | 27976 | 1255 | 34157 | 1028 | 24399 |
| 10-#11 | 1.33 | MA | 16391 | 3686 | 23620 | 3090 | 28201 | 2510 | 30421 | 2076 | 32665 | 1443 | 40079 | 1357 | 19732 |
| 2L-5S | | MI | 9151 | 3686 | 13912 | 2999 | 15978 | 2429 | 16614 | 2009 | 16600 | 1371 | 19866 | 1024 | 12290 |
| 10-#11 | 1.33 | MA | 15381 | 3686 | 22323 | 3091 | 26556 | 2509 | 28429 | 2084 | 29977 | 1449 | 36459 | 1266 | 19692 |
| 3L-4S | | MI | 9570 | 3686 | 14524 | 2991 | 16712 | 2434 | 17495 | 2003 | 17797 | 1376 | 21327 | 1066 | 12572 |
| 10-#11 | 1.33 | MA | 14650 | 3686 | 21360 | 3092 | 25254 | 2519 | 26851 | 2083 | 27848 | 1445 | 34072 | 1174 | 19556 |
| 4L-3S | | MI | 10029 | 3686 | 15126 | 2993 | 17526 | 2428 | 18466 | 2009 | 19027 | 1371 | 22701 | 1155 | 12599 |
| 10-#11 | 1.33 | MA | 13988 | 3686 | 20387 | 3103 | 24086 | 2519 | 25425 | 2091 | 25906 | 1451 | 31583 | 1128 | 18984 |
| 5L-2S | | MI | 10650 | 3686 | 15927 | 2996 | 18541 | 2432 | 19681 | 2003 | 20626 | 1366 | 24796 | 1246 | 12585 |
| 10-#14 | 1.91 | MA | 17685 | 3937 | 26498 | 3237 | 31772 | 2616 | 34713 | 2142 | 38433 | 1426 | 47667 | 1314 | 28058 |
| 2L-5S | | MI | 9297 | 3937 | 14823 | 3140 | 17057 | 2528 | 17851 | 2065 | 18212 | 1334 | 22075 | 849 | 16497 |
| 10-#14 | 1.91 | MA | 16275 | 3937 | 24642 | 3238 | 29418 | 2615 | 31862 | 2153 | 34586 | 1434 | 42519 | 1183 | 27912 |
| 3L-4S | | MI | 9882 | 3937 | 15697 | 3129 | 18106 | 2535 | 19096 | 2057 | 19904 | 1342 | 24133 | 911 | 17423 |
| 10-#14 | 1.91 | MA | 15254 | 3937 | 23263 | 3238 | 27553 | 2629 | 29601 | 2150 | 31535 | 1427 | 39129 | 1051 | 27496 |
| 4L-3S | | MI | 10523 | 3937 | 16558 | 3133 | 19268 | 2528 | 20469 | 2065 | 21644 | 1334 | 26072 | 1036 | 17678 |
| 10-#14 | 1.91 | MA | 14329 | 3937 | 21866 | 3254 | 25877 | 2628 | 27556 | 2162 | 28750 | 1435 | 35582 | 986 | 25718 |
| 5L-2S | | MI | 11388 | 3937 | 17698 | 3138 | 20714 | 2535 | 22187 | 2057 | 23904 | 1327 | 29023 | 1168 | 17719 |
| 10-#18 | 3.40 | MA | 18363 | 4573 | 30373 | 3614 | 36530 | 2887 | 40410 | 2331 | 45880 | 1387 | 57399 | 960 | 48018 |
| 3L-4S | | MI | 10593 | 4573 | 18542 | 3485 | 21410 | 2785 | 22964 | 2188 | 25007 | 1246 | 30860 | 497 | 27472 |
| 10-#18 | 3.40 | MA | 16668 | 4573 | 27951 | 3614 | 33257 | 2909 | 36444 | 2322 | 40576 | 1373 | 51555 | 726 | 44199 |
| 4L-3S | | MI | 11659 | 4573 | 20040 | 3495 | 23394 | 2771 | 25309 | 2202 | 27976 | 1233 | 34157 | 714 | 29878 |
| 10-#18 | 3.40 | MA | 15132 | 4573 | 25499 | 3640 | 30314 | 2905 | 32852 | 2341 | 35735 | 1387 | 45402 | 612 | 40931 |
| 5L-2S | | MI | 13094 | 4573 | 22016 | 3506 | 25863 | 2785 | 28241 | 2188 | 31835 | 1220 | 39155 | 947 | 30214 |
| 12-#11 | 1.59 | MA | 17010 | 3799 | 24917 | 3161 | 29845 | 2562 | 32414 | 2109 | 35353 | 1438 | 43699 | 1344 | 23573 |
| 2L-6S | | MI | 9131 | 3799 | 14167 | 3067 | 16267 | 2487 | 16961 | 2035 | 17086 | 1365 | 20597 | 936 | 14148 |
| 12-#11 | 1.59 | MA | 16012 | 3799 | 23620 | 3162 | 28201 | 2561 | 30421 | 2117 | 32665 | 1444 | 40079 | 1253 | 23511 |
| 3L-5S | | MI | 9530 | 3799 | 14712 | 3070 | 16993 | 2481 | 17829 | 2040 | 18199 | 1360 | 21961 | 998 | 14536 |
| 12-#11 | 1.59 | MA | 15290 | 3799 | 22657 | 3163 | 26899 | 2571 | 28844 | 2116 | 30536 | 1440 | 37692 | 1162 | 23348 |
| 4E | | MI | 9944 | 3799 | 15324 | 3062 | 17727 | 2486 | 18710 | 2035 | 19396 | 1365 | 23421 | 1041 | 14922 |
| 12-#11 | 1.59 | MA | 14637 | 3799 | 21683 | 3174 | 25730 | 2571 | 27417 | 2124 | 28594 | 1446 | 35202 | 1116 | 22667 |
| 5L-3S | | MI | 10399 | 3799 | 15927 | 3064 | 18541 | 2480 | 19681 | 2040 | 20626 | 1360 | 24796 | 1129 | 14970 |
| 12-#11 | 1.59 | MA | 14010 | 3799 | 20819 | 3175 | 24577 | 2581 | 26013 | 2123 | 26726 | 1452 | 32675 | 1040 | 21860 |
| 6L-2S | | MI | 11013 | 3799 | 16728 | 3067 | 19557 | 2484 | 20896 | 2035 | 22225 | 1355 | 26890 | 1221 | 14975 |
| 12-#14 | 2.30 | MA | 18535 | 4100 | 28354 | 3339 | 34125 | 2691 | 37565 | 2189 | 42280 | 1419 | 52814 | 1294 | 33537 |
| 2L-6S | | MI | 9268 | 4100 | 15184 | 3238 | 17466 | 2610 | 18341 | 2101 | 18898 | 1325 | 23106 | 720 | 18846 |
| 12-#14 | 2.30 | MA | 17145 | 4100 | 26498 | 3340 | 31772 | 2690 | 34713 | 2201 | 38433 | 1427 | 47667 | 1163 | 33350 |
| 3L-5S | | MI | 9822 | 4100 | 15963 | 3242 | 18504 | 2602 | 19569 | 2109 | 20472 | 1318 | 25026 | 810 | 19704 |
| 12-#14 | 2.30 | MA | 16141 | 4100 | 25118 | 3341 | 29907 | 2704 | 32453 | 2198 | 35382 | 1420 | 44276 | 1031 | 32787 |
| 4E | | MI | 10399 | 4100 | 16837 | 3231 | 19552 | 2610 | 20814 | 2101 | 22165 | 1325 | 27083 | 872 | 20567 |
| 12-#14 | 2.30 | MA | 15232 | 4100 | 23722 | 3356 | 28231 | 2703 | 30408 | 2209 | 32597 | 1427 | 40729 | 966 | 31011 |
| 5L-3S | | MI | 11031 | 4100 | 17698 | 3236 | 20714 | 2602 | 22187 | 2109 | 23904 | 1318 | 29023 | 997 | 21023 |
| 12-#14 | 2.30 | MA | 14360 | 4100 | 22482 | 3357 | 26577 | 2716 | 28394 | 2206 | 29920 | 1435 | 37135 | 857 | 29557 |
| 6L-2S | | MI | 11886 | 4100 | 18838 | 3240 | 22160 | 2610 | 23905 | 2101 | 26164 | 1310 | 31974 | 1129 | 21095 |
| 12-#18 | 4.08 | MA | 18135 | 4863 | 31199 | 3796 | 37376 | 3042 | 41434 | 2407 | 47261 | 1357 | 60449 | 684 | 53384 |
| 4E | | MI | 11486 | 4863 | 20518 | 3667 | 23879 | 2914 | 25896 | 2263 | 28866 | 1211 | 35858 | 417 | 32956 |
| 12-#18 | 4.08 | MA | 16636 | 4863 | 28747 | 3822 | 34433 | 3038 | 37843 | 2425 | 42420 | 1371 | 54296 | 570 | 49992 |
| 5L-3S | | MI | 12517 | 4863 | 22016 | 3677 | 25863 | 2901 | 28241 | 2276 | 31835 | 1198 | 39155 | 634 | 35590 |
| 12-#18 | 4.08 | MA | 15197 | 4863 | 26567 | 3822 | 31527 | 3060 | 34306 | 2417 | 37764 | 1384 | 48088 | 376 | 46158 |
| 6L-2S | | MI | 13894 | 4863 | 23992 | 3688 | 28332 | 2914 | 31173 | 2263 | 35694 | 1185 | 44154 | 867 | 36008 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis

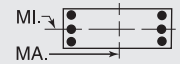


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.86 | MA | 17619 | 3913 | 26213 | 3232 | 31490 | 2614 | 34406 | 2142 | 38041 | 1433 | 47319 | 1331 | 27408 |
| 2L-7S | | MI | 9123 | 3913 | 14436 | 3136 | 16580 | 2534 | 17334 | 2072 | 17593 | 1360 | 21295 | 828 | 15877 |
| 14-#11 | 1.86 | MA | 16632 | 3913 | 24917 | 3233 | 29845 | 2613 | 32414 | 2150 | 35353 | 1439 | 43699 | 1240 | 27325 |
| 3L-6S | | MI | 9509 | 3913 | 14968 | 3138 | 17282 | 2539 | 18176 | 2066 | 18684 | 1355 | 22691 | 911 | 16425 |
| 14-#11 | 1.86 | MA | 15919 | 3913 | 23954 | 3234 | 28544 | 2623 | 30836 | 2148 | 33224 | 1435 | 41312 | 1149 | 27138 |
| 4L-5S | | MI | 9903 | 3913 | 15513 | 3141 | 18008 | 2533 | 19044 | 2072 | 19797 | 1350 | 24055 | 973 | 16792 |
| 14-#11 | 1.86 | MA | 15274 | 3913 | 22980 | 3245 | 27375 | 2623 | 29409 | 2157 | 31282 | 1441 | 38822 | 1103 | 26362 |
| 5L-4S | | MI | 10313 | 3913 | 16125 | 3133 | 18743 | 2538 | 19925 | 2066 | 20994 | 1355 | 25516 | 1016 | 17265 |
| 14-#11 | 1.86 | MA | 14656 | 3913 | 22115 | 3246 | 26222 | 2633 | 28005 | 2155 | 29414 | 1447 | 36295 | 1028 | 25585 |
| 6L-3S | | MI | 10763 | 3913 | 16728 | 3135 | 19557 | 2532 | 20896 | 2072 | 22225 | 1350 | 26890 | 1104 | 17333 |
| 14-#11 | 1.86 | MA | 14050 | 3913 | 21273 | 3247 | 25107 | 2632 | 26644 | 2164 | 27521 | 1442 | 34045 | 957 | 24625 |
| 7L-2S | | MI | 11371 | 3913 | 17528 | 3138 | 20572 | 2536 | 22111 | 2066 | 23823 | 1345 | 28985 | 1195 | 17355 |
| 14-#14 | 2.68 | MA | 17998 | 4264 | 28354 | 3442 | 34125 | 2765 | 37565 | 2248 | 42280 | 1419 | 52814 | 1143 | 38784 |
| 3L-6S | | MI | 9791 | 4264 | 16324 | 3340 | 18913 | 2685 | 20059 | 2146 | 21159 | 1308 | 26057 | 681 | 21982 |
| 14-#14 | 2.68 | MA | 17010 | 4264 | 26974 | 3443 | 32260 | 2779 | 35304 | 2245 | 39229 | 1412 | 49424 | 1011 | 38017 |
| 4L-5S | | MI | 10337 | 4264 | 17104 | 3344 | 19950 | 2677 | 21287 | 2153 | 22732 | 1301 | 27976 | 770 | 22922 |
| 14-#14 | 2.68 | MA | 16116 | 4264 | 25578 | 3459 | 30585 | 2778 | 33259 | 2257 | 36444 | 1420 | 45877 | 945 | 36317 |
| 5L-4S | | MI | 10907 | 4264 | 17978 | 3334 | 20998 | 2685 | 22532 | 2146 | 24425 | 1308 | 30034 | 832 | 23732 |
| 14-#14 | 2.68 | MA | 15259 | 4264 | 24338 | 3460 | 28931 | 2791 | 31246 | 2254 | 33767 | 1428 | 42283 | 837 | 34790 |
| 6L-3S | | MI | 11531 | 4264 | 18838 | 3338 | 22160 | 2677 | 23905 | 2153 | 26164 | 1301 | 31974 | 958 | 24359 |
| 14-#14 | 2.68 | MA | 14419 | 4264 | 23130 | 3460 | 27333 | 2790 | 29294 | 2265 | 31052 | 1421 | 39087 | 734 | 33036 |
| 7L-2S | | MI | 12375 | 4264 | 19978 | 3342 | 23606 | 2685 | 25623 | 2146 | 28425 | 1294 | 34924 | 1089 | 24461 |
| 14-#18 | 4.76 | MA | 18101 | 5154 | 31995 | 4004 | 38552 | 3171 | 42833 | 2509 | 49104 | 1355 | 63189 | 527 | 59082 |
| 5L-4S | | MI | 12311 | 5154 | 22494 | 3848 | 26348 | 3044 | 28829 | 2338 | 32725 | 1176 | 40857 | 337 | 38471 |
| 14-#18 | 4.76 | MA | 16695 | 5154 | 29815 | 4004 | 35646 | 3193 | 39296 | 2501 | 44449 | 1368 | 56981 | 334 | 55312 |
| 6L-3S | | MI | 13316 | 5154 | 23992 | 3859 | 28332 | 3031 | 31173 | 2351 | 35694 | 1163 | 44154 | 553 | 40994 |
| 14-#18 | 4.76 | MA | 15317 | 5154 | 27692 | 4003 | 32838 | 3189 | 35866 | 2520 | 39728 | 1355 | 51470 | 151 | 50478 |
| 7L-2S | | MI | 14663 | 5154 | 25967 | 3869 | 30801 | 3044 | 34106 | 2338 | 39553 | 1149 | 49152 | 787 | 41789 |
| 16-#11 | 2.12 | MA | 17242 | 4026 | 26213 | 3303 | 31490 | 2665 | 34406 | 2183 | 38041 | 1434 | 47319 | 1227 | 31136 |
| 3L-7S | | MI | 9499 | 4026 | 15237 | 3207 | 17596 | 2586 | 18549 | 2103 | 19192 | 1349 | 23389 | 803 | 18109 |
| 16-#11 | 2.12 | MA | 16538 | 4026 | 25251 | 3304 | 30188 | 2675 | 32828 | 2181 | 35912 | 1429 | 44932 | 1136 | 30926 |
| 4L-6S | | MI | 9881 | 4026 | 15768 | 3209 | 18298 | 2591 | 19391 | 2098 | 20283 | 1344 | 24786 | 886 | 18707 |
| 16-#11 | 2.12 | MA | 15901 | 4026 | 24277 | 3316 | 29019 | 2675 | 31402 | 2190 | 33970 | 1435 | 42442 | 1090 | 30066 |
| 5E | | MI | 10271 | 4026 | 16314 | 3211 | 19024 | 2585 | 20260 | 2103 | 21396 | 1339 | 26150 | 948 | 19057 |
| 16-#11 | 2.12 | MA | 15290 | 4026 | 23412 | 3317 | 27866 | 2685 | 29998 | 2188 | 32102 | 1441 | 39915 | 1015 | 29316 |
| 6L-4S | | MI | 10676 | 4026 | 16925 | 3204 | 19758 | 2589 | 21140 | 2098 | 22593 | 1344 | 27611 | 991 | 19603 |
| 16-#11 | 2.12 | MA | 14692 | 4026 | 22570 | 3318 | 26752 | 2684 | 28637 | 2197 | 30209 | 1437 | 37665 | 944 | 28309 |
| 7L-3S | | MI | 11122 | 4026 | 17528 | 3206 | 20572 | 2583 | 22111 | 2103 | 23823 | 1339 | 28985 | 1079 | 19690 |
| 16-#11 | 2.12 | MA | 14101 | 4026 | 21742 | 3318 | 25660 | 2684 | 27273 | 2195 | 28383 | 1443 | 35340 | 891 | 27334 |
| 8L-2S | | MI | 11725 | 4026 | 18329 | 3208 | 21587 | 2588 | 23326 | 2098 | 25422 | 1334 | 31080 | 1170 | 19726 |
| 16-#14 | 3.06 | MA | 17863 | 4427 | 28830 | 3545 | 34614 | 2853 | 38155 | 2292 | 43076 | 1405 | 54572 | 991 | 43266 |
| 4L-6S | | MI | 10305 | 4427 | 17465 | 3442 | 20359 | 2760 | 21777 | 2190 | 23419 | 1292 | 29008 | 641 | 25133 |
| 16-#14 | 3.06 | MA | 16983 | 4427 | 27434 | 3561 | 32938 | 2852 | 36110 | 2304 | 40291 | 1413 | 51025 | 925 | 41634 |
| 5E | | MI | 10845 | 4427 | 18244 | 3446 | 21396 | 2752 | 23005 | 2198 | 24993 | 1284 | 30927 | 731 | 26151 |
| 16-#14 | 3.06 | MA | 16139 | 4427 | 26194 | 3562 | 31284 | 2866 | 34097 | 2301 | 37614 | 1420 | 47431 | 817 | 40036 |
| 6L-4S | | MI | 11406 | 4427 | 19118 | 3436 | 22444 | 2759 | 24250 | 2190 | 26685 | 1292 | 32985 | 793 | 26913 |
| 16-#14 | 3.06 | MA | 15313 | 4427 | 24986 | 3563 | 29687 | 2865 | 32145 | 2313 | 34899 | 1413 | 44235 | 714 | 38333 |
| 7L-3S | | MI | 12023 | 4427 | 19978 | 3440 | 23606 | 2752 | 25623 | 2198 | 28425 | 1284 | 34924 | 919 | 27689 |
| 16-#14 | 3.06 | MA | 14495 | 4427 | 23797 | 3563 | 28121 | 2864 | 30190 | 2310 | 32280 | 1421 | 40922 | 638 | 36081 |
| 8L-2S | | MI | 12857 | 4427 | 21118 | 3444 | 25052 | 2759 | 27341 | 2190 | 30685 | 1277 | 37875 | 1050 | 27818 |
| 16-#18 | 5.44 | MA | 18159 | 5445 | 33063 | 4185 | 39766 | 3326 | 44287 | 2585 | 51133 | 1352 | 65875 | 292 | 64370 |
| 6L-4S | | MI | 13117 | 5445 | 24469 | 4030 | 28817 | 3173 | 31761 | 2413 | 36584 | 1141 | 45855 | 257 | 44009 |
| 16-#18 | 5.44 | MA | 16811 | 5445 | 30940 | 4185 | 36957 | 3322 | 40856 | 2604 | 46412 | 1339 | 60363 | 109 | 59659 |
| 7L-3S | | MI | 14099 | 5445 | 25967 | 4041 | 30801 | 3160 | 34106 | 2426 | 39553 | 1128 | 49152 | 473 | 46367 |
| 18-#11 | 2.39 | MA | 17148 | 4139 | 26547 | 3375 | 31833 | 2727 | 34821 | 2214 | 38600 | 1424 | 48552 | 1124 | 34715 |
| 4L-7S | | MI | 9870 | 4139 | 16037 | 3277 | 18611 | 2638 | 19764 | 2135 | 20791 | 1339 | 25484 | 777 | 20348 |
| 18-#11 | 2.39 | MA | 16518 | 4139 | 25573 | 3387 | 30664 | 2726 | 33394 | 2223 | 36658 | 1430 | 46062 | 1077 | 33778 |
| 5L-6S | | MI | 10248 | 4139 | 16569 | 3280 | 19313 | 2643 | 20606 | 2129 | 21881 | 1334 | 26881 | 861 | 20993 |

## RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

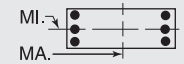
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.39 | MA | 15915 | 4139 | 24709 | 3387 | 29511 | 2736 | 31990 | 2221 | 34790 | 1436 | 43535 | 1002 | 33052 |
| 6L-5S | | MI | 10634 | 4139 | 17114 | 3282 | 20039 | 2637 | 21475 | 2135 | 22995 | 1329 | 28245 | 923 | 21328 |
| 18-#11 | 2.39 | MA | 15325 | 4139 | 23867 | 3388 | 28397 | 2736 | 30629 | 2230 | 32897 | 1432 | 41285 | 931 | 32000 |
| 7L-4S | | MI | 11035 | 4139 | 17726 | 3274 | 20773 | 2641 | 22355 | 2129 | 24191 | 1334 | 29705 | 966 | 21939 |
| 18-#11 | 2.39 | MA | 14741 | 4139 | 23038 | 3389 | 27305 | 2736 | 29265 | 2228 | 31071 | 1438 | 38960 | 878 | 31050 |
| 8L-3S | | MI | 11476 | 4139 | 18329 | 3277 | 21587 | 2635 | 23326 | 2135 | 25422 | 1329 | 31080 | 1054 | 22042 |
| 18-#11 | 2.39 | MA | 14161 | 4139 | 22123 | 3401 | 26180 | 2746 | 27924 | 2237 | 29262 | 1444 | 36666 | 819 | 29678 |
| 9L-2S | | MI | 12074 | 4139 | 19129 | 3279 | 22603 | 2640 | 24541 | 2129 | 27020 | 1323 | 33175 | 1145 | 22092 |
| 18-#14 | 3.44 | MA | 17835 | 4591 | 29290 | 3663 | 35292 | 2927 | 38962 | 2352 | 44138 | 1405 | 56173 | 905 | 46961 |
| 5L-6S | | MI | 10811 | 4591 | 18605 | 3544 | 21805 | 2834 | 23495 | 2234 | 25679 | 1275 | 31959 | 602 | 28297 |
| 18-#14 | 3.44 | MA | 17004 | 4591 | 28049 | 3664 | 33638 | 2941 | 36949 | 2348 | 41461 | 1413 | 52579 | 797 | 45293 |
| 6L-5S | | MI | 11344 | 4591 | 19384 | 3549 | 22842 | 2827 | 24722 | 2242 | 27253 | 1268 | 33878 | 692 | 29387 |
| 18-#14 | 3.44 | MA | 16190 | 4591 | 26842 | 3665 | 32040 | 2940 | 34997 | 2360 | 38746 | 1406 | 49383 | 694 | 43638 |
| 7L-4S | | MI | 11899 | 4591 | 20258 | 3538 | 23891 | 2834 | 25968 | 2234 | 28946 | 1275 | 35936 | 754 | 30108 |
| 18-#14 | 3.44 | MA | 15385 | 4591 | 25653 | 3666 | 30474 | 2939 | 33041 | 2357 | 36127 | 1414 | 46070 | 618 | 41351 |
| 8L-3S | | MI | 12508 | 4591 | 21118 | 3542 | 25052 | 2827 | 27341 | 2242 | 30685 | 1268 | 37875 | 880 | 31015 |
| 18-#14 | 3.44 | MA | 14585 | 4591 | 24341 | 3681 | 28861 | 2952 | 31117 | 2369 | 33533 | 1421 | 42809 | 533 | 39085 |
| 9L-2S | | MI | 13333 | 4591 | 22259 | 3547 | 26498 | 2834 | 29059 | 2234 | 32945 | 1260 | 40826 | 1011 | 31170 |
| 18-#18 | 6.12 | MA | 18273 | 5736 | 34187 | 4367 | 41077 | 3455 | 45847 | 2688 | 53097 | 1323 | 69256 | 67 | 68856 |
| 7L-4S | | MI | 13909 | 5736 | 26445 | 4212 | 31286 | 3303 | 34693 | 2487 | 40443 | 1106 | 50854 | 177 | 49568 |
| 20-#11 | 2.65 | MA | 17127 | 4253 | 26870 | 3457 | 32309 | 2778 | 35387 | 2256 | 39346 | 1425 | 49682 | 1065 | 37497 |
| 5L-7S | | MI | 10236 | 4253 | 16838 | 3348 | 19626 | 2690 | 20979 | 2166 | 22389 | 1328 | 27579 | 752 | 22593 |
| 20-#11 | 2.65 | MA | 16531 | 4253 | 26005 | 3458 | 31155 | 2788 | 33983 | 2254 | 37478 | 1431 | 47155 | 989 | 36792 |
| 6E | | MI | 10610 | 4253 | 17369 | 3351 | 20328 | 2695 | 21822 | 2161 | 23480 | 1323 | 28975 | 836 | 23263 |
| 20-#11 | 2.65 | MA | 15947 | 4253 | 25164 | 3459 | 30041 | 2788 | 32621 | 2263 | 35585 | 1427 | 44905 | 919 | 35698 |
| 7L-5S | | MI | 10992 | 4253 | 17915 | 3353 | 21054 | 2689 | 22690 | 2166 | 24593 | 1318 | 30339 | 898 | 23605 |
| 20-#11 | 2.65 | MA | 15371 | 4253 | 24335 | 3460 | 28949 | 2788 | 31258 | 2261 | 33759 | 1433 | 42580 | 865 | 34728 |
| 8L-4S | | MI | 11390 | 4253 | 18526 | 3345 | 21789 | 2693 | 23570 | 2161 | 25790 | 1323 | 31800 | 940 | 24220 |
| 20-#11 | 2.65 | MA | 14798 | 4253 | 23420 | 3471 | 27824 | 2797 | 29916 | 2270 | 31950 | 1439 | 40286 | 807 | 33374 |
| 9L-3S | | MI | 11827 | 4253 | 19129 | 3348 | 22603 | 2687 | 24541 | 2166 | 27020 | 1318 | 33175 | 1029 | 24390 |
| 20-#11 | 2.65 | MA | 14227 | 4253 | 22595 | 3472 | 26740 | 2797 | 28568 | 2268 | 30090 | 1435 | 37913 | 726 | 32016 |
| 10L-2S | | MI | 12420 | 4253 | 19930 | 3350 | 23618 | 2692 | 25756 | 2161 | 28619 | 1313 | 35269 | 1120 | 24453 |
| 20-#14 | 3.83 | MA | 17854 | 4754 | 29905 | 3766 | 35992 | 3016 | 39800 | 2396 | 45308 | 1405 | 57726 | 776 | 50560 |
| 6E | | MI | 11311 | 4754 | 19745 | 3647 | 23251 | 2909 | 25213 | 2279 | 27939 | 1258 | 34909 | 563 | 31472 |
| 20-#14 | 3.83 | MA | 17053 | 4754 | 28698 | 3767 | 34394 | 3015 | 37848 | 2408 | 42593 | 1398 | 54530 | 674 | 48903 |
| 7L-5S | | MI | 11837 | 4754 | 20524 | 3651 | 24288 | 2902 | 26440 | 2286 | 29513 | 1251 | 36829 | 653 | 32630 |
| 20-#14 | 3.83 | MA | 16260 | 4754 | 27509 | 3768 | 32828 | 3013 | 35892 | 2404 | 39974 | 1406 | 51218 | 598 | 46628 |
| 8L-4S | | MI | 12385 | 4754 | 21398 | 3640 | 25337 | 2909 | 27685 | 2279 | 31206 | 1258 | 38886 | 715 | 33314 |
| 20-#14 | 3.83 | MA | 15472 | 4754 | 26196 | 3784 | 31215 | 3027 | 33968 | 2416 | 37380 | 1414 | 47957 | 513 | 44336 |
| 9L-3S | | MI | 12988 | 4754 | 22259 | 3645 | 26498 | 2902 | 29059 | 2286 | 32945 | 1251 | 40826 | 840 | 34337 |
| 22-#11 | 2.92 | MA | 17139 | 4366 | 27302 | 3529 | 32800 | 2840 | 35975 | 2287 | 40167 | 1426 | 50775 | 977 | 40536 |
| 6L-7S | | MI | 10597 | 4366 | 17638 | 3419 | 20642 | 2742 | 22194 | 2198 | 23988 | 1318 | 29674 | 727 | 24845 |
| 22-#11 | 2.92 | MA | 16562 | 4366 | 26460 | 3530 | 31686 | 2840 | 34614 | 2296 | 38273 | 1422 | 48525 | 906 | 39401 |
| 7L-6S | | MI | 10968 | 4366 | 18170 | 3422 | 21344 | 2746 | 23037 | 2193 | 25079 | 1313 | 31070 | 811 | 25489 |
| 22-#11 | 2.92 | MA | 15992 | 4366 | 25632 | 3531 | 30594 | 2839 | 33250 | 2294 | 36447 | 1428 | 46200 | 852 | 38401 |
| 8L-5S | | MI | 11347 | 4366 | 18715 | 3424 | 22070 | 2740 | 23905 | 2198 | 26192 | 1307 | 32434 | 873 | 25886 |
| 22-#11 | 2.92 | MA | 15425 | 4366 | 24717 | 3542 | 29469 | 2849 | 31908 | 2302 | 34638 | 1434 | 43906 | 794 | 37074 |
| 9L-4S | | MI | 11741 | 4366 | 19327 | 3416 | 22804 | 2745 | 24785 | 2193 | 27389 | 1313 | 33895 | 915 | 26472 |
| 22-#11 | 2.92 | MA | 14861 | 4366 | 23891 | 3543 | 28385 | 2849 | 30561 | 2301 | 32778 | 1429 | 41533 | 714 | 35697 |
| 10L-3S | | MI | 12174 | 4366 | 19930 | 3419 | 23618 | 2739 | 25756 | 2198 | 28619 | 1307 | 35269 | 1004 | 26735 |
| 22-#11 | 2.92 | MA | 14263 | 4366 | 23072 | 3544 | 27273 | 2859 | 29227 | 2309 | 30977 | 1435 | 39248 | 657 | 34307 |
| 11L-2S | | MI | 12762 | 4366 | 20730 | 3421 | 24633 | 2744 | 26971 | 2193 | 30217 | 1302 | 37364 | 1095 | 26811 |
| 22-#14 | 4.21 | MA | 17902 | 4918 | 30553 | 3869 | 36747 | 3089 | 40699 | 2455 | 46440 | 1391 | 59678 | 654 | 54139 |
| 7L-6S | | MI | 11804 | 4918 | 20885 | 3749 | 24697 | 2984 | 26931 | 2323 | 30200 | 1242 | 37860 | 524 | 34656 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

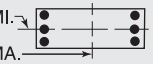
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 4.21 | MA | 17120 | 4918 | 29365 | 3870 | 35182 | 3088 | 38744 | 2452 | 43821 | 1399 | 56366 | 578 | 51913 |
| 8L-5S | | MI | 12324 | 4918 | 21665 | 3753 | 25734 | 2976 | 28158 | 2331 | 31774 | 1234 | 39779 | 614 | 35878 |
| 22-#14 | 4.21 | MA | 16344 | 4918 | 28052 | 3886 | 33568 | 3102 | 36820 | 2464 | 41227 | 1406 | 53104 | 493 | 49595 |
| 9L-4S | | MI | 12866 | 4918 | 22538 | 3742 | 26783 | 2984 | 29403 | 2323 | 33466 | 1242 | 41837 | 676 | 36530 |
| 24-#11 | 3.18 | MA | 17168 | 4480 | 27757 | 3601 | 33330 | 2892 | 36606 | 2328 | 40961 | 1416 | 52145 | 893 | 43109 |
| 7E | | MI | 10955 | 4480 | 18439 | 3490 | 21657 | 2794 | 23409 | 2229 | 25586 | 1307 | 31768 | 702 | 27101 |
| 24-#11 | 3.18 | MA | 16604 | 4480 | 26928 | 3602 | 32239 | 2891 | 35243 | 2327 | 39135 | 1423 | 49820 | 840 | 42080 |
| 8L-6S | | MI | 11322 | 4480 | 18971 | 3493 | 22359 | 2798 | 24252 | 2224 | 26677 | 1302 | 33165 | 785 | 27722 |
| 24-#11 | 3.18 | MA | 16044 | 4480 | 26013 | 3613 | 31114 | 2901 | 33901 | 2335 | 37326 | 1429 | 47525 | 781 | 40779 |
| 9L-5S | | MI | 11697 | 4480 | 19516 | 3495 | 23085 | 2792 | 25120 | 2229 | 27790 | 1297 | 34529 | 847 | 28171 |
| 24-#11 | 3.18 | MA | 15487 | 4480 | 25188 | 3614 | 30030 | 2901 | 32553 | 2334 | 35466 | 1424 | 45153 | 701 | 39383 |
| 10L-4S | | MI | 12088 | 4480 | 20128 | 3487 | 23819 | 2797 | 26000 | 2224 | 28987 | 1302 | 35990 | 890 | 28730 |
| 24-#11 | 3.18 | MA | 14891 | 4480 | 24368 | 3615 | 28917 | 2911 | 31219 | 2342 | 33665 | 1430 | 42868 | 645 | 37979 |
| 11L-3S | | MI | 12517 | 4480 | 20730 | 3489 | 24633 | 2791 | 26971 | 2229 | 30217 | 1297 | 37364 | 979 | 29078 |
| 24-#14 | 4.59 | MA | 17969 | 5082 | 31221 | 3972 | 37535 | 3163 | 41595 | 2499 | 47668 | 1391 | 61513 | 557 | 57204 |
| 8L-6S | | MI | 12341 | 5082 | 22025 | 3851 | 26143 | 3059 | 28648 | 2367 | 32460 | 1225 | 40811 | 485 | 37850 |
| 24-#14 | 4.59 | MA | 17203 | 5082 | 29908 | 3988 | 35922 | 3177 | 39671 | 2511 | 45074 | 1399 | 58252 | 473 | 54860 |
| 9L-5S | | MI | 12848 | 5082 | 22805 | 3855 | 27180 | 3051 | 29876 | 2375 | 34034 | 1217 | 42730 | 574 | 39055 |

## RECTANGULAR TIED COLUMNS 28" x 44"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.30 | MA | 17821 | 3849 | 25846 | 3209 | 30681 | 2607 | 32986 | 2157 | 35219 | 1499 | 42916 | 1399 | 21010 |
| 2E | | MI | 10989 | 3849 | 16666 | 3084 | 19100 | 2498 | 20091 | 2051 | 20856 | 1391 | 24834 | 1252 | 12689 |
| 6-#14 | 1.10 | MA | 17384 | 3758 | 24689 | 3172 | 29378 | 2581 | 31479 | 2144 | 33274 | 1516 | 40507 | 1432 | 17973 |
| 2L-3S | | MI | 9893 | 3758 | 14848 | 3054 | 17018 | 2481 | 17681 | 2063 | 17723 | 1435 | 20850 | 1180 | 10978 |
| 6-#14 | 1.10 | MA | 15843 | 3758 | 22731 | 3173 | 26895 | 2581 | 28471 | 2157 | 29215 | 1525 | 35043 | 1301 | 17925 |
| 3L-2S | | MI | 10784 | 3758 | 15989 | 3058 | 18464 | 2488 | 19399 | 2056 | 19984 | 1428 | 23801 | 1311 | 10938 |
| 6-#18 | 1.95 | MA | 19427 | 4140 | 29276 | 3390 | 35031 | 2740 | 38256 | 2241 | 42309 | 1485 | 52369 | 1360 | 31166 |
| 2L-3S | | MI | 10360 | 4140 | 16666 | 3256 | 19100 | 2614 | 20091 | 2139 | 20856 | 1369 | 24834 | 938 | 18490 |
| 6-#18 | 1.95 | MA | 16823 | 4140 | 25846 | 3391 | 30681 | 2737 | 32986 | 2261 | 35219 | 1498 | 42916 | 1126 | 30746 |
| 3L-2S | | MI | 11857 | 4140 | 18642 | 3266 | 21569 | 2627 | 23023 | 2125 | 24714 | 1356 | 29833 | 1172 | 18598 |
| 8-#11 | 1.01 | MA | 17203 | 3721 | 24198 | 3158 | 28838 | 2573 | 30862 | 2140 | 32465 | 1523 | 39526 | 1446 | 16722 |
| 2L-4S | | MI | 9605 | 3721 | 14291 | 3046 | 16338 | 2485 | 16928 | 2060 | 16800 | 1454 | 19914 | 1157 | 10252 |
| 8-#11 | 1.01 | MA | 16122 | 3721 | 22830 | 3159 | 27104 | 2572 | 28760 | 2149 | 29630 | 1530 | 35687 | 1355 | 16708 |
| 3E | | MI | 10071 | 3721 | 14894 | 3048 | 17152 | 2480 | 17899 | 2065 | 18030 | 1449 | 21288 | 1245 | 10241 |
| 8-#11 | 1.01 | MA | 15340 | 3721 | 21816 | 3161 | 25732 | 2583 | 27098 | 2148 | 27387 | 1526 | 33153 | 1264 | 16604 |
| 4L-2S | | MI | 10699 | 3721 | 15694 | 3051 | 18167 | 2484 | 19114 | 2060 | 19629 | 1444 | 23383 | 1336 | 10211 |
| 8-#14 | 1.46 | MA | 18330 | 3922 | 26647 | 3274 | 31861 | 2656 | 34488 | 2192 | 37333 | 1509 | 45970 | 1413 | 23784 |
| 2L-4S | | MI | 9771 | 3922 | 15128 | 3152 | 17302 | 2563 | 18026 | 2100 | 18244 | 1426 | 21861 | 1015 | 14270 |
| 8-#14 | 1.46 | MA | 16814 | 3922 | 24689 | 3275 | 29378 | 2656 | 31479 | 2204 | 33274 | 1517 | 40507 | 1282 | 23683 |
| 3E | | MI | 10424 | 3922 | 15989 | 3156 | 18464 | 2556 | 19399 | 2108 | 19984 | 1418 | 23801 | 1141 | 14363 |
| 8-#14 | 1.46 | MA | 15716 | 3922 | 23235 | 3276 | 27412 | 2670 | 29097 | 2201 | 30058 | 1511 | 36905 | 1151 | 23318 |
| 4L-2S | | MI | 11303 | 3922 | 17129 | 3161 | 19910 | 2563 | 21117 | 2100 | 22244 | 1411 | 26752 | 1272 | 14358 |
| 8-#18 | 2.60 | MA | 20977 | 4430 | 32706 | 3572 | 39380 | 2873 | 43526 | 2325 | 49399 | 1471 | 61822 | 1321 | 41286 |
| 2L-4S | | MI | 10140 | 4430 | 17144 | 3427 | 19585 | 2757 | 20679 | 2200 | 21745 | 1348 | 26536 | 642 | 22244 |
| 8-#18 | 2.60 | MA | 18436 | 4430 | 29276 | 3573 | 35031 | 2870 | 38256 | 2345 | 42309 | 1484 | 52369 | 1087 | 40732 |
| 3E | | MI | 11233 | 4430 | 18642 | 3437 | 21569 | 2744 | 23023 | 2213 | 24714 | 1334 | 29833 | 858 | 24237 |
| 8-#18 | 2.60 | MA | 16595 | 4430 | 26722 | 3573 | 31579 | 2893 | 34073 | 2338 | 36683 | 1471 | 46151 | 854 | 37249 |
| 4L-2S | | MI | 12701 | 4430 | 20618 | 3448 | 24038 | 2757 | 25956 | 2200 | 28573 | 1321 | 34831 | 1092 | 24450 |
| 10-#11 | 1.27 | MA | 17874 | 3834 | 25565 | 3229 | 30573 | 2624 | 32963 | 2173 | 35300 | 1518 | 43364 | 1434 | 20785 |
| 2L-5S | | MI | 9567 | 3834 | 14480 | 3125 | 16619 | 2533 | 17262 | 2096 | 17202 | 1438 | 20548 | 1089 | 12399 |
| 10-#11 | 1.27 | MA | 16805 | 3834 | 24198 | 3230 | 28838 | 2624 | 30862 | 2182 | 32465 | 1525 | 39526 | 1343 | 20745 |
| 3L-4S | | MI | 9987 | 3834 | 15091 | 3117 | 17353 | 2537 | 18143 | 2091 | 18399 | 1444 | 22009 | 1131 | 12615 |
| 10-#11 | 1.27 | MA | 16033 | 3834 | 23184 | 3232 | 27467 | 2635 | 29200 | 2181 | 30222 | 1521 | 36992 | 1252 | 20609 |
| 4L-3S | | MI | 10447 | 3834 | 15694 | 3119 | 18167 | 2531 | 19114 | 2096 | 19629 | 1438 | 23383 | 1220 | 12631 |
| 10-#11 | 1.27 | MA | 15334 | 3834 | 22158 | 3243 | 26236 | 2635 | 27697 | 2190 | 28177 | 1527 | 34357 | 1205 | 20101 |
| 5L-2S | | MI | 11069 | 3834 | 16495 | 3122 | 19182 | 2536 | 20329 | 2091 | 21228 | 1433 | 25478 | 1311 | 12614 |

## RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

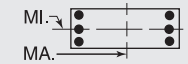
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.83 | MA | 19255 | 4085 | 28605 | 3376 | 34345 | 2731 | 37496 | 2239 | 41392 | 1501 | 51433 | 1395 | 29577 |
| 2L-5S | | MI | 9713 | 4085 | 15395 | 3265 | 17700 | 2631 | 18499 | 2152 | 18812 | 1402 | 22754 | 914 | 16635 |
| 10-#14 | 1.83 | MA | 17761 | 4085 | 26647 | 3377 | 31861 | 2730 | 34488 | 2251 | 37333 | 1510 | 45970 | 1264 | 29430 |
| 3L-4S | | MI | 10300 | 4085 | 16268 | 3254 | 18748 | 2638 | 19744 | 2145 | 20504 | 1409 | 24812 | 976 | 17583 |
| 10-#14 | 1.83 | MA | 16682 | 4085 | 25193 | 3379 | 29896 | 2745 | 32105 | 2249 | 34117 | 1504 | 42368 | 1132 | 29014 |
| 4L-3S | | MI | 10943 | 4085 | 17129 | 3259 | 19910 | 2630 | 21117 | 2152 | 22244 | 1402 | 26752 | 1101 | 17725 |
| 10-#14 | 1.83 | MA | 15705 | 4085 | 23723 | 3395 | 28131 | 2744 | 29951 | 2261 | 31184 | 1512 | 38610 | 1066 | 27237 |
| 5L-2S | | MI | 11811 | 4085 | 18269 | 3263 | 21356 | 2638 | 22835 | 2145 | 24504 | 1394 | 29702 | 1233 | 17757 |
| 10-#18 | 3.25 | MA | 19997 | 4721 | 32706 | 3755 | 39380 | 3003 | 43526 | 2429 | 49399 | 1470 | 61822 | 1048 | 50718 |
| 3L-4S | | MI | 11012 | 4721 | 19120 | 3608 | 22054 | 2886 | 23611 | 2275 | 25604 | 1312 | 31534 | 562 | 27685 |
| 10-#18 | 3.25 | MA | 18202 | 4721 | 30152 | 3755 | 35929 | 3026 | 39343 | 2422 | 43774 | 1457 | 55604 | 815 | 46922 |
| 4L-3S | | MI | 12083 | 4721 | 20618 | 3619 | 24038 | 2873 | 25956 | 2288 | 28573 | 1299 | 34831 | 778 | 29965 |
| 10-#18 | 3.25 | MA | 16576 | 4721 | 27567 | 3782 | 32827 | 3023 | 35557 | 2442 | 38639 | 1470 | 49077 | 699 | 43673 |
| 5L-2S | | MI | 13524 | 4721 | 22594 | 3630 | 26507 | 2886 | 28888 | 2275 | 32432 | 1286 | 39830 | 1012 | 30270 |
| 12-#11 | 1.52 | MA | 18533 | 3948 | 26933 | 3300 | 32307 | 2676 | 35064 | 2206 | 38135 | 1513 | 47203 | 1423 | 24837 |
| 2L-6S | | MI | 9547 | 3948 | 14735 | 3193 | 16908 | 2591 | 17609 | 2123 | 17687 | 1433 | 21279 | 1002 | 14251 |
| 12-#11 | 1.52 | MA | 17476 | 3948 | 25565 | 3301 | 30573 | 2676 | 32963 | 2215 | 35300 | 1519 | 43364 | 1332 | 24774 |
| 3L-5S | | MI | 9947 | 3948 | 15280 | 3195 | 17634 | 2585 | 18477 | 2128 | 18800 | 1428 | 22643 | 1064 | 14644 |
| 12-#11 | 1.52 | MA | 16714 | 3948 | 24551 | 3302 | 29201 | 2687 | 31301 | 2214 | 33057 | 1516 | 40831 | 1241 | 24611 |
| 4E | | MI | 10362 | 3948 | 15892 | 3188 | 18369 | 2589 | 19358 | 2123 | 19997 | 1433 | 24103 | 1106 | 14968 |
| 12-#11 | 1.52 | MA | 16024 | 3948 | 23526 | 3314 | 27971 | 2687 | 29799 | 2223 | 31012 | 1522 | 38195 | 1194 | 23989 |
| 5L-3S | | MI | 10818 | 3948 | 16495 | 3190 | 19182 | 2583 | 20329 | 2128 | 21228 | 1428 | 25478 | 1195 | 15007 |
| 12-#11 | 1.52 | MA | 15362 | 3948 | 22615 | 3315 | 26756 | 2697 | 28320 | 2222 | 29045 | 1529 | 35515 | 1119 | 23108 |
| 6L-2S | | MI | 11434 | 3948 | 17295 | 3192 | 20198 | 2588 | 21544 | 2123 | 22826 | 1423 | 27572 | 1286 | 15006 |
| 12-#14 | 2.19 | MA | 20160 | 4249 | 30563 | 3478 | 36828 | 2806 | 40505 | 2286 | 45451 | 1494 | 56896 | 1376 | 35360 |
| 2L-6S | | MI | 9683 | 4249 | 15755 | 3363 | 18109 | 2713 | 18989 | 2189 | 19498 | 1392 | 23786 | 785 | 19066 |
| 12-#14 | 2.19 | MA | 18687 | 4249 | 28605 | 3480 | 34345 | 2805 | 37496 | 2299 | 41392 | 1502 | 51433 | 1245 | 35172 |
| 3L-5S | | MI | 10239 | 4249 | 16535 | 3367 | 19146 | 2705 | 20216 | 2196 | 21072 | 1385 | 25705 | 875 | 19840 |
| 12-#14 | 2.19 | MA | 17626 | 4249 | 27151 | 3481 | 32379 | 2819 | 35114 | 2296 | 38176 | 1496 | 47831 | 1114 | 34712 |
| 4E | | MI | 10818 | 4249 | 17409 | 3356 | 20194 | 2713 | 21462 | 2189 | 22765 | 1392 | 27763 | 936 | 20724 |
| 12-#14 | 2.19 | MA | 16665 | 4249 | 25681 | 3497 | 30614 | 2819 | 32960 | 2309 | 35243 | 1505 | 44073 | 1047 | 32827 |
| 5L-3S | | MI | 11453 | 4249 | 18269 | 3361 | 21356 | 2705 | 22835 | 2196 | 24504 | 1385 | 29702 | 1062 | 21074 |
| 12-#14 | 2.19 | MA | 15744 | 4249 | 24374 | 3498 | 28872 | 2833 | 30839 | 2306 | 32423 | 1513 | 40259 | 939 | 31423 |
| 6L-2S | | MI | 12310 | 4249 | 19409 | 3365 | 22802 | 2713 | 24553 | 2189 | 26765 | 1377 | 32653 | 1194 | 21137 |
| 12-#18 | 3.90 | MA | 19764 | 5012 | 33582 | 3937 | 40278 | 3159 | 44612 | 2507 | 50864 | 1442 | 65057 | 776 | 56632 |
| 4E | | MI | 11909 | 5012 | 21096 | 3790 | 24523 | 3016 | 26543 | 2350 | 29463 | 1277 | 36533 | 481 | 33165 |
| 12-#18 | 3.90 | MA | 18177 | 5012 | 30997 | 3964 | 37176 | 3156 | 40826 | 2526 | 45729 | 1455 | 58530 | 660 | 53263 |
| 5L-3S | | MI | 12947 | 5012 | 22594 | 3801 | 26507 | 3003 | 28888 | 2363 | 32432 | 1264 | 39830 | 698 | 35683 |
| 12-#18 | 3.90 | MA | 16654 | 5012 | 28700 | 3965 | 34114 | 3179 | 37099 | 2519 | 40791 | 1469 | 51931 | 467 | 49064 |
| 6L-2S | | MI | 14333 | 5012 | 24570 | 3811 | 28976 | 3016 | 31820 | 2350 | 36291 | 1251 | 44828 | 931 | 36069 |
| 14-#11 | 1.77 | MA | 19182 | 4061 | 28300 | 3371 | 34042 | 2728 | 37166 | 2239 | 40970 | 1508 | 51042 | 1411 | 28882 |
| 2L-7S | | MI | 9538 | 4061 | 15004 | 3261 | 17221 | 2638 | 17982 | 2159 | 18195 | 1428 | 21977 | 893 | 16038 |
| 14-#11 | 1.77 | MA | 18136 | 4061 | 26933 | 3372 | 32307 | 2728 | 35064 | 2248 | 38135 | 1514 | 47203 | 1320 | 28799 |
| 3L-6S | | MI | 9925 | 4061 | 15535 | 3264 | 17924 | 2642 | 18824 | 2154 | 19286 | 1422 | 23373 | 976 | 16528 |
| 14-#11 | 1.77 | MA | 17383 | 4061 | 25919 | 3373 | 30936 | 2738 | 33402 | 2247 | 35892 | 1510 | 44669 | 1229 | 28612 |
| 4L-5S | | MI | 10321 | 4061 | 16081 | 3266 | 18650 | 2637 | 19692 | 2159 | 20399 | 1417 | 24737 | 1039 | 16899 |
| 14-#11 | 1.77 | MA | 16701 | 4061 | 24893 | 3385 | 29705 | 2738 | 31900 | 2256 | 33847 | 1517 | 42034 | 1182 | 27889 |
| 5L-4S | | MI | 10732 | 4061 | 16693 | 3258 | 19384 | 2641 | 20573 | 2154 | 21596 | 1422 | 26198 | 1081 | 17315 |
| 14-#11 | 1.77 | MA | 16048 | 4061 | 23983 | 3386 | 28491 | 2749 | 30422 | 2254 | 31880 | 1524 | 39354 | 1107 | 27040 |
| 6L-3S | | MI | 11183 | 4061 | 17295 | 3261 | 20198 | 2635 | 21544 | 2159 | 22826 | 1417 | 27572 | 1170 | 17373 |
| 14-#11 | 1.77 | MA | 15409 | 4061 | 23097 | 3387 | 27318 | 2749 | 28989 | 2264 | 29887 | 1520 | 36966 | 1036 | 26115 |
| 7L-2S | | MI | 11794 | 4061 | 18096 | 3263 | 21213 | 2640 | 22759 | 2154 | 24425 | 1412 | 29667 | 1261 | 17390 |
| 14-#14 | 2.56 | MA | 19596 | 4412 | 30563 | 3582 | 36828 | 2880 | 40505 | 2346 | 45451 | 1495 | 56896 | 1226 | 40910 |
| 3L-6S | | MI | 10207 | 4412 | 16896 | 3465 | 19555 | 2788 | 20707 | 2233 | 21759 | 1376 | 26737 | 746 | 22198 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

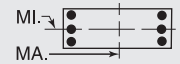



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.56 | MA | 18550 | 4412 | 29109 | 3583 | 34862 | 2894 | 38122 | 2344 | 42235 | 1489 | 53294 | 1095 | 40305 |
| 4L-5S | | MI | 10756 | 4412 | 17675 | 3469 | 20592 | 2780 | 21934 | 2241 | 23333 | 1368 | 28656 | 835 | 23057 |
| 14-#14 | 2.56 | MA | 17605 | 4412 | 27639 | 3599 | 33097 | 2894 | 35968 | 2356 | 39302 | 1497 | 49537 | 1028 | 38431 |
| 5L-4S | | MI | 11328 | 4412 | 18549 | 3459 | 21641 | 2788 | 23180 | 2233 | 25025 | 1376 | 30714 | 897 | 23886 |
| 14-#14 | 2.56 | MA | 16699 | 4412 | 26333 | 3601 | 31355 | 2908 | 33848 | 2353 | 36482 | 1506 | 45722 | 920 | 36954 |
| 6L-3S | | MI | 11955 | 4412 | 19409 | 3463 | 22802 | 2780 | 24553 | 2241 | 26765 | 1368 | 32653 | 1023 | 24415 |
| 14-#14 | 2.56 | MA | 15811 | 4412 | 25061 | 3602 | 29673 | 2907 | 31792 | 2366 | 33622 | 1500 | 42328 | 818 | 35039 |
| 7L-2S | | MI | 12802 | 4412 | 20550 | 3467 | 24248 | 2787 | 26270 | 2233 | 29025 | 1361 | 35604 | 1154 | 24505 |
| 14-#18 | 4.55 | MA | 19737 | 5303 | 34427 | 4146 | 41526 | 3289 | 46096 | 2610 | 52819 | 1441 | 67983 | 621 | 62883 |
| 5L-4S | | MI | 12738 | 5303 | 23072 | 3972 | 26992 | 3146 | 29475 | 2424 | 33322 | 1242 | 41531 | 401 | 38676 |
| 14-#18 | 4.55 | MA | 18248 | 5303 | 32129 | 4146 | 38464 | 3312 | 42368 | 2604 | 47881 | 1454 | 61384 | 428 | 58819 |
| 6L-3S | | MI | 13750 | 5303 | 24570 | 3982 | 28976 | 3132 | 31820 | 2438 | 36291 | 1229 | 44828 | 618 | 41275 |
| 14-#18 | 4.55 | MA | 16789 | 5303 | 29893 | 4147 | 35505 | 3309 | 38754 | 2623 | 42875 | 1441 | 55520 | 246 | 53780 |
| 7L-2S | | MI | 15106 | 5303 | 26545 | 3993 | 31445 | 3146 | 34752 | 2424 | 40150 | 1216 | 49827 | 851 | 41854 |
| 16-#11 | 2.03 | MA | 18786 | 4175 | 28300 | 3443 | 34042 | 2780 | 37166 | 2281 | 40970 | 1509 | 51042 | 1308 | 32821 |
| 3L-7S | | MI | 9915 | 4175 | 15805 | 3332 | 18237 | 2690 | 19197 | 2191 | 19794 | 1417 | 24071 | 868 | 18268 |
| 16-#11 | 2.03 | MA | 18041 | 4175 | 27286 | 3444 | 32670 | 2790 | 35504 | 2279 | 38727 | 1505 | 48508 | 1217 | 32611 |
| 4L-6S | | MI | 10298 | 4175 | 16336 | 3335 | 18939 | 2694 | 20039 | 2186 | 20884 | 1412 | 25468 | 951 | 18810 |
| 16-#11 | 2.03 | MA | 17368 | 4175 | 26261 | 3456 | 31440 | 2790 | 34001 | 2289 | 36682 | 1512 | 45873 | 1170 | 31798 |
| 5E | | MI | 10690 | 4175 | 16881 | 3337 | 19665 | 2688 | 20907 | 2191 | 21998 | 1407 | 26832 | 1013 | 19163 |
| 16-#11 | 2.03 | MA | 16723 | 4175 | 25350 | 3457 | 30225 | 2801 | 32523 | 2287 | 34715 | 1518 | 43192 | 1095 | 30978 |
| 6L-4S | | MI | 11097 | 4175 | 17493 | 3329 | 20399 | 2693 | 21788 | 2186 | 23194 | 1412 | 28293 | 1056 | 19657 |
| 16-#11 | 2.03 | MA | 16092 | 4175 | 24464 | 3458 | 29053 | 2801 | 31090 | 2296 | 32722 | 1515 | 40805 | 1025 | 30005 |
| 7L-3S | | MI | 11544 | 4175 | 18096 | 3332 | 21213 | 2687 | 22759 | 2191 | 24425 | 1407 | 29667 | 1145 | 19732 |
| 16-#11 | 2.03 | MA | 15467 | 4175 | 23592 | 3459 | 27903 | 2800 | 29654 | 2295 | 30799 | 1521 | 38343 | 971 | 28946 |
| 8L-2S | | MI | 12149 | 4175 | 18897 | 3334 | 22228 | 2691 | 23974 | 2186 | 26023 | 1402 | 31762 | 1236 | 19763 |
| 16-#14 | 2.92 | MA | 19458 | 4576 | 31067 | 3685 | 37345 | 2969 | 41131 | 2391 | 46294 | 1481 | 58757 | 1077 | 45847 |
| 4L-6S | | MI | 10723 | 4576 | 18036 | 3567 | 21001 | 2862 | 22425 | 2277 | 24019 | 1359 | 29687 | 706 | 25346 |
| 16-#14 | 2.92 | MA | 18527 | 4576 | 29597 | 3702 | 35580 | 2968 | 38977 | 2403 | 43361 | 1490 | 55000 | 1010 | 44046 |
| 5E | | MI | 11265 | 4576 | 18815 | 3571 | 22038 | 2855 | 23652 | 2285 | 25593 | 1351 | 31607 | 796 | 26285 |
| 16-#14 | 2.92 | MA | 17635 | 4576 | 28291 | 3703 | 33839 | 2983 | 36856 | 2401 | 40540 | 1498 | 51185 | 902 | 42496 |
| 6L-4S | | MI | 11829 | 4576 | 19689 | 3561 | 23087 | 2862 | 24897 | 2277 | 27285 | 1359 | 33664 | 858 | 27065 |
| 16-#14 | 2.92 | MA | 16761 | 4576 | 27019 | 3704 | 32156 | 2982 | 34801 | 2413 | 37681 | 1492 | 47791 | 799 | 40635 |
| 7L-3S | | MI | 12449 | 4576 | 20550 | 3565 | 24248 | 2855 | 26270 | 2285 | 29025 | 1351 | 35604 | 984 | 27748 |
| 16-#14 | 2.92 | MA | 15897 | 4576 | 25768 | 3705 | 30507 | 2982 | 32741 | 2411 | 34923 | 1501 | 44281 | 722 | 38358 |
| 8L-2S | | MI | 13287 | 4576 | 21690 | 3569 | 25694 | 2862 | 27988 | 2277 | 31285 | 1344 | 38555 | 1115 | 27865 |
| 16-#18 | 5.19 | MA | 19806 | 5594 | 35559 | 4328 | 42813 | 3445 | 47638 | 2688 | 54971 | 1440 | 70837 | 389 | 68593 |
| 6L-4S | | MI | 13548 | 5594 | 25047 | 4154 | 29461 | 3275 | 32408 | 2499 | 37181 | 1207 | 46530 | 321 | 44211 |
| 16-#18 | 5.19 | MA | 18378 | 5594 | 33322 | 4329 | 39854 | 3442 | 44023 | 2708 | 49965 | 1427 | 64973 | 207 | 63494 |
| 7L-3S | | MI | 14537 | 5594 | 26545 | 4164 | 31445 | 3262 | 34752 | 2512 | 40150 | 1194 | 49827 | 537 | 46641 |
| 18-#11 | 2.28 | MA | 18690 | 4288 | 28654 | 3515 | 34405 | 2842 | 37605 | 2312 | 41562 | 1500 | 52347 | 1206 | 36610 |
| 4L-7S | | MI | 10287 | 4288 | 16605 | 3403 | 19252 | 2742 | 20412 | 2223 | 21392 | 1406 | 26166 | 843 | 20505 |
| 18-#11 | 2.28 | MA | 18025 | 4288 | 27628 | 3527 | 33174 | 2842 | 36103 | 2321 | 39517 | 1507 | 49712 | 1159 | 35715 |
| 5L-6S | | MI | 10666 | 4288 | 17137 | 3406 | 19954 | 2746 | 21254 | 2217 | 22483 | 1401 | 27563 | 926 | 21096 |
| 18-#11 | 2.28 | MA | 17387 | 4288 | 26718 | 3528 | 31960 | 2852 | 34624 | 2320 | 37550 | 1513 | 47031 | 1084 | 34922 |
| 6L-5S | | MI | 11054 | 4288 | 17682 | 3408 | 20680 | 2740 | 22122 | 2223 | 23596 | 1396 | 28927 | 988 | 21434 |
| 18-#11 | 2.28 | MA | 16763 | 4288 | 25832 | 3529 | 30787 | 2852 | 33191 | 2329 | 35557 | 1510 | 44644 | 1013 | 33903 |
| 7L-4S | | MI | 11457 | 4288 | 18294 | 3400 | 21414 | 2745 | 23003 | 2217 | 24793 | 1401 | 30387 | 1031 | 21995 |
| 18-#11 | 2.28 | MA | 16147 | 4288 | 24960 | 3530 | 29638 | 2852 | 31756 | 2328 | 33634 | 1516 | 42182 | 959 | 32869 |
| 8L-3S | | MI | 11900 | 4288 | 18897 | 3403 | 22228 | 2739 | 23974 | 2223 | 26023 | 1396 | 31762 | 1119 | 22087 |
| 18-#11 | 2.28 | MA | 15534 | 4288 | 23997 | 3542 | 28454 | 2863 | 30343 | 2337 | 31729 | 1523 | 39748 | 900 | 31496 |
| 9L-2S | | MI | 12500 | 4288 | 19697 | 3405 | 23244 | 2743 | 25189 | 2217 | 27622 | 1391 | 33857 | 1210 | 22131 |
| 18-#14 | 3.29 | MA | 19434 | 4739 | 31555 | 3804 | 38064 | 3043 | 41985 | 2451 | 47420 | 1482 | 60463 | 991 | 49671 |
| 5L-6S | | MI | 11231 | 4739 | 19176 | 3669 | 22447 | 2937 | 24142 | 2322 | 26279 | 1342 | 32638 | 667 | 28507 |
| 18-#14 | 3.29 | MA | 18555 | 4739 | 30249 | 3805 | 36322 | 3058 | 39865 | 2448 | 44599 | 1491 | 56648 | 883 | 48051 |
| 6L-5S | | MI | 11766 | 4739 | 19955 | 3674 | 23484 | 2930 | 25370 | 2329 | 27853 | 1335 | 34557 | 757 | 29521 |
| 18-#14 | 3.29 | MA | 17694 | 4739 | 28977 | 3806 | 34639 | 3057 | 37809 | 2461 | 41740 | 1485 | 53254 | 781 | 46239 |
| 7L-4S | | MI | 12324 | 4739 | 20829 | 3663 | 24533 | 2937 | 26615 | 2322 | 29546 | 1342 | 36615 | 819 | 30258 |

## RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

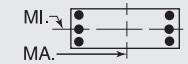



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 3.29 | MA | 16843 | 4739 | 27726 | 3808 | 32991 | 3056 | 35749 | 2458 | 38982 | 1493 | 49744 | 704 | 43927 |
| 8L-3S | | MI | 12936 | 4739 | 21690 | 3667 | 25694 | 2930 | 27988 | 2329 | 31285 | 1335 | 38555 | 945 | 31076 |
| 18-#14 | 3.29 | MA | 15997 | 4739 | 26344 | 3824 | 31292 | 3071 | 33723 | 2471 | 36250 | 1502 | 46282 | 619 | 41629 |
| 9L-2S | | MI | 13765 | 4739 | 22830 | 3672 | 27140 | 2937 | 29706 | 2322 | 33546 | 1327 | 41505 | 1076 | 31218 |
| 18-#18 | 5.84 | MA | 19933 | 5884 | 36752 | 4511 | 44204 | 3575 | 49293 | 2792 | 57055 | 1413 | 74426 | 168 | 73225 |
| 7L-4S | | MI | 14343 | 5884 | 27023 | 4335 | 31929 | 3405 | 35340 | 2574 | 41040 | 1172 | 51528 | 241 | 49767 |
| 20-#11 | 2.53 | MA | 18672 | 4401 | 28996 | 3598 | 34909 | 2894 | 38204 | 2354 | 42352 | 1502 | 53550 | 1147 | 39640 |
| 5L-7S | | MI | 10654 | 4401 | 17406 | 3474 | 20267 | 2794 | 21627 | 2254 | 22991 | 1396 | 28261 | 818 | 22749 |
| 20-#11 | 2.53 | MA | 18042 | 4401 | 28086 | 3599 | 33694 | 2904 | 36726 | 2353 | 40385 | 1508 | 50870 | 1072 | 38870 |
| 6E | | MI | 11030 | 4401 | 17937 | 3477 | 20970 | 2798 | 22469 | 2249 | 24082 | 1391 | 29657 | 901 | 23386 |
| 20-#11 | 2.53 | MA | 17426 | 4401 | 27200 | 3600 | 32521 | 2904 | 35293 | 2362 | 38392 | 1504 | 48483 | 1001 | 37807 |
| 7L-5S | | MI | 11414 | 4401 | 18482 | 3479 | 21695 | 2792 | 23337 | 2254 | 25195 | 1386 | 31021 | 963 | 23710 |
| 20-#11 | 2.53 | MA | 16816 | 4401 | 26327 | 3601 | 31372 | 2904 | 33857 | 2361 | 36469 | 1511 | 46021 | 947 | 36797 |
| 8L-4S | | MI | 11813 | 4401 | 19094 | 3471 | 22430 | 2797 | 24218 | 2249 | 26392 | 1391 | 32482 | 1006 | 24330 |
| 20-#11 | 2.53 | MA | 16211 | 4401 | 25364 | 3613 | 30188 | 2915 | 32445 | 2370 | 34564 | 1518 | 43586 | 889 | 35399 |
| 9L-3S | | MI | 12252 | 4401 | 19697 | 3473 | 23244 | 2791 | 25189 | 2254 | 27622 | 1386 | 33857 | 1094 | 24437 |
| 20-#11 | 2.53 | MA | 15607 | 4401 | 24495 | 3614 | 29047 | 2915 | 31026 | 2369 | 32606 | 1514 | 41070 | 809 | 34041 |
| 10L-2S | | MI | 12847 | 4401 | 20498 | 3476 | 24259 | 2795 | 26404 | 2249 | 29220 | 1380 | 35951 | 1185 | 24494 |
| 20-#14 | 3.65 | MA | 19460 | 4903 | 32207 | 3907 | 38805 | 3132 | 42873 | 2496 | 48658 | 1484 | 62111 | 865 | 53615 |
| 6E | | MI | 11732 | 4903 | 20316 | 3772 | 23893 | 3012 | 25860 | 2366 | 28540 | 1325 | 35589 | 628 | 31679 |
| 20-#14 | 3.65 | MA | 18612 | 4903 | 30935 | 3909 | 37123 | 3132 | 40817 | 2508 | 45799 | 1477 | 58717 | 762 | 51851 |
| 7L-5S | | MI | 12261 | 4903 | 21096 | 3776 | 24930 | 3005 | 27088 | 2374 | 30113 | 1318 | 37508 | 718 | 32763 |
| 20-#14 | 3.65 | MA | 17773 | 4903 | 29684 | 3910 | 35474 | 3131 | 38758 | 2506 | 43041 | 1486 | 55208 | 685 | 49504 |
| 8L-4S | | MI | 12812 | 4903 | 21969 | 3765 | 25979 | 3012 | 28333 | 2366 | 31806 | 1325 | 39566 | 780 | 33463 |
| 20-#14 | 3.65 | MA | 16940 | 4903 | 28302 | 3926 | 33775 | 3146 | 36732 | 2518 | 40309 | 1494 | 51745 | 601 | 47181 |
| 9L-3S | | MI | 13418 | 4903 | 22830 | 3770 | 27140 | 3004 | 29706 | 2374 | 33546 | 1318 | 41505 | 905 | 34401 |
| 22-#11 | 2.79 | MA | 18688 | 4515 | 29453 | 3670 | 35429 | 2956 | 38827 | 2386 | 43220 | 1503 | 54709 | 1061 | 42822 |
| 6L-7S | | MI | 11017 | 4515 | 18206 | 3545 | 21283 | 2845 | 22842 | 2286 | 24589 | 1385 | 30356 | 792 | 24999 |
| 22-#11 | 2.79 | MA | 18079 | 4515 | 28567 | 3671 | 34256 | 2956 | 37394 | 2395 | 41227 | 1499 | 52321 | 990 | 41716 |
| 7L-6S | | MI | 11389 | 4515 | 18738 | 3547 | 21985 | 2850 | 23684 | 2280 | 25680 | 1380 | 31752 | 876 | 25660 |
| 22-#11 | 2.79 | MA | 17476 | 4515 | 27695 | 3672 | 33107 | 2956 | 35958 | 2394 | 39304 | 1506 | 49860 | 936 | 40729 |
| 8L-5S | | MI | 11770 | 4515 | 19283 | 3550 | 22711 | 2844 | 24552 | 2286 | 26793 | 1375 | 33116 | 938 | 25991 |
| 22-#11 | 2.79 | MA | 16878 | 4515 | 26732 | 3684 | 31922 | 2966 | 34546 | 2403 | 37399 | 1512 | 47425 | 877 | 39307 |
| 9L-4S | | MI | 12165 | 4515 | 19895 | 3542 | 23445 | 2848 | 25433 | 2280 | 27990 | 1380 | 34577 | 981 | 26595 |
| 22-#11 | 2.79 | MA | 16280 | 4515 | 25863 | 3685 | 30781 | 2966 | 33127 | 2401 | 35441 | 1509 | 44908 | 797 | 37930 |
| 10L-3S | | MI | 12600 | 4515 | 20498 | 3544 | 24259 | 2843 | 26404 | 2286 | 29220 | 1375 | 35951 | 1069 | 26785 |
| 22-#11 | 2.79 | MA | 15641 | 4515 | 25001 | 3686 | 29611 | 2977 | 31723 | 2411 | 33545 | 1515 | 42489 | 740 | 36534 |
| 11L-2S | | MI | 13191 | 4515 | 21298 | 3547 | 25274 | 2847 | 27619 | 2280 | 30819 | 1370 | 38046 | 1160 | 26853 |
| 22-#14 | 4.02 | MA | 19515 | 5066 | 32893 | 4011 | 39606 | 3207 | 43826 | 2555 | 49858 | 1470 | 64180 | 744 | 57469 |
| 7L-6S | | MI | 12226 | 5066 | 21457 | 3874 | 25339 | 3087 | 27578 | 2410 | 30800 | 1309 | 38540 | 589 | 34861 |
| 22-#14 | 4.02 | MA | 18688 | 5066 | 31642 | 4012 | 37957 | 3206 | 41766 | 2553 | 47099 | 1478 | 60671 | 667 | 55088 |
| 8L-5S | | MI | 12750 | 5066 | 22236 | 3878 | 26376 | 3079 | 28806 | 2418 | 32374 | 1301 | 40459 | 679 | 36011 |
| 22-#14 | 4.02 | MA | 17866 | 5066 | 30260 | 4028 | 36258 | 3220 | 39740 | 2565 | 44368 | 1487 | 57208 | 582 | 52739 |
| 9L-4S | | MI | 13295 | 5066 | 23110 | 3868 | 27425 | 3087 | 30051 | 2410 | 34066 | 1309 | 42517 | 741 | 36677 |
| 24-#11 | 3.04 | MA | 18723 | 4628 | 29935 | 3742 | 35990 | 3008 | 39495 | 2428 | 44062 | 1494 | 56160 | 978 | 45630 |
| 7E | | MI | 11375 | 4628 | 19007 | 3616 | 22298 | 2897 | 24057 | 2317 | 26188 | 1375 | 32450 | 767 | 27255 |
| 24-#11 | 3.04 | MA | 18127 | 4628 | 29063 | 3743 | 34841 | 3008 | 38060 | 2426 | 42139 | 1501 | 53699 | 924 | 44641 |
| 8L-6S | | MI | 11745 | 4628 | 19538 | 3618 | 23000 | 2902 | 24899 | 2312 | 27279 | 1370 | 33847 | 851 | 27891 |
| 24-#11 | 3.04 | MA | 17536 | 4628 | 28099 | 3755 | 33657 | 3018 | 36647 | 2436 | 40234 | 1507 | 51264 | 866 | 43219 |
| 9L-5S | | MI | 12122 | 4628 | 20084 | 3621 | 23726 | 2896 | 25767 | 2317 | 28392 | 1364 | 35211 | 913 | 28276 |
| 24-#11 | 3.04 | MA | 16940 | 4628 | 27231 | 3756 | 32516 | 3018 | 35228 | 2434 | 38276 | 1503 | 48747 | 785 | 41823 |
| 10L-4S | | MI | 12514 | 4628 | 20695 | 3613 | 24460 | 2900 | 26648 | 2312 | 29589 | 1370 | 36672 | 955 | 28852 |
| 24-#11 | 3.04 | MA | 16308 | 4628 | 26368 | 3757 | 31345 | 3029 | 33824 | 2443 | 36380 | 1510 | 46328 | 729 | 40414 |
| 11L-3S | | MI | 12945 | 4628 | 21298 | 3615 | 25274 | 2894 | 27619 | 2317 | 30819 | 1364 | 38046 | 1044 | 29129 |
| 24-#14 | 4.38 | MA | 19590 | 5230 | 33600 | 4114 | 40440 | 3281 | 44775 | 2600 | 51158 | 1471 | 66134 | 648 | 60678 |
| 8L-6S | | MI | 12716 | 5230 | 22597 | 3976 | 26785 | 3162 | 29296 | 2455 | 33060 | 1292 | 41490 | 550 | 38052 |
| 24-#14 | 4.38 | MA | 18779 | 5230 | 32218 | 4131 | 38741 | 3295 | 42749 | 2613 | 48427 | 1480 | 62671 | 564 | 58304 |
| 9L-5S | | MI | 13233 | 5230 | 23376 | 3980 | 27822 | 3154 | 30523 | 2462 | 34634 | 1285 | 43410 | 639 | 39264 |

## RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

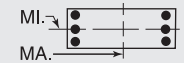
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.24 | MA | 19368 | 3997 | 27885 | 3348 | 33158 | 2721 | 35636 | 2254 | 37999 | 1576 | 46325 | 1477 | 22090 |
| 2E | | MI | 11409 | 3997 | 17244 | 3208 | 19744 | 2599 | 20738 | 2137 | 21453 | 1458 | 25509 | 1317 | 12725 |
| 6-#14 | 1.05 | MA | 18900 | 3906 | 26661 | 3311 | 31779 | 2696 | 34041 | 2241 | 35898 | 1591 | 43746 | 1509 | 18884 |
| 2L-3S | | MI | 10310 | 3906 | 15420 | 3179 | 17660 | 2584 | 18329 | 2151 | 18323 | 1502 | 21530 | 1245 | 11012 |
| 6-#14 | 1.05 | MA | 17274 | 3906 | 24601 | 3313 | 29166 | 2696 | 30875 | 2254 | 31627 | 1600 | 37968 | 1377 | 18837 |
| 3L-2S | | MI | 11203 | 3906 | 16560 | 3183 | 19106 | 2591 | 20047 | 2143 | 20584 | 1495 | 24480 | 1376 | 10967 |
| 6-#18 | 1.86 | MA | 21074 | 4288 | 31497 | 3530 | 37738 | 2854 | 41185 | 2338 | 45485 | 1563 | 56339 | 1441 | 32786 |
| 2L-3S | | MI | 10778 | 4288 | 17244 | 3379 | 19744 | 2716 | 20738 | 2225 | 21453 | 1436 | 25509 | 1003 | 18557 |
| 6-#18 | 1.86 | MA | 18323 | 4288 | 27885 | 3531 | 33158 | 2852 | 35636 | 2359 | 37999 | 1577 | 46325 | 1208 | 32366 |
| 3L-2S | | MI | 12280 | 4288 | 19220 | 3390 | 22213 | 2729 | 23670 | 2212 | 25312 | 1422 | 30507 | 1236 | 18641 |
| 8-#14 | 1.40 | MA | 19904 | 4070 | 28722 | 3413 | 34392 | 2771 | 37206 | 2289 | 40169 | 1583 | 49525 | 1492 | 24999 |
| 2L-4S | | MI | 10188 | 4070 | 15699 | 3277 | 17944 | 2666 | 18674 | 2188 | 18844 | 1493 | 22541 | 1080 | 14329 |
| 8-#14 | 1.40 | MA | 18303 | 4070 | 26661 | 3415 | 31779 | 2771 | 34041 | 2302 | 35898 | 1593 | 43746 | 1360 | 24898 |
| 3E | | MI | 10842 | 4070 | 16560 | 3281 | 19106 | 2658 | 20047 | 2195 | 20584 | 1485 | 24480 | 1206 | 14404 |
| 8-#14 | 1.40 | MA | 17146 | 4070 | 25133 | 3416 | 29713 | 2785 | 31537 | 2300 | 32518 | 1587 | 39933 | 1229 | 24533 |
| 4L-2S | | MI | 11723 | 4070 | 17700 | 3286 | 20552 | 2666 | 21764 | 2188 | 22844 | 1478 | 27431 | 1337 | 14390 |
| 8-#18 | 2.48 | MA | 22722 | 4579 | 35108 | 3711 | 42318 | 2987 | 46733 | 2423 | 52971 | 1550 | 66352 | 1405 | 43446 |
| 2L-4S | | MI | 10556 | 4579 | 17722 | 3550 | 20228 | 2859 | 21325 | 2287 | 22342 | 1414 | 27210 | 706 | 22458 |
| 8-#18 | 2.48 | MA | 20035 | 4579 | 31497 | 3713 | 37738 | 2985 | 41185 | 2443 | 45485 | 1563 | 56339 | 1172 | 42892 |
| 3E | | MI | 11653 | 4579 | 19220 | 3561 | 22213 | 2845 | 23670 | 2300 | 25312 | 1401 | 30507 | 922 | 24312 |
| 8-#18 | 2.48 | MA | 18092 | 4579 | 28811 | 3714 | 34108 | 3010 | 36785 | 2438 | 39547 | 1551 | 49745 | 938 | 39468 |
| 4L-2S | | MI | 13126 | 4579 | 21196 | 3571 | 24682 | 2859 | 26602 | 2287 | 29171 | 1387 | 35506 | 1156 | 24501 |
| 10-#11 | 1.21 | MA | 19418 | 3983 | 27580 | 3368 | 33032 | 2739 | 35597 | 2270 | 38025 | 1593 | 46754 | 1512 | 21838 |
| 2L-5S | | MI | 9983 | 3983 | 15047 | 3250 | 17260 | 2636 | 17910 | 2184 | 17803 | 1506 | 21230 | 1154 | 12506 |
| 10-#11 | 1.21 | MA | 18290 | 3983 | 26142 | 3370 | 31208 | 2739 | 33387 | 2280 | 35043 | 1600 | 42697 | 1421 | 21798 |
| 3L-4S | | MI | 10404 | 3983 | 15659 | 3242 | 17994 | 2641 | 18791 | 2179 | 19000 | 1511 | 22691 | 1197 | 12655 |
| 10-#11 | 1.21 | MA | 17476 | 3983 | 25076 | 3371 | 29767 | 2750 | 31641 | 2279 | 32686 | 1597 | 40016 | 1329 | 21662 |
| 4L-3S | | MI | 10866 | 3983 | 16262 | 3245 | 18808 | 2635 | 19762 | 2184 | 20231 | 1506 | 24065 | 1285 | 12663 |
| 10-#11 | 1.21 | MA | 16741 | 3983 | 23999 | 3383 | 28475 | 2750 | 30063 | 2288 | 30537 | 1604 | 37235 | 1282 | 21228 |
| 5L-2S | | MI | 11489 | 3983 | 17063 | 3247 | 19824 | 2639 | 20977 | 2179 | 21829 | 1501 | 26160 | 1376 | 12642 |
| 10-#14 | 1.75 | MA | 20885 | 4234 | 30782 | 3515 | 37005 | 2846 | 40372 | 2336 | 44440 | 1576 | 55304 | 1475 | 31096 |
| 2L-5S | | MI | 10128 | 4234 | 15966 | 3390 | 18342 | 2733 | 19146 | 2239 | 19412 | 1469 | 23434 | 979 | 16768 |
| 10-#14 | 1.75 | MA | 19308 | 4234 | 28722 | 3517 | 34392 | 2845 | 37206 | 2349 | 40169 | 1585 | 49525 | 1343 | 30949 |
| 3L-4S | | MI | 10717 | 4234 | 16840 | 3379 | 19390 | 2741 | 20391 | 2232 | 21105 | 1476 | 25492 | 1041 | 17652 |
| 10-#14 | 1.75 | MA | 18170 | 4234 | 27194 | 3519 | 32326 | 2860 | 34702 | 2347 | 36789 | 1580 | 45712 | 1212 | 30533 |
| 4L-3S | | MI | 11363 | 4234 | 17700 | 3384 | 20552 | 2733 | 21764 | 2239 | 22844 | 1469 | 27431 | 1166 | 17771 |
| 10-#14 | 1.75 | MA | 17140 | 4234 | 25648 | 3535 | 30472 | 2860 | 32439 | 2360 | 33707 | 1589 | 41744 | 1145 | 28767 |
| 5L-2S | | MI | 12233 | 4234 | 18840 | 3388 | 21998 | 2741 | 23482 | 2232 | 25104 | 1461 | 30382 | 1298 | 17793 |
| 10-#18 | 3.11 | MA | 21693 | 4870 | 35108 | 3895 | 42318 | 3118 | 46733 | 2528 | 52971 | 1550 | 66352 | 1135 | 53418 |
| 3L-4S | | MI | 11430 | 4870 | 19698 | 3732 | 22697 | 2988 | 24257 | 2361 | 26201 | 1379 | 32209 | 626 | 27894 |
| 10-#18 | 3.11 | MA | 19798 | 4870 | 32423 | 3896 | 38688 | 3143 | 42334 | 2522 | 47034 | 1537 | 59758 | 902 | 49667 |
| 4L-3S | | MI | 12507 | 4870 | 21196 | 3743 | 24682 | 2975 | 26602 | 2375 | 29171 | 1366 | 35506 | 842 | 30048 |
| 10-#18 | 3.11 | MA | 18082 | 4870 | 29705 | 3924 | 35427 | 3140 | 38354 | 2543 | 41615 | 1551 | 52857 | 785 | 46454 |
| 5L-2S | | MI | 13953 | 4870 | 23172 | 3753 | 27151 | 2988 | 29534 | 2361 | 33030 | 1352 | 40504 | 1076 | 30325 |
| 12-#11 | 1.45 | MA | 20117 | 4096 | 29019 | 3439 | 34857 | 2791 | 37808 | 2303 | 41007 | 1588 | 50812 | 1501 | 26100 |
| 2L-6S | | MI | 9963 | 4096 | 15303 | 3319 | 17549 | 2694 | 18257 | 2211 | 18289 | 1501 | 21961 | 1067 | 14350 |
| 12-#11 | 1.45 | MA | 19001 | 4096 | 27580 | 3441 | 33032 | 2791 | 35597 | 2313 | 38025 | 1595 | 46754 | 1410 | 26038 |
| 3L-5S | | MI | 10363 | 4096 | 15848 | 3321 | 18275 | 2688 | 19125 | 2216 | 19402 | 1495 | 23325 | 1129 | 14749 |
| 12-#11 | 1.45 | MA | 18198 | 4096 | 26515 | 3442 | 31592 | 2802 | 33851 | 2312 | 35668 | 1591 | 44074 | 1319 | 25875 |
| 4E | | MI | 10780 | 4096 | 16460 | 3313 | 19010 | 2693 | 20006 | 2211 | 20599 | 1501 | 24785 | 1172 | 15013 |
| 12-#11 | 1.45 | MA | 17471 | 4096 | 25437 | 3454 | 30299 | 2802 | 32273 | 2321 | 33519 | 1598 | 41293 | 1271 | 25320 |
| 5L-3S | | MI | 11237 | 4096 | 17063 | 3316 | 19824 | 2687 | 20977 | 2216 | 21829 | 1495 | 26160 | 1260 | 15043 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

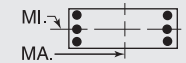
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.45 | MA | 16774 | 4096 | 24482 | 3456 | 29024 | 2813 | 30721 | 2320 | 31454 | 1606 | 38459 | 1197 | 24363 |
| 6L-2S | | MI | 11855 | 4096 | 17863 | 3318 | 20839 | 2691 | 22192 | 2211 | 23428 | 1490 | 28255 | 1351 | 15037 |
| 12-#14 | 2.10 | MA | 21846 | 4397 | 32842 | 3618 | 39618 | 2920 | 43537 | 2384 | 48711 | 1569 | 61083 | 1458 | 37182 |
| 2L-6S | | MI | 10098 | 4397 | 16327 | 3488 | 18751 | 2816 | 19636 | 2276 | 20098 | 1460 | 24465 | 850 | 19281 |
| 12-#14 | 2.10 | MA | 20290 | 4397 | 30782 | 3619 | 37005 | 2920 | 40372 | 2397 | 44440 | 1578 | 55304 | 1326 | 36995 |
| 3L-5S | | MI | 10656 | 4397 | 17106 | 3492 | 19788 | 2808 | 20864 | 2284 | 21672 | 1452 | 26385 | 939 | 19972 |
| 12-#14 | 2.10 | MA | 19171 | 4397 | 29254 | 3621 | 34939 | 2935 | 37868 | 2395 | 41060 | 1572 | 51490 | 1195 | 36534 |
| 4E | | MI | 11237 | 4397 | 17980 | 3481 | 20837 | 2816 | 22109 | 2276 | 23365 | 1460 | 28442 | 1001 | 20877 |
| 12-#14 | 2.10 | MA | 18158 | 4397 | 27709 | 3638 | 33085 | 2935 | 35604 | 2408 | 37978 | 1582 | 47522 | 1128 | 34654 |
| 5L-3S | | MI | 11875 | 4397 | 18840 | 3486 | 21998 | 2808 | 23482 | 2284 | 25104 | 1452 | 30382 | 1127 | 21124 |
| 12-#14 | 2.10 | MA | 17187 | 4397 | 26337 | 3639 | 31255 | 2950 | 33377 | 2406 | 35015 | 1591 | 43487 | 1019 | 33311 |
| 6L-2S | | MI | 12735 | 4397 | 19981 | 3490 | 23444 | 2816 | 25200 | 2276 | 27365 | 1445 | 33333 | 1259 | 21177 |
| 12-#18 | 3.73 | MA | 21455 | 5160 | 36034 | 4078 | 43268 | 3276 | 47883 | 2606 | 54520 | 1524 | 69771 | 866 | 59904 |
| 4E | | MI | 12285 | 5160 | 21674 | 3914 | 25166 | 3118 | 27190 | 2436 | 30060 | 1344 | 37207 | 546 | 33370 |
| 12-#18 | 3.73 | MA | 19780 | 5160 | 33317 | 4106 | 40007 | 3273 | 43903 | 2627 | 49101 | 1538 | 62870 | 749 | 56575 |
| 5L-3S | | MI | 13377 | 5160 | 23172 | 3924 | 27151 | 3105 | 29534 | 2449 | 33030 | 1331 | 40504 | 762 | 35772 |
| 12-#18 | 3.73 | MA | 18172 | 5160 | 30902 | 4107 | 36788 | 3298 | 39984 | 2621 | 43890 | 1552 | 55880 | 556 | 51998 |
| 6L-2S | | MI | 14771 | 5160 | 25148 | 3935 | 29620 | 3118 | 32467 | 2436 | 36888 | 1317 | 45503 | 996 | 36129 |
| 14-#11 | 1.70 | MA | 20804 | 4210 | 30457 | 3510 | 36681 | 2843 | 40018 | 2336 | 43989 | 1582 | 54870 | 1490 | 30356 |
| 2L-7S | | MI | 9953 | 4210 | 15572 | 3387 | 17863 | 2741 | 18630 | 2247 | 18797 | 1495 | 22659 | 958 | 16196 |
| 14-#11 | 1.70 | MA | 19701 | 4210 | 29019 | 3512 | 34857 | 2843 | 37808 | 2346 | 41007 | 1589 | 50812 | 1399 | 30274 |
| 3L-6S | | MI | 10342 | 4210 | 16103 | 3390 | 18565 | 2746 | 19472 | 2242 | 19887 | 1490 | 24055 | 1042 | 16627 |
| 14-#11 | 1.70 | MA | 18907 | 4210 | 27953 | 3513 | 33416 | 2854 | 36061 | 2345 | 38649 | 1586 | 48132 | 1308 | 30086 |
| 4L-5S | | MI | 10739 | 4210 | 16649 | 3392 | 19291 | 2740 | 20340 | 2247 | 21001 | 1485 | 25419 | 1104 | 17004 |
| 14-#11 | 1.70 | MA | 18189 | 4210 | 26876 | 3525 | 32123 | 2854 | 34483 | 2354 | 36501 | 1593 | 45350 | 1261 | 29425 |
| 5L-4S | | MI | 11151 | 4210 | 17260 | 3384 | 20025 | 2744 | 21221 | 2242 | 22197 | 1490 | 26880 | 1146 | 17363 |
| 14-#11 | 1.70 | MA | 17501 | 4210 | 25920 | 3526 | 30848 | 2865 | 32931 | 2353 | 34436 | 1600 | 42517 | 1186 | 28502 |
| 6L-3S | | MI | 11604 | 4210 | 17863 | 3387 | 20839 | 2739 | 22192 | 2247 | 23428 | 1485 | 28255 | 1235 | 17412 |
| 14-#11 | 1.70 | MA | 16828 | 4210 | 24990 | 3528 | 29616 | 2865 | 31426 | 2363 | 32342 | 1597 | 39992 | 1115 | 27619 |
| 7L-2S | | MI | 12216 | 4210 | 18664 | 3389 | 21854 | 2743 | 23407 | 2242 | 25026 | 1480 | 30349 | 1326 | 17422 |
| 14-#14 | 2.45 | MA | 21254 | 4561 | 32842 | 3721 | 39618 | 2995 | 43537 | 2444 | 48711 | 1570 | 61083 | 1309 | 43036 |
| 3L-6S | | MI | 10623 | 4561 | 17467 | 3590 | 20197 | 2891 | 21354 | 2321 | 22359 | 1443 | 27416 | 811 | 22410 |
| 14-#14 | 2.45 | MA | 20152 | 4561 | 31314 | 3723 | 37552 | 3010 | 41033 | 2442 | 45331 | 1565 | 57269 | 1178 | 42537 |
| 4L-5S | | MI | 11175 | 4561 | 18246 | 3594 | 21234 | 2883 | 22582 | 2328 | 23933 | 1435 | 29335 | 900 | 23189 |
| 14-#14 | 2.45 | MA | 19155 | 4561 | 29769 | 3740 | 35697 | 3010 | 38770 | 2455 | 42249 | 1574 | 53301 | 1111 | 40555 |
| 5L-4S | | MI | 11749 | 4561 | 19120 | 3584 | 22283 | 2890 | 23827 | 2321 | 25625 | 1443 | 31393 | 962 | 24037 |
| 14-#14 | 2.45 | MA | 18200 | 4561 | 28397 | 3741 | 33868 | 3025 | 36542 | 2453 | 39286 | 1584 | 49266 | 1002 | 39139 |
| 6L-3S | | MI | 12378 | 4561 | 19981 | 3588 | 23444 | 2883 | 25200 | 2328 | 27365 | 1435 | 33333 | 1088 | 24468 |
| 14-#14 | 2.45 | MA | 17263 | 4561 | 27062 | 3743 | 32100 | 3024 | 34383 | 2466 | 36282 | 1578 | 45673 | 900 | 37058 |
| 7L-2S | | MI | 13228 | 4561 | 21121 | 3592 | 24890 | 2890 | 26918 | 2321 | 29625 | 1428 | 36283 | 1219 | 24548 |
| 14-#18 | 4.35 | MA | 21435 | 5451 | 36928 | 4287 | 44587 | 3406 | 49451 | 2711 | 56587 | 1525 | 72883 | 713 | 66724 |
| 5L-4S | | MI | 13165 | 5451 | 23650 | 4096 | 27635 | 3247 | 30122 | 2511 | 33919 | 1309 | 42206 | 465 | 38877 |
| 14-#18 | 4.35 | MA | 19863 | 5451 | 34514 | 4289 | 41369 | 3431 | 45533 | 2706 | 51376 | 1538 | 65893 | 520 | 62286 |
| 6L-3S | | MI | 14184 | 5451 | 25148 | 4106 | 29620 | 3234 | 32467 | 2524 | 36888 | 1296 | 45503 | 682 | 41489 |
| 14-#18 | 4.35 | MA | 18322 | 5451 | 32164 | 4290 | 38259 | 3429 | 41734 | 2726 | 46093 | 1526 | 59676 | 338 | 57123 |
| 7L-2S | | MI | 15549 | 5451 | 27123 | 4117 | 32089 | 3247 | 35399 | 2511 | 40747 | 1282 | 50501 | 915 | 41917 |
| 16-#11 | 1.94 | MA | 20389 | 4323 | 30457 | 3582 | 36681 | 2895 | 40018 | 2378 | 43989 | 1584 | 54870 | 1389 | 34506 |
| 3L-7S | | MI | 10331 | 4323 | 16372 | 3458 | 18878 | 2793 | 19845 | 2279 | 20395 | 1485 | 24753 | 933 | 18423 |
| 16-#11 | 1.94 | MA | 19604 | 4323 | 29392 | 3584 | 35240 | 2905 | 38271 | 2378 | 41631 | 1581 | 52189 | 1297 | 34296 |
| 4L-6S | | MI | 10716 | 4323 | 16904 | 3461 | 19580 | 2798 | 20687 | 2274 | 21486 | 1479 | 26150 | 1017 | 18910 |
| 16-#11 | 1.94 | MA | 18895 | 4323 | 28314 | 3596 | 33948 | 2906 | 36694 | 2387 | 39483 | 1588 | 49408 | 1250 | 33539 |
| 5E | | MI | 11109 | 4323 | 17449 | 3463 | 20306 | 2792 | 21555 | 2279 | 22599 | 1474 | 27514 | 1079 | 19267 |
| 16-#11 | 1.94 | MA | 18216 | 4323 | 27359 | 3597 | 32672 | 2916 | 35141 | 2386 | 37417 | 1595 | 46574 | 1175 | 32647 |
| 6L-4S | | MI | 11517 | 4323 | 18061 | 3455 | 21040 | 2796 | 22436 | 2274 | 23796 | 1479 | 28975 | 1121 | 19708 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis

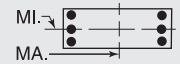



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.94 | MA | 17551 | 4323 | 26428 | 3599 | 31441 | 2917 | 33636 | 2396 | 35324 | 1592 | 44049 | 1104 | 31716 |
| 7L-3S | | MI | 11966 | 4323 | 18664 | 3458 | 21854 | 2790 | 23407 | 2279 | 25026 | 1474 | 30349 | 1210 | 19774 |
| 16-#11 | 1.94 | MA | 16893 | 4323 | 25513 | 3600 | 30234 | 2917 | 32128 | 2395 | 33304 | 1599 | 41451 | 1050 | 30568 |
| 8L-2S | | MI | 12573 | 4323 | 19464 | 3460 | 22870 | 2795 | 24622 | 2274 | 26625 | 1469 | 32444 | 1301 | 19799 |
| 16-#14 | 2.80 | MA | 21114 | 4724 | 33374 | 3825 | 40165 | 3085 | 44199 | 2489 | 49602 | 1558 | 63048 | 1161 | 48447 |
| 4L-6S | | MI | 11140 | 4724 | 18607 | 3692 | 21643 | 2965 | 23072 | 2365 | 24619 | 1426 | 30367 | 771 | 25554 |
| 16-#14 | 2.80 | MA | 20133 | 4724 | 31829 | 3842 | 38310 | 3085 | 41935 | 2502 | 46520 | 1567 | 59080 | 1094 | 46468 |
| 5E | | MI | 11685 | 4724 | 19386 | 3697 | 22680 | 2958 | 24300 | 2372 | 26193 | 1419 | 32286 | 861 | 26416 |
| 16-#14 | 2.80 | MA | 19192 | 4724 | 30457 | 3844 | 36481 | 3099 | 39708 | 2501 | 43557 | 1576 | 55045 | 985 | 44979 |
| 6L-4S | | MI | 12252 | 4724 | 20260 | 3686 | 23729 | 2965 | 25545 | 2365 | 27885 | 1426 | 34344 | 923 | 27214 |
| 16-#14 | 2.80 | MA | 18271 | 4724 | 29122 | 3845 | 34713 | 3099 | 37548 | 2514 | 40553 | 1571 | 51451 | 883 | 42953 |
| 7L-3S | | MI | 12874 | 4724 | 21121 | 3690 | 24890 | 2958 | 26918 | 2372 | 29625 | 1419 | 36283 | 1049 | 27805 |
| 16-#14 | 2.80 | MA | 17359 | 4724 | 27808 | 3847 | 32982 | 3099 | 35385 | 2512 | 37655 | 1580 | 47745 | 805 | 40661 |
| 8L-2S | | MI | 13715 | 4724 | 22261 | 3695 | 26336 | 2965 | 28636 | 2365 | 31885 | 1411 | 39234 | 1180 | 27911 |
| 16-#18 | 4.97 | MA | 21515 | 5742 | 38125 | 4471 | 45949 | 3564 | 51082 | 2790 | 58863 | 1525 | 75906 | 484 | 72592 |
| 6L-4S | | MI | 13978 | 5742 | 25625 | 4277 | 30104 | 3377 | 33054 | 2586 | 37778 | 1274 | 47204 | 385 | 44409 |
| 16-#18 | 4.97 | MA | 20007 | 5742 | 35775 | 4472 | 42839 | 3562 | 47283 | 2811 | 53579 | 1512 | 69689 | 302 | 67372 |
| 7L-3S | | MI | 14975 | 5742 | 27123 | 4288 | 32089 | 3364 | 35399 | 2599 | 40747 | 1261 | 50501 | 602 | 46912 |
| 16-#18 | 4.97 | MA | 18514 | 5742 | 33461 | 4474 | 39791 | 3560 | 43477 | 2805 | 48481 | 1526 | 63245 | 167 | 62159 |
| 8L-2S | | MI | 16312 | 5742 | 29099 | 4298 | 34558 | 3377 | 38331 | 2586 | 44606 | 1247 | 55500 | 835 | 47694 |
| 18-#11 | 2.18 | MA | 20292 | 4436 | 30830 | 3655 | 37065 | 2957 | 40482 | 2410 | 44613 | 1576 | 56247 | 1287 | 38505 |
| 4L-7S | | MI | 10704 | 4436 | 17173 | 3529 | 19893 | 2845 | 21060 | 2310 | 21994 | 1474 | 26848 | 908 | 20659 |
| 18-#11 | 2.18 | MA | 19591 | 4436 | 29753 | 3667 | 35772 | 2958 | 38904 | 2420 | 42465 | 1583 | 53466 | 1239 | 37662 |
| 5L-6S | | MI | 11085 | 4436 | 17704 | 3531 | 20595 | 2850 | 21902 | 2305 | 23085 | 1469 | 28245 | 992 | 21196 |
| 18-#11 | 2.18 | MA | 18920 | 4436 | 28797 | 3668 | 34497 | 2968 | 37351 | 2419 | 40399 | 1590 | 50632 | 1165 | 36798 |
| 6L-5S | | MI | 11474 | 4436 | 18250 | 3534 | 21321 | 2844 | 22770 | 2310 | 24198 | 1464 | 29609 | 1054 | 21537 |
| 18-#11 | 2.18 | MA | 18263 | 4436 | 27867 | 3670 | 33265 | 2969 | 35846 | 2428 | 38306 | 1587 | 48107 | 1094 | 35819 |
| 7L-4S | | MI | 11879 | 4436 | 18862 | 3526 | 22056 | 2848 | 23651 | 2305 | 25395 | 1469 | 31069 | 1096 | 22049 |
| 18-#11 | 2.18 | MA | 17613 | 4436 | 26951 | 3671 | 32059 | 2969 | 34339 | 2428 | 36286 | 1594 | 45509 | 1039 | 34699 |
| 8L-3S | | MI | 12323 | 4436 | 19464 | 3528 | 22870 | 2842 | 24622 | 2310 | 26625 | 1464 | 32444 | 1185 | 22131 |
| 18-#11 | 2.18 | MA | 16967 | 4436 | 25940 | 3683 | 30815 | 2979 | 32856 | 2437 | 34286 | 1601 | 42934 | 981 | 33332 |
| 9L-2S | | MI | 12925 | 4436 | 20265 | 3531 | 23885 | 2847 | 25837 | 2305 | 28223 | 1458 | 34539 | 1276 | 22168 |
| 18-#14 | 3.14 | MA | 21094 | 4888 | 33889 | 3944 | 40923 | 3159 | 45101 | 2550 | 50790 | 1559 | 64858 | 1077 | 52391 |
| 5L-6S | | MI | 11650 | 4888 | 19747 | 3794 | 23089 | 3040 | 24790 | 2409 | 26879 | 1409 | 33318 | 732 | 28712 |
| 18-#14 | 3.14 | MA | 20167 | 4888 | 32518 | 3946 | 39094 | 3174 | 42873 | 2548 | 47828 | 1569 | 60823 | 968 | 50831 |
| 6L-5S | | MI | 12188 | 4888 | 20527 | 3799 | 24126 | 3033 | 26017 | 2417 | 28453 | 1402 | 35237 | 822 | 29651 |
| 18-#14 | 3.14 | MA | 19260 | 4888 | 31182 | 3948 | 37326 | 3174 | 40714 | 2561 | 44824 | 1563 | 57230 | 866 | 48856 |
| 7L-4S | | MI | 12748 | 4888 | 21400 | 3788 | 25175 | 3040 | 27263 | 2409 | 30146 | 1409 | 37295 | 884 | 30405 |
| 18-#14 | 3.14 | MA | 18362 | 4888 | 29868 | 3949 | 35595 | 3174 | 38551 | 2559 | 41926 | 1573 | 53524 | 788 | 46530 |
| 8L-3S | | MI | 13363 | 4888 | 22261 | 3792 | 26336 | 3033 | 28636 | 2417 | 31885 | 1402 | 39234 | 1010 | 31136 |
| 18-#14 | 3.14 | MA | 17470 | 4888 | 28417 | 3966 | 33810 | 3189 | 36422 | 2572 | 39056 | 1582 | 49859 | 704 | 44207 |
| 9L-2S | | MI | 14196 | 4888 | 23401 | 3797 | 27782 | 3040 | 30354 | 2409 | 34146 | 1394 | 42185 | 1141 | 31266 |
| 18-#18 | 5.59 | MA | 21656 | 6033 | 39387 | 4654 | 47419 | 3695 | 52832 | 2895 | 61066 | 1499 | 79702 | 266 | 77637 |
| 7L-4S | | MI | 14776 | 6033 | 27601 | 4459 | 32573 | 3507 | 35987 | 2660 | 41637 | 1239 | 52203 | 305 | 49962 |
| 18-#18 | 5.59 | MA | 20193 | 6033 | 37073 | 4655 | 44372 | 3693 | 49026 | 2889 | 55967 | 1513 | 73259 | 130 | 72384 |
| 8L-3S | | MI | 15751 | 6033 | 29099 | 4470 | 34558 | 3493 | 38331 | 2673 | 44606 | 1225 | 55500 | 521 | 52309 |
| 20-#11 | 2.42 | MA | 20278 | 4550 | 31191 | 3738 | 37596 | 3009 | 41114 | 2453 | 45447 | 1578 | 57524 | 1229 | 41792 |
| 5L-7S | | MI | 11072 | 4550 | 17973 | 3600 | 20909 | 2897 | 22275 | 2342 | 23592 | 1463 | 28943 | 883 | 22902 |
| 20-#11 | 2.42 | MA | 19614 | 4550 | 30235 | 3739 | 36321 | 3020 | 39561 | 2452 | 43381 | 1585 | 54690 | 1154 | 40954 |
| 6E | | MI | 11449 | 4550 | 18505 | 3602 | 21611 | 2901 | 23117 | 2337 | 24683 | 1458 | 30340 | 966 | 23486 |
| 20-#11 | 2.42 | MA | 18964 | 4550 | 29305 | 3741 | 35090 | 3020 | 38056 | 2461 | 41288 | 1582 | 52165 | 1083 | 39929 |
| 7L-5S | | MI | 11835 | 4550 | 19050 | 3605 | 22337 | 2896 | 23985 | 2342 | 25796 | 1453 | 31703 | 1028 | 23813 |
| 20-#11 | 2.42 | MA | 18322 | 4550 | 28390 | 3742 | 33883 | 3021 | 36549 | 2460 | 39268 | 1589 | 49566 | 1029 | 38834 |
| 8L-4S | | MI | 12236 | 4550 | 19662 | 3597 | 23071 | 2900 | 24866 | 2337 | 26993 | 1458 | 33164 | 1071 | 24387 |
| 20-#11 | 2.42 | MA | 17684 | 4550 | 27378 | 3754 | 32639 | 3031 | 35066 | 2470 | 37268 | 1596 | 46992 | 970 | 37442 |
| 9L-3S | | MI | 12677 | 4550 | 20265 | 3599 | 23885 | 2894 | 25837 | 2342 | 28223 | 1453 | 34539 | 1160 | 24483 |
| 20-#11 | 2.42 | MA | 17043 | 4550 | 26466 | 3755 | 31441 | 3032 | 33576 | 2469 | 35212 | 1592 | 44331 | 890 | 36090 |
| 10L-2S | | MI | 13274 | 4550 | 21065 | 3602 | 24900 | 2899 | 27052 | 2337 | 29822 | 1448 | 36633 | 1251 | 24533 |

## RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

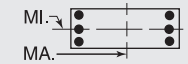
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 3.49 | MA | 21126 | 5051 | 34578 | 4048 | 41707 | 3249 | 46039 | 2595 | 52098 | 1561 | 66602 | 951 | 56693 |
| 6E | | MI | 12152 | 5051 | 20888 | 3897 | 24535 | 3115 | 26508 | 2454 | 29140 | 1393 | 36268 | 693 | 31882 |
| 20-#14 | 3.49 | MA | 20232 | 5051 | 33243 | 4050 | 39939 | 3249 | 43880 | 2608 | 49095 | 1556 | 63009 | 849 | 54767 |
| 7L-5S | | MI | 12684 | 5051 | 21667 | 3901 | 25572 | 3107 | 27735 | 2461 | 30714 | 1385 | 38188 | 783 | 32893 |
| 20-#14 | 3.49 | MA | 19347 | 5051 | 31928 | 4052 | 38208 | 3249 | 41716 | 2606 | 46197 | 1565 | 59302 | 771 | 52406 |
| 8L-4S | | MI | 13238 | 5051 | 22541 | 3890 | 26621 | 3115 | 28981 | 2454 | 32406 | 1393 | 40245 | 845 | 33608 |
| 20-#14 | 3.49 | MA | 18468 | 5051 | 30477 | 4068 | 36423 | 3264 | 39588 | 2619 | 43327 | 1575 | 55638 | 687 | 50060 |
| 9L-3S | | MI | 13847 | 5051 | 23401 | 3895 | 27782 | 3107 | 30354 | 2461 | 34146 | 1385 | 42185 | 970 | 34464 |
| 20-#14 | 3.49 | MA | 17577 | 5051 | 29168 | 4070 | 34704 | 3263 | 37450 | 2617 | 40377 | 1569 | 51849 | 571 | 47638 |
| 10L-2S | | MI | 14671 | 5051 | 24541 | 3899 | 29228 | 3115 | 32071 | 2454 | 36406 | 1378 | 45136 | 1102 | 34616 |
| 20-#18 | 6.21 | MA | 21839 | 6324 | 40684 | 4837 | 48952 | 3826 | 54574 | 2973 | 63454 | 1499 | 83272 | 94 | 82623 |
| 8L-4S | | MI | 15561 | 6324 | 29577 | 4641 | 35042 | 3636 | 38919 | 2735 | 45496 | 1204 | 57201 | 225 | 55531 |
| 22-#11 | 2.66 | MA | 20299 | 4663 | 31674 | 3810 | 38145 | 3072 | 41772 | 2485 | 46363 | 1580 | 58748 | 1143 | 45114 |
| 6L-7S | | MI | 11436 | 4663 | 18774 | 3671 | 21924 | 2949 | 23490 | 2373 | 25191 | 1453 | 31038 | 858 | 25150 |
| 22-#11 | 2.66 | MA | 19656 | 4663 | 30744 | 3811 | 36914 | 3072 | 40267 | 2494 | 44270 | 1576 | 56222 | 1073 | 44045 |
| 7L-6S | | MI | 11810 | 4663 | 19306 | 3673 | 22626 | 2953 | 24332 | 2368 | 26282 | 1448 | 32434 | 941 | 25778 |
| 22-#11 | 2.66 | MA | 19021 | 4663 | 29828 | 3813 | 35707 | 3073 | 38759 | 2493 | 42250 | 1584 | 53624 | 1018 | 42974 |
| 8L-5S | | MI | 12192 | 4663 | 19851 | 3676 | 23352 | 2947 | 25200 | 2373 | 27395 | 1443 | 33798 | 1003 | 26094 |
| 22-#11 | 2.66 | MA | 18390 | 4663 | 28817 | 3825 | 34464 | 3083 | 37276 | 2503 | 40250 | 1591 | 51050 | 960 | 41557 |
| 9L-4S | | MI | 12590 | 4663 | 20463 | 3668 | 24086 | 2952 | 26081 | 2368 | 28592 | 1448 | 35259 | 1046 | 26715 |
| 22-#11 | 2.66 | MA | 17752 | 4663 | 27905 | 3826 | 33266 | 3084 | 35786 | 2502 | 38194 | 1587 | 48388 | 880 | 40187 |
| 10L-3S | | MI | 13026 | 4663 | 21065 | 3670 | 24900 | 2946 | 27052 | 2373 | 29822 | 1443 | 36633 | 1134 | 26833 |
| 22-#11 | 2.66 | MA | 17078 | 4663 | 26999 | 3828 | 32036 | 3094 | 34312 | 2511 | 36203 | 1594 | 45835 | 822 | 38694 |
| 11L-2S | | MI | 13619 | 4663 | 21866 | 3673 | 25916 | 2951 | 28267 | 2368 | 31421 | 1437 | 38728 | 1225 | 26895 |
| 22-#14 | 3.84 | MA | 21189 | 5215 | 35303 | 4152 | 42552 | 3324 | 47045 | 2656 | 53366 | 1548 | 68787 | 832 | 60685 |
| 7L-6S | | MI | 12649 | 5215 | 22028 | 3999 | 25981 | 3190 | 28226 | 2498 | 31400 | 1376 | 39219 | 654 | 35061 |
| 22-#14 | 3.84 | MA | 20317 | 5215 | 33989 | 4154 | 40821 | 3324 | 44882 | 2654 | 50468 | 1558 | 65081 | 754 | 58289 |
| 8L-5S | | MI | 13175 | 5215 | 22807 | 4003 | 27018 | 3182 | 29453 | 2505 | 32974 | 1368 | 41138 | 743 | 36141 |
| 22-#14 | 3.84 | MA | 19450 | 5215 | 32537 | 4170 | 39036 | 3338 | 42754 | 2667 | 47598 | 1567 | 61416 | 670 | 55919 |
| 9L-4S | | MI | 13723 | 5215 | 23681 | 3993 | 28067 | 3190 | 30698 | 2498 | 34666 | 1376 | 43196 | 805 | 36821 |
| 22-#14 | 3.84 | MA | 18563 | 5215 | 31228 | 4172 | 37316 | 3338 | 40615 | 2665 | 44647 | 1562 | 57628 | 554 | 53481 |
| 10L-3S | | MI | 14325 | 5215 | 24541 | 3997 | 29228 | 3182 | 32071 | 2505 | 36406 | 1368 | 45136 | 931 | 37787 |
| 24-#11 | 2.91 | MA | 20339 | 4777 | 32182 | 3882 | 38738 | 3124 | 42477 | 2527 | 47252 | 1571 | 60280 | 1062 | 48166 |
| 7E | | MI | 11796 | 4777 | 19575 | 3742 | 22939 | 3001 | 24705 | 2405 | 26790 | 1442 | 33132 | 833 | 27404 |
| 24-#11 | 2.91 | MA | 19711 | 4777 | 31267 | 3884 | 37532 | 3124 | 40969 | 2526 | 45232 | 1578 | 57682 | 1007 | 47117 |
| 8L-6S | | MI | 12167 | 4777 | 20106 | 3744 | 23641 | 3005 | 25547 | 2400 | 27880 | 1437 | 34529 | 916 | 28057 |
| 24-#11 | 2.91 | MA | 19087 | 4777 | 30255 | 3896 | 36288 | 3135 | 39486 | 2536 | 43232 | 1585 | 55107 | 949 | 45677 |
| 9L-5S | | MI | 12545 | 4777 | 20651 | 3746 | 24367 | 2999 | 26415 | 2405 | 28994 | 1432 | 35893 | 978 | 28378 |
| 24-#11 | 2.91 | MA | 18452 | 4777 | 29343 | 3897 | 35090 | 3135 | 37996 | 2535 | 41176 | 1582 | 52446 | 869 | 44288 |
| 10L-4S | | MI | 12940 | 4777 | 21263 | 3739 | 25102 | 3004 | 27296 | 2400 | 30190 | 1437 | 37354 | 1021 | 28971 |
| 24-#11 | 2.91 | MA | 17785 | 4777 | 28438 | 3899 | 33861 | 3146 | 36522 | 2544 | 39184 | 1589 | 49892 | 812 | 42816 |
| 11L-3S | | MI | 13373 | 4777 | 21866 | 3741 | 25916 | 2998 | 28267 | 2405 | 31421 | 1432 | 38728 | 1109 | 29179 |
| 24-#11 | 2.91 | MA | 17126 | 4777 | 27537 | 3900 | 32666 | 3146 | 35041 | 2543 | 37203 | 1596 | 47338 | 754 | 41135 |
| 12L-2S | | MI | 13961 | 4777 | 22667 | 3743 | 26931 | 3002 | 29482 | 2400 | 33019 | 1427 | 40823 | 1200 | 29253 |
| 24-#14 | 4.19 | MA | 21273 | 5379 | 36049 | 4256 | 43433 | 3398 | 48047 | 2701 | 54739 | 1550 | 70860 | 737 | 64179 |
| 8L-6S | | MI | 13139 | 5379 | 23168 | 4101 | 27427 | 3265 | 29943 | 2542 | 33660 | 1359 | 42170 | 615 | 38250 |
| 24-#14 | 4.19 | MA | 20418 | 5379 | 34598 | 4273 | 41649 | 3413 | 45919 | 2714 | 51869 | 1560 | 67195 | 653 | 61784 |
| 9L-5S | | MI | 13660 | 5379 | 23947 | 4105 | 28464 | 3257 | 31171 | 2550 | 35234 | 1352 | 44089 | 704 | 39393 |
| 24-#14 | 4.19 | MA | 19534 | 5379 | 33288 | 4274 | 39929 | 3413 | 43781 | 2712 | 48918 | 1554 | 63406 | 537 | 59330 |
| 10L-4S | | MI | 14203 | 5379 | 24821 | 4095 | 29513 | 3264 | 32416 | 2542 | 36927 | 1359 | 46147 | 766 | 40043 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis

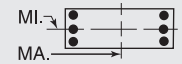



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.19 | MA | 20976 | 4146 | 29993 | 3487 | 35723 | 2836 | 38378 | 2351 | 40828 | 1651 | 49839 | 1555 | 23170 |
| 2E | | MI | 11828 | 4146 | 17822 | 3332 | 20388 | 2701 | 21384 | 2224 | 22050 | 1524 | 26183 | 1381 | 12760 |
| 6-#14 | 1.00 | MA | 20476 | 4055 | 28703 | 3450 | 34268 | 2810 | 36695 | 2339 | 38612 | 1666 | 47091 | 1585 | 19795 |
| 2L-3S | | MI | 10727 | 4055 | 15991 | 3304 | 18302 | 2687 | 18976 | 2238 | 18924 | 1569 | 22209 | 1310 | 11044 |
| 6-#14 | 1.00 | MA | 18764 | 4055 | 26540 | 3452 | 31526 | 2811 | 33372 | 2352 | 34129 | 1676 | 40996 | 1454 | 19748 |
| 3L-2S | | MI | 11621 | 4055 | 17131 | 3309 | 19748 | 2694 | 20694 | 2231 | 21184 | 1562 | 25160 | 1441 | 10995 |
| 6-#18 | 1.79 | MA | 22782 | 4437 | 33787 | 3669 | 40533 | 2969 | 44206 | 2436 | 48691 | 1638 | 60413 | 1522 | 34406 |
| 2L-3S | | MI | 11196 | 4437 | 17822 | 3503 | 20388 | 2817 | 21384 | 2312 | 22050 | 1502 | 26183 | 1067 | 18620 |
| 6-#18 | 1.79 | MA | 19883 | 4437 | 29993 | 3671 | 35723 | 2968 | 38378 | 2457 | 40828 | 1653 | 49839 | 1288 | 33986 |
| 3L-2S | | MI | 12701 | 4437 | 19798 | 3513 | 22856 | 2831 | 24317 | 2298 | 25909 | 1489 | 31182 | 1301 | 18683 |
| 8-#14 | 1.34 | MA | 21538 | 4219 | 30865 | 3552 | 37011 | 2885 | 40017 | 2386 | 43095 | 1658 | 53185 | 1570 | 26214 |
| 2L-4S | | MI | 10604 | 4219 | 16271 | 3402 | 18586 | 2769 | 19321 | 2275 | 19444 | 1560 | 23220 | 1145 | 14384 |
| 8-#14 | 1.34 | MA | 19852 | 4219 | 28703 | 3554 | 34268 | 2886 | 36695 | 2400 | 38612 | 1668 | 47091 | 1438 | 26113 |
| 3E | | MI | 11260 | 4219 | 17131 | 3406 | 19748 | 2761 | 20694 | 2282 | 21184 | 1553 | 25160 | 1270 | 14443 |
| 8-#14 | 1.34 | MA | 18636 | 4219 | 27101 | 3556 | 32102 | 2901 | 34069 | 2398 | 35068 | 1663 | 43066 | 1307 | 25748 |
| 4L-2S | | MI | 12143 | 4219 | 18271 | 3411 | 21194 | 2769 | 22412 | 2275 | 23444 | 1545 | 28111 | 1402 | 14422 |
| 8-#18 | 2.38 | MA | 24528 | 4727 | 37580 | 3851 | 45344 | 3102 | 50034 | 2520 | 56554 | 1625 | 70987 | 1488 | 45606 |
| 2L-4S | | MI | 10973 | 4727 | 18300 | 3674 | 20872 | 2960 | 21972 | 2373 | 22939 | 1480 | 27885 | 770 | 22667 |
| 8-#18 | 2.38 | MA | 21695 | 4727 | 33787 | 3853 | 40533 | 3101 | 44206 | 2542 | 48691 | 1640 | 60413 | 1255 | 45052 |
| 3E | | MI | 12074 | 4727 | 19798 | 3685 | 22856 | 2947 | 24317 | 2386 | 25909 | 1467 | 31182 | 987 | 24385 |
| 8-#18 | 2.38 | MA | 19649 | 4727 | 30969 | 3855 | 36725 | 3126 | 39590 | 2537 | 42461 | 1628 | 53443 | 1021 | 41709 |
| 4L-2S | | MI | 13551 | 4727 | 21774 | 3695 | 25325 | 2960 | 27249 | 2373 | 29768 | 1454 | 36180 | 1220 | 24550 |
| 10-#11 | 1.16 | MA | 21021 | 4131 | 29665 | 3508 | 35580 | 2853 | 38325 | 2368 | 40839 | 1668 | 50249 | 1588 | 22891 |
| 2L-5S | | MI | 10399 | 4131 | 15615 | 3376 | 17901 | 2740 | 18558 | 2272 | 18405 | 1573 | 21912 | 1219 | 12610 |
| 10-#11 | 1.16 | MA | 19834 | 4131 | 28155 | 3509 | 33666 | 2854 | 36005 | 2378 | 37710 | 1675 | 45972 | 1497 | 22851 |
| 3L-4S | | MI | 10821 | 4131 | 16227 | 3368 | 18636 | 2744 | 19439 | 2267 | 19602 | 1579 | 23373 | 1262 | 12694 |
| 10-#11 | 1.16 | MA | 18980 | 4131 | 27038 | 3511 | 32155 | 2865 | 34175 | 2377 | 35238 | 1672 | 43145 | 1406 | 22715 |
| 4L-3S | | MI | 11284 | 4131 | 16830 | 3371 | 19449 | 2738 | 20410 | 2272 | 20832 | 1573 | 24747 | 1351 | 12694 |
| 10-#11 | 1.16 | MA | 18207 | 4131 | 25910 | 3523 | 30801 | 2866 | 32521 | 2387 | 32987 | 1680 | 40218 | 1358 | 22362 |
| 5L-2S | | MI | 11908 | 4131 | 17630 | 3373 | 20465 | 2743 | 21625 | 2267 | 22431 | 1568 | 26842 | 1442 | 12670 |
| 10-#14 | 1.67 | MA | 22576 | 4382 | 33028 | 3655 | 39753 | 2960 | 43340 | 2433 | 47578 | 1651 | 59280 | 1554 | 32615 |
| 2L-5S | | MI | 10544 | 4382 | 16537 | 3515 | 18984 | 2836 | 19794 | 2327 | 20012 | 1536 | 24113 | 1044 | 16899 |
| 10-#14 | 1.67 | MA | 20915 | 4382 | 30865 | 3657 | 37011 | 2960 | 40017 | 2447 | 43095 | 1661 | 53185 | 1422 | 32468 |
| 3L-4S | | MI | 11135 | 4382 | 17411 | 3504 | 20033 | 2844 | 21039 | 2319 | 21705 | 1543 | 26171 | 1106 | 17713 |
| 10-#14 | 1.67 | MA | 19718 | 4382 | 29263 | 3659 | 34844 | 2976 | 37392 | 2446 | 39550 | 1656 | 49160 | 1291 | 32052 |
| 4L-3S | | MI | 11783 | 4382 | 18271 | 3509 | 21194 | 2836 | 22412 | 2327 | 23444 | 1536 | 28111 | 1231 | 17815 |
| 10-#14 | 1.67 | MA | 18635 | 4382 | 27644 | 3676 | 32900 | 2976 | 35019 | 2459 | 36320 | 1666 | 44982 | 1223 | 30307 |
| 5L-2S | | MI | 12655 | 4382 | 19412 | 3513 | 22640 | 2844 | 24130 | 2319 | 25705 | 1528 | 31061 | 1363 | 17828 |
| 10-#18 | 2.98 | MA | 23450 | 5018 | 37580 | 4035 | 45344 | 3234 | 50034 | 2626 | 56554 | 1626 | 70987 | 1221 | 56118 |
| 3L-4S | | MI | 11849 | 5018 | 20276 | 3856 | 23341 | 3090 | 24904 | 2448 | 26798 | 1445 | 32883 | 690 | 28098 |
| 10-#18 | 2.98 | MA | 21454 | 5018 | 34763 | 4037 | 41535 | 3259 | 45418 | 2621 | 50324 | 1615 | 64017 | 988 | 52435 |
| 4L-3S | | MI | 12930 | 5018 | 21774 | 3866 | 25325 | 3077 | 27249 | 2461 | 29768 | 1432 | 36180 | 906 | 30128 |
| 10-#18 | 2.98 | MA | 19647 | 5018 | 31913 | 4065 | 38115 | 3258 | 41243 | 2643 | 44641 | 1630 | 56742 | 870 | 49140 |
| 5L-2S | | MI | 14381 | 5018 | 23750 | 3877 | 27794 | 3090 | 30181 | 2448 | 33627 | 1419 | 41179 | 1140 | 30380 |
| 12-#11 | 1.39 | MA | 21760 | 4245 | 31174 | 3578 | 37494 | 2905 | 40644 | 2401 | 43967 | 1662 | 54526 | 1579 | 27364 |
| 2L-6S | | MI | 10379 | 4245 | 15871 | 3445 | 18191 | 2797 | 18905 | 2299 | 18890 | 1568 | 22643 | 1132 | 14446 |
| 12-#11 | 1.39 | MA | 20586 | 4245 | 29665 | 3580 | 35580 | 2906 | 38325 | 2410 | 40839 | 1670 | 50249 | 1488 | 27302 |
| 3L-5S | | MI | 10780 | 4245 | 16416 | 3447 | 18917 | 2792 | 19773 | 2304 | 20004 | 1563 | 24007 | 1194 | 14852 |
| 12-#11 | 1.39 | MA | 19741 | 4245 | 28548 | 3582 | 34069 | 2917 | 36494 | 2410 | 38367 | 1667 | 47422 | 1396 | 27138 |
| 4E | | MI | 11198 | 4245 | 17028 | 3439 | 19651 | 2796 | 20654 | 2299 | 21200 | 1568 | 25467 | 1237 | 15056 |
| 12-#11 | 1.39 | MA | 18978 | 4245 | 27419 | 3594 | 32715 | 2917 | 34840 | 2420 | 36115 | 1675 | 44494 | 1349 | 26660 |
| 5L-3S | | MI | 11656 | 4245 | 17630 | 3442 | 20465 | 2790 | 21625 | 2304 | 22431 | 1563 | 26842 | 1325 | 15078 |
| 12-#11 | 1.39 | MA | 18246 | 4245 | 26418 | 3596 | 31379 | 2928 | 33213 | 2419 | 33951 | 1682 | 41507 | 1274 | 25623 |
| 6L-2S | | MI | 12275 | 4245 | 18431 | 3444 | 21480 | 2795 | 22840 | 2299 | 24029 | 1558 | 28937 | 1417 | 15067 |
| 12-#14 | 2.01 | MA | 23593 | 4546 | 35190 | 3757 | 42496 | 3035 | 46663 | 2481 | 52060 | 1643 | 65374 | 1538 | 39005 |
| 2L-6S | | MI | 10513 | 4546 | 16898 | 3613 | 19393 | 2919 | 20284 | 2364 | 20699 | 1527 | 25145 | 915 | 19491 |

## RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

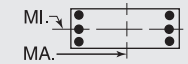
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 2.01 | MA | 21954 | 4546 | 33028 | 3759 | 39753 | 3035 | 43340 | 2494 | 47578 | 1653 | 59280 | 1407 | 38817 |
| 3L-5S | | MI | 11073 | 4546 | 17677 | 3617 | 20430 | 2911 | 21511 | 2371 | 22272 | 1519 | 27064 | 1004 | 20101 |
| 12-#14 | 2.01 | MA | 20776 | 4546 | 31426 | 3761 | 37587 | 3050 | 40714 | 2493 | 44033 | 1649 | 55255 | 1275 | 38357 |
| 4E | | MI | 11657 | 4546 | 18551 | 3607 | 21479 | 2919 | 22757 | 2364 | 23965 | 1527 | 29122 | 1066 | 21027 |
| 12-#14 | 2.01 | MA | 19711 | 4546 | 29806 | 3778 | 35643 | 3051 | 38341 | 2507 | 40802 | 1659 | 51076 | 1207 | 36492 |
| 5L-3S | | MI | 12296 | 4546 | 19412 | 3611 | 22640 | 2911 | 24130 | 2371 | 25705 | 1519 | 31061 | 1192 | 21173 |
| 12-#14 | 2.01 | MA | 18690 | 4546 | 28369 | 3780 | 33725 | 3066 | 36007 | 2505 | 37697 | 1669 | 46820 | 1099 | 35142 |
| 6L-2S | | MI | 13158 | 4546 | 20552 | 3615 | 24086 | 2918 | 25848 | 2364 | 27965 | 1512 | 34012 | 1323 | 21217 |
| 12-#18 | 3.57 | MA | 23208 | 5309 | 38556 | 4219 | 46346 | 3392 | 51246 | 2706 | 58187 | 1602 | 74590 | 954 | 63199 |
| 4E | | MI | 12706 | 5309 | 22252 | 4038 | 25810 | 3220 | 27836 | 2522 | 30657 | 1410 | 37882 | 610 | 33570 |
| 12-#18 | 3.57 | MA | 21444 | 5309 | 35706 | 4247 | 42926 | 3391 | 47072 | 2727 | 52504 | 1617 | 67316 | 836 | 59926 |
| 5L-3S | | MI | 13767 | 5309 | 23750 | 4048 | 27794 | 3206 | 30181 | 2536 | 33627 | 1397 | 41179 | 826 | 35858 |
| 12-#18 | 3.57 | MA | 19751 | 5309 | 33175 | 4249 | 39551 | 3416 | 42963 | 2723 | 47039 | 1632 | 59933 | 644 | 54961 |
| 6L-2S | | MI | 15196 | 5309 | 25726 | 4059 | 30263 | 3220 | 33113 | 2522 | 37486 | 1384 | 46177 | 1060 | 36187 |
| 14-#11 | 1.63 | MA | 22488 | 4358 | 32683 | 3649 | 39408 | 2957 | 42963 | 2433 | 47096 | 1657 | 58803 | 1569 | 31830 |
| 2L-7S | | MI | 10369 | 4358 | 16140 | 3513 | 18504 | 2845 | 19278 | 2335 | 19398 | 1563 | 23341 | 1024 | 16349 |
| 14-#11 | 1.63 | MA | 21325 | 4358 | 31174 | 3651 | 37494 | 2958 | 40644 | 2443 | 43967 | 1665 | 54526 | 1478 | 31748 |
| 3L-6S | | MI | 10758 | 4358 | 16671 | 3515 | 19206 | 2849 | 20120 | 2330 | 20489 | 1558 | 24737 | 1107 | 16724 |
| 14-#11 | 1.63 | MA | 20491 | 4358 | 30057 | 3653 | 35984 | 2969 | 38813 | 2443 | 41496 | 1662 | 51699 | 1387 | 31560 |
| 4L-5S | | MI | 11156 | 4358 | 17216 | 3518 | 19932 | 2843 | 20988 | 2335 | 21602 | 1552 | 26101 | 1169 | 17105 |
| 14-#11 | 1.63 | MA | 19737 | 4358 | 28928 | 3665 | 34629 | 2969 | 37159 | 2452 | 39244 | 1669 | 48771 | 1339 | 30969 |
| 5L-4S | | MI | 11570 | 4358 | 17828 | 3510 | 20666 | 2848 | 21869 | 2330 | 22799 | 1558 | 27562 | 1212 | 17409 |
| 14-#11 | 1.63 | MA | 19014 | 4358 | 27927 | 3667 | 33293 | 2980 | 35532 | 2452 | 37080 | 1677 | 45784 | 1264 | 29969 |
| 6L-3S | | MI | 12024 | 4358 | 18431 | 3512 | 21480 | 2842 | 22840 | 2335 | 24029 | 1552 | 28937 | 1300 | 17450 |
| 14-#11 | 1.63 | MA | 18306 | 4358 | 26952 | 3668 | 32003 | 2981 | 33956 | 2462 | 34887 | 1674 | 43121 | 1193 | 29136 |
| 7L-2S | | MI | 12638 | 4358 | 19232 | 3515 | 22495 | 2847 | 24055 | 2330 | 25628 | 1547 | 31031 | 1391 | 17455 |
| 14-#14 | 2.34 | MA | 22974 | 4709 | 35190 | 3861 | 42496 | 3110 | 46663 | 2542 | 52060 | 1646 | 65374 | 1391 | 45163 |
| 3L-6S | | MI | 11040 | 4709 | 18038 | 3715 | 20839 | 2993 | 22002 | 2408 | 22959 | 1510 | 28096 | 875 | 22617 |
| 14-#14 | 2.34 | MA | 21813 | 4709 | 33588 | 3863 | 40329 | 3125 | 44037 | 2540 | 48516 | 1641 | 61349 | 1260 | 44663 |
| 4L-5S | | MI | 11593 | 4709 | 18818 | 3719 | 21876 | 2986 | 23229 | 2415 | 24533 | 1503 | 30015 | 965 | 23317 |
| 14-#14 | 2.34 | MA | 20765 | 4709 | 31969 | 3880 | 38386 | 3126 | 41664 | 2554 | 45285 | 1651 | 57170 | 1192 | 42690 |
| 5L-4S | | MI | 12169 | 4709 | 19691 | 3709 | 22925 | 2993 | 24475 | 2408 | 26225 | 1510 | 32073 | 1027 | 24185 |
| 14-#14 | 2.34 | MA | 19760 | 4709 | 30531 | 3882 | 36468 | 3141 | 39329 | 2553 | 42179 | 1661 | 52914 | 1084 | 41346 |
| 6L-3S | | MI | 12801 | 4709 | 20552 | 3713 | 24086 | 2986 | 25848 | 2415 | 27965 | 1503 | 34012 | 1153 | 24520 |
| 14-#14 | 2.34 | MA | 18776 | 4709 | 29132 | 3884 | 34616 | 3141 | 37066 | 2566 | 39031 | 1656 | 49122 | 982 | 39093 |
| 7L-2S | | MI | 13654 | 4709 | 21692 | 3717 | 25532 | 2993 | 27565 | 2408 | 30225 | 1495 | 36963 | 1284 | 24590 |
| 14-#18 | 4.17 | MA | 23194 | 5600 | 39499 | 4429 | 47737 | 3524 | 52900 | 2812 | 60367 | 1603 | 77889 | 803 | 70606 |
| 5L-4S | | MI | 13591 | 5600 | 24227 | 4219 | 28279 | 3349 | 30769 | 2597 | 34516 | 1375 | 42880 | 530 | 39074 |
| 14-#18 | 4.17 | MA | 21539 | 5600 | 36968 | 4431 | 44361 | 3549 | 48791 | 2807 | 54902 | 1619 | 70507 | 610 | 65781 |
| 6L-3S | | MI | 14617 | 5600 | 25726 | 4230 | 30263 | 3336 | 33113 | 2610 | 37486 | 1362 | 46177 | 746 | 41580 |
| 14-#18 | 4.17 | MA | 19916 | 5600 | 34504 | 4433 | 41101 | 3548 | 44808 | 2829 | 49362 | 1607 | 63938 | 428 | 60507 |
| 7L-2S | | MI | 15990 | 5600 | 27701 | 4240 | 32732 | 3349 | 36046 | 2597 | 41345 | 1349 | 51176 | 980 | 41979 |
| 16-#11 | 1.86 | MA | 22054 | 4472 | 32683 | 3722 | 39408 | 3010 | 42963 | 2476 | 47096 | 1660 | 58803 | 1468 | 36190 |
| 3L-7S | | MI | 10747 | 4472 | 16940 | 3584 | 19519 | 2897 | 20493 | 2367 | 20997 | 1552 | 25435 | 999 | 18575 |
| 16-#11 | 1.86 | MA | 21228 | 4472 | 31567 | 3724 | 37898 | 3021 | 41132 | 2476 | 44625 | 1657 | 55975 | 1377 | 35981 |
| 4L-6S | | MI | 11133 | 4472 | 17472 | 3586 | 20221 | 2901 | 21335 | 2362 | 22088 | 1547 | 26832 | 1082 | 19006 |
| 16-#11 | 1.86 | MA | 20483 | 4472 | 30438 | 3736 | 36543 | 3021 | 39478 | 2485 | 42373 | 1664 | 53048 | 1329 | 35289 |
| 5E | | MI | 11527 | 4472 | 18017 | 3589 | 20947 | 2895 | 22203 | 2367 | 23201 | 1542 | 28196 | 1144 | 19368 |
| 16-#11 | 1.86 | MA | 19769 | 4472 | 29436 | 3737 | 35207 | 3032 | 37851 | 2485 | 40209 | 1672 | 50061 | 1254 | 34322 |
| 6L-4S | | MI | 11937 | 4472 | 18629 | 3581 | 21682 | 2900 | 23084 | 2362 | 24398 | 1547 | 29657 | 1187 | 19757 |
| 16-#11 | 1.86 | MA | 19070 | 4472 | 28462 | 3739 | 33917 | 3033 | 36275 | 2495 | 38015 | 1669 | 47398 | 1184 | 33439 |
| 7L-3S | | MI | 12387 | 4472 | 19232 | 3583 | 22495 | 2894 | 24055 | 2367 | 25628 | 1542 | 31031 | 1275 | 19814 |
| 16-#11 | 1.86 | MA | 18379 | 4472 | 27503 | 3741 | 32653 | 3033 | 34695 | 2494 | 35899 | 1677 | 44663 | 1129 | 32201 |
| 8L-2S | | MI | 12996 | 4472 | 20032 | 3586 | 23511 | 2898 | 25270 | 2362 | 27226 | 1537 | 33126 | 1366 | 19834 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis

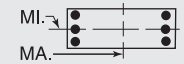


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.68 | MA | 22832 | 4873 | 35751 | 3965 | 43072 | 3200 | 47360 | 2588 | 52999 | 1634 | 67443 | 1244 | 50971 |
| 4L-6S | | MI | 11558 | 4873 | 19178 | 3817 | 22285 | 3068 | 23720 | 2452 | 25219 | 1493 | 31046 | 836 | 25758 |
| 16-#14 | 2.68 | MA | 21799 | 4873 | 34131 | 3982 | 41128 | 3200 | 44987 | 2601 | 49768 | 1644 | 63265 | 1176 | 48901 |
| 5E | | MI | 12105 | 4873 | 19958 | 3822 | 23322 | 3061 | 24947 | 2460 | 26793 | 1486 | 32966 | 926 | 26543 |
| 16-#14 | 2.68 | MA | 20810 | 4873 | 32694 | 3984 | 39211 | 3216 | 42652 | 2600 | 46662 | 1654 | 59009 | 1068 | 47484 |
| 6L-4S | | MI | 12674 | 4873 | 20832 | 3811 | 24371 | 3068 | 26192 | 2452 | 28486 | 1493 | 35023 | 988 | 27360 |
| 16-#14 | 2.68 | MA | 19841 | 4873 | 31295 | 3986 | 37359 | 3216 | 40389 | 2613 | 43514 | 1649 | 55217 | 966 | 45287 |
| 7L-3S | | MI | 13299 | 4873 | 21692 | 3815 | 25532 | 3061 | 27565 | 2460 | 30225 | 1486 | 36963 | 1114 | 27860 |
| 16-#14 | 2.68 | MA | 18882 | 4873 | 29918 | 3989 | 35544 | 3216 | 38122 | 2612 | 40477 | 1659 | 51313 | 887 | 42989 |
| 8L-2S | | MI | 14143 | 4873 | 22832 | 3820 | 26978 | 3068 | 29283 | 2452 | 32485 | 1478 | 39914 | 1245 | 27955 |
| 16-#18 | 4.76 | MA | 23286 | 5891 | 40761 | 4613 | 49172 | 3682 | 54619 | 2891 | 62765 | 1605 | 81080 | 577 | 76621 |
| 6L-4S | | MI | 14408 | 5891 | 26203 | 4401 | 30748 | 3479 | 33701 | 2672 | 38375 | 1340 | 47879 | 449 | 44603 |
| 16-#18 | 4.76 | MA | 21697 | 5891 | 38298 | 4615 | 45912 | 3681 | 50636 | 2913 | 57225 | 1594 | 74511 | 395 | 71292 |
| 7L-3S | | MI | 15411 | 5891 | 27701 | 4412 | 32732 | 3465 | 36046 | 2685 | 41345 | 1327 | 51176 | 666 | 47177 |
| 16-#18 | 4.76 | MA | 20125 | 5891 | 35872 | 4617 | 42717 | 3679 | 46645 | 2909 | 51879 | 1609 | 67717 | 258 | 65942 |
| 8L-2S | | MI | 16757 | 5891 | 29677 | 4422 | 35201 | 3479 | 38978 | 2672 | 45204 | 1314 | 56174 | 899 | 47759 |
| 18-#11 | 2.09 | MA | 21955 | 4585 | 33076 | 3795 | 39812 | 3072 | 43451 | 2508 | 47754 | 1652 | 60252 | 1367 | 40401 |
| 4L-7S | | MI | 11121 | 4585 | 17741 | 3655 | 20534 | 2949 | 21708 | 2398 | 22595 | 1542 | 27530 | 973 | 20809 |
| 18-#11 | 2.09 | MA | 21219 | 4585 | 31947 | 3807 | 38458 | 3073 | 41797 | 2518 | 45502 | 1659 | 57325 | 1319 | 39618 |
| 5L-6S | | MI | 11503 | 4585 | 18272 | 3657 | 21237 | 2953 | 22550 | 2393 | 23686 | 1536 | 28927 | 1057 | 21293 |
| 18-#11 | 2.09 | MA | 20513 | 4585 | 30946 | 3808 | 37121 | 3084 | 40171 | 2518 | 43338 | 1667 | 54338 | 1245 | 38680 |
| 6L-5S | | MI | 11894 | 4585 | 18818 | 3660 | 21962 | 2947 | 23418 | 2398 | 24799 | 1531 | 30291 | 1119 | 21638 |
| 18-#11 | 2.09 | MA | 19822 | 4585 | 29971 | 3810 | 35831 | 3085 | 38594 | 2527 | 41144 | 1664 | 51675 | 1174 | 37749 |
| 7L-4S | | MI | 12300 | 4585 | 19429 | 3652 | 22697 | 2952 | 24299 | 2393 | 25996 | 1536 | 31751 | 1161 | 22101 |
| 18-#11 | 2.09 | MA | 19139 | 4585 | 29012 | 3812 | 34567 | 3085 | 37014 | 2527 | 39028 | 1671 | 48940 | 1119 | 36539 |
| 8L-3S | | MI | 12746 | 4585 | 20032 | 3654 | 23511 | 2946 | 25270 | 2398 | 27226 | 1531 | 33126 | 1250 | 22173 |
| 18-#11 | 2.09 | MA | 18460 | 4585 | 27952 | 3824 | 33264 | 3096 | 35460 | 2537 | 36933 | 1679 | 46225 | 1061 | 35184 |
| 9L-2S | | MI | 13350 | 4585 | 20833 | 3657 | 24526 | 2950 | 26485 | 2393 | 28825 | 1526 | 35221 | 1341 | 22206 |
| 18-#14 | 3.01 | MA | 22816 | 5036 | 36294 | 4085 | 43871 | 3275 | 48309 | 2649 | 54251 | 1636 | 69359 | 1160 | 55122 |
| 5L-6S | | MI | 12069 | 5036 | 20319 | 3920 | 23731 | 3143 | 25438 | 2497 | 27479 | 1477 | 33997 | 797 | 28914 |
| 18-#14 | 3.01 | MA | 21841 | 5036 | 34856 | 4087 | 41953 | 3290 | 45975 | 2647 | 51145 | 1646 | 65103 | 1052 | 53633 |
| 6L-5S | | MI | 12609 | 5036 | 21098 | 3924 | 24768 | 3136 | 26665 | 2504 | 29053 | 1469 | 35916 | 887 | 29778 |
| 18-#14 | 3.01 | MA | 20886 | 5036 | 33457 | 4089 | 40101 | 3291 | 43712 | 2661 | 47997 | 1642 | 61311 | 950 | 51490 |
| 7L-4S | | MI | 13172 | 5036 | 21972 | 3913 | 25817 | 3143 | 27910 | 2497 | 30746 | 1477 | 37974 | 949 | 30549 |
| 18-#14 | 3.01 | MA | 19941 | 5036 | 32080 | 4091 | 38287 | 3291 | 41445 | 2659 | 44960 | 1652 | 57408 | 872 | 49157 |
| 8L-3S | | MI | 13790 | 5036 | 22832 | 3918 | 26978 | 3135 | 29283 | 2504 | 32485 | 1469 | 39914 | 1074 | 31194 |
| 18-#14 | 3.01 | MA | 19003 | 5036 | 30559 | 4108 | 36417 | 3306 | 39214 | 2673 | 41953 | 1662 | 53541 | 788 | 46819 |
| 9L-2S | | MI | 14625 | 5036 | 23972 | 3922 | 28424 | 3143 | 31001 | 2497 | 34746 | 1462 | 42864 | 1206 | 31313 |
| 18-#18 | 5.36 | MA | 23440 | 6181 | 42091 | 4797 | 50722 | 3814 | 56464 | 2997 | 65088 | 1581 | 85085 | 362 | 82092 |
| 7L-4S | | MI | 15209 | 6181 | 28179 | 4583 | 33217 | 3608 | 36633 | 2747 | 42234 | 1305 | 52877 | 369 | 50153 |
| 18-#18 | 5.36 | MA | 21900 | 6181 | 39666 | 4799 | 47527 | 3812 | 52473 | 2993 | 59742 | 1596 | 78291 | 225 | 76704 |
| 8L-3S | | MI | 16191 | 6181 | 29677 | 4593 | 35201 | 3595 | 38978 | 2760 | 45204 | 1292 | 56174 | 586 | 52570 |
| 20-#11 | 2.32 | MA | 21944 | 4698 | 33456 | 3878 | 40372 | 3125 | 44116 | 2551 | 48631 | 1654 | 61601 | 1310 | 43954 |
| 5L-7S | | MI | 11490 | 4698 | 18541 | 3726 | 21550 | 3000 | 22923 | 2430 | 24194 | 1531 | 29625 | 948 | 23051 |
| 20-#11 | 2.32 | MA | 21246 | 4698 | 32455 | 3879 | 39036 | 3136 | 42490 | 2550 | 46467 | 1661 | 58615 | 1235 | 43044 |
| 6E | | MI | 11869 | 4698 | 19073 | 3728 | 22252 | 3005 | 23765 | 2425 | 25285 | 1526 | 31022 | 1032 | 23583 |
| 20-#11 | 2.32 | MA | 20563 | 4698 | 31480 | 3881 | 37745 | 3136 | 40913 | 2560 | 44273 | 1659 | 55952 | 1164 | 42066 |
| 7L-5S | | MI | 12256 | 4698 | 19618 | 3731 | 22978 | 2999 | 24633 | 2430 | 26398 | 1521 | 32385 | 1094 | 23914 |
| 20-#11 | 2.32 | MA | 19888 | 4698 | 30521 | 3883 | 36481 | 3137 | 39333 | 2560 | 42157 | 1666 | 53217 | 1109 | 40882 |
| 8L-4S | | MI | 12658 | 4698 | 20230 | 3723 | 23712 | 3004 | 25514 | 2425 | 27595 | 1526 | 33846 | 1136 | 24441 |
| 20-#11 | 2.32 | MA | 19217 | 4698 | 29462 | 3895 | 35179 | 3148 | 37780 | 2570 | 40062 | 1674 | 50502 | 1051 | 39503 |
| 9L-3S | | MI | 13101 | 4698 | 20833 | 3725 | 24526 | 2998 | 26485 | 2430 | 28825 | 1521 | 35221 | 1225 | 24528 |
| 20-#11 | 2.32 | MA | 18536 | 4698 | 28507 | 3897 | 33923 | 3149 | 36218 | 2569 | 37907 | 1671 | 47696 | 971 | 38163 |
| 10L-2S | | MI | 13700 | 4698 | 21633 | 3727 | 25541 | 3002 | 27700 | 2425 | 30424 | 1515 | 37315 | 1316 | 24572 |
| 20-#14 | 3.35 | MA | 22855 | 5200 | 37019 | 4189 | 44696 | 3365 | 49297 | 2695 | 55628 | 1639 | 71198 | 1037 | 59793 |
| 6E | | MI | 12573 | 5200 | 21459 | 4022 | 25177 | 3218 | 27155 | 2541 | 29740 | 1460 | 36948 | 758 | 32080 |
| 20-#14 | 3.35 | MA | 21914 | 5200 | 35620 | 4191 | 42844 | 3366 | 47034 | 2708 | 52480 | 1634 | 67406 | 935 | 57700 |
| 7L-5S | | MI | 13107 | 5200 | 22238 | 4026 | 26214 | 3210 | 28383 | 2548 | 31314 | 1452 | 38867 | 848 | 33019 |

## RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

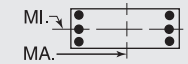
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 3.35 | MA | 20983 | 5200 | 34243 | 4193 | 41029 | 3366 | 44767 | 2707 | 49443 | 1644 | 63502 | 856 | 55334 |
| 8L-4S | | MI | 13664 | 5200 | 23112 | 4015 | 27263 | 3218 | 29628 | 2541 | 33006 | 1460 | 40925 | 910 | 33751 |
| 20-#14 | 3.35 | MA | 20057 | 5200 | 32722 | 4210 | 39159 | 3381 | 42537 | 2720 | 46435 | 1654 | 59636 | 772 | 52972 |
| 9L-3S | | MI | 14275 | 5200 | 23972 | 4020 | 28424 | 3210 | 31001 | 2548 | 34746 | 1452 | 42864 | 1035 | 34524 |
| 20-#14 | 3.35 | MA | 19108 | 5200 | 31350 | 4212 | 37357 | 3382 | 40296 | 2719 | 43343 | 1649 | 55639 | 657 | 50421 |
| 10L-2S | | MI | 15103 | 5200 | 25113 | 4024 | 29870 | 3218 | 32719 | 2541 | 37006 | 1445 | 45815 | 1167 | 34665 |
| 20-#18 | 5.95 | MA | 23639 | 6472 | 43459 | 4981 | 52338 | 3945 | 58301 | 3077 | 67605 | 1582 | 88865 | 191 | 87480 |
| 8L-4S | | MI | 15997 | 6472 | 30155 | 4765 | 35686 | 3738 | 39566 | 2821 | 46093 | 1270 | 57876 | 289 | 55721 |
| 22-#11 | 2.55 | MA | 21970 | 4812 | 33964 | 3950 | 40950 | 3188 | 44809 | 2583 | 49596 | 1656 | 62891 | 1225 | 47412 |
| 6L-7S | | MI | 11855 | 4812 | 19342 | 3797 | 22565 | 3052 | 24138 | 2461 | 25793 | 1520 | 31720 | 923 | 25298 |
| 22-#11 | 2.55 | MA | 21294 | 4812 | 32990 | 3952 | 39660 | 3188 | 43232 | 2593 | 47402 | 1653 | 60228 | 1154 | 46388 |
| 7L-6S | | MI | 12230 | 4812 | 19873 | 3799 | 23267 | 3057 | 24980 | 2456 | 26883 | 1515 | 33116 | 1007 | 25876 |
| 22-#11 | 2.55 | MA | 20627 | 4812 | 32031 | 3954 | 38396 | 3189 | 41652 | 2593 | 45286 | 1661 | 57493 | 1099 | 45229 |
| 8L-5S | | MI | 12614 | 4812 | 20419 | 3801 | 23993 | 3051 | 25848 | 2461 | 27997 | 1510 | 34480 | 1069 | 26194 |
| 22-#11 | 2.55 | MA | 19963 | 4812 | 30971 | 3966 | 37093 | 3200 | 40099 | 2602 | 43191 | 1669 | 54779 | 1041 | 43825 |
| 9L-4S | | MI | 13013 | 4812 | 21030 | 3793 | 24727 | 3055 | 26729 | 2456 | 29193 | 1515 | 35941 | 1111 | 26779 |
| 22-#11 | 2.55 | MA | 19285 | 4812 | 30016 | 3967 | 35838 | 3200 | 38538 | 2602 | 41036 | 1666 | 51973 | 961 | 42468 |
| 10L-3S | | MI | 13452 | 4812 | 21633 | 3796 | 25541 | 3050 | 27700 | 2461 | 30424 | 1510 | 37315 | 1200 | 26879 |
| 22-#11 | 2.55 | MA | 18576 | 4812 | 29068 | 3969 | 34550 | 3211 | 36993 | 2612 | 38950 | 1673 | 49285 | 903 | 40856 |
| 11L-2S | | MI | 14046 | 4812 | 22434 | 3798 | 26557 | 3054 | 28915 | 2456 | 32022 | 1505 | 39410 | 1291 | 26935 |
| 22-#14 | 3.68 | MA | 22925 | 5364 | 37782 | 4293 | 45586 | 3440 | 50357 | 2756 | 56962 | 1627 | 73500 | 919 | 63918 |
| 7L-6S | | MI | 13071 | 5364 | 22599 | 4124 | 26623 | 3293 | 28873 | 2585 | 32000 | 1443 | 39898 | 719 | 35258 |
| 22-#14 | 3.68 | MA | 22008 | 5364 | 36405 | 4295 | 43772 | 3441 | 48090 | 2754 | 53925 | 1637 | 69597 | 841 | 61517 |
| 8L-5S | | MI | 13600 | 5364 | 23378 | 4128 | 27660 | 3285 | 30101 | 2593 | 33574 | 1436 | 41818 | 808 | 36267 |
| 22-#14 | 3.68 | MA | 21095 | 5364 | 34884 | 4312 | 41902 | 3456 | 45860 | 2768 | 50918 | 1647 | 65730 | 756 | 59132 |
| 9L-4S | | MI | 14151 | 5364 | 24252 | 4118 | 28709 | 3293 | 31346 | 2585 | 35267 | 1443 | 43876 | 870 | 36963 |
| 22-#14 | 3.68 | MA | 20150 | 5364 | 33513 | 4314 | 40100 | 3456 | 43619 | 2766 | 47826 | 1642 | 61733 | 641 | 56618 |
| 10L-3S | | MI | 14755 | 5364 | 25113 | 4122 | 29870 | 3285 | 32719 | 2593 | 37006 | 1436 | 45815 | 996 | 37850 |
| 24-#11 | 2.79 | MA | 22016 | 4925 | 34499 | 4023 | 41574 | 3240 | 45551 | 2626 | 50531 | 1648 | 64505 | 1145 | 50716 |
| 7E | | MI | 12216 | 4925 | 20142 | 3867 | 23580 | 3104 | 25353 | 2493 | 27391 | 1510 | 33814 | 898 | 27551 |
| 24-#11 | 2.79 | MA | 21356 | 4925 | 33540 | 4024 | 40310 | 3241 | 43972 | 2625 | 48415 | 1656 | 61770 | 1090 | 49581 |
| 8L-6S | | MI | 12588 | 4925 | 20674 | 3870 | 24283 | 3109 | 26195 | 2488 | 28482 | 1505 | 35211 | 981 | 28171 |
| 24-#11 | 2.79 | MA | 20700 | 4925 | 32481 | 4037 | 39007 | 3252 | 42418 | 2635 | 46319 | 1663 | 59055 | 1031 | 48152 |
| 9L-5S | | MI | 12969 | 4925 | 21219 | 3872 | 25008 | 3103 | 27063 | 2493 | 29595 | 1499 | 36575 | 1043 | 28479 |
| 24-#11 | 2.79 | MA | 20024 | 4925 | 31525 | 4038 | 37752 | 3252 | 40857 | 2635 | 44165 | 1661 | 56250 | 951 | 46777 |
| 10L-4S | | MI | 13365 | 4925 | 21831 | 3864 | 25743 | 3107 | 27944 | 2488 | 30792 | 1505 | 38036 | 1086 | 29088 |
| 24-#11 | 2.79 | MA | 19322 | 4925 | 30577 | 4040 | 36464 | 3263 | 39313 | 2645 | 42079 | 1668 | 53562 | 893 | 45187 |
| 11L-3S | | MI | 13800 | 4925 | 22434 | 3867 | 26557 | 3101 | 28915 | 2493 | 32022 | 1499 | 39410 | 1175 | 29228 |
| 24-#11 | 2.79 | MA | 18630 | 4925 | 29634 | 4042 | 35212 | 3264 | 37761 | 2644 | 39942 | 1665 | 50868 | 836 | 43491 |
| 12L-2S | | MI | 14390 | 4925 | 23234 | 3869 | 27572 | 3106 | 30130 | 2488 | 33621 | 1494 | 41505 | 1266 | 29295 |
| 24-#14 | 4.02 | MA | 23018 | 5527 | 38568 | 4397 | 46514 | 3516 | 51413 | 2802 | 58408 | 1629 | 75691 | 825 | 67706 |
| 8L-6S | | MI | 13563 | 5527 | 23739 | 4226 | 28069 | 3367 | 30591 | 2630 | 34260 | 1426 | 42849 | 679 | 38444 |
| 24-#14 | 4.02 | MA | 22117 | 5527 | 37047 | 4414 | 44644 | 3531 | 49182 | 2815 | 55401 | 1639 | 71825 | 741 | 65298 |
| 9L-5S | | MI | 14087 | 5527 | 24519 | 4231 | 29106 | 3360 | 31818 | 2637 | 35834 | 1419 | 44769 | 769 | 39519 |
| 24-#14 | 4.02 | MA | 21177 | 5527 | 35675 | 4417 | 42843 | 3531 | 46942 | 2814 | 52309 | 1634 | 67828 | 625 | 62816 |
| 10L-4S | | MI | 14632 | 5527 | 25392 | 4220 | 30155 | 3367 | 33064 | 2630 | 37527 | 1426 | 46826 | 831 | 40183 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

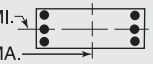
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.04 | MA | 8441 | 2727 | 12314 | 2249 | 14335 | 1830 | 15168 | 1520 | 15658 | 1065 | 18733 | 989 | 8250 |
| 2L-3S | | MI | 7757 | 2727 | 11443 | 2247 | 13230 | 1827 | 13834 | 1525 | 13902 | 1071 | 16422 | 898 | 8272 |
| 6-#14 | 1.50 | MA | 8941 | 2877 | 13484 | 2332 | 15762 | 1891 | 16830 | 1553 | 17828 | 1043 | 21547 | 946 | 11629 |
| 2L-3S | | MI | 7984 | 2877 | 12242 | 2329 | 14187 | 1885 | 14939 | 1560 | 15341 | 1051 | 18284 | 814 | 11599 |
| 6-#18 | 2.67 | MA | 10102 | 3259 | 16340 | 2549 | 19244 | 2045 | 20860 | 1634 | 23103 | 983 | 28331 | 823 | 19880 |
| 2L-3S | | MI | 8505 | 3259 | 14182 | 2541 | 16517 | 2032 | 17622 | 1647 | 18842 | 996 | 22780 | 590 | 19518 |
| 8-#11 | 1.39 | MA | 8846 | 2840 | 13185 | 2319 | 15440 | 1882 | 16503 | 1553 | 17414 | 1056 | 21045 | 967 | 10857 |
| 2L-4S | | MI | 7675 | 2840 | 11660 | 2316 | 13451 | 1885 | 14102 | 1553 | 14264 | 1056 | 17220 | 785 | 10770 |
| 8-#14 | 2.00 | MA | 9498 | 3041 | 14727 | 2434 | 17338 | 1965 | 18720 | 1599 | 20315 | 1029 | 24810 | 910 | 15320 |
| 2L-4S | | MI | 7865 | 3041 | 12549 | 2428 | 14500 | 1968 | 15319 | 1599 | 15914 | 1044 | 19407 | 651 | 14534 |
| 8-#18 | 3.56 | MA | 11004 | 3550 | 18498 | 2731 | 21970 | 2178 | 24098 | 1712 | 27363 | 952 | 33882 | 751 | 26226 |
| 2L-4S | | MI | 8298 | 3550 | 14710 | 2714 | 17053 | 2178 | 18272 | 1712 | 19824 | 978 | 24679 | 296 | 22653 |
| 10-#11 | 1.73 | MA | 9244 | 2954 | 14057 | 2390 | 16546 | 1934 | 17838 | 1585 | 19170 | 1047 | 23357 | 944 | 13449 |
| 2L-5S | | MI | 7643 | 2954 | 11868 | 2395 | 13760 | 1934 | 14469 | 1590 | 14748 | 1052 | 17919 | 721 | 12622 |
| 10-#11 | 1.73 | MA | 8578 | 2954 | 13185 | 2389 | 15440 | 1931 | 16503 | 1590 | 17414 | 1052 | 21045 | 853 | 13419 |
| 3L-4S | | MI | 8089 | 2954 | 12531 | 2387 | 14557 | 1937 | 15437 | 1585 | 16020 | 1047 | 19531 | 763 | 13307 |
| 10-#14 | 2.50 | MA | 10041 | 3205 | 15969 | 2536 | 18914 | 2040 | 20610 | 1645 | 22802 | 1014 | 28073 | 875 | 18991 |
| 2L-5S | | MI | 7818 | 3205 | 12843 | 2542 | 14937 | 2037 | 15839 | 1652 | 16539 | 1021 | 20395 | 554 | 17025 |
| 10-#14 | 2.50 | MA | 9117 | 3205 | 14727 | 2533 | 17338 | 2034 | 18720 | 1652 | 20315 | 1021 | 24810 | 744 | 18865 |
| 3L-4S | | MI | 8437 | 3205 | 13792 | 2530 | 16076 | 2043 | 17209 | 1645 | 18401 | 1029 | 22670 | 616 | 17965 |
| 10-#18 | 4.44 | MA | 11880 | 3841 | 20655 | 2913 | 24697 | 2310 | 27336 | 1789 | 31624 | 921 | 39433 | 679 | 32549 |
| 2L-5S | | MI | 8266 | 3841 | 15211 | 2914 | 17802 | 2297 | 19163 | 1803 | 20894 | 934 | 26359 | 113 | 25804 |
| 10-#18 | 4.44 | MA | 10395 | 3841 | 18498 | 2905 | 21970 | 2297 | 24098 | 1803 | 27363 | 934 | 33882 | 445 | 31520 |
| 3L-4S | | MI | 9242 | 3841 | 16867 | 2896 | 19780 | 2310 | 21510 | 1789 | 24085 | 947 | 30230 | 223 | 28653 |

## RECTANGULAR TIED COLUMNS 30" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.67 | MA | 10358 | 3127 | 15819 | 2517 | 18499 | 2038 | 19781 | 1666 | 21106 | 1101 | 25561 | 987 | 14573 |
| 2E | | MI | 9653 | 3127 | 14840 | 2501 | 17255 | 2023 | 18365 | 1649 | 19530 | 1086 | 23559 | 965 | 13536 |
| 6-#14 | 1.41 | MA | 10101 | 3037 | 15053 | 2481 | 17649 | 2013 | 18893 | 1661 | 19970 | 1129 | 24164 | 1033 | 12540 |
| 2L-3S | | MI | 8464 | 3037 | 12892 | 2464 | 14922 | 1996 | 15683 | 1655 | 16032 | 1123 | 19068 | 884 | 11648 |
| 6-#14 | 1.41 | MA | 9061 | 3037 | 13708 | 2479 | 15944 | 2008 | 16830 | 1668 | 17256 | 1136 | 20588 | 902 | 12510 |
| 3L-2S | | MI | 9424 | 3037 | 14135 | 2467 | 16498 | 2002 | 17574 | 1647 | 18519 | 1116 | 22331 | 1016 | 11663 |
| 6-#18 | 2.50 | MA | 11386 | 3418 | 18158 | 2699 | 21466 | 2171 | 23325 | 1746 | 25769 | 1073 | 31667 | 921 | 21500 |
| 2L-3S | | MI | 8986 | 3418 | 14840 | 2675 | 17255 | 2142 | 18365 | 1740 | 19530 | 1068 | 23559 | 659 | 19621 |
| 6-#18 | 2.50 | MA | 9646 | 3418 | 15819 | 2692 | 18499 | 2159 | 19781 | 1759 | 21106 | 1087 | 25561 | 688 | 21138 |
| 3L-2S | | MI | 10592 | 3418 | 16998 | 2683 | 19981 | 2155 | 21603 | 1727 | 23791 | 1055 | 29110 | 893 | 19932 |
| 8-#11 | 1.30 | MA | 9995 | 3000 | 14726 | 2469 | 17296 | 2005 | 18500 | 1658 | 19506 | 1141 | 23594 | 1053 | 11699 |
| 2L-4S | | MI | 8154 | 3000 | 12306 | 2452 | 14186 | 1997 | 14846 | 1648 | 14957 | 1129 | 18006 | 856 | 10828 |
| 8-#11 | 1.30 | MA | 9262 | 3000 | 13784 | 2467 | 16101 | 2002 | 17052 | 1664 | 17593 | 1146 | 21065 | 962 | 11694 |
| 3E | | MI | 8652 | 3000 | 12961 | 2453 | 15070 | 1990 | 15913 | 1653 | 16351 | 1134 | 19520 | 946 | 10890 |
| 8-#11 | 1.30 | MA | 8725 | 3000 | 13078 | 2466 | 15147 | 2010 | 15897 | 1659 | 16074 | 1141 | 19410 | 871 | 11613 |
| 4L-2S | | MI | 9329 | 3000 | 13832 | 2455 | 16175 | 1994 | 17247 | 1648 | 18106 | 1129 | 21832 | 1037 | 10887 |
| 8-#14 | 1.88 | MA | 10713 | 3200 | 16398 | 2583 | 19354 | 2088 | 20956 | 1708 | 22684 | 1116 | 27739 | 1001 | 16535 |
| 2L-4S | | MI | 8344 | 3200 | 13200 | 2563 | 15236 | 2079 | 16063 | 1693 | 16605 | 1116 | 20191 | 721 | 14744 |
| 8-#14 | 1.88 | MA | 9691 | 3200 | 15053 | 2581 | 17649 | 2083 | 18893 | 1716 | 19970 | 1123 | 24164 | 870 | 16453 |
| 3E | | MI | 9040 | 3200 | 14135 | 2566 | 16498 | 2070 | 17574 | 1700 | 18519 | 1109 | 22331 | 849 | 15294 |
| 8-#14 | 1.88 | MA | 8940 | 3200 | 14044 | 2579 | 16286 | 2093 | 17245 | 1708 | 17816 | 1116 | 21823 | 740 | 15853 |
| 4L-2S | | MI | 9984 | 3200 | 15377 | 2569 | 18074 | 2077 | 19464 | 1693 | 21006 | 1101 | 25594 | 981 | 15359 |
| 8-#18 | 3.33 | MA | 12379 | 3709 | 20497 | 2880 | 24433 | 2304 | 26869 | 1826 | 30433 | 1046 | 37772 | 855 | 28386 |
| 2L-4S | | MI | 8776 | 3709 | 15368 | 2848 | 17791 | 2288 | 19015 | 1805 | 20512 | 1050 | 25458 | 365 | 22931 |
| 8-#18 | 3.33 | MA | 10682 | 3709 | 18158 | 2874 | 21466 | 2292 | 23325 | 1840 | 25769 | 1059 | 31667 | 622 | 27895 |
| 3E | | MI | 9933 | 3709 | 16998 | 2856 | 19981 | 2274 | 21603 | 1818 | 23791 | 1037 | 29110 | 587 | 25849 |
| 8-#18 | 3.33 | MA | 9434 | 3709 | 16396 | 2867 | 19087 | 2306 | 20493 | 1826 | 22180 | 1072 | 27659 | 396 | 24731 |
| 4L-2S | | MI | 11500 | 3709 | 19155 | 2865 | 22708 | 2288 | 24841 | 1805 | 28052 | 1024 | 34661 | 820 | 26285 |

## RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

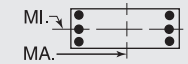
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.63 | MA | 10431 | 3113 | 15668 | 2539 | 18491 | 2057 | 19948 | 1691 | 21420 | 1133 | 26123 | 1033 | 14502 |
| 2L-5S | | MI | 8121 | 3113 | 12514 | 2531 | 14495 | 2045 | 15213 | 1685 | 15441 | 1125 | 18706 | 791 | 12765 |
| 10-#11 | 1.63 | MA | 9708 | 3113 | 14726 | 2538 | 17296 | 2054 | 18500 | 1697 | 19506 | 1138 | 23594 | 941 | 14472 |
| 3L-4S | | MI | 8568 | 3113 | 13178 | 2522 | 15291 | 2049 | 16181 | 1680 | 16712 | 1120 | 20318 | 833 | 13370 |
| 10-#11 | 1.63 | MA | 9178 | 3113 | 14020 | 2537 | 16342 | 2061 | 17345 | 1692 | 17987 | 1133 | 21939 | 850 | 14360 |
| 4L-3S | | MI | 9060 | 3113 | 13832 | 2524 | 16175 | 2042 | 17247 | 1685 | 18106 | 1125 | 21832 | 923 | 13462 |
| 10-#11 | 1.63 | MA | 8696 | 3113 | 13305 | 2546 | 15484 | 2059 | 16298 | 1698 | 16602 | 1138 | 20178 | 808 | 13694 |
| 5L-2S | | MI | 9728 | 3113 | 14704 | 2526 | 17280 | 2046 | 18582 | 1680 | 19862 | 1120 | 24143 | 1015 | 13484 |
| 10-#14 | 2.34 | MA | 11310 | 3364 | 17742 | 2686 | 21060 | 2163 | 23019 | 1755 | 25398 | 1103 | 31315 | 970 | 20510 |
| 2L-5S | | MI | 8295 | 3364 | 13494 | 2677 | 15673 | 2148 | 16583 | 1746 | 17230 | 1094 | 21179 | 624 | 17207 |
| 10-#14 | 2.34 | MA | 10305 | 3364 | 16398 | 2683 | 19354 | 2158 | 20956 | 1763 | 22684 | 1110 | 27739 | 838 | 20384 |
| 3L-4S | | MI | 8918 | 3364 | 14442 | 2665 | 16811 | 2154 | 17953 | 1739 | 19092 | 1101 | 23454 | 686 | 18169 |
| 10-#14 | 2.34 | MA | 9568 | 3364 | 15389 | 2681 | 17992 | 2168 | 19308 | 1755 | 20530 | 1103 | 25399 | 708 | 19573 |
| 4L-3S | | MI | 9602 | 3364 | 15377 | 2668 | 18074 | 2145 | 19464 | 1746 | 21006 | 1094 | 25594 | 814 | 18928 |
| 10-#14 | 2.34 | MA | 8897 | 3364 | 14365 | 2694 | 16763 | 2163 | 17812 | 1763 | 18564 | 1110 | 22905 | 647 | 18490 |
| 5L-2S | | MI | 10531 | 3364 | 16619 | 2671 | 19649 | 2151 | 21354 | 1739 | 23493 | 1086 | 28857 | 945 | 19035 |
| 10-#18 | 4.17 | MA | 13346 | 4000 | 22837 | 3062 | 27400 | 2437 | 30414 | 1907 | 35096 | 1018 | 43878 | 790 | 35249 |
| 2L-5S | | MI | 8696 | 4000 | 15869 | 3048 | 18539 | 2406 | 19906 | 1896 | 21582 | 1006 | 27137 | 182 | 26227 |
| 10-#18 | 4.17 | MA | 11688 | 4000 | 20497 | 3056 | 24433 | 2425 | 26869 | 1920 | 30433 | 1031 | 37772 | 556 | 34603 |
| 3L-4S | | MI | 9724 | 4000 | 17525 | 3030 | 20517 | 2420 | 22253 | 1883 | 24773 | 1019 | 31009 | 293 | 28924 |
| 10-#18 | 4.17 | MA | 10471 | 4000 | 18735 | 3049 | 22054 | 2439 | 24037 | 1907 | 26844 | 1044 | 33765 | 330 | 31251 |
| 4L-3S | | MI | 10853 | 4000 | 19155 | 3038 | 22708 | 2406 | 24841 | 1896 | 28052 | 1006 | 34661 | 514 | 31891 |
| 10-#18 | 4.17 | MA | 9365 | 4000 | 16946 | 3069 | 19907 | 2428 | 21468 | 1920 | 23352 | 1031 | 29507 | 221 | 28332 |
| 5L-2S | | MI | 12385 | 4000 | 21313 | 3047 | 25435 | 2420 | 28079 | 1883 | 32312 | 993 | 40212 | 748 | 32614 |
| 12-#11 | 1.95 | MA | 10859 | 3226 | 16611 | 2610 | 19686 | 2109 | 21396 | 1724 | 23333 | 1124 | 28652 | 1012 | 17294 |
| 2L-6S | | MI | 8109 | 3226 | 12795 | 2600 | 14813 | 2104 | 15595 | 1713 | 15974 | 1121 | 19405 | 692 | 14788 |
| 12-#11 | 1.95 | MA | 10145 | 3226 | 15668 | 2609 | 18491 | 2106 | 19948 | 1730 | 21420 | 1130 | 26123 | 921 | 17242 |
| 3L-5S | | MI | 8533 | 3226 | 13386 | 2602 | 15600 | 2097 | 16548 | 1718 | 17197 | 1116 | 21018 | 768 | 15220 |
| 12-#11 | 1.95 | MA | 9622 | 3226 | 14963 | 2608 | 17537 | 2113 | 18793 | 1725 | 19901 | 1124 | 24468 | 830 | 17103 |
| 4E | | MI | 8975 | 3226 | 14049 | 2593 | 16397 | 2101 | 17516 | 1713 | 18468 | 1111 | 22630 | 811 | 15907 |
| 12-#11 | 1.95 | MA | 9147 | 3226 | 14247 | 2617 | 16679 | 2110 | 17745 | 1731 | 18515 | 1130 | 22707 | 788 | 16354 |
| 5L-3S | | MI | 9461 | 3226 | 14704 | 2595 | 17280 | 2094 | 18582 | 1718 | 19862 | 1116 | 24143 | 901 | 16026 |
| 12-#11 | 1.95 | MA | 8690 | 3226 | 13610 | 2616 | 15831 | 2118 | 16713 | 1726 | 17183 | 1135 | 20942 | 712 | 15867 |
| 6L-2S | | MI | 10121 | 3226 | 15575 | 2597 | 18385 | 2098 | 19917 | 1713 | 21618 | 1111 | 26455 | 992 | 16067 |
| 12-#14 | 2.81 | MA | 11895 | 3527 | 19087 | 2788 | 22765 | 2238 | 25082 | 1802 | 28112 | 1090 | 34891 | 938 | 24473 |
| 2L-6S | | MI | 8279 | 3527 | 13891 | 2776 | 16123 | 2231 | 17123 | 1785 | 17986 | 1087 | 22317 | 500 | 19417 |
| 12-#14 | 2.81 | MA | 10905 | 3527 | 17742 | 2786 | 21060 | 2233 | 23019 | 1810 | 25398 | 1097 | 31315 | 806 | 24308 |
| 3L-5S | | MI | 8867 | 3527 | 14736 | 2779 | 17249 | 2223 | 18473 | 1792 | 19717 | 1079 | 24442 | 589 | 20715 |
| 12-#14 | 2.81 | MA | 10181 | 3527 | 16733 | 2783 | 19697 | 2243 | 21371 | 1802 | 23244 | 1090 | 28975 | 676 | 23317 |
| 4E | | MI | 9479 | 3527 | 15685 | 2767 | 18387 | 2229 | 19844 | 1785 | 21579 | 1087 | 26717 | 650 | 21618 |
| 12-#14 | 2.81 | MA | 9522 | 3527 | 15710 | 2796 | 18469 | 2238 | 19875 | 1810 | 21278 | 1097 | 26481 | 615 | 22297 |
| 5L-3S | | MI | 10152 | 3527 | 16619 | 2770 | 19649 | 2220 | 21354 | 1792 | 23493 | 1079 | 28857 | 779 | 22553 |
| 12-#14 | 2.81 | MA | 8890 | 3527 | 14799 | 2793 | 17255 | 2248 | 18402 | 1802 | 19388 | 1104 | 23987 | 505 | 20887 |
| 6L-2S | | MI | 11067 | 3527 | 17862 | 2774 | 21225 | 2226 | 23244 | 1785 | 25980 | 1072 | 32120 | 910 | 22698 |
| 12-#18 | 5.00 | MA | 12702 | 4291 | 22837 | 3237 | 27400 | 2558 | 30414 | 2000 | 35096 | 1004 | 43878 | 491 | 40946 |
| 3L-5S | | MI | 9694 | 4291 | 18027 | 3230 | 21266 | 2539 | 23144 | 1974 | 25842 | 975 | 32689 | 110 | 32115 |
| 12-#18 | 5.00 | MA | 11535 | 4291 | 21074 | 3231 | 25020 | 2572 | 27581 | 1987 | 31507 | 1017 | 39870 | 264 | 37807 |
| 4E | | MI | 10691 | 4291 | 19683 | 3212 | 23244 | 2552 | 25491 | 1960 | 29033 | 988 | 36560 | 220 | 34952 |
| 12-#18 | 5.00 | MA | 10462 | 4291 | 19285 | 3251 | 22873 | 2561 | 25012 | 2000 | 28016 | 1004 | 35612 | 155 | 34751 |
| 5L-3S | | MI | 11774 | 4291 | 21313 | 3220 | 25435 | 2539 | 28079 | 1974 | 32312 | 975 | 40212 | 442 | 37716 |
| 14-#11 | 2.27 | MA | 11280 | 3340 | 17553 | 2681 | 20881 | 2161 | 22844 | 1757 | 25247 | 1116 | 31181 | 992 | 20078 |
| 2L-7S | | MI | 8110 | 3340 | 13090 | 2669 | 15157 | 2152 | 16004 | 1750 | 16489 | 1106 | 20287 | 599 | 16419 |
| 14-#11 | 2.27 | MA | 10574 | 3340 | 16611 | 2680 | 19686 | 2158 | 21396 | 1763 | 23333 | 1121 | 28652 | 901 | 20007 |
| 3L-6S | | MI | 8520 | 3340 | 13666 | 2671 | 15918 | 2156 | 16930 | 1745 | 17730 | 1112 | 21717 | 670 | 17193 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis

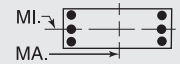


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.27 | MA | 10058 | 3340 | 15905 | 2679 | 18733 | 2165 | 20241 | 1758 | 21815 | 1116 | 26997 | 810 | 19844 |
| 4L-5S | | MI | 8939 | 3340 | 14257 | 2673 | 16705 | 2149 | 17883 | 1750 | 18953 | 1106 | 23329 | 746 | 17685 |
| 14-#11 | 2.27 | MA | 9589 | 3340 | 15189 | 2688 | 17874 | 2162 | 19193 | 1764 | 20429 | 1121 | 25236 | 767 | 19024 |
| 5L-4S | | MI | 9375 | 3340 | 14921 | 2664 | 17502 | 2153 | 18851 | 1745 | 20224 | 1101 | 24941 | 788 | 18419 |
| 14-#11 | 2.27 | MA | 9139 | 3340 | 14553 | 2687 | 17026 | 2170 | 18161 | 1759 | 19096 | 1127 | 23471 | 691 | 18492 |
| 6L-3S | | MI | 9854 | 3340 | 15575 | 2666 | 18385 | 2146 | 19917 | 1750 | 21618 | 1106 | 26455 | 878 | 18584 |
| 14-#11 | 2.27 | MA | 8698 | 3340 | 13932 | 2686 | 16206 | 2167 | 17160 | 1765 | 17744 | 1121 | 21908 | 620 | 17627 |
| 7L-2S | | MI | 10507 | 3340 | 16446 | 2668 | 19491 | 2150 | 21252 | 1745 | 23374 | 1101 | 28766 | 969 | 18644 |
| 14-#14 | 3.28 | MA | 11494 | 3691 | 19087 | 2888 | 22765 | 2308 | 25082 | 1857 | 28112 | 1084 | 34891 | 774 | 28228 |
| 3L-6S | | MI | 8848 | 3691 | 15133 | 2878 | 17699 | 2306 | 19013 | 1831 | 20473 | 1072 | 25579 | 464 | 22866 |
| 14-#14 | 3.28 | MA | 10781 | 3691 | 18078 | 2885 | 21402 | 2317 | 23434 | 1850 | 25958 | 1076 | 32550 | 644 | 27080 |
| 4L-5S | | MI | 9427 | 3691 | 15979 | 2881 | 18824 | 2297 | 20364 | 1838 | 22204 | 1064 | 27705 | 554 | 24236 |
| 14-#14 | 3.28 | MA | 10134 | 3691 | 17055 | 2898 | 20174 | 2312 | 21938 | 1857 | 23992 | 1084 | 30057 | 583 | 26115 |
| 5L-4S | | MI | 10029 | 3691 | 16927 | 2869 | 19963 | 2304 | 21734 | 1831 | 24066 | 1072 | 29980 | 615 | 25087 |
| 14-#14 | 3.28 | MA | 9512 | 3691 | 16144 | 2896 | 18961 | 2322 | 20465 | 1850 | 22102 | 1091 | 27562 | 473 | 24635 |
| 6L-3S | | MI | 10692 | 3691 | 17862 | 2873 | 21225 | 2295 | 23244 | 1838 | 25980 | 1064 | 32120 | 743 | 26173 |
| 14-#14 | 3.28 | MA | 8903 | 3691 | 15256 | 2893 | 17787 | 2317 | 19035 | 1857 | 20185 | 1084 | 25352 | 371 | 23196 |
| 7L-2S | | MI | 11594 | 3691 | 19104 | 2876 | 22801 | 2301 | 25135 | 1831 | 28467 | 1057 | 35383 | 875 | 26353 |
| 14-#18 | 5.83 | MA | 12513 | 4581 | 23413 | 3412 | 27987 | 2705 | 31126 | 2067 | 36170 | 989 | 45975 | 199 | 44393 |
| 4L-5S | | MI | 10619 | 4581 | 20184 | 3411 | 23993 | 2671 | 26382 | 2051 | 30103 | 944 | 38240 | 37 | 38037 |
| 14-#18 | 5.83 | MA | 11473 | 4581 | 21625 | 3432 | 25840 | 2694 | 28556 | 2081 | 32679 | 976 | 41718 | 89 | 41202 |
| 5L-4S | | MI | 11585 | 4581 | 21840 | 3393 | 25971 | 2684 | 28729 | 2038 | 33294 | 957 | 42111 | 148 | 41009 |
| 16-#11 | 2.60 | MA | 10997 | 3453 | 17553 | 2751 | 20881 | 2210 | 22844 | 1795 | 25247 | 1113 | 31181 | 880 | 22768 |
| 3L-7S | | MI | 8519 | 3453 | 13962 | 2740 | 16262 | 2204 | 17339 | 1783 | 18245 | 1097 | 22598 | 577 | 18865 |
| 16-#11 | 2.60 | MA | 10487 | 3453 | 16847 | 2750 | 19928 | 2217 | 21689 | 1791 | 23728 | 1108 | 29525 | 789 | 22488 |
| 4L-6S | | MI | 8924 | 3453 | 14538 | 2742 | 17023 | 2208 | 18264 | 1778 | 19486 | 1102 | 24028 | 647 | 19609 |
| 16-#11 | 2.60 | MA | 10024 | 3453 | 16132 | 2759 | 19069 | 2214 | 20641 | 1796 | 22342 | 1113 | 27764 | 747 | 21702 |
| 5E | | MI | 9338 | 3453 | 15129 | 2744 | 17810 | 2201 | 19218 | 1783 | 20709 | 1097 | 25641 | 723 | 20157 |
| 16-#11 | 2.60 | MA | 9580 | 3453 | 15495 | 2758 | 18221 | 2222 | 19609 | 1792 | 21010 | 1118 | 26000 | 671 | 21114 |
| 6L-4S | | MI | 9769 | 3453 | 15792 | 2735 | 18607 | 2205 | 20185 | 1778 | 21980 | 1092 | 27253 | 766 | 20853 |
| 16-#11 | 2.60 | MA | 9145 | 3453 | 14875 | 2757 | 17401 | 2219 | 18608 | 1797 | 19658 | 1113 | 24437 | 600 | 20281 |
| 7L-3S | | MI | 10242 | 3453 | 16446 | 2737 | 19491 | 2198 | 21252 | 1783 | 23374 | 1097 | 28766 | 856 | 21137 |
| 16-#11 | 2.60 | MA | 8715 | 3453 | 14264 | 2756 | 16597 | 2216 | 17604 | 1793 | 18354 | 1118 | 22794 | 550 | 19375 |
| 8L-2S | | MI | 10888 | 3453 | 17318 | 2739 | 20596 | 2201 | 22586 | 1778 | 25130 | 1092 | 31078 | 947 | 21214 |
| 16-#14 | 3.75 | MA | 11371 | 3854 | 19423 | 2988 | 23108 | 2392 | 25497 | 1897 | 28672 | 1063 | 36126 | 612 | 30860 |
| 4L-6S | | MI | 9407 | 3854 | 16376 | 2980 | 19275 | 2381 | 20904 | 1876 | 22960 | 1057 | 28842 | 429 | 26328 |
| 16-#14 | 3.75 | MA | 10734 | 3854 | 18399 | 3000 | 21880 | 2387 | 24002 | 1904 | 26706 | 1071 | 33633 | 551 | 29943 |
| 5E | | MI | 9977 | 3854 | 17221 | 2983 | 20400 | 2372 | 22254 | 1884 | 24691 | 1050 | 30968 | 518 | 27765 |
| 16-#14 | 3.75 | MA | 10122 | 3854 | 17488 | 2998 | 20666 | 2397 | 22528 | 1897 | 24816 | 1078 | 31138 | 441 | 28396 |
| 6L-4S | | MI | 10570 | 3854 | 18170 | 2972 | 21539 | 2378 | 23624 | 1876 | 26553 | 1057 | 33243 | 580 | 28572 |
| 16-#14 | 3.75 | MA | 9523 | 3854 | 16600 | 2996 | 19493 | 2392 | 21098 | 1904 | 22899 | 1071 | 28927 | 339 | 26912 |
| 7L-3S | | MI | 11223 | 3854 | 19104 | 2975 | 22801 | 2370 | 25135 | 1884 | 28467 | 1050 | 35383 | 708 | 29790 |
| 16-#18 | 6.67 | MA | 12458 | 4872 | 23964 | 3614 | 28807 | 2827 | 32101 | 2161 | 37342 | 948 | 47823 | 24 | 47682 |
| 5E | | MI | 11519 | 4872 | 22342 | 3593 | 26719 | 2803 | 29620 | 2129 | 34364 | 913 | 43791 | -35 | 43531 |
| 18-#11 | 2.92 | MA | 10910 | 3567 | 17790 | 2821 | 21123 | 2269 | 23137 | 1824 | 25642 | 1100 | 32054 | 769 | 25136 |
| 4L-7S | | MI | 8922 | 3567 | 14833 | 2811 | 17368 | 2256 | 18674 | 1815 | 20001 | 1088 | 24910 | 554 | 21317 |
| 18-#11 | 2.92 | MA | 10452 | 3567 | 17074 | 2830 | 20264 | 2266 | 22089 | 1829 | 24256 | 1105 | 30293 | 726 | 24387 |
| 5L-6S | | MI | 9322 | 3567 | 15409 | 2813 | 18129 | 2260 | 19599 | 1810 | 21242 | 1093 | 26340 | 625 | 22033 |
| 18-#11 | 2.92 | MA | 10014 | 3567 | 16437 | 2829 | 19416 | 2273 | 21057 | 1825 | 22923 | 1110 | 28529 | 651 | 23744 |
| 6L-5S | | MI | 9731 | 3567 | 16000 | 2815 | 18916 | 2253 | 20552 | 1815 | 22465 | 1088 | 27952 | 701 | 22636 |
| 18-#11 | 2.92 | MA | 9584 | 3567 | 15817 | 2828 | 18596 | 2271 | 20055 | 1830 | 21571 | 1105 | 26966 | 579 | 22941 |
| 7L-4S | | MI | 10156 | 3567 | 16664 | 2806 | 19712 | 2256 | 21520 | 1810 | 23736 | 1083 | 29564 | 743 | 23297 |
| 18-#11 | 2.92 | MA | 9160 | 3567 | 15206 | 2826 | 17792 | 2268 | 19052 | 1826 | 20267 | 1110 | 25323 | 530 | 22004 |
| 8L-3S | | MI | 10625 | 3567 | 17318 | 2808 | 20596 | 2250 | 22586 | 1815 | 25130 | 1088 | 31078 | 833 | 23687 |
| 18-#14 | 4.22 | MA | 11324 | 4018 | 19744 | 3102 | 23585 | 2462 | 26065 | 1951 | 29420 | 1058 | 37209 | 519 | 33722 |
| 5L-6S | | MI | 9957 | 4018 | 17618 | 3082 | 20850 | 2456 | 22794 | 1922 | 25446 | 1042 | 32105 | 394 | 29802 |
| 18-#14 | 4.22 | MA | 10721 | 4018 | 18833 | 3100 | 22371 | 2472 | 24591 | 1944 | 27530 | 1065 | 34714 | 410 | 32168 |
| 6L-5S | | MI | 10518 | 4018 | 18463 | 3086 | 21976 | 2447 | 24144 | 1930 | 27178 | 1035 | 34230 | 483 | 31182 |

## RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 4.22 | MA | 10132 | 4018 | 17945 | 3098 | 21198 | 2467 | 23161 | 1951 | 25613 | 1058 | 32503 | 307 | 30588 |
| 7L-4S | | MI | 11103 | 4018 | 19412 | 3074 | 23114 | 2453 | 25514 | 1922 | 29040 | 1042 | 36506 | 545 | 32069 |
| 20-#11 | 3.25 | MA | 10875 | 3680 | 18016 | 2901 | 21459 | 2318 | 23537 | 1862 | 26169 | 1097 | 32822 | 706 | 27076 |
| 5L-7S | | MI | 9319 | 3680 | 15704 | 2882 | 18473 | 2308 | 20009 | 1848 | 21757 | 1079 | 27221 | 531 | 23776 |
| 20-#11 | 3.25 | MA | 10441 | 3680 | 17380 | 2900 | 20611 | 2325 | 22505 | 1857 | 24837 | 1102 | 31058 | 630 | 26382 |
| 6E | | MI | 9715 | 3680 | 16280 | 2884 | 19234 | 2311 | 20934 | 1843 | 22998 | 1084 | 28651 | 602 | 24466 |
| 20-#11 | 3.25 | MA | 10017 | 3680 | 16759 | 2898 | 19791 | 2322 | 21503 | 1863 | 23485 | 1097 | 29495 | 559 | 25606 |
| 7L-5S | | MI | 10118 | 3680 | 16871 | 2885 | 20021 | 2305 | 21887 | 1848 | 24220 | 1079 | 30264 | 678 | 25119 |
| 20-#11 | 3.25 | MA | 9598 | 3680 | 16149 | 2897 | 18987 | 2320 | 20500 | 1858 | 22181 | 1102 | 27852 | 509 | 24639 |
| 8L-4S | | MI | 10539 | 3680 | 17535 | 2877 | 20817 | 2308 | 22855 | 1843 | 25492 | 1073 | 31876 | 720 | 25749 |
| 20-#14 | 4.69 | MA | 11312 | 4182 | 20178 | 3202 | 24077 | 2547 | 26654 | 1991 | 30244 | 1052 | 38290 | 378 | 35950 |
| 6E | | MI | 10498 | 4182 | 18861 | 3185 | 22426 | 2531 | 24684 | 1968 | 27933 | 1028 | 35368 | 359 | 33286 |
| 20-#14 | 4.69 | MA | 10730 | 4182 | 19290 | 3200 | 22903 | 2542 | 25224 | 1999 | 28327 | 1045 | 36079 | 275 | 34329 |
| 7L-5S | | MI | 11051 | 4182 | 19706 | 3188 | 23551 | 2522 | 26035 | 1976 | 29665 | 1020 | 37493 | 448 | 34611 |
| 22-#11 | 3.57 | MA | 10864 | 3793 | 18322 | 2970 | 21806 | 2377 | 23953 | 1890 | 26750 | 1094 | 33586 | 610 | 29028 |
| 6L-7S | | MI | 9711 | 3793 | 16576 | 2953 | 19578 | 2360 | 21343 | 1880 | 23513 | 1069 | 29533 | 509 | 26240 |
| 22-#11 | 3.57 | MA | 10444 | 3793 | 17702 | 2969 | 20986 | 2374 | 22951 | 1896 | 25398 | 1089 | 32024 | 538 | 28277 |
| 7L-6S | | MI | 10102 | 3793 | 17152 | 2955 | 20339 | 2363 | 22269 | 1875 | 24754 | 1074 | 30963 | 579 | 26905 |
| 22-#11 | 3.57 | MA | 10030 | 3793 | 17091 | 2968 | 20182 | 2371 | 21948 | 1891 | 24095 | 1094 | 30381 | 489 | 27255 |
| 8L-5S | | MI | 10501 | 3793 | 17743 | 2956 | 21126 | 2357 | 23222 | 1880 | 25976 | 1069 | 32575 | 656 | 27608 |
| 22-#14 | 5.16 | MA | 11321 | 4345 | 20634 | 3302 | 24609 | 2617 | 27287 | 2046 | 31041 | 1032 | 39655 | 243 | 38079 |
| 7L-6S | | MI | 11032 | 4345 | 20103 | 3287 | 24002 | 2606 | 26574 | 2014 | 30420 | 1013 | 38631 | 323 | 36779 |
| 24-#11 | 3.90 | MA | 10866 | 3907 | 18644 | 3040 | 22181 | 2426 | 24399 | 1929 | 27312 | 1081 | 34553 | 518 | 30953 |
| 7E | | MI | 10098 | 3907 | 17447 | 3024 | 20683 | 2411 | 22678 | 1913 | 25269 | 1060 | 31844 | 486 | 28687 |
| 24-#11 | 3.90 | MA | 10456 | 3907 | 18033 | 3039 | 21377 | 2423 | 23396 | 1924 | 26008 | 1086 | 32909 | 469 | 29903 |
| 8L-6S | | MI | 10485 | 3907 | 18023 | 3025 | 21444 | 2415 | 23603 | 1908 | 26510 | 1065 | 33274 | 557 | 29351 |

## RECTANGULAR TIED COLUMNS 30" x 34"

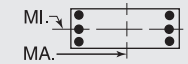
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.57 | MA | 11613 | 3287 | 17530 | 2666 | 20556 | 2160 | 22040 | 1774 | 23467 | 1187 | 28457 | 1076 | 15653 |
| 2E | | MI | 10137 | 3287 | 15498 | 2635 | 17992 | 2133 | 19108 | 1743 | 20218 | 1158 | 24337 | 1035 | 13577 |
| 6-#14 | 1.32 | MA | 11326 | 3196 | 16697 | 2630 | 19630 | 2136 | 21017 | 1766 | 22209 | 1213 | 26893 | 1120 | 13451 |
| 2L-3S | | MI | 8943 | 3196 | 13543 | 2599 | 15658 | 2107 | 16427 | 1749 | 16723 | 1196 | 19852 | 955 | 11694 |
| 6-#14 | 1.32 | MA | 10203 | 3196 | 15250 | 2629 | 17795 | 2132 | 18794 | 1774 | 19268 | 1221 | 23004 | 988 | 13422 |
| 3L-2S | | MI | 9906 | 3196 | 14785 | 2602 | 17234 | 2113 | 18317 | 1742 | 19210 | 1188 | 23115 | 1086 | 11696 |
| 6-#18 | 2.35 | MA | 12736 | 3577 | 20051 | 2848 | 23754 | 2293 | 25891 | 1857 | 28534 | 1162 | 35118 | 1016 | 23120 |
| 2L-3S | | MI | 9467 | 3577 | 15498 | 2808 | 17992 | 2252 | 19108 | 1834 | 20218 | 1140 | 24337 | 729 | 19717 |
| 6-#18 | 2.35 | MA | 10852 | 3577 | 17530 | 2843 | 20556 | 2283 | 22040 | 1870 | 23467 | 1176 | 28457 | 783 | 22758 |
| 3L-2S | | MI | 11080 | 3577 | 17656 | 2817 | 20719 | 2265 | 22346 | 1821 | 24479 | 1127 | 29888 | 962 | 19983 |
| 8-#11 | 1.22 | MA | 11207 | 3159 | 16341 | 2618 | 19245 | 2128 | 20580 | 1763 | 21695 | 1225 | 26256 | 1138 | 12541 |
| 2L-4S | | MI | 8632 | 3159 | 12953 | 2587 | 14921 | 2109 | 15591 | 1742 | 15649 | 1202 | 18793 | 926 | 10881 |
| 8-#11 | 1.22 | MA | 10417 | 3159 | 15328 | 2617 | 17960 | 2126 | 19023 | 1769 | 19624 | 1230 | 23510 | 1047 | 12536 |
| 3E | | MI | 9132 | 3159 | 13607 | 2589 | 15804 | 2102 | 16657 | 1748 | 17043 | 1207 | 20307 | 1017 | 10927 |
| 8-#11 | 1.22 | MA | 9839 | 3159 | 14571 | 2616 | 16937 | 2134 | 17783 | 1765 | 17980 | 1225 | 21708 | 956 | 12455 |
| 4L-2S | | MI | 9811 | 3159 | 14479 | 2591 | 16910 | 2106 | 17992 | 1742 | 18799 | 1202 | 22618 | 1108 | 10916 |
| 8-#14 | 1.76 | MA | 11993 | 3359 | 18144 | 2733 | 21465 | 2211 | 23241 | 1813 | 25150 | 1202 | 30782 | 1091 | 17750 |
| 2L-4S | | MI | 8822 | 3359 | 13850 | 2698 | 15971 | 2190 | 16807 | 1787 | 17296 | 1189 | 20975 | 791 | 14947 |
| 8-#14 | 1.76 | MA | 10889 | 3359 | 16697 | 2731 | 19630 | 2207 | 21017 | 1822 | 22209 | 1209 | 26893 | 959 | 17668 |
| 3E | | MI | 9522 | 3359 | 14785 | 2701 | 17234 | 2181 | 18317 | 1795 | 19210 | 1181 | 23115 | 919 | 15348 |
| 8-#14 | 1.76 | MA | 10080 | 3359 | 15613 | 2730 | 18167 | 2218 | 19244 | 1815 | 19874 | 1202 | 24346 | 828 | 17193 |
| 4L-2S | | MI | 10469 | 3359 | 16027 | 2704 | 18809 | 2188 | 20208 | 1787 | 21697 | 1174 | 26378 | 1051 | 15398 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis

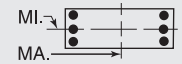



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.14 | MA | 13821 | 3868 | 22572 | 3030 | 26951 | 2426 | 29742 | 1940 | 33601 | 1138 | 41779 | 956 | 30546 |
| 2L-4S | | MI | 9254 | 3868 | 16025 | 2982 | 18528 | 2397 | 19758 | 1898 | 21200 | 1122 | 26236 | 435 | 23201 |
| 8-#18 | 3.14 | MA | 11984 | 3868 | 20051 | 3025 | 23754 | 2416 | 25891 | 1953 | 28534 | 1151 | 35118 | 723 | 30055 |
| 3E | | MI | 10419 | 3868 | 17656 | 2990 | 20719 | 2384 | 22346 | 1912 | 24479 | 1109 | 29888 | 656 | 25954 |
| 8-#18 | 3.14 | MA | 10637 | 3868 | 18156 | 3020 | 21195 | 2433 | 22814 | 1940 | 24511 | 1138 | 30754 | 493 | 26836 |
| 4L-2S | | MI | 11994 | 3868 | 19813 | 2998 | 23446 | 2397 | 25584 | 1898 | 28740 | 1095 | 35439 | 890 | 26342 |
| 10-#11 | 1.53 | MA | 11682 | 3272 | 17354 | 2689 | 20530 | 2180 | 22137 | 1795 | 23767 | 1218 | 29003 | 1120 | 15555 |
| 2L-5S | | MI | 8598 | 3272 | 13161 | 2667 | 15229 | 2157 | 15958 | 1780 | 16133 | 1198 | 19493 | 862 | 12903 |
| 10-#11 | 1.53 | MA | 10902 | 3272 | 16341 | 2688 | 19245 | 2177 | 20580 | 1802 | 21695 | 1223 | 26256 | 1029 | 15525 |
| 3L-4S | | MI | 9048 | 3272 | 13824 | 2658 | 16026 | 2161 | 16925 | 1775 | 17405 | 1193 | 21105 | 904 | 13428 |
| 10-#11 | 1.53 | MA | 10332 | 3272 | 15584 | 2687 | 18222 | 2185 | 19340 | 1798 | 20051 | 1218 | 24455 | 937 | 15413 |
| 4L-3S | | MI | 9542 | 3272 | 14479 | 2660 | 16910 | 2154 | 17992 | 1780 | 18799 | 1198 | 22618 | 994 | 13503 |
| 10-#11 | 1.53 | MA | 9813 | 3272 | 14817 | 2697 | 17302 | 2183 | 18217 | 1804 | 18551 | 1223 | 22549 | 894 | 14777 |
| 5L-2S | | MI | 10212 | 3272 | 15350 | 2662 | 18015 | 2158 | 19326 | 1775 | 20555 | 1193 | 24930 | 1085 | 13516 |
| 10-#14 | 2.21 | MA | 12645 | 3523 | 19590 | 2835 | 23300 | 2286 | 25464 | 1861 | 28092 | 1190 | 34672 | 1062 | 22028 |
| 2L-5S | | MI | 8772 | 3523 | 14144 | 2812 | 16409 | 2259 | 17327 | 1841 | 17922 | 1166 | 21963 | 694 | 17381 |
| 10-#14 | 2.21 | MA | 11558 | 3523 | 18144 | 2833 | 21465 | 2282 | 23241 | 1869 | 25150 | 1198 | 30782 | 930 | 21903 |
| 3L-4S | | MI | 9399 | 3523 | 15093 | 2800 | 17547 | 2265 | 18697 | 1833 | 19783 | 1174 | 24238 | 756 | 18368 |
| 10-#14 | 2.21 | MA | 10764 | 3523 | 17060 | 2832 | 20002 | 2293 | 21467 | 1863 | 22816 | 1190 | 28236 | 799 | 21203 |
| 4L-3S | | MI | 10086 | 3523 | 16027 | 2803 | 18809 | 2256 | 20208 | 1841 | 21697 | 1166 | 26378 | 884 | 18987 |
| 10-#14 | 2.21 | MA | 10042 | 3523 | 15962 | 2845 | 18684 | 2288 | 19860 | 1871 | 20686 | 1198 | 25529 | 738 | 19968 |
| 5L-2S | | MI | 11019 | 3523 | 17270 | 2806 | 20385 | 2262 | 22098 | 1833 | 24184 | 1159 | 29641 | 1015 | 19077 |
| 10-#18 | 3.92 | MA | 14877 | 4159 | 25093 | 3211 | 30148 | 2559 | 33593 | 2022 | 38667 | 1113 | 48440 | 897 | 37949 |
| 2L-5S | | MI | 9170 | 4159 | 16527 | 3182 | 19277 | 2516 | 20649 | 1989 | 22270 | 1078 | 27916 | 252 | 26642 |
| 10-#18 | 3.92 | MA | 13081 | 4159 | 22572 | 3206 | 26951 | 2549 | 29742 | 2036 | 33601 | 1126 | 41779 | 663 | 37349 |
| 3L-4S | | MI | 10205 | 4159 | 18183 | 3163 | 21255 | 2530 | 22996 | 1976 | 25461 | 1091 | 31787 | 362 | 29187 |
| 10-#18 | 3.92 | MA | 11768 | 4159 | 20677 | 3201 | 24393 | 2566 | 26665 | 2022 | 29578 | 1113 | 37415 | 433 | 33877 |
| 4L-3S | | MI | 11343 | 4159 | 19813 | 3172 | 23446 | 2516 | 25584 | 1989 | 28740 | 1078 | 35439 | 584 | 32184 |
| 10-#18 | 3.92 | MA | 10574 | 4159 | 18756 | 3223 | 22086 | 2556 | 23873 | 2036 | 25909 | 1126 | 32770 | 324 | 30908 |
| 5L-2S | | MI | 12885 | 4159 | 21971 | 3180 | 26172 | 2530 | 28822 | 1976 | 33000 | 1064 | 40990 | 817 | 32676 |
| 12-#11 | 1.84 | MA | 12149 | 3385 | 18367 | 2759 | 21815 | 2232 | 23693 | 1828 | 25838 | 1210 | 31749 | 1101 | 18557 |
| 2L-6S | | MI | 8586 | 3385 | 13441 | 2736 | 15548 | 2216 | 16339 | 1807 | 16667 | 1194 | 20192 | 763 | 14923 |
| 12-#11 | 1.84 | MA | 11378 | 3385 | 17354 | 2759 | 20530 | 2229 | 22137 | 1835 | 23767 | 1216 | 29003 | 1010 | 18506 |
| 3L-5S | | MI | 9013 | 3385 | 14032 | 2738 | 16335 | 2209 | 17293 | 1813 | 17889 | 1189 | 21804 | 839 | 15356 |
| 12-#11 | 1.84 | MA | 10815 | 3385 | 16597 | 2758 | 19507 | 2237 | 20897 | 1831 | 22123 | 1210 | 27202 | 919 | 18367 |
| 4E | | MI | 9456 | 3385 | 14696 | 2729 | 17131 | 2212 | 18260 | 1807 | 19161 | 1183 | 23416 | 881 | 15970 |
| 12-#11 | 1.84 | MA | 10304 | 3385 | 15830 | 2768 | 18586 | 2235 | 19773 | 1837 | 20623 | 1216 | 25295 | 876 | 17640 |
| 5L-3S | | MI | 9944 | 3385 | 15350 | 2731 | 18015 | 2206 | 19326 | 1813 | 20555 | 1189 | 24930 | 971 | 16071 |
| 12-#11 | 1.84 | MA | 9813 | 3385 | 15148 | 2767 | 17677 | 2243 | 18667 | 1833 | 19180 | 1221 | 23378 | 800 | 17093 |
| 6L-2S | | MI | 10607 | 3385 | 16222 | 2733 | 19120 | 2209 | 20661 | 1807 | 22311 | 1183 | 27241 | 1062 | 16104 |
| 12-#14 | 2.65 | MA | 13283 | 3686 | 21037 | 2937 | 25135 | 2361 | 27687 | 1908 | 31033 | 1179 | 38561 | 1033 | 26296 |
| 2L-6S | | MI | 8755 | 3686 | 14541 | 2911 | 16859 | 2343 | 17867 | 1879 | 18677 | 1159 | 23100 | 570 | 19690 |
| 12-#14 | 2.65 | MA | 12213 | 3686 | 19590 | 2935 | 23300 | 2356 | 25464 | 1916 | 28092 | 1186 | 34672 | 901 | 26131 |
| 3L-5S | | MI | 9346 | 3686 | 15387 | 2914 | 17984 | 2334 | 19217 | 1887 | 20409 | 1152 | 25226 | 659 | 20888 |
| 12-#14 | 2.65 | MA | 11432 | 3686 | 18507 | 2934 | 21837 | 2367 | 23691 | 1910 | 25757 | 1179 | 32125 | 770 | 25237 |
| 4E | | MI | 9962 | 3686 | 16335 | 2902 | 19123 | 2340 | 20588 | 1879 | 22270 | 1159 | 27501 | 720 | 21813 |
| 12-#14 | 2.65 | MA | 10722 | 3686 | 17409 | 2947 | 20519 | 2363 | 22083 | 1918 | 23627 | 1186 | 29418 | 709 | 24070 |
| 5L-3S | | MI | 10639 | 3686 | 17270 | 2905 | 20385 | 2331 | 22098 | 1887 | 24184 | 1152 | 29641 | 849 | 22617 |
| 12-#14 | 2.65 | MA | 10042 | 3686 | 16432 | 2946 | 19217 | 2374 | 20499 | 1912 | 21579 | 1193 | 26704 | 599 | 22665 |
| 6L-2S | | MI | 11559 | 3686 | 18512 | 2909 | 21961 | 2337 | 23988 | 1879 | 26671 | 1144 | 32904 | 980 | 22744 |
| 12-#18 | 4.71 | MA | 14152 | 4450 | 25093 | 3388 | 30148 | 2682 | 33593 | 2118 | 38667 | 1101 | 48440 | 603 | 44594 |
| 3L-5S | | MI | 10173 | 4450 | 18685 | 3363 | 22004 | 2649 | 23887 | 2067 | 26531 | 1047 | 33467 | 179 | 32520 |
| 12-#18 | 4.71 | MA | 12868 | 4450 | 23198 | 3383 | 27590 | 2699 | 30516 | 2105 | 34645 | 1088 | 44076 | 373 | 40956 |
| 4E | | MI | 11180 | 4450 | 20340 | 3345 | 23982 | 2662 | 26234 | 2054 | 29721 | 1060 | 37339 | 290 | 35209 |
| 12-#18 | 4.71 | MA | 11703 | 4450 | 21277 | 3405 | 25283 | 2689 | 27724 | 2118 | 30975 | 1101 | 39431 | 265 | 37850 |
| 5L-3S | | MI | 12274 | 4450 | 21971 | 3354 | 26172 | 2649 | 28822 | 2067 | 33000 | 1047 | 40990 | 511 | 38070 |
| 14-#11 | 2.14 | MA | 12608 | 3499 | 19381 | 2830 | 23100 | 2283 | 25250 | 1861 | 27909 | 1203 | 34496 | 1083 | 21552 |
| 2L-7S | | MI | 8586 | 3499 | 13737 | 2805 | 15892 | 2264 | 16749 | 1845 | 17182 | 1179 | 21073 | 670 | 16622 |

## RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

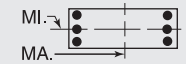
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.14 | MA | 11845 | 3499 | 18367 | 2830 | 21815 | 2281 | 23693 | 1868 | 25838 | 1208 | 31749 | 992 | 21481 |
| 3L-6S | | MI | 8999 | 3499 | 14313 | 2807 | 16653 | 2267 | 17674 | 1840 | 18423 | 1184 | 22503 | 740 | 17406 |
| 14-#11 | 2.14 | MA | 11289 | 3499 | 17610 | 2829 | 20792 | 2289 | 22454 | 1864 | 24194 | 1203 | 29948 | 900 | 21319 |
| 4L-5S | | MI | 9420 | 3499 | 14904 | 2809 | 17440 | 2261 | 18627 | 1845 | 19645 | 1179 | 24116 | 816 | 17819 |
| 14-#11 | 2.14 | MA | 10785 | 3499 | 16843 | 2839 | 19871 | 2287 | 21330 | 1870 | 22694 | 1208 | 28042 | 857 | 20514 |
| 5L-4S | | MI | 9858 | 3499 | 15567 | 2800 | 18236 | 2264 | 19595 | 1840 | 20917 | 1174 | 25728 | 859 | 18509 |
| 14-#11 | 2.14 | MA | 10301 | 3499 | 16161 | 2838 | 18962 | 2295 | 20224 | 1866 | 21251 | 1213 | 26125 | 781 | 19989 |
| 6L-3S | | MI | 10340 | 3499 | 16222 | 2802 | 19120 | 2258 | 20661 | 1845 | 22311 | 1179 | 27241 | 949 | 18632 |
| 14-#11 | 2.14 | MA | 9827 | 3499 | 15496 | 2838 | 18083 | 2293 | 19150 | 1873 | 19788 | 1208 | 24425 | 710 | 19063 |
| 7L-2S | | MI | 10996 | 3499 | 17093 | 2803 | 20225 | 2261 | 21996 | 1840 | 24067 | 1174 | 29553 | 1040 | 18683 |
| 14-#14 | 3.09 | MA | 12855 | 3850 | 21037 | 3038 | 25135 | 2431 | 27687 | 1964 | 31033 | 1174 | 38561 | 872 | 30354 |
| 3L-6S | | MI | 9326 | 3850 | 15784 | 3013 | 18435 | 2417 | 19757 | 1925 | 21164 | 1144 | 26363 | 534 | 23134 |
| 14-#14 | 3.09 | MA | 12086 | 3850 | 19954 | 3036 | 23672 | 2442 | 25914 | 1957 | 28698 | 1167 | 36014 | 741 | 29291 |
| 4L-5S | | MI | 9909 | 3850 | 16629 | 3016 | 19560 | 2409 | 21108 | 1932 | 22895 | 1137 | 28489 | 624 | 24406 |
| 14-#14 | 3.09 | MA | 11388 | 3850 | 18856 | 3050 | 22354 | 2438 | 24306 | 1966 | 26568 | 1174 | 33307 | 680 | 28185 |
| 5L-4S | | MI | 10515 | 3850 | 17578 | 3004 | 20698 | 2415 | 22478 | 1925 | 24757 | 1144 | 30764 | 685 | 25278 |
| 14-#14 | 3.09 | MA | 10719 | 3850 | 17879 | 3048 | 21052 | 2449 | 22722 | 1959 | 24520 | 1182 | 30594 | 570 | 26707 |
| 6L-3S | | MI | 11182 | 3850 | 18512 | 3008 | 21961 | 2406 | 23988 | 1932 | 26671 | 1137 | 32904 | 813 | 26241 |
| 14-#14 | 3.09 | MA | 10063 | 3850 | 16927 | 3047 | 19794 | 2445 | 21185 | 1967 | 22442 | 1174 | 28190 | 467 | 25261 |
| 7L-2S | | MI | 12089 | 3850 | 19755 | 3011 | 23536 | 2412 | 25879 | 1925 | 29158 | 1129 | 36167 | 945 | 26402 |
| 14-#18 | 5.49 | MA | 14005 | 4741 | 25719 | 3565 | 30787 | 2832 | 34367 | 2188 | 39711 | 1063 | 50737 | 313 | 48064 |
| 4L-5S | | MI | 11102 | 4741 | 20842 | 3545 | 24730 | 2781 | 27125 | 2145 | 30791 | 1015 | 39018 | 107 | 38433 |
| 14-#18 | 5.49 | MA | 12880 | 4741 | 23798 | 3586 | 28481 | 2822 | 31576 | 2201 | 36042 | 1077 | 46092 | 205 | 44824 |
| 5L-4S | | MI | 12079 | 4741 | 22498 | 3527 | 26708 | 2794 | 29472 | 2132 | 33982 | 1029 | 42890 | 217 | 41260 |
| 16-#11 | 2.45 | MA | 12306 | 3612 | 19381 | 2901 | 23100 | 2333 | 25250 | 1900 | 27909 | 1201 | 34496 | 973 | 24453 |
| 3L-7S | | MI | 8997 | 3612 | 14608 | 2876 | 16997 | 2316 | 18083 | 1878 | 18938 | 1170 | 23385 | 647 | 19065 |
| 16-#11 | 2.45 | MA | 11757 | 3612 | 18623 | 2900 | 22077 | 2341 | 24010 | 1896 | 26265 | 1196 | 32695 | 882 | 24269 |
| 4L-6S | | MI | 9404 | 3612 | 15184 | 2878 | 17758 | 2319 | 19009 | 1872 | 20178 | 1175 | 24815 | 718 | 19830 |
| 16-#11 | 2.45 | MA | 11258 | 3612 | 17856 | 2910 | 21156 | 2339 | 22887 | 1903 | 24765 | 1201 | 30788 | 839 | 23396 |
| 5E | | MI | 9820 | 3612 | 15775 | 2879 | 18545 | 2313 | 19962 | 1878 | 21401 | 1170 | 26427 | 794 | 20290 |
| 16-#11 | 2.45 | MA | 10781 | 3612 | 17174 | 2909 | 20247 | 2347 | 21780 | 1899 | 23323 | 1206 | 28872 | 763 | 22869 |
| 6L-4S | | MI | 10253 | 3612 | 16439 | 2871 | 19342 | 2316 | 20930 | 1872 | 22673 | 1165 | 28039 | 836 | 21009 |
| 16-#11 | 2.45 | MA | 10312 | 3612 | 16509 | 2908 | 19368 | 2345 | 20707 | 1905 | 21860 | 1201 | 27172 | 692 | 21921 |
| 7L-3S | | MI | 10730 | 3612 | 17093 | 2873 | 20225 | 2310 | 21996 | 1878 | 24067 | 1170 | 29553 | 926 | 21188 |
| 16-#11 | 2.45 | MA | 9850 | 3612 | 15855 | 2908 | 18507 | 2342 | 19631 | 1902 | 20448 | 1206 | 25392 | 641 | 21024 |
| 8L-2S | | MI | 11379 | 3612 | 17965 | 2874 | 21330 | 2313 | 23331 | 1872 | 25823 | 1165 | 31864 | 1017 | 21256 |
| 16-#14 | 3.53 | MA | 12728 | 4014 | 21401 | 3138 | 25507 | 2517 | 28137 | 2005 | 31640 | 1155 | 39904 | 712 | 33363 |
| 4L-6S | | MI | 9887 | 4014 | 17026 | 3115 | 20010 | 2492 | 21647 | 1971 | 23651 | 1130 | 29626 | 499 | 26592 |
| 16-#14 | 3.53 | MA | 12042 | 4014 | 20303 | 3152 | 24189 | 2513 | 26529 | 2013 | 29510 | 1163 | 37197 | 651 | 32309 |
| 5E | | MI | 10461 | 4014 | 17871 | 3118 | 21136 | 2483 | 22998 | 1978 | 25382 | 1122 | 31751 | 589 | 27934 |
| 16-#14 | 3.53 | MA | 11383 | 4014 | 19326 | 3150 | 22887 | 2524 | 24945 | 2006 | 27461 | 1170 | 34483 | 541 | 30762 |
| 6L-4S | | MI | 11059 | 4014 | 18820 | 3107 | 22274 | 2490 | 24368 | 1971 | 27244 | 1130 | 34027 | 650 | 28759 |
| 16-#14 | 3.53 | MA | 10738 | 4014 | 18374 | 3149 | 21629 | 2520 | 23408 | 2015 | 25383 | 1163 | 32079 | 438 | 29272 |
| 7L-3S | | MI | 11716 | 4014 | 19755 | 3110 | 23536 | 2481 | 25879 | 1978 | 29158 | 1122 | 36167 | 778 | 29861 |
| 16-#18 | 6.27 | MA | 13955 | 5031 | 26319 | 3768 | 31678 | 2955 | 35427 | 2283 | 41109 | 1052 | 52753 | 145 | 51826 |
| 5E | | MI | 12007 | 5031 | 23000 | 3727 | 27457 | 2913 | 30363 | 2223 | 35052 | 984 | 44569 | 34 | 44375 |
| 18-#11 | 2.75 | MA | 12217 | 3726 | 19637 | 2971 | 23362 | 2393 | 25567 | 1929 | 28337 | 1189 | 35441 | 864 | 27153 |
| 4L-7S | | MI | 9401 | 3726 | 15480 | 2947 | 18102 | 2368 | 19418 | 1910 | 20694 | 1161 | 25696 | 624 | 21515 |
| 18-#11 | 2.75 | MA | 11725 | 3726 | 18870 | 2981 | 22441 | 2391 | 24444 | 1936 | 26837 | 1194 | 33535 | 820 | 26286 |
| 5L-6S | | MI | 9804 | 3726 | 16056 | 2949 | 18863 | 2371 | 20343 | 1905 | 21934 | 1166 | 27126 | 695 | 22251 |
| 18-#11 | 2.75 | MA | 11253 | 3726 | 18187 | 2980 | 21532 | 2399 | 23337 | 1932 | 25394 | 1199 | 31618 | 745 | 25703 |
| 6L-5S | | MI | 10215 | 3726 | 16647 | 2950 | 19650 | 2364 | 21297 | 1910 | 23157 | 1161 | 28739 | 771 | 22768 |
| 18-#11 | 2.75 | MA | 10790 | 3726 | 17523 | 2979 | 20653 | 2396 | 22264 | 1938 | 23931 | 1194 | 29918 | 673 | 24786 |
| 7L-4S | | MI | 10643 | 3726 | 17310 | 2942 | 20447 | 2368 | 22264 | 1905 | 24429 | 1156 | 30351 | 813 | 23451 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

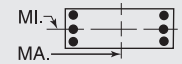
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.75 | MA | 10334 | 3726 | 16868 | 2979 | 19792 | 2394 | 21188 | 1934 | 22520 | 1199 | 28139 | 623 | 23858 |
| 8L-3S | | MI | 11114 | 3726 | 17965 | 2943 | 21330 | 2361 | 23331 | 1910 | 25823 | 1161 | 31864 | 904 | 23741 |
| 18-#14 | 3.97 | MA | 12684 | 4177 | 21750 | 3254 | 26024 | 2588 | 28752 | 2060 | 32451 | 1151 | 41086 | 622 | 36442 |
| 5L-6S | | MI | 10439 | 4177 | 18269 | 3217 | 21586 | 2567 | 23538 | 2017 | 26138 | 1115 | 32889 | 464 | 30061 |
| 18-#14 | 3.97 | MA | 12035 | 4177 | 20773 | 3252 | 24722 | 2599 | 27168 | 2054 | 30403 | 1159 | 38372 | 512 | 34829 |
| 6L-5S | | MI | 11005 | 4177 | 19114 | 3221 | 22711 | 2558 | 24888 | 2024 | 27869 | 1107 | 35014 | 553 | 31469 |
| 18-#14 | 3.97 | MA | 11400 | 4177 | 19821 | 3251 | 23464 | 2595 | 25631 | 2062 | 28325 | 1151 | 35968 | 409 | 33294 |
| 7L-4S | | MI | 11594 | 4177 | 20062 | 3209 | 23850 | 2564 | 26258 | 2017 | 29731 | 1115 | 37290 | 615 | 32254 |
| 20-#11 | 3.06 | MA | 12184 | 3839 | 19883 | 3051 | 23726 | 2443 | 26001 | 1969 | 28908 | 1187 | 36281 | 802 | 29181 |
| 5L-7S | | MI | 9800 | 3839 | 16351 | 3018 | 19207 | 2419 | 20753 | 1943 | 22450 | 1151 | 28008 | 602 | 23972 |
| 20-#11 | 3.06 | MA | 11718 | 3839 | 19200 | 3051 | 22817 | 2451 | 24894 | 1965 | 27465 | 1192 | 34365 | 726 | 28544 |
| 6E | | MI | 10198 | 3839 | 16927 | 3019 | 19968 | 2423 | 21678 | 1937 | 23690 | 1157 | 29438 | 672 | 24681 |
| 20-#11 | 3.06 | MA | 11261 | 3839 | 18536 | 3050 | 21938 | 2448 | 23821 | 1971 | 26002 | 1187 | 32665 | 655 | 27657 |
| 7L-5S | | MI | 10605 | 3839 | 17518 | 3021 | 20756 | 2416 | 22632 | 1943 | 24913 | 1151 | 31050 | 749 | 25251 |
| 20-#11 | 3.06 | MA | 10810 | 3839 | 17881 | 3050 | 21077 | 2446 | 22745 | 1967 | 24591 | 1192 | 30886 | 604 | 26698 |
| 8L-4S | | MI | 11028 | 3839 | 18182 | 3013 | 21552 | 2420 | 23599 | 1937 | 26185 | 1146 | 32662 | 791 | 25902 |
| 20-#14 | 4.41 | MA | 12677 | 4341 | 22220 | 3355 | 26557 | 2673 | 29391 | 2101 | 33344 | 1147 | 42262 | 483 | 38907 |
| 6E | | MI | 10983 | 4341 | 19511 | 3320 | 23162 | 2642 | 25428 | 2062 | 28625 | 1100 | 36152 | 429 | 33541 |
| 20-#14 | 4.41 | MA | 12051 | 4341 | 21268 | 3353 | 25299 | 2669 | 27854 | 2110 | 31266 | 1140 | 39858 | 380 | 37327 |
| 7L-5S | | MI | 11541 | 4341 | 20356 | 3323 | 24287 | 2633 | 26778 | 2070 | 30356 | 1093 | 38277 | 518 | 34913 |
| 22-#11 | 3.36 | MA | 12177 | 3953 | 20214 | 3122 | 24102 | 2502 | 26451 | 1998 | 29537 | 1185 | 37111 | 708 | 31393 |
| 6L-7S | | MI | 10194 | 3953 | 17223 | 3089 | 20313 | 2471 | 22088 | 1975 | 24206 | 1142 | 30320 | 579 | 26433 |
| 22-#11 | 3.36 | MA | 11726 | 3953 | 19549 | 3121 | 23223 | 2500 | 25377 | 2004 | 28074 | 1180 | 35411 | 636 | 30533 |
| 7L-6S | | MI | 10587 | 3953 | 17799 | 3090 | 21074 | 2475 | 23013 | 1970 | 25446 | 1147 | 31749 | 650 | 27118 |
| 22-#11 | 3.36 | MA | 11280 | 3953 | 18894 | 3120 | 22362 | 2498 | 24302 | 2000 | 26662 | 1185 | 33632 | 586 | 29543 |
| 8L-5S | | MI | 10989 | 3953 | 18390 | 3092 | 21861 | 2468 | 23966 | 1975 | 26669 | 1142 | 33362 | 726 | 27738 |
| 22-#14 | 4.85 | MA | 12693 | 4504 | 22715 | 3455 | 27134 | 2744 | 30077 | 2157 | 34207 | 1128 | 43747 | 351 | 41321 |
| 7L-6S | | MI | 11519 | 4504 | 20753 | 3422 | 24737 | 2717 | 27318 | 2108 | 31112 | 1085 | 39415 | 393 | 37031 |
| 24-#11 | 3.67 | MA | 12184 | 4066 | 20562 | 3192 | 24508 | 2552 | 26934 | 2037 | 30145 | 1172 | 38158 | 618 | 33414 |
| 7E | | MI | 10582 | 4066 | 18094 | 3159 | 21418 | 2523 | 23422 | 2008 | 25961 | 1133 | 32631 | 557 | 28900 |
| 24-#11 | 3.67 | MA | 11743 | 4066 | 19908 | 3191 | 23647 | 2550 | 25859 | 2033 | 28734 | 1177 | 36379 | 567 | 32369 |
| 8L-6S | | MI | 10972 | 4066 | 18670 | 3161 | 22179 | 2527 | 24348 | 2002 | 27202 | 1138 | 34061 | 627 | 29561 |

## RECTANGULAR TIED COLUMNS 30" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.48 | MA | 12932 | 3446 | 19315 | 2815 | 22707 | 2283 | 24387 | 1882 | 25925 | 1272 | 31466 | 1164 | 16733 |
| 2E | | MI | 10620 | 3446 | 16156 | 2769 | 18730 | 2243 | 19852 | 1836 | 20906 | 1229 | 25116 | 1104 | 13617 |
| 6-#14 | 1.25 | MA | 12616 | 3355 | 18415 | 2780 | 21705 | 2259 | 23232 | 1870 | 24544 | 1297 | 29735 | 1205 | 14363 |
| 2L-3S | | MI | 9422 | 3355 | 14193 | 2734 | 16394 | 2218 | 17171 | 1843 | 17415 | 1268 | 20636 | 1025 | 11738 |
| 6-#14 | 1.25 | MA | 11409 | 3355 | 16866 | 2779 | 19740 | 2256 | 20852 | 1880 | 21375 | 1305 | 25532 | 1073 | 14333 |
| 3L-2S | | MI | 10388 | 3355 | 15435 | 2737 | 17969 | 2224 | 19061 | 1836 | 19902 | 1261 | 23899 | 1156 | 11728 |
| 6-#18 | 2.22 | MA | 14152 | 3737 | 22018 | 2997 | 26135 | 2416 | 28539 | 1966 | 31396 | 1250 | 38684 | 1109 | 24740 |
| 2L-3S | | MI | 9948 | 3737 | 16156 | 2942 | 18730 | 2362 | 19852 | 1927 | 20906 | 1212 | 25116 | 798 | 19806 |
| 6-#18 | 2.22 | MA | 12124 | 3737 | 19315 | 2993 | 22707 | 2408 | 24387 | 1980 | 25925 | 1264 | 31466 | 875 | 24378 |
| 3L-2S | | MI | 11568 | 3737 | 18314 | 2950 | 21457 | 2375 | 23090 | 1914 | 25167 | 1198 | 30667 | 1032 | 20033 |
| 8-#11 | 1.16 | MA | 12485 | 3318 | 18031 | 2767 | 21289 | 2251 | 22759 | 1867 | 23981 | 1308 | 29031 | 1222 | 13384 |
| 2L-4S | | MI | 9110 | 3318 | 13600 | 2723 | 15655 | 2220 | 16335 | 1837 | 16342 | 1275 | 19580 | 997 | 10929 |
| 8-#11 | 1.16 | MA | 11636 | 3318 | 16947 | 2767 | 19914 | 2249 | 21093 | 1874 | 21751 | 1313 | 26066 | 1131 | 13379 |
| 3E | | MI | 9612 | 3318 | 14254 | 2725 | 16539 | 2214 | 17401 | 1842 | 17736 | 1280 | 21093 | 1087 | 10962 |
| 8-#11 | 1.16 | MA | 11017 | 3318 | 16138 | 2767 | 18821 | 2257 | 19769 | 1871 | 19982 | 1308 | 24119 | 1040 | 13298 |
| 4L-2S | | MI | 10292 | 3318 | 15125 | 2727 | 17644 | 2217 | 18736 | 1837 | 19492 | 1275 | 23405 | 1178 | 10945 |
| 8-#14 | 1.67 | MA | 13339 | 3518 | 19964 | 2882 | 23670 | 2334 | 25612 | 1918 | 27713 | 1287 | 33939 | 1179 | 18965 |
| 2L-4S | | MI | 9301 | 3518 | 14501 | 2833 | 16707 | 2301 | 17551 | 1882 | 17987 | 1261 | 21759 | 861 | 15145 |
| 8-#14 | 1.67 | MA | 12152 | 3518 | 18415 | 2881 | 21705 | 2330 | 23232 | 1927 | 24544 | 1294 | 29735 | 1047 | 18883 |
| 3E | | MI | 10003 | 3518 | 15435 | 2836 | 17969 | 2293 | 19061 | 1889 | 19902 | 1254 | 23899 | 989 | 15398 |

## RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

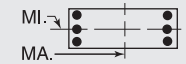
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.67 | MA | 11285 | 3518 | 17257 | 2880 | 20141 | 2342 | 21337 | 1921 | 22029 | 1287 | 26978 | 916 | 18552 |
| 4L-2S | | MI | 10954 | 3518 | 16678 | 2839 | 19545 | 2299 | 20952 | 1882 | 22388 | 1246 | 27162 | 1121 | 15435 |
| 8-#18 | 2.96 | MA | 15331 | 4027 | 24721 | 3179 | 29563 | 2549 | 32692 | 2050 | 36866 | 1228 | 45902 | 1054 | 32706 |
| 2L-4S | | MI | 9732 | 4027 | 16683 | 3115 | 19266 | 2507 | 20501 | 1992 | 21888 | 1194 | 27015 | 504 | 23464 |
| 8-#18 | 2.96 | MA | 13352 | 4027 | 22018 | 3175 | 26135 | 2541 | 28539 | 2064 | 31396 | 1241 | 38684 | 821 | 32215 |
| 3E | | MI | 10904 | 4027 | 18314 | 3124 | 21457 | 2494 | 23090 | 2005 | 25167 | 1181 | 30667 | 726 | 26053 |
| 8-#18 | 2.96 | MA | 11905 | 4027 | 19991 | 3172 | 23398 | 2559 | 25223 | 2051 | 27053 | 1228 | 33962 | 587 | 28968 |
| 4L-2S | | MI | 12487 | 4027 | 20471 | 3132 | 24183 | 2507 | 26328 | 1992 | 29428 | 1167 | 36218 | 959 | 26398 |
| 10-#11 | 1.44 | MA | 12999 | 3431 | 19115 | 2838 | 22664 | 2302 | 24424 | 1900 | 26210 | 1302 | 31996 | 1206 | 16608 |
| 2L-5S | | MI | 9076 | 3431 | 13807 | 2803 | 15964 | 2269 | 16702 | 1875 | 16826 | 1271 | 20279 | 932 | 13036 |
| 10-#11 | 1.44 | MA | 12161 | 3431 | 18031 | 2838 | 21289 | 2301 | 22759 | 1907 | 23981 | 1307 | 29031 | 1114 | 16578 |
| 3L-4S | | MI | 9527 | 3431 | 14471 | 2794 | 16761 | 2272 | 17670 | 1870 | 18098 | 1266 | 21891 | 974 | 13482 |
| 10-#11 | 1.44 | MA | 11550 | 3431 | 17222 | 2837 | 20196 | 2309 | 21434 | 1903 | 22212 | 1302 | 27084 | 1023 | 16466 |
| 4L-3S | | MI | 10023 | 3431 | 15125 | 2796 | 17644 | 2266 | 18736 | 1875 | 19492 | 1271 | 23405 | 1064 | 13543 |
| 10-#11 | 1.44 | MA | 10995 | 3431 | 16403 | 2848 | 19213 | 2308 | 20235 | 1911 | 20597 | 1307 | 25032 | 979 | 15869 |
| 5L-2S | | MI | 10696 | 3431 | 15997 | 2797 | 18749 | 2269 | 20071 | 1870 | 21248 | 1266 | 25716 | 1156 | 13548 |
| 10-#14 | 2.08 | MA | 14046 | 3682 | 21513 | 2984 | 25634 | 2408 | 27993 | 1965 | 30882 | 1277 | 38142 | 1152 | 23547 |
| 2L-5S | | MI | 9250 | 3682 | 14795 | 2947 | 17144 | 2370 | 18071 | 1935 | 18613 | 1239 | 22747 | 764 | 17549 |
| 10-#14 | 2.08 | MA | 12877 | 3682 | 19964 | 2983 | 23670 | 2405 | 25612 | 1974 | 27713 | 1284 | 33939 | 1021 | 23422 |
| 3L-4S | | MI | 9879 | 3682 | 15743 | 2935 | 18283 | 2376 | 19441 | 1928 | 20474 | 1246 | 25022 | 826 | 18561 |
| 10-#14 | 2.08 | MA | 12025 | 3682 | 18806 | 2982 | 22106 | 2417 | 23717 | 1969 | 25198 | 1277 | 31182 | 889 | 22852 |
| 4L-3S | | MI | 10570 | 3682 | 16678 | 2938 | 19545 | 2367 | 20952 | 1935 | 22388 | 1239 | 27162 | 954 | 19043 |
| 10-#14 | 2.08 | MA | 11252 | 3682 | 17634 | 2996 | 20698 | 2414 | 22000 | 1978 | 22903 | 1284 | 28265 | 827 | 21457 |
| 5L-2S | | MI | 11507 | 3682 | 17920 | 2942 | 21121 | 2373 | 22842 | 1928 | 24875 | 1231 | 30425 | 1086 | 19119 |
| 10-#18 | 3.70 | MA | 16477 | 4318 | 27423 | 3361 | 32991 | 2682 | 36845 | 2135 | 42337 | 1206 | 53120 | 1000 | 40649 |
| 2L-5S | | MI | 9644 | 4318 | 17185 | 3315 | 20015 | 2626 | 21392 | 2083 | 22958 | 1149 | 28694 | 321 | 27047 |
| 10-#18 | 3.70 | MA | 14542 | 4318 | 24721 | 3357 | 29563 | 2674 | 32692 | 2148 | 36866 | 1219 | 45902 | 766 | 40049 |
| 3L-4S | | MI | 10687 | 4318 | 18841 | 3297 | 21993 | 2640 | 23739 | 2069 | 26149 | 1163 | 32566 | 432 | 29443 |
| 10-#18 | 3.70 | MA | 13131 | 4318 | 22694 | 3353 | 26826 | 2692 | 29376 | 2135 | 32524 | 1206 | 41180 | 533 | 36531 |
| 4L-3S | | MI | 11832 | 4318 | 20471 | 3305 | 24183 | 2626 | 26328 | 2083 | 29428 | 1149 | 36218 | 653 | 32291 |
| 10-#18 | 3.70 | MA | 11849 | 4318 | 20640 | 3376 | 24360 | 2684 | 26367 | 2149 | 28562 | 1219 | 36147 | 425 | 33532 |
| 5L-2S | | MI | 13383 | 4318 | 22629 | 3314 | 26910 | 2640 | 29566 | 2069 | 33688 | 1136 | 41769 | 887 | 32737 |
| 12-#11 | 1.73 | MA | 13505 | 3545 | 20199 | 2909 | 24038 | 2354 | 26090 | 1933 | 28439 | 1296 | 34960 | 1189 | 19821 |
| 2L-6S | | MI | 9063 | 3545 | 14088 | 2872 | 16282 | 2327 | 17083 | 1902 | 17359 | 1267 | 20978 | 833 | 15051 |
| 12-#11 | 1.73 | MA | 12676 | 3545 | 19115 | 2908 | 22664 | 2353 | 24424 | 1940 | 26210 | 1301 | 31996 | 1098 | 19770 |
| 3L-5S | | MI | 9492 | 3545 | 14679 | 2873 | 17069 | 2321 | 18037 | 1907 | 18582 | 1261 | 22591 | 909 | 15487 |
| 12-#11 | 1.73 | MA | 12072 | 3545 | 18306 | 2908 | 21571 | 2361 | 23100 | 1936 | 24441 | 1296 | 30048 | 1007 | 19630 |
| 4E | | MI | 9937 | 3545 | 15343 | 2865 | 17866 | 2324 | 19004 | 1902 | 19854 | 1256 | 24203 | 952 | 16029 |
| 12-#11 | 1.73 | MA | 11525 | 3545 | 17487 | 2918 | 20588 | 2359 | 21901 | 1943 | 22826 | 1301 | 27996 | 962 | 18937 |
| 5L-3S | | MI | 10427 | 3545 | 15997 | 2867 | 18749 | 2317 | 20071 | 1907 | 21248 | 1261 | 25716 | 1042 | 16114 |
| 12-#11 | 1.73 | MA | 11000 | 3545 | 16759 | 2918 | 19618 | 2368 | 20720 | 1940 | 21274 | 1306 | 25927 | 887 | 18326 |
| 6L-2S | | MI | 11093 | 3545 | 16868 | 2868 | 19855 | 2321 | 21405 | 1902 | 23004 | 1256 | 28028 | 1133 | 16139 |
| 12-#14 | 2.50 | MA | 14737 | 3846 | 23062 | 3086 | 27599 | 2483 | 30373 | 2012 | 34051 | 1267 | 42346 | 1126 | 28118 |
| 2L-6S | | MI | 9231 | 3846 | 15192 | 3046 | 17595 | 2454 | 18611 | 1973 | 19368 | 1232 | 23884 | 640 | 19956 |
| 12-#14 | 2.50 | MA | 13586 | 3846 | 21513 | 3085 | 25634 | 2480 | 27993 | 2022 | 30882 | 1274 | 38142 | 994 | 27953 |
| 3L-5S | | MI | 9826 | 3846 | 16037 | 3049 | 18720 | 2445 | 19961 | 1981 | 21100 | 1224 | 26010 | 729 | 21053 |
| 12-#14 | 2.50 | MA | 12748 | 3846 | 20356 | 3085 | 24070 | 2492 | 26097 | 2016 | 28367 | 1267 | 35385 | 863 | 27177 |
| 4E | | MI | 10445 | 3846 | 16986 | 3037 | 19858 | 2451 | 21331 | 1973 | 22961 | 1232 | 28285 | 791 | 22002 |
| 12-#14 | 2.50 | MA | 11988 | 3846 | 19183 | 3099 | 22663 | 2489 | 24380 | 2026 | 26072 | 1274 | 32468 | 800 | 25856 |
| 5L-3S | | MI | 11126 | 3846 | 17920 | 3040 | 21121 | 2442 | 22842 | 1981 | 24875 | 1224 | 30425 | 919 | 22678 |
| 12-#14 | 2.50 | MA | 11258 | 3846 | 18140 | 3098 | 21273 | 2500 | 22689 | 2020 | 23865 | 1281 | 29535 | 691 | 24468 |
| 6L-2S | | MI | 12050 | 3846 | 19163 | 3044 | 22696 | 2448 | 24732 | 1973 | 27362 | 1217 | 33688 | 1050 | 22789 |
| 12-#18 | 4.44 | MA | 15703 | 4609 | 27423 | 3539 | 32991 | 2807 | 36845 | 2232 | 42337 | 1197 | 53120 | 712 | 47883 |
| 3L-5S | | MI | 10597 | 4609 | 19342 | 3497 | 22741 | 2759 | 24630 | 2160 | 27219 | 1118 | 34246 | 249 | 32917 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis

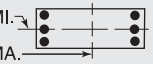


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 4.44 | MA | 14324 | 4609 | 25397 | 3535 | 30253 | 2825 | 33529 | 2220 | 37994 | 1184 | 48398 | 478 | 44132 |
| 4E | | MI | 11618 | 4609 | 20998 | 3479 | 24719 | 2772 | 26977 | 2147 | 30409 | 1132 | 38117 | 359 | 35459 |
| 12-#18 | 4.44 | MA | 13073 | 4609 | 23342 | 3558 | 27788 | 2817 | 30520 | 2233 | 34032 | 1197 | 43365 | 370 | 40998 |
| 5L-3S | | MI | 12772 | 4609 | 22629 | 3487 | 26910 | 2759 | 29566 | 2160 | 33688 | 1118 | 41769 | 581 | 38416 |
| 12-#18 | 4.44 | MA | 11872 | 4609 | 21513 | 3554 | 25352 | 2835 | 27556 | 2220 | 30223 | 1210 | 38329 | 176 | 37703 |
| 6L-2S | | MI | 14256 | 4609 | 24786 | 3496 | 29637 | 2772 | 32804 | 2147 | 37949 | 1105 | 47320 | 814 | 39059 |
| 14-#11 | 2.02 | MA | 14002 | 3658 | 21283 | 2980 | 25413 | 2406 | 27756 | 1965 | 30668 | 1289 | 37925 | 1172 | 23026 |
| 2L-7S | | MI | 9063 | 3658 | 14383 | 2941 | 16626 | 2375 | 17493 | 1940 | 17874 | 1252 | 21860 | 740 | 16818 |
| 14-#11 | 2.02 | MA | 13182 | 3658 | 20199 | 2979 | 24038 | 2404 | 26090 | 1972 | 28439 | 1294 | 34960 | 1081 | 22956 |
| 3L-6S | | MI | 9477 | 3658 | 14959 | 2943 | 17387 | 2379 | 18418 | 1935 | 19115 | 1257 | 23290 | 811 | 17533 |
| 14-#11 | 2.02 | MA | 12586 | 3658 | 19390 | 2979 | 22946 | 2413 | 24766 | 1969 | 26670 | 1289 | 33013 | 990 | 22793 |
| 4L-5S | | MI | 9900 | 3658 | 15550 | 2944 | 18175 | 2372 | 19372 | 1940 | 20338 | 1252 | 24902 | 887 | 17949 |
| 14-#11 | 2.02 | MA | 12046 | 3658 | 18571 | 2989 | 21963 | 2411 | 23566 | 1976 | 25056 | 1294 | 30961 | 946 | 22014 |
| 5L-4S | | MI | 10341 | 3658 | 16214 | 2936 | 18971 | 2376 | 20339 | 1935 | 21610 | 1247 | 26514 | 929 | 18571 |
| 14-#11 | 2.02 | MA | 11528 | 3658 | 17843 | 2989 | 20993 | 2420 | 22386 | 1973 | 23503 | 1300 | 28892 | 870 | 21428 |
| 6L-3S | | MI | 10825 | 3658 | 16868 | 2937 | 19855 | 2369 | 21405 | 1940 | 23004 | 1252 | 28028 | 1019 | 18678 |
| 14-#11 | 2.02 | MA | 11020 | 3658 | 17134 | 2989 | 20055 | 2418 | 21240 | 1980 | 21929 | 1294 | 27055 | 799 | 20514 |
| 7L-2S | | MI | 11483 | 3658 | 17740 | 2939 | 20960 | 2373 | 22740 | 1935 | 24760 | 1247 | 30339 | 1110 | 18720 |
| 14-#14 | 2.92 | MA | 14281 | 4009 | 23062 | 3188 | 27599 | 2555 | 30373 | 2069 | 34051 | 1264 | 42346 | 968 | 32481 |
| 3L-6S | | MI | 9804 | 4009 | 16434 | 3148 | 19170 | 2528 | 20501 | 2019 | 21855 | 1217 | 27147 | 605 | 23395 |
| 14-#14 | 2.92 | MA | 13457 | 4009 | 21905 | 3187 | 26035 | 2567 | 28478 | 2064 | 31536 | 1256 | 39588 | 837 | 31524 |
| 4L-5S | | MI | 10390 | 4009 | 17279 | 3151 | 20296 | 2520 | 21851 | 2027 | 23587 | 1209 | 29272 | 694 | 24570 |
| 14-#14 | 2.92 | MA | 12709 | 4009 | 20732 | 3201 | 24628 | 2563 | 26760 | 2073 | 29241 | 1264 | 36672 | 774 | 30267 |
| 5L-4S | | MI | 11000 | 4009 | 18228 | 3139 | 21434 | 2526 | 23222 | 2019 | 25448 | 1217 | 31548 | 755 | 25464 |
| 14-#14 | 2.92 | MA | 11991 | 4009 | 19689 | 3200 | 23238 | 2575 | 25069 | 2067 | 27034 | 1271 | 33738 | 665 | 28805 |
| 6L-3S | | MI | 11671 | 4009 | 19163 | 3143 | 22696 | 2517 | 24732 | 2027 | 27362 | 1209 | 33688 | 884 | 26306 |
| 14-#14 | 2.92 | MA | 11288 | 4009 | 18673 | 3199 | 21895 | 2572 | 23428 | 2077 | 24796 | 1264 | 31137 | 562 | 27365 |
| 7L-2S | | MI | 12583 | 4009 | 20405 | 3146 | 24272 | 2523 | 26623 | 2019 | 29849 | 1202 | 36951 | 1015 | 26450 |
| 14-#18 | 5.19 | MA | 15567 | 4900 | 28100 | 3717 | 33681 | 2958 | 37681 | 2304 | 43465 | 1162 | 55616 | 423 | 51763 |
| 4L-5S | | MI | 11585 | 4900 | 21500 | 3679 | 25468 | 2891 | 27868 | 2238 | 31479 | 1087 | 39797 | 176 | 38820 |
| 14-#18 | 5.19 | MA | 14266 | 4900 | 26045 | 3740 | 31215 | 2950 | 34673 | 2317 | 39503 | 1175 | 50583 | 316 | 48495 |
| 5L-4S | | MI | 12572 | 4900 | 23156 | 3661 | 27446 | 2904 | 30215 | 2225 | 34670 | 1100 | 43668 | 287 | 41505 |
| 14-#18 | 5.19 | MA | 13092 | 4900 | 24216 | 3736 | 28779 | 2968 | 31708 | 2305 | 35693 | 1188 | 45547 | 121 | 45131 |
| 6L-3S | | MI | 13646 | 4900 | 24786 | 3669 | 29637 | 2891 | 32804 | 2238 | 37949 | 1087 | 47320 | 508 | 44272 |
| 16-#11 | 2.31 | MA | 13680 | 3771 | 21283 | 3050 | 25413 | 2456 | 27756 | 2005 | 30668 | 1288 | 37925 | 1064 | 26138 |
| 3L-7S | | MI | 9475 | 3771 | 15255 | 3012 | 17732 | 2427 | 18828 | 1972 | 19630 | 1243 | 24171 | 718 | 19259 |
| 16-#11 | 2.31 | MA | 13092 | 3771 | 20474 | 3050 | 24321 | 2465 | 26431 | 2002 | 28899 | 1283 | 35977 | 973 | 25953 |
| 4L-6S | | MI | 9884 | 3771 | 15831 | 3013 | 18493 | 2431 | 19753 | 1967 | 20871 | 1248 | 25601 | 788 | 20020 |
| 16-#11 | 2.31 | MA | 12558 | 3771 | 19656 | 3060 | 23338 | 2463 | 25232 | 2009 | 27285 | 1288 | 33925 | 929 | 25101 |
| 5E | | MI | 10302 | 3771 | 16422 | 3015 | 19280 | 2424 | 20706 | 1972 | 22094 | 1243 | 27214 | 864 | 20419 |
| 16-#11 | 2.31 | MA | 12046 | 3771 | 18928 | 3060 | 22368 | 2472 | 24051 | 2006 | 25732 | 1293 | 31856 | 853 | 24536 |
| 6L-4S | | MI | 10738 | 3771 | 17085 | 3007 | 20076 | 2428 | 21674 | 1967 | 23366 | 1238 | 28826 | 906 | 21111 |
| 16-#11 | 2.31 | MA | 11545 | 3771 | 18219 | 3060 | 21430 | 2470 | 22906 | 2013 | 24158 | 1288 | 30019 | 782 | 23577 |
| 7L-3S | | MI | 11217 | 3771 | 17740 | 3008 | 20960 | 2421 | 22740 | 1972 | 24760 | 1243 | 30339 | 997 | 21237 |
| 16-#11 | 2.31 | MA | 11050 | 3771 | 17520 | 3060 | 20511 | 2468 | 21758 | 2010 | 22639 | 1293 | 28104 | 731 | 22699 |
| 8L-2S | | MI | 11869 | 3771 | 18611 | 3010 | 22065 | 2425 | 24075 | 1967 | 26516 | 1238 | 32651 | 1088 | 21296 |
| 16-#14 | 3.33 | MA | 14152 | 4173 | 23454 | 3289 | 28000 | 2641 | 30858 | 2111 | 34705 | 1246 | 43792 | 810 | 35887 |
| 4L-6S | | MI | 10367 | 4173 | 17677 | 3250 | 20746 | 2603 | 22391 | 2065 | 24342 | 1202 | 30410 | 569 | 26848 |
| 16-#14 | 3.33 | MA | 13416 | 4173 | 22281 | 3303 | 26592 | 2638 | 29141 | 2120 | 32410 | 1253 | 40875 | 748 | 34688 |
| 5E | | MI | 10945 | 4173 | 18522 | 3253 | 21871 | 2594 | 23742 | 2073 | 26074 | 1195 | 32535 | 659 | 28097 |
| 16-#14 | 3.33 | MA | 12710 | 4173 | 21238 | 3302 | 25203 | 2650 | 27449 | 2115 | 30203 | 1261 | 37942 | 638 | 33156 |
| 6L-4S | | MI | 11546 | 4173 | 19470 | 3242 | 23010 | 2601 | 25112 | 2065 | 27935 | 1202 | 34811 | 720 | 28942 |
| 16-#14 | 3.33 | MA | 12018 | 4173 | 20222 | 3301 | 23859 | 2647 | 25809 | 2124 | 27965 | 1253 | 35340 | 536 | 31671 |
| 7L-3S | | MI | 12208 | 4173 | 20405 | 3245 | 24272 | 2592 | 26623 | 2073 | 29849 | 1195 | 36951 | 848 | 29930 |
| 16-#14 | 3.33 | MA | 11334 | 4173 | 19222 | 3301 | 22542 | 2644 | 24165 | 2119 | 25805 | 1261 | 32618 | 463 | 29856 |
| 8L-2S | | MI | 13109 | 4173 | 21648 | 3248 | 25848 | 2598 | 28513 | 2065 | 32336 | 1187 | 40213 | 980 | 30103 |
| 16-#18 | 5.93 | MA | 15521 | 5190 | 28748 | 3921 | 34643 | 3083 | 38826 | 2402 | 44973 | 1153 | 57801 | 261 | 56021 |
| 5E | | MI | 12494 | 5190 | 23657 | 3860 | 28195 | 3023 | 31106 | 2316 | 35740 | 1056 | 45348 | 104 | 44754 |

## RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

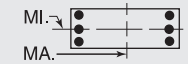
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 5.93 | MA | 14380 | 5190 | 26919 | 3918 | 32207 | 3101 | 35861 | 2389 | 41164 | 1166 | 52765 | 66 | 52585 |
| 6L-4S | | MI | 13455 | 5190 | 25313 | 3842 | 30173 | 3036 | 33453 | 2303 | 38931 | 1069 | 49219 | 214 | 47575 |
| 18-#11 | 2.60 | MA | 13590 | 3885 | 21558 | 3121 | 25695 | 2517 | 28097 | 2035 | 31129 | 1277 | 38942 | 956 | 29113 |
| 4L-7S | | MI | 9880 | 3885 | 16126 | 3083 | 18837 | 2479 | 20162 | 2005 | 21386 | 1234 | 26483 | 695 | 21707 |
| 18-#11 | 2.60 | MA | 13063 | 3885 | 20740 | 3131 | 24713 | 2515 | 26898 | 2042 | 29514 | 1282 | 36890 | 912 | 28195 |
| 5L-6S | | MI | 10285 | 3885 | 16702 | 3084 | 19598 | 2483 | 21088 | 2000 | 22627 | 1239 | 27913 | 766 | 22464 |
| 18-#11 | 2.60 | MA | 12557 | 3885 | 20012 | 3131 | 23742 | 2524 | 25717 | 2039 | 27962 | 1287 | 34821 | 837 | 27649 |
| 6L-5S | | MI | 10699 | 3885 | 17293 | 3086 | 20385 | 2476 | 22041 | 2005 | 23850 | 1234 | 29525 | 842 | 22895 |
| 18-#11 | 2.60 | MA | 12062 | 3885 | 19303 | 3131 | 22805 | 2522 | 24572 | 2046 | 26387 | 1282 | 32984 | 765 | 26647 |
| 7L-4S | | MI | 11130 | 3885 | 17957 | 3077 | 21181 | 2480 | 23009 | 2000 | 25122 | 1228 | 31137 | 884 | 23602 |
| 18-#11 | 2.60 | MA | 11573 | 3885 | 18605 | 3131 | 21886 | 2520 | 23424 | 2043 | 24868 | 1287 | 31068 | 714 | 25737 |
| 8L-3S | | MI | 11603 | 3885 | 18611 | 3079 | 22065 | 2473 | 24075 | 2005 | 26516 | 1234 | 32651 | 974 | 23793 |
| 18-#11 | 2.60 | MA | 11087 | 3885 | 17834 | 3141 | 20939 | 2529 | 22294 | 2050 | 23364 | 1292 | 29192 | 655 | 24678 |
| 9L-2S | | MI | 12249 | 3885 | 19483 | 3081 | 23170 | 2477 | 25410 | 2000 | 28272 | 1228 | 34962 | 1065 | 23866 |
| 18-#14 | 3.75 | MA | 14111 | 4336 | 23830 | 3405 | 28557 | 2713 | 31521 | 2168 | 35579 | 1243 | 45079 | 721 | 39119 |
| 5L-6S | | MI | 10921 | 4336 | 18919 | 3352 | 22322 | 2678 | 24282 | 2111 | 26829 | 1187 | 33673 | 534 | 30314 |
| 18-#14 | 3.75 | MA | 13416 | 4336 | 22787 | 3404 | 27167 | 2725 | 29829 | 2162 | 33372 | 1251 | 42145 | 612 | 37518 |
| 6L-5S | | MI | 11491 | 4336 | 19764 | 3356 | 23447 | 2669 | 25632 | 2118 | 28561 | 1180 | 35798 | 623 | 31631 |
| 18-#14 | 3.75 | MA | 12734 | 4336 | 21772 | 3404 | 25824 | 2722 | 28189 | 2172 | 31134 | 1243 | 39543 | 509 | 35989 |
| 7L-4S | | MI | 12084 | 4336 | 20713 | 3344 | 24586 | 2675 | 27002 | 2111 | 30422 | 1187 | 38074 | 685 | 32434 |
| 18-#14 | 3.75 | MA | 12061 | 4336 | 20771 | 3403 | 24507 | 2718 | 26545 | 2166 | 28974 | 1251 | 36821 | 436 | 34224 |
| 8L-3S | | MI | 12737 | 4336 | 21648 | 3347 | 25848 | 2667 | 28513 | 2118 | 32336 | 1180 | 40213 | 813 | 33550 |
| 18-#18 | 6.67 | MA | 15550 | 5481 | 29622 | 4100 | 35635 | 3234 | 40014 | 2473 | 46634 | 1144 | 59983 | 12 | 59923 |
| 6L-5S | | MI | 13384 | 5481 | 25815 | 4042 | 30921 | 3155 | 34344 | 2394 | 40001 | 1025 | 50899 | 31 | 50715 |
| 20-#11 | 2.89 | MA | 13560 | 3998 | 21824 | 3202 | 26088 | 2567 | 28564 | 2075 | 31743 | 1275 | 39854 | 895 | 31295 |
| 5L-7S | | MI | 10281 | 3998 | 16998 | 3153 | 19942 | 2531 | 21497 | 2037 | 23142 | 1224 | 28795 | 672 | 24161 |
| 20-#11 | 2.89 | MA | 13060 | 3998 | 21096 | 3202 | 25117 | 2576 | 27383 | 2072 | 30191 | 1281 | 37785 | 820 | 30729 |
| 6E | | MI | 10681 | 3998 | 17574 | 3155 | 20703 | 2535 | 22422 | 2032 | 24383 | 1230 | 30224 | 743 | 24890 |
| 20-#11 | 2.89 | MA | 12571 | 3998 | 20387 | 3202 | 24180 | 2574 | 26237 | 2079 | 28616 | 1275 | 35948 | 749 | 29723 |
| 7L-5S | | MI | 11090 | 3998 | 18165 | 3157 | 21490 | 2528 | 23376 | 2037 | 25606 | 1224 | 31837 | 819 | 25378 |
| 20-#11 | 2.89 | MA | 12088 | 3998 | 19689 | 3201 | 23261 | 2572 | 25089 | 2075 | 27097 | 1281 | 34033 | 697 | 28782 |
| 8L-4S | | MI | 11516 | 3998 | 18828 | 3148 | 22287 | 2532 | 24343 | 2032 | 26878 | 1219 | 33449 | 861 | 26050 |
| 20-#11 | 2.89 | MA | 11608 | 3998 | 18918 | 3212 | 22313 | 2581 | 23960 | 2082 | 25593 | 1286 | 32157 | 638 | 27749 |
| 9L-3S | | MI | 11985 | 3998 | 19483 | 3150 | 23170 | 2525 | 25410 | 2037 | 28272 | 1224 | 34962 | 951 | 26345 |
| 20-#14 | 4.17 | MA | 14110 | 4500 | 24337 | 3507 | 29132 | 2800 | 32210 | 2210 | 36541 | 1240 | 46348 | 586 | 41890 |
| 6E | | MI | 11467 | 4500 | 20161 | 3455 | 23897 | 2753 | 26172 | 2157 | 29316 | 1173 | 36936 | 499 | 33790 |
| 20-#14 | 4.17 | MA | 13439 | 4500 | 23321 | 3506 | 27789 | 2796 | 30569 | 2219 | 34303 | 1233 | 43747 | 483 | 40318 |
| 7L-5S | | MI | 12029 | 4500 | 21007 | 3458 | 25023 | 2744 | 27522 | 2164 | 31048 | 1165 | 39061 | 588 | 35172 |
| 20-#14 | 4.17 | MA | 12776 | 4500 | 22320 | 3505 | 26472 | 2793 | 28925 | 2213 | 32143 | 1240 | 41024 | 410 | 38580 |
| 8L-4S | | MI | 12615 | 4500 | 21955 | 3446 | 26161 | 2750 | 28893 | 2157 | 32909 | 1173 | 41337 | 649 | 35937 |
| 22-#11 | 3.18 | MA | 13557 | 4112 | 22180 | 3273 | 26492 | 2627 | 29048 | 2104 | 32420 | 1274 | 40750 | 803 | 33781 |
| 6L-7S | | MI | 10676 | 4112 | 17869 | 3224 | 21047 | 2583 | 22832 | 2070 | 24898 | 1215 | 31106 | 650 | 26621 |
| 22-#11 | 3.18 | MA | 13073 | 4112 | 21471 | 3273 | 25555 | 2626 | 27903 | 2112 | 30846 | 1269 | 38913 | 732 | 32805 |
| 7L-6S | | MI | 11072 | 4112 | 18445 | 3226 | 21808 | 2587 | 23757 | 2065 | 26139 | 1220 | 32536 | 720 | 27324 |
| 22-#11 | 3.18 | MA | 12596 | 4112 | 20773 | 3272 | 24635 | 2624 | 26755 | 2108 | 29327 | 1274 | 36997 | 680 | 31833 |
| 8L-5S | | MI | 11477 | 4112 | 19036 | 3228 | 22595 | 2580 | 24711 | 2070 | 27362 | 1215 | 34149 | 796 | 27865 |
| 22-#11 | 3.18 | MA | 12121 | 4112 | 20002 | 3283 | 23688 | 2633 | 25626 | 2115 | 27822 | 1279 | 35121 | 621 | 30809 |
| 9L-4S | | MI | 11899 | 4112 | 19700 | 3219 | 23392 | 2583 | 25678 | 2065 | 28633 | 1210 | 35760 | 839 | 28507 |
| 22-#14 | 4.58 | MA | 14133 | 4663 | 24870 | 3608 | 29753 | 2871 | 32949 | 2266 | 37472 | 1223 | 47950 | 457 | 44656 |
| 7L-6S | | MI | 12006 | 4663 | 21404 | 3557 | 25473 | 2828 | 28062 | 2203 | 31803 | 1158 | 40199 | 463 | 37276 |
| 22-#14 | 4.58 | MA | 13479 | 4663 | 23869 | 3607 | 28436 | 2868 | 31305 | 2261 | 35312 | 1230 | 45228 | 384 | 42892 |
| 8L-5S | | MI | 12561 | 4663 | 22249 | 3560 | 26598 | 2819 | 29413 | 2210 | 33535 | 1150 | 42324 | 553 | 38641 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

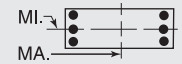
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 3.47 | MA | 13569 | 4225 | 22555 | 3343 | 26929 | 2678 | 29569 | 2144 | 33075 | 1263 | 41877 | 715 | 35892 |
| 7E | | MI | 11066 | 4225 | 18741 | 3295 | 22152 | 2635 | 24167 | 2102 | 26654 | 1206 | 33418 | 627 | 29086 |
| 24-#11 | 3.47 | MA | 13097 | 4225 | 21857 | 3343 | 26010 | 2676 | 28421 | 2141 | 31556 | 1268 | 39962 | 664 | 34889 |
| 8L-6S | | MI | 11459 | 4225 | 19317 | 3297 | 22914 | 2638 | 25092 | 2097 | 27895 | 1211 | 34848 | 698 | 29765 |
| 24-#11 | 3.47 | MA | 12628 | 4225 | 21086 | 3353 | 25063 | 2684 | 27291 | 2148 | 30052 | 1273 | 38086 | 605 | 33846 |
| 9L-5S | | MI | 11859 | 4225 | 19908 | 3299 | 23701 | 2632 | 26045 | 2102 | 29118 | 1206 | 36460 | 774 | 30355 |
| 24-#14 | 5.00 | MA | 14173 | 4827 | 25419 | 3710 | 30401 | 2943 | 33685 | 2308 | 38481 | 1220 | 49431 | 357 | 47213 |
| 8L-6S | | MI | 12538 | 4827 | 22646 | 3659 | 27049 | 2902 | 29953 | 2249 | 34290 | 1143 | 43462 | 428 | 40771 |

## RECTANGULAR TIED COLUMNS 30" x 38"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.40 | MA | 14317 | 3605 | 21175 | 2964 | 24952 | 2406 | 26789 | 1986 | 28480 | 1357 | 34588 | 1250 | 17813 |
| 2E | | MI | 11102 | 3605 | 16814 | 2902 | 19468 | 2353 | 20595 | 1930 | 21594 | 1301 | 25894 | 1173 | 13656 |
| 6-#14 | 1.18 | MA | 13970 | 3514 | 20207 | 2929 | 23874 | 2382 | 25546 | 1974 | 26976 | 1381 | 32690 | 1289 | 15274 |
| 2L-3S | | MI | 9901 | 3514 | 14844 | 2869 | 17129 | 2329 | 17915 | 1938 | 18106 | 1341 | 21420 | 1095 | 11779 |
| 6-#14 | 1.18 | MA | 12679 | 3514 | 18556 | 2928 | 21779 | 2379 | 23009 | 1985 | 23579 | 1388 | 28173 | 1158 | 15244 |
| 3L-2S | | MI | 10870 | 3514 | 16086 | 2872 | 18705 | 2335 | 19805 | 1930 | 20593 | 1333 | 24683 | 1226 | 11759 |
| 6-#18 | 2.11 | MA | 15635 | 3896 | 24060 | 3146 | 28611 | 2539 | 31221 | 2070 | 34355 | 1337 | 42364 | 1200 | 26360 |
| 2L-3S | | MI | 10429 | 3896 | 16814 | 3076 | 19468 | 2472 | 20595 | 2021 | 21594 | 1283 | 25894 | 867 | 19889 |
| 6-#18 | 2.11 | MA | 13460 | 3896 | 21175 | 3144 | 24952 | 2532 | 26789 | 2086 | 28480 | 1351 | 34588 | 967 | 25998 |
| 3L-2S | | MI | 12055 | 3896 | 18971 | 3084 | 22194 | 2485 | 23833 | 2007 | 25855 | 1270 | 31445 | 1101 | 20081 |
| 8-#11 | 1.09 | MA | 13827 | 3477 | 19795 | 2916 | 23426 | 2373 | 25037 | 1971 | 26362 | 1391 | 31918 | 1306 | 14226 |
| 2L-4S | | MI | 9588 | 3477 | 14246 | 2859 | 16390 | 2332 | 17079 | 1932 | 17035 | 1348 | 20366 | 1067 | 10975 |
| 8-#11 | 1.09 | MA | 12919 | 3477 | 18640 | 2916 | 21961 | 2372 | 23262 | 1979 | 23975 | 1397 | 28735 | 1215 | 14221 |
| 3E | | MI | 10091 | 3477 | 14901 | 2861 | 17274 | 2325 | 18145 | 1937 | 18429 | 1353 | 21880 | 1157 | 10994 |
| 8-#11 | 1.09 | MA | 12259 | 3477 | 17780 | 2917 | 20799 | 2381 | 21853 | 1976 | 22080 | 1391 | 26642 | 1124 | 14140 |
| 4L-2S | | MI | 10773 | 3477 | 15772 | 2862 | 18379 | 2329 | 19480 | 1932 | 20184 | 1348 | 24191 | 1249 | 10973 |
| 8-#14 | 1.58 | MA | 14750 | 3678 | 21859 | 3031 | 25968 | 2456 | 28083 | 2022 | 30373 | 1372 | 37208 | 1265 | 20180 |
| 2L-4S | | MI | 9779 | 3678 | 15151 | 2968 | 17443 | 2412 | 18295 | 1976 | 18679 | 1334 | 22543 | 931 | 15284 |
| 8-#14 | 1.58 | MA | 13480 | 3678 | 20207 | 3031 | 23874 | 2454 | 25546 | 2032 | 26976 | 1379 | 32690 | 1134 | 20098 |
| 3E | | MI | 10484 | 3678 | 16086 | 2971 | 18705 | 2404 | 19805 | 1984 | 20593 | 1326 | 24683 | 1060 | 15446 |
| 8-#14 | 1.58 | MA | 12554 | 3678 | 18976 | 3031 | 22209 | 2466 | 23529 | 2027 | 24280 | 1372 | 29723 | 1002 | 19787 |
| 4L-2S | | MI | 11438 | 3678 | 17328 | 2974 | 20281 | 2410 | 21696 | 1976 | 23080 | 1319 | 27946 | 1191 | 15470 |
| 8-#18 | 2.81 | MA | 16908 | 4186 | 26944 | 3328 | 32269 | 2672 | 35652 | 2155 | 40230 | 1317 | 50139 | 1150 | 34866 |
| 2L-4S | | MI | 10210 | 4186 | 17341 | 3249 | 20004 | 2617 | 21244 | 2085 | 22576 | 1266 | 27793 | 573 | 23721 |
| 8-#18 | 2.81 | MA | 14785 | 4186 | 24060 | 3326 | 28611 | 2665 | 31221 | 2170 | 34355 | 1331 | 42364 | 917 | 34375 |
| 3E | | MI | 11388 | 4186 | 18971 | 3257 | 22194 | 2604 | 23833 | 2098 | 25855 | 1252 | 31445 | 795 | 26146 |
| 8-#18 | 2.81 | MA | 13238 | 4186 | 21901 | 3323 | 25695 | 2685 | 27688 | 2159 | 29692 | 1317 | 37270 | 683 | 31125 |
| 4L-2S | | MI | 12979 | 4186 | 21129 | 3266 | 24921 | 2617 | 27071 | 2085 | 30116 | 1239 | 36996 | 1029 | 26453 |
| 10-#11 | 1.37 | MA | 14381 | 3590 | 20950 | 2987 | 24891 | 2425 | 26811 | 2004 | 28749 | 1386 | 35101 | 1291 | 17661 |
| 2L-5S | | MI | 9554 | 3590 | 14454 | 2938 | 16699 | 2380 | 17446 | 1970 | 17519 | 1344 | 21066 | 1002 | 13165 |
| 10-#11 | 1.37 | MA | 13484 | 3590 | 19795 | 2987 | 23426 | 2424 | 25037 | 2012 | 26362 | 1391 | 31918 | 1199 | 17631 |
| 3L-4S | | MI | 10007 | 3590 | 15118 | 2930 | 17495 | 2384 | 18414 | 1965 | 18791 | 1338 | 22678 | 1045 | 13533 |
| 10-#11 | 1.37 | MA | 12832 | 3590 | 18935 | 2987 | 22264 | 2433 | 23628 | 2009 | 24468 | 1386 | 29824 | 1108 | 17519 |
| 4L-3S | | MI | 10504 | 3590 | 15772 | 2931 | 18379 | 2377 | 19480 | 1970 | 20184 | 1344 | 24191 | 1135 | 13580 |
| 10-#11 | 1.37 | MA | 12241 | 3590 | 18064 | 2998 | 21219 | 2432 | 22353 | 2017 | 22739 | 1391 | 27627 | 1063 | 16972 |
| 5L-2S | | MI | 11179 | 3590 | 16643 | 2933 | 19484 | 2381 | 20815 | 1965 | 21940 | 1338 | 26503 | 1226 | 13578 |
| 10-#14 | 1.97 | MA | 15512 | 3841 | 23510 | 3133 | 28062 | 2531 | 30621 | 2069 | 33769 | 1363 | 41726 | 1241 | 25066 |
| 2L-5S | | MI | 9727 | 3841 | 15445 | 3082 | 17880 | 2481 | 18815 | 2029 | 19304 | 1311 | 23531 | 835 | 17711 |
| 10-#14 | 1.97 | MA | 14261 | 3841 | 21859 | 3133 | 25968 | 2529 | 28083 | 2079 | 30373 | 1370 | 37208 | 1110 | 24940 |
| 3L-4S | | MI | 10359 | 3841 | 16394 | 3070 | 19018 | 2487 | 20185 | 2022 | 21165 | 1319 | 25806 | 896 | 18749 |
| 10-#14 | 1.97 | MA | 13351 | 3841 | 20627 | 3133 | 24304 | 2541 | 26066 | 2075 | 27677 | 1363 | 34240 | 978 | 24521 |
| 4L-3S | | MI | 11053 | 3841 | 17328 | 3073 | 20281 | 2478 | 21696 | 2029 | 23080 | 1311 | 27946 | 1024 | 19096 |
| 10-#14 | 1.97 | MA | 12526 | 3841 | 19380 | 3147 | 22807 | 2539 | 24240 | 2085 | 25217 | 1370 | 31114 | 914 | 22959 |
| 5L-2S | | MI | 11994 | 3841 | 18571 | 3077 | 21856 | 2485 | 23586 | 2022 | 25567 | 1304 | 31209 | 1156 | 19160 |
| 10-#18 | 3.51 | MA | 18146 | 4477 | 29829 | 3510 | 35927 | 2805 | 40084 | 2239 | 46104 | 1298 | 57915 | 1100 | 43349 |
| 2L-5S | | MI | 10119 | 4477 | 17843 | 3449 | 20752 | 2736 | 22135 | 2176 | 23646 | 1221 | 29473 | 390 | 27445 |

## RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis



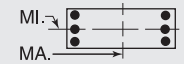

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.51 | MA | 16070 | 4477 | 26944 | 3507 | 32269 | 2798 | 35652 | 2254 | 40230 | 1311 | 50139 | 866 | 42749 |
| 3L-4S | | MI | 11168 | 4477 | 19499 | 3431 | 22730 | 2750 | 24482 | 2163 | 26837 | 1234 | 33344 | 501 | 29693 |
| 10-#18 | 3.51 | MA | 14560 | 4477 | 24786 | 3505 | 29353 | 2818 | 32119 | 2243 | 35567 | 1298 | 45045 | 633 | 39210 |
| 4L-3S | | MI | 12320 | 4477 | 21129 | 3439 | 24921 | 2736 | 27071 | 2176 | 30116 | 1221 | 36996 | 723 | 32392 |
| 10-#18 | 3.51 | MA | 13190 | 4477 | 22599 | 3529 | 26728 | 2811 | 28916 | 2258 | 31312 | 1311 | 39639 | 523 | 36202 |
| 5L-2S | | MI | 13879 | 4477 | 23286 | 3447 | 27648 | 2750 | 30309 | 2163 | 34376 | 1208 | 42547 | 956 | 32797 |
| 12-#11 | 1.64 | MA | 14925 | 3704 | 22105 | 3058 | 26356 | 2477 | 28586 | 2037 | 31137 | 1380 | 38284 | 1275 | 21084 |
| 2L-6S | | MI | 9541 | 3704 | 14735 | 3007 | 17017 | 2439 | 17828 | 1997 | 18052 | 1340 | 21765 | 904 | 15173 |
| 12-#11 | 1.64 | MA | 14039 | 3704 | 20950 | 3058 | 24891 | 2476 | 26811 | 2044 | 28749 | 1385 | 35101 | 1184 | 21033 |
| 3L-5S | | MI | 9970 | 3704 | 15326 | 3009 | 17804 | 2432 | 18781 | 2002 | 19275 | 1334 | 23377 | 980 | 15614 |
| 12-#11 | 1.64 | MA | 13395 | 3704 | 20090 | 3058 | 23729 | 2485 | 25402 | 2042 | 26855 | 1380 | 33007 | 1093 | 20894 |
| 4E | | MI | 10418 | 3704 | 15989 | 3001 | 18600 | 2436 | 19749 | 1997 | 20546 | 1329 | 24989 | 1022 | 16084 |
| 12-#11 | 1.64 | MA | 12811 | 3704 | 19219 | 3069 | 22684 | 2484 | 24127 | 2049 | 25126 | 1385 | 30809 | 1048 | 20243 |
| 5L-3S | | MI | 10910 | 3704 | 16643 | 3002 | 19484 | 2429 | 20815 | 2002 | 21940 | 1334 | 26503 | 1112 | 16155 |
| 12-#11 | 1.64 | MA | 12251 | 3704 | 18446 | 3069 | 21652 | 2493 | 22872 | 2047 | 23464 | 1391 | 28588 | 973 | 19565 |
| 6L-2S | | MI | 11577 | 3704 | 17515 | 3004 | 20589 | 2433 | 22150 | 1997 | 23696 | 1329 | 28814 | 1203 | 16174 |
| 12-#14 | 2.37 | MA | 16258 | 4005 | 25162 | 3235 | 30157 | 2606 | 33158 | 2117 | 37166 | 1354 | 46244 | 1217 | 29941 |
| 2L-6S | | MI | 9707 | 4005 | 15842 | 3181 | 18330 | 2565 | 19355 | 2068 | 20059 | 1304 | 24668 | 710 | 20215 |
| 12-#14 | 2.37 | MA | 15025 | 4005 | 23510 | 3235 | 28062 | 2604 | 30621 | 2127 | 33769 | 1361 | 41726 | 1086 | 29776 |
| 3L-5S | | MI | 10305 | 4005 | 16687 | 3184 | 19456 | 2556 | 20705 | 2075 | 21791 | 1297 | 26793 | 799 | 21214 |
| 12-#14 | 2.37 | MA | 14130 | 4005 | 22279 | 3235 | 26398 | 2616 | 28604 | 2122 | 31074 | 1354 | 38758 | 954 | 29138 |
| 4E | | MI | 10927 | 4005 | 17636 | 3172 | 20594 | 2562 | 22075 | 2068 | 23652 | 1304 | 29069 | 861 | 22186 |
| 12-#14 | 2.37 | MA | 13319 | 4005 | 21031 | 3250 | 24901 | 2614 | 26777 | 2132 | 28614 | 1361 | 35632 | 890 | 27653 |
| 5L-3S | | MI | 11611 | 4005 | 18571 | 3176 | 21856 | 2553 | 23586 | 2075 | 25567 | 1297 | 31209 | 989 | 22736 |
| 12-#14 | 2.37 | MA | 12540 | 4005 | 19923 | 3249 | 23423 | 2626 | 24978 | 2128 | 26248 | 1368 | 32478 | 781 | 26297 |
| 6L-2S | | MI | 12539 | 4005 | 19813 | 3179 | 23432 | 2559 | 25476 | 2068 | 28054 | 1289 | 34472 | 1120 | 22833 |
| 12-#18 | 4.21 | MA | 17322 | 4768 | 29829 | 3689 | 35927 | 2931 | 40084 | 2338 | 46104 | 1291 | 57915 | 816 | 51123 |
| 3L-5S | | MI | 11075 | 4768 | 20000 | 3631 | 23479 | 2868 | 25373 | 2254 | 27907 | 1190 | 35024 | 318 | 33305 |
| 12-#18 | 4.21 | MA | 15846 | 4768 | 27670 | 3687 | 33011 | 2951 | 36551 | 2327 | 41442 | 1278 | 52821 | 583 | 47334 |
| 4E | | MI | 12103 | 4768 | 21656 | 3612 | 25457 | 2882 | 27720 | 2241 | 31097 | 1203 | 38896 | 429 | 35703 |
| 12-#18 | 4.21 | MA | 14508 | 4768 | 25483 | 3711 | 30386 | 2944 | 33348 | 2343 | 37187 | 1291 | 47414 | 473 | 44193 |
| 5L-3S | | MI | 13232 | 4768 | 23286 | 3621 | 27648 | 2868 | 30309 | 2254 | 34376 | 1190 | 42547 | 650 | 38631 |
| 12-#18 | 4.21 | MA | 13225 | 4768 | 23537 | 3709 | 27793 | 2964 | 30193 | 2332 | 33096 | 1304 | 41988 | 279 | 40821 |
| 6L-2S | | MI | 14762 | 4768 | 25444 | 3629 | 30374 | 2882 | 33547 | 2241 | 38637 | 1177 | 48099 | 884 | 39124 |
| 14-#11 | 1.92 | MA | 15461 | 3817 | 23260 | 3129 | 27820 | 2529 | 30360 | 2070 | 33524 | 1375 | 41466 | 1260 | 24501 |
| 2L-7S | | MI | 9539 | 3817 | 15030 | 3077 | 17361 | 2487 | 18237 | 2035 | 18567 | 1325 | 22646 | 811 | 17009 |
| 14-#11 | 1.92 | MA | 14584 | 3817 | 22105 | 3129 | 26356 | 2528 | 28586 | 2077 | 31137 | 1380 | 38284 | 1169 | 24430 |
| 3L-6S | | MI | 9955 | 3817 | 15606 | 3078 | 18122 | 2491 | 19162 | 2030 | 19808 | 1330 | 24076 | 881 | 17655 |
| 14-#11 | 1.92 | MA | 13948 | 3817 | 21245 | 3129 | 25193 | 2537 | 27177 | 2075 | 29242 | 1375 | 36190 | 1078 | 24267 |
| 4L-5S | | MI | 10380 | 3817 | 16197 | 3080 | 18909 | 2484 | 20116 | 2035 | 21031 | 1325 | 25689 | 957 | 18075 |
| 14-#11 | 1.92 | MA | 13372 | 3817 | 20374 | 3140 | 24149 | 2536 | 25902 | 2082 | 27514 | 1380 | 33992 | 1033 | 23525 |
| 5L-4S | | MI | 10823 | 3817 | 16861 | 3071 | 19706 | 2488 | 21083 | 2030 | 22302 | 1320 | 27301 | 1000 | 18630 |
| 14-#11 | 1.92 | MA | 12819 | 3817 | 19601 | 3140 | 23117 | 2545 | 24647 | 2080 | 25851 | 1385 | 31770 | 957 | 22874 |
| 6L-3S | | MI | 11309 | 3817 | 17515 | 3073 | 20589 | 2481 | 22150 | 2035 | 23696 | 1325 | 28814 | 1090 | 18723 |
| 14-#11 | 1.92 | MA | 12278 | 3817 | 18847 | 3140 | 22121 | 2543 | 23429 | 2087 | 24165 | 1380 | 29796 | 886 | 21981 |
| 7L-2S | | MI | 11970 | 3817 | 18386 | 3075 | 21694 | 2485 | 23484 | 2030 | 25452 | 1320 | 31126 | 1181 | 18757 |
| 14-#14 | 2.76 | MA | 15774 | 4168 | 25162 | 3337 | 30157 | 2678 | 33158 | 2174 | 37166 | 1352 | 46244 | 1062 | 34607 |
| 3L-6S | | MI | 10282 | 4168 | 17085 | 3283 | 19906 | 2640 | 21245 | 2114 | 22546 | 1289 | 27931 | 675 | 23650 |
| 14-#14 | 2.76 | MA | 14893 | 4168 | 23930 | 3337 | 28492 | 2691 | 31141 | 2170 | 34471 | 1344 | 43276 | 930 | 33776 |
| 4L-5S | | MI | 10872 | 4168 | 17930 | 3286 | 21031 | 2631 | 22595 | 2121 | 24278 | 1282 | 30056 | 764 | 24729 |
| 14-#14 | 2.76 | MA | 14095 | 4168 | 22683 | 3352 | 26996 | 2688 | 29314 | 2180 | 32011 | 1352 | 40149 | 866 | 32361 |
| 5L-4S | | MI | 11485 | 4168 | 18878 | 3275 | 22170 | 2637 | 23966 | 2114 | 26139 | 1289 | 32332 | 825 | 25644 |
| 14-#14 | 2.76 | MA | 13329 | 4168 | 21574 | 3352 | 25518 | 2701 | 27516 | 2175 | 29645 | 1359 | 36996 | 757 | 30929 |
| 6L-3S | | MI | 12159 | 4168 | 19813 | 3278 | 23432 | 2628 | 25476 | 2121 | 28054 | 1282 | 34472 | 954 | 26368 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis

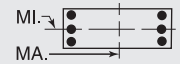


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.76 | MA | 12578 | 4168 | 20494 | 3351 | 24090 | 2698 | 25771 | 2185 | 27246 | 1352 | 34196 | 655 | 29446 |
| 7L-2S | | MI | 13076 | 4168 | 21056 | 3281 | 25008 | 2634 | 27366 | 2114 | 30541 | 1274 | 37734 | 1085 | 26497 |
| 14-#18 | 4.91 | MA | 17103 | 5059 | 30555 | 3868 | 36669 | 3084 | 40983 | 2412 | 47316 | 1258 | 60597 | 533 | 55490 |
| 4L-5S | | MI | 12068 | 5059 | 22158 | 3812 | 26205 | 3001 | 28611 | 2332 | 32167 | 1159 | 40575 | 246 | 39201 |
| 14-#18 | 4.91 | MA | 15794 | 5059 | 28368 | 3893 | 34044 | 3077 | 37780 | 2427 | 43062 | 1271 | 55190 | 423 | 52215 |
| 5L-4S | | MI | 13064 | 5059 | 23814 | 3794 | 28183 | 3014 | 30958 | 2318 | 35358 | 1172 | 44447 | 356 | 41744 |
| 14-#18 | 4.91 | MA | 14539 | 5059 | 26421 | 3890 | 31452 | 3097 | 34625 | 2416 | 38970 | 1284 | 49764 | 228 | 48779 |
| 6L-3S | | MI | 14148 | 5059 | 25444 | 3803 | 30374 | 3001 | 33547 | 2332 | 38637 | 1159 | 48099 | 578 | 44603 |
| 16-#11 | 2.19 | MA | 15121 | 3931 | 23260 | 3200 | 27820 | 2580 | 30360 | 2110 | 33524 | 1374 | 41466 | 1154 | 27823 |
| 3L-7S | | MI | 9952 | 3931 | 15901 | 3147 | 18466 | 2539 | 19572 | 2067 | 20323 | 1316 | 24958 | 788 | 19447 |
| 16-#11 | 2.19 | MA | 14492 | 3931 | 22400 | 3200 | 26658 | 2589 | 28952 | 2107 | 31630 | 1369 | 39373 | 1062 | 27638 |
| 4L-6S | | MI | 10364 | 3931 | 16477 | 3149 | 19227 | 2543 | 20497 | 2062 | 21564 | 1321 | 26388 | 859 | 20142 |
| 16-#11 | 2.19 | MA | 13923 | 3931 | 21529 | 3211 | 25613 | 2587 | 27677 | 2115 | 29901 | 1374 | 37175 | 1018 | 26816 |
| 5E | | MI | 10784 | 3931 | 17068 | 3151 | 20014 | 2536 | 21451 | 2067 | 22787 | 1316 | 28000 | 935 | 20543 |
| 16-#11 | 2.19 | MA | 13377 | 3931 | 20756 | 3211 | 24582 | 2597 | 26421 | 2112 | 28238 | 1379 | 34953 | 942 | 26189 |
| 6L-4S | | MI | 11222 | 3931 | 17732 | 3142 | 20811 | 2540 | 22418 | 2062 | 24058 | 1311 | 29612 | 977 | 21173 |
| 16-#11 | 2.19 | MA | 12842 | 3931 | 20002 | 3211 | 23586 | 2595 | 25204 | 2120 | 26552 | 1374 | 32979 | 871 | 25249 |
| 7L-3S | | MI | 11703 | 3931 | 18386 | 3144 | 21694 | 2533 | 23484 | 2067 | 25452 | 1316 | 31126 | 1067 | 21285 |
| 16-#11 | 2.19 | MA | 12314 | 3931 | 19261 | 3211 | 22609 | 2594 | 23984 | 2117 | 24926 | 1379 | 30927 | 819 | 24398 |
| 8L-2S | | MI | 12357 | 3931 | 19258 | 3146 | 22800 | 2536 | 24819 | 2062 | 27208 | 1311 | 33438 | 1158 | 21335 |
| 16-#14 | 3.16 | MA | 15643 | 4332 | 25581 | 3439 | 30587 | 2766 | 33678 | 2217 | 37867 | 1335 | 47794 | 906 | 38432 |
| 4L-6S | | MI | 10847 | 4332 | 18327 | 3385 | 21482 | 2714 | 23135 | 2159 | 25033 | 1275 | 31194 | 639 | 27099 |
| 16-#14 | 3.16 | MA | 14856 | 4332 | 24334 | 3454 | 29090 | 2763 | 31852 | 2227 | 35408 | 1343 | 44667 | 842 | 37079 |
| 5E | | MI | 11428 | 4332 | 19172 | 3388 | 22607 | 2706 | 24486 | 2167 | 26765 | 1267 | 33319 | 729 | 28254 |
| 16-#14 | 3.16 | MA | 14102 | 4332 | 23225 | 3454 | 27612 | 2776 | 30053 | 2223 | 33042 | 1350 | 41514 | 733 | 35575 |
| 6L-4S | | MI | 12034 | 4332 | 20121 | 3377 | 23746 | 2712 | 25856 | 2159 | 28626 | 1275 | 35595 | 790 | 29120 |
| 16-#14 | 3.16 | MA | 13364 | 4332 | 22146 | 3454 | 26184 | 2773 | 28308 | 2233 | 30643 | 1343 | 38714 | 631 | 34108 |
| 7L-3S | | MI | 12699 | 4332 | 21056 | 3380 | 25008 | 2703 | 27366 | 2167 | 30541 | 1267 | 37734 | 918 | 29995 |
| 16-#14 | 3.16 | MA | 12634 | 4332 | 21082 | 3453 | 24784 | 2771 | 26560 | 2228 | 28328 | 1350 | 35795 | 557 | 32089 |
| 8L-2S | | MI | 13604 | 4332 | 22298 | 3383 | 26583 | 2709 | 29257 | 2159 | 33027 | 1260 | 40997 | 1050 | 30153 |
| 16-#18 | 5.61 | MA | 17053 | 5350 | 31252 | 4074 | 37703 | 3210 | 42212 | 2511 | 48937 | 1251 | 62965 | 373 | 60266 |
| 5E | | MI | 12982 | 5350 | 24315 | 3994 | 28932 | 3133 | 31849 | 2409 | 36428 | 1128 | 46126 | 173 | 45127 |
| 16-#18 | 5.61 | MA | 15824 | 5350 | 29306 | 4072 | 35110 | 3230 | 39057 | 2500 | 44845 | 1265 | 57540 | 178 | 56761 |
| 6L-4S | | MI | 13952 | 5350 | 25971 | 3976 | 30910 | 3146 | 34196 | 2396 | 39619 | 1141 | 49998 | 284 | 47810 |
| 18-#11 | 2.46 | MA | 15028 | 4044 | 23555 | 3271 | 28123 | 2640 | 30726 | 2140 | 34017 | 1363 | 42556 | 1047 | 31008 |
| 4L-7S | | MI | 10359 | 4044 | 16773 | 3218 | 19571 | 2591 | 20907 | 2100 | 22079 | 1307 | 27270 | 765 | 21893 |
| 18-#11 | 2.46 | MA | 14466 | 4044 | 22684 | 3282 | 27078 | 2639 | 29451 | 2148 | 32288 | 1369 | 40358 | 1002 | 30115 |
| 5L-6S | | MI | 10767 | 4044 | 17349 | 3220 | 20333 | 2594 | 21832 | 2095 | 23320 | 1312 | 28699 | 836 | 22634 |
| 18-#11 | 2.46 | MA | 13927 | 4044 | 21911 | 3282 | 26047 | 2648 | 28196 | 2145 | 30626 | 1374 | 38136 | 927 | 29509 |
| 6L-5S | | MI | 11182 | 4044 | 17940 | 3222 | 21120 | 2588 | 22785 | 2100 | 24543 | 1307 | 30312 | 912 | 23019 |
| 18-#11 | 2.46 | MA | 13398 | 4044 | 21157 | 3282 | 25050 | 2647 | 26979 | 2153 | 28940 | 1369 | 36162 | 856 | 28525 |
| 7L-4S | | MI | 11615 | 4044 | 18604 | 3213 | 21916 | 2591 | 23753 | 2095 | 25814 | 1301 | 31924 | 954 | 23713 |
| 18-#11 | 2.46 | MA | 12877 | 4044 | 20416 | 3282 | 24074 | 2646 | 25759 | 2150 | 27313 | 1374 | 34110 | 804 | 27642 |
| 8L-3S | | MI | 12091 | 4044 | 19258 | 3215 | 22800 | 2585 | 24819 | 2100 | 27208 | 1307 | 33438 | 1045 | 23842 |
| 18-#11 | 2.46 | MA | 12358 | 4044 | 19597 | 3293 | 23067 | 2655 | 24559 | 2158 | 25702 | 1379 | 32095 | 745 | 26466 |
| 9L-2S | | MI | 12740 | 4044 | 20129 | 3217 | 23905 | 2588 | 26154 | 2095 | 28964 | 1301 | 35749 | 1136 | 23907 |
| 18-#14 | 3.55 | MA | 15605 | 4495 | 25985 | 3556 | 31184 | 2838 | 34389 | 2275 | 38804 | 1334 | 49185 | 818 | 41807 |
| 5L-6S | | MI | 11403 | 4495 | 19569 | 3487 | 23057 | 2789 | 25026 | 2205 | 27520 | 1260 | 34457 | 604 | 30561 |
| 18-#14 | 3.55 | MA | 14862 | 4495 | 24877 | 3556 | 29706 | 2850 | 32590 | 2270 | 36439 | 1341 | 46032 | 709 | 40232 |
| 6L-5S | | MI | 11977 | 4495 | 20415 | 3491 | 24183 | 2780 | 26376 | 2213 | 29252 | 1252 | 36582 | 693 | 31787 |
| 18-#14 | 3.55 | MA | 14135 | 4495 | 23797 | 3556 | 28278 | 2848 | 30846 | 2280 | 34040 | 1334 | 43232 | 607 | 38722 |
| 7L-4S | | MI | 12574 | 4495 | 21363 | 3479 | 25321 | 2786 | 27746 | 2205 | 31113 | 1260 | 38858 | 755 | 32609 |
| 18-#14 | 3.55 | MA | 13416 | 4495 | 22734 | 3556 | 26878 | 2846 | 29098 | 2276 | 31725 | 1341 | 40313 | 533 | 36754 |
| 8L-3S | | MI | 13231 | 4495 | 22298 | 3482 | 26583 | 2778 | 29257 | 2213 | 33027 | 1252 | 40997 | 883 | 33619 |
| 18-#18 | 6.32 | MA | 17195 | 5640 | 32190 | 4254 | 38768 | 3363 | 43489 | 2584 | 50720 | 1245 | 65315 | 128 | 64766 |
| 6L-5S | | MI | 13875 | 5640 | 26473 | 4176 | 31659 | 3265 | 35087 | 2487 | 40689 | 1097 | 51678 | 101 | 51080 |
| 20-#11 | 2.74 | MA | 15001 | 4157 | 23839 | 3352 | 28543 | 2691 | 31226 | 2181 | 34676 | 1363 | 43541 | 987 | 33421 |
| 5L-7S | | MI | 10761 | 4157 | 17644 | 3289 | 20677 | 2643 | 22242 | 2132 | 23835 | 1297 | 29581 | 743 | 24345 |

## RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.74 | MA | 14468 | 4157 | 23066 | 3353 | 27512 | 2700 | 29970 | 2178 | 33013 | 1368 | 41319 | 912 | 32833 |
| 6E | | MI | 11164 | 4157 | 18220 | 3291 | 21438 | 2646 | 23167 | 2127 | 25076 | 1302 | 31011 | 813 | 25094 |
| 20-#11 | 2.74 | MA | 13946 | 4157 | 22312 | 3353 | 26515 | 2699 | 28753 | 2186 | 31327 | 1363 | 39345 | 841 | 31806 |
| 7L-5S | | MI | 11575 | 4157 | 18811 | 3293 | 22225 | 2640 | 24120 | 2132 | 26298 | 1297 | 32624 | 890 | 25501 |
| 20-#11 | 2.74 | MA | 13430 | 4157 | 21571 | 3353 | 25538 | 2698 | 27533 | 2183 | 29700 | 1368 | 37293 | 788 | 30892 |
| 8L-4S | | MI | 12004 | 4157 | 19475 | 3284 | 23021 | 2643 | 25088 | 2127 | 27570 | 1292 | 34235 | 932 | 26195 |
| 20-#11 | 2.74 | MA | 12918 | 4157 | 20752 | 3364 | 24532 | 2707 | 26333 | 2191 | 28089 | 1373 | 35277 | 730 | 29744 |
| 9L-3S | | MI | 12475 | 4157 | 20129 | 3286 | 23905 | 2637 | 26154 | 2132 | 28964 | 1297 | 35749 | 1022 | 26397 |
| 20-#11 | 2.74 | MA | 12408 | 4157 | 20013 | 3364 | 23562 | 2706 | 25127 | 2188 | 26433 | 1368 | 33322 | 663 | 28500 |
| 10L-2S | | MI | 13118 | 4157 | 21001 | 3288 | 25010 | 2640 | 27489 | 2127 | 30720 | 1292 | 38061 | 1113 | 26476 |
| 20-#14 | 3.95 | MA | 15610 | 4659 | 26528 | 3658 | 31801 | 2925 | 35128 | 2317 | 39835 | 1332 | 50549 | 685 | 44901 |
| 6E | | MI | 11951 | 4659 | 20812 | 3590 | 24633 | 2864 | 26916 | 2251 | 30007 | 1245 | 37720 | 569 | 34033 |
| 20-#14 | 3.95 | MA | 14893 | 4659 | 25448 | 3658 | 30372 | 2923 | 33383 | 2328 | 37436 | 1325 | 47750 | 583 | 43347 |
| 7L-5S | | MI | 12517 | 4659 | 21657 | 3593 | 25758 | 2855 | 28266 | 2259 | 31739 | 1238 | 39845 | 658 | 35328 |
| 20-#14 | 3.95 | MA | 14184 | 4659 | 24385 | 3658 | 28973 | 2920 | 31635 | 2323 | 35122 | 1332 | 44831 | 508 | 41428 |
| 8L-4S | | MI | 13107 | 4659 | 22606 | 3581 | 26897 | 2861 | 29637 | 2251 | 33600 | 1245 | 42120 | 720 | 36110 |
| 22-#11 | 3.01 | MA | 15003 | 4271 | 24221 | 3424 | 28976 | 2752 | 31745 | 2211 | 35400 | 1363 | 44502 | 896 | 36161 |
| 6L-7S | | MI | 11158 | 4271 | 18516 | 3360 | 21782 | 2695 | 23576 | 2165 | 25591 | 1288 | 31893 | 720 | 26803 |
| 22-#11 | 3.01 | MA | 14487 | 4271 | 23467 | 3424 | 27980 | 2751 | 30528 | 2219 | 33714 | 1357 | 42527 | 825 | 35094 |
| 7L-6S | | MI | 11556 | 4271 | 19092 | 3362 | 22543 | 2698 | 24501 | 2160 | 26832 | 1293 | 33323 | 791 | 27526 |
| 22-#11 | 3.01 | MA | 13977 | 4271 | 22726 | 3424 | 27003 | 2750 | 29308 | 2216 | 32088 | 1363 | 40475 | 773 | 34148 |
| 8L-5S | | MI | 11964 | 4271 | 19683 | 3364 | 23330 | 2692 | 25455 | 2165 | 28054 | 1288 | 34935 | 867 | 27987 |
| 22-#11 | 3.01 | MA | 13470 | 4271 | 21907 | 3435 | 25997 | 2759 | 28108 | 2224 | 30477 | 1368 | 38460 | 714 | 33026 |
| 9L-4S | | MI | 12388 | 4271 | 20346 | 3355 | 24126 | 2695 | 26422 | 2160 | 29326 | 1283 | 36547 | 909 | 28650 |
| 22-#11 | 3.01 | MA | 12966 | 4271 | 21168 | 3435 | 25027 | 2758 | 26902 | 2221 | 28820 | 1363 | 36505 | 648 | 31762 |
| 10L-3S | | MI | 12855 | 4271 | 21001 | 3357 | 25010 | 2688 | 27489 | 2165 | 30720 | 1288 | 38061 | 999 | 28949 |
| 22-#14 | 4.34 | MA | 15640 | 4823 | 27100 | 3760 | 32467 | 2998 | 35920 | 2375 | 40833 | 1316 | 52268 | 558 | 47981 |
| 7L-6S | | MI | 12492 | 4823 | 22054 | 3692 | 26209 | 2939 | 28806 | 2297 | 32494 | 1230 | 40983 | 534 | 37516 |
| 22-#14 | 4.34 | MA | 14941 | 4823 | 26036 | 3760 | 31067 | 2995 | 34172 | 2370 | 38519 | 1323 | 49349 | 484 | 46108 |
| 8L-5S | | MI | 13051 | 4823 | 22900 | 3695 | 27334 | 2930 | 30157 | 2304 | 34226 | 1223 | 43108 | 623 | 38874 |
| 24-#11 | 3.28 | MA | 15020 | 4384 | 24622 | 3495 | 29445 | 2803 | 32302 | 2252 | 36102 | 1352 | 45710 | 810 | 38386 |
| 7E | | MI | 11550 | 4384 | 19387 | 3431 | 22887 | 2746 | 24911 | 2197 | 27347 | 1279 | 34204 | 698 | 29266 |
| 24-#11 | 3.28 | MA | 14516 | 4384 | 23881 | 3495 | 28468 | 2802 | 31083 | 2249 | 34475 | 1357 | 43658 | 758 | 37410 |
| 8L-6S | | MI | 11945 | 4384 | 19963 | 3433 | 23648 | 2750 | 25836 | 2192 | 28588 | 1284 | 35634 | 768 | 29964 |
| 24-#11 | 3.28 | MA | 14015 | 4384 | 23062 | 3505 | 27462 | 2811 | 29882 | 2256 | 32864 | 1362 | 41643 | 699 | 36312 |
| 9L-5S | | MI | 12348 | 4384 | 20554 | 3434 | 24435 | 2743 | 26790 | 2197 | 29810 | 1279 | 37247 | 844 | 30477 |
| 24-#11 | 3.28 | MA | 13516 | 4384 | 22323 | 3506 | 26492 | 2809 | 28677 | 2254 | 31207 | 1357 | 39688 | 633 | 35029 |
| 10L-4S | | MI | 12768 | 4384 | 21218 | 3426 | 25232 | 2747 | 27757 | 2192 | 31082 | 1273 | 38859 | 887 | 31112 |
| 24-#14 | 4.74 | MA | 15688 | 4986 | 27688 | 3862 | 33161 | 3070 | 36710 | 2418 | 41915 | 1314 | 53867 | 460 | 50796 |
| 8L-6S | | MI | 13027 | 4986 | 23297 | 3794 | 27785 | 3014 | 30696 | 2343 | 34981 | 1216 | 44246 | 498 | 41007 |

## RECTANGULAR TIED COLUMNS 30" x 40"

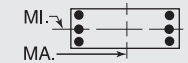
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.33 | MA | 15767 | 3764 | 23110 | 3114 | 27291 | 2529 | 29290 | 2090 | 31131 | 1441 | 37823 | 1336 | 18893 |
| 2E | | MI | 11584 | 3764 | 17472 | 3036 | 20205 | 2463 | 21338 | 2023 | 22282 | 1373 | 26673 | 1243 | 13694 |
| 6-#14 | 1.13 | MA | 15389 | 3673 | 22075 | 3078 | 26137 | 2504 | 27959 | 2079 | 29504 | 1464 | 35758 | 1373 | 16185 |
| 2L-3S | | MI | 10380 | 3673 | 15494 | 3004 | 17865 | 2440 | 18659 | 2032 | 18797 | 1413 | 22204 | 1165 | 11819 |
| 6-#14 | 1.13 | MA | 14013 | 3673 | 20321 | 3078 | 23913 | 2503 | 25265 | 2090 | 25879 | 1472 | 30925 | 1241 | 16155 |
| 3L-2S | | MI | 11351 | 3673 | 16736 | 3007 | 19441 | 2446 | 20549 | 2025 | 21284 | 1406 | 25467 | 1296 | 11790 |
| 6-#18 | 2.00 | MA | 17183 | 4055 | 26176 | 3295 | 31180 | 2662 | 34001 | 2175 | 37410 | 1424 | 46157 | 1290 | 27980 |
| 2L-3S | | MI | 10909 | 4055 | 17472 | 3209 | 20205 | 2582 | 21338 | 2114 | 22282 | 1355 | 26673 | 937 | 19967 |
| 6-#18 | 2.00 | MA | 14862 | 4055 | 23110 | 3294 | 27291 | 2656 | 29290 | 2192 | 31131 | 1437 | 37823 | 1056 | 27618 |
| 3L-2S | | MI | 12541 | 4055 | 19629 | 3218 | 22932 | 2595 | 24576 | 2101 | 26543 | 1342 | 32224 | 1170 | 20129 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis

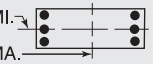



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.04 | MA | 15233 | 3636 | 21634 | 3065 | 25658 | 2496 | 27414 | 2075 | 28822 | 1473 | 34917 | 1389 | 15069 |
| 2L-4S | | MI | 10066 | 3636 | 14893 | 2995 | 17125 | 2444 | 17823 | 2027 | 17727 | 1421 | 21153 | 1138 | 11017 |
| 8-#11 | 1.04 | MA | 14267 | 3636 | 20408 | 3066 | 24103 | 2495 | 25530 | 2083 | 26281 | 1479 | 31516 | 1297 | 15064 |
| 3E | | MI | 10571 | 3636 | 15547 | 2996 | 18008 | 2437 | 18890 | 2032 | 19121 | 1426 | 22666 | 1228 | 11025 |
| 8-#11 | 1.04 | MA | 13565 | 3636 | 19497 | 3066 | 22871 | 2505 | 24037 | 2081 | 24266 | 1474 | 29276 | 1206 | 14982 |
| 4L-2S | | MI | 11254 | 3636 | 16419 | 2998 | 19113 | 2441 | 20225 | 2027 | 20877 | 1421 | 24978 | 1319 | 11000 |
| 8-#14 | 1.50 | MA | 16226 | 3837 | 23828 | 3180 | 28361 | 2579 | 30654 | 2126 | 33128 | 1456 | 40590 | 1351 | 21395 |
| 2L-4S | | MI | 10257 | 3837 | 15802 | 3103 | 18178 | 2524 | 19039 | 2070 | 19370 | 1406 | 23327 | 1001 | 15356 |
| 8-#14 | 1.50 | MA | 14872 | 3837 | 22075 | 3180 | 26137 | 2577 | 27959 | 2137 | 29504 | 1463 | 35758 | 1219 | 21313 |
| 3E | | MI | 10964 | 3837 | 16736 | 3106 | 19441 | 2515 | 20549 | 2078 | 21284 | 1399 | 25467 | 1130 | 15492 |
| 8-#14 | 1.50 | MA | 13887 | 3837 | 20769 | 3181 | 24372 | 2590 | 25820 | 2133 | 26627 | 1456 | 32579 | 1088 | 21002 |
| 4L-2S | | MI | 11921 | 3837 | 17979 | 3109 | 21016 | 2521 | 22439 | 2070 | 23771 | 1391 | 28730 | 1261 | 15505 |
| 8-#18 | 2.67 | MA | 18551 | 4346 | 29242 | 3477 | 35069 | 2794 | 38712 | 2259 | 43690 | 1406 | 54492 | 1244 | 37026 |
| 2L-4S | | MI | 10688 | 4346 | 17999 | 3383 | 20741 | 2727 | 21987 | 2178 | 23264 | 1337 | 28572 | 643 | 23971 |
| 8-#18 | 2.67 | MA | 16285 | 4346 | 26176 | 3476 | 31180 | 2789 | 34001 | 2276 | 37410 | 1419 | 46157 | 1010 | 36535 |
| 3E | | MI | 11872 | 4346 | 19629 | 3391 | 22932 | 2714 | 24576 | 2192 | 26543 | 1324 | 32224 | 864 | 26234 |
| 8-#18 | 2.67 | MA | 14636 | 4346 | 23886 | 3475 | 28085 | 2810 | 30251 | 2266 | 32427 | 1406 | 40689 | 777 | 33306 |
| 4L-2S | | MI | 13469 | 4346 | 21787 | 3399 | 25658 | 2727 | 27814 | 2178 | 30804 | 1311 | 37775 | 1098 | 26507 |
| 10-#11 | 1.30 | MA | 15827 | 3749 | 22860 | 3136 | 27212 | 2548 | 29297 | 2108 | 31363 | 1468 | 38319 | 1375 | 18714 |
| 2L-5S | | MI | 10032 | 3749 | 15101 | 3074 | 17433 | 2492 | 18191 | 2065 | 18211 | 1417 | 21852 | 1073 | 13290 |
| 10-#11 | 1.30 | MA | 14872 | 3749 | 21634 | 3137 | 25658 | 2547 | 27414 | 2116 | 28822 | 1473 | 34917 | 1284 | 18684 |
| 3L-4S | | MI | 10486 | 3749 | 15764 | 3065 | 18230 | 2496 | 19158 | 2059 | 19483 | 1411 | 23464 | 1115 | 13581 |
| 10-#11 | 1.30 | MA | 14179 | 3749 | 20722 | 3137 | 24426 | 2557 | 25921 | 2114 | 26807 | 1469 | 32677 | 1192 | 18572 |
| 4L-3S | | MI | 10984 | 3749 | 16419 | 3067 | 19113 | 2489 | 20225 | 2065 | 20877 | 1417 | 24978 | 1205 | 13617 |
| 10-#11 | 1.30 | MA | 13551 | 3749 | 19800 | 3148 | 23319 | 2556 | 24570 | 2122 | 24968 | 1474 | 30334 | 1147 | 18085 |
| 5L-2S | | MI | 11661 | 3749 | 17290 | 3069 | 20219 | 2493 | 21559 | 2059 | 22633 | 1411 | 27289 | 1296 | 13609 |
| 10-#14 | 1.88 | MA | 17044 | 4000 | 25582 | 3282 | 30585 | 2654 | 33348 | 2173 | 36753 | 1448 | 45423 | 1329 | 26585 |
| 2L-5S | | MI | 10205 | 4000 | 16095 | 3217 | 18616 | 2592 | 19559 | 2124 | 19995 | 1384 | 24314 | 905 | 17869 |
| 10-#14 | 1.88 | MA | 15710 | 4000 | 23828 | 3283 | 28361 | 2652 | 30654 | 2184 | 33128 | 1455 | 40590 | 1197 | 26459 |
| 3L-4S | | MI | 10839 | 4000 | 17044 | 3205 | 19754 | 2598 | 20929 | 2116 | 21857 | 1391 | 26590 | 966 | 18933 |
| 10-#14 | 1.88 | MA | 14742 | 4000 | 22523 | 3283 | 26596 | 2665 | 28515 | 2181 | 30252 | 1448 | 37411 | 1066 | 26097 |
| 4L-3S | | MI | 11536 | 4000 | 17979 | 3208 | 21016 | 2590 | 22439 | 2124 | 23771 | 1384 | 28730 | 1094 | 19148 |
| 10-#14 | 1.88 | MA | 13864 | 4000 | 21201 | 3298 | 25010 | 2664 | 26579 | 2192 | 27627 | 1455 | 34075 | 1001 | 24472 |
| 5L-2S | | MI | 12480 | 4000 | 19221 | 3212 | 22592 | 2596 | 24330 | 2116 | 26258 | 1376 | 31993 | 1226 | 19199 |
| 10-#18 | 3.33 | MA | 19882 | 4636 | 32308 | 3659 | 38957 | 2927 | 43423 | 2343 | 49970 | 1388 | 62826 | 1198 | 46049 |
| 2L-5S | | MI | 10595 | 4636 | 18501 | 3582 | 21490 | 2846 | 22878 | 2269 | 24334 | 1293 | 30251 | 460 | 27834 |
| 10-#18 | 3.33 | MA | 17664 | 4636 | 29242 | 3658 | 35069 | 2922 | 38712 | 2360 | 43690 | 1401 | 54492 | 964 | 45449 |
| 3L-4S | | MI | 11650 | 4636 | 20156 | 3564 | 23468 | 2859 | 25225 | 2256 | 27525 | 1306 | 34123 | 570 | 29937 |
| 10-#18 | 3.33 | MA | 16055 | 4636 | 26952 | 3656 | 31974 | 2943 | 34962 | 2350 | 38707 | 1388 | 49023 | 731 | 41915 |
| 4L-3S | | MI | 12808 | 4636 | 21787 | 3573 | 25658 | 2846 | 27814 | 2269 | 30804 | 1293 | 37775 | 792 | 32487 |
| 10-#18 | 3.33 | MA | 14596 | 4636 | 24632 | 3682 | 29190 | 2938 | 31565 | 2367 | 34159 | 1401 | 43243 | 619 | 38915 |
| 5L-2S | | MI | 14375 | 4636 | 23944 | 3581 | 28385 | 2859 | 31052 | 2256 | 35064 | 1280 | 43326 | 1026 | 32856 |
| 12-#11 | 1.56 | MA | 16411 | 3863 | 24086 | 3207 | 28767 | 2600 | 31181 | 2141 | 33904 | 1463 | 41720 | 1361 | 22348 |
| 2L-6S | | MI | 10018 | 3863 | 15381 | 3143 | 17752 | 2551 | 18572 | 2092 | 18745 | 1412 | 22551 | 974 | 15291 |
| 12-#11 | 1.56 | MA | 15466 | 3863 | 22860 | 3208 | 27212 | 2599 | 29297 | 2149 | 31363 | 1468 | 38319 | 1270 | 22297 |
| 3L-5S | | MI | 10449 | 3863 | 15972 | 3145 | 18539 | 2544 | 19525 | 2097 | 19967 | 1407 | 24164 | 1050 | 15738 |
| 12-#11 | 1.56 | MA | 14782 | 3863 | 21948 | 3208 | 25980 | 2609 | 27804 | 2147 | 29348 | 1463 | 36078 | 1179 | 22158 |
| 4E | | MI | 10898 | 3863 | 16636 | 3136 | 19335 | 2547 | 20493 | 2092 | 21239 | 1402 | 25776 | 1093 | 16136 |
| 12-#11 | 1.56 | MA | 14162 | 3863 | 21026 | 3219 | 24874 | 2608 | 26453 | 2155 | 27509 | 1469 | 33735 | 1133 | 21559 |
| 5L-3S | | MI | 11392 | 3863 | 17290 | 3138 | 20219 | 2541 | 21559 | 2097 | 22633 | 1407 | 27289 | 1183 | 16195 |
| 12-#11 | 1.56 | MA | 13567 | 3863 | 20207 | 3220 | 23781 | 2617 | 25124 | 2153 | 25740 | 1474 | 31360 | 1058 | 20810 |
| 6L-2S | | MI | 12061 | 3863 | 18162 | 3140 | 21324 | 2544 | 22894 | 2092 | 24389 | 1402 | 29601 | 1274 | 16206 |
| 12-#14 | 2.25 | MA | 17844 | 4164 | 27335 | 3385 | 32808 | 2729 | 36042 | 2221 | 40378 | 1440 | 50256 | 1307 | 31763 |
| 2L-6S | | MI | 10184 | 4164 | 16493 | 3316 | 19066 | 2676 | 20099 | 2162 | 20750 | 1377 | 25452 | 780 | 20467 |
| 12-#14 | 2.25 | MA | 16529 | 4164 | 25582 | 3385 | 30585 | 2727 | 33348 | 2232 | 36753 | 1447 | 45423 | 1175 | 31598 |
| 3L-5S | | MI | 10784 | 4164 | 17338 | 3319 | 20191 | 2667 | 21449 | 2170 | 22482 | 1369 | 27577 | 869 | 21369 |
| 12-#14 | 2.25 | MA | 15577 | 4164 | 24276 | 3385 | 28820 | 2740 | 31209 | 2228 | 33877 | 1440 | 42244 | 1044 | 31118 |
| 4E | | MI | 11410 | 4164 | 18286 | 3307 | 21330 | 2673 | 22819 | 2162 | 24344 | 1377 | 29853 | 931 | 22366 |

## RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis



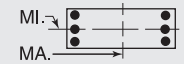

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 2.25 | MA | 14714 | 4164 | 22954 | 3401 | 27234 | 2738 | 29273 | 2239 | 31252 | 1447 | 38907 | 979 | 29463 |
| 5L-3S | | MI | 12096 | 4164 | 19221 | 3311 | 22592 | 2664 | 24330 | 2170 | 26258 | 1369 | 31993 | 1059 | 22792 |
| 12-#14 | 2.25 | MA | 13886 | 4164 | 21780 | 3401 | 25668 | 2751 | 27367 | 2235 | 28727 | 1455 | 35534 | 870 | 28149 |
| 6L-2S | | MI | 13028 | 4164 | 20464 | 3314 | 24168 | 2670 | 26220 | 2162 | 28745 | 1362 | 35255 | 1190 | 22876 |
| 12-#18 | 4.00 | MA | 19008 | 4927 | 32308 | 3839 | 38957 | 3055 | 43423 | 2444 | 49970 | 1383 | 62826 | 918 | 54363 |
| 3L-5S | | MI | 11554 | 4927 | 20658 | 3764 | 24216 | 2978 | 26116 | 2347 | 28595 | 1262 | 35803 | 387 | 33686 |
| 12-#18 | 4.00 | MA | 17436 | 4927 | 30018 | 3838 | 35863 | 3076 | 39674 | 2435 | 44986 | 1370 | 57357 | 685 | 50564 |
| 4E | | MI | 12588 | 4927 | 22314 | 3746 | 26194 | 2992 | 28463 | 2334 | 31786 | 1275 | 39674 | 498 | 35942 |
| 12-#18 | 4.00 | MA | 16011 | 4927 | 27698 | 3863 | 33079 | 3071 | 36276 | 2452 | 40438 | 1383 | 51577 | 573 | 47433 |
| 5L-3S | | MI | 13723 | 4927 | 23944 | 3754 | 28385 | 2978 | 31052 | 2347 | 35064 | 1262 | 43326 | 720 | 38733 |
| 12-#18 | 4.00 | MA | 14643 | 4927 | 25635 | 3862 | 30329 | 3092 | 32930 | 2442 | 36065 | 1397 | 45761 | 379 | 43854 |
| 6L-2S | | MI | 15262 | 4927 | 26102 | 3763 | 31112 | 2992 | 34290 | 2334 | 39325 | 1249 | 48877 | 953 | 39187 |
| 14-#11 | 1.82 | MA | 16985 | 3976 | 25311 | 3278 | 30322 | 2652 | 33064 | 2174 | 36446 | 1458 | 45121 | 1347 | 25975 |
| 2L-7S | | MI | 10016 | 3976 | 15677 | 3212 | 18096 | 2599 | 18982 | 2130 | 19260 | 1398 | 23433 | 881 | 17194 |
| 14-#11 | 1.82 | MA | 16050 | 3976 | 24086 | 3278 | 28767 | 2651 | 31181 | 2182 | 33904 | 1463 | 41720 | 1256 | 25904 |
| 3L-6S | | MI | 10434 | 3976 | 16253 | 3214 | 18857 | 2602 | 19907 | 2124 | 20501 | 1403 | 24863 | 952 | 17772 |
| 14-#11 | 1.82 | MA | 15374 | 3976 | 23174 | 3279 | 27535 | 2660 | 29688 | 2180 | 31889 | 1458 | 39480 | 1165 | 25741 |
| 4L-5S | | MI | 10860 | 3976 | 16844 | 3216 | 19644 | 2596 | 20860 | 2130 | 21723 | 1398 | 26476 | 1028 | 18197 |
| 14-#11 | 1.82 | MA | 14762 | 3976 | 22252 | 3290 | 26428 | 2660 | 28337 | 2188 | 30050 | 1464 | 37136 | 1119 | 25046 |
| 5L-4S | | MI | 11305 | 3976 | 17507 | 3207 | 20440 | 2599 | 21828 | 2124 | 22995 | 1393 | 28087 | 1070 | 18686 |
| 14-#11 | 1.82 | MA | 14175 | 3976 | 21433 | 3291 | 25336 | 2669 | 27007 | 2186 | 28282 | 1469 | 34762 | 1044 | 24326 |
| 6L-3S | | MI | 11793 | 3976 | 18162 | 3209 | 21324 | 2593 | 22894 | 2130 | 24389 | 1398 | 29601 | 1160 | 18765 |
| 14-#11 | 1.82 | MA | 13600 | 3976 | 20635 | 3291 | 24281 | 2668 | 25718 | 2194 | 26489 | 1464 | 32650 | 973 | 23463 |
| 7L-2S | | MI | 12456 | 3976 | 19033 | 3211 | 22429 | 2596 | 24229 | 2124 | 26145 | 1393 | 31913 | 1251 | 18794 |
| 14-#14 | 2.63 | MA | 17333 | 4327 | 27335 | 3487 | 32808 | 2802 | 36042 | 2279 | 40378 | 1439 | 50256 | 1153 | 36733 |
| 3L-6S | | MI | 10761 | 4327 | 17735 | 3418 | 20642 | 2751 | 21989 | 2208 | 23237 | 1362 | 28715 | 745 | 23898 |
| 14-#14 | 2.63 | MA | 16395 | 4327 | 26030 | 3487 | 31044 | 2815 | 33903 | 2275 | 37502 | 1432 | 47077 | 1022 | 36049 |
| 4L-5S | | MI | 11353 | 4327 | 18580 | 3421 | 21767 | 2742 | 23339 | 2215 | 24969 | 1354 | 30840 | 834 | 24883 |
| 14-#14 | 2.63 | MA | 15546 | 4327 | 24708 | 3503 | 29457 | 2813 | 31968 | 2286 | 34877 | 1439 | 43740 | 957 | 34467 |
| 5L-4S | | MI | 11969 | 4327 | 19529 | 3410 | 22905 | 2748 | 24710 | 2208 | 26831 | 1362 | 33116 | 895 | 25821 |
| 14-#14 | 2.63 | MA | 14731 | 4327 | 23533 | 3503 | 27892 | 2826 | 30062 | 2283 | 32352 | 1447 | 40366 | 848 | 33078 |
| 6L-3S | | MI | 12647 | 4327 | 20464 | 3413 | 24168 | 2739 | 26220 | 2215 | 28745 | 1354 | 35255 | 1024 | 26428 |
| 14-#14 | 2.63 | MA | 13933 | 4327 | 22390 | 3503 | 26379 | 2825 | 28213 | 2294 | 29793 | 1439 | 37369 | 746 | 31440 |
| 7L-2S | | MI | 13567 | 4327 | 21706 | 3416 | 25743 | 2745 | 28110 | 2208 | 31232 | 1347 | 38518 | 1155 | 26542 |
| 14-#18 | 4.67 | MA | 18784 | 5218 | 33084 | 4020 | 39752 | 3209 | 44385 | 2519 | 51266 | 1352 | 65691 | 639 | 59244 |
| 4L-5S | | MI | 12552 | 5218 | 22816 | 3946 | 26943 | 3111 | 29354 | 2425 | 32855 | 1231 | 41354 | 315 | 39574 |
| 14-#18 | 4.67 | MA | 17390 | 5218 | 30765 | 4045 | 36968 | 3204 | 40987 | 2536 | 46718 | 1366 | 59912 | 527 | 55982 |
| 5L-4S | | MI | 13556 | 5218 | 24471 | 3928 | 28921 | 3124 | 31701 | 2412 | 36046 | 1244 | 45225 | 426 | 41978 |
| 14-#18 | 4.67 | MA | 16052 | 5218 | 28701 | 4044 | 34218 | 3225 | 37641 | 2526 | 42345 | 1379 | 54095 | 333 | 52487 |
| 6L-3S | | MI | 14649 | 5218 | 26102 | 3936 | 31112 | 3111 | 34290 | 2425 | 39325 | 1231 | 48877 | 647 | 44928 |
| 16-#11 | 2.08 | MA | 16626 | 4090 | 25311 | 3349 | 30322 | 2703 | 33064 | 2215 | 36446 | 1458 | 45121 | 1242 | 29507 |
| 3L-7S | | MI | 10430 | 4090 | 16548 | 3283 | 19201 | 2651 | 20316 | 2162 | 21016 | 1389 | 25745 | 858 | 19630 |
| 16-#11 | 2.08 | MA | 15957 | 4090 | 24400 | 3350 | 29090 | 2712 | 31571 | 2213 | 34430 | 1453 | 42881 | 1151 | 29323 |
| 4L-6S | | MI | 10843 | 4090 | 17124 | 3285 | 19962 | 2654 | 21241 | 2157 | 22256 | 1394 | 27175 | 929 | 20259 |
| 16-#11 | 2.08 | MA | 15352 | 4090 | 23478 | 3361 | 27983 | 2711 | 30220 | 2221 | 32591 | 1458 | 40537 | 1105 | 28541 |
| 5E | | MI | 11266 | 4090 | 17715 | 3287 | 20749 | 2648 | 22195 | 2162 | 23479 | 1389 | 28787 | 1005 | 20664 |
| 16-#11 | 2.08 | MA | 14772 | 4090 | 22659 | 3362 | 26891 | 2721 | 28891 | 2219 | 30823 | 1464 | 38163 | 1030 | 27848 |
| 6L-4S | | MI | 11705 | 4090 | 18379 | 3278 | 21545 | 2651 | 23162 | 2157 | 24751 | 1384 | 30399 | 1047 | 21232 |
| 16-#11 | 2.08 | MA | 14204 | 4090 | 21861 | 3362 | 25835 | 2720 | 27601 | 2227 | 29030 | 1459 | 36051 | 959 | 26937 |
| 7L-3S | | MI | 12188 | 4090 | 19033 | 3280 | 22429 | 2644 | 24229 | 2162 | 26145 | 1389 | 31913 | 1138 | 21330 |
| 16-#11 | 2.08 | MA | 13643 | 4090 | 21076 | 3363 | 24801 | 2719 | 26310 | 2225 | 27300 | 1464 | 33863 | 906 | 26029 |
| 8L-2S | | MI | 12845 | 4090 | 19904 | 3282 | 23534 | 2648 | 25564 | 2157 | 27901 | 1384 | 34224 | 1229 | 21373 |
| 16-#14 | 3.00 | MA | 17199 | 4491 | 27783 | 3590 | 33268 | 2890 | 36598 | 2323 | 41127 | 1424 | 51909 | 1000 | 40997 |
| 4L-6S | | MI | 11327 | 4491 | 18977 | 3520 | 22217 | 2825 | 23879 | 2254 | 25724 | 1347 | 31978 | 710 | 27343 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis

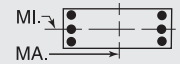


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.00 | MA | 16362 | 4491 | 26462 | 3605 | 31681 | 2888 | 34662 | 2334 | 38502 | 1431 | 48573 | 935 | 39483 |
| 5E | | MI | 11912 | 4491 | 19823 | 3523 | 23343 | 2817 | 25230 | 2261 | 27456 | 1340 | 34103 | 799 | 28407 |
| 16-#14 | 3.00 | MA | 15560 | 4491 | 25287 | 3605 | 30116 | 2901 | 32756 | 2330 | 35977 | 1439 | 45199 | 826 | 38019 |
| 6L-4S | | MI | 12520 | 4491 | 20771 | 3512 | 24481 | 2823 | 26600 | 2254 | 29318 | 1347 | 36379 | 860 | 29294 |
| 16-#14 | 3.00 | MA | 14775 | 4491 | 24143 | 3606 | 28603 | 2899 | 30908 | 2341 | 33417 | 1431 | 42201 | 724 | 36431 |
| 7L-3S | | MI | 13189 | 4491 | 21706 | 3515 | 25743 | 2814 | 28110 | 2261 | 31232 | 1340 | 38518 | 989 | 30058 |
| 16-#14 | 3.00 | MA | 13998 | 4491 | 23017 | 3606 | 27120 | 2898 | 29056 | 2337 | 30947 | 1439 | 39086 | 649 | 34351 |
| 8L-2S | | MI | 14099 | 4491 | 22949 | 3518 | 27319 | 2820 | 30001 | 2254 | 33719 | 1332 | 41781 | 1120 | 30201 |
| 16-#18 | 5.33 | MA | 18740 | 5509 | 33831 | 4227 | 40856 | 3337 | 45699 | 2620 | 52998 | 1348 | 68246 | 481 | 64558 |
| 5E | | MI | 13469 | 5509 | 24973 | 4128 | 29670 | 3243 | 32592 | 2503 | 37116 | 1200 | 46905 | 242 | 45493 |
| 16-#18 | 5.33 | MA | 17430 | 5509 | 31768 | 4226 | 38107 | 3358 | 42352 | 2611 | 48624 | 1361 | 62429 | 287 | 61000 |
| 6L-4S | | MI | 14448 | 5509 | 26629 | 4110 | 31648 | 3256 | 34939 | 2489 | 40307 | 1213 | 50776 | 353 | 48040 |
| 18-#11 | 2.34 | MA | 16532 | 4203 | 25626 | 3421 | 30644 | 2764 | 33455 | 2246 | 36971 | 1448 | 46282 | 1137 | 32904 |
| 4L-7S | | MI | 10838 | 4203 | 17420 | 3354 | 20306 | 2703 | 21651 | 2195 | 22772 | 1379 | 28056 | 836 | 22073 |
| 18-#11 | 2.34 | MA | 15934 | 4203 | 24704 | 3432 | 29538 | 2763 | 32104 | 2254 | 35132 | 1453 | 43939 | 1091 | 32045 |
| 5L-6S | | MI | 11248 | 4203 | 17996 | 3356 | 21067 | 2706 | 22576 | 2189 | 24012 | 1385 | 29486 | 906 | 22751 |
| 18-#11 | 2.34 | MA | 15361 | 4203 | 23884 | 3432 | 28445 | 2773 | 30774 | 2252 | 33364 | 1459 | 41564 | 1016 | 31376 |
| 6L-5S | | MI | 11665 | 4203 | 18587 | 3357 | 21854 | 2699 | 23530 | 2195 | 25235 | 1379 | 31099 | 983 | 23139 |
| 18-#11 | 2.34 | MA | 14800 | 4203 | 23087 | 3433 | 27390 | 2772 | 29485 | 2260 | 31571 | 1454 | 39452 | 945 | 30418 |
| 7L-4S | | MI | 12100 | 4203 | 19250 | 3349 | 22651 | 2703 | 24497 | 2189 | 26507 | 1374 | 32711 | 1025 | 23775 |
| 18-#11 | 2.34 | MA | 14245 | 4203 | 22302 | 3434 | 26356 | 2771 | 28193 | 2258 | 29841 | 1459 | 37264 | 892 | 29534 |
| 8L-3S | | MI | 12578 | 4203 | 19904 | 3351 | 23534 | 2696 | 25564 | 2195 | 27901 | 1379 | 34224 | 1115 | 23890 |
| 18-#11 | 2.34 | MA | 13694 | 4203 | 21435 | 3445 | 25290 | 2781 | 26922 | 2266 | 28127 | 1465 | 35109 | 833 | 28275 |
| 9L-2S | | MI | 13230 | 4203 | 20776 | 3352 | 24640 | 2700 | 26898 | 2189 | 29657 | 1374 | 36536 | 1206 | 23948 |
| 18-#14 | 3.38 | MA | 17165 | 4654 | 28215 | 3707 | 33905 | 2963 | 37356 | 2381 | 42126 | 1423 | 53405 | 913 | 44508 |
| 5L-6S | | MI | 11885 | 4654 | 20220 | 3622 | 23793 | 2900 | 25769 | 2300 | 28211 | 1332 | 35241 | 674 | 30801 |
| 18-#14 | 3.38 | MA | 16375 | 4654 | 27041 | 3708 | 32340 | 2976 | 35450 | 2377 | 39602 | 1431 | 50032 | 804 | 42973 |
| 6L-5S | | MI | 12462 | 4654 | 21065 | 3626 | 24918 | 2891 | 27120 | 2307 | 29943 | 1325 | 37366 | 764 | 31939 |
| 18-#14 | 3.38 | MA | 15601 | 4654 | 25897 | 3708 | 30827 | 2974 | 33602 | 2388 | 37042 | 1423 | 47034 | 702 | 41432 |
| 7L-4S | | MI | 13063 | 4654 | 22014 | 3614 | 26057 | 2898 | 28490 | 2300 | 31804 | 1332 | 39641 | 825 | 32780 |
| 18-#14 | 3.38 | MA | 14836 | 4654 | 24771 | 3708 | 29344 | 2972 | 31750 | 2385 | 34572 | 1431 | 43918 | 627 | 39314 |
| 8L-3S | | MI | 13723 | 4654 | 22949 | 3617 | 27319 | 2889 | 30001 | 2307 | 33719 | 1325 | 41781 | 953 | 33685 |
| 18-#14 | 3.38 | MA | 14075 | 4654 | 23528 | 3723 | 27816 | 2986 | 29928 | 2396 | 32126 | 1438 | 40859 | 542 | 37216 |
| 9L-2S | | MI | 14623 | 4654 | 24191 | 3620 | 28895 | 2895 | 31891 | 2300 | 36206 | 1318 | 45044 | 1085 | 33854 |
| 18-#18 | 6.00 | MA | 18909 | 5799 | 34834 | 4407 | 41996 | 3491 | 47064 | 2695 | 54904 | 1343 | 70763 | 241 | 69534 |
| 6L-5S | | MI | 14366 | 5799 | 27131 | 4309 | 32396 | 3375 | 35830 | 2580 | 41377 | 1169 | 52456 | 170 | 51439 |
| 20-#11 | 2.60 | MA | 16508 | 4316 | 25929 | 3503 | 31092 | 2815 | 33987 | 2287 | 37674 | 1448 | 47340 | 1077 | 35556 |
| 5L-7S | | MI | 11241 | 4316 | 18291 | 3425 | 21411 | 2754 | 22986 | 2227 | 24528 | 1370 | 30368 | 813 | 24524 |
| 20-#11 | 2.60 | MA | 15941 | 4316 | 25110 | 3503 | 30000 | 2825 | 32658 | 2284 | 35905 | 1454 | 44965 | 1002 | 34907 |
| 6E | | MI | 11646 | 4316 | 18867 | 3427 | 22172 | 2758 | 23911 | 2222 | 25768 | 1375 | 31798 | 884 | 25246 |
| 20-#11 | 2.60 | MA | 15387 | 4316 | 24313 | 3504 | 28945 | 2824 | 31368 | 2293 | 34112 | 1449 | 42854 | 931 | 33905 |
| 7L-5S | | MI | 12060 | 4316 | 19458 | 3428 | 22959 | 2751 | 24864 | 2227 | 26991 | 1370 | 33410 | 960 | 25620 |
| 20-#11 | 2.60 | MA | 14838 | 4316 | 23528 | 3504 | 27910 | 2823 | 30077 | 2290 | 32382 | 1454 | 40665 | 878 | 33026 |
| 8L-4S | | MI | 12491 | 4316 | 20122 | 3420 | 23756 | 2755 | 25832 | 2222 | 28263 | 1365 | 35022 | 1002 | 26316 |
| 20-#11 | 2.60 | MA | 14294 | 4316 | 22661 | 3515 | 26845 | 2833 | 28806 | 2299 | 30669 | 1459 | 38510 | 819 | 31759 |
| 9L-3S | | MI | 12964 | 4316 | 20776 | 3422 | 24640 | 2748 | 26898 | 2227 | 29657 | 1370 | 36536 | 1092 | 26447 |
| 20-#11 | 2.60 | MA | 13751 | 4316 | 21879 | 3516 | 25818 | 2832 | 27529 | 2296 | 28907 | 1455 | 36282 | 739 | 30510 |
| 10L-2S | | MI | 13610 | 4316 | 21647 | 3423 | 25745 | 2752 | 28233 | 2222 | 31413 | 1365 | 38847 | 1184 | 26518 |
| 20-#14 | 3.75 | MA | 17176 | 4818 | 28794 | 3810 | 34564 | 3051 | 38145 | 2425 | 43227 | 1423 | 54864 | 782 | 47937 |
| 6E | | MI | 12435 | 4818 | 21462 | 3725 | 25369 | 2975 | 27660 | 2346 | 30698 | 1318 | 38504 | 639 | 34271 |
| 20-#14 | 3.75 | MA | 16413 | 4818 | 27651 | 3810 | 33051 | 3049 | 36296 | 2436 | 40667 | 1415 | 51867 | 680 | 46413 |
| 7L-5S | | MI | 13005 | 4818 | 22308 | 3728 | 26494 | 2966 | 29010 | 2353 | 32430 | 1310 | 40629 | 728 | 35478 |
| 20-#14 | 3.75 | MA | 15659 | 4818 | 26525 | 3810 | 31568 | 3047 | 34445 | 2432 | 38197 | 1423 | 48751 | 605 | 44285 |
| 8L-4S | | MI | 13598 | 4818 | 23256 | 3716 | 27633 | 2972 | 30380 | 2346 | 34291 | 1318 | 42904 | 790 | 36279 |
| 20-#14 | 3.75 | MA | 14910 | 4818 | 25282 | 3826 | 30040 | 3060 | 32622 | 2443 | 35751 | 1430 | 45691 | 520 | 42160 |
| 9L-3S | | MI | 14251 | 4818 | 24191 | 3719 | 28895 | 2964 | 31891 | 2353 | 36206 | 1310 | 45044 | 918 | 37308 |
| 22-#11 | 2.86 | MA | 16514 | 4430 | 26336 | 3574 | 31555 | 2877 | 34541 | 2317 | 38446 | 1448 | 48367 | 988 | 38442 |
| 6L-7S | | MI | 11639 | 4430 | 19162 | 3496 | 22516 | 2806 | 24321 | 2260 | 26284 | 1361 | 32679 | 791 | 26980 |

## RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

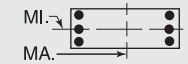
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.86 | MA | 15966 | 4430 | 25539 | 3575 | 30499 | 2876 | 33252 | 2325 | 36653 | 1443 | 46255 | 917 | 37398 |
| 7L-6S | | MI | 12040 | 4430 | 19738 | 3498 | 23278 | 2810 | 25246 | 2254 | 27524 | 1366 | 34109 | 861 | 27723 |
| 22-#11 | 2.86 | MA | 15423 | 4430 | 24753 | 3575 | 29465 | 2875 | 31960 | 2323 | 34923 | 1449 | 44066 | 864 | 36488 |
| 8L-5S | | MI | 12450 | 4430 | 20329 | 3499 | 24065 | 2803 | 26199 | 2260 | 28747 | 1361 | 35722 | 937 | 28106 |
| 22-#11 | 2.86 | MA | 14885 | 4430 | 23887 | 3586 | 28399 | 2885 | 30689 | 2332 | 33210 | 1454 | 41912 | 805 | 35247 |
| 9L-4S | | MI | 12877 | 4430 | 20993 | 3491 | 24861 | 2807 | 27167 | 2254 | 30019 | 1356 | 37334 | 980 | 28790 |
| 22-#11 | 2.86 | MA | 14348 | 4430 | 23104 | 3587 | 27372 | 2884 | 29412 | 2329 | 31448 | 1449 | 39683 | 725 | 33979 |
| 10L-3S | | MI | 13346 | 4430 | 21647 | 3492 | 25745 | 2800 | 28233 | 2260 | 31413 | 1361 | 38847 | 1070 | 29001 |
| 22-#14 | 4.13 | MA | 17214 | 4982 | 29404 | 3912 | 35274 | 3124 | 38991 | 2483 | 44292 | 1407 | 56699 | 658 | 51344 |
| 7L-6S | | MI | 12978 | 4982 | 22705 | 3827 | 26944 | 3050 | 29550 | 2391 | 33185 | 1303 | 41767 | 604 | 37750 |
| 22-#14 | 4.13 | MA | 16470 | 4982 | 28278 | 3913 | 33792 | 3122 | 37139 | 2479 | 41822 | 1414 | 53584 | 583 | 49264 |
| 8L-5S | | MI | 13541 | 4982 | 23550 | 3830 | 28070 | 3041 | 30900 | 2399 | 34917 | 1295 | 43892 | 693 | 39024 |
| 22-#14 | 4.13 | MA | 15731 | 4982 | 27035 | 3928 | 32264 | 3135 | 35317 | 2490 | 39376 | 1422 | 50524 | 498 | 47111 |
| 9L-4S | | MI | 14128 | 4982 | 24499 | 3818 | 29208 | 3047 | 32271 | 2391 | 36778 | 1303 | 46167 | 754 | 39788 |
| 24-#11 | 3.12 | MA | 16537 | 4543 | 26764 | 3646 | 32054 | 2928 | 35135 | 2358 | 39194 | 1438 | 49656 | 903 | 40896 |
| 7E | | MI | 12033 | 4543 | 20034 | 3567 | 23622 | 2858 | 25655 | 2292 | 28040 | 1352 | 34991 | 768 | 29441 |
| 24-#11 | 3.12 | MA | 16001 | 4543 | 25979 | 3646 | 31020 | 2927 | 33844 | 2356 | 37464 | 1444 | 47468 | 850 | 39955 |
| 8L-6S | | MI | 12430 | 4543 | 20610 | 3568 | 24383 | 2862 | 26580 | 2287 | 29280 | 1357 | 36421 | 839 | 30159 |
| 24-#11 | 3.12 | MA | 15468 | 4543 | 25112 | 3657 | 29954 | 2936 | 32573 | 2364 | 35751 | 1449 | 45313 | 792 | 38740 |
| 9L-5S | | MI | 12836 | 4543 | 21201 | 3570 | 25170 | 2855 | 27534 | 2292 | 30503 | 1352 | 38033 | 915 | 30596 |
| 24-#11 | 3.12 | MA | 14938 | 4543 | 24330 | 3658 | 28927 | 2936 | 31296 | 2362 | 33989 | 1444 | 43084 | 711 | 37452 |
| 10L-4S | | MI | 13258 | 4543 | 21865 | 3562 | 25966 | 2859 | 28501 | 2287 | 31775 | 1346 | 39645 | 957 | 31251 |
| 24-#14 | 4.50 | MA | 17269 | 5145 | 30032 | 4015 | 36016 | 3197 | 39833 | 2527 | 45446 | 1406 | 58416 | 561 | 54250 |
| 8L-6S | | MI | 13515 | 5145 | 23947 | 3929 | 28520 | 3125 | 31440 | 2437 | 35672 | 1288 | 45030 | 568 | 41239 |
| 24-#14 | 4.50 | MA | 16540 | 5145 | 28789 | 4030 | 34488 | 3210 | 38011 | 2538 | 43001 | 1414 | 55356 | 476 | 52069 |
| 9L-5S | | MI | 14071 | 5145 | 24793 | 3932 | 29645 | 3116 | 32791 | 2445 | 37404 | 1281 | 47155 | 658 | 42574 |

## RECTANGULAR TIED COLUMNS 30" x 42"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.27 | MA | 17281 | 3923 | 25119 | 3263 | 29724 | 2651 | 31890 | 2195 | 33878 | 1525 | 41171 | 1421 | 19973 |
| 2E | | MI | 12066 | 3923 | 18129 | 3169 | 20943 | 2573 | 22081 | 2116 | 22970 | 1445 | 27451 | 1312 | 13732 |
| 6-#14 | 1.07 | MA | 16873 | 3832 | 24017 | 3227 | 28493 | 2627 | 30472 | 2183 | 32110 | 1546 | 38937 | 1456 | 17096 |
| 2L-3S | | MI | 10859 | 3832 | 16144 | 3139 | 18601 | 2551 | 19403 | 2126 | 19488 | 1486 | 22988 | 1235 | 11855 |
| 6-#14 | 1.07 | MA | 15411 | 3832 | 22161 | 3228 | 26140 | 2626 | 27620 | 2195 | 28263 | 1554 | 33790 | 1324 | 17067 |
| 3L-2S | | MI | 11832 | 3832 | 17387 | 3142 | 20176 | 2557 | 21293 | 2119 | 21975 | 1478 | 26251 | 1366 | 11820 |
| 6-#18 | 1.90 | MA | 18797 | 4214 | 28367 | 3445 | 33843 | 2784 | 36880 | 2279 | 40563 | 1509 | 50064 | 1378 | 29600 |
| 2L-3S | | MI | 11390 | 4214 | 18129 | 3343 | 20943 | 2692 | 22081 | 2207 | 22970 | 1427 | 27451 | 1006 | 20040 |
| 6-#18 | 1.90 | MA | 16328 | 4214 | 25119 | 3444 | 29724 | 2780 | 31890 | 2297 | 33878 | 1522 | 41171 | 1145 | 29238 |
| 3L-2S | | MI | 13027 | 4214 | 20287 | 3351 | 23669 | 2705 | 25319 | 2194 | 27231 | 1414 | 33002 | 1240 | 20175 |
| 8-#14 | 1.43 | MA | 17767 | 3996 | 25872 | 3329 | 30847 | 2702 | 33323 | 2230 | 35957 | 1539 | 44085 | 1436 | 22610 |
| 2L-4S | | MI | 10736 | 3996 | 16452 | 3238 | 18914 | 2635 | 19783 | 2165 | 20061 | 1479 | 24111 | 1071 | 15422 |
| 8-#14 | 1.43 | MA | 16328 | 3996 | 24017 | 3330 | 28493 | 2701 | 30472 | 2242 | 32110 | 1546 | 38937 | 1304 | 22528 |
| 3E | | MI | 11445 | 3996 | 17387 | 3241 | 20176 | 2626 | 21293 | 2172 | 21975 | 1471 | 26251 | 1200 | 15536 |
| 8-#14 | 1.43 | MA | 15285 | 3996 | 22637 | 3331 | 26628 | 2714 | 28211 | 2239 | 29059 | 1539 | 35547 | 1173 | 22217 |
| 4L-2S | | MI | 12404 | 3996 | 18629 | 3244 | 21752 | 2632 | 23183 | 2165 | 24462 | 1464 | 29514 | 1331 | 15539 |
| 8-#18 | 2.54 | MA | 20261 | 4505 | 31615 | 3626 | 37963 | 2917 | 41871 | 2363 | 47248 | 1493 | 58958 | 1336 | 39186 |
| 2L-4S | | MI | 11167 | 4505 | 18657 | 3516 | 21479 | 2837 | 22730 | 2272 | 23952 | 1409 | 29350 | 712 | 24216 |
| 8-#18 | 2.54 | MA | 17850 | 4505 | 28367 | 3626 | 33843 | 2913 | 36880 | 2381 | 40563 | 1506 | 50064 | 1102 | 38695 |
| 3E | | MI | 12355 | 4505 | 20287 | 3525 | 23669 | 2824 | 25319 | 2285 | 27231 | 1396 | 33002 | 934 | 26317 |
| 8-#18 | 2.54 | MA | 16100 | 4505 | 25945 | 3626 | 30570 | 2935 | 32914 | 2373 | 35258 | 1493 | 44221 | 869 | 35512 |
| 4L-2S | | MI | 13959 | 4505 | 22445 | 3533 | 26396 | 2837 | 28557 | 2272 | 31492 | 1383 | 38553 | 1167 | 26559 |
| 10-#11 | 1.24 | MA | 17338 | 3909 | 24844 | 3285 | 29628 | 2671 | 31882 | 2212 | 34038 | 1548 | 41649 | 1458 | 19767 |
| 2L-5S | | MI | 10509 | 3909 | 15747 | 3210 | 18168 | 2604 | 18935 | 2159 | 18904 | 1489 | 22639 | 1143 | 13411 |
| 10-#11 | 1.24 | MA | 16324 | 3909 | 23547 | 3286 | 27983 | 2670 | 29890 | 2221 | 31350 | 1554 | 38029 | 1367 | 19737 |
| 3L-4S | | MI | 10965 | 3909 | 16411 | 3201 | 18964 | 2607 | 19902 | 2154 | 20176 | 1484 | 24251 | 1186 | 13625 |
| 10-#11 | 1.24 | MA | 15590 | 3909 | 22584 | 3287 | 26681 | 2680 | 28313 | 2219 | 29221 | 1550 | 35642 | 1276 | 19625 |
| 4L-3S | | MI | 11465 | 3909 | 17065 | 3203 | 19848 | 2601 | 20969 | 2159 | 21570 | 1489 | 25765 | 1276 | 13652 |

## RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

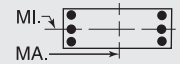
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.24 | MA | 14925 | 3909 | 21611 | 3298 | 25513 | 2680 | 26886 | 2228 | 27279 | 1556 | 33152 | 1230 | 19206 |
| 5L-2S | | MI | 12143 | 3909 | 17937 | 3205 | 20953 | 2604 | 22304 | 2154 | 23326 | 1484 | 28076 | 1367 | 13638 |
| 10-#14 | 1.79 | MA | 18640 | 4159 | 27728 | 3432 | 33201 | 2777 | 36174 | 2278 | 39804 | 1531 | 49233 | 1415 | 28103 |
| 2L-5S | | MI | 10682 | 4159 | 16746 | 3352 | 19351 | 2703 | 20303 | 2218 | 20686 | 1456 | 25098 | 975 | 18021 |
| 10-#14 | 1.79 | MA | 17223 | 4159 | 25872 | 3432 | 30847 | 2775 | 33323 | 2289 | 35957 | 1539 | 44085 | 1284 | 27978 |
| 3L-4S | | MI | 11319 | 4159 | 17694 | 3340 | 20490 | 2709 | 21673 | 2211 | 22548 | 1464 | 27374 | 1036 | 19037 |
| 10-#14 | 1.79 | MA | 16197 | 4159 | 24493 | 3433 | 28982 | 2789 | 31062 | 2286 | 32906 | 1532 | 40695 | 1153 | 27615 |
| 4L-3S | | MI | 12018 | 4159 | 18629 | 3343 | 21752 | 2701 | 23183 | 2218 | 24462 | 1456 | 29514 | 1164 | 19197 |
| 10-#14 | 1.79 | MA | 15267 | 4159 | 23096 | 3449 | 27306 | 2788 | 29017 | 2298 | 30121 | 1539 | 37148 | 1087 | 25997 |
| 5L-2S | | MI | 12965 | 4159 | 19872 | 3347 | 23328 | 2707 | 25074 | 2211 | 26949 | 1449 | 32776 | 1296 | 19238 |
| 10-#18 | 3.17 | MA | 21685 | 4795 | 34863 | 3808 | 42082 | 3050 | 46861 | 2447 | 53932 | 1477 | 67851 | 1294 | 48749 |
| 2L-5S | | MI | 11070 | 4795 | 19158 | 3716 | 22227 | 2956 | 23621 | 2363 | 25022 | 1365 | 31030 | 529 | 28217 |
| 10-#18 | 3.17 | MA | 19325 | 4795 | 31615 | 3808 | 37963 | 3046 | 41871 | 2466 | 47248 | 1491 | 58958 | 1060 | 48149 |
| 3L-4S | | MI | 12131 | 4795 | 20814 | 3698 | 24205 | 2969 | 25968 | 2350 | 28213 | 1378 | 34901 | 640 | 30175 |
| 10-#18 | 3.17 | MA | 17617 | 4795 | 29193 | 3807 | 34689 | 3068 | 37905 | 2458 | 41943 | 1477 | 53114 | 826 | 44645 |
| 4L-3S | | MI | 13295 | 4795 | 22445 | 3706 | 26396 | 2956 | 28557 | 2363 | 31492 | 1365 | 38553 | 861 | 32578 |
| 10-#18 | 3.17 | MA | 16068 | 4795 | 26740 | 3834 | 31746 | 3064 | 34313 | 2476 | 37102 | 1491 | 46961 | 713 | 41672 |
| 5L-2S | | MI | 14869 | 4795 | 24602 | 3715 | 29123 | 2969 | 31795 | 2350 | 35752 | 1351 | 44104 | 1095 | 32914 |
| 12-#11 | 1.49 | MA | 17961 | 4022 | 26141 | 3356 | 31272 | 2722 | 33875 | 2245 | 36727 | 1543 | 45269 | 1445 | 23612 |
| 2L-6S | | MI | 10495 | 4022 | 16028 | 3279 | 18486 | 2662 | 19316 | 2187 | 19437 | 1485 | 23338 | 1045 | 15404 |
| 12-#11 | 1.49 | MA | 16958 | 4022 | 24844 | 3357 | 29628 | 2722 | 31882 | 2254 | 34038 | 1549 | 41649 | 1354 | 23560 |
| 3L-5S | | MI | 10928 | 4022 | 16619 | 3281 | 19273 | 2656 | 20270 | 2192 | 20660 | 1480 | 24951 | 1121 | 15857 |
| 12-#11 | 1.49 | MA | 16233 | 4022 | 23881 | 3358 | 28326 | 2732 | 30305 | 2252 | 31909 | 1545 | 39262 | 1263 | 23421 |
| 4E | | MI | 11379 | 4022 | 17282 | 3272 | 20070 | 2659 | 21237 | 2187 | 21932 | 1475 | 26562 | 1163 | 16185 |
| 12-#11 | 1.49 | MA | 15576 | 4022 | 22907 | 3369 | 27157 | 2732 | 28878 | 2261 | 29967 | 1551 | 36772 | 1217 | 22885 |
| 5L-3S | | MI | 11873 | 4022 | 17937 | 3274 | 20953 | 2652 | 22304 | 2192 | 23326 | 1480 | 28076 | 1253 | 16233 |
| 12-#11 | 1.49 | MA | 14947 | 4022 | 22043 | 3370 | 26004 | 2742 | 27474 | 2259 | 28099 | 1557 | 34245 | 1142 | 22063 |
| 6L-2S | | MI | 12545 | 4022 | 18808 | 3275 | 22059 | 2656 | 23638 | 2187 | 25082 | 1475 | 30388 | 1344 | 16238 |
| 12-#14 | 2.14 | MA | 19496 | 4323 | 29584 | 3534 | 35554 | 2851 | 39026 | 2325 | 43651 | 1524 | 54381 | 1395 | 33586 |
| 2L-6S | | MI | 10660 | 4323 | 17143 | 3451 | 19802 | 2787 | 20843 | 2256 | 21441 | 1449 | 26236 | 850 | 20714 |
| 12-#14 | 2.14 | MA | 18099 | 4323 | 27728 | 3535 | 33201 | 2850 | 36174 | 2337 | 39804 | 1531 | 49233 | 1264 | 33421 |
| 3L-5S | | MI | 11263 | 4323 | 17988 | 3454 | 20927 | 2778 | 22193 | 2264 | 23173 | 1442 | 28361 | 940 | 21520 |
| 12-#14 | 2.14 | MA | 17089 | 4323 | 26348 | 3535 | 31335 | 2864 | 33914 | 2334 | 36753 | 1524 | 45843 | 1132 | 33014 |
| 4E | | MI | 11891 | 4323 | 18937 | 3442 | 22065 | 2784 | 23563 | 2256 | 25035 | 1449 | 30637 | 1001 | 22542 |
| 12-#14 | 2.14 | MA | 16174 | 4323 | 24952 | 3551 | 29660 | 2863 | 31869 | 2345 | 33969 | 1532 | 42296 | 1067 | 31284 |
| 5L-3S | | MI | 12581 | 4323 | 19872 | 3446 | 23328 | 2775 | 25074 | 2264 | 26949 | 1442 | 32776 | 1129 | 22845 |
| 12-#14 | 2.14 | MA | 15296 | 4323 | 23712 | 3552 | 28006 | 2877 | 29856 | 2342 | 31291 | 1540 | 38702 | 958 | 30025 |
| 6L-2S | | MI | 13516 | 4323 | 21114 | 3449 | 24903 | 2782 | 26964 | 2256 | 29436 | 1434 | 36039 | 1261 | 22918 |
| 12-#18 | 3.81 | MA | 20762 | 5086 | 34863 | 3990 | 42082 | 3179 | 46861 | 2550 | 53932 | 1475 | 67851 | 1018 | 57603 |
| 3L-5S | | MI | 12032 | 5086 | 21316 | 3898 | 24954 | 3088 | 26859 | 2441 | 29283 | 1334 | 36581 | 457 | 34060 |
| 12-#18 | 3.81 | MA | 19092 | 5086 | 32441 | 3989 | 38809 | 3201 | 42895 | 2542 | 48628 | 1461 | 62008 | 784 | 53818 |
| 4E | | MI | 13072 | 5086 | 22972 | 3880 | 26932 | 3102 | 29206 | 2427 | 32474 | 1347 | 40453 | 567 | 36175 |
| 12-#18 | 3.81 | MA | 17579 | 5086 | 29988 | 4015 | 35866 | 3197 | 39303 | 2560 | 43787 | 1475 | 55855 | 670 | 50718 |
| 5L-3S | | MI | 14214 | 5086 | 24602 | 3888 | 29123 | 3088 | 31795 | 2441 | 35752 | 1334 | 44104 | 789 | 38830 |
| 12-#18 | 3.81 | MA | 16127 | 5086 | 27808 | 4015 | 32960 | 3219 | 35766 | 2552 | 39131 | 1488 | 49647 | 477 | 46773 |
| 6L-2S | | MI | 15761 | 5086 | 26760 | 3896 | 31849 | 3102 | 35033 | 2427 | 40013 | 1320 | 49656 | 1023 | 39248 |
| 14-#11 | 1.73 | MA | 18575 | 4135 | 27437 | 3427 | 32917 | 2774 | 35867 | 2278 | 39415 | 1538 | 48888 | 1433 | 27449 |
| 2L-7S | | MI | 10493 | 4135 | 16323 | 3348 | 18830 | 2710 | 19726 | 2224 | 19952 | 1471 | 24220 | 952 | 17374 |
| 14-#11 | 1.73 | MA | 17582 | 4135 | 26141 | 3428 | 31272 | 2774 | 33875 | 2287 | 36727 | 1544 | 45269 | 1342 | 27378 |
| 3L-6S | | MI | 10912 | 4135 | 16899 | 3350 | 19591 | 2714 | 20651 | 2219 | 21193 | 1476 | 25650 | 1022 | 17885 |
| 14-#11 | 1.73 | MA | 16865 | 4135 | 25178 | 3429 | 29971 | 2784 | 32297 | 2285 | 34597 | 1540 | 42882 | 1250 | 27215 |
| 4L-5S | | MI | 11340 | 4135 | 17490 | 3351 | 20378 | 2707 | 21604 | 2224 | 22416 | 1471 | 27262 | 1098 | 18315 |
| 14-#11 | 1.73 | MA | 16217 | 4135 | 24204 | 3440 | 28802 | 2784 | 30871 | 2294 | 32655 | 1546 | 40392 | 1204 | 26576 |
| 5L-4S | | MI | 11786 | 4135 | 18154 | 3343 | 21175 | 2711 | 22572 | 2219 | 23688 | 1466 | 28874 | 1140 | 18739 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

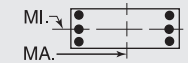
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.73 | MA | 15595 | 4135 | 23339 | 3441 | 27649 | 2793 | 29467 | 2292 | 30788 | 1552 | 37865 | 1129 | 25785 |
| 6L-3S | | MI | 12276 | 4135 | 18808 | 3345 | 22059 | 2704 | 23638 | 2224 | 25082 | 1471 | 30388 | 1231 | 18807 |
| 14-#11 | 1.73 | MA | 14986 | 4135 | 22497 | 3442 | 26534 | 2793 | 28106 | 2301 | 28894 | 1547 | 35615 | 1058 | 24960 |
| 7L-2S | | MI | 12941 | 4135 | 19680 | 3346 | 23164 | 2708 | 24973 | 2219 | 26838 | 1466 | 32699 | 1322 | 18829 |
| 14-#14 | 2.50 | MA | 18958 | 4486 | 29584 | 3637 | 35554 | 2925 | 39026 | 2384 | 43651 | 1524 | 54381 | 1244 | 38859 |
| 3L-6S | | MI | 11239 | 4486 | 18385 | 3553 | 21377 | 2862 | 22733 | 2302 | 23928 | 1434 | 29499 | 815 | 24141 |
| 14-#14 | 2.50 | MA | 17963 | 4486 | 28204 | 3638 | 33689 | 2939 | 36765 | 2381 | 40600 | 1517 | 50990 | 1112 | 38340 |
| 4L-5S | | MI | 11834 | 4486 | 19231 | 3556 | 22503 | 2853 | 24083 | 2310 | 25660 | 1427 | 31624 | 904 | 25032 |
| 14-#14 | 2.50 | MA | 17062 | 4486 | 26808 | 3653 | 32013 | 2938 | 34720 | 2393 | 37816 | 1525 | 47443 | 1046 | 36585 |
| 5L-4S | | MI | 12453 | 4486 | 20179 | 3545 | 23641 | 2859 | 25453 | 2302 | 27522 | 1434 | 33900 | 966 | 25994 |
| 14-#14 | 2.50 | MA | 16199 | 4486 | 25568 | 3654 | 30360 | 2951 | 32707 | 2390 | 35138 | 1532 | 43849 | 938 | 35250 |
| 6L-3S | | MI | 13134 | 4486 | 21114 | 3548 | 24903 | 2850 | 26964 | 2310 | 29436 | 1427 | 36039 | 1094 | 26485 |
| 14-#14 | 2.50 | MA | 15353 | 4486 | 24360 | 3655 | 28762 | 2950 | 30755 | 2401 | 32423 | 1525 | 40653 | 836 | 33451 |
| 7L-2S | | MI | 14058 | 4486 | 22357 | 3551 | 26479 | 2856 | 28854 | 2302 | 31923 | 1420 | 39302 | 1225 | 26587 |
| 14-#18 | 4.44 | MA | 20532 | 5377 | 35689 | 4171 | 42928 | 3334 | 47885 | 2626 | 55312 | 1445 | 70901 | 741 | 63024 |
| 4L-5S | | MI | 12973 | 5377 | 23473 | 4080 | 27681 | 3220 | 30097 | 2518 | 33543 | 1302 | 42132 | 384 | 39940 |
| 14-#18 | 4.44 | MA | 19052 | 5377 | 33236 | 4197 | 39985 | 3330 | 44294 | 2644 | 50471 | 1459 | 64748 | 628 | 59794 |
| 5L-4S | | MI | 13994 | 5377 | 25129 | 4061 | 29659 | 3234 | 32444 | 2505 | 36734 | 1316 | 46004 | 495 | 42207 |
| 14-#18 | 4.44 | MA | 17632 | 5377 | 31056 | 4197 | 37079 | 3352 | 40757 | 2636 | 45816 | 1472 | 58540 | 434 | 55983 |
| 6L-3S | | MI | 15149 | 5377 | 26760 | 4070 | 31849 | 3220 | 35033 | 2518 | 40013 | 1302 | 49656 | 717 | 45076 |
| 14-#18 | 4.44 | MA | 16240 | 5377 | 28933 | 4197 | 34271 | 3348 | 37327 | 2655 | 41095 | 1459 | 53029 | 252 | 51285 |
| 7L-2S | | MI | 16632 | 5377 | 28917 | 4078 | 34576 | 3234 | 38271 | 2505 | 44274 | 1289 | 55207 | 950 | 45569 |
| 16-#11 | 1.98 | MA | 18196 | 4249 | 27437 | 3499 | 32917 | 2826 | 35867 | 2320 | 39415 | 1539 | 48888 | 1329 | 31192 |
| 3L-7S | | MI | 10908 | 4249 | 17195 | 3419 | 19935 | 2762 | 21061 | 2257 | 21708 | 1462 | 26531 | 929 | 19808 |
| 16-#11 | 1.98 | MA | 17488 | 4249 | 26475 | 3500 | 31615 | 2836 | 34290 | 2318 | 37285 | 1534 | 46502 | 1238 | 31008 |
| 4L-6S | | MI | 11323 | 4249 | 17771 | 3421 | 20697 | 2766 | 21986 | 2252 | 22949 | 1467 | 27961 | 1000 | 20372 |
| 16-#11 | 1.98 | MA | 16847 | 4249 | 25501 | 3511 | 30446 | 2835 | 32863 | 2327 | 35343 | 1540 | 44012 | 1191 | 30276 |
| 5E | | MI | 11747 | 4249 | 18362 | 3422 | 21484 | 2759 | 22939 | 2257 | 24172 | 1462 | 29574 | 1076 | 20782 |
| 16-#11 | 1.98 | MA | 16232 | 4249 | 24636 | 3512 | 29293 | 2845 | 31459 | 2325 | 33476 | 1546 | 41485 | 1116 | 29514 |
| 6L-4S | | MI | 12188 | 4249 | 19025 | 3414 | 22280 | 2763 | 23907 | 2252 | 25444 | 1456 | 31186 | 1118 | 21288 |
| 16-#11 | 1.98 | MA | 15631 | 4249 | 23794 | 3513 | 28179 | 2845 | 30098 | 2333 | 31582 | 1542 | 39235 | 1045 | 28640 |
| 7L-3S | | MI | 12673 | 4249 | 19680 | 3415 | 23164 | 2756 | 24973 | 2257 | 26838 | 1462 | 32699 | 1208 | 21374 |
| 16-#11 | 1.98 | MA | 15036 | 4249 | 22966 | 3514 | 27087 | 2845 | 28734 | 2332 | 29756 | 1548 | 36910 | 992 | 27647 |
| 8L-2S | | MI | 13332 | 4249 | 20551 | 3417 | 24269 | 2760 | 26308 | 2252 | 28594 | 1456 | 35011 | 1299 | 21411 |
| 16-#14 | 2.86 | MA | 18821 | 4650 | 30060 | 3740 | 36043 | 3014 | 39617 | 2428 | 44447 | 1509 | 56138 | 1092 | 43582 |
| 4L-6S | | MI | 11807 | 4650 | 19628 | 3655 | 22953 | 2937 | 24623 | 2348 | 26415 | 1420 | 32762 | 780 | 27582 |
| 16-#14 | 2.86 | MA | 17934 | 4650 | 28664 | 3756 | 34367 | 3012 | 37572 | 2440 | 41663 | 1517 | 52591 | 1026 | 41898 |
| 5E | | MI | 12395 | 4650 | 20473 | 3658 | 24078 | 2928 | 25974 | 2356 | 28147 | 1412 | 34887 | 869 | 28555 |
| 16-#14 | 2.86 | MA | 17084 | 4650 | 27423 | 3756 | 32713 | 3026 | 35558 | 2437 | 38985 | 1525 | 48997 | 918 | 40488 |
| 6L-4S | | MI | 13006 | 4650 | 21422 | 3647 | 25217 | 2934 | 27344 | 2348 | 30009 | 1420 | 37162 | 930 | 29463 |
| 16-#14 | 2.86 | MA | 16251 | 4650 | 26216 | 3757 | 31115 | 3025 | 33606 | 2449 | 36270 | 1518 | 45801 | 815 | 38741 |
| 7L-3S | | MI | 13678 | 4650 | 22357 | 3650 | 26479 | 2925 | 28854 | 2356 | 31923 | 1412 | 39302 | 1059 | 30119 |
| 16-#14 | 2.86 | MA | 15427 | 4650 | 25027 | 3758 | 29550 | 3024 | 31651 | 2446 | 33651 | 1526 | 42489 | 739 | 36640 |
| 8L-2S | | MI | 14592 | 4650 | 23599 | 3653 | 28055 | 2931 | 30745 | 2348 | 34410 | 1405 | 42565 | 1190 | 30248 |
| 16-#18 | 5.08 | MA | 20494 | 5668 | 36484 | 4379 | 44104 | 3463 | 49284 | 2729 | 57156 | 1443 | 73641 | 585 | 68897 |
| 5E | | MI | 13956 | 5668 | 25631 | 4261 | 30407 | 3353 | 33335 | 2596 | 37804 | 1271 | 47683 | 312 | 45852 |
| 16-#18 | 5.08 | MA | 19103 | 5668 | 34304 | 4379 | 41198 | 3485 | 45747 | 2721 | 52501 | 1456 | 67434 | 392 | 65213 |
| 6L-4S | | MI | 14943 | 5668 | 27287 | 4243 | 32385 | 3366 | 35682 | 2583 | 40995 | 1285 | 51555 | 423 | 48264 |
| 16-#18 | 5.08 | MA | 17741 | 5668 | 32181 | 4378 | 38390 | 3481 | 42317 | 2739 | 47780 | 1443 | 61922 | 209 | 60451 |
| 7L-3S | | MI | 16019 | 5668 | 28917 | 4252 | 34576 | 3353 | 38271 | 2596 | 44274 | 1271 | 55207 | 644 | 51124 |
| 18-#11 | 2.23 | MA | 18101 | 4362 | 27771 | 3571 | 33260 | 2888 | 36282 | 2351 | 39973 | 1529 | 50122 | 1225 | 34799 |
| 4L-7S | | MI | 11317 | 4362 | 18066 | 3490 | 21041 | 2814 | 22395 | 2289 | 23464 | 1452 | 28843 | 906 | 22249 |
| 18-#11 | 2.23 | MA | 17468 | 4362 | 26798 | 3582 | 32091 | 2887 | 34856 | 2359 | 38031 | 1535 | 47632 | 1179 | 33985 |
| 5L-6S | | MI | 11728 | 4362 | 18642 | 3491 | 21802 | 2818 | 23320 | 2284 | 24705 | 1457 | 30273 | 977 | 22864 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis

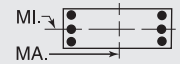



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.23 | MA | 16860 | 4362 | 25933 | 3583 | 30938 | 2897 | 33452 | 2358 | 36164 | 1541 | 45105 | 1104 | 33248 |
| 6L-5S | | MI | 12148 | 4362 | 19233 | 3493 | 22589 | 2811 | 24274 | 2289 | 25928 | 1452 | 31885 | 1053 | 23256 |
| 18-#11 | 2.23 | MA | 16266 | 4362 | 25091 | 3584 | 29824 | 2897 | 32090 | 2366 | 34271 | 1537 | 42855 | 1033 | 32326 |
| 7L-4S | | MI | 12585 | 4362 | 19897 | 3485 | 23385 | 2815 | 25241 | 2284 | 27200 | 1447 | 33497 | 1095 | 23834 |
| 18-#11 | 2.23 | MA | 15678 | 4362 | 24262 | 3585 | 28732 | 2896 | 30727 | 2365 | 32444 | 1543 | 40530 | 979 | 31358 |
| 8L-3S | | MI | 13065 | 4362 | 20551 | 3486 | 24269 | 2808 | 26308 | 2289 | 28594 | 1452 | 35011 | 1185 | 23937 |
| 18-#11 | 2.23 | MA | 15094 | 4362 | 23347 | 3596 | 27607 | 2906 | 29385 | 2373 | 30635 | 1549 | 38236 | 921 | 30102 |
| 9L-2S | | MI | 13719 | 4362 | 21423 | 3488 | 25374 | 2812 | 27643 | 2284 | 30350 | 1447 | 37322 | 1277 | 23987 |
| 18-#14 | 3.21 | MA | 18791 | 4814 | 30520 | 3858 | 36721 | 3087 | 40423 | 2488 | 45510 | 1510 | 57739 | 1006 | 47221 |
| 5L-6S | | MI | 12367 | 4814 | 20870 | 3757 | 24529 | 3011 | 26513 | 2394 | 28902 | 1405 | 36025 | 744 | 31037 |
| 18-#14 | 3.21 | MA | 17953 | 4814 | 29279 | 3859 | 35067 | 3101 | 38410 | 2484 | 42832 | 1517 | 54145 | 898 | 45738 |
| 6L-5S | | MI | 12947 | 4814 | 21716 | 3761 | 25654 | 3003 | 27864 | 2401 | 30634 | 1397 | 38150 | 834 | 32086 |
| 18-#14 | 3.21 | MA | 17132 | 4814 | 28072 | 3860 | 33469 | 3100 | 36458 | 2496 | 40117 | 1510 | 50949 | 795 | 44040 |
| 7L-4S | | MI | 13551 | 4814 | 22664 | 3749 | 26793 | 3009 | 29234 | 2394 | 32496 | 1405 | 40425 | 895 | 32948 |
| 18-#14 | 3.21 | MA | 16321 | 4814 | 26883 | 3860 | 31903 | 3099 | 34502 | 2493 | 37498 | 1518 | 47637 | 719 | 41902 |
| 8L-3S | | MI | 14215 | 4814 | 23599 | 3752 | 28055 | 3000 | 30745 | 2401 | 34410 | 1397 | 42565 | 1023 | 33748 |
| 18-#14 | 3.21 | MA | 15514 | 4814 | 25571 | 3876 | 30290 | 3113 | 32578 | 2505 | 34904 | 1526 | 44375 | 634 | 39775 |
| 9L-2S | | MI | 15119 | 4814 | 24841 | 3755 | 29631 | 3006 | 32635 | 2394 | 36897 | 1390 | 45828 | 1155 | 33903 |
| 18-#18 | 5.71 | MA | 20545 | 5959 | 37552 | 4560 | 45317 | 3618 | 50738 | 2805 | 59185 | 1440 | 76327 | 350 | 74364 |
| 6L-5S | | MI | 14857 | 5959 | 27789 | 4443 | 33134 | 3485 | 36573 | 2674 | 42065 | 1240 | 53235 | 239 | 51791 |
| 18-#18 | 5.71 | MA | 19210 | 5959 | 35429 | 4560 | 42509 | 3614 | 47307 | 2823 | 54464 | 1427 | 70815 | 167 | 69636 |
| 7L-4S | | MI | 15822 | 5959 | 29444 | 4425 | 35112 | 3498 | 38920 | 2661 | 45256 | 1254 | 57106 | 350 | 54343 |
| 20-#11 | 2.48 | MA | 18080 | 4476 | 28094 | 3653 | 33736 | 2939 | 36848 | 2392 | 40719 | 1530 | 51252 | 1166 | 37702 |
| 5L-7S | | MI | 11722 | 4476 | 18938 | 3561 | 22146 | 2866 | 23730 | 2322 | 25220 | 1443 | 31154 | 884 | 24698 |
| 20-#11 | 2.48 | MA | 17480 | 4476 | 27229 | 3654 | 32582 | 2949 | 35444 | 2391 | 38852 | 1536 | 48725 | 1091 | 36987 |
| 6E | | MI | 12129 | 4476 | 19514 | 3562 | 22907 | 2870 | 24655 | 2317 | 26461 | 1448 | 32584 | 954 | 25359 |
| 20-#11 | 2.48 | MA | 16892 | 4476 | 26388 | 3655 | 31468 | 2949 | 34083 | 2399 | 36959 | 1532 | 46475 | 1020 | 36019 |
| 7L-5S | | MI | 12544 | 4476 | 20105 | 3564 | 23694 | 2863 | 25609 | 2322 | 27684 | 1443 | 34197 | 1030 | 25736 |
| 20-#11 | 2.48 | MA | 16311 | 4476 | 25559 | 3656 | 30376 | 2948 | 32719 | 2398 | 35132 | 1538 | 44150 | 967 | 35075 |
| 8L-4S | | MI | 12977 | 4476 | 20768 | 3556 | 24491 | 2867 | 26576 | 2317 | 28956 | 1438 | 35809 | 1073 | 26377 |
| 20-#11 | 2.48 | MA | 15734 | 4476 | 24644 | 3667 | 29251 | 2958 | 31377 | 2406 | 33323 | 1544 | 41855 | 908 | 33792 |
| 9L-3S | | MI | 13453 | 4476 | 21423 | 3557 | 25374 | 2860 | 27643 | 2322 | 30350 | 1443 | 37322 | 1163 | 26496 |
| 20-#11 | 2.48 | MA | 15159 | 4476 | 23819 | 3668 | 28167 | 2958 | 30029 | 2404 | 31463 | 1540 | 39483 | 828 | 32547 |
| 10L-2S | | MI | 14101 | 4476 | 22294 | 3559 | 26479 | 2864 | 28977 | 2317 | 32105 | 1438 | 39634 | 1254 | 26559 |
| 20-#14 | 3.57 | MA | 18809 | 4977 | 31135 | 3961 | 37420 | 3176 | 41261 | 2532 | 46679 | 1510 | 59293 | 877 | 50998 |
| 6E | | MI | 12919 | 4977 | 22113 | 3860 | 26104 | 3086 | 28404 | 2440 | 31389 | 1390 | 39288 | 709 | 34503 |
| 20-#14 | 3.57 | MA | 17999 | 4977 | 29928 | 3962 | 35823 | 3175 | 39309 | 2544 | 43964 | 1503 | 56097 | 775 | 49346 |
| 7L-5S | | MI | 13492 | 4977 | 22958 | 3863 | 27230 | 3077 | 29754 | 2447 | 33121 | 1383 | 41413 | 798 | 35625 |
| 20-#14 | 3.57 | MA | 17199 | 4977 | 28739 | 3963 | 34257 | 3174 | 37353 | 2540 | 41345 | 1511 | 52784 | 699 | 47172 |
| 8L-4S | | MI | 14089 | 4977 | 23907 | 3851 | 28368 | 3083 | 31124 | 2440 | 34983 | 1390 | 43688 | 860 | 36445 |
| 20-#14 | 3.57 | MA | 16405 | 4977 | 27426 | 3978 | 32643 | 3187 | 35429 | 2552 | 38751 | 1518 | 49523 | 614 | 45019 |
| 9L-3S | | MI | 14745 | 4977 | 24841 | 3854 | 29631 | 3075 | 32635 | 2447 | 36897 | 1383 | 45828 | 988 | 37374 |
| 20-#18 | 6.35 | MA | 20652 | 6249 | 38677 | 4742 | 46628 | 3747 | 52298 | 2907 | 61149 | 1411 | 79708 | 125 | 78836 |
| 7L-5S | | MI | 15742 | 6249 | 29946 | 4625 | 35861 | 3617 | 39811 | 2752 | 46325 | 1209 | 58786 | 167 | 57755 |
| 22-#11 | 2.72 | MA | 18091 | 4589 | 28526 | 3725 | 34227 | 3001 | 37436 | 2423 | 41540 | 1531 | 52345 | 1078 | 40730 |
| 6L-7S | | MI | 12121 | 4589 | 19809 | 3631 | 23251 | 2918 | 25065 | 2355 | 26976 | 1434 | 33466 | 861 | 27152 |
| 22-#11 | 2.72 | MA | 17510 | 4589 | 27684 | 3726 | 33113 | 3001 | 36075 | 2432 | 39647 | 1527 | 50095 | 1007 | 39718 |
| 7L-6S | | MI | 12524 | 4589 | 20385 | 3633 | 24012 | 2922 | 25990 | 2349 | 28217 | 1439 | 34896 | 932 | 27857 |
| 22-#11 | 2.72 | MA | 16935 | 4589 | 26856 | 3726 | 32021 | 3000 | 34712 | 2430 | 37820 | 1533 | 47770 | 954 | 38796 |
| 8L-5S | | MI | 12936 | 4589 | 20976 | 3635 | 24799 | 2915 | 26943 | 2355 | 29440 | 1434 | 36508 | 1008 | 28222 |
| 22-#11 | 2.72 | MA | 16364 | 4589 | 25941 | 3738 | 30896 | 3010 | 33370 | 2439 | 36011 | 1539 | 45475 | 895 | 37488 |
| 9L-4S | | MI | 13364 | 4589 | 21640 | 3626 | 25596 | 2918 | 27911 | 2349 | 30711 | 1429 | 38120 | 1050 | 28919 |
| 22-#11 | 2.72 | MA | 15796 | 4589 | 25115 | 3739 | 29812 | 3010 | 32022 | 2437 | 34151 | 1534 | 43103 | 815 | 36223 |
| 10L-3S | | MI | 13836 | 4589 | 22294 | 3628 | 26479 | 2912 | 28977 | 2355 | 32105 | 1434 | 39634 | 1140 | 29052 |
| 22-#11 | 2.72 | MA | 15197 | 4589 | 24296 | 3740 | 28700 | 3020 | 30688 | 2446 | 32350 | 1540 | 40818 | 759 | 34924 |
| 11L-2S | | MI | 14479 | 4589 | 23165 | 3630 | 27585 | 2915 | 30312 | 2349 | 33861 | 1429 | 41945 | 1231 | 29128 |
| 22-#14 | 3.93 | MA | 18854 | 5141 | 31783 | 4064 | 38176 | 3250 | 42161 | 2591 | 47811 | 1495 | 61244 | 755 | 54660 |
| 7L-6S | | MI | 13464 | 5141 | 23355 | 3962 | 27680 | 3161 | 30294 | 2486 | 33876 | 1375 | 42551 | 674 | 37979 |

## RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 3.93 | MA | 18065 | 5141 | 30595 | 4065 | 36610 | 3248 | 40205 | 2588 | 45192 | 1503 | 57932 | 679 | 52449 |
| 8L-5S | | MI | 14030 | 5141 | 24201 | 3965 | 28805 | 3152 | 31644 | 2493 | 35608 | 1368 | 44676 | 763 | 39169 |
| 22-#14 | 3.93 | MA | 17281 | 5141 | 29282 | 4081 | 34997 | 3262 | 38281 | 2600 | 42598 | 1511 | 54671 | 594 | 50269 |
| 9L-4S | | MI | 14620 | 5141 | 25149 | 3953 | 29944 | 3158 | 33015 | 2486 | 37470 | 1375 | 46951 | 824 | 39952 |
| 24-#11 | 2.97 | MA | 18119 | 4702 | 28981 | 3796 | 34757 | 3052 | 38068 | 2465 | 42335 | 1521 | 53715 | 995 | 43422 |
| 7E | | MI | 12516 | 4702 | 20681 | 3702 | 24356 | 2970 | 26400 | 2387 | 28732 | 1424 | 35777 | 839 | 29612 |
| 24-#11 | 2.97 | MA | 17551 | 4702 | 28152 | 3797 | 33666 | 3052 | 36704 | 2463 | 40508 | 1527 | 51390 | 941 | 42521 |
| 8L-6S | | MI | 12915 | 4702 | 21257 | 3704 | 25117 | 2973 | 27325 | 2382 | 29973 | 1430 | 37207 | 909 | 30349 |
| 24-#11 | 2.97 | MA | 16986 | 4702 | 27237 | 3809 | 32541 | 3062 | 35362 | 2472 | 38699 | 1533 | 49095 | 882 | 41188 |
| 9L-5S | | MI | 13323 | 4702 | 21848 | 3706 | 25904 | 2967 | 28278 | 2387 | 31196 | 1424 | 38820 | 985 | 30711 |
| 24-#11 | 2.97 | MA | 16424 | 4702 | 26412 | 3810 | 31456 | 3062 | 34014 | 2470 | 36839 | 1529 | 46723 | 802 | 39903 |
| 10L-4S | | MI | 13748 | 4702 | 22511 | 3697 | 26701 | 2970 | 29246 | 2382 | 32467 | 1419 | 40432 | 1027 | 31386 |
| 24-#11 | 2.97 | MA | 15827 | 4702 | 25592 | 3810 | 30344 | 3072 | 32681 | 2479 | 35038 | 1535 | 44438 | 746 | 38606 |
| 11L-3S | | MI | 14215 | 4702 | 23165 | 3699 | 27585 | 2964 | 30312 | 2387 | 33861 | 1424 | 41945 | 1118 | 31605 |
| 24-#14 | 4.29 | MA | 18917 | 5304 | 32450 | 4167 | 38964 | 3323 | 43056 | 2635 | 49039 | 1496 | 63080 | 659 | 57734 |
| 8L-6S | | MI | 14002 | 5304 | 24598 | 4064 | 29256 | 3236 | 32184 | 2532 | 36363 | 1361 | 45813 | 639 | 41465 |
| 24-#14 | 4.29 | MA | 18144 | 5304 | 31138 | 4183 | 37351 | 3337 | 41132 | 2647 | 46445 | 1503 | 59818 | 574 | 55526 |
| 9L-5S | | MI | 14563 | 5304 | 25443 | 4067 | 30381 | 3227 | 33535 | 2539 | 38095 | 1353 | 47939 | 728 | 42719 |

## RECTANGULAR TIED COLUMNS 30" x 44"

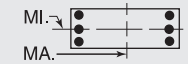
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.21 | MA | 18859 | 4082 | 27203 | 3412 | 32251 | 2774 | 34590 | 2299 | 36722 | 1609 | 44631 | 1505 | 21053 |
| 2E | | MI | 12547 | 4082 | 18787 | 3303 | 21680 | 2683 | 22824 | 2210 | 23658 | 1516 | 28230 | 1382 | 13769 |
| 6-#14 | 1.02 | MA | 18420 | 3991 | 26033 | 3376 | 30944 | 2750 | 33083 | 2287 | 34781 | 1626 | 42229 | 1538 | 18008 |
| 2L-3S | | MI | 11338 | 3991 | 16795 | 3274 | 19336 | 2662 | 20147 | 2221 | 20179 | 1558 | 23772 | 1305 | 11890 |
| 6-#14 | 1.02 | MA | 16874 | 3991 | 24075 | 3378 | 28461 | 2749 | 30075 | 2300 | 30722 | 1635 | 36766 | 1407 | 17978 |
| 3L-2S | | MI | 12312 | 3991 | 18037 | 3277 | 20912 | 2668 | 22037 | 2213 | 22666 | 1551 | 27035 | 1437 | 11850 |
| 6-#18 | 1.82 | MA | 20475 | 4373 | 30632 | 3594 | 36601 | 2907 | 39859 | 2383 | 43812 | 1594 | 54084 | 1466 | 31220 |
| 2L-3S | | MI | 11870 | 4373 | 18787 | 3476 | 21680 | 2802 | 22824 | 2301 | 23658 | 1499 | 28230 | 1076 | 20110 |
| 6-#18 | 1.82 | MA | 17859 | 4373 | 27203 | 3594 | 32251 | 2904 | 34590 | 2403 | 36722 | 1608 | 44631 | 1232 | 30858 |
| 3L-2S | | MI | 13511 | 4373 | 20945 | 3485 | 24407 | 2815 | 26062 | 2287 | 27919 | 1485 | 33781 | 1309 | 20218 |
| 8-#14 | 1.36 | MA | 19372 | 4155 | 27991 | 3478 | 33428 | 2825 | 36092 | 2335 | 38840 | 1619 | 47692 | 1520 | 23825 |
| 2L-4S | | MI | 11214 | 4155 | 17102 | 3373 | 19650 | 2746 | 20526 | 2259 | 20752 | 1551 | 24895 | 1142 | 15485 |
| 8-#14 | 1.36 | MA | 17849 | 4155 | 26033 | 3480 | 30944 | 2824 | 33083 | 2347 | 34781 | 1627 | 42229 | 1388 | 23743 |
| 3E | | MI | 11925 | 4155 | 18037 | 3376 | 20912 | 2737 | 22037 | 2267 | 22666 | 1544 | 27035 | 1270 | 15578 |
| 8-#14 | 1.36 | MA | 16746 | 4155 | 24579 | 3481 | 28979 | 2838 | 30701 | 2344 | 31565 | 1621 | 38627 | 1257 | 23432 |
| 4L-2S | | MI | 12887 | 4155 | 19280 | 3379 | 22488 | 2743 | 23927 | 2259 | 25153 | 1536 | 30297 | 1401 | 15573 |
| 8-#18 | 2.42 | MA | 22037 | 4664 | 34062 | 3775 | 40951 | 3040 | 45129 | 2467 | 50902 | 1580 | 63537 | 1427 | 41346 |
| 2L-4S | | MI | 11645 | 4664 | 19315 | 3650 | 22216 | 2947 | 23474 | 2365 | 24640 | 1481 | 30129 | 781 | 24455 |
| 8-#18 | 2.42 | MA | 19481 | 4664 | 30632 | 3776 | 36601 | 3037 | 39859 | 2487 | 43812 | 1593 | 54084 | 1193 | 40855 |
| 3E | | MI | 12838 | 4664 | 20945 | 3658 | 24407 | 2934 | 26062 | 2378 | 27919 | 1468 | 33781 | 1003 | 26397 |
| 8-#18 | 2.42 | MA | 17628 | 4664 | 28079 | 3777 | 33149 | 3060 | 35676 | 2480 | 38186 | 1580 | 47866 | 959 | 37741 |
| 4L-2S | | MI | 14448 | 4664 | 23102 | 3667 | 27134 | 2947 | 29300 | 2365 | 32180 | 1454 | 39332 | 1237 | 26610 |
| 10-#11 | 1.18 | MA | 18913 | 4068 | 26903 | 3434 | 32137 | 2793 | 34567 | 2317 | 36809 | 1628 | 45091 | 1541 | 20820 |
| 2L-5S | | MI | 10987 | 4068 | 16394 | 3345 | 18903 | 2715 | 19679 | 2254 | 19597 | 1562 | 23426 | 1214 | 13529 |
| 10-#11 | 1.18 | MA | 17840 | 4068 | 25535 | 3436 | 30403 | 2793 | 32466 | 2326 | 33974 | 1635 | 41252 | 1450 | 20790 |
| 3L-4S | | MI | 11444 | 4068 | 17058 | 3337 | 19699 | 2719 | 20647 | 2249 | 20869 | 1557 | 25038 | 1256 | 13668 |
| 10-#11 | 1.18 | MA | 17065 | 4068 | 24521 | 3437 | 29031 | 2804 | 30804 | 2324 | 31731 | 1631 | 38718 | 1359 | 20678 |
| 4L-3S | | MI | 11945 | 4068 | 17712 | 3339 | 20583 | 2712 | 21713 | 2254 | 22263 | 1562 | 26551 | 1346 | 13684 |
| 10-#11 | 1.18 | MA | 16363 | 4068 | 23496 | 3448 | 27801 | 2804 | 29302 | 2333 | 29686 | 1638 | 36083 | 1312 | 20337 |
| 5L-2S | | MI | 12625 | 4068 | 18583 | 3340 | 21688 | 2716 | 23048 | 2249 | 24018 | 1557 | 28863 | 1437 | 13667 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis

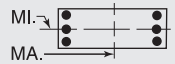



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.70 | MA | 20302 | 4318 | 29949 | 3581 | 35911 | 2899 | 39100 | 2382 | 42899 | 1611 | 53155 | 1501 | 29622 |
| 2L-5S | | MI | 11160 | 4318 | 17396 | 3487 | 20087 | 2814 | 21047 | 2312 | 21377 | 1529 | 25882 | 1045 | 18170 |
| 10-#14 | 1.70 | MA | 18801 | 4318 | 27991 | 3582 | 33428 | 2899 | 36092 | 2394 | 38840 | 1620 | 47692 | 1370 | 29497 |
| 3L-4S | | MI | 11799 | 4318 | 18345 | 3475 | 21225 | 2820 | 22417 | 2305 | 23239 | 1536 | 28158 | 1106 | 19105 |
| 10-#14 | 1.70 | MA | 17716 | 4318 | 26537 | 3583 | 31462 | 2913 | 33709 | 2392 | 35624 | 1613 | 44091 | 1238 | 29134 |
| 4L-3S | | MI | 12500 | 4318 | 19280 | 3478 | 22488 | 2812 | 23927 | 2312 | 25153 | 1529 | 30297 | 1235 | 19244 |
| 10-#14 | 1.70 | MA | 16734 | 4318 | 25066 | 3599 | 29697 | 2912 | 31555 | 2404 | 32691 | 1622 | 40333 | 1172 | 27532 |
| 5L-2S | | MI | 13450 | 4318 | 20522 | 3482 | 24063 | 2818 | 25818 | 2305 | 27640 | 1522 | 33560 | 1366 | 19276 |
| 10-#18 | 3.03 | MA | 23556 | 4955 | 37492 | 3957 | 45300 | 3173 | 50399 | 2551 | 57992 | 1566 | 72990 | 1387 | 51449 |
| 2L-5S | | MI | 11546 | 4955 | 19816 | 3850 | 22965 | 3066 | 24364 | 2456 | 25710 | 1436 | 31809 | 598 | 28592 |
| 10-#18 | 3.03 | MA | 21052 | 4955 | 34062 | 3958 | 40951 | 3170 | 45129 | 2571 | 50902 | 1579 | 63537 | 1154 | 50849 |
| 3L-4S | | MI | 12612 | 4955 | 21472 | 3832 | 24943 | 3079 | 26712 | 2443 | 28901 | 1450 | 35680 | 709 | 30409 |
| 10-#18 | 3.03 | MA | 19243 | 4955 | 31508 | 3958 | 37499 | 3193 | 40946 | 2564 | 45276 | 1566 | 57319 | 920 | 47399 |
| 4L-3S | | MI | 13782 | 4955 | 23102 | 3840 | 27134 | 3066 | 29300 | 2456 | 32180 | 1436 | 39332 | 931 | 32665 |
| 10-#18 | 3.03 | MA | 17604 | 4955 | 28923 | 3986 | 34397 | 3190 | 37160 | 2584 | 40142 | 1579 | 50792 | 805 | 44471 |
| 5L-2S | | MI | 15362 | 4955 | 25260 | 3848 | 29860 | 3079 | 32538 | 2443 | 36440 | 1423 | 44883 | 1164 | 32970 |
| 12-#11 | 1.42 | MA | 19576 | 4181 | 28270 | 3505 | 33871 | 2845 | 36668 | 2349 | 39644 | 1623 | 48929 | 1529 | 24875 |
| 2L-6S | | MI | 10973 | 4181 | 16674 | 3415 | 19221 | 2774 | 20060 | 2282 | 20130 | 1558 | 24125 | 1115 | 15513 |
| 12-#11 | 1.42 | MA | 18514 | 4181 | 26903 | 3507 | 32137 | 2845 | 34567 | 2359 | 36809 | 1630 | 45091 | 1438 | 24824 |
| 3L-5S | | MI | 11407 | 4181 | 17265 | 3416 | 20008 | 2767 | 21014 | 2287 | 21353 | 1553 | 25737 | 1191 | 15974 |
| 12-#11 | 1.42 | MA | 17748 | 4181 | 25889 | 3508 | 30766 | 2855 | 32905 | 2357 | 34566 | 1626 | 42557 | 1347 | 24685 |
| 4E | | MI | 11858 | 4181 | 17929 | 3408 | 20804 | 2771 | 21981 | 2282 | 22624 | 1548 | 27349 | 1234 | 16232 |
| 12-#11 | 1.42 | MA | 17055 | 4181 | 24863 | 3519 | 29535 | 2855 | 31403 | 2366 | 32521 | 1632 | 39922 | 1300 | 24220 |
| 5L-3S | | MI | 12355 | 4181 | 18583 | 3409 | 21688 | 2764 | 23048 | 2287 | 24018 | 1553 | 28863 | 1324 | 16271 |
| 12-#11 | 1.42 | MA | 16390 | 4181 | 23953 | 3521 | 28321 | 2866 | 29925 | 2365 | 30554 | 1639 | 37241 | 1225 | 23321 |
| 6L-2S | | MI | 13028 | 4181 | 19455 | 3411 | 22793 | 2768 | 24383 | 2282 | 25774 | 1548 | 31174 | 1415 | 16269 |
| 12-#14 | 2.05 | MA | 21214 | 4482 | 31907 | 3683 | 38394 | 2974 | 42109 | 2429 | 46957 | 1604 | 58619 | 1483 | 35408 |
| 2L-6S | | MI | 11137 | 4482 | 17794 | 3586 | 20537 | 2898 | 21586 | 2351 | 22132 | 1522 | 27020 | 920 | 20956 |
| 12-#14 | 2.05 | MA | 19733 | 4482 | 29949 | 3684 | 35911 | 2974 | 39100 | 2442 | 42899 | 1612 | 53155 | 1351 | 35243 |
| 3L-5S | | MI | 11743 | 4482 | 18639 | 3589 | 21663 | 2889 | 22937 | 2358 | 23864 | 1514 | 29145 | 1010 | 21666 |
| 12-#14 | 2.05 | MA | 18665 | 4482 | 28495 | 3685 | 33945 | 2988 | 36718 | 2439 | 39683 | 1606 | 49554 | 1220 | 34837 |
| 4E | | MI | 12373 | 4482 | 19587 | 3577 | 22801 | 2895 | 24307 | 2351 | 25726 | 1522 | 31421 | 1071 | 22714 |
| 12-#14 | 2.05 | MA | 17698 | 4482 | 27024 | 3702 | 32180 | 2987 | 34563 | 2452 | 36750 | 1615 | 45796 | 1153 | 33116 |
| 5L-3S | | MI | 13065 | 4482 | 20522 | 3581 | 24063 | 2886 | 25818 | 2358 | 27640 | 1514 | 33560 | 1199 | 22897 |
| 12-#14 | 2.05 | MA | 16771 | 4482 | 25718 | 3703 | 30438 | 3002 | 32443 | 2449 | 33930 | 1623 | 41982 | 1045 | 31924 |
| 6L-2S | | MI | 14003 | 4482 | 21765 | 3584 | 25639 | 2893 | 27708 | 2351 | 30127 | 1507 | 36823 | 1331 | 22959 |
| 12-#18 | 3.64 | MA | 22584 | 5245 | 37492 | 4140 | 45300 | 3303 | 50399 | 2655 | 57992 | 1565 | 72990 | 1115 | 60843 |
| 3L-5S | | MI | 12511 | 5245 | 21974 | 4031 | 25692 | 3198 | 27602 | 2534 | 29971 | 1405 | 37360 | 526 | 34428 |
| 12-#18 | 3.64 | MA | 20814 | 5245 | 34938 | 4140 | 41849 | 3326 | 46216 | 2649 | 52366 | 1551 | 66772 | 881 | 57097 |
| 4E | | MI | 13556 | 5245 | 23630 | 4013 | 27670 | 3211 | 29950 | 2521 | 33162 | 1419 | 41231 | 637 | 36403 |
| 12-#18 | 3.64 | MA | 19213 | 5245 | 32353 | 4167 | 38746 | 3323 | 42430 | 2668 | 47232 | 1565 | 60245 | 766 | 54045 |
| 5L-3S | | MI | 14704 | 5245 | 25260 | 4022 | 29860 | 3198 | 32538 | 2534 | 36440 | 1405 | 44883 | 858 | 38923 |
| 12-#18 | 3.64 | MA | 17676 | 5245 | 30056 | 4168 | 35684 | 3347 | 38702 | 2661 | 42294 | 1578 | 53646 | 573 | 49722 |
| 6L-2S | | MI | 16258 | 5245 | 27417 | 4030 | 32587 | 3211 | 35776 | 2521 | 40701 | 1392 | 50434 | 1092 | 39309 |
| 14-#11 | 1.65 | MA | 20229 | 4294 | 29638 | 3576 | 35606 | 2897 | 38770 | 2382 | 42479 | 1618 | 52768 | 1518 | 28923 |
| 2L-7S | | MI | 10970 | 4294 | 16970 | 3484 | 19565 | 2822 | 20470 | 2319 | 20645 | 1544 | 25006 | 1022 | 17550 |
| 14-#11 | 1.65 | MA | 19178 | 4294 | 28270 | 3577 | 33871 | 2897 | 36668 | 2391 | 39644 | 1625 | 48929 | 1427 | 28852 |
| 3L-6S | | MI | 11390 | 4294 | 17546 | 3485 | 20326 | 2826 | 21395 | 2314 | 21886 | 1549 | 26436 | 1093 | 17994 |
| 14-#11 | 1.65 | MA | 18421 | 4294 | 27256 | 3579 | 32500 | 2907 | 35006 | 2390 | 37401 | 1621 | 46396 | 1335 | 28690 |
| 4L-5S | | MI | 11820 | 4294 | 18137 | 3487 | 21113 | 2819 | 22349 | 2319 | 23109 | 1544 | 28049 | 1169 | 18431 |
| 14-#11 | 1.65 | MA | 17736 | 4294 | 26231 | 3590 | 31270 | 2907 | 33504 | 2399 | 35356 | 1627 | 43761 | 1289 | 28116 |
| 5L-4S | | MI | 12267 | 4294 | 18801 | 3479 | 21910 | 2823 | 23316 | 2314 | 24380 | 1539 | 29661 | 1211 | 18789 |
| 14-#11 | 1.65 | MA | 17079 | 4294 | 25320 | 3591 | 30055 | 2918 | 32026 | 2398 | 33389 | 1634 | 41080 | 1214 | 27250 |
| 6L-3S | | MI | 12759 | 4294 | 19455 | 3480 | 22793 | 2816 | 24383 | 2319 | 25774 | 1544 | 31174 | 1301 | 18847 |
| 14-#11 | 1.65 | MA | 16436 | 4294 | 24434 | 3593 | 28882 | 2918 | 30593 | 2407 | 31396 | 1630 | 38693 | 1143 | 26472 |
| 7L-2S | | MI | 13426 | 4294 | 20326 | 3482 | 23898 | 2820 | 25717 | 2314 | 27530 | 1539 | 33486 | 1392 | 18864 |
| 14-#14 | 2.39 | MA | 20648 | 4646 | 31907 | 3786 | 38394 | 3048 | 42109 | 2489 | 46957 | 1605 | 58619 | 1333 | 40986 |
| 3L-6S | | MI | 11717 | 4646 | 19036 | 3688 | 22113 | 2973 | 23477 | 2397 | 24619 | 1507 | 30283 | 885 | 24378 |

## RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis



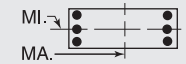

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.39 | MA | 19595 | 4646 | 30453 | 3788 | 36428 | 3063 | 39726 | 2487 | 43742 | 1599 | 55017 | 1201 | 40540 |
| 4L-5S | | MI | 12315 | 4646 | 19881 | 3691 | 23238 | 2964 | 24827 | 2404 | 26351 | 1499 | 32408 | 974 | 25177 |
| 14-#14 | 2.39 | MA | 18644 | 4646 | 28983 | 3804 | 34663 | 3062 | 37572 | 2499 | 40809 | 1607 | 51259 | 1135 | 38714 |
| 5L-4S | | MI | 12937 | 4646 | 20830 | 3680 | 24377 | 2970 | 26197 | 2397 | 28213 | 1507 | 34683 | 1036 | 26163 |
| 14-#14 | 2.39 | MA | 17731 | 4646 | 27676 | 3805 | 32922 | 3076 | 35452 | 2496 | 37988 | 1616 | 47445 | 1026 | 37446 |
| 6L-3S | | MI | 13620 | 4646 | 21765 | 3683 | 25639 | 2961 | 27708 | 2404 | 30127 | 1499 | 36823 | 1164 | 26541 |
| 14-#14 | 2.39 | MA | 16837 | 4646 | 26405 | 3807 | 31239 | 3076 | 33396 | 2509 | 35129 | 1610 | 44050 | 924 | 35479 |
| 7L-2S | | MI | 14548 | 4646 | 23007 | 3686 | 27215 | 2967 | 29598 | 2397 | 32614 | 1492 | 40086 | 1295 | 26631 |
| 14-#18 | 4.24 | MA | 22348 | 5536 | 38368 | 4322 | 46198 | 3459 | 51485 | 2733 | 59456 | 1537 | 76225 | 842 | 66828 |
| 4L-5S | | MI | 13454 | 5536 | 24131 | 4213 | 28418 | 3330 | 30840 | 2612 | 34231 | 1374 | 42911 | 454 | 40301 |
| 14-#18 | 4.24 | MA | 20781 | 5536 | 35783 | 4349 | 43096 | 3456 | 47699 | 2752 | 54322 | 1550 | 69698 | 727 | 63650 |
| 5L-4S | | MI | 14482 | 5536 | 25787 | 4195 | 30396 | 3344 | 33188 | 2598 | 37422 | 1388 | 46782 | 564 | 42431 |
| 14-#18 | 4.24 | MA | 19278 | 5536 | 33486 | 4350 | 40034 | 3480 | 43972 | 2746 | 49384 | 1564 | 63099 | 533 | 59463 |
| 6L-3S | | MI | 15610 | 5536 | 27417 | 4203 | 32587 | 3330 | 35776 | 2612 | 40701 | 1374 | 50434 | 786 | 45174 |
| 14-#18 | 4.24 | MA | 17805 | 5536 | 31249 | 4350 | 37075 | 3476 | 40357 | 2765 | 44377 | 1550 | 57235 | 351 | 54648 |
| 7L-2S | | MI | 17139 | 5536 | 29575 | 4212 | 35314 | 3344 | 39014 | 2598 | 44962 | 1361 | 55985 | 1020 | 45634 |
| 16-#11 | 1.89 | MA | 19832 | 4408 | 29638 | 3648 | 35606 | 2949 | 38770 | 2424 | 42479 | 1619 | 52768 | 1415 | 32877 |
| 3L-7S | | MI | 11386 | 4408 | 17841 | 3555 | 20670 | 2874 | 21805 | 2352 | 22401 | 1534 | 27318 | 999 | 19981 |
| 16-#11 | 1.89 | MA | 19083 | 4408 | 28624 | 3650 | 34235 | 2959 | 37108 | 2423 | 40236 | 1616 | 50235 | 1324 | 32693 |
| 4L-6S | | MI | 11802 | 4408 | 18417 | 3556 | 21431 | 2878 | 22730 | 2347 | 23642 | 1540 | 28748 | 1070 | 20481 |
| 16-#11 | 1.89 | MA | 18406 | 4408 | 27598 | 3661 | 33004 | 2959 | 35605 | 2432 | 38191 | 1622 | 47599 | 1277 | 32021 |
| 5E | | MI | 12228 | 4408 | 19008 | 3558 | 22218 | 2871 | 23683 | 2352 | 24865 | 1534 | 30360 | 1146 | 20897 |
| 16-#11 | 1.89 | MA | 17757 | 4408 | 26688 | 3662 | 31790 | 2969 | 34127 | 2431 | 36224 | 1629 | 44919 | 1202 | 31186 |
| 6L-4S | | MI | 12671 | 4408 | 19672 | 3549 | 23015 | 2875 | 24651 | 2347 | 26136 | 1529 | 31972 | 1188 | 21342 |
| 16-#11 | 1.89 | MA | 17122 | 4408 | 25802 | 3664 | 30617 | 2969 | 32694 | 2440 | 34231 | 1625 | 42532 | 1131 | 30357 |
| 7L-3S | | MI | 13157 | 4408 | 20326 | 3551 | 23898 | 2868 | 25717 | 2352 | 27530 | 1534 | 33486 | 1279 | 21417 |
| 16-#11 | 1.89 | MA | 16493 | 4408 | 24930 | 3665 | 29468 | 2969 | 31258 | 2439 | 32308 | 1632 | 40070 | 1077 | 29275 |
| 8L-2S | | MI | 13819 | 4408 | 21198 | 3553 | 25004 | 2871 | 27052 | 2347 | 29286 | 1529 | 35797 | 1370 | 21448 |
| 16-#14 | 2.73 | MA | 20509 | 4809 | 32411 | 3890 | 38912 | 3137 | 42735 | 2534 | 47801 | 1591 | 60480 | 1183 | 46186 |
| 4L-6S | | MI | 12287 | 4809 | 20278 | 3790 | 23689 | 3048 | 25367 | 2443 | 27106 | 1492 | 33546 | 850 | 27816 |
| 16-#14 | 2.73 | MA | 19571 | 4809 | 30941 | 3906 | 37147 | 3137 | 40580 | 2546 | 44868 | 1600 | 56722 | 1116 | 44324 |
| 5E | | MI | 12877 | 4809 | 21124 | 3793 | 24814 | 3039 | 26717 | 2450 | 28838 | 1485 | 35671 | 939 | 28699 |
| 16-#14 | 2.73 | MA | 18672 | 4809 | 29634 | 3907 | 35405 | 3151 | 38460 | 2544 | 42047 | 1608 | 52908 | 1008 | 42980 |
| 6L-4S | | MI | 13492 | 4809 | 22072 | 3782 | 25953 | 3045 | 28088 | 2443 | 30700 | 1492 | 37946 | 1000 | 29630 |
| 16-#14 | 2.73 | MA | 17791 | 4809 | 28363 | 3909 | 33722 | 3151 | 36404 | 2556 | 39188 | 1602 | 49513 | 906 | 41068 |
| 7L-3S | | MI | 14167 | 4809 | 23007 | 3785 | 27215 | 3036 | 29598 | 2450 | 32614 | 1485 | 40086 | 1129 | 30178 |
| 16-#14 | 2.73 | MA | 16920 | 4809 | 27112 | 3910 | 32074 | 3150 | 34345 | 2554 | 36430 | 1611 | 46004 | 829 | 38956 |
| 8L-2S | | MI | 15084 | 4809 | 24249 | 3788 | 28790 | 3042 | 31488 | 2443 | 35101 | 1477 | 43349 | 1260 | 30295 |
| 16-#18 | 4.85 | MA | 22316 | 5827 | 39213 | 4531 | 47446 | 3589 | 52969 | 2837 | 61412 | 1536 | 79151 | 688 | 73281 |
| 5E | | MI | 14443 | 5827 | 26289 | 4395 | 31145 | 3463 | 34078 | 2689 | 38492 | 1343 | 48462 | 381 | 46205 |
| 16-#18 | 4.85 | MA | 20843 | 5827 | 36915 | 4531 | 44383 | 3613 | 49241 | 2830 | 56474 | 1549 | 72552 | 494 | 69224 |
| 6L-4S | | MI | 15438 | 5827 | 27945 | 4377 | 33123 | 3476 | 36426 | 2676 | 41683 | 1356 | 52333 | 492 | 48485 |
| 16-#18 | 4.85 | MA | 19401 | 5827 | 34679 | 4532 | 41424 | 3609 | 45627 | 2850 | 51467 | 1536 | 66688 | 312 | 64348 |
| 7L-3S | | MI | 16522 | 5827 | 29575 | 4385 | 35314 | 3463 | 39014 | 2689 | 44962 | 1343 | 55985 | 714 | 51421 |
| 18-#11 | 2.13 | MA | 19736 | 4521 | 29992 | 3720 | 35969 | 3011 | 39209 | 2456 | 43071 | 1610 | 54073 | 1312 | 36695 |
| 4L-7S | | MI | 11796 | 4521 | 18713 | 3625 | 21775 | 2926 | 23140 | 2384 | 24157 | 1525 | 29629 | 977 | 22421 |
| 18-#11 | 2.13 | MA | 19066 | 4521 | 28966 | 3732 | 34738 | 3011 | 37707 | 2465 | 41026 | 1617 | 51438 | 1265 | 35935 |
| 5L-6S | | MI | 12209 | 4521 | 19289 | 3627 | 22536 | 2929 | 24065 | 2379 | 25398 | 1530 | 31059 | 1047 | 22973 |
| 18-#11 | 2.13 | MA | 18425 | 4521 | 28056 | 3733 | 33524 | 3021 | 36228 | 2464 | 39059 | 1624 | 48758 | 1190 | 35128 |
| 6L-5S | | MI | 12630 | 4521 | 19880 | 3629 | 23323 | 2923 | 25018 | 2384 | 26621 | 1525 | 32672 | 1124 | 23370 |
| 18-#11 | 2.13 | MA | 17797 | 4521 | 27170 | 3734 | 32351 | 3021 | 34795 | 2473 | 37066 | 1620 | 46370 | 1120 | 34250 |
| 7L-4S | | MI | 13069 | 4521 | 20543 | 3620 | 24120 | 2926 | 25986 | 2379 | 27892 | 1520 | 34284 | 1166 | 23890 |
| 18-#11 | 2.13 | MA | 17176 | 4521 | 26298 | 3736 | 31202 | 3021 | 33360 | 2471 | 35143 | 1626 | 43909 | 1066 | 33195 |
| 8L-3S | | MI | 13551 | 4521 | 21198 | 3622 | 25004 | 2920 | 27052 | 2384 | 29286 | 1525 | 35797 | 1256 | 23982 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis

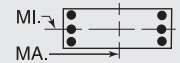



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.13 | MA | 16559 | 4521 | 25334 | 3747 | 30018 | 3032 | 31947 | 2480 | 33238 | 1633 | 41474 | 1007 | 31947 |
| 9L-2S | | MI | 14207 | 4521 | 22069 | 3624 | 26109 | 2923 | 28387 | 2379 | 31042 | 1520 | 38109 | 1347 | 24026 |
| 18-#14 | 3.07 | MA | 20483 | 4973 | 32899 | 4008 | 39630 | 3212 | 43589 | 2594 | 48927 | 1592 | 62185 | 1098 | 49945 |
| 5L-6S | | MI | 12849 | 4973 | 21521 | 3892 | 25264 | 3122 | 27257 | 2488 | 29593 | 1477 | 36809 | 814 | 31267 |
| 18-#14 | 3.07 | MA | 19597 | 4973 | 31593 | 4010 | 37888 | 3226 | 41469 | 2591 | 46106 | 1601 | 58371 | 989 | 48526 |
| 6L-5S | | MI | 13432 | 4973 | 22366 | 3896 | 26390 | 3114 | 28608 | 2496 | 31325 | 1470 | 38934 | 904 | 32229 |
| 18-#14 | 3.07 | MA | 18729 | 4973 | 30321 | 4011 | 36206 | 3225 | 39413 | 2604 | 43247 | 1595 | 54976 | 887 | 46665 |
| 7L-4S | | MI | 14039 | 4973 | 23315 | 3884 | 27528 | 3120 | 29978 | 2488 | 33187 | 1477 | 41209 | 965 | 33112 |
| 18-#14 | 3.07 | MA | 17871 | 4973 | 29070 | 4012 | 34557 | 3225 | 37353 | 2601 | 40488 | 1603 | 51467 | 810 | 44517 |
| 8L-3S | | MI | 14706 | 4973 | 24249 | 3887 | 28790 | 3111 | 31488 | 2496 | 35101 | 1470 | 43349 | 1093 | 33810 |
| 18-#14 | 3.07 | MA | 17018 | 4973 | 27688 | 4028 | 32858 | 3239 | 35327 | 2614 | 37757 | 1612 | 48004 | 726 | 42371 |
| 9L-2S | | MI | 15614 | 4973 | 25492 | 3891 | 30366 | 3117 | 33379 | 2488 | 37588 | 1463 | 46612 | 1225 | 33952 |
| 18-#18 | 5.45 | MA | 22378 | 6118 | 40345 | 4713 | 48733 | 3746 | 54511 | 2914 | 63564 | 1535 | 82005 | 455 | 79004 |
| 6L-5S | | MI | 15348 | 6118 | 28446 | 4577 | 33872 | 3595 | 37316 | 2767 | 42753 | 1312 | 54013 | 309 | 52138 |
| 18-#18 | 5.45 | MA | 20963 | 6118 | 38108 | 4714 | 45774 | 3742 | 50896 | 2934 | 58557 | 1522 | 76141 | 273 | 74065 |
| 7L-4S | | MI | 16320 | 6118 | 30102 | 4558 | 35850 | 3608 | 39663 | 2754 | 45944 | 1325 | 57885 | 420 | 54560 |
| 20-#11 | 2.36 | MA | 19717 | 4635 | 30334 | 3803 | 36473 | 3063 | 39808 | 2498 | 43861 | 1612 | 55277 | 1254 | 39857 |
| 5L-7S | | MI | 12202 | 4635 | 19584 | 3696 | 22881 | 2978 | 24474 | 2417 | 25913 | 1516 | 31941 | 954 | 24867 |
| 20-#11 | 2.36 | MA | 19083 | 4635 | 29423 | 3804 | 35259 | 3073 | 38330 | 2496 | 41894 | 1618 | 52596 | 1179 | 39074 |
| 6E | | MI | 12610 | 4635 | 20160 | 3698 | 23642 | 2981 | 25399 | 2412 | 27154 | 1521 | 33371 | 1025 | 25468 |
| 20-#11 | 2.36 | MA | 18462 | 4635 | 28537 | 3805 | 34086 | 3073 | 36897 | 2506 | 39901 | 1615 | 50209 | 1108 | 38148 |
| 7L-5S | | MI | 13028 | 4635 | 20751 | 3700 | 24429 | 2975 | 26353 | 2417 | 28377 | 1516 | 34983 | 1101 | 25850 |
| 20-#11 | 2.36 | MA | 17848 | 4635 | 27665 | 3807 | 32937 | 3073 | 35461 | 2504 | 37978 | 1621 | 47747 | 1054 | 37118 |
| 8L-4S | | MI | 13462 | 4635 | 21415 | 3691 | 25225 | 2978 | 27320 | 2412 | 29648 | 1511 | 36595 | 1143 | 26436 |
| 20-#11 | 2.36 | MA | 17238 | 4635 | 26702 | 3818 | 31752 | 3083 | 34049 | 2513 | 36073 | 1628 | 45313 | 995 | 35845 |
| 9L-3S | | MI | 13940 | 4635 | 22069 | 3693 | 26109 | 2972 | 28387 | 2417 | 31042 | 1516 | 38109 | 1233 | 26543 |
| 20-#11 | 2.36 | MA | 16631 | 4635 | 25833 | 3819 | 30611 | 3083 | 32630 | 2512 | 34115 | 1624 | 42796 | 915 | 34609 |
| 10L-2S | | MI | 14591 | 4635 | 22941 | 3695 | 27214 | 2975 | 29722 | 2412 | 32798 | 1511 | 40420 | 1324 | 26600 |
| 20-#14 | 3.41 | MA | 20507 | 5136 | 33551 | 4112 | 40371 | 3301 | 44477 | 2639 | 50165 | 1593 | 63834 | 971 | 54084 |
| 6E | | MI | 13403 | 5136 | 22763 | 3995 | 26840 | 3197 | 29148 | 2534 | 32080 | 1463 | 40072 | 779 | 34730 |
| 20-#14 | 3.41 | MA | 19651 | 5136 | 32279 | 4113 | 38689 | 3300 | 42421 | 2651 | 47306 | 1587 | 60440 | 869 | 52271 |
| 7L-5S | | MI | 13979 | 5136 | 23609 | 3998 | 27965 | 3188 | 30498 | 2542 | 33812 | 1455 | 42197 | 869 | 35767 |
| 20-#14 | 3.41 | MA | 18805 | 5136 | 31028 | 4114 | 37040 | 3300 | 40362 | 2649 | 44547 | 1596 | 56930 | 792 | 50086 |
| 8L-4S | | MI | 14579 | 5136 | 24557 | 3986 | 29104 | 3195 | 31868 | 2534 | 35674 | 1463 | 44472 | 930 | 36607 |
| 20-#14 | 3.41 | MA | 17964 | 5136 | 29646 | 4131 | 35341 | 3314 | 38335 | 2661 | 41816 | 1604 | 53467 | 707 | 47914 |
| 9L-3S | | MI | 15239 | 5136 | 25492 | 3989 | 30366 | 3186 | 33379 | 2542 | 37588 | 1455 | 46612 | 1058 | 37439 |
| 20-#18 | 6.06 | MA | 22497 | 6408 | 41538 | 4896 | 50124 | 3875 | 56166 | 3018 | 65647 | 1507 | 85594 | 234 | 83798 |
| 7L-5S | | MI | 16236 | 6408 | 30604 | 4758 | 36598 | 3727 | 40554 | 2845 | 47014 | 1281 | 59564 | 236 | 58095 |
| 22-#11 | 2.60 | MA | 19733 | 4748 | 30791 | 3875 | 36993 | 3125 | 40431 | 2529 | 44729 | 1613 | 56435 | 1167 | 43025 |
| 6L-7S | | MI | 12602 | 4748 | 20456 | 3767 | 23986 | 3030 | 25809 | 2449 | 27669 | 1507 | 34252 | 932 | 27320 |
| 22-#11 | 2.60 | MA | 19119 | 4748 | 29905 | 3876 | 35820 | 3125 | 38998 | 2538 | 42736 | 1609 | 54048 | 1096 | 42053 |
| 7L-6S | | MI | 13007 | 4748 | 21032 | 3769 | 24747 | 3033 | 26734 | 2444 | 28910 | 1512 | 35682 | 1002 | 27966 |
| 22-#11 | 2.60 | MA | 18511 | 4748 | 29033 | 3877 | 34671 | 3125 | 37562 | 2537 | 40813 | 1616 | 51586 | 1042 | 41047 |
| 8L-5S | | MI | 13421 | 4748 | 21623 | 3771 | 25534 | 3026 | 27688 | 2449 | 30132 | 1507 | 37295 | 1078 | 28334 |
| 22-#11 | 2.60 | MA | 17908 | 4748 | 28069 | 3889 | 33487 | 3135 | 36150 | 2546 | 38908 | 1623 | 49152 | 984 | 39748 |
| 9L-4S | | MI | 13852 | 4748 | 22286 | 3762 | 26330 | 3030 | 28655 | 2444 | 31404 | 1501 | 38907 | 1121 | 28980 |
| 22-#11 | 2.60 | MA | 17308 | 4748 | 27201 | 3890 | 32346 | 3135 | 34731 | 2545 | 36950 | 1619 | 46635 | 904 | 38492 |
| 10L-3S | | MI | 14325 | 4748 | 22941 | 3764 | 27214 | 3023 | 29722 | 2449 | 32798 | 1507 | 40420 | 1211 | 29101 |
| 22-#11 | 2.60 | MA | 16666 | 4748 | 26338 | 3891 | 31175 | 3146 | 33327 | 2554 | 35054 | 1625 | 44216 | 847 | 37079 |
| 11L-2S | | MI | 14971 | 4748 | 23812 | 3766 | 28319 | 3027 | 31056 | 2444 | 34554 | 1501 | 42732 | 1302 | 29170 |
| 22-#14 | 3.75 | MA | 20560 | 5300 | 34237 | 4215 | 41172 | 3375 | 45430 | 2698 | 51365 | 1580 | 65903 | 850 | 57883 |
| 7L-6S | | MI | 13949 | 5300 | 24006 | 4097 | 28416 | 3272 | 31038 | 2580 | 34567 | 1448 | 43334 | 744 | 38204 |
| 22-#14 | 3.75 | MA | 19725 | 5300 | 32986 | 4217 | 39523 | 3374 | 43370 | 2696 | 48606 | 1588 | 62393 | 773 | 55662 |
| 8L-5S | | MI | 14519 | 5300 | 24851 | 4100 | 29541 | 3263 | 32388 | 2588 | 36299 | 1441 | 45460 | 833 | 39311 |
| 22-#14 | 3.75 | MA | 18896 | 5300 | 31604 | 4233 | 37824 | 3389 | 41344 | 2708 | 45875 | 1597 | 58930 | 688 | 53464 |
| 9L-4S | | MI | 15112 | 5300 | 25800 | 4088 | 30680 | 3269 | 33759 | 2580 | 38161 | 1448 | 47735 | 895 | 40112 |
| 24-#11 | 2.84 | MA | 19767 | 4862 | 31272 | 3947 | 37555 | 3177 | 41099 | 2571 | 45571 | 1604 | 57887 | 1085 | 45964 |
| 7E | | MI | 12999 | 4862 | 21327 | 3838 | 25091 | 3081 | 27144 | 2482 | 29425 | 1497 | 36564 | 909 | 29778 |

## RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.84 | MA | 19166 | 4862 | 30400 | 3948 | 36405 | 3177 | 39664 | 2570 | 43648 | 1611 | 55425 | 1031 | 44979 |
| 8L-6S | | MI | 13400 | 4862 | 21903 | 3840 | 25852 | 3085 | 28069 | 2477 | 30666 | 1503 | 37994 | 980 | 30467 |
| 24-#11 | 2.84 | MA | 18570 | 4862 | 29437 | 3960 | 35221 | 3187 | 38251 | 2579 | 41743 | 1617 | 52990 | 972 | 43655 |
| 9L-5S | | MI | 13810 | 4862 | 22494 | 3842 | 26639 | 3078 | 29022 | 2482 | 31888 | 1497 | 39606 | 1056 | 30823 |
| 24-#11 | 2.84 | MA | 17973 | 4862 | 28568 | 3961 | 34080 | 3187 | 36832 | 2578 | 39785 | 1614 | 50474 | 892 | 42380 |
| 10L-4S | | MI | 14237 | 4862 | 23158 | 3833 | 27436 | 3082 | 29990 | 2477 | 33160 | 1492 | 41218 | 1098 | 31519 |
| 24-#11 | 2.84 | MA | 17336 | 4862 | 27706 | 3962 | 32909 | 3197 | 35428 | 2587 | 37889 | 1620 | 48054 | 835 | 40988 |
| 11L-3S | | MI | 14707 | 4862 | 23812 | 3835 | 28319 | 3075 | 31056 | 2482 | 34554 | 1497 | 42732 | 1188 | 31657 |
| 24-#14 | 4.09 | MA | 20632 | 5463 | 34944 | 4319 | 42007 | 3449 | 46379 | 2743 | 52665 | 1581 | 67856 | 755 | 61245 |
| 8L-6S | | MI | 14490 | 5463 | 25248 | 4199 | 29992 | 3347 | 32928 | 2626 | 37054 | 1433 | 46597 | 709 | 41686 |
| 24-#14 | 4.09 | MA | 19813 | 5463 | 33562 | 4335 | 40308 | 3463 | 44352 | 2756 | 49933 | 1589 | 64394 | 670 | 59021 |
| 9L-5S | | MI | 15053 | 5463 | 26093 | 4202 | 31117 | 3338 | 34279 | 2633 | 38786 | 1426 | 48723 | 798 | 42861 |

## RECTANGULAR TIED COLUMNS 30" x 46"

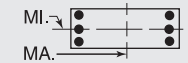
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.16 | MA | 20502 | 4241 | 29361 | 3561 | 34872 | 2897 | 37388 | 2403 | 39643 | 1691 | 48204 | 1588 | 22133 |
| 2E | | MI | 13028 | 4241 | 19445 | 3437 | 22418 | 2793 | 23567 | 2303 | 24346 | 1588 | 29008 | 1451 | 13805 |
| 6-#18 | 1.74 | MA | 22219 | 4532 | 32972 | 3743 | 39452 | 3030 | 42937 | 2487 | 47130 | 1677 | 58217 | 1552 | 32840 |
| 2L-3S | | MI | 12350 | 4532 | 19445 | 3610 | 22418 | 2912 | 23567 | 2394 | 24346 | 1570 | 29008 | 1145 | 20177 |
| 6-#18 | 1.74 | MA | 19455 | 4532 | 29361 | 3744 | 34872 | 3028 | 37388 | 2508 | 39643 | 1691 | 48204 | 1318 | 32478 |
| 3L-2S | | MI | 13996 | 4532 | 21603 | 3618 | 25145 | 2925 | 26805 | 2381 | 28607 | 1557 | 34559 | 1379 | 20261 |
| 8-#14 | 1.30 | MA | 21042 | 4314 | 30184 | 3628 | 36102 | 2947 | 38959 | 2439 | 41818 | 1699 | 51412 | 1603 | 25040 |
| 2L-4S | | MI | 11692 | 4314 | 17753 | 3508 | 20385 | 2857 | 21270 | 2353 | 21443 | 1624 | 25679 | 1212 | 15544 |
| 8-#14 | 1.30 | MA | 19434 | 4314 | 28124 | 3629 | 33489 | 2947 | 35794 | 2452 | 37547 | 1708 | 45633 | 1472 | 24958 |
| 3E | | MI | 12405 | 4314 | 18688 | 3511 | 21648 | 2848 | 22781 | 2361 | 23357 | 1616 | 27818 | 1340 | 15619 |
| 8-#14 | 1.30 | MA | 18272 | 4314 | 26596 | 3631 | 31423 | 2962 | 33290 | 2450 | 34167 | 1703 | 41820 | 1340 | 24647 |
| 4L-2S | | MI | 13369 | 4314 | 19930 | 3514 | 23223 | 2854 | 24671 | 2353 | 25844 | 1609 | 31081 | 1471 | 15605 |
| 8-#18 | 2.32 | MA | 23879 | 4823 | 36584 | 3925 | 44033 | 3163 | 48486 | 2571 | 54616 | 1664 | 68230 | 1516 | 43506 |
| 2L-4S | | MI | 12124 | 4823 | 19972 | 3783 | 22954 | 3057 | 24217 | 2459 | 25328 | 1553 | 30907 | 851 | 24689 |
| 8-#18 | 2.32 | MA | 21176 | 4823 | 32972 | 3926 | 39452 | 3161 | 42937 | 2592 | 47130 | 1678 | 58217 | 1282 | 43015 |
| 3E | | MI | 13321 | 4823 | 21603 | 3792 | 25145 | 3044 | 26805 | 2472 | 28607 | 1539 | 34559 | 1072 | 26472 |
| 8-#18 | 2.32 | MA | 19221 | 4823 | 30287 | 3928 | 35822 | 3185 | 38538 | 2587 | 41192 | 1665 | 51623 | 1049 | 39993 |
| 4L-2S | | MI | 14936 | 4823 | 23760 | 3800 | 27871 | 3057 | 30043 | 2459 | 32868 | 1526 | 40110 | 1306 | 26661 |
| 10-#11 | 1.13 | MA | 20552 | 4227 | 29036 | 3584 | 34740 | 2916 | 37351 | 2421 | 39676 | 1708 | 48645 | 1623 | 21873 |
| 2L-5S | | MI | 11465 | 4227 | 17041 | 3481 | 19637 | 2827 | 20423 | 2349 | 20289 | 1635 | 24212 | 1284 | 13642 |
| 10-#11 | 1.13 | MA | 19420 | 4227 | 27598 | 3585 | 32916 | 2916 | 35141 | 2430 | 36694 | 1715 | 44587 | 1532 | 21843 |
| 3L-4S | | MI | 11922 | 4227 | 17704 | 3473 | 20434 | 2831 | 21391 | 2344 | 21561 | 1630 | 25824 | 1327 | 13708 |
| 10-#11 | 1.13 | MA | 18604 | 4227 | 26532 | 3587 | 31475 | 2927 | 33394 | 2429 | 34337 | 1712 | 41907 | 1441 | 21731 |
| 4L-3S | | MI | 12425 | 4227 | 18359 | 3474 | 21317 | 2824 | 22457 | 2349 | 22955 | 1635 | 27338 | 1417 | 13716 |
| 10-#11 | 1.13 | MA | 17865 | 4227 | 25455 | 3598 | 30183 | 2927 | 31816 | 2439 | 32188 | 1719 | 39125 | 1394 | 21464 |
| 5L-2S | | MI | 13106 | 4227 | 19230 | 3476 | 22423 | 2828 | 23792 | 2344 | 24711 | 1630 | 29649 | 1508 | 13695 |
| 10-#14 | 1.63 | MA | 22029 | 4478 | 32245 | 3730 | 38715 | 3022 | 42125 | 2486 | 46089 | 1691 | 57190 | 1586 | 31141 |
| 2L-5S | | MI | 11638 | 4478 | 18047 | 3622 | 20823 | 2925 | 21790 | 2407 | 22068 | 1601 | 26666 | 1115 | 18314 |
| 10-#14 | 1.63 | MA | 20444 | 4478 | 30184 | 3732 | 36102 | 3022 | 38959 | 2499 | 41818 | 1701 | 51412 | 1455 | 31015 |
| 3L-4S | | MI | 12279 | 4478 | 18995 | 3610 | 21961 | 2932 | 23161 | 2399 | 23930 | 1609 | 28942 | 1176 | 19170 |
| 10-#14 | 1.63 | MA | 19300 | 4478 | 28656 | 3733 | 34036 | 3037 | 36455 | 2497 | 38438 | 1695 | 47598 | 1323 | 30653 |
| 4L-3S | | MI | 12982 | 4478 | 19930 | 3613 | 23223 | 2923 | 24671 | 2407 | 25844 | 1601 | 31081 | 1305 | 19290 |
| 10-#14 | 1.63 | MA | 18265 | 4478 | 27111 | 3750 | 32182 | 3037 | 34192 | 2510 | 35356 | 1704 | 43630 | 1256 | 29079 |
| 5L-2S | | MI | 13934 | 4478 | 21173 | 3617 | 24799 | 2929 | 26562 | 2399 | 28331 | 1594 | 34344 | 1436 | 19312 |
| 10-#18 | 2.90 | MA | 25493 | 5114 | 40195 | 4106 | 48613 | 3296 | 54035 | 2656 | 62103 | 1651 | 78243 | 1480 | 54149 |
| 2L-5S | | MI | 12022 | 5114 | 20474 | 3983 | 23703 | 3176 | 25107 | 2550 | 26398 | 1508 | 32587 | 668 | 28961 |
| 10-#18 | 2.90 | MA | 22845 | 5114 | 36584 | 4108 | 44033 | 3294 | 48486 | 2677 | 54616 | 1665 | 68230 | 1246 | 53549 |
| 3L-4S | | MI | 13093 | 5114 | 22130 | 3965 | 25681 | 3189 | 27455 | 2536 | 29589 | 1521 | 36458 | 778 | 30637 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis

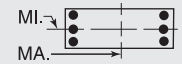



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 2.90 | MA | 20935 | 5114 | 33898 | 4109 | 40402 | 3318 | 44087 | 2671 | 48678 | 1652 | 61636 | 1013 | 50176 |
| 4L-3S | | MI | 14268 | 5114 | 23760 | 3974 | 27871 | 3176 | 30043 | 2550 | 32868 | 1508 | 40110 | 1000 | 32748 |
| 10-#18 | 2.90 | MA | 19206 | 5114 | 31181 | 4137 | 37141 | 3316 | 40106 | 2692 | 43259 | 1666 | 54736 | 896 | 47073 |
| 5L-2S | | MI | 15855 | 5114 | 25918 | 3982 | 30598 | 3189 | 33281 | 2536 | 37129 | 1495 | 45662 | 1234 | 33025 |
| 12-#11 | 1.36 | MA | 21255 | 4340 | 30475 | 3655 | 36565 | 2968 | 39561 | 2454 | 42658 | 1703 | 52703 | 1613 | 26139 |
| 2L-6S | | MI | 11450 | 4340 | 17321 | 3550 | 19955 | 2886 | 20805 | 2376 | 20823 | 1631 | 24911 | 1186 | 15619 |
| 12-#11 | 1.36 | MA | 20135 | 4340 | 29036 | 3656 | 34740 | 2968 | 37351 | 2463 | 39676 | 1710 | 48645 | 1522 | 26088 |
| 3L-5S | | MI | 11885 | 4340 | 17912 | 3552 | 20742 | 2879 | 21758 | 2382 | 22045 | 1626 | 26524 | 1262 | 16088 |
| 12-#11 | 1.36 | MA | 19328 | 4340 | 27971 | 3658 | 33299 | 2979 | 35604 | 2462 | 37319 | 1707 | 45964 | 1431 | 25948 |
| 4E | | MI | 12338 | 4340 | 18576 | 3543 | 21539 | 2882 | 22726 | 2376 | 23317 | 1621 | 28136 | 1304 | 16277 |
| 12-#11 | 1.36 | MA | 18598 | 4340 | 26894 | 3669 | 32007 | 2979 | 34026 | 2472 | 35170 | 1714 | 43183 | 1383 | 25565 |
| 5L-3S | | MI | 12836 | 4340 | 19230 | 3545 | 22423 | 2876 | 23792 | 2382 | 24711 | 1626 | 29649 | 1394 | 16307 |
| 12-#11 | 1.36 | MA | 17898 | 4340 | 25938 | 3671 | 30732 | 2990 | 32474 | 2471 | 33105 | 1721 | 40349 | 1308 | 24585 |
| 6L-2S | | MI | 13511 | 4340 | 20101 | 3547 | 23528 | 2879 | 25127 | 2376 | 26467 | 1621 | 31961 | 1485 | 16300 |
| 12-#14 | 1.96 | MA | 22997 | 4641 | 34305 | 3832 | 41328 | 3097 | 45291 | 2534 | 50360 | 1684 | 62969 | 1569 | 37231 |
| 2L-6S | | MI | 11614 | 4641 | 18444 | 3721 | 21273 | 3009 | 22330 | 2445 | 22824 | 1594 | 27804 | 990 | 21192 |
| 12-#14 | 1.96 | MA | 21433 | 4641 | 32245 | 3834 | 38715 | 3097 | 42125 | 2547 | 46089 | 1693 | 57190 | 1438 | 37066 |
| 3L-5S | | MI | 12222 | 4641 | 19289 | 3724 | 22398 | 3000 | 23681 | 2453 | 24555 | 1587 | 29929 | 1080 | 21809 |
| 12-#14 | 1.96 | MA | 20306 | 4641 | 30717 | 3835 | 36649 | 3112 | 39621 | 2545 | 42709 | 1688 | 53377 | 1306 | 36659 |
| 4E | | MI | 12854 | 4641 | 20238 | 3712 | 23537 | 3006 | 25051 | 2445 | 26417 | 1594 | 32204 | 1141 | 22789 |
| 12-#14 | 1.96 | MA | 19288 | 4641 | 29171 | 3852 | 34795 | 3111 | 37357 | 2558 | 39627 | 1697 | 49409 | 1239 | 34959 |
| 5L-3S | | MI | 13549 | 4641 | 21173 | 3716 | 24799 | 2998 | 26562 | 2453 | 28331 | 1587 | 34344 | 1269 | 22947 |
| 12-#14 | 1.96 | MA | 18310 | 4641 | 27800 | 3854 | 32965 | 3126 | 35130 | 2556 | 36664 | 1706 | 45374 | 1131 | 33695 |
| 6L-2S | | MI | 14490 | 4641 | 22415 | 3719 | 26375 | 3004 | 28452 | 2445 | 30818 | 1579 | 37607 | 1401 | 23000 |
| 12-#18 | 3.48 | MA | 24471 | 5404 | 40195 | 4290 | 48613 | 3427 | 54035 | 2761 | 62103 | 1651 | 78243 | 1210 | 64083 |
| 3L-5S | | MI | 12989 | 5404 | 22632 | 4165 | 26429 | 3308 | 28345 | 2627 | 30659 | 1477 | 38138 | 595 | 34789 |
| 12-#18 | 3.48 | MA | 22603 | 5404 | 37510 | 4291 | 44982 | 3451 | 49636 | 2755 | 56165 | 1639 | 71649 | 976 | 60400 |
| 4E | | MI | 14040 | 5404 | 24287 | 4147 | 28407 | 3321 | 30693 | 2614 | 33850 | 1490 | 42010 | 706 | 36627 |
| 12-#18 | 3.48 | MA | 20913 | 5404 | 34792 | 4319 | 41721 | 3449 | 45655 | 2776 | 50746 | 1652 | 64749 | 860 | 57415 |
| 5L-3S | | MI | 15194 | 5404 | 25918 | 4155 | 30598 | 3308 | 33281 | 2627 | 37129 | 1477 | 45662 | 928 | 39012 |
| 12-#18 | 3.48 | MA | 19291 | 5404 | 32378 | 4320 | 38503 | 3473 | 41737 | 2770 | 45534 | 1666 | 57758 | 667 | 52700 |
| 6L-2S | | MI | 16755 | 5404 | 28075 | 4164 | 33325 | 3321 | 36519 | 2614 | 41389 | 1464 | 51213 | 1161 | 39369 |
| 14-#11 | 1.58 | MA | 21948 | 4454 | 31913 | 3725 | 38389 | 3020 | 41771 | 2487 | 45640 | 1698 | 56760 | 1602 | 30397 |
| 2L-7S | | MI | 11447 | 4454 | 17617 | 3619 | 20300 | 2934 | 21214 | 2414 | 21338 | 1617 | 25793 | 1092 | 17721 |
| 14-#11 | 1.58 | MA | 20839 | 4454 | 30475 | 3727 | 36565 | 3020 | 39561 | 2496 | 42658 | 1705 | 52703 | 1511 | 30327 |
| 3L-6S | | MI | 11869 | 4454 | 18193 | 3621 | 21061 | 2937 | 22140 | 2409 | 22579 | 1622 | 27223 | 1163 | 18100 |
| 14-#11 | 1.58 | MA | 20041 | 4454 | 29409 | 3728 | 35124 | 3031 | 37815 | 2495 | 40301 | 1702 | 50022 | 1420 | 30164 |
| 4L-5S | | MI | 12300 | 4454 | 18784 | 3623 | 21848 | 2931 | 23093 | 2414 | 23801 | 1617 | 28835 | 1239 | 18543 |
| 14-#11 | 1.58 | MA | 19319 | 4454 | 28332 | 3740 | 33831 | 3031 | 36237 | 2505 | 38152 | 1709 | 47241 | 1373 | 29665 |
| 5L-4S | | MI | 12748 | 4454 | 19447 | 3614 | 22644 | 2934 | 24060 | 2409 | 25073 | 1611 | 30447 | 1281 | 18837 |
| 14-#11 | 1.58 | MA | 18628 | 4454 | 27376 | 3742 | 32556 | 3042 | 34684 | 2504 | 36087 | 1716 | 44407 | 1298 | 28722 |
| 6L-3S | | MI | 13241 | 4454 | 20101 | 3616 | 23528 | 2928 | 25127 | 2414 | 26467 | 1617 | 31961 | 1372 | 18886 |
| 14-#11 | 1.58 | MA | 17951 | 4454 | 26446 | 3743 | 31324 | 3042 | 33179 | 2513 | 33993 | 1713 | 41882 | 1227 | 27998 |
| 7L-2S | | MI | 13910 | 4454 | 20973 | 3618 | 24633 | 2931 | 26462 | 2409 | 28223 | 1611 | 34272 | 1463 | 18897 |
| 14-#14 | 2.28 | MA | 22403 | 4805 | 34305 | 3936 | 41328 | 3172 | 45291 | 2594 | 50360 | 1686 | 62969 | 1421 | 43112 |
| 3L-6S | | MI | 12195 | 4805 | 19686 | 3823 | 22849 | 3084 | 24221 | 2491 | 25311 | 1579 | 31067 | 955 | 24611 |
| 14-#14 | 2.28 | MA | 21293 | 4805 | 32777 | 3938 | 39262 | 3186 | 42786 | 2592 | 46980 | 1680 | 59156 | 1289 | 42666 |
| 4L-5S | | MI | 12795 | 4805 | 20532 | 3826 | 23974 | 3075 | 25571 | 2498 | 27042 | 1572 | 33192 | 1044 | 25318 |
| 14-#14 | 2.28 | MA | 20290 | 4805 | 31232 | 3954 | 37408 | 3186 | 40523 | 2605 | 43898 | 1690 | 55188 | 1222 | 40854 |
| 5L-4S | | MI | 13420 | 4805 | 21480 | 3815 | 25113 | 3081 | 26941 | 2491 | 28904 | 1579 | 35467 | 1106 | 26328 |
| 14-#14 | 2.28 | MA | 19328 | 4805 | 29860 | 3956 | 35578 | 3201 | 38295 | 2603 | 40935 | 1699 | 51152 | 1114 | 39631 |
| 6L-3S | | MI | 14106 | 4805 | 22415 | 3818 | 26375 | 3072 | 28452 | 2498 | 30818 | 1572 | 37607 | 1234 | 26594 |
| 14-#14 | 2.28 | MA | 18385 | 4805 | 28525 | 3958 | 33811 | 3201 | 36136 | 2616 | 37931 | 1693 | 47559 | 1012 | 37524 |
| 7L-2S | | MI | 15037 | 4805 | 23658 | 3821 | 27950 | 3079 | 30342 | 2491 | 33305 | 1565 | 40870 | 1366 | 26674 |
| 14-#18 | 4.06 | MA | 24231 | 5695 | 41121 | 4473 | 49563 | 3584 | 55185 | 2839 | 63651 | 1625 | 81662 | 940 | 70658 |
| 4L-5S | | MI | 13936 | 5695 | 24789 | 4347 | 29156 | 3440 | 31583 | 2705 | 34919 | 1446 | 43689 | 523 | 40655 |
| 14-#18 | 4.06 | MA | 22577 | 5695 | 38404 | 4501 | 46301 | 3582 | 51204 | 2860 | 58232 | 1639 | 74762 | 824 | 67548 |
| 5L-4S | | MI | 14969 | 5695 | 26445 | 4329 | 31134 | 3454 | 33931 | 2692 | 38110 | 1459 | 47561 | 634 | 42650 |

## RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis



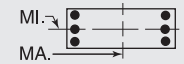

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 4.06 | MA | 20990 | 5695 | 35990 | 4502 | 43083 | 3606 | 47286 | 2855 | 53021 | 1653 | 67771 | 631 | 62973 |
| 6L-3S | | MI | 16103 | 5695 | 28075 | 4337 | 33325 | 3440 | 36519 | 2705 | 41389 | 1446 | 51213 | 855 | 45269 |
| 14-#18 | 4.06 | MA | 19434 | 5695 | 33640 | 4504 | 39973 | 3604 | 43487 | 2875 | 47738 | 1640 | 61555 | 449 | 58054 |
| 7L-2S | | MI | 17639 | 5695 | 30233 | 4345 | 36051 | 3454 | 39757 | 2692 | 45650 | 1433 | 56764 | 1089 | 45697 |
| 16-#11 | 1.81 | MA | 21532 | 4567 | 31913 | 3798 | 38389 | 3072 | 41771 | 2529 | 45640 | 1700 | 56760 | 1500 | 34562 |
| 3L-7S | | MI | 11864 | 4567 | 18488 | 3690 | 21405 | 2986 | 22549 | 2447 | 23094 | 1607 | 28104 | 1070 | 20150 |
| 16-#11 | 1.81 | MA | 20742 | 4567 | 30848 | 3799 | 36948 | 3083 | 40025 | 2528 | 43282 | 1697 | 54080 | 1409 | 34377 |
| 4L-6S | | MI | 12282 | 4567 | 19064 | 3692 | 22166 | 2989 | 23474 | 2441 | 24335 | 1613 | 29534 | 1141 | 20587 |
| 16-#11 | 1.81 | MA | 20029 | 4567 | 29771 | 3811 | 35656 | 3083 | 38447 | 2537 | 41134 | 1704 | 51299 | 1362 | 33775 |
| 5E | | MI | 12709 | 4567 | 19655 | 3694 | 22953 | 2983 | 24428 | 2447 | 25557 | 1607 | 31147 | 1217 | 21008 |
| 16-#11 | 1.81 | MA | 19346 | 4567 | 28815 | 3813 | 34380 | 3094 | 36894 | 2537 | 39069 | 1711 | 48465 | 1287 | 32864 |
| 6L-4S | | MI | 13153 | 4567 | 20319 | 3685 | 23749 | 2986 | 25395 | 2441 | 26829 | 1602 | 32759 | 1259 | 21393 |
| 16-#11 | 1.81 | MA | 18677 | 4567 | 27885 | 3814 | 33149 | 3094 | 35389 | 2546 | 36975 | 1708 | 45940 | 1216 | 32089 |
| 7L-3S | | MI | 13641 | 4567 | 20973 | 3687 | 24633 | 2979 | 26462 | 2447 | 28223 | 1607 | 34272 | 1349 | 21459 |
| 16-#11 | 1.81 | MA | 18015 | 4567 | 26969 | 3816 | 31942 | 3094 | 33882 | 2545 | 34955 | 1715 | 43341 | 1162 | 30915 |
| 8L-2S | | MI | 14305 | 4567 | 21844 | 3689 | 25738 | 2983 | 27796 | 2441 | 29979 | 1602 | 36584 | 1440 | 21484 |
| 16-#14 | 2.61 | MA | 22262 | 4968 | 34837 | 4040 | 41875 | 3261 | 45952 | 2639 | 51251 | 1673 | 64934 | 1272 | 48674 |
| 4L-6S | | MI | 12767 | 4968 | 20929 | 3925 | 24424 | 3159 | 26111 | 2537 | 27798 | 1565 | 34330 | 920 | 28045 |
| 16-#14 | 2.61 | MA | 21273 | 4968 | 33292 | 4057 | 40020 | 3261 | 43688 | 2652 | 48169 | 1682 | 60966 | 1205 | 46762 |
| 5E | | MI | 13360 | 4968 | 21774 | 3928 | 25550 | 3150 | 27461 | 2544 | 29529 | 1557 | 36455 | 1009 | 28839 |
| 16-#14 | 2.61 | MA | 20325 | 4968 | 31920 | 4058 | 38191 | 3276 | 41461 | 2650 | 45206 | 1692 | 56931 | 1097 | 45496 |
| 6L-4S | | MI | 13977 | 4968 | 22723 | 3917 | 26688 | 3156 | 28832 | 2537 | 31391 | 1565 | 38730 | 1071 | 29792 |
| 16-#14 | 2.61 | MA | 19397 | 4968 | 30585 | 4060 | 36423 | 3276 | 39302 | 2663 | 42202 | 1686 | 53338 | 995 | 43412 |
| 7L-3S | | MI | 14655 | 4968 | 23658 | 3920 | 27950 | 3147 | 30342 | 2544 | 33305 | 1557 | 40870 | 1199 | 30235 |
| 16-#14 | 2.61 | MA | 18479 | 4968 | 29271 | 4062 | 34692 | 3276 | 37138 | 2662 | 39304 | 1695 | 49631 | 917 | 41299 |
| 8L-2S | | MI | 15576 | 4968 | 24900 | 3923 | 29526 | 3153 | 32232 | 2537 | 35792 | 1550 | 44133 | 1330 | 30341 |
| 16-#18 | 4.64 | MA | 24204 | 5986 | 42015 | 4682 | 50882 | 3715 | 56753 | 2944 | 65719 | 1626 | 84775 | 787 | 77708 |
| 5E | | MI | 14930 | 5986 | 26947 | 4528 | 31883 | 3573 | 34821 | 2783 | 39180 | 1415 | 49240 | 451 | 46553 |
| 16-#18 | 4.64 | MA | 22650 | 5986 | 39601 | 4684 | 47663 | 3739 | 52835 | 2939 | 60507 | 1640 | 77784 | 594 | 73266 |
| 6L-4S | | MI | 15933 | 5986 | 28602 | 4510 | 33860 | 3586 | 37169 | 2770 | 42371 | 1428 | 53112 | 561 | 48701 |
| 16-#18 | 4.64 | MA | 21127 | 5986 | 37251 | 4685 | 44553 | 3737 | 49036 | 2960 | 55224 | 1627 | 71568 | 412 | 68288 |
| 7L-3S | | MI | 17025 | 5986 | 30233 | 4519 | 36051 | 3573 | 39757 | 2783 | 45650 | 1415 | 56764 | 783 | 51520 |
| 16-#18 | 4.64 | MA | 19619 | 5986 | 34937 | 4687 | 41506 | 3735 | 45229 | 2954 | 50126 | 1640 | 65124 | 277 | 63282 |
| 8L-2S | | MI | 18498 | 5986 | 32390 | 4527 | 38778 | 3586 | 42995 | 2770 | 49911 | 1402 | 62315 | 1017 | 52014 |
| 18-#11 | 2.03 | MA | 21435 | 4680 | 32286 | 3870 | 38772 | 3134 | 42235 | 2561 | 46264 | 1692 | 58138 | 1399 | 38590 |
| 4L-7S | | MI | 12275 | 4680 | 19360 | 3761 | 22510 | 3038 | 23884 | 2479 | 24850 | 1598 | 30416 | 1047 | 22588 |
| 18-#11 | 2.03 | MA | 20729 | 4680 | 31209 | 3882 | 37480 | 3135 | 40657 | 2570 | 44116 | 1699 | 55356 | 1351 | 37894 |
| 5L-6S | | MI | 12689 | 4680 | 19935 | 3763 | 23271 | 3041 | 24809 | 2474 | 26090 | 1603 | 31846 | 1118 | 23078 |
| 18-#11 | 2.03 | MA | 20053 | 4680 | 30253 | 3883 | 36205 | 3145 | 39104 | 2569 | 42050 | 1706 | 52523 | 1276 | 37013 |
| 6L-5S | | MI | 13112 | 4680 | 20526 | 3765 | 24058 | 3034 | 25762 | 2479 | 27313 | 1598 | 33458 | 1194 | 23481 |
| 18-#11 | 2.03 | MA | 19392 | 4680 | 29323 | 3885 | 34973 | 3146 | 37600 | 2579 | 39957 | 1702 | 49997 | 1206 | 36187 |
| 7L-4S | | MI | 13552 | 4680 | 21190 | 3756 | 24855 | 3038 | 26730 | 2474 | 28585 | 1593 | 35070 | 1236 | 23944 |
| 18-#11 | 2.03 | MA | 18738 | 4680 | 28407 | 3886 | 33766 | 3146 | 36092 | 2578 | 37937 | 1709 | 47399 | 1151 | 35042 |
| 8L-3S | | MI | 14036 | 4680 | 21844 | 3758 | 25738 | 3031 | 27796 | 2479 | 29979 | 1598 | 36584 | 1326 | 24026 |
| 18-#11 | 2.03 | MA | 18088 | 4680 | 27396 | 3898 | 32523 | 3157 | 34609 | 2587 | 35938 | 1717 | 44825 | 1093 | 33811 |
| 9L-2S | | MI | 14695 | 4680 | 22716 | 3760 | 26843 | 3035 | 29131 | 2474 | 31735 | 1593 | 38895 | 1418 | 24064 |
| 18-#14 | 2.93 | MA | 22240 | 5132 | 35352 | 4159 | 42633 | 3336 | 46854 | 2700 | 52439 | 1675 | 66745 | 1188 | 52680 |
| 5L-6S | | MI | 13330 | 5132 | 22171 | 4027 | 26000 | 3233 | 28001 | 2583 | 30284 | 1550 | 37593 | 885 | 31493 |
| 18-#14 | 2.93 | MA | 21306 | 5132 | 33980 | 4160 | 40804 | 3351 | 44627 | 2698 | 49477 | 1684 | 62710 | 1080 | 51339 |
| 6L-5S | | MI | 13916 | 5132 | 23017 | 4031 | 27125 | 3225 | 29352 | 2590 | 32016 | 1543 | 39718 | 974 | 32368 |
| 18-#14 | 2.93 | MA | 20391 | 5132 | 32645 | 4162 | 39036 | 3351 | 42467 | 2711 | 46473 | 1679 | 59117 | 978 | 49308 |
| 7L-4S | | MI | 14526 | 5132 | 23965 | 4019 | 28264 | 3231 | 30722 | 2583 | 33878 | 1550 | 41993 | 1035 | 33272 |
| 18-#14 | 2.93 | MA | 19486 | 5132 | 31331 | 4164 | 37305 | 3350 | 40304 | 2709 | 43575 | 1688 | 55410 | 900 | 47159 |
| 8L-3S | | MI | 15196 | 5132 | 24900 | 4022 | 29526 | 3222 | 32232 | 2590 | 35792 | 1543 | 44133 | 1164 | 33870 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis

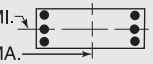


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.93 | MA | 18587 | 5132 | 29880 | 4180 | 35520 | 3365 | 38176 | 2722 | 40705 | 1697 | 51745 | 815 | 45002 |
| 9L-2S | | MI | 16108 | 5132 | 26142 | 4026 | 31102 | 3228 | 34123 | 2583 | 38279 | 1535 | 47396 | 1295 | 34000 |
| 18-#18 | 5.22 | MA | 24277 | 6277 | 43213 | 4866 | 52243 | 3872 | 58384 | 3023 | 67994 | 1626 | 87797 | 558 | 83577 |
| 6L-5S | | MI | 15838 | 6277 | 29104 | 4710 | 34609 | 3705 | 38059 | 2861 | 43441 | 1384 | 54792 | 378 | 52479 |
| 18-#18 | 5.22 | MA | 22783 | 6277 | 40862 | 4867 | 49133 | 3870 | 54585 | 3044 | 62710 | 1614 | 81581 | 376 | 78539 |
| 7L-4S | | MI | 16819 | 6277 | 30760 | 4692 | 36587 | 3718 | 40407 | 2847 | 46632 | 1397 | 58663 | 489 | 54773 |
| 18-#18 | 5.22 | MA | 21305 | 6277 | 38549 | 4868 | 46086 | 3868 | 50778 | 3038 | 57612 | 1627 | 75137 | 241 | 73492 |
| 8L-3S | | MI | 17888 | 6277 | 32390 | 4700 | 38778 | 3705 | 42995 | 2861 | 49911 | 1384 | 62315 | 710 | 57634 |
| 20-#11 | 2.26 | MA | 21420 | 4794 | 32648 | 3953 | 39304 | 3187 | 42867 | 2603 | 47098 | 1693 | 59414 | 1341 | 42021 |
| 5L-7S | | MI | 12682 | 4794 | 20231 | 3832 | 23615 | 3089 | 25219 | 2512 | 26606 | 1589 | 32727 | 1025 | 25033 |
| 20-#11 | 2.26 | MA | 20751 | 4794 | 31692 | 3954 | 38029 | 3197 | 41315 | 2602 | 45032 | 1700 | 56580 | 1266 | 41167 |
| 6E | | MI | 13092 | 4794 | 20807 | 3834 | 24376 | 3093 | 26144 | 2507 | 27846 | 1594 | 34157 | 1095 | 25574 |
| 20-#11 | 2.26 | MA | 20097 | 4794 | 30761 | 3956 | 36797 | 3198 | 39810 | 2612 | 42939 | 1697 | 54055 | 1195 | 40292 |
| 7L-5S | | MI | 13511 | 4794 | 21398 | 3836 | 25163 | 3086 | 27097 | 2512 | 29069 | 1589 | 35770 | 1171 | 25960 |
| 20-#11 | 2.26 | MA | 19450 | 4794 | 29846 | 3957 | 35591 | 3198 | 38302 | 2611 | 40919 | 1704 | 51457 | 1140 | 39173 |
| 8L-4S | | MI | 13947 | 4794 | 22062 | 3827 | 25960 | 3090 | 28065 | 2507 | 30341 | 1584 | 37382 | 1214 | 26493 |
| 20-#11 | 2.26 | MA | 18807 | 4794 | 28834 | 3969 | 34347 | 3208 | 36819 | 2620 | 38919 | 1711 | 48882 | 1082 | 37916 |
| 9L-3S | | MI | 14427 | 4794 | 22716 | 3829 | 26843 | 3083 | 29131 | 2512 | 31735 | 1589 | 38895 | 1304 | 26589 |
| 20-#11 | 2.26 | MA | 18166 | 4794 | 27922 | 3971 | 33149 | 3209 | 35329 | 2619 | 36863 | 1708 | 46221 | 1002 | 36686 |
| 10L-2S | | MI | 15080 | 4794 | 23587 | 3830 | 27949 | 3087 | 30466 | 2507 | 33491 | 1584 | 41207 | 1395 | 26639 |
| 20-#14 | 3.26 | MA | 22271 | 5295 | 36041 | 4263 | 43417 | 3425 | 47792 | 2745 | 53747 | 1677 | 68488 | 1063 | 57193 |
| 6E | | MI | 13886 | 5295 | 23414 | 4130 | 27576 | 3308 | 29892 | 2629 | 32771 | 1535 | 40855 | 849 | 34953 |
| 20-#14 | 3.26 | MA | 21368 | 5295 | 34706 | 4264 | 41649 | 3425 | 45633 | 2758 | 50744 | 1671 | 64895 | 961 | 55212 |
| 7L-5S | | MI | 14465 | 5295 | 24259 | 4133 | 28701 | 3299 | 31242 | 2636 | 34503 | 1528 | 42981 | 939 | 35906 |
| 20-#14 | 3.26 | MA | 20476 | 5295 | 33391 | 4266 | 39918 | 3425 | 43469 | 2756 | 47846 | 1680 | 61189 | 883 | 53027 |
| 8L-4S | | MI | 15068 | 5295 | 25208 | 4121 | 29840 | 3306 | 32612 | 2629 | 36365 | 1535 | 45256 | 1000 | 36765 |
| 20-#14 | 3.26 | MA | 19589 | 5295 | 31940 | 4283 | 38133 | 3440 | 41341 | 2769 | 44976 | 1690 | 57524 | 798 | 50845 |
| 9L-3S | | MI | 15731 | 5295 | 26142 | 4125 | 31102 | 3297 | 34123 | 2636 | 38279 | 1528 | 47396 | 1128 | 37501 |
| 20-#14 | 3.26 | MA | 18695 | 5295 | 30631 | 4284 | 36414 | 3440 | 39203 | 2767 | 42026 | 1684 | 53736 | 683 | 48419 |
| 10L-2S | | MI | 16634 | 5295 | 27385 | 4128 | 32678 | 3303 | 36013 | 2629 | 40766 | 1520 | 50659 | 1260 | 37654 |
| 20-#18 | 5.80 | MA | 24409 | 6568 | 44474 | 5049 | 53713 | 4003 | 60134 | 3128 | 70197 | 1600 | 91594 | 340 | 88805 |
| 7L-5S | | MI | 16730 | 6568 | 31262 | 4892 | 37336 | 3837 | 41297 | 2938 | 47702 | 1353 | 60343 | 306 | 58431 |
| 20-#18 | 5.80 | MA | 22959 | 6568 | 42160 | 5050 | 50666 | 4001 | 56327 | 3122 | 65098 | 1614 | 85150 | 205 | 83716 |
| 8L-4S | | MI | 17689 | 6568 | 32918 | 4874 | 39314 | 3850 | 43645 | 2925 | 50892 | 1366 | 64214 | 416 | 60863 |
| 22-#11 | 2.49 | MA | 21440 | 4907 | 33130 | 4025 | 39853 | 3249 | 43525 | 2635 | 48014 | 1695 | 60638 | 1255 | 45325 |
| 6L-7S | | MI | 13084 | 4907 | 21102 | 3903 | 24720 | 3141 | 26553 | 2544 | 28362 | 1580 | 35039 | 1002 | 27484 |
| 22-#11 | 2.49 | MA | 20793 | 4907 | 32200 | 4027 | 38622 | 3249 | 42020 | 2645 | 45921 | 1692 | 58113 | 1184 | 44403 |
| 7L-6S | | MI | 13490 | 4907 | 21678 | 3905 | 25481 | 3145 | 27479 | 2539 | 29602 | 1585 | 36469 | 1073 | 28072 |
| 22-#11 | 2.49 | MA | 20153 | 4907 | 31284 | 4028 | 37415 | 3250 | 40512 | 2644 | 43901 | 1699 | 55515 | 1130 | 43309 |
| 8L-5S | | MI | 13906 | 4907 | 22269 | 3906 | 26269 | 3138 | 28432 | 2544 | 30825 | 1580 | 38081 | 1149 | 28444 |
| 22-#11 | 2.49 | MA | 19517 | 4907 | 30273 | 4040 | 36172 | 3260 | 39029 | 2653 | 41901 | 1706 | 52940 | 1071 | 42026 |
| 9L-4S | | MI | 14338 | 4907 | 22933 | 3898 | 27065 | 3142 | 29399 | 2539 | 32097 | 1574 | 39693 | 1191 | 29039 |
| 22-#11 | 2.49 | MA | 18878 | 4907 | 29361 | 4041 | 34974 | 3261 | 37539 | 2652 | 39845 | 1703 | 50279 | 991 | 40787 |
| 10L-3S | | MI | 14814 | 4907 | 23587 | 3900 | 27949 | 3135 | 30466 | 2544 | 33491 | 1580 | 41207 | 1281 | 29149 |
| 22-#11 | 2.49 | MA | 18199 | 4907 | 28456 | 4043 | 33744 | 3271 | 36065 | 2662 | 37854 | 1710 | 47725 | 934 | 39254 |
| 11L-2S | | MI | 15462 | 4907 | 24459 | 3901 | 29054 | 3139 | 31801 | 2539 | 35247 | 1574 | 43519 | 1372 | 29211 |
| 22-#14 | 3.59 | MA | 22331 | 5459 | 36766 | 4367 | 44262 | 3500 | 48798 | 2806 | 55015 | 1664 | 70674 | 944 | 61124 |
| 7L-6S | | MI | 14434 | 5459 | 24656 | 4232 | 29151 | 3383 | 31782 | 2674 | 35258 | 1520 | 44118 | 814 | 38424 |
| 22-#14 | 3.59 | MA | 21451 | 5459 | 35452 | 4368 | 42531 | 3500 | 46635 | 2804 | 52117 | 1673 | 66968 | 866 | 58903 |
| 8L-5S | | MI | 15007 | 5459 | 25501 | 4235 | 30277 | 3374 | 33132 | 2682 | 36990 | 1513 | 46244 | 903 | 39449 |
| 22-#14 | 3.59 | MA | 20576 | 5459 | 34000 | 4385 | 40746 | 3515 | 44507 | 2817 | 49247 | 1682 | 63303 | 781 | 56696 |
| 9L-4S | | MI | 15604 | 5459 | 26450 | 4223 | 31415 | 3380 | 34502 | 2674 | 38852 | 1520 | 48519 | 965 | 40269 |
| 22-#14 | 3.59 | MA | 19686 | 5459 | 32691 | 4387 | 39027 | 3515 | 42368 | 2815 | 46296 | 1677 | 59514 | 666 | 54307 |
| 10L-3S | | MI | 16260 | 5459 | 27385 | 4227 | 32678 | 3372 | 36013 | 2682 | 40766 | 1513 | 50659 | 1093 | 41129 |
| 22-#18 | 6.38 | MA | 24584 | 6858 | 45772 | 5232 | 55246 | 4134 | 61876 | 3207 | 72585 | 1601 | 95163 | 169 | 93954 |
| 8L-5S | | MI | 17607 | 6858 | 33419 | 5074 | 40062 | 3969 | 44535 | 3016 | 51962 | 1322 | 65894 | 233 | 64405 |
| 24-#11 | 2.71 | MA | 21480 | 5021 | 33638 | 4098 | 40446 | 3301 | 44230 | 2677 | 48903 | 1687 | 62171 | 1174 | 48520 |
| 7E | | MI | 13481 | 5021 | 21974 | 3974 | 25826 | 3193 | 27888 | 2577 | 30118 | 1570 | 37351 | 980 | 29941 |

## RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.71 | MA | 20847 | 5021 | 32723 | 4099 | 39239 | 3302 | 42723 | 2677 | 46883 | 1694 | 59572 | 1119 | 47449 |
| 8L-6S | | MI | 13884 | 5021 | 22550 | 3976 | 26587 | 3197 | 28813 | 2572 | 31358 | 1575 | 38780 | 1050 | 30574 |
| 24-#11 | 2.71 | MA | 20218 | 5021 | 31711 | 4111 | 37996 | 3312 | 41239 | 2686 | 44883 | 1701 | 56998 | 1061 | 46140 |
| 9L-5S | | MI | 14296 | 5021 | 23141 | 3977 | 27374 | 3190 | 29767 | 2577 | 32581 | 1570 | 40393 | 1126 | 30933 |
| 24-#11 | 2.71 | MA | 19581 | 5021 | 30799 | 4112 | 36798 | 3312 | 39749 | 2685 | 42827 | 1698 | 54337 | 981 | 44882 |
| 10L-4S | | MI | 14725 | 5021 | 23804 | 3969 | 28170 | 3194 | 30734 | 2572 | 33853 | 1565 | 42005 | 1168 | 31583 |
| 24-#11 | 2.71 | MA | 18909 | 5021 | 29894 | 4114 | 35569 | 3323 | 38275 | 2695 | 40836 | 1705 | 51783 | 923 | 43371 |
| 11L-3S | | MI | 15197 | 5021 | 24459 | 3970 | 29054 | 3187 | 31801 | 2577 | 35247 | 1570 | 43519 | 1259 | 31706 |
| 24-#11 | 2.71 | MA | 18246 | 5021 | 28993 | 4115 | 34374 | 3323 | 36794 | 2694 | 38854 | 1712 | 49229 | 865 | 41803 |
| 12L-2S | | MI | 15840 | 5021 | 25330 | 3972 | 30159 | 3191 | 33135 | 2572 | 37003 | 1565 | 45830 | 1350 | 31780 |
| 24-#14 | 3.91 | MA | 22412 | 5623 | 37512 | 4471 | 45143 | 3575 | 49801 | 2851 | 56388 | 1666 | 72746 | 849 | 64785 |
| 8L-6S | | MI | 14977 | 5623 | 25899 | 4334 | 30727 | 3458 | 33672 | 2720 | 37745 | 1506 | 47381 | 779 | 41904 |
| 24-#14 | 3.91 | MA | 21549 | 5623 | 36060 | 4487 | 43359 | 3590 | 47672 | 2864 | 53518 | 1675 | 69082 | 764 | 62552 |
| 9L-5S | | MI | 15544 | 5623 | 26744 | 4337 | 31853 | 3449 | 35023 | 2728 | 39477 | 1498 | 49506 | 868 | 42998 |
| 24-#14 | 3.91 | MA | 20663 | 5623 | 34751 | 4489 | 41639 | 3590 | 45534 | 2862 | 50567 | 1669 | 65293 | 649 | 60200 |
| 10L-4S | | MI | 16134 | 5623 | 27692 | 4326 | 32991 | 3455 | 36393 | 2720 | 41339 | 1506 | 51782 | 929 | 43782 |

## RECTANGULAR TIED COLUMNS 30" x 48"

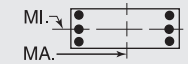
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.11 | MA | 22210 | 4400 | 31594 | 3710 | 37587 | 3019 | 40286 | 2507 | 42621 | 1771 | 51889 | 1671 | 23213 |
| 2E | | MI | 13509 | 4400 | 20103 | 3570 | 23156 | 2903 | 24310 | 2396 | 25034 | 1660 | 29787 | 1520 | 13840 |
| 6-#18 | 1.67 | MA | 24028 | 4691 | 35387 | 3892 | 42398 | 3152 | 46114 | 2591 | 50484 | 1758 | 62462 | 1638 | 34460 |
| 2L-3S | | MI | 12829 | 4691 | 20103 | 3744 | 23156 | 3022 | 24310 | 2487 | 25034 | 1642 | 29787 | 1214 | 20240 |
| 6-#18 | 1.67 | MA | 21115 | 4691 | 31594 | 3894 | 37587 | 3151 | 40286 | 2613 | 42621 | 1773 | 51889 | 1404 | 34098 |
| 3L-2S | | MI | 14480 | 4691 | 22260 | 3752 | 25882 | 3035 | 27548 | 2474 | 29295 | 1629 | 35338 | 1448 | 20303 |
| 8-#14 | 1.25 | MA | 22776 | 4473 | 32452 | 3777 | 38871 | 3070 | 41927 | 2543 | 44892 | 1779 | 55243 | 1686 | 26255 |
| 2L-4S | | MI | 12170 | 4473 | 18403 | 3643 | 21121 | 2968 | 22014 | 2448 | 22134 | 1696 | 26463 | 1282 | 15599 |
| 8-#14 | 1.25 | MA | 21083 | 4473 | 30290 | 3779 | 36128 | 3070 | 38604 | 2557 | 40410 | 1789 | 49149 | 1555 | 26173 |
| 3E | | MI | 12885 | 4473 | 19338 | 3646 | 22383 | 2959 | 23525 | 2455 | 24048 | 1689 | 28602 | 1410 | 15658 |
| 8-#14 | 1.25 | MA | 19861 | 4473 | 28688 | 3781 | 33962 | 3086 | 35978 | 2555 | 36865 | 1784 | 45123 | 1423 | 25862 |
| 4L-2S | | MI | 13851 | 4473 | 20581 | 3649 | 23959 | 2965 | 25415 | 2448 | 26535 | 1681 | 31865 | 1541 | 15637 |
| 8-#18 | 2.22 | MA | 25787 | 4982 | 39180 | 4074 | 47208 | 3285 | 51943 | 2676 | 58347 | 1744 | 73036 | 1604 | 45666 |
| 2L-4S | | MI | 12602 | 4982 | 20630 | 3917 | 23692 | 3167 | 24960 | 2552 | 26016 | 1624 | 31686 | 920 | 24919 |
| 8-#18 | 2.22 | MA | 22937 | 4982 | 35387 | 4076 | 42398 | 3284 | 46114 | 2698 | 50484 | 1759 | 62462 | 1371 | 45175 |
| 3E | | MI | 13804 | 4982 | 22260 | 3925 | 25882 | 3154 | 27548 | 2565 | 29295 | 1611 | 35338 | 1142 | 26545 |
| 8-#18 | 2.22 | MA | 20878 | 4982 | 32570 | 4078 | 38589 | 3309 | 41498 | 2693 | 44254 | 1748 | 55492 | 1137 | 42267 |
| 4L-2S | | MI | 15424 | 4982 | 24418 | 3934 | 28609 | 3167 | 30786 | 2552 | 33556 | 1598 | 40889 | 1376 | 26710 |
| 10-#11 | 1.08 | MA | 22256 | 4386 | 31244 | 3733 | 37438 | 3039 | 40234 | 2525 | 42638 | 1788 | 52311 | 1705 | 22926 |
| 2L-5S | | MI | 11942 | 4386 | 17687 | 3617 | 20372 | 2939 | 21168 | 2444 | 20982 | 1708 | 24999 | 1355 | 13694 |
| 10-#11 | 1.08 | MA | 21065 | 4386 | 29735 | 3735 | 35523 | 3039 | 37915 | 2535 | 39509 | 1796 | 48034 | 1614 | 22896 |
| 3L-4S | | MI | 12401 | 4386 | 18351 | 3608 | 21168 | 2942 | 22135 | 2439 | 22254 | 1703 | 26611 | 1397 | 13747 |
| 10-#11 | 1.08 | MA | 20207 | 4386 | 28618 | 3736 | 34013 | 3050 | 36084 | 2534 | 37038 | 1793 | 45207 | 1523 | 22784 |
| 4L-3S | | MI | 12905 | 4386 | 19005 | 3610 | 22052 | 2936 | 23202 | 2444 | 23648 | 1708 | 28124 | 1487 | 13747 |
| 10-#11 | 1.08 | MA | 19431 | 4386 | 27489 | 3748 | 32658 | 3051 | 34430 | 2544 | 34786 | 1801 | 42279 | 1475 | 22517 |
| 5L-2S | | MI | 13587 | 4386 | 19877 | 3612 | 23157 | 2939 | 24536 | 2439 | 25404 | 1703 | 30436 | 1578 | 13723 |
| 10-#14 | 1.56 | MA | 23820 | 4637 | 34615 | 3879 | 41613 | 3145 | 45249 | 2590 | 49375 | 1771 | 61337 | 1670 | 32660 |
| 2L-5S | | MI | 12115 | 4637 | 18697 | 3757 | 21558 | 3037 | 22534 | 2501 | 22760 | 1674 | 27450 | 1185 | 18455 |
| 10-#14 | 1.56 | MA | 22151 | 4637 | 32452 | 3881 | 38871 | 3145 | 41927 | 2604 | 44892 | 1781 | 55243 | 1539 | 32534 |
| 3L-4S | | MI | 12758 | 4637 | 19646 | 3745 | 22697 | 3043 | 23905 | 2494 | 24621 | 1681 | 29725 | 1246 | 19232 |
| 10-#14 | 1.56 | MA | 20948 | 4637 | 30850 | 3883 | 36704 | 3160 | 39301 | 2603 | 41348 | 1777 | 51218 | 1408 | 32172 |
| 4L-3S | | MI | 13463 | 4637 | 20581 | 3748 | 23959 | 3034 | 25415 | 2501 | 26535 | 1674 | 31865 | 1375 | 19334 |
| 10-#14 | 1.56 | MA | 19860 | 4637 | 29230 | 3900 | 34760 | 3161 | 36928 | 2616 | 38117 | 1787 | 47039 | 1340 | 30635 |
| 5L-2S | | MI | 14418 | 4637 | 21823 | 3752 | 25535 | 3040 | 27305 | 2494 | 29022 | 1667 | 35128 | 1506 | 19347 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis

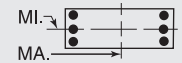



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 2.78 | MA | 27496 | 5273 | 42974 | 4256 | 52019 | 3418 | 57771 | 2760 | 66211 | 1731 | 83610 | 1571 | 56849 |
| 2L-5S | | MI | 12499 | 5273 | 21132 | 4117 | 24440 | 3286 | 25850 | 2643 | 27086 | 1580 | 33366 | 737 | 29324 |
| 10-#18 | 2.78 | MA | 24704 | 5273 | 39180 | 4258 | 47208 | 3417 | 51943 | 2782 | 58347 | 1746 | 73036 | 1337 | 56249 |
| 3L-4S | | MI | 13574 | 5273 | 22788 | 4099 | 26418 | 3299 | 28198 | 2630 | 30277 | 1593 | 37237 | 848 | 30861 |
| 10-#18 | 2.78 | MA | 22693 | 5273 | 36363 | 4260 | 43400 | 3442 | 47327 | 2777 | 52117 | 1735 | 66066 | 1104 | 52977 |
| 4L-3S | | MI | 14754 | 5273 | 24418 | 4107 | 28609 | 3286 | 30786 | 2643 | 33556 | 1580 | 40889 | 1069 | 32828 |
| 10-#18 | 2.78 | MA | 20872 | 5273 | 33513 | 4289 | 39980 | 3441 | 43152 | 2799 | 46434 | 1750 | 58792 | 985 | 49619 |
| 5L-2S | | MI | 16346 | 5273 | 26576 | 4116 | 31335 | 3299 | 34024 | 2630 | 37817 | 1567 | 46440 | 1303 | 33080 |
| 12-#11 | 1.30 | MA | 22999 | 4499 | 32754 | 3804 | 39352 | 3091 | 42553 | 2558 | 45767 | 1783 | 56588 | 1696 | 27402 |
| 2L-6S | | MI | 11927 | 4499 | 17968 | 3686 | 20690 | 2997 | 21549 | 2471 | 21515 | 1704 | 25698 | 1256 | 15721 |
| 12-#11 | 1.30 | MA | 21820 | 4499 | 31244 | 3805 | 37438 | 3091 | 40234 | 2568 | 42638 | 1791 | 52311 | 1604 | 27351 |
| 3L-5S | | MI | 12364 | 4499 | 18559 | 3688 | 21477 | 2990 | 22502 | 2476 | 22738 | 1699 | 27310 | 1332 | 16199 |
| 12-#11 | 1.30 | MA | 20972 | 4499 | 30128 | 3807 | 35927 | 3102 | 38403 | 2567 | 40167 | 1788 | 49484 | 1513 | 27212 |
| 4E | | MI | 12818 | 4499 | 19222 | 3679 | 22274 | 2994 | 23470 | 2471 | 24010 | 1694 | 28922 | 1374 | 16319 |
| 12-#11 | 1.30 | MA | 20205 | 4499 | 28999 | 3819 | 34573 | 3103 | 36749 | 2577 | 37915 | 1796 | 46556 | 1466 | 26918 |
| 5L-3S | | MI | 13317 | 4499 | 19877 | 3681 | 23157 | 2987 | 24536 | 2476 | 25404 | 1699 | 30436 | 1465 | 16342 |
| 12-#11 | 1.30 | MA | 19470 | 4499 | 27997 | 3821 | 33237 | 3114 | 35122 | 2576 | 35751 | 1803 | 43569 | 1391 | 25856 |
| 6L-2S | | MI | 13993 | 4499 | 20748 | 3683 | 24262 | 2991 | 25871 | 2471 | 27160 | 1694 | 32747 | 1556 | 16330 |
| 12-#14 | 1.88 | MA | 24845 | 4800 | 36777 | 3981 | 44356 | 3220 | 48572 | 2638 | 53858 | 1764 | 67432 | 1655 | 39053 |
| 2L-6S | | MI | 12091 | 4800 | 19094 | 3856 | 22009 | 3120 | 23074 | 2540 | 23515 | 1667 | 28588 | 1060 | 21356 |
| 12-#14 | 1.88 | MA | 23197 | 4800 | 34615 | 3983 | 41613 | 3220 | 45249 | 2651 | 49375 | 1774 | 61337 | 1523 | 38888 |
| 3L-5S | | MI | 12701 | 4800 | 19940 | 3859 | 23134 | 3111 | 24425 | 2547 | 25247 | 1659 | 30713 | 1150 | 21948 |
| 12-#14 | 1.88 | MA | 22012 | 4800 | 33013 | 3985 | 39447 | 3235 | 42623 | 2650 | 45831 | 1769 | 57312 | 1392 | 38482 |
| 4E | | MI | 13335 | 4800 | 20888 | 3847 | 24272 | 3117 | 25795 | 2540 | 27108 | 1667 | 32988 | 1211 | 22855 |
| 12-#14 | 1.88 | MA | 20941 | 4800 | 31393 | 4002 | 37503 | 3236 | 40251 | 2663 | 42600 | 1779 | 53134 | 1324 | 36813 |
| 5L-3S | | MI | 14032 | 4800 | 21823 | 3851 | 25535 | 3109 | 27305 | 2547 | 29022 | 1659 | 35128 | 1339 | 22995 |
| 12-#14 | 1.88 | MA | 19914 | 4800 | 29955 | 4004 | 35585 | 3251 | 37916 | 2662 | 39494 | 1789 | 48878 | 1216 | 35455 |
| 6L-2S | | MI | 14976 | 4800 | 23066 | 3854 | 27110 | 3115 | 29196 | 2540 | 31509 | 1652 | 38391 | 1471 | 23039 |
| 12-#18 | 3.33 | MA | 26426 | 5564 | 42974 | 4439 | 52019 | 3550 | 57771 | 2866 | 66211 | 1733 | 83610 | 1304 | 67323 |
| 3L-5S | | MI | 13468 | 5564 | 23289 | 4299 | 27167 | 3418 | 29088 | 2721 | 31347 | 1549 | 38917 | 665 | 35144 |
| 12-#18 | 3.33 | MA | 24457 | 5564 | 40156 | 4442 | 48210 | 3575 | 53155 | 2861 | 59980 | 1721 | 76640 | 1070 | 63726 |
| 4E | | MI | 14524 | 5564 | 24945 | 4280 | 29145 | 3431 | 31436 | 2707 | 34538 | 1562 | 42788 | 775 | 36847 |
| 12-#18 | 3.33 | MA | 22678 | 5564 | 37306 | 4470 | 44790 | 3574 | 48980 | 2883 | 54297 | 1737 | 69365 | 952 | 60511 |
| 5L-3S | | MI | 15683 | 5564 | 26576 | 4289 | 31335 | 3418 | 34024 | 2721 | 37817 | 1549 | 46440 | 997 | 39098 |
| 12-#18 | 3.33 | MA | 20970 | 5564 | 34775 | 4472 | 41415 | 3599 | 44872 | 2879 | 48832 | 1752 | 61983 | 759 | 55708 |
| 6L-2S | | MI | 17250 | 5564 | 28733 | 4297 | 34062 | 3431 | 37262 | 2707 | 42077 | 1536 | 51991 | 1231 | 39427 |
| 14-#11 | 1.52 | MA | 23732 | 4613 | 34263 | 3875 | 41266 | 3142 | 44872 | 2591 | 48896 | 1778 | 60865 | 1686 | 31872 |
| 2L-7S | | MI | 11924 | 4613 | 18263 | 3755 | 21034 | 3045 | 21959 | 2509 | 22031 | 1690 | 26579 | 1163 | 17888 |
| 14-#11 | 1.52 | MA | 22564 | 4613 | 32754 | 3876 | 39352 | 3143 | 42553 | 2601 | 45767 | 1786 | 56588 | 1595 | 31801 |
| 3L-6S | | MI | 12347 | 4613 | 18839 | 3757 | 21795 | 3049 | 22884 | 2504 | 23271 | 1695 | 28009 | 1234 | 18202 |
| 14-#11 | 1.52 | MA | 21725 | 4613 | 31637 | 3878 | 37841 | 3154 | 40722 | 2600 | 43296 | 1783 | 53760 | 1504 | 31638 |
| 4L-5S | | MI | 12779 | 4613 | 19430 | 3759 | 22582 | 3042 | 23837 | 2509 | 24494 | 1690 | 29622 | 1310 | 18653 |
| 14-#11 | 1.52 | MA | 20967 | 4613 | 30508 | 3890 | 36487 | 3155 | 39068 | 2610 | 41044 | 1790 | 50833 | 1456 | 31223 |
| 5L-4S | | MI | 13229 | 4613 | 20094 | 3750 | 23379 | 3046 | 24805 | 2504 | 25766 | 1684 | 31234 | 1352 | 18884 |
| 14-#11 | 1.52 | MA | 20240 | 4613 | 29507 | 3892 | 35151 | 3166 | 37442 | 2609 | 38880 | 1798 | 47846 | 1381 | 30199 |
| 6L-3S | | MI | 13723 | 4613 | 20748 | 3752 | 24262 | 3039 | 25871 | 2509 | 27160 | 1690 | 32747 | 1442 | 18924 |
| 14-#11 | 1.52 | MA | 19529 | 4613 | 28532 | 3894 | 33860 | 3166 | 35865 | 2619 | 36686 | 1795 | 45183 | 1310 | 29480 |
| 7L-2S | | MI | 14394 | 4613 | 21620 | 3754 | 25368 | 3043 | 27206 | 2504 | 28916 | 1684 | 35059 | 1533 | 18929 |
| 14-#14 | 2.19 | MA | 24224 | 4964 | 36777 | 4086 | 44356 | 3295 | 48572 | 2699 | 53858 | 1767 | 67432 | 1508 | 45238 |
| 3L-6S | | MI | 12673 | 4964 | 20337 | 3958 | 23584 | 3195 | 24965 | 2585 | 26002 | 1652 | 31851 | 1025 | 24838 |
| 14-#14 | 2.19 | MA | 23056 | 4964 | 35175 | 4088 | 42189 | 3310 | 45946 | 2697 | 50313 | 1762 | 63407 | 1376 | 44792 |
| 4L-5S | | MI | 13276 | 4964 | 21182 | 3961 | 24710 | 3186 | 26315 | 2593 | 27734 | 1645 | 33976 | 1115 | 25456 |
| 14-#14 | 2.19 | MA | 22000 | 4964 | 33555 | 4105 | 40246 | 3310 | 43573 | 2711 | 47082 | 1772 | 59228 | 1308 | 43006 |
| 5L-4S | | MI | 13903 | 4964 | 22131 | 3950 | 25848 | 3192 | 27685 | 2585 | 29595 | 1652 | 36251 | 1176 | 26473 |
| 14-#14 | 2.19 | MA | 20989 | 4964 | 32118 | 4107 | 38328 | 3326 | 41239 | 2709 | 43977 | 1782 | 54972 | 1200 | 41692 |
| 6L-3S | | MI | 14591 | 4964 | 23066 | 3953 | 27110 | 3183 | 29196 | 2593 | 31509 | 1645 | 38391 | 1304 | 26646 |
| 14-#14 | 2.19 | MA | 19998 | 4964 | 30719 | 4109 | 36476 | 3326 | 38976 | 2723 | 40829 | 1777 | 51180 | 1098 | 39586 |
| 7L-2S | | MI | 15525 | 4964 | 24308 | 3956 | 28686 | 3190 | 31086 | 2585 | 33996 | 1637 | 41654 | 1436 | 26717 |

## RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

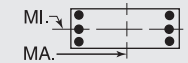
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.89 | MA | 26180 | 5854 | 43950 | 4623 | 53021 | 3708 | 58983 | 2946 | 67843 | 1708 | 87213 | 1037 | 74511 |
| 4L-5S | | MI | 14417 | 5854 | 25447 | 4480 | 29893 | 3550 | 32326 | 2798 | 35608 | 1518 | 44468 | 592 | 41003 |
| 14-#18 | 3.89 | MA | 24438 | 5854 | 41100 | 4652 | 49601 | 3707 | 54808 | 2968 | 62160 | 1723 | 79939 | 919 | 71424 |
| 5L-4S | | MI | 15455 | 5854 | 27103 | 4462 | 31871 | 3564 | 34674 | 2785 | 38798 | 1531 | 48339 | 703 | 42866 |
| 14-#18 | 3.89 | MA | 22767 | 5854 | 38569 | 4654 | 46226 | 3732 | 50700 | 2963 | 56695 | 1738 | 72556 | 726 | 66514 |
| 6L-3S | | MI | 16595 | 5854 | 28733 | 4471 | 34062 | 3550 | 37262 | 2798 | 42077 | 1518 | 51991 | 925 | 45360 |
| 14-#18 | 3.89 | MA | 21129 | 5854 | 36105 | 4656 | 42965 | 3731 | 46716 | 2985 | 51155 | 1727 | 65987 | 544 | 61503 |
| 7L-2S | | MI | 18138 | 5854 | 30891 | 4479 | 36789 | 3564 | 40500 | 2785 | 46338 | 1505 | 57542 | 1158 | 45759 |
| 16-#11 | 1.73 | MA | 23297 | 4726 | 34263 | 3947 | 41266 | 3195 | 44872 | 2633 | 48896 | 1781 | 60865 | 1585 | 36247 |
| 3L-7S | | MI | 12342 | 4726 | 19135 | 3826 | 22139 | 3097 | 23293 | 2542 | 23786 | 1680 | 28891 | 1140 | 20316 |
| 16-#11 | 1.73 | MA | 22467 | 4726 | 33146 | 3949 | 39756 | 3206 | 43041 | 2633 | 46425 | 1778 | 58037 | 1494 | 36062 |
| 4L-6S | | MI | 12761 | 4726 | 19711 | 3828 | 22900 | 3101 | 24219 | 2536 | 25027 | 1685 | 30321 | 1211 | 20689 |
| 16-#11 | 1.73 | MA | 21717 | 4726 | 32018 | 3961 | 38401 | 3206 | 41387 | 2643 | 44173 | 1785 | 55110 | 1446 | 35538 |
| 5E | | MI | 13189 | 4726 | 20302 | 3830 | 23688 | 3094 | 25172 | 2542 | 26250 | 1680 | 31933 | 1287 | 21117 |
| 16-#11 | 1.73 | MA | 20999 | 4726 | 31016 | 3963 | 37065 | 3217 | 39761 | 2642 | 42009 | 1793 | 52123 | 1371 | 34549 |
| 6L-4S | | MI | 13635 | 4726 | 20965 | 3821 | 24484 | 3098 | 26139 | 2536 | 27522 | 1675 | 33545 | 1329 | 21442 |
| 16-#11 | 1.73 | MA | 20296 | 4726 | 30042 | 3964 | 35775 | 3218 | 38184 | 2652 | 39815 | 1790 | 49460 | 1301 | 33834 |
| 7L-3S | | MI | 14125 | 4726 | 21620 | 3823 | 25368 | 3091 | 27206 | 2542 | 28916 | 1680 | 35059 | 1419 | 21499 |
| 16-#11 | 1.73 | MA | 19601 | 4726 | 29083 | 3966 | 34511 | 3219 | 36604 | 2651 | 37699 | 1797 | 46725 | 1246 | 32566 |
| 8L-2S | | MI | 14790 | 4726 | 22491 | 3824 | 26473 | 3095 | 28541 | 2536 | 30672 | 1675 | 37370 | 1511 | 21519 |
| 16-#14 | 2.50 | MA | 24081 | 5127 | 37338 | 4190 | 44932 | 3385 | 49269 | 2745 | 54796 | 1754 | 69501 | 1361 | 51104 |
| 4L-6S | | MI | 13247 | 5127 | 21579 | 4060 | 25160 | 3270 | 26855 | 2631 | 28489 | 1637 | 35114 | 990 | 28269 |
| 16-#14 | 2.50 | MA | 23040 | 5127 | 35718 | 4207 | 42988 | 3385 | 46896 | 2758 | 51565 | 1764 | 65323 | 1293 | 49211 |
| 5E | | MI | 13842 | 5127 | 22425 | 4064 | 26285 | 3261 | 28205 | 2639 | 30220 | 1630 | 37239 | 1079 | 28975 |
| 16-#14 | 2.50 | MA | 22044 | 5127 | 34280 | 4209 | 41071 | 3400 | 44561 | 2757 | 48460 | 1774 | 61067 | 1185 | 47936 |
| 6L-4S | | MI | 14461 | 5127 | 23373 | 4052 | 27424 | 3267 | 29575 | 2631 | 32082 | 1637 | 39514 | 1141 | 29952 |
| 16-#14 | 2.50 | MA | 21067 | 5127 | 32881 | 4211 | 39219 | 3401 | 42298 | 2770 | 45312 | 1770 | 57275 | 1083 | 45773 |
| 7L-3S | | MI | 15142 | 5127 | 24308 | 4055 | 28686 | 3258 | 31086 | 2639 | 33996 | 1630 | 41654 | 1269 | 30290 |
| 16-#14 | 2.50 | MA | 20101 | 5127 | 31505 | 4213 | 37404 | 3401 | 40031 | 2769 | 42275 | 1780 | 53371 | 1004 | 43668 |
| 8L-2S | | MI | 16066 | 5127 | 25550 | 4058 | 30262 | 3264 | 32976 | 2631 | 36483 | 1622 | 44917 | 1400 | 30385 |
| 16-#18 | 4.44 | MA | 26160 | 6145 | 44893 | 4834 | 54412 | 3840 | 60637 | 3052 | 70023 | 1710 | 90513 | 885 | 82178 |
| 5E | | MI | 15349 | 6145 | 27604 | 4662 | 32620 | 3682 | 35564 | 2876 | 39868 | 1487 | 50019 | 520 | 46895 |
| 16-#18 | 4.44 | MA | 24523 | 6145 | 42362 | 4836 | 51036 | 3865 | 56528 | 3047 | 64558 | 1725 | 83130 | 693 | 77339 |
| 6L-4S | | MI | 16371 | 6145 | 29260 | 4644 | 34598 | 3696 | 37912 | 2863 | 43059 | 1500 | 53890 | 631 | 48912 |
| 16-#18 | 4.44 | MA | 22919 | 6145 | 39898 | 4838 | 47776 | 3864 | 52544 | 3069 | 59018 | 1714 | 76561 | 511 | 72272 |
| 7L-3S | | MI | 17526 | 6145 | 30891 | 4652 | 36789 | 3682 | 40500 | 2876 | 46338 | 1487 | 57542 | 852 | 51615 |
| 16-#18 | 4.44 | MA | 21330 | 6145 | 37473 | 4840 | 44581 | 3863 | 48553 | 3064 | 53672 | 1729 | 69767 | 374 | 67146 |
| 8L-2S | | MI | 19008 | 6145 | 33048 | 4661 | 39515 | 3696 | 43738 | 2863 | 50599 | 1473 | 63093 | 1086 | 52079 |
| 18-#11 | 1.95 | MA | 23198 | 4840 | 34656 | 4020 | 41670 | 3258 | 45360 | 2666 | 49553 | 1773 | 62314 | 1484 | 40485 |
| 4L-7S | | MI | 12754 | 4840 | 20006 | 3897 | 23245 | 3149 | 24628 | 2574 | 25542 | 1671 | 31203 | 1118 | 22751 |
| 18-#11 | 1.95 | MA | 22457 | 4840 | 33527 | 4032 | 40315 | 3258 | 43707 | 2676 | 47302 | 1780 | 59387 | 1436 | 39863 |
| 5L-6S | | MI | 13170 | 4840 | 20582 | 3899 | 24006 | 3153 | 25553 | 2569 | 26783 | 1676 | 32632 | 1188 | 23181 |
| 18-#11 | 1.95 | MA | 21746 | 4840 | 32525 | 4034 | 38979 | 3269 | 42080 | 2675 | 45137 | 1788 | 56400 | 1362 | 38905 |
| 6L-5S | | MI | 13594 | 4840 | 21173 | 3900 | 24793 | 3146 | 26507 | 2574 | 28006 | 1671 | 34245 | 1264 | 23589 |
| 18-#11 | 1.95 | MA | 21051 | 4840 | 31551 | 4035 | 37689 | 3270 | 40503 | 2685 | 42944 | 1785 | 53737 | 1291 | 38139 |
| 7L-4S | | MI | 14036 | 4840 | 21837 | 3892 | 25589 | 3150 | 27474 | 2569 | 29278 | 1666 | 35857 | 1307 | 23996 |
| 18-#11 | 1.95 | MA | 20364 | 4840 | 30592 | 4037 | 36425 | 3270 | 38923 | 2684 | 40828 | 1792 | 51002 | 1236 | 36900 |
| 8L-3S | | MI | 14521 | 4840 | 22491 | 3894 | 26473 | 3143 | 28541 | 2574 | 30672 | 1671 | 37370 | 1397 | 24069 |
| 18-#11 | 1.95 | MA | 19681 | 4840 | 29532 | 4049 | 35122 | 3281 | 37370 | 2694 | 38732 | 1800 | 48287 | 1178 | 35732 |
| 9L-2S | | MI | 15182 | 4840 | 23362 | 3895 | 27578 | 3147 | 29875 | 2569 | 32428 | 1666 | 39682 | 1488 | 24101 |
| 18-#14 | 2.81 | MA | 24063 | 5291 | 37880 | 4309 | 45731 | 3460 | 50218 | 2806 | 56048 | 1757 | 71417 | 1277 | 55427 |
| 5L-6S | | MI | 13812 | 5291 | 22822 | 4162 | 26736 | 3345 | 28745 | 2677 | 30976 | 1622 | 38376 | 955 | 31714 |
| 18-#14 | 2.81 | MA | 23080 | 5291 | 36443 | 4311 | 43813 | 3475 | 47884 | 2804 | 52942 | 1767 | 67161 | 1169 | 54174 |
| 6L-5S | | MI | 14400 | 5291 | 23667 | 4166 | 27861 | 3336 | 30096 | 2685 | 32707 | 1615 | 40502 | 1044 | 32504 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis

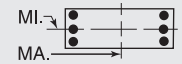


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.81 | MA | 22118 | 5291 | 35044 | 4313 | 41961 | 3476 | 45621 | 2818 | 49794 | 1762 | 63369 | 1067 | 51968 |
| 7L-4S | | MI | 15013 | 5291 | 24616 | 4154 | 29000 | 3342 | 31466 | 2677 | 34569 | 1622 | 42777 | 1105 | 33430 |
| 18-#14 | 2.81 | MA | 21166 | 5291 | 33667 | 4315 | 40147 | 3476 | 43354 | 2816 | 46757 | 1772 | 59465 | 988 | 49828 |
| 8L-3S | | MI | 15686 | 5291 | 25550 | 4157 | 30262 | 3333 | 32976 | 2685 | 36483 | 1615 | 44917 | 1234 | 33928 |
| 18-#14 | 2.81 | MA | 20220 | 5291 | 32146 | 4332 | 38277 | 3491 | 41123 | 2830 | 43750 | 1782 | 55599 | 904 | 47663 |
| 9L-2S | | MI | 16601 | 5291 | 26793 | 4161 | 31838 | 3339 | 34867 | 2677 | 38970 | 1608 | 48180 | 1365 | 34047 |
| 18-#18 | 5.00 | MA | 26244 | 6436 | 46155 | 5018 | 55847 | 3998 | 62356 | 3131 | 72421 | 1712 | 93704 | 659 | 88182 |
| 6L-5S | | MI | 16329 | 6436 | 29762 | 4844 | 35347 | 3815 | 38802 | 2954 | 44129 | 1456 | 55570 | 448 | 52815 |
| 18-#18 | 5.00 | MA | 24670 | 6436 | 43691 | 5020 | 52587 | 3997 | 58373 | 3153 | 66881 | 1700 | 87134 | 477 | 83057 |
| 7L-4S | | MI | 17316 | 6436 | 31418 | 4826 | 37325 | 3828 | 41150 | 2941 | 47320 | 1469 | 59442 | 558 | 54981 |
| 18-#18 | 5.00 | MA | 23113 | 6436 | 41266 | 5022 | 49392 | 3996 | 54381 | 3149 | 61535 | 1716 | 80340 | 341 | 77893 |
| 8L-3S | | MI | 18393 | 6436 | 33048 | 4834 | 39515 | 3815 | 43738 | 2954 | 50599 | 1456 | 63093 | 780 | 57867 |
| 20-#11 | 2.17 | MA | 23187 | 4953 | 35036 | 4103 | 42230 | 3310 | 46026 | 2708 | 50430 | 1775 | 63663 | 1427 | 44195 |
| 5L-7S | | MI | 13162 | 4953 | 20878 | 3968 | 24350 | 3201 | 25963 | 2607 | 27298 | 1662 | 33514 | 1095 | 25195 |
| 20-#11 | 2.17 | MA | 22484 | 4953 | 34035 | 4104 | 40893 | 3321 | 44399 | 2708 | 48266 | 1782 | 60676 | 1352 | 43266 |
| 6E | | MI | 13574 | 4953 | 21454 | 3970 | 25111 | 3205 | 26888 | 2601 | 28539 | 1667 | 34944 | 1166 | 25676 |
| 20-#11 | 2.17 | MA | 21796 | 4953 | 33060 | 4106 | 39603 | 3322 | 42822 | 2718 | 46073 | 1780 | 58013 | 1281 | 42450 |
| 7L-5S | | MI | 13994 | 4953 | 22045 | 3971 | 25898 | 3198 | 27841 | 2607 | 29762 | 1662 | 36557 | 1242 | 26068 |
| 20-#11 | 2.17 | MA | 21116 | 4953 | 32101 | 4108 | 38339 | 3322 | 41243 | 2717 | 43957 | 1787 | 55278 | 1226 | 41238 |
| 8L-4S | | MI | 14432 | 4953 | 22708 | 3963 | 26694 | 3202 | 28809 | 2601 | 31034 | 1657 | 38168 | 1284 | 26547 |
| 20-#11 | 2.17 | MA | 20441 | 4953 | 31042 | 4120 | 37036 | 3333 | 39689 | 2727 | 41861 | 1795 | 52564 | 1168 | 40043 |
| 9L-3S | | MI | 14914 | 4953 | 23362 | 3964 | 27578 | 3195 | 29875 | 2607 | 32428 | 1662 | 39682 | 1374 | 26634 |
| 20-#11 | 2.17 | MA | 19758 | 4953 | 30086 | 4122 | 35781 | 3334 | 38128 | 2726 | 39707 | 1792 | 49758 | 1088 | 38680 |
| 10L-2S | | MI | 15569 | 4953 | 24234 | 3966 | 28683 | 3198 | 31210 | 2601 | 34183 | 1657 | 41994 | 1465 | 26678 |
| 20-#14 | 3.13 | MA | 24100 | 5455 | 38605 | 4413 | 46556 | 3550 | 51206 | 2852 | 57425 | 1759 | 73255 | 1153 | 60325 |
| 6E | | MI | 14369 | 5455 | 24064 | 4265 | 28311 | 3419 | 30635 | 2723 | 33463 | 1608 | 41639 | 919 | 35171 |
| 20-#14 | 3.13 | MA | 23151 | 5455 | 37206 | 4415 | 44704 | 3550 | 48943 | 2865 | 54277 | 1755 | 69463 | 1051 | 58171 |
| 7L-5S | | MI | 14951 | 5455 | 24909 | 4268 | 29437 | 3411 | 31986 | 2730 | 35194 | 1600 | 43765 | 1009 | 36041 |
| 20-#14 | 3.13 | MA | 22212 | 5455 | 35830 | 4418 | 42889 | 3551 | 46676 | 2864 | 51240 | 1765 | 65560 | 973 | 55995 |
| 8L-4S | | MI | 15557 | 5455 | 25858 | 4256 | 30575 | 3417 | 33356 | 2723 | 37056 | 1608 | 46040 | 1070 | 36921 |
| 20-#14 | 3.13 | MA | 21279 | 5455 | 34309 | 4434 | 41019 | 3566 | 44446 | 2877 | 48233 | 1775 | 61693 | 889 | 53811 |
| 9L-3S | | MI | 16223 | 5455 | 26793 | 4260 | 31838 | 3408 | 34867 | 2730 | 38970 | 1600 | 48180 | 1198 | 37562 |
| 20-#14 | 3.13 | MA | 20327 | 5455 | 32937 | 4437 | 39217 | 3566 | 42205 | 2876 | 45140 | 1770 | 57697 | 773 | 51189 |
| 10L-2S | | MI | 17129 | 5455 | 28035 | 4263 | 33413 | 3414 | 36757 | 2723 | 41457 | 1593 | 51443 | 1330 | 37703 |
| 20-#18 | 5.56 | MA | 26389 | 6727 | 47484 | 5202 | 57397 | 4130 | 64201 | 3238 | 74744 | 1687 | 97708 | 444 | 93857 |
| 7L-5S | | MI | 17223 | 6727 | 31920 | 5026 | 38073 | 3947 | 42040 | 3032 | 48390 | 1424 | 61121 | 375 | 58761 |
| 20-#18 | 5.56 | MA | 24861 | 6727 | 45059 | 5204 | 54202 | 4129 | 60210 | 3233 | 69398 | 1702 | 90914 | 307 | 88654 |
| 8L-4S | | MI | 18191 | 6727 | 33575 | 5007 | 40051 | 3960 | 44388 | 3018 | 51580 | 1438 | 64993 | 486 | 61069 |
| 22-#11 | 2.38 | MA | 23212 | 5066 | 35544 | 4175 | 42808 | 3373 | 46718 | 2741 | 51395 | 1777 | 64953 | 1342 | 47632 |
| 6L-7S | | MI | 13565 | 5066 | 21749 | 4039 | 25455 | 3253 | 27298 | 2639 | 29054 | 1652 | 35826 | 1073 | 27644 |
| 22-#11 | 2.38 | MA | 22531 | 5066 | 34570 | 4177 | 41517 | 3374 | 45141 | 2751 | 49201 | 1774 | 62290 | 1271 | 46768 |
| 7L-6S | | MI | 13973 | 5066 | 22325 | 4040 | 26216 | 3257 | 28223 | 2634 | 30295 | 1658 | 37255 | 1143 | 28175 |
| 22-#11 | 2.38 | MA | 21859 | 5066 | 33611 | 4179 | 40253 | 3374 | 43562 | 2750 | 47085 | 1782 | 59555 | 1216 | 45582 |
| 8L-5S | | MI | 14390 | 5066 | 22916 | 4042 | 27003 | 3250 | 29176 | 2639 | 31518 | 1652 | 38868 | 1219 | 28552 |
| 22-#11 | 2.38 | MA | 21191 | 5066 | 32551 | 4191 | 38951 | 3385 | 42008 | 2760 | 44990 | 1789 | 56840 | 1158 | 44322 |
| 9L-4S | | MI | 14824 | 5066 | 23580 | 4034 | 27800 | 3253 | 30144 | 2634 | 32789 | 1647 | 40480 | 1262 | 29096 |
| 22-#11 | 2.38 | MA | 20511 | 5066 | 31596 | 4193 | 37695 | 3386 | 40447 | 2759 | 42835 | 1787 | 54035 | 1078 | 43019 |
| 10L-3S | | MI | 15302 | 5066 | 24234 | 4035 | 28683 | 3247 | 31210 | 2639 | 34183 | 1652 | 41994 | 1352 | 29196 |
| 22-#11 | 2.38 | MA | 19797 | 5066 | 30647 | 4194 | 36408 | 3397 | 38903 | 2769 | 40749 | 1794 | 51347 | 1020 | 41451 |
| 11L-2S | | MI | 15952 | 5066 | 25105 | 4037 | 29788 | 3250 | 32545 | 2634 | 35939 | 1647 | 44305 | 1443 | 29252 |
| 22-#14 | 3.44 | MA | 24169 | 5618 | 39369 | 4518 | 47446 | 3625 | 52266 | 2913 | 58760 | 1747 | 75558 | 1036 | 64382 |
| 7L-6S | | MI | 14919 | 5618 | 25307 | 4367 | 29887 | 3494 | 32526 | 2769 | 35950 | 1593 | 44902 | 884 | 38639 |
| 22-#14 | 3.44 | MA | 23243 | 5618 | 37992 | 4520 | 45632 | 3626 | 49999 | 2911 | 55723 | 1757 | 71654 | 957 | 62170 |
| 8L-5S | | MI | 15495 | 5618 | 26152 | 4370 | 31012 | 3485 | 33876 | 2776 | 37681 | 1586 | 47027 | 973 | 39584 |
| 22-#14 | 3.44 | MA | 22322 | 5618 | 36471 | 4537 | 43762 | 3641 | 47769 | 2925 | 52716 | 1767 | 67788 | 873 | 59962 |
| 9L-4S | | MI | 16094 | 5618 | 27100 | 4359 | 32151 | 3491 | 35246 | 2769 | 39543 | 1593 | 49303 | 1035 | 40423 |
| 22-#14 | 3.44 | MA | 21374 | 5618 | 35100 | 4539 | 41960 | 3641 | 45528 | 2923 | 49623 | 1762 | 63791 | 757 | 57377 |
| 10L-3S | | MI | 16754 | 5618 | 28035 | 4362 | 33413 | 3483 | 36757 | 2776 | 41457 | 1586 | 51443 | 1163 | 41192 |

## RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#18 | 6.11 | MA | 26578 | 7018 | 48852 | 5386 | 59013 | 4262 | 66038 | 3317 | 77261 | 1689 | 101488 | 274 | 99428 |
| 8L-5S | | MI | 18104 | 7018 | 34077 | 5207 | 40800 | 4079 | 45278 | 3109 | 52650 | 1393 | 66672 | 303 | 64729 |
| 24-#11 | 2.60 | MA | 23258 | 5180 | 36079 | 4248 | 43432 | 3425 | 47460 | 2783 | 52330 | 1769 | 66567 | 1262 | 51091 |
| 7E | | MI | 13963 | 5180 | 22621 | 4110 | 26560 | 3305 | 28632 | 2672 | 30810 | 1643 | 38137 | 1050 | 30100 |
| 24-#11 | 2.60 | MA | 22592 | 5180 | 35120 | 4250 | 42168 | 3426 | 45881 | 2783 | 50214 | 1777 | 63832 | 1207 | 49929 |
| 8L-6S | | MI | 14368 | 5180 | 23196 | 4111 | 27321 | 3308 | 29558 | 2666 | 32051 | 1648 | 39567 | 1121 | 30677 |
| 24-#11 | 2.60 | MA | 21931 | 5180 | 34060 | 4262 | 40865 | 3437 | 44327 | 2793 | 48119 | 1784 | 61117 | 1148 | 48643 |
| 9L-5S | | MI | 14782 | 5180 | 23787 | 4113 | 28108 | 3302 | 30511 | 2672 | 33274 | 1643 | 41180 | 1197 | 31040 |
| 24-#11 | 2.60 | MA | 21253 | 5180 | 33105 | 4263 | 39610 | 3438 | 42766 | 2792 | 45964 | 1781 | 58312 | 1068 | 47362 |
| 10L-4S | | MI | 15213 | 5180 | 24451 | 4104 | 28905 | 3305 | 31478 | 2666 | 34545 | 1638 | 42792 | 1239 | 31642 |
| 24-#11 | 2.60 | MA | 20546 | 5180 | 32157 | 4265 | 38322 | 3449 | 41222 | 2802 | 43878 | 1789 | 55623 | 1010 | 45776 |
| 11L-3S | | MI | 15686 | 5180 | 25105 | 4106 | 29788 | 3299 | 32545 | 2672 | 35939 | 1643 | 44305 | 1329 | 31755 |
| 24-#11 | 2.60 | MA | 19831 | 5180 | 31214 | 4267 | 37070 | 3449 | 39670 | 2801 | 41742 | 1786 | 52930 | 953 | 44202 |
| 12L-2S | | MI | 16332 | 5180 | 25977 | 4108 | 30894 | 3302 | 33880 | 2666 | 37695 | 1638 | 46617 | 1420 | 31822 |
| 24-#14 | 3.75 | MA | 24258 | 5782 | 40155 | 4622 | 48374 | 3700 | 53322 | 2959 | 60206 | 1750 | 77749 | 941 | 68351 |
| 8L-6S | | MI | 15463 | 5782 | 26549 | 4469 | 31463 | 3569 | 34416 | 2815 | 38437 | 1578 | 48165 | 849 | 42117 |
| 24-#14 | 3.75 | MA | 23349 | 5782 | 38634 | 4639 | 46504 | 3716 | 51091 | 2972 | 57198 | 1760 | 73882 | 857 | 66119 |
| 9L-5S | | MI | 16033 | 5782 | 27394 | 4472 | 32588 | 3560 | 35766 | 2822 | 40168 | 1571 | 50290 | 938 | 43132 |
| 24-#14 | 3.75 | MA | 22406 | 5782 | 37262 | 4641 | 44703 | 3716 | 48851 | 2971 | 54106 | 1755 | 69886 | 742 | 63571 |
| 10L-4S | | MI | 16627 | 5782 | 28343 | 4461 | 33727 | 3566 | 37137 | 2815 | 42030 | 1578 | 52566 | 1000 | 43934 |

## RECTANGULAR TIED COLUMNS 32" x 32"

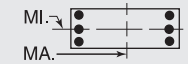
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#14 | 1.32 | MA | 10650 | 3206 | 15788 | 2626 | 18485 | 2133 | 19740 | 1762 | 20759 | 1207 | 25059 | 1109 | 12574 |
| 2L-3S | | MI | 9607 | 3206 | 14443 | 2624 | 16779 | 2128 | 17677 | 1770 | 18045 | 1214 | 21483 | 977 | 12560 |
| 6-#18 | 2.34 | MA | 11942 | 3588 | 18901 | 2842 | 22304 | 2289 | 24171 | 1846 | 26555 | 1150 | 32557 | 996 | 21552 |
| 2L-3S | | MI | 10194 | 3588 | 16561 | 2836 | 19337 | 2277 | 20627 | 1859 | 21891 | 1164 | 26451 | 762 | 21241 |
| 8-#11 | 1.22 | MA | 10543 | 3169 | 15456 | 2614 | 18130 | 2125 | 19348 | 1760 | 20296 | 1219 | 24493 | 1129 | 11729 |
| 2L-4S | | MI | 9269 | 3169 | 13808 | 2612 | 15982 | 2129 | 16745 | 1761 | 16864 | 1219 | 20309 | 946 | 11670 |
| 8-#14 | 1.76 | MA | 11265 | 3370 | 17132 | 2728 | 20190 | 2207 | 21803 | 1809 | 23473 | 1193 | 28635 | 1077 | 16574 |
| 2L-4S | | MI | 9485 | 3370 | 14779 | 2724 | 17122 | 2212 | 18092 | 1809 | 18604 | 1193 | 22719 | 815 | 16083 |
| 8-#18 | 3.13 | MA | 12942 | 3879 | 21240 | 3024 | 25271 | 2422 | 27716 | 1927 | 31218 | 1123 | 38662 | 930 | 28445 |
| 2L-4S | | MI | 9979 | 3879 | 17138 | 3011 | 19925 | 2425 | 21339 | 1927 | 22966 | 1149 | 28549 | 470 | 25035 |
| 10-#11 | 1.52 | MA | 10982 | 3283 | 16399 | 2685 | 19325 | 2177 | 20795 | 1793 | 22210 | 1211 | 27022 | 1108 | 14537 |
| 2L-5S | | MI | 9240 | 3283 | 14035 | 2692 | 16318 | 2178 | 17145 | 1800 | 17392 | 1216 | 21076 | 884 | 13848 |
| 10-#11 | 1.52 | MA | 10256 | 3283 | 15456 | 2684 | 18130 | 2174 | 19348 | 1799 | 20296 | 1216 | 24493 | 1017 | 14515 |
| 3L-4S | | MI | 9724 | 3283 | 14751 | 2683 | 17177 | 2181 | 18192 | 1794 | 18778 | 1211 | 22837 | 926 | 14423 |
| 10-#14 | 2.20 | MA | 11866 | 3533 | 18477 | 2831 | 21895 | 2282 | 23866 | 1857 | 26187 | 1180 | 32211 | 1045 | 20553 |
| 2L-5S | | MI | 9441 | 3533 | 15100 | 2839 | 17599 | 2282 | 18659 | 1864 | 19353 | 1188 | 23801 | 722 | 18685 |
| 10-#14 | 2.20 | MA | 10856 | 3533 | 17132 | 2828 | 20190 | 2277 | 21803 | 1864 | 23473 | 1188 | 28635 | 913 | 20446 |
| 3L-4S | | MI | 10115 | 3533 | 16123 | 2826 | 18827 | 2287 | 20155 | 1857 | 21318 | 1180 | 26295 | 783 | 19796 |
| 10-#18 | 3.91 | MA | 13916 | 4170 | 23579 | 3206 | 28237 | 2555 | 31260 | 2007 | 35881 | 1095 | 44768 | 864 | 35314 |
| 2L-5S | | MI | 9905 | 4170 | 17689 | 3213 | 20744 | 2546 | 22314 | 2020 | 24138 | 1108 | 30397 | 295 | 28801 |
| 10-#18 | 3.91 | MA | 12246 | 4170 | 21240 | 3199 | 25271 | 2543 | 27716 | 2020 | 31218 | 1108 | 38662 | 631 | 34771 |
| 3L-4S | | MI | 11020 | 4170 | 19478 | 3193 | 22891 | 2558 | 24883 | 2007 | 27629 | 1122 | 34655 | 405 | 31546 |

## RECTANGULAR TIED COLUMNS 32" x 34"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.47 | MA | 12234 | 3467 | 18362 | 2820 | 21500 | 2287 | 22995 | 1882 | 24356 | 1270 | 29466 | 1156 | 15696 |
| 2E | | MI | 11458 | 3467 | 17304 | 2804 | 20175 | 2274 | 21473 | 1866 | 22677 | 1255 | 27341 | 1136 | 14657 |
| 6-#14 | 1.24 | MA | 11946 | 3376 | 17520 | 2785 | 20572 | 2264 | 21974 | 1874 | 23101 | 1296 | 27908 | 1200 | 13485 |
| 2L-3S | | MI | 10152 | 3376 | 15178 | 2769 | 17615 | 2247 | 18524 | 1871 | 18833 | 1292 | 22379 | 1052 | 12606 |
| 6-#14 | 1.24 | MA | 10819 | 3376 | 16073 | 2784 | 18737 | 2259 | 19751 | 1883 | 20160 | 1304 | 24019 | 1069 | 13471 |
| 3L-2S | | MI | 11199 | 3376 | 16522 | 2771 | 19320 | 2252 | 20587 | 1864 | 21547 | 1284 | 25955 | 1184 | 12607 |
| 6-#18 | 2.21 | MA | 13364 | 3758 | 20883 | 3001 | 24698 | 2420 | 26847 | 1964 | 29423 | 1245 | 36127 | 1096 | 23172 |
| 2L-3S | | MI | 10741 | 3758 | 17304 | 2979 | 20175 | 2395 | 21473 | 1960 | 22677 | 1241 | 27341 | 837 | 21337 |

## RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

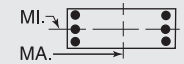
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 2.21 | MA | 11471 | 3758 | 18362 | 2996 | 21500 | 2410 | 22995 | 1978 | 24356 | 1258 | 29466 | 862 | 22861 |
| 3L-2S | | MI | 12498 | 3758 | 19643 | 2986 | 23142 | 2407 | 25017 | 1947 | 27340 | 1228 | 33447 | 1070 | 21603 |
| 8-#11 | 1.15 | MA | 11826 | 3339 | 17160 | 2773 | 20186 | 2256 | 21537 | 1871 | 22589 | 1308 | 27274 | 1219 | 12572 |
| 2L-4S | | MI | 9813 | 3339 | 14539 | 2758 | 16816 | 2249 | 17592 | 1863 | 17654 | 1297 | 21207 | 1022 | 11723 |
| 8-#11 | 1.15 | MA | 11034 | 3339 | 16147 | 2773 | 18901 | 2254 | 19980 | 1878 | 20518 | 1313 | 24528 | 1128 | 12575 |
| 3E | | MI | 10354 | 3339 | 15244 | 2759 | 17769 | 2242 | 18747 | 1868 | 19173 | 1302 | 22863 | 1113 | 11769 |
| 8-#11 | 1.15 | MA | 10453 | 3339 | 15390 | 2772 | 17878 | 2262 | 18740 | 1874 | 18874 | 1308 | 22727 | 1037 | 12513 |
| 4L-2S | | MI | 11091 | 3339 | 16187 | 2760 | 18964 | 2245 | 20195 | 1862 | 21087 | 1297 | 25391 | 1204 | 11759 |
| 8-#14 | 1.65 | MA | 12617 | 3540 | 18967 | 2887 | 22407 | 2338 | 24197 | 1922 | 26043 | 1285 | 31797 | 1171 | 17789 |
| 2L-4S | | MI | 10030 | 3540 | 15513 | 2869 | 17957 | 2332 | 18939 | 1911 | 19393 | 1271 | 23615 | 890 | 16305 |
| 8-#14 | 1.65 | MA | 11508 | 3540 | 17520 | 2886 | 20572 | 2334 | 21974 | 1930 | 23101 | 1292 | 27908 | 1040 | 17724 |
| 3E | | MI | 10787 | 3540 | 16522 | 2871 | 19320 | 2322 | 20587 | 1918 | 21547 | 1279 | 25955 | 1021 | 16563 |
| 8-#14 | 1.65 | MA | 10695 | 3540 | 16437 | 2884 | 19108 | 2345 | 20201 | 1923 | 20767 | 1285 | 25361 | 908 | 17442 |
| 4L-2S | | MI | 11817 | 3540 | 17867 | 2873 | 21026 | 2327 | 22650 | 1911 | 24261 | 1271 | 29531 | 1152 | 16613 |
| 8-#18 | 2.94 | MA | 14456 | 4049 | 23404 | 3183 | 27895 | 2553 | 30698 | 2047 | 34490 | 1220 | 42788 | 1036 | 30605 |
| 2L-4S | | MI | 10523 | 4049 | 17881 | 3154 | 20762 | 2543 | 22185 | 2027 | 23751 | 1226 | 29439 | 545 | 25330 |
| 8-#18 | 2.94 | MA | 12608 | 4049 | 20883 | 3178 | 24698 | 2543 | 26847 | 2060 | 29423 | 1233 | 36127 | 802 | 30169 |
| 3E | | MI | 11788 | 4049 | 19643 | 3161 | 23142 | 2528 | 25017 | 2040 | 27340 | 1213 | 33447 | 771 | 28114 |
| 8-#18 | 2.94 | MA | 11252 | 4049 | 18989 | 3173 | 22140 | 2559 | 23769 | 2047 | 25400 | 1220 | 31763 | 572 | 27167 |
| 4L-2S | | MI | 13504 | 4049 | 21983 | 3168 | 26108 | 2540 | 28562 | 2027 | 32003 | 1200 | 39552 | 1005 | 28502 |
| 10-#11 | 1.43 | MA | 12304 | 3452 | 18173 | 2844 | 21471 | 2308 | 23093 | 1904 | 24661 | 1301 | 30021 | 1200 | 15590 |
| 2L-5S | | MI | 9783 | 3452 | 14766 | 2838 | 17153 | 2298 | 17992 | 1901 | 18182 | 1294 | 21975 | 959 | 13996 |
| 10-#11 | 1.43 | MA | 11521 | 3452 | 17160 | 2844 | 20186 | 2305 | 21537 | 1911 | 22589 | 1306 | 27274 | 1109 | 15568 |
| 3L-4S | | MI | 10269 | 3452 | 15481 | 2828 | 18011 | 2301 | 19040 | 1896 | 19568 | 1289 | 23736 | 1002 | 14481 |
| 10-#11 | 1.43 | MA | 10948 | 3452 | 16403 | 2843 | 19163 | 2314 | 20297 | 1907 | 20945 | 1301 | 25473 | 1018 | 15476 |
| 4L-3S | | MI | 10804 | 3452 | 16187 | 2830 | 18964 | 2294 | 20195 | 1900 | 21087 | 1294 | 25391 | 1093 | 14556 |
| 10-#11 | 1.43 | MA | 10427 | 3452 | 15636 | 2853 | 18242 | 2311 | 19174 | 1913 | 19445 | 1306 | 23567 | 975 | 14942 |
| 5L-2S | | MI | 11532 | 3452 | 17129 | 2831 | 20160 | 2297 | 21643 | 1895 | 23000 | 1289 | 27920 | 1184 | 14569 |
| 10-#14 | 2.07 | MA | 13272 | 3703 | 20414 | 2990 | 24242 | 2413 | 26420 | 1969 | 28984 | 1273 | 35687 | 1142 | 22072 |
| 2L-5S | | MI | 9984 | 3703 | 15835 | 2983 | 18435 | 2401 | 19506 | 1965 | 20141 | 1266 | 24697 | 797 | 18872 |
| 10-#14 | 2.07 | MA | 12181 | 3703 | 18967 | 2988 | 22407 | 2409 | 24197 | 1977 | 26043 | 1281 | 31797 | 1011 | 21965 |
| 3L-4S | | MI | 10662 | 3703 | 16858 | 2971 | 19663 | 2406 | 21002 | 1958 | 22107 | 1258 | 27190 | 858 | 20013 |
| 10-#14 | 2.07 | MA | 11382 | 3703 | 17884 | 2987 | 20943 | 2420 | 22424 | 1971 | 23708 | 1273 | 29251 | 879 | 21446 |
| 4L-3S | | MI | 11407 | 3703 | 17867 | 2973 | 21026 | 2396 | 22650 | 1965 | 24261 | 1266 | 29531 | 989 | 20505 |
| 10-#14 | 2.07 | MA | 10656 | 3703 | 16786 | 3000 | 19626 | 2416 | 20816 | 1979 | 21578 | 1281 | 26544 | 818 | 20176 |
| 5L-2S | | MI | 12422 | 3703 | 19212 | 2976 | 22731 | 2401 | 24713 | 1958 | 26975 | 1258 | 33107 | 1120 | 20596 |
| 10-#18 | 3.68 | MA | 15520 | 4339 | 25925 | 3365 | 31092 | 2686 | 34549 | 2130 | 39556 | 1195 | 49449 | 976 | 38014 |
| 2L-5S | | MI | 10446 | 4339 | 18431 | 3356 | 21582 | 2664 | 23160 | 2121 | 24923 | 1185 | 31287 | 370 | 29260 |
| 10-#18 | 3.68 | MA | 13712 | 4339 | 23404 | 3360 | 27895 | 2676 | 30698 | 2143 | 34490 | 1209 | 42788 | 743 | 37471 |
| 3L-4S | | MI | 11569 | 4339 | 20220 | 3336 | 23729 | 2676 | 25729 | 2107 | 28414 | 1199 | 35545 | 479 | 31834 |
| 10-#18 | 3.68 | MA | 12388 | 4339 | 21510 | 3355 | 25337 | 2692 | 27621 | 2130 | 30467 | 1195 | 38424 | 513 | 34199 |
| 4L-3S | | MI | 12804 | 4339 | 21983 | 3343 | 26108 | 2661 | 28562 | 2121 | 32003 | 1185 | 39552 | 705 | 34884 |
| 10-#18 | 3.68 | MA | 11185 | 4339 | 19588 | 3376 | 23030 | 2682 | 24829 | 2143 | 26798 | 1209 | 33779 | 404 | 31425 |
| 5L-2S | | MI | 14484 | 4339 | 24322 | 3349 | 29075 | 2673 | 32106 | 2107 | 36667 | 1172 | 45658 | 939 | 35376 |
| 12-#11 | 1.72 | MA | 12773 | 3566 | 19187 | 2915 | 22756 | 2360 | 24650 | 1937 | 26732 | 1294 | 32767 | 1182 | 18595 |
| 2L-6S | | MI | 9776 | 3566 | 15071 | 2907 | 17499 | 2358 | 18408 | 1930 | 18763 | 1291 | 22739 | 863 | 16158 |
| 12-#11 | 1.72 | MA | 11999 | 3566 | 18173 | 2914 | 21471 | 2357 | 23093 | 1943 | 24661 | 1299 | 30021 | 1091 | 18553 |
| 3L-5S | | MI | 10237 | 3566 | 15708 | 2909 | 18348 | 2350 | 19440 | 1934 | 20095 | 1286 | 24504 | 939 | 16652 |
| 12-#11 | 1.72 | MA | 11433 | 3566 | 17416 | 2914 | 20447 | 2365 | 21854 | 1940 | 23017 | 1294 | 28220 | 1000 | 18435 |
| 4E | | MI | 10717 | 3566 | 16423 | 2899 | 19206 | 2353 | 20488 | 1929 | 21481 | 1281 | 26265 | 981 | 17234 |
| 12-#11 | 1.72 | MA | 10919 | 3566 | 16649 | 2924 | 19527 | 2363 | 20730 | 1946 | 21517 | 1299 | 26313 | 956 | 17803 |
| 5L-3S | | MI | 11245 | 3566 | 17129 | 2901 | 20160 | 2346 | 21643 | 1933 | 23000 | 1286 | 27920 | 1072 | 17334 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis



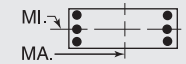

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.72 | MA | 10426 | 3566 | 15967 | 2923 | 18618 | 2371 | 19624 | 1942 | 20074 | 1304 | 24396 | 881 | 17250 |
| 6L-2S | | MI | 11965 | 3566 | 18071 | 2902 | 21355 | 2349 | 23091 | 1928 | 24914 | 1281 | 30449 | 1163 | 17367 |
| 12-#14 | 2.48 | MA | 13915 | 3867 | 21861 | 3092 | 26077 | 2488 | 28643 | 2016 | 31925 | 1262 | 39576 | 1113 | 26343 |
| 2L-6S | | MI | 9974 | 3867 | 16268 | 3083 | 18926 | 2486 | 20096 | 2005 | 20965 | 1260 | 25778 | 656 | 21494 |
| 12-#14 | 2.48 | MA | 12839 | 3867 | 20414 | 3090 | 24242 | 2484 | 26420 | 2025 | 28984 | 1269 | 35687 | 982 | 26198 |
| 3L-5S | | MI | 10614 | 3867 | 17179 | 3086 | 20140 | 2476 | 21569 | 2013 | 22855 | 1253 | 28273 | 765 | 22673 |
| 12-#14 | 2.48 | MA | 12053 | 3867 | 19331 | 3089 | 22778 | 2495 | 24647 | 2018 | 26649 | 1262 | 33140 | 850 | 25474 |
| 4E | | MI | 11281 | 3867 | 18203 | 3073 | 21368 | 2481 | 23065 | 2005 | 24821 | 1245 | 30766 | 826 | 23747 |
| 12-#14 | 2.48 | MA | 11339 | 3867 | 18233 | 3102 | 21461 | 2491 | 23039 | 2027 | 24519 | 1269 | 30433 | 789 | 24275 |
| 5L-3S | | MI | 12014 | 3867 | 19212 | 3075 | 22731 | 2471 | 24713 | 2013 | 26975 | 1253 | 33107 | 957 | 24440 |
| 12-#14 | 2.48 | MA | 10654 | 3867 | 17256 | 3101 | 20159 | 2502 | 21455 | 2020 | 22471 | 1277 | 27719 | 680 | 23000 |
| 6L-2S | | MI | 13014 | 3867 | 20556 | 3078 | 24436 | 2476 | 26776 | 2005 | 29689 | 1245 | 36682 | 1088 | 24567 |
| 12-#18 | 4.41 | MA | 14788 | 4630 | 25925 | 3542 | 31092 | 2809 | 34549 | 2225 | 39556 | 1184 | 49449 | 683 | 44771 |
| 3L-5S | | MI | 11489 | 4630 | 20771 | 3538 | 24549 | 2797 | 26704 | 2201 | 29586 | 1158 | 37392 | 304 | 35658 |
| 12-#18 | 4.41 | MA | 13494 | 4630 | 24031 | 3537 | 28534 | 2825 | 31472 | 2212 | 35534 | 1171 | 45085 | 453 | 41268 |
| 4E | | MI | 12587 | 4630 | 22560 | 3518 | 26696 | 2809 | 29274 | 2188 | 33078 | 1171 | 41650 | 414 | 38375 |
| 12-#18 | 4.41 | MA | 12319 | 4630 | 22109 | 3558 | 26228 | 2815 | 28680 | 2225 | 31864 | 1184 | 40440 | 344 | 38355 |
| 5L-3S | | MI | 13796 | 4630 | 24322 | 3524 | 29075 | 2794 | 32106 | 2201 | 36667 | 1158 | 45658 | 640 | 41650 |
| 14-#11 | 2.01 | MA | 13235 | 3679 | 20200 | 2986 | 24041 | 2411 | 26207 | 1970 | 28803 | 1287 | 35514 | 1164 | 21592 |
| 2L-7S | | MI | 9782 | 3679 | 15393 | 2977 | 17875 | 2407 | 18854 | 1968 | 19325 | 1278 | 23705 | 771 | 18075 |
| 14-#11 | 2.01 | MA | 12469 | 3679 | 19187 | 2985 | 22756 | 2409 | 24650 | 1976 | 26732 | 1292 | 32767 | 1072 | 21532 |
| 3L-6S | | MI | 10228 | 3679 | 16014 | 2978 | 18695 | 2409 | 19856 | 1963 | 20676 | 1283 | 25268 | 843 | 18846 |
| 14-#11 | 2.01 | MA | 11910 | 3679 | 18429 | 2985 | 21732 | 2417 | 23411 | 1972 | 25088 | 1287 | 30966 | 981 | 21390 |
| 4L-5S | | MI | 10683 | 3679 | 16650 | 2979 | 19543 | 2402 | 20888 | 1967 | 22009 | 1278 | 27033 | 918 | 19318 |
| 14-#11 | 2.01 | MA | 11403 | 3679 | 17662 | 2994 | 20812 | 2415 | 22287 | 1979 | 23588 | 1292 | 29060 | 938 | 20674 |
| 5L-4S | | MI | 11157 | 3679 | 17366 | 2970 | 20401 | 2405 | 21935 | 1961 | 23395 | 1273 | 28794 | 961 | 19983 |
| 14-#11 | 2.01 | MA | 10916 | 3679 | 16980 | 2994 | 19903 | 2423 | 21181 | 1975 | 22145 | 1297 | 27143 | 862 | 20145 |
| 6L-3S | | MI | 11679 | 3679 | 18071 | 2971 | 21355 | 2397 | 23091 | 1966 | 24914 | 1278 | 30449 | 1052 | 20106 |
| 14-#11 | 2.01 | MA | 10439 | 3679 | 16315 | 2993 | 19024 | 2421 | 20107 | 1981 | 20682 | 1292 | 25443 | 791 | 19309 |
| 7L-2S | | MI | 12391 | 3679 | 19014 | 2973 | 22550 | 2400 | 24538 | 1960 | 26827 | 1273 | 32978 | 1143 | 20157 |
| 14-#14 | 2.90 | MA | 14546 | 4030 | 23308 | 3194 | 27912 | 2563 | 30866 | 2064 | 34867 | 1250 | 43465 | 1084 | 30605 |
| 2L-7S | | MI | 9983 | 4030 | 16725 | 3183 | 19458 | 2556 | 20729 | 2060 | 21762 | 1240 | 27143 | 522 | 24003 |
| 14-#14 | 2.90 | MA | 13484 | 4030 | 21861 | 3193 | 26077 | 2559 | 28643 | 2072 | 31925 | 1258 | 39576 | 953 | 30426 |
| 3L-6S | | MI | 10600 | 4030 | 17613 | 3186 | 20632 | 2561 | 22159 | 2052 | 23679 | 1247 | 29354 | 624 | 25231 |
| 14-#14 | 2.90 | MA | 12710 | 4030 | 20778 | 3191 | 24613 | 2570 | 26870 | 2066 | 29591 | 1250 | 37029 | 821 | 29524 |
| 4L-5S | | MI | 11231 | 4030 | 18524 | 3188 | 21845 | 2551 | 23632 | 2060 | 25569 | 1240 | 31848 | 734 | 26487 |
| 14-#14 | 2.90 | MA | 12008 | 4030 | 19680 | 3204 | 23296 | 2566 | 25262 | 2074 | 27461 | 1258 | 34323 | 760 | 28387 |
| 5L-4S | | MI | 11887 | 4030 | 19547 | 3175 | 23073 | 2556 | 25128 | 2052 | 27535 | 1232 | 34342 | 794 | 27502 |
| 14-#14 | 2.90 | MA | 11334 | 4030 | 18703 | 3203 | 21994 | 2576 | 23678 | 2067 | 25412 | 1265 | 31609 | 651 | 27036 |
| 6L-3S | | MI | 12610 | 4030 | 20556 | 3178 | 24436 | 2546 | 26776 | 2060 | 29689 | 1240 | 36682 | 925 | 28368 |
| 14-#14 | 2.90 | MA | 10673 | 4030 | 17751 | 3201 | 20735 | 2572 | 22141 | 2076 | 23334 | 1258 | 29205 | 548 | 25710 |
| 7L-2S | | MI | 13597 | 4030 | 21901 | 3180 | 26142 | 2551 | 28839 | 2052 | 32403 | 1232 | 40258 | 1056 | 28528 |
| 14-#18 | 5.15 | MA | 14576 | 4921 | 26552 | 3718 | 31731 | 2958 | 35323 | 2295 | 40600 | 1146 | 51746 | 393 | 48369 |
| 4L-5S | | MI | 12576 | 4921 | 23110 | 3720 | 27515 | 2930 | 30249 | 2281 | 34250 | 1130 | 43498 | 238 | 42089 |
| 14-#18 | 5.15 | MA | 13425 | 4921 | 24630 | 3740 | 29425 | 2948 | 32531 | 2308 | 36931 | 1159 | 47101 | 285 | 45318 |
| 5L-4S | | MI | 13639 | 4921 | 24899 | 3700 | 29663 | 2942 | 32818 | 2268 | 37741 | 1143 | 47756 | 348 | 44948 |
| 16-#11 | 2.29 | MA | 13690 | 3793 | 21213 | 3057 | 25326 | 2463 | 27764 | 2003 | 30875 | 1280 | 38260 | 1145 | 24584 |
| 2L-8S | | MI | 9797 | 3793 | 15725 | 3047 | 18266 | 2455 | 19299 | 1996 | 19934 | 1275 | 24591 | 701 | 19979 |
| 16-#11 | 2.29 | MA | 12932 | 3793 | 20200 | 3056 | 24041 | 2461 | 26207 | 2009 | 28803 | 1285 | 35514 | 1054 | 24506 |
| 3L-7S | | MI | 10232 | 3793 | 16336 | 3048 | 19070 | 2458 | 20302 | 2001 | 21238 | 1270 | 26234 | 751 | 20722 |
| 16-#11 | 2.29 | MA | 12380 | 3793 | 19443 | 3056 | 23017 | 2469 | 24967 | 2005 | 27159 | 1280 | 33713 | 963 | 24344 |
| 4L-6S | | MI | 10672 | 3793 | 16956 | 3049 | 19890 | 2461 | 21304 | 1995 | 22590 | 1275 | 27797 | 822 | 21540 |
| 16-#11 | 2.29 | MA | 11878 | 3793 | 18676 | 3065 | 22097 | 2467 | 23844 | 2012 | 25659 | 1285 | 31806 | 919 | 23555 |
| 5E | | MI | 11122 | 3793 | 17593 | 3050 | 20738 | 2454 | 22336 | 2000 | 23923 | 1270 | 29562 | 898 | 21993 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis

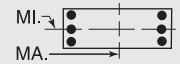


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.29 | MA | 11398 | 3793 | 17993 | 3065 | 21188 | 2475 | 22737 | 2008 | 24217 | 1290 | 29890 | 844 | 23046 |
| 6L-4S | | MI | 11591 | 3793 | 18308 | 3041 | 21596 | 2457 | 23383 | 1994 | 25308 | 1265 | 31323 | 940 | 22730 |
| 16-#11 | 2.29 | MA | 10927 | 3793 | 17329 | 3064 | 20309 | 2473 | 21664 | 2014 | 22754 | 1285 | 28190 | 773 | 22163 |
| 7L-3S | | MI | 12106 | 3793 | 19014 | 3042 | 22550 | 2449 | 24538 | 1999 | 26827 | 1270 | 32978 | 1032 | 22873 |
| 16-#11 | 2.29 | MA | 10461 | 3793 | 16674 | 3063 | 19447 | 2470 | 20588 | 2010 | 21342 | 1290 | 26411 | 722 | 21358 |
| 8L-2S | | MI | 12812 | 3793 | 19956 | 3043 | 23745 | 2452 | 25986 | 1993 | 28741 | 1265 | 35507 | 1123 | 22940 |
| 16-#14 | 3.31 | MA | 14119 | 4194 | 23308 | 3295 | 27912 | 2634 | 30866 | 2119 | 34867 | 1246 | 43465 | 924 | 34650 |
| 3L-7S | | MI | 10607 | 4194 | 18069 | 3286 | 21164 | 2631 | 22792 | 2107 | 24476 | 1227 | 30719 | 490 | 27706 |
| 16-#14 | 3.31 | MA | 13357 | 4194 | 22225 | 3293 | 26448 | 2644 | 29093 | 2113 | 32532 | 1239 | 40919 | 792 | 33591 |
| 4L-6S | | MI | 11216 | 4194 | 18957 | 3288 | 22337 | 2636 | 24222 | 2099 | 26393 | 1234 | 32930 | 592 | 28981 |
| 16-#14 | 3.31 | MA | 12665 | 4194 | 21127 | 3307 | 25131 | 2640 | 27485 | 2121 | 30402 | 1246 | 38212 | 731 | 32509 |
| 5E | | MI | 11836 | 4194 | 19869 | 3290 | 23551 | 2626 | 25695 | 2107 | 28283 | 1227 | 35424 | 702 | 30311 |
| 16-#14 | 3.31 | MA | 12001 | 4194 | 20150 | 3305 | 23829 | 2651 | 25901 | 2115 | 28354 | 1254 | 35498 | 622 | 31086 |
| 6L-4S | | MI | 12483 | 4194 | 20892 | 3278 | 24779 | 2631 | 27191 | 2099 | 30249 | 1219 | 37918 | 762 | 31274 |
| 16-#14 | 3.31 | MA | 11351 | 4194 | 19198 | 3304 | 22570 | 2647 | 24365 | 2123 | 26276 | 1246 | 33094 | 519 | 29714 |
| 7L-3S | | MI | 13196 | 4194 | 21901 | 3280 | 26142 | 2621 | 28839 | 2107 | 32403 | 1227 | 40258 | 893 | 32291 |
| 16-#18 | 5.88 | MA | 14584 | 5212 | 27151 | 3922 | 32622 | 3081 | 36383 | 2391 | 41998 | 1134 | 53762 | 225 | 52310 |
| 5E | | MI | 13571 | 5212 | 25449 | 3901 | 30482 | 3063 | 33793 | 2362 | 38913 | 1102 | 49603 | 173 | 48550 |
| 18-#11 | 2.58 | MA | 13389 | 3906 | 21213 | 3127 | 25326 | 2513 | 27764 | 2042 | 30875 | 1277 | 38260 | 1035 | 27478 |
| 3L-8S | | MI | 10245 | 3906 | 16667 | 3118 | 19461 | 2507 | 20746 | 2029 | 21848 | 1267 | 27120 | 681 | 22600 |
| 18-#11 | 2.58 | MA | 12843 | 3906 | 20456 | 3126 | 24302 | 2521 | 26524 | 2038 | 29231 | 1272 | 36459 | 944 | 27296 |
| 4L-7S | | MI | 10675 | 3906 | 17278 | 3119 | 20265 | 2510 | 21750 | 2034 | 23152 | 1262 | 28763 | 730 | 23377 |
| 18-#11 | 2.58 | MA | 12347 | 3906 | 19689 | 3136 | 23382 | 2519 | 25401 | 2045 | 27731 | 1277 | 34553 | 901 | 26442 |
| 5L-6S | | MI | 11110 | 3906 | 17898 | 3120 | 21085 | 2513 | 22751 | 2028 | 24503 | 1267 | 30326 | 802 | 24228 |
| 18-#11 | 2.58 | MA | 11872 | 3906 | 19006 | 3136 | 22473 | 2527 | 24294 | 2041 | 26288 | 1283 | 32636 | 825 | 25951 |
| 6L-5S | | MI | 11555 | 3906 | 18535 | 3121 | 21933 | 2506 | 23784 | 2033 | 25836 | 1262 | 32090 | 878 | 24675 |
| 18-#11 | 2.58 | MA | 11407 | 3906 | 18342 | 3135 | 21594 | 2524 | 23221 | 2047 | 24825 | 1277 | 30936 | 754 | 25025 |
| 7L-4S | | MI | 12018 | 3906 | 19250 | 3112 | 22792 | 2509 | 24831 | 2027 | 27222 | 1256 | 33851 | 920 | 25474 |
| 18-#11 | 2.58 | MA | 10947 | 3906 | 17687 | 3134 | 20732 | 2522 | 22145 | 2043 | 23414 | 1283 | 29157 | 704 | 24187 |
| 8L-3S | | MI | 12528 | 3906 | 19956 | 3113 | 23745 | 2501 | 25986 | 2032 | 28741 | 1262 | 35507 | 1011 | 25636 |
| 18-#14 | 3.72 | MA | 13992 | 4357 | 23672 | 3396 | 28283 | 2719 | 31316 | 2160 | 35473 | 1227 | 44808 | 764 | 37672 |
| 4L-7S | | MI | 11221 | 4357 | 19414 | 3388 | 22869 | 2706 | 24855 | 2154 | 27190 | 1214 | 34295 | 458 | 31422 |
| 18-#14 | 3.72 | MA | 13310 | 4357 | 22574 | 3409 | 26966 | 2715 | 29709 | 2169 | 33343 | 1235 | 42101 | 702 | 36640 |
| 5L-6S | | MI | 11820 | 4357 | 20302 | 3390 | 24042 | 2711 | 26285 | 2147 | 29107 | 1221 | 36505 | 560 | 32744 |
| 18-#14 | 3.72 | MA | 12656 | 4357 | 21596 | 3407 | 25664 | 2726 | 28125 | 2162 | 31295 | 1242 | 39387 | 593 | 35147 |
| 6L-5S | | MI | 12432 | 4357 | 21213 | 3392 | 25256 | 2701 | 27758 | 2154 | 30997 | 1214 | 39000 | 670 | 34143 |
| 18-#14 | 3.72 | MA | 12016 | 4357 | 20645 | 3406 | 24405 | 2722 | 26588 | 2171 | 29217 | 1235 | 36983 | 490 | 33729 |
| 7L-4S | | MI | 13070 | 4357 | 22237 | 3380 | 26484 | 2706 | 29254 | 2147 | 32963 | 1206 | 41494 | 731 | 35060 |
| 20-#11 | 2.87 | MA | 13299 | 4019 | 21469 | 3197 | 25587 | 2573 | 28081 | 2071 | 31302 | 1265 | 39206 | 926 | 30196 |
| 4L-8S | | MI | 10686 | 4019 | 17609 | 3189 | 20656 | 2559 | 22194 | 2062 | 23761 | 1259 | 29649 | 661 | 25228 |
| 20-#11 | 2.87 | MA | 12809 | 4019 | 20702 | 3207 | 24667 | 2571 | 26957 | 2077 | 29802 | 1270 | 37299 | 883 | 29336 |
| 5L-7S | | MI | 11112 | 4019 | 18220 | 3190 | 21460 | 2562 | 23198 | 2067 | 25065 | 1253 | 31292 | 710 | 26037 |
| 20-#11 | 2.87 | MA | 12340 | 4019 | 20020 | 3206 | 23758 | 2579 | 25851 | 2073 | 28359 | 1275 | 35383 | 807 | 28808 |
| 6E | | MI | 11542 | 4019 | 18841 | 3191 | 22280 | 2565 | 24199 | 2061 | 26417 | 1259 | 32855 | 781 | 26860 |
| 20-#11 | 2.87 | MA | 11880 | 4019 | 19355 | 3206 | 22879 | 2576 | 24777 | 2080 | 26896 | 1270 | 33683 | 736 | 27893 |
| 7L-5S | | MI | 11982 | 4019 | 19477 | 3192 | 23128 | 2558 | 25231 | 2066 | 27750 | 1253 | 34619 | 857 | 27362 |
| 20-#11 | 2.87 | MA | 11425 | 4019 | 18700 | 3205 | 22017 | 2574 | 23702 | 2076 | 25485 | 1275 | 31904 | 685 | 27023 |
| 8L-4S | | MI | 12440 | 4019 | 20193 | 3183 | 23987 | 2560 | 26279 | 2060 | 29135 | 1248 | 36380 | 900 | 28129 |
| 20-#14 | 4.14 | MA | 13947 | 4521 | 24021 | 3511 | 28801 | 2790 | 31932 | 2216 | 36285 | 1223 | 45991 | 673 | 40778 |
| 5L-7S | | MI | 11825 | 4521 | 20759 | 3490 | 24574 | 2780 | 26918 | 2201 | 29904 | 1201 | 37871 | 426 | 35148 |
| 20-#14 | 4.14 | MA | 13302 | 4521 | 23043 | 3510 | 27499 | 2801 | 30348 | 2210 | 34236 | 1230 | 43277 | 564 | 39220 |
| 6E | | MI | 12416 | 4521 | 21647 | 3492 | 25748 | 2785 | 28348 | 2194 | 31821 | 1208 | 40081 | 528 | 36518 |
| 20-#14 | 4.14 | MA | 12670 | 4521 | 22091 | 3508 | 26240 | 2797 | 28811 | 2218 | 32158 | 1223 | 40873 | 461 | 37756 |
| 7L-5S | | MI | 13020 | 4521 | 22558 | 3495 | 26961 | 2775 | 29821 | 2201 | 33711 | 1201 | 42576 | 638 | 37982 |
| 22-#11 | 3.15 | MA | 13266 | 4133 | 21715 | 3278 | 25952 | 2622 | 28514 | 2110 | 31873 | 1263 | 40046 | 864 | 32234 |
| 5L-8S | | MI | 11122 | 4133 | 18552 | 3259 | 21851 | 2611 | 23642 | 2095 | 25675 | 1250 | 32178 | 640 | 27862 |
| 22-#11 | 3.15 | MA | 12801 | 4133 | 21033 | 3277 | 25043 | 2630 | 27408 | 2106 | 30431 | 1268 | 38129 | 788 | 31653 |
| 6L-7S | | MI | 11543 | 4133 | 19163 | 3261 | 22655 | 2614 | 24646 | 2100 | 26979 | 1245 | 33821 | 690 | 28703 |

## RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.15 | MA | 12346 | 4133 | 20368 | 3277 | 24164 | 2628 | 26334 | 2113 | 28968 | 1263 | 36429 | 717 | 30766 |
| 7L-6S | | MI | 11968 | 4133 | 19783 | 3262 | 23475 | 2617 | 25647 | 2094 | 28331 | 1250 | 35384 | 761 | 29499 |
| 22-#11 | 3.15 | MA | 11897 | 4133 | 19714 | 3276 | 23302 | 2626 | 25259 | 2109 | 27556 | 1268 | 34650 | 667 | 29865 |
| 8L-5S | | MI | 12403 | 4133 | 20420 | 3263 | 24323 | 2609 | 26679 | 2099 | 29663 | 1245 | 37148 | 837 | 30055 |
| 22-#14 | 4.55 | MA | 13938 | 4685 | 24490 | 3612 | 29334 | 2876 | 32571 | 2257 | 37178 | 1219 | 47166 | 535 | 43302 |
| 6L-7S | | MI | 12420 | 4685 | 22103 | 3592 | 26280 | 2855 | 28981 | 2248 | 32618 | 1187 | 41446 | 394 | 38885 |
| 22-#14 | 4.55 | MA | 13315 | 4685 | 23538 | 3610 | 28075 | 2872 | 31034 | 2265 | 35100 | 1211 | 44762 | 432 | 41793 |
| 7L-6S | | MI | 13004 | 4685 | 22991 | 3595 | 27453 | 2860 | 30411 | 2241 | 34535 | 1195 | 43657 | 496 | 40301 |
| 24-#11 | 3.44 | MA | 13257 | 4246 | 22046 | 3348 | 26328 | 2682 | 28964 | 2139 | 32502 | 1261 | 40876 | 770 | 34505 |
| 6L-8S | | MI | 11552 | 4246 | 19494 | 3330 | 23046 | 2663 | 25090 | 2128 | 27588 | 1242 | 34707 | 620 | 30502 |
| 24-#11 | 3.44 | MA | 12807 | 4246 | 21381 | 3348 | 25449 | 2680 | 27891 | 2146 | 31039 | 1256 | 39176 | 699 | 33645 |
| 7E | | MI | 11968 | 4246 | 20105 | 3332 | 23850 | 2666 | 26094 | 2132 | 28892 | 1237 | 36350 | 669 | 31375 |
| 24-#11 | 3.44 | MA | 12363 | 4246 | 20727 | 3347 | 24587 | 2678 | 26815 | 2142 | 29628 | 1261 | 37397 | 648 | 32713 |
| 8L-6S | | MI | 12390 | 4246 | 20725 | 3333 | 24670 | 2669 | 27095 | 2127 | 30244 | 1242 | 37913 | 741 | 32145 |
| 24-#14 | 4.96 | MA | 13951 | 4848 | 24985 | 3713 | 29910 | 2946 | 33257 | 2313 | 38041 | 1200 | 48651 | 403 | 45838 |
| 7E | | MI | 13008 | 4848 | 23448 | 3694 | 27985 | 2930 | 31044 | 2295 | 35332 | 1174 | 45022 | 362 | 42631 |

## RECTANGULAR TIED COLUMNS 32" x 36"

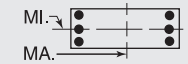
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.39 | MA | 13628 | 3637 | 20242 | 2979 | 23764 | 2418 | 25459 | 1996 | 26924 | 1360 | 32601 | 1249 | 16776 |
| 2E | | MI | 12008 | 3637 | 18047 | 2948 | 21013 | 2392 | 22319 | 1967 | 23462 | 1332 | 28232 | 1210 | 14697 |
| 6-#14 | 1.17 | MA | 13310 | 3546 | 19333 | 2944 | 22759 | 2394 | 24305 | 1985 | 25547 | 1386 | 30877 | 1290 | 14397 |
| 2L-3S | | MI | 10697 | 3546 | 15912 | 2914 | 18450 | 2366 | 19371 | 1972 | 19622 | 1370 | 23275 | 1128 | 12649 |
| 6-#14 | 1.17 | MA | 12099 | 3546 | 17783 | 2944 | 20794 | 2391 | 21925 | 1995 | 22378 | 1393 | 26674 | 1159 | 14382 |
| 3L-2S | | MI | 11747 | 3546 | 17257 | 2916 | 20156 | 2371 | 21434 | 1965 | 22336 | 1362 | 26851 | 1259 | 12639 |
| 6-#18 | 2.08 | MA | 14856 | 3927 | 22945 | 3160 | 27192 | 2551 | 29611 | 2080 | 32395 | 1338 | 39819 | 1194 | 24792 |
| 2L-3S | | MI | 11288 | 3927 | 18047 | 3123 | 21013 | 2513 | 22319 | 2060 | 23462 | 1318 | 28232 | 911 | 21426 |
| 6-#18 | 2.08 | MA | 12817 | 3927 | 20242 | 3157 | 23764 | 2542 | 25459 | 2094 | 26924 | 1351 | 32601 | 960 | 24481 |
| 3L-2S | | MI | 13052 | 3927 | 20386 | 3129 | 23979 | 2525 | 25864 | 2047 | 28125 | 1305 | 34337 | 1145 | 21653 |
| 8-#11 | 1.08 | MA | 13178 | 3509 | 18944 | 2932 | 22341 | 2387 | 23832 | 1982 | 24985 | 1397 | 30176 | 1308 | 13414 |
| 2L-4S | | MI | 10357 | 3509 | 15269 | 2903 | 17650 | 2369 | 18439 | 1965 | 18444 | 1375 | 22106 | 1098 | 11772 |
| 8-#11 | 1.08 | MA | 12327 | 3509 | 17860 | 2932 | 20966 | 2385 | 22166 | 1990 | 22756 | 1402 | 27211 | 1217 | 13417 |
| 3E | | MI | 10900 | 3509 | 15975 | 2904 | 18604 | 2362 | 19594 | 1969 | 19963 | 1381 | 23761 | 1189 | 11804 |
| 8-#11 | 1.08 | MA | 11705 | 3509 | 17051 | 2932 | 19874 | 2394 | 20842 | 1986 | 20987 | 1397 | 25264 | 1126 | 13355 |
| 4L-2S | | MI | 11639 | 3509 | 16917 | 2906 | 19799 | 2365 | 21042 | 1964 | 21877 | 1375 | 26290 | 1280 | 11787 |
| 8-#14 | 1.56 | MA | 14037 | 3709 | 20882 | 3047 | 24724 | 2469 | 26685 | 2033 | 28716 | 1376 | 35081 | 1264 | 19004 |
| 2L-4S | | MI | 10574 | 3709 | 16248 | 3014 | 18793 | 2451 | 19785 | 2012 | 20181 | 1349 | 24510 | 965 | 16421 |
| 8-#14 | 1.56 | MA | 12845 | 3709 | 19333 | 3046 | 22759 | 2466 | 24305 | 2042 | 25547 | 1383 | 30877 | 1133 | 18939 |
| 3E | | MI | 11335 | 3709 | 17257 | 3016 | 20156 | 2441 | 21434 | 2020 | 22336 | 1357 | 26851 | 1096 | 16613 |
| 8-#14 | 1.56 | MA | 11975 | 3709 | 18175 | 3045 | 21195 | 2478 | 22410 | 2037 | 23032 | 1376 | 28120 | 1001 | 18674 |
| 4L-2S | | MI | 12368 | 3709 | 18602 | 3018 | 21861 | 2446 | 23497 | 2012 | 25050 | 1349 | 30427 | 1227 | 16650 |
| 8-#18 | 2.78 | MA | 16042 | 4218 | 25648 | 3342 | 30620 | 2684 | 33764 | 2164 | 37865 | 1316 | 47037 | 1139 | 32765 |
| 2L-4S | | MI | 11068 | 4218 | 18624 | 3298 | 21600 | 2661 | 23031 | 2127 | 24536 | 1303 | 30329 | 619 | 25618 |
| 8-#18 | 2.78 | MA | 14051 | 4218 | 22945 | 3339 | 27192 | 2675 | 29611 | 2178 | 32395 | 1329 | 39819 | 906 | 32329 |
| 3E | | MI | 12339 | 4218 | 20386 | 3305 | 23979 | 2646 | 25864 | 2141 | 28125 | 1290 | 34337 | 845 | 28213 |
| 8-#18 | 2.78 | MA | 12595 | 4218 | 20919 | 3335 | 24455 | 2694 | 26295 | 2165 | 28052 | 1316 | 35098 | 672 | 29326 |
| 4L-2S | | MI | 14064 | 4218 | 22725 | 3311 | 26946 | 2658 | 29408 | 2127 | 32789 | 1277 | 40442 | 1079 | 28558 |
| 10-#11 | 1.35 | MA | 13696 | 3622 | 20028 | 3003 | 23716 | 2439 | 25497 | 2015 | 27214 | 1391 | 33140 | 1292 | 16643 |
| 2L-5S | | MI | 10327 | 3622 | 15496 | 2983 | 17987 | 2418 | 18839 | 2003 | 18972 | 1372 | 22874 | 1035 | 14140 |
| 10-#11 | 1.35 | MA | 12854 | 3622 | 18944 | 3003 | 22341 | 2437 | 23832 | 2022 | 24985 | 1396 | 30176 | 1200 | 16621 |
| 3L-4S | | MI | 10815 | 3622 | 16211 | 2974 | 18845 | 2421 | 19887 | 1998 | 20358 | 1367 | 24635 | 1077 | 14535 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis

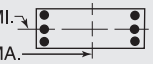



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.35 | MA | 12240 | 3622 | 18135 | 3003 | 21249 | 2446 | 22507 | 2019 | 23216 | 1391 | 28228 | 1109 | 16529 |
| 4L-3S | | MI | 11351 | 3622 | 16917 | 2975 | 19799 | 2414 | 21042 | 2002 | 21877 | 1372 | 26290 | 1168 | 14596 |
| 10-#11 | 1.35 | MA | 11683 | 3622 | 17316 | 3013 | 20266 | 2444 | 21308 | 2026 | 21601 | 1396 | 26176 | 1065 | 16047 |
| 5L-2S | | MI | 12081 | 3622 | 17860 | 2976 | 20994 | 2416 | 22490 | 1997 | 23790 | 1367 | 28819 | 1260 | 14601 |
| 10-#14 | 1.95 | MA | 14748 | 3873 | 22431 | 3149 | 26688 | 2544 | 29065 | 2080 | 31885 | 1365 | 39284 | 1238 | 23591 |
| 2L-5S | | MI | 10528 | 3873 | 16569 | 3128 | 19270 | 2521 | 20353 | 2067 | 20930 | 1344 | 25593 | 873 | 19053 |
| 10-#14 | 1.95 | MA | 13574 | 3873 | 20882 | 3148 | 24724 | 2541 | 26685 | 2090 | 28716 | 1373 | 35081 | 1106 | 23484 |
| 3L-4S | | MI | 11209 | 3873 | 17592 | 3116 | 20498 | 2526 | 21849 | 2059 | 22895 | 1336 | 28086 | 933 | 20224 |
| 10-#14 | 1.95 | MA | 12718 | 3873 | 19724 | 3147 | 23160 | 2553 | 24790 | 2084 | 26201 | 1365 | 32323 | 975 | 23115 |
| 4L-3S | | MI | 11957 | 3873 | 18602 | 3118 | 21861 | 2516 | 23497 | 2067 | 25050 | 1344 | 30427 | 1064 | 20562 |
| 10-#14 | 1.95 | MA | 11940 | 3873 | 18552 | 3161 | 21752 | 2549 | 23073 | 2093 | 23906 | 1373 | 29407 | 912 | 21680 |
| 5L-2S | | MI | 12976 | 3873 | 19946 | 3121 | 23566 | 2521 | 25560 | 2059 | 27764 | 1336 | 34002 | 1195 | 20638 |
| 10-#18 | 3.47 | MA | 17197 | 4509 | 28351 | 3524 | 34047 | 2817 | 37917 | 2249 | 43336 | 1294 | 54255 | 1085 | 40714 |
| 2L-5S | | MI | 10987 | 4509 | 19174 | 3500 | 22420 | 2782 | 24006 | 2221 | 25708 | 1263 | 32177 | 444 | 29709 |
| 10-#18 | 3.47 | MA | 15248 | 4509 | 25648 | 3520 | 30620 | 2808 | 33764 | 2262 | 37865 | 1307 | 47037 | 851 | 40171 |
| 3L-4S | | MI | 12117 | 4509 | 20963 | 3480 | 24567 | 2794 | 26575 | 2208 | 29200 | 1276 | 36435 | 554 | 32113 |
| 10-#18 | 3.47 | MA | 13827 | 4509 | 23621 | 3517 | 27883 | 2827 | 30448 | 2250 | 33523 | 1294 | 42316 | 618 | 36879 |
| 4L-3S | | MI | 13360 | 4509 | 22725 | 3486 | 26946 | 2779 | 29408 | 2221 | 32789 | 1263 | 40442 | 780 | 34991 |
| 10-#18 | 3.47 | MA | 12535 | 4509 | 21567 | 3540 | 25417 | 2818 | 27439 | 2263 | 29561 | 1307 | 37283 | 510 | 34098 |
| 5L-2S | | MI | 15050 | 4509 | 25065 | 3493 | 29913 | 2791 | 32952 | 2208 | 37452 | 1249 | 46548 | 1013 | 35437 |
| 12-#11 | 1.63 | MA | 14204 | 3736 | 21112 | 3074 | 25091 | 2490 | 27163 | 2048 | 29443 | 1384 | 36105 | 1275 | 19858 |
| 2L-6S | | MI | 10320 | 3736 | 15802 | 3053 | 18334 | 2477 | 19255 | 2031 | 19553 | 1369 | 23638 | 939 | 16293 |
| 12-#11 | 1.63 | MA | 13371 | 3736 | 20028 | 3074 | 23716 | 2489 | 25497 | 2055 | 27214 | 1390 | 33140 | 1184 | 19817 |
| 3L-5S | | MI | 10782 | 3736 | 16438 | 3054 | 19182 | 2470 | 20287 | 2036 | 20886 | 1364 | 25402 | 1014 | 16793 |
| 12-#11 | 1.63 | MA | 12765 | 3736 | 19219 | 3074 | 22623 | 2497 | 24173 | 2052 | 25445 | 1384 | 31193 | 1093 | 19698 |
| 4E | | MI | 11264 | 3736 | 17154 | 3045 | 20041 | 2473 | 21335 | 2030 | 22271 | 1359 | 27163 | 1057 | 17293 |
| 12-#11 | 1.63 | MA | 12215 | 3736 | 18400 | 3084 | 21641 | 2496 | 22974 | 2059 | 23831 | 1390 | 29141 | 1048 | 19111 |
| 5L-3S | | MI | 11794 | 3736 | 17860 | 3046 | 20994 | 2465 | 22490 | 2035 | 23790 | 1364 | 28819 | 1148 | 17377 |
| 12-#11 | 1.63 | MA | 11688 | 3736 | 17672 | 3084 | 20670 | 2504 | 21793 | 2056 | 22278 | 1395 | 27072 | 973 | 18491 |
| 6L-2S | | MI | 12517 | 3736 | 18802 | 3047 | 22189 | 2468 | 23938 | 2029 | 25704 | 1359 | 31348 | 1239 | 17403 |
| 12-#14 | 2.34 | MA | 15445 | 4036 | 23980 | 3251 | 28653 | 2619 | 31445 | 2128 | 35054 | 1355 | 43487 | 1211 | 28166 |
| 2L-6S | | MI | 10516 | 4037 | 17003 | 3228 | 19762 | 2605 | 20943 | 2106 | 21754 | 1338 | 26674 | 731 | 21785 |
| 12-#14 | 2.34 | MA | 14287 | 4037 | 22431 | 3250 | 26688 | 2616 | 29065 | 2137 | 31885 | 1362 | 39284 | 1080 | 28021 |
| 3L-5S | | MI | 11160 | 4037 | 17914 | 3231 | 20975 | 2595 | 22416 | 2114 | 23644 | 1331 | 29168 | 841 | 22851 |
| 12-#14 | 2.34 | MA | 13444 | 4037 | 21273 | 3249 | 25124 | 2627 | 27170 | 2131 | 29370 | 1355 | 36527 | 949 | 27435 |
| 4E | | MI | 11830 | 4036 | 18937 | 3218 | 22204 | 2600 | 23912 | 2106 | 25609 | 1323 | 31662 | 902 | 23954 |
| 12-#14 | 2.34 | MA | 12679 | 4037 | 20101 | 3263 | 23717 | 2624 | 25453 | 2141 | 27075 | 1362 | 33610 | 886 | 26074 |
| 5L-3S | | MI | 12567 | 4036 | 19946 | 3220 | 23566 | 2591 | 25560 | 2114 | 27764 | 1331 | 34002 | 1032 | 24500 |
| 12-#14 | 2.34 | MA | 11945 | 4037 | 19058 | 3263 | 22327 | 2636 | 23762 | 2135 | 24868 | 1370 | 30677 | 777 | 24832 |
| 6L-2S | | MI | 13572 | 4036 | 21291 | 3223 | 25272 | 2596 | 27623 | 2106 | 30478 | 1323 | 37578 | 1163 | 24612 |
| 12-#18 | 4.17 | MA | 16416 | 4800 | 28351 | 3702 | 34047 | 2941 | 37917 | 2347 | 43336 | 1285 | 54255 | 796 | 48011 |
| 3L-5S | | MI | 12034 | 4800 | 21513 | 3681 | 25386 | 2915 | 27550 | 2301 | 30372 | 1235 | 38282 | 379 | 36096 |
| 12-#18 | 4.17 | MA | 15025 | 4800 | 26324 | 3699 | 31310 | 2960 | 34601 | 2334 | 38993 | 1272 | 49534 | 563 | 44470 |
| 4E | | MI | 13140 | 4800 | 23302 | 3661 | 27534 | 2927 | 30120 | 2288 | 33863 | 1248 | 42540 | 488 | 38648 |
| 12-#18 | 4.17 | MA | 13764 | 4800 | 24270 | 3721 | 28845 | 2951 | 31592 | 2347 | 35031 | 1285 | 44501 | 455 | 41551 |
| 5L-3S | | MI | 14357 | 4800 | 25065 | 3668 | 29913 | 2912 | 32952 | 2301 | 37452 | 1235 | 46548 | 714 | 41764 |
| 12-#18 | 4.17 | MA | 12553 | 4800 | 22441 | 3718 | 26408 | 2970 | 28628 | 2335 | 31222 | 1298 | 39465 | 260 | 38428 |
| 6L-2S | | MI | 16015 | 4800 | 27404 | 3675 | 32880 | 2924 | 36497 | 2288 | 42115 | 1222 | 52653 | 948 | 42299 |
| 14-#11 | 1.90 | MA | 14704 | 3849 | 22196 | 3145 | 26466 | 2542 | 28829 | 2081 | 31673 | 1378 | 39069 | 1258 | 23066 |
| 2L-7S | | MI | 10325 | 3849 | 16124 | 3123 | 18709 | 2526 | 19702 | 2070 | 20115 | 1356 | 24604 | 847 | 18288 |
| 14-#11 | 1.90 | MA | 13881 | 3849 | 21112 | 3145 | 25091 | 2541 | 27163 | 2088 | 29443 | 1383 | 36105 | 1167 | 23006 |
| 3L-6S | | MI | 10773 | 3849 | 16744 | 3124 | 19529 | 2529 | 20703 | 2064 | 21467 | 1361 | 26167 | 918 | 18981 |
| 14-#11 | 1.90 | MA | 13282 | 3849 | 20303 | 3145 | 23998 | 2549 | 25839 | 2085 | 27674 | 1378 | 34158 | 1076 | 22865 |
| 4L-5S | | MI | 11230 | 3849 | 17381 | 3125 | 20377 | 2522 | 21735 | 2069 | 22799 | 1356 | 27931 | 994 | 19458 |
| 14-#11 | 1.90 | MA | 12738 | 3849 | 19484 | 3155 | 23016 | 2548 | 24640 | 2092 | 26060 | 1383 | 32106 | 1032 | 22186 |
| 5L-4S | | MI | 11706 | 3849 | 18096 | 3116 | 21236 | 2525 | 22783 | 2063 | 24185 | 1351 | 29692 | 1036 | 20046 |
| 14-#11 | 1.90 | MA | 12217 | 3849 | 18756 | 3155 | 22045 | 2556 | 23459 | 2089 | 24507 | 1388 | 30036 | 956 | 21593 |
| 6L-3S | | MI | 12230 | 3849 | 18802 | 3117 | 22189 | 2517 | 23938 | 2068 | 25704 | 1356 | 31348 | 1128 | 20152 |

## RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

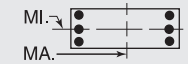
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.90 | MA | 11707 | 3849 | 18047 | 3155 | 21108 | 2554 | 22313 | 2096 | 22933 | 1383 | 28199 | 885 | 20779 |
| 7L-2S | | MI | 12945 | 3849 | 19744 | 3118 | 23384 | 2520 | 25386 | 2062 | 27617 | 1351 | 33877 | 1219 | 20195 |
| 14-#14 | 2.73 | MA | 16129 | 4200 | 25529 | 3353 | 30618 | 2694 | 33826 | 2175 | 38223 | 1345 | 47691 | 1185 | 32732 |
| 2L-7S | | MI | 10524 | 4200 | 17459 | 3328 | 20294 | 2675 | 21576 | 2161 | 22550 | 1318 | 28039 | 597 | 24392 |
| 14-#14 | 2.73 | MA | 14987 | 4200 | 23980 | 3352 | 28653 | 2690 | 31445 | 2184 | 35054 | 1352 | 43487 | 1054 | 32552 |
| 3L-6S | | MI | 11145 | 4200 | 18347 | 3331 | 21467 | 2680 | 23006 | 2154 | 24468 | 1325 | 30250 | 699 | 25516 |
| 14-#14 | 2.73 | MA | 14157 | 4200 | 22822 | 3352 | 27089 | 2702 | 29550 | 2179 | 32539 | 1345 | 40730 | 922 | 31775 |
| 4L-5S | | MI | 11779 | 4200 | 19259 | 3333 | 22681 | 2670 | 24479 | 2161 | 26358 | 1318 | 32744 | 809 | 26663 |
| 14-#14 | 2.73 | MA | 13404 | 4200 | 21650 | 3366 | 25682 | 2699 | 27833 | 2188 | 30244 | 1352 | 37813 | 860 | 30482 |
| 5L-4S | | MI | 12439 | 4200 | 20282 | 3320 | 23909 | 2675 | 25975 | 2154 | 28323 | 1310 | 35238 | 870 | 27705 |
| 14-#14 | 2.73 | MA | 12681 | 4200 | 20607 | 3365 | 24292 | 2711 | 26142 | 2183 | 28037 | 1360 | 34880 | 750 | 29163 |
| 6L-3S | | MI | 13166 | 4200 | 21291 | 3323 | 25272 | 2665 | 27623 | 2161 | 30478 | 1318 | 37578 | 1000 | 28432 |
| 14-#14 | 2.73 | MA | 11973 | 4200 | 19591 | 3364 | 22949 | 2708 | 24501 | 2192 | 25798 | 1352 | 32278 | 648 | 27799 |
| 7L-2S | | MI | 14158 | 4200 | 22636 | 3325 | 26977 | 2670 | 29686 | 2154 | 33192 | 1310 | 41154 | 1132 | 28576 |
| 14-#18 | 4.86 | MA | 16197 | 5091 | 29027 | 3880 | 34738 | 3093 | 38753 | 2418 | 44464 | 1249 | 56752 | 508 | 52094 |
| 4L-5S | | MI | 13127 | 5091 | 23853 | 3863 | 28353 | 3048 | 31095 | 2382 | 35035 | 1207 | 44388 | 313 | 42519 |
| 14-#18 | 4.86 | MA | 14962 | 5091 | 26973 | 3903 | 32272 | 3084 | 35745 | 2432 | 40502 | 1263 | 51718 | 401 | 49037 |
| 5L-4S | | MI | 14200 | 5091 | 25641 | 3843 | 30500 | 3060 | 33664 | 2368 | 38526 | 1220 | 48646 | 422 | 45215 |
| 14-#18 | 4.86 | MA | 13777 | 5091 | 25143 | 3900 | 29836 | 3103 | 32781 | 2419 | 36692 | 1276 | 46683 | 206 | 45844 |
| 6L-3S | | MI | 15370 | 5091 | 27404 | 3850 | 32880 | 3045 | 36497 | 2382 | 42115 | 1207 | 52653 | 648 | 48489 |
| 16-#11 | 2.17 | MA | 15197 | 3962 | 23280 | 3216 | 27841 | 2594 | 30494 | 2114 | 33902 | 1372 | 42034 | 1241 | 26269 |
| 2L-8S | | MI | 10339 | 3962 | 16455 | 3193 | 19100 | 2575 | 20146 | 2098 | 20724 | 1353 | 25490 | 777 | 20269 |
| 16-#11 | 2.17 | MA | 14382 | 3962 | 22196 | 3216 | 26466 | 2592 | 28829 | 2121 | 31673 | 1377 | 39069 | 1150 | 26191 |
| 3L-7S | | MI | 10776 | 3962 | 17066 | 3194 | 19904 | 2578 | 21149 | 2103 | 22028 | 1348 | 27133 | 826 | 20932 |
| 16-#11 | 2.17 | MA | 13790 | 3962 | 21387 | 3216 | 25373 | 2601 | 27504 | 2118 | 29904 | 1372 | 37122 | 1059 | 26029 |
| 4L-6S | | MI | 11219 | 3962 | 17686 | 3195 | 20724 | 2581 | 22151 | 2097 | 23380 | 1353 | 28696 | 898 | 21674 |
| 16-#11 | 2.17 | MA | 13253 | 3962 | 20568 | 3226 | 24391 | 2599 | 26305 | 2125 | 28289 | 1377 | 35070 | 1015 | 25270 |
| 5E | | MI | 11671 | 3962 | 18323 | 3196 | 21572 | 2574 | 23183 | 2102 | 24713 | 1348 | 30460 | 974 | 22131 |
| 16-#11 | 2.17 | MA | 12738 | 3962 | 19840 | 3226 | 23420 | 2608 | 25124 | 2122 | 26737 | 1382 | 33001 | 939 | 24700 |
| 6L-4S | | MI | 12141 | 3962 | 19038 | 3187 | 22431 | 2577 | 24231 | 2096 | 26098 | 1343 | 32221 | 1016 | 22796 |
| 16-#11 | 2.17 | MA | 12234 | 3962 | 19132 | 3225 | 22482 | 2606 | 23979 | 2129 | 25162 | 1377 | 31164 | 868 | 23838 |
| 7L-3S | | MI | 12660 | 3962 | 19744 | 3188 | 23384 | 2569 | 25386 | 2101 | 27617 | 1348 | 33877 | 1107 | 22922 |
| 16-#11 | 2.17 | MA | 11736 | 3962 | 18433 | 3225 | 21563 | 2605 | 22831 | 2125 | 23643 | 1382 | 29248 | 817 | 23061 |
| 8L-2S | | MI | 13368 | 3962 | 20687 | 3189 | 24579 | 2572 | 26834 | 2095 | 29531 | 1343 | 36405 | 1198 | 22981 |
| 16-#14 | 3.13 | MA | 15675 | 4364 | 25529 | 3455 | 30618 | 2765 | 33826 | 2232 | 38223 | 1342 | 47691 | 1027 | 37080 |
| 3L-7S | | MI | 11150 | 4364 | 18804 | 3430 | 21999 | 2750 | 23639 | 2208 | 25264 | 1304 | 31615 | 565 | 28089 |
| 16-#14 | 3.13 | MA | 14856 | 4364 | 24372 | 3454 | 29054 | 2777 | 31931 | 2226 | 35708 | 1335 | 44933 | 896 | 36134 |
| 4L-6S | | MI | 11762 | 4364 | 19692 | 3433 | 23173 | 2755 | 25069 | 2201 | 27182 | 1312 | 33825 | 667 | 29262 |
| 16-#14 | 3.13 | MA | 14114 | 4364 | 23199 | 3468 | 27646 | 2774 | 30213 | 2235 | 33413 | 1342 | 42017 | 833 | 34901 |
| 5E | | MI | 12387 | 4364 | 20603 | 3435 | 24386 | 2745 | 26542 | 2208 | 29072 | 1304 | 36320 | 777 | 30485 |
| 16-#14 | 3.13 | MA | 13403 | 4364 | 22156 | 3467 | 26257 | 2786 | 28522 | 2230 | 31206 | 1349 | 39083 | 724 | 33507 |
| 6L-4S | | MI | 13038 | 4364 | 21626 | 3423 | 25614 | 2750 | 28038 | 2201 | 31037 | 1297 | 38813 | 838 | 31473 |
| 16-#14 | 3.13 | MA | 12706 | 4364 | 21140 | 3466 | 24913 | 2782 | 26881 | 2239 | 28967 | 1342 | 36482 | 621 | 32153 |
| 7L-3S | | MI | 13755 | 4364 | 22636 | 3425 | 26977 | 2740 | 29686 | 2208 | 33192 | 1304 | 41154 | 968 | 32360 |
| 16-#14 | 3.13 | MA | 12017 | 4364 | 20140 | 3465 | 23596 | 2779 | 25237 | 2234 | 26808 | 1349 | 33759 | 548 | 30291 |
| 8L-2S | | MI | 14735 | 4364 | 23980 | 3427 | 28682 | 2745 | 31749 | 2201 | 35906 | 1297 | 44730 | 1100 | 32533 |
| 16-#18 | 5.56 | MA | 16228 | 5381 | 29675 | 4085 | 35700 | 3217 | 39898 | 2516 | 45972 | 1241 | 58936 | 346 | 56552 |
| 5E | | MI | 14127 | 5381 | 26192 | 4045 | 31320 | 3181 | 34639 | 2462 | 39698 | 1179 | 50493 | 247 | 48971 |
| 16-#18 | 5.56 | MA | 15073 | 5381 | 27846 | 4081 | 33264 | 3236 | 36933 | 2503 | 42163 | 1254 | 53900 | 151 | 53287 |
| 6L-4S | | MI | 15172 | 5381 | 27981 | 4025 | 33467 | 3193 | 37208 | 2449 | 43190 | 1193 | 54751 | 357 | 51806 |
| 18-#11 | 2.44 | MA | 14876 | 4076 | 23280 | 3287 | 27841 | 2644 | 30494 | 2154 | 33902 | 1371 | 42034 | 1133 | 29373 |
| 3L-8S | | MI | 10788 | 4076 | 17398 | 3263 | 20295 | 2627 | 21594 | 2131 | 22638 | 1345 | 28019 | 757 | 22886 |
| 18-#11 | 2.44 | MA | 14291 | 4076 | 22471 | 3287 | 26748 | 2653 | 29170 | 2151 | 32133 | 1365 | 40087 | 1042 | 29191 |
| 4L-7S | | MI | 11220 | 4076 | 18008 | 3265 | 21099 | 2630 | 22597 | 2136 | 23942 | 1340 | 29662 | 806 | 23584 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis

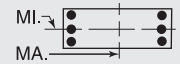



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.44 | MA | 13760 | 4076 | 21653 | 3297 | 25765 | 2651 | 27971 | 2158 | 30518 | 1371 | 38035 | 998 | 28362 |
| 5L-6S | | MI | 11658 | 4076 | 18629 | 3266 | 21919 | 2633 | 23599 | 2130 | 25294 | 1345 | 31225 | 877 | 24372 |
| 18-#11 | 2.44 | MA | 13251 | 4076 | 20925 | 3297 | 24795 | 2660 | 26790 | 2154 | 28966 | 1376 | 35965 | 922 | 27812 |
| 6L-5S | | MI | 12105 | 4076 | 19265 | 3267 | 22767 | 2626 | 24631 | 2135 | 26626 | 1340 | 32989 | 953 | 24811 |
| 18-#11 | 2.44 | MA | 12753 | 4076 | 20216 | 3296 | 23857 | 2658 | 25645 | 2161 | 27391 | 1371 | 34129 | 851 | 26904 |
| 7L-4S | | MI | 12571 | 4076 | 19981 | 3258 | 23626 | 2628 | 25678 | 2129 | 28012 | 1335 | 34750 | 996 | 25543 |
| 18-#11 | 2.44 | MA | 12260 | 4076 | 19518 | 3296 | 22938 | 2656 | 24497 | 2158 | 25872 | 1376 | 32213 | 800 | 26095 |
| 8L-3S | | MI | 13084 | 4076 | 20687 | 3259 | 24579 | 2621 | 26834 | 2134 | 29531 | 1340 | 36405 | 1087 | 25688 |
| 18-#11 | 2.44 | MA | 11771 | 4076 | 18747 | 3306 | 21991 | 2665 | 23368 | 2165 | 24368 | 1381 | 30337 | 741 | 25011 |
| 9L-2S | | MI | 13786 | 4076 | 21629 | 3260 | 25774 | 2624 | 28281 | 2128 | 31444 | 1335 | 38934 | 1178 | 25762 |
| 18-#14 | 3.52 | MA | 15545 | 4527 | 25921 | 3556 | 31018 | 2852 | 34311 | 2274 | 38877 | 1324 | 49137 | 869 | 40508 |
| 4L-7S | | MI | 11766 | 4527 | 20149 | 3533 | 23704 | 2825 | 25702 | 2255 | 27978 | 1291 | 35190 | 533 | 31799 |
| 18-#14 | 3.52 | MA | 14814 | 4527 | 24748 | 3570 | 29611 | 2849 | 32594 | 2283 | 36582 | 1332 | 46220 | 807 | 39329 |
| 5L-6S | | MI | 12369 | 4527 | 21037 | 3535 | 24878 | 2830 | 27132 | 2248 | 29896 | 1299 | 37401 | 635 | 33021 |
| 18-#14 | 3.52 | MA | 14112 | 4527 | 23705 | 3569 | 28221 | 2860 | 30902 | 2277 | 34375 | 1339 | 43287 | 698 | 37863 |
| 6L-5S | | MI | 12986 | 4527 | 21948 | 3537 | 26092 | 2820 | 28605 | 2255 | 31786 | 1291 | 39896 | 745 | 34315 |
| 18-#14 | 3.52 | MA | 13425 | 4527 | 22689 | 3569 | 26878 | 2857 | 29262 | 2287 | 32136 | 1332 | 40685 | 595 | 36465 |
| 7L-4S | | MI | 13628 | 4527 | 22971 | 3525 | 27320 | 2825 | 30101 | 2248 | 33751 | 1284 | 42389 | 806 | 35256 |
| 18-#14 | 3.52 | MA | 12747 | 4527 | 21689 | 3568 | 25561 | 2854 | 27617 | 2281 | 29977 | 1339 | 37963 | 522 | 34652 |
| 8L-3S | | MI | 14336 | 4527 | 23980 | 3527 | 28682 | 2815 | 31749 | 2255 | 35906 | 1291 | 44730 | 936 | 36284 |
| 18-#18 | 6.25 | MA | 16250 | 5672 | 30549 | 4263 | 36692 | 3369 | 41086 | 2587 | 47633 | 1232 | 61118 | 97 | 60753 |
| 6L-5S | | MI | 15105 | 5672 | 28531 | 4227 | 34287 | 3314 | 38183 | 2542 | 44362 | 1152 | 56599 | 182 | 55450 |
| 20-#11 | 2.71 | MA | 14785 | 4189 | 23555 | 3357 | 28123 | 2705 | 30836 | 2183 | 34362 | 1359 | 43051 | 1025 | 32353 |
| 4L-8S | | MI | 11231 | 4189 | 18340 | 3334 | 21490 | 2679 | 23042 | 2164 | 24551 | 1337 | 30547 | 736 | 25510 |
| 20-#11 | 2.71 | MA | 14260 | 4189 | 22737 | 3368 | 27140 | 2703 | 29637 | 2191 | 32748 | 1364 | 40999 | 981 | 31461 |
| 5L-7S | | MI | 11659 | 4189 | 18951 | 3335 | 22294 | 2682 | 24045 | 2169 | 25855 | 1332 | 32191 | 786 | 26242 |
| 20-#11 | 2.71 | MA | 13757 | 4189 | 22009 | 3367 | 26170 | 2712 | 28456 | 2187 | 31195 | 1369 | 38930 | 906 | 30928 |
| 6E | | MI | 12092 | 4189 | 19571 | 3337 | 23114 | 2685 | 25047 | 2163 | 27207 | 1337 | 33753 | 857 | 27073 |
| 20-#11 | 2.71 | MA | 13264 | 4189 | 21300 | 3367 | 25232 | 2710 | 27310 | 2194 | 29621 | 1364 | 37093 | 835 | 29977 |
| 7L-5S | | MI | 12534 | 4189 | 20208 | 3338 | 23962 | 2677 | 26079 | 2168 | 28540 | 1332 | 35518 | 933 | 27498 |
| 20-#11 | 2.71 | MA | 12778 | 4189 | 20602 | 3367 | 24313 | 2708 | 26163 | 2191 | 28102 | 1369 | 35178 | 783 | 29136 |
| 8L-4S | | MI | 12995 | 4189 | 20923 | 3329 | 24821 | 2680 | 27126 | 2162 | 29926 | 1326 | 37279 | 975 | 28289 |
| 20-#11 | 2.71 | MA | 12294 | 4189 | 19831 | 3377 | 23366 | 2717 | 25033 | 2198 | 26597 | 1375 | 33302 | 724 | 28078 |
| 9L-3S | | MI | 13503 | 4189 | 21629 | 3330 | 25774 | 2673 | 28281 | 2166 | 31444 | 1332 | 38934 | 1066 | 28451 |
| 20-#14 | 3.91 | MA | 15502 | 4691 | 26297 | 3672 | 31576 | 2923 | 34974 | 2330 | 39751 | 1321 | 50424 | 780 | 43764 |
| 5L-7S | | MI | 12372 | 4691 | 21493 | 3635 | 25410 | 2900 | 27765 | 2302 | 30692 | 1278 | 38766 | 501 | 35520 |
| 20-#14 | 3.91 | MA | 14810 | 4691 | 25254 | 3672 | 30186 | 2935 | 33282 | 2325 | 37544 | 1329 | 47490 | 671 | 42230 |
| 6E | | MI | 12968 | 4691 | 22381 | 3637 | 26583 | 2905 | 29195 | 2295 | 32610 | 1286 | 40977 | 603 | 36790 |
| 20-#14 | 3.91 | MA | 14133 | 4691 | 24238 | 3671 | 28843 | 2932 | 31642 | 2334 | 35305 | 1321 | 44888 | 569 | 40786 |
| 7L-5S | | MI | 13576 | 4691 | 23293 | 3640 | 27797 | 2895 | 30668 | 2302 | 34500 | 1278 | 43472 | 713 | 38153 |
| 20-#14 | 3.91 | MA | 13464 | 4691 | 23238 | 3670 | 27526 | 2929 | 29998 | 2329 | 33146 | 1329 | 42166 | 496 | 39021 |
| 8L-4S | | MI | 14210 | 4691 | 24316 | 3627 | 29025 | 2900 | 32164 | 2295 | 36465 | 1271 | 45965 | 774 | 39051 |
| 22-#11 | 2.98 | MA | 14754 | 4303 | 23821 | 3438 | 28515 | 2755 | 31302 | 2223 | 34977 | 1358 | 43964 | 964 | 34565 |
| 5L-8S | | MI | 11668 | 4303 | 19282 | 3405 | 22685 | 2731 | 24489 | 2197 | 26465 | 1329 | 33076 | 716 | 28141 |
| 22-#11 | 2.98 | MA | 14257 | 4303 | 23093 | 3438 | 27545 | 2764 | 30121 | 2220 | 33424 | 1363 | 41895 | 889 | 34047 |
| 6L-7S | | MI | 12092 | 4303 | 19893 | 3406 | 23489 | 2734 | 25493 | 2201 | 27769 | 1323 | 34719 | 765 | 28906 |
| 22-#11 | 2.98 | MA | 13769 | 4303 | 22384 | 3438 | 26607 | 2762 | 28976 | 2227 | 31850 | 1358 | 40058 | 818 | 33056 |
| 7L-6S | | MI | 12520 | 4303 | 20513 | 3407 | 24309 | 2737 | 26494 | 2196 | 29121 | 1329 | 36282 | 837 | 29725 |
| 22-#11 | 2.98 | MA | 13288 | 4303 | 21686 | 3438 | 25688 | 2760 | 27828 | 2224 | 30331 | 1363 | 38142 | 766 | 32182 |
| 8L-5S | | MI | 12958 | 4303 | 21150 | 3409 | 25158 | 2729 | 27527 | 2200 | 30453 | 1323 | 38047 | 913 | 30190 |
| 22-#11 | 2.98 | MA | 12810 | 4303 | 20915 | 3448 | 24741 | 2769 | 26699 | 2231 | 28827 | 1368 | 36266 | 707 | 31150 |
| 9L-4S | | MI | 13414 | 4303 | 21865 | 3399 | 26016 | 2732 | 28574 | 2195 | 31839 | 1318 | 39808 | 955 | 30949 |
| 22-#14 | 4.30 | MA | 15499 | 4854 | 26803 | 3774 | 32151 | 3010 | 35663 | 2372 | 40713 | 1319 | 51693 | 645 | 46607 |
| 6L-7S | | MI | 12970 | 4854 | 22838 | 3737 | 27115 | 2974 | 29828 | 2350 | 33406 | 1265 | 42342 | 469 | 39252 |
| 22-#14 | 4.30 | MA | 14831 | 4854 | 25788 | 3773 | 30807 | 3007 | 34022 | 2381 | 38474 | 1311 | 49092 | 542 | 45118 |
| 7L-6S | | MI | 13558 | 4854 | 23726 | 3739 | 28289 | 2979 | 31258 | 2342 | 35324 | 1273 | 44553 | 572 | 40569 |
| 22-#14 | 4.30 | MA | 14171 | 4854 | 24787 | 3772 | 29490 | 3004 | 32378 | 2376 | 36315 | 1319 | 46369 | 469 | 43398 |
| 8L-5S | | MI | 14159 | 4854 | 24637 | 3742 | 29502 | 2969 | 32731 | 2350 | 37214 | 1265 | 47047 | 681 | 41997 |

## RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 3.25 | MA | 14750 | 4416 | 24177 | 3509 | 28920 | 2815 | 31787 | 2253 | 35654 | 1357 | 44859 | 872 | 37119 |
| 6L-8S | | MI | 12100 | 4416 | 20225 | 3476 | 23880 | 2783 | 25937 | 2230 | 28379 | 1320 | 35605 | 695 | 30778 |
| 24-#11 | 3.25 | MA | 14268 | 4416 | 23468 | 3509 | 27982 | 2814 | 30642 | 2260 | 34079 | 1352 | 43022 | 801 | 36140 |
| 7E | | MI | 12519 | 4416 | 20835 | 3477 | 24684 | 2786 | 26941 | 2234 | 29682 | 1315 | 37248 | 745 | 31575 |
| 24-#11 | 3.25 | MA | 13791 | 4416 | 22770 | 3509 | 27063 | 2812 | 29494 | 2257 | 32560 | 1357 | 41107 | 750 | 35234 |
| 8L-6S | | MI | 12943 | 4416 | 21456 | 3478 | 25504 | 2789 | 27942 | 2229 | 31034 | 1320 | 38811 | 816 | 32368 |
| 24-#11 | 3.25 | MA | 13318 | 4416 | 21999 | 3519 | 26116 | 2821 | 28365 | 2264 | 31056 | 1362 | 39231 | 691 | 34226 |
| 9L-5S | | MI | 13377 | 4416 | 22092 | 3479 | 26353 | 2781 | 28974 | 2233 | 32367 | 1315 | 40576 | 892 | 32886 |
| 24-#14 | 4.69 | MA | 15519 | 5018 | 27337 | 3875 | 32772 | 3082 | 36402 | 2429 | 41643 | 1301 | 53295 | 516 | 49459 |
| 7E | | MI | 13560 | 5018 | 24183 | 3839 | 28821 | 3049 | 31891 | 2397 | 36120 | 1252 | 45918 | 437 | 42993 |
| 24-#14 | 4.69 | MA | 14868 | 5018 | 26336 | 3874 | 31455 | 3078 | 34758 | 2423 | 39484 | 1308 | 50573 | 443 | 47783 |
| 8L-6S | | MI | 14141 | 5018 | 25071 | 3842 | 29994 | 3054 | 33321 | 2389 | 38038 | 1260 | 48129 | 540 | 44357 |

## RECTANGULAR TIED COLUMNS 32" x 38"

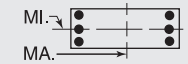
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.32 | MA | 15092 | 3806 | 22202 | 3138 | 26128 | 2548 | 27984 | 2107 | 29595 | 1450 | 35857 | 1340 | 17856 |
| 2E | | MI | 12556 | 3806 | 18789 | 3091 | 21850 | 2510 | 23165 | 2067 | 24247 | 1409 | 29122 | 1285 | 14736 |
| 6-#14 | 1.11 | MA | 14743 | 3716 | 21224 | 3103 | 25046 | 2525 | 26742 | 2097 | 28095 | 1475 | 33966 | 1380 | 15308 |
| 2L-3S | | MI | 11242 | 3716 | 16647 | 3059 | 19286 | 2485 | 20218 | 2074 | 20410 | 1448 | 24171 | 1203 | 12690 |
| 6-#14 | 1.11 | MA | 13448 | 3716 | 19573 | 3103 | 22952 | 2523 | 24204 | 2107 | 24698 | 1482 | 29448 | 1249 | 15293 |
| 3L-2S | | MI | 12294 | 3716 | 17991 | 3061 | 20991 | 2490 | 22281 | 2066 | 23124 | 1440 | 27747 | 1334 | 12671 |
| 6-#18 | 1.97 | MA | 16418 | 4097 | 25087 | 3320 | 29786 | 2681 | 32416 | 2191 | 35470 | 1430 | 43633 | 1290 | 26412 |
| 2L-3S | | MI | 11835 | 4097 | 18789 | 3266 | 21850 | 2631 | 23165 | 2160 | 24247 | 1395 | 29122 | 986 | 21509 |
| 6-#18 | 1.97 | MA | 14233 | 4097 | 22202 | 3317 | 26128 | 2675 | 27984 | 2207 | 29595 | 1444 | 35857 | 1057 | 26101 |
| 3L-2S | | MI | 13606 | 4097 | 21129 | 3273 | 24817 | 2643 | 26710 | 2147 | 28911 | 1382 | 35227 | 1219 | 21701 |
| 8-#11 | 1.03 | MA | 14599 | 3678 | 20807 | 3092 | 24597 | 2518 | 26232 | 2094 | 27483 | 1486 | 33197 | 1397 | 14256 |
| 2L-4S | | MI | 10901 | 3678 | 16000 | 3049 | 18485 | 2489 | 19286 | 2067 | 19235 | 1454 | 23004 | 1173 | 11817 |
| 8-#11 | 1.03 | MA | 13689 | 3678 | 19652 | 3092 | 23133 | 2516 | 24458 | 2101 | 25096 | 1491 | 30014 | 1306 | 14260 |
| 3E | | MI | 11445 | 3678 | 16705 | 3050 | 19438 | 2482 | 20441 | 2071 | 20753 | 1459 | 24660 | 1264 | 11836 |
| 8-#11 | 1.03 | MA | 13026 | 3678 | 18792 | 3092 | 21970 | 2526 | 23049 | 2099 | 23201 | 1486 | 27921 | 1215 | 14198 |
| 4L-2S | | MI | 12186 | 3678 | 17648 | 3051 | 20633 | 2484 | 21889 | 2065 | 22667 | 1454 | 27189 | 1356 | 11815 |
| 8-#14 | 1.48 | MA | 15528 | 3879 | 22876 | 3206 | 27141 | 2600 | 29279 | 2144 | 31492 | 1466 | 38484 | 1356 | 20219 |
| 2L-4S | | MI | 11119 | 3879 | 16982 | 3159 | 19628 | 2570 | 20632 | 2113 | 20970 | 1427 | 25406 | 1041 | 16499 |
| 8-#14 | 1.48 | MA | 14252 | 3879 | 21224 | 3206 | 25046 | 2598 | 26742 | 2154 | 28095 | 1473 | 33966 | 1224 | 20154 |
| 3E | | MI | 11882 | 3879 | 17991 | 3161 | 20991 | 2560 | 22281 | 2121 | 23124 | 1434 | 27747 | 1171 | 16661 |
| 8-#14 | 1.48 | MA | 13322 | 3879 | 19993 | 3205 | 23382 | 2610 | 24725 | 2150 | 25399 | 1466 | 30998 | 1093 | 19889 |
| 4L-2S | | MI | 12918 | 3879 | 19336 | 3163 | 22697 | 2565 | 24344 | 2113 | 25838 | 1427 | 31322 | 1303 | 16685 |
| 8-#18 | 2.63 | MA | 17699 | 4388 | 27971 | 3501 | 33444 | 2814 | 36847 | 2276 | 41345 | 1411 | 51409 | 1240 | 34925 |
| 2L-4S | | MI | 11612 | 4388 | 19366 | 3442 | 22438 | 2779 | 23877 | 2228 | 25322 | 1381 | 31219 | 694 | 25898 |
| 8-#18 | 2.63 | MA | 15565 | 4388 | 25087 | 3499 | 29786 | 2808 | 32416 | 2291 | 35470 | 1424 | 43633 | 1007 | 34489 |
| 3E | | MI | 12890 | 4388 | 21129 | 3448 | 24817 | 2764 | 26710 | 2241 | 28911 | 1367 | 35227 | 920 | 28306 |
| 8-#18 | 2.63 | MA | 14007 | 4388 | 22928 | 3497 | 26870 | 2827 | 28883 | 2280 | 30807 | 1411 | 38539 | 773 | 31511 |
| 4L-2S | | MI | 14623 | 4388 | 23468 | 3455 | 27784 | 2776 | 30254 | 2228 | 33574 | 1354 | 41332 | 1154 | 28613 |
| 10-#11 | 1.28 | MA | 15156 | 3792 | 21962 | 3162 | 26062 | 2570 | 28007 | 2127 | 29870 | 1480 | 36380 | 1382 | 17696 |
| 2L-5S | | MI | 10871 | 3792 | 16227 | 3129 | 18821 | 2538 | 19687 | 2105 | 19762 | 1451 | 23772 | 1111 | 14279 |
| 10-#11 | 1.28 | MA | 14256 | 3792 | 20807 | 3163 | 24597 | 2568 | 26232 | 2134 | 27483 | 1485 | 33197 | 1291 | 17674 |
| 3L-4S | | MI | 11360 | 3792 | 16942 | 3120 | 19680 | 2541 | 20734 | 2099 | 21148 | 1446 | 25533 | 1153 | 14586 |
| 10-#11 | 1.28 | MA | 13602 | 3792 | 19947 | 3163 | 23435 | 2577 | 24824 | 2132 | 25589 | 1480 | 31103 | 1199 | 17582 |
| 4L-3S | | MI | 11898 | 3792 | 17648 | 3121 | 20633 | 2533 | 21889 | 2104 | 22667 | 1451 | 27189 | 1244 | 14633 |
| 10-#11 | 1.28 | MA | 13008 | 3792 | 19076 | 3174 | 22390 | 2576 | 23549 | 2139 | 23860 | 1485 | 28906 | 1154 | 17161 |
| 5L-2S | | MI | 12630 | 3792 | 18590 | 3122 | 21828 | 2536 | 23337 | 2098 | 24580 | 1446 | 29717 | 1335 | 14631 |
| 10-#14 | 1.85 | MA | 16294 | 4043 | 24527 | 3308 | 29235 | 2675 | 31816 | 2191 | 34888 | 1457 | 43002 | 1332 | 25110 |
| 2L-5S | | MI | 11072 | 4043 | 17304 | 3273 | 20106 | 2640 | 21200 | 2168 | 21718 | 1421 | 26488 | 948 | 19227 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis

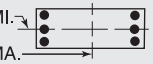



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.85 | MA | 15037 | 4043 | 22876 | 3308 | 27141 | 2673 | 29279 | 2202 | 31492 | 1464 | 38484 | 1200 | 25003 |
| 3L-4S | | MI | 11755 | 4043 | 18327 | 3261 | 21334 | 2645 | 22695 | 2161 | 23684 | 1414 | 28982 | 1009 | 20404 |
| 10-#14 | 1.85 | MA | 14123 | 4043 | 21644 | 3308 | 25476 | 2685 | 27262 | 2197 | 28796 | 1457 | 35516 | 1069 | 24686 |
| 4L-3S | | MI | 12507 | 4043 | 19336 | 3263 | 22697 | 2635 | 24344 | 2168 | 25838 | 1421 | 31322 | 1139 | 20615 |
| 10-#14 | 1.85 | MA | 13293 | 4043 | 20397 | 3322 | 23980 | 2683 | 25435 | 2207 | 26336 | 1464 | 32389 | 1005 | 23196 |
| 5L-2S | | MI | 13529 | 4043 | 20681 | 3265 | 24402 | 2640 | 26407 | 2161 | 28552 | 1414 | 34898 | 1271 | 20678 |
| 10-#18 | 3.29 | MA | 18946 | 4679 | 30856 | 3683 | 37103 | 2947 | 41279 | 2360 | 47220 | 1391 | 59184 | 1190 | 43414 |
| 2L-5S | | MI | 11528 | 4679 | 19917 | 3643 | 23257 | 2900 | 24852 | 2321 | 26494 | 1340 | 33067 | 519 | 30148 |
| 10-#18 | 3.29 | MA | 16857 | 4679 | 27971 | 3681 | 33444 | 2941 | 36847 | 2375 | 41345 | 1404 | 51409 | 956 | 42871 |
| 3L-4S | | MI | 12666 | 4679 | 21706 | 3623 | 25405 | 2912 | 27421 | 2308 | 29985 | 1353 | 37325 | 628 | 32386 |
| 10-#18 | 3.29 | MA | 15336 | 4679 | 25813 | 3678 | 30529 | 2960 | 33314 | 2364 | 36682 | 1391 | 46314 | 723 | 39586 |
| 4L-3S | | MI | 13916 | 4679 | 23468 | 3630 | 27784 | 2897 | 30254 | 2321 | 33574 | 1340 | 41332 | 854 | 35092 |
| 10-#18 | 3.29 | MA | 13955 | 4679 | 23626 | 3703 | 27904 | 2954 | 30111 | 2380 | 32427 | 1404 | 40908 | 613 | 36818 |
| 5L-2S | | MI | 15614 | 4679 | 25807 | 3636 | 30751 | 2909 | 33798 | 2308 | 38237 | 1326 | 47438 | 1088 | 35497 |
| 12-#11 | 1.54 | MA | 15704 | 3905 | 23117 | 3233 | 27527 | 2621 | 29782 | 2159 | 32258 | 1474 | 39563 | 1366 | 21122 |
| 2L-6S | | MI | 10863 | 3905 | 16532 | 3199 | 19168 | 2597 | 20102 | 2133 | 20343 | 1448 | 24537 | 1014 | 16423 |
| 12-#11 | 1.54 | MA | 14813 | 3905 | 21962 | 3234 | 26062 | 2620 | 28007 | 2167 | 29870 | 1480 | 36380 | 1275 | 21080 |
| 3L-5S | | MI | 11327 | 3905 | 17169 | 3200 | 20016 | 2590 | 21134 | 2138 | 21676 | 1443 | 26301 | 1090 | 16930 |
| 12-#11 | 1.54 | MA | 14167 | 3905 | 21102 | 3234 | 24900 | 2629 | 26598 | 2164 | 27976 | 1474 | 34286 | 1184 | 20962 |
| 4E | | MI | 11811 | 3905 | 17884 | 3191 | 20875 | 2593 | 22182 | 2132 | 23062 | 1437 | 28062 | 1133 | 17348 |
| 12-#11 | 1.54 | MA | 13580 | 3905 | 20231 | 3244 | 23855 | 2628 | 25323 | 2172 | 26247 | 1480 | 32089 | 1139 | 20429 |
| 5L-3S | | MI | 12343 | 3905 | 18590 | 3192 | 21828 | 2585 | 23337 | 2137 | 24580 | 1443 | 29717 | 1224 | 17419 |
| 12-#11 | 1.54 | MA | 13018 | 3905 | 19457 | 3245 | 22824 | 2637 | 24068 | 2169 | 24584 | 1485 | 29867 | 1064 | 19739 |
| 6L-2S | | MI | 13068 | 3905 | 19532 | 3193 | 23023 | 2588 | 24785 | 2131 | 26494 | 1437 | 32246 | 1315 | 17437 |
| 12-#14 | 2.22 | MA | 17045 | 4206 | 26178 | 3410 | 31329 | 2750 | 34353 | 2239 | 38285 | 1447 | 47520 | 1308 | 29988 |
| 2L-6S | | MI | 11058 | 4206 | 17737 | 3373 | 20597 | 2725 | 21790 | 2208 | 22542 | 1416 | 27570 | 806 | 22068 |
| 12-#14 | 2.22 | MA | 15806 | 4206 | 24527 | 3410 | 29235 | 2747 | 31816 | 2249 | 34888 | 1455 | 43002 | 1176 | 29843 |
| 3L-5S | | MI | 11705 | 4206 | 18648 | 3376 | 21811 | 2715 | 23263 | 2215 | 24432 | 1408 | 30064 | 916 | 23023 |
| 12-#14 | 2.22 | MA | 14905 | 4206 | 23295 | 3410 | 27571 | 2760 | 29799 | 2244 | 32193 | 1447 | 40034 | 1045 | 29416 |
| 4E | | MI | 12379 | 4206 | 19672 | 3363 | 23039 | 2720 | 24759 | 2208 | 26398 | 1401 | 32558 | 977 | 24155 |
| 12-#14 | 2.22 | MA | 14089 | 4206 | 22048 | 3424 | 26074 | 2757 | 27973 | 2255 | 29733 | 1455 | 36907 | 981 | 27886 |
| 5L-3S | | MI | 13119 | 4206 | 20681 | 3365 | 24402 | 2710 | 26407 | 2215 | 28552 | 1408 | 34898 | 1107 | 24558 |
| 12-#14 | 2.22 | MA | 13306 | 4206 | 20940 | 3424 | 24596 | 2770 | 26174 | 2250 | 27367 | 1462 | 33754 | 872 | 26690 |
| 6L-2S | | MI | 14129 | 4206 | 22025 | 3368 | 26107 | 2715 | 28470 | 2208 | 31266 | 1401 | 38474 | 1239 | 24655 |
| 12-#18 | 3.95 | MA | 18116 | 4970 | 30856 | 3862 | 37103 | 3074 | 41279 | 2460 | 47220 | 1384 | 59184 | 906 | 51251 |
| 3L-5S | | MI | 12579 | 4970 | 22256 | 3825 | 26224 | 3033 | 28397 | 2402 | 31157 | 1312 | 39172 | 453 | 36527 |
| 12-#18 | 3.95 | MA | 16628 | 4970 | 28697 | 3860 | 34187 | 3093 | 37746 | 2448 | 42557 | 1371 | 54090 | 673 | 47700 |
| 4E | | MI | 13693 | 4970 | 24045 | 3805 | 28371 | 3045 | 30966 | 2388 | 34648 | 1325 | 43430 | 563 | 38915 |
| 12-#18 | 3.95 | MA | 15279 | 4970 | 26510 | 3884 | 31562 | 3087 | 34543 | 2464 | 38302 | 1384 | 48683 | 563 | 44796 |
| 5L-3S | | MI | 14918 | 4970 | 25807 | 3812 | 30751 | 3030 | 33798 | 2402 | 38237 | 1312 | 47438 | 789 | 41871 |
| 12-#18 | 3.95 | MA | 13985 | 4970 | 24564 | 3882 | 28969 | 3107 | 31388 | 2453 | 34211 | 1397 | 43257 | 369 | 41483 |
| 6L-2S | | MI | 16585 | 4970 | 28147 | 3818 | 33717 | 3042 | 37343 | 2388 | 42901 | 1299 | 53543 | 1022 | 42364 |
| 14-#11 | 1.80 | MA | 16243 | 4019 | 24272 | 3304 | 28992 | 2673 | 31556 | 2192 | 34645 | 1469 | 42746 | 1351 | 24540 |
| 2L-7S | | MI | 10867 | 4019 | 16854 | 3268 | 19543 | 2646 | 20549 | 2172 | 20905 | 1434 | 25503 | 922 | 18495 |
| 14-#11 | 1.80 | MA | 15361 | 4019 | 23117 | 3304 | 27527 | 2672 | 29782 | 2200 | 32258 | 1474 | 39563 | 1260 | 24480 |
| 3L-6S | | MI | 11317 | 4019 | 17475 | 3270 | 20363 | 2649 | 21550 | 2166 | 22257 | 1440 | 27065 | 994 | 19110 |
| 14-#11 | 1.80 | MA | 14722 | 4019 | 22257 | 3305 | 26364 | 2681 | 28373 | 2197 | 30363 | 1469 | 37469 | 1169 | 24339 |
| 4L-5S | | MI | 11776 | 4019 | 18111 | 3271 | 21211 | 2642 | 22582 | 2171 | 23589 | 1434 | 28830 | 1070 | 19593 |
| 14-#11 | 1.80 | MA | 14143 | 4019 | 21386 | 3315 | 25320 | 2680 | 27098 | 2205 | 28634 | 1474 | 35271 | 1124 | 23708 |
| 5L-4S | | MI | 12254 | 4019 | 18827 | 3262 | 22070 | 2645 | 23630 | 2165 | 24975 | 1429 | 30591 | 1112 | 20105 |
| 14-#11 | 1.80 | MA | 13587 | 4019 | 20612 | 3316 | 24288 | 2689 | 25843 | 2202 | 26972 | 1479 | 33050 | 1049 | 23047 |
| 6L-3S | | MI | 12781 | 4019 | 19532 | 3263 | 23023 | 2637 | 24785 | 2170 | 26494 | 1434 | 32246 | 1203 | 20197 |
| 14-#11 | 1.80 | MA | 13043 | 4019 | 19859 | 3316 | 23292 | 2688 | 24625 | 2210 | 25286 | 1474 | 31075 | 977 | 22265 |
| 7L-2S | | MI | 13499 | 4019 | 20475 | 3264 | 24219 | 2640 | 26233 | 2164 | 28407 | 1429 | 34775 | 1294 | 20232 |
| 14-#14 | 2.59 | MA | 17783 | 4370 | 27830 | 3512 | 33424 | 2825 | 36891 | 2286 | 41682 | 1438 | 52038 | 1284 | 34858 |
| 2L-7S | | MI | 11065 | 4370 | 18194 | 3473 | 21129 | 2794 | 22423 | 2262 | 23339 | 1395 | 28935 | 672 | 24655 |
| 14-#14 | 2.59 | MA | 16560 | 4370 | 26178 | 3512 | 31329 | 2822 | 34353 | 2296 | 38285 | 1446 | 47520 | 1152 | 34678 |
| 3L-6S | | MI | 11689 | 4370 | 19082 | 3476 | 22303 | 2799 | 23853 | 2255 | 25256 | 1403 | 31145 | 774 | 25795 |

## RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis



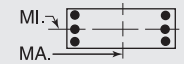

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.59 | MA | 15673 | 4370 | 24947 | 3512 | 29665 | 2835 | 32337 | 2292 | 35590 | 1438 | 44552 | 1021 | 34048 |
| 4L-5S | | MI | 12327 | 4370 | 19993 | 3478 | 23516 | 2790 | 25326 | 2262 | 27146 | 1395 | 33640 | 884 | 26833 |
| 14-#14 | 2.59 | MA | 14869 | 4370 | 23700 | 3527 | 28168 | 2832 | 30510 | 2302 | 33130 | 1446 | 41425 | 957 | 32590 |
| 5L-4S | | MI | 12991 | 4370 | 21016 | 3465 | 24744 | 2795 | 26822 | 2255 | 29112 | 1388 | 36133 | 945 | 27902 |
| 14-#14 | 2.59 | MA | 14098 | 4370 | 22591 | 3526 | 26690 | 2845 | 28711 | 2297 | 30764 | 1453 | 38272 | 848 | 31315 |
| 6L-3S | | MI | 13721 | 4370 | 22025 | 3468 | 26107 | 2785 | 28470 | 2262 | 31266 | 1395 | 38474 | 1075 | 28495 |
| 14-#14 | 2.59 | MA | 13342 | 4370 | 21511 | 3526 | 25262 | 2842 | 26967 | 2308 | 28365 | 1446 | 35472 | 746 | 29797 |
| 7L-2S | | MI | 14718 | 4370 | 23370 | 3470 | 27813 | 2790 | 30533 | 2255 | 33980 | 1388 | 42050 | 1207 | 28623 |
| 14-#18 | 4.61 | MA | 17892 | 5260 | 31582 | 4042 | 37845 | 3226 | 42178 | 2533 | 48432 | 1351 | 61866 | 623 | 55847 |
| 4L-5S | | MI | 13605 | 5260 | 24595 | 4007 | 29191 | 3166 | 31941 | 2482 | 35820 | 1284 | 45278 | 387 | 42940 |
| 14-#18 | 4.61 | MA | 16571 | 5260 | 29395 | 4066 | 35220 | 3220 | 38975 | 2548 | 44177 | 1364 | 56459 | 513 | 52806 |
| 5L-4S | | MI | 14761 | 5260 | 26384 | 3987 | 31338 | 3178 | 34510 | 2469 | 39312 | 1297 | 49536 | 497 | 45475 |
| 14-#18 | 4.61 | MA | 15304 | 5260 | 27449 | 4064 | 32627 | 3240 | 35820 | 2537 | 40086 | 1378 | 51033 | 319 | 49559 |
| 6L-3S | | MI | 15941 | 5260 | 28147 | 3993 | 33717 | 3163 | 37343 | 2482 | 42901 | 1284 | 53543 | 723 | 48646 |
| 16-#11 | 2.05 | MA | 16774 | 4132 | 25427 | 3375 | 30456 | 2725 | 33331 | 2225 | 37032 | 1463 | 45928 | 1336 | 27954 |
| 2L-8S | | MI | 10880 | 4132 | 17186 | 3338 | 19934 | 2695 | 20993 | 2200 | 21515 | 1431 | 26388 | 853 | 20507 |
| 16-#11 | 2.05 | MA | 15902 | 4132 | 24272 | 3375 | 28992 | 2724 | 31556 | 2233 | 34645 | 1468 | 42746 | 1245 | 27876 |
| 3L-7S | | MI | 11320 | 4132 | 17797 | 3339 | 20738 | 2698 | 21997 | 2205 | 22818 | 1426 | 28031 | 902 | 21136 |
| 16-#11 | 2.05 | MA | 15269 | 4132 | 23412 | 3376 | 27829 | 2733 | 30148 | 2230 | 32751 | 1463 | 40652 | 1154 | 27714 |
| 4L-6S | | MI | 11765 | 4132 | 18417 | 3340 | 21558 | 2701 | 22998 | 2199 | 24170 | 1431 | 29594 | 973 | 21803 |
| 16-#11 | 2.05 | MA | 14697 | 4132 | 22541 | 3386 | 26784 | 2732 | 28872 | 2238 | 31022 | 1468 | 38454 | 1109 | 26996 |
| 5E | | MI | 12219 | 4132 | 19054 | 3342 | 22407 | 2694 | 24030 | 2204 | 25503 | 1426 | 31359 | 1049 | 22265 |
| 16-#11 | 2.05 | MA | 14148 | 4132 | 21767 | 3386 | 25753 | 2741 | 27617 | 2235 | 29359 | 1474 | 36232 | 1033 | 26361 |
| 6L-4S | | MI | 12692 | 4132 | 19769 | 3332 | 23265 | 2696 | 25078 | 2198 | 26889 | 1421 | 33120 | 1092 | 22858 |
| 16-#11 | 2.05 | MA | 13610 | 4132 | 21014 | 3387 | 24757 | 2740 | 26400 | 2243 | 27673 | 1468 | 34258 | 962 | 25529 |
| 7L-3S | | MI | 13212 | 4132 | 20475 | 3334 | 24219 | 2689 | 26233 | 2203 | 28407 | 1426 | 34775 | 1183 | 22969 |
| 16-#11 | 2.05 | MA | 13079 | 4132 | 20273 | 3387 | 23780 | 2738 | 25180 | 2240 | 26046 | 1474 | 32206 | 910 | 24689 |
| 8L-2S | | MI | 13924 | 4132 | 21417 | 3335 | 25414 | 2692 | 27681 | 2197 | 30321 | 1421 | 37304 | 1274 | 23020 |
| 16-#14 | 2.96 | MA | 17301 | 4533 | 27830 | 3614 | 33424 | 2897 | 36891 | 2344 | 41682 | 1437 | 52038 | 1128 | 39510 |
| 3L-7S | | MI | 11693 | 4533 | 19539 | 3575 | 22835 | 2869 | 24486 | 2309 | 26053 | 1382 | 32510 | 640 | 28440 |
| 16-#14 | 2.96 | MA | 16426 | 4533 | 26598 | 3614 | 31759 | 2909 | 34874 | 2339 | 38986 | 1429 | 49070 | 997 | 38698 |
| 4L-6S | | MI | 12309 | 4533 | 20427 | 3578 | 24008 | 2874 | 25916 | 2302 | 27970 | 1390 | 34721 | 743 | 29536 |
| 16-#14 | 2.96 | MA | 15634 | 4533 | 25351 | 3629 | 30263 | 2907 | 33047 | 2349 | 36527 | 1437 | 45943 | 933 | 37305 |
| 5E | | MI | 12937 | 4533 | 21338 | 3580 | 25222 | 2864 | 27389 | 2309 | 29860 | 1382 | 37216 | 852 | 30653 |
| 16-#14 | 2.96 | MA | 14875 | 4533 | 24242 | 3629 | 28785 | 2919 | 31249 | 2345 | 34161 | 1444 | 42790 | 824 | 35954 |
| 6L-4S | | MI | 13592 | 4533 | 22361 | 3568 | 26450 | 2869 | 28885 | 2302 | 31826 | 1375 | 39709 | 913 | 31667 |
| 16-#14 | 2.96 | MA | 14131 | 4533 | 23162 | 3629 | 27357 | 2917 | 29504 | 2355 | 31762 | 1437 | 39990 | 721 | 34485 |
| 7L-3S | | MI | 14313 | 4533 | 23370 | 3570 | 27813 | 2859 | 30533 | 2309 | 33980 | 1382 | 42050 | 1044 | 32425 |
| 16-#14 | 2.96 | MA | 13395 | 4533 | 22099 | 3628 | 25957 | 2915 | 27756 | 2350 | 29447 | 1444 | 37071 | 647 | 32558 |
| 8L-2S | | MI | 15298 | 4533 | 24715 | 3572 | 29518 | 2864 | 32596 | 2302 | 36694 | 1375 | 45626 | 1175 | 32583 |
| 16-#18 | 5.26 | MA | 17836 | 5551 | 32279 | 4248 | 38878 | 3353 | 43407 | 2632 | 50052 | 1344 | 64235 | 463 | 60845 |
| 5E | | MI | 14683 | 5551 | 26935 | 4188 | 32158 | 3299 | 35485 | 2562 | 40484 | 1257 | 51383 | 322 | 49384 |
| 16-#18 | 5.26 | MA | 16595 | 5551 | 30333 | 4245 | 36286 | 3373 | 40252 | 2621 | 45961 | 1358 | 58809 | 268 | 57529 |
| 6L-4S | | MI | 15738 | 5551 | 28723 | 4168 | 34305 | 3311 | 38055 | 2549 | 43975 | 1270 | 55641 | 431 | 52062 |
| 18-#11 | 2.31 | MA | 16434 | 4245 | 25427 | 3446 | 30456 | 2776 | 33331 | 2266 | 37032 | 1463 | 45928 | 1229 | 31269 |
| 3L-8S | | MI | 11331 | 4245 | 18128 | 3409 | 21130 | 2747 | 22441 | 2233 | 23428 | 1423 | 28917 | 832 | 23165 |
| 18-#11 | 2.31 | MA | 15809 | 4245 | 24567 | 3446 | 29294 | 2785 | 31922 | 2263 | 35138 | 1458 | 43835 | 1138 | 31087 |
| 4L-7S | | MI | 11766 | 4245 | 18739 | 3410 | 21933 | 2750 | 23445 | 2237 | 24732 | 1418 | 30560 | 882 | 23785 |
| 18-#11 | 2.31 | MA | 15243 | 4245 | 23696 | 3457 | 28249 | 2784 | 30647 | 2271 | 33409 | 1463 | 41637 | 1093 | 30293 |
| 5L-6S | | MI | 12206 | 4245 | 19359 | 3411 | 22754 | 2753 | 24446 | 2232 | 26084 | 1423 | 32123 | 953 | 24500 |
| 18-#11 | 2.31 | MA | 14700 | 4245 | 22922 | 3457 | 27218 | 2793 | 29392 | 2268 | 31746 | 1468 | 39415 | 1018 | 29680 |
| 6L-5S | | MI | 12655 | 4245 | 19996 | 3413 | 23602 | 2745 | 25478 | 2236 | 27416 | 1418 | 33888 | 1029 | 24944 |
| 18-#11 | 2.31 | MA | 14169 | 4245 | 22169 | 3457 | 26221 | 2792 | 28174 | 2276 | 30061 | 1463 | 37441 | 947 | 28801 |
| 7L-4S | | MI | 13123 | 4245 | 20711 | 3403 | 24460 | 2748 | 26526 | 2231 | 28802 | 1413 | 35649 | 1071 | 25608 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis

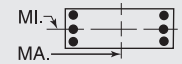


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.31 | MA | 13643 | 4245 | 21427 | 3458 | 25245 | 2790 | 26955 | 2273 | 28434 | 1468 | 35389 | 895 | 27984 |
| 8L-3S | | MI | 13639 | 4245 | 21417 | 3404 | 25414 | 2741 | 27681 | 2235 | 30321 | 1418 | 37304 | 1162 | 25738 |
| 18-#11 | 2.31 | MA | 13122 | 4245 | 20609 | 3468 | 24238 | 2799 | 25755 | 2281 | 26823 | 1473 | 33374 | 836 | 26824 |
| 9L-2S | | MI | 14344 | 4245 | 22359 | 3406 | 26609 | 2744 | 29129 | 2230 | 32235 | 1413 | 39833 | 1254 | 25803 |
| 18-#14 | 3.33 | MA | 17168 | 4697 | 28250 | 3716 | 33854 | 2984 | 37411 | 2386 | 42383 | 1420 | 53587 | 973 | 43365 |
| 4L-7S | | MI | 12311 | 4697 | 20883 | 3678 | 24540 | 2944 | 26549 | 2357 | 28767 | 1369 | 36086 | 608 | 32169 |
| 18-#14 | 3.33 | MA | 16387 | 4697 | 27002 | 3731 | 32357 | 2982 | 35585 | 2397 | 39923 | 1428 | 50461 | 909 | 42030 |
| 5L-6S | | MI | 12918 | 4697 | 21771 | 3680 | 25714 | 2949 | 27979 | 2349 | 30684 | 1377 | 38297 | 711 | 33290 |
| 18-#14 | 3.33 | MA | 15639 | 4697 | 25894 | 3731 | 30879 | 2994 | 33786 | 2392 | 37558 | 1435 | 47307 | 800 | 40606 |
| 6L-5S | | MI | 13539 | 4697 | 22682 | 3682 | 26927 | 2939 | 29452 | 2357 | 32574 | 1369 | 40792 | 820 | 34482 |
| 18-#14 | 3.33 | MA | 14905 | 4697 | 24814 | 3731 | 29451 | 2992 | 32041 | 2402 | 35159 | 1428 | 44508 | 697 | 39183 |
| 7L-4S | | MI | 14185 | 4697 | 23706 | 3670 | 28155 | 2944 | 30948 | 2349 | 34540 | 1362 | 43285 | 881 | 35447 |
| 18-#14 | 3.33 | MA | 14180 | 4697 | 23751 | 3731 | 28051 | 2989 | 30293 | 2398 | 32844 | 1435 | 41589 | 623 | 37217 |
| 8L-3S | | MI | 14897 | 4697 | 24715 | 3672 | 29518 | 2934 | 32596 | 2357 | 36694 | 1369 | 45626 | 1012 | 36352 |
| 18-#18 | 5.92 | MA | 17976 | 5842 | 33217 | 4427 | 39944 | 3506 | 44684 | 2706 | 51835 | 1338 | 66584 | 218 | 65523 |
| 6L-5S | | MI | 15665 | 5842 | 29274 | 4370 | 35124 | 3432 | 39030 | 2643 | 45147 | 1229 | 57489 | 256 | 55855 |
| 20-#11 | 2.57 | MA | 16341 | 4359 | 25721 | 3517 | 30759 | 2837 | 33697 | 2296 | 37525 | 1452 | 47017 | 1123 | 34459 |
| 4L-8S | | MI | 11775 | 4359 | 19070 | 3480 | 22325 | 2799 | 23889 | 2266 | 25342 | 1415 | 31446 | 812 | 25786 |
| 20-#11 | 2.57 | MA | 15781 | 4359 | 24851 | 3528 | 29714 | 2836 | 32422 | 2303 | 35796 | 1457 | 44820 | 1078 | 33596 |
| 5L-7S | | MI | 12206 | 4359 | 19681 | 3481 | 23129 | 2802 | 24892 | 2270 | 26645 | 1410 | 33089 | 861 | 26441 |
| 20-#11 | 2.57 | MA | 15244 | 4359 | 24077 | 3528 | 28683 | 2845 | 31166 | 2301 | 34134 | 1462 | 42598 | 1003 | 33003 |
| 6E | | MI | 12641 | 4359 | 20302 | 3482 | 23949 | 2805 | 25894 | 2265 | 27997 | 1415 | 34652 | 933 | 27202 |
| 20-#11 | 2.57 | MA | 14719 | 4359 | 23324 | 3528 | 27686 | 2843 | 29949 | 2308 | 32448 | 1457 | 40624 | 932 | 32079 |
| 7L-5S | | MI | 13086 | 4359 | 20938 | 3483 | 24797 | 2797 | 26926 | 2269 | 29330 | 1410 | 36416 | 1009 | 27630 |
| 20-#11 | 2.57 | MA | 14200 | 4359 | 22582 | 3529 | 26710 | 2842 | 28729 | 2306 | 30821 | 1462 | 38572 | 880 | 31274 |
| 8L-4S | | MI | 13549 | 4359 | 21654 | 3474 | 25655 | 2800 | 27974 | 2264 | 30716 | 1405 | 38177 | 1051 | 28357 |
| 20-#11 | 2.57 | MA | 13684 | 4359 | 21764 | 3539 | 25703 | 2851 | 27529 | 2313 | 29210 | 1468 | 36556 | 821 | 30097 |
| 9L-3S | | MI | 14060 | 4359 | 22359 | 3475 | 26609 | 2793 | 29129 | 2268 | 32235 | 1410 | 39833 | 1142 | 28503 |
| 20-#11 | 2.57 | MA | 13170 | 4359 | 21025 | 3539 | 24733 | 2850 | 26323 | 2311 | 27554 | 1462 | 34602 | 755 | 28945 |
| 10L-2S | | MI | 14758 | 4359 | 23302 | 3477 | 27804 | 2796 | 30577 | 2263 | 34148 | 1405 | 42362 | 1233 | 28582 |
| 20-#14 | 3.70 | MA | 17129 | 4860 | 28654 | 3833 | 34451 | 3057 | 38122 | 2444 | 43320 | 1419 | 54979 | 885 | 46763 |
| 5L-7S | | MI | 12919 | 4860 | 22228 | 3780 | 26245 | 3019 | 28612 | 2404 | 31481 | 1356 | 39662 | 576 | 35885 |
| 20-#14 | 3.70 | MA | 16390 | 4860 | 27545 | 3833 | 32973 | 3069 | 36323 | 2439 | 40954 | 1426 | 51825 | 776 | 45268 |
| 6E | | MI | 13519 | 4860 | 23116 | 3782 | 27419 | 3024 | 30042 | 2396 | 33398 | 1364 | 41873 | 679 | 37056 |
| 20-#14 | 3.70 | MA | 15667 | 4860 | 26465 | 3833 | 31545 | 3067 | 34579 | 2450 | 38555 | 1419 | 49026 | 673 | 43856 |
| 7L-5S | | MI | 14132 | 4860 | 24027 | 3785 | 28632 | 3014 | 31515 | 2404 | 35288 | 1356 | 44367 | 788 | 38319 |
| 20-#14 | 3.70 | MA | 14953 | 4860 | 25402 | 3833 | 30145 | 3064 | 32831 | 2445 | 36241 | 1426 | 46107 | 599 | 41884 |
| 8L-4S | | MI | 14770 | 4860 | 25050 | 3772 | 29861 | 3019 | 33011 | 2396 | 37254 | 1349 | 46861 | 849 | 39239 |
| 22-#11 | 2.82 | MA | 16313 | 4472 | 26006 | 3599 | 31179 | 2887 | 34196 | 2336 | 38184 | 1452 | 48003 | 1063 | 36906 |
| 5L-8S | | MI | 12214 | 4472 | 20013 | 3551 | 23520 | 2851 | 25337 | 2299 | 27255 | 1407 | 33975 | 791 | 28413 |
| 22-#11 | 2.82 | MA | 15782 | 4472 | 25232 | 3599 | 30148 | 2897 | 32941 | 2334 | 36521 | 1457 | 45781 | 987 | 36330 |
| 6L-7S | | MI | 12640 | 4472 | 20624 | 3552 | 24324 | 2854 | 26340 | 2303 | 28559 | 1402 | 35618 | 841 | 29103 |
| 22-#11 | 2.82 | MA | 15262 | 4472 | 24479 | 3599 | 29151 | 2895 | 31724 | 2341 | 34835 | 1452 | 43806 | 916 | 35362 |
| 7L-6S | | MI | 13071 | 4472 | 21244 | 3553 | 25144 | 2857 | 27342 | 2298 | 29911 | 1407 | 37181 | 912 | 29906 |
| 22-#11 | 2.82 | MA | 14748 | 4472 | 23737 | 3599 | 28174 | 2894 | 30504 | 2339 | 33208 | 1457 | 41755 | 864 | 34525 |
| 8L-5S | | MI | 13512 | 4472 | 21881 | 3554 | 25992 | 2849 | 28374 | 2302 | 31243 | 1402 | 38945 | 988 | 30320 |
| 22-#11 | 2.82 | MA | 14238 | 4472 | 22919 | 3610 | 27168 | 2903 | 29304 | 2346 | 31598 | 1462 | 39739 | 805 | 33375 |
| 9L-4S | | MI | 13970 | 4472 | 22596 | 3545 | 26850 | 2852 | 29421 | 2296 | 32629 | 1396 | 40706 | 1031 | 31104 |
| 22-#11 | 2.82 | MA | 13730 | 4472 | 22180 | 3610 | 26198 | 2902 | 28098 | 2344 | 29941 | 1457 | 37784 | 739 | 32203 |
| 10L-3S | | MI | 14476 | 4472 | 23302 | 3546 | 27804 | 2845 | 30577 | 2301 | 34148 | 1402 | 42362 | 1122 | 31265 |
| 22-#14 | 4.07 | MA | 17131 | 5024 | 29196 | 3935 | 35068 | 3144 | 38860 | 2487 | 44351 | 1417 | 56343 | 752 | 49940 |
| 6L-7S | | MI | 13519 | 5024 | 23573 | 3882 | 27951 | 3094 | 30675 | 2451 | 34195 | 1343 | 43238 | 545 | 39611 |
| 22-#14 | 4.07 | MA | 16418 | 5024 | 28117 | 3935 | 33640 | 3141 | 37116 | 2497 | 41952 | 1409 | 53544 | 649 | 48484 |
| 7L-6S | | MI | 14112 | 5024 | 24461 | 3884 | 29124 | 3099 | 32105 | 2443 | 36112 | 1351 | 45449 | 647 | 40831 |
| 22-#14 | 4.07 | MA | 15713 | 5024 | 27053 | 3935 | 32240 | 3139 | 35368 | 2492 | 39638 | 1417 | 50625 | 575 | 46558 |
| 8L-5S | | MI | 14717 | 5024 | 25372 | 3887 | 30338 | 3089 | 33578 | 2451 | 38002 | 1343 | 47943 | 757 | 42162 |
| 24-#11 | 3.08 | MA | 16313 | 4586 | 26387 | 3670 | 31612 | 2948 | 34715 | 2366 | 38908 | 1451 | 48964 | 972 | 39660 |
| 6L-8S | | MI | 12648 | 4586 | 20955 | 3622 | 24715 | 2903 | 26785 | 2331 | 29169 | 1399 | 36504 | 771 | 31047 |

## RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

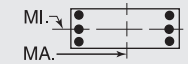
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 3.08 | MA | 15799 | 4586 | 25634 | 3670 | 30616 | 2947 | 33498 | 2374 | 37223 | 1446 | 46989 | 901 | 38652 |
| 7E | | MI | 13070 | 4586 | 21566 | 3623 | 25519 | 2906 | 27788 | 2336 | 30473 | 1393 | 38147 | 821 | 31770 |
| 24-#11 | 3.08 | MA | 15290 | 4586 | 24892 | 3670 | 29639 | 2946 | 32278 | 2371 | 35596 | 1451 | 44937 | 849 | 37783 |
| 8L-6S | | MI | 13496 | 4586 | 22186 | 3624 | 26339 | 2908 | 28790 | 2330 | 31824 | 1399 | 39710 | 892 | 32586 |
| 24-#11 | 3.08 | MA | 14786 | 4586 | 24074 | 3681 | 28633 | 2955 | 31078 | 2379 | 33985 | 1456 | 42922 | 790 | 36658 |
| 9L-5S | | MI | 13933 | 4586 | 22823 | 3625 | 27187 | 2901 | 29822 | 2335 | 33157 | 1393 | 41474 | 968 | 33016 |
| 24-#11 | 3.08 | MA | 14283 | 4586 | 23335 | 3681 | 27663 | 2954 | 29872 | 2376 | 32328 | 1451 | 40967 | 724 | 35465 |
| 10L-4S | | MI | 14387 | 4586 | 23538 | 3616 | 28046 | 2904 | 30869 | 2329 | 34543 | 1388 | 43235 | 1010 | 33768 |
| 24-#14 | 4.44 | MA | 17159 | 5188 | 29768 | 4037 | 35734 | 3216 | 39653 | 2545 | 45349 | 1400 | 58061 | 625 | 53120 |
| 7E | | MI | 14112 | 5188 | 24917 | 3984 | 29656 | 3168 | 32738 | 2498 | 36909 | 1330 | 46814 | 513 | 43348 |
| 24-#14 | 4.44 | MA | 16463 | 5188 | 28705 | 4037 | 34334 | 3214 | 37905 | 2540 | 43034 | 1408 | 55143 | 551 | 51240 |
| 8L-6S | | MI | 14697 | 5188 | 25805 | 3987 | 30830 | 3173 | 34168 | 2491 | 38826 | 1338 | 49024 | 615 | 44616 |
| **RECTANGULAR TIED COLUMNS 32" x 40"** | | | | | | | | | | | | | | | |
| 4-#18 | 1.25 | MA | 16625 | 3976 | 24241 | 3297 | 28592 | 2679 | 30614 | 2218 | 32369 | 1540 | 39234 | 1431 | 18936 |
| 2E | | MI | 13104 | 3976 | 19532 | 3235 | 22688 | 2628 | 24011 | 2167 | 25033 | 1487 | 30012 | 1360 | 14774 |
| 6-#14 | 1.05 | MA | 16245 | 3885 | 23196 | 3263 | 27434 | 2656 | 29284 | 2208 | 30746 | 1563 | 37175 | 1469 | 16219 |
| 2L-3S | | MI | 11787 | 3885 | 17381 | 3204 | 20121 | 2605 | 21064 | 2175 | 21199 | 1525 | 25066 | 1278 | 12730 |
| 6-#14 | 1.05 | MA | 14865 | 3885 | 21442 | 3263 | 25210 | 2654 | 26590 | 2219 | 27121 | 1571 | 32343 | 1337 | 16205 |
| 3L-2S | | MI | 12841 | 3885 | 18726 | 3206 | 21827 | 2610 | 23128 | 2167 | 23913 | 1518 | 28642 | 1410 | 12701 |
| 6-#18 | 1.88 | MA | 18050 | 4267 | 27308 | 3479 | 32481 | 2812 | 35325 | 2303 | 38649 | 1522 | 47568 | 1385 | 28032 |
| 2L-3S | | MI | 12382 | 4267 | 19532 | 3410 | 22688 | 2749 | 24011 | 2261 | 25033 | 1472 | 30012 | 1060 | 21587 |
| 6-#18 | 1.88 | MA | 15718 | 4267 | 24241 | 3477 | 28592 | 2807 | 30614 | 2320 | 32369 | 1535 | 39234 | 1151 | 27721 |
| 3L-2S | | MI | 14159 | 4267 | 21871 | 3416 | 25655 | 2761 | 27556 | 2248 | 29696 | 1459 | 36117 | 1294 | 21749 |
| 8-#14 | 1.41 | MA | 17087 | 4049 | 24949 | 3365 | 29658 | 2731 | 31979 | 2255 | 34370 | 1555 | 42008 | 1447 | 21434 |
| 2L-4S | | MI | 11663 | 4049 | 17717 | 3304 | 20464 | 2689 | 21479 | 2215 | 21758 | 1505 | 26302 | 1116 | 16571 |
| 8-#14 | 1.41 | MA | 15727 | 4049 | 23196 | 3365 | 27434 | 2729 | 29284 | 2266 | 30746 | 1563 | 37175 | 1315 | 21369 |
| 3E | | MI | 12428 | 4049 | 18726 | 3306 | 21827 | 2679 | 23128 | 2222 | 23913 | 1512 | 28642 | 1246 | 16707 |
| 8-#14 | 1.41 | MA | 14738 | 4049 | 21890 | 3366 | 25669 | 2742 | 27146 | 2262 | 27869 | 1555 | 33996 | 1184 | 21104 |
| 4L-2S | | MI | 13468 | 4049 | 20071 | 3308 | 23532 | 2684 | 25191 | 2215 | 26627 | 1505 | 32218 | 1378 | 16720 |
| 8-#18 | 2.50 | MA | 19427 | 4558 | 30374 | 3660 | 36370 | 2945 | 40037 | 2387 | 44928 | 1504 | 55902 | 1339 | 37085 |
| 2L-4S | | MI | 12157 | 4558 | 20109 | 3585 | 23276 | 2897 | 24723 | 2328 | 26107 | 1458 | 32109 | 768 | 26171 |
| 8-#18 | 2.50 | MA | 17148 | 4558 | 27308 | 3659 | 32481 | 2940 | 35325 | 2404 | 38649 | 1517 | 47568 | 1105 | 36649 |
| 3E | | MI | 13441 | 4558 | 21871 | 3592 | 25655 | 2882 | 27556 | 2341 | 29696 | 1444 | 36117 | 995 | 28394 |
| 8-#18 | 2.50 | MA | 15489 | 4558 | 25018 | 3658 | 29386 | 2961 | 31576 | 2394 | 33665 | 1504 | 42099 | 872 | 33722 |
| 4L-2S | | MI | 15181 | 4558 | 24211 | 3598 | 28622 | 2894 | 31100 | 2328 | 34359 | 1431 | 42222 | 1228 | 28667 |
| 10-#11 | 1.22 | MA | 16685 | 3962 | 23975 | 3322 | 28508 | 2700 | 30623 | 2238 | 32607 | 1568 | 39739 | 1471 | 18749 |
| 2L-5S | | MI | 11414 | 3962 | 16957 | 3275 | 19656 | 2658 | 20534 | 2207 | 20552 | 1529 | 24671 | 1186 | 14414 |
| 10-#11 | 1.22 | MA | 15727 | 3962 | 22749 | 3322 | 26954 | 2700 | 28739 | 2246 | 30066 | 1573 | 36338 | 1380 | 18727 |
| 3L-4S | | MI | 11905 | 3962 | 17672 | 3265 | 20514 | 2661 | 21581 | 2201 | 21938 | 1524 | 26432 | 1229 | 14634 |
| 10-#11 | 1.22 | MA | 15031 | 3962 | 21838 | 3323 | 25721 | 2709 | 27246 | 2244 | 28051 | 1568 | 34098 | 1289 | 18635 |
| 4L-3S | | MI | 12444 | 3962 | 18378 | 3267 | 21468 | 2653 | 22737 | 2206 | 23457 | 1529 | 28087 | 1320 | 14670 |
| 10-#11 | 1.22 | MA | 14401 | 3962 | 20916 | 3334 | 24615 | 2708 | 25895 | 2252 | 26212 | 1574 | 31754 | 1243 | 18286 |
| 5L-2S | | MI | 13179 | 3962 | 19320 | 3268 | 22663 | 2656 | 24184 | 2200 | 25371 | 1524 | 30616 | 1411 | 14662 |
| 10-#14 | 1.76 | MA | 17909 | 4212 | 26703 | 3467 | 31882 | 2806 | 34673 | 2303 | 37995 | 1547 | 46840 | 1425 | 26628 |
| 2L-5S | | MI | 11615 | 4212 | 18038 | 3418 | 20941 | 2759 | 22047 | 2269 | 22507 | 1499 | 27384 | 1023 | 19396 |
| 10-#14 | 1.76 | MA | 16569 | 4212 | 24949 | 3467 | 29658 | 2804 | 31979 | 2314 | 34370 | 1555 | 42008 | 1293 | 26521 |
| 3L-4S | | MI | 12301 | 4212 | 19062 | 3406 | 22169 | 2764 | 23542 | 2262 | 24472 | 1492 | 29878 | 1084 | 20482 |
| 10-#14 | 1.76 | MA | 15596 | 4212 | 23644 | 3468 | 27893 | 2817 | 29840 | 2310 | 31494 | 1547 | 38829 | 1162 | 26205 |
| 4L-3S | | MI | 13056 | 4212 | 20071 | 3408 | 23532 | 2754 | 25191 | 2269 | 26627 | 1499 | 32218 | 1215 | 20666 |
| 10-#14 | 1.76 | MA | 14714 | 4212 | 22322 | 3483 | 26307 | 2816 | 27904 | 2321 | 28869 | 1555 | 35492 | 1097 | 24724 |
| 5L-2S | | MI | 14082 | 4212 | 21415 | 3410 | 25237 | 2759 | 27254 | 2262 | 29341 | 1492 | 35794 | 1346 | 20718 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis

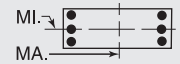



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.13 | MA | 20768 | 4848 | 33440 | 3842 | 40258 | 3078 | 44748 | 2471 | 51208 | 1486 | 64236 | 1293 | 46114 |
| 2L-5S | | MI | 12070 | 4848 | 20660 | 3787 | 24095 | 3018 | 25698 | 2422 | 27279 | 1417 | 33957 | 593 | 30579 |
| 10-#18 | 3.13 | MA | 18536 | 4848 | 30374 | 3841 | 36370 | 3073 | 40037 | 2488 | 44928 | 1500 | 55902 | 1059 | 45571 |
| 3L-4S | | MI | 13214 | 4848 | 22448 | 3767 | 26242 | 3030 | 28268 | 2408 | 30770 | 1430 | 38215 | 703 | 32652 |
| 10-#18 | 3.13 | MA | 16915 | 4848 | 28084 | 3840 | 33275 | 3094 | 36287 | 2479 | 39945 | 1486 | 50433 | 826 | 42319 |
| 4L-3S | | MI | 14471 | 4848 | 24211 | 3773 | 28622 | 3015 | 31100 | 2422 | 34359 | 1417 | 42222 | 929 | 35187 |
| 10-#18 | 3.13 | MA | 15445 | 4848 | 25764 | 3865 | 30491 | 3089 | 32889 | 2496 | 35397 | 1500 | 44654 | 714 | 39584 |
| 5L-2S | | MI | 16178 | 4848 | 26550 | 3780 | 31588 | 3027 | 34645 | 2408 | 39023 | 1403 | 48328 | 1163 | 35556 |
| 12-#11 | 1.46 | MA | 17273 | 4075 | 25201 | 3392 | 30063 | 2752 | 32506 | 2271 | 35148 | 1562 | 43141 | 1457 | 22385 |
| 2L-6S | | MI | 11406 | 4075 | 17263 | 3344 | 20003 | 2717 | 20950 | 2235 | 21133 | 1526 | 25435 | 1090 | 16547 |
| 12-#11 | 1.46 | MA | 16324 | 4075 | 23975 | 3393 | 28508 | 2752 | 30623 | 2279 | 32607 | 1568 | 39739 | 1366 | 22344 |
| 3L-5S | | MI | 11872 | 4075 | 17899 | 3346 | 20851 | 2710 | 21982 | 2240 | 22466 | 1521 | 27200 | 1166 | 17063 |
| 12-#11 | 1.46 | MA | 15636 | 4075 | 23064 | 3394 | 27276 | 2761 | 29129 | 2277 | 30592 | 1563 | 37499 | 1275 | 22225 |
| 4E | | MI | 12357 | 4075 | 18615 | 3336 | 21709 | 2713 | 23029 | 2234 | 23852 | 1516 | 28961 | 1208 | 17400 |
| 12-#11 | 1.46 | MA | 15014 | 4075 | 22141 | 3405 | 26169 | 2760 | 27779 | 2285 | 28753 | 1568 | 35156 | 1229 | 21757 |
| 5L-3S | | MI | 12891 | 4075 | 19320 | 3338 | 22663 | 2705 | 24184 | 2239 | 25371 | 1521 | 30616 | 1299 | 17459 |
| 12-#11 | 1.46 | MA | 14416 | 4075 | 21322 | 3405 | 25077 | 2770 | 26449 | 2283 | 26984 | 1574 | 32781 | 1154 | 20994 |
| 6L-2S | | MI | 13618 | 4075 | 20263 | 3339 | 23858 | 2708 | 25632 | 2233 | 27284 | 1516 | 33145 | 1390 | 17470 |
| 12-#14 | 2.11 | MA | 18716 | 4376 | 28456 | 3569 | 34106 | 2881 | 37367 | 2350 | 41620 | 1539 | 51673 | 1403 | 31811 |
| 2L-6S | | MI | 11601 | 4376 | 18472 | 3518 | 21433 | 2844 | 22636 | 2309 | 23331 | 1494 | 28465 | 882 | 22345 |
| 12-#14 | 2.11 | MA | 17394 | 4376 | 26703 | 3570 | 31882 | 2879 | 34673 | 2361 | 37995 | 1547 | 46840 | 1271 | 31666 |
| 3L-5S | | MI | 12251 | 4376 | 19383 | 3521 | 22646 | 2834 | 24110 | 2316 | 25221 | 1486 | 30960 | 991 | 23190 |
| 12-#14 | 2.11 | MA | 16436 | 4376 | 25397 | 3570 | 30117 | 2892 | 32534 | 2357 | 35119 | 1539 | 43661 | 1140 | 31305 |
| 4E | | MI | 12927 | 4376 | 20406 | 3508 | 23875 | 2839 | 25605 | 2309 | 27186 | 1479 | 33453 | 1052 | 24351 |
| 12-#14 | 2.11 | MA | 15568 | 4376 | 24075 | 3585 | 28531 | 2890 | 30598 | 2368 | 32494 | 1547 | 40325 | 1075 | 29710 |
| 5L-3S | | MI | 13671 | 4376 | 21415 | 3510 | 25237 | 2829 | 27254 | 2316 | 29341 | 1486 | 35794 | 1183 | 24614 |
| 12-#14 | 2.11 | MA | 14735 | 4376 | 22901 | 3586 | 26965 | 2903 | 28692 | 2364 | 29969 | 1554 | 36951 | 966 | 28572 |
| 6L-2S | | MI | 14684 | 4376 | 22760 | 3513 | 26943 | 2834 | 29317 | 2309 | 32055 | 1479 | 39370 | 1314 | 24698 |
| 12-#18 | 3.75 | MA | 19888 | 5139 | 33440 | 4023 | 40258 | 3206 | 44748 | 2572 | 51208 | 1482 | 64236 | 1013 | 54491 |
| 3L-5S | | MI | 13124 | 5139 | 22999 | 3969 | 27062 | 3151 | 29243 | 2502 | 31942 | 1389 | 40062 | 528 | 36948 |
| 12-#18 | 3.75 | MA | 18302 | 5139 | 31150 | 4021 | 37164 | 3227 | 40998 | 2563 | 46224 | 1469 | 58768 | 780 | 50957 |
| 4E | | MI | 14244 | 5139 | 24788 | 3949 | 29209 | 3163 | 31812 | 2489 | 35434 | 1402 | 44320 | 637 | 39175 |
| 12-#18 | 3.75 | MA | 16866 | 5139 | 28830 | 4047 | 34380 | 3222 | 37601 | 2580 | 41677 | 1482 | 52988 | 668 | 48088 |
| 5L-3S | | MI | 15477 | 5139 | 26550 | 3955 | 31588 | 3148 | 34645 | 2502 | 39023 | 1389 | 48328 | 863 | 41973 |
| 12-#18 | 3.75 | MA | 15487 | 5139 | 26767 | 4045 | 31630 | 3243 | 34255 | 2570 | 37303 | 1495 | 47171 | 474 | 44410 |
| 6L-2S | | MI | 17154 | 5139 | 28889 | 3962 | 34555 | 3160 | 38189 | 2489 | 43686 | 1376 | 54433 | 1097 | 42427 |
| 14-#11 | 1.71 | MA | 17851 | 4188 | 26427 | 3463 | 31618 | 2804 | 34389 | 2303 | 37689 | 1557 | 46542 | 1443 | 26015 |
| 2L-7S | | MI | 11410 | 4188 | 17585 | 3414 | 20378 | 2766 | 21396 | 2274 | 21695 | 1513 | 26401 | 998 | 18696 |
| 14-#11 | 1.71 | MA | 16912 | 4188 | 25201 | 3464 | 30063 | 2803 | 32506 | 2312 | 35148 | 1563 | 43141 | 1352 | 25955 |
| 3L-6S | | MI | 11861 | 4188 | 18205 | 3415 | 21198 | 2769 | 22397 | 2268 | 23047 | 1518 | 27964 | 1069 | 19234 |
| 14-#11 | 1.71 | MA | 16232 | 4188 | 24289 | 3465 | 28831 | 2813 | 31013 | 2309 | 33133 | 1558 | 40900 | 1261 | 25813 |
| 4L-5S | | MI | 12322 | 4188 | 18842 | 3416 | 22046 | 2762 | 23430 | 2273 | 24379 | 1513 | 29729 | 1145 | 19724 |
| 14-#11 | 1.71 | MA | 15616 | 4188 | 23367 | 3475 | 27724 | 2812 | 29662 | 2318 | 31294 | 1563 | 38557 | 1215 | 25240 |
| 5L-4S | | MI | 12802 | 4188 | 19557 | 3407 | 22904 | 2764 | 24477 | 2267 | 25765 | 1507 | 31489 | 1188 | 20160 |
| 14-#11 | 1.71 | MA | 15026 | 4188 | 22548 | 3476 | 26632 | 2822 | 28332 | 2315 | 29525 | 1569 | 36182 | 1140 | 24508 |
| 6L-3S | | MI | 13331 | 4188 | 20263 | 3408 | 23858 | 2757 | 25632 | 2272 | 27284 | 1513 | 33145 | 1279 | 20240 |
| 14-#11 | 1.71 | MA | 14448 | 4188 | 21751 | 3477 | 25576 | 2821 | 27043 | 2324 | 27733 | 1564 | 34071 | 1069 | 23767 |
| 7L-2S | | MI | 14051 | 4188 | 21205 | 3410 | 25053 | 2760 | 27080 | 2266 | 29198 | 1507 | 35674 | 1370 | 20268 |
| 14-#14 | 2.46 | MA | 19508 | 4540 | 30210 | 3672 | 36330 | 2955 | 40062 | 2397 | 45245 | 1531 | 56506 | 1381 | 36984 |
| 2L-7S | | MI | 11606 | 4540 | 18929 | 3618 | 21965 | 2914 | 23270 | 2364 | 24127 | 1473 | 29830 | 747 | 24903 |
| 14-#14 | 2.46 | MA | 18203 | 4540 | 28456 | 3672 | 34106 | 2954 | 37367 | 2408 | 41620 | 1538 | 51673 | 1249 | 36805 |
| 3L-6S | | MI | 12234 | 4540 | 19817 | 3621 | 23138 | 2919 | 24699 | 2356 | 26045 | 1481 | 32041 | 850 | 26067 |
| 14-#14 | 2.46 | MA | 17259 | 4540 | 27151 | 3672 | 32341 | 2967 | 35229 | 2404 | 38744 | 1531 | 48494 | 1118 | 36341 |
| 4L-5S | | MI | 12874 | 4540 | 20728 | 3623 | 24352 | 2909 | 26173 | 2364 | 27935 | 1473 | 34536 | 959 | 26997 |
| 14-#14 | 2.46 | MA | 16404 | 4540 | 25829 | 3687 | 30755 | 2965 | 33293 | 2416 | 36119 | 1538 | 45157 | 1053 | 34710 |
| 5L-4S | | MI | 13542 | 4540 | 21751 | 3610 | 25580 | 2914 | 27668 | 2356 | 29900 | 1466 | 37029 | 1020 | 28095 |
| 14-#14 | 2.46 | MA | 15584 | 4540 | 24654 | 3688 | 29189 | 2978 | 31387 | 2412 | 33594 | 1546 | 41784 | 944 | 33493 |
| 6L-3S | | MI | 14276 | 4540 | 22760 | 3613 | 26943 | 2904 | 29317 | 2364 | 32055 | 1473 | 39370 | 1151 | 28554 |

## RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis



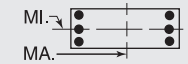

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.46 | MA | 14780 | 4540 | 23511 | 3688 | 27676 | 2977 | 29539 | 2423 | 31035 | 1538 | 38786 | 842 | 31814 |
| 7L-2S | | MI | 15276 | 4540 | 24105 | 3615 | 28648 | 2909 | 31380 | 2356 | 34769 | 1466 | 42945 | 1282 | 28669 |
| 14-#18 | 4.38 | MA | 19658 | 5430 | 34216 | 4203 | 41053 | 3360 | 45709 | 2647 | 52504 | 1451 | 67102 | 734 | 59627 |
| 4L-5S | | MI | 14154 | 5430 | 25338 | 4150 | 30029 | 3284 | 32787 | 2582 | 36606 | 1361 | 46168 | 462 | 43353 |
| 14-#18 | 4.38 | MA | 18251 | 5430 | 31896 | 4228 | 38268 | 3355 | 42312 | 2664 | 47956 | 1464 | 61322 | 622 | 56623 |
| 5L-4S | | MI | 15254 | 5430 | 27127 | 4130 | 32176 | 3296 | 35356 | 2569 | 40097 | 1375 | 50426 | 571 | 45730 |
| 14-#18 | 4.38 | MA | 16902 | 5430 | 29833 | 4227 | 35519 | 3376 | 38966 | 2655 | 43583 | 1477 | 55505 | 428 | 53078 |
| 6L-3S | | MI | 16464 | 5430 | 28889 | 4137 | 34555 | 3281 | 38189 | 2582 | 43686 | 1361 | 54433 | 798 | 48753 |
| 16-#11 | 1.95 | MA | 18420 | 4302 | 27653 | 3534 | 33172 | 2856 | 36273 | 2336 | 40230 | 1552 | 49943 | 1429 | 29638 |
| 2L-8S | | MI | 11422 | 4302 | 17916 | 3484 | 20769 | 2815 | 21840 | 2302 | 22305 | 1510 | 27287 | 928 | 20696 |
| 16-#11 | 1.95 | MA | 17491 | 4302 | 26427 | 3535 | 31618 | 2855 | 34389 | 2344 | 37689 | 1558 | 46542 | 1338 | 29561 |
| 3L-7S | | MI | 11864 | 4302 | 18527 | 3485 | 21573 | 2818 | 22844 | 2306 | 23609 | 1504 | 28930 | 978 | 21334 |
| 16-#11 | 1.95 | MA | 16818 | 4302 | 25515 | 3535 | 30385 | 2865 | 32896 | 2342 | 35674 | 1553 | 44302 | 1247 | 29398 |
| 4L-6S | | MI | 12310 | 4302 | 19147 | 3486 | 22393 | 2821 | 23845 | 2301 | 24960 | 1510 | 30493 | 1049 | 21927 |
| 16-#11 | 1.95 | MA | 16210 | 4302 | 24593 | 3546 | 29279 | 2864 | 31546 | 2350 | 33835 | 1558 | 41958 | 1201 | 28733 |
| 5E | | MI | 12766 | 4302 | 19784 | 3487 | 23241 | 2813 | 24877 | 2305 | 26293 | 1504 | 32257 | 1125 | 22395 |
| 16-#11 | 1.95 | MA | 15626 | 4302 | 23774 | 3547 | 28186 | 2874 | 30216 | 2348 | 32067 | 1563 | 39584 | 1126 | 28029 |
| 6L-4S | | MI | 13241 | 4302 | 20499 | 3478 | 24099 | 2816 | 25925 | 2300 | 27679 | 1499 | 34018 | 1167 | 22917 |
| 16-#11 | 1.95 | MA | 15055 | 4302 | 22976 | 3548 | 27131 | 2873 | 28927 | 2357 | 30274 | 1559 | 37472 | 1055 | 27236 |
| 7L-3S | | MI | 13764 | 4302 | 21205 | 3479 | 25053 | 2809 | 27080 | 2304 | 29198 | 1504 | 35674 | 1258 | 23015 |
| 16-#11 | 1.95 | MA | 14491 | 4302 | 22191 | 3548 | 26097 | 2872 | 27635 | 2354 | 28543 | 1564 | 35283 | 1002 | 26311 |
| 8L-2S | | MI | 14478 | 4302 | 22147 | 3480 | 26248 | 2812 | 28528 | 2299 | 31111 | 1499 | 38203 | 1350 | 23058 |
| 16-#14 | 2.81 | MA | 18998 | 4703 | 30210 | 3774 | 36330 | 3029 | 40062 | 2456 | 45245 | 1530 | 56506 | 1227 | 41940 |
| 3L-7S | | MI | 12236 | 4703 | 20273 | 3720 | 23670 | 2988 | 25333 | 2411 | 26841 | 1460 | 33406 | 716 | 28685 |
| 16-#14 | 2.81 | MA | 18067 | 4703 | 28904 | 3774 | 34565 | 3042 | 37923 | 2452 | 42368 | 1523 | 53327 | 1096 | 41284 |
| 4L-6S | | MI | 12855 | 4703 | 21161 | 3723 | 24844 | 2994 | 26763 | 2403 | 28759 | 1468 | 35617 | 818 | 29804 |
| 16-#14 | 2.81 | MA | 17224 | 4703 | 27583 | 3790 | 32979 | 3040 | 35987 | 2463 | 39743 | 1530 | 49990 | 1031 | 39722 |
| 5E | | MI | 13487 | 4703 | 22072 | 3725 | 26057 | 2984 | 28236 | 2411 | 30649 | 1460 | 38111 | 927 | 30816 |
| 16-#14 | 2.81 | MA | 16416 | 4703 | 26408 | 3790 | 31413 | 3053 | 34081 | 2459 | 37219 | 1538 | 46616 | 922 | 38428 |
| 6L-4S | | MI | 14146 | 4703 | 23096 | 3712 | 27285 | 2989 | 29732 | 2403 | 32614 | 1453 | 40605 | 988 | 31856 |
| 16-#14 | 2.81 | MA | 15625 | 4703 | 25264 | 3790 | 29900 | 3051 | 32233 | 2470 | 34659 | 1530 | 43619 | 820 | 36800 |
| 7L-3S | | MI | 14871 | 4703 | 24105 | 3715 | 28648 | 2979 | 31380 | 2411 | 34769 | 1460 | 42945 | 1119 | 32488 |
| 16-#14 | 2.81 | MA | 14843 | 4703 | 24138 | 3791 | 28417 | 3050 | 30381 | 2466 | 32189 | 1538 | 40503 | 745 | 34856 |
| 8L-2S | | MI | 15860 | 4703 | 25449 | 3717 | 30354 | 2984 | 33443 | 2403 | 37483 | 1453 | 46521 | 1250 | 32631 |
| 16-#18 | 5.00 | MA | 19608 | 5721 | 34963 | 4410 | 42157 | 3488 | 47023 | 2748 | 54236 | 1446 | 69656 | 576 | 65187 |
| 5E | | MI | 15238 | 5721 | 27677 | 4332 | 32995 | 3417 | 36331 | 2663 | 41269 | 1334 | 52273 | 396 | 49789 |
| 16-#18 | 5.00 | MA | 18286 | 5721 | 32899 | 4409 | 39408 | 3509 | 43677 | 2739 | 49862 | 1460 | 63840 | 382 | 61766 |
| 6L-4S | | MI | 16303 | 5721 | 29466 | 4312 | 35143 | 3429 | 38901 | 2649 | 44760 | 1347 | 56531 | 506 | 52312 |
| 18-#11 | 2.19 | MA | 18062 | 4415 | 27653 | 3606 | 33172 | 2907 | 36273 | 2377 | 40230 | 1552 | 49943 | 1324 | 33164 |
| 3L-8S | | MI | 11874 | 4415 | 18858 | 3555 | 21964 | 2867 | 23288 | 2335 | 24218 | 1501 | 29816 | 908 | 23364 |
| 18-#11 | 2.19 | MA | 17396 | 4415 | 26741 | 3606 | 31940 | 2917 | 34780 | 2375 | 38215 | 1547 | 47703 | 1233 | 32982 |
| 4L-7S | | MI | 12311 | 4415 | 19469 | 3556 | 22768 | 2870 | 24292 | 2339 | 25522 | 1496 | 31459 | 957 | 23981 |
| 18-#11 | 2.19 | MA | 16795 | 4415 | 25819 | 3617 | 30833 | 2916 | 33429 | 2383 | 36376 | 1553 | 45360 | 1187 | 32234 |
| 5L-6S | | MI | 12753 | 4415 | 20090 | 3557 | 23588 | 2873 | 25293 | 2334 | 26874 | 1501 | 33022 | 1029 | 24624 |
| 18-#11 | 2.19 | MA | 16218 | 4415 | 25000 | 3618 | 29741 | 2925 | 32099 | 2381 | 34608 | 1558 | 42985 | 1112 | 31554 |
| 6L-5S | | MI | 13204 | 4415 | 20726 | 3558 | 24436 | 2865 | 26325 | 2338 | 28206 | 1496 | 34786 | 1105 | 25073 |
| 18-#11 | 2.19 | MA | 15653 | 4415 | 24202 | 3618 | 28686 | 2925 | 30810 | 2389 | 32815 | 1553 | 40873 | 1041 | 30713 |
| 7L-4S | | MI | 13675 | 4415 | 21442 | 3549 | 25295 | 2868 | 27373 | 2333 | 29592 | 1491 | 36547 | 1147 | 25670 |
| 18-#11 | 2.19 | MA | 15095 | 4415 | 23417 | 3619 | 27652 | 2924 | 29518 | 2387 | 31085 | 1559 | 38685 | 988 | 29813 |
| 8L-3S | | MI | 14192 | 4415 | 22147 | 3550 | 26248 | 2861 | 28528 | 2337 | 31111 | 1496 | 38203 | 1238 | 25786 |
| 18-#11 | 2.19 | MA | 14541 | 4415 | 22550 | 3630 | 26586 | 2933 | 28248 | 2395 | 29371 | 1564 | 36530 | 930 | 28658 |
| 9L-2S | | MI | 14900 | 4415 | 23090 | 3551 | 27443 | 2864 | 29976 | 2332 | 33025 | 1491 | 40731 | 1329 | 25843 |
| 18-#14 | 3.16 | MA | 18862 | 4867 | 30658 | 3877 | 36789 | 3116 | 40617 | 2499 | 45993 | 1515 | 58159 | 1074 | 46243 |
| 4L-7S | | MI | 12856 | 4867 | 21618 | 3823 | 25376 | 3063 | 27396 | 2458 | 29555 | 1447 | 36982 | 684 | 32477 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis

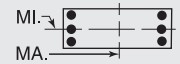


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 3.16 | MA | 18032 | 4867 | 29336 | 3892 | 35203 | 3115 | 38681 | 2510 | 43368 | 1522 | 54823 | 1009 | 44744 |
| 5L-6S | | MI | 13467 | 4867 | 22506 | 3825 | 26549 | 3068 | 28826 | 2450 | 31473 | 1455 | 39193 | 786 | 33554 |
| 18-#14 | 3.16 | MA | 17235 | 4867 | 28162 | 3892 | 33637 | 3128 | 36775 | 2506 | 40844 | 1530 | 51449 | 900 | 43374 |
| 6L-5S | | MI | 14091 | 4867 | 23417 | 3827 | 27763 | 3058 | 30299 | 2458 | 33363 | 1447 | 41687 | 896 | 34644 |
| 18-#14 | 3.16 | MA | 16455 | 4867 | 27018 | 3893 | 32124 | 3126 | 34927 | 2518 | 38284 | 1522 | 48451 | 798 | 41795 |
| 7L-4S | | MI | 14741 | 4867 | 24440 | 3815 | 28991 | 3063 | 31795 | 2450 | 35329 | 1440 | 44181 | 956 | 35633 |
| 18-#14 | 3.16 | MA | 15684 | 4867 | 25892 | 3893 | 30641 | 3124 | 33075 | 2514 | 35814 | 1530 | 45336 | 723 | 39812 |
| 8L-3S | | MI | 15457 | 4867 | 25449 | 3817 | 30354 | 3054 | 33443 | 2458 | 37483 | 1447 | 46521 | 1087 | 36418 |
| 18-#14 | 3.16 | MA | 14918 | 4867 | 24649 | 3908 | 29113 | 3138 | 31253 | 2525 | 33368 | 1537 | 42276 | 638 | 37839 |
| 9L-2S | | MI | 16436 | 4867 | 26794 | 3819 | 32059 | 3059 | 35506 | 2450 | 40197 | 1440 | 50097 | 1218 | 36587 |
| 18-#18 | 5.63 | MA | 19643 | 6012 | 35966 | 4591 | 43297 | 3642 | 48388 | 2823 | 56142 | 1442 | 72174 | 336 | 70359 |
| 6L-5S | | MI | 16225 | 6012 | 30017 | 4514 | 35962 | 3550 | 39876 | 2743 | 45932 | 1306 | 58379 | 331 | 56252 |
| 20-#11 | 2.44 | MA | 17967 | 4529 | 27967 | 3677 | 33495 | 2969 | 36663 | 2408 | 40756 | 1542 | 51104 | 1219 | 36565 |
| 4L-8S | | MI | 12320 | 4529 | 19801 | 3626 | 23159 | 2919 | 24736 | 2367 | 26132 | 1493 | 32345 | 887 | 26037 |
| 20-#11 | 2.44 | MA | 17372 | 4529 | 27045 | 3688 | 32388 | 2968 | 35313 | 2416 | 38917 | 1548 | 48761 | 1173 | 35743 |
| 5L-7S | | MI | 12752 | 4529 | 20412 | 3627 | 23963 | 2922 | 25740 | 2372 | 27436 | 1488 | 33988 | 937 | 26635 |
| 20-#11 | 2.44 | MA | 16801 | 4529 | 26226 | 3689 | 31296 | 2977 | 33983 | 2414 | 37149 | 1553 | 46386 | 1098 | 35085 |
| 6E | | MI | 13190 | 4529 | 21032 | 3628 | 24783 | 2925 | 26741 | 2366 | 28787 | 1493 | 35551 | 1008 | 27325 |
| 20-#11 | 2.44 | MA | 16243 | 4529 | 25428 | 3689 | 30240 | 2977 | 32694 | 2422 | 35356 | 1548 | 44274 | 1027 | 34196 |
| 7L-5S | | MI | 13637 | 4529 | 21669 | 3629 | 25631 | 2917 | 27773 | 2371 | 30120 | 1488 | 37315 | 1084 | 27757 |
| 20-#11 | 2.44 | MA | 15691 | 4529 | 24643 | 3690 | 29206 | 2976 | 31402 | 2420 | 33626 | 1554 | 42086 | 974 | 33319 |
| 8L-4S | | MI | 14103 | 4529 | 22384 | 3620 | 26490 | 2920 | 28821 | 2365 | 31506 | 1483 | 39076 | 1127 | 28422 |
| 20-#11 | 2.44 | MA | 15142 | 4529 | 23776 | 3701 | 28141 | 2985 | 30131 | 2428 | 31912 | 1559 | 39931 | 916 | 32137 |
| 9L-3S | | MI | 14616 | 4529 | 23090 | 3621 | 27443 | 2913 | 29976 | 2370 | 33025 | 1488 | 40731 | 1218 | 28553 |
| 20-#11 | 2.44 | MA | 14596 | 4529 | 22994 | 3701 | 27114 | 2985 | 28854 | 2426 | 30151 | 1554 | 37703 | 835 | 30990 |
| 10L-2S | | MI | 15317 | 4529 | 24032 | 3622 | 28638 | 2915 | 31424 | 2364 | 34938 | 1483 | 43260 | 1309 | 28624 |
| 20-#14 | 3.52 | MA | 18827 | 5030 | 31090 | 3994 | 37427 | 3190 | 41376 | 2558 | 46993 | 1514 | 59655 | 987 | 49775 |
| 5L-7S | | MI | 13467 | 5030 | 22963 | 3925 | 27081 | 3138 | 29459 | 2505 | 32269 | 1434 | 40558 | 652 | 36241 |
| 20-#14 | 3.52 | MA | 18041 | 5030 | 29915 | 3995 | 35861 | 3203 | 39470 | 2554 | 44468 | 1522 | 56282 | 878 | 48332 |
| 6E | | MI | 14070 | 5030 | 23851 | 3927 | 28254 | 3143 | 30889 | 2498 | 34187 | 1442 | 42768 | 754 | 37315 |
| 20-#14 | 3.52 | MA | 17272 | 5030 | 28772 | 3995 | 34348 | 3201 | 37622 | 2565 | 41909 | 1514 | 53284 | 776 | 46798 |
| 7L-5S | | MI | 14686 | 5030 | 24762 | 3930 | 29468 | 3133 | 32362 | 2505 | 36077 | 1434 | 45263 | 864 | 38479 |
| 20-#14 | 3.52 | MA | 16511 | 5030 | 27646 | 3995 | 32865 | 3199 | 35770 | 2561 | 39439 | 1522 | 50168 | 701 | 44777 |
| 8L-4S | | MI | 15329 | 5030 | 25785 | 3917 | 30696 | 3138 | 33858 | 2498 | 38043 | 1427 | 47757 | 924 | 39423 |
| 20-#14 | 3.52 | MA | 15756 | 5030 | 26403 | 4010 | 31337 | 3212 | 33947 | 2572 | 36993 | 1529 | 47109 | 616 | 42776 |
| 9L-3S | | MI | 16036 | 5030 | 26794 | 3919 | 32059 | 3128 | 35506 | 2505 | 40197 | 1434 | 50097 | 1055 | 40345 |
| 22-#11 | 2.68 | MA | 17942 | 4642 | 28271 | 3759 | 33943 | 3020 | 37196 | 2449 | 41459 | 1543 | 52162 | 1159 | 39257 |
| 5L-8S | | MI | 12760 | 4642 | 20743 | 3696 | 24354 | 2971 | 26184 | 2400 | 28045 | 1485 | 34873 | 867 | 28679 |
| 22-#11 | 2.68 | MA | 17377 | 4642 | 27451 | 3760 | 32850 | 3029 | 35866 | 2447 | 39690 | 1548 | 49788 | 1084 | 38619 |
| 6L-7S | | MI | 13188 | 4642 | 21354 | 3698 | 25158 | 2974 | 27188 | 2405 | 29349 | 1480 | 36517 | 917 | 29295 |
| 22-#11 | 2.68 | MA | 16825 | 4642 | 26654 | 3760 | 31795 | 3028 | 34577 | 2455 | 37897 | 1543 | 47676 | 1013 | 37685 |
| 7L-6S | | MI | 13622 | 4642 | 21974 | 3699 | 25978 | 2976 | 28189 | 2399 | 30701 | 1485 | 38079 | 988 | 30030 |
| 22-#11 | 2.68 | MA | 16278 | 4642 | 25869 | 3761 | 30761 | 3028 | 33285 | 2453 | 36167 | 1548 | 45487 | 960 | 36830 |
| 8L-5S | | MI | 14065 | 4642 | 22611 | 3700 | 26826 | 2969 | 29221 | 2404 | 32034 | 1480 | 39844 | 1064 | 30447 |
| 22-#11 | 2.68 | MA | 15736 | 4642 | 25002 | 3772 | 29695 | 3037 | 32014 | 2461 | 34454 | 1554 | 43332 | 902 | 35621 |
| 9L-4S | | MI | 14526 | 4642 | 23326 | 3691 | 27685 | 2972 | 30269 | 2398 | 33419 | 1475 | 41605 | 1106 | 31171 |
| 22-#11 | 2.68 | MA | 15196 | 4642 | 24220 | 3772 | 28668 | 3036 | 30738 | 2459 | 32692 | 1549 | 41104 | 821 | 34454 |
| 10L-3S | | MI | 15034 | 4642 | 24032 | 3692 | 28638 | 2964 | 31424 | 2403 | 34938 | 1480 | 43260 | 1197 | 31318 |
| 22-#14 | 3.87 | MA | 18835 | 5194 | 31669 | 4097 | 38085 | 3278 | 42164 | 2601 | 48093 | 1514 | 61114 | 856 | 53300 |
| 6L-7S | | MI | 14069 | 5194 | 24307 | 4027 | 28786 | 3213 | 31522 | 2552 | 34983 | 1421 | 44134 | 620 | 39963 |
| 22-#14 | 3.87 | MA | 18076 | 5194 | 30525 | 4097 | 36572 | 3276 | 40316 | 2612 | 45534 | 1506 | 58117 | 754 | 51809 |
| 7L-6S | | MI | 14665 | 5194 | 25195 | 4029 | 29960 | 3218 | 32952 | 2545 | 36901 | 1428 | 46344 | 722 | 41087 |
| 22-#14 | 3.87 | MA | 17326 | 5194 | 29399 | 4097 | 35089 | 3274 | 38464 | 2608 | 43064 | 1514 | 55001 | 679 | 49749 |
| 8L-5S | | MI | 15274 | 5194 | 26106 | 4032 | 31173 | 3208 | 34425 | 2552 | 38791 | 1421 | 48839 | 832 | 42321 |
| 22-#14 | 3.87 | MA | 16580 | 5194 | 28156 | 4113 | 33561 | 3287 | 36642 | 2619 | 40618 | 1521 | 51941 | 594 | 47720 |
| 9L-4S | | MI | 15909 | 5194 | 27130 | 4019 | 32401 | 3213 | 35921 | 2545 | 40757 | 1414 | 51332 | 893 | 43224 |
| 24-#11 | 2.92 | MA | 17946 | 4755 | 28677 | 3830 | 34405 | 3081 | 37750 | 2480 | 42231 | 1543 | 53189 | 1070 | 42157 |
| 6L-8S | | MI | 13195 | 4755 | 21685 | 3767 | 25549 | 3022 | 27632 | 2433 | 29959 | 1477 | 37402 | 847 | 31309 |

## RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.92 | MA | 17399 | 4755 | 27880 | 3831 | 33350 | 3080 | 36461 | 2488 | 40438 | 1538 | 51077 | 999 | 41180 |
| 7E | | MI | 13620 | 4755 | 22296 | 3769 | 26353 | 3025 | 28635 | 2438 | 31263 | 1472 | 39046 | 896 | 31960 |
| 24-#11 | 2.92 | MA | 16859 | 4755 | 27095 | 3832 | 32316 | 3079 | 35169 | 2486 | 38708 | 1543 | 48889 | 947 | 40345 |
| 8L-6S | | MI | 14049 | 4755 | 22917 | 3770 | 27173 | 3028 | 29637 | 2432 | 32614 | 1477 | 40608 | 968 | 32737 |
| 24-#11 | 2.92 | MA | 16322 | 4755 | 26228 | 3843 | 31250 | 3089 | 33898 | 2494 | 36995 | 1549 | 46734 | 888 | 39110 |
| 9L-5S | | MI | 14487 | 4755 | 23553 | 3771 | 28021 | 3021 | 30669 | 2437 | 33947 | 1472 | 42373 | 1043 | 33142 |
| 24-#11 | 2.92 | MA | 15788 | 4755 | 25446 | 3843 | 30223 | 3088 | 32621 | 2492 | 35233 | 1544 | 44505 | 808 | 37922 |
| 10L-4S | | MI | 14944 | 4755 | 24269 | 3762 | 28880 | 3024 | 31717 | 2431 | 35333 | 1467 | 44134 | 1086 | 33918 |
| 24-#14 | 4.22 | MA | 18870 | 5357 | 32279 | 4199 | 38796 | 3351 | 43010 | 2660 | 49158 | 1498 | 62949 | 732 | 56821 |
| 7E | | MI | 14664 | 5357 | 25652 | 4129 | 30492 | 3288 | 33585 | 2599 | 37697 | 1408 | 47709 | 588 | 43696 |
| 24-#14 | 4.22 | MA | 18129 | 5357 | 31153 | 4200 | 37313 | 3349 | 41158 | 2656 | 46688 | 1506 | 59834 | 657 | 54729 |
| 8L-6S | | MI | 15253 | 5357 | 26540 | 4132 | 31665 | 3293 | 35015 | 2592 | 39615 | 1415 | 49920 | 690 | 44869 |
| 24-#14 | 4.22 | MA | 17393 | 5357 | 29910 | 4215 | 35785 | 3362 | 39336 | 2667 | 44242 | 1513 | 56774 | 572 | 52671 |
| 9L-5S | | MI | 15855 | 5357 | 27451 | 4134 | 32879 | 3283 | 36488 | 2599 | 41505 | 1408 | 52415 | 800 | 46169 |

## RECTANGULAR TIED COLUMNS 32" x 42"

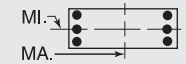
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.19 | MA | 18226 | 4146 | 26360 | 3456 | 31157 | 2810 | 33351 | 2330 | 35246 | 1629 | 42730 | 1521 | 20016 |
| 2E | | MI | 13652 | 4146 | 20275 | 3378 | 23526 | 2746 | 24858 | 2267 | 25818 | 1564 | 30902 | 1434 | 14812 |
| 6-#14 | 1.00 | MA | 17816 | 4055 | 25247 | 3422 | 29922 | 2787 | 31933 | 2319 | 33481 | 1651 | 40504 | 1557 | 17130 |
| 2L-3S | | MI | 12332 | 4055 | 18116 | 3349 | 20957 | 2724 | 21911 | 2276 | 21988 | 1603 | 25962 | 1354 | 12766 |
| 6-#14 | 1.00 | MA | 16350 | 4055 | 23391 | 3423 | 27569 | 2786 | 29081 | 2331 | 29634 | 1658 | 35356 | 1425 | 17116 |
| 3L-2S | | MI | 13388 | 4055 | 19461 | 3351 | 22662 | 2729 | 23974 | 2269 | 24702 | 1596 | 29538 | 1485 | 12731 |
| 6-#18 | 1.79 | MA | 19751 | 4437 | 29608 | 3638 | 35276 | 2943 | 38341 | 2414 | 41930 | 1613 | 51623 | 1479 | 29652 |
| 2L-3S | | MI | 12928 | 4437 | 20275 | 3553 | 23526 | 2867 | 24858 | 2361 | 25818 | 1549 | 30902 | 1135 | 21660 |
| 6-#18 | 1.79 | MA | 17272 | 4437 | 26360 | 3638 | 31157 | 2939 | 33351 | 2432 | 35246 | 1626 | 42730 | 1245 | 29341 |
| 3L-2S | | MI | 14711 | 4437 | 22614 | 3560 | 26493 | 2879 | 28402 | 2348 | 30481 | 1536 | 37007 | 1368 | 21795 |
| 8-#14 | 1.34 | MA | 18715 | 4219 | 27102 | 3524 | 32276 | 2862 | 34784 | 2366 | 37328 | 1643 | 45652 | 1537 | 22649 |
| 2L-4S | | MI | 12207 | 4219 | 18452 | 3449 | 21299 | 2809 | 22326 | 2316 | 22547 | 1583 | 27197 | 1191 | 16637 |
| 8-#14 | 1.34 | MA | 17271 | 4219 | 25247 | 3525 | 29922 | 2861 | 31933 | 2378 | 33481 | 1651 | 40504 | 1405 | 22584 |
| 3E | | MI | 12975 | 4219 | 19461 | 3451 | 22662 | 2799 | 23974 | 2323 | 24702 | 1590 | 29538 | 1322 | 16751 |
| 8-#14 | 1.34 | MA | 16223 | 4219 | 23867 | 3526 | 28057 | 2875 | 29672 | 2375 | 30430 | 1644 | 37113 | 1274 | 22319 |
| 4L-2S | | MI | 14017 | 4219 | 20805 | 3453 | 24368 | 2804 | 26037 | 2316 | 27416 | 1583 | 33114 | 1453 | 16754 |
| 8-#18 | 2.38 | MA | 21226 | 4727 | 32856 | 3820 | 39395 | 3076 | 43331 | 2498 | 48615 | 1597 | 60517 | 1436 | 39245 |
| 2L-4S | | MI | 12702 | 4727 | 20852 | 3729 | 24113 | 3015 | 25569 | 2428 | 26892 | 1535 | 32999 | 843 | 26438 |
| 8-#18 | 2.38 | MA | 18801 | 4727 | 29608 | 3819 | 35276 | 3072 | 38341 | 2516 | 41930 | 1610 | 51623 | 1203 | 38809 |
| 3E | | MI | 13991 | 4727 | 22614 | 3735 | 26493 | 3000 | 28402 | 2441 | 30481 | 1522 | 37007 | 1069 | 28477 |
| 8-#18 | 2.38 | MA | 17040 | 4727 | 27186 | 3819 | 32003 | 3094 | 34375 | 2508 | 36626 | 1597 | 45780 | 969 | 35958 |
| 4L-2S | | MI | 15738 | 4727 | 24953 | 3742 | 29459 | 3012 | 31946 | 2428 | 35145 | 1508 | 43113 | 1303 | 28719 |
| 10-#11 | 1.16 | MA | 18283 | 4131 | 26068 | 3481 | 31055 | 2831 | 33344 | 2349 | 35412 | 1653 | 43219 | 1560 | 19802 |
| 2L-5S | | MI | 11958 | 4131 | 17687 | 3420 | 20490 | 2778 | 21381 | 2309 | 21343 | 1607 | 25569 | 1262 | 14545 |
| 10-#11 | 1.16 | MA | 17266 | 4131 | 24771 | 3482 | 29410 | 2831 | 31351 | 2358 | 32724 | 1659 | 39599 | 1468 | 19780 |
| 3L-4S | | MI | 12450 | 4131 | 18403 | 3411 | 21349 | 2781 | 22429 | 2303 | 22728 | 1602 | 27330 | 1304 | 14678 |
| 10-#11 | 1.16 | MA | 16529 | 4131 | 23809 | 3483 | 28108 | 2841 | 29774 | 2356 | 30594 | 1655 | 37212 | 1377 | 19688 |
| 4L-3S | | MI | 12991 | 4131 | 19109 | 3412 | 22302 | 2773 | 23584 | 2308 | 24247 | 1607 | 28986 | 1395 | 14705 |
| 10-#11 | 1.16 | MA | 15862 | 4131 | 22835 | 3494 | 26940 | 2841 | 28347 | 2365 | 28652 | 1661 | 34722 | 1331 | 19421 |
| 5L-2S | | MI | 13727 | 4131 | 20051 | 3413 | 23497 | 2776 | 25032 | 2302 | 26161 | 1602 | 31515 | 1486 | 14691 |
| 10-#14 | 1.67 | MA | 19594 | 4382 | 28958 | 3626 | 34630 | 2937 | 37636 | 2414 | 41175 | 1636 | 50799 | 1517 | 28147 |
| 2L-5S | | MI | 12159 | 4382 | 18773 | 3563 | 21777 | 2878 | 22894 | 2371 | 23295 | 1577 | 28280 | 1098 | 19561 |
| 10-#14 | 1.67 | MA | 18170 | 4382 | 27102 | 3627 | 32276 | 2936 | 34784 | 2425 | 37328 | 1643 | 45652 | 1385 | 28040 |
| 3L-4S | | MI | 12847 | 4382 | 19796 | 3551 | 23005 | 2883 | 24389 | 2363 | 25261 | 1570 | 30773 | 1159 | 20555 |
| 10-#14 | 1.67 | MA | 17139 | 4382 | 25723 | 3628 | 30411 | 2949 | 32524 | 2422 | 34277 | 1636 | 42261 | 1254 | 27724 |
| 4L-3S | | MI | 13604 | 4382 | 20805 | 3553 | 24368 | 2874 | 26037 | 2371 | 27416 | 1577 | 33114 | 1290 | 20716 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis

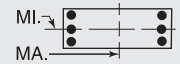



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.67 | MA | 16204 | 4382 | 24326 | 3644 | 28735 | 2948 | 30478 | 2434 | 31493 | 1644 | 38714 | 1188 | 26264 |
| 5L-2S | | MI | 14634 | 4382 | 22150 | 3555 | 26073 | 2879 | 28101 | 2363 | 30130 | 1570 | 36690 | 1421 | 20757 |
| 10-#18 | 2.98 | MA | 22660 | 5018 | 36104 | 4001 | 43514 | 3209 | 48322 | 2582 | 55300 | 1581 | 69410 | 1394 | 48814 |
| 2L-5S | | MI | 12612 | 5018 | 21402 | 3930 | 24933 | 3136 | 26544 | 2522 | 28064 | 1494 | 34847 | 668 | 31002 |
| 10-#18 | 2.98 | MA | 20285 | 5018 | 32856 | 4001 | 39395 | 3205 | 43331 | 2601 | 48615 | 1594 | 60517 | 1160 | 48271 |
| 3L-4S | | MI | 13762 | 5018 | 23191 | 3910 | 27080 | 3148 | 29114 | 2509 | 31555 | 1507 | 39105 | 777 | 32913 |
| 10-#18 | 2.98 | MA | 18564 | 5018 | 30434 | 4001 | 36122 | 3227 | 39365 | 2593 | 43310 | 1581 | 54673 | 927 | 45078 |
| 4L-3S | | MI | 15025 | 5018 | 24953 | 3917 | 29459 | 3133 | 31946 | 2522 | 35145 | 1494 | 43113 | 1003 | 35278 |
| 10-#18 | 2.98 | MA | 17004 | 5018 | 27982 | 4027 | 33179 | 3223 | 35773 | 2611 | 38469 | 1594 | 48520 | 813 | 42395 |
| 5L-2S | | MI | 16739 | 5018 | 27293 | 3924 | 32426 | 3145 | 35491 | 2509 | 39808 | 1481 | 49218 | 1237 | 35614 |
| 12-#11 | 1.39 | MA | 18910 | 4245 | 27365 | 3552 | 32699 | 2883 | 35336 | 2382 | 38100 | 1648 | 46838 | 1547 | 23649 |
| 2L-6S | | MI | 11949 | 4245 | 17993 | 3490 | 20837 | 2837 | 21797 | 2337 | 21923 | 1604 | 26334 | 1166 | 16668 |
| 12-#11 | 1.39 | MA | 17903 | 4245 | 26068 | 3553 | 31055 | 2883 | 33344 | 2390 | 35412 | 1654 | 43219 | 1456 | 23608 |
| 3L-5S | | MI | 12417 | 4245 | 18630 | 3491 | 21685 | 2829 | 22829 | 2341 | 23256 | 1599 | 28098 | 1241 | 17192 |
| 12-#11 | 1.39 | MA | 17175 | 4245 | 25105 | 3553 | 29753 | 2893 | 31766 | 2389 | 33282 | 1650 | 40832 | 1365 | 23489 |
| 4E | | MI | 12903 | 4245 | 19345 | 3482 | 22544 | 2832 | 23877 | 2336 | 24642 | 1594 | 29859 | 1284 | 17449 |
| 12-#11 | 1.39 | MA | 16515 | 4245 | 24131 | 3565 | 28584 | 2892 | 30340 | 2397 | 31340 | 1656 | 38342 | 1318 | 23095 |
| 5L-3S | | MI | 13439 | 4245 | 20051 | 3483 | 23497 | 2825 | 25032 | 2340 | 26161 | 1599 | 31515 | 1375 | 17497 |
| 12-#11 | 1.39 | MA | 15883 | 4245 | 23267 | 3566 | 27431 | 2902 | 28936 | 2396 | 29473 | 1662 | 35815 | 1243 | 22255 |
| 6L-2S | | MI | 14168 | 4245 | 20993 | 3484 | 24692 | 2828 | 26480 | 2335 | 28074 | 1594 | 34043 | 1466 | 17502 |
| 12-#14 | 2.01 | MA | 20456 | 4546 | 30814 | 3728 | 36983 | 3012 | 40487 | 2461 | 45022 | 1628 | 55947 | 1496 | 33633 |
| 2L-6S | | MI | 12144 | 4546 | 19206 | 3663 | 22269 | 2963 | 23483 | 2410 | 24119 | 1572 | 29361 | 957 | 22615 |
| 12-#14 | 2.01 | MA | 19051 | 4546 | 28958 | 3729 | 34630 | 3010 | 37636 | 2473 | 41175 | 1636 | 50799 | 1365 | 33488 |
| 3L-5S | | MI | 12796 | 4546 | 20118 | 3666 | 23482 | 2953 | 24957 | 2418 | 26009 | 1564 | 31856 | 1067 | 23352 |
| 12-#14 | 2.01 | MA | 18035 | 4546 | 27578 | 3730 | 32764 | 3024 | 35375 | 2470 | 38124 | 1629 | 47409 | 1233 | 33128 |
| 4E | | MI | 13475 | 4546 | 21141 | 3653 | 24710 | 2958 | 26452 | 2410 | 27975 | 1557 | 34349 | 1127 | 24467 |
| 12-#14 | 2.01 | MA | 17115 | 4546 | 26182 | 3746 | 31089 | 3023 | 33330 | 2481 | 35340 | 1637 | 43862 | 1168 | 31546 |
| 5L-3S | | MI | 14222 | 4546 | 22150 | 3655 | 26073 | 2948 | 28101 | 2418 | 30130 | 1564 | 36690 | 1258 | 24668 |
| 12-#14 | 2.01 | MA | 16232 | 4546 | 24942 | 3747 | 29435 | 3037 | 31317 | 2478 | 32662 | 1644 | 40268 | 1059 | 30457 |
| 6L-2S | | MI | 15239 | 4546 | 23495 | 3658 | 27778 | 2953 | 30164 | 2410 | 32844 | 1557 | 40265 | 1389 | 24740 |
| 12-#18 | 3.57 | MA | 21732 | 5309 | 36104 | 4183 | 43514 | 3338 | 48322 | 2685 | 55300 | 1578 | 69410 | 1118 | 57731 |
| 3L-5S | | MI | 13669 | 5309 | 23741 | 4112 | 27900 | 3269 | 30089 | 2602 | 32728 | 1466 | 40952 | 602 | 37362 |
| 12-#18 | 3.57 | MA | 20047 | 5309 | 33682 | 4183 | 40241 | 3360 | 44356 | 2677 | 49995 | 1565 | 63567 | 884 | 54240 |
| 4E | | MI | 14796 | 5309 | 25530 | 4092 | 30047 | 3281 | 32658 | 2589 | 36219 | 1479 | 45210 | 712 | 39429 |
| 12-#18 | 3.57 | MA | 18522 | 5309 | 31230 | 4209 | 37298 | 3356 | 40764 | 2695 | 45154 | 1578 | 57413 | 771 | 51426 |
| 5L-3S | | MI | 16035 | 5309 | 27293 | 4099 | 32426 | 3266 | 35491 | 2602 | 39808 | 1466 | 49218 | 938 | 42070 |
| 12-#18 | 3.57 | MA | 17058 | 5309 | 29050 | 4209 | 34392 | 3379 | 37227 | 2687 | 40499 | 1592 | 51206 | 577 | 47369 |
| 6L-2S | | MI | 17720 | 5309 | 29632 | 4105 | 35393 | 3278 | 39035 | 2589 | 44471 | 1453 | 55323 | 1171 | 42488 |
| 14-#11 | 1.63 | MA | 19528 | 4358 | 28661 | 3622 | 34344 | 2935 | 37329 | 2415 | 40788 | 1643 | 50458 | 1534 | 27489 |
| 2L-7S | | MI | 11953 | 4358 | 18315 | 3560 | 21212 | 2886 | 22243 | 2375 | 22485 | 1591 | 27300 | 1074 | 18891 |
| 14-#11 | 1.63 | MA | 18531 | 4358 | 27365 | 3623 | 32699 | 2935 | 35336 | 2423 | 38100 | 1649 | 46838 | 1443 | 27429 |
| 3L-6S | | MI | 12406 | 4358 | 18935 | 3561 | 22032 | 2889 | 23245 | 2370 | 23837 | 1596 | 28863 | 1145 | 19354 |
| 14-#11 | 1.63 | MA | 17810 | 4358 | 26402 | 3624 | 31397 | 2945 | 33759 | 2422 | 35970 | 1644 | 44452 | 1352 | 27287 |
| 4L-5S | | MI | 12868 | 4358 | 19572 | 3562 | 22880 | 2881 | 24277 | 2374 | 25170 | 1591 | 30627 | 1221 | 19852 |
| 14-#11 | 1.63 | MA | 17159 | 4358 | 25428 | 3636 | 30229 | 2944 | 32332 | 2430 | 34028 | 1650 | 41962 | 1306 | 26782 |
| 5L-4S | | MI | 13350 | 4358 | 20287 | 3553 | 23739 | 2884 | 25324 | 2369 | 26555 | 1586 | 32388 | 1263 | 20213 |
| 14-#11 | 1.63 | MA | 16534 | 4358 | 24563 | 3636 | 29076 | 2954 | 30928 | 2429 | 32161 | 1657 | 39435 | 1231 | 25976 |
| 6L-3S | | MI | 13880 | 4358 | 20993 | 3554 | 24692 | 2877 | 26480 | 2373 | 28074 | 1591 | 34043 | 1355 | 20281 |
| 14-#11 | 1.63 | MA | 15922 | 4358 | 23722 | 3637 | 27961 | 2954 | 29567 | 2437 | 30268 | 1652 | 37185 | 1160 | 25284 |
| 7L-2S | | MI | 14603 | 4358 | 21936 | 3555 | 25887 | 2880 | 27927 | 2368 | 29988 | 1586 | 36572 | 1446 | 20303 |
| 14-#14 | 2.34 | MA | 21302 | 4709 | 32670 | 3831 | 39337 | 3086 | 43338 | 2508 | 48869 | 1621 | 61095 | 1476 | 39110 |
| 2L-7S | | MI | 12148 | 4709 | 19663 | 3763 | 22800 | 3033 | 24116 | 2465 | 24916 | 1551 | 30726 | 823 | 25144 |
| 14-#14 | 2.34 | MA | 19915 | 4709 | 30814 | 3831 | 36983 | 3085 | 40487 | 2520 | 45022 | 1628 | 55947 | 1345 | 38931 |
| 3L-6S | | MI | 12778 | 4709 | 20551 | 3765 | 23974 | 3038 | 25546 | 2457 | 26833 | 1559 | 32937 | 925 | 26332 |
| 14-#14 | 2.34 | MA | 18914 | 4709 | 29434 | 3832 | 35118 | 3099 | 38226 | 2517 | 41971 | 1621 | 52557 | 1213 | 38532 |
| 4L-5S | | MI | 13422 | 4709 | 21462 | 3768 | 25187 | 3028 | 27020 | 2465 | 28723 | 1551 | 35431 | 1035 | 27157 |
| 14-#14 | 2.34 | MA | 18008 | 4709 | 28038 | 3848 | 33442 | 3098 | 36181 | 2529 | 39187 | 1629 | 49010 | 1148 | 36843 |
| 5L-4S | | MI | 14092 | 4709 | 22486 | 3755 | 26416 | 3033 | 28515 | 2457 | 30689 | 1544 | 37925 | 1095 | 28283 |

## RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

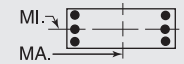
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.34 | MA | 17139 | 4709 | 26798 | 3849 | 31788 | 3112 | 34168 | 2526 | 36509 | 1637 | 45416 | 1039 | 35696 |
| 6L-3S | | MI | 14829 | 4709 | 23495 | 3758 | 27778 | 3023 | 30164 | 2465 | 32844 | 1551 | 40265 | 1226 | 28612 |
| 14-#14 | 2.34 | MA | 16287 | 4709 | 25590 | 3850 | 30191 | 3110 | 32216 | 2537 | 33795 | 1630 | 42220 | 937 | 33850 |
| 7L-2S | | MI | 15834 | 4709 | 24839 | 3760 | 29484 | 3028 | 32227 | 2457 | 35558 | 1544 | 43841 | 1357 | 28713 |
| 14-#18 | 4.17 | MA | 21496 | 5600 | 36930 | 4364 | 44360 | 3493 | 49346 | 2761 | 56680 | 1549 | 72460 | 842 | 63435 |
| 4L-5S | | MI | 14702 | 5600 | 26081 | 4294 | 30866 | 3402 | 33633 | 2683 | 37391 | 1438 | 47058 | 536 | 43758 |
| 14-#18 | 4.17 | MA | 20003 | 5600 | 34478 | 4391 | 41417 | 3489 | 45754 | 2779 | 51839 | 1562 | 66307 | 728 | 60488 |
| 5L-4S | | MI | 15809 | 5600 | 27870 | 4274 | 33013 | 3414 | 36202 | 2669 | 40882 | 1452 | 51316 | 646 | 45979 |
| 14-#18 | 4.17 | MA | 18570 | 5600 | 32298 | 4390 | 38511 | 3511 | 42217 | 2771 | 47183 | 1576 | 60099 | 535 | 56567 |
| 6L-3S | | MI | 17026 | 5600 | 29632 | 4280 | 35393 | 3399 | 39035 | 2683 | 44471 | 1438 | 55323 | 872 | 48856 |
| 14-#18 | 4.17 | MA | 17166 | 5600 | 30175 | 4390 | 35703 | 3507 | 38787 | 2790 | 42462 | 1562 | 54588 | 352 | 52071 |
| 7L-2S | | MI | 18684 | 5600 | 31971 | 4287 | 38360 | 3411 | 42579 | 2669 | 49135 | 1425 | 61429 | 1106 | 49349 |
| 16-#11 | 1.86 | MA | 20136 | 4472 | 29958 | 3693 | 35988 | 2987 | 39321 | 2447 | 43476 | 1638 | 54078 | 1521 | 31323 |
| 2L-8S | | MI | 11965 | 4472 | 18647 | 3630 | 21603 | 2935 | 22688 | 2404 | 23095 | 1588 | 28185 | 1004 | 20878 |
| 16-#11 | 1.86 | MA | 19149 | 4472 | 28661 | 3694 | 34344 | 2987 | 37329 | 2456 | 40788 | 1644 | 50458 | 1430 | 31246 |
| 3L-7S | | MI | 12408 | 4472 | 19257 | 3631 | 22407 | 2938 | 23691 | 2408 | 24399 | 1583 | 29829 | 1053 | 21527 |
| 16-#11 | 1.86 | MA | 18436 | 4472 | 27699 | 3695 | 33042 | 2997 | 35751 | 2454 | 38659 | 1639 | 48072 | 1339 | 31083 |
| 4L-6S | | MI | 12856 | 4472 | 19878 | 3632 | 23227 | 2941 | 24693 | 2403 | 25751 | 1588 | 31391 | 1125 | 22046 |
| 16-#11 | 1.86 | MA | 17792 | 4472 | 26725 | 3706 | 31873 | 2996 | 34325 | 2463 | 36716 | 1645 | 45582 | 1293 | 30479 |
| 5E | | MI | 13314 | 4472 | 20514 | 3633 | 24075 | 2933 | 25725 | 2407 | 27083 | 1583 | 33156 | 1201 | 22521 |
| 16-#11 | 1.86 | MA | 17174 | 4472 | 25860 | 3707 | 30720 | 3006 | 32921 | 2461 | 34849 | 1651 | 43055 | 1218 | 29703 |
| 6L-4S | | MI | 13791 | 4472 | 21230 | 3624 | 24934 | 2936 | 26772 | 2402 | 28469 | 1577 | 34917 | 1243 | 22973 |
| 16-#11 | 1.86 | MA | 16569 | 4472 | 25018 | 3708 | 29606 | 3006 | 31559 | 2470 | 32956 | 1647 | 40805 | 1147 | 28959 |
| 7L-3S | | MI | 14316 | 4472 | 21936 | 3625 | 25887 | 2929 | 27927 | 2406 | 29988 | 1583 | 36572 | 1334 | 23059 |
| 16-#11 | 1.86 | MA | 15971 | 4472 | 24190 | 3709 | 28514 | 3005 | 30196 | 2468 | 31129 | 1653 | 38480 | 1094 | 27945 |
| 8L-2S | | MI | 15032 | 4472 | 22878 | 3626 | 27082 | 2932 | 29375 | 2400 | 31901 | 1577 | 39101 | 1425 | 23096 |
| 16-#14 | 2.68 | MA | 20765 | 4873 | 32670 | 3934 | 39337 | 3160 | 43338 | 2568 | 48869 | 1621 | 61095 | 1325 | 44370 |
| 3L-7S | | MI | 12780 | 4873 | 21008 | 3865 | 24506 | 3108 | 26180 | 2512 | 27630 | 1538 | 34302 | 791 | 28923 |
| 16-#14 | 2.68 | MA | 19777 | 4873 | 31290 | 3935 | 37471 | 3174 | 41078 | 2564 | 45818 | 1614 | 57704 | 1193 | 43889 |
| 4L-6S | | MI | 13402 | 4873 | 21896 | 3868 | 25679 | 3113 | 27609 | 2505 | 29547 | 1545 | 36513 | 893 | 30065 |
| 16-#14 | 2.68 | MA | 18884 | 4873 | 29894 | 3950 | 35796 | 3173 | 39033 | 2576 | 43034 | 1622 | 54157 | 1127 | 42151 |
| 5E | | MI | 14037 | 4873 | 22807 | 3870 | 26893 | 3103 | 29083 | 2512 | 31437 | 1538 | 39007 | 1003 | 30974 |
| 16-#14 | 2.68 | MA | 18028 | 4873 | 28653 | 3951 | 34142 | 3186 | 37020 | 2573 | 40356 | 1629 | 50563 | 1019 | 40926 |
| 6L-4S | | MI | 14699 | 4873 | 23830 | 3857 | 28121 | 3108 | 30578 | 2505 | 33403 | 1531 | 41501 | 1064 | 32041 |
| 16-#14 | 2.68 | MA | 17189 | 4873 | 27446 | 3952 | 32544 | 3185 | 35068 | 2585 | 37642 | 1622 | 47367 | 916 | 39133 |
| 7L-3S | | MI | 15427 | 4873 | 24839 | 3860 | 29484 | 3098 | 32227 | 2512 | 35558 | 1538 | 43841 | 1194 | 32549 |
| 16-#14 | 2.68 | MA | 16359 | 4873 | 26257 | 3953 | 30979 | 3184 | 33112 | 2582 | 35022 | 1630 | 44055 | 840 | 37182 |
| 8L-2S | | MI | 16421 | 4873 | 26184 | 3862 | 31189 | 3103 | 34290 | 2505 | 38272 | 1531 | 47417 | 1326 | 32678 |
| 16-#18 | 4.76 | MA | 21452 | 5891 | 37726 | 4572 | 45536 | 3622 | 50745 | 2864 | 58523 | 1546 | 75200 | 686 | 69578 |
| 5E | | MI | 15794 | 5891 | 28420 | 4476 | 33833 | 3535 | 37178 | 2763 | 42054 | 1411 | 53163 | 471 | 50186 |
| 16-#18 | 4.76 | MA | 20048 | 5891 | 35546 | 4572 | 42630 | 3644 | 47208 | 2856 | 53868 | 1560 | 68992 | 492 | 65786 |
| 6L-4S | | MI | 16867 | 5891 | 30209 | 4456 | 35980 | 3547 | 39747 | 2750 | 45545 | 1424 | 57421 | 580 | 52556 |
| 16-#18 | 4.76 | MA | 18672 | 5891 | 33423 | 4572 | 39822 | 3640 | 43778 | 2874 | 49147 | 1546 | 63481 | 310 | 61225 |
| 7L-3S | | MI | 18038 | 5891 | 31971 | 4462 | 38360 | 3532 | 42579 | 2763 | 49135 | 1411 | 61429 | 806 | 55638 |
| 18-#11 | 2.09 | MA | 19759 | 4585 | 29958 | 3765 | 35988 | 3038 | 39321 | 2489 | 43476 | 1638 | 54078 | 1418 | 35059 |
| 3L-8S | | MI | 12417 | 4585 | 19589 | 3700 | 22798 | 2987 | 24135 | 2436 | 25008 | 1580 | 30714 | 984 | 23545 |
| 18-#11 | 2.09 | MA | 19053 | 4585 | 28995 | 3766 | 34687 | 3048 | 37743 | 2487 | 41347 | 1634 | 51691 | 1326 | 34878 |
| 4L-7S | | MI | 12856 | 4585 | 20200 | 3702 | 23602 | 2990 | 25139 | 2441 | 26312 | 1574 | 32358 | 1033 | 24172 |
| 18-#11 | 2.09 | MA | 18416 | 4585 | 28022 | 3777 | 33518 | 3048 | 36317 | 2496 | 39404 | 1640 | 49202 | 1280 | 34186 |
| 5L-6S | | MI | 13300 | 4585 | 20820 | 3703 | 24422 | 2993 | 26140 | 2435 | 27664 | 1580 | 33920 | 1104 | 24743 |
| 18-#11 | 2.09 | MA | 17805 | 4585 | 27157 | 3778 | 32365 | 3058 | 34913 | 2494 | 37537 | 1646 | 46675 | 1205 | 33436 |
| 6L-5S | | MI | 13753 | 4585 | 21457 | 3704 | 25270 | 2985 | 27173 | 2440 | 28997 | 1574 | 35685 | 1180 | 25198 |
| 18-#11 | 2.09 | MA | 17207 | 4585 | 26315 | 3779 | 31251 | 3058 | 33552 | 2503 | 35644 | 1642 | 44425 | 1134 | 32641 |
| 7L-4S | | MI | 14226 | 4585 | 22172 | 3695 | 26129 | 2988 | 28220 | 2434 | 30382 | 1569 | 37446 | 1223 | 25729 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis

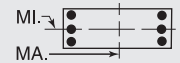



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.09 | MA | 16615 | 4585 | 25486 | 3780 | 30159 | 3057 | 32188 | 2501 | 33817 | 1648 | 42100 | 1081 | 31654 |
| 8L-3S | | MI | 14746 | 4585 | 22878 | 3696 | 27082 | 2981 | 29375 | 2439 | 31901 | 1574 | 39101 | 1314 | 25832 |
| 18-#11 | 2.09 | MA | 16028 | 4585 | 24571 | 3791 | 29034 | 3067 | 30846 | 2510 | 32008 | 1654 | 39805 | 1022 | 30545 |
| 9L-2S | | MI | 15456 | 4585 | 23820 | 3697 | 28277 | 2983 | 30823 | 2433 | 33815 | 1569 | 41630 | 1405 | 25883 |
| 18-#14 | 3.01 | MA | 20627 | 5036 | 33146 | 4037 | 39825 | 3249 | 43929 | 2612 | 49665 | 1606 | 62852 | 1173 | 49141 |
| 4L-7S | | MI | 13401 | 5036 | 22353 | 3968 | 26211 | 3183 | 28243 | 2559 | 30344 | 1525 | 37878 | 759 | 32712 |
| 18-#14 | 3.01 | MA | 19746 | 5036 | 31750 | 4053 | 38150 | 3247 | 41884 | 2624 | 46881 | 1614 | 59305 | 1107 | 47471 |
| 5L-6S | | MI | 14016 | 5036 | 23240 | 3970 | 27385 | 3188 | 29672 | 2552 | 32261 | 1532 | 40088 | 861 | 33811 |
| 18-#14 | 3.01 | MA | 18902 | 5036 | 30509 | 4053 | 36496 | 3261 | 39871 | 2620 | 44203 | 1622 | 55711 | 999 | 46169 |
| 6L-5S | | MI | 14643 | 5036 | 24152 | 3972 | 28598 | 3178 | 31146 | 2559 | 34151 | 1525 | 42583 | 971 | 34801 |
| 18-#14 | 3.01 | MA | 18075 | 5036 | 29302 | 4054 | 34898 | 3260 | 37919 | 2632 | 41489 | 1615 | 52515 | 896 | 44426 |
| 7L-4S | | MI | 15297 | 5036 | 25175 | 3960 | 29826 | 3183 | 32641 | 2552 | 36117 | 1518 | 45077 | 1032 | 35815 |
| 18-#14 | 3.01 | MA | 17257 | 5036 | 28113 | 4055 | 33332 | 3259 | 35963 | 2629 | 38869 | 1623 | 49203 | 820 | 42436 |
| 8L-3S | | MI | 16016 | 5036 | 26184 | 3962 | 31189 | 3173 | 34290 | 2559 | 38272 | 1525 | 47417 | 1162 | 36482 |
| 18-#14 | 3.01 | MA | 16444 | 5036 | 26801 | 4071 | 31719 | 3273 | 34039 | 2641 | 36275 | 1630 | 45941 | 735 | 40447 |
| 9L-2S | | MI | 16999 | 5036 | 27529 | 3964 | 32894 | 3178 | 36353 | 2552 | 40986 | 1518 | 50993 | 1294 | 36637 |
| 18-#18 | 5.36 | MA | 21497 | 6181 | 38794 | 4754 | 46750 | 3777 | 52198 | 2940 | 60552 | 1544 | 77886 | 450 | 75023 |
| 6L-5S | | MI | 16785 | 6181 | 30759 | 4657 | 36800 | 3668 | 40722 | 2843 | 46718 | 1383 | 59269 | 405 | 56642 |
| 18-#18 | 5.36 | MA | 20147 | 6181 | 36671 | 4753 | 43941 | 3773 | 48768 | 2958 | 55832 | 1530 | 72374 | 267 | 70396 |
| 7L-4S | | MI | 17834 | 6181 | 32548 | 4637 | 38947 | 3680 | 43291 | 2830 | 50209 | 1396 | 63527 | 515 | 59156 |
| 20-#11 | 2.32 | MA | 19663 | 4698 | 30292 | 3837 | 36331 | 3100 | 39736 | 2520 | 44035 | 1629 | 55311 | 1314 | 38671 |
| 4L-8S | | MI | 12865 | 4698 | 20531 | 3771 | 23993 | 3039 | 25583 | 2469 | 26922 | 1571 | 33243 | 963 | 26216 |
| 20-#11 | 2.32 | MA | 19032 | 4698 | 29318 | 3848 | 35162 | 3100 | 38309 | 2529 | 42092 | 1635 | 52822 | 1267 | 37899 |
| 5L-7S | | MI | 13299 | 4698 | 21142 | 3772 | 24797 | 3041 | 26587 | 2474 | 28226 | 1566 | 34886 | 1013 | 26823 |
| 20-#11 | 2.32 | MA | 18427 | 4698 | 28453 | 3849 | 34009 | 3110 | 36905 | 2527 | 40225 | 1641 | 50295 | 1192 | 37173 |
| 6E | | MI | 13739 | 4698 | 21762 | 3774 | 25617 | 3044 | 27588 | 2468 | 29578 | 1571 | 36449 | 1084 | 27444 |
| 20-#11 | 2.32 | MA | 17836 | 4698 | 27612 | 3850 | 32895 | 3109 | 35544 | 2536 | 38332 | 1637 | 48045 | 1121 | 36330 |
| 7L-5S | | MI | 14188 | 4698 | 22399 | 3775 | 26465 | 3037 | 28620 | 2473 | 30910 | 1566 | 38214 | 1160 | 27882 |
| 20-#11 | 2.32 | MA | 17251 | 4698 | 26783 | 3851 | 31803 | 3109 | 34181 | 2534 | 36505 | 1643 | 45720 | 1068 | 35367 |
| 8L-4S | | MI | 14656 | 4698 | 23114 | 3766 | 27324 | 3040 | 29668 | 2467 | 32296 | 1561 | 39975 | 1202 | 28483 |
| 20-#11 | 2.32 | MA | 16670 | 4698 | 25868 | 3862 | 30678 | 3119 | 32839 | 2543 | 34696 | 1649 | 43425 | 1009 | 34197 |
| 9L-3S | | MI | 15171 | 4698 | 23820 | 3767 | 28277 | 3032 | 30823 | 2472 | 33815 | 1566 | 41630 | 1293 | 28602 |
| 20-#11 | 2.32 | MA | 16091 | 4698 | 25043 | 3863 | 29594 | 3119 | 31491 | 2541 | 32836 | 1644 | 41053 | 929 | 33062 |
| 10L-2S | | MI | 15875 | 4698 | 24763 | 3768 | 29473 | 3035 | 32271 | 2466 | 35728 | 1561 | 44159 | 1384 | 28665 |
| 20-#14 | 3.35 | MA | 20595 | 5200 | 33605 | 4155 | 40503 | 3322 | 44735 | 2671 | 50728 | 1607 | 64453 | 1087 | 52799 |
| 5L-7S | | MI | 14014 | 5200 | 23697 | 4070 | 27916 | 3257 | 30306 | 2606 | 33058 | 1512 | 41454 | 727 | 36510 |
| 20-#14 | 3.35 | MA | 19762 | 5200 | 32365 | 4156 | 38849 | 3336 | 42722 | 2668 | 48050 | 1615 | 60859 | 979 | 51423 |
| 6E | | MI | 14621 | 5200 | 24585 | 4072 | 29090 | 3262 | 31736 | 2599 | 34975 | 1519 | 43664 | 829 | 37569 |
| 20-#14 | 3.35 | MA | 18946 | 5200 | 31158 | 4156 | 37252 | 3335 | 40770 | 2680 | 45336 | 1607 | 57663 | 876 | 49728 |
| 7L-5S | | MI | 15241 | 5200 | 25496 | 4074 | 30303 | 3252 | 33209 | 2606 | 36865 | 1512 | 46159 | 939 | 38635 |
| 20-#14 | 3.35 | MA | 18139 | 5200 | 29969 | 4157 | 35686 | 3334 | 38815 | 2677 | 42716 | 1615 | 54351 | 800 | 47699 |
| 8L-4S | | MI | 15887 | 5200 | 26520 | 4062 | 31532 | 3257 | 34705 | 2599 | 38831 | 1504 | 48652 | 1000 | 39603 |
| 20-#14 | 3.35 | MA | 17338 | 5200 | 28656 | 4173 | 34072 | 3347 | 36890 | 2688 | 40122 | 1623 | 51089 | 715 | 45683 |
| 9L-3S | | MI | 16598 | 5200 | 27529 | 4064 | 32894 | 3248 | 36353 | 2606 | 40986 | 1512 | 50993 | 1130 | 40412 |
| 20-#18 | 5.95 | MA | 21596 | 6472 | 39919 | 4935 | 48061 | 3906 | 53758 | 3043 | 62516 | 1515 | 81267 | 225 | 79584 |
| 7L-5S | | MI | 17757 | 6472 | 33099 | 4839 | 39767 | 3801 | 44266 | 2924 | 51381 | 1355 | 65374 | 340 | 63123 |
| 22-#11 | 2.55 | MA | 19640 | 4812 | 30615 | 3919 | 36807 | 3152 | 40302 | 2562 | 44780 | 1630 | 56442 | 1255 | 41619 |
| 5L-8S | | MI | 13306 | 4812 | 21473 | 3842 | 25188 | 3090 | 27031 | 2502 | 28835 | 1563 | 35772 | 943 | 28893 |
| 22-#11 | 2.55 | MA | 19042 | 4812 | 29750 | 3920 | 35654 | 3162 | 38898 | 2560 | 42913 | 1636 | 53914 | 1180 | 40915 |
| 6L-7S | | MI | 13737 | 4812 | 22084 | 3843 | 25992 | 3093 | 28035 | 2507 | 30139 | 1558 | 37415 | 992 | 29481 |
| 22-#11 | 2.55 | MA | 18456 | 4812 | 28908 | 3921 | 34540 | 3161 | 37537 | 2569 | 41020 | 1632 | 51665 | 1109 | 40024 |
| 7L-6S | | MI | 14172 | 4812 | 22705 | 3844 | 26812 | 3096 | 29036 | 2501 | 31491 | 1563 | 38978 | 1064 | 30149 |
| 22-#11 | 2.55 | MA | 17878 | 4812 | 28080 | 3922 | 33448 | 3161 | 36173 | 2567 | 39193 | 1638 | 49340 | 1055 | 39085 |
| 8L-5S | | MI | 14617 | 4812 | 23341 | 3846 | 27661 | 3089 | 30068 | 2506 | 32824 | 1558 | 40743 | 1139 | 30571 |
| 22-#11 | 2.55 | MA | 17303 | 4812 | 27165 | 3933 | 32323 | 3171 | 34831 | 2576 | 37384 | 1644 | 47045 | 997 | 37887 |
| 9L-4S | | MI | 15081 | 4812 | 24057 | 3836 | 28519 | 3092 | 31116 | 2500 | 34210 | 1553 | 42503 | 1182 | 31235 |
| 22-#11 | 2.55 | MA | 16731 | 4812 | 26339 | 3934 | 31239 | 3170 | 33483 | 2574 | 35524 | 1639 | 44673 | 917 | 36732 |
| 10L-3S | | MI | 15591 | 4812 | 24763 | 3838 | 29473 | 3084 | 32271 | 2505 | 35728 | 1558 | 44159 | 1273 | 31369 |

## RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.55 | MA | 16130 | 4812 | 25520 | 3935 | 30127 | 3180 | 32150 | 2583 | 33723 | 1645 | 42388 | 860 | 35402 |
| 11L-2S | | MI | 16290 | 4812 | 25705 | 3839 | 30668 | 3087 | 33719 | 2499 | 37642 | 1553 | 46688 | 1364 | 31444 |
| 22-#14 | 3.68 | MA | 20610 | 5364 | 34221 | 4258 | 41203 | 3411 | 45574 | 2715 | 51897 | 1607 | 66007 | 958 | 56687 |
| 6L-7S | | MI | 14618 | 5364 | 25042 | 4172 | 29622 | 3332 | 32369 | 2654 | 35772 | 1499 | 45029 | 695 | 40309 |
| 22-#14 | 3.68 | MA | 19805 | 5364 | 33013 | 4259 | 39605 | 3410 | 43622 | 2727 | 49183 | 1600 | 62811 | 856 | 55036 |
| 7L-6S | | MI | 15218 | 5364 | 25930 | 4174 | 30795 | 3337 | 33799 | 2646 | 37690 | 1506 | 47240 | 797 | 41338 |
| 22-#14 | 3.68 | MA | 19009 | 5364 | 31825 | 4260 | 38039 | 3409 | 41666 | 2724 | 46563 | 1608 | 59498 | 780 | 52970 |
| 8L-5S | | MI | 15831 | 5364 | 26841 | 4177 | 32009 | 3327 | 35272 | 2654 | 39579 | 1499 | 49735 | 907 | 42476 |
| 22-#14 | 3.68 | MA | 18218 | 5364 | 30512 | 4275 | 36426 | 3422 | 39742 | 2736 | 43969 | 1616 | 56237 | 695 | 50926 |
| 9L-4S | | MI | 16470 | 5364 | 27864 | 4164 | 33237 | 3332 | 36768 | 2646 | 41545 | 1491 | 52228 | 968 | 43401 |
| 24-#11 | 2.79 | MA | 19649 | 4925 | 31047 | 3991 | 37298 | 3214 | 40890 | 2593 | 45601 | 1631 | 57534 | 1167 | 44660 |
| 6L-8S | | MI | 13743 | 4925 | 22416 | 3913 | 26384 | 3142 | 28479 | 2535 | 30749 | 1555 | 38301 | 922 | 31566 |
| 24-#11 | 2.79 | MA | 19070 | 4925 | 30205 | 3992 | 36184 | 3213 | 39529 | 2601 | 43708 | 1626 | 55285 | 1096 | 43725 |
| 7E | | MI | 14169 | 4925 | 23027 | 3914 | 27187 | 3145 | 29483 | 2540 | 32053 | 1550 | 39944 | 972 | 32144 |
| 24-#11 | 2.79 | MA | 18497 | 4925 | 29376 | 3993 | 35093 | 3213 | 38165 | 2600 | 41881 | 1632 | 52960 | 1043 | 42807 |
| 8L-6S | | MI | 14601 | 4925 | 23647 | 3915 | 28008 | 3148 | 30484 | 2534 | 33405 | 1555 | 41507 | 1043 | 32856 |
| 24-#11 | 2.79 | MA | 17928 | 4925 | 28461 | 4004 | 33968 | 3223 | 36824 | 2608 | 40072 | 1638 | 50665 | 984 | 41583 |
| 9L-5S | | MI | 15042 | 4925 | 24284 | 3916 | 28856 | 3141 | 31516 | 2539 | 34737 | 1550 | 43271 | 1119 | 33265 |
| 24-#11 | 2.79 | MA | 17362 | 4925 | 27636 | 4005 | 32883 | 3222 | 35476 | 2607 | 38212 | 1634 | 48293 | 904 | 40408 |
| 10L-4S | | MI | 15501 | 4925 | 24999 | 3907 | 29714 | 3144 | 32564 | 2533 | 36123 | 1545 | 45032 | 1161 | 33986 |
| 24-#11 | 2.79 | MA | 16763 | 4925 | 26816 | 4006 | 31771 | 3232 | 34142 | 2615 | 36411 | 1640 | 46008 | 847 | 39098 |
| 11L-3S | | MI | 16007 | 4925 | 25705 | 3908 | 30668 | 3136 | 33719 | 2538 | 37642 | 1550 | 46688 | 1253 | 34133 |
| 24-#14 | 4.02 | MA | 20652 | 5527 | 34869 | 4361 | 41959 | 3484 | 46473 | 2774 | 53030 | 1592 | 67958 | 836 | 60352 |
| 7E | | MI | 15215 | 5527 | 26387 | 4274 | 31327 | 3407 | 34432 | 2701 | 38486 | 1486 | 48605 | 663 | 44036 |
| 24-#14 | 4.02 | MA | 19866 | 5527 | 33680 | 4362 | 40393 | 3483 | 44517 | 2771 | 50410 | 1600 | 64646 | 760 | 58248 |
| 8L-6S | | MI | 15808 | 5527 | 27274 | 4277 | 32501 | 3412 | 35862 | 2693 | 40404 | 1493 | 50816 | 765 | 45116 |
| 24-#14 | 4.02 | MA | 19085 | 5527 | 32368 | 4378 | 38779 | 3497 | 42593 | 2783 | 47816 | 1608 | 61385 | 675 | 56176 |
| 9L-5S | | MI | 16414 | 5527 | 28186 | 4279 | 33714 | 3402 | 37335 | 2701 | 42293 | 1486 | 53310 | 875 | 46323 |

## RECTANGULAR TIED COLUMNS 32" x 44"

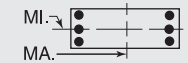
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.14 | MA | 19896 | 4316 | 28559 | 3615 | 33821 | 2941 | 36193 | 2441 | 38225 | 1718 | 46346 | 1610 | 21096 |
| 2E | | MI | 14199 | 4316 | 21018 | 3522 | 24364 | 2864 | 25704 | 2368 | 26603 | 1641 | 31792 | 1509 | 14849 |
| 6-#18 | 1.70 | MA | 21522 | 4606 | 31989 | 3797 | 38171 | 3074 | 41463 | 2525 | 45315 | 1703 | 55799 | 1571 | 31272 |
| 2L-3S | | MI | 13474 | 4606 | 21018 | 3697 | 24364 | 2986 | 25704 | 2461 | 26603 | 1626 | 31792 | 1209 | 21730 |
| 6-#18 | 1.70 | MA | 18894 | 4606 | 28559 | 3798 | 33821 | 3071 | 36193 | 2545 | 38225 | 1717 | 46346 | 1337 | 30961 |
| 3L-2S | | MI | 15262 | 4606 | 23357 | 3704 | 27330 | 2997 | 29248 | 2448 | 31267 | 1613 | 37897 | 1443 | 21838 |
| 8-#14 | 1.28 | MA | 20412 | 4388 | 29335 | 3683 | 34994 | 2993 | 37695 | 2478 | 40347 | 1729 | 49415 | 1626 | 23864 |
| 2L-4S | | MI | 12751 | 4388 | 19186 | 3593 | 22135 | 2928 | 23173 | 2417 | 23336 | 1661 | 28093 | 1266 | 16700 |
| 8-#14 | 1.28 | MA | 18883 | 4388 | 27377 | 3684 | 32511 | 2992 | 34687 | 2490 | 36288 | 1737 | 43952 | 1495 | 23799 |
| 3E | | MI | 13521 | 4388 | 20195 | 3596 | 23498 | 2918 | 24821 | 2425 | 25490 | 1668 | 30434 | 1397 | 16793 |
| 8-#14 | 1.28 | MA | 17776 | 4388 | 25923 | 3686 | 30545 | 3007 | 32305 | 2487 | 33072 | 1731 | 40350 | 1363 | 23534 |
| 4L-2S | | MI | 14566 | 4388 | 21540 | 3598 | 25203 | 2923 | 26884 | 2417 | 28204 | 1661 | 34010 | 1528 | 16788 |
| 8-#18 | 2.27 | MA | 23095 | 4897 | 35418 | 3979 | 42521 | 3207 | 46732 | 2609 | 52405 | 1689 | 65252 | 1532 | 41405 |
| 2L-4S | | MI | 13246 | 4897 | 21594 | 3872 | 24951 | 3133 | 26416 | 2529 | 27677 | 1612 | 33889 | 918 | 26700 |
| 8-#18 | 2.27 | MA | 20524 | 4897 | 31989 | 3979 | 38171 | 3204 | 41463 | 2629 | 45315 | 1702 | 55799 | 1298 | 40969 |
| 3E | | MI | 14541 | 4897 | 23357 | 3879 | 27330 | 3119 | 29248 | 2542 | 31267 | 1599 | 37897 | 1144 | 28557 |
| 8-#18 | 2.27 | MA | 18660 | 4897 | 29435 | 3980 | 34719 | 3227 | 37280 | 2622 | 39689 | 1689 | 49581 | 1065 | 38218 |
| 4L-2S | | MI | 16294 | 4897 | 25696 | 3885 | 30297 | 3130 | 32792 | 2529 | 35930 | 1585 | 44003 | 1377 | 28770 |
| 10-#11 | 1.11 | MA | 19950 | 4301 | 28241 | 3640 | 33701 | 2962 | 36171 | 2460 | 38318 | 1739 | 46817 | 1648 | 20855 |
| 2L-5S | | MI | 12501 | 4301 | 18418 | 3566 | 21324 | 2897 | 22228 | 2410 | 22133 | 1685 | 26468 | 1337 | 14639 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis

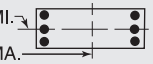



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.11 | MA | 18874 | 4301 | 26873 | 3641 | 31967 | 2962 | 34070 | 2469 | 35483 | 1745 | 42978 | 1557 | 20833 |
| 3L-4S | | MI | 12995 | 4301 | 19133 | 3557 | 22183 | 2900 | 23276 | 2405 | 23518 | 1680 | 28229 | 1380 | 14721 |
| 10-#11 | 1.11 | MA | 18096 | 4301 | 25859 | 3642 | 30596 | 2973 | 32408 | 2468 | 33240 | 1741 | 40445 | 1465 | 20741 |
| 4L-3S | | MI | 13537 | 4301 | 19839 | 3558 | 23136 | 2893 | 24431 | 2409 | 25037 | 1685 | 29884 | 1471 | 14737 |
| 10-#11 | 1.11 | MA | 17391 | 4301 | 24833 | 3654 | 29365 | 2972 | 30906 | 2477 | 31195 | 1748 | 37810 | 1419 | 20513 |
| 5L-2S | | MI | 14275 | 4301 | 20781 | 3559 | 24331 | 2896 | 25879 | 2404 | 26951 | 1680 | 32413 | 1562 | 14720 |
| 10-#14 | 1.60 | MA | 21348 | 4552 | 31293 | 3785 | 37477 | 3068 | 40704 | 2525 | 44405 | 1721 | 54878 | 1607 | 29666 |
| 2L-5S | | MI | 12702 | 4552 | 19508 | 3708 | 22612 | 2998 | 23741 | 2472 | 24084 | 1655 | 29176 | 1174 | 19720 |
| 10-#14 | 1.60 | MA | 19840 | 4552 | 29335 | 3787 | 34994 | 3067 | 37695 | 2537 | 40347 | 1730 | 49415 | 1476 | 29559 |
| 3L-4S | | MI | 13393 | 4552 | 20531 | 3696 | 23840 | 3003 | 25236 | 2464 | 26050 | 1648 | 31669 | 1235 | 20624 |
| 10-#14 | 1.60 | MA | 18750 | 4552 | 27881 | 3788 | 33028 | 3081 | 35313 | 2535 | 37131 | 1723 | 45813 | 1345 | 29242 |
| 4L-3S | | MI | 14153 | 4552 | 21540 | 3698 | 25203 | 2993 | 26884 | 2472 | 28204 | 1655 | 34010 | 1365 | 20763 |
| 10-#14 | 1.60 | MA | 17763 | 4552 | 26410 | 3804 | 31263 | 3081 | 33159 | 2547 | 34198 | 1732 | 42056 | 1278 | 27815 |
| 5L-2S | | MI | 15185 | 4552 | 22885 | 3700 | 26909 | 2998 | 28947 | 2464 | 30918 | 1648 | 37585 | 1496 | 20794 |
| 10-#18 | 2.84 | MA | 24624 | 5188 | 38848 | 4160 | 46870 | 3340 | 52002 | 2693 | 59495 | 1675 | 74705 | 1493 | 51514 |
| 2L-5S | | MI | 13154 | 5188 | 22145 | 4074 | 25771 | 3254 | 27391 | 2622 | 28850 | 1571 | 35737 | 742 | 31417 |
| 10-#18 | 2.84 | MA | 22105 | 5188 | 35418 | 4161 | 42521 | 3337 | 46732 | 2713 | 52405 | 1688 | 65252 | 1259 | 50971 |
| 3L-4S | | MI | 14309 | 5188 | 23934 | 4054 | 27918 | 3266 | 29960 | 2609 | 32341 | 1584 | 39995 | 852 | 33167 |
| 10-#18 | 2.84 | MA | 20283 | 5188 | 32865 | 4162 | 39069 | 3360 | 42549 | 2706 | 46779 | 1675 | 59034 | 1026 | 47862 |
| 4L-3S | | MI | 15578 | 5188 | 25696 | 4061 | 30297 | 3251 | 32792 | 2622 | 35930 | 1571 | 44003 | 1078 | 35365 |
| 10-#18 | 2.84 | MA | 18633 | 5188 | 30280 | 4189 | 35967 | 3357 | 38763 | 2726 | 41645 | 1688 | 52507 | 910 | 44956 |
| 5L-2S | | MI | 17300 | 5188 | 28035 | 4067 | 33264 | 3263 | 36337 | 2609 | 40593 | 1558 | 50108 | 1312 | 35670 |
| 12-#11 | 1.33 | MA | 20617 | 4414 | 29608 | 3711 | 35436 | 3014 | 38272 | 2493 | 41153 | 1733 | 50656 | 1636 | 24913 |
| 2L-6S | | MI | 12492 | 4414 | 18724 | 3636 | 21671 | 2957 | 22644 | 2439 | 22714 | 1682 | 27232 | 1241 | 16784 |
| 12-#11 | 1.33 | MA | 19551 | 4414 | 28241 | 3712 | 33701 | 3014 | 36171 | 2502 | 38318 | 1740 | 46817 | 1545 | 24871 |
| 3L-5S | | MI | 12961 | 4414 | 19360 | 3637 | 22519 | 2949 | 23676 | 2443 | 24046 | 1677 | 28997 | 1317 | 17318 |
| 12-#11 | 1.33 | MA | 18782 | 4414 | 27226 | 3713 | 32330 | 3024 | 34509 | 2501 | 36075 | 1736 | 44284 | 1454 | 24753 |
| 4E | | MI | 13449 | 4414 | 20076 | 3628 | 23378 | 2952 | 24724 | 2438 | 25432 | 1672 | 30758 | 1359 | 17496 |
| 12-#11 | 1.33 | MA | 18086 | 4414 | 26201 | 3725 | 31099 | 3024 | 33007 | 2510 | 34030 | 1743 | 41648 | 1407 | 24443 |
| 5L-3S | | MI | 13986 | 4414 | 20781 | 3629 | 24331 | 2945 | 25879 | 2442 | 26951 | 1677 | 32413 | 1451 | 17534 |
| 12-#11 | 1.33 | MA | 17418 | 4414 | 25291 | 3726 | 29885 | 3035 | 31529 | 2509 | 32063 | 1749 | 38968 | 1332 | 23523 |
| 6L-2S | | MI | 14717 | 4414 | 21724 | 3630 | 25526 | 2948 | 27327 | 2437 | 28864 | 1672 | 34942 | 1542 | 17533 |
| 12-#14 | 1.92 | MA | 22266 | 4715 | 33251 | 3888 | 39960 | 3142 | 43712 | 2572 | 48464 | 1714 | 60341 | 1589 | 35456 |
| 2L-6S | | MI | 12687 | 4715 | 19941 | 3808 | 23104 | 3082 | 24330 | 2512 | 24908 | 1649 | 30257 | 1032 | 22838 |
| 12-#14 | 1.92 | MA | 20778 | 4715 | 31293 | 3889 | 37477 | 3142 | 40704 | 2585 | 44405 | 1722 | 54878 | 1457 | 35311 |
| 3L-5S | | MI | 13341 | 4715 | 20852 | 3811 | 24318 | 3073 | 25804 | 2519 | 26798 | 1642 | 32751 | 1142 | 23509 |
| 12-#14 | 1.92 | MA | 19704 | 4715 | 29839 | 3890 | 35511 | 3156 | 38322 | 2582 | 41190 | 1716 | 51276 | 1326 | 34950 |
| 4E | | MI | 14023 | 4715 | 21876 | 3798 | 25546 | 3078 | 27299 | 2512 | 28764 | 1634 | 35245 | 1203 | 24541 |
| 12-#14 | 1.92 | MA | 18731 | 4715 | 28368 | 3906 | 33747 | 3156 | 36167 | 2595 | 38257 | 1725 | 47519 | 1259 | 33393 |
| 5L-3S | | MI | 14772 | 4715 | 22885 | 3800 | 26909 | 3068 | 28947 | 2519 | 30918 | 1642 | 37585 | 1333 | 24719 |
| 12-#14 | 1.92 | MA | 17799 | 4715 | 27062 | 3908 | 32005 | 3170 | 34047 | 2592 | 35436 | 1733 | 43704 | 1151 | 32215 |
| 6L-2S | | MI | 15793 | 4715 | 24229 | 3803 | 28614 | 3073 | 31011 | 2512 | 33632 | 1634 | 41161 | 1465 | 24782 |
| 12-#18 | 3.41 | MA | 23646 | 5479 | 38848 | 4343 | 46870 | 3470 | 52002 | 2797 | 59495 | 1674 | 74705 | 1220 | 60971 |
| 3L-5S | | MI | 14214 | 5479 | 24484 | 4256 | 28737 | 3387 | 30935 | 2703 | 33513 | 1543 | 41843 | 677 | 37769 |
| 12-#18 | 3.41 | MA | 21863 | 5479 | 36294 | 4343 | 43419 | 3493 | 47819 | 2791 | 53869 | 1660 | 68487 | 987 | 57548 |
| 4E | | MI | 15347 | 5479 | 26273 | 4236 | 30884 | 3399 | 33504 | 2689 | 37004 | 1556 | 46100 | 786 | 39678 |
| 12-#18 | 3.41 | MA | 20249 | 5479 | 33709 | 4371 | 40317 | 3490 | 44033 | 2810 | 48735 | 1674 | 61960 | 871 | 54775 |
| 5L-3S | | MI | 16593 | 5479 | 28035 | 4242 | 33264 | 3384 | 36337 | 2703 | 40593 | 1543 | 50108 | 1012 | 42163 |
| 12-#18 | 3.41 | MA | 18700 | 5479 | 31412 | 4371 | 37254 | 3514 | 40305 | 2803 | 43797 | 1687 | 55361 | 678 | 50360 |
| 6L-2S | | MI | 18286 | 5479 | 30375 | 4249 | 36231 | 3396 | 39881 | 2689 | 45257 | 1530 | 56213 | 1246 | 42549 |
| 14-#11 | 1.55 | MA | 21274 | 4528 | 30976 | 3782 | 37170 | 3066 | 40374 | 2526 | 43988 | 1728 | 54495 | 1624 | 28963 |
| 2L-7S | | MI | 12496 | 4528 | 19046 | 3705 | 22046 | 3006 | 23091 | 2477 | 23275 | 1669 | 28198 | 1149 | 19082 |
| 14-#11 | 1.55 | MA | 20219 | 4528 | 29608 | 3783 | 35436 | 3066 | 38272 | 2535 | 41153 | 1735 | 50656 | 1533 | 28903 |
| 3L-6S | | MI | 12950 | 4528 | 19666 | 3707 | 22866 | 3009 | 24092 | 2471 | 24627 | 1674 | 29761 | 1221 | 19469 |
| 14-#11 | 1.55 | MA | 19458 | 4528 | 28594 | 3784 | 34064 | 3076 | 36610 | 2534 | 38910 | 1731 | 48122 | 1442 | 28761 |
| 4L-5S | | MI | 13414 | 4528 | 20303 | 3708 | 23715 | 3001 | 25124 | 2476 | 25960 | 1669 | 31526 | 1297 | 19976 |
| 14-#11 | 1.55 | MA | 18769 | 4528 | 27568 | 3796 | 32834 | 3076 | 35108 | 2543 | 36865 | 1738 | 45487 | 1395 | 28334 |
| 5L-4S | | MI | 13897 | 4528 | 21018 | 3699 | 24573 | 3004 | 26172 | 2470 | 27346 | 1664 | 33287 | 1339 | 20263 |

## RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

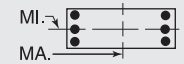
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.55 | MA | 18109 | 4528 | 26658 | 3797 | 31620 | 3087 | 33630 | 2541 | 34898 | 1744 | 42806 | 1320 | 27450 |
| 6L-3S | | MI | 14429 | 4528 | 21724 | 3700 | 25526 | 2997 | 27327 | 2475 | 28864 | 1669 | 34942 | 1430 | 20321 |
| 14-#11 | 1.55 | MA | 17463 | 4528 | 25772 | 3798 | 30447 | 3087 | 32197 | 2550 | 32905 | 1740 | 40419 | 1250 | 26816 |
| 7L-2S | | MI | 15154 | 4528 | 22666 | 3701 | 26722 | 3000 | 28775 | 2469 | 30778 | 1664 | 37471 | 1521 | 20338 |
| 14-#14 | 2.24 | MA | 23167 | 4879 | 35209 | 3990 | 42444 | 3217 | 46721 | 2620 | 52523 | 1706 | 65804 | 1570 | 41237 |
| 2L-7S | | MI | 12690 | 4879 | 20398 | 3908 | 23636 | 3152 | 24963 | 2566 | 25704 | 1629 | 31622 | 898 | 25380 |
| 14-#14 | 2.24 | MA | 21698 | 4879 | 33251 | 3991 | 39960 | 3217 | 43712 | 2632 | 48464 | 1715 | 60341 | 1439 | 41057 |
| 3L-6S | | MI | 13323 | 4879 | 21286 | 3910 | 24809 | 3157 | 26393 | 2559 | 27622 | 1636 | 33833 | 1000 | 26592 |
| 14-#14 | 2.24 | MA | 20639 | 4879 | 31797 | 3992 | 37995 | 3231 | 41330 | 2630 | 45249 | 1708 | 56739 | 1308 | 40658 |
| 4L-5S | | MI | 13969 | 4879 | 22197 | 3913 | 26023 | 3147 | 27867 | 2566 | 29512 | 1629 | 36327 | 1110 | 27313 |
| 14-#14 | 2.24 | MA | 19681 | 4879 | 30326 | 4009 | 36230 | 3230 | 39176 | 2642 | 42316 | 1717 | 52982 | 1241 | 38987 |
| 5L-4S | | MI | 14642 | 4879 | 23220 | 3900 | 27251 | 3152 | 29362 | 2559 | 31478 | 1621 | 38821 | 1171 | 28454 |
| 14-#14 | 2.24 | MA | 18762 | 4879 | 29020 | 4010 | 34488 | 3245 | 37055 | 2639 | 39495 | 1726 | 49167 | 1133 | 37848 |
| 6L-3S | | MI | 15382 | 4879 | 24229 | 3903 | 28614 | 3142 | 31011 | 2566 | 33632 | 1629 | 41161 | 1301 | 28667 |
| 14-#14 | 2.24 | MA | 17863 | 4879 | 27749 | 4011 | 32805 | 3244 | 35000 | 2652 | 36636 | 1719 | 45773 | 1030 | 35903 |
| 7L-2S | | MI | 16391 | 4879 | 25574 | 3905 | 30319 | 3147 | 33074 | 2559 | 36346 | 1621 | 44737 | 1433 | 28757 |
| 14-#18 | 3.98 | MA | 23406 | 5770 | 39724 | 4525 | 47768 | 3626 | 53089 | 2875 | 60959 | 1646 | 77940 | 947 | 67268 |
| 4L-5S | | MI | 15251 | 5770 | 26823 | 4437 | 31704 | 3520 | 34479 | 2783 | 38176 | 1516 | 47948 | 611 | 44157 |
| 14-#18 | 3.98 | MA | 21825 | 5770 | 37139 | 4552 | 44666 | 3623 | 49303 | 2895 | 55825 | 1659 | 71413 | 832 | 64397 |
| 5L-4S | | MI | 16364 | 5770 | 28612 | 4417 | 33851 | 3532 | 37049 | 2770 | 41667 | 1529 | 52206 | 721 | 46223 |
| 14-#18 | 3.98 | MA | 20309 | 5770 | 34842 | 4553 | 41604 | 3647 | 45575 | 2888 | 50887 | 1673 | 64814 | 639 | 60088 |
| 6L-3S | | MI | 17588 | 5770 | 30375 | 4424 | 36231 | 3517 | 39881 | 2783 | 45257 | 1516 | 56213 | 947 | 48954 |
| 14-#18 | 3.98 | MA | 18822 | 5770 | 32605 | 4554 | 38645 | 3644 | 41960 | 2907 | 45880 | 1659 | 58950 | 457 | 55494 |
| 7L-2S | | MI | 19254 | 5770 | 32714 | 4431 | 39197 | 3529 | 43426 | 2770 | 49920 | 1502 | 62319 | 1180 | 49414 |
| 16-#11 | 1.77 | MA | 21922 | 4641 | 32343 | 3852 | 38905 | 3118 | 42475 | 2559 | 46823 | 1723 | 58333 | 1613 | 33008 |
| 2L-8S | | MI | 12507 | 4641 | 19377 | 3775 | 22437 | 3055 | 23535 | 2505 | 23885 | 1666 | 29084 | 1080 | 21055 |
| 16-#11 | 1.77 | MA | 20876 | 4641 | 30976 | 3854 | 37170 | 3118 | 40374 | 2568 | 43988 | 1730 | 54495 | 1522 | 32930 |
| 3L-7S | | MI | 12951 | 4641 | 19988 | 3776 | 23241 | 3058 | 24538 | 2510 | 25189 | 1661 | 30727 | 1129 | 21715 |
| 16-#11 | 1.77 | MA | 20123 | 4641 | 29962 | 3855 | 35799 | 3128 | 38712 | 2566 | 41745 | 1726 | 51961 | 1430 | 32768 |
| 4L-6S | | MI | 13401 | 4641 | 20608 | 3778 | 24061 | 3061 | 25540 | 2504 | 26541 | 1666 | 32290 | 1200 | 22161 |
| 16-#11 | 1.77 | MA | 19442 | 4641 | 28936 | 3866 | 34568 | 3128 | 37209 | 2576 | 39700 | 1732 | 49326 | 1384 | 32236 |
| 5E | | MI | 13861 | 4641 | 21245 | 3779 | 24910 | 3053 | 26572 | 2509 | 27873 | 1661 | 34055 | 1276 | 22644 |
| 16-#11 | 1.77 | MA | 18790 | 4641 | 28026 | 3868 | 33354 | 3138 | 35731 | 2574 | 37733 | 1739 | 46645 | 1309 | 31384 |
| 6L-4S | | MI | 14340 | 4641 | 21960 | 3769 | 25768 | 3056 | 27620 | 2503 | 29259 | 1656 | 35815 | 1319 | 23027 |
| 16-#11 | 1.77 | MA | 18151 | 4641 | 27140 | 3869 | 32181 | 3138 | 34298 | 2583 | 35740 | 1735 | 44258 | 1238 | 30696 |
| 7L-3S | | MI | 14866 | 4641 | 22666 | 3771 | 26722 | 3049 | 28775 | 2508 | 30778 | 1661 | 37471 | 1410 | 23102 |
| 16-#11 | 1.77 | MA | 17520 | 4641 | 26268 | 3870 | 31032 | 3138 | 32862 | 2582 | 33817 | 1742 | 41796 | 1184 | 29591 |
| 8L-2S | | MI | 15585 | 4641 | 23608 | 3772 | 27917 | 3051 | 30223 | 2502 | 32691 | 1656 | 40000 | 1501 | 23132 |
| 16-#14 | 2.56 | MA | 22603 | 5043 | 35209 | 4093 | 42444 | 3291 | 46721 | 2679 | 52523 | 1707 | 65804 | 1420 | 46800 |
| 3L-7S | | MI | 13323 | 5043 | 21743 | 4010 | 25341 | 3227 | 27026 | 2613 | 28418 | 1616 | 35198 | 866 | 29155 |
| 16-#14 | 2.56 | MA | 21558 | 5043 | 33755 | 4095 | 40478 | 3306 | 44339 | 2677 | 49308 | 1701 | 62203 | 1289 | 46366 |
| 4L-6S | | MI | 13948 | 5043 | 22630 | 4013 | 26515 | 3232 | 28456 | 2606 | 30336 | 1623 | 37408 | 968 | 30321 |
| 16-#14 | 2.56 | MA | 20613 | 5043 | 32284 | 4111 | 38713 | 3305 | 42184 | 2689 | 46375 | 1710 | 58445 | 1222 | 44592 |
| 5E | | MI | 14586 | 5043 | 23542 | 4015 | 27728 | 3222 | 29930 | 2613 | 32226 | 1616 | 39903 | 1078 | 31129 |
| 16-#14 | 2.56 | MA | 19708 | 5043 | 30978 | 4112 | 36971 | 3320 | 40064 | 2687 | 43554 | 1718 | 54631 | 1114 | 43449 |
| 6L-4S | | MI | 15251 | 5043 | 24565 | 4002 | 28956 | 3227 | 31425 | 2606 | 34192 | 1608 | 42396 | 1139 | 32222 |
| 16-#14 | 2.56 | MA | 18821 | 5043 | 29707 | 4113 | 35289 | 3319 | 38008 | 2699 | 40695 | 1712 | 51236 | 1012 | 41485 |
| 7L-3S | | MI | 15982 | 5043 | 25574 | 4005 | 30319 | 3217 | 33074 | 2613 | 36346 | 1616 | 44737 | 1269 | 32608 |
| 16-#14 | 2.56 | MA | 17945 | 5043 | 28456 | 4115 | 33640 | 3318 | 35949 | 2697 | 37936 | 1721 | 47727 | 935 | 39536 |
| 8L-2S | | MI | 16980 | 5043 | 26919 | 4007 | 32025 | 3222 | 35137 | 2606 | 39060 | 1608 | 48313 | 1401 | 32725 |
| 16-#18 | 4.55 | MA | 23368 | 6060 | 40569 | 4734 | 49016 | 3756 | 54572 | 2979 | 62915 | 1645 | 80866 | 793 | 74014 |
| 5E | | MI | 16268 | 6060 | 29163 | 4619 | 34671 | 3653 | 38024 | 2863 | 42840 | 1488 | 54053 | 545 | 50577 |
| 16-#18 | 4.55 | MA | 21881 | 6060 | 38272 | 4735 | 45954 | 3780 | 50845 | 2972 | 57977 | 1658 | 74267 | 600 | 69837 |
| 6L-4S | | MI | 17431 | 6060 | 30951 | 4599 | 36818 | 3665 | 40593 | 2850 | 46331 | 1501 | 58311 | 655 | 52795 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis

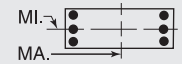


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 4.55 | MA | 20425 | 6060 | 36035 | 4735 | 42994 | 3777 | 47230 | 2992 | 52970 | 1645 | 68403 | 418 | 65180 |
| 7L-3S | | MI | 18611 | 6060 | 32714 | 4606 | 39197 | 3650 | 43426 | 2863 | 49920 | 1488 | 62319 | 881 | 55741 |
| 18-#11 | 1.99 | MA | 21525 | 4755 | 32343 | 3925 | 38905 | 3170 | 42475 | 2601 | 46823 | 1724 | 58333 | 1510 | 36955 |
| 3L-8S | | MI | 12961 | 4755 | 20319 | 3846 | 23633 | 3107 | 24983 | 2538 | 25798 | 1658 | 31613 | 1059 | 23720 |
| 18-#11 | 1.99 | MA | 20780 | 4755 | 31329 | 3926 | 37533 | 3180 | 40813 | 2599 | 44580 | 1721 | 55800 | 1419 | 36773 |
| 4L-7S | | MI | 13401 | 4755 | 20930 | 3847 | 24437 | 3109 | 25986 | 2543 | 27102 | 1653 | 33256 | 1109 | 24357 |
| 18-#11 | 1.99 | MA | 20106 | 4755 | 30304 | 3937 | 36303 | 3180 | 39311 | 2608 | 42535 | 1727 | 53165 | 1372 | 36147 |
| 5L-6S | | MI | 13847 | 4755 | 21551 | 3848 | 25257 | 3112 | 26988 | 2537 | 28454 | 1658 | 34819 | 1180 | 24858 |
| 18-#11 | 1.99 | MA | 19461 | 4755 | 29393 | 3939 | 35088 | 3190 | 37832 | 2607 | 40568 | 1734 | 50484 | 1297 | 35324 |
| 6L-5S | | MI | 14302 | 4755 | 22187 | 3850 | 26105 | 3105 | 28020 | 2542 | 29787 | 1653 | 36583 | 1256 | 25320 |
| 18-#11 | 1.99 | MA | 18829 | 4755 | 28507 | 3940 | 33916 | 3190 | 36399 | 2616 | 38575 | 1730 | 48097 | 1226 | 34584 |
| 7L-4S | | MI | 14776 | 4755 | 22903 | 3840 | 26963 | 3108 | 29067 | 2536 | 31173 | 1648 | 38344 | 1298 | 25786 |
| 18-#11 | 1.99 | MA | 18205 | 4755 | 27635 | 3941 | 32766 | 3190 | 34964 | 2615 | 36652 | 1737 | 45635 | 1172 | 33506 |
| 8L-3S | | MI | 15298 | 4755 | 23608 | 3841 | 27917 | 3100 | 30223 | 2541 | 32691 | 1653 | 40000 | 1389 | 25878 |
| 18-#11 | 1.99 | MA | 17584 | 4755 | 26672 | 3953 | 31582 | 3201 | 33551 | 2624 | 34747 | 1743 | 43201 | 1114 | 32418 |
| 9L-2S | | MI | 16011 | 4755 | 24551 | 3843 | 29112 | 3103 | 31670 | 2535 | 34605 | 1648 | 42529 | 1480 | 25921 |
| 18-#14 | 2.88 | MA | 22462 | 5206 | 35713 | 4197 | 42961 | 3381 | 47347 | 2724 | 53367 | 1694 | 67666 | 1271 | 52059 |
| 4L-7S | | MI | 13946 | 5206 | 23087 | 4113 | 27047 | 3302 | 29089 | 2661 | 31132 | 1603 | 38773 | 834 | 32941 |
| 18-#14 | 2.88 | MA | 21530 | 5206 | 34243 | 4213 | 41196 | 3380 | 45193 | 2737 | 50434 | 1702 | 63908 | 1204 | 50209 |
| 5L-6S | | MI | 14564 | 5206 | 23975 | 4115 | 28220 | 3307 | 30519 | 2653 | 33050 | 1610 | 40984 | 936 | 34063 |
| 18-#14 | 2.88 | MA | 20638 | 5206 | 32936 | 4214 | 39455 | 3394 | 43072 | 2734 | 47613 | 1711 | 60094 | 1096 | 48988 |
| 6L-5S | | MI | 15194 | 5206 | 24886 | 4117 | 29434 | 3297 | 31993 | 2661 | 34940 | 1603 | 43479 | 1046 | 34954 |
| 18-#14 | 2.88 | MA | 19763 | 5206 | 31665 | 4216 | 37772 | 3394 | 41017 | 2747 | 44754 | 1704 | 56699 | 993 | 47076 |
| 7L-4S | | MI | 15851 | 5206 | 25910 | 4105 | 30662 | 3302 | 33488 | 2653 | 36906 | 1595 | 45972 | 1107 | 35994 |
| 18-#14 | 2.88 | MA | 18899 | 5206 | 30414 | 4217 | 36123 | 3393 | 38957 | 2744 | 41995 | 1713 | 53190 | 916 | 45089 |
| 8L-3S | | MI | 16574 | 5206 | 26919 | 4107 | 32025 | 3292 | 35137 | 2661 | 39060 | 1603 | 48313 | 1237 | 36544 |
| 18-#14 | 2.88 | MA | 18040 | 5206 | 29032 | 4233 | 34424 | 3407 | 36931 | 2757 | 39264 | 1722 | 49727 | 832 | 43092 |
| 9L-2S | | MI | 17562 | 5206 | 28263 | 4109 | 33730 | 3297 | 37200 | 2653 | 41774 | 1595 | 51889 | 1369 | 36686 |
| 18-#18 | 5.11 | MA | 23423 | 6351 | 41701 | 4916 | 50303 | 3913 | 56114 | 3056 | 65067 | 1644 | 83720 | 561 | 79605 |
| 6L-5S | | MI | 17344 | 6351 | 31502 | 4801 | 37638 | 3786 | 41568 | 2944 | 47503 | 1460 | 60159 | 480 | 57026 |
| 18-#18 | 5.11 | MA | 21994 | 6351 | 39465 | 4917 | 47344 | 3910 | 52500 | 3076 | 60060 | 1631 | 77856 | 379 | 74884 |
| 7L-4S | | MI | 18402 | 6351 | 33291 | 4781 | 39785 | 3798 | 44137 | 2930 | 50994 | 1473 | 64417 | 589 | 59391 |
| 20-#11 | 2.22 | MA | 21428 | 4868 | 32697 | 3997 | 39268 | 3232 | 42914 | 2632 | 47415 | 1715 | 59639 | 1407 | 40777 |
| 4L-8S | | MI | 13409 | 4868 | 21262 | 3917 | 24828 | 3158 | 26431 | 2571 | 27712 | 1650 | 34142 | 1039 | 26390 |
| 20-#11 | 2.22 | MA | 20761 | 4868 | 31671 | 4008 | 38037 | 3232 | 41412 | 2641 | 45369 | 1722 | 57003 | 1360 | 40066 |
| 5L-7S | | MI | 13845 | 4868 | 21873 | 3918 | 25632 | 3161 | 27434 | 2576 | 29016 | 1645 | 35785 | 1088 | 27007 |
| 20-#11 | 2.22 | MA | 20123 | 4868 | 30761 | 4009 | 36823 | 3242 | 39934 | 2640 | 43403 | 1729 | 54323 | 1285 | 39268 |
| 6E | | MI | 14287 | 4868 | 22493 | 3919 | 26452 | 3164 | 28436 | 2570 | 30368 | 1650 | 37348 | 1160 | 27559 |
| 20-#11 | 2.22 | MA | 19498 | 4868 | 29875 | 4011 | 35650 | 3242 | 38501 | 2649 | 41410 | 1725 | 51936 | 1215 | 38478 |
| 7L-5S | | MI | 14738 | 4868 | 23130 | 3920 | 27300 | 3157 | 29468 | 2575 | 31700 | 1645 | 39112 | 1235 | 28003 |
| 20-#11 | 2.22 | MA | 18880 | 4868 | 29003 | 4012 | 34501 | 3242 | 37065 | 2648 | 39487 | 1731 | 49474 | 1161 | 37427 |
| 8L-4S | | MI | 15208 | 4868 | 23845 | 3911 | 28158 | 3160 | 30515 | 2569 | 33086 | 1639 | 40873 | 1278 | 28542 |
| 20-#11 | 2.22 | MA | 18266 | 4868 | 28040 | 4023 | 33317 | 3252 | 35653 | 2657 | 37582 | 1738 | 47039 | 1102 | 36309 |
| 9L-3S | | MI | 15725 | 4868 | 24551 | 3912 | 29112 | 3152 | 31670 | 2574 | 34605 | 1645 | 42529 | 1369 | 28649 |
| 20-#11 | 2.22 | MA | 17655 | 4868 | 27171 | 4025 | 32176 | 3252 | 34234 | 2656 | 35624 | 1734 | 44522 | 1022 | 35117 |
| 10L-2S | | MI | 16432 | 4868 | 25493 | 3914 | 30307 | 3155 | 33118 | 2568 | 36519 | 1639 | 45057 | 1460 | 28706 |
| 20-#14 | 3.20 | MA | 22434 | 5370 | 36201 | 4315 | 43680 | 3455 | 48201 | 2784 | 54493 | 1695 | 69371 | 1185 | 55835 |
| 5L-7S | | MI | 14561 | 5370 | 24432 | 4215 | 28752 | 3377 | 31153 | 2708 | 33846 | 1590 | 42349 | 802 | 36736 |
| 20-#14 | 3.20 | MA | 21553 | 5370 | 34895 | 4317 | 41938 | 3469 | 46081 | 2782 | 51672 | 1703 | 65557 | 1077 | 54538 |
| 6E | | MI | 15171 | 5370 | 25320 | 4217 | 29925 | 3382 | 32582 | 2700 | 35764 | 1597 | 44560 | 905 | 37818 |
| 20-#14 | 3.20 | MA | 20690 | 5370 | 33623 | 4318 | 40255 | 3469 | 44025 | 2794 | 48813 | 1697 | 62162 | 975 | 52676 |
| 7L-5S | | MI | 15794 | 5370 | 26231 | 4219 | 31139 | 3372 | 34056 | 2708 | 37654 | 1590 | 47055 | 1014 | 38787 |
| 20-#14 | 3.20 | MA | 19837 | 5370 | 32372 | 4319 | 38607 | 3468 | 41966 | 2792 | 46054 | 1706 | 58653 | 898 | 50651 |
| 8L-4S | | MI | 16444 | 5370 | 27254 | 4207 | 32367 | 3377 | 35551 | 2700 | 39620 | 1582 | 49548 | 1075 | 39779 |
| 20-#14 | 3.20 | MA | 18990 | 5370 | 30990 | 4335 | 36908 | 3482 | 39939 | 2804 | 43323 | 1714 | 55190 | 813 | 48628 |
| 9L-3S | | MI | 17159 | 5370 | 28263 | 4209 | 33730 | 3367 | 37200 | 2708 | 41774 | 1590 | 51889 | 1206 | 40476 |
| 20-#18 | 5.68 | MA | 23535 | 6642 | 42894 | 5099 | 51694 | 4043 | 57769 | 3160 | 67150 | 1617 | 87309 | 339 | 84604 |
| 7L-5S | | MI | 18321 | 6642 | 33841 | 4983 | 40604 | 3919 | 45112 | 3024 | 52166 | 1432 | 66264 | 414 | 63500 |

## RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.44 | MA | 21408 | 4981 | 33039 | 4079 | 39772 | 3284 | 43513 | 2674 | 48204 | 1717 | 60842 | 1349 | 43991 |
| 5L-8S | | MI | 13852 | 4981 | 22204 | 3988 | 26023 | 3210 | 27878 | 2604 | 29626 | 1642 | 36671 | 1018 | 29065 |
| 22-#11 | 2.44 | MA | 20776 | 4981 | 32129 | 4080 | 38557 | 3294 | 42035 | 2673 | 46238 | 1723 | 58162 | 1274 | 43217 |
| 6L-7S | | MI | 14284 | 4981 | 22815 | 3989 | 26827 | 3213 | 28882 | 2609 | 30929 | 1636 | 38314 | 1068 | 29663 |
| 22-#11 | 2.44 | MA | 20158 | 4981 | 31243 | 4082 | 37385 | 3294 | 40602 | 2682 | 44245 | 1720 | 55774 | 1203 | 42379 |
| 7L-6S | | MI | 14722 | 4981 | 23435 | 3990 | 27647 | 3216 | 29883 | 2603 | 32281 | 1642 | 39877 | 1139 | 30264 |
| 22-#11 | 2.44 | MA | 19546 | 4981 | 30370 | 4083 | 36235 | 3294 | 39166 | 2681 | 42322 | 1726 | 53313 | 1149 | 41352 |
| 8L-5S | | MI | 15169 | 4981 | 24072 | 3991 | 28495 | 3209 | 30916 | 2608 | 33614 | 1636 | 41641 | 1215 | 30691 |
| 22-#11 | 2.44 | MA | 18939 | 4981 | 29407 | 4094 | 35051 | 3304 | 37754 | 2690 | 40417 | 1733 | 50878 | 1090 | 40173 |
| 9L-4S | | MI | 15634 | 4981 | 24787 | 3982 | 29354 | 3212 | 31963 | 2602 | 35000 | 1631 | 43402 | 1257 | 31297 |
| 22-#11 | 2.44 | MA | 18334 | 4981 | 28538 | 4096 | 33910 | 3304 | 36335 | 2688 | 38459 | 1729 | 48361 | 1010 | 39036 |
| 10L-3S | | MI | 16147 | 4981 | 25493 | 3983 | 30307 | 3204 | 33118 | 2607 | 36519 | 1636 | 45057 | 1349 | 31418 |
| 22-#11 | 2.44 | MA | 17691 | 4981 | 27676 | 4097 | 32739 | 3315 | 34931 | 2697 | 36563 | 1736 | 45942 | 953 | 37588 |
| 11L-2S | | MI | 16849 | 4981 | 26435 | 3984 | 31502 | 3207 | 34566 | 2601 | 38432 | 1631 | 47586 | 1440 | 31487 |
| 22-#14 | 3.52 | MA | 22455 | 5533 | 36853 | 4419 | 44421 | 3544 | 49089 | 2829 | 55731 | 1696 | 71020 | 1059 | 60099 |
| 6L-7S | | MI | 15167 | 5533 | 25777 | 4317 | 30457 | 3451 | 33216 | 2755 | 36560 | 1577 | 45925 | 770 | 40539 |
| 22-#14 | 3.52 | MA | 21603 | 5533 | 35581 | 4420 | 42738 | 3543 | 47034 | 2841 | 52872 | 1690 | 67625 | 956 | 58283 |
| 7L-6S | | MI | 15771 | 5533 | 26664 | 4319 | 31631 | 3456 | 34646 | 2747 | 38478 | 1584 | 48136 | 873 | 41583 |
| 22-#14 | 3.52 | MA | 20762 | 5533 | 34330 | 4421 | 41090 | 3543 | 44974 | 2839 | 50113 | 1698 | 64116 | 879 | 56220 |
| 8L-5S | | MI | 16387 | 5533 | 27576 | 4322 | 32844 | 3447 | 36119 | 2755 | 40368 | 1577 | 50630 | 982 | 42627 |
| 22-#14 | 3.52 | MA | 19925 | 5533 | 32948 | 4438 | 39391 | 3557 | 42948 | 2851 | 47381 | 1707 | 60653 | 795 | 54170 |
| 9L-4S | | MI | 17029 | 5533 | 28599 | 4309 | 34073 | 3452 | 37615 | 2747 | 42334 | 1569 | 53124 | 1043 | 43575 |
| 24-#11 | 2.66 | MA | 21422 | 5095 | 33496 | 4151 | 40292 | 3346 | 44136 | 2706 | 49073 | 1718 | 62000 | 1262 | 47170 |
| 6L-8S | | MI | 14290 | 5095 | 23146 | 4059 | 27218 | 3262 | 29326 | 2637 | 31539 | 1633 | 39199 | 998 | 31745 |
| 24-#11 | 2.66 | MA | 20810 | 5095 | 32610 | 4152 | 39119 | 3346 | 42703 | 2715 | 47080 | 1715 | 59613 | 1191 | 46285 |
| 7E | | MI | 14719 | 5095 | 23757 | 4060 | 28022 | 3265 | 30330 | 2641 | 32843 | 1628 | 40843 | 1047 | 32324 |
| 24-#11 | 2.66 | MA | 20204 | 5095 | 31738 | 4154 | 37970 | 3346 | 41268 | 2713 | 45157 | 1721 | 57151 | 1137 | 45281 |
| 8L-6S | | MI | 15152 | 5095 | 24377 | 4061 | 28842 | 3268 | 31331 | 2636 | 34195 | 1633 | 42405 | 1119 | 32972 |
| 24-#11 | 2.66 | MA | 19603 | 5095 | 30775 | 4165 | 36786 | 3356 | 39855 | 2723 | 43252 | 1728 | 54717 | 1079 | 44075 |
| 9L-5S | | MI | 15595 | 5095 | 25014 | 4062 | 29690 | 3261 | 32363 | 2640 | 35527 | 1628 | 44170 | 1195 | 33385 |
| 24-#11 | 2.66 | MA | 19005 | 5095 | 29906 | 4166 | 35644 | 3356 | 38436 | 2721 | 41294 | 1724 | 52200 | 999 | 42920 |
| 10L-4S | | MI | 16057 | 5095 | 25730 | 4053 | 30549 | 3263 | 33411 | 2635 | 36913 | 1623 | 45931 | 1237 | 34049 |
| 24-#11 | 2.66 | MA | 18364 | 5095 | 29044 | 4168 | 34474 | 3366 | 37032 | 2730 | 39398 | 1731 | 49781 | 942 | 41492 |
| 11L-3S | | MI | 16565 | 5095 | 26435 | 4054 | 31502 | 3256 | 34566 | 2639 | 38432 | 1628 | 47586 | 1328 | 34184 |
| 24-#14 | 3.84 | MA | 22504 | 5697 | 37539 | 4522 | 45222 | 3618 | 50042 | 2889 | 56931 | 1682 | 73088 | 938 | 63897 |
| 7E | | MI | 15766 | 5697 | 27121 | 4419 | 32163 | 3526 | 35279 | 2802 | 39274 | 1564 | 49501 | 738 | 44349 |
| 24-#14 | 3.84 | MA | 21673 | 5697 | 36288 | 4524 | 43573 | 3618 | 47983 | 2886 | 54172 | 1691 | 69579 | 861 | 61796 |
| 8L-6S | | MI | 16363 | 5697 | 28009 | 4422 | 33336 | 3531 | 36709 | 2795 | 41192 | 1571 | 51712 | 841 | 45358 |
| 24-#14 | 3.84 | MA | 20847 | 5697 | 34906 | 4540 | 41874 | 3632 | 45956 | 2899 | 51440 | 1699 | 66116 | 776 | 59719 |
| 9L-5S | | MI | 16973 | 5697 | 28920 | 4424 | 34550 | 3521 | 38182 | 2802 | 43082 | 1564 | 54206 | 950 | 46473 |

## RECTANGULAR TIED COLUMNS 32" x 46"

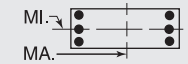
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.09 | MA | 21635 | 4485 | 30837 | 3774 | 36586 | 3072 | 39141 | 2552 | 41288 | 1805 | 50083 | 1699 | 22176 |
| 2E | | MI | 14747 | 4485 | 21760 | 3665 | 25201 | 2982 | 26550 | 2468 | 27389 | 1718 | 32682 | 1583 | 14885 |
| 6-#18 | 1.63 | MA | 23362 | 4776 | 34448 | 3956 | 41166 | 3205 | 44690 | 2636 | 48774 | 1792 | 60096 | 1663 | 32892 |
| 2L-3S | | MI | 14020 | 4776 | 21760 | 3841 | 25201 | 3104 | 26550 | 2562 | 27389 | 1703 | 32682 | 1284 | 21797 |
| 6-#18 | 1.63 | MA | 20586 | 4776 | 30837 | 3958 | 36586 | 3203 | 39141 | 2657 | 41288 | 1806 | 50083 | 1429 | 32581 |
| 3L-2S | | MI | 15813 | 4776 | 24099 | 3847 | 28168 | 3115 | 30094 | 2548 | 32052 | 1690 | 38787 | 1517 | 21881 |
| 8-#14 | 1.22 | MA | 22177 | 4558 | 31647 | 3842 | 37812 | 3124 | 40713 | 2589 | 43467 | 1814 | 53298 | 1715 | 25079 |
| 2L-4S | | MI | 13296 | 4558 | 19921 | 3738 | 22971 | 3047 | 24020 | 2519 | 24124 | 1738 | 28989 | 1342 | 16759 |
| 8-#14 | 1.22 | MA | 20564 | 4558 | 29587 | 3844 | 35199 | 3124 | 37547 | 2602 | 39196 | 1823 | 47519 | 1583 | 25014 |
| 3E | | MI | 14067 | 4558 | 20930 | 3741 | 24333 | 3037 | 25668 | 2526 | 26279 | 1746 | 31330 | 1472 | 16834 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.22 | MA | 19397 | 4558 | 28059 | 3846 | 33133 | 3138 | 35043 | 2600 | 35816 | 1818 | 43706 | 1452 | 24749 |
| 4L-2S | | MI | 15114 | 4558 | 22275 | 3743 | 26039 | 3042 | 27731 | 2519 | 28993 | 1738 | 34905 | 1604 | 16820 |
| 8-#18 | 2.17 | MA | 25034 | 5067 | 38060 | 4138 | 45747 | 3338 | 50239 | 2720 | 56261 | 1779 | 70109 | 1627 | 43565 |
| 2L-4S | | MI | 13791 | 5067 | 22337 | 4016 | 25789 | 3251 | 27262 | 2629 | 28463 | 1689 | 34779 | 992 | 26955 |
| 8-#18 | 2.17 | MA | 22316 | 5067 | 34448 | 4139 | 41166 | 3336 | 44690 | 2741 | 48774 | 1792 | 60096 | 1393 | 43129 |
| 3E | | MI | 15090 | 5067 | 24099 | 4022 | 28168 | 3237 | 30094 | 2642 | 32052 | 1676 | 38787 | 1218 | 28632 |
| 8-#18 | 2.17 | MA | 20349 | 5067 | 31763 | 4141 | 37536 | 3360 | 40290 | 2736 | 42837 | 1780 | 53502 | 1159 | 40501 |
| 4L-2S | | MI | 16849 | 5067 | 26439 | 4029 | 31135 | 3248 | 33639 | 2629 | 36715 | 1662 | 44893 | 1452 | 28821 |
| 10-#11 | 1.06 | MA | 21685 | 4471 | 30493 | 3799 | 36448 | 3093 | 39104 | 2571 | 41327 | 1824 | 50535 | 1735 | 21908 |
| 2L-5S | | MI | 13045 | 4471 | 19148 | 3712 | 22159 | 3017 | 23076 | 2512 | 22923 | 1764 | 27367 | 1413 | 14695 |
| 10-#11 | 1.06 | MA | 20550 | 4471 | 29054 | 3800 | 34624 | 3093 | 36894 | 2581 | 38345 | 1831 | 46478 | 1644 | 21886 |
| 3L-4S | | MI | 13539 | 4471 | 19864 | 3702 | 23017 | 3020 | 24123 | 2507 | 24309 | 1758 | 29128 | 1455 | 14761 |
| 10-#11 | 1.06 | MA | 19730 | 4471 | 27989 | 3802 | 33183 | 3104 | 35147 | 2580 | 35988 | 1828 | 43797 | 1553 | 21794 |
| 4L-3S | | MI | 14083 | 4471 | 20569 | 3704 | 23971 | 3013 | 25278 | 2511 | 25827 | 1764 | 30783 | 1547 | 14769 |
| 10-#11 | 1.06 | MA | 18989 | 4471 | 26912 | 3814 | 31890 | 3104 | 33570 | 2589 | 33839 | 1835 | 41016 | 1506 | 21566 |
| 5L-2S | | MI | 14822 | 4471 | 21512 | 3705 | 25166 | 3016 | 26726 | 2506 | 27741 | 1758 | 33312 | 1638 | 14748 |
| 10-#14 | 1.53 | MA | 23171 | 4722 | 33708 | 3944 | 40425 | 3199 | 43878 | 2636 | 47738 | 1807 | 59077 | 1698 | 31185 |
| 2L-5S | | MI | 13246 | 4722 | 20242 | 3853 | 23448 | 3117 | 24588 | 2573 | 24873 | 1733 | 30071 | 1249 | 19876 |
| 10-#14 | 1.53 | MA | 21579 | 4722 | 31647 | 3946 | 37812 | 3198 | 40713 | 2649 | 43467 | 1816 | 53298 | 1566 | 31078 |
| 3L-4S | | MI | 13939 | 4722 | 21266 | 3841 | 24676 | 3122 | 26083 | 2566 | 26838 | 1725 | 32565 | 1310 | 20689 |
| 10-#14 | 1.53 | MA | 20430 | 4722 | 30119 | 3948 | 35746 | 3213 | 38209 | 2647 | 40087 | 1810 | 49485 | 1435 | 30761 |
| 4L-3S | | MI | 14700 | 4722 | 22275 | 3843 | 26039 | 3112 | 27731 | 2573 | 28993 | 1733 | 34905 | 1440 | 20809 |
| 10-#14 | 1.53 | MA | 19390 | 4722 | 28574 | 3964 | 33892 | 3213 | 35945 | 2660 | 37005 | 1820 | 45517 | 1367 | 29378 |
| 5L-2S | | MI | 15735 | 4722 | 23619 | 3845 | 27744 | 3117 | 29794 | 2566 | 31707 | 1725 | 38481 | 1572 | 20830 |
| 10-#18 | 2.72 | MA | 26659 | 5358 | 41671 | 4320 | 50327 | 3471 | 55788 | 2805 | 63747 | 1765 | 80122 | 1590 | 54214 |
| 2L-5S | | MI | 13697 | 5358 | 22888 | 4217 | 26608 | 3372 | 28237 | 2722 | 29635 | 1648 | 36627 | 817 | 31729 |
| 10-#18 | 2.72 | MA | 23995 | 5358 | 38060 | 4321 | 45747 | 3469 | 50239 | 2826 | 56261 | 1779 | 70109 | 1357 | 53671 |
| 3L-4S | | MI | 14857 | 5358 | 24676 | 4198 | 28755 | 3384 | 30806 | 2709 | 33126 | 1661 | 40885 | 926 | 33417 |
| 10-#18 | 2.72 | MA | 22072 | 5358 | 35374 | 4322 | 42116 | 3493 | 45839 | 2820 | 50323 | 1766 | 63515 | 1123 | 50670 |
| 4L-3S | | MI | 16131 | 5358 | 26439 | 4204 | 31135 | 3370 | 33639 | 2722 | 36715 | 1648 | 44893 | 1153 | 35448 |
| 10-#18 | 2.72 | MA | 20331 | 5358 | 32657 | 4350 | 38855 | 3491 | 41859 | 2841 | 44904 | 1780 | 56614 | 1006 | 47509 |
| 5L-2S | | MI | 17860 | 5358 | 28778 | 4211 | 34101 | 3381 | 37183 | 2709 | 41379 | 1635 | 50998 | 1386 | 35725 |
| 12-#11 | 1.27 | MA | 22392 | 4584 | 31931 | 3870 | 38273 | 3145 | 41314 | 2604 | 44309 | 1819 | 54593 | 1725 | 26176 |
| 2L-6S | | MI | 13036 | 4584 | 19454 | 3781 | 22506 | 3077 | 23491 | 2540 | 23504 | 1761 | 28131 | 1317 | 16896 |
| 12-#11 | 1.27 | MA | 21268 | 4584 | 30493 | 3871 | 36448 | 3145 | 39104 | 2614 | 41327 | 1826 | 50535 | 1633 | 26135 |
| 3L-5S | | MI | 13506 | 4584 | 20091 | 3783 | 23354 | 3069 | 24523 | 2545 | 24836 | 1755 | 29895 | 1393 | 17440 |
| 12-#11 | 1.27 | MA | 20457 | 4584 | 29427 | 3873 | 35007 | 3156 | 37358 | 2613 | 38970 | 1823 | 47855 | 1542 | 26016 |
| 4E | | MI | 13995 | 4584 | 20806 | 3773 | 24212 | 3072 | 25571 | 2539 | 26222 | 1750 | 31656 | 1435 | 17540 |
| 12-#11 | 1.27 | MA | 19724 | 4584 | 28350 | 3885 | 33715 | 3156 | 35780 | 2622 | 36821 | 1830 | 45074 | 1495 | 25762 |
| 5L-3S | | MI | 14533 | 4584 | 21512 | 3775 | 25166 | 3065 | 26726 | 2544 | 27741 | 1755 | 33312 | 1526 | 17570 |
| 12-#11 | 1.27 | MA | 19022 | 4584 | 27394 | 3886 | 32440 | 3167 | 34227 | 2621 | 34756 | 1837 | 42240 | 1420 | 24797 |
| 6L-2S | | MI | 15266 | 4584 | 22454 | 3776 | 26361 | 3068 | 28174 | 2538 | 29655 | 1750 | 35841 | 1617 | 17564 |
| 12-#14 | 1.83 | MA | 24145 | 4885 | 35768 | 4047 | 43038 | 3273 | 47044 | 2683 | 52009 | 1799 | 64855 | 1681 | 37278 |
| 2L-6S | | MI | 13229 | 4885 | 20676 | 3953 | 23940 | 3202 | 25177 | 2613 | 25697 | 1727 | 31152 | 1107 | 22988 |
| 12-#14 | 1.83 | MA | 22574 | 4885 | 33708 | 4048 | 40425 | 3273 | 43878 | 2696 | 47738 | 1808 | 59077 | 1549 | 37133 |
| 3L-5S | | MI | 13886 | 4885 | 21587 | 3956 | 25153 | 3192 | 26651 | 2620 | 27587 | 1720 | 33647 | 1217 | 23662 |
| 12-#14 | 1.83 | MA | 21441 | 4885 | 32180 | 4050 | 38359 | 3288 | 41374 | 2695 | 44358 | 1803 | 55263 | 1418 | 36773 |
| 4E | | MI | 14571 | 4885 | 22610 | 3943 | 26381 | 3197 | 28146 | 2613 | 29552 | 1712 | 36141 | 1278 | 24611 |
| 12-#14 | 1.83 | MA | 20416 | 4885 | 30634 | 4067 | 36505 | 3288 | 39110 | 2708 | 41276 | 1812 | 51295 | 1350 | 35252 |
| 5L-3S | | MI | 15323 | 4885 | 23619 | 3945 | 27744 | 3187 | 29794 | 2620 | 31707 | 1720 | 38481 | 1408 | 24769 |
| 12-#14 | 1.83 | MA | 19434 | 4885 | 29263 | 4068 | 34675 | 3303 | 36883 | 2706 | 38313 | 1822 | 47260 | 1242 | 33980 |
| 6L-2S | | MI | 16346 | 4885 | 24964 | 3948 | 29449 | 3192 | 31857 | 2613 | 34421 | 1712 | 42057 | 1540 | 24822 |
| 12-#18 | 3.26 | MA | 25632 | 5648 | 41671 | 4503 | 50327 | 3602 | 55788 | 2910 | 63747 | 1766 | 80122 | 1321 | 64211 |
| 3L-5S | | MI | 14759 | 5648 | 25227 | 4399 | 29575 | 3505 | 31781 | 2803 | 34298 | 1620 | 42733 | 751 | 38168 |
| 12-#18 | 3.26 | MA | 23749 | 5648 | 38986 | 4504 | 46697 | 3626 | 51388 | 2904 | 57809 | 1753 | 73528 | 1087 | 60881 |
| 4E | | MI | 15898 | 5648 | 27016 | 4379 | 31722 | 3517 | 34350 | 2790 | 37789 | 1634 | 46990 | 861 | 39922 |
| 12-#18 | 3.26 | MA | 22045 | 5648 | 36268 | 4532 | 43435 | 3624 | 47408 | 2925 | 52391 | 1767 | 66627 | 970 | 57860 |
| 5L-3S | | MI | 17150 | 5648 | 28778 | 4386 | 34101 | 3503 | 37183 | 2803 | 41379 | 1620 | 50998 | 1087 | 42252 |

## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

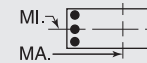
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 3.26 | MA | 20411 | 5648 | 33854 | 4534 | 40217 | 3649 | 43490 | 2919 | 47179 | 1781 | 59637 | 777 | 53382 |
| 6L-2S | | MI | 18850 | 5648 | 31117 | 4392 | 37068 | 3514 | 40727 | 2790 | 46042 | 1607 | 57103 | 1321 | 42609 |
| 14-#11 | 1.48 | MA | 23089 | 4698 | 33370 | 3941 | 40097 | 3197 | 43524 | 2637 | 47291 | 1814 | 58651 | 1714 | 30437 |
| 2L-7S | | MI | 13038 | 4698 | 19776 | 3851 | 22881 | 3126 | 23938 | 2579 | 24065 | 1747 | 29097 | 1225 | 19238 |
| 14-#11 | 1.48 | MA | 21975 | 4698 | 31931 | 3942 | 38273 | 3197 | 41314 | 2646 | 44309 | 1821 | 54593 | 1623 | 30377 |
| 3L-6S | | MI | 13494 | 4698 | 20396 | 3852 | 23701 | 3128 | 24939 | 2573 | 25417 | 1752 | 30660 | 1296 | 19581 |
| 14-#11 | 1.48 | MA | 21173 | 4698 | 30866 | 3944 | 36832 | 3208 | 39568 | 2646 | 41952 | 1817 | 51913 | 1532 | 30236 |
| 4L-5S | | MI | 13960 | 4698 | 21033 | 3853 | 24549 | 3121 | 25971 | 2578 | 26750 | 1747 | 32424 | 1372 | 20097 |
| 14-#11 | 1.48 | MA | 20449 | 4698 | 29788 | 3955 | 35539 | 3208 | 37990 | 2655 | 39803 | 1825 | 49131 | 1484 | 29896 |
| 5L-4S | | MI | 14445 | 4698 | 21748 | 3844 | 25407 | 3124 | 27019 | 2572 | 28136 | 1742 | 34185 | 1415 | 20312 |
| 14-#11 | 1.48 | MA | 19754 | 4698 | 28833 | 3957 | 34264 | 3219 | 36437 | 2654 | 37738 | 1832 | 46298 | 1409 | 28931 |
| 6L-3S | | MI | 14978 | 4698 | 22454 | 3845 | 26361 | 3117 | 28174 | 2577 | 29655 | 1747 | 35841 | 1506 | 20360 |
| 14-#11 | 1.48 | MA | 19073 | 4698 | 27902 | 3958 | 33032 | 3219 | 34932 | 2664 | 35644 | 1828 | 43772 | 1339 | 28263 |
| 7L-2S | | MI | 15704 | 4698 | 23396 | 3847 | 27556 | 3119 | 29622 | 2571 | 31568 | 1742 | 38369 | 1597 | 20371 |
| 14-#14 | 2.14 | MA | 25102 | 5049 | 37828 | 4149 | 45651 | 3348 | 50209 | 2731 | 56280 | 1792 | 70634 | 1664 | 43363 |
| 2L-7S | | MI | 13232 | 5049 | 21132 | 4053 | 24471 | 3271 | 25810 | 2667 | 26493 | 1707 | 32518 | 973 | 25609 |
| 14-#14 | 2.14 | MA | 23550 | 5049 | 35768 | 4151 | 43038 | 3348 | 47044 | 2744 | 52009 | 1801 | 64855 | 1532 | 43183 |
| 3L-6S | | MI | 13867 | 5049 | 22020 | 4055 | 25645 | 3276 | 27240 | 2660 | 28411 | 1714 | 34728 | 1076 | 26820 |
| 14-#14 | 2.14 | MA | 22433 | 5049 | 34240 | 4152 | 40972 | 3363 | 44540 | 2742 | 48629 | 1795 | 61042 | 1401 | 42784 |
| 4L-5S | | MI | 14516 | 5049 | 22932 | 4058 | 26858 | 3267 | 28714 | 2667 | 30301 | 1707 | 37223 | 1185 | 27464 |
| 14-#14 | 2.14 | MA | 21423 | 5049 | 32695 | 4169 | 39118 | 3363 | 42276 | 2755 | 45547 | 1805 | 57074 | 1333 | 41142 |
| 5L-4S | | MI | 15191 | 5049 | 23955 | 4045 | 28087 | 3272 | 30209 | 2660 | 32266 | 1699 | 39716 | 1246 | 28528 |
| 14-#14 | 2.14 | MA | 20455 | 5049 | 31323 | 4171 | 37288 | 3378 | 40049 | 2753 | 42584 | 1814 | 53039 | 1225 | 39912 |
| 6L-3S | | MI | 15934 | 5049 | 24964 | 4047 | 29449 | 3262 | 31857 | 2667 | 34421 | 1707 | 42057 | 1377 | 28721 |
| 14-#14 | 2.14 | MA | 19507 | 5049 | 29988 | 4172 | 35521 | 3377 | 37889 | 2766 | 39580 | 1809 | 49446 | 1123 | 37974 |
| 7L-2S | | MI | 16946 | 5049 | 26309 | 4050 | 31155 | 3267 | 33920 | 2660 | 37135 | 1699 | 45633 | 1508 | 28801 |
| 14-#18 | 3.80 | MA | 25387 | 5939 | 42597 | 4686 | 51277 | 3759 | 56937 | 2988 | 65296 | 1740 | 83541 | 1051 | 71126 |
| 4L-5S | | MI | 15799 | 5939 | 27566 | 4581 | 32542 | 3638 | 35325 | 2883 | 38962 | 1593 | 48838 | 686 | 44548 |
| 14-#18 | 3.80 | MA | 23718 | 5939 | 39880 | 4714 | 48016 | 3757 | 52957 | 3009 | 59877 | 1754 | 76640 | 934 | 68231 |
| 5L-4S | | MI | 16918 | 5939 | 29355 | 4561 | 34689 | 3650 | 37895 | 2870 | 42453 | 1606 | 53096 | 795 | 46462 |
| 14-#18 | 3.80 | MA | 22117 | 5939 | 37466 | 4715 | 44797 | 3782 | 49039 | 3003 | 54666 | 1767 | 69650 | 741 | 63641 |
| 6L-3S | | MI | 18149 | 5939 | 31117 | 4568 | 37068 | 3636 | 40727 | 2883 | 46042 | 1593 | 57103 | 1021 | 49049 |
| 14-#18 | 3.80 | MA | 20548 | 5939 | 35115 | 4717 | 41687 | 3779 | 45240 | 3024 | 49382 | 1755 | 63433 | 559 | 58962 |
| 7L-2S | | MI | 19823 | 5939 | 33457 | 4574 | 40035 | 3647 | 44272 | 2870 | 50705 | 1579 | 63209 | 1255 | 49477 |
| 16-#11 | 1.70 | MA | 23776 | 4811 | 34808 | 4012 | 41921 | 3249 | 45735 | 2670 | 50273 | 1808 | 62708 | 1703 | 34693 |
| 2L-8S | | MI | 13049 | 4811 | 20107 | 3921 | 23272 | 3175 | 24382 | 2607 | 24675 | 1744 | 29983 | 1155 | 21227 |
| 16-#11 | 1.70 | MA | 22673 | 4811 | 33370 | 4013 | 40097 | 3249 | 43524 | 2679 | 47291 | 1816 | 58651 | 1612 | 34615 |
| 3L-7S | | MI | 13495 | 4811 | 20718 | 3922 | 24076 | 3177 | 25386 | 2612 | 25979 | 1739 | 31626 | 1205 | 21899 |
| 16-#11 | 1.70 | MA | 21879 | 4811 | 32304 | 4015 | 38656 | 3260 | 41778 | 2678 | 44934 | 1812 | 55970 | 1521 | 34453 |
| 4L-6S | | MI | 13947 | 4811 | 21339 | 3923 | 24896 | 3180 | 26387 | 2606 | 27331 | 1744 | 33189 | 1276 | 22273 |
| 16-#11 | 1.70 | MA | 21162 | 4811 | 31227 | 4026 | 37363 | 3260 | 40200 | 2688 | 42785 | 1819 | 53189 | 1474 | 34002 |
| 5E | | MI | 14408 | 4811 | 21975 | 3924 | 25744 | 3173 | 27419 | 2611 | 28663 | 1739 | 34953 | 1352 | 22764 |
| 16-#11 | 1.70 | MA | 20475 | 4811 | 30271 | 4028 | 36088 | 3271 | 38648 | 2687 | 40720 | 1826 | 50355 | 1399 | 33071 |
| 6L-4S | | MI | 14888 | 4811 | 22691 | 3915 | 26603 | 3176 | 28467 | 2605 | 30049 | 1734 | 36714 | 1394 | 23078 |
| 16-#11 | 1.70 | MA | 19802 | 4811 | 29341 | 4029 | 34857 | 3271 | 37143 | 2696 | 38626 | 1823 | 47830 | 1328 | 32419 |
| 7L-3S | | MI | 15416 | 4811 | 23396 | 3916 | 27556 | 3168 | 29622 | 2610 | 31568 | 1739 | 38369 | 1485 | 23143 |
| 16-#11 | 1.70 | MA | 19137 | 4811 | 28425 | 4031 | 33650 | 3271 | 35635 | 2696 | 36606 | 1830 | 45232 | 1274 | 31248 |
| 8L-2S | | MI | 16137 | 4811 | 24339 | 3917 | 28751 | 3171 | 31070 | 2604 | 33482 | 1734 | 40898 | 1577 | 23168 |
| 16-#14 | 2.45 | MA | 24510 | 5212 | 37828 | 4253 | 45651 | 3423 | 50209 | 2791 | 56280 | 1794 | 70634 | 1515 | 49230 |
| 3L-7S | | MI | 13866 | 5212 | 22477 | 4155 | 26177 | 3346 | 27873 | 2715 | 29207 | 1694 | 36093 | 941 | 29382 |
| 16-#14 | 2.45 | MA | 23408 | 5212 | 36300 | 4255 | 43585 | 3438 | 47705 | 2789 | 52900 | 1788 | 66821 | 1384 | 48796 |
| 4L-6S | | MI | 14494 | 5212 | 23365 | 4158 | 27350 | 3351 | 29303 | 2707 | 31125 | 1701 | 38304 | 1044 | 30571 |
| 16-#14 | 2.45 | MA | 22412 | 5212 | 34755 | 4271 | 41730 | 3438 | 45442 | 2802 | 49818 | 1797 | 62853 | 1316 | 47045 |
| 5E | | MI | 15135 | 5212 | 24276 | 4160 | 28564 | 3341 | 30777 | 2715 | 33015 | 1694 | 40799 | 1153 | 31279 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis

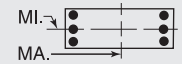



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.45 | MA | 21458 | 5212 | 33383 | 4273 | 39901 | 3452 | 43214 | 2800 | 46855 | 1807 | 58818 | 1208 | 45853 |
| 6L-4S | | MI | 15803 | 5212 | 25300 | 4147 | 29792 | 3346 | 32272 | 2707 | 34980 | 1686 | 43292 | 1214 | 32399 |
| 16-#14 | 2.45 | MA | 20523 | 5212 | 32048 | 4275 | 38133 | 3452 | 41055 | 2813 | 43851 | 1801 | 55224 | 1106 | 43854 |
| 7L-3S | | MI | 16537 | 5212 | 26309 | 4150 | 31155 | 3336 | 33920 | 2715 | 37135 | 1694 | 45633 | 1345 | 32665 |
| 16-#14 | 2.45 | MA | 19599 | 5212 | 30734 | 4276 | 36402 | 3452 | 38891 | 2811 | 40953 | 1811 | 51518 | 1028 | 41988 |
| 8L-2S | | MI | 17539 | 5212 | 27653 | 4152 | 32860 | 3341 | 35984 | 2707 | 39849 | 1686 | 49209 | 1476 | 32771 |
| 16-#18 | 4.35 | MA | 25355 | 6230 | 43491 | 4896 | 52596 | 3890 | 58506 | 3093 | 67363 | 1740 | 86653 | 898 | 78496 |
| 5E | | MI | 16820 | 6230 | 29905 | 4763 | 35509 | 3771 | 38870 | 2964 | 43625 | 1565 | 54943 | 620 | 50961 |
| 16-#18 | 4.35 | MA | 23786 | 6230 | 41077 | 4897 | 49377 | 3915 | 54588 | 3088 | 62152 | 1754 | 79663 | 705 | 73921 |
| 6L-4S | | MI | 17921 | 6230 | 31694 | 4743 | 37656 | 3783 | 41439 | 2950 | 47116 | 1578 | 59201 | 729 | 53030 |
| 16-#18 | 4.35 | MA | 22248 | 6230 | 38727 | 4898 | 46267 | 3912 | 50789 | 3109 | 56869 | 1741 | 73446 | 523 | 69182 |
| 7L-3S | | MI | 19132 | 6230 | 33457 | 4749 | 40035 | 3769 | 44272 | 2964 | 50705 | 1565 | 63209 | 956 | 55840 |
| 16-#18 | 4.35 | MA | 20726 | 6230 | 36413 | 4900 | 43220 | 3910 | 46982 | 3103 | 51770 | 1755 | 67003 | 388 | 64380 |
| 8L-2S | | MI | 20782 | 6230 | 35796 | 4756 | 43002 | 3780 | 47816 | 2950 | 55369 | 1552 | 69314 | 1189 | 56334 |
| 18-#11 | 1.91 | MA | 23361 | 4924 | 34808 | 4084 | 41921 | 3301 | 45735 | 2712 | 50273 | 1810 | 62708 | 1601 | 38850 |
| 3L-8S | | MI | 13504 | 4924 | 21050 | 3992 | 24467 | 3226 | 25830 | 2640 | 26589 | 1736 | 32512 | 1135 | 23890 |
| 18-#11 | 1.91 | MA | 22575 | 4924 | 33743 | 4085 | 40480 | 3312 | 43988 | 2711 | 47915 | 1807 | 60028 | 1510 | 38669 |
| 4L-7S | | MI | 13946 | 4924 | 21661 | 3993 | 25271 | 3229 | 26834 | 2645 | 27893 | 1731 | 34155 | 1184 | 24539 |
| 18-#11 | 1.91 | MA | 21865 | 4924 | 32665 | 4097 | 39188 | 3312 | 42410 | 2721 | 45767 | 1814 | 57247 | 1463 | 38118 |
| 5L-6S | | MI | 14394 | 4924 | 22281 | 3994 | 26091 | 3232 | 27835 | 2639 | 29244 | 1736 | 35717 | 1256 | 24970 |
| 18-#11 | 1.91 | MA | 21186 | 4924 | 31710 | 4099 | 37913 | 3322 | 40858 | 2720 | 43702 | 1821 | 54413 | 1388 | 37218 |
| 6L-5S | | MI | 14850 | 4924 | 22918 | 3995 | 26939 | 3225 | 28867 | 2644 | 30577 | 1731 | 37482 | 1332 | 25439 |
| 18-#11 | 1.91 | MA | 20520 | 4924 | 30779 | 4100 | 36681 | 3323 | 39353 | 2729 | 41608 | 1818 | 51888 | 1317 | 36542 |
| 7L-4S | | MI | 15326 | 4924 | 23633 | 3986 | 27798 | 3228 | 29915 | 2638 | 31963 | 1726 | 39243 | 1374 | 25840 |
| 18-#11 | 1.91 | MA | 19862 | 4924 | 29864 | 4102 | 35474 | 3323 | 37845 | 2728 | 39588 | 1825 | 49290 | 1263 | 35370 |
| 8L-3S | | MI | 15850 | 4924 | 24339 | 3987 | 28751 | 3220 | 31070 | 2643 | 33482 | 1731 | 40898 | 1465 | 25921 |
| 18-#11 | 1.91 | MA | 19209 | 4924 | 28852 | 4114 | 34231 | 3334 | 36362 | 2738 | 37589 | 1832 | 46715 | 1204 | 34310 |
| 9L-2S | | MI | 16565 | 4924 | 25281 | 3988 | 29946 | 3223 | 32518 | 2637 | 35395 | 1726 | 43427 | 1556 | 25959 |
| 18-#14 | 2.75 | MA | 24367 | 5376 | 38360 | 4357 | 46198 | 3513 | 50871 | 2837 | 57171 | 1781 | 72599 | 1367 | 54808 |
| 4L-7S | | MI | 14492 | 5376 | 23822 | 4258 | 27882 | 3421 | 29936 | 2762 | 31921 | 1681 | 39669 | 909 | 33165 |
| 18-#14 | 2.75 | MA | 23385 | 5376 | 36815 | 4373 | 44343 | 3512 | 48607 | 2850 | 54088 | 1790 | 68631 | 1299 | 52959 |
| 5L-6S | | MI | 15112 | 5376 | 24710 | 4260 | 29056 | 3426 | 31366 | 2754 | 33839 | 1688 | 41880 | 1012 | 34310 |
| 18-#14 | 2.75 | MA | 22443 | 5376 | 35443 | 4375 | 42514 | 3527 | 46380 | 2848 | 51125 | 1799 | 64596 | 1191 | 51801 |
| 6L-5S | | MI | 15745 | 5376 | 25621 | 4262 | 30269 | 3416 | 32840 | 2762 | 35729 | 1681 | 44375 | 1121 | 35103 |
| 18-#14 | 2.75 | MA | 21522 | 5376 | 34108 | 4377 | 40746 | 3527 | 44220 | 2861 | 48122 | 1794 | 61003 | 1089 | 49744 |
| 7L-4S | | MI | 16405 | 5376 | 26644 | 4250 | 31497 | 3421 | 34335 | 2754 | 37694 | 1673 | 46868 | 1182 | 36168 |
| 18-#14 | 2.75 | MA | 20610 | 5376 | 32794 | 4378 | 39015 | 3527 | 42057 | 2859 | 45224 | 1803 | 57297 | 1011 | 47770 |
| 8L-3S | | MI | 17132 | 5376 | 27653 | 4252 | 32860 | 3411 | 35984 | 2762 | 39849 | 1681 | 49209 | 1313 | 36604 |
| 18-#14 | 2.75 | MA | 19704 | 5376 | 31342 | 4395 | 37230 | 3542 | 39929 | 2872 | 42354 | 1813 | 53632 | 927 | 45719 |
| 9L-2S | | MI | 18123 | 5376 | 28998 | 4254 | 34566 | 3416 | 38047 | 2754 | 42563 | 1673 | 52784 | 1444 | 36734 |
| 18-#18 | 4.89 | MA | 25421 | 6521 | 44689 | 5079 | 53957 | 4048 | 60137 | 3172 | 69638 | 1741 | 89676 | 669 | 84220 |
| 6L-5S | | MI | 17903 | 6521 | 32245 | 4944 | 38475 | 3904 | 42414 | 3044 | 48288 | 1537 | 61049 | 554 | 57403 |
| 18-#18 | 4.89 | MA | 23912 | 6521 | 42338 | 5080 | 50847 | 4045 | 56337 | 3193 | 64355 | 1728 | 83460 | 487 | 79418 |
| 7L-4S | | MI | 18969 | 6521 | 34033 | 4924 | 40622 | 3916 | 44983 | 3031 | 51779 | 1550 | 65307 | 664 | 59622 |
| 18-#18 | 4.89 | MA | 22419 | 6521 | 40025 | 5082 | 47800 | 4043 | 52531 | 3187 | 59257 | 1742 | 77016 | 352 | 74576 |
| 8L-3S | | MI | 20133 | 6521 | 35796 | 4931 | 43002 | 3902 | 47816 | 3044 | 55369 | 1537 | 69314 | 890 | 62627 |
| 20-#11 | 2.12 | MA | 23262 | 5038 | 35181 | 4156 | 42305 | 3363 | 46198 | 2744 | 50897 | 1802 | 64086 | 1500 | 42883 |
| 4L-8S | | MI | 13954 | 5038 | 21992 | 4063 | 25662 | 3278 | 27278 | 2673 | 28502 | 1728 | 35040 | 1114 | 26559 |
| 20-#11 | 2.12 | MA | 22560 | 5038 | 34104 | 4168 | 41012 | 3364 | 44621 | 2754 | 48749 | 1809 | 61304 | 1452 | 42242 |
| 5L-7S | | MI | 14392 | 5038 | 22603 | 4064 | 26466 | 3281 | 28281 | 2678 | 29806 | 1723 | 36684 | 1164 | 27186 |
| 20-#11 | 2.12 | MA | 21887 | 5038 | 33148 | 4170 | 39737 | 3374 | 43068 | 2753 | 46683 | 1816 | 58471 | 1377 | 41370 |
| 6E | | MI | 14835 | 5038 | 23223 | 4065 | 27286 | 3284 | 29283 | 2672 | 31158 | 1728 | 38246 | 1235 | 27671 |
| 20-#11 | 2.12 | MA | 21229 | 5038 | 32218 | 4171 | 38505 | 3375 | 41563 | 2762 | 44590 | 1813 | 55946 | 1307 | 40642 |
| 7L-5S | | MI | 15288 | 5038 | 23860 | 4066 | 28134 | 3277 | 30315 | 2676 | 32490 | 1723 | 40011 | 1311 | 28121 |
| 20-#11 | 2.12 | MA | 20578 | 5038 | 31302 | 4173 | 37299 | 3375 | 40055 | 2761 | 42570 | 1820 | 53347 | 1252 | 39498 |
| 8L-4S | | MI | 15759 | 5038 | 24575 | 4057 | 28993 | 3280 | 31363 | 2671 | 33876 | 1718 | 41772 | 1353 | 28599 |
| 20-#11 | 2.12 | MA | 19931 | 5038 | 30291 | 4184 | 36055 | 3386 | 38572 | 2771 | 40571 | 1827 | 50773 | 1194 | 38408 |
| 9L-3S | | MI | 16279 | 5038 | 25281 | 4058 | 29946 | 3272 | 32518 | 2675 | 35395 | 1723 | 43427 | 1445 | 28695 |

## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

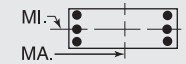
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.12 | MA | 19287 | 5038 | 29379 | 4186 | 34857 | 3386 | 37082 | 2770 | 38514 | 1824 | 48112 | 1114 | 37119 |
| 10L-2S | | MI | 16988 | 5038 | 26223 | 4059 | 31141 | 3275 | 33966 | 2670 | 37309 | 1718 | 45956 | 1536 | 28745 |
| 20-#14 | 3.06 | MA | 24343 | 5539 | 38875 | 4476 | 46956 | 3587 | 51773 | 2897 | 58359 | 1782 | 74410 | 1282 | 58882 |
| 5L-7S | | MI | 15108 | 5539 | 25166 | 4360 | 29588 | 3496 | 31999 | 2809 | 34635 | 1668 | 43245 | 878 | 36957 |
| 20-#14 | 3.06 | MA | 23414 | 5539 | 37504 | 4477 | 45127 | 3602 | 49545 | 2895 | 55396 | 1792 | 70375 | 1174 | 57678 |
| 6E | | MI | 15721 | 5539 | 26054 | 4362 | 30761 | 3501 | 33429 | 2802 | 36553 | 1675 | 45456 | 980 | 38061 |
| 20-#14 | 3.06 | MA | 22504 | 5539 | 36168 | 4479 | 43359 | 3602 | 47386 | 2908 | 52393 | 1786 | 66782 | 1072 | 55642 |
| 7L-5S | | MI | 16348 | 5539 | 26966 | 4364 | 31975 | 3491 | 34903 | 2809 | 38443 | 1668 | 47950 | 1090 | 38935 |
| 20-#14 | 3.06 | MA | 21605 | 5539 | 34854 | 4481 | 41628 | 3602 | 45223 | 2906 | 49495 | 1796 | 63075 | 994 | 53630 |
| 8L-4S | | MI | 17000 | 5539 | 27989 | 4352 | 33203 | 3496 | 36398 | 2802 | 40408 | 1660 | 50444 | 1150 | 39951 |
| 20-#14 | 3.06 | MA | 20711 | 5539 | 33403 | 4497 | 39843 | 3617 | 43094 | 2919 | 46625 | 1805 | 59411 | 910 | 51610 |
| 9L-3S | | MI | 17719 | 5539 | 28998 | 4354 | 34566 | 3486 | 38047 | 2809 | 42563 | 1668 | 52784 | 1281 | 40539 |
| 20-#14 | 3.06 | MA | 19815 | 5539 | 32094 | 4499 | 38124 | 3616 | 40956 | 2917 | 43675 | 1800 | 55622 | 794 | 49118 |
| 10L-2S | | MI | 18701 | 5539 | 30343 | 4357 | 36271 | 3491 | 40110 | 2802 | 45277 | 1660 | 56360 | 1412 | 40691 |
| 20-#18 | 5.43 | MA | 25546 | 6812 | 45950 | 5262 | 55428 | 4178 | 61886 | 3277 | 71841 | 1715 | 93473 | 451 | 89671 |
| 7L-5S | | MI | 18884 | 6812 | 34584 | 5126 | 41442 | 4037 | 45958 | 3124 | 52952 | 1510 | 67154 | 489 | 63871 |
| 20-#18 | 5.43 | MA | 24080 | 6812 | 43636 | 5263 | 52380 | 4176 | 58080 | 3271 | 66743 | 1728 | 87029 | 316 | 84787 |
| 8L-4S | | MI | 19927 | 6812 | 36373 | 5106 | 43589 | 4049 | 48528 | 3111 | 56443 | 1523 | 71412 | 598 | 66234 |
| 22-#11 | 2.33 | MA | 23246 | 5151 | 35542 | 4239 | 42836 | 3416 | 46831 | 2786 | 51731 | 1804 | 65362 | 1442 | 46373 |
| 5L-8S | | MI | 14398 | 5151 | 22934 | 4134 | 26857 | 3330 | 28726 | 2706 | 30416 | 1720 | 37569 | 1094 | 29233 |
| 22-#11 | 2.33 | MA | 22580 | 5151 | 34586 | 4240 | 41561 | 3426 | 45278 | 2786 | 49665 | 1811 | 62528 | 1367 | 45526 |
| 6L-7S | | MI | 14832 | 5151 | 23545 | 4135 | 27661 | 3333 | 29729 | 2710 | 31720 | 1715 | 39212 | 1143 | 29840 |
| 22-#11 | 2.33 | MA | 21928 | 5151 | 33656 | 4242 | 40330 | 3427 | 43773 | 2795 | 47572 | 1808 | 60003 | 1296 | 44749 |
| 7L-6S | | MI | 15271 | 5151 | 24166 | 4136 | 28481 | 3336 | 30731 | 2705 | 33071 | 1720 | 40775 | 1215 | 30376 |
| 22-#11 | 2.33 | MA | 21284 | 5151 | 32741 | 4243 | 39123 | 3427 | 42266 | 2794 | 45552 | 1815 | 57405 | 1242 | 43630 |
| 8L-5S | | MI | 15720 | 5151 | 24802 | 4137 | 29329 | 3329 | 31763 | 2709 | 34404 | 1715 | 42540 | 1291 | 30809 |
| 22-#11 | 2.33 | MA | 20644 | 5151 | 31729 | 4255 | 37880 | 3437 | 40783 | 2804 | 43552 | 1822 | 54830 | 1183 | 42512 |
| 9L-4S | | MI | 16188 | 5151 | 25518 | 4128 | 30188 | 3331 | 32810 | 2704 | 35790 | 1709 | 44301 | 1333 | 31355 |
| 22-#11 | 2.33 | MA | 20003 | 5151 | 30817 | 4257 | 36681 | 3438 | 39292 | 2803 | 41496 | 1819 | 52169 | 1103 | 41246 |
| 10L-3S | | MI | 16703 | 5151 | 26223 | 4129 | 31141 | 3324 | 33966 | 2708 | 37309 | 1715 | 45956 | 1424 | 31466 |
| 22-#11 | 2.33 | MA | 19320 | 5151 | 29912 | 4258 | 35452 | 3448 | 37819 | 2812 | 39505 | 1826 | 49616 | 1046 | 39795 |
| 11L-2S | | MI | 17407 | 5151 | 27166 | 4130 | 32336 | 3327 | 35413 | 2703 | 39222 | 1709 | 48485 | 1515 | 31528 |
| 22-#14 | 3.36 | MA | 24370 | 5703 | 39564 | 4580 | 47740 | 3677 | 52711 | 2943 | 59667 | 1784 | 76154 | 1157 | 63535 |
| 6L-7S | | MI | 15716 | 5703 | 26511 | 4462 | 31293 | 3571 | 34063 | 2856 | 37349 | 1655 | 46821 | 846 | 40758 |
| 22-#14 | 3.36 | MA | 23472 | 5703 | 38229 | 4581 | 45972 | 3677 | 50551 | 2956 | 56664 | 1779 | 72560 | 1055 | 61548 |
| 7L-6S | | MI | 16323 | 5703 | 27399 | 4464 | 32466 | 3576 | 35492 | 2849 | 39267 | 1662 | 49032 | 948 | 41823 |
| 22-#14 | 3.36 | MA | 22585 | 5703 | 36914 | 4583 | 44241 | 3677 | 48388 | 2954 | 53766 | 1788 | 68854 | 977 | 59498 |
| 8L-5S | | MI | 16942 | 5703 | 28310 | 4467 | 33680 | 3566 | 36966 | 2856 | 41157 | 1655 | 51526 | 1058 | 42774 |
| 22-#14 | 3.36 | MA | 21702 | 5703 | 35463 | 4600 | 42456 | 3691 | 46260 | 2967 | 50896 | 1798 | 65189 | 893 | 57452 |
| 9L-4S | | MI | 17588 | 5703 | 29334 | 4454 | 34908 | 3571 | 38461 | 2849 | 43122 | 1647 | 54020 | 1118 | 43745 |
| 22-#14 | 3.36 | MA | 20810 | 5703 | 34154 | 4601 | 40737 | 3691 | 44122 | 2965 | 47945 | 1792 | 61401 | 777 | 54998 |
| 10L-3S | | MI | 18299 | 5703 | 30343 | 4456 | 36271 | 3561 | 40110 | 2856 | 45277 | 1655 | 56360 | 1249 | 44470 |
| 22-#18 | 5.98 | MA | 25712 | 7102 | 47248 | 5445 | 56960 | 4309 | 63629 | 3356 | 74229 | 1715 | 97042 | 280 | 95011 |
| 8L-5S | | MI | 19848 | 7102 | 36923 | 5308 | 44409 | 4170 | 49503 | 3205 | 57615 | 1482 | 73260 | 423 | 70361 |
| 24-#11 | 2.54 | MA | 23264 | 5265 | 36025 | 4311 | 43386 | 3478 | 47488 | 2818 | 52647 | 1806 | 66586 | 1356 | 49687 |
| 6L-8S | | MI | 14837 | 5265 | 23877 | 4204 | 28052 | 3382 | 30174 | 2739 | 32329 | 1712 | 40098 | 1074 | 31911 |
| 24-#11 | 2.54 | MA | 22619 | 5265 | 35095 | 4313 | 42154 | 3478 | 45983 | 2828 | 50554 | 1802 | 64061 | 1285 | 48861 |
| 7E | | MI | 15268 | 5265 | 24488 | 4206 | 28856 | 3385 | 31177 | 2743 | 33633 | 1706 | 41741 | 1123 | 32500 |
| 24-#11 | 2.54 | MA | 21981 | 5265 | 34179 | 4314 | 40947 | 3479 | 44476 | 2827 | 48534 | 1810 | 61463 | 1231 | 47766 |
| 8L-6S | | MI | 15703 | 5265 | 25108 | 4207 | 29676 | 3388 | 32179 | 2738 | 34985 | 1712 | 43304 | 1194 | 33083 |
| 24-#11 | 2.54 | MA | 21348 | 5265 | 33168 | 4326 | 39704 | 3489 | 42993 | 2836 | 46534 | 1817 | 58888 | 1172 | 46619 |
| 9L-5S | | MI | 16148 | 5265 | 25745 | 4208 | 30524 | 3380 | 33211 | 2742 | 36318 | 1706 | 45069 | 1270 | 33502 |
| 24-#11 | 2.54 | MA | 20710 | 5265 | 32256 | 4328 | 38506 | 3490 | 41503 | 2836 | 44478 | 1813 | 56227 | 1092 | 45376 |
| 10L-4S | | MI | 16612 | 5265 | 26460 | 4199 | 31383 | 3383 | 34258 | 2737 | 37703 | 1701 | 46830 | 1313 | 34110 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.54 | MA | 20033 | 5265 | 31350 | 4329 | 37276 | 3500 | 40029 | 2845 | 42487 | 1820 | 53673 | 1035 | 43907 |
| 11L-3S | | MI | 17123 | 5265 | 27166 | 4200 | 32336 | 3376 | 35413 | 2741 | 39222 | 1706 | 48485 | 1404 | 34234 |
| 24-#11 | 2.54 | MA | 19349 | 5265 | 30450 | 4331 | 36082 | 3501 | 38547 | 2844 | 40505 | 1828 | 51119 | 977 | 42451 |
| 12L-2S | | MI | 17822 | 5265 | 28108 | 4201 | 33531 | 3379 | 36861 | 2735 | 41136 | 1701 | 51014 | 1495 | 34307 |
| 24-#14 | 3.67 | MA | 24427 | 5867 | 40289 | 4683 | 48585 | 3752 | 53717 | 3003 | 60934 | 1771 | 78339 | 1038 | 67460 |
| 7E | | MI | 16317 | 5867 | 27856 | 4564 | 32998 | 3646 | 36126 | 2903 | 40063 | 1642 | 50397 | 814 | 44565 |
| 24-#14 | 3.67 | MA | 23551 | 5867 | 38975 | 4685 | 46853 | 3751 | 51554 | 3001 | 58037 | 1781 | 74633 | 960 | 65372 |
| 8L-6S | | MI | 16917 | 5867 | 28744 | 4567 | 34172 | 3651 | 37555 | 2896 | 41981 | 1649 | 52607 | 916 | 45595 |
| 24-#14 | 3.67 | MA | 22679 | 5867 | 37523 | 4702 | 45069 | 3766 | 49425 | 3014 | 55167 | 1790 | 70968 | 876 | 63300 |
| 9L-5S | | MI | 17530 | 5867 | 29655 | 4569 | 35385 | 3641 | 39029 | 2903 | 43871 | 1642 | 55102 | 1026 | 46620 |
| 24-#14 | 3.67 | MA | 21791 | 5867 | 36214 | 4703 | 43349 | 3766 | 47287 | 3012 | 52216 | 1785 | 67179 | 760 | 60884 |
| 10L-4S | | MI | 18169 | 5867 | 30678 | 4556 | 36613 | 3646 | 40524 | 2896 | 45836 | 1634 | 57595 | 1086 | 47550 |

## RECTANGULAR TIED COLUMNS 32" x 48"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.04 | MA | 23443 | 4655 | 33194 | 3933 | 39451 | 3203 | 42195 | 2663 | 44414 | 1891 | 53938 | 1787 | 23256 |
| 2E | | MI | 15293 | 4655 | 22503 | 3809 | 26039 | 3101 | 27396 | 2568 | 28174 | 1795 | 33572 | 1658 | 14920 |
| 6-#18 | 1.56 | MA | 25272 | 4946 | 36988 | 4115 | 44262 | 3336 | 48023 | 2747 | 52277 | 1877 | 64512 | 1753 | 34512 |
| 2L-3S | | MI | 14566 | 4946 | 22503 | 3984 | 26039 | 3222 | 27396 | 2662 | 28174 | 1781 | 33572 | 1358 | 21860 |
| 6-#18 | 1.56 | MA | 22346 | 4946 | 33194 | 4117 | 39451 | 3335 | 42195 | 2769 | 44414 | 1893 | 53938 | 1520 | 34201 |
| 3L-2S | | MI | 16363 | 4946 | 24842 | 3991 | 29006 | 3234 | 30940 | 2649 | 32837 | 1767 | 39677 | 1592 | 21923 |
| 8-#14 | 1.17 | MA | 24012 | 4728 | 34039 | 4001 | 40731 | 3255 | 43836 | 2700 | 46690 | 1899 | 57301 | 1803 | 26294 |
| 2L-4S | | MI | 13840 | 4728 | 20655 | 3883 | 23806 | 3166 | 24867 | 2620 | 24913 | 1816 | 29885 | 1417 | 16814 |
| 8-#14 | 1.17 | MA | 22313 | 4728 | 31877 | 4003 | 37988 | 3255 | 40513 | 2713 | 42207 | 1909 | 51206 | 1671 | 26229 |
| 3E | | MI | 14613 | 4728 | 21665 | 3886 | 25169 | 3157 | 26515 | 2627 | 27067 | 1824 | 32225 | 1547 | 16873 |
| 8-#14 | 1.17 | MA | 21087 | 4728 | 30275 | 4005 | 35822 | 3270 | 37887 | 2712 | 38663 | 1905 | 47181 | 1540 | 25964 |
| 4L-2S | | MI | 15662 | 4728 | 23009 | 3888 | 26874 | 3162 | 28578 | 2620 | 29781 | 1816 | 35801 | 1679 | 16852 |
| 8-#18 | 2.08 | MA | 27042 | 5237 | 40781 | 4297 | 49073 | 3469 | 53851 | 2832 | 60140 | 1864 | 75086 | 1720 | 45725 |
| 2L-4S | | MI | 14335 | 5237 | 23080 | 4159 | 26626 | 3369 | 28108 | 2729 | 29248 | 1766 | 35669 | 1067 | 27206 |
| 8-#18 | 2.08 | MA | 24177 | 5237 | 36988 | 4299 | 44262 | 3468 | 48023 | 2854 | 52277 | 1879 | 64512 | 1486 | 45289 |
| 3E | | MI | 15639 | 5237 | 24842 | 4166 | 29006 | 3355 | 30940 | 2742 | 32837 | 1753 | 39677 | 1293 | 28705 |
| 8-#18 | 2.08 | MA | 22107 | 5237 | 34170 | 4301 | 40453 | 3493 | 43407 | 2849 | 46047 | 1868 | 57542 | 1253 | 42808 |
| 4L-2S | | MI | 17403 | 5237 | 27181 | 4172 | 31972 | 3367 | 34485 | 2729 | 37501 | 1740 | 45783 | 1526 | 28870 |
| 10-#11 | 1.02 | MA | 23489 | 4641 | 32824 | 3958 | 39295 | 3224 | 42143 | 2682 | 44438 | 1909 | 54373 | 1822 | 22961 |
| 2L-5S | | MI | 13589 | 4641 | 19879 | 3857 | 22993 | 3137 | 23923 | 2614 | 23713 | 1842 | 28265 | 1489 | 14747 |
| 10-#11 | 1.02 | MA | 22294 | 4640 | 31315 | 3960 | 37381 | 3225 | 39824 | 2692 | 41309 | 1917 | 50096 | 1731 | 22939 |
| 3L-4S | | MI | 14084 | 4641 | 20594 | 3848 | 23852 | 3140 | 24970 | 2608 | 25099 | 1837 | 30026 | 1531 | 14800 |
| 10-#11 | 1.02 | MA | 21433 | 4640 | 30198 | 3962 | 35871 | 3236 | 37993 | 2692 | 38838 | 1914 | 47269 | 1640 | 22847 |
| 4L-3S | | MI | 14628 | 4640 | 21300 | 3849 | 24805 | 3133 | 26126 | 2613 | 26618 | 1842 | 31681 | 1622 | 14800 |
| 10-#11 | 1.02 | MA | 20654 | 4641 | 29069 | 3974 | 34516 | 3236 | 36339 | 2702 | 36586 | 1922 | 44341 | 1592 | 22619 |
| 5L-2S | | MI | 15369 | 4641 | 22242 | 3850 | 26000 | 3136 | 27573 | 2607 | 28531 | 1837 | 34210 | 1713 | 14776 |
| 10-#14 | 1.46 | MA | 25063 | 4891 | 36202 | 4104 | 43473 | 3329 | 47158 | 2747 | 51173 | 1892 | 63395 | 1787 | 32703 |
| 2L-5S | | MI | 13790 | 4891 | 20977 | 3998 | 24283 | 3236 | 25435 | 2674 | 25661 | 1811 | 30967 | 1324 | 20027 |
| 10-#14 | 1.46 | MA | 23387 | 4891 | 34039 | 4106 | 40731 | 3330 | 43836 | 2761 | 46690 | 1902 | 57301 | 1656 | 32596 |
| 3L-4S | | MI | 14485 | 4891 | 22000 | 3986 | 25511 | 3241 | 26930 | 2667 | 27627 | 1803 | 33461 | 1385 | 20751 |
| 10-#14 | 1.46 | MA | 22178 | 4891 | 32437 | 4108 | 38564 | 3345 | 41210 | 2759 | 43145 | 1897 | 53275 | 1524 | 32280 |
| 4L-3S | | MI | 15248 | 4891 | 23009 | 3988 | 26874 | 3231 | 28578 | 2674 | 29781 | 1811 | 35801 | 1516 | 20853 |
| 10-#14 | 1.46 | MA | 21085 | 4891 | 30817 | 4125 | 36621 | 3345 | 38837 | 2773 | 39914 | 1907 | 49097 | 1456 | 30951 |
| 5L-2S | | MI | 16285 | 4891 | 24354 | 3990 | 28580 | 3236 | 30641 | 2667 | 32495 | 1803 | 39377 | 1647 | 20866 |
| 10-#18 | 2.60 | MA | 28765 | 5527 | 44574 | 4479 | 53884 | 3602 | 59679 | 2916 | 68004 | 1851 | 85659 | 1687 | 56914 |
| 2L-5S | | MI | 14240 | 5527 | 23630 | 4361 | 27446 | 3491 | 29083 | 2823 | 30420 | 1725 | 37517 | 891 | 31951 |
| 10-#18 | 2.60 | MA | 25955 | 5527 | 40781 | 4481 | 49073 | 3601 | 53851 | 2938 | 60140 | 1866 | 75086 | 1453 | 56371 |
| 3L-4S | | MI | 15404 | 5527 | 25419 | 4341 | 29593 | 3502 | 31652 | 2810 | 33911 | 1738 | 41775 | 1001 | 33661 |
| 10-#18 | 2.60 | MA | 23930 | 5527 | 37964 | 4483 | 45264 | 3626 | 49235 | 2933 | 53910 | 1855 | 68116 | 1219 | 53502 |
| 4L-3S | | MI | 16684 | 5527 | 27181 | 4348 | 31972 | 3488 | 34485 | 2823 | 37501 | 1725 | 45783 | 1227 | 35528 |
| 10-#18 | 2.60 | MA | 22097 | 5527 | 35114 | 4512 | 41844 | 3625 | 45061 | 2955 | 48227 | 1870 | 60841 | 1101 | 50077 |
| 5L-2S | | MI | 18418 | 5527 | 29521 | 4354 | 34939 | 3500 | 38029 | 2810 | 42164 | 1712 | 51888 | 1461 | 35780 |

## RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

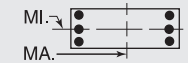
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.22 | MA | 24237 | 4754 | 34334 | 4029 | 41210 | 3276 | 44462 | 2715 | 47567 | 1904 | 58650 | 1813 | 27440 |
| 2L-6S | | MI | 13579 | 4754 | 20184 | 3927 | 23340 | 3196 | 24339 | 2642 | 24294 | 1839 | 29029 | 1392 | 17005 |
| 12-#11 | 1.22 | MA | 23053 | 4754 | 32824 | 4031 | 39295 | 3277 | 42143 | 2725 | 44438 | 1912 | 54373 | 1721 | 27398 |
| 3L-5S | | MI | 14050 | 4754 | 20821 | 3928 | 24188 | 3189 | 25371 | 2647 | 25626 | 1834 | 30794 | 1468 | 17506 |
| 12-#11 | 1.22 | MA | 22201 | 4754 | 31707 | 4032 | 37785 | 3287 | 40312 | 2725 | 41967 | 1909 | 51545 | 1630 | 27280 |
| 4E | | MI | 14541 | 4754 | 21536 | 3919 | 25047 | 3192 | 26418 | 2641 | 27012 | 1828 | 32555 | 1511 | 17583 |
| 12-#11 | 1.22 | MA | 21431 | 4754 | 30579 | 4044 | 36430 | 3288 | 38659 | 2734 | 39715 | 1917 | 48618 | 1583 | 27026 |
| 5L-3S | | MI | 15080 | 4754 | 22242 | 3920 | 26000 | 3184 | 27573 | 2646 | 28531 | 1834 | 34210 | 1602 | 17605 |
| 12-#11 | 1.22 | MA | 20693 | 4754 | 29577 | 4046 | 35094 | 3299 | 37032 | 2734 | 37551 | 1924 | 45631 | 1508 | 26078 |
| 6L-2S | | MI | 15815 | 4754 | 23185 | 3921 | 27195 | 3187 | 29021 | 2640 | 30445 | 1828 | 36739 | 1693 | 17594 |
| 12-#14 | 1.76 | MA | 26094 | 5055 | 38364 | 4206 | 46216 | 3404 | 50481 | 2795 | 55655 | 1885 | 69490 | 1771 | 39101 |
| 2L-6S | | MI | 13772 | 5055 | 21410 | 4098 | 24775 | 3321 | 26024 | 2714 | 26485 | 1805 | 32048 | 1183 | 23134 |
| 12-#14 | 1.76 | MA | 24438 | 5055 | 36202 | 4208 | 43473 | 3405 | 47158 | 2808 | 51173 | 1895 | 63395 | 1640 | 38956 |
| 3L-5S | | MI | 14431 | 5055 | 22322 | 4100 | 25989 | 3311 | 27498 | 2722 | 28375 | 1798 | 34543 | 1292 | 23812 |
| 12-#14 | 1.76 | MA | 23247 | 5055 | 34600 | 4210 | 41307 | 3420 | 44532 | 2807 | 47628 | 1890 | 59370 | 1509 | 38595 |
| 4E | | MI | 15118 | 5055 | 23345 | 4088 | 27217 | 3316 | 28993 | 2714 | 30341 | 1790 | 37036 | 1353 | 24678 |
| 12-#14 | 1.76 | MA | 22170 | 5055 | 32980 | 4227 | 39363 | 3420 | 42160 | 2820 | 44397 | 1900 | 55191 | 1441 | 37122 |
| 5L-3S | | MI | 15872 | 5055 | 24354 | 4090 | 28580 | 3306 | 30641 | 2722 | 32495 | 1798 | 39377 | 1484 | 24818 |
| 12-#14 | 1.76 | MA | 21137 | 5055 | 31542 | 4229 | 37445 | 3436 | 39825 | 2819 | 41292 | 1910 | 50935 | 1333 | 35752 |
| 6L-2S | | MI | 16898 | 5055 | 25699 | 4093 | 30285 | 3311 | 32704 | 2714 | 35209 | 1790 | 42953 | 1615 | 24862 |
| 12-#18 | 3.13 | MA | 27688 | 5818 | 44574 | 4663 | 53884 | 3734 | 59679 | 3022 | 68004 | 1853 | 85659 | 1420 | 67451 |
| 3L-5S | | MI | 15305 | 5818 | 25969 | 4543 | 30413 | 3624 | 32627 | 2903 | 35083 | 1697 | 43623 | 826 | 38556 |
| 12-#18 | 3.13 | MA | 25705 | 5818 | 41757 | 4665 | 50075 | 3759 | 55063 | 3017 | 61773 | 1841 | 78689 | 1186 | 64238 |
| 4E | | MI | 16449 | 5818 | 27758 | 4523 | 32560 | 3635 | 35197 | 2890 | 38575 | 1711 | 47880 | 935 | 40161 |
| 12-#18 | 3.13 | MA | 23911 | 5818 | 38907 | 4693 | 46655 | 3758 | 50889 | 3039 | 56090 | 1856 | 71415 | 1068 | 60960 |
| 5L-3S | | MI | 17706 | 5818 | 29521 | 4529 | 34939 | 3621 | 38029 | 2903 | 42164 | 1697 | 51888 | 1161 | 42338 |
| 12-#18 | 3.13 | MA | 22191 | 5818 | 36376 | 4696 | 43279 | 3783 | 46780 | 3035 | 50625 | 1872 | 64032 | 875 | 56433 |
| 6L-2S | | MI | 19413 | 5818 | 31860 | 4536 | 37906 | 3633 | 41573 | 2890 | 46827 | 1684 | 57993 | 1395 | 42667 |
| 14-#11 | 1.42 | MA | 24973 | 4867 | 35843 | 4100 | 43124 | 3328 | 46781 | 2748 | 50696 | 1899 | 62926 | 1803 | 31911 |
| 2L-7S | | MI | 13581 | 4867 | 20506 | 3997 | 23715 | 3245 | 24785 | 2681 | 24856 | 1825 | 29996 | 1301 | 19349 |
| 14-#11 | 1.42 | MA | 23801 | 4867 | 34334 | 4102 | 41210 | 3328 | 44462 | 2758 | 47567 | 1907 | 58650 | 1712 | 31851 |
| 3L-6S | | MI | 14039 | 4867 | 21127 | 3998 | 24535 | 3248 | 25786 | 2675 | 26207 | 1831 | 31558 | 1372 | 19690 |
| 14-#11 | 1.42 | MA | 22958 | 4867 | 33217 | 4103 | 39699 | 3339 | 42631 | 2757 | 45095 | 1904 | 55822 | 1621 | 31710 |
| 4L-5S | | MI | 14505 | 4867 | 21763 | 3999 | 25383 | 3241 | 26819 | 2680 | 27540 | 1825 | 33323 | 1448 | 20215 |
| 14-#11 | 1.42 | MA | 22196 | 4867 | 32088 | 4115 | 38345 | 3340 | 40978 | 2767 | 42843 | 1911 | 52895 | 1573 | 31433 |
| 5L-4S | | MI | 14991 | 4867 | 22479 | 3990 | 26242 | 3244 | 27866 | 2674 | 28926 | 1820 | 35084 | 1490 | 20358 |
| 14-#11 | 1.42 | MA | 21466 | 4867 | 31087 | 4117 | 37009 | 3351 | 39351 | 2767 | 40679 | 1919 | 49908 | 1498 | 30418 |
| 6L-3S | | MI | 15526 | 4867 | 23185 | 3991 | 27195 | 3236 | 29021 | 2679 | 30445 | 1825 | 36739 | 1581 | 20398 |
| 14-#11 | 1.42 | MA | 20752 | 4867 | 30112 | 4119 | 35718 | 3351 | 37774 | 2777 | 38486 | 1916 | 47245 | 1427 | 29704 |
| 7L-2S | | MI | 16254 | 4867 | 24127 | 3992 | 28390 | 3239 | 30469 | 2673 | 32358 | 1820 | 39268 | 1673 | 20403 |
| 14-#14 | 2.05 | MA | 27107 | 5218 | 40527 | 4308 | 48958 | 3479 | 53804 | 2842 | 60138 | 1877 | 75584 | 1756 | 45489 |
| 2L-7S | | MI | 13774 | 5218 | 21867 | 4198 | 25307 | 3391 | 26657 | 2769 | 27282 | 1785 | 33413 | 1049 | 25833 |
| 14-#14 | 2.05 | MA | 25471 | 5218 | 38364 | 4310 | 46216 | 3479 | 50481 | 2856 | 55655 | 1887 | 69490 | 1624 | 45310 |
| 3L-6S | | MI | 14411 | 5218 | 22755 | 4200 | 26480 | 3396 | 28087 | 2761 | 29199 | 1792 | 35624 | 1151 | 26965 |
| 14-#14 | 2.05 | MA | 24296 | 5218 | 36762 | 4312 | 44049 | 3495 | 47855 | 2854 | 52111 | 1882 | 65464 | 1493 | 44910 |
| 4L-5S | | MI | 15063 | 5218 | 23666 | 4203 | 27694 | 3386 | 29561 | 2769 | 31089 | 1785 | 38119 | 1260 | 27612 |
| 14-#14 | 2.05 | MA | 23234 | 5218 | 35142 | 4329 | 42106 | 3495 | 45482 | 2868 | 48880 | 1892 | 61286 | 1425 | 43309 |
| 5L-4S | | MI | 15741 | 5218 | 24689 | 4190 | 28922 | 3391 | 31056 | 2761 | 33055 | 1777 | 40612 | 1321 | 28599 |
| 14-#14 | 2.05 | MA | 22217 | 5218 | 33705 | 4331 | 40188 | 3510 | 43148 | 2866 | 45774 | 1902 | 57030 | 1317 | 41984 |
| 6L-3S | | MI | 16486 | 5218 | 25699 | 4192 | 30285 | 3381 | 32704 | 2769 | 35209 | 1785 | 42953 | 1452 | 28773 |
| 14-#14 | 2.05 | MA | 21220 | 5218 | 32306 | 4333 | 38336 | 3511 | 40885 | 2880 | 42626 | 1898 | 53238 | 1215 | 40062 |
| 7L-2S | | MI | 17501 | 5218 | 27043 | 4195 | 31990 | 3386 | 34767 | 2761 | 37923 | 1777 | 46528 | 1583 | 28843 |
| 14-#18 | 3.65 | MA | 27438 | 6109 | 45550 | 4846 | 54885 | 3892 | 60892 | 3102 | 69636 | 1828 | 89263 | 1153 | 75010 |
| 4L-5S | | MI | 16348 | 6109 | 28309 | 4725 | 33380 | 3757 | 36172 | 2984 | 39747 | 1670 | 49728 | 760 | 44933 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

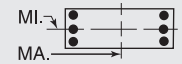


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.65 | MA | 25681 | 6109 | 42700 | 4875 | 51465 | 3891 | 56717 | 3124 | 63953 | 1843 | 81988 | 1034 | 71863 |
| 5L-4S | | MI | 17472 | 6109 | 30098 | 4705 | 35527 | 3768 | 38741 | 2970 | 43238 | 1683 | 53986 | 870 | 46696 |
| 14-#18 | 3.65 | MA | 23996 | 6109 | 40169 | 4877 | 48090 | 3916 | 52608 | 3119 | 58488 | 1858 | 74606 | 842 | 67224 |
| 6L-3S | | MI | 18709 | 6109 | 31860 | 4711 | 37906 | 3754 | 41573 | 2984 | 46827 | 1670 | 57993 | 1096 | 49140 |
| 14-#18 | 3.65 | MA | 22344 | 6109 | 37705 | 4880 | 44830 | 3915 | 48625 | 3141 | 52948 | 1847 | 68036 | 660 | 62474 |
| 7L-2S | | MI | 20391 | 6109 | 34199 | 4718 | 40873 | 3766 | 45118 | 2970 | 51490 | 1656 | 64099 | 1329 | 49539 |
| 16-#11 | 1.63 | MA | 25700 | 4981 | 37352 | 4171 | 45038 | 3380 | 49100 | 2781 | 53824 | 1894 | 67203 | 1793 | 36378 |
| 2L-8S | | MI | 13592 | 4981 | 20838 | 4067 | 24106 | 3294 | 25229 | 2709 | 25465 | 1822 | 30881 | 1231 | 21395 |
| 16-#11 | 1.63 | MA | 24538 | 4981 | 35843 | 4172 | 43124 | 3380 | 46781 | 2791 | 50696 | 1901 | 62926 | 1702 | 36300 |
| 3L-7S | | MI | 14039 | 4981 | 21449 | 4068 | 24910 | 3297 | 26233 | 2714 | 26769 | 1817 | 32524 | 1280 | 22051 |
| 16-#11 | 1.63 | MA | 23704 | 4981 | 34726 | 4174 | 41613 | 3391 | 44950 | 2790 | 48224 | 1899 | 60099 | 1611 | 36138 |
| 4L-6S | | MI | 14492 | 4981 | 22069 | 4069 | 25730 | 3300 | 27234 | 2708 | 28121 | 1822 | 34087 | 1352 | 22381 |
| 16-#11 | 1.63 | MA | 22950 | 4981 | 33597 | 4186 | 40259 | 3392 | 43297 | 2800 | 45972 | 1906 | 57172 | 1563 | 35778 |
| 5E | | MI | 14955 | 4981 | 22706 | 4070 | 26578 | 3293 | 28266 | 2713 | 29454 | 1817 | 35852 | 1428 | 22881 |
| 16-#11 | 1.63 | MA | 22228 | 4981 | 32596 | 4188 | 38923 | 3403 | 41670 | 2800 | 43808 | 1914 | 54185 | 1488 | 34765 |
| 6L-4S | | MI | 15436 | 4981 | 23421 | 4061 | 27437 | 3296 | 29314 | 2707 | 30839 | 1812 | 37613 | 1470 | 23127 |
| 16-#11 | 1.63 | MA | 21521 | 4981 | 31621 | 4190 | 37632 | 3403 | 40093 | 2809 | 41615 | 1911 | 51522 | 1418 | 34069 |
| 7L-3S | | MI | 15966 | 4981 | 24127 | 4062 | 28390 | 3288 | 30469 | 2712 | 32358 | 1817 | 39268 | 1561 | 23184 |
| 16-#11 | 1.63 | MA | 20823 | 4981 | 30662 | 4191 | 36368 | 3404 | 38514 | 2809 | 39498 | 1918 | 48787 | 1363 | 32916 |
| 8L-2S | | MI | 16689 | 4981 | 25069 | 4063 | 29585 | 3291 | 31917 | 2706 | 34272 | 1812 | 41797 | 1652 | 23204 |
| 16-#14 | 2.34 | MA | 26487 | 5382 | 40527 | 4412 | 48958 | 3554 | 53804 | 2903 | 60138 | 1880 | 75584 | 1609 | 51660 |
| 3L-7S | | MI | 14410 | 5382 | 23212 | 4300 | 27012 | 3466 | 28720 | 2816 | 29996 | 1772 | 36989 | 1017 | 29602 |
| 16-#14 | 2.34 | MA | 25327 | 5382 | 38925 | 4414 | 46792 | 3570 | 51178 | 2902 | 56594 | 1875 | 71559 | 1477 | 51226 |
| 4L-6S | | MI | 15040 | 5382 | 24100 | 4303 | 28186 | 3471 | 30150 | 2808 | 31913 | 1779 | 39200 | 1119 | 30804 |
| 16-#14 | 2.34 | MA | 24280 | 5382 | 37305 | 4431 | 44848 | 3570 | 48805 | 2915 | 53363 | 1885 | 67380 | 1409 | 49509 |
| 5E | | MI | 15684 | 5382 | 25011 | 4305 | 29399 | 3461 | 31624 | 2816 | 33803 | 1772 | 41694 | 1229 | 31425 |
| 16-#14 | 2.34 | MA | 23276 | 5382 | 35867 | 4433 | 42931 | 3585 | 46470 | 2914 | 50257 | 1895 | 63124 | 1301 | 48225 |
| 6L-4S | | MI | 16354 | 5382 | 26034 | 4292 | 30628 | 3466 | 33119 | 2808 | 35769 | 1764 | 44188 | 1289 | 32516 |
| 16-#14 | 2.34 | MA | 22294 | 5382 | 34468 | 4436 | 41079 | 3585 | 44207 | 2927 | 47109 | 1890 | 59332 | 1199 | 46241 |
| 7L-3S | | MI | 17091 | 5382 | 27043 | 4295 | 31990 | 3456 | 34767 | 2816 | 37923 | 1772 | 46528 | 1420 | 32720 |
| 16-#14 | 2.34 | MA | 21322 | 5382 | 33091 | 4438 | 39264 | 3586 | 41940 | 2926 | 44072 | 1900 | 55429 | 1121 | 44399 |
| 8L-2S | | MI | 18096 | 5382 | 28388 | 4297 | 33696 | 3461 | 36830 | 2808 | 40637 | 1764 | 50104 | 1551 | 32815 |
| 16-#18 | 4.17 | MA | 27413 | 6400 | 46493 | 5057 | 56276 | 4024 | 62545 | 3208 | 71816 | 1830 | 92562 | 1001 | 82784 |
| 5E | | MI | 17371 | 6400 | 30648 | 4906 | 36346 | 3889 | 39716 | 3064 | 44410 | 1642 | 55833 | 694 | 51339 |
| 16-#18 | 4.17 | MA | 25760 | 6400 | 43962 | 5059 | 52901 | 4049 | 58437 | 3203 | 66351 | 1845 | 85179 | 808 | 78036 |
| 6L-4S | | MI | 18478 | 6400 | 32437 | 4886 | 38493 | 3901 | 42285 | 3051 | 47901 | 1655 | 60091 | 804 | 53260 |
| 16-#18 | 4.17 | MA | 24141 | 6400 | 41499 | 5061 | 49640 | 4048 | 54453 | 3225 | 60811 | 1834 | 78610 | 627 | 73228 |
| 7L-3S | | MI | 19696 | 6400 | 34199 | 4893 | 40873 | 3887 | 45118 | 3064 | 51490 | 1642 | 64099 | 1030 | 55935 |
| 16-#18 | 4.17 | MA | 22538 | 6400 | 39073 | 5063 | 46445 | 4047 | 50462 | 3220 | 55465 | 1849 | 71816 | 490 | 68324 |
| 8L-2S | | MI | 21353 | 6400 | 36538 | 4899 | 43839 | 3899 | 48662 | 3051 | 56154 | 1629 | 70204 | 1264 | 56399 |
| 18-#11 | 1.83 | MA | 25266 | 5094 | 37352 | 4243 | 45038 | 3432 | 49100 | 2824 | 53824 | 1896 | 67203 | 1692 | 40746 |
| 3L-8S | | MI | 14048 | 5094 | 21780 | 4137 | 25301 | 3346 | 26677 | 2742 | 27379 | 1814 | 33410 | 1210 | 24056 |
| 18-#11 | 1.83 | MA | 24439 | 5094 | 36236 | 4245 | 43528 | 3443 | 47269 | 2823 | 51353 | 1893 | 64376 | 1601 | 40564 |
| 4L-7S | | MI | 14491 | 5094 | 22391 | 4139 | 26105 | 3349 | 27681 | 2746 | 28683 | 1809 | 35053 | 1260 | 24716 |
| 18-#11 | 1.83 | MA | 23694 | 5094 | 35107 | 4257 | 42173 | 3444 | 45616 | 2833 | 49101 | 1901 | 61448 | 1553 | 40099 |
| 5L-6S | | MI | 14940 | 5094 | 23011 | 4140 | 26925 | 3352 | 28682 | 2741 | 30034 | 1814 | 36616 | 1331 | 25078 |
| 18-#11 | 1.83 | MA | 22979 | 5094 | 34105 | 4259 | 40837 | 3455 | 43989 | 2832 | 46937 | 1909 | 58461 | 1479 | 39118 |
| 6L-5S | | MI | 15398 | 5094 | 23648 | 4141 | 27773 | 3345 | 29714 | 2745 | 31367 | 1809 | 38381 | 1407 | 25555 |
| 18-#11 | 1.83 | MA | 22280 | 5094 | 33131 | 4261 | 39547 | 3455 | 42412 | 2842 | 44743 | 1906 | 55798 | 1408 | 38438 |
| 7L-4S | | MI | 15876 | 5094 | 24363 | 4132 | 28632 | 3348 | 30762 | 2740 | 32753 | 1804 | 40142 | 1450 | 25892 |
| 18-#11 | 1.83 | MA | 21589 | 5094 | 32172 | 4262 | 38283 | 3456 | 40833 | 2842 | 42627 | 1913 | 53063 | 1353 | 37245 |
| 8L-3S | | MI | 16401 | 5094 | 25069 | 4133 | 29585 | 3340 | 31917 | 2744 | 34272 | 1809 | 41797 | 1541 | 25964 |
| 18-#11 | 1.83 | MA | 20902 | 5094 | 31112 | 4274 | 36980 | 3467 | 39279 | 2851 | 40532 | 1921 | 50349 | 1295 | 36221 |
| 9L-2S | | MI | 17118 | 5094 | 26012 | 4134 | 30781 | 3343 | 33365 | 2739 | 36185 | 1804 | 44326 | 1632 | 25996 |
| 18-#14 | 2.64 | MA | 26342 | 5546 | 41087 | 4517 | 49534 | 3644 | 54500 | 2949 | 61076 | 1867 | 77653 | 1462 | 57542 |
| 4L-7S | | MI | 15037 | 5546 | 24556 | 4402 | 28718 | 3540 | 30783 | 2863 | 32710 | 1759 | 40565 | 985 | 33383 |
| 18-#14 | 2.64 | MA | 25308 | 5546 | 39467 | 4534 | 47591 | 3645 | 52128 | 2962 | 57845 | 1877 | 73475 | 1394 | 55720 |
| 5L-6S | | MI | 15660 | 5546 | 25444 | 4405 | 29891 | 3545 | 32213 | 2856 | 34627 | 1766 | 42776 | 1087 | 34552 |

## RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

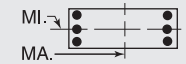
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.64 | MA | 24318 | 5546 | 38030 | 4536 | 45673 | 3660 | 49793 | 2961 | 54740 | 1888 | 69219 | 1286 | 54473 |
| 6L-5S | | MI | 16296 | 5546 | 26356 | 4407 | 31105 | 3535 | 33687 | 2863 | 36517 | 1759 | 45270 | 1197 | 35248 |
| 18-#14 | 2.64 | MA | 23349 | 5546 | 36631 | 4538 | 43821 | 3660 | 47530 | 2975 | 51592 | 1883 | 65427 | 1183 | 52429 |
| 7L-4S | | MI | 16959 | 5546 | 27379 | 4395 | 32333 | 3540 | 35182 | 2856 | 38483 | 1751 | 47764 | 1257 | 36339 |
| 18-#14 | 2.64 | MA | 22390 | 5546 | 35254 | 4540 | 42007 | 3661 | 45263 | 2973 | 48555 | 1893 | 61523 | 1105 | 50548 |
| 8L-3S | | MI | 17688 | 5546 | 28388 | 4397 | 33696 | 3531 | 36830 | 2863 | 40637 | 1759 | 50104 | 1388 | 36662 |
| 18-#14 | 2.64 | MA | 21437 | 5546 | 33733 | 4557 | 40137 | 3676 | 43032 | 2987 | 45547 | 1903 | 57657 | 1021 | 48262 |
| 9L-2S | | MI | 18683 | 5546 | 29733 | 4399 | 35401 | 3536 | 38894 | 2856 | 43351 | 1751 | 53680 | 1519 | 36781 |
| 18-#18 | 4.69 | MA | 27490 | 6691 | 47756 | 5241 | 57712 | 4182 | 64265 | 3287 | 74214 | 1832 | 95753 | 775 | 88866 |
| 6L-5S | | MI | 18462 | 6691 | 32987 | 5088 | 39313 | 4022 | 43260 | 3144 | 49073 | 1614 | 61939 | 629 | 57775 |
| 18-#18 | 4.69 | MA | 25901 | 6691 | 45292 | 5243 | 54451 | 4181 | 60281 | 3309 | 68674 | 1820 | 89184 | 593 | 83998 |
| 7L-4S | | MI | 19535 | 6691 | 34776 | 5068 | 41460 | 4034 | 45830 | 3131 | 52565 | 1628 | 66197 | 738 | 59849 |
| 18-#18 | 4.69 | MA | 24328 | 6691 | 42867 | 5245 | 51256 | 4180 | 56290 | 3305 | 63328 | 1835 | 82390 | 457 | 79056 |
| 8L-3S | | MI | 20708 | 6691 | 36538 | 5075 | 43839 | 4020 | 48662 | 3144 | 56154 | 1614 | 70204 | 964 | 62727 |
| 20-#11 | 2.03 | MA | 25166 | 5208 | 37745 | 4316 | 45442 | 3495 | 49589 | 2856 | 54482 | 1888 | 68653 | 1591 | 44989 |
| 4L-8S | | MI | 14498 | 5208 | 22722 | 4208 | 26496 | 3398 | 28125 | 2775 | 29292 | 1806 | 35939 | 1190 | 26724 |
| 20-#11 | 2.03 | MA | 24427 | 5208 | 36616 | 4328 | 44087 | 3496 | 47935 | 2866 | 52230 | 1896 | 65725 | 1544 | 44428 |
| 5L-7S | | MI | 14938 | 5208 | 23333 | 4209 | 27300 | 3401 | 29129 | 2779 | 30596 | 1801 | 37582 | 1239 | 27361 |
| 20-#11 | 2.03 | MA | 23720 | 5208 | 35615 | 4330 | 42751 | 3506 | 46308 | 2865 | 50066 | 1903 | 62738 | 1469 | 43477 |
| 6E | | MI | 15383 | 5208 | 23954 | 4211 | 28120 | 3404 | 30130 | 2774 | 31948 | 1806 | 39145 | 1311 | 27779 |
| 20-#11 | 2.03 | MA | 23028 | 5208 | 34640 | 4331 | 41461 | 3507 | 44731 | 2875 | 47872 | 1901 | 60075 | 1398 | 42810 |
| 7L-5S | | MI | 15837 | 5208 | 24590 | 4212 | 28969 | 3396 | 31162 | 2778 | 33281 | 1801 | 40909 | 1387 | 28236 |
| 20-#11 | 2.03 | MA | 22344 | 5208 | 33681 | 4333 | 40197 | 3508 | 43152 | 2875 | 45756 | 1908 | 57340 | 1343 | 41580 |
| 8L-4S | | MI | 16310 | 5208 | 25306 | 4203 | 29827 | 3399 | 32210 | 2773 | 34666 | 1796 | 42670 | 1429 | 28653 |
| 20-#11 | 2.03 | MA | 21665 | 5208 | 32621 | 4345 | 38894 | 3519 | 41598 | 2884 | 43661 | 1916 | 54626 | 1285 | 40526 |
| 9L-3S | | MI | 16831 | 5208 | 26012 | 4204 | 30781 | 3392 | 33365 | 2777 | 36185 | 1801 | 44326 | 1520 | 28740 |
| 20-#11 | 2.03 | MA | 20981 | 5208 | 31666 | 4347 | 37639 | 3519 | 40037 | 2884 | 41506 | 1913 | 51820 | 1205 | 39137 |
| 10L-2S | | MI | 17543 | 5208 | 26954 | 4205 | 31976 | 3395 | 34813 | 2772 | 38099 | 1796 | 46855 | 1611 | 28784 |
| 20-#14 | 2.93 | MA | 26322 | 5709 | 41630 | 4636 | 50333 | 3719 | 55450 | 3010 | 62328 | 1870 | 79569 | 1378 | 61941 |
| 5L-7S | | MI | 15655 | 5709 | 25901 | 4505 | 30423 | 3615 | 32846 | 2910 | 35424 | 1745 | 44141 | 953 | 37173 |
| 20-#14 | 2.93 | MA | 25344 | 5709 | 40192 | 4638 | 48416 | 3735 | 53116 | 3008 | 59223 | 1880 | 75313 | 1270 | 60728 |
| 6E | | MI | 16271 | 5709 | 26789 | 4507 | 31597 | 3620 | 34276 | 2903 | 37341 | 1753 | 46351 | 1055 | 38299 |
| 20-#14 | 2.93 | MA | 24388 | 5709 | 38793 | 4640 | 46564 | 3735 | 50853 | 3022 | 56075 | 1875 | 71521 | 1168 | 58626 |
| 7L-5S | | MI | 16900 | 5709 | 27700 | 4509 | 32810 | 3610 | 35750 | 2910 | 39231 | 1745 | 48846 | 1165 | 39079 |
| 20-#14 | 2.93 | MA | 23441 | 5709 | 37416 | 4642 | 44749 | 3735 | 48585 | 3021 | 53037 | 1885 | 67618 | 1089 | 56704 |
| 8L-4S | | MI | 17556 | 5709 | 28723 | 4497 | 34038 | 3615 | 37245 | 2903 | 41197 | 1738 | 51340 | 1226 | 40120 |
| 20-#14 | 2.93 | MA | 22501 | 5709 | 35895 | 4659 | 42879 | 3751 | 46355 | 3034 | 50030 | 1895 | 63751 | 1005 | 54462 |
| 9L-3S | | MI | 18278 | 5709 | 29733 | 4499 | 35401 | 3605 | 38894 | 2910 | 43351 | 1745 | 53680 | 1356 | 40599 |
| 20-#14 | 2.93 | MA | 21547 | 5709 | 34524 | 4661 | 41077 | 3751 | 44114 | 3033 | 46938 | 1891 | 59754 | 890 | 51933 |
| 10L-2S | | MI | 19263 | 5709 | 31077 | 4501 | 37106 | 3610 | 40957 | 2903 | 46065 | 1738 | 57256 | 1488 | 40740 |
| 20-#18 | 5.21 | MA | 27628 | 6981 | 49085 | 5425 | 59262 | 4314 | 66109 | 3393 | 76537 | 1807 | 99757 | 560 | 94784 |
| 7L-5S | | MI | 19446 | 6981 | 35327 | 5270 | 42280 | 4155 | 46805 | 3225 | 53737 | 1587 | 68044 | 563 | 64236 |
| 20-#18 | 5.21 | MA | 26084 | 6981 | 46660 | 5427 | 56067 | 4313 | 62118 | 3389 | 71191 | 1822 | 92963 | 423 | 89803 |
| 8L-4S | | MI | 20498 | 6981 | 37115 | 5250 | 44427 | 4167 | 49374 | 3211 | 57228 | 1600 | 72302 | 673 | 66457 |
| 22-#11 | 2.23 | MA | 25153 | 5321 | 38125 | 4399 | 46002 | 3547 | 50254 | 2899 | 55359 | 1891 | 70002 | 1534 | 48764 |
| 5L-8S | | MI | 14943 | 5321 | 23665 | 4279 | 27692 | 3450 | 29573 | 2807 | 31206 | 1798 | 38468 | 1170 | 29396 |
| 22-#11 | 2.23 | MA | 24452 | 5321 | 37124 | 4401 | 44665 | 3558 | 48627 | 2898 | 53195 | 1898 | 67015 | 1459 | 47841 |
| 6L-7S | | MI | 15379 | 5321 | 24276 | 4280 | 28495 | 3453 | 30577 | 2812 | 32510 | 1793 | 40111 | 1219 | 30014 |
| 22-#11 | 2.23 | MA | 23767 | 5321 | 36150 | 4402 | 43375 | 3559 | 47050 | 2908 | 51001 | 1895 | 64352 | 1388 | 47134 |
| 7L-6S | | MI | 15821 | 5321 | 24896 | 4281 | 29315 | 3456 | 31578 | 2806 | 33862 | 1798 | 41674 | 1290 | 30484 |
| 22-#11 | 2.23 | MA | 23090 | 5321 | 35190 | 4404 | 42111 | 3559 | 45471 | 2907 | 48885 | 1903 | 61617 | 1333 | 45919 |
| 8L-5S | | MI | 16271 | 5321 | 25533 | 4283 | 30164 | 3448 | 32610 | 2811 | 35194 | 1793 | 43438 | 1366 | 30923 |
| 22-#11 | 2.23 | MA | 22418 | 5321 | 34131 | 4416 | 40808 | 3570 | 43917 | 2917 | 46790 | 1910 | 58902 | 1275 | 44836 |
| 9L-4S | | MI | 16741 | 5321 | 26248 | 4273 | 31022 | 3451 | 33658 | 2805 | 36580 | 1788 | 45199 | 1409 | 31412 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

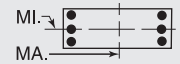
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.23 | MA | 21736 | 5321 | 33176 | 4418 | 39553 | 3571 | 42356 | 2917 | 44635 | 1908 | 56097 | 1195 | 43471 |
| 10L-3S | | MI | 17257 | 5321 | 26954 | 4275 | 31976 | 3444 | 34813 | 2810 | 38099 | 1793 | 46855 | 1500 | 31513 |
| 22-#11 | 2.23 | MA | 21004 | 5321 | 32227 | 4420 | 38265 | 3582 | 40812 | 2926 | 42549 | 1915 | 53408 | 1137 | 42025 |
| 11L-2S | | MI | 17964 | 5321 | 27896 | 4276 | 33171 | 3447 | 36261 | 2804 | 40012 | 1788 | 49383 | 1591 | 31568 |
| 22-#14 | 3.22 | MA | 26356 | 5873 | 42355 | 4740 | 51158 | 3810 | 56438 | 3056 | 63705 | 1873 | 81408 | 1254 | 66988 |
| 6L-7S | | MI | 16265 | 5873 | 27246 | 4607 | 32128 | 3690 | 34909 | 2957 | 38138 | 1732 | 47717 | 921 | 40971 |
| 22-#14 | 3.22 | MA | 25411 | 5873 | 40956 | 4742 | 49306 | 3810 | 54175 | 3069 | 60557 | 1868 | 77616 | 1152 | 64830 |
| 7L-6S | | MI | 16875 | 5873 | 28134 | 4609 | 33302 | 3695 | 36339 | 2950 | 40055 | 1740 | 49927 | 1023 | 42059 |
| 22-#14 | 3.22 | MA | 24477 | 5873 | 39579 | 4744 | 47492 | 3810 | 51908 | 3068 | 57520 | 1878 | 73712 | 1074 | 62803 |
| 8L-5S | | MI | 17497 | 5873 | 29045 | 4612 | 34515 | 3685 | 37813 | 2957 | 41945 | 1732 | 52422 | 1133 | 42918 |
| 22-#14 | 3.22 | MA | 23549 | 5873 | 38058 | 4761 | 45622 | 3825 | 49678 | 3082 | 54513 | 1888 | 69846 | 989 | 60668 |
| 9L-4S | | MI | 18146 | 5873 | 30068 | 4599 | 35744 | 3690 | 39308 | 2950 | 43911 | 1725 | 54915 | 1194 | 43912 |
| 22-#14 | 3.22 | MA | 22599 | 5873 | 36686 | 4763 | 43820 | 3826 | 47437 | 3080 | 51421 | 1883 | 65849 | 874 | 58113 |
| 10L-3S | | MI | 18860 | 5873 | 31077 | 4601 | 37106 | 3680 | 40957 | 2957 | 46065 | 1732 | 57256 | 1324 | 44533 |
| 22-#18 | 5.73 | MA | 27809 | 7272 | 50453 | 5609 | 60877 | 4446 | 67946 | 3473 | 79054 | 1809 | 103537 | 390 | 100562 |
| 8L-5S | | MI | 20415 | 7272 | 37666 | 5451 | 45247 | 4288 | 50349 | 3305 | 58400 | 1559 | 74150 | 497 | 70721 |
| 24-#11 | 2.44 | MA | 25176 | 5434 | 38633 | 4471 | 46580 | 3610 | 50946 | 2931 | 56324 | 1893 | 71292 | 1449 | 52209 |
| 6L-8S | | MI | 15384 | 5434 | 24607 | 4350 | 28887 | 3502 | 31021 | 2840 | 33119 | 1790 | 40997 | 1149 | 32073 |
| 24-#11 | 2.44 | MA | 24498 | 5434 | 37659 | 4473 | 45289 | 3611 | 49370 | 2941 | 54130 | 1890 | 68629 | 1379 | 51452 |
| 7E | | MI | 15816 | 5434 | 25218 | 4351 | 29691 | 3505 | 32024 | 2845 | 34423 | 1785 | 42640 | 1199 | 32672 |
| 24-#11 | 2.44 | MA | 23827 | 5434 | 36700 | 4475 | 44025 | 3611 | 47790 | 2940 | 52014 | 1898 | 65894 | 1324 | 50263 |
| 8L-6S | | MI | 16254 | 5434 | 25838 | 4352 | 30511 | 3508 | 33026 | 2839 | 35775 | 1790 | 44203 | 1270 | 33192 |
| 24-#11 | 2.44 | MA | 23161 | 5434 | 35640 | 4487 | 42723 | 3622 | 46236 | 2950 | 49919 | 1905 | 63179 | 1265 | 49151 |
| 9L-5S | | MI | 16701 | 5434 | 26475 | 4354 | 31359 | 3500 | 34058 | 2844 | 37108 | 1785 | 45967 | 1346 | 33616 |
| 24-#11 | 2.44 | MA | 22482 | 5434 | 34685 | 4489 | 41467 | 3623 | 44675 | 2950 | 47764 | 1902 | 60373 | 1185 | 47809 |
| 10L-4S | | MI | 17166 | 5434 | 27190 | 4344 | 32217 | 3503 | 35106 | 2838 | 38493 | 1779 | 47728 | 1388 | 34169 |
| 24-#11 | 2.44 | MA | 21771 | 5434 | 33737 | 4490 | 40180 | 3634 | 43131 | 2959 | 45678 | 1910 | 57685 | 1127 | 46345 |
| 11L-3S | | MI | 17679 | 5434 | 27896 | 4345 | 33171 | 3496 | 36261 | 2843 | 40012 | 1785 | 49383 | 1479 | 34282 |
| 24-#11 | 2.44 | MA | 21051 | 5434 | 32793 | 4492 | 38928 | 3634 | 41579 | 2959 | 43541 | 1907 | 54992 | 1070 | 44891 |
| 12L-2S | | MI | 18381 | 5434 | 28839 | 4347 | 34366 | 3499 | 37709 | 2837 | 41926 | 1779 | 51912 | 1571 | 34349 |
| 24-#14 | 3.52 | MA | 26421 | 6036 | 43118 | 4844 | 52049 | 3885 | 57498 | 3117 | 65040 | 1860 | 83710 | 1137 | 71042 |
| 7E | | MI | 16868 | 6036 | 28590 | 4709 | 33834 | 3765 | 36972 | 3005 | 40852 | 1719 | 51292 | 889 | 44777 |
| 24-#14 | 3.52 | MA | 25498 | 6036 | 41741 | 4846 | 50234 | 3885 | 55231 | 3115 | 62003 | 1870 | 79806 | 1058 | 68977 |
| 8L-6S | | MI | 17471 | 6036 | 29478 | 4712 | 35007 | 3770 | 38402 | 2997 | 42769 | 1727 | 53503 | 991 | 45828 |
| 24-#14 | 3.52 | MA | 24581 | 6036 | 40220 | 4863 | 48364 | 3900 | 53000 | 3129 | 58996 | 1880 | 75940 | 974 | 66879 |
| 9L-5S | | MI | 18088 | 6036 | 30390 | 4714 | 36221 | 3760 | 39876 | 3005 | 44659 | 1719 | 55998 | 1101 | 46762 |
| 24-#14 | 3.52 | MA | 23636 | 6036 | 38849 | 4866 | 46563 | 3901 | 50760 | 3128 | 55903 | 1876 | 71943 | 858 | 64300 |
| 10L-4S | | MI | 18730 | 6036 | 31413 | 4701 | 37449 | 3765 | 41371 | 2997 | 46625 | 1712 | 58491 | 1162 | 47715 |

## RECTANGULAR TIED COLUMNS 34" x 34"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#14 | 1.17 | MA | 12565 | 3556 | 18344 | 2940 | 21513 | 2391 | 22930 | 1982 | 23994 | 1380 | 28923 | 1281 | 13518 |
| 2L-3S | | MI | 11434 | 3556 | 16897 | 2939 | 19678 | 2387 | 20707 | 1991 | 21052 | 1387 | 25034 | 1149 | 13517 |
| 6-#18 | 2.08 | MA | 13990 | 3938 | 21716 | 3155 | 25642 | 2546 | 27802 | 2072 | 30312 | 1327 | 37136 | 1176 | 23223 |
| 2L-3S | | MI | 12089 | 3938 | 19195 | 3150 | 22445 | 2536 | 23951 | 2085 | 25245 | 1341 | 30475 | 942 | 22957 |
| 8-#11 | 1.08 | MA | 12445 | 3519 | 17979 | 2929 | 21126 | 2384 | 22494 | 1980 | 23483 | 1392 | 28292 | 1300 | 12601 |
| 2L-4S | | MI | 11067 | 3519 | 16209 | 2928 | 18818 | 2390 | 19697 | 1983 | 19768 | 1392 | 23745 | 1117 | 12565 |
| 8-#14 | 1.56 | MA | 13239 | 3720 | 19791 | 3042 | 23348 | 2466 | 25154 | 2030 | 26935 | 1368 | 32812 | 1252 | 17828 |
| 2L-4S | | MI | 11310 | 3720 | 17261 | 3039 | 20050 | 2473 | 21157 | 2032 | 21659 | 1368 | 26376 | 989 | 17551 |
| 8-#18 | 2.77 | MA | 15090 | 4229 | 24237 | 3337 | 28839 | 2679 | 31654 | 2154 | 35378 | 1302 | 43797 | 1116 | 30662 |
| 2L-4S | | MI | 11867 | 4229 | 19821 | 3327 | 23084 | 2686 | 24725 | 2154 | 26289 | 1302 | 32772 | 652 | 27488 |
| 10-#11 | 1.35 | MA | 12925 | 3633 | 18993 | 3000 | 22411 | 2436 | 24050 | 2013 | 25555 | 1385 | 31039 | 1281 | 15622 |
| 2L-5S | | MI | 11041 | 3633 | 16455 | 3008 | 19182 | 2439 | 20130 | 2022 | 20339 | 1390 | 24585 | 1056 | 15102 |
| 10-#11 | 1.35 | MA | 12139 | 3633 | 17979 | 2999 | 21126 | 2433 | 22494 | 2019 | 23483 | 1390 | 28292 | 1190 | 15609 |
| 3L-4S | | MI | 11564 | 3633 | 17222 | 2999 | 20103 | 2442 | 21254 | 2015 | 21839 | 1385 | 26491 | 1099 | 15534 |
| 10-#14 | 1.95 | MA | 13899 | 3884 | 21238 | 3145 | 25183 | 2541 | 27377 | 2077 | 29876 | 1356 | 36702 | 1223 | 22115 |
| 2L-5S | | MI | 11270 | 3884 | 17610 | 3155 | 20567 | 2543 | 21773 | 2087 | 22470 | 1364 | 27559 | 898 | 20377 |

## RECTANGULAR TIED COLUMNS 34" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

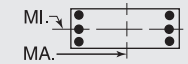
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.95 | MA | 12802 | 3884 | 19791 | 3143 | 23348 | 2537 | 25154 | 2086 | 26935 | 1364 | 32812 | 1091 | 22024 |
| 3L-4S | | MI | 11999 | 3884 | 18708 | 3142 | 21885 | 2547 | 23380 | 2079 | 24600 | 1356 | 30266 | 960 | 21682 |
| 10-#18 | 3.46 | MA | 16160 | 4520 | 26758 | 3518 | 32036 | 2812 | 35505 | 2237 | 40445 | 1278 | 50458 | 1056 | 38076 |
| 2L-5S | | MI | 11797 | 4520 | 20421 | 3530 | 23974 | 2809 | 25785 | 2250 | 27687 | 1291 | 34788 | 484 | 31930 |
| 10-#18 | 3.46 | MA | 14341 | 4520 | 24237 | 3513 | 28839 | 2802 | 31654 | 2250 | 35378 | 1291 | 43797 | 822 | 37584 |
| 3L-4S | | MI | 13008 | 4520 | 22342 | 3508 | 26281 | 2819 | 28576 | 2237 | 31356 | 1278 | 39433 | 592 | 34511 |
| **RECTANGULAR TIED COLUMNS 34" x 36"** | | | | | | | | | | | | | | | |
| 4-#18 | 1.31 | MA | 14323 | 3828 | 21170 | 3142 | 24821 | 2552 | 26531 | 2110 | 27923 | 1448 | 33737 | 1333 | 16817 |
| 2E | | MI | 13474 | 3828 | 20027 | 3127 | 23389 | 2539 | 24907 | 2096 | 26134 | 1434 | 31484 | 1315 | 15777 |
| 6-#14 | 1.10 | MA | 14004 | 3737 | 20250 | 3109 | 23813 | 2530 | 25378 | 2101 | 26549 | 1474 | 32019 | 1376 | 14430 |
| 2L-3S | | MI | 12049 | 3737 | 17721 | 3094 | 20620 | 2514 | 21664 | 2099 | 21945 | 1470 | 26049 | 1230 | 13560 |
| 6-#14 | 1.10 | MA | 12789 | 3737 | 18701 | 3108 | 21848 | 2527 | 22997 | 2110 | 23380 | 1482 | 27815 | 1245 | 14428 |
| 3L-2S | | MI | 13183 | 3737 | 19168 | 3095 | 22455 | 2518 | 23887 | 2091 | 24886 | 1463 | 29938 | 1361 | 13550 |
| 6-#18 | 1.96 | MA | 15557 | 4118 | 23872 | 3324 | 28249 | 2685 | 30684 | 2194 | 33394 | 1426 | 40955 | 1279 | 24843 |
| 2L-3S | | MI | 12706 | 4118 | 20027 | 3303 | 23389 | 2662 | 24907 | 2192 | 26134 | 1423 | 31484 | 1022 | 23046 |
| 6-#18 | 1.96 | MA | 13510 | 4118 | 21170 | 3320 | 24821 | 2677 | 26531 | 2208 | 27923 | 1439 | 33737 | 1045 | 24577 |
| 3L-2S | | MI | 14616 | 4118 | 22548 | 3308 | 26586 | 2672 | 28758 | 2179 | 31201 | 1410 | 38145 | 1255 | 23273 |
| 8-#11 | 1.02 | MA | 13871 | 3700 | 19857 | 3098 | 23394 | 2523 | 24905 | 2098 | 25989 | 1486 | 31321 | 1394 | 13443 |
| 2L-4S | | MI | 11682 | 3700 | 17028 | 3083 | 19758 | 2518 | 20654 | 2091 | 20662 | 1475 | 24763 | 1198 | 12614 |
| 8-#11 | 1.02 | MA | 13018 | 3700 | 18773 | 3098 | 22019 | 2521 | 23239 | 2105 | 23760 | 1491 | 28356 | 1303 | 13454 |
| 3E | | MI | 12265 | 3700 | 17785 | 3084 | 20781 | 2510 | 21894 | 2095 | 22306 | 1481 | 26564 | 1289 | 12646 |
| 8-#11 | 1.02 | MA | 12394 | 3700 | 17964 | 3098 | 20926 | 2530 | 21915 | 2102 | 21991 | 1486 | 26409 | 1212 | 13408 |
| 4L-2S | | MI | 13063 | 3700 | 18799 | 3085 | 22066 | 2512 | 23450 | 2089 | 24377 | 1475 | 29310 | 1381 | 12630 |
| 8-#14 | 1.47 | MA | 14735 | 3900 | 21800 | 3211 | 25778 | 2605 | 27758 | 2148 | 29718 | 1464 | 36222 | 1350 | 19043 |
| 2L-4S | | MI | 11925 | 3900 | 18085 | 3194 | 20992 | 2600 | 22114 | 2140 | 22551 | 1451 | 27391 | 1069 | 17636 |
| 8-#14 | 1.47 | MA | 13538 | 3900 | 20250 | 3211 | 23813 | 2602 | 25378 | 2157 | 26549 | 1472 | 32019 | 1218 | 18993 |
| 3E | | MI | 12744 | 3900 | 19168 | 3196 | 22455 | 2589 | 23887 | 2146 | 24886 | 1459 | 29938 | 1201 | 17828 |
| 8-#14 | 1.47 | MA | 12664 | 3900 | 19093 | 3210 | 22249 | 2613 | 23483 | 2152 | 24034 | 1464 | 29262 | 1087 | 18766 |
| 4L-2S | | MI | 13861 | 3900 | 20615 | 3197 | 24290 | 2593 | 26110 | 2138 | 27827 | 1451 | 33827 | 1332 | 17865 |
| 8-#18 | 2.61 | MA | 16752 | 4409 | 26575 | 3506 | 31676 | 2818 | 34836 | 2279 | 38864 | 1404 | 48172 | 1224 | 32822 |
| 2L-4S | | MI | 12482 | 4409 | 20654 | 3480 | 24028 | 2812 | 25681 | 2261 | 27178 | 1385 | 33781 | 732 | 27801 |
| 8-#18 | 2.61 | MA | 14750 | 4409 | 23872 | 3502 | 28249 | 2810 | 30684 | 2292 | 33394 | 1417 | 40955 | 991 | 32434 |
| 3E | | MI | 13854 | 4409 | 22548 | 3485 | 26586 | 2795 | 28758 | 2275 | 31201 | 1398 | 38145 | 962 | 30373 |
| 8-#18 | 2.61 | MA | 13285 | 4409 | 21846 | 3498 | 25512 | 2828 | 27367 | 2279 | 29051 | 1404 | 36233 | 757 | 29674 |
| 4L-2S | | MI | 15722 | 4409 | 25069 | 3490 | 29783 | 2805 | 32609 | 2261 | 36267 | 1385 | 44806 | 1196 | 30718 |
| 10-#11 | 1.27 | MA | 14391 | 3813 | 20941 | 3169 | 24769 | 2575 | 26570 | 2131 | 28218 | 1480 | 34285 | 1378 | 16675 |
| 2L-5S | | MI | 11655 | 3813 | 17274 | 3164 | 20123 | 2567 | 21087 | 2131 | 21233 | 1473 | 25603 | 1136 | 15256 |
| 10-#11 | 1.27 | MA | 13547 | 3813 | 19857 | 3169 | 23394 | 2573 | 24905 | 2138 | 25989 | 1485 | 31321 | 1286 | 16662 |
| 3L-4S | | MI | 12179 | 3813 | 18041 | 3154 | 21043 | 2570 | 22211 | 2124 | 22733 | 1468 | 27509 | 1180 | 15588 |
| 10-#11 | 1.27 | MA | 12931 | 3813 | 19048 | 3169 | 22301 | 2582 | 23580 | 2135 | 24220 | 1480 | 29373 | 1195 | 16587 |
| 4L-3S | | MI | 12756 | 3813 | 18799 | 3155 | 22066 | 2561 | 23450 | 2128 | 24377 | 1473 | 29310 | 1271 | 15649 |
| 10-#11 | 1.27 | MA | 12372 | 3813 | 18229 | 3179 | 21318 | 2580 | 22381 | 2142 | 22606 | 1485 | 27321 | 1151 | 16217 |
| 5L-2S | | MI | 13545 | 3813 | 19812 | 3155 | 23351 | 2564 | 25007 | 2122 | 26449 | 1468 | 32057 | 1362 | 15654 |
| 10-#14 | 1.84 | MA | 15450 | 4064 | 23349 | 3314 | 27742 | 2680 | 30138 | 2195 | 32887 | 1454 | 40426 | 1323 | 23634 |
| 2L-5S | | MI | 11884 | 4064 | 18433 | 3310 | 21509 | 2671 | 22729 | 2196 | 23363 | 1447 | 28574 | 979 | 20570 |
| 10-#14 | 1.84 | MA | 14270 | 4064 | 21800 | 3313 | 25778 | 2676 | 27758 | 2205 | 29718 | 1461 | 36222 | 1192 | 23543 |
| 3L-4S | | MI | 12616 | 4064 | 19531 | 3296 | 22827 | 2675 | 24337 | 2187 | 25493 | 1440 | 31281 | 1040 | 21838 |
| 10-#14 | 1.84 | MA | 13410 | 4064 | 20642 | 3312 | 24214 | 2688 | 25863 | 2199 | 27203 | 1454 | 33465 | 1061 | 23266 |
| 4L-3S | | MI | 13423 | 4064 | 20615 | 3298 | 24290 | 2664 | 26110 | 2194 | 27827 | 1447 | 33827 | 1172 | 22080 |
| 10-#14 | 1.84 | MA | 12628 | 4064 | 19470 | 3326 | 22806 | 2685 | 24146 | 2209 | 24908 | 1461 | 30548 | 998 | 21894 |
| 5L-2S | | MI | 14524 | 4064 | 22062 | 3300 | 26125 | 2668 | 28333 | 2185 | 30769 | 1440 | 37717 | 1303 | 22156 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis

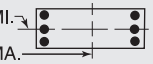



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.27 | MA | 17914 | 4700 | 29278 | 3687 | 35104 | 2951 | 38989 | 2363 | 44335 | 1382 | 55390 | 1170 | 40776 |
| 2L-5S | | MI | 12408 | 4700 | 21253 | 3683 | 24919 | 2935 | 26741 | 2357 | 28575 | 1373 | 35797 | 564 | 32424 |
| 10-#18 | 3.27 | MA | 15954 | 4700 | 26575 | 3684 | 31676 | 2943 | 34836 | 2377 | 38864 | 1395 | 48172 | 936 | 40284 |
| 3L-4S | | MI | 13627 | 4700 | 23175 | 3662 | 27225 | 2945 | 29532 | 2344 | 32245 | 1360 | 40442 | 672 | 34815 |
| 10-#18 | 3.27 | MA | 14522 | 4700 | 24549 | 3680 | 28939 | 2961 | 31520 | 2364 | 34522 | 1382 | 43451 | 702 | 37217 |
| 4L-3S | | MI | 14969 | 4700 | 25069 | 3667 | 29783 | 2928 | 32609 | 2357 | 36267 | 1373 | 44806 | 902 | 37691 |
| 10-#18 | 3.27 | MA | 13222 | 4700 | 22494 | 3703 | 26474 | 2953 | 28512 | 2377 | 30560 | 1395 | 38418 | 595 | 34651 |
| 5L-2S | | MI | 16799 | 4700 | 27590 | 3672 | 32980 | 2938 | 36461 | 2344 | 41334 | 1360 | 51467 | 1136 | 38137 |
| 12-#11 | 1.53 | MA | 14902 | 3926 | 22025 | 3240 | 26144 | 2627 | 28236 | 2164 | 30448 | 1473 | 37250 | 1361 | 19895 |
| 2L-6S | | MI | 11653 | 3926 | 17605 | 3234 | 20498 | 2627 | 21537 | 2160 | 21862 | 1471 | 26432 | 1042 | 17543 |
| 12-#11 | 1.53 | MA | 14066 | 3926 | 20941 | 3240 | 24769 | 2625 | 26570 | 2171 | 28218 | 1479 | 34285 | 1270 | 19862 |
| 3L-5S | | MI | 12150 | 3926 | 18288 | 3235 | 21408 | 2619 | 22644 | 2163 | 23305 | 1466 | 28349 | 1118 | 18111 |
| 12-#11 | 1.53 | MA | 13458 | 3926 | 20132 | 3239 | 23676 | 2634 | 25246 | 2168 | 26449 | 1473 | 32338 | 1178 | 19761 |
| 4E | | MI | 12668 | 3926 | 19055 | 3225 | 22328 | 2621 | 23767 | 2157 | 24805 | 1461 | 30256 | 1161 | 18556 |
| 12-#11 | 1.53 | MA | 12905 | 3926 | 19313 | 3250 | 22693 | 2632 | 24047 | 2175 | 24835 | 1479 | 30286 | 1134 | 19278 |
| 5L-3S | | MI | 13239 | 3926 | 19812 | 3226 | 23351 | 2613 | 25007 | 2161 | 26449 | 1466 | 32057 | 1252 | 18641 |
| 12-#11 | 1.53 | MA | 12375 | 3926 | 18585 | 3249 | 21723 | 2641 | 22866 | 2172 | 23282 | 1484 | 28217 | 1059 | 18649 |
| 6L-2S | | MI | 14019 | 3926 | 20825 | 3226 | 24636 | 2616 | 26564 | 2154 | 28520 | 1461 | 34803 | 1344 | 18666 |
| 12-#14 | 2.21 | MA | 16151 | 4227 | 24898 | 3416 | 29707 | 2754 | 32518 | 2243 | 36056 | 1444 | 44629 | 1297 | 28212 |
| 2L-6S | | MI | 11879 | 4227 | 18903 | 3411 | 22042 | 2757 | 23368 | 2236 | 24255 | 1443 | 29749 | 841 | 23643 |
| 12-#14 | 2.21 | MA | 14987 | 4227 | 23349 | 3415 | 27742 | 2751 | 30138 | 2252 | 32887 | 1451 | 40426 | 1166 | 28085 |
| 3L-5S | | MI | 12572 | 4227 | 19880 | 3412 | 23344 | 2746 | 24952 | 2243 | 26304 | 1436 | 32463 | 950 | 24663 |
| 12-#14 | 2.21 | MA | 14140 | 4227 | 22191 | 3414 | 26178 | 2763 | 28243 | 2247 | 30372 | 1444 | 37668 | 1034 | 27684 |
| 4E | | MI | 13293 | 4227 | 20978 | 3399 | 24662 | 2750 | 26560 | 2235 | 28434 | 1428 | 35170 | 1011 | 25929 |
| 12-#14 | 2.21 | MA | 13371 | 4227 | 21019 | 3428 | 24771 | 2760 | 26526 | 2256 | 28077 | 1451 | 34752 | 971 | 26285 |
| 5L-3S | | MI | 14087 | 4227 | 22062 | 3400 | 26125 | 2739 | 28333 | 2241 | 30769 | 1436 | 37717 | 1143 | 26323 |
| 12-#14 | 2.21 | MA | 12632 | 4227 | 19976 | 3428 | 23381 | 2772 | 24834 | 2250 | 25870 | 1458 | 31818 | 862 | 25185 |
| 6L-2S | | MI | 15174 | 4227 | 23508 | 3402 | 27960 | 2743 | 30556 | 2233 | 33710 | 1428 | 41606 | 1274 | 26434 |
| 12-#18 | 3.92 | MA | 17128 | 4991 | 29278 | 3866 | 35104 | 3076 | 38989 | 2461 | 44335 | 1373 | 55390 | 881 | 48130 |
| 3L-5S | | MI | 13550 | 4991 | 23774 | 3865 | 28116 | 3068 | 30592 | 2440 | 33642 | 1349 | 42458 | 504 | 39332 |
| 12-#18 | 3.92 | MA | 15726 | 4991 | 27252 | 3862 | 32367 | 3094 | 35673 | 2448 | 39992 | 1359 | 50669 | 648 | 44800 |
| 4E | | MI | 14743 | 4991 | 25696 | 3844 | 30422 | 3078 | 33383 | 2427 | 37312 | 1335 | 47103 | 612 | 41869 |
| 12-#18 | 3.92 | MA | 14455 | 4991 | 25197 | 3885 | 29901 | 3086 | 32664 | 2462 | 36030 | 1373 | 45636 | 540 | 42092 |
| 5L-3S | | MI | 16057 | 4991 | 27590 | 3849 | 32980 | 3061 | 36461 | 2440 | 41334 | 1349 | 51467 | 842 | 45004 |
| 12-#18 | 3.92 | MA | 13234 | 4991 | 23368 | 3881 | 27465 | 3104 | 29700 | 2449 | 32221 | 1386 | 40600 | 345 | 39055 |
| 6L-2S | | MI | 17853 | 4991 | 30111 | 3854 | 36178 | 3071 | 40312 | 2427 | 46401 | 1335 | 58128 | 1076 | 45539 |
| 14-#11 | 1.78 | MA | 15405 | 4040 | 23109 | 3311 | 27519 | 2679 | 29902 | 2197 | 32677 | 1467 | 40214 | 1344 | 23105 |
| 2L-7S | | MI | 11664 | 4040 | 17954 | 3304 | 20904 | 2677 | 22021 | 2199 | 22470 | 1459 | 27479 | 953 | 19776 |
| 14-#11 | 1.78 | MA | 14578 | 4040 | 22025 | 3310 | 26144 | 2677 | 28236 | 2204 | 30448 | 1472 | 37250 | 1253 | 23054 |
| 3L-6S | | MI | 12146 | 4040 | 18618 | 3305 | 21783 | 2679 | 23094 | 2192 | 23933 | 1464 | 29179 | 1024 | 20436 |
| 14-#11 | 1.78 | MA | 13976 | 4040 | 21216 | 3310 | 25051 | 2685 | 26912 | 2201 | 28679 | 1467 | 35302 | 1162 | 22931 |
| 4L-5S | | MI | 12637 | 4040 | 19301 | 3306 | 22693 | 2671 | 24201 | 2196 | 25376 | 1459 | 31096 | 1100 | 20979 |
| 14-#11 | 1.78 | MA | 13430 | 4040 | 20397 | 3320 | 24068 | 2684 | 25713 | 2208 | 27064 | 1472 | 33250 | 1118 | 22351 |
| 5L-4S | | MI | 13149 | 4040 | 20068 | 3296 | 23613 | 2673 | 25324 | 2190 | 26876 | 1454 | 33002 | 1143 | 21520 |
| 14-#11 | 1.78 | MA | 12907 | 4040 | 19669 | 3320 | 23098 | 2692 | 24532 | 2204 | 25512 | 1477 | 31181 | 1042 | 21750 |
| 6L-3S | | MI | 13713 | 4040 | 20825 | 3297 | 24636 | 2665 | 26564 | 2194 | 28520 | 1459 | 34803 | 1234 | 21627 |
| 14-#11 | 1.78 | MA | 12394 | 4040 | 18960 | 3320 | 22160 | 2691 | 23386 | 2211 | 23937 | 1472 | 29344 | 971 | 21035 |
| 7L-2S | | MI | 14486 | 4040 | 21838 | 3297 | 25921 | 2667 | 28121 | 2187 | 30591 | 1454 | 37550 | 1325 | 21669 |
| 14-#14 | 2.57 | MA | 16839 | 4391 | 26447 | 3518 | 31672 | 2829 | 34898 | 2290 | 39225 | 1433 | 48832 | 1271 | 32781 |
| 2L-7S | | MI | 11895 | 4391 | 19398 | 3511 | 22619 | 2827 | 24055 | 2292 | 25119 | 1424 | 31235 | 709 | 26399 |
| 14-#14 | 2.57 | MA | 15691 | 4391 | 24898 | 3517 | 29707 | 2826 | 32518 | 2299 | 36056 | 1441 | 44629 | 1139 | 32620 |
| 3L-6S | | MI | 12564 | 4391 | 20350 | 3513 | 23877 | 2831 | 25591 | 2284 | 27197 | 1431 | 33639 | 812 | 27667 |
| 14-#14 | 2.57 | MA | 14856 | 4391 | 23740 | 3516 | 28143 | 2838 | 30623 | 2294 | 33541 | 1433 | 41872 | 1008 | 32020 |
| 4L-5S | | MI | 13246 | 4391 | 21327 | 3514 | 25179 | 2820 | 27175 | 2290 | 29245 | 1424 | 36353 | 921 | 28769 |
| 14-#14 | 2.57 | MA | 14098 | 4391 | 22568 | 3531 | 26736 | 2835 | 28906 | 2303 | 31246 | 1441 | 38955 | 945 | 30690 |
| 5L-4S | | MI | 13957 | 4391 | 22425 | 3501 | 26497 | 2824 | 28783 | 2282 | 31375 | 1417 | 39059 | 982 | 29970 |
| 14-#14 | 2.57 | MA | 13371 | 4391 | 21525 | 3530 | 25346 | 2846 | 27215 | 2298 | 29039 | 1448 | 36022 | 836 | 29510 |
| 6L-3S | | MI | 14740 | 4391 | 23508 | 3502 | 27960 | 2814 | 30556 | 2289 | 33710 | 1424 | 41606 | 1114 | 30559 |

## RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis



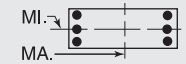

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.57 | MA | 12659 | 4391 | 20509 | 3529 | 24003 | 2843 | 25574 | 2307 | 26801 | 1441 | 33420 | 733 | 28115 |
| 7L-2S | | MI | 15813 | 4391 | 24955 | 3504 | 29795 | 2818 | 32780 | 2280 | 36651 | 1417 | 45495 | 1245 | 30702 |
| 14-#18 | 4.58 | MA | 16904 | 5282 | 29954 | 4044 | 35795 | 3227 | 39825 | 2532 | 45463 | 1337 | 57887 | 593 | 52415 |
| 4L-5S | | MI | 14665 | 5282 | 26295 | 4047 | 31313 | 3201 | 34443 | 2523 | 38709 | 1324 | 49119 | 444 | 46274 |
| 14-#18 | 4.58 | MA | 15659 | 5282 | 27900 | 4067 | 33329 | 3219 | 36817 | 2546 | 41501 | 1350 | 52854 | 485 | 49566 |
| 5L-4S | | MI | 15835 | 5282 | 28217 | 4025 | 33620 | 3211 | 37235 | 2509 | 42378 | 1311 | 53764 | 552 | 48956 |
| 14-#18 | 4.58 | MA | 14463 | 5282 | 26071 | 4063 | 30893 | 3237 | 33853 | 2533 | 37691 | 1364 | 47818 | 291 | 46543 |
| 6L-3S | | MI | 17123 | 5282 | 30111 | 4030 | 36178 | 3194 | 40312 | 2523 | 46401 | 1324 | 58128 | 782 | 52314 |
| 16-#11 | 2.04 | MA | 15901 | 4153 | 24193 | 3382 | 28893 | 2730 | 31567 | 2230 | 34906 | 1461 | 43179 | 1327 | 26310 |
| 2L-8S | | MI | 11685 | 4153 | 18312 | 3375 | 21328 | 2726 | 22502 | 2228 | 23130 | 1457 | 28447 | 884 | 21924 |
| 16-#11 | 2.04 | MA | 15082 | 4153 | 23109 | 3381 | 27519 | 2729 | 29902 | 2237 | 32677 | 1466 | 40214 | 1236 | 26243 |
| 3L-7S | | MI | 12155 | 4153 | 18967 | 3375 | 22189 | 2729 | 23578 | 2232 | 24542 | 1452 | 30226 | 934 | 22624 |
| 16-#11 | 2.04 | MA | 14487 | 4153 | 22300 | 3381 | 26426 | 2737 | 28578 | 2233 | 30908 | 1461 | 38267 | 1145 | 26099 |
| 4L-6S | | MI | 12631 | 4153 | 19632 | 3376 | 23068 | 2731 | 24651 | 2225 | 26005 | 1457 | 31926 | 1005 | 23336 |
| 16-#11 | 2.04 | MA | 13947 | 4153 | 21481 | 3391 | 25443 | 2736 | 27378 | 2241 | 29293 | 1466 | 36215 | 1101 | 25433 |
| 5E | | MI | 13117 | 4153 | 20314 | 3377 | 23978 | 2723 | 25758 | 2229 | 27447 | 1452 | 33842 | 1081 | 23855 |
| 16-#11 | 2.04 | MA | 13430 | 4153 | 20753 | 3391 | 24473 | 2744 | 26197 | 2237 | 27741 | 1471 | 34146 | 1025 | 24856 |
| 6L-4S | | MI | 13623 | 4153 | 21081 | 3367 | 24898 | 2725 | 26881 | 2223 | 28947 | 1447 | 35749 | 1124 | 24480 |
| 16-#11 | 2.04 | MA | 12923 | 4153 | 20044 | 3391 | 23535 | 2743 | 25052 | 2244 | 26166 | 1466 | 32309 | 954 | 24090 |
| 7L-3S | | MI | 14182 | 4153 | 21838 | 3367 | 25921 | 2717 | 28121 | 2227 | 30591 | 1452 | 37550 | 1216 | 24607 |
| 16-#11 | 2.04 | MA | 12422 | 4153 | 19346 | 3391 | 22616 | 2741 | 23904 | 2241 | 24647 | 1471 | 30393 | 903 | 23320 |
| 8L-2S | | MI | 14947 | 4153 | 22852 | 3368 | 27206 | 2719 | 29677 | 2220 | 32663 | 1447 | 40296 | 1307 | 24665 |
| 16-#14 | 2.94 | MA | 16383 | 4555 | 26447 | 3620 | 31672 | 2901 | 34898 | 2347 | 39225 | 1431 | 48832 | 1113 | 37151 |
| 3L-7S | | MI | 12577 | 4555 | 20845 | 3613 | 24454 | 2902 | 26278 | 2340 | 28060 | 1412 | 35124 | 680 | 30485 |
| 16-#14 | 2.94 | MA | 15559 | 4555 | 25289 | 3619 | 30108 | 2913 | 33003 | 2341 | 36710 | 1423 | 46075 | 981 | 36374 |
| 4L-6S | | MI | 13236 | 4555 | 21797 | 3615 | 25712 | 2906 | 27815 | 2331 | 30138 | 1420 | 37528 | 783 | 31706 |
| 16-#14 | 2.94 | MA | 14812 | 4555 | 24117 | 3633 | 28700 | 2909 | 31286 | 2351 | 34415 | 1431 | 43159 | 919 | 35105 |
| 5E | | MI | 13909 | 4555 | 22774 | 3617 | 27014 | 2895 | 29399 | 2338 | 32187 | 1412 | 40242 | 892 | 32887 |
| 16-#14 | 2.94 | MA | 14096 | 4555 | 23074 | 3632 | 27311 | 2921 | 29595 | 2345 | 32208 | 1438 | 40225 | 810 | 33848 |
| 6L-4S | | MI | 14610 | 4555 | 23872 | 3603 | 28332 | 2899 | 31006 | 2329 | 34317 | 1405 | 42949 | 953 | 34028 |
| 16-#14 | 2.94 | MA | 13394 | 4555 | 22058 | 3631 | 25967 | 2918 | 27954 | 2355 | 29970 | 1431 | 37623 | 707 | 32501 |
| 7L-3S | | MI | 15382 | 4555 | 24955 | 3605 | 29795 | 2888 | 32780 | 2336 | 36651 | 1412 | 45495 | 1085 | 34790 |
| 16-#14 | 2.94 | MA | 12700 | 4555 | 21058 | 3630 | 24651 | 2915 | 26310 | 2349 | 27810 | 1438 | 34901 | 634 | 30712 |
| 8L-2S | | MI | 16442 | 4555 | 26402 | 3606 | 31630 | 2892 | 35003 | 2328 | 39593 | 1405 | 49385 | 1216 | 34963 |
| 16-#18 | 5.23 | MA | 16934 | 5572 | 30603 | 4248 | 36757 | 3352 | 40970 | 2630 | 46971 | 1328 | 60072 | 431 | 57070 |
| 5E | | MI | 15759 | 5572 | 28816 | 4229 | 34510 | 3334 | 38294 | 2605 | 43775 | 1299 | 55780 | 384 | 53246 |
| 16-#18 | 5.23 | MA | 15666 | 5572 | 28774 | 4245 | 34321 | 3370 | 38005 | 2617 | 43162 | 1342 | 55036 | 236 | 53974 |
| 6L-4S | | MI | 16906 | 5572 | 30738 | 4207 | 36817 | 3344 | 41086 | 2592 | 47445 | 1286 | 60425 | 493 | 56070 |
| 18-#11 | 2.29 | MA | 15580 | 4267 | 24193 | 3452 | 28893 | 2781 | 31567 | 2270 | 34906 | 1460 | 43179 | 1219 | 29427 |
| 3L-8S | | MI | 12173 | 4267 | 19326 | 3446 | 22613 | 2778 | 24059 | 2261 | 25202 | 1450 | 31193 | 865 | 24802 |
| 18-#11 | 2.29 | MA | 14991 | 4267 | 23384 | 3452 | 27801 | 2789 | 30243 | 2266 | 33137 | 1454 | 41231 | 1128 | 29265 |
| 4L-7S | | MI | 12638 | 4267 | 19980 | 3446 | 23474 | 2781 | 25134 | 2265 | 26613 | 1445 | 32972 | 916 | 25480 |
| 18-#11 | 2.29 | MA | 14457 | 4267 | 22566 | 3462 | 26818 | 2787 | 29044 | 2273 | 31523 | 1460 | 39180 | 1084 | 28523 |
| 5L-6S | | MI | 13109 | 4267 | 20645 | 3447 | 24353 | 2783 | 26208 | 2258 | 28076 | 1450 | 34672 | 987 | 26240 |
| 18-#11 | 2.29 | MA | 13945 | 4267 | 21838 | 3462 | 25848 | 2796 | 27863 | 2270 | 29970 | 1465 | 37110 | 1008 | 27967 |
| 6L-5S | | MI | 13590 | 4267 | 21327 | 3447 | 25263 | 2775 | 27314 | 2262 | 29519 | 1445 | 36589 | 1063 | 26740 |
| 18-#11 | 2.29 | MA | 13444 | 4267 | 21129 | 3462 | 24910 | 2794 | 26718 | 2277 | 28396 | 1460 | 35273 | 937 | 27153 |
| 7L-4S | | MI | 14091 | 4267 | 22094 | 3438 | 26183 | 2777 | 28438 | 2256 | 31019 | 1439 | 38495 | 1106 | 27439 |
| 18-#11 | 2.29 | MA | 12948 | 4267 | 20430 | 3462 | 23991 | 2793 | 25570 | 2274 | 26877 | 1465 | 33358 | 886 | 26405 |
| 8L-3S | | MI | 14643 | 4267 | 22852 | 3438 | 27206 | 2769 | 29677 | 2259 | 32663 | 1445 | 40296 | 1197 | 27583 |
| 18-#11 | 2.29 | MA | 12456 | 4267 | 19660 | 3472 | 23044 | 2801 | 24441 | 2281 | 25372 | 1470 | 31482 | 827 | 25333 |
| 9L-2S | | MI | 15402 | 4267 | 23865 | 3439 | 28491 | 2771 | 31234 | 2253 | 34734 | 1439 | 43043 | 1288 | 27657 |
| 18-#14 | 3.31 | MA | 16251 | 4718 | 26839 | 3721 | 32072 | 2987 | 35384 | 2389 | 39879 | 1413 | 50279 | 955 | 40743 |
| 4L-7S | | MI | 13247 | 4718 | 22292 | 3716 | 26289 | 2977 | 28501 | 2387 | 31002 | 1401 | 39013 | 651 | 34568 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis

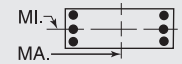



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 3.31 | MA | 15515 | 4718 | 25666 | 3735 | 30665 | 2984 | 33666 | 2398 | 37584 | 1420 | 47362 | 892 | 39531 |
| 5L-6S | | MI | 13897 | 4718 | 23244 | 3717 | 27547 | 2981 | 30038 | 2379 | 33080 | 1408 | 41417 | 754 | 35758 |
| 18-#14 | 3.31 | MA | 14808 | 4718 | 24623 | 3734 | 29275 | 2996 | 31975 | 2393 | 35377 | 1428 | 44428 | 783 | 38199 |
| 6L-5S | | MI | 14561 | 4718 | 24221 | 3719 | 28849 | 2970 | 31622 | 2385 | 35128 | 1401 | 44131 | 863 | 37014 |
| 18-#14 | 3.31 | MA | 14116 | 4718 | 23607 | 3733 | 27932 | 2993 | 30334 | 2402 | 33139 | 1420 | 41827 | 680 | 36897 |
| 7L-4S | | MI | 15253 | 4718 | 25319 | 3705 | 30167 | 2974 | 33230 | 2377 | 37258 | 1393 | 46838 | 924 | 38102 |
| 18-#14 | 3.31 | MA | 13433 | 4718 | 22607 | 3733 | 26615 | 2990 | 28690 | 2396 | 30979 | 1428 | 39104 | 608 | 35067 |
| 8L-3S | | MI | 16015 | 4718 | 26402 | 3707 | 31630 | 2963 | 35003 | 2383 | 39593 | 1401 | 49385 | 1056 | 39017 |
| 18-#18 | 5.88 | MA | 16950 | 5863 | 31476 | 4427 | 37748 | 3503 | 42158 | 2701 | 48632 | 1319 | 62254 | 181 | 61429 |
| 6L-5S | | MI | 16910 | 5863 | 31337 | 4410 | 37708 | 3467 | 42146 | 2688 | 48842 | 1274 | 62441 | 324 | 60246 |
| 20-#11 | 2.55 | MA | 15488 | 4380 | 24468 | 3523 | 29176 | 2841 | 31909 | 2299 | 35366 | 1448 | 44196 | 1111 | 32429 |
| 4L-8S | | MI | 12655 | 4380 | 20339 | 3516 | 23898 | 2830 | 25616 | 2293 | 27273 | 1443 | 33940 | 847 | 27647 |
| 20-#11 | 2.55 | MA | 14960 | 4380 | 23650 | 3533 | 28193 | 2839 | 30710 | 2306 | 33752 | 1453 | 42144 | 1067 | 31620 |
| 5L-7S | | MI | 13115 | 4380 | 20993 | 3517 | 24759 | 2832 | 26691 | 2297 | 28684 | 1437 | 35719 | 897 | 28342 |
| 20-#11 | 2.55 | MA | 14453 | 4380 | 22922 | 3533 | 27223 | 2848 | 29529 | 2303 | 32199 | 1458 | 40075 | 992 | 31082 |
| 6E | | MI | 13581 | 4380 | 21658 | 3518 | 25638 | 2835 | 27765 | 2291 | 30147 | 1443 | 37419 | 968 | 29148 |
| 20-#11 | 2.55 | MA | 13958 | 4380 | 22213 | 3533 | 26285 | 2846 | 28383 | 2310 | 30625 | 1453 | 38238 | 921 | 30223 |
| 7L-5S | | MI | 14057 | 4380 | 22340 | 3518 | 26548 | 2827 | 28871 | 2295 | 31590 | 1437 | 39335 | 1044 | 29630 |
| 20-#11 | 2.55 | MA | 13468 | 4380 | 21515 | 3533 | 25366 | 2845 | 27236 | 2307 | 29106 | 1458 | 36322 | 869 | 29479 |
| 8L-4S | | MI | 14553 | 4380 | 23108 | 3509 | 27468 | 2829 | 29995 | 2288 | 33090 | 1432 | 41242 | 1087 | 30395 |
| 20-#11 | 2.55 | MA | 12981 | 4380 | 20744 | 3543 | 24419 | 2853 | 26106 | 2314 | 27602 | 1464 | 34447 | 810 | 28396 |
| 9L-3S | | MI | 15100 | 4380 | 23865 | 3509 | 28491 | 2821 | 31234 | 2292 | 34734 | 1437 | 43043 | 1179 | 30557 |
| 20-#14 | 3.68 | MA | 16207 | 4882 | 27215 | 3837 | 32630 | 3059 | 36047 | 2445 | 40753 | 1410 | 51565 | 866 | 43964 |
| 5L-7S | | MI | 13907 | 4882 | 23739 | 3818 | 28124 | 3052 | 30724 | 2434 | 33943 | 1389 | 42903 | 622 | 38583 |
| 20-#14 | 3.68 | MA | 15510 | 4882 | 26172 | 3836 | 31240 | 3071 | 34355 | 2440 | 38546 | 1417 | 48632 | 752 | 42560 |
| 6E | | MI | 14548 | 4882 | 24691 | 3819 | 29382 | 3056 | 32261 | 2426 | 36021 | 1397 | 45307 | 725 | 39821 |
| 20-#14 | 3.68 | MA | 14827 | 4882 | 25156 | 3836 | 29897 | 3068 | 32715 | 2449 | 36308 | 1410 | 46030 | 654 | 41243 |
| 7L-5S | | MI | 15203 | 4882 | 25668 | 3821 | 30684 | 3045 | 33845 | 2433 | 38069 | 1389 | 48021 | 834 | 41148 |
| 20-#14 | 3.68 | MA | 14153 | 4882 | 24156 | 3835 | 28580 | 3064 | 31070 | 2444 | 34148 | 1417 | 43308 | 581 | 39431 |
| 8L-4S | | MI | 15886 | 4882 | 26766 | 3808 | 32002 | 3049 | 35453 | 2424 | 40199 | 1382 | 50727 | 895 | 42190 |
| 22-#11 | 2.80 | MA | 15456 | 4494 | 24734 | 3604 | 29568 | 2891 | 32375 | 2339 | 35981 | 1447 | 45109 | 1050 | 34723 |
| 5L-8S | | MI | 13131 | 4494 | 21352 | 3587 | 25183 | 2882 | 27172 | 2326 | 29344 | 1435 | 36686 | 828 | 30482 |
| 22-#11 | 2.80 | MA | 14955 | 4494 | 24006 | 3604 | 28597 | 2900 | 31194 | 2336 | 34429 | 1452 | 43039 | 975 | 34201 |
| 6L-7S | | MI | 13586 | 4494 | 22007 | 3588 | 26044 | 2884 | 28248 | 2330 | 30756 | 1430 | 38465 | 879 | 31211 |
| 22-#11 | 2.80 | MA | 14465 | 4494 | 23297 | 3604 | 27660 | 2898 | 30049 | 2343 | 32854 | 1447 | 41202 | 904 | 33298 |
| 7L-6S | | MI | 14047 | 4494 | 22671 | 3589 | 26923 | 2887 | 29321 | 2324 | 32219 | 1435 | 40165 | 950 | 32059 |
| 22-#11 | 2.80 | MA | 13980 | 4494 | 22599 | 3603 | 26741 | 2896 | 28901 | 2340 | 31335 | 1452 | 39287 | 852 | 32521 |
| 8L-5S | | MI | 14518 | 4494 | 23354 | 3589 | 27833 | 2878 | 30428 | 2328 | 33661 | 1430 | 42082 | 1026 | 32527 |
| 22-#11 | 2.80 | MA | 13498 | 4494 | 21828 | 3614 | 25794 | 2905 | 27772 | 2347 | 29831 | 1457 | 37411 | 793 | 31464 |
| 9L-4S | | MI | 15009 | 4494 | 24121 | 3579 | 28753 | 2881 | 31551 | 2321 | 35161 | 1425 | 43988 | 1069 | 33350 |
| 22-#14 | 4.04 | MA | 16202 | 5045 | 27721 | 3939 | 33205 | 3146 | 36735 | 2487 | 41715 | 1407 | 52835 | 731 | 46932 |
| 6L-7S | | MI | 14558 | 5045 | 25186 | 3920 | 29959 | 3127 | 32947 | 2482 | 36884 | 1378 | 46792 | 593 | 42609 |
| 22-#14 | 4.04 | MA | 15528 | 5045 | 26705 | 3938 | 31861 | 3142 | 35095 | 2497 | 39477 | 1400 | 50233 | 628 | 45569 |
| 7L-6S | | MI | 15191 | 5045 | 26138 | 3922 | 31217 | 3131 | 34484 | 2473 | 38962 | 1385 | 49196 | 696 | 43894 |
| 22-#14 | 4.04 | MA | 14862 | 5045 | 25705 | 3937 | 30545 | 3139 | 33451 | 2491 | 37317 | 1407 | 47511 | 555 | 43803 |
| 8L-5S | | MI | 15838 | 5045 | 27115 | 3923 | 32519 | 3120 | 36068 | 2480 | 41011 | 1378 | 51910 | 805 | 45290 |
| 24-#11 | 3.06 | MA | 15451 | 4607 | 25090 | 3675 | 29972 | 2952 | 32860 | 2369 | 36658 | 1446 | 46004 | 958 | 37323 |
| 6L-8S | | MI | 13601 | 4607 | 22365 | 3658 | 26468 | 2934 | 28729 | 2359 | 31416 | 1428 | 39433 | 810 | 33322 |
| 24-#11 | 3.06 | MA | 14966 | 4607 | 24381 | 3675 | 29035 | 2950 | 31715 | 2376 | 35083 | 1440 | 44167 | 887 | 36379 |
| 7E | | MI | 14052 | 4607 | 23020 | 3659 | 27329 | 2936 | 29805 | 2363 | 32827 | 1423 | 41212 | 860 | 34084 |
| 24-#11 | 3.06 | MA | 14486 | 4607 | 23683 | 3674 | 28116 | 2948 | 30567 | 2372 | 33564 | 1446 | 42251 | 836 | 35570 |
| 8L-6S | | MI | 14508 | 4607 | 23684 | 3659 | 28208 | 2938 | 30878 | 2357 | 34290 | 1428 | 42912 | 932 | 34974 |
| 24-#11 | 3.06 | MA | 14009 | 4607 | 22912 | 3685 | 27168 | 2957 | 29438 | 2380 | 32060 | 1451 | 40376 | 777 | 34537 |
| 9L-5S | | MI | 14974 | 4607 | 24367 | 3660 | 29118 | 2930 | 31985 | 2361 | 35733 | 1423 | 44828 | 1007 | 35428 |
| 24-#14 | 4.41 | MA | 16220 | 5209 | 28255 | 4040 | 33826 | 3217 | 37475 | 2544 | 42646 | 1390 | 54437 | 601 | 49904 |
| 7E | | MI | 15200 | 5209 | 26633 | 4022 | 31794 | 3201 | 35170 | 2529 | 39826 | 1366 | 50681 | 564 | 46643 |
| 24-#14 | 4.41 | MA | 15562 | 5209 | 27254 | 4039 | 32509 | 3214 | 35831 | 2539 | 40486 | 1397 | 51715 | 529 | 48182 |
| 8L-6S | | MI | 15825 | 5209 | 27585 | 4024 | 33052 | 3205 | 36707 | 2521 | 41904 | 1374 | 53085 | 667 | 47976 |

## RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

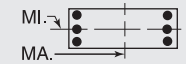
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.24 | MA | 15866 | 4008 | 23229 | 3311 | 27304 | 2691 | 29179 | 2228 | 30711 | 1543 | 37127 | 1430 | 17897 |
| 2E | | MI | 14093 | 4008 | 20860 | 3280 | 24333 | 2666 | 25863 | 2203 | 27023 | 1517 | 32493 | 1395 | 15816 |
| 6-#14 | 1.04 | MA | 15516 | 3917 | 22241 | 3278 | 26219 | 2669 | 27937 | 2219 | 29214 | 1569 | 35242 | 1471 | 15341 |
| 2L-3S | | MI | 12665 | 3917 | 18545 | 3248 | 21562 | 2642 | 22620 | 2207 | 22837 | 1553 | 27064 | 1310 | 13602 |
| 6-#14 | 1.04 | MA | 14216 | 3917 | 20590 | 3278 | 24125 | 2667 | 25400 | 2229 | 25817 | 1576 | 30724 | 1339 | 15339 |
| 3L-2S | | MI | 13801 | 3917 | 19992 | 3250 | 23397 | 2646 | 24844 | 2199 | 25778 | 1546 | 30953 | 1441 | 13582 |
| 6-#18 | 1.86 | MA | 17199 | 4299 | 26114 | 3493 | 30962 | 2824 | 33610 | 2313 | 36585 | 1524 | 44902 | 1380 | 26463 |
| 2L-3S | | MI | 13324 | 4299 | 20860 | 3457 | 24333 | 2789 | 25863 | 2299 | 27023 | 1505 | 32493 | 1101 | 23129 |
| 6-#18 | 1.86 | MA | 15005 | 4299 | 23229 | 3491 | 27304 | 2817 | 29179 | 2328 | 30711 | 1537 | 37127 | 1147 | 26197 |
| 3L-2S | | MI | 15240 | 4299 | 23381 | 3462 | 27530 | 2798 | 29714 | 2286 | 32090 | 1492 | 39154 | 1335 | 23321 |
| 8-#14 | 1.39 | MA | 16304 | 4081 | 23893 | 3381 | 28313 | 2744 | 30475 | 2266 | 32611 | 1559 | 39760 | 1447 | 20258 |
| 2L-4S | | MI | 12540 | 4081 | 18908 | 3349 | 21933 | 2728 | 23070 | 2248 | 23444 | 1534 | 28406 | 1150 | 17714 |
| 8-#14 | 1.39 | MA | 15024 | 4081 | 22241 | 3380 | 26219 | 2742 | 27937 | 2276 | 29214 | 1567 | 35242 | 1315 | 20208 |
| 3E | | MI | 13361 | 4081 | 19992 | 3351 | 23397 | 2717 | 24844 | 2255 | 25778 | 1542 | 30953 | 1281 | 17876 |
| 8-#14 | 1.39 | MA | 14090 | 4081 | 21010 | 3380 | 24555 | 2754 | 25920 | 2272 | 26518 | 1559 | 32274 | 1184 | 19981 |
| 4L-2S | | MI | 14481 | 4081 | 21438 | 3352 | 25232 | 2721 | 27067 | 2246 | 28720 | 1534 | 34842 | 1412 | 17900 |
| 8-#18 | 2.48 | MA | 18489 | 4590 | 28998 | 3675 | 34620 | 2957 | 38042 | 2397 | 42460 | 1504 | 52678 | 1330 | 34982 |
| 2L-4S | | MI | 13097 | 4590 | 21486 | 3634 | 24972 | 2938 | 26637 | 2369 | 28067 | 1467 | 34790 | 812 | 28105 |
| 8-#18 | 2.48 | MA | 16343 | 4590 | 26114 | 3672 | 30962 | 2950 | 33610 | 2412 | 36585 | 1517 | 44902 | 1097 | 34594 |
| 3E | | MI | 14476 | 4590 | 23381 | 3639 | 27530 | 2922 | 29714 | 2382 | 32090 | 1481 | 39154 | 1042 | 30466 |
| 8-#18 | 2.48 | MA | 14776 | 4590 | 23955 | 3670 | 28046 | 2970 | 30077 | 2401 | 31923 | 1504 | 39808 | 863 | 31887 |
| 4L-2S | | MI | 16352 | 4590 | 25902 | 3644 | 30727 | 2931 | 33565 | 2369 | 37156 | 1467 | 45815 | 1275 | 30773 |
| 10-#11 | 1.21 | MA | 15930 | 3993 | 22973 | 3338 | 27233 | 2714 | 29203 | 2249 | 30991 | 1574 | 37659 | 1473 | 17728 |
| 2L-5S | | MI | 12269 | 3993 | 18094 | 3320 | 21063 | 2695 | 22044 | 2239 | 22127 | 1557 | 26621 | 1217 | 15405 |
| 10-#11 | 1.21 | MA | 15027 | 3993 | 21818 | 3338 | 25768 | 2713 | 27428 | 2257 | 28604 | 1579 | 34476 | 1382 | 17715 |
| 3L-4S | | MI | 12795 | 3993 | 18861 | 3310 | 21984 | 2698 | 23168 | 2233 | 23627 | 1552 | 28527 | 1261 | 15639 |
| 10-#11 | 1.21 | MA | 14371 | 3993 | 20958 | 3338 | 24606 | 2722 | 26020 | 2254 | 26709 | 1574 | 32383 | 1291 | 17640 |
| 4L-3S | | MI | 13373 | 3993 | 19618 | 3310 | 23007 | 2689 | 24407 | 2237 | 25271 | 1557 | 30328 | 1352 | 15686 |
| 10-#11 | 1.21 | MA | 13775 | 3993 | 20088 | 3349 | 23561 | 2721 | 24745 | 2262 | 24981 | 1579 | 30185 | 1246 | 17344 |
| 5L-2S | | MI | 14164 | 3993 | 20631 | 3311 | 24292 | 2692 | 25964 | 2230 | 27343 | 1552 | 33075 | 1443 | 15684 |
| 10-#14 | 1.74 | MA | 17075 | 4244 | 25544 | 3483 | 30408 | 2819 | 33012 | 2313 | 36007 | 1550 | 44278 | 1423 | 25152 |
| 2L-5S | | MI | 12498 | 4244 | 19257 | 3465 | 22451 | 2798 | 23686 | 2304 | 24255 | 1530 | 29589 | 1059 | 20757 |
| 10-#14 | 1.74 | MA | 15812 | 4244 | 23893 | 3483 | 28313 | 2816 | 30475 | 2324 | 32611 | 1558 | 39760 | 1291 | 25062 |
| 3L-4S | | MI | 13233 | 4244 | 20355 | 3451 | 23768 | 2802 | 25294 | 2296 | 26385 | 1523 | 32296 | 1121 | 21922 |
| 10-#14 | 1.74 | MA | 14894 | 4244 | 22661 | 3482 | 26649 | 2829 | 28458 | 2319 | 29915 | 1550 | 36792 | 1160 | 24785 |
| 4L-3S | | MI | 14043 | 4244 | 21438 | 3453 | 25232 | 2791 | 27067 | 2302 | 28720 | 1530 | 34842 | 1252 | 22134 |
| 10-#14 | 1.74 | MA | 14060 | 4244 | 21414 | 3497 | 25152 | 2826 | 26631 | 2329 | 27455 | 1558 | 33665 | 1096 | 23425 |
| 5L-2S | | MI | 15148 | 4244 | 22885 | 3454 | 27067 | 2795 | 29290 | 2294 | 31661 | 1523 | 38732 | 1383 | 22197 |
| 10-#18 | 3.10 | MA | 19744 | 4880 | 31883 | 3856 | 38278 | 3090 | 42474 | 2481 | 48335 | 1484 | 60453 | 1280 | 43476 |
| 2L-5S | | MI | 13020 | 4880 | 22086 | 3837 | 25863 | 3061 | 27696 | 2465 | 29464 | 1456 | 36806 | 643 | 32908 |
| 10-#18 | 3.10 | MA | 17642 | 4880 | 28998 | 3854 | 34620 | 3083 | 38042 | 2497 | 42460 | 1497 | 52678 | 1046 | 42984 |
| 3L-4S | | MI | 14247 | 4880 | 24007 | 3815 | 28169 | 3071 | 30488 | 2451 | 33134 | 1443 | 41451 | 752 | 35111 |
| 10-#18 | 3.10 | MA | 16111 | 4880 | 26840 | 3852 | 31704 | 3103 | 34509 | 2485 | 37797 | 1484 | 47584 | 813 | 39951 |
| 4L-3S | | MI | 15596 | 4880 | 25902 | 3820 | 30727 | 3055 | 33565 | 2465 | 37156 | 1456 | 45815 | 982 | 37792 |
| 10-#18 | 3.10 | MA | 14721 | 4880 | 24653 | 3876 | 29079 | 3096 | 31306 | 2501 | 33543 | 1497 | 42177 | 703 | 37420 |
| 5L-2S | | MI | 17435 | 4880 | 28423 | 3825 | 33925 | 3064 | 37416 | 2451 | 42223 | 1443 | 52476 | 1215 | 38197 |
| 12-#11 | 1.45 | MA | 16481 | 4107 | 24128 | 3409 | 28698 | 2766 | 30977 | 2282 | 33378 | 1569 | 40842 | 1458 | 21158 |
| 2L-6S | | MI | 12266 | 4107 | 18424 | 3390 | 21439 | 2755 | 22494 | 2268 | 22756 | 1555 | 27450 | 1123 | 17680 |
| 12-#11 | 1.45 | MA | 15587 | 4107 | 22973 | 3409 | 27233 | 2765 | 29203 | 2290 | 30991 | 1574 | 37659 | 1366 | 21125 |
| 3L-5S | | MI | 12765 | 4107 | 19107 | 3390 | 22348 | 2747 | 23601 | 2272 | 24199 | 1550 | 29367 | 1199 | 18258 |
| 12-#11 | 1.45 | MA | 14938 | 4107 | 22113 | 3409 | 26071 | 2774 | 27794 | 2287 | 29097 | 1569 | 35565 | 1275 | 21025 |
| 4E | | MI | 13285 | 4107 | 19874 | 3381 | 23269 | 2749 | 24724 | 2266 | 25699 | 1545 | 31274 | 1242 | 18611 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis

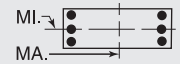


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.45 | MA | 14349 | 4107 | 21243 | 3420 | 25026 | 2772 | 26519 | 2295 | 27368 | 1574 | 33368 | 1230 | 20608 |
| 5L-3S | | MI | 13858 | 4107 | 20631 | 3381 | 24292 | 2741 | 25964 | 2270 | 27343 | 1550 | 33075 | 1333 | 18682 |
| 12-#11 | 1.45 | MA | 13784 | 4107 | 20469 | 3420 | 23995 | 2782 | 25264 | 2292 | 25705 | 1579 | 31146 | 1155 | 19906 |
| 6L-2S | | MI | 14641 | 4107 | 21644 | 3382 | 25577 | 2744 | 27521 | 2263 | 29414 | 1545 | 35821 | 1424 | 18701 |
| 12-#14 | 2.09 | MA | 17831 | 4408 | 27195 | 3585 | 32502 | 2894 | 35549 | 2361 | 39404 | 1541 | 48796 | 1399 | 30034 |
| 2L-6S | | MI | 12492 | 4408 | 19727 | 3565 | 22984 | 2884 | 24325 | 2345 | 25148 | 1526 | 30764 | 921 | 23952 |
| 12-#14 | 2.09 | MA | 16585 | 4408 | 25544 | 3585 | 30408 | 2891 | 33012 | 2371 | 36007 | 1549 | 44278 | 1267 | 29907 |
| 3L-5S | | MI | 13188 | 4408 | 20704 | 3567 | 24286 | 2873 | 25909 | 2351 | 27196 | 1519 | 33478 | 1030 | 24847 |
| 12-#14 | 2.09 | MA | 15680 | 4408 | 24312 | 3585 | 28743 | 2904 | 30995 | 2366 | 33312 | 1541 | 41310 | 1136 | 29587 |
| 4E | | MI | 13913 | 4408 | 21802 | 3554 | 25603 | 2877 | 27517 | 2343 | 29326 | 1511 | 36185 | 1092 | 26128 |
| 12-#14 | 2.09 | MA | 14859 | 4408 | 23065 | 3599 | 27247 | 2901 | 29168 | 2377 | 30852 | 1549 | 38183 | 1072 | 28111 |
| 5L-3S | | MI | 14711 | 4408 | 22885 | 3555 | 27067 | 2866 | 29290 | 2349 | 31661 | 1519 | 38732 | 1223 | 26381 |
| 12-#14 | 2.09 | MA | 14071 | 4408 | 21956 | 3599 | 25769 | 2914 | 27370 | 2372 | 28486 | 1556 | 35030 | 963 | 27071 |
| 6L-2S | | MI | 15801 | 4408 | 24332 | 3557 | 28902 | 2870 | 31513 | 2341 | 34602 | 1511 | 42621 | 1355 | 26478 |
| 12-#18 | 3.72 | MA | 18909 | 5171 | 31883 | 4036 | 38278 | 3216 | 42474 | 2581 | 48335 | 1477 | 60453 | 996 | 51370 |
| 3L-5S | | MI | 14166 | 5171 | 24607 | 4019 | 29060 | 3194 | 31548 | 2547 | 34531 | 1431 | 43467 | 583 | 39805 |
| 12-#18 | 3.72 | MA | 17410 | 5171 | 29724 | 4034 | 35363 | 3236 | 38941 | 2570 | 43672 | 1464 | 55359 | 763 | 48055 |
| 4E | | MI | 15367 | 5171 | 26528 | 3997 | 31366 | 3204 | 34339 | 2534 | 38200 | 1418 | 48112 | 692 | 42158 |
| 12-#18 | 3.72 | MA | 16050 | 5171 | 27537 | 4058 | 32738 | 3229 | 35738 | 2585 | 39418 | 1477 | 49952 | 653 | 45385 |
| 5L-3S | | MI | 16689 | 5171 | 28423 | 4002 | 33925 | 3188 | 37416 | 2547 | 42223 | 1431 | 52476 | 922 | 45111 |
| 12-#18 | 3.72 | MA | 14746 | 5171 | 25591 | 4055 | 30145 | 3249 | 32583 | 2574 | 35326 | 1490 | 44527 | 459 | 41986 |
| 6L-2S | | MI | 18496 | 5171 | 30944 | 4007 | 37122 | 3197 | 41268 | 2534 | 47290 | 1418 | 59137 | 1156 | 45604 |
| 14-#11 | 1.69 | MA | 17023 | 4220 | 25283 | 3480 | 30163 | 2818 | 32752 | 2315 | 35766 | 1563 | 44025 | 1442 | 24579 |
| 2L-7S | | MI | 12277 | 4220 | 18773 | 3460 | 21845 | 2805 | 22978 | 2308 | 23364 | 1543 | 28497 | 1033 | 20000 |
| 14-#11 | 1.69 | MA | 16138 | 4220 | 24128 | 3480 | 28698 | 2816 | 30977 | 2323 | 33378 | 1568 | 40842 | 1351 | 24529 |
| 3L-6S | | MI | 12760 | 4220 | 19438 | 3461 | 22724 | 2807 | 24051 | 2301 | 24827 | 1548 | 30197 | 1105 | 20573 |
| 14-#11 | 1.69 | MA | 15496 | 4220 | 23268 | 3480 | 27536 | 2826 | 29569 | 2320 | 31484 | 1563 | 38748 | 1260 | 24406 |
| 4L-5S | | MI | 13254 | 4220 | 20120 | 3461 | 23633 | 2799 | 25158 | 2305 | 26270 | 1543 | 32114 | 1180 | 21123 |
| 14-#11 | 1.69 | MA | 14914 | 4220 | 22398 | 3491 | 26491 | 2824 | 28294 | 2328 | 29755 | 1568 | 36551 | 1215 | 23884 |
| 5L-4S | | MI | 13768 | 4220 | 20887 | 3452 | 24554 | 2801 | 26281 | 2299 | 27770 | 1537 | 34020 | 1224 | 21579 |
| 14-#11 | 1.69 | MA | 14356 | 4220 | 21624 | 3491 | 25460 | 2833 | 27038 | 2325 | 28093 | 1573 | 34329 | 1140 | 23212 |
| 6L-3S | | MI | 14335 | 4220 | 21644 | 3452 | 25577 | 2793 | 27521 | 2303 | 29414 | 1543 | 35821 | 1315 | 21671 |
| 14-#11 | 1.69 | MA | 13809 | 4220 | 20871 | 3491 | 24463 | 2832 | 25821 | 2333 | 26407 | 1568 | 32354 | 1069 | 22539 |
| 7L-2S | | MI | 15110 | 4220 | 22658 | 3453 | 26862 | 2796 | 29078 | 2296 | 31485 | 1537 | 38568 | 1406 | 21706 |
| 14-#14 | 2.44 | MA | 18573 | 4571 | 28847 | 3687 | 34596 | 2968 | 38086 | 2408 | 42801 | 1532 | 53313 | 1374 | 34907 |
| 2L-7S | | MI | 12507 | 4571 | 20222 | 3666 | 23560 | 2955 | 25011 | 2400 | 26011 | 1507 | 32250 | 789 | 26675 |
| 14-#14 | 2.44 | MA | 17343 | 4571 | 27195 | 3687 | 32502 | 2966 | 35549 | 2419 | 39404 | 1540 | 48796 | 1243 | 34746 |
| 3L-6S | | MI | 13179 | 4571 | 21174 | 3668 | 24819 | 2959 | 26548 | 2392 | 28089 | 1515 | 34654 | 892 | 27971 |
| 14-#14 | 2.44 | MA | 16451 | 4571 | 25964 | 3687 | 30838 | 2978 | 33532 | 2414 | 36709 | 1532 | 45828 | 1112 | 34312 |
| 4L-5S | | MI | 13865 | 4571 | 22151 | 3669 | 26121 | 2948 | 28132 | 2399 | 30138 | 1507 | 37368 | 1001 | 28951 |
| 14-#14 | 2.44 | MA | 15642 | 4571 | 24717 | 3701 | 29341 | 2976 | 31706 | 2424 | 34249 | 1540 | 42701 | 1048 | 32811 |
| 5L-4S | | MI | 14579 | 4571 | 23249 | 3656 | 27438 | 2952 | 29740 | 2390 | 32268 | 1500 | 40074 | 1063 | 30184 |
| 14-#14 | 2.44 | MA | 14867 | 4571 | 23608 | 3701 | 27863 | 2988 | 29907 | 2419 | 31883 | 1547 | 39548 | 939 | 31690 |
| 6L-3S | | MI | 15367 | 4571 | 24332 | 3657 | 28902 | 2941 | 31513 | 2397 | 34602 | 1507 | 42621 | 1194 | 30621 |
| 14-#14 | 2.44 | MA | 14107 | 4571 | 22528 | 3701 | 26435 | 2986 | 28162 | 2430 | 29484 | 1540 | 36748 | 836 | 30136 |
| 7L-2S | | MI | 16444 | 4571 | 25779 | 3659 | 30737 | 2945 | 33736 | 2388 | 37544 | 1500 | 46510 | 1326 | 30749 |
| 14-#18 | 4.33 | MA | 18679 | 5462 | 32609 | 4215 | 39021 | 3369 | 43373 | 2654 | 49547 | 1444 | 63135 | 713 | 56194 |
| 4L-5S | | MI | 15286 | 5462 | 27128 | 4200 | 32257 | 3327 | 35399 | 2630 | 39598 | 1406 | 50128 | 524 | 46738 |
| 14-#18 | 4.33 | MA | 17348 | 5462 | 30422 | 4239 | 36396 | 3362 | 40170 | 2669 | 45292 | 1457 | 57728 | 603 | 53383 |
| 5L-4S | | MI | 16464 | 5462 | 29049 | 4179 | 34564 | 3337 | 38191 | 2617 | 43267 | 1393 | 54773 | 632 | 49239 |
| 14-#18 | 4.33 | MA | 16070 | 5462 | 28476 | 4237 | 33803 | 3382 | 37015 | 2658 | 41201 | 1471 | 52302 | 409 | 50113 |
| 6L-3S | | MI | 17761 | 5462 | 30944 | 4184 | 37122 | 3321 | 41268 | 2630 | 47290 | 1406 | 59137 | 862 | 52426 |
| 16-#11 | 1.93 | MA | 17558 | 4334 | 26438 | 3551 | 31628 | 2870 | 34527 | 2348 | 38153 | 1558 | 47207 | 1427 | 27995 |
| 2L-8S | | MI | 12297 | 4334 | 19132 | 3530 | 22268 | 2854 | 23459 | 2336 | 24024 | 1541 | 29465 | 964 | 22133 |
| 16-#11 | 1.93 | MA | 16681 | 4334 | 25283 | 3551 | 30163 | 2868 | 32752 | 2355 | 35766 | 1563 | 44025 | 1336 | 27927 |
| 3L-7S | | MI | 12769 | 4334 | 19786 | 3531 | 23130 | 2857 | 24534 | 2340 | 25436 | 1535 | 31244 | 1015 | 22845 |
| 16-#11 | 1.93 | MA | 16046 | 4334 | 24423 | 3551 | 29000 | 2877 | 31343 | 2353 | 33871 | 1558 | 41931 | 1245 | 27784 |
| 4L-6S | | MI | 13247 | 4334 | 20451 | 3532 | 24009 | 2859 | 25608 | 2334 | 26899 | 1541 | 32944 | 1086 | 23471 |

## RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

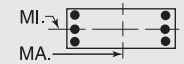
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.93 | MA | 15470 | 4334 | 23553 | 3562 | 27956 | 2876 | 30068 | 2360 | 32143 | 1563 | 39733 | 1200 | 27170 |
| 5E | | MI | 13736 | 4334 | 21133 | 3532 | 24918 | 2851 | 26714 | 2338 | 28341 | 1535 | 34860 | 1162 | 23998 |
| 16-#11 | 1.93 | MA | 14918 | 4334 | 22779 | 3562 | 26924 | 2885 | 28813 | 2358 | 30480 | 1568 | 37511 | 1124 | 26525 |
| 6L-4S | | MI | 14244 | 4334 | 21900 | 3522 | 25839 | 2853 | 27838 | 2331 | 29841 | 1530 | 36767 | 1205 | 24543 |
| 16-#11 | 1.93 | MA | 14378 | 4334 | 22026 | 3562 | 25928 | 2884 | 27596 | 2365 | 28794 | 1563 | 35537 | 1053 | 25799 |
| 7L-3S | | MI | 14805 | 4334 | 22658 | 3523 | 26862 | 2845 | 29078 | 2335 | 31485 | 1535 | 38568 | 1296 | 24654 |
| 16-#11 | 1.93 | MA | 13844 | 4334 | 21284 | 3562 | 24951 | 2883 | 26376 | 2363 | 27167 | 1568 | 33485 | 1001 | 24945 |
| 8L-2S | | MI | 15573 | 4334 | 23671 | 3524 | 28147 | 2847 | 30634 | 2329 | 33557 | 1530 | 41314 | 1387 | 24705 |
| 16-#14 | 2.79 | MA | 18089 | 4735 | 28847 | 3789 | 34596 | 3041 | 38086 | 2466 | 42801 | 1531 | 53313 | 1219 | 39581 |
| 3L-7S | | MI | 13191 | 4735 | 21669 | 3768 | 25395 | 3030 | 27234 | 2448 | 28953 | 1496 | 36139 | 760 | 30756 |
| 16-#14 | 2.79 | MA | 17209 | 4735 | 27615 | 3789 | 32932 | 3053 | 36069 | 2461 | 40105 | 1523 | 50345 | 1088 | 38957 |
| 4L-6S | | MI | 13853 | 4735 | 22621 | 3770 | 26654 | 3034 | 28771 | 2439 | 31031 | 1503 | 38543 | 863 | 32005 |
| 16-#14 | 2.79 | MA | 16412 | 4735 | 26368 | 3804 | 31435 | 3051 | 34243 | 2472 | 37646 | 1531 | 47219 | 1024 | 37523 |
| 5E | | MI | 14530 | 4735 | 23598 | 3771 | 27956 | 3023 | 30355 | 2446 | 33079 | 1496 | 41257 | 972 | 33067 |
| 16-#14 | 2.79 | MA | 15647 | 4735 | 25259 | 3804 | 29957 | 3063 | 32444 | 2467 | 35280 | 1538 | 44065 | 915 | 36323 |
| 6L-4S | | MI | 15235 | 4735 | 24696 | 3758 | 29273 | 3027 | 31963 | 2438 | 35209 | 1488 | 43964 | 1034 | 34239 |
| 16-#14 | 2.79 | MA | 14898 | 4735 | 24179 | 3803 | 28529 | 3061 | 30700 | 2477 | 32881 | 1531 | 41266 | 812 | 34819 |
| 7L-3S | | MI | 16012 | 4735 | 25779 | 3760 | 30737 | 3016 | 33736 | 2444 | 37544 | 1496 | 46510 | 1165 | 34855 |
| 16-#14 | 2.79 | MA | 14158 | 4735 | 23116 | 3803 | 27129 | 3058 | 28952 | 2472 | 30566 | 1538 | 38347 | 738 | 33014 |
| 8L-2S | | MI | 17077 | 4735 | 27226 | 3761 | 32572 | 3020 | 35959 | 2436 | 40485 | 1488 | 50400 | 1297 | 35013 |
| 16-#18 | 4.95 | MA | 18619 | 5753 | 33306 | 4421 | 40054 | 3495 | 44602 | 2754 | 51167 | 1438 | 65504 | 553 | 61411 |
| 5E | | MI | 16383 | 5753 | 29649 | 4382 | 35454 | 3460 | 39250 | 2713 | 44664 | 1382 | 56789 | 464 | 53701 |
| 16-#18 | 4.95 | MA | 17366 | 5753 | 31360 | 4419 | 37461 | 3515 | 41447 | 2742 | 47076 | 1451 | 60078 | 358 | 58263 |
| 6L-4S | | MI | 17540 | 5753 | 31570 | 4361 | 37761 | 3470 | 42042 | 2699 | 48334 | 1368 | 61434 | 572 | 56347 |
| 18-#11 | 2.17 | MA | 17217 | 4447 | 26438 | 3622 | 31628 | 2920 | 34527 | 2388 | 38153 | 1557 | 47207 | 1321 | 31322 |
| 3L-8S | | MI | 12787 | 4447 | 20145 | 3601 | 23553 | 2906 | 25016 | 2369 | 26096 | 1533 | 32211 | 946 | 25009 |
| 18-#11 | 2.17 | MA | 16588 | 4447 | 25578 | 3622 | 30465 | 2929 | 33118 | 2386 | 36259 | 1552 | 45114 | 1229 | 31160 |
| 4L-7S | | MI | 13254 | 4447 | 20799 | 3602 | 24415 | 2909 | 26091 | 2373 | 27507 | 1528 | 33990 | 996 | 25697 |
| 18-#11 | 2.17 | MA | 16019 | 4447 | 24708 | 3633 | 29420 | 2928 | 31843 | 2393 | 34530 | 1557 | 42916 | 1184 | 30464 |
| 5L-6S | | MI | 13727 | 4447 | 21464 | 3602 | 25294 | 2911 | 27165 | 2367 | 28970 | 1533 | 35690 | 1068 | 26375 |
| 18-#11 | 2.17 | MA | 15473 | 4447 | 23934 | 3633 | 28389 | 2937 | 30588 | 2391 | 32867 | 1562 | 40694 | 1109 | 29842 |
| 6L-5S | | MI | 14211 | 4447 | 22146 | 3603 | 26203 | 2903 | 28271 | 2371 | 30413 | 1528 | 37607 | 1143 | 26881 |
| 18-#11 | 2.17 | MA | 14938 | 4447 | 23181 | 3633 | 27393 | 2936 | 29370 | 2398 | 31181 | 1557 | 38720 | 1038 | 29067 |
| 7L-4S | | MI | 14714 | 4447 | 22914 | 3593 | 27124 | 2905 | 29395 | 2364 | 31913 | 1523 | 39513 | 1187 | 27504 |
| 18-#11 | 2.17 | MA | 14410 | 4447 | 22439 | 3633 | 26416 | 2935 | 28151 | 2396 | 29555 | 1562 | 36668 | 986 | 28237 |
| 8L-3S | | MI | 15269 | 4447 | 23671 | 3594 | 28147 | 2897 | 30634 | 2368 | 33557 | 1528 | 41314 | 1278 | 27633 |
| 18-#11 | 2.17 | MA | 13885 | 4447 | 21621 | 3644 | 25410 | 2944 | 26950 | 2403 | 27944 | 1567 | 34653 | 927 | 27200 |
| 9L-2S | | MI | 16031 | 4447 | 24684 | 3595 | 29432 | 2899 | 32191 | 2362 | 35628 | 1523 | 44061 | 1369 | 27698 |
| 18-#14 | 3.13 | MA | 17955 | 4898 | 29266 | 3891 | 35026 | 3128 | 38607 | 2509 | 43502 | 1514 | 54863 | 1063 | 43619 |
| 4L-7S | | MI | 13863 | 4898 | 23116 | 3871 | 27230 | 3104 | 29457 | 2495 | 31894 | 1484 | 40028 | 731 | 34847 |
| 18-#14 | 3.13 | MA | 17169 | 4898 | 28019 | 3906 | 33530 | 3126 | 36780 | 2519 | 41042 | 1521 | 51737 | 1000 | 42245 |
| 5L-6S | | MI | 14517 | 4898 | 24068 | 3872 | 28489 | 3108 | 30994 | 2487 | 33972 | 1492 | 42432 | 834 | 36052 |
| 18-#14 | 3.13 | MA | 16414 | 4898 | 26910 | 3906 | 32052 | 3138 | 34981 | 2514 | 38677 | 1529 | 48583 | 891 | 40968 |
| 6L-5S | | MI | 15185 | 4898 | 25045 | 3874 | 29791 | 3098 | 32578 | 2493 | 36020 | 1484 | 45146 | 943 | 37192 |
| 18-#14 | 3.13 | MA | 15676 | 4898 | 25831 | 3906 | 30624 | 3136 | 33237 | 2525 | 36278 | 1521 | 45784 | 788 | 39511 |
| 7L-4S | | MI | 15881 | 4898 | 26143 | 3860 | 31108 | 3102 | 34186 | 2485 | 38150 | 1477 | 47853 | 1005 | 38309 |
| 18-#14 | 3.13 | MA | 14946 | 4898 | 24768 | 3905 | 29224 | 3133 | 31489 | 2520 | 33963 | 1529 | 42865 | 714 | 37666 |
| 8L-3S | | MI | 16648 | 4898 | 27226 | 3862 | 32572 | 3091 | 35959 | 2492 | 40485 | 1484 | 50400 | 1136 | 39086 |
| 18-#18 | 5.57 | MA | 18637 | 6043 | 34245 | 4601 | 41120 | 3648 | 45879 | 2827 | 52951 | 1431 | 67853 | 308 | 66264 |
| 6L-5S | | MI | 17544 | 6043 | 32170 | 4564 | 38652 | 3593 | 43101 | 2795 | 49731 | 1357 | 63450 | 404 | 60691 |
| 20-#11 | 2.41 | MA | 17123 | 4560 | 26733 | 3693 | 31930 | 2981 | 34893 | 2418 | 38646 | 1546 | 48297 | 1214 | 34535 |
| 4L-8S | | MI | 13270 | 4560 | 21158 | 3672 | 24838 | 2958 | 26572 | 2402 | 28167 | 1526 | 34958 | 928 | 27889 |
| 20-#11 | 2.41 | MA | 16560 | 4560 | 25863 | 3703 | 30885 | 2980 | 33618 | 2426 | 36917 | 1552 | 46099 | 1169 | 33766 |
| 5L-7S | | MI | 13733 | 4560 | 21813 | 3673 | 25700 | 2960 | 27648 | 2406 | 29578 | 1521 | 36737 | 978 | 28557 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis

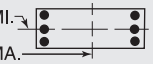


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.41 | MA | 16020 | 4560 | 25089 | 3704 | 29854 | 2989 | 32362 | 2423 | 35255 | 1557 | 43877 | 1094 | 33165 |
| 6E | | MI | 14201 | 4560 | 22477 | 3673 | 26579 | 2963 | 28721 | 2400 | 31041 | 1526 | 38437 | 1049 | 29283 |
| 20-#11 | 2.41 | MA | 15491 | 4560 | 24336 | 3704 | 28857 | 2988 | 31145 | 2431 | 33569 | 1552 | 41903 | 1023 | 32342 |
| 7L-5S | | MI | 14679 | 4560 | 23160 | 3674 | 27488 | 2955 | 29828 | 2404 | 32484 | 1521 | 40353 | 1125 | 29771 |
| 20-#11 | 2.41 | MA | 14969 | 4560 | 23594 | 3704 | 27881 | 2987 | 29925 | 2428 | 31942 | 1557 | 39851 | 971 | 31534 |
| 8L-4S | | MI | 15178 | 4560 | 23927 | 3664 | 28409 | 2957 | 30951 | 2397 | 33984 | 1516 | 42260 | 1168 | 30463 |
| 20-#11 | 2.41 | MA | 14450 | 4560 | 22776 | 3715 | 26874 | 2996 | 28725 | 2436 | 30331 | 1562 | 37836 | 912 | 30439 |
| 9L-3S | | MI | 15728 | 4560 | 24684 | 3665 | 29432 | 2949 | 32191 | 2401 | 35628 | 1521 | 44061 | 1259 | 30609 |
| 20-#11 | 2.41 | MA | 13933 | 4560 | 22037 | 3715 | 25904 | 2994 | 27519 | 2433 | 28674 | 1557 | 35881 | 846 | 29378 |
| 10L-2S | | MI | 16483 | 4560 | 25697 | 3665 | 30717 | 2951 | 33748 | 2395 | 37699 | 1516 | 46808 | 1351 | 30688 |
| 20-#14 | 3.48 | MA | 17914 | 5062 | 29671 | 4008 | 35624 | 3200 | 39317 | 2566 | 44439 | 1512 | 56254 | 976 | 46976 |
| 5L-7S | | MI | 14525 | 5062 | 24563 | 3973 | 29065 | 3179 | 31680 | 2543 | 34835 | 1473 | 43918 | 702 | 38947 |
| 20-#14 | 3.48 | MA | 17170 | 5062 | 28562 | 4008 | 34146 | 3213 | 37519 | 2562 | 42073 | 1520 | 53101 | 867 | 45625 |
| 6E | | MI | 15171 | 5062 | 25515 | 3974 | 30324 | 3183 | 33217 | 2534 | 36913 | 1480 | 46322 | 805 | 40110 |
| 20-#14 | 3.48 | MA | 16441 | 5062 | 27482 | 4008 | 32718 | 3210 | 35774 | 2572 | 39675 | 1512 | 50302 | 764 | 44212 |
| 7L-5S | | MI | 15831 | 5062 | 26492 | 3976 | 31626 | 3172 | 34801 | 2541 | 38962 | 1473 | 49036 | 915 | 41325 |
| 20-#14 | 3.48 | MA | 15721 | 5062 | 26419 | 4008 | 31318 | 3208 | 34026 | 2567 | 37360 | 1520 | 47383 | 690 | 42327 |
| 8L-4S | | MI | 16518 | 5062 | 27590 | 3963 | 32943 | 3176 | 36409 | 2532 | 41092 | 1465 | 51742 | 976 | 42393 |
| 22-#11 | 2.66 | MA | 17095 | 4674 | 27018 | 3774 | 32350 | 3032 | 35392 | 2459 | 39305 | 1546 | 49282 | 1154 | 37074 |
| 5L-8S | | MI | 13748 | 4674 | 22171 | 3743 | 26123 | 3010 | 28129 | 2435 | 30238 | 1519 | 37704 | 909 | 30774 |
| 22-#11 | 2.66 | MA | 16560 | 4674 | 26244 | 3775 | 31319 | 3041 | 34137 | 2456 | 37642 | 1551 | 47060 | 1079 | 36491 |
| 6L-7S | | MI | 14206 | 4674 | 22826 | 3744 | 26985 | 3012 | 29205 | 2439 | 31650 | 1514 | 39483 | 960 | 31423 |
| 22-#11 | 2.66 | MA | 16037 | 4674 | 25491 | 3775 | 30322 | 3040 | 32919 | 2464 | 35956 | 1546 | 45086 | 1008 | 35622 |
| 7L-6S | | MI | 14669 | 4674 | 23490 | 3744 | 27864 | 3015 | 30278 | 2433 | 33113 | 1519 | 41183 | 1031 | 32194 |
| 22-#11 | 2.66 | MA | 15520 | 4674 | 24749 | 3775 | 29345 | 3038 | 31700 | 2461 | 34329 | 1551 | 43034 | 955 | 34835 |
| 8L-5S | | MI | 15143 | 4674 | 24173 | 3745 | 28773 | 3006 | 31385 | 2436 | 34555 | 1514 | 43100 | 1106 | 32666 |
| 22-#11 | 2.66 | MA | 15006 | 4674 | 23930 | 3786 | 28339 | 3048 | 30500 | 2469 | 32718 | 1556 | 41018 | 897 | 33713 |
| 9L-4S | | MI | 15637 | 4674 | 24940 | 3735 | 29694 | 3009 | 32508 | 2430 | 36055 | 1509 | 45006 | 1150 | 33421 |
| 22-#11 | 2.66 | MA | 14495 | 4674 | 23192 | 3786 | 27369 | 3046 | 29294 | 2466 | 31062 | 1551 | 39063 | 830 | 32631 |
| 10L-3S | | MI | 16181 | 4674 | 25697 | 3736 | 30717 | 3001 | 33748 | 2434 | 37699 | 1514 | 46808 | 1241 | 33582 |
| 22-#14 | 3.83 | MA | 17915 | 5226 | 30213 | 4110 | 36240 | 3288 | 40056 | 2609 | 45470 | 1511 | 57619 | 843 | 50292 |
| 6L-7S | | MI | 15179 | 5226 | 26010 | 4075 | 30900 | 3254 | 33904 | 2590 | 37777 | 1461 | 47807 | 673 | 43003 |
| 22-#14 | 3.83 | MA | 17195 | 5226 | 29133 | 4110 | 34812 | 3285 | 38312 | 2619 | 43071 | 1503 | 54819 | 740 | 48920 |
| 7L-6S | | MI | 15816 | 5226 | 26961 | 4077 | 32159 | 3258 | 35440 | 2582 | 39855 | 1468 | 50211 | 776 | 44179 |
| 22-#14 | 3.83 | MA | 16485 | 5226 | 28070 | 4110 | 33412 | 3283 | 36564 | 2615 | 40757 | 1511 | 51900 | 666 | 46996 |
| 8L-5S | | MI | 16468 | 5226 | 27939 | 4078 | 33461 | 3247 | 37024 | 2588 | 41903 | 1461 | 52925 | 886 | 45465 |
| 24-#11 | 2.90 | MA | 17094 | 4787 | 27399 | 3845 | 32783 | 3093 | 35911 | 2489 | 40029 | 1546 | 50243 | 1063 | 39820 |
| 6L-8S | | MI | 14219 | 4787 | 23185 | 3814 | 27408 | 3062 | 29686 | 2468 | 32310 | 1512 | 40451 | 891 | 33615 |
| 24-#11 | 2.90 | MA | 16576 | 4787 | 26646 | 3846 | 31787 | 3092 | 34694 | 2497 | 38343 | 1540 | 48268 | 992 | 38909 |
| 7E | | MI | 14673 | 4787 | 23839 | 3814 | 28270 | 3064 | 30762 | 2472 | 33721 | 1507 | 42230 | 941 | 34294 |
| 24-#11 | 2.90 | MA | 16064 | 4787 | 25904 | 3846 | 30810 | 3090 | 33474 | 2494 | 36717 | 1546 | 46216 | 940 | 38141 |
| 8L-6S | | MI | 15132 | 4787 | 24504 | 3815 | 29149 | 3066 | 31835 | 2465 | 35184 | 1512 | 43930 | 1012 | 35109 |
| 24-#11 | 2.90 | MA | 15556 | 4787 | 25085 | 3856 | 29804 | 3099 | 32274 | 2502 | 35106 | 1551 | 44201 | 881 | 36992 |
| 9L-5S | | MI | 15601 | 4787 | 25186 | 3816 | 30058 | 3058 | 32942 | 2469 | 36627 | 1507 | 45846 | 1088 | 35566 |
| 24-#11 | 2.90 | MA | 15050 | 4787 | 24347 | 3857 | 28834 | 3098 | 31068 | 2499 | 33449 | 1546 | 42246 | 815 | 35888 |
| 10L-4S | | MI | 16090 | 4787 | 25953 | 3806 | 30979 | 3061 | 34065 | 2463 | 38127 | 1501 | 47753 | 1131 | 36377 |
| 24-#14 | 4.18 | MA | 17940 | 5389 | 30785 | 4212 | 36907 | 3360 | 40849 | 2667 | 46468 | 1494 | 59337 | 716 | 53604 |
| 7E | | MI | 15823 | 5389 | 27456 | 4177 | 32735 | 3329 | 36127 | 2637 | 40718 | 1449 | 51696 | 644 | 47033 |
| 24-#14 | 4.18 | MA | 17238 | 5389 | 29722 | 4212 | 35507 | 3358 | 39101 | 2662 | 44153 | 1502 | 56418 | 642 | 51672 |
| 8L-6S | | MI | 16454 | 5389 | 28408 | 4179 | 33994 | 3333 | 37664 | 2629 | 42796 | 1457 | 54100 | 747 | 48258 |

## RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

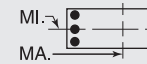
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.18 | MA | 17482 | 4188 | 25373 | 3480 | 29893 | 2830 | 31939 | 2347 | 33607 | 1638 | 40644 | 1526 | 18977 |
| 2E | | MI | 14711 | 4188 | 21692 | 3434 | 25277 | 2792 | 26819 | 2311 | 27912 | 1599 | 33502 | 1475 | 15854 |
| 6-#18 | 1.76 | MA | 18914 | 4479 | 28440 | 3662 | 33782 | 2963 | 36650 | 2431 | 39887 | 1620 | 48978 | 1480 | 28083 |
| 2L-3S | | MI | 13941 | 4479 | 21692 | 3610 | 25277 | 2915 | 26819 | 2407 | 27912 | 1588 | 33502 | 1181 | 23207 |
| 6-#18 | 1.76 | MA | 16573 | 4479 | 25373 | 3661 | 29893 | 2958 | 31939 | 2448 | 33607 | 1634 | 40644 | 1247 | 27817 |
| 3L-2S | | MI | 15864 | 4479 | 24213 | 3615 | 28474 | 2925 | 30670 | 2393 | 32979 | 1575 | 40163 | 1415 | 23369 |
| 8-#14 | 1.32 | MA | 17946 | 4261 | 26070 | 3550 | 30956 | 2883 | 33304 | 2384 | 35612 | 1654 | 43425 | 1543 | 21473 |
| 2L-4S | | MI | 13154 | 4261 | 19732 | 3504 | 22875 | 2855 | 24027 | 2356 | 24336 | 1618 | 29421 | 1230 | 17786 |
| 8-#14 | 1.32 | MA | 16582 | 4261 | 24317 | 3550 | 28732 | 2881 | 30609 | 2395 | 31987 | 1662 | 38593 | 1411 | 21423 |
| 3E | | MI | 13978 | 4261 | 20815 | 3506 | 24338 | 2844 | 25800 | 2363 | 26671 | 1625 | 31968 | 1361 | 17922 |
| 8-#14 | 1.32 | MA | 15589 | 4261 | 23011 | 3550 | 26967 | 2894 | 28471 | 2391 | 29111 | 1654 | 35414 | 1280 | 21196 |
| 4L-2S | | MI | 15102 | 4261 | 22262 | 3507 | 26173 | 2848 | 28023 | 2355 | 29612 | 1618 | 35857 | 1493 | 17935 |
| 8-#18 | 2.35 | MA | 20301 | 4770 | 31506 | 3844 | 37671 | 3096 | 41361 | 2515 | 46166 | 1603 | 57312 | 1434 | 37142 |
| 2L-4S | | MI | 13713 | 4770 | 22319 | 3787 | 25916 | 3064 | 27593 | 2476 | 28956 | 1550 | 35799 | 891 | 28403 |
| 8-#18 | 2.35 | MA | 18010 | 4770 | 28440 | 3843 | 33782 | 3091 | 36650 | 2532 | 39887 | 1616 | 48978 | 1201 | 36754 |
| 3E | | MI | 15097 | 4770 | 24213 | 3792 | 28474 | 3048 | 30670 | 2489 | 32979 | 1563 | 40163 | 1121 | 30554 |
| 8-#18 | 2.35 | MA | 16342 | 4770 | 26149 | 3841 | 30687 | 3112 | 32900 | 2522 | 34903 | 1603 | 43510 | 967 | 34126 |
| 4L-2S | | MI | 16981 | 4770 | 26734 | 3797 | 31671 | 3058 | 34521 | 2476 | 38045 | 1550 | 46824 | 1355 | 30827 |
| 10-#11 | 1.15 | MA | 17543 | 4174 | 25090 | 3507 | 29804 | 2853 | 31948 | 2367 | 33851 | 1667 | 41160 | 1567 | 18781 |
| 2L-5S | | MI | 12882 | 4174 | 18913 | 3475 | 22003 | 2823 | 23001 | 2348 | 23021 | 1641 | 27639 | 1298 | 15550 |
| 10-#11 | 1.15 | MA | 16581 | 4174 | 23865 | 3508 | 28249 | 2852 | 30064 | 2376 | 31310 | 1673 | 37759 | 1476 | 18768 |
| 3L-4S | | MI | 13410 | 4174 | 19680 | 3465 | 22924 | 2826 | 24124 | 2342 | 24521 | 1635 | 29545 | 1341 | 15687 |
| 10-#11 | 1.15 | MA | 15883 | 4174 | 22953 | 3508 | 27017 | 2862 | 28571 | 2373 | 29295 | 1668 | 35519 | 1385 | 18693 |
| 4L-3S | | MI | 13990 | 4174 | 20437 | 3466 | 23947 | 2818 | 25364 | 2346 | 26165 | 1641 | 31346 | 1433 | 15723 |
| 10-#11 | 1.15 | MA | 15250 | 4174 | 22031 | 3519 | 25911 | 2861 | 27220 | 2382 | 27456 | 1673 | 33175 | 1339 | 18481 |
| 5L-2S | | MI | 14783 | 4174 | 21450 | 3467 | 25232 | 2820 | 26921 | 2339 | 28237 | 1635 | 34093 | 1524 | 15715 |
| 10-#14 | 1.65 | MA | 18773 | 4425 | 27824 | 3652 | 33180 | 2958 | 35998 | 2432 | 39237 | 1646 | 48258 | 1521 | 26671 |
| 2L-5S | | MI | 13111 | 4425 | 20081 | 3620 | 23392 | 2926 | 24642 | 2412 | 25147 | 1614 | 30604 | 1140 | 20939 |
| 10-#14 | 1.65 | MA | 17428 | 4425 | 26070 | 3652 | 30956 | 2956 | 33304 | 2443 | 35612 | 1654 | 43425 | 1389 | 26580 |
| 3L-4S | | MI | 13850 | 4425 | 21179 | 3606 | 24710 | 2930 | 26250 | 2404 | 27277 | 1606 | 33311 | 1201 | 22001 |
| 10-#14 | 1.65 | MA | 16451 | 4425 | 24764 | 3653 | 29191 | 2969 | 31165 | 2439 | 32736 | 1646 | 40246 | 1258 | 26304 |
| 4L-3S | | MI | 14662 | 4425 | 22262 | 3608 | 26173 | 2919 | 28023 | 2410 | 29612 | 1614 | 35857 | 1333 | 22185 |
| 10-#14 | 1.65 | MA | 15564 | 4425 | 23443 | 3668 | 27605 | 2967 | 29229 | 2450 | 30111 | 1654 | 36909 | 1193 | 24967 |
| 5L-2S | | MI | 15771 | 4425 | 23709 | 3609 | 28008 | 2923 | 30246 | 2402 | 32553 | 1606 | 39747 | 1464 | 22237 |
| 10-#18 | 2.94 | MA | 21650 | 5061 | 34572 | 4026 | 41559 | 3229 | 46072 | 2599 | 52446 | 1585 | 65646 | 1388 | 46176 |
| 2L-5S | | MI | 13633 | 5061 | 22918 | 3990 | 26807 | 3188 | 28652 | 2572 | 30353 | 1538 | 37815 | 723 | 33381 |
| 10-#18 | 2.94 | MA | 19405 | 5061 | 31506 | 4024 | 37671 | 3224 | 41361 | 2616 | 46166 | 1598 | 57312 | 1155 | 45684 |
| 3L-4S | | MI | 14866 | 5061 | 24840 | 3969 | 29113 | 3197 | 31444 | 2559 | 34023 | 1525 | 42460 | 831 | 35401 |
| 10-#18 | 2.94 | MA | 17774 | 5061 | 29216 | 4023 | 34576 | 3245 | 37611 | 2607 | 41183 | 1585 | 51844 | 921 | 42712 |
| 4L-3S | | MI | 16222 | 5061 | 26734 | 3974 | 31671 | 3181 | 34521 | 2572 | 38045 | 1538 | 46824 | 1061 | 37887 |
| 10-#18 | 2.94 | MA | 16294 | 5061 | 26896 | 4048 | 31792 | 3240 | 34214 | 2624 | 36635 | 1598 | 46064 | 809 | 40237 |
| 5L-2S | | MI | 18070 | 5061 | 29255 | 3979 | 34869 | 3191 | 38372 | 2559 | 43112 | 1525 | 53485 | 1295 | 38256 |
| 12-#11 | 1.38 | MA | 18133 | 4287 | 26316 | 3578 | 31359 | 2905 | 33831 | 2400 | 36392 | 1662 | 44561 | 1553 | 22422 |
| 2L-6S | | MI | 12880 | 4287 | 19244 | 3545 | 22379 | 2883 | 23451 | 2377 | 23650 | 1639 | 28468 | 1204 | 17812 |
| 12-#11 | 1.38 | MA | 17181 | 4287 | 25090 | 3579 | 29804 | 2904 | 31948 | 2408 | 33851 | 1667 | 41160 | 1462 | 22389 |
| 3L-5S | | MI | 13380 | 4287 | 19926 | 3546 | 23288 | 2875 | 24558 | 2381 | 25093 | 1633 | 30385 | 1280 | 18401 |
| 12-#11 | 1.38 | MA | 16491 | 4287 | 24179 | 3579 | 28572 | 2914 | 30455 | 2406 | 31836 | 1663 | 38920 | 1371 | 22288 |
| 4E | | MI | 13902 | 4287 | 20693 | 3536 | 24209 | 2877 | 25681 | 2374 | 26593 | 1628 | 32292 | 1323 | 18663 |
| 12-#11 | 1.38 | MA | 15865 | 4287 | 23257 | 3590 | 27465 | 2913 | 29104 | 2414 | 29997 | 1668 | 36577 | 1325 | 21948 |
| 5L-3S | | MI | 14476 | 4287 | 21450 | 3537 | 25232 | 2869 | 26921 | 2378 | 28237 | 1633 | 34093 | 1414 | 18722 |
| 12-#11 | 1.38 | MA | 15266 | 4287 | 22438 | 3591 | 26373 | 2922 | 27774 | 2412 | 28228 | 1673 | 34202 | 1250 | 21169 |
| 6L-2S | | MI | 15261 | 4287 | 22464 | 3538 | 26517 | 2872 | 28478 | 2372 | 30308 | 1628 | 36839 | 1505 | 18734 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis

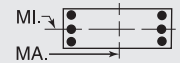


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 1.99 | MA | 19585 | 4588 | 29577 | 3754 | 35404 | 3033 | 38692 | 2479 | 42862 | 1638 | 53090 | 1499 | 31857 |
| 2L-6S | | MI | 13105 | 4588 | 20551 | 3720 | 23926 | 3011 | 25281 | 2453 | 26040 | 1609 | 31779 | 1001 | 24253 |
| 12-#14 | 1.99 | MA | 18257 | 4588 | 27824 | 3754 | 33180 | 3031 | 35998 | 2490 | 39237 | 1646 | 48258 | 1367 | 31730 |
| 3L-5S | | MI | 13804 | 4588 | 21528 | 3722 | 25227 | 3001 | 26865 | 2460 | 28089 | 1602 | 34493 | 1111 | 25026 |
| 12-#14 | 1.99 | MA | 17294 | 4588 | 26518 | 3755 | 31415 | 3044 | 33859 | 2486 | 36361 | 1638 | 45079 | 1236 | 31409 |
| 4E | | MI | 14532 | 4588 | 22626 | 3709 | 26545 | 3005 | 28473 | 2451 | 30219 | 1595 | 37200 | 1172 | 26211 |
| 12-#14 | 1.99 | MA | 16421 | 4588 | 25196 | 3770 | 29829 | 3042 | 31923 | 2497 | 33736 | 1646 | 41742 | 1171 | 29949 |
| 5L-3S | | MI | 15333 | 4588 | 23709 | 3710 | 28008 | 2994 | 30246 | 2458 | 32553 | 1602 | 39747 | 1304 | 26437 |
| 12-#14 | 1.99 | MA | 15584 | 4588 | 24022 | 3770 | 28263 | 3055 | 30017 | 2493 | 31211 | 1653 | 38368 | 1062 | 28945 |
| 6L-2S | | MI | 16428 | 4588 | 25156 | 3712 | 29843 | 2998 | 32469 | 2449 | 35495 | 1595 | 43636 | 1435 | 26521 |
| 12-#18 | 3.53 | MA | 20766 | 5351 | 34572 | 4206 | 41559 | 3357 | 46072 | 2700 | 52446 | 1580 | 65646 | 1109 | 54610 |
| 3L-5S | | MI | 14782 | 5351 | 25439 | 4172 | 30004 | 3321 | 32503 | 2654 | 35420 | 1514 | 44476 | 663 | 40269 |
| 12-#18 | 3.53 | MA | 19168 | 5351 | 32282 | 4205 | 38465 | 3378 | 42323 | 2691 | 47462 | 1567 | 60178 | 875 | 51339 |
| 4E | | MI | 15991 | 5351 | 27361 | 4151 | 32311 | 3330 | 35295 | 2641 | 39089 | 1500 | 49121 | 772 | 42441 |
| 12-#18 | 3.53 | MA | 17721 | 5351 | 29962 | 4230 | 35681 | 3373 | 38925 | 2708 | 42915 | 1580 | 54398 | 763 | 48728 |
| 5L-3S | | MI | 17321 | 5351 | 29255 | 4156 | 34869 | 3314 | 38372 | 2654 | 43112 | 1514 | 53485 | 1002 | 45213 |
| 12-#18 | 3.53 | MA | 16331 | 5351 | 27899 | 4229 | 32931 | 3394 | 35579 | 2698 | 38541 | 1594 | 48582 | 569 | 44951 |
| 6L-2S | | MI | 19137 | 5351 | 31776 | 4161 | 38066 | 3324 | 42223 | 2641 | 48179 | 1500 | 60146 | 1235 | 45667 |
| 14-#11 | 1.61 | MA | 18714 | 4401 | 27542 | 3649 | 32913 | 2957 | 35715 | 2433 | 38933 | 1657 | 47963 | 1539 | 26054 |
| 2L-7S | | MI | 12890 | 4401 | 19592 | 3616 | 22785 | 2933 | 23935 | 2416 | 24258 | 1626 | 29515 | 1114 | 20217 |
| 14-#11 | 1.61 | MA | 17772 | 4401 | 26316 | 3649 | 31359 | 2956 | 33831 | 2441 | 36392 | 1662 | 44561 | 1448 | 26003 |
| 3L-6S | | MI | 13375 | 4401 | 20257 | 3616 | 23664 | 2935 | 25008 | 2410 | 25721 | 1631 | 31215 | 1185 | 20704 |
| 14-#11 | 1.61 | MA | 17089 | 4401 | 25405 | 3650 | 30127 | 2966 | 32338 | 2439 | 34377 | 1657 | 42321 | 1357 | 25880 |
| 4L-5S | | MI | 13871 | 4401 | 20939 | 3617 | 24573 | 2927 | 26114 | 2414 | 27164 | 1626 | 33132 | 1261 | 21264 |
| 14-#11 | 1.61 | MA | 16471 | 4401 | 24483 | 3661 | 29020 | 2965 | 30987 | 2447 | 32538 | 1663 | 39978 | 1312 | 25427 |
| 5L-4S | | MI | 14387 | 4401 | 21706 | 3607 | 25494 | 2929 | 27238 | 2407 | 28664 | 1621 | 35038 | 1304 | 21634 |
| 14-#11 | 1.61 | MA | 15878 | 4401 | 23663 | 3662 | 27928 | 2974 | 29658 | 2445 | 30769 | 1668 | 37603 | 1236 | 24682 |
| 6L-3S | | MI | 14955 | 4401 | 22464 | 3608 | 26517 | 2921 | 28478 | 2411 | 30308 | 1626 | 36839 | 1396 | 21714 |
| 14-#11 | 1.61 | MA | 15297 | 4401 | 22866 | 3662 | 26872 | 2974 | 28369 | 2453 | 28976 | 1663 | 35491 | 1165 | 24060 |
| 7L-2S | | MI | 15733 | 4401 | 23477 | 3608 | 27802 | 2924 | 30034 | 2405 | 32379 | 1621 | 39586 | 1487 | 21742 |
| 14-#14 | 2.32 | MA | 20382 | 4752 | 31331 | 3856 | 37628 | 3107 | 41387 | 2526 | 46487 | 1630 | 57923 | 1477 | 37033 |
| 2L-7S | | MI | 13118 | 4752 | 21046 | 3821 | 24502 | 3082 | 25968 | 2509 | 26904 | 1590 | 33265 | 869 | 26943 |
| 14-#14 | 2.32 | MA | 19070 | 4752 | 29577 | 3857 | 35404 | 3106 | 38692 | 2537 | 42862 | 1638 | 53090 | 1345 | 36873 |
| 3L-6S | | MI | 13794 | 4752 | 21998 | 3823 | 25761 | 3086 | 27504 | 2500 | 28982 | 1598 | 35669 | 972 | 28267 |
| 14-#14 | 2.32 | MA | 18121 | 4752 | 28272 | 3857 | 33639 | 3119 | 36554 | 2534 | 39986 | 1630 | 49911 | 1214 | 36514 |
| 4L-5S | | MI | 14483 | 4752 | 22975 | 3824 | 27062 | 3075 | 29088 | 2507 | 31030 | 1590 | 38383 | 1082 | 29127 |
| 14-#14 | 2.32 | MA | 17261 | 4752 | 26950 | 3872 | 32053 | 3117 | 34618 | 2545 | 37361 | 1638 | 46575 | 1149 | 34945 |
| 5L-4S | | MI | 15201 | 4752 | 24073 | 3811 | 28380 | 3079 | 30696 | 2499 | 33160 | 1583 | 41089 | 1143 | 30393 |
| 14-#14 | 2.32 | MA | 16436 | 4752 | 25775 | 3873 | 30487 | 3130 | 32712 | 2541 | 34836 | 1645 | 43201 | 1040 | 33897 |
| 6L-3S | | MI | 15992 | 4752 | 25156 | 3812 | 29843 | 3068 | 32469 | 2505 | 35495 | 1590 | 43636 | 1275 | 30680 |
| 14-#14 | 2.32 | MA | 15628 | 4752 | 24632 | 3873 | 28974 | 3129 | 30864 | 2552 | 32276 | 1638 | 40203 | 938 | 32176 |
| 7L-2S | | MI | 17074 | 4752 | 26603 | 3814 | 31678 | 3073 | 34693 | 2497 | 38436 | 1583 | 47525 | 1406 | 30795 |
| 14-#18 | 4.12 | MA | 20531 | 5642 | 35348 | 4387 | 42353 | 3511 | 47034 | 2775 | 53742 | 1549 | 68512 | 829 | 60000 |
| 4L-5S | | MI | 15906 | 5642 | 27960 | 4354 | 33201 | 3453 | 36355 | 2737 | 40487 | 1489 | 51137 | 603 | 47192 |
| 14-#18 | 4.12 | MA | 19113 | 5642 | 33028 | 4412 | 39569 | 3505 | 43636 | 2792 | 49194 | 1563 | 62732 | 717 | 57250 |
| 5L-4S | | MI | 17092 | 5642 | 29882 | 4332 | 35508 | 3463 | 39146 | 2724 | 44156 | 1476 | 55782 | 712 | 49515 |
| 14-#18 | 4.12 | MA | 17752 | 5642 | 30965 | 4411 | 36820 | 3527 | 40290 | 2783 | 44821 | 1576 | 56916 | 523 | 53607 |
| 6L-3S | | MI | 18397 | 5642 | 31776 | 4337 | 38066 | 3447 | 42223 | 2737 | 48179 | 1489 | 60146 | 942 | 52533 |
| 16-#11 | 1.84 | MA | 19288 | 4514 | 28768 | 3720 | 34468 | 3009 | 37598 | 2466 | 41474 | 1652 | 51364 | 1525 | 29680 |
| 2L-8S | | MI | 12909 | 4514 | 19951 | 3686 | 23209 | 2982 | 24416 | 2445 | 24918 | 1624 | 30483 | 1045 | 22335 |
| 16-#11 | 1.84 | MA | 18354 | 4514 | 27542 | 3720 | 32913 | 3008 | 35715 | 2474 | 38933 | 1657 | 47963 | 1434 | 29612 |
| 3L-7S | | MI | 13383 | 4514 | 20605 | 3687 | 24070 | 2985 | 25491 | 2449 | 26330 | 1619 | 32262 | 1096 | 23059 |
| 16-#11 | 1.84 | MA | 17678 | 4514 | 26631 | 3721 | 31681 | 3017 | 34222 | 2472 | 36918 | 1652 | 45723 | 1343 | 29469 |
| 4L-6S | | MI | 13864 | 4514 | 21270 | 3687 | 24949 | 2987 | 26565 | 2443 | 27793 | 1624 | 33962 | 1167 | 23602 |
| 16-#11 | 1.84 | MA | 17067 | 4514 | 25708 | 3732 | 30575 | 3017 | 32871 | 2480 | 35079 | 1658 | 43379 | 1298 | 28918 |
| 5E | | MI | 14354 | 4514 | 21952 | 3688 | 25858 | 2979 | 27671 | 2447 | 29235 | 1619 | 35878 | 1243 | 24137 |
| 16-#11 | 1.84 | MA | 16480 | 4514 | 24889 | 3732 | 29482 | 3026 | 31541 | 2478 | 33310 | 1663 | 41004 | 1222 | 28200 |
| 6L-4S | | MI | 14865 | 4514 | 22720 | 3678 | 26779 | 2981 | 28795 | 2440 | 30735 | 1614 | 37785 | 1286 | 24602 |

## RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

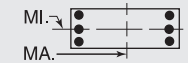
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.84 | MA | 15906 | 4514 | 24092 | 3733 | 28427 | 3025 | 30252 | 2486 | 31518 | 1658 | 38893 | 1151 | 27525 |
| 7L-3S | | MI | 15427 | 4514 | 23477 | 3679 | 27802 | 2973 | 30034 | 2444 | 32379 | 1619 | 39586 | 1377 | 24700 |
| 16-#11 | 1.84 | MA | 15338 | 4514 | 23307 | 3734 | 27393 | 3025 | 28960 | 2484 | 29787 | 1664 | 36704 | 1099 | 26582 |
| 8L-2S | | MI | 16199 | 4514 | 24490 | 3679 | 29087 | 2975 | 31591 | 2438 | 34451 | 1614 | 42332 | 1468 | 24743 |
| 16-#14 | 2.65 | MA | 19870 | 4915 | 31331 | 3959 | 37628 | 3181 | 41387 | 2585 | 46487 | 1630 | 57923 | 1323 | 42011 |
| 3L-7S | | MI | 13804 | 4915 | 22493 | 3923 | 26337 | 3157 | 28191 | 2556 | 29845 | 1579 | 37154 | 841 | 31020 |
| 16-#14 | 2.65 | MA | 18934 | 4915 | 30025 | 3959 | 35863 | 3194 | 39248 | 2581 | 43610 | 1622 | 54744 | 1192 | 41562 |
| 4L-6S | | MI | 14471 | 4915 | 23445 | 3925 | 27596 | 3161 | 29728 | 2548 | 31923 | 1586 | 39558 | 943 | 32296 |
| 16-#14 | 2.65 | MA | 18086 | 4915 | 28704 | 3974 | 34277 | 3192 | 37312 | 2592 | 40985 | 1630 | 51407 | 1127 | 39953 |
| 5E | | MI | 15151 | 4915 | 24422 | 3926 | 28897 | 3150 | 31312 | 2554 | 33971 | 1579 | 42272 | 1053 | 33241 |
| 16-#14 | 2.65 | MA | 17272 | 4915 | 27529 | 3975 | 32711 | 3205 | 35406 | 2588 | 38461 | 1637 | 48034 | 1018 | 38824 |
| 6L-4S | | MI | 15860 | 4915 | 25520 | 3913 | 30215 | 3154 | 32919 | 2546 | 36101 | 1571 | 44979 | 1114 | 34444 |
| 16-#14 | 2.65 | MA | 16476 | 4915 | 26385 | 3975 | 31198 | 3203 | 33558 | 2599 | 35901 | 1630 | 45036 | 916 | 37156 |
| 7L-3S | | MI | 16641 | 4915 | 26603 | 3915 | 31678 | 3143 | 34693 | 2552 | 38436 | 1579 | 47525 | 1246 | 34918 |
| 16-#14 | 2.65 | MA | 15688 | 4915 | 25259 | 3975 | 29715 | 3202 | 31706 | 2595 | 33431 | 1637 | 41920 | 841 | 35347 |
| 8L-2S | | MI | 17711 | 4915 | 28050 | 3916 | 33513 | 3147 | 36916 | 2544 | 41377 | 1571 | 51415 | 1377 | 35061 |
| 16-#18 | 4.71 | MA | 20476 | 5933 | 36095 | 4594 | 43458 | 3638 | 48347 | 2876 | 55474 | 1545 | 71066 | 671 | 65802 |
| 5E | | MI | 17007 | 5933 | 30481 | 4536 | 36399 | 3586 | 40206 | 2820 | 45553 | 1464 | 57798 | 544 | 54147 |
| 16-#18 | 4.71 | MA | 19142 | 5933 | 34031 | 4592 | 40709 | 3660 | 45001 | 2867 | 51101 | 1558 | 65250 | 477 | 62285 |
| 6L-4S | | MI | 18172 | 5933 | 32403 | 4514 | 38705 | 3596 | 42998 | 2807 | 49223 | 1451 | 62443 | 652 | 56618 |
| 18-#11 | 2.06 | MA | 18928 | 4627 | 28768 | 3791 | 34468 | 3060 | 37598 | 2507 | 41474 | 1652 | 51364 | 1420 | 33218 |
| 3L-8S | | MI | 13400 | 4627 | 20964 | 3757 | 24494 | 3034 | 25972 | 2478 | 26990 | 1617 | 33229 | 1027 | 25208 |
| 18-#11 | 2.06 | MA | 18259 | 4627 | 27857 | 3792 | 33236 | 3069 | 36105 | 2505 | 39459 | 1647 | 49124 | 1329 | 33056 |
| 4L-7S | | MI | 13870 | 4627 | 21619 | 3757 | 25355 | 3037 | 27048 | 2482 | 28401 | 1612 | 35008 | 1077 | 25909 |
| 18-#11 | 2.06 | MA | 17654 | 4627 | 26934 | 3803 | 32129 | 3068 | 34754 | 2513 | 37620 | 1652 | 46780 | 1284 | 32416 |
| 5L-6S | | MI | 14345 | 4627 | 22283 | 3758 | 26234 | 3039 | 28121 | 2476 | 29864 | 1617 | 36708 | 1149 | 26505 |
| 18-#11 | 2.06 | MA | 17074 | 4627 | 26115 | 3803 | 31037 | 3078 | 33425 | 2511 | 35852 | 1658 | 44406 | 1208 | 31725 |
| 6L-5S | | MI | 14831 | 4627 | 22966 | 3759 | 27143 | 3031 | 29228 | 2479 | 31307 | 1612 | 38625 | 1224 | 27019 |
| 18-#11 | 2.06 | MA | 16506 | 4627 | 25318 | 3804 | 29982 | 3077 | 32135 | 2519 | 34059 | 1653 | 42294 | 1137 | 30998 |
| 7L-4S | | MI | 15336 | 4627 | 23733 | 3749 | 28064 | 3033 | 30351 | 2473 | 32807 | 1607 | 40531 | 1268 | 27566 |
| 18-#11 | 2.06 | MA | 15945 | 4627 | 24532 | 3804 | 28948 | 3076 | 30844 | 2517 | 32328 | 1658 | 40106 | 1085 | 30081 |
| 8L-3S | | MI | 15894 | 4627 | 24490 | 3750 | 29087 | 3025 | 31591 | 2477 | 34451 | 1612 | 42332 | 1359 | 27681 |
| 18-#11 | 2.06 | MA | 15387 | 4627 | 23666 | 3815 | 27882 | 3086 | 29573 | 2525 | 30615 | 1664 | 37951 | 1026 | 29059 |
| 9L-2S | | MI | 16658 | 4627 | 25503 | 3750 | 30372 | 3027 | 33148 | 2471 | 36522 | 1607 | 45079 | 1450 | 27739 |
| 18-#14 | 2.98 | MA | 19734 | 5079 | 31779 | 4061 | 38087 | 3268 | 41942 | 2628 | 47235 | 1614 | 59577 | 1170 | 46516 |
| 4L-7S | | MI | 14479 | 5079 | 23940 | 4026 | 28172 | 3232 | 30414 | 2604 | 32786 | 1567 | 41043 | 812 | 35108 |
| 18-#14 | 2.98 | MA | 18897 | 5079 | 30457 | 4077 | 36501 | 3267 | 40006 | 2639 | 44610 | 1622 | 56240 | 1105 | 44972 |
| 5L-6S | | MI | 15137 | 5079 | 24891 | 4027 | 29431 | 3236 | 31951 | 2595 | 34864 | 1575 | 43447 | 915 | 36339 |
| 18-#14 | 2.98 | MA | 18095 | 5079 | 29283 | 4077 | 34935 | 3280 | 38101 | 2636 | 42086 | 1629 | 52866 | 996 | 43765 |
| 6L-5S | | MI | 15808 | 5079 | 25869 | 4029 | 30732 | 3225 | 33535 | 2602 | 36913 | 1567 | 46161 | 1024 | 37364 |
| 18-#14 | 2.98 | MA | 17309 | 5079 | 28139 | 4077 | 33422 | 3278 | 36252 | 2647 | 39526 | 1622 | 49869 | 894 | 42146 |
| 7L-4S | | MI | 16509 | 5079 | 26966 | 4015 | 32050 | 3229 | 35143 | 2593 | 39043 | 1560 | 48868 | 1085 | 38512 |
| 18-#14 | 2.98 | MA | 16533 | 5079 | 27013 | 4078 | 31939 | 3276 | 34400 | 2643 | 37056 | 1629 | 46753 | 819 | 40296 |
| 8L-3S | | MI | 17280 | 5079 | 28050 | 4017 | 33513 | 3218 | 36916 | 2600 | 41377 | 1567 | 51415 | 1217 | 39152 |
| 18-#14 | 2.98 | MA | 15761 | 5079 | 25770 | 4093 | 30411 | 3290 | 32578 | 2654 | 34610 | 1636 | 43693 | 734 | 38447 |
| 9L-2S | | MI | 18338 | 5079 | 29497 | 4018 | 35348 | 3222 | 39139 | 2591 | 44319 | 1560 | 55304 | 1348 | 39321 |
| 18-#18 | 5.29 | MA | 20505 | 6224 | 37098 | 4774 | 44597 | 3793 | 49713 | 2951 | 57380 | 1540 | 73584 | 431 | 70983 |
| 6L-5S | | MI | 18177 | 6224 | 33002 | 4717 | 39596 | 3719 | 44057 | 2902 | 50620 | 1439 | 64459 | 484 | 61129 |
| 20-#11 | 2.29 | MA | 18833 | 4741 | 29082 | 3863 | 34791 | 3121 | 37989 | 2538 | 42000 | 1642 | 52525 | 1315 | 36641 |
| 4L-8S | | MI | 13885 | 4741 | 21977 | 3828 | 25779 | 3086 | 27529 | 2511 | 29061 | 1610 | 35976 | 1008 | 28087 |
| 20-#11 | 2.29 | MA | 18234 | 4741 | 28160 | 3874 | 33684 | 3120 | 36638 | 2546 | 40161 | 1647 | 50182 | 1270 | 35923 |
| 5L-7S | | MI | 14350 | 4741 | 22632 | 3828 | 26640 | 3088 | 28605 | 2515 | 30472 | 1605 | 37755 | 1059 | 28766 |
| 20-#11 | 2.29 | MA | 17660 | 4741 | 27341 | 3874 | 32592 | 3130 | 35308 | 2544 | 38393 | 1653 | 47807 | 1194 | 35254 |
| 6E | | MI | 14821 | 4741 | 23296 | 3829 | 27519 | 3091 | 29678 | 2508 | 31935 | 1610 | 39455 | 1130 | 29413 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis

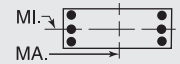



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.29 | MA | 17098 | 4741 | 26543 | 3875 | 31536 | 3129 | 34019 | 2552 | 36600 | 1648 | 45695 | 1124 | 34477 |
| 7L-5S | | MI | 15301 | 4741 | 23979 | 3830 | 28428 | 3083 | 30785 | 2512 | 33378 | 1605 | 41371 | 1206 | 29907 |
| 20-#11 | 2.29 | MA | 16543 | 4741 | 25758 | 3875 | 30502 | 3128 | 32727 | 2550 | 34870 | 1653 | 43507 | 1071 | 33584 |
| 8L-4S | | MI | 15802 | 4741 | 24746 | 3820 | 29349 | 3085 | 31908 | 2506 | 34878 | 1599 | 43278 | 1249 | 30528 |
| 20-#11 | 2.29 | MA | 15991 | 4741 | 24891 | 3886 | 29437 | 3138 | 31456 | 2558 | 33156 | 1659 | 41352 | 1012 | 32533 |
| 9L-3S | | MI | 16355 | 4741 | 25503 | 3820 | 30372 | 3077 | 33148 | 2510 | 36522 | 1605 | 45079 | 1340 | 30659 |
| 20-#11 | 2.29 | MA | 15442 | 4741 | 24109 | 3887 | 28410 | 3137 | 30179 | 2556 | 31394 | 1654 | 39123 | 932 | 31456 |
| 10L-2S | | MI | 17113 | 4741 | 26516 | 3821 | 31657 | 3079 | 34705 | 2503 | 38593 | 1599 | 47826 | 1431 | 30730 |
| 20-#14 | 3.31 | MA | 19696 | 5242 | 32211 | 4179 | 38725 | 3342 | 42701 | 2687 | 48235 | 1614 | 61073 | 1083 | 50000 |
| 5L-7S | | MI | 15144 | 5242 | 25386 | 4128 | 30007 | 3307 | 32637 | 2651 | 35728 | 1556 | 44933 | 783 | 39204 |
| 20-#14 | 3.31 | MA | 18905 | 5242 | 31036 | 4179 | 37159 | 3355 | 40795 | 2683 | 45710 | 1621 | 57699 | 974 | 48717 |
| 6E | | MI | 15793 | 5242 | 26338 | 4129 | 31266 | 3311 | 34174 | 2643 | 37806 | 1563 | 47337 | 886 | 40393 |
| 20-#14 | 3.31 | MA | 18129 | 5242 | 29892 | 4180 | 35646 | 3353 | 38947 | 2694 | 43151 | 1614 | 54701 | 872 | 47144 |
| 7L-5S | | MI | 16457 | 5242 | 27315 | 4131 | 32567 | 3300 | 35758 | 2649 | 39854 | 1556 | 50051 | 995 | 41496 |
| 20-#14 | 3.31 | MA | 17363 | 5242 | 28766 | 4180 | 34163 | 3351 | 37095 | 2690 | 40681 | 1621 | 51586 | 797 | 45254 |
| 8L-4S | | MI | 17149 | 5242 | 28413 | 4117 | 33885 | 3304 | 37366 | 2641 | 41984 | 1548 | 52757 | 1056 | 42593 |
| 20-#14 | 3.31 | MA | 16602 | 5242 | 27524 | 4195 | 32635 | 3364 | 35273 | 2701 | 38235 | 1628 | 48526 | 712 | 43376 |
| 9L-3S | | MI | 17911 | 5242 | 29497 | 4119 | 35348 | 3293 | 39139 | 2647 | 44319 | 1556 | 55304 | 1188 | 43383 |
| 22-#11 | 2.52 | MA | 18807 | 4854 | 29386 | 3944 | 35239 | 3172 | 38521 | 2579 | 42702 | 1642 | 53583 | 1256 | 39435 |
| 5L-8S | | MI | 14364 | 4854 | 22991 | 3899 | 27064 | 3138 | 29086 | 2544 | 31132 | 1603 | 38722 | 990 | 30970 |
| 22-#11 | 2.52 | MA | 18239 | 4854 | 28567 | 3945 | 34146 | 3182 | 37192 | 2576 | 40934 | 1648 | 51208 | 1181 | 38788 |
| 6L-7S | | MI | 14825 | 4854 | 23645 | 3899 | 27925 | 3140 | 30162 | 2548 | 32544 | 1597 | 40501 | 1040 | 31629 |
| 22-#11 | 2.52 | MA | 17683 | 4854 | 27769 | 3946 | 33091 | 3181 | 35902 | 2585 | 39141 | 1643 | 49097 | 1110 | 37963 |
| 7L-6S | | MI | 15291 | 4854 | 24310 | 3900 | 28804 | 3143 | 31235 | 2541 | 34007 | 1603 | 42201 | 1112 | 32324 |
| 22-#11 | 2.52 | MA | 17133 | 4854 | 26984 | 3946 | 32057 | 3180 | 34611 | 2583 | 37411 | 1648 | 46908 | 1057 | 37092 |
| 8L-5S | | MI | 15767 | 4854 | 24992 | 3900 | 29713 | 3135 | 32342 | 2545 | 35449 | 1597 | 44118 | 1187 | 32802 |
| 22-#11 | 2.52 | MA | 16587 | 4854 | 26117 | 3957 | 30991 | 3190 | 33340 | 2591 | 35697 | 1653 | 44753 | 998 | 35983 |
| 9L-4S | | MI | 16263 | 4854 | 25759 | 3891 | 30634 | 3137 | 33465 | 2539 | 36949 | 1592 | 46024 | 1231 | 33488 |
| 22-#11 | 2.52 | MA | 16044 | 4854 | 25335 | 3958 | 29964 | 3189 | 32063 | 2589 | 33936 | 1649 | 42525 | 918 | 34915 |
| 10L-3S | | MI | 16810 | 4854 | 26516 | 3891 | 31657 | 3129 | 34705 | 2543 | 38593 | 1597 | 47826 | 1322 | 33634 |
| 22-#14 | 3.64 | MA | 19703 | 5406 | 32790 | 4281 | 39383 | 3429 | 43489 | 2730 | 49335 | 1613 | 62532 | 952 | 53679 |
| 6L-7S | | MI | 15799 | 5406 | 26833 | 4230 | 31842 | 3381 | 34860 | 2698 | 38669 | 1544 | 48822 | 754 | 43308 |
| 22-#14 | 3.64 | MA | 18938 | 5406 | 31646 | 4282 | 37870 | 3428 | 41641 | 2741 | 46776 | 1605 | 59534 | 850 | 52150 |
| 7L-6S | | MI | 16441 | 5406 | 27785 | 4232 | 33101 | 3385 | 36397 | 2690 | 40747 | 1552 | 51226 | 857 | 44458 |
| 22-#14 | 3.64 | MA | 18181 | 5406 | 30520 | 4282 | 36387 | 3426 | 39789 | 2738 | 44306 | 1613 | 56418 | 774 | 50220 |
| 8L-5S | | MI | 17097 | 5406 | 28762 | 4233 | 34402 | 3375 | 37981 | 2696 | 42795 | 1544 | 53940 | 966 | 45634 |
| 22-#14 | 3.64 | MA | 17430 | 5406 | 29277 | 4297 | 34859 | 3439 | 37967 | 2749 | 41860 | 1620 | 53359 | 690 | 48314 |
| 9L-4S | | MI | 17781 | 5406 | 29860 | 4220 | 35720 | 3379 | 39589 | 2688 | 44926 | 1537 | 56647 | 1027 | 46685 |
| 24-#11 | 2.75 | MA | 18811 | 4968 | 29793 | 4016 | 35701 | 3234 | 39075 | 2609 | 43475 | 1642 | 54610 | 1167 | 42324 |
| 6L-8S | | MI | 14838 | 4968 | 24004 | 3969 | 28349 | 3190 | 30643 | 2577 | 33204 | 1595 | 41469 | 971 | 33858 |
| 24-#11 | 2.75 | MA | 18260 | 4968 | 28995 | 4017 | 34646 | 3233 | 37786 | 2618 | 41682 | 1637 | 52498 | 1096 | 41455 |
| 7E | | MI | 15294 | 4968 | 24658 | 3970 | 29210 | 3192 | 31718 | 2581 | 34615 | 1590 | 43248 | 1022 | 34499 |
| 24-#11 | 2.75 | MA | 17716 | 4968 | 28210 | 4017 | 33612 | 3232 | 36494 | 2615 | 39952 | 1643 | 50309 | 1043 | 40605 |
| 8L-6S | | MI | 15756 | 4968 | 25323 | 3971 | 30089 | 3194 | 32792 | 2574 | 36078 | 1595 | 44948 | 1093 | 35238 |
| 24-#11 | 2.75 | MA | 17176 | 4968 | 27343 | 4028 | 32546 | 3242 | 35223 | 2624 | 38238 | 1648 | 48154 | 984 | 39468 |
| 9L-5S | | MI | 16227 | 4968 | 26005 | 3971 | 30998 | 3186 | 33898 | 2578 | 37521 | 1590 | 46864 | 1169 | 35701 |
| 24-#11 | 2.75 | MA | 16638 | 4968 | 26561 | 4029 | 31519 | 3241 | 33946 | 2621 | 36477 | 1643 | 45926 | 904 | 38379 |
| 10L-4S | | MI | 16719 | 4968 | 26772 | 3962 | 31919 | 3189 | 35022 | 2572 | 39021 | 1585 | 48771 | 1212 | 36447 |
| 24-#14 | 3.97 | MA | 19735 | 5570 | 33400 | 4384 | 40094 | 3503 | 44335 | 2789 | 50400 | 1597 | 64367 | 828 | 57163 |
| 7E | | MI | 16447 | 5570 | 28280 | 4332 | 33677 | 3456 | 37083 | 2746 | 41610 | 1533 | 52711 | 725 | 47414 |
| 24-#14 | 3.97 | MA | 18988 | 5570 | 32274 | 4384 | 38611 | 3501 | 42483 | 2785 | 47930 | 1605 | 61251 | 752 | 55194 |
| 8L-6S | | MI | 17081 | 5570 | 29232 | 4334 | 34936 | 3460 | 38620 | 2737 | 43688 | 1540 | 55115 | 828 | 48533 |
| 24-#14 | 3.97 | MA | 18246 | 5570 | 31031 | 4400 | 37083 | 3514 | 40661 | 2796 | 45484 | 1612 | 58191 | 668 | 53258 |
| 9L-5S | | MI | 17730 | 5570 | 30209 | 4335 | 36237 | 3449 | 40204 | 2744 | 45737 | 1533 | 57829 | 937 | 49779 |

## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

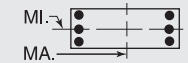
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.12 | MA | 19171 | 4369 | 27602 | 3649 | 32589 | 2969 | 34811 | 2465 | 36613 | 1733 | 44289 | 1621 | 20057 |
| 2E | | MI | 15329 | 4369 | 22525 | 3587 | 26221 | 2918 | 27774 | 2418 | 28801 | 1682 | 34511 | 1554 | 15892 |
| 6-#18 | 1.68 | MA | 20704 | 4659 | 30850 | 3831 | 36708 | 3102 | 39802 | 2549 | 43297 | 1717 | 53182 | 1579 | 29703 |
| 2L-3S | | MI | 14558 | 4659 | 22525 | 3764 | 26221 | 3041 | 27774 | 2514 | 28801 | 1670 | 34511 | 1261 | 23280 |
| 6-#18 | 1.68 | MA | 18214 | 4659 | 27602 | 3831 | 32589 | 3098 | 34811 | 2567 | 36613 | 1730 | 44289 | 1345 | 29437 |
| 3L-2S | | MI | 16486 | 4659 | 25046 | 3769 | 29418 | 3051 | 31626 | 2501 | 33868 | 1657 | 41172 | 1494 | 23415 |
| 8-#14 | 1.26 | MA | 19662 | 4441 | 28332 | 3719 | 33705 | 3022 | 36245 | 2502 | 38699 | 1748 | 47218 | 1638 | 22688 |
| 2L-4S | | MI | 13769 | 4441 | 20556 | 3659 | 23817 | 2982 | 24983 | 2465 | 25228 | 1701 | 30436 | 1310 | 17852 |
| 8-#14 | 1.26 | MA | 18213 | 4441 | 26477 | 3719 | 31351 | 3021 | 33394 | 2514 | 34852 | 1755 | 42070 | 1506 | 22638 |
| 3E | | MI | 14595 | 4441 | 21639 | 3661 | 25280 | 2972 | 26757 | 2471 | 27563 | 1708 | 32983 | 1442 | 17966 |
| 8-#14 | 1.26 | MA | 17161 | 4441 | 25097 | 3720 | 29486 | 3035 | 31133 | 2511 | 31801 | 1748 | 38680 | 1375 | 22411 |
| 4L-2S | | MI | 15721 | 4441 | 23086 | 3662 | 27115 | 2976 | 28980 | 2463 | 30504 | 1701 | 36872 | 1573 | 17969 |
| 8-#18 | 2.24 | MA | 22188 | 4950 | 34098 | 4013 | 40827 | 3235 | 44792 | 2633 | 49982 | 1701 | 62076 | 1537 | 39302 |
| 2L-4S | | MI | 14328 | 4950 | 23151 | 3941 | 26860 | 3191 | 28548 | 2583 | 29845 | 1632 | 36808 | 971 | 28693 |
| 8-#18 | 2.24 | MA | 19751 | 4950 | 30850 | 4013 | 36708 | 3231 | 39802 | 2652 | 43297 | 1714 | 53182 | 1303 | 38914 |
| 3E | | MI | 15718 | 4950 | 25046 | 3946 | 29418 | 3174 | 31626 | 2596 | 33868 | 1646 | 41172 | 1201 | 30637 |
| 8-#18 | 2.24 | MA | 17980 | 4950 | 28428 | 4012 | 33435 | 3253 | 35835 | 2643 | 37993 | 1701 | 47339 | 1069 | 36391 |
| 4L-2S | | MI | 17609 | 4950 | 27567 | 3951 | 32616 | 3184 | 35477 | 2583 | 38934 | 1632 | 47833 | 1435 | 30879 |
| 10-#11 | 1.09 | MA | 19228 | 4354 | 27292 | 3676 | 32482 | 2992 | 34805 | 2485 | 36785 | 1758 | 44788 | 1661 | 19834 |
| 2L-5S | | MI | 13496 | 4354 | 19732 | 3631 | 22944 | 2951 | 23958 | 2457 | 23915 | 1724 | 28657 | 1379 | 15633 |
| 10-#11 | 1.09 | MA | 18208 | 4354 | 25995 | 3677 | 30837 | 2992 | 32813 | 2494 | 34097 | 1764 | 41168 | 1570 | 19821 |
| 3L-4S | | MI | 14025 | 4354 | 20499 | 3621 | 23864 | 2954 | 25081 | 2450 | 25415 | 1719 | 30563 | 1422 | 15731 |
| 10-#11 | 1.09 | MA | 17468 | 4354 | 25033 | 3678 | 29535 | 3002 | 31235 | 2492 | 31968 | 1760 | 38782 | 1479 | 19746 |
| 4L-3S | | MI | 14607 | 4354 | 21256 | 3622 | 24887 | 2946 | 26321 | 2454 | 27059 | 1724 | 32364 | 1513 | 15758 |
| 10-#11 | 1.09 | MA | 16799 | 4354 | 24059 | 3689 | 28367 | 3001 | 29809 | 2501 | 30025 | 1766 | 36292 | 1433 | 19552 |
| 5L-2S | | MI | 15401 | 4354 | 22270 | 3622 | 26172 | 2948 | 27878 | 2448 | 29131 | 1719 | 35111 | 1604 | 15744 |
| 10-#14 | 1.58 | MA | 20546 | 4605 | 30188 | 3821 | 36058 | 3097 | 39097 | 2550 | 42546 | 1740 | 52366 | 1618 | 28190 |
| 2L-5S | | MI | 13725 | 4605 | 20905 | 3775 | 24334 | 3053 | 25599 | 2520 | 26040 | 1697 | 31619 | 1220 | 21115 |
| 10-#14 | 1.58 | MA | 19116 | 4605 | 28332 | 3822 | 33705 | 3096 | 36245 | 2562 | 38699 | 1748 | 47218 | 1486 | 28099 |
| 3L-4S | | MI | 14466 | 4605 | 22003 | 3761 | 25652 | 3057 | 27207 | 2512 | 28170 | 1689 | 34326 | 1282 | 22074 |
| 10-#14 | 1.58 | MA | 18080 | 4605 | 26953 | 3823 | 31839 | 3110 | 33985 | 2558 | 35648 | 1741 | 43827 | 1355 | 27822 |
| 4L-3S | | MI | 15281 | 4605 | 23086 | 3763 | 27115 | 3046 | 28980 | 2519 | 30504 | 1697 | 36872 | 1413 | 22234 |
| 10-#14 | 1.58 | MA | 17142 | 4605 | 25556 | 3838 | 30164 | 3108 | 31940 | 2570 | 32864 | 1749 | 40280 | 1289 | 26522 |
| 5L-2S | | MI | 16393 | 4605 | 24533 | 3764 | 28950 | 3050 | 31203 | 2510 | 33446 | 1689 | 40762 | 1544 | 22276 |
| 10-#18 | 2.80 | MA | 23632 | 5241 | 37346 | 4195 | 44947 | 3368 | 49783 | 2717 | 56667 | 1685 | 70969 | 1494 | 48876 |
| 2L-5S | | MI | 14246 | 5241 | 23751 | 4144 | 27751 | 3314 | 29608 | 2679 | 31242 | 1621 | 38824 | 803 | 33810 |
| 10-#18 | 2.80 | MA | 21243 | 5241 | 34098 | 4194 | 40827 | 3364 | 44792 | 2736 | 49982 | 1698 | 62076 | 1261 | 48384 |
| 3L-4S | | MI | 15485 | 5241 | 25672 | 4122 | 30057 | 3324 | 32400 | 2666 | 34912 | 1608 | 43469 | 911 | 35684 |
| 10-#18 | 2.80 | MA | 19511 | 5241 | 31676 | 4194 | 37554 | 3386 | 40826 | 2728 | 44678 | 1685 | 56232 | 1027 | 45499 |
| 4L-3S | | MI | 16848 | 5241 | 27567 | 4127 | 32616 | 3307 | 35477 | 2679 | 38934 | 1621 | 47833 | 1141 | 37978 |
| 10-#18 | 2.80 | MA | 17941 | 5241 | 29224 | 4220 | 34611 | 3382 | 37234 | 2746 | 39837 | 1698 | 50079 | 913 | 42795 |
| 5L-2S | | MI | 18704 | 5241 | 30088 | 4132 | 35813 | 3317 | 39328 | 2666 | 44001 | 1608 | 54494 | 1375 | 38314 |
| 12-#11 | 1.31 | MA | 19858 | 4467 | 28589 | 3747 | 34126 | 3044 | 36798 | 2518 | 39473 | 1753 | 48408 | 1648 | 23685 |
| 2L-6S | | MI | 13493 | 4467 | 20063 | 3701 | 23319 | 3011 | 24408 | 2486 | 24544 | 1722 | 29486 | 1285 | 17940 |
| 12-#11 | 1.31 | MA | 18848 | 4467 | 27292 | 3748 | 32482 | 3044 | 34805 | 2527 | 36785 | 1759 | 44788 | 1557 | 23652 |
| 3L-5S | | MI | 13995 | 4467 | 20745 | 3702 | 24229 | 3003 | 25515 | 2490 | 25987 | 1717 | 31403 | 1360 | 18539 |
| 12-#11 | 1.31 | MA | 18117 | 4467 | 26329 | 3749 | 31180 | 3054 | 33228 | 2525 | 34656 | 1755 | 42402 | 1466 | 23552 |
| 4E | | MI | 14518 | 4467 | 21512 | 3692 | 25149 | 3005 | 26638 | 2483 | 27487 | 1712 | 33310 | 1404 | 18713 |
| 12-#11 | 1.31 | MA | 17454 | 4467 | 25355 | 3760 | 30011 | 3053 | 31801 | 2534 | 32713 | 1761 | 39912 | 1420 | 23298 |
| 5L-3S | | MI | 15094 | 4467 | 22270 | 3693 | 26172 | 2997 | 27878 | 2487 | 29131 | 1717 | 35111 | 1495 | 18761 |
| 12-#11 | 1.31 | MA | 16820 | 4467 | 24491 | 3761 | 28858 | 3063 | 30397 | 2532 | 30846 | 1767 | 37385 | 1345 | 22440 |
| 6L-2S | | MI | 15882 | 4467 | 23283 | 3693 | 27457 | 3000 | 29434 | 2481 | 31202 | 1712 | 37857 | 1586 | 18765 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

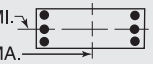



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 1.89 | MA | 21413 | 4768 | 32044 | 3923 | 38412 | 3172 | 41948 | 2597 | 46393 | 1733 | 57513 | 1597 | 33679 |
| 2L-6S | | MI | 13718 | 4768 | 21374 | 3875 | 24867 | 3139 | 26238 | 2561 | 26932 | 1693 | 32794 | 1082 | 24445 |
| 12-#14 | 1.89 | MA | 20002 | 4768 | 30188 | 3924 | 36058 | 3171 | 39097 | 2609 | 42546 | 1740 | 52366 | 1466 | 33552 |
| 3L-5S | | MI | 14419 | 4768 | 22352 | 3877 | 26169 | 3128 | 27822 | 2568 | 28981 | 1685 | 35508 | 1191 | 25199 |
| 12-#14 | 1.89 | MA | 18981 | 4768 | 28808 | 3925 | 34193 | 3184 | 36836 | 2606 | 39495 | 1733 | 48975 | 1335 | 33232 |
| 4E | | MI | 15150 | 4768 | 23450 | 3863 | 27487 | 3132 | 29430 | 2559 | 31111 | 1678 | 38215 | 1253 | 26290 |
| 12-#14 | 1.89 | MA | 18056 | 4768 | 27412 | 3941 | 32518 | 3183 | 34791 | 2618 | 36711 | 1741 | 45428 | 1269 | 31799 |
| 5L-3S | | MI | 15955 | 4768 | 24533 | 3865 | 28950 | 3121 | 31203 | 2566 | 33446 | 1685 | 40762 | 1384 | 26490 |
| 12-#14 | 1.89 | MA | 17169 | 4768 | 26172 | 3941 | 30864 | 3197 | 32778 | 2614 | 34033 | 1749 | 41834 | 1160 | 30705 |
| 6L-2S | | MI | 17053 | 4768 | 25980 | 3866 | 30785 | 3125 | 33426 | 2558 | 36387 | 1678 | 44651 | 1515 | 26563 |
| 12-#18 | 3.36 | MA | 22698 | 5532 | 37346 | 4376 | 44947 | 3497 | 49783 | 2820 | 56667 | 1682 | 70969 | 1218 | 57850 |
| 3L-5S | | MI | 15398 | 5532 | 26272 | 4326 | 30948 | 3447 | 33459 | 2762 | 36309 | 1596 | 45485 | 743 | 40724 |
| 12-#18 | 3.36 | MA | 21002 | 5532 | 34924 | 4376 | 41673 | 3519 | 45816 | 2812 | 51362 | 1669 | 65126 | 985 | 54649 |
| 4E | | MI | 16614 | 5532 | 28193 | 4304 | 33255 | 3457 | 36251 | 2749 | 39978 | 1583 | 50130 | 851 | 42717 |
| 12-#18 | 3.36 | MA | 19465 | 5532 | 32472 | 4402 | 38730 | 3515 | 42224 | 2830 | 46521 | 1682 | 58972 | 871 | 52075 |
| 5L-3S | | MI | 17951 | 5532 | 30088 | 4309 | 35813 | 3440 | 39328 | 2762 | 44001 | 1596 | 54494 | 1081 | 45310 |
| 12-#18 | 3.36 | MA | 17991 | 5532 | 30291 | 4402 | 35824 | 3538 | 38688 | 2822 | 41866 | 1695 | 52765 | 677 | 47950 |
| 6L-2S | | MI | 19776 | 5532 | 32609 | 4314 | 39010 | 3450 | 43179 | 2749 | 49067 | 1583 | 61155 | 1315 | 45728 |
| 14-#11 | 1.53 | MA | 20479 | 4581 | 29885 | 3818 | 35771 | 3096 | 38790 | 2551 | 42161 | 1748 | 52028 | 1636 | 27528 |
| 2L-7S | | MI | 13503 | 4581 | 20411 | 3771 | 23725 | 3061 | 24891 | 2525 | 25152 | 1710 | 30533 | 1195 | 20428 |
| 14-#11 | 1.53 | MA | 19478 | 4581 | 28589 | 3819 | 34126 | 3095 | 36798 | 2560 | 39473 | 1754 | 48408 | 1544 | 27477 |
| 3L-6S | | MI | 13990 | 4581 | 21076 | 3772 | 24604 | 3063 | 25965 | 2519 | 26615 | 1715 | 32233 | 1266 | 20831 |
| 14-#11 | 1.53 | MA | 18755 | 4581 | 27626 | 3820 | 32824 | 3105 | 35220 | 2558 | 37344 | 1749 | 46022 | 1453 | 27354 |
| 4L-5S | | MI | 14487 | 4581 | 21758 | 3773 | 25514 | 3055 | 27071 | 2523 | 28058 | 1710 | 34150 | 1342 | 21401 |
| 14-#11 | 1.53 | MA | 18100 | 4581 | 26652 | 3831 | 31656 | 3105 | 33794 | 2567 | 35401 | 1755 | 43532 | 1407 | 26981 |
| 5L-4S | | MI | 15005 | 4581 | 22526 | 3763 | 26434 | 3057 | 28195 | 2516 | 29558 | 1705 | 36056 | 1385 | 21687 |
| 14-#11 | 1.53 | MA | 17472 | 4581 | 25787 | 3832 | 30503 | 3115 | 32390 | 2565 | 33534 | 1761 | 41005 | 1332 | 26158 |
| 6L-3S | | MI | 15575 | 4581 | 23283 | 3763 | 27457 | 3049 | 29434 | 2520 | 31202 | 1710 | 37857 | 1476 | 21755 |
| 14-#11 | 1.53 | MA | 16857 | 4581 | 24946 | 3833 | 29388 | 3115 | 31028 | 2574 | 31641 | 1757 | 38755 | 1261 | 25582 |
| 7L-2S | | MI | 16355 | 4581 | 24296 | 3764 | 28742 | 3052 | 30991 | 2514 | 33273 | 1705 | 40604 | 1568 | 21778 |
| 14-#14 | 2.21 | MA | 22265 | 4932 | 33900 | 4025 | 40766 | 3247 | 44799 | 2645 | 50240 | 1725 | 62661 | 1577 | 39159 |
| 2L-7S | | MI | 13730 | 4932 | 21869 | 3976 | 25444 | 3210 | 26924 | 2617 | 27796 | 1674 | 34280 | 950 | 27204 |
| 14-#14 | 2.21 | MA | 20871 | 4932 | 32044 | 4026 | 38412 | 3245 | 41948 | 2656 | 46393 | 1733 | 57513 | 1446 | 38999 |
| 3L-6S | | MI | 14408 | 4932 | 22821 | 3978 | 26702 | 3214 | 28461 | 2609 | 29874 | 1681 | 36684 | 1053 | 28556 |
| 14-#14 | 2.21 | MA | 19864 | 4932 | 30664 | 4027 | 36547 | 3259 | 39688 | 2653 | 43342 | 1726 | 54123 | 1314 | 38640 |
| 4L-5S | | MI | 15101 | 4932 | 23798 | 3979 | 28004 | 3203 | 30045 | 2615 | 31922 | 1674 | 39398 | 1162 | 29298 |
| 14-#14 | 2.21 | MA | 18952 | 4932 | 29268 | 4043 | 34871 | 3258 | 37642 | 2665 | 40558 | 1734 | 50576 | 1249 | 37091 |
| 5L-4S | | MI | 15822 | 4932 | 24896 | 3966 | 29322 | 3207 | 31653 | 2607 | 34052 | 1666 | 42104 | 1224 | 30501 |
| 14-#14 | 2.21 | MA | 18078 | 4932 | 28028 | 4044 | 33217 | 3272 | 35629 | 2662 | 37880 | 1741 | 46982 | 1140 | 36036 |
| 6L-3S | | MI | 16616 | 4932 | 25980 | 3967 | 30785 | 3196 | 33426 | 2613 | 36387 | 1674 | 44651 | 1355 | 30738 |
| 14-#14 | 2.21 | MA | 17222 | 4932 | 26820 | 4044 | 31620 | 3271 | 33677 | 2674 | 35166 | 1734 | 43786 | 1038 | 34235 |
| 7L-2S | | MI | 17703 | 4932 | 27427 | 3969 | 32620 | 3200 | 35649 | 2605 | 39328 | 1666 | 48540 | 1486 | 30840 |
| 14-#18 | 3.92 | MA | 22459 | 5823 | 38172 | 4558 | 45793 | 3652 | 50807 | 2896 | 58047 | 1653 | 74019 | 942 | 63835 |
| 4L-5S | | MI | 16526 | 5823 | 28793 | 4507 | 34145 | 3580 | 37310 | 2844 | 41376 | 1571 | 52146 | 683 | 47638 |
| 14-#18 | 3.92 | MA | 20953 | 5823 | 35719 | 4584 | 42850 | 3648 | 47215 | 2915 | 53206 | 1666 | 67866 | 829 | 61165 |
| 5L-4S | | MI | 17719 | 5823 | 30714 | 4486 | 36452 | 3590 | 40102 | 2831 | 45045 | 1558 | 56791 | 792 | 49785 |
| 14-#18 | 3.92 | MA | 19509 | 5823 | 33539 | 4584 | 39944 | 3671 | 43678 | 2906 | 48550 | 1679 | 61658 | 635 | 57135 |
| 6L-3S | | MI | 19032 | 5823 | 32609 | 4491 | 39010 | 3573 | 43179 | 2844 | 49067 | 1571 | 61155 | 1022 | 52636 |
| 14-#18 | 3.92 | MA | 18093 | 5823 | 31416 | 4583 | 37135 | 3666 | 40248 | 2925 | 43830 | 1666 | 56147 | 453 | 52840 |
| 7L-2S | | MI | 20828 | 5823 | 35130 | 4496 | 42207 | 3583 | 47031 | 2831 | 54134 | 1558 | 67816 | 1255 | 53129 |
| 16-#11 | 1.75 | MA | 21092 | 4694 | 31182 | 3889 | 37415 | 3148 | 40782 | 2584 | 44849 | 1743 | 55648 | 1623 | 31364 |
| 2L-8S | | MI | 13521 | 4694 | 20770 | 3842 | 24149 | 3110 | 25372 | 2554 | 25812 | 1708 | 31501 | 1126 | 22531 |
| 16-#11 | 1.75 | MA | 20100 | 4694 | 29885 | 3890 | 35771 | 3147 | 38790 | 2593 | 42161 | 1749 | 52028 | 1532 | 31297 |
| 3L-7S | | MI | 13998 | 4694 | 21425 | 3842 | 25010 | 3113 | 26448 | 2558 | 27224 | 1703 | 33280 | 1177 | 23267 |
| 16-#11 | 1.75 | MA | 19384 | 4694 | 28923 | 3891 | 34469 | 3157 | 37212 | 2591 | 40032 | 1744 | 49641 | 1441 | 31154 |
| 4L-6S | | MI | 14479 | 4694 | 22089 | 3843 | 25889 | 3115 | 27522 | 2551 | 28687 | 1708 | 34980 | 1248 | 23728 |
| 16-#11 | 1.75 | MA | 18736 | 4694 | 27949 | 3902 | 33300 | 3157 | 35786 | 2600 | 38089 | 1750 | 47152 | 1394 | 30675 |
| 5E | | MI | 14972 | 4694 | 22772 | 3843 | 26799 | 3107 | 28628 | 2555 | 30129 | 1703 | 36896 | 1323 | 24272 |

## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

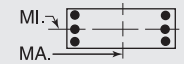
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.75 | MA | 18115 | 4694 | 27084 | 3903 | 32147 | 3167 | 34382 | 2598 | 36222 | 1756 | 44625 | 1319 | 29883 |
| 6L-4S | | MI | 15484 | 4694 | 23539 | 3834 | 27719 | 3109 | 29752 | 2549 | 31629 | 1697 | 38803 | 1367 | 24658 |
| 16-#11 | 1.75 | MA | 17507 | 4694 | 26242 | 3904 | 31033 | 3166 | 33021 | 2607 | 34329 | 1752 | 42375 | 1248 | 29267 |
| 7L-3S | | MI | 16049 | 4694 | 24296 | 3834 | 28742 | 3101 | 30991 | 2553 | 33273 | 1703 | 40604 | 1458 | 24744 |
| 16-#11 | 1.75 | MA | 16906 | 4694 | 25414 | 3905 | 29941 | 3166 | 31657 | 2605 | 32502 | 1758 | 40050 | 1195 | 28232 |
| 8L-2S | | MI | 16823 | 4694 | 25309 | 3835 | 30027 | 3103 | 32548 | 2546 | 35345 | 1697 | 43351 | 1549 | 24780 |
| 16-#14 | 2.52 | MA | 21726 | 5096 | 33900 | 4128 | 40766 | 3320 | 44799 | 2704 | 50240 | 1726 | 62661 | 1426 | 44441 |
| 3L-7S | | MI | 14418 | 5096 | 23316 | 4078 | 27279 | 3284 | 29147 | 2664 | 30737 | 1662 | 38169 | 921 | 31277 |
| 16-#14 | 2.52 | MA | 20732 | 5096 | 32520 | 4129 | 38900 | 3334 | 42539 | 2701 | 47189 | 1718 | 59271 | 1294 | 44049 |
| 4L-6S | | MI | 15088 | 5096 | 24268 | 4080 | 28537 | 3288 | 30684 | 2656 | 32815 | 1670 | 40573 | 1024 | 32581 |
| 16-#14 | 2.52 | MA | 19833 | 5096 | 31124 | 4145 | 37225 | 3333 | 40494 | 2712 | 44405 | 1726 | 55724 | 1228 | 42396 |
| 5E | | MI | 15771 | 5096 | 25245 | 4081 | 29839 | 3278 | 32268 | 2663 | 34864 | 1662 | 43287 | 1133 | 33410 |
| 16-#14 | 2.52 | MA | 18971 | 5096 | 29883 | 4146 | 35571 | 3347 | 38481 | 2709 | 41727 | 1734 | 52130 | 1120 | 41352 |
| 6L-4S | | MI | 16484 | 5096 | 26343 | 4068 | 31157 | 3282 | 33876 | 2654 | 36994 | 1655 | 45994 | 1195 | 34645 |
| 16-#14 | 2.52 | MA | 18127 | 5096 | 28676 | 4147 | 33973 | 3345 | 36529 | 2721 | 39013 | 1727 | 48934 | 1018 | 39513 |
| 7L-3S | | MI | 17268 | 5096 | 27427 | 4069 | 32620 | 3271 | 35649 | 2661 | 39328 | 1662 | 48540 | 1326 | 34979 |
| 16-#14 | 2.52 | MA | 17292 | 5096 | 27487 | 4148 | 32407 | 3344 | 34573 | 2718 | 36393 | 1735 | 45621 | 941 | 37771 |
| 8L-2S | | MI | 18343 | 5096 | 28873 | 4071 | 34455 | 3275 | 37872 | 2652 | 42270 | 1655 | 52430 | 1457 | 35108 |
| 16-#18 | 4.48 | MA | 22409 | 6113 | 38967 | 4766 | 46969 | 3781 | 52205 | 2999 | 59891 | 1650 | 76759 | 786 | 70242 |
| 5E | | MI | 17631 | 6113 | 31314 | 4689 | 37343 | 3713 | 41162 | 2927 | 46442 | 1547 | 58807 | 623 | 54584 |
| 16-#18 | 4.48 | MA | 20993 | 6113 | 36787 | 4765 | 44063 | 3804 | 48668 | 2991 | 55235 | 1663 | 70551 | 593 | 66343 |
| 6L-4S | | MI | 18804 | 6113 | 33235 | 4668 | 39649 | 3723 | 43953 | 2914 | 50112 | 1533 | 63452 | 732 | 56883 |
| 16-#18 | 4.48 | MA | 19605 | 6113 | 34664 | 4765 | 41255 | 3799 | 45238 | 3009 | 50514 | 1650 | 65040 | 410 | 61981 |
| 7L-3S | | MI | 20096 | 6113 | 35130 | 4673 | 42207 | 3706 | 47031 | 2927 | 54134 | 1547 | 67816 | 962 | 59958 |
| 18-#11 | 1.97 | MA | 20713 | 4808 | 31182 | 3961 | 37415 | 3199 | 40782 | 2626 | 44849 | 1743 | 55648 | 1519 | 35113 |
| 3L-8S | | MI | 14014 | 4808 | 21783 | 3912 | 25434 | 3162 | 26929 | 2587 | 27884 | 1701 | 34247 | 1108 | 25402 |
| 18-#11 | 1.97 | MA | 20004 | 4808 | 30219 | 3961 | 36114 | 3209 | 39205 | 2624 | 42720 | 1739 | 53261 | 1428 | 34951 |
| 4L-7S | | MI | 14486 | 4808 | 22438 | 3913 | 26295 | 3165 | 28005 | 2591 | 29295 | 1695 | 36026 | 1158 | 26114 |
| 18-#11 | 1.97 | MA | 19363 | 4808 | 29246 | 3973 | 34945 | 3209 | 37778 | 2632 | 40778 | 1745 | 50772 | 1382 | 34379 |
| 5L-6S | | MI | 14963 | 4808 | 23102 | 3914 | 27174 | 3167 | 29078 | 2584 | 30758 | 1701 | 37726 | 1229 | 26631 |
| 18-#11 | 1.97 | MA | 18749 | 4808 | 28381 | 3974 | 33792 | 3219 | 36374 | 2631 | 38910 | 1751 | 48245 | 1307 | 33614 |
| 6L-5S | | MI | 15450 | 4808 | 23785 | 3914 | 28084 | 3159 | 30185 | 2588 | 32201 | 1695 | 39643 | 1305 | 27153 |
| 18-#11 | 1.97 | MA | 18147 | 4808 | 27539 | 3975 | 32678 | 3218 | 35013 | 2639 | 37017 | 1747 | 45995 | 1236 | 32945 |
| 7L-4S | | MI | 15958 | 4808 | 24552 | 3905 | 29004 | 3161 | 31308 | 2582 | 33701 | 1690 | 41549 | 1348 | 27625 |
| 18-#11 | 1.97 | MA | 17553 | 4808 | 26710 | 3975 | 31586 | 3218 | 33649 | 2638 | 35190 | 1753 | 43670 | 1182 | 31937 |
| 8L-3S | | MI | 16518 | 4808 | 25309 | 3905 | 30027 | 3153 | 32548 | 2586 | 35345 | 1695 | 43351 | 1439 | 27728 |
| 18-#11 | 1.97 | MA | 16962 | 4808 | 25795 | 3987 | 30461 | 3228 | 32308 | 2646 | 33381 | 1759 | 41375 | 1124 | 30938 |
| 9L-2S | | MI | 17285 | 4808 | 26322 | 3906 | 31312 | 3155 | 34105 | 2579 | 37416 | 1690 | 46097 | 1531 | 27778 |
| 18-#14 | 2.84 | MA | 21587 | 5259 | 34376 | 4231 | 41254 | 3409 | 45390 | 2748 | 51036 | 1711 | 64418 | 1274 | 49434 |
| 4L-7S | | MI | 15095 | 5259 | 24763 | 4180 | 29114 | 3359 | 31370 | 2712 | 33679 | 1650 | 42058 | 892 | 35361 |
| 18-#14 | 2.84 | MA | 20700 | 5259 | 32979 | 4247 | 39578 | 3408 | 43345 | 2760 | 48252 | 1719 | 60871 | 1208 | 47711 |
| 5L-6S | | MI | 15756 | 5259 | 25715 | 4182 | 30372 | 3363 | 32907 | 2703 | 35757 | 1658 | 44462 | 995 | 36619 |
| 18-#14 | 2.84 | MA | 19849 | 5259 | 31739 | 4248 | 37925 | 3421 | 41332 | 2757 | 45574 | 1727 | 57277 | 1100 | 46588 |
| 6L-5S | | MI | 16431 | 5259 | 26692 | 4183 | 31674 | 3352 | 34491 | 2710 | 37805 | 1650 | 47176 | 1104 | 37531 |
| 18-#14 | 2.84 | MA | 19016 | 5259 | 30532 | 4249 | 36327 | 3420 | 39380 | 2768 | 42860 | 1719 | 54081 | 997 | 44800 |
| 7L-4S | | MI | 17135 | 5259 | 27790 | 4170 | 32992 | 3356 | 36099 | 2702 | 39935 | 1643 | 49883 | 1166 | 38709 |
| 18-#14 | 2.84 | MA | 18193 | 5259 | 29343 | 4250 | 34761 | 3419 | 37424 | 2765 | 40240 | 1727 | 50769 | 921 | 42956 |
| 8L-3S | | MI | 17911 | 5259 | 28873 | 4172 | 34455 | 3346 | 37872 | 2708 | 42270 | 1650 | 52430 | 1297 | 39216 |
| 18-#14 | 2.84 | MA | 17375 | 5259 | 28031 | 4266 | 33147 | 3433 | 35500 | 2777 | 37646 | 1735 | 47508 | 837 | 41102 |
| 9L-2S | | MI | 18974 | 5259 | 30320 | 4173 | 36290 | 3350 | 40095 | 2700 | 45211 | 1643 | 56319 | 1429 | 39371 |
| 18-#18 | 5.04 | MA | 22449 | 6404 | 40035 | 4947 | 48182 | 3936 | 53659 | 3075 | 61920 | 1648 | 79445 | 550 | 75569 |
| 6L-5S | | MI | 18719 | 6404 | 33835 | 4871 | 40540 | 3846 | 45013 | 3010 | 51509 | 1522 | 65468 | 563 | 61558 |
| 18-#18 | 5.04 | MA | 21086 | 6404 | 37912 | 4947 | 45374 | 3932 | 50229 | 3093 | 57199 | 1634 | 73933 | 368 | 71140 |
| 7L-4S | | MI | 19872 | 6404 | 35756 | 4849 | 42846 | 3856 | 47805 | 2996 | 55178 | 1509 | 70113 | 672 | 64004 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

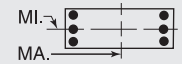



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.18 | MA | 20617 | 4921 | 31516 | 4032 | 37758 | 3261 | 41197 | 2657 | 45408 | 1734 | 56881 | 1415 | 38747 |
| 4L-8S | | MI | 14500 | 4921 | 22797 | 3983 | 26719 | 3214 | 28486 | 2620 | 29955 | 1693 | 36994 | 1089 | 28279 |
| 20-#11 | 2.18 | MA | 19982 | 4921 | 30542 | 4044 | 36589 | 3261 | 39771 | 2665 | 43466 | 1740 | 54392 | 1369 | 38090 |
| 5L-7S | | MI | 14967 | 4921 | 23451 | 3984 | 27580 | 3216 | 29562 | 2624 | 31366 | 1688 | 38773 | 1140 | 28969 |
| 20-#11 | 2.18 | MA | 19374 | 4921 | 29677 | 4045 | 35436 | 3271 | 38367 | 2664 | 41598 | 1746 | 51864 | 1294 | 37351 |
| 6E | | MI | 15440 | 4921 | 24116 | 3985 | 28459 | 3219 | 30635 | 2617 | 32829 | 1693 | 40473 | 1211 | 29538 |
| 20-#11 | 2.18 | MA | 18779 | 4921 | 28836 | 4045 | 34322 | 3270 | 37006 | 2672 | 39705 | 1742 | 49615 | 1223 | 36630 |
| 7L-5S | | MI | 15923 | 4921 | 24798 | 3985 | 29369 | 3211 | 31742 | 2621 | 34272 | 1688 | 42389 | 1287 | 30040 |
| 20-#11 | 2.18 | MA | 18191 | 4921 | 28007 | 4046 | 33230 | 3270 | 35642 | 2671 | 37878 | 1748 | 47290 | 1169 | 35647 |
| 8L-4S | | MI | 16426 | 4921 | 25565 | 3975 | 30289 | 3213 | 32865 | 2615 | 35772 | 1683 | 44296 | 1330 | 30589 |
| 20-#11 | 2.18 | MA | 17606 | 4921 | 27092 | 4058 | 32105 | 3280 | 34300 | 2679 | 36069 | 1754 | 44995 | 1111 | 34618 |
| 9L-3S | | MI | 16981 | 4921 | 26322 | 3976 | 31312 | 3205 | 34105 | 2619 | 37416 | 1688 | 46097 | 1421 | 30708 |
| 20-#11 | 2.18 | MA | 17025 | 4921 | 26267 | 4059 | 31021 | 3279 | 32952 | 2678 | 34209 | 1749 | 42623 | 1031 | 33502 |
| 10L-2S | | MI | 17742 | 4921 | 27336 | 3977 | 32597 | 3207 | 35662 | 2612 | 39487 | 1683 | 48844 | 1512 | 30771 |
| 20-#14 | 3.15 | MA | 21553 | 5423 | 34835 | 4349 | 41932 | 3482 | 46197 | 2807 | 52099 | 1711 | 66019 | 1188 | 53036 |
| 5L-7S | | MI | 15762 | 5423 | 26210 | 4283 | 30949 | 3434 | 33594 | 2759 | 36620 | 1639 | 45948 | 863 | 39454 |
| 20-#14 | 3.15 | MA | 20714 | 5423 | 33595 | 4350 | 40278 | 3496 | 44184 | 2804 | 49421 | 1719 | 62425 | 1080 | 51835 |
| 6E | | MI | 16415 | 5423 | 27162 | 4284 | 32207 | 3438 | 35130 | 2751 | 38698 | 1646 | 48352 | 966 | 40669 |
| 20-#14 | 3.15 | MA | 19892 | 5423 | 32387 | 4351 | 38680 | 3495 | 42232 | 2816 | 46707 | 1712 | 59229 | 977 | 50096 |
| 7L-5S | | MI | 17083 | 5423 | 28139 | 4286 | 33509 | 3427 | 36714 | 2757 | 40746 | 1639 | 51066 | 1075 | 41662 |
| 20-#14 | 3.15 | MA | 19079 | 5423 | 31199 | 4352 | 37115 | 3494 | 40276 | 2813 | 44087 | 1720 | 55917 | 901 | 48212 |
| 8L-4S | | MI | 17778 | 5423 | 29237 | 4272 | 34827 | 3431 | 38322 | 2749 | 42876 | 1631 | 53772 | 1137 | 42787 |
| 20-#14 | 3.15 | MA | 18272 | 5423 | 29886 | 4368 | 35501 | 3508 | 38352 | 2824 | 41493 | 1728 | 52655 | 816 | 46330 |
| 9L-3S | | MI | 18545 | 5423 | 30320 | 4274 | 36290 | 3420 | 40095 | 2755 | 45211 | 1639 | 56319 | 1268 | 43449 |
| 20-#18 | 5.60 | MA | 22541 | 6695 | 41160 | 5128 | 49493 | 4065 | 55219 | 3178 | 63884 | 1618 | 82826 | 325 | 80316 |
| 7L-5S | | MI | 19872 | 6695 | 36356 | 5053 | 43737 | 3979 | 48864 | 3092 | 56575 | 1497 | 72129 | 504 | 68558 |
| 22-#11 | 2.40 | MA | 20594 | 5035 | 31839 | 4114 | 38234 | 3312 | 41763 | 2698 | 46154 | 1735 | 58012 | 1356 | 41808 |
| 5L-8S | | MI | 14981 | 5035 | 23810 | 4054 | 28004 | 3266 | 30043 | 2653 | 32026 | 1686 | 39740 | 1071 | 31160 |
| 22-#11 | 2.40 | MA | 19992 | 5035 | 30974 | 4115 | 37081 | 3322 | 40359 | 2696 | 44286 | 1741 | 55484 | 1281 | 41091 |
| 6L-7S | | MI | 15443 | 5035 | 24464 | 4055 | 28865 | 3268 | 31118 | 2656 | 33438 | 1681 | 41519 | 1121 | 31830 |
| 22-#11 | 2.40 | MA | 19403 | 5035 | 30132 | 4116 | 35967 | 3322 | 38998 | 2705 | 42393 | 1736 | 53235 | 1210 | 40321 |
| 7L-6S | | MI | 15912 | 5035 | 25129 | 4055 | 29744 | 3271 | 32192 | 2650 | 34901 | 1686 | 43219 | 1192 | 32449 |
| 22-#11 | 2.40 | MA | 18820 | 5035 | 29304 | 4117 | 34875 | 3322 | 37634 | 2703 | 40566 | 1742 | 50910 | 1157 | 39362 |
| 8L-5S | | MI | 16390 | 5035 | 25811 | 4056 | 30654 | 3263 | 33298 | 2654 | 36343 | 1681 | 45136 | 1268 | 32933 |
| 22-#11 | 2.40 | MA | 18242 | 5035 | 28389 | 4129 | 33750 | 3332 | 36293 | 2712 | 38758 | 1749 | 48615 | 1098 | 38304 |
| 9L-4S | | MI | 16889 | 5035 | 26578 | 4046 | 31574 | 3265 | 34422 | 2647 | 37843 | 1676 | 47042 | 1311 | 33552 |
| 22-#11 | 2.40 | MA | 17666 | 5035 | 27563 | 4129 | 32666 | 3331 | 34945 | 2710 | 36897 | 1744 | 46243 | 1018 | 37209 |
| 10L-3S | | MI | 17439 | 5035 | 27336 | 4047 | 32597 | 3257 | 35662 | 2651 | 39487 | 1681 | 48844 | 1403 | 33685 |
| 22-#11 | 2.40 | MA | 17064 | 5035 | 26744 | 4130 | 31554 | 3341 | 33611 | 2719 | 35096 | 1750 | 43958 | 962 | 35864 |
| 11L-2S | | MI | 18194 | 5035 | 28349 | 4048 | 33882 | 3259 | 37218 | 2645 | 41558 | 1676 | 51590 | 1494 | 33761 |
| 22-#14 | 3.47 | MA | 21566 | 5586 | 35451 | 4453 | 42632 | 3571 | 47035 | 2851 | 53269 | 1712 | 67573 | 1059 | 57093 |
| 6L-7S | | MI | 16420 | 5586 | 27657 | 4385 | 32784 | 3509 | 35817 | 2807 | 39561 | 1627 | 49837 | 834 | 43555 |
| 22-#14 | 3.47 | MA | 20755 | 5586 | 34243 | 4453 | 41034 | 3570 | 45083 | 2863 | 50554 | 1704 | 64377 | 957 | 55400 |
| 7L-6S | | MI | 17066 | 5586 | 28609 | 4386 | 34042 | 3513 | 37354 | 2798 | 41639 | 1635 | 52241 | 937 | 44730 |
| 22-#14 | 3.47 | MA | 19953 | 5586 | 33055 | 4454 | 39468 | 3569 | 43127 | 2860 | 47934 | 1712 | 61065 | 881 | 53476 |
| 8L-5S | | MI | 17725 | 5586 | 29586 | 4388 | 35344 | 3502 | 38937 | 2805 | 43688 | 1627 | 54955 | 1046 | 45799 |
| 22-#14 | 3.47 | MA | 19156 | 5586 | 31742 | 4470 | 37855 | 3582 | 41203 | 2872 | 45340 | 1720 | 57803 | 796 | 51566 |
| 9L-4S | | MI | 18413 | 5586 | 30684 | 4375 | 36662 | 3506 | 40545 | 2796 | 45818 | 1620 | 57662 | 1108 | 46877 |
| 24-#11 | 2.62 | MA | 20602 | 5148 | 32271 | 4186 | 38725 | 3374 | 42352 | 2729 | 46974 | 1736 | 59104 | 1268 | 44835 |
| 6L-8S | | MI | 15456 | 5148 | 24823 | 4125 | 29289 | 3318 | 31600 | 2685 | 34098 | 1679 | 42487 | 1052 | 34046 |
| 24-#11 | 2.62 | MA | 20019 | 5148 | 31429 | 4187 | 37611 | 3374 | 40990 | 2738 | 45081 | 1731 | 56855 | 1197 | 44018 |
| 7E | | MI | 15914 | 5148 | 25477 | 4126 | 30150 | 3320 | 32675 | 2689 | 35509 | 1674 | 44266 | 1103 | 34698 |
| 24-#11 | 2.62 | MA | 19442 | 5148 | 30601 | 4188 | 36520 | 3374 | 39627 | 2736 | 43254 | 1737 | 54530 | 1144 | 43081 |
| 8L-6S | | MI | 16378 | 5148 | 26142 | 4126 | 31029 | 3322 | 33749 | 2683 | 36972 | 1679 | 45966 | 1174 | 35363 |
| 24-#11 | 2.62 | MA | 18870 | 5148 | 29685 | 4199 | 35395 | 3383 | 38285 | 2745 | 41446 | 1743 | 52235 | 1085 | 41994 |
| 9L-5S | | MI | 16853 | 5148 | 26824 | 4127 | 31939 | 3314 | 34855 | 2687 | 38415 | 1674 | 47882 | 1250 | 35832 |
| 24-#11 | 2.62 | MA | 18300 | 5148 | 28860 | 4200 | 34310 | 3383 | 36937 | 2743 | 39586 | 1739 | 49863 | 1005 | 40897 |
| 10L-4S | | MI | 17347 | 5148 | 27592 | 4117 | 32859 | 3317 | 35979 | 2680 | 39915 | 1669 | 49789 | 1293 | 36513 |

## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis



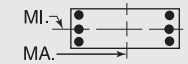

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.62 | MA | 17700 | 5148 | 28041 | 4201 | 33198 | 3393 | 35604 | 2752 | 37784 | 1745 | 47578 | 949 | 39556 |
| 11L-3S | | MI | 17892 | 5148 | 28349 | 4118 | 33882 | 3309 | 37218 | 2684 | 41558 | 1674 | 51590 | 1384 | 36660 |
| 24-#14 | 3.78 | MA | 21606 | 5750 | 36099 | 4556 | 43388 | 3645 | 47934 | 2910 | 54401 | 1697 | 69525 | 937 | 60711 |
| 7E | | MI | 17070 | 5750 | 29104 | 4487 | 34619 | 3584 | 38040 | 2854 | 42503 | 1616 | 53726 | 805 | 47663 |
| 24-#14 | 3.78 | MA | 20814 | 5750 | 34910 | 4556 | 41822 | 3644 | 45979 | 2907 | 51781 | 1705 | 66212 | 861 | 58747 |
| 8L-6S | | MI | 17708 | 5750 | 30056 | 4489 | 35877 | 3588 | 39577 | 2846 | 44581 | 1623 | 56130 | 908 | 48802 |
| 24-#14 | 3.78 | MA | 20027 | 5750 | 33598 | 4572 | 40208 | 3657 | 44054 | 2919 | 49187 | 1713 | 62951 | 776 | 56809 |
| 9L-5S | | MI | 18361 | 5750 | 31033 | 4490 | 37179 | 3577 | 41161 | 2852 | 46629 | 1616 | 58844 | 1017 | 49943 |
| **RECTANGULAR TIED COLUMNS 34" x 44"** | | | | | | | | | | | | | | | |
| 4-#18 | 1.07 | MA | 20932 | 4549 | 29915 | 3818 | 35391 | 3108 | 37796 | 2583 | 39728 | 1827 | 48062 | 1716 | 21137 |
| 2E | | MI | 15947 | 4549 | 23357 | 3741 | 27165 | 3044 | 28730 | 2525 | 29690 | 1764 | 35520 | 1634 | 15929 |
| 6-#18 | 1.60 | MA | 22567 | 4840 | 33345 | 4000 | 39741 | 3241 | 43066 | 2667 | 46818 | 1813 | 57514 | 1677 | 31323 |
| 2L-3S | | MI | 15174 | 4840 | 23357 | 3917 | 27165 | 3167 | 28730 | 2621 | 29690 | 1753 | 35520 | 1341 | 23350 |
| 6-#18 | 1.60 | MA | 19928 | 4840 | 29915 | 4001 | 35391 | 3238 | 37796 | 2687 | 39728 | 1826 | 48062 | 1443 | 31057 |
| 3L-2S | | MI | 17108 | 4840 | 25878 | 3922 | 30362 | 3177 | 32581 | 2608 | 34756 | 1739 | 42181 | 1574 | 23458 |
| 8-#14 | 1.20 | MA | 21450 | 4622 | 30679 | 3888 | 36560 | 3161 | 39299 | 2621 | 41853 | 1838 | 51138 | 1732 | 23903 |
| 2L-4S | | MI | 14383 | 4622 | 21379 | 3814 | 24758 | 3110 | 25940 | 2573 | 26121 | 1784 | 31451 | 1391 | 17915 |
| 8-#14 | 1.20 | MA | 19917 | 4622 | 28721 | 3889 | 34077 | 3161 | 36291 | 2633 | 37795 | 1847 | 45675 | 1601 | 23853 |
| 3E | | MI | 15212 | 4622 | 22463 | 3815 | 26222 | 3099 | 27713 | 2579 | 28455 | 1791 | 33998 | 1522 | 18008 |
| 8-#14 | 1.20 | MA | 18806 | 4622 | 27267 | 3890 | 32111 | 3175 | 33908 | 2630 | 34579 | 1841 | 42073 | 1469 | 23626 |
| 4L-2S | | MI | 16340 | 4622 | 23910 | 3817 | 28057 | 3103 | 29936 | 2571 | 31397 | 1784 | 37887 | 1654 | 18003 |
| 8-#18 | 2.14 | MA | 24149 | 5131 | 36774 | 4182 | 44091 | 3374 | 48336 | 2751 | 53908 | 1798 | 66967 | 1638 | 41462 |
| 2L-4S | | MI | 14943 | 5131 | 23984 | 4094 | 27804 | 3317 | 29504 | 2691 | 30734 | 1715 | 37817 | 1051 | 28977 |
| 8-#18 | 2.14 | MA | 21566 | 5131 | 33345 | 4183 | 39741 | 3371 | 43066 | 2771 | 46818 | 1812 | 57514 | 1404 | 41074 |
| 3E | | MI | 16339 | 5131 | 25878 | 4099 | 30362 | 3300 | 32581 | 2704 | 34756 | 1728 | 42181 | 1281 | 30717 |
| 8-#18 | 2.14 | MA | 19692 | 5131 | 30791 | 4183 | 36289 | 3395 | 38883 | 2764 | 41192 | 1798 | 51296 | 1170 | 38681 |
| 4L-2S | | MI | 18236 | 5131 | 28399 | 4104 | 33560 | 3310 | 36433 | 2691 | 39823 | 1715 | 48842 | 1514 | 30930 |
| 10-#11 | 1.04 | MA | 20986 | 4534 | 29578 | 3845 | 35266 | 3131 | 37775 | 2604 | 39827 | 1849 | 48544 | 1754 | 20887 |
| 2L-5S | | MI | 14110 | 4534 | 20551 | 3786 | 23884 | 3079 | 24915 | 2566 | 24809 | 1808 | 29675 | 1460 | 15692 |
| 10-#11 | 1.04 | MA | 19907 | 4534 | 28211 | 3846 | 33531 | 3131 | 35674 | 2613 | 36992 | 1855 | 44705 | 1663 | 20874 |
| 3L-4S | | MI | 14640 | 4534 | 21318 | 3777 | 24805 | 3082 | 26038 | 2559 | 26309 | 1803 | 31581 | 1503 | 15774 |
| 10-#11 | 1.04 | MA | 19126 | 4534 | 27196 | 3848 | 32160 | 3141 | 34012 | 2611 | 34749 | 1852 | 42171 | 1572 | 20799 |
| 4L-3S | | MI | 15223 | 4534 | 22076 | 3777 | 25828 | 3074 | 27278 | 2563 | 27953 | 1808 | 33382 | 1594 | 15790 |
| 10-#11 | 1.04 | MA | 18419 | 4534 | 26171 | 3859 | 30929 | 3141 | 32510 | 2620 | 32704 | 1858 | 39536 | 1525 | 20605 |
| 5L-2S | | MI | 16019 | 4534 | 23089 | 3778 | 27113 | 3076 | 28835 | 2557 | 30025 | 1803 | 36129 | 1685 | 15773 |
| 10-#14 | 1.50 | MA | 22392 | 4785 | 32637 | 3990 | 39044 | 3236 | 42308 | 2668 | 45912 | 1831 | 56601 | 1714 | 29709 |
| 2L-5S | | MI | 14339 | 4785 | 21728 | 3929 | 25276 | 3181 | 26555 | 2629 | 26932 | 1780 | 32634 | 1301 | 21286 |
| 10-#14 | 1.50 | MA | 20878 | 4785 | 30679 | 3991 | 36560 | 3235 | 39299 | 2680 | 41853 | 1840 | 51138 | 1582 | 29618 |
| 3L-4S | | MI | 15082 | 4785 | 22826 | 3916 | 26593 | 3185 | 28163 | 2620 | 29062 | 1772 | 35341 | 1362 | 22143 |
| 10-#14 | 1.50 | MA | 19783 | 4785 | 29225 | 3993 | 34594 | 3250 | 36917 | 2678 | 38638 | 1833 | 47536 | 1451 | 29341 |
| 4L-3S | | MI | 15900 | 4785 | 23910 | 3918 | 28057 | 3174 | 29936 | 2627 | 31397 | 1780 | 37887 | 1493 | 22282 |
| 10-#14 | 1.50 | MA | 18792 | 4785 | 27754 | 4009 | 32830 | 3249 | 34763 | 2690 | 35705 | 1842 | 43778 | 1384 | 28088 |
| 5L-2S | | MI | 17015 | 4785 | 25356 | 3919 | 29892 | 3178 | 32159 | 2618 | 34338 | 1772 | 41777 | 1625 | 22313 |
| 10-#18 | 2.67 | MA | 25690 | 5421 | 40204 | 4364 | 48440 | 3507 | 53605 | 2836 | 60998 | 1784 | 76420 | 1598 | 51576 |
| 2L-5S | | MI | 14858 | 5421 | 24583 | 4297 | 28695 | 3440 | 30564 | 2786 | 32131 | 1703 | 39833 | 882 | 34061 |
| 10-#18 | 2.67 | MA | 23156 | 5421 | 36774 | 4364 | 44091 | 3504 | 48336 | 2855 | 53908 | 1797 | 66967 | 1365 | 51084 |
| 3L-4S | | MI | 16103 | 5421 | 26505 | 4276 | 31002 | 3450 | 33355 | 2773 | 35801 | 1690 | 44478 | 991 | 35960 |
| 10-#18 | 2.67 | MA | 21323 | 5421 | 34221 | 4365 | 40639 | 3528 | 44153 | 2848 | 48282 | 1784 | 60749 | 1131 | 48312 |
| 4L-3S | | MI | 17472 | 5421 | 28399 | 4281 | 33560 | 3433 | 36433 | 2786 | 39823 | 1703 | 48842 | 1221 | 38065 |
| 10-#18 | 2.67 | MA | 19662 | 5421 | 31636 | 4392 | 37537 | 3525 | 40367 | 2868 | 43147 | 1797 | 54222 | 1016 | 45354 |
| 5L-2S | | MI | 19336 | 5421 | 30920 | 4286 | 36757 | 3443 | 40284 | 2773 | 44890 | 1690 | 55503 | 1455 | 38370 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis

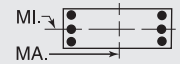



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.25 | MA | 21657 | 4648 | 30946 | 3916 | 37000 | 3183 | 39876 | 2636 | 42662 | 1844 | 52382 | 1743 | 24949 |
| 2L-6S | | MI | 14106 | 4648 | 20882 | 3857 | 24260 | 3139 | 25365 | 2594 | 25438 | 1806 | 30504 | 1366 | 18063 |
| 12-#11 | 1.25 | MA | 20587 | 4648 | 29578 | 3917 | 35266 | 3183 | 37775 | 2646 | 39827 | 1850 | 48544 | 1652 | 24916 |
| 3L-5S | | MI | 14610 | 4648 | 21564 | 3857 | 25169 | 3131 | 26471 | 2598 | 26881 | 1801 | 32421 | 1441 | 18652 |
| 12-#11 | 1.25 | MA | 19815 | 4648 | 28564 | 3918 | 33894 | 3193 | 36113 | 2644 | 37584 | 1846 | 46010 | 1560 | 24816 |
| 4E | | MI | 15135 | 4648 | 22332 | 3848 | 26090 | 3134 | 27595 | 2592 | 28381 | 1795 | 34328 | 1485 | 18759 |
| 12-#11 | 1.25 | MA | 19116 | 4648 | 27539 | 3930 | 32664 | 3193 | 34611 | 2653 | 35539 | 1853 | 43375 | 1514 | 24595 |
| 5L-3S | | MI | 15712 | 4648 | 23089 | 3848 | 27113 | 3125 | 28835 | 2596 | 30025 | 1801 | 36129 | 1576 | 18798 |
| 12-#11 | 1.25 | MA | 18446 | 4648 | 26628 | 3931 | 31449 | 3204 | 33133 | 2652 | 33572 | 1860 | 40694 | 1439 | 23717 |
| 6L-2S | | MI | 16501 | 4648 | 24102 | 3849 | 28398 | 3128 | 30391 | 2589 | 32096 | 1795 | 38875 | 1667 | 18797 |
| 12-#14 | 1.80 | MA | 23315 | 4949 | 34595 | 4092 | 41527 | 3311 | 45316 | 2715 | 49971 | 1823 | 62064 | 1695 | 35502 |
| 2L-6S | | MI | 14331 | 4949 | 22198 | 4030 | 25809 | 3266 | 27194 | 2669 | 27825 | 1776 | 33809 | 1162 | 24610 |
| 12-#14 | 1.80 | MA | 21821 | 4949 | 32637 | 4093 | 39044 | 3310 | 42308 | 2728 | 45912 | 1832 | 56601 | 1564 | 35375 |
| 3L-5S | | MI | 15035 | 4949 | 23175 | 4032 | 27111 | 3255 | 28778 | 2676 | 29873 | 1768 | 36523 | 1272 | 25368 |
| 12-#14 | 1.80 | MA | 20741 | 4949 | 31183 | 4095 | 37078 | 3325 | 39925 | 2725 | 42697 | 1826 | 52999 | 1432 | 35054 |
| 4E | | MI | 15769 | 4949 | 24273 | 4018 | 28428 | 3259 | 30386 | 2668 | 32003 | 1761 | 39230 | 1333 | 26364 |
| 12-#14 | 1.80 | MA | 19764 | 4949 | 29712 | 4111 | 35313 | 3324 | 37771 | 2738 | 39764 | 1834 | 49241 | 1366 | 33661 |
| 5L-3S | | MI | 16576 | 4949 | 25356 | 4020 | 29892 | 3249 | 32159 | 2674 | 34338 | 1768 | 41777 | 1464 | 26542 |
| 12-#14 | 1.80 | MA | 18827 | 4949 | 28406 | 4112 | 33571 | 3338 | 35651 | 2735 | 36943 | 1843 | 45427 | 1257 | 32474 |
| 6L-2S | | MI | 17678 | 4949 | 26803 | 4021 | 31727 | 3253 | 34383 | 2666 | 37279 | 1761 | 45666 | 1596 | 26604 |
| 12-#18 | 3.21 | MA | 24706 | 5712 | 40204 | 4546 | 48440 | 3637 | 53605 | 2939 | 60998 | 1783 | 76420 | 1326 | 61090 |
| 3L-5S | | MI | 16015 | 5712 | 27104 | 4479 | 31892 | 3573 | 34415 | 2869 | 37198 | 1678 | 46494 | 823 | 41171 |
| 12-#18 | 3.21 | MA | 22910 | 5712 | 37650 | 4547 | 44989 | 3661 | 49422 | 2933 | 55372 | 1770 | 70202 | 1092 | 57986 |
| 4E | | MI | 17236 | 5712 | 29026 | 4458 | 34199 | 3583 | 37207 | 2856 | 40867 | 1665 | 51139 | 931 | 42987 |
| 12-#18 | 3.21 | MA | 21284 | 5712 | 35066 | 4574 | 41887 | 3658 | 45636 | 2952 | 50237 | 1783 | 63675 | 977 | 55164 |
| 5L-3S | | MI | 18580 | 5712 | 30920 | 4463 | 36757 | 3566 | 40284 | 2869 | 44890 | 1678 | 55503 | 1161 | 45403 |
| 12-#18 | 3.21 | MA | 19724 | 5712 | 32768 | 4574 | 38824 | 3681 | 41909 | 2945 | 45299 | 1796 | 57076 | 784 | 50981 |
| 6L-2S | | MI | 20413 | 5712 | 33441 | 4468 | 39954 | 3576 | 44135 | 2856 | 49956 | 1665 | 62164 | 1395 | 45789 |
| 14-#11 | 1.46 | MA | 22317 | 4761 | 32313 | 3987 | 38735 | 3235 | 41978 | 2669 | 45497 | 1838 | 56221 | 1731 | 29002 |
| 2L-7S | | MI | 14116 | 4761 | 21231 | 3927 | 24666 | 3189 | 25848 | 2634 | 26046 | 1793 | 31551 | 1276 | 20566 |
| 14-#11 | 1.46 | MA | 21258 | 4761 | 30946 | 3988 | 37000 | 3235 | 39876 | 2678 | 42662 | 1845 | 52382 | 1640 | 28951 |
| 3L-6S | | MI | 14604 | 4761 | 21895 | 3927 | 25545 | 3191 | 26922 | 2627 | 27509 | 1798 | 33251 | 1347 | 20953 |
| 14-#11 | 1.46 | MA | 20494 | 4761 | 29932 | 3989 | 35629 | 3245 | 38214 | 2677 | 40419 | 1841 | 49849 | 1549 | 28828 |
| 4L-5S | | MI | 15103 | 4761 | 22578 | 3928 | 26454 | 3183 | 28028 | 2631 | 28952 | 1793 | 35168 | 1423 | 21534 |
| 14-#11 | 1.46 | MA | 19802 | 4761 | 28906 | 4001 | 34398 | 3245 | 36712 | 2686 | 38373 | 1848 | 47214 | 1502 | 28545 |
| 5L-4S | | MI | 15622 | 4761 | 23345 | 3918 | 27375 | 3185 | 29152 | 2625 | 30452 | 1788 | 37074 | 1466 | 21738 |
| 14-#11 | 1.46 | MA | 19140 | 4761 | 27996 | 4002 | 33184 | 3255 | 35234 | 2685 | 36407 | 1854 | 44533 | 1427 | 27641 |
| 6L-3S | | MI | 16195 | 4761 | 24102 | 3919 | 28398 | 3177 | 30391 | 2629 | 32096 | 1793 | 38875 | 1557 | 21795 |
| 14-#11 | 1.46 | MA | 18491 | 4761 | 27110 | 4003 | 32011 | 3255 | 33801 | 2694 | 34414 | 1851 | 42146 | 1356 | 27022 |
| 7L-2S | | MI | 16977 | 4761 | 25115 | 3920 | 29683 | 3180 | 31948 | 2622 | 34167 | 1788 | 41622 | 1648 | 21812 |
| 14-#14 | 2.11 | MA | 24223 | 5112 | 36553 | 4194 | 44010 | 3386 | 48325 | 2763 | 54030 | 1816 | 67527 | 1677 | 41286 |
| 2L-7S | | MI | 14342 | 5112 | 22693 | 4131 | 26385 | 3337 | 27881 | 2725 | 28688 | 1757 | 35295 | 1030 | 27457 |
| 14-#14 | 2.11 | MA | 22746 | 5112 | 34595 | 4196 | 41527 | 3385 | 45316 | 2775 | 49971 | 1825 | 62064 | 1545 | 41125 |
| 3L-6S | | MI | 15023 | 5112 | 23645 | 4132 | 27644 | 3341 | 29418 | 2717 | 30766 | 1764 | 37699 | 1133 | 28739 |
| 14-#14 | 2.11 | MA | 21681 | 5112 | 33141 | 4197 | 39561 | 3399 | 42934 | 2773 | 46756 | 1818 | 58462 | 1414 | 40767 |
| 4L-5S | | MI | 15719 | 5112 | 24622 | 4134 | 28946 | 3330 | 31002 | 2723 | 32815 | 1757 | 40413 | 1243 | 29465 |
| 14-#14 | 2.11 | MA | 20718 | 5112 | 31670 | 4213 | 37796 | 3399 | 40780 | 2785 | 43823 | 1827 | 54705 | 1347 | 39249 |
| 5L-4S | | MI | 16443 | 5112 | 25720 | 4121 | 30263 | 3334 | 32609 | 2715 | 34945 | 1749 | 43119 | 1304 | 30580 |
| 14-#14 | 2.11 | MA | 19794 | 5112 | 30364 | 4214 | 36054 | 3413 | 38659 | 2782 | 41002 | 1836 | 50890 | 1239 | 38104 |
| 6L-3S | | MI | 17240 | 5112 | 26803 | 4122 | 31727 | 3323 | 34383 | 2722 | 37279 | 1757 | 45666 | 1435 | 30793 |
| 14-#14 | 2.11 | MA | 18889 | 5112 | 29093 | 4216 | 34372 | 3412 | 36604 | 2795 | 38143 | 1829 | 47496 | 1137 | 36312 |
| 7L-2S | | MI | 18331 | 5112 | 28250 | 4124 | 33562 | 3327 | 36606 | 2713 | 40221 | 1749 | 49555 | 1567 | 30884 |
| 14-#18 | 3.74 | MA | 24462 | 6003 | 41080 | 4728 | 49338 | 3794 | 54692 | 3017 | 62462 | 1755 | 79655 | 1053 | 67695 |
| 4L-5S | | MI | 17146 | 6003 | 29625 | 4661 | 35090 | 3706 | 38266 | 2952 | 42264 | 1654 | 53155 | 763 | 48076 |
| 14-#18 | 3.74 | MA | 22868 | 6003 | 38495 | 4756 | 46236 | 3791 | 50906 | 3037 | 57327 | 1769 | 73128 | 938 | 64996 |
| 5L-4S | | MI | 18345 | 6003 | 31547 | 4639 | 37396 | 3716 | 41058 | 2938 | 45934 | 1640 | 57800 | 871 | 50050 |
| 14-#18 | 3.74 | MA | 21340 | 6003 | 36198 | 4756 | 43174 | 3814 | 47178 | 3030 | 52389 | 1782 | 66529 | 745 | 60697 |
| 6L-3S | | MI | 19666 | 6003 | 33441 | 4644 | 39954 | 3699 | 44135 | 2952 | 49956 | 1654 | 62164 | 1101 | 52734 |
| 14-#18 | 3.74 | MA | 19842 | 6003 | 33961 | 4757 | 40215 | 3811 | 43564 | 3049 | 47383 | 1769 | 60665 | 562 | 56321 |
| 7L-2S | | MI | 21471 | 6003 | 35962 | 4649 | 43151 | 3709 | 47986 | 2938 | 55023 | 1640 | 68825 | 1335 | 53194 |

## RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis



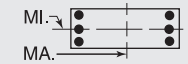

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.67 | MA | 22969 | 4875 | 33681 | 4058 | 40469 | 3287 | 44079 | 2702 | 48332 | 1833 | 60060 | 1719 | 33049 |
| 2L-8S | | MI | 14134 | 4875 | 21589 | 3997 | 25089 | 3238 | 26329 | 2663 | 26706 | 1791 | 32519 | 1207 | 22720 |
| 16-#11 | 1.67 | MA | 21919 | 4875 | 32313 | 4059 | 38735 | 3287 | 41978 | 2711 | 45497 | 1840 | 56221 | 1628 | 32982 |
| 3L-7S | | MI | 14612 | 4875 | 22244 | 3998 | 25951 | 3241 | 27405 | 2667 | 28118 | 1786 | 34298 | 1257 | 23470 |
| 16-#11 | 1.67 | MA | 21162 | 4875 | 31299 | 4060 | 37363 | 3297 | 40316 | 2710 | 43254 | 1836 | 53688 | 1537 | 32838 |
| 4L-6S | | MI | 15095 | 4875 | 22908 | 3998 | 26830 | 3243 | 28478 | 2660 | 29581 | 1791 | 35998 | 1329 | 23850 |
| 16-#11 | 1.67 | MA | 20478 | 4875 | 30274 | 4072 | 36133 | 3297 | 38813 | 2719 | 41208 | 1843 | 51052 | 1490 | 32444 |
| 5E | | MI | 15589 | 4875 | 23591 | 3999 | 27739 | 3235 | 29585 | 2664 | 31023 | 1786 | 37914 | 1404 | 24404 |
| 16-#11 | 1.67 | MA | 19823 | 4875 | 29363 | 4073 | 34918 | 3307 | 37335 | 2718 | 39242 | 1849 | 48372 | 1415 | 31573 |
| 6L-4S | | MI | 16104 | 4875 | 24358 | 3989 | 28660 | 3237 | 30708 | 2658 | 32523 | 1781 | 39821 | 1448 | 24711 |
| 16-#11 | 1.67 | MA | 19181 | 4875 | 28477 | 4074 | 33745 | 3307 | 35902 | 2727 | 37249 | 1846 | 45984 | 1345 | 30969 |
| 7L-3S | | MI | 16671 | 4875 | 25115 | 3990 | 29683 | 3229 | 31948 | 2662 | 34167 | 1786 | 41622 | 1539 | 24787 |
| 16-#11 | 1.67 | MA | 18546 | 4875 | 27605 | 4075 | 32596 | 3307 | 34466 | 2726 | 35326 | 1852 | 43523 | 1290 | 29894 |
| 8L-2S | | MI | 17447 | 4875 | 26128 | 3991 | 30968 | 3231 | 33505 | 2655 | 36239 | 1781 | 44369 | 1630 | 24817 |
| 16-#14 | 2.41 | MA | 23656 | 5276 | 36553 | 4298 | 44010 | 3460 | 48325 | 2822 | 54030 | 1817 | 67527 | 1527 | 46871 |
| 3L-7S | | MI | 15032 | 5276 | 24140 | 4233 | 28220 | 3412 | 30104 | 2773 | 31630 | 1745 | 39184 | 1001 | 31527 |
| 16-#14 | 2.41 | MA | 22605 | 5276 | 35099 | 4299 | 42044 | 3474 | 45942 | 2820 | 50815 | 1811 | 63925 | 1395 | 46479 |
| 4L-6S | | MI | 15705 | 5276 | 25092 | 4235 | 29479 | 3416 | 31641 | 2764 | 33708 | 1753 | 41588 | 1104 | 32859 |
| 16-#14 | 2.41 | MA | 21655 | 5276 | 33628 | 4315 | 40279 | 3474 | 43788 | 2832 | 47882 | 1820 | 60168 | 1329 | 44851 |
| 5E | | MI | 16391 | 5276 | 26069 | 4236 | 30781 | 3405 | 33225 | 2771 | 35756 | 1745 | 44302 | 1214 | 33574 |
| 16-#14 | 2.41 | MA | 20744 | 5276 | 32322 | 4317 | 38538 | 3488 | 41668 | 2830 | 45061 | 1828 | 56353 | 1220 | 43742 |
| 6L-4S | | MI | 17107 | 5276 | 27167 | 4223 | 32098 | 3409 | 34833 | 2762 | 37886 | 1738 | 47009 | 1275 | 34793 |
| 16-#14 | 2.41 | MA | 19851 | 5276 | 31051 | 4318 | 36855 | 3487 | 39612 | 2842 | 42202 | 1822 | 52959 | 1118 | 41888 |
| 7L-3S | | MI | 17895 | 5276 | 28250 | 4224 | 33562 | 3398 | 36606 | 2769 | 40221 | 1745 | 49555 | 1407 | 35038 |
| 16-#14 | 2.41 | MA | 18969 | 5276 | 29800 | 4319 | 35206 | 3487 | 37552 | 2840 | 39443 | 1830 | 49449 | 1041 | 40165 |
| 8L-2S | | MI | 18973 | 5276 | 29697 | 4226 | 35397 | 3402 | 38829 | 2761 | 43162 | 1738 | 53445 | 1538 | 35155 |
| 16-#18 | 4.28 | MA | 24419 | 6294 | 41925 | 4937 | 50586 | 3924 | 56176 | 3121 | 64417 | 1754 | 82581 | 899 | 74731 |
| 5E | | MI | 18255 | 6294 | 32146 | 4843 | 38287 | 3839 | 42118 | 3034 | 47331 | 1629 | 59816 | 703 | 55014 |
| 16-#18 | 4.28 | MA | 22919 | 6294 | 39628 | 4938 | 47524 | 3947 | 52448 | 3114 | 59479 | 1768 | 75982 | 705 | 70434 |
| 6L-4S | | MI | 19435 | 6294 | 34068 | 4821 | 40593 | 3849 | 44909 | 3021 | 51001 | 1616 | 64461 | 811 | 57142 |
| 16-#18 | 4.28 | MA | 21450 | 6294 | 37391 | 4939 | 44565 | 3944 | 48833 | 3134 | 54473 | 1754 | 70118 | 523 | 65994 |
| 7L-3S | | MI | 20734 | 6294 | 35962 | 4826 | 43151 | 3832 | 47986 | 3034 | 55023 | 1629 | 68825 | 1042 | 60061 |
| 18-#11 | 1.88 | MA | 22572 | 4988 | 33681 | 4130 | 40469 | 3339 | 44079 | 2744 | 48332 | 1835 | 60060 | 1617 | 37009 |
| 3L-8S | | MI | 14628 | 4988 | 22603 | 4068 | 26374 | 3290 | 27886 | 2696 | 28778 | 1784 | 35265 | 1188 | 25589 |
| 18-#11 | 1.88 | MA | 21822 | 4988 | 32667 | 4131 | 39098 | 3349 | 42417 | 2743 | 46089 | 1831 | 57526 | 1525 | 36847 |
| 4L-7S | | MI | 15101 | 4988 | 23257 | 4069 | 27236 | 3293 | 28962 | 2699 | 30189 | 1779 | 37044 | 1239 | 26315 |
| 18-#11 | 1.88 | MA | 21145 | 4988 | 31641 | 4143 | 37867 | 3349 | 40915 | 2752 | 44043 | 1838 | 54891 | 1479 | 36352 |
| 5L-6S | | MI | 15580 | 4988 | 23922 | 4069 | 28115 | 3295 | 30035 | 2693 | 31652 | 1784 | 38744 | 1310 | 26752 |
| 18-#11 | 1.88 | MA | 20496 | 4988 | 30731 | 4144 | 36653 | 3359 | 39436 | 2751 | 42077 | 1844 | 52210 | 1404 | 35511 |
| 6L-5S | | MI | 16069 | 4988 | 24604 | 4070 | 29024 | 3287 | 31142 | 2697 | 33095 | 1779 | 40661 | 1386 | 27283 |
| 18-#11 | 1.88 | MA | 19861 | 4988 | 29845 | 4145 | 35480 | 3359 | 38003 | 2760 | 40084 | 1840 | 49823 | 1333 | 34907 |
| 7L-4S | | MI | 16579 | 4988 | 25371 | 4060 | 29945 | 3289 | 32265 | 2691 | 34595 | 1774 | 42567 | 1429 | 27681 |
| 18-#11 | 1.88 | MA | 19233 | 4988 | 28973 | 4146 | 34331 | 3359 | 36568 | 2758 | 38161 | 1847 | 47362 | 1279 | 33806 |
| 8L-3S | | MI | 17141 | 4988 | 26128 | 4061 | 30968 | 3281 | 33505 | 2694 | 36239 | 1779 | 44369 | 1520 | 27773 |
| 18-#11 | 1.88 | MA | 18610 | 4988 | 28010 | 4158 | 33147 | 3369 | 35155 | 2767 | 36256 | 1853 | 44927 | 1220 | 32838 |
| 9L-2S | | MI | 17911 | 4988 | 27142 | 4061 | 32253 | 3283 | 35062 | 2688 | 38310 | 1774 | 47115 | 1611 | 27817 |
| 18-#14 | 2.71 | MA | 23515 | 5439 | 37057 | 4401 | 44528 | 3549 | 48951 | 2867 | 54874 | 1803 | 69388 | 1377 | 52191 |
| 4L-7S | | MI | 15711 | 5439 | 25587 | 4335 | 30055 | 3487 | 32327 | 2820 | 34571 | 1734 | 43073 | 972 | 35608 |
| 18-#14 | 2.71 | MA | 22577 | 5439 | 35586 | 4418 | 42763 | 3548 | 46797 | 2880 | 51940 | 1812 | 65631 | 1310 | 50463 |
| 5L-6S | | MI | 16375 | 5439 | 26539 | 4337 | 31314 | 3491 | 33864 | 2812 | 36649 | 1741 | 45477 | 1075 | 36893 |
| 18-#14 | 2.71 | MA | 21678 | 5439 | 34280 | 4419 | 41021 | 3563 | 44676 | 2877 | 49120 | 1821 | 61816 | 1202 | 49388 |
| 6L-5S | | MI | 17054 | 5439 | 27516 | 4338 | 32616 | 3480 | 35448 | 2818 | 38697 | 1734 | 48191 | 1185 | 37694 |
| 18-#14 | 2.71 | MA | 20797 | 5439 | 33009 | 4420 | 39338 | 3562 | 42621 | 2890 | 46261 | 1814 | 58422 | 1100 | 47473 |
| 7L-4S | | MI | 17761 | 5439 | 28614 | 4325 | 33933 | 3484 | 37056 | 2810 | 40827 | 1726 | 50898 | 1246 | 38902 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis

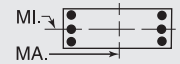



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.71 | MA | 19927 | 5439 | 31758 | 4422 | 37690 | 3561 | 40561 | 2887 | 43502 | 1823 | 54912 | 1023 | 45708 |
| 8L-3S | | MI | 18540 | 5439 | 29697 | 4327 | 35397 | 3473 | 38829 | 2816 | 43162 | 1734 | 53445 | 1378 | 39278 |
| 18-#14 | 2.71 | MA | 19062 | 5439 | 30376 | 4438 | 35991 | 3576 | 38535 | 2900 | 40771 | 1832 | 51450 | 938 | 43713 |
| 9L-2S | | MI | 19608 | 5439 | 31144 | 4328 | 37232 | 3477 | 41052 | 2808 | 46103 | 1726 | 57334 | 1509 | 39420 |
| 18-#18 | 4.81 | MA | 24468 | 6584 | 43058 | 5120 | 51873 | 4080 | 57718 | 3198 | 66569 | 1753 | 85435 | 666 | 80190 |
| 6L-5S | | MI | 19346 | 6584 | 34667 | 5024 | 41484 | 3972 | 45969 | 3117 | 52398 | 1604 | 66477 | 643 | 61980 |
| 18-#18 | 4.81 | MA | 23026 | 6584 | 40821 | 5120 | 48914 | 4077 | 54103 | 3218 | 61563 | 1740 | 79571 | 484 | 75685 |
| 7L-4S | | MI | 20507 | 6584 | 36589 | 5003 | 43790 | 3982 | 48760 | 3104 | 56067 | 1591 | 71122 | 752 | 64259 |
| 20-#11 | 2.09 | MA | 22474 | 5101 | 34034 | 4202 | 40832 | 3401 | 44518 | 2776 | 48924 | 1826 | 61365 | 1514 | 40853 |
| 4L-8S | | MI | 15115 | 5101 | 23616 | 4139 | 27659 | 3342 | 29443 | 2728 | 30849 | 1777 | 38012 | 1170 | 28464 |
| 20-#11 | 2.09 | MA | 21804 | 5101 | 33009 | 4214 | 39601 | 3401 | 43016 | 2785 | 46878 | 1832 | 58730 | 1467 | 40268 |
| 5L-7S | | MI | 15584 | 5101 | 24270 | 4140 | 28521 | 3344 | 30519 | 2732 | 32260 | 1772 | 39791 | 1220 | 29167 |
| 20-#11 | 2.09 | MA | 21161 | 5101 | 32099 | 4215 | 38387 | 3411 | 41538 | 2783 | 44912 | 1839 | 56049 | 1392 | 39454 |
| 6E | | MI | 16059 | 5101 | 24935 | 4140 | 29400 | 3347 | 31592 | 2726 | 33723 | 1777 | 41491 | 1292 | 29659 |
| 20-#11 | 2.09 | MA | 20533 | 5101 | 31213 | 4216 | 37214 | 3411 | 40105 | 2793 | 42919 | 1835 | 53662 | 1321 | 38798 |
| 7L-5S | | MI | 16544 | 5101 | 25617 | 4141 | 30309 | 3339 | 32698 | 2730 | 35166 | 1772 | 43407 | 1367 | 30169 |
| 20-#11 | 2.09 | MA | 19911 | 5101 | 30340 | 4217 | 36065 | 3411 | 38669 | 2791 | 40996 | 1842 | 51200 | 1267 | 37722 |
| 8L-4S | | MI | 17049 | 5101 | 26384 | 4131 | 31230 | 3341 | 33822 | 2723 | 36666 | 1767 | 45314 | 1411 | 30648 |
| 20-#11 | 2.09 | MA | 19294 | 5101 | 29377 | 4229 | 34881 | 3421 | 37257 | 2800 | 39091 | 1848 | 48766 | 1209 | 36724 |
| 9L-3S | | MI | 17606 | 5101 | 27142 | 4132 | 32253 | 3333 | 35062 | 2727 | 38310 | 1772 | 47115 | 1502 | 30755 |
| 20-#11 | 2.09 | MA | 18680 | 5101 | 28508 | 4230 | 33740 | 3421 | 35838 | 2799 | 37133 | 1845 | 46249 | 1129 | 35511 |
| 10L-2S | | MI | 18370 | 5101 | 28155 | 4132 | 33538 | 3335 | 36618 | 2721 | 40381 | 1767 | 49862 | 1593 | 30812 |
| 20-#14 | 3.01 | MA | 23485 | 5603 | 37545 | 4520 | 45246 | 3623 | 49805 | 2927 | 55999 | 1805 | 71094 | 1292 | 56086 |
| 5L-7S | | MI | 16380 | 5603 | 27034 | 4438 | 31890 | 3561 | 34550 | 2867 | 37512 | 1722 | 46963 | 943 | 39698 |
| 20-#14 | 3.01 | MA | 22597 | 5603 | 36238 | 4521 | 43504 | 3637 | 47685 | 2925 | 53179 | 1813 | 67279 | 1183 | 54980 |
| 6E | | MI | 17037 | 5603 | 27986 | 4439 | 33149 | 3566 | 36087 | 2859 | 39590 | 1730 | 49367 | 1046 | 40940 |
| 20-#14 | 3.01 | MA | 21729 | 5603 | 34967 | 4522 | 41822 | 3637 | 45629 | 2937 | 50320 | 1807 | 63885 | 1081 | 53067 |
| 7L-5S | | MI | 17708 | 5603 | 28963 | 4441 | 34451 | 3555 | 37671 | 2866 | 41639 | 1722 | 52081 | 1156 | 41823 |
| 20-#14 | 3.01 | MA | 20870 | 5603 | 33716 | 4524 | 40173 | 3636 | 43569 | 2935 | 47561 | 1816 | 60376 | 1004 | 51199 |
| 8L-4S | | MI | 18407 | 5603 | 30061 | 4427 | 35768 | 3559 | 39279 | 2857 | 43769 | 1715 | 54787 | 1217 | 42978 |
| 20-#14 | 3.01 | MA | 20016 | 5603 | 32334 | 4540 | 38474 | 3651 | 41543 | 2947 | 44829 | 1824 | 56913 | 919 | 49306 |
| 9L-3S | | MI | 19177 | 5603 | 31144 | 4429 | 37232 | 3548 | 41052 | 2864 | 46103 | 1722 | 57334 | 1349 | 43514 |
| 20-#18 | 5.35 | MA | 24574 | 6875 | 44251 | 5302 | 53264 | 4210 | 59373 | 3302 | 68653 | 1726 | 89024 | 445 | 85393 |
| 7L-5S | | MI | 20509 | 6875 | 37188 | 5206 | 44681 | 4105 | 49820 | 3200 | 57464 | 1579 | 73138 | 583 | 68973 |
| 22-#11 | 2.29 | MA | 22454 | 5215 | 34377 | 4284 | 41336 | 3453 | 45117 | 2818 | 49713 | 1827 | 62569 | 1455 | 44191 |
| 5L-8S | | MI | 15597 | 5215 | 24629 | 4210 | 28944 | 3394 | 31000 | 2761 | 32920 | 1770 | 40758 | 1151 | 31345 |
| 22-#11 | 2.29 | MA | 21818 | 5215 | 33466 | 4286 | 40122 | 3463 | 43639 | 2816 | 47747 | 1834 | 59888 | 1380 | 43401 |
| 6L-7S | | MI | 16062 | 5215 | 25283 | 4210 | 29806 | 3396 | 32075 | 2765 | 34332 | 1765 | 42537 | 1202 | 32026 |
| 22-#11 | 2.29 | MA | 21196 | 5215 | 32580 | 4287 | 38949 | 3463 | 42206 | 2825 | 45754 | 1830 | 57501 | 1310 | 42694 |
| 7L-6S | | MI | 16532 | 5215 | 25948 | 4211 | 30685 | 3399 | 33149 | 2759 | 35795 | 1770 | 44237 | 1273 | 32570 |
| 22-#11 | 2.29 | MA | 20581 | 5215 | 31708 | 4288 | 37800 | 3463 | 40770 | 2824 | 43831 | 1837 | 55039 | 1256 | 41644 |
| 8L-5S | | MI | 17013 | 5215 | 26630 | 4212 | 31594 | 3391 | 34255 | 2763 | 37237 | 1765 | 46154 | 1349 | 33062 |
| 22-#11 | 2.29 | MA | 19970 | 5215 | 30745 | 4300 | 36615 | 3473 | 39358 | 2833 | 41926 | 1843 | 52605 | 1197 | 40616 |
| 9L-4S | | MI | 17514 | 5215 | 27398 | 4202 | 32515 | 3393 | 35379 | 2756 | 38737 | 1759 | 48060 | 1392 | 33613 |
| 22-#11 | 2.29 | MA | 19361 | 5215 | 29876 | 4301 | 35474 | 3473 | 37939 | 2832 | 39968 | 1839 | 50088 | 1117 | 39426 |
| 10L-3S | | MI | 18066 | 5215 | 28155 | 4203 | 33538 | 3385 | 36618 | 2760 | 40381 | 1765 | 49862 | 1483 | 33735 |
| 22-#11 | 2.29 | MA | 18717 | 5215 | 29014 | 4302 | 34304 | 3483 | 36535 | 2841 | 38072 | 1846 | 47668 | 1060 | 38081 |
| 11L-2S | | MI | 18824 | 5215 | 29168 | 4203 | 34823 | 3387 | 38175 | 2754 | 42452 | 1759 | 52608 | 1574 | 33803 |
| 22-#14 | 3.31 | MA | 23504 | 5767 | 38196 | 4623 | 45987 | 3712 | 50693 | 2972 | 57238 | 1806 | 72743 | 1165 | 60534 |
| 6L-7S | | MI | 17040 | 5767 | 28481 | 4540 | 33725 | 3636 | 36773 | 2915 | 40454 | 1711 | 50852 | 915 | 43796 |
| 22-#14 | 3.31 | MA | 22646 | 5767 | 36925 | 4625 | 44305 | 3712 | 48637 | 2984 | 54379 | 1799 | 69348 | 1063 | 58669 |
| 7L-6S | | MI | 17690 | 5767 | 29433 | 4541 | 34984 | 3640 | 38310 | 2906 | 42532 | 1718 | 53256 | 1017 | 44997 |
| 22-#14 | 3.31 | MA | 21798 | 5767 | 35674 | 4626 | 42656 | 3711 | 46578 | 2982 | 51620 | 1808 | 65839 | 986 | 56761 |
| 8L-5S | | MI | 18353 | 5767 | 30410 | 4543 | 36286 | 3629 | 39894 | 2913 | 44580 | 1711 | 55970 | 1127 | 45960 |
| 22-#14 | 3.31 | MA | 20955 | 5767 | 34292 | 4642 | 40957 | 3725 | 44552 | 2994 | 48888 | 1817 | 62376 | 901 | 54858 |
| 9L-4S | | MI | 19044 | 5767 | 31508 | 4529 | 37603 | 3633 | 41502 | 2905 | 46710 | 1703 | 58677 | 1188 | 47065 |
| 24-#11 | 2.50 | MA | 22467 | 5328 | 34834 | 4357 | 41856 | 3515 | 45740 | 2849 | 50582 | 1829 | 63727 | 1369 | 47353 |
| 6L-8S | | MI | 16074 | 5328 | 25642 | 4281 | 30229 | 3446 | 32556 | 2794 | 34992 | 1762 | 43505 | 1133 | 34229 |

## RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.50 | MA | 21851 | 5328 | 33948 | 4358 | 40683 | 3515 | 44307 | 2858 | 48589 | 1825 | 61340 | 1298 | 46597 |
| 7E | | MI | 16534 | 5328 | 26297 | 4281 | 31091 | 3448 | 33632 | 2798 | 36403 | 1757 | 45284 | 1183 | 34892 |
| 24-#11 | 2.50 | MA | 21242 | 5328 | 33076 | 4359 | 39534 | 3515 | 42872 | 2857 | 46666 | 1831 | 58878 | 1244 | 45570 |
| 8L-6S | | MI | 17001 | 5328 | 26961 | 4282 | 31970 | 3451 | 34706 | 2792 | 37866 | 1762 | 46984 | 1255 | 35484 |
| 24-#11 | 2.50 | MA | 20637 | 5328 | 32112 | 4371 | 38350 | 3525 | 41459 | 2866 | 44761 | 1838 | 56443 | 1185 | 44512 |
| 9L-5S | | MI | 17477 | 5328 | 27644 | 4283 | 32879 | 3442 | 35812 | 2796 | 39309 | 1757 | 48901 | 1330 | 35959 |
| 24-#11 | 2.50 | MA | 20034 | 5328 | 31244 | 4372 | 37209 | 3525 | 40040 | 2865 | 42803 | 1834 | 53926 | 1105 | 43344 |
| 10L-4S | | MI | 17974 | 5328 | 28411 | 4273 | 33800 | 3445 | 36936 | 2789 | 40809 | 1752 | 50807 | 1374 | 36576 |
| 24-#11 | 2.50 | MA | 19392 | 5328 | 30381 | 4373 | 36038 | 3535 | 38636 | 2874 | 40907 | 1841 | 51507 | 1048 | 41980 |
| 11L-3S | | MI | 18521 | 5328 | 29168 | 4273 | 34823 | 3437 | 38175 | 2793 | 42452 | 1757 | 52608 | 1465 | 36711 |
| 24-#14 | 3.61 | MA | 23552 | 5930 | 38883 | 4727 | 46788 | 3786 | 51646 | 3032 | 58438 | 1792 | 74811 | 1044 | 64278 |
| 7E | | MI | 17692 | 5930 | 29928 | 4642 | 35560 | 3711 | 38996 | 2962 | 43395 | 1699 | 54741 | 886 | 47902 |
| 24-#14 | 3.61 | MA | 22714 | 5930 | 37632 | 4728 | 45139 | 3786 | 49586 | 3029 | 55679 | 1801 | 71302 | 967 | 62331 |
| 8L-6S | | MI | 18335 | 5930 | 30880 | 4644 | 36819 | 3715 | 40533 | 2954 | 45473 | 1706 | 57145 | 989 | 49065 |
| 24-#14 | 3.61 | MA | 21881 | 5930 | 36250 | 4744 | 43440 | 3800 | 47560 | 3042 | 52947 | 1809 | 67839 | 882 | 60400 |
| 9L-5S | | MI | 18991 | 5930 | 31857 | 4645 | 38121 | 3704 | 42117 | 2960 | 47521 | 1699 | 59859 | 1098 | 50102 |

## RECTANGULAR TIED COLUMNS 34" x 46"

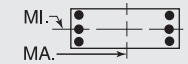
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.02 | MA | 22767 | 4729 | 32313 | 3988 | 38300 | 3247 | 40894 | 2701 | 42933 | 1920 | 51961 | 1809 | 22217 |
| 2E | | MI | 16564 | 4729 | 24190 | 3894 | 28109 | 3171 | 29686 | 2633 | 30579 | 1847 | 36529 | 1714 | 15965 |
| 6-#18 | 1.53 | MA | 24503 | 5020 | 35924 | 4169 | 42881 | 3380 | 46443 | 2785 | 50419 | 1906 | 61974 | 1773 | 32943 |
| 2L-3S | | MI | 15791 | 5020 | 24190 | 4071 | 28109 | 3294 | 29686 | 2728 | 30579 | 1835 | 36529 | 1420 | 23417 |
| 6-#18 | 1.53 | MA | 21716 | 5020 | 32313 | 4171 | 38300 | 3378 | 40894 | 2806 | 42933 | 1920 | 51961 | 1540 | 32677 |
| 3L-2S | | MI | 17730 | 5020 | 26711 | 4076 | 31307 | 3304 | 33537 | 2715 | 35645 | 1822 | 43190 | 1654 | 23501 |
| 8-#14 | 1.15 | MA | 23312 | 4802 | 33110 | 4057 | 39522 | 3300 | 42466 | 2739 | 45116 | 1929 | 55185 | 1826 | 25118 |
| 2L-4S | | MI | 14997 | 4802 | 22203 | 3969 | 25700 | 3237 | 26897 | 2681 | 27013 | 1867 | 32466 | 1471 | 17974 |
| 8-#14 | 1.15 | MA | 21693 | 4802 | 31050 | 4058 | 36909 | 3300 | 39300 | 2752 | 40845 | 1939 | 49406 | 1695 | 25068 |
| 3E | | MI | 15828 | 4802 | 23286 | 3970 | 27163 | 3226 | 28670 | 2688 | 29348 | 1875 | 35013 | 1603 | 18049 |
| 8-#14 | 1.15 | MA | 20523 | 4802 | 29522 | 4060 | 34843 | 3315 | 36796 | 2750 | 37465 | 1933 | 45592 | 1563 | 24841 |
| 4L-2S | | MI | 16959 | 4802 | 24733 | 3972 | 28998 | 3230 | 30893 | 2679 | 32289 | 1867 | 38902 | 1734 | 18035 |
| 8-#18 | 2.05 | MA | 26185 | 5311 | 39536 | 4351 | 47461 | 3513 | 51992 | 2869 | 57906 | 1893 | 71987 | 1737 | 43622 |
| 2L-4S | | MI | 15558 | 5311 | 24816 | 4248 | 28748 | 3443 | 30460 | 2798 | 31623 | 1797 | 38826 | 1130 | 29255 |
| 8-#18 | 2.05 | MA | 23454 | 5311 | 35924 | 4352 | 42881 | 3511 | 46443 | 2890 | 50419 | 1907 | 61974 | 1504 | 43234 |
| 3E | | MI | 16959 | 5311 | 26711 | 4253 | 31307 | 3427 | 33537 | 2811 | 35645 | 1810 | 43190 | 1360 | 30792 |
| 8-#18 | 2.05 | MA | 21477 | 5311 | 33239 | 4354 | 39250 | 3536 | 42043 | 2885 | 44481 | 1894 | 55380 | 1270 | 40995 |
| 4L-2S | | MI | 18862 | 5311 | 29232 | 4258 | 34504 | 3437 | 37388 | 2798 | 40712 | 1797 | 49851 | 1594 | 30981 |
| 10-#14 | 1.44 | MA | 24311 | 4966 | 35170 | 4159 | 42135 | 3375 | 45631 | 2786 | 49387 | 1922 | 60963 | 1809 | 31227 |
| 2L-5S | | MI | 14953 | 4966 | 22552 | 4084 | 26217 | 3308 | 27512 | 2737 | 27824 | 1863 | 33649 | 1381 | 21453 |
| 10-#14 | 1.44 | MA | 22713 | 4966 | 33110 | 4161 | 39522 | 3375 | 42466 | 2799 | 45116 | 1931 | 55185 | 1678 | 31137 |
| 3L-4S | | MI | 15698 | 4966 | 23650 | 4071 | 27535 | 3312 | 29120 | 2729 | 29954 | 1856 | 36356 | 1442 | 22208 |
| 10-#14 | 1.44 | MA | 21559 | 4966 | 31582 | 4162 | 37456 | 3390 | 39962 | 2797 | 41736 | 1926 | 51371 | 1546 | 30860 |
| 4L-3S | | MI | 16518 | 4966 | 24733 | 4073 | 28998 | 3301 | 30893 | 2735 | 32289 | 1863 | 38902 | 1574 | 22327 |
| 10-#14 | 1.44 | MA | 20514 | 4966 | 30037 | 4179 | 35602 | 3390 | 37698 | 2810 | 38654 | 1935 | 47403 | 1479 | 29666 |
| 5L-2S | | MI | 17636 | 4966 | 26180 | 4074 | 30833 | 3305 | 33116 | 2727 | 35230 | 1856 | 42792 | 1705 | 22349 |
| 10-#18 | 2.56 | MA | 27822 | 5602 | 43147 | 4533 | 52041 | 3646 | 57540 | 2954 | 65392 | 1880 | 82000 | 1701 | 54276 |
| 2L-5S | | MI | 15471 | 5602 | 25416 | 4451 | 29639 | 3566 | 31520 | 2894 | 33020 | 1786 | 40842 | 962 | 34304 |
| 10-#18 | 2.56 | MA | 25143 | 5602 | 39536 | 4534 | 47461 | 3644 | 51992 | 2974 | 57906 | 1894 | 71987 | 1468 | 53784 |
| 3L-4S | | MI | 16722 | 5602 | 27337 | 4429 | 31946 | 3576 | 34311 | 2880 | 36690 | 1772 | 45487 | 1071 | 36231 |
| 10-#18 | 2.56 | MA | 23208 | 5602 | 36850 | 4536 | 43830 | 3669 | 47592 | 2969 | 51968 | 1881 | 65393 | 1234 | 51150 |
| 4L-3S | | MI | 18096 | 5602 | 29232 | 4434 | 34504 | 3560 | 37388 | 2894 | 40712 | 1786 | 49851 | 1301 | 38148 |
| 10-#18 | 2.56 | MA | 21455 | 5602 | 34133 | 4564 | 40569 | 3667 | 43612 | 2990 | 46549 | 1895 | 58493 | 1117 | 47928 |
| 5L-2S | | MI | 19967 | 5602 | 31753 | 4439 | 37701 | 3570 | 41240 | 2880 | 45779 | 1772 | 56512 | 1534 | 38425 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis

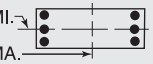



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.20 | MA | 23528 | 4828 | 33387 | 4085 | 39981 | 3322 | 43068 | 2755 | 45960 | 1934 | 56483 | 1836 | 26213 |
| 2L-6S | | MI | 14720 | 4828 | 21701 | 4012 | 25200 | 3267 | 26322 | 2703 | 26332 | 1889 | 31523 | 1446 | 18182 |
| 12-#11 | 1.20 | MA | 22400 | 4828 | 31949 | 4087 | 38156 | 3322 | 40857 | 2764 | 42978 | 1942 | 52426 | 1745 | 26180 |
| 3L-5S | | MI | 15225 | 4828 | 22384 | 4013 | 26109 | 3259 | 27428 | 2707 | 27775 | 1884 | 33439 | 1522 | 18712 |
| 12-#11 | 1.20 | MA | 21586 | 4828 | 30883 | 4088 | 36715 | 3333 | 39111 | 2763 | 40621 | 1938 | 49745 | 1654 | 26079 |
| 4E | | MI | 15751 | 4828 | 23151 | 4003 | 27030 | 3262 | 28552 | 2701 | 29275 | 1879 | 35346 | 1565 | 18804 |
| 12-#11 | 1.20 | MA | 20850 | 4828 | 29806 | 4100 | 35423 | 3333 | 37533 | 2773 | 38472 | 1945 | 46964 | 1607 | 25858 |
| 5L-3S | | MI | 16330 | 4828 | 23908 | 4004 | 28053 | 3253 | 29791 | 2705 | 30919 | 1884 | 37147 | 1656 | 18834 |
| 12-#11 | 1.20 | MA | 20145 | 4828 | 28850 | 4101 | 34147 | 3344 | 35980 | 2772 | 36407 | 1952 | 44130 | 1532 | 25000 |
| 6L-2S | | MI | 17121 | 4828 | 24921 | 4004 | 29338 | 3256 | 31348 | 2698 | 32990 | 1879 | 39893 | 1748 | 18827 |
| 12-#14 | 1.73 | MA | 25291 | 5129 | 37231 | 4261 | 44748 | 3450 | 48797 | 2833 | 53658 | 1914 | 66742 | 1792 | 37324 |
| 2L-6S | | MI | 14944 | 5129 | 23022 | 4185 | 26751 | 3394 | 28151 | 2778 | 28717 | 1859 | 34824 | 1243 | 24768 |
| 12-#14 | 1.73 | MA | 23713 | 5129 | 35170 | 4263 | 42135 | 3450 | 45631 | 2846 | 49387 | 1924 | 60963 | 1661 | 37197 |
| 3L-5S | | MI | 15650 | 5129 | 23999 | 4187 | 28052 | 3383 | 29735 | 2784 | 30766 | 1852 | 37538 | 1352 | 25532 |
| 12-#14 | 1.73 | MA | 22574 | 5129 | 33642 | 4265 | 40069 | 3465 | 43127 | 2845 | 46007 | 1918 | 57150 | 1529 | 36877 |
| 4E | | MI | 16386 | 5129 | 25097 | 4173 | 29370 | 3387 | 31343 | 2776 | 32896 | 1844 | 40245 | 1413 | 26434 |
| 12-#14 | 1.73 | MA | 21545 | 5129 | 32097 | 4281 | 38215 | 3465 | 40864 | 2858 | 42925 | 1928 | 53182 | 1462 | 35535 |
| 5L-3S | | MI | 17196 | 5129 | 26180 | 4175 | 30833 | 3376 | 33116 | 2782 | 35230 | 1852 | 42792 | 1545 | 26592 |
| 12-#14 | 1.73 | MA | 20558 | 5129 | 30725 | 4283 | 36385 | 3479 | 38636 | 2856 | 39962 | 1937 | 49147 | 1354 | 34250 |
| 6L-2S | | MI | 18302 | 5129 | 27627 | 4176 | 32668 | 3380 | 35339 | 2774 | 38172 | 1844 | 46681 | 1676 | 26645 |
| 12-#18 | 3.07 | MA | 26789 | 5892 | 43147 | 4716 | 52041 | 3777 | 57540 | 3059 | 65392 | 1880 | 82000 | 1431 | 64330 |
| 3L-5S | | MI | 16631 | 5892 | 27937 | 4633 | 32836 | 3699 | 35371 | 2976 | 38087 | 1761 | 47503 | 902 | 41438 |
| 12-#18 | 3.07 | MA | 24893 | 5892 | 40462 | 4717 | 48411 | 3802 | 53141 | 3053 | 59454 | 1868 | 75406 | 1198 | 61348 |
| 4E | | MI | 17858 | 5892 | 29858 | 4611 | 35143 | 3709 | 38163 | 2963 | 41756 | 1748 | 52148 | 1011 | 43252 |
| 12-#18 | 3.07 | MA | 23178 | 5892 | 37744 | 4745 | 45150 | 3800 | 49161 | 3074 | 54035 | 1881 | 68506 | 1081 | 58269 |
| 5L-3S | | MI | 19209 | 5892 | 31753 | 4616 | 37701 | 3693 | 41240 | 2976 | 45779 | 1761 | 56512 | 1241 | 45492 |
| 12-#18 | 3.07 | MA | 21531 | 5892 | 35330 | 4747 | 41931 | 3824 | 45243 | 3068 | 48824 | 1895 | 61515 | 888 | 54044 |
| 6L-2S | | MI | 21050 | 5892 | 34274 | 4621 | 40898 | 3703 | 45091 | 2963 | 50845 | 1748 | 63173 | 1474 | 45849 |
| 14-#11 | 1.40 | MA | 24229 | 4942 | 34826 | 4156 | 41805 | 3374 | 45278 | 2787 | 48942 | 1929 | 60541 | 1826 | 30476 |
| 2L-7S | | MI | 14729 | 4942 | 22050 | 4082 | 25606 | 3317 | 26805 | 2743 | 26940 | 1877 | 32569 | 1357 | 20687 |
| 14-#11 | 1.40 | MA | 23111 | 4942 | 33387 | 4157 | 39981 | 3374 | 43068 | 2797 | 45960 | 1936 | 56483 | 1735 | 30425 |
| 3L-6S | | MI | 15219 | 4942 | 22714 | 4083 | 26485 | 3319 | 27878 | 2736 | 28403 | 1882 | 34269 | 1428 | 21071 |
| 14-#11 | 1.40 | MA | 22305 | 4942 | 32322 | 4159 | 38540 | 3385 | 41321 | 2796 | 43603 | 1933 | 53803 | 1643 | 30302 |
| 4L-5S | | MI | 15719 | 4942 | 23397 | 4084 | 27394 | 3311 | 28985 | 2740 | 29846 | 1877 | 36186 | 1504 | 21664 |
| 14-#11 | 1.40 | MA | 21577 | 4942 | 31245 | 4171 | 37247 | 3385 | 39743 | 2805 | 41454 | 1940 | 51022 | 1596 | 30058 |
| 5L-4S | | MI | 16240 | 4942 | 24164 | 4074 | 28315 | 3313 | 30108 | 2734 | 31346 | 1872 | 38092 | 1547 | 21786 |
| 14-#11 | 1.40 | MA | 20880 | 4942 | 30289 | 4172 | 35972 | 3396 | 38191 | 2805 | 39389 | 1947 | 48188 | 1521 | 29131 |
| 6L-3S | | MI | 16814 | 4942 | 24921 | 4075 | 29338 | 3305 | 31348 | 2737 | 32990 | 1877 | 39893 | 1638 | 21834 |
| 14-#11 | 1.40 | MA | 20196 | 4942 | 29359 | 4174 | 34740 | 3396 | 36686 | 2814 | 37295 | 1944 | 45663 | 1451 | 28467 |
| 7L-2S | | MI | 17598 | 4942 | 25934 | 4075 | 30623 | 3308 | 32905 | 2731 | 35061 | 1872 | 42640 | 1729 | 21845 |
| 14-#14 | 2.01 | MA | 26254 | 5293 | 39291 | 4363 | 47361 | 3525 | 51962 | 2881 | 57929 | 1907 | 72521 | 1775 | 43412 |
| 2L-7S | | MI | 14955 | 5293 | 23517 | 4286 | 27327 | 3465 | 28837 | 2833 | 29581 | 1840 | 36310 | 1111 | 27705 |
| 14-#14 | 2.01 | MA | 24694 | 5293 | 37231 | 4365 | 44748 | 3525 | 48797 | 2894 | 53658 | 1916 | 66742 | 1644 | 43251 |
| 3L-6S | | MI | 15638 | 5293 | 24469 | 4287 | 28586 | 3469 | 30374 | 2825 | 31658 | 1847 | 38714 | 1214 | 28897 |
| 14-#14 | 2.01 | MA | 23571 | 5293 | 35703 | 4367 | 42682 | 3539 | 46293 | 2892 | 50278 | 1911 | 62928 | 1512 | 42893 |
| 4L-5S | | MI | 16336 | 5293 | 25446 | 4289 | 29887 | 3458 | 31958 | 2832 | 33707 | 1840 | 41428 | 1323 | 29627 |
| 14-#14 | 2.01 | MA | 22556 | 5293 | 34157 | 4383 | 40828 | 3539 | 44029 | 2905 | 47196 | 1920 | 58960 | 1445 | 41419 |
| 5L-4S | | MI | 17063 | 5293 | 26544 | 4275 | 31205 | 3462 | 33566 | 2823 | 35837 | 1833 | 44134 | 1384 | 30654 |
| 14-#14 | 2.01 | MA | 21583 | 5293 | 32786 | 4385 | 38998 | 3554 | 41802 | 2903 | 44233 | 1929 | 54925 | 1337 | 40180 |
| 6L-3S | | MI | 17863 | 5293 | 27627 | 4277 | 32668 | 3451 | 35339 | 2830 | 38172 | 1840 | 46681 | 1516 | 30847 |
| 14-#14 | 2.01 | MA | 20629 | 5293 | 31451 | 4387 | 37231 | 3554 | 39642 | 2916 | 41229 | 1924 | 51332 | 1234 | 38408 |
| 7L-2S | | MI | 18957 | 5293 | 29074 | 4279 | 34503 | 3455 | 37562 | 2821 | 41113 | 1833 | 50570 | 1647 | 30927 |
| 14-#18 | 3.58 | MA | 26540 | 6183 | 44073 | 4899 | 52991 | 3935 | 58690 | 3137 | 66941 | 1854 | 85419 | 1162 | 71582 |
| 4L-5S | | MI | 17765 | 6183 | 30458 | 4814 | 36034 | 3832 | 39222 | 3059 | 43153 | 1736 | 54164 | 842 | 48507 |
| 14-#18 | 3.58 | MA | 24858 | 6183 | 41356 | 4927 | 49730 | 3933 | 54710 | 3158 | 61522 | 1868 | 78519 | 1045 | 68633 |
| 5L-4S | | MI | 18972 | 6183 | 32379 | 4793 | 38340 | 3842 | 42014 | 3046 | 46823 | 1723 | 58809 | 951 | 50309 |
| 14-#18 | 3.58 | MA | 23245 | 6183 | 38942 | 4928 | 46511 | 3957 | 50791 | 3152 | 56310 | 1882 | 71528 | 852 | 64290 |
| 6L-3S | | MI | 20299 | 6183 | 34274 | 4798 | 40898 | 3826 | 45091 | 3059 | 50845 | 1736 | 63173 | 1181 | 52829 |
| 14-#18 | 3.58 | MA | 21664 | 6183 | 36591 | 4930 | 43401 | 3955 | 46992 | 3173 | 51027 | 1869 | 65312 | 670 | 59848 |
| 7L-2S | | MI | 22112 | 6183 | 36795 | 4803 | 44096 | 3836 | 48942 | 3046 | 55912 | 1723 | 69834 | 1415 | 53257 |

## RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

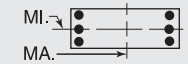
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.60 | MA | 24920 | 5055 | 36264 | 4227 | 43629 | 3426 | 47488 | 2820 | 51924 | 1924 | 64599 | 1815 | 34734 |
| 2L-8S | | MI | 14746 | 5055 | 22409 | 4153 | 26030 | 3367 | 27286 | 2771 | 27600 | 1875 | 33537 | 1288 | 22904 |
| 16-#11 | 1.60 | MA | 23812 | 5055 | 34826 | 4228 | 41805 | 3426 | 45278 | 2830 | 48942 | 1931 | 60541 | 1724 | 34667 |
| 3L-7S | | MI | 15226 | 5055 | 23063 | 4153 | 26891 | 3369 | 28362 | 2775 | 29012 | 1870 | 35316 | 1338 | 23595 |
| 16-#11 | 1.60 | MA | 23014 | 5055 | 33760 | 4230 | 40364 | 3437 | 43531 | 2829 | 46585 | 1928 | 57861 | 1633 | 34523 |
| 4L-6S | | MI | 15711 | 5055 | 23728 | 4154 | 27770 | 3371 | 29435 | 2769 | 30475 | 1875 | 37016 | 1409 | 23968 |
| 16-#11 | 1.60 | MA | 22294 | 5055 | 32683 | 4242 | 39071 | 3437 | 41953 | 2838 | 44436 | 1935 | 55079 | 1586 | 34222 |
| 5E | | MI | 16207 | 5055 | 24410 | 4155 | 28679 | 3363 | 30542 | 2773 | 31917 | 1870 | 38932 | 1485 | 24533 |
| 16-#11 | 1.60 | MA | 21603 | 5055 | 31727 | 4243 | 37796 | 3448 | 40401 | 2837 | 42371 | 1942 | 52246 | 1511 | 33269 |
| 6L-4S | | MI | 16723 | 5055 | 25177 | 4145 | 29600 | 3365 | 31665 | 2766 | 33417 | 1865 | 40839 | 1528 | 24763 |
| 16-#11 | 1.60 | MA | 20927 | 5055 | 30797 | 4245 | 36565 | 3448 | 38896 | 2847 | 40277 | 1939 | 49721 | 1440 | 32622 |
| 7L-3S | | MI | 17291 | 5055 | 25934 | 4146 | 30623 | 3357 | 32905 | 2770 | 35061 | 1870 | 42640 | 1620 | 24828 |
| 16-#11 | 1.60 | MA | 20259 | 5055 | 29881 | 4246 | 35358 | 3448 | 37388 | 2846 | 38258 | 1946 | 47122 | 1385 | 31568 |
| 8L-2S | | MI | 18070 | 5055 | 26948 | 4146 | 31908 | 3359 | 34462 | 2764 | 37133 | 1865 | 45387 | 1711 | 24853 |
| 16-#14 | 2.30 | MA | 25660 | 5456 | 39291 | 4467 | 47361 | 3599 | 51962 | 2941 | 57929 | 1909 | 72521 | 1627 | 49301 |
| 3L-7S | | MI | 15646 | 5456 | 24964 | 4388 | 29162 | 3539 | 31060 | 2881 | 32522 | 1828 | 40199 | 1082 | 31771 |
| 16-#14 | 2.30 | MA | 24552 | 5456 | 37763 | 4469 | 45295 | 3614 | 49458 | 2939 | 54549 | 1903 | 68707 | 1495 | 48909 |
| 4L-6S | | MI | 16321 | 5456 | 25916 | 4390 | 30421 | 3543 | 32597 | 2873 | 34600 | 1836 | 42603 | 1185 | 33034 |
| 16-#14 | 2.30 | MA | 23550 | 5456 | 36218 | 4486 | 43441 | 3614 | 47195 | 2952 | 51467 | 1913 | 64739 | 1428 | 47317 |
| 5E | | MI | 17011 | 5456 | 26893 | 4391 | 31722 | 3532 | 34181 | 2879 | 36648 | 1828 | 45317 | 1294 | 33735 |
| 16-#14 | 2.30 | MA | 22589 | 5456 | 34846 | 4487 | 41611 | 3629 | 44967 | 2950 | 48504 | 1922 | 60704 | 1320 | 46118 |
| 6L-4S | | MI | 17729 | 5456 | 27991 | 4378 | 33040 | 3537 | 35789 | 2871 | 38778 | 1821 | 48024 | 1356 | 34871 |
| 16-#14 | 2.30 | MA | 21649 | 5456 | 33511 | 4489 | 39844 | 3629 | 42808 | 2963 | 45500 | 1916 | 57111 | 1217 | 44281 |
| 7L-3S | | MI | 18520 | 5456 | 29074 | 4379 | 34503 | 3526 | 37562 | 2877 | 41113 | 1828 | 50570 | 1487 | 35095 |
| 16-#14 | 2.30 | MA | 20719 | 5456 | 32197 | 4491 | 38112 | 3629 | 40645 | 2961 | 42602 | 1926 | 53404 | 1140 | 42587 |
| 8L-2S | | MI | 19603 | 5456 | 30521 | 4381 | 36338 | 3530 | 39785 | 2869 | 44054 | 1821 | 54460 | 1618 | 35201 |
| 16-#18 | 4.09 | MA | 26503 | 6474 | 44967 | 5109 | 54310 | 4066 | 60258 | 3242 | 69008 | 1855 | 88532 | 1009 | 79014 |
| 5E | | MI | 18878 | 6474 | 32979 | 4996 | 39231 | 3965 | 43073 | 3142 | 48220 | 1711 | 60825 | 783 | 55437 |
| 16-#18 | 4.09 | MA | 24921 | 6474 | 42553 | 5110 | 51091 | 4090 | 56340 | 3237 | 63797 | 1869 | 81541 | 816 | 74558 |
| 6L-4S | | MI | 20065 | 6474 | 34900 | 4975 | 41537 | 3975 | 45865 | 3128 | 51890 | 1698 | 65470 | 891 | 57397 |
| 16-#18 | 4.09 | MA | 23370 | 6474 | 40203 | 5112 | 47981 | 4088 | 52541 | 3258 | 58513 | 1856 | 75325 | 634 | 70054 |
| 7L-3S | | MI | 21372 | 6474 | 36795 | 4980 | 44096 | 3959 | 48942 | 3142 | 55912 | 1711 | 69834 | 1121 | 60160 |
| 16-#18 | 4.09 | MA | 21836 | 6474 | 37889 | 5113 | 44934 | 4086 | 48735 | 3252 | 53415 | 1869 | 68881 | 499 | 65455 |
| 8L-2S | | MI | 23159 | 6474 | 39316 | 4985 | 47293 | 3969 | 52793 | 3128 | 60979 | 1698 | 76495 | 1355 | 60654 |
| 18-#11 | 1.80 | MA | 24504 | 5168 | 36264 | 4299 | 43629 | 3478 | 47488 | 2863 | 51924 | 1926 | 64599 | 1713 | 38904 |
| 3L-8S | | MI | 15241 | 5168 | 23422 | 4224 | 27315 | 3418 | 28843 | 2804 | 29672 | 1868 | 36283 | 1269 | 25772 |
| 18-#11 | 1.80 | MA | 23714 | 5168 | 35199 | 4301 | 42188 | 3489 | 45742 | 2862 | 49567 | 1923 | 61918 | 1622 | 38742 |
| 4L-7S | | MI | 15716 | 5168 | 24076 | 4224 | 28176 | 3421 | 29919 | 2808 | 31083 | 1862 | 38062 | 1320 | 26507 |
| 18-#11 | 1.80 | MA | 23001 | 5168 | 34122 | 4313 | 40896 | 3489 | 44164 | 2871 | 47418 | 1930 | 59137 | 1575 | 38334 |
| 5L-6S | | MI | 16197 | 5168 | 24741 | 4225 | 29055 | 3423 | 30992 | 2802 | 32546 | 1868 | 39762 | 1391 | 26870 |
| 18-#11 | 1.80 | MA | 22317 | 5168 | 33166 | 4314 | 39620 | 3500 | 42611 | 2870 | 45353 | 1937 | 56303 | 1500 | 37414 |
| 6L-5S | | MI | 16688 | 5168 | 25423 | 4225 | 29964 | 3415 | 32099 | 2806 | 33989 | 1862 | 41679 | 1467 | 27410 |
| 18-#11 | 1.80 | MA | 21648 | 5168 | 32236 | 4316 | 38389 | 3500 | 41106 | 2880 | 43259 | 1934 | 53778 | 1429 | 36781 |
| 7L-4S | | MI | 17200 | 5168 | 26190 | 4216 | 30885 | 3417 | 33222 | 2799 | 35489 | 1857 | 43585 | 1510 | 27735 |
| 18-#11 | 1.80 | MA | 20987 | 5168 | 31320 | 4317 | 37182 | 3500 | 39599 | 2879 | 41239 | 1941 | 51180 | 1375 | 35686 |
| 8L-3S | | MI | 17764 | 5168 | 26948 | 4216 | 31908 | 3409 | 34462 | 2803 | 37133 | 1862 | 45387 | 1601 | 27817 |
| 18-#11 | 1.80 | MA | 20330 | 5168 | 30308 | 4329 | 35939 | 3511 | 38115 | 2888 | 39240 | 1948 | 48605 | 1316 | 34756 |
| 9L-2S | | MI | 18536 | 5168 | 27961 | 4217 | 33193 | 3411 | 36018 | 2797 | 39204 | 1857 | 48133 | 1692 | 27855 |
| 18-#14 | 2.59 | MA | 25517 | 5620 | 39823 | 4571 | 47908 | 3689 | 52624 | 2987 | 58820 | 1896 | 74486 | 1478 | 54925 |
| 4L-7S | | MI | 16327 | 5620 | 26411 | 4490 | 30997 | 3614 | 33283 | 2928 | 35463 | 1817 | 44088 | 1053 | 35849 |
| 18-#14 | 2.59 | MA | 24528 | 5620 | 38278 | 4588 | 46053 | 3689 | 50360 | 3000 | 55737 | 1905 | 70518 | 1411 | 53227 |
| 5L-6S | | MI | 16994 | 5620 | 27363 | 4492 | 32256 | 3618 | 34820 | 2920 | 37541 | 1824 | 46492 | 1156 | 37161 |
| 18-#14 | 2.59 | MA | 23580 | 5620 | 36906 | 4590 | 44224 | 3704 | 48133 | 2998 | 52774 | 1915 | 66483 | 1303 | 52063 |
| 6L-5S | | MI | 17676 | 5620 | 28340 | 4493 | 33557 | 3607 | 36404 | 2926 | 39590 | 1817 | 49206 | 1265 | 37853 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis

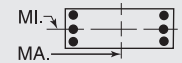



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.59 | MA | 22652 | 5620 | 35571 | 4591 | 42456 | 3704 | 45973 | 3011 | 49771 | 1909 | 62889 | 1200 | 50165 |
| 7L-4S | | MI | 18386 | 5620 | 29438 | 4480 | 34875 | 3611 | 38012 | 2918 | 41720 | 1809 | 51913 | 1327 | 39085 |
| 18-#14 | 2.59 | MA | 21734 | 5620 | 34257 | 4593 | 40725 | 3704 | 43810 | 3009 | 46873 | 1918 | 59183 | 1123 | 48428 |
| 8L-3S | | MI | 19169 | 5620 | 30521 | 4481 | 36338 | 3600 | 39785 | 2925 | 44054 | 1817 | 54460 | 1458 | 39338 |
| 18-#14 | 2.59 | MA | 20823 | 5620 | 32805 | 4610 | 38940 | 3718 | 41682 | 3022 | 44003 | 1928 | 55518 | 1038 | 46266 |
| 9L-2S | | MI | 20241 | 5620 | 31968 | 4483 | 38173 | 3604 | 42008 | 2916 | 46996 | 1809 | 58349 | 1589 | 39467 |
| 18-#18 | 4.60 | MA | 26564 | 6765 | 46164 | 5292 | 55671 | 4223 | 61889 | 3321 | 71283 | 1855 | 91554 | 780 | 84845 |
| 6L-5S | | MI | 19973 | 6765 | 35500 | 5178 | 42428 | 4098 | 46925 | 3224 | 53287 | 1687 | 67486 | 723 | 62396 |
| 18-#18 | 4.60 | MA | 25042 | 6765 | 43814 | 5293 | 52561 | 4221 | 58090 | 3342 | 66000 | 1842 | 85338 | 598 | 80278 |
| 7L-4S | | MI | 21141 | 6765 | 37421 | 5156 | 44735 | 4108 | 49716 | 3211 | 56956 | 1673 | 72131 | 831 | 64509 |
| 18-#18 | 4.60 | MA | 23535 | 6765 | 41501 | 5295 | 49514 | 4219 | 54284 | 3336 | 60901 | 1856 | 78894 | 463 | 75638 |
| 8L-3S | | MI | 22428 | 6765 | 39316 | 5161 | 47293 | 4092 | 52793 | 3224 | 60979 | 1687 | 76495 | 1061 | 67487 |
| 20-#11 | 1.99 | MA | 24405 | 5282 | 36637 | 4372 | 44013 | 3541 | 47952 | 2895 | 52548 | 1918 | 65976 | 1611 | 42959 |
| 4L-8S | | MI | 15730 | 5282 | 24435 | 4294 | 28600 | 3470 | 30400 | 2837 | 31743 | 1860 | 39030 | 1251 | 28645 |
| 20-#11 | 1.99 | MA | 23699 | 5282 | 35560 | 4383 | 42720 | 3541 | 46374 | 2904 | 50400 | 1925 | 63195 | 1564 | 42455 |
| 5L-7S | | MI | 16201 | 5282 | 25089 | 4295 | 29461 | 3473 | 31475 | 2841 | 33154 | 1855 | 40809 | 1301 | 29361 |
| 20-#11 | 1.99 | MA | 23022 | 5282 | 34604 | 4385 | 41445 | 3551 | 44821 | 2903 | 48335 | 1932 | 60361 | 1489 | 41564 |
| 6E | | MI | 16678 | 5282 | 25754 | 4296 | 30340 | 3475 | 32549 | 2835 | 34617 | 1860 | 42509 | 1372 | 29777 |
| 20-#11 | 1.99 | MA | 22360 | 5282 | 33674 | 4386 | 40213 | 3552 | 43316 | 2913 | 46241 | 1928 | 57836 | 1419 | 40944 |
| 7L-5S | | MI | 17164 | 5282 | 26436 | 4296 | 31249 | 3467 | 33655 | 2839 | 36060 | 1855 | 44425 | 1448 | 30295 |
| 20-#11 | 1.99 | MA | 21705 | 5282 | 32758 | 4388 | 39007 | 3552 | 41809 | 2912 | 44221 | 1936 | 55238 | 1364 | 39810 |
| 8L-4S | | MI | 17671 | 5282 | 27204 | 4287 | 32170 | 3469 | 34779 | 2832 | 37560 | 1850 | 46332 | 1491 | 30705 |
| 20-#11 | 1.99 | MA | 21055 | 5282 | 31747 | 4400 | 37763 | 3563 | 40326 | 2921 | 42222 | 1943 | 52663 | 1306 | 38849 |
| 9L-3S | | MI | 18230 | 5282 | 27961 | 4287 | 33193 | 3461 | 36018 | 2836 | 39204 | 1855 | 48133 | 1583 | 30801 |
| 20-#11 | 1.99 | MA | 20408 | 5282 | 30835 | 4401 | 36565 | 3563 | 38836 | 2920 | 40165 | 1939 | 50002 | 1226 | 37536 |
| 10L-2S | | MI | 18997 | 5282 | 28974 | 4288 | 34478 | 3463 | 37575 | 2830 | 41275 | 1850 | 50880 | 1674 | 30851 |
| 20-#14 | 2.88 | MA | 25491 | 5783 | 40338 | 4690 | 48666 | 3764 | 53526 | 3047 | 60008 | 1898 | 76297 | 1394 | 59147 |
| 5L-7S | | MI | 16998 | 5783 | 27858 | 4592 | 32832 | 3689 | 35507 | 2976 | 38405 | 1805 | 47978 | 1024 | 39936 |
| 20-#14 | 2.88 | MA | 24555 | 5783 | 38966 | 4692 | 46837 | 3779 | 51298 | 3045 | 57045 | 1907 | 72261 | 1286 | 58015 |
| 6E | | MI | 17658 | 5783 | 28809 | 4594 | 34091 | 3693 | 37043 | 2967 | 40483 | 1813 | 50382 | 1127 | 41204 |
| 20-#14 | 2.88 | MA | 23639 | 5783 | 37631 | 4694 | 45069 | 3778 | 49139 | 3058 | 54042 | 1902 | 68668 | 1183 | 56057 |
| 7L-5S | | MI | 18332 | 5783 | 29787 | 4596 | 35392 | 3682 | 38627 | 2974 | 42531 | 1805 | 53096 | 1236 | 41981 |
| 20-#14 | 2.88 | MA | 22733 | 5783 | 36317 | 4695 | 43338 | 3778 | 46976 | 3056 | 51144 | 1911 | 64962 | 1106 | 54278 |
| 8L-4S | | MI | 19034 | 5783 | 30885 | 4582 | 36710 | 3686 | 40235 | 2965 | 44661 | 1798 | 55802 | 1298 | 43164 |
| 20-#14 | 2.88 | MA | 21833 | 5783 | 34866 | 4712 | 41553 | 3793 | 44847 | 3069 | 48274 | 1920 | 61297 | 1021 | 52159 |
| 9L-3S | | MI | 19809 | 5783 | 31968 | 4584 | 38173 | 3675 | 42008 | 2972 | 46996 | 1805 | 58349 | 1429 | 43576 |
| 20-#14 | 2.88 | MA | 20935 | 5783 | 33557 | 4714 | 39834 | 3793 | 42709 | 3067 | 45323 | 1915 | 57508 | 906 | 49797 |
| 10L-2S | | MI | 20870 | 5783 | 33415 | 4585 | 40008 | 3679 | 44232 | 2964 | 49937 | 1798 | 62238 | 1560 | 43729 |
| 20-#18 | 5.12 | MA | 26683 | 7056 | 47426 | 5475 | 57142 | 4354 | 63639 | 3426 | 73486 | 1829 | 95351 | 562 | 90518 |
| 7L-5S | | MI | 21052 | 7056 | 38021 | 5360 | 45625 | 4231 | 50776 | 3307 | 58353 | 1662 | 74147 | 663 | 69380 |
| 20-#18 | 5.12 | MA | 25203 | 7056 | 45112 | 5477 | 54094 | 4352 | 59833 | 3420 | 68388 | 1843 | 88907 | 426 | 85835 |
| 8L-4S | | MI | 22203 | 7056 | 39942 | 5338 | 47932 | 4241 | 53567 | 3294 | 62023 | 1649 | 78792 | 772 | 71642 |
| 22-#11 | 2.19 | MA | 24388 | 5395 | 36999 | 4454 | 44544 | 3593 | 48584 | 2937 | 53382 | 1919 | 67253 | 1554 | 46583 |
| 5L-8S | | MI | 16213 | 5395 | 25448 | 4365 | 29885 | 3522 | 31957 | 2870 | 33814 | 1853 | 41776 | 1232 | 31524 |
| 22-#11 | 2.19 | MA | 23718 | 5395 | 36043 | 4456 | 43269 | 3603 | 47031 | 2936 | 51316 | 1927 | 64419 | 1479 | 45718 |
| 6L-7S | | MI | 16680 | 5395 | 26103 | 4366 | 30746 | 3524 | 33032 | 2874 | 35226 | 1848 | 43555 | 1283 | 32218 |
| 22-#11 | 2.19 | MA | 23062 | 5395 | 35112 | 4457 | 42038 | 3604 | 45527 | 2945 | 49223 | 1923 | 61894 | 1408 | 45083 |
| 7L-6S | | MI | 17153 | 5395 | 26767 | 4367 | 31625 | 3527 | 34106 | 2867 | 36689 | 1853 | 45255 | 1354 | 32688 |
| 22-#11 | 2.19 | MA | 22414 | 5395 | 34197 | 4459 | 40831 | 3604 | 44019 | 2945 | 47203 | 1930 | 59295 | 1353 | 43938 |
| 8L-5S | | MI | 17635 | 5395 | 27450 | 4367 | 32534 | 3519 | 35212 | 2871 | 38131 | 1848 | 47172 | 1430 | 33187 |
| 22-#11 | 2.19 | MA | 21771 | 5395 | 33185 | 4471 | 39587 | 3615 | 42536 | 2954 | 45204 | 1937 | 56721 | 1295 | 42947 |
| 9L-4S | | MI | 18138 | 5395 | 28217 | 4358 | 33455 | 3521 | 36336 | 2865 | 39631 | 1843 | 49078 | 1473 | 33672 |
| 22-#11 | 2.19 | MA | 21129 | 5395 | 32273 | 4472 | 38389 | 3615 | 41046 | 2953 | 43147 | 1934 | 54060 | 1215 | 41658 |
| 10L-3S | | MI | 18692 | 5395 | 28974 | 4358 | 34478 | 3513 | 37575 | 2869 | 41275 | 1848 | 50880 | 1564 | 33783 |
| 22-#11 | 2.19 | MA | 20442 | 5395 | 31368 | 4474 | 37160 | 3625 | 39572 | 2963 | 41156 | 1941 | 51506 | 1158 | 40319 |
| 11L-2S | | MI | 19453 | 5395 | 29987 | 4359 | 35763 | 3515 | 39132 | 2862 | 43346 | 1843 | 53626 | 1655 | 33844 |
| 22-#14 | 3.16 | MA | 25517 | 5947 | 41027 | 4794 | 49450 | 3853 | 54464 | 3093 | 61316 | 1900 | 78040 | 1269 | 63972 |
| 6L-7S | | MI | 17660 | 5947 | 29304 | 4695 | 34667 | 3764 | 37730 | 3023 | 41346 | 1794 | 51867 | 995 | 44031 |

## RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 3.16 | MA | 24612 | 5947 | 39692 | 4796 | 47682 | 3853 | 52305 | 3106 | 58313 | 1894 | 74447 | 1166 | 61957 |
| 7L-6S | | MI | 18313 | 5947 | 30256 | 4696 | 35926 | 3768 | 39267 | 3015 | 43424 | 1801 | 54271 | 1098 | 45258 |
| 22-#14 | 3.16 | MA | 23718 | 5947 | 38377 | 4797 | 45951 | 3853 | 50141 | 3104 | 55415 | 1903 | 70740 | 1089 | 60076 |
| 8L-5S | | MI | 18980 | 5947 | 31234 | 4698 | 37227 | 3757 | 40851 | 3021 | 45472 | 1794 | 56985 | 1207 | 46116 |
| 22-#14 | 3.16 | MA | 22829 | 5947 | 36926 | 4814 | 44166 | 3868 | 48013 | 3117 | 52545 | 1913 | 67076 | 1004 | 58058 |
| 9L-4S | | MI | 19675 | 5947 | 32331 | 4684 | 38545 | 3761 | 42458 | 3013 | 47602 | 1786 | 59692 | 1269 | 47250 |
| 22-#14 | 3.16 | MA | 21935 | 5947 | 35617 | 4816 | 42447 | 3868 | 45875 | 3115 | 49594 | 1907 | 63287 | 889 | 55670 |
| 10L-3S | | MI | 20441 | 5947 | 33415 | 4686 | 40008 | 3750 | 44232 | 3019 | 49937 | 1794 | 62238 | 1400 | 47811 |
| 22-#18 | 5.63 | MA | 26842 | 7346 | 48723 | 5658 | 58674 | 4485 | 65381 | 3505 | 75874 | 1830 | 98920 | 390 | 96046 |
| 8L-5S | | MI | 22198 | 7346 | 40542 | 5541 | 48823 | 4364 | 54627 | 3389 | 63420 | 1637 | 80808 | 603 | 76389 |
| 24-#11 | 2.39 | MA | 24406 | 5509 | 37481 | 4527 | 45093 | 3655 | 49242 | 2969 | 54298 | 1921 | 68477 | 1468 | 49877 |
| 6L-8S | | MI | 16691 | 5509 | 26461 | 4436 | 31170 | 3574 | 33513 | 2903 | 35886 | 1846 | 44523 | 1214 | 34407 |
| 24-#11 | 2.39 | MA | 23757 | 5509 | 36551 | 4528 | 43862 | 3655 | 47737 | 2978 | 52205 | 1918 | 65951 | 1397 | 49192 |
| 7E | | MI | 17154 | 5509 | 27116 | 4437 | 32031 | 3576 | 34589 | 2907 | 37297 | 1841 | 46302 | 1264 | 35081 |
| 24-#11 | 2.39 | MA | 23115 | 5509 | 35635 | 4530 | 42655 | 3656 | 46229 | 2977 | 50185 | 1925 | 63353 | 1343 | 48071 |
| 8L-6S | | MI | 17623 | 5509 | 27781 | 4438 | 32910 | 3579 | 35662 | 2900 | 38760 | 1846 | 48002 | 1336 | 35602 |
| 24-#11 | 2.39 | MA | 22478 | 5509 | 34624 | 4541 | 41412 | 3666 | 44746 | 2987 | 48185 | 1932 | 60779 | 1284 | 47050 |
| 9L-5S | | MI | 18101 | 5509 | 28463 | 4438 | 33819 | 3570 | 36769 | 2904 | 40203 | 1841 | 49919 | 1411 | 36084 |
| 24-#11 | 2.39 | MA | 21838 | 5509 | 33712 | 4543 | 40214 | 3667 | 43256 | 2986 | 46129 | 1929 | 58117 | 1204 | 45784 |
| 10L-4S | | MI | 18600 | 5509 | 29230 | 4428 | 34740 | 3573 | 37892 | 2898 | 41703 | 1836 | 51825 | 1455 | 36637 |
| 24-#11 | 2.39 | MA | 21157 | 5509 | 32807 | 4544 | 38984 | 3677 | 41782 | 2995 | 44138 | 1936 | 55564 | 1147 | 44426 |
| 11L-3S | | MI | 19150 | 5509 | 29987 | 4429 | 35763 | 3565 | 39132 | 2902 | 43346 | 1841 | 53626 | 1546 | 36761 |
| 24-#11 | 2.39 | MA | 20469 | 5509 | 31906 | 4546 | 37790 | 3678 | 40301 | 2995 | 42156 | 1943 | 53009 | 1089 | 43080 |
| 12L-2S | | MI | 19905 | 5509 | 31000 | 4430 | 37048 | 3567 | 40689 | 2895 | 45418 | 1836 | 56373 | 1637 | 36834 |
| 24-#14 | 3.45 | MA | 25572 | 6111 | 41752 | 4898 | 50295 | 3928 | 55470 | 3153 | 62583 | 1887 | 80226 | 1149 | 67864 |
| 7E | | MI | 18315 | 6111 | 30751 | 4797 | 36502 | 3839 | 39953 | 3070 | 44287 | 1782 | 55756 | 966 | 48135 |
| 24-#14 | 3.45 | MA | 24688 | 6111 | 40438 | 4900 | 48564 | 3928 | 53307 | 3151 | 59685 | 1896 | 76519 | 1072 | 65944 |
| 8L-6S | | MI | 18961 | 6111 | 31703 | 4798 | 37761 | 3843 | 41490 | 3062 | 46365 | 1790 | 58160 | 1069 | 49323 |
| 24-#14 | 3.45 | MA | 23810 | 6111 | 38986 | 4916 | 46779 | 3943 | 51179 | 3164 | 56816 | 1905 | 72854 | 987 | 63963 |
| 9L-5S | | MI | 19620 | 6111 | 32680 | 4800 | 39062 | 3832 | 43074 | 3069 | 48414 | 1782 | 60874 | 1178 | 50258 |
| 24-#14 | 3.45 | MA | 22920 | 6111 | 37677 | 4918 | 45059 | 3943 | 49040 | 3162 | 53865 | 1900 | 69066 | 872 | 61549 |
| 10L-4S | | MI | 20308 | 6111 | 33778 | 4787 | 40380 | 3836 | 44682 | 3060 | 50544 | 1775 | 63581 | 1240 | 51346 |

## RECTANGULAR TIED COLUMNS 34" x 48"

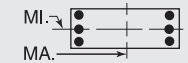
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.47 | MA | 26513 | 5200 | 38588 | 4338 | 46127 | 3520 | 49932 | 2903 | 54070 | 1997 | 66561 | 1869 | 34563 |
| 2L-3S | | MI | 16407 | 5200 | 25022 | 4224 | 29054 | 3420 | 30642 | 2836 | 31468 | 1918 | 37538 | 1500 | 23480 |
| 6-#18 | 1.47 | MA | 23576 | 5200 | 34795 | 4340 | 41316 | 3518 | 44104 | 2925 | 46207 | 2012 | 55988 | 1636 | 34297 |
| 3L-2S | | MI | 18351 | 5200 | 27543 | 4229 | 32251 | 3430 | 34493 | 2822 | 36534 | 1904 | 44199 | 1734 | 23543 |
| 8-#14 | 1.10 | MA | 25246 | 4982 | 35626 | 4226 | 42591 | 3439 | 45745 | 2857 | 48487 | 2020 | 59358 | 1919 | 26333 |
| 2L-4S | | MI | 15612 | 4982 | 23027 | 4124 | 26642 | 3365 | 27853 | 2789 | 27905 | 1950 | 33481 | 1552 | 18029 |
| 8-#14 | 1.10 | MA | 23543 | 4982 | 33463 | 4228 | 39848 | 3440 | 42422 | 2870 | 44004 | 2030 | 53264 | 1788 | 26283 |
| 3E | | MI | 16444 | 4982 | 24110 | 4125 | 28105 | 3354 | 29626 | 2796 | 30240 | 1958 | 36028 | 1683 | 18088 |
| 8-#14 | 1.10 | MA | 22312 | 4982 | 31861 | 4230 | 37682 | 3455 | 39796 | 2869 | 40460 | 2025 | 49239 | 1656 | 26056 |
| 4L-2S | | MI | 17577 | 4982 | 25557 | 4127 | 29940 | 3358 | 31849 | 2788 | 33181 | 1950 | 39917 | 1815 | 18067 |
| 8-#18 | 1.96 | MA | 28295 | 5491 | 42381 | 4520 | 50937 | 3653 | 55760 | 2988 | 61933 | 1984 | 77135 | 1836 | 45782 |
| 2L-4S | | MI | 16173 | 5491 | 25649 | 4401 | 29693 | 3570 | 31416 | 2905 | 32512 | 1880 | 39835 | 1210 | 29528 |
| 8-#18 | 1.96 | MA | 25416 | 5491 | 38588 | 4522 | 46127 | 3651 | 49932 | 3009 | 54070 | 1999 | 66561 | 1602 | 45394 |
| 3E | | MI | 17578 | 5491 | 27543 | 4406 | 32251 | 3553 | 34493 | 2918 | 36534 | 1893 | 44199 | 1440 | 30865 |
| 8-#18 | 1.96 | MA | 23335 | 5491 | 35771 | 4524 | 42318 | 3677 | 45316 | 3005 | 47840 | 1988 | 59591 | 1369 | 43333 |
| 4L-2S | | MI | 19488 | 5491 | 30064 | 4411 | 35448 | 3563 | 38344 | 2905 | 41601 | 1880 | 50860 | 1674 | 31030 |
| 10-#14 | 1.38 | MA | 26303 | 5146 | 37788 | 4328 | 45333 | 3514 | 49067 | 2904 | 52970 | 2013 | 65453 | 1904 | 32746 |
| 2L-5S | | MI | 15567 | 5146 | 23376 | 4239 | 27159 | 3435 | 28468 | 2845 | 28717 | 1946 | 34664 | 1461 | 21615 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis

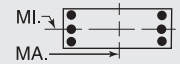



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.38 | MA | 24621 | 5146 | 35626 | 4330 | 42591 | 3515 | 45745 | 2918 | 48487 | 2023 | 59358 | 1772 | 32655 |
| 3L-4S | | MI | 16314 | 5146 | 24474 | 4226 | 28477 | 3440 | 30076 | 2837 | 30847 | 1939 | 37371 | 1523 | 22269 |
| 10-#14 | 1.38 | MA | 23407 | 5146 | 34024 | 4332 | 40424 | 3530 | 43119 | 2916 | 44943 | 2018 | 55333 | 1641 | 32379 |
| 4L-3S | | MI | 17136 | 5146 | 25557 | 4227 | 29940 | 3429 | 31849 | 2843 | 33181 | 1946 | 39917 | 1654 | 22372 |
| 10-#14 | 1.38 | MA | 22310 | 5146 | 32404 | 4349 | 38481 | 3530 | 40746 | 2930 | 41712 | 2028 | 51155 | 1573 | 31255 |
| 5L-2S | | MI | 18257 | 5146 | 27004 | 4229 | 31775 | 3433 | 34072 | 2835 | 36123 | 1939 | 43807 | 1786 | 22384 |
| 10-#18 | 2.45 | MA | 30029 | 5782 | 46175 | 4702 | 55748 | 3786 | 61588 | 3072 | 69797 | 1971 | 87709 | 1803 | 56976 |
| 2L-5S | | MI | 16084 | 5782 | 26248 | 4604 | 30583 | 3693 | 32475 | 3001 | 33909 | 1868 | 41851 | 1042 | 34540 |
| 10-#18 | 2.45 | MA | 27204 | 5782 | 42381 | 4704 | 50937 | 3784 | 55760 | 3094 | 61933 | 1986 | 77135 | 1569 | 56484 |
| 3L-4S | | MI | 17340 | 5782 | 28170 | 4583 | 32890 | 3703 | 35267 | 2988 | 37579 | 1855 | 46496 | 1150 | 36497 |
| 10-#18 | 2.45 | MA | 25167 | 5782 | 39564 | 4706 | 47128 | 3810 | 51144 | 3089 | 55703 | 1974 | 70165 | 1335 | 54013 |
| 4L-3S | | MI | 18720 | 5782 | 30064 | 4588 | 35448 | 3686 | 38344 | 3001 | 41601 | 1868 | 50860 | 1380 | 38228 |
| 10-#18 | 2.45 | MA | 23323 | 5782 | 36714 | 4735 | 43708 | 3808 | 46969 | 3111 | 50020 | 1989 | 62890 | 1217 | 50517 |
| 5L-2S | | MI | 20597 | 5782 | 32585 | 4593 | 38645 | 3696 | 42195 | 2988 | 46668 | 1855 | 57521 | 1614 | 38480 |
| 12-#11 | 1.15 | MA | 25472 | 5008 | 35914 | 4254 | 43067 | 3461 | 46371 | 2873 | 49366 | 2025 | 60711 | 1929 | 27476 |
| 2L-6S | | MI | 15333 | 5008 | 22520 | 4168 | 26140 | 3395 | 27279 | 2812 | 27226 | 1973 | 32541 | 1527 | 18298 |
| 12-#11 | 1.15 | MA | 24285 | 5008 | 34404 | 4256 | 41153 | 3462 | 44052 | 2883 | 46237 | 2033 | 56435 | 1838 | 27443 |
| 3L-5S | | MI | 15839 | 5008 | 23203 | 4168 | 27050 | 3387 | 28385 | 2816 | 28669 | 1968 | 34457 | 1603 | 18769 |
| 12-#11 | 1.15 | MA | 23430 | 5008 | 33287 | 4258 | 39643 | 3473 | 42221 | 2882 | 43766 | 2030 | 53607 | 1747 | 27343 |
| 4E | | MI | 16367 | 5008 | 23970 | 4159 | 27970 | 3390 | 29509 | 2809 | 30169 | 1962 | 36364 | 1646 | 18846 |
| 12-#11 | 1.15 | MA | 22657 | 5008 | 32159 | 4270 | 38288 | 3473 | 40568 | 2892 | 41514 | 2037 | 50680 | 1700 | 27122 |
| 5L-3S | | MI | 16947 | 5008 | 24727 | 4159 | 28993 | 3381 | 30748 | 2813 | 31813 | 1968 | 38165 | 1737 | 18869 |
| 12-#11 | 1.15 | MA | 21917 | 5008 | 31157 | 4271 | 36952 | 3484 | 38941 | 2891 | 39350 | 2045 | 47693 | 1625 | 26290 |
| 6L-2S | | MI | 17740 | 5008 | 25740 | 4160 | 30278 | 3384 | 32305 | 2807 | 33884 | 1962 | 40911 | 1828 | 18857 |
| 12-#14 | 1.65 | MA | 27340 | 5309 | 39951 | 4430 | 48076 | 3589 | 52390 | 2952 | 57453 | 2005 | 71547 | 1888 | 39147 |
| 2L-6S | | MI | 15557 | 5309 | 23846 | 4340 | 27692 | 3521 | 29107 | 2886 | 29609 | 1942 | 35839 | 1323 | 24922 |
| 12-#14 | 1.65 | MA | 25678 | 5309 | 37788 | 4432 | 45333 | 3589 | 49067 | 2965 | 52970 | 2015 | 65453 | 1757 | 39020 |
| 3L-5S | | MI | 16266 | 5309 | 24823 | 4342 | 28994 | 3510 | 30691 | 2893 | 31658 | 1935 | 38553 | 1433 | 25692 |
| 12-#14 | 1.65 | MA | 24481 | 5309 | 36186 | 4434 | 43167 | 3605 | 46441 | 2964 | 49425 | 2010 | 61428 | 1625 | 38699 |
| 4E | | MI | 17004 | 5309 | 25921 | 4328 | 30312 | 3514 | 32299 | 2884 | 33788 | 1927 | 41260 | 1494 | 26500 |
| 12-#14 | 1.65 | MA | 23399 | 5309 | 34567 | 4451 | 41223 | 3605 | 44069 | 2977 | 46195 | 2020 | 57249 | 1557 | 37420 |
| 5L-3S | | MI | 17816 | 5309 | 27004 | 4330 | 31775 | 3503 | 34072 | 2891 | 36123 | 1935 | 43807 | 1625 | 26640 |
| 12-#14 | 1.65 | MA | 22361 | 5309 | 33129 | 4454 | 39305 | 3620 | 41734 | 2976 | 43089 | 2030 | 52993 | 1449 | 36034 |
| 6L-2S | | MI | 18925 | 5309 | 28451 | 4331 | 33610 | 3508 | 36296 | 2882 | 39064 | 1927 | 47696 | 1757 | 26684 |
| 12-#18 | 2.94 | MA | 28947 | 6073 | 46175 | 4886 | 55748 | 3917 | 61588 | 3178 | 69797 | 1973 | 87709 | 1536 | 67570 |
| 3L-5S | | MI | 17247 | 6073 | 28769 | 4786 | 33781 | 3826 | 36327 | 3084 | 38976 | 1843 | 48512 | 982 | 41671 |
| 12-#18 | 2.94 | MA | 26951 | 6073 | 43357 | 4888 | 51939 | 3943 | 56972 | 3173 | 63566 | 1961 | 80739 | 1302 | 64735 |
| 4E | | MI | 18480 | 6073 | 30691 | 4765 | 36087 | 3836 | 39118 | 3070 | 42645 | 1830 | 53157 | 1091 | 43511 |
| 12-#18 | 2.94 | MA | 25144 | 6073 | 40507 | 4917 | 48519 | 3941 | 52798 | 3195 | 57883 | 1976 | 73464 | 1184 | 61390 |
| 5L-3S | | MI | 19836 | 6073 | 32585 | 4770 | 38645 | 3819 | 42195 | 3084 | 46668 | 1843 | 57521 | 1321 | 45578 |
| 12-#18 | 2.94 | MA | 23412 | 6073 | 37976 | 4919 | 45144 | 3967 | 48689 | 3191 | 52418 | 1991 | 66081 | 991 | 57138 |
| 6L-2S | | MI | 21684 | 6073 | 35106 | 4775 | 41842 | 3829 | 46047 | 3070 | 51734 | 1830 | 64182 | 1554 | 45907 |
| 14-#11 | 1.34 | MA | 26213 | 5122 | 37423 | 4325 | 44982 | 3513 | 48690 | 2906 | 52495 | 2020 | 64988 | 1920 | 31950 |
| 2L-7S | | MI | 15342 | 5122 | 22869 | 4238 | 26547 | 3445 | 27762 | 2851 | 27834 | 1960 | 33587 | 1437 | 20803 |
| 14-#11 | 1.34 | MA | 25036 | 5122 | 35914 | 4327 | 43067 | 3514 | 46371 | 2915 | 49366 | 2028 | 60711 | 1829 | 31900 |
| 3L-6S | | MI | 15833 | 5122 | 23534 | 4239 | 27425 | 3447 | 28835 | 2845 | 29297 | 1966 | 35287 | 1509 | 21186 |
| 14-#11 | 1.34 | MA | 24190 | 5122 | 34797 | 4329 | 41557 | 3525 | 44540 | 2915 | 46895 | 2025 | 57884 | 1737 | 31777 |
| 4L-5S | | MI | 16335 | 5122 | 24216 | 4239 | 28335 | 3439 | 29942 | 2849 | 30740 | 1960 | 37204 | 1584 | 21733 |
| 14-#11 | 1.34 | MA | 23425 | 5122 | 33668 | 4341 | 40202 | 3525 | 42887 | 2925 | 44643 | 2032 | 54957 | 1690 | 31533 |
| 5L-4S | | MI | 16857 | 5122 | 24983 | 4230 | 29255 | 3441 | 31065 | 2842 | 32240 | 1955 | 39110 | 1628 | 21832 |
| 14-#11 | 1.34 | MA | 22692 | 5122 | 32666 | 4342 | 38866 | 3536 | 41260 | 2924 | 42479 | 2040 | 51970 | 1615 | 30627 |
| 6L-3S | | MI | 17432 | 5122 | 25740 | 4230 | 30278 | 3433 | 32305 | 2846 | 33884 | 1960 | 40911 | 1719 | 21872 |
| 14-#11 | 1.34 | MA | 21975 | 5122 | 31692 | 4344 | 37576 | 3537 | 39683 | 2934 | 40285 | 2037 | 49307 | 1544 | 29916 |
| 7L-2S | | MI | 18219 | 5122 | 26754 | 4231 | 31563 | 3436 | 33862 | 2840 | 35955 | 1955 | 43658 | 1810 | 21877 |
| 14-#14 | 1.93 | MA | 28360 | 5473 | 42113 | 4533 | 50818 | 3664 | 55713 | 2999 | 61935 | 1998 | 77642 | 1872 | 45538 |
| 2L-7S | | MI | 15567 | 5473 | 24341 | 4441 | 28269 | 3592 | 29794 | 2942 | 30473 | 1923 | 37325 | 1191 | 27946 |
| 14-#14 | 1.93 | MA | 26716 | 5473 | 39951 | 4535 | 48076 | 3664 | 52390 | 3012 | 57453 | 2008 | 71547 | 1741 | 45378 |
| 3L-6S | | MI | 16253 | 5473 | 25293 | 4442 | 29527 | 3596 | 31331 | 2933 | 32551 | 1931 | 39729 | 1294 | 29050 |

## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

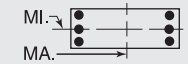
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 1.93 | MA | 25535 | 5473 | 38349 | 4537 | 45909 | 3679 | 49764 | 3011 | 53908 | 2003 | 67522 | 1610 | 45019 |
| 4L-5S | | MI | 16953 | 5473 | 26270 | 4444 | 30829 | 3585 | 32915 | 2940 | 34599 | 1923 | 42443 | 1404 | 29785 |
| 14-#14 | 1.93 | MA | 24468 | 5473 | 36729 | 4554 | 43966 | 3680 | 47391 | 3025 | 50677 | 2013 | 63343 | 1542 | 43601 |
| 5L-4S | | MI | 17683 | 5473 | 27368 | 4430 | 32147 | 3589 | 34522 | 2932 | 36729 | 1916 | 45149 | 1465 | 30725 |
| 14-#14 | 1.93 | MA | 23444 | 5473 | 35292 | 4556 | 42048 | 3695 | 45057 | 3023 | 47572 | 2023 | 59087 | 1433 | 42263 |
| 6L-3S | | MI | 18486 | 5473 | 28451 | 4432 | 33610 | 3578 | 36296 | 2938 | 39064 | 1923 | 47696 | 1596 | 30899 |
| 14-#14 | 1.93 | MA | 22442 | 5473 | 33893 | 4558 | 40196 | 3695 | 42794 | 3037 | 44424 | 2018 | 55295 | 1331 | 40521 |
| 7L-2S | | MI | 19583 | 5473 | 29898 | 4433 | 35445 | 3582 | 38519 | 2930 | 42005 | 1916 | 51585 | 1728 | 30969 |
| 14-#18 | 3.43 | MA | 28694 | 6364 | 47151 | 5070 | 56750 | 4076 | 62800 | 3258 | 71429 | 1948 | 91312 | 1268 | 75495 |
| 4L-5S | | MI | 18385 | 6364 | 31290 | 4968 | 36978 | 3959 | 40178 | 3166 | 44042 | 1819 | 55173 | 922 | 48824 |
| 14-#18 | 3.43 | MA | 26923 | 6364 | 44301 | 5098 | 53330 | 4074 | 58626 | 3279 | 65746 | 1963 | 84038 | 1150 | 72285 |
| 5L-4S | | MI | 19597 | 6364 | 33212 | 4946 | 39284 | 3969 | 42970 | 3153 | 47712 | 1805 | 59818 | 1031 | 50564 |
| 14-#18 | 3.43 | MA | 25224 | 6364 | 41770 | 5100 | 49955 | 4100 | 54517 | 3275 | 60281 | 1978 | 76655 | 958 | 67915 |
| 6L-3S | | MI | 20931 | 6364 | 35106 | 4951 | 41842 | 3952 | 46047 | 3166 | 51734 | 1819 | 64182 | 1261 | 52920 |
| 14-#18 | 3.43 | MA | 23560 | 6364 | 39306 | 5103 | 46694 | 4098 | 50534 | 3297 | 54741 | 1967 | 70086 | 776 | 63421 |
| 7L-2S | | MI | 22752 | 6364 | 37627 | 4956 | 45040 | 3962 | 49898 | 3153 | 56801 | 1805 | 70843 | 1494 | 53319 |
| 16-#11 | 1.53 | MA | 26944 | 5235 | 38932 | 4396 | 46896 | 3565 | 51009 | 2938 | 55624 | 2015 | 69265 | 1910 | 36419 |
| 2L-8S | | MI | 15359 | 5235 | 23228 | 4308 | 26970 | 3495 | 28243 | 2880 | 28494 | 1958 | 34555 | 1368 | 23084 |
| 16-#11 | 1.53 | MA | 25777 | 5235 | 37423 | 4398 | 44982 | 3566 | 48690 | 2948 | 52495 | 2022 | 64988 | 1819 | 36351 |
| 3L-7S | | MI | 15840 | 5235 | 23882 | 4309 | 27832 | 3497 | 29319 | 2884 | 29906 | 1953 | 36334 | 1419 | 23711 |
| 16-#11 | 1.53 | MA | 24939 | 5235 | 36306 | 4399 | 43471 | 3576 | 46860 | 2948 | 50024 | 2020 | 62161 | 1728 | 36208 |
| 4L-6S | | MI | 16327 | 5235 | 24547 | 4310 | 28710 | 3499 | 30392 | 2878 | 31369 | 1958 | 38034 | 1490 | 24082 |
| 16-#11 | 1.53 | MA | 24182 | 5235 | 35177 | 4411 | 42117 | 3577 | 45206 | 2958 | 47772 | 2027 | 59233 | 1680 | 35943 |
| 5E | | MI | 16824 | 5235 | 25229 | 4310 | 29620 | 3491 | 31499 | 2882 | 32811 | 1953 | 39950 | 1566 | 24658 |
| 16-#11 | 1.53 | MA | 23457 | 5235 | 34176 | 4413 | 40781 | 3588 | 43579 | 2957 | 45608 | 2035 | 56246 | 1605 | 34972 |
| 6L-4S | | MI | 17341 | 5235 | 25996 | 4301 | 30540 | 3493 | 32622 | 2875 | 34311 | 1948 | 41857 | 1609 | 24812 |
| 16-#11 | 1.53 | MA | 22747 | 5235 | 33201 | 4415 | 39490 | 3589 | 42002 | 2967 | 43414 | 2032 | 53583 | 1535 | 34279 |
| 7L-3S | | MI | 17912 | 5235 | 26754 | 4301 | 31563 | 3485 | 33862 | 2879 | 35955 | 1953 | 43658 | 1700 | 24869 |
| 16-#11 | 1.53 | MA | 22045 | 5235 | 32242 | 4417 | 38226 | 3589 | 40423 | 2966 | 41298 | 2039 | 50848 | 1480 | 33253 |
| 8L-2S | | MI | 18692 | 5235 | 27767 | 4302 | 32848 | 3487 | 35419 | 2873 | 38027 | 1948 | 46405 | 1791 | 24889 |
| 16-#14 | 2.21 | MA | 27738 | 5637 | 42113 | 4637 | 50818 | 3739 | 55713 | 3060 | 61935 | 2000 | 77642 | 1725 | 51731 |
| 3L-7S | | MI | 16260 | 5637 | 25788 | 4543 | 30104 | 3667 | 32017 | 2989 | 33414 | 1912 | 41214 | 1162 | 32010 |
| 16-#14 | 2.21 | MA | 26572 | 5637 | 40511 | 4639 | 48652 | 3754 | 53087 | 3058 | 58391 | 1995 | 73617 | 1594 | 51339 |
| 4L-6S | | MI | 16938 | 5637 | 26739 | 4544 | 31362 | 3671 | 33554 | 2981 | 35492 | 1919 | 43618 | 1265 | 33186 |
| 16-#14 | 2.21 | MA | 25518 | 5637 | 38892 | 4656 | 46708 | 3755 | 50714 | 3072 | 55160 | 2005 | 69438 | 1526 | 49796 |
| 5E | | MI | 17630 | 5637 | 27717 | 4546 | 32664 | 3660 | 35138 | 2987 | 37541 | 1912 | 46332 | 1375 | 33891 |
| 16-#14 | 2.21 | MA | 24509 | 5637 | 37454 | 4658 | 44791 | 3770 | 48379 | 3071 | 52055 | 2016 | 65182 | 1418 | 48500 |
| 6L-4S | | MI | 18351 | 5637 | 28814 | 4533 | 33982 | 3664 | 36746 | 2979 | 39671 | 1904 | 49039 | 1436 | 34946 |
| 16-#14 | 2.21 | MA | 23520 | 5637 | 36055 | 4660 | 42939 | 3770 | 46116 | 3084 | 48906 | 2011 | 61390 | 1316 | 46693 |
| 7L-3S | | MI | 19145 | 5637 | 29898 | 4534 | 35445 | 3653 | 38519 | 2985 | 42005 | 1912 | 51585 | 1567 | 35150 |
| 16-#14 | 2.21 | MA | 22542 | 5637 | 34678 | 4662 | 41124 | 3771 | 43849 | 3083 | 45869 | 2021 | 57486 | 1237 | 45030 |
| 8L-2S | | MI | 20232 | 5637 | 31345 | 4536 | 37280 | 3657 | 40742 | 2977 | 44947 | 1904 | 55475 | 1699 | 35245 |
| 16-#18 | 3.92 | MA | 28664 | 6654 | 48094 | 5280 | 58140 | 4207 | 64454 | 3364 | 73609 | 1950 | 94611 | 1117 | 83198 |
| 5E | | MI | 19501 | 6654 | 33811 | 5150 | 40175 | 4092 | 44029 | 3249 | 49109 | 1794 | 61834 | 862 | 55852 |
| 16-#18 | 3.92 | MA | 26997 | 6654 | 45563 | 5282 | 54765 | 4233 | 60345 | 3359 | 68144 | 1965 | 87229 | 924 | 78714 |
| 6L-4S | | MI | 20694 | 6654 | 35733 | 5128 | 42482 | 4102 | 46821 | 3236 | 52778 | 1781 | 66479 | 971 | 57646 |
| 16-#18 | 3.92 | MA | 25364 | 6654 | 43099 | 5284 | 51505 | 4231 | 56362 | 3381 | 62604 | 1953 | 80660 | 742 | 74161 |
| 7L-3S | | MI | 22008 | 6654 | 37627 | 5133 | 45040 | 4085 | 49898 | 3249 | 56801 | 1794 | 70843 | 1201 | 60255 |
| 16-#18 | 3.92 | MA | 23748 | 6654 | 40674 | 5287 | 48310 | 4230 | 52371 | 3376 | 57258 | 1968 | 73866 | 606 | 69476 |
| 8L-2S | | MI | 23804 | 6654 | 40148 | 5138 | 48237 | 4095 | 53749 | 3236 | 61868 | 1781 | 77504 | 1435 | 60719 |
| 18-#11 | 1.72 | MA | 26509 | 5349 | 38932 | 4469 | 46896 | 3617 | 51009 | 2981 | 55624 | 2017 | 69265 | 1809 | 40799 |
| 3L-8S | | MI | 15855 | 5349 | 24241 | 4379 | 28255 | 3546 | 29800 | 2913 | 30566 | 1951 | 37301 | 1350 | 25949 |
| 18-#11 | 1.72 | MA | 25679 | 5349 | 37815 | 4470 | 45385 | 3628 | 49179 | 2981 | 53153 | 2014 | 66438 | 1718 | 40637 |
| 4L-7S | | MI | 16332 | 5349 | 24895 | 4380 | 29117 | 3549 | 30875 | 2917 | 31977 | 1946 | 39080 | 1400 | 26623 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis

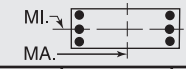



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.72 | MA | 24929 | 5349 | 36687 | 4482 | 44031 | 3629 | 47525 | 2990 | 50901 | 2022 | 63510 | 1670 | 40327 |
| 5L-6S | | MI | 16814 | 5349 | 25560 | 4380 | 29995 | 3551 | 31949 | 2911 | 33440 | 1951 | 40780 | 1472 | 26984 |
| 18-#11 | 1.72 | MA | 24211 | 5349 | 35685 | 4484 | 42695 | 3640 | 45898 | 2990 | 48737 | 2029 | 60523 | 1595 | 39323 |
| 6L-5S | | MI | 17307 | 5349 | 26242 | 4381 | 30905 | 3543 | 33055 | 2914 | 34883 | 1946 | 42697 | 1547 | 27534 |
| 18-#11 | 1.72 | MA | 23508 | 5349 | 34711 | 4486 | 41404 | 3640 | 44321 | 3000 | 46543 | 2027 | 57860 | 1525 | 38647 |
| 7L-4S | | MI | 17820 | 5349 | 27010 | 4371 | 31825 | 3545 | 34179 | 2908 | 36383 | 1941 | 44603 | 1591 | 27787 |
| 18-#11 | 1.72 | MA | 22813 | 5349 | 33752 | 4488 | 40140 | 3641 | 42742 | 2999 | 44427 | 2034 | 55125 | 1470 | 37578 |
| 8L-3S | | MI | 18385 | 5349 | 27767 | 4372 | 32848 | 3537 | 35419 | 2912 | 38027 | 1946 | 46405 | 1682 | 27860 |
| 18-#11 | 1.72 | MA | 22123 | 5349 | 32692 | 4500 | 38838 | 3652 | 41188 | 3009 | 42332 | 2042 | 52411 | 1411 | 36603 |
| 9L-2S | | MI | 19160 | 5349 | 28780 | 4373 | 34133 | 3539 | 36975 | 2906 | 40098 | 1941 | 49151 | 1773 | 27892 |
| 18-#14 | 2.48 | MA | 27592 | 5800 | 42674 | 4741 | 51394 | 3829 | 56409 | 3106 | 62874 | 1988 | 79711 | 1578 | 57658 |
| 4L-7S | | MI | 16942 | 5800 | 27234 | 4645 | 31939 | 3742 | 34240 | 3037 | 36356 | 1900 | 45103 | 1133 | 36084 |
| 18-#14 | 2.48 | MA | 26552 | 5800 | 41054 | 4758 | 49451 | 3829 | 54037 | 3119 | 59643 | 1998 | 75532 | 1510 | 56003 |
| 5L-6S | | MI | 17613 | 5800 | 28186 | 4647 | 33197 | 3746 | 35777 | 3028 | 38434 | 1908 | 47507 | 1236 | 37329 |
| 18-#14 | 2.48 | MA | 25556 | 5800 | 39617 | 4760 | 47533 | 3845 | 51702 | 3118 | 56537 | 2008 | 71276 | 1402 | 54746 |
| 6L-5S | | MI | 18297 | 5800 | 29163 | 4648 | 34499 | 3735 | 37361 | 3035 | 40482 | 1900 | 50221 | 1346 | 38008 |
| 18-#14 | 2.48 | MA | 24580 | 5800 | 38218 | 4762 | 45681 | 3845 | 49439 | 3132 | 53389 | 2003 | 67484 | 1300 | 52874 |
| 7L-4S | | MI | 19011 | 5800 | 30261 | 4635 | 35817 | 3739 | 38969 | 3026 | 42612 | 1893 | 52928 | 1407 | 39163 |
| 18-#14 | 2.48 | MA | 23615 | 5800 | 36841 | 4764 | 43867 | 3845 | 47172 | 3130 | 50352 | 2013 | 63581 | 1222 | 51176 |
| 8L-3S | | MI | 19796 | 5800 | 31345 | 4636 | 37280 | 3728 | 40742 | 3033 | 44947 | 1900 | 55475 | 1538 | 39396 |
| 18-#14 | 2.48 | MA | 22656 | 5800 | 35320 | 4781 | 41997 | 3861 | 44942 | 3144 | 47345 | 2023 | 59714 | 1137 | 48842 |
| 9L-2S | | MI | 20872 | 5800 | 32792 | 4638 | 39115 | 3732 | 42965 | 3024 | 47888 | 1893 | 59364 | 1670 | 39515 |
| 18-#18 | 4.41 | MA | 28735 | 6945 | 49356 | 5464 | 59576 | 4366 | 66173 | 3443 | 76007 | 1952 | 97802 | 891 | 89532 |
| 6L-5S | | MI | 20600 | 6945 | 36332 | 5331 | 43372 | 4225 | 47880 | 3331 | 54176 | 1769 | 68495 | 803 | 62804 |
| 18-#18 | 4.41 | MA | 27132 | 6945 | 46892 | 5466 | 56315 | 4364 | 62190 | 3465 | 70467 | 1940 | 91233 | 709 | 84917 |
| 7L-4S | | MI | 21774 | 6945 | 38254 | 5310 | 45679 | 4235 | 50672 | 3318 | 57845 | 1756 | 73140 | 911 | 64754 |
| 18-#18 | 4.41 | MA | 25546 | 6945 | 44467 | 5468 | 53120 | 4363 | 58199 | 3461 | 65121 | 1955 | 84439 | 572 | 80195 |
| 8L-3S | | MI | 23069 | 6945 | 40148 | 5315 | 48237 | 4218 | 53749 | 3331 | 61868 | 1769 | 77504 | 1141 | 67587 |
| 20-#11 | 1.91 | MA | 26409 | 5462 | 39325 | 4541 | 47300 | 3680 | 51498 | 3013 | 56281 | 2009 | 70714 | 1708 | 45065 |
| 4L-8S | | MI | 16345 | 5462 | 25254 | 4450 | 29540 | 3598 | 31357 | 2946 | 32637 | 1944 | 40048 | 1332 | 28821 |
| 20-#11 | 1.91 | MA | 25667 | 5462 | 38196 | 4553 | 45945 | 3681 | 49844 | 3023 | 54030 | 2017 | 67787 | 1660 | 44653 |
| 5L-7S | | MI | 16817 | 5462 | 25909 | 4451 | 30401 | 3601 | 32432 | 2950 | 34048 | 1939 | 41827 | 1382 | 29539 |
| 20-#11 | 1.91 | MA | 24956 | 5462 | 37194 | 4555 | 44609 | 3692 | 48217 | 3023 | 51865 | 2024 | 64800 | 1586 | 43680 |
| 6E | | MI | 17296 | 5462 | 26573 | 4451 | 31280 | 3603 | 33506 | 2943 | 35511 | 1944 | 43527 | 1453 | 29891 |
| 20-#11 | 1.91 | MA | 24260 | 5462 | 36220 | 4557 | 43319 | 3692 | 46641 | 3032 | 49672 | 2022 | 62137 | 1515 | 43018 |
| 7L-5S | | MI | 17784 | 5462 | 27256 | 4452 | 32190 | 3595 | 34612 | 2947 | 36954 | 1939 | 45443 | 1529 | 30419 |
| 20-#11 | 1.91 | MA | 23572 | 5462 | 35261 | 4558 | 42055 | 3693 | 45061 | 3032 | 47556 | 2029 | 59402 | 1460 | 41908 |
| 8L-4S | | MI | 18293 | 5462 | 28023 | 4442 | 33110 | 3597 | 35736 | 2941 | 38454 | 1934 | 47350 | 1572 | 30759 |
| 20-#11 | 1.91 | MA | 22889 | 5462 | 34201 | 4570 | 40752 | 3704 | 43507 | 3042 | 45461 | 2037 | 56687 | 1402 | 40953 |
| 9L-3S | | MI | 18854 | 5462 | 28780 | 4443 | 34133 | 3589 | 36975 | 2945 | 40098 | 1939 | 49151 | 1663 | 30846 |
| 20-#11 | 1.91 | MA | 22204 | 5462 | 33246 | 4572 | 39497 | 3704 | 41946 | 3041 | 43306 | 2034 | 53882 | 1322 | 39577 |
| 10L-2S | | MI | 19623 | 5462 | 29793 | 4444 | 35418 | 3591 | 38532 | 2938 | 42169 | 1934 | 51898 | 1755 | 30890 |
| 20-#14 | 2.76 | MA | 27571 | 5964 | 43217 | 4860 | 52193 | 3904 | 57359 | 3167 | 64126 | 1991 | 81627 | 1495 | 62220 |
| 5L-7S | | MI | 17616 | 5964 | 28681 | 4747 | 33774 | 3816 | 36463 | 3084 | 39297 | 1889 | 48993 | 1104 | 40168 |
| 20-#14 | 2.76 | MA | 26587 | 5964 | 41779 | 4862 | 50276 | 3919 | 55025 | 3165 | 61020 | 2001 | 77371 | 1387 | 60997 |
| 6E | | MI | 18279 | 5964 | 29633 | 4749 | 35032 | 3820 | 38000 | 3076 | 41375 | 1896 | 51397 | 1207 | 41464 |
| 20-#14 | 2.76 | MA | 25623 | 5964 | 40380 | 4864 | 48424 | 3920 | 52762 | 3179 | 57872 | 1996 | 73579 | 1284 | 59065 |
| 7L-5S | | MI | 18956 | 5964 | 30610 | 4750 | 36334 | 3810 | 39584 | 3082 | 43423 | 1889 | 54111 | 1317 | 42134 |
| 20-#14 | 2.76 | MA | 24671 | 5964 | 39003 | 4867 | 46609 | 3920 | 50494 | 3178 | 54835 | 2006 | 69675 | 1206 | 57325 |
| 8L-4S | | MI | 19661 | 5964 | 31708 | 4737 | 37652 | 3814 | 41192 | 3074 | 45553 | 1881 | 56817 | 1378 | 43347 |
| 20-#14 | 2.76 | MA | 23724 | 5964 | 37482 | 4884 | 44739 | 3935 | 48264 | 3191 | 51828 | 2016 | 65809 | 1122 | 55035 |
| 9L-3S | | MI | 20439 | 5964 | 32792 | 4739 | 39115 | 3803 | 42965 | 3080 | 47888 | 1889 | 59364 | 1509 | 43637 |
| 20-#14 | 2.76 | MA | 22768 | 5964 | 36111 | 4886 | 42937 | 3936 | 46023 | 3190 | 48735 | 2011 | 61812 | 1006 | 52656 |
| 10L-2S | | MI | 21505 | 5964 | 34238 | 4740 | 40950 | 3807 | 45188 | 3072 | 50829 | 1881 | 63253 | 1641 | 43778 |
| 20-#18 | 4.90 | MA | 28868 | 7236 | 50686 | 5648 | 61126 | 4497 | 68018 | 3549 | 78330 | 1927 | 101807 | 676 | 95690 |
| 7L-5S | | MI | 21682 | 7236 | 38853 | 5513 | 46570 | 4358 | 51732 | 3414 | 59242 | 1744 | 75156 | 743 | 69782 |
| 20-#18 | 4.90 | MA | 27309 | 7236 | 48260 | 5650 | 57931 | 4496 | 64027 | 3545 | 72984 | 1942 | 95013 | 539 | 90927 |
| 8L-4S | | MI | 22840 | 7236 | 40775 | 5492 | 48876 | 4368 | 54523 | 3401 | 62912 | 1731 | 79801 | 851 | 71884 |

## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

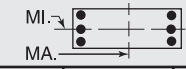
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.10 | MA | 26396 | 5576 | 39705 | 4624 | 47859 | 3733 | 52163 | 3056 | 57158 | 2012 | 72064 | 1651 | 48986 |
| 5L-8S | | MI | 16829 | 5576 | 26267 | 4521 | 30825 | 3650 | 32913 | 2979 | 34708 | 1937 | 42794 | 1313 | 31698 |
| 22-#11 | 2.10 | MA | 25691 | 5576 | 38704 | 4626 | 46523 | 3744 | 50536 | 3056 | 54994 | 2019 | 69077 | 1576 | 48042 |
| 6L-7S | | MI | 17298 | 5576 | 26922 | 4522 | 31686 | 3652 | 33989 | 2983 | 36120 | 1932 | 44574 | 1364 | 32405 |
| 22-#11 | 2.10 | MA | 25002 | 5576 | 37729 | 4628 | 45233 | 3744 | 48960 | 3065 | 52801 | 2016 | 66414 | 1505 | 47393 |
| 7L-6S | | MI | 17772 | 5576 | 27587 | 4522 | 32565 | 3655 | 35062 | 2976 | 37583 | 1937 | 46273 | 1435 | 32801 |
| 22-#11 | 2.10 | MA | 24321 | 5576 | 36770 | 4629 | 43969 | 3745 | 47380 | 3065 | 50685 | 2024 | 63679 | 1450 | 46244 |
| 8L-5S | | MI | 18257 | 5576 | 28269 | 4523 | 33475 | 3647 | 36169 | 2980 | 39025 | 1932 | 48190 | 1510 | 33309 |
| 22-#11 | 2.10 | MA | 23645 | 5576 | 35711 | 4641 | 42666 | 3756 | 45826 | 3075 | 48589 | 2031 | 60964 | 1392 | 45298 |
| 9L-4S | | MI | 18762 | 5576 | 29036 | 4513 | 34395 | 3649 | 37292 | 2974 | 40525 | 1926 | 50096 | 1554 | 33729 |
| 22-#11 | 2.10 | MA | 22962 | 5576 | 34755 | 4643 | 41411 | 3756 | 44265 | 3074 | 46435 | 2029 | 58159 | 1312 | 43906 |
| 10L-3S | | MI | 19318 | 5576 | 29793 | 4514 | 35418 | 3641 | 38532 | 2978 | 42169 | 1932 | 51898 | 1645 | 33829 |
| 22-#11 | 2.10 | MA | 22225 | 5576 | 33807 | 4645 | 40123 | 3767 | 42721 | 3084 | 44349 | 2036 | 55470 | 1254 | 42581 |
| 11L-2S | | MI | 20081 | 5576 | 30806 | 4514 | 36703 | 3643 | 40089 | 2971 | 44240 | 1926 | 54644 | 1736 | 33885 |
| 22-#14 | 3.03 | MA | 27604 | 6127 | 43942 | 4965 | 53018 | 3994 | 58347 | 3213 | 65503 | 1993 | 83465 | 1371 | 67255 |
| 6L-7S | | MI | 18280 | 6127 | 30128 | 4850 | 35609 | 3891 | 38686 | 3131 | 42238 | 1877 | 52882 | 1075 | 44261 |
| 22-#14 | 3.03 | MA | 26652 | 6127 | 42543 | 4967 | 51166 | 3995 | 56084 | 3226 | 62355 | 1988 | 79673 | 1269 | 65263 |
| 7L-6S | | MI | 18936 | 6127 | 31080 | 4851 | 36867 | 3895 | 40223 | 3123 | 44316 | 1884 | 55286 | 1178 | 45514 |
| 22-#14 | 3.03 | MA | 25711 | 6127 | 41166 | 4969 | 49352 | 3995 | 53817 | 3225 | 59318 | 1998 | 75770 | 1190 | 63481 |
| 8L-5S | | MI | 19606 | 6127 | 32057 | 4853 | 38169 | 3884 | 41807 | 3129 | 46365 | 1877 | 58000 | 1288 | 46268 |
| 22-#14 | 3.03 | MA | 24776 | 6127 | 39645 | 4986 | 47482 | 4010 | 51587 | 3238 | 56310 | 2008 | 71903 | 1106 | 61233 |
| 9L-4S | | MI | 20304 | 6127 | 33155 | 4839 | 39487 | 3888 | 43415 | 3121 | 48495 | 1870 | 60707 | 1349 | 47430 |
| 22-#14 | 3.03 | MA | 23824 | 6127 | 38273 | 4988 | 45680 | 4011 | 49346 | 3237 | 53218 | 2004 | 67906 | 991 | 58829 |
| 10L-3S | | MI | 21074 | 6127 | 34238 | 4841 | 40950 | 3877 | 45188 | 3128 | 50829 | 1877 | 63253 | 1481 | 47874 |
| 22-#18 | 5.39 | MA | 29042 | 7527 | 52053 | 5832 | 62742 | 4629 | 69855 | 3629 | 80847 | 1929 | 105587 | 506 | 101674 |
| 8L-5S | | MI | 22838 | 7527 | 41374 | 5695 | 49767 | 4491 | 55583 | 3497 | 64309 | 1720 | 81817 | 683 | 76784 |
| 24-#11 | 2.29 | MA | 26419 | 5689 | 40213 | 4697 | 48437 | 3795 | 52855 | 3088 | 58123 | 2014 | 73354 | 1566 | 52408 |
| 6L-8S | | MI | 17309 | 5689 | 27281 | 4592 | 32110 | 3702 | 34470 | 3012 | 36780 | 1930 | 45541 | 1295 | 34580 |
| 24-#11 | 2.29 | MA | 25736 | 5689 | 39239 | 4698 | 47147 | 3796 | 51279 | 3098 | 55930 | 2011 | 70691 | 1495 | 51771 |
| 7E | | MI | 17774 | 5689 | 27935 | 4592 | 32971 | 3704 | 35546 | 3016 | 38191 | 1924 | 47320 | 1345 | 35266 |
| 24-#11 | 2.29 | MA | 25061 | 5689 | 38280 | 4700 | 45883 | 3797 | 49699 | 3098 | 53813 | 2019 | 67956 | 1440 | 50584 |
| 8L-6S | | MI | 18244 | 5689 | 28600 | 4593 | 33850 | 3707 | 36619 | 3009 | 39654 | 1930 | 49020 | 1416 | 35716 |
| 24-#11 | 2.29 | MA | 24391 | 5689 | 37220 | 4712 | 44580 | 3808 | 48145 | 3107 | 51718 | 2026 | 65241 | 1382 | 49608 |
| 9L-5S | | MI | 18724 | 5689 | 29282 | 4594 | 34760 | 3698 | 37726 | 3013 | 41097 | 1924 | 50937 | 1492 | 36206 |
| 24-#11 | 2.29 | MA | 23711 | 5689 | 36265 | 4714 | 43325 | 3808 | 46584 | 3107 | 49564 | 2023 | 62435 | 1302 | 48240 |
| 10L-4S | | MI | 19225 | 5689 | 30049 | 4584 | 35680 | 3701 | 38849 | 3007 | 42597 | 1919 | 52843 | 1535 | 36696 |
| 24-#11 | 2.29 | MA | 22995 | 5689 | 35316 | 4716 | 42037 | 3819 | 45040 | 3117 | 47477 | 2031 | 59747 | 1244 | 46895 |
| 11L-3S | | MI | 19777 | 5689 | 30806 | 4585 | 36703 | 3693 | 40089 | 3010 | 44240 | 1924 | 54644 | 1626 | 36809 |
| 24-#11 | 2.29 | MA | 22271 | 5689 | 34373 | 4717 | 40786 | 3820 | 43488 | 3116 | 45341 | 2028 | 57054 | 1187 | 45510 |
| 12L-2S | | MI | 20536 | 5689 | 31820 | 4585 | 37988 | 3695 | 41646 | 3004 | 46312 | 1919 | 57391 | 1718 | 36876 |
| 24-#14 | 3.31 | MA | 27667 | 6291 | 44705 | 5069 | 53909 | 4069 | 59407 | 3274 | 66838 | 1981 | 85768 | 1253 | 71469 |
| 7E | | MI | 18936 | 6291 | 31575 | 4952 | 37444 | 3966 | 40909 | 3179 | 45180 | 1865 | 56771 | 1046 | 48362 |
| 24-#14 | 3.31 | MA | 26737 | 6291 | 43328 | 5071 | 52094 | 4070 | 57140 | 3272 | 63800 | 1991 | 81864 | 1175 | 69646 |
| 8L-6S | | MI | 19586 | 6291 | 32527 | 4953 | 38702 | 3970 | 42446 | 3170 | 47258 | 1873 | 59175 | 1149 | 49576 |
| 24-#14 | 3.31 | MA | 25813 | 6291 | 41807 | 5088 | 50224 | 4085 | 54909 | 3286 | 60793 | 2001 | 77998 | 1090 | 67438 |
| 9L-5S | | MI | 20249 | 6291 | 33504 | 4955 | 40004 | 3959 | 44030 | 3177 | 49306 | 1865 | 61889 | 1259 | 50409 |
| 24-#14 | 3.31 | MA | 24865 | 6291 | 40436 | 5090 | 48423 | 4085 | 52669 | 3284 | 57701 | 1996 | 74001 | 975 | 65008 |
| 10L-4S | | MI | 20940 | 6291 | 34602 | 4942 | 41322 | 3963 | 45638 | 3168 | 51436 | 1858 | 64596 | 1320 | 51524 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

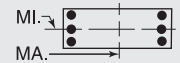
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.04 | MA | 14696 | 3928 | 21168 | 3274 | 24867 | 2666 | 26450 | 2216 | 27552 | 1563 | 33161 | 1462 | 14462 |
| 2L-3S | | MI | 13479 | 3928 | 19619 | 3273 | 22902 | 2663 | 24070 | 2225 | 24383 | 1570 | 28957 | 1330 | 14472 |
| 6-#18 | 1.85 | MA | 16258 | 4309 | 24800 | 3487 | 29305 | 2819 | 31756 | 2309 | 34393 | 1514 | 42090 | 1364 | 24893 |
| 2L-3S | | MI | 14202 | 4309 | 22097 | 3484 | 25878 | 2811 | 27603 | 2322 | 28922 | 1527 | 34872 | 1130 | 24666 |
| 8-#14 | 1.39 | MA | 15431 | 4091 | 22717 | 3376 | 26832 | 2740 | 28831 | 2263 | 30721 | 1553 | 37364 | 1435 | 19080 |
| 2L-4S | | MI | 13353 | 4091 | 20011 | 3375 | 23303 | 2749 | 24555 | 2267 | 25037 | 1553 | 30403 | 1172 | 18851 |
| 8-#18 | 2.47 | MA | 17459 | 4600 | 27502 | 3669 | 32733 | 2952 | 35908 | 2393 | 39863 | 1491 | 49308 | 1309 | 32878 |
| 2L-4S | | MI | 13975 | 4600 | 22773 | 3662 | 26568 | 2963 | 28439 | 2394 | 30050 | 1491 | 37369 | 842 | 30013 |
| 10-#11 | 1.20 | MA | 15086 | 4004 | 21854 | 3334 | 25821 | 2711 | 27643 | 2247 | 29223 | 1569 | 35430 | 1463 | 16707 |
| 2L-5S | | MI | 13060 | 4004 | 19142 | 3344 | 22371 | 2716 | 23454 | 2258 | 23610 | 1574 | 28466 | 1237 | 16383 |
| 10-#11 | 1.20 | MA | 14239 | 4004 | 20770 | 3334 | 24447 | 2709 | 25978 | 2254 | 26993 | 1574 | 32466 | 1372 | 16702 |
| 3L-4S | | MI | 13621 | 4004 | 19961 | 3334 | 23354 | 2718 | 24654 | 2251 | 25224 | 1569 | 30518 | 1281 | 16641 |
| 10-#14 | 1.74 | MA | 16150 | 4255 | 24266 | 3479 | 28796 | 2815 | 31211 | 2311 | 33890 | 1542 | 41567 | 1409 | 23675 |
| 2L-5S | | MI | 13317 | 4255 | 20387 | 3491 | 23861 | 2821 | 25218 | 2324 | 25911 | 1550 | 31690 | 1083 | 22101 |
| 10-#14 | 1.74 | MA | 14966 | 4255 | 22717 | 3478 | 26832 | 2812 | 28831 | 2320 | 30721 | 1550 | 37364 | 1278 | 23599 |
| 3L-4S | | MI | 14102 | 4255 | 21560 | 3477 | 25268 | 2824 | 26936 | 2314 | 28206 | 1542 | 34607 | 1146 | 23357 |
| 10-#18 | 3.09 | MA | 18629 | 4891 | 30205 | 3851 | 36161 | 3085 | 40061 | 2477 | 45334 | 1469 | 56526 | 1254 | 40837 |
| 2L-5S | | MI | 13908 | 4891 | 23422 | 3867 | 27530 | 3087 | 29584 | 2492 | 31559 | 1483 | 39553 | 680 | 35191 |
| 10-#18 | 3.09 | MA | 16657 | 4891 | 27502 | 3847 | 32733 | 3077 | 35908 | 2491 | 39863 | 1483 | 49308 | 1021 | 40391 |
| 3L-4S | | MI | 15217 | 4891 | 25476 | 3844 | 29996 | 3096 | 32592 | 2478 | 35521 | 1469 | 44586 | 787 | 37546 |

## RECTANGULAR TIED COLUMNS 36" x 38"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.17 | MA | 16639 | 4210 | 24256 | 3485 | 28479 | 2834 | 30374 | 2350 | 31826 | 1636 | 38396 | 1520 | 17937 |
| 2E | | MI | 15711 | 4210 | 23024 | 3469 | 26934 | 2821 | 28675 | 2339 | 29921 | 1624 | 36007 | 1503 | 16896 |
| 6-#18 | 1.75 | MA | 17979 | 4500 | 27141 | 3666 | 32138 | 2967 | 34805 | 2434 | 37701 | 1617 | 46171 | 1470 | 26513 |
| 2L-3S | | MI | 14894 | 4500 | 23024 | 3647 | 26934 | 2946 | 28675 | 2437 | 29921 | 1615 | 36007 | 1215 | 24749 |
| 6-#18 | 1.75 | MA | 15776 | 4500 | 24256 | 3664 | 28479 | 2960 | 30374 | 2449 | 31826 | 1630 | 38396 | 1237 | 26286 |
| 3L-2S | | MI | 16957 | 4500 | 25727 | 3651 | 30362 | 2954 | 32828 | 2423 | 35392 | 1601 | 43225 | 1449 | 24941 |
| 8-#14 | 1.32 | MA | 17079 | 4282 | 24909 | 3555 | 29486 | 2888 | 31670 | 2388 | 33730 | 1653 | 41036 | 1537 | 20295 |
| 2L-4S | | MI | 14042 | 4282 | 20929 | 3540 | 24357 | 2885 | 25628 | 2382 | 26039 | 1641 | 31545 | 1258 | 18929 |
| 8-#14 | 1.32 | MA | 15795 | 4282 | 23258 | 3555 | 27392 | 2885 | 29133 | 2399 | 30333 | 1661 | 36518 | 1406 | 20258 |
| 3E | | MI | 14923 | 4282 | 22086 | 3540 | 25921 | 2873 | 27523 | 2388 | 28554 | 1649 | 34302 | 1389 | 19091 |
| 8-#14 | 1.32 | MA | 14858 | 4282 | 22027 | 3555 | 25727 | 2898 | 27116 | 2394 | 27637 | 1653 | 33550 | 1275 | 20066 |
| 4L-2S | | MI | 16126 | 4282 | 23635 | 3541 | 27886 | 2876 | 29903 | 2378 | 31723 | 1641 | 38506 | 1521 | 19115 |
| 8-#18 | 2.34 | MA | 19276 | 4791 | 30025 | 3848 | 35796 | 3100 | 39237 | 2518 | 43576 | 1597 | 53947 | 1420 | 35038 |
| 2L-4S | | MI | 14665 | 4791 | 23701 | 3825 | 27625 | 3097 | 29512 | 2508 | 31049 | 1579 | 38504 | 927 | 30343 |
| 8-#18 | 2.34 | MA | 17120 | 4791 | 27141 | 3846 | 32138 | 3093 | 34805 | 2533 | 37701 | 1610 | 46171 | 1187 | 34693 |
| 3E | | MI | 16145 | 4791 | 25727 | 3829 | 30362 | 3079 | 32828 | 2521 | 35392 | 1593 | 43225 | 1160 | 32626 |
| 8-#18 | 2.34 | MA | 15546 | 4791 | 24983 | 3843 | 29222 | 3113 | 31272 | 2522 | 33038 | 1597 | 41077 | 953 | 32253 |
| 4L-2S | | MI | 18165 | 4791 | 28430 | 3833 | 33790 | 3087 | 36980 | 2507 | 40862 | 1579 | 50443 | 1394 | 32933 |
| 10-#11 | 1.14 | MA | 16704 | 4195 | 23985 | 3513 | 28404 | 2858 | 30399 | 2372 | 32112 | 1669 | 38938 | 1564 | 17760 |
| 2L-5S | | MI | 13748 | 4195 | 20055 | 3510 | 23424 | 2852 | 24527 | 2373 | 24614 | 1663 | 29611 | 1323 | 16543 |
| 10-#11 | 1.14 | MA | 15798 | 4195 | 22830 | 3514 | 26940 | 2857 | 28624 | 2379 | 29725 | 1674 | 35755 | 1473 | 17755 |
| 3L-4S | | MI | 14311 | 4195 | 20874 | 3500 | 24406 | 2854 | 25727 | 2366 | 26228 | 1658 | 31663 | 1367 | 16692 |
| 10-#11 | 1.14 | MA | 15139 | 4195 | 21970 | 3514 | 25777 | 2866 | 27216 | 2377 | 27830 | 1669 | 33662 | 1382 | 17694 |
| 4L-3S | | MI | 14930 | 4195 | 21683 | 3500 | 25499 | 2846 | 27051 | 2370 | 27997 | 1663 | 33610 | 1458 | 16739 |
| 10-#11 | 1.14 | MA | 14542 | 4195 | 21099 | 3525 | 24732 | 2865 | 25940 | 2384 | 26101 | 1674 | 31464 | 1337 | 17520 |
| 5L-2S | | MI | 15780 | 4195 | 22767 | 3500 | 26874 | 2847 | 28716 | 2362 | 30227 | 1658 | 36575 | 1549 | 16737 |
| 10-#14 | 1.64 | MA | 17854 | 4446 | 26561 | 3658 | 31581 | 2963 | 34207 | 2436 | 37126 | 1644 | 45554 | 1513 | 25194 |
| 2L-5S | | MI | 14005 | 4446 | 21305 | 3656 | 24915 | 2956 | 26291 | 2439 | 26913 | 1638 | 32832 | 1169 | 22301 |
| 10-#14 | 1.64 | MA | 16587 | 4446 | 24909 | 3657 | 29486 | 2960 | 31670 | 2446 | 33730 | 1652 | 41036 | 1382 | 25118 |
| 3L-4S | | MI | 14793 | 4446 | 22478 | 3642 | 26322 | 2959 | 28008 | 2430 | 29208 | 1631 | 35748 | 1232 | 23441 |
| 10-#14 | 1.64 | MA | 15664 | 4446 | 23678 | 3657 | 27822 | 2973 | 29653 | 2441 | 31034 | 1644 | 38068 | 1251 | 24876 |
| 4L-3S | | MI | 15661 | 4446 | 23635 | 3643 | 27886 | 2948 | 29903 | 2435 | 31723 | 1638 | 38506 | 1363 | 23653 |

## RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

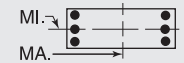
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.64 | MA | 14827 | 4446 | 22431 | 3672 | 26325 | 2970 | 27827 | 2452 | 28574 | 1652 | 34941 | 1187 | 23645 |
| 5L-2S | | MI | 16849 | 4446 | 25184 | 3643 | 29850 | 2951 | 32284 | 2426 | 34892 | 1631 | 42709 | 1495 | 23716 |
| 10-#18 | 2.92 | MA | 20540 | 5082 | 32910 | 4030 | 39454 | 3233 | 43669 | 2602 | 49450 | 1577 | 61722 | 1370 | 43537 |
| 2L-5S | | MI | 14595 | 5082 | 24349 | 4030 | 28587 | 3222 | 30656 | 2606 | 32558 | 1570 | 40689 | 765 | 35720 |
| 10-#18 | 2.92 | MA | 18426 | 5082 | 30025 | 4028 | 35796 | 3226 | 39237 | 2618 | 43576 | 1590 | 53947 | 1137 | 43091 |
| 3L-4S | | MI | 15911 | 5082 | 26403 | 4007 | 31053 | 3230 | 33664 | 2592 | 36520 | 1557 | 45722 | 872 | 37867 |
| 10-#18 | 2.92 | MA | 16885 | 5082 | 27867 | 4025 | 32880 | 3246 | 35704 | 2607 | 38913 | 1577 | 48853 | 903 | 40306 |
| 4L-3S | | MI | 17360 | 5082 | 28430 | 4011 | 33790 | 3212 | 36980 | 2605 | 40862 | 1570 | 50443 | 1106 | 40492 |
| 10-#18 | 2.92 | MA | 15487 | 5082 | 25680 | 4049 | 30255 | 3239 | 32501 | 2622 | 34658 | 1590 | 43446 | 793 | 38009 |
| 5L-2S | | MI | 19342 | 5082 | 31132 | 4014 | 37218 | 3220 | 41133 | 2591 | 46333 | 1557 | 57661 | 1339 | 40897 |
| 12-#11 | 1.37 | MA | 17257 | 4308 | 25140 | 3584 | 29869 | 2910 | 32173 | 2405 | 34499 | 1663 | 42121 | 1549 | 21194 |
| 2L-6S | | MI | 13751 | 4308 | 20411 | 3581 | 23828 | 2913 | 25012 | 2403 | 25291 | 1662 | 30506 | 1231 | 18946 |
| 12-#11 | 1.37 | MA | 16360 | 4308 | 23985 | 3585 | 28404 | 2909 | 30399 | 2412 | 32112 | 1668 | 38938 | 1458 | 21168 |
| 3L-5S | | MI | 14285 | 4308 | 21139 | 3581 | 24799 | 2904 | 26193 | 2406 | 26843 | 1656 | 32576 | 1306 | 19598 |
| 12-#11 | 1.37 | MA | 15709 | 4308 | 23125 | 3585 | 27242 | 2918 | 28990 | 2410 | 30218 | 1663 | 36844 | 1366 | 21083 |
| 4E | | MI | 14841 | 4308 | 21958 | 3571 | 25781 | 2906 | 27392 | 2399 | 28458 | 1651 | 34628 | 1350 | 19875 |
| 12-#11 | 1.37 | MA | 15118 | 4308 | 22254 | 3595 | 26197 | 2917 | 27715 | 2417 | 28489 | 1668 | 34647 | 1321 | 20781 |
| 5L-3S | | MI | 15454 | 4308 | 22767 | 3571 | 26874 | 2897 | 28716 | 2402 | 30227 | 1656 | 36575 | 1442 | 19946 |
| 12-#11 | 1.37 | MA | 14551 | 4308 | 21481 | 3596 | 25166 | 2926 | 26460 | 2415 | 26826 | 1673 | 32425 | 1246 | 20065 |
| 6L-2S | | MI | 16296 | 4308 | 23851 | 3571 | 28249 | 2899 | 30382 | 2395 | 32456 | 1651 | 39539 | 1533 | 19965 |
| 12-#14 | 1.97 | MA | 18614 | 4609 | 28212 | 3760 | 33675 | 3037 | 36745 | 2483 | 40523 | 1635 | 50071 | 1489 | 30079 |
| 2L-6S | | MI | 14007 | 4609 | 21811 | 3757 | 25489 | 3043 | 26980 | 2481 | 27875 | 1636 | 34102 | 1034 | 25850 |
| 12-#14 | 1.97 | MA | 17363 | 4609 | 26561 | 3760 | 31581 | 3035 | 34207 | 2493 | 37126 | 1643 | 45554 | 1358 | 29968 |
| 3L-5S | | MI | 14752 | 4609 | 22854 | 3758 | 26879 | 3031 | 28671 | 2486 | 30082 | 1628 | 37035 | 1143 | 26685 |
| 12-#14 | 1.97 | MA | 16454 | 4609 | 25329 | 3759 | 29916 | 3047 | 32191 | 2489 | 34431 | 1635 | 42586 | 1226 | 29683 |
| 4E | | MI | 15529 | 4609 | 24027 | 3744 | 28286 | 3034 | 30389 | 2477 | 32377 | 1621 | 39952 | 1205 | 27950 |
| 12-#14 | 1.97 | MA | 15629 | 4609 | 24082 | 3774 | 28419 | 3045 | 30364 | 2499 | 31971 | 1643 | 39459 | 1163 | 28327 |
| 5L-3S | | MI | 16384 | 4609 | 25184 | 3745 | 29850 | 3023 | 32284 | 2482 | 34892 | 1628 | 42709 | 1337 | 28203 |
| 12-#14 | 1.97 | MA | 14837 | 4609 | 22973 | 3774 | 26942 | 3057 | 28565 | 2494 | 29605 | 1650 | 36306 | 1054 | 27408 |
| 6L-2S | | MI | 17558 | 4609 | 26733 | 3746 | 31815 | 3026 | 34664 | 2473 | 38061 | 1621 | 46912 | 1468 | 28300 |
| 12-#18 | 3.51 | MA | 21775 | 5373 | 35794 | 4212 | 43112 | 3366 | 48101 | 2687 | 55325 | 1557 | 69498 | 1320 | 52019 |
| 2L-6S | | MI | 14600 | 5373 | 25223 | 4208 | 29579 | 3373 | 31844 | 2677 | 34219 | 1561 | 42871 | 515 | 39949 |
| 12-#18 | 3.51 | MA | 19699 | 5373 | 32910 | 4209 | 39454 | 3359 | 43669 | 2702 | 49450 | 1570 | 61722 | 1086 | 51484 |
| 3L-5S | | MI | 15837 | 5373 | 27052 | 4212 | 32015 | 3355 | 34808 | 2690 | 38028 | 1548 | 47907 | 710 | 43139 |
| 12-#18 | 3.51 | MA | 18190 | 5373 | 30751 | 4207 | 36538 | 3379 | 40136 | 2691 | 44788 | 1557 | 56628 | 853 | 48402 |
| 4E | | MI | 17126 | 5373 | 29106 | 4189 | 34481 | 3363 | 37817 | 2676 | 41990 | 1535 | 52940 | 818 | 45434 |
| 12-#18 | 3.51 | MA | 16821 | 5373 | 28564 | 4231 | 33913 | 3372 | 36933 | 2706 | 40533 | 1570 | 51222 | 743 | 45962 |
| 5L-3S | | MI | 18546 | 5373 | 31132 | 4192 | 37218 | 3345 | 41133 | 2689 | 46333 | 1548 | 57661 | 1051 | 48351 |
| 12-#18 | 3.51 | MA | 15508 | 5373 | 26618 | 4229 | 31321 | 3392 | 33778 | 2695 | 36442 | 1584 | 45796 | 549 | 42475 |
| 6L-2S | | MI | 20493 | 5373 | 33835 | 4196 | 40645 | 3353 | 45286 | 2676 | 51803 | 1535 | 64879 | 1285 | 48844 |
| 14-#11 | 1.60 | MA | 17802 | 4422 | 26295 | 3655 | 31334 | 2962 | 33948 | 2438 | 36887 | 1657 | 45304 | 1533 | 24617 |
| 2L-7S | | MI | 13768 | 4422 | 20786 | 3651 | 24265 | 2963 | 25532 | 2443 | 25946 | 1650 | 31634 | 1143 | 21523 |
| 14-#11 | 1.60 | MA | 16914 | 4422 | 25140 | 3655 | 29869 | 2961 | 32173 | 2445 | 34499 | 1663 | 42121 | 1442 | 24575 |
| 3L-6S | | MI | 14285 | 4422 | 21495 | 3651 | 25203 | 2965 | 26678 | 2436 | 27520 | 1655 | 33471 | 1214 | 22044 |
| 14-#11 | 1.60 | MA | 16269 | 4422 | 24280 | 3656 | 28707 | 2970 | 30765 | 2443 | 32605 | 1657 | 40027 | 1351 | 24468 |
| 4L-5S | | MI | 14814 | 4422 | 22223 | 3652 | 26173 | 2956 | 27859 | 2439 | 29073 | 1650 | 35540 | 1289 | 22666 |
| 14-#11 | 1.60 | MA | 15685 | 4422 | 23409 | 3666 | 27662 | 2969 | 29490 | 2450 | 30876 | 1663 | 37830 | 1306 | 24054 |
| 5L-4S | | MI | 15364 | 4422 | 23042 | 3641 | 27156 | 2958 | 29058 | 2432 | 30687 | 1645 | 37592 | 1334 | 23053 |
| 14-#11 | 1.60 | MA | 15124 | 4422 | 22636 | 3667 | 26631 | 2978 | 28234 | 2447 | 29213 | 1668 | 35608 | 1231 | 23370 |
| 6L-3S | | MI | 15971 | 4422 | 23851 | 3642 | 28249 | 2949 | 30382 | 2435 | 32456 | 1650 | 39539 | 1425 | 23145 |
| 14-#11 | 1.60 | MA | 14575 | 4422 | 21883 | 3667 | 25634 | 2977 | 27017 | 2455 | 27528 | 1663 | 33634 | 1160 | 22805 |
| 7L-2S | | MI | 16804 | 4422 | 24935 | 3642 | 29624 | 2951 | 32048 | 2428 | 34685 | 1645 | 42504 | 1516 | 23180 |
| 14-#14 | 2.30 | MA | 19362 | 4773 | 29864 | 3862 | 35769 | 3112 | 39282 | 2530 | 43920 | 1626 | 54589 | 1465 | 34955 |
| 2L-7S | | MI | 14030 | 4773 | 22345 | 3859 | 26111 | 3114 | 27719 | 2538 | 28806 | 1618 | 35703 | 904 | 28718 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis

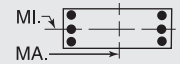



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.30 | MA | 18126 | 4773 | 28212 | 3862 | 33675 | 3110 | 36745 | 2541 | 40523 | 1634 | 50071 | 1334 | 34811 |
| 3L-6S | | MI | 14750 | 4773 | 23360 | 3859 | 27454 | 3118 | 29360 | 2528 | 31044 | 1625 | 38305 | 1007 | 30176 |
| 14-#14 | 2.30 | MA | 17229 | 4773 | 26981 | 3862 | 32010 | 3122 | 34728 | 2536 | 37828 | 1626 | 47103 | 1202 | 34489 |
| 4L-5S | | MI | 15485 | 4773 | 24403 | 3860 | 28844 | 3106 | 31051 | 2534 | 33251 | 1618 | 41239 | 1116 | 31084 |
| 14-#14 | 2.30 | MA | 16416 | 4773 | 25733 | 3876 | 30514 | 3120 | 32901 | 2546 | 35368 | 1634 | 43977 | 1139 | 33024 |
| 5L-4S | | MI | 16251 | 4773 | 25576 | 3846 | 30251 | 3109 | 32769 | 2524 | 35546 | 1610 | 44155 | 1179 | 32457 |
| 14-#14 | 2.30 | MA | 15635 | 4773 | 24625 | 3876 | 29036 | 3132 | 31103 | 2542 | 33002 | 1641 | 40823 | 1030 | 32055 |
| 6L-3S | | MI | 17095 | 4773 | 26733 | 3847 | 31815 | 3097 | 34664 | 2530 | 38061 | 1618 | 46912 | 1310 | 32747 |
| 14-#14 | 2.30 | MA | 14871 | 4773 | 23545 | 3876 | 27608 | 3130 | 29358 | 2552 | 30603 | 1634 | 38024 | 927 | 30463 |
| 7L-2S | | MI | 18254 | 4773 | 28283 | 3848 | 33780 | 3101 | 37044 | 2521 | 41230 | 1610 | 51116 | 1442 | 32875 |
| 14-#18 | 4.09 | MA | 20946 | 5663 | 35794 | 4391 | 43112 | 3492 | 48101 | 2786 | 55325 | 1551 | 69498 | 1036 | 59874 |
| 3L-6S | | MI | 15838 | 5663 | 27925 | 4390 | 33007 | 3506 | 35997 | 2761 | 39689 | 1539 | 50089 | 460 | 47530 |
| 14-#18 | 4.09 | MA | 19466 | 5663 | 33636 | 4389 | 40197 | 3512 | 44568 | 2775 | 50662 | 1537 | 64404 | 803 | 56532 |
| 4L-5S | | MI | 17051 | 5663 | 29754 | 4394 | 35443 | 3488 | 38961 | 2774 | 43499 | 1526 | 55124 | 655 | 50592 |
| 14-#18 | 4.09 | MA | 18124 | 5663 | 31449 | 4413 | 37572 | 3505 | 41365 | 2790 | 46408 | 1551 | 58997 | 693 | 53948 |
| 5L-4S | | MI | 18315 | 5663 | 31809 | 4371 | 37908 | 3496 | 41970 | 2761 | 47461 | 1513 | 60158 | 763 | 53035 |
| 14-#18 | 4.09 | MA | 16837 | 5663 | 29503 | 4410 | 34979 | 3525 | 38210 | 2779 | 42316 | 1564 | 53571 | 499 | 50593 |
| 6L-3S | | MI | 19709 | 5663 | 33835 | 4374 | 40645 | 3478 | 45286 | 2774 | 51803 | 1526 | 64879 | 996 | 56206 |
| 16-#11 | 1.82 | MA | 18340 | 4535 | 27450 | 3726 | 32799 | 3014 | 35723 | 2470 | 39274 | 1652 | 48487 | 1518 | 28035 |
| 2L-8S | | MI | 13795 | 4535 | 21172 | 3722 | 24721 | 3013 | 26050 | 2472 | 26656 | 1649 | 32683 | 1075 | 23774 |
| 16-#11 | 1.82 | MA | 17460 | 4535 | 26295 | 3726 | 31334 | 3013 | 33948 | 2478 | 36887 | 1657 | 45304 | 1427 | 27976 |
| 3L-7S | | MI | 14300 | 4535 | 21870 | 3722 | 25640 | 3015 | 27198 | 2476 | 28175 | 1644 | 34599 | 1126 | 24571 |
| 16-#11 | 1.82 | MA | 16821 | 4535 | 25435 | 3727 | 30171 | 3022 | 32539 | 2475 | 34992 | 1652 | 43210 | 1336 | 27850 |
| 4L-6S | | MI | 14812 | 4535 | 22579 | 3722 | 26578 | 3017 | 28343 | 2469 | 29749 | 1649 | 36435 | 1197 | 25148 |
| 16-#11 | 1.82 | MA | 16243 | 4535 | 24564 | 3737 | 29127 | 3021 | 31264 | 2483 | 33263 | 1657 | 41012 | 1291 | 27338 |
| 5E | | MI | 15335 | 4535 | 23307 | 3722 | 27548 | 3008 | 29524 | 2472 | 31302 | 1644 | 38505 | 1273 | 25744 |
| 16-#11 | 1.82 | MA | 15689 | 4535 | 23791 | 3737 | 28095 | 3030 | 30009 | 2480 | 31601 | 1662 | 38791 | 1216 | 26681 |
| 6L-4S | | MI | 15879 | 4535 | 24126 | 3712 | 28531 | 3010 | 30724 | 2465 | 32916 | 1639 | 40557 | 1317 | 26227 |
| 16-#11 | 1.82 | MA | 15145 | 4535 | 23037 | 3738 | 27099 | 3028 | 28792 | 2488 | 29915 | 1657 | 36816 | 1144 | 26061 |
| 7L-3S | | MI | 16480 | 4535 | 24935 | 3712 | 29624 | 3001 | 32048 | 2468 | 34685 | 1644 | 42504 | 1408 | 26339 |
| 16-#11 | 1.82 | MA | 14609 | 4535 | 22296 | 3738 | 26122 | 3027 | 27572 | 2485 | 28288 | 1662 | 34764 | 1092 | 25190 |
| 8L-2S | | MI | 17306 | 4535 | 26019 | 3713 | 30999 | 3003 | 33714 | 2461 | 36915 | 1639 | 45469 | 1499 | 26389 |
| 16-#14 | 2.63 | MA | 20097 | 4936 | 31515 | 3964 | 37863 | 3187 | 41819 | 2578 | 47317 | 1617 | 59107 | 1441 | 39823 |
| 2L-8S | | MI | 14069 | 4936 | 22893 | 3960 | 26759 | 3186 | 28456 | 2579 | 29815 | 1615 | 37184 | 805 | 31573 |
| 16-#14 | 2.63 | MA | 18876 | 4936 | 29864 | 3964 | 35769 | 3185 | 39282 | 2588 | 43920 | 1624 | 54589 | 1310 | 39650 |
| 3L-7S | | MI | 14771 | 4936 | 23894 | 3961 | 28075 | 3189 | 30100 | 2585 | 31975 | 1608 | 39907 | 878 | 33095 |
| 16-#14 | 2.63 | MA | 17990 | 4936 | 28632 | 3964 | 34105 | 3197 | 37265 | 2583 | 41225 | 1617 | 51621 | 1178 | 39209 |
| 4L-6S | | MI | 15481 | 4936 | 24910 | 3962 | 29419 | 3192 | 31740 | 2576 | 34213 | 1615 | 42508 | 981 | 34503 |
| 16-#14 | 2.63 | MA | 17188 | 4936 | 27385 | 3979 | 32608 | 3195 | 35438 | 2594 | 38765 | 1624 | 48495 | 1115 | 37733 |
| 5E | | MI | 16206 | 4936 | 25953 | 3963 | 30809 | 3181 | 33432 | 2581 | 36420 | 1608 | 45442 | 1090 | 35495 |
| 16-#14 | 2.63 | MA | 16419 | 4936 | 26276 | 3978 | 31130 | 3207 | 33640 | 2589 | 36399 | 1632 | 45341 | 1006 | 36681 |
| 6L-4S | | MI | 16961 | 4936 | 27125 | 3948 | 32216 | 3184 | 35149 | 2572 | 38715 | 1600 | 48359 | 1153 | 36835 |
| 16-#14 | 2.63 | MA | 15665 | 4936 | 25196 | 3978 | 29702 | 3205 | 31895 | 2599 | 34000 | 1624 | 42542 | 903 | 35142 |
| 7L-3S | | MI | 17795 | 4936 | 28283 | 3949 | 33780 | 3172 | 37044 | 2577 | 41230 | 1608 | 51116 | 1284 | 37285 |
| 16-#14 | 2.63 | MA | 14921 | 4936 | 24133 | 3978 | 28302 | 3202 | 30147 | 2595 | 31685 | 1632 | 39623 | 829 | 33513 |
| 8L-2S | | MI | 18941 | 4936 | 29832 | 3950 | 35744 | 3175 | 39424 | 2568 | 44399 | 1600 | 55319 | 1415 | 37443 |
| 16-#18 | 4.68 | MA | 20717 | 5954 | 36520 | 4570 | 43855 | 3645 | 49000 | 2859 | 56537 | 1517 | 72180 | 753 | 64691 |
| 4L-6S | | MI | 17049 | 5954 | 30628 | 4572 | 36434 | 3639 | 40150 | 2846 | 45160 | 1517 | 57306 | 406 | 55135 |
| 16-#18 | 4.68 | MA | 19401 | 5954 | 34333 | 4595 | 41230 | 3638 | 45797 | 2875 | 52283 | 1531 | 66773 | 643 | 61964 |
| 5E | | MI | 18240 | 5954 | 32457 | 4575 | 38870 | 3621 | 43114 | 2859 | 48969 | 1504 | 62342 | 601 | 58076 |
| 16-#18 | 4.68 | MA | 18138 | 5954 | 32387 | 4592 | 38637 | 3658 | 42642 | 2864 | 48191 | 1544 | 61347 | 449 | 58733 |
| 6L-4S | | MI | 19481 | 5954 | 34512 | 4552 | 41336 | 3629 | 46122 | 2845 | 52931 | 1491 | 67375 | 708 | 60664 |
| 18-#11 | 2.05 | MA | 18871 | 4649 | 28605 | 3797 | 34263 | 3066 | 37497 | 2503 | 41661 | 1646 | 51669 | 1503 | 31448 |
| 2L-9S | | MI | 13828 | 4649 | 21486 | 3803 | 25149 | 3074 | 26587 | 2512 | 27381 | 1648 | 33772 | 999 | 25973 |
| 18-#11 | 2.05 | MA | 17998 | 4649 | 27450 | 3797 | 32799 | 3065 | 35723 | 2511 | 39274 | 1651 | 48487 | 1412 | 31374 |
| 3L-8S | | MI | 14324 | 4649 | 22256 | 3793 | 26096 | 3065 | 27716 | 2505 | 28885 | 1643 | 35648 | 1058 | 26854 |
| 18-#11 | 2.05 | MA | 17366 | 4649 | 26590 | 3797 | 31636 | 3074 | 34314 | 2508 | 37380 | 1646 | 46393 | 1321 | 31229 |
| 4L-7S | | MI | 14825 | 4649 | 22954 | 3793 | 27015 | 3067 | 28864 | 2509 | 30404 | 1637 | 37563 | 1109 | 27628 |

## RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

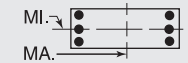
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.05 | MA | 16794 | 4649 | 25719 | 3808 | 30592 | 3072 | 33039 | 2516 | 35651 | 1651 | 44195 | 1276 | 30630 |
| 5L-6S | | MI | 15331 | 4649 | 23663 | 3793 | 27953 | 3069 | 30009 | 2501 | 31979 | 1643 | 39400 | 1180 | 28258 |
| 18-#11 | 2.05 | MA | 16245 | 4649 | 24946 | 3808 | 29560 | 3082 | 31784 | 2513 | 33988 | 1657 | 41973 | 1200 | 29998 |
| 6L-5S | | MI | 15849 | 4649 | 24391 | 3793 | 28923 | 3060 | 31190 | 2505 | 33531 | 1637 | 41469 | 1256 | 28830 |
| 18-#11 | 2.05 | MA | 15708 | 4649 | 24192 | 3809 | 28564 | 3080 | 30566 | 2521 | 32302 | 1651 | 39999 | 1129 | 29325 |
| 7L-4S | | MI | 16388 | 4649 | 25210 | 3783 | 29906 | 3062 | 32389 | 2498 | 35146 | 1632 | 43521 | 1300 | 29399 |
| 18-#11 | 2.05 | MA | 15177 | 4649 | 23451 | 3809 | 27587 | 3079 | 29346 | 2518 | 30675 | 1657 | 37947 | 1077 | 28480 |
| 8L-3S | | MI | 16982 | 4649 | 26019 | 3783 | 30999 | 3053 | 33714 | 2501 | 36915 | 1637 | 45469 | 1391 | 29529 |
| 18-#11 | 2.05 | MA | 14650 | 4649 | 22632 | 3819 | 26581 | 3088 | 28146 | 2526 | 29065 | 1662 | 35932 | 1018 | 27533 |
| 9L-2S | | MI | 17801 | 4649 | 27103 | 3784 | 32374 | 3055 | 35379 | 2494 | 39144 | 1632 | 48433 | 1482 | 29594 |
| 18-#14 | 2.96 | MA | 19615 | 5100 | 31515 | 4066 | 37863 | 3259 | 41819 | 2635 | 47317 | 1615 | 59107 | 1286 | 44485 |
| 3L-8S | | MI | 14806 | 5100 | 24442 | 4062 | 28723 | 3261 | 30836 | 2627 | 32984 | 1605 | 41388 | 779 | 35867 |
| 18-#14 | 2.96 | MA | 18740 | 5100 | 30283 | 4066 | 36199 | 3272 | 39802 | 2631 | 44621 | 1608 | 56139 | 1154 | 43866 |
| 4L-7S | | MI | 15498 | 5100 | 25443 | 4063 | 30040 | 3264 | 32480 | 2632 | 35144 | 1597 | 44110 | 852 | 37482 |
| 18-#14 | 2.96 | MA | 17949 | 5100 | 29036 | 4081 | 34702 | 3269 | 37976 | 2641 | 42161 | 1615 | 53012 | 1090 | 42452 |
| 5L-6S | | MI | 16199 | 5100 | 26459 | 4064 | 31383 | 3267 | 34121 | 2623 | 37382 | 1605 | 46712 | 954 | 38844 |
| 18-#14 | 2.96 | MA | 17190 | 5100 | 27927 | 4081 | 33225 | 3282 | 36177 | 2636 | 39796 | 1623 | 49859 | 982 | 41321 |
| 6L-5S | | MI | 16915 | 5100 | 27502 | 4065 | 32773 | 3256 | 35812 | 2628 | 39589 | 1597 | 49645 | 1064 | 39915 |
| 18-#14 | 2.96 | MA | 16446 | 5100 | 26848 | 4080 | 31796 | 3279 | 34433 | 2647 | 37397 | 1615 | 47059 | 879 | 39829 |
| 7L-4S | | MI | 17661 | 5100 | 28674 | 4051 | 34180 | 3259 | 37529 | 2619 | 41884 | 1590 | 52562 | 1126 | 41196 |
| 18-#14 | 2.96 | MA | 15711 | 5100 | 25784 | 4080 | 30396 | 3277 | 32685 | 2642 | 35082 | 1623 | 44141 | 805 | 38104 |
| 8L-3S | | MI | 18484 | 5100 | 29832 | 4051 | 35744 | 3247 | 39424 | 2625 | 44399 | 1597 | 55319 | 1258 | 41820 |
| 18-#18 | 5.26 | MA | 20655 | 6245 | 37218 | 4776 | 44888 | 3771 | 50229 | 2959 | 58158 | 1511 | 74548 | 593 | 70008 |
| 5L-6S | | MI | 18350 | 6245 | 33331 | 4753 | 39862 | 3772 | 44302 | 2930 | 50630 | 1495 | 64524 | 351 | 62744 |
| 18-#18 | 5.26 | MA | 19414 | 6245 | 35272 | 4774 | 42295 | 3791 | 47074 | 2948 | 54066 | 1524 | 69123 | 398 | 66892 |
| 6L-5S | | MI | 19510 | 6245 | 35160 | 4757 | 42298 | 3754 | 47267 | 2943 | 54440 | 1482 | 69560 | 546 | 65587 |
| 20-#11 | 2.28 | MA | 18530 | 4762 | 28605 | 3868 | 34263 | 3116 | 37497 | 2544 | 41661 | 1646 | 51669 | 1396 | 34769 |
| 3L-9S | | MI | 14355 | 4762 | 22570 | 3874 | 26524 | 3126 | 28252 | 2545 | 29610 | 1641 | 36736 | 982 | 29028 |
| 20-#11 | 2.28 | MA | 17905 | 4762 | 27745 | 3868 | 33101 | 3126 | 36088 | 2541 | 39767 | 1641 | 49576 | 1305 | 34607 |
| 4L-8S | | MI | 14847 | 4762 | 23340 | 3864 | 27471 | 3117 | 29382 | 2538 | 31114 | 1636 | 38612 | 1041 | 29941 |
| 20-#11 | 2.28 | MA | 17338 | 4762 | 26874 | 3879 | 32056 | 3124 | 34813 | 2549 | 38038 | 1646 | 47378 | 1260 | 33930 |
| 5L-7S | | MI | 15343 | 4762 | 24039 | 3864 | 28390 | 3119 | 30529 | 2541 | 32633 | 1631 | 40528 | 1092 | 30692 |
| 20-#11 | 2.28 | MA | 16795 | 4762 | 26101 | 3879 | 31025 | 3133 | 33558 | 2546 | 36375 | 1651 | 45156 | 1185 | 33320 |
| 6E | | MI | 15844 | 4762 | 24748 | 3864 | 29328 | 3120 | 31675 | 2534 | 34208 | 1636 | 42365 | 1164 | 31372 |
| 20-#11 | 2.28 | MA | 16263 | 4762 | 25347 | 3879 | 30028 | 3132 | 32341 | 2554 | 34690 | 1646 | 43182 | 1114 | 32597 |
| 7L-5S | | MI | 16356 | 4762 | 25476 | 3864 | 30298 | 3112 | 32856 | 2538 | 35760 | 1631 | 44434 | 1239 | 31924 |
| 20-#11 | 2.28 | MA | 15737 | 4762 | 24606 | 3880 | 29052 | 3131 | 31121 | 2551 | 33063 | 1651 | 41130 | 1062 | 31774 |
| 8L-4S | | MI | 16890 | 4762 | 26294 | 3854 | 31281 | 3113 | 34055 | 2531 | 37375 | 1626 | 46486 | 1283 | 32569 |
| 20-#11 | 2.28 | MA | 15216 | 4762 | 23787 | 3890 | 28045 | 3140 | 29921 | 2559 | 31452 | 1656 | 39115 | 1003 | 30797 |
| 9L-3S | | MI | 17479 | 4762 | 27103 | 3854 | 32374 | 3105 | 35379 | 2534 | 39144 | 1631 | 48433 | 1374 | 32715 |
| 20-#11 | 2.28 | MA | 14696 | 4762 | 23048 | 3890 | 27075 | 3139 | 28715 | 2556 | 29795 | 1651 | 37160 | 937 | 29799 |
| 10L-2S | | MI | 18291 | 4762 | 28187 | 3854 | 33748 | 3107 | 37045 | 2527 | 41373 | 1626 | 51398 | 1466 | 32794 |
| 20-#14 | 3.29 | MA | 19480 | 5264 | 31935 | 4168 | 38293 | 3347 | 42340 | 2678 | 48018 | 1599 | 60657 | 1130 | 48538 |
| 4L-8S | | MI | 15531 | 5264 | 25992 | 4164 | 30688 | 3336 | 33216 | 2674 | 36153 | 1595 | 45591 | 752 | 40220 |
| 20-#14 | 3.29 | MA | 18698 | 5264 | 30688 | 4183 | 36797 | 3344 | 40513 | 2688 | 45558 | 1606 | 57530 | 1066 | 47181 |
| 5L-7S | | MI | 16215 | 5264 | 26992 | 4165 | 32005 | 3339 | 34860 | 2680 | 38313 | 1587 | 48313 | 825 | 41877 |
| 20-#14 | 3.29 | MA | 17949 | 5264 | 29579 | 4183 | 35319 | 3357 | 38714 | 2684 | 43192 | 1614 | 54377 | 957 | 45972 |
| 6E | | MI | 16907 | 5264 | 28008 | 4166 | 33348 | 3342 | 36501 | 2670 | 40551 | 1595 | 50915 | 928 | 43196 |
| 20-#14 | 3.29 | MA | 17215 | 5264 | 28499 | 4183 | 33891 | 3354 | 36970 | 2694 | 40794 | 1606 | 51577 | 855 | 44526 |
| 7L-5S | | MI | 17614 | 5264 | 29051 | 4167 | 34738 | 3330 | 38192 | 2676 | 42758 | 1587 | 53849 | 1037 | 44345 |
| 20-#14 | 3.29 | MA | 16489 | 5264 | 27436 | 4182 | 32491 | 3352 | 35222 | 2689 | 38479 | 1614 | 48658 | 781 | 42759 |
| 8L-4S | | MI | 18351 | 5264 | 30223 | 4153 | 36145 | 3334 | 39909 | 2666 | 45053 | 1580 | 56765 | 1100 | 45572 |
| 20-#18 | 5.85 | MA | 20794 | 6536 | 38156 | 4956 | 45954 | 3924 | 51506 | 3032 | 59941 | 1504 | 76898 | 348 | 74983 |
| 6E | | MI | 19518 | 6536 | 36034 | 4935 | 43290 | 3905 | 48455 | 3014 | 56101 | 1473 | 71742 | 296 | 70202 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

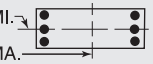
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.51 | MA | 18436 | 4875 | 28900 | 3939 | 34566 | 3177 | 37863 | 2574 | 42154 | 1635 | 52758 | 1290 | 37984 |
| 4L-9S | | MI | 14876 | 4875 | 23654 | 3945 | 27899 | 3177 | 29918 | 2578 | 31839 | 1635 | 39701 | 965 | 32088 |
| 22-#11 | 2.51 | MA | 17875 | 4875 | 28029 | 3950 | 33521 | 3176 | 36588 | 2582 | 40425 | 1640 | 50561 | 1245 | 37236 |
| 5L-8S | | MI | 15363 | 4875 | 24425 | 3935 | 28846 | 3169 | 31047 | 2571 | 33344 | 1630 | 41577 | 1024 | 33031 |
| 22-#11 | 2.51 | MA | 17337 | 4875 | 27256 | 3950 | 32490 | 3185 | 35333 | 2579 | 38763 | 1645 | 48339 | 1170 | 36645 |
| 6L-7S | | MI | 15854 | 4875 | 25123 | 3935 | 29765 | 3171 | 32195 | 2574 | 34863 | 1625 | 43492 | 1076 | 33762 |
| 22-#11 | 2.51 | MA | 16811 | 4875 | 26502 | 3950 | 31493 | 3184 | 34115 | 2587 | 37077 | 1640 | 46365 | 1099 | 35874 |
| 7L-6S | | MI | 16350 | 4875 | 25832 | 3935 | 30703 | 3172 | 33340 | 2567 | 36437 | 1630 | 45329 | 1147 | 34490 |
| 22-#11 | 2.51 | MA | 16291 | 4875 | 25761 | 3950 | 30517 | 3183 | 32896 | 2584 | 35450 | 1645 | 44313 | 1047 | 35073 |
| 8L-5S | | MI | 16857 | 4875 | 26560 | 3935 | 31673 | 3164 | 34521 | 2570 | 37990 | 1625 | 47398 | 1222 | 35024 |
| 22-#11 | 2.51 | MA | 15774 | 4875 | 24942 | 3961 | 29510 | 3192 | 31695 | 2592 | 33839 | 1651 | 42298 | 988 | 34066 |
| 9L-4S | | MI | 17386 | 4875 | 27378 | 3925 | 32656 | 3165 | 35721 | 2563 | 39604 | 1619 | 49450 | 1267 | 35737 |
| 22-#11 | 2.51 | MA | 15260 | 4875 | 24203 | 3961 | 28540 | 3191 | 30490 | 2589 | 32183 | 1645 | 40343 | 922 | 33047 |
| 10L-3S | | MI | 17970 | 4875 | 28187 | 3925 | 33748 | 3157 | 37045 | 2567 | 41373 | 1625 | 51398 | 1358 | 35899 |
| 22-#14 | 3.62 | MA | 19437 | 5427 | 32339 | 4285 | 38891 | 3419 | 43050 | 2736 | 48955 | 1597 | 62048 | 1042 | 51917 |
| 5L-8S | | MI | 16246 | 5427 | 27541 | 4267 | 32653 | 3410 | 35596 | 2722 | 39322 | 1584 | 49795 | 726 | 44581 |
| 22-#14 | 3.62 | MA | 18697 | 5427 | 31230 | 4285 | 37413 | 3432 | 41252 | 2731 | 46589 | 1605 | 58895 | 933 | 50634 |
| 6L-7S | | MI | 16922 | 5427 | 28541 | 4268 | 33969 | 3414 | 37240 | 2727 | 41482 | 1577 | 52517 | 799 | 46281 |
| 22-#14 | 3.62 | MA | 17972 | 5427 | 30150 | 4285 | 35985 | 3429 | 39507 | 2741 | 44190 | 1597 | 56095 | 831 | 49230 |
| 7L-6S | | MI | 17605 | 5427 | 29557 | 4268 | 35313 | 3417 | 38881 | 2718 | 43720 | 1584 | 55119 | 902 | 47559 |
| 22-#14 | 3.62 | MA | 17256 | 5427 | 29087 | 4285 | 34585 | 3427 | 37759 | 2737 | 41876 | 1605 | 53176 | 757 | 47422 |
| 8L-5S | | MI | 18304 | 5427 | 30600 | 4269 | 36703 | 3405 | 40572 | 2723 | 45927 | 1577 | 58052 | 1011 | 48782 |
| 24-#11 | 2.74 | MA | 18407 | 4989 | 29184 | 4021 | 34986 | 3228 | 38363 | 2614 | 42813 | 1635 | 53744 | 1230 | 40548 |
| 5L-9S | | MI | 15391 | 4989 | 24738 | 4016 | 29274 | 3229 | 31584 | 2611 | 34069 | 1629 | 42665 | 949 | 35154 |
| 24-#11 | 2.74 | MA | 17874 | 4989 | 28411 | 4021 | 33955 | 3237 | 37107 | 2612 | 41150 | 1640 | 51522 | 1154 | 39974 |
| 6L-8S | | MI | 15873 | 4989 | 25509 | 4005 | 30221 | 3221 | 32713 | 2604 | 35573 | 1623 | 44541 | 1008 | 36127 |
| 24-#11 | 2.74 | MA | 17353 | 4989 | 27657 | 4021 | 32958 | 3236 | 35890 | 2619 | 39464 | 1635 | 49548 | 1083 | 39158 |
| 7E | | MI | 16359 | 4989 | 26207 | 4006 | 31140 | 3222 | 33861 | 2607 | 37092 | 1618 | 46457 | 1059 | 36838 |
| 24-#11 | 2.74 | MA | 16837 | 4989 | 26916 | 4021 | 31981 | 3235 | 34670 | 2617 | 37837 | 1640 | 47496 | 1031 | 38377 |
| 8L-6S | | MI | 16851 | 4989 | 26916 | 4006 | 32078 | 3224 | 35006 | 2600 | 38666 | 1623 | 48294 | 1130 | 37611 |
| 24-#11 | 2.74 | MA | 16326 | 4989 | 26097 | 4032 | 30975 | 3244 | 33470 | 2624 | 36227 | 1645 | 45480 | 972 | 37316 |
| 9L-5S | | MI | 17353 | 4989 | 27644 | 4006 | 33048 | 3215 | 36187 | 2603 | 40219 | 1618 | 50363 | 1206 | 38129 |
| 24-#11 | 2.74 | MA | 15817 | 4989 | 25358 | 4032 | 30005 | 3243 | 32264 | 2622 | 34570 | 1640 | 43525 | 906 | 36301 |
| 10L-4S | | MI | 17877 | 4989 | 28463 | 3996 | 34031 | 3217 | 37386 | 2596 | 41833 | 1613 | 52415 | 1250 | 38904 |
| 24-#14 | 3.95 | MA | 19436 | 5591 | 32881 | 4387 | 39507 | 3506 | 43789 | 2779 | 49986 | 1596 | 63413 | 909 | 55306 |
| 6L-8S | | MI | 16952 | 5591 | 29090 | 4369 | 34617 | 3485 | 37976 | 2769 | 42491 | 1574 | 53998 | 700 | 48951 |
| 24-#14 | 3.95 | MA | 18720 | 5591 | 31802 | 4387 | 38079 | 3504 | 42044 | 2789 | 47587 | 1588 | 60613 | 807 | 53941 |
| 7E | | MI | 17620 | 5591 | 30090 | 4370 | 35934 | 3488 | 39620 | 2774 | 44651 | 1567 | 56720 | 773 | 50691 |
| 24-#14 | 3.95 | MA | 18013 | 5591 | 30738 | 4387 | 36679 | 3501 | 40296 | 2784 | 45272 | 1596 | 57694 | 733 | 52093 |
| 8L-6S | | MI | 18295 | 5591 | 31106 | 4371 | 37277 | 3492 | 41261 | 2765 | 46889 | 1574 | 59322 | 875 | 51931 |

## RECTANGULAR TIED COLUMNS 36" x 40"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.11 | MA | 18338 | 4400 | 26505 | 3664 | 31194 | 2981 | 33263 | 2475 | 34845 | 1737 | 42054 | 1622 | 19017 |
| 2E | | MI | 16404 | 4400 | 23952 | 3633 | 27991 | 2955 | 29747 | 2453 | 30920 | 1711 | 37143 | 1588 | 16934 |
| 6-#18 | 1.67 | MA | 19778 | 4691 | 29571 | 3845 | 35083 | 3114 | 37974 | 2559 | 41125 | 1719 | 50389 | 1575 | 28133 |
| 2L-3S | | MI | 15586 | 4691 | 23952 | 3811 | 27991 | 3080 | 29747 | 2551 | 30920 | 1702 | 37143 | 1300 | 24827 |
| 6-#18 | 1.67 | MA | 17427 | 4691 | 26505 | 3844 | 31194 | 3109 | 33263 | 2576 | 34845 | 1732 | 42054 | 1342 | 27906 |
| 3L-2S | | MI | 17656 | 4691 | 26654 | 3814 | 31419 | 3088 | 33900 | 2537 | 36391 | 1689 | 44361 | 1533 | 24989 |
| 8-#14 | 1.25 | MA | 18805 | 4473 | 27191 | 3734 | 32254 | 3035 | 34629 | 2513 | 36854 | 1754 | 44842 | 1639 | 21510 |
| 2L-4S | | MI | 14731 | 4473 | 21846 | 3704 | 25411 | 3020 | 26701 | 2497 | 27042 | 1730 | 32687 | 1344 | 19001 |
| 8-#14 | 1.25 | MA | 17436 | 4473 | 25438 | 3735 | 30030 | 3033 | 31934 | 2524 | 33229 | 1761 | 40010 | 1507 | 21473 |
| 3E | | MI | 15614 | 4473 | 23004 | 3705 | 26975 | 3009 | 28596 | 2503 | 29557 | 1737 | 35444 | 1475 | 19137 |
| 8-#14 | 1.25 | MA | 16440 | 4473 | 24132 | 3735 | 28265 | 3046 | 29796 | 2521 | 30353 | 1754 | 36831 | 1376 | 21281 |
| 4L-2S | | MI | 16821 | 4473 | 24553 | 3706 | 28940 | 3012 | 30976 | 2494 | 32726 | 1730 | 39647 | 1607 | 19150 |
| 8-#18 | 2.22 | MA | 21173 | 4982 | 32638 | 4027 | 38971 | 3247 | 42686 | 2643 | 47404 | 1701 | 58723 | 1529 | 37198 |
| 2L-4S | | MI | 15355 | 4982 | 24628 | 3989 | 28682 | 3231 | 30584 | 2622 | 32048 | 1667 | 39639 | 1012 | 30665 |

## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

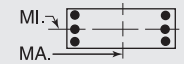
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 2.22 | MA | 18871 | 4982 | 29571 | 4026 | 35083 | 3242 | 37974 | 2660 | 41125 | 1714 | 50389 | 1296 | 36853 |
| 3E | | MI | 16841 | 4982 | 26654 | 3992 | 31419 | 3213 | 33900 | 2635 | 36391 | 1680 | 44361 | 1245 | 32714 |
| 8-#18 | 2.22 | MA | 17194 | 4982 | 27281 | 4025 | 31988 | 3263 | 34225 | 2651 | 36141 | 1701 | 44920 | 1062 | 34519 |
| 4L-2S | | MI | 18870 | 4982 | 29357 | 3996 | 34847 | 3221 | 38053 | 2621 | 41861 | 1667 | 51578 | 1479 | 32987 |
| 10-#11 | 1.08 | MA | 18399 | 4386 | 26206 | 3692 | 31100 | 3006 | 33273 | 2497 | 35095 | 1767 | 42581 | 1664 | 18813 |
| 2L-5S | | MI | 14436 | 4386 | 20968 | 3675 | 24476 | 2989 | 25600 | 2489 | 25618 | 1752 | 30756 | 1409 | 16621 |
| 10-#11 | 1.08 | MA | 17435 | 4386 | 24980 | 3693 | 29545 | 3005 | 31390 | 2505 | 32554 | 1772 | 39180 | 1572 | 18808 |
| 3L-4S | | MI | 15000 | 4386 | 21787 | 3665 | 25459 | 2990 | 26800 | 2482 | 27233 | 1746 | 32808 | 1453 | 16740 |
| 10-#11 | 1.08 | MA | 16735 | 4386 | 24069 | 3694 | 28313 | 3014 | 29897 | 2503 | 30538 | 1767 | 36940 | 1481 | 18747 |
| 4L-3S | | MI | 15622 | 4386 | 22595 | 3665 | 26552 | 2982 | 28124 | 2485 | 29002 | 1752 | 34755 | 1544 | 16776 |
| 10-#11 | 1.08 | MA | 16100 | 4386 | 23146 | 3705 | 27207 | 3014 | 28546 | 2511 | 28699 | 1773 | 34596 | 1436 | 18582 |
| 5L-2S | | MI | 16473 | 4386 | 23680 | 3666 | 27927 | 2983 | 29790 | 2478 | 31231 | 1746 | 37720 | 1635 | 16768 |
| 10-#14 | 1.56 | MA | 19636 | 4637 | 28945 | 3837 | 34477 | 3110 | 37323 | 2561 | 40479 | 1746 | 49675 | 1617 | 26713 |
| 2L-5S | | MI | 14693 | 4637 | 22223 | 3821 | 25969 | 3092 | 27364 | 2554 | 27916 | 1727 | 33973 | 1255 | 22495 |
| 10-#14 | 1.56 | MA | 18286 | 4637 | 27191 | 3837 | 32254 | 3108 | 34629 | 2572 | 36854 | 1753 | 44842 | 1485 | 26637 |
| 3L-4S | | MI | 15484 | 4637 | 23396 | 3807 | 27376 | 3095 | 29081 | 2545 | 30211 | 1719 | 36890 | 1317 | 23520 |
| 10-#14 | 1.56 | MA | 17304 | 4637 | 25885 | 3837 | 30489 | 3121 | 32490 | 2568 | 33978 | 1746 | 41663 | 1354 | 26395 |
| 4L-3S | | MI | 16355 | 4637 | 24553 | 3807 | 28940 | 3083 | 30976 | 2550 | 32726 | 1727 | 39647 | 1449 | 23704 |
| 10-#14 | 1.56 | MA | 16415 | 4637 | 24564 | 3853 | 28902 | 3119 | 30554 | 2579 | 31353 | 1753 | 38327 | 1289 | 25202 |
| 5L-2S | | MI | 17547 | 4637 | 26102 | 3808 | 30904 | 3087 | 33356 | 2541 | 35895 | 1719 | 43851 | 1580 | 23756 |
| 10-#18 | 2.78 | MA | 22531 | 5273 | 35704 | 4209 | 42860 | 3380 | 47397 | 2727 | 53684 | 1683 | 67057 | 1483 | 46237 |
| 2L-5S | | MI | 15283 | 5273 | 25276 | 4194 | 29644 | 3356 | 31728 | 2720 | 33557 | 1658 | 41824 | 849 | 36098 |
| 10-#18 | 2.78 | MA | 20273 | 5273 | 32638 | 4208 | 38971 | 3375 | 42686 | 2744 | 47404 | 1697 | 58723 | 1250 | 45791 |
| 3L-4S | | MI | 16606 | 5273 | 27331 | 4171 | 32110 | 3364 | 34736 | 2706 | 37519 | 1645 | 46857 | 957 | 38180 |
| 10-#18 | 2.78 | MA | 18632 | 5273 | 30347 | 4206 | 35877 | 3396 | 38936 | 2735 | 42421 | 1683 | 53254 | 1016 | 43094 |
| 4L-3S | | MI | 18062 | 5273 | 29357 | 4174 | 34847 | 3346 | 38053 | 2719 | 41861 | 1658 | 51578 | 1191 | 40587 |
| 10-#18 | 2.78 | MA | 17144 | 5273 | 28028 | 4232 | 33093 | 3390 | 35538 | 2752 | 37873 | 1697 | 47474 | 904 | 40595 |
| 5L-2S | | MI | 20053 | 5273 | 32060 | 4178 | 38274 | 3354 | 42205 | 2706 | 47332 | 1645 | 58796 | 1424 | 40956 |
| 12-#11 | 1.30 | MA | 18992 | 4499 | 27432 | 3763 | 32655 | 3057 | 35157 | 2530 | 37636 | 1762 | 45982 | 1650 | 22457 |
| 2L-6S | | MI | 14439 | 4499 | 21324 | 3746 | 24881 | 3049 | 26085 | 2519 | 26295 | 1750 | 31651 | 1317 | 19085 |
| 12-#11 | 1.30 | MA | 18037 | 4499 | 26206 | 3764 | 31100 | 3057 | 33273 | 2538 | 35095 | 1767 | 42581 | 1558 | 22432 |
| 3L-5S | | MI | 14974 | 4499 | 22052 | 3746 | 25851 | 3040 | 27266 | 2522 | 27848 | 1745 | 33720 | 1392 | 19751 |
| 12-#11 | 1.30 | MA | 17345 | 4499 | 25294 | 3765 | 29868 | 3066 | 31780 | 2536 | 33080 | 1762 | 40341 | 1467 | 22347 |
| 4E | | MI | 15533 | 4499 | 22871 | 3736 | 26834 | 3042 | 28465 | 2515 | 29462 | 1740 | 35772 | 1436 | 19927 |
| 12-#11 | 1.30 | MA | 16717 | 4499 | 24372 | 3775 | 28761 | 3065 | 30429 | 2544 | 31241 | 1768 | 37997 | 1422 | 22132 |
| 5L-3S | | MI | 16148 | 4499 | 23680 | 3736 | 27927 | 3034 | 29790 | 2518 | 31231 | 1745 | 37720 | 1527 | 19986 |
| 12-#11 | 1.30 | MA | 16115 | 4499 | 23553 | 3776 | 27669 | 3075 | 29100 | 2542 | 29472 | 1773 | 35623 | 1347 | 21337 |
| 6L-2S | | MI | 16991 | 4499 | 24764 | 3736 | 29302 | 3035 | 31455 | 2511 | 33460 | 1740 | 40684 | 1619 | 19997 |
| 12-#14 | 1.88 | MA | 20452 | 4800 | 30698 | 3939 | 36701 | 3185 | 40017 | 2608 | 44104 | 1738 | 54508 | 1595 | 31902 |
| 2L-6S | | MI | 14694 | 4800 | 22729 | 3922 | 26544 | 3178 | 28053 | 2596 | 28878 | 1724 | 35243 | 1119 | 26038 |
| 12-#14 | 1.88 | MA | 19118 | 4800 | 28945 | 3939 | 34477 | 3183 | 37323 | 2619 | 40479 | 1745 | 49675 | 1463 | 31790 |
| 3L-5S | | MI | 15443 | 4800 | 23772 | 3923 | 27933 | 3167 | 29744 | 2602 | 31085 | 1717 | 38177 | 1228 | 26876 |
| 12-#14 | 1.88 | MA | 18151 | 4800 | 27639 | 3939 | 32713 | 3196 | 35184 | 2615 | 37603 | 1738 | 46496 | 1332 | 31506 |
| 4E | | MI | 16223 | 4800 | 24945 | 3909 | 29341 | 3170 | 31461 | 2592 | 33380 | 1709 | 41094 | 1291 | 28034 |
| 12-#14 | 1.88 | MA | 17274 | 4800 | 26317 | 3955 | 31126 | 3194 | 33248 | 2626 | 34978 | 1745 | 43159 | 1267 | 30179 |
| 5L-3S | | MI | 17082 | 4800 | 26102 | 3910 | 30904 | 3158 | 33356 | 2598 | 35895 | 1717 | 43851 | 1422 | 28259 |
| 12-#14 | 1.88 | MA | 16433 | 4800 | 25143 | 3955 | 29561 | 3207 | 31343 | 2622 | 32453 | 1752 | 39786 | 1158 | 29171 |
| 6L-2S | | MI | 18259 | 4800 | 27651 | 3910 | 32869 | 3161 | 35737 | 2588 | 39064 | 1709 | 48054 | 1554 | 28343 |
| 12-#18 | 3.33 | MA | 23858 | 5564 | 38770 | 4391 | 46749 | 3513 | 52108 | 2812 | 59964 | 1666 | 75391 | 1437 | 55259 |
| 2L-6S | | MI | 15284 | 5564 | 26150 | 4372 | 30636 | 3508 | 32916 | 2791 | 35218 | 1649 | 44006 | 600 | 40380 |
| 12-#18 | 3.33 | MA | 21641 | 5564 | 35704 | 4389 | 42860 | 3508 | 47397 | 2829 | 53684 | 1679 | 67057 | 1204 | 54724 |
| 3L-5S | | MI | 16529 | 5564 | 27979 | 4375 | 33072 | 3489 | 35881 | 2804 | 39027 | 1636 | 49042 | 795 | 43647 |
| 12-#18 | 3.33 | MA | 20033 | 5564 | 33414 | 4388 | 39766 | 3529 | 43647 | 2819 | 48700 | 1666 | 61588 | 970 | 51711 |
| 4E | | MI | 17826 | 5564 | 30033 | 4352 | 35537 | 3497 | 38889 | 2791 | 42989 | 1623 | 54075 | 902 | 45739 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis

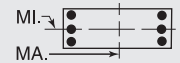


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 3.33 | MA | 18576 | 5564 | 31094 | 4413 | 36982 | 3523 | 40250 | 2836 | 44153 | 1679 | 55808 | 858 | 49337 |
| 5L-3S | | MI | 19254 | 5564 | 32060 | 4356 | 38274 | 3479 | 42205 | 2804 | 47332 | 1636 | 58796 | 1136 | 48453 |
| 12-#18 | 3.33 | MA | 17177 | 5564 | 29031 | 4412 | 34232 | 3544 | 36904 | 2827 | 39779 | 1692 | 49992 | 664 | 45477 |
| 6L-2S | | MI | 21210 | 5564 | 34763 | 4360 | 41702 | 3487 | 46358 | 2790 | 52802 | 1623 | 66014 | 1370 | 48907 |
| 14-#11 | 1.52 | MA | 19577 | 4613 | 28657 | 3834 | 34209 | 3109 | 37040 | 2563 | 40177 | 1756 | 49384 | 1636 | 26091 |
| 2L-7S | | MI | 14456 | 4613 | 21699 | 3817 | 25318 | 3099 | 26605 | 2559 | 26950 | 1739 | 32779 | 1229 | 21747 |
| 14-#11 | 1.52 | MA | 18631 | 4613 | 27432 | 3835 | 32655 | 3109 | 35157 | 2571 | 37636 | 1762 | 45982 | 1545 | 26049 |
| 3L-6S | | MI | 14975 | 4613 | 22408 | 3817 | 26256 | 3101 | 27751 | 2551 | 28524 | 1744 | 34616 | 1300 | 22182 |
| 14-#11 | 1.52 | MA | 17945 | 4613 | 26520 | 3835 | 31423 | 3118 | 33664 | 2569 | 35621 | 1757 | 43742 | 1453 | 25942 |
| 4L-5S | | MI | 15505 | 4613 | 23136 | 3817 | 27226 | 3092 | 28932 | 2555 | 30077 | 1739 | 36685 | 1375 | 22816 |
| 14-#11 | 1.52 | MA | 17324 | 4613 | 25598 | 3846 | 30316 | 3117 | 32313 | 2577 | 33782 | 1762 | 41399 | 1408 | 25609 |
| 5L-4S | | MI | 16057 | 4613 | 23955 | 3807 | 28209 | 3094 | 30131 | 2548 | 31691 | 1734 | 38737 | 1420 | 23109 |
| 14-#11 | 1.52 | MA | 16729 | 4613 | 24779 | 3847 | 29224 | 3127 | 30983 | 2575 | 32013 | 1768 | 39024 | 1333 | 24848 |
| 6L-3S | | MI | 16666 | 4613 | 24764 | 3807 | 29302 | 3085 | 31455 | 2551 | 33460 | 1739 | 40684 | 1511 | 23188 |
| 14-#11 | 1.52 | MA | 16146 | 4613 | 23981 | 3848 | 28168 | 3126 | 29694 | 2583 | 30220 | 1763 | 36912 | 1262 | 24320 |
| 7L-2S | | MI | 17502 | 4613 | 25848 | 3807 | 30676 | 3087 | 33121 | 2544 | 35689 | 1734 | 43649 | 1602 | 23216 |
| 14-#14 | 2.19 | MA | 21254 | 4964 | 32452 | 4041 | 38925 | 3259 | 42712 | 2655 | 47729 | 1729 | 59340 | 1573 | 37081 |
| 2L-7S | | MI | 14717 | 4964 | 23262 | 4023 | 27165 | 3250 | 28792 | 2653 | 29808 | 1706 | 36845 | 990 | 29006 |
| 14-#14 | 2.19 | MA | 19936 | 4964 | 30698 | 4041 | 36701 | 3258 | 40017 | 2667 | 44104 | 1737 | 54508 | 1441 | 36937 |
| 3L-6S | | MI | 15440 | 4964 | 24278 | 4024 | 28508 | 3253 | 30433 | 2643 | 32047 | 1714 | 39447 | 1093 | 30467 |
| 14-#14 | 2.19 | MA | 18982 | 4964 | 29393 | 4042 | 34937 | 3271 | 37879 | 2663 | 41228 | 1729 | 51329 | 1310 | 36615 |
| 4L-5S | | MI | 16178 | 4964 | 25321 | 4025 | 29898 | 3242 | 32124 | 2649 | 34254 | 1706 | 42380 | 1202 | 31272 |
| 14-#14 | 2.19 | MA | 18117 | 4964 | 28071 | 4057 | 33350 | 3269 | 35943 | 2674 | 38603 | 1737 | 47992 | 1245 | 35171 |
| 5L-4S | | MI | 16948 | 4964 | 26494 | 4011 | 31305 | 3245 | 33841 | 2640 | 36549 | 1699 | 45297 | 1265 | 32545 |
| 14-#14 | 2.19 | MA | 17288 | 4964 | 26896 | 4057 | 31785 | 3282 | 34037 | 2670 | 36078 | 1744 | 44618 | 1136 | 34200 |
| 6L-3S | | MI | 17796 | 4964 | 27651 | 4012 | 32869 | 3233 | 35737 | 2645 | 39064 | 1706 | 48054 | 1396 | 32807 |
| 14-#14 | 2.19 | MA | 16475 | 4964 | 25753 | 4058 | 30272 | 3281 | 32189 | 2681 | 33518 | 1737 | 41621 | 1034 | 32526 |
| 7L-2S | | MI | 18960 | 4964 | 29200 | 4013 | 34834 | 3236 | 38117 | 2636 | 42233 | 1699 | 52257 | 1527 | 32921 |
| 14-#18 | 3.89 | MA | 22980 | 5854 | 38770 | 4571 | 46749 | 3641 | 52108 | 2913 | 59964 | 1661 | 75391 | 1158 | 63654 |
| 3L-6S | | MI | 16526 | 5854 | 28853 | 4553 | 34063 | 3641 | 37069 | 2876 | 40688 | 1627 | 51224 | 545 | 47953 |
| 14-#18 | 3.89 | MA | 21403 | 5854 | 36480 | 4570 | 43654 | 3662 | 48358 | 2903 | 54980 | 1648 | 69922 | 924 | 60364 |
| 4L-5S | | MI | 17747 | 5854 | 30682 | 4557 | 36499 | 3622 | 40033 | 2889 | 44498 | 1614 | 56260 | 740 | 51090 |
| 14-#18 | 3.89 | MA | 19974 | 5854 | 34160 | 4595 | 40870 | 3656 | 44961 | 2920 | 50432 | 1661 | 64143 | 812 | 57863 |
| 5L-4S | | MI | 19019 | 5854 | 32736 | 4534 | 38965 | 3630 | 43042 | 2875 | 48460 | 1601 | 61293 | 848 | 53334 |
| 14-#18 | 3.89 | MA | 18603 | 5854 | 32097 | 4594 | 38121 | 3677 | 41615 | 2911 | 46059 | 1674 | 58326 | 618 | 54123 |
| 6L-3S | | MI | 20422 | 5854 | 34763 | 4538 | 41702 | 3612 | 46358 | 2888 | 52802 | 1614 | 66014 | 1081 | 56313 |
| 16-#11 | 1.73 | MA | 20154 | 4726 | 29883 | 3905 | 35764 | 3161 | 38924 | 2595 | 42718 | 1751 | 52785 | 1622 | 29720 |
| 2L-8S | | MI | 14481 | 4726 | 22085 | 3888 | 25774 | 3149 | 27123 | 2588 | 27660 | 1738 | 33828 | 1161 | 23989 |
| 16-#11 | 1.73 | MA | 19216 | 4726 | 28657 | 3906 | 34209 | 3160 | 37040 | 2604 | 40177 | 1757 | 49384 | 1531 | 29661 |
| 3L-7S | | MI | 14989 | 4726 | 22783 | 3888 | 26693 | 3151 | 28271 | 2591 | 29179 | 1733 | 35743 | 1212 | 24801 |
| 16-#11 | 1.73 | MA | 18537 | 4726 | 27746 | 3906 | 32977 | 3170 | 35547 | 2601 | 38162 | 1752 | 47143 | 1439 | 29535 |
| 4L-6S | | MI | 15503 | 4726 | 23492 | 3888 | 27631 | 3153 | 29417 | 2584 | 30753 | 1738 | 37580 | 1283 | 25286 |
| 16-#11 | 1.73 | MA | 17923 | 4726 | 26824 | 3917 | 31871 | 3169 | 34196 | 2610 | 36323 | 1757 | 44800 | 1394 | 29096 |
| 5E | | MI | 16027 | 4726 | 24220 | 3888 | 28601 | 3144 | 30597 | 2588 | 32306 | 1733 | 39650 | 1359 | 25892 |
| 16-#11 | 1.73 | MA | 17333 | 4726 | 26005 | 3918 | 30778 | 3179 | 32867 | 2608 | 34554 | 1763 | 42425 | 1319 | 28365 |
| 6L-4S | | MI | 16574 | 4726 | 25039 | 3878 | 29584 | 3146 | 31797 | 2580 | 33920 | 1727 | 41701 | 1403 | 26286 |
| 16-#11 | 1.73 | MA | 16757 | 4726 | 25207 | 3918 | 29723 | 3178 | 31577 | 2616 | 32761 | 1758 | 40313 | 1248 | 27805 |
| 7L-3S | | MI | 17177 | 4726 | 25848 | 3878 | 30676 | 3137 | 33121 | 2584 | 35689 | 1733 | 43649 | 1494 | 26385 |
| 16-#11 | 1.73 | MA | 16186 | 4726 | 24422 | 3919 | 28689 | 3177 | 30286 | 2614 | 31031 | 1763 | 38125 | 1195 | 26843 |
| 8L-2S | | MI | 18006 | 4726 | 26932 | 3878 | 32051 | 3139 | 34787 | 2577 | 37919 | 1727 | 46613 | 1585 | 26428 |
| 16-#14 | 2.50 | MA | 22044 | 5127 | 34205 | 4143 | 41149 | 3334 | 45406 | 2703 | 51353 | 1721 | 64173 | 1550 | 42253 |
| 2L-8S | | MI | 14754 | 5127 | 23811 | 4125 | 27813 | 3322 | 29528 | 2695 | 30818 | 1704 | 38326 | 891 | 31962 |
| 16-#14 | 2.50 | MA | 20741 | 5127 | 32452 | 4144 | 38925 | 3333 | 42712 | 2714 | 47729 | 1729 | 59340 | 1419 | 42080 |
| 3L-7S | | MI | 15459 | 5127 | 24812 | 4126 | 29130 | 3325 | 31172 | 2700 | 32977 | 1696 | 41048 | 964 | 33378 |
| 16-#14 | 2.50 | MA | 19799 | 5127 | 31146 | 4144 | 37161 | 3346 | 40573 | 2710 | 44852 | 1721 | 56161 | 1288 | 41724 |
| 4L-6S | | MI | 16173 | 5127 | 25827 | 4127 | 30473 | 3328 | 32813 | 2691 | 35216 | 1704 | 43650 | 1066 | 34819 |
| 16-#14 | 2.50 | MA | 18946 | 5127 | 29824 | 4159 | 35574 | 3344 | 38637 | 2721 | 42227 | 1729 | 52825 | 1223 | 40176 |
| 5E | | MI | 16902 | 5127 | 26870 | 4127 | 31863 | 3316 | 34504 | 2696 | 37423 | 1696 | 46584 | 1176 | 35680 |

## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

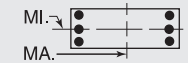
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.50 | MA | 18128 | 5127 | 28650 | 4160 | 34009 | 3357 | 36731 | 2717 | 39703 | 1736 | 49451 | 1114 | 39211 |
| 6L-4S | | MI | 17661 | 5127 | 28043 | 4113 | 33270 | 3320 | 36222 | 2687 | 39718 | 1689 | 49500 | 1238 | 37054 |
| 16-#14 | 2.50 | MA | 17326 | 5127 | 27506 | 4160 | 32496 | 3355 | 34883 | 2728 | 37143 | 1729 | 46453 | 1012 | 37501 |
| 7L-3S | | MI | 18499 | 5127 | 29200 | 4114 | 34834 | 3308 | 38117 | 2692 | 42233 | 1696 | 52257 | 1370 | 37348 |
| 16-#14 | 2.50 | MA | 16534 | 5127 | 26380 | 4160 | 31013 | 3354 | 33031 | 2724 | 34673 | 1736 | 43338 | 936 | 35882 |
| 8L-2S | | MI | 19650 | 5127 | 30749 | 4115 | 36798 | 3311 | 40497 | 2683 | 45401 | 1689 | 56461 | 1501 | 37491 |
| 16-#18 | 4.44 | MA | 22746 | 6145 | 39546 | 4752 | 47543 | 3795 | 53069 | 2988 | 61260 | 1630 | 78256 | 878 | 69046 |
| 4L-6S | | MI | 17741 | 6145 | 31555 | 4735 | 37491 | 3773 | 41222 | 2960 | 46159 | 1605 | 58442 | 491 | 55549 |
| 16-#18 | 4.44 | MA | 21343 | 6145 | 37226 | 4777 | 44759 | 3789 | 49672 | 3005 | 56712 | 1643 | 72477 | 766 | 66403 |
| 5E | | MI | 18941 | 6145 | 33384 | 4739 | 39927 | 3755 | 44186 | 2973 | 49968 | 1592 | 63478 | 685 | 58564 |
| 16-#18 | 4.44 | MA | 19998 | 6145 | 35163 | 4776 | 42010 | 3810 | 46326 | 2995 | 52339 | 1656 | 66660 | 572 | 62791 |
| 6L-4S | | MI | 20191 | 6145 | 35439 | 4716 | 42393 | 3763 | 47194 | 2959 | 53930 | 1578 | 68511 | 793 | 60957 |
| 18-#11 | 1.95 | MA | 20723 | 4840 | 31109 | 3976 | 37319 | 3213 | 40807 | 2628 | 45259 | 1746 | 56186 | 1608 | 33343 |
| 2L-9S | | MI | 14514 | 4840 | 22399 | 3969 | 26202 | 3210 | 27660 | 2628 | 28385 | 1737 | 34917 | 1085 | 26267 |
| 18-#11 | 1.95 | MA | 19793 | 4840 | 29883 | 3977 | 35764 | 3212 | 38924 | 2637 | 42718 | 1752 | 52785 | 1517 | 33270 |
| 3L-8S | | MI | 15013 | 4840 | 23169 | 3958 | 27149 | 3201 | 28789 | 2621 | 29889 | 1731 | 36792 | 1144 | 27067 |
| 18-#11 | 1.95 | MA | 19121 | 4840 | 28972 | 3977 | 34532 | 3222 | 37431 | 2634 | 40703 | 1747 | 50545 | 1426 | 33125 |
| 4L-7S | | MI | 15515 | 4840 | 23867 | 3959 | 28068 | 3203 | 29937 | 2624 | 31408 | 1726 | 38708 | 1195 | 27855 |
| 18-#11 | 1.95 | MA | 18513 | 4840 | 28050 | 3988 | 33425 | 3221 | 36080 | 2643 | 38864 | 1752 | 48201 | 1380 | 32593 |
| 5L-6S | | MI | 16024 | 4840 | 24576 | 3959 | 29006 | 3205 | 31082 | 2617 | 32983 | 1731 | 40545 | 1266 | 28395 |
| 18-#11 | 1.95 | MA | 17930 | 4840 | 27230 | 3989 | 32333 | 3231 | 34750 | 2640 | 37095 | 1757 | 45827 | 1305 | 31888 |
| 6L-5S | | MI | 16543 | 4840 | 25304 | 3959 | 29976 | 3196 | 32263 | 2620 | 34535 | 1726 | 42614 | 1342 | 28977 |
| 18-#11 | 1.95 | MA | 17359 | 4840 | 26433 | 3989 | 31278 | 3230 | 33461 | 2649 | 35302 | 1753 | 43715 | 1234 | 31274 |
| 7L-4S | | MI | 17085 | 4840 | 26123 | 3949 | 30959 | 3198 | 33462 | 2613 | 36150 | 1721 | 44666 | 1386 | 29461 |
| 18-#11 | 1.95 | MA | 16795 | 4840 | 25648 | 3990 | 30244 | 3229 | 32169 | 2646 | 33572 | 1758 | 41526 | 1181 | 30338 |
| 8L-3S | | MI | 17682 | 4840 | 26932 | 3949 | 32051 | 3189 | 34787 | 2617 | 37919 | 1726 | 46613 | 1477 | 29577 |
| 18-#11 | 1.95 | MA | 16235 | 4840 | 24781 | 4001 | 29178 | 3239 | 30898 | 2655 | 31859 | 1763 | 39371 | 1122 | 29416 |
| 9L-2S | | MI | 18504 | 4840 | 28016 | 3949 | 33426 | 3191 | 36452 | 2610 | 40148 | 1721 | 49578 | 1568 | 29634 |
| 18-#14 | 2.81 | MA | 21534 | 5291 | 34205 | 4246 | 41149 | 3407 | 45406 | 2761 | 51353 | 1721 | 64173 | 1397 | 47219 |
| 3L-8S | | MI | 15493 | 5291 | 25360 | 4227 | 29777 | 3396 | 31909 | 2742 | 33987 | 1693 | 42530 | 864 | 36298 |
| 18-#14 | 2.81 | MA | 20603 | 5291 | 32900 | 4246 | 39384 | 3420 | 43267 | 2757 | 48477 | 1713 | 60994 | 1266 | 46781 |
| 4L-7S | | MI | 16189 | 5291 | 26361 | 4228 | 31094 | 3400 | 33553 | 2748 | 36146 | 1686 | 45252 | 937 | 37761 |
| 18-#14 | 2.81 | MA | 19761 | 5291 | 31578 | 4261 | 37798 | 3419 | 41332 | 2769 | 45852 | 1721 | 57657 | 1201 | 45192 |
| 5L-6S | | MI | 16894 | 5291 | 27377 | 4229 | 32438 | 3403 | 35193 | 2738 | 38385 | 1693 | 47853 | 1040 | 39155 |
| 18-#14 | 2.81 | MA | 18954 | 5291 | 30403 | 4262 | 36233 | 3432 | 39426 | 2765 | 43328 | 1728 | 54284 | 1092 | 44145 |
| 6L-5S | | MI | 17614 | 5291 | 28419 | 4230 | 33827 | 3391 | 36885 | 2744 | 40592 | 1686 | 50787 | 1149 | 40099 |
| 18-#14 | 2.81 | MA | 18163 | 5291 | 29260 | 4262 | 34720 | 3430 | 37577 | 2776 | 40768 | 1721 | 51286 | 990 | 42486 |
| 7L-4S | | MI | 18364 | 5291 | 29592 | 4216 | 35235 | 3394 | 38602 | 2734 | 42887 | 1678 | 53704 | 1212 | 41415 |
| 18-#14 | 2.81 | MA | 17382 | 5291 | 28134 | 4262 | 33237 | 3428 | 35725 | 2772 | 38298 | 1728 | 48170 | 914 | 40822 |
| 8L-3S | | MI | 19192 | 5291 | 30749 | 4216 | 36798 | 3383 | 40497 | 2740 | 45401 | 1686 | 56461 | 1343 | 41886 |
| 18-#14 | 2.81 | MA | 16605 | 5291 | 26891 | 4278 | 31709 | 3442 | 33903 | 2783 | 35852 | 1736 | 45111 | 830 | 39040 |
| 9L-2S | | MI | 20330 | 5291 | 32299 | 4217 | 38763 | 3386 | 42877 | 2730 | 48570 | 1678 | 60664 | 1475 | 42055 |
| 18-#18 | 5.00 | MA | 22688 | 6436 | 40293 | 4959 | 48648 | 3922 | 54383 | 3089 | 62992 | 1625 | 80811 | 720 | 74970 |
| 5L-6S | | MI | 18935 | 6436 | 34258 | 4917 | 40919 | 3906 | 45374 | 3044 | 51629 | 1583 | 65660 | 436 | 63166 |
| 18-#18 | 5.00 | MA | 21367 | 6436 | 38229 | 4957 | 45898 | 3943 | 51037 | 3079 | 58618 | 1639 | 74994 | 526 | 71479 |
| 6L-5S | | MI | 20114 | 6436 | 36087 | 4920 | 43355 | 3888 | 48339 | 3057 | 55439 | 1570 | 70696 | 631 | 66066 |
| 20-#11 | 2.17 | MA | 20364 | 4953 | 31109 | 4047 | 37319 | 3264 | 40807 | 2669 | 45259 | 1746 | 56186 | 1503 | 36875 |
| 3L-9S | | MI | 15043 | 4953 | 23483 | 4039 | 27577 | 3262 | 29325 | 2661 | 30614 | 1730 | 37881 | 1068 | 29318 |
| 20-#11 | 2.17 | MA | 19698 | 4953 | 30198 | 4048 | 36087 | 3274 | 39314 | 2667 | 43244 | 1741 | 53946 | 1412 | 36713 |
| 4L-8S | | MI | 15537 | 4953 | 24253 | 4029 | 28524 | 3253 | 30455 | 2654 | 32119 | 1725 | 39757 | 1127 | 30152 |
| 20-#11 | 2.17 | MA | 19096 | 4953 | 29276 | 4059 | 34980 | 3273 | 37963 | 2675 | 41405 | 1747 | 51602 | 1366 | 36097 |
| 5L-7S | | MI | 16035 | 4953 | 24952 | 4029 | 29443 | 3255 | 31602 | 2657 | 33638 | 1720 | 41672 | 1178 | 30916 |
| 20-#11 | 2.17 | MA | 18519 | 4953 | 28456 | 4060 | 33888 | 3282 | 36634 | 2673 | 39637 | 1752 | 49228 | 1291 | 35417 |
| 6E | | MI | 16538 | 4953 | 25660 | 4030 | 30380 | 3257 | 32748 | 2650 | 35212 | 1725 | 43509 | 1250 | 31508 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis

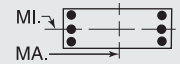


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.17 | MA | 17953 | 4953 | 27659 | 4060 | 32832 | 3282 | 35344 | 2681 | 37844 | 1747 | 47116 | 1220 | 34750 |
| 7L-5S | | MI | 17053 | 4953 | 26388 | 4030 | 31351 | 3248 | 33929 | 2653 | 36765 | 1720 | 45579 | 1325 | 32070 |
| 20-#11 | 2.17 | MA | 17395 | 4953 | 26874 | 4061 | 31798 | 3281 | 34053 | 2679 | 36113 | 1753 | 44928 | 1167 | 33839 |
| 8L-4S | | MI | 17589 | 4953 | 27207 | 4020 | 32333 | 3250 | 35128 | 2646 | 38379 | 1715 | 47631 | 1369 | 32634 |
| 20-#11 | 2.17 | MA | 16841 | 4953 | 26007 | 4072 | 30732 | 3290 | 32782 | 2687 | 34400 | 1758 | 42773 | 1108 | 32886 |
| 9L-3S | | MI | 18181 | 4953 | 28016 | 4020 | 33426 | 3241 | 36452 | 2649 | 40148 | 1720 | 49578 | 1460 | 32765 |
| 20-#11 | 2.17 | MA | 16288 | 4953 | 25225 | 4072 | 29705 | 3290 | 31505 | 2685 | 32638 | 1753 | 40544 | 1028 | 31848 |
| 10L-2S | | MI | 18996 | 4953 | 29100 | 4020 | 34801 | 3243 | 38118 | 2642 | 42377 | 1715 | 52542 | 1552 | 32836 |
| 20-#14 | 3.13 | MA | 21396 | 5455 | 34653 | 4348 | 41608 | 3495 | 45962 | 2805 | 52102 | 1705 | 65827 | 1244 | 51746 |
| 4L-8S | | MI | 16221 | 5455 | 26909 | 4329 | 31742 | 3471 | 34289 | 2789 | 37156 | 1683 | 46733 | 838 | 40644 |
| 20-#14 | 3.13 | MA | 20565 | 5455 | 33332 | 4364 | 40022 | 3494 | 44026 | 2816 | 49477 | 1713 | 62490 | 1179 | 50217 |
| 5L-7S | | MI | 16909 | 5455 | 27910 | 4330 | 33059 | 3474 | 35933 | 2795 | 39315 | 1676 | 49455 | 911 | 42154 |
| 20-#14 | 3.13 | MA | 19767 | 5455 | 32157 | 4364 | 38456 | 3507 | 42120 | 2812 | 46952 | 1720 | 59116 | 1070 | 49091 |
| 6E | | MI | 17605 | 5455 | 28926 | 4331 | 34402 | 3478 | 37574 | 2786 | 41554 | 1683 | 52057 | 1014 | 43502 |
| 20-#14 | 3.13 | MA | 18987 | 5455 | 31013 | 4364 | 36943 | 3505 | 40272 | 2823 | 44393 | 1713 | 56119 | 968 | 47479 |
| 7L-5S | | MI | 18316 | 5455 | 29969 | 4332 | 35792 | 3466 | 39265 | 2791 | 43761 | 1676 | 54990 | 1123 | 44527 |
| 20-#14 | 3.13 | MA | 18215 | 5455 | 29887 | 4365 | 35461 | 3503 | 38420 | 2819 | 41923 | 1720 | 53003 | 892 | 45719 |
| 8L-4S | | MI | 19057 | 5455 | 31141 | 4318 | 37199 | 3469 | 40982 | 2782 | 46055 | 1668 | 57907 | 1185 | 45787 |
| 20-#14 | 3.13 | MA | 17449 | 5455 | 28645 | 4380 | 33933 | 3516 | 36598 | 2830 | 39477 | 1728 | 49943 | 807 | 43963 |
| 9L-3S | | MI | 19875 | 5455 | 32299 | 4319 | 38763 | 3457 | 42877 | 2787 | 48570 | 1676 | 60664 | 1317 | 46420 |
| 20-#18 | 5.56 | MA | 22713 | 6727 | 41296 | 5139 | 49787 | 4076 | 55748 | 3163 | 64898 | 1621 | 83328 | 480 | 80185 |
| 6E | | MI | 20224 | 6727 | 36961 | 5099 | 44347 | 4039 | 49527 | 3128 | 57100 | 1561 | 72878 | 381 | 70801 |
| 22-#11 | 2.38 | MA | 20268 | 5066 | 31424 | 4119 | 37641 | 3326 | 41197 | 2700 | 45785 | 1736 | 57347 | 1398 | 40300 |
| 4L-9S | | MI | 15565 | 5066 | 24567 | 4110 | 28951 | 3314 | 30991 | 2694 | 32844 | 1724 | 40846 | 1051 | 32375 |
| 22-#11 | 2.38 | MA | 19672 | 5066 | 30501 | 4130 | 36535 | 3325 | 39847 | 2708 | 43946 | 1742 | 55004 | 1352 | 39608 |
| 5L-8S | | MI | 16055 | 5066 | 25338 | 4100 | 29898 | 3305 | 32120 | 2687 | 34348 | 1719 | 42721 | 1110 | 33240 |
| 22-#11 | 2.38 | MA | 19100 | 5066 | 29682 | 4130 | 35442 | 3334 | 38517 | 2706 | 42178 | 1747 | 52629 | 1277 | 38949 |
| 6L-7S | | MI | 16548 | 5066 | 26036 | 4100 | 30818 | 3307 | 33268 | 2690 | 35867 | 1714 | 44637 | 1162 | 33984 |
| 22-#11 | 2.38 | MA | 18541 | 5066 | 28885 | 4131 | 34387 | 3334 | 37228 | 2714 | 40385 | 1742 | 50517 | 1206 | 38233 |
| 7L-6S | | MI | 17047 | 5066 | 26745 | 4101 | 31755 | 3308 | 34414 | 2683 | 37441 | 1719 | 46474 | 1233 | 34626 |
| 22-#11 | 2.38 | MA | 17988 | 5066 | 28100 | 4132 | 33353 | 3333 | 35936 | 2712 | 38655 | 1748 | 48329 | 1153 | 37345 |
| 8L-5S | | MI | 17557 | 5066 | 27473 | 4101 | 32726 | 3300 | 35594 | 2686 | 38994 | 1714 | 48543 | 1308 | 35168 |
| 22-#11 | 2.38 | MA | 17439 | 5066 | 27233 | 4143 | 32287 | 3342 | 34665 | 2720 | 36941 | 1753 | 46174 | 1094 | 36361 |
| 9L-4S | | MI | 18088 | 5066 | 28291 | 4091 | 33708 | 3302 | 36794 | 2679 | 40608 | 1708 | 50595 | 1352 | 35804 |
| 22-#11 | 2.38 | MA | 16892 | 5066 | 26451 | 4143 | 31260 | 3342 | 33388 | 2718 | 35179 | 1748 | 43945 | 1014 | 35344 |
| 10L-3S | | MI | 18675 | 5066 | 29100 | 4091 | 34801 | 3293 | 38118 | 2682 | 42377 | 1714 | 52542 | 1444 | 35951 |
| 22-#14 | 3.44 | MA | 21357 | 5618 | 35085 | 4466 | 42246 | 3568 | 46720 | 2863 | 53102 | 1705 | 67323 | 1157 | 55250 |
| 5L-8S | | MI | 16938 | 5618 | 28459 | 4432 | 33707 | 3546 | 36669 | 2837 | 40325 | 1673 | 50936 | 812 | 44957 |
| 22-#14 | 3.44 | MA | 20570 | 5618 | 33911 | 4466 | 40680 | 3581 | 44814 | 2859 | 50577 | 1712 | 63949 | 1048 | 54048 |
| 6L-7S | | MI | 17618 | 5618 | 29459 | 4432 | 35024 | 3549 | 38313 | 2842 | 42484 | 1665 | 53659 | 885 | 46554 |
| 22-#14 | 3.44 | MA | 19799 | 5618 | 32767 | 4467 | 39167 | 3580 | 42966 | 2870 | 48018 | 1705 | 60951 | 946 | 52481 |
| 7L-6S | | MI | 18306 | 5618 | 30475 | 4433 | 36367 | 3552 | 39954 | 2833 | 44722 | 1673 | 56260 | 987 | 47861 |
| 22-#14 | 3.44 | MA | 19037 | 5618 | 31641 | 4467 | 37685 | 3578 | 41114 | 2867 | 45548 | 1712 | 57836 | 870 | 50679 |
| 8L-5S | | MI | 19009 | 5618 | 31518 | 4434 | 37757 | 3541 | 41645 | 2838 | 46929 | 1665 | 59194 | 1096 | 48962 |
| 22-#14 | 3.44 | MA | 18280 | 5618 | 30398 | 4482 | 36157 | 3591 | 39292 | 2878 | 43102 | 1720 | 54776 | 785 | 48893 |
| 9L-4S | | MI | 19742 | 5618 | 32690 | 4420 | 39164 | 3544 | 43362 | 2829 | 49224 | 1658 | 62110 | 1159 | 50172 |
| 24-#11 | 2.60 | MA | 20241 | 5180 | 31727 | 4201 | 38089 | 3377 | 41730 | 2741 | 46487 | 1737 | 58405 | 1338 | 43124 |
| 5L-9S | | MI | 16082 | 5180 | 25651 | 4181 | 30326 | 3366 | 32657 | 2727 | 35073 | 1718 | 43810 | 1034 | 35438 |
| 24-#11 | 2.60 | MA | 19675 | 5180 | 30908 | 4201 | 36997 | 3386 | 40401 | 2739 | 44719 | 1742 | 56030 | 1263 | 42485 |
| 6L-8S | | MI | 16567 | 5180 | 26422 | 4171 | 31273 | 3357 | 33786 | 2720 | 36577 | 1712 | 45686 | 1094 | 36334 |
| 24-#11 | 2.60 | MA | 19121 | 5180 | 30110 | 4202 | 35942 | 3385 | 39111 | 2747 | 42926 | 1737 | 53919 | 1192 | 41721 |
| 7E | | MI | 17055 | 5180 | 27120 | 4171 | 32192 | 3359 | 34934 | 2723 | 38096 | 1707 | 47602 | 1145 | 37057 |
| 24-#11 | 2.60 | MA | 18573 | 5180 | 29325 | 4203 | 34908 | 3385 | 37820 | 2745 | 41196 | 1742 | 51730 | 1139 | 40855 |
| 8L-6S | | MI | 17550 | 5180 | 27829 | 4171 | 33130 | 3360 | 36079 | 2716 | 39671 | 1712 | 49438 | 1216 | 37747 |
| 24-#11 | 2.60 | MA | 18030 | 5180 | 28459 | 4214 | 33842 | 3394 | 36549 | 2753 | 39482 | 1748 | 49575 | 1080 | 39841 |
| 9L-5S | | MI | 18055 | 5180 | 28557 | 4172 | 34100 | 3352 | 37260 | 2719 | 41223 | 1707 | 51508 | 1292 | 38272 |
| 24-#11 | 2.60 | MA | 17488 | 5180 | 27676 | 4214 | 32815 | 3393 | 35272 | 2751 | 37721 | 1743 | 47347 | 1000 | 38823 |
| 10L-4S | | MI | 18582 | 5180 | 29375 | 4161 | 35083 | 3353 | 38459 | 2712 | 42838 | 1702 | 53560 | 1336 | 38974 |

## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#14 | 3.75 | MA | 21362 | 5782 | 35664 | 4568 | 42904 | 3656 | 47509 | 2907 | 54202 | 1704 | 68782 | 1026 | 59014 |
| 6L-8S | | MI | 17647 | 5782 | 30008 | 4534 | 35671 | 3621 | 39049 | 2884 | 43494 | 1663 | 55140 | 785 | 49321 |
| 24-#14 | 3.75 | MA | 20600 | 5782 | 34521 | 4569 | 41391 | 3655 | 45660 | 2918 | 51642 | 1697 | 65784 | 924 | 57489 |
| 7E | | MI | 18319 | 5782 | 31008 | 4535 | 36988 | 3624 | 40693 | 2890 | 45653 | 1655 | 57862 | 858 | 50961 |
| 24-#14 | 3.75 | MA | 19847 | 5782 | 33395 | 4569 | 39909 | 3653 | 43808 | 2914 | 49172 | 1704 | 62668 | 848 | 55647 |
| 8L-6S | | MI | 18999 | 5782 | 32024 | 4535 | 38332 | 3627 | 42334 | 2880 | 47891 | 1663 | 60464 | 961 | 52229 |
| 24-#14 | 3.75 | MA | 19100 | 5782 | 32152 | 4584 | 38381 | 3666 | 41986 | 2925 | 46726 | 1712 | 59608 | 763 | 53832 |
| 9L-5S | | MI | 19694 | 5782 | 33067 | 4536 | 39721 | 3616 | 44025 | 2886 | 50098 | 1655 | 63397 | 1070 | 53404 |

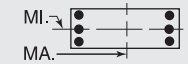
## RECTANGULAR TIED COLUMNS 36" x 42"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.06 | MA | 20114 | 4591 | 28843 | 3843 | 34021 | 3128 | 36272 | 2600 | 37980 | 1837 | 45848 | 1722 | 20097 |
| 2E | | MI | 17097 | 4591 | 24879 | 3796 | 29048 | 3090 | 30819 | 2567 | 31919 | 1799 | 38278 | 1673 | 16972 |
| 6-#18 | 1.59 | MA | 21655 | 4882 | 32091 | 4024 | 38141 | 3261 | 41262 | 2684 | 44665 | 1821 | 54741 | 1679 | 29753 |
| 2L-3S | | MI | 16278 | 4882 | 24879 | 3974 | 29048 | 3215 | 30819 | 2665 | 31919 | 1790 | 38278 | 1385 | 24900 |
| 6-#18 | 1.59 | MA | 19156 | 4882 | 28843 | 4024 | 34021 | 3257 | 36272 | 2702 | 37980 | 1834 | 45848 | 1446 | 29526 |
| 3L-2S | | MI | 18354 | 4882 | 27582 | 3978 | 32476 | 3223 | 34972 | 2651 | 37389 | 1777 | 45496 | 1618 | 25035 |
| 8-#14 | 1.19 | MA | 20608 | 4664 | 29562 | 3913 | 35134 | 3182 | 37706 | 2638 | 40071 | 1852 | 48784 | 1739 | 22725 |
| 2L-4S | | MI | 15420 | 4664 | 22764 | 3869 | 26465 | 3156 | 27774 | 2613 | 28044 | 1818 | 33828 | 1429 | 19067 |
| 8-#14 | 1.19 | MA | 19154 | 4664 | 27706 | 3914 | 32780 | 3181 | 34855 | 2650 | 36223 | 1860 | 43636 | 1607 | 22688 |
| 3E | | MI | 16305 | 4664 | 23922 | 3870 | 28029 | 3144 | 29669 | 2618 | 30559 | 1826 | 36586 | 1561 | 19181 |
| 8-#14 | 1.19 | MA | 18099 | 4664 | 26327 | 3915 | 30915 | 3195 | 32594 | 2647 | 33172 | 1853 | 40246 | 1476 | 22496 |
| 4L-2S | | MI | 17516 | 4664 | 25471 | 3871 | 29994 | 3147 | 32049 | 2609 | 33728 | 1818 | 40789 | 1692 | 19184 |
| 8-#18 | 2.12 | MA | 23148 | 5173 | 35339 | 4206 | 42260 | 3394 | 46253 | 2768 | 51349 | 1805 | 63635 | 1637 | 39358 |
| 2L-4S | | MI | 16045 | 5173 | 25555 | 4152 | 29739 | 3366 | 31656 | 2736 | 33047 | 1755 | 40775 | 1097 | 30979 |
| 8-#18 | 2.12 | MA | 20700 | 5173 | 32091 | 4206 | 38141 | 3390 | 41262 | 2787 | 44665 | 1818 | 54741 | 1403 | 39013 |
| 3E | | MI | 17537 | 5173 | 27582 | 4156 | 32476 | 3348 | 34972 | 2749 | 37389 | 1768 | 45496 | 1330 | 32797 |
| 8-#18 | 2.12 | MA | 18920 | 5173 | 29669 | 4206 | 34867 | 3412 | 37296 | 2778 | 39360 | 1805 | 48898 | 1170 | 36813 |
| 4L-2S | | MI | 19573 | 5173 | 30284 | 4159 | 35904 | 3356 | 39125 | 2736 | 42860 | 1755 | 52714 | 1564 | 33039 |
| 10-#11 | 1.03 | MA | 20172 | 4577 | 28516 | 3871 | 33909 | 3153 | 36267 | 2622 | 38158 | 1863 | 46358 | 1763 | 19866 |
| 2L-5S | | MI | 15124 | 4577 | 21881 | 3841 | 25529 | 3125 | 26673 | 2605 | 26623 | 1841 | 31901 | 1495 | 16686 |
| 10-#11 | 1.03 | MA | 19149 | 4577 | 27219 | 3872 | 32264 | 3152 | 34274 | 2631 | 35470 | 1869 | 42738 | 1671 | 19861 |
| 3L-4S | | MI | 15690 | 4577 | 22700 | 3831 | 26512 | 3127 | 27873 | 2598 | 28237 | 1835 | 33953 | 1539 | 16784 |
| 10-#11 | 1.03 | MA | 18407 | 4577 | 26257 | 3873 | 30962 | 3162 | 32697 | 2629 | 33341 | 1865 | 40352 | 1580 | 19800 |
| 4L-3S | | MI | 16313 | 4577 | 23508 | 3831 | 27604 | 3118 | 29197 | 2601 | 30006 | 1841 | 35900 | 1630 | 16811 |
| 10-#11 | 1.03 | MA | 17736 | 4577 | 25283 | 3885 | 29794 | 3162 | 31270 | 2638 | 31399 | 1871 | 37862 | 1534 | 19635 |
| 5L-2S | | MI | 17166 | 4577 | 24593 | 3831 | 28979 | 3120 | 30863 | 2594 | 32235 | 1835 | 38865 | 1721 | 16797 |
| 10-#14 | 1.49 | MA | 21496 | 4828 | 31418 | 4016 | 37487 | 3257 | 40558 | 2686 | 43918 | 1845 | 53932 | 1719 | 28231 |
| 2L-5S | | MI | 15382 | 4828 | 23141 | 3986 | 27023 | 3228 | 28437 | 2669 | 28918 | 1815 | 35115 | 1340 | 22684 |
| 10-#14 | 1.49 | MA | 20062 | 4828 | 29562 | 4016 | 35134 | 3256 | 37706 | 2698 | 40071 | 1853 | 48784 | 1587 | 28155 |
| 3L-4S | | MI | 16175 | 4828 | 24313 | 3971 | 28430 | 3231 | 30154 | 2660 | 31213 | 1808 | 38032 | 1403 | 23593 |
| 10-#14 | 1.49 | MA | 19022 | 4828 | 28182 | 4017 | 33268 | 3270 | 35446 | 2694 | 37020 | 1845 | 45394 | 1456 | 27913 |
| 4L-3S | | MI | 17049 | 4828 | 25471 | 3972 | 29994 | 3219 | 32049 | 2666 | 33728 | 1815 | 40789 | 1534 | 23753 |
| 10-#14 | 1.49 | MA | 18079 | 4828 | 26786 | 4033 | 31593 | 3269 | 33401 | 2706 | 34235 | 1853 | 41847 | 1390 | 26771 |
| 5L-2S | | MI | 18244 | 4828 | 27020 | 3973 | 31959 | 3222 | 34429 | 2656 | 36897 | 1808 | 44992 | 1666 | 23794 |
| 10-#18 | 2.65 | MA | 24601 | 5464 | 38587 | 4388 | 46379 | 3527 | 51243 | 2852 | 58034 | 1789 | 72528 | 1595 | 48937 |
| 2L-5S | | MI | 15970 | 5464 | 26204 | 4357 | 30701 | 3491 | 32800 | 2834 | 34556 | 1746 | 42959 | 934 | 36373 |
| 10-#18 | 2.65 | MA | 22200 | 5464 | 35339 | 4388 | 42260 | 3523 | 46253 | 2871 | 51349 | 1802 | 63635 | 1361 | 48491 |
| 3L-4S | | MI | 17300 | 5464 | 28258 | 4334 | 33167 | 3499 | 35808 | 2821 | 38517 | 1733 | 47992 | 1042 | 38486 |
| 10-#18 | 2.65 | MA | 20458 | 5464 | 32917 | 4387 | 38987 | 3545 | 42286 | 2863 | 46045 | 1789 | 57791 | 1127 | 45909 |
| 4L-3S | | MI | 18763 | 5464 | 30284 | 4338 | 35904 | 3481 | 39125 | 2833 | 42860 | 1746 | 52714 | 1275 | 40678 |
| 10-#18 | 2.65 | MA | 18878 | 5464 | 30465 | 4414 | 36044 | 3541 | 38695 | 2881 | 41204 | 1802 | 51638 | 1014 | 43157 |
| 5L-2S | | MI | 20762 | 5464 | 32987 | 4341 | 39331 | 3489 | 43277 | 2820 | 48331 | 1733 | 59932 | 1509 | 41014 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis

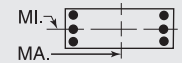



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.24 | MA | 20805 | 4690 | 29813 | 3942 | 35553 | 3205 | 38259 | 2655 | 40846 | 1858 | 49978 | 1750 | 23721 |
| 2L-6S | | MI | 15127 | 4690 | 22237 | 3912 | 25934 | 3185 | 27158 | 2634 | 27299 | 1839 | 32796 | 1403 | 19220 |
| 12-#11 | 1.24 | MA | 19791 | 4690 | 28516 | 3943 | 33909 | 3204 | 36267 | 2664 | 38158 | 1864 | 46358 | 1659 | 23695 |
| 3L-5S | | MI | 15664 | 4690 | 22965 | 3912 | 26904 | 3177 | 28339 | 2638 | 28852 | 1834 | 34865 | 1478 | 19852 |
| 12-#11 | 1.24 | MA | 19058 | 4690 | 27553 | 3944 | 32607 | 3214 | 34689 | 2662 | 36029 | 1860 | 43972 | 1568 | 23611 |
| 4E | | MI | 16224 | 4690 | 23784 | 3902 | 27886 | 3178 | 29538 | 2630 | 30466 | 1829 | 36917 | 1522 | 19976 |
| 12-#11 | 1.24 | MA | 18393 | 4690 | 26579 | 3955 | 31438 | 3214 | 33263 | 2670 | 34087 | 1866 | 41482 | 1521 | 23419 |
| 5L-3S | | MI | 16840 | 4690 | 24593 | 3902 | 28979 | 3170 | 30863 | 2634 | 32235 | 1834 | 38865 | 1613 | 20024 |
| 12-#11 | 1.24 | MA | 17756 | 4690 | 25715 | 3956 | 30285 | 3224 | 31859 | 2669 | 32219 | 1872 | 38955 | 1446 | 22616 |
| 6L-2S | | MI | 17686 | 4690 | 25677 | 3902 | 30354 | 3171 | 32528 | 2627 | 34464 | 1829 | 41829 | 1705 | 20029 |
| 12-#14 | 1.79 | MA | 22369 | 4991 | 33274 | 4118 | 39841 | 3332 | 43409 | 2733 | 47765 | 1837 | 59080 | 1699 | 33724 |
| 2L-6S | | MI | 15382 | 4991 | 23647 | 4087 | 27598 | 3314 | 29125 | 2711 | 29880 | 1813 | 36385 | 1205 | 26218 |
| 12-#14 | 1.79 | MA | 20951 | 4991 | 31418 | 4119 | 37487 | 3331 | 40558 | 2745 | 43918 | 1845 | 53932 | 1567 | 33613 |
| 3L-5S | | MI | 16133 | 4991 | 24690 | 4088 | 28987 | 3302 | 30817 | 2717 | 32087 | 1805 | 39319 | 1314 | 27061 |
| 12-#14 | 1.79 | MA | 19926 | 4991 | 30038 | 4119 | 35622 | 3345 | 38297 | 2742 | 40867 | 1838 | 50542 | 1436 | 33328 |
| 4E | | MI | 16916 | 4991 | 25862 | 4074 | 30395 | 3306 | 32534 | 2707 | 34382 | 1798 | 42235 | 1377 | 28112 |
| 12-#14 | 1.79 | MA | 18996 | 4991 | 28642 | 4135 | 33946 | 3343 | 36252 | 2754 | 38082 | 1846 | 46994 | 1370 | 32043 |
| 5L-3S | | MI | 17778 | 4991 | 27020 | 4075 | 31959 | 3294 | 34429 | 2713 | 36897 | 1805 | 44992 | 1508 | 28313 |
| 12-#14 | 1.79 | MA | 18105 | 4991 | 27402 | 4136 | 32293 | 3357 | 34239 | 2750 | 35405 | 1853 | 43401 | 1261 | 30942 |
| 6L-2S | | MI | 18960 | 4991 | 28569 | 4075 | 33923 | 3297 | 36809 | 2704 | 40066 | 1798 | 49196 | 1639 | 28385 |
| 12-#18 | 3.17 | MA | 26022 | 5755 | 41835 | 4570 | 50498 | 3660 | 56234 | 2937 | 64719 | 1773 | 81421 | 1552 | 58499 |
| 2L-6S | | MI | 15969 | 5755 | 27077 | 4535 | 31692 | 3642 | 33988 | 2906 | 36216 | 1737 | 45141 | 685 | 40801 |
| 12-#18 | 3.17 | MA | 23663 | 5755 | 38587 | 4569 | 46379 | 3656 | 51243 | 2955 | 58034 | 1786 | 72528 | 1319 | 57964 |
| 3L-5S | | MI | 17220 | 5755 | 28906 | 4539 | 34128 | 3624 | 36953 | 2919 | 40026 | 1724 | 50177 | 880 | 44042 |
| 12-#18 | 3.17 | MA | 21955 | 5755 | 36165 | 4569 | 43106 | 3678 | 47277 | 2947 | 52730 | 1773 | 66685 | 1085 | 55048 |
| 4E | | MI | 18524 | 5755 | 30961 | 4516 | 36594 | 3632 | 39961 | 2905 | 43988 | 1711 | 55210 | 987 | 46038 |
| 12-#18 | 3.17 | MA | 20408 | 5755 | 33713 | 4595 | 40163 | 3674 | 43685 | 2965 | 47889 | 1786 | 60531 | 971 | 52430 |
| 5L-3S | | MI | 19960 | 5755 | 32987 | 4519 | 39331 | 3614 | 43277 | 2918 | 48331 | 1724 | 59932 | 1221 | 48550 |
| 12-#18 | 3.17 | MA | 18924 | 5755 | 31533 | 4595 | 37257 | 3697 | 40148 | 2957 | 43233 | 1799 | 54324 | 778 | 48514 |
| 6L-2S | | MI | 21926 | 5755 | 35690 | 4523 | 42759 | 3622 | 47430 | 2904 | 53801 | 1711 | 67150 | 1454 | 48968 |
| 14-#11 | 1.44 | MA | 21429 | 4804 | 31109 | 4013 | 37198 | 3257 | 40251 | 2688 | 43534 | 1853 | 53598 | 1737 | 27566 |
| 2L-7S | | MI | 15143 | 4804 | 22612 | 3982 | 26371 | 3235 | 27678 | 2674 | 27954 | 1828 | 33924 | 1315 | 21884 |
| 14-#11 | 1.44 | MA | 20425 | 4804 | 29813 | 4014 | 35553 | 3256 | 38259 | 2696 | 40846 | 1859 | 49978 | 1646 | 27523 |
| 3L-6S | | MI | 15664 | 4804 | 23321 | 3983 | 27308 | 3237 | 28824 | 2667 | 29528 | 1833 | 35761 | 1386 | 22316 |
| 14-#11 | 1.44 | MA | 19698 | 4804 | 28850 | 4015 | 34251 | 3266 | 36681 | 2695 | 38717 | 1854 | 47591 | 1555 | 27417 |
| 4L-5S | | MI | 16196 | 4804 | 24049 | 3983 | 28279 | 3229 | 30005 | 2670 | 31081 | 1828 | 37830 | 1461 | 22962 |
| 14-#11 | 1.44 | MA | 19041 | 4804 | 27876 | 4026 | 33083 | 3266 | 35255 | 2703 | 36775 | 1860 | 45102 | 1509 | 27174 |
| 5L-4S | | MI | 16750 | 4804 | 24868 | 3973 | 29261 | 3230 | 31204 | 2663 | 32695 | 1823 | 39882 | 1506 | 23162 |
| 14-#11 | 1.44 | MA | 18411 | 4804 | 27011 | 4027 | 31930 | 3276 | 33851 | 2702 | 34907 | 1866 | 42575 | 1433 | 26333 |
| 6L-3S | | MI | 17361 | 4804 | 25677 | 3973 | 30354 | 3222 | 32528 | 2667 | 34464 | 1828 | 41829 | 1597 | 23229 |
| 14-#11 | 1.44 | MA | 17793 | 4804 | 26170 | 4028 | 30815 | 3275 | 32490 | 2710 | 33014 | 1862 | 40325 | 1363 | 25762 |
| 7L-2S | | MI | 18199 | 4804 | 26761 | 3973 | 31729 | 3223 | 34194 | 2660 | 36694 | 1823 | 44794 | 1688 | 23252 |
| 14-#14 | 2.08 | MA | 23226 | 5155 | 35130 | 4220 | 42194 | 3407 | 46261 | 2781 | 51612 | 1830 | 64227 | 1678 | 39207 |
| 2L-7S | | MI | 15403 | 5155 | 24180 | 4188 | 28219 | 3386 | 29865 | 2768 | 30811 | 1795 | 37987 | 1076 | 29286 |
| 14-#14 | 2.08 | MA | 21825 | 5155 | 33274 | 4221 | 39841 | 3406 | 43409 | 2792 | 47765 | 1838 | 59080 | 1547 | 39064 |
| 3L-6S | | MI | 16130 | 5155 | 25196 | 4189 | 29562 | 3389 | 31506 | 2759 | 33049 | 1802 | 40588 | 1178 | 30646 |
| 14-#14 | 2.08 | MA | 20813 | 5155 | 31894 | 4222 | 37976 | 3419 | 41149 | 2789 | 44714 | 1830 | 55689 | 1415 | 38741 |
| 4L-5S | | MI | 16871 | 5155 | 26239 | 4190 | 30952 | 3377 | 33197 | 2764 | 35256 | 1795 | 43522 | 1288 | 31454 |
| 14-#14 | 2.08 | MA | 19897 | 5155 | 30498 | 4237 | 36300 | 3418 | 39104 | 2801 | 41929 | 1838 | 52142 | 1350 | 37331 |
| 5L-4S | | MI | 17644 | 5155 | 27412 | 4176 | 32359 | 3380 | 34914 | 2755 | 37551 | 1787 | 46439 | 1350 | 32628 |
| 14-#14 | 2.08 | MA | 19018 | 5155 | 29257 | 4238 | 34646 | 3432 | 37090 | 2798 | 39252 | 1846 | 48548 | 1241 | 36270 |
| 6L-3S | | MI | 18495 | 5155 | 28569 | 4177 | 33923 | 3369 | 36809 | 2760 | 40066 | 1795 | 49196 | 1482 | 32864 |
| 14-#14 | 2.08 | MA | 18157 | 5155 | 28050 | 4239 | 33048 | 3431 | 35138 | 2810 | 36537 | 1839 | 45352 | 1139 | 34608 |
| 7L-2S | | MI | 19664 | 5155 | 30118 | 4178 | 35888 | 3372 | 39190 | 2751 | 43235 | 1787 | 53399 | 1613 | 32966 |
| 14-#18 | 3.70 | MA | 25095 | 6045 | 41835 | 4751 | 50498 | 3789 | 56234 | 3039 | 64719 | 1770 | 81421 | 1276 | 67434 |
| 3L-6S | | MI | 17214 | 6045 | 29780 | 4717 | 35120 | 3775 | 38141 | 2990 | 41687 | 1715 | 52359 | 630 | 48366 |
| 14-#18 | 3.70 | MA | 23419 | 6045 | 39413 | 4751 | 47225 | 3811 | 52267 | 3031 | 59414 | 1757 | 75578 | 1043 | 64224 |
| 4L-5S | | MI | 18442 | 6045 | 31609 | 4720 | 37556 | 3757 | 41105 | 3003 | 45497 | 1702 | 57395 | 825 | 51578 |
| 14-#18 | 3.70 | MA | 21903 | 6045 | 36961 | 4777 | 44282 | 3807 | 48675 | 3050 | 54573 | 1770 | 69425 | 929 | 61724 |
| 5L-4S | | MI | 19723 | 6045 | 33663 | 4698 | 40022 | 3765 | 44114 | 2989 | 49459 | 1688 | 62428 | 933 | 53626 |

## RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

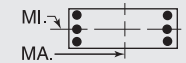
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.70 | MA | 20447 | 6045 | 34781 | 4777 | 41376 | 3830 | 45139 | 3042 | 49918 | 1783 | 63217 | 735 | 57689 |
| 6L-3S | | MI | 21133 | 6045 | 35690 | 4701 | 42759 | 3747 | 47430 | 3002 | 53801 | 1702 | 67150 | 1166 | 56416 |
| 14-#18 | 3.70 | MA | 19022 | 6045 | 32658 | 4777 | 38568 | 3825 | 41708 | 3060 | 45197 | 1770 | 57706 | 553 | 53591 |
| 7L-2S | | MI | 23068 | 6045 | 38393 | 4705 | 46187 | 3755 | 51583 | 2988 | 59272 | 1688 | 74368 | 1400 | 56909 |
| 16-#11 | 1.65 | MA | 22045 | 4917 | 32406 | 4084 | 38842 | 3308 | 42244 | 2721 | 46222 | 1847 | 57218 | 1724 | 31405 |
| 2L-8S | | MI | 15168 | 4917 | 22998 | 4053 | 26826 | 3286 | 28196 | 2704 | 28664 | 1827 | 34973 | 1247 | 24198 |
| 16-#11 | 1.65 | MA | 21049 | 4917 | 31109 | 4085 | 37198 | 3308 | 40251 | 2729 | 43534 | 1853 | 53598 | 1633 | 31346 |
| 3L-7S | | MI | 15678 | 4917 | 23696 | 4053 | 27746 | 3287 | 29344 | 2707 | 30183 | 1822 | 36888 | 1298 | 24999 |
| 16-#11 | 1.65 | MA | 20330 | 4917 | 30147 | 4086 | 35896 | 3318 | 38674 | 2728 | 41405 | 1849 | 51211 | 1542 | 31220 |
| 4L-6S | | MI | 16193 | 4917 | 24405 | 4053 | 28683 | 3289 | 30490 | 2700 | 31758 | 1827 | 38725 | 1369 | 25418 |
| 16-#11 | 1.65 | MA | 19679 | 4917 | 29173 | 4097 | 34727 | 3318 | 37247 | 2736 | 39463 | 1855 | 48722 | 1496 | 30865 |
| 5E | | MI | 16720 | 4917 | 25133 | 4054 | 29654 | 3280 | 31670 | 2703 | 33310 | 1822 | 40794 | 1445 | 26037 |
| 16-#11 | 1.65 | MA | 19056 | 4917 | 28308 | 4098 | 33574 | 3328 | 35843 | 2734 | 37595 | 1861 | 46195 | 1421 | 30056 |
| 6L-4S | | MI | 17269 | 4917 | 25952 | 4043 | 30636 | 3282 | 32870 | 2696 | 34925 | 1816 | 42846 | 1489 | 26343 |
| 16-#11 | 1.65 | MA | 18445 | 4917 | 27466 | 4099 | 32460 | 3327 | 34482 | 2743 | 35702 | 1857 | 43945 | 1350 | 29500 |
| 7L-3S | | MI | 17874 | 4917 | 26761 | 4044 | 31729 | 3274 | 34194 | 2699 | 36694 | 1822 | 44794 | 1580 | 26429 |
| 16-#11 | 1.65 | MA | 17841 | 4917 | 26638 | 4100 | 31368 | 3327 | 33118 | 2741 | 33875 | 1863 | 41620 | 1296 | 28508 |
| 8L-2S | | MI | 18706 | 4917 | 27845 | 4044 | 33104 | 3275 | 35860 | 2692 | 38923 | 1816 | 47758 | 1671 | 26465 |
| 16-#14 | 2.38 | MA | 24070 | 5318 | 36986 | 4322 | 44548 | 3482 | 49112 | 2828 | 55459 | 1822 | 69375 | 1658 | 44683 |
| 2L-8S | | MI | 15439 | 5318 | 24729 | 4290 | 28867 | 3457 | 30601 | 2810 | 31820 | 1792 | 39468 | 976 | 32341 |
| 16-#14 | 2.38 | MA | 22685 | 5318 | 35130 | 4323 | 42194 | 3480 | 46261 | 2840 | 51612 | 1830 | 64227 | 1527 | 44510 |
| 3L-7S | | MI | 16148 | 5318 | 25729 | 4291 | 30184 | 3460 | 32245 | 2815 | 33980 | 1785 | 42190 | 1049 | 33654 |
| 16-#14 | 2.38 | MA | 21686 | 5318 | 33750 | 4324 | 40329 | 3494 | 44000 | 2837 | 48561 | 1823 | 60837 | 1395 | 44154 |
| 4L-6S | | MI | 16865 | 5318 | 26745 | 4291 | 31527 | 3464 | 33886 | 2806 | 36218 | 1792 | 44792 | 1152 | 35082 |
| 16-#14 | 2.38 | MA | 20781 | 5318 | 32354 | 4340 | 38654 | 3493 | 41955 | 2848 | 45776 | 1831 | 57290 | 1330 | 42632 |
| 5E | | MI | 17597 | 5318 | 27788 | 4292 | 32917 | 3452 | 35577 | 2811 | 38425 | 1785 | 47725 | 1261 | 35860 |
| 16-#14 | 2.38 | MA | 19914 | 5318 | 31113 | 4341 | 37000 | 3507 | 39942 | 2845 | 43099 | 1839 | 53696 | 1221 | 41607 |
| 6L-4S | | MI | 18360 | 5318 | 28961 | 4278 | 34324 | 3455 | 37294 | 2802 | 40720 | 1777 | 50642 | 1324 | 37141 |
| 16-#14 | 2.38 | MA | 19065 | 5318 | 29906 | 4341 | 35402 | 3506 | 37990 | 2857 | 40384 | 1831 | 50500 | 1119 | 39880 |
| 7L-3S | | MI | 19202 | 5318 | 30118 | 4279 | 35888 | 3443 | 39190 | 2808 | 43235 | 1785 | 53399 | 1455 | 37409 |
| 16-#14 | 2.38 | MA | 18226 | 5318 | 28717 | 4342 | 33836 | 3504 | 36034 | 2854 | 37765 | 1839 | 47188 | 1043 | 38281 |
| 8L-2S | | MI | 20358 | 5318 | 31667 | 4280 | 37852 | 3447 | 41570 | 2798 | 46404 | 1777 | 57602 | 1587 | 37538 |
| 16-#18 | 4.23 | MA | 24855 | 6336 | 42661 | 4933 | 51344 | 3944 | 57258 | 3115 | 66099 | 1741 | 84471 | 1000 | 73430 |
| 4L-6S | | MI | 18433 | 6336 | 32483 | 4899 | 38548 | 3908 | 42294 | 3074 | 47158 | 1693 | 59577 | 576 | 55955 |
| 16-#18 | 4.23 | MA | 23366 | 6336 | 40209 | 4959 | 48401 | 3940 | 53666 | 3134 | 61258 | 1754 | 78318 | 887 | 70893 |
| 5E | | MI | 19641 | 6336 | 34312 | 4902 | 40984 | 3890 | 45258 | 3087 | 50967 | 1679 | 64613 | 770 | 59043 |
| 16-#18 | 4.23 | MA | 21938 | 6336 | 38029 | 4959 | 45495 | 3963 | 50129 | 3126 | 56602 | 1767 | 72110 | 693 | 66886 |
| 6L-4S | | MI | 20899 | 6336 | 36366 | 4879 | 43450 | 3898 | 48267 | 3073 | 54929 | 1666 | 69646 | 878 | 61243 |
| 16-#18 | 4.23 | MA | 20539 | 6336 | 35906 | 4958 | 42687 | 3958 | 46699 | 3144 | 51882 | 1754 | 66599 | 511 | 62720 |
| 7L-3S | | MI | 22286 | 6336 | 38393 | 4883 | 46187 | 3880 | 51583 | 3086 | 59272 | 1679 | 74368 | 1111 | 64278 |
| 18-#11 | 1.86 | MA | 22654 | 5030 | 33703 | 4155 | 40487 | 3360 | 44236 | 2753 | 48910 | 1842 | 60838 | 1712 | 35239 |
| 2L-9S | | MI | 15200 | 5030 | 23312 | 4134 | 27254 | 3346 | 28733 | 2744 | 29389 | 1826 | 36061 | 1171 | 26552 |
| 18-#11 | 1.86 | MA | 21666 | 5030 | 32406 | 4156 | 38842 | 3360 | 42244 | 2762 | 46222 | 1848 | 57218 | 1620 | 35165 |
| 3L-8S | | MI | 15701 | 5030 | 24082 | 4124 | 28201 | 3337 | 29862 | 2737 | 30894 | 1820 | 37937 | 1230 | 27274 |
| 18-#11 | 1.86 | MA | 20954 | 5030 | 31443 | 4157 | 37541 | 3370 | 40666 | 2760 | 44093 | 1844 | 54831 | 1529 | 35020 |
| 4L-7S | | MI | 16205 | 5030 | 24780 | 4124 | 29120 | 3339 | 31010 | 2740 | 32413 | 1815 | 39853 | 1281 | 28076 |
| 18-#11 | 1.86 | MA | 20309 | 5030 | 30470 | 4168 | 36372 | 3369 | 39240 | 2769 | 42151 | 1850 | 52342 | 1483 | 34566 |
| 5L-6S | | MI | 16716 | 5030 | 25489 | 4124 | 30058 | 3341 | 32155 | 2733 | 33987 | 1820 | 41690 | 1352 | 28527 |
| 18-#11 | 1.86 | MA | 19692 | 5030 | 29605 | 4169 | 35219 | 3379 | 37836 | 2767 | 40283 | 1856 | 49814 | 1408 | 33786 |
| 6L-5S | | MI | 17238 | 5030 | 26217 | 4124 | 31028 | 3332 | 33336 | 2736 | 35540 | 1815 | 43759 | 1428 | 29120 |
| 18-#11 | 1.86 | MA | 19087 | 5030 | 28763 | 4170 | 34105 | 3379 | 36475 | 2776 | 38390 | 1852 | 47565 | 1337 | 33239 |
| 7L-4S | | MI | 17782 | 5030 | 27036 | 4114 | 32011 | 3334 | 34535 | 2729 | 37154 | 1810 | 45811 | 1472 | 29520 |
| 18-#11 | 1.86 | MA | 18490 | 5030 | 27934 | 4171 | 33013 | 3379 | 35111 | 2774 | 36563 | 1858 | 45240 | 1284 | 32210 |
| 8L-3S | | MI | 18381 | 5030 | 27845 | 4114 | 33104 | 3325 | 35860 | 2732 | 38923 | 1815 | 47758 | 1563 | 29623 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis

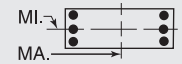


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.86 | MA | 17897 | 5030 | 27019 | 4182 | 31888 | 3389 | 33769 | 2783 | 34755 | 1864 | 42945 | 1225 | 31320 |
| 9L-2S | | MI | 19206 | 5030 | 28929 | 4115 | 34479 | 3327 | 37525 | 2725 | 41152 | 1810 | 50723 | 1654 | 29673 |
| 18-#14 | 2.68 | MA | 23532 | 5482 | 36986 | 4425 | 44548 | 3555 | 49112 | 2887 | 55459 | 1823 | 69375 | 1507 | 49952 |
| 3L-8S | | MI | 16180 | 5482 | 26278 | 4392 | 30831 | 3532 | 32981 | 2857 | 34989 | 1782 | 43671 | 950 | 36672 |
| 18-#14 | 2.68 | MA | 22545 | 5482 | 35606 | 4426 | 42683 | 3569 | 46852 | 2884 | 52408 | 1816 | 65985 | 1375 | 49565 |
| 4L-7S | | MI | 16880 | 5482 | 27278 | 4393 | 32148 | 3535 | 34625 | 2863 | 37149 | 1774 | 46393 | 1023 | 38034 |
| 18-#14 | 2.68 | MA | 21652 | 5482 | 34209 | 4442 | 41007 | 3568 | 44806 | 2896 | 49623 | 1823 | 62438 | 1309 | 47944 |
| 5L-6S | | MI | 17589 | 5482 | 28294 | 4394 | 33492 | 3538 | 36266 | 2853 | 39387 | 1782 | 48995 | 1126 | 39458 |
| 18-#14 | 2.68 | MA | 20796 | 5482 | 32969 | 4443 | 39353 | 3582 | 42793 | 2893 | 46946 | 1831 | 58844 | 1201 | 46950 |
| 6L-5S | | MI | 18312 | 5482 | 29337 | 4394 | 34881 | 3527 | 37957 | 2859 | 41594 | 1774 | 51929 | 1235 | 40277 |
| 18-#14 | 2.68 | MA | 19958 | 5482 | 31762 | 4444 | 37756 | 3580 | 40841 | 2904 | 44231 | 1824 | 55648 | 1098 | 45162 |
| 7L-4S | | MI | 19066 | 5482 | 30510 | 4380 | 36289 | 3530 | 39675 | 2850 | 43889 | 1767 | 54845 | 1297 | 41628 |
| 18-#14 | 2.68 | MA | 19130 | 5482 | 30573 | 4444 | 36190 | 3579 | 38886 | 2901 | 41612 | 1832 | 52335 | 1022 | 43519 |
| 8L-3S | | MI | 19898 | 5482 | 31667 | 4381 | 37852 | 3518 | 41570 | 2855 | 46404 | 1774 | 57602 | 1429 | 41950 |
| 18-#14 | 2.68 | MA | 18307 | 5482 | 29260 | 4460 | 34576 | 3593 | 36961 | 2913 | 39018 | 1840 | 49074 | 938 | 41652 |
| 9L-2S | | MI | 21042 | 5482 | 33216 | 4382 | 39817 | 3521 | 43950 | 2846 | 49573 | 1767 | 61806 | 1560 | 42105 |
| 18-#18 | 4.76 | MA | 24802 | 6627 | 43457 | 5141 | 52520 | 4073 | 58656 | 3218 | 67943 | 1738 | 87211 | 844 | 79984 |
| 5L-6S | | MI | 19631 | 6627 | 35185 | 5080 | 41976 | 4041 | 46446 | 3158 | 52628 | 1671 | 66795 | 521 | 63564 |
| 18-#18 | 4.76 | MA | 23400 | 6627 | 41277 | 5140 | 49614 | 4096 | 55120 | 3210 | 63287 | 1751 | 81004 | 651 | 76102 |
| 6L-5S | | MI | 20818 | 6627 | 37015 | 5084 | 44412 | 4023 | 49411 | 3171 | 56438 | 1657 | 71831 | 716 | 66537 |
| 18-#18 | 4.76 | MA | 22026 | 6627 | 39154 | 5140 | 46806 | 4091 | 51689 | 3228 | 58566 | 1738 | 75492 | 468 | 71868 |
| 7L-4S | | MI | 22056 | 6627 | 39069 | 5061 | 46877 | 4031 | 52419 | 3158 | 60400 | 1644 | 76864 | 823 | 68886 |
| 20-#11 | 2.06 | MA | 22275 | 5144 | 33703 | 4227 | 40487 | 3412 | 44236 | 2795 | 48910 | 1843 | 60838 | 1608 | 38981 |
| 3L-9S | | MI | 15730 | 5144 | 24396 | 4205 | 28629 | 3398 | 30398 | 2777 | 31619 | 1819 | 39026 | 1154 | 29601 |
| 20-#11 | 2.06 | MA | 21569 | 5144 | 32740 | 4228 | 39185 | 3422 | 42659 | 2793 | 46781 | 1839 | 58451 | 1517 | 38819 |
| 4L-8S | | MI | 16227 | 5144 | 25166 | 4195 | 29576 | 3389 | 31528 | 2770 | 33123 | 1814 | 40902 | 1213 | 30356 |
| 20-#11 | 2.06 | MA | 20931 | 5144 | 31766 | 4239 | 38016 | 3421 | 41232 | 2802 | 44839 | 1845 | 55962 | 1470 | 38275 |
| 5L-7S | | MI | 16727 | 5144 | 25864 | 4195 | 30495 | 3391 | 32676 | 2773 | 34642 | 1809 | 42817 | 1264 | 31135 |
| 20-#11 | 2.06 | MA | 20320 | 5144 | 30902 | 4240 | 36863 | 3431 | 39828 | 2800 | 42971 | 1851 | 53434 | 1395 | 37521 |
| 6E | | MI | 17233 | 5144 | 26573 | 4195 | 31433 | 3393 | 33821 | 2766 | 36216 | 1814 | 44654 | 1336 | 31640 |
| 20-#11 | 2.06 | MA | 19722 | 5144 | 30060 | 4241 | 35749 | 3431 | 38467 | 2809 | 41078 | 1847 | 51185 | 1324 | 36920 |
| 7L-5S | | MI | 17749 | 5144 | 27301 | 4195 | 32403 | 3384 | 35002 | 2769 | 37769 | 1809 | 46723 | 1411 | 32211 |
| 20-#11 | 2.06 | MA | 19130 | 5144 | 29231 | 4242 | 34657 | 3431 | 37103 | 2807 | 39251 | 1853 | 48860 | 1271 | 35917 |
| 8L-4S | | MI | 18288 | 5144 | 28120 | 4185 | 33386 | 3386 | 36201 | 2762 | 39383 | 1804 | 48775 | 1455 | 32695 |
| 20-#11 | 2.06 | MA | 18543 | 5144 | 28316 | 4253 | 33532 | 3440 | 35762 | 2816 | 37443 | 1859 | 46565 | 1212 | 34996 |
| 9L-3S | | MI | 18883 | 5144 | 28929 | 4185 | 34479 | 3377 | 37525 | 2765 | 41152 | 1809 | 50723 | 1546 | 32814 |
| 20-#11 | 2.06 | MA | 17958 | 5144 | 27491 | 4254 | 32448 | 3440 | 34414 | 2814 | 35583 | 1854 | 44193 | 1132 | 33861 |
| 10L-2S | | MI | 19701 | 5144 | 30013 | 4186 | 35854 | 3379 | 39191 | 2758 | 43382 | 1804 | 53687 | 1637 | 32877 |
| 20-#14 | 2.98 | MA | 23392 | 5645 | 37461 | 4528 | 45036 | 3644 | 49703 | 2931 | 56255 | 1808 | 71133 | 1355 | 54975 |
| 4L-8S | | MI | 16910 | 5645 | 27827 | 4494 | 32796 | 3607 | 35362 | 2905 | 38158 | 1772 | 47875 | 924 | 41013 |
| 20-#14 | 2.98 | MA | 22510 | 5645 | 36065 | 4544 | 43361 | 3643 | 47658 | 2943 | 53470 | 1816 | 67585 | 1289 | 53266 |
| 5L-7S | | MI | 17602 | 5645 | 28828 | 4495 | 34113 | 3610 | 37006 | 2910 | 40318 | 1764 | 50597 | 997 | 42422 |
| 20-#14 | 2.98 | MA | 21665 | 5645 | 34825 | 4545 | 41707 | 3656 | 45645 | 2940 | 50793 | 1824 | 63992 | 1181 | 52237 |
| 6E | | MI | 18302 | 5645 | 29843 | 4496 | 35456 | 3613 | 38646 | 2901 | 42556 | 1772 | 53199 | 1099 | 43802 |
| 20-#14 | 2.98 | MA | 20837 | 5645 | 33617 | 4546 | 40109 | 3655 | 43693 | 2952 | 48078 | 1817 | 60795 | 1078 | 50453 |
| 7L-5S | | MI | 19017 | 5645 | 30886 | 4497 | 36846 | 3602 | 40338 | 2906 | 44763 | 1764 | 56132 | 1208 | 44703 |
| 20-#14 | 2.98 | MA | 20019 | 5645 | 32429 | 4547 | 38543 | 3654 | 41737 | 2949 | 45459 | 1824 | 57483 | 1002 | 48766 |
| 8L-4S | | MI | 19762 | 5645 | 32059 | 4483 | 38253 | 3605 | 42055 | 2897 | 47058 | 1757 | 59049 | 1271 | 45997 |
| 20-#14 | 2.98 | MA | 19207 | 5645 | 31116 | 4562 | 36930 | 3668 | 39813 | 2960 | 42865 | 1832 | 54222 | 917 | 46940 |
| 9L-3S | | MI | 20585 | 5645 | 33216 | 4483 | 39817 | 3593 | 43950 | 2902 | 49573 | 1764 | 61806 | 1403 | 46487 |
| 20-#18 | 5.29 | MA | 24837 | 6918 | 44525 | 5322 | 53734 | 4228 | 60110 | 3294 | 69972 | 1735 | 89897 | 608 | 85337 |
| 6E | | MI | 20929 | 6918 | 37888 | 5262 | 45403 | 4174 | 50599 | 3243 | 58099 | 1648 | 74013 | 466 | 71193 |
| 20-#18 | 5.29 | MA | 23487 | 6918 | 42402 | 5322 | 50925 | 4224 | 56680 | 3313 | 65251 | 1722 | 84385 | 426 | 81033 |
| 7L-5S | | MI | 22084 | 6918 | 39717 | 5266 | 47839 | 4156 | 53563 | 3255 | 61908 | 1635 | 79049 | 661 | 74056 |
| 22-#11 | 2.27 | MA | 22178 | 5257 | 34037 | 4299 | 40830 | 3474 | 44651 | 2826 | 49469 | 1834 | 62071 | 1504 | 42617 |
| 4L-9S | | MI | 16254 | 5257 | 25480 | 4276 | 30004 | 3450 | 32064 | 2809 | 33848 | 1813 | 41991 | 1137 | 32655 |
| 22-#11 | 2.27 | MA | 21546 | 5257 | 33063 | 4310 | 39661 | 3473 | 43224 | 2835 | 47527 | 1840 | 59582 | 1458 | 41990 |
| 5L-8S | | MI | 16746 | 5257 | 26250 | 4266 | 30951 | 3441 | 33194 | 2802 | 35352 | 1808 | 43866 | 1196 | 33443 |

## RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

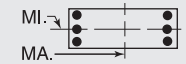
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.27 | MA | 20941 | 5257 | 32198 | 4311 | 38508 | 3483 | 41821 | 2833 | 45659 | 1846 | 57054 | 1383 | 41260 |
| 6L-7S | | MI | 17242 | 5257 | 26949 | 4266 | 31870 | 3443 | 34341 | 2806 | 36871 | 1802 | 45782 | 1248 | 34200 |
| 22-#11 | 2.27 | MA | 20348 | 5257 | 31356 | 4312 | 37394 | 3483 | 40459 | 2842 | 43766 | 1841 | 54805 | 1312 | 40608 |
| 7L-6S | | MI | 17743 | 5257 | 27658 | 4266 | 32808 | 3445 | 35487 | 2799 | 38446 | 1808 | 47619 | 1319 | 34758 |
| 22-#11 | 2.27 | MA | 19762 | 5257 | 30528 | 4313 | 36302 | 3482 | 39096 | 2840 | 41940 | 1847 | 52480 | 1258 | 39629 |
| 8L-5S | | MI | 18255 | 5257 | 28386 | 4266 | 33778 | 3436 | 36668 | 2802 | 39998 | 1802 | 49688 | 1394 | 35309 |
| 22-#11 | 2.27 | MA | 19181 | 5257 | 29613 | 4324 | 35177 | 3492 | 37754 | 2849 | 40131 | 1853 | 50185 | 1200 | 38677 |
| 9L-4S | | MI | 18789 | 5257 | 29204 | 4256 | 34761 | 3438 | 37867 | 2795 | 41612 | 1797 | 51740 | 1438 | 35868 |
| 22-#11 | 2.27 | MA | 18602 | 5257 | 28787 | 4325 | 34093 | 3492 | 36406 | 2847 | 38271 | 1849 | 47813 | 1119 | 37565 |
| 10L-3S | | MI | 19378 | 5257 | 30013 | 4256 | 35854 | 3429 | 39191 | 2798 | 43382 | 1802 | 53687 | 1530 | 36002 |
| 22-#11 | 2.27 | MA | 17999 | 5257 | 27968 | 4326 | 32981 | 3502 | 35072 | 2856 | 36469 | 1855 | 45528 | 1063 | 36313 |
| 11L-2S | | MI | 20190 | 5257 | 31097 | 4256 | 37229 | 3431 | 40857 | 2791 | 45611 | 1797 | 56652 | 1621 | 36078 |
| 22-#14 | 3.27 | MA | 23357 | 5809 | 37921 | 4646 | 45714 | 3717 | 50509 | 2991 | 57317 | 1808 | 72733 | 1269 | 58597 |
| 5L-8S | | MI | 17630 | 5809 | 29376 | 4596 | 34761 | 3682 | 37742 | 2952 | 41327 | 1761 | 52078 | 897 | 45363 |
| 22-#14 | 3.27 | MA | 22522 | 5809 | 36681 | 4647 | 44061 | 3731 | 48496 | 2987 | 54640 | 1816 | 69139 | 1161 | 57489 |
| 6L-7S | | MI | 18314 | 5809 | 30377 | 4597 | 36078 | 3685 | 39386 | 2957 | 43487 | 1754 | 54800 | 970 | 46819 |
| 22-#14 | 3.27 | MA | 21704 | 5809 | 35473 | 4648 | 42463 | 3730 | 46544 | 2999 | 51925 | 1809 | 65943 | 1058 | 55752 |
| 7L-6S | | MI | 19006 | 5809 | 31393 | 4598 | 37421 | 3688 | 41026 | 2948 | 45725 | 1761 | 57402 | 1073 | 48156 |
| 22-#14 | 3.27 | MA | 20896 | 5809 | 34284 | 4649 | 40897 | 3729 | 44588 | 2996 | 49306 | 1817 | 62631 | 982 | 53968 |
| 8L-5S | | MI | 19713 | 5809 | 32436 | 4599 | 38811 | 3676 | 42718 | 2954 | 47932 | 1754 | 60335 | 1182 | 49137 |
| 22-#14 | 3.27 | MA | 20094 | 5809 | 32972 | 4665 | 39284 | 3743 | 42664 | 3008 | 46712 | 1825 | 59370 | 897 | 52191 |
| 9L-4S | | MI | 20450 | 5809 | 33608 | 4585 | 40218 | 3680 | 44435 | 2944 | 50227 | 1746 | 63252 | 1245 | 50379 |
| 22-#18 | 5.82 | MA | 24924 | 7208 | 45650 | 5504 | 55045 | 4357 | 61670 | 3397 | 71936 | 1706 | 93279 | 383 | 90214 |
| 7L-6S | | MI | 22086 | 7208 | 40591 | 5444 | 48831 | 4307 | 54752 | 3327 | 63569 | 1626 | 81231 | 412 | 78838 |
| 24-#11 | 2.48 | MA | 22154 | 5371 | 34360 | 4381 | 41306 | 3525 | 45217 | 2868 | 50215 | 1835 | 63202 | 1445 | 45712 |
| 5L-9S | | MI | 16773 | 5371 | 26564 | 4347 | 31379 | 3502 | 33730 | 2842 | 36077 | 1806 | 44955 | 1120 | 35714 |
| 24-#11 | 2.48 | MA | 21554 | 5371 | 33495 | 4382 | 40152 | 3535 | 43813 | 2866 | 48347 | 1841 | 60674 | 1370 | 45003 |
| 6L-8S | | MI | 17260 | 5371 | 27335 | 4337 | 32326 | 3493 | 34859 | 2835 | 37581 | 1801 | 46831 | 1179 | 36535 |
| 24-#11 | 2.48 | MA | 20967 | 5371 | 32653 | 4383 | 39038 | 3535 | 42452 | 2875 | 46454 | 1836 | 58425 | 1299 | 44301 |
| 7E | | MI | 17751 | 5371 | 28033 | 4337 | 33245 | 3495 | 36007 | 2839 | 39100 | 1796 | 48746 | 1231 | 37271 |
| 24-#11 | 2.48 | MA | 20387 | 5371 | 31825 | 4384 | 37947 | 3534 | 41088 | 2873 | 44628 | 1842 | 56100 | 1245 | 43346 |
| 8L-6S | | MI | 18248 | 5371 | 28742 | 4337 | 34183 | 3497 | 37152 | 2831 | 40675 | 1801 | 50583 | 1302 | 37879 |
| 24-#11 | 2.48 | MA | 19811 | 5371 | 30910 | 4395 | 36822 | 3544 | 39746 | 2881 | 42819 | 1848 | 53805 | 1187 | 42363 |
| 9L-5S | | MI | 18755 | 5371 | 29470 | 4337 | 35153 | 3488 | 38333 | 2835 | 42227 | 1796 | 52653 | 1377 | 38412 |
| 24-#11 | 2.48 | MA | 19237 | 5371 | 30084 | 4396 | 35737 | 3544 | 38398 | 2880 | 40959 | 1844 | 51433 | 1107 | 41272 |
| 10L-4S | | MI | 19285 | 5371 | 30288 | 4327 | 36136 | 3490 | 39532 | 2828 | 43842 | 1791 | 54705 | 1422 | 39040 |
| 24-#11 | 2.48 | MA | 18637 | 5371 | 29265 | 4397 | 34625 | 3554 | 37065 | 2888 | 39158 | 1850 | 49148 | 1050 | 40000 |
| 11L-3S | | MI | 19869 | 5371 | 31097 | 4327 | 37229 | 3481 | 40857 | 2831 | 45611 | 1796 | 56652 | 1513 | 39187 |
| 24-#14 | 3.57 | MA | 23367 | 5973 | 38537 | 4749 | 46414 | 3806 | 51348 | 3035 | 58487 | 1809 | 74287 | 1140 | 62751 |
| 6L-8S | | MI | 18341 | 5973 | 30926 | 4699 | 36725 | 3757 | 40122 | 2999 | 44496 | 1751 | 56281 | 871 | 49722 |
| 24-#14 | 3.57 | MA | 22560 | 5973 | 37329 | 4750 | 44816 | 3805 | 49396 | 3047 | 55772 | 1802 | 71091 | 1038 | 61058 |
| 7E | | MI | 19017 | 5973 | 31926 | 4699 | 38042 | 3760 | 41766 | 3005 | 46656 | 1744 | 59004 | 944 | 51224 |
| 24-#14 | 3.57 | MA | 21761 | 5973 | 36140 | 4751 | 43251 | 3804 | 47440 | 3043 | 53153 | 1809 | 67779 | 962 | 59234 |
| 8L-6S | | MI | 19702 | 5973 | 32942 | 4700 | 39386 | 3763 | 43407 | 2995 | 48894 | 1751 | 61605 | 1047 | 52521 |
| 24-#14 | 3.57 | MA | 20968 | 5973 | 34828 | 4767 | 41637 | 3817 | 45516 | 3055 | 50559 | 1817 | 64517 | 877 | 57427 |
| 9L-5S | | MI | 20401 | 5973 | 33985 | 4701 | 40775 | 3751 | 45098 | 3001 | 51101 | 1744 | 64539 | 1156 | 53577 |

## RECTANGULAR TIED COLUMNS 36" x 44"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.01 | MA | 21968 | 4782 | 31271 | 4022 | 36962 | 3276 | 39400 | 2725 | 41230 | 1936 | 49777 | 1821 | 21177 |
| 2E | | MI | 17789 | 4782 | 25806 | 3959 | 30105 | 3224 | 31891 | 2681 | 32918 | 1887 | 39413 | 1758 | 17009 |
| 6-#18 | 1.52 | MA | 23610 | 5073 | 34701 | 4203 | 41311 | 3409 | 44669 | 2809 | 48320 | 1922 | 59229 | 1782 | 31373 |
| 2L-3S | | MI | 16969 | 5073 | 25806 | 4138 | 30105 | 3349 | 31891 | 2779 | 32918 | 1878 | 39413 | 1470 | 24970 |
| 6-#18 | 1.52 | MA | 20962 | 5073 | 31271 | 4204 | 36962 | 3405 | 39400 | 2829 | 41230 | 1935 | 49777 | 1549 | 31146 |
| 3L-2S | | MI | 19050 | 5073 | 28509 | 4141 | 33533 | 3357 | 36044 | 2766 | 38388 | 1865 | 46631 | 1703 | 25078 |
| 8-#14 | 1.14 | MA | 22488 | 4855 | 32023 | 4092 | 38127 | 3330 | 40903 | 2764 | 43360 | 1948 | 52860 | 1838 | 23940 |
| 2L-4S | | MI | 16109 | 4855 | 23682 | 4034 | 27519 | 3292 | 28846 | 2728 | 29047 | 1907 | 34970 | 1515 | 19130 |

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

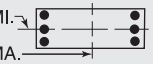
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.14 | MA | 20950 | 4855 | 30065 | 4094 | 35643 | 3329 | 37895 | 2776 | 39301 | 1957 | 47397 | 1707 | 23903 |
| 3E | | MI | 16996 | 4855 | 24840 | 4035 | 29083 | 3280 | 30741 | 2733 | 31562 | 1914 | 37727 | 1646 | 19223 |
| 8-#14 | 1.14 | MA | 19835 | 4855 | 28611 | 4095 | 33678 | 3343 | 35512 | 2773 | 36086 | 1951 | 43795 | 1576 | 23711 |
| 4L-2S | | MI | 18209 | 4855 | 26389 | 4036 | 31048 | 3283 | 33122 | 2724 | 34731 | 1907 | 41931 | 1778 | 19218 |
| 8-#18 | 2.02 | MA | 25202 | 5364 | 38131 | 4385 | 45661 | 3542 | 49939 | 2893 | 55410 | 1907 | 68682 | 1743 | 41518 |
| 2L-4S | | MI | 16734 | 5364 | 26483 | 4316 | 30796 | 3500 | 32728 | 2851 | 34046 | 1843 | 41910 | 1181 | 31287 |
| 8-#18 | 2.02 | MA | 22607 | 5364 | 34701 | 4386 | 41311 | 3538 | 44669 | 2913 | 48320 | 1921 | 59229 | 1509 | 41173 |
| 3E | | MI | 18233 | 5364 | 28509 | 4319 | 33533 | 3482 | 36044 | 2863 | 38388 | 1856 | 46631 | 1415 | 32877 |
| 8-#18 | 2.02 | MA | 20724 | 5364 | 32147 | 4386 | 37859 | 3562 | 40486 | 2906 | 42695 | 1907 | 53011 | 1276 | 39131 |
| 4L-2S | | MI | 20276 | 5364 | 31212 | 4323 | 36960 | 3490 | 40197 | 2850 | 43859 | 1843 | 53849 | 1649 | 33090 |
| 10-#14 | 1.42 | MA | 23434 | 5019 | 33981 | 4195 | 40610 | 3404 | 43912 | 2811 | 47419 | 1941 | 58323 | 1820 | 29750 |
| 2L-5S | | MI | 16070 | 5019 | 24059 | 4150 | 28077 | 3363 | 29509 | 2785 | 29921 | 1904 | 36257 | 1426 | 22867 |
| 10-#14 | 1.42 | MA | 21915 | 5019 | 32023 | 4196 | 38127 | 3404 | 40903 | 2823 | 43360 | 1949 | 52860 | 1689 | 29674 |
| 3L-4S | | MI | 16866 | 5019 | 25231 | 4136 | 29484 | 3366 | 31227 | 2775 | 32216 | 1896 | 39174 | 1488 | 23662 |
| 10-#14 | 1.42 | MA | 20816 | 5019 | 30569 | 4197 | 36161 | 3418 | 38521 | 2821 | 40145 | 1943 | 49259 | 1557 | 29432 |
| 4L-3S | | MI | 17742 | 5019 | 26389 | 4137 | 31048 | 3355 | 33122 | 2781 | 34731 | 1904 | 41931 | 1620 | 23800 |
| 10-#14 | 1.42 | MA | 19820 | 5019 | 29098 | 4213 | 34396 | 3417 | 36366 | 2833 | 37212 | 1952 | 45501 | 1491 | 28352 |
| 5L-2S | | MI | 18941 | 5019 | 27938 | 4138 | 33013 | 3358 | 35502 | 2771 | 37900 | 1896 | 46134 | 1751 | 23832 |
| 10-#18 | 2.53 | MA | 26752 | 5655 | 41560 | 4567 | 50011 | 3675 | 55209 | 2978 | 62500 | 1893 | 78135 | 1704 | 51637 |
| 2L-5S | | MI | 16658 | 5655 | 27131 | 4520 | 31758 | 3625 | 33872 | 2948 | 35555 | 1834 | 44095 | 1019 | 36640 |
| 10-#18 | 2.53 | MA | 24205 | 5655 | 38131 | 4568 | 45661 | 3671 | 49939 | 2997 | 55410 | 1906 | 68682 | 1470 | 51191 |
| 3L-4S | | MI | 17993 | 5655 | 29185 | 4498 | 34223 | 3633 | 36880 | 2935 | 39516 | 1820 | 49128 | 1127 | 38786 |
| 10-#18 | 2.53 | MA | 22361 | 5655 | 35577 | 4568 | 42209 | 3695 | 45756 | 2990 | 49785 | 1893 | 62464 | 1237 | 48750 |
| 4L-3S | | MI | 19463 | 5655 | 31212 | 4501 | 36960 | 3615 | 40197 | 2948 | 43859 | 1834 | 53849 | 1360 | 40765 |
| 10-#18 | 2.53 | MA | 20690 | 5655 | 32992 | 4595 | 39107 | 3692 | 41970 | 3010 | 44650 | 1906 | 55937 | 1121 | 45736 |
| 5L-2S | | MI | 21470 | 5655 | 33914 | 4505 | 40388 | 3623 | 44349 | 2934 | 49329 | 1820 | 61067 | 1594 | 41070 |
| 12-#11 | 1.18 | MA | 22695 | 4881 | 32283 | 4121 | 38564 | 3352 | 41480 | 2780 | 44171 | 1954 | 54109 | 1849 | 24984 |
| 2L-6S | | MI | 15814 | 4881 | 23150 | 4077 | 26986 | 3322 | 28231 | 2750 | 28303 | 1928 | 33941 | 1489 | 19350 |
| 12-#11 | 1.18 | MA | 21623 | 4881 | 30916 | 4123 | 36830 | 3352 | 39379 | 2789 | 41336 | 1960 | 50270 | 1758 | 24959 |
| 3L-5S | | MI | 16353 | 4881 | 23878 | 4077 | 27956 | 3313 | 29412 | 2753 | 29856 | 1923 | 36010 | 1564 | 19916 |
| 12-#11 | 1.18 | MA | 20848 | 4881 | 29902 | 4124 | 35459 | 3362 | 37717 | 2788 | 39093 | 1957 | 47737 | 1667 | 24874 |
| 4E | | MI | 16914 | 4881 | 24697 | 4067 | 28939 | 3315 | 30611 | 2746 | 31470 | 1918 | 38062 | 1608 | 20023 |
| 12-#11 | 1.18 | MA | 20146 | 4881 | 28876 | 4135 | 34228 | 3362 | 36215 | 2797 | 37047 | 1963 | 45101 | 1620 | 24682 |
| 5L-3S | | MI | 17533 | 4881 | 25505 | 4067 | 30032 | 3306 | 31936 | 2749 | 33239 | 1923 | 40009 | 1699 | 20061 |
| 12-#11 | 1.18 | MA | 19474 | 4881 | 27966 | 4137 | 33014 | 3373 | 34737 | 2796 | 35081 | 1970 | 42421 | 1545 | 23902 |
| 6L-2S | | MI | 18380 | 4881 | 26590 | 4068 | 31407 | 3308 | 33601 | 2742 | 35469 | 1918 | 42974 | 1791 | 20060 |
| 12-#14 | 1.70 | MA | 24363 | 5182 | 35939 | 4297 | 43093 | 3479 | 46920 | 2858 | 51478 | 1933 | 63787 | 1801 | 35547 |
| 2L-6S | | MI | 16069 | 5182 | 24565 | 4252 | 28652 | 3450 | 30198 | 2826 | 30883 | 1901 | 37527 | 1290 | 26391 |
| 12-#14 | 1.70 | MA | 22862 | 5182 | 33981 | 4298 | 40610 | 3479 | 43912 | 2871 | 47419 | 1942 | 58323 | 1670 | 35435 |
| 3L-5S | | MI | 16823 | 5182 | 25608 | 4253 | 30041 | 3438 | 31890 | 2832 | 33090 | 1894 | 40460 | 1399 | 27241 |
| 12-#14 | 1.70 | MA | 21778 | 5182 | 32527 | 4299 | 38644 | 3493 | 41529 | 2868 | 44204 | 1936 | 54722 | 1539 | 35151 |
| 4E | | MI | 17609 | 5182 | 26780 | 4239 | 31449 | 3441 | 33607 | 2823 | 35385 | 1886 | 43377 | 1462 | 28186 |
| 12-#14 | 1.70 | MA | 20796 | 5182 | 31056 | 4316 | 36879 | 3492 | 39375 | 2881 | 41271 | 1944 | 50964 | 1472 | 33919 |
| 5L-3S | | MI | 18474 | 5182 | 27938 | 4239 | 33013 | 3429 | 35502 | 2828 | 37900 | 1894 | 46134 | 1594 | 28364 |
| 12-#14 | 1.70 | MA | 19855 | 5182 | 29750 | 4317 | 35137 | 3507 | 37255 | 2878 | 38450 | 1953 | 47150 | 1364 | 32721 |
| 6L-2S | | MI | 19659 | 5182 | 29487 | 4240 | 34977 | 3433 | 37882 | 2819 | 41069 | 1886 | 50337 | 1725 | 28427 |
| 12-#18 | 3.03 | MA | 28267 | 5945 | 44990 | 4749 | 54360 | 3808 | 60478 | 3062 | 69590 | 1879 | 87588 | 1665 | 61739 |
| 2L-6S | | MI | 16653 | 5945 | 28005 | 4699 | 32749 | 3776 | 35060 | 3020 | 37215 | 1825 | 46277 | 770 | 41214 |
| 12-#18 | 3.03 | MA | 25764 | 5945 | 41560 | 4749 | 50011 | 3804 | 55209 | 3081 | 62500 | 1892 | 78135 | 1431 | 61204 |
| 3L-5S | | MI | 17912 | 5945 | 29834 | 4702 | 35185 | 3758 | 38025 | 3033 | 41025 | 1812 | 51313 | 964 | 44304 |
| 12-#18 | 3.03 | MA | 23956 | 5945 | 39007 | 4750 | 46559 | 3828 | 51026 | 3075 | 56875 | 1879 | 71917 | 1198 | 58413 |
| 4E | | MI | 19222 | 5945 | 31888 | 4679 | 37651 | 3766 | 41033 | 3019 | 44987 | 1798 | 56346 | 1072 | 46330 |
| 12-#18 | 3.03 | MA | 22320 | 5945 | 36422 | 4777 | 43457 | 3825 | 47240 | 3094 | 51740 | 1892 | 65390 | 1082 | 55539 |
| 5L-3S | | MI | 20665 | 5945 | 33914 | 4683 | 40388 | 3748 | 44349 | 3032 | 49329 | 1812 | 61067 | 1306 | 48643 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

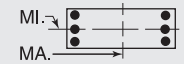
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 3.03 | MA | 20749 | 5945 | 34125 | 4778 | 40394 | 3848 | 43512 | 3087 | 46802 | 1905 | 58791 | 889 | 51585 |
| 6L-2S | | MI | 22640 | 5945 | 36617 | 4686 | 43816 | 3756 | 48502 | 3018 | 54800 | 1798 | 68285 | 1539 | 49029 |
| 14-#11 | 1.38 | MA | 23359 | 4995 | 33651 | 4192 | 40299 | 3404 | 43582 | 2813 | 47006 | 1949 | 57948 | 1838 | 29040 |
| 2L-7S | | MI | 15830 | 4995 | 23525 | 4148 | 27423 | 3372 | 28752 | 2790 | 28958 | 1917 | 35069 | 1401 | 22016 |
| 14-#11 | 1.38 | MA | 22296 | 4995 | 32283 | 4193 | 38564 | 3404 | 41480 | 2822 | 44171 | 1955 | 54109 | 1746 | 28998 |
| 3L-6S | | MI | 16353 | 4995 | 24234 | 4148 | 28361 | 3373 | 29897 | 2783 | 30533 | 1922 | 36905 | 1472 | 22445 |
| 14-#11 | 1.38 | MA | 21529 | 4995 | 31269 | 4195 | 37193 | 3414 | 39818 | 2821 | 41928 | 1952 | 51575 | 1655 | 28891 |
| 4L-5S | | MI | 16886 | 4995 | 24962 | 4148 | 29331 | 3365 | 31078 | 2786 | 32085 | 1917 | 38975 | 1547 | 23083 |
| 14-#11 | 1.38 | MA | 20835 | 4995 | 30244 | 4206 | 35962 | 3414 | 38316 | 2830 | 39882 | 1958 | 48940 | 1609 | 28676 |
| 5L-4S | | MI | 17442 | 4995 | 25781 | 4138 | 30314 | 3366 | 32277 | 2779 | 33700 | 1912 | 41027 | 1592 | 23212 |
| 14-#11 | 1.38 | MA | 20169 | 4995 | 29333 | 4207 | 34748 | 3424 | 36838 | 2828 | 37916 | 1965 | 46259 | 1534 | 27824 |
| 6L-3S | | MI | 18055 | 4995 | 26590 | 4138 | 31407 | 3358 | 33601 | 2782 | 35469 | 1917 | 42974 | 1683 | 23270 |
| 14-#11 | 1.38 | MA | 19518 | 4995 | 28447 | 4209 | 33575 | 3424 | 35405 | 2837 | 35923 | 1961 | 43872 | 1463 | 27209 |
| 7L-2S | | MI | 18895 | 4995 | 27674 | 4138 | 32782 | 3360 | 35267 | 2775 | 37698 | 1912 | 45939 | 1774 | 23286 |
| 14-#14 | 1.99 | MA | 25276 | 5346 | 37897 | 4399 | 45576 | 3554 | 49929 | 2906 | 55537 | 1926 | 69250 | 1783 | 41333 |
| 2L-7S | | MI | 16090 | 5346 | 25098 | 4353 | 29273 | 3521 | 30938 | 2883 | 31813 | 1883 | 39128 | 1161 | 29558 |
| 14-#14 | 1.99 | MA | 23792 | 5346 | 35939 | 4400 | 43093 | 3553 | 46920 | 2918 | 51478 | 1935 | 63787 | 1651 | 41190 |
| 3L-6S | | MI | 16819 | 5346 | 26114 | 4354 | 30616 | 3525 | 32578 | 2874 | 34052 | 1891 | 41730 | 1264 | 30818 |
| 14-#14 | 1.99 | MA | 22722 | 5346 | 34485 | 4402 | 41127 | 3568 | 44538 | 2916 | 48263 | 1928 | 60185 | 1520 | 40868 |
| 4L-5S | | MI | 17564 | 5346 | 27157 | 4355 | 32006 | 3513 | 34270 | 2879 | 36259 | 1883 | 44664 | 1373 | 31632 |
| 14-#14 | 1.99 | MA | 21754 | 5346 | 33014 | 4418 | 39362 | 3567 | 42383 | 2928 | 45330 | 1937 | 56427 | 1453 | 39503 |
| 5L-4S | | MI | 18339 | 5346 | 28329 | 4341 | 33413 | 3516 | 35987 | 2870 | 38554 | 1876 | 47580 | 1436 | 32706 |
| 14-#14 | 1.99 | MA | 20825 | 5346 | 31708 | 4419 | 37621 | 3581 | 40263 | 2925 | 42509 | 1946 | 52613 | 1345 | 38348 |
| 6L-3S | | MI | 19194 | 5346 | 29487 | 4342 | 34977 | 3504 | 37882 | 2875 | 41069 | 1883 | 50337 | 1567 | 32920 |
| 14-#14 | 1.99 | MA | 19916 | 5346 | 30437 | 4420 | 35938 | 3581 | 38207 | 2938 | 39650 | 1939 | 49218 | 1243 | 36708 |
| 7L-2S | | MI | 20367 | 5346 | 31036 | 4342 | 36942 | 3507 | 40262 | 2866 | 44238 | 1876 | 54541 | 1699 | 33010 |
| 14-#18 | 3.54 | MA | 27290 | 6236 | 44990 | 4931 | 54360 | 3937 | 60478 | 3166 | 69590 | 1878 | 87588 | 1392 | 71214 |
| 3L-6S | | MI | 17902 | 6236 | 30707 | 4880 | 36177 | 3909 | 39213 | 3104 | 42686 | 1803 | 53495 | 715 | 48771 |
| 14-#18 | 3.54 | MA | 25516 | 6236 | 42436 | 4932 | 50909 | 3961 | 56295 | 3159 | 63965 | 1864 | 81370 | 1159 | 68112 |
| 4L-5S | | MI | 19138 | 6236 | 32536 | 4884 | 38613 | 3891 | 42177 | 3117 | 46496 | 1789 | 58530 | 910 | 51991 |
| 14-#18 | 3.54 | MA | 23911 | 6236 | 39851 | 4959 | 47806 | 3958 | 52509 | 3179 | 58830 | 1878 | 74843 | 1043 | 65364 |
| 5L-4S | | MI | 20425 | 6236 | 34591 | 4861 | 41079 | 3899 | 45186 | 3103 | 50457 | 1776 | 63564 | 1018 | 53912 |
| 14-#18 | 3.54 | MA | 22371 | 6236 | 37554 | 4959 | 44744 | 3981 | 48782 | 3172 | 53892 | 1891 | 68244 | 850 | 61289 |
| 6L-3S | | MI | 21844 | 6236 | 36617 | 4865 | 43816 | 3881 | 48502 | 3116 | 54800 | 1789 | 68285 | 1251 | 56514 |
| 14-#18 | 3.54 | MA | 20862 | 6236 | 35318 | 4960 | 41785 | 3978 | 45167 | 3191 | 48886 | 1878 | 62380 | 668 | 57129 |
| 7L-2S | | MI | 23788 | 6236 | 39320 | 4868 | 47244 | 3889 | 52655 | 3103 | 60271 | 1776 | 75503 | 1485 | 56974 |
| 16-#11 | 1.58 | MA | 24015 | 5108 | 35019 | 4263 | 42033 | 3456 | 45683 | 2846 | 49841 | 1944 | 61786 | 1826 | 33089 |
| 2L-8S | | MI | 15855 | 5108 | 23911 | 4219 | 27879 | 3422 | 29270 | 2820 | 29669 | 1916 | 36118 | 1333 | 24400 |
| 16-#11 | 1.58 | MA | 22961 | 5108 | 33651 | 4264 | 40299 | 3456 | 43582 | 2855 | 47006 | 1950 | 57948 | 1735 | 33031 |
| 3L-7S | | MI | 16366 | 5108 | 24609 | 4219 | 28798 | 3424 | 30417 | 2823 | 31188 | 1910 | 38033 | 1384 | 25131 |
| 16-#11 | 1.58 | MA | 22201 | 5108 | 32637 | 4266 | 38928 | 3466 | 41920 | 2853 | 44763 | 1946 | 55414 | 1644 | 32904 |
| 4L-6S | | MI | 16884 | 5108 | 25318 | 4219 | 29736 | 3425 | 31563 | 2816 | 32762 | 1916 | 39870 | 1455 | 25547 |
| 16-#11 | 1.58 | MA | 21513 | 5108 | 31611 | 4277 | 37697 | 3466 | 40417 | 2863 | 42717 | 1953 | 52779 | 1597 | 32645 |
| 5E | | MI | 17412 | 5108 | 26046 | 4219 | 30706 | 3417 | 32744 | 2819 | 34315 | 1910 | 41939 | 1531 | 26177 |
| 16-#11 | 1.58 | MA | 20855 | 5108 | 30701 | 4278 | 36483 | 3476 | 38939 | 2861 | 40751 | 1960 | 50098 | 1522 | 31754 |
| 6L-4S | | MI | 17963 | 5108 | 26865 | 4209 | 31689 | 3418 | 33943 | 2812 | 35929 | 1905 | 43991 | 1575 | 26396 |
| 16-#11 | 1.58 | MA | 20210 | 5108 | 29815 | 4280 | 35310 | 3476 | 37506 | 2870 | 38758 | 1956 | 47711 | 1451 | 31155 |
| 7L-3S | | MI | 18570 | 5108 | 27674 | 4209 | 32782 | 3410 | 35267 | 2815 | 37698 | 1910 | 45939 | 1666 | 26471 |
| 16-#11 | 1.58 | MA | 19573 | 5108 | 28943 | 4281 | 34161 | 3476 | 36071 | 2869 | 36835 | 1962 | 45249 | 1397 | 30186 |
| 8L-2S | | MI | 19404 | 5108 | 28758 | 4209 | 34157 | 3411 | 36933 | 2808 | 39927 | 1905 | 48903 | 1757 | 26502 |
| 16-#14 | 2.27 | MA | 26175 | 5509 | 39855 | 4501 | 48060 | 3629 | 52937 | 2953 | 59596 | 1918 | 74713 | 1764 | 47113 |
| 2L-8S | | MI | 16124 | 5509 | 25647 | 4455 | 29921 | 3593 | 31674 | 2925 | 32823 | 1881 | 40610 | 1062 | 32713 |
| 16-#14 | 2.27 | MA | 24708 | 5509 | 37897 | 4503 | 45576 | 3628 | 49929 | 2965 | 55537 | 1927 | 69250 | 1633 | 46940 |
| 3L-7S | | MI | 16836 | 5509 | 26647 | 4455 | 31238 | 3596 | 33318 | 2931 | 34982 | 1873 | 43332 | 1135 | 33923 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis

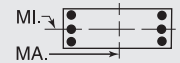



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.27 | MA | 23651 | 5509 | 36443 | 4504 | 43611 | 3643 | 47546 | 2963 | 52322 | 1921 | 65648 | 1502 | 46584 |
| 4L-6S | | MI | 17556 | 5509 | 27663 | 4456 | 32581 | 3599 | 34959 | 2921 | 37221 | 1881 | 45933 | 1238 | 35254 |
| 16-#14 | 2.27 | MA | 22695 | 5509 | 34972 | 4520 | 41846 | 3642 | 45392 | 2975 | 49388 | 1929 | 61890 | 1435 | 45100 |
| 5E | | MI | 18292 | 5509 | 28706 | 4457 | 33971 | 3588 | 36650 | 2927 | 39428 | 1873 | 48867 | 1347 | 36036 |
| 16-#14 | 2.27 | MA | 21779 | 5509 | 33666 | 4521 | 40104 | 3656 | 43272 | 2973 | 46568 | 1938 | 58076 | 1327 | 43984 |
| 6L-4S | | MI | 19059 | 5509 | 29879 | 4443 | 35378 | 3591 | 38367 | 2917 | 41723 | 1866 | 51784 | 1409 | 37223 |
| 16-#14 | 2.27 | MA | 20881 | 5509 | 32395 | 4523 | 38421 | 3656 | 41216 | 2985 | 43709 | 1932 | 54681 | 1224 | 42278 |
| 7L-3S | | MI | 19904 | 5509 | 31036 | 4444 | 36942 | 3579 | 40262 | 2923 | 44238 | 1873 | 54541 | 1541 | 37468 |
| 16-#14 | 2.27 | MA | 19994 | 5509 | 31143 | 4524 | 36773 | 3655 | 39156 | 2983 | 40950 | 1940 | 51172 | 1147 | 40710 |
| 8L-2S | | MI | 21064 | 5509 | 32585 | 4445 | 38907 | 3582 | 42642 | 2913 | 47406 | 1866 | 58744 | 1672 | 37585 |
| 16-#18 | 4.04 | MA | 27044 | 6527 | 45866 | 5113 | 55258 | 4094 | 61565 | 3243 | 71055 | 1850 | 90823 | 1119 | 77842 |
| 4L-6S | | MI | 19126 | 6527 | 33410 | 5062 | 39605 | 4042 | 43366 | 3188 | 48156 | 1781 | 60712 | 660 | 56352 |
| 16-#18 | 4.04 | MA | 25469 | 6527 | 43281 | 5141 | 52156 | 4091 | 57779 | 3263 | 65920 | 1863 | 84296 | 1004 | 75207 |
| 5E | | MI | 20340 | 6527 | 35239 | 5066 | 42041 | 4024 | 46330 | 3201 | 51966 | 1767 | 65748 | 855 | 59514 |
| 16-#18 | 4.04 | MA | 23957 | 6527 | 40984 | 5141 | 49094 | 4114 | 54051 | 3256 | 60982 | 1877 | 77697 | 811 | 71015 |
| 6L-4S | | MI | 21606 | 6527 | 37294 | 5043 | 44506 | 4032 | 49339 | 3188 | 55928 | 1754 | 70781 | 963 | 61524 |
| 16-#18 | 4.04 | MA | 22477 | 6527 | 38747 | 5142 | 46135 | 4111 | 50437 | 3276 | 55976 | 1863 | 71833 | 629 | 66789 |
| 7L-3S | | MI | 23002 | 6527 | 39320 | 5046 | 47244 | 4014 | 52655 | 3200 | 60271 | 1767 | 75503 | 1196 | 64381 |
| 18-#11 | 1.77 | MA | 24662 | 5221 | 36386 | 4334 | 43768 | 3508 | 47784 | 2879 | 52676 | 1938 | 65625 | 1814 | 37134 |
| 2L-9S | | MI | 15886 | 5221 | 24225 | 4300 | 28307 | 3482 | 29806 | 2859 | 30394 | 1914 | 37206 | 1257 | 26831 |
| 18-#11 | 1.77 | MA | 23617 | 5221 | 35019 | 4335 | 42033 | 3508 | 45683 | 2888 | 49841 | 1945 | 61786 | 1723 | 37060 |
| 3L-8S | | MI | 16389 | 5221 | 24995 | 4290 | 29254 | 3474 | 30935 | 2852 | 31898 | 1909 | 39082 | 1316 | 27474 |
| 18-#11 | 1.77 | MA | 22864 | 5221 | 34005 | 4336 | 40662 | 3518 | 44021 | 2886 | 47598 | 1941 | 59253 | 1632 | 36916 |
| 4L-7S | | MI | 16895 | 5221 | 25693 | 4290 | 30173 | 3475 | 32083 | 2856 | 33417 | 1904 | 40998 | 1367 | 28249 |
| 18-#11 | 1.77 | MA | 22183 | 5221 | 32979 | 4348 | 39431 | 3518 | 42519 | 2895 | 45552 | 1948 | 56617 | 1585 | 36550 |
| 5L-6S | | MI | 17408 | 5221 | 26402 | 4290 | 31111 | 3477 | 33228 | 2849 | 34991 | 1909 | 42835 | 1438 | 28655 |
| 18-#11 | 1.77 | MA | 21531 | 5221 | 32069 | 4349 | 38217 | 3528 | 41041 | 2894 | 43586 | 1954 | 53937 | 1510 | 35690 |
| 6L-5S | | MI | 17932 | 5221 | 27130 | 4290 | 32081 | 3468 | 34409 | 2852 | 36544 | 1904 | 44904 | 1514 | 29259 |
| 18-#11 | 1.77 | MA | 20893 | 5221 | 31183 | 4350 | 37044 | 3528 | 39607 | 2903 | 41593 | 1951 | 51550 | 1439 | 35105 |
| 7L-4S | | MI | 18477 | 5221 | 27949 | 4280 | 33064 | 3470 | 35608 | 2845 | 38158 | 1899 | 46956 | 1558 | 29577 |
| 18-#11 | 1.77 | MA | 20262 | 5221 | 30310 | 4352 | 35895 | 3528 | 38172 | 2902 | 39670 | 1957 | 49088 | 1385 | 34094 |
| 8L-3S | | MI | 19079 | 5221 | 28758 | 4280 | 34157 | 3462 | 36933 | 2848 | 39927 | 1904 | 48903 | 1649 | 29668 |
| 18-#11 | 1.77 | MA | 19636 | 5221 | 29347 | 4363 | 34711 | 3538 | 36759 | 2911 | 37765 | 1964 | 46654 | 1327 | 33244 |
| 9L-2S | | MI | 19907 | 5221 | 29842 | 4280 | 35531 | 3463 | 38598 | 2841 | 42156 | 1899 | 51868 | 1740 | 29712 |
| 18-#14 | 2.56 | MA | 25610 | 5673 | 39855 | 4605 | 48060 | 3703 | 52937 | 3013 | 59596 | 1920 | 74713 | 1614 | 52686 |
| 3L-8S | | MI | 16868 | 5673 | 27196 | 4557 | 31885 | 3668 | 34054 | 2972 | 35992 | 1870 | 44813 | 1036 | 37039 |
| 18-#14 | 2.56 | MA | 24565 | 5673 | 38401 | 4606 | 46094 | 3717 | 50555 | 3010 | 56381 | 1913 | 71111 | 1483 | 52299 |
| 4L-7S | | MI | 17571 | 5673 | 28196 | 4558 | 33202 | 3671 | 35698 | 2978 | 38151 | 1863 | 47535 | 1108 | 38299 |
| 18-#14 | 2.56 | MA | 23621 | 5673 | 36930 | 4622 | 44329 | 3717 | 48400 | 3023 | 53447 | 1922 | 67353 | 1416 | 50709 |
| 5L-6S | | MI | 18283 | 5673 | 29212 | 4558 | 34546 | 3674 | 37339 | 2969 | 40390 | 1870 | 50137 | 1211 | 39696 |
| 18-#14 | 2.56 | MA | 22717 | 5673 | 35624 | 4624 | 42587 | 3731 | 46280 | 3020 | 50627 | 1931 | 63539 | 1308 | 49627 |
| 6L-5S | | MI | 19010 | 5673 | 30255 | 4559 | 35935 | 3662 | 39030 | 2974 | 42597 | 1863 | 53070 | 1320 | 40451 |
| 18-#14 | 2.56 | MA | 21831 | 5673 | 34353 | 4625 | 40905 | 3730 | 44224 | 3033 | 47768 | 1924 | 60144 | 1206 | 47858 |
| 7L-4S | | MI | 19767 | 5673 | 31428 | 4545 | 37343 | 3666 | 40747 | 2965 | 44891 | 1855 | 55987 | 1383 | 41737 |
| 18-#14 | 2.56 | MA | 20955 | 5673 | 33102 | 4626 | 39256 | 3730 | 42165 | 3030 | 45009 | 1933 | 56635 | 1129 | 46246 |
| 8L-3S | | MI | 20603 | 5673 | 32585 | 4546 | 38907 | 3654 | 42642 | 2970 | 47406 | 1863 | 58744 | 1514 | 42011 |
| 18-#14 | 2.56 | MA | 20086 | 5673 | 31720 | 4642 | 37557 | 3744 | 40139 | 3043 | 42277 | 1942 | 53172 | 1044 | 44212 |
| 9L-2S | | MI | 21752 | 5673 | 34134 | 4547 | 40871 | 3657 | 45023 | 2961 | 50575 | 1855 | 62948 | 1646 | 42153 |
| 18-#18 | 4.55 | MA | 26998 | 6818 | 46711 | 5322 | 56506 | 4224 | 63049 | 3347 | 73010 | 1849 | 93749 | 965 | 85049 |
| 5L-6S | | MI | 20327 | 6818 | 36113 | 5244 | 43032 | 4175 | 47519 | 3273 | 53627 | 1758 | 67930 | 606 | 63955 |
| 18-#18 | 4.55 | MA | 25513 | 6818 | 44414 | 5323 | 53443 | 4247 | 59321 | 3340 | 68072 | 1862 | 87150 | 772 | 80761 |
| 6L-5S | | MI | 21522 | 6818 | 37942 | 5247 | 45468 | 4157 | 50483 | 3285 | 57437 | 1745 | 72966 | 801 | 66999 |
| 18-#18 | 4.55 | MA | 24059 | 6818 | 42177 | 5324 | 50484 | 4244 | 55706 | 3360 | 63066 | 1849 | 81286 | 590 | 76468 |
| 7L-4S | | MI | 22768 | 6818 | 39996 | 5224 | 47934 | 4165 | 53491 | 3272 | 61399 | 1732 | 77999 | 908 | 69162 |
| 20-#11 | 1.97 | MA | 24265 | 5335 | 36386 | 4406 | 43768 | 3559 | 47784 | 2920 | 52676 | 1940 | 65625 | 1712 | 41087 |
| 3L-9S | | MI | 16418 | 5335 | 25309 | 4371 | 29682 | 3534 | 31472 | 2892 | 32623 | 1908 | 40171 | 1240 | 29876 |
| 20-#11 | 1.97 | MA | 23519 | 5335 | 35372 | 4407 | 42396 | 3570 | 46122 | 2919 | 50433 | 1936 | 63092 | 1620 | 40925 |
| 4L-8S | | MI | 16916 | 5335 | 26079 | 4360 | 30629 | 3526 | 32601 | 2885 | 34127 | 1903 | 42047 | 1299 | 30554 |

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

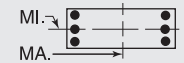
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.97 | MA | 22845 | 5335 | 34347 | 4419 | 41166 | 3570 | 44620 | 2928 | 48387 | 1943 | 60456 | 1574 | 40463 |
| 5L-7S | | MI | 17418 | 5335 | 26777 | 4361 | 31548 | 3527 | 33749 | 2888 | 35646 | 1898 | 43962 | 1350 | 31348 |
| 20-#11 | 1.97 | MA | 22199 | 5335 | 33436 | 4420 | 39952 | 3580 | 43142 | 2927 | 46421 | 1949 | 57776 | 1499 | 39632 |
| 6E | | MI | 17926 | 5335 | 27486 | 4361 | 32486 | 3529 | 34894 | 2881 | 37220 | 1903 | 45799 | 1421 | 31768 |
| 20-#11 | 1.97 | MA | 21567 | 5335 | 32550 | 4421 | 38779 | 3580 | 41709 | 2936 | 44428 | 1945 | 55388 | 1428 | 39059 |
| 7L-5S | | MI | 18445 | 5335 | 28214 | 4361 | 33456 | 3520 | 36075 | 2885 | 38773 | 1898 | 47868 | 1497 | 32349 |
| 20-#11 | 1.97 | MA | 20943 | 5335 | 31678 | 4423 | 37630 | 3580 | 40273 | 2935 | 42505 | 1952 | 52927 | 1374 | 38007 |
| 8L-4S | | MI | 18986 | 5335 | 29033 | 4351 | 34439 | 3522 | 37274 | 2878 | 40387 | 1893 | 49920 | 1541 | 32754 |
| 20-#11 | 1.97 | MA | 20322 | 5335 | 30715 | 4434 | 36445 | 3590 | 38861 | 2944 | 40600 | 1959 | 50492 | 1315 | 37126 |
| 9L-3S | | MI | 19583 | 5335 | 29842 | 4351 | 35531 | 3513 | 38598 | 2881 | 42156 | 1898 | 51868 | 1632 | 32861 |
| 20-#11 | 1.97 | MA | 19705 | 5335 | 29846 | 4435 | 35304 | 3590 | 37442 | 2943 | 38642 | 1955 | 47975 | 1235 | 35891 |
| 10L-2S | | MI | 20404 | 5335 | 30926 | 4351 | 36906 | 3515 | 40264 | 2874 | 44386 | 1893 | 54832 | 1723 | 32918 |
| 20-#14 | 2.84 | MA | 25467 | 5836 | 40359 | 4708 | 48577 | 3792 | 53563 | 3058 | 60440 | 1906 | 76574 | 1464 | 58014 |
| 4L-8S | | MI | 17600 | 5836 | 28745 | 4659 | 33850 | 3743 | 36434 | 3020 | 39161 | 1860 | 49016 | 1009 | 41375 |
| 20-#14 | 2.84 | MA | 24534 | 5836 | 38888 | 4725 | 46812 | 3792 | 51409 | 3070 | 57506 | 1915 | 72817 | 1398 | 56328 |
| 5L-7S | | MI | 18295 | 5836 | 29745 | 4660 | 35167 | 3746 | 38078 | 3025 | 41320 | 1853 | 51739 | 1082 | 42684 |
| 20-#14 | 2.84 | MA | 23641 | 5836 | 37582 | 4726 | 45070 | 3806 | 49289 | 3068 | 54686 | 1923 | 69002 | 1290 | 55277 |
| 6E | | MI | 18999 | 5836 | 30761 | 4661 | 36510 | 3749 | 39719 | 3016 | 43559 | 1860 | 54340 | 1185 | 44095 |
| 20-#14 | 2.84 | MA | 22766 | 5836 | 36311 | 4727 | 43388 | 3805 | 47233 | 3080 | 51827 | 1917 | 65608 | 1187 | 53446 |
| 7L-5S | | MI | 19717 | 5836 | 31804 | 4662 | 37900 | 3737 | 41410 | 3021 | 45765 | 1853 | 57274 | 1294 | 44875 |
| 20-#14 | 2.84 | MA | 21902 | 5836 | 35060 | 4728 | 41739 | 3805 | 45173 | 3078 | 49068 | 1925 | 62098 | 1110 | 51791 |
| 8L-4S | | MI | 20467 | 5836 | 32977 | 4647 | 39307 | 3740 | 43128 | 3012 | 48060 | 1845 | 60190 | 1357 | 46203 |
| 20-#14 | 2.84 | MA | 21043 | 5836 | 33678 | 4745 | 40040 | 3819 | 43147 | 3090 | 46336 | 1934 | 58635 | 1026 | 49799 |
| 9L-3S | | MI | 21293 | 5836 | 34134 | 4648 | 40871 | 3729 | 45023 | 3018 | 50575 | 1853 | 62948 | 1488 | 46551 |
| 20-#18 | 5.05 | MA | 27043 | 7109 | 47843 | 5505 | 57793 | 4380 | 64591 | 3424 | 75162 | 1848 | 96603 | 733 | 90525 |
| 6E | | MI | 21510 | 7109 | 38816 | 5426 | 46460 | 4308 | 51671 | 3357 | 59098 | 1736 | 75148 | 551 | 71576 |
| 20-#18 | 5.05 | MA | 25613 | 7109 | 45607 | 5505 | 54834 | 4377 | 60976 | 3444 | 70156 | 1835 | 90739 | 551 | 86164 |
| 7L-5S | | MI | 22798 | 7109 | 40645 | 5429 | 48896 | 4290 | 54636 | 3370 | 62907 | 1723 | 80184 | 746 | 74510 |
| 22-#11 | 2.17 | MA | 24166 | 5448 | 36740 | 4478 | 44131 | 3622 | 48224 | 2952 | 53268 | 1931 | 66930 | 1609 | 44933 |
| 4L-9S | | MI | 16943 | 5448 | 26393 | 4441 | 31057 | 3586 | 33137 | 2925 | 34852 | 1902 | 43135 | 1223 | 32927 |
| 22-#11 | 2.17 | MA | 23499 | 5448 | 35714 | 4490 | 42900 | 3622 | 46721 | 2961 | 51222 | 1937 | 64295 | 1562 | 44384 |
| 5L-8S | | MI | 17437 | 5448 | 27163 | 4431 | 32004 | 3577 | 34267 | 2918 | 36356 | 1897 | 45011 | 1282 | 33639 |
| 22-#11 | 2.17 | MA | 22859 | 5448 | 34804 | 4491 | 41686 | 3632 | 45243 | 2960 | 49256 | 1944 | 61614 | 1487 | 43578 |
| 6L-7S | | MI | 17935 | 5448 | 27862 | 4431 | 32923 | 3579 | 35414 | 2921 | 37875 | 1891 | 46927 | 1334 | 34410 |
| 22-#11 | 2.17 | MA | 22233 | 5448 | 33918 | 4492 | 40513 | 3632 | 43810 | 2969 | 47263 | 1940 | 59227 | 1416 | 43000 |
| 7L-6S | | MI | 18438 | 5448 | 28570 | 4432 | 33861 | 3581 | 36560 | 2914 | 39450 | 1897 | 48764 | 1405 | 34885 |
| 22-#11 | 2.17 | MA | 21615 | 5448 | 33046 | 4493 | 39364 | 3632 | 42374 | 2968 | 45340 | 1947 | 56766 | 1362 | 41926 |
| 8L-5S | | MI | 18953 | 5448 | 29298 | 4432 | 34831 | 3572 | 37741 | 2918 | 41002 | 1891 | 50833 | 1480 | 35445 |
| 22-#11 | 2.17 | MA | 21000 | 5448 | 32082 | 4505 | 38180 | 3642 | 40962 | 2977 | 43435 | 1953 | 54331 | 1304 | 41013 |
| 9L-4S | | MI | 19489 | 5448 | 30117 | 4422 | 35814 | 3574 | 38940 | 2910 | 42617 | 1886 | 52885 | 1524 | 35930 |
| 22-#11 | 2.17 | MA | 20389 | 5448 | 31214 | 4506 | 37039 | 3642 | 39543 | 2975 | 41477 | 1950 | 51814 | 1224 | 39802 |
| 10L-3S | | MI | 20081 | 5448 | 30926 | 4422 | 36906 | 3565 | 40264 | 2914 | 44386 | 1891 | 54832 | 1616 | 36051 |
| 22-#11 | 2.17 | MA | 19743 | 5448 | 30351 | 4507 | 35868 | 3652 | 38139 | 2984 | 39581 | 1956 | 49395 | 1167 | 38559 |
| 11L-2S | | MI | 20896 | 5448 | 32010 | 4422 | 38281 | 3567 | 41930 | 2907 | 46615 | 1886 | 57797 | 1707 | 36120 |
| 22-#14 | 3.13 | MA | 25435 | 6000 | 40846 | 4827 | 49295 | 3866 | 54417 | 3118 | 61565 | 1907 | 78280 | 1379 | 61956 |
| 5L-8S | | MI | 18322 | 6000 | 30294 | 4761 | 35815 | 3817 | 38814 | 3067 | 42330 | 1850 | 53220 | 983 | 45721 |
| 22-#14 | 3.13 | MA | 24553 | 6000 | 39540 | 4828 | 47554 | 3881 | 52297 | 3115 | 58745 | 1916 | 74465 | 1271 | 60933 |
| 6L-7S | | MI | 19010 | 6000 | 31295 | 4762 | 37132 | 3821 | 40459 | 3073 | 44489 | 1842 | 55942 | 1056 | 47078 |
| 22-#14 | 3.13 | MA | 23688 | 6000 | 38269 | 4829 | 45871 | 3880 | 50241 | 3127 | 55886 | 1909 | 71071 | 1169 | 59043 |
| 7L-6S | | MI | 19706 | 6000 | 32310 | 4763 | 38475 | 3824 | 42099 | 3063 | 46727 | 1850 | 58544 | 1159 | 48445 |
| 22-#14 | 3.13 | MA | 22834 | 6000 | 37018 | 4831 | 44222 | 3879 | 48182 | 3125 | 53127 | 1918 | 67561 | 1092 | 57344 |
| 8L-5S | | MI | 20416 | 6000 | 33353 | 4764 | 39865 | 3812 | 43791 | 3069 | 48934 | 1842 | 61477 | 1268 | 49307 |
| 22-#14 | 3.13 | MA | 21986 | 6000 | 35636 | 4847 | 42523 | 3894 | 46156 | 3137 | 50395 | 1927 | 64098 | 1007 | 55393 |
| 9L-4S | | MI | 21158 | 6000 | 34526 | 4750 | 41272 | 3815 | 45508 | 3059 | 51229 | 1835 | 64394 | 1330 | 50582 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

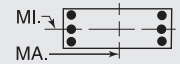
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#18 | 5.56 | MA | 27143 | 7399 | 49036 | 5687 | 59184 | 4510 | 66246 | 3528 | 77246 | 1821 | 100192 | 511 | 95876 |
| 7L-6S | | MI | 22796 | 7399 | 41518 | 5607 | 49888 | 4441 | 55824 | 3441 | 64568 | 1714 | 82366 | 496 | 79215 |
| 24-#11 | 2.36 | MA | 24145 | 5562 | 37082 | 4561 | 44635 | 3673 | 48823 | 2994 | 54057 | 1932 | 68134 | 1550 | 48311 |
| 5L-9S | | MI | 17463 | 5562 | 27477 | 4512 | 32432 | 3638 | 34803 | 2958 | 37081 | 1895 | 46100 | 1206 | 35984 |
| 24-#11 | 2.36 | MA | 23512 | 5562 | 36171 | 4562 | 43420 | 3684 | 47344 | 2993 | 52091 | 1939 | 65453 | 1475 | 47529 |
| 6L-8S | | MI | 17953 | 5562 | 28248 | 4502 | 33379 | 3629 | 35932 | 2951 | 38586 | 1890 | 47976 | 1265 | 36730 |
| 24-#11 | 2.36 | MA | 22891 | 5562 | 35285 | 4563 | 42248 | 3684 | 45911 | 3002 | 50098 | 1935 | 63066 | 1405 | 46898 |
| 7E | | MI | 18446 | 5562 | 28946 | 4502 | 34298 | 3631 | 37080 | 2954 | 40105 | 1885 | 49891 | 1317 | 37479 |
| 24-#11 | 2.36 | MA | 22279 | 5562 | 34413 | 4564 | 41098 | 3684 | 44476 | 3000 | 48174 | 1942 | 60604 | 1351 | 45849 |
| 8L-6S | | MI | 18945 | 5562 | 29655 | 4503 | 35235 | 3633 | 38225 | 2947 | 41679 | 1890 | 51728 | 1388 | 38006 |
| 24-#11 | 2.36 | MA | 21670 | 5562 | 33450 | 4576 | 39914 | 3694 | 43063 | 3010 | 46270 | 1948 | 58170 | 1292 | 44906 |
| 9L-5S | | MI | 19455 | 5562 | 30383 | 4503 | 36206 | 3624 | 39406 | 2950 | 43232 | 1885 | 53797 | 1463 | 38547 |
| 24-#11 | 2.36 | MA | 21064 | 5562 | 32581 | 4577 | 38773 | 3694 | 41644 | 3008 | 44312 | 1944 | 55653 | 1212 | 43717 |
| 10L-4S | | MI | 19987 | 5562 | 31201 | 4493 | 37188 | 3626 | 40606 | 2943 | 44846 | 1880 | 55849 | 1508 | 39103 |
| 24-#11 | 2.36 | MA | 20420 | 5562 | 31719 | 4578 | 37602 | 3704 | 40241 | 3017 | 42416 | 1951 | 53234 | 1155 | 42453 |
| 11L-3S | | MI | 20574 | 5562 | 32010 | 4493 | 38281 | 3617 | 41930 | 2947 | 46615 | 1885 | 57797 | 1599 | 39238 |
| 24-#14 | 3.41 | MA | 25452 | 6164 | 41498 | 4930 | 50037 | 3955 | 55306 | 3162 | 62804 | 1908 | 79928 | 1253 | 66515 |
| 6L-8S | | MI | 19035 | 6164 | 31843 | 4863 | 37779 | 3892 | 41195 | 3115 | 45499 | 1840 | 57423 | 956 | 50075 |
| 24-#14 | 3.41 | MA | 24598 | 6164 | 40227 | 4932 | 48354 | 3955 | 53250 | 3175 | 59945 | 1902 | 76534 | 1150 | 64647 |
| 7E | | MI | 19716 | 6164 | 32844 | 4864 | 39096 | 3895 | 42839 | 3120 | 47658 | 1832 | 60145 | 1029 | 51479 |
| 24-#14 | 3.41 | MA | 23754 | 6164 | 38976 | 4933 | 46706 | 3954 | 51190 | 3172 | 57186 | 1911 | 73024 | 1073 | 62905 |
| 8L-6S | | MI | 20404 | 6164 | 33860 | 4865 | 40440 | 3899 | 44479 | 3111 | 49896 | 1840 | 62747 | 1132 | 52806 |
| 24-#14 | 3.41 | MA | 22915 | 6164 | 37594 | 4949 | 45007 | 3969 | 49164 | 3185 | 54454 | 1919 | 69562 | 989 | 60993 |
| 9L-5S | | MI | 21107 | 6164 | 34902 | 4866 | 41829 | 3887 | 46171 | 3116 | 52103 | 1832 | 65680 | 1241 | 53746 |

## RECTANGULAR TIED COLUMNS 36" x 46"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.45 | MA | 25643 | 5264 | 37400 | 4382 | 44595 | 3556 | 48195 | 2934 | 52064 | 2021 | 63853 | 1884 | 32993 |
| 2L-3S | | MI | 17660 | 5264 | 26733 | 4301 | 31162 | 3484 | 32963 | 2893 | 33917 | 1966 | 40549 | 1554 | 25037 |
| 6-#18 | 1.45 | MA | 22845 | 5264 | 33789 | 4384 | 40014 | 3554 | 42646 | 2955 | 44577 | 2035 | 53840 | 1650 | 32766 |
| 3L-2S | | MI | 19747 | 5264 | 29436 | 4305 | 34589 | 3492 | 37116 | 2880 | 39387 | 1953 | 47767 | 1788 | 25121 |
| 8-#14 | 1.09 | MA | 24445 | 5046 | 34573 | 4271 | 41232 | 3477 | 44219 | 2889 | 46765 | 2044 | 57071 | 1937 | 25155 |
| 2L-4S | | MI | 16797 | 5046 | 24600 | 4199 | 28573 | 3427 | 29919 | 2843 | 30049 | 1995 | 36112 | 1600 | 19189 |
| 8-#14 | 1.09 | MA | 22822 | 5046 | 32513 | 4273 | 38619 | 3477 | 41053 | 2902 | 42494 | 2054 | 51292 | 1806 | 25118 |
| 3E | | MI | 17687 | 5046 | 25757 | 4200 | 30137 | 3415 | 31814 | 2849 | 32564 | 2003 | 38869 | 1732 | 19264 |
| 8-#14 | 1.09 | MA | 21648 | 5046 | 30985 | 4275 | 36553 | 3492 | 38549 | 2900 | 39114 | 2048 | 47479 | 1675 | 24926 |
| 4L-2S | | MI | 18902 | 5046 | 27306 | 4201 | 32102 | 3419 | 34194 | 2839 | 35733 | 1995 | 43072 | 1863 | 19250 |
| 8-#18 | 1.93 | MA | 27334 | 5555 | 41012 | 4564 | 49175 | 3689 | 53744 | 3018 | 59550 | 2008 | 73866 | 1848 | 43678 |
| 2L-4S | | MI | 17424 | 5555 | 27410 | 4479 | 31852 | 3635 | 33800 | 2965 | 35045 | 1930 | 43045 | 1266 | 31588 |
| 8-#18 | 1.93 | MA | 24591 | 5555 | 37400 | 4566 | 44595 | 3687 | 48195 | 3039 | 52064 | 2021 | 63853 | 1614 | 43333 |
| 3E | | MI | 18927 | 5555 | 29436 | 4483 | 34589 | 3617 | 37116 | 2978 | 39387 | 1944 | 47767 | 1500 | 32952 |
| 8-#18 | 1.93 | MA | 22605 | 5555 | 34715 | 4567 | 40964 | 3711 | 43796 | 3034 | 46126 | 2009 | 57259 | 1381 | 41475 |
| 4L-2S | | MI | 20977 | 5555 | 32139 | 4486 | 38017 | 3625 | 41269 | 2964 | 44858 | 1930 | 54985 | 1733 | 33141 |
| 10-#14 | 1.36 | MA | 25449 | 5210 | 36633 | 4374 | 43845 | 3552 | 47384 | 2936 | 51036 | 2037 | 62850 | 1920 | 31269 |
| 2L-5S | | MI | 16758 | 5210 | 24976 | 4315 | 29131 | 3499 | 30582 | 2900 | 30923 | 1992 | 37399 | 1511 | 23045 |
| 10-#14 | 1.36 | MA | 23846 | 5210 | 34573 | 4375 | 41232 | 3552 | 44219 | 2949 | 46765 | 2046 | 57071 | 1789 | 31193 |
| 3L-4S | | MI | 17556 | 5210 | 26149 | 4301 | 30538 | 3502 | 32299 | 2890 | 33218 | 1985 | 40315 | 1574 | 23727 |
| 10-#14 | 1.36 | MA | 22687 | 5210 | 33045 | 4377 | 39166 | 3566 | 41715 | 2947 | 43385 | 2041 | 53258 | 1658 | 30951 |
| 4L-3S | | MI | 18435 | 5210 | 27306 | 4302 | 32102 | 3490 | 34194 | 2896 | 35733 | 1992 | 43072 | 1706 | 23846 |
| 10-#14 | 1.36 | MA | 21639 | 5210 | 31500 | 4394 | 37312 | 3566 | 39451 | 2960 | 40303 | 2050 | 49290 | 1590 | 29945 |
| 5L-2S | | MI | 19637 | 5210 | 28856 | 4303 | 34067 | 3493 | 36575 | 2887 | 38902 | 1985 | 47276 | 1837 | 23868 |
| 10-#18 | 2.42 | MA | 28981 | 5846 | 44623 | 4746 | 53755 | 3822 | 59293 | 3103 | 67037 | 1994 | 83879 | 1812 | 54337 |
| 2L-5S | | MI | 17346 | 5846 | 28058 | 4684 | 32814 | 3760 | 34944 | 3063 | 36553 | 1921 | 45230 | 1104 | 36898 |
| 10-#18 | 2.42 | MA | 26289 | 5846 | 41012 | 4747 | 49175 | 3820 | 53744 | 3123 | 59550 | 2008 | 73866 | 1578 | 53891 |
| 3L-4S | | MI | 18687 | 5846 | 30113 | 4661 | 35280 | 3768 | 37953 | 3049 | 40515 | 1908 | 50263 | 1212 | 39079 |
| 10-#18 | 2.42 | MA | 24343 | 5846 | 38326 | 4749 | 45545 | 3844 | 49345 | 3118 | 53612 | 1995 | 67272 | 1345 | 51617 |
| 4L-3S | | MI | 20162 | 5846 | 32139 | 4665 | 38017 | 3750 | 41269 | 3062 | 44858 | 1921 | 54985 | 1445 | 40848 |

## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

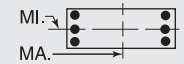
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 2.42 | MA | 22580 | 5846 | 35609 | 4777 | 42283 | 3842 | 45364 | 3139 | 48194 | 2009 | 60371 | 1228 | 48330 |
| 5L-2S | | MI | 22177 | 5846 | 34842 | 4668 | 41445 | 3758 | 45422 | 3048 | 50328 | 1908 | 62202 | 1679 | 41125 |
| 12-#11 | 1.13 | MA | 24663 | 5072 | 34844 | 4300 | 41688 | 3499 | 44821 | 2905 | 47611 | 2050 | 58374 | 1948 | 26248 |
| 2L-6S | | MI | 16502 | 5072 | 24063 | 4243 | 28039 | 3458 | 29304 | 2866 | 29308 | 2017 | 35086 | 1575 | 19477 |
| 12-#11 | 1.13 | MA | 23531 | 5072 | 33405 | 4302 | 39864 | 3500 | 42611 | 2914 | 44629 | 2057 | 54316 | 1857 | 26223 |
| 3L-5S | | MI | 17042 | 5072 | 24791 | 4243 | 29009 | 3449 | 30485 | 2869 | 30860 | 2012 | 37155 | 1650 | 19976 |
| 12-#11 | 1.13 | MA | 22715 | 5072 | 32340 | 4303 | 38423 | 3510 | 40864 | 2914 | 42272 | 2054 | 51636 | 1766 | 26138 |
| 4E | | MI | 17605 | 5072 | 25610 | 4233 | 29992 | 3451 | 31685 | 2862 | 32475 | 2007 | 39207 | 1694 | 20067 |
| 12-#11 | 1.13 | MA | 21976 | 5072 | 31263 | 4315 | 37131 | 3510 | 39286 | 2923 | 40123 | 2061 | 48854 | 1719 | 25946 |
| 5L-3S | | MI | 18225 | 5072 | 26418 | 4233 | 31084 | 3442 | 33009 | 2865 | 34244 | 2012 | 41154 | 1785 | 20097 |
| 12-#11 | 1.13 | MA | 21269 | 5072 | 30307 | 4317 | 35855 | 3521 | 37734 | 2922 | 38058 | 2068 | 46021 | 1644 | 25195 |
| 6L-2S | | MI | 19074 | 5072 | 27503 | 4233 | 32459 | 3444 | 34674 | 2858 | 36473 | 2007 | 44119 | 1877 | 20091 |
| 12-#14 | 1.63 | MA | 26435 | 5373 | 38694 | 4476 | 46458 | 3626 | 50550 | 2983 | 55307 | 2030 | 68628 | 1903 | 37369 |
| 2L-6S | | MI | 16757 | 5373 | 25483 | 4417 | 29706 | 3585 | 31271 | 2942 | 31885 | 1990 | 38668 | 1376 | 26559 |
| 12-#14 | 1.63 | MA | 24850 | 5373 | 36633 | 4478 | 43845 | 3626 | 47384 | 2996 | 51036 | 2039 | 62850 | 1772 | 37258 |
| 3L-5S | | MI | 17513 | 5373 | 26526 | 4417 | 31095 | 3574 | 32962 | 2947 | 34092 | 1982 | 41602 | 1485 | 27416 |
| 12-#14 | 1.63 | MA | 23707 | 5373 | 35105 | 4479 | 41779 | 3641 | 44880 | 2994 | 47656 | 2033 | 59036 | 1641 | 36973 |
| 4E | | MI | 18302 | 5373 | 27698 | 4403 | 32503 | 3577 | 34680 | 2938 | 36387 | 1975 | 44519 | 1548 | 28256 |
| 12-#14 | 1.63 | MA | 22673 | 5373 | 33560 | 4496 | 39925 | 3641 | 42617 | 3007 | 44574 | 2043 | 55068 | 1573 | 35808 |
| 5L-3S | | MI | 19170 | 5373 | 28856 | 4404 | 34067 | 3565 | 36575 | 2943 | 38902 | 1982 | 47276 | 1679 | 28414 |
| 12-#14 | 1.63 | MA | 21681 | 5373 | 32188 | 4498 | 38095 | 3656 | 40389 | 3006 | 41611 | 2052 | 51033 | 1465 | 34508 |
| 6L-2S | | MI | 20358 | 5373 | 30405 | 4405 | 36031 | 3568 | 38955 | 2934 | 42071 | 1975 | 51479 | 1811 | 28467 |
| 12-#18 | 2.90 | MA | 30591 | 6136 | 48234 | 4928 | 58335 | 3955 | 64842 | 3187 | 74523 | 1981 | 93892 | 1776 | 64979 |
| 2L-6S | | MI | 17339 | 6136 | 28932 | 4862 | 33806 | 3911 | 36132 | 3134 | 38214 | 1913 | 47412 | 855 | 41617 |
| 12-#18 | 2.90 | MA | 27944 | 6136 | 44623 | 4929 | 53755 | 3953 | 59293 | 3208 | 67037 | 1995 | 83879 | 1542 | 64444 |
| 3L-5S | | MI | 18603 | 6136 | 30761 | 4866 | 36242 | 3893 | 39097 | 3147 | 42024 | 1899 | 52448 | 1049 | 44559 |
| 12-#18 | 2.90 | MA | 26036 | 6136 | 41938 | 4931 | 50125 | 3977 | 54894 | 3202 | 61099 | 1982 | 77285 | 1308 | 61803 |
| 4E | | MI | 19920 | 6136 | 32815 | 4843 | 38708 | 3901 | 42105 | 3133 | 45986 | 1886 | 57481 | 1157 | 46617 |
| 12-#18 | 2.90 | MA | 24309 | 6136 | 39220 | 4958 | 46864 | 3975 | 50913 | 3223 | 55680 | 1996 | 70384 | 1192 | 58664 |
| 5L-3S | | MI | 21369 | 6136 | 34842 | 4846 | 41445 | 3883 | 45422 | 3146 | 50328 | 1899 | 62202 | 1390 | 48732 |
| 12-#18 | 2.90 | MA | 22652 | 6136 | 36806 | 4960 | 43645 | 3999 | 46995 | 3217 | 50469 | 2010 | 63394 | 999 | 54688 |
| 6L-2S | | MI | 23352 | 6136 | 37544 | 4850 | 44873 | 3891 | 49574 | 3133 | 55799 | 1886 | 69420 | 1624 | 49089 |
| 14-#11 | 1.32 | MA | 25367 | 5186 | 36282 | 4371 | 43513 | 3551 | 47031 | 2938 | 50593 | 2045 | 62432 | 1937 | 30514 |
| 2L-7S | | MI | 16518 | 5186 | 24438 | 4314 | 28476 | 3508 | 29825 | 2906 | 29963 | 2006 | 36213 | 1487 | 22142 |
| 14-#11 | 1.32 | MA | 24245 | 5186 | 34844 | 4373 | 41688 | 3551 | 44821 | 2947 | 47611 | 2052 | 58374 | 1846 | 30472 |
| 3L-6S | | MI | 17042 | 5186 | 25147 | 4314 | 29414 | 3510 | 30970 | 2899 | 31537 | 2011 | 38050 | 1558 | 22570 |
| 14-#11 | 1.32 | MA | 23436 | 5186 | 33778 | 4374 | 40248 | 3562 | 43075 | 2946 | 45254 | 2049 | 55693 | 1755 | 30365 |
| 4L-5S | | MI | 17577 | 5186 | 25875 | 4314 | 30384 | 3501 | 32151 | 2902 | 33090 | 2006 | 40120 | 1633 | 23147 |
| 14-#11 | 1.32 | MA | 22706 | 5186 | 32701 | 4386 | 38955 | 3562 | 41497 | 2956 | 43105 | 2056 | 52912 | 1708 | 30150 |
| 5L-4S | | MI | 18134 | 5186 | 26694 | 4304 | 31367 | 3503 | 33350 | 2895 | 34704 | 2001 | 42171 | 1677 | 23260 |
| 14-#11 | 1.32 | MA | 22005 | 5186 | 31745 | 4388 | 37680 | 3573 | 39944 | 2955 | 41040 | 2063 | 50078 | 1633 | 29323 |
| 6L-3S | | MI | 18748 | 5186 | 27503 | 4304 | 32459 | 3494 | 34674 | 2898 | 36473 | 2006 | 44119 | 1769 | 23309 |
| 14-#11 | 1.32 | MA | 21319 | 5186 | 30815 | 4389 | 36448 | 3573 | 38439 | 2964 | 38946 | 2060 | 47553 | 1562 | 28660 |
| 7L-2S | | MI | 19591 | 5186 | 28587 | 4304 | 33834 | 3496 | 36340 | 2891 | 38702 | 2001 | 47083 | 1860 | 23319 |
| 14-#14 | 1.90 | MA | 27404 | 5537 | 40754 | 4578 | 49071 | 3701 | 53716 | 3031 | 59578 | 2022 | 74407 | 1886 | 43460 |
| 2L-7S | | MI | 16777 | 5537 | 26016 | 4518 | 30327 | 3657 | 32011 | 2998 | 32816 | 1972 | 40270 | 1247 | 29824 |
| 14-#14 | 1.90 | MA | 25837 | 5537 | 38694 | 4580 | 46458 | 3701 | 50550 | 3044 | 55307 | 2031 | 68628 | 1755 | 43316 |
| 3L-6S | | MI | 17508 | 5537 | 27032 | 4519 | 31670 | 3660 | 33651 | 2989 | 35054 | 1979 | 42872 | 1350 | 30985 |
| 14-#14 | 1.90 | MA | 24708 | 5537 | 37166 | 4581 | 44392 | 3716 | 48046 | 3042 | 51927 | 2026 | 64815 | 1624 | 42994 |
| 4L-5S | | MI | 18256 | 5537 | 28075 | 4520 | 33060 | 3648 | 35343 | 2995 | 37261 | 1972 | 45805 | 1459 | 31805 |
| 14-#14 | 1.90 | MA | 23688 | 5537 | 35620 | 4598 | 42538 | 3716 | 45782 | 3055 | 48845 | 2035 | 60847 | 1556 | 41687 |
| 5L-4S | | MI | 19035 | 5537 | 29247 | 4506 | 34467 | 3652 | 37060 | 2985 | 39556 | 1965 | 48722 | 1521 | 32781 |
| 14-#14 | 1.90 | MA | 22710 | 5537 | 34249 | 4600 | 40708 | 3731 | 43555 | 3053 | 45882 | 2045 | 56812 | 1448 | 40434 |
| 6L-3S | | MI | 19892 | 5537 | 30405 | 4506 | 36031 | 3640 | 38955 | 2991 | 42071 | 1972 | 51479 | 1653 | 32973 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis

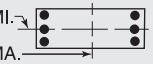


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 1.90 | MA | 21752 | 5537 | 32913 | 4601 | 38941 | 3731 | 41395 | 3066 | 42878 | 2039 | 53219 | 1346 | 38828 |
| 7L-2S | | MI | 21069 | 5537 | 31954 | 4507 | 37996 | 3643 | 41335 | 2981 | 45240 | 1965 | 55682 | 1784 | 33053 |
| 14-#18 | 3.38 | MA | 29565 | 6427 | 48234 | 5111 | 58335 | 4086 | 64842 | 3292 | 74523 | 1982 | 93892 | 1506 | 74994 |
| 3L-6S | | MI | 18591 | 6427 | 31635 | 5044 | 37234 | 4044 | 40285 | 3218 | 43685 | 1890 | 54630 | 800 | 49167 |
| 14-#18 | 3.38 | MA | 27692 | 6427 | 45549 | 5112 | 54705 | 4110 | 60443 | 3286 | 68585 | 1969 | 87298 | 1272 | 72026 |
| 4L-5S | | MI | 19833 | 6427 | 33464 | 5047 | 39670 | 4026 | 43249 | 3231 | 47495 | 1877 | 59666 | 995 | 52242 |
| 14-#18 | 3.38 | MA | 25998 | 6427 | 42832 | 5140 | 51444 | 4108 | 56462 | 3307 | 63166 | 1983 | 80397 | 1156 | 69019 |
| 5L-4S | | MI | 21127 | 6427 | 35518 | 5024 | 42136 | 4034 | 46258 | 3218 | 51456 | 1864 | 64699 | 1102 | 54192 |
| 14-#18 | 3.38 | MA | 24373 | 6427 | 40417 | 5142 | 48225 | 4132 | 52544 | 3301 | 57955 | 1996 | 73407 | 963 | 64922 |
| 6L-3S | | MI | 22553 | 6427 | 37544 | 5028 | 44873 | 4016 | 49574 | 3230 | 55799 | 1877 | 69420 | 1336 | 56609 |
| 14-#18 | 3.38 | MA | 22780 | 6427 | 38067 | 5143 | 45115 | 4130 | 48745 | 3322 | 52672 | 1983 | 67190 | 781 | 60714 |
| 7L-2S | | MI | 24506 | 6427 | 40247 | 5032 | 48300 | 4024 | 53727 | 3217 | 61269 | 1864 | 76638 | 1569 | 57037 |
| 16-#11 | 1.51 | MA | 26062 | 5299 | 37721 | 4442 | 45337 | 3603 | 49241 | 2971 | 53575 | 2040 | 66489 | 1927 | 34774 |
| 2L-8S | | MI | 16542 | 5299 | 24824 | 4384 | 28932 | 3558 | 30343 | 2935 | 30673 | 2005 | 37262 | 1419 | 24597 |
| 16-#11 | 1.51 | MA | 24949 | 5299 | 36282 | 4444 | 43513 | 3603 | 47031 | 2980 | 50593 | 2047 | 62432 | 1836 | 34716 |
| 3L-7S | | MI | 17055 | 5299 | 25522 | 4384 | 29851 | 3560 | 31490 | 2938 | 32192 | 1999 | 39178 | 1470 | 25257 |
| 16-#11 | 1.51 | MA | 24148 | 5299 | 35217 | 4445 | 42072 | 3614 | 45285 | 2979 | 48236 | 2044 | 59751 | 1745 | 34589 |
| 4L-6S | | MI | 17574 | 5299 | 26231 | 4385 | 30788 | 3561 | 32636 | 2931 | 33766 | 2005 | 41015 | 1541 | 25672 |
| 16-#11 | 1.51 | MA | 23425 | 5299 | 34139 | 4457 | 40779 | 3614 | 43707 | 2989 | 46087 | 2051 | 56970 | 1697 | 34354 |
| 5E | | MI | 18104 | 5299 | 26959 | 4385 | 31759 | 3553 | 33817 | 2935 | 35319 | 1999 | 43084 | 1617 | 26315 |
| 16-#11 | 1.51 | MA | 22731 | 5299 | 33184 | 4458 | 39504 | 3625 | 42154 | 2988 | 44022 | 2058 | 54136 | 1622 | 33459 |
| 6L-4S | | MI | 18657 | 5299 | 27778 | 4375 | 32741 | 3555 | 35016 | 2928 | 36933 | 1994 | 45136 | 1661 | 26447 |
| 16-#11 | 1.51 | MA | 22053 | 5299 | 32253 | 4460 | 38272 | 3625 | 40649 | 2997 | 41928 | 2054 | 51611 | 1552 | 32814 |
| 7L-3S | | MI | 19266 | 5299 | 28587 | 4375 | 33834 | 3546 | 36340 | 2931 | 38702 | 1999 | 47083 | 1752 | 26513 |
| 16-#11 | 1.51 | MA | 21382 | 5299 | 31338 | 4461 | 37066 | 3625 | 39142 | 2996 | 39909 | 2061 | 49013 | 1497 | 31876 |
| 8L-2S | | MI | 20102 | 5299 | 29671 | 4375 | 35209 | 3548 | 38006 | 2924 | 40931 | 1994 | 50048 | 1843 | 26538 |
| 16-#14 | 2.17 | MA | 28359 | 5700 | 42814 | 4680 | 51684 | 3776 | 56881 | 3078 | 63848 | 2015 | 80186 | 1869 | 49543 |
| 2L-8S | | MI | 16810 | 5700 | 26565 | 4619 | 30975 | 3729 | 32747 | 3040 | 33825 | 1969 | 41751 | 1148 | 33076 |
| 16-#14 | 2.17 | MA | 26808 | 5700 | 40754 | 4682 | 49071 | 3776 | 53716 | 3091 | 59578 | 2024 | 74407 | 1738 | 49370 |
| 3L-7S | | MI | 17525 | 5700 | 27565 | 4620 | 32292 | 3732 | 34391 | 3046 | 35985 | 1962 | 44474 | 1220 | 34185 |
| 16-#14 | 2.17 | MA | 25694 | 5700 | 39226 | 4684 | 47005 | 3791 | 51211 | 3089 | 56198 | 2018 | 70594 | 1607 | 49014 |
| 4L-6S | | MI | 18248 | 5700 | 28581 | 4621 | 33635 | 3735 | 36031 | 3036 | 38223 | 1969 | 47075 | 1323 | 35419 |
| 16-#14 | 2.17 | MA | 24686 | 5700 | 37681 | 4700 | 45151 | 3791 | 48948 | 3102 | 53116 | 2028 | 66626 | 1539 | 47581 |
| 5E | | MI | 18987 | 5700 | 29624 | 4622 | 35025 | 3723 | 37723 | 3042 | 40430 | 1962 | 50009 | 1432 | 36206 |
| 16-#14 | 2.17 | MA | 23721 | 5700 | 36309 | 4702 | 43321 | 3805 | 46720 | 3100 | 50153 | 2037 | 62590 | 1431 | 46370 |
| 6L-4S | | MI | 19756 | 5700 | 30796 | 4608 | 36432 | 3726 | 39440 | 3033 | 42725 | 1954 | 52925 | 1495 | 37301 |
| 16-#14 | 2.17 | MA | 22775 | 5700 | 34974 | 4704 | 41554 | 3805 | 44561 | 3113 | 47149 | 2032 | 58997 | 1329 | 44695 |
| 7L-3S | | MI | 20605 | 5700 | 31954 | 4609 | 37996 | 3715 | 41335 | 3038 | 45240 | 1962 | 55682 | 1626 | 37525 |
| 16-#14 | 2.17 | MA | 21840 | 5700 | 33659 | 4705 | 39822 | 3805 | 42398 | 3111 | 44251 | 2041 | 55291 | 1251 | 43131 |
| 8L-2S | | MI | 21769 | 5700 | 33503 | 4610 | 39961 | 3718 | 43715 | 3029 | 48409 | 1954 | 59886 | 1758 | 37631 |
| 16-#18 | 3.86 | MA | 29314 | 6718 | 49160 | 5294 | 59285 | 4243 | 65992 | 3371 | 76072 | 1956 | 97311 | 1236 | 82281 |
| 4L-6S | | MI | 19818 | 6718 | 34337 | 5226 | 40661 | 4177 | 44438 | 3303 | 49155 | 1868 | 61848 | 745 | 56741 |
| 16-#18 | 3.86 | MA | 27651 | 6718 | 46443 | 5322 | 56024 | 4241 | 62011 | 3391 | 70653 | 1969 | 90410 | 1119 | 79394 |
| 5E | | MI | 21040 | 6718 | 36166 | 5229 | 43098 | 4159 | 47402 | 3315 | 52965 | 1855 | 66884 | 940 | 59944 |
| 16-#18 | 3.86 | MA | 26056 | 6718 | 44029 | 5323 | 52805 | 4265 | 58093 | 3386 | 65441 | 1983 | 83420 | 927 | 75178 |
| 6L-4S | | MI | 22313 | 6718 | 38221 | 5206 | 45563 | 4167 | 50411 | 3302 | 56927 | 1842 | 71917 | 1048 | 61799 |
| 16-#18 | 3.86 | MA | 24493 | 6718 | 41679 | 5325 | 49695 | 4263 | 54294 | 3406 | 60158 | 1970 | 77203 | 745 | 70907 |
| 7L-3S | | MI | 23716 | 6718 | 40247 | 5210 | 48300 | 4149 | 53727 | 3315 | 61269 | 1855 | 76638 | 1281 | 64480 |
| 16-#18 | 3.86 | MA | 22947 | 6718 | 39365 | 5326 | 46648 | 4261 | 50487 | 3401 | 55060 | 1984 | 70760 | 609 | 66508 |
| 8L-2S | | MI | 25642 | 6718 | 42950 | 5213 | 51728 | 4157 | 57880 | 3301 | 66740 | 1842 | 83856 | 1515 | 64974 |
| 18-#11 | 1.70 | MA | 26749 | 5412 | 39159 | 4513 | 47161 | 3655 | 51452 | 3004 | 56557 | 2035 | 70547 | 1916 | 39029 |
| 2L-9S | | MI | 16572 | 5412 | 25138 | 4465 | 29359 | 3619 | 30879 | 2975 | 31398 | 2003 | 38351 | 1343 | 27054 |
| 18-#11 | 1.70 | MA | 25645 | 5412 | 37721 | 4515 | 45337 | 3655 | 49241 | 3013 | 53575 | 2042 | 66489 | 1825 | 38956 |
| 3L-8S | | MI | 17077 | 5412 | 25908 | 4455 | 30307 | 3610 | 32008 | 2968 | 32902 | 1998 | 40227 | 1402 | 27669 |
| 18-#11 | 1.70 | MA | 24851 | 5412 | 36655 | 4516 | 43896 | 3666 | 47495 | 3012 | 51218 | 2038 | 63809 | 1734 | 38811 |
| 4L-7S | | MI | 17585 | 5412 | 26606 | 4455 | 31226 | 3612 | 33156 | 2971 | 34421 | 1993 | 42143 | 1453 | 28376 |
| 18-#11 | 1.70 | MA | 24135 | 5412 | 35578 | 4528 | 42604 | 3666 | 45917 | 3022 | 49069 | 2045 | 61028 | 1687 | 38544 |
| 5L-6S | | MI | 18100 | 5412 | 27315 | 4455 | 32163 | 3613 | 34301 | 2964 | 35995 | 1998 | 43979 | 1524 | 28779 |

## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

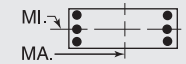
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.70 | MA | 23448 | 5412 | 34622 | 4529 | 41328 | 3677 | 44364 | 3021 | 47004 | 2053 | 58194 | 1612 | 37601 |
| 6L-5S | | MI | 18625 | 5412 | 28043 | 4456 | 33134 | 3605 | 35482 | 2968 | 37548 | 1993 | 46049 | 1600 | 29395 |
| 18-#11 | 1.70 | MA | 22776 | 5412 | 33692 | 4531 | 40097 | 3677 | 42860 | 3030 | 44910 | 2049 | 55669 | 1541 | 36972 |
| 7L-4S | | MI | 19173 | 5412 | 28862 | 4445 | 34116 | 3606 | 36682 | 2960 | 39162 | 1988 | 48101 | 1644 | 29631 |
| 18-#11 | 1.70 | MA | 22112 | 5412 | 32776 | 4532 | 38890 | 3677 | 41352 | 3029 | 42891 | 2056 | 53070 | 1486 | 35990 |
| 8L-3S | | MI | 19777 | 5412 | 29671 | 4446 | 35209 | 3598 | 38006 | 2964 | 40931 | 1993 | 50048 | 1735 | 29712 |
| 18-#11 | 1.70 | MA | 21452 | 5412 | 31765 | 4544 | 37647 | 3688 | 39869 | 3039 | 40891 | 2063 | 50496 | 1428 | 35075 |
| 9L-2S | | MI | 20607 | 5412 | 30755 | 4446 | 36584 | 3600 | 39671 | 2957 | 43161 | 1988 | 53013 | 1826 | 29750 |
| 18-#14 | 2.45 | MA | 27766 | 5864 | 42814 | 4784 | 51684 | 3851 | 56881 | 3139 | 63848 | 2017 | 80186 | 1721 | 55420 |
| 3L-8S | | MI | 17555 | 5864 | 28114 | 4722 | 32940 | 3803 | 35127 | 3088 | 36994 | 1959 | 45955 | 1121 | 37398 |
| 18-#14 | 2.45 | MA | 26664 | 5864 | 41286 | 4786 | 49618 | 3866 | 54377 | 3137 | 60468 | 2011 | 76372 | 1590 | 55033 |
| 4L-7S | | MI | 18262 | 5864 | 29114 | 4722 | 34256 | 3807 | 36771 | 3093 | 39154 | 1951 | 48677 | 1194 | 38558 |
| 18-#14 | 2.45 | MA | 25669 | 5864 | 39741 | 4803 | 47763 | 3865 | 52113 | 3150 | 57386 | 2020 | 72404 | 1522 | 53487 |
| 5L-6S | | MI | 18977 | 5864 | 30130 | 4723 | 35600 | 3810 | 38412 | 3084 | 41392 | 1959 | 51279 | 1297 | 39861 |
| 18-#14 | 2.45 | MA | 24715 | 5864 | 38369 | 4804 | 45934 | 3880 | 49886 | 3148 | 54423 | 2030 | 68369 | 1414 | 52312 |
| 6L-5S | | MI | 19707 | 5864 | 31173 | 4724 | 36989 | 3798 | 40103 | 3089 | 43599 | 1951 | 54212 | 1406 | 40620 |
| 18-#14 | 2.45 | MA | 23782 | 5864 | 37034 | 4806 | 44166 | 3880 | 47727 | 3161 | 51420 | 2024 | 64776 | 1312 | 50572 |
| 7L-4S | | MI | 20468 | 5864 | 32346 | 4710 | 38397 | 3801 | 41820 | 3080 | 45894 | 1944 | 57129 | 1469 | 41819 |
| 18-#14 | 2.45 | MA | 22859 | 5864 | 35720 | 4808 | 42435 | 3880 | 45563 | 3159 | 48522 | 2034 | 61070 | 1234 | 49002 |
| 8L-3S | | MI | 21307 | 5864 | 33503 | 4711 | 39961 | 3789 | 43715 | 3085 | 48409 | 1951 | 59886 | 1600 | 42071 |
| 18-#14 | 2.45 | MA | 21942 | 5864 | 34268 | 4824 | 40650 | 3895 | 43435 | 3172 | 45652 | 2043 | 57405 | 1150 | 46796 |
| 9L-2S | | MI | 22460 | 5864 | 35052 | 4712 | 41925 | 3793 | 46095 | 3076 | 51578 | 1944 | 64089 | 1731 | 42201 |
| 18-#18 | 4.35 | MA | 29274 | 7009 | 50054 | 5504 | 60604 | 4374 | 67560 | 3476 | 78139 | 1956 | 100423 | 1083 | 89785 |
| 5L-6S | | MI | 21023 | 7009 | 37040 | 5407 | 44089 | 4310 | 48591 | 3387 | 54626 | 1846 | 69066 | 691 | 64337 |
| 18-#18 | 4.35 | MA | 27707 | 7009 | 47640 | 5505 | 57385 | 4398 | 63642 | 3470 | 72928 | 1970 | 93433 | 890 | 85454 |
| 6L-5S | | MI | 22226 | 7009 | 38869 | 5411 | 46525 | 4292 | 51555 | 3400 | 58436 | 1833 | 74102 | 885 | 67453 |
| 18-#18 | 4.35 | MA | 26172 | 7009 | 45290 | 5507 | 54276 | 4396 | 59843 | 3491 | 67644 | 1957 | 87217 | 708 | 81118 |
| 7L-4S | | MI | 23479 | 7009 | 40924 | 5388 | 48991 | 4300 | 54563 | 3386 | 62397 | 1820 | 79135 | 993 | 69431 |
| 18-#18 | 4.35 | MA | 24653 | 7009 | 42976 | 5508 | 51228 | 4394 | 56036 | 3485 | 62546 | 1971 | 80773 | 573 | 76678 |
| 8L-3S | | MI | 24862 | 7009 | 42950 | 5392 | 51728 | 4282 | 57880 | 3399 | 66740 | 1833 | 83856 | 1227 | 72347 |
| 20-#11 | 1.88 | MA | 26332 | 5526 | 39159 | 4585 | 47161 | 3707 | 51452 | 3046 | 56557 | 2036 | 70547 | 1814 | 43193 |
| 3L-9S | | MI | 17105 | 5526 | 26222 | 4536 | 30734 | 3670 | 32545 | 3008 | 33627 | 1997 | 41316 | 1326 | 30145 |
| 20-#11 | 1.88 | MA | 25546 | 5526 | 38094 | 4587 | 45721 | 3718 | 49705 | 3045 | 54200 | 2033 | 67867 | 1723 | 43031 |
| 4L-8S | | MI | 17606 | 5526 | 26992 | 4526 | 31681 | 3662 | 33674 | 3001 | 35131 | 1992 | 43191 | 1385 | 30747 |
| 20-#11 | 1.88 | MA | 24836 | 5526 | 37016 | 4599 | 44428 | 3718 | 48127 | 3054 | 52051 | 2040 | 65085 | 1676 | 42662 |
| 5L-7S | | MI | 18110 | 5526 | 27690 | 4526 | 32601 | 3663 | 34822 | 3004 | 36650 | 1987 | 45107 | 1436 | 31498 |
| 20-#11 | 1.88 | MA | 24156 | 5526 | 36061 | 4600 | 43153 | 3729 | 46575 | 3054 | 49986 | 2047 | 62252 | 1601 | 41750 |
| 6E | | MI | 18619 | 5526 | 28399 | 4526 | 33538 | 3665 | 35967 | 2997 | 38225 | 1992 | 46944 | 1507 | 31891 |
| 20-#11 | 1.88 | MA | 23490 | 5526 | 35130 | 4602 | 41921 | 3729 | 45070 | 3063 | 47892 | 2044 | 59726 | 1530 | 41135 |
| 7L-5S | | MI | 19140 | 5526 | 29127 | 4526 | 34509 | 3657 | 37148 | 3000 | 39777 | 1987 | 49013 | 1583 | 32483 |
| 20-#11 | 1.88 | MA | 22832 | 5526 | 34215 | 4603 | 40715 | 3729 | 43562 | 3062 | 45872 | 2051 | 57128 | 1476 | 40110 |
| 8L-4S | | MI | 19683 | 5526 | 29946 | 4516 | 35491 | 3658 | 38347 | 2993 | 41392 | 1981 | 51065 | 1627 | 32811 |
| 20-#11 | 1.88 | MA | 22179 | 5526 | 33203 | 4615 | 39471 | 3740 | 42079 | 3072 | 43873 | 2058 | 54554 | 1417 | 39214 |
| 9L-3S | | MI | 20282 | 5526 | 30755 | 4516 | 36584 | 3650 | 39671 | 2997 | 43161 | 1987 | 53013 | 1718 | 32907 |
| 20-#11 | 1.88 | MA | 21528 | 5526 | 32291 | 4616 | 38273 | 3740 | 40589 | 3071 | 41816 | 2055 | 51892 | 1337 | 37938 |
| 10L-2S | | MI | 21106 | 5526 | 31839 | 4517 | 37959 | 3651 | 41337 | 2989 | 45390 | 1981 | 55977 | 1809 | 32957 |
| 20-#14 | 2.72 | MA | 27621 | 6027 | 43346 | 4888 | 52231 | 3940 | 57543 | 3184 | 64739 | 2004 | 82151 | 1572 | 61052 |
| 4L-8S | | MI | 18289 | 6027 | 29663 | 4824 | 34904 | 3878 | 37507 | 3135 | 40163 | 1949 | 50158 | 1095 | 41729 |
| 20-#14 | 2.72 | MA | 26637 | 6027 | 41801 | 4905 | 50376 | 3940 | 55279 | 3197 | 61657 | 2013 | 78183 | 1505 | 59403 |
| 5L-7S | | MI | 18988 | 6027 | 30663 | 4825 | 36221 | 3881 | 39151 | 3141 | 42323 | 1941 | 52880 | 1168 | 42940 |
| 20-#14 | 2.72 | MA | 25695 | 6027 | 40429 | 4906 | 48547 | 3955 | 53052 | 3195 | 58694 | 2022 | 74148 | 1397 | 58262 |
| 6E | | MI | 19695 | 6027 | 31679 | 4826 | 37564 | 3885 | 40792 | 3131 | 44561 | 1949 | 55482 | 1270 | 44308 |
| 20-#14 | 2.72 | MA | 24773 | 6027 | 39094 | 4908 | 46779 | 3955 | 50892 | 3208 | 55691 | 2017 | 70555 | 1295 | 56459 |
| 7L-5S | | MI | 20417 | 6027 | 32722 | 4826 | 38954 | 3873 | 42483 | 3137 | 46768 | 1941 | 58415 | 1380 | 45042 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis

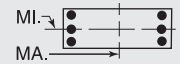


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.72 | MA | 23862 | 6027 | 37780 | 4910 | 45048 | 3955 | 48729 | 3206 | 52793 | 2026 | 66848 | 1217 | 54845 |
| 8L-4S | | MI | 21170 | 6027 | 33895 | 4812 | 40361 | 3876 | 44200 | 3127 | 49063 | 1934 | 61332 | 1442 | 46335 |
| 20-#14 | 2.72 | MA | 22956 | 6027 | 36329 | 4926 | 43263 | 3970 | 46601 | 3219 | 49923 | 2036 | 63184 | 1133 | 52683 |
| 9L-3S | | MI | 22000 | 6027 | 35052 | 4813 | 41925 | 3864 | 46095 | 3133 | 51578 | 1941 | 64089 | 1574 | 46614 |
| 20-#14 | 2.72 | MA | 22054 | 6027 | 35019 | 4928 | 41544 | 3970 | 44462 | 3217 | 46972 | 2030 | 59395 | 1017 | 50459 |
| 10L-2S | | MI | 23143 | 6027 | 36601 | 4814 | 43890 | 3867 | 48476 | 3123 | 54747 | 1934 | 68293 | 1705 | 46766 |
| 20-#18 | 4.83 | MA | 29329 | 7300 | 51252 | 5687 | 61966 | 4531 | 69191 | 3554 | 80414 | 1956 | 103446 | 854 | 95748 |
| 6E | | MI | 22210 | 7300 | 39743 | 5589 | 47517 | 4443 | 52743 | 3471 | 60096 | 1824 | 76284 | 636 | 71953 |
| 20-#18 | 4.83 | MA | 27820 | 7300 | 48902 | 5688 | 58856 | 4529 | 65392 | 3575 | 75131 | 1944 | 97230 | 672 | 91346 |
| 7L-5S | | MI | 23394 | 7300 | 41572 | 5593 | 49953 | 4425 | 55708 | 3484 | 63906 | 1811 | 81320 | 831 | 74956 |
| 20-#18 | 4.83 | MA | 26327 | 7300 | 46588 | 5690 | 55808 | 4527 | 61585 | 3569 | 70032 | 1957 | 90786 | 537 | 86862 |
| 8L-4S | | MI | 24629 | 7300 | 43626 | 5570 | 52419 | 4433 | 58716 | 3470 | 67868 | 1797 | 86353 | 938 | 77087 |
| 22-#11 | 2.07 | MA | 26233 | 5639 | 39532 | 4658 | 47545 | 3770 | 51915 | 3078 | 57181 | 2028 | 71924 | 1713 | 47250 |
| 4L-9S | | MI | 17632 | 5639 | 27306 | 4607 | 32109 | 3722 | 34210 | 3041 | 35856 | 1991 | 44280 | 1309 | 33193 |
| 22-#11 | 2.07 | MA | 25529 | 5639 | 38455 | 4670 | 46252 | 3770 | 50337 | 3087 | 55033 | 2035 | 69143 | 1665 | 46787 |
| 5L-8S | | MI | 18128 | 5639 | 28076 | 4597 | 33056 | 3714 | 35340 | 3034 | 37361 | 1985 | 46156 | 1368 | 33830 |
| 22-#11 | 2.07 | MA | 24855 | 5639 | 37499 | 4671 | 44977 | 3780 | 48785 | 3086 | 52968 | 2042 | 66309 | 1590 | 45903 |
| 6L-7S | | MI | 18628 | 5639 | 28774 | 4597 | 33975 | 3715 | 36487 | 3037 | 38880 | 1980 | 48072 | 1420 | 34616 |
| 22-#11 | 2.07 | MA | 24196 | 5639 | 36569 | 4673 | 43745 | 3781 | 47280 | 3096 | 50874 | 2039 | 63784 | 1520 | 45300 |
| 7L-6S | | MI | 19133 | 5639 | 29483 | 4597 | 34913 | 3717 | 37633 | 3030 | 40454 | 1985 | 49909 | 1491 | 35008 |
| 22-#11 | 2.07 | MA | 23544 | 5639 | 35653 | 4674 | 42539 | 3781 | 45772 | 3095 | 48854 | 2046 | 61186 | 1465 | 44235 |
| 8L-5S | | MI | 19650 | 5639 | 30211 | 4597 | 35883 | 3708 | 38814 | 3033 | 42007 | 1980 | 51978 | 1566 | 35579 |
| 22-#11 | 2.07 | MA | 22897 | 5639 | 34642 | 4686 | 41295 | 3792 | 44289 | 3104 | 46855 | 2053 | 58611 | 1407 | 43357 |
| 9L-4S | | MI | 20188 | 5639 | 31030 | 4587 | 36866 | 3710 | 40013 | 3026 | 43621 | 1975 | 54030 | 1610 | 35989 |
| 22-#11 | 2.07 | MA | 22253 | 5639 | 33730 | 4687 | 40097 | 3792 | 42799 | 3104 | 44798 | 2050 | 55950 | 1327 | 42056 |
| 10L-3S | | MI | 20783 | 5639 | 31839 | 4587 | 37959 | 3702 | 41337 | 3029 | 45390 | 1980 | 55977 | 1702 | 36099 |
| 22-#11 | 2.07 | MA | 21550 | 5639 | 32824 | 4689 | 38868 | 3803 | 41325 | 3113 | 42807 | 2057 | 53396 | 1269 | 40828 |
| 11L-2S | | MI | 21601 | 5639 | 32923 | 4588 | 39334 | 3703 | 43003 | 3022 | 47619 | 1975 | 58942 | 1793 | 36161 |
| 22-#14 | 2.99 | MA | 27593 | 6191 | 43861 | 5007 | 52989 | 4015 | 58445 | 3244 | 65928 | 2005 | 83962 | 1488 | 65328 |
| 5L-8S | | MI | 19014 | 6191 | 31212 | 4926 | 36869 | 3953 | 39887 | 3182 | 43332 | 1938 | 54361 | 1068 | 46071 |
| 22-#14 | 2.99 | MA | 26662 | 6191 | 42490 | 5009 | 51160 | 4030 | 56217 | 3242 | 62965 | 2015 | 79927 | 1380 | 64217 |
| 6L-7S | | MI | 19705 | 6191 | 32212 | 4927 | 38186 | 3956 | 41531 | 3188 | 45492 | 1931 | 57084 | 1141 | 47331 |
| 22-#14 | 2.99 | MA | 25751 | 6191 | 41154 | 5010 | 49392 | 4030 | 54058 | 3255 | 59962 | 2009 | 76333 | 1278 | 62353 |
| 7L-6S | | MI | 20405 | 6191 | 33228 | 4928 | 39529 | 3959 | 43172 | 3179 | 47730 | 1938 | 59685 | 1244 | 48728 |
| 22-#14 | 2.99 | MA | 24850 | 6191 | 39840 | 5012 | 47661 | 4030 | 51894 | 3254 | 57064 | 2019 | 72627 | 1200 | 60696 |
| 8L-5S | | MI | 21119 | 6191 | 34271 | 4929 | 40919 | 3948 | 44863 | 3184 | 49937 | 1931 | 62619 | 1353 | 49473 |
| 22-#14 | 2.99 | MA | 23955 | 6191 | 38389 | 5029 | 45876 | 4044 | 49766 | 3267 | 54194 | 2028 | 68962 | 1116 | 58575 |
| 9L-4S | | MI | 21864 | 6191 | 35444 | 4915 | 42326 | 3951 | 46581 | 3175 | 52232 | 1924 | 65535 | 1416 | 50781 |
| 22-#14 | 2.99 | MA | 23059 | 6191 | 37080 | 5030 | 44157 | 4044 | 47628 | 3265 | 51243 | 2023 | 65174 | 1000 | 56324 |
| 10L-3S | | MI | 22686 | 6191 | 36601 | 4915 | 43890 | 3939 | 48476 | 3180 | 54747 | 1931 | 68293 | 1547 | 51152 |
| 22-#18 | 5.31 | MA | 29442 | 7590 | 52513 | 5870 | 63436 | 4662 | 70941 | 3659 | 82617 | 1930 | 107243 | 636 | 101589 |
| 7L-6S | | MI | 23505 | 7590 | 42446 | 5771 | 50945 | 4576 | 56896 | 3555 | 65567 | 1802 | 83502 | 581 | 79586 |
| 22-#18 | 5.31 | MA | 27973 | 7590 | 50199 | 5871 | 60388 | 4660 | 67134 | 3654 | 77519 | 1944 | 100799 | 501 | 97061 |
| 8L-5S | | MI | 24655 | 7590 | 44275 | 5774 | 53381 | 4558 | 59860 | 3568 | 69377 | 1789 | 88537 | 776 | 82484 |
| 24-#11 | 2.26 | MA | 26215 | 5753 | 39893 | 4740 | 48077 | 3822 | 52548 | 3120 | 58015 | 2030 | 73201 | 1655 | 50920 |
| 5L-9S | | MI | 18154 | 5753 | 28390 | 4678 | 33484 | 3774 | 35876 | 3074 | 38086 | 1984 | 47245 | 1292 | 36247 |
| 24-#11 | 2.26 | MA | 25547 | 5753 | 38937 | 4742 | 46801 | 3832 | 50995 | 3119 | 55949 | 2037 | 70367 | 1580 | 50061 |
| 6L-8S | | MI | 18645 | 5753 | 29161 | 4668 | 34431 | 3765 | 37005 | 3067 | 39590 | 1979 | 49121 | 1351 | 36919 |
| 24-#11 | 2.26 | MA | 24894 | 5753 | 38007 | 4743 | 45570 | 3833 | 49490 | 3129 | 53856 | 2034 | 67842 | 1509 | 49469 |
| 7E | | MI | 19141 | 5753 | 29859 | 4668 | 35350 | 3767 | 38153 | 3070 | 41109 | 1974 | 51036 | 1403 | 37683 |
| 24-#11 | 2.26 | MA | 24248 | 5753 | 37092 | 4745 | 44363 | 3833 | 47982 | 3128 | 51836 | 2041 | 65244 | 1454 | 48365 |
| 8L-6S | | MI | 19642 | 5753 | 30568 | 4668 | 36288 | 3769 | 39298 | 3063 | 42683 | 1979 | 52873 | 1474 | 38129 |
| 24-#11 | 2.26 | MA | 23607 | 5753 | 36080 | 4757 | 43120 | 3844 | 46499 | 3137 | 49837 | 2048 | 62669 | 1396 | 47469 |
| 9L-5S | | MI | 20154 | 5753 | 31296 | 4668 | 37258 | 3760 | 40479 | 3066 | 44236 | 1974 | 54942 | 1549 | 38680 |
| 24-#11 | 2.26 | MA | 22966 | 5753 | 35168 | 4758 | 41922 | 3844 | 45009 | 3136 | 47780 | 2045 | 60008 | 1316 | 46178 |
| 10L-4S | | MI | 20688 | 5753 | 32114 | 4658 | 38241 | 3762 | 41679 | 3059 | 45850 | 1969 | 56994 | 1594 | 39164 |
| 24-#11 | 2.26 | MA | 22282 | 5753 | 34263 | 4760 | 40692 | 3854 | 43535 | 3146 | 45789 | 2052 | 57454 | 1259 | 44930 |
| 11L-3S | | MI | 21278 | 5753 | 32923 | 4658 | 39334 | 3753 | 43003 | 3062 | 47619 | 1974 | 58942 | 1685 | 39288 |

## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.26 | MA | 21589 | 5753 | 33362 | 4761 | 39497 | 3855 | 42054 | 3145 | 43807 | 2059 | 54900 | 1201 | 43620 |
| 12L-2S | | MI | 22090 | 5753 | 34007 | 4658 | 40709 | 3755 | 44668 | 3055 | 49849 | 1969 | 61906 | 1776 | 39361 |
| 24-#14 | 3.26 | MA | 27616 | 6355 | 44550 | 5111 | 53772 | 4105 | 59383 | 3290 | 67236 | 2007 | 85705 | 1363 | 70178 |
| 6L-8S | | MI | 19730 | 6355 | 32761 | 5028 | 38834 | 4028 | 42267 | 3230 | 46501 | 1928 | 58565 | 1042 | 50421 |
| 24-#14 | 3.26 | MA | 26716 | 6355 | 43215 | 5113 | 52005 | 4105 | 57223 | 3303 | 64232 | 2002 | 82112 | 1261 | 68256 |
| 7E | | MI | 20413 | 6355 | 33762 | 5029 | 40150 | 4031 | 43912 | 3235 | 48661 | 1921 | 61287 | 1115 | 51729 |
| 24-#14 | 3.26 | MA | 25825 | 6355 | 41901 | 5114 | 50274 | 4104 | 55060 | 3301 | 61334 | 2011 | 78406 | 1183 | 66555 |
| 8L-6S | | MI | 21106 | 6355 | 34777 | 5030 | 41494 | 4034 | 45552 | 3226 | 50899 | 1928 | 63889 | 1218 | 53085 |
| 24-#14 | 3.26 | MA | 24941 | 6355 | 40449 | 5131 | 48489 | 4119 | 52932 | 3314 | 58465 | 2021 | 74741 | 1099 | 64474 |
| 9L-5S | | MI | 21813 | 6355 | 35820 | 5031 | 42883 | 4022 | 47244 | 3231 | 53106 | 1921 | 66822 | 1327 | 53911 |
| 24-#14 | 3.26 | MA | 24049 | 6355 | 39140 | 5133 | 46770 | 4119 | 50793 | 3312 | 55514 | 2015 | 70952 | 983 | 62196 |
| 10L-4S | | MI | 22550 | 6355 | 36993 | 5017 | 44291 | 4026 | 48961 | 3222 | 55401 | 1913 | 69739 | 1390 | 55169 |
| 24-#18 | 5.80 | MA | 29594 | 7881 | 53811 | 6053 | 64969 | 4793 | 72683 | 3738 | 85005 | 1931 | 110812 | 465 | 107274 |
| 8L-6S | | MI | 24653 | 7881 | 45148 | 5952 | 54372 | 4709 | 61049 | 3640 | 71038 | 1780 | 90719 | 527 | 87234 |

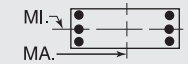
## RECTANGULAR TIED COLUMNS 36" x 48"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.39 | MA | 27753 | 5455 | 40189 | 4561 | 47991 | 3703 | 51840 | 3059 | 55863 | 2117 | 68611 | 1985 | 34613 |
| 2L-3S | | MI | 18351 | 5455 | 27661 | 4465 | 32218 | 3618 | 34035 | 3008 | 34916 | 2054 | 41684 | 1639 | 25100 |
| 6-#18 | 1.39 | MA | 24805 | 5455 | 36396 | 4564 | 43180 | 3702 | 46012 | 3081 | 48000 | 2132 | 58037 | 1752 | 34386 |
| 3L-2S | | MI | 20442 | 5455 | 30364 | 4468 | 35646 | 3626 | 38188 | 2994 | 40386 | 2040 | 48902 | 1873 | 25163 |
| 8-#14 | 1.04 | MA | 26480 | 5237 | 37213 | 4450 | 44451 | 3624 | 47654 | 3014 | 50285 | 2141 | 61416 | 2036 | 26370 |
| 2L-4S | | MI | 17486 | 5237 | 25518 | 4364 | 29627 | 3563 | 30992 | 2958 | 31052 | 2084 | 37254 | 1686 | 19244 |
| 8-#14 | 1.04 | MA | 24771 | 5237 | 35050 | 4452 | 41708 | 3624 | 44331 | 3027 | 45802 | 2151 | 55322 | 1904 | 26333 |
| 3E | | MI | 18378 | 5237 | 26675 | 4365 | 31191 | 3551 | 32887 | 2964 | 33567 | 2091 | 40011 | 1817 | 19303 |
| 8-#14 | 1.04 | MA | 23537 | 5237 | 33448 | 4455 | 39542 | 3640 | 41705 | 3026 | 42257 | 2146 | 51296 | 1773 | 26141 |
| 4L-2S | | MI | 19595 | 5237 | 28224 | 4365 | 33156 | 3554 | 35267 | 2954 | 36736 | 2084 | 44214 | 1949 | 19282 |
| 8-#18 | 1.85 | MA | 29545 | 5746 | 43982 | 4743 | 52802 | 3836 | 57669 | 3143 | 63726 | 2104 | 79184 | 1952 | 45838 |
| 2L-4S | | MI | 18113 | 5746 | 28337 | 4643 | 32909 | 3769 | 34872 | 3079 | 36044 | 2018 | 44181 | 1351 | 31883 |
| 8-#18 | 1.85 | MA | 26654 | 5746 | 40189 | 4745 | 47991 | 3835 | 51840 | 3165 | 55863 | 2119 | 68611 | 1718 | 45493 |
| 3E | | MI | 19622 | 5746 | 30364 | 4646 | 35646 | 3751 | 38188 | 3092 | 40386 | 2031 | 48902 | 1585 | 33025 |
| 8-#18 | 1.85 | MA | 24563 | 5746 | 37371 | 4748 | 44182 | 3860 | 47224 | 3161 | 49633 | 2107 | 61641 | 1485 | 43843 |
| 4L-2S | | MI | 21677 | 5746 | 33066 | 4650 | 39074 | 3759 | 42341 | 3078 | 45857 | 2018 | 56120 | 1818 | 33190 |
| 10-#14 | 1.30 | MA | 27542 | 5400 | 39375 | 4553 | 47193 | 3699 | 50976 | 3061 | 54767 | 2133 | 67511 | 2020 | 32788 |
| 2L-5S | | MI | 17446 | 5400 | 25894 | 4480 | 30185 | 3634 | 31655 | 3015 | 31926 | 2081 | 38540 | 1597 | 23219 |
| 10-#14 | 1.30 | MA | 25853 | 5400 | 37213 | 4555 | 44451 | 3699 | 47654 | 3075 | 50285 | 2143 | 61416 | 1889 | 32712 |
| 3L-4S | | MI | 18247 | 5400 | 27067 | 4466 | 31592 | 3638 | 33372 | 3006 | 34221 | 2074 | 41457 | 1660 | 23788 |
| 10-#14 | 1.30 | MA | 24636 | 5400 | 35611 | 4557 | 42284 | 3715 | 45028 | 3073 | 46740 | 2138 | 57391 | 1757 | 32470 |
| 4L-3S | | MI | 19127 | 5400 | 28224 | 4467 | 33156 | 3626 | 35267 | 3011 | 36736 | 2081 | 44214 | 1791 | 23890 |
| 10-#14 | 1.30 | MA | 23534 | 5400 | 33991 | 4574 | 40341 | 3715 | 42655 | 3087 | 43509 | 2148 | 53212 | 1689 | 31550 |
| 5L-2S | | MI | 20332 | 5400 | 29773 | 4468 | 35121 | 3629 | 37647 | 3002 | 39905 | 2074 | 48417 | 1923 | 23903 |
| 10-#18 | 2.31 | MA | 31290 | 6037 | 47775 | 4925 | 57612 | 3969 | 63497 | 3228 | 71590 | 2091 | 89758 | 1918 | 57037 |
| 2L-5S | | MI | 18033 | 6037 | 28985 | 4847 | 33871 | 3894 | 36016 | 3177 | 37552 | 2009 | 46365 | 1189 | 37150 |
| 10-#18 | 2.31 | MA | 28451 | 6037 | 43982 | 4927 | 52802 | 3968 | 57669 | 3250 | 63726 | 2106 | 79184 | 1685 | 56591 |
| 3L-4S | | MI | 19380 | 6037 | 31040 | 4824 | 36337 | 3902 | 39025 | 3163 | 41514 | 1996 | 51398 | 1297 | 39366 |
| 10-#18 | 2.31 | MA | 26402 | 6037 | 41165 | 4929 | 48993 | 3993 | 53053 | 3245 | 57496 | 2094 | 72214 | 1451 | 54509 |
| 4L-3S | | MI | 20861 | 6037 | 33066 | 4828 | 39074 | 3884 | 42341 | 3176 | 45857 | 2009 | 56120 | 1530 | 40928 |
| 10-#18 | 2.31 | MA | 24548 | 6037 | 38315 | 4958 | 45573 | 3992 | 48878 | 3267 | 51812 | 2109 | 64940 | 1333 | 50940 |
| 5L-2S | | MI | 22883 | 6037 | 35769 | 4832 | 42502 | 3892 | 46494 | 3162 | 51327 | 1996 | 63338 | 1764 | 41180 |
| 12-#11 | 1.08 | MA | 26707 | 5263 | 37493 | 4479 | 44925 | 3647 | 48280 | 3030 | 51166 | 2146 | 62773 | 2046 | 27512 |
| 2L-6S | | MI | 17190 | 5263 | 24976 | 4408 | 29091 | 3594 | 30377 | 2981 | 30312 | 2106 | 36231 | 1661 | 19599 |
| 12-#11 | 1.08 | MA | 25516 | 5263 | 35984 | 4481 | 43011 | 3647 | 45961 | 3040 | 48037 | 2154 | 58496 | 1955 | 27486 |
| 3L-5S | | MI | 17731 | 5263 | 25704 | 4409 | 30062 | 3585 | 31558 | 2985 | 31864 | 2101 | 38300 | 1736 | 20033 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

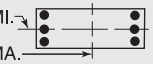



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.08 | MA | 24658 | 5263 | 34867 | 4483 | 41501 | 3658 | 44131 | 3039 | 45566 | 2151 | 55669 | 1864 | 27401 |
| 4E | | MI | 18295 | 5263 | 26523 | 4398 | 31044 | 3587 | 32758 | 2978 | 33479 | 2096 | 40352 | 1780 | 20110 |
| 12-#11 | 1.08 | MA | 23883 | 5263 | 33738 | 4495 | 40146 | 3659 | 42477 | 3049 | 43314 | 2158 | 52742 | 1817 | 27210 |
| 5L-3S | | MI | 18916 | 5263 | 27331 | 4399 | 32137 | 3578 | 34082 | 2981 | 35248 | 2101 | 42299 | 1871 | 20132 |
| 12-#11 | 1.08 | MA | 23140 | 5263 | 32737 | 4497 | 38810 | 3670 | 40850 | 3049 | 41150 | 2166 | 49755 | 1742 | 26494 |
| 6L-2S | | MI | 19768 | 5263 | 28415 | 4399 | 33512 | 3580 | 35747 | 2974 | 37477 | 2096 | 45264 | 1962 | 20121 |
| 12-#14 | 1.56 | MA | 28584 | 5564 | 41538 | 4655 | 49936 | 3774 | 54299 | 3108 | 59250 | 2126 | 73605 | 2005 | 39192 |
| 2L-6S | | MI | 17444 | 5564 | 26400 | 4581 | 30760 | 3721 | 32344 | 3057 | 32888 | 2078 | 39810 | 1462 | 26721 |
| 12-#14 | 1.56 | MA | 26916 | 5564 | 39375 | 4657 | 47193 | 3774 | 50976 | 3122 | 54767 | 2136 | 67511 | 1873 | 39080 |
| 3L-5S | | MI | 18203 | 5564 | 27443 | 4582 | 32150 | 3709 | 34035 | 3062 | 35095 | 2071 | 42744 | 1571 | 27588 |
| 12-#14 | 1.56 | MA | 25714 | 5564 | 37773 | 4659 | 45027 | 3789 | 48351 | 3121 | 51223 | 2131 | 63485 | 1742 | 38796 |
| 4E | | MI | 18994 | 5564 | 28616 | 4568 | 33557 | 3712 | 35752 | 3053 | 37390 | 2063 | 45660 | 1633 | 28323 |
| 12-#14 | 1.56 | MA | 24627 | 5564 | 36153 | 4676 | 43083 | 3790 | 45978 | 3134 | 47992 | 2141 | 59307 | 1674 | 37708 |
| 5L-3S | | MI | 19864 | 5564 | 29773 | 4569 | 35121 | 3701 | 37647 | 3058 | 39905 | 2071 | 48417 | 1765 | 28463 |
| 12-#14 | 1.56 | MA | 23585 | 5564 | 34716 | 4678 | 41166 | 3805 | 43643 | 3133 | 44886 | 2151 | 55051 | 1566 | 36303 |
| 6L-2S | | MI | 21056 | 5564 | 31323 | 4570 | 37085 | 3704 | 40028 | 3049 | 43074 | 2063 | 52621 | 1896 | 28507 |
| 12-#18 | 2.78 | MA | 32995 | 6327 | 51568 | 5107 | 62423 | 4102 | 69325 | 3312 | 79453 | 2077 | 100332 | 1885 | 68219 |
| 2L-6S | | MI | 18024 | 6327 | 29859 | 5025 | 34863 | 4045 | 37205 | 3248 | 39213 | 2000 | 48547 | 939 | 42013 |
| 12-#18 | 2.78 | MA | 30204 | 6327 | 47775 | 5109 | 57612 | 4101 | 63497 | 3334 | 71590 | 2092 | 89758 | 1651 | 67684 |
| 3L-5S | | MI | 19294 | 6327 | 31688 | 5029 | 37299 | 4027 | 40169 | 3261 | 43023 | 1987 | 53583 | 1134 | 44807 |
| 12-#18 | 2.78 | MA | 28195 | 6327 | 44958 | 5111 | 53803 | 4126 | 58881 | 3329 | 65359 | 2081 | 82788 | 1418 | 65219 |
| 4E | | MI | 20617 | 6327 | 33743 | 5006 | 39765 | 4035 | 43177 | 3248 | 46985 | 1974 | 58616 | 1242 | 46897 |
| 12-#18 | 2.78 | MA | 26377 | 6327 | 42108 | 5140 | 50383 | 4125 | 54706 | 3351 | 59676 | 2096 | 75513 | 1300 | 61804 |
| 5L-3S | | MI | 22073 | 6327 | 35769 | 5010 | 42502 | 4017 | 46494 | 3260 | 51327 | 1987 | 63338 | 1475 | 48818 |
| 12-#18 | 2.78 | MA | 24633 | 6327 | 39577 | 5142 | 47008 | 4150 | 50598 | 3346 | 54211 | 2111 | 68131 | 1107 | 57823 |
| 6L-2S | | MI | 24063 | 6327 | 38472 | 5013 | 45929 | 4025 | 50646 | 3247 | 56798 | 1974 | 70556 | 1709 | 49147 |
| 14-#11 | 1.26 | MA | 27451 | 5376 | 39003 | 4550 | 46839 | 3698 | 50600 | 3063 | 54295 | 2141 | 67050 | 2037 | 31988 |
| 2L-7S | | MI | 17205 | 5376 | 25351 | 4479 | 29528 | 3644 | 30898 | 3021 | 30967 | 2095 | 37358 | 1573 | 22263 |
| 14-#11 | 1.26 | MA | 26271 | 5376 | 37493 | 4552 | 44925 | 3699 | 48280 | 3073 | 51166 | 2149 | 62773 | 1946 | 31946 |
| 3L-6S | | MI | 17730 | 5376 | 26060 | 4479 | 30466 | 3646 | 32043 | 3014 | 32541 | 2100 | 39195 | 1644 | 22692 |
| 14-#11 | 1.26 | MA | 25421 | 5376 | 36377 | 4554 | 43415 | 3710 | 46450 | 3072 | 48695 | 2146 | 59946 | 1854 | 31839 |
| 4L-5S | | MI | 18267 | 5376 | 26788 | 4479 | 31437 | 3637 | 33224 | 3017 | 34094 | 2095 | 41264 | 1719 | 23207 |
| 14-#11 | 1.26 | MA | 24653 | 5376 | 35248 | 4566 | 42060 | 3710 | 44796 | 3082 | 46443 | 2153 | 57018 | 1807 | 31624 |
| 5L-4S | | MI | 18826 | 5376 | 27607 | 4469 | 32419 | 3639 | 34423 | 3010 | 35708 | 2089 | 43316 | 1763 | 23306 |
| 14-#11 | 1.26 | MA | 23918 | 5376 | 34246 | 4568 | 40724 | 3721 | 43169 | 3081 | 44279 | 2161 | 54031 | 1732 | 30828 |
| 6L-3S | | MI | 19442 | 5376 | 28415 | 4469 | 33512 | 3630 | 35747 | 3014 | 37477 | 2095 | 45264 | 1855 | 23346 |
| 14-#11 | 1.26 | MA | 23197 | 5376 | 33272 | 4569 | 39434 | 3722 | 41592 | 3091 | 42085 | 2158 | 51368 | 1661 | 30116 |
| 7L-2S | | MI | 20286 | 5376 | 29500 | 4470 | 34887 | 3632 | 37413 | 3007 | 39706 | 2089 | 48228 | 1946 | 23351 |
| 14-#14 | 1.82 | MA | 29610 | 5728 | 43700 | 4757 | 52679 | 3849 | 57622 | 3156 | 63733 | 2118 | 79699 | 1989 | 45586 |
| 2L-7S | | MI | 17463 | 5728 | 26934 | 4683 | 31381 | 3793 | 33083 | 3114 | 33818 | 2061 | 41412 | 1332 | 30084 |
| 14-#14 | 1.82 | MA | 27960 | 5728 | 41538 | 4759 | 49936 | 3849 | 54299 | 3169 | 59250 | 2128 | 73605 | 1858 | 45442 |
| 3L-6S | | MI | 18198 | 5728 | 27950 | 4684 | 32724 | 3796 | 34724 | 3104 | 36057 | 2068 | 44013 | 1435 | 31146 |
| 14-#14 | 1.82 | MA | 26773 | 5728 | 39936 | 4761 | 47769 | 3864 | 51673 | 3168 | 55706 | 2123 | 69580 | 1726 | 45120 |
| 4L-5S | | MI | 18948 | 5728 | 28993 | 4685 | 34114 | 3784 | 36415 | 3110 | 38264 | 2061 | 46947 | 1544 | 31973 |
| 14-#14 | 1.82 | MA | 25700 | 5728 | 38316 | 4778 | 45826 | 3864 | 49300 | 3182 | 52475 | 2134 | 65401 | 1658 | 43884 |
| 5L-4S | | MI | 19729 | 5728 | 30165 | 4670 | 35521 | 3787 | 38133 | 3100 | 40559 | 2053 | 49864 | 1607 | 32852 |
| 14-#14 | 1.82 | MA | 24672 | 5728 | 36878 | 4780 | 43908 | 3880 | 46966 | 3180 | 49369 | 2144 | 61145 | 1550 | 42529 |
| 6L-3S | | MI | 20590 | 5728 | 31323 | 4671 | 37085 | 3775 | 40028 | 3106 | 43074 | 2061 | 52621 | 1738 | 33025 |
| 14-#14 | 1.82 | MA | 23664 | 5728 | 35479 | 4782 | 42056 | 3880 | 44703 | 3194 | 46221 | 2139 | 57353 | 1448 | 40965 |
| 7L-2S | | MI | 21770 | 5728 | 32872 | 4672 | 39050 | 3779 | 42408 | 3097 | 46242 | 2053 | 56824 | 1870 | 33095 |
| 14-#18 | 3.24 | MA | 31920 | 6618 | 51568 | 5291 | 62423 | 4234 | 69325 | 3418 | 79453 | 2079 | 100332 | 1618 | 78774 |
| 3L-6S | | MI | 19280 | 6618 | 32562 | 5207 | 38290 | 4178 | 41357 | 3333 | 44684 | 1978 | 55765 | 885 | 49555 |
| 14-#18 | 3.24 | MA | 29947 | 6618 | 48751 | 5293 | 58614 | 4259 | 64709 | 3413 | 73222 | 2068 | 93362 | 1384 | 75967 |
| 4L-5S | | MI | 20528 | 6618 | 34391 | 5211 | 40727 | 4160 | 44322 | 3345 | 48493 | 1965 | 60801 | 1080 | 52487 |
| 14-#18 | 3.24 | MA | 28164 | 6618 | 45901 | 5321 | 55194 | 4258 | 60534 | 3435 | 67539 | 2083 | 86087 | 1266 | 72691 |
| 5L-4S | | MI | 21828 | 6618 | 36445 | 5188 | 43192 | 4168 | 47330 | 3332 | 52455 | 1952 | 65834 | 1187 | 54467 |
| 14-#18 | 3.24 | MA | 26453 | 6618 | 43370 | 5324 | 51819 | 4283 | 56426 | 3431 | 62074 | 2098 | 78705 | 1074 | 68588 |
| 6L-3S | | MI | 23261 | 6618 | 38472 | 5191 | 45929 | 4150 | 50646 | 3345 | 56798 | 1965 | 70556 | 1421 | 56700 |
| 14-#18 | 3.24 | MA | 24777 | 6618 | 40906 | 5326 | 48558 | 4282 | 52442 | 3453 | 56534 | 2086 | 72135 | 892 | 64347 |
| 7L-2S | | MI | 25223 | 6618 | 41174 | 5195 | 49357 | 4158 | 54799 | 3331 | 62268 | 1952 | 77774 | 1654 | 57099 |

## RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

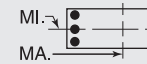



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.44 | MA | 28186 | 5490 | 40512 | 4621 | 48754 | 3750 | 52919 | 3096 | 57424 | 2136 | 71327 | 2027 | 36459 |
| 2L-8S | | MI | 17229 | 5490 | 25737 | 4550 | 29984 | 3694 | 31416 | 3051 | 31677 | 2093 | 38407 | 1504 | 24788 |
| 16-#11 | 1.44 | MA | 27015 | 5490 | 39003 | 4623 | 46839 | 3751 | 50600 | 3106 | 54295 | 2143 | 67050 | 1936 | 36400 |
| 3L-7S | | MI | 17743 | 5490 | 26435 | 4550 | 30903 | 3696 | 32563 | 3054 | 33196 | 2088 | 40323 | 1556 | 25378 |
| 16-#11 | 1.44 | MA | 26173 | 5490 | 37886 | 4625 | 45329 | 3762 | 48769 | 3105 | 51823 | 2141 | 64223 | 1845 | 36274 |
| 4L-6S | | MI | 18264 | 5490 | 27144 | 4550 | 31841 | 3698 | 33709 | 3047 | 34770 | 2093 | 42160 | 1627 | 25793 |
| 16-#11 | 1.44 | MA | 25413 | 5490 | 36757 | 4637 | 43974 | 3762 | 47115 | 3115 | 49572 | 2148 | 61295 | 1797 | 36038 |
| 5E | | MI | 18796 | 5490 | 27872 | 4550 | 32811 | 3689 | 34890 | 3050 | 36323 | 2088 | 44229 | 1702 | 26379 |
| 16-#11 | 1.44 | MA | 24685 | 5490 | 35756 | 4638 | 42638 | 3773 | 45488 | 3114 | 47407 | 2156 | 58308 | 1722 | 35170 |
| 6L-4S | | MI | 19350 | 5490 | 28691 | 4540 | 33794 | 3691 | 36089 | 3043 | 37937 | 2083 | 46281 | 1747 | 26497 |
| 16-#11 | 1.44 | MA | 23972 | 5490 | 34781 | 4640 | 41348 | 3774 | 43912 | 3124 | 45214 | 2153 | 55645 | 1651 | 34478 |
| 7L-3S | | MI | 19961 | 5490 | 29500 | 4540 | 34887 | 3682 | 37413 | 3047 | 39706 | 2088 | 48228 | 1838 | 26553 |
| 16-#11 | 1.44 | MA | 23267 | 5490 | 33822 | 4642 | 40084 | 3774 | 42332 | 3124 | 43098 | 2160 | 52910 | 1596 | 33577 |
| 8L-2S | | MI | 20799 | 5490 | 30584 | 4540 | 36262 | 3684 | 39079 | 3039 | 41936 | 2083 | 51193 | 1929 | 26573 |
| 16-#14 | 2.08 | MA | 30620 | 5891 | 45863 | 4859 | 55421 | 3923 | 60944 | 3203 | 68216 | 2111 | 85794 | 1973 | 51973 |
| 2L-8S | | MI | 17496 | 5891 | 27482 | 4784 | 32029 | 3864 | 33819 | 3155 | 34828 | 2058 | 42893 | 1233 | 33374 |
| 16-#14 | 2.08 | MA | 28987 | 5891 | 43700 | 4861 | 52679 | 3924 | 57622 | 3217 | 63733 | 2121 | 79699 | 1842 | 51800 |
| 3L-7S | | MI | 18213 | 5891 | 28483 | 4785 | 33346 | 3867 | 35463 | 3161 | 36987 | 2050 | 45615 | 1306 | 34441 |
| 16-#14 | 2.08 | MA | 27814 | 5891 | 42098 | 4863 | 50512 | 3939 | 54996 | 3215 | 60188 | 2116 | 75674 | 1710 | 51444 |
| 4L-6S | | MI | 18939 | 5891 | 29499 | 4786 | 34689 | 3871 | 37104 | 3152 | 39226 | 2058 | 48217 | 1409 | 35579 |
| 16-#14 | 2.08 | MA | 26755 | 5891 | 40478 | 4880 | 48568 | 3939 | 52623 | 3229 | 56957 | 2126 | 71496 | 1642 | 50074 |
| 5E | | MI | 19681 | 5891 | 30542 | 4787 | 36079 | 3859 | 38796 | 3157 | 41433 | 2050 | 51150 | 1518 | 36373 |
| 16-#14 | 2.08 | MA | 25740 | 5891 | 39041 | 4882 | 46651 | 3955 | 50288 | 3228 | 53852 | 2136 | 67240 | 1534 | 48763 |
| 6L-4S | | MI | 20453 | 5891 | 31714 | 4773 | 37486 | 3862 | 40513 | 3148 | 43728 | 2043 | 54067 | 1581 | 37376 |
| 16-#14 | 2.08 | MA | 24746 | 5891 | 37642 | 4885 | 44799 | 3955 | 48025 | 3241 | 50704 | 2131 | 63448 | 1432 | 47130 |
| 7L-3S | | MI | 21305 | 5891 | 32872 | 4774 | 39050 | 3850 | 42408 | 3153 | 46242 | 2050 | 56824 | 1712 | 37580 |
| 16-#14 | 2.08 | MA | 23763 | 5891 | 36265 | 4887 | 42984 | 3955 | 45758 | 3240 | 47667 | 2141 | 59544 | 1354 | 45445 |
| 8L-2S | | MI | 22473 | 5891 | 34421 | 4774 | 41015 | 3853 | 44788 | 3144 | 49411 | 2043 | 61028 | 1843 | 37675 |
| 16-#18 | 3.70 | MA | 31664 | 6909 | 52544 | 5474 | 63425 | 4392 | 70537 | 3498 | 81086 | 2054 | 103935 | 1351 | 86747 |
| 4L-6S | | MI | 20510 | 6909 | 35265 | 5389 | 41718 | 4311 | 45510 | 3417 | 50154 | 1956 | 62983 | 830 | 57123 |
| 16-#18 | 3.70 | MA | 29913 | 6909 | 49694 | 5503 | 60005 | 4391 | 66363 | 3520 | 75402 | 2070 | 96661 | 1233 | 83597 |
| 5E | | MI | 21738 | 6909 | 37094 | 5393 | 44154 | 4293 | 48474 | 3430 | 53964 | 1943 | 68019 | 1025 | 60185 |
| 16-#18 | 3.70 | MA | 28234 | 6909 | 47163 | 5505 | 56630 | 4416 | 62254 | 3515 | 69937 | 2085 | 89278 | 1040 | 79374 |
| 6L-4S | | MI | 23018 | 6909 | 39148 | 5370 | 46620 | 4301 | 51483 | 3416 | 57926 | 1930 | 73052 | 1133 | 62068 |
| 16-#18 | 3.70 | MA | 26588 | 6909 | 44700 | 5508 | 53369 | 4415 | 58270 | 3537 | 64397 | 2073 | 82709 | 858 | 75073 |
| 7L-3S | | MI | 24429 | 6909 | 41174 | 5373 | 49357 | 4283 | 54799 | 3429 | 62268 | 1943 | 77774 | 1366 | 64575 |
| 16-#18 | 3.70 | MA | 24960 | 6909 | 42274 | 5510 | 50174 | 4414 | 54279 | 3532 | 59051 | 2088 | 75915 | 722 | 70605 |
| 8L-2S | | MI | 26364 | 6909 | 43877 | 5377 | 52785 | 4291 | 58952 | 3415 | 67739 | 1930 | 84991 | 1600 | 65039 |
| 18-#11 | 1.63 | MA | 28913 | 5603 | 42021 | 4692 | 50668 | 3802 | 55238 | 3129 | 60552 | 2131 | 75604 | 2017 | 40925 |
| 2L-9S | | MI | 17259 | 5603 | 26051 | 4631 | 30412 | 3755 | 31952 | 3091 | 32402 | 2092 | 39496 | 1429 | 27239 |
| 18-#11 | 1.63 | MA | 27751 | 5603 | 40512 | 4694 | 48754 | 3803 | 52919 | 3138 | 57424 | 2138 | 71327 | 1926 | 40851 |
| 3L-8S | | MI | 17765 | 5603 | 26821 | 4621 | 31359 | 3746 | 33081 | 3084 | 33906 | 2087 | 41372 | 1488 | 27858 |
| 18-#11 | 1.63 | MA | 26916 | 5603 | 39395 | 4695 | 47243 | 3814 | 51088 | 3138 | 54952 | 2135 | 68499 | 1835 | 40706 |
| 4L-7S | | MI | 18275 | 5603 | 27519 | 4621 | 32278 | 3748 | 34229 | 3087 | 35425 | 2082 | 43287 | 1539 | 28497 |
| 18-#11 | 1.63 | MA | 26163 | 5603 | 38266 | 4708 | 45889 | 3814 | 49434 | 3148 | 52700 | 2143 | 65572 | 1787 | 40452 |
| 5L-6S | | MI | 18791 | 5603 | 28228 | 4621 | 33216 | 3750 | 35374 | 3080 | 37000 | 2087 | 45124 | 1610 | 28899 |
| 18-#11 | 1.63 | MA | 25442 | 5603 | 37265 | 4709 | 44553 | 3825 | 47807 | 3147 | 50536 | 2150 | 62585 | 1712 | 39519 |
| 6L-5S | | MI | 19318 | 5603 | 28956 | 4621 | 34186 | 3741 | 36555 | 3083 | 38552 | 2082 | 47193 | 1686 | 29528 |
| 18-#11 | 1.63 | MA | 24736 | 5603 | 36290 | 4711 | 43262 | 3826 | 46231 | 3157 | 48343 | 2148 | 59922 | 1642 | 38844 |
| 7L-4S | | MI | 19868 | 5603 | 29775 | 4611 | 35169 | 3743 | 37755 | 3076 | 40167 | 2077 | 49245 | 1730 | 29683 |
| 18-#11 | 1.63 | MA | 24038 | 5603 | 35331 | 4713 | 41998 | 3826 | 44651 | 3156 | 46226 | 2155 | 57187 | 1587 | 37898 |
| 8L-3S | | MI | 20474 | 5603 | 30584 | 4611 | 36262 | 3734 | 39079 | 3079 | 41936 | 2082 | 51193 | 1821 | 29755 |
| 18-#11 | 1.63 | MA | 23345 | 5603 | 34272 | 4725 | 40695 | 3837 | 43097 | 3166 | 44131 | 2163 | 54472 | 1528 | 36914 |
| 9L-2S | | MI | 21306 | 5603 | 31668 | 4611 | 37637 | 3736 | 40744 | 3072 | 44165 | 2077 | 54157 | 1912 | 29787 |
| 18-#14 | 2.34 | MA | 30000 | 6055 | 45863 | 4964 | 55421 | 3998 | 60944 | 3264 | 68216 | 2113 | 85794 | 1826 | 58154 |
| 3L-8S | | MI | 18243 | 6055 | 29032 | 4887 | 33994 | 3939 | 36200 | 3203 | 37997 | 2047 | 47096 | 1207 | 37749 |
| 18-#14 | 2.34 | MA | 28841 | 6055 | 44261 | 4966 | 53255 | 4014 | 58318 | 3263 | 64671 | 2109 | 81769 | 1695 | 57767 |
| 4L-7S | | MI | 18952 | 6055 | 30032 | 4887 | 35310 | 3942 | 37844 | 3208 | 40156 | 2040 | 49819 | 1280 | 38810 |
| 18-#14 | 2.34 | MA | 27794 | 6055 | 42641 | 4983 | 51311 | 4014 | 55946 | 3276 | 61440 | 2119 | 77590 | 1627 | 56276 |
| 5L-6S | | MI | 19670 | 6055 | 31048 | 4888 | 36654 | 3945 | 39484 | 3199 | 42395 | 2047 | 52420 | 1382 | 40020 |


## RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

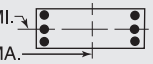

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.34 | MA | 26792 | 6055 | 41203 | 4985 | 49393 | 4029 | 53611 | 3275 | 58335 | 2129 | 73334 | 1519 | 55005 |
| 6L-5S | | MI | 20403 | 6055 | 32091 | 4889 | 38044 | 3934 | 41176 | 3204 | 44601 | 2040 | 55354 | 1492 | 40785 |
| 18-#14 | 2.34 | MA | 25810 | 6055 | 39804 | 4987 | 47541 | 4030 | 51348 | 3288 | 55187 | 2124 | 69542 | 1417 | 53306 |
| 7L-4S | | MI | 21167 | 6055 | 33263 | 4875 | 39451 | 3937 | 42893 | 3195 | 46896 | 2033 | 58270 | 1554 | 41897 |
| 18-#14 | 2.34 | MA | 24840 | 6055 | 38428 | 4989 | 45727 | 4030 | 49081 | 3287 | 52150 | 2134 | 65638 | 1338 | 51660 |
| 8L-3S | | MI | 22010 | 6055 | 34421 | 4876 | 41015 | 3925 | 44788 | 3201 | 49411 | 2040 | 61028 | 1686 | 42129 |
| 18-#14 | 2.34 | MA | 23875 | 6055 | 36907 | 5006 | 43857 | 4045 | 46851 | 3301 | 49142 | 2144 | 61772 | 1254 | 49404 |
| 9L-2S | | MI | 23167 | 6055 | 35970 | 4877 | 42979 | 3928 | 47168 | 3191 | 52580 | 2033 | 65231 | 1817 | 42248 |
| 18-#18 | 4.17 | MA | 31630 | 7200 | 53487 | 5685 | 64815 | 4524 | 72191 | 3604 | 83265 | 2056 | 107235 | 1199 | 94520 |
| 5L-6S | | MI | 21719 | 7200 | 37967 | 5571 | 45146 | 4444 | 49663 | 3501 | 55625 | 1934 | 70201 | 775 | 64712 |
| 18-#18 | 4.17 | MA | 29980 | 7200 | 50957 | 5687 | 61440 | 4549 | 68082 | 3599 | 77800 | 2071 | 99852 | 1007 | 90181 |
| 6L-5S | | MI | 22929 | 7200 | 39796 | 5574 | 47582 | 4426 | 52627 | 3514 | 59435 | 1921 | 75237 | 970 | 67900 |
| 18-#18 | 4.17 | MA | 28364 | 7200 | 48493 | 5689 | 58180 | 4548 | 64099 | 3621 | 72260 | 2060 | 93283 | 825 | 85816 |
| 7L-4S | | MI | 24189 | 7200 | 41851 | 5551 | 50048 | 4434 | 55636 | 3500 | 63396 | 1907 | 80270 | 1078 | 69696 |
| 18-#18 | 4.17 | MA | 26764 | 7200 | 46068 | 5691 | 54985 | 4547 | 60107 | 3616 | 66914 | 2075 | 86489 | 688 | 81310 |
| 8L-3S | | MI | 25579 | 7200 | 43877 | 5555 | 52785 | 4416 | 58952 | 3513 | 67739 | 1921 | 84991 | 1311 | 72447 |
| 20-#11 | 1.81 | MA | 28478 | 5717 | 42021 | 4765 | 50668 | 3855 | 55238 | 3171 | 60552 | 2133 | 75604 | 1916 | 45299 |
| 3L-9S | | MI | 17793 | 5717 | 27135 | 4702 | 31787 | 3807 | 33618 | 3124 | 34631 | 2086 | 42461 | 1412 | 30331 |
| 20-#11 | 1.81 | MA | 27651 | 5717 | 40905 | 4766 | 49157 | 3866 | 53407 | 3171 | 58081 | 2130 | 72776 | 1825 | 45137 |
| 4L-8S | | MI | 18295 | 5717 | 27905 | 4692 | 32734 | 3798 | 34747 | 3117 | 36136 | 2081 | 44336 | 1471 | 30935 |
| 20-#11 | 1.81 | MA | 26904 | 5717 | 39776 | 4778 | 47803 | 3866 | 51753 | 3181 | 55829 | 2138 | 69849 | 1777 | 44866 |
| 5L-7S | | MI | 18801 | 5717 | 28603 | 4692 | 33653 | 3800 | 35895 | 3120 | 37655 | 2076 | 46252 | 1522 | 31620 |
| 20-#11 | 1.81 | MA | 26190 | 5717 | 38774 | 4780 | 46467 | 3877 | 50127 | 3180 | 53665 | 2145 | 66862 | 1703 | 43874 |
| 6E | | MI | 19312 | 5717 | 29312 | 4692 | 34591 | 3801 | 37040 | 3113 | 39229 | 2081 | 48089 | 1593 | 32011 |
| 20-#11 | 1.81 | MA | 25490 | 5717 | 37800 | 4782 | 45176 | 3878 | 48550 | 3190 | 51471 | 2142 | 64199 | 1632 | 43215 |
| 7L-5S | | MI | 19835 | 5717 | 30040 | 4692 | 35561 | 3793 | 38221 | 3116 | 40782 | 2076 | 50158 | 1669 | 32615 |
| 20-#11 | 1.81 | MA | 24799 | 5717 | 36841 | 4784 | 43912 | 3878 | 46970 | 3189 | 49355 | 2150 | 61464 | 1577 | 42225 |
| 8L-4S | | MI | 20380 | 5717 | 30859 | 4682 | 36544 | 3794 | 39420 | 3109 | 42396 | 2070 | 52210 | 1713 | 32865 |
| 20-#11 | 1.81 | MA | 24113 | 5717 | 35781 | 4796 | 42610 | 3889 | 45416 | 3199 | 47260 | 2158 | 58749 | 1519 | 41261 |
| 9L-3S | | MI | 20981 | 5717 | 31668 | 4682 | 37637 | 3786 | 40744 | 3112 | 44165 | 2076 | 54157 | 1804 | 32952 |
| 20-#11 | 1.81 | MA | 23415 | 5717 | 34826 | 4797 | 41355 | 3890 | 43855 | 3199 | 45105 | 2155 | 55944 | 1439 | 40001 |
| 10L-2S | | MI | 21807 | 5717 | 32752 | 4682 | 39011 | 3788 | 42410 | 3105 | 46394 | 2070 | 57122 | 1895 | 32996 |
| 20-#14 | 2.60 | MA | 29853 | 6218 | 46423 | 5068 | 55997 | 4089 | 61641 | 3310 | 69154 | 2101 | 87863 | 1679 | 64089 |
| 4L-8S | | MI | 18979 | 6218 | 30581 | 4989 | 35958 | 4014 | 38580 | 3250 | 41166 | 2037 | 51300 | 1180 | 42077 |
| 20-#14 | 2.60 | MA | 28819 | 6218 | 44803 | 5085 | 54053 | 4089 | 59268 | 3324 | 65923 | 2111 | 83685 | 1611 | 62489 |
| 5L-7S | | MI | 19681 | 6218 | 31581 | 4990 | 37275 | 4017 | 40224 | 3256 | 43325 | 2030 | 54022 | 1253 | 43189 |
| 20-#14 | 2.60 | MA | 27828 | 6218 | 43366 | 5087 | 52136 | 4104 | 56934 | 3322 | 62817 | 2121 | 79429 | 1503 | 61255 |
| 6E | | MI | 20391 | 6218 | 32597 | 4990 | 38618 | 4020 | 41865 | 3246 | 45563 | 2037 | 56624 | 1356 | 44467 |
| 20-#14 | 2.60 | MA | 26858 | 6218 | 41967 | 5089 | 50284 | 4105 | 54671 | 3336 | 59669 | 2116 | 75636 | 1401 | 59490 |
| 7L-5S | | MI | 21116 | 6218 | 33640 | 4991 | 40008 | 4008 | 43556 | 3252 | 47770 | 2030 | 59557 | 1465 | 45206 |
| 20-#14 | 2.60 | MA | 25900 | 6218 | 40590 | 5091 | 48469 | 4105 | 52404 | 3334 | 56632 | 2126 | 71733 | 1323 | 57881 |
| 8L-4S | | MI | 21872 | 6218 | 34812 | 4977 | 41415 | 4012 | 45273 | 3242 | 50065 | 2022 | 62474 | 1528 | 46416 |
| 20-#14 | 2.60 | MA | 24947 | 6218 | 39069 | 5108 | 46599 | 4120 | 50173 | 3348 | 53625 | 2137 | 67866 | 1238 | 55589 |
| 9L-3S | | MI | 22706 | 6218 | 35970 | 4978 | 42979 | 4000 | 47168 | 3248 | 52580 | 2030 | 65231 | 1659 | 46674 |
| 20-#14 | 2.60 | MA | 23989 | 6218 | 37698 | 5110 | 44798 | 4120 | 47933 | 3347 | 50533 | 2132 | 63870 | 1123 | 53360 |
| 10L-2S | | MI | 23853 | 6218 | 37519 | 4979 | 44944 | 4003 | 49548 | 3239 | 55749 | 2022 | 69434 | 1791 | 46815 |
| 20-#18 | 4.63 | MA | 31696 | 7490 | 54750 | 5869 | 66251 | 4682 | 73910 | 3683 | 85663 | 2058 | 110426 | 973 | 101005 |
| 6E | | MI | 22910 | 7490 | 40670 | 5752 | 48574 | 4577 | 53815 | 3585 | 61095 | 1912 | 77419 | 721 | 72322 |
| 20-#18 | 4.63 | MA | 30107 | 7490 | 52286 | 5871 | 62990 | 4681 | 69927 | 3705 | 80123 | 2047 | 103856 | 792 | 96576 |
| 7L-5S | | MI | 24101 | 7490 | 42499 | 5756 | 51010 | 4559 | 56780 | 3598 | 64905 | 1899 | 82455 | 916 | 75396 |
| 20-#18 | 4.63 | MA | 28534 | 7490 | 49861 | 5873 | 59795 | 4680 | 65936 | 3701 | 74777 | 2062 | 97062 | 655 | 92029 |
| 8L-4S | | MI | 25344 | 7490 | 44554 | 5733 | 53476 | 4567 | 59788 | 3584 | 68867 | 1885 | 87488 | 1023 | 77347 |
| 22-#11 | 1.99 | MA | 28377 | 5830 | 42414 | 4837 | 51072 | 3917 | 55726 | 3204 | 61210 | 2125 | 77053 | 1815 | 49567 |
| 4L-9S | | MI | 18321 | 5830 | 28219 | 4773 | 33162 | 3858 | 35283 | 3157 | 36861 | 2080 | 45425 | 1395 | 33428 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

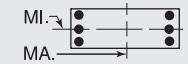



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.99 | MA | 27637 | 5830 | 41285 | 4849 | 49717 | 3918 | 54072 | 3213 | 58958 | 2133 | 74125 | 1768 | 49201 |
| 5L-8S | | MI | 18819 | 5830 | 28989 | 4762 | 34109 | 3850 | 36413 | 3149 | 38365 | 2074 | 47301 | 1454 | 34016 |
| 22-#11 | 1.99 | MA | 26929 | 5830 | 40284 | 4851 | 48381 | 3929 | 52446 | 3213 | 56794 | 2140 | 71139 | 1693 | 48235 |
| 6L-7S | | MI | 19321 | 5830 | 29687 | 4763 | 35028 | 3852 | 37560 | 3153 | 39884 | 2069 | 49216 | 1505 | 34745 |
| 22-#11 | 1.99 | MA | 26236 | 5830 | 39309 | 4853 | 47091 | 3929 | 50869 | 3223 | 54600 | 2137 | 68476 | 1622 | 47589 |
| 7L-6S | | MI | 19828 | 5830 | 30396 | 4763 | 35966 | 3853 | 38706 | 3146 | 41458 | 2074 | 51053 | 1577 | 35128 |
| 22-#11 | 1.99 | MA | 25551 | 5830 | 38350 | 4855 | 45827 | 3930 | 49289 | 3222 | 52484 | 2145 | 65741 | 1567 | 46557 |
| 8L-5S | | MI | 20346 | 5830 | 31124 | 4763 | 36936 | 3845 | 39887 | 3149 | 43011 | 2069 | 53123 | 1652 | 35709 |
| 22-#11 | 1.99 | MA | 24871 | 5830 | 37291 | 4867 | 44524 | 3941 | 47736 | 3232 | 50389 | 2152 | 63026 | 1509 | 45612 |
| 9L-4S | | MI | 20887 | 5830 | 31943 | 4753 | 37919 | 3846 | 41086 | 3142 | 44625 | 2064 | 55175 | 1696 | 36045 |
| 22-#11 | 1.99 | MA | 24187 | 5830 | 36335 | 4868 | 43269 | 3942 | 46174 | 3231 | 48234 | 2150 | 60220 | 1429 | 44327 |
| 10L-3S | | MI | 21483 | 5830 | 32752 | 4753 | 39011 | 3838 | 42410 | 3145 | 46394 | 2069 | 57122 | 1787 | 36146 |
| 22-#11 | 1.99 | MA | 23446 | 5830 | 35387 | 4870 | 41981 | 3953 | 44630 | 3241 | 46148 | 2157 | 57532 | 1371 | 43120 |
| 11L-2S | | MI | 22304 | 5830 | 33836 | 4753 | 40386 | 3839 | 44076 | 3138 | 48623 | 2064 | 60086 | 1879 | 36202 |
| 22-#14 | 2.86 | MA | 29829 | 6382 | 46966 | 5187 | 56796 | 4164 | 62591 | 3371 | 70406 | 2104 | 89779 | 1596 | 68712 |
| 5L-8S | | MI | 19706 | 6382 | 32130 | 5091 | 37923 | 4089 | 40960 | 3298 | 44335 | 2027 | 55503 | 1154 | 46414 |
| 22-#14 | 2.86 | MA | 28850 | 6382 | 45528 | 5189 | 54878 | 4179 | 60256 | 3370 | 67300 | 2114 | 85523 | 1487 | 67510 |
| 6L-7S | | MI | 20400 | 6382 | 33130 | 5092 | 39240 | 4092 | 42604 | 3303 | 46494 | 2020 | 58225 | 1227 | 47577 |
| 22-#14 | 2.86 | MA | 27892 | 6382 | 44129 | 5191 | 53026 | 4179 | 57993 | 3383 | 64152 | 2109 | 81731 | 1385 | 65683 |
| 7L-6S | | MI | 21103 | 6382 | 34146 | 5093 | 40583 | 4095 | 44245 | 3294 | 48732 | 2027 | 60827 | 1330 | 48919 |
| 22-#14 | 2.86 | MA | 26944 | 6382 | 42753 | 5193 | 51212 | 4180 | 55726 | 3382 | 61115 | 2119 | 77827 | 1307 | 64078 |
| 8L-5S | | MI | 21821 | 6382 | 35189 | 5093 | 41973 | 4083 | 45936 | 3299 | 50939 | 2020 | 63760 | 1439 | 49635 |
| 22-#14 | 2.86 | MA | 26003 | 6382 | 41232 | 5210 | 49342 | 4195 | 53496 | 3395 | 58108 | 2129 | 73961 | 1223 | 61782 |
| 9L-4S | | MI | 22569 | 6382 | 36362 | 5079 | 43380 | 4086 | 47653 | 3290 | 53234 | 2012 | 66677 | 1502 | 50933 |
| 22-#14 | 2.86 | MA | 25049 | 6382 | 39860 | 5212 | 47540 | 4195 | 51255 | 3394 | 55015 | 2124 | 69964 | 1107 | 59525 |
| 10L-3S | | MI | 23395 | 6382 | 37519 | 5080 | 44944 | 4075 | 49548 | 3295 | 55749 | 2020 | 69434 | 1633 | 51215 |
| 22-#18 | 5.09 | MA | 31822 | 7781 | 56079 | 6053 | 67801 | 4814 | 75755 | 3790 | 87986 | 2033 | 114430 | 758 | 107351 |
| 7L-6S | | MI | 24084 | 7781 | 43373 | 5934 | 52001 | 4710 | 57968 | 3670 | 66566 | 1890 | 84637 | 666 | 79949 |
| 22-#18 | 5.09 | MA | 30275 | 7781 | 53654 | 6055 | 64606 | 4813 | 71764 | 3785 | 82640 | 2049 | 107636 | 622 | 102763 |
| 8L-5S | | MI | 25373 | 7781 | 45202 | 5938 | 54438 | 4692 | 60932 | 3682 | 70376 | 1876 | 89673 | 861 | 82916 |
| 24-#11 | 2.17 | MA | 28362 | 5944 | 42795 | 4920 | 51631 | 3970 | 56392 | 3246 | 62087 | 2127 | 78402 | 1758 | 53539 |
| 5L-9S | | MI | 18844 | 5944 | 29303 | 4843 | 34537 | 3910 | 36949 | 3189 | 39090 | 2073 | 48390 | 1378 | 36505 |
| 24-#11 | 2.17 | MA | 27660 | 5944 | 41793 | 4922 | 50295 | 3981 | 54765 | 3246 | 59923 | 2135 | 75415 | 1683 | 52600 |
| 6L-8S | | MI | 19338 | 5944 | 30073 | 4833 | 35484 | 3902 | 38078 | 3182 | 40594 | 2068 | 50265 | 1437 | 37103 |
| 24-#11 | 2.17 | MA | 26973 | 5944 | 40819 | 4924 | 49005 | 3981 | 53188 | 3256 | 57729 | 2132 | 72752 | 1612 | 51966 |
| 7E | | MI | 19835 | 5944 | 30772 | 4833 | 36403 | 3903 | 39226 | 3186 | 42113 | 2063 | 52181 | 1489 | 37873 |
| 24-#11 | 2.17 | MA | 26295 | 5944 | 39859 | 4925 | 47741 | 3982 | 51608 | 3255 | 55613 | 2140 | 70017 | 1557 | 50894 |
| 8L-6S | | MI | 20338 | 5944 | 31480 | 4834 | 37341 | 3905 | 40371 | 3178 | 43687 | 2068 | 54018 | 1560 | 38248 |
| 24-#11 | 2.17 | MA | 25621 | 5944 | 38800 | 4937 | 46438 | 3993 | 50055 | 3265 | 53518 | 2147 | 67303 | 1499 | 49967 |
| 9L-5S | | MI | 20853 | 5944 | 32208 | 4834 | 38311 | 3897 | 41552 | 3182 | 45240 | 2063 | 56087 | 1635 | 38809 |
| 24-#11 | 2.17 | MA | 24939 | 5944 | 37845 | 4939 | 45183 | 3993 | 48494 | 3264 | 51363 | 2144 | 64497 | 1419 | 48656 |
| 10L-4S | | MI | 21389 | 5944 | 33027 | 4824 | 39294 | 3898 | 42752 | 3175 | 46854 | 2058 | 58139 | 1680 | 39223 |
| 24-#11 | 2.17 | MA | 24207 | 5944 | 36896 | 4941 | 43895 | 4004 | 46949 | 3274 | 49277 | 2152 | 61809 | 1361 | 47429 |
| 11L-3S | | MI | 21981 | 5944 | 33836 | 4824 | 40386 | 3890 | 44076 | 3178 | 48623 | 2063 | 60086 | 1771 | 39337 |
| 24-#11 | 2.17 | MA | 23491 | 5944 | 35953 | 4943 | 42644 | 4005 | 45397 | 3274 | 47140 | 2149 | 59116 | 1304 | 46018 |
| 12L-2S | | MI | 22796 | 5944 | 34920 | 4824 | 41761 | 3891 | 45742 | 3171 | 50853 | 2058 | 63051 | 1862 | 39403 |
| 24-#14 | 3.13 | MA | 29859 | 6545 | 47691 | 5291 | 57621 | 4254 | 63579 | 3417 | 71783 | 2106 | 91617 | 1472 | 73771 |
| 6L-8S | | MI | 20423 | 6545 | 33679 | 5193 | 39888 | 4163 | 43340 | 3345 | 47504 | 2017 | 59706 | 1128 | 50760 |
| 24-#14 | 3.13 | MA | 28912 | 6545 | 46292 | 5293 | 55769 | 4254 | 61316 | 3431 | 68635 | 2101 | 87825 | 1370 | 71883 |
| 7E | | MI | 21111 | 6545 | 34679 | 5194 | 41204 | 4167 | 44984 | 3350 | 49663 | 2009 | 62429 | 1201 | 51973 |
| 24-#14 | 3.13 | MA | 27975 | 6545 | 44915 | 5296 | 53954 | 4254 | 59049 | 3429 | 65598 | 2112 | 83922 | 1291 | 70235 |
| 8L-6S | | MI | 21806 | 6545 | 35695 | 5195 | 42548 | 4170 | 46625 | 3341 | 51901 | 2017 | 65030 | 1303 | 53359 |
| 24-#14 | 3.13 | MA | 27045 | 6545 | 43394 | 5313 | 52084 | 4270 | 56819 | 3443 | 62591 | 2122 | 80055 | 1207 | 67980 |
| 9L-5S | | MI | 22517 | 6545 | 36738 | 5196 | 43938 | 4158 | 48316 | 3347 | 54108 | 2009 | 67964 | 1412 | 54072 |
| 24-#14 | 3.13 | MA | 26095 | 6545 | 42023 | 5315 | 50283 | 4270 | 54578 | 3441 | 59498 | 2117 | 76059 | 1092 | 65697 |
| 10L-4S | | MI | 23258 | 6545 | 37911 | 5182 | 45345 | 4161 | 50034 | 3337 | 56403 | 2002 | 70881 | 1475 | 55361 |
| 24-#18 | 5.56 | MA | 31988 | 8072 | 57447 | 6237 | 69417 | 4946 | 77592 | 3869 | 90503 | 2035 | 118210 | 588 | 113510 |
| 8L-6S | | MI | 25366 | 8072 | 46076 | 6116 | 55429 | 4843 | 62121 | 3754 | 72036 | 1867 | 91855 | 612 | 87592 |

## RECTANGULAR TIED COLUMNS 38" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.66 | MA | 18757 | 4702 | 28168 | 3840 | 33313 | 3109 | 36000 | 2555 | 38816 | 1710 | 47440 | 1560 | 26561 |
| 2L-3S | | MI | 16547 | 4702 | 25283 | 3837 | 29655 | 3103 | 31568 | 2570 | 32941 | 1723 | 39665 | 1327 | 26369 |
| 8-#14 | 1.25 | MA | 17853 | 4484 | 25926 | 3730 | 30659 | 3032 | 32866 | 2510 | 34849 | 1747 | 42311 | 1628 | 20330 |
| 2L-4S | | MI | 15626 | 4484 | 23043 | 3730 | 26900 | 3042 | 28312 | 2516 | 28756 | 1747 | 34826 | 1365 | 20144 |
| 8-#18 | 2.22 | MA | 20062 | 4993 | 31052 | 4022 | 36972 | 3242 | 40432 | 2639 | 44691 | 1690 | 55216 | 1510 | 35093 |
| 2L-4S | | MI | 16315 | 4993 | 26010 | 4017 | 30398 | 3255 | 32467 | 2644 | 34153 | 1690 | 42346 | 1043 | 32609 |
| 10-#11 | 1.08 | MA | 17477 | 4397 | 24997 | 3689 | 29575 | 3003 | 31595 | 2494 | 33233 | 1763 | 40217 | 1655 | 17790 |
| 2L-5S | | MI | 15308 | 4397 | 22111 | 3700 | 25904 | 3009 | 27136 | 2507 | 27222 | 1768 | 32743 | 1428 | 17605 |
| 10-#11 | 1.08 | MA | 16569 | 4397 | 23842 | 3689 | 28111 | 3001 | 29820 | 2502 | 30845 | 1768 | 37035 | 1564 | 17792 |
| 3L-4S | | MI | 15908 | 4397 | 22982 | 3689 | 26948 | 3011 | 28411 | 2499 | 28951 | 1763 | 34941 | 1473 | 17745 |
| 10-#14 | 1.56 | MA | 18632 | 4647 | 27578 | 3832 | 32753 | 3106 | 35403 | 2558 | 38245 | 1738 | 46829 | 1604 | 25235 |
| 2L-5S | | MI | 15594 | 4647 | 23448 | 3847 | 27498 | 3114 | 29022 | 2574 | 29693 | 1746 | 36217 | 1277 | 23859 |
| 10-#14 | 1.56 | MA | 17361 | 4647 | 25926 | 3832 | 30659 | 3104 | 32866 | 2568 | 34849 | 1746 | 42311 | 1473 | 25171 |
| 3L-4S | | MI | 16435 | 4647 | 24695 | 3832 | 28994 | 3116 | 30849 | 2563 | 32153 | 1738 | 39344 | 1341 | 24960 |
| 10-#18 | 2.77 | MA | 21333 | 5283 | 33937 | 4203 | 40630 | 3375 | 44864 | 2723 | 50566 | 1670 | 62992 | 1460 | 43597 |
| 2L-5S | | MI | 16253 | 5283 | 26707 | 4223 | 31431 | 3382 | 33696 | 2743 | 35773 | 1683 | 44715 | 883 | 38361 |
| 10-#18 | 2.77 | MA | 19208 | 5283 | 31052 | 4201 | 36972 | 3369 | 40432 | 2739 | 44691 | 1683 | 55216 | 1227 | 43192 |
| 3L-4S | | MI | 17659 | 5283 | 28894 | 4199 | 34056 | 3388 | 36899 | 2728 | 40028 | 1670 | 50122 | 993 | 40652 |

## RECTANGULAR TIED COLUMNS 38" x 40"

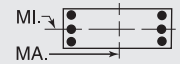
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.05 | MA | 19193 | 4613 | 27637 | 3847 | 32495 | 3132 | 34588 | 2603 | 36083 | 1835 | 43465 | 1717 | 19056 |
| 2E | | MI | 18183 | 4613 | 26310 | 3831 | 30831 | 3119 | 32763 | 2592 | 34057 | 1823 | 40934 | 1700 | 18014 |
| 6-#18 | 1.58 | MA | 20640 | 4903 | 30703 | 4029 | 36384 | 3265 | 39299 | 2687 | 42363 | 1817 | 51799 | 1671 | 28181 |
| 2L-3S | | MI | 17318 | 4903 | 26310 | 4011 | 30831 | 3245 | 32763 | 2692 | 34057 | 1816 | 40934 | 1417 | 26447 |
| 6-#18 | 1.58 | MA | 18282 | 4903 | 27637 | 4027 | 32495 | 3259 | 34588 | 2704 | 36083 | 1831 | 43465 | 1437 | 27989 |
| 3L-2S | | MI | 19535 | 4903 | 29195 | 4013 | 34489 | 3252 | 37195 | 2676 | 39931 | 1803 | 48710 | 1650 | 26609 |
| 8-#14 | 1.18 | MA | 19662 | 4685 | 28312 | 3919 | 33551 | 3187 | 35954 | 2642 | 38096 | 1853 | 46260 | 1735 | 21545 |
| 2L-4S | | MI | 16394 | 4685 | 24060 | 3905 | 28073 | 3185 | 29507 | 2638 | 29875 | 1841 | 36102 | 1456 | 20216 |
| 8-#14 | 1.18 | MA | 18290 | 4685 | 26558 | 3919 | 31327 | 3185 | 33259 | 2653 | 34471 | 1860 | 41427 | 1603 | 21521 |
| 3E | | MI | 17336 | 4685 | 25292 | 3905 | 29737 | 3173 | 31524 | 2643 | 32571 | 1849 | 39069 | 1588 | 20352 |
| 8-#14 | 1.18 | MA | 17291 | 4685 | 25253 | 3920 | 29562 | 3198 | 31121 | 2650 | 31595 | 1853 | 38248 | 1472 | 21359 |
| 4L-2S | | MI | 18627 | 4685 | 26943 | 3905 | 31832 | 3175 | 34061 | 2633 | 35968 | 1841 | 43587 | 1719 | 20365 |
| 8-#18 | 2.11 | MA | 22042 | 5194 | 33769 | 4210 | 40272 | 3398 | 44010 | 2771 | 48643 | 1800 | 60133 | 1625 | 37253 |
| 2L-4S | | MI | 17083 | 5194 | 27037 | 4190 | 31573 | 3398 | 33662 | 2765 | 35269 | 1783 | 43615 | 1133 | 32956 |
| 8-#18 | 2.11 | MA | 19731 | 5194 | 30703 | 4209 | 36384 | 3392 | 39299 | 2788 | 42363 | 1813 | 51799 | 1391 | 36946 |
| 3E | | MI | 18672 | 5194 | 29195 | 4193 | 34489 | 3378 | 37195 | 2776 | 39931 | 1796 | 48710 | 1367 | 34874 |
| 8-#18 | 2.11 | MA | 18046 | 5194 | 28413 | 4208 | 33289 | 3414 | 35549 | 2779 | 37379 | 1800 | 46330 | 1157 | 34902 |
| 4L-2S | | MI | 20846 | 5194 | 32079 | 4195 | 38147 | 3385 | 41627 | 2760 | 45806 | 1783 | 56485 | 1600 | 35147 |
| 10-#11 | 1.03 | MA | 19255 | 4598 | 27321 | 3878 | 32396 | 3158 | 34598 | 2626 | 36339 | 1866 | 44002 | 1760 | 18843 |
| 2L-5S | | MI | 16075 | 4598 | 23123 | 3876 | 27075 | 3154 | 28332 | 2630 | 28343 | 1862 | 34022 | 1519 | 17674 |
| 10-#11 | 1.03 | MA | 18289 | 4598 | 26095 | 3879 | 30841 | 3157 | 32715 | 2635 | 33797 | 1872 | 40601 | 1669 | 18845 |
| 3L-4S | | MI | 16676 | 4598 | 23993 | 3865 | 28119 | 3155 | 29607 | 2622 | 30072 | 1857 | 36220 | 1564 | 17793 |
| 10-#11 | 1.03 | MA | 17586 | 4598 | 25184 | 3879 | 29609 | 3167 | 31222 | 2633 | 31782 | 1867 | 38360 | 1578 | 18798 |
| 4L-3S | | MI | 17339 | 4598 | 24853 | 3865 | 29282 | 3146 | 31016 | 2625 | 31966 | 1862 | 38314 | 1655 | 17829 |
| 10-#11 | 1.03 | MA | 16950 | 4598 | 24262 | 3890 | 28503 | 3166 | 29871 | 2641 | 29943 | 1872 | 36017 | 1532 | 18658 |
| 5L-2S | | MI | 18249 | 4598 | 26008 | 3864 | 30747 | 3147 | 32791 | 2617 | 34354 | 1857 | 41496 | 1746 | 17821 |
| 10-#14 | 1.48 | MA | 20498 | 4849 | 30066 | 4021 | 35775 | 3262 | 38648 | 2690 | 41721 | 1845 | 51092 | 1712 | 26753 |
| 2L-5S | | MI | 16361 | 4849 | 24465 | 4021 | 28671 | 3258 | 30218 | 2696 | 30812 | 1839 | 37493 | 1368 | 24065 |
| 10-#14 | 1.48 | MA | 19143 | 4849 | 28312 | 4022 | 33551 | 3260 | 35954 | 2701 | 38096 | 1852 | 46260 | 1581 | 26690 |
| 3L-4S | | MI | 17205 | 4849 | 25712 | 4007 | 30167 | 3260 | 32044 | 2686 | 33272 | 1832 | 40619 | 1432 | 25038 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

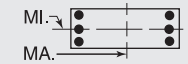
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.48 | MA | 18158 | 4849 | 27006 | 4022 | 31786 | 3273 | 33815 | 2697 | 35220 | 1845 | 43081 | 1450 | 26479 |
| 4L-3S | | MI | 18134 | 4849 | 26943 | 4007 | 31832 | 3248 | 34061 | 2690 | 35968 | 1839 | 43587 | 1563 | 25223 |
| 10-#14 | 1.48 | MA | 17265 | 4849 | 25685 | 4037 | 30200 | 3271 | 31879 | 2708 | 32595 | 1852 | 39744 | 1385 | 25429 |
| 5L-2S | | MI | 19409 | 4849 | 28595 | 4007 | 33926 | 3250 | 36599 | 2680 | 39364 | 1832 | 48105 | 1695 | 25274 |
| 10-#18 | 2.63 | MA | 23409 | 5485 | 36836 | 4392 | 44161 | 3531 | 48721 | 2855 | 54922 | 1782 | 68467 | 1579 | 46297 |
| 2L-5S | | MI | 17019 | 5485 | 27734 | 4396 | 32607 | 3524 | 34891 | 2864 | 36889 | 1776 | 45984 | 973 | 38663 |
| 10-#18 | 2.63 | MA | 21140 | 5485 | 33769 | 4391 | 40272 | 3525 | 44010 | 2872 | 48643 | 1795 | 60133 | 1345 | 45892 |
| 3L-4S | | MI | 18433 | 5485 | 29921 | 4372 | 35232 | 3531 | 38094 | 2849 | 41143 | 1763 | 51391 | 1083 | 40990 |
| 10-#18 | 2.63 | MA | 19490 | 5485 | 31479 | 4390 | 37178 | 3547 | 40260 | 2863 | 43659 | 1782 | 54665 | 1111 | 43466 |
| 4L-3S | | MI | 19990 | 5485 | 32079 | 4374 | 38147 | 3511 | 41627 | 2860 | 45806 | 1776 | 56485 | 1317 | 43287 |
| 10-#18 | 2.63 | MA | 17993 | 5485 | 29159 | 4415 | 34394 | 3541 | 36863 | 2880 | 39111 | 1795 | 48885 | 1000 | 40926 |
| 5L-2S | | MI | 22124 | 5485 | 34964 | 4377 | 41806 | 3518 | 46059 | 2845 | 51681 | 1763 | 64261 | 1550 | 43656 |
| 12-#11 | 1.23 | MA | 19851 | 4711 | 28547 | 3949 | 33951 | 3210 | 36482 | 2659 | 38880 | 1861 | 47403 | 1746 | 22492 |
| 2L-6S | | MI | 16083 | 4711 | 23504 | 3947 | 27508 | 3215 | 28852 | 2660 | 29068 | 1862 | 34983 | 1428 | 20366 |
| 12-#11 | 1.23 | MA | 18893 | 4711 | 27321 | 3949 | 32396 | 3209 | 34598 | 2668 | 36339 | 1867 | 44002 | 1655 | 22473 |
| 3L-5S | | MI | 16654 | 4711 | 24278 | 3946 | 28539 | 3206 | 30107 | 2663 | 30730 | 1857 | 37205 | 1504 | 21046 |
| 12-#11 | 1.23 | MA | 18198 | 4711 | 26410 | 3950 | 31164 | 3219 | 33105 | 2665 | 34323 | 1862 | 41762 | 1564 | 22402 |
| 4E | | MI | 17249 | 4711 | 25148 | 3936 | 29584 | 3207 | 31382 | 2655 | 32459 | 1851 | 39403 | 1549 | 21191 |
| 12-#11 | 1.23 | MA | 17568 | 4711 | 25488 | 3961 | 30057 | 3218 | 31755 | 2674 | 32484 | 1867 | 39418 | 1518 | 22236 |
| 5L-3S | | MI | 17905 | 4711 | 26008 | 3936 | 30747 | 3198 | 32791 | 2658 | 34354 | 1857 | 41496 | 1640 | 21249 |
| 12-#11 | 1.23 | MA | 16964 | 4711 | 24668 | 3962 | 28965 | 3228 | 30425 | 2671 | 30716 | 1873 | 37044 | 1443 | 21499 |
| 6L-2S | | MI | 18807 | 4711 | 27163 | 3935 | 32211 | 3199 | 34565 | 2650 | 36741 | 1851 | 44679 | 1731 | 21261 |
| 12-#14 | 1.78 | MA | 21318 | 5012 | 31819 | 4124 | 37999 | 3337 | 41343 | 2737 | 45346 | 1837 | 55925 | 1690 | 31945 |
| 2L-6S | | MI | 16370 | 5012 | 25007 | 4123 | 29287 | 3345 | 30957 | 2739 | 31843 | 1838 | 38857 | 1235 | 27811 |
| 12-#14 | 1.78 | MA | 19979 | 5012 | 30066 | 4124 | 35775 | 3335 | 38648 | 2748 | 41721 | 1844 | 51092 | 1559 | 31848 |
| 3L-5S | | MI | 17168 | 5012 | 26116 | 4124 | 30765 | 3333 | 32755 | 2743 | 34209 | 1830 | 42011 | 1344 | 28740 |
| 12-#14 | 1.78 | MA | 19008 | 5012 | 28760 | 4124 | 34010 | 3348 | 36509 | 2744 | 38845 | 1837 | 47913 | 1428 | 31595 |
| 4E | | MI | 18000 | 5012 | 27363 | 4109 | 32262 | 3335 | 34582 | 2733 | 36669 | 1823 | 45137 | 1408 | 29856 |
| 12-#14 | 1.78 | MA | 18127 | 5012 | 27438 | 4139 | 32424 | 3346 | 34574 | 2755 | 36220 | 1844 | 44577 | 1363 | 30401 |
| 5L-3S | | MI | 18917 | 5012 | 28595 | 4109 | 33926 | 3323 | 36599 | 2738 | 39364 | 1830 | 48105 | 1539 | 30082 |
| 12-#14 | 1.78 | MA | 17282 | 5012 | 26264 | 4140 | 30858 | 3359 | 32668 | 2752 | 33695 | 1852 | 41203 | 1254 | 29387 |
| 6L-2S | | MI | 20178 | 5012 | 30246 | 4109 | 36020 | 3325 | 39136 | 2727 | 42761 | 1823 | 52623 | 1671 | 30166 |
| 12-#18 | 3.16 | MA | 24744 | 5776 | 39902 | 4574 | 48050 | 3664 | 53432 | 2940 | 61202 | 1764 | 76801 | 1533 | 55324 |
| 2L-6S | | MI | 17033 | 5776 | 28672 | 4576 | 33672 | 3677 | 36168 | 2937 | 38672 | 1770 | 48334 | 729 | 43417 |
| 12-#18 | 3.16 | MA | 22515 | 5776 | 36836 | 4573 | 44161 | 3658 | 48721 | 2957 | 54922 | 1777 | 68467 | 1299 | 54831 |
| 3L-5S | | MI | 18363 | 5776 | 30618 | 4578 | 36265 | 3657 | 39323 | 2949 | 42764 | 1757 | 53760 | 923 | 46865 |
| 12-#18 | 3.16 | MA | 20897 | 5776 | 34545 | 4571 | 41067 | 3680 | 44972 | 2947 | 49939 | 1764 | 62999 | 1065 | 52074 |
| 4E | | MI | 19749 | 5776 | 32806 | 4554 | 38890 | 3664 | 42526 | 2933 | 47018 | 1743 | 59167 | 1033 | 49069 |
| 12-#18 | 3.16 | MA | 19430 | 5776 | 32226 | 4597 | 38283 | 3674 | 41574 | 2964 | 45391 | 1777 | 57219 | 954 | 49662 |
| 5L-3S | | MI | 21276 | 5776 | 34964 | 4556 | 41806 | 3644 | 46059 | 2944 | 51681 | 1757 | 64261 | 1266 | 51693 |
| 12-#18 | 3.16 | MA | 18023 | 5776 | 30162 | 4595 | 35533 | 3695 | 38228 | 2955 | 41018 | 1791 | 51402 | 760 | 45991 |
| 6L-2S | | MI | 23374 | 5776 | 37848 | 4558 | 45464 | 3651 | 50491 | 2929 | 57556 | 1743 | 72036 | 1500 | 52147 |
| 14-#11 | 1.44 | MA | 20438 | 4825 | 29773 | 4020 | 35505 | 3262 | 38365 | 2692 | 41421 | 1856 | 50804 | 1732 | 26128 |
| 2L-7S | | MI | 16107 | 4825 | 23906 | 4018 | 27976 | 3265 | 29409 | 2700 | 29769 | 1851 | 36192 | 1342 | 23191 |
| 14-#11 | 1.44 | MA | 19489 | 4825 | 28547 | 4020 | 33951 | 3261 | 36482 | 2700 | 38880 | 1861 | 47403 | 1641 | 26094 |
| 3L-6S | | MI | 16660 | 4825 | 24659 | 4018 | 28973 | 3267 | 30626 | 2693 | 31455 | 1856 | 38166 | 1413 | 23668 |
| 14-#11 | 1.44 | MA | 18801 | 4825 | 27636 | 4021 | 32719 | 3271 | 34989 | 2698 | 36865 | 1857 | 45163 | 1550 | 26001 |
| 4L-5S | | MI | 17225 | 4825 | 25433 | 4017 | 30004 | 3257 | 31881 | 2695 | 33118 | 1851 | 40388 | 1488 | 24380 |
| 14-#11 | 1.44 | MA | 18177 | 4825 | 26713 | 4032 | 31612 | 3270 | 33638 | 2706 | 35026 | 1862 | 42819 | 1504 | 25785 |
| 5L-4S | | MI | 17813 | 4825 | 26303 | 4007 | 31049 | 3259 | 33156 | 2688 | 34847 | 1846 | 42586 | 1533 | 24583 |
| 14-#11 | 1.44 | MA | 17580 | 4825 | 25894 | 4032 | 30520 | 3279 | 32308 | 2704 | 33257 | 1867 | 40445 | 1429 | 25007 |
| 6L-3S | | MI | 18463 | 4825 | 27163 | 4006 | 32211 | 3250 | 34565 | 2690 | 36741 | 1851 | 44679 | 1624 | 24662 |
| 14-#11 | 1.44 | MA | 16994 | 4825 | 25097 | 4033 | 29464 | 3279 | 31019 | 2712 | 31464 | 1863 | 38333 | 1358 | 24484 |
| 7L-2S | | MI | 19357 | 4825 | 28318 | 4006 | 33676 | 3251 | 36340 | 2683 | 39128 | 1846 | 47862 | 1716 | 24690 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis

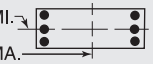



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.07 | MA | 22125 | 5176 | 33573 | 4226 | 40223 | 3411 | 44037 | 2785 | 48970 | 1829 | 60758 | 1668 | 37128 |
| 2L-7S | | MI | 16401 | 5176 | 25579 | 4225 | 29953 | 3417 | 31749 | 2796 | 32841 | 1821 | 40575 | 1109 | 31090 |
| 14-#14 | 2.07 | MA | 20801 | 5176 | 31819 | 4226 | 37999 | 3410 | 41343 | 2796 | 45346 | 1836 | 55925 | 1537 | 37000 |
| 3L-6S | | MI | 17173 | 5176 | 26658 | 4226 | 31381 | 3420 | 33494 | 2786 | 35240 | 1829 | 43375 | 1211 | 32538 |
| 14-#14 | 2.07 | MA | 19842 | 5176 | 30513 | 4226 | 36234 | 3423 | 39204 | 2792 | 42470 | 1829 | 52746 | 1406 | 36709 |
| 4L-5S | | MI | 17960 | 5176 | 27767 | 4226 | 32859 | 3407 | 35292 | 2791 | 37606 | 1821 | 46528 | 1320 | 33430 |
| 14-#14 | 2.07 | MA | 18973 | 5176 | 29192 | 4242 | 34648 | 3421 | 37268 | 2803 | 39845 | 1836 | 49409 | 1341 | 35390 |
| 5L-4S | | MI | 18781 | 5176 | 29014 | 4211 | 34356 | 3410 | 37119 | 2780 | 40066 | 1814 | 49655 | 1384 | 34671 |
| 14-#14 | 2.07 | MA | 18140 | 5176 | 28017 | 4242 | 33082 | 3434 | 35362 | 2799 | 37320 | 1844 | 46036 | 1232 | 34414 |
| 6L-3S | | MI | 19687 | 5176 | 30246 | 4211 | 36020 | 3397 | 39136 | 2785 | 42761 | 1821 | 52623 | 1515 | 34933 |
| 14-#14 | 2.07 | MA | 17323 | 5176 | 26874 | 4242 | 31569 | 3432 | 33514 | 2810 | 34760 | 1836 | 43038 | 1130 | 32865 |
| 7L-2S | | MI | 20933 | 5176 | 31897 | 4212 | 38115 | 3400 | 41673 | 2775 | 46158 | 1814 | 57141 | 1647 | 35047 |
| 14-#18 | 3.68 | MA | 23861 | 6067 | 39902 | 4754 | 48050 | 3791 | 53432 | 3041 | 61202 | 1759 | 76801 | 1253 | 63766 |
| 3L-6S | | MI | 18371 | 6067 | 31557 | 4757 | 37330 | 3810 | 40600 | 3022 | 44547 | 1750 | 56110 | 679 | 51516 |
| 14-#18 | 3.68 | MA | 22273 | 6067 | 37612 | 4753 | 44955 | 3813 | 49683 | 3031 | 56218 | 1746 | 71333 | 1019 | 60718 |
| 4L-5S | | MI | 19676 | 6067 | 33503 | 4760 | 39923 | 3790 | 43755 | 3033 | 48638 | 1737 | 61535 | 873 | 55043 |
| 14-#18 | 3.68 | MA | 20834 | 6067 | 35292 | 4778 | 42171 | 3807 | 46285 | 3048 | 51670 | 1759 | 65553 | 907 | 58420 |
| 5L-4S | | MI | 21036 | 6067 | 35690 | 4735 | 42548 | 3797 | 46958 | 3017 | 52893 | 1723 | 66942 | 983 | 57184 |
| 14-#18 | 3.68 | MA | 19454 | 6067 | 33229 | 4777 | 39422 | 3828 | 42939 | 3039 | 47297 | 1773 | 59736 | 714 | 54626 |
| 6L-3S | | MI | 22536 | 6067 | 37848 | 4738 | 45464 | 3777 | 50491 | 3028 | 57556 | 1737 | 72036 | 1216 | 60093 |
| 16-#11 | 1.64 | MA | 21018 | 4938 | 30999 | 4091 | 37060 | 3314 | 40249 | 2725 | 43962 | 1851 | 54206 | 1718 | 29759 |
| 2L-8S | | MI | 16139 | 4938 | 24319 | 4089 | 28465 | 3316 | 29964 | 2731 | 30530 | 1851 | 37323 | 1275 | 25657 |
| 16-#11 | 1.64 | MA | 20077 | 4938 | 29773 | 4091 | 35505 | 3313 | 38365 | 2733 | 41421 | 1856 | 50804 | 1627 | 29709 |
| 3L-7S | | MI | 16680 | 4938 | 25061 | 4089 | 29441 | 3317 | 31183 | 2733 | 32157 | 1845 | 39375 | 1327 | 26513 |
| 16-#11 | 1.64 | MA | 19395 | 4938 | 28861 | 4092 | 34273 | 3323 | 36872 | 2731 | 39406 | 1851 | 48564 | 1536 | 29597 |
| 4L-6S | | MI | 17228 | 4938 | 25814 | 4088 | 30438 | 3318 | 32401 | 2726 | 33842 | 1851 | 41349 | 1398 | 26977 |
| 16-#11 | 1.64 | MA | 18778 | 4938 | 27939 | 4103 | 33167 | 3322 | 35522 | 2739 | 37567 | 1857 | 46221 | 1490 | 29270 |
| 5E | | MI | 17787 | 4938 | 26588 | 4088 | 31469 | 3309 | 33656 | 2728 | 35505 | 1845 | 43571 | 1473 | 27659 |
| 16-#11 | 1.64 | MA | 18186 | 4938 | 27120 | 4103 | 32074 | 3331 | 34192 | 2737 | 35798 | 1862 | 43846 | 1415 | 28523 |
| 6L-4S | | MI | 18370 | 4938 | 27458 | 4078 | 32514 | 3311 | 34931 | 2721 | 37234 | 1840 | 45768 | 1518 | 27971 |
| 16-#11 | 1.64 | MA | 17607 | 4938 | 26322 | 4104 | 31019 | 3331 | 32903 | 2745 | 34005 | 1857 | 41734 | 1344 | 28014 |
| 7L-3S | | MI | 19014 | 4938 | 28318 | 4077 | 33676 | 3301 | 36340 | 2723 | 39128 | 1845 | 47862 | 1609 | 28069 |
| 16-#11 | 1.64 | MA | 17035 | 4938 | 25537 | 4104 | 29985 | 3330 | 31611 | 2743 | 32275 | 1863 | 39546 | 1291 | 27095 |
| 8L-2S | | MI | 19900 | 4938 | 29473 | 4077 | 35141 | 3303 | 38114 | 2716 | 41516 | 1840 | 51045 | 1700 | 28113 |
| 16-#14 | 2.37 | MA | 22919 | 5340 | 35326 | 4328 | 42447 | 3486 | 46731 | 2832 | 52595 | 1821 | 65590 | 1646 | 42303 |
| 2L-8S | | MI | 16448 | 5340 | 26167 | 4327 | 30648 | 3490 | 32539 | 2839 | 33923 | 1820 | 42174 | 1010 | 34363 |
| 16-#14 | 2.37 | MA | 21610 | 5340 | 33573 | 4328 | 40223 | 3484 | 44037 | 2843 | 48970 | 1828 | 60758 | 1515 | 42145 |
| 3L-7S | | MI | 17200 | 5340 | 27230 | 4328 | 32047 | 3492 | 34287 | 2844 | 36238 | 1812 | 45093 | 1085 | 35758 |
| 16-#14 | 2.37 | MA | 20663 | 5340 | 32267 | 4329 | 38458 | 3498 | 41898 | 2839 | 46094 | 1821 | 57579 | 1384 | 41822 |
| 4L-6S | | MI | 17962 | 5340 | 28310 | 4328 | 33476 | 3495 | 36031 | 2833 | 38637 | 1820 | 47893 | 1187 | 37274 |
| 16-#14 | 2.37 | MA | 19805 | 5340 | 30945 | 4344 | 36872 | 3496 | 39962 | 2850 | 43469 | 1828 | 54242 | 1319 | 40392 |
| 5E | | MI | 18739 | 5340 | 29419 | 4328 | 34953 | 3482 | 37830 | 2838 | 41003 | 1812 | 51046 | 1296 | 38134 |
| 16-#14 | 2.37 | MA | 18983 | 5340 | 29771 | 4344 | 35306 | 3509 | 38056 | 2846 | 40945 | 1836 | 50868 | 1210 | 39450 |
| 6L-4S | | MI | 19550 | 5340 | 30666 | 4313 | 36450 | 3485 | 39656 | 2828 | 43463 | 1805 | 54173 | 1360 | 39484 |
| 16-#14 | 2.37 | MA | 18177 | 5340 | 28627 | 4345 | 33793 | 3507 | 36208 | 2857 | 38385 | 1828 | 47871 | 1108 | 37835 |
| 7L-3S | | MI | 20445 | 5340 | 31897 | 4314 | 38115 | 3472 | 41673 | 2832 | 46158 | 1812 | 57141 | 1491 | 39778 |
| 16-#14 | 2.37 | MA | 17381 | 5340 | 27501 | 4345 | 32310 | 3506 | 34356 | 2854 | 35915 | 1836 | 44755 | 1032 | 36345 |
| 8L-2S | | MI | 21677 | 5340 | 33549 | 4314 | 40209 | 3475 | 44210 | 2822 | 49555 | 1805 | 61659 | 1623 | 39921 |
| 16-#18 | 4.21 | MA | 23623 | 6357 | 40678 | 4935 | 48844 | 3946 | 54394 | 3116 | 62498 | 1728 | 79667 | 973 | 69393 |
| 4L-6S | | MI | 19682 | 6357 | 34441 | 4939 | 40989 | 3943 | 45032 | 3106 | 50422 | 1730 | 63885 | 629 | 59639 |
| 16-#18 | 4.21 | MA | 22209 | 6357 | 38358 | 4960 | 46060 | 3940 | 50996 | 3133 | 57950 | 1742 | 73887 | 861 | 66992 |
| 5E | | MI | 20963 | 6357 | 36387 | 4941 | 43581 | 3923 | 48187 | 3117 | 54513 | 1717 | 69311 | 823 | 63039 |
| 16-#18 | 4.21 | MA | 20854 | 6357 | 36295 | 4959 | 43311 | 3961 | 47650 | 3123 | 53577 | 1755 | 68071 | 668 | 63285 |
| 6L-4S | | MI | 22299 | 6357 | 38575 | 4917 | 46206 | 3930 | 51390 | 3102 | 58768 | 1704 | 74718 | 933 | 65329 |
| 18-#11 | 1.85 | MA | 21590 | 5052 | 32224 | 4161 | 38615 | 3366 | 42132 | 2758 | 46503 | 1846 | 57607 | 1704 | 33384 |
| 2L-9S | | MI | 16179 | 5052 | 24656 | 4170 | 28923 | 3377 | 30538 | 2771 | 31306 | 1850 | 38490 | 1200 | 28173 |
| 18-#11 | 1.85 | MA | 20657 | 5052 | 30999 | 4162 | 37060 | 3365 | 40249 | 2766 | 43962 | 1851 | 54206 | 1613 | 33319 |
| 3L-8S | | MI | 16711 | 5052 | 25474 | 4160 | 29929 | 3368 | 31738 | 2763 | 32917 | 1845 | 40505 | 1259 | 28941 |

## RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

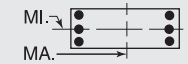
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.85 | MA | 19982 | 5052 | 30087 | 4163 | 35828 | 3374 | 38756 | 2764 | 41947 | 1846 | 51965 | 1522 | 33190 |
| 4L-7S | | MI | 17247 | 5052 | 26216 | 4160 | 30906 | 3369 | 32958 | 2766 | 34544 | 1840 | 42557 | 1311 | 29820 |
| 18-#11 | 1.85 | MA | 19371 | 5052 | 29165 | 4174 | 34721 | 3374 | 37405 | 2772 | 40108 | 1852 | 49622 | 1476 | 32764 |
| 5L-6S | | MI | 17789 | 5052 | 26969 | 4159 | 31903 | 3370 | 34175 | 2758 | 36230 | 1845 | 44532 | 1383 | 30292 |
| 18-#11 | 1.85 | MA | 18785 | 5052 | 28346 | 4174 | 33629 | 3383 | 36075 | 2770 | 38339 | 1857 | 47247 | 1401 | 32046 |
| 6L-5S | | MI | 18343 | 5052 | 27743 | 4159 | 32934 | 3361 | 35431 | 2761 | 37892 | 1840 | 46753 | 1458 | 30948 |
| 18-#11 | 1.85 | MA | 18212 | 5052 | 27548 | 4175 | 32574 | 3382 | 34786 | 2778 | 36546 | 1852 | 45136 | 1330 | 31542 |
| 7L-4S | | MI | 18920 | 5052 | 28613 | 4148 | 33979 | 3362 | 36706 | 2754 | 39621 | 1835 | 48951 | 1503 | 31357 |
| 18-#11 | 1.85 | MA | 17645 | 5052 | 26763 | 4175 | 31539 | 3382 | 33494 | 2776 | 34816 | 1858 | 42947 | 1277 | 30587 |
| 8L-3S | | MI | 19558 | 5052 | 29473 | 4148 | 35141 | 3353 | 38114 | 2756 | 41516 | 1840 | 51045 | 1594 | 31472 |
| 18-#11 | 1.85 | MA | 17082 | 5052 | 25896 | 4186 | 30474 | 3391 | 32223 | 2784 | 33103 | 1863 | 40792 | 1218 | 29764 |
| 9L-2S | | MI | 20437 | 5052 | 30628 | 4148 | 36606 | 3355 | 39889 | 2749 | 43903 | 1835 | 54228 | 1685 | 31529 |
| 18-#14 | 2.66 | MA | 22407 | 5503 | 35326 | 4431 | 42447 | 3559 | 46731 | 2890 | 52595 | 1820 | 65590 | 1493 | 47287 |
| 3L-8S | | MI | 17243 | 5503 | 27818 | 4430 | 32742 | 3565 | 35076 | 2886 | 37320 | 1811 | 46692 | 986 | 38995 |
| 18-#14 | 2.66 | MA | 21471 | 5503 | 34021 | 4431 | 40682 | 3572 | 44592 | 2887 | 49719 | 1813 | 62411 | 1362 | 46933 |
| 4L-7S | | MI | 17987 | 5503 | 28881 | 4430 | 34142 | 3567 | 36824 | 2891 | 39635 | 1803 | 49611 | 1060 | 40437 |
| 18-#14 | 2.66 | MA | 20624 | 5503 | 32699 | 4446 | 39096 | 3571 | 42657 | 2898 | 47094 | 1820 | 59075 | 1297 | 45405 |
| 5L-6S | | MI | 18739 | 5503 | 29961 | 4430 | 35570 | 3570 | 38568 | 2881 | 42034 | 1811 | 52411 | 1163 | 42001 |
| 18-#14 | 2.66 | MA | 19812 | 5503 | 31524 | 4447 | 37530 | 3584 | 40751 | 2894 | 44570 | 1827 | 55701 | 1188 | 44492 |
| 6L-5S | | MI | 19507 | 5503 | 31070 | 4430 | 37048 | 3557 | 40367 | 2885 | 44399 | 1803 | 55564 | 1272 | 42848 |
| 18-#14 | 2.66 | MA | 19017 | 5503 | 30381 | 4447 | 36017 | 3582 | 38902 | 2905 | 42010 | 1820 | 52703 | 1086 | 42815 |
| 7L-4S | | MI | 20307 | 5503 | 32317 | 4416 | 38544 | 3559 | 42194 | 2875 | 46859 | 1796 | 58691 | 1336 | 44295 |
| 18-#14 | 2.66 | MA | 18231 | 5503 | 29255 | 4447 | 34534 | 3580 | 37051 | 2901 | 39540 | 1827 | 49588 | 1010 | 41279 |
| 8L-3S | | MI | 21191 | 5503 | 33549 | 4416 | 40209 | 3547 | 44210 | 2880 | 49555 | 1803 | 61659 | 1467 | 44620 |
| 18-#14 | 2.66 | MA | 17450 | 5503 | 28012 | 4462 | 33006 | 3594 | 35228 | 2912 | 37094 | 1835 | 46528 | 925 | 39544 |
| 9L-2S | | MI | 22411 | 5503 | 35200 | 4416 | 42303 | 3549 | 46748 | 2869 | 52952 | 1796 | 66176 | 1599 | 44789 |
| 18-#18 | 4.74 | MA | 23560 | 6648 | 41424 | 5142 | 49949 | 4073 | 55708 | 3217 | 64230 | 1724 | 82221 | 815 | 75548 |
| 5L-6S | | MI | 20968 | 6648 | 37326 | 5121 | 44647 | 4076 | 49464 | 3190 | 56297 | 1710 | 71661 | 578 | 67782 |
| 18-#18 | 4.74 | MA | 22228 | 6648 | 39361 | 5141 | 47199 | 4094 | 52362 | 3207 | 59856 | 1737 | 76405 | 622 | 71964 |
| 6L-5S | | MI | 22228 | 6648 | 39272 | 5123 | 47240 | 4056 | 52619 | 3201 | 60388 | 1697 | 77087 | 773 | 71063 |
| 20-#11 | 2.05 | MA | 22156 | 5165 | 33450 | 4232 | 40169 | 3417 | 44016 | 2791 | 49044 | 1841 | 61008 | 1690 | 37006 |
| 2L-10S | | MI | 16223 | 5165 | 25072 | 4241 | 29418 | 3428 | 31107 | 2801 | 32037 | 1839 | 39718 | 1119 | 30456 |
| 20-#11 | 2.05 | MA | 21230 | 5165 | 32224 | 4233 | 38615 | 3417 | 42132 | 2799 | 46503 | 1846 | 57607 | 1599 | 36927 |
| 3L-9S | | MI | 16748 | 5165 | 25811 | 4241 | 30388 | 3429 | 32313 | 2804 | 33694 | 1845 | 41673 | 1185 | 31429 |
| 20-#11 | 2.05 | MA | 20561 | 5165 | 31313 | 4234 | 37383 | 3426 | 40639 | 2797 | 44488 | 1841 | 55367 | 1508 | 36781 |
| 4L-8S | | MI | 17275 | 5165 | 26629 | 4231 | 31394 | 3420 | 33513 | 2796 | 35305 | 1839 | 43688 | 1244 | 32230 |
| 20-#11 | 2.05 | MA | 19956 | 5165 | 30391 | 4244 | 36276 | 3425 | 39289 | 2805 | 42649 | 1846 | 53023 | 1462 | 36266 |
| 5L-7S | | MI | 17806 | 5165 | 27371 | 4230 | 32371 | 3421 | 34732 | 2799 | 36931 | 1834 | 45740 | 1296 | 33085 |
| 20-#11 | 2.05 | MA | 19376 | 5165 | 29572 | 4245 | 35184 | 3435 | 37959 | 2803 | 40880 | 1852 | 50649 | 1387 | 35573 |
| 6E | | MI | 18343 | 5165 | 28124 | 4230 | 33367 | 3422 | 35950 | 2791 | 38617 | 1839 | 47714 | 1367 | 33612 |
| 20-#11 | 2.05 | MA | 18808 | 5165 | 28774 | 4246 | 34128 | 3434 | 36670 | 2811 | 39087 | 1847 | 48537 | 1316 | 35015 |
| 7L-5S | | MI | 18891 | 5165 | 28898 | 4230 | 34399 | 3413 | 37205 | 2794 | 40280 | 1834 | 49936 | 1443 | 34244 |
| 20-#11 | 2.05 | MA | 18247 | 5165 | 27989 | 4246 | 33094 | 3433 | 35378 | 2809 | 37357 | 1852 | 46348 | 1263 | 34085 |
| 8L-4S | | MI | 19463 | 5165 | 29768 | 4219 | 35443 | 3414 | 38480 | 2786 | 42009 | 1829 | 52134 | 1488 | 34740 |
| 20-#11 | 2.05 | MA | 17690 | 5165 | 27122 | 4257 | 32028 | 3443 | 34107 | 2817 | 35644 | 1858 | 44194 | 1205 | 33229 |
| 9L-3S | | MI | 20095 | 5165 | 30628 | 4219 | 36606 | 3405 | 39889 | 2789 | 43903 | 1834 | 54228 | 1579 | 34871 |
| 20-#11 | 2.05 | MA | 17135 | 5165 | 26340 | 4258 | 31001 | 3442 | 32830 | 2815 | 33882 | 1853 | 41965 | 1124 | 32174 |
| 10L-2S | | MI | 20967 | 5165 | 31783 | 4219 | 38070 | 3406 | 41663 | 2781 | 46290 | 1829 | 57410 | 1670 | 34942 |
| 20-#14 | 2.96 | MA | 22269 | 5667 | 35774 | 4533 | 42906 | 3647 | 47287 | 2934 | 53344 | 1804 | 67244 | 1340 | 52000 |
| 4L-8S | | MI | 18027 | 5667 | 29470 | 4532 | 34836 | 3639 | 37613 | 2934 | 40717 | 1801 | 51210 | 962 | 43636 |
| 20-#14 | 2.96 | MA | 21432 | 5667 | 34453 | 4548 | 41320 | 3646 | 45351 | 2945 | 50719 | 1812 | 63907 | 1275 | 50427 |
| 5L-7S | | MI | 18761 | 5667 | 30533 | 4532 | 36236 | 3642 | 39361 | 2938 | 43032 | 1794 | 54129 | 1036 | 45126 |
| 20-#14 | 2.96 | MA | 20629 | 5667 | 33278 | 4549 | 39754 | 3659 | 43445 | 2941 | 48194 | 1819 | 60534 | 1166 | 49456 |
| 6E | | MI | 19504 | 5667 | 31613 | 4532 | 37664 | 3644 | 41106 | 2928 | 45431 | 1801 | 56928 | 1139 | 46642 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis

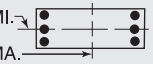


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.96 | MA | 19844 | 5667 | 32134 | 4549 | 38241 | 3657 | 41597 | 2952 | 45635 | 1812 | 57536 | 1064 | 47804 |
| 7L-5S | | MI | 20263 | 5667 | 32721 | 4533 | 39142 | 3632 | 42904 | 2933 | 47796 | 1794 | 60082 | 1248 | 47572 |
| 20-#14 | 2.96 | MA | 19068 | 5667 | 31008 | 4549 | 36758 | 3655 | 39745 | 2948 | 43165 | 1819 | 54420 | 988 | 46223 |
| 8L-4S | | MI | 21054 | 5667 | 33968 | 4518 | 40639 | 3634 | 44731 | 2922 | 50256 | 1787 | 63208 | 1312 | 49006 |
| 20-#14 | 2.96 | MA | 18296 | 5667 | 29765 | 4565 | 35230 | 3668 | 37923 | 2959 | 40719 | 1827 | 51361 | 903 | 44527 |
| 9L-3S | | MI | 21928 | 5667 | 35200 | 4518 | 42303 | 3622 | 46748 | 2927 | 52952 | 1794 | 66176 | 1443 | 49458 |
| 20-#18 | 5.26 | MA | 23580 | 6939 | 42427 | 5322 | 51088 | 4227 | 57073 | 3292 | 66136 | 1719 | 84739 | 575 | 80661 |
| 6E | | MI | 22233 | 6939 | 40210 | 5302 | 48305 | 4209 | 53896 | 3274 | 62172 | 1690 | 79436 | 528 | 75944 |
| 22-#11 | 2.26 | MA | 21798 | 5279 | 33450 | 4304 | 40169 | 3469 | 44016 | 2832 | 49044 | 1841 | 61008 | 1585 | 40532 |
| 3L-10S | | MI | 16791 | 5279 | 26227 | 4312 | 30882 | 3480 | 32881 | 2834 | 34424 | 1834 | 42901 | 1104 | 33739 |
| 22-#11 | 2.26 | MA | 21134 | 5279 | 32539 | 4304 | 38937 | 3478 | 42523 | 2830 | 47029 | 1836 | 58768 | 1494 | 40371 |
| 4L-9S | | MI | 17310 | 5279 | 26966 | 4312 | 31852 | 3481 | 34087 | 2837 | 36081 | 1839 | 44856 | 1170 | 34691 |
| 22-#11 | 2.26 | MA | 20535 | 5279 | 31617 | 4315 | 37831 | 3477 | 41172 | 2838 | 45190 | 1841 | 56425 | 1448 | 39775 |
| 5L-8S | | MI | 17832 | 5279 | 27784 | 4302 | 32859 | 3472 | 35287 | 2829 | 37692 | 1834 | 46871 | 1229 | 35525 |
| 22-#11 | 2.26 | MA | 19960 | 5279 | 30798 | 4316 | 36738 | 3487 | 39842 | 2836 | 43421 | 1847 | 54050 | 1373 | 39104 |
| 6L-7S | | MI | 18358 | 5279 | 28526 | 4301 | 33836 | 3473 | 36507 | 2832 | 39319 | 1829 | 48923 | 1281 | 36357 |
| 22-#11 | 2.26 | MA | 19398 | 5279 | 30000 | 4317 | 35683 | 3486 | 38553 | 2844 | 41629 | 1842 | 51938 | 1302 | 38494 |
| 7L-6S | | MI | 18890 | 5279 | 29279 | 4301 | 34832 | 3474 | 37724 | 2824 | 41004 | 1834 | 50897 | 1352 | 36936 |
| 22-#11 | 2.26 | MA | 18842 | 5279 | 29215 | 4317 | 34649 | 3485 | 37261 | 2842 | 39898 | 1847 | 49750 | 1249 | 37588 |
| 8L-5S | | MI | 19433 | 5279 | 30053 | 4301 | 35863 | 3465 | 38980 | 2827 | 42667 | 1829 | 53119 | 1427 | 37547 |
| 22-#11 | 2.26 | MA | 18290 | 5279 | 28348 | 4328 | 33583 | 3495 | 35990 | 2850 | 38185 | 1853 | 47595 | 1191 | 36700 |
| 9L-4S | | MI | 20000 | 5279 | 30923 | 4290 | 36908 | 3466 | 40255 | 2819 | 44396 | 1824 | 55317 | 1472 | 38121 |
| 22-#11 | 2.26 | MA | 17740 | 5279 | 27566 | 4329 | 32556 | 3494 | 34714 | 2848 | 36423 | 1848 | 45366 | 1110 | 35668 |
| 10L-3S | | MI | 20627 | 5279 | 31783 | 4290 | 38070 | 3457 | 41663 | 2822 | 46290 | 1829 | 57410 | 1563 | 38268 |
| 22-#14 | 3.26 | MA | 22228 | 5830 | 36206 | 4651 | 43544 | 3720 | 48045 | 2992 | 54344 | 1804 | 68740 | 1253 | 55458 |
| 5L-8S | | MI | 18799 | 5830 | 31121 | 4634 | 36931 | 3714 | 40150 | 2981 | 44114 | 1792 | 55728 | 938 | 48287 |
| 22-#14 | 3.26 | MA | 21436 | 5830 | 35032 | 4651 | 41978 | 3733 | 46139 | 2989 | 51819 | 1811 | 65366 | 1144 | 54408 |
| 6L-7S | | MI | 19525 | 5830 | 32184 | 4634 | 38330 | 3717 | 41898 | 2986 | 46428 | 1785 | 58647 | 1012 | 49822 |
| 22-#14 | 3.26 | MA | 20659 | 5830 | 33888 | 4651 | 40465 | 3732 | 44291 | 3000 | 49259 | 1804 | 62369 | 1041 | 52801 |
| 7L-6S | | MI | 20259 | 5830 | 33264 | 4635 | 39759 | 3719 | 43643 | 2975 | 48827 | 1792 | 61446 | 1115 | 51295 |
| 22-#14 | 3.26 | MA | 19892 | 5830 | 32762 | 4652 | 38982 | 3730 | 42439 | 2996 | 46789 | 1811 | 59253 | 966 | 51175 |
| 8L-5S | | MI | 21009 | 5830 | 34373 | 4635 | 41236 | 3707 | 45442 | 2980 | 51193 | 1785 | 64600 | 1224 | 52304 |
| 22-#14 | 3.26 | MA | 19131 | 5830 | 31519 | 4667 | 37454 | 3743 | 40617 | 3007 | 44344 | 1819 | 56193 | 881 | 49460 |
| 9L-4S | | MI | 21792 | 5830 | 35620 | 4620 | 42733 | 3709 | 47268 | 2970 | 53653 | 1777 | 67726 | 1288 | 53683 |
| 24-#11 | 2.46 | MA | 21701 | 5392 | 33765 | 4375 | 40492 | 3530 | 44406 | 2862 | 49570 | 1831 | 62169 | 1480 | 43959 |
| 4L-10S | | MI | 17351 | 5392 | 27382 | 4383 | 32347 | 3531 | 34656 | 2867 | 36812 | 1828 | 46084 | 1089 | 37027 |
| 24-#11 | 2.46 | MA | 21107 | 5392 | 32843 | 4386 | 39385 | 3529 | 43055 | 2871 | 47731 | 1836 | 59826 | 1434 | 43290 |
| 5L-9S | | MI | 17866 | 5392 | 28120 | 4383 | 33317 | 3533 | 35862 | 2870 | 38468 | 1833 | 48039 | 1155 | 37959 |
| 24-#11 | 2.46 | MA | 20538 | 5392 | 32023 | 4387 | 38293 | 3539 | 41726 | 2869 | 45963 | 1842 | 57451 | 1359 | 42640 |
| 6L-8S | | MI | 18383 | 5392 | 28939 | 4372 | 34324 | 3523 | 37062 | 2862 | 40079 | 1828 | 50054 | 1214 | 38825 |
| 24-#11 | 2.46 | MA | 19980 | 5392 | 31226 | 4387 | 37238 | 3538 | 40437 | 2877 | 44170 | 1837 | 55339 | 1288 | 41979 |
| 7E | | MI | 18904 | 5392 | 29681 | 4372 | 35300 | 3525 | 38282 | 2865 | 41706 | 1823 | 52106 | 1266 | 39635 |
| 24-#11 | 2.46 | MA | 19430 | 5392 | 30441 | 4388 | 36203 | 3537 | 39145 | 2875 | 42440 | 1842 | 53151 | 1235 | 41096 |
| 8L-6S | | MI | 19431 | 5392 | 30434 | 4372 | 36297 | 3526 | 39499 | 2857 | 43392 | 1828 | 54080 | 1337 | 40264 |
| 24-#11 | 2.46 | MA | 18883 | 5392 | 29574 | 4399 | 35138 | 3547 | 37874 | 2883 | 40726 | 1848 | 50996 | 1177 | 40177 |
| 9L-5S | | MI | 19970 | 5392 | 31208 | 4372 | 37328 | 3517 | 40754 | 2860 | 45054 | 1823 | 56302 | 1412 | 40856 |
| 24-#11 | 2.46 | MA | 18339 | 5392 | 28792 | 4400 | 34111 | 3546 | 36597 | 2881 | 38964 | 1843 | 48768 | 1096 | 39165 |
| 10L-4S | | MI | 20532 | 5392 | 32078 | 4361 | 38373 | 3518 | 42029 | 2852 | 46783 | 1818 | 58500 | 1457 | 41501 |
| 24-#14 | 3.55 | MA | 22232 | 5994 | 36785 | 4753 | 44202 | 3808 | 48834 | 3036 | 55444 | 1803 | 70199 | 1122 | 59369 |
| 6L-8S | | MI | 19562 | 5994 | 32772 | 4736 | 39025 | 3789 | 42688 | 3028 | 47511 | 1783 | 60246 | 914 | 52946 |
| 24-#14 | 3.55 | MA | 21464 | 5994 | 35641 | 4754 | 42689 | 3807 | 46985 | 3047 | 52884 | 1796 | 67201 | 1019 | 57806 |
| 7E | | MI | 20279 | 5994 | 33835 | 4737 | 40425 | 3792 | 44436 | 3033 | 49825 | 1776 | 63165 | 988 | 54526 |
| 24-#14 | 3.55 | MA | 20706 | 5994 | 34516 | 4754 | 41206 | 3805 | 45134 | 3043 | 50414 | 1803 | 64086 | 944 | 56089 |
| 8L-6S | | MI | 21005 | 5994 | 34915 | 4737 | 41853 | 3794 | 46180 | 3023 | 52224 | 1783 | 65964 | 1091 | 55957 |
| 24-#14 | 3.55 | MA | 19953 | 5994 | 33273 | 4769 | 39678 | 3818 | 43311 | 3054 | 47968 | 1811 | 61026 | 859 | 54392 |
| 9L-5S | | MI | 21747 | 5994 | 36024 | 4737 | 43331 | 3781 | 47979 | 3027 | 54590 | 1776 | 69117 | 1200 | 57043 |

## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

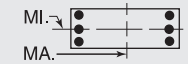
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.00 | MA | 21057 | 4814 | 30085 | 4036 | 35454 | 3287 | 37732 | 2735 | 39347 | 1940 | 47407 | 1822 | 20136 |
| 2E | | MI | 18955 | 4814 | 27337 | 4005 | 32007 | 3262 | 33958 | 2713 | 35172 | 1916 | 42203 | 1791 | 18052 |
| 6-#18 | 1.50 | MA | 22605 | 5105 | 33333 | 4218 | 39573 | 3420 | 42723 | 2819 | 46032 | 1924 | 56300 | 1780 | 29801 |
| 2L-3S | | MI | 18088 | 5105 | 27337 | 4184 | 32007 | 3388 | 33958 | 2813 | 35172 | 1909 | 42203 | 1507 | 26520 |
| 6-#18 | 1.50 | MA | 20098 | 5105 | 30085 | 4217 | 35454 | 3416 | 37732 | 2837 | 39347 | 1938 | 47407 | 1546 | 29609 |
| 3L-2S | | MI | 20312 | 5105 | 30222 | 4187 | 35665 | 3395 | 38390 | 2797 | 41047 | 1896 | 49979 | 1740 | 26655 |
| 8-#14 | 1.13 | MA | 21553 | 4887 | 30792 | 4108 | 36562 | 3342 | 39168 | 2774 | 41442 | 1957 | 50350 | 1840 | 22760 |
| 2L-4S | | MI | 17161 | 4887 | 25077 | 4079 | 29246 | 3329 | 30703 | 2760 | 30994 | 1935 | 37377 | 1547 | 20282 |
| 8-#14 | 1.13 | MA | 20095 | 4887 | 28936 | 4109 | 34209 | 3341 | 36316 | 2786 | 37595 | 1965 | 45203 | 1709 | 22736 |
| 3E | | MI | 18106 | 4887 | 26309 | 4080 | 30910 | 3317 | 32720 | 2765 | 33690 | 1942 | 40345 | 1678 | 20396 |
| 8-#14 | 1.13 | MA | 19037 | 4887 | 27557 | 4110 | 32344 | 3355 | 34056 | 2783 | 34544 | 1957 | 41812 | 1577 | 22574 |
| 4L-2S | | MI | 19400 | 4887 | 27960 | 4080 | 33004 | 3319 | 35257 | 2755 | 37087 | 1935 | 44863 | 1810 | 20399 |
| 8-#18 | 2.01 | MA | 24106 | 5396 | 36581 | 4399 | 43692 | 3553 | 47713 | 2903 | 52717 | 1908 | 65194 | 1737 | 39413 |
| 2L-4S | | MI | 17852 | 5396 | 28064 | 4364 | 32749 | 3541 | 34857 | 2886 | 36384 | 1876 | 44885 | 1223 | 33295 |
| 8-#18 | 2.01 | MA | 21648 | 5396 | 33333 | 4399 | 39573 | 3549 | 42723 | 2922 | 46032 | 1922 | 56300 | 1504 | 39106 |
| 3E | | MI | 19447 | 5396 | 30222 | 4366 | 35665 | 3521 | 38390 | 2897 | 41047 | 1889 | 49979 | 1457 | 34957 |
| 8-#18 | 2.01 | MA | 19860 | 5396 | 30911 | 4399 | 36300 | 3571 | 38757 | 2914 | 40728 | 1908 | 50457 | 1270 | 37223 |
| 4L-2S | | MI | 21629 | 5396 | 33106 | 4368 | 39323 | 3528 | 42822 | 2882 | 46922 | 1876 | 57754 | 1690 | 35199 |
| 10-#14 | 1.41 | MA | 22445 | 5050 | 32648 | 4210 | 38916 | 3417 | 42019 | 2822 | 45289 | 1949 | 55498 | 1820 | 28272 |
| 2L-5S | | MI | 17128 | 5050 | 25481 | 4196 | 29843 | 3402 | 31414 | 2818 | 31931 | 1933 | 38768 | 1459 | 24266 |
| 10-#14 | 1.41 | MA | 21006 | 5050 | 30792 | 4211 | 36562 | 3416 | 39168 | 2834 | 41442 | 1957 | 50350 | 1688 | 28209 |
| 3L-4S | | MI | 17974 | 5050 | 26729 | 4182 | 31340 | 3404 | 33240 | 2808 | 34391 | 1926 | 41895 | 1523 | 25112 |
| 10-#14 | 1.41 | MA | 19962 | 5050 | 29412 | 4212 | 34697 | 3430 | 36907 | 2830 | 38391 | 1950 | 46960 | 1557 | 27997 |
| 4L-3S | | MI | 18907 | 5050 | 27960 | 4182 | 33004 | 3392 | 35257 | 2812 | 37087 | 1933 | 44863 | 1654 | 25272 |
| 10-#14 | 1.41 | MA | 19016 | 5050 | 28016 | 4228 | 33022 | 3429 | 34862 | 2842 | 35606 | 1958 | 43413 | 1491 | 27012 |
| 5L-2S | | MI | 20186 | 5050 | 29612 | 4182 | 35099 | 3394 | 37794 | 2802 | 40484 | 1926 | 49381 | 1786 | 25313 |
| 10-#18 | 2.51 | MA | 25568 | 5687 | 39829 | 4581 | 47811 | 3686 | 52704 | 2988 | 59401 | 1892 | 74087 | 1695 | 48997 |
| 2L-5S | | MI | 17786 | 5687 | 28761 | 4570 | 33782 | 3667 | 36086 | 2986 | 38004 | 1870 | 47253 | 1063 | 38954 |
| 10-#18 | 2.51 | MA | 23155 | 5687 | 36581 | 4581 | 43692 | 3682 | 47713 | 3006 | 52717 | 1906 | 65194 | 1461 | 48592 |
| 3L-4S | | MI | 19206 | 5687 | 30948 | 4545 | 36407 | 3674 | 39289 | 2970 | 42259 | 1856 | 52660 | 1173 | 41320 |
| 10-#18 | 2.51 | MA | 21403 | 5687 | 34159 | 4581 | 40419 | 3704 | 43747 | 2998 | 47412 | 1892 | 59350 | 1228 | 46308 |
| 4L-3S | | MI | 20770 | 5687 | 33106 | 4548 | 39323 | 3654 | 42822 | 2981 | 46922 | 1870 | 57754 | 1407 | 43378 |
| 10-#18 | 2.51 | MA | 19815 | 5687 | 31707 | 4607 | 37476 | 3700 | 40155 | 3016 | 42571 | 1906 | 53197 | 1114 | 43507 |
| 5L-2S | | MI | 22914 | 5687 | 35991 | 4550 | 42981 | 3661 | 47254 | 2966 | 52796 | 1856 | 65530 | 1640 | 43714 |
| 12-#11 | 1.17 | MA | 21751 | 4913 | 31037 | 4138 | 36980 | 3365 | 39720 | 2791 | 42219 | 1963 | 51548 | 1851 | 23755 |
| 2L-6S | | MI | 16850 | 4913 | 24516 | 4122 | 28679 | 3359 | 30047 | 2783 | 30189 | 1956 | 36262 | 1519 | 20508 |
| 12-#11 | 1.17 | MA | 20734 | 4913 | 29740 | 4139 | 35336 | 3365 | 37728 | 2800 | 39531 | 1969 | 47928 | 1760 | 23737 |
| 3L-5S | | MI | 17422 | 4913 | 25289 | 4122 | 29711 | 3350 | 31303 | 2785 | 31851 | 1951 | 38484 | 1595 | 21115 |
| 12-#11 | 1.17 | MA | 19998 | 4913 | 28777 | 4140 | 34034 | 3375 | 36150 | 2798 | 37402 | 1964 | 45541 | 1669 | 23666 |
| 4E | | MI | 18019 | 4913 | 26160 | 4111 | 30755 | 3351 | 32578 | 2778 | 33580 | 1946 | 40682 | 1640 | 21240 |
| 12-#11 | 1.17 | MA | 19332 | 4913 | 27803 | 4151 | 32865 | 3375 | 34724 | 2807 | 35460 | 1970 | 43052 | 1623 | 23499 |
| 5L-3S | | MI | 18676 | 4913 | 27020 | 4111 | 31918 | 3342 | 33986 | 2780 | 35474 | 1951 | 42776 | 1731 | 21288 |
| 12-#11 | 1.17 | MA | 18692 | 4913 | 26939 | 4152 | 31712 | 3385 | 33320 | 2805 | 33592 | 1977 | 40525 | 1548 | 22786 |
| 6L-2S | | MI | 19581 | 4913 | 28175 | 4111 | 33383 | 3343 | 35761 | 2773 | 37862 | 1946 | 45958 | 1822 | 21293 |
| 12-#14 | 1.69 | MA | 23322 | 5214 | 34504 | 4312 | 41270 | 3492 | 44870 | 2869 | 49136 | 1942 | 60646 | 1800 | 33768 |
| 2L-6S | | MI | 17136 | 5214 | 26024 | 4298 | 30460 | 3489 | 32152 | 2861 | 32962 | 1932 | 40133 | 1326 | 28001 |
| 12-#14 | 1.69 | MA | 21900 | 5214 | 32648 | 4313 | 38916 | 3491 | 42019 | 2881 | 45289 | 1950 | 55498 | 1668 | 33671 |
| 3L-5S | | MI | 17937 | 5214 | 27133 | 4298 | 31938 | 3476 | 33951 | 2865 | 35328 | 1924 | 43286 | 1435 | 28937 |
| 12-#14 | 1.69 | MA | 20870 | 5214 | 31268 | 4314 | 37051 | 3505 | 39758 | 2878 | 42238 | 1942 | 52108 | 1537 | 33418 |
| 4E | | MI | 18772 | 5214 | 28380 | 4284 | 33434 | 3479 | 35777 | 2855 | 37788 | 1917 | 46413 | 1499 | 29935 |
| 12-#14 | 1.69 | MA | 19937 | 5214 | 29872 | 4330 | 35375 | 3504 | 37713 | 2890 | 39453 | 1950 | 48561 | 1471 | 32279 |
| 5L-3S | | MI | 19693 | 5214 | 29612 | 4284 | 35099 | 3466 | 37794 | 2860 | 40484 | 1924 | 49381 | 1630 | 30135 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

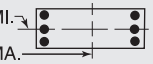


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 1.69 | MA | 19041 | 5214 | 28632 | 4331 | 33721 | 3517 | 35700 | 2886 | 36776 | 1958 | 44967 | 1363 | 31168 |
| 6L-2S | | MI | 20957 | 5214 | 31263 | 4284 | 37193 | 3469 | 40332 | 2849 | 43880 | 1917 | 53899 | 1762 | 30208 |
| 12-#18 | 3.01 | MA | 26998 | 5977 | 43077 | 4763 | 51931 | 3819 | 57694 | 3072 | 66086 | 1877 | 82980 | 1653 | 58564 |
| 2L-6S | | MI | 17797 | 5977 | 29699 | 4749 | 34848 | 3820 | 37363 | 3059 | 39788 | 1863 | 49603 | 819 | 43872 |
| 12-#18 | 3.01 | MA | 24625 | 5977 | 39829 | 4763 | 47811 | 3815 | 52704 | 3090 | 59401 | 1890 | 74087 | 1419 | 58071 |
| 3L-5S | | MI | 19134 | 5977 | 31646 | 4751 | 37441 | 3800 | 40518 | 3070 | 43879 | 1850 | 55029 | 1013 | 47151 |
| 12-#18 | 3.01 | MA | 22908 | 5977 | 37407 | 4762 | 44538 | 3837 | 48737 | 3082 | 54097 | 1877 | 68244 | 1185 | 55437 |
| 4E | | MI | 20527 | 5977 | 33833 | 4727 | 40066 | 3807 | 43721 | 3054 | 48134 | 1836 | 60436 | 1123 | 49391 |
| 12-#18 | 3.01 | MA | 21351 | 5977 | 34955 | 4789 | 41595 | 3833 | 45146 | 3100 | 49256 | 1890 | 62090 | 1072 | 52773 |
| 5L-3S | | MI | 22062 | 5977 | 35991 | 4729 | 42981 | 3787 | 47254 | 3065 | 52796 | 1850 | 65530 | 1357 | 51790 |
| 12-#18 | 3.01 | MA | 19858 | 5977 | 32774 | 4788 | 38689 | 3856 | 41609 | 3092 | 44600 | 1903 | 55883 | 878 | 49065 |
| 6L-2S | | MI | 24171 | 5977 | 38875 | 4732 | 46640 | 3794 | 51686 | 3050 | 58671 | 1836 | 73305 | 1590 | 52208 |
| 14-#11 | 1.37 | MA | 22378 | 5026 | 32334 | 4209 | 38625 | 3417 | 41713 | 2824 | 44907 | 1958 | 55168 | 1838 | 27603 |
| 2L-7S | | MI | 16873 | 5026 | 24918 | 4193 | 29148 | 3410 | 30605 | 2823 | 30890 | 1945 | 37471 | 1433 | 23334 |
| 14-#11 | 1.37 | MA | 21370 | 5026 | 31037 | 4210 | 36980 | 3417 | 39720 | 2833 | 42219 | 1964 | 51548 | 1747 | 27568 |
| 3L-6S | | MI | 17428 | 5026 | 25671 | 4193 | 30144 | 3411 | 31822 | 2815 | 32576 | 1950 | 39445 | 1504 | 23809 |
| 14-#11 | 1.37 | MA | 20641 | 5026 | 30074 | 4210 | 35678 | 3427 | 38143 | 2831 | 40090 | 1959 | 49161 | 1656 | 27476 |
| 4L-5S | | MI | 17994 | 5026 | 26444 | 4193 | 31175 | 3402 | 33077 | 2818 | 34239 | 1945 | 41667 | 1580 | 24489 |
| 14-#11 | 1.37 | MA | 19981 | 5026 | 29100 | 4222 | 34510 | 3427 | 36716 | 2840 | 38148 | 1965 | 46672 | 1610 | 27286 |
| 5L-4S | | MI | 18585 | 5026 | 27315 | 4182 | 32220 | 3403 | 34352 | 2810 | 35968 | 1940 | 43865 | 1625 | 24636 |
| 14-#11 | 1.37 | MA | 19349 | 5026 | 28235 | 4223 | 33356 | 3436 | 35312 | 2838 | 36280 | 1971 | 44144 | 1535 | 26500 |
| 6L-3S | | MI | 19237 | 5026 | 28175 | 4182 | 33383 | 3394 | 35761 | 2813 | 37862 | 1945 | 45958 | 1716 | 24704 |
| 14-#11 | 1.37 | MA | 18729 | 5026 | 27394 | 4224 | 32242 | 3436 | 33951 | 2847 | 34387 | 1967 | 41895 | 1464 | 25932 |
| 7L-2S | | MI | 20133 | 5026 | 29330 | 4182 | 34847 | 3395 | 37536 | 2805 | 40249 | 1940 | 49141 | 1807 | 24726 |
| 14-#14 | 1.97 | MA | 24185 | 5378 | 36360 | 4415 | 43623 | 3567 | 47722 | 2917 | 52983 | 1934 | 65794 | 1779 | 39254 |
| 2L-7S | | MI | 17166 | 5378 | 26596 | 4400 | 31126 | 3561 | 32945 | 2918 | 33960 | 1915 | 41851 | 1199 | 31390 |
| 14-#14 | 1.97 | MA | 22778 | 5378 | 34504 | 4416 | 41270 | 3566 | 44870 | 2928 | 49136 | 1942 | 60646 | 1648 | 39126 |
| 3L-6S | | MI | 17941 | 5378 | 27675 | 4400 | 32554 | 3564 | 34689 | 2908 | 36359 | 1923 | 44651 | 1302 | 32726 |
| 14-#14 | 1.97 | MA | 21761 | 5378 | 33124 | 4416 | 39404 | 3580 | 42610 | 2925 | 46085 | 1935 | 57256 | 1517 | 38835 |
| 4L-5S | | MI | 18732 | 5378 | 28784 | 4401 | 34032 | 3551 | 36488 | 2913 | 38725 | 1915 | 47804 | 1411 | 33624 |
| 14-#14 | 1.97 | MA | 20840 | 5378 | 31728 | 4432 | 37729 | 3578 | 40565 | 2937 | 43301 | 1943 | 53708 | 1451 | 37563 |
| 5L-4S | | MI | 19557 | 5378 | 30031 | 4386 | 35529 | 3554 | 38315 | 2902 | 41185 | 1908 | 50931 | 1475 | 34754 |
| 14-#14 | 1.97 | MA | 19957 | 5378 | 30487 | 4433 | 36075 | 3592 | 38552 | 2934 | 40623 | 1951 | 50115 | 1342 | 36494 |
| 6L-3S | | MI | 20466 | 5378 | 31263 | 4386 | 37193 | 3541 | 40332 | 2907 | 43880 | 1915 | 53899 | 1606 | 34990 |
| 14-#14 | 1.97 | MA | 19092 | 5378 | 29280 | 4434 | 34477 | 3591 | 36600 | 2946 | 37908 | 1943 | 46919 | 1240 | 34969 |
| 7L-2S | | MI | 21717 | 5378 | 32914 | 4386 | 39287 | 3544 | 42869 | 2897 | 47277 | 1908 | 58417 | 1738 | 35092 |
| 14-#18 | 3.51 | MA | 26065 | 6268 | 43077 | 4944 | 51931 | 3948 | 57694 | 3174 | 66086 | 1874 | 82980 | 1377 | 67546 |
| 3L-6S | | MI | 19139 | 6268 | 32584 | 4931 | 38506 | 3953 | 41795 | 3143 | 45662 | 1843 | 57379 | 769 | 51963 |
| 14-#18 | 3.51 | MA | 24379 | 6268 | 40655 | 4944 | 48657 | 3970 | 53728 | 3166 | 60782 | 1861 | 77137 | 1143 | 64604 |
| 4L-5S | | MI | 20452 | 6268 | 34530 | 4933 | 41099 | 3933 | 44950 | 3154 | 49754 | 1830 | 62805 | 963 | 55370 |
| 14-#18 | 3.51 | MA | 22851 | 6268 | 38203 | 4970 | 45714 | 3966 | 50136 | 3185 | 55941 | 1874 | 70984 | 1029 | 62060 |
| 5L-4S | | MI | 21820 | 6268 | 36717 | 4909 | 43724 | 3940 | 48153 | 3139 | 54008 | 1817 | 68211 | 1073 | 57498 |
| 14-#18 | 3.51 | MA | 21386 | 6268 | 36022 | 4970 | 42808 | 3989 | 46599 | 3177 | 51285 | 1887 | 64776 | 836 | 58229 |
| 6L-3S | | MI | 23329 | 6268 | 38875 | 4911 | 46640 | 3920 | 51686 | 3150 | 58671 | 1830 | 73305 | 1306 | 60196 |
| 14-#18 | 3.51 | MA | 19951 | 6268 | 33899 | 4970 | 40000 | 3984 | 43169 | 3195 | 46564 | 1874 | 59265 | 653 | 54326 |
| 7L-2S | | MI | 25404 | 6268 | 41760 | 4914 | 50298 | 3927 | 56118 | 3134 | 64546 | 1817 | 81081 | 1540 | 60689 |
| 16-#11 | 1.56 | MA | 22997 | 5140 | 33630 | 4280 | 40269 | 3469 | 43705 | 2857 | 47595 | 1952 | 58788 | 1826 | 31444 |
| 2L-8S | | MI | 16905 | 5140 | 25331 | 4264 | 29636 | 3460 | 31159 | 2853 | 31651 | 1945 | 38602 | 1366 | 25879 |
| 16-#11 | 1.56 | MA | 21998 | 5140 | 32334 | 4280 | 38625 | 3469 | 41713 | 2866 | 44907 | 1958 | 55168 | 1735 | 31393 |
| 3L-7S | | MI | 17448 | 5140 | 26073 | 4264 | 30612 | 3462 | 32379 | 2856 | 33277 | 1940 | 40654 | 1418 | 26656 |
| 16-#11 | 1.56 | MA | 21276 | 5140 | 31371 | 4281 | 37323 | 3479 | 40135 | 2864 | 42778 | 1954 | 52781 | 1644 | 31282 |
| 4L-6S | | MI | 17997 | 5140 | 26826 | 4264 | 31609 | 3463 | 33597 | 2848 | 34963 | 1945 | 42628 | 1489 | 27117 |
| 16-#11 | 1.56 | MA | 20622 | 5140 | 30397 | 4293 | 36154 | 3478 | 38709 | 2873 | 40836 | 1960 | 50292 | 1597 | 31049 |
| 5E | | MI | 18559 | 5140 | 27599 | 4264 | 32640 | 3454 | 34852 | 2851 | 36626 | 1940 | 44850 | 1564 | 27813 |
| 16-#11 | 1.56 | MA | 19996 | 5140 | 29532 | 4294 | 35001 | 3488 | 37305 | 2871 | 38968 | 1966 | 47764 | 1522 | 30222 |
| 6L-4S | | MI | 19144 | 5140 | 28470 | 4253 | 33685 | 3455 | 36127 | 2843 | 38355 | 1935 | 47047 | 1609 | 28027 |
| 16-#11 | 1.56 | MA | 19383 | 5140 | 28690 | 4294 | 33887 | 3488 | 35944 | 2880 | 37075 | 1962 | 45515 | 1451 | 29670 |
| 7L-3S | | MI | 19790 | 5140 | 29330 | 4253 | 34847 | 3446 | 37536 | 2846 | 40249 | 1940 | 49141 | 1700 | 28114 |

## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

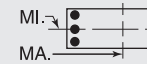



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.56 | MA | 18777 | 5140 | 27862 | 4295 | 32795 | 3488 | 34580 | 2878 | 35249 | 1968 | 43190 | 1398 | 28775 |
| 8L-2S | | MI | 20679 | 5140 | 30485 | 4253 | 36312 | 3447 | 39310 | 2838 | 42636 | 1935 | 52324 | 1791 | 28150 |
| 16-#14 | 2.26 | MA | 25034 | 5541 | 38215 | 4517 | 45977 | 3642 | 50573 | 2964 | 56830 | 1927 | 70941 | 1759 | 44733 |
| 2L-8S | | MI | 17212 | 5541 | 27184 | 4502 | 31820 | 3634 | 33734 | 2961 | 35042 | 1914 | 43450 | 1101 | 34773 |
| 16-#14 | 2.26 | MA | 23642 | 5541 | 36360 | 4518 | 43623 | 3641 | 47722 | 2976 | 52983 | 1935 | 65794 | 1628 | 44575 |
| 3L-7S | | MI | 17968 | 5541 | 28247 | 4503 | 33220 | 3636 | 35482 | 2966 | 37357 | 1906 | 46369 | 1175 | 36054 |
| 16-#14 | 2.26 | MA | 22638 | 5541 | 34980 | 4519 | 41758 | 3654 | 45461 | 2973 | 49932 | 1928 | 62403 | 1496 | 44252 |
| 4L-6S | | MI | 18733 | 5541 | 29327 | 4503 | 34648 | 3639 | 37227 | 2955 | 39756 | 1914 | 49169 | 1278 | 37461 |
| 16-#14 | 2.26 | MA | 21729 | 5541 | 33584 | 4534 | 40082 | 3653 | 43416 | 2984 | 47148 | 1935 | 58856 | 1431 | 42860 |
| 5E | | MI | 19514 | 5541 | 30435 | 4503 | 36126 | 3626 | 39025 | 2960 | 42122 | 1906 | 52322 | 1387 | 38325 |
| 16-#14 | 2.26 | MA | 20857 | 5541 | 32343 | 4535 | 38429 | 3667 | 41403 | 2981 | 44470 | 1943 | 55262 | 1322 | 41828 |
| 6L-4S | | MI | 20328 | 5541 | 31683 | 4488 | 37623 | 3628 | 40852 | 2950 | 44582 | 1899 | 55449 | 1451 | 39571 |
| 16-#14 | 2.26 | MA | 20003 | 5541 | 31136 | 4536 | 36831 | 3666 | 39451 | 2993 | 41755 | 1936 | 52066 | 1220 | 40236 |
| 7L-3S | | MI | 21227 | 5541 | 32914 | 4488 | 39287 | 3616 | 42869 | 2954 | 47277 | 1906 | 58417 | 1582 | 39839 |
| 16-#14 | 2.26 | MA | 19159 | 5541 | 29947 | 4537 | 35265 | 3665 | 37495 | 2990 | 39136 | 1944 | 48754 | 1144 | 38778 |
| 8L-2S | | MI | 22465 | 5541 | 34566 | 4489 | 41382 | 3618 | 45406 | 2944 | 50674 | 1899 | 62934 | 1713 | 39968 |
| 16-#18 | 4.01 | MA | 25821 | 6559 | 43903 | 5126 | 52777 | 4103 | 58718 | 3251 | 67466 | 1845 | 86030 | 1101 | 73802 |
| 4L-6S | | MI | 20454 | 6559 | 35468 | 5112 | 42164 | 4086 | 46227 | 3227 | 51537 | 1823 | 65154 | 719 | 60077 |
| 16-#18 | 4.01 | MA | 24321 | 6559 | 41450 | 5152 | 49834 | 4099 | 55126 | 3269 | 62625 | 1858 | 79877 | 987 | 71367 |
| 5E | | MI | 21744 | 6559 | 37415 | 5115 | 44757 | 4066 | 49382 | 3238 | 55629 | 1810 | 70580 | 913 | 63561 |
| 16-#18 | 4.01 | MA | 22883 | 6559 | 39270 | 5152 | 46928 | 4122 | 51590 | 3261 | 57970 | 1871 | 73669 | 793 | 67416 |
| 6L-4S | | MI | 23089 | 6559 | 39602 | 5091 | 47382 | 4073 | 52585 | 3223 | 59883 | 1797 | 75987 | 1023 | 65637 |
| 16-#18 | 4.01 | MA | 21474 | 6559 | 37147 | 5152 | 44119 | 4117 | 48159 | 3279 | 53249 | 1858 | 68158 | 611 | 63443 |
| 7L-3S | | MI | 24572 | 6559 | 41760 | 5093 | 50298 | 4053 | 56118 | 3234 | 64546 | 1810 | 81081 | 1256 | 68598 |
| 18-#11 | 1.76 | MA | 23609 | 5253 | 34927 | 4350 | 41914 | 3521 | 45698 | 2890 | 50284 | 1947 | 62408 | 1813 | 35280 |
| 2L-9S | | MI | 16944 | 5253 | 25667 | 4346 | 30094 | 3521 | 31734 | 2894 | 32427 | 1944 | 39769 | 1292 | 28480 |
| 18-#11 | 1.76 | MA | 22617 | 5253 | 33630 | 4351 | 40269 | 3521 | 43705 | 2899 | 47595 | 1953 | 58788 | 1722 | 35215 |
| 3L-8S | | MI | 17478 | 5253 | 26486 | 4335 | 31100 | 3512 | 32934 | 2886 | 34038 | 1939 | 41785 | 1350 | 29160 |
| 18-#11 | 1.76 | MA | 21902 | 5253 | 32667 | 4352 | 38968 | 3531 | 42128 | 2897 | 45466 | 1949 | 56401 | 1631 | 35085 |
| 4L-7S | | MI | 18016 | 5253 | 27227 | 4335 | 32077 | 3513 | 34154 | 2889 | 35665 | 1934 | 43836 | 1403 | 29982 |
| 18-#11 | 1.76 | MA | 21255 | 5253 | 31694 | 4364 | 37799 | 3530 | 40701 | 2906 | 43524 | 1955 | 53912 | 1585 | 34747 |
| 5L-6S | | MI | 18560 | 5253 | 27981 | 4335 | 33074 | 3515 | 35371 | 2881 | 37351 | 1939 | 45811 | 1474 | 30431 |
| 18-#11 | 1.76 | MA | 20635 | 5253 | 30829 | 4364 | 36646 | 3540 | 39297 | 2904 | 41656 | 1961 | 51384 | 1509 | 33951 |
| 6L-5S | | MI | 19116 | 5253 | 28754 | 4335 | 34105 | 3506 | 36626 | 2884 | 39013 | 1934 | 48033 | 1549 | 31100 |
| 18-#11 | 1.76 | MA | 20027 | 5253 | 29987 | 4365 | 35532 | 3540 | 37936 | 2913 | 39763 | 1957 | 49135 | 1439 | 33412 |
| 7L-4S | | MI | 19696 | 5253 | 29625 | 4324 | 35150 | 3507 | 37901 | 2876 | 40742 | 1929 | 50230 | 1594 | 31416 |
| 18-#11 | 1.76 | MA | 19427 | 5253 | 29158 | 4366 | 34440 | 3539 | 36572 | 2911 | 37937 | 1963 | 46810 | 1385 | 32473 |
| 8L-3S | | MI | 20336 | 5253 | 30485 | 4324 | 36312 | 3498 | 39310 | 2879 | 42636 | 1934 | 52324 | 1685 | 31519 |
| 18-#11 | 1.76 | MA | 18831 | 5253 | 28243 | 4378 | 33315 | 3549 | 35231 | 2919 | 36128 | 1969 | 44515 | 1327 | 31683 |
| 9L-2S | | MI | 21218 | 5253 | 31640 | 4323 | 37777 | 3499 | 41085 | 2871 | 45024 | 1929 | 55507 | 1776 | 31569 |
| 18-#14 | 2.54 | MA | 24494 | 5705 | 38215 | 4620 | 45977 | 3715 | 50573 | 3023 | 56830 | 1927 | 70941 | 1608 | 50021 |
| 3L-8S | | MI | 18010 | 5705 | 28835 | 4605 | 33915 | 3708 | 36271 | 3008 | 38439 | 1904 | 47968 | 1077 | 39399 |
| 18-#14 | 2.54 | MA | 23501 | 5705 | 36836 | 4621 | 44112 | 3729 | 48313 | 3020 | 53779 | 1920 | 67551 | 1476 | 49667 |
| 4L-7S | | MI | 18757 | 5705 | 29898 | 4605 | 35314 | 3711 | 38019 | 3013 | 40754 | 1897 | 50887 | 1151 | 40729 |
| 18-#14 | 2.54 | MA | 22603 | 5705 | 35439 | 4637 | 42436 | 3728 | 46268 | 3032 | 50995 | 1928 | 64004 | 1410 | 48170 |
| 5L-6S | | MI | 19512 | 5705 | 30978 | 4605 | 36743 | 3713 | 39764 | 3003 | 43153 | 1904 | 53686 | 1254 | 42202 |
| 18-#14 | 2.54 | MA | 21743 | 5705 | 34199 | 4637 | 40782 | 3742 | 44254 | 3029 | 48317 | 1936 | 60410 | 1302 | 47170 |
| 6L-5S | | MI | 20284 | 5705 | 32087 | 4605 | 38220 | 3701 | 41563 | 3007 | 45518 | 1897 | 56840 | 1363 | 43038 |
| 18-#14 | 2.54 | MA | 20900 | 5705 | 32992 | 4638 | 39184 | 3741 | 42302 | 3040 | 45602 | 1929 | 57214 | 1200 | 45513 |
| 7L-4S | | MI | 21089 | 5705 | 33334 | 4590 | 39717 | 3703 | 43389 | 2997 | 47978 | 1890 | 59966 | 1427 | 44385 |
| 18-#14 | 2.54 | MA | 20066 | 5705 | 31803 | 4639 | 37619 | 3739 | 40347 | 3037 | 42983 | 1936 | 53902 | 1123 | 44009 |
| 8L-3S | | MI | 21977 | 5705 | 34566 | 4591 | 41382 | 3691 | 45406 | 3002 | 50674 | 1897 | 62934 | 1558 | 44683 |
| 18-#14 | 2.54 | MA | 19239 | 5705 | 30490 | 4655 | 36005 | 3753 | 38422 | 3049 | 40389 | 1944 | 50640 | 1039 | 42108 |
| 9L-2S | | MI | 23203 | 5705 | 36217 | 4591 | 43476 | 3693 | 47943 | 2992 | 54071 | 1890 | 67452 | 1689 | 44838 |
| 18-#18 | 4.51 | MA | 25765 | 6850 | 44698 | 5334 | 53953 | 4232 | 60117 | 3353 | 69310 | 1842 | 88770 | 945 | 80610 |
| 5L-6S | | MI | 21744 | 6850 | 38353 | 5294 | 45822 | 4219 | 50659 | 3311 | 57412 | 1803 | 72930 | 669 | 68212 |
| 18-#18 | 4.51 | MA | 24351 | 6850 | 42518 | 5334 | 51047 | 4255 | 56580 | 3345 | 64654 | 1855 | 82563 | 751 | 76623 |
| 6L-5S | | MI | 23013 | 6850 | 40299 | 5296 | 48415 | 4199 | 53814 | 3322 | 61504 | 1790 | 78356 | 863 | 71575 |
| 18-#18 | 4.51 | MA | 22966 | 6850 | 40395 | 5333 | 48239 | 4250 | 53150 | 3363 | 59933 | 1842 | 77051 | 569 | 72580 |
| 7L-4S | | MI | 24336 | 6850 | 42486 | 5272 | 51040 | 4206 | 57017 | 3307 | 65758 | 1777 | 83763 | 973 | 73802 |

## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

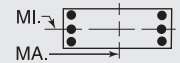
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.95 | MA | 24213 | 5367 | 36224 | 4421 | 43558 | 3573 | 47690 | 2923 | 52972 | 1942 | 66028 | 1800 | 39112 |
| 2L-10S | | MI | 16988 | 5367 | 26083 | 4417 | 30589 | 3572 | 32303 | 2924 | 33158 | 1934 | 40997 | 1210 | 30744 |
| 20-#11 | 1.95 | MA | 23230 | 5367 | 34927 | 4422 | 41914 | 3573 | 45698 | 2931 | 50284 | 1948 | 62408 | 1709 | 39033 |
| 3L-9S | | MI | 17514 | 5367 | 26822 | 4417 | 31559 | 3573 | 33508 | 2927 | 34814 | 1939 | 42952 | 1276 | 31733 |
| 20-#11 | 1.95 | MA | 22521 | 5367 | 33964 | 4423 | 40612 | 3582 | 44120 | 2930 | 48154 | 1944 | 60021 | 1618 | 38887 |
| 4L-8S | | MI | 18043 | 5367 | 27641 | 4406 | 32565 | 3564 | 34709 | 2919 | 36425 | 1934 | 44967 | 1335 | 32448 |
| 20-#11 | 1.95 | MA | 21880 | 5367 | 32990 | 4434 | 39443 | 3582 | 42693 | 2938 | 46212 | 1950 | 57532 | 1572 | 38454 |
| 5L-7S | | MI | 18576 | 5367 | 28382 | 4406 | 33542 | 3565 | 35928 | 2922 | 38052 | 1929 | 47019 | 1387 | 33311 |
| 20-#11 | 1.95 | MA | 21265 | 5367 | 32126 | 4435 | 38290 | 3592 | 41289 | 2937 | 44345 | 1956 | 55004 | 1497 | 37684 |
| 6E | | MI | 19116 | 5367 | 29136 | 4406 | 34538 | 3567 | 37146 | 2914 | 39738 | 1934 | 48994 | 1458 | 33750 |
| 20-#11 | 1.95 | MA | 20664 | 5367 | 31284 | 4436 | 37176 | 3592 | 39928 | 2945 | 42451 | 1952 | 52755 | 1426 | 37157 |
| 7L-5S | | MI | 19667 | 5367 | 29909 | 4405 | 35570 | 3557 | 38401 | 2917 | 41401 | 1929 | 51215 | 1534 | 34395 |
| 20-#11 | 1.95 | MA | 20070 | 5367 | 30455 | 4437 | 36084 | 3591 | 38565 | 2944 | 40625 | 1958 | 50430 | 1372 | 36177 |
| 8L-4S | | MI | 20241 | 5367 | 30780 | 4395 | 36614 | 3559 | 39676 | 2909 | 43130 | 1923 | 53413 | 1579 | 34801 |
| 20-#11 | 1.95 | MA | 19479 | 5367 | 29540 | 4448 | 34959 | 3601 | 37223 | 2952 | 38816 | 1964 | 48135 | 1314 | 35363 |
| 9L-3S | | MI | 20876 | 5367 | 31640 | 4395 | 37777 | 3550 | 41085 | 2912 | 45024 | 1929 | 55507 | 1670 | 34920 |
| 20-#11 | 1.95 | MA | 18892 | 5367 | 28715 | 4449 | 33875 | 3601 | 35875 | 2951 | 36956 | 1959 | 45763 | 1234 | 34208 |
| 10L-2S | | MI | 21751 | 5367 | 32795 | 4394 | 39242 | 3551 | 42859 | 2904 | 47411 | 1923 | 58690 | 1761 | 34983 |
| 20-#14 | 2.82 | MA | 24353 | 5868 | 38691 | 4723 | 46465 | 3804 | 51164 | 3067 | 57626 | 1913 | 72699 | 1456 | 55082 |
| 4L-8S | | MI | 18796 | 5868 | 30486 | 4707 | 36009 | 3783 | 38809 | 3056 | 41836 | 1895 | 52486 | 1053 | 44036 |
| 20-#14 | 2.82 | MA | 23466 | 5868 | 37295 | 4739 | 44790 | 3803 | 49119 | 3079 | 54842 | 1920 | 69152 | 1390 | 53489 |
| 5L-7S | | MI | 19534 | 5868 | 31550 | 4707 | 37409 | 3786 | 40557 | 3060 | 44151 | 1888 | 55405 | 1127 | 45414 |
| 20-#14 | 2.82 | MA | 22615 | 5868 | 36055 | 4740 | 43136 | 3817 | 47106 | 3076 | 52164 | 1928 | 65558 | 1282 | 52519 |
| 6E | | MI | 20281 | 5868 | 32629 | 4707 | 38837 | 3788 | 42301 | 3050 | 46550 | 1895 | 58204 | 1230 | 46950 |
| 20-#14 | 2.82 | MA | 21783 | 5868 | 34847 | 4741 | 41538 | 3815 | 45154 | 3088 | 49449 | 1921 | 62362 | 1179 | 50799 |
| 7L-5S | | MI | 21044 | 5868 | 33738 | 4707 | 40315 | 3776 | 44100 | 3055 | 48915 | 1888 | 61358 | 1339 | 47759 |
| 20-#14 | 2.82 | MA | 20959 | 5868 | 33659 | 4741 | 39972 | 3814 | 43198 | 3085 | 46830 | 1929 | 59049 | 1103 | 49250 |
| 8L-4S | | MI | 21839 | 5868 | 34985 | 4693 | 41811 | 3778 | 45926 | 3045 | 51375 | 1880 | 64484 | 1402 | 49199 |
| 20-#14 | 2.82 | MA | 20142 | 5868 | 32346 | 4757 | 38359 | 3828 | 41274 | 3096 | 44236 | 1937 | 55788 | 1019 | 47390 |
| 9L-3S | | MI | 22718 | 5868 | 36217 | 4693 | 43476 | 3766 | 47943 | 3049 | 54071 | 1888 | 67452 | 1534 | 49524 |
| 20-#18 | 5.01 | MA | 25794 | 7140 | 45766 | 5515 | 55166 | 4388 | 61571 | 3429 | 71339 | 1839 | 91456 | 709 | 85848 |
| 6E | | MI | 23014 | 7140 | 41237 | 5476 | 49481 | 4352 | 55091 | 3396 | 63287 | 1784 | 80706 | 618 | 76367 |
| 20-#18 | 5.01 | MA | 24433 | 7140 | 43643 | 5515 | 52358 | 4383 | 58140 | 3448 | 66618 | 1826 | 85944 | 526 | 81734 |
| 7L-5S | | MI | 24263 | 7140 | 43183 | 5478 | 52073 | 4332 | 58246 | 3407 | 67378 | 1770 | 86131 | 813 | 79615 |
| 22-#11 | 2.15 | MA | 23836 | 5480 | 36224 | 4493 | 43558 | 3624 | 47690 | 2964 | 52972 | 1943 | 66028 | 1696 | 42848 |
| 3L-10S | | MI | 17556 | 5480 | 27238 | 4488 | 32054 | 3624 | 34077 | 2957 | 35545 | 1928 | 44180 | 1195 | 34025 |
| 22-#11 | 2.15 | MA | 23133 | 5480 | 35261 | 4494 | 42257 | 3634 | 46112 | 2963 | 50842 | 1939 | 63641 | 1605 | 42687 |
| 4L-9S | | MI | 18078 | 5480 | 27977 | 4488 | 33024 | 3625 | 35283 | 2959 | 37202 | 1933 | 46135 | 1261 | 34992 |
| 22-#11 | 2.15 | MA | 22497 | 5480 | 34287 | 4505 | 41088 | 3634 | 44686 | 2971 | 48900 | 1945 | 61152 | 1559 | 42168 |
| 5L-8S | | MI | 18602 | 5480 | 28796 | 4477 | 34030 | 3616 | 36483 | 2952 | 38813 | 1928 | 48150 | 1320 | 35740 |
| 22-#11 | 2.15 | MA | 21889 | 5480 | 33422 | 4506 | 39935 | 3644 | 43282 | 2970 | 47033 | 1951 | 58624 | 1484 | 41423 |
| 6L-7S | | MI | 19131 | 5480 | 29537 | 4477 | 35007 | 3617 | 37703 | 2954 | 40439 | 1923 | 50202 | 1372 | 36588 |
| 22-#11 | 2.15 | MA | 21293 | 5480 | 32580 | 4507 | 38821 | 3644 | 41921 | 2978 | 45139 | 1946 | 56375 | 1413 | 40887 |
| 7L-6S | | MI | 19665 | 5480 | 30291 | 4477 | 36003 | 3618 | 38920 | 2947 | 42125 | 1928 | 52176 | 1443 | 37074 |
| 22-#11 | 2.15 | MA | 20704 | 5480 | 31752 | 4508 | 37729 | 3643 | 40557 | 2977 | 43313 | 1952 | 54050 | 1360 | 39887 |
| 8L-5S | | MI | 20211 | 5480 | 31064 | 4476 | 37035 | 3609 | 40176 | 2950 | 43788 | 1923 | 54398 | 1518 | 37696 |
| 22-#11 | 2.15 | MA | 20119 | 5480 | 30837 | 4519 | 36604 | 3653 | 39215 | 2985 | 41504 | 1958 | 51755 | 1301 | 39039 |
| 9L-4S | | MI | 20781 | 5480 | 31935 | 4466 | 38079 | 3611 | 41451 | 2942 | 45517 | 1918 | 56596 | 1563 | 38185 |
| 22-#11 | 2.15 | MA | 19537 | 5480 | 30011 | 4520 | 35520 | 3653 | 37867 | 2983 | 39644 | 1954 | 49382 | 1221 | 37908 |
| 10L-3S | | MI | 21410 | 5480 | 32795 | 4465 | 39242 | 3601 | 42859 | 2945 | 47411 | 1923 | 58690 | 1655 | 38318 |
| 22-#11 | 2.15 | MA | 18934 | 5480 | 29192 | 4521 | 34408 | 3663 | 36534 | 2992 | 37843 | 1960 | 47098 | 1165 | 36749 |
| 11L-2S | | MI | 22279 | 5480 | 33950 | 4465 | 40706 | 3603 | 44634 | 2937 | 49798 | 1918 | 61872 | 1746 | 38394 |
| 22-#14 | 3.10 | MA | 24316 | 6032 | 39151 | 4841 | 47143 | 3878 | 51970 | 3127 | 58689 | 1913 | 74299 | 1370 | 58817 |
| 5L-8S | | MI | 19571 | 6032 | 32138 | 4809 | 38103 | 3858 | 41346 | 3103 | 45233 | 1886 | 57004 | 1029 | 48682 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 3.10 | MA | 23476 | 6032 | 37911 | 4842 | 45489 | 3891 | 49957 | 3123 | 56011 | 1921 | 70706 | 1262 | 57873 |
| 6L-7S | | MI | 20301 | 6032 | 33201 | 4809 | 39503 | 3861 | 43094 | 3108 | 47547 | 1879 | 59923 | 1103 | 50107 |
| 22-#14 | 3.10 | MA | 22653 | 6032 | 36703 | 4843 | 43892 | 3890 | 48005 | 3135 | 53296 | 1914 | 67510 | 1159 | 56093 |
| 7L-6S | | MI | 21039 | 6032 | 34281 | 4809 | 40931 | 3863 | 44838 | 3098 | 49946 | 1886 | 62722 | 1206 | 51614 |
| 22-#14 | 3.10 | MA | 21840 | 6032 | 35514 | 4844 | 42326 | 3889 | 46050 | 3132 | 50677 | 1921 | 64197 | 1083 | 54499 |
| 8L-5S | | MI | 21794 | 6032 | 35390 | 4810 | 42409 | 3850 | 46637 | 3102 | 52312 | 1879 | 65875 | 1315 | 52489 |
| 22-#14 | 3.10 | MA | 21032 | 6032 | 34202 | 4859 | 40712 | 3903 | 44125 | 3144 | 48083 | 1929 | 60936 | 998 | 52679 |
| 9L-4S | | MI | 22581 | 6032 | 36637 | 4795 | 43906 | 3853 | 48464 | 3092 | 54772 | 1871 | 69002 | 1378 | 53906 |
| 22-#18 | 5.51 | MA | 25876 | 7431 | 46891 | 5697 | 56477 | 4516 | 63131 | 3532 | 73303 | 1810 | 94838 | 484 | 90905 |
| 7L-6S | | MI | 24266 | 7431 | 44122 | 5658 | 53139 | 4485 | 59523 | 3480 | 69162 | 1764 | 88481 | 568 | 84538 |
| 24-#11 | 2.35 | MA | 23738 | 5593 | 36558 | 4565 | 43901 | 3686 | 48105 | 2995 | 53530 | 1933 | 67261 | 1593 | 46486 |
| 4L-10S | | MI | 18118 | 5593 | 28393 | 4559 | 33518 | 3676 | 35852 | 2990 | 37933 | 1923 | 47363 | 1180 | 37310 |
| 24-#11 | 2.35 | MA | 23108 | 5593 | 35584 | 4576 | 42733 | 3686 | 46678 | 3004 | 51588 | 1939 | 64772 | 1546 | 45887 |
| 5L-9S | | MI | 18636 | 5593 | 29132 | 4558 | 34488 | 3677 | 37058 | 2992 | 39589 | 1928 | 49318 | 1246 | 38256 |
| 24-#11 | 2.35 | MA | 22505 | 5593 | 34719 | 4577 | 41579 | 3696 | 45274 | 3002 | 49721 | 1945 | 62244 | 1471 | 45165 |
| 6L-8S | | MI | 19155 | 5593 | 29951 | 4548 | 35495 | 3668 | 38258 | 2985 | 41200 | 1923 | 51333 | 1305 | 39038 |
| 24-#11 | 2.35 | MA | 21915 | 5593 | 33877 | 4578 | 40465 | 3695 | 43913 | 3011 | 47828 | 1941 | 59995 | 1400 | 44577 |
| 7E | | MI | 19679 | 5593 | 30692 | 4548 | 36471 | 3669 | 39478 | 2987 | 42827 | 1917 | 53385 | 1357 | 39864 |
| 24-#11 | 2.35 | MA | 21331 | 5593 | 33049 | 4579 | 39374 | 3695 | 42549 | 3009 | 46001 | 1947 | 57670 | 1347 | 43601 |
| 8L-6S | | MI | 20209 | 5593 | 31446 | 4547 | 37468 | 3670 | 40695 | 2980 | 44513 | 1923 | 55359 | 1428 | 40402 |
| 24-#11 | 2.35 | MA | 20752 | 5593 | 32134 | 4590 | 38249 | 3705 | 41208 | 3018 | 44192 | 1953 | 55375 | 1288 | 42722 |
| 9L-5S | | MI | 20750 | 5593 | 32219 | 4547 | 38499 | 3661 | 41950 | 2982 | 46175 | 1917 | 57581 | 1503 | 41004 |
| 24-#11 | 2.35 | MA | 20175 | 5593 | 31308 | 4591 | 37164 | 3705 | 39860 | 3016 | 42332 | 1949 | 53002 | 1208 | 41612 |
| 10L-4S | | MI | 21315 | 5593 | 33090 | 4537 | 39544 | 3662 | 43225 | 2975 | 47904 | 1912 | 59779 | 1548 | 41567 |
| 24-#11 | 2.35 | MA | 19573 | 5593 | 30489 | 4592 | 36052 | 3715 | 38526 | 3025 | 40531 | 1955 | 50718 | 1152 | 40432 |
| 11L-3S | | MI | 21939 | 5593 | 33950 | 4536 | 40706 | 3653 | 44634 | 2977 | 49798 | 1917 | 61872 | 1639 | 41714 |
| 24-#14 | 3.38 | MA | 24326 | 6195 | 39766 | 4944 | 47843 | 3966 | 52809 | 3171 | 59858 | 1913 | 75853 | 1241 | 63132 |
| 6L-8S | | MI | 20336 | 6195 | 33789 | 4911 | 40198 | 3933 | 43883 | 3151 | 48630 | 1877 | 61522 | 1005 | 53336 |
| 24-#14 | 3.38 | MA | 23512 | 6195 | 38559 | 4945 | 46245 | 3965 | 50857 | 3183 | 57143 | 1906 | 72657 | 1139 | 61395 |
| 7E | | MI | 21058 | 6195 | 34852 | 4911 | 41597 | 3935 | 45631 | 3155 | 50944 | 1870 | 64440 | 1079 | 54807 |
| 24-#14 | 3.38 | MA | 22708 | 6195 | 37370 | 4946 | 44679 | 3964 | 48901 | 3179 | 54524 | 1914 | 69345 | 1063 | 59757 |
| 8L-6S | | MI | 21788 | 6195 | 35932 | 4912 | 43026 | 3938 | 47376 | 3145 | 53343 | 1877 | 67240 | 1182 | 56272 |
| 24-#14 | 3.38 | MA | 21910 | 6195 | 36058 | 4962 | 43066 | 3978 | 46977 | 3191 | 51930 | 1922 | 66084 | 978 | 57975 |
| 9L-5S | | MI | 22535 | 6195 | 37041 | 4912 | 44503 | 3925 | 49174 | 3150 | 55709 | 1870 | 70393 | 1291 | 57227 |

## RECTANGULAR TIED COLUMNS 38" x 44"

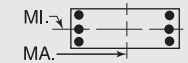
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.44 | MA | 24652 | 5306 | 36057 | 4407 | 42881 | 3576 | 46273 | 2951 | 49823 | 2031 | 60945 | 1888 | 31421 |
| 2L-3S | | MI | 18858 | 5306 | 28365 | 4358 | 33182 | 3531 | 35153 | 2934 | 36287 | 2002 | 43472 | 1597 | 26590 |
| 6-#18 | 1.44 | MA | 21995 | 5306 | 32628 | 4407 | 38532 | 3573 | 41003 | 2971 | 42733 | 2044 | 51492 | 1654 | 31229 |
| 3L-2S | | MI | 21088 | 5306 | 31249 | 4360 | 36841 | 3537 | 39585 | 2918 | 42162 | 1989 | 51248 | 1830 | 26698 |
| 8-#14 | 1.08 | MA | 23524 | 5088 | 33367 | 4297 | 39693 | 3498 | 42507 | 2907 | 44867 | 2058 | 54583 | 1945 | 23975 |
| 2L-4S | | MI | 17928 | 5088 | 26094 | 4254 | 30418 | 3473 | 31898 | 2882 | 32113 | 2029 | 38653 | 1638 | 20345 |
| 8-#14 | 1.08 | MA | 21982 | 5088 | 31409 | 4298 | 37210 | 3497 | 39498 | 2919 | 40808 | 2067 | 49120 | 1813 | 23951 |
| 3E | | MI | 18875 | 5088 | 27326 | 4254 | 32083 | 3461 | 33915 | 2887 | 34809 | 2036 | 41621 | 1769 | 20438 |
| 8-#14 | 1.08 | MA | 20864 | 5088 | 29955 | 4300 | 35244 | 3512 | 37116 | 2916 | 37593 | 2061 | 45518 | 1682 | 23789 |
| 4L-2S | | MI | 20173 | 5088 | 28977 | 4255 | 34177 | 3463 | 36453 | 2877 | 38206 | 2029 | 46139 | 1900 | 20433 |
| 8-#18 | 1.91 | MA | 26252 | 5597 | 39487 | 4588 | 47231 | 3709 | 51542 | 3035 | 56913 | 2017 | 70397 | 1849 | 41573 |
| 2L-4S | | MI | 18621 | 5597 | 29091 | 4537 | 33925 | 3683 | 36052 | 3007 | 37499 | 1969 | 46154 | 1313 | 33627 |
| 8-#18 | 1.91 | MA | 23646 | 5597 | 36057 | 4589 | 42881 | 3706 | 46273 | 3055 | 49823 | 2030 | 60945 | 1615 | 41266 |
| 3E | | MI | 20222 | 5597 | 31249 | 4539 | 36841 | 3664 | 39585 | 3018 | 42162 | 1983 | 51248 | 1547 | 35037 |
| 8-#18 | 1.91 | MA | 21755 | 5597 | 33504 | 4590 | 39430 | 3729 | 42090 | 3048 | 44197 | 2017 | 54726 | 1381 | 39570 |
| 4L-2S | | MI | 22411 | 5597 | 34134 | 4542 | 40499 | 3670 | 44017 | 3003 | 48037 | 1969 | 59023 | 1780 | 35250 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis

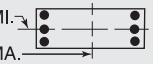



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.35 | MA | 24475 | 5252 | 35325 | 4399 | 42176 | 3573 | 45515 | 2954 | 48926 | 2051 | 60046 | 1926 | 29791 |
| 2L-5S | | MI | 17895 | 5252 | 26498 | 4371 | 31016 | 3545 | 32609 | 2940 | 33050 | 2027 | 40044 | 1550 | 24462 |
| 10-#14 | 1.35 | MA | 22951 | 5252 | 33367 | 4401 | 39693 | 3572 | 42507 | 2966 | 44867 | 2059 | 54583 | 1795 | 29728 |
| 3L-4S | | MI | 18744 | 5252 | 27745 | 4356 | 32513 | 3548 | 34436 | 2930 | 35510 | 2020 | 43171 | 1614 | 25180 |
| 10-#14 | 1.35 | MA | 21848 | 5252 | 31913 | 4402 | 37727 | 3586 | 40125 | 2964 | 41652 | 2053 | 50981 | 1663 | 29516 |
| 4L-3S | | MI | 19679 | 5252 | 28977 | 4357 | 34177 | 3535 | 36453 | 2934 | 38206 | 2027 | 46139 | 1745 | 25319 |
| 10-#14 | 1.35 | MA | 20849 | 5252 | 30442 | 4418 | 35962 | 3586 | 37970 | 2976 | 38719 | 2062 | 47224 | 1597 | 28607 |
| 5L-2S | | MI | 20961 | 5252 | 30628 | 4357 | 36271 | 3538 | 38990 | 2924 | 41603 | 2020 | 50657 | 1876 | 25351 |
| 10-#18 | 2.39 | MA | 27811 | 5888 | 42917 | 4770 | 51581 | 3842 | 56812 | 3120 | 64003 | 2002 | 79850 | 1810 | 51697 |
| 2L-5S | | MI | 18553 | 5888 | 29788 | 4743 | 34958 | 3810 | 37281 | 3107 | 39119 | 1963 | 48523 | 1153 | 39237 |
| 10-#18 | 2.39 | MA | 25252 | 5888 | 39487 | 4771 | 47231 | 3839 | 51542 | 3139 | 56913 | 2015 | 70397 | 1576 | 51292 |
| 3L-4S | | MI | 19979 | 5888 | 31975 | 4719 | 37583 | 3816 | 40484 | 3091 | 43374 | 1949 | 53929 | 1263 | 41643 |
| 10-#18 | 2.39 | MA | 23399 | 5888 | 36933 | 4771 | 43779 | 3862 | 47359 | 3132 | 51287 | 2002 | 64179 | 1342 | 49177 |
| 4L-3S | | MI | 21550 | 5888 | 34134 | 4721 | 40499 | 3797 | 44017 | 3102 | 48037 | 1963 | 59023 | 1497 | 43465 |
| 10-#18 | 2.39 | MA | 21719 | 5888 | 34348 | 4799 | 40677 | 3859 | 43573 | 3152 | 46153 | 2015 | 57652 | 1227 | 46105 |
| 5L-2S | | MI | 23702 | 5888 | 37018 | 4723 | 44157 | 3803 | 48449 | 3087 | 53912 | 1949 | 66799 | 1730 | 43770 |
| 12-#11 | 1.12 | MA | 23733 | 5115 | 33621 | 4327 | 40129 | 3521 | 43084 | 2923 | 45680 | 2064 | 55835 | 1956 | 25019 |
| 2L-6S | | MI | 17616 | 5115 | 25527 | 4298 | 29850 | 3504 | 31243 | 2905 | 31309 | 2050 | 37541 | 1611 | 20646 |
| 12-#11 | 1.12 | MA | 22657 | 5115 | 32254 | 4328 | 38394 | 3521 | 40983 | 2933 | 42845 | 2071 | 51997 | 1865 | 25000 |
| 3L-5S | | MI | 18190 | 5115 | 26301 | 4297 | 30882 | 3494 | 32499 | 2908 | 32972 | 2045 | 39763 | 1686 | 21179 |
| 12-#11 | 1.12 | MA | 21880 | 5115 | 31239 | 4329 | 37023 | 3531 | 39321 | 2931 | 40602 | 2067 | 49463 | 1774 | 24929 |
| 4E | | MI | 18788 | 5115 | 27172 | 4287 | 31926 | 3496 | 33774 | 2900 | 34701 | 2040 | 41961 | 1731 | 21286 |
| 12-#11 | 1.12 | MA | 21176 | 5115 | 30214 | 4341 | 35792 | 3531 | 37819 | 2940 | 38556 | 2074 | 46828 | 1727 | 24763 |
| 5L-3S | | MI | 19448 | 5115 | 28032 | 4287 | 33089 | 3486 | 35182 | 2903 | 36595 | 2045 | 44055 | 1822 | 21325 |
| 12-#11 | 1.12 | MA | 20502 | 5115 | 29304 | 4342 | 34578 | 3541 | 36341 | 2939 | 36590 | 2080 | 44147 | 1652 | 24080 |
| 6L-2S | | MI | 20354 | 5115 | 29187 | 4286 | 34554 | 3488 | 36957 | 2895 | 38983 | 2040 | 47237 | 1913 | 21324 |
| 12-#14 | 1.61 | MA | 25408 | 5416 | 37283 | 4501 | 44659 | 3648 | 48524 | 3001 | 52985 | 2043 | 65509 | 1908 | 35590 |
| 2L-6S | | MI | 17902 | 5416 | 27041 | 4473 | 31632 | 3633 | 33348 | 2983 | 34081 | 2026 | 41409 | 1417 | 28183 |
| 12-#14 | 1.61 | MA | 23902 | 5416 | 35325 | 4503 | 42176 | 3647 | 45515 | 3014 | 48926 | 2052 | 60046 | 1776 | 35493 |
| 3L-5S | | MI | 18706 | 5416 | 28150 | 4473 | 33110 | 3620 | 35146 | 2987 | 36447 | 2018 | 44562 | 1526 | 29129 |
| 12-#14 | 1.61 | MA | 22813 | 5416 | 33871 | 4504 | 40210 | 3661 | 43133 | 3011 | 45711 | 2046 | 56444 | 1645 | 35240 |
| 4E | | MI | 19544 | 5416 | 29397 | 4459 | 34607 | 3623 | 36973 | 2977 | 38907 | 2011 | 47689 | 1590 | 30009 |
| 12-#14 | 1.61 | MA | 21828 | 5416 | 32400 | 4520 | 38445 | 3661 | 40979 | 3024 | 42778 | 2054 | 52687 | 1578 | 34170 |
| 5L-3S | | MI | 20468 | 5416 | 30628 | 4459 | 36271 | 3610 | 38990 | 2982 | 41603 | 2018 | 50657 | 1721 | 30187 |
| 12-#14 | 1.61 | MA | 20882 | 5416 | 31094 | 4522 | 36704 | 3675 | 38858 | 3021 | 39957 | 2063 | 48872 | 1470 | 32957 |
| 6L-2S | | MI | 21736 | 5416 | 32280 | 4459 | 38366 | 3613 | 41527 | 2972 | 44999 | 2011 | 55175 | 1852 | 30249 |
| 12-#18 | 2.87 | MA | 29336 | 6179 | 46346 | 4952 | 55930 | 3975 | 62082 | 3204 | 71093 | 1988 | 89303 | 1770 | 61804 |
| 2L-6S | | MI | 18561 | 6179 | 30726 | 4922 | 36024 | 3962 | 38558 | 3180 | 40903 | 1956 | 50872 | 909 | 44318 |
| 12-#18 | 2.87 | MA | 26820 | 6179 | 42917 | 4953 | 51581 | 3972 | 56812 | 3223 | 64003 | 2001 | 79850 | 1537 | 61311 |
| 3L-5S | | MI | 19905 | 6179 | 32673 | 4925 | 38616 | 3943 | 41713 | 3191 | 44994 | 1943 | 56298 | 1103 | 47429 |
| 12-#18 | 2.87 | MA | 25001 | 6179 | 40363 | 4953 | 48129 | 3995 | 52629 | 3217 | 58377 | 1988 | 73632 | 1303 | 58829 |
| 4E | | MI | 21305 | 6179 | 34860 | 4901 | 41241 | 3949 | 44916 | 3175 | 49249 | 1930 | 61705 | 1213 | 49706 |
| 12-#18 | 2.87 | MA | 23355 | 6179 | 37778 | 4980 | 45027 | 3992 | 48843 | 3236 | 53243 | 2001 | 67105 | 1188 | 55900 |
| 5L-3S | | MI | 22848 | 6179 | 37018 | 4903 | 44157 | 3930 | 48449 | 3187 | 53912 | 1943 | 66799 | 1447 | 51883 |
| 12-#18 | 2.87 | MA | 21775 | 6179 | 35481 | 4981 | 41965 | 4015 | 45115 | 3229 | 48305 | 2014 | 60506 | 995 | 52174 |
| 6L-2S | | MI | 24965 | 6179 | 39903 | 4905 | 47815 | 3936 | 52881 | 3171 | 59787 | 1930 | 74575 | 1680 | 52269 |
| 14-#11 | 1.31 | MA | 24400 | 5228 | 34989 | 4398 | 41863 | 3573 | 45186 | 2956 | 48515 | 2059 | 59674 | 1944 | 29077 |
| 2L-7S | | MI | 17639 | 5228 | 25929 | 4369 | 30319 | 3554 | 31801 | 2946 | 32011 | 2040 | 38750 | 1524 | 23471 |
| 14-#11 | 1.31 | MA | 23333 | 5228 | 33621 | 4399 | 40129 | 3573 | 43084 | 2965 | 45680 | 2066 | 55835 | 1853 | 29042 |
| 3L-6S | | MI | 18195 | 5228 | 26682 | 4369 | 31315 | 3555 | 33018 | 2938 | 33697 | 2045 | 40724 | 1595 | 23945 |
| 14-#11 | 1.31 | MA | 22563 | 5228 | 32607 | 4400 | 38757 | 3583 | 41422 | 2964 | 43437 | 2062 | 53302 | 1762 | 28950 |
| 4L-5S | | MI | 18764 | 5228 | 27456 | 4368 | 32347 | 3546 | 34273 | 2941 | 35360 | 2040 | 42946 | 1671 | 24557 |
| 14-#11 | 1.31 | MA | 21867 | 5228 | 31581 | 4412 | 37527 | 3583 | 39920 | 2973 | 41391 | 2068 | 50666 | 1715 | 28760 |
| 5L-4S | | MI | 19356 | 5228 | 28327 | 4358 | 33391 | 3547 | 35548 | 2933 | 37088 | 2034 | 45144 | 1716 | 24686 |
| 14-#11 | 1.31 | MA | 21199 | 5228 | 30671 | 4413 | 36312 | 3593 | 38442 | 2972 | 39425 | 2075 | 47986 | 1640 | 28000 |
| 6L-3S | | MI | 20010 | 5228 | 29187 | 4357 | 34554 | 3538 | 36957 | 2936 | 38983 | 2040 | 47237 | 1807 | 24744 |
| 14-#11 | 1.31 | MA | 20545 | 5228 | 29785 | 4414 | 35140 | 3593 | 37009 | 2981 | 37432 | 2071 | 45599 | 1569 | 27386 |
| 7L-2S | | MI | 20909 | 5228 | 30342 | 4357 | 36018 | 3540 | 38731 | 2928 | 41370 | 2034 | 50420 | 1898 | 24761 |

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

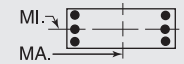
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 1.88 | MA | 26327 | 5579 | 39241 | 4604 | 47143 | 3722 | 51532 | 3049 | 57044 | 2036 | 70972 | 1889 | 41380 |
| 2L-7S | | MI | 17932 | 5579 | 27612 | 4575 | 32299 | 3705 | 34141 | 3040 | 35079 | 2009 | 43127 | 1290 | 31682 |
| 14-#14 | 1.88 | MA | 24837 | 5579 | 37283 | 4605 | 44659 | 3722 | 48524 | 3061 | 52985 | 2044 | 65509 | 1758 | 41252 |
| 3L-6S | | MI | 18709 | 5579 | 28692 | 4575 | 33727 | 3708 | 35885 | 3030 | 37478 | 2017 | 45927 | 1393 | 32907 |
| 14-#14 | 1.88 | MA | 23762 | 5579 | 35829 | 4606 | 42694 | 3736 | 46142 | 3059 | 49770 | 2038 | 61907 | 1626 | 40962 |
| 4L-5S | | MI | 19504 | 5579 | 29801 | 4576 | 35205 | 3695 | 37684 | 3035 | 39844 | 2009 | 49080 | 1502 | 33813 |
| 14-#14 | 1.88 | MA | 22789 | 5579 | 34358 | 4622 | 40929 | 3735 | 43987 | 3071 | 46836 | 2047 | 58150 | 1560 | 39749 |
| 5L-4S | | MI | 20331 | 5579 | 31048 | 4561 | 36701 | 3697 | 39510 | 3025 | 42304 | 2002 | 52207 | 1565 | 34832 |
| 14-#14 | 1.88 | MA | 21856 | 5579 | 33052 | 4624 | 39187 | 3750 | 41867 | 3068 | 44016 | 2055 | 54335 | 1451 | 38582 |
| 6L-3S | | MI | 21244 | 5579 | 32280 | 4561 | 38366 | 3685 | 41527 | 3029 | 44999 | 2009 | 55175 | 1697 | 35046 |
| 14-#14 | 1.88 | MA | 20942 | 5579 | 31781 | 4625 | 37504 | 3749 | 39811 | 3081 | 41157 | 2049 | 50941 | 1349 | 37093 |
| 7L-2S | | MI | 22499 | 5579 | 33931 | 4561 | 40460 | 3687 | 44064 | 3019 | 48396 | 2002 | 59692 | 1828 | 35136 |
| 14-#18 | 3.35 | MA | 28354 | 6470 | 46346 | 5134 | 55930 | 4105 | 62082 | 3308 | 71093 | 1987 | 89303 | 1498 | 71326 |
| 3L-6S | | MI | 19907 | 6470 | 33611 | 5104 | 39682 | 4095 | 42990 | 3264 | 46778 | 1936 | 58648 | 859 | 52400 |
| 14-#18 | 3.35 | MA | 26568 | 6470 | 43793 | 5135 | 52479 | 4128 | 57899 | 3301 | 65468 | 1974 | 83085 | 1264 | 68518 |
| 4L-5S | | MI | 21227 | 6470 | 35557 | 5106 | 42275 | 4076 | 46145 | 3275 | 50869 | 1923 | 64074 | 1053 | 55644 |
| 14-#18 | 3.35 | MA | 24952 | 6470 | 41208 | 5162 | 49377 | 4125 | 54113 | 3321 | 60333 | 1987 | 76558 | 1149 | 65718 |
| 5L-4S | | MI | 22603 | 6470 | 37744 | 5082 | 44899 | 4082 | 49348 | 3260 | 55124 | 1910 | 69480 | 1163 | 57807 |
| 14-#18 | 3.35 | MA | 23402 | 6470 | 38911 | 5163 | 46314 | 4148 | 50385 | 3314 | 55395 | 2000 | 69959 | 956 | 61867 |
| 6L-3S | | MI | 24120 | 6470 | 39903 | 5085 | 47815 | 4063 | 52881 | 3271 | 59787 | 1923 | 74575 | 1396 | 60294 |
| 14-#18 | 3.35 | MA | 21883 | 6470 | 36674 | 5163 | 43355 | 4145 | 46770 | 3333 | 50388 | 1987 | 64096 | 773 | 57919 |
| 7L-2S | | MI | 26205 | 6470 | 42787 | 5087 | 51473 | 4069 | 57313 | 3255 | 65662 | 1910 | 82350 | 1630 | 60754 |
| 16-#11 | 1.49 | MA | 25059 | 5341 | 36356 | 4468 | 43598 | 3625 | 47287 | 2989 | 51350 | 2054 | 63513 | 1933 | 33129 |
| 2L-8S | | MI | 17670 | 5341 | 26343 | 4440 | 30807 | 3605 | 32355 | 2976 | 32772 | 2039 | 39881 | 1457 | 26094 |
| 16-#11 | 1.49 | MA | 24001 | 5341 | 34989 | 4470 | 41863 | 3625 | 45186 | 2998 | 48515 | 2060 | 59674 | 1841 | 33078 |
| 3L-7S | | MI | 18215 | 5341 | 27084 | 4440 | 31783 | 3606 | 33575 | 2979 | 34398 | 2034 | 41933 | 1509 | 26793 |
| 16-#11 | 1.49 | MA | 23238 | 5341 | 33975 | 4471 | 40492 | 3635 | 43524 | 2997 | 46272 | 2057 | 57141 | 1750 | 32967 |
| 4L-6S | | MI | 18767 | 5341 | 27837 | 4439 | 32780 | 3607 | 34792 | 2971 | 36084 | 2039 | 43907 | 1580 | 27252 |
| 16-#11 | 1.49 | MA | 22548 | 5341 | 32949 | 4482 | 39261 | 3635 | 42022 | 3006 | 44226 | 2063 | 54505 | 1704 | 32757 |
| 5E | | MI | 19330 | 5341 | 28611 | 4439 | 33811 | 3598 | 36048 | 2974 | 37747 | 2034 | 46129 | 1655 | 27932 |
| 16-#11 | 1.49 | MA | 21887 | 5341 | 32039 | 4484 | 38047 | 3645 | 40543 | 3005 | 42260 | 2070 | 51825 | 1629 | 31928 |
| 6L-4S | | MI | 19917 | 5341 | 29482 | 4429 | 34856 | 3599 | 37323 | 2966 | 39476 | 2029 | 48327 | 1700 | 28081 |
| 16-#11 | 1.49 | MA | 21240 | 5341 | 31153 | 4485 | 36874 | 3645 | 39110 | 3014 | 40267 | 2066 | 49437 | 1558 | 31331 |
| 7L-3S | | MI | 20565 | 5341 | 30342 | 4428 | 36018 | 3590 | 38731 | 2969 | 41370 | 2034 | 50420 | 1791 | 28156 |
| 16-#11 | 1.49 | MA | 20600 | 5341 | 30281 | 4486 | 35725 | 3645 | 37675 | 3013 | 38344 | 2073 | 46976 | 1504 | 30468 |
| 8L-2S | | MI | 21457 | 5341 | 31497 | 4428 | 37483 | 3591 | 40506 | 2961 | 43757 | 2029 | 53603 | 1883 | 28187 |
| 16-#14 | 2.15 | MA | 27231 | 5743 | 41199 | 4706 | 49626 | 3797 | 54541 | 3096 | 61103 | 2028 | 76435 | 1871 | 47163 |
| 2L-8S | | MI | 17976 | 5743 | 28201 | 4677 | 32993 | 3777 | 34930 | 3083 | 36161 | 2007 | 44726 | 1192 | 35174 |
| 16-#14 | 2.15 | MA | 25757 | 5743 | 39241 | 4707 | 47143 | 3797 | 51532 | 3108 | 57044 | 2037 | 70972 | 1739 | 47005 |
| 3L-7S | | MI | 18735 | 5743 | 29264 | 4677 | 34393 | 3780 | 36678 | 3088 | 38476 | 2000 | 47645 | 1266 | 36342 |
| 16-#14 | 2.15 | MA | 24695 | 5743 | 37787 | 4708 | 45177 | 3811 | 49150 | 3106 | 53829 | 2031 | 67370 | 1608 | 46682 |
| 4L-6S | | MI | 19504 | 5743 | 30344 | 4678 | 35821 | 3782 | 38422 | 3078 | 40875 | 2007 | 50444 | 1369 | 37641 |
| 16-#14 | 2.15 | MA | 23734 | 5743 | 36316 | 4725 | 43412 | 3810 | 46996 | 3118 | 50895 | 2039 | 63613 | 1541 | 45342 |
| 5E | | MI | 20288 | 5743 | 31452 | 4678 | 37299 | 3770 | 40221 | 3082 | 43241 | 2000 | 53598 | 1478 | 38512 |
| 16-#14 | 2.15 | MA | 22813 | 5743 | 35010 | 4726 | 41670 | 3825 | 44875 | 3116 | 48075 | 2048 | 59799 | 1433 | 44216 |
| 6L-4S | | MI | 21106 | 5743 | 32700 | 4663 | 38796 | 3772 | 42048 | 3072 | 45701 | 1992 | 56724 | 1541 | 39653 |
| 16-#14 | 2.15 | MA | 21911 | 5743 | 33739 | 4727 | 39988 | 3824 | 42820 | 3128 | 45216 | 2042 | 56404 | 1331 | 42656 |
| 7L-3S | | MI | 22008 | 5743 | 33931 | 4663 | 40460 | 3760 | 44064 | 3077 | 48396 | 2000 | 59692 | 1673 | 39898 |
| 16-#14 | 2.15 | MA | 21020 | 5743 | 32487 | 4729 | 38339 | 3823 | 40760 | 3126 | 42457 | 2050 | 52895 | 1254 | 41192 |
| 8L-2S | | MI | 23251 | 5743 | 35582 | 4663 | 42554 | 3762 | 46602 | 3066 | 51793 | 1992 | 64210 | 1804 | 40015 |
| 16-#18 | 3.83 | MA | 28105 | 6760 | 47222 | 5317 | 56828 | 4261 | 63168 | 3385 | 72558 | 1959 | 92538 | 1225 | 78239 |
| 4L-6S | | MI | 21226 | 6760 | 36495 | 5286 | 43340 | 4228 | 47422 | 3348 | 52653 | 1916 | 66423 | 809 | 60506 |
| 16-#18 | 3.83 | MA | 26517 | 6760 | 44637 | 5344 | 53726 | 4258 | 59382 | 3405 | 67423 | 1973 | 86011 | 1110 | 75555 |
| 5E | | MI | 22524 | 6760 | 38442 | 5288 | 45933 | 4209 | 50577 | 3359 | 56744 | 1903 | 71849 | 1003 | 63878 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis

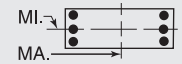


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 3.83 | MA | 24995 | 6760 | 42340 | 5344 | 50664 | 4281 | 55655 | 3398 | 62485 | 1986 | 79412 | 916 | 71582 |
| 6L-4S | | MI | 23877 | 6760 | 40629 | 5264 | 48558 | 4215 | 53780 | 3344 | 60999 | 1890 | 77256 | 1113 | 65939 |
| 16-#18 | 3.83 | MA | 23504 | 6760 | 40104 | 5345 | 47705 | 4278 | 52040 | 3418 | 57479 | 1973 | 73548 | 734 | 67568 |
| 7L-3S | | MI | 25369 | 6760 | 42787 | 5266 | 51473 | 4196 | 57313 | 3355 | 65662 | 1903 | 82350 | 1346 | 68701 |
| 18-#11 | 1.68 | MA | 25710 | 5455 | 37724 | 4539 | 45332 | 3676 | 49388 | 3022 | 54185 | 2049 | 67352 | 1921 | 37175 |
| 2L-9S | | MI | 17709 | 5455 | 26679 | 4521 | 31265 | 3666 | 32930 | 3016 | 33548 | 2039 | 41048 | 1383 | 28698 |
| 18-#11 | 1.68 | MA | 24660 | 5455 | 36356 | 4541 | 43598 | 3676 | 47287 | 3031 | 51350 | 2055 | 63513 | 1830 | 37110 |
| 3L-8S | | MI | 18245 | 5455 | 27498 | 4511 | 32272 | 3657 | 34130 | 3009 | 35159 | 2034 | 43064 | 1442 | 29374 |
| 18-#11 | 1.68 | MA | 23904 | 5455 | 35342 | 4542 | 42226 | 3687 | 45625 | 3030 | 49107 | 2051 | 60979 | 1739 | 36981 |
| 4L-7S | | MI | 18784 | 5455 | 28239 | 4511 | 33248 | 3658 | 35350 | 3011 | 36786 | 2028 | 45116 | 1494 | 30119 |
| 18-#11 | 1.68 | MA | 23221 | 5455 | 34317 | 4553 | 40996 | 3687 | 44123 | 3039 | 47061 | 2058 | 58344 | 1692 | 36742 |
| 5L-6S | | MI | 19331 | 5455 | 28992 | 4510 | 34245 | 3659 | 36567 | 3004 | 38471 | 2034 | 47090 | 1565 | 30566 |
| 18-#11 | 1.68 | MA | 22566 | 5455 | 33406 | 4555 | 39781 | 3697 | 42645 | 3038 | 45095 | 2065 | 55663 | 1617 | 35863 |
| 6L-5S | | MI | 19889 | 5455 | 29766 | 4510 | 35276 | 3650 | 37822 | 3006 | 40134 | 2028 | 49312 | 1640 | 31248 |
| 18-#11 | 1.68 | MA | 21925 | 5455 | 32520 | 4556 | 38609 | 3697 | 41212 | 3047 | 43102 | 2061 | 53276 | 1546 | 35280 |
| 7L-4S | | MI | 20471 | 5455 | 30637 | 4499 | 36321 | 3651 | 39097 | 2999 | 41863 | 2023 | 51509 | 1685 | 31472 |
| 18-#11 | 1.68 | MA | 21291 | 5455 | 31648 | 4557 | 37459 | 3697 | 39776 | 3045 | 41178 | 2067 | 50815 | 1492 | 34372 |
| 8L-3S | | MI | 21113 | 5455 | 31497 | 4499 | 37483 | 3642 | 40506 | 3001 | 43757 | 2028 | 53603 | 1776 | 31564 |
| 18-#11 | 1.68 | MA | 20662 | 5455 | 30685 | 4569 | 36275 | 3707 | 38363 | 3054 | 39274 | 2074 | 48380 | 1434 | 33517 |
| 9L-2S | | MI | 21998 | 5455 | 32652 | 4499 | 38948 | 3643 | 42281 | 2994 | 46145 | 2023 | 56786 | 1867 | 31608 |
| 18-#14 | 2.42 | MA | 26664 | 5906 | 41199 | 4809 | 49626 | 3871 | 54541 | 3156 | 61103 | 2030 | 76435 | 1721 | 52755 |
| 3L-8S | | MI | 18776 | 5906 | 29852 | 4779 | 35087 | 3852 | 37467 | 3131 | 39558 | 1998 | 49244 | 1168 | 39795 |
| 18-#14 | 2.42 | MA | 25614 | 5906 | 39745 | 4811 | 47660 | 3886 | 52159 | 3153 | 57888 | 2023 | 72834 | 1589 | 52401 |
| 4L-7S | | MI | 19526 | 5906 | 30915 | 4780 | 36487 | 3855 | 39215 | 3135 | 41873 | 1991 | 52163 | 1242 | 41013 |
| 18-#14 | 2.42 | MA | 24665 | 5906 | 38274 | 4827 | 45895 | 3885 | 50004 | 3166 | 54954 | 2032 | 69076 | 1523 | 50947 |
| 5L-6S | | MI | 20286 | 5906 | 31995 | 4780 | 37915 | 3857 | 40960 | 3125 | 44272 | 1998 | 54962 | 1345 | 42381 |
| 18-#14 | 2.42 | MA | 23755 | 5906 | 36968 | 4828 | 44153 | 3899 | 47884 | 3163 | 52134 | 2040 | 65262 | 1414 | 49857 |
| 6L-5S | | MI | 21061 | 5906 | 33104 | 4780 | 39393 | 3845 | 42758 | 3130 | 46637 | 1991 | 58116 | 1453 | 43222 |
| 18-#14 | 2.42 | MA | 22865 | 5906 | 35697 | 4830 | 42471 | 3899 | 45828 | 3176 | 49275 | 2034 | 61867 | 1312 | 48230 |
| 7L-4S | | MI | 21870 | 5906 | 34351 | 4765 | 40890 | 3847 | 44585 | 3119 | 49097 | 1983 | 61242 | 1517 | 44471 |
| 18-#14 | 2.42 | MA | 21984 | 5906 | 34445 | 4831 | 40822 | 3898 | 43769 | 3173 | 46516 | 2043 | 58358 | 1235 | 46771 |
| 8L-3S | | MI | 22762 | 5906 | 35582 | 4765 | 42554 | 3835 | 46602 | 3124 | 51793 | 1991 | 64210 | 1649 | 44745 |
| 18-#14 | 2.42 | MA | 21109 | 5906 | 33063 | 4847 | 39123 | 3912 | 41742 | 3186 | 43784 | 2051 | 54895 | 1151 | 44697 |
| 9L-2S | | MI | 23993 | 5906 | 37234 | 4766 | 44649 | 3837 | 49139 | 3114 | 55190 | 1983 | 68728 | 1780 | 44887 |
| 18-#18 | 4.31 | MA | 28054 | 7051 | 48067 | 5525 | 58076 | 4391 | 64652 | 3489 | 74513 | 1958 | 95464 | 1071 | 85409 |
| 5L-6S | | MI | 22521 | 7051 | 39380 | 5468 | 46998 | 4361 | 51854 | 3433 | 58528 | 1897 | 74199 | 759 | 68634 |
| 18-#18 | 4.31 | MA | 26558 | 7051 | 45770 | 5526 | 55014 | 4414 | 60924 | 3482 | 69575 | 1972 | 88865 | 877 | 81318 |
| 6L-5S | | MI | 23798 | 7051 | 41326 | 5470 | 49591 | 4342 | 55009 | 3444 | 62619 | 1883 | 79625 | 953 | 72079 |
| 18-#18 | 4.31 | MA | 25092 | 7051 | 43533 | 5527 | 52055 | 4411 | 57310 | 3502 | 64569 | 1958 | 83001 | 695 | 77235 |
| 7L-4S | | MI | 25130 | 7051 | 43513 | 5446 | 52216 | 4348 | 58212 | 3428 | 66874 | 1870 | 85032 | 1063 | 74098 |
| 20-#11 | 1.87 | MA | 26353 | 5568 | 39092 | 4610 | 47067 | 3728 | 51490 | 3055 | 57020 | 2044 | 71190 | 1909 | 41218 |
| 2L-10S | | MI | 17752 | 5568 | 27095 | 4592 | 31760 | 3716 | 33499 | 3047 | 34279 | 2028 | 42276 | 1301 | 31047 |
| 20-#11 | 1.87 | MA | 25312 | 5568 | 37724 | 4611 | 45332 | 3728 | 49388 | 3064 | 54185 | 2050 | 67352 | 1818 | 41139 |
| 3L-9S | | MI | 18281 | 5568 | 27834 | 4592 | 32730 | 3718 | 34704 | 3049 | 35935 | 2033 | 44231 | 1367 | 32000 |
| 20-#11 | 1.87 | MA | 24562 | 5568 | 36710 | 4613 | 43961 | 3739 | 47726 | 3063 | 51942 | 2046 | 64818 | 1727 | 40993 |
| 4L-8S | | MI | 18812 | 5568 | 28652 | 4582 | 33736 | 3709 | 35905 | 3042 | 37546 | 2028 | 46246 | 1426 | 32659 |
| 20-#11 | 1.87 | MA | 23885 | 5568 | 35684 | 4624 | 42730 | 3739 | 46224 | 3072 | 49896 | 2053 | 62183 | 1680 | 40653 |
| 5L-7S | | MI | 19347 | 5568 | 29394 | 4581 | 34713 | 3710 | 37124 | 3044 | 39173 | 2023 | 48298 | 1478 | 33448 |
| 20-#11 | 1.87 | MA | 23236 | 5568 | 34774 | 4625 | 41516 | 3749 | 44746 | 3070 | 47930 | 2059 | 59502 | 1605 | 39803 |
| 6E | | MI | 19888 | 5568 | 30147 | 4581 | 35710 | 3711 | 38342 | 3037 | 40859 | 2028 | 50273 | 1549 | 33885 |
| 20-#11 | 1.87 | MA | 22601 | 5568 | 33888 | 4627 | 40343 | 3749 | 43313 | 3080 | 45937 | 2056 | 57115 | 1534 | 39234 |
| 7L-5S | | MI | 20442 | 5568 | 30921 | 4581 | 36741 | 3702 | 39597 | 3039 | 42522 | 2023 | 52495 | 1625 | 34541 |
| 20-#11 | 1.87 | MA | 21974 | 5568 | 33016 | 4628 | 39194 | 3749 | 41877 | 3078 | 44013 | 2062 | 54653 | 1480 | 38283 |
| 8L-4S | | MI | 21018 | 5568 | 31792 | 4570 | 37786 | 3703 | 40872 | 3032 | 44250 | 2018 | 54692 | 1670 | 34860 |
| 20-#11 | 1.87 | MA | 21350 | 5568 | 32053 | 4639 | 38010 | 3759 | 40465 | 3087 | 42109 | 2069 | 52219 | 1422 | 37446 |
| 9L-3S | | MI | 21655 | 5568 | 32652 | 4570 | 38948 | 3694 | 42281 | 3034 | 46145 | 2023 | 56786 | 1761 | 34967 |
| 20-#11 | 1.87 | MA | 20730 | 5568 | 31184 | 4641 | 36868 | 3759 | 39046 | 3086 | 40151 | 2065 | 49702 | 1342 | 36259 |
| 10L-2S | | MI | 22534 | 5568 | 33806 | 4570 | 40413 | 3695 | 44055 | 3027 | 48532 | 2018 | 59969 | 1852 | 35024 |

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

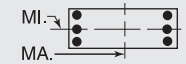
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.69 | MA | 26521 | 6070 | 41703 | 4913 | 50143 | 3960 | 55167 | 3201 | 61946 | 2016 | 78297 | 1571 | 58119 |
| 4L-8S | | MI | 19564 | 6070 | 31503 | 4882 | 37182 | 3927 | 40004 | 3178 | 42955 | 1989 | 53762 | 1144 | 44427 |
| 20-#14 | 2.69 | MA | 25582 | 6070 | 40232 | 4929 | 48378 | 3960 | 53013 | 3213 | 59013 | 2024 | 74539 | 1504 | 56563 |
| 5L-7S | | MI | 20306 | 6070 | 32567 | 4882 | 38582 | 3930 | 41752 | 3183 | 45270 | 1982 | 56680 | 1218 | 45694 |
| 20-#14 | 2.69 | MA | 24684 | 6070 | 38926 | 4930 | 46637 | 3974 | 50892 | 3211 | 56193 | 2033 | 70725 | 1396 | 55505 |
| 6E | | MI | 21057 | 6070 | 33646 | 4882 | 40010 | 3932 | 43497 | 3172 | 47669 | 1989 | 59480 | 1321 | 47128 |
| 20-#14 | 2.69 | MA | 23804 | 6070 | 37655 | 4932 | 44954 | 3974 | 48837 | 3223 | 53334 | 2027 | 67330 | 1294 | 53814 |
| 7L-5S | | MI | 21824 | 6070 | 34755 | 4882 | 41488 | 3919 | 45295 | 3177 | 50034 | 1982 | 62633 | 1429 | 47942 |
| 20-#14 | 2.69 | MA | 22934 | 6070 | 36403 | 4933 | 43305 | 3973 | 46777 | 3221 | 50575 | 2035 | 63821 | 1217 | 52309 |
| 8L-4S | | MI | 22624 | 6070 | 36002 | 4867 | 42984 | 3922 | 47122 | 3167 | 52494 | 1974 | 65760 | 1493 | 49288 |
| 20-#14 | 2.69 | MA | 22070 | 6070 | 35022 | 4949 | 41606 | 3987 | 44751 | 3233 | 47843 | 2044 | 60358 | 1132 | 50278 |
| 9L-3S | | MI | 23507 | 6070 | 37234 | 4868 | 44649 | 3909 | 49139 | 3171 | 55190 | 1982 | 68728 | 1625 | 49589 |
| 20-#18 | 4.78 | MA | 28094 | 7342 | 49200 | 5708 | 59363 | 4547 | 66194 | 3566 | 76665 | 1957 | 98318 | 838 | 91072 |
| 6E | | MI | 23795 | 7342 | 42264 | 5649 | 50656 | 4494 | 56286 | 3517 | 64402 | 1877 | 81975 | 708 | 76781 |
| 20-#18 | 4.78 | MA | 26653 | 7342 | 46963 | 5708 | 56404 | 4544 | 62579 | 3586 | 71659 | 1944 | 92454 | 656 | 86919 |
| 7L-5S | | MI | 25053 | 7342 | 44211 | 5652 | 53249 | 4475 | 59441 | 3528 | 68494 | 1863 | 87401 | 903 | 80110 |
| 22-#11 | 2.05 | MA | 25956 | 5682 | 39092 | 4682 | 47067 | 3780 | 51490 | 3097 | 57020 | 2045 | 71190 | 1806 | 45165 |
| 3L-10S | | MI | 18322 | 5682 | 28250 | 4663 | 33225 | 3768 | 35273 | 3079 | 36666 | 2022 | 45459 | 1286 | 34324 |
| 22-#11 | 2.05 | MA | 25213 | 5682 | 38077 | 4684 | 45695 | 3791 | 49828 | 3095 | 54777 | 2041 | 68657 | 1715 | 45004 |
| 4L-9S | | MI | 18846 | 5682 | 28989 | 4663 | 34195 | 3770 | 36479 | 3082 | 38323 | 2028 | 47414 | 1352 | 35285 |
| 22-#11 | 2.05 | MA | 24542 | 5682 | 37052 | 4695 | 44465 | 3790 | 48325 | 3105 | 52731 | 2048 | 66021 | 1669 | 44571 |
| 5L-8S | | MI | 19373 | 5682 | 29807 | 4653 | 35201 | 3760 | 37679 | 3074 | 39934 | 2022 | 49429 | 1411 | 35949 |
| 22-#11 | 2.05 | MA | 23899 | 5682 | 36142 | 4696 | 43250 | 3801 | 46847 | 3103 | 50765 | 2054 | 63341 | 1594 | 43748 |
| 6L-7S | | MI | 19903 | 5682 | 30549 | 4652 | 36178 | 3762 | 38899 | 3077 | 41560 | 2017 | 51481 | 1463 | 36781 |
| 22-#11 | 2.05 | MA | 23270 | 5682 | 35255 | 4698 | 42077 | 3801 | 45414 | 3112 | 48772 | 2051 | 60954 | 1523 | 43191 |
| 7L-6S | | MI | 20440 | 5682 | 31302 | 4652 | 37174 | 3763 | 40116 | 3069 | 43246 | 2022 | 53455 | 1534 | 37208 |
| 22-#11 | 2.05 | MA | 22648 | 5682 | 34383 | 4699 | 40928 | 3801 | 43978 | 3111 | 46848 | 2057 | 58492 | 1469 | 42198 |
| 8L-5S | | MI | 20988 | 5682 | 32076 | 4652 | 38206 | 3754 | 41371 | 3072 | 44909 | 2017 | 55677 | 1610 | 37841 |
| 22-#11 | 2.05 | MA | 22031 | 5682 | 33420 | 4710 | 39744 | 3811 | 42566 | 3120 | 44944 | 2064 | 56057 | 1410 | 41379 |
| 9L-4S | | MI | 21560 | 5682 | 32946 | 4641 | 39250 | 3755 | 42647 | 3064 | 46638 | 2012 | 57875 | 1655 | 38246 |
| 22-#11 | 2.05 | MA | 21416 | 5682 | 32551 | 4712 | 38603 | 3811 | 41147 | 3119 | 42986 | 2060 | 53541 | 1330 | 40166 |
| 10L-3S | | MI | 22192 | 5682 | 33806 | 4641 | 40413 | 3746 | 44055 | 3067 | 48532 | 2017 | 59969 | 1746 | 38368 |
| 22-#11 | 2.05 | MA | 20757 | 5682 | 31689 | 4713 | 37432 | 3821 | 39743 | 3128 | 41090 | 2067 | 51121 | 1273 | 39023 |
| 11L-2S | | MI | 23064 | 5682 | 34961 | 4641 | 41878 | 3747 | 45830 | 3060 | 50919 | 2012 | 63151 | 1837 | 38436 |
| 22-#14 | 2.96 | MA | 26488 | 6233 | 42190 | 5031 | 50862 | 4035 | 56021 | 3261 | 63072 | 2017 | 80002 | 1486 | 62188 |
| 5L-8S | | MI | 20342 | 6233 | 33155 | 4984 | 39276 | 4002 | 42542 | 3225 | 46352 | 1980 | 58279 | 1120 | 49068 |
| 22-#14 | 2.96 | MA | 25599 | 6233 | 40884 | 5033 | 49120 | 4049 | 53901 | 3258 | 60252 | 2026 | 76188 | 1377 | 61158 |
| 6L-7S | | MI | 21076 | 6233 | 34218 | 4984 | 40676 | 4004 | 44290 | 3230 | 48666 | 1973 | 61198 | 1194 | 50384 |
| 22-#14 | 2.96 | MA | 24730 | 6233 | 39613 | 5034 | 47437 | 4048 | 51845 | 3270 | 57393 | 2019 | 72793 | 1275 | 59406 |
| 7L-6S | | MI | 21818 | 6233 | 35298 | 4984 | 42104 | 4007 | 46034 | 3220 | 51065 | 1980 | 63998 | 1296 | 51880 |
| 22-#14 | 2.96 | MA | 23870 | 6233 | 38362 | 5035 | 45789 | 4048 | 49786 | 3268 | 54634 | 2028 | 69284 | 1198 | 57856 |
| 8L-5S | | MI | 22577 | 6233 | 36406 | 4984 | 43582 | 3994 | 47833 | 3224 | 53431 | 1973 | 67151 | 1405 | 52670 |
| 22-#14 | 2.96 | MA | 23016 | 6233 | 36980 | 5051 | 44090 | 4062 | 47759 | 3280 | 51902 | 2037 | 65821 | 1113 | 55866 |
| 9L-4S | | MI | 23368 | 6233 | 37654 | 4970 | 45079 | 3997 | 49659 | 3214 | 55891 | 1965 | 70278 | 1469 | 54103 |
| 22-#18 | 5.26 | MA | 28188 | 7633 | 50393 | 5890 | 60754 | 4677 | 67849 | 3670 | 78749 | 1930 | 101907 | 617 | 96620 |
| 7L-6S | | MI | 25052 | 7633 | 45149 | 5831 | 54315 | 4627 | 60718 | 3601 | 70277 | 1857 | 89750 | 658 | 84946 |
| 24-#11 | 2.24 | MA | 25857 | 5795 | 39445 | 4754 | 47430 | 3842 | 51929 | 3128 | 57612 | 2036 | 72496 | 1704 | 49013 |
| 4L-10S | | MI | 18885 | 5795 | 29405 | 4734 | 34690 | 3820 | 37048 | 3112 | 39053 | 2017 | 48642 | 1271 | 37584 |
| 24-#11 | 2.24 | MA | 25192 | 5795 | 38419 | 4766 | 46199 | 3842 | 50427 | 3137 | 55566 | 2043 | 69860 | 1657 | 48496 |
| 5L-9S | | MI | 19405 | 5795 | 30144 | 4734 | 35660 | 3821 | 38254 | 3115 | 40710 | 2022 | 50597 | 1337 | 38546 |
| 24-#11 | 2.24 | MA | 24554 | 5795 | 37509 | 4767 | 44985 | 3853 | 48948 | 3136 | 53600 | 2049 | 67180 | 1582 | 47698 |
| 6L-8S | | MI | 19927 | 5795 | 30962 | 4723 | 36666 | 3812 | 39454 | 3107 | 42321 | 2017 | 52612 | 1396 | 39245 |
| 24-#11 | 2.24 | MA | 23931 | 5795 | 36623 | 4768 | 43812 | 3853 | 47515 | 3145 | 51607 | 2045 | 64792 | 1511 | 47151 |
| 7E | | MI | 20453 | 5795 | 31704 | 4723 | 37643 | 3813 | 40673 | 3110 | 43948 | 2012 | 54664 | 1448 | 40087 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

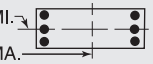
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.24 | MA | 23315 | 5795 | 35751 | 4770 | 42663 | 3853 | 46080 | 3144 | 49683 | 2052 | 62331 | 1457 | 46119 |
| 8L-6S | | MI | 20985 | 5795 | 32457 | 4723 | 38639 | 3815 | 41891 | 3102 | 45633 | 2017 | 56638 | 1519 | 40535 |
| 24-#11 | 2.24 | MA | 22703 | 5795 | 34788 | 4781 | 41479 | 3863 | 44667 | 3153 | 47779 | 2059 | 59896 | 1399 | 45288 |
| 9L-5S | | MI | 21529 | 5795 | 33231 | 4723 | 39670 | 3806 | 43146 | 3105 | 47296 | 2012 | 58860 | 1594 | 41148 |
| 24-#11 | 2.24 | MA | 22094 | 5795 | 33919 | 4782 | 40337 | 3863 | 43248 | 3152 | 45821 | 2055 | 57379 | 1319 | 44077 |
| 10L-4S | | MI | 22096 | 5795 | 34101 | 4712 | 40715 | 3807 | 44421 | 3097 | 49025 | 2006 | 61058 | 1639 | 41631 |
| 24-#11 | 2.24 | MA | 21449 | 5795 | 33057 | 4784 | 39167 | 3873 | 41845 | 3161 | 43925 | 2061 | 54960 | 1262 | 42913 |
| 11L-3S | | MI | 22723 | 5795 | 34961 | 4712 | 41878 | 3798 | 45830 | 3100 | 50919 | 2012 | 63151 | 1730 | 41765 |
| 24-#14 | 3.23 | MA | 26504 | 6397 | 42842 | 5135 | 51603 | 4124 | 56909 | 3305 | 64311 | 2018 | 81651 | 1359 | 66817 |
| 6L-8S | | MI | 21110 | 6397 | 34806 | 5086 | 41370 | 4077 | 45079 | 3273 | 49749 | 1971 | 62797 | 1096 | 53717 |
| 24-#14 | 3.23 | MA | 25644 | 6397 | 41571 | 5136 | 49921 | 4123 | 54854 | 3318 | 61452 | 2012 | 78256 | 1257 | 65005 |
| 7E | | MI | 21836 | 6397 | 35869 | 5086 | 42770 | 4079 | 46827 | 3277 | 52063 | 1964 | 65716 | 1170 | 55081 |
| 24-#14 | 3.23 | MA | 24794 | 6397 | 40320 | 5137 | 48272 | 4123 | 52794 | 3315 | 58693 | 2020 | 74747 | 1180 | 63410 |
| 8L-6S | | MI | 22571 | 6397 | 36949 | 5086 | 44198 | 4082 | 48571 | 3267 | 54462 | 1971 | 68516 | 1272 | 56580 |
| 24-#14 | 3.23 | MA | 23949 | 6397 | 38938 | 5154 | 46573 | 4137 | 50768 | 3328 | 55961 | 2029 | 71284 | 1095 | 61460 |
| 9L-5S | | MI | 23321 | 6397 | 38058 | 5087 | 45676 | 4069 | 50370 | 3272 | 56828 | 1964 | 71669 | 1381 | 57406 |

## RECTANGULAR TIED COLUMNS 38" x 46"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.37 | MA | 26780 | 5508 | 38876 | 4596 | 46309 | 3731 | 49948 | 3083 | 53709 | 2135 | 65731 | 1995 | 33041 |
| 2L-3S | | MI | 19628 | 5508 | 29392 | 4531 | 34358 | 3673 | 36348 | 3055 | 37403 | 2096 | 44741 | 1687 | 26657 |
| 6-#18 | 1.37 | MA | 23974 | 5508 | 35265 | 4597 | 41729 | 3729 | 44399 | 3104 | 46222 | 2149 | 55718 | 1761 | 32849 |
| 3L-2S | | MI | 21863 | 5508 | 32276 | 4533 | 38016 | 3680 | 40780 | 3040 | 43277 | 2082 | 52517 | 1921 | 26741 |
| 8-#14 | 1.03 | MA | 25578 | 5290 | 36036 | 4486 | 42942 | 3653 | 45972 | 3039 | 48414 | 2160 | 58957 | 2049 | 25190 |
| 2L-4S | | MI | 18696 | 5290 | 27111 | 4429 | 31591 | 3617 | 33094 | 3005 | 33233 | 2123 | 39929 | 1728 | 20404 |
| 8-#14 | 1.03 | MA | 23950 | 5290 | 33976 | 4488 | 40329 | 3653 | 42806 | 3052 | 44143 | 2169 | 53179 | 1917 | 25166 |
| 3E | | MI | 19645 | 5290 | 28343 | 4429 | 33255 | 3604 | 35111 | 3009 | 35928 | 2130 | 42897 | 1860 | 20479 |
| 8-#14 | 1.03 | MA | 22772 | 5290 | 32448 | 4489 | 38263 | 3668 | 40302 | 3050 | 40763 | 2164 | 49365 | 1786 | 25004 |
| 4L-2S | | MI | 20945 | 5290 | 29994 | 4429 | 35350 | 3607 | 37648 | 2999 | 39325 | 2123 | 47415 | 1991 | 20465 |
| 8-#18 | 1.83 | MA | 28481 | 5799 | 42487 | 4777 | 50889 | 3864 | 55497 | 3167 | 61195 | 2122 | 75744 | 1959 | 43733 |
| 2L-4S | | MI | 19389 | 5799 | 30118 | 4710 | 35101 | 3826 | 37247 | 3128 | 38615 | 2062 | 47423 | 1403 | 33952 |
| 8-#18 | 1.83 | MA | 25727 | 5799 | 38876 | 4779 | 46309 | 3862 | 49948 | 3188 | 53709 | 2136 | 65731 | 1725 | 43426 |
| 3E | | MI | 20996 | 5799 | 32276 | 4713 | 38016 | 3806 | 40780 | 3139 | 43277 | 2076 | 52517 | 1637 | 35112 |
| 8-#18 | 1.83 | MA | 23732 | 5799 | 36191 | 4780 | 42678 | 3886 | 45549 | 3183 | 47771 | 2123 | 59137 | 1491 | 41943 |
| 4L-2S | | MI | 23192 | 5799 | 35161 | 4715 | 41675 | 3813 | 45212 | 3124 | 49152 | 2062 | 60293 | 1870 | 35301 |
| 10-#14 | 1.29 | MA | 26586 | 5454 | 38096 | 4588 | 45555 | 3728 | 49138 | 3086 | 52685 | 2152 | 64736 | 2032 | 31310 |
| 2L-5S | | MI | 18662 | 5454 | 27515 | 4546 | 32189 | 3689 | 33805 | 3062 | 34169 | 2121 | 41320 | 1641 | 24652 |
| 10-#14 | 1.29 | MA | 24978 | 5454 | 36036 | 4590 | 42942 | 3728 | 45972 | 3099 | 48414 | 2162 | 58957 | 1900 | 31246 |
| 3L-4S | | MI | 19513 | 5454 | 28762 | 4531 | 33685 | 3692 | 35631 | 3052 | 36629 | 2114 | 44447 | 1704 | 25245 |
| 10-#14 | 1.29 | MA | 23815 | 5454 | 34508 | 4592 | 40876 | 3743 | 43468 | 3097 | 45034 | 2156 | 55144 | 1769 | 31035 |
| 4L-3S | | MI | 20450 | 5454 | 29994 | 4531 | 35350 | 3679 | 37648 | 3057 | 39325 | 2121 | 47415 | 1836 | 25365 |
| 10-#14 | 1.29 | MA | 22763 | 5454 | 32963 | 4608 | 39022 | 3743 | 41204 | 3110 | 41952 | 2165 | 51176 | 1702 | 30215 |
| 5L-2S | | MI | 21736 | 5454 | 31645 | 4532 | 37444 | 3682 | 40185 | 3046 | 42722 | 2114 | 51933 | 1967 | 25387 |
| 10-#18 | 2.29 | MA | 30138 | 6090 | 46099 | 4959 | 55469 | 3997 | 61046 | 3252 | 68681 | 2109 | 85757 | 1923 | 54397 |
| 2L-5S | | MI | 19319 | 6090 | 30815 | 4916 | 36134 | 3952 | 38476 | 3228 | 40235 | 2056 | 49792 | 1243 | 39512 |
| 10-#18 | 2.29 | MA | 27433 | 6090 | 42487 | 4961 | 50889 | 3995 | 55497 | 3272 | 61195 | 2123 | 75744 | 1689 | 53992 |
| 3L-4S | | MI | 20752 | 6090 | 33002 | 4892 | 38759 | 3959 | 41679 | 3212 | 44489 | 2043 | 55198 | 1353 | 41960 |
| 10-#18 | 2.29 | MA | 25477 | 6090 | 39802 | 4962 | 47259 | 4019 | 51097 | 3267 | 55257 | 2110 | 69150 | 1455 | 52072 |
| 4L-3S | | MI | 22329 | 6090 | 35161 | 4895 | 41675 | 3939 | 45212 | 3224 | 49152 | 2056 | 60293 | 1587 | 43548 |
| 10-#18 | 2.29 | MA | 23705 | 6090 | 37084 | 4990 | 43998 | 4017 | 47117 | 3288 | 49838 | 2124 | 62250 | 1339 | 48719 |
| 5L-2S | | MI | 24489 | 6090 | 38045 | 4897 | 45333 | 3946 | 49644 | 3208 | 55027 | 2043 | 68068 | 1820 | 43825 |
| 12-#11 | 1.07 | MA | 25796 | 5316 | 36300 | 4516 | 43396 | 3676 | 46574 | 3055 | 49262 | 2166 | 60264 | 2060 | 26283 |
| 2L-6S | | MI | 18383 | 5316 | 26539 | 4473 | 31022 | 3648 | 32439 | 3028 | 32430 | 2145 | 38821 | 1702 | 20780 |
| 12-#11 | 1.07 | MA | 24661 | 5316 | 34861 | 4517 | 41572 | 3677 | 44364 | 3065 | 46280 | 2173 | 56207 | 1969 | 26264 |
| 3L-5S | | MI | 18958 | 5316 | 27313 | 4473 | 32053 | 3639 | 33694 | 3031 | 34093 | 2139 | 41042 | 1777 | 21240 |
| 12-#11 | 1.07 | MA | 23842 | 5316 | 33796 | 4519 | 40131 | 3687 | 42618 | 3064 | 43923 | 2169 | 53526 | 1878 | 26193 |
| 4E | | MI | 19557 | 5316 | 28183 | 4462 | 33098 | 3640 | 34969 | 3023 | 35822 | 2134 | 43240 | 1822 | 21331 |

## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

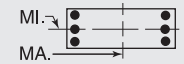
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.07 | MA | 23102 | 5316 | 32719 | 4530 | 38838 | 3688 | 41040 | 3073 | 41774 | 2177 | 50745 | 1830 | 26026 |
| 5L-3S | | MI | 20218 | 5316 | 29043 | 4462 | 34260 | 3631 | 36378 | 3026 | 37716 | 2139 | 45334 | 1913 | 21361 |
| 12-#11 | 1.07 | MA | 22392 | 5316 | 31763 | 4532 | 37563 | 3698 | 39487 | 3073 | 39709 | 2184 | 47911 | 1755 | 25382 |
| 6L-2S | | MI | 21127 | 5316 | 30198 | 4462 | 35725 | 3632 | 38153 | 3018 | 40103 | 2134 | 48517 | 2004 | 21355 |
| 12-#14 | 1.54 | MA | 27577 | 5617 | 40157 | 4690 | 48168 | 3803 | 52303 | 3133 | 56956 | 2145 | 70515 | 2015 | 37413 |
| 2L-6S | | MI | 18669 | 5617 | 28058 | 4648 | 32805 | 3777 | 34543 | 3105 | 35200 | 2119 | 42685 | 1508 | 28359 |
| 12-#14 | 1.54 | MA | 25986 | 5617 | 38096 | 4692 | 45555 | 3803 | 49138 | 3146 | 52685 | 2154 | 64736 | 1883 | 37316 |
| 3L-5S | | MI | 19475 | 5617 | 29167 | 4648 | 34283 | 3764 | 36342 | 3110 | 37566 | 2112 | 45838 | 1616 | 29316 |
| 12-#14 | 1.54 | MA | 24839 | 5617 | 36568 | 4694 | 43489 | 3818 | 46634 | 3144 | 49305 | 2149 | 60923 | 1752 | 37063 |
| 4E | | MI | 20316 | 5617 | 30414 | 4633 | 35780 | 3766 | 38169 | 3099 | 40026 | 2105 | 48965 | 1680 | 30079 |
| 12-#14 | 1.54 | MA | 23800 | 5617 | 35023 | 4710 | 41635 | 3818 | 44370 | 3157 | 46223 | 2158 | 56955 | 1685 | 36072 |
| 5L-3S | | MI | 21242 | 5617 | 31645 | 4634 | 37444 | 3754 | 40185 | 3104 | 42722 | 2112 | 51933 | 1812 | 30237 |
| 12-#14 | 1.54 | MA | 22805 | 5617 | 33651 | 4712 | 39805 | 3832 | 42142 | 3155 | 43260 | 2167 | 52920 | 1576 | 34755 |
| 6L-2S | | MI | 22514 | 5617 | 33297 | 4634 | 39538 | 3756 | 42723 | 3094 | 46118 | 2105 | 56450 | 1943 | 30290 |
| 12-#18 | 2.75 | MA | 31758 | 6380 | 49710 | 5141 | 60049 | 4130 | 66595 | 3336 | 76168 | 2096 | 95770 | 1886 | 65044 |
| 2L-6S | | MI | 19325 | 6380 | 31754 | 5096 | 37199 | 4105 | 39753 | 3301 | 42018 | 2049 | 52141 | 999 | 44754 |
| 12-#18 | 2.75 | MA | 29097 | 6380 | 46099 | 5142 | 55469 | 4128 | 61046 | 3357 | 68681 | 2109 | 85757 | 1653 | 64551 |
| 3L-5S | | MI | 20675 | 6380 | 33700 | 5098 | 39792 | 4085 | 42908 | 3312 | 46110 | 2036 | 57567 | 1193 | 47700 |
| 12-#18 | 2.75 | MA | 27178 | 6380 | 43413 | 5144 | 51839 | 4152 | 56646 | 3351 | 62744 | 2097 | 79163 | 1419 | 62247 |
| 4E | | MI | 22082 | 6380 | 35887 | 5074 | 42417 | 4092 | 46111 | 3297 | 50364 | 2023 | 62974 | 1303 | 50015 |
| 12-#18 | 2.75 | MA | 25441 | 6380 | 40696 | 5172 | 48578 | 4150 | 52666 | 3372 | 57325 | 2110 | 72263 | 1302 | 59044 |
| 5L-3S | | MI | 23632 | 6380 | 38045 | 5076 | 45333 | 4072 | 49644 | 3308 | 55027 | 2036 | 68068 | 1537 | 51972 |
| 12-#18 | 2.75 | MA | 23774 | 6380 | 38282 | 5173 | 45359 | 4175 | 48748 | 3366 | 52113 | 2124 | 65272 | 1109 | 55316 |
| 6L-2S | | MI | 25758 | 6380 | 40930 | 5079 | 48991 | 4079 | 54076 | 3292 | 60902 | 2023 | 75844 | 1770 | 52329 |
| 14-#11 | 1.25 | MA | 26503 | 5430 | 37738 | 4587 | 45221 | 3728 | 48784 | 3088 | 52244 | 2160 | 64322 | 2049 | 30551 |
| 2L-7S | | MI | 18405 | 5430 | 26941 | 4544 | 31490 | 3699 | 32996 | 3068 | 33132 | 2134 | 40029 | 1615 | 23603 |
| 14-#11 | 1.25 | MA | 25378 | 5430 | 36300 | 4588 | 43396 | 3729 | 46574 | 3098 | 49262 | 2168 | 60264 | 1958 | 30516 |
| 3L-6S | | MI | 18963 | 5430 | 27694 | 4544 | 32486 | 3700 | 34214 | 3061 | 34818 | 2139 | 42003 | 1686 | 24078 |
| 14-#11 | 1.25 | MA | 24567 | 5430 | 35234 | 4590 | 41955 | 3739 | 44828 | 3097 | 46905 | 2164 | 57584 | 1867 | 30424 |
| 4L-5S | | MI | 19533 | 5430 | 28468 | 4544 | 33518 | 3691 | 35469 | 3063 | 36480 | 2134 | 44225 | 1762 | 24621 |
| 14-#11 | 1.25 | MA | 23833 | 5430 | 34157 | 4601 | 40663 | 3739 | 43250 | 3106 | 44756 | 2171 | 54802 | 1820 | 30234 |
| 5L-4S | | MI | 20127 | 5430 | 29338 | 4533 | 34562 | 3692 | 36744 | 3056 | 38209 | 2129 | 46423 | 1807 | 24734 |
| 14-#11 | 1.25 | MA | 23130 | 5430 | 33201 | 4603 | 39388 | 3750 | 41697 | 3105 | 42691 | 2178 | 51969 | 1745 | 29507 |
| 6L-3S | | MI | 20782 | 5430 | 30198 | 4533 | 35725 | 3683 | 38153 | 3058 | 40103 | 2134 | 48517 | 1898 | 24783 |
| 14-#11 | 1.25 | MA | 22442 | 5430 | 32271 | 4604 | 38156 | 3750 | 40192 | 3115 | 40597 | 2175 | 49444 | 1674 | 28844 |
| 7L-2S | | MI | 21683 | 5430 | 31353 | 4533 | 37190 | 3684 | 39927 | 3051 | 42491 | 2129 | 51699 | 1989 | 24793 |
| 14-#14 | 1.80 | MA | 28551 | 5781 | 42217 | 4793 | 50781 | 3878 | 55469 | 3181 | 61227 | 2137 | 76294 | 1998 | 43507 |
| 2L-7S | | MI | 18697 | 5781 | 28629 | 4750 | 33471 | 3849 | 35336 | 3163 | 36198 | 2103 | 44403 | 1381 | 31967 |
| 14-#14 | 1.80 | MA | 26978 | 5781 | 40157 | 4794 | 48168 | 3878 | 52303 | 3194 | 56956 | 2147 | 70515 | 1866 | 43378 |
| 3L-6S | | MI | 19478 | 5781 | 29709 | 4750 | 34899 | 3851 | 37081 | 3152 | 38597 | 2110 | 47202 | 1483 | 33082 |
| 14-#14 | 1.80 | MA | 25844 | 5781 | 38629 | 4796 | 46102 | 3893 | 49799 | 3192 | 53576 | 2141 | 66701 | 1735 | 43088 |
| 4L-5S | | MI | 20275 | 5781 | 30818 | 4750 | 36377 | 3839 | 38879 | 3157 | 40963 | 2103 | 50356 | 1592 | 33998 |
| 14-#14 | 1.80 | MA | 24819 | 5781 | 37083 | 4813 | 44248 | 3892 | 47535 | 3205 | 50494 | 2151 | 62733 | 1668 | 41947 |
| 5L-4S | | MI | 21105 | 5781 | 32065 | 4736 | 37874 | 3841 | 40706 | 3147 | 43423 | 2095 | 53482 | 1656 | 34907 |
| 14-#14 | 1.80 | MA | 23837 | 5781 | 35711 | 4814 | 42418 | 3907 | 45308 | 3203 | 47531 | 2160 | 58698 | 1559 | 40678 |
| 6L-3S | | MI | 22021 | 5781 | 33297 | 4736 | 39538 | 3829 | 42723 | 3151 | 46118 | 2103 | 56450 | 1788 | 35099 |
| 14-#14 | 1.80 | MA | 22874 | 5781 | 34376 | 4816 | 40651 | 3907 | 43149 | 3216 | 44527 | 2154 | 55105 | 1457 | 39235 |
| 7L-2S | | MI | 23280 | 5781 | 34948 | 4736 | 41633 | 3831 | 45260 | 3141 | 49515 | 2095 | 60968 | 1919 | 35179 |
| 14-#18 | 3.20 | MA | 30727 | 6671 | 49710 | 5324 | 60049 | 4261 | 66595 | 3441 | 76168 | 2096 | 95770 | 1617 | 75106 |
| 3L-6S | | MI | 20675 | 6671 | 34638 | 5277 | 40857 | 4238 | 44185 | 3385 | 47893 | 2029 | 59917 | 949 | 52827 |
| 14-#18 | 3.20 | MA | 28842 | 6671 | 47025 | 5325 | 56419 | 4285 | 62195 | 3435 | 70230 | 2083 | 89176 | 1383 | 72459 |
| 4L-5S | | MI | 22002 | 6671 | 36584 | 5280 | 43450 | 4218 | 47340 | 3396 | 51985 | 2016 | 65343 | 1143 | 55910 |
| 14-#18 | 3.20 | MA | 27136 | 6671 | 44307 | 5353 | 53158 | 4283 | 58215 | 3456 | 64811 | 2097 | 82276 | 1266 | 69393 |
| 5L-4S | | MI | 23385 | 6671 | 38771 | 5256 | 46075 | 4225 | 50543 | 3381 | 56239 | 2003 | 70750 | 1253 | 58109 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

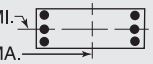


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.20 | MA | 25501 | 6671 | 41893 | 5355 | 49939 | 4308 | 54297 | 3450 | 59600 | 2111 | 75285 | 1073 | 65539 |
| 6L-3S | | MI | 24909 | 6671 | 40930 | 5258 | 48991 | 4205 | 54076 | 3392 | 60902 | 2016 | 75844 | 1487 | 60389 |
| 14-#18 | 3.20 | MA | 23898 | 6671 | 39543 | 5356 | 46829 | 4306 | 50498 | 3471 | 54316 | 2098 | 69069 | 891 | 61726 |
| 7L-2S | | MI | 27004 | 6671 | 43814 | 5260 | 52649 | 4212 | 58508 | 3377 | 66777 | 2003 | 83619 | 1720 | 60817 |
| 16-#11 | 1.43 | MA | 27202 | 5543 | 39177 | 4657 | 47045 | 3780 | 50995 | 3121 | 55226 | 2155 | 68380 | 2039 | 34813 |
| 2L-8S | | MI | 18436 | 5543 | 27354 | 4615 | 31978 | 3749 | 33551 | 3099 | 33892 | 2133 | 41160 | 1548 | 26304 |
| 16-#11 | 1.43 | MA | 26085 | 5543 | 37738 | 4659 | 45221 | 3780 | 48784 | 3131 | 52244 | 2162 | 64322 | 1947 | 34763 |
| 3L-7S | | MI | 18982 | 5543 | 28096 | 4615 | 32955 | 3750 | 34771 | 3101 | 35519 | 2128 | 43212 | 1600 | 26925 |
| 16-#11 | 1.43 | MA | 25282 | 5543 | 36673 | 4660 | 43780 | 3791 | 47038 | 3130 | 49887 | 2159 | 61642 | 1856 | 34651 |
| 4L-6S | | MI | 19536 | 5543 | 28849 | 4615 | 33951 | 3752 | 35988 | 3094 | 37205 | 2133 | 45186 | 1671 | 27384 |
| 16-#11 | 1.43 | MA | 24555 | 5543 | 35596 | 4672 | 42487 | 3791 | 45460 | 3139 | 47738 | 2166 | 58860 | 1809 | 34441 |
| 5E | | MI | 20100 | 5543 | 29623 | 4615 | 34982 | 3742 | 37244 | 3096 | 38868 | 2128 | 47408 | 1747 | 28000 |
| 16-#11 | 1.43 | MA | 23859 | 5543 | 34640 | 4674 | 41212 | 3802 | 43908 | 3138 | 45673 | 2173 | 56027 | 1734 | 33641 |
| 6L-4S | | MI | 20689 | 5543 | 30493 | 4604 | 36027 | 3744 | 38519 | 3089 | 40597 | 2123 | 49606 | 1791 | 28132 |
| 16-#11 | 1.43 | MA | 23178 | 5543 | 33710 | 4675 | 39980 | 3802 | 42403 | 3148 | 43579 | 2170 | 53501 | 1663 | 32997 |
| 7L-3S | | MI | 21339 | 5543 | 31353 | 4604 | 37190 | 3735 | 39927 | 3091 | 42491 | 2128 | 51699 | 1883 | 28198 |
| 16-#11 | 1.43 | MA | 22504 | 5543 | 32794 | 4677 | 38774 | 3803 | 40895 | 3147 | 41560 | 2177 | 50903 | 1609 | 32173 |
| 8L-2S | | MI | 22233 | 5543 | 32508 | 4604 | 38654 | 3736 | 41702 | 3084 | 44878 | 2123 | 54882 | 1974 | 28223 |
| 16-#14 | 2.06 | MA | 29512 | 5944 | 44277 | 4895 | 53394 | 3953 | 58634 | 3228 | 65497 | 2130 | 82072 | 1981 | 49593 |
| 2L-8S | | MI | 18740 | 5944 | 29218 | 4852 | 34166 | 3921 | 36125 | 3205 | 37281 | 2101 | 46002 | 1283 | 35451 |
| 16-#14 | 2.06 | MA | 27955 | 5944 | 42217 | 4897 | 50781 | 3953 | 55469 | 3241 | 61227 | 2139 | 76294 | 1849 | 49435 |
| 3L-7S | | MI | 19503 | 5944 | 30281 | 4852 | 35566 | 3924 | 37873 | 3210 | 39595 | 2094 | 48921 | 1357 | 36623 |
| 16-#14 | 2.06 | MA | 26834 | 5944 | 40689 | 4898 | 48715 | 3967 | 52965 | 3239 | 57847 | 2134 | 72480 | 1718 | 49112 |
| 4L-6S | | MI | 20274 | 5944 | 31360 | 4852 | 36994 | 3926 | 39618 | 3200 | 41994 | 2101 | 51720 | 1459 | 37814 |
| 16-#14 | 2.06 | MA | 25822 | 5944 | 39144 | 4915 | 46861 | 3967 | 50701 | 3252 | 54765 | 2143 | 68512 | 1651 | 47836 |
| 5E | | MI | 21062 | 5944 | 32469 | 4853 | 38472 | 3914 | 41417 | 3204 | 44360 | 2094 | 54874 | 1568 | 38694 |
| 16-#14 | 2.06 | MA | 24851 | 5944 | 37772 | 4917 | 45031 | 3982 | 48474 | 3250 | 51802 | 2152 | 64477 | 1542 | 46611 |
| 6L-4S | | MI | 21883 | 5944 | 33716 | 4838 | 39968 | 3916 | 43243 | 3194 | 46820 | 2086 | 58000 | 1632 | 39731 |
| 16-#14 | 2.06 | MA | 23901 | 5944 | 36437 | 4918 | 43264 | 3982 | 46314 | 3263 | 48798 | 2147 | 60884 | 1440 | 45096 |
| 7L-3S | | MI | 22789 | 5944 | 34948 | 4838 | 41633 | 3904 | 45260 | 3199 | 49515 | 2094 | 60968 | 1764 | 39955 |
| 16-#14 | 2.06 | MA | 22961 | 5944 | 35122 | 4920 | 41532 | 3982 | 44151 | 3261 | 45900 | 2156 | 57177 | 1362 | 43511 |
| 8L-2S | | MI | 24036 | 5944 | 36599 | 4838 | 43727 | 3906 | 47797 | 3189 | 52912 | 2086 | 65486 | 1895 | 40061 |
| 16-#18 | 3.66 | MA | 30473 | 6962 | 50636 | 5507 | 60999 | 4418 | 67744 | 3519 | 77716 | 2070 | 99189 | 1347 | 82705 |
| 4L-6S | | MI | 21998 | 6962 | 37522 | 5459 | 44516 | 4371 | 48617 | 3469 | 53768 | 2010 | 67693 | 899 | 60926 |
| 16-#18 | 3.66 | MA | 28797 | 6962 | 47919 | 5535 | 57738 | 4416 | 63764 | 3540 | 72297 | 2084 | 92289 | 1230 | 79761 |
| 5E | | MI | 23303 | 6962 | 39469 | 5462 | 47108 | 4351 | 51772 | 3481 | 57859 | 1996 | 73118 | 1093 | 64140 |
| 16-#18 | 3.66 | MA | 27191 | 6962 | 45505 | 5537 | 54519 | 4441 | 59846 | 3535 | 67086 | 2098 | 85298 | 1037 | 75783 |
| 6L-4S | | MI | 24664 | 6962 | 41656 | 5437 | 49733 | 4358 | 54975 | 3465 | 62114 | 1983 | 78525 | 1203 | 66235 |
| 16-#18 | 3.66 | MA | 25617 | 6962 | 43155 | 5538 | 51410 | 4439 | 56047 | 3555 | 61803 | 2085 | 79082 | 855 | 71742 |
| 7L-3S | | MI | 26164 | 6962 | 43814 | 5440 | 52649 | 4338 | 58508 | 3476 | 66777 | 1996 | 83619 | 1436 | 68800 |
| 16-#18 | 3.66 | MA | 24060 | 6962 | 40841 | 5539 | 48362 | 4436 | 52240 | 3550 | 56704 | 2098 | 72638 | 720 | 67540 |
| 8L-2S | | MI | 28230 | 6962 | 46699 | 5442 | 56307 | 4345 | 62940 | 3461 | 72652 | 1983 | 91395 | 1670 | 69294 |
| 18-#11 | 1.61 | MA | 27892 | 5656 | 40615 | 4728 | 48869 | 3832 | 53205 | 3154 | 58208 | 2150 | 72437 | 2028 | 39071 |
| 2L-9S | | MI | 18474 | 5656 | 27691 | 4697 | 32436 | 3810 | 34126 | 3139 | 34669 | 2133 | 42328 | 1474 | 28900 |
| 18-#11 | 1.61 | MA | 26784 | 5656 | 39177 | 4730 | 47045 | 3832 | 50995 | 3163 | 55226 | 2157 | 68380 | 1937 | 39006 |
| 3L-8S | | MI | 19011 | 5656 | 28509 | 4686 | 33443 | 3801 | 35326 | 3131 | 36280 | 2128 | 44343 | 1533 | 29581 |
| 18-#11 | 1.61 | MA | 25988 | 5656 | 38111 | 4731 | 45604 | 3843 | 49248 | 3163 | 52869 | 2154 | 65699 | 1846 | 38876 |
| 4L-7S | | MI | 19553 | 5656 | 29251 | 4686 | 34419 | 3802 | 36546 | 3134 | 37907 | 2123 | 46395 | 1585 | 30250 |
| 18-#11 | 1.61 | MA | 25268 | 5656 | 37034 | 4743 | 44312 | 3843 | 47670 | 3172 | 50720 | 2161 | 62918 | 1798 | 38648 |
| 5L-6S | | MI | 20101 | 5656 | 30004 | 4686 | 35416 | 3803 | 37763 | 3126 | 39592 | 2128 | 48369 | 1656 | 30696 |
| 18-#11 | 1.61 | MA | 24578 | 5656 | 36078 | 4745 | 43036 | 3854 | 46118 | 3171 | 48655 | 2168 | 60084 | 1724 | 37782 |
| 6L-5S | | MI | 20661 | 5656 | 30778 | 4686 | 36447 | 3794 | 39018 | 3129 | 41255 | 2123 | 50591 | 1731 | 31376 |
| 18-#11 | 1.61 | MA | 23903 | 5656 | 35148 | 4746 | 41805 | 3854 | 44613 | 3181 | 46561 | 2165 | 57559 | 1653 | 37154 |
| 7L-4S | | MI | 21245 | 5656 | 31648 | 4675 | 37492 | 3796 | 40293 | 3121 | 42984 | 2117 | 52788 | 1776 | 31526 |
| 18-#11 | 1.61 | MA | 23236 | 5656 | 34232 | 4748 | 40598 | 3854 | 43105 | 3180 | 44542 | 2172 | 54961 | 1598 | 36284 |
| 8L-3S | | MI | 21889 | 5656 | 32508 | 4675 | 38654 | 3786 | 41702 | 3124 | 44878 | 2123 | 54882 | 1867 | 31608 |
| 18-#11 | 1.61 | MA | 22574 | 5656 | 33221 | 4759 | 39355 | 3865 | 41622 | 3189 | 42542 | 2179 | 52386 | 1540 | 35360 |
| 9L-2S | | MI | 22777 | 5656 | 33663 | 4675 | 40119 | 3788 | 43476 | 3116 | 47265 | 2117 | 58065 | 1958 | 31645 |

## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

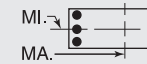
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.32 | MA | 28917 | 6108 | 44277 | 4999 | 53394 | 4027 | 58634 | 3288 | 65497 | 2132 | 82072 | 1832 | 55489 |
| 3L-8S | | MI | 19542 | 6108 | 30869 | 4954 | 36260 | 3996 | 38663 | 3253 | 40677 | 2092 | 50520 | 1259 | 40153 |
| 18-#14 | 2.32 | MA | 27809 | 6108 | 42749 | 5000 | 51328 | 4042 | 56130 | 3287 | 62117 | 2126 | 78259 | 1701 | 55134 |
| 4L-7S | | MI | 20296 | 6108 | 31932 | 4954 | 37660 | 3999 | 40411 | 3257 | 42992 | 2085 | 53438 | 1333 | 41290 |
| 18-#14 | 2.32 | MA | 26809 | 6108 | 41204 | 5017 | 49473 | 4042 | 53867 | 3300 | 59035 | 2136 | 74291 | 1634 | 53738 |
| 5L-6S | | MI | 21059 | 6108 | 33012 | 4955 | 39088 | 4001 | 42155 | 3247 | 45391 | 2092 | 56238 | 1435 | 42554 |
| 18-#14 | 2.32 | MA | 25850 | 6108 | 39832 | 5019 | 47644 | 4057 | 51639 | 3298 | 56072 | 2145 | 70256 | 1525 | 52552 |
| 6L-5S | | MI | 21838 | 6108 | 34121 | 4955 | 40566 | 3988 | 43954 | 3252 | 47757 | 2085 | 59391 | 1544 | 43401 |
| 18-#14 | 2.32 | MA | 24911 | 6108 | 38497 | 5021 | 45876 | 4057 | 49480 | 3311 | 53069 | 2139 | 66662 | 1423 | 50968 |
| 7L-4S | | MI | 22650 | 6108 | 35368 | 4940 | 42063 | 3991 | 45780 | 3242 | 50216 | 2077 | 62518 | 1608 | 44553 |
| 18-#14 | 2.32 | MA | 23983 | 6108 | 37183 | 5022 | 44145 | 4057 | 47316 | 3309 | 50171 | 2149 | 62956 | 1345 | 49421 |
| 8L-3S | | MI | 23546 | 6108 | 36599 | 4940 | 43727 | 3978 | 47797 | 3246 | 52912 | 2085 | 65486 | 1739 | 44805 |
| 18-#14 | 2.32 | MA | 23061 | 6108 | 35731 | 5039 | 42360 | 4071 | 45188 | 3322 | 47301 | 2158 | 59291 | 1261 | 47311 |
| 9L-2S | | MI | 24781 | 6108 | 38251 | 4940 | 45821 | 3981 | 50335 | 3236 | 56309 | 2077 | 70004 | 1871 | 44935 |
| 18-#18 | 4.12 | MA | 30428 | 7253 | 51530 | 5717 | 62318 | 4549 | 69313 | 3625 | 79784 | 2071 | 102302 | 1194 | 90146 |
| 5L-6S | | MI | 23297 | 7253 | 40407 | 5641 | 48174 | 4504 | 53049 | 3554 | 59643 | 1990 | 75468 | 849 | 69047 |
| 18-#18 | 4.12 | MA | 28849 | 7253 | 49116 | 5718 | 59100 | 4574 | 65395 | 3619 | 74572 | 2084 | 95311 | 1001 | 86048 |
| 6L-5S | | MI | 24582 | 7253 | 42353 | 5643 | 50767 | 4484 | 56204 | 3565 | 63734 | 1976 | 80894 | 1043 | 72386 |
| 18-#18 | 4.12 | MA | 27302 | 7253 | 46766 | 5720 | 55990 | 4572 | 61596 | 3640 | 69289 | 2071 | 89095 | 819 | 81940 |
| 7L-4S | | MI | 25922 | 7253 | 44540 | 5619 | 53392 | 4491 | 59407 | 3549 | 67989 | 1963 | 86301 | 1153 | 74389 |
| 18-#18 | 4.12 | MA | 25772 | 7253 | 44452 | 5721 | 52942 | 4569 | 57789 | 3634 | 64191 | 2085 | 82651 | 684 | 77698 |
| 8L-3S | | MI | 27400 | 7253 | 46699 | 5621 | 56307 | 4471 | 62940 | 3560 | 72652 | 1976 | 91395 | 1386 | 77207 |
| 20-#11 | 1.78 | MA | 28575 | 5770 | 42054 | 4799 | 50694 | 3884 | 55415 | 3187 | 61190 | 2145 | 76495 | 2017 | 43324 |
| 2L-10S | | MI | 18516 | 5770 | 28107 | 4768 | 32931 | 3861 | 34694 | 3169 | 35400 | 2122 | 43555 | 1392 | 31318 |
| 20-#11 | 1.78 | MA | 27476 | 5770 | 40615 | 4801 | 48869 | 3884 | 53205 | 3196 | 58208 | 2152 | 72437 | 1926 | 43245 |
| 3L-9S | | MI | 19047 | 5770 | 28846 | 4768 | 33901 | 3862 | 35900 | 3172 | 37056 | 2127 | 45510 | 1459 | 32201 |
| 20-#11 | 1.78 | MA | 26686 | 5770 | 39550 | 4802 | 47428 | 3895 | 51458 | 3195 | 55851 | 2149 | 69757 | 1835 | 43099 |
| 4L-8S | | MI | 19580 | 5770 | 29664 | 4757 | 34907 | 3853 | 37100 | 3164 | 38667 | 2122 | 47526 | 1517 | 32864 |
| 20-#11 | 1.78 | MA | 25972 | 5770 | 38473 | 4814 | 46136 | 3895 | 49880 | 3205 | 53702 | 2156 | 66976 | 1788 | 42853 |
| 5L-7S | | MI | 20117 | 5770 | 30406 | 4757 | 35884 | 3854 | 38320 | 3167 | 40294 | 2117 | 49578 | 1570 | 33580 |
| 20-#11 | 1.78 | MA | 25289 | 5770 | 37517 | 4815 | 44861 | 3906 | 48328 | 3204 | 51637 | 2163 | 64142 | 1713 | 41929 |
| 6E | | MI | 20661 | 5770 | 31159 | 4757 | 36881 | 3855 | 39537 | 3159 | 41980 | 2122 | 51552 | 1641 | 34014 |
| 20-#11 | 1.78 | MA | 24620 | 5770 | 36587 | 4817 | 43629 | 3906 | 46823 | 3213 | 49543 | 2160 | 61617 | 1642 | 41316 |
| 7L-5S | | MI | 21216 | 5770 | 31933 | 4756 | 37912 | 3846 | 40793 | 3162 | 43642 | 2117 | 53774 | 1716 | 34684 |
| 20-#11 | 1.78 | MA | 23959 | 5770 | 35671 | 4818 | 42422 | 3906 | 45315 | 3213 | 47524 | 2167 | 59019 | 1588 | 40401 |
| 8L-4S | | MI | 21795 | 5770 | 32803 | 4746 | 38957 | 3847 | 42068 | 3154 | 45371 | 2112 | 55971 | 1761 | 34917 |
| 20-#11 | 1.78 | MA | 23303 | 5770 | 34660 | 4830 | 41179 | 3917 | 43832 | 3222 | 45524 | 2174 | 56444 | 1529 | 39496 |
| 9L-3S | | MI | 22434 | 5770 | 33663 | 4746 | 40119 | 3838 | 43476 | 3157 | 47265 | 2117 | 58065 | 1852 | 35013 |
| 20-#11 | 1.78 | MA | 22649 | 5770 | 33747 | 4832 | 39981 | 3917 | 42342 | 3221 | 43467 | 2171 | 53783 | 1449 | 38327 |
| 10L-2S | | MI | 23315 | 5770 | 34818 | 4745 | 41584 | 3840 | 45251 | 3149 | 49653 | 2112 | 61248 | 1943 | 35063 |
| 20-#14 | 2.57 | MA | 28771 | 6271 | 44809 | 5103 | 53941 | 4117 | 59296 | 3334 | 66388 | 2119 | 84037 | 1684 | 61157 |
| 4L-8S | | MI | 20333 | 6271 | 32520 | 5056 | 38354 | 4071 | 41200 | 3300 | 44074 | 2083 | 55037 | 1235 | 44810 |
| 20-#14 | 2.57 | MA | 27782 | 6271 | 43264 | 5119 | 52086 | 4117 | 57032 | 3347 | 63306 | 2128 | 80069 | 1617 | 59651 |
| 5L-7S | | MI | 21078 | 6271 | 33583 | 5057 | 39754 | 4073 | 42948 | 3305 | 46389 | 2076 | 57956 | 1309 | 45968 |
| 20-#14 | 2.57 | MA | 26835 | 6271 | 41892 | 5121 | 50257 | 4132 | 54805 | 3345 | 60343 | 2138 | 76034 | 1508 | 58499 |
| 6E | | MI | 21833 | 6271 | 34663 | 5057 | 41182 | 4076 | 44692 | 3295 | 48788 | 2083 | 60756 | 1411 | 47300 |
| 20-#14 | 2.57 | MA | 25907 | 6271 | 40557 | 5123 | 48489 | 4132 | 52645 | 3358 | 57340 | 2132 | 72441 | 1406 | 56849 |
| 7L-5S | | MI | 22603 | 6271 | 35772 | 5057 | 42660 | 4063 | 46491 | 3299 | 51153 | 2076 | 63909 | 1520 | 48120 |
| 20-#14 | 2.57 | MA | 24990 | 6271 | 39243 | 5124 | 46758 | 4131 | 50482 | 3356 | 54442 | 2141 | 68735 | 1328 | 55338 |
| 8L-4S | | MI | 23407 | 6271 | 37019 | 5042 | 44157 | 4066 | 48318 | 3289 | 53613 | 2068 | 67036 | 1584 | 49373 |
| 20-#14 | 2.57 | MA | 24079 | 6271 | 37791 | 5141 | 44973 | 4146 | 48354 | 3369 | 51572 | 2151 | 65070 | 1244 | 53191 |
| 9L-3S | | MI | 24294 | 6271 | 38251 | 5042 | 45821 | 4053 | 50335 | 3294 | 56309 | 2076 | 70004 | 1715 | 49651 |
| 20-#14 | 2.57 | MA | 23172 | 6271 | 36482 | 5143 | 43254 | 4146 | 46215 | 3367 | 48621 | 2145 | 61281 | 1129 | 51103 |
| 10L-2S | | MI | 25517 | 6271 | 39902 | 5043 | 47916 | 4056 | 52872 | 3283 | 59705 | 2068 | 74522 | 1847 | 49804 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

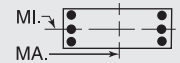


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#18 | 4.58 | MA | 30479 | 7544 | 52728 | 5900 | 63680 | 4707 | 70944 | 3703 | 82059 | 2071 | 105324 | 965 | 96332 |
| 6E | | MI | 24576 | 7544 | 43291 | 5823 | 51832 | 4637 | 57481 | 3638 | 65518 | 1970 | 83244 | 798 | 77187 |
| 20-#18 | 4.58 | MA | 28957 | 7544 | 50377 | 5901 | 60570 | 4705 | 67144 | 3724 | 76776 | 2058 | 99108 | 783 | 92156 |
| 7L-5S | | MI | 25842 | 7544 | 45238 | 5825 | 54425 | 4617 | 60636 | 3649 | 69609 | 1957 | 88670 | 993 | 80597 |
| 20-#18 | 4.58 | MA | 27452 | 7544 | 48064 | 5903 | 57522 | 4702 | 63338 | 3718 | 71677 | 2072 | 92664 | 648 | 87870 |
| 8L-4S | | MI | 27162 | 7544 | 47425 | 5801 | 57050 | 4624 | 63839 | 3634 | 73864 | 1943 | 94076 | 1103 | 82566 |
| 22-#11 | 1.96 | MA | 28159 | 5883 | 42054 | 4872 | 50694 | 3936 | 55415 | 3229 | 61190 | 2147 | 76495 | 1915 | 47482 |
| 3L-10S | | MI | 19088 | 5883 | 29262 | 4839 | 34396 | 3913 | 36469 | 3202 | 37787 | 2117 | 46738 | 1377 | 34593 |
| 22-#11 | 1.96 | MA | 27376 | 5883 | 40988 | 4873 | 49253 | 3947 | 53669 | 3228 | 58833 | 2144 | 73815 | 1824 | 47320 |
| 4L-9S | | MI | 19614 | 5883 | 30001 | 4839 | 35366 | 3914 | 37675 | 3205 | 39443 | 2122 | 48693 | 1443 | 35505 |
| 22-#11 | 1.96 | MA | 26669 | 5883 | 39911 | 4885 | 47960 | 3947 | 52091 | 3238 | 56684 | 2151 | 71033 | 1777 | 46985 |
| 5L-8S | | MI | 20142 | 5883 | 30819 | 4828 | 36372 | 3905 | 38875 | 3197 | 41054 | 2117 | 50708 | 1502 | 36153 |
| 22-#11 | 1.96 | MA | 25991 | 5883 | 38955 | 4886 | 46685 | 3958 | 50538 | 3237 | 54619 | 2158 | 68200 | 1702 | 46081 |
| 6L-7S | | MI | 20675 | 5883 | 31561 | 4828 | 37349 | 3906 | 40095 | 3200 | 42681 | 2111 | 52760 | 1554 | 36913 |
| 22-#11 | 1.96 | MA | 25329 | 5883 | 38025 | 4888 | 45453 | 3958 | 49033 | 3246 | 52525 | 2155 | 65675 | 1631 | 45481 |
| 7L-6S | | MI | 21214 | 5883 | 32314 | 4828 | 38345 | 3907 | 41312 | 3192 | 44367 | 2117 | 54735 | 1625 | 37337 |
| 22-#11 | 1.96 | MA | 24674 | 5883 | 37109 | 4889 | 44247 | 3958 | 47526 | 3245 | 50505 | 2162 | 63076 | 1577 | 44523 |
| 8L-5S | | MI | 21764 | 5883 | 33088 | 4827 | 39377 | 3898 | 42567 | 3195 | 46030 | 2111 | 56956 | 1701 | 37983 |
| 22-#11 | 1.96 | MA | 24023 | 5883 | 36098 | 4901 | 43003 | 3969 | 46043 | 3255 | 48506 | 2169 | 60502 | 1518 | 43637 |
| 9L-4S | | MI | 22339 | 5883 | 33958 | 4817 | 40421 | 3899 | 43842 | 3187 | 47759 | 2106 | 59154 | 1746 | 38305 |
| 22-#11 | 1.96 | MA | 23376 | 5883 | 35186 | 4903 | 41805 | 3969 | 44552 | 3254 | 46449 | 2165 | 57841 | 1439 | 42441 |
| 10L-3S | | MI | 22973 | 5883 | 34818 | 4817 | 41584 | 3890 | 45251 | 3190 | 49653 | 2111 | 61248 | 1837 | 38416 |
| 22-#11 | 1.96 | MA | 22672 | 5883 | 34281 | 4904 | 40576 | 3980 | 43078 | 3263 | 44458 | 2172 | 55287 | 1381 | 41322 |
| 11L-2S | | MI | 23848 | 5883 | 35973 | 4816 | 43049 | 3891 | 47026 | 3182 | 52040 | 2106 | 64431 | 1928 | 38478 |
| 22-#14 | 2.83 | MA | 28743 | 6435 | 45324 | 5222 | 54699 | 4192 | 60198 | 3394 | 67577 | 2121 | 85848 | 1600 | 65573 |
| 5L-8S | | MI | 21113 | 6435 | 34172 | 5159 | 40449 | 4146 | 43737 | 3348 | 47471 | 2074 | 59555 | 1210 | 49446 |
| 22-#14 | 2.83 | MA | 27806 | 6435 | 43953 | 5223 | 52870 | 4206 | 57970 | 3392 | 64614 | 2130 | 81813 | 1491 | 64453 |
| 6L-7S | | MI | 21851 | 6435 | 35235 | 5159 | 41849 | 4148 | 45485 | 3352 | 49785 | 2067 | 62474 | 1285 | 50654 |
| 22-#14 | 2.83 | MA | 26889 | 6435 | 42617 | 5225 | 51102 | 4206 | 55811 | 3405 | 61611 | 2125 | 78220 | 1389 | 62738 |
| 7L-6S | | MI | 22597 | 6435 | 36315 | 5159 | 43277 | 4151 | 47230 | 3342 | 52184 | 2074 | 65274 | 1387 | 52051 |
| 22-#14 | 2.83 | MA | 25982 | 6435 | 41303 | 5227 | 49371 | 4206 | 53648 | 3403 | 58713 | 2134 | 74513 | 1311 | 61243 |
| 8L-5S | | MI | 23359 | 6435 | 37423 | 5159 | 44755 | 4138 | 49028 | 3347 | 54550 | 2067 | 68427 | 1496 | 52846 |
| 22-#14 | 2.83 | MA | 25082 | 6435 | 39852 | 5243 | 47586 | 4221 | 51519 | 3416 | 55843 | 2143 | 70849 | 1227 | 59078 |
| 9L-4S | | MI | 24154 | 6435 | 38670 | 5145 | 46251 | 4141 | 50855 | 3336 | 57010 | 2059 | 71554 | 1560 | 54191 |
| 22-#14 | 2.83 | MA | 24184 | 6435 | 38543 | 5245 | 45867 | 4221 | 49381 | 3415 | 52892 | 2138 | 67060 | 1112 | 56962 |
| 10L-3S | | MI | 25032 | 6435 | 39902 | 5145 | 47916 | 4128 | 52872 | 3341 | 59705 | 2067 | 74522 | 1691 | 54494 |
| 22-#18 | 5.03 | MA | 30586 | 7834 | 53989 | 6083 | 65150 | 4838 | 72693 | 3808 | 84262 | 2045 | 109121 | 747 | 102388 |
| 7L-6S | | MI | 25837 | 7834 | 46176 | 6004 | 55490 | 4770 | 61913 | 3722 | 71393 | 1950 | 91019 | 748 | 85346 |
| 22-#18 | 5.03 | MA | 29105 | 7834 | 51675 | 6085 | 62103 | 4835 | 68887 | 3803 | 79164 | 2059 | 102677 | 612 | 98057 |
| 8L-5S | | MI | 27084 | 7834 | 48122 | 6007 | 58083 | 4750 | 65068 | 3733 | 75484 | 1937 | 96445 | 943 | 88644 |
| 24-#11 | 2.14 | MA | 28059 | 5997 | 42427 | 4944 | 51077 | 3998 | 55879 | 3261 | 61815 | 2138 | 77872 | 1814 | 51540 |
| 4L-10S | | MI | 19653 | 5997 | 30417 | 4910 | 35861 | 3965 | 38244 | 3235 | 40174 | 2111 | 49921 | 1362 | 37872 |
| 24-#11 | 2.14 | MA | 27357 | 5997 | 41350 | 4956 | 49785 | 3999 | 54301 | 3271 | 59666 | 2146 | 75091 | 1766 | 51115 |
| 5L-9S | | MI | 20175 | 5997 | 31155 | 4909 | 36831 | 3966 | 39449 | 3238 | 41831 | 2116 | 51876 | 1428 | 38814 |
| 24-#11 | 2.14 | MA | 26686 | 5997 | 40394 | 4957 | 48509 | 4009 | 52748 | 3270 | 57601 | 2153 | 72257 | 1692 | 50237 |
| 6L-8S | | MI | 20699 | 5997 | 31974 | 4899 | 37837 | 3957 | 40650 | 3230 | 43442 | 2111 | 53891 | 1487 | 39446 |
| 24-#11 | 2.14 | MA | 26029 | 5997 | 39463 | 4959 | 47278 | 4010 | 51243 | 3279 | 55507 | 2149 | 69732 | 1621 | 49649 |
| 7E | | MI | 21227 | 5997 | 32716 | 4899 | 38814 | 3958 | 41869 | 3233 | 45069 | 2106 | 55943 | 1539 | 40248 |
| 24-#11 | 2.14 | MA | 25380 | 5997 | 38548 | 4960 | 46071 | 4010 | 49736 | 3278 | 53487 | 2156 | 67134 | 1566 | 48650 |
| 8L-6S | | MI | 21761 | 5997 | 33469 | 4898 | 39810 | 3959 | 43087 | 3225 | 46754 | 2111 | 57917 | 1610 | 40664 |
| 24-#11 | 2.14 | MA | 24736 | 5997 | 37536 | 4972 | 44828 | 4021 | 48253 | 3288 | 51488 | 2163 | 64559 | 1508 | 47781 |
| 9L-5S | | MI | 22307 | 5997 | 34243 | 4898 | 40842 | 3950 | 44342 | 3228 | 48417 | 2106 | 60139 | 1685 | 41288 |
| 24-#11 | 2.14 | MA | 24094 | 5997 | 36624 | 4974 | 43629 | 4021 | 46763 | 3287 | 49431 | 2160 | 61898 | 1428 | 46559 |
| 10L-4S | | MI | 22877 | 5997 | 35113 | 4888 | 41886 | 3951 | 45617 | 3220 | 50146 | 2101 | 62337 | 1730 | 41692 |
| 24-#11 | 2.14 | MA | 23394 | 5997 | 35719 | 4975 | 42400 | 4032 | 45289 | 3296 | 47440 | 2167 | 59345 | 1370 | 45419 |
| 11L-3S | | MI | 23506 | 5997 | 35973 | 4887 | 43049 | 3942 | 47026 | 3223 | 52040 | 2106 | 64431 | 1821 | 41815 |
| 24-#11 | 2.14 | MA | 22710 | 5997 | 34818 | 4976 | 41205 | 4032 | 43807 | 3295 | 45458 | 2174 | 56790 | 1313 | 44085 |
| 12L-2S | | MI | 24376 | 5997 | 37128 | 4887 | 44513 | 3943 | 48800 | 3215 | 54427 | 2101 | 67613 | 1913 | 41889 |

## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#14 | 3.09 | MA | 28765 | 6598 | 46013 | 5325 | 55483 | 4281 | 61136 | 3440 | 68885 | 2123 | 87592 | 1474 | 70411 |
| 6L-8S | | MI | 21884 | 6598 | 35823 | 5261 | 42543 | 4221 | 46274 | 3395 | 50868 | 2065 | 64073 | 1186 | 54091 |
| 24-#14 | 3.09 | MA | 27858 | 6598 | 44678 | 5327 | 53715 | 4281 | 58976 | 3453 | 65881 | 2117 | 83998 | 1372 | 68636 |
| 7E | | MI | 22613 | 6598 | 36886 | 5261 | 43943 | 4223 | 48022 | 3400 | 53182 | 2057 | 66992 | 1261 | 55348 |
| 24-#14 | 3.09 | MA | 26962 | 6598 | 43363 | 5329 | 51984 | 4281 | 56813 | 3451 | 62983 | 2126 | 80292 | 1294 | 67095 |
| 8L-6S | | MI | 23352 | 6598 | 37966 | 5261 | 45371 | 4225 | 49767 | 3389 | 55581 | 2065 | 69792 | 1363 | 56808 |
| 24-#14 | 3.09 | MA | 26072 | 6598 | 41912 | 5346 | 50199 | 4296 | 54685 | 3464 | 60114 | 2136 | 76627 | 1210 | 64971 |
| 9L-5S | | MI | 24106 | 6598 | 39075 | 5261 | 46849 | 4213 | 51566 | 3394 | 57947 | 2057 | 72945 | 1472 | 57580 |
| 24-#14 | 3.09 | MA | 25177 | 6598 | 40603 | 5347 | 48480 | 4296 | 52547 | 3462 | 57163 | 2130 | 72839 | 1094 | 62827 |
| 10L-4S | | MI | 24894 | 6598 | 40322 | 5247 | 48346 | 4215 | 53392 | 3384 | 60407 | 2050 | 76072 | 1536 | 59008 |
| 24-#18 | 5.49 | MA | 30732 | 8125 | 55287 | 6266 | 66683 | 4968 | 74436 | 3887 | 86650 | 2045 | 112690 | 576 | 108258 |
| 8L-6S | | MI | 27081 | 8125 | 49060 | 6186 | 59149 | 4903 | 66345 | 3806 | 77267 | 1930 | 98795 | 698 | 93520 |

## RECTANGULAR TIED COLUMNS 38" x 48"

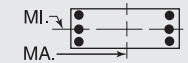
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.32 | MA | 28991 | 5710 | 41789 | 4785 | 49855 | 3887 | 53749 | 3215 | 57656 | 2237 | 70660 | 2101 | 34661 |
| 2L-3S | | MI | 20397 | 5710 | 30419 | 4704 | 35534 | 3816 | 37543 | 3176 | 38518 | 2189 | 46010 | 1777 | 26720 |
| 6-#18 | 1.32 | MA | 26034 | 5710 | 37996 | 4787 | 45045 | 3885 | 47921 | 3237 | 49793 | 2252 | 60086 | 1867 | 34469 |
| 3L-2S | | MI | 22638 | 5710 | 33303 | 4707 | 39192 | 3823 | 41975 | 3161 | 44393 | 2175 | 53786 | 2011 | 26783 |
| 8-#18 | 1.75 | MA | 30792 | 6000 | 45582 | 4966 | 54666 | 4020 | 59577 | 3299 | 65519 | 2224 | 81234 | 2068 | 45893 |
| 2L-4S | | MI | 20158 | 6000 | 31145 | 4884 | 36276 | 3969 | 38442 | 3249 | 39730 | 2156 | 48692 | 1493 | 34270 |
| 8-#18 | 1.75 | MA | 27890 | 6000 | 41789 | 4968 | 49855 | 4018 | 53749 | 3321 | 57656 | 2239 | 70660 | 1834 | 45586 |
| 3E | | MI | 21769 | 6000 | 33303 | 4886 | 39192 | 3949 | 41975 | 3260 | 44393 | 2169 | 53786 | 1727 | 35185 |
| 8-#18 | 1.75 | MA | 25790 | 6000 | 38972 | 4971 | 46046 | 4044 | 49133 | 3317 | 51426 | 2227 | 63690 | 1600 | 44341 |
| 4L-2S | | MI | 23972 | 6000 | 36188 | 4889 | 42850 | 3956 | 46407 | 3245 | 50268 | 2156 | 61562 | 1960 | 35350 |
| 10-#14 | 1.23 | MA | 28779 | 5655 | 40962 | 4777 | 49053 | 3884 | 52885 | 3218 | 56565 | 2254 | 69568 | 2137 | 32828 |
| 2L-5S | | MI | 19429 | 5655 | 28532 | 4721 | 33361 | 3833 | 35000 | 3184 | 35288 | 2215 | 42596 | 1731 | 24838 |
| 10-#14 | 1.23 | MA | 27085 | 5655 | 38800 | 4779 | 46311 | 3884 | 49563 | 3232 | 52082 | 2264 | 63474 | 2005 | 32765 |
| 3L-4S | | MI | 20282 | 5655 | 29779 | 4706 | 34858 | 3835 | 36827 | 3174 | 37748 | 2208 | 45723 | 1795 | 25307 |
| 10-#14 | 1.23 | MA | 25864 | 5655 | 37198 | 4781 | 44144 | 3899 | 46937 | 3230 | 48538 | 2259 | 59449 | 1874 | 32554 |
| 4L-3S | | MI | 21222 | 5655 | 31011 | 4706 | 36523 | 3823 | 38844 | 3179 | 40444 | 2215 | 48690 | 1927 | 25409 |
| 10-#14 | 1.23 | MA | 24758 | 5655 | 35578 | 4798 | 42201 | 3900 | 44564 | 3244 | 45307 | 2269 | 55270 | 1806 | 31835 |
| 5L-2S | | MI | 22510 | 5655 | 32662 | 4706 | 38617 | 3825 | 41381 | 3169 | 43841 | 2208 | 53208 | 2058 | 25422 |
| 10-#18 | 2.19 | MA | 32548 | 6291 | 49376 | 5148 | 59477 | 4153 | 65405 | 3384 | 73383 | 2210 | 91808 | 2034 | 57097 |
| 2L-5S | | MI | 20086 | 6291 | 31842 | 5090 | 37310 | 4095 | 39671 | 3349 | 41350 | 2149 | 51061 | 1333 | 39780 |
| 10-#18 | 2.19 | MA | 29695 | 6291 | 45582 | 5150 | 54666 | 4151 | 59577 | 3406 | 65519 | 2225 | 81234 | 1801 | 56692 |
| 3L-4S | | MI | 21524 | 6291 | 34029 | 5066 | 39934 | 4102 | 42874 | 3334 | 45605 | 2136 | 56468 | 1443 | 42269 |
| 10-#18 | 2.19 | MA | 27637 | 6291 | 42765 | 5152 | 50857 | 4177 | 54961 | 3401 | 59289 | 2214 | 74264 | 1567 | 54993 |
| 4L-3S | | MI | 23107 | 6291 | 36188 | 5068 | 42850 | 4082 | 46407 | 3345 | 50268 | 2149 | 61562 | 1677 | 43628 |
| 10-#18 | 2.19 | MA | 25773 | 6291 | 39915 | 5181 | 47437 | 4175 | 50787 | 3423 | 53605 | 2229 | 66989 | 1449 | 51348 |
| 5L-2S | | MI | 25274 | 6291 | 39072 | 5070 | 46508 | 4089 | 50839 | 3329 | 56143 | 2136 | 69337 | 1910 | 43880 |
| 12-#11 | 1.03 | MA | 27940 | 5518 | 39073 | 4705 | 46783 | 3832 | 50190 | 3188 | 52966 | 2267 | 64835 | 2163 | 27546 |
| 2L-6S | | MI | 19149 | 5518 | 27551 | 4649 | 32193 | 3792 | 33635 | 3150 | 33551 | 2239 | 40100 | 1793 | 20909 |
| 12-#11 | 1.03 | MA | 26746 | 5518 | 37564 | 4706 | 44869 | 3832 | 47871 | 3197 | 49837 | 2275 | 60558 | 2072 | 27528 |
| 3L-5S | | MI | 19725 | 5518 | 28324 | 4648 | 33224 | 3783 | 34890 | 3153 | 35214 | 2234 | 42322 | 1868 | 21296 |
| 12-#11 | 1.03 | MA | 25886 | 5518 | 36447 | 4708 | 43358 | 3843 | 46040 | 3197 | 47365 | 2272 | 57731 | 1981 | 27457 |
| 4E | | MI | 20326 | 5518 | 29195 | 4638 | 34269 | 3784 | 36165 | 3146 | 36943 | 2228 | 44519 | 1913 | 21374 |
| 12-#11 | 1.03 | MA | 25108 | 5518 | 35318 | 4720 | 42004 | 3844 | 44386 | 3207 | 45113 | 2279 | 54803 | 1933 | 27290 |
| 5L-3S | | MI | 20989 | 5518 | 30055 | 4638 | 35431 | 3775 | 37574 | 3148 | 38837 | 2234 | 46613 | 2004 | 21396 |
| 12-#11 | 1.03 | MA | 24363 | 5518 | 34317 | 4722 | 40668 | 3855 | 42759 | 3206 | 42949 | 2287 | 51816 | 1859 | 26690 |
| 6L-2S | | MI | 21899 | 5518 | 31210 | 4637 | 36896 | 3776 | 39349 | 3141 | 41224 | 2228 | 49796 | 2095 | 21385 |
| 12-#14 | 1.48 | MA | 29827 | 5819 | 43125 | 4879 | 51796 | 3958 | 56208 | 3265 | 61048 | 2246 | 75663 | 2121 | 39235 |
| 2L-6S | | MI | 19435 | 5819 | 29075 | 4823 | 33978 | 3920 | 35739 | 3227 | 36319 | 2213 | 43960 | 1598 | 28530 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

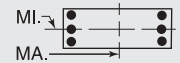



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 1.48 | MA | 28152 | 5819 | 40962 | 4881 | 49053 | 3959 | 52885 | 3279 | 56565 | 2256 | 69568 | 1990 | 39138 |
| 3L-5S | | MI | 20244 | 5819 | 30183 | 4823 | 35456 | 3908 | 37538 | 3232 | 38685 | 2206 | 47114 | 1707 | 29499 |
| 12-#14 | 1.48 | MA | 26945 | 5819 | 39360 | 4884 | 46887 | 3974 | 50260 | 3278 | 53020 | 2251 | 65543 | 1858 | 38885 |
| 4E | | MI | 21087 | 5819 | 31431 | 4808 | 36952 | 3910 | 39364 | 3222 | 41145 | 2198 | 50240 | 1771 | 30145 |
| 12-#14 | 1.48 | MA | 25854 | 5819 | 37740 | 4900 | 44943 | 3974 | 47887 | 3291 | 49789 | 2262 | 61364 | 1790 | 37987 |
| 5L-3S | | MI | 22016 | 5819 | 32662 | 4808 | 38617 | 3898 | 41381 | 3226 | 43841 | 2206 | 53208 | 1902 | 30285 |
| 12-#14 | 1.48 | MA | 24808 | 5819 | 36303 | 4903 | 43026 | 3990 | 45552 | 3290 | 46684 | 2272 | 57108 | 1682 | 36561 |
| 6L-2S | | MI | 23291 | 5819 | 34314 | 4809 | 40711 | 3900 | 43918 | 3216 | 47237 | 2198 | 57726 | 2034 | 30329 |
| 12-#18 | 2.63 | MA | 34264 | 6582 | 53169 | 5330 | 64287 | 4286 | 71234 | 3468 | 81246 | 2197 | 102381 | 2001 | 68284 |
| 2L-6S | | MI | 20090 | 6582 | 32781 | 5269 | 38375 | 4248 | 40948 | 3422 | 43134 | 2142 | 53411 | 1089 | 45181 |
| 12-#18 | 2.63 | MA | 31458 | 6582 | 49376 | 5332 | 59477 | 4284 | 65405 | 3490 | 73383 | 2212 | 91808 | 1767 | 67791 |
| 3L-5S | | MI | 21446 | 6582 | 34727 | 5271 | 40968 | 4228 | 44103 | 3433 | 47225 | 2129 | 58836 | 1283 | 47963 |
| 12-#18 | 2.63 | MA | 29437 | 6582 | 46558 | 5334 | 55668 | 4310 | 60789 | 3485 | 67152 | 2201 | 84837 | 1534 | 65691 |
| 4E | | MI | 22858 | 6582 | 36914 | 5247 | 43593 | 4235 | 47306 | 3418 | 51480 | 2116 | 64243 | 1393 | 50317 |
| 12-#18 | 2.63 | MA | 27609 | 6582 | 43708 | 5363 | 52248 | 4308 | 56615 | 3507 | 61469 | 2216 | 77563 | 1415 | 62204 |
| 5L-3S | | MI | 24415 | 6582 | 39072 | 5250 | 46508 | 4215 | 50839 | 3429 | 56143 | 2129 | 69337 | 1627 | 52058 |
| 12-#18 | 2.63 | MA | 25855 | 6582 | 41177 | 5365 | 48873 | 4334 | 52506 | 3502 | 56004 | 2231 | 70180 | 1223 | 58492 |
| 6L-2S | | MI | 26549 | 6582 | 41957 | 5252 | 50167 | 4222 | 55271 | 3414 | 62017 | 2116 | 77113 | 1860 | 52387 |
| 14-#11 | 1.20 | MA | 28688 | 5631 | 40583 | 4776 | 48697 | 3884 | 52509 | 3220 | 56094 | 2262 | 69112 | 2154 | 32025 |
| 2L-7S | | MI | 19171 | 5631 | 27953 | 4720 | 32661 | 3843 | 34192 | 3191 | 34253 | 2228 | 41308 | 1707 | 23729 |
| 14-#11 | 1.20 | MA | 27504 | 5631 | 39073 | 4777 | 46783 | 3884 | 50190 | 3230 | 52966 | 2270 | 64835 | 2063 | 31990 |
| 3L-6S | | MI | 19730 | 5631 | 28706 | 4720 | 33658 | 3844 | 35410 | 3183 | 35938 | 2233 | 43283 | 1778 | 24206 |
| 14-#11 | 1.20 | MA | 26651 | 5631 | 37956 | 4779 | 45273 | 3895 | 48359 | 3230 | 50494 | 2267 | 62008 | 1971 | 31898 |
| 4L-5S | | MI | 20302 | 5631 | 29479 | 4719 | 34689 | 3835 | 36665 | 3186 | 37601 | 2228 | 45504 | 1853 | 24682 |
| 14-#11 | 1.20 | MA | 25881 | 5631 | 36828 | 4791 | 43918 | 3896 | 46705 | 3239 | 48242 | 2274 | 59080 | 1924 | 31709 |
| 5L-4S | | MI | 20897 | 5631 | 30350 | 4709 | 35734 | 3836 | 37940 | 3178 | 39330 | 2223 | 47702 | 1898 | 24780 |
| 14-#11 | 1.20 | MA | 25143 | 5631 | 35826 | 4793 | 42582 | 3907 | 45078 | 3239 | 46078 | 2282 | 56093 | 1849 | 31021 |
| 6L-3S | | MI | 21554 | 5631 | 31210 | 4708 | 36896 | 3827 | 39349 | 3181 | 41224 | 2228 | 49796 | 1989 | 24821 |
| 14-#11 | 1.20 | MA | 24420 | 5631 | 34852 | 4794 | 41292 | 3907 | 43502 | 3249 | 43885 | 2279 | 53430 | 1778 | 30307 |
| 7L-2S | | MI | 22457 | 5631 | 32365 | 4708 | 38361 | 3828 | 41123 | 3173 | 43612 | 2223 | 52979 | 2080 | 24826 |
| 14-#14 | 1.73 | MA | 30858 | 5982 | 45287 | 4982 | 54539 | 4033 | 59531 | 3313 | 65530 | 2239 | 81757 | 2106 | 45633 |
| 2L-7S | | MI | 19463 | 5982 | 29646 | 4925 | 34644 | 3993 | 36532 | 3285 | 37317 | 2197 | 45679 | 1472 | 32245 |
| 14-#14 | 1.73 | MA | 29201 | 5982 | 43125 | 4984 | 51796 | 4034 | 56208 | 3326 | 61048 | 2249 | 75663 | 1974 | 45505 |
| 3L-6S | | MI | 20246 | 5982 | 30726 | 4925 | 36072 | 3995 | 38276 | 3275 | 39716 | 2204 | 48478 | 1574 | 33251 |
| 14-#14 | 1.73 | MA | 28009 | 5982 | 41523 | 4986 | 49629 | 4049 | 53582 | 3325 | 57503 | 2244 | 71637 | 1843 | 45214 |
| 4L-5S | | MI | 21046 | 5982 | 31835 | 4925 | 37550 | 3983 | 40075 | 3279 | 42082 | 2197 | 51632 | 1683 | 34177 |
| 14-#14 | 1.73 | MA | 26931 | 5982 | 39903 | 5003 | 47686 | 4049 | 51209 | 3338 | 54272 | 2254 | 67459 | 1775 | 44158 |
| 5L-4S | | MI | 21879 | 5982 | 33082 | 4910 | 39047 | 3985 | 41901 | 3269 | 44542 | 2189 | 54758 | 1747 | 34978 |
| 14-#14 | 1.73 | MA | 25898 | 5982 | 38465 | 5005 | 45768 | 4064 | 48875 | 3337 | 51167 | 2264 | 63203 | 1667 | 42783 |
| 6L-3S | | MI | 22798 | 5982 | 34314 | 4911 | 40711 | 3973 | 43918 | 3274 | 47237 | 2197 | 57726 | 1878 | 35151 |
| 14-#14 | 1.73 | MA | 24887 | 5982 | 37066 | 5007 | 43916 | 4065 | 46612 | 3351 | 48019 | 2259 | 59411 | 1565 | 41396 |
| 7L-2S | | MI | 24061 | 5982 | 35965 | 4911 | 42805 | 3975 | 46456 | 3263 | 50634 | 2189 | 62244 | 2010 | 35222 |
| 14-#18 | 3.07 | MA | 33184 | 6873 | 53169 | 5514 | 64287 | 4417 | 71234 | 3574 | 81246 | 2199 | 102381 | 1734 | 78886 |
| 3L-6S | | MI | 21443 | 6873 | 35665 | 5451 | 42033 | 4381 | 45380 | 3506 | 49008 | 2122 | 61186 | 1039 | 53247 |
| 14-#18 | 3.07 | MA | 31198 | 6873 | 50352 | 5516 | 60478 | 4443 | 66618 | 3569 | 75015 | 2188 | 95411 | 1500 | 76428 |
| 4L-5S | | MI | 22776 | 6873 | 37611 | 5453 | 44626 | 4361 | 48535 | 3517 | 53100 | 2109 | 66612 | 1233 | 56169 |
| 14-#18 | 3.07 | MA | 29403 | 6873 | 47502 | 5545 | 57058 | 4441 | 62443 | 3591 | 69332 | 2203 | 88137 | 1382 | 73083 |
| 5L-4S | | MI | 24166 | 6873 | 39798 | 5429 | 47251 | 4368 | 51738 | 3502 | 57354 | 2096 | 72019 | 1343 | 58405 |
| 14-#18 | 3.07 | MA | 27682 | 6873 | 44971 | 5547 | 53683 | 4467 | 58334 | 3587 | 63867 | 2218 | 80754 | 1189 | 69244 |
| 6L-3S | | MI | 25697 | 6873 | 41957 | 5431 | 50167 | 4348 | 55271 | 3513 | 62017 | 2109 | 77113 | 1577 | 60480 |
| 14-#18 | 3.07 | MA | 25995 | 6873 | 42507 | 5549 | 50423 | 4466 | 54351 | 3609 | 58326 | 2206 | 74185 | 1008 | 65424 |
| 7L-2S | | MI | 27801 | 6873 | 44841 | 5434 | 53825 | 4355 | 59703 | 3498 | 67892 | 2096 | 84888 | 1810 | 60879 |
| 16-#11 | 1.37 | MA | 29427 | 5744 | 42092 | 4846 | 50611 | 3936 | 54828 | 3253 | 59223 | 2257 | 73389 | 2144 | 36498 |
| 2L-8S | | MI | 19202 | 5744 | 28366 | 4791 | 33149 | 3894 | 34747 | 3221 | 35013 | 2228 | 42439 | 1639 | 26508 |
| 16-#11 | 1.37 | MA | 28252 | 5744 | 40583 | 4848 | 48697 | 3936 | 52509 | 3263 | 56094 | 2264 | 69112 | 2053 | 36448 |
| 3L-7S | | MI | 19750 | 5744 | 29108 | 4791 | 34126 | 3895 | 35967 | 3224 | 36640 | 2222 | 44491 | 1691 | 27051 |
| 16-#11 | 1.37 | MA | 27407 | 5744 | 39466 | 4850 | 47187 | 3947 | 50678 | 3262 | 53623 | 2262 | 66284 | 1962 | 36336 |
| 4L-6S | | MI | 20304 | 5744 | 29861 | 4790 | 35122 | 3896 | 37184 | 3216 | 38326 | 2228 | 46465 | 1762 | 27511 |

## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

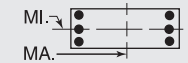
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.37 | MA | 26643 | 5744 | 38337 | 4862 | 45832 | 3948 | 49024 | 3272 | 51371 | 2269 | 63357 | 1914 | 36126 |
| 5E | | MI | 20871 | 5744 | 30634 | 4790 | 36154 | 3887 | 38439 | 3219 | 39989 | 2222 | 48687 | 1838 | 28064 |
| 16-#11 | 1.37 | MA | 25912 | 5744 | 37335 | 4864 | 44496 | 3959 | 47398 | 3272 | 49207 | 2277 | 60370 | 1839 | 35361 |
| 6L-4S | | MI | 21461 | 5744 | 31505 | 4780 | 37198 | 3888 | 39715 | 3211 | 41717 | 2217 | 50885 | 1883 | 28181 |
| 16-#11 | 1.37 | MA | 25197 | 5744 | 36361 | 4865 | 43206 | 3959 | 45821 | 3282 | 47013 | 2274 | 57707 | 1768 | 34667 |
| 7L-3S | | MI | 22113 | 5744 | 32365 | 4779 | 38361 | 3879 | 41123 | 3214 | 43612 | 2222 | 52979 | 1974 | 28238 |
| 16-#11 | 1.37 | MA | 24489 | 5744 | 35402 | 4867 | 41942 | 3960 | 44241 | 3281 | 44897 | 2281 | 54972 | 1713 | 33891 |
| 8L-2S | | MI | 23009 | 5744 | 33520 | 4779 | 39825 | 3880 | 42898 | 3206 | 45999 | 2217 | 56161 | 2065 | 28258 |
| 16-#14 | 1.97 | MA | 31875 | 6146 | 47450 | 5084 | 57281 | 4108 | 62853 | 3360 | 70013 | 2231 | 87852 | 2090 | 52023 |
| 2L-8S | | MI | 19505 | 6146 | 30234 | 5027 | 35338 | 4065 | 37321 | 3328 | 38400 | 2195 | 47278 | 1373 | 35711 |
| 16-#14 | 1.97 | MA | 30234 | 6146 | 45287 | 5086 | 54539 | 4108 | 59531 | 3374 | 65530 | 2241 | 81757 | 1958 | 51865 |
| 3L-7S | | MI | 20270 | 6146 | 31298 | 5027 | 36738 | 4068 | 39069 | 3332 | 40714 | 2188 | 50196 | 1448 | 36897 |
| 16-#14 | 1.97 | MA | 29056 | 6146 | 43685 | 5088 | 52372 | 4124 | 56905 | 3372 | 61986 | 2237 | 77732 | 1827 | 51542 |
| 4L-6S | | MI | 21044 | 6146 | 32377 | 5027 | 38167 | 4070 | 40814 | 3322 | 43113 | 2195 | 52996 | 1550 | 37982 |
| 16-#14 | 1.97 | MA | 27991 | 6146 | 42065 | 5105 | 50428 | 4124 | 54532 | 3386 | 58755 | 2247 | 73553 | 1759 | 50343 |
| 5E | | MI | 21835 | 6146 | 33486 | 5027 | 39644 | 4057 | 42612 | 3327 | 45479 | 2188 | 56149 | 1659 | 38871 |
| 16-#14 | 1.97 | MA | 26971 | 6146 | 40628 | 5107 | 48511 | 4139 | 52197 | 3384 | 55649 | 2257 | 69297 | 1651 | 49015 |
| 6L-4S | | MI | 22659 | 6146 | 34733 | 5013 | 41141 | 4060 | 44439 | 3316 | 47939 | 2180 | 59276 | 1723 | 39806 |
| 16-#14 | 1.97 | MA | 25972 | 6146 | 39229 | 5109 | 46659 | 4140 | 49934 | 3398 | 52501 | 2252 | 65505 | 1549 | 47555 |
| 7L-3S | | MI | 23568 | 6146 | 35965 | 5013 | 42805 | 4047 | 46456 | 3321 | 50634 | 2188 | 62244 | 1854 | 40010 |
| 16-#14 | 1.97 | MA | 24984 | 6146 | 37852 | 5111 | 44844 | 4140 | 47667 | 3397 | 49464 | 2262 | 61602 | 1470 | 45844 |
| 8L-2S | | MI | 24819 | 6146 | 37616 | 5013 | 44900 | 4050 | 48993 | 3311 | 54031 | 2180 | 66762 | 1986 | 40105 |
| 16-#18 | 3.51 | MA | 32925 | 7164 | 54145 | 5698 | 65289 | 4576 | 72446 | 3654 | 82879 | 2174 | 105985 | 1467 | 87197 |
| 4L-6S | | MI | 22770 | 7164 | 38550 | 5633 | 45691 | 4514 | 49812 | 3591 | 54883 | 2103 | 68962 | 989 | 61338 |
| 16-#18 | 3.51 | MA | 31161 | 7164 | 51295 | 5726 | 61869 | 4574 | 68271 | 3676 | 77195 | 2189 | 98710 | 1349 | 83982 |
| 5E | | MI | 24082 | 7164 | 40496 | 5635 | 48284 | 4494 | 52967 | 3602 | 58975 | 2089 | 74388 | 1183 | 64396 |
| 16-#18 | 3.51 | MA | 29470 | 7164 | 48764 | 5728 | 58494 | 4600 | 64163 | 3671 | 71730 | 2204 | 91328 | 1156 | 80018 |
| 6L-4S | | MI | 25450 | 7164 | 42683 | 5611 | 50909 | 4501 | 56170 | 3586 | 63229 | 2076 | 79794 | 1293 | 66525 |
| 16-#18 | 3.51 | MA | 27813 | 7164 | 46300 | 5731 | 55233 | 4598 | 60179 | 3693 | 66190 | 2193 | 84758 | 974 | 76130 |
| 7L-3S | | MI | 26958 | 7164 | 44841 | 5613 | 53825 | 4481 | 59703 | 3597 | 67892 | 2089 | 84888 | 1526 | 68895 |
| 16-#18 | 3.51 | MA | 26174 | 7164 | 43875 | 5733 | 52039 | 4597 | 56188 | 3688 | 60844 | 2208 | 77964 | 838 | 71463 |
| 8L-2S | | MI | 29033 | 7164 | 47726 | 5615 | 57483 | 4488 | 64135 | 3582 | 73767 | 2076 | 92664 | 1760 | 69359 |
| 18-#11 | 1.54 | MA | 30157 | 5858 | 43601 | 4917 | 52526 | 3987 | 57147 | 3286 | 62352 | 2252 | 77665 | 2134 | 40966 |
| 2L-9S | | MI | 19239 | 5858 | 28702 | 4872 | 33607 | 3955 | 35322 | 3262 | 35790 | 2227 | 43607 | 1565 | 29096 |
| 18-#11 | 1.54 | MA | 28991 | 5858 | 42092 | 4919 | 50611 | 3988 | 54828 | 3296 | 59223 | 2259 | 73389 | 2043 | 40901 |
| 3L-8S | | MI | 19778 | 5858 | 29521 | 4862 | 34614 | 3945 | 36522 | 3254 | 37401 | 2222 | 45622 | 1624 | 29783 |
| 18-#11 | 1.54 | MA | 28153 | 5858 | 40975 | 4921 | 49101 | 3999 | 52997 | 3295 | 56752 | 2256 | 70561 | 1952 | 40772 |
| 4L-7S | | MI | 20322 | 5858 | 30262 | 4862 | 35591 | 3947 | 37741 | 3257 | 39027 | 2217 | 47674 | 1676 | 30377 |
| 18-#11 | 1.54 | MA | 27397 | 5858 | 39846 | 4933 | 47746 | 4000 | 51343 | 3305 | 54500 | 2264 | 67634 | 1904 | 40543 |
| 5L-6S | | MI | 20872 | 5858 | 31016 | 4861 | 36587 | 3948 | 38959 | 3249 | 40713 | 2222 | 49648 | 1747 | 30823 |
| 18-#11 | 1.54 | MA | 26672 | 5858 | 38845 | 4935 | 46410 | 4010 | 49717 | 3305 | 52336 | 2271 | 64647 | 1829 | 39708 |
| 6L-5S | | MI | 21433 | 5858 | 31789 | 4861 | 37618 | 3939 | 40214 | 3252 | 42376 | 2217 | 51870 | 1822 | 31443 |
| 18-#11 | 1.54 | MA | 25963 | 5858 | 37870 | 4936 | 45120 | 4011 | 48140 | 3314 | 50142 | 2269 | 61984 | 1759 | 39033 |
| 7L-4S | | MI | 22019 | 5858 | 32660 | 4850 | 38663 | 3940 | 41489 | 3244 | 44105 | 2212 | 54068 | 1867 | 31578 |
| 18-#11 | 1.54 | MA | 25263 | 5858 | 36911 | 4938 | 43856 | 4012 | 46560 | 3314 | 48026 | 2276 | 59249 | 1704 | 38208 |
| 8L-3S | | MI | 22665 | 5858 | 33520 | 4850 | 39825 | 3931 | 42898 | 3247 | 45999 | 2217 | 56161 | 1958 | 31650 |
| 18-#11 | 1.54 | MA | 24567 | 5858 | 35852 | 4950 | 42553 | 4023 | 45007 | 3324 | 45931 | 2284 | 56534 | 1645 | 37213 |
| 9L-2S | | MI | 23555 | 5858 | 34675 | 4850 | 41290 | 3932 | 44672 | 3239 | 48386 | 2212 | 59344 | 2050 | 31683 |
| 18-#14 | 2.22 | MA | 31253 | 6309 | 47450 | 5188 | 57281 | 4183 | 62853 | 3421 | 70013 | 2234 | 87852 | 1943 | 58222 |
| 3L-8S | | MI | 20309 | 6309 | 31886 | 5129 | 37433 | 4140 | 39858 | 3375 | 41796 | 2186 | 51795 | 1349 | 40410 |
| 18-#14 | 2.22 | MA | 30087 | 6309 | 45847 | 5190 | 55115 | 4198 | 60227 | 3420 | 66469 | 2229 | 83826 | 1811 | 57868 |
| 4L-7S | | MI | 21066 | 6309 | 32949 | 5129 | 38833 | 4142 | 41606 | 3380 | 44111 | 2179 | 54714 | 1423 | 41561 |
| 18-#14 | 2.22 | MA | 29035 | 6309 | 44228 | 5207 | 53171 | 4199 | 57855 | 3433 | 63238 | 2239 | 79648 | 1743 | 56541 |
| 5L-6S | | MI | 21831 | 6309 | 34029 | 5129 | 40261 | 4145 | 43351 | 3369 | 46510 | 2186 | 57514 | 1526 | 42721 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

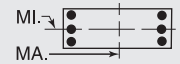


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.22 | MA | 28027 | 6309 | 42790 | 5209 | 51253 | 4214 | 55520 | 3432 | 60132 | 2249 | 75392 | 1635 | 55254 |
| 6L-5S | | MI | 22614 | 6309 | 35138 | 5130 | 41739 | 4132 | 45149 | 3374 | 48876 | 2179 | 60667 | 1635 | 43577 |
| 18-#14 | 2.22 | MA | 27040 | 6309 | 41391 | 5211 | 49401 | 4214 | 53257 | 3445 | 56984 | 2244 | 71600 | 1533 | 53724 |
| 7L-4S | | MI | 23429 | 6309 | 36385 | 5115 | 43235 | 4135 | 46976 | 3364 | 51335 | 2171 | 63794 | 1699 | 44631 |
| 18-#14 | 2.22 | MA | 26064 | 6309 | 40014 | 5213 | 47587 | 4215 | 50990 | 3444 | 53947 | 2254 | 67696 | 1455 | 52054 |
| 8L-3S | | MI | 24329 | 6309 | 37616 | 5115 | 44900 | 4122 | 48993 | 3368 | 54031 | 2179 | 66762 | 1830 | 44863 |
| 18-#14 | 2.22 | MA | 25095 | 6309 | 38493 | 5230 | 45717 | 4230 | 48760 | 3457 | 50940 | 2265 | 63830 | 1370 | 49949 |
| 9L-2S | | MI | 25568 | 6309 | 39268 | 5115 | 46994 | 4125 | 51530 | 3358 | 57428 | 2171 | 71280 | 1962 | 44982 |
| 18-#18 | 3.95 | MA | 32886 | 7454 | 55088 | 5908 | 66680 | 4707 | 74099 | 3760 | 85058 | 2176 | 109284 | 1315 | 94899 |
| 5L-6S | | MI | 24073 | 7454 | 41434 | 5814 | 49350 | 4647 | 54244 | 3675 | 60758 | 2083 | 76737 | 939 | 69452 |
| 18-#18 | 3.95 | MA | 31224 | 7454 | 52557 | 5910 | 63305 | 4733 | 69991 | 3755 | 79593 | 2191 | 101901 | 1123 | 90813 |
| 6L-5S | | MI | 25366 | 7454 | 43380 | 5817 | 51942 | 4627 | 57399 | 3686 | 64850 | 2070 | 82163 | 1133 | 72639 |
| 18-#18 | 3.95 | MA | 29595 | 7454 | 50093 | 5912 | 60044 | 4731 | 66007 | 3777 | 74053 | 2180 | 95332 | 941 | 86696 |
| 7L-4S | | MI | 26713 | 7454 | 45567 | 5793 | 54567 | 4634 | 60602 | 3671 | 69104 | 2056 | 87570 | 1243 | 74674 |
| 18-#18 | 3.95 | MA | 27984 | 7454 | 47668 | 5915 | 56849 | 4730 | 62016 | 3772 | 68707 | 2195 | 88538 | 804 | 82288 |
| 8L-3S | | MI | 28199 | 7454 | 47726 | 5795 | 57483 | 4614 | 64135 | 3682 | 73767 | 2070 | 92664 | 1476 | 77307 |
| 20-#11 | 1.71 | MA | 30879 | 5971 | 45111 | 4988 | 54440 | 4039 | 59466 | 3319 | 65481 | 2246 | 81942 | 2124 | 45430 |
| 2L-10S | | MI | 19281 | 5971 | 29118 | 4943 | 34102 | 4005 | 35890 | 3292 | 36520 | 2216 | 44835 | 1484 | 31583 |
| 20-#11 | 1.71 | MA | 29721 | 5971 | 43601 | 4990 | 52526 | 4040 | 57147 | 3329 | 62352 | 2254 | 77665 | 2033 | 45351 |
| 3L-9S | | MI | 19813 | 5971 | 29857 | 4943 | 35072 | 4006 | 37096 | 3295 | 38177 | 2222 | 46789 | 1550 | 32395 |
| 20-#11 | 1.71 | MA | 28891 | 5971 | 42484 | 4992 | 51015 | 4051 | 55316 | 3328 | 59881 | 2251 | 74838 | 1942 | 45205 |
| 4L-8S | | MI | 20348 | 5971 | 30676 | 4933 | 36079 | 3997 | 38296 | 3287 | 39788 | 2216 | 48805 | 1609 | 33064 |
| 20-#11 | 1.71 | MA | 28141 | 5971 | 41356 | 5004 | 49661 | 4051 | 53663 | 3338 | 57629 | 2259 | 71911 | 1894 | 44959 |
| 5L-7S | | MI | 20887 | 5971 | 31417 | 4932 | 37055 | 3999 | 39516 | 3290 | 41415 | 2211 | 50857 | 1661 | 33707 |
| 20-#11 | 1.71 | MA | 27423 | 5971 | 40354 | 5005 | 48325 | 4062 | 52036 | 3337 | 55465 | 2266 | 68924 | 1820 | 44062 |
| 6E | | MI | 21433 | 5971 | 32171 | 4932 | 38052 | 4000 | 40733 | 3282 | 43100 | 2216 | 52831 | 1732 | 34141 |
| 20-#11 | 1.71 | MA | 26720 | 5971 | 39380 | 5007 | 47034 | 4063 | 50459 | 3347 | 53271 | 2263 | 66261 | 1749 | 43402 |
| 7L-5S | | MI | 21990 | 5971 | 32944 | 4932 | 39083 | 3991 | 41989 | 3285 | 44763 | 2211 | 55053 | 1807 | 34820 |
| 20-#11 | 1.71 | MA | 26026 | 5971 | 38421 | 5009 | 45770 | 4064 | 48879 | 3347 | 51155 | 2271 | 63526 | 1694 | 42531 |
| 8L-4S | | MI | 22571 | 5971 | 33815 | 4921 | 40128 | 3992 | 43264 | 3277 | 46492 | 2206 | 57250 | 1852 | 34971 |
| 20-#11 | 1.71 | MA | 25337 | 5971 | 37361 | 5021 | 44467 | 4074 | 47326 | 3357 | 49060 | 2278 | 60811 | 1636 | 41557 |
| 9L-3S | | MI | 23212 | 5971 | 34675 | 4921 | 41290 | 3983 | 44672 | 3280 | 48386 | 2211 | 59344 | 1943 | 35058 |
| 20-#11 | 1.71 | MA | 24637 | 5971 | 36406 | 5023 | 43212 | 4075 | 45765 | 3356 | 46905 | 2276 | 58005 | 1556 | 40444 |
| 10L-2S | | MI | 24096 | 5971 | 35830 | 4921 | 42755 | 3984 | 46447 | 3272 | 50774 | 2206 | 62527 | 2034 | 35102 |
| 20-#14 | 2.47 | MA | 31105 | 6473 | 48010 | 5292 | 57857 | 4273 | 63550 | 3467 | 70951 | 2222 | 89921 | 1796 | 64194 |
| 4L-8S | | MI | 21102 | 6473 | 33537 | 5231 | 39527 | 4215 | 42396 | 3422 | 45193 | 2177 | 56313 | 1325 | 45116 |
| 20-#14 | 2.47 | MA | 30064 | 6473 | 46390 | 5309 | 55913 | 4274 | 61177 | 3481 | 67720 | 2232 | 85742 | 1728 | 62750 |
| 5L-7S | | MI | 21850 | 6473 | 34600 | 5231 | 40927 | 4217 | 44144 | 3427 | 47508 | 2170 | 59232 | 1399 | 46235 |
| 20-#14 | 2.47 | MA | 29068 | 6473 | 44953 | 5311 | 53996 | 4289 | 58843 | 3479 | 64615 | 2242 | 81486 | 1620 | 61501 |
| 6E | | MI | 22608 | 6473 | 35680 | 5232 | 42355 | 4220 | 45888 | 3417 | 49907 | 2177 | 62032 | 1502 | 47466 |
| 20-#14 | 2.47 | MA | 28092 | 6473 | 43554 | 5314 | 52144 | 4289 | 56580 | 3493 | 61467 | 2237 | 77694 | 1518 | 59903 |
| 7L-5S | | MI | 23382 | 6473 | 36789 | 5232 | 43833 | 4207 | 47687 | 3421 | 52272 | 2170 | 65185 | 1611 | 48293 |
| 20-#14 | 2.47 | MA | 27128 | 6473 | 42177 | 5316 | 50329 | 4290 | 54313 | 3491 | 58430 | 2247 | 73791 | 1439 | 58271 |
| 8L-4S | | MI | 24189 | 6473 | 38036 | 5217 | 45330 | 4210 | 49513 | 3411 | 54732 | 2162 | 68312 | 1675 | 49454 |
| 20-#14 | 2.47 | MA | 26170 | 6473 | 40656 | 5333 | 48459 | 4305 | 52082 | 3505 | 55423 | 2257 | 69924 | 1355 | 56128 |
| 9L-3S | | MI | 25079 | 6473 | 39268 | 5217 | 46994 | 4197 | 51530 | 3416 | 57428 | 2170 | 71280 | 1806 | 49712 |
| 20-#14 | 2.47 | MA | 25210 | 6473 | 39284 | 5335 | 46658 | 4305 | 49842 | 3503 | 52330 | 2252 | 65927 | 1239 | 54045 |
| 10L-2S | | MI | 26308 | 6473 | 40919 | 5218 | 49088 | 4199 | 54067 | 3405 | 60825 | 2162 | 75797 | 1938 | 49853 |
| 20-#18 | 4.39 | MA | 32948 | 7745 | 56350 | 6092 | 68115 | 4866 | 75819 | 3839 | 87456 | 2178 | 112475 | 1089 | 101627 |
| 6E | | MI | 25357 | 7745 | 44319 | 5996 | 53008 | 4780 | 58676 | 3759 | 66633 | 2063 | 84513 | 889 | 77586 |
| 20-#18 | 4.39 | MA | 31346 | 7745 | 53887 | 6094 | 64855 | 4864 | 71835 | 3861 | 81916 | 2167 | 105906 | 907 | 97443 |
| 7L-5S | | MI | 26630 | 7745 | 46265 | 5998 | 55601 | 4760 | 61831 | 3770 | 70724 | 2050 | 89939 | 1083 | 80896 |
| 20-#18 | 4.39 | MA | 29761 | 7745 | 51461 | 6096 | 61660 | 4863 | 67844 | 3857 | 76570 | 2182 | 99112 | 771 | 93110 |
| 8L-4S | | MI | 27957 | 7745 | 48452 | 5974 | 58226 | 4767 | 65034 | 3755 | 74979 | 2036 | 95346 | 1193 | 82846 |
| 22-#11 | 1.88 | MA | 30444 | 6085 | 45111 | 5061 | 54440 | 4092 | 59466 | 3362 | 65481 | 2249 | 81942 | 2023 | 49798 |
| 3L-10S | | MI | 19854 | 6085 | 30273 | 5014 | 35567 | 4057 | 37665 | 3325 | 38908 | 2211 | 48017 | 1468 | 34855 |
| 22-#11 | 1.88 | MA | 29620 | 6085 | 43994 | 5062 | 52929 | 4103 | 57635 | 3361 | 63010 | 2246 | 79115 | 1932 | 49637 |
| 4L-9S | | MI | 20382 | 6085 | 31012 | 5014 | 36537 | 4058 | 38871 | 3327 | 40564 | 2216 | 49972 | 1534 | 35698 |

## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

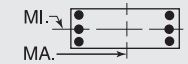



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.88 | MA | 28877 | 6085 | 42865 | 5075 | 51575 | 4103 | 55982 | 3371 | 60758 | 2254 | 76187 | 1885 | 49376 |
| 5L-8S | | MI | 20912 | 6085 | 31831 | 5004 | 37543 | 4049 | 40071 | 3320 | 42175 | 2211 | 51988 | 1593 | 36350 |
| 22-#11 | 1.88 | MA | 28165 | 6085 | 41864 | 5076 | 50239 | 4114 | 54355 | 3370 | 58594 | 2261 | 73200 | 1810 | 48420 |
| 6L-7S | | MI | 21447 | 6085 | 32572 | 5003 | 38520 | 4050 | 41291 | 3322 | 43802 | 2206 | 54039 | 1645 | 37040 |
| 22-#11 | 1.88 | MA | 27469 | 6085 | 40889 | 5078 | 48948 | 4115 | 52778 | 3380 | 56400 | 2258 | 70537 | 1739 | 47775 |
| 7L-6S | | MI | 21988 | 6085 | 33326 | 5003 | 39517 | 4052 | 42508 | 3315 | 45488 | 2211 | 56014 | 1716 | 37463 |
| 22-#11 | 1.88 | MA | 26781 | 6085 | 39930 | 5080 | 47684 | 4115 | 51199 | 3380 | 54284 | 2266 | 67802 | 1684 | 46859 |
| 8L-5S | | MI | 22540 | 6085 | 34099 | 5003 | 40548 | 4042 | 43763 | 3317 | 47151 | 2206 | 58236 | 1792 | 38122 |
| 22-#11 | 1.88 | MA | 26098 | 6085 | 38870 | 5092 | 46382 | 4126 | 49645 | 3389 | 52189 | 2273 | 65088 | 1626 | 45905 |
| 9L-4S | | MI | 23116 | 6085 | 34970 | 4992 | 41593 | 4044 | 45038 | 3310 | 48879 | 2201 | 60433 | 1837 | 38362 |
| 22-#11 | 1.88 | MA | 25413 | 6085 | 37915 | 5094 | 45127 | 4127 | 48084 | 3389 | 50034 | 2270 | 62282 | 1546 | 44763 |
| 10L-3S | | MI | 23753 | 6085 | 35830 | 4992 | 42755 | 4035 | 46447 | 3312 | 50774 | 2206 | 62527 | 1928 | 38462 |
| 22-#11 | 1.88 | MA | 24668 | 6085 | 36967 | 5095 | 43839 | 4138 | 46539 | 3399 | 47948 | 2278 | 59594 | 1488 | 43603 |
| 11L-2S | | MI | 24631 | 6085 | 36985 | 4992 | 44220 | 4036 | 48222 | 3305 | 53161 | 2201 | 65710 | 2019 | 38518 |
| 22-#14 | 2.71 | MA | 31080 | 6636 | 48553 | 5412 | 58656 | 4348 | 64500 | 3528 | 72203 | 2224 | 91837 | 1712 | 68970 |
| 5L-8S | | MI | 21884 | 6636 | 35189 | 5333 | 41621 | 4290 | 44933 | 3470 | 48590 | 2168 | 60831 | 1301 | 49817 |
| 22-#14 | 2.71 | MA | 30095 | 6636 | 47115 | 5414 | 56738 | 4364 | 62165 | 3527 | 69098 | 2234 | 87581 | 1604 | 67755 |
| 6L-7S | | MI | 22625 | 6636 | 36252 | 5334 | 43021 | 4292 | 46681 | 3474 | 50904 | 2160 | 63750 | 1375 | 50918 |
| 22-#14 | 2.71 | MA | 29130 | 6636 | 45716 | 5416 | 54886 | 4364 | 59902 | 3540 | 65950 | 2229 | 83789 | 1502 | 66090 |
| 7L-6S | | MI | 23375 | 6636 | 37331 | 5334 | 44449 | 4294 | 48425 | 3464 | 53303 | 2168 | 66549 | 1478 | 52217 |
| 22-#14 | 2.71 | MA | 28177 | 6636 | 44339 | 5418 | 53072 | 4364 | 57635 | 3539 | 62912 | 2240 | 79885 | 1423 | 64494 |
| 8L-5S | | MI | 24141 | 6636 | 38440 | 5334 | 45927 | 4282 | 50224 | 3469 | 55669 | 2160 | 69703 | 1587 | 53018 |
| 22-#14 | 2.71 | MA | 27230 | 6636 | 42818 | 5435 | 51202 | 4380 | 55405 | 3552 | 59905 | 2250 | 76019 | 1339 | 62314 |
| 9L-4S | | MI | 24939 | 6636 | 39687 | 5319 | 47424 | 4284 | 52051 | 3458 | 58129 | 2153 | 72830 | 1651 | 54275 |
| 22-#14 | 2.71 | MA | 26274 | 6636 | 41447 | 5437 | 49400 | 4380 | 53164 | 3551 | 56813 | 2245 | 72022 | 1224 | 60204 |
| 10L-3S | | MI | 25821 | 6636 | 40919 | 5320 | 49088 | 4272 | 54067 | 3463 | 60825 | 2160 | 75797 | 1782 | 54557 |
| 22-#18 | 4.82 | MA | 33068 | 8036 | 57680 | 6276 | 69666 | 4997 | 77664 | 3945 | 89779 | 2153 | 116479 | 874 | 108207 |
| 7L-6S | | MI | 26621 | 8036 | 47203 | 6178 | 56666 | 4913 | 63108 | 3843 | 72508 | 2043 | 92289 | 838 | 85738 |
| 22-#18 | 4.82 | MA | 31508 | 8036 | 55254 | 6278 | 66471 | 4996 | 73672 | 3941 | 84433 | 2168 | 109685 | 737 | 103831 |
| 8L-5S | | MI | 27877 | 8036 | 49149 | 6180 | 59259 | 4893 | 66263 | 3854 | 76599 | 2030 | 97714 | 1033 | 89115 |
| 24-#11 | 2.05 | MA | 30342 | 6198 | 45503 | 5133 | 54844 | 4155 | 59954 | 3394 | 66138 | 2241 | 83392 | 1923 | 54068 |
| 4L-10S | | MI | 20420 | 6198 | 31428 | 5085 | 37032 | 4109 | 39439 | 3358 | 41295 | 2205 | 51200 | 1453 | 38131 |
| 24-#11 | 2.05 | MA | 29605 | 6198 | 44374 | 5145 | 53489 | 4155 | 58301 | 3404 | 63887 | 2248 | 80464 | 1875 | 53745 |
| 5L-9S | | MI | 20944 | 6198 | 32167 | 5085 | 38002 | 4110 | 40645 | 3360 | 42952 | 2210 | 53155 | 1519 | 39005 |
| 24-#11 | 2.05 | MA | 28900 | 6198 | 43373 | 5147 | 52153 | 4166 | 56674 | 3403 | 61722 | 2256 | 77477 | 1800 | 52784 |
| 6L-8S | | MI | 21470 | 6198 | 32986 | 5074 | 39008 | 4101 | 41845 | 3353 | 44563 | 2205 | 55170 | 1578 | 39643 |
| 24-#11 | 2.05 | MA | 28209 | 6198 | 42398 | 5149 | 50863 | 4167 | 55097 | 3413 | 59529 | 2253 | 74814 | 1729 | 52152 |
| 7E | | MI | 22000 | 6198 | 33727 | 5074 | 39985 | 4102 | 43065 | 3355 | 46189 | 2200 | 57222 | 1630 | 40375 |
| 24-#11 | 2.05 | MA | 27527 | 6198 | 41439 | 5151 | 49599 | 4167 | 53518 | 3412 | 57413 | 2261 | 72079 | 1674 | 51193 |
| 8L-6S | | MI | 22537 | 6198 | 34481 | 5074 | 40981 | 4103 | 44283 | 3348 | 47875 | 2205 | 59197 | 1701 | 40789 |
| 24-#11 | 2.05 | MA | 26850 | 6198 | 40380 | 5163 | 48296 | 4178 | 51964 | 3422 | 55317 | 2268 | 69364 | 1616 | 50257 |
| 9L-5S | | MI | 23085 | 6198 | 35254 | 5074 | 42013 | 4094 | 45538 | 3350 | 49538 | 2200 | 61418 | 1777 | 41426 |
| 24-#11 | 2.05 | MA | 26167 | 6198 | 39424 | 5164 | 47041 | 4179 | 50403 | 3422 | 53163 | 2265 | 66559 | 1536 | 49058 |
| 10L-4S | | MI | 23657 | 6198 | 36125 | 5063 | 43057 | 4096 | 46813 | 3343 | 51267 | 2195 | 63616 | 1822 | 41750 |
| 24-#11 | 2.05 | MA | 25431 | 6198 | 38476 | 5166 | 45753 | 4190 | 48859 | 3431 | 51077 | 2273 | 63871 | 1478 | 47946 |
| 11L-3S | | MI | 24289 | 6198 | 36985 | 5063 | 44220 | 4086 | 48222 | 3345 | 53161 | 2200 | 65710 | 1913 | 41864 |
| 24-#11 | 2.05 | MA | 24712 | 6198 | 37533 | 5168 | 44501 | 4190 | 47307 | 3431 | 48940 | 2270 | 61178 | 1421 | 46509 |
| 12L-2S | | MI | 25161 | 6198 | 38140 | 5063 | 45685 | 4088 | 49996 | 3338 | 55548 | 2195 | 68893 | 2004 | 41931 |
| 24-#14 | 2.96 | MA | 31109 | 6800 | 49278 | 5516 | 59481 | 4438 | 65488 | 3574 | 73580 | 2227 | 93675 | 1588 | 74014 |
| 6L-8S | | MI | 22657 | 6800 | 36840 | 5436 | 43716 | 4364 | 47470 | 3517 | 51987 | 2159 | 65349 | 1277 | 54457 |
| 24-#14 | 2.96 | MA | 30155 | 6800 | 47879 | 5518 | 57629 | 4439 | 63225 | 3587 | 70432 | 2222 | 89883 | 1486 | 72285 |
| 7E | | MI | 23390 | 6800 | 37903 | 5436 | 45116 | 4367 | 49218 | 3522 | 54301 | 2151 | 68268 | 1351 | 55610 |
| 24-#14 | 2.96 | MA | 29213 | 6800 | 46502 | 5520 | 55814 | 4439 | 60958 | 3586 | 67395 | 2232 | 85980 | 1408 | 70723 |
| 8L-6S | | MI | 24133 | 6800 | 38983 | 5436 | 46544 | 4369 | 50963 | 3511 | 56700 | 2159 | 71067 | 1454 | 56973 |
| 24-#14 | 2.96 | MA | 28276 | 6800 | 44981 | 5537 | 53944 | 4454 | 58728 | 3600 | 64388 | 2242 | 82113 | 1324 | 68506 |
| 9L-5S | | MI | 24891 | 6800 | 40092 | 5436 | 48022 | 4357 | 52761 | 3516 | 59066 | 2151 | 74221 | 1563 | 57751 |
| 24-#14 | 2.96 | MA | 27324 | 6800 | 43609 | 5539 | 52143 | 4455 | 56487 | 3598 | 61296 | 2237 | 78116 | 1208 | 66369 |
| 10L-4S | | MI | 25682 | 6800 | 41339 | 5422 | 49518 | 4359 | 54588 | 3506 | 61526 | 2144 | 77347 | 1627 | 59094 |
| 24-#18 | 5.26 | MA | 33229 | 8327 | 59048 | 6460 | 71281 | 5129 | 79501 | 4025 | 92296 | 2155 | 120259 | 704 | 114566 |
| 8L-6S | | MI | 27870 | 8327 | 50088 | 6360 | 60324 | 5046 | 67540 | 3928 | 78383 | 2023 | 100064 | 788 | 93907 |

## RECTANGULAR TIED COLUMNS 40" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.50 | MA | 21501 | 5116 | 31835 | 4212 | 37685 | 3416 | 40623 | 2815 | 43601 | 1916 | 53209 | 1766 | 28229 |
| 2L-3S | | MI | 19135 | 5116 | 28769 | 4211 | 33796 | 3410 | 35912 | 2832 | 37321 | 1929 | 44875 | 1532 | 28067 |
| 8-#14 | 1.13 | MA | 20519 | 4897 | 29433 | 4104 | 34849 | 3339 | 37279 | 2772 | 39338 | 1952 | 47677 | 1830 | 21580 |
| 2L-4S | | MI | 18141 | 4897 | 26374 | 4105 | 30860 | 3350 | 32446 | 2779 | 32837 | 1952 | 39665 | 1568 | 21431 |
| 8-#18 | 2.00 | MA | 22911 | 5406 | 34901 | 4394 | 41573 | 3549 | 45335 | 2899 | 49881 | 1898 | 61543 | 1720 | 37307 |
| 2L-4S | | MI | 18898 | 5406 | 29545 | 4391 | 34590 | 3564 | 36874 | 2907 | 38617 | 1898 | 47741 | 1253 | 35276 |
| 10-#14 | 1.41 | MA | 21358 | 5061 | 31187 | 4206 | 37073 | 3414 | 39973 | 2819 | 42963 | 1944 | 52510 | 1808 | 26793 |
| 2L-5S | | MI | 18115 | 5061 | 26806 | 4222 | 31498 | 3423 | 33204 | 2837 | 33837 | 1951 | 41161 | 1481 | 25649 |
| 10-#14 | 1.41 | MA | 19999 | 5061 | 29433 | 4206 | 34849 | 3412 | 37279 | 2830 | 39338 | 1951 | 47677 | 1677 | 26741 |
| 3L-4S | | MI | 19011 | 5061 | 28127 | 4207 | 33084 | 3425 | 35140 | 2826 | 36462 | 1944 | 44498 | 1546 | 26557 |
| 10-#18 | 2.50 | MA | 24284 | 5697 | 37967 | 4576 | 45462 | 3682 | 50046 | 2984 | 56160 | 1880 | 69877 | 1674 | 46356 |
| 2L-5S | | MI | 18843 | 5697 | 30291 | 4598 | 35695 | 3692 | 38187 | 3008 | 40349 | 1894 | 50295 | 1095 | 41245 |
| 10-#18 | 2.50 | MA | 22005 | 5697 | 34901 | 4574 | 41573 | 3676 | 45335 | 3001 | 49881 | 1894 | 61543 | 1440 | 45987 |
| 3L-4S | | MI | 20347 | 5697 | 32611 | 4573 | 38479 | 3697 | 41585 | 2991 | 44897 | 1880 | 56075 | 1207 | 43830 |

## RECTANGULAR TIED COLUMNS 40" x 42"

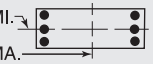
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.43 | MA | 23554 | 5328 | 34574 | 4411 | 41005 | 3579 | 44184 | 2954 | 47399 | 2028 | 57859 | 1880 | 29849 |
| 2L-3S | | MI | 19989 | 5328 | 29901 | 4394 | 35097 | 3561 | 37237 | 2960 | 38560 | 2028 | 46285 | 1627 | 28140 |
| 6-#18 | 1.43 | MA | 21039 | 5328 | 31327 | 4411 | 36886 | 3575 | 39193 | 2973 | 40715 | 2041 | 48966 | 1646 | 29687 |
| 3L-2S | | MI | 22361 | 5328 | 32967 | 4395 | 38985 | 3567 | 41948 | 2943 | 44839 | 2014 | 54620 | 1861 | 28275 |
| 8-#14 | 1.07 | MA | 22497 | 5110 | 32022 | 4303 | 37991 | 3503 | 40629 | 2911 | 42813 | 2061 | 51917 | 1941 | 22795 |
| 2L-4S | | MI | 18992 | 5110 | 27495 | 4289 | 32158 | 3502 | 33771 | 2908 | 34079 | 2051 | 41083 | 1664 | 21497 |
| 8-#14 | 1.07 | MA | 21036 | 5110 | 30166 | 4304 | 35638 | 3501 | 37777 | 2922 | 38966 | 2069 | 46769 | 1810 | 22782 |
| 3E | | MI | 19996 | 5110 | 28800 | 4289 | 33922 | 3489 | 35910 | 2912 | 36955 | 2059 | 44262 | 1795 | 21611 |
| 8-#14 | 1.07 | MA | 19975 | 5110 | 28787 | 4304 | 33772 | 3515 | 35517 | 2919 | 35915 | 2062 | 43379 | 1678 | 22646 |
| 4L-2S | | MI | 21375 | 5110 | 30554 | 4289 | 36146 | 3491 | 38604 | 2901 | 40580 | 2051 | 49094 | 1926 | 21614 |
| 8-#18 | 1.90 | MA | 25062 | 5618 | 37822 | 4593 | 45125 | 3712 | 49174 | 3038 | 54084 | 2012 | 66753 | 1838 | 39467 |
| 2L-4S | | MI | 19750 | 5618 | 30677 | 4575 | 35891 | 3715 | 38198 | 3035 | 39856 | 1997 | 49151 | 1348 | 35641 |
| 8-#18 | 1.90 | MA | 22594 | 5618 | 34574 | 4592 | 41005 | 3708 | 44184 | 3057 | 47399 | 2025 | 57859 | 1604 | 39194 |
| 3E | | MI | 21449 | 5618 | 32967 | 4576 | 38985 | 3694 | 41948 | 3044 | 44839 | 2010 | 54620 | 1581 | 37117 |
| 8-#18 | 1.90 | MA | 20799 | 5618 | 32153 | 4592 | 37732 | 3730 | 40217 | 3049 | 42095 | 2012 | 52016 | 1370 | 37624 |
| 4L-2S | | MI | 23777 | 5618 | 36033 | 4577 | 42874 | 3700 | 46659 | 3027 | 51119 | 1997 | 62954 | 1815 | 37359 |
| 10-#14 | 1.34 | MA | 23393 | 5273 | 33878 | 4405 | 40345 | 3577 | 43480 | 2958 | 46660 | 2054 | 57064 | 1921 | 28312 |
| 2L-5S | | MI | 18964 | 5273 | 27927 | 4407 | 32795 | 3575 | 34529 | 2966 | 35079 | 2051 | 42579 | 1577 | 25863 |
| 10-#14 | 1.34 | MA | 21950 | 5273 | 32022 | 4406 | 37991 | 3576 | 40629 | 2970 | 42813 | 2062 | 51917 | 1789 | 28260 |
| 3L-4S | | MI | 19863 | 5273 | 29248 | 4391 | 34382 | 3577 | 36465 | 2955 | 37704 | 2043 | 45915 | 1641 | 26630 |
| 10-#14 | 1.34 | MA | 20903 | 5273 | 30642 | 4407 | 36126 | 3590 | 38368 | 2967 | 39762 | 2054 | 48526 | 1658 | 28076 |
| 4L-3S | | MI | 20855 | 5273 | 30554 | 4391 | 36146 | 3564 | 38604 | 2959 | 40580 | 2051 | 49094 | 1773 | 26791 |
| 10-#14 | 1.34 | MA | 19953 | 5273 | 29246 | 4422 | 34450 | 3589 | 36323 | 2978 | 36978 | 2062 | 44979 | 1592 | 27246 |
| 5L-2S | | MI | 22218 | 5273 | 32308 | 4391 | 38370 | 3566 | 41298 | 2948 | 44205 | 2043 | 53927 | 1904 | 26832 |
| 10-#18 | 2.38 | MA | 26532 | 5909 | 41070 | 4774 | 49244 | 3845 | 54164 | 3123 | 60769 | 1996 | 75646 | 1795 | 49056 |
| 2L-5S | | MI | 19692 | 5909 | 31423 | 4782 | 36996 | 3843 | 39512 | 3136 | 41588 | 1992 | 51705 | 1190 | 41554 |
| 10-#18 | 2.38 | MA | 24108 | 5909 | 37822 | 4774 | 45125 | 3841 | 49174 | 3141 | 54084 | 2010 | 66753 | 1562 | 48687 |
| 3L-4S | | MI | 21204 | 5909 | 33743 | 4756 | 39780 | 3848 | 42909 | 3119 | 46135 | 1979 | 57485 | 1302 | 44185 |
| 10-#18 | 2.38 | MA | 22348 | 5909 | 35401 | 4774 | 41851 | 3863 | 45208 | 3133 | 48779 | 1996 | 60909 | 1328 | 46698 |
| 4L-3S | | MI | 22870 | 5909 | 36033 | 4758 | 42874 | 3827 | 46659 | 3129 | 51119 | 1992 | 62954 | 1535 | 46078 |
| 10-#18 | 2.38 | MA | 20752 | 5909 | 32948 | 4800 | 38908 | 3859 | 41616 | 3151 | 43938 | 2010 | 54756 | 1214 | 43844 |
| 5L-2S | | MI | 25158 | 5909 | 39099 | 4759 | 46763 | 3833 | 51370 | 3112 | 57398 | 1979 | 71288 | 1769 | 46414 |
| 12-#11 | 1.11 | MA | 22696 | 5136 | 32261 | 4333 | 38407 | 3526 | 41182 | 2928 | 43593 | 2068 | 53118 | 1953 | 23788 |
| 2L-6S | | MI | 18663 | 5136 | 26899 | 4332 | 31557 | 3533 | 33076 | 2931 | 33204 | 2072 | 39885 | 1635 | 21804 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

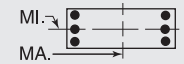
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.11 | MA | 21677 | 5136 | 30964 | 4334 | 36763 | 3526 | 39189 | 2937 | 40905 | 2074 | 49498 | 1862 | 23777 |
| 3L-5S | | MI | 19270 | 5136 | 27718 | 4332 | 32649 | 3523 | 34405 | 2933 | 34972 | 2066 | 42260 | 1711 | 22379 |
| 12-#11 | 1.11 | MA | 20938 | 5136 | 30001 | 4335 | 35461 | 3536 | 37612 | 2935 | 38775 | 2069 | 47111 | 1770 | 23718 |
| 4E | | MI | 19904 | 5136 | 28640 | 4321 | 33756 | 3524 | 35756 | 2925 | 36811 | 2061 | 44603 | 1756 | 22503 |
| 12-#11 | 1.11 | MA | 20270 | 5136 | 29027 | 4346 | 34292 | 3535 | 36185 | 2944 | 36833 | 2075 | 44622 | 1724 | 23573 |
| 5L-3S | | MI | 20603 | 5136 | 29552 | 4320 | 34988 | 3514 | 37249 | 2927 | 38826 | 2066 | 46843 | 1847 | 22551 |
| 12-#11 | 1.11 | MA | 19629 | 5136 | 28163 | 4347 | 33139 | 3545 | 34781 | 2942 | 34966 | 2081 | 42094 | 1649 | 22950 |
| 6L-2S | | MI | 21565 | 5136 | 30778 | 4320 | 36543 | 3515 | 39133 | 2919 | 41367 | 2060 | 50245 | 1938 | 22556 |
| 12-#14 | 1.61 | MA | 24274 | 5437 | 35734 | 4507 | 42699 | 3652 | 46332 | 3005 | 50507 | 2046 | 62212 | 1901 | 33811 |
| 2L-6S | | MI | 18980 | 5437 | 28506 | 4509 | 33454 | 3663 | 35318 | 3010 | 36179 | 2050 | 44038 | 1446 | 29792 |
| 12-#14 | 1.61 | MA | 22847 | 5437 | 33878 | 4508 | 40345 | 3651 | 43480 | 3017 | 46660 | 2054 | 57064 | 1769 | 33727 |
| 3L-5S | | MI | 19832 | 5437 | 29680 | 4509 | 35019 | 3650 | 37224 | 3014 | 38704 | 2043 | 47411 | 1555 | 30827 |
| 12-#14 | 1.61 | MA | 21813 | 5437 | 32498 | 4509 | 38480 | 3665 | 41220 | 3014 | 43609 | 2047 | 53674 | 1638 | 33501 |
| 4E | | MI | 20719 | 5437 | 31002 | 4494 | 36606 | 3652 | 39160 | 3003 | 41329 | 2035 | 50748 | 1619 | 31757 |
| 12-#14 | 1.61 | MA | 20876 | 5437 | 31102 | 4525 | 36804 | 3664 | 39174 | 3026 | 40825 | 2055 | 50127 | 1572 | 32508 |
| 5L-3S | | MI | 21698 | 5437 | 32308 | 4493 | 38370 | 3639 | 41298 | 3006 | 44205 | 2043 | 53927 | 1751 | 31958 |
| 12-#14 | 1.61 | MA | 19978 | 5437 | 29862 | 4525 | 35150 | 3677 | 37161 | 3023 | 38147 | 2063 | 46533 | 1464 | 31384 |
| 6L-2S | | MI | 23046 | 5437 | 34061 | 4493 | 40594 | 3641 | 43993 | 2995 | 47830 | 2035 | 58760 | 1882 | 32030 |
| 12-#18 | 2.86 | MA | 27970 | 6200 | 44318 | 4956 | 53363 | 3978 | 59155 | 3207 | 67453 | 1980 | 84539 | 1753 | 58627 |
| 2L-6S | | MI | 19716 | 6200 | 32426 | 4962 | 38135 | 3997 | 40877 | 3211 | 43494 | 1987 | 54223 | 950 | 46982 |
| 12-#18 | 2.86 | MA | 25586 | 6200 | 41070 | 4956 | 49244 | 3974 | 54164 | 3225 | 60769 | 1994 | 75646 | 1519 | 58173 |
| 3L-5S | | MI | 21139 | 6200 | 34489 | 4963 | 40884 | 3976 | 44223 | 3220 | 47867 | 1974 | 60040 | 1144 | 50279 |
| 12-#18 | 2.86 | MA | 23859 | 6200 | 38648 | 4956 | 45971 | 3996 | 50198 | 3217 | 55464 | 1980 | 69803 | 1286 | 55817 |
| 4E | | MI | 22622 | 6200 | 36809 | 4938 | 43668 | 3981 | 47621 | 3203 | 52415 | 1961 | 65819 | 1256 | 52775 |
| 12-#18 | 2.86 | MA | 22294 | 6200 | 36196 | 4982 | 43028 | 3992 | 46606 | 3236 | 50623 | 1994 | 63649 | 1172 | 53104 |
| 5L-3S | | MI | 24258 | 6200 | 39099 | 4939 | 46763 | 3960 | 51370 | 3213 | 57398 | 1974 | 71288 | 1489 | 55030 |
| 12-#18 | 2.86 | MA | 20792 | 6200 | 34016 | 4982 | 40122 | 4015 | 43069 | 3227 | 45968 | 2007 | 57442 | 978 | 49603 |
| 6L-2S | | MI | 26509 | 6200 | 42165 | 4941 | 50652 | 3965 | 56081 | 3196 | 63678 | 1961 | 79622 | 1723 | 55448 |
| 14-#11 | 1.30 | MA | 23326 | 5249 | 33558 | 4404 | 40052 | 3578 | 43174 | 2961 | 46281 | 2062 | 56738 | 1940 | 27639 |
| 2L-7S | | MI | 18692 | 5249 | 27327 | 4404 | 32056 | 3584 | 33670 | 2972 | 33952 | 2062 | 41175 | 1550 | 24789 |
| 14-#11 | 1.30 | MA | 22315 | 5249 | 32261 | 4405 | 38407 | 3578 | 41182 | 2969 | 43593 | 2069 | 53118 | 1849 | 27611 |
| 3L-6S | | MI | 19281 | 5249 | 28125 | 4403 | 33111 | 3585 | 34959 | 2963 | 35745 | 2067 | 43286 | 1621 | 25310 |
| 14-#11 | 1.30 | MA | 21584 | 5249 | 31298 | 4406 | 37105 | 3588 | 39604 | 2968 | 41463 | 2064 | 50731 | 1758 | 27531 |
| 4L-5S | | MI | 19883 | 5249 | 28944 | 4403 | 34204 | 3575 | 36289 | 2966 | 37513 | 2061 | 45661 | 1697 | 25963 |
| 14-#11 | 1.30 | MA | 20922 | 5249 | 30324 | 4417 | 35937 | 3587 | 38178 | 2976 | 39521 | 2070 | 48242 | 1711 | 27364 |
| 5L-4S | | MI | 20510 | 5249 | 29866 | 4392 | 35310 | 3576 | 37639 | 2957 | 39352 | 2056 | 48005 | 1742 | 26110 |
| 14-#11 | 1.30 | MA | 20287 | 5249 | 29459 | 4418 | 34783 | 3597 | 36774 | 2975 | 37654 | 2076 | 45714 | 1636 | 26662 |
| 6L-3S | | MI | 21203 | 5249 | 30778 | 4391 | 36543 | 3566 | 39133 | 2960 | 41367 | 2061 | 50245 | 1833 | 26178 |
| 14-#11 | 1.30 | MA | 19665 | 5249 | 28618 | 4419 | 33669 | 3597 | 35413 | 2983 | 35760 | 2072 | 43465 | 1565 | 26095 |
| 7L-2S | | MI | 22158 | 5249 | 32004 | 4391 | 38097 | 3567 | 41016 | 2951 | 43909 | 2055 | 53646 | 1925 | 26200 |
| 14-#14 | 1.88 | MA | 25141 | 5600 | 37590 | 4609 | 45052 | 3727 | 49183 | 3053 | 54354 | 2039 | 67360 | 1881 | 39300 |
| 2L-7S | | MI | 19020 | 5600 | 29115 | 4612 | 34165 | 3736 | 36164 | 3068 | 37244 | 2035 | 45873 | 1321 | 33515 |
| 14-#14 | 1.88 | MA | 23729 | 5600 | 35734 | 4610 | 42699 | 3726 | 46332 | 3064 | 50507 | 2047 | 62212 | 1749 | 39185 |
| 3L-6S | | MI | 19843 | 5600 | 30259 | 4612 | 35678 | 3738 | 38012 | 3057 | 39804 | 2042 | 48870 | 1424 | 34816 |
| 14-#14 | 1.88 | MA | 22708 | 5600 | 34354 | 4611 | 40833 | 3740 | 44071 | 3061 | 47456 | 2040 | 58822 | 1618 | 38923 |
| 4L-5S | | MI | 20684 | 5600 | 31434 | 4611 | 37243 | 3725 | 39918 | 3061 | 42328 | 2035 | 52244 | 1533 | 35809 |
| 14-#14 | 1.88 | MA | 21783 | 5600 | 32958 | 4627 | 39158 | 3739 | 42026 | 3073 | 44672 | 2047 | 55275 | 1552 | 37788 |
| 5L-4S | | MI | 21560 | 5600 | 32755 | 4596 | 38829 | 3727 | 41854 | 3050 | 44953 | 2027 | 55581 | 1597 | 36880 |
| 14-#14 | 1.88 | MA | 20896 | 5600 | 31717 | 4628 | 37504 | 3752 | 40013 | 3070 | 41994 | 2055 | 51681 | 1443 | 36708 |
| 6L-3S | | MI | 22527 | 5600 | 34061 | 4596 | 40594 | 3714 | 43993 | 3054 | 47830 | 2035 | 58760 | 1729 | 37117 |
| 14-#14 | 1.88 | MA | 20028 | 5600 | 30510 | 4629 | 35906 | 3751 | 38061 | 3082 | 39280 | 2048 | 48485 | 1341 | 35320 |
| 7L-2S | | MI | 23861 | 5600 | 35815 | 4595 | 42818 | 3715 | 46687 | 3043 | 51454 | 2027 | 63592 | 1860 | 37218 |
| 14-#18 | 3.33 | MA | 27034 | 6491 | 44318 | 5138 | 53363 | 4107 | 59155 | 3309 | 67453 | 1978 | 84539 | 1477 | 67653 |
| 3L-6S | | MI | 21156 | 6491 | 35492 | 5144 | 42024 | 4130 | 45588 | 3295 | 49773 | 1970 | 62557 | 904 | 55598 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

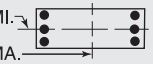



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.33 | MA | 25337 | 6491 | 41896 | 5137 | 50090 | 4129 | 55188 | 3301 | 62149 | 1964 | 78696 | 1243 | 64975 |
| 4L-5S | | MI | 22554 | 6491 | 37556 | 5145 | 44773 | 4109 | 48934 | 3305 | 54147 | 1956 | 68374 | 1098 | 59027 |
| 14-#18 | 3.33 | MA | 23800 | 6491 | 39444 | 5164 | 47147 | 4125 | 51597 | 3320 | 57308 | 1978 | 72543 | 1130 | 62386 |
| 5L-4S | | MI | 24010 | 6491 | 39875 | 5120 | 47557 | 4114 | 52332 | 3288 | 58694 | 1943 | 74153 | 1210 | 61403 |
| 14-#18 | 3.33 | MA | 22326 | 6491 | 37264 | 5163 | 44241 | 4148 | 48060 | 3312 | 52652 | 1991 | 66335 | 936 | 58756 |
| 6L-3S | | MI | 25618 | 6491 | 42165 | 5121 | 50652 | 4093 | 56081 | 3297 | 63678 | 1956 | 79622 | 1443 | 63976 |
| 14-#18 | 3.33 | MA | 20881 | 6491 | 35141 | 5163 | 41433 | 4143 | 44630 | 3330 | 47931 | 1978 | 60824 | 754 | 55193 |
| 7L-2S | | MI | 27834 | 6491 | 45232 | 5122 | 54540 | 4098 | 60793 | 3280 | 69958 | 1943 | 87956 | 1677 | 64469 |
| 16-#11 | 1.49 | MA | 23948 | 5363 | 34854 | 4475 | 41696 | 3630 | 45167 | 2994 | 48969 | 2057 | 60358 | 1927 | 31482 |
| 2L-8S | | MI | 18731 | 5363 | 27768 | 4475 | 32577 | 3635 | 34262 | 3002 | 34763 | 2062 | 42388 | 1484 | 27574 |
| 16-#11 | 1.49 | MA | 22945 | 5363 | 33558 | 4476 | 40052 | 3630 | 43174 | 3002 | 46281 | 2063 | 56738 | 1836 | 31439 |
| 3L-7S | | MI | 19308 | 5363 | 28553 | 4475 | 33611 | 3636 | 35553 | 3004 | 36493 | 2057 | 44576 | 1537 | 28318 |
| 16-#11 | 1.49 | MA | 22220 | 5363 | 32595 | 4477 | 38750 | 3640 | 41597 | 3001 | 44151 | 2059 | 54351 | 1745 | 31341 |
| 4L-6S | | MI | 19892 | 5363 | 29351 | 4474 | 34666 | 3636 | 36843 | 2996 | 38286 | 2061 | 46688 | 1608 | 28823 |
| 16-#11 | 1.49 | MA | 21565 | 5363 | 31621 | 4488 | 37581 | 3639 | 40170 | 3009 | 42209 | 2065 | 51862 | 1699 | 31154 |
| 5E | | MI | 20488 | 5363 | 30170 | 4474 | 35758 | 3627 | 38172 | 2998 | 40054 | 2056 | 49062 | 1683 | 29545 |
| 16-#11 | 1.49 | MA | 20936 | 5363 | 30756 | 4489 | 36428 | 3649 | 38766 | 3008 | 40342 | 2071 | 49334 | 1624 | 30382 |
| 6L-4S | | MI | 21109 | 5363 | 31092 | 4463 | 36865 | 3628 | 39523 | 2990 | 41893 | 2051 | 51406 | 1728 | 29712 |
| 16-#11 | 1.49 | MA | 20320 | 5363 | 29914 | 4490 | 35314 | 3649 | 37405 | 3016 | 38449 | 2067 | 47085 | 1553 | 29832 |
| 7L-3S | | MI | 21795 | 5363 | 32004 | 4462 | 38097 | 3618 | 41016 | 2992 | 43909 | 2056 | 53646 | 1819 | 29798 |
| 16-#11 | 1.49 | MA | 19712 | 5363 | 29086 | 4491 | 34222 | 3648 | 36041 | 3015 | 36622 | 2073 | 44760 | 1499 | 29033 |
| 8L-2S | | MI | 22743 | 5363 | 33229 | 4461 | 39652 | 3619 | 42900 | 2984 | 46450 | 2050 | 57047 | 1911 | 29835 |
| 16-#14 | 2.14 | MA | 25995 | 5764 | 39445 | 4712 | 47406 | 3802 | 52034 | 3100 | 58201 | 2031 | 72508 | 1860 | 44781 |
| 2L-8S | | MI | 19075 | 5764 | 29743 | 4714 | 34906 | 3810 | 37006 | 3112 | 38399 | 2034 | 47590 | 1224 | 37214 |
| 16-#14 | 2.14 | MA | 24598 | 5764 | 37590 | 4712 | 45052 | 3801 | 49183 | 3112 | 54354 | 2039 | 67360 | 1729 | 44638 |
| 3L-7S | | MI | 19878 | 5764 | 30869 | 4714 | 36388 | 3811 | 38858 | 3116 | 40869 | 2026 | 50705 | 1299 | 38475 |
| 16-#14 | 2.14 | MA | 23589 | 5764 | 36210 | 4713 | 43187 | 3814 | 46922 | 3109 | 51303 | 2032 | 63970 | 1597 | 44344 |
| 4L-6S | | MI | 20692 | 5764 | 32013 | 4714 | 37902 | 3813 | 40706 | 3105 | 43429 | 2034 | 53703 | 1402 | 39849 |
| 16-#14 | 2.14 | MA | 22675 | 5764 | 34814 | 4729 | 41511 | 3813 | 44877 | 3120 | 48519 | 2040 | 60422 | 1532 | 43082 |
| 5E | | MI | 21522 | 5764 | 33187 | 4713 | 39467 | 3800 | 42612 | 3108 | 45953 | 2026 | 57077 | 1511 | 40805 |
| 16-#14 | 2.14 | MA | 21799 | 5764 | 33573 | 4730 | 39857 | 3827 | 42864 | 3117 | 45841 | 2048 | 56829 | 1423 | 42041 |
| 6L-4S | | MI | 22388 | 5764 | 34509 | 4698 | 41053 | 3802 | 44548 | 3097 | 48578 | 2019 | 60413 | 1575 | 42001 |
| 16-#14 | 2.14 | MA | 20941 | 5764 | 32366 | 4731 | 38260 | 3826 | 40912 | 3129 | 43127 | 2041 | 53633 | 1321 | 40582 |
| 7L-3S | | MI | 23344 | 5764 | 35815 | 4698 | 42818 | 3788 | 46687 | 3101 | 51454 | 2026 | 63592 | 1707 | 42269 |
| 16-#14 | 2.14 | MA | 20094 | 5764 | 31177 | 4732 | 36694 | 3825 | 38956 | 3126 | 40507 | 2048 | 50320 | 1245 | 39218 |
| 8L-2S | | MI | 24664 | 5764 | 37568 | 4697 | 45042 | 3790 | 49381 | 3090 | 55079 | 2019 | 68425 | 1838 | 42398 |
| 16-#18 | 3.81 | MA | 26786 | 6782 | 45144 | 5319 | 54209 | 4262 | 60179 | 3386 | 68833 | 1948 | 87589 | 1201 | 74164 |
| 4L-6S | | MI | 22567 | 6782 | 38559 | 5326 | 45912 | 4263 | 50299 | 3379 | 56053 | 1952 | 70891 | 858 | 64239 |
| 16-#18 | 3.81 | MA | 25276 | 6782 | 42692 | 5345 | 51266 | 4258 | 56587 | 3404 | 63992 | 1962 | 81436 | 1087 | 71687 |
| 5E | | MI | 23940 | 6782 | 40622 | 5327 | 48662 | 4242 | 53645 | 3389 | 60426 | 1939 | 76708 | 1052 | 67793 |
| 16-#18 | 3.81 | MA | 23828 | 6782 | 40512 | 5345 | 48360 | 4281 | 53050 | 3396 | 59337 | 1975 | 75228 | 894 | 67933 |
| 6L-4S | | MI | 25372 | 6782 | 42942 | 5302 | 51446 | 4247 | 57043 | 3372 | 64974 | 1925 | 82487 | 1164 | 70063 |
| 16-#18 | 3.81 | MA | 22409 | 6782 | 38389 | 5345 | 45552 | 4276 | 49620 | 3414 | 54616 | 1962 | 69717 | 711 | 64152 |
| 7L-3S | | MI | 26953 | 6782 | 45232 | 5303 | 54540 | 4226 | 60793 | 3381 | 69958 | 1939 | 87956 | 1397 | 72918 |
| 18-#11 | 1.67 | MA | 24563 | 5476 | 36151 | 4546 | 43341 | 3682 | 47159 | 3026 | 51657 | 2052 | 63978 | 1914 | 35320 |
| 2L-9S | | MI | 18777 | 5476 | 28127 | 4557 | 33066 | 3696 | 34874 | 3043 | 35590 | 2062 | 43634 | 1411 | 30326 |
| 18-#11 | 1.67 | MA | 23568 | 5476 | 34854 | 4547 | 41696 | 3681 | 45167 | 3035 | 48969 | 2058 | 60358 | 1823 | 35263 |
| 3L-8S | | MI | 19345 | 5476 | 28994 | 4546 | 34131 | 3687 | 36145 | 3035 | 37304 | 2057 | 45789 | 1470 | 31061 |
| 18-#11 | 1.67 | MA | 22849 | 5476 | 33892 | 4548 | 40395 | 3691 | 43589 | 3033 | 46839 | 2054 | 57971 | 1732 | 35147 |
| 4L-7S | | MI | 19916 | 5476 | 29779 | 4546 | 35165 | 3688 | 37437 | 3037 | 39034 | 2051 | 47977 | 1523 | 31852 |
| 18-#11 | 1.67 | MA | 22199 | 5476 | 32918 | 4559 | 39226 | 3691 | 42162 | 3042 | 44897 | 2060 | 55482 | 1686 | 34924 |
| 5L-6S | | MI | 20494 | 5476 | 30577 | 4545 | 36221 | 3688 | 38726 | 3029 | 40827 | 2056 | 50089 | 1594 | 32343 |
| 18-#11 | 1.67 | MA | 21577 | 5476 | 32053 | 4560 | 38073 | 3701 | 40758 | 3040 | 43030 | 2066 | 52954 | 1611 | 34109 |
| 6L-5S | | MI | 21085 | 5476 | 31396 | 4544 | 37313 | 3679 | 40056 | 3031 | 42595 | 2051 | 52464 | 1669 | 33092 |
| 18-#11 | 1.67 | MA | 20967 | 5476 | 31211 | 4561 | 36959 | 3701 | 39397 | 3049 | 41137 | 2062 | 50705 | 1540 | 33573 |
| 7L-4S | | MI | 21701 | 5476 | 32318 | 4534 | 38420 | 3680 | 41406 | 3023 | 44434 | 2045 | 54807 | 1714 | 33311 |
| 18-#11 | 1.67 | MA | 20364 | 5476 | 30382 | 4562 | 35867 | 3700 | 38034 | 3047 | 39310 | 2068 | 48380 | 1487 | 32728 |
| 8L-3S | | MI | 22381 | 5476 | 33229 | 4533 | 39652 | 3670 | 42900 | 3025 | 46450 | 2050 | 57047 | 1806 | 33414 |

## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

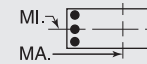



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.67 | MA | 19766 | 5476 | 29467 | 4573 | 34742 | 3710 | 36692 | 3056 | 37501 | 2074 | 46085 | 1428 | 31933 |
| 9L-2S | | MI | 23321 | 5476 | 34455 | 4532 | 41207 | 3671 | 44783 | 3017 | 48991 | 2045 | 60449 | 1897 | 33464 |
| 18-#14 | 2.41 | MA | 26838 | 5927 | 41301 | 4814 | 49759 | 3877 | 54886 | 3147 | 62048 | 2024 | 77655 | 1840 | 50256 |
| 2L-9S | | MI | 19141 | 5927 | 30254 | 4832 | 35602 | 3897 | 37879 | 3170 | 39578 | 2033 | 49363 | 1117 | 40362 |
| 18-#14 | 2.41 | MA | 25454 | 5927 | 39445 | 4815 | 47406 | 3876 | 52034 | 3159 | 58201 | 2032 | 72508 | 1709 | 50087 |
| 3L-8S | | MI | 19930 | 5927 | 31497 | 4817 | 37130 | 3884 | 39701 | 3159 | 42024 | 2026 | 52422 | 1202 | 42161 |
| 18-#14 | 2.41 | MA | 24456 | 5927 | 38066 | 4816 | 45540 | 3889 | 49774 | 3156 | 55150 | 2025 | 69117 | 1577 | 49762 |
| 4L-7S | | MI | 20724 | 5927 | 32623 | 4816 | 38612 | 3886 | 41553 | 3163 | 44494 | 2018 | 55538 | 1277 | 43446 |
| 18-#14 | 2.41 | MA | 23554 | 5927 | 36669 | 4831 | 43865 | 3888 | 47729 | 3168 | 52366 | 2032 | 65570 | 1512 | 48388 |
| 5L-6S | | MI | 21527 | 5927 | 33766 | 4816 | 40125 | 3888 | 43401 | 3152 | 47053 | 2026 | 58536 | 1380 | 44889 |
| 18-#14 | 2.41 | MA | 22688 | 5927 | 35429 | 4832 | 42211 | 3902 | 45716 | 3165 | 49688 | 2040 | 61976 | 1403 | 47381 |
| 6L-5S | | MI | 22348 | 5927 | 34941 | 4816 | 41691 | 3875 | 45307 | 3156 | 49578 | 2018 | 61909 | 1489 | 45812 |
| 18-#14 | 2.41 | MA | 21841 | 5927 | 34222 | 4833 | 40613 | 3901 | 43764 | 3176 | 46974 | 2033 | 58780 | 1301 | 45854 |
| 7L-4S | | MI | 23204 | 5927 | 36263 | 4800 | 43277 | 3876 | 47243 | 3145 | 52203 | 2011 | 65246 | 1553 | 47119 |
| 18-#14 | 2.41 | MA | 21003 | 5927 | 33033 | 4834 | 39047 | 3900 | 41808 | 3173 | 44354 | 2041 | 55468 | 1225 | 44488 |
| 8L-3S | | MI | 24149 | 5927 | 37568 | 4800 | 45042 | 3863 | 49381 | 3149 | 55079 | 2018 | 68425 | 1685 | 47417 |
| 18-#14 | 2.41 | MA | 20171 | 5927 | 31720 | 4850 | 37434 | 3913 | 39884 | 3185 | 41760 | 2049 | 52207 | 1140 | 42550 |
| 9L-2S | | MI | 25456 | 5927 | 39322 | 4800 | 47266 | 3865 | 52076 | 3138 | 58704 | 2011 | 73258 | 1816 | 47572 |
| 18-#18 | 4.29 | MA | 26726 | 7072 | 45940 | 5527 | 55385 | 4391 | 61578 | 3488 | 70677 | 1946 | 90329 | 1045 | 81005 |
| 5L-6S | | MI | 23952 | 7072 | 41625 | 5507 | 49801 | 4396 | 55011 | 3464 | 62333 | 1934 | 79225 | 812 | 72901 |
| 18-#18 | 4.29 | MA | 25302 | 7072 | 43760 | 5527 | 52479 | 4414 | 58041 | 3480 | 66022 | 1959 | 84122 | 851 | 77131 |
| 6L-5S | | MI | 25302 | 7072 | 43688 | 5509 | 52551 | 4375 | 58357 | 3473 | 66706 | 1921 | 85042 | 1006 | 76576 |
| 18-#18 | 4.29 | MA | 23907 | 7072 | 41637 | 5527 | 49671 | 4409 | 54610 | 3499 | 61301 | 1946 | 78610 | 669 | 73278 |
| 7L-4S | | MI | 26711 | 7072 | 46008 | 5483 | 55335 | 4380 | 61754 | 3456 | 71254 | 1908 | 90822 | 1118 | 78750 |
| 20-#11 | 1.86 | MA | 25171 | 5589 | 37448 | 4617 | 44985 | 3734 | 49151 | 3059 | 54345 | 2047 | 67598 | 1902 | 39154 |
| 2L-10S | | MI | 18829 | 5589 | 28571 | 4629 | 33593 | 3747 | 35481 | 3074 | 36370 | 2052 | 44807 | 1317 | 32823 |
| 20-#11 | 1.86 | MA | 24183 | 5589 | 36151 | 4618 | 43341 | 3733 | 47159 | 3068 | 51657 | 2053 | 63978 | 1811 | 39083 |
| 3L-9S | | MI | 19388 | 5589 | 29353 | 4628 | 34620 | 3748 | 36758 | 3076 | 38132 | 2057 | 47035 | 1397 | 33836 |
| 20-#11 | 1.86 | MA | 23471 | 5589 | 35188 | 4619 | 42039 | 3743 | 45581 | 3066 | 49527 | 2049 | 61591 | 1720 | 38952 |
| 4L-8S | | MI | 19951 | 5589 | 30220 | 4617 | 35686 | 3739 | 38029 | 3068 | 39845 | 2052 | 49190 | 1456 | 34554 |
| 20-#11 | 1.86 | MA | 22827 | 5589 | 34214 | 4630 | 40870 | 3743 | 44155 | 3075 | 47585 | 2055 | 59102 | 1673 | 38628 |
| 5L-7S | | MI | 20517 | 5589 | 31005 | 4617 | 36720 | 3739 | 39320 | 3070 | 41575 | 2046 | 51378 | 1509 | 35389 |
| 20-#11 | 1.86 | MA | 22210 | 5589 | 33350 | 4631 | 39717 | 3753 | 42751 | 3073 | 45718 | 2061 | 56574 | 1598 | 37842 |
| 6E | | MI | 21089 | 5589 | 31802 | 4616 | 37775 | 3740 | 40609 | 3062 | 43368 | 2051 | 53490 | 1580 | 35869 |
| 20-#11 | 1.86 | MA | 21606 | 5589 | 32508 | 4632 | 38603 | 3752 | 41390 | 3082 | 43825 | 2056 | 54325 | 1527 | 37318 |
| 7L-5S | | MI | 21675 | 5589 | 32622 | 4615 | 38868 | 3731 | 41939 | 3064 | 45137 | 2046 | 55865 | 1655 | 36590 |
| 20-#11 | 1.86 | MA | 21009 | 5589 | 31679 | 4633 | 37511 | 3752 | 40026 | 3080 | 41998 | 2062 | 52000 | 1474 | 36430 |
| 8L-4S | | MI | 22285 | 5589 | 33544 | 4604 | 39974 | 3731 | 43290 | 3056 | 46976 | 2040 | 58208 | 1700 | 36907 |
| 20-#11 | 1.86 | MA | 20416 | 5589 | 30764 | 4644 | 36386 | 3762 | 38684 | 3089 | 40189 | 2069 | 49705 | 1415 | 35652 |
| 9L-3S | | MI | 22960 | 5589 | 34455 | 4604 | 41207 | 3722 | 44783 | 3058 | 48991 | 2045 | 60449 | 1792 | 37026 |
| 20-#11 | 1.86 | MA | 19826 | 5589 | 29939 | 4645 | 35302 | 3762 | 37336 | 3087 | 38329 | 2064 | 47332 | 1335 | 34544 |
| 10L-2S | | MI | 23893 | 5589 | 35681 | 4603 | 42761 | 3723 | 46667 | 3050 | 51532 | 2040 | 63850 | 1883 | 37089 |
| 20-#14 | 2.68 | MA | 26299 | 6091 | 41301 | 4917 | 49759 | 3950 | 54886 | 3207 | 62048 | 2024 | 77655 | 1689 | 55533 |
| 3L-9S | | MI | 19992 | 6091 | 32007 | 4934 | 37826 | 3972 | 40573 | 3218 | 43203 | 2025 | 54195 | 1095 | 45336 |
| 20-#14 | 2.68 | MA | 25312 | 6091 | 39921 | 4918 | 47894 | 3964 | 52625 | 3203 | 58997 | 2017 | 74265 | 1557 | 55180 |
| 4L-8S | | MI | 20772 | 6091 | 33250 | 4919 | 39354 | 3959 | 42395 | 3207 | 45649 | 2018 | 57255 | 1180 | 47093 |
| 20-#14 | 2.68 | MA | 24420 | 6091 | 38525 | 4934 | 46218 | 3963 | 50580 | 3215 | 56213 | 2025 | 70718 | 1491 | 53705 |
| 5L-7S | | MI | 21557 | 6091 | 34376 | 4919 | 40836 | 3961 | 44247 | 3210 | 48119 | 2010 | 60371 | 1255 | 48427 |
| 20-#14 | 2.68 | MA | 23564 | 6091 | 37285 | 4934 | 44565 | 3977 | 48567 | 3212 | 53535 | 2033 | 67124 | 1383 | 52728 |
| 6E | | MI | 22351 | 6091 | 35520 | 4918 | 42349 | 3963 | 46095 | 3199 | 50678 | 2018 | 63368 | 1358 | 49935 |
| 20-#14 | 2.68 | MA | 22727 | 6091 | 36077 | 4935 | 42967 | 3976 | 46615 | 3224 | 50821 | 2026 | 63928 | 1280 | 51135 |
| 7L-5S | | MI | 23162 | 6091 | 36694 | 4918 | 43915 | 3949 | 48001 | 3203 | 53203 | 2010 | 66742 | 1467 | 50830 |
| 20-#14 | 2.68 | MA | 21899 | 6091 | 34889 | 4936 | 41401 | 3974 | 44659 | 3221 | 48201 | 2033 | 60616 | 1204 | 49723 |
| 8L-4S | | MI | 24009 | 6091 | 38016 | 4903 | 45501 | 3951 | 49937 | 3192 | 55828 | 2003 | 70079 | 1531 | 52236 |
| 20-#14 | 2.68 | MA | 21077 | 6091 | 33576 | 4952 | 39788 | 3988 | 42735 | 3232 | 45607 | 2041 | 57354 | 1120 | 47827 |
| 9L-3S | | MI | 24944 | 6091 | 39322 | 4902 | 47266 | 3938 | 52076 | 3196 | 58704 | 2010 | 73258 | 1663 | 52562 |
| 20-#18 | 4.76 | MA | 26751 | 7363 | 47008 | 5709 | 56598 | 4547 | 63031 | 3564 | 72706 | 1943 | 93015 | 809 | 86348 |
| 6E | | MI | 25314 | 7363 | 44691 | 5689 | 53690 | 4529 | 59722 | 3548 | 68612 | 1916 | 87559 | 766 | 81582 |
| 20-#18 | 4.76 | MA | 25379 | 7363 | 44885 | 5708 | 53790 | 4542 | 59601 | 3583 | 67985 | 1930 | 87503 | 627 | 82422 |
| 7L-5S | | MI | 26644 | 7363 | 46754 | 5690 | 56439 | 4508 | 63068 | 3557 | 72986 | 1903 | 93376 | 960 | 85233 |


## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

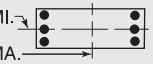



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.04 | MA | 24792 | 5703 | 37448 | 4688 | 44985 | 3785 | 49151 | 3101 | 54345 | 2048 | 67598 | 1798 | 42901 |
| 3L-10S | | MI | 19438 | 5703 | 29797 | 4700 | 35148 | 3799 | 37364 | 3107 | 38911 | 2047 | 48208 | 1303 | 36285 |
| 22-#11 | 2.04 | MA | 24086 | 5703 | 36485 | 4689 | 43684 | 3795 | 47574 | 3099 | 52216 | 2044 | 65211 | 1707 | 42754 |
| 4L-9S | | MI | 19992 | 5703 | 30579 | 4699 | 36175 | 3800 | 38641 | 3109 | 40673 | 2052 | 50436 | 1383 | 37350 |
| 22-#11 | 2.04 | MA | 23447 | 5703 | 35511 | 4701 | 42515 | 3795 | 46147 | 3108 | 50273 | 2050 | 62722 | 1661 | 42340 |
| 5L-8S | | MI | 20549 | 5703 | 31446 | 4688 | 37241 | 3790 | 39912 | 3101 | 42386 | 2046 | 52591 | 1442 | 38052 |
| 22-#11 | 2.04 | MA | 22836 | 5703 | 34646 | 4702 | 41362 | 3805 | 44743 | 3106 | 48406 | 2056 | 60194 | 1585 | 41579 |
| 6L-7S | | MI | 21110 | 5703 | 32231 | 4687 | 38275 | 3791 | 41204 | 3103 | 44116 | 2041 | 54780 | 1495 | 38929 |
| 22-#11 | 2.04 | MA | 22237 | 5703 | 33805 | 4703 | 40248 | 3804 | 43382 | 3115 | 46513 | 2051 | 57945 | 1515 | 41066 |
| 7L-6S | | MI | 21678 | 5703 | 33028 | 4687 | 39330 | 3792 | 42493 | 3095 | 45909 | 2046 | 56892 | 1566 | 39399 |
| 22-#11 | 2.04 | MA | 21645 | 5703 | 32976 | 4703 | 39156 | 3804 | 42018 | 3113 | 44686 | 2057 | 55620 | 1461 | 40136 |
| 8L-5S | | MI | 22258 | 5703 | 33847 | 4686 | 40422 | 3782 | 43823 | 3097 | 47678 | 2041 | 59266 | 1641 | 40096 |
| 22-#11 | 2.04 | MA | 21058 | 5703 | 32061 | 4715 | 38031 | 3814 | 40677 | 3122 | 42877 | 2063 | 53325 | 1402 | 39375 |
| 9L-4S | | MI | 22864 | 5703 | 34770 | 4675 | 41529 | 3783 | 45173 | 3089 | 49517 | 2035 | 61610 | 1687 | 40502 |
| 22-#11 | 2.04 | MA | 20473 | 5703 | 31235 | 4716 | 36947 | 3813 | 39329 | 3120 | 41017 | 2059 | 50952 | 1322 | 38241 |
| 10L-3S | | MI | 23533 | 5703 | 35681 | 4675 | 42761 | 3774 | 46667 | 3091 | 51532 | 2040 | 63850 | 1778 | 40635 |
| 22-#11 | 2.04 | MA | 19869 | 5703 | 30416 | 4717 | 35835 | 3823 | 37995 | 3129 | 39216 | 2065 | 48668 | 1266 | 37173 |
| 11L-2S | | MI | 24459 | 5703 | 36907 | 4674 | 44316 | 3774 | 48550 | 3083 | 54073 | 2035 | 67251 | 1869 | 40711 |
| 22-#14 | 2.95 | MA | 26157 | 6255 | 41777 | 5020 | 50248 | 4039 | 55477 | 3251 | 62844 | 2010 | 79413 | 1537 | 60597 |
| 4L-9S | | MI | 20832 | 6255 | 33761 | 5036 | 40050 | 4047 | 43267 | 3265 | 46827 | 2017 | 59028 | 1073 | 50317 |
| 22-#14 | 2.95 | MA | 25275 | 6255 | 40381 | 5036 | 48572 | 4038 | 53432 | 3263 | 60060 | 2018 | 75866 | 1471 | 59030 |
| 5L-8S | | MI | 21603 | 6255 | 35004 | 5021 | 41578 | 4034 | 45089 | 3254 | 49273 | 2010 | 62088 | 1158 | 52035 |
| 22-#14 | 2.95 | MA | 24429 | 6255 | 39141 | 5037 | 46918 | 4052 | 51418 | 3259 | 57382 | 2025 | 72272 | 1363 | 58081 |
| 6L-7S | | MI | 22379 | 6255 | 36130 | 5021 | 43060 | 4036 | 46941 | 3258 | 51743 | 2002 | 65203 | 1233 | 53417 |
| 22-#14 | 2.95 | MA | 23601 | 6255 | 37933 | 5037 | 45321 | 4050 | 49466 | 3271 | 54668 | 2018 | 69076 | 1260 | 56425 |
| 7L-6S | | MI | 23164 | 6255 | 37273 | 5020 | 44573 | 4037 | 48790 | 3247 | 54303 | 2010 | 68201 | 1336 | 54987 |
| 22-#14 | 2.95 | MA | 22783 | 6255 | 36744 | 5038 | 43755 | 4049 | 47511 | 3268 | 52048 | 2026 | 65763 | 1184 | 54966 |
| 8L-5S | | MI | 23967 | 6255 | 38448 | 5020 | 46139 | 4024 | 50695 | 3251 | 56828 | 2002 | 71574 | 1445 | 55857 |
| 22-#14 | 2.95 | MA | 21970 | 6255 | 35432 | 5054 | 42141 | 4063 | 45586 | 3280 | 49454 | 2034 | 62502 | 1099 | 53111 |
| 9L-4S | | MI | 24804 | 6255 | 39770 | 5005 | 47725 | 4026 | 52631 | 3240 | 59453 | 1995 | 74911 | 1509 | 57353 |
| 22-#18 | 5.24 | MA | 26828 | 7654 | 48133 | 5890 | 57909 | 4675 | 64591 | 3667 | 74670 | 1914 | 96397 | 584 | 91583 |
| 7L-6S | | MI | 26656 | 7654 | 47757 | 5871 | 57579 | 4662 | 64433 | 3632 | 74892 | 1898 | 95894 | 720 | 90280 |
| 24-#11 | 2.23 | MA | 24694 | 5816 | 37782 | 4760 | 45328 | 3847 | 49566 | 3132 | 54904 | 2038 | 68831 | 1694 | 46555 |
| 4L-10S | | MI | 20039 | 5816 | 31022 | 4770 | 36703 | 3851 | 39248 | 3140 | 41452 | 2042 | 51609 | 1289 | 39776 |
| 24-#11 | 2.23 | MA | 24061 | 5816 | 36808 | 4772 | 44160 | 3847 | 48140 | 3141 | 52961 | 2044 | 66342 | 1648 | 46058 |
| 5L-9S | | MI | 20589 | 5816 | 31805 | 4770 | 37730 | 3852 | 40525 | 3142 | 43214 | 2047 | 53838 | 1369 | 40822 |
| 24-#11 | 2.23 | MA | 23455 | 5816 | 35943 | 4772 | 43006 | 3857 | 46736 | 3139 | 51094 | 2050 | 63814 | 1573 | 45321 |
| 6L-8S | | MI | 21141 | 5816 | 32671 | 4759 | 38795 | 3842 | 41795 | 3134 | 44927 | 2041 | 55993 | 1428 | 41556 |
| 24-#11 | 2.23 | MA | 22861 | 5816 | 35101 | 4773 | 41892 | 3856 | 45374 | 3148 | 49201 | 2046 | 61565 | 1502 | 44818 |
| 7E | | MI | 21698 | 5816 | 33457 | 4758 | 39829 | 3843 | 43087 | 3136 | 46657 | 2036 | 58181 | 1481 | 42472 |
| 24-#11 | 2.23 | MA | 22275 | 5816 | 34273 | 4774 | 40801 | 3856 | 44011 | 3146 | 47374 | 2052 | 59240 | 1448 | 43848 |
| 8L-6S | | MI | 22261 | 5816 | 34254 | 4758 | 40885 | 3844 | 44376 | 3128 | 48450 | 2041 | 60293 | 1552 | 42933 |
| 24-#11 | 2.23 | MA | 21693 | 5816 | 33358 | 4786 | 39676 | 3866 | 42669 | 3155 | 45565 | 2058 | 56945 | 1390 | 43071 |
| 9L-5S | | MI | 22836 | 5816 | 35073 | 4757 | 41977 | 3834 | 45706 | 3130 | 50219 | 2035 | 62667 | 1627 | 43608 |
| 24-#11 | 2.23 | MA | 21113 | 5816 | 32532 | 4787 | 38591 | 3865 | 41321 | 3153 | 43705 | 2054 | 54572 | 1310 | 41942 |
| 10L-4S | | MI | 23436 | 5816 | 35996 | 4746 | 43084 | 3835 | 47057 | 3122 | 52058 | 2030 | 65011 | 1673 | 44094 |
| 24-#11 | 2.23 | MA | 20510 | 5816 | 31713 | 4787 | 37479 | 3875 | 39988 | 3162 | 41904 | 2060 | 52287 | 1253 | 40852 |
| 11L-3S | | MI | 24100 | 5816 | 36907 | 4746 | 44316 | 3826 | 48550 | 3124 | 54073 | 2035 | 67251 | 1764 | 44241 |
| 24-#14 | 3.21 | MA | 26119 | 6418 | 42237 | 5138 | 50926 | 4113 | 56283 | 3310 | 63907 | 2010 | 81013 | 1451 | 64363 |
| 5L-9S | | MI | 21660 | 6418 | 35515 | 5139 | 42274 | 4122 | 45962 | 3312 | 50452 | 2009 | 63860 | 1051 | 55305 |
| 24-#14 | 3.21 | MA | 25283 | 6418 | 40996 | 5139 | 49272 | 4126 | 54270 | 3307 | 61229 | 2018 | 77420 | 1342 | 63439 |
| 6L-8S | | MI | 22423 | 6418 | 36757 | 5123 | 43802 | 4109 | 47784 | 3301 | 52898 | 2002 | 66920 | 1136 | 56985 |
| 24-#14 | 3.21 | MA | 24464 | 6418 | 39789 | 5140 | 47674 | 4125 | 52318 | 3319 | 58515 | 2011 | 74224 | 1240 | 61723 |
| 7E | | MI | 23191 | 6418 | 37883 | 5123 | 45284 | 4111 | 49636 | 3305 | 55368 | 1994 | 70036 | 1211 | 58414 |
| 24-#14 | 3.21 | MA | 23655 | 6418 | 38600 | 5141 | 46108 | 4124 | 50362 | 3315 | 55895 | 2018 | 70911 | 1164 | 60218 |
| 8L-6S | | MI | 23967 | 6418 | 39027 | 5123 | 46797 | 4112 | 51484 | 3294 | 57928 | 2002 | 73034 | 1314 | 60044 |
| 24-#14 | 3.21 | MA | 22852 | 6418 | 37288 | 5156 | 44495 | 4138 | 48438 | 3327 | 53301 | 2026 | 67650 | 1079 | 58402 |
| 9L-5S | | MI | 24761 | 6418 | 40202 | 5122 | 48363 | 4099 | 53390 | 3298 | 60452 | 1994 | 76407 | 1423 | 60891 |

## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

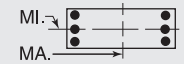
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.36 | MA | 25692 | 5540 | 37413 | 4610 | 44451 | 3743 | 47876 | 3093 | 51326 | 2140 | 62660 | 1993 | 31469 |
| 2L-3S | | MI | 20842 | 5540 | 31032 | 4578 | 36398 | 3712 | 38561 | 3088 | 39798 | 2126 | 47696 | 1723 | 28210 |
| 6-#18 | 1.36 | MA | 23028 | 5540 | 33984 | 4611 | 40102 | 3740 | 42606 | 3113 | 44236 | 2153 | 53207 | 1760 | 31307 |
| 3L-2S | | MI | 23221 | 5540 | 34099 | 4579 | 40286 | 3717 | 43272 | 3071 | 46077 | 2113 | 56030 | 1956 | 28318 |
| 8-#14 | 1.02 | MA | 24560 | 5322 | 34711 | 4502 | 41259 | 3666 | 44111 | 3050 | 46374 | 2168 | 56306 | 2051 | 24010 |
| 2L-4S | | MI | 19842 | 5322 | 28616 | 4474 | 33455 | 3654 | 35096 | 3037 | 35321 | 2150 | 42500 | 1759 | 21560 |
| 8-#14 | 1.02 | MA | 23014 | 5322 | 32753 | 4503 | 38776 | 3666 | 41102 | 3062 | 42315 | 2177 | 50843 | 1920 | 23997 |
| 3E | | MI | 20849 | 5322 | 29921 | 4474 | 35220 | 3641 | 37235 | 3041 | 38197 | 2158 | 45679 | 1891 | 21653 |
| 8-#14 | 1.02 | MA | 21893 | 5322 | 31299 | 4504 | 36810 | 3680 | 38720 | 3059 | 39100 | 2170 | 47241 | 1788 | 23861 |
| 4L-2S | | MI | 22231 | 5322 | 31675 | 4473 | 37444 | 3643 | 39929 | 3030 | 41822 | 2150 | 50512 | 2022 | 21648 |
| 8-#18 | 1.82 | MA | 27301 | 5831 | 40843 | 4792 | 48801 | 3876 | 53146 | 3177 | 58416 | 2126 | 72112 | 1954 | 41627 |
| 2L-4S | | MI | 20602 | 5831 | 31808 | 4758 | 37192 | 3866 | 39523 | 3163 | 41094 | 2095 | 50561 | 1443 | 35998 |
| 8-#18 | 1.82 | MA | 24685 | 5831 | 37413 | 4792 | 44451 | 3873 | 47876 | 3197 | 51326 | 2139 | 62660 | 1721 | 41354 |
| 3E | | MI | 22306 | 5831 | 34099 | 4759 | 40286 | 3845 | 43272 | 3173 | 46077 | 2108 | 56030 | 1677 | 37197 |
| 8-#18 | 1.82 | MA | 22786 | 5831 | 34860 | 4793 | 41000 | 3896 | 43693 | 3190 | 45700 | 2126 | 56441 | 1487 | 39998 |
| 4L-2S | | MI | 24643 | 5831 | 37165 | 4761 | 44175 | 3850 | 47983 | 3156 | 52357 | 2095 | 64364 | 1910 | 37410 |
| 10-#14 | 1.28 | MA | 25515 | 5485 | 36669 | 4604 | 43742 | 3741 | 47119 | 3097 | 50433 | 2161 | 61769 | 2032 | 29831 |
| 2L-5S | | MI | 19814 | 5485 | 29047 | 4591 | 34093 | 3727 | 35854 | 3095 | 36321 | 2150 | 43996 | 1673 | 26071 |
| 10-#14 | 1.28 | MA | 23986 | 5485 | 34711 | 4605 | 41259 | 3740 | 44111 | 3109 | 46374 | 2169 | 56306 | 1901 | 29779 |
| 3L-4S | | MI | 20716 | 5485 | 30369 | 4576 | 35679 | 3729 | 37790 | 3084 | 38946 | 2142 | 47333 | 1737 | 26699 |
| 10-#14 | 1.28 | MA | 22880 | 5485 | 33257 | 4606 | 39293 | 3755 | 41728 | 3107 | 43159 | 2163 | 52704 | 1770 | 29595 |
| 4L-3S | | MI | 21710 | 5485 | 31675 | 4576 | 37444 | 3716 | 39929 | 3088 | 41822 | 2150 | 50512 | 1869 | 26838 |
| 10-#14 | 1.28 | MA | 21878 | 5485 | 31786 | 4623 | 37528 | 3754 | 39574 | 3119 | 40226 | 2172 | 48946 | 1703 | 28855 |
| 5L-2S | | MI | 23077 | 5485 | 33428 | 4576 | 39668 | 3718 | 42623 | 3077 | 45447 | 2142 | 55344 | 2000 | 26869 |
| 10-#18 | 2.27 | MA | 28868 | 6121 | 44273 | 4973 | 53151 | 4009 | 58415 | 3262 | 65506 | 2111 | 81565 | 1915 | 51756 |
| 2L-5S | | MI | 20542 | 6121 | 32555 | 4965 | 38297 | 3994 | 40836 | 3264 | 42826 | 2090 | 53116 | 1285 | 41854 |
| 10-#18 | 2.27 | MA | 26298 | 6121 | 40843 | 4974 | 48801 | 4006 | 53146 | 3281 | 58416 | 2125 | 72112 | 1681 | 51387 |
| 3L-4S | | MI | 22060 | 6121 | 34875 | 4940 | 41081 | 3999 | 44234 | 3247 | 47373 | 2077 | 58896 | 1397 | 44532 |
| 10-#18 | 2.27 | MA | 24436 | 6121 | 38289 | 4975 | 45349 | 4029 | 48963 | 3274 | 52790 | 2111 | 65894 | 1448 | 49593 |
| 4L-3S | | MI | 23733 | 6121 | 37165 | 4941 | 44175 | 3978 | 47983 | 3257 | 52357 | 2090 | 64364 | 1631 | 46165 |
| 10-#18 | 2.27 | MA | 22748 | 6121 | 35704 | 5002 | 42247 | 4026 | 45177 | 3294 | 47656 | 2125 | 59367 | 1332 | 46461 |
| 5L-2S | | MI | 26030 | 6121 | 40231 | 4942 | 48064 | 3983 | 52695 | 3240 | 58636 | 2077 | 72698 | 1864 | 46470 |
| 12-#11 | 1.06 | MA | 24769 | 5348 | 34959 | 4532 | 41693 | 3690 | 44688 | 3067 | 47189 | 2174 | 57562 | 2062 | 25052 |
| 2L-6S | | MI | 19512 | 5348 | 28014 | 4518 | 32853 | 3685 | 34401 | 3060 | 34447 | 2171 | 41306 | 1732 | 21950 |
| 12-#11 | 1.06 | MA | 23691 | 5348 | 33591 | 4533 | 39959 | 3690 | 42587 | 3076 | 44354 | 2181 | 53723 | 1971 | 25040 |
| 3L-5S | | MI | 20121 | 5348 | 28834 | 4517 | 33945 | 3676 | 35731 | 3062 | 36216 | 2166 | 43681 | 1807 | 22443 |
| 12-#11 | 1.06 | MA | 22911 | 5348 | 32577 | 4534 | 38587 | 3700 | 40925 | 3075 | 42111 | 2177 | 51189 | 1880 | 24981 |
| 4E | | MI | 20756 | 5348 | 29756 | 4506 | 35052 | 3676 | 37081 | 3054 | 38055 | 2161 | 46024 | 1853 | 22550 |
| 12-#11 | 1.06 | MA | 22206 | 5348 | 31552 | 4546 | 37357 | 3700 | 39423 | 3084 | 40065 | 2184 | 48554 | 1833 | 24837 |
| 5L-3S | | MI | 21457 | 5348 | 30667 | 4506 | 36284 | 3667 | 38574 | 3056 | 40070 | 2165 | 48264 | 1944 | 22589 |
| 12-#11 | 1.06 | MA | 21529 | 5348 | 30641 | 4547 | 36142 | 3710 | 37945 | 3083 | 38099 | 2190 | 45874 | 1758 | 24252 |
| 6L-2S | | MI | 22422 | 5348 | 31893 | 4505 | 37838 | 3668 | 40458 | 3048 | 42611 | 2160 | 51666 | 2035 | 22587 |
| 12-#14 | 1.53 | MA | 26453 | 5649 | 38627 | 4706 | 46226 | 3816 | 50128 | 3144 | 54492 | 2153 | 67232 | 2014 | 35633 |
| 2L-6S | | MI | 19829 | 5649 | 29626 | 4694 | 34751 | 3815 | 36643 | 3139 | 37421 | 2149 | 45455 | 1542 | 29984 |
| 12-#14 | 1.53 | MA | 24941 | 5649 | 36669 | 4707 | 43742 | 3815 | 47119 | 3157 | 50433 | 2162 | 61769 | 1883 | 35549 |
| 3L-5S | | MI | 20684 | 5649 | 30801 | 4694 | 36317 | 3802 | 38549 | 3143 | 39946 | 2142 | 48829 | 1651 | 31032 |
| 12-#14 | 1.53 | MA | 23849 | 5649 | 35215 | 4709 | 41777 | 3830 | 44737 | 3154 | 47218 | 2156 | 58167 | 1751 | 35324 |
| 4E | | MI | 21574 | 5649 | 32123 | 4678 | 37903 | 3804 | 40485 | 3132 | 42571 | 2134 | 52165 | 1715 | 31831 |
| 12-#14 | 1.53 | MA | 22859 | 5649 | 33744 | 4725 | 40012 | 3829 | 42583 | 3167 | 44284 | 2164 | 54409 | 1685 | 34412 |
| 5L-3S | | MI | 22556 | 5649 | 33428 | 4678 | 39668 | 3791 | 42623 | 3136 | 45447 | 2142 | 55344 | 1847 | 32009 |
| 12-#14 | 1.53 | MA | 21910 | 5649 | 32438 | 4726 | 38270 | 3843 | 40462 | 3164 | 41464 | 2173 | 50595 | 1576 | 33184 |
| 6L-2S | | MI | 23908 | 5649 | 35182 | 4678 | 41892 | 3793 | 45318 | 3124 | 49072 | 2134 | 60177 | 1978 | 32072 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

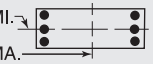


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 2.73 | MA | 30402 | 6412 | 47703 | 5155 | 57501 | 4142 | 63685 | 3346 | 72596 | 2097 | 91018 | 1876 | 61867 |
| 2L-6S | | MI | 20563 | 6412 | 33558 | 5146 | 39436 | 4148 | 42201 | 3339 | 44732 | 2086 | 55633 | 1045 | 47461 |
| 12-#18 | 2.73 | MA | 27873 | 6412 | 44273 | 5156 | 53151 | 4139 | 58415 | 3365 | 65506 | 2110 | 81565 | 1642 | 61413 |
| 3L-5S | | MI | 21994 | 6412 | 35621 | 5147 | 42185 | 4127 | 45548 | 3349 | 49105 | 2073 | 61450 | 1239 | 50573 |
| 12-#18 | 2.73 | MA | 26045 | 6412 | 41719 | 5156 | 49699 | 4162 | 54232 | 3359 | 59880 | 2097 | 75347 | 1409 | 59234 |
| 4E | | MI | 23484 | 6412 | 37941 | 5121 | 44969 | 4132 | 48945 | 3332 | 53653 | 2059 | 67230 | 1351 | 53113 |
| 12-#18 | 2.73 | MA | 24389 | 6412 | 39134 | 5184 | 46597 | 4159 | 50446 | 3378 | 54746 | 2110 | 68820 | 1293 | 56249 |
| 5L-3S | | MI | 25127 | 6412 | 40231 | 5123 | 48064 | 4111 | 52695 | 3341 | 58636 | 2073 | 72698 | 1585 | 55123 |
| 12-#18 | 2.73 | MA | 22801 | 6412 | 36837 | 5184 | 43535 | 4183 | 46719 | 3372 | 49808 | 2124 | 62221 | 1100 | 52749 |
| 6L-2S | | MI | 27388 | 6412 | 43297 | 5124 | 51953 | 4116 | 57406 | 3324 | 64916 | 2059 | 81032 | 1818 | 55509 |
| 14-#11 | 1.24 | MA | 25439 | 5461 | 36326 | 4603 | 43427 | 3742 | 46790 | 3100 | 50024 | 2169 | 61401 | 2051 | 29113 |
| 2L-7S | | MI | 19541 | 5461 | 28443 | 4589 | 33352 | 3736 | 34995 | 3101 | 35196 | 2161 | 42595 | 1647 | 24932 |
| 14-#11 | 1.24 | MA | 24370 | 5461 | 34959 | 4604 | 41693 | 3742 | 44688 | 3109 | 47189 | 2176 | 57562 | 1960 | 29085 |
| 3L-6S | | MI | 20132 | 5461 | 29240 | 4589 | 34407 | 3737 | 36284 | 3093 | 36988 | 2166 | 44707 | 1718 | 25454 |
| 14-#11 | 1.24 | MA | 23597 | 5461 | 33945 | 4605 | 40322 | 3752 | 43027 | 3108 | 44946 | 2172 | 55028 | 1869 | 29005 |
| 4L-5S | | MI | 20735 | 5461 | 30059 | 4588 | 35500 | 3728 | 37614 | 3095 | 38757 | 2161 | 47082 | 1793 | 26031 |
| 14-#11 | 1.24 | MA | 22898 | 5461 | 32919 | 4617 | 39091 | 3752 | 41524 | 3117 | 42900 | 2179 | 52393 | 1822 | 28839 |
| 5L-4S | | MI | 21364 | 5461 | 30982 | 4577 | 36606 | 3728 | 38965 | 3087 | 40596 | 2155 | 49425 | 1839 | 26160 |
| 14-#11 | 1.24 | MA | 22228 | 5461 | 32009 | 4618 | 37877 | 3762 | 40046 | 3115 | 40934 | 2185 | 49712 | 1747 | 28170 |
| 6L-3S | | MI | 22059 | 5461 | 31893 | 4577 | 37838 | 3719 | 40458 | 3089 | 42611 | 2160 | 51666 | 1930 | 26218 |
| 14-#11 | 1.24 | MA | 21573 | 5461 | 31123 | 4619 | 36704 | 3762 | 38613 | 3124 | 38941 | 2182 | 47325 | 1676 | 27554 |
| 7L-2S | | MI | 23016 | 5461 | 33119 | 4576 | 39393 | 3720 | 42341 | 3081 | 45152 | 2155 | 55067 | 2021 | 26235 |
| 14-#14 | 1.79 | MA | 27376 | 5812 | 40585 | 4808 | 48709 | 3891 | 53136 | 3192 | 58551 | 2146 | 72695 | 1995 | 41426 |
| 2L-7S | | MI | 19868 | 5812 | 30236 | 4797 | 35462 | 3888 | 37489 | 3197 | 38486 | 2134 | 47290 | 1417 | 33828 |
| 14-#14 | 1.79 | MA | 25880 | 5812 | 38627 | 4810 | 46226 | 3890 | 50128 | 3204 | 54492 | 2154 | 67232 | 1864 | 41312 |
| 3L-6S | | MI | 20695 | 5812 | 31380 | 4796 | 36975 | 3890 | 39337 | 3186 | 41046 | 2141 | 50288 | 1520 | 35006 |
| 14-#14 | 1.79 | MA | 24801 | 5812 | 37173 | 4811 | 44260 | 3904 | 47745 | 3202 | 51277 | 2148 | 63630 | 1733 | 41050 |
| 4L-5S | | MI | 21538 | 5812 | 32555 | 4796 | 38541 | 3877 | 41243 | 3190 | 43570 | 2134 | 53661 | 1629 | 36010 |
| 14-#14 | 1.79 | MA | 23824 | 5812 | 35702 | 4827 | 42495 | 3904 | 45591 | 3214 | 48343 | 2157 | 59873 | 1666 | 39987 |
| 5L-4S | | MI | 22418 | 5812 | 33876 | 4781 | 40127 | 3879 | 43179 | 3179 | 46195 | 2126 | 56998 | 1693 | 36959 |
| 14-#14 | 1.79 | MA | 22887 | 5812 | 34396 | 4828 | 40753 | 3918 | 43471 | 3211 | 45523 | 2165 | 56058 | 1558 | 38806 |
| 6L-3S | | MI | 23389 | 5812 | 35182 | 4780 | 41892 | 3866 | 45318 | 3183 | 49072 | 2134 | 60177 | 1825 | 37172 |
| 14-#14 | 1.79 | MA | 21969 | 5812 | 33125 | 4830 | 39071 | 3918 | 41415 | 3224 | 42664 | 2159 | 52664 | 1455 | 37466 |
| 7L-2S | | MI | 24727 | 5812 | 36936 | 4780 | 44116 | 3867 | 48012 | 3172 | 52696 | 2126 | 65010 | 1956 | 37262 |
| 14-#18 | 3.18 | MA | 29416 | 6703 | 47703 | 5337 | 57501 | 4272 | 63685 | 3450 | 72596 | 2096 | 91018 | 1603 | 71433 |
| 3L-6S | | MI | 22008 | 6703 | 36624 | 5327 | 43325 | 4281 | 46913 | 3423 | 51011 | 2068 | 63968 | 999 | 56068 |
| 14-#18 | 3.18 | MA | 27619 | 6703 | 45149 | 5338 | 54049 | 4295 | 59502 | 3443 | 66970 | 2083 | 84800 | 1370 | 68914 |
| 4L-5S | | MI | 23413 | 6703 | 38687 | 5328 | 46074 | 4260 | 50259 | 3433 | 55385 | 2055 | 69784 | 1193 | 59316 |
| 14-#18 | 3.18 | MA | 25993 | 6703 | 42564 | 5365 | 50947 | 4292 | 55716 | 3463 | 61836 | 2096 | 78273 | 1254 | 66061 |
| 5L-4S | | MI | 24877 | 6703 | 41007 | 5303 | 48858 | 4265 | 53656 | 3416 | 59933 | 2042 | 75564 | 1305 | 61734 |
| 14-#18 | 3.18 | MA | 24434 | 6703 | 40267 | 5366 | 47884 | 4316 | 51988 | 3456 | 56898 | 2109 | 71674 | 1061 | 62431 |
| 6L-3S | | MI | 26493 | 6703 | 43297 | 5304 | 51953 | 4244 | 57406 | 3425 | 64916 | 2055 | 81032 | 1539 | 64074 |
| 14-#18 | 3.18 | MA | 22906 | 6703 | 38030 | 5366 | 44925 | 4312 | 48374 | 3475 | 51891 | 2096 | 65811 | 879 | 58847 |
| 7L-2S | | MI | 28721 | 6703 | 46363 | 5306 | 55841 | 4249 | 62117 | 3408 | 71196 | 2042 | 89366 | 1772 | 64534 |
| 16-#11 | 1.42 | MA | 26101 | 5575 | 37694 | 4674 | 45162 | 3794 | 48891 | 3133 | 52859 | 2164 | 65239 | 2039 | 33167 |
| 2L-8S | | MI | 19580 | 5575 | 28883 | 4661 | 33873 | 3787 | 35587 | 3132 | 36007 | 2162 | 43808 | 1580 | 27803 |
| 16-#11 | 1.42 | MA | 25040 | 5575 | 36326 | 4675 | 43427 | 3794 | 46790 | 3142 | 50024 | 2171 | 61401 | 1948 | 33124 |
| 3L-7S | | MI | 20158 | 5575 | 29669 | 4660 | 34907 | 3788 | 36879 | 3134 | 37737 | 2156 | 45997 | 1633 | 28461 |
| 16-#11 | 1.42 | MA | 24274 | 5575 | 35312 | 4676 | 42056 | 3804 | 45128 | 3140 | 47781 | 2167 | 58867 | 1857 | 33026 |
| 4L-6S | | MI | 20744 | 5575 | 30466 | 4660 | 35962 | 3789 | 38168 | 3126 | 39530 | 2161 | 48109 | 1704 | 28966 |
| 16-#11 | 1.42 | MA | 23582 | 5575 | 34287 | 4688 | 40826 | 3804 | 43626 | 3149 | 45735 | 2174 | 56232 | 1810 | 32838 |
| 5E | | MI | 21342 | 5575 | 31285 | 4659 | 37054 | 3779 | 39497 | 3128 | 41298 | 2156 | 50483 | 1779 | 29617 |
| 16-#11 | 1.42 | MA | 22918 | 5575 | 33376 | 4689 | 39611 | 3814 | 42147 | 3148 | 43769 | 2180 | 53551 | 1735 | 32096 |
| 6L-4S | | MI | 21965 | 5575 | 32208 | 4648 | 38161 | 3780 | 40848 | 3120 | 43137 | 2150 | 52827 | 1825 | 29766 |
| 16-#11 | 1.42 | MA | 22269 | 5575 | 32490 | 4690 | 38438 | 3814 | 40714 | 3157 | 41776 | 2176 | 51164 | 1664 | 31499 |
| 7L-3S | | MI | 22654 | 5575 | 33119 | 4648 | 39393 | 3771 | 42341 | 3122 | 45152 | 2155 | 55067 | 1916 | 29841 |
| 16-#11 | 1.42 | MA | 21627 | 5575 | 31618 | 4691 | 37289 | 3814 | 39279 | 3156 | 39852 | 2183 | 48702 | 1610 | 30741 |
| 8L-2S | | MI | 23604 | 5575 | 34345 | 4647 | 40948 | 3771 | 44225 | 3114 | 47694 | 2150 | 58468 | 2007 | 29872 |

## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

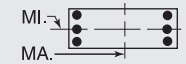
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.05 | MA | 28285 | 5976 | 42543 | 4911 | 51192 | 3966 | 56145 | 3239 | 62610 | 2138 | 78158 | 1977 | 47211 |
| 2L-8S | | MI | 19922 | 5976 | 30864 | 4899 | 36203 | 3962 | 38331 | 3241 | 39641 | 2133 | 49007 | 1320 | 37507 |
| 16-#14 | 2.05 | MA | 26805 | 5976 | 40585 | 4912 | 48709 | 3965 | 53136 | 3251 | 58551 | 2147 | 72695 | 1845 | 47068 |
| 3L-7S | | MI | 20729 | 5976 | 31990 | 4899 | 37686 | 3963 | 40183 | 3245 | 42111 | 2126 | 52123 | 1395 | 38783 |
| 16-#14 | 2.05 | MA | 25738 | 5976 | 39131 | 4913 | 46743 | 3979 | 50754 | 3249 | 55336 | 2141 | 69093 | 1714 | 46774 |
| 4L-6S | | MI | 21546 | 5976 | 33134 | 4899 | 39199 | 3965 | 42032 | 3234 | 44671 | 2133 | 55120 | 1498 | 40037 |
| 16-#14 | 2.05 | MA | 24773 | 5976 | 37660 | 4929 | 44978 | 3979 | 48600 | 3261 | 52402 | 2149 | 65336 | 1647 | 45577 |
| 5E | | MI | 22380 | 5976 | 34308 | 4898 | 40765 | 3952 | 43937 | 3238 | 47195 | 2126 | 58494 | 1607 | 41003 |
| 16-#14 | 2.05 | MA | 23847 | 5976 | 36354 | 4931 | 43236 | 3993 | 46479 | 3259 | 49582 | 2158 | 61521 | 1539 | 44438 |
| 6L-4S | | MI | 23249 | 5976 | 35630 | 4883 | 42351 | 3954 | 45873 | 3226 | 49820 | 2118 | 61831 | 1671 | 42083 |
| 16-#14 | 2.05 | MA | 22941 | 5976 | 35083 | 4932 | 41554 | 3992 | 44424 | 3271 | 46723 | 2152 | 58127 | 1437 | 43024 |
| 7L-3S | | MI | 24209 | 5976 | 36936 | 4883 | 44116 | 3940 | 48012 | 3230 | 52696 | 2126 | 65010 | 1803 | 42328 |
| 16-#14 | 2.05 | MA | 22045 | 5976 | 33831 | 4933 | 39905 | 3992 | 42364 | 3269 | 43964 | 2160 | 54617 | 1360 | 41540 |
| 8L-2S | | MI | 25534 | 5976 | 38689 | 4882 | 46340 | 3942 | 50706 | 3219 | 56321 | 2118 | 69842 | 1934 | 42445 |
| 16-#18 | 3.64 | MA | 29163 | 6994 | 48579 | 5520 | 58398 | 4428 | 64772 | 3527 | 74060 | 2068 | 94253 | 1331 | 78627 |
| 4L-6S | | MI | 23423 | 6994 | 39690 | 5509 | 47213 | 4414 | 51624 | 3507 | 57291 | 2050 | 72302 | 953 | 64700 |
| 16-#18 | 3.64 | MA | 27565 | 6994 | 45994 | 5547 | 55296 | 4425 | 60986 | 3547 | 68926 | 2082 | 87726 | 1215 | 75893 |
| 5E | | MI | 24805 | 6994 | 41754 | 5510 | 49963 | 4393 | 54970 | 3517 | 61664 | 2037 | 78118 | 1147 | 68079 |
| 16-#18 | 3.64 | MA | 26033 | 6994 | 43696 | 5548 | 52234 | 4449 | 57258 | 3540 | 63988 | 2095 | 81127 | 1022 | 72136 |
| 6L-4S | | MI | 26245 | 6994 | 44073 | 5485 | 52747 | 4398 | 58367 | 3500 | 66212 | 2024 | 83898 | 1259 | 70387 |
| 16-#18 | 3.64 | MA | 24531 | 6994 | 41460 | 5548 | 49275 | 4445 | 53643 | 3560 | 58981 | 2082 | 75263 | 840 | 68330 |
| 7L-3S | | MI | 27835 | 6994 | 46363 | 5486 | 55841 | 4377 | 62117 | 3510 | 71196 | 2037 | 89366 | 1493 | 73021 |
| 18-#11 | 1.60 | MA | 26755 | 5688 | 39062 | 4745 | 46896 | 3845 | 50992 | 3165 | 55694 | 2159 | 69078 | 2028 | 37216 |
| 2L-9S | | MI | 19625 | 5688 | 29242 | 4743 | 34362 | 3849 | 36199 | 3173 | 36834 | 2162 | 45055 | 1507 | 30546 |
| 18-#11 | 1.60 | MA | 25702 | 5688 | 37694 | 4746 | 45162 | 3845 | 48891 | 3175 | 52859 | 2166 | 65239 | 1936 | 37158 |
| 3L-8S | | MI | 20195 | 5688 | 30109 | 4732 | 35427 | 3839 | 37470 | 3165 | 38548 | 2156 | 47210 | 1566 | 31287 |
| 18-#11 | 1.60 | MA | 24943 | 5688 | 36680 | 4747 | 43791 | 3856 | 47229 | 3173 | 50616 | 2162 | 62706 | 1845 | 37043 |
| 4L-7S | | MI | 20768 | 5688 | 30894 | 4731 | 36461 | 3840 | 38762 | 3167 | 40278 | 2151 | 49398 | 1619 | 31994 |
| 18-#11 | 1.60 | MA | 24257 | 5688 | 35654 | 4759 | 42560 | 3856 | 45727 | 3182 | 48570 | 2168 | 60070 | 1799 | 36837 |
| 5L-6S | | MI | 21348 | 5688 | 31692 | 4731 | 37517 | 3841 | 40051 | 3159 | 42071 | 2156 | 51510 | 1690 | 32485 |
| 18-#11 | 1.60 | MA | 23599 | 5688 | 34744 | 4760 | 41346 | 3866 | 44249 | 3181 | 46604 | 2175 | 57390 | 1724 | 36029 |
| 6L-5S | | MI | 21941 | 5688 | 32511 | 4730 | 38609 | 3831 | 41381 | 3161 | 43839 | 2150 | 53884 | 1765 | 33201 |
| 18-#11 | 1.60 | MA | 22956 | 5688 | 33858 | 4761 | 40173 | 3866 | 42816 | 3190 | 44611 | 2171 | 55003 | 1653 | 35448 |
| 7L-4S | | MI | 22559 | 5688 | 33433 | 4719 | 39716 | 3832 | 42732 | 3153 | 45678 | 2145 | 56228 | 1811 | 33367 |
| 18-#11 | 1.60 | MA | 22320 | 5688 | 32986 | 4762 | 39024 | 3866 | 41380 | 3189 | 42687 | 2178 | 52541 | 1599 | 34642 |
| 8L-3S | | MI | 23242 | 5688 | 34345 | 4718 | 40948 | 3823 | 44225 | 3155 | 47694 | 2150 | 58468 | 1902 | 33459 |
| 18-#11 | 1.60 | MA | 21688 | 5688 | 32023 | 4774 | 37839 | 3876 | 39967 | 3198 | 40783 | 2184 | 50106 | 1540 | 33778 |
| 9L-2S | | MI | 24185 | 5688 | 35571 | 4718 | 42502 | 3823 | 46108 | 3147 | 50235 | 2145 | 61869 | 1993 | 33503 |
| 18-#14 | 2.30 | MA | 29182 | 6140 | 44501 | 5013 | 53675 | 4040 | 59153 | 3286 | 66669 | 2131 | 83621 | 1958 | 52990 |
| 2L-9S | | MI | 19987 | 6140 | 31375 | 5017 | 36899 | 4049 | 39204 | 3299 | 40820 | 2133 | 50780 | 1213 | 40756 |
| 18-#14 | 2.30 | MA | 27717 | 6140 | 42543 | 5014 | 51192 | 4040 | 56145 | 3299 | 62610 | 2139 | 78158 | 1827 | 52821 |
| 3L-8S | | MI | 20779 | 6140 | 32618 | 5001 | 38427 | 4036 | 41026 | 3288 | 43266 | 2125 | 53840 | 1298 | 42509 |
| 18-#14 | 2.30 | MA | 26661 | 6140 | 41089 | 5015 | 49226 | 4054 | 53762 | 3296 | 59394 | 2133 | 74556 | 1696 | 52496 |
| 4L-7S | | MI | 21577 | 6140 | 33744 | 5001 | 39910 | 4038 | 42878 | 3292 | 45736 | 2118 | 56955 | 1373 | 43750 |
| 18-#14 | 2.30 | MA | 25707 | 6140 | 39618 | 5032 | 47462 | 4053 | 51608 | 3309 | 56461 | 2142 | 70799 | 1629 | 51179 |
| 5L-6S | | MI | 22384 | 6140 | 34887 | 5001 | 41423 | 4040 | 44726 | 3281 | 48295 | 2125 | 59953 | 1476 | 45076 |
| 18-#14 | 2.30 | MA | 24793 | 6140 | 38312 | 5033 | 45720 | 4068 | 49488 | 3306 | 53641 | 2150 | 66984 | 1521 | 50077 |
| 6L-5S | | MI | 23209 | 6140 | 36062 | 5000 | 42989 | 4027 | 46632 | 3285 | 50820 | 2118 | 63327 | 1585 | 46008 |
| 18-#14 | 2.30 | MA | 23898 | 6140 | 37041 | 5034 | 44037 | 4067 | 47432 | 3319 | 50782 | 2144 | 63590 | 1418 | 48593 |
| 7L-4S | | MI | 24068 | 6140 | 37383 | 4985 | 44575 | 4028 | 48568 | 3274 | 53445 | 2110 | 66663 | 1649 | 47205 |
| 18-#14 | 2.30 | MA | 23013 | 6140 | 35789 | 5035 | 42388 | 4067 | 45372 | 3316 | 48023 | 2153 | 60080 | 1341 | 47147 |
| 8L-3S | | MI | 25018 | 6140 | 38689 | 4985 | 46340 | 4015 | 50706 | 3278 | 56321 | 2118 | 69842 | 1781 | 47479 |
| 18-#14 | 2.30 | MA | 22133 | 6140 | 34407 | 5052 | 40689 | 4081 | 43346 | 3329 | 45291 | 2161 | 56618 | 1257 | 45168 |
| 9L-2S | | MI | 26330 | 6140 | 40443 | 4984 | 48564 | 4017 | 53401 | 3267 | 59946 | 2110 | 74675 | 1912 | 47621 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

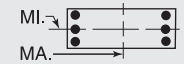


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 4.09 | MA | 29109 | 7285 | 49423 | 5729 | 59646 | 4558 | 66255 | 3631 | 76016 | 2067 | 97179 | 1176 | 85741 |
| 5L-6S | | MI | 24813 | 7285 | 42757 | 5691 | 51102 | 4547 | 56335 | 3592 | 63571 | 2033 | 80636 | 907 | 73354 |
| 18-#18 | 4.09 | MA | 27602 | 7285 | 47126 | 5729 | 56584 | 4582 | 62528 | 3624 | 71078 | 2081 | 90580 | 983 | 81862 |
| 6L-5S | | MI | 26172 | 7285 | 44820 | 5692 | 53851 | 4526 | 59681 | 3601 | 67944 | 2019 | 86452 | 1101 | 76858 |
| 18-#18 | 4.09 | MA | 26126 | 7285 | 44889 | 5730 | 53625 | 4578 | 58913 | 3644 | 66071 | 2067 | 84716 | 801 | 77986 |
| 7L-4S | | MI | 27590 | 7285 | 47140 | 5667 | 56635 | 4531 | 63079 | 3584 | 72492 | 2006 | 92232 | 1213 | 79068 |
| 20-#11 | 1.77 | MA | 27402 | 5802 | 40429 | 4816 | 48631 | 3897 | 53094 | 3198 | 58529 | 2154 | 72917 | 2016 | 41260 |
| 2L-10S | | MI | 19676 | 5802 | 29686 | 4814 | 34889 | 3900 | 36806 | 3204 | 37614 | 2152 | 46227 | 1413 | 33120 |
| 20-#11 | 1.77 | MA | 26357 | 5802 | 39062 | 4817 | 46896 | 3897 | 50992 | 3207 | 55694 | 2160 | 69078 | 1925 | 41189 |
| 3L-9S | | MI | 20238 | 5802 | 30468 | 4814 | 35916 | 3901 | 38083 | 3206 | 39375 | 2157 | 48456 | 1493 | 34054 |
| 20-#11 | 1.77 | MA | 25604 | 5802 | 38047 | 4818 | 45525 | 3908 | 49330 | 3206 | 53451 | 2157 | 66544 | 1834 | 41058 |
| 4L-8S | | MI | 20802 | 5802 | 31335 | 4803 | 36982 | 3891 | 39354 | 3198 | 41089 | 2151 | 50611 | 1552 | 34778 |
| 20-#11 | 1.77 | MA | 24924 | 5802 | 37022 | 4830 | 44294 | 3908 | 47828 | 3215 | 51405 | 2163 | 63909 | 1787 | 40835 |
| 5L-7S | | MI | 21370 | 5802 | 32120 | 4802 | 38016 | 3892 | 40646 | 3200 | 42819 | 2146 | 52799 | 1605 | 35531 |
| 20-#11 | 1.77 | MA | 24272 | 5802 | 36112 | 4831 | 43080 | 3918 | 46350 | 3214 | 49439 | 2170 | 61229 | 1712 | 39968 |
| 6E | | MI | 21945 | 5802 | 32918 | 4801 | 39071 | 3893 | 41935 | 3192 | 44612 | 2151 | 54911 | 1676 | 36009 |
| 20-#11 | 1.77 | MA | 23635 | 5802 | 35226 | 4832 | 41907 | 3918 | 44917 | 3223 | 47446 | 2166 | 58841 | 1641 | 39401 |
| 7L-5S | | MI | 22533 | 5802 | 33737 | 4801 | 40164 | 3883 | 43264 | 3194 | 46380 | 2145 | 57286 | 1751 | 36746 |
| 20-#11 | 1.77 | MA | 23004 | 5802 | 34353 | 4833 | 40758 | 3918 | 43481 | 3222 | 45522 | 2173 | 56380 | 1587 | 38549 |
| 8L-4S | | MI | 23146 | 5802 | 34659 | 4790 | 41270 | 3884 | 44615 | 3186 | 48219 | 2140 | 59629 | 1797 | 36966 |
| 20-#11 | 1.77 | MA | 22379 | 5802 | 33390 | 4845 | 39574 | 3928 | 42069 | 3231 | 43618 | 2179 | 53945 | 1529 | 37705 |
| 9L-3S | | MI | 23823 | 5802 | 35571 | 4789 | 42502 | 3874 | 46108 | 3188 | 50235 | 2145 | 61869 | 1888 | 37073 |
| 20-#11 | 1.77 | MA | 21755 | 5802 | 32521 | 4846 | 38433 | 3928 | 40650 | 3230 | 41660 | 2175 | 51428 | 1448 | 36644 |
| 10L-2S | | MI | 24759 | 5802 | 36796 | 4789 | 44057 | 3875 | 47992 | 3180 | 52776 | 2139 | 65271 | 1979 | 37130 |
| 20-#14 | 2.56 | MA | 28617 | 6303 | 44501 | 5116 | 53675 | 4115 | 59153 | 3346 | 66669 | 2132 | 83621 | 1808 | 58570 |
| 3L-9S | | MI | 20841 | 6303 | 33128 | 5119 | 39123 | 4124 | 41898 | 3347 | 44445 | 2125 | 55613 | 1191 | 45725 |
| 20-#14 | 2.56 | MA | 27572 | 6303 | 43047 | 5118 | 51710 | 4129 | 56771 | 3344 | 63453 | 2126 | 80019 | 1677 | 58218 |
| 4L-8S | | MI | 21624 | 6303 | 34371 | 5104 | 40651 | 4111 | 43720 | 3336 | 46891 | 2117 | 58672 | 1276 | 47514 |
| 20-#14 | 2.56 | MA | 26629 | 6303 | 41576 | 5134 | 49945 | 4128 | 54617 | 3356 | 60520 | 2134 | 76262 | 1610 | 56791 |
| 5L-7S | | MI | 22413 | 6303 | 35497 | 5103 | 42134 | 4113 | 45572 | 3339 | 49361 | 2110 | 61788 | 1351 | 48727 |
| 20-#14 | 2.56 | MA | 25725 | 6303 | 40270 | 5135 | 48203 | 4143 | 52496 | 3354 | 57700 | 2143 | 72447 | 1502 | 55723 |
| 6E | | MI | 23211 | 6303 | 36641 | 5103 | 43647 | 4115 | 47420 | 3328 | 51920 | 2117 | 64786 | 1454 | 50121 |
| 20-#14 | 2.56 | MA | 24840 | 6303 | 38999 | 5136 | 46520 | 4142 | 50441 | 3366 | 54841 | 2137 | 69053 | 1400 | 54171 |
| 7L-5S | | MI | 24026 | 6303 | 37815 | 5103 | 45213 | 4101 | 49326 | 3332 | 54445 | 2110 | 68159 | 1562 | 51023 |
| 20-#14 | 2.56 | MA | 23966 | 6303 | 37747 | 5138 | 44872 | 4141 | 48381 | 3364 | 52082 | 2145 | 65544 | 1323 | 52761 |
| 8L-4S | | MI | 24877 | 6303 | 39137 | 5087 | 46799 | 4103 | 51262 | 3321 | 57070 | 2102 | 71496 | 1627 | 52325 |
| 20-#14 | 2.56 | MA | 23097 | 6303 | 36365 | 5154 | 43173 | 4156 | 46355 | 3376 | 49350 | 2154 | 62081 | 1238 | 50744 |
| 9L-3S | | MI | 25817 | 6303 | 40443 | 5087 | 48564 | 4090 | 53401 | 3325 | 59946 | 2110 | 74675 | 1759 | 52626 |
| 20-#18 | 4.55 | MA | 29145 | 7575 | 50556 | 5911 | 60933 | 4715 | 67798 | 3708 | 78168 | 2066 | 100033 | 944 | 91607 |
| 6E | | MI | 26180 | 7575 | 45823 | 5872 | 54991 | 4680 | 61046 | 3676 | 69850 | 2015 | 88970 | 861 | 82028 |
| 20-#18 | 4.55 | MA | 27692 | 7575 | 48319 | 5912 | 57974 | 4711 | 64183 | 3728 | 73161 | 2053 | 94169 | 762 | 87660 |
| 7L-5S | | MI | 27519 | 7575 | 47886 | 5874 | 57740 | 4659 | 64392 | 3685 | 74224 | 2001 | 94786 | 1055 | 85651 |
| 22-#11 | 1.95 | MA | 27005 | 5915 | 40429 | 4888 | 48631 | 3949 | 53094 | 3240 | 58529 | 2155 | 72917 | 1913 | 45217 |
| 3L-10S | | MI | 20286 | 5915 | 30912 | 4885 | 36444 | 3952 | 38689 | 3236 | 40155 | 2147 | 49629 | 1399 | 36603 |
| 22-#11 | 1.95 | MA | 26258 | 5915 | 39415 | 4889 | 47260 | 3959 | 51432 | 3239 | 56286 | 2151 | 70383 | 1822 | 45071 |
| 4L-9S | | MI | 20843 | 5915 | 31694 | 4884 | 37471 | 3953 | 39966 | 3239 | 41917 | 2151 | 51857 | 1479 | 37567 |
| 22-#11 | 1.95 | MA | 25584 | 5915 | 38390 | 4900 | 46029 | 3959 | 49929 | 3248 | 54240 | 2158 | 67748 | 1775 | 44753 |
| 5L-8S | | MI | 21403 | 5915 | 32561 | 4873 | 38537 | 3943 | 41237 | 3230 | 43630 | 2146 | 54012 | 1538 | 38274 |
| 22-#11 | 1.95 | MA | 24938 | 5915 | 37479 | 4902 | 44815 | 3970 | 48451 | 3247 | 52274 | 2165 | 65067 | 1700 | 43912 |
| 6L-7S | | MI | 21966 | 5915 | 33346 | 4873 | 39571 | 3944 | 42529 | 3233 | 45360 | 2141 | 56201 | 1591 | 39072 |
| 22-#11 | 1.95 | MA | 24306 | 5915 | 36593 | 4903 | 43642 | 3970 | 47018 | 3256 | 50281 | 2161 | 62680 | 1629 | 43357 |
| 7L-6S | | MI | 22536 | 5915 | 34144 | 4872 | 40626 | 3945 | 43818 | 3224 | 47153 | 2146 | 58312 | 1662 | 39539 |
| 22-#11 | 1.95 | MA | 23681 | 5915 | 35721 | 4904 | 42493 | 3970 | 45582 | 3255 | 48357 | 2167 | 60219 | 1575 | 42462 |
| 8L-5S | | MI | 23119 | 5915 | 34963 | 4872 | 41718 | 3935 | 45148 | 3227 | 48922 | 2140 | 60687 | 1737 | 40250 |
| 22-#11 | 1.95 | MA | 23061 | 5915 | 34758 | 4916 | 41308 | 3980 | 44170 | 3264 | 46453 | 2174 | 57784 | 1517 | 41636 |
| 9L-4S | | MI | 23727 | 5915 | 35885 | 4861 | 42825 | 3936 | 46499 | 3218 | 50761 | 2135 | 63030 | 1783 | 40563 |
| 22-#11 | 1.95 | MA | 22443 | 5915 | 33889 | 4917 | 40167 | 3980 | 42751 | 3262 | 44495 | 2170 | 55267 | 1437 | 40519 |
| 10L-3S | | MI | 24398 | 5915 | 36796 | 4860 | 44057 | 3926 | 47992 | 3221 | 52776 | 2140 | 65271 | 1874 | 40684 |

## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.95 | MA | 21783 | 5915 | 33027 | 4918 | 38996 | 3990 | 41347 | 3271 | 42599 | 2177 | 52848 | 1380 | 39475 |
| 11L-2S | | MI | 25328 | 5915 | 38022 | 4860 | 45612 | 3927 | 49875 | 3212 | 55317 | 2134 | 68672 | 1965 | 40753 |
| 22-#14 | 2.81 | MA | 28472 | 6467 | 45005 | 5220 | 54193 | 4204 | 59779 | 3391 | 67512 | 2118 | 85482 | 1658 | 63939 |
| 4L-9S | | MI | 21683 | 6467 | 34882 | 5221 | 41347 | 4199 | 44592 | 3394 | 48069 | 2116 | 60445 | 1169 | 50702 |
| 22-#14 | 2.81 | MA | 27539 | 6467 | 43534 | 5236 | 52428 | 4203 | 57625 | 3404 | 64579 | 2127 | 81725 | 1592 | 62414 |
| 5L-8S | | MI | 22458 | 6467 | 36125 | 5206 | 42875 | 4186 | 46414 | 3383 | 50515 | 2109 | 63505 | 1254 | 52451 |
| 22-#14 | 2.81 | MA | 26645 | 6467 | 42228 | 5237 | 50686 | 4217 | 55505 | 3401 | 61759 | 2135 | 77911 | 1484 | 61375 |
| 6L-7S | | MI | 23238 | 6467 | 37251 | 5206 | 44358 | 4188 | 48266 | 3387 | 52985 | 2102 | 66621 | 1329 | 53712 |
| 22-#14 | 2.81 | MA | 25770 | 6467 | 40957 | 5239 | 49004 | 4217 | 53449 | 3413 | 58900 | 2129 | 74516 | 1381 | 59759 |
| 7L-6S | | MI | 24027 | 6467 | 38394 | 5205 | 45871 | 4189 | 50115 | 3376 | 55545 | 2109 | 69618 | 1432 | 55173 |
| 22-#14 | 2.81 | MA | 24905 | 6467 | 39705 | 5240 | 47355 | 4216 | 51389 | 3411 | 56141 | 2138 | 71007 | 1304 | 58355 |
| 8L-5S | | MI | 24834 | 6467 | 39569 | 5205 | 47437 | 4176 | 52020 | 3380 | 58070 | 2102 | 72992 | 1540 | 56048 |
| 22-#14 | 2.81 | MA | 24046 | 6467 | 38323 | 5256 | 45656 | 4230 | 49363 | 3423 | 53409 | 2146 | 67544 | 1220 | 56326 |
| 9L-4S | | MI | 25675 | 6467 | 40891 | 5190 | 49023 | 4178 | 53956 | 3369 | 60695 | 2094 | 76329 | 1605 | 57444 |
| 22-#18 | 5.00 | MA | 29234 | 7866 | 51749 | 6093 | 62324 | 4844 | 69452 | 3812 | 80251 | 2039 | 103622 | 722 | 97350 |
| 7L-6S | | MI | 27527 | 7866 | 48889 | 6054 | 58879 | 4813 | 65757 | 3760 | 76130 | 1997 | 97304 | 815 | 90719 |
| 24-#11 | 2.13 | MA | 26905 | 6028 | 40783 | 4960 | 48994 | 4011 | 53533 | 3272 | 59121 | 2146 | 74222 | 1810 | 49083 |
| 4L-10S | | MI | 20890 | 6028 | 32138 | 4956 | 37998 | 4004 | 40573 | 3269 | 42696 | 2141 | 53030 | 1385 | 40091 |
| 24-#11 | 2.13 | MA | 26237 | 6028 | 39757 | 4971 | 47763 | 4011 | 52031 | 3281 | 57075 | 2153 | 71587 | 1764 | 48676 |
| 5L-9S | | MI | 21442 | 6028 | 32920 | 4955 | 39026 | 4004 | 41850 | 3272 | 44458 | 2146 | 55259 | 1466 | 41084 |
| 24-#11 | 2.13 | MA | 25596 | 6028 | 38847 | 4973 | 46549 | 4022 | 50552 | 3280 | 55109 | 2159 | 68906 | 1689 | 47861 |
| 6L-8S | | MI | 21997 | 6028 | 33787 | 4944 | 40091 | 3995 | 43121 | 3263 | 46171 | 2141 | 57413 | 1524 | 41775 |
| 24-#11 | 2.13 | MA | 24969 | 6028 | 37961 | 4974 | 45376 | 4022 | 49119 | 3289 | 53116 | 2156 | 66519 | 1618 | 47316 |
| 7E | | MI | 22555 | 6028 | 34572 | 4944 | 41125 | 3996 | 44413 | 3265 | 47901 | 2135 | 59602 | 1577 | 42615 |
| 24-#11 | 2.13 | MA | 24350 | 6028 | 37089 | 4975 | 44227 | 4022 | 47684 | 3287 | 51192 | 2162 | 64057 | 1564 | 46380 |
| 8L-6S | | MI | 23121 | 6028 | 35369 | 4943 | 42181 | 3996 | 45702 | 3257 | 49694 | 2140 | 61714 | 1648 | 43072 |
| 24-#11 | 2.13 | MA | 23735 | 6028 | 36125 | 4987 | 43043 | 4032 | 46271 | 3297 | 49288 | 2169 | 61623 | 1505 | 45570 |
| 9L-5S | | MI | 23699 | 6028 | 36189 | 4943 | 43273 | 3987 | 47031 | 3259 | 51463 | 2135 | 64088 | 1723 | 43760 |
| 24-#11 | 2.13 | MA | 23123 | 6028 | 35257 | 4988 | 41902 | 4032 | 44852 | 3295 | 47330 | 2165 | 59106 | 1425 | 44426 |
| 10L-4S | | MI | 24301 | 6028 | 37111 | 4932 | 44380 | 3988 | 48382 | 3251 | 53302 | 2130 | 66432 | 1769 | 44158 |
| 24-#11 | 2.13 | MA | 22477 | 6028 | 34394 | 4989 | 40731 | 4042 | 43449 | 3304 | 45434 | 2172 | 56687 | 1368 | 43361 |
| 11L-3S | | MI | 24968 | 6028 | 38022 | 4931 | 45612 | 3978 | 49875 | 3253 | 55317 | 2134 | 68672 | 1860 | 44293 |
| 24-#14 | 3.07 | MA | 28438 | 6630 | 45492 | 5338 | 54911 | 4278 | 60634 | 3451 | 68638 | 2119 | 87188 | 1573 | 68044 |
| 5L-9S | | MI | 22514 | 6630 | 36635 | 5323 | 43571 | 4274 | 47287 | 3441 | 51694 | 2108 | 65278 | 1147 | 55685 |
| 24-#14 | 3.07 | MA | 27554 | 6630 | 44186 | 5340 | 53170 | 4292 | 58513 | 3448 | 65818 | 2128 | 83374 | 1465 | 67033 |
| 6L-8S | | MI | 23281 | 6630 | 37878 | 5308 | 45099 | 4261 | 49109 | 3430 | 54140 | 2101 | 68338 | 1232 | 57396 |
| 24-#14 | 3.07 | MA | 26688 | 6630 | 42915 | 5341 | 51487 | 4292 | 56458 | 3461 | 62959 | 2122 | 79979 | 1363 | 65354 |
| 7E | | MI | 24053 | 6630 | 39004 | 5308 | 46582 | 4262 | 50961 | 3434 | 56610 | 2093 | 71453 | 1307 | 58706 |
| 24-#14 | 3.07 | MA | 25833 | 6630 | 41663 | 5342 | 49838 | 4291 | 54398 | 3458 | 60200 | 2130 | 76470 | 1286 | 63904 |
| 8L-6S | | MI | 24834 | 6630 | 40148 | 5307 | 48095 | 4264 | 52809 | 3423 | 59170 | 2101 | 74451 | 1410 | 60229 |
| 24-#14 | 3.07 | MA | 24983 | 6630 | 40282 | 5358 | 48139 | 4305 | 52372 | 3471 | 57468 | 2139 | 73007 | 1201 | 61915 |
| 9L-5S | | MI | 25632 | 6630 | 41323 | 5307 | 49661 | 4251 | 54715 | 3427 | 61694 | 2093 | 77824 | 1518 | 61080 |

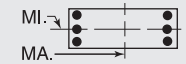
## RECTANGULAR TIED COLUMNS 40" x 46"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.30 | MA | 27917 | 5752 | 40352 | 4809 | 48023 | 3907 | 51701 | 3232 | 55353 | 2250 | 67610 | 2105 | 33089 |
| 2L-3S | | MI | 21694 | 5752 | 32164 | 4761 | 37699 | 3863 | 39886 | 3216 | 41036 | 2224 | 49106 | 1818 | 28277 |
| 6-#18 | 1.30 | MA | 25102 | 5752 | 36740 | 4810 | 43443 | 3904 | 46152 | 3253 | 47867 | 2264 | 57597 | 1872 | 32927 |
| 3L-2S | | MI | 24079 | 5752 | 35230 | 4762 | 41587 | 3868 | 44597 | 3199 | 47315 | 2211 | 57440 | 2051 | 28361 |
| 8-#18 | 1.74 | MA | 29626 | 6043 | 43963 | 4991 | 52603 | 4040 | 57250 | 3316 | 62840 | 2237 | 77623 | 2069 | 43787 |
| 2L-4S | | MI | 21454 | 6043 | 32940 | 4941 | 38493 | 4017 | 40847 | 3291 | 42332 | 2193 | 51972 | 1538 | 36347 |
| 8-#18 | 1.74 | MA | 26862 | 6043 | 40352 | 4992 | 48023 | 4037 | 51701 | 3337 | 55353 | 2250 | 67610 | 1836 | 43514 |
| 3E | | MI | 23164 | 6043 | 35230 | 4943 | 41587 | 3996 | 44597 | 3301 | 47315 | 2207 | 57440 | 1772 | 37272 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

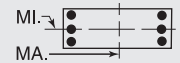



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.74 | MA | 24859 | 6043 | 37666 | 4993 | 44393 | 4062 | 47301 | 3331 | 49415 | 2238 | 61016 | 1602 | 42399 |
| 4L-2S | | MI | 25507 | 6043 | 38297 | 4944 | 45476 | 4001 | 49308 | 3284 | 53595 | 2193 | 65774 | 2005 | 37461 |
| 10-#14 | 1.22 | MA | 27722 | 5698 | 39559 | 4803 | 47265 | 3905 | 50891 | 3236 | 54334 | 2267 | 66623 | 2143 | 31349 |
| 2L-5S | | MI | 20664 | 5698 | 30168 | 4776 | 35391 | 3879 | 37180 | 3224 | 37563 | 2249 | 45413 | 1769 | 26274 |
| 10-#14 | 1.22 | MA | 26109 | 5698 | 37499 | 4804 | 44652 | 3905 | 47725 | 3249 | 50063 | 2277 | 60844 | 2012 | 31298 |
| 3L-4S | | MI | 21568 | 5698 | 31490 | 4761 | 36977 | 3881 | 39115 | 3213 | 40188 | 2242 | 48750 | 1833 | 26764 |
| 10-#14 | 1.22 | MA | 24943 | 5698 | 35971 | 4806 | 42586 | 3919 | 45221 | 3247 | 46683 | 2271 | 57030 | 1880 | 31113 |
| 4L-3S | | MI | 22565 | 5698 | 32796 | 4761 | 38742 | 3868 | 41254 | 3217 | 43064 | 2249 | 51929 | 1965 | 26884 |
| 10-#14 | 1.22 | MA | 23887 | 5698 | 34426 | 4823 | 40732 | 3919 | 42958 | 3260 | 43601 | 2281 | 53062 | 1813 | 30477 |
| 5L-2S | | MI | 23935 | 5698 | 34549 | 4760 | 40966 | 3870 | 43948 | 3206 | 46689 | 2242 | 56762 | 2096 | 26905 |
| 10-#18 | 2.17 | MA | 31292 | 6334 | 47575 | 5172 | 57183 | 4173 | 62799 | 3401 | 70326 | 2223 | 87636 | 2033 | 54456 |
| 2L-5S | | MI | 21392 | 6334 | 33687 | 5148 | 39598 | 4145 | 42161 | 3392 | 44064 | 2189 | 54526 | 1380 | 42145 |
| 10-#18 | 2.17 | MA | 28575 | 6334 | 43963 | 5174 | 52603 | 4170 | 57250 | 3421 | 62840 | 2237 | 77623 | 1800 | 54087 |
| 3L-4S | | MI | 22916 | 6334 | 36007 | 5123 | 42382 | 4150 | 45558 | 3375 | 48611 | 2176 | 60306 | 1492 | 44872 |
| 10-#18 | 2.17 | MA | 26610 | 6334 | 41278 | 5175 | 48973 | 4195 | 52850 | 3416 | 56902 | 2224 | 71029 | 1566 | 52516 |
| 4L-3S | | MI | 24596 | 6334 | 38297 | 5124 | 45476 | 4129 | 49308 | 3385 | 53595 | 2189 | 65774 | 1726 | 46248 |
| 10-#18 | 2.17 | MA | 24830 | 6334 | 38560 | 5203 | 45712 | 4193 | 48870 | 3437 | 51483 | 2238 | 64128 | 1449 | 49094 |
| 5L-2S | | MI | 26901 | 6334 | 41363 | 5126 | 49365 | 4134 | 54019 | 3368 | 59875 | 2176 | 74108 | 1959 | 46525 |
| 12-#11 | 1.02 | MA | 26928 | 5560 | 37756 | 4731 | 45104 | 3853 | 48328 | 3206 | 50913 | 2281 | 62155 | 2172 | 26315 |
| 2L-6S | | MI | 20361 | 5560 | 29130 | 4703 | 34149 | 3838 | 35726 | 3190 | 35691 | 2271 | 42727 | 1828 | 22091 |
| 12-#11 | 1.02 | MA | 25791 | 5560 | 36318 | 4732 | 43280 | 3854 | 46117 | 3215 | 47931 | 2288 | 58097 | 2081 | 26304 |
| 3L-5S | | MI | 20972 | 5560 | 29949 | 4703 | 35241 | 3828 | 37056 | 3192 | 37460 | 2266 | 45101 | 1903 | 22503 |
| 12-#11 | 1.02 | MA | 24970 | 5560 | 35252 | 4734 | 41839 | 3864 | 44371 | 3214 | 45574 | 2285 | 55417 | 1989 | 26245 |
| 4E | | MI | 21608 | 5560 | 30871 | 4692 | 36348 | 3829 | 38407 | 3184 | 39299 | 2260 | 47445 | 1949 | 22595 |
| 12-#11 | 1.02 | MA | 24227 | 5560 | 34175 | 4746 | 40546 | 3865 | 42793 | 3224 | 43425 | 2292 | 52635 | 1942 | 26101 |
| 5L-3S | | MI | 22310 | 5560 | 31783 | 4691 | 37580 | 3819 | 39900 | 3186 | 41314 | 2265 | 49685 | 2040 | 22625 |
| 12-#11 | 1.02 | MA | 23515 | 5560 | 33219 | 4747 | 39271 | 3875 | 41240 | 3223 | 41360 | 2299 | 49801 | 1867 | 25562 |
| 6L-2S | | MI | 23277 | 5560 | 33008 | 4691 | 39134 | 3820 | 41783 | 3178 | 43855 | 2260 | 53086 | 2131 | 22618 |
| 12-#14 | 1.47 | MA | 28717 | 5861 | 41619 | 4905 | 49878 | 3980 | 54056 | 3283 | 58605 | 2260 | 72401 | 2126 | 37456 |
| 2L-6S | | MI | 20679 | 5861 | 30747 | 4879 | 36049 | 3967 | 37968 | 3268 | 38663 | 2249 | 46872 | 1638 | 30169 |
| 12-#14 | 1.47 | MA | 27121 | 5861 | 39559 | 4907 | 47265 | 3979 | 50891 | 3296 | 54334 | 2269 | 66623 | 1995 | 37372 |
| 3L-5S | | MI | 21536 | 5861 | 31922 | 4878 | 37615 | 3954 | 39874 | 3272 | 41188 | 2241 | 50246 | 1746 | 31231 |
| 12-#14 | 1.47 | MA | 25970 | 5861 | 38031 | 4908 | 45199 | 3994 | 48387 | 3294 | 50954 | 2264 | 62809 | 1863 | 37146 |
| 4E | | MI | 22429 | 5861 | 33244 | 4863 | 39201 | 3956 | 41810 | 3261 | 43813 | 2234 | 53583 | 1811 | 31901 |
| 12-#14 | 1.47 | MA | 24928 | 5861 | 36486 | 4925 | 43345 | 3994 | 46123 | 3307 | 47872 | 2273 | 58841 | 1796 | 36329 |
| 5L-3S | | MI | 23414 | 5861 | 34549 | 4863 | 40966 | 3943 | 43948 | 3265 | 46689 | 2241 | 56762 | 1943 | 32059 |
| 12-#14 | 1.47 | MA | 23928 | 5861 | 35114 | 4927 | 41515 | 4009 | 43896 | 3305 | 44909 | 2283 | 54806 | 1688 | 34992 |
| 6L-2S | | MI | 24770 | 5861 | 36303 | 4863 | 43190 | 3945 | 46643 | 3254 | 50313 | 2234 | 61594 | 2074 | 32112 |
| 12-#18 | 2.61 | MA | 32922 | 6624 | 51186 | 5354 | 61763 | 4306 | 68347 | 3485 | 77812 | 2210 | 97649 | 1997 | 65107 |
| 2L-6S | | MI | 21411 | 6624 | 34690 | 5329 | 40737 | 4299 | 43526 | 3467 | 45970 | 2184 | 57044 | 1140 | 47930 |
| 12-#18 | 2.61 | MA | 30248 | 6624 | 47575 | 5355 | 57183 | 4303 | 62799 | 3506 | 70326 | 2224 | 87636 | 1763 | 64653 |
| 3L-5S | | MI | 22848 | 6624 | 36753 | 5330 | 43486 | 4278 | 46872 | 3477 | 50343 | 2171 | 62860 | 1334 | 50860 |
| 12-#18 | 2.61 | MA | 28318 | 6624 | 44889 | 5357 | 53553 | 4328 | 58399 | 3500 | 64388 | 2211 | 81042 | 1530 | 62679 |
| 4E | | MI | 24345 | 6624 | 39073 | 5305 | 46270 | 4283 | 50269 | 3460 | 54891 | 2158 | 68640 | 1446 | 53445 |
| 12-#18 | 2.61 | MA | 26572 | 6624 | 42172 | 5385 | 50292 | 4326 | 54419 | 3521 | 58969 | 2225 | 74141 | 1413 | 59412 |
| 5L-3S | | MI | 25995 | 6624 | 41363 | 5306 | 49365 | 4262 | 54019 | 3469 | 59875 | 2171 | 74108 | 1680 | 55212 |
| 12-#18 | 2.61 | MA | 24896 | 6624 | 39758 | 5386 | 47073 | 4350 | 50501 | 3515 | 53758 | 2239 | 67151 | 1220 | 55930 |
| 6L-2S | | MI | 28266 | 6624 | 44429 | 5307 | 53253 | 4267 | 58730 | 3452 | 66154 | 2158 | 82443 | 1913 | 55569 |
| 14-#11 | 1.19 | MA | 27639 | 5674 | 39195 | 4802 | 46929 | 3905 | 50538 | 3239 | 53895 | 2276 | 66212 | 2161 | 30587 |
| 2L-7S | | MI | 20390 | 5674 | 29558 | 4775 | 34648 | 3889 | 36320 | 3231 | 36439 | 2261 | 44016 | 1743 | 25069 |
| 14-#11 | 1.19 | MA | 26510 | 5674 | 37756 | 4803 | 45104 | 3906 | 48328 | 3248 | 50913 | 2283 | 62155 | 2070 | 30559 |
| 3L-6S | | MI | 20982 | 5674 | 30356 | 4774 | 35703 | 3890 | 37610 | 3223 | 38232 | 2266 | 46128 | 1814 | 25593 |
| 14-#11 | 1.19 | MA | 25696 | 5674 | 36691 | 4805 | 43663 | 3916 | 46581 | 3247 | 48556 | 2280 | 59474 | 1979 | 30480 |
| 4L-5S | | MI | 21587 | 5674 | 31175 | 4774 | 36796 | 3880 | 38939 | 3225 | 40001 | 2260 | 48503 | 1889 | 26095 |
| 14-#11 | 1.19 | MA | 24961 | 5674 | 35614 | 4817 | 42371 | 3917 | 45003 | 3257 | 46407 | 2287 | 56693 | 1932 | 30313 |
| 5L-4S | | MI | 22218 | 5674 | 32097 | 4763 | 37902 | 3881 | 40290 | 3217 | 41840 | 2255 | 50846 | 1935 | 26208 |
| 14-#11 | 1.19 | MA | 24255 | 5674 | 34658 | 4818 | 41096 | 3927 | 43451 | 3256 | 44342 | 2294 | 53859 | 1857 | 29686 |
| 6L-3S | | MI | 22914 | 5674 | 33008 | 4762 | 39134 | 3871 | 41783 | 3219 | 43855 | 2260 | 53086 | 2026 | 26257 |

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

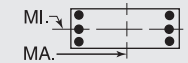
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.19 | MA | 23565 | 5674 | 33727 | 4820 | 39864 | 3928 | 41946 | 3265 | 42249 | 2291 | 51334 | 1786 | 29019 |
| 7L-2S | | MI | 23874 | 5674 | 34234 | 4761 | 40689 | 3872 | 43667 | 3211 | 46396 | 2254 | 56488 | 2117 | 26268 |
| 14-#14 | 1.71 | MA | 29697 | 6025 | 43680 | 5007 | 52491 | 4054 | 57222 | 3331 | 62876 | 2253 | 78180 | 2109 | 43552 |
| 2L-7S | | MI | 20717 | 6025 | 31357 | 4981 | 36760 | 4040 | 38814 | 3326 | 39728 | 2233 | 48707 | 1513 | 34132 |
| 14-#14 | 1.71 | MA | 28118 | 6025 | 41619 | 5009 | 49878 | 4054 | 54056 | 3344 | 58605 | 2262 | 72401 | 1978 | 43438 |
| 3L-6S | | MI | 21546 | 6025 | 32501 | 4981 | 38273 | 4042 | 40662 | 3315 | 42288 | 2240 | 51705 | 1616 | 35189 |
| 14-#14 | 1.71 | MA | 26979 | 6025 | 40091 | 5011 | 47812 | 4069 | 51552 | 3342 | 55225 | 2256 | 68588 | 1846 | 43176 |
| 4L-5S | | MI | 22393 | 6025 | 33676 | 4981 | 39839 | 4029 | 42568 | 3319 | 44812 | 2233 | 55079 | 1724 | 36206 |
| 14-#14 | 1.71 | MA | 25950 | 6025 | 38546 | 5027 | 45958 | 4069 | 49289 | 3355 | 52143 | 2266 | 64620 | 1779 | 42199 |
| 5L-4S | | MI | 23275 | 6025 | 34997 | 4965 | 41425 | 4031 | 44504 | 3308 | 47437 | 2226 | 58415 | 1789 | 37033 |
| 14-#14 | 1.71 | MA | 24963 | 6025 | 37174 | 5029 | 44128 | 4084 | 47061 | 3353 | 49180 | 2275 | 60585 | 1671 | 40913 |
| 6L-3S | | MI | 24249 | 6025 | 36303 | 4965 | 43190 | 4018 | 46643 | 3312 | 50313 | 2233 | 61594 | 1921 | 37226 |
| 14-#14 | 1.71 | MA | 23997 | 6025 | 35839 | 5031 | 42361 | 4084 | 44902 | 3366 | 46176 | 2270 | 56991 | 1569 | 39631 |
| 7L-2S | | MI | 25592 | 6025 | 38057 | 4965 | 45414 | 4019 | 49337 | 3301 | 53938 | 2226 | 66427 | 2052 | 37306 |
| 14-#18 | 3.04 | MA | 31886 | 6915 | 51186 | 5537 | 61763 | 4436 | 68347 | 3590 | 77812 | 2211 | 97649 | 1727 | 75213 |
| 3L-6S | | MI | 22859 | 6915 | 37756 | 5511 | 44626 | 4432 | 48237 | 3551 | 52250 | 2167 | 65378 | 1094 | 56529 |
| 14-#18 | 3.04 | MA | 29990 | 6915 | 48501 | 5539 | 58133 | 4461 | 63948 | 3584 | 71875 | 2198 | 91055 | 1494 | 72882 |
| 4L-5S | | MI | 24272 | 6915 | 39819 | 5512 | 47375 | 4411 | 51583 | 3561 | 56623 | 2153 | 71194 | 1288 | 59598 |
| 14-#18 | 3.04 | MA | 28274 | 6915 | 45783 | 5567 | 54872 | 4459 | 59968 | 3605 | 66456 | 2212 | 84154 | 1377 | 69754 |
| 5L-4S | | MI | 25744 | 6915 | 42139 | 5487 | 50159 | 4416 | 54981 | 3544 | 61171 | 2140 | 76974 | 1400 | 62058 |
| 14-#18 | 3.04 | MA | 26629 | 6915 | 43369 | 5568 | 51653 | 4483 | 56050 | 3599 | 61244 | 2225 | 77164 | 1184 | 66140 |
| 6L-3S | | MI | 27368 | 6915 | 44429 | 5488 | 53253 | 4395 | 58730 | 3553 | 66154 | 2153 | 82443 | 1634 | 64169 |
| 14-#18 | 3.04 | MA | 25016 | 6915 | 41019 | 5569 | 48543 | 4481 | 52250 | 3620 | 55961 | 2212 | 70947 | 1002 | 62552 |
| 7L-2S | | MI | 29605 | 6915 | 47495 | 5489 | 57142 | 4400 | 63442 | 3536 | 72434 | 2140 | 90777 | 1867 | 64597 |
| 16-#11 | 1.36 | MA | 28341 | 5787 | 40633 | 4873 | 48753 | 3957 | 52748 | 3272 | 56877 | 2271 | 70270 | 2150 | 34852 |
| 2L-8S | | MI | 20428 | 5787 | 29999 | 4846 | 35168 | 3940 | 36912 | 3261 | 37250 | 2261 | 45229 | 1676 | 28026 |
| 16-#11 | 1.36 | MA | 27221 | 5787 | 39195 | 4874 | 46929 | 3957 | 50538 | 3281 | 53895 | 2278 | 66212 | 2059 | 34809 |
| 3L-7S | | MI | 21008 | 5787 | 30784 | 4846 | 36203 | 3941 | 38204 | 3264 | 38981 | 2256 | 47418 | 1729 | 28598 |
| 16-#11 | 1.36 | MA | 26414 | 5787 | 38129 | 4876 | 45488 | 3968 | 48791 | 3280 | 51538 | 2275 | 63532 | 1968 | 34710 |
| 4L-6S | | MI | 21596 | 5787 | 31581 | 4845 | 37258 | 3942 | 39493 | 3255 | 40773 | 2261 | 49529 | 1800 | 29104 |
| 16-#11 | 1.36 | MA | 25685 | 5787 | 37052 | 4888 | 44195 | 3968 | 47213 | 3290 | 49389 | 2282 | 60751 | 1921 | 34523 |
| 5E | | MI | 22195 | 5787 | 32401 | 4845 | 38350 | 3932 | 40823 | 3258 | 42542 | 2255 | 51904 | 1875 | 29684 |
| 16-#11 | 1.36 | MA | 24986 | 5787 | 36096 | 4889 | 42920 | 3979 | 45661 | 3289 | 47324 | 2289 | 57917 | 1846 | 33817 |
| 6L-4S | | MI | 22821 | 5787 | 33323 | 4834 | 39457 | 3933 | 42174 | 3249 | 44381 | 2250 | 54247 | 1921 | 29817 |
| 16-#11 | 1.36 | MA | 24302 | 5787 | 35166 | 4890 | 41688 | 3979 | 44156 | 3298 | 45230 | 2286 | 55392 | 1775 | 33171 |
| 7L-3S | | MI | 23511 | 5787 | 34234 | 4833 | 40689 | 3923 | 43667 | 3252 | 46396 | 2255 | 56488 | 2012 | 29883 |
| 16-#11 | 1.36 | MA | 23627 | 5787 | 34250 | 4892 | 40482 | 3980 | 42648 | 3297 | 43211 | 2293 | 52794 | 1721 | 32461 |
| 8L-2S | | MI | 24464 | 5787 | 35460 | 4832 | 42244 | 3924 | 45550 | 3243 | 48937 | 2249 | 59889 | 2103 | 29908 |
| 16-#14 | 1.96 | MA | 30662 | 6188 | 45740 | 5109 | 55104 | 4129 | 60387 | 3378 | 67146 | 2245 | 83959 | 2092 | 49641 |
| 2L-8S | | MI | 20769 | 6188 | 31985 | 5084 | 37501 | 4113 | 39656 | 3370 | 40883 | 2232 | 50424 | 1416 | 37791 |
| 16-#14 | 1.96 | MA | 29099 | 6188 | 43680 | 5111 | 52491 | 4129 | 57222 | 3391 | 62876 | 2254 | 78180 | 1961 | 49498 |
| 3L-7S | | MI | 21580 | 6188 | 33111 | 5084 | 38984 | 4115 | 41508 | 3374 | 43353 | 2225 | 53540 | 1491 | 39084 |
| 16-#14 | 1.96 | MA | 27973 | 6188 | 42152 | 5113 | 50425 | 4144 | 54718 | 3389 | 59496 | 2249 | 74367 | 1829 | 49204 |
| 4L-6S | | MI | 22399 | 6188 | 34255 | 5083 | 40497 | 4117 | 43357 | 3363 | 45913 | 2232 | 56538 | 1594 | 40219 |
| 16-#14 | 1.96 | MA | 26956 | 6188 | 40606 | 5129 | 48571 | 4144 | 52454 | 3402 | 56414 | 2258 | 70399 | 1762 | 48084 |
| 5E | | MI | 23237 | 6188 | 35429 | 5083 | 42063 | 4104 | 45263 | 3367 | 48437 | 2225 | 59911 | 1702 | 41196 |
| 16-#14 | 1.96 | MA | 25981 | 6188 | 39235 | 5131 | 46741 | 4159 | 50227 | 3400 | 53451 | 2268 | 66363 | 1654 | 46843 |
| 6L-4S | | MI | 24109 | 6188 | 36751 | 5068 | 43649 | 4106 | 47198 | 3356 | 51062 | 2217 | 63248 | 1767 | 42161 |
| 16-#14 | 1.96 | MA | 25027 | 6188 | 37899 | 5133 | 44974 | 4158 | 48067 | 3413 | 50447 | 2262 | 62770 | 1552 | 45486 |
| 7L-3S | | MI | 25073 | 6188 | 38057 | 5067 | 45414 | 4092 | 49337 | 3359 | 53938 | 2225 | 66427 | 1899 | 42385 |
| 16-#14 | 1.96 | MA | 24083 | 6188 | 36585 | 5135 | 43242 | 4158 | 45904 | 3411 | 47549 | 2272 | 59064 | 1474 | 43878 |
| 8L-2S | | MI | 26402 | 6188 | 39810 | 5067 | 47638 | 4094 | 52031 | 3348 | 57563 | 2217 | 71260 | 2030 | 42491 |
| 16-#18 | 3.48 | MA | 31629 | 7206 | 52112 | 5720 | 62713 | 4594 | 69497 | 3668 | 79361 | 2185 | 101068 | 1458 | 83118 |
| 4L-6S | | MI | 24279 | 7206 | 40822 | 5692 | 48514 | 4565 | 52948 | 3636 | 58529 | 2149 | 73712 | 1048 | 65153 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

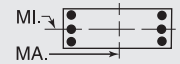


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 3.48 | MA | 29942 | 7206 | 49395 | 5748 | 59452 | 4592 | 65517 | 3689 | 73942 | 2198 | 94167 | 1341 | 80116 |
| 5E | | MI | 25668 | 7206 | 42885 | 5694 | 51264 | 4543 | 56294 | 3645 | 62903 | 2136 | 79528 | 1242 | 68356 |
| 16-#18 | 3.48 | MA | 28325 | 7206 | 46981 | 5750 | 56233 | 4616 | 61598 | 3684 | 68731 | 2212 | 87177 | 1148 | 76374 |
| 6L-4S | | MI | 27117 | 7206 | 45205 | 5668 | 54048 | 4549 | 59692 | 3628 | 67450 | 2122 | 85308 | 1354 | 70705 |
| 16-#18 | 3.48 | MA | 26741 | 7206 | 44630 | 5751 | 53124 | 4614 | 57799 | 3704 | 63448 | 2199 | 80961 | 966 | 72713 |
| 7L-3S | | MI | 28716 | 7206 | 47495 | 5670 | 57142 | 4528 | 63442 | 3638 | 72434 | 2136 | 90777 | 1588 | 73120 |
| 16-#18 | 3.48 | MA | 25174 | 7206 | 42317 | 5753 | 50076 | 4612 | 53993 | 3699 | 58349 | 2213 | 74517 | 831 | 68317 |
| 8L-2S | | MI | 30922 | 7206 | 50562 | 5671 | 61031 | 4533 | 68153 | 3621 | 78713 | 2122 | 99111 | 1821 | 73614 |
| 18-#11 | 1.53 | MA | 29034 | 5900 | 42072 | 4944 | 50577 | 4009 | 54958 | 3304 | 59859 | 2266 | 74328 | 2140 | 39111 |
| 2L-9S | | MI | 20473 | 5900 | 30358 | 4928 | 35657 | 4001 | 37525 | 3303 | 38078 | 2261 | 46475 | 1604 | 30759 |
| 18-#11 | 1.53 | MA | 27923 | 5900 | 40633 | 4945 | 48753 | 4009 | 52748 | 3314 | 56877 | 2273 | 70270 | 2049 | 39054 |
| 3L-8S | | MI | 21044 | 5900 | 31225 | 4917 | 36723 | 3992 | 38796 | 3294 | 39791 | 2256 | 48630 | 1662 | 31508 |
| 18-#11 | 1.53 | MA | 27123 | 5900 | 39568 | 4947 | 47312 | 4020 | 51002 | 3313 | 54520 | 2270 | 67590 | 1957 | 38938 |
| 4L-7S | | MI | 21620 | 5900 | 32010 | 4917 | 37757 | 3993 | 40087 | 3297 | 41522 | 2251 | 50819 | 1715 | 32131 |
| 18-#11 | 1.53 | MA | 26400 | 5900 | 38490 | 4958 | 46019 | 4020 | 49424 | 3322 | 52371 | 2277 | 64808 | 1910 | 38733 |
| 5L-6S | | MI | 22202 | 5900 | 32807 | 4916 | 38813 | 3993 | 41377 | 3288 | 43315 | 2255 | 52931 | 1786 | 32622 |
| 18-#11 | 1.53 | MA | 25708 | 5900 | 37535 | 4960 | 44744 | 4031 | 47871 | 3322 | 50306 | 2284 | 61975 | 1835 | 37957 |
| 6L-5S | | MI | 22796 | 5900 | 33627 | 4915 | 39905 | 3984 | 42706 | 3290 | 45083 | 2250 | 55305 | 1861 | 33271 |
| 18-#11 | 1.53 | MA | 25030 | 5900 | 36604 | 4961 | 43513 | 4031 | 46366 | 3331 | 48212 | 2280 | 59450 | 1765 | 37327 |
| 7L-4S | | MI | 23416 | 5900 | 34549 | 4904 | 41012 | 3985 | 44057 | 3282 | 46922 | 2245 | 57649 | 1907 | 33421 |
| 18-#11 | 1.53 | MA | 24361 | 5900 | 35689 | 4963 | 42306 | 4032 | 44859 | 3330 | 46193 | 2288 | 56851 | 1710 | 36568 |
| 8L-3S | | MI | 24101 | 5900 | 35460 | 4904 | 42244 | 3975 | 45550 | 3284 | 48937 | 2250 | 59889 | 1998 | 33503 |
| 18-#11 | 1.53 | MA | 23696 | 5900 | 34677 | 4975 | 41063 | 4042 | 43375 | 3340 | 44193 | 2295 | 54277 | 1652 | 35634 |
| 9L-2S | | MI | 25047 | 5900 | 36686 | 4903 | 43798 | 3976 | 47434 | 3276 | 51478 | 2244 | 63290 | 2089 | 33541 |
| 18-#14 | 2.20 | MA | 31615 | 6352 | 47800 | 5212 | 57717 | 4204 | 63553 | 3425 | 71417 | 2238 | 89737 | 2075 | 55724 |
| 2L-9S | | MI | 20833 | 6352 | 32496 | 5201 | 38197 | 4201 | 40529 | 3428 | 42062 | 2232 | 52197 | 1309 | 41140 |
| 18-#14 | 2.20 | MA | 30066 | 6352 | 45740 | 5213 | 55104 | 4204 | 60387 | 3438 | 67146 | 2247 | 83959 | 1944 | 55555 |
| 3L-8S | | MI | 21629 | 6352 | 33739 | 5186 | 39725 | 4188 | 42351 | 3417 | 44508 | 2224 | 55257 | 1394 | 42790 |
| 18-#14 | 2.20 | MA | 28953 | 6352 | 44212 | 5215 | 53038 | 4219 | 57883 | 3437 | 63766 | 2241 | 80145 | 1812 | 55230 |
| 4L-7S | | MI | 22430 | 6352 | 34864 | 5186 | 41208 | 4190 | 44203 | 3421 | 46978 | 2217 | 58373 | 1469 | 44046 |
| 18-#14 | 2.20 | MA | 27948 | 6352 | 42667 | 5232 | 51184 | 4219 | 55620 | 3450 | 60684 | 2251 | 76177 | 1745 | 53982 |
| 5L-6S | | MI | 23241 | 6352 | 36008 | 5186 | 42721 | 4192 | 46051 | 3410 | 49537 | 2224 | 61370 | 1572 | 45257 |
| 18-#14 | 2.20 | MA | 26984 | 6352 | 41295 | 5233 | 49354 | 4233 | 53392 | 3448 | 57721 | 2260 | 72142 | 1637 | 52781 |
| 6L-5S | | MI | 24069 | 6352 | 37183 | 5185 | 44287 | 4179 | 47957 | 3414 | 52062 | 2217 | 64744 | 1680 | 46198 |
| 18-#14 | 2.20 | MA | 26041 | 6352 | 39960 | 5235 | 47587 | 4233 | 51233 | 3461 | 54718 | 2255 | 68549 | 1535 | 51352 |
| 7L-4S | | MI | 24932 | 6352 | 38504 | 5170 | 45873 | 4180 | 49893 | 3403 | 54687 | 2209 | 68081 | 1745 | 47287 |
| 18-#14 | 2.20 | MA | 25108 | 6352 | 38646 | 5237 | 45855 | 4233 | 49070 | 3459 | 51820 | 2264 | 64842 | 1457 | 49783 |
| 8L-3S | | MI | 25885 | 6352 | 39810 | 5170 | 47638 | 4167 | 52031 | 3407 | 57563 | 2217 | 71260 | 1877 | 47539 |
| 18-#14 | 2.20 | MA | 24181 | 6352 | 37194 | 5253 | 44070 | 4248 | 46941 | 3472 | 48950 | 2273 | 61178 | 1372 | 47811 |
| 9L-2S | | MI | 27203 | 6352 | 41564 | 5169 | 49862 | 4169 | 54726 | 3396 | 61188 | 2209 | 76092 | 2008 | 47669 |
| 18-#18 | 3.91 | MA | 31581 | 7497 | 53006 | 5930 | 64032 | 4725 | 71066 | 3774 | 81429 | 2185 | 104181 | 1305 | 90495 |
| 5L-6S | | MI | 25673 | 7497 | 43888 | 5874 | 52403 | 4698 | 57660 | 3720 | 64809 | 2131 | 82046 | 1002 | 73799 |
| 18-#18 | 3.91 | MA | 29990 | 7497 | 50592 | 5931 | 60814 | 4749 | 67147 | 3768 | 76217 | 2199 | 97190 | 1112 | 86629 |
| 6L-5S | | MI | 27041 | 7497 | 45952 | 5875 | 55152 | 4676 | 61006 | 3729 | 69182 | 2118 | 87862 | 1196 | 77132 |
| 18-#18 | 3.91 | MA | 28432 | 7497 | 48242 | 5933 | 57704 | 4747 | 63348 | 3789 | 70934 | 2186 | 90974 | 930 | 82893 |
| 7L-4S | | MI | 28467 | 7497 | 48271 | 5850 | 57936 | 4682 | 64403 | 3712 | 73730 | 2104 | 93642 | 1308 | 79380 |
| 18-#18 | 3.91 | MA | 26892 | 7497 | 45928 | 5934 | 54656 | 4745 | 59542 | 3783 | 65835 | 2200 | 84530 | 795 | 78597 |
| 8L-3S | | MI | 30043 | 7497 | 50562 | 5851 | 61031 | 4661 | 68153 | 3722 | 78713 | 2118 | 99111 | 1542 | 82067 |
| 20-#11 | 1.70 | MA | 29721 | 6014 | 43510 | 5014 | 52402 | 4061 | 57168 | 3337 | 62841 | 2261 | 78386 | 2129 | 43366 |
| 2L-10S | | MI | 20524 | 6014 | 30801 | 5000 | 36185 | 4053 | 38131 | 3333 | 38858 | 2251 | 47648 | 1509 | 33409 |
| 20-#11 | 1.70 | MA | 28617 | 6014 | 42072 | 5016 | 50577 | 4061 | 54958 | 3347 | 59859 | 2268 | 74328 | 2038 | 43295 |
| 3L-9S | | MI | 21087 | 6014 | 31584 | 4999 | 37212 | 4053 | 39408 | 3335 | 40619 | 2256 | 49877 | 1590 | 34265 |
| 20-#11 | 1.70 | MA | 27824 | 6014 | 41006 | 5017 | 49136 | 4072 | 53212 | 3346 | 57502 | 2264 | 71647 | 1947 | 43164 |
| 4L-8S | | MI | 21653 | 6014 | 32450 | 4988 | 38278 | 4044 | 40679 | 3327 | 42333 | 2251 | 52032 | 1648 | 34996 |
| 20-#11 | 1.70 | MA | 27107 | 6014 | 39929 | 5029 | 47844 | 4072 | 51634 | 3355 | 55353 | 2271 | 68866 | 1900 | 42941 |
| 5L-7S | | MI | 22224 | 6014 | 33236 | 4987 | 39312 | 4045 | 41971 | 3329 | 44063 | 2245 | 54220 | 1701 | 35668 |
| 20-#11 | 1.70 | MA | 26421 | 6014 | 38973 | 5031 | 46569 | 4083 | 50081 | 3354 | 53288 | 2279 | 66032 | 1825 | 42102 |
| 6E | | MI | 22801 | 6014 | 34033 | 4987 | 40367 | 4045 | 43260 | 3321 | 45856 | 2250 | 56332 | 1772 | 36146 |

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

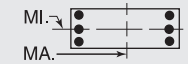
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.70 | MA | 25749 | 6014 | 38043 | 5032 | 45337 | 4083 | 48576 | 3364 | 51194 | 2275 | 63507 | 1754 | 41488 |
| 7L-5S | | MI | 23390 | 6014 | 34852 | 4986 | 41460 | 4036 | 44590 | 3323 | 47624 | 2245 | 58707 | 1847 | 36856 |
| 20-#11 | 1.70 | MA | 25086 | 6014 | 37127 | 5034 | 44130 | 4083 | 47069 | 3363 | 49175 | 2282 | 60909 | 1699 | 40682 |
| 8L-4S | | MI | 24006 | 6014 | 35775 | 4975 | 42566 | 4037 | 45941 | 3315 | 49463 | 2239 | 61050 | 1893 | 37023 |
| 20-#11 | 1.70 | MA | 24427 | 6014 | 36116 | 5046 | 42887 | 4094 | 45586 | 3372 | 47175 | 2289 | 58334 | 1641 | 39768 |
| 9L-3S | | MI | 24685 | 6014 | 36686 | 4975 | 43798 | 4027 | 47434 | 3317 | 51478 | 2244 | 63290 | 1984 | 37119 |
| 20-#11 | 1.70 | MA | 23759 | 6014 | 35204 | 5047 | 41689 | 4094 | 44096 | 3372 | 45118 | 2286 | 55673 | 1561 | 38733 |
| 10L-2S | | MI | 25624 | 6014 | 37912 | 4974 | 45353 | 4028 | 49317 | 3309 | 54020 | 2239 | 66691 | 2075 | 37169 |
| 20-#14 | 2.45 | MA | 31021 | 6515 | 47800 | 5316 | 57717 | 4279 | 63553 | 3486 | 71417 | 2240 | 89737 | 1927 | 61608 |
| 3L-9S | | MI | 21689 | 6515 | 34249 | 5304 | 40421 | 4276 | 43223 | 3476 | 45687 | 2224 | 57030 | 1287 | 46105 |
| 20-#14 | 2.45 | MA | 29920 | 6515 | 46272 | 5317 | 55651 | 4293 | 61049 | 3484 | 68037 | 2234 | 85924 | 1795 | 61255 |
| 4L-8S | | MI | 22476 | 6515 | 35492 | 5288 | 41949 | 4263 | 45045 | 3465 | 48133 | 2216 | 60090 | 1372 | 47797 |
| 20-#14 | 2.45 | MA | 28925 | 6515 | 44727 | 5334 | 53796 | 4293 | 58785 | 3497 | 64955 | 2243 | 81956 | 1728 | 59891 |
| 5L-7S | | MI | 23269 | 6515 | 36618 | 5288 | 43432 | 4265 | 46897 | 3469 | 50602 | 2209 | 63205 | 1447 | 49019 |
| 20-#14 | 2.45 | MA | 27973 | 6515 | 43355 | 5336 | 51967 | 4308 | 56558 | 3495 | 61992 | 2253 | 77921 | 1620 | 58727 |
| 6E | | MI | 24070 | 6515 | 37762 | 5288 | 44945 | 4267 | 48745 | 3458 | 53162 | 2216 | 66203 | 1550 | 50301 |
| 20-#14 | 2.45 | MA | 27040 | 6515 | 42020 | 5337 | 50199 | 4308 | 54398 | 3508 | 58989 | 2247 | 74328 | 1518 | 57228 |
| 7L-5S | | MI | 24889 | 6515 | 38936 | 5287 | 46511 | 4253 | 50651 | 3461 | 55687 | 2209 | 69577 | 1658 | 51212 |
| 20-#14 | 2.45 | MA | 26118 | 6515 | 40706 | 5339 | 48468 | 4308 | 52235 | 3506 | 56091 | 2257 | 70621 | 1440 | 55696 |
| 8L-4S | | MI | 25744 | 6515 | 40258 | 5272 | 48097 | 4255 | 52587 | 3450 | 58312 | 2201 | 72913 | 1723 | 52410 |
| 20-#14 | 2.45 | MA | 25202 | 6515 | 39254 | 5356 | 46683 | 4323 | 50107 | 3519 | 53221 | 2266 | 66956 | 1355 | 53685 |
| 9L-3S | | MI | 26688 | 6515 | 41564 | 5272 | 49862 | 4242 | 54726 | 3454 | 61188 | 2209 | 76092 | 1855 | 52689 |
| 20-#14 | 2.45 | MA | 24290 | 6515 | 37945 | 5357 | 44964 | 4323 | 47969 | 3517 | 50270 | 2260 | 63168 | 1240 | 51732 |
| 10L-2S | | MI | 27993 | 6515 | 43317 | 5271 | 52086 | 4244 | 57420 | 3443 | 64813 | 2201 | 80925 | 1986 | 52841 |
| 20-#18 | 4.35 | MA | 31627 | 7788 | 54204 | 6113 | 65394 | 4882 | 72696 | 3852 | 83704 | 2185 | 107203 | 1076 | 96903 |
| 6E | | MI | 27045 | 7788 | 46955 | 6056 | 56292 | 4831 | 62371 | 3804 | 71088 | 2113 | 90380 | 956 | 82465 |
| 20-#18 | 4.35 | MA | 30094 | 7788 | 51853 | 6115 | 62284 | 4880 | 68897 | 3873 | 78420 | 2173 | 100987 | 894 | 92950 |
| 7L-5S | | MI | 28393 | 7788 | 49018 | 6057 | 59041 | 4809 | 65717 | 3814 | 75462 | 2100 | 96197 | 1150 | 85922 |
| 20-#18 | 4.35 | MA | 28578 | 7788 | 49540 | 6116 | 59236 | 4878 | 65091 | 3867 | 73322 | 2186 | 94543 | 758 | 88859 |
| 8L-4S | | MI | 29798 | 7788 | 51338 | 6032 | 61825 | 4815 | 69114 | 3797 | 80009 | 2087 | 101976 | 1262 | 88079 |
| 22-#11 | 1.87 | MA | 29304 | 6127 | 43510 | 5087 | 52402 | 4113 | 57168 | 3380 | 62841 | 2263 | 78386 | 2027 | 47534 |
| 3L-10S | | MI | 21135 | 6127 | 32027 | 5070 | 37740 | 4104 | 40015 | 3366 | 41399 | 2246 | 51050 | 1496 | 36890 |
| 22-#11 | 1.87 | MA | 28517 | 6127 | 42445 | 5088 | 50961 | 4124 | 55422 | 3379 | 60484 | 2259 | 75705 | 1936 | 47387 |
| 4L-9S | | MI | 21694 | 6127 | 32809 | 5070 | 38767 | 4105 | 41292 | 3368 | 43160 | 2251 | 53278 | 1576 | 37777 |
| 22-#11 | 1.87 | MA | 27807 | 6127 | 41367 | 5100 | 49668 | 4124 | 53844 | 3388 | 58335 | 2266 | 72924 | 1889 | 47149 |
| 5L-8S | | MI | 22256 | 6127 | 33676 | 5059 | 39832 | 4096 | 42563 | 3360 | 44874 | 2246 | 55433 | 1635 | 38490 |
| 22-#11 | 1.87 | MA | 27126 | 6127 | 40412 | 5102 | 48393 | 4135 | 52291 | 3387 | 56270 | 2273 | 70090 | 1814 | 46252 |
| 6L-7S | | MI | 22821 | 6127 | 34461 | 5058 | 40867 | 4096 | 43854 | 3362 | 46604 | 2240 | 57621 | 1687 | 39208 |
| 22-#11 | 1.87 | MA | 26461 | 6127 | 39481 | 5103 | 47161 | 4135 | 50787 | 3397 | 54176 | 2270 | 67565 | 1743 | 45653 |
| 7L-6S | | MI | 23394 | 6127 | 35259 | 5058 | 41922 | 4097 | 45144 | 3354 | 48397 | 2245 | 59733 | 1758 | 39675 |
| 22-#11 | 1.87 | MA | 25803 | 6127 | 38566 | 5105 | 45955 | 4135 | 49279 | 3396 | 52157 | 2277 | 64967 | 1689 | 44801 |
| 8L-5S | | MI | 23978 | 6127 | 36078 | 5057 | 43014 | 4088 | 46473 | 3356 | 50165 | 2240 | 62108 | 1834 | 40400 |
| 22-#11 | 1.87 | MA | 25149 | 6127 | 37554 | 5116 | 44711 | 4146 | 47796 | 3405 | 50157 | 2284 | 62392 | 1630 | 43906 |
| 9L-4S | | MI | 24589 | 6127 | 37000 | 5046 | 44121 | 4088 | 47824 | 3348 | 52004 | 2234 | 64451 | 1879 | 40622 |
| 22-#11 | 1.87 | MA | 24499 | 6127 | 36642 | 5118 | 43513 | 4146 | 46306 | 3404 | 48100 | 2281 | 59731 | 1550 | 42842 |
| 10L-3S | | MI | 25263 | 6127 | 37912 | 5046 | 45353 | 4079 | 49317 | 3350 | 54020 | 2239 | 66691 | 1970 | 40732 |
| 22-#11 | 1.87 | MA | 23794 | 6127 | 35737 | 5119 | 42284 | 4157 | 44832 | 3414 | 46109 | 2288 | 57177 | 1493 | 41751 |
| 11L-2S | | MI | 26196 | 6127 | 39138 | 5045 | 46908 | 4080 | 51201 | 3342 | 56561 | 2234 | 70093 | 2061 | 40794 |
| 22-#14 | 2.69 | MA | 30874 | 6679 | 48332 | 5420 | 58264 | 4368 | 64214 | 3531 | 72308 | 2227 | 91703 | 1778 | 67280 |
| 4L-9S | | MI | 22534 | 6679 | 36003 | 5406 | 42645 | 4351 | 45917 | 3523 | 49311 | 2216 | 61862 | 1265 | 51077 |
| 22-#14 | 2.69 | MA | 29890 | 6679 | 46787 | 5436 | 56409 | 4368 | 61951 | 3544 | 69226 | 2236 | 87735 | 1711 | 65810 |
| 5L-8S | | MI | 23312 | 6679 | 37246 | 5391 | 44173 | 4338 | 47740 | 3512 | 51757 | 2208 | 64922 | 1350 | 52810 |
| 22-#14 | 2.69 | MA | 28948 | 6679 | 45415 | 5438 | 54580 | 4383 | 59723 | 3542 | 66263 | 2245 | 83699 | 1603 | 64678 |
| 6L-7S | | MI | 24096 | 6679 | 38372 | 5390 | 45656 | 4340 | 49591 | 3516 | 54227 | 2201 | 68038 | 1425 | 54001 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

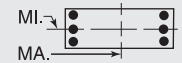
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 2.69 | MA | 28026 | 6679 | 44080 | 5440 | 52812 | 4383 | 57564 | 3555 | 63260 | 2240 | 80106 | 1501 | 63112 |
| 7L-6S | | MI | 24890 | 6679 | 39515 | 5390 | 47169 | 4341 | 51440 | 3505 | 56787 | 2208 | 71036 | 1528 | 55352 |
| 22-#14 | 2.69 | MA | 27114 | 6679 | 42766 | 5441 | 51081 | 4383 | 55401 | 3553 | 60362 | 2249 | 76400 | 1423 | 61616 |
| 8L-5S | | MI | 25700 | 6679 | 40690 | 5390 | 48735 | 4328 | 53346 | 3509 | 59311 | 2201 | 74409 | 1636 | 56234 |
| 22-#14 | 2.69 | MA | 26209 | 6679 | 41315 | 5458 | 49296 | 4398 | 53272 | 3566 | 57492 | 2259 | 72735 | 1338 | 59566 |
| 9L-4S | | MI | 26546 | 6679 | 42012 | 5374 | 50321 | 4330 | 55281 | 3498 | 61936 | 2193 | 77746 | 1701 | 57532 |
| 22-#14 | 2.69 | MA | 25307 | 6679 | 40005 | 5460 | 47577 | 4397 | 51134 | 3565 | 54541 | 2253 | 68947 | 1223 | 57584 |
| 10L-3S | | MI | 27480 | 6679 | 43317 | 5374 | 52086 | 4317 | 57420 | 3502 | 64813 | 2201 | 80925 | 1833 | 57835 |
| 22-#18 | 4.78 | MA | 31730 | 8078 | 55465 | 6296 | 66864 | 5013 | 74446 | 3957 | 85907 | 2159 | 111000 | 858 | 103171 |
| 7L-6S | | MI | 28398 | 8078 | 50021 | 6238 | 60180 | 4964 | 67082 | 3888 | 77368 | 2095 | 98714 | 910 | 91149 |
| 22-#18 | 4.78 | MA | 30236 | 8078 | 53151 | 6298 | 63817 | 5011 | 70640 | 3951 | 80808 | 2173 | 104556 | 722 | 99035 |
| 8L-5S | | MI | 29726 | 8078 | 52084 | 6239 | 62930 | 4942 | 70428 | 3898 | 81741 | 2082 | 104531 | 1104 | 94725 |
| 24-#11 | 2.03 | MA | 29203 | 6241 | 43883 | 5159 | 52785 | 4176 | 57632 | 3412 | 63466 | 2254 | 79763 | 1925 | 51610 |
| 4L-10S | | MI | 21740 | 6241 | 33253 | 5141 | 39294 | 4156 | 41898 | 3399 | 43940 | 2241 | 54451 | 1482 | 40374 |
| 24-#11 | 2.03 | MA | 28499 | 6241 | 42806 | 5171 | 51492 | 4176 | 56054 | 3421 | 61317 | 2261 | 76981 | 1878 | 51305 |
| 5L-9S | | MI | 22295 | 6241 | 34035 | 5141 | 40321 | 4157 | 43175 | 3401 | 45702 | 2246 | 56679 | 1562 | 41292 |
| 24-#11 | 2.03 | MA | 27824 | 6241 | 41850 | 5173 | 50217 | 4187 | 54502 | 3420 | 59252 | 2268 | 74148 | 1803 | 50407 |
| 6L-8S | | MI | 22852 | 6241 | 34902 | 5130 | 41387 | 4147 | 44446 | 3393 | 47415 | 2240 | 58834 | 1621 | 41989 |
| 24-#11 | 2.03 | MA | 27164 | 6241 | 40920 | 5174 | 48986 | 4187 | 52997 | 3430 | 57158 | 2265 | 71623 | 1733 | 49820 |
| 7E | | MI | 23412 | 6241 | 35687 | 5129 | 42421 | 4148 | 45738 | 3395 | 49145 | 2235 | 61023 | 1673 | 42751 |
| 24-#11 | 2.03 | MA | 26512 | 6241 | 40004 | 5175 | 47779 | 4187 | 51489 | 3429 | 55138 | 2272 | 69024 | 1678 | 48925 |
| 8L-6S | | MI | 23980 | 6241 | 36485 | 5129 | 43477 | 4149 | 47027 | 3387 | 50938 | 2240 | 63134 | 1744 | 43208 |
| 24-#11 | 2.03 | MA | 25864 | 6241 | 38993 | 5187 | 46536 | 4198 | 50006 | 3438 | 53139 | 2279 | 66450 | 1620 | 48048 |
| 9L-5S | | MI | 24560 | 6241 | 37304 | 5128 | 44569 | 4139 | 48357 | 3389 | 52707 | 2235 | 65509 | 1820 | 43910 |
| 24-#11 | 2.03 | MA | 25219 | 6241 | 38081 | 5189 | 45337 | 4198 | 48516 | 3437 | 51082 | 2276 | 63789 | 1540 | 46956 |
| 10L-4S | | MI | 25166 | 6241 | 38226 | 5117 | 45676 | 4140 | 49708 | 3381 | 54546 | 2229 | 67853 | 1865 | 44219 |
| 24-#11 | 2.03 | MA | 24518 | 6241 | 37175 | 5190 | 44108 | 4209 | 47042 | 3447 | 49091 | 2283 | 61235 | 1482 | 45883 |
| 11L-3S | | MI | 25835 | 6241 | 39138 | 5116 | 46908 | 4131 | 51201 | 3383 | 56561 | 2234 | 70093 | 1956 | 44342 |
| 24-#11 | 2.03 | MA | 23831 | 6241 | 36275 | 5192 | 42913 | 4209 | 45561 | 3446 | 47109 | 2290 | 58681 | 1424 | 44537 |
| 12L-2S | | MI | 26762 | 6241 | 40363 | 5116 | 48462 | 4131 | 53084 | 3375 | 59102 | 2229 | 73494 | 2047 | 44416 |
| 24-#14 | 2.93 | MA | 30844 | 6842 | 48847 | 5538 | 59022 | 4443 | 65116 | 3592 | 73497 | 2228 | 93513 | 1694 | 71738 |
| 5L-9S | | MI | 23367 | 6842 | 37756 | 5508 | 44869 | 4426 | 48612 | 3571 | 52936 | 2208 | 66695 | 1243 | 56057 |
| 24-#14 | 2.93 | MA | 29912 | 6842 | 47476 | 5540 | 57193 | 4458 | 62889 | 3590 | 70534 | 2238 | 89478 | 1586 | 70636 |
| 6L-8S | | MI | 24138 | 6842 | 38999 | 5493 | 46397 | 4413 | 50434 | 3560 | 55382 | 2200 | 69755 | 1328 | 57798 |
| 24-#14 | 2.93 | MA | 28999 | 6842 | 46141 | 5542 | 55425 | 4458 | 60730 | 3603 | 67530 | 2232 | 85885 | 1484 | 69005 |
| 7E | | MI | 24914 | 6842 | 40125 | 5493 | 47880 | 4414 | 52286 | 3563 | 57852 | 2193 | 72871 | 1403 | 58992 |
| 24-#14 | 2.93 | MA | 28098 | 6842 | 44826 | 5543 | 53694 | 4458 | 58566 | 3601 | 64632 | 2242 | 82178 | 1406 | 67541 |
| 8L-6S | | MI | 25699 | 6842 | 41269 | 5492 | 49393 | 4416 | 54134 | 3552 | 60412 | 2200 | 75868 | 1506 | 60407 |
| 24-#14 | 2.93 | MA | 27202 | 6842 | 43375 | 5560 | 51909 | 4472 | 56438 | 3614 | 61763 | 2251 | 78514 | 1321 | 65454 |
| 9L-5S | | MI | 26502 | 6842 | 42443 | 5492 | 50958 | 4403 | 56040 | 3556 | 62936 | 2193 | 79242 | 1614 | 61265 |
| 24-#14 | 2.93 | MA | 26306 | 6842 | 42066 | 5562 | 50190 | 4472 | 54300 | 3612 | 58812 | 2246 | 74725 | 1206 | 63443 |
| 10L-4S | | MI | 27339 | 6842 | 43765 | 5477 | 52545 | 4405 | 57976 | 3545 | 65561 | 2185 | 82579 | 1679 | 62653 |
| 24-#18 | 5.22 | MA | 31871 | 8369 | 56763 | 6480 | 68397 | 5144 | 76189 | 4036 | 88295 | 2160 | 114569 | 686 | 109225 |
| 8L-6S | | MI | 29732 | 8369 | 53087 | 6419 | 64069 | 5097 | 71793 | 3973 | 83648 | 2078 | 107048 | 864 | 99850 |

## RECTANGULAR TIED COLUMNS 40" x 48"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.25 | MA | 30228 | 5964 | 43390 | 5008 | 51720 | 4070 | 55658 | 3371 | 59449 | 2357 | 72710 | 2217 | 34709 |
| 2L-3S | | MI | 22547 | 5964 | 33296 | 4944 | 39000 | 4014 | 41210 | 3345 | 42274 | 2323 | 50517 | 1913 | 28340 |
| 6-#18 | 1.25 | MA | 27263 | 5964 | 39597 | 5010 | 46909 | 4069 | 49830 | 3393 | 51586 | 2372 | 62136 | 1983 | 34547 |
| 3L-2S | | MI | 24937 | 5964 | 36362 | 4945 | 42888 | 4019 | 45921 | 3328 | 48554 | 2310 | 58851 | 2147 | 28403 |
| 8-#18 | 1.67 | MA | 32038 | 6255 | 47183 | 5189 | 56530 | 4203 | 61486 | 3455 | 67312 | 2343 | 83283 | 2183 | 45947 |
| 2L-4S | | MI | 22305 | 6255 | 34072 | 5125 | 39794 | 4168 | 42172 | 3419 | 43570 | 2292 | 53382 | 1633 | 36689 |
| 8-#18 | 1.67 | MA | 29125 | 6255 | 43390 | 5192 | 51720 | 4202 | 55658 | 3477 | 59449 | 2359 | 72710 | 1950 | 45674 |
| 3E | | MI | 24020 | 6255 | 36362 | 5126 | 42888 | 4147 | 45921 | 3429 | 48554 | 2305 | 58851 | 1867 | 37345 |
| 8-#18 | 1.67 | MA | 27017 | 6255 | 40573 | 5194 | 47911 | 4227 | 51042 | 3473 | 53219 | 2347 | 65740 | 1716 | 44750 |
| 4L-2S | | MI | 26370 | 6255 | 39428 | 5127 | 46777 | 4152 | 50632 | 3412 | 54833 | 2292 | 67185 | 2101 | 37510 |

## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

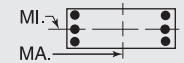
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.17 | MA | 30015 | 5910 | 42549 | 5002 | 50913 | 4068 | 54795 | 3375 | 58362 | 2374 | 71626 | 2253 | 32868 |
| 2L-5S | | MI | 21514 | 5910 | 31289 | 4961 | 36688 | 4031 | 38505 | 3354 | 38805 | 2348 | 46831 | 1864 | 26472 |
| 10-#14 | 1.17 | MA | 28317 | 5910 | 40386 | 5004 | 48171 | 4069 | 51472 | 3388 | 53879 | 2384 | 65531 | 2122 | 32816 |
| 3L-4S | | MI | 22420 | 5910 | 32611 | 4946 | 38275 | 4033 | 40440 | 3343 | 41430 | 2341 | 50167 | 1929 | 26826 |
| 10-#14 | 1.17 | MA | 27091 | 5910 | 38784 | 5006 | 46004 | 4084 | 48846 | 3387 | 50335 | 2380 | 61506 | 1991 | 32632 |
| 4L-3S | | MI | 23419 | 5910 | 33917 | 4945 | 40039 | 4020 | 42579 | 3346 | 44306 | 2348 | 53346 | 2061 | 26928 |
| 10-#14 | 1.17 | MA | 25982 | 5910 | 37165 | 5023 | 44061 | 4084 | 46473 | 3401 | 47104 | 2390 | 57328 | 1923 | 32111 |
| 5L-2S | | MI | 24792 | 5910 | 35670 | 4945 | 42263 | 4022 | 45274 | 3335 | 47931 | 2341 | 58179 | 2192 | 26941 |
| 10-#18 | 2.08 | MA | 33803 | 6546 | 50976 | 5371 | 61341 | 4336 | 67314 | 3540 | 75176 | 2330 | 93857 | 2150 | 57156 |
| 2L-5S | | MI | 22242 | 6546 | 34819 | 5332 | 40898 | 4295 | 43485 | 3521 | 45302 | 2287 | 55936 | 1476 | 42429 |
| 10-#18 | 2.08 | MA | 30939 | 6546 | 47183 | 5373 | 56530 | 4335 | 61486 | 3561 | 67312 | 2345 | 83283 | 1916 | 56787 |
| 3L-4S | | MI | 23772 | 6546 | 37138 | 5306 | 43682 | 4301 | 46883 | 3504 | 49850 | 2274 | 61716 | 1587 | 45205 |
| 10-#18 | 2.08 | MA | 28870 | 6546 | 44366 | 5376 | 52722 | 4360 | 56870 | 3557 | 61082 | 2334 | 76313 | 1683 | 55465 |
| 4L-3S | | MI | 25457 | 6546 | 39428 | 5308 | 46777 | 4280 | 50632 | 3513 | 54833 | 2287 | 67185 | 1821 | 46328 |
| 10-#18 | 2.08 | MA | 26998 | 6546 | 41516 | 5404 | 49302 | 4359 | 52695 | 3579 | 55398 | 2349 | 69039 | 1565 | 51743 |
| 5L-2S | | MI | 27770 | 6546 | 42495 | 5309 | 50666 | 4285 | 55344 | 3496 | 61113 | 2274 | 75519 | 2055 | 46580 |
| 12-#14 | 1.41 | MA | 31068 | 6073 | 44711 | 5104 | 53656 | 4143 | 58117 | 3422 | 62845 | 2367 | 77720 | 2238 | 39278 |
| 2L-6S | | MI | 21528 | 6073 | 31868 | 5064 | 37347 | 4119 | 39293 | 3397 | 39905 | 2348 | 48290 | 1734 | 30348 |
| 12-#14 | 1.41 | MA | 29388 | 6073 | 42549 | 5106 | 50913 | 4144 | 54795 | 3436 | 58362 | 2377 | 71626 | 2106 | 39194 |
| 3L-5S | | MI | 22387 | 6073 | 33043 | 5063 | 38912 | 4106 | 41199 | 3401 | 42429 | 2340 | 51663 | 1842 | 31425 |
| 12-#14 | 1.41 | MA | 28177 | 6073 | 40947 | 5108 | 48747 | 4159 | 52169 | 3434 | 54818 | 2372 | 67601 | 1975 | 38969 |
| 4E | | MI | 23283 | 6073 | 34365 | 5048 | 40498 | 4108 | 43135 | 3390 | 45055 | 2333 | 55000 | 1907 | 31968 |
| 12-#14 | 1.41 | MA | 27081 | 6073 | 39327 | 5125 | 46803 | 4159 | 49796 | 3448 | 51587 | 2382 | 63422 | 1907 | 38258 |
| 5L-3S | | MI | 24271 | 6073 | 35670 | 5048 | 42263 | 4095 | 45274 | 3394 | 47931 | 2340 | 58179 | 2039 | 32108 |
| 12-#14 | 1.41 | MA | 26032 | 6073 | 37890 | 5127 | 44886 | 4174 | 47461 | 3447 | 48481 | 2392 | 59166 | 1799 | 36809 |
| 6L-2S | | MI | 25630 | 6073 | 37424 | 5047 | 44487 | 4097 | 47968 | 3383 | 51555 | 2333 | 63012 | 2170 | 32152 |
| 12-#18 | 2.50 | MA | 35529 | 6837 | 54769 | 5553 | 66152 | 4469 | 73142 | 3624 | 83039 | 2317 | 104431 | 2117 | 68347 |
| 2L-6S | | MI | 22259 | 6837 | 35822 | 5512 | 42038 | 4449 | 44850 | 3595 | 47208 | 2283 | 58454 | 1236 | 48390 |
| 12-#18 | 2.50 | MA | 32710 | 6837 | 50976 | 5555 | 61341 | 4468 | 67314 | 3646 | 75176 | 2332 | 93857 | 1883 | 67893 |
| 3L-5S | | MI | 23702 | 6837 | 37885 | 5513 | 44787 | 4428 | 48197 | 3605 | 51581 | 2270 | 64271 | 1430 | 51138 |
| 12-#18 | 2.50 | MA | 30679 | 6837 | 48159 | 5557 | 57532 | 4493 | 62698 | 3641 | 68945 | 2321 | 86887 | 1649 | 66151 |
| 4E | | MI | 25205 | 6837 | 40205 | 5488 | 47571 | 4434 | 51594 | 3588 | 56129 | 2256 | 70050 | 1541 | 53770 |
| 12-#18 | 2.50 | MA | 28841 | 6837 | 45309 | 5586 | 54112 | 4492 | 58524 | 3663 | 63262 | 2336 | 79612 | 1531 | 62591 |
| 5L-3S | | MI | 26862 | 6837 | 42495 | 5489 | 50666 | 4413 | 55344 | 3597 | 61113 | 2270 | 75519 | 1775 | 55298 |
| 12-#18 | 2.50 | MA | 27077 | 6837 | 42778 | 5588 | 50737 | 4517 | 54415 | 3658 | 57797 | 2351 | 72230 | 1339 | 59144 |
| 6L-2S | | MI | 29141 | 6837 | 45561 | 5491 | 54554 | 4418 | 60055 | 3580 | 67392 | 2256 | 83853 | 2009 | 55627 |
| 14-#11 | 1.14 | MA | 29924 | 5886 | 42162 | 5001 | 50555 | 4069 | 54418 | 3378 | 57894 | 2383 | 71174 | 2271 | 32061 |
| 2L-7S | | MI | 21239 | 5886 | 30673 | 4960 | 35944 | 4041 | 37646 | 3360 | 37683 | 2360 | 45437 | 1839 | 25202 |
| 14-#11 | 1.14 | MA | 28736 | 5886 | 40653 | 5002 | 48641 | 4070 | 52099 | 3388 | 54765 | 2390 | 66897 | 2179 | 32033 |
| 3L-6S | | MI | 21833 | 5886 | 31471 | 4960 | 36999 | 4042 | 38935 | 3352 | 39476 | 2365 | 47549 | 1910 | 25729 |
| 14-#11 | 1.14 | MA | 27881 | 5886 | 39536 | 5004 | 47130 | 4080 | 50268 | 3387 | 52294 | 2388 | 64069 | 2088 | 31954 |
| 4L-5S | | MI | 22439 | 5886 | 32290 | 4959 | 38092 | 4033 | 40265 | 3354 | 41245 | 2360 | 49923 | 1986 | 26156 |
| 14-#11 | 1.14 | MA | 27108 | 5886 | 38407 | 5016 | 45776 | 4081 | 48614 | 3397 | 50042 | 2395 | 61142 | 2041 | 31787 |
| 5L-4S | | MI | 23072 | 5886 | 33212 | 4948 | 39198 | 4033 | 41615 | 3346 | 43084 | 2355 | 52267 | 2031 | 26255 |
| 14-#11 | 1.14 | MA | 26368 | 5886 | 37406 | 5018 | 44440 | 4092 | 46988 | 3396 | 47878 | 2403 | 58155 | 1966 | 31208 |
| 6L-3S | | MI | 23770 | 5886 | 34124 | 4948 | 40430 | 4024 | 43109 | 3348 | 45099 | 2359 | 54507 | 2122 | 26295 |
| 14-#11 | 1.14 | MA | 25643 | 5886 | 36431 | 5020 | 43149 | 4093 | 45411 | 3406 | 45684 | 2400 | 55492 | 1895 | 30488 |
| 7L-2S | | MI | 24731 | 5886 | 35350 | 4947 | 41985 | 4025 | 44992 | 3340 | 47640 | 2354 | 57908 | 2213 | 26300 |
| 14-#14 | 1.64 | MA | 32104 | 6237 | 46874 | 5206 | 56399 | 4218 | 61440 | 3470 | 67328 | 2359 | 83815 | 2222 | 45679 |
| 2L-7S | | MI | 21565 | 6237 | 32478 | 5166 | 38057 | 4192 | 40139 | 3456 | 40970 | 2332 | 50125 | 1609 | 34430 |
| 14-#14 | 1.64 | MA | 30441 | 6237 | 44711 | 5208 | 53656 | 4218 | 58117 | 3483 | 62845 | 2369 | 77720 | 2091 | 45564 |
| 3L-6S | | MI | 22397 | 6237 | 33622 | 5166 | 39570 | 4194 | 41987 | 3444 | 43530 | 2340 | 53122 | 1712 | 35367 |
| 14-#14 | 1.64 | MA | 29244 | 6237 | 43109 | 5210 | 51489 | 4234 | 55491 | 3482 | 59301 | 2365 | 73695 | 1959 | 45302 |
| 4L-5S | | MI | 23247 | 6237 | 34796 | 5165 | 41136 | 4181 | 43893 | 3448 | 46054 | 2332 | 56496 | 1820 | 36397 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis

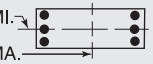



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 1.64 | MA | 28162 | 6237 | 41490 | 5227 | 49546 | 4234 | 53119 | 3495 | 56070 | 2375 | 69517 | 1891 | 44423 |
| 5L-4S | | MI | 24132 | 6237 | 36118 | 5150 | 42722 | 4183 | 45829 | 3437 | 48679 | 2325 | 59833 | 1885 | 37104 |
| 14-#14 | 1.64 | MA | 27125 | 6237 | 40052 | 5229 | 47628 | 4249 | 50784 | 3494 | 52964 | 2385 | 65261 | 1783 | 43028 |
| 6L-3S | | MI | 25109 | 6237 | 37424 | 5150 | 44487 | 4170 | 47968 | 3441 | 51555 | 2332 | 63012 | 2017 | 37278 |
| 14-#14 | 1.64 | MA | 26110 | 6237 | 38653 | 5231 | 45776 | 4250 | 48521 | 3507 | 49816 | 2380 | 61468 | 1681 | 41815 |
| 7L-2S | | MI | 26456 | 6237 | 39177 | 5149 | 46711 | 4171 | 50662 | 3430 | 55180 | 2325 | 67844 | 2148 | 37348 |
| 14-#18 | 2.92 | MA | 34445 | 7127 | 54769 | 5737 | 66152 | 4601 | 73142 | 3730 | 83039 | 2319 | 104431 | 1850 | 78993 |
| 3L-6S | | MI | 23711 | 7127 | 38888 | 5694 | 45926 | 4582 | 49562 | 3679 | 53488 | 2265 | 66788 | 1190 | 56980 |
| 14-#18 | 2.92 | MA | 32448 | 7127 | 51952 | 5739 | 62343 | 4626 | 68526 | 3725 | 76808 | 2307 | 97461 | 1616 | 76877 |
| 4L-5S | | MI | 25130 | 7127 | 40951 | 5695 | 48676 | 4561 | 52908 | 3689 | 57861 | 2252 | 72605 | 1383 | 59872 |
| 14-#18 | 2.92 | MA | 30642 | 7127 | 49102 | 5768 | 58923 | 4625 | 64352 | 3747 | 71125 | 2322 | 90186 | 1498 | 73463 |
| 5L-4S | | MI | 26609 | 7127 | 43271 | 5670 | 51460 | 4567 | 56305 | 3672 | 62409 | 2239 | 78384 | 1495 | 62376 |
| 14-#18 | 2.92 | MA | 28911 | 7127 | 46571 | 5770 | 55548 | 4650 | 60243 | 3743 | 65660 | 2338 | 82803 | 1305 | 69884 |
| 6L-3S | | MI | 28240 | 7127 | 45561 | 5671 | 54554 | 4546 | 60055 | 3682 | 67392 | 2252 | 83853 | 1729 | 64260 |
| 14-#18 | 2.92 | MA | 27214 | 7127 | 44107 | 5772 | 52287 | 4649 | 56260 | 3764 | 60119 | 2326 | 76234 | 1123 | 66307 |
| 7L-2S | | MI | 30487 | 7127 | 48627 | 5672 | 58443 | 4551 | 64766 | 3665 | 73672 | 2239 | 92187 | 1963 | 64659 |
| 16-#11 | 1.30 | MA | 30666 | 5999 | 43672 | 5072 | 52469 | 4121 | 56737 | 3411 | 61023 | 2378 | 75450 | 2261 | 36537 |
| 2L-8S | | MI | 21277 | 5999 | 31114 | 5032 | 36464 | 4093 | 38237 | 3391 | 38494 | 2361 | 46650 | 1773 | 28243 |
| 16-#11 | 1.30 | MA | 29487 | 5999 | 42162 | 5073 | 50555 | 4121 | 54418 | 3420 | 57894 | 2385 | 71174 | 2170 | 36493 |
| 3L-7S | | MI | 21859 | 5999 | 31899 | 5031 | 37499 | 4093 | 39529 | 3393 | 40224 | 2355 | 48838 | 1825 | 28730 |
| 16-#11 | 1.30 | MA | 28639 | 5999 | 41046 | 5075 | 49045 | 4132 | 52587 | 3420 | 55423 | 2382 | 68346 | 2079 | 36395 |
| 4L-6S | | MI | 22447 | 5999 | 32697 | 5031 | 38554 | 4094 | 40818 | 3385 | 42017 | 2360 | 50950 | 1896 | 29239 |
| 16-#11 | 1.30 | MA | 27873 | 5999 | 39917 | 5087 | 47690 | 4133 | 50934 | 3430 | 53171 | 2390 | 65419 | 2031 | 36208 |
| 5E | | MI | 23049 | 5999 | 33516 | 5030 | 39646 | 4085 | 42148 | 3387 | 43786 | 2355 | 53325 | 1972 | 29748 |
| 16-#11 | 1.30 | MA | 27140 | 5999 | 38915 | 5089 | 46354 | 4144 | 49307 | 3429 | 51007 | 2398 | 62432 | 1956 | 35546 |
| 6L-4S | | MI | 23676 | 5999 | 34438 | 5019 | 40753 | 4085 | 43499 | 3379 | 45625 | 2349 | 55668 | 2017 | 29866 |
| 16-#11 | 1.30 | MA | 26421 | 5999 | 37941 | 5091 | 45064 | 4144 | 47730 | 3439 | 48813 | 2395 | 59769 | 1885 | 34848 |
| 7L-3S | | MI | 24368 | 5999 | 35350 | 5018 | 41985 | 4076 | 44992 | 3381 | 47640 | 2354 | 57908 | 2108 | 29923 |
| 16-#11 | 1.30 | MA | 25712 | 5999 | 36982 | 5092 | 43799 | 4145 | 46150 | 3438 | 46697 | 2402 | 57034 | 1830 | 34194 |
| 8L-2S | | MI | 25323 | 5999 | 36575 | 5018 | 43540 | 4077 | 46876 | 3373 | 50181 | 2349 | 61310 | 2199 | 29943 |
| 16-#14 | 1.88 | MA | 33126 | 6400 | 49036 | 5308 | 59141 | 4293 | 64762 | 3517 | 71810 | 2352 | 89909 | 2206 | 52071 |
| 2L-8S | | MI | 21617 | 6400 | 33106 | 5269 | 38799 | 4265 | 40982 | 3499 | 42125 | 2332 | 51842 | 1512 | 38067 |
| 16-#14 | 1.88 | MA | 31479 | 6400 | 46874 | 5310 | 56399 | 4293 | 61440 | 3531 | 67328 | 2362 | 83815 | 2075 | 51928 |
| 3L-7S | | MI | 22430 | 6400 | 34232 | 5268 | 40281 | 4267 | 42833 | 3503 | 44595 | 2324 | 54957 | 1587 | 39377 |
| 16-#14 | 1.88 | MA | 30295 | 6400 | 45272 | 5312 | 54232 | 4308 | 58814 | 3529 | 63783 | 2357 | 79790 | 1944 | 51634 |
| 4L-6S | | MI | 23253 | 6400 | 35375 | 5268 | 41794 | 4269 | 44682 | 3492 | 47155 | 2332 | 57955 | 1690 | 40395 |
| 16-#14 | 1.88 | MA | 29226 | 6400 | 43652 | 5329 | 52288 | 4309 | 56441 | 3543 | 60552 | 2367 | 75611 | 1876 | 50604 |
| 5E | | MI | 24093 | 6400 | 36550 | 5268 | 43360 | 4256 | 46588 | 3496 | 49679 | 2324 | 61329 | 1798 | 41384 |
| 16-#14 | 1.88 | MA | 28201 | 6400 | 42215 | 5332 | 50371 | 4324 | 54107 | 3541 | 57447 | 2377 | 71355 | 1768 | 49256 |
| 6L-4S | | MI | 24969 | 6400 | 37872 | 5252 | 44946 | 4258 | 48523 | 3485 | 52304 | 2317 | 64665 | 1863 | 42236 |
| 16-#14 | 1.88 | MA | 27198 | 6400 | 40816 | 5334 | 48519 | 4324 | 51844 | 3555 | 54299 | 2372 | 67563 | 1665 | 47968 |
| 7L-3S | | MI | 25936 | 6400 | 39177 | 5252 | 46711 | 4244 | 50662 | 3489 | 55180 | 2324 | 67844 | 1995 | 42440 |
| 16-#14 | 1.88 | MA | 26206 | 6400 | 39439 | 5336 | 46704 | 4325 | 49576 | 3553 | 51262 | 2383 | 63659 | 1587 | 46230 |
| 8L-2S | | MI | 27270 | 6400 | 40931 | 5252 | 48935 | 4246 | 53357 | 3477 | 58805 | 2317 | 72677 | 2126 | 42535 |
| 16-#18 | 3.33 | MA | 34183 | 7418 | 55745 | 5921 | 67154 | 4759 | 74354 | 3810 | 84672 | 2294 | 108034 | 1583 | 87637 |
| 4L-6S | | MI | 25135 | 7418 | 41954 | 5876 | 49815 | 4715 | 54273 | 3764 | 59767 | 2247 | 75122 | 1144 | 65596 |
| 16-#18 | 3.33 | MA | 32408 | 7418 | 52895 | 5949 | 63734 | 4758 | 70180 | 3831 | 78988 | 2309 | 100760 | 1465 | 84355 |
| 5E | | MI | 26532 | 7418 | 44017 | 5877 | 52565 | 4694 | 57619 | 3773 | 64141 | 2234 | 80939 | 1337 | 68627 |
| 16-#18 | 3.33 | MA | 30705 | 7418 | 50364 | 5952 | 60358 | 4783 | 66071 | 3827 | 73523 | 2324 | 93377 | 1272 | 80647 |
| 6L-4S | | MI | 27987 | 7418 | 46337 | 5852 | 55349 | 4700 | 61016 | 3756 | 68688 | 2221 | 86719 | 1449 | 71016 |
| 16-#18 | 3.33 | MA | 29038 | 7418 | 47901 | 5954 | 57098 | 4782 | 62088 | 3849 | 67983 | 2313 | 86808 | 1090 | 77000 |
| 7L-3S | | MI | 29594 | 7418 | 48627 | 5853 | 58443 | 4679 | 64766 | 3766 | 73672 | 2234 | 92187 | 1683 | 73215 |
| 16-#18 | 3.33 | MA | 27388 | 7418 | 45475 | 5956 | 53903 | 4781 | 58097 | 3844 | 62637 | 2328 | 80014 | 953 | 72241 |
| 8L-2S | | MI | 31811 | 7418 | 51693 | 5854 | 62332 | 4684 | 69477 | 3749 | 79952 | 2221 | 100521 | 1917 | 73679 |
| 18-#11 | 1.46 | MA | 31399 | 6112 | 45181 | 5142 | 54383 | 4173 | 59056 | 3443 | 64152 | 2373 | 79727 | 2251 | 41006 |
| 2L-9S | | MI | 21322 | 6112 | 31473 | 5114 | 36953 | 4154 | 38850 | 3432 | 39322 | 2361 | 47896 | 1700 | 30965 |
| 18-#11 | 1.46 | MA | 30229 | 6112 | 43672 | 5144 | 52469 | 4173 | 56737 | 3453 | 61023 | 2380 | 75450 | 2160 | 40949 |
| 3L-8S | | MI | 21894 | 6112 | 32340 | 5103 | 38019 | 4144 | 40121 | 3424 | 41035 | 2356 | 50051 | 1759 | 31722 |

## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

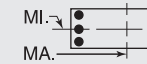
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.46 | MA | 29388 | 6112 | 42555 | 5146 | 50959 | 4184 | 54906 | 3453 | 58551 | 2377 | 72623 | 2069 | 40834 |
| 4L-7S | | MI | 22471 | 6112 | 33125 | 5102 | 39053 | 4145 | 41413 | 3426 | 42766 | 2350 | 52240 | 1811 | 32263 |
| 18-#11 | 1.46 | MA | 28629 | 6112 | 41426 | 5158 | 49604 | 4185 | 53253 | 3463 | 56300 | 2385 | 69696 | 2021 | 40628 |
| 5L-6S | | MI | 23055 | 6112 | 33923 | 5101 | 40109 | 4146 | 42702 | 3418 | 44558 | 2355 | 54351 | 1882 | 32756 |
| 18-#11 | 1.46 | MA | 27902 | 6112 | 40425 | 5160 | 48268 | 4196 | 51626 | 3462 | 54135 | 2392 | 66709 | 1946 | 39891 |
| 6L-5S | | MI | 23651 | 6112 | 34742 | 5101 | 41201 | 4136 | 44032 | 3420 | 46327 | 2350 | 56726 | 1958 | 33338 |
| 18-#11 | 1.46 | MA | 27190 | 6112 | 39450 | 5161 | 46978 | 4196 | 50049 | 3472 | 51942 | 2390 | 64046 | 1876 | 39212 |
| 7L-4S | | MI | 24273 | 6112 | 35664 | 5090 | 42308 | 4137 | 45382 | 3412 | 48166 | 2344 | 59070 | 2003 | 33473 |
| 18-#11 | 1.46 | MA | 26487 | 6112 | 38491 | 5163 | 45714 | 4197 | 48470 | 3471 | 49826 | 2397 | 61311 | 1821 | 38507 |
| 8L-3S | | MI | 24960 | 6112 | 36575 | 5089 | 43540 | 4128 | 46876 | 3414 | 50181 | 2349 | 61310 | 2094 | 33546 |
| 18-#11 | 1.46 | MA | 25788 | 6112 | 37432 | 5175 | 44411 | 4208 | 46916 | 3481 | 47730 | 2405 | 58596 | 1762 | 37500 |
| 9L-2S | | MI | 25909 | 6112 | 37801 | 5089 | 45094 | 4128 | 48759 | 3406 | 52722 | 2344 | 64711 | 2186 | 33578 |
| 18-#14 | 2.11 | MA | 34134 | 6564 | 51199 | 5411 | 61884 | 4368 | 68085 | 3564 | 76293 | 2344 | 96004 | 2191 | 58457 |
| 2L-9S | | MI | 21680 | 6564 | 33617 | 5386 | 39495 | 4353 | 41854 | 3558 | 43304 | 2331 | 53615 | 1405 | 41559 |
| 18-#14 | 2.11 | MA | 32503 | 6564 | 49036 | 5413 | 59141 | 4368 | 64762 | 3578 | 71810 | 2355 | 89909 | 2059 | 58288 |
| 3L-8S | | MI | 22479 | 6564 | 34859 | 5371 | 41023 | 4340 | 43676 | 3546 | 45750 | 2324 | 56674 | 1490 | 43063 |
| 18-#14 | 2.11 | MA | 31332 | 6564 | 47434 | 5415 | 56975 | 4383 | 62137 | 3577 | 68266 | 2350 | 85884 | 1928 | 57964 |
| 4L-7S | | MI | 23283 | 6564 | 35985 | 5371 | 42505 | 4342 | 45528 | 3550 | 48220 | 2316 | 59790 | 1565 | 44335 |
| 18-#14 | 2.11 | MA | 30274 | 6564 | 45815 | 5432 | 55031 | 4384 | 59764 | 3590 | 65035 | 2360 | 81705 | 1860 | 56798 |
| 5L-6S | | MI | 24097 | 6564 | 37129 | 5370 | 44018 | 4344 | 47376 | 3539 | 50779 | 2324 | 62788 | 1668 | 45432 |
| 18-#14 | 2.11 | MA | 29261 | 6564 | 44377 | 5434 | 53113 | 4399 | 57429 | 3589 | 61930 | 2370 | 77449 | 1752 | 55494 |
| 6L-5S | | MI | 24928 | 6564 | 38304 | 5370 | 45584 | 4331 | 49282 | 3543 | 53304 | 2316 | 66161 | 1776 | 46384 |
| 18-#14 | 2.11 | MA | 28270 | 6564 | 42978 | 5436 | 51261 | 4399 | 55166 | 3602 | 58781 | 2365 | 73657 | 1650 | 54131 |
| 7L-4S | | MI | 25795 | 6564 | 39625 | 5355 | 47170 | 4332 | 51218 | 3532 | 55929 | 2309 | 69498 | 1841 | 47365 |
| 18-#14 | 2.11 | MA | 27289 | 6564 | 41601 | 5438 | 49447 | 4399 | 52899 | 3601 | 55744 | 2375 | 69754 | 1571 | 52435 |
| 8L-3S | | MI | 26752 | 6564 | 40931 | 5354 | 48935 | 4319 | 53357 | 3536 | 58805 | 2316 | 72677 | 1973 | 47597 |
| 18-#14 | 2.11 | MA | 26315 | 6564 | 40080 | 5455 | 47577 | 4415 | 50669 | 3614 | 52737 | 2385 | 65887 | 1487 | 50478 |
| 9L-2S | | MI | 28073 | 6564 | 42685 | 5354 | 51159 | 4321 | 56051 | 3525 | 62430 | 2309 | 77510 | 2104 | 47716 |
| 18-#18 | 3.75 | MA | 34141 | 7709 | 56688 | 6131 | 68544 | 4891 | 76008 | 3916 | 86851 | 2296 | 111333 | 1431 | 95266 |
| 5L-6S | | MI | 26534 | 7709 | 45020 | 6057 | 53704 | 4848 | 58984 | 3848 | 66047 | 2229 | 83456 | 1097 | 74235 |
| 18-#18 | 3.75 | MA | 32467 | 7709 | 54158 | 6133 | 65169 | 4916 | 71899 | 3911 | 81386 | 2311 | 103951 | 1238 | 91432 |
| 6L-5S | | MI | 27909 | 7709 | 47083 | 6059 | 56453 | 4827 | 62330 | 3857 | 70420 | 2216 | 89273 | 1291 | 77399 |
| 18-#18 | 3.75 | MA | 30827 | 7709 | 51694 | 6135 | 61909 | 4915 | 67916 | 3933 | 75846 | 2300 | 97381 | 1057 | 87711 |
| 7L-4S | | MI | 29343 | 7709 | 49403 | 6033 | 59237 | 4833 | 65728 | 3840 | 74968 | 2203 | 95053 | 1403 | 79686 |
| 18-#18 | 3.75 | MA | 29204 | 7709 | 49269 | 6138 | 58714 | 4914 | 63925 | 3928 | 70500 | 2315 | 90587 | 920 | 83055 |
| 8L-3S | | MI | 30927 | 7709 | 51693 | 6035 | 62332 | 4812 | 69477 | 3850 | 79952 | 2216 | 100521 | 1637 | 82167 |
| 20-#11 | 1.63 | MA | 32125 | 6226 | 46690 | 5213 | 56298 | 4225 | 61375 | 3476 | 67280 | 2367 | 84004 | 2241 | 45472 |
| 2L-10S | | MI | 21371 | 6226 | 31917 | 5185 | 37481 | 4205 | 39457 | 3463 | 40101 | 2351 | 49069 | 1606 | 33692 |
| 20-#11 | 1.63 | MA | 30963 | 6226 | 45181 | 5215 | 54383 | 4225 | 59056 | 3486 | 64152 | 2375 | 79727 | 2150 | 45401 |
| 3L-9S | | MI | 21937 | 6226 | 32699 | 5184 | 38508 | 4206 | 40734 | 3465 | 41863 | 2356 | 51298 | 1686 | 34470 |
| 20-#11 | 1.63 | MA | 30129 | 6226 | 44064 | 5217 | 52873 | 4236 | 57225 | 3486 | 61680 | 2372 | 76900 | 2059 | 45270 |
| 4L-8S | | MI | 22505 | 6226 | 33566 | 5174 | 39574 | 4196 | 42004 | 3457 | 43576 | 2350 | 53452 | 1745 | 35208 |
| 20-#11 | 1.63 | MA | 29376 | 6226 | 42935 | 5229 | 51518 | 4237 | 55572 | 3495 | 59428 | 2380 | 73972 | 2011 | 45047 |
| 5L-7S | | MI | 23077 | 6226 | 34351 | 5173 | 40608 | 4197 | 43296 | 3459 | 45307 | 2345 | 55641 | 1798 | 35800 |
| 20-#11 | 1.63 | MA | 28655 | 6226 | 41934 | 5231 | 50182 | 4248 | 53945 | 3495 | 57264 | 2387 | 70985 | 1937 | 44242 |
| 6E | | MI | 23656 | 6226 | 35148 | 5172 | 41663 | 4198 | 44585 | 3451 | 47100 | 2350 | 57753 | 1869 | 36279 |
| 20-#11 | 1.63 | MA | 27950 | 6226 | 40960 | 5232 | 48892 | 4248 | 52368 | 3505 | 55071 | 2384 | 68322 | 1866 | 43581 |
| 7L-5S | | MI | 24247 | 6226 | 35968 | 5172 | 42756 | 4188 | 45915 | 3453 | 48868 | 2344 | 60127 | 1944 | 36926 |
| 20-#11 | 1.63 | MA | 27253 | 6226 | 40000 | 5234 | 47628 | 4249 | 50789 | 3504 | 52955 | 2392 | 65587 | 1811 | 42827 |
| 8L-4S | | MI | 24865 | 6226 | 36890 | 5161 | 43862 | 4189 | 47266 | 3445 | 50707 | 2339 | 62471 | 1989 | 37077 |
| 20-#11 | 1.63 | MA | 26561 | 6226 | 38941 | 5246 | 46325 | 4260 | 49235 | 3514 | 50859 | 2399 | 62873 | 1753 | 41841 |
| 9L-3S | | MI | 25546 | 6226 | 37801 | 5160 | 45094 | 4180 | 48759 | 3447 | 52722 | 2344 | 64711 | 2080 | 37164 |
| 20-#11 | 1.63 | MA | 25858 | 6226 | 37986 | 5248 | 45070 | 4260 | 47674 | 3513 | 48705 | 2397 | 60067 | 1673 | 40840 |
| 10L-2S | | MI | 26488 | 6226 | 39027 | 5160 | 46649 | 4180 | 50642 | 3439 | 55263 | 2339 | 68112 | 2172 | 37208 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis

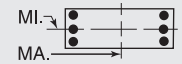



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.34 | MA | 33513 | 6727 | 51199 | 5515 | 61884 | 4443 | 68085 | 3625 | 76293 | 2347 | 96004 | 2044 | 64645 |
| 3L-9S | | MI | 22538 | 6727 | 35370 | 5488 | 41719 | 4428 | 44548 | 3605 | 46928 | 2323 | 58447 | 1383 | 46518 |
| 20-#14 | 2.34 | MA | 32354 | 6728 | 49597 | 5517 | 59717 | 4458 | 65459 | 3624 | 72749 | 2342 | 91978 | 1912 | 64293 |
| 4L-8S | | MI | 23328 | 6727 | 36613 | 5473 | 43247 | 4415 | 46370 | 3594 | 49374 | 2315 | 61507 | 1468 | 48066 |
| 20-#14 | 2.34 | MA | 31308 | 6727 | 47977 | 5534 | 57773 | 4458 | 63086 | 3637 | 69518 | 2352 | 87800 | 1844 | 63004 |
| 5L-7S | | MI | 24124 | 6727 | 37739 | 5473 | 44729 | 4417 | 48222 | 3598 | 51844 | 2308 | 64623 | 1543 | 49305 |
| 20-#14 | 2.34 | MA | 30307 | 6728 | 46540 | 5536 | 55856 | 4474 | 60752 | 3636 | 66412 | 2362 | 83544 | 1736 | 61739 |
| 6E | | MI | 24929 | 6728 | 38883 | 5472 | 46242 | 4419 | 50070 | 3587 | 54404 | 2315 | 67620 | 1646 | 50476 |
| 20-#14 | 2.34 | MA | 29326 | 6728 | 45141 | 5538 | 54004 | 4474 | 58489 | 3650 | 63264 | 2358 | 79752 | 1634 | 60304 |
| 7L-5S | | MI | 25752 | 6727 | 40057 | 5472 | 47808 | 4405 | 51976 | 3590 | 56929 | 2308 | 70994 | 1754 | 51396 |
| 20-#14 | 2.34 | MA | 28357 | 6728 | 43764 | 5540 | 52189 | 4474 | 56222 | 3648 | 60227 | 2368 | 75848 | 1556 | 58647 |
| 8L-4S | | MI | 26610 | 6728 | 41379 | 5457 | 49394 | 4407 | 53912 | 3579 | 59554 | 2301 | 74331 | 1819 | 52491 |
| 20-#14 | 2.34 | MA | 27394 | 6728 | 42243 | 5557 | 50319 | 4490 | 53991 | 3662 | 57220 | 2378 | 71982 | 1471 | 56652 |
| 9L-3S | | MI | 27557 | 6727 | 42685 | 5457 | 51159 | 4394 | 56051 | 3583 | 62430 | 2308 | 77510 | 1951 | 52749 |
| 20-#14 | 2.34 | MA | 26432 | 6728 | 40871 | 5559 | 48518 | 4490 | 51751 | 3660 | 54127 | 2373 | 67985 | 1356 | 54714 |
| 10L-2S | | MI | 28868 | 6727 | 44438 | 5456 | 53383 | 4396 | 58745 | 3572 | 66055 | 2301 | 82342 | 2082 | 52890 |
| 20-#18 | 4.17 | MA | 34199 | 8000 | 57951 | 6315 | 69980 | 5049 | 77728 | 3995 | 89249 | 2298 | 114524 | 1205 | 102235 |
| 6E | | MI | 27911 | 8000 | 48086 | 6239 | 57593 | 4981 | 63695 | 3932 | 72327 | 2212 | 91790 | 1051 | 82894 |
| 20-#18 | 4.17 | MA | 32584 | 8000 | 55487 | 6317 | 66719 | 5048 | 73744 | 4017 | 83709 | 2286 | 107955 | 1023 | 98441 |
| 7L-5S | | MI | 29266 | 8000 | 50150 | 6240 | 60342 | 4960 | 67041 | 3942 | 76700 | 2198 | 97607 | 1245 | 86186 |
| 20-#18 | 4.17 | MA | 30988 | 8000 | 53062 | 6319 | 63524 | 5047 | 69753 | 4013 | 78363 | 2301 | 101161 | 887 | 93883 |
| 8L-4S | | MI | 30680 | 8000 | 52469 | 6215 | 63126 | 4966 | 70439 | 3925 | 81248 | 2185 | 103387 | 1357 | 88380 |
| 22-#11 | 1.79 | MA | 31690 | 6339 | 46690 | 5286 | 56298 | 4277 | 61375 | 3519 | 67280 | 2370 | 84004 | 2140 | 49851 |
| 3L-10S | | MI | 21984 | 6339 | 33143 | 5256 | 39036 | 4257 | 41340 | 3496 | 42643 | 2346 | 52470 | 1592 | 37169 |
| 22-#11 | 1.79 | MA | 30862 | 6339 | 45574 | 5288 | 54787 | 4288 | 59545 | 3518 | 64809 | 2367 | 81177 | 2049 | 49704 |
| 4L-9S | | MI | 22545 | 6339 | 33925 | 5255 | 40063 | 4258 | 42617 | 3498 | 44404 | 2351 | 54699 | 1672 | 37980 |
| 22-#11 | 1.79 | MA | 30116 | 6339 | 44445 | 5300 | 53433 | 4289 | 57891 | 3528 | 62557 | 2374 | 78249 | 2002 | 49466 |
| 5L-8S | | MI | 23108 | 6339 | 34792 | 5244 | 41128 | 4248 | 43888 | 3490 | 46118 | 2345 | 56854 | 1731 | 38700 |
| 22-#11 | 1.79 | MA | 29401 | 6339 | 43443 | 5302 | 52097 | 4299 | 56264 | 3528 | 60393 | 2382 | 75262 | 1927 | 48599 |
| 6L-7S | | MI | 23676 | 6339 | 35577 | 5244 | 42163 | 4249 | 45180 | 3492 | 47848 | 2340 | 59042 | 1784 | 39340 |
| 22-#11 | 1.79 | MA | 28701 | 6339 | 42469 | 5303 | 50806 | 4300 | 54687 | 3537 | 58200 | 2379 | 72599 | 1856 | 47953 |
| 7L-6S | | MI | 24251 | 6339 | 36374 | 5243 | 43218 | 4250 | 46469 | 3484 | 49641 | 2345 | 61154 | 1855 | 39807 |
| 22-#11 | 1.79 | MA | 28010 | 6339 | 41510 | 5305 | 49542 | 4301 | 53108 | 3537 | 56083 | 2387 | 69864 | 1801 | 47152 |
| 8L-5S | | MI | 24837 | 6339 | 37194 | 5243 | 44310 | 4240 | 47799 | 3486 | 51409 | 2339 | 63529 | 1930 | 40512 |
| 22-#11 | 1.79 | MA | 27324 | 6339 | 40450 | 5317 | 48239 | 4312 | 51554 | 3547 | 53988 | 2394 | 67150 | 1743 | 46186 |
| 9L-4S | | MI | 25450 | 6339 | 38116 | 5232 | 45417 | 4241 | 49149 | 3478 | 53248 | 2334 | 65872 | 1975 | 40679 |
| 22-#11 | 1.79 | MA | 26628 | 6339 | 39495 | 5319 | 46984 | 4312 | 49993 | 3546 | 51833 | 2391 | 64344 | 1663 | 45156 |
| 10L-3S | | MI | 26126 | 6339 | 39027 | 5231 | 46649 | 4231 | 50642 | 3480 | 55263 | 2339 | 68112 | 2067 | 40779 |
| 22-#11 | 1.79 | MA | 25890 | 6339 | 38547 | 5320 | 45696 | 4323 | 48449 | 3556 | 49747 | 2399 | 61656 | 1605 | 43983 |
| 11L-2S | | MI | 27062 | 6339 | 40253 | 5230 | 48204 | 4232 | 52526 | 3472 | 57805 | 2333 | 71514 | 2158 | 40835 |
| 22-#14 | 2.58 | MA | 33364 | 6891 | 51759 | 5619 | 62460 | 4533 | 68782 | 3671 | 77232 | 2335 | 98073 | 1897 | 70621 |
| 4L-9S | | MI | 23385 | 6891 | 37124 | 5591 | 43943 | 4503 | 47242 | 3652 | 50553 | 2315 | 63280 | 1361 | 51444 |
| 22-#14 | 2.58 | MA | 32329 | 6891 | 50140 | 5636 | 60516 | 4533 | 66409 | 3685 | 74001 | 2345 | 93894 | 1829 | 69220 |
| 5L-8S | | MI | 24167 | 6891 | 38367 | 5575 | 45470 | 4490 | 49065 | 3641 | 52999 | 2307 | 66340 | 1446 | 53077 |
| 22-#14 | 2.58 | MA | 31338 | 6891 | 48702 | 5638 | 58598 | 4548 | 64074 | 3683 | 70895 | 2355 | 89638 | 1721 | 67990 |
| 6L-7S | | MI | 24954 | 6891 | 39493 | 5575 | 46953 | 4492 | 50916 | 3645 | 55469 | 2300 | 69455 | 1521 | 54283 |
| 22-#14 | 2.58 | MA | 30368 | 6891 | 47303 | 5640 | 56746 | 4549 | 61811 | 3697 | 67747 | 2350 | 85846 | 1619 | 66486 |
| 7L-6S | | MI | 25751 | 6891 | 40636 | 5575 | 48466 | 4493 | 52765 | 3634 | 58029 | 2307 | 72453 | 1624 | 55525 |
| 22-#14 | 2.58 | MA | 29410 | 6891 | 45926 | 5642 | 54932 | 4549 | 59544 | 3696 | 64710 | 2360 | 81943 | 1540 | 64865 |
| 8L-5S | | MI | 26566 | 6891 | 41811 | 5574 | 50032 | 4480 | 54671 | 3638 | 60553 | 2300 | 75826 | 1732 | 56416 |
| 22-#14 | 2.58 | MA | 28457 | 6891 | 44405 | 5659 | 53062 | 4564 | 57314 | 3709 | 61703 | 2370 | 78076 | 1456 | 62832 |
| 9L-4S | | MI | 27415 | 6891 | 43132 | 5559 | 51618 | 4482 | 56607 | 3627 | 63178 | 2293 | 79163 | 1797 | 57616 |
| 22-#14 | 2.58 | MA | 27500 | 6891 | 43034 | 5661 | 51260 | 4565 | 55073 | 3708 | 58610 | 2365 | 74080 | 1340 | 60866 |
| 10L-3S | | MI | 28354 | 6891 | 44438 | 5559 | 53383 | 4469 | 58745 | 3631 | 66055 | 2300 | 82342 | 1929 | 57898 |
| 22-#18 | 4.58 | MA | 34314 | 8290 | 59280 | 6499 | 71530 | 5181 | 79572 | 4101 | 91572 | 2273 | 118529 | 990 | 109045 |
| 7L-6S | | MI | 29267 | 8290 | 51153 | 6421 | 61481 | 5114 | 68406 | 4016 | 78606 | 2194 | 100125 | 1005 | 91572 |
| 22-#18 | 4.58 | MA | 32742 | 8290 | 56855 | 6501 | 68335 | 5180 | 75581 | 4097 | 86226 | 2288 | 111735 | 853 | 104724 |
| 8L-5S | | MI | 30604 | 8290 | 53216 | 6422 | 64231 | 5093 | 71752 | 4026 | 82979 | 2181 | 105941 | 1199 | 94986 |

## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 1.95 | MA | 31588 | 6453 | 47083 | 5359 | 56701 | 4340 | 61864 | 3551 | 67938 | 2362 | 85453 | 2040 | 54137 |
| 4L-10S | | MI | 22591 | 6453 | 34369 | 5327 | 40590 | 4309 | 43224 | 3529 | 45184 | 2341 | 55872 | 1578 | 40651 |
| 24-#11 | 1.95 | MA | 30847 | 6453 | 45954 | 5371 | 55347 | 4340 | 60210 | 3561 | 65686 | 2369 | 82526 | 1992 | 53884 |
| 5L-9S | | MI | 23147 | 6453 | 35151 | 5326 | 41617 | 4310 | 44501 | 3531 | 46945 | 2345 | 58100 | 1658 | 41493 |
| 24-#11 | 1.95 | MA | 30138 | 6453 | 44953 | 5372 | 54011 | 4351 | 58583 | 3561 | 63522 | 2377 | 79539 | 1917 | 52961 |
| 6L-8S | | MI | 23706 | 6453 | 36018 | 5315 | 42683 | 4300 | 45771 | 3522 | 48659 | 2340 | 60255 | 1717 | 42197 |
| 24-#11 | 1.95 | MA | 29445 | 6453 | 43978 | 5374 | 52720 | 4352 | 57006 | 3570 | 61328 | 2374 | 76876 | 1846 | 52329 |
| 7E | | MI | 24269 | 6453 | 36803 | 5315 | 43717 | 4301 | 47063 | 3525 | 50389 | 2335 | 62443 | 1770 | 42883 |
| 24-#11 | 1.95 | MA | 28759 | 6453 | 43019 | 5376 | 51456 | 4353 | 55427 | 3570 | 59212 | 2382 | 74141 | 1791 | 51483 |
| 8L-6S | | MI | 24839 | 6453 | 37600 | 5314 | 44773 | 4302 | 48352 | 3516 | 52182 | 2340 | 64555 | 1841 | 43339 |
| 24-#11 | 1.95 | MA | 28079 | 6453 | 41960 | 5388 | 50154 | 4363 | 53873 | 3580 | 57117 | 2389 | 71426 | 1733 | 50536 |
| 9L-5S | | MI | 25422 | 6453 | 38419 | 5313 | 45865 | 4292 | 49682 | 3519 | 53950 | 2334 | 66930 | 1916 | 44055 |
| 24-#11 | 1.95 | MA | 27395 | 6453 | 41004 | 5390 | 48899 | 4364 | 52312 | 3579 | 54962 | 2386 | 68621 | 1653 | 49476 |
| 10L-4S | | MI | 26029 | 6453 | 39342 | 5303 | 46972 | 4293 | 51033 | 3510 | 55789 | 2329 | 69273 | 1961 | 44278 |
| 24-#11 | 1.95 | MA | 26655 | 6453 | 40056 | 5391 | 47611 | 4375 | 50768 | 3589 | 52876 | 2394 | 65932 | 1595 | 48322 |
| 11L-3S | | MI | 26701 | 6453 | 40253 | 5302 | 48204 | 4283 | 52526 | 3513 | 57805 | 2334 | 71514 | 2053 | 44391 |
| 24-#11 | 1.95 | MA | 25933 | 6453 | 39113 | 5393 | 46359 | 4376 | 49216 | 3588 | 50740 | 2391 | 63239 | 1537 | 46986 |
| 12L-2S | | MI | 27631 | 6453 | 41479 | 5301 | 49758 | 4284 | 54409 | 3504 | 60346 | 2328 | 74915 | 2144 | 44458 |
| 24-#14 | 2.81 | MA | 33338 | 7055 | 52302 | 5738 | 63259 | 4608 | 69732 | 3732 | 78483 | 2337 | 99989 | 1813 | 75444 |
| 5L-9S | | MI | 24221 | 7055 | 38877 | 5693 | 46166 | 4578 | 49937 | 3700 | 54178 | 2307 | 68112 | 1339 | 56419 |
| 24-#14 | 2.81 | MA | 32357 | 7055 | 50865 | 5740 | 61341 | 4623 | 67397 | 3731 | 75378 | 2347 | 95733 | 1705 | 74247 |
| 6L-8S | | MI | 24995 | 7055 | 40120 | 5678 | 47694 | 4565 | 51759 | 3689 | 56624 | 2299 | 71172 | 1424 | 58095 |
| 24-#14 | 2.81 | MA | 31398 | 7055 | 49466 | 5743 | 59489 | 4624 | 65134 | 3744 | 72230 | 2343 | 91941 | 1603 | 72676 |
| 7E | | MI | 25775 | 7055 | 41246 | 5677 | 49177 | 4566 | 53611 | 3692 | 59094 | 2292 | 74288 | 1499 | 59270 |
| 24-#14 | 2.81 | MA | 30449 | 7055 | 48089 | 5745 | 57674 | 4624 | 62867 | 3743 | 69193 | 2353 | 88037 | 1524 | 71090 |
| 8L-6S | | MI | 26564 | 7055 | 42390 | 5677 | 50690 | 4568 | 55459 | 3681 | 61654 | 2299 | 77286 | 1602 | 60580 |
| 24-#14 | 2.81 | MA | 29507 | 7055 | 46568 | 5762 | 55804 | 4639 | 60637 | 3757 | 66185 | 2363 | 84171 | 1440 | 69018 |
| 9L-5S | | MI | 27370 | 7055 | 43564 | 5677 | 52256 | 4555 | 57365 | 3685 | 64178 | 2292 | 80659 | 1710 | 61445 |
| 24-#14 | 2.81 | MA | 28553 | 7055 | 45196 | 5764 | 54003 | 4639 | 58396 | 3755 | 63093 | 2358 | 80174 | 1325 | 67024 |
| 10L-4S | | MI | 28211 | 7055 | 44886 | 5661 | 53842 | 4557 | 59301 | 3674 | 66803 | 2284 | 83996 | 1775 | 62739 |
| 24-#18 | 5.00 | MA | 34470 | 8581 | 60648 | 6683 | 73146 | 5313 | 81409 | 4181 | 94089 | 2275 | 122309 | 820 | 115577 |
| 8L-6S | | MI | 30607 | 8581 | 54219 | 6603 | 65370 | 5247 | 73118 | 4101 | 84886 | 2176 | 108459 | 959 | 100266 |

## RECTANGULAR TIED COLUMNS 42" x 42"

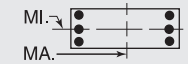
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.36 | MA | 24501 | 5550 | 35816 | 4604 | 42438 | 3738 | 45644 | 3089 | 48767 | 2132 | 59418 | 1980 | 29895 |
| 2L-3S | | MI | 21979 | 5550 | 32568 | 4604 | 38319 | 3734 | 40654 | 3108 | 42082 | 2145 | 50525 | 1747 | 29760 |
| 8-#14 | 1.02 | MA | 23440 | 5332 | 33252 | 4497 | 39420 | 3663 | 42090 | 3047 | 44184 | 2166 | 53483 | 2042 | 22829 |
| 2L-4S | | MI | 20912 | 5332 | 30016 | 4499 | 35201 | 3675 | 36978 | 3055 | 37286 | 2166 | 44945 | 1779 | 22712 |
| 8-#18 | 1.81 | MA | 26017 | 5841 | 39064 | 4786 | 46557 | 3871 | 50635 | 3173 | 55451 | 2116 | 68312 | 1938 | 39519 |
| 2L-4S | | MI | 21739 | 5841 | 33394 | 4785 | 39165 | 3889 | 41678 | 3184 | 43462 | 2116 | 53575 | 1471 | 38015 |
| 10-#14 | 1.28 | MA | 24341 | 5496 | 35108 | 4600 | 41774 | 3738 | 44941 | 3094 | 48031 | 2158 | 58631 | 2022 | 28351 |
| 2L-5S | | MI | 20890 | 5496 | 30476 | 4617 | 35879 | 3749 | 37784 | 3114 | 38349 | 2167 | 46546 | 1693 | 27473 |
| 10-#14 | 1.28 | MA | 22893 | 5496 | 33252 | 4600 | 39420 | 3736 | 42090 | 3106 | 44184 | 2166 | 53483 | 1891 | 28309 |
| 3L-4S | | MI | 21843 | 5496 | 31872 | 4601 | 37555 | 3750 | 39829 | 3103 | 41133 | 2159 | 50093 | 1759 | 28149 |
| 10-#18 | 2.27 | MA | 27495 | 6132 | 42312 | 4968 | 50676 | 4004 | 55625 | 3258 | 62136 | 2100 | 77205 | 1896 | 49114 |
| 2L-5S | | MI | 21690 | 6132 | 34190 | 4993 | 40341 | 4018 | 43076 | 3286 | 45306 | 2113 | 56315 | 1315 | 44172 |
| 10-#18 | 2.27 | MA | 25061 | 6132 | 39064 | 4967 | 46557 | 4000 | 50635 | 3276 | 55451 | 2113 | 68312 | 1662 | 48778 |
| 3L-4S | | MI | 23293 | 6132 | 36642 | 4967 | 43284 | 4022 | 46668 | 3268 | 50147 | 2100 | 62468 | 1428 | 47078 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis

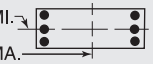



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.30 | MA | 26732 | 5773 | 38770 | 4813 | 46022 | 3910 | 49479 | 3235 | 52829 | 2249 | 64375 | 2099 | 31515 |
| 2L-3S | | MI | 22920 | 5773 | 33810 | 4797 | 39751 | 3893 | 42114 | 3243 | 43449 | 2249 | 52084 | 1847 | 29830 |
| 6-#18 | 1.30 | MA | 24060 | 5773 | 35340 | 4814 | 41672 | 3907 | 44210 | 3255 | 45739 | 2262 | 54922 | 1865 | 31380 |
| 3L-2S | | MI | 25448 | 5773 | 37058 | 4798 | 43870 | 3897 | 47105 | 3224 | 50134 | 2236 | 60977 | 2081 | 29938 |
| 8-#18 | 1.73 | MA | 28347 | 6064 | 42199 | 4995 | 50371 | 4043 | 54749 | 3319 | 59919 | 2235 | 73828 | 2060 | 41679 |
| 2L-4S | | MI | 22678 | 6064 | 34636 | 4979 | 40597 | 4048 | 43138 | 3319 | 44829 | 2220 | 55134 | 1571 | 38397 |
| 8-#18 | 1.73 | MA | 25723 | 6064 | 38770 | 4995 | 46022 | 4040 | 49479 | 3339 | 52829 | 2248 | 64375 | 1826 | 41437 |
| 3E | | MI | 24486 | 6064 | 37058 | 4979 | 43870 | 4026 | 47105 | 3327 | 50134 | 2233 | 60977 | 1805 | 39357 |
| 8-#18 | 1.73 | MA | 23817 | 6064 | 36216 | 4996 | 42570 | 4063 | 45296 | 3332 | 47203 | 2235 | 58156 | 1592 | 40416 |
| 4L-2S | | MI | 26970 | 6064 | 40305 | 4979 | 47989 | 4030 | 52095 | 3308 | 56818 | 2220 | 69871 | 2038 | 39570 |
| 10-#14 | 1.22 | MA | 26553 | 5719 | 38013 | 4808 | 45309 | 3909 | 48723 | 3240 | 51940 | 2271 | 63491 | 2139 | 29869 |
| 2L-5S | | MI | 21827 | 5719 | 31706 | 4812 | 37308 | 3909 | 39245 | 3250 | 39720 | 2271 | 48112 | 1794 | 27694 |
| 10-#14 | 1.22 | MA | 25021 | 5719 | 36055 | 4810 | 42825 | 3909 | 45715 | 3252 | 47881 | 2279 | 58028 | 2007 | 29828 |
| 3L-4S | | MI | 22782 | 5719 | 33102 | 4796 | 38984 | 3910 | 41290 | 3239 | 42504 | 2264 | 51659 | 1860 | 28218 |
| 10-#14 | 1.22 | MA | 23911 | 5719 | 34601 | 4811 | 40860 | 3923 | 43332 | 3250 | 44666 | 2273 | 54426 | 1876 | 29668 |
| 4L-3S | | MI | 23835 | 5719 | 34482 | 4795 | 40849 | 3897 | 43551 | 3242 | 45555 | 2271 | 55049 | 1992 | 28357 |
| 10-#14 | 1.22 | MA | 22906 | 5719 | 33130 | 4827 | 39095 | 3923 | 41178 | 3262 | 41732 | 2281 | 50669 | 1809 | 29096 |
| 5L-2S | | MI | 25287 | 5719 | 36338 | 4794 | 43203 | 3898 | 46402 | 3230 | 49403 | 2263 | 60197 | 2123 | 28388 |
| 10-#18 | 2.16 | MA | 29923 | 6355 | 45629 | 5177 | 54721 | 4176 | 60019 | 3404 | 67009 | 2221 | 83280 | 2021 | 51814 |
| 2L-5S | | MI | 22627 | 6355 | 35431 | 5187 | 41773 | 4177 | 44537 | 3421 | 46673 | 2217 | 57874 | 1415 | 44489 |
| 10-#18 | 2.16 | MA | 27343 | 6355 | 42199 | 5177 | 50371 | 4173 | 54749 | 3423 | 59919 | 2234 | 73828 | 1787 | 51478 |
| 3L-4S | | MI | 24237 | 6355 | 37884 | 5161 | 44716 | 4181 | 48129 | 3403 | 51514 | 2204 | 64027 | 1529 | 47450 |
| 10-#18 | 2.16 | MA | 25472 | 6355 | 39646 | 5178 | 46920 | 4196 | 50566 | 3416 | 54293 | 2221 | 67609 | 1553 | 50000 |
| 4L-3S | | MI | 26012 | 6355 | 40305 | 5161 | 47989 | 4159 | 52095 | 3411 | 56818 | 2217 | 69871 | 1762 | 48865 |
| 10-#18 | 2.16 | MA | 23777 | 6355 | 37061 | 5205 | 43817 | 4193 | 46780 | 3436 | 49159 | 2234 | 61082 | 1438 | 46806 |
| 5L-2S | | MI | 28455 | 6355 | 43553 | 5161 | 52109 | 4163 | 57086 | 3393 | 63503 | 2204 | 78764 | 1996 | 49170 |
| 12-#11 | 1.01 | MA | 25805 | 5581 | 36296 | 4737 | 43257 | 3859 | 46293 | 3210 | 48698 | 2285 | 59288 | 2169 | 25083 |
| 2L-6S | | MI | 21501 | 5581 | 30611 | 4738 | 35993 | 3867 | 37704 | 3215 | 37712 | 2291 | 45234 | 1852 | 23261 |
| 12-#11 | 1.01 | MA | 24724 | 5581 | 34929 | 4739 | 41523 | 3859 | 44191 | 3219 | 45863 | 2291 | 55449 | 2078 | 25079 |
| 3L-5S | | MI | 22146 | 5581 | 31476 | 4737 | 37146 | 3857 | 39108 | 3217 | 39579 | 2285 | 47762 | 1927 | 23707 |
| 12-#11 | 1.01 | MA | 23943 | 5581 | 33915 | 4740 | 40152 | 3869 | 42529 | 3218 | 43620 | 2288 | 52916 | 1987 | 25031 |
| 4E | | MI | 22818 | 5581 | 32449 | 4726 | 38315 | 3857 | 40535 | 3208 | 41522 | 2279 | 50251 | 1973 | 23814 |
| 12-#11 | 1.01 | MA | 23235 | 5581 | 32889 | 4751 | 38921 | 3869 | 41027 | 3227 | 41574 | 2294 | 50281 | 1940 | 24906 |
| 5L-3S | | MI | 23560 | 5581 | 33412 | 4725 | 39617 | 3847 | 42112 | 3210 | 43651 | 2284 | 52638 | 2064 | 23852 |
| 12-#11 | 1.01 | MA | 22557 | 5581 | 31979 | 4753 | 37707 | 3879 | 39549 | 3226 | 39608 | 2301 | 47600 | 1865 | 24419 |
| 6L-2S | | MI | 24584 | 5581 | 34709 | 4724 | 41261 | 3848 | 44104 | 3201 | 46339 | 2278 | 56258 | 2156 | 23851 |
| 12-#14 | 1.46 | MA | 27496 | 5882 | 39971 | 4911 | 47792 | 3984 | 51732 | 3287 | 55999 | 2263 | 68954 | 2120 | 35675 |
| 2L-6S | | MI | 21851 | 5882 | 32321 | 4915 | 38008 | 3998 | 40084 | 3295 | 40890 | 2272 | 49666 | 1666 | 31794 |
| 12-#14 | 1.46 | MA | 25980 | 5882 | 38013 | 4912 | 45309 | 3984 | 48723 | 3300 | 51940 | 2272 | 63491 | 1989 | 35603 |
| 3L-5S | | MI | 22755 | 5882 | 33562 | 4914 | 39662 | 3984 | 42097 | 3298 | 43567 | 2264 | 53260 | 1774 | 32948 |
| 12-#14 | 1.46 | MA | 24883 | 5882 | 36559 | 4913 | 43343 | 3998 | 46341 | 3297 | 48725 | 2265 | 59890 | 1857 | 35402 |
| 4E | | MI | 23698 | 5882 | 34958 | 4898 | 41337 | 3985 | 44142 | 3286 | 46352 | 2256 | 56807 | 1840 | 33654 |
| 12-#14 | 1.46 | MA | 23890 | 5882 | 35088 | 4930 | 41578 | 3997 | 44186 | 3310 | 45791 | 2274 | 56132 | 1791 | 34648 |
| 5L-3S | | MI | 24739 | 5882 | 36338 | 4897 | 43203 | 3971 | 46402 | 3289 | 49403 | 2263 | 60197 | 1971 | 33832 |
| 12-#14 | 1.46 | MA | 22938 | 5882 | 33782 | 4931 | 39836 | 4012 | 42066 | 3307 | 42971 | 2283 | 52318 | 1682 | 33403 |
| 6L-2S | | MI | 26175 | 5882 | 38194 | 4897 | 45556 | 3973 | 49254 | 3277 | 53250 | 2255 | 65345 | 2103 | 33894 |
| 12-#18 | 2.60 | MA | 31465 | 6646 | 49059 | 5358 | 59071 | 4309 | 65288 | 3488 | 74099 | 2206 | 92733 | 1981 | 61928 |
| 2L-6S | | MI | 22661 | 6646 | 36499 | 5368 | 42986 | 4333 | 45991 | 3498 | 48702 | 2214 | 60560 | 1179 | 50642 |
| 12-#18 | 2.60 | MA | 28925 | 6646 | 45629 | 5359 | 54721 | 4306 | 60019 | 3508 | 67009 | 2219 | 83280 | 1748 | 61510 |
| 3L-5S | | MI | 24178 | 6646 | 38679 | 5369 | 45892 | 4310 | 49527 | 3506 | 53358 | 2201 | 66767 | 1373 | 53736 |
| 12-#18 | 2.60 | MA | 27088 | 6646 | 43075 | 5360 | 51269 | 4329 | 55836 | 3501 | 61383 | 2206 | 77062 | 1514 | 59631 |
| 4E | | MI | 25759 | 6646 | 41132 | 5342 | 48835 | 4314 | 53119 | 3487 | 58199 | 2188 | 72921 | 1486 | 56551 |
| 12-#18 | 2.60 | MA | 25424 | 6646 | 40490 | 5387 | 48167 | 4326 | 52050 | 3520 | 56249 | 2219 | 70535 | 1399 | 56588 |
| 5L-3S | | MI | 27503 | 6646 | 43553 | 5343 | 52109 | 4292 | 57086 | 3495 | 63503 | 2201 | 78764 | 1720 | 58363 |
| 12-#18 | 2.60 | MA | 23827 | 6646 | 38193 | 5387 | 45105 | 4350 | 48322 | 3514 | 51311 | 2233 | 63936 | 1206 | 53311 |
| 6L-2S | | MI | 29909 | 6646 | 46801 | 5343 | 56228 | 4296 | 62076 | 3477 | 70188 | 2188 | 87657 | 1954 | 58749 |

## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis

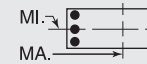



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.18 | MA | 26478 | 5695 | 37664 | 4808 | 44992 | 3911 | 48394 | 3243 | 51533 | 2280 | 63127 | 2157 | 29149 |
| 2L-7S | | MI | 21537 | 5695 | 31066 | 4810 | 36523 | 3918 | 38335 | 3256 | 38507 | 2282 | 46605 | 1768 | 26399 |
| 14-#11 | 1.18 | MA | 25405 | 5695 | 36296 | 4809 | 43257 | 3911 | 46293 | 3252 | 48698 | 2286 | 59288 | 2066 | 29126 |
| 3L-6S | | MI | 22162 | 5695 | 31907 | 4809 | 37637 | 3919 | 39696 | 3248 | 40400 | 2286 | 48854 | 1839 | 26970 |
| 14-#11 | 1.18 | MA | 24631 | 5695 | 35282 | 4811 | 41886 | 3921 | 44631 | 3251 | 46455 | 2282 | 56755 | 1975 | 29058 |
| 4L-5S | | MI | 22801 | 5695 | 32772 | 4808 | 38791 | 3909 | 41100 | 3249 | 42267 | 2280 | 51382 | 1914 | 27505 |
| 14-#11 | 1.18 | MA | 23930 | 5695 | 34257 | 4822 | 40655 | 3921 | 43128 | 3260 | 44409 | 2289 | 54119 | 1928 | 28911 |
| 5L-4S | | MI | 23467 | 5695 | 33746 | 4797 | 39959 | 3909 | 42527 | 3241 | 44210 | 2274 | 53871 | 1961 | 27634 |
| 14-#11 | 1.18 | MA | 23258 | 5695 | 33346 | 4823 | 39441 | 3931 | 41650 | 3259 | 42443 | 2296 | 51439 | 1853 | 28335 |
| 6L-3S | | MI | 24202 | 5695 | 34709 | 4796 | 41261 | 3899 | 44104 | 3243 | 46339 | 2278 | 56258 | 2052 | 27692 |
| 14-#11 | 1.18 | MA | 22600 | 5695 | 32460 | 4825 | 38268 | 3931 | 40217 | 3268 | 40450 | 2292 | 49052 | 1783 | 27716 |
| 7L-2S | | MI | 25219 | 5695 | 36006 | 4795 | 42906 | 3900 | 46097 | 3234 | 49027 | 2272 | 59878 | 2143 | 27709 |
| 14-#14 | 1.70 | MA | 28423 | 6046 | 41929 | 5013 | 50275 | 4059 | 54740 | 3335 | 60058 | 2256 | 74418 | 2102 | 41471 |
| 2L-7S | | MI | 21899 | 6046 | 32970 | 5018 | 38764 | 4071 | 40983 | 3354 | 42022 | 2257 | 51617 | 1543 | 35995 |
| 14-#14 | 1.70 | MA | 26923 | 6046 | 39971 | 5014 | 47792 | 4058 | 51732 | 3347 | 55999 | 2264 | 68954 | 1970 | 41369 |
| 3L-6S | | MI | 22774 | 6046 | 34177 | 5017 | 40362 | 4073 | 42935 | 3342 | 44737 | 2264 | 54813 | 1646 | 37114 |
| 14-#14 | 1.70 | MA | 25839 | 6046 | 38517 | 5016 | 45826 | 4073 | 49349 | 3345 | 52784 | 2258 | 65353 | 1839 | 41133 |
| 4L-5S | | MI | 23668 | 6046 | 35418 | 5016 | 42015 | 4059 | 44948 | 3345 | 47414 | 2256 | 58407 | 1754 | 38220 |
| 14-#14 | 1.70 | MA | 24858 | 6046 | 37046 | 5032 | 44061 | 4072 | 47195 | 3357 | 49850 | 2267 | 61595 | 1772 | 40219 |
| 5L-4S | | MI | 24600 | 6046 | 36814 | 5000 | 43691 | 4060 | 46993 | 3333 | 50199 | 2249 | 61954 | 1820 | 39085 |
| 14-#14 | 1.70 | MA | 23917 | 6046 | 35740 | 5033 | 42320 | 4086 | 45075 | 3354 | 47030 | 2275 | 57781 | 1664 | 39022 |
| 6L-3S | | MI | 25629 | 6046 | 38194 | 5000 | 45556 | 4046 | 49254 | 3337 | 53250 | 2256 | 65345 | 1951 | 39298 |
| 14-#14 | 1.70 | MA | 22996 | 6046 | 34469 | 5034 | 40637 | 4086 | 43019 | 3367 | 44171 | 2269 | 54386 | 1562 | 37829 |
| 7L-2S | | MI | 27050 | 6046 | 40050 | 4999 | 47910 | 4047 | 52105 | 3325 | 57097 | 2248 | 70492 | 2083 | 39389 |
| 14-#18 | 3.03 | MA | 32978 | 6936 | 52488 | 5540 | 63420 | 4442 | 70558 | 3572 | 81189 | 2192 | 102186 | 1942 | 72029 |
| 2L-7S | | MI | 22744 | 6936 | 37624 | 5550 | 44297 | 4461 | 47551 | 3600 | 50666 | 2185 | 63942 | 954 | 56585 |
| 14-#18 | 3.03 | MA | 30476 | 6936 | 49059 | 5541 | 59071 | 4439 | 65288 | 3592 | 74099 | 2205 | 92733 | 1709 | 71536 |
| 3L-6S | | MI | 24205 | 6936 | 39747 | 5550 | 47106 | 4466 | 50981 | 3582 | 55387 | 2198 | 69453 | 1137 | 59776 |
| 14-#18 | 3.03 | MA | 28669 | 6936 | 46505 | 5541 | 55619 | 4462 | 61105 | 3585 | 68473 | 2192 | 86515 | 1475 | 69302 |
| 4L-5S | | MI | 25695 | 6936 | 41927 | 5550 | 50011 | 4443 | 54518 | 3590 | 60042 | 2185 | 75661 | 1330 | 63007 |
| 14-#18 | 3.03 | MA | 27034 | 6936 | 43920 | 5568 | 52517 | 4459 | 57319 | 3605 | 63339 | 2205 | 79988 | 1360 | 66394 |
| 5L-4S | | MI | 27249 | 6936 | 44380 | 5524 | 52955 | 4447 | 58110 | 3571 | 64883 | 2172 | 81814 | 1444 | 65692 |
| 14-#18 | 3.03 | MA | 25465 | 6936 | 41623 | 5569 | 49454 | 4483 | 53592 | 3598 | 58401 | 2218 | 73389 | 1167 | 62982 |
| 6L-3S | | MI | 28965 | 6936 | 46801 | 5524 | 56228 | 4425 | 62076 | 3580 | 70188 | 2185 | 87657 | 1678 | 67854 |
| 14-#18 | 3.03 | MA | 23929 | 6936 | 39386 | 5570 | 46495 | 4480 | 49977 | 3617 | 53394 | 2205 | 67526 | 984 | 59603 |
| 7L-2S | | MI | 31335 | 6936 | 50049 | 5525 | 60347 | 4429 | 67066 | 3561 | 76872 | 2172 | 96550 | 1911 | 68313 |
| 16-#11 | 1.35 | MA | 27143 | 5808 | 39032 | 4879 | 46726 | 3962 | 50495 | 3276 | 54368 | 2274 | 66966 | 2146 | 33204 |
| 2L-8S | | MI | 21583 | 5808 | 31534 | 4882 | 37076 | 3970 | 38964 | 3288 | 39368 | 2283 | 47900 | 1702 | 29526 |
| 16-#11 | 1.35 | MA | 26078 | 5808 | 37664 | 4880 | 44992 | 3962 | 48394 | 3285 | 51533 | 2281 | 63127 | 2055 | 33168 |
| 3L-7S | | MI | 22195 | 5808 | 32362 | 4881 | 38168 | 3970 | 40328 | 3289 | 41195 | 2277 | 50225 | 1756 | 30134 |
| 16-#11 | 1.35 | MA | 25310 | 5808 | 36650 | 4882 | 43620 | 3973 | 46732 | 3284 | 49290 | 2277 | 60593 | 1964 | 33082 |
| 4L-6S | | MI | 22815 | 5808 | 33204 | 4880 | 39282 | 3971 | 41689 | 3281 | 43088 | 2281 | 52474 | 1827 | 30687 |
| 16-#11 | 1.35 | MA | 24615 | 5808 | 35624 | 4893 | 42390 | 3973 | 45230 | 3293 | 47244 | 2284 | 57958 | 1917 | 32915 |
| 5E | | MI | 23448 | 5808 | 34069 | 4879 | 40435 | 3961 | 43093 | 3282 | 44956 | 2275 | 55002 | 1902 | 31302 |
| 16-#11 | 1.35 | MA | 23949 | 5808 | 34714 | 4894 | 41176 | 3983 | 43751 | 3292 | 45278 | 2290 | 55278 | 1842 | 32259 |
| 6L-4S | | MI | 24108 | 5808 | 35043 | 4868 | 41604 | 3961 | 44519 | 3274 | 46898 | 2269 | 57491 | 1948 | 31451 |
| 16-#11 | 1.35 | MA | 23298 | 5808 | 33828 | 4896 | 40003 | 3983 | 42318 | 3301 | 43285 | 2287 | 52890 | 1771 | 31659 |
| 7L-3S | | MI | 24837 | 5808 | 36006 | 4867 | 42906 | 3951 | 46097 | 3275 | 49027 | 2273 | 59878 | 2039 | 31526 |
| 16-#11 | 1.35 | MA | 22654 | 5808 | 32956 | 4897 | 38854 | 3983 | 40883 | 3300 | 41361 | 2293 | 50429 | 1717 | 31005 |
| 8L-2S | | MI | 25846 | 5808 | 37302 | 4866 | 44550 | 3951 | 48089 | 3267 | 51715 | 2267 | 63498 | 2130 | 31556 |
| 16-#14 | 1.95 | MA | 29337 | 6209 | 43887 | 5115 | 52759 | 4134 | 57749 | 3382 | 64117 | 2248 | 79881 | 2083 | 47258 |
| 2L-8S | | MI | 21963 | 6209 | 33637 | 5121 | 39552 | 4145 | 41879 | 3398 | 43250 | 2257 | 53453 | 1447 | 39847 |
| 16-#14 | 1.95 | MA | 27852 | 6209 | 41929 | 5116 | 50275 | 4133 | 54740 | 3394 | 60058 | 2257 | 74418 | 1952 | 47129 |
| 3L-7S | | MI | 22818 | 6209 | 34826 | 5120 | 41117 | 4146 | 43834 | 3401 | 45869 | 2250 | 56765 | 1523 | 41246 |
| 16-#14 | 1.95 | MA | 26780 | 6209 | 40475 | 5118 | 48310 | 4148 | 52358 | 3392 | 56842 | 2250 | 70816 | 1820 | 46861 |
| 4L-6S | | MI | 23683 | 6209 | 36033 | 5119 | 42715 | 4147 | 45786 | 3389 | 48584 | 2257 | 59961 | 1625 | 42443 |
| 16-#14 | 1.95 | MA | 25810 | 6209 | 39004 | 5134 | 46545 | 4147 | 50203 | 3404 | 53909 | 2259 | 67058 | 1754 | 45805 |
| 5E | | MI | 24566 | 6209 | 37273 | 5118 | 44369 | 4134 | 47800 | 3393 | 51261 | 2249 | 63555 | 1734 | 43508 |
| 16-#14 | 1.95 | MA | 24881 | 6209 | 37698 | 5135 | 44803 | 4161 | 48083 | 3402 | 51089 | 2268 | 63244 | 1645 | 44651 |
| 6L-4S | | MI | 25487 | 6209 | 38670 | 5103 | 46045 | 4135 | 49845 | 3381 | 54046 | 2241 | 67102 | 1800 | 44513 |


## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

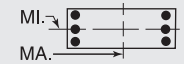

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 1.95 | MA | 23971 | 6209 | 36427 | 5137 | 43120 | 4161 | 46027 | 3414 | 48230 | 2261 | 59849 | 1543 | 43382 |
| 7L-3S | | MI | 26505 | 6209 | 40050 | 5102 | 47910 | 4121 | 52105 | 3384 | 57097 | 2248 | 70492 | 1931 | 44758 |
| 16-#14 | 1.95 | MA | 23071 | 6209 | 35175 | 5138 | 41472 | 4160 | 43968 | 3412 | 45471 | 2270 | 56340 | 1466 | 41877 |
| 8L-2S | | MI | 27913 | 6209 | 41905 | 5101 | 50263 | 4122 | 54957 | 3372 | 60944 | 2241 | 75640 | 2063 | 44875 |
| 16-#18 | 3.46 | MA | 31998 | 7227 | 52488 | 5722 | 63420 | 4572 | 70558 | 3676 | 81189 | 2191 | 102186 | 1670 | 81558 |
| 3L-7S | | MI | 24281 | 7227 | 40872 | 5731 | 48416 | 4594 | 52541 | 3684 | 57351 | 2169 | 72835 | 912 | 65664 |
| 16-#18 | 3.46 | MA | 30220 | 7227 | 49935 | 5723 | 59969 | 4595 | 66375 | 3669 | 75563 | 2178 | 95968 | 1436 | 79006 |
| 4L-6S | | MI | 25717 | 7227 | 42995 | 5732 | 51225 | 4599 | 55972 | 3666 | 62071 | 2183 | 78346 | 1094 | 68935 |
| 16-#18 | 3.46 | MA | 28612 | 7227 | 47350 | 5750 | 56866 | 4592 | 62589 | 3689 | 70429 | 2191 | 89441 | 1321 | 76220 |
| 5E | | MI | 27183 | 7227 | 45175 | 5732 | 54131 | 4576 | 59508 | 3674 | 66727 | 2169 | 84554 | 1288 | 72299 |
| 16-#18 | 3.46 | MA | 27070 | 7227 | 45053 | 5751 | 53804 | 4616 | 58862 | 3682 | 65491 | 2204 | 82842 | 1128 | 72677 |
| 6L-4S | | MI | 28711 | 7227 | 47627 | 5706 | 57074 | 4580 | 63100 | 3656 | 71568 | 2156 | 90707 | 1402 | 74867 |
| 16-#18 | 3.46 | MA | 25560 | 7227 | 42816 | 5751 | 50845 | 4613 | 55247 | 3702 | 60484 | 2191 | 76979 | 945 | 69221 |
| 7L-3S | | MI | 30400 | 7227 | 50049 | 5706 | 60347 | 4558 | 67066 | 3664 | 76872 | 2169 | 96550 | 1635 | 77341 |
| 18-#11 | 1.52 | MA | 27800 | 5922 | 40399 | 4950 | 48461 | 4014 | 52596 | 3309 | 57203 | 2269 | 70805 | 2134 | 37255 |
| 2L-9S | | MI | 21636 | 5922 | 31915 | 4964 | 37596 | 4032 | 39615 | 3329 | 40247 | 2284 | 49225 | 1631 | 32404 |
| 18-#11 | 1.52 | MA | 26743 | 5922 | 39032 | 4951 | 46726 | 4014 | 50495 | 3318 | 54368 | 2276 | 66966 | 2043 | 37205 |
| 3L-8S | | MI | 22239 | 5922 | 32830 | 4952 | 38721 | 4022 | 40956 | 3320 | 42056 | 2278 | 51520 | 1689 | 33215 |
| 18-#11 | 1.52 | MA | 25981 | 5922 | 38018 | 4952 | 45355 | 4025 | 48833 | 3317 | 52125 | 2272 | 64432 | 1952 | 37102 |
| 4L-7S | | MI | 22846 | 5922 | 33659 | 4952 | 39812 | 4022 | 42320 | 3322 | 43883 | 2271 | 53845 | 1743 | 33875 |
| 18-#11 | 1.52 | MA | 25293 | 5922 | 36992 | 4964 | 44124 | 4025 | 47331 | 3326 | 50079 | 2279 | 61797 | 1905 | 36917 |
| 5L-6S | | MI | 23460 | 5922 | 34501 | 4951 | 40927 | 4022 | 43681 | 3313 | 45776 | 2276 | 56094 | 1814 | 34412 |
| 18-#11 | 1.52 | MA | 24633 | 5922 | 36082 | 4965 | 42910 | 4035 | 45853 | 3325 | 48113 | 2285 | 59116 | 1830 | 36190 |
| 6L-5S | | MI | 24087 | 5922 | 35366 | 4950 | 42080 | 4012 | 45085 | 3315 | 47644 | 2270 | 58622 | 1889 | 35096 |
| 18-#11 | 1.52 | MA | 23987 | 5922 | 35196 | 4966 | 41737 | 4035 | 44420 | 3334 | 46120 | 2281 | 56729 | 1759 | 35608 |
| 7L-4S | | MI | 24742 | 5922 | 36340 | 4938 | 43249 | 4013 | 46512 | 3307 | 49586 | 2264 | 61111 | 1935 | 35263 |
| 18-#11 | 1.52 | MA | 23348 | 5922 | 34323 | 4968 | 40588 | 4035 | 42984 | 3332 | 44196 | 2288 | 54267 | 1705 | 34903 |
| 8L-3S | | MI | 25465 | 5922 | 37302 | 4938 | 44550 | 4003 | 48089 | 3308 | 51715 | 2268 | 63498 | 2026 | 35355 |
| 18-#11 | 1.52 | MA | 22715 | 5922 | 33360 | 4979 | 39404 | 4045 | 41572 | 3341 | 42292 | 2295 | 51833 | 1647 | 34030 |
| 9L-2S | | MI | 26466 | 5922 | 38599 | 4937 | 46195 | 4003 | 50082 | 3300 | 54403 | 2262 | 67118 | 2117 | 35398 |
| 18-#14 | 2.19 | MA | 30239 | 6373 | 45845 | 5217 | 55242 | 4209 | 60757 | 3429 | 68176 | 2241 | 85344 | 2065 | 53040 |
| 2L-9S | | MI | 22038 | 6373 | 34180 | 5239 | 40292 | 4234 | 42806 | 3457 | 44503 | 2258 | 55339 | 1342 | 43401 |
| 18-#14 | 2.19 | MA | 28768 | 6373 | 43887 | 5219 | 52759 | 4208 | 57749 | 3442 | 64117 | 2249 | 79881 | 1933 | 52885 |
| 3L-8S | | MI | 22877 | 6373 | 35493 | 5223 | 41905 | 4220 | 44730 | 3445 | 47097 | 2250 | 58600 | 1427 | 45148 |
| 18-#14 | 2.19 | MA | 27707 | 6373 | 42433 | 5220 | 50793 | 4222 | 55366 | 3439 | 60901 | 2243 | 76279 | 1802 | 52587 |
| 4L-7S | | MI | 23723 | 6373 | 36681 | 5222 | 43471 | 4221 | 46686 | 3449 | 49716 | 2242 | 61913 | 1503 | 46509 |
| 18-#14 | 2.19 | MA | 26749 | 6373 | 40962 | 5236 | 49028 | 4222 | 53212 | 3452 | 57968 | 2252 | 72521 | 1735 | 51404 |
| 5L-6S | | MI | 24578 | 6373 | 37889 | 5222 | 45069 | 4222 | 48638 | 3437 | 52431 | 2249 | 65109 | 1605 | 47780 |
| 18-#14 | 2.19 | MA | 25830 | 6373 | 39656 | 5237 | 47286 | 4236 | 51092 | 3449 | 55148 | 2260 | 68707 | 1627 | 50289 |
| 6L-5S | | MI | 25451 | 6373 | 39129 | 5221 | 46723 | 4208 | 50651 | 3440 | 55108 | 2242 | 68703 | 1714 | 48808 |
| 18-#14 | 2.19 | MA | 24930 | 6373 | 38385 | 5239 | 45603 | 4235 | 49036 | 3462 | 52289 | 2254 | 65312 | 1525 | 48946 |
| 7L-4S | | MI | 26362 | 6373 | 40525 | 5205 | 48398 | 4210 | 52696 | 3428 | 57893 | 2234 | 72250 | 1779 | 49939 |
| 18-#14 | 2.19 | MA | 24041 | 6373 | 37133 | 5240 | 43955 | 4235 | 46976 | 3459 | 49530 | 2263 | 61803 | 1448 | 47480 |
| 8L-3S | | MI | 27370 | 6373 | 41905 | 5204 | 50263 | 4196 | 54957 | 3431 | 60944 | 2241 | 75640 | 1911 | 50213 |
| 18-#14 | 2.19 | MA | 23158 | 6373 | 35751 | 5256 | 42256 | 4249 | 44950 | 3472 | 46798 | 2271 | 58340 | 1363 | 45627 |
| 9L-2S | | MI | 28764 | 6373 | 43761 | 5203 | 52617 | 4197 | 57808 | 3420 | 64791 | 2233 | 80788 | 2042 | 50355 |
| 18-#18 | 3.90 | MA | 31745 | 7518 | 53364 | 5905 | 64318 | 4728 | 71645 | 3753 | 82653 | 2163 | 105421 | 1397 | 88739 |
| 4L-7S | | MI | 25789 | 7518 | 44120 | 5913 | 52536 | 4727 | 57532 | 3769 | 64035 | 2153 | 81728 | 870 | 74763 |
| 18-#18 | 3.90 | MA | 30162 | 7518 | 50780 | 5932 | 61216 | 4725 | 67859 | 3773 | 77519 | 2177 | 98894 | 1282 | 86063 |
| 5L-6S | | MI | 27202 | 7518 | 46243 | 5913 | 55344 | 4732 | 60962 | 3750 | 68756 | 2167 | 87240 | 1052 | 78115 |
| 18-#18 | 3.90 | MA | 28645 | 7518 | 48482 | 5933 | 58154 | 4749 | 64131 | 3766 | 72581 | 2190 | 92295 | 1088 | 82394 |
| 6L-5S | | MI | 28645 | 7518 | 48423 | 5914 | 58250 | 4709 | 64499 | 3758 | 73412 | 2153 | 93447 | 1246 | 81608 |
| 18-#18 | 3.90 | MA | 27159 | 7518 | 46246 | 5933 | 55195 | 4746 | 60516 | 3786 | 67574 | 2177 | 86431 | 906 | 78860 |
| 7L-4S | | MI | 30149 | 7518 | 50875 | 5887 | 61193 | 4713 | 68091 | 3740 | 78253 | 2140 | 99600 | 1359 | 84070 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis



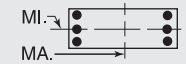

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.69 | MA | 28450 | 6035 | 41767 | 5021 | 50195 | 4066 | 54698 | 3342 | 60038 | 2264 | 74643 | 2122 | 41301 |
| 2L-10S | | MI | 21695 | 6035 | 32387 | 5036 | 38156 | 4083 | 40259 | 3360 | 41075 | 2274 | 50472 | 1538 | 35213 |
| 20-#11 | 1.69 | MA | 27401 | 6035 | 40399 | 5022 | 48461 | 4066 | 52596 | 3351 | 57203 | 2271 | 70805 | 2031 | 41238 |
| 3L-9S | | MI | 22289 | 6035 | 33212 | 5035 | 39240 | 4083 | 41607 | 3362 | 42935 | 2278 | 52845 | 1618 | 36119 |
| 20-#11 | 1.69 | MA | 26645 | 6035 | 39385 | 5023 | 47089 | 4077 | 50934 | 3350 | 54960 | 2267 | 68271 | 1940 | 41119 |
| 4L-8S | | MI | 22887 | 6035 | 34127 | 5023 | 40365 | 4074 | 42949 | 3353 | 44744 | 2272 | 55140 | 1677 | 36911 |
| 20-#11 | 1.69 | MA | 25962 | 6035 | 38360 | 5035 | 45859 | 4076 | 49432 | 3359 | 52914 | 2273 | 65636 | 1894 | 40917 |
| 5L-7S | | MI | 23488 | 6035 | 34956 | 5022 | 41457 | 4074 | 44312 | 3355 | 46571 | 2266 | 57465 | 1730 | 37620 |
| 20-#11 | 1.69 | MA | 25308 | 6035 | 37449 | 5036 | 44644 | 4087 | 47954 | 3357 | 50948 | 2280 | 62955 | 1819 | 40128 |
| 6E | | MI | 24097 | 6035 | 35798 | 5022 | 42571 | 4074 | 45674 | 3346 | 48464 | 2271 | 59714 | 1801 | 38142 |
| 20-#11 | 1.69 | MA | 24668 | 6035 | 36563 | 5037 | 43472 | 4087 | 46521 | 3366 | 48955 | 2276 | 60568 | 1748 | 39560 |
| 7L-5S | | MI | 24719 | 6035 | 36662 | 5021 | 43724 | 4064 | 47078 | 3348 | 50332 | 2265 | 62242 | 1876 | 38889 |
| 20-#11 | 1.69 | MA | 24035 | 6035 | 35691 | 5039 | 42322 | 4087 | 45085 | 3365 | 47031 | 2283 | 58106 | 1694 | 38808 |
| 8L-4S | | MI | 25368 | 6035 | 37636 | 5009 | 44893 | 4065 | 48504 | 3339 | 52274 | 2259 | 64731 | 1922 | 39072 |
| 20-#11 | 1.69 | MA | 23407 | 6035 | 34728 | 5050 | 41138 | 4097 | 43673 | 3374 | 45127 | 2289 | 55672 | 1635 | 37954 |
| 9L-3S | | MI | 26086 | 6035 | 38599 | 5008 | 46195 | 4055 | 50082 | 3341 | 54403 | 2263 | 67118 | 2014 | 39179 |
| 20-#11 | 1.69 | MA | 22781 | 6035 | 33859 | 5051 | 39997 | 4097 | 42254 | 3373 | 43169 | 2286 | 53155 | 1555 | 36988 |
| 10L-2S | | MI | 27080 | 6035 | 39896 | 5007 | 47839 | 4055 | 52074 | 3332 | 57091 | 2257 | 70738 | 2105 | 39236 |
| 20-#14 | 2.44 | MA | 29672 | 6537 | 45845 | 5321 | 55242 | 4283 | 60757 | 3489 | 68176 | 2242 | 85344 | 1915 | 58637 |
| 3L-9S | | MI | 22949 | 6537 | 36036 | 5341 | 42645 | 4309 | 45657 | 3505 | 48350 | 2250 | 60487 | 1322 | 48668 |
| 20-#14 | 2.44 | MA | 28623 | 6537 | 44391 | 5322 | 53276 | 4297 | 58375 | 3487 | 64960 | 2236 | 81742 | 1783 | 58311 |
| 4L-8S | | MI | 23779 | 6537 | 37348 | 5325 | 44259 | 4295 | 47582 | 3493 | 50944 | 2243 | 63748 | 1407 | 50456 |
| 20-#14 | 2.44 | MA | 27674 | 6537 | 42920 | 5338 | 51511 | 4297 | 56220 | 3499 | 62027 | 2244 | 77985 | 1717 | 57013 |
| 5L-7S | | MI | 24615 | 6537 | 38537 | 5325 | 45825 | 4296 | 49537 | 3496 | 53563 | 2235 | 67061 | 1483 | 51782 |
| 20-#14 | 2.44 | MA | 26766 | 6537 | 41614 | 5340 | 49769 | 4311 | 54100 | 3497 | 59207 | 2253 | 74170 | 1608 | 55933 |
| 6E | | MI | 25461 | 6537 | 39745 | 5324 | 47422 | 4297 | 51489 | 3484 | 56278 | 2242 | 70257 | 1585 | 53124 |
| 20-#14 | 2.44 | MA | 25876 | 6537 | 40343 | 5341 | 48087 | 4310 | 52044 | 3509 | 56348 | 2247 | 70776 | 1506 | 54519 |
| 7L-5S | | MI | 26325 | 6537 | 40985 | 5323 | 49076 | 4283 | 53502 | 3487 | 58955 | 2234 | 73851 | 1694 | 54119 |
| 20-#14 | 2.44 | MA | 24997 | 6537 | 39091 | 5342 | 46438 | 4310 | 49985 | 3507 | 53589 | 2255 | 67266 | 1429 | 53090 |
| 8L-4S | | MI | 27226 | 6537 | 42381 | 5307 | 50752 | 4284 | 55548 | 3476 | 61740 | 2226 | 77398 | 1759 | 55363 |
| 20-#14 | 2.44 | MA | 24124 | 6537 | 37709 | 5359 | 44739 | 4324 | 47959 | 3519 | 50857 | 2264 | 63803 | 1345 | 51197 |
| 9L-3S | | MI | 28223 | 6537 | 43761 | 5306 | 52617 | 4271 | 57808 | 3479 | 64791 | 2233 | 80788 | 1891 | 55664 |
| 20-#18 | 4.33 | MA | 31688 | 7809 | 54209 | 6114 | 65566 | 4858 | 73128 | 3857 | 84609 | 2162 | 108347 | 1243 | 95922 |
| 5L-7S | | MI | 27271 | 7809 | 47368 | 6095 | 56655 | 4860 | 62522 | 3853 | 70720 | 2137 | 90621 | 827 | 83882 |
| 20-#18 | 4.33 | MA | 30194 | 7809 | 51912 | 6114 | 62504 | 4882 | 69401 | 3850 | 79671 | 2176 | 101748 | 1049 | 92130 |
| 6E | | MI | 28662 | 7809 | 49491 | 6095 | 59463 | 4865 | 65952 | 3835 | 75441 | 2151 | 96133 | 1010 | 87315 |
| 20-#18 | 4.33 | MA | 28731 | 7809 | 49675 | 6115 | 59544 | 4879 | 65786 | 3870 | 74664 | 2162 | 95884 | 867 | 88386 |
| 7L-5S | | MI | 30083 | 7809 | 51671 | 6095 | 62369 | 4842 | 69489 | 3843 | 80096 | 2137 | 102340 | 1203 | 90932 |
| 22-#11 | 1.86 | MA | 29093 | 6148 | 43134 | 5092 | 51930 | 4118 | 56799 | 3375 | 62873 | 2259 | 78482 | 2111 | 45344 |
| 2L-11S | | MI | 21727 | 6148 | 32864 | 5107 | 38689 | 4145 | 40918 | 3402 | 41962 | 2275 | 51807 | 1469 | 37951 |
| 22-#11 | 1.86 | MA | 28052 | 6148 | 41767 | 5093 | 50195 | 4118 | 54698 | 3384 | 60038 | 2265 | 74643 | 2020 | 45268 |
| 3L-10S | | MI | 22345 | 6148 | 33683 | 5106 | 39801 | 4135 | 42251 | 3393 | 43764 | 2269 | 54092 | 1525 | 38902 |
| 22-#11 | 1.86 | MA | 27302 | 6148 | 40753 | 5094 | 48824 | 4128 | 53036 | 3382 | 57795 | 2262 | 72110 | 1929 | 45135 |
| 4L-9S | | MI | 22935 | 6148 | 34509 | 5105 | 40885 | 4135 | 43599 | 3395 | 45624 | 2273 | 56465 | 1605 | 39839 |
| 22-#11 | 1.86 | MA | 26625 | 6148 | 39727 | 5106 | 47593 | 4128 | 51533 | 3392 | 55749 | 2268 | 69474 | 1882 | 44917 |
| 5L-8S | | MI | 23527 | 6148 | 35424 | 5094 | 42010 | 4125 | 44941 | 3386 | 47432 | 2267 | 58760 | 1664 | 40613 |
| 22-#11 | 1.86 | MA | 25976 | 6148 | 38817 | 5107 | 46379 | 4139 | 50055 | 3390 | 53783 | 2275 | 66794 | 1807 | 44071 |
| 6L-7S | | MI | 24124 | 6148 | 36253 | 5093 | 43102 | 4126 | 46305 | 3388 | 49259 | 2261 | 61085 | 1717 | 41368 |
| 22-#11 | 1.86 | MA | 25341 | 6148 | 37931 | 5108 | 45206 | 4139 | 48622 | 3399 | 51790 | 2271 | 64407 | 1736 | 43516 |
| 7L-6S | | MI | 24727 | 6148 | 37094 | 5092 | 44216 | 4126 | 47666 | 3379 | 51152 | 2265 | 63334 | 1788 | 41878 |
| 22-#11 | 1.86 | MA | 24714 | 6148 | 37059 | 5109 | 44057 | 4139 | 47187 | 3398 | 49866 | 2278 | 61945 | 1682 | 42718 |
| 8L-5S | | MI | 25344 | 6148 | 37959 | 5091 | 45369 | 4116 | 49070 | 3381 | 53020 | 2259 | 65862 | 1863 | 42671 |
| 22-#11 | 1.86 | MA | 24091 | 6148 | 36095 | 5121 | 42873 | 4149 | 45774 | 3407 | 47962 | 2284 | 59510 | 1624 | 41883 |
| 9L-4S | | MI | 25988 | 6148 | 38933 | 5080 | 46538 | 4117 | 50496 | 3372 | 54962 | 2253 | 68351 | 1910 | 42880 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

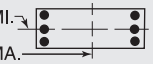
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.86 | MA | 23471 | 6148 | 35227 | 5122 | 41732 | 4149 | 44355 | 3406 | 46004 | 2280 | 56994 | 1543 | 40887 |
| 10L-3S | | MI | 26700 | 6148 | 39896 | 5079 | 47839 | 4107 | 52074 | 3374 | 57091 | 2258 | 70738 | 2001 | 43001 |
| 22-#11 | 1.86 | MA | 22809 | 6148 | 34364 | 5123 | 40561 | 4159 | 42951 | 3415 | 44108 | 2287 | 54574 | 1487 | 39866 |
| 11L-2S | | MI | 27688 | 6148 | 41192 | 5078 | 49484 | 4107 | 54066 | 3365 | 59779 | 2252 | 74358 | 2092 | 43070 |
| 22-#14 | 2.68 | MA | 29527 | 6700 | 46349 | 5424 | 55759 | 4372 | 61383 | 3534 | 69019 | 2228 | 87205 | 1765 | 64035 |
| 4L-9S | | MI | 23847 | 6700 | 37892 | 5443 | 44999 | 4383 | 48509 | 3552 | 52197 | 2243 | 65635 | 1302 | 53943 |
| 22-#14 | 2.68 | MA | 28588 | 6700 | 44878 | 5441 | 53994 | 4371 | 59229 | 3547 | 66086 | 2237 | 83448 | 1698 | 62633 |
| 5L-8S | | MI | 24669 | 6700 | 39204 | 5428 | 46612 | 4370 | 50433 | 3540 | 54791 | 2235 | 68896 | 1386 | 55770 |
| 22-#14 | 2.68 | MA | 27690 | 6700 | 43572 | 5442 | 52253 | 4386 | 57109 | 3544 | 63266 | 2245 | 79633 | 1590 | 61584 |
| 6L-7S | | MI | 25496 | 6700 | 40393 | 5427 | 48178 | 4371 | 52389 | 3543 | 57410 | 2227 | 72208 | 1462 | 57064 |
| 22-#14 | 2.68 | MA | 26810 | 6700 | 42301 | 5443 | 50570 | 4385 | 55053 | 3556 | 60407 | 2239 | 76239 | 1488 | 60102 |
| 7L-6S | | MI | 26332 | 6700 | 41601 | 5426 | 49776 | 4372 | 54341 | 3532 | 60125 | 2234 | 75404 | 1565 | 58475 |
| 22-#14 | 2.68 | MA | 25940 | 6700 | 41049 | 5445 | 48921 | 4384 | 52993 | 3554 | 57648 | 2248 | 72729 | 1411 | 58707 |
| 8L-5S | | MI | 27187 | 6700 | 42841 | 5425 | 51430 | 4358 | 56354 | 3535 | 62802 | 2227 | 78998 | 1673 | 59440 |
| 22-#14 | 2.68 | MA | 25077 | 6700 | 39667 | 5461 | 47222 | 4399 | 50967 | 3566 | 54916 | 2256 | 69266 | 1326 | 56774 |
| 9L-4S | | MI | 28079 | 6700 | 44237 | 5409 | 53105 | 4359 | 58399 | 3523 | 65587 | 2219 | 82545 | 1739 | 60785 |
| 22-#18 | 4.76 | MA | 31720 | 8100 | 55342 | 6296 | 66853 | 5015 | 74671 | 3935 | 86761 | 2161 | 111201 | 1010 | 101884 |
| 6L-7S | | MI | 28731 | 8100 | 50616 | 6277 | 60774 | 4993 | 67513 | 3937 | 77405 | 2121 | 99515 | 785 | 92902 |
| 22-#18 | 4.76 | MA | 30279 | 8100 | 53105 | 6297 | 63894 | 5012 | 71056 | 3954 | 81754 | 2148 | 105337 | 828 | 98066 |
| 7L-6S | | MI | 30102 | 8100 | 52739 | 6277 | 63582 | 4998 | 70943 | 3919 | 82125 | 2135 | 105026 | 967 | 96533 |
| 24-#11 | 2.03 | MA | 28696 | 6262 | 43134 | 5164 | 51930 | 4170 | 56799 | 3417 | 62873 | 2260 | 78482 | 2008 | 49296 |
| 3L-11S | | MI | 22384 | 6262 | 34161 | 5178 | 40333 | 4197 | 42910 | 3435 | 44650 | 2270 | 55427 | 1456 | 41661 |
| 24-#11 | 2.03 | MA | 27952 | 6262 | 42120 | 5165 | 50558 | 4180 | 55137 | 3415 | 60630 | 2257 | 75948 | 1917 | 49149 |
| 4L-10S | | MI | 22989 | 6262 | 34980 | 5177 | 41445 | 4187 | 44244 | 3426 | 46452 | 2264 | 57712 | 1513 | 42595 |
| 24-#11 | 2.03 | MA | 27280 | 6262 | 41095 | 5177 | 49328 | 4180 | 53635 | 3424 | 58584 | 2263 | 73313 | 1870 | 48851 |
| 5L-9S | | MI | 23574 | 6262 | 35806 | 5176 | 42530 | 4187 | 45592 | 3428 | 48312 | 2268 | 60085 | 1593 | 43563 |
| 24-#11 | 2.03 | MA | 26637 | 6262 | 40184 | 5178 | 48113 | 4191 | 52157 | 3423 | 56618 | 2270 | 70633 | 1795 | 48018 |
| 6L-8S | | MI | 24161 | 6262 | 36721 | 5165 | 43654 | 4177 | 46934 | 3419 | 50120 | 2262 | 62380 | 1651 | 44320 |
| 24-#11 | 2.03 | MA | 26007 | 6262 | 39298 | 5179 | 46941 | 4191 | 50723 | 3432 | 54625 | 2266 | 68245 | 1724 | 47475 |
| 7E | | MI | 24753 | 6262 | 37549 | 5164 | 44746 | 4178 | 48297 | 3421 | 51947 | 2256 | 64705 | 1705 | 45118 |
| 24-#11 | 2.03 | MA | 25385 | 6262 | 38426 | 5180 | 45791 | 4190 | 49288 | 3431 | 52701 | 2273 | 65784 | 1670 | 46633 |
| 8L-6S | | MI | 25351 | 6262 | 38391 | 5163 | 45860 | 4178 | 49658 | 3412 | 53840 | 2260 | 66954 | 1776 | 45618 |
| 24-#11 | 2.03 | MA | 24768 | 6262 | 37463 | 5192 | 44607 | 4201 | 47875 | 3440 | 50797 | 2279 | 63349 | 1612 | 45816 |
| 9L-5S | | MI | 25963 | 6262 | 39256 | 5162 | 47014 | 4168 | 51062 | 3414 | 55708 | 2254 | 69482 | 1851 | 46385 |
| 24-#11 | 2.03 | MA | 24153 | 6262 | 36594 | 5193 | 43466 | 4201 | 46456 | 3439 | 48839 | 2275 | 60832 | 1532 | 44790 |
| 10L-4S | | MI | 26602 | 6262 | 40230 | 5151 | 48182 | 4168 | 52489 | 3405 | 57650 | 2248 | 71971 | 1897 | 46685 |
| 24-#11 | 2.03 | MA | 23495 | 6262 | 35732 | 5194 | 42295 | 4211 | 45053 | 3448 | 46943 | 2282 | 58413 | 1475 | 43787 |
| 11L-3S | | MI | 27309 | 6262 | 41192 | 5150 | 49484 | 4159 | 54066 | 3407 | 59779 | 2253 | 74358 | 1988 | 46820 |
| 24-#14 | 2.92 | MA | 29492 | 6864 | 46836 | 5543 | 56478 | 4446 | 62237 | 3594 | 70145 | 2229 | 88911 | 1680 | 68261 |
| 5L-9S | | MI | 24735 | 6864 | 39748 | 5546 | 47353 | 4458 | 51360 | 3599 | 56044 | 2235 | 70782 | 1281 | 59224 |
| 24-#14 | 2.92 | MA | 28602 | 6864 | 45530 | 5544 | 54736 | 4461 | 60117 | 3591 | 67325 | 2238 | 85096 | 1571 | 67240 |
| 6L-8S | | MI | 25547 | 6864 | 41060 | 5530 | 48966 | 4444 | 53284 | 3588 | 58638 | 2228 | 74044 | 1366 | 61091 |
| 24-#14 | 2.92 | MA | 27732 | 6864 | 44259 | 5545 | 53053 | 4460 | 58061 | 3604 | 64466 | 2232 | 81702 | 1469 | 65693 |
| 7E | | MI | 26366 | 6864 | 42249 | 5529 | 50532 | 4446 | 55240 | 3591 | 61257 | 2220 | 77356 | 1442 | 62354 |
| 24-#14 | 2.92 | MA | 26871 | 6864 | 43007 | 5547 | 51405 | 4459 | 56002 | 3601 | 61707 | 2240 | 78192 | 1392 | 64330 |
| 8L-6S | | MI | 27194 | 6864 | 43456 | 5528 | 52130 | 4447 | 57192 | 3579 | 63972 | 2227 | 80552 | 1545 | 63830 |
| 24-#14 | 2.92 | MA | 26017 | 6864 | 41625 | 5563 | 49706 | 4474 | 53976 | 3614 | 58975 | 2249 | 74729 | 1307 | 62358 |
| 9L-5S | | MI | 28040 | 6864 | 44697 | 5527 | 53783 | 4433 | 59205 | 3582 | 66649 | 2219 | 84146 | 1653 | 64769 |
| 24-#18 | 5.19 | MA | 31805 | 8390 | 56535 | 6478 | 68244 | 5145 | 76325 | 4039 | 88844 | 2134 | 114790 | 789 | 107763 |
| 7E | | MI | 30170 | 8390 | 53864 | 6458 | 64893 | 5126 | 72503 | 4021 | 84089 | 2105 | 108408 | 742 | 102060 |

## RECTANGULAR TIED COLUMNS 42" x 46"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.24 | MA | 29052 | 5996 | 41828 | 5022 | 49737 | 4082 | 53453 | 3381 | 56998 | 2364 | 69488 | 2216 | 33135 |
| 2L-3S | | MI | 23860 | 5996 | 35051 | 4991 | 41183 | 4052 | 43575 | 3378 | 44816 | 2353 | 53643 | 1948 | 29897 |
| 6-#18 | 1.24 | MA | 26230 | 5996 | 38216 | 5023 | 45157 | 4080 | 47905 | 3402 | 49512 | 2378 | 59475 | 1983 | 33000 |
| 3L-2S | | MI | 26394 | 5996 | 38299 | 4991 | 45302 | 4056 | 48565 | 3359 | 51501 | 2340 | 62536 | 2181 | 29981 |
| 8-#18 | 1.66 | MA | 30769 | 6287 | 45439 | 5204 | 54317 | 4215 | 59002 | 3465 | 64484 | 2351 | 79501 | 2180 | 43839 |
| 2L-4S | | MI | 23617 | 6287 | 35877 | 5172 | 42029 | 4208 | 44599 | 3454 | 46197 | 2324 | 56693 | 1672 | 38745 |

## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis



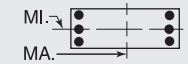

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.66 | MA | 27996 | 6287 | 41828 | 5205 | 49737 | 4213 | 53453 | 3486 | 56998 | 2365 | 69488 | 1946 | 43597 |
| 3E | | MI | 25431 | 6287 | 38299 | 5172 | 45302 | 4185 | 48565 | 3462 | 51501 | 2337 | 62536 | 1905 | 39432 |
| 8-#18 | 1.66 | MA | 25986 | 6287 | 39142 | 5207 | 46107 | 4237 | 49054 | 3480 | 51060 | 2352 | 62894 | 1713 | 42761 |
| 4L-2S | | MI | 27922 | 6287 | 41547 | 5173 | 49422 | 4189 | 53556 | 3444 | 58186 | 2324 | 71429 | 2139 | 39621 |
| 10-#14 | 1.16 | MA | 28856 | 5941 | 41022 | 5017 | 48975 | 4081 | 52644 | 3386 | 55983 | 2383 | 68509 | 2255 | 31388 |
| 2L-5S | | MI | 22764 | 5941 | 32936 | 5006 | 38737 | 4069 | 40706 | 3386 | 41091 | 2376 | 49678 | 1896 | 27909 |
| 10-#14 | 1.16 | MA | 27239 | 5941 | 38962 | 5019 | 46362 | 4081 | 49478 | 3399 | 51712 | 2392 | 62730 | 2123 | 31347 |
| 3L-4S | | MI | 23722 | 5941 | 34332 | 4991 | 40413 | 4071 | 42752 | 3375 | 43876 | 2368 | 53225 | 1961 | 28283 |
| 10-#14 | 1.16 | MA | 26070 | 5941 | 37434 | 5021 | 44296 | 4096 | 46974 | 3397 | 48332 | 2387 | 58917 | 1992 | 31187 |
| 4L-3S | | MI | 24777 | 5941 | 35712 | 4990 | 42278 | 4057 | 45012 | 3378 | 46927 | 2375 | 56616 | 2093 | 28402 |
| 10-#14 | 1.16 | MA | 25011 | 5941 | 35888 | 5037 | 42442 | 4096 | 44711 | 3410 | 45250 | 2396 | 54949 | 1924 | 30732 |
| 5L-2S | | MI | 26232 | 5941 | 37568 | 4989 | 44631 | 4058 | 47864 | 3366 | 50774 | 2367 | 61763 | 2224 | 28424 |
| 10-#18 | 2.07 | MA | 32444 | 6578 | 49051 | 5385 | 58897 | 4348 | 64551 | 3550 | 71971 | 2338 | 89514 | 2144 | 54514 |
| 2L-5S | | MI | 23564 | 6578 | 36673 | 5380 | 43205 | 4336 | 45998 | 3556 | 48040 | 2321 | 59433 | 1516 | 44797 |
| 10-#18 | 2.07 | MA | 29716 | 6578 | 45439 | 5387 | 54317 | 4346 | 59002 | 3570 | 64484 | 2352 | 79501 | 1910 | 54178 |
| 3L-4S | | MI | 25180 | 6578 | 39125 | 5354 | 46149 | 4340 | 49589 | 3538 | 52881 | 2308 | 65586 | 1629 | 47814 |
| 10-#18 | 2.07 | MA | 27743 | 6578 | 42754 | 5388 | 50687 | 4370 | 54603 | 3565 | 58547 | 2339 | 72907 | 1677 | 52950 |
| 4L-3S | | MI | 26962 | 6578 | 41547 | 5354 | 49422 | 4318 | 53556 | 3546 | 58186 | 2321 | 71429 | 1863 | 48948 |
| 10-#18 | 2.07 | MA | 25955 | 6578 | 40036 | 5416 | 47426 | 4368 | 50623 | 3586 | 53128 | 2353 | 66007 | 1560 | 49458 |
| 5L-2S | | MI | 29414 | 6578 | 44795 | 5354 | 53541 | 4322 | 58546 | 3528 | 64870 | 2308 | 80323 | 2096 | 49225 |
| 12-#14 | 1.40 | MA | 29856 | 6105 | 43082 | 5120 | 51588 | 4156 | 55809 | 3433 | 60254 | 2375 | 74288 | 2238 | 37498 |
| 2L-6S | | MI | 22787 | 6105 | 33551 | 5110 | 39437 | 4158 | 41545 | 3431 | 42261 | 2376 | 51232 | 1767 | 31988 |
| 12-#14 | 1.40 | MA | 28256 | 6105 | 41022 | 5121 | 48975 | 4156 | 52644 | 3446 | 55983 | 2385 | 68509 | 2106 | 37425 |
| 3L-5S | | MI | 23694 | 6105 | 34792 | 5109 | 41091 | 4144 | 43558 | 3434 | 44938 | 2368 | 54826 | 1875 | 33159 |
| 12-#14 | 1.40 | MA | 27100 | 6105 | 39494 | 5123 | 46909 | 4171 | 50140 | 3444 | 52603 | 2379 | 64696 | 1975 | 37225 |
| 4E | | MI | 24640 | 6105 | 36188 | 5093 | 42766 | 4145 | 45603 | 3422 | 47723 | 2361 | 58373 | 1941 | 33724 |
| 12-#14 | 1.40 | MA | 26054 | 6105 | 37949 | 5140 | 45055 | 4171 | 47876 | 3457 | 49521 | 2388 | 60728 | 1907 | 36578 |
| 5L-3S | | MI | 25684 | 6105 | 37568 | 5092 | 44631 | 4132 | 47864 | 3425 | 50774 | 2368 | 61763 | 2073 | 33882 |
| 12-#14 | 1.40 | MA | 25052 | 6105 | 36577 | 5141 | 43225 | 4185 | 45649 | 3455 | 46558 | 2398 | 56692 | 1799 | 35221 |
| 6L-2S | | MI | 27124 | 6105 | 39424 | 5091 | 46985 | 4133 | 50715 | 3413 | 54621 | 2360 | 66911 | 2204 | 33935 |
| 12-#18 | 2.48 | MA | 34082 | 6868 | 52662 | 5567 | 63478 | 4481 | 70100 | 3634 | 79457 | 2325 | 99528 | 2108 | 65168 |
| 2L-6S | | MI | 23596 | 6868 | 37740 | 5562 | 44419 | 4492 | 47451 | 3633 | 50069 | 2318 | 62119 | 1280 | 51145 |
| 12-#18 | 2.48 | MA | 31397 | 6868 | 49051 | 5569 | 58897 | 4479 | 64551 | 3655 | 71971 | 2338 | 89514 | 1874 | 64750 |
| 3L-5S | | MI | 25120 | 6868 | 39921 | 5562 | 47325 | 4469 | 50988 | 3641 | 54725 | 2305 | 68326 | 1473 | 54039 |
| 12-#18 | 2.48 | MA | 29458 | 6868 | 46365 | 5570 | 55267 | 4503 | 60152 | 3649 | 66033 | 2326 | 82920 | 1641 | 63102 |
| 4E | | MI | 26708 | 6868 | 42373 | 5536 | 50268 | 4473 | 54580 | 3622 | 59566 | 2292 | 74479 | 1587 | 56907 |
| 12-#18 | 2.48 | MA | 27702 | 6868 | 43648 | 5598 | 52006 | 4501 | 56171 | 3670 | 60614 | 2339 | 76020 | 1524 | 59769 |
| 5L-3S | | MI | 28460 | 6868 | 44795 | 5536 | 53541 | 4451 | 58546 | 3630 | 64870 | 2305 | 80323 | 1820 | 58452 |
| 12-#18 | 2.48 | MA | 26018 | 6868 | 41234 | 5599 | 48787 | 4525 | 52253 | 3664 | 55403 | 2353 | 69029 | 1331 | 56529 |
| 6L-2S | | MI | 30875 | 6868 | 48043 | 5536 | 57660 | 4455 | 63537 | 3612 | 71555 | 2292 | 89216 | 2054 | 58809 |
| 14-#11 | 1.13 | MA | 28773 | 5918 | 40651 | 5017 | 48636 | 4082 | 52291 | 3389 | 55546 | 2392 | 68103 | 2273 | 30623 |
| 2L-7S | | MI | 22473 | 5918 | 32290 | 5005 | 37950 | 4079 | 39797 | 3393 | 39880 | 2387 | 48175 | 1870 | 26542 |
| 14-#11 | 1.13 | MA | 27641 | 5918 | 39212 | 5019 | 46812 | 4083 | 50081 | 3399 | 52564 | 2399 | 64045 | 2182 | 30600 |
| 3L-6S | | MI | 23100 | 5918 | 33131 | 5004 | 39064 | 4079 | 41158 | 3384 | 41773 | 2391 | 50424 | 1941 | 27117 |
| 14-#11 | 1.13 | MA | 26825 | 5918 | 38147 | 5020 | 45371 | 4093 | 48334 | 3398 | 50207 | 2396 | 61365 | 2091 | 30533 |
| 4L-5S | | MI | 23740 | 5918 | 33996 | 5003 | 40218 | 4070 | 42562 | 3386 | 43641 | 2385 | 52952 | 2016 | 27570 |
| 14-#11 | 1.13 | MA | 26088 | 5918 | 37070 | 5032 | 44079 | 4094 | 46757 | 3407 | 48058 | 2403 | 58583 | 2043 | 30386 |
| 5L-4S | | MI | 24408 | 5918 | 34970 | 4992 | 41386 | 4070 | 43988 | 3377 | 45583 | 2379 | 55441 | 2062 | 27683 |
| 14-#11 | 1.13 | MA | 25380 | 5918 | 36114 | 5033 | 42803 | 4104 | 45204 | 3406 | 45993 | 2410 | 55750 | 1968 | 29858 |
| 6L-3S | | MI | 25145 | 5918 | 35933 | 4991 | 42688 | 4060 | 45566 | 3379 | 47712 | 2383 | 57828 | 2153 | 27731 |
| 14-#11 | 1.13 | MA | 24688 | 5918 | 35184 | 5035 | 41572 | 4105 | 43699 | 3416 | 43900 | 2406 | 53225 | 1898 | 29187 |
| 7L-2S | | MI | 26164 | 5918 | 37230 | 4990 | 44333 | 4060 | 47558 | 3370 | 50400 | 2377 | 61448 | 2244 | 27742 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

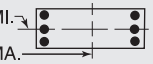



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 1.63 | MA | 30840 | 6269 | 45143 | 5222 | 54201 | 4231 | 58975 | 3481 | 64525 | 2368 | 80066 | 2221 | 43597 |
| 2L-7S | | MI | 22834 | 6269 | 34200 | 5213 | 40193 | 4232 | 42444 | 3490 | 43393 | 2362 | 53184 | 1644 | 36320 |
| 14-#14 | 1.63 | MA | 29256 | 6269 | 43082 | 5223 | 51588 | 4231 | 55809 | 3494 | 60254 | 2377 | 74288 | 2089 | 43495 |
| 3L-6S | | MI | 23713 | 6269 | 35407 | 5212 | 41790 | 4233 | 44396 | 3478 | 46108 | 2369 | 56380 | 1747 | 37306 |
| 14-#14 | 1.63 | MA | 28113 | 6269 | 41554 | 5225 | 49522 | 4246 | 53305 | 3492 | 56874 | 2372 | 70474 | 1958 | 43259 |
| 4L-5S | | MI | 24609 | 6269 | 36648 | 5211 | 43444 | 4219 | 46409 | 3481 | 48785 | 2361 | 59974 | 1855 | 38428 |
| 14-#14 | 1.63 | MA | 27080 | 6269 | 40009 | 5242 | 47668 | 4245 | 51042 | 3505 | 53792 | 2381 | 66506 | 1890 | 42444 |
| 5L-4S | | MI | 25545 | 6269 | 38044 | 5195 | 45120 | 4220 | 48454 | 3469 | 51570 | 2353 | 63521 | 1921 | 39159 |
| 14-#14 | 1.63 | MA | 26089 | 6269 | 38637 | 5244 | 45838 | 4260 | 48814 | 3503 | 50829 | 2390 | 62471 | 1782 | 41138 |
| 6L-3S | | MI | 26577 | 6269 | 39424 | 5194 | 46985 | 4206 | 50715 | 3473 | 54621 | 2360 | 66911 | 2052 | 39352 |
| 14-#14 | 1.63 | MA | 25119 | 6269 | 37302 | 5245 | 44071 | 4260 | 46655 | 3516 | 47825 | 2385 | 58878 | 1680 | 40016 |
| 7L-2S | | MI | 28003 | 6269 | 41279 | 5193 | 49339 | 4208 | 53566 | 3461 | 58468 | 2353 | 72059 | 2184 | 39432 |
| 14-#18 | 2.90 | MA | 35690 | 7159 | 56274 | 5749 | 68058 | 4614 | 75649 | 3718 | 86944 | 2311 | 109541 | 2072 | 75809 |
| 2L-7S | | MI | 23676 | 7159 | 38865 | 5743 | 45730 | 4620 | 49011 | 3735 | 52033 | 2289 | 65501 | 1055 | 57262 |
| 14-#18 | 2.90 | MA | 33043 | 7159 | 52662 | 5750 | 63478 | 4612 | 70100 | 3739 | 79457 | 2325 | 99528 | 1838 | 75316 |
| 3L-6S | | MI | 25144 | 7159 | 40988 | 5743 | 48538 | 4625 | 52442 | 3717 | 56754 | 2302 | 71012 | 1237 | 60270 |
| 14-#18 | 2.90 | MA | 31136 | 7159 | 49977 | 5752 | 59847 | 4636 | 65701 | 3733 | 73519 | 2312 | 92933 | 1604 | 73295 |
| 4L-5S | | MI | 26642 | 7159 | 43169 | 5744 | 51444 | 4602 | 55978 | 3725 | 61410 | 2289 | 77220 | 1431 | 63305 |
| 14-#18 | 2.90 | MA | 29411 | 7159 | 47259 | 5780 | 56586 | 4634 | 61720 | 3754 | 68100 | 2326 | 86033 | 1488 | 70104 |
| 5L-4S | | MI | 28204 | 7159 | 45621 | 5717 | 54387 | 4606 | 59570 | 3707 | 66251 | 2276 | 83373 | 1544 | 66040 |
| 14-#18 | 2.90 | MA | 27757 | 7159 | 44845 | 5781 | 53367 | 4658 | 57802 | 3748 | 62889 | 2340 | 79042 | 1295 | 66728 |
| 6L-3S | | MI | 29928 | 7159 | 48043 | 5718 | 57660 | 4584 | 63537 | 3715 | 71555 | 2289 | 89216 | 1778 | 67949 |
| 14-#18 | 2.90 | MA | 26136 | 7159 | 42495 | 5783 | 50258 | 4656 | 54003 | 3769 | 57606 | 2327 | 72826 | 1113 | 63362 |
| 7L-2S | | MI | 32308 | 7159 | 51291 | 5718 | 61779 | 4588 | 68527 | 3696 | 78240 | 2276 | 98109 | 2012 | 68377 |
| 16-#11 | 1.29 | MA | 29478 | 6031 | 42089 | 5088 | 50461 | 4134 | 54501 | 3422 | 58528 | 2387 | 72161 | 2262 | 34889 |
| 2L-8S | | MI | 22519 | 6031 | 32758 | 5077 | 38503 | 4131 | 40425 | 3424 | 40741 | 2388 | 49470 | 1804 | 29762 |
| 16-#11 | 1.29 | MA | 28355 | 6031 | 40651 | 5089 | 48636 | 4135 | 52291 | 3432 | 55546 | 2394 | 68103 | 2171 | 34853 |
| 3L-7S | | MI | 23133 | 6031 | 33586 | 5076 | 39595 | 4131 | 41789 | 3426 | 42568 | 2382 | 51795 | 1857 | 30277 |
| 16-#11 | 1.29 | MA | 27545 | 6031 | 39585 | 5091 | 47196 | 4145 | 50545 | 3431 | 53189 | 2390 | 65422 | 2080 | 34767 |
| 4L-6S | | MI | 23754 | 6031 | 34428 | 5075 | 40709 | 4131 | 43150 | 3417 | 44461 | 2386 | 54044 | 1928 | 30833 |
| 16-#11 | 1.29 | MA | 26814 | 6031 | 38508 | 5103 | 45903 | 4146 | 48967 | 3440 | 51040 | 2397 | 62641 | 2033 | 34600 |
| 5E | | MI | 24389 | 6031 | 35293 | 5074 | 41862 | 4121 | 44554 | 3419 | 46329 | 2380 | 56572 | 2003 | 31369 |
| 16-#11 | 1.29 | MA | 26113 | 6031 | 37552 | 5104 | 44628 | 4156 | 47414 | 3439 | 48975 | 2405 | 59807 | 1958 | 33988 |
| 6L-4S | | MI | 25051 | 6031 | 36267 | 5063 | 43031 | 4122 | 45981 | 3410 | 48271 | 2374 | 59061 | 2049 | 31502 |
| 16-#11 | 1.29 | MA | 25427 | 6031 | 36622 | 5106 | 43396 | 4156 | 45909 | 3449 | 46882 | 2401 | 57282 | 1887 | 33337 |
| 7L-3S | | MI | 25782 | 6031 | 37230 | 5062 | 44333 | 4112 | 47558 | 3412 | 50400 | 2378 | 61448 | 2140 | 31567 |
| 16-#11 | 1.29 | MA | 24749 | 6031 | 35706 | 5107 | 42190 | 4157 | 44402 | 3448 | 44862 | 2408 | 54684 | 1832 | 32741 |
| 8L-2S | | MI | 26794 | 6031 | 38526 | 5061 | 45977 | 4112 | 49551 | 3403 | 53088 | 2372 | 65068 | 2232 | 31592 |
| 16-#14 | 1.86 | MA | 31811 | 6432 | 47203 | 5324 | 56814 | 4306 | 62141 | 3528 | 68795 | 2360 | 85845 | 2204 | 49688 |
| 2L-8S | | MI | 22897 | 6432 | 34867 | 5316 | 40980 | 4305 | 43340 | 3534 | 44621 | 2362 | 55019 | 1548 | 40147 |
| 16-#14 | 1.86 | MA | 30242 | 6432 | 45143 | 5326 | 54201 | 4306 | 58975 | 3541 | 64525 | 2370 | 80066 | 2072 | 49559 |
| 3L-7S | | MI | 23755 | 6432 | 36056 | 5315 | 42546 | 4306 | 45296 | 3537 | 47240 | 2354 | 58331 | 1624 | 41566 |
| 16-#14 | 1.86 | MA | 29112 | 6432 | 43615 | 5327 | 52135 | 4320 | 56471 | 3539 | 61145 | 2364 | 76253 | 1941 | 49291 |
| 4L-6S | | MI | 24624 | 6432 | 37263 | 5314 | 44144 | 4308 | 47248 | 3525 | 49955 | 2361 | 61527 | 1726 | 42633 |
| 16-#14 | 1.86 | MA | 28090 | 6432 | 42069 | 5344 | 50281 | 4320 | 54207 | 3552 | 58062 | 2374 | 72285 | 1873 | 48325 |
| 5E | | MI | 25511 | 6432 | 38503 | 5313 | 45798 | 4294 | 49261 | 3529 | 52633 | 2354 | 65121 | 1835 | 43712 |
| 16-#14 | 1.86 | MA | 27111 | 6432 | 40698 | 5346 | 48451 | 4335 | 51980 | 3550 | 55100 | 2383 | 68250 | 1765 | 47066 |
| 6L-4S | | MI | 26435 | 6432 | 39900 | 5297 | 47473 | 4295 | 51306 | 3517 | 55417 | 2346 | 68668 | 1901 | 44591 |
| 16-#14 | 1.86 | MA | 26152 | 6432 | 39362 | 5347 | 46684 | 4335 | 49820 | 3563 | 52096 | 2377 | 64657 | 1663 | 45866 |
| 7L-3S | | MI | 27457 | 6432 | 41279 | 5297 | 49339 | 4281 | 53566 | 3520 | 58468 | 2353 | 72059 | 2032 | 44815 |
| 16-#14 | 1.86 | MA | 25204 | 6432 | 38048 | 5349 | 44952 | 4335 | 47657 | 3561 | 49198 | 2387 | 60950 | 1585 | 44233 |
| 8L-2S | | MI | 28870 | 6432 | 43135 | 5296 | 51692 | 4282 | 56418 | 3508 | 62315 | 2345 | 77206 | 2164 | 44921 |
| 16-#18 | 3.31 | MA | 34660 | 7450 | 56274 | 5932 | 68058 | 4745 | 75649 | 3823 | 86944 | 2312 | 109541 | 1802 | 85878 |
| 3L-7S | | MI | 25217 | 7450 | 42113 | 5925 | 49849 | 4753 | 54002 | 3820 | 58718 | 2273 | 74394 | 1012 | 66331 |
| 16-#18 | 3.31 | MA | 32783 | 7450 | 53588 | 5934 | 64427 | 4769 | 71250 | 3817 | 81006 | 2299 | 102947 | 1568 | 83522 |
| 4L-6S | | MI | 26661 | 7450 | 44236 | 5925 | 52657 | 4758 | 57432 | 3801 | 63439 | 2286 | 79905 | 1195 | 69420 |
| 16-#18 | 3.31 | MA | 31086 | 7450 | 50871 | 5961 | 61166 | 4767 | 67269 | 3838 | 75587 | 2313 | 96046 | 1452 | 80460 |
| 5E | | MI | 28135 | 7450 | 46417 | 5925 | 55563 | 4735 | 60969 | 3809 | 68094 | 2273 | 86113 | 1388 | 72592 |
| 16-#18 | 3.31 | MA | 29460 | 7450 | 48457 | 5963 | 57948 | 4791 | 63351 | 3833 | 70375 | 2326 | 89055 | 1259 | 76952 |
| 6L-4S | | MI | 29672 | 7450 | 48869 | 5899 | 58506 | 4739 | 64561 | 3791 | 72935 | 2260 | 92266 | 1502 | 75207 |

## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

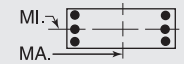
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 3.31 | MA | 27866 | 7450 | 46106 | 5964 | 54838 | 4789 | 59552 | 3853 | 65092 | 2314 | 82839 | 1077 | 73511 |
| 7L-3S | | MI | 31370 | 7450 | 51291 | 5899 | 61779 | 4717 | 68527 | 3799 | 78240 | 2273 | 98109 | 1736 | 77440 |
| 16-#18 | 3.31 | MA | 26289 | 7450 | 43793 | 5966 | 51790 | 4787 | 55746 | 3848 | 59994 | 2327 | 76395 | 941 | 69032 |
| 8L-2S | | MI | 33718 | 7450 | 54539 | 5900 | 65899 | 4721 | 73518 | 3781 | 84924 | 2260 | 107002 | 1969 | 77934 |
| 18-#11 | 1.45 | MA | 30175 | 6144 | 43528 | 5159 | 52285 | 4186 | 56711 | 3455 | 61510 | 2381 | 76218 | 2251 | 39150 |
| 2L-9S | | MI | 22571 | 6144 | 33139 | 5159 | 39023 | 4192 | 41076 | 3466 | 41621 | 2388 | 50795 | 1732 | 32628 |
| 18-#11 | 1.45 | MA | 29060 | 6144 | 42089 | 5160 | 50461 | 4186 | 54501 | 3464 | 58528 | 2388 | 72161 | 2160 | 39100 |
| 3L-8S | | MI | 23176 | 6144 | 34054 | 5148 | 40148 | 4182 | 42418 | 3457 | 43429 | 2382 | 53090 | 1791 | 33449 |
| 18-#11 | 1.45 | MA | 28257 | 6144 | 41024 | 5162 | 49020 | 4197 | 52755 | 3463 | 56171 | 2385 | 69480 | 2069 | 38997 |
| 4L-7S | | MI | 23785 | 6144 | 34883 | 5147 | 41239 | 4183 | 43781 | 3459 | 45256 | 2376 | 55415 | 1844 | 34017 |
| 18-#11 | 1.45 | MA | 27532 | 6144 | 39947 | 5174 | 47727 | 4197 | 51177 | 3473 | 54022 | 2392 | 66699 | 2022 | 38812 |
| 5L-6S | | MI | 24401 | 6144 | 35725 | 5146 | 42354 | 4183 | 45143 | 3450 | 47149 | 2381 | 57664 | 1915 | 34556 |
| 18-#11 | 1.45 | MA | 26837 | 6144 | 38991 | 5175 | 46452 | 4208 | 49624 | 3472 | 51957 | 2399 | 63865 | 1947 | 38125 |
| 6L-5S | | MI | 25030 | 6144 | 36590 | 5145 | 43507 | 4173 | 46547 | 3452 | 49017 | 2375 | 60192 | 1990 | 35167 |
| 18-#11 | 1.45 | MA | 26157 | 6144 | 38061 | 5177 | 45221 | 4208 | 48119 | 3481 | 49864 | 2396 | 61340 | 1876 | 37493 |
| 7L-4S | | MI | 25687 | 6144 | 37564 | 5134 | 44676 | 4174 | 47973 | 3443 | 50959 | 2369 | 62681 | 2037 | 35317 |
| 18-#11 | 1.45 | MA | 25485 | 6144 | 37145 | 5178 | 44014 | 4209 | 46612 | 3481 | 47844 | 2403 | 58742 | 1822 | 36844 |
| 8L-3S | | MI | 26412 | 6144 | 38526 | 5133 | 45977 | 4164 | 49551 | 3445 | 53088 | 2373 | 65068 | 2128 | 35398 |
| 18-#11 | 1.45 | MA | 24818 | 6144 | 36134 | 5190 | 42770 | 4219 | 45129 | 3490 | 45844 | 2410 | 56167 | 1763 | 35898 |
| 9L-2S | | MI | 27416 | 6144 | 39823 | 5132 | 47622 | 4164 | 51543 | 3436 | 55776 | 2367 | 68688 | 2219 | 35436 |
| 18-#14 | 2.10 | MA | 32768 | 6596 | 49263 | 5426 | 59427 | 4380 | 65306 | 3575 | 73066 | 2353 | 91624 | 2187 | 55773 |
| 2L-9S | | MI | 22971 | 6596 | 35410 | 5434 | 41721 | 4394 | 44267 | 3593 | 45874 | 2362 | 56905 | 1443 | 43859 |
| 18-#14 | 2.10 | MA | 31214 | 6596 | 47203 | 5428 | 56814 | 4380 | 62141 | 3588 | 68795 | 2362 | 85845 | 2055 | 55618 |
| 3L-8S | | MI | 23814 | 6596 | 36723 | 5418 | 43334 | 4380 | 46191 | 3581 | 48468 | 2355 | 60167 | 1528 | 45444 |
| 18-#14 | 2.10 | MA | 30096 | 6596 | 45675 | 5430 | 54748 | 4395 | 59636 | 3586 | 65415 | 2357 | 82032 | 1924 | 55320 |
| 4L-7S | | MI | 24663 | 6596 | 37911 | 5417 | 44900 | 4381 | 48147 | 3585 | 51087 | 2347 | 63479 | 1604 | 46825 |
| 18-#14 | 2.10 | MA | 29085 | 6596 | 44130 | 5446 | 52894 | 4395 | 57373 | 3599 | 62333 | 2366 | 78064 | 1856 | 54219 |
| 5L-6S | | MI | 25522 | 6596 | 39119 | 5416 | 46498 | 4382 | 50099 | 3573 | 53802 | 2354 | 66675 | 1706 | 47969 |
| 18-#14 | 2.10 | MA | 28117 | 6596 | 42758 | 5448 | 51064 | 4410 | 55145 | 3598 | 59370 | 2375 | 74029 | 1748 | 53002 |
| 6L-5S | | MI | 26399 | 6596 | 40359 | 5415 | 48151 | 4369 | 52112 | 3576 | 56480 | 2346 | 70269 | 1815 | 49010 |
| 18-#14 | 2.10 | MA | 27169 | 6596 | 41423 | 5450 | 49297 | 4410 | 52986 | 3611 | 56367 | 2370 | 70435 | 1646 | 51726 |
| 7L-4S | | MI | 27314 | 6596 | 41755 | 5400 | 49827 | 4370 | 54157 | 3564 | 59264 | 2338 | 73816 | 1881 | 50020 |
| 18-#14 | 2.10 | MA | 26232 | 6596 | 40108 | 5451 | 47565 | 4410 | 50823 | 3609 | 53469 | 2379 | 66729 | 1568 | 50134 |
| 8L-3S | | MI | 28325 | 6596 | 43135 | 5399 | 51692 | 4356 | 56418 | 3567 | 62315 | 2345 | 77206 | 2012 | 50273 |
| 18-#14 | 2.10 | MA | 25302 | 6596 | 38657 | 5468 | 45780 | 4424 | 48694 | 3622 | 50599 | 2389 | 63064 | 1484 | 48298 |
| 9L-2S | | MI | 29725 | 6596 | 44991 | 5398 | 54046 | 4357 | 59269 | 3556 | 66162 | 2338 | 82354 | 2143 | 50402 |
| 18-#18 | 3.73 | MA | 34402 | 7741 | 57199 | 6115 | 69008 | 4902 | 76799 | 3902 | 88492 | 2286 | 112960 | 1532 | 93779 |
| 4L-7S | | MI | 26730 | 7741 | 45361 | 6106 | 53968 | 4886 | 58992 | 3904 | 65402 | 2257 | 83287 | 970 | 75421 |
| 18-#18 | 3.73 | MA | 32732 | 7741 | 54482 | 6143 | 65747 | 4900 | 72818 | 3922 | 83073 | 2299 | 106059 | 1415 | 90834 |
| 5L-6S | | MI | 28151 | 7741 | 47484 | 6107 | 56776 | 4891 | 62423 | 3885 | 70123 | 2270 | 88799 | 1152 | 78592 |
| 18-#18 | 3.73 | MA | 31131 | 7741 | 52068 | 6145 | 62528 | 4924 | 68900 | 3917 | 77862 | 2313 | 99068 | 1223 | 87197 |
| 6L-5S | | MI | 29602 | 7741 | 49665 | 6107 | 59682 | 4868 | 65959 | 3893 | 74779 | 2257 | 95006 | 1346 | 81897 |
| 18-#18 | 3.73 | MA | 29563 | 7741 | 49718 | 6146 | 59418 | 4922 | 65101 | 3938 | 72579 | 2300 | 92852 | 1040 | 83680 |
| 7L-4S | | MI | 31116 | 7741 | 52117 | 6081 | 62625 | 4872 | 69551 | 3875 | 79620 | 2244 | 101159 | 1460 | 84404 |
| 18-#18 | 3.73 | MA | 28012 | 7741 | 47404 | 6148 | 56370 | 4920 | 61294 | 3932 | 67480 | 2314 | 86408 | 905 | 79302 |
| 8L-3S | | MI | 32789 | 7741 | 54539 | 6081 | 65899 | 4850 | 73518 | 3883 | 84924 | 2257 | 107002 | 1693 | 86927 |
| 20-#11 | 1.61 | MA | 30864 | 6258 | 44966 | 5230 | 54110 | 4238 | 58922 | 3488 | 64492 | 2376 | 80276 | 2241 | 43407 |
| 2L-10S | | MI | 22629 | 6258 | 33611 | 5231 | 39583 | 4244 | 41720 | 3497 | 42449 | 2379 | 52042 | 1639 | 35520 |
| 20-#11 | 1.61 | MA | 29757 | 6258 | 43528 | 5231 | 52285 | 4238 | 56711 | 3497 | 61510 | 2383 | 76218 | 2150 | 43344 |
| 3L-9S | | MI | 23226 | 6258 | 34436 | 5230 | 40667 | 4244 | 43068 | 3498 | 44309 | 2383 | 54415 | 1720 | 36342 |
| 20-#11 | 1.61 | MA | 28961 | 6258 | 42462 | 5233 | 50844 | 4249 | 54965 | 3496 | 59153 | 2380 | 73538 | 2059 | 43225 |
| 4L-8S | | MI | 23825 | 6258 | 35351 | 5219 | 41792 | 4234 | 44410 | 3490 | 46118 | 2377 | 56710 | 1778 | 37142 |
| 20-#11 | 1.61 | MA | 28242 | 6258 | 41385 | 5245 | 49552 | 4249 | 53387 | 3506 | 57004 | 2387 | 70756 | 2011 | 43023 |
| 5L-7S | | MI | 24429 | 6258 | 36180 | 5218 | 42884 | 4235 | 45774 | 3492 | 47944 | 2371 | 59035 | 1832 | 37761 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

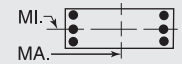


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.61 | MA | 27553 | 6258 | 40429 | 5246 | 48276 | 4260 | 51835 | 3505 | 54939 | 2394 | 67923 | 1936 | 42269 |
| 6E | | MI | 25040 | 6258 | 37022 | 5217 | 43998 | 4235 | 47135 | 3483 | 49837 | 2376 | 61284 | 1903 | 38285 |
| 20-#11 | 1.61 | MA | 26878 | 6258 | 39499 | 5248 | 47045 | 4260 | 50330 | 3514 | 52845 | 2391 | 65398 | 1866 | 41654 |
| 7L-5S | | MI | 25664 | 6258 | 37886 | 5216 | 45151 | 4225 | 48539 | 3485 | 51705 | 2370 | 63812 | 1978 | 38962 |
| 20-#11 | 1.61 | MA | 26212 | 6258 | 38583 | 5249 | 45838 | 4261 | 48822 | 3513 | 50826 | 2398 | 62799 | 1811 | 40955 |
| 8L-4S | | MI | 26315 | 6258 | 38860 | 5205 | 46320 | 4225 | 49965 | 3476 | 53647 | 2363 | 66301 | 2024 | 39129 |
| 20-#11 | 1.61 | MA | 25551 | 6258 | 37572 | 5261 | 44595 | 4271 | 47339 | 3523 | 48826 | 2405 | 60225 | 1753 | 40029 |
| 9L-3S | | MI | 27036 | 6258 | 39823 | 5204 | 47622 | 4216 | 51543 | 3478 | 55776 | 2368 | 68688 | 2115 | 39225 |
| 20-#11 | 1.61 | MA | 24880 | 6258 | 36660 | 5262 | 43397 | 4271 | 45849 | 3522 | 46770 | 2402 | 57564 | 1673 | 39098 |
| 10L-2S | | MI | 28033 | 6258 | 41120 | 5203 | 49266 | 4216 | 53535 | 3469 | 58464 | 2362 | 72308 | 2206 | 39275 |
| 20-#14 | 2.33 | MA | 32174 | 6759 | 49263 | 5530 | 59427 | 4455 | 65306 | 3636 | 73066 | 2355 | 91624 | 2038 | 61674 |
| 3L-9S | | MI | 23885 | 6759 | 37266 | 5536 | 44074 | 4469 | 47118 | 3641 | 49721 | 2355 | 62053 | 1423 | 49119 |
| 20-#14 | 2.33 | MA | 31067 | 6759 | 47735 | 5532 | 57361 | 4470 | 62802 | 3634 | 69686 | 2349 | 87810 | 1907 | 61349 |
| 4L-8S | | MI | 24719 | 6759 | 38578 | 5520 | 45688 | 4455 | 49043 | 3629 | 52315 | 2347 | 65315 | 1508 | 50749 |
| 20-#14 | 2.33 | MA | 30067 | 6759 | 46190 | 5548 | 55506 | 4470 | 60538 | 3647 | 66604 | 2359 | 83842 | 1839 | 60125 |
| 5L-7S | | MI | 25558 | 6759 | 39767 | 5519 | 47253 | 4456 | 50998 | 3632 | 54934 | 2339 | 68627 | 1584 | 52093 |
| 20-#14 | 2.33 | MA | 29110 | 6759 | 44818 | 5550 | 53677 | 4485 | 58311 | 3645 | 63641 | 2368 | 79807 | 1731 | 58946 |
| 6E | | MI | 26408 | 6759 | 40975 | 5518 | 48851 | 4457 | 52950 | 3620 | 57649 | 2346 | 71823 | 1686 | 53312 |
| 20-#14 | 2.33 | MA | 28172 | 6759 | 43483 | 5552 | 51909 | 4485 | 56152 | 3658 | 60638 | 2362 | 76214 | 1629 | 57597 |
| 7L-5S | | MI | 27276 | 6759 | 42215 | 5518 | 50505 | 4443 | 54964 | 3623 | 60327 | 2339 | 75417 | 1795 | 54319 |
| 20-#14 | 2.33 | MA | 27246 | 6759 | 42169 | 5554 | 50178 | 4484 | 53988 | 3656 | 57740 | 2372 | 72508 | 1551 | 56043 |
| 8L-4S | | MI | 28181 | 6759 | 43611 | 5502 | 52181 | 4445 | 57009 | 3612 | 63111 | 2331 | 78964 | 1860 | 55448 |
| 20-#14 | 2.33 | MA | 26326 | 6759 | 40717 | 5570 | 48393 | 4499 | 51860 | 3669 | 54870 | 2381 | 68843 | 1467 | 54166 |
| 9L-3S | | MI | 29182 | 6759 | 44991 | 5501 | 54046 | 4431 | 59269 | 3615 | 66162 | 2338 | 82354 | 1992 | 55726 |
| 20-#14 | 2.33 | MA | 25409 | 6759 | 39408 | 5572 | 46674 | 4499 | 49722 | 3667 | 51919 | 2376 | 65054 | 1351 | 52346 |
| 10L-2S | | MI | 30570 | 6759 | 46847 | 5500 | 56400 | 4432 | 62121 | 3603 | 70009 | 2330 | 87502 | 2123 | 55879 |
| 20-#18 | 4.14 | MA | 34351 | 8032 | 58093 | 6325 | 70327 | 5033 | 78367 | 4007 | 90560 | 2286 | 116072 | 1379 | 101223 |
| 5L-7S | | MI | 28217 | 8032 | 48609 | 6288 | 58087 | 5019 | 63983 | 3988 | 72087 | 2241 | 92180 | 928 | 84530 |
| 20-#18 | 4.14 | MA | 32775 | 8032 | 55679 | 6326 | 67108 | 5057 | 74449 | 4001 | 85348 | 2300 | 109082 | 1186 | 97461 |
| 6E | | MI | 29617 | 8032 | 50732 | 6288 | 60896 | 5024 | 67413 | 3970 | 76808 | 2254 | 97692 | 1110 | 87784 |
| 20-#18 | 4.14 | MA | 31231 | 8032 | 53329 | 6328 | 63998 | 5055 | 70650 | 4022 | 80065 | 2287 | 102865 | 1004 | 93867 |
| 7L-5S | | MI | 31047 | 8032 | 52913 | 6289 | 63801 | 5001 | 70950 | 3978 | 81464 | 2241 | 103899 | 1304 | 91217 |
| 20-#18 | 4.14 | MA | 29704 | 8032 | 51015 | 6329 | 60951 | 5053 | 66843 | 4016 | 74967 | 2301 | 96421 | 869 | 89586 |
| 8L-4S | | MI | 32539 | 8032 | 55365 | 6263 | 66745 | 5005 | 74542 | 3959 | 86305 | 2228 | 110052 | 1417 | 93626 |
| 22-#11 | 1.78 | MA | 31547 | 6371 | 46405 | 5301 | 55934 | 4290 | 61132 | 3521 | 67474 | 2371 | 84334 | 2230 | 47661 |
| 2L-11S | | MI | 22663 | 6371 | 34088 | 5303 | 40116 | 4306 | 42379 | 3538 | 43336 | 2380 | 53377 | 1570 | 38246 |
| 22-#11 | 1.78 | MA | 30447 | 6371 | 44966 | 5302 | 54110 | 4290 | 58922 | 3530 | 64492 | 2378 | 80276 | 2139 | 47585 |
| 3L-10S | | MI | 23281 | 6371 | 34907 | 5302 | 41228 | 4296 | 43713 | 3530 | 45137 | 2374 | 55662 | 1627 | 39206 |
| 22-#11 | 1.78 | MA | 29657 | 6371 | 43901 | 5304 | 52669 | 4301 | 57175 | 3529 | 62135 | 2375 | 77596 | 2048 | 47451 |
| 4L-9S | | MI | 23873 | 6371 | 35733 | 5301 | 42312 | 4296 | 45061 | 3531 | 46997 | 2378 | 58035 | 1707 | 40059 |
| 22-#11 | 1.78 | MA | 28944 | 6371 | 42824 | 5315 | 51376 | 4301 | 55597 | 3539 | 59986 | 2382 | 74814 | 2001 | 47234 |
| 5L-8S | | MI | 24468 | 6371 | 36648 | 5290 | 43437 | 4286 | 46402 | 3523 | 48806 | 2372 | 60330 | 1765 | 40842 |
| 22-#11 | 1.78 | MA | 28261 | 6371 | 41868 | 5317 | 50101 | 4312 | 54045 | 3538 | 57921 | 2389 | 71980 | 1926 | 46418 |
| 6L-7S | | MI | 25066 | 6371 | 37477 | 5289 | 44529 | 4287 | 47766 | 3524 | 50632 | 2366 | 62655 | 1819 | 41509 |
| 22-#11 | 1.78 | MA | 27592 | 6371 | 40938 | 5318 | 48869 | 4312 | 52540 | 3547 | 55827 | 2386 | 69455 | 1855 | 45817 |
| 7L-6S | | MI | 25672 | 6371 | 38318 | 5288 | 45643 | 4287 | 49127 | 3516 | 52525 | 2370 | 64904 | 1890 | 42020 |
| 22-#11 | 1.78 | MA | 26931 | 6371 | 40022 | 5320 | 47663 | 4312 | 51032 | 3546 | 53808 | 2393 | 66857 | 1800 | 45071 |
| 8L-5S | | MI | 26292 | 6371 | 39183 | 5287 | 46796 | 4277 | 50531 | 3517 | 54393 | 2364 | 67432 | 1965 | 42757 |
| 22-#11 | 1.78 | MA | 26275 | 6371 | 39011 | 5332 | 46419 | 4323 | 49549 | 3556 | 51808 | 2400 | 64283 | 1742 | 44165 |
| 9L-4S | | MI | 26938 | 6371 | 40157 | 5276 | 47965 | 4277 | 51958 | 3509 | 56335 | 2358 | 69921 | 2011 | 42938 |
| 22-#11 | 1.78 | MA | 25622 | 6371 | 38099 | 5333 | 45221 | 4323 | 48059 | 3555 | 49751 | 2397 | 61621 | 1662 | 43203 |
| 10L-3S | | MI | 27653 | 6371 | 41120 | 5275 | 49266 | 4267 | 53535 | 3510 | 58464 | 2363 | 72308 | 2102 | 43049 |
| 22-#11 | 1.78 | MA | 24916 | 6371 | 37193 | 5335 | 43992 | 4334 | 46585 | 3564 | 47760 | 2404 | 59068 | 1605 | 42101 |
| 11L-2S | | MI | 28643 | 6371 | 42417 | 5274 | 50911 | 4268 | 55528 | 3502 | 61152 | 2357 | 75928 | 2193 | 43111 |
| 22-#14 | 2.56 | MA | 32026 | 6923 | 49795 | 5634 | 59974 | 4545 | 65968 | 3681 | 73957 | 2342 | 93589 | 1890 | 67376 |
| 4L-9S | | MI | 24786 | 6923 | 39122 | 5638 | 46428 | 4543 | 49970 | 3688 | 53568 | 2347 | 67201 | 1403 | 54343 |
| 22-#14 | 2.56 | MA | 31037 | 6923 | 48250 | 5651 | 58119 | 4545 | 63704 | 3694 | 70875 | 2351 | 89621 | 1822 | 66041 |
| 5L-8S | | MI | 25611 | 6923 | 40434 | 5622 | 48041 | 4530 | 51894 | 3676 | 56162 | 2340 | 70462 | 1487 | 56061 |
| 22-#14 | 2.56 | MA | 30089 | 6923 | 46878 | 5652 | 56290 | 4559 | 61477 | 3692 | 67912 | 2361 | 85586 | 1714 | 64896 |
| 6L-7S | | MI | 26442 | 6923 | 41623 | 5622 | 49607 | 4531 | 53850 | 3679 | 58781 | 2332 | 73775 | 1564 | 57371 |

## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

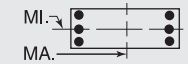
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 2.56 | MA | 29162 | 6923 | 45543 | 5654 | 54522 | 4559 | 59317 | 3705 | 64909 | 2355 | 81993 | 1612 | 63477 |
| 7L-6S | | MI | 27283 | 6923 | 42830 | 5621 | 51205 | 4532 | 55802 | 3668 | 61496 | 2339 | 76971 | 1666 | 58662 |
| 22-#14 | 2.56 | MA | 28246 | 6923 | 44229 | 5656 | 52791 | 4559 | 57154 | 3703 | 62011 | 2364 | 78286 | 1534 | 61958 |
| 8L-5S | | MI | 28142 | 6923 | 44071 | 5620 | 52859 | 4518 | 57815 | 3671 | 64174 | 2331 | 80565 | 1774 | 59637 |
| 22-#14 | 2.56 | MA | 27335 | 6923 | 42777 | 5672 | 51006 | 4574 | 55026 | 3716 | 59141 | 2374 | 74622 | 1450 | 60042 |
| 9L-4S | | MI | 29038 | 6923 | 45467 | 5604 | 54534 | 4519 | 59860 | 3659 | 66958 | 2323 | 84112 | 1840 | 60873 |
| 22-#14 | 2.56 | MA | 26428 | 6923 | 41468 | 5674 | 49287 | 4574 | 52887 | 3714 | 56190 | 2368 | 70833 | 1334 | 58192 |
| 10L-3S | | MI | 30030 | 6923 | 46847 | 5603 | 56400 | 4506 | 62121 | 3662 | 70009 | 2331 | 87502 | 1972 | 61176 |
| 22-#18 | 4.55 | MA | 34394 | 8322 | 59291 | 6508 | 71688 | 5190 | 79998 | 4085 | 92835 | 2287 | 119095 | 1150 | 107744 |
| 6L-7S | | MI | 29682 | 8322 | 51857 | 6470 | 62206 | 5152 | 68973 | 4072 | 78772 | 2225 | 101074 | 885 | 93657 |
| 22-#18 | 4.55 | MA | 32873 | 8322 | 56941 | 6510 | 68578 | 5188 | 76199 | 4106 | 87551 | 2274 | 112878 | 968 | 103940 |
| 7L-6S | | MI | 31062 | 8322 | 53980 | 6470 | 65015 | 5157 | 72403 | 4054 | 83493 | 2238 | 106585 | 1068 | 96995 |
| 22-#18 | 4.55 | MA | 31369 | 8322 | 54627 | 6511 | 65531 | 5186 | 72392 | 4100 | 82453 | 2288 | 106434 | 833 | 99885 |
| 8L-5S | | MI | 32471 | 8322 | 56161 | 6470 | 67921 | 5134 | 75940 | 4062 | 88148 | 2225 | 112792 | 1261 | 100550 |
| 24-#11 | 1.94 | MA | 31131 | 6485 | 46405 | 5373 | 55934 | 4342 | 61132 | 3563 | 67474 | 2373 | 84334 | 2128 | 51823 |
| 3L-11S | | MI | 23311 | 6485 | 35385 | 5374 | 41760 | 4358 | 44372 | 3571 | 46024 | 2375 | 56997 | 1558 | 41955 |
| 24-#11 | 1.94 | MA | 30347 | 6485 | 45339 | 5374 | 54493 | 4353 | 59385 | 3562 | 65117 | 2370 | 81653 | 2037 | 51676 |
| 4L-10S | | MI | 23926 | 6485 | 36204 | 5373 | 42872 | 4348 | 45705 | 3562 | 47825 | 2369 | 59282 | 1614 | 42897 |
| 24-#11 | 1.94 | MA | 29639 | 6485 | 44262 | 5386 | 53200 | 4353 | 57808 | 3571 | 62968 | 2377 | 78872 | 1990 | 51444 |
| 5L-9S | | MI | 24514 | 6485 | 37030 | 5372 | 43957 | 4348 | 47053 | 3564 | 49685 | 2373 | 61655 | 1694 | 43781 |
| 24-#11 | 1.94 | MA | 28961 | 6485 | 43306 | 5388 | 51925 | 4364 | 56255 | 3571 | 60903 | 2384 | 76038 | 1915 | 50572 |
| 6L-8S | | MI | 25103 | 6485 | 37945 | 5360 | 45081 | 4338 | 48395 | 3556 | 51494 | 2367 | 63949 | 1753 | 44546 |
| 24-#11 | 1.94 | MA | 28298 | 6485 | 42376 | 5389 | 50694 | 4364 | 54750 | 3580 | 58809 | 2381 | 73513 | 1844 | 49985 |
| 7E | | MI | 25697 | 6485 | 38773 | 5360 | 46173 | 4338 | 49759 | 3557 | 53320 | 2361 | 66274 | 1806 | 45260 |
| 24-#11 | 1.94 | MA | 27643 | 6485 | 41460 | 5391 | 49487 | 4364 | 53242 | 3579 | 56790 | 2388 | 70915 | 1790 | 49192 |
| 8L-6S | | MI | 26299 | 6485 | 39615 | 5359 | 47287 | 4339 | 51120 | 3549 | 55214 | 2365 | 68524 | 1877 | 45759 |
| 24-#11 | 1.94 | MA | 26992 | 6485 | 40449 | 5403 | 48243 | 4375 | 51759 | 3589 | 54790 | 2395 | 68340 | 1731 | 48305 |
| 9L-5S | | MI | 26913 | 6485 | 40480 | 5358 | 48441 | 4329 | 52524 | 3550 | 57081 | 2359 | 71051 | 1952 | 46543 |
| 24-#11 | 1.94 | MA | 26345 | 6485 | 39537 | 5404 | 47045 | 4375 | 50269 | 3588 | 52733 | 2391 | 65679 | 1651 | 47313 |
| 10L-4S | | MI | 27554 | 6485 | 41454 | 5346 | 49609 | 4329 | 53950 | 3542 | 59023 | 2353 | 73541 | 1998 | 46746 |
| 24-#11 | 1.94 | MA | 25642 | 6485 | 38632 | 5406 | 45816 | 4386 | 48795 | 3597 | 50742 | 2399 | 63125 | 1594 | 46229 |
| 11L-3S | | MI | 28264 | 6485 | 42417 | 5346 | 50911 | 4319 | 55528 | 3543 | 61152 | 2357 | 75928 | 2090 | 46870 |
| 24-#11 | 1.94 | MA | 24952 | 6485 | 37731 | 5407 | 44621 | 4386 | 47314 | 3596 | 48760 | 2406 | 60571 | 1536 | 44975 |
| 12L-2S | | MI | 29248 | 6485 | 43713 | 5345 | 52555 | 4320 | 57520 | 3535 | 63841 | 2351 | 79548 | 2181 | 46943 |
| 24-#14 | 2.80 | MA | 31995 | 7086 | 50310 | 5753 | 60732 | 4619 | 66870 | 3742 | 75146 | 2344 | 95400 | 1805 | 71966 |
| 5L-9S | | MI | 25676 | 7086 | 40978 | 5740 | 48781 | 4618 | 52821 | 3735 | 57415 | 2340 | 72349 | 1383 | 59620 |
| 24-#14 | 2.80 | MA | 31057 | 7086 | 48939 | 5755 | 58903 | 4634 | 64642 | 3740 | 72183 | 2353 | 91365 | 1697 | 70852 |
| 6L-8S | | MI | 26493 | 7086 | 42290 | 5725 | 50395 | 4605 | 54746 | 3724 | 60009 | 2332 | 75610 | 1467 | 61379 |
| 24-#14 | 2.80 | MA | 30140 | 7086 | 47603 | 5756 | 57135 | 4634 | 62483 | 3753 | 69179 | 2348 | 87771 | 1595 | 69365 |
| 7E | | MI | 27315 | 7086 | 43479 | 5724 | 51961 | 4606 | 56701 | 3727 | 62628 | 2324 | 78922 | 1543 | 62658 |
| 24-#14 | 2.80 | MA | 29233 | 7086 | 46289 | 5758 | 55404 | 4634 | 60319 | 3751 | 66281 | 2357 | 84065 | 1517 | 67880 |
| 8L-6S | | MI | 28147 | 7086 | 44686 | 5723 | 53558 | 4607 | 58653 | 3715 | 65343 | 2332 | 82118 | 1646 | 64016 |
| 24-#14 | 2.80 | MA | 28332 | 7086 | 44838 | 5775 | 53619 | 4649 | 58191 | 3764 | 63412 | 2366 | 80400 | 1433 | 65925 |
| 9L-5S | | MI | 28998 | 7086 | 45927 | 5722 | 55212 | 4593 | 60666 | 3718 | 68021 | 2324 | 85712 | 1754 | 64964 |
| 24-#14 | 2.80 | MA | 27434 | 7086 | 43529 | 5776 | 51900 | 4649 | 56053 | 3762 | 60461 | 2361 | 76612 | 1317 | 64045 |
| 10L-4S | | MI | 29885 | 7086 | 47323 | 5706 | 56888 | 4594 | 62712 | 3706 | 70805 | 2316 | 89259 | 1820 | 66298 |
| 24-#18 | 4.97 | MA | 34491 | 8613 | 60552 | 6691 | 73159 | 5321 | 81748 | 4190 | 95038 | 2261 | 122891 | 932 | 114166 |
| 7E | | MI | 31126 | 8613 | 55105 | 6652 | 66326 | 5285 | 73964 | 4156 | 85456 | 2209 | 109967 | 843 | 102694 |
| 24-#18 | 4.97 | MA | 33009 | 8613 | 58238 | 6693 | 70111 | 5319 | 77941 | 4185 | 89939 | 2274 | 116447 | 797 | 110174 |
| 8L-6S | | MI | 32487 | 8613 | 57228 | 6652 | 69134 | 5290 | 77394 | 4138 | 90177 | 2222 | 115478 | 1025 | 106223 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

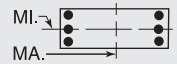



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.19 | MA | 31464 | 6219 | 44990 | 5231 | 53584 | 4254 | 57566 | 3527 | 61242 | 2477 | 74759 | 2333 | 34755 |
| 2L-3S | | MI | 24799 | 6219 | 36293 | 5184 | 42616 | 4211 | 45035 | 3513 | 46184 | 2457 | 55202 | 2048 | 29960 |
| 6-#18 | 1.19 | MA | 28491 | 6219 | 41197 | 5233 | 48773 | 4253 | 51738 | 3549 | 53379 | 2492 | 64185 | 2099 | 34620 |
| 3L-2S | | MI | 27339 | 6219 | 39541 | 5184 | 46735 | 4215 | 50026 | 3494 | 52868 | 2443 | 64095 | 2282 | 30023 |
| 8-#18 | 1.59 | MA | 33282 | 6510 | 48783 | 5413 | 58395 | 4387 | 63395 | 3611 | 69105 | 2463 | 85333 | 2299 | 45999 |
| 2L-4S | | MI | 24555 | 6510 | 37119 | 5365 | 43462 | 4367 | 46060 | 3589 | 47564 | 2427 | 58252 | 1772 | 38881 |
| 8-#18 | 1.59 | MA | 30359 | 6510 | 44990 | 5415 | 53584 | 4386 | 57566 | 3633 | 61242 | 2478 | 74759 | 2066 | 45757 |
| 3E | | MI | 26375 | 6510 | 39541 | 5366 | 46735 | 4344 | 50026 | 3597 | 52868 | 2441 | 64095 | 2006 | 39505 |
| 8-#18 | 1.59 | MA | 28244 | 6510 | 42173 | 5417 | 49775 | 4411 | 52950 | 3628 | 55012 | 2467 | 67789 | 1832 | 44921 |
| 4L-2S | | MI | 28873 | 6510 | 42789 | 5366 | 50854 | 4348 | 55016 | 3579 | 59553 | 2427 | 72988 | 2239 | 39670 |
| 10-#14 | 1.12 | MA | 31249 | 6164 | 44136 | 5226 | 52773 | 4253 | 56704 | 3532 | 60160 | 2495 | 73684 | 2370 | 32907 |
| 2L-5S | | MI | 23701 | 6164 | 34166 | 5201 | 40166 | 4230 | 42168 | 3522 | 42463 | 2480 | 51244 | 1997 | 28072 |
| 10-#14 | 1.12 | MA | 29547 | 6164 | 41973 | 5228 | 50031 | 4253 | 53381 | 3545 | 55677 | 2505 | 67589 | 2239 | 32866 |
| 3L-4S | | MI | 24661 | 6164 | 35562 | 5185 | 41841 | 4231 | 44213 | 3511 | 45247 | 2473 | 54791 | 2062 | 28344 |
| 10-#14 | 1.12 | MA | 28318 | 6164 | 40371 | 5230 | 47864 | 4269 | 50755 | 3544 | 52132 | 2500 | 63564 | 2107 | 32705 |
| 4L-3S | | MI | 25719 | 6164 | 36942 | 5185 | 43707 | 4217 | 46473 | 3514 | 48298 | 2480 | 58182 | 2194 | 28447 |
| 10-#14 | 1.12 | MA | 27206 | 6164 | 38751 | 5247 | 45921 | 4269 | 48382 | 3557 | 48901 | 2510 | 59385 | 2039 | 32320 |
| 5L-2S | | MI | 27177 | 6164 | 38798 | 5184 | 46060 | 4218 | 49325 | 3502 | 52145 | 2472 | 63330 | 2325 | 28459 |
| 10-#18 | 1.98 | MA | 35056 | 6800 | 52577 | 5594 | 63205 | 4520 | 69223 | 3695 | 76969 | 2450 | 95906 | 2266 | 57214 |
| 2L-5S | | MI | 24501 | 6800 | 37914 | 5573 | 44638 | 4495 | 47458 | 3692 | 49408 | 2425 | 60992 | 1616 | 45097 |
| 10-#18 | 1.98 | MA | 32180 | 6800 | 48783 | 5596 | 58395 | 4519 | 63395 | 3717 | 69105 | 2465 | 85333 | 2032 | 56878 |
| 3L-4S | | MI | 26123 | 6800 | 40367 | 5547 | 47581 | 4500 | 51050 | 3673 | 54249 | 2411 | 67145 | 1729 | 48171 |
| 10-#18 | 1.98 | MA | 30103 | 6800 | 45966 | 5599 | 54586 | 4544 | 58779 | 3713 | 62875 | 2454 | 78363 | 1799 | 55926 |
| 4L-3S | | MI | 27912 | 6800 | 42789 | 5547 | 50854 | 4477 | 55016 | 3681 | 59553 | 2425 | 72988 | 1963 | 49028 |
| 10-#18 | 1.98 | MA | 28223 | 6800 | 43116 | 5627 | 51166 | 4543 | 54604 | 3735 | 57191 | 2469 | 71088 | 1681 | 52127 |
| 5L-2S | | MI | 30372 | 6800 | 46037 | 5548 | 54973 | 4481 | 60007 | 3663 | 66238 | 2411 | 81882 | 2197 | 49280 |
| 12-#14 | 1.34 | MA | 32307 | 6328 | 46298 | 5328 | 55516 | 4328 | 60026 | 3579 | 64642 | 2487 | 79778 | 2354 | 39320 |
| 2L-6S | | MI | 23723 | 6328 | 34781 | 5304 | 40866 | 4318 | 43006 | 3567 | 43632 | 2481 | 52798 | 1868 | 32177 |
| 12-#14 | 1.34 | MA | 30622 | 6328 | 44136 | 5330 | 52773 | 4328 | 56704 | 3593 | 60160 | 2497 | 73684 | 2223 | 39248 |
| 3L-5S | | MI | 24633 | 6328 | 36022 | 5303 | 42519 | 4304 | 45019 | 3570 | 46310 | 2473 | 56392 | 1976 | 33365 |
| 12-#14 | 1.34 | MA | 29407 | 6328 | 42534 | 5333 | 50607 | 4343 | 54078 | 3591 | 56615 | 2493 | 69658 | 2091 | 39047 |
| 4E | | MI | 25582 | 6328 | 37418 | 5288 | 44195 | 4306 | 47064 | 3558 | 49094 | 2465 | 59939 | 2042 | 33790 |
| 12-#14 | 1.34 | MA | 28308 | 6328 | 40914 | 5350 | 48663 | 4344 | 51705 | 3605 | 53384 | 2503 | 65480 | 2023 | 38521 |
| 5L-3S | | MI | 26629 | 6328 | 38798 | 5287 | 46060 | 4292 | 49325 | 3561 | 52145 | 2472 | 63330 | 2174 | 33930 |
| 12-#14 | 1.34 | MA | 27255 | 6328 | 39476 | 5352 | 46746 | 4359 | 49370 | 3603 | 50279 | 2513 | 61224 | 1915 | 37048 |
| 6L-2S | | MI | 28072 | 6328 | 40654 | 5286 | 48414 | 4293 | 52176 | 3549 | 55992 | 2465 | 68477 | 2305 | 33974 |
| 12-#18 | 2.38 | MA | 36792 | 7091 | 56370 | 5776 | 68016 | 4653 | 75051 | 3780 | 84832 | 2437 | 106480 | 2233 | 68408 |
| 2L-6S | | MI | 24531 | 7091 | 38982 | 5755 | 45851 | 4651 | 48912 | 3768 | 51437 | 2422 | 63678 | 1380 | 51638 |
| 12-#18 | 2.38 | MA | 33960 | 7091 | 52577 | 5778 | 63205 | 4652 | 69223 | 3802 | 76969 | 2452 | 95906 | 1999 | 67990 |
| 3L-5S | | MI | 26061 | 7091 | 41162 | 5755 | 48757 | 4628 | 52449 | 3776 | 56092 | 2409 | 69885 | 1573 | 54333 |
| 12-#18 | 2.38 | MA | 31919 | 7091 | 49759 | 5780 | 59397 | 4677 | 64607 | 3797 | 70738 | 2440 | 88936 | 1765 | 66601 |
| 4E | | MI | 27656 | 7091 | 43615 | 5729 | 51700 | 4633 | 56040 | 3757 | 60933 | 2396 | 76038 | 1687 | 57255 |
| 12-#18 | 2.38 | MA | 30072 | 7091 | 46909 | 5809 | 55977 | 4676 | 60432 | 3819 | 65055 | 2456 | 81662 | 1647 | 62966 |
| 5L-3S | | MI | 29415 | 7091 | 46037 | 5729 | 54973 | 4610 | 60007 | 3766 | 66238 | 2409 | 81882 | 1921 | 58538 |
| 12-#18 | 2.38 | MA | 28300 | 7091 | 44378 | 5811 | 52601 | 4701 | 56324 | 3814 | 59590 | 2471 | 74279 | 1454 | 59781 |
| 6L-2S | | MI | 31839 | 7091 | 49284 | 5729 | 59092 | 4614 | 64997 | 3747 | 72922 | 2396 | 90775 | 2154 | 58867 |
| 14-#11 | 1.08 | MA | 31158 | 6140 | 43742 | 5226 | 52413 | 4254 | 56327 | 3535 | 59694 | 2504 | 73235 | 2388 | 32097 |
| 2L-7S | | MI | 23409 | 6140 | 33514 | 5201 | 39377 | 4240 | 41258 | 3530 | 41253 | 2492 | 49745 | 1971 | 26680 |
| 14-#11 | 1.08 | MA | 29967 | 6140 | 42233 | 5228 | 50499 | 4255 | 54008 | 3545 | 56565 | 2511 | 68959 | 2296 | 32075 |
| 3L-6S | | MI | 24037 | 6140 | 34355 | 5200 | 40491 | 4240 | 42619 | 3521 | 43146 | 2496 | 51994 | 2042 | 27260 |
| 14-#11 | 1.08 | MA | 29110 | 6140 | 41116 | 5229 | 48988 | 4266 | 52177 | 3544 | 54093 | 2509 | 66131 | 2205 | 32007 |
| 4L-5S | | MI | 24679 | 6140 | 35220 | 5199 | 41645 | 4230 | 44023 | 3523 | 45014 | 2490 | 54522 | 2117 | 27630 |
| 14-#11 | 1.08 | MA | 28335 | 6140 | 39987 | 5241 | 47634 | 4266 | 50524 | 3554 | 51841 | 2516 | 63204 | 2158 | 31860 |
| 5L-4S | | MI | 25348 | 6140 | 36194 | 5187 | 42813 | 4231 | 45450 | 3514 | 46956 | 2484 | 57011 | 2164 | 27729 |
| 14-#11 | 1.08 | MA | 27593 | 6140 | 38986 | 5243 | 46297 | 4277 | 48897 | 3554 | 49677 | 2524 | 60217 | 2083 | 31389 |
| 6L-3S | | MI | 26088 | 6140 | 37157 | 5187 | 44115 | 4221 | 47027 | 3516 | 49085 | 2488 | 59398 | 2255 | 27769 |

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

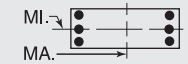



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.08 | MA | 26866 | 6140 | 38011 | 5245 | 45007 | 4278 | 47320 | 3563 | 47484 | 2521 | 57554 | 2012 | 30663 |
| 7L-2S | | MI | 27108 | 6140 | 38454 | 5186 | 45760 | 4221 | 49020 | 3507 | 51773 | 2482 | 63018 | 2346 | 27774 |
| 14-#14 | 1.56 | MA | 33349 | 6491 | 48461 | 5431 | 58259 | 4403 | 63349 | 3627 | 69125 | 2480 | 85873 | 2339 | 45723 |
| 2L-7S | | MI | 23770 | 6491 | 35430 | 5407 | 41621 | 4392 | 43905 | 3626 | 44765 | 2466 | 54750 | 1745 | 36637 |
| 14-#14 | 1.56 | MA | 31680 | 6491 | 46298 | 5433 | 55516 | 4403 | 60026 | 3640 | 64642 | 2490 | 79778 | 2207 | 45622 |
| 3L-6S | | MI | 24651 | 6491 | 36637 | 5406 | 43219 | 4393 | 45857 | 3614 | 47479 | 2473 | 57946 | 1848 | 37492 |
| 14-#14 | 1.56 | MA | 30478 | 6491 | 44696 | 5435 | 53349 | 4418 | 57400 | 3639 | 61098 | 2485 | 75753 | 2076 | 45385 |
| 4L-5S | | MI | 25551 | 6491 | 37878 | 5406 | 44873 | 4379 | 47870 | 3617 | 50157 | 2466 | 61540 | 1956 | 38631 |
| 14-#14 | 1.56 | MA | 29392 | 6491 | 43076 | 5452 | 51406 | 4419 | 55028 | 3652 | 57867 | 2495 | 71574 | 2008 | 44682 |
| 5L-4S | | MI | 26489 | 6491 | 39274 | 5390 | 46549 | 4380 | 49916 | 3605 | 52941 | 2458 | 65087 | 2022 | 39230 |
| 14-#14 | 1.56 | MA | 28351 | 6491 | 41639 | 5454 | 49488 | 4434 | 52693 | 3651 | 54761 | 2505 | 67318 | 1900 | 43263 |
| 6L-3S | | MI | 27525 | 6491 | 40654 | 5389 | 48414 | 4367 | 52176 | 3609 | 55992 | 2465 | 68477 | 2153 | 39404 |
| 14-#14 | 1.56 | MA | 27332 | 6491 | 40240 | 5456 | 47636 | 4434 | 50430 | 3664 | 51613 | 2500 | 63526 | 1798 | 42223 |
| 7L-2S | | MI | 28954 | 6491 | 42509 | 5388 | 50768 | 4368 | 55028 | 3597 | 59839 | 2457 | 73625 | 2285 | 39474 |
| 14-#18 | 2.78 | MA | 38495 | 7382 | 60163 | 5958 | 72827 | 4786 | 80879 | 3864 | 92695 | 2424 | 117054 | 2199 | 79589 |
| 2L-7S | | MI | 24609 | 7382 | 40107 | 5936 | 47162 | 4779 | 50472 | 3870 | 53400 | 2393 | 67060 | 1155 | 57836 |
| 14-#18 | 2.78 | MA | 35704 | 7382 | 56370 | 5960 | 68016 | 4785 | 75051 | 3886 | 84832 | 2439 | 106480 | 1966 | 79096 |
| 3L-6S | | MI | 26083 | 7382 | 42230 | 5937 | 49970 | 4784 | 53902 | 3852 | 58121 | 2406 | 72571 | 1338 | 60754 |
| 14-#18 | 2.78 | MA | 33696 | 7382 | 53553 | 5962 | 64207 | 4810 | 70435 | 3881 | 78601 | 2427 | 99510 | 1732 | 77317 |
| 4L-5S | | MI | 27589 | 7382 | 44410 | 5937 | 52876 | 4761 | 57439 | 3860 | 62777 | 2393 | 78779 | 1531 | 63595 |
| 14-#18 | 2.78 | MA | 31880 | 7382 | 50703 | 5991 | 60787 | 4809 | 66260 | 3903 | 72918 | 2442 | 92235 | 1614 | 73831 |
| 5L-4S | | MI | 29157 | 7382 | 46863 | 5911 | 55819 | 4765 | 61031 | 3842 | 67618 | 2380 | 84932 | 1645 | 66380 |
| 14-#18 | 2.78 | MA | 30139 | 7382 | 48172 | 5993 | 57412 | 4834 | 62152 | 3898 | 67453 | 2457 | 84853 | 1421 | 70510 |
| 6L-3S | | MI | 30889 | 7382 | 49284 | 5911 | 59092 | 4743 | 64997 | 3850 | 72922 | 2393 | 90775 | 1878 | 68040 |
| 14-#18 | 2.78 | MA | 28433 | 7382 | 45708 | 5995 | 54152 | 4833 | 58168 | 3920 | 61912 | 2446 | 78284 | 1239 | 66919 |
| 7L-2S | | MI | 33279 | 7382 | 52532 | 5911 | 63212 | 4747 | 69988 | 3831 | 79607 | 2380 | 99668 | 2112 | 68439 |
| 16-#11 | 1.24 | MA | 31903 | 6254 | 45252 | 5297 | 54327 | 4306 | 58646 | 3568 | 62822 | 2499 | 77512 | 2378 | 36574 |
| 2L-8S | | MI | 23454 | 6254 | 33982 | 5272 | 39930 | 4291 | 41887 | 3561 | 42115 | 2493 | 51040 | 1905 | 29974 |
| 16-#11 | 1.24 | MA | 30721 | 6254 | 43742 | 5299 | 52413 | 4307 | 56327 | 3578 | 59694 | 2506 | 73235 | 2287 | 36538 |
| 3L-7S | | MI | 24070 | 6254 | 34810 | 5271 | 41022 | 4292 | 43250 | 3562 | 43941 | 2487 | 53365 | 1959 | 30414 |
| 16-#11 | 1.24 | MA | 29871 | 6254 | 42625 | 5300 | 50902 | 4318 | 54496 | 3577 | 57222 | 2503 | 70408 | 2196 | 36451 |
| 4L-6S | | MI | 24693 | 6254 | 35652 | 5271 | 42136 | 4292 | 44612 | 3554 | 45834 | 2491 | 55614 | 2029 | 30974 |
| 16-#11 | 1.24 | MA | 29102 | 6254 | 41497 | 5312 | 49548 | 4318 | 52843 | 3587 | 54970 | 2511 | 67481 | 2148 | 36284 |
| 5E | | MI | 25329 | 6254 | 36517 | 5270 | 43289 | 4282 | 46016 | 3555 | 47702 | 2485 | 58142 | 2105 | 31433 |
| 16-#11 | 1.24 | MA | 28366 | 6254 | 40495 | 5314 | 48212 | 4329 | 51216 | 3587 | 52806 | 2518 | 64494 | 2073 | 35724 |
| 6L-4S | | MI | 25993 | 6254 | 37491 | 5258 | 44458 | 4283 | 47442 | 3547 | 49644 | 2479 | 60631 | 2151 | 31551 |
| 16-#11 | 1.24 | MA | 27646 | 6254 | 39521 | 5316 | 46921 | 4330 | 49639 | 3596 | 50613 | 2516 | 61831 | 2002 | 35021 |
| 7L-3S | | MI | 26727 | 6254 | 38454 | 5257 | 45760 | 4273 | 49020 | 3548 | 51773 | 2483 | 63018 | 2242 | 31608 |
| 16-#11 | 1.24 | MA | 26934 | 6254 | 38562 | 5318 | 45657 | 4330 | 48060 | 3596 | 48496 | 2523 | 59096 | 1947 | 34461 |
| 8L-2S | | MI | 27740 | 6254 | 39750 | 5256 | 47404 | 4273 | 51012 | 3540 | 54462 | 2477 | 66638 | 2333 | 31628 |
| 16-#14 | 1.79 | MA | 34375 | 6655 | 50623 | 5533 | 61001 | 4477 | 66671 | 3674 | 73608 | 2472 | 91967 | 2323 | 52118 |
| 2L-8S | | MI | 23832 | 6655 | 36097 | 5510 | 42409 | 4465 | 44801 | 3670 | 45992 | 2467 | 56585 | 1649 | 40439 |
| 16-#14 | 1.79 | MA | 32723 | 6655 | 48461 | 5535 | 58259 | 4478 | 63349 | 3687 | 69125 | 2483 | 85873 | 2192 | 51989 |
| 3L-7S | | MI | 24693 | 6655 | 37285 | 5510 | 43975 | 4467 | 46757 | 3673 | 48612 | 2459 | 59898 | 1725 | 41879 |
| 16-#14 | 1.79 | MA | 31534 | 6655 | 46859 | 5537 | 56092 | 4493 | 60723 | 3686 | 65581 | 2478 | 81847 | 2060 | 51721 |
| 4L-6S | | MI | 25565 | 6655 | 38493 | 5509 | 45573 | 4468 | 48709 | 3662 | 51326 | 2466 | 63094 | 1828 | 42818 |
| 16-#14 | 1.79 | MA | 30460 | 6655 | 45239 | 5554 | 54148 | 4493 | 58350 | 3700 | 62350 | 2488 | 77669 | 1992 | 50858 |
| 5E | | MI | 26455 | 6655 | 39733 | 5508 | 47227 | 4454 | 50722 | 3665 | 54004 | 2458 | 66688 | 1936 | 43912 |
| 16-#14 | 1.79 | MA | 29431 | 6655 | 43801 | 5556 | 52231 | 4509 | 56016 | 3698 | 59244 | 2498 | 73413 | 1884 | 49489 |
| 6L-4S | | MI | 27383 | 6655 | 41130 | 5492 | 48902 | 4455 | 52767 | 3653 | 56788 | 2450 | 70235 | 2002 | 44666 |
| 16-#14 | 1.79 | MA | 28423 | 6655 | 42402 | 5558 | 50379 | 4509 | 53753 | 3712 | 56096 | 2493 | 69621 | 1782 | 48370 |
| 7L-3S | | MI | 28408 | 6655 | 42509 | 5491 | 50768 | 4441 | 55028 | 3656 | 59839 | 2457 | 73625 | 2133 | 44870 |
| 16-#14 | 1.79 | MA | 27427 | 6655 | 41025 | 5560 | 48564 | 4509 | 51485 | 3710 | 53059 | 2503 | 65717 | 1704 | 46603 |
| 8L-2S | | MI | 29825 | 6655 | 44365 | 5490 | 53121 | 4443 | 57879 | 3644 | 63686 | 2450 | 78773 | 2265 | 44965 |
| 16-#18 | 3.17 | MA | 37416 | 7673 | 60163 | 6142 | 72827 | 4918 | 80879 | 3970 | 92695 | 2425 | 117054 | 1932 | 90198 |
| 3L-7S | | MI | 26154 | 7673 | 43355 | 6118 | 51281 | 4912 | 55462 | 3955 | 60085 | 2377 | 75953 | 1113 | 66986 |
| 16-#18 | 3.17 | MA | 35439 | 7673 | 57346 | 6144 | 69018 | 4943 | 76263 | 3965 | 86465 | 2414 | 110084 | 1698 | 88067 |
| 4L-6S | | MI | 27605 | 7673 | 45478 | 6118 | 54090 | 4917 | 58893 | 3936 | 64806 | 2390 | 81464 | 1295 | 69895 |
| 16-#18 | 3.17 | MA | 33653 | 7673 | 54496 | 6173 | 65598 | 4942 | 72089 | 3987 | 80781 | 2429 | 102809 | 1580 | 84717 |
| 5E | | MI | 29087 | 7673 | 47658 | 6119 | 56995 | 4894 | 62430 | 3944 | 69462 | 2377 | 87672 | 1489 | 72877 |

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

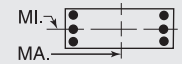
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 3.17 | MA | 31941 | 7673 | 51965 | 6175 | 62223 | 4967 | 67980 | 3983 | 75316 | 2444 | 95426 | 1388 | 81262 |
| 6L-4S | | MI | 30631 | 7673 | 50111 | 6092 | 59939 | 4898 | 66021 | 3926 | 74302 | 2364 | 93825 | 1602 | 75541 |
| 16-#18 | 3.17 | MA | 30263 | 7673 | 49501 | 6177 | 58962 | 4966 | 63996 | 4005 | 69776 | 2433 | 88857 | 1206 | 77772 |
| 7L-3S | | MI | 32337 | 7673 | 52532 | 6093 | 63212 | 4876 | 69988 | 3934 | 79607 | 2377 | 99668 | 1836 | 77535 |
| 16-#18 | 3.17 | MA | 28604 | 7673 | 47076 | 6179 | 55767 | 4964 | 60005 | 4000 | 64430 | 2448 | 82063 | 1069 | 73002 |
| 8L-2S | | MI | 34696 | 7673 | 55780 | 6093 | 67331 | 4880 | 74978 | 3916 | 86292 | 2364 | 108561 | 2070 | 77999 |
| 18-#11 | 1.39 | MA | 32640 | 6367 | 46761 | 5368 | 56241 | 4358 | 60965 | 3601 | 65951 | 2494 | 81789 | 2368 | 41046 |
| 2L-9S | | MI | 23507 | 6367 | 34363 | 5355 | 40450 | 4353 | 42537 | 3602 | 42994 | 2493 | 52365 | 1834 | 32845 |
| 18-#11 | 1.39 | MA | 31466 | 6367 | 45252 | 5369 | 54327 | 4359 | 58646 | 3611 | 62822 | 2501 | 77512 | 2277 | 40996 |
| 3L-8S | | MI | 24113 | 6367 | 35279 | 5343 | 41575 | 4343 | 43879 | 3594 | 44803 | 2487 | 54660 | 1892 | 33676 |
| 18-#11 | 1.39 | MA | 30623 | 6367 | 44135 | 5371 | 52817 | 4370 | 56816 | 3610 | 60351 | 2498 | 74685 | 2186 | 40893 |
| 4L-7S | | MI | 24723 | 6367 | 36107 | 5342 | 42666 | 4344 | 45243 | 3595 | 46629 | 2481 | 56985 | 1946 | 34154 |
| 18-#11 | 1.39 | MA | 29861 | 6367 | 43006 | 5383 | 51462 | 4370 | 55162 | 3620 | 58099 | 2506 | 71757 | 2138 | 40707 |
| 5L-6S | | MI | 25341 | 6367 | 36949 | 5341 | 43781 | 4344 | 46604 | 3587 | 48523 | 2486 | 59234 | 2017 | 34696 |
| 18-#11 | 1.39 | MA | 29131 | 6367 | 42005 | 5385 | 50126 | 4381 | 53535 | 3619 | 55935 | 2513 | 68770 | 2063 | 40067 |
| 6L-5S | | MI | 25972 | 6367 | 37814 | 5340 | 44934 | 4334 | 48008 | 3588 | 50390 | 2480 | 61762 | 2092 | 35234 |
| 18-#11 | 1.39 | MA | 28417 | 6367 | 41030 | 5387 | 48836 | 4382 | 51958 | 3629 | 53741 | 2511 | 66107 | 1993 | 39384 |
| 7L-4S | | MI | 26631 | 6367 | 38788 | 5329 | 46103 | 4334 | 49434 | 3580 | 52332 | 2474 | 64251 | 2138 | 35369 |
| 18-#11 | 1.39 | MA | 27711 | 6367 | 40071 | 5388 | 47571 | 4382 | 50379 | 3629 | 51625 | 2518 | 63372 | 1938 | 38798 |
| 8L-3S | | MI | 27359 | 6367 | 39750 | 5328 | 47404 | 4324 | 51012 | 3581 | 54462 | 2478 | 66638 | 2229 | 35441 |
| 18-#11 | 1.39 | MA | 27010 | 6367 | 39011 | 5401 | 46269 | 4393 | 48825 | 3638 | 49530 | 2526 | 60658 | 1879 | 37776 |
| 9L-2S | | MI | 28366 | 6367 | 41047 | 5327 | 49049 | 4325 | 53004 | 3573 | 57150 | 2472 | 70258 | 2320 | 35473 |
| 18-#14 | 2.01 | MA | 35389 | 6819 | 52786 | 5635 | 63744 | 4552 | 69994 | 3721 | 78091 | 2465 | 98061 | 2307 | 58507 |
| 2L-9S | | MI | 23905 | 6819 | 36640 | 5628 | 43149 | 4554 | 45728 | 3729 | 47245 | 2467 | 58472 | 1544 | 44258 |
| 18-#14 | 2.01 | MA | 33751 | 6819 | 50623 | 5637 | 61001 | 4553 | 66671 | 3735 | 73608 | 2475 | 91967 | 2176 | 58352 |
| 3L-8S | | MI | 24751 | 6819 | 37953 | 5613 | 44763 | 4540 | 47652 | 3718 | 49839 | 2459 | 61733 | 1629 | 45733 |
| 18-#14 | 2.01 | MA | 32575 | 6819 | 49021 | 5639 | 58835 | 4568 | 64046 | 3733 | 70063 | 2470 | 87942 | 2045 | 58054 |
| 4L-7S | | MI | 25603 | 6819 | 39141 | 5612 | 46329 | 4541 | 49608 | 3721 | 52459 | 2451 | 65045 | 1705 | 47133 |
| 18-#14 | 2.01 | MA | 31513 | 6819 | 47401 | 5656 | 56891 | 4568 | 61673 | 3747 | 66833 | 2480 | 83763 | 1977 | 57049 |
| 5L-6S | | MI | 26465 | 6819 | 40349 | 5611 | 47926 | 4543 | 51560 | 3709 | 55173 | 2458 | 68241 | 1807 | 48153 |
| 18-#14 | 2.01 | MA | 30495 | 6819 | 45964 | 5658 | 54973 | 4584 | 59338 | 3746 | 63727 | 2490 | 79507 | 1868 | 55724 |
| 6L-5S | | MI | 27346 | 6819 | 41589 | 5610 | 49580 | 4529 | 53573 | 3712 | 57851 | 2451 | 71835 | 1916 | 49207 |
| 18-#14 | 2.01 | MA | 29499 | 6819 | 44565 | 5660 | 53121 | 4584 | 57075 | 3759 | 60579 | 2486 | 75715 | 1766 | 54527 |
| 7L-4S | | MI | 28264 | 6819 | 42985 | 5594 | 51256 | 4530 | 55618 | 3700 | 60635 | 2443 | 75382 | 1982 | 50098 |
| 18-#14 | 2.01 | MA | 28514 | 6819 | 43188 | 5662 | 51307 | 4584 | 54808 | 3758 | 57542 | 2496 | 71812 | 1688 | 52803 |
| 8L-3S | | MI | 29279 | 6819 | 44365 | 5593 | 53121 | 4516 | 57879 | 3703 | 63686 | 2450 | 78773 | 2113 | 50331 |
| 18-#14 | 2.01 | MA | 27536 | 6819 | 41667 | 5679 | 49437 | 4599 | 52578 | 3771 | 54535 | 2506 | 67945 | 1604 | 51052 |
| 9L-2S | | MI | 30684 | 6819 | 46221 | 5593 | 55475 | 4517 | 60730 | 3692 | 67533 | 2442 | 83921 | 2245 | 50450 |
| 18-#18 | 3.57 | MA | 37153 | 7963 | 61139 | 6326 | 73829 | 5076 | 82091 | 4050 | 94328 | 2401 | 120657 | 1665 | 98848 |
| 4L-7S | | MI | 27671 | 7963 | 46603 | 6300 | 55400 | 5045 | 60453 | 4039 | 66770 | 2361 | 84846 | 1070 | 76067 |
| 18-#18 | 3.57 | MA | 35394 | 7963 | 58289 | 6354 | 70409 | 5075 | 77917 | 4072 | 88644 | 2416 | 113383 | 1547 | 95621 |
| 5L-6S | | MI | 29100 | 7963 | 48726 | 6300 | 58209 | 5050 | 63883 | 4020 | 71491 | 2374 | 90358 | 1253 | 79060 |
| 18-#18 | 3.57 | MA | 33709 | 7963 | 55758 | 6356 | 67033 | 5100 | 73808 | 4067 | 83179 | 2431 | 106000 | 1354 | 92036 |
| 6L-5S | | MI | 30559 | 7963 | 50906 | 6300 | 61115 | 5027 | 67420 | 4029 | 76146 | 2361 | 96565 | 1446 | 82178 |
| 18-#18 | 3.57 | MA | 32058 | 7963 | 53294 | 6359 | 63773 | 5099 | 69825 | 4089 | 77639 | 2419 | 99431 | 1172 | 88552 |
| 7L-4S | | MI | 32081 | 7963 | 53358 | 6274 | 64058 | 5031 | 71012 | 4010 | 80987 | 2348 | 102718 | 1560 | 84731 |
| 18-#18 | 3.57 | MA | 30426 | 7963 | 50869 | 6361 | 60578 | 5097 | 65833 | 4084 | 72293 | 2435 | 92637 | 1036 | 83805 |
| 8L-3S | | MI | 33763 | 7963 | 55780 | 6274 | 67331 | 5009 | 74978 | 4018 | 86292 | 2361 | 108561 | 1794 | 87027 |
| 20-#11 | 1.55 | MA | 33370 | 6480 | 48270 | 5439 | 58155 | 4410 | 63285 | 3634 | 69080 | 2488 | 86066 | 2358 | 45513 |
| 2L-10S | | MI | 23564 | 6480 | 34835 | 5426 | 41010 | 4405 | 43182 | 3633 | 43822 | 2484 | 53612 | 1741 | 35820 |
| 20-#11 | 1.55 | MA | 32204 | 6480 | 46761 | 5440 | 56241 | 4410 | 60965 | 3644 | 65951 | 2496 | 81789 | 2267 | 45450 |
| 3L-9S | | MI | 24162 | 6480 | 35660 | 5425 | 42094 | 4405 | 44530 | 3635 | 45682 | 2488 | 55985 | 1821 | 36557 |
| 20-#11 | 1.55 | MA | 31367 | 6480 | 45644 | 5442 | 54731 | 4421 | 59135 | 3643 | 63480 | 2493 | 78962 | 2176 | 45331 |
| 4L-8S | | MI | 24764 | 6480 | 36575 | 5414 | 43219 | 4395 | 45871 | 3626 | 47491 | 2482 | 58280 | 1880 | 37367 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

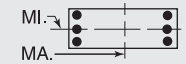
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.55 | MA | 30611 | 6480 | 44515 | 5454 | 53376 | 4422 | 57481 | 3653 | 61228 | 2501 | 76034 | 2128 | 45129 |
| 5L-7S | | MI | 25369 | 6480 | 37404 | 5413 | 44311 | 4395 | 47235 | 3628 | 49317 | 2476 | 60605 | 1933 | 37898 |
| 20-#11 | 1.55 | MA | 29887 | 6480 | 43514 | 5456 | 52040 | 4433 | 55854 | 3652 | 59064 | 2508 | 73047 | 2053 | 44417 |
| 6E | | MI | 25982 | 6480 | 38246 | 5412 | 45425 | 4396 | 48596 | 3619 | 51211 | 2480 | 62854 | 2004 | 38425 |
| 20-#11 | 1.55 | MA | 29179 | 6480 | 42539 | 5458 | 50750 | 4434 | 54277 | 3662 | 56870 | 2505 | 70384 | 1983 | 43752 |
| 7L-5S | | MI | 26609 | 6480 | 39110 | 5411 | 46578 | 4386 | 50000 | 3621 | 53078 | 2474 | 65381 | 2079 | 39032 |
| 20-#11 | 1.55 | MA | 28479 | 6480 | 41580 | 5459 | 49486 | 4434 | 52698 | 3661 | 54754 | 2513 | 67649 | 1928 | 43114 |
| 8L-4S | | MI | 27262 | 6480 | 40084 | 5400 | 47747 | 4386 | 51427 | 3612 | 55020 | 2468 | 67871 | 2125 | 39183 |
| 20-#11 | 1.55 | MA | 27784 | 6480 | 40521 | 5471 | 48183 | 4445 | 51144 | 3671 | 52659 | 2520 | 64935 | 1869 | 42115 |
| 9L-3S | | MI | 27984 | 6480 | 41047 | 5399 | 49049 | 4376 | 53004 | 3614 | 57150 | 2473 | 70258 | 2216 | 39270 |
| 20-#11 | 1.55 | MA | 27079 | 6480 | 39565 | 5473 | 46928 | 4446 | 49583 | 3671 | 50504 | 2518 | 62129 | 1790 | 41225 |
| 10L-2S | | MI | 28984 | 6480 | 42344 | 5398 | 50693 | 4377 | 54997 | 3606 | 59838 | 2467 | 73878 | 2308 | 39314 |
| 20-#14 | 2.23 | MA | 34767 | 6982 | 52786 | 5739 | 63744 | 4627 | 69994 | 3782 | 78091 | 2468 | 98061 | 2160 | 64712 |
| 3L-9S | | MI | 24821 | 6982 | 38496 | 5731 | 45503 | 4629 | 48580 | 3777 | 51092 | 2459 | 63619 | 1524 | 49513 |
| 20-#14 | 2.23 | MA | 33602 | 6982 | 51184 | 5741 | 61577 | 4643 | 67368 | 3781 | 74546 | 2463 | 94036 | 2029 | 64386 |
| 4L-8S | | MI | 25658 | 6982 | 39808 | 5715 | 47116 | 4615 | 50504 | 3765 | 53686 | 2452 | 66881 | 1609 | 51034 |
| 20-#14 | 2.23 | MA | 32551 | 6982 | 49564 | 5758 | 59633 | 4643 | 64995 | 3794 | 71315 | 2473 | 89858 | 1961 | 63251 |
| 5L-7S | | MI | 26501 | 6982 | 40997 | 5714 | 48682 | 4616 | 52460 | 3768 | 56306 | 2444 | 70193 | 1685 | 52398 |
| 20-#14 | 2.23 | MA | 31544 | 6982 | 48126 | 5761 | 57716 | 4658 | 62661 | 3793 | 68210 | 2483 | 85602 | 1853 | 61967 |
| 6E | | MI | 27354 | 6982 | 42205 | 5713 | 50280 | 4617 | 54412 | 3756 | 59020 | 2451 | 73389 | 1787 | 53495 |
| 20-#14 | 2.23 | MA | 30559 | 6982 | 46727 | 5763 | 55864 | 4659 | 60398 | 3807 | 65062 | 2478 | 81810 | 1751 | 60695 |
| 7L-5S | | MI | 28226 | 6982 | 43445 | 5712 | 51934 | 4604 | 56425 | 3759 | 61698 | 2443 | 76983 | 1896 | 54513 |
| 20-#14 | 2.23 | MA | 29585 | 6982 | 45350 | 5765 | 54049 | 4659 | 58131 | 3805 | 62025 | 2488 | 77906 | 1672 | 59011 |
| 8L-4S | | MI | 29135 | 6982 | 44841 | 5697 | 53609 | 4605 | 58470 | 3748 | 64482 | 2435 | 80530 | 1961 | 55529 |
| 20-#14 | 2.23 | MA | 28617 | 6982 | 43830 | 5782 | 52179 | 4674 | 55900 | 3819 | 59017 | 2498 | 74039 | 1588 | 57162 |
| 9L-3S | | MI | 30140 | 6982 | 46221 | 5696 | 55475 | 4591 | 60730 | 3751 | 67533 | 2443 | 83921 | 2093 | 55787 |
| 20-#14 | 2.23 | MA | 27653 | 6982 | 42458 | 5784 | 50378 | 4675 | 53660 | 3817 | 55925 | 2493 | 70043 | 1473 | 55311 |
| 10L-2S | | MI | 31533 | 6982 | 48077 | 5695 | 57828 | 4592 | 63582 | 3739 | 71380 | 2435 | 89068 | 2224 | 55928 |
| 20-#18 | 3.97 | MA | 37108 | 8254 | 62082 | 6536 | 75219 | 5208 | 83745 | 4156 | 96507 | 2402 | 123956 | 1514 | 106542 |
| 5L-7S | | MI | 29163 | 8254 | 49851 | 6482 | 59520 | 5178 | 65443 | 4123 | 73454 | 2345 | 93739 | 1028 | 85167 |
| 20-#18 | 3.97 | MA | 35448 | 8254 | 59551 | 6538 | 71844 | 5233 | 79636 | 4151 | 91042 | 2418 | 116574 | 1321 | 102829 |
| 6E | | MI | 30571 | 8254 | 51974 | 6482 | 62328 | 5183 | 68874 | 4105 | 78175 | 2358 | 99251 | 1210 | 88245 |
| 20-#18 | 3.97 | MA | 33823 | 8254 | 57088 | 6540 | 68584 | 5232 | 75653 | 4173 | 85502 | 2406 | 110005 | 1139 | 99270 |
| 7L-5S | | MI | 32010 | 8254 | 54154 | 6482 | 65234 | 5160 | 72410 | 4113 | 82831 | 2345 | 105458 | 1404 | 91495 |
| 20-#18 | 3.97 | MA | 32215 | 8254 | 54662 | 6543 | 65389 | 5230 | 71662 | 4168 | 80156 | 2421 | 103211 | 1002 | 94622 |
| 8L-4S | | MI | 33510 | 8254 | 56606 | 6456 | 68177 | 5164 | 76002 | 4094 | 87672 | 2332 | 111611 | 1518 | 93947 |
| 22-#11 | 1.70 | MA | 34092 | 6594 | 49780 | 5509 | 60070 | 4462 | 65604 | 3667 | 72209 | 2483 | 90343 | 2348 | 49977 |
| 2L-11S | | MI | 23598 | 6594 | 35312 | 5498 | 41543 | 4466 | 43841 | 3675 | 44709 | 2485 | 54947 | 1672 | 38533 |
| 22-#11 | 1.70 | MA | 32934 | 6594 | 48270 | 5511 | 58155 | 4462 | 63285 | 3676 | 69080 | 2491 | 86066 | 2257 | 49901 |
| 3L-10S | | MI | 24217 | 6594 | 36131 | 5497 | 42655 | 4456 | 45174 | 3666 | 46510 | 2479 | 57232 | 1728 | 39503 |
| 22-#11 | 1.70 | MA | 32103 | 6594 | 47153 | 5513 | 56645 | 4473 | 61454 | 3676 | 66609 | 2488 | 83238 | 2166 | 49768 |
| 4L-9S | | MI | 24811 | 6594 | 36957 | 5496 | 43739 | 4457 | 46522 | 3668 | 48370 | 2483 | 59605 | 1808 | 40273 |
| 22-#11 | 1.70 | MA | 31353 | 6594 | 46025 | 5525 | 55290 | 4474 | 59800 | 3686 | 64357 | 2495 | 80311 | 2119 | 49551 |
| 5L-8S | | MI | 25408 | 6594 | 37872 | 5485 | 44864 | 4447 | 47864 | 3659 | 50179 | 2477 | 61899 | 1867 | 41064 |
| 22-#11 | 1.70 | MA | 30635 | 6594 | 45023 | 5527 | 53954 | 4485 | 58173 | 3685 | 62193 | 2503 | 77324 | 2044 | 48773 |
| 6L-7S | | MI | 26009 | 6594 | 38701 | 5484 | 45956 | 4447 | 49228 | 3661 | 52006 | 2471 | 64224 | 1920 | 41646 |
| 22-#11 | 1.70 | MA | 29933 | 6594 | 44049 | 5528 | 52664 | 4485 | 56597 | 3695 | 59999 | 2500 | 74661 | 1973 | 48124 |
| 7L-6S | | MI | 26617 | 6594 | 39542 | 5483 | 47070 | 4448 | 50589 | 3652 | 53899 | 2475 | 66474 | 1991 | 42159 |
| 22-#11 | 1.70 | MA | 29239 | 6594 | 43090 | 5530 | 51400 | 4486 | 55017 | 3694 | 57883 | 2508 | 71926 | 1918 | 47437 |
| 8L-5S | | MI | 27238 | 6594 | 40407 | 5482 | 48223 | 4438 | 51993 | 3654 | 55766 | 2469 | 69001 | 2066 | 42829 |
| 22-#11 | 1.70 | MA | 28550 | 6594 | 42030 | 5542 | 50097 | 4497 | 53463 | 3704 | 55788 | 2515 | 69211 | 1860 | 46458 |
| 9L-4S | | MI | 27887 | 6594 | 41381 | 5471 | 49392 | 4438 | 53419 | 3645 | 57708 | 2463 | 71491 | 2113 | 42995 |
| 22-#11 | 1.70 | MA | 27853 | 6594 | 41075 | 5544 | 48842 | 4497 | 51902 | 3704 | 53633 | 2512 | 66406 | 1780 | 45537 |
| 10L-3S | | MI | 28604 | 6594 | 42344 | 5470 | 50693 | 4428 | 54997 | 3647 | 59838 | 2468 | 73878 | 2204 | 43096 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

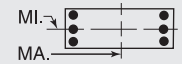



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.70 | MA | 27112 | 6594 | 40126 | 5546 | 47554 | 4508 | 50358 | 3713 | 51547 | 2520 | 63717 | 1722 | 44350 |
| 11L-2S | | MI | 29597 | 6594 | 43641 | 5469 | 52338 | 4429 | 56989 | 3638 | 62526 | 2462 | 77498 | 2295 | 43151 |
| 22-#14 | 2.46 | MA | 34617 | 7146 | 53346 | 5844 | 64320 | 4718 | 70691 | 3828 | 79029 | 2455 | 100131 | 2013 | 70718 |
| 4L-9S | | MI | 25724 | 7146 | 40352 | 5833 | 47857 | 4704 | 51431 | 3824 | 54939 | 2452 | 68767 | 1504 | 54777 |
| 22-#14 | 2.46 | MA | 33576 | 7146 | 51726 | 5861 | 62376 | 4718 | 68318 | 3842 | 75798 | 2465 | 95952 | 1945 | 69463 |
| 5L-8S | | MI | 26553 | 7146 | 41664 | 5817 | 49470 | 4690 | 53355 | 3812 | 57533 | 2444 | 72029 | 1589 | 56343 |
| 22-#14 | 2.46 | MA | 32580 | 7146 | 50289 | 5863 | 60458 | 4733 | 65983 | 3840 | 72692 | 2475 | 91696 | 1837 | 68216 |
| 6L-7S | | MI | 27388 | 7146 | 42853 | 5816 | 51036 | 4691 | 55311 | 3815 | 60153 | 2436 | 75341 | 1665 | 57672 |
| 22-#14 | 2.46 | MA | 31605 | 7146 | 48890 | 5865 | 58606 | 4733 | 63720 | 3854 | 69544 | 2471 | 87904 | 1735 | 66872 |
| 7L-6S | | MI | 28232 | 7146 | 44060 | 5815 | 52634 | 4692 | 57263 | 3804 | 62867 | 2444 | 78537 | 1767 | 58843 |
| 22-#14 | 2.46 | MA | 30641 | 7146 | 47513 | 5867 | 56792 | 4734 | 61453 | 3853 | 66507 | 2481 | 84000 | 1657 | 65225 |
| 8L-5S | | MI | 29095 | 7146 | 45301 | 5815 | 54287 | 4678 | 59276 | 3807 | 65545 | 2436 | 82131 | 1876 | 59830 |
| 22-#14 | 2.46 | MA | 29684 | 7146 | 45992 | 5884 | 54922 | 4749 | 59223 | 3866 | 63500 | 2491 | 80134 | 1572 | 63336 |
| 9L-4S | | MI | 29996 | 7146 | 46697 | 5799 | 55963 | 4680 | 61321 | 3795 | 68329 | 2428 | 85678 | 1941 | 60957 |
| 22-#14 | 2.46 | MA | 28725 | 7146 | 44620 | 5886 | 53120 | 4749 | 56982 | 3865 | 60408 | 2486 | 76137 | 1457 | 61513 |
| 10L-3S | | MI | 30991 | 7146 | 48077 | 5798 | 57828 | 4666 | 63582 | 3798 | 71380 | 2435 | 89068 | 2073 | 61239 |
| 22-#18 | 4.37 | MA | 37161 | 8545 | 63344 | 6720 | 76655 | 5366 | 85464 | 4235 | 98905 | 2404 | 127148 | 1288 | 113641 |
| 6L-7S | | MI | 30632 | 8545 | 53099 | 6663 | 63639 | 5311 | 70434 | 4207 | 80139 | 2329 | 102633 | 986 | 94286 |
| 22-#18 | 4.37 | MA | 35559 | 8545 | 60881 | 6722 | 73394 | 5365 | 81481 | 4257 | 93365 | 2393 | 120578 | 1106 | 110005 |
| 7L-6S | | MI | 32021 | 8545 | 55222 | 6664 | 66447 | 5316 | 73864 | 4189 | 84860 | 2342 | 108144 | 1168 | 97448 |
| 22-#18 | 4.37 | MA | 33976 | 8545 | 58455 | 6724 | 70199 | 5363 | 77490 | 4253 | 88019 | 2408 | 113784 | 969 | 105453 |
| 8L-5S | | MI | 33440 | 8545 | 57402 | 6664 | 69353 | 5293 | 77401 | 4197 | 89516 | 2329 | 114351 | 1362 | 100825 |
| 24-#11 | 1.86 | MA | 33656 | 6707 | 49780 | 5582 | 60070 | 4514 | 65604 | 3709 | 72209 | 2486 | 90343 | 2248 | 54350 |
| 3L-11S | | MI | 24248 | 6707 | 36609 | 5569 | 43187 | 4518 | 45833 | 3708 | 47397 | 2480 | 58567 | 1659 | 42239 |
| 24-#11 | 1.86 | MA | 32832 | 6707 | 48663 | 5584 | 58559 | 4525 | 63773 | 3709 | 69738 | 2483 | 87515 | 2156 | 54203 |
| 4L-10S | | MI | 24864 | 6707 | 37428 | 5568 | 44299 | 4508 | 47167 | 3699 | 49198 | 2474 | 60852 | 1715 | 43191 |
| 24-#11 | 1.86 | MA | 32088 | 6707 | 47534 | 5596 | 57205 | 4526 | 62119 | 3718 | 67486 | 2490 | 84588 | 2109 | 53971 |
| 5L-9S | | MI | 25453 | 6707 | 38254 | 5567 | 45384 | 4509 | 48515 | 3701 | 51058 | 2478 | 63225 | 1796 | 43993 |
| 24-#11 | 1.86 | MA | 31376 | 6707 | 46533 | 5598 | 55869 | 4537 | 60492 | 3718 | 65322 | 2498 | 81601 | 2034 | 53133 |
| 6L-8S | | MI | 26045 | 6707 | 39169 | 5556 | 46508 | 4499 | 49856 | 3692 | 52867 | 2472 | 65519 | 1854 | 44767 |
| 24-#11 | 1.86 | MA | 30679 | 6707 | 45558 | 5599 | 54578 | 4537 | 58916 | 3728 | 63128 | 2495 | 78938 | 1963 | 52499 |
| 7E | | MI | 26642 | 6707 | 39997 | 5555 | 47600 | 4499 | 51220 | 3694 | 54694 | 2466 | 67844 | 1908 | 45397 |
| 24-#11 | 1.86 | MA | 29991 | 6707 | 44599 | 5601 | 53314 | 4538 | 57336 | 3727 | 61012 | 2503 | 76203 | 1908 | 51764 |
| 8L-6S | | MI | 27245 | 6707 | 40839 | 5554 | 48714 | 4500 | 52581 | 3685 | 56587 | 2470 | 70094 | 1979 | 45897 |
| 24-#11 | 1.86 | MA | 29307 | 6707 | 43539 | 5613 | 52011 | 4549 | 55782 | 3737 | 58917 | 2510 | 73488 | 1850 | 50805 |
| 9L-5S | | MI | 27862 | 6707 | 41704 | 5553 | 49868 | 4490 | 53985 | 3687 | 58454 | 2464 | 72621 | 2054 | 46625 |
| 24-#11 | 1.86 | MA | 28622 | 6707 | 42584 | 5615 | 50756 | 4549 | 54221 | 3736 | 56762 | 2507 | 70683 | 1770 | 49854 |
| 10L-4S | | MI | 28505 | 6707 | 42678 | 5542 | 51036 | 4490 | 55412 | 3678 | 60396 | 2458 | 75111 | 2100 | 46805 |
| 24-#11 | 1.86 | MA | 27879 | 6707 | 41636 | 5617 | 49468 | 4560 | 52677 | 3746 | 54676 | 2515 | 67994 | 1712 | 48686 |
| 11L-3S | | MI | 29217 | 6707 | 43641 | 5541 | 52338 | 4480 | 56989 | 3680 | 62526 | 2462 | 77498 | 2191 | 46918 |
| 24-#11 | 1.86 | MA | 27154 | 6707 | 40693 | 5618 | 48217 | 4561 | 51125 | 3746 | 52539 | 2512 | 65301 | 1654 | 47450 |
| 12L-2S | | MI | 30205 | 6707 | 44937 | 5540 | 53982 | 4480 | 58982 | 3671 | 65214 | 2456 | 81117 | 2282 | 46985 |
| 24-#14 | 2.68 | MA | 34590 | 7309 | 53889 | 5963 | 65119 | 4793 | 71641 | 3889 | 80281 | 2458 | 102046 | 1930 | 75685 |
| 5L-9S | | MI | 26617 | 7309 | 42208 | 5935 | 50210 | 4778 | 54282 | 3871 | 58786 | 2444 | 73915 | 1484 | 60007 |
| 24-#14 | 2.68 | MA | 33604 | 7309 | 52451 | 5965 | 63201 | 4808 | 69306 | 3888 | 77175 | 2468 | 97790 | 1822 | 74472 |
| 6L-8S | | MI | 27438 | 7309 | 43520 | 5919 | 51824 | 4765 | 56207 | 3860 | 61380 | 2437 | 77176 | 1568 | 61659 |
| 24-#14 | 2.68 | MA | 32639 | 7309 | 51052 | 5967 | 61349 | 4808 | 67043 | 3901 | 74027 | 2463 | 93998 | 1719 | 73057 |
| 7E | | MI | 28264 | 7309 | 44709 | 5918 | 53389 | 4766 | 58162 | 3863 | 64000 | 2429 | 80489 | 1644 | 62955 |
| 24-#14 | 2.68 | MA | 31685 | 7309 | 49675 | 5969 | 59534 | 4809 | 64776 | 3900 | 70990 | 2473 | 90095 | 1641 | 71446 |
| 8L-6S | | MI | 29100 | 7309 | 45916 | 5918 | 54987 | 4767 | 60114 | 3851 | 66714 | 2436 | 83685 | 1747 | 64197 |
| 24-#14 | 2.68 | MA | 30738 | 7309 | 48155 | 5986 | 57664 | 4824 | 62546 | 3913 | 67983 | 2483 | 86228 | 1557 | 69517 |
| 9L-5S | | MI | 29955 | 7309 | 47157 | 5917 | 56641 | 4753 | 62128 | 3854 | 69392 | 2428 | 87279 | 1855 | 65155 |
| 24-#14 | 2.68 | MA | 29782 | 7309 | 46783 | 5988 | 55863 | 4824 | 60305 | 3912 | 64890 | 2478 | 82232 | 1441 | 67665 |
| 10L-4S | | MI | 30846 | 7309 | 48553 | 5901 | 58317 | 4754 | 64173 | 3842 | 72176 | 2420 | 90826 | 1921 | 66384 |
| 24-#18 | 4.76 | MA | 37271 | 8836 | 64674 | 6904 | 78205 | 5498 | 87309 | 4342 | 101228 | 2380 | 131152 | 1072 | 120756 |
| 7E | | MI | 32082 | 8836 | 56347 | 6845 | 67758 | 5444 | 75424 | 4292 | 86824 | 2313 | 111526 | 943 | 103422 |
| 24-#18 | 4.76 | MA | 35710 | 8836 | 62249 | 6906 | 75010 | 5496 | 83318 | 4337 | 95882 | 2395 | 124358 | 936 | 116296 |
| 8L-6S | | MI | 33452 | 8836 | 58470 | 6845 | 70566 | 5449 | 78854 | 4273 | 91545 | 2326 | 117037 | 1126 | 106669 |

## RECTANGULAR TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.24 | MA | 27770 | 6007 | 40126 | 5016 | 47592 | 4077 | 51083 | 3377 | 54332 | 2358 | 66090 | 2204 | 31558 |
| 2L-3S | | MI | 25092 | 6007 | 36696 | 5017 | 43242 | 4074 | 45813 | 3397 | 47242 | 2372 | 56637 | 1971 | 31450 |
| 8-#18 | 1.65 | MA | 29393 | 6297 | 43556 | 5198 | 51941 | 4210 | 56352 | 3461 | 61422 | 2344 | 75543 | 2165 | 41730 |
| 2L-4S | | MI | 24848 | 6297 | 37572 | 5199 | 44140 | 4231 | 46900 | 3474 | 48706 | 2344 | 59871 | 1698 | 40758 |
| 10-#14 | 1.16 | MA | 27591 | 5952 | 39357 | 5013 | 46875 | 4078 | 50327 | 3383 | 53447 | 2380 | 65214 | 2245 | 29907 |
| 2L-5S | | MI | 23934 | 5952 | 34474 | 5032 | 40661 | 4091 | 42782 | 3405 | 43239 | 2391 | 52392 | 1916 | 29330 |
| 10-#14 | 1.16 | MA | 26055 | 5952 | 37399 | 5014 | 44392 | 4077 | 47318 | 3395 | 49388 | 2389 | 59751 | 2114 | 29875 |
| 3L-4S | | MI | 24942 | 5952 | 35945 | 5016 | 42426 | 4092 | 44936 | 3393 | 46173 | 2383 | 56149 | 1982 | 29737 |
| 10-#18 | 2.07 | MA | 30976 | 6588 | 46985 | 5380 | 56291 | 4343 | 61622 | 3546 | 68512 | 2330 | 84995 | 2126 | 51870 |
| 2L-5S | | MI | 24806 | 6588 | 38417 | 5408 | 45388 | 4361 | 48383 | 3578 | 50661 | 2343 | 62797 | 1544 | 47141 |
| 10-#18 | 2.07 | MA | 28386 | 6588 | 43556 | 5380 | 51941 | 4340 | 56352 | 3565 | 61422 | 2343 | 75543 | 1892 | 51565 |
| 3L-4S | | MI | 26508 | 6588 | 41002 | 5381 | 48490 | 4364 | 52169 | 3558 | 55796 | 2330 | 69324 | 1659 | 50398 |

## RECTANGULAR TIED COLUMNS 44" x 46"

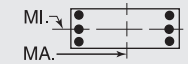
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.19 | MA | 30187 | 6240 | 43304 | 5235 | 51451 | 4257 | 55206 | 3530 | 58643 | 2479 | 71367 | 2327 | 33178 |
| 2L-3S | | MI | 26123 | 6240 | 38052 | 5220 | 44812 | 4241 | 47416 | 3539 | 48744 | 2481 | 58352 | 2076 | 31517 |
| 6-#18 | 1.19 | MA | 27358 | 6240 | 39692 | 5237 | 46871 | 4255 | 49657 | 3551 | 51156 | 2493 | 61354 | 2093 | 33070 |
| 3L-2S | | MI | 28808 | 6240 | 41482 | 5220 | 49162 | 4245 | 52686 | 3519 | 55834 | 2467 | 67805 | 2310 | 31601 |
| 8-#18 | 1.58 | MA | 31911 | 6531 | 46915 | 5417 | 56031 | 4390 | 60755 | 3614 | 66129 | 2466 | 81380 | 2291 | 43890 |
| 2L-4S | | MI | 25878 | 6531 | 38928 | 5403 | 45710 | 4398 | 48503 | 3616 | 50209 | 2453 | 61586 | 1803 | 40905 |
| 8-#18 | 1.58 | MA | 29129 | 6531 | 43304 | 5418 | 51451 | 4388 | 55206 | 3635 | 58643 | 2479 | 71367 | 2057 | 43677 |
| 3E | | MI | 27797 | 6531 | 41482 | 5402 | 49162 | 4374 | 52686 | 3623 | 55834 | 2466 | 67805 | 2037 | 41592 |
| 8-#18 | 1.58 | MA | 27112 | 6531 | 40618 | 5420 | 47821 | 4413 | 50807 | 3629 | 52705 | 2467 | 64773 | 1823 | 42918 |
| 4L-2S | | MI | 30437 | 6531 | 44912 | 5401 | 53512 | 4378 | 57956 | 3603 | 62924 | 2453 | 77258 | 2271 | 41781 |
| 10-#14 | 1.11 | MA | 29990 | 6185 | 42485 | 5232 | 50685 | 4258 | 54397 | 3536 | 57632 | 2498 | 70396 | 2366 | 31426 |
| 2L-5S | | MI | 24963 | 6185 | 35818 | 5237 | 42227 | 4259 | 44386 | 3548 | 44746 | 2501 | 54114 | 2022 | 29496 |
| 10-#14 | 1.11 | MA | 28369 | 6185 | 40425 | 5234 | 48072 | 4258 | 51231 | 3549 | 53361 | 2507 | 64617 | 2235 | 31394 |
| 3L-4S | | MI | 25973 | 6185 | 37289 | 5220 | 43992 | 4260 | 46540 | 3536 | 47679 | 2493 | 57872 | 2088 | 29802 |
| 10-#14 | 1.11 | MA | 27197 | 6185 | 38897 | 5235 | 46006 | 4272 | 48727 | 3547 | 49981 | 2502 | 60803 | 2103 | 31255 |
| 4L-3S | | MI | 27089 | 6185 | 38743 | 5219 | 45958 | 4246 | 48922 | 3538 | 50895 | 2499 | 61474 | 2220 | 29921 |
| 10-#14 | 1.11 | MA | 26135 | 6185 | 37351 | 5252 | 44152 | 4272 | 46464 | 3560 | 46899 | 2511 | 56835 | 2036 | 30912 |
| 5L-2S | | MI | 28628 | 6185 | 40701 | 5218 | 48441 | 4246 | 51931 | 3526 | 54954 | 2490 | 66937 | 2351 | 29943 |
| 10-#18 | 1.98 | MA | 33594 | 6822 | 50526 | 5599 | 60612 | 4523 | 66304 | 3698 | 73615 | 2452 | 91393 | 2255 | 54570 |
| 2L-5S | | MI | 25835 | 6822 | 39773 | 5611 | 46958 | 4528 | 49987 | 3720 | 52164 | 2452 | 64512 | 1649 | 47467 |
| 10-#18 | 1.98 | MA | 30856 | 6822 | 46915 | 5600 | 56031 | 4521 | 60755 | 3719 | 66129 | 2466 | 81380 | 2021 | 54265 |
| 3L-4S | | MI | 27544 | 6822 | 42358 | 5584 | 50060 | 4531 | 53773 | 3700 | 57299 | 2439 | 71039 | 1764 | 50787 |
| 10-#18 | 1.98 | MA | 28875 | 6822 | 44230 | 5601 | 52401 | 4546 | 56356 | 3714 | 60191 | 2453 | 74786 | 1787 | 53373 |
| 4L-3S | | MI | 29429 | 6822 | 44912 | 5584 | 53512 | 4507 | 57956 | 3707 | 62924 | 2452 | 77258 | 1998 | 51648 |
| 10-#18 | 1.98 | MA | 27080 | 6822 | 41512 | 5629 | 49140 | 4543 | 52375 | 3734 | 54772 | 2467 | 67885 | 1671 | 49811 |
| 5L-2S | | MI | 32028 | 6822 | 48341 | 5583 | 57861 | 4511 | 63225 | 3688 | 70014 | 2439 | 86711 | 2232 | 51925 |
| 12-#14 | 1.33 | MA | 30994 | 6349 | 44545 | 5334 | 53298 | 4333 | 57563 | 3583 | 61903 | 2490 | 76174 | 2349 | 37539 |
| 2L-6S | | MI | 24994 | 6349 | 36470 | 5340 | 42969 | 4348 | 45274 | 3593 | 45985 | 2502 | 55763 | 1895 | 33817 |
| 12-#14 | 1.33 | MA | 29389 | 6349 | 42485 | 5336 | 50685 | 4332 | 54397 | 3596 | 57632 | 2500 | 70396 | 2218 | 37477 |
| 3L-5S | | MI | 25952 | 6349 | 37776 | 5339 | 44711 | 4334 | 47394 | 3596 | 48805 | 2494 | 59577 | 2003 | 35102 |
| 12-#14 | 1.33 | MA | 28230 | 6349 | 40957 | 5338 | 48619 | 4347 | 51893 | 3594 | 54252 | 2494 | 66582 | 2086 | 37299 |
| 4E | | MI | 26950 | 6349 | 39247 | 5323 | 46476 | 4335 | 49548 | 3583 | 51738 | 2485 | 63335 | 2070 | 35546 |
| 12-#14 | 1.33 | MA | 27181 | 6349 | 39412 | 5354 | 46765 | 4347 | 49629 | 3607 | 51170 | 2504 | 62614 | 2019 | 36821 |
| 5L-3S | | MI | 28054 | 6349 | 40701 | 5321 | 48441 | 4320 | 51931 | 3586 | 54954 | 2491 | 66937 | 2201 | 35704 |
| 12-#14 | 1.33 | MA | 26175 | 6349 | 38040 | 5356 | 44935 | 4362 | 47402 | 3605 | 48207 | 2513 | 58579 | 1911 | 35441 |
| 6L-2S | | MI | 29578 | 6349 | 42659 | 5320 | 50925 | 4321 | 54939 | 3573 | 59013 | 2483 | 72400 | 2333 | 35757 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

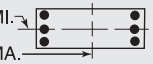



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 2.37 | MA | 35241 | 7112 | 54138 | 5780 | 65192 | 4656 | 71853 | 3783 | 81102 | 2439 | 101406 | 2219 | 65229 |
| 2L-6S | | MI | 25880 | 7112 | 40906 | 5794 | 48245 | 4684 | 51529 | 3798 | 54316 | 2451 | 67366 | 1417 | 54398 |
| 12-#18 | 2.37 | MA | 32544 | 7112 | 50526 | 5782 | 60612 | 4654 | 66304 | 3804 | 73615 | 2453 | 91393 | 1985 | 64843 |
| 3L-5S | | MI | 27491 | 7112 | 43203 | 5793 | 51307 | 4661 | 55256 | 3804 | 59254 | 2438 | 73965 | 1610 | 57236 |
| 12-#18 | 2.37 | MA | 30596 | 7112 | 47841 | 5783 | 56981 | 4679 | 61905 | 3798 | 67678 | 2440 | 84799 | 1751 | 63516 |
| 4E | | MI | 29171 | 7112 | 45788 | 5766 | 54409 | 4664 | 59042 | 3785 | 64389 | 2425 | 80492 | 1725 | 60399 |
| 12-#18 | 2.37 | MA | 28833 | 7112 | 45124 | 5811 | 53720 | 4676 | 57924 | 3819 | 62259 | 2454 | 77898 | 1634 | 60115 |
| 5L-3S | | MI | 31025 | 7112 | 48341 | 5765 | 57861 | 4640 | 63225 | 3792 | 70014 | 2438 | 86711 | 1959 | 61692 |
| 12-#18 | 2.37 | MA | 27141 | 7112 | 42709 | 5813 | 50501 | 4701 | 54006 | 3813 | 57047 | 2467 | 70908 | 1442 | 57115 |
| 6L-2S | | MI | 33585 | 7112 | 51771 | 5765 | 62211 | 4644 | 68495 | 3772 | 77104 | 2425 | 96163 | 2193 | 62049 |
| 14-#11 | 1.08 | MA | 29906 | 6161 | 42107 | 5232 | 50344 | 4260 | 54044 | 3540 | 57197 | 2507 | 69993 | 2385 | 30657 |
| 2L-7S | | MI | 24655 | 6161 | 35136 | 5235 | 41397 | 4269 | 43425 | 3555 | 43468 | 2512 | 52504 | 1996 | 28019 |
| 14-#11 | 1.08 | MA | 28772 | 6161 | 40669 | 5234 | 48520 | 4260 | 51834 | 3549 | 54216 | 2514 | 65936 | 2293 | 30641 |
| 3L-6S | | MI | 25316 | 6161 | 36022 | 5234 | 42570 | 4269 | 44858 | 3546 | 45461 | 2516 | 54892 | 2067 | 28648 |
| 14-#11 | 1.08 | MA | 27954 | 6161 | 39603 | 5235 | 47079 | 4270 | 50088 | 3548 | 51858 | 2511 | 63255 | 2202 | 30583 |
| 4L-5S | | MI | 25991 | 6161 | 36932 | 5233 | 43784 | 4259 | 46336 | 3547 | 47427 | 2510 | 57572 | 2142 | 29044 |
| 14-#11 | 1.08 | MA | 27214 | 6161 | 38526 | 5247 | 45787 | 4271 | 48510 | 3558 | 49710 | 2518 | 60474 | 2155 | 30454 |
| 5L-4S | | MI | 26696 | 6161 | 37958 | 5221 | 45015 | 4259 | 47839 | 3538 | 49473 | 2503 | 60208 | 2188 | 29157 |
| 14-#11 | 1.08 | MA | 26505 | 6161 | 37570 | 5249 | 44511 | 4281 | 46957 | 3557 | 47644 | 2525 | 57640 | 2080 | 30025 |
| 6L-3S | | MI | 27475 | 6161 | 38972 | 5220 | 46386 | 4248 | 49501 | 3539 | 51716 | 2507 | 62741 | 2280 | 29205 |
| 14-#11 | 1.08 | MA | 25811 | 6161 | 36640 | 5250 | 43280 | 4282 | 45452 | 3566 | 45551 | 2522 | 55115 | 2009 | 29348 |
| 7L-2S | | MI | 28552 | 6161 | 40339 | 5219 | 48120 | 4248 | 51602 | 3530 | 54551 | 2500 | 66580 | 2371 | 29216 |
| 14-#14 | 1.56 | MA | 31983 | 6513 | 46605 | 5436 | 55911 | 4407 | 60728 | 3631 | 66174 | 2483 | 81953 | 2332 | 43641 |
| 2L-7S | | MI | 25050 | 6513 | 37157 | 5444 | 43770 | 4423 | 46227 | 3653 | 47185 | 2489 | 57832 | 1774 | 38529 |
| 14-#14 | 1.56 | MA | 30393 | 6513 | 44545 | 5438 | 53298 | 4407 | 57563 | 3644 | 61903 | 2492 | 76174 | 2201 | 43551 |
| 3L-6S | | MI | 25978 | 6513 | 38428 | 5442 | 45452 | 4423 | 48282 | 3640 | 50044 | 2495 | 61226 | 1876 | 39432 |
| 14-#14 | 1.56 | MA | 29247 | 6513 | 43017 | 5440 | 51232 | 4422 | 55059 | 3642 | 58523 | 2487 | 72361 | 2069 | 43337 |
| 4L-5S | | MI | 26925 | 6513 | 39734 | 5441 | 47194 | 4409 | 50403 | 3643 | 52864 | 2486 | 65041 | 1985 | 40665 |
| 14-#14 | 1.56 | MA | 28210 | 6513 | 41472 | 5456 | 49378 | 4422 | 52795 | 3655 | 55441 | 2496 | 68393 | 2002 | 42682 |
| 5L-4S | | MI | 27912 | 6513 | 41205 | 5425 | 48959 | 4409 | 52557 | 3631 | 55797 | 2478 | 68798 | 2051 | 41286 |
| 14-#14 | 1.56 | MA | 27216 | 6513 | 40100 | 5458 | 47548 | 4437 | 50567 | 3653 | 52478 | 2506 | 64358 | 1894 | 41356 |
| 6L-3S | | MI | 29004 | 6513 | 42659 | 5424 | 50925 | 4395 | 54939 | 3633 | 59013 | 2484 | 72400 | 2183 | 41478 |
| 14-#14 | 1.56 | MA | 26242 | 6513 | 38765 | 5460 | 45781 | 4437 | 48408 | 3666 | 49474 | 2500 | 60764 | 1792 | 40392 |
| 7L-2S | | MI | 30514 | 6513 | 44617 | 5422 | 53408 | 4396 | 57948 | 3621 | 63072 | 2475 | 77863 | 2314 | 41558 |
| 14-#18 | 2.77 | MA | 36857 | 7403 | 57749 | 5962 | 69772 | 4789 | 77402 | 3867 | 88588 | 2426 | 111419 | 2182 | 75874 |
| 2L-7S | | MI | 25976 | 7403 | 42099 | 5976 | 49636 | 4814 | 53184 | 3901 | 56400 | 2423 | 70956 | 1195 | 60904 |
| 14-#18 | 2.77 | MA | 34198 | 7403 | 54138 | 5964 | 65192 | 4787 | 71853 | 3888 | 81102 | 2440 | 101406 | 1949 | 75414 |
| 3L-6S | | MI | 27528 | 7403 | 44335 | 5976 | 52595 | 4817 | 56799 | 3882 | 61406 | 2437 | 76819 | 1378 | 64050 |
| 14-#18 | 2.77 | MA | 32282 | 7403 | 51452 | 5965 | 61561 | 4812 | 67453 | 3882 | 75164 | 2427 | 94812 | 1715 | 73699 |
| 4L-5S | | MI | 29113 | 7403 | 46633 | 5975 | 55657 | 4794 | 60526 | 3889 | 66344 | 2423 | 83418 | 1571 | 67030 |
| 14-#18 | 2.77 | MA | 30548 | 7403 | 48735 | 5993 | 58300 | 4809 | 63473 | 3903 | 69745 | 2440 | 87911 | 1598 | 70444 |
| 5L-4S | | MI | 30764 | 7403 | 49217 | 5948 | 58759 | 4797 | 64312 | 3869 | 71479 | 2410 | 89945 | 1686 | 70052 |
| 14-#18 | 2.77 | MA | 28885 | 7403 | 46321 | 5994 | 55082 | 4834 | 59555 | 3897 | 64534 | 2454 | 80921 | 1405 | 67304 |
| 6L-3S | | MI | 32589 | 7403 | 51771 | 5947 | 62211 | 4773 | 68495 | 3876 | 77104 | 2423 | 96163 | 1920 | 71729 |
| 14-#18 | 2.77 | MA | 27255 | 7403 | 43971 | 5996 | 51972 | 4832 | 55756 | 3918 | 59251 | 2441 | 74704 | 1223 | 63934 |
| 7L-2S | | MI | 35114 | 7403 | 55201 | 5947 | 66561 | 4777 | 73765 | 3856 | 84194 | 2410 | 105616 | 2153 | 72157 |
| 16-#11 | 1.23 | MA | 30614 | 6275 | 43546 | 5303 | 52169 | 4311 | 56255 | 3573 | 60179 | 2502 | 74051 | 2374 | 34926 |
| 2L-8S | | MI | 24707 | 6275 | 35631 | 5307 | 41982 | 4321 | 44091 | 3586 | 44379 | 2514 | 53882 | 1930 | 31482 |
| 16-#11 | 1.23 | MA | 29488 | 6275 | 42107 | 5305 | 50344 | 4312 | 54044 | 3582 | 57197 | 2509 | 69993 | 2283 | 34895 |
| 3L-7S | | MI | 25355 | 6275 | 36503 | 5306 | 43131 | 4321 | 45526 | 3588 | 46303 | 2507 | 56343 | 1984 | 31962 |
| 16-#11 | 1.23 | MA | 28676 | 6275 | 41042 | 5306 | 48903 | 4322 | 52298 | 3581 | 54840 | 2506 | 67313 | 2192 | 34820 |
| 4L-6S | | MI | 26011 | 6275 | 37389 | 5305 | 44304 | 4321 | 46959 | 3579 | 48296 | 2511 | 58730 | 2055 | 32569 |
| 16-#11 | 1.23 | MA | 27943 | 6275 | 39965 | 5318 | 47611 | 4323 | 50720 | 3591 | 52691 | 2513 | 64531 | 2144 | 34671 |
| 5E | | MI | 26681 | 6275 | 38300 | 5304 | 45518 | 4311 | 48438 | 3580 | 50262 | 2504 | 61411 | 2130 | 33054 |
| 16-#11 | 1.23 | MA | 27240 | 6275 | 39009 | 5320 | 46336 | 4333 | 49167 | 3590 | 50626 | 2520 | 61698 | 2070 | 34153 |
| 6L-4S | | MI | 27379 | 6275 | 39325 | 5292 | 46749 | 4311 | 49940 | 3571 | 52308 | 2498 | 64046 | 2177 | 33187 |
| 16-#11 | 1.23 | MA | 26552 | 6275 | 38078 | 5321 | 45104 | 4334 | 47663 | 3599 | 48533 | 2517 | 59173 | 1999 | 33498 |
| 7L-3S | | MI | 28152 | 6275 | 40339 | 5291 | 48120 | 4300 | 51602 | 3572 | 54551 | 2502 | 66580 | 2268 | 33252 |

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

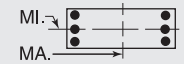



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.23 | MA | 25872 | 6275 | 37163 | 5323 | 43897 | 4334 | 46155 | 3598 | 46513 | 2524 | 56574 | 1944 | 32979 |
| 8L-2S | | MI | 29222 | 6275 | 41707 | 5290 | 49855 | 4300 | 53703 | 3563 | 57386 | 2495 | 70419 | 2359 | 33277 |
| 16-#14 | 1.78 | MA | 32958 | 6676 | 48666 | 5539 | 58524 | 4482 | 63894 | 3678 | 70444 | 2476 | 87732 | 2315 | 49735 |
| 2L-8S | | MI | 25124 | 6676 | 37863 | 5547 | 44604 | 4497 | 47176 | 3698 | 48485 | 2490 | 59785 | 1679 | 42521 |
| 16-#14 | 1.78 | MA | 31383 | 6676 | 46605 | 5540 | 55911 | 4482 | 60728 | 3691 | 66174 | 2485 | 81953 | 2184 | 49618 |
| 3L-7S | | MI | 26030 | 6676 | 39115 | 5546 | 46253 | 4497 | 49235 | 3700 | 51244 | 2481 | 63295 | 1756 | 44071 |
| 16-#14 | 1.78 | MA | 30249 | 6676 | 45077 | 5542 | 53845 | 4497 | 58224 | 3689 | 62794 | 2479 | 78139 | 2052 | 49373 |
| 4L-6S | | MI | 26947 | 6676 | 40386 | 5545 | 47935 | 4498 | 51291 | 3688 | 54103 | 2488 | 66689 | 1858 | 45057 |
| 16-#14 | 1.78 | MA | 29223 | 6676 | 43532 | 5559 | 51991 | 4497 | 55960 | 3702 | 59711 | 2489 | 74171 | 1985 | 48560 |
| 5E | | MI | 27883 | 6676 | 41692 | 5543 | 49677 | 4484 | 53411 | 3690 | 56923 | 2479 | 70504 | 1966 | 46243 |
| 16-#14 | 1.78 | MA | 28240 | 6676 | 42160 | 5560 | 50161 | 4512 | 53733 | 3700 | 56749 | 2498 | 70136 | 1877 | 47282 |
| 6L-4S | | MI | 28860 | 6676 | 43163 | 5527 | 51442 | 4484 | 55565 | 3678 | 59856 | 2470 | 74261 | 2033 | 47021 |
| 16-#14 | 1.78 | MA | 27278 | 6676 | 40825 | 5562 | 48394 | 4511 | 51574 | 3713 | 53745 | 2493 | 66543 | 1775 | 46236 |
| 7L-3S | | MI | 29940 | 6676 | 44617 | 5526 | 53408 | 4470 | 57948 | 3680 | 63072 | 2477 | 77863 | 2164 | 47245 |
| 16-#14 | 1.78 | MA | 26326 | 6676 | 39511 | 5564 | 46662 | 4511 | 49410 | 3711 | 50847 | 2502 | 62837 | 1697 | 44577 |
| 8L-2S | | MI | 31436 | 6676 | 46575 | 5524 | 55891 | 4471 | 60956 | 3668 | 67131 | 2468 | 83326 | 2296 | 47351 |
| 16-#18 | 3.16 | MA | 35823 | 7694 | 57749 | 6145 | 69772 | 4920 | 77402 | 3972 | 88588 | 2426 | 111419 | 1913 | 85981 |
| 3L-7S | | MI | 27617 | 7694 | 45528 | 6158 | 53985 | 4947 | 58453 | 3986 | 63490 | 2409 | 80409 | 1156 | 70669 |
| 16-#18 | 3.16 | MA | 33936 | 7694 | 55064 | 6147 | 66142 | 4945 | 73002 | 3966 | 82650 | 2414 | 104825 | 1679 | 83918 |
| 4L-6S | | MI | 29144 | 7694 | 47765 | 6157 | 56944 | 4950 | 62068 | 3966 | 68496 | 2422 | 86272 | 1339 | 73726 |
| 16-#18 | 3.16 | MA | 32229 | 7694 | 52346 | 6175 | 62880 | 4942 | 69022 | 3987 | 77232 | 2427 | 97924 | 1562 | 80794 |
| 5E | | MI | 30703 | 7694 | 50062 | 6157 | 60007 | 4927 | 65796 | 3973 | 73434 | 2409 | 92871 | 1532 | 76846 |
| 16-#18 | 3.16 | MA | 30593 | 7694 | 49932 | 6176 | 59662 | 4967 | 65104 | 3982 | 72020 | 2441 | 90934 | 1369 | 77517 |
| 6L-4S | | MI | 32329 | 7694 | 52647 | 6130 | 63109 | 4930 | 69582 | 3953 | 78569 | 2396 | 99398 | 1647 | 79741 |
| 16-#18 | 3.16 | MA | 28991 | 7694 | 47582 | 6178 | 56552 | 4965 | 61305 | 4002 | 66737 | 2428 | 84718 | 1187 | 74246 |
| 7L-3S | | MI | 34126 | 7694 | 55201 | 6129 | 66561 | 4906 | 73765 | 3960 | 84194 | 2409 | 105616 | 1881 | 81760 |
| 16-#18 | 3.16 | MA | 27405 | 7694 | 45268 | 6179 | 53504 | 4963 | 57498 | 3997 | 61638 | 2442 | 78274 | 1052 | 69731 |
| 8L-2S | | MI | 36617 | 7694 | 58631 | 6128 | 70910 | 4910 | 79034 | 3940 | 91284 | 2396 | 115069 | 2114 | 82254 |
| 18-#11 | 1.39 | MA | 31314 | 6388 | 44984 | 5374 | 53993 | 4363 | 58465 | 3605 | 63161 | 2497 | 78109 | 2363 | 39189 |
| 2L-9S | | MI | 24768 | 6388 | 36036 | 5390 | 42532 | 4383 | 44780 | 3628 | 45310 | 2515 | 55286 | 1860 | 34509 |
| 18-#11 | 1.39 | MA | 30196 | 6388 | 43546 | 5376 | 52169 | 4364 | 56255 | 3615 | 60179 | 2504 | 74051 | 2272 | 39145 |
| 3L-8S | | MI | 25405 | 6388 | 36999 | 5378 | 43717 | 4373 | 46192 | 3619 | 47214 | 2509 | 57720 | 1919 | 35404 |
| 18-#11 | 1.39 | MA | 29390 | 6388 | 42480 | 5377 | 50728 | 4374 | 54508 | 3614 | 57822 | 2501 | 71371 | 2181 | 39054 |
| 4L-7S | | MI | 26048 | 6388 | 37871 | 5377 | 44866 | 4373 | 47628 | 3621 | 49138 | 2502 | 60182 | 1973 | 35909 |
| 18-#11 | 1.39 | MA | 28663 | 6388 | 41403 | 5389 | 49435 | 4375 | 52930 | 3623 | 55673 | 2508 | 68589 | 2134 | 38887 |
| 5L-6S | | MI | 26698 | 6388 | 38757 | 5376 | 46039 | 4373 | 49061 | 3612 | 51131 | 2506 | 62569 | 2043 | 36498 |
| 18-#11 | 1.39 | MA | 27966 | 6388 | 40447 | 5390 | 48160 | 4385 | 51378 | 3622 | 53608 | 2515 | 65755 | 2059 | 38289 |
| 6L-5S | | MI | 27362 | 6388 | 39667 | 5375 | 47253 | 4362 | 50539 | 3613 | 53097 | 2499 | 65250 | 2118 | 37062 |
| 18-#11 | 1.39 | MA | 27283 | 6388 | 39517 | 5392 | 46928 | 4385 | 49873 | 3632 | 51515 | 2512 | 63230 | 1988 | 37653 |
| 7L-4S | | MI | 28055 | 6388 | 40693 | 5363 | 48484 | 4363 | 52041 | 3604 | 55143 | 2493 | 67885 | 2165 | 37212 |
| 18-#11 | 1.39 | MA | 26609 | 6388 | 38601 | 5393 | 45722 | 4386 | 48365 | 3631 | 49495 | 2519 | 60632 | 1934 | 37113 |
| 8L-3S | | MI | 28822 | 6388 | 41707 | 5362 | 49855 | 4352 | 53703 | 3605 | 57386 | 2496 | 70419 | 2256 | 37294 |
| 18-#11 | 1.39 | MA | 25940 | 6388 | 37590 | 5405 | 44478 | 4396 | 46882 | 3640 | 47495 | 2526 | 58058 | 1875 | 36153 |
| 9L-2S | | MI | 29885 | 6388 | 43075 | 5361 | 51589 | 4352 | 55804 | 3596 | 60221 | 2490 | 74257 | 2347 | 37332 |
| 18-#14 | 2.00 | MA | 33920 | 6840 | 50726 | 5641 | 61137 | 4557 | 67059 | 3725 | 74715 | 2468 | 93510 | 2298 | 55822 |
| 2L-9S | | MI | 25208 | 6840 | 38439 | 5666 | 45388 | 4586 | 48158 | 3758 | 49812 | 2491 | 61785 | 1576 | 46560 |
| 18-#14 | 2.00 | MA | 32360 | 6840 | 48666 | 5643 | 58524 | 4557 | 63894 | 3738 | 70444 | 2477 | 87732 | 2167 | 55680 |
| 3L-8S | | MI | 26099 | 6840 | 39821 | 5649 | 47087 | 4572 | 50184 | 3745 | 52544 | 2482 | 65248 | 1660 | 48116 |
| 18-#14 | 2.00 | MA | 31237 | 6840 | 47138 | 5644 | 56458 | 4572 | 61390 | 3736 | 67064 | 2472 | 83918 | 2035 | 55406 |
| 4L-7S | | MI | 26995 | 6840 | 41073 | 5648 | 48736 | 4572 | 52244 | 3748 | 55303 | 2474 | 68758 | 1737 | 49625 |
| 18-#14 | 2.00 | MA | 30222 | 6840 | 45592 | 5661 | 54604 | 4572 | 59126 | 3749 | 63982 | 2481 | 79950 | 1968 | 54451 |
| 5L-6S | | MI | 27902 | 6840 | 42344 | 5647 | 50419 | 4573 | 54299 | 3735 | 58162 | 2480 | 72152 | 1839 | 50691 |
| 18-#14 | 2.00 | MA | 29250 | 6840 | 44221 | 5663 | 52774 | 4586 | 56899 | 3747 | 61019 | 2491 | 75915 | 1860 | 53216 |
| 6L-5S | | MI | 28829 | 6840 | 43650 | 5645 | 52160 | 4558 | 56420 | 3738 | 60982 | 2471 | 75967 | 1948 | 51836 |
| 18-#14 | 2.00 | MA | 28298 | 6840 | 42886 | 5664 | 51007 | 4586 | 54739 | 3760 | 58016 | 2485 | 72322 | 1757 | 52091 |
| 7L-4S | | MI | 29796 | 6840 | 45121 | 5629 | 53925 | 4559 | 58574 | 3725 | 63915 | 2463 | 79724 | 2014 | 52754 |
| 18-#14 | 2.00 | MA | 27357 | 6840 | 41571 | 5666 | 49275 | 4586 | 52576 | 3759 | 55118 | 2495 | 68615 | 1680 | 50474 |
| 8L-3S | | MI | 30865 | 6840 | 46575 | 5628 | 55891 | 4545 | 60956 | 3728 | 67131 | 2469 | 83326 | 2146 | 53006 |
| 18-#14 | 2.00 | MA | 26423 | 6840 | 40120 | 5683 | 47490 | 4601 | 50448 | 3772 | 52248 | 2504 | 64951 | 1595 | 48826 |
| 9L-2S | | MI | 32347 | 6840 | 48533 | 5627 | 58374 | 4545 | 63965 | 3715 | 71190 | 2461 | 88789 | 2277 | 53136 |

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

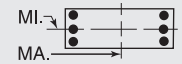
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 3.56 | MA | 35562 | 7985 | 58675 | 6328 | 70722 | 5078 | 78551 | 4051 | 90137 | 2400 | 114838 | 1643 | 94167 |
| 4L-7S | | MI | 29227 | 7985 | 48958 | 6340 | 58335 | 5080 | 63723 | 4070 | 70580 | 2395 | 89862 | 1117 | 80287 |
| 18-#18 | 3.56 | MA | 33882 | 7985 | 55958 | 6356 | 67461 | 5075 | 74571 | 4071 | 84718 | 2414 | 107938 | 1526 | 91163 |
| 5L-6S | | MI | 30730 | 7985 | 51195 | 6339 | 61294 | 5083 | 67338 | 4050 | 75586 | 2408 | 95725 | 1299 | 83425 |
| 18-#18 | 3.56 | MA | 32271 | 7985 | 53544 | 6358 | 64242 | 5100 | 70653 | 4066 | 79507 | 2428 | 100947 | 1333 | 87753 |
| 6L-5S | | MI | 32266 | 7985 | 53492 | 6338 | 64356 | 5060 | 71065 | 4057 | 80524 | 2395 | 102324 | 1493 | 86681 |
| 18-#18 | 3.56 | MA | 30693 | 7985 | 51194 | 6359 | 61132 | 5098 | 66854 | 4087 | 74223 | 2415 | 94731 | 1151 | 84452 |
| 7L-4S | | MI | 33867 | 7985 | 56077 | 6311 | 67459 | 5063 | 74851 | 4037 | 85659 | 2382 | 108851 | 1608 | 89460 |
| 18-#18 | 3.56 | MA | 29133 | 7985 | 48880 | 6361 | 58085 | 5096 | 63047 | 4081 | 69125 | 2429 | 88287 | 1016 | 79991 |
| 8L-3S | | MI | 35638 | 7985 | 58631 | 6311 | 70910 | 5039 | 79034 | 4044 | 91284 | 2395 | 115069 | 1842 | 91787 |
| 20-#11 | 1.54 | MA | 32007 | 6502 | 46423 | 5445 | 55817 | 4415 | 60675 | 3638 | 66143 | 2492 | 82166 | 2353 | 43448 |
| 2L-10S | | MI | 24822 | 6502 | 36534 | 5462 | 43126 | 4435 | 45462 | 3660 | 46187 | 2506 | 56608 | 1768 | 37650 |
| 20-#11 | 1.54 | MA | 30896 | 6502 | 44984 | 5447 | 53993 | 4415 | 58465 | 3648 | 63161 | 2499 | 78109 | 2261 | 43391 |
| 3L-9S | | MI | 25463 | 6502 | 37403 | 5461 | 44267 | 4435 | 46881 | 3661 | 48145 | 2510 | 59125 | 1848 | 38429 |
| 20-#11 | 1.54 | MA | 30097 | 6502 | 43919 | 5448 | 52552 | 4426 | 56718 | 3647 | 60804 | 2496 | 75428 | 2170 | 43284 |
| 4L-8S | | MI | 26096 | 6502 | 38366 | 5449 | 45451 | 4425 | 48293 | 3652 | 50049 | 2503 | 61559 | 1907 | 39303 |
| 20-#11 | 1.54 | MA | 29375 | 6502 | 42842 | 5460 | 51260 | 4426 | 55140 | 3656 | 58655 | 2503 | 72647 | 2123 | 43101 |
| 5L-7S | | MI | 26733 | 6502 | 39239 | 5448 | 46600 | 4425 | 49729 | 3653 | 51973 | 2497 | 64021 | 1961 | 39861 |
| 20-#11 | 1.54 | MA | 28683 | 6502 | 41886 | 5461 | 49984 | 4437 | 53588 | 3655 | 56590 | 2510 | 69813 | 2048 | 42431 |
| 6E | | MI | 27378 | 6502 | 40125 | 5447 | 47773 | 4425 | 51162 | 3644 | 53966 | 2501 | 66408 | 2032 | 40433 |
| 20-#11 | 1.54 | MA | 28007 | 6502 | 40955 | 5463 | 48753 | 4437 | 52083 | 3665 | 54497 | 2507 | 67288 | 1977 | 41812 |
| 7L-5S | | MI | 28036 | 6502 | 41035 | 5446 | 48987 | 4414 | 52640 | 3646 | 55932 | 2494 | 69089 | 2107 | 41068 |
| 20-#11 | 1.54 | MA | 27338 | 6502 | 40040 | 5464 | 47546 | 4438 | 50575 | 3664 | 52477 | 2514 | 64690 | 1923 | 41220 |
| 8L-4S | | MI | 28724 | 6502 | 42060 | 5434 | 50218 | 4414 | 54143 | 3637 | 57978 | 2487 | 71724 | 2153 | 41235 |
| 20-#11 | 1.54 | MA | 26674 | 6502 | 39028 | 5476 | 46303 | 4448 | 49092 | 3673 | 50477 | 2521 | 62115 | 1865 | 40282 |
| 9L-3S | | MI | 29485 | 6502 | 43075 | 5433 | 51589 | 4404 | 55804 | 3638 | 60221 | 2491 | 74257 | 2245 | 41331 |
| 20-#11 | 1.54 | MA | 26001 | 6502 | 38116 | 5478 | 45105 | 4449 | 47602 | 3672 | 48421 | 2517 | 59454 | 1785 | 39453 |
| 10L-2S | | MI | 30541 | 6502 | 44442 | 5432 | 53324 | 4404 | 57906 | 3629 | 63056 | 2485 | 78096 | 2336 | 41381 |
| 20-#14 | 2.22 | MA | 33324 | 7003 | 50726 | 5745 | 61137 | 4632 | 67059 | 3786 | 74715 | 2470 | 93510 | 2150 | 61739 |
| 3L-9S | | MI | 26179 | 7003 | 40397 | 5768 | 47872 | 4661 | 51166 | 3805 | 53871 | 2484 | 67249 | 1557 | 52117 |
| 20-#14 | 2.22 | MA | 32212 | 7003 | 49198 | 5746 | 59071 | 4647 | 64555 | 3784 | 71335 | 2464 | 89697 | 2018 | 61438 |
| 4L-8S | | MI | 27060 | 7003 | 41779 | 5752 | 49571 | 4646 | 53193 | 3793 | 56603 | 2475 | 70712 | 1642 | 53718 |
| 20-#14 | 2.22 | MA | 31208 | 7003 | 47653 | 5763 | 57217 | 4646 | 62292 | 3797 | 68253 | 2474 | 85729 | 1951 | 60353 |
| 5L-7S | | MI | 27947 | 7003 | 43031 | 5750 | 51219 | 4647 | 55252 | 3795 | 59362 | 2466 | 74221 | 1719 | 55190 |
| 20-#14 | 2.22 | MA | 30246 | 7003 | 46281 | 5765 | 55387 | 4661 | 60064 | 3795 | 65290 | 2483 | 81694 | 1843 | 59158 |
| 6E | | MI | 28845 | 7003 | 44302 | 5749 | 52902 | 4648 | 57308 | 3783 | 62221 | 2473 | 77615 | 1821 | 56333 |
| 20-#14 | 2.22 | MA | 29304 | 7003 | 44946 | 5766 | 53620 | 4661 | 57905 | 3808 | 62287 | 2478 | 78100 | 1740 | 57957 |
| 7L-5S | | MI | 29762 | 7003 | 45608 | 5748 | 54644 | 4633 | 59428 | 3785 | 65041 | 2464 | 81430 | 1929 | 57440 |
| 20-#14 | 2.22 | MA | 28373 | 7003 | 43632 | 5768 | 51888 | 4661 | 55741 | 3806 | 59389 | 2487 | 74394 | 1663 | 56378 |
| 8L-4S | | MI | 30719 | 7003 | 47079 | 5731 | 56409 | 4634 | 61582 | 3773 | 67974 | 2455 | 85187 | 1996 | 58485 |
| 20-#14 | 2.22 | MA | 27449 | 7003 | 42180 | 5785 | 50103 | 4676 | 53613 | 3819 | 56519 | 2496 | 70729 | 1578 | 54687 |
| 9L-3S | | MI | 31777 | 7003 | 48533 | 5730 | 58374 | 4620 | 63965 | 3775 | 71190 | 2462 | 88789 | 2127 | 58764 |
| 20-#14 | 2.22 | MA | 26528 | 7003 | 40871 | 5786 | 48384 | 4676 | 51475 | 3817 | 53568 | 2491 | 66941 | 1463 | 52896 |
| 10L-2S | | MI | 33247 | 7003 | 50491 | 5729 | 60858 | 4620 | 66973 | 3763 | 75249 | 2453 | 94252 | 2259 | 58916 |
| 20-#18 | 3.95 | MA | 35508 | 8275 | 59569 | 6538 | 72041 | 5208 | 80120 | 4156 | 92204 | 2401 | 117951 | 1490 | 101548 |
| 5L-7S | | MI | 30810 | 8275 | 52388 | 6521 | 62685 | 5213 | 68993 | 4154 | 77670 | 2381 | 99314 | 1078 | 89925 |
| 20-#18 | 3.95 | MA | 33921 | 8275 | 57155 | 6540 | 68822 | 5233 | 76202 | 4150 | 86993 | 2414 | 110960 | 1297 | 98008 |
| 6E | | MI | 32291 | 8275 | 54625 | 6521 | 65644 | 5216 | 72608 | 4135 | 82676 | 2394 | 105178 | 1260 | 93144 |
| 20-#18 | 3.95 | MA | 32367 | 8275 | 54805 | 6541 | 65712 | 5231 | 72403 | 4171 | 81710 | 2402 | 104744 | 1115 | 94629 |
| 7L-5S | | MI | 33804 | 8275 | 56922 | 6520 | 68706 | 5193 | 76335 | 4141 | 87614 | 2381 | 111777 | 1454 | 96531 |
| 20-#18 | 3.95 | MA | 30831 | 8275 | 52491 | 6542 | 62665 | 5229 | 68596 | 4165 | 76611 | 2415 | 98300 | 980 | 90266 |
| 8L-4S | | MI | 35382 | 8275 | 59507 | 6493 | 71808 | 5196 | 80121 | 4122 | 92749 | 2367 | 118304 | 1569 | 99205 |
| 22-#11 | 1.70 | MA | 32693 | 6615 | 47861 | 5516 | 57642 | 4467 | 62885 | 3671 | 69125 | 2487 | 86224 | 2342 | 47703 |
| 2L-11S | | MI | 24862 | 6615 | 37040 | 5534 | 43689 | 4497 | 46159 | 3702 | 47126 | 2508 | 58027 | 1700 | 40499 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

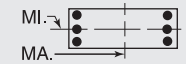



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.70 | MA | 31589 | 6615 | 46423 | 5517 | 55817 | 4467 | 60675 | 3681 | 66143 | 2494 | 82166 | 2251 | 47634 |
| 3L-10S | | MI | 25526 | 6615 | 37902 | 5533 | 44860 | 4487 | 47563 | 3693 | 49022 | 2501 | 60446 | 1757 | 41542 |
| 22-#11 | 1.70 | MA | 30796 | 6615 | 45357 | 5519 | 54377 | 4478 | 58929 | 3680 | 63786 | 2490 | 79486 | 2160 | 47513 |
| 4L-9S | | MI | 26151 | 6615 | 38771 | 5532 | 46001 | 4487 | 48982 | 3694 | 50980 | 2505 | 62963 | 1837 | 42353 |
| 22-#11 | 1.70 | MA | 30080 | 6615 | 44280 | 5531 | 53084 | 4478 | 57351 | 3689 | 61637 | 2498 | 76705 | 2112 | 47314 |
| 5L-8S | | MI | 26778 | 6615 | 39734 | 5520 | 47186 | 4476 | 50395 | 3685 | 52884 | 2498 | 65398 | 1895 | 43208 |
| 22-#11 | 1.70 | MA | 29394 | 6615 | 43324 | 5532 | 51809 | 4489 | 55798 | 3688 | 59572 | 2505 | 73871 | 2038 | 46579 |
| 6L-7S | | MI | 27410 | 6615 | 40606 | 5519 | 48335 | 4477 | 51830 | 3686 | 54808 | 2492 | 67860 | 1949 | 43816 |
| 22-#11 | 1.70 | MA | 28723 | 6615 | 42394 | 5534 | 50577 | 4489 | 54293 | 3698 | 57478 | 2501 | 71346 | 1967 | 45976 |
| 7L-6S | | MI | 28050 | 6615 | 41492 | 5518 | 49508 | 4477 | 53263 | 3677 | 56801 | 2495 | 70247 | 2020 | 44374 |
| 22-#11 | 1.70 | MA | 28060 | 6615 | 41478 | 5535 | 49371 | 4489 | 52786 | 3697 | 55459 | 2508 | 68748 | 1912 | 45333 |
| 8L-5S | | MI | 28704 | 6615 | 42403 | 5516 | 50722 | 4466 | 54742 | 3679 | 58767 | 2489 | 72927 | 2095 | 45073 |
| 22-#11 | 1.70 | MA | 27401 | 6615 | 40467 | 5547 | 48127 | 4500 | 51302 | 3706 | 53459 | 2516 | 66173 | 1854 | 44416 |
| 9L-4S | | MI | 29386 | 6615 | 43428 | 5505 | 51952 | 4466 | 56244 | 3669 | 60813 | 2482 | 75563 | 2142 | 45255 |
| 22-#11 | 1.70 | MA | 26736 | 6615 | 39555 | 5548 | 46929 | 4500 | 49812 | 3705 | 51403 | 2512 | 63512 | 1774 | 43554 |
| 10L-3S | | MI | 30141 | 6615 | 44442 | 5504 | 53324 | 4456 | 57906 | 3671 | 63056 | 2486 | 78096 | 2233 | 45366 |
| 22-#11 | 1.70 | MA | 26038 | 6615 | 38649 | 5550 | 45700 | 4511 | 48338 | 3715 | 49411 | 2519 | 60958 | 1716 | 42439 |
| 11L-2S | | MI | 31190 | 6615 | 45810 | 5502 | 55058 | 4456 | 60007 | 3662 | 65891 | 2479 | 81935 | 2324 | 45427 |
| 22-#14 | 2.45 | MA | 33176 | 7167 | 51258 | 5849 | 61684 | 4721 | 67721 | 3831 | 75606 | 2457 | 95476 | 2001 | 67468 |
| 4L-9S | | MI | 27138 | 7167 | 42355 | 5870 | 50355 | 4735 | 54175 | 3852 | 57930 | 2476 | 72712 | 1538 | 57683 |
| 22-#14 | 2.45 | MA | 32182 | 7167 | 49713 | 5865 | 59829 | 4721 | 65457 | 3844 | 72524 | 2466 | 91508 | 1934 | 66267 |
| 5L-8S | | MI | 28009 | 7167 | 43737 | 5854 | 52054 | 4721 | 56201 | 3840 | 60662 | 2467 | 76175 | 1623 | 59328 |
| 22-#14 | 2.45 | MA | 31229 | 7167 | 48341 | 5867 | 58000 | 4736 | 63230 | 3842 | 69561 | 2476 | 87472 | 1826 | 65106 |
| 6L-7S | | MI | 28887 | 7167 | 44989 | 5853 | 53703 | 4722 | 58261 | 3842 | 63421 | 2459 | 79684 | 1700 | 60764 |
| 22-#14 | 2.45 | MA | 30298 | 7167 | 47006 | 5869 | 56232 | 4736 | 61070 | 3855 | 66558 | 2470 | 83879 | 1723 | 63832 |
| 7L-6S | | MI | 29776 | 7167 | 46260 | 5851 | 55385 | 4722 | 60316 | 3830 | 66280 | 2465 | 83079 | 1802 | 61981 |
| 22-#14 | 2.45 | MA | 29376 | 7167 | 45692 | 5870 | 54501 | 4736 | 58907 | 3853 | 63660 | 2480 | 80173 | 1646 | 62290 |
| 8L-5S | | MI | 30684 | 7167 | 47566 | 5850 | 57127 | 4708 | 62437 | 3833 | 69100 | 2457 | 86893 | 1911 | 63055 |
| 22-#14 | 2.45 | MA | 28462 | 7167 | 44240 | 5887 | 52716 | 4751 | 56779 | 3866 | 60790 | 2489 | 76508 | 1561 | 60506 |
| 9L-4S | | MI | 31631 | 7167 | 49037 | 5834 | 58892 | 4709 | 64591 | 3820 | 72033 | 2448 | 90650 | 1977 | 64214 |
| 22-#14 | 2.45 | MA | 27551 | 7167 | 42931 | 5889 | 50997 | 4751 | 54640 | 3864 | 57839 | 2483 | 72719 | 1446 | 58787 |
| 10L-3S | | MI | 32680 | 7167 | 50491 | 5832 | 60858 | 4694 | 66973 | 3823 | 75249 | 2454 | 94252 | 2109 | 64517 |
| 22-#18 | 4.35 | MA | 35547 | 8566 | 60767 | 6721 | 73402 | 5366 | 81751 | 4234 | 94479 | 2401 | 120973 | 1261 | 108282 |
| 6L-7S | | MI | 32369 | 8566 | 55818 | 6703 | 67034 | 5346 | 74262 | 4238 | 84760 | 2366 | 108767 | 1039 | 99580 |
| 22-#18 | 4.35 | MA | 34015 | 8566 | 58417 | 6723 | 70292 | 5364 | 77951 | 4255 | 89196 | 2388 | 114757 | 1079 | 104823 |
| 7L-6S | | MI | 33829 | 8566 | 58054 | 6703 | 69993 | 5349 | 77877 | 4219 | 89766 | 2380 | 114631 | 1221 | 102882 |
| 22-#18 | 4.35 | MA | 32501 | 8566 | 56103 | 6724 | 67245 | 5362 | 74145 | 4249 | 84098 | 2402 | 108313 | 944 | 100555 |
| 8L-5S | | MI | 35321 | 8566 | 60351 | 6702 | 73056 | 5326 | 81605 | 4226 | 94704 | 2366 | 121230 | 1415 | 106395 |
| 24-#11 | 1.85 | MA | 32276 | 6729 | 47861 | 5588 | 57642 | 4519 | 62885 | 3713 | 69125 | 2489 | 86224 | 2240 | 51874 |
| 3L-11S | | MI | 25552 | 6729 | 38407 | 5605 | 45424 | 4549 | 48261 | 3735 | 49961 | 2502 | 61866 | 1688 | 44415 |
| 24-#11 | 1.85 | MA | 31488 | 6729 | 46796 | 5590 | 56201 | 4530 | 61139 | 3712 | 66768 | 2485 | 83544 | 2149 | 51739 |
| 4L-10S | | MI | 26212 | 6729 | 39270 | 5604 | 46595 | 4539 | 49664 | 3726 | 51857 | 2496 | 64285 | 1745 | 45439 |
| 24-#11 | 1.85 | MA | 30778 | 6729 | 45718 | 5602 | 54908 | 4530 | 59561 | 3722 | 64619 | 2492 | 80762 | 2102 | 51526 |
| 5L-9S | | MI | 26831 | 6729 | 40138 | 5603 | 47736 | 4539 | 51083 | 3727 | 53815 | 2500 | 66802 | 1825 | 46282 |
| 24-#11 | 1.85 | MA | 30097 | 6729 | 44763 | 5603 | 53633 | 4541 | 58008 | 3721 | 62554 | 2499 | 77929 | 2027 | 50732 |
| 6L-8S | | MI | 27454 | 6729 | 41102 | 5591 | 48920 | 4528 | 52496 | 3718 | 55719 | 2493 | 69237 | 1884 | 47118 |
| 24-#11 | 1.85 | MA | 29431 | 6729 | 43832 | 5605 | 52401 | 4541 | 56503 | 3730 | 60460 | 2496 | 75404 | 1956 | 50142 |
| 7E | | MI | 28081 | 6729 | 41974 | 5590 | 50069 | 4528 | 53932 | 3719 | 57643 | 2486 | 71698 | 1938 | 47775 |
| 24-#11 | 1.85 | MA | 28773 | 6729 | 42917 | 5606 | 51195 | 4541 | 54996 | 3730 | 58441 | 2503 | 72805 | 1902 | 49451 |
| 8L-6S | | MI | 28716 | 6729 | 42860 | 5589 | 51242 | 4528 | 55365 | 3710 | 59636 | 2490 | 74085 | 2008 | 48319 |
| 24-#11 | 1.85 | MA | 28120 | 6729 | 41905 | 5618 | 49951 | 4552 | 53513 | 3739 | 56441 | 2510 | 70231 | 1843 | 48554 |
| 9L-5S | | MI | 29365 | 6729 | 43770 | 5587 | 52456 | 4518 | 56843 | 3711 | 61602 | 2484 | 76766 | 2083 | 49077 |
| 24-#11 | 1.85 | MA | 27470 | 6729 | 40993 | 5619 | 48753 | 4552 | 52023 | 3738 | 54384 | 2507 | 67570 | 1763 | 47661 |
| 10L-4S | | MI | 30042 | 6729 | 44796 | 5576 | 53687 | 4518 | 58345 | 3702 | 63648 | 2477 | 79401 | 2130 | 49273 |
| 24-#11 | 1.85 | MA | 26766 | 6729 | 40088 | 5621 | 47524 | 4563 | 50549 | 3748 | 52393 | 2514 | 65016 | 1706 | 46565 |
| 11L-3S | | MI | 30792 | 6729 | 45810 | 5575 | 55058 | 4508 | 60007 | 3704 | 65891 | 2481 | 81935 | 2221 | 49397 |
| 24-#11 | 1.85 | MA | 26074 | 6729 | 39187 | 5622 | 46329 | 4563 | 49067 | 3747 | 50411 | 2521 | 62462 | 1648 | 45402 |
| 12L-2S | | MI | 31834 | 6729 | 47177 | 5573 | 56793 | 4508 | 62108 | 3695 | 68726 | 2474 | 85774 | 2312 | 49470 |
| 24-#14 | 2.67 | MA | 33144 | 7330 | 51773 | 5968 | 62442 | 4796 | 68623 | 3892 | 76795 | 2459 | 97286 | 1917 | 72189 |
| 5L-9S | | MI | 28084 | 7330 | 44313 | 5972 | 52838 | 4810 | 57183 | 3900 | 61989 | 2469 | 78175 | 1520 | 63212 |

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#14 | 2.67 | MA | 32201 | 7330 | 50401 | 5969 | 60613 | 4811 | 66395 | 3890 | 73832 | 2468 | 93251 | 1809 | 71061 |
| 6L-8S | | MI | 28947 | 7330 | 45695 | 5956 | 54537 | 4796 | 59209 | 3887 | 64721 | 2460 | 81638 | 1605 | 64945 |
| 24-#14 | 2.67 | MA | 31279 | 7330 | 49066 | 5971 | 58845 | 4811 | 64236 | 3903 | 70828 | 2463 | 89658 | 1706 | 69716 |
| 7E | | MI | 29816 | 7330 | 46947 | 5955 | 56186 | 4797 | 61269 | 3890 | 67479 | 2451 | 85147 | 1682 | 66347 |
| 24-#14 | 2.67 | MA | 30367 | 7330 | 47752 | 5973 | 57114 | 4811 | 62073 | 3901 | 67930 | 2472 | 85951 | 1629 | 68209 |
| 8L-6S | | MI | 30696 | 7330 | 48218 | 5953 | 57868 | 4797 | 63325 | 3877 | 70339 | 2458 | 88542 | 1784 | 67635 |
| 24-#14 | 2.67 | MA | 29462 | 7330 | 46301 | 5989 | 55329 | 4825 | 59944 | 3914 | 65061 | 2482 | 82287 | 1544 | 66384 |
| 9L-5S | | MI | 31595 | 7330 | 49524 | 5952 | 59610 | 4783 | 65445 | 3880 | 73159 | 2449 | 92356 | 1892 | 68678 |
| 24-#14 | 2.67 | MA | 28560 | 7330 | 44992 | 5991 | 53610 | 4825 | 57806 | 3912 | 62110 | 2476 | 78498 | 1429 | 64634 |
| 10L-4S | | MI | 32533 | 7330 | 50995 | 5936 | 61375 | 4784 | 67599 | 3867 | 76092 | 2440 | 96114 | 1959 | 69943 |
| 24-#18 | 4.74 | MA | 35640 | 8857 | 62028 | 6904 | 74873 | 5497 | 83500 | 4339 | 96682 | 2375 | 124770 | 1043 | 115034 |
| 7E | | MI | 33906 | 8857 | 59247 | 6885 | 71384 | 5479 | 79532 | 4323 | 91850 | 2352 | 118220 | 1000 | 109253 |
| 24-#18 | 4.74 | MA | 34147 | 8857 | 59714 | 6906 | 71825 | 5495 | 79694 | 4334 | 91584 | 2389 | 118326 | 908 | 110856 |
| 8L-6S | | MI | 35346 | 8857 | 61484 | 6884 | 74343 | 5482 | 83147 | 4303 | 96856 | 2365 | 124084 | 1182 | 112637 |

## RECTANGULAR TIED COLUMNS 44" x 48"

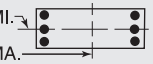
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.14 | MA | 32698 | 6473 | 46591 | 5454 | 55448 | 4437 | 59475 | 3683 | 63035 | 2596 | 76808 | 2449 | 34798 |
| 2L-3S | | MI | 27154 | 6473 | 39409 | 5423 | 46382 | 4409 | 49020 | 3681 | 50247 | 2590 | 60067 | 2182 | 31580 |
| 6-#18 | 1.14 | MA | 29718 | 6473 | 42798 | 5456 | 50638 | 4436 | 53647 | 3705 | 55172 | 2611 | 66235 | 2215 | 34690 |
| 3L-2S | | MI | 29845 | 6473 | 42838 | 5423 | 50732 | 4412 | 54289 | 3661 | 57337 | 2577 | 69520 | 2415 | 31643 |
| 8-#18 | 1.52 | MA | 34524 | 6764 | 50384 | 5636 | 60259 | 4570 | 65303 | 3767 | 70898 | 2583 | 87382 | 2415 | 46050 |
| 2L-4S | | MI | 26908 | 6764 | 40285 | 5606 | 47280 | 4565 | 50106 | 3758 | 51711 | 2562 | 63301 | 1909 | 41041 |
| 8-#18 | 1.52 | MA | 31593 | 6764 | 46591 | 5638 | 55448 | 4569 | 59475 | 3789 | 63035 | 2598 | 76808 | 2182 | 45837 |
| 3E | | MI | 28833 | 6764 | 42838 | 5605 | 50732 | 4542 | 54289 | 3765 | 57337 | 2576 | 69520 | 2143 | 41665 |
| 8-#18 | 1.52 | MA | 29471 | 6764 | 43774 | 5640 | 51640 | 4594 | 54859 | 3784 | 56805 | 2587 | 69838 | 1948 | 45078 |
| 4L-2S | | MI | 31480 | 6764 | 46268 | 5605 | 55082 | 4545 | 59559 | 3745 | 64427 | 2562 | 78973 | 2376 | 41830 |
| 10-#14 | 1.07 | MA | 32483 | 6419 | 45723 | 5451 | 54633 | 4438 | 58613 | 3689 | 61957 | 2615 | 75741 | 2487 | 32944 |
| 2L-5S | | MI | 25991 | 6419 | 37162 | 5441 | 43794 | 4428 | 45989 | 3691 | 46253 | 2611 | 55837 | 2128 | 29591 |
| 10-#14 | 1.07 | MA | 30777 | 6419 | 43560 | 5453 | 51891 | 4438 | 55290 | 3702 | 57474 | 2626 | 69647 | 2355 | 32913 |
| 3L-4S | | MI | 27004 | 6419 | 38633 | 5425 | 45559 | 4428 | 48144 | 3679 | 49186 | 2603 | 59594 | 2195 | 29863 |
| 10-#14 | 1.07 | MA | 29545 | 6419 | 41958 | 5455 | 49724 | 4453 | 52664 | 3701 | 53930 | 2621 | 65622 | 2224 | 32774 |
| 4L-3S | | MI | 28122 | 6419 | 40087 | 5424 | 47524 | 4414 | 50526 | 3681 | 52402 | 2609 | 63196 | 2326 | 29965 |
| 10-#14 | 1.07 | MA | 28430 | 6419 | 40338 | 5472 | 47781 | 4454 | 50291 | 3714 | 50699 | 2631 | 61443 | 2156 | 32431 |
| 5L-2S | | MI | 29665 | 6419 | 42045 | 5422 | 50008 | 4415 | 53535 | 3669 | 56461 | 2600 | 68659 | 2457 | 29978 |
| 10-#18 | 1.89 | MA | 36306 | 7055 | 54177 | 5817 | 65070 | 4703 | 71131 | 3851 | 78762 | 2570 | 97956 | 2382 | 57270 |
| 2L-5S | | MI | 26864 | 7055 | 41129 | 5815 | 48528 | 4695 | 51590 | 3862 | 53667 | 2561 | 66227 | 1755 | 47784 |
| 10-#18 | 1.89 | MA | 33421 | 7055 | 50384 | 5820 | 60259 | 4702 | 65303 | 3873 | 70898 | 2585 | 87382 | 2148 | 56965 |
| 3L-4S | | MI | 28579 | 7055 | 43714 | 5788 | 51630 | 4698 | 55376 | 3842 | 58801 | 2548 | 72754 | 1870 | 51004 |
| 10-#18 | 1.89 | MA | 31336 | 7055 | 47567 | 5822 | 56450 | 4727 | 60687 | 3869 | 64668 | 2574 | 80412 | 1915 | 56106 |
| 4L-3S | | MI | 30470 | 7055 | 46268 | 5787 | 55082 | 4675 | 59559 | 3849 | 64427 | 2561 | 78973 | 2104 | 51728 |
| 10-#18 | 1.89 | MA | 29448 | 7055 | 44717 | 5850 | 53030 | 4726 | 56513 | 3891 | 59984 | 2589 | 73138 | 1796 | 52498 |
| 5L-2S | | MI | 33077 | 7055 | 49698 | 5786 | 59431 | 4678 | 64829 | 3830 | 71517 | 2548 | 88426 | 2337 | 51980 |
| 12-#14 | 1.28 | MA | 33545 | 6582 | 47885 | 5553 | 57376 | 4513 | 61935 | 3736 | 66440 | 2608 | 81836 | 2471 | 39362 |
| 2L-6S | | MI | 26022 | 6582 | 37814 | 5545 | 44535 | 4517 | 46878 | 3736 | 47492 | 2612 | 57486 | 2001 | 34014 |
| 12-#14 | 1.28 | MA | 31855 | 6582 | 45723 | 5555 | 54633 | 4513 | 58613 | 3750 | 61957 | 2618 | 75741 | 2339 | 39299 |
| 3L-5S | | MI | 26982 | 6582 | 39120 | 5543 | 46277 | 4502 | 48998 | 3739 | 50312 | 2604 | 61300 | 2110 | 35301 |
| 12-#14 | 1.28 | MA | 30637 | 6582 | 44120 | 5557 | 52467 | 4528 | 55987 | 3748 | 58413 | 2613 | 71716 | 2208 | 39121 |
| 4E | | MI | 27984 | 6582 | 40591 | 5527 | 48042 | 4503 | 51152 | 3726 | 53245 | 2595 | 65058 | 2176 | 35613 |
| 12-#14 | 1.28 | MA | 29535 | 6582 | 42501 | 5574 | 50523 | 4529 | 53614 | 3762 | 55182 | 2623 | 67537 | 2140 | 38738 |
| 5L-3S | | MI | 29090 | 6582 | 42045 | 5526 | 50008 | 4489 | 53535 | 3729 | 56461 | 2601 | 68659 | 2308 | 35753 |
| 12-#14 | 1.28 | MA | 28478 | 6582 | 41063 | 5576 | 48606 | 4544 | 51279 | 3760 | 52076 | 2633 | 63281 | 2032 | 37278 |
| 6L-2S | | MI | 30618 | 6582 | 44003 | 5525 | 52491 | 4489 | 56543 | 3716 | 60520 | 2593 | 74122 | 2439 | 35797 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 2.27 | MA | 38051 | 7346 | 57970 | 5999 | 69880 | 4836 | 76960 | 3936 | 86625 | 2557 | 108529 | 2348 | 68469 |
| 2L-6S | | MI | 26907 | 7346 | 42262 | 5997 | 49815 | 4851 | 53132 | 3940 | 55819 | 2560 | 69082 | 1522 | 54926 |
| 12-#18 | 2.27 | MA | 35208 | 7346 | 54177 | 6001 | 65070 | 4835 | 71131 | 3958 | 78762 | 2572 | 97956 | 2115 | 68083 |
| 3L-5S | | MI | 28525 | 7346 | 44559 | 5996 | 52877 | 4828 | 56860 | 3946 | 60757 | 2547 | 75680 | 1716 | 57547 |
| 12-#18 | 2.27 | MA | 33158 | 7346 | 51360 | 6003 | 61261 | 4860 | 66515 | 3953 | 72531 | 2560 | 90986 | 1881 | 67041 |
| 4E | | MI | 30211 | 7346 | 47144 | 5969 | 55980 | 4831 | 60646 | 3927 | 65891 | 2534 | 82207 | 1831 | 60771 |
| 12-#18 | 2.27 | MA | 31302 | 7346 | 48510 | 6032 | 57841 | 4859 | 62341 | 3975 | 66848 | 2575 | 83711 | 1763 | 63330 |
| 5L-3S | | MI | 32072 | 7346 | 49698 | 5969 | 59431 | 4808 | 64829 | 3934 | 71517 | 2547 | 88426 | 2064 | 61778 |
| 12-#18 | 2.27 | MA | 29523 | 7346 | 45979 | 6034 | 54466 | 4884 | 58232 | 3970 | 61383 | 2590 | 76329 | 1570 | 60405 |
| 6L-2S | | MI | 34642 | 7346 | 53127 | 5968 | 63781 | 4811 | 70098 | 3914 | 78607 | 2534 | 97878 | 2298 | 62107 |
| 14-#11 | 1.03 | MA | 32392 | 6395 | 45322 | 5451 | 54271 | 4440 | 58236 | 3693 | 61493 | 2625 | 75297 | 2504 | 32132 |
| 2L-7S | | MI | 25682 | 6395 | 36473 | 5441 | 42961 | 4438 | 45029 | 3698 | 44977 | 2623 | 54231 | 2102 | 28163 |
| 14-#11 | 1.03 | MA | 31198 | 6395 | 43813 | 5453 | 52356 | 4440 | 55917 | 3702 | 58364 | 2632 | 71020 | 2413 | 32115 |
| 3L-6S | | MI | 26345 | 6395 | 37359 | 5440 | 44134 | 4438 | 46462 | 3689 | 46970 | 2626 | 56618 | 2173 | 28799 |
| 14-#11 | 1.03 | MA | 30338 | 6395 | 42696 | 5455 | 50846 | 4451 | 54087 | 3702 | 55893 | 2630 | 68193 | 2322 | 32057 |
| 4L-5S | | MI | 27022 | 6395 | 38270 | 5438 | 45348 | 4428 | 47940 | 3691 | 48936 | 2620 | 59299 | 2248 | 29104 |
| 14-#11 | 1.03 | MA | 29562 | 6395 | 41567 | 5467 | 49491 | 4452 | 52433 | 3712 | 53641 | 2637 | 65266 | 2275 | 31928 |
| 5L-4S | | MI | 27728 | 6395 | 39295 | 5427 | 46579 | 4428 | 49443 | 3682 | 50982 | 2613 | 61934 | 2295 | 29203 |
| 14-#11 | 1.03 | MA | 28817 | 6395 | 40566 | 5468 | 48155 | 4463 | 50806 | 3711 | 51477 | 2645 | 62279 | 2200 | 31564 |
| 6L-3S | | MI | 28508 | 6395 | 40309 | 5426 | 47950 | 4417 | 51105 | 3683 | 53225 | 2617 | 64468 | 2386 | 29243 |
| 14-#11 | 1.03 | MA | 28089 | 6395 | 39591 | 5470 | 46865 | 4463 | 49229 | 3721 | 49283 | 2642 | 59616 | 2129 | 30830 |
| 7L-2S | | MI | 29588 | 6395 | 41677 | 5424 | 49685 | 4417 | 53206 | 3674 | 56060 | 2610 | 68306 | 2477 | 29248 |
| 14-#14 | 1.49 | MA | 34591 | 6746 | 50048 | 5655 | 60119 | 4587 | 65258 | 3783 | 70923 | 2601 | 87930 | 2455 | 45767 |
| 2L-7S | | MI | 26078 | 6746 | 38501 | 5648 | 45336 | 4591 | 47830 | 3796 | 48692 | 2599 | 59554 | 1880 | 38764 |
| 14-#14 | 1.49 | MA | 32917 | 6746 | 47885 | 5657 | 57376 | 4588 | 61935 | 3797 | 66440 | 2611 | 81836 | 2324 | 45677 |
| 3L-6S | | MI | 27008 | 6746 | 39772 | 5647 | 47018 | 4592 | 49886 | 3783 | 51551 | 2605 | 62949 | 1983 | 39627 |
| 14-#14 | 1.49 | MA | 31712 | 6746 | 46283 | 5659 | 55210 | 4603 | 59309 | 3796 | 62895 | 2606 | 77810 | 2192 | 45464 |
| 4L-5S | | MI | 27958 | 6746 | 41078 | 5646 | 48760 | 4577 | 52006 | 3786 | 54371 | 2596 | 66763 | 2091 | 40879 |
| 14-#14 | 1.49 | MA | 30622 | 6746 | 44663 | 5676 | 53266 | 4603 | 56937 | 3809 | 59664 | 2616 | 73632 | 2124 | 44933 |
| 5L-4S | | MI | 28948 | 6746 | 42549 | 5629 | 50525 | 4578 | 54161 | 3774 | 57304 | 2588 | 70521 | 2158 | 41357 |
| 14-#14 | 1.49 | MA | 29578 | 6746 | 43226 | 5678 | 51348 | 4619 | 54602 | 3808 | 56559 | 2626 | 69376 | 2016 | 43491 |
| 6L-3S | | MI | 30043 | 6746 | 44003 | 5628 | 52491 | 4564 | 56543 | 3776 | 60520 | 2594 | 74122 | 2289 | 41530 |
| 14-#14 | 1.49 | MA | 28555 | 6746 | 41827 | 5680 | 49496 | 4619 | 52339 | 3821 | 53411 | 2621 | 65584 | 1914 | 42490 |
| 7L-2S | | MI | 31557 | 6746 | 45961 | 5627 | 54974 | 4564 | 59552 | 3764 | 64579 | 2585 | 79586 | 2420 | 41600 |
| 14-#18 | 2.65 | MA | 39764 | 7637 | 61763 | 6181 | 74691 | 4969 | 82788 | 4020 | 94488 | 2543 | 119103 | 2315 | 79654 |
| 2L-7S | | MI | 27001 | 7637 | 43455 | 6179 | 51206 | 4981 | 54787 | 4043 | 57902 | 2533 | 72671 | 1301 | 61374 |
| 14-#18 | 2.65 | MA | 36960 | 7637 | 57970 | 6183 | 69880 | 4968 | 76960 | 4042 | 86625 | 2558 | 108529 | 2081 | 79194 |
| 3L-6S | | MI | 28560 | 7637 | 45692 | 6179 | 54165 | 4984 | 58402 | 4024 | 62909 | 2546 | 78534 | 1483 | 64567 |
| 14-#18 | 2.65 | MA | 34942 | 7637 | 55153 | 6185 | 66072 | 4993 | 72344 | 4037 | 80394 | 2547 | 101559 | 1848 | 77747 |
| 4L-5S | | MI | 30151 | 7637 | 47989 | 6178 | 57227 | 4961 | 62129 | 4031 | 67847 | 2533 | 85133 | 1676 | 67336 |
| 14-#18 | 2.65 | MA | 33117 | 7637 | 52303 | 6214 | 62652 | 4992 | 68169 | 4059 | 74711 | 2562 | 94285 | 1730 | 74188 |
| 5L-4S | | MI | 31811 | 7637 | 50574 | 6151 | 60329 | 4964 | 65915 | 4011 | 72981 | 2519 | 91660 | 1792 | 70416 |
| 14-#18 | 2.65 | MA | 31367 | 7637 | 49772 | 6216 | 59276 | 5017 | 64060 | 4054 | 69246 | 2577 | 86902 | 1537 | 71122 |
| 6L-3S | | MI | 33643 | 7637 | 53127 | 6150 | 63781 | 4941 | 70098 | 4018 | 78607 | 2533 | 97878 | 2025 | 71820 |
| 14-#18 | 2.65 | MA | 29653 | 7637 | 47308 | 6218 | 56016 | 5016 | 60077 | 4076 | 63705 | 2566 | 80333 | 1355 | 67472 |
| 7L-2S | | MI | 36178 | 7637 | 56557 | 6150 | 68131 | 4944 | 75368 | 3998 | 85697 | 2519 | 107331 | 2259 | 72219 |
| 16-#11 | 1.18 | MA | 33140 | 6508 | 46831 | 5522 | 56185 | 4491 | 60556 | 3725 | 64622 | 2620 | 79574 | 2495 | 36611 |
| 2L-8S | | MI | 25734 | 6508 | 36969 | 5513 | 43547 | 4490 | 45695 | 3730 | 45888 | 2624 | 55608 | 2037 | 31633 |
| 16-#11 | 1.18 | MA | 31954 | 6508 | 45322 | 5524 | 54271 | 4492 | 58236 | 3735 | 61493 | 2627 | 75297 | 2404 | 36580 |
| 3L-7S | | MI | 26384 | 6508 | 37841 | 5512 | 44696 | 4490 | 47130 | 3731 | 47812 | 2617 | 58070 | 2091 | 32105 |
| 16-#11 | 1.18 | MA | 31102 | 6508 | 44205 | 5526 | 52760 | 4503 | 56406 | 3735 | 59022 | 2624 | 72470 | 2312 | 36505 |
| 4L-6S | | MI | 27041 | 6508 | 38727 | 5510 | 45869 | 4490 | 48563 | 3722 | 49805 | 2621 | 60457 | 2162 | 32718 |
| 16-#11 | 1.18 | MA | 30331 | 6508 | 43076 | 5538 | 51406 | 4504 | 54752 | 3744 | 56770 | 2632 | 69542 | 2265 | 36356 |
| 5E | | MI | 27713 | 6508 | 39637 | 5509 | 47083 | 4480 | 50042 | 3723 | 51771 | 2615 | 63137 | 2237 | 33118 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

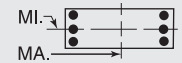
MI.
MA.

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.18 | MA | 29593 | 6508 | 42075 | 5539 | 50069 | 4514 | 53125 | 3744 | 54606 | 2639 | 66555 | 2190 | 35897 |
| 6L-4S | | MI | 28413 | 6508 | 40663 | 5498 | 48313 | 4480 | 51544 | 3714 | 53817 | 2608 | 65773 | 2283 | 33236 |
| 16-#11 | 1.18 | MA | 28870 | 6508 | 41100 | 5541 | 48779 | 4515 | 51548 | 3754 | 52412 | 2637 | 63892 | 2119 | 35187 |
| 7L-3S | | MI | 29188 | 6508 | 41677 | 5496 | 49685 | 4469 | 53206 | 3716 | 56060 | 2612 | 68306 | 2375 | 33293 |
| 16-#11 | 1.18 | MA | 28156 | 6508 | 40141 | 5543 | 47515 | 4516 | 49969 | 3753 | 50296 | 2644 | 61157 | 2064 | 34636 |
| 8L-2S | | MI | 30260 | 6508 | 43045 | 5495 | 51419 | 4469 | 55307 | 3707 | 58895 | 2605 | 72145 | 2466 | 33313 |
| 16-#14 | 1.70 | MA | 35623 | 6910 | 52210 | 5757 | 62861 | 4662 | 68581 | 3831 | 75405 | 2593 | 94025 | 2440 | 52165 |
| 2L-8S | | MI | 26150 | 6910 | 39207 | 5752 | 46170 | 4665 | 48779 | 3841 | 49992 | 2600 | 61508 | 1785 | 42829 |
| 16-#14 | 1.70 | MA | 33964 | 6910 | 50048 | 5759 | 60119 | 4663 | 65258 | 3844 | 70923 | 2603 | 87930 | 2308 | 52048 |
| 3L-7S | | MI | 27059 | 6910 | 40459 | 5750 | 47819 | 4666 | 50839 | 3843 | 52751 | 2591 | 65017 | 1862 | 44403 |
| 16-#14 | 1.70 | MA | 32771 | 6910 | 48445 | 5762 | 57952 | 4678 | 62632 | 3843 | 67378 | 2598 | 83905 | 2177 | 51803 |
| 4L-6S | | MI | 27979 | 6910 | 41730 | 5749 | 49502 | 4666 | 52895 | 3831 | 55610 | 2597 | 68412 | 1964 | 45251 |
| 16-#14 | 1.70 | MA | 31693 | 6910 | 46826 | 5779 | 56008 | 4678 | 60259 | 3856 | 64147 | 2608 | 79726 | 2109 | 51106 |
| 5E | | MI | 28919 | 6910 | 43036 | 5748 | 51243 | 4652 | 55015 | 3833 | 58430 | 2589 | 72226 | 2072 | 46455 |
| 16-#14 | 1.70 | MA | 30660 | 6910 | 45388 | 5781 | 54091 | 4693 | 57925 | 3855 | 61042 | 2618 | 75470 | 2001 | 49714 |
| 6L-4S | | MI | 29900 | 6910 | 44507 | 5732 | 53008 | 4653 | 57169 | 3821 | 61363 | 2580 | 75984 | 2139 | 47096 |
| 16-#14 | 1.70 | MA | 29649 | 6910 | 43989 | 5783 | 52239 | 4694 | 55662 | 3869 | 57894 | 2614 | 71678 | 1899 | 48737 |
| 7L-3S | | MI | 30983 | 6910 | 45961 | 5730 | 54974 | 4638 | 59552 | 3823 | 64579 | 2586 | 79586 | 2270 | 47300 |
| 16-#14 | 1.70 | MA | 28649 | 6910 | 42612 | 5785 | 50424 | 4694 | 53395 | 3867 | 54856 | 2624 | 67775 | 1820 | 46965 |
| 8L-2S | | MI | 32484 | 6910 | 47919 | 5729 | 57457 | 4639 | 62560 | 3811 | 68638 | 2578 | 85049 | 2402 | 47395 |
| 16-#18 | 3.03 | MA | 38681 | 7927 | 61763 | 6365 | 74691 | 5101 | 82788 | 4126 | 94488 | 2545 | 119103 | 2048 | 90301 |
| 3L-7S | | MI | 28645 | 7927 | 46885 | 6361 | 55555 | 5114 | 60057 | 4128 | 64992 | 2518 | 82124 | 1262 | 71140 |
| 16-#18 | 3.03 | MA | 36693 | 7927 | 58946 | 6367 | 70882 | 5126 | 78172 | 4121 | 88258 | 2534 | 112133 | 1814 | 88488 |
| 4L-6S | | MI | 30180 | 7927 | 49121 | 6361 | 58514 | 5117 | 63672 | 4108 | 69999 | 2532 | 87987 | 1444 | 74235 |
| 16-#18 | 3.03 | MA | 34897 | 7927 | 56096 | 6396 | 67462 | 5125 | 73997 | 4143 | 82574 | 2549 | 104859 | 1696 | 85068 |
| 5E | | MI | 31747 | 7927 | 51418 | 6360 | 61577 | 5094 | 67399 | 4115 | 74937 | 2518 | 94586 | 1637 | 77147 |
| 16-#18 | 3.03 | MA | 33175 | 7927 | 53565 | 6398 | 64087 | 5150 | 69889 | 4139 | 77109 | 2564 | 97476 | 1504 | 81864 |
| 6L-4S | | MI | 33381 | 7927 | 54003 | 6333 | 64679 | 5097 | 71185 | 4095 | 80071 | 2505 | 101113 | 1753 | 80097 |
| 16-#18 | 3.03 | MA | 31489 | 7927 | 51102 | 6400 | 60827 | 5149 | 65905 | 4161 | 71569 | 2553 | 90907 | 1322 | 78316 |
| 7L-3S | | MI | 35187 | 7927 | 56557 | 6332 | 68131 | 5074 | 75368 | 4102 | 85697 | 2518 | 107331 | 1986 | 81855 |
| 16-#18 | 3.03 | MA | 29820 | 7927 | 48676 | 6402 | 57632 | 5148 | 61914 | 4156 | 66223 | 2568 | 84113 | 1185 | 73746 |
| 8L-2S | | MI | 37689 | 7927 | 59987 | 6332 | 72480 | 5077 | 80638 | 4082 | 92787 | 2505 | 116784 | 2220 | 82319 |
| 18-#11 | 1.33 | MA | 33880 | 6622 | 48341 | 5593 | 58099 | 4543 | 62875 | 3758 | 67751 | 2615 | 83851 | 2485 | 41085 |
| 2L-9S | | MI | 25794 | 6622 | 37373 | 5595 | 44097 | 4552 | 46384 | 3772 | 46819 | 2625 | 57012 | 1967 | 34737 |
| 18-#11 | 1.33 | MA | 32703 | 6622 | 46831 | 5595 | 56185 | 4544 | 60556 | 3768 | 64622 | 2622 | 79574 | 2394 | 41041 |
| 3L-8S | | MI | 26434 | 6622 | 38336 | 5584 | 45281 | 4542 | 47796 | 3763 | 48723 | 2619 | 59447 | 2025 | 35588 |
| 18-#11 | 1.33 | MA | 31856 | 6622 | 45715 | 5596 | 54674 | 4555 | 58725 | 3768 | 62151 | 2619 | 76747 | 2303 | 40949 |
| 4L-7S | | MI | 27078 | 6622 | 39209 | 5582 | 46430 | 4542 | 49232 | 3764 | 50647 | 2612 | 61908 | 2079 | 36051 |
| 18-#11 | 1.33 | MA | 31092 | 6622 | 44586 | 5608 | 53320 | 4555 | 57071 | 3777 | 59899 | 2627 | 73819 | 2255 | 40782 |
| 5L-6S | | MI | 27730 | 6622 | 40095 | 5581 | 47603 | 4542 | 50665 | 3755 | 52640 | 2616 | 64296 | 2150 | 36645 |
| 18-#11 | 1.33 | MA | 30360 | 6622 | 43584 | 5610 | 51984 | 4566 | 55444 | 3777 | 57735 | 2634 | 70832 | 2180 | 40238 |
| 6L-5S | | MI | 28396 | 6622 | 41005 | 5580 | 48817 | 4531 | 52143 | 3756 | 54606 | 2609 | 66976 | 2225 | 37129 |
| 18-#11 | 1.33 | MA | 29643 | 6622 | 42610 | 5612 | 50693 | 4567 | 53868 | 3787 | 55541 | 2631 | 68169 | 2109 | 39550 |
| 7L-4S | | MI | 29091 | 6622 | 42030 | 5568 | 50048 | 4531 | 53645 | 3747 | 56652 | 2603 | 69612 | 2272 | 37264 |
| 18-#11 | 1.33 | MA | 28935 | 6622 | 41651 | 5614 | 49429 | 4568 | 52288 | 3786 | 53425 | 2639 | 65434 | 2054 | 39008 |
| 8L-3S | | MI | 29860 | 6622 | 43045 | 5567 | 51419 | 4521 | 55307 | 3749 | 58895 | 2607 | 72145 | 2363 | 37337 |
| 18-#11 | 1.33 | MA | 28232 | 6622 | 40591 | 5626 | 48126 | 4578 | 50734 | 3796 | 51330 | 2647 | 62720 | 1996 | 38044 |
| 9L-2S | | MI | 30926 | 6622 | 44412 | 5566 | 53154 | 4521 | 57409 | 3739 | 61730 | 2600 | 75984 | 2454 | 37369 |
| 18-#14 | 1.92 | MA | 36641 | 7073 | 54373 | 5860 | 65604 | 4737 | 71903 | 3878 | 79888 | 2586 | 100119 | 2424 | 58556 |
| 2L-9S | | MI | 26234 | 7073 | 39783 | 5870 | 46955 | 4754 | 49762 | 3901 | 51319 | 2601 | 63508 | 1682 | 46985 |
| 18-#14 | 1.92 | MA | 34998 | 7073 | 52210 | 5862 | 62861 | 4737 | 68581 | 3892 | 75405 | 2596 | 94025 | 2293 | 58414 |
| 3L-8S | | MI | 27127 | 7073 | 41165 | 5854 | 48654 | 4740 | 51788 | 3888 | 54051 | 2592 | 66971 | 1766 | 48420 |
| 18-#14 | 1.92 | MA | 33816 | 7073 | 50608 | 5864 | 60695 | 4753 | 65955 | 3890 | 71861 | 2591 | 89999 | 2161 | 58140 |
| 4L-7S | | MI | 28027 | 7073 | 42417 | 5853 | 50302 | 4741 | 53847 | 3891 | 56810 | 2584 | 70480 | 1843 | 49953 |
| 18-#14 | 1.92 | MA | 32750 | 7073 | 48988 | 5881 | 58751 | 4753 | 63582 | 3904 | 68630 | 2601 | 85821 | 2093 | 57292 |
| 5L-6S | | MI | 28938 | 7073 | 43688 | 5851 | 51985 | 4741 | 55903 | 3878 | 59669 | 2590 | 73875 | 1946 | 50883 |
| 18-#14 | 1.92 | MA | 31728 | 7073 | 47551 | 5883 | 56833 | 4768 | 61247 | 3902 | 65524 | 2611 | 81565 | 1985 | 55947 |
| 6L-5S | | MI | 29868 | 7073 | 44994 | 5850 | 53727 | 4727 | 58023 | 3881 | 62489 | 2581 | 77689 | 2054 | 52044 |
| 18-#14 | 1.92 | MA | 30727 | 7073 | 46152 | 5885 | 54981 | 4769 | 58984 | 3916 | 62376 | 2606 | 77773 | 1883 | 54913 |
| 7L-4S | | MI | 30838 | 7073 | 46465 | 5834 | 55492 | 4727 | 60178 | 3868 | 65422 | 2573 | 81447 | 2121 | 52832 |

## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

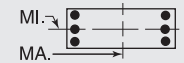
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 1.92 | MA | 29738 | 7073 | 44775 | 5887 | 53167 | 4769 | 56717 | 3915 | 59339 | 2616 | 73869 | 1804 | 53161 |
| 8L-3S | | MI | 31911 | 7073 | 47919 | 5833 | 57457 | 4713 | 62560 | 3871 | 68638 | 2579 | 85049 | 2252 | 53064 |
| 18-#14 | 1.92 | MA | 28756 | 7073 | 43254 | 5904 | 51297 | 4784 | 54487 | 3928 | 56332 | 2626 | 70003 | 1720 | 51553 |
| 9L-2S | | MI | 33399 | 7073 | 49877 | 5831 | 59941 | 4714 | 65569 | 3858 | 72697 | 2570 | 90512 | 2383 | 53183 |
| 18-#18 | 3.41 | MA | 38415 | 8218 | 62739 | 6549 | 75693 | 5259 | 84000 | 4206 | 96121 | 2520 | 122707 | 1781 | 99260 |
| 4L-7S | | MI | 30260 | 8218 | 50314 | 6543 | 59905 | 5247 | 65326 | 4212 | 72082 | 2504 | 91577 | 1223 | 80922 |
| 18-#18 | 3.41 | MA | 36646 | 8218 | 59890 | 6577 | 72273 | 5258 | 79825 | 4228 | 90437 | 2536 | 115432 | 1663 | 95967 |
| 5L-6S | | MI | 31772 | 8218 | 52551 | 6542 | 62864 | 5250 | 68941 | 4192 | 77089 | 2517 | 97440 | 1405 | 83925 |
| 18-#18 | 3.41 | MA | 34950 | 8218 | 57359 | 6580 | 68898 | 5283 | 75717 | 4223 | 84972 | 2551 | 108050 | 1470 | 92628 |
| 6L-5S | | MI | 33316 | 8218 | 54848 | 6542 | 65927 | 5227 | 72669 | 4199 | 82027 | 2504 | 104039 | 1598 | 86977 |
| 18-#18 | 3.41 | MA | 33290 | 8218 | 54895 | 6582 | 65637 | 5282 | 71733 | 4245 | 79432 | 2539 | 101480 | 1288 | 89175 |
| 7L-4S | | MI | 34926 | 8218 | 57433 | 6515 | 69029 | 5230 | 76455 | 4179 | 87162 | 2491 | 110566 | 1714 | 89809 |
| 18-#18 | 3.41 | MA | 31648 | 8218 | 52470 | 6584 | 62442 | 5281 | 67742 | 4240 | 74086 | 2554 | 94686 | 1152 | 84538 |
| 8L-3S | | MI | 36706 | 8218 | 59987 | 6514 | 72480 | 5207 | 80638 | 4186 | 92787 | 2504 | 116784 | 1947 | 91887 |
| 20-#11 | 1.48 | MA | 34612 | 6735 | 49850 | 5664 | 60013 | 4595 | 65194 | 3791 | 70880 | 2609 | 88128 | 2475 | 45554 |
| 2L-10S | | MI | 25848 | 6735 | 37872 | 5667 | 44690 | 4604 | 47066 | 3803 | 47696 | 2616 | 58334 | 1875 | 37948 |
| 20-#11 | 1.48 | MA | 33443 | 6735 | 48341 | 5666 | 58099 | 4596 | 62875 | 3801 | 67751 | 2617 | 83851 | 2384 | 45497 |
| 3L-9S | | MI | 26491 | 6735 | 38741 | 5666 | 45831 | 4604 | 48485 | 3805 | 49654 | 2620 | 60851 | 1955 | 38655 |
| 20-#11 | 1.48 | MA | 32603 | 6735 | 47224 | 5667 | 56589 | 4607 | 61044 | 3800 | 65280 | 2614 | 81023 | 2293 | 45390 |
| 4L-8S | | MI | 27126 | 6735 | 39704 | 5655 | 47015 | 4594 | 49897 | 3796 | 51558 | 2614 | 63286 | 2014 | 39541 |
| 20-#11 | 1.48 | MA | 31844 | 6735 | 46095 | 5679 | 55234 | 4607 | 59390 | 3810 | 63028 | 2622 | 78096 | 2245 | 45207 |
| 5L-7S | | MI | 27765 | 6735 | 40576 | 5653 | 48165 | 4594 | 51333 | 3797 | 53481 | 2607 | 65747 | 2068 | 40003 |
| 20-#11 | 1.48 | MA | 31118 | 6735 | 45094 | 5681 | 53898 | 4618 | 57763 | 3810 | 60864 | 2629 | 75109 | 2170 | 44587 |
| 6E | | MI | 28412 | 6735 | 41462 | 5652 | 49337 | 4594 | 52766 | 3788 | 55475 | 2611 | 68134 | 2138 | 40579 |
| 20-#11 | 1.48 | MA | 30407 | 6735 | 44119 | 5683 | 52608 | 4619 | 56187 | 3819 | 58670 | 2626 | 72446 | 2100 | 43917 |
| 7L-5S | | MI | 29073 | 6735 | 42373 | 5651 | 50552 | 4583 | 54244 | 3789 | 57441 | 2604 | 70815 | 2213 | 41138 |
| 20-#11 | 1.48 | MA | 29705 | 6735 | 43160 | 5685 | 51343 | 4619 | 54607 | 3819 | 56554 | 2634 | 69711 | 2045 | 43383 |
| 8L-4S | | MI | 29762 | 6735 | 43398 | 5639 | 51782 | 4583 | 55747 | 3780 | 59487 | 2598 | 73450 | 2260 | 41289 |
| 20-#11 | 1.48 | MA | 29008 | 6735 | 42101 | 5697 | 50041 | 4630 | 53053 | 3829 | 54459 | 2641 | 66996 | 1986 | 42380 |
| 9L-3S | | MI | 30526 | 6735 | 44412 | 5638 | 53154 | 4573 | 57409 | 3781 | 61730 | 2601 | 75984 | 2351 | 41376 |
| 20-#11 | 1.48 | MA | 28300 | 6735 | 41145 | 5698 | 48786 | 4631 | 51492 | 3828 | 52304 | 2639 | 64191 | 1907 | 41567 |
| 10L-2S | | MI | 31584 | 6735 | 45780 | 5637 | 54888 | 4573 | 59510 | 3772 | 64565 | 2595 | 79823 | 2442 | 41420 |
| 20-#14 | 2.13 | MA | 36018 | 7237 | 54373 | 5964 | 65604 | 4812 | 71903 | 3939 | 79888 | 2588 | 100119 | 2277 | 64776 |
| 3L-9S | | MI | 27207 | 7237 | 41741 | 5972 | 49438 | 4829 | 52770 | 3948 | 55378 | 2593 | 68971 | 1663 | 52537 |
| 20-#14 | 2.13 | MA | 34848 | 7237 | 52770 | 5966 | 63437 | 4827 | 69277 | 3938 | 76344 | 2583 | 96094 | 2145 | 64475 |
| 4L-8S | | MI | 28092 | 7237 | 43123 | 5956 | 51137 | 4815 | 54796 | 3936 | 58110 | 2585 | 72434 | 1748 | 54020 |
| 20-#14 | 2.13 | MA | 33792 | 7237 | 51151 | 5983 | 61494 | 4828 | 66905 | 3951 | 73113 | 2593 | 91915 | 2077 | 63491 |
| 5L-7S | | MI | 28982 | 7237 | 44375 | 5955 | 52786 | 4815 | 56856 | 3938 | 60869 | 2576 | 75944 | 1825 | 55513 |
| 20-#14 | 2.13 | MA | 32781 | 7237 | 49713 | 5985 | 59576 | 4843 | 64570 | 3950 | 70007 | 2604 | 87659 | 1969 | 62188 |
| 6E | | MI | 29883 | 7237 | 45646 | 5954 | 54468 | 4816 | 58912 | 3926 | 63728 | 2583 | 79338 | 1927 | 56523 |
| 20-#14 | 2.13 | MA | 31791 | 7237 | 48314 | 5987 | 57724 | 4843 | 62307 | 3963 | 66859 | 2599 | 83867 | 1867 | 61076 |
| 7L-5S | | MI | 30804 | 7237 | 46952 | 5952 | 56210 | 4802 | 61032 | 3928 | 66548 | 2574 | 83153 | 2035 | 57646 |
| 20-#14 | 2.13 | MA | 30813 | 7237 | 46937 | 5989 | 55909 | 4844 | 60040 | 3962 | 63822 | 2609 | 79964 | 1789 | 59364 |
| 8L-4S | | MI | 31765 | 7237 | 48423 | 5936 | 57975 | 4802 | 63186 | 3916 | 69481 | 2565 | 86910 | 2102 | 58566 |
| 20-#14 | 2.13 | MA | 29841 | 7237 | 45416 | 6006 | 54039 | 4859 | 57810 | 3976 | 60815 | 2619 | 76097 | 1705 | 57712 |
| 9L-3S | | MI | 32828 | 7237 | 49877 | 5935 | 59941 | 4788 | 65569 | 3918 | 72697 | 2572 | 90512 | 2233 | 58824 |
| 20-#14 | 2.13 | MA | 28873 | 7237 | 44045 | 6008 | 52238 | 4859 | 55569 | 3974 | 57722 | 2614 | 72100 | 1589 | 55782 |
| 10L-2S | | MI | 34303 | 7237 | 51835 | 5934 | 62424 | 4789 | 68577 | 3906 | 76756 | 2563 | 95975 | 2365 | 58965 |
| 20-#18 | 3.79 | MA | 38367 | 8509 | 63683 | 6759 | 77084 | 5391 | 85654 | 4312 | 98300 | 2522 | 126006 | 1629 | 106883 |
| 5L-7S | | MI | 31848 | 8509 | 53744 | 6725 | 64255 | 5380 | 70596 | 4296 | 79173 | 2490 | 101029 | 1184 | 90610 |
| 20-#18 | 3.79 | MA | 36696 | 8509 | 61152 | 6761 | 73708 | 5416 | 81545 | 4307 | 92835 | 2537 | 118623 | 1437 | 103411 |
| 6E | | MI | 33338 | 8509 | 55981 | 6724 | 67214 | 5383 | 74211 | 4277 | 84179 | 2503 | 106893 | 1366 | 93637 |
| 20-#18 | 3.79 | MA | 35061 | 8509 | 58688 | 6763 | 70448 | 5415 | 77561 | 4329 | 87295 | 2526 | 112054 | 1255 | 100050 |
| 7L-5S | | MI | 34860 | 8509 | 58278 | 6723 | 70276 | 5360 | 77938 | 4283 | 89117 | 2490 | 113492 | 1559 | 96824 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

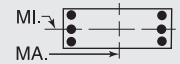


$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#18 | 3.79 | MA | 33443 | 8509 | 56263 | 6766 | 67253 | 5414 | 73570 | 4324 | 81949 | 2541 | 105260 | 1118 | 95345 |
| 8L-4S | | MI | 36448 | 8509 | 60863 | 6696 | 73378 | 5363 | 81725 | 4264 | 94252 | 2476 | 120019 | 1674 | 99548 |
| 22-#11 | 1.63 | MA | 35338 | 6848 | 51360 | 5735 | 61927 | 4647 | 67513 | 3824 | 74009 | 2604 | 92404 | 2465 | 50019 |
| 2L-11S | | MI | 25889 | 6848 | 38377 | 5739 | 45254 | 4666 | 47763 | 3845 | 48634 | 2618 | 59754 | 1806 | 40802 |
| 22-#11 | 1.63 | MA | 34176 | 6848 | 49850 | 5736 | 60013 | 4648 | 65194 | 3834 | 70880 | 2612 | 88128 | 2374 | 49951 |
| 3L-10S | | MI | 26545 | 6848 | 39240 | 5738 | 46425 | 4656 | 49167 | 3836 | 50531 | 2611 | 62173 | 1863 | 41857 |
| 22-#11 | 1.63 | MA | 33342 | 6848 | 48733 | 5738 | 58503 | 4659 | 63363 | 3833 | 68408 | 2609 | 85300 | 2283 | 49829 |
| 4L-9S | | MI | 27180 | 6848 | 40108 | 5737 | 47566 | 4656 | 50586 | 3838 | 52489 | 2615 | 64690 | 1943 | 42578 |
| 22-#11 | 1.63 | MA | 32589 | 6848 | 47605 | 5750 | 57148 | 4659 | 61709 | 3843 | 66156 | 2616 | 82373 | 2235 | 49631 |
| 5L-8S | | MI | 27810 | 6848 | 41072 | 5725 | 48750 | 4645 | 51999 | 3829 | 54393 | 2608 | 67124 | 2002 | 43443 |
| 22-#11 | 1.63 | MA | 31869 | 6848 | 46603 | 5752 | 55812 | 4670 | 60082 | 3842 | 63992 | 2624 | 79386 | 2161 | 48941 |
| 6L-7S | | MI | 28444 | 6848 | 41944 | 5724 | 49899 | 4645 | 53434 | 3830 | 56316 | 2602 | 69586 | 2056 | 43958 |
| 22-#11 | 1.63 | MA | 31164 | 6848 | 45629 | 5754 | 54522 | 4671 | 58506 | 3852 | 61799 | 2621 | 76723 | 2090 | 48288 |
| 7L-6S | | MI | 29086 | 6848 | 42830 | 5723 | 51072 | 4645 | 54867 | 3821 | 58310 | 2606 | 71973 | 2127 | 44519 |
| 22-#11 | 1.63 | MA | 30467 | 6848 | 44669 | 5755 | 53258 | 4671 | 56926 | 3852 | 59683 | 2629 | 73988 | 2035 | 47713 |
| 8L-5S | | MI | 29742 | 6848 | 43740 | 5722 | 52286 | 4635 | 56346 | 3822 | 60276 | 2599 | 74654 | 2202 | 45146 |
| 22-#11 | 1.63 | MA | 29776 | 6848 | 43610 | 5767 | 51955 | 4682 | 55372 | 3862 | 57587 | 2636 | 71273 | 1977 | 46720 |
| 9L-4S | | MI | 30427 | 6848 | 44766 | 5710 | 53517 | 4635 | 57848 | 3813 | 62322 | 2593 | 77289 | 2248 | 45312 |
| 22-#11 | 1.63 | MA | 29076 | 6848 | 42655 | 5769 | 50700 | 4683 | 53811 | 3861 | 55433 | 2633 | 68468 | 1897 | 45908 |
| 10L-3S | | MI | 31185 | 6848 | 45780 | 5709 | 54888 | 4625 | 59510 | 3814 | 64565 | 2596 | 79823 | 2340 | 45412 |
| 22-#11 | 1.63 | MA | 28334 | 6848 | 41706 | 5771 | 49412 | 4694 | 52267 | 3871 | 53347 | 2641 | 65779 | 1839 | 44706 |
| 11L-2S | | MI | 32236 | 6848 | 47147 | 5708 | 56623 | 4625 | 61611 | 3805 | 67400 | 2590 | 83661 | 2431 | 45468 |
| 22-#14 | 2.34 | MA | 35868 | 7400 | 54933 | 6068 | 66180 | 4902 | 72600 | 3985 | 80826 | 2576 | 102188 | 2130 | 70809 |
| 4L-9S | | MI | 28168 | 7400 | 43699 | 6075 | 51921 | 4904 | 55779 | 3995 | 59437 | 2586 | 74434 | 1645 | 58098 |
| 22-#14 | 2.34 | MA | 34822 | 7400 | 53313 | 6085 | 64236 | 4903 | 70227 | 3999 | 77595 | 2586 | 98010 | 2062 | 69700 |
| 5L-8S | | MI | 29044 | 7400 | 45081 | 6058 | 53620 | 4890 | 57805 | 3983 | 62169 | 2577 | 77897 | 1729 | 59626 |
| 22-#14 | 2.34 | MA | 33821 | 7400 | 51876 | 6087 | 62318 | 4918 | 67893 | 3997 | 74490 | 2596 | 93754 | 1954 | 68435 |
| 6L-7S | | MI | 29925 | 7400 | 46333 | 6057 | 55269 | 4890 | 59864 | 3985 | 64927 | 2569 | 81407 | 1806 | 61084 |
| 22-#14 | 2.34 | MA | 32841 | 7400 | 50477 | 6089 | 60466 | 4918 | 65630 | 4011 | 71342 | 2591 | 89962 | 1852 | 67248 |
| 7L-6S | | MI | 30818 | 7400 | 47604 | 6056 | 56951 | 4891 | 61920 | 3973 | 67787 | 2575 | 84801 | 1909 | 62170 |
| 22-#14 | 2.34 | MA | 31873 | 7400 | 49100 | 6091 | 58652 | 4919 | 63362 | 4009 | 68305 | 2601 | 86058 | 1773 | 65575 |
| 8L-5S | | MI | 31729 | 7400 | 48910 | 6055 | 58693 | 4876 | 64040 | 3976 | 70607 | 2566 | 88616 | 2017 | 63258 |
| 22-#14 | 2.34 | MA | 30911 | 7400 | 47579 | 6108 | 56782 | 4934 | 61132 | 4023 | 65298 | 2611 | 82192 | 1689 | 63878 |
| 9L-4S | | MI | 32681 | 7400 | 50381 | 6038 | 60458 | 4877 | 66195 | 3963 | 73540 | 2558 | 92373 | 2083 | 64298 |
| 22-#14 | 2.34 | MA | 29950 | 7400 | 46207 | 6110 | 54980 | 4934 | 58891 | 4022 | 62205 | 2607 | 78195 | 1574 | 61984 |
| 10L-3S | | MI | 33734 | 7400 | 51835 | 6037 | 62424 | 4863 | 68577 | 3966 | 76756 | 2564 | 95975 | 2215 | 64580 |
| 22-#18 | 4.17 | MA | 38416 | 8800 | 64945 | 6943 | 78519 | 5549 | 87373 | 4391 | 100698 | 2524 | 129197 | 1403 | 114214 |
| 6L-7S | | MI | 33413 | 8800 | 57174 | 6906 | 68604 | 5513 | 75866 | 4380 | 86263 | 2475 | 110482 | 1145 | 100256 |
| 22-#18 | 4.17 | MA | 36804 | 8800 | 62481 | 6945 | 75259 | 5548 | 83390 | 4413 | 95158 | 2513 | 122628 | 1222 | 110809 |
| 7L-6S | | MI | 34882 | 8800 | 59410 | 6906 | 71564 | 5516 | 79481 | 4361 | 91269 | 2489 | 116346 | 1327 | 103367 |
| 22-#18 | 4.17 | MA | 35210 | 8800 | 60056 | 6947 | 72064 | 5547 | 79398 | 4409 | 89812 | 2528 | 115834 | 1085 | 106166 |
| 8L-5S | | MI | 36383 | 8800 | 61708 | 6905 | 74626 | 5493 | 83208 | 4368 | 96207 | 2475 | 122945 | 1520 | 106684 |
| 24-#11 | 1.77 | MA | 34902 | 6962 | 51360 | 5807 | 61927 | 4699 | 67513 | 3867 | 74009 | 2607 | 92404 | 2365 | 54401 |
| 3L-11S | | MI | 26580 | 6962 | 39745 | 5810 | 46988 | 4718 | 49865 | 3878 | 51469 | 2613 | 63592 | 1795 | 44715 |
| 24-#11 | 1.77 | MA | 34074 | 6962 | 50243 | 5809 | 60417 | 4710 | 65682 | 3866 | 71537 | 2604 | 89577 | 2273 | 54267 |
| 4L-10S | | MI | 27241 | 6962 | 40607 | 5809 | 48159 | 4708 | 51268 | 3869 | 53366 | 2606 | 66012 | 1852 | 45751 |
| 24-#11 | 1.77 | MA | 33327 | 6962 | 49114 | 5821 | 59062 | 4711 | 64028 | 3876 | 69285 | 2611 | 86650 | 2226 | 54054 |
| 5L-9S | | MI | 27863 | 6962 | 41476 | 5808 | 49300 | 4708 | 52688 | 3870 | 55324 | 2610 | 68529 | 1932 | 46505 |
| 24-#11 | 1.77 | MA | 32612 | 6962 | 48112 | 5823 | 57726 | 4722 | 62402 | 3875 | 67121 | 2619 | 83663 | 2151 | 53300 |
| 6L-8S | | MI | 28488 | 6962 | 42439 | 5796 | 50484 | 4697 | 54100 | 3861 | 57228 | 2603 | 70963 | 1990 | 47351 |
| 24-#11 | 1.77 | MA | 31912 | 6962 | 47138 | 5825 | 56436 | 4723 | 60825 | 3885 | 64928 | 2616 | 81000 | 2080 | 52662 |
| 7E | | MI | 29117 | 6962 | 43311 | 5795 | 51633 | 4697 | 55536 | 3863 | 59151 | 2597 | 73425 | 2044 | 47916 |
| 24-#11 | 1.77 | MA | 31221 | 6962 | 46179 | 5826 | 55172 | 4723 | 59245 | 3885 | 62811 | 2623 | 78265 | 2025 | 52037 |
| 8L-6S | | MI | 29754 | 6962 | 44197 | 5794 | 52806 | 4697 | 56969 | 3854 | 61145 | 2601 | 75812 | 2115 | 48463 |
| 24-#11 | 1.77 | MA | 30535 | 6962 | 45119 | 5838 | 53869 | 4734 | 57691 | 3894 | 60716 | 2631 | 75550 | 1967 | 51065 |
| 9L-5S | | MI | 30405 | 6962 | 45108 | 5793 | 54021 | 4687 | 58447 | 3855 | 63111 | 2594 | 78493 | 2190 | 49152 |
| 24-#11 | 1.77 | MA | 29841 | 6962 | 44164 | 5840 | 52614 | 4735 | 56130 | 3894 | 58562 | 2628 | 72744 | 1887 | 50221 |
| 10L-4S | | MI | 31085 | 6962 | 46133 | 5781 | 55251 | 4687 | 59949 | 3846 | 65157 | 2587 | 81128 | 2237 | 49332 |

## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 1.77 | MA | 29103 | 6962 | 43216 | 5842 | 51326 | 4746 | 54586 | 3904 | 56475 | 2636 | 70056 | 1829 | 49039 |
| 11L-3S | | MI | 31837 | 6962 | 47147 | 5780 | 56623 | 4677 | 61611 | 3847 | 67400 | 2591 | 83661 | 2328 | 49445 |
| 24-#11 | 1.77 | MA | 28375 | 6962 | 42272 | 5844 | 50075 | 4746 | 53034 | 3903 | 54339 | 2633 | 67363 | 1771 | 47901 |
| 12L-2S | | MI | 32883 | 6962 | 48515 | 5779 | 58357 | 4677 | 63712 | 3838 | 70235 | 2585 | 87500 | 2419 | 49512 |
| 24-#14 | 2.56 | MA | 35840 | 7564 | 55476 | 6187 | 66979 | 4977 | 73550 | 4046 | 82078 | 2579 | 104104 | 2046 | 75919 |
| 5L-9S | | MI | 29117 | 7564 | 45657 | 6177 | 54404 | 4979 | 58787 | 4043 | 63496 | 2579 | 79897 | 1626 | 63666 |
| 24-#14 | 2.56 | MA | 34849 | 7564 | 54038 | 6190 | 65061 | 4993 | 71215 | 4045 | 78973 | 2589 | 99848 | 1938 | 74689 |
| 6L-8S | | MI | 29984 | 7564 | 47039 | 6161 | 56103 | 4964 | 60813 | 4030 | 66228 | 2570 | 83360 | 1711 | 65240 |
| 24-#14 | 2.56 | MA | 33879 | 7564 | 52639 | 6192 | 63209 | 4993 | 68952 | 4058 | 75825 | 2584 | 96056 | 1836 | 73429 |
| 7E | | MI | 30857 | 7564 | 48291 | 6159 | 57752 | 4965 | 62873 | 4033 | 68986 | 2561 | 86870 | 1788 | 66663 |
| 24-#14 | 2.56 | MA | 32920 | 7564 | 51262 | 6194 | 61394 | 4993 | 66685 | 4057 | 72787 | 2594 | 92153 | 1758 | 71792 |
| 8L-6S | | MI | 31741 | 7564 | 49562 | 6158 | 59435 | 4966 | 64929 | 4020 | 71845 | 2568 | 90264 | 1890 | 67823 |
| 24-#14 | 2.56 | MA | 31968 | 7564 | 49741 | 6211 | 59525 | 5009 | 64455 | 4070 | 69780 | 2604 | 88286 | 1673 | 70052 |
| 9L-5S | | MI | 32644 | 7564 | 50868 | 6157 | 61177 | 4951 | 67049 | 4023 | 74666 | 2559 | 94079 | 1998 | 68879 |
| 24-#14 | 2.56 | MA | 31011 | 7564 | 48370 | 6213 | 57723 | 5009 | 62214 | 4069 | 66688 | 2599 | 84289 | 1558 | 68191 |
| 10L-4S | | MI | 33587 | 7564 | 52339 | 6141 | 62941 | 4952 | 69203 | 4010 | 77599 | 2550 | 97836 | 2065 | 70029 |
| 24-#18 | 4.55 | MA | 38523 | 9090 | 66274 | 7127 | 80069 | 5681 | 89218 | 4497 | 103021 | 2499 | 133201 | 1188 | 121549 |
| 7E | | MI | 34955 | 9090 | 60603 | 7088 | 72954 | 5646 | 81136 | 4465 | 93353 | 2461 | 119935 | 1106 | 109920 |
| 24-#18 | 4.55 | MA | 36951 | 9090 | 63849 | 7129 | 76874 | 5680 | 85227 | 4493 | 97675 | 2515 | 126407 | 1052 | 117000 |
| 8L-6S | | MI | 36405 | 9090 | 62840 | 7088 | 75913 | 5649 | 84750 | 4445 | 98359 | 2474 | 125799 | 1288 | 113115 |

## RECTANGULAR TIED COLUMNS 46" x 46"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.13 | MA | 31320 | 6484 | 44779 | 5448 | 53165 | 4433 | 56959 | 3679 | 60287 | 2593 | 73245 | 2438 | 33221 |
| 2L-3S | | MI | 28485 | 6484 | 41168 | 5450 | 48585 | 4431 | 51410 | 3700 | 52801 | 2607 | 63232 | 2204 | 33137 |
| 8-#18 | 1.51 | MA | 33051 | 6775 | 48391 | 5630 | 57745 | 4566 | 62508 | 3763 | 67774 | 2580 | 83258 | 2401 | 43941 |
| 2L-4S | | MI | 28238 | 6775 | 42094 | 5633 | 49535 | 4588 | 52559 | 3778 | 54350 | 2581 | 66651 | 1934 | 43065 |
| 10-#14 | 1.06 | MA | 31123 | 6429 | 43948 | 5447 | 52395 | 4434 | 56150 | 3686 | 59281 | 2613 | 72282 | 2478 | 31462 |
| 2L-5S | | MI | 27259 | 6429 | 38814 | 5467 | 45862 | 4449 | 48217 | 3710 | 48548 | 2626 | 58722 | 2147 | 31014 |
| 10-#14 | 1.06 | MA | 29498 | 6429 | 41888 | 5448 | 49782 | 4434 | 52985 | 3699 | 55010 | 2623 | 66503 | 2346 | 31440 |
| 3L-4S | | MI | 28323 | 6429 | 40360 | 5450 | 47716 | 4449 | 50481 | 3697 | 51630 | 2617 | 62690 | 2215 | 31320 |
| 10-#18 | 1.89 | MA | 34741 | 7066 | 52002 | 5812 | 62326 | 4699 | 68057 | 3847 | 75260 | 2567 | 93271 | 2365 | 54625 |
| 2L-5S | | MI | 28204 | 7066 | 42988 | 5843 | 50854 | 4719 | 54128 | 3883 | 56417 | 2581 | 69764 | 1781 | 50155 |
| 10-#18 | 1.89 | MA | 31995 | 7066 | 48391 | 5813 | 57745 | 4697 | 62508 | 3868 | 67774 | 2581 | 83258 | 2132 | 54348 |
| 3L-4S | | MI | 30006 | 7066 | 45705 | 5815 | 54115 | 4721 | 58108 | 3863 | 61836 | 2568 | 76664 | 1898 | 53560 |

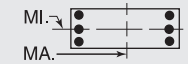
## RECTANGULAR TIED COLUMNS 46" x 48"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.09 | MA | 33932 | 6728 | 48191 | 5677 | 57313 | 4621 | 61384 | 3839 | 64828 | 2716 | 78858 | 2564 | 34841 |
| 2L-3S | | MI | 29612 | 6728 | 42644 | 5663 | 50299 | 4606 | 53163 | 3849 | 54446 | 2722 | 65111 | 2315 | 33200 |
| 6-#18 | 1.09 | MA | 30945 | 6728 | 44398 | 5679 | 52502 | 4620 | 55556 | 3861 | 56965 | 2731 | 68284 | 2331 | 34757 |
| 3L-2S | | MI | 32453 | 6728 | 46255 | 5662 | 54879 | 4608 | 58712 | 3828 | 61932 | 2708 | 75124 | 2548 | 33263 |
| 8-#18 | 1.45 | MA | 35764 | 7019 | 51984 | 5859 | 62124 | 4754 | 67212 | 3923 | 72691 | 2703 | 89432 | 2531 | 46101 |
| 2L-4S | | MI | 29364 | 7019 | 43570 | 5846 | 51249 | 4763 | 54312 | 3927 | 55994 | 2696 | 68530 | 2045 | 43201 |
| 8-#18 | 1.45 | MA | 32825 | 7019 | 48191 | 5861 | 57313 | 4753 | 61384 | 3945 | 64828 | 2718 | 78858 | 2297 | 45912 |
| 3E | | MI | 31394 | 7019 | 46255 | 5845 | 54879 | 4739 | 58712 | 3933 | 61932 | 2708 | 75124 | 2278 | 43825 |
| 8-#18 | 1.45 | MA | 30697 | 7019 | 45374 | 5863 | 53504 | 4778 | 56768 | 3940 | 58598 | 2707 | 71888 | 2064 | 45225 |
| 4L-2S | | MI | 34190 | 7019 | 49867 | 5843 | 59460 | 4741 | 64260 | 3912 | 69418 | 2695 | 85137 | 2512 | 43990 |
| 10-#14 | 1.02 | MA | 33716 | 6673 | 47309 | 5675 | 56494 | 4623 | 60522 | 3846 | 63754 | 2736 | 77799 | 2603 | 32980 |
| 2L-5S | | MI | 28383 | 6673 | 40277 | 5681 | 47572 | 4625 | 49970 | 3860 | 50197 | 2742 | 60608 | 2259 | 31110 |
| 10-#14 | 1.02 | MA | 32006 | 6673 | 45147 | 5677 | 53751 | 4623 | 57199 | 3859 | 59272 | 2746 | 71705 | 2472 | 32959 |
| 3L-4S | | MI | 29449 | 6673 | 41822 | 5664 | 49426 | 4626 | 52234 | 3847 | 53279 | 2732 | 64576 | 2326 | 31382 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

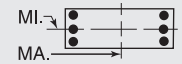



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.02 | MA | 30771 | 6673 | 43545 | 5679 | 51584 | 4638 | 54573 | 3858 | 55727 | 2741 | 67679 | 2340 | 32839 |
| 4L-3S | | MI | 30627 | 6673 | 43350 | 5663 | 51492 | 4611 | 54738 | 3849 | 56659 | 2738 | 68390 | 2458 | 31484 |
| 10-#14 | 1.02 | MA | 29654 | 6673 | 41925 | 5696 | 49641 | 4638 | 52200 | 3871 | 52496 | 2751 | 63501 | 2272 | 32533 |
| 5L-2S | | MI | 32255 | 6673 | 45411 | 5661 | 54105 | 4611 | 57903 | 3836 | 60930 | 2728 | 74168 | 2589 | 31497 |
| 10-#18 | 1.81 | MA | 37555 | 7310 | 55778 | 6041 | 66934 | 4887 | 73040 | 4007 | 80555 | 2690 | 100005 | 2498 | 57325 |
| 2L-5S | | MI | 29329 | 7310 | 44464 | 6056 | 52568 | 4894 | 55881 | 4032 | 58062 | 2696 | 71642 | 1892 | 50490 |
| 10-#18 | 1.81 | MA | 34660 | 7310 | 51984 | 6043 | 62124 | 4886 | 67212 | 4029 | 72691 | 2705 | 89432 | 2264 | 57048 |
| 3L-4S | | MI | 31137 | 7310 | 47181 | 6028 | 55829 | 4896 | 59861 | 4012 | 63481 | 2682 | 78543 | 2009 | 53704 |
| 10-#18 | 1.81 | MA | 32567 | 7310 | 49167 | 6045 | 58315 | 4911 | 62596 | 4025 | 66461 | 2693 | 82462 | 2030 | 56260 |
| 4L-3S | | MI | 33132 | 7310 | 49867 | 6026 | 59460 | 4872 | 64260 | 4017 | 69418 | 2695 | 85137 | 2242 | 54428 |
| 10-#18 | 1.81 | MA | 30673 | 7310 | 46317 | 6074 | 54895 | 4910 | 58421 | 4046 | 60777 | 2708 | 75187 | 1912 | 52860 |
| 5L-2S | | MI | 35888 | 7310 | 53478 | 6025 | 64040 | 4874 | 69809 | 3996 | 76905 | 2681 | 95150 | 2476 | 54680 |
| 12-#14 | 1.22 | MA | 34782 | 6837 | 49472 | 5777 | 59236 | 4697 | 63844 | 3893 | 68237 | 2729 | 83893 | 2587 | 39402 |
| 2L-6S | | MI | 28422 | 6837 | 40966 | 5785 | 48355 | 4715 | 50908 | 3905 | 51505 | 2744 | 62352 | 2134 | 35862 |
| 12-#14 | 1.22 | MA | 33088 | 6837 | 47309 | 5780 | 56494 | 4698 | 60522 | 3906 | 63754 | 2739 | 77799 | 2456 | 39349 |
| 3L-5S | | MI | 29433 | 6837 | 42337 | 5783 | 50185 | 4700 | 53136 | 3907 | 54468 | 2734 | 66387 | 2242 | 37123 |
| 12-#14 | 1.22 | MA | 31866 | 6837 | 45707 | 5782 | 54327 | 4713 | 57896 | 3905 | 60210 | 2734 | 73774 | 2325 | 39191 |
| 4E | | MI | 30488 | 6837 | 43883 | 5767 | 52039 | 4700 | 55399 | 3894 | 57550 | 2725 | 70355 | 2309 | 37435 |
| 12-#14 | 1.22 | MA | 30761 | 6837 | 44088 | 5799 | 52383 | 4713 | 55523 | 3919 | 56979 | 2744 | 69595 | 2257 | 38845 |
| 5L-3S | | MI | 31653 | 6837 | 45411 | 5765 | 54105 | 4686 | 57903 | 3896 | 60930 | 2730 | 74168 | 2440 | 37575 |
| 12-#14 | 1.22 | MA | 29702 | 6837 | 42650 | 5801 | 50466 | 4729 | 53188 | 3917 | 53873 | 2754 | 65339 | 2149 | 37501 |
| 6L-2S | | MI | 33266 | 6837 | 47471 | 5763 | 56718 | 4686 | 61069 | 3883 | 65201 | 2721 | 79947 | 2572 | 37619 |
| 12-#18 | 2.17 | MA | 39308 | 7600 | 59571 | 6222 | 71745 | 5020 | 78868 | 4092 | 88418 | 2676 | 110579 | 2464 | 68529 |
| 2L-6S | | MI | 29386 | 7600 | 45661 | 6239 | 53930 | 5052 | 57511 | 4111 | 60337 | 2696 | 74665 | 1663 | 58251 |
| 12-#18 | 2.17 | MA | 36455 | 7600 | 55778 | 6224 | 66934 | 5019 | 73040 | 4113 | 80555 | 2692 | 100005 | 2231 | 68172 |
| 3L-5S | | MI | 31092 | 7600 | 48075 | 6238 | 57148 | 5027 | 61430 | 4117 | 65548 | 2683 | 81655 | 1856 | 60779 |
| 12-#18 | 2.17 | MA | 34396 | 7600 | 52960 | 6227 | 63125 | 5044 | 68424 | 4109 | 74324 | 2680 | 93035 | 1997 | 67297 |
| 4E | | MI | 32870 | 7600 | 50793 | 6210 | 60409 | 5029 | 65410 | 4096 | 70967 | 2669 | 88556 | 1973 | 64208 |
| 12-#18 | 2.17 | MA | 32533 | 7600 | 50110 | 6255 | 59705 | 5043 | 64250 | 4131 | 68641 | 2695 | 85761 | 1879 | 63685 |
| 5L-3S | | MI | 34834 | 7600 | 53478 | 6208 | 64040 | 5005 | 69809 | 4102 | 76905 | 2682 | 95150 | 2206 | 65018 |
| 12-#18 | 2.17 | MA | 30745 | 7600 | 47580 | 6257 | 56330 | 5068 | 60141 | 4126 | 63176 | 2710 | 78378 | 1686 | 61015 |
| 6L-2S | | MI | 37550 | 7600 | 57090 | 6207 | 68620 | 5007 | 75358 | 4081 | 84391 | 2668 | 105163 | 2440 | 65347 |
| 14-#14 | 1.43 | MA | 35832 | 7001 | 51634 | 5880 | 61979 | 4772 | 67167 | 3940 | 72720 | 2721 | 89988 | 2572 | 45811 |
| 2L-7S | | MI | 28488 | 7001 | 41691 | 5889 | 49201 | 4790 | 51914 | 3966 | 52772 | 2731 | 64537 | 2014 | 40845 |
| 14-#14 | 1.43 | MA | 34154 | 7001 | 49472 | 5882 | 59236 | 4772 | 63844 | 3954 | 68237 | 2731 | 83893 | 2440 | 45731 |
| 3L-6S | | MI | 29467 | 7001 | 43026 | 5887 | 50968 | 4790 | 54074 | 3953 | 55776 | 2736 | 68131 | 2117 | 41771 |
| 14-#14 | 1.43 | MA | 32944 | 7001 | 47870 | 5884 | 57070 | 4788 | 61218 | 3952 | 64693 | 2726 | 79868 | 2309 | 45538 |
| 4L-5S | | MI | 30467 | 7001 | 44398 | 5886 | 52798 | 4775 | 56301 | 3955 | 58739 | 2727 | 72166 | 2225 | 43136 |
| 14-#14 | 1.43 | MA | 31851 | 7001 | 46250 | 5901 | 55126 | 4788 | 58846 | 3966 | 61462 | 2736 | 75690 | 2241 | 45157 |
| 5L-4S | | MI | 31511 | 7001 | 45943 | 5869 | 54652 | 4775 | 58565 | 3942 | 61821 | 2717 | 76134 | 2292 | 43483 |
| 14-#14 | 1.43 | MA | 30803 | 7001 | 44813 | 5903 | 53208 | 4803 | 56511 | 3965 | 58356 | 2746 | 71434 | 2133 | 43711 |
| 6L-3S | | MI | 32665 | 7001 | 47471 | 5867 | 56718 | 4760 | 61069 | 3943 | 65201 | 2723 | 79947 | 2423 | 43656 |
| 14-#14 | 1.43 | MA | 29778 | 7001 | 43414 | 5905 | 51356 | 4804 | 54248 | 3978 | 55208 | 2742 | 67642 | 2031 | 42716 |
| 7L-2S | | MI | 34263 | 7001 | 49531 | 5866 | 59331 | 4760 | 64234 | 3930 | 69472 | 2713 | 85726 | 2555 | 43727 |
| 14-#18 | 2.54 | MA | 41030 | 7891 | 63364 | 6404 | 76556 | 5153 | 84696 | 4176 | 96281 | 2663 | 121153 | 2431 | 79717 |
| 2L-7S | | MI | 29496 | 7891 | 46922 | 6422 | 55400 | 5182 | 59261 | 4216 | 62540 | 2670 | 78462 | 1445 | 64942 |
| 14-#18 | 2.54 | MA | 38214 | 7891 | 59571 | 6406 | 71745 | 5152 | 78868 | 4198 | 88418 | 2678 | 110579 | 2197 | 79289 |
| 3L-6S | | MI | 31140 | 7891 | 49273 | 6421 | 58510 | 5185 | 63060 | 4195 | 67823 | 2683 | 84678 | 1627 | 68419 |
| 14-#18 | 2.54 | MA | 36187 | 7891 | 56754 | 6408 | 67936 | 5177 | 74252 | 4193 | 82187 | 2667 | 103609 | 1964 | 78167 |
| 4L-5S | | MI | 32818 | 7891 | 51687 | 6419 | 61729 | 5160 | 66978 | 4201 | 73035 | 2669 | 91668 | 1820 | 71096 |
| 14-#18 | 2.54 | MA | 34354 | 7891 | 53904 | 6437 | 64516 | 5176 | 70078 | 4215 | 76504 | 2682 | 96334 | 1845 | 74536 |
| 5L-4S | | MI | 34569 | 7891 | 54404 | 6391 | 64990 | 5162 | 70959 | 4180 | 78453 | 2656 | 98569 | 1936 | 74483 |
| 14-#18 | 2.54 | MA | 32596 | 7891 | 51373 | 6439 | 61141 | 5201 | 65969 | 4210 | 71039 | 2697 | 88952 | 1653 | 71721 |
| 6L-3S | | MI | 36503 | 7891 | 57090 | 6390 | 68620 | 5138 | 75358 | 4186 | 84391 | 2669 | 105163 | 2170 | 75600 |
| 14-#18 | 2.54 | MA | 30873 | 7891 | 48909 | 6441 | 57880 | 5200 | 61986 | 4232 | 65498 | 2686 | 82382 | 1471 | 68011 |
| 7L-2S | | MI | 39183 | 7891 | 60701 | 6388 | 73200 | 5140 | 80907 | 4165 | 91878 | 2655 | 115176 | 2404 | 75999 |
| 16-#11 | 1.13 | MA | 34375 | 6763 | 48411 | 5747 | 58043 | 4677 | 62465 | 3883 | 66422 | 2741 | 81636 | 2612 | 36647 |
| 2L-8S | | MI | 28117 | 6763 | 40075 | 5753 | 47313 | 4688 | 49662 | 3899 | 49815 | 2755 | 60355 | 2168 | 33296 |

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis



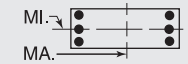

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.13 | MA | 33187 | 6763 | 46902 | 5749 | 56128 | 4677 | 60146 | 3893 | 63293 | 2748 | 77359 | 2521 | 36622 |
| 3L-7S | | MI | 28800 | 6763 | 40991 | 5752 | 48520 | 4688 | 51169 | 3900 | 51835 | 2748 | 62954 | 2222 | 33801 |
| 16-#11 | 1.13 | MA | 32332 | 6763 | 45785 | 5751 | 54618 | 4688 | 58315 | 3892 | 60821 | 2745 | 74532 | 2429 | 36556 |
| 4L-6S | | MI | 29492 | 6763 | 41921 | 5750 | 49752 | 4688 | 52674 | 3891 | 53928 | 2751 | 65479 | 2293 | 34469 |
| 16-#11 | 1.13 | MA | 31559 | 6763 | 44656 | 5763 | 53263 | 4689 | 56661 | 3902 | 58570 | 2753 | 71604 | 2382 | 36424 |
| 5E | | MI | 30199 | 6763 | 42877 | 5749 | 51027 | 4677 | 54227 | 3891 | 55994 | 2744 | 68312 | 2368 | 34803 |
| 16-#11 | 1.13 | MA | 30819 | 6763 | 43655 | 5765 | 51927 | 4700 | 55034 | 3901 | 56405 | 2760 | 68617 | 2307 | 36065 |
| 6L-4S | | MI | 30936 | 6763 | 43954 | 5737 | 52319 | 4677 | 55805 | 3882 | 58142 | 2737 | 71094 | 2415 | 34921 |
| 16-#11 | 1.13 | MA | 30095 | 6763 | 42680 | 5766 | 50637 | 4700 | 53458 | 3911 | 54212 | 2758 | 65954 | 2236 | 35347 |
| 7L-3S | | MI | 31752 | 6763 | 45020 | 5735 | 53760 | 4666 | 57551 | 3883 | 60500 | 2740 | 73774 | 2506 | 34977 |
| 16-#11 | 1.13 | MA | 29379 | 6763 | 41721 | 5768 | 49373 | 4701 | 51878 | 3911 | 52096 | 2765 | 63219 | 2181 | 34803 |
| 8L-2S | | MI | 32883 | 6763 | 46458 | 5734 | 55585 | 4666 | 59761 | 3873 | 63482 | 2733 | 77832 | 2597 | 34997 |
| 16-#14 | 1.63 | MA | 36869 | 7164 | 53797 | 5982 | 64721 | 4847 | 70490 | 3988 | 77203 | 2714 | 96082 | 2556 | 52211 |
| 2L-8S | | MI | 28570 | 7164 | 42437 | 5993 | 50082 | 4864 | 52917 | 4011 | 54145 | 2732 | 66610 | 1920 | 45236 |
| 16-#14 | 1.63 | MA | 35205 | 7164 | 51634 | 5984 | 61979 | 4847 | 67167 | 4001 | 72720 | 2724 | 89988 | 2425 | 52105 |
| 3L-7S | | MI | 29528 | 7164 | 43751 | 5991 | 51814 | 4865 | 55080 | 4013 | 57043 | 2723 | 70316 | 1997 | 46790 |
| 16-#14 | 1.63 | MA | 34008 | 7164 | 50032 | 5986 | 59812 | 4863 | 64541 | 4000 | 69176 | 2719 | 85963 | 2293 | 51881 |
| 4L-6S | | MI | 30497 | 7164 | 45086 | 5989 | 53581 | 4865 | 57239 | 4000 | 60046 | 2729 | 73909 | 2100 | 47692 |
| 16-#14 | 1.63 | MA | 32926 | 7164 | 48413 | 6003 | 57868 | 4863 | 62168 | 4013 | 65945 | 2729 | 81784 | 2225 | 51347 |
| 5E | | MI | 31487 | 7164 | 46458 | 5988 | 55411 | 4850 | 59467 | 4002 | 63009 | 2719 | 77944 | 2208 | 49012 |
| 16-#14 | 1.63 | MA | 31889 | 7164 | 46975 | 6005 | 55951 | 4878 | 59834 | 4012 | 62839 | 2739 | 77528 | 2117 | 49932 |
| 6L-4S | | MI | 32520 | 7164 | 48003 | 5971 | 57265 | 4850 | 61730 | 3989 | 66092 | 2710 | 81912 | 2275 | 49526 |
| 16-#14 | 1.63 | MA | 30874 | 7164 | 45576 | 6007 | 54099 | 4878 | 57571 | 4026 | 59691 | 2734 | 73736 | 2015 | 48962 |
| 7L-3S | | MI | 33662 | 7164 | 49531 | 5969 | 59331 | 4835 | 64234 | 3991 | 69472 | 2715 | 85726 | 2406 | 49730 |
| 16-#14 | 1.63 | MA | 29871 | 7164 | 44199 | 6009 | 52284 | 4879 | 55304 | 4024 | 56654 | 2744 | 69832 | 1937 | 47317 |
| 8L-2S | | MI | 35246 | 7164 | 51592 | 5968 | 61944 | 4835 | 67400 | 3978 | 73742 | 2706 | 91505 | 2538 | 49825 |
| 16-#18 | 2.90 | MA | 42722 | 8182 | 67157 | 6586 | 81366 | 5286 | 90525 | 4260 | 104144 | 2650 | 131726 | 2397 | 90894 |
| 2L-8S | | MI | 29640 | 8182 | 48220 | 6605 | 56933 | 5313 | 61004 | 4295 | 64928 | 2671 | 82031 | 1273 | 71087 |
| 16-#18 | 2.90 | MA | 39943 | 8182 | 63364 | 6588 | 76556 | 5285 | 84696 | 4282 | 96281 | 2665 | 121153 | 2164 | 90400 |
| 3L-7S | | MI | 31241 | 8182 | 50534 | 6604 | 59980 | 5315 | 64810 | 4300 | 70026 | 2657 | 88475 | 1409 | 75237 |
| 16-#18 | 2.90 | MA | 37945 | 8182 | 60547 | 6590 | 72747 | 5310 | 80080 | 4277 | 90051 | 2654 | 114183 | 1930 | 88900 |
| 4L-6S | | MI | 32860 | 8182 | 52884 | 6602 | 63090 | 5318 | 68609 | 4279 | 75310 | 2670 | 94691 | 1591 | 78614 |
| 16-#18 | 2.90 | MA | 36140 | 8182 | 57697 | 6619 | 69327 | 5309 | 75906 | 4299 | 84367 | 2669 | 106908 | 1812 | 85410 |
| 5E | | MI | 34512 | 8182 | 55298 | 6601 | 66309 | 5293 | 72527 | 4285 | 80521 | 2656 | 101682 | 1784 | 81436 |
| 16-#18 | 2.90 | MA | 34410 | 8182 | 55166 | 6621 | 65952 | 5334 | 71797 | 4295 | 78902 | 2684 | 99525 | 1619 | 82453 |
| 6L-4S | | MI | 36236 | 8182 | 58016 | 6573 | 69570 | 5295 | 76508 | 4264 | 85940 | 2642 | 108582 | 1900 | 84685 |
| 16-#18 | 2.90 | MA | 32714 | 8182 | 52702 | 6623 | 62691 | 5333 | 67814 | 4316 | 73362 | 2672 | 92956 | 1438 | 78846 |
| 7L-3S | | MI | 38142 | 8182 | 60701 | 6572 | 73200 | 5271 | 80907 | 4270 | 91878 | 2655 | 115176 | 2134 | 86175 |
| 16-#18 | 2.90 | MA | 31038 | 8182 | 50277 | 6625 | 59496 | 5332 | 63823 | 4312 | 68016 | 2687 | 86162 | 1301 | 74474 |
| 8L-2S | | MI | 40788 | 8182 | 64313 | 6570 | 77780 | 5273 | 86456 | 4249 | 99364 | 2642 | 125189 | 2368 | 86639 |
| 18-#11 | 1.27 | MA | 35118 | 6876 | 49921 | 5818 | 59957 | 4729 | 64784 | 3916 | 69550 | 2735 | 85913 | 2602 | 41122 |
| 2L-9S | | MI | 28184 | 6876 | 40502 | 5836 | 47894 | 4751 | 50389 | 3941 | 50797 | 2757 | 61838 | 2099 | 36640 |
| 18-#11 | 1.27 | MA | 33938 | 6876 | 48411 | 5820 | 58043 | 4729 | 62465 | 3925 | 66422 | 2743 | 81636 | 2511 | 41085 |
| 3L-8S | | MI | 28857 | 6876 | 41514 | 5824 | 49138 | 4740 | 51872 | 3932 | 52797 | 2750 | 64413 | 2157 | 37459 |
| 18-#11 | 1.27 | MA | 33089 | 6876 | 47294 | 5822 | 56532 | 4740 | 60634 | 3925 | 63950 | 2740 | 78808 | 2420 | 41003 |
| 4L-7S | | MI | 29535 | 6876 | 42429 | 5822 | 50344 | 4740 | 53379 | 3933 | 54817 | 2743 | 67011 | 2212 | 37954 |
| 18-#11 | 1.27 | MA | 32322 | 6876 | 46166 | 5834 | 55178 | 4741 | 58980 | 3935 | 61698 | 2748 | 75881 | 2372 | 40853 |
| 5L-6S | | MI | 30222 | 6876 | 43360 | 5821 | 51576 | 4739 | 54884 | 3923 | 56910 | 2746 | 69536 | 2282 | 38602 |
| 18-#11 | 1.27 | MA | 31588 | 6876 | 45164 | 5835 | 53841 | 4752 | 57353 | 3934 | 59534 | 2755 | 72894 | 2297 | 40405 |
| 6L-5S | | MI | 30923 | 6876 | 44316 | 5820 | 52851 | 4729 | 56437 | 3924 | 58976 | 2739 | 72370 | 2357 | 39024 |
| 18-#11 | 1.27 | MA | 30869 | 6876 | 44190 | 5837 | 52551 | 4752 | 55777 | 3944 | 57341 | 2752 | 70231 | 2226 | 39709 |
| 7L-4S | | MI | 31655 | 6876 | 45393 | 5808 | 54144 | 4728 | 58015 | 3915 | 61124 | 2732 | 75151 | 2405 | 39160 |
| 18-#11 | 1.27 | MA | 30159 | 6876 | 43231 | 5839 | 51287 | 4753 | 54197 | 3943 | 55224 | 2760 | 67496 | 2171 | 39175 |
| 8L-3S | | MI | 32465 | 6876 | 46458 | 5806 | 55585 | 4718 | 59761 | 3916 | 63482 | 2735 | 77832 | 2496 | 39232 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

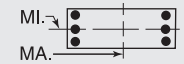



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.27 | MA | 29446 | 6876 | 42171 | 5851 | 49984 | 4764 | 52643 | 3953 | 53129 | 2767 | 64781 | 2113 | 38303 |
| 9L-2S | | MI | 33589 | 6876 | 47897 | 5805 | 57409 | 4718 | 61971 | 3906 | 66463 | 2728 | 81890 | 2587 | 39264 |
| 18-#14 | 1.83 | MA | 37892 | 7328 | 55959 | 6084 | 67464 | 4922 | 73812 | 4035 | 81686 | 2706 | 102177 | 2541 | 58604 |
| 2L-9S | | MI | 28665 | 7328 | 43046 | 6112 | 50911 | 4954 | 53954 | 4071 | 55546 | 2734 | 68724 | 1818 | 49739 |
| 18-#14 | 1.83 | MA | 36242 | 7328 | 53797 | 6086 | 64721 | 4922 | 70490 | 4049 | 77203 | 2716 | 96082 | 2409 | 58474 |
| 3L-8S | | MI | 29606 | 7328 | 44497 | 6095 | 52695 | 4939 | 56082 | 4058 | 58416 | 2725 | 72388 | 1903 | 51125 |
| 18-#14 | 1.83 | MA | 35057 | 7328 | 52195 | 6088 | 62555 | 4937 | 67864 | 4047 | 73658 | 2711 | 92057 | 2278 | 58222 |
| 4L-7S | | MI | 30554 | 7328 | 45811 | 6093 | 54427 | 4939 | 58246 | 4060 | 61314 | 2716 | 76095 | 1980 | 52741 |
| 18-#14 | 1.83 | MA | 33986 | 7328 | 50575 | 6105 | 60611 | 4938 | 65491 | 4061 | 70427 | 2721 | 87878 | 2210 | 57530 |
| 5L-6S | | MI | 31513 | 7328 | 47146 | 6092 | 56194 | 4939 | 60405 | 4047 | 64317 | 2721 | 79688 | 2082 | 53623 |
| 18-#14 | 1.83 | MA | 32960 | 7328 | 49138 | 6107 | 58693 | 4953 | 63156 | 4059 | 67322 | 2732 | 83622 | 2102 | 56163 |
| 6L-5S | | MI | 32493 | 7328 | 48518 | 6090 | 58024 | 4925 | 62632 | 4049 | 67280 | 2712 | 83723 | 2191 | 54896 |
| 18-#14 | 1.83 | MA | 31956 | 7328 | 47739 | 6109 | 56841 | 4953 | 60893 | 4073 | 64174 | 2727 | 79830 | 2000 | 55214 |
| 7L-4S | | MI | 33515 | 7328 | 50064 | 6073 | 59878 | 4925 | 64896 | 4036 | 70362 | 2702 | 87691 | 2258 | 55566 |
| 18-#14 | 1.83 | MA | 30963 | 7328 | 46362 | 6111 | 55027 | 4954 | 58626 | 4072 | 61137 | 2737 | 75927 | 1921 | 53508 |
| 8L-3S | | MI | 34647 | 7328 | 51592 | 6072 | 61944 | 4910 | 67400 | 4038 | 73742 | 2708 | 91505 | 2389 | 55798 |
| 18-#14 | 1.83 | MA | 29977 | 7328 | 44841 | 6128 | 53157 | 4969 | 56396 | 4085 | 58129 | 2747 | 72060 | 1837 | 52042 |
| 9L-2S | | MI | 36218 | 7328 | 53652 | 6070 | 64557 | 4910 | 70566 | 4025 | 78013 | 2699 | 97283 | 2521 | 55917 |
| 18-#18 | 3.26 | MA | 41644 | 8473 | 67157 | 6770 | 81366 | 5418 | 90525 | 4366 | 104144 | 2652 | 131726 | 2130 | 101507 |
| 3L-8S | | MI | 31377 | 8473 | 51832 | 6787 | 61513 | 5446 | 66553 | 4379 | 72414 | 2658 | 92044 | 1237 | 81328 |
| 18-#18 | 3.26 | MA | 39675 | 8473 | 64340 | 6772 | 77557 | 5443 | 85909 | 4362 | 97914 | 2640 | 124756 | 1897 | 99664 |
| 4L-7S | | MI | 32954 | 8473 | 54145 | 6786 | 64560 | 5448 | 70359 | 4385 | 77513 | 2644 | 98488 | 1373 | 85550 |
| 18-#18 | 3.26 | MA | 37896 | 8473 | 61490 | 6801 | 74137 | 5442 | 81734 | 4383 | 92230 | 2655 | 117482 | 1779 | 96304 |
| 5L-6S | | MI | 34549 | 8473 | 56496 | 6784 | 67670 | 5451 | 74158 | 4364 | 82796 | 2657 | 104704 | 1555 | 88831 |
| 18-#18 | 3.26 | MA | 36191 | 8473 | 58959 | 6803 | 70762 | 5467 | 77625 | 4379 | 86765 | 2671 | 110099 | 1586 | 93207 |
| 6L-5S | | MI | 36178 | 8473 | 58910 | 6783 | 70889 | 5426 | 78076 | 4369 | 88007 | 2643 | 111695 | 1748 | 91795 |
| 18-#18 | 3.26 | MA | 34521 | 8473 | 56495 | 6805 | 67502 | 5466 | 73642 | 4401 | 81225 | 2659 | 103530 | 1404 | 89697 |
| 7L-4S | | MI | 37876 | 8473 | 61627 | 6755 | 74150 | 5428 | 82057 | 4349 | 93426 | 2629 | 118595 | 1864 | 94919 |
| 18-#18 | 3.26 | MA | 32870 | 8473 | 54070 | 6807 | 64307 | 5465 | 69651 | 4396 | 75879 | 2674 | 96736 | 1268 | 85257 |
| 8L-3S | | MI | 39756 | 8473 | 64313 | 6753 | 77780 | 5404 | 86456 | 4354 | 99364 | 2642 | 125189 | 2098 | 96747 |
| 20-#11 | 1.41 | MA | 35853 | 6990 | 51430 | 5889 | 61871 | 4780 | 67103 | 3948 | 72679 | 2730 | 90189 | 2592 | 45593 |
| 2L-10S | | MI | 28244 | 6990 | 41029 | 5908 | 48520 | 4803 | 51109 | 3973 | 51723 | 2749 | 63235 | 2008 | 40004 |
| 20-#11 | 1.41 | MA | 34681 | 6990 | 49921 | 5891 | 59957 | 4781 | 64784 | 3958 | 69550 | 2738 | 85913 | 2501 | 45543 |
| 3L-9S | | MI | 28922 | 6990 | 41941 | 5907 | 49718 | 4802 | 52599 | 3974 | 53779 | 2752 | 65896 | 2088 | 40765 |
| 20-#11 | 1.41 | MA | 33838 | 6990 | 48804 | 5893 | 58446 | 4792 | 62953 | 3958 | 67079 | 2735 | 83085 | 2410 | 45447 |
| 4L-8S | | MI | 29590 | 6990 | 42952 | 5895 | 50962 | 4792 | 54082 | 3965 | 55779 | 2745 | 68471 | 2146 | 41626 |
| 20-#11 | 1.41 | MA | 33077 | 6990 | 47675 | 5905 | 57092 | 4793 | 61299 | 3968 | 64827 | 2743 | 80158 | 2362 | 45280 |
| 5L-7S | | MI | 30263 | 6990 | 43868 | 5893 | 52169 | 4792 | 55590 | 3966 | 57799 | 2738 | 71069 | 2201 | 42113 |
| 20-#11 | 1.41 | MA | 32349 | 6990 | 46674 | 5906 | 55756 | 4804 | 59673 | 3967 | 62663 | 2750 | 77171 | 2287 | 44751 |
| 6E | | MI | 30944 | 6990 | 44798 | 5892 | 53400 | 4791 | 57095 | 3956 | 59892 | 2741 | 73594 | 2272 | 42741 |
| 20-#11 | 1.41 | MA | 31636 | 6990 | 45699 | 5908 | 54465 | 4804 | 58096 | 3977 | 60469 | 2747 | 74508 | 2217 | 44075 |
| 7L-5S | | MI | 31640 | 6990 | 45754 | 5890 | 54675 | 4781 | 58647 | 3957 | 61957 | 2734 | 76428 | 2347 | 43244 |
| 20-#11 | 1.41 | MA | 30931 | 6990 | 44740 | 5910 | 53201 | 4805 | 56516 | 3976 | 58353 | 2755 | 71773 | 2162 | 43550 |
| 8L-4S | | MI | 32366 | 6990 | 46831 | 5879 | 55968 | 4780 | 60225 | 3948 | 64106 | 2727 | 79209 | 2394 | 43395 |
| 20-#11 | 1.41 | MA | 30232 | 6990 | 43680 | 5922 | 51898 | 4816 | 54962 | 3986 | 56258 | 2762 | 69058 | 2103 | 42636 |
| 9L-3S | | MI | 33170 | 6990 | 47897 | 5877 | 57409 | 4770 | 61971 | 3949 | 66463 | 2730 | 81890 | 2485 | 43482 |
| 20-#11 | 1.41 | MA | 29521 | 6990 | 42725 | 5924 | 50643 | 4816 | 53401 | 3986 | 54103 | 2759 | 66253 | 2023 | 41823 |
| 10L-2S | | MI | 34287 | 6990 | 49335 | 5876 | 59233 | 4769 | 64182 | 3939 | 69445 | 2723 | 85947 | 2576 | 43526 |
| 20-#14 | 2.04 | MA | 38903 | 7491 | 58122 | 6186 | 70206 | 4997 | 77135 | 4082 | 86168 | 2699 | 108271 | 2525 | 64991 |
| 2L-10S | | MI | 28768 | 7491 | 43797 | 6216 | 51804 | 5029 | 54981 | 4117 | 56866 | 2721 | 70714 | 1686 | 53753 |
| 20-#14 | 2.04 | MA | 37267 | 7491 | 55959 | 6188 | 67464 | 4997 | 73812 | 4096 | 81686 | 2709 | 102177 | 2393 | 64839 |
| 3L-9S | | MI | 29696 | 7491 | 45106 | 6214 | 53523 | 5029 | 57119 | 4119 | 59817 | 2727 | 74502 | 1801 | 55589 |
| 20-#14 | 2.04 | MA | 36093 | 7491 | 54357 | 6191 | 65297 | 5012 | 71186 | 4095 | 78141 | 2704 | 98152 | 2262 | 64560 |
| 4L-8S | | MI | 30628 | 7491 | 46557 | 6197 | 55308 | 5014 | 59248 | 4106 | 62687 | 2718 | 78167 | 1886 | 57022 |
| 20-#14 | 2.04 | MA | 35032 | 7491 | 52738 | 6208 | 63354 | 5012 | 68814 | 4108 | 74910 | 2714 | 93973 | 2194 | 63725 |
| 5L-7S | | MI | 31566 | 7491 | 47872 | 6196 | 57040 | 5014 | 61411 | 4108 | 65585 | 2708 | 81873 | 1963 | 58651 |
| 20-#14 | 2.04 | MA | 34017 | 7491 | 51300 | 6210 | 61436 | 5028 | 66479 | 4107 | 71805 | 2724 | 89717 | 2086 | 62402 |
| 6E | | MI | 32516 | 7491 | 49207 | 6194 | 58807 | 5014 | 63570 | 4095 | 68588 | 2714 | 85467 | 2065 | 59561 |
| 20-#14 | 2.04 | MA | 33023 | 7491 | 49901 | 6212 | 59584 | 5028 | 64216 | 4120 | 68656 | 2719 | 85925 | 1984 | 61448 |
| 7L-5S | | MI | 33486 | 7491 | 50579 | 6192 | 60637 | 4999 | 65798 | 4097 | 71551 | 2704 | 89502 | 2174 | 60793 |

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

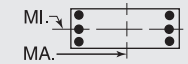



$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.04 | MA | 32040 | 7491 | 48524 | 6214 | 57769 | 5028 | 61949 | 4119 | 65619 | 2729 | 82021 | 1905 | 59707 |
| 8L-4S | | MI | 34499 | 7491 | 52124 | 6176 | 62491 | 5000 | 68061 | 4084 | 74633 | 2695 | 93470 | 2241 | 61604 |
| 20-#14 | 2.04 | MA | 31064 | 7491 | 47003 | 6231 | 55899 | 5044 | 59719 | 4132 | 62612 | 2739 | 78155 | 1821 | 58195 |
| 9L-3S | | MI | 35619 | 7491 | 53652 | 6174 | 64557 | 4985 | 70566 | 4086 | 78013 | 2701 | 97283 | 2372 | 61862 |
| 20-#14 | 2.04 | MA | 30093 | 7491 | 45632 | 6233 | 54098 | 5044 | 57478 | 4131 | 59520 | 2735 | 74158 | 1706 | 56240 |
| 10L-2S | | MI | 37177 | 7491 | 55712 | 6172 | 67170 | 4985 | 73731 | 4073 | 82284 | 2691 | 103062 | 2504 | 62003 |
| 20-#18 | 3.62 | MA | 41378 | 8763 | 68133 | 6954 | 82368 | 5576 | 91737 | 4446 | 105777 | 2627 | 135330 | 1863 | 110456 |
| 4L-8S | | MI | 33085 | 8763 | 55443 | 6969 | 66093 | 5579 | 72101 | 4463 | 79901 | 2644 | 102057 | 1201 | 91585 |
| 20-#18 | 3.62 | MA | 39624 | 8763 | 65283 | 6982 | 78948 | 5575 | 87562 | 4468 | 100093 | 2642 | 128055 | 1745 | 107214 |
| 5L-7S | | MI | 34639 | 8763 | 57757 | 6967 | 69140 | 5581 | 75908 | 4469 | 84999 | 2631 | 108501 | 1336 | 95878 |
| 20-#18 | 3.62 | MA | 37944 | 8763 | 62752 | 6984 | 75573 | 5600 | 83454 | 4463 | 94628 | 2657 | 120673 | 1553 | 103982 |
| 6E | | MI | 36211 | 8763 | 60107 | 6966 | 72250 | 5584 | 79707 | 4448 | 90282 | 2643 | 114717 | 1518 | 99069 |
| 20-#18 | 3.62 | MA | 36298 | 8763 | 60289 | 6987 | 72312 | 5599 | 79470 | 4485 | 89088 | 2646 | 114103 | 1371 | 100564 |
| 7L-5S | | MI | 37817 | 8763 | 62521 | 6965 | 75469 | 5559 | 83625 | 4454 | 95494 | 2630 | 121708 | 1711 | 102171 |
| 20-#18 | 3.62 | MA | 34671 | 8763 | 57863 | 6989 | 69117 | 5598 | 75479 | 4480 | 83742 | 2661 | 107309 | 1234 | 96054 |
| 8L-4S | | MI | 39492 | 8763 | 65239 | 6937 | 78730 | 5561 | 87606 | 4433 | 100913 | 2616 | 128608 | 1828 | 105181 |
| 22-#11 | 1.55 | MA | 36582 | 7103 | 52939 | 5960 | 63785 | 4832 | 69422 | 3981 | 75808 | 2725 | 94466 | 2582 | 50061 |
| 2L-11S | | MI | 28282 | 7103 | 41562 | 5981 | 49115 | 4865 | 51845 | 4016 | 52713 | 2751 | 64739 | 1940 | 43111 |
| 22-#11 | 1.55 | MA | 35417 | 7103 | 51430 | 5962 | 61871 | 4833 | 67103 | 3991 | 72679 | 2733 | 90189 | 2491 | 49999 |
| 3L-10S | | MI | 28982 | 7103 | 42467 | 5979 | 50345 | 4855 | 53319 | 4006 | 54705 | 2743 | 67293 | 1997 | 44147 |
| 22-#11 | 1.55 | MA | 34580 | 7103 | 50313 | 5963 | 60361 | 4844 | 65272 | 3991 | 70208 | 2730 | 87362 | 2400 | 49888 |
| 4L-9S | | MI | 29652 | 7103 | 43379 | 5978 | 51543 | 4854 | 54809 | 4007 | 56761 | 2747 | 69954 | 2077 | 44894 |
| 22-#11 | 1.55 | MA | 33825 | 7103 | 49184 | 5975 | 59006 | 4844 | 63619 | 4000 | 67956 | 2737 | 84435 | 2352 | 49707 |
| 5L-8S | | MI | 30315 | 7103 | 44391 | 5966 | 52786 | 4844 | 56292 | 3998 | 58761 | 2740 | 72528 | 2136 | 45795 |
| 22-#11 | 1.55 | MA | 33102 | 7103 | 48183 | 5977 | 57670 | 4855 | 61992 | 4000 | 65792 | 2745 | 81448 | 2278 | 49104 |
| 6L-7S | | MI | 30983 | 7103 | 45306 | 5964 | 53993 | 4843 | 57800 | 3999 | 60781 | 2733 | 75127 | 2190 | 46275 |
| 22-#11 | 1.55 | MA | 32394 | 7103 | 47208 | 5979 | 56380 | 4856 | 60415 | 4010 | 63598 | 2742 | 78785 | 2207 | 48446 |
| 7L-6S | | MI | 31659 | 7103 | 46237 | 5963 | 55225 | 4843 | 59305 | 3989 | 62874 | 2736 | 77652 | 2261 | 46887 |
| 22-#11 | 1.55 | MA | 31695 | 7103 | 46249 | 5981 | 55115 | 4857 | 58835 | 4009 | 61482 | 2750 | 76050 | 2152 | 47928 |
| 8L-5S | | MI | 32349 | 7103 | 47193 | 5961 | 56500 | 4832 | 60857 | 3990 | 64939 | 2729 | 80485 | 2336 | 47462 |
| 22-#11 | 1.55 | MA | 31001 | 7103 | 45190 | 5993 | 53813 | 4867 | 57282 | 4019 | 59387 | 2757 | 73335 | 2094 | 46974 |
| 9L-4S | | MI | 33070 | 7103 | 48270 | 5949 | 57792 | 4832 | 62435 | 3981 | 67088 | 2722 | 83267 | 2383 | 47628 |
| 22-#11 | 1.55 | MA | 30298 | 7103 | 44234 | 5994 | 52558 | 4868 | 55721 | 4018 | 57232 | 2754 | 70529 | 2014 | 46175 |
| 10L-3S | | MI | 33869 | 7103 | 49335 | 5948 | 59233 | 4822 | 64182 | 3981 | 69445 | 2725 | 85947 | 2474 | 47729 |
| 22-#11 | 1.55 | MA | 29556 | 7103 | 43286 | 5996 | 51270 | 4879 | 54176 | 4028 | 55146 | 2762 | 67841 | 1956 | 45051 |
| 11L-2S | | MI | 34979 | 7103 | 50774 | 5946 | 61058 | 4821 | 66392 | 3972 | 72427 | 2718 | 90005 | 2565 | 47785 |
| 22-#14 | 2.24 | MA | 38280 | 7655 | 58122 | 6291 | 70206 | 5072 | 77135 | 4143 | 86168 | 2701 | 108271 | 2378 | 71200 |
| 3L-10S | | MI | 29796 | 7655 | 45857 | 6318 | 54417 | 5104 | 58147 | 4164 | 61137 | 2714 | 76492 | 1669 | 59647 |
| 22-#14 | 2.24 | MA | 37117 | 7655 | 56520 | 6293 | 68040 | 5087 | 74509 | 4142 | 82624 | 2696 | 104246 | 2246 | 70897 |
| 4L-9S | | MI | 30715 | 7655 | 47166 | 6316 | 56136 | 5104 | 60285 | 4166 | 64088 | 2719 | 80281 | 1784 | 61447 |
| 22-#14 | 2.24 | MA | 36066 | 7655 | 54900 | 6310 | 66096 | 5087 | 72136 | 4156 | 79393 | 2707 | 100067 | 2178 | 69932 |
| 5L-8S | | MI | 31637 | 7655 | 48618 | 6300 | 57921 | 5089 | 62413 | 4153 | 66958 | 2710 | 83946 | 1869 | 62927 |
| 22-#14 | 2.24 | MA | 35061 | 7655 | 53463 | 6312 | 64178 | 5103 | 69802 | 4154 | 76287 | 2717 | 95811 | 2070 | 68647 |
| 6L-7S | | MI | 32566 | 7655 | 49932 | 6298 | 59652 | 5089 | 64577 | 4155 | 69855 | 2701 | 87652 | 1946 | 64518 |
| 22-#14 | 2.24 | MA | 34076 | 7655 | 52064 | 6314 | 62326 | 5103 | 67539 | 4168 | 73139 | 2712 | 92019 | 1968 | 67615 |
| 7L-6S | | MI | 33507 | 7655 | 51267 | 6296 | 61420 | 5089 | 66736 | 4142 | 72859 | 2706 | 91245 | 2048 | 65507 |
| 22-#14 | 2.24 | MA | 33104 | 7655 | 50687 | 6316 | 60512 | 5103 | 65271 | 4166 | 70102 | 2722 | 88116 | 1890 | 65914 |
| 8L-5S | | MI | 34467 | 7655 | 52639 | 6294 | 63249 | 5074 | 68963 | 4144 | 75822 | 2697 | 95280 | 2157 | 66701 |
| 22-#14 | 2.24 | MA | 32138 | 7655 | 49166 | 6333 | 58642 | 5118 | 63041 | 4180 | 67095 | 2732 | 84249 | 1806 | 64357 |
| 9L-4S | | MI | 35470 | 7655 | 54184 | 6278 | 65104 | 5074 | 71227 | 4131 | 78904 | 2688 | 99248 | 2224 | 67640 |
| 22-#14 | 2.24 | MA | 31176 | 7655 | 47794 | 6335 | 56840 | 5119 | 60800 | 4178 | 64002 | 2727 | 80253 | 1690 | 62437 |
| 10L-3S | | MI | 36581 | 7655 | 55712 | 6276 | 67170 | 5060 | 73731 | 4133 | 82284 | 2693 | 103062 | 2355 | 67922 |
| 22-#18 | 3.99 | MA | 41328 | 9054 | 69076 | 7164 | 83759 | 5708 | 93390 | 4552 | 107956 | 2629 | 138629 | 1712 | 118140 |
| 5L-8S | | MI | 34766 | 9054 | 59055 | 7151 | 70673 | 5712 | 77650 | 4547 | 87387 | 2631 | 112070 | 1165 | 101856 |
| 22-#18 | 3.99 | MA | 39671 | 9054 | 66545 | 7166 | 80384 | 5733 | 89282 | 4547 | 102491 | 2644 | 131246 | 1519 | 114775 |
| 6L-7S | | MI | 36299 | 9054 | 61368 | 7149 | 73721 | 5714 | 81457 | 4553 | 92485 | 2617 | 118514 | 1300 | 106220 |
| 22-#18 | 3.99 | MA | 38048 | 9054 | 64082 | 7168 | 77123 | 5732 | 85298 | 4569 | 96951 | 2633 | 124677 | 1337 | 111444 |
| 7L-6S | | MI | 37850 | 9054 | 63718 | 7148 | 76830 | 5717 | 85256 | 4532 | 97769 | 2630 | 124730 | 1482 | 109327 |
| 22-#18 | 3.99 | MA | 36444 | 9054 | 61656 | 7171 | 73928 | 5730 | 81307 | 4565 | 91605 | 2648 | 117883 | 1201 | 106865 |
| 8L-5S | | MI | 39433 | 9054 | 66133 | 7146 | 80049 | 5692 | 89174 | 4538 | 102980 | 2616 | 131721 | 1675 | 112562 |

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 1.70 | MA | 37304 | 7216 | 54449 | 6031 | 65699 | 4884 | 71741 | 4014 | 78937 | 2720 | 98743 | 2573 | 54525 |
| 2L-12S | | MI | 28317 | 7216 | 42100 | 6053 | 49745 | 4917 | 52574 | 4048 | 53713 | 2752 | 66242 | 1872 | 46224 |
| 24-#11 | 1.70 | MA | 36146 | 7216 | 52939 | 6033 | 63785 | 4885 | 69422 | 4024 | 75808 | 2727 | 94466 | 2481 | 54451 |
| 3L-11S | | MI | 29014 | 7216 | 43000 | 6051 | 50940 | 4917 | 54055 | 4048 | 55695 | 2745 | 68797 | 1929 | 47207 |
| 24-#11 | 1.70 | MA | 35315 | 7216 | 51823 | 6034 | 62275 | 4896 | 67591 | 4023 | 73337 | 2725 | 91639 | 2390 | 54328 |
| 4L-10S | | MI | 29712 | 7216 | 43906 | 6050 | 52169 | 4907 | 55529 | 4039 | 57687 | 2738 | 71350 | 1987 | 48294 |
| 24-#11 | 1.70 | MA | 34565 | 7216 | 50694 | 6046 | 60920 | 4896 | 65938 | 4033 | 71085 | 2732 | 88711 | 2343 | 54132 |
| 5L-9S | | MI | 30375 | 7216 | 44818 | 6048 | 53367 | 4906 | 57019 | 4040 | 59743 | 2742 | 74012 | 2067 | 49028 |
| 24-#11 | 1.70 | MA | 33847 | 7216 | 49692 | 6048 | 59584 | 4907 | 64311 | 4033 | 68921 | 2740 | 85724 | 2268 | 53462 |
| 6L-8S | | MI | 31033 | 7216 | 45829 | 6037 | 54611 | 4896 | 58502 | 4030 | 61743 | 2734 | 76586 | 2125 | 49950 |
| 24-#11 | 1.70 | MA | 33145 | 7216 | 48718 | 6050 | 58294 | 4908 | 62734 | 4043 | 66727 | 2737 | 83061 | 2197 | 52820 |
| 7E | | MI | 31696 | 7216 | 46745 | 6035 | 55817 | 4895 | 60010 | 4031 | 63763 | 2727 | 79184 | 2180 | 50441 |
| 24-#11 | 1.70 | MA | 32452 | 7216 | 47759 | 6052 | 57030 | 4908 | 61154 | 4042 | 64611 | 2744 | 80326 | 2142 | 52304 |
| 8L-6S | | MI | 32367 | 7216 | 47675 | 6034 | 57049 | 4895 | 61515 | 4022 | 65856 | 2731 | 81709 | 2250 | 51038 |
| 24-#11 | 1.70 | MA | 31763 | 7216 | 46699 | 6064 | 55727 | 4919 | 59601 | 4052 | 62516 | 2752 | 77612 | 2084 | 51317 |
| 9L-5S | | MI | 33052 | 7216 | 48631 | 6032 | 58324 | 4884 | 63067 | 4023 | 67921 | 2724 | 84543 | 2325 | 51679 |
| 24-#11 | 1.70 | MA | 31067 | 7216 | 45744 | 6065 | 54472 | 4920 | 58040 | 4051 | 60361 | 2749 | 74806 | 2004 | 50532 |
| 10L-4S | | MI | 33768 | 7216 | 49708 | 6020 | 59617 | 4884 | 64645 | 4013 | 70070 | 2717 | 87325 | 2373 | 51859 |
| 24-#11 | 1.70 | MA | 30327 | 7216 | 44796 | 6067 | 53184 | 4931 | 56495 | 4061 | 58275 | 2757 | 72118 | 1946 | 49381 |
| 11L-3S | | MI | 34561 | 7216 | 50774 | 6019 | 61058 | 4873 | 66392 | 4014 | 72427 | 2720 | 90005 | 2464 | 51973 |
| 24-#11 | 1.70 | MA | 29597 | 7216 | 43852 | 6069 | 51932 | 4931 | 54944 | 4060 | 56138 | 2754 | 69425 | 1888 | 48341 |
| 12L-2S | | MI | 35665 | 7216 | 52212 | 6017 | 62882 | 4873 | 68602 | 4005 | 75409 | 2713 | 94063 | 2555 | 52039 |
| 24-#14 | 2.45 | MA | 38129 | 7818 | 58682 | 6395 | 70782 | 5162 | 77832 | 4189 | 87107 | 2689 | 110340 | 2231 | 77233 |
| 4L-10S | | MI | 30810 | 7818 | 47917 | 6420 | 57030 | 5178 | 61312 | 4212 | 65408 | 2706 | 82271 | 1652 | 65546 |
| 24-#14 | 2.45 | MA | 37089 | 7818 | 57063 | 6412 | 68839 | 5162 | 75459 | 4203 | 83876 | 2699 | 106162 | 2163 | 76148 |
| 5L-9S | | MI | 31721 | 7818 | 49226 | 6418 | 58749 | 5178 | 63451 | 4214 | 68359 | 2712 | 86060 | 1767 | 67313 |
| 24-#14 | 2.45 | MA | 36093 | 7818 | 55625 | 6414 | 66921 | 5177 | 73124 | 4202 | 80770 | 2709 | 101906 | 2055 | 74899 |
| 6L-8S | | MI | 32634 | 7818 | 50678 | 6402 | 60534 | 5164 | 65579 | 4201 | 71228 | 2703 | 89724 | 1851 | 68838 |
| 24-#14 | 2.45 | MA | 35118 | 7818 | 54226 | 6416 | 65069 | 5178 | 70861 | 4215 | 77622 | 2704 | 98114 | 1953 | 73791 |
| 7E | | MI | 33555 | 7818 | 51992 | 6400 | 62265 | 5164 | 67742 | 4203 | 74126 | 2693 | 93431 | 1929 | 70393 |
| 24-#14 | 2.45 | MA | 34155 | 7818 | 52849 | 6418 | 63255 | 5178 | 68594 | 4214 | 74585 | 2714 | 94210 | 1874 | 72127 |
| 8L-6S | | MI | 34486 | 7818 | 53327 | 6398 | 64033 | 5164 | 69902 | 4190 | 77130 | 2699 | 97024 | 2031 | 71459 |
| 24-#14 | 2.45 | MA | 33198 | 7818 | 51328 | 6435 | 61385 | 5193 | 66364 | 4227 | 71578 | 2724 | 90344 | 1790 | 70525 |
| 9L-5S | | MI | 35438 | 7818 | 54699 | 6397 | 65862 | 5149 | 72129 | 4191 | 80093 | 2689 | 101059 | 2140 | 72618 |
| 24-#14 | 2.45 | MA | 32239 | 7818 | 49957 | 6437 | 59583 | 5194 | 64123 | 4226 | 68485 | 2720 | 86347 | 1674 | 68640 |
| 10L-4S | | MI | 36432 | 7818 | 56244 | 6380 | 67717 | 5149 | 74393 | 4178 | 83175 | 2680 | 105027 | 2207 | 73674 |
| 24-#18 | 4.35 | MA | 41374 | 9345 | 70339 | 7348 | 85194 | 5866 | 95110 | 4632 | 110354 | 2631 | 141820 | 1486 | 125586 |
| 6L-8S | | MI | 36423 | 9345 | 62666 | 7332 | 75253 | 5845 | 83199 | 4632 | 94873 | 2618 | 122083 | 1129 | 112140 |
| 24-#18 | 4.35 | MA | 39773 | 9345 | 67875 | 7350 | 81934 | 5865 | 91126 | 4653 | 104814 | 2619 | 135251 | 1304 | 122328 |
| 7E | | MI | 37936 | 9345 | 64980 | 7331 | 78301 | 5847 | 87006 | 4637 | 99972 | 2604 | 128527 | 1264 | 116478 |
| 24-#18 | 4.35 | MA | 38191 | 9345 | 65450 | 7352 | 78739 | 5863 | 87135 | 4649 | 99468 | 2634 | 128457 | 1167 | 117690 |
| 8L-6S | | MI | 39466 | 9345 | 67330 | 7329 | 81411 | 5850 | 90805 | 4616 | 105255 | 2617 | 134743 | 1446 | 119601 |

## RECTANGULAR TIED COLUMNS 48" x 48"

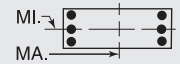
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.04 | MA | 35165 | 6983 | 49792 | 5900 | 59177 | 4804 | 63292 | 3995 | 66621 | 2836 | 80907 | 2680 | 34883 |
| 2L-3S | | MI | 32172 | 6983 | 45999 | 5902 | 54367 | 4803 | 57464 | 4017 | 58758 | 2851 | 70334 | 2447 | 34820 |
| 8-#18 | 1.39 | MA | 37004 | 7273 | 53585 | 6082 | 63988 | 4937 | 69121 | 4079 | 74484 | 2823 | 91481 | 2647 | 46150 |
| 2L-4S | | MI | 31923 | 7273 | 46975 | 6086 | 55368 | 4962 | 58676 | 4096 | 60391 | 2826 | 73937 | 2180 | 45361 |
| 10-#18 | 1.74 | MA | 38802 | 7564 | 57378 | 6264 | 68799 | 5070 | 74949 | 4163 | 82348 | 2810 | 102055 | 2614 | 57380 |
| 2L-5S | | MI | 31897 | 7564 | 47918 | 6297 | 56759 | 5093 | 60330 | 4202 | 62570 | 2828 | 77236 | 2028 | 53213 |
| 10-#18 | 1.74 | MA | 35898 | 7564 | 53585 | 6266 | 63988 | 5069 | 69121 | 4185 | 74484 | 2825 | 91481 | 2380 | 57128 |
| 3L-4S | | MI | 33799 | 7564 | 50768 | 6268 | 60179 | 5095 | 64505 | 4180 | 68254 | 2813 | 84511 | 2146 | 56404 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.63 | MA | 5747 | 2369 | 9386 | 1676 | 10036 | 1354 | 10231 | 1108 | 10338 | 742 | 12093 | 660 | 6366 |
| 2L-3S | | MI | 5326 | 2369 | 8743 | 1670 | 9230 | 1361 | 9271 | 1115 | 9069 | 749 | 10452 | 571 | 6404 |
| 6-#14 | 2.34 | MA | 6088 | 2515 | 10214 | 1758 | 11015 | 1407 | 11388 | 1133 | 11865 | 710 | 14030 | 599 | 8918 |
| 2L-3S | | MI | 5498 | 2515 | 9301 | 1748 | 9881 | 1417 | 10037 | 1143 | 10079 | 720 | 11732 | 471 | 8922 |
| 6-#18 | 4.17 | MA | 6894 | 2888 | 12155 | 1963 | 13351 | 1540 | 14154 | 1193 | 15518 | 624 | 18604 | 428 | 15084 |
| 2L-3S | | MI | 5903 | 2888 | 10606 | 1945 | 11434 | 1557 | 11870 | 1211 | 12498 | 642 | 14758 | 200 | 14009 |
| 8-#11 | 2.17 | MA | 6026 | 2479 | 10029 | 1745 | 10842 | 1403 | 11192 | 1135 | 11607 | 726 | 13733 | 626 | 8349 |
| 2L-4S | | MI | 5305 | 2479 | 8860 | 1747 | 9381 | 1403 | 9456 | 1135 | 9366 | 740 | 11017 | 456 | 8105 |
| 8-#14 | 3.13 | MA | 6476 | 2675 | 11127 | 1858 | 12149 | 1476 | 12740 | 1171 | 13651 | 686 | 16328 | 547 | 11714 |
| 2L-4S | | MI | 5467 | 2675 | 9465 | 1858 | 10093 | 1476 | 10297 | 1171 | 10496 | 706 | 12521 | 303 | 10687 |
| 8-#18 | 5.56 | MA | 7540 | 3172 | 13704 | 2138 | 15267 | 1658 | 16439 | 1256 | 18538 | 574 | 22450 | 321 | 19836 |
| 2L-4S | | MI | 5849 | 3172 | 10880 | 2138 | 11790 | 1658 | 12308 | 1256 | 13204 | 610 | 16067 | -103 | 15751 |
| 10-#11 | 2.71 | MA | 6302 | 2590 | 10672 | 1814 | 11648 | 1451 | 12152 | 1162 | 12876 | 711 | 15374 | 592 | 10320 |
| 2L-5S | | MI | 5315 | 2590 | 9037 | 1810 | 9601 | 1458 | 9719 | 1169 | 9672 | 717 | 11521 | 380 | 9499 |
| 10-#11 | 2.71 | MA | 5889 | 2590 | 10029 | 1808 | 10842 | 1458 | 11192 | 1169 | 11607 | 717 | 13733 | 503 | 10313 |
| 3L-4S | | MI | 5587 | 2590 | 9503 | 1816 | 10187 | 1451 | 10416 | 1162 | 10634 | 724 | 12658 | 422 | 9914 |
| 10-#14 | 3.91 | MA | 6860 | 2835 | 12040 | 1957 | 13283 | 1545 | 14091 | 1209 | 15437 | 662 | 18626 | 494 | 14490 |
| 2L-5S | | MI | 5481 | 2835 | 9714 | 1949 | 10402 | 1555 | 10667 | 1219 | 11018 | 692 | 13225 | 190 | 12371 |
| 10-#14 | 3.91 | MA | 6283 | 2835 | 11127 | 1948 | 12149 | 1555 | 12740 | 1219 | 13651 | 672 | 16328 | 366 | 14399 |
| 3L-4S | | MI | 5862 | 2835 | 10378 | 1958 | 11227 | 1545 | 11648 | 1209 | 12282 | 682 | 14819 | 250 | 13269 |
| 10-#18 | 6.94 | MA | 7251 | 3455 | 13704 | 2295 | 15267 | 1794 | 16439 | 1336 | 18538 | 542 | 22450 | -13 | 22387 |
| 3L-4S | | MI | 6561 | 3455 | 12429 | 2312 | 13707 | 1777 | 14592 | 1318 | 16224 | 560 | 19913 | -209 | 19109 |

## RECTANGULAR TIED COLUMNS 24" x 26"

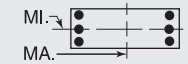
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.00 | MA | 6384 | 2428 | 10144 | 1745 | 10758 | 1421 | 10809 | 1180 | 10554 | 835 | 12182 | 773 | 4784 |
| 2E | | MI | 5872 | 2428 | 9365 | 1729 | 9865 | 1406 | 9884 | 1166 | 9614 | 823 | 11049 | 758 | 4389 |
| 4-#14 | 1.44 | MA | 6645 | 2526 | 10766 | 1796 | 11496 | 1455 | 11678 | 1196 | 11699 | 814 | 13646 | 734 | 6704 |
| 2E | | MI | 6103 | 2526 | 9924 | 1780 | 10515 | 1438 | 10648 | 1180 | 10622 | 800 | 12326 | 715 | 6131 |
| 4-#18 | 2.56 | MA | 7264 | 2774 | 12280 | 1932 | 13269 | 1542 | 13770 | 1236 | 14458 | 759 | 17138 | 628 | 11364 |
| 2E | | MI | 6650 | 2774 | 11231 | 1908 | 12067 | 1520 | 12478 | 1214 | 13037 | 738 | 15347 | 597 | 10335 |
| 6-#11 | 1.50 | MA | 6701 | 2538 | 10856 | 1814 | 11662 | 1471 | 11887 | 1208 | 11978 | 821 | 14036 | 742 | 6998 |
| 2L-3S | | MI | 5734 | 2538 | 9365 | 1792 | 9865 | 1462 | 9884 | 1200 | 9614 | 814 | 11049 | 635 | 6441 |
| 6-#11 | 1.50 | MA | 6234 | 2538 | 10144 | 1809 | 10758 | 1478 | 10809 | 1215 | 10554 | 828 | 12182 | 654 | 7036 |
| 3L-2S | | MI | 6155 | 2538 | 10008 | 1798 | 10671 | 1455 | 10844 | 1193 | 10883 | 807 | 12690 | 724 | 6398 |
| 6-#14 | 2.16 | MA | 7087 | 2685 | 11779 | 1896 | 12772 | 1526 | 13198 | 1236 | 13708 | 793 | 16251 | 687 | 9829 |
| 2L-3S | | MI | 5906 | 2685 | 9924 | 1870 | 10515 | 1517 | 10648 | 1228 | 10622 | 786 | 12326 | 534 | 8981 |
| 6-#14 | 2.16 | MA | 6431 | 2685 | 10766 | 1888 | 11496 | 1536 | 11678 | 1246 | 11699 | 803 | 13646 | 559 | 9834 |
| 3L-2S | | MI | 6498 | 2685 | 10837 | 1879 | 11649 | 1507 | 12000 | 1218 | 12407 | 776 | 14624 | 662 | 8958 |
| 6-#18 | 3.85 | MA | 8002 | 3058 | 14030 | 2109 | 15438 | 1664 | 16353 | 1302 | 17873 | 715 | 21525 | 532 | 16704 |
| 2L-3S | | MI | 6311 | 3058 | 11231 | 2065 | 12067 | 1656 | 12478 | 1295 | 13037 | 706 | 15347 | 263 | 14342 |
| 6-#18 | 3.85 | MA | 6896 | 3058 | 12280 | 2092 | 13269 | 1682 | 13770 | 1320 | 14458 | 732 | 17138 | 305 | 15881 |
| 3L-2S | | MI | 7306 | 3058 | 12781 | 2083 | 13984 | 1638 | 14763 | 1277 | 16056 | 688 | 19193 | 490 | 15148 |
| 8-#11 | 2.00 | MA | 7014 | 2649 | 11568 | 1883 | 12567 | 1521 | 12964 | 1237 | 13402 | 807 | 15890 | 712 | 9191 |
| 2L-4S | | MI | 5712 | 2649 | 9481 | 1869 | 10015 | 1503 | 10068 | 1221 | 9910 | 806 | 11615 | 519 | 8260 |
| 8-#11 | 2.00 | MA | 6551 | 2649 | 10856 | 1878 | 11662 | 1528 | 11887 | 1244 | 11978 | 814 | 14036 | 623 | 9209 |
| 3E | | MI | 6017 | 2649 | 10008 | 1861 | 10671 | 1510 | 10844 | 1228 | 10883 | 799 | 12690 | 601 | 8411 |
| 8-#11 | 2.00 | MA | 6215 | 2649 | 10275 | 1887 | 10927 | 1521 | 11017 | 1237 | 10886 | 821 | 12825 | 539 | 9038 |
| 4L-2S | | MI | 6435 | 2649 | 10651 | 1867 | 11477 | 1503 | 11804 | 1221 | 12151 | 792 | 14331 | 690 | 8385 |
| 8-#14 | 2.88 | MA | 7523 | 2845 | 12792 | 1995 | 14049 | 1597 | 14719 | 1276 | 15717 | 771 | 18856 | 640 | 12929 |
| 2L-4S | | MI | 5873 | 2845 | 10088 | 1980 | 10727 | 1576 | 10908 | 1256 | 11039 | 771 | 13115 | 366 | 10874 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis

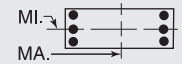



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.88 | MA | 6874 | 2845 | 11779 | 1987 | 12772 | 1607 | 13198 | 1286 | 13708 | 781 | 16251 | 512 | 12882 |
| 3E | | MI | 6302 | 2845 | 10837 | 1970 | 11649 | 1586 | 12000 | 1266 | 12407 | 761 | 14624 | 482 | 11734 |
| 8-#14 | 2.88 | MA | 6403 | 2845 | 10951 | 1999 | 11735 | 1597 | 11971 | 1276 | 12168 | 791 | 14546 | 393 | 11929 |
| 4L-2S | | MI | 6887 | 2845 | 11750 | 1979 | 12784 | 1576 | 13351 | 1256 | 14193 | 751 | 16923 | 610 | 11760 |
| 8-#18 | 5.13 | MA | 8728 | 3341 | 15781 | 2286 | 17606 | 1786 | 18937 | 1369 | 21288 | 671 | 25913 | 437 | 21996 |
| 2L-4S | | MI | 6254 | 3341 | 11506 | 2258 | 12424 | 1757 | 12916 | 1339 | 13743 | 674 | 16656 | -41 | 16532 |
| 8-#18 | 5.13 | MA | 7641 | 3341 | 14030 | 2269 | 15438 | 1804 | 16353 | 1387 | 17873 | 688 | 21525 | 209 | 20591 |
| 3E | | MI | 6973 | 3341 | 12781 | 2240 | 13984 | 1775 | 14763 | 1357 | 16056 | 656 | 19193 | 156 | 18545 |
| 8-#18 | 5.13 | MA | 6848 | 3341 | 12592 | 2287 | 13673 | 1786 | 14266 | 1369 | 15256 | 706 | 18642 | 5 | 18612 |
| 4L-2S | | MI | 7954 | 3341 | 14330 | 2258 | 15901 | 1757 | 17047 | 1339 | 19076 | 639 | 23039 | 384 | 19908 |
| 10-#11 | 2.50 | MA | 7324 | 2760 | 12280 | 1952 | 13472 | 1571 | 14042 | 1266 | 14826 | 794 | 17744 | 681 | 11373 |
| 2L-5S | | MI | 5721 | 2760 | 9659 | 1932 | 10236 | 1559 | 10332 | 1255 | 10216 | 783 | 12118 | 444 | 9633 |
| 10-#11 | 2.50 | MA | 6865 | 2760 | 11568 | 1947 | 12567 | 1578 | 12964 | 1273 | 13402 | 800 | 15890 | 593 | 11366 |
| 3L-4S | | MI | 5995 | 2760 | 10124 | 1938 | 10821 | 1552 | 11029 | 1248 | 11179 | 790 | 13256 | 485 | 10066 |
| 10-#11 | 2.50 | MA | 6533 | 2760 | 10987 | 1956 | 11832 | 1571 | 12095 | 1266 | 12310 | 807 | 14679 | 509 | 11044 |
| 4L-3S | | MI | 6298 | 2760 | 10651 | 1931 | 11477 | 1559 | 11804 | 1255 | 12151 | 783 | 14331 | 567 | 10365 |
| 10-#11 | 2.50 | MA | 6232 | 2760 | 10475 | 1951 | 11175 | 1578 | 11312 | 1273 | 11231 | 800 | 13393 | 468 | 10532 |
| 5L-2S | | MI | 6712 | 2760 | 11293 | 1936 | 12283 | 1552 | 12764 | 1248 | 13420 | 776 | 15972 | 656 | 10360 |
| 10-#14 | 3.61 | MA | 7954 | 3004 | 13805 | 2095 | 15325 | 1668 | 16239 | 1316 | 17726 | 750 | 21460 | 593 | 16009 |
| 2L-5S | | MI | 5886 | 3004 | 10337 | 2070 | 11037 | 1655 | 11278 | 1304 | 11560 | 757 | 13820 | 253 | 12661 |
| 10-#14 | 3.61 | MA | 7313 | 3004 | 12792 | 2087 | 14049 | 1678 | 14719 | 1326 | 15717 | 760 | 18856 | 465 | 15918 |
| 3L-4S | | MI | 6269 | 3004 | 11001 | 2080 | 11861 | 1645 | 12260 | 1294 | 12825 | 747 | 15414 | 313 | 13452 |
| 10-#14 | 3.61 | MA | 6847 | 3004 | 11964 | 2099 | 13011 | 1668 | 13491 | 1316 | 14177 | 770 | 17151 | 346 | 14797 |
| 4L-3S | | MI | 6693 | 3004 | 11750 | 2069 | 12784 | 1655 | 13351 | 1304 | 14193 | 737 | 16923 | 429 | 14474 |
| 10-#14 | 3.61 | MA | 6426 | 3004 | 11232 | 2091 | 12084 | 1678 | 12387 | 1326 | 12653 | 760 | 15345 | 286 | 13923 |
| 5L-2S | | MI | 7272 | 3004 | 12663 | 2079 | 13918 | 1645 | 14702 | 1294 | 15979 | 727 | 19221 | 557 | 14544 |
| 10-#18 | 6.41 | MA | 8374 | 3625 | 15781 | 2446 | 17606 | 1926 | 18937 | 1453 | 21288 | 644 | 25913 | 114 | 25372 |
| 3L-4S | | MI | 6968 | 3625 | 13055 | 2432 | 14340 | 1875 | 15201 | 1402 | 16762 | 625 | 20502 | -147 | 19937 |
| 10-#18 | 6.41 | MA | 7595 | 3625 | 14342 | 2464 | 15842 | 1908 | 16850 | 1436 | 18671 | 662 | 23030 | -90 | 22609 |
| 4L-3S | | MI | 7666 | 3625 | 14330 | 2414 | 15901 | 1893 | 17047 | 1420 | 19076 | 607 | 23039 | 50 | 22820 |
| 12-#11 | 3.00 | MA | 7632 | 2870 | 12992 | 2021 | 14377 | 1621 | 15120 | 1294 | 16249 | 780 | 19598 | 651 | 13546 |
| 2L-6S | | MI | 5744 | 2870 | 9835 | 2009 | 10458 | 1601 | 10626 | 1289 | 10603 | 774 | 12702 | 349 | 10904 |
| 12-#11 | 3.00 | MA | 7176 | 2870 | 12280 | 2016 | 13472 | 1627 | 14042 | 1301 | 14826 | 787 | 17744 | 562 | 13515 |
| 3L-5S | | MI | 6004 | 2870 | 10302 | 2002 | 11042 | 1608 | 11292 | 1282 | 11485 | 768 | 13759 | 410 | 11493 |
| 12-#11 | 3.00 | MA | 6847 | 2870 | 11699 | 2025 | 12737 | 1621 | 13172 | 1294 | 13734 | 794 | 16533 | 478 | 13066 |
| 4E | | MI | 6276 | 2870 | 10767 | 2008 | 11627 | 1601 | 11989 | 1275 | 12448 | 774 | 14897 | 451 | 11889 |
| 12-#11 | 3.00 | MA | 6549 | 2870 | 11187 | 2020 | 12079 | 1627 | 12390 | 1301 | 12654 | 787 | 15247 | 437 | 12595 |
| 5L-3S | | MI | 6576 | 2870 | 11293 | 2000 | 12283 | 1608 | 12764 | 1282 | 13420 | 768 | 15972 | 533 | 12308 |
| 12-#11 | 3.00 | MA | 6264 | 2870 | 10701 | 2015 | 11425 | 1621 | 11643 | 1308 | 11665 | 794 | 14050 | 377 | 11941 |
| 6L-2S | | MI | 6987 | 2870 | 11936 | 2006 | 13089 | 1601 | 13725 | 1275 | 14689 | 761 | 17612 | 621 | 12325 |
| 12-#14 | 4.33 | MA | 7746 | 3164 | 13805 | 2187 | 15325 | 1749 | 16239 | 1366 | 17726 | 738 | 21460 | 418 | 18946 |
| 3L-5S | | MI | 6282 | 3164 | 11250 | 2170 | 12171 | 1724 | 12630 | 1342 | 13346 | 733 | 16118 | 201 | 15167 |
| 12-#14 | 4.33 | MA | 7286 | 3164 | 12976 | 2199 | 14287 | 1739 | 15012 | 1356 | 16185 | 748 | 19755 | 298 | 17686 |
| 4E | | MI | 6661 | 3164 | 11914 | 2179 | 12995 | 1714 | 13611 | 1332 | 14610 | 723 | 17712 | 261 | 16051 |
| 12-#14 | 4.33 | MA | 6870 | 3164 | 12245 | 2191 | 13360 | 1749 | 13908 | 1366 | 14662 | 738 | 17949 | 239 | 16720 |
| 5L-3S | | MI | 7080 | 3164 | 12663 | 2169 | 13918 | 1724 | 14702 | 1342 | 15979 | 713 | 19221 | 376 | 17205 |
| 12-#18 | 7.69 | MA | 8332 | 3909 | 16093 | 2641 | 18010 | 2030 | 19434 | 1502 | 22085 | 618 | 27418 | -186 | 26419 |
| 4E | | MI | 7626 | 3909 | 14604 | 2607 | 16257 | 1994 | 17485 | 1464 | 19782 | 575 | 24348 | -254 | 23213 |
| 14-#11 | 3.50 | MA | 7485 | 2981 | 12992 | 2085 | 14377 | 1677 | 15120 | 1330 | 16249 | 773 | 19598 | 532 | 15658 |
| 3L-6S | | MI | 6027 | 2981 | 10478 | 2079 | 11264 | 1649 | 11586 | 1316 | 11872 | 759 | 14343 | 315 | 12715 |
| 14-#11 | 3.50 | MA | 7158 | 2981 | 12411 | 2094 | 13641 | 1670 | 14250 | 1323 | 15158 | 780 | 18387 | 448 | 15102 |
| 4L-5S | | MI | 6285 | 2981 | 10944 | 2071 | 11848 | 1656 | 12252 | 1309 | 12754 | 752 | 15400 | 376 | 13359 |
| 14-#11 | 3.50 | MA | 6863 | 2981 | 11899 | 2089 | 12984 | 1677 | 13468 | 1330 | 14078 | 773 | 17101 | 407 | 14665 |
| 5L-4S | | MI | 6554 | 2981 | 11410 | 2077 | 12433 | 1649 | 12949 | 1302 | 13716 | 759 | 16537 | 417 | 13723 |
| 14-#11 | 3.50 | MA | 6580 | 2981 | 11413 | 2084 | 12329 | 1670 | 12721 | 1337 | 13089 | 780 | 15904 | 347 | 13955 |
| 6L-3S | | MI | 6852 | 2981 | 11936 | 2069 | 13089 | 1656 | 13725 | 1309 | 14689 | 752 | 17612 | 499 | 14244 |
| 14-#14 | 5.05 | MA | 7720 | 3324 | 13989 | 2298 | 15564 | 1809 | 16532 | 1396 | 18194 | 727 | 22360 | 251 | 20592 |
| 4L-5S | | MI | 6674 | 3324 | 12163 | 2270 | 13305 | 1793 | 13981 | 1380 | 15132 | 708 | 18416 | 148 | 17693 |

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 5.05 | MA | 7309 | 3324 | 13257 | 2290 | 14636 | 1819 | 15428 | 1406 | 16671 | 717 | 20554 | 192 | 19537 |
| 5L-4S | | MI | 7049 | 3324 | 12827 | 2279 | 14129 | 1783 | 14962 | 1370 | 16396 | 699 | 20010 | 208 | 18664 |
| 16-#11 | 4.00 | MA | 7466 | 3092 | 13123 | 2163 | 14546 | 1720 | 15328 | 1352 | 16582 | 766 | 20240 | 417 | 17147 |
| 4L-6S | | MI | 6307 | 3092 | 11121 | 2148 | 12070 | 1698 | 12547 | 1343 | 13141 | 743 | 15983 | 281 | 14535 |
| 16-#11 | 4.00 | MA | 7174 | 3092 | 12611 | 2158 | 13889 | 1727 | 14546 | 1358 | 15502 | 759 | 18955 | 376 | 16741 |
| 5E | | MI | 6563 | 3092 | 11587 | 2140 | 12654 | 1705 | 13212 | 1337 | 14023 | 736 | 17040 | 342 | 15213 |
| 16-#11 | 4.00 | MA | 6894 | 3092 | 12125 | 2153 | 13234 | 1720 | 13798 | 1365 | 14512 | 766 | 17758 | 316 | 15979 |
| 6L-4S | | MI | 6830 | 3092 | 12052 | 2146 | 13239 | 1698 | 13910 | 1330 | 14985 | 743 | 18178 | 383 | 15568 |
| 16-#14 | 5.77 | MA | 7743 | 3483 | 14270 | 2390 | 15913 | 1890 | 16949 | 1446 | 18679 | 695 | 23159 | 145 | 22371 |
| 5E | | MI | 7062 | 3483 | 13076 | 2369 | 14439 | 1862 | 15333 | 1418 | 16918 | 684 | 20714 | 95 | 20236 |
| 18-#11 | 4.50 | MA | 7482 | 3202 | 13323 | 2228 | 14794 | 1777 | 15623 | 1387 | 16926 | 745 | 20809 | 346 | 18766 |
| 5L-6S | | MI | 6586 | 3202 | 11763 | 2217 | 12876 | 1747 | 13507 | 1371 | 14410 | 728 | 17624 | 247 | 16363 |
| 18-#11 | 4.50 | MA | 7205 | 3202 | 12837 | 2223 | 14139 | 1770 | 14876 | 1394 | 15936 | 752 | 19612 | 286 | 18010 |
| 6L-5S | | MI | 6839 | 3202 | 12230 | 2209 | 13460 | 1754 | 14173 | 1364 | 15291 | 721 | 18681 | 307 | 17004 |
| 20-#11 | 5.00 | MA | 7514 | 3313 | 13549 | 2292 | 15044 | 1820 | 15954 | 1423 | 17360 | 738 | 21466 | 255 | 20049 |
| 6E | | MI | 6862 | 3313 | 12406 | 2286 | 13682 | 1796 | 14467 | 1398 | 15678 | 712 | 19265 | 213 | 18199 |

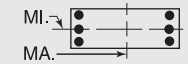
## RECTANGULAR TIED COLUMNS 24" x 28"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.34 | MA | 7663 | 2695 | 12328 | 1934 | 13217 | 1572 | 13424 | 1296 | 13416 | 893 | 15672 | 815 | 7311 |
| 2E | | MI | 6512 | 2695 | 10547 | 1901 | 11150 | 1538 | 11259 | 1265 | 11164 | 865 | 12921 | 778 | 6164 |
| 4-#18 | 2.38 | MA | 8357 | 2944 | 14002 | 2070 | 15212 | 1661 | 15777 | 1339 | 16518 | 842 | 19631 | 718 | 12444 |
| 2E | | MI | 7059 | 2944 | 11857 | 2028 | 12701 | 1618 | 13087 | 1298 | 13575 | 802 | 15936 | 659 | 10384 |
| 6-#11 | 1.39 | MA | 7724 | 2708 | 12423 | 1952 | 13371 | 1585 | 13648 | 1308 | 13715 | 900 | 16090 | 823 | 7629 |
| 2L-3S | | MI | 6141 | 2708 | 9986 | 1915 | 10500 | 1562 | 10496 | 1286 | 10158 | 880 | 11647 | 699 | 6476 |
| 6-#11 | 1.39 | MA | 7210 | 2708 | 11642 | 1947 | 12376 | 1593 | 12453 | 1315 | 12136 | 907 | 14022 | 734 | 7667 |
| 3L-2S | | MI | 6564 | 2708 | 10629 | 1921 | 11306 | 1555 | 11456 | 1279 | 11427 | 873 | 13288 | 787 | 6429 |
| 6-#14 | 2.01 | MA | 8155 | 2855 | 13440 | 2034 | 14635 | 1644 | 15114 | 1338 | 15649 | 874 | 18584 | 773 | 10740 |
| 2L-3S | | MI | 6314 | 2855 | 10547 | 1991 | 11150 | 1617 | 11259 | 1313 | 11164 | 851 | 12921 | 598 | 9035 |
| 6-#14 | 2.01 | MA | 7432 | 2855 | 12328 | 2027 | 13217 | 1654 | 13424 | 1347 | 13416 | 884 | 15672 | 645 | 10745 |
| 3L-2S | | MI | 6907 | 2855 | 11460 | 2001 | 12284 | 1607 | 12611 | 1303 | 12950 | 841 | 15219 | 725 | 8998 |
| 6-#18 | 3.57 | MA | 9180 | 3227 | 15930 | 2247 | 17633 | 1786 | 18661 | 1409 | 20328 | 803 | 24563 | 631 | 18324 |
| 2L-3S | | MI | 6719 | 3227 | 11857 | 2185 | 12701 | 1755 | 13087 | 1378 | 13575 | 771 | 15936 | 325 | 14665 |
| 6-#18 | 3.57 | MA | 7959 | 3227 | 14002 | 2232 | 15212 | 1804 | 15777 | 1427 | 16518 | 820 | 19631 | 404 | 17809 |
| 3L-2S | | MI | 7718 | 3227 | 13406 | 2203 | 14617 | 1737 | 15371 | 1361 | 16595 | 753 | 19782 | 552 | 15210 |
| 8-#11 | 1.86 | MA | 8072 | 2819 | 13204 | 2021 | 14367 | 1635 | 14844 | 1338 | 15294 | 887 | 18158 | 795 | 10034 |
| 2L-4S | | MI | 6119 | 2819 | 10103 | 1992 | 10650 | 1604 | 10681 | 1306 | 10454 | 871 | 12212 | 583 | 8410 |
| 8-#11 | 1.86 | MA | 7562 | 2819 | 12423 | 2017 | 13371 | 1643 | 13648 | 1345 | 13715 | 894 | 16090 | 707 | 10051 |
| 3E | | MI | 6425 | 2819 | 10629 | 1984 | 11306 | 1611 | 11456 | 1313 | 11427 | 864 | 13288 | 664 | 8452 |
| 8-#11 | 1.86 | MA | 7194 | 2819 | 11788 | 2026 | 12564 | 1637 | 12684 | 1338 | 12504 | 901 | 14742 | 621 | 9990 |
| 4L-2S | | MI | 6844 | 2819 | 11272 | 1990 | 12112 | 1604 | 12417 | 1306 | 12696 | 858 | 14928 | 753 | 8420 |
| 8-#14 | 2.68 | MA | 8640 | 3015 | 14553 | 2133 | 16053 | 1716 | 16805 | 1379 | 17881 | 855 | 21496 | 730 | 14144 |
| 2L-4S | | MI | 6280 | 3015 | 10711 | 2101 | 11361 | 1676 | 11519 | 1341 | 11581 | 837 | 13710 | 429 | 11054 |
| 8-#14 | 2.68 | MA | 7925 | 3015 | 13440 | 2127 | 14635 | 1726 | 15114 | 1389 | 15649 | 865 | 18584 | 602 | 14097 |
| 3E | | MI | 6710 | 3015 | 11460 | 2091 | 12284 | 1686 | 12611 | 1351 | 12950 | 827 | 15219 | 545 | 11797 |
| 8-#14 | 2.68 | MA | 7409 | 3015 | 12534 | 2140 | 13483 | 1716 | 13751 | 1379 | 13937 | 874 | 16683 | 480 | 13192 |
| 4L-2S | | MI | 7298 | 3015 | 12373 | 2101 | 13418 | 1676 | 13962 | 1341 | 14736 | 817 | 17517 | 673 | 11805 |
| 8-#18 | 4.76 | MA | 9989 | 3511 | 17858 | 2424 | 20054 | 1912 | 21545 | 1480 | 24139 | 763 | 29495 | 545 | 24156 |
| 2L-4S | | MI | 6659 | 3511 | 12132 | 2377 | 13057 | 1856 | 13525 | 1423 | 14281 | 739 | 17245 | 22 | 17124 |
| 8-#18 | 4.76 | MA | 8788 | 3511 | 15930 | 2409 | 17633 | 1929 | 18661 | 1497 | 20328 | 781 | 24563 | 318 | 23018 |
| 3E | | MI | 7382 | 3511 | 13406 | 2360 | 14617 | 1873 | 15371 | 1441 | 16595 | 721 | 19782 | 218 | 18859 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

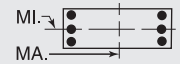



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 4.76 | MA | 7918 | 3511 | 14352 | 2430 | 15664 | 1912 | 16332 | 1480 | 17407 | 799 | 21333 | 107 | 20619 |
| 4L-2S | | MI | 8367 | 3511 | 14955 | 2377 | 16534 | 1856 | 17655 | 1423 | 19614 | 703 | 23628 | 446 | 19978 |
| 10-#11 | 2.32 | MA | 8416 | 2929 | 13985 | 2090 | 15363 | 1686 | 16039 | 1368 | 16874 | 875 | 20225 | 768 | 12426 |
| 2L-5S | | MI | 6128 | 2929 | 10280 | 2055 | 10870 | 1660 | 10944 | 1340 | 10760 | 849 | 12716 | 507 | 9760 |
| 10-#11 | 2.32 | MA | 7911 | 2929 | 13204 | 2086 | 14367 | 1693 | 14844 | 1375 | 15294 | 882 | 18158 | 679 | 12419 |
| 3L-4S | | MI | 6403 | 2929 | 10746 | 2061 | 11456 | 1653 | 11641 | 1333 | 11723 | 856 | 13853 | 549 | 10213 |
| 10-#11 | 2.32 | MA | 7547 | 2929 | 12569 | 2095 | 13560 | 1687 | 13879 | 1368 | 14084 | 889 | 16810 | 593 | 12193 |
| 4L-3S | | MI | 6707 | 2929 | 11272 | 2053 | 12112 | 1660 | 12417 | 1340 | 12696 | 849 | 14928 | 630 | 10415 |
| 10-#11 | 2.32 | MA | 7218 | 2929 | 12009 | 2091 | 12839 | 1695 | 13011 | 1375 | 12887 | 882 | 15376 | 553 | 11576 |
| 5L-2S | | MI | 7122 | 2929 | 11915 | 2059 | 12918 | 1653 | 13377 | 1333 | 13965 | 842 | 16569 | 719 | 10398 |
| 10-#14 | 3.35 | MA | 9120 | 3174 | 15665 | 2233 | 17471 | 1788 | 18495 | 1421 | 20114 | 835 | 24409 | 687 | 17527 |
| 2L-5S | | MI | 6292 | 3174 | 10960 | 2192 | 11671 | 1755 | 11890 | 1389 | 12102 | 822 | 14415 | 316 | 12943 |
| 10-#14 | 3.35 | MA | 8412 | 3174 | 14553 | 2226 | 16053 | 1798 | 16805 | 1431 | 17881 | 845 | 21496 | 559 | 17437 |
| 3L-4S | | MI | 6677 | 3174 | 11624 | 2201 | 12495 | 1745 | 12871 | 1379 | 13367 | 812 | 16008 | 377 | 13629 |
| 10-#14 | 3.35 | MA | 7902 | 3174 | 13646 | 2239 | 14901 | 1789 | 15441 | 1421 | 16169 | 855 | 19595 | 437 | 16348 |
| 4L-3S | | MI | 7103 | 3174 | 12373 | 2191 | 13418 | 1755 | 13962 | 1389 | 14736 | 802 | 17517 | 492 | 14544 |
| 10-#14 | 3.35 | MA | 7441 | 3174 | 12846 | 2233 | 13870 | 1799 | 14214 | 1431 | 14477 | 845 | 17576 | 379 | 15515 |
| 5L-2S | | MI | 7684 | 3174 | 13286 | 2200 | 14552 | 1745 | 15314 | 1379 | 16521 | 792 | 19815 | 620 | 14595 |
| 10-#18 | 5.95 | MA | 9604 | 3795 | 17858 | 2587 | 20054 | 2054 | 21545 | 1568 | 24139 | 741 | 29495 | 231 | 28300 |
| 3L-4S | | MI | 7324 | 3795 | 13681 | 2552 | 14974 | 1974 | 15809 | 1486 | 17301 | 689 | 21091 | -85 | 20760 |
| 10-#18 | 5.95 | MA | 8749 | 3795 | 16280 | 2607 | 18085 | 2037 | 19217 | 1550 | 21218 | 759 | 26265 | 21 | 26121 |
| 4L-3S | | MI | 8038 | 3795 | 14955 | 2534 | 16534 | 1992 | 17655 | 1503 | 19614 | 671 | 23628 | 112 | 23126 |
| 12-#11 | 2.79 | MA | 8757 | 3040 | 14766 | 2159 | 16359 | 1736 | 17235 | 1398 | 18453 | 863 | 22293 | 740 | 14809 |
| 2L-6S | | MI | 6150 | 3040 | 10457 | 2132 | 11093 | 1701 | 11239 | 1374 | 11147 | 840 | 13299 | 413 | 11104 |
| 12-#11 | 2.79 | MA | 8256 | 3040 | 13985 | 2155 | 15363 | 1743 | 16039 | 1404 | 16874 | 870 | 20225 | 652 | 14778 |
| 3L-5S | | MI | 6411 | 3040 | 10923 | 2124 | 11676 | 1708 | 11904 | 1368 | 12029 | 833 | 14356 | 473 | 11620 |
| 12-#11 | 2.79 | MA | 7895 | 3040 | 13350 | 2165 | 14556 | 1737 | 15075 | 1398 | 15663 | 877 | 18878 | 566 | 14413 |
| 4E | | MI | 6684 | 3040 | 11388 | 2130 | 12262 | 1701 | 12602 | 1361 | 12992 | 840 | 15494 | 515 | 12034 |
| 12-#11 | 2.79 | MA | 7569 | 3040 | 12790 | 2160 | 13834 | 1745 | 14207 | 1404 | 14466 | 870 | 17444 | 525 | 13842 |
| 5L-3S | | MI | 6985 | 3040 | 11915 | 2122 | 12918 | 1708 | 13377 | 1368 | 13965 | 833 | 16569 | 596 | 12361 |
| 12-#11 | 2.79 | MA | 7258 | 3040 | 12260 | 2156 | 13116 | 1739 | 13378 | 1411 | 13368 | 877 | 16107 | 466 | 13210 |
| 6L-2S | | MI | 7398 | 3040 | 12558 | 2128 | 13724 | 1701 | 14337 | 1361 | 15233 | 826 | 18210 | 685 | 12367 |
| 12-#14 | 4.02 | MA | 8894 | 3334 | 15665 | 2326 | 17471 | 1871 | 18495 | 1473 | 20114 | 826 | 24409 | 517 | 20768 |
| 3L-5S | | MI | 6688 | 3334 | 11873 | 2291 | 12805 | 1824 | 13241 | 1427 | 13888 | 798 | 16713 | 264 | 15444 |
| 12-#14 | 4.02 | MA | 8389 | 3334 | 14759 | 2339 | 16319 | 1861 | 17131 | 1463 | 18402 | 836 | 22508 | 395 | 19526 |
| 4E | | MI | 7070 | 3334 | 12537 | 2301 | 13630 | 1814 | 14222 | 1417 | 15153 | 788 | 18306 | 324 | 16225 |
| 12-#14 | 4.02 | MA | 7934 | 3334 | 13959 | 2332 | 15289 | 1871 | 15904 | 1473 | 16709 | 826 | 20488 | 336 | 18600 |
| 5L-3S | | MI | 7491 | 3334 | 13286 | 2291 | 14552 | 1824 | 15314 | 1427 | 16521 | 778 | 19815 | 439 | 17281 |
| 12-#14 | 4.02 | MA | 7500 | 3334 | 13202 | 2326 | 14263 | 1861 | 14732 | 1483 | 15158 | 836 | 18607 | 250 | 17415 |
| 6L-2S | | MI | 8067 | 3334 | 14199 | 2300 | 15686 | 1814 | 16665 | 1417 | 18307 | 768 | 22113 | 567 | 17366 |
| 12-#18 | 7.14 | MA | 9568 | 4078 | 18207 | 2784 | 20506 | 2162 | 22101 | 1620 | 25029 | 720 | 31197 | -65 | 30770 |
| 4E | | MI | 8035 | 4078 | 15230 | 2727 | 16890 | 2093 | 18093 | 1548 | 20320 | 639 | 24937 | -191 | 24082 |
| 14-#11 | 3.25 | MA | 8598 | 3151 | 14766 | 2224 | 16359 | 1793 | 17235 | 1434 | 18453 | 858 | 22293 | 624 | 17132 |
| 3L-6S | | MI | 6433 | 3151 | 11099 | 2201 | 11899 | 1750 | 12199 | 1402 | 12416 | 825 | 14940 | 379 | 12913 |
| 14-#11 | 3.25 | MA | 8240 | 3151 | 14131 | 2234 | 15552 | 1787 | 16270 | 1427 | 17242 | 864 | 20946 | 538 | 16648 |
| 4L-5S | | MI | 6692 | 3151 | 11566 | 2193 | 12483 | 1757 | 12865 | 1395 | 13298 | 818 | 15997 | 439 | 13486 |
| 14-#11 | 3.25 | MA | 7918 | 3151 | 13571 | 2230 | 14830 | 1795 | 15403 | 1434 | 16045 | 858 | 19512 | 498 | 16115 |
| 5L-4S | | MI | 6963 | 3151 | 12031 | 2199 | 13068 | 1750 | 13562 | 1388 | 14261 | 825 | 17135 | 480 | 13866 |
| 14-#11 | 3.25 | MA | 7609 | 3151 | 13041 | 2225 | 14112 | 1789 | 14573 | 1441 | 14948 | 864 | 18175 | 438 | 15425 |
| 6L-3S | | MI | 7262 | 3151 | 12558 | 2191 | 13724 | 1757 | 14337 | 1395 | 15233 | 818 | 18210 | 562 | 14302 |
| 14-#11 | 3.25 | MA | 7309 | 3151 | 12475 | 2235 | 13422 | 1796 | 13712 | 1434 | 13874 | 871 | 16913 | 371 | 14767 |
| 7L-2S | | MI | 7672 | 3151 | 13200 | 2197 | 14530 | 1750 | 15297 | 1388 | 16502 | 811 | 19851 | 651 | 14329 |
| 14-#14 | 4.69 | MA | 8871 | 3493 | 15871 | 2439 | 17737 | 1933 | 18821 | 1505 | 20634 | 817 | 25420 | 352 | 22721 |
| 4L-5S | | MI | 7081 | 3493 | 12786 | 2391 | 13940 | 1893 | 14592 | 1465 | 15674 | 774 | 19011 | 211 | 17965 |
| 14-#14 | 4.69 | MA | 8421 | 3493 | 15071 | 2432 | 16707 | 1943 | 17594 | 1515 | 18942 | 807 | 23401 | 293 | 21704 |
| 5L-4S | | MI | 7459 | 3493 | 13450 | 2401 | 14764 | 1883 | 15573 | 1455 | 16939 | 764 | 20604 | 271 | 18837 |
| 14-#14 | 4.69 | MA | 7992 | 3493 | 14314 | 2425 | 15681 | 1933 | 16422 | 1525 | 17390 | 817 | 21520 | 207 | 20585 |
| 6L-3S | | MI | 7876 | 3493 | 14199 | 2390 | 15686 | 1893 | 16665 | 1465 | 18307 | 754 | 22113 | 387 | 20011 |

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 3.71 | MA | 8583 | 3261 | 14912 | 2303 | 16547 | 1837 | 17466 | 1457 | 18821 | 852 | 23013 | 511 | 18893 |
| 4L-6S | | MI | 6714 | 3261 | 11742 | 2270 | 12705 | 1799 | 13159 | 1429 | 13685 | 809 | 16581 | 345 | 14730 |
| 16-#11 | 3.71 | MA | 8263 | 3261 | 14352 | 2299 | 15826 | 1845 | 16598 | 1464 | 17624 | 845 | 21580 | 470 | 18395 |
| 5E | | MI | 6971 | 3261 | 12209 | 2262 | 13289 | 1806 | 13825 | 1422 | 14567 | 802 | 17638 | 405 | 15358 |
| 16-#11 | 3.71 | MA | 7957 | 3261 | 13822 | 2295 | 15108 | 1839 | 15769 | 1471 | 16527 | 852 | 20243 | 411 | 17650 |
| 6L-4S | | MI | 7240 | 3261 | 12674 | 2268 | 13874 | 1799 | 14522 | 1415 | 15530 | 809 | 18776 | 446 | 15709 |
| 16-#11 | 3.71 | MA | 7659 | 3261 | 13256 | 2304 | 14418 | 1846 | 14907 | 1464 | 15453 | 859 | 18981 | 344 | 16953 |
| 7L-3S | | MI | 7537 | 3261 | 13200 | 2260 | 14530 | 1806 | 15297 | 1422 | 16502 | 802 | 19851 | 528 | 16238 |
| 16-#14 | 5.36 | MA | 8904 | 3653 | 16184 | 2532 | 18125 | 2016 | 19284 | 1557 | 21175 | 788 | 26313 | 251 | 24826 |
| 5E | | MI | 7470 | 3653 | 13699 | 2491 | 15074 | 1962 | 15944 | 1503 | 17460 | 749 | 21309 | 158 | 20504 |
| 16-#14 | 5.36 | MA | 8479 | 3653 | 15427 | 2525 | 17100 | 2006 | 18112 | 1567 | 19623 | 798 | 24432 | 164 | 23696 |
| 6L-4S | | MI | 7845 | 3653 | 14363 | 2500 | 15898 | 1952 | 16925 | 1493 | 18724 | 740 | 22902 | 219 | 21461 |
| 18-#11 | 4.18 | MA | 8605 | 3372 | 15133 | 2368 | 16822 | 1895 | 17794 | 1494 | 19203 | 833 | 23647 | 443 | 20680 |
| 5L-6S | | MI | 6993 | 3372 | 12385 | 2339 | 13511 | 1848 | 14120 | 1456 | 14954 | 793 | 18222 | 311 | 16557 |
| 18-#11 | 4.18 | MA | 8302 | 3372 | 14604 | 2364 | 16104 | 1889 | 16965 | 1501 | 18106 | 840 | 22310 | 383 | 19882 |
| 6L-5S | | MI | 7248 | 3372 | 12851 | 2331 | 14095 | 1854 | 14785 | 1449 | 15836 | 787 | 19279 | 371 | 17231 |
| 18-#11 | 4.18 | MA | 8006 | 3372 | 14037 | 2373 | 15413 | 1897 | 16103 | 1494 | 17032 | 847 | 21049 | 316 | 19148 |
| 7L-4S | | MI | 7515 | 3372 | 13317 | 2337 | 14680 | 1848 | 15482 | 1442 | 16798 | 793 | 20416 | 412 | 17561 |
| 18-#14 | 6.03 | MA | 8961 | 3812 | 16539 | 2625 | 18518 | 2078 | 19802 | 1608 | 21855 | 778 | 27344 | 122 | 26781 |
| 6L-5S | | MI | 7857 | 3812 | 14612 | 2591 | 16208 | 2031 | 17295 | 1541 | 19246 | 725 | 23607 | 106 | 23057 |
| 20-#11 | 4.64 | MA | 8644 | 3483 | 15385 | 2433 | 17100 | 1939 | 18160 | 1531 | 19685 | 828 | 24378 | 356 | 22123 |
| 6E | | MI | 7270 | 3483 | 13028 | 2408 | 14317 | 1896 | 15080 | 1483 | 16223 | 778 | 19863 | 277 | 18390 |
| 20-#11 | 4.64 | MA | 8351 | 3483 | 14818 | 2442 | 16409 | 1947 | 17298 | 1524 | 18611 | 834 | 23116 | 289 | 21352 |
| 7L-5S | | MI | 7523 | 3483 | 13494 | 2401 | 14901 | 1903 | 15746 | 1477 | 17105 | 771 | 20920 | 337 | 19029 |
| 22-#11 | 5.11 | MA | 8693 | 3593 | 15599 | 2512 | 17405 | 1997 | 18494 | 1553 | 20190 | 822 | 25184 | 261 | 23562 |
| 7L-6S | | MI | 7545 | 3593 | 13670 | 2478 | 15123 | 1945 | 16040 | 1511 | 17492 | 762 | 21503 | 243 | 20229 |

## RECTANGULAR TIED COLUMNS 24" x 30"

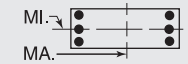
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.25 | MA | 8750 | 2865 | 13986 | 2072 | 15013 | 1685 | 15277 | 1395 | 15231 | 971 | 17807 | 895 | 7919 |
| 2E | | MI | 6920 | 2865 | 11170 | 2023 | 11784 | 1638 | 11871 | 1350 | 11706 | 931 | 13516 | 841 | 6196 |
| 4-#18 | 2.22 | MA | 9521 | 3113 | 15821 | 2207 | 17261 | 1780 | 17891 | 1441 | 18675 | 924 | 22237 | 805 | 13524 |
| 2E | | MI | 7469 | 3113 | 12483 | 2148 | 13334 | 1717 | 13695 | 1382 | 14113 | 867 | 16525 | 721 | 10432 |
| 6-#11 | 1.30 | MA | 8815 | 2878 | 14086 | 2090 | 15177 | 1699 | 15516 | 1408 | 15550 | 978 | 18254 | 902 | 8261 |
| 2L-3S | | MI | 6549 | 2878 | 10608 | 2037 | 11134 | 1663 | 11109 | 1371 | 10702 | 946 | 12244 | 762 | 6509 |
| 6-#11 | 1.30 | MA | 8254 | 2878 | 13236 | 2086 | 14093 | 1707 | 14202 | 1414 | 13815 | 985 | 15972 | 814 | 8299 |
| 3L-2S | | MI | 6972 | 2878 | 11251 | 2043 | 11940 | 1656 | 12069 | 1364 | 11971 | 939 | 13885 | 851 | 6459 |
| 6-#14 | 1.88 | MA | 9292 | 3025 | 15198 | 2172 | 16558 | 1757 | 17137 | 1438 | 17687 | 954 | 21028 | 856 | 11651 |
| 2L-3S | | MI | 6721 | 3025 | 11170 | 2113 | 11784 | 1717 | 11871 | 1398 | 11706 | 916 | 13516 | 661 | 9083 |
| 6-#14 | 1.88 | MA | 8502 | 3025 | 13986 | 2166 | 15013 | 1769 | 15277 | 1448 | 15231 | 964 | 17807 | 728 | 11656 |
| 3L-2S | | MI | 7316 | 3025 | 12083 | 2122 | 12918 | 1707 | 13222 | 1388 | 13492 | 906 | 15814 | 789 | 9036 |
| 6-#18 | 3.33 | MA | 10429 | 3397 | 17926 | 2385 | 19935 | 1908 | 21076 | 1515 | 22884 | 888 | 27716 | 727 | 19944 |
| 2L-3S | | MI | 7126 | 3397 | 12483 | 2305 | 13334 | 1853 | 13695 | 1462 | 14113 | 835 | 16525 | 387 | 14980 |
| 6-#18 | 3.33 | MA | 9091 | 3397 | 15821 | 2372 | 17261 | 1925 | 17891 | 1532 | 18675 | 906 | 22237 | 499 | 19660 |
| 3L-2S | | MI | 8129 | 3397 | 14032 | 2323 | 15251 | 1836 | 15979 | 1445 | 17133 | 817 | 20371 | 615 | 15265 |
| 8-#11 | 1.73 | MA | 9198 | 2989 | 14936 | 2159 | 16261 | 1749 | 16829 | 1438 | 17285 | 967 | 20536 | 877 | 10876 |
| 2L-4S | | MI | 6526 | 2989 | 10724 | 2114 | 11285 | 1705 | 11294 | 1392 | 10999 | 937 | 12810 | 646 | 8494 |
| 8-#11 | 1.73 | MA | 8642 | 2989 | 14086 | 2155 | 15177 | 1757 | 15516 | 1445 | 15550 | 974 | 18254 | 789 | 10893 |
| 3E | | MI | 6833 | 2989 | 11251 | 2106 | 11940 | 1712 | 12069 | 1399 | 11971 | 930 | 13885 | 728 | 8491 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis

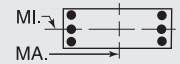



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.73 | MA | 8242 | 2989 | 13396 | 2166 | 14301 | 1752 | 14456 | 1438 | 14220 | 980 | 16770 | 701 | 10838 |
| 4L-2S | | MI | 7253 | 2989 | 11893 | 2112 | 12746 | 1705 | 13029 | 1392 | 13240 | 923 | 15526 | 817 | 8455 |
| 8-#14 | 2.50 | MA | 9827 | 3184 | 16410 | 2271 | 18104 | 1830 | 18997 | 1482 | 20144 | 937 | 24249 | 817 | 15359 |
| 2L-4S | | MI | 6687 | 3184 | 11333 | 2223 | 11996 | 1776 | 12131 | 1426 | 12123 | 902 | 14305 | 492 | 11228 |
| 8-#14 | 2.50 | MA | 9045 | 3184 | 15198 | 2266 | 16558 | 1841 | 17137 | 1492 | 17687 | 947 | 21028 | 689 | 15312 |
| 3E | | MI | 7119 | 3184 | 12083 | 2213 | 12918 | 1786 | 13222 | 1436 | 13492 | 892 | 15814 | 608 | 11856 |
| 8-#14 | 2.50 | MA | 8483 | 3184 | 14213 | 2280 | 15306 | 1832 | 15637 | 1482 | 15803 | 956 | 18930 | 564 | 14477 |
| 4L-2S | | MI | 7708 | 3184 | 12996 | 2222 | 14052 | 1776 | 14573 | 1426 | 15278 | 882 | 18112 | 736 | 11848 |
| 8-#18 | 4.44 | MA | 11322 | 3681 | 20032 | 2562 | 22610 | 2035 | 24262 | 1588 | 27092 | 853 | 33194 | 648 | 26316 |
| 2L-4S | | MI | 7064 | 3681 | 12757 | 2497 | 13690 | 1954 | 14133 | 1507 | 14819 | 803 | 17834 | 84 | 17357 |
| 8-#18 | 4.44 | MA | 10006 | 3681 | 17926 | 2549 | 19935 | 2053 | 21076 | 1606 | 22884 | 871 | 27716 | 420 | 25501 |
| 3E | | MI | 7791 | 3681 | 14032 | 2480 | 15251 | 1972 | 15979 | 1525 | 17133 | 785 | 20371 | 281 | 19165 |
| 8-#18 | 4.44 | MA | 9058 | 3681 | 16209 | 2572 | 17762 | 2035 | 18505 | 1588 | 19657 | 888 | 24136 | 205 | 22654 |
| 4L-2S | | MI | 8780 | 3681 | 15581 | 2497 | 17168 | 1954 | 18264 | 1507 | 20153 | 768 | 24217 | 508 | 20046 |
| 10-#11 | 2.17 | MA | 9577 | 3099 | 15787 | 2228 | 17345 | 1799 | 18143 | 1469 | 19020 | 956 | 22818 | 852 | 13479 |
| 2L-5S | | MI | 6535 | 3099 | 10902 | 2177 | 11505 | 1760 | 11557 | 1426 | 11305 | 915 | 13313 | 571 | 9882 |
| 10-#11 | 2.17 | MA | 9025 | 3099 | 14936 | 2224 | 16261 | 1807 | 16829 | 1476 | 17285 | 963 | 20536 | 764 | 13472 |
| 3L-4S | | MI | 6811 | 3099 | 11367 | 2183 | 12091 | 1753 | 12254 | 1419 | 12267 | 922 | 14451 | 612 | 10355 |
| 10-#11 | 2.17 | MA | 8629 | 3099 | 14247 | 2235 | 15385 | 1802 | 15770 | 1469 | 15954 | 969 | 19052 | 676 | 13360 |
| 4L-3S | | MI | 7115 | 3099 | 11893 | 2175 | 12746 | 1760 | 13029 | 1426 | 13240 | 915 | 15526 | 694 | 10458 |
| 10-#11 | 2.17 | MA | 8273 | 3099 | 13640 | 2231 | 14602 | 1811 | 14816 | 1476 | 14640 | 963 | 17469 | 636 | 12631 |
| 5L-2S | | MI | 7532 | 3099 | 12536 | 2181 | 13552 | 1753 | 13989 | 1419 | 14509 | 908 | 17167 | 783 | 10436 |
| 10-#14 | 3.13 | MA | 10355 | 3344 | 17623 | 2371 | 19649 | 1902 | 20857 | 1525 | 22601 | 919 | 27470 | 779 | 19046 |
| 2L-5S | | MI | 6698 | 3344 | 11583 | 2313 | 12306 | 1855 | 12501 | 1474 | 12645 | 888 | 15009 | 380 | 13216 |
| 10-#14 | 3.13 | MA | 9581 | 3344 | 16410 | 2365 | 18104 | 1913 | 18997 | 1535 | 20144 | 929 | 24249 | 651 | 18955 |
| 3L-4S | | MI | 7085 | 3344 | 12246 | 2323 | 13130 | 1845 | 13482 | 1464 | 13909 | 878 | 16603 | 440 | 13800 |
| 10-#14 | 3.13 | MA | 9026 | 3344 | 15425 | 2379 | 16852 | 1905 | 17497 | 1525 | 18260 | 939 | 22151 | 526 | 17921 |
| 4L-3S | | MI | 7512 | 3344 | 12996 | 2312 | 14052 | 1855 | 14573 | 1474 | 15278 | 868 | 18112 | 555 | 14610 |
| 10-#14 | 3.13 | MA | 8526 | 3344 | 14557 | 2374 | 15733 | 1916 | 16147 | 1535 | 16398 | 929 | 19918 | 468 | 17084 |
| 5L-2S | | MI | 8095 | 3344 | 13909 | 2322 | 15187 | 1845 | 15925 | 1464 | 17064 | 858 | 20410 | 683 | 14643 |
| 10-#18 | 5.56 | MA | 10906 | 3964 | 20032 | 2727 | 22610 | 2181 | 24262 | 1679 | 27092 | 835 | 33194 | 342 | 31286 |
| 3L-4S | | MI | 7731 | 3964 | 14306 | 2672 | 15607 | 2073 | 16417 | 1570 | 17839 | 753 | 21680 | -23 | 21590 |
| 10-#18 | 5.56 | MA | 9973 | 3964 | 18314 | 2749 | 20436 | 2163 | 21691 | 1661 | 23865 | 853 | 29615 | 126 | 28674 |
| 4L-3S | | MI | 8448 | 3964 | 15581 | 2654 | 17168 | 2090 | 18264 | 1587 | 20153 | 736 | 24217 | 174 | 23424 |
| 10-#18 | 5.56 | MA | 9134 | 3964 | 16798 | 2736 | 18493 | 2181 | 19379 | 1679 | 20674 | 835 | 25816 | 22 | 25702 |
| 5L-2S | | MI | 9425 | 3964 | 17130 | 2672 | 19084 | 2073 | 20548 | 1570 | 23172 | 718 | 28063 | 402 | 24794 |
| 12-#11 | 2.60 | MA | 9953 | 3210 | 16637 | 2297 | 18429 | 1849 | 19456 | 1500 | 20754 | 945 | 25101 | 827 | 16073 |
| 2L-6S | | MI | 6557 | 3210 | 11078 | 2254 | 11728 | 1802 | 11851 | 1460 | 11692 | 906 | 13897 | 476 | 11299 |
| 12-#11 | 2.60 | MA | 9405 | 3210 | 15787 | 2294 | 17345 | 1858 | 18143 | 1507 | 19020 | 952 | 22818 | 739 | 16042 |
| 3L-5S | | MI | 6819 | 3210 | 11545 | 2246 | 12311 | 1809 | 12517 | 1453 | 12574 | 899 | 14954 | 537 | 11741 |
| 12-#11 | 2.60 | MA | 9013 | 3210 | 15097 | 2304 | 16469 | 1852 | 17083 | 1500 | 17689 | 958 | 21334 | 651 | 15779 |
| 4E | | MI | 7092 | 3210 | 12010 | 2252 | 12897 | 1802 | 13214 | 1446 | 13536 | 906 | 16092 | 578 | 12174 |
| 12-#11 | 2.60 | MA | 8659 | 3210 | 14490 | 2300 | 15686 | 1861 | 16130 | 1507 | 16375 | 952 | 19752 | 611 | 15099 |
| 5L-3S | | MI | 7395 | 3210 | 12536 | 2244 | 13552 | 1809 | 13989 | 1453 | 14509 | 899 | 17167 | 660 | 12412 |
| 12-#11 | 2.60 | MA | 8322 | 3210 | 13916 | 2297 | 14908 | 1855 | 15219 | 1514 | 15169 | 958 | 18274 | 552 | 14502 |
| 6L-2S | | MI | 7809 | 3210 | 13179 | 2250 | 14358 | 1802 | 14950 | 1446 | 15778 | 892 | 18808 | 749 | 12408 |
| 12-#14 | 3.75 | MA | 10112 | 3503 | 17623 | 2465 | 19649 | 1986 | 20857 | 1578 | 22601 | 912 | 27470 | 612 | 22591 |
| 3L-5S | | MI | 7095 | 3503 | 12496 | 2413 | 13440 | 1924 | 13852 | 1512 | 14431 | 863 | 17307 | 327 | 15712 |
| 12-#14 | 3.75 | MA | 9562 | 3503 | 16638 | 2479 | 18397 | 1977 | 19357 | 1569 | 20717 | 922 | 25372 | 487 | 21388 |
| 4E | | MI | 7478 | 3503 | 13159 | 2423 | 14264 | 1914 | 14833 | 1502 | 15695 | 853 | 18901 | 387 | 16393 |
| 12-#14 | 3.75 | MA | 9068 | 3503 | 15770 | 2473 | 17279 | 1988 | 18007 | 1578 | 18855 | 912 | 23139 | 429 | 20519 |
| 5L-3S | | MI | 7901 | 3503 | 13909 | 2412 | 15187 | 1924 | 15925 | 1512 | 17064 | 843 | 20410 | 503 | 17353 |
| 12-#14 | 3.75 | MA | 8596 | 3503 | 14948 | 2468 | 16165 | 1980 | 16717 | 1588 | 17148 | 922 | 21055 | 343 | 19125 |
| 6L-2S | | MI | 8480 | 3503 | 14822 | 2422 | 16321 | 1914 | 17276 | 1502 | 18850 | 833 | 22708 | 631 | 17420 |
| 12-#18 | 6.67 | MA | 10877 | 4248 | 20419 | 2926 | 23111 | 2291 | 24876 | 1735 | 28074 | 817 | 35093 | 48 | 34728 |
| 4E | | MI | 8445 | 4248 | 15855 | 2847 | 17524 | 2191 | 18702 | 1632 | 20859 | 704 | 25526 | -129 | 24944 |
| 12-#18 | 6.67 | MA | 10050 | 4248 | 18903 | 2914 | 21168 | 2309 | 22564 | 1752 | 24883 | 800 | 31294 | -57 | 31007 |
| 5L-3S | | MI | 9137 | 4248 | 17130 | 2829 | 19084 | 2209 | 20548 | 1650 | 23172 | 686 | 28063 | 68 | 27740 |

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

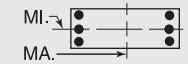
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 3.03 | MA | 9782 | 3320 | 16637 | 2363 | 18429 | 1908 | 19456 | 1538 | 20754 | 941 | 25101 | 714 | 18606 |
| 3L-6S | | MI | 6840 | 3320 | 11721 | 2323 | 12534 | 1851 | 12811 | 1487 | 12961 | 890 | 15538 | 442 | 13104 |
| 14-#11 | 3.03 | MA | 9392 | 3320 | 15947 | 2373 | 17553 | 1902 | 18397 | 1531 | 19424 | 947 | 23616 | 626 | 18213 |
| 4L-5S | | MI | 7100 | 3320 | 12187 | 2315 | 13117 | 1858 | 13477 | 1480 | 13842 | 883 | 16595 | 503 | 13608 |
| 14-#11 | 3.03 | MA | 9042 | 3320 | 15340 | 2370 | 16771 | 1911 | 17443 | 1538 | 18110 | 941 | 22034 | 586 | 17576 |
| 5L-4S | | MI | 7372 | 3320 | 12653 | 2321 | 13703 | 1851 | 14174 | 1473 | 14805 | 890 | 17732 | 544 | 14005 |
| 14-#11 | 3.03 | MA | 8707 | 3320 | 14766 | 2366 | 15992 | 1906 | 16532 | 1544 | 16904 | 947 | 20556 | 527 | 16918 |
| 6L-3S | | MI | 7672 | 3320 | 13179 | 2314 | 14358 | 1858 | 14950 | 1480 | 15778 | 883 | 18808 | 626 | 14357 |
| 14-#11 | 3.03 | MA | 8381 | 3320 | 14152 | 2376 | 15244 | 1914 | 15586 | 1538 | 15724 | 954 | 19167 | 458 | 16240 |
| 7L-2S | | MI | 8083 | 3320 | 13822 | 2319 | 15164 | 1851 | 15910 | 1473 | 17046 | 877 | 20448 | 714 | 14372 |
| 14-#14 | 4.38 | MA | 10093 | 3663 | 17850 | 2579 | 19943 | 2049 | 21217 | 1612 | 23174 | 905 | 28593 | 448 | 24873 |
| 4L-5S | | MI | 7488 | 3663 | 13409 | 2513 | 14574 | 1993 | 15204 | 1550 | 16216 | 839 | 19606 | 274 | 18229 |
| 14-#14 | 4.38 | MA | 9604 | 3663 | 16982 | 2573 | 18824 | 2061 | 19867 | 1622 | 21312 | 895 | 26360 | 390 | 23911 |
| 5L-4S | | MI | 7868 | 3663 | 14072 | 2522 | 15398 | 1983 | 16185 | 1540 | 17481 | 829 | 21199 | 334 | 19003 |
| 14-#14 | 4.38 | MA | 9137 | 3663 | 16161 | 2567 | 17711 | 2052 | 18577 | 1632 | 19604 | 905 | 24277 | 304 | 22588 |
| 6L-3S | | MI | 8287 | 3663 | 14822 | 2512 | 16321 | 1993 | 17276 | 1550 | 18850 | 819 | 22708 | 450 | 20088 |
| 14-#18 | 7.78 | MA | 10955 | 4532 | 21008 | 3091 | 23842 | 2436 | 25750 | 1826 | 29091 | 764 | 36773 | -135 | 35922 |
| 5L-4S | | MI | 9096 | 4532 | 17404 | 3021 | 19441 | 2310 | 20986 | 1695 | 23878 | 654 | 29372 | -236 | 28193 |
| 16-#11 | 3.47 | MA | 9769 | 3431 | 16797 | 2442 | 18637 | 1953 | 19710 | 1561 | 21159 | 936 | 25899 | 601 | 20658 |
| 4L-6S | | MI | 7121 | 3431 | 12364 | 2393 | 13340 | 1900 | 13772 | 1514 | 14229 | 875 | 17178 | 408 | 14920 |
| 16-#11 | 3.47 | MA | 9421 | 3431 | 16190 | 2439 | 17855 | 1961 | 18757 | 1568 | 19845 | 930 | 24316 | 561 | 20061 |
| 5E | | MI | 7380 | 3431 | 12830 | 2385 | 13923 | 1906 | 14438 | 1508 | 15111 | 868 | 18235 | 469 | 15480 |
| 16-#11 | 3.47 | MA | 9090 | 3431 | 15616 | 2435 | 17076 | 1956 | 17846 | 1575 | 18639 | 936 | 22838 | 502 | 19344 |
| 6L-4S | | MI | 7650 | 3431 | 13295 | 2391 | 14509 | 1900 | 15135 | 1501 | 16074 | 875 | 19373 | 510 | 15847 |
| 16-#11 | 3.47 | MA | 8766 | 3431 | 15002 | 2446 | 16328 | 1964 | 16900 | 1568 | 17459 | 943 | 21450 | 433 | 18672 |
| 7L-3S | | MI | 7948 | 3431 | 13822 | 2383 | 15164 | 1906 | 15910 | 1508 | 17046 | 868 | 20448 | 592 | 16296 |
| 16-#14 | 5.00 | MA | 10135 | 3823 | 18194 | 2673 | 20370 | 2133 | 21727 | 1665 | 23769 | 878 | 29581 | 352 | 27322 |
| 5E | | MI | 7878 | 3823 | 14322 | 2613 | 15708 | 2062 | 16555 | 1588 | 18002 | 815 | 21904 | 221 | 20764 |
| 16-#14 | 5.00 | MA | 9673 | 3823 | 17373 | 2667 | 19256 | 2124 | 20437 | 1675 | 22061 | 888 | 27498 | 266 | 26063 |
| 6L-4S | | MI | 8255 | 3823 | 14985 | 2622 | 16532 | 2052 | 17536 | 1578 | 19267 | 805 | 23497 | 282 | 21626 |
| 18-#11 | 3.90 | MA | 9798 | 3542 | 17041 | 2508 | 18939 | 2011 | 20071 | 1599 | 21579 | 919 | 26598 | 536 | 22550 |
| 5L-6S | | MI | 7401 | 3542 | 13006 | 2462 | 14146 | 1948 | 14732 | 1542 | 15498 | 859 | 18819 | 374 | 16744 |
| 18-#11 | 3.90 | MA | 9469 | 3542 | 16467 | 2504 | 18160 | 2006 | 19160 | 1606 | 20373 | 925 | 25121 | 477 | 21779 |
| 6L-5S | | MI | 7657 | 3542 | 13473 | 2454 | 14729 | 1955 | 15398 | 1535 | 16380 | 852 | 19876 | 435 | 17356 |
| 18-#11 | 3.90 | MA | 9148 | 3542 | 15852 | 2515 | 17412 | 2014 | 18213 | 1599 | 19193 | 932 | 23732 | 408 | 21069 |
| 7L-4S | | MI | 7925 | 3542 | 13938 | 2460 | 15315 | 1948 | 16095 | 1528 | 17343 | 859 | 21014 | 476 | 17697 |
| 18-#14 | 5.63 | MA | 10204 | 3982 | 18585 | 2767 | 20802 | 2197 | 22297 | 1718 | 24518 | 870 | 30719 | 227 | 29549 |
| 6L-5S | | MI | 8266 | 3982 | 15235 | 2712 | 16842 | 2131 | 17906 | 1626 | 19788 | 790 | 24202 | 169 | 23314 |
| 20-#11 | 4.33 | MA | 9845 | 3652 | 17317 | 2574 | 19244 | 2056 | 20473 | 1637 | 22108 | 914 | 27403 | 452 | 24221 |
| 6E | | MI | 7678 | 3652 | 13649 | 2531 | 14952 | 1997 | 15692 | 1569 | 16767 | 844 | 20460 | 340 | 18575 |
| 20-#11 | 4.33 | MA | 9527 | 3652 | 16703 | 2584 | 18496 | 2064 | 19527 | 1630 | 20928 | 921 | 26014 | 383 | 23474 |
| 7L-5S | | MI | 7933 | 3652 | 14116 | 2523 | 15535 | 2004 | 16358 | 1562 | 17649 | 837 | 21517 | 400 | 19236 |
| 22-#11 | 4.77 | MA | 9903 | 3763 | 17553 | 2653 | 19580 | 2115 | 20840 | 1661 | 22663 | 910 | 28296 | 358 | 25886 |
| 7L-6S | | MI | 7954 | 3763 | 14292 | 2600 | 15758 | 2046 | 16653 | 1596 | 18036 | 828 | 22101 | 306 | 20413 |

## RECTANGULAR TIED COLUMNS 24" x 32"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.17 | MA | 9906 | 3035 | 15741 | 2210 | 16915 | 1798 | 17235 | 1494 | 17142 | 1048 | 20053 | 973 | 8527 |
| 2E | | MI | 7328 | 3035 | 11793 | 2144 | 12418 | 1738 | 12482 | 1435 | 12249 | 996 | 14110 | 904 | 6226 |
| 4-#18 | 2.08 | MA | 10753 | 3283 | 17737 | 2345 | 19381 | 1895 | 20111 | 1543 | 20931 | 1005 | 24955 | 890 | 14604 |
| 2E | | MI | 7878 | 3283 | 13108 | 2268 | 13967 | 1816 | 14303 | 1466 | 14651 | 931 | 17114 | 783 | 10479 |
| 6-#11 | 1.22 | MA | 9976 | 3048 | 15846 | 2227 | 17089 | 1812 | 17468 | 1505 | 17482 | 1055 | 20528 | 980 | 8893 |
| 2L-3S | | MI | 6957 | 3048 | 11229 | 2159 | 11769 | 1764 | 11721 | 1457 | 11247 | 1012 | 12842 | 826 | 6540 |
| 6-#11 | 1.22 | MA | 9367 | 3048 | 14926 | 2225 | 15917 | 1821 | 16043 | 1512 | 15591 | 1062 | 18031 | 892 | 8931 |
| 3L-2S | | MI | 7380 | 3048 | 11872 | 2165 | 12575 | 1757 | 12681 | 1450 | 12515 | 1005 | 14483 | 914 | 6488 |

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

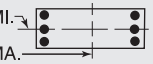
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.76 | MA | 10499 | 3194 | 17053 | 2309 | 18587 | 1871 | 19266 | 1539 | 19824 | 1033 | 23583 | 938 | 12563 |
| 2L-3S | | MI | 7129 | 3194 | 11793 | 2234 | 12418 | 1817 | 12482 | 1483 | 12249 | 982 | 14110 | 724 | 9128 |
| 6-#14 | 1.76 | MA | 9640 | 3194 | 15741 | 2305 | 16915 | 1883 | 17235 | 1549 | 17142 | 1043 | 20053 | 810 | 12567 |
| 3L-2S | | MI | 7725 | 3194 | 12706 | 2244 | 13553 | 1807 | 13833 | 1473 | 14034 | 972 | 16408 | 852 | 9073 |
| 6-#18 | 3.13 | MA | 11748 | 3567 | 20019 | 2523 | 22291 | 2023 | 23599 | 1619 | 25538 | 973 | 30981 | 818 | 21564 |
| 2L-3S | | MI | 7534 | 3567 | 13108 | 2425 | 13967 | 1952 | 14303 | 1546 | 14651 | 899 | 17114 | 449 | 15230 |
| 6-#18 | 3.13 | MA | 10293 | 3567 | 17737 | 2512 | 19381 | 2043 | 20111 | 1637 | 20931 | 990 | 24955 | 591 | 21280 |
| 3L-2S | | MI | 8540 | 3567 | 14657 | 2443 | 15884 | 1934 | 16588 | 1528 | 17671 | 882 | 20960 | 677 | 15320 |
| 8-#11 | 1.63 | MA | 10394 | 3158 | 16765 | 2297 | 18261 | 1862 | 18893 | 1536 | 19372 | 1045 | 23025 | 958 | 11718 |
| 2L-4S | | MI | 6934 | 3158 | 11346 | 2236 | 11920 | 1805 | 11906 | 1477 | 11543 | 1003 | 13407 | 710 | 8545 |
| 8-#11 | 1.63 | MA | 9790 | 3158 | 15846 | 2294 | 17089 | 1872 | 17468 | 1543 | 17482 | 1052 | 20528 | 869 | 11736 |
| 3E | | MI | 7241 | 3158 | 11872 | 2228 | 12575 | 1812 | 12681 | 1484 | 12515 | 996 | 14483 | 792 | 8528 |
| 8-#11 | 1.63 | MA | 9358 | 3158 | 15102 | 2305 | 16143 | 1867 | 16321 | 1537 | 16032 | 1059 | 18904 | 780 | 11680 |
| 4L-2S | | MI | 7662 | 3158 | 12515 | 2234 | 13381 | 1805 | 13642 | 1477 | 13784 | 989 | 16123 | 880 | 8488 |
| 8-#14 | 2.34 | MA | 11083 | 3354 | 18365 | 2409 | 20260 | 1943 | 21296 | 1583 | 22505 | 1017 | 27114 | 902 | 16574 |
| 2L-4S | | MI | 7094 | 3354 | 11956 | 2345 | 12630 | 1876 | 12742 | 1511 | 12666 | 967 | 14899 | 556 | 11397 |
| 8-#14 | 2.34 | MA | 10234 | 3354 | 17053 | 2404 | 18587 | 1955 | 19266 | 1593 | 19824 | 1027 | 23583 | 774 | 16527 |
| 3E | | MI | 7527 | 3354 | 12706 | 2334 | 13553 | 1886 | 13833 | 1521 | 14034 | 957 | 16408 | 671 | 11911 |
| 8-#14 | 2.34 | MA | 9626 | 3354 | 15989 | 2419 | 17235 | 1948 | 17629 | 1583 | 17767 | 1037 | 21288 | 647 | 15782 |
| 4L-2S | | MI | 8117 | 3354 | 13619 | 2344 | 14687 | 1876 | 15185 | 1511 | 15820 | 947 | 18706 | 799 | 11890 |
| 8-#18 | 4.17 | MA | 12726 | 3850 | 22302 | 2700 | 25201 | 2152 | 27086 | 1695 | 30144 | 941 | 37008 | 747 | 28476 |
| 2L-4S | | MI | 7470 | 3850 | 13383 | 2617 | 14324 | 2053 | 14741 | 1591 | 15357 | 867 | 18423 | 146 | 17583 |
| 8-#18 | 4.17 | MA | 11294 | 3850 | 20019 | 2689 | 22291 | 2171 | 23599 | 1713 | 25538 | 958 | 30981 | 519 | 28037 |
| 3E | | MI | 8200 | 3850 | 14657 | 2600 | 15884 | 2071 | 16588 | 1609 | 17671 | 850 | 20960 | 343 | 19464 |
| 8-#18 | 4.17 | MA | 10267 | 3850 | 18162 | 2713 | 19931 | 2155 | 20785 | 1695 | 22005 | 976 | 27052 | 299 | 24716 |
| 4L-2S | | MI | 9193 | 3850 | 16207 | 2617 | 17801 | 2053 | 18872 | 1591 | 20691 | 832 | 24806 | 570 | 20112 |
| 10-#11 | 2.03 | MA | 10808 | 3269 | 17685 | 2366 | 19433 | 1913 | 20318 | 1567 | 21263 | 1035 | 25522 | 935 | 14532 |
| 2L-5S | | MI | 6942 | 3269 | 11523 | 2300 | 12140 | 1861 | 12169 | 1511 | 11849 | 980 | 13911 | 634 | 10000 |
| 10-#11 | 2.03 | MA | 10209 | 3269 | 16765 | 2363 | 18261 | 1922 | 18893 | 1575 | 19372 | 1042 | 23025 | 846 | 14525 |
| 3L-4S | | MI | 7218 | 3269 | 11989 | 2305 | 12726 | 1854 | 12866 | 1504 | 12812 | 987 | 15048 | 676 | 10489 |
| 10-#11 | 2.03 | MA | 9781 | 3269 | 16021 | 2374 | 17315 | 1917 | 17746 | 1568 | 17922 | 1049 | 21401 | 757 | 14440 |
| 4L-3S | | MI | 7524 | 3269 | 12515 | 2298 | 13381 | 1861 | 13642 | 1511 | 13784 | 980 | 16123 | 757 | 10500 |
| 10-#11 | 2.03 | MA | 9396 | 3269 | 15367 | 2371 | 16472 | 1926 | 16713 | 1576 | 16491 | 1042 | 19672 | 717 | 13696 |
| 5L-2S | | MI | 7942 | 3269 | 13158 | 2304 | 14187 | 1854 | 14602 | 1504 | 15053 | 973 | 17764 | 846 | 10472 |
| 10-#14 | 2.93 | MA | 11660 | 3514 | 19677 | 2509 | 21933 | 2015 | 23327 | 1628 | 25186 | 1002 | 30644 | 867 | 20565 |
| 2L-5S | | MI | 7104 | 3514 | 12206 | 2435 | 12940 | 1955 | 13112 | 1559 | 13187 | 953 | 15604 | 443 | 13426 |
| 10-#14 | 2.93 | MA | 10820 | 3514 | 18365 | 2504 | 20260 | 2028 | 21296 | 1638 | 22505 | 1012 | 27114 | 739 | 20474 |
| 3L-4S | | MI | 7492 | 3514 | 12869 | 2444 | 13764 | 1945 | 14093 | 1549 | 14451 | 943 | 17197 | 503 | 13966 |
| 10-#14 | 2.93 | MA | 10219 | 3514 | 17301 | 2519 | 18908 | 2020 | 19659 | 1628 | 20448 | 1022 | 24818 | 612 | 19515 |
| 4L-3S | | MI | 7921 | 3514 | 13619 | 2434 | 14687 | 1955 | 15185 | 1559 | 15820 | 933 | 18706 | 618 | 14672 |
| 10-#14 | 2.93 | MA | 9679 | 3514 | 16365 | 2514 | 17702 | 2033 | 18185 | 1638 | 18417 | 1012 | 22370 | 555 | 18542 |
| 5L-2S | | MI | 8506 | 3514 | 14532 | 2443 | 15821 | 1945 | 16536 | 1549 | 17606 | 923 | 21005 | 746 | 14689 |
| 10-#18 | 5.21 | MA | 12279 | 4134 | 22302 | 2866 | 25201 | 2300 | 27086 | 1789 | 30144 | 926 | 37008 | 447 | 34328 |
| 3L-4S | | MI | 8137 | 4134 | 14932 | 2792 | 16240 | 2171 | 17026 | 1653 | 18377 | 818 | 22269 | 40 | 22035 |
| 10-#18 | 5.21 | MA | 11269 | 4134 | 20445 | 2891 | 22841 | 2283 | 24273 | 1771 | 26612 | 944 | 33079 | 227 | 31255 |
| 4L-3S | | MI | 8858 | 4134 | 16207 | 2774 | 17801 | 2189 | 18872 | 1671 | 20691 | 800 | 24806 | 236 | 23716 |
| 10-#18 | 5.21 | MA | 10361 | 4134 | 18808 | 2880 | 20731 | 2303 | 21741 | 1789 | 23121 | 926 | 28900 | 124 | 28203 |
| 5L-2S | | MI | 9839 | 4134 | 17756 | 2792 | 19718 | 2171 | 21157 | 1653 | 23711 | 782 | 28652 | 464 | 24867 |
| 12-#11 | 2.44 | MA | 11218 | 3380 | 18604 | 2435 | 20605 | 1963 | 21743 | 1598 | 23154 | 1025 | 28019 | 912 | 17337 |
| 2L-6S | | MI | 6963 | 3380 | 11699 | 2377 | 12363 | 1903 | 12464 | 1545 | 12236 | 972 | 14494 | 540 | 11487 |
| 12-#11 | 2.44 | MA | 10623 | 3380 | 17685 | 2432 | 19433 | 1972 | 20318 | 1606 | 21263 | 1032 | 25522 | 823 | 17305 |
| 3L-5S | | MI | 7226 | 3380 | 12166 | 2369 | 12946 | 1910 | 13130 | 1539 | 13118 | 965 | 15551 | 600 | 11858 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

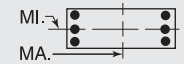
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.44 | MA | 10199 | 3380 | 16941 | 2443 | 18487 | 1967 | 19171 | 1599 | 19813 | 1039 | 23898 | 735 | 17162 |
| 4E | | MI | 7501 | 3380 | 12631 | 2375 | 13532 | 1903 | 13827 | 1532 | 14081 | 972 | 16689 | 642 | 12309 |
| 12-#11 | 2.44 | MA | 9818 | 3380 | 16286 | 2440 | 17644 | 1976 | 18138 | 1607 | 18381 | 1032 | 22169 | 695 | 16367 |
| 5L-3S | | MI | 7804 | 3380 | 13158 | 2367 | 14187 | 1910 | 14602 | 1539 | 15053 | 965 | 17764 | 723 | 12462 |
| 12-#11 | 2.44 | MA | 9453 | 3380 | 15668 | 2437 | 16805 | 1972 | 17152 | 1614 | 17067 | 1039 | 20551 | 636 | 15816 |
| 6L-2S | | MI | 8219 | 3380 | 13801 | 2373 | 14993 | 1903 | 15562 | 1532 | 16322 | 958 | 19405 | 812 | 12447 |
| 12-#14 | 3.52 | MA | 11399 | 3673 | 19677 | 2604 | 21933 | 2100 | 23327 | 1683 | 25186 | 996 | 30644 | 704 | 24413 |
| 3L-5S | | MI | 7502 | 3673 | 13119 | 2535 | 14074 | 2024 | 14463 | 1597 | 14973 | 929 | 17902 | 390 | 15974 |
| 12-#14 | 3.52 | MA | 10805 | 3673 | 18613 | 2619 | 20581 | 2093 | 21689 | 1673 | 23130 | 1006 | 28349 | 577 | 23271 |
| 4E | | MI | 7886 | 3673 | 13782 | 2544 | 14898 | 2014 | 15444 | 1587 | 16237 | 919 | 19496 | 450 | 16557 |
| 12-#14 | 3.52 | MA | 10271 | 3673 | 17677 | 2614 | 19374 | 2105 | 20216 | 1683 | 21099 | 996 | 25901 | 519 | 22364 |
| 5L-3S | | MI | 8311 | 3673 | 14532 | 2534 | 15821 | 2024 | 16536 | 1597 | 17606 | 909 | 21005 | 566 | 17421 |
| 12-#14 | 3.52 | MA | 9761 | 3673 | 16792 | 2609 | 18174 | 2097 | 18807 | 1693 | 19235 | 1006 | 23614 | 434 | 20862 |
| 6L-2S | | MI | 8892 | 3673 | 15445 | 2543 | 16955 | 2014 | 17887 | 1587 | 19392 | 899 | 23303 | 694 | 17473 |
| 12-#18 | 6.25 | MA | 12256 | 4418 | 22727 | 3068 | 25751 | 2412 | 27760 | 1847 | 31218 | 912 | 39106 | 155 | 37830 |
| 4E | | MI | 8854 | 4418 | 16481 | 2967 | 18157 | 2290 | 19310 | 1716 | 21397 | 768 | 26115 | -67 | 25800 |
| 12-#18 | 6.25 | MA | 11362 | 4418 | 21090 | 3057 | 23641 | 2431 | 25229 | 1864 | 27727 | 894 | 34927 | 52 | 34622 |
| 5L-3S | | MI | 9552 | 4418 | 17756 | 2949 | 19718 | 2308 | 21157 | 1734 | 23711 | 750 | 28652 | 130 | 28025 |
| 14-#11 | 2.84 | MA | 11034 | 3490 | 18604 | 2501 | 20605 | 2022 | 21743 | 1637 | 23154 | 1022 | 28019 | 801 | 20080 |
| 3L-6S | | MI | 7247 | 3490 | 12342 | 2446 | 13169 | 1951 | 13424 | 1573 | 13505 | 956 | 16135 | 506 | 13290 |
| 14-#11 | 2.84 | MA | 10614 | 3490 | 17860 | 2512 | 19660 | 2017 | 20596 | 1630 | 21704 | 1029 | 26396 | 712 | 19796 |
| 4L-5S | | MI | 7508 | 3490 | 12809 | 2438 | 13752 | 1958 | 14090 | 1566 | 14387 | 949 | 17192 | 566 | 13724 |
| 14-#11 | 2.84 | MA | 10235 | 3490 | 17206 | 2509 | 18816 | 2026 | 19563 | 1638 | 20272 | 1022 | 24666 | 672 | 19048 |
| 5L-4S | | MI | 7781 | 3490 | 13274 | 2444 | 14338 | 1951 | 14787 | 1559 | 15349 | 956 | 18330 | 608 | 14139 |
| 14-#11 | 2.84 | MA | 9874 | 3490 | 16587 | 2506 | 17977 | 2022 | 18577 | 1645 | 18958 | 1029 | 23048 | 613 | 18434 |
| 6L-3S | | MI | 8082 | 3490 | 13801 | 2436 | 14993 | 1958 | 15562 | 1566 | 16322 | 949 | 19405 | 689 | 14409 |
| 14-#11 | 2.84 | MA | 9522 | 3490 | 15926 | 2517 | 17171 | 2031 | 17553 | 1639 | 17672 | 1036 | 21360 | 525 | 17650 |
| 7L-2S | | MI | 8494 | 3490 | 14443 | 2442 | 15799 | 1951 | 16523 | 1559 | 17591 | 942 | 21046 | 778 | 14414 |
| 14-#14 | 4.10 | MA | 11385 | 3833 | 19925 | 2719 | 22253 | 2165 | 23720 | 1717 | 25811 | 991 | 31879 | 541 | 27046 |
| 4L-5S | | MI | 7896 | 3833 | 14032 | 2634 | 15208 | 2093 | 15815 | 1635 | 16759 | 904 | 20200 | 337 | 18487 |
| 14-#14 | 4.10 | MA | 10856 | 3833 | 18989 | 2714 | 21047 | 2177 | 22246 | 1727 | 23780 | 981 | 29431 | 484 | 26158 |
| 5L-4S | | MI | 8277 | 3833 | 14695 | 2644 | 16032 | 2083 | 16796 | 1625 | 18023 | 894 | 21794 | 397 | 19165 |
| 14-#14 | 4.10 | MA | 10352 | 3833 | 18104 | 2709 | 19847 | 2170 | 20838 | 1737 | 21916 | 991 | 27145 | 398 | 24618 |
| 6L-3S | | MI | 8698 | 3833 | 15445 | 2633 | 16955 | 2093 | 17887 | 1635 | 19392 | 884 | 23303 | 513 | 20161 |
| 14-#14 | 4.10 | MA | 9860 | 3833 | 17157 | 2724 | 18693 | 2182 | 19375 | 1727 | 20092 | 1001 | 24998 | 300 | 23109 |
| 7L-2S | | MI | 9274 | 3833 | 16358 | 2643 | 18089 | 2083 | 19239 | 1625 | 21178 | 874 | 25601 | 641 | 20242 |
| 14-#18 | 7.29 | MA | 12351 | 4702 | 23372 | 3234 | 26551 | 2560 | 28716 | 1940 | 32334 | 862 | 40953 | -20 | 40815 |
| 5L-4S | | MI | 9507 | 4702 | 18030 | 3141 | 20074 | 2409 | 21595 | 1778 | 24416 | 719 | 29961 | -173 | 29091 |
| 16-#11 | 3.25 | MA | 11024 | 3601 | 18779 | 2581 | 20832 | 2067 | 22021 | 1662 | 23594 | 1019 | 28893 | 689 | 22442 |
| 4L-6S | | MI | 7529 | 3601 | 12985 | 2515 | 13975 | 2000 | 14384 | 1600 | 14774 | 940 | 17776 | 472 | 15103 |
| 16-#11 | 3.25 | MA | 10649 | 3601 | 18125 | 2578 | 19989 | 2077 | 20988 | 1669 | 22163 | 1013 | 27163 | 649 | 21736 |
| 5E | | MI | 7788 | 3601 | 13452 | 2507 | 14558 | 2007 | 15050 | 1593 | 15655 | 934 | 18833 | 532 | 15596 |
| 16-#11 | 3.25 | MA | 10292 | 3601 | 17507 | 2575 | 19150 | 2072 | 20002 | 1676 | 20848 | 1019 | 25545 | 590 | 21062 |
| 6L-4S | | MI | 8059 | 3601 | 13917 | 2513 | 15144 | 2000 | 15747 | 1586 | 16618 | 940 | 19971 | 573 | 15980 |
| 16-#11 | 3.25 | MA | 9942 | 3601 | 16845 | 2586 | 18343 | 2081 | 18978 | 1670 | 19562 | 1026 | 23857 | 502 | 20311 |
| 7L-3S | | MI | 8358 | 3601 | 14443 | 2505 | 15799 | 2007 | 16523 | 1593 | 17591 | 934 | 21046 | 655 | 16352 |
| 16-#11 | 3.25 | MA | 9598 | 3601 | 16238 | 2584 | 17530 | 2077 | 18010 | 1677 | 18292 | 1033 | 22243 | 455 | 19347 |
| 8L-2S | | MI | 8768 | 3601 | 15086 | 2511 | 16605 | 2000 | 17483 | 1586 | 18860 | 927 | 22687 | 744 | 16376 |
| 16-#14 | 4.69 | MA | 11436 | 3992 | 20301 | 2814 | 22720 | 2250 | 24276 | 1772 | 26461 | 965 | 32962 | 449 | 29858 |
| 5E | | MI | 8287 | 3992 | 14945 | 2734 | 16342 | 2162 | 17166 | 1673 | 18545 | 880 | 22498 | 285 | 21017 |
| 16-#14 | 4.69 | MA | 10937 | 3992 | 19416 | 2809 | 21519 | 2242 | 22868 | 1782 | 24598 | 975 | 30675 | 363 | 28386 |
| 6L-4S | | MI | 8665 | 3992 | 15608 | 2744 | 17167 | 2152 | 18147 | 1663 | 19809 | 870 | 24092 | 345 | 21786 |
| 16-#14 | 4.69 | MA | 10450 | 3992 | 18469 | 2824 | 20365 | 2255 | 21406 | 1772 | 22774 | 985 | 28528 | 264 | 26824 |
| 7L-3S | | MI | 9083 | 3992 | 16358 | 2733 | 18089 | 2162 | 19239 | 1673 | 21178 | 860 | 25601 | 460 | 22894 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

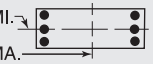
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 3.66 | MA | 11060 | 3711 | 19045 | 2648 | 21161 | 2127 | 22413 | 1700 | 24053 | 1003 | 29661 | 626 | 24431 |
| 5L-6S | | MI | 7808 | 3711 | 13628 | 2584 | 14781 | 2049 | 15345 | 1627 | 16043 | 925 | 19417 | 438 | 16925 |
| 18-#11 | 3.66 | MA | 10705 | 3711 | 18426 | 2645 | 20322 | 2122 | 21427 | 1708 | 22739 | 1010 | 28042 | 567 | 23699 |
| 6L-5S | | MI | 8066 | 3711 | 14094 | 2576 | 15364 | 2056 | 16010 | 1620 | 16924 | 918 | 20474 | 498 | 17473 |
| 18-#11 | 3.66 | MA | 10359 | 3711 | 17765 | 2656 | 19515 | 2131 | 20403 | 1701 | 21453 | 1016 | 26354 | 479 | 22979 |
| 7L-4S | | MI | 8335 | 3711 | 14560 | 2582 | 15950 | 2049 | 16707 | 1613 | 17887 | 925 | 21611 | 539 | 17829 |
| 18-#11 | 3.66 | MA | 10017 | 3711 | 17157 | 2653 | 18702 | 2127 | 19435 | 1709 | 20183 | 1023 | 24740 | 432 | 21980 |
| 8L-3S | | MI | 8632 | 3711 | 15086 | 2574 | 16605 | 2056 | 17483 | 1620 | 18860 | 918 | 22687 | 621 | 18290 |
| 18-#14 | 5.27 | MA | 11516 | 4152 | 20728 | 2908 | 23192 | 2314 | 24898 | 1827 | 27279 | 960 | 34206 | 328 | 32165 |
| 6L-5S | | MI | 8675 | 4152 | 15858 | 2834 | 17477 | 2231 | 18518 | 1710 | 20330 | 856 | 24796 | 232 | 23564 |
| 18-#14 | 5.27 | MA | 11035 | 4152 | 19781 | 2924 | 22038 | 2327 | 23436 | 1817 | 25455 | 970 | 32059 | 229 | 30552 |
| 7L-4S | | MI | 9050 | 4152 | 16521 | 2843 | 18301 | 2221 | 19499 | 1701 | 21595 | 846 | 26390 | 292 | 24418 |
| 20-#11 | 4.06 | MA | 11116 | 3822 | 19346 | 2714 | 21494 | 2172 | 22852 | 1739 | 24630 | 1000 | 30539 | 544 | 26344 |
| 6E | | MI | 8087 | 3822 | 14271 | 2653 | 15587 | 2098 | 16305 | 1654 | 17311 | 909 | 21058 | 404 | 18755 |
| 20-#11 | 4.06 | MA | 10772 | 3822 | 18684 | 2725 | 20688 | 2181 | 21828 | 1732 | 23343 | 1007 | 28852 | 456 | 25630 |
| 7L-5S | | MI | 8343 | 3822 | 14737 | 2645 | 16170 | 2104 | 16971 | 1648 | 18193 | 902 | 22115 | 464 | 19353 |
| 20-#11 | 4.06 | MA | 10433 | 3822 | 18076 | 2722 | 19874 | 2177 | 20860 | 1740 | 22073 | 1013 | 27237 | 409 | 24619 |
| 8L-4S | | MI | 8610 | 3822 | 15202 | 2651 | 16756 | 2098 | 17668 | 1641 | 19156 | 909 | 23252 | 505 | 19685 |
| 20-#14 | 5.86 | MA | 11614 | 4312 | 21093 | 3023 | 23711 | 2399 | 25466 | 1861 | 28136 | 954 | 35589 | 194 | 34291 |
| 7L-5S | | MI | 9060 | 4312 | 16771 | 2934 | 18611 | 2300 | 19869 | 1748 | 22116 | 831 | 27094 | 179 | 26124 |
| 22-#11 | 4.47 | MA | 11182 | 3933 | 19603 | 2794 | 21860 | 2232 | 23252 | 1763 | 25234 | 997 | 31349 | 434 | 28245 |
| 7L-6S | | MI | 8363 | 3933 | 14913 | 2722 | 16393 | 2146 | 17265 | 1682 | 18580 | 894 | 22698 | 370 | 20591 |
| 22-#11 | 4.47 | MA | 10846 | 3933 | 18996 | 2791 | 21046 | 2227 | 22285 | 1771 | 23964 | 1004 | 29734 | 386 | 27265 |
| 8L-5S | | MI | 8617 | 3933 | 15380 | 2714 | 16976 | 2153 | 17931 | 1675 | 19462 | 887 | 23755 | 430 | 21236 |
| 24-#11 | 4.88 | MA | 11256 | 4043 | 19915 | 2860 | 22218 | 2277 | 23710 | 1802 | 25855 | 994 | 32231 | 364 | 29915 |
| 8L-6S | | MI | 8638 | 4043 | 15556 | 2791 | 17199 | 2195 | 18225 | 1709 | 19849 | 878 | 24339 | 336 | 22433 |

## RECTANGULAR TIED COLUMNS 24" x 34"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.10 | MA | 11130 | 3205 | 17592 | 2348 | 18922 | 1912 | 19274 | 1591 | 19151 | 1126 | 22407 | 1051 | 9134 |
| 2E | | MI | 7736 | 3205 | 12416 | 2266 | 13053 | 1838 | 13093 | 1520 | 12791 | 1061 | 14705 | 968 | 6257 |
| 4-#18 | 1.96 | MA | 12055 | 3453 | 19749 | 2483 | 21588 | 2008 | 22438 | 1644 | 23285 | 1085 | 27783 | 973 | 15684 |
| 2E | | MI | 8287 | 3453 | 13734 | 2388 | 14601 | 1914 | 14912 | 1550 | 15190 | 996 | 17702 | 846 | 10524 |
| 6-#11 | 1.15 | MA | 11204 | 3217 | 17702 | 2365 | 19106 | 1926 | 19513 | 1601 | 19511 | 1132 | 22911 | 1058 | 9525 |
| 2L-3S | | MI | 7364 | 3217 | 11851 | 2282 | 12404 | 1864 | 12334 | 1542 | 11791 | 1077 | 13439 | 889 | 6570 |
| 6-#11 | 1.15 | MA | 10548 | 3217 | 16713 | 2363 | 17846 | 1935 | 17981 | 1609 | 17464 | 1139 | 20199 | 969 | 9563 |
| 3L-2S | | MI | 7788 | 3217 | 12494 | 2288 | 13210 | 1857 | 13294 | 1535 | 13060 | 1070 | 15080 | 978 | 6516 |
| 6-#14 | 1.65 | MA | 11774 | 3364 | 19004 | 2447 | 20722 | 1984 | 21462 | 1636 | 22057 | 1111 | 26248 | 1018 | 13474 |
| 2L-3S | | MI | 7537 | 3364 | 12416 | 2356 | 13053 | 1917 | 13093 | 1568 | 12791 | 1047 | 14705 | 787 | 9171 |
| 6-#14 | 1.65 | MA | 10847 | 3364 | 17592 | 2443 | 18922 | 1998 | 19274 | 1647 | 19151 | 1121 | 22407 | 890 | 13479 |
| 3L-2S | | MI | 8134 | 3364 | 13329 | 2366 | 14187 | 1907 | 14444 | 1558 | 14577 | 1037 | 17003 | 915 | 9110 |
| 6-#18 | 2.94 | MA | 13137 | 3737 | 22209 | 2661 | 24724 | 2137 | 26228 | 1722 | 28290 | 1056 | 34360 | 908 | 23184 |
| 2L-3S | | MI | 7942 | 3737 | 13734 | 2545 | 14601 | 2051 | 14912 | 1630 | 15190 | 964 | 17702 | 512 | 15318 |
| 6-#18 | 2.94 | MA | 11564 | 3737 | 19749 | 2651 | 21588 | 2158 | 22438 | 1740 | 23285 | 1073 | 27783 | 680 | 22900 |
| 3L-2S | | MI | 8950 | 3737 | 15283 | 2563 | 16518 | 2033 | 17196 | 1612 | 18209 | 946 | 21549 | 739 | 15374 |
| 8-#11 | 1.53 | MA | 11658 | 3328 | 18691 | 2434 | 20366 | 1976 | 21046 | 1632 | 21557 | 1123 | 25624 | 1037 | 12561 |
| 2L-4S | | MI | 7341 | 3328 | 11967 | 2359 | 12555 | 1906 | 12519 | 1563 | 12087 | 1069 | 14005 | 773 | 8591 |
| 8-#11 | 1.53 | MA | 11007 | 3328 | 17702 | 2432 | 19106 | 1986 | 19513 | 1641 | 19511 | 1130 | 22911 | 948 | 12578 |
| 3E | | MI | 7649 | 3328 | 12494 | 2351 | 13210 | 1913 | 13294 | 1570 | 13060 | 1062 | 15080 | 855 | 8563 |
| 8-#11 | 1.53 | MA | 10542 | 3328 | 16904 | 2444 | 18091 | 1982 | 18282 | 1635 | 17941 | 1137 | 21144 | 860 | 12523 |
| 4L-2S | | MI | 8071 | 3328 | 13136 | 2357 | 14016 | 1906 | 14254 | 1563 | 14329 | 1055 | 16721 | 944 | 8520 |
| 8-#14 | 2.21 | MA | 12408 | 3524 | 20415 | 2547 | 22522 | 2057 | 23650 | 1681 | 24963 | 1097 | 30089 | 986 | 17789 |
| 2L-4S | | MI | 7502 | 3524 | 12579 | 2466 | 13264 | 1976 | 13353 | 1596 | 13208 | 1032 | 15494 | 619 | 11560 |
| 8-#14 | 2.21 | MA | 11492 | 3524 | 19004 | 2543 | 20722 | 2070 | 21462 | 1692 | 22057 | 1107 | 26248 | 858 | 17742 |
| 3E | | MI | 7935 | 3524 | 13329 | 2456 | 14187 | 1986 | 14444 | 1606 | 14577 | 1023 | 17003 | 734 | 11964 |

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

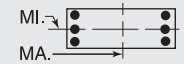



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.21 | MA | 10838 | 3524 | 17862 | 2559 | 19270 | 2063 | 19700 | 1683 | 19828 | 1117 | 23750 | 730 | 17106 |
| 4L-2S | | MI | 8527 | 3524 | 14242 | 2465 | 15321 | 1976 | 15796 | 1596 | 16363 | 1013 | 19301 | 862 | 11931 |
| 8-#18 | 3.92 | MA | 14200 | 4020 | 24669 | 2838 | 27859 | 2266 | 30018 | 1800 | 33296 | 1027 | 40936 | 842 | 30636 |
| 2L-4S | | MI | 7876 | 4020 | 14008 | 2737 | 14957 | 2152 | 15350 | 1675 | 15896 | 932 | 19012 | 208 | 17802 |
| 8-#18 | 3.92 | MA | 12652 | 4020 | 22209 | 2829 | 24724 | 2287 | 26228 | 1818 | 28290 | 1044 | 34360 | 614 | 30228 |
| 3E | | MI | 8609 | 4020 | 15283 | 2720 | 16518 | 2169 | 17196 | 1692 | 18209 | 914 | 21549 | 405 | 19756 |
| 8-#18 | 3.92 | MA | 11545 | 4020 | 20212 | 2854 | 22186 | 2272 | 23171 | 1800 | 24452 | 1062 | 30080 | 390 | 26805 |
| 4L-2S | | MI | 9605 | 4020 | 16832 | 2737 | 18434 | 2152 | 19481 | 1675 | 21229 | 896 | 25395 | 633 | 20177 |
| 10-#11 | 1.91 | MA | 12107 | 3439 | 19679 | 2504 | 21627 | 2026 | 22578 | 1664 | 23604 | 1114 | 28336 | 1016 | 15585 |
| 2L-5S | | MI | 7348 | 3439 | 12145 | 2422 | 12775 | 1962 | 12782 | 1597 | 12393 | 1046 | 14508 | 698 | 10113 |
| 10-#11 | 1.91 | MA | 11461 | 3439 | 18691 | 2501 | 20366 | 2036 | 21046 | 1672 | 21557 | 1121 | 25624 | 927 | 15578 |
| 3L-4S | | MI | 7626 | 3439 | 12610 | 2428 | 13361 | 1955 | 13479 | 1590 | 13356 | 1053 | 15646 | 739 | 10542 |
| 10-#11 | 1.91 | MA | 11001 | 3439 | 17892 | 2513 | 19351 | 2032 | 19814 | 1666 | 19987 | 1128 | 23856 | 839 | 15493 |
| 4L-3S | | MI | 7932 | 3439 | 13136 | 2420 | 14016 | 1962 | 14254 | 1597 | 14329 | 1046 | 16721 | 821 | 10540 |
| 10-#11 | 1.91 | MA | 10587 | 3439 | 17191 | 2510 | 18447 | 2042 | 18707 | 1674 | 18438 | 1121 | 21984 | 798 | 14771 |
| 5L-2S | | MI | 8351 | 3439 | 13779 | 2426 | 14822 | 1955 | 15215 | 1590 | 15597 | 1039 | 18362 | 910 | 10508 |
| 10-#14 | 2.76 | MA | 13035 | 3683 | 21827 | 2647 | 24322 | 2129 | 25838 | 1726 | 27869 | 1083 | 33929 | 953 | 22084 |
| 2L-5S | | MI | 7510 | 3683 | 12829 | 2556 | 13574 | 2055 | 13723 | 1644 | 13729 | 1018 | 16199 | 506 | 13570 |
| 10-#14 | 2.76 | MA | 12128 | 3683 | 20415 | 2643 | 22522 | 2142 | 23650 | 1736 | 24963 | 1093 | 30089 | 825 | 21993 |
| 3L-4S | | MI | 7900 | 3683 | 13492 | 2566 | 14399 | 2045 | 14704 | 1634 | 14994 | 1008 | 17792 | 566 | 14127 |
| 10-#14 | 2.76 | MA | 11482 | 3683 | 19273 | 2659 | 21070 | 2136 | 21888 | 1727 | 22734 | 1103 | 27591 | 697 | 21128 |
| 4L-3S | | MI | 8330 | 3683 | 14242 | 2556 | 15321 | 2055 | 15796 | 1644 | 16363 | 998 | 19301 | 681 | 14731 |
| 10-#14 | 2.76 | MA | 10901 | 3683 | 18269 | 2655 | 19776 | 2149 | 20304 | 1738 | 20534 | 1093 | 24933 | 640 | 20012 |
| 5L-2S | | MI | 8917 | 3683 | 15155 | 2565 | 16455 | 2045 | 17147 | 1634 | 18148 | 988 | 21599 | 809 | 14734 |
| 10-#18 | 4.90 | MA | 13723 | 4304 | 24669 | 3006 | 27859 | 2415 | 30018 | 1896 | 33296 | 1015 | 40936 | 548 | 37422 |
| 3L-4S | | MI | 8544 | 4304 | 15558 | 2912 | 16874 | 2270 | 17634 | 1737 | 18915 | 882 | 22858 | 102 | 22250 |
| 10-#18 | 4.90 | MA | 12634 | 4304 | 22672 | 3032 | 25322 | 2401 | 26961 | 1879 | 29457 | 1033 | 36656 | 324 | 33864 |
| 4L-3S | | MI | 9268 | 4304 | 16832 | 2894 | 18434 | 2288 | 19481 | 1755 | 21229 | 864 | 25395 | 299 | 24000 |
| 10-#18 | 4.90 | MA | 11657 | 4304 | 20914 | 3022 | 23056 | 2422 | 24210 | 1896 | 25665 | 1015 | 32096 | 222 | 30752 |
| 5L-2S | | MI | 10252 | 4304 | 18381 | 2912 | 20351 | 2270 | 21765 | 1737 | 24249 | 847 | 29241 | 526 | 24938 |
| 12-#11 | 2.29 | MA | 12551 | 3549 | 20668 | 2573 | 22887 | 2076 | 24110 | 1695 | 25651 | 1105 | 31048 | 995 | 18600 |
| 2L-6S | | MI | 7369 | 3549 | 12321 | 2499 | 12998 | 2003 | 13076 | 1631 | 12780 | 1037 | 15092 | 604 | 11669 |
| 12-#11 | 2.29 | MA | 11910 | 3549 | 19679 | 2570 | 21627 | 2086 | 22578 | 1703 | 23604 | 1112 | 28336 | 907 | 18569 |
| 3L-5S | | MI | 7633 | 3549 | 12787 | 2491 | 13581 | 2010 | 13742 | 1624 | 13662 | 1030 | 16149 | 664 | 11971 |
| 12-#11 | 2.29 | MA | 11454 | 3549 | 18881 | 2582 | 20612 | 2082 | 21346 | 1697 | 22034 | 1119 | 26569 | 818 | 18458 |
| 4E | | MI | 7909 | 3549 | 13253 | 2497 | 14167 | 2003 | 14439 | 1617 | 14625 | 1037 | 17287 | 705 | 12441 |
| 12-#11 | 2.29 | MA | 11045 | 3549 | 18179 | 2580 | 19708 | 2092 | 20239 | 1705 | 20485 | 1112 | 24697 | 777 | 17646 |
| 5L-3S | | MI | 8213 | 3549 | 13779 | 2489 | 14822 | 2010 | 15215 | 1624 | 15597 | 1030 | 18362 | 787 | 12505 |
| 12-#11 | 2.29 | MA | 10654 | 3549 | 17517 | 2577 | 18808 | 2088 | 19143 | 1700 | 19062 | 1119 | 22937 | 718 | 17151 |
| 6L-2S | | MI | 8629 | 3549 | 14422 | 2495 | 15628 | 2003 | 16175 | 1617 | 16866 | 1024 | 20003 | 876 | 12486 |
| 12-#14 | 3.31 | MA | 12756 | 3843 | 21827 | 2743 | 24322 | 2215 | 25838 | 1781 | 27869 | 1079 | 33929 | 793 | 26236 |
| 3L-5S | | MI | 7908 | 3843 | 13742 | 2656 | 14709 | 2124 | 15075 | 1682 | 15515 | 994 | 18497 | 453 | 16210 |
| 12-#14 | 3.31 | MA | 12117 | 3843 | 20685 | 2758 | 22870 | 2208 | 24076 | 1772 | 25640 | 1089 | 31431 | 665 | 25175 |
| 4E | | MI | 8295 | 3843 | 14405 | 2666 | 15533 | 2114 | 16056 | 1672 | 16780 | 984 | 20090 | 513 | 16716 |
| 12-#14 | 3.31 | MA | 11543 | 3843 | 19681 | 2754 | 21576 | 2221 | 22492 | 1783 | 23440 | 1079 | 28773 | 607 | 24129 |
| 5L-3S | | MI | 8721 | 3843 | 15155 | 2655 | 16455 | 2124 | 17147 | 1682 | 18148 | 974 | 21599 | 629 | 17485 |
| 12-#14 | 3.31 | MA | 10995 | 3843 | 18732 | 2750 | 20288 | 2215 | 20978 | 1794 | 21420 | 1089 | 26283 | 522 | 22625 |
| 6L-2S | | MI | 9303 | 3843 | 16068 | 2665 | 17589 | 2114 | 18499 | 1672 | 19934 | 964 | 23897 | 757 | 17525 |
| 12-#18 | 5.88 | MA | 13707 | 4588 | 25132 | 3209 | 28458 | 2529 | 30751 | 1957 | 34462 | 1004 | 43233 | 258 | 40959 |
| 4E | | MI | 9206 | 4588 | 17107 | 3086 | 18791 | 2389 | 19919 | 1800 | 21935 | 833 | 26704 | -5 | 26682 |
| 12-#18 | 5.88 | MA | 12745 | 4588 | 23374 | 3200 | 26192 | 2550 | 28000 | 1974 | 30670 | 986 | 38673 | 156 | 37690 |
| 5L-3S | | MI | 9922 | 4588 | 18381 | 3069 | 20351 | 2406 | 21765 | 1817 | 24249 | 815 | 29241 | 192 | 28303 |
| 14-#11 | 2.68 | MA | 12356 | 3660 | 20668 | 2640 | 22887 | 2136 | 24110 | 1734 | 25651 | 1103 | 31048 | 886 | 21554 |
| 3L-6S | | MI | 7654 | 3660 | 12964 | 2568 | 13804 | 2052 | 14037 | 1658 | 14049 | 1022 | 16733 | 569 | 13470 |
| 14-#11 | 2.68 | MA | 11904 | 3660 | 19869 | 2651 | 21872 | 2132 | 22878 | 1728 | 24081 | 1110 | 29281 | 797 | 21396 |
| 4L-5S | | MI | 7916 | 3660 | 13430 | 2560 | 14387 | 2059 | 14702 | 1651 | 14931 | 1015 | 17790 | 630 | 13837 |
| 14-#11 | 2.68 | MA | 11498 | 3660 | 19168 | 2649 | 20968 | 2142 | 21771 | 1736 | 22531 | 1103 | 27409 | 756 | 20530 |
| 5L-4S | | MI | 8189 | 3660 | 13896 | 2566 | 14973 | 2052 | 15399 | 1644 | 15894 | 1022 | 18927 | 671 | 14269 |


## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

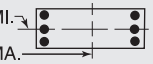


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.68 | MA | 11110 | 3660 | 18505 | 2646 | 20068 | 2138 | 20675 | 1731 | 21109 | 1110 | 25649 | 697 | 19971 |
| 6L-3S | | MI | 8491 | 3660 | 14422 | 2558 | 15628 | 2059 | 16175 | 1651 | 16866 | 1015 | 20003 | 753 | 14459 |
| 14-#11 | 2.68 | MA | 10732 | 3660 | 17796 | 2658 | 19204 | 2148 | 19616 | 1739 | 19716 | 1117 | 23815 | 609 | 19076 |
| 7L-2S | | MI | 8905 | 3660 | 15065 | 2564 | 16434 | 2052 | 17135 | 1644 | 18135 | 1008 | 21643 | 842 | 14455 |
| 14-#14 | 3.86 | MA | 12746 | 4002 | 22097 | 2858 | 24670 | 2280 | 26264 | 1817 | 28547 | 1075 | 35272 | 633 | 29241 |
| 4L-5S | | MI | 8303 | 4002 | 14655 | 2756 | 15843 | 2193 | 16426 | 1720 | 17301 | 970 | 20795 | 400 | 18738 |
| 14-#14 | 3.86 | MA | 12178 | 4002 | 21093 | 2854 | 23375 | 2294 | 24680 | 1828 | 26346 | 1065 | 32614 | 575 | 28258 |
| 5L-4S | | MI | 8686 | 4002 | 15318 | 2765 | 16667 | 2183 | 17407 | 1710 | 18565 | 960 | 22388 | 461 | 19322 |
| 14-#14 | 3.86 | MA | 11637 | 4002 | 20144 | 2850 | 22088 | 2287 | 23166 | 1839 | 24326 | 1075 | 30124 | 489 | 26674 |
| 6L-3S | | MI | 9109 | 4002 | 16068 | 2755 | 17589 | 2193 | 18499 | 1720 | 19934 | 950 | 23897 | 576 | 20230 |
| 14-#14 | 3.86 | MA | 11108 | 4002 | 19128 | 2866 | 20850 | 2301 | 21594 | 1830 | 22349 | 1085 | 27528 | 362 | 25152 |
| 7L-2S | | MI | 9687 | 4002 | 16981 | 2765 | 18724 | 2183 | 19850 | 1710 | 21720 | 940 | 26195 | 704 | 20297 |
| 14-#18 | 6.86 | MA | 13818 | 4871 | 25833 | 3377 | 29328 | 2679 | 31790 | 2053 | 35676 | 957 | 45249 | 90 | 44662 |
| 5L-4S | | MI | 9919 | 4871 | 18656 | 3261 | 20707 | 2507 | 22203 | 1862 | 24955 | 783 | 30550 | -111 | 29981 |
| 16-#11 | 3.06 | MA | 12349 | 3771 | 20858 | 2720 | 23132 | 2182 | 24411 | 1759 | 26127 | 1101 | 31994 | 776 | 24243 |
| 4L-6S | | MI | 7936 | 3771 | 13607 | 2637 | 14610 | 2101 | 14997 | 1685 | 15318 | 1006 | 18373 | 535 | 15281 |
| 16-#11 | 3.06 | MA | 11947 | 3771 | 20157 | 2718 | 22228 | 2192 | 23304 | 1768 | 24578 | 1094 | 30121 | 735 | 23423 |
| 5E | | MI | 8196 | 3771 | 14073 | 2629 | 15193 | 2108 | 15663 | 1679 | 16200 | 999 | 19431 | 596 | 15709 |
| 16-#11 | 3.06 | MA | 11562 | 3771 | 19494 | 2715 | 21329 | 2188 | 22207 | 1762 | 23155 | 1101 | 28362 | 676 | 22802 |
| 6L-4S | | MI | 8468 | 3771 | 14538 | 2635 | 15779 | 2101 | 16360 | 1672 | 17162 | 1006 | 20568 | 637 | 16109 |
| 16-#11 | 3.06 | MA | 11187 | 3771 | 18785 | 2727 | 20465 | 2198 | 21148 | 1770 | 21763 | 1108 | 26528 | 588 | 21941 |
| 7L-3S | | MI | 8768 | 3771 | 15065 | 2627 | 16434 | 2108 | 17135 | 1679 | 18135 | 999 | 21643 | 719 | 16405 |
| 16-#11 | 3.06 | MA | 10818 | 3771 | 18134 | 2725 | 19593 | 2194 | 20111 | 1778 | 20303 | 1101 | 24779 | 540 | 20982 |
| 8L-2S | | MI | 9179 | 3771 | 15708 | 2633 | 17240 | 2101 | 18095 | 1672 | 19404 | 992 | 23284 | 807 | 16420 |
| 16-#14 | 4.41 | MA | 12807 | 4162 | 22504 | 2954 | 25175 | 2366 | 26868 | 1873 | 29252 | 1051 | 36454 | 542 | 32396 |
| 5E | | MI | 8695 | 4162 | 15568 | 2856 | 16977 | 2262 | 17777 | 1757 | 19087 | 945 | 23093 | 348 | 21265 |
| 16-#14 | 4.41 | MA | 12271 | 4162 | 21555 | 2950 | 23888 | 2359 | 25354 | 1884 | 27232 | 1061 | 33965 | 457 | 30735 |
| 6L-4S | | MI | 9075 | 4162 | 16231 | 2865 | 17801 | 2252 | 18758 | 1748 | 20351 | 935 | 24686 | 408 | 21942 |
| 16-#14 | 4.41 | MA | 11748 | 4162 | 20540 | 2966 | 22650 | 2373 | 23782 | 1875 | 25255 | 1071 | 31369 | 330 | 29162 |
| 7L-3S | | MI | 9494 | 4162 | 16981 | 2855 | 18724 | 2262 | 19850 | 1757 | 21720 | 925 | 26195 | 523 | 22968 |
| 18-#11 | 3.44 | MA | 12392 | 3881 | 21145 | 2787 | 23489 | 2242 | 24836 | 1799 | 26625 | 1085 | 32834 | 714 | 26322 |
| 5L-6S | | MI | 8216 | 3881 | 14249 | 2706 | 15416 | 2150 | 15957 | 1713 | 16587 | 991 | 20014 | 501 | 17101 |
| 18-#11 | 3.44 | MA | 12011 | 3881 | 20482 | 2785 | 22589 | 2238 | 23739 | 1793 | 25202 | 1092 | 31074 | 655 | 25641 |
| 6L-5S | | MI | 8475 | 3881 | 14716 | 2699 | 15999 | 2156 | 16623 | 1706 | 17469 | 984 | 21071 | 562 | 17586 |
| 18-#11 | 3.44 | MA | 11639 | 3881 | 19773 | 2796 | 21725 | 2248 | 22680 | 1801 | 23809 | 1099 | 29240 | 567 | 24814 |
| 7L-4S | | MI | 8745 | 3881 | 15181 | 2704 | 16585 | 2150 | 17320 | 1699 | 18431 | 991 | 22209 | 603 | 17957 |
| 18-#11 | 3.44 | MA | 11272 | 3881 | 19122 | 2794 | 20853 | 2244 | 21643 | 1809 | 22350 | 1092 | 27492 | 519 | 23819 |
| 8L-3S | | MI | 9043 | 3881 | 15708 | 2697 | 17240 | 2156 | 18095 | 1706 | 19404 | 984 | 23284 | 685 | 18347 |
| 18-#14 | 4.96 | MA | 12899 | 4322 | 22967 | 3050 | 25687 | 2432 | 27542 | 1929 | 30138 | 1047 | 37805 | 425 | 34809 |
| 6L-5S | | MI | 9084 | 4322 | 16481 | 2955 | 18111 | 2331 | 19129 | 1795 | 20873 | 921 | 25391 | 295 | 23808 |
| 18-#14 | 4.96 | MA | 12382 | 4322 | 21952 | 3065 | 24450 | 2445 | 25970 | 1920 | 28161 | 1057 | 35210 | 298 | 33183 |
| 7L-4S | | MI | 9461 | 4322 | 17144 | 2965 | 18935 | 2321 | 20110 | 1785 | 22137 | 911 | 26984 | 355 | 24573 |
| 20-#11 | 3.82 | MA | 12456 | 3992 | 21471 | 2854 | 23850 | 2288 | 25271 | 1824 | 27249 | 1083 | 33786 | 634 | 28488 |
| 6E | | MI | 8495 | 3992 | 14892 | 2776 | 16222 | 2198 | 16917 | 1740 | 17856 | 975 | 21655 | 467 | 18929 |
| 20-#11 | 3.82 | MA | 12087 | 3992 | 20762 | 2865 | 22985 | 2298 | 24212 | 1832 | 25856 | 1090 | 31953 | 546 | 27692 |
| 7L-5S | | MI | 8752 | 3992 | 15359 | 2768 | 16805 | 2205 | 17583 | 1733 | 18737 | 968 | 22712 | 528 | 19467 |
| 20-#11 | 3.82 | MA | 11723 | 3992 | 20111 | 2863 | 22113 | 2294 | 23176 | 1841 | 24397 | 1083 | 30204 | 498 | 26662 |
| 8L-4S | | MI | 9020 | 3992 | 15824 | 2774 | 17391 | 2198 | 18280 | 1726 | 19700 | 975 | 23850 | 569 | 19812 |
| 20-#14 | 5.51 | MA | 13009 | 4481 | 23364 | 3165 | 26250 | 2517 | 28158 | 1965 | 31067 | 1043 | 39050 | 265 | 37216 |
| 7L-5S | | MI | 9470 | 4481 | 17394 | 3055 | 19245 | 2400 | 20480 | 1833 | 22658 | 897 | 27689 | 242 | 26365 |
| 22-#11 | 4.21 | MA | 12531 | 4103 | 21751 | 2934 | 24246 | 2348 | 25745 | 1864 | 27903 | 1081 | 34665 | 526 | 30575 |
| 7L-6S | | MI | 8772 | 4102 | 15535 | 2845 | 17028 | 2247 | 17878 | 1767 | 19125 | 959 | 23296 | 433 | 20764 |
| 22-#11 | 4.21 | MA | 12170 | 4103 | 21100 | 2932 | 23374 | 2344 | 24708 | 1872 | 26443 | 1074 | 32916 | 478 | 29511 |
| 8L-5S | | MI | 9027 | 4103 | 16001 | 2837 | 17611 | 2254 | 18543 | 1760 | 20006 | 952 | 24353 | 493 | 21350 |
| 24-#11 | 4.59 | MA | 12615 | 4213 | 22088 | 3001 | 24634 | 2394 | 26240 | 1903 | 28490 | 1066 | 35629 | 457 | 32366 |
| 8L-6S | | MI | 9048 | 4213 | 16178 | 2914 | 17834 | 2296 | 18838 | 1795 | 20393 | 944 | 24937 | 399 | 22604 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

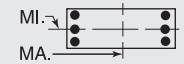
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.04 | MA | 12423 | 3374 | 19540 | 2485 | 21035 | 2025 | 21411 | 1687 | 21257 | 1202 | 24872 | 1127 | 9742 |
| 2E | | MI | 8144 | 3374 | 13039 | 2387 | 13687 | 1938 | 13704 | 1605 | 13333 | 1126 | 15300 | 1031 | 6286 |
| 4-#18 | 1.85 | MA | 13426 | 3623 | 21858 | 2621 | 23900 | 2122 | 24859 | 1743 | 25736 | 1164 | 30723 | 1055 | 16764 |
| 2E | | MI | 8696 | 3623 | 14360 | 2508 | 15234 | 2013 | 15520 | 1633 | 15728 | 1060 | 18291 | 908 | 10568 |
| 6-#11 | 1.08 | MA | 12501 | 3387 | 19655 | 2503 | 21228 | 2039 | 21664 | 1698 | 21636 | 1209 | 25404 | 1135 | 10157 |
| 2L-3S | | MI | 7772 | 3387 | 12472 | 2404 | 13039 | 1965 | 12946 | 1628 | 12335 | 1143 | 14037 | 953 | 6599 |
| 6-#11 | 1.08 | MA | 11797 | 3387 | 18597 | 2501 | 19880 | 2049 | 20025 | 1706 | 19433 | 1216 | 22476 | 1046 | 10195 |
| 3L-2S | | MI | 8196 | 3387 | 13115 | 2410 | 13845 | 1958 | 13907 | 1621 | 13604 | 1136 | 15678 | 1041 | 6544 |
| 6-#14 | 1.56 | MA | 13117 | 3534 | 21051 | 2585 | 22962 | 2098 | 23754 | 1732 | 24388 | 1189 | 29023 | 1098 | 14385 |
| 2L-3S | | MI | 7944 | 3534 | 13039 | 2478 | 13687 | 2017 | 13704 | 1653 | 13333 | 1112 | 15300 | 850 | 9211 |
| 6-#14 | 1.56 | MA | 12122 | 3534 | 19540 | 2582 | 21035 | 2112 | 21411 | 1744 | 21257 | 1199 | 24872 | 970 | 14390 |
| 3L-2S | | MI | 8542 | 3534 | 13952 | 2487 | 14821 | 2007 | 15056 | 1643 | 15119 | 1102 | 17598 | 978 | 9145 |
| 6-#18 | 2.78 | MA | 14596 | 3906 | 24495 | 2799 | 27262 | 2250 | 28946 | 1823 | 31141 | 1138 | 37849 | 995 | 24804 |
| 2L-3S | | MI | 8349 | 3906 | 14360 | 2665 | 15234 | 2149 | 15520 | 1714 | 15728 | 1028 | 18291 | 574 | 15400 |
| 6-#18 | 2.78 | MA | 12904 | 3906 | 21858 | 2791 | 23900 | 2273 | 24859 | 1841 | 25736 | 1155 | 30723 | 767 | 24520 |
| 3L-2S | | MI | 9360 | 3906 | 15909 | 2683 | 17151 | 2132 | 17805 | 1696 | 18748 | 1010 | 22137 | 801 | 15426 |
| 8-#11 | 1.44 | MA | 12990 | 3498 | 20712 | 2572 | 22577 | 2089 | 23303 | 1729 | 23839 | 1201 | 28332 | 1115 | 13403 |
| 2L-4S | | MI | 7748 | 3498 | 12589 | 2481 | 13189 | 2007 | 13131 | 1648 | 12631 | 1134 | 14603 | 837 | 8633 |
| 8-#11 | 1.44 | MA | 12292 | 3498 | 19655 | 2570 | 21228 | 2100 | 21664 | 1738 | 21636 | 1208 | 25404 | 1027 | 13421 |
| 3E | | MI | 8057 | 3498 | 13115 | 2473 | 13845 | 2014 | 13907 | 1655 | 13604 | 1127 | 15678 | 919 | 8597 |
| 8-#11 | 1.44 | MA | 11795 | 3498 | 18802 | 2582 | 20145 | 2096 | 20349 | 1733 | 19946 | 1214 | 23493 | 938 | 13365 |
| 4L-2S | | MI | 8479 | 3498 | 13758 | 2479 | 14651 | 2007 | 14867 | 1648 | 14873 | 1120 | 17318 | 1007 | 8551 |
| 8-#14 | 2.08 | MA | 13802 | 3693 | 22562 | 2685 | 24889 | 2170 | 26096 | 1777 | 27519 | 1177 | 33174 | 1068 | 19004 |
| 2L-4S | | MI | 7909 | 3693 | 13202 | 2588 | 13899 | 2076 | 13964 | 1681 | 13750 | 1098 | 16089 | 682 | 11719 |
| 8-#14 | 2.08 | MA | 12818 | 3693 | 21051 | 2682 | 22962 | 2184 | 23754 | 1789 | 24388 | 1187 | 29023 | 940 | 18957 |
| 3E | | MI | 8344 | 3693 | 13952 | 2577 | 14821 | 2086 | 15056 | 1691 | 15119 | 1088 | 17598 | 797 | 12012 |
| 8-#14 | 2.08 | MA | 12118 | 3693 | 19831 | 2698 | 21411 | 2179 | 21871 | 1781 | 21986 | 1197 | 26318 | 812 | 18450 |
| 4L-2S | | MI | 8936 | 3693 | 14865 | 2587 | 15956 | 2076 | 16407 | 1681 | 16905 | 1078 | 19896 | 925 | 11971 |
| 8-#18 | 3.70 | MA | 15745 | 4190 | 27132 | 2976 | 30624 | 2379 | 33033 | 1903 | 36546 | 1111 | 44976 | 934 | 32796 |
| 2L-4S | | MI | 8282 | 4190 | 14634 | 2857 | 15590 | 2250 | 15958 | 1758 | 16434 | 996 | 19600 | 271 | 18016 |
| 8-#18 | 3.70 | MA | 14080 | 4190 | 24495 | 2968 | 27262 | 2402 | 28946 | 1921 | 31141 | 1129 | 37849 | 706 | 32388 |
| 3E | | MI | 9018 | 4190 | 15909 | 2839 | 17151 | 2268 | 17805 | 1776 | 18748 | 979 | 22137 | 467 | 20041 |
| 8-#18 | 3.70 | MA | 12893 | 4190 | 22359 | 2995 | 24546 | 2389 | 25652 | 1904 | 26996 | 1146 | 33219 | 479 | 28919 |
| 4L-2S | | MI | 10016 | 4190 | 17458 | 2857 | 19068 | 2250 | 20089 | 1758 | 21767 | 961 | 25983 | 695 | 20239 |
| 10-#11 | 1.81 | MA | 13475 | 3608 | 21770 | 2642 | 23926 | 2139 | 24943 | 1760 | 26042 | 1193 | 31260 | 1096 | 16638 |
| 2L-5S | | MI | 7755 | 3608 | 12766 | 2544 | 13410 | 2062 | 13394 | 1682 | 12938 | 1112 | 15106 | 761 | 10222 |
| 10-#11 | 1.81 | MA | 12781 | 3608 | 20712 | 2640 | 22577 | 2150 | 23303 | 1769 | 23839 | 1199 | 28332 | 1007 | 16631 |
| 3L-4S | | MI | 8034 | 3608 | 13231 | 2550 | 13995 | 2055 | 14091 | 1675 | 13900 | 1119 | 16243 | 803 | 10592 |
| 10-#11 | 1.81 | MA | 12289 | 3608 | 19860 | 2652 | 21493 | 2146 | 21988 | 1764 | 22149 | 1206 | 26421 | 919 | 16546 |
| 4L-3S | | MI | 8340 | 3608 | 13758 | 2542 | 14651 | 2062 | 14867 | 1682 | 14873 | 1112 | 17318 | 884 | 10578 |
| 10-#11 | 1.81 | MA | 11847 | 3608 | 19111 | 2650 | 20528 | 2157 | 20806 | 1773 | 20482 | 1199 | 24405 | 877 | 15855 |
| 5L-2S | | MI | 8760 | 3608 | 14401 | 2548 | 15457 | 2055 | 15827 | 1675 | 16142 | 1105 | 18959 | 973 | 10543 |
| 10-#14 | 2.60 | MA | 14479 | 3853 | 24074 | 2785 | 26816 | 2242 | 28439 | 1822 | 30651 | 1164 | 37325 | 1038 | 23602 |
| 2L-5S | | MI | 7917 | 3853 | 13452 | 2678 | 14209 | 2155 | 14334 | 1729 | 14272 | 1083 | 16793 | 569 | 13708 |
| 10-#14 | 2.60 | MA | 13505 | 3853 | 22562 | 2781 | 24889 | 2257 | 26096 | 1834 | 27519 | 1174 | 33174 | 910 | 23512 |
| 3L-4S | | MI | 8308 | 3853 | 14115 | 2687 | 15033 | 2145 | 15315 | 1719 | 15536 | 1073 | 18387 | 629 | 14283 |
| 10-#14 | 2.60 | MA | 12813 | 3853 | 21342 | 2798 | 23338 | 2251 | 24214 | 1826 | 25117 | 1184 | 30469 | 782 | 22761 |
| 4L-3S | | MI | 8739 | 3853 | 14865 | 2677 | 15956 | 2155 | 16407 | 1729 | 16905 | 1064 | 19896 | 745 | 14787 |
| 10-#14 | 2.60 | MA | 12191 | 3853 | 20270 | 2795 | 21956 | 2265 | 22522 | 1838 | 22747 | 1174 | 27605 | 723 | 21494 |
| 5L-2S | | MI | 9327 | 3853 | 15778 | 2687 | 17090 | 2145 | 17758 | 1719 | 18691 | 1054 | 22194 | 873 | 14778 |
| 10-#18 | 4.63 | MA | 15237 | 4474 | 27132 | 3145 | 30624 | 2530 | 33033 | 2001 | 36546 | 1102 | 44976 | 646 | 40250 |
| 3L-4S | | MI | 8951 | 4474 | 16183 | 3032 | 17507 | 2369 | 18243 | 1821 | 19454 | 947 | 23446 | 164 | 22461 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

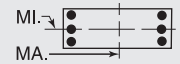


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 4.63 | MA | 14070 | 4474 | 24996 | 3172 | 27908 | 2518 | 29739 | 1984 | 32400 | 1120 | 40346 | 418 | 36498 |
| 4L-3S | | MI | 9678 | 4474 | 17458 | 3014 | 19068 | 2386 | 20089 | 1839 | 21767 | 929 | 25983 | 361 | 24279 |
| 10-#18 | 4.63 | MA | 13022 | 4474 | 23117 | 3164 | 25486 | 2540 | 26774 | 2002 | 28307 | 1102 | 35404 | 317 | 33345 |
| 5L-2S | | MI | 10666 | 4474 | 19007 | 3032 | 20984 | 2369 | 22374 | 1821 | 24787 | 911 | 29829 | 589 | 25007 |
| 12-#11 | 2.17 | MA | 13954 | 3719 | 22828 | 2711 | 25274 | 2190 | 26582 | 1791 | 28245 | 1184 | 34188 | 1077 | 19864 |
| 2L-6S | | MI | 7776 | 3719 | 12942 | 2621 | 13632 | 2104 | 13689 | 1716 | 13325 | 1103 | 15689 | 667 | 11847 |
| 12-#11 | 2.17 | MA | 13266 | 3719 | 21770 | 2709 | 23926 | 2200 | 24943 | 1800 | 26042 | 1191 | 31260 | 988 | 19833 |
| 3L-5S | | MI | 8040 | 3719 | 13409 | 2613 | 14216 | 2111 | 14355 | 1710 | 14206 | 1096 | 16746 | 727 | 12080 |
| 12-#11 | 2.17 | MA | 12778 | 3719 | 20918 | 2721 | 22842 | 2196 | 23627 | 1795 | 24352 | 1198 | 29349 | 900 | 19722 |
| 4E | | MI | 8317 | 3719 | 13874 | 2619 | 14801 | 2104 | 15052 | 1703 | 15169 | 1103 | 17884 | 769 | 12538 |
| 12-#11 | 2.17 | MA | 12340 | 3719 | 20169 | 2719 | 21876 | 2207 | 22445 | 1804 | 22685 | 1191 | 27333 | 858 | 18934 |
| 5L-3S | | MI | 8622 | 3719 | 14401 | 2611 | 15457 | 2111 | 15827 | 1710 | 16142 | 1096 | 18959 | 850 | 12547 |
| 12-#11 | 2.17 | MA | 11922 | 3719 | 19462 | 2717 | 20917 | 2203 | 21275 | 1799 | 21154 | 1198 | 25432 | 799 | 18394 |
| 6L-2S | | MI | 9038 | 3719 | 15044 | 2617 | 16263 | 2104 | 16787 | 1703 | 17411 | 1089 | 20600 | 939 | 12523 |
| 12-#14 | 3.13 | MA | 14183 | 4013 | 24074 | 2881 | 26816 | 2329 | 28439 | 1879 | 30651 | 1161 | 37325 | 880 | 28058 |
| 3L-5S | | MI | 8315 | 4013 | 14365 | 2778 | 15343 | 2224 | 15686 | 1766 | 16057 | 1059 | 19091 | 516 | 16348 |
| 12-#14 | 3.13 | MA | 13499 | 4013 | 22854 | 2898 | 25265 | 2323 | 26556 | 1871 | 28249 | 1171 | 34620 | 752 | 27098 |
| 4E | | MI | 8703 | 4013 | 15028 | 2787 | 16167 | 2214 | 16667 | 1757 | 17322 | 1049 | 20685 | 576 | 16870 |
| 12-#14 | 3.13 | MA | 12884 | 4013 | 21782 | 2894 | 23883 | 2337 | 24864 | 1883 | 25878 | 1161 | 31756 | 693 | 25907 |
| 5L-3S | | MI | 9131 | 4013 | 15778 | 2777 | 17090 | 2224 | 17758 | 1766 | 18691 | 1039 | 22194 | 692 | 17547 |
| 12-#14 | 3.13 | MA | 12298 | 4013 | 20769 | 2891 | 22508 | 2332 | 23188 | 1875 | 23701 | 1171 | 29062 | 608 | 24412 |
| 6L-2S | | MI | 9714 | 4013 | 16691 | 2786 | 18224 | 2214 | 19110 | 1757 | 20477 | 1029 | 24492 | 820 | 17571 |
| 12-#18 | 5.56 | MA | 15228 | 4757 | 27633 | 3350 | 31270 | 2646 | 33826 | 2064 | 37805 | 1093 | 47473 | 357 | 44115 |
| 4E | | MI | 9613 | 4757 | 17732 | 3206 | 19424 | 2487 | 20527 | 1883 | 22473 | 897 | 27292 | 58 | 26939 |
| 12-#18 | 5.56 | MA | 14197 | 4757 | 25754 | 3342 | 28848 | 2669 | 30861 | 2082 | 33712 | 1076 | 42531 | 256 | 40805 |
| 5L-3S | | MI | 10333 | 4757 | 19007 | 3189 | 20984 | 2505 | 22374 | 1901 | 24787 | 879 | 29829 | 255 | 28576 |
| 12-#18 | 5.56 | MA | 13214 | 4757 | 23977 | 3334 | 26439 | 2656 | 28028 | 2100 | 29955 | 1093 | 37914 | 104 | 37418 |
| 6L-2S | | MI | 11310 | 4757 | 20556 | 3206 | 22901 | 2487 | 24658 | 1883 | 27807 | 862 | 33676 | 482 | 29753 |
| 14-#11 | 2.53 | MA | 13747 | 3830 | 22828 | 2778 | 25274 | 2250 | 26582 | 1831 | 28245 | 1183 | 34188 | 969 | 23029 |
| 3L-6S | | MI | 8060 | 3830 | 13585 | 2690 | 14438 | 2153 | 14649 | 1744 | 14594 | 1087 | 17330 | 633 | 13645 |
| 14-#11 | 2.53 | MA | 13263 | 3830 | 21975 | 2790 | 24190 | 2247 | 25266 | 1826 | 26555 | 1190 | 32277 | 880 | 22895 |
| 4L-5S | | MI | 8323 | 3830 | 14052 | 2683 | 15022 | 2160 | 15315 | 1737 | 15475 | 1081 | 18387 | 693 | 13946 |
| 14-#11 | 2.53 | MA | 12829 | 3830 | 21227 | 2788 | 23225 | 2257 | 24085 | 1835 | 24888 | 1183 | 30261 | 839 | 22022 |
| 5L-4S | | MI | 8598 | 3830 | 14517 | 2689 | 15607 | 2153 | 16012 | 1730 | 16438 | 1087 | 19525 | 735 | 14396 |
| 14-#11 | 2.53 | MA | 12414 | 3830 | 20520 | 2786 | 22265 | 2254 | 22914 | 1830 | 23356 | 1190 | 28360 | 780 | 21508 |
| 6L-3S | | MI | 8901 | 3830 | 15044 | 2681 | 16263 | 2160 | 16787 | 1737 | 17411 | 1081 | 20600 | 816 | 14509 |
| 14-#11 | 2.53 | MA | 12010 | 3830 | 19763 | 2798 | 21343 | 2264 | 21785 | 1839 | 21858 | 1197 | 26380 | 692 | 20517 |
| 7L-2S | | MI | 9315 | 3830 | 15686 | 2687 | 17069 | 2153 | 17748 | 1730 | 18679 | 1074 | 22241 | 905 | 14495 |
| 14-#14 | 3.65 | MA | 14177 | 4172 | 24365 | 2997 | 27192 | 2395 | 28899 | 1916 | 31380 | 1158 | 38772 | 722 | 31456 |
| 4L-5S | | MI | 8711 | 4172 | 15278 | 2877 | 16477 | 2293 | 17037 | 1804 | 17843 | 1035 | 21389 | 463 | 18983 |
| 14-#14 | 3.65 | MA | 13570 | 4172 | 23293 | 2994 | 25810 | 2410 | 27207 | 1927 | 29010 | 1148 | 35907 | 663 | 30331 |
| 5L-4S | | MI | 9095 | 4172 | 15941 | 2887 | 17301 | 2283 | 18018 | 1794 | 19108 | 1025 | 22983 | 524 | 19475 |
| 14-#14 | 3.65 | MA | 12990 | 4172 | 22280 | 2991 | 24435 | 2404 | 25530 | 1919 | 26833 | 1158 | 33214 | 578 | 28755 |
| 6L-3S | | MI | 9520 | 4172 | 16691 | 2877 | 18224 | 2293 | 19110 | 1804 | 20477 | 1015 | 24492 | 639 | 20297 |
| 14-#14 | 3.65 | MA | 12424 | 4172 | 21196 | 3007 | 23114 | 2418 | 23912 | 1931 | 24702 | 1168 | 30407 | 451 | 27232 |
| 7L-2S | | MI | 10099 | 4172 | 17604 | 2886 | 19358 | 2283 | 20461 | 1794 | 22262 | 1005 | 26790 | 767 | 20350 |
| 14-#18 | 6.48 | MA | 15356 | 5041 | 28391 | 3519 | 32210 | 2797 | 34948 | 2161 | 39117 | 1049 | 49658 | 195 | 48298 |
| 5L-4S | | MI | 10330 | 5041 | 19281 | 3381 | 21341 | 2606 | 22811 | 1946 | 25493 | 847 | 31139 | -49 | 30876 |
| 14-#18 | 6.48 | MA | 14388 | 5041 | 26614 | 3511 | 29801 | 2785 | 32115 | 2180 | 35359 | 1067 | 45040 | 43 | 44825 |
| 6L-3S | | MI | 11023 | 5041 | 20556 | 3363 | 22901 | 2624 | 24658 | 1964 | 27807 | 830 | 33676 | 148 | 32920 |
| 16-#11 | 2.89 | MA | 13743 | 3940 | 23033 | 2859 | 25539 | 2297 | 26906 | 1857 | 28758 | 1182 | 35205 | 861 | 26060 |
| 4L-6S | | MI | 8343 | 3940 | 14228 | 2760 | 15244 | 2201 | 15609 | 1771 | 15862 | 1072 | 18971 | 599 | 15454 |
| 16-#11 | 2.89 | MA | 13313 | 3940 | 22285 | 2857 | 24573 | 2307 | 25724 | 1866 | 27091 | 1175 | 33189 | 819 | 25119 |
| 5E | | MI | 8604 | 3940 | 14695 | 2752 | 15828 | 2208 | 16275 | 1764 | 16744 | 1065 | 20028 | 659 | 15818 |
| 16-#11 | 2.89 | MA | 12902 | 3940 | 21578 | 2855 | 23614 | 2304 | 24554 | 1861 | 25559 | 1182 | 31288 | 761 | 24563 |
| 6L-4S | | MI | 8877 | 3940 | 15160 | 2758 | 16413 | 2201 | 16972 | 1757 | 17707 | 1072 | 21166 | 701 | 16234 |
| 16-#11 | 2.89 | MA | 12501 | 3940 | 20821 | 2867 | 22692 | 2314 | 23424 | 1870 | 24061 | 1189 | 29308 | 673 | 23587 |
| 7L-3S | | MI | 9178 | 3940 | 15686 | 2750 | 17069 | 2208 | 17748 | 1764 | 18679 | 1065 | 22241 | 782 | 16457 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

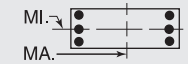
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.89 | MA | 12106 | 3940 | 20127 | 2865 | 21761 | 2311 | 22318 | 1879 | 22490 | 1182 | 27425 | 624 | 22641 |
| 8L-2S | | MI | 9590 | 3940 | 16329 | 2756 | 17875 | 2201 | 18708 | 1757 | 19948 | 1058 | 23882 | 871 | 16462 |
| 16-#14 | 4.17 | MA | 14248 | 4332 | 24804 | 3094 | 27736 | 2482 | 29549 | 1972 | 32141 | 1136 | 40058 | 633 | 34766 |
| 5E | | MI | 9103 | 4332 | 16191 | 2977 | 17611 | 2362 | 18389 | 1842 | 19629 | 1011 | 23688 | 411 | 21506 |
| 16-#14 | 4.17 | MA | 13674 | 4332 | 23792 | 3091 | 26362 | 2476 | 27873 | 1964 | 29964 | 1146 | 37365 | 548 | 33111 |
| 6L-4S | | MI | 9484 | 4332 | 16854 | 2987 | 18435 | 2352 | 19370 | 1832 | 20894 | 1001 | 25281 | 471 | 22094 |
| 16-#14 | 4.17 | MA | 13115 | 4332 | 22708 | 3107 | 25041 | 2491 | 26255 | 1976 | 27834 | 1156 | 34558 | 421 | 31536 |
| 7L-3S | | MI | 9906 | 4332 | 17604 | 2976 | 19358 | 2362 | 20461 | 1842 | 22262 | 991 | 26790 | 587 | 23039 |
| 16-#14 | 4.17 | MA | 12563 | 4332 | 21713 | 3104 | 23708 | 2485 | 24670 | 1988 | 25601 | 1146 | 31883 | 352 | 29891 |
| 8L-2S | | MI | 10481 | 4332 | 18517 | 2986 | 20492 | 2352 | 21813 | 1832 | 24048 | 981 | 29088 | 715 | 23117 |
| 16-#18 | 7.41 | MA | 15547 | 5325 | 29251 | 3688 | 33163 | 2913 | 36202 | 2259 | 40764 | 1040 | 52167 | -18 | 52035 |
| 6L-4S | | MI | 10978 | 5325 | 20830 | 3556 | 23257 | 2724 | 25096 | 2008 | 28513 | 798 | 34985 | -155 | 34127 |
| 18-#11 | 3.25 | MA | 13793 | 4051 | 23342 | 2926 | 25922 | 2357 | 27363 | 1897 | 29294 | 1167 | 36117 | 800 | 28223 |
| 5L-6S | | MI | 8624 | 4051 | 14871 | 2829 | 16050 | 2250 | 16570 | 1798 | 17131 | 1056 | 20612 | 565 | 17273 |
| 18-#11 | 3.25 | MA | 13385 | 4051 | 22635 | 2924 | 24962 | 2354 | 26193 | 1892 | 27762 | 1174 | 34216 | 741 | 27605 |
| 6L-5S | | MI | 8883 | 4051 | 15337 | 2821 | 16634 | 2257 | 17235 | 1791 | 18013 | 1049 | 21669 | 625 | 17695 |
| 18-#11 | 3.25 | MA | 12988 | 4051 | 21879 | 2936 | 24040 | 2364 | 25063 | 1901 | 26263 | 1181 | 32236 | 654 | 26664 |
| 7L-4S | | MI | 9155 | 4051 | 15803 | 2827 | 17219 | 2250 | 17933 | 1784 | 18976 | 1056 | 22807 | 666 | 18082 |
| 18-#11 | 3.25 | MA | 12596 | 4051 | 21185 | 2934 | 23110 | 2361 | 23957 | 1910 | 24693 | 1174 | 30353 | 605 | 25682 |
| 8L-3S | | MI | 9454 | 4051 | 16329 | 2819 | 17875 | 2257 | 18708 | 1791 | 19948 | 1049 | 23882 | 748 | 18401 |
| 18-#11 | 3.25 | MA | 12207 | 4051 | 20450 | 2946 | 22201 | 2371 | 22813 | 1905 | 23209 | 1181 | 28511 | 548 | 24700 |
| 9L-2S | | MI | 9864 | 4051 | 16972 | 2825 | 18681 | 2250 | 19668 | 1784 | 21217 | 1042 | 25522 | 837 | 18423 |
| 18-#14 | 4.69 | MA | 14352 | 4491 | 25303 | 3190 | 28289 | 2549 | 30215 | 2009 | 33095 | 1133 | 41516 | 519 | 37479 |
| 6L-5S | | MI | 9492 | 4491 | 17104 | 3077 | 18745 | 2431 | 19740 | 1880 | 21415 | 986 | 25986 | 358 | 24046 |
| 18-#14 | 4.69 | MA | 13798 | 4491 | 24219 | 3207 | 26968 | 2563 | 28597 | 2021 | 30965 | 1143 | 38709 | 392 | 35852 |
| 7L-4S | | MI | 9871 | 4491 | 17767 | 3086 | 19570 | 2421 | 20721 | 1870 | 22679 | 976 | 27579 | 418 | 24724 |
| 18-#14 | 4.69 | MA | 13252 | 4491 | 23224 | 3204 | 25635 | 2557 | 27013 | 2033 | 28732 | 1133 | 36034 | 322 | 34045 |
| 8L-3S | | MI | 10289 | 4491 | 18517 | 3076 | 20492 | 2431 | 21813 | 1880 | 24048 | 966 | 29088 | 534 | 25776 |
| 20-#11 | 3.61 | MA | 13865 | 4162 | 23693 | 2994 | 26311 | 2404 | 27832 | 1923 | 29965 | 1166 | 37144 | 722 | 30655 |
| 6E | | MI | 8903 | 4162 | 15514 | 2898 | 16856 | 2299 | 17530 | 1826 | 18400 | 1041 | 22253 | 531 | 19099 |
| 20-#11 | 3.61 | MA | 13470 | 4162 | 22937 | 3005 | 25389 | 2414 | 26703 | 1932 | 28466 | 1173 | 35164 | 634 | 29747 |
| 7L-5S | | MI | 9161 | 4162 | 15980 | 2890 | 17440 | 2306 | 18196 | 1819 | 19282 | 1034 | 23310 | 591 | 19576 |
| 20-#11 | 3.61 | MA | 13082 | 4162 | 22242 | 3004 | 24458 | 2411 | 25596 | 1941 | 26896 | 1166 | 33281 | 586 | 28729 |
| 8L-4S | | MI | 9431 | 4162 | 16445 | 2896 | 18026 | 2299 | 18893 | 1812 | 20244 | 1041 | 24447 | 632 | 19936 |
| 20-#11 | 3.61 | MA | 12696 | 4162 | 21508 | 3015 | 23549 | 2421 | 24452 | 1936 | 25412 | 1173 | 31439 | 529 | 27722 |
| 9L-3S | | MI | 9728 | 4162 | 16972 | 2888 | 18681 | 2306 | 19668 | 1819 | 21217 | 1034 | 25522 | 714 | 20341 |
| 20-#14 | 5.21 | MA | 14475 | 4651 | 25731 | 3307 | 28895 | 2635 | 30940 | 2066 | 34096 | 1130 | 42860 | 362 | 40179 |
| 7L-5S | | MI | 9880 | 4651 | 18017 | 3177 | 19880 | 2500 | 21091 | 1918 | 23201 | 962 | 28284 | 305 | 26600 |
| 20-#14 | 5.21 | MA | 13935 | 4651 | 24736 | 3303 | 27562 | 2630 | 29355 | 2078 | 31863 | 1120 | 40185 | 292 | 38341 |
| 8L-4S | | MI | 10256 | 4651 | 18680 | 3186 | 20704 | 2491 | 22072 | 1908 | 24465 | 952 | 29877 | 366 | 27362 |
| 22-#11 | 3.97 | MA | 13950 | 4272 | 23994 | 3075 | 26737 | 2464 | 28342 | 1963 | 30669 | 1165 | 38092 | 615 | 32836 |
| 7L-6S | | MI | 9181 | 4272 | 16156 | 2967 | 17662 | 2348 | 18490 | 1853 | 19669 | 1025 | 23893 | 497 | 20932 |
| 22-#11 | 3.97 | MA | 13564 | 4272 | 23300 | 3073 | 25807 | 2461 | 27236 | 1972 | 29099 | 1158 | 36209 | 566 | 31783 |
| 8L-5S | | MI | 9437 | 4272 | 16623 | 2959 | 18246 | 2354 | 19156 | 1846 | 20551 | 1018 | 24950 | 557 | 21460 |
| 22-#11 | 3.97 | MA | 13182 | 4272 | 22565 | 3085 | 24898 | 2471 | 26091 | 1967 | 27615 | 1165 | 34367 | 510 | 30751 |
| 9L-4S | | MI | 9705 | 4272 | 17088 | 2965 | 18832 | 2348 | 19853 | 1839 | 21513 | 1025 | 26088 | 598 | 21797 |
| 22-#14 | 5.73 | MA | 14611 | 4811 | 26247 | 3403 | 29489 | 2702 | 31698 | 2123 | 34995 | 1107 | 44336 | 263 | 42647 |
| 8L-5S | | MI | 10264 | 4811 | 18930 | 3276 | 21014 | 2570 | 22443 | 1956 | 24987 | 938 | 30582 | 253 | 29166 |
| 24-#11 | 4.33 | MA | 14043 | 4383 | 24358 | 3142 | 27155 | 2511 | 28875 | 2003 | 31302 | 1150 | 39137 | 547 | 34842 |
| 8L-6S | | MI | 9457 | 4383 | 16799 | 3036 | 18468 | 2396 | 19451 | 1880 | 20938 | 1009 | 25534 | 463 | 22772 |
| 24-#11 | 4.33 | MA | 13663 | 4383 | 23623 | 3154 | 26246 | 2522 | 27731 | 1998 | 29818 | 1157 | 37295 | 491 | 33719 |
| 9L-5S | | MI | 9712 | 4383 | 17266 | 3028 | 19052 | 2403 | 20116 | 1873 | 21819 | 1003 | 26591 | 523 | 23346 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

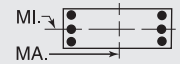



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.75 | MA | 14865 | 3792 | 24063 | 2759 | 26317 | 2235 | 27341 | 1840 | 28285 | 1243 | 33772 | 1136 | 17844 |
| 2E | | MI | 9104 | 3792 | 14985 | 2628 | 15868 | 2112 | 16129 | 1717 | 16266 | 1124 | 18880 | 970 | 10611 |
| 6-#11 | 1.03 | MA | 13867 | 3557 | 21704 | 2641 | 23457 | 2153 | 23920 | 1794 | 23859 | 1285 | 28005 | 1211 | 10788 |
| 2L-3S | | MI | 8179 | 3557 | 13094 | 2526 | 13674 | 2066 | 13559 | 1713 | 12880 | 1209 | 14634 | 1016 | 6626 |
| 6-#11 | 1.03 | MA | 13114 | 3557 | 20577 | 2640 | 22020 | 2163 | 22173 | 1803 | 21500 | 1292 | 24861 | 1122 | 10826 |
| 3L-2S | | MI | 8604 | 3557 | 13737 | 2532 | 14480 | 2059 | 14519 | 1706 | 14148 | 1202 | 16275 | 1105 | 6571 |
| 6-#14 | 1.48 | MA | 14530 | 3704 | 23195 | 2723 | 25308 | 2211 | 26151 | 1829 | 26816 | 1267 | 31907 | 1176 | 15296 |
| 2L-3S | | MI | 8352 | 3704 | 13662 | 2599 | 14322 | 2117 | 14315 | 1738 | 13875 | 1177 | 15894 | 913 | 9250 |
| 6-#14 | 1.48 | MA | 13466 | 3704 | 21584 | 2720 | 23254 | 2226 | 23654 | 1841 | 23459 | 1277 | 27445 | 1048 | 15301 |
| 3L-2S | | MI | 8951 | 3704 | 14575 | 2609 | 15456 | 2107 | 15667 | 1728 | 15661 | 1167 | 18192 | 1041 | 9179 |
| 6-#18 | 2.63 | MA | 16124 | 4076 | 26877 | 2936 | 29905 | 2364 | 31703 | 1920 | 34089 | 1218 | 41450 | 1080 | 26424 |
| 2L-3S | | MI | 8757 | 4076 | 14985 | 2785 | 15868 | 2248 | 16129 | 1797 | 16266 | 1093 | 18880 | 636 | 15477 |
| 6-#18 | 2.63 | MA | 14312 | 4076 | 24063 | 2930 | 26317 | 2388 | 27341 | 1940 | 28285 | 1236 | 33772 | 852 | 26140 |
| 3L-2S | | MI | 9770 | 4076 | 16534 | 2802 | 17784 | 2230 | 18413 | 1780 | 19286 | 1075 | 22726 | 864 | 15478 |
| 8-#11 | 1.37 | MA | 14392 | 3667 | 22831 | 2710 | 24893 | 2203 | 25666 | 1825 | 26218 | 1278 | 31149 | 1193 | 14246 |
| 2L-4S | | MI | 8156 | 3667 | 13210 | 2603 | 13824 | 2107 | 13744 | 1734 | 13176 | 1200 | 15200 | 900 | 8672 |
| 8-#11 | 1.37 | MA | 13645 | 3667 | 21704 | 2709 | 23457 | 2214 | 23920 | 1835 | 23859 | 1285 | 28005 | 1104 | 14263 |
| 3E | | MI | 8465 | 3667 | 13737 | 2596 | 14480 | 2114 | 14519 | 1741 | 14148 | 1193 | 16275 | 982 | 8630 |
| 8-#11 | 1.37 | MA | 13116 | 3667 | 20797 | 2721 | 22304 | 2211 | 22520 | 1830 | 22049 | 1291 | 25950 | 1016 | 14207 |
| 4L-2S | | MI | 8888 | 3667 | 14379 | 2601 | 15286 | 2107 | 15479 | 1734 | 15417 | 1186 | 17916 | 1071 | 8582 |
| 8-#14 | 1.97 | MA | 15266 | 3863 | 24806 | 2823 | 27362 | 2283 | 28648 | 1873 | 30172 | 1255 | 36370 | 1149 | 20219 |
| 2L-4S | | MI | 8316 | 3863 | 13825 | 2709 | 14533 | 2176 | 14575 | 1766 | 14293 | 1163 | 16683 | 745 | 11874 |
| 8-#14 | 1.97 | MA | 14213 | 3863 | 23195 | 2820 | 25308 | 2298 | 26151 | 1886 | 26816 | 1265 | 31907 | 1021 | 20172 |
| 3E | | MI | 8752 | 3863 | 14575 | 2699 | 15456 | 2186 | 15667 | 1776 | 15661 | 1153 | 18192 | 860 | 12057 |
| 8-#14 | 1.97 | MA | 13466 | 3863 | 21896 | 2837 | 23657 | 2293 | 24147 | 1879 | 24241 | 1275 | 28995 | 893 | 19811 |
| 4L-2S | | MI | 9346 | 3863 | 15488 | 2708 | 16590 | 2176 | 17018 | 1766 | 17447 | 1143 | 20490 | 988 | 12010 |
| 8-#18 | 3.51 | MA | 17361 | 4360 | 29692 | 3114 | 33493 | 2492 | 36065 | 2000 | 39894 | 1194 | 49129 | 1024 | 34956 |
| 2L-4S | | MI | 8688 | 4360 | 15260 | 2977 | 16224 | 2349 | 16567 | 1842 | 16972 | 1061 | 20189 | 333 | 18224 |
| 8-#18 | 3.51 | MA | 15577 | 4360 | 26877 | 3107 | 29905 | 2517 | 31703 | 2019 | 34089 | 1212 | 41450 | 796 | 34548 |
| 3E | | MI | 9426 | 4360 | 16534 | 2959 | 17784 | 2367 | 18413 | 1860 | 19286 | 1043 | 22726 | 530 | 20193 |
| 8-#18 | 3.51 | MA | 14310 | 4360 | 24602 | 3136 | 27013 | 2505 | 28193 | 2004 | 29637 | 1230 | 36453 | 569 | 31057 |
| 4L-2S | | MI | 10428 | 4360 | 18083 | 2977 | 19701 | 2349 | 20698 | 1842 | 22306 | 1025 | 26572 | 757 | 20297 |
| 10-#11 | 1.71 | MA | 14911 | 3778 | 23958 | 2779 | 26330 | 2253 | 27413 | 1856 | 28577 | 1270 | 34293 | 1175 | 17691 |
| 2L-5S | | MI | 8162 | 3778 | 13388 | 2667 | 14045 | 2163 | 14007 | 1768 | 13482 | 1177 | 15703 | 825 | 10328 |
| 10-#11 | 1.71 | MA | 14170 | 3778 | 22831 | 2778 | 24893 | 2264 | 25666 | 1866 | 26218 | 1277 | 31149 | 1087 | 17684 |
| 3L-4S | | MI | 8441 | 3778 | 13853 | 2673 | 14630 | 2156 | 14704 | 1761 | 14445 | 1184 | 16841 | 866 | 10638 |
| 10-#11 | 1.71 | MA | 13646 | 3778 | 21924 | 2790 | 23740 | 2261 | 24267 | 1861 | 24408 | 1284 | 29094 | 998 | 17599 |
| 4L-3S | | MI | 8749 | 3778 | 14379 | 2665 | 15286 | 2163 | 15479 | 1768 | 15417 | 1177 | 17916 | 948 | 10615 |
| 10-#11 | 1.71 | MA | 13175 | 3778 | 21128 | 2789 | 22714 | 2272 | 23010 | 1871 | 22623 | 1277 | 26935 | 955 | 16950 |
| 5L-2S | | MI | 9169 | 3778 | 15022 | 2671 | 16092 | 2156 | 16440 | 1761 | 16686 | 1171 | 19557 | 1037 | 10577 |
| 10-#14 | 2.47 | MA | 15992 | 4023 | 26417 | 2923 | 29416 | 2356 | 31145 | 1918 | 33529 | 1244 | 40832 | 1121 | 25121 |
| 2L-5S | | MI | 8323 | 4023 | 14075 | 2799 | 14843 | 2255 | 14946 | 1813 | 14814 | 1149 | 17388 | 632 | 13842 |
| 10-#14 | 2.47 | MA | 14950 | 4023 | 24806 | 2920 | 27362 | 2371 | 28648 | 1931 | 30172 | 1254 | 36370 | 993 | 25030 |
| 3L-4S | | MI | 8715 | 4023 | 14738 | 2809 | 15667 | 2245 | 15927 | 1804 | 16078 | 1139 | 18981 | 692 | 14435 |
| 10-#14 | 2.47 | MA | 14212 | 4023 | 23508 | 2937 | 25711 | 2366 | 26645 | 1924 | 27597 | 1264 | 33457 | 865 | 24413 |
| 4L-3S | | MI | 9148 | 4023 | 15488 | 2799 | 16590 | 2255 | 17018 | 1813 | 17447 | 1129 | 20490 | 808 | 14841 |
| 10-#14 | 2.47 | MA | 13550 | 4023 | 22368 | 2934 | 24241 | 2381 | 24845 | 1937 | 25057 | 1254 | 30386 | 805 | 22987 |
| 5L-2S | | MI | 9737 | 4023 | 16401 | 2808 | 17724 | 2245 | 18370 | 1804 | 19233 | 1119 | 22788 | 936 | 14821 |
| 10-#18 | 4.39 | MA | 16821 | 4643 | 29692 | 3284 | 33493 | 2645 | 36065 | 2099 | 39894 | 1188 | 49129 | 740 | 42950 |
| 3L-4S | | MI | 9358 | 4643 | 16809 | 3152 | 18140 | 2467 | 18851 | 1905 | 19992 | 1011 | 24035 | 226 | 22665 |
| 10-#18 | 4.39 | MA | 15575 | 4643 | 27417 | 3313 | 30601 | 2634 | 32555 | 2084 | 35442 | 1205 | 44132 | 512 | 39158 |
| 4L-3S | | MI | 10088 | 4643 | 18083 | 3134 | 19701 | 2485 | 20698 | 1922 | 22306 | 993 | 26572 | 423 | 24551 |
| 10-#18 | 4.39 | MA | 14457 | 4643 | 25417 | 3306 | 28023 | 2658 | 29399 | 2103 | 31047 | 1188 | 38822 | 409 | 35983 |
| 5L-2S | | MI | 11078 | 4643 | 19632 | 3152 | 21618 | 2467 | 22982 | 1905 | 25325 | 976 | 30418 | 651 | 25075 |
| 12-#11 | 2.05 | MA | 15426 | 3889 | 25085 | 2849 | 27767 | 2303 | 29159 | 1887 | 30937 | 1263 | 37437 | 1158 | 21127 |
| 2L-6S | | MI | 8182 | 3889 | 13564 | 2744 | 14267 | 2205 | 14301 | 1802 | 13869 | 1169 | 16287 | 731 | 11952 |

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

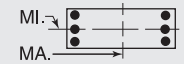
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.05 | MA | 14691 | 3889 | 23958 | 2847 | 26330 | 2314 | 27413 | 1897 | 28577 | 1270 | 34293 | 1069 | 21096 |
| 3L-5S | | MI | 8448 | 3889 | 14030 | 2736 | 14851 | 2212 | 14967 | 1795 | 14751 | 1162 | 17344 | 791 | 12185 |
| 12-#11 | 2.05 | MA | 14171 | 3889 | 23051 | 2859 | 25177 | 2311 | 26013 | 1892 | 26767 | 1277 | 32238 | 980 | 20986 |
| 4E | | MI | 8725 | 3889 | 14496 | 2742 | 15436 | 2205 | 15664 | 1788 | 15713 | 1169 | 18482 | 832 | 12589 |
| 12-#11 | 2.05 | MA | 13704 | 3889 | 22255 | 2858 | 24151 | 2322 | 24757 | 1902 | 24982 | 1270 | 30079 | 938 | 20232 |
| 5L-3S | | MI | 9030 | 3889 | 15022 | 2734 | 16092 | 2212 | 16440 | 1795 | 16686 | 1162 | 19557 | 914 | 12588 |
| 12-#11 | 2.05 | MA | 13259 | 3889 | 21504 | 2856 | 23131 | 2319 | 23513 | 1897 | 23342 | 1277 | 28036 | 879 | 19629 |
| 6L-2S | | MI | 9448 | 3889 | 15665 | 2740 | 16898 | 2205 | 17400 | 1788 | 17955 | 1155 | 21198 | 1003 | 12560 |
| 12-#14 | 2.96 | MA | 15679 | 4182 | 26417 | 3020 | 29416 | 2443 | 31145 | 1976 | 33529 | 1242 | 40832 | 966 | 29881 |
| 3L-5S | | MI | 8722 | 4182 | 14988 | 2899 | 15977 | 2324 | 16297 | 1851 | 16600 | 1124 | 19686 | 579 | 16482 |
| 12-#14 | 2.96 | MA | 14949 | 4182 | 25119 | 3037 | 27765 | 2438 | 29142 | 1969 | 30954 | 1252 | 37919 | 838 | 29041 |
| 4E | | MI | 9111 | 4182 | 15651 | 2909 | 16802 | 2314 | 17278 | 1841 | 17864 | 1114 | 21279 | 639 | 17021 |
| 12-#14 | 2.96 | MA | 14294 | 4182 | 23979 | 3034 | 26295 | 2453 | 27342 | 1982 | 28414 | 1242 | 34848 | 777 | 27696 |
| 5L-3S | | MI | 9540 | 4182 | 16401 | 2898 | 17724 | 2324 | 18370 | 1851 | 19233 | 1105 | 22788 | 755 | 17606 |
| 12-#14 | 2.96 | MA | 13670 | 4182 | 22902 | 3031 | 24833 | 2448 | 25559 | 1974 | 26080 | 1252 | 31951 | 692 | 26223 |
| 6L-2S | | MI | 10125 | 4182 | 17314 | 2908 | 18858 | 2314 | 19721 | 1841 | 21019 | 1095 | 25087 | 883 | 17618 |
| 12-#18 | 5.26 | MA | 16820 | 4927 | 30231 | 3490 | 34189 | 2763 | 36917 | 2163 | 41246 | 1181 | 51810 | 456 | 47296 |
| 4E | | MI | 10021 | 4927 | 18358 | 3326 | 20057 | 2586 | 21135 | 1967 | 23011 | 961 | 27881 | 120 | 27141 |
| 12-#18 | 5.26 | MA | 15720 | 4927 | 28231 | 3483 | 31611 | 2787 | 33761 | 2183 | 36851 | 1163 | 46501 | 353 | 43966 |
| 5L-3S | | MI | 10743 | 4927 | 19632 | 3309 | 21618 | 2604 | 22982 | 1985 | 25325 | 944 | 30418 | 317 | 28843 |
| 12-#18 | 5.26 | MA | 14671 | 4927 | 26341 | 3477 | 29046 | 2776 | 30634 | 2168 | 32816 | 1181 | 41522 | 201 | 40495 |
| 6L-2S | | MI | 11724 | 4927 | 21182 | 3326 | 23535 | 2586 | 25266 | 1967 | 28345 | 926 | 34264 | 544 | 29826 |
| 14-#11 | 2.39 | MA | 15206 | 3999 | 25085 | 2916 | 27767 | 2364 | 29159 | 1928 | 30937 | 1263 | 37437 | 1051 | 24503 |
| 3L-6S | | MI | 8467 | 3999 | 14207 | 2813 | 15073 | 2253 | 15262 | 1829 | 15138 | 1153 | 17928 | 697 | 13816 |
| 14-#11 | 2.39 | MA | 14691 | 3999 | 24178 | 2929 | 26614 | 2361 | 27760 | 1924 | 29127 | 1270 | 35382 | 963 | 24369 |
| 4L-5S | | MI | 8731 | 3999 | 14673 | 2805 | 15657 | 2260 | 15927 | 1822 | 16020 | 1146 | 18985 | 757 | 14051 |
| 14-#11 | 2.39 | MA | 14228 | 3999 | 23382 | 2927 | 25588 | 2372 | 26503 | 1933 | 27341 | 1263 | 33223 | 920 | 23524 |
| 5L-4S | | MI | 9006 | 3999 | 15139 | 2811 | 16242 | 2253 | 16625 | 1815 | 16982 | 1153 | 20122 | 798 | 14519 |
| 14-#11 | 2.39 | MA | 13787 | 3999 | 22631 | 2926 | 24568 | 2369 | 25259 | 1929 | 25701 | 1270 | 31180 | 861 | 22949 |
| 6L-3S | | MI | 9310 | 3999 | 15665 | 2803 | 16898 | 2260 | 17400 | 1822 | 17955 | 1146 | 21198 | 880 | 14552 |
| 14-#11 | 2.39 | MA | 13357 | 3999 | 21827 | 2938 | 23588 | 2380 | 24059 | 1938 | 24096 | 1276 | 29053 | 774 | 21973 |
| 7L-2S | | MI | 9725 | 3999 | 16308 | 2809 | 17704 | 2253 | 18360 | 1815 | 19224 | 1139 | 22838 | 969 | 14535 |
| 14-#14 | 3.45 | MA | 15677 | 4342 | 26730 | 3137 | 29819 | 2510 | 31639 | 2014 | 34311 | 1241 | 42382 | 810 | 33690 |
| 4L-5S | | MI | 9118 | 4342 | 15901 | 2999 | 17111 | 2393 | 17648 | 1889 | 18386 | 1100 | 21984 | 527 | 19131 |
| 14-#14 | 3.45 | MA | 15030 | 4342 | 25590 | 3134 | 28349 | 2525 | 29839 | 2026 | 31770 | 1231 | 39311 | 750 | 32417 |
| 5L-4S | | MI | 9504 | 4342 | 16564 | 3008 | 17936 | 2383 | 18629 | 1879 | 19650 | 1090 | 23578 | 587 | 19624 |
| 14-#14 | 3.45 | MA | 14412 | 4342 | 24513 | 3131 | 26887 | 2520 | 28056 | 2019 | 29437 | 1241 | 36413 | 665 | 30860 |
| 6L-3S | | MI | 9930 | 4342 | 17314 | 2998 | 18858 | 2393 | 19721 | 1889 | 21019 | 1080 | 25087 | 702 | 20361 |
| 14-#14 | 3.45 | MA | 13809 | 4342 | 23361 | 3148 | 25483 | 2535 | 26336 | 2032 | 27153 | 1251 | 33395 | 538 | 29347 |
| 7L-2S | | MI | 10511 | 4342 | 18227 | 3008 | 19992 | 2383 | 21072 | 1879 | 22805 | 1070 | 27385 | 830 | 20403 |
| 14-#18 | 6.14 | MA | 16965 | 5211 | 31045 | 3661 | 35199 | 2915 | 38122 | 2263 | 42656 | 1139 | 54179 | 296 | 51982 |
| 5L-4S | | MI | 10679 | 5211 | 19907 | 3501 | 21974 | 2705 | 23420 | 2030 | 26031 | 912 | 31727 | 13 | 31643 |
| 14-#18 | 6.14 | MA | 15932 | 5211 | 29155 | 3654 | 32634 | 2904 | 34995 | 2248 | 38621 | 1157 | 49200 | 145 | 48428 |
| 6L-3S | | MI | 11440 | 5211 | 21182 | 3483 | 23535 | 2722 | 25266 | 2047 | 28345 | 894 | 34264 | 210 | 33182 |
| 16-#11 | 2.74 | MA | 15206 | 4110 | 25305 | 2998 | 28050 | 2411 | 29506 | 1955 | 31486 | 1262 | 38526 | 945 | 27751 |
| 4L-6S | | MI | 8750 | 4110 | 14850 | 2882 | 15879 | 2302 | 16222 | 1856 | 16407 | 1138 | 19569 | 662 | 15623 |
| 16-#11 | 2.74 | MA | 14747 | 4110 | 24509 | 2996 | 27024 | 2422 | 28250 | 1964 | 29701 | 1255 | 36367 | 902 | 26826 |
| 5E | | MI | 9012 | 4110 | 15316 | 2874 | 16463 | 2309 | 16888 | 1850 | 17288 | 1131 | 20626 | 723 | 15923 |
| 16-#11 | 2.74 | MA | 14310 | 4110 | 23758 | 2995 | 26004 | 2419 | 27006 | 1960 | 28061 | 1262 | 34324 | 844 | 26275 |
| 6L-4S | | MI | 9286 | 4110 | 15781 | 2880 | 17048 | 2302 | 17585 | 1843 | 18251 | 1138 | 21763 | 764 | 16356 |
| 16-#11 | 2.74 | MA | 13883 | 4110 | 22954 | 3007 | 25025 | 2430 | 25805 | 1969 | 26455 | 1269 | 32197 | 756 | 25248 |
| 7L-3S | | MI | 9588 | 4110 | 16308 | 2872 | 17704 | 2309 | 18360 | 1850 | 19224 | 1131 | 22838 | 846 | 16506 |
| 16-#11 | 2.74 | MA | 13462 | 4110 | 22216 | 3006 | 24036 | 2427 | 24630 | 1978 | 24774 | 1262 | 30180 | 706 | 24323 |
| 8L-2S | | MI | 10001 | 4110 | 16951 | 2878 | 18510 | 2302 | 19320 | 1843 | 20493 | 1124 | 24479 | 935 | 16503 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

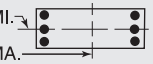


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.95 | MA | 15758 | 4502 | 27201 | 3234 | 30403 | 2598 | 32336 | 2071 | 35127 | 1219 | 43773 | 722 | 37148 |
| 5E | | MI | 9511 | 4502 | 16814 | 3099 | 18246 | 2462 | 19000 | 1927 | 20171 | 1076 | 24282 | 474 | 21742 |
| 16-#14 | 3.95 | MA | 15147 | 4502 | 26124 | 3231 | 28942 | 2593 | 30553 | 2064 | 32793 | 1229 | 40875 | 637 | 35511 |
| 6L-4S | | MI | 9894 | 4502 | 17477 | 3108 | 19070 | 2452 | 19981 | 1917 | 21436 | 1066 | 25876 | 534 | 22242 |
| 16-#14 | 3.95 | MA | 14550 | 4502 | 24972 | 3248 | 27538 | 2608 | 28833 | 2077 | 30510 | 1239 | 37857 | 511 | 33946 |
| 7L-3S | | MI | 10317 | 4502 | 18227 | 3098 | 19992 | 2462 | 21072 | 1927 | 22805 | 1056 | 27385 | 650 | 23107 |
| 16-#14 | 3.95 | MA | 13963 | 4502 | 23915 | 3245 | 26120 | 2603 | 27148 | 2090 | 28117 | 1229 | 34988 | 440 | 32146 |
| 8L-2S | | MI | 10894 | 4502 | 19140 | 3107 | 21127 | 2452 | 22424 | 1917 | 24590 | 1046 | 29683 | 778 | 23173 |
| 16-#18 | 7.02 | MA | 17177 | 5495 | 31969 | 3831 | 36222 | 3033 | 39357 | 2327 | 44426 | 1132 | 56879 | 89 | 56387 |
| 6L-4S | | MI | 11391 | 5495 | 21456 | 3676 | 23891 | 2823 | 25704 | 2092 | 29051 | 862 | 35573 | -93 | 35041 |
| 18-#11 | 3.08 | MA | 15262 | 4221 | 25636 | 3065 | 28461 | 2472 | 29996 | 1995 | 32060 | 1248 | 39511 | 885 | 30134 |
| 5L-6S | | MI | 9032 | 4221 | 15492 | 2951 | 16685 | 2351 | 17182 | 1884 | 17675 | 1122 | 21209 | 628 | 17440 |
| 18-#11 | 3.08 | MA | 14829 | 4221 | 24885 | 3064 | 27441 | 2469 | 28752 | 1991 | 30420 | 1255 | 37468 | 826 | 29590 |
| 6L-5S | | MI | 9292 | 4221 | 15959 | 2943 | 17269 | 2358 | 17848 | 1877 | 18557 | 1115 | 22266 | 689 | 17801 |
| 18-#11 | 3.08 | MA | 14405 | 4221 | 24081 | 3076 | 26461 | 2480 | 27552 | 2000 | 28814 | 1262 | 35341 | 738 | 28530 |
| 7L-4S | | MI | 9564 | 4221 | 16424 | 2949 | 17854 | 2351 | 18545 | 1870 | 19520 | 1122 | 23404 | 730 | 18203 |
| 18-#11 | 3.08 | MA | 13988 | 4221 | 23343 | 3075 | 25473 | 2477 | 26376 | 2010 | 27133 | 1255 | 33324 | 688 | 27569 |
| 8L-3S | | MI | 9864 | 4221 | 16951 | 2941 | 18510 | 2358 | 19320 | 1877 | 20493 | 1115 | 24479 | 812 | 18453 |
| 18-#11 | 3.08 | MA | 13574 | 4221 | 22563 | 3087 | 24506 | 2488 | 25160 | 2005 | 25544 | 1262 | 31345 | 632 | 26528 |
| 9L-2S | | MI | 10275 | 4221 | 17593 | 2947 | 19316 | 2351 | 20281 | 1870 | 21761 | 1108 | 26120 | 900 | 18467 |
| 18-#14 | 4.44 | MA | 15874 | 4661 | 27736 | 3331 | 30996 | 2665 | 33051 | 2109 | 36150 | 1217 | 45337 | 610 | 40173 |
| 6L-5S | | MI | 9901 | 4661 | 17727 | 3198 | 19380 | 2531 | 20351 | 1965 | 21957 | 1052 | 26580 | 421 | 24279 |
| 18-#14 | 4.44 | MA | 15284 | 4661 | 26584 | 3348 | 29592 | 2680 | 31330 | 2122 | 33866 | 1227 | 42319 | 483 | 38557 |
| 7L-4S | | MI | 10282 | 4661 | 18390 | 3208 | 20204 | 2521 | 21332 | 1955 | 23222 | 1042 | 28174 | 481 | 24870 |
| 18-#14 | 4.44 | MA | 14702 | 4661 | 25526 | 3345 | 28175 | 2675 | 29645 | 2135 | 31473 | 1217 | 39451 | 412 | 36809 |
| 8L-3S | | MI | 10701 | 4661 | 19140 | 3198 | 21127 | 2531 | 22424 | 1965 | 24590 | 1032 | 29683 | 597 | 25848 |
| 20-#11 | 3.42 | MA | 15343 | 4331 | 26012 | 3133 | 28878 | 2519 | 30499 | 2022 | 32779 | 1248 | 40612 | 808 | 32843 |
| 6E | | MI | 9311 | 4331 | 16135 | 3020 | 17491 | 2400 | 18142 | 1911 | 18944 | 1106 | 22850 | 594 | 19265 |
| 20-#11 | 3.42 | MA | 14923 | 4331 | 25208 | 3145 | 27898 | 2530 | 29298 | 2031 | 31174 | 1254 | 38485 | 721 | 31818 |
| 7L-5S | | MI | 9570 | 4331 | 16602 | 3012 | 18075 | 2406 | 18808 | 1904 | 19826 | 1099 | 23907 | 655 | 19682 |
| 20-#11 | 3.42 | MA | 14509 | 4331 | 24470 | 3144 | 26909 | 2527 | 28123 | 2041 | 29492 | 1248 | 36468 | 671 | 30821 |
| 8L-4S | | MI | 9841 | 4331 | 17067 | 3018 | 18660 | 2400 | 19505 | 1897 | 20789 | 1106 | 25045 | 696 | 20057 |
| 20-#11 | 3.42 | MA | 14099 | 4331 | 23690 | 3156 | 25943 | 2538 | 26907 | 2036 | 27903 | 1254 | 34489 | 614 | 29807 |
| 9L-3S | | MI | 10139 | 4331 | 17593 | 3010 | 19316 | 2406 | 20281 | 1904 | 21761 | 1099 | 26120 | 778 | 20396 |
| 20-#11 | 3.42 | MA | 13651 | 4331 | 22956 | 3155 | 24967 | 2535 | 25738 | 2046 | 26326 | 1261 | 32571 | 551 | 28460 |
| 10L-2S | | MI | 10548 | 4331 | 18236 | 3016 | 20122 | 2400 | 21241 | 1897 | 23030 | 1093 | 27761 | 866 | 20422 |
| 20-#14 | 4.93 | MA | 16010 | 4821 | 28195 | 3448 | 31646 | 2752 | 33827 | 2167 | 37223 | 1216 | 46781 | 456 | 43179 |
| 7L-5S | | MI | 10289 | 4821 | 18640 | 3298 | 20514 | 2600 | 21703 | 2003 | 23743 | 1027 | 28878 | 369 | 26830 |
| 20-#14 | 4.93 | MA | 15435 | 4821 | 27137 | 3445 | 30229 | 2748 | 32142 | 2180 | 34830 | 1206 | 43913 | 385 | 41322 |
| 8L-4S | | MI | 10667 | 4821 | 19303 | 3308 | 21338 | 2591 | 22684 | 1993 | 25008 | 1017 | 30472 | 429 | 27508 |
| 22-#11 | 3.76 | MA | 15437 | 4442 | 26335 | 3215 | 29335 | 2580 | 31045 | 2062 | 33533 | 1247 | 41629 | 703 | 35112 |
| 7L-6S | | MI | 9589 | 4442 | 16778 | 3089 | 18297 | 2448 | 19103 | 1938 | 20213 | 1091 | 24491 | 560 | 21096 |
| 22-#11 | 3.76 | MA | 15026 | 4442 | 25597 | 3213 | 28346 | 2577 | 29869 | 2072 | 31851 | 1240 | 39612 | 653 | 34080 |
| 8L-5S | | MI | 9847 | 4442 | 17244 | 3082 | 18881 | 2455 | 19769 | 1931 | 21095 | 1084 | 25548 | 621 | 21566 |
| 22-#11 | 3.76 | MA | 14617 | 4442 | 24817 | 3225 | 27380 | 2588 | 28653 | 2067 | 30262 | 1247 | 37633 | 597 | 33061 |
| 9L-4S | | MI | 10116 | 4442 | 17710 | 3087 | 19466 | 2448 | 20466 | 1924 | 22058 | 1091 | 26686 | 662 | 21917 |
| 22-#11 | 3.76 | MA | 14172 | 4442 | 24082 | 3224 | 26403 | 2585 | 27485 | 2077 | 28685 | 1254 | 35715 | 533 | 31723 |
| 10L-3S | | MI | 10413 | 4442 | 18236 | 3080 | 20122 | 2455 | 21241 | 1931 | 23030 | 1084 | 27761 | 744 | 22335 |
| 22-#14 | 5.43 | MA | 16161 | 4980 | 28749 | 3545 | 32283 | 2820 | 34640 | 2224 | 38187 | 1194 | 48375 | 357 | 45923 |
| 8L-5S | | MI | 10675 | 4980 | 19553 | 3398 | 21648 | 2670 | 23054 | 2041 | 25529 | 1003 | 31176 | 316 | 29394 |
| 24-#11 | 4.11 | MA | 15540 | 4553 | 26724 | 3282 | 29783 | 2628 | 31616 | 2103 | 34211 | 1233 | 42756 | 636 | 37344 |
| 8L-6S | | MI | 9866 | 4553 | 17421 | 3159 | 19103 | 2497 | 20063 | 1966 | 21482 | 1075 | 26132 | 526 | 22934 |
| 24-#11 | 4.11 | MA | 15131 | 4553 | 25944 | 3294 | 28816 | 2638 | 30400 | 2099 | 32622 | 1240 | 40777 | 579 | 36230 |
| 9L-5S | | MI | 10122 | 4553 | 17887 | 3151 | 19687 | 2504 | 20729 | 1959 | 22364 | 1068 | 27189 | 586 | 23453 |
| 24-#11 | 4.11 | MA | 14689 | 4553 | 25209 | 3293 | 27840 | 2635 | 29231 | 2108 | 31045 | 1247 | 38859 | 515 | 34989 |
| 10L-4S | | MI | 10390 | 4553 | 18353 | 3157 | 20272 | 2497 | 21426 | 1952 | 23326 | 1075 | 28326 | 628 | 23783 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

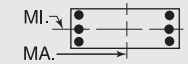
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.67 | MA | 16374 | 3962 | 26365 | 2897 | 28840 | 2349 | 29928 | 1936 | 30930 | 1321 | 36931 | 1216 | 18924 |
| 2E | | MI | 9513 | 3962 | 15611 | 2748 | 16501 | 2210 | 16737 | 1801 | 16804 | 1189 | 19469 | 1032 | 10653 |
| 6-#14 | 1.41 | MA | 16010 | 3873 | 25435 | 2861 | 27759 | 2325 | 28653 | 1925 | 29341 | 1344 | 34901 | 1254 | 16208 |
| 2L-3S | | MI | 8760 | 3873 | 14285 | 2721 | 14956 | 2217 | 14927 | 1823 | 14418 | 1243 | 16489 | 976 | 9287 |
| 6-#14 | 1.41 | MA | 14878 | 3873 | 23724 | 2859 | 25578 | 2340 | 26002 | 1938 | 25758 | 1354 | 30127 | 1126 | 16212 |
| 3L-2S | | MI | 9359 | 3873 | 15198 | 2730 | 16090 | 2207 | 16278 | 1813 | 16204 | 1233 | 18787 | 1104 | 9213 |
| 6-#18 | 2.50 | MA | 17722 | 4246 | 29356 | 3074 | 32654 | 2477 | 34565 | 2016 | 37135 | 1299 | 45162 | 1164 | 28044 |
| 2L-3S | | MI | 9165 | 4246 | 15611 | 2905 | 16501 | 2347 | 16737 | 1881 | 16804 | 1157 | 19469 | 698 | 15550 |
| 6-#18 | 2.50 | MA | 15790 | 4246 | 26365 | 3069 | 28840 | 2503 | 29928 | 2037 | 30930 | 1316 | 36931 | 936 | 27760 |
| 3L-2S | | MI | 10180 | 4246 | 17160 | 2922 | 18418 | 2329 | 19022 | 1864 | 19824 | 1139 | 23315 | 926 | 15528 |
| 8-#11 | 1.30 | MA | 15861 | 3837 | 25046 | 2848 | 27315 | 2316 | 28134 | 1922 | 28676 | 1353 | 34076 | 1270 | 15088 |
| 2L-4S | | MI | 8563 | 3837 | 13832 | 2726 | 14459 | 2208 | 14356 | 1819 | 13720 | 1266 | 15798 | 964 | 8709 |
| 8-#11 | 1.30 | MA | 15066 | 3837 | 23850 | 2847 | 25790 | 2327 | 26280 | 1931 | 26165 | 1361 | 30716 | 1181 | 15105 |
| 3E | | MI | 8873 | 3837 | 14358 | 2718 | 15114 | 2215 | 15132 | 1826 | 14693 | 1259 | 16873 | 1046 | 8662 |
| 8-#11 | 1.30 | MA | 14505 | 3837 | 22889 | 2860 | 24568 | 2325 | 24797 | 1928 | 24239 | 1368 | 28517 | 1092 | 15050 |
| 4L-2S | | MI | 9296 | 3837 | 15001 | 2724 | 15920 | 2208 | 16092 | 1819 | 15962 | 1252 | 18513 | 1134 | 8612 |
| 8-#14 | 1.88 | MA | 16797 | 4033 | 27146 | 2961 | 29940 | 2397 | 31305 | 1970 | 32923 | 1334 | 39675 | 1228 | 21434 |
| 2L-4S | | MI | 8723 | 4033 | 14448 | 2831 | 15168 | 2276 | 15187 | 1851 | 14835 | 1228 | 17278 | 808 | 12025 |
| 8-#14 | 1.88 | MA | 15676 | 4033 | 25435 | 2959 | 27759 | 2413 | 28653 | 1983 | 29341 | 1344 | 34901 | 1100 | 21387 |
| 3E | | MI | 9160 | 4033 | 15198 | 2820 | 16090 | 2286 | 16278 | 1860 | 16204 | 1218 | 18787 | 923 | 12101 |
| 8-#14 | 1.88 | MA | 14883 | 4033 | 24059 | 2976 | 26008 | 2408 | 26529 | 1977 | 26592 | 1353 | 31781 | 972 | 21127 |
| 4L-2S | | MI | 9755 | 4033 | 16111 | 2830 | 17224 | 2276 | 17629 | 1851 | 17989 | 1208 | 21085 | 1051 | 12048 |
| 8-#18 | 3.33 | MA | 19046 | 4529 | 32348 | 3252 | 36468 | 2606 | 39201 | 2096 | 43340 | 1276 | 53393 | 1111 | 37116 |
| 2L-4S | | MI | 9094 | 4529 | 15885 | 3097 | 16857 | 2448 | 17175 | 1926 | 17510 | 1125 | 20778 | 395 | 18427 |
| 8-#18 | 3.33 | MA | 17144 | 4529 | 29356 | 3246 | 32654 | 2631 | 34565 | 2117 | 37135 | 1294 | 45162 | 884 | 36708 |
| 3E | | MI | 9835 | 4529 | 17160 | 3079 | 18418 | 2465 | 19022 | 1944 | 19824 | 1107 | 23315 | 592 | 20278 |
| 8-#18 | 3.33 | MA | 15796 | 4529 | 26942 | 3276 | 29585 | 2622 | 30840 | 2103 | 32376 | 1312 | 39797 | 656 | 33219 |
| 4L-2S | | MI | 10838 | 4529 | 18709 | 3097 | 20334 | 2448 | 21306 | 1926 | 22844 | 1090 | 27161 | 820 | 20354 |
| 10-#11 | 1.63 | MA | 16416 | 3948 | 26242 | 2917 | 28840 | 2366 | 29988 | 1953 | 31188 | 1347 | 37436 | 1254 | 18744 |
| 2L-5S | | MI | 8570 | 3948 | 14009 | 2789 | 14679 | 2264 | 14619 | 1853 | 14026 | 1243 | 16301 | 888 | 10431 |
| 10-#11 | 1.63 | MA | 15628 | 3948 | 25046 | 2916 | 27315 | 2378 | 28134 | 1963 | 28676 | 1354 | 34076 | 1165 | 18737 |
| 3L-4S | | MI | 8849 | 3948 | 14474 | 2795 | 15265 | 2257 | 15316 | 1846 | 14989 | 1250 | 17438 | 930 | 10680 |
| 10-#11 | 1.63 | MA | 15071 | 3948 | 24085 | 2929 | 26093 | 2375 | 26651 | 1959 | 26750 | 1361 | 31877 | 1076 | 18652 |
| 4L-3S | | MI | 9157 | 3948 | 15001 | 2787 | 15920 | 2264 | 16092 | 1853 | 15962 | 1243 | 18513 | 1012 | 10651 |
| 10-#11 | 1.63 | MA | 14572 | 3948 | 23242 | 2928 | 25006 | 2386 | 25320 | 1969 | 24852 | 1354 | 29575 | 1033 | 18053 |
| 5L-2S | | MI | 9578 | 3948 | 15644 | 2793 | 16726 | 2257 | 17052 | 1846 | 17230 | 1236 | 20154 | 1100 | 10610 |
| 10-#14 | 2.34 | MA | 17575 | 4193 | 28857 | 3061 | 32122 | 2469 | 33957 | 2015 | 36505 | 1323 | 44448 | 1203 | 26640 |
| 2L-5S | | MI | 8730 | 4193 | 14698 | 2921 | 15478 | 2355 | 15557 | 1898 | 15356 | 1214 | 17983 | 695 | 13971 |
| 10-#14 | 2.34 | MA | 16465 | 4192 | 27146 | 3058 | 29940 | 2485 | 31305 | 2028 | 32923 | 1333 | 39675 | 1075 | 26549 |
| 3L-4S | | MI | 9123 | 4193 | 15361 | 2931 | 16302 | 2345 | 16538 | 1888 | 16621 | 1204 | 19576 | 755 | 14584 |
| 10-#14 | 2.34 | MA | 15680 | 4192 | 25770 | 3076 | 28190 | 2481 | 29181 | 2022 | 30175 | 1343 | 36555 | 947 | 26084 |
| 4L-3S | | MI | 9556 | 4193 | 16111 | 2920 | 17224 | 2355 | 17629 | 1898 | 17989 | 1194 | 21085 | 871 | 14893 |
| 10-#14 | 2.34 | MA | 14977 | 4192 | 24562 | 3074 | 26632 | 2496 | 27273 | 2035 | 27464 | 1333 | 33277 | 886 | 24491 |
| 5L-2S | | MI | 10147 | 4192 | 17024 | 2930 | 18358 | 2345 | 18981 | 1888 | 19775 | 1184 | 23383 | 999 | 14863 |
| 10-#18 | 4.17 | MA | 18475 | 4813 | 32348 | 3423 | 36468 | 2760 | 39201 | 2197 | 43340 | 1272 | 53393 | 832 | 45650 |
| 3L-4S | | MI | 9765 | 4813 | 17434 | 3272 | 18774 | 2566 | 19459 | 1989 | 20530 | 1075 | 24624 | 289 | 22865 |
| 10-#18 | 4.17 | MA | 17149 | 4813 | 29934 | 3453 | 33399 | 2750 | 35477 | 2183 | 38581 | 1290 | 48028 | 604 | 41842 |
| 4L-3S | | MI | 10498 | 4813 | 18709 | 3254 | 20334 | 2584 | 21306 | 2006 | 22844 | 1058 | 27161 | 486 | 24818 |
| 10-#18 | 4.17 | MA | 15960 | 4813 | 27813 | 3447 | 30664 | 2776 | 32129 | 2205 | 33884 | 1272 | 42351 | 499 | 38664 |
| 5L-2S | | MI | 11491 | 4813 | 20258 | 3272 | 22251 | 2566 | 23590 | 1989 | 25864 | 1040 | 31007 | 713 | 25141 |
| 12-#11 | 1.95 | MA | 16967 | 4058 | 27438 | 2986 | 30365 | 2416 | 31841 | 1984 | 33699 | 1340 | 40796 | 1237 | 22391 |
| 2L-6S | | MI | 8589 | 4058 | 14185 | 2866 | 14902 | 2305 | 14914 | 1887 | 14413 | 1234 | 16884 | 794 | 12050 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

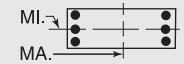



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.95 | MA | 16184 | 4058 | 26242 | 2985 | 28840 | 2428 | 29988 | 1994 | 31188 | 1347 | 37436 | 1149 | 22360 |
| 3L-5S | | MI | 8855 | 4058 | 14652 | 2858 | 15485 | 2312 | 15580 | 1881 | 15295 | 1228 | 17941 | 854 | 12287 |
| 12-#11 | 1.95 | MA | 15632 | 4058 | 25281 | 2998 | 27618 | 2425 | 28505 | 1990 | 29262 | 1354 | 35237 | 1060 | 22249 |
| 4E | | MI | 9133 | 4058 | 15117 | 2864 | 16071 | 2305 | 16277 | 1874 | 16258 | 1234 | 19079 | 896 | 12639 |
| 12-#11 | 1.95 | MA | 15137 | 4058 | 24438 | 2997 | 26531 | 2437 | 27174 | 2000 | 27363 | 1347 | 32935 | 1017 | 21539 |
| 5L-3S | | MI | 9439 | 4058 | 15644 | 2856 | 16726 | 2312 | 17052 | 1881 | 17230 | 1228 | 20154 | 977 | 12627 |
| 12-#11 | 1.95 | MA | 14665 | 4058 | 23643 | 2996 | 25451 | 2434 | 25856 | 1996 | 25618 | 1354 | 30750 | 958 | 20870 |
| 6L-2S | | MI | 9857 | 4058 | 16287 | 2862 | 17532 | 2305 | 18012 | 1874 | 18499 | 1221 | 21795 | 1066 | 12596 |
| 12-#14 | 2.81 | MA | 17244 | 4352 | 28857 | 3158 | 32122 | 2557 | 33957 | 2073 | 36505 | 1322 | 44448 | 1049 | 31703 |
| 3L-5S | | MI | 9129 | 4352 | 15611 | 3021 | 16612 | 2424 | 16908 | 1936 | 17142 | 1190 | 20281 | 642 | 16611 |
| 12-#14 | 2.81 | MA | 16468 | 4352 | 27480 | 3176 | 30371 | 2553 | 31832 | 2067 | 33757 | 1332 | 41328 | 921 | 31003 |
| 4E | | MI | 9519 | 4352 | 16274 | 3030 | 17436 | 2414 | 17889 | 1926 | 18407 | 1180 | 21874 | 703 | 17167 |
| 12-#14 | 2.81 | MA | 15773 | 4352 | 26272 | 3174 | 28813 | 2569 | 29925 | 2080 | 31046 | 1322 | 38051 | 860 | 29496 |
| 5L-3S | | MI | 9950 | 4352 | 17024 | 3020 | 18358 | 2424 | 18981 | 1936 | 19775 | 1170 | 23383 | 818 | 17663 |
| 12-#14 | 2.81 | MA | 15110 | 4352 | 25132 | 3172 | 27265 | 2564 | 28036 | 2074 | 28556 | 1332 | 34949 | 775 | 28058 |
| 6L-2S | | MI | 10536 | 4352 | 17937 | 3029 | 19493 | 2414 | 20332 | 1926 | 21561 | 1160 | 25681 | 946 | 17663 |
| 12-#18 | 5.00 | MA | 18481 | 5097 | 32925 | 3630 | 37213 | 2879 | 40113 | 2263 | 44786 | 1267 | 56258 | 552 | 50503 |
| 4E | | MI | 10429 | 5097 | 18984 | 3446 | 20691 | 2685 | 21744 | 2051 | 23550 | 1026 | 28470 | 182 | 27339 |
| 12-#18 | 5.00 | MA | 17312 | 5097 | 30804 | 3625 | 34478 | 2904 | 36766 | 2284 | 40089 | 1250 | 50582 | 446 | 47171 |
| 5L-3S | | MI | 11154 | 5097 | 20258 | 3429 | 22251 | 2702 | 23590 | 2069 | 25864 | 1008 | 31007 | 379 | 29104 |
| 12-#18 | 5.00 | MA | 16196 | 5097 | 28801 | 3619 | 31759 | 2894 | 33449 | 2270 | 35775 | 1267 | 45240 | 295 | 43630 |
| 6L-2S | | MI | 12138 | 5097 | 21807 | 3446 | 24168 | 2685 | 25875 | 2051 | 28883 | 990 | 34853 | 607 | 29898 |
| 14-#11 | 2.27 | MA | 16735 | 4169 | 27438 | 3055 | 30365 | 2478 | 31841 | 2025 | 33699 | 1340 | 40796 | 1132 | 25977 |
| 3L-6S | | MI | 8874 | 4169 | 14828 | 2935 | 15708 | 2354 | 15874 | 1915 | 15682 | 1219 | 18525 | 760 | 13934 |
| 14-#11 | 2.27 | MA | 16187 | 4169 | 26477 | 3067 | 29143 | 2475 | 30358 | 2021 | 31773 | 1347 | 38597 | 1044 | 25844 |
| 4L-5S | | MI | 9139 | 4169 | 15295 | 2927 | 16291 | 2361 | 16540 | 1908 | 16564 | 1212 | 19582 | 820 | 14153 |
| 14-#11 | 2.27 | MA | 15696 | 4169 | 25634 | 3066 | 28056 | 2487 | 29027 | 2031 | 29874 | 1340 | 36295 | 1000 | 25036 |
| 5L-4S | | MI | 9415 | 4169 | 15760 | 2933 | 16877 | 2354 | 17237 | 1901 | 17527 | 1219 | 20720 | 862 | 14586 |
| 14-#11 | 2.27 | MA | 15228 | 4169 | 24839 | 3065 | 26976 | 2484 | 27710 | 2027 | 28130 | 1348 | 34110 | 942 | 24397 |
| 6L-3S | | MI | 9719 | 4169 | 16287 | 2925 | 17532 | 2361 | 18012 | 1908 | 18499 | 1212 | 21795 | 943 | 14594 |
| 14-#11 | 2.27 | MA | 14772 | 4169 | 23988 | 3078 | 25938 | 2495 | 26438 | 2037 | 26422 | 1355 | 31836 | 854 | 23444 |
| 7L-2S | | MI | 10135 | 4169 | 16929 | 2931 | 18339 | 2354 | 18973 | 1901 | 19768 | 1205 | 23436 | 1032 | 14573 |
| 14-#14 | 3.28 | MA | 17247 | 4512 | 29191 | 3276 | 32552 | 2625 | 34484 | 2112 | 37339 | 1322 | 46102 | 896 | 35944 |
| 4L-5S | | MI | 9526 | 4512 | 16524 | 3120 | 17746 | 2493 | 18260 | 1974 | 18928 | 1165 | 22579 | 590 | 19261 |
| 14-#14 | 3.28 | MA | 16559 | 4512 | 27983 | 3273 | 30995 | 2641 | 32576 | 2125 | 34629 | 1312 | 42824 | 835 | 34513 |
| 5L-4S | | MI | 9913 | 4512 | 17187 | 3130 | 18570 | 2483 | 19241 | 1964 | 20192 | 1155 | 24172 | 650 | 19769 |
| 14-#14 | 3.28 | MA | 15903 | 4512 | 26843 | 3271 | 29446 | 2637 | 30688 | 2119 | 32138 | 1322 | 39722 | 750 | 32990 |
| 6L-3S | | MI | 10340 | 4512 | 17937 | 3120 | 19493 | 2493 | 20332 | 1974 | 21561 | 1146 | 25681 | 765 | 20422 |
| 14-#14 | 3.28 | MA | 15263 | 4512 | 25623 | 3289 | 27958 | 2652 | 28865 | 2132 | 29701 | 1332 | 36492 | 623 | 31496 |
| 7L-2S | | MI | 10922 | 4512 | 18850 | 3129 | 20627 | 2483 | 21684 | 1964 | 23347 | 1136 | 27979 | 893 | 20454 |
| 14-#18 | 5.83 | MA | 18643 | 5381 | 33796 | 3802 | 38293 | 3033 | 41402 | 2364 | 46294 | 1227 | 58813 | 394 | 55710 |
| 5L-4S | | MI | 11088 | 5381 | 20533 | 3621 | 22607 | 2803 | 24028 | 2114 | 26569 | 976 | 32316 | 76 | 31839 |
| 14-#18 | 5.83 | MA | 17545 | 5381 | 31793 | 3796 | 35573 | 3023 | 38086 | 2350 | 41980 | 1245 | 53471 | 243 | 52090 |
| 6L-3S | | MI | 11805 | 5381 | 21807 | 3603 | 24168 | 2821 | 25875 | 2131 | 28883 | 958 | 34853 | 273 | 33439 |
| 16-#11 | 2.60 | MA | 16738 | 4280 | 27673 | 3136 | 30668 | 2526 | 32212 | 2052 | 34284 | 1340 | 41957 | 1027 | 29436 |
| 4L-6S | | MI | 9158 | 4280 | 15471 | 3004 | 16514 | 2403 | 16834 | 1942 | 16951 | 1203 | 20166 | 726 | 15788 |
| 16-#11 | 2.60 | MA | 16251 | 4280 | 26830 | 3135 | 29581 | 2537 | 30881 | 2062 | 32386 | 1334 | 39655 | 984 | 28542 |
| 5E | | MI | 9420 | 4280 | 15938 | 2996 | 17097 | 2410 | 17500 | 1935 | 17833 | 1196 | 21223 | 786 | 16026 |
| 16-#11 | 2.60 | MA | 15787 | 4280 | 26035 | 3134 | 28500 | 2534 | 29563 | 2058 | 30641 | 1341 | 37470 | 925 | 27929 |
| 6L-4S | | MI | 9695 | 4280 | 16403 | 3002 | 17683 | 2403 | 18197 | 1928 | 18795 | 1203 | 22361 | 828 | 16476 |
| 16-#11 | 2.60 | MA | 15334 | 4280 | 25184 | 3147 | 27463 | 2546 | 28292 | 2068 | 28934 | 1348 | 35196 | 838 | 26924 |
| 7L-3S | | MI | 9997 | 4280 | 16929 | 2995 | 18339 | 2410 | 18973 | 1935 | 19768 | 1196 | 23436 | 909 | 16556 |
| 16-#11 | 2.60 | MA | 14888 | 4280 | 24403 | 3146 | 26416 | 2543 | 27047 | 2078 | 27145 | 1341 | 33045 | 787 | 26029 |
| 8L-2S | | MI | 10412 | 4280 | 17572 | 3000 | 19145 | 2403 | 19933 | 1928 | 21037 | 1190 | 25077 | 998 | 16544 |
| 16-#14 | 3.75 | MA | 17337 | 4671 | 29694 | 3373 | 33176 | 2713 | 35228 | 2170 | 38211 | 1301 | 47598 | 809 | 39541 |
| 5E | | MI | 9919 | 4671 | 17437 | 3220 | 18880 | 2562 | 19611 | 2012 | 20714 | 1141 | 24877 | 537 | 21918 |
| 16-#14 | 3.75 | MA | 16688 | 4671 | 28554 | 3371 | 31627 | 2709 | 33339 | 2164 | 35720 | 1311 | 44496 | 725 | 37935 |
| 6L-4S | | MI | 10304 | 4671 | 18100 | 3230 | 19704 | 2552 | 20592 | 2002 | 21978 | 1131 | 26470 | 597 | 22386 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

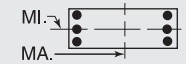
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.75 | MA | 16055 | 4671 | 27334 | 3389 | 30140 | 2725 | 31517 | 2177 | 33283 | 1321 | 41266 | 598 | 36391 |
| 7L-3S | | MI | 10727 | 4671 | 18850 | 3219 | 20627 | 2562 | 21684 | 2012 | 23347 | 1121 | 27979 | 713 | 23173 |
| 16-#14 | 3.75 | MA | 15431 | 4671 | 26214 | 3387 | 28639 | 2720 | 29732 | 2191 | 30730 | 1311 | 38204 | 526 | 34394 |
| 8L-2S | | MI | 11306 | 4671 | 19763 | 3229 | 21761 | 2552 | 23035 | 2002 | 25133 | 1111 | 30277 | 841 | 23227 |
| 16-#18 | 6.67 | MA | 18877 | 5664 | 34784 | 3974 | 39387 | 3152 | 42723 | 2430 | 48185 | 1223 | 61702 | 191 | 60576 |
| 6L-4S | | MI | 11804 | 5664 | 22082 | 3795 | 24524 | 2922 | 26313 | 2176 | 29589 | 927 | 36162 | -31 | 35982 |
| 18-#11 | 2.92 | MA | 16801 | 4390 | 28026 | 3204 | 31106 | 2587 | 32735 | 2093 | 34897 | 1327 | 43015 | 968 | 32055 |
| 5L-6S | | MI | 9439 | 4390 | 16114 | 3073 | 17320 | 2452 | 17795 | 1969 | 18220 | 1188 | 21807 | 692 | 17603 |
| 18-#11 | 2.92 | MA | 16341 | 4390 | 27231 | 3203 | 30025 | 2584 | 31417 | 2089 | 33152 | 1334 | 40830 | 909 | 31466 |
| 6L-5S | | MI | 9701 | 4390 | 16580 | 3066 | 17903 | 2458 | 18461 | 1962 | 19102 | 1181 | 22864 | 752 | 17903 |
| 18-#11 | 2.92 | MA | 15892 | 4390 | 26380 | 3216 | 28988 | 2596 | 30146 | 2099 | 31445 | 1341 | 38556 | 821 | 30411 |
| 7L-4S | | MI | 9973 | 4390 | 17046 | 3072 | 18489 | 2452 | 19158 | 1955 | 20064 | 1188 | 24002 | 794 | 18322 |
| 18-#11 | 2.92 | MA | 15449 | 4390 | 25599 | 3215 | 27941 | 2593 | 28901 | 2109 | 29657 | 1334 | 36405 | 771 | 29479 |
| 8L-3S | | MI | 10274 | 4390 | 17572 | 3064 | 19145 | 2458 | 19933 | 1962 | 21037 | 1181 | 25077 | 875 | 18504 |
| 18-#11 | 2.92 | MA | 15004 | 4390 | 24772 | 3227 | 26918 | 2605 | 27613 | 2105 | 27967 | 1341 | 34288 | 715 | 28325 |
| 9L-2S | | MI | 10686 | 4390 | 18215 | 3070 | 19951 | 2452 | 20893 | 1955 | 22306 | 1174 | 26717 | 964 | 18509 |
| 18-#14 | 4.22 | MA | 17466 | 4831 | 30265 | 3471 | 33808 | 2781 | 35991 | 2209 | 39302 | 1301 | 49269 | 699 | 42893 |
| 6L-5S | | MI | 10310 | 4831 | 18350 | 3320 | 20014 | 2631 | 20962 | 2050 | 22500 | 1117 | 27175 | 484 | 24507 |
| 18-#14 | 4.22 | MA | 16839 | 4831 | 29044 | 3489 | 32321 | 2797 | 34168 | 2222 | 36865 | 1311 | 46039 | 572 | 41298 |
| 7L-4S | | MI | 10692 | 4831 | 19013 | 3329 | 20838 | 2621 | 21943 | 2040 | 23764 | 1107 | 28768 | 545 | 25014 |
| 18-#14 | 4.22 | MA | 16221 | 4831 | 27925 | 3486 | 30820 | 2793 | 32383 | 2236 | 34312 | 1301 | 42977 | 501 | 39354 |
| 8L-3S | | MI | 11113 | 4831 | 19763 | 3319 | 21761 | 2631 | 23035 | 2050 | 25133 | 1097 | 30277 | 660 | 25917 |
| 18-#14 | 4.22 | MA | 15601 | 4831 | 26740 | 3504 | 29353 | 2808 | 30537 | 2229 | 31899 | 1311 | 39972 | 419 | 37094 |
| 9L-2S | | MI | 11688 | 4831 | 20676 | 3329 | 22895 | 2621 | 24386 | 2040 | 26919 | 1087 | 32575 | 788 | 25993 |
| 20-#11 | 3.25 | MA | 16890 | 4501 | 28427 | 3272 | 31550 | 2635 | 33271 | 2120 | 35664 | 1327 | 44190 | 893 | 35007 |
| 6E | | MI | 9719 | 4501 | 16757 | 3143 | 18126 | 2500 | 18755 | 1997 | 19489 | 1172 | 23448 | 658 | 19426 |
| 20-#11 | 3.25 | MA | 16445 | 4501 | 27576 | 3285 | 30513 | 2646 | 31999 | 2130 | 33956 | 1334 | 41916 | 805 | 33905 |
| 7L-5S | | MI | 9979 | 4501 | 17223 | 3135 | 18709 | 2507 | 19421 | 1990 | 20370 | 1165 | 24505 | 718 | 19785 |
| 20-#11 | 3.25 | MA | 16006 | 4501 | 26795 | 3284 | 29466 | 2643 | 30754 | 2140 | 32168 | 1327 | 39765 | 755 | 32936 |
| 8L-4S | | MI | 10250 | 4501 | 17688 | 3141 | 19295 | 2500 | 20118 | 1983 | 21333 | 1172 | 25642 | 759 | 20175 |
| 20-#11 | 3.25 | MA | 15562 | 4501 | 25968 | 3297 | 28443 | 2655 | 29466 | 2136 | 30478 | 1335 | 37648 | 698 | 31811 |
| 9L-3S | | MI | 10550 | 4501 | 18215 | 3133 | 19951 | 2507 | 20893 | 1990 | 22306 | 1165 | 26717 | 841 | 20450 |
| 20-#11 | 3.25 | MA | 15086 | 4501 | 25191 | 3295 | 27409 | 2652 | 28229 | 2146 | 28801 | 1342 | 35596 | 635 | 30453 |
| 10L-2S | | MI | 10960 | 4501 | 18858 | 3139 | 20757 | 2500 | 21854 | 1983 | 23575 | 1158 | 28358 | 930 | 20470 |
| 20-#14 | 4.69 | MA | 17615 | 4990 | 30755 | 3588 | 34502 | 2869 | 36820 | 2267 | 40447 | 1300 | 50813 | 547 | 46215 |
| 7L-5S | | MI | 10698 | 4990 | 19263 | 3420 | 21148 | 2700 | 22314 | 2088 | 24285 | 1093 | 29473 | 432 | 27056 |
| 20-#14 | 4.69 | MA | 17004 | 4990 | 29635 | 3586 | 33001 | 2865 | 35035 | 2281 | 37894 | 1290 | 47751 | 475 | 44322 |
| 8L-4S | | MI | 11078 | 4990 | 19926 | 3429 | 21972 | 2691 | 23295 | 2078 | 25550 | 1083 | 31066 | 492 | 27651 |
| 20-#14 | 4.69 | MA | 16385 | 4990 | 28451 | 3604 | 31534 | 2881 | 33189 | 2274 | 35481 | 1300 | 44746 | 394 | 42031 |
| 9L-3S | | MI | 11496 | 4990 | 20676 | 3419 | 22895 | 2700 | 24386 | 2088 | 26919 | 1073 | 32575 | 607 | 28656 |
| 22-#11 | 3.57 | MA | 16994 | 4612 | 28772 | 3354 | 32038 | 2696 | 33853 | 2161 | 36468 | 1327 | 45276 | 789 | 37404 |
| 7L-6S | | MI | 9998 | 4612 | 17399 | 3212 | 18932 | 2549 | 19715 | 2024 | 20757 | 1157 | 25088 | 624 | 21257 |
| 22-#11 | 3.57 | MA | 16558 | 4612 | 27991 | 3353 | 30991 | 2694 | 32608 | 2171 | 34679 | 1320 | 43125 | 738 | 36400 |
| 8L-5S | | MI | 10256 | 4612 | 17866 | 3204 | 19515 | 2556 | 20381 | 2017 | 21639 | 1150 | 26145 | 684 | 21670 |
| 22-#11 | 3.57 | MA | 16115 | 4612 | 27164 | 3366 | 29968 | 2705 | 31320 | 2167 | 32989 | 1328 | 41008 | 682 | 35301 |
| 9L-4S | | MI | 10526 | 4612 | 18331 | 3210 | 20101 | 2549 | 21078 | 2010 | 22602 | 1157 | 27283 | 725 | 22035 |
| 22-#11 | 3.57 | MA | 15643 | 4612 | 26387 | 3365 | 28934 | 2702 | 30083 | 2177 | 31312 | 1335 | 38956 | 618 | 33921 |
| 10L-3S | | MI | 10824 | 4612 | 18858 | 3202 | 20757 | 2556 | 21854 | 2017 | 23575 | 1150 | 28358 | 807 | 22391 |
| 22-#14 | 5.16 | MA | 17779 | 5150 | 31346 | 3686 | 35183 | 2937 | 37687 | 2326 | 41476 | 1280 | 52524 | 450 | 49233 |
| 8L-5S | | MI | 11085 | 5150 | 20176 | 3519 | 22282 | 2770 | 23665 | 2126 | 26071 | 1068 | 31771 | 379 | 29617 |
| 22-#14 | 5.16 | MA | 17162 | 5150 | 30161 | 3704 | 33716 | 2953 | 35840 | 2319 | 39064 | 1290 | 49519 | 368 | 46977 |
| 9L-4S | | MI | 11461 | 5150 | 20839 | 3529 | 23107 | 2760 | 24646 | 2116 | 27336 | 1058 | 33365 | 439 | 30296 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

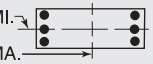
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 3.90 | MA | 17106 | 4722 | 29187 | 3422 | 32516 | 2744 | 34462 | 2202 | 37190 | 1314 | 46485 | 722 | 39869 |
| 8L-6S | | MI | 10275 | 4722 | 18042 | 3281 | 19738 | 2598 | 20676 | 2051 | 22026 | 1141 | 26729 | 590 | 23093 |
| 24-#11 | 3.90 | MA | 16664 | 4722 | 28360 | 3435 | 31492 | 2755 | 33174 | 2199 | 35501 | 1321 | 44368 | 666 | 38796 |
| 9L-5S | | MI | 10532 | 4722 | 18509 | 3273 | 20321 | 2604 | 21341 | 2044 | 22908 | 1134 | 27786 | 650 | 23557 |
| 24-#11 | 3.90 | MA | 16195 | 4722 | 27583 | 3434 | 30459 | 2752 | 31937 | 2208 | 33823 | 1328 | 42316 | 602 | 37394 |
| 10L-4S | | MI | 10801 | 4722 | 18974 | 3279 | 20907 | 2598 | 22038 | 2037 | 23871 | 1141 | 28924 | 691 | 23900 |
| 24-#14 | 5.63 | MA | 17932 | 5310 | 31872 | 3803 | 35897 | 3025 | 38492 | 2364 | 42646 | 1279 | 54293 | 343 | 51929 |
| 9L-5S | | MI | 11469 | 5310 | 21089 | 3619 | 23417 | 2839 | 25016 | 2164 | 27857 | 1044 | 34069 | 326 | 32189 |

## RECTANGULAR TIED COLUMNS 24" x 42"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.59 | MA | 17950 | 4132 | 28763 | 3035 | 31469 | 2462 | 32620 | 2033 | 33673 | 1399 | 40200 | 1295 | 20004 |
| 2E | | MI | 9921 | 4132 | 16236 | 2868 | 17134 | 2309 | 17346 | 1885 | 17343 | 1253 | 20058 | 1095 | 10694 |
| 6-#14 | 1.34 | MA | 17560 | 4043 | 27772 | 2999 | 30316 | 2438 | 31261 | 2021 | 31945 | 1420 | 38004 | 1331 | 17119 |
| 2L-3S | | MI | 9167 | 4043 | 14908 | 2842 | 15590 | 2317 | 15538 | 1907 | 14960 | 1308 | 17083 | 1039 | 9323 |
| 6-#14 | 1.34 | MA | 16358 | 4043 | 25962 | 2997 | 28007 | 2454 | 28455 | 2035 | 28143 | 1430 | 32919 | 1203 | 17124 |
| 3L-2S | | MI | 9767 | 4043 | 15821 | 2852 | 16725 | 2307 | 16889 | 1898 | 16746 | 1298 | 19382 | 1167 | 9245 |
| 6-#18 | 2.38 | MA | 19389 | 4415 | 31932 | 3212 | 35509 | 2591 | 37532 | 2112 | 40279 | 1378 | 48984 | 1246 | 29664 |
| 2L-3S | | MI | 9572 | 4415 | 16236 | 3025 | 17134 | 2445 | 17346 | 1965 | 17343 | 1221 | 20058 | 761 | 15620 |
| 6-#18 | 2.38 | MA | 17336 | 4415 | 28763 | 3208 | 31469 | 2618 | 32620 | 2135 | 33673 | 1396 | 40200 | 1019 | 29380 |
| 3L-2S | | MI | 10589 | 4415 | 17786 | 3042 | 19051 | 2428 | 19630 | 1947 | 20362 | 1204 | 23904 | 988 | 15577 |
| 8-#11 | 1.24 | MA | 17399 | 4007 | 27357 | 2986 | 29843 | 2430 | 30707 | 2018 | 31203 | 1428 | 37111 | 1346 | 15930 |
| 2L-4S | | MI | 8970 | 4007 | 14453 | 2848 | 15094 | 2309 | 14969 | 1905 | 14264 | 1331 | 16395 | 1027 | 8744 |
| 8-#11 | 1.24 | MA | 16556 | 4007 | 26092 | 2985 | 28230 | 2428 | 28746 | 2028 | 28547 | 1435 | 33535 | 1258 | 15948 |
| 3E | | MI | 9281 | 4007 | 14980 | 2840 | 15749 | 2316 | 15744 | 1912 | 15237 | 1324 | 17470 | 1109 | 8692 |
| 8-#11 | 1.24 | MA | 15962 | 4007 | 25077 | 2998 | 26939 | 2439 | 27179 | 2025 | 26512 | 1443 | 31192 | 1169 | 15892 |
| 4L-2S | | MI | 9704 | 4007 | 15622 | 2846 | 16555 | 2309 | 16704 | 1905 | 16506 | 1318 | 19111 | 1198 | 8641 |
| 8-#14 | 1.79 | MA | 18398 | 4203 | 29583 | 3099 | 32624 | 2510 | 34067 | 2066 | 35746 | 1410 | 43089 | 1307 | 22649 |
| 2L-4S | | MI | 9130 | 4203 | 15071 | 2952 | 15802 | 2376 | 15798 | 1935 | 15377 | 1294 | 17872 | 871 | 12155 |
| 8-#14 | 1.79 | MA | 17208 | 4203 | 27772 | 3097 | 30316 | 2527 | 31261 | 2080 | 31945 | 1420 | 38004 | 1179 | 22602 |
| 3E | | MI | 9568 | 4203 | 15821 | 2942 | 16725 | 2386 | 16889 | 1945 | 16746 | 1284 | 19382 | 987 | 12143 |
| 8-#14 | 1.79 | MA | 16368 | 4203 | 26317 | 3115 | 28466 | 2523 | 29015 | 2075 | 29029 | 1431 | 34676 | 1051 | 22342 |
| 4L-2S | | MI | 10164 | 4203 | 16734 | 2951 | 17859 | 2376 | 18241 | 1935 | 18532 | 1274 | 21680 | 1115 | 12086 |
| 8-#18 | 3.17 | MA | 20801 | 4699 | 35101 | 3390 | 39549 | 2719 | 42443 | 2192 | 46884 | 1358 | 57768 | 1198 | 39276 |
| 2L-4S | | MI | 9501 | 4699 | 16511 | 3217 | 17490 | 2546 | 17783 | 2010 | 18049 | 1189 | 21367 | 457 | 18625 |
| 8-#18 | 3.17 | MA | 18779 | 4699 | 31932 | 3385 | 35509 | 2746 | 37532 | 2215 | 40279 | 1376 | 48984 | 970 | 38868 |
| 3E | | MI | 10243 | 4699 | 17786 | 3199 | 19051 | 2564 | 19630 | 2028 | 20362 | 1172 | 23904 | 654 | 20358 |
| 8-#18 | 3.17 | MA | 17350 | 4699 | 29379 | 3416 | 32262 | 2737 | 33592 | 2203 | 35211 | 1393 | 43250 | 743 | 35404 |
| 4L-2S | | MI | 11249 | 4699 | 19335 | 3217 | 20968 | 2546 | 21914 | 2010 | 23382 | 1154 | 27750 | 882 | 20409 |
| 10-#11 | 1.55 | MA | 17990 | 4118 | 28622 | 3055 | 31456 | 2480 | 32668 | 2049 | 33860 | 1421 | 40688 | 1331 | 19797 |
| 2L-5S | | MI | 8977 | 4118 | 14631 | 2911 | 15314 | 2364 | 15232 | 1939 | 14571 | 1309 | 16898 | 952 | 10530 |
| 10-#11 | 1.55 | MA | 17154 | 4118 | 27357 | 3054 | 29843 | 2478 | 30707 | 2059 | 31203 | 1428 | 37111 | 1242 | 19790 |
| 3L-4S | | MI | 9256 | 4118 | 15096 | 2917 | 15900 | 2357 | 15929 | 1932 | 15533 | 1316 | 18036 | 993 | 10720 |
| 10-#11 | 1.55 | MA | 16564 | 4118 | 26342 | 3067 | 28552 | 2489 | 29140 | 2056 | 29169 | 1436 | 34768 | 1154 | 19705 |
| 4L-3S | | MI | 9565 | 4118 | 15622 | 2909 | 16555 | 2364 | 16704 | 1939 | 16506 | 1309 | 19111 | 1075 | 10685 |
| 10-#11 | 1.55 | MA | 16036 | 4118 | 25452 | 3067 | 27404 | 2487 | 27735 | 2066 | 27163 | 1430 | 32322 | 1110 | 19166 |
| 5L-2S | | MI | 9986 | 4118 | 16265 | 2915 | 17361 | 2357 | 17665 | 1932 | 17775 | 1302 | 20752 | 1164 | 10642 |
| 10-#14 | 2.23 | MA | 19226 | 4362 | 31394 | 3198 | 34933 | 2583 | 36874 | 2111 | 39548 | 1400 | 48174 | 1284 | 28159 |
| 2L-5S | | MI | 9137 | 4362 | 15321 | 3043 | 16112 | 2455 | 16168 | 1983 | 15899 | 1279 | 18577 | 758 | 14097 |
| 10-#14 | 2.23 | MA | 18048 | 4362 | 29583 | 3197 | 32624 | 2599 | 34067 | 2125 | 35746 | 1410 | 43089 | 1156 | 28068 |
| 3L-4S | | MI | 9531 | 4362 | 15984 | 3052 | 16936 | 2445 | 17149 | 1973 | 17163 | 1269 | 20171 | 818 | 14729 |
| 10-#14 | 2.23 | MA | 17217 | 4362 | 28128 | 3215 | 30774 | 2595 | 31822 | 2120 | 32831 | 1421 | 39761 | 1028 | 27759 |
| 4L-3S | | MI | 9965 | 4362 | 16734 | 3042 | 17859 | 2455 | 18241 | 1983 | 18532 | 1259 | 21680 | 934 | 14940 |
| 10-#14 | 2.23 | MA | 16473 | 4362 | 26852 | 3213 | 29129 | 2612 | 29807 | 2134 | 29956 | 1411 | 36277 | 965 | 26006 |
| 5L-2S | | MI | 10556 | 4362 | 17647 | 3051 | 18993 | 2445 | 19592 | 1973 | 20318 | 1249 | 23978 | 1062 | 14904 |
| 10-#18 | 3.97 | MA | 20198 | 4983 | 35101 | 3562 | 39549 | 2875 | 42443 | 2295 | 46884 | 1355 | 57768 | 922 | 48350 |
| 3L-4S | | MI | 10172 | 4983 | 18060 | 3392 | 19407 | 2665 | 20068 | 2072 | 21068 | 1140 | 25213 | 351 | 23060 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

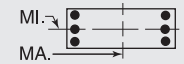
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.97 | MA | 18793 | 4983 | 32547 | 3593 | 36302 | 2866 | 38503 | 2282 | 41817 | 1373 | 52034 | 694 | 44550 |
| 4L-3S | | MI | 10907 | 4983 | 19335 | 3374 | 20968 | 2682 | 21914 | 2090 | 23382 | 1122 | 27750 | 548 | 25069 |
| 10-#18 | 3.97 | MA | 17533 | 4983 | 30306 | 3588 | 33412 | 2893 | 34964 | 2305 | 36818 | 1355 | 45990 | 587 | 41386 |
| 5L-2S | | MI | 11903 | 4983 | 20884 | 3392 | 22884 | 2665 | 24199 | 2072 | 26402 | 1104 | 31596 | 775 | 25205 |
| 12-#11 | 1.86 | MA | 18576 | 4228 | 29888 | 3124 | 33069 | 2530 | 34629 | 2080 | 36516 | 1414 | 44264 | 1316 | 23655 |
| 2L-6S | | MI | 8996 | 4228 | 14807 | 2988 | 15537 | 2406 | 15526 | 1973 | 14958 | 1300 | 17482 | 858 | 12144 |
| 12-#11 | 1.86 | MA | 17745 | 4228 | 28622 | 3124 | 31456 | 2528 | 32668 | 2091 | 33860 | 1421 | 40688 | 1227 | 23623 |
| 3L-5S | | MI | 9262 | 4228 | 15273 | 2981 | 16120 | 2413 | 16192 | 1966 | 15839 | 1293 | 18539 | 918 | 12387 |
| 12-#11 | 1.86 | MA | 17161 | 4228 | 27607 | 3137 | 30165 | 2539 | 31101 | 2087 | 31825 | 1429 | 38344 | 1139 | 23513 |
| 4E | | MI | 9541 | 4228 | 15739 | 2986 | 16706 | 2406 | 16889 | 1959 | 16802 | 1300 | 19677 | 959 | 12685 |
| 12-#11 | 1.86 | MA | 16637 | 4228 | 26717 | 3136 | 29017 | 2537 | 29696 | 2097 | 29820 | 1423 | 35899 | 1095 | 22856 |
| 5L-3S | | MI | 9847 | 4228 | 16265 | 2979 | 17361 | 2413 | 17665 | 1966 | 17775 | 1293 | 20752 | 1041 | 12665 |
| 12-#11 | 1.86 | MA | 16138 | 4228 | 25878 | 3135 | 27876 | 2549 | 28304 | 2094 | 27978 | 1431 | 33572 | 1036 | 22117 |
| 6L-2S | | MI | 10266 | 4228 | 16908 | 2985 | 18167 | 2406 | 18625 | 1959 | 19044 | 1286 | 22393 | 1130 | 12631 |
| 12-#14 | 2.68 | MA | 18877 | 4522 | 31394 | 3297 | 34933 | 2671 | 36874 | 2170 | 39548 | 1400 | 48174 | 1132 | 33526 |
| 3L-5S | | MI | 9537 | 4522 | 16234 | 3142 | 17246 | 2524 | 17519 | 2021 | 17684 | 1255 | 20875 | 705 | 16737 |
| 12-#14 | 2.68 | MA | 18056 | 4522 | 29939 | 3315 | 33083 | 2668 | 34628 | 2165 | 36633 | 1411 | 44847 | 1004 | 32983 |
| 4E | | MI | 9928 | 4522 | 16897 | 3152 | 18070 | 2514 | 18500 | 2011 | 18949 | 1245 | 22469 | 766 | 17311 |
| 12-#14 | 2.68 | MA | 17320 | 4522 | 28663 | 3313 | 31437 | 2684 | 32613 | 2179 | 33758 | 1401 | 41362 | 942 | 31307 |
| 5L-3S | | MI | 10359 | 4522 | 17647 | 3141 | 18993 | 2524 | 19592 | 2021 | 20318 | 1235 | 23978 | 881 | 17718 |
| 12-#14 | 2.68 | MA | 16618 | 4522 | 27459 | 3311 | 29801 | 2680 | 30618 | 2173 | 31117 | 1411 | 38056 | 857 | 29915 |
| 6L-2S | | MI | 10946 | 4522 | 18560 | 3151 | 20127 | 2514 | 20943 | 2011 | 22103 | 1225 | 26276 | 1009 | 17707 |
| 12-#18 | 4.76 | MA | 20212 | 5267 | 35716 | 3770 | 40342 | 2995 | 43415 | 2362 | 48423 | 1352 | 60818 | 646 | 53735 |
| 4E | | MI | 10837 | 5267 | 19609 | 3566 | 21324 | 2783 | 22352 | 2135 | 24088 | 1090 | 29059 | 244 | 27532 |
| 12-#18 | 4.76 | MA | 18973 | 5267 | 33475 | 3765 | 37452 | 3021 | 39876 | 2385 | 43424 | 1335 | 54774 | 538 | 50418 |
| 5L-3S | | MI | 11565 | 5267 | 20884 | 3548 | 22884 | 2801 | 24199 | 2153 | 26402 | 1073 | 31596 | 441 | 29361 |
| 12-#18 | 4.76 | MA | 17791 | 5267 | 31358 | 3761 | 34578 | 3013 | 36370 | 2372 | 38831 | 1352 | 49070 | 387 | 46795 |
| 6L-2S | | MI | 12551 | 5267 | 22433 | 3566 | 24801 | 2783 | 26483 | 2135 | 29422 | 1055 | 35442 | 669 | 29967 |
| 14-#11 | 2.17 | MA | 18332 | 4339 | 29888 | 3193 | 33069 | 2578 | 34629 | 2122 | 36516 | 1415 | 44264 | 1212 | 27451 |
| 3L-6S | | MI | 9281 | 4339 | 15450 | 3058 | 16343 | 2455 | 16487 | 2000 | 16226 | 1285 | 19123 | 824 | 14029 |
| 14-#11 | 2.17 | MA | 17752 | 4339 | 28872 | 3206 | 31778 | 2590 | 33062 | 2118 | 34482 | 1422 | 41921 | 1124 | 27318 |
| 4L-5S | | MI | 9546 | 4339 | 15916 | 3050 | 16926 | 2462 | 17152 | 1993 | 17108 | 1278 | 20180 | 884 | 14253 |
| 14-#11 | 2.17 | MA | 17233 | 4339 | 27983 | 3205 | 30630 | 2588 | 31656 | 2129 | 32476 | 1416 | 39475 | 1080 | 26556 |
| 5L-4S | | MI | 9823 | 4339 | 16382 | 3056 | 17512 | 2455 | 17850 | 1986 | 18071 | 1285 | 21317 | 925 | 14637 |
| 14-#11 | 2.17 | MA | 16738 | 4339 | 27143 | 3204 | 29489 | 2599 | 30265 | 2125 | 30634 | 1424 | 37148 | 1021 | 25850 |
| 6L-3S | | MI | 10128 | 4339 | 16908 | 3048 | 18167 | 2462 | 18625 | 1993 | 19044 | 1278 | 22393 | 1007 | 14635 |
| 14-#11 | 2.17 | MA | 16255 | 4339 | 26244 | 3217 | 28394 | 2597 | 28923 | 2136 | 28831 | 1432 | 34727 | 934 | 24929 |
| 7L-2S | | MI | 10545 | 4339 | 17551 | 3054 | 18973 | 2455 | 19585 | 1986 | 20312 | 1271 | 24033 | 1096 | 14610 |
| 14-#14 | 3.13 | MA | 18885 | 4681 | 31749 | 3415 | 35391 | 2740 | 37434 | 2209 | 40435 | 1401 | 49932 | 980 | 38216 |
| 4L-5S | | MI | 9933 | 4681 | 17147 | 3242 | 18380 | 2593 | 18871 | 2059 | 19470 | 1231 | 23173 | 653 | 19387 |
| 14-#14 | 3.13 | MA | 18157 | 4681 | 30474 | 3413 | 33746 | 2756 | 35419 | 2224 | 37560 | 1391 | 46447 | 918 | 36621 |
| 5L-4S | | MI | 10322 | 4681 | 17810 | 3252 | 19204 | 2583 | 19852 | 2049 | 20735 | 1221 | 24767 | 713 | 19911 |
| 14-#14 | 3.13 | MA | 17463 | 4681 | 29269 | 3411 | 32110 | 2753 | 33424 | 2218 | 34919 | 1401 | 43141 | 834 | 35142 |
| 6L-3S | | MI | 10750 | 4681 | 18560 | 3241 | 20127 | 2593 | 20943 | 2059 | 22103 | 1211 | 26276 | 829 | 20481 |
| 14-#14 | 3.13 | MA | 16786 | 4681 | 27981 | 3429 | 30539 | 2769 | 31499 | 2232 | 32333 | 1412 | 39699 | 707 | 33504 |
| 7L-2S | | MI | 11333 | 4681 | 19473 | 3251 | 21261 | 2583 | 22295 | 2049 | 23889 | 1201 | 28574 | 957 | 20500 |
| 14-#18 | 5.56 | MA | 20392 | 5550 | 36644 | 3943 | 41492 | 3150 | 44787 | 2465 | 50029 | 1314 | 63558 | 490 | 59482 |
| 5L-4S | | MI | 11497 | 5550 | 21158 | 3741 | 23241 | 2902 | 24637 | 2197 | 27108 | 1041 | 32905 | 138 | 32030 |
| 14-#18 | 5.56 | MA | 19229 | 5550 | 34527 | 3938 | 38618 | 3141 | 41282 | 2452 | 45437 | 1332 | 57853 | 339 | 55810 |
| 6L-3S | | MI | 12217 | 5550 | 22433 | 3723 | 24801 | 2920 | 26483 | 2215 | 29422 | 1023 | 35442 | 335 | 33691 |
| 14-#18 | 5.56 | MA | 18093 | 5550 | 32261 | 3969 | 35857 | 3168 | 37899 | 2475 | 40943 | 1350 | 51912 | 114 | 51137 |
| 7L-2S | | MI | 13194 | 5550 | 23982 | 3741 | 26718 | 2902 | 28768 | 2197 | 32441 | 1005 | 39288 | 562 | 34712 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

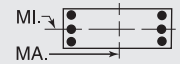


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.48 | MA | 18338 | 4449 | 30138 | 3275 | 33391 | 2640 | 35023 | 2149 | 37138 | 1415 | 45497 | 1108 | 31121 |
| 4L-6S | | MI | 9565 | 4449 | 16093 | 3127 | 17149 | 2503 | 17447 | 2027 | 17495 | 1269 | 20764 | 789 | 15917 |
| 16-#11 | 2.48 | MA | 17823 | 4449 | 29248 | 3274 | 32243 | 2638 | 33617 | 2160 | 35133 | 1409 | 43051 | 1065 | 30267 |
| 5E | | MI | 9828 | 4449 | 16559 | 3119 | 17732 | 2510 | 18113 | 2021 | 18377 | 1262 | 21821 | 850 | 16125 |
| 16-#11 | 2.48 | MA | 17332 | 4449 | 28408 | 3273 | 31102 | 2649 | 32226 | 2156 | 33291 | 1417 | 40725 | 1006 | 29590 |
| 6L-4S | | MI | 10104 | 4449 | 17024 | 3125 | 18318 | 2503 | 18810 | 2014 | 19340 | 1269 | 22958 | 891 | 16582 |
| 16-#11 | 2.48 | MA | 16853 | 4449 | 27510 | 3286 | 30007 | 2647 | 30884 | 2167 | 31488 | 1425 | 38303 | 919 | 28615 |
| 7L-3S | | MI | 10407 | 4449 | 17551 | 3117 | 18973 | 2510 | 19585 | 2021 | 20312 | 1262 | 24033 | 973 | 16599 |
| 16-#11 | 2.48 | MA | 16381 | 4449 | 26686 | 3285 | 28902 | 2659 | 29570 | 2177 | 29600 | 1419 | 36018 | 868 | 27720 |
| 8L-2S | | MI | 10822 | 4449 | 18194 | 3123 | 19779 | 2503 | 20546 | 2014 | 21581 | 1255 | 25674 | 1062 | 16583 |
| 16-#14 | 3.57 | MA | 18986 | 4841 | 32284 | 3513 | 36054 | 2828 | 38226 | 2269 | 41362 | 1381 | 51533 | 895 | 41946 |
| 5E | | MI | 10327 | 4841 | 18060 | 3342 | 19514 | 2662 | 20222 | 2097 | 21256 | 1206 | 25471 | 600 | 22044 |
| 16-#14 | 3.57 | MA | 18299 | 4841 | 31080 | 3511 | 34418 | 2825 | 36230 | 2263 | 38720 | 1391 | 48226 | 810 | 40383 |
| 6L-4S | | MI | 10713 | 4841 | 18723 | 3351 | 20339 | 2652 | 21203 | 2087 | 22521 | 1196 | 27065 | 660 | 22527 |
| 16-#14 | 3.57 | MA | 17629 | 4841 | 29791 | 3529 | 32848 | 2841 | 34306 | 2277 | 36135 | 1402 | 44784 | 684 | 38800 |
| 7L-3S | | MI | 11138 | 4841 | 19473 | 3341 | 21261 | 2662 | 22295 | 2097 | 23889 | 1187 | 28574 | 776 | 23236 |
| 16-#14 | 3.57 | MA | 16968 | 4841 | 28609 | 3528 | 31262 | 2837 | 32421 | 2292 | 33428 | 1392 | 41528 | 611 | 36668 |
| 8L-2S | | MI | 11718 | 4841 | 20386 | 3350 | 22395 | 2652 | 23646 | 2087 | 25675 | 1177 | 30872 | 904 | 23280 |
| 16-#18 | 6.35 | MA | 20647 | 5834 | 37696 | 4115 | 42658 | 3270 | 46193 | 2532 | 52043 | 1312 | 66637 | 290 | 64824 |
| 6L-4S | | MI | 12216 | 5834 | 22707 | 3915 | 25157 | 3020 | 26921 | 2260 | 30127 | 991 | 36751 | 32 | 36549 |
| 16-#18 | 6.35 | MA | 19528 | 5834 | 35430 | 4146 | 39897 | 3297 | 42810 | 2555 | 47548 | 1329 | 60696 | 65 | 60287 |
| 7L-3S | | MI | 12910 | 5834 | 23982 | 3898 | 26718 | 3038 | 28768 | 2278 | 32441 | 973 | 39288 | 228 | 38061 |
| 18-#11 | 2.79 | MA | 18409 | 4560 | 30513 | 3343 | 33856 | 2688 | 35578 | 2191 | 37789 | 1403 | 46628 | 1049 | 33985 |
| 5L-6S | | MI | 9847 | 4560 | 16735 | 3196 | 17955 | 2552 | 18407 | 2055 | 18764 | 1253 | 22404 | 755 | 17762 |
| 18-#11 | 2.79 | MA | 17922 | 4560 | 29673 | 3342 | 32715 | 2699 | 34187 | 2187 | 35947 | 1410 | 44301 | 991 | 33334 |
| 6L-5S | | MI | 10109 | 4560 | 17202 | 3188 | 18538 | 2559 | 19073 | 2048 | 19646 | 1247 | 23461 | 816 | 18003 |
| 18-#11 | 2.79 | MA | 17447 | 4560 | 28775 | 3355 | 31620 | 2697 | 32845 | 2198 | 34144 | 1418 | 41880 | 903 | 32307 |
| 7L-4S | | MI | 10383 | 4560 | 17667 | 3194 | 19124 | 2552 | 19770 | 2041 | 20609 | 1253 | 24599 | 857 | 18437 |
| 18-#11 | 2.79 | MA | 16978 | 4560 | 27951 | 3355 | 30515 | 2709 | 31530 | 2208 | 32256 | 1412 | 39594 | 852 | 31412 |
| 8L-3S | | MI | 10684 | 4560 | 18194 | 3186 | 19779 | 2559 | 20546 | 2048 | 21581 | 1247 | 25674 | 939 | 18553 |
| 18-#11 | 2.79 | MA | 16500 | 4560 | 27078 | 3368 | 29435 | 2707 | 30171 | 2205 | 30472 | 1420 | 37340 | 796 | 30141 |
| 9L-2S | | MI | 11097 | 4560 | 18836 | 3192 | 20585 | 2552 | 21506 | 2041 | 22850 | 1240 | 27315 | 1028 | 18551 |
| 18-#14 | 4.02 | MA | 19126 | 5001 | 32891 | 3611 | 36727 | 2897 | 39037 | 2308 | 42522 | 1382 | 53311 | 786 | 45636 |
| 6L-5S | | MI | 10719 | 5001 | 18973 | 3442 | 20649 | 2731 | 21574 | 2135 | 23042 | 1182 | 27770 | 547 | 24708 |
| 18-#14 | 4.02 | MA | 18463 | 5001 | 31602 | 3629 | 35156 | 2913 | 37112 | 2322 | 39937 | 1392 | 49870 | 660 | 44073 |
| 7L-4S | | MI | 11102 | 5001 | 19636 | 3451 | 21473 | 2721 | 22555 | 2125 | 24306 | 1172 | 29363 | 608 | 25154 |
| 18-#14 | 4.02 | MA | 17809 | 5001 | 30420 | 3627 | 33571 | 2910 | 35227 | 2336 | 37230 | 1382 | 46614 | 587 | 41925 |
| 8L-3S | | MI | 11524 | 5001 | 20386 | 3441 | 22395 | 2731 | 23646 | 2135 | 25675 | 1162 | 30872 | 723 | 25984 |
| 18-#14 | 4.02 | MA | 17141 | 5001 | 29168 | 3646 | 32022 | 2926 | 33277 | 2331 | 34671 | 1392 | 43410 | 506 | 39628 |
| 9L-2S | | MI | 12101 | 5001 | 21299 | 3450 | 23529 | 2721 | 24997 | 2125 | 27461 | 1152 | 33170 | 851 | 26049 |
| 18-#18 | 7.14 | MA | 20945 | 6118 | 38599 | 4323 | 43937 | 3425 | 47722 | 2635 | 54154 | 1309 | 69479 | 17 | 69401 |
| 7L-4S | | MI | 12861 | 6118 | 24256 | 4090 | 27074 | 3139 | 29206 | 2322 | 33147 | 941 | 40597 | -75 | 40120 |
| 20-#11 | 3.10 | MA | 18507 | 4671 | 30939 | 3412 | 34328 | 2750 | 36148 | 2219 | 38604 | 1403 | 47877 | 976 | 37082 |
| 6E | | MI | 10127 | 4671 | 17378 | 3265 | 18761 | 2601 | 19368 | 2082 | 20033 | 1238 | 24045 | 721 | 19584 |
| 20-#11 | 3.10 | MA | 18035 | 4671 | 30040 | 3425 | 33233 | 2748 | 34805 | 2229 | 36801 | 1411 | 45456 | 888 | 36006 |
| 7L-5S | | MI | 10388 | 4671 | 17845 | 3257 | 19344 | 2608 | 20033 | 2075 | 20915 | 1231 | 25102 | 782 | 19885 |
| 20-#11 | 3.10 | MA | 17571 | 4671 | 29216 | 3424 | 32128 | 2759 | 33491 | 2239 | 34913 | 1405 | 43170 | 837 | 35075 |
| 8L-4S | | MI | 10660 | 4671 | 18310 | 3263 | 19930 | 2601 | 20730 | 2068 | 21877 | 1238 | 26240 | 823 | 20290 |
| 20-#11 | 3.10 | MA | 17093 | 4671 | 28344 | 3437 | 31048 | 2757 | 32132 | 2236 | 33129 | 1413 | 40916 | 781 | 33833 |
| 9L-3S | | MI | 10960 | 4671 | 18836 | 3255 | 20585 | 2608 | 21506 | 2075 | 22850 | 1231 | 27315 | 905 | 20501 |
| 20-#11 | 3.10 | MA | 16575 | 4671 | 27523 | 3436 | 29957 | 2769 | 30826 | 2246 | 31358 | 1421 | 38730 | 718 | 32471 |
| 10L-2S | | MI | 11371 | 4671 | 19479 | 3261 | 21391 | 2601 | 22466 | 2068 | 24119 | 1224 | 28956 | 993 | 20514 |
| 20-#14 | 4.46 | MA | 19289 | 5160 | 33413 | 3729 | 37465 | 2986 | 39918 | 2367 | 43739 | 1382 | 54955 | 636 | 49287 |
| 7L-5S | | MI | 11108 | 5160 | 19886 | 3541 | 21783 | 2800 | 22925 | 2173 | 24828 | 1158 | 30068 | 495 | 27276 |
| 20-#14 | 4.46 | MA | 18642 | 5160 | 32230 | 3727 | 35879 | 2982 | 38033 | 2381 | 41031 | 1372 | 51699 | 564 | 47191 |
| 8L-4S | | MI | 11488 | 5160 | 20549 | 3551 | 22607 | 2791 | 23906 | 2163 | 26092 | 1148 | 31661 | 555 | 27791 |
| 20-#14 | 4.46 | MA | 17975 | 5160 | 30979 | 3745 | 34330 | 2998 | 36083 | 2376 | 38473 | 1383 | 48496 | 482 | 44863 |
| 9L-3S | | MI | 11908 | 5160 | 21299 | 3540 | 23529 | 2800 | 24997 | 2173 | 27461 | 1138 | 33170 | 670 | 28726 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.40 | MA | 18619 | 4781 | 31305 | 3494 | 34846 | 2798 | 36766 | 2260 | 39457 | 1404 | 49032 | 873 | 39710 |
| 7L-6S | | MI | 10406 | 4781 | 18021 | 3334 | 19567 | 2650 | 20328 | 2109 | 21302 | 1222 | 25686 | 687 | 21413 |
| 22-#11 | 3.40 | MA | 18158 | 4781 | 30481 | 3493 | 33741 | 2809 | 35452 | 2270 | 37569 | 1398 | 46747 | 822 | 38743 |
| 8L-5S | | MI | 10666 | 4781 | 18487 | 3326 | 20150 | 2656 | 20994 | 2102 | 22184 | 1215 | 26743 | 748 | 21770 |
| 22-#11 | 3.40 | MA | 17682 | 4781 | 29609 | 3506 | 32661 | 2807 | 34092 | 2267 | 35785 | 1406 | 44493 | 766 | 37529 |
| 9L-4S | | MI | 10936 | 4781 | 18953 | 3332 | 20736 | 2650 | 21691 | 2095 | 23146 | 1222 | 27881 | 789 | 22150 |
| 22-#11 | 3.40 | MA | 17182 | 4781 | 28789 | 3505 | 31570 | 2819 | 32786 | 2277 | 34014 | 1414 | 42307 | 702 | 36146 |
| 10L-3S | | MI | 11235 | 4781 | 19479 | 3324 | 21391 | 2656 | 22466 | 2102 | 24119 | 1215 | 28956 | 871 | 22445 |
| 22-#11 | 3.40 | MA | 16671 | 4781 | 27980 | 3504 | 30496 | 2817 | 31442 | 2274 | 32152 | 1408 | 40075 | 649 | 34796 |
| 11L-2S | | MI | 11644 | 4781 | 20122 | 3330 | 22197 | 2650 | 23426 | 2095 | 25388 | 1208 | 30597 | 959 | 22469 |
| 22-#14 | 4.91 | MA | 19467 | 5320 | 34041 | 3827 | 38188 | 3054 | 40840 | 2426 | 44833 | 1362 | 56784 | 540 | 52465 |
| 8L-5S | | MI | 11495 | 5320 | 20799 | 3641 | 22917 | 2870 | 24276 | 2211 | 26614 | 1134 | 32366 | 442 | 29835 |
| 22-#14 | 4.91 | MA | 18802 | 5320 | 32790 | 3845 | 36639 | 3071 | 38890 | 2421 | 42275 | 1373 | 53581 | 459 | 50106 |
| 9L-4S | | MI | 11873 | 5320 | 21462 | 3651 | 23741 | 2860 | 25257 | 2201 | 27878 | 1124 | 33959 | 502 | 30435 |
| 24-#11 | 3.71 | MA | 18742 | 4892 | 31746 | 3562 | 35354 | 2859 | 37413 | 2302 | 40226 | 1391 | 50323 | 807 | 42417 |
| 8L-6S | | MI | 10684 | 4892 | 18664 | 3403 | 20373 | 2698 | 21288 | 2137 | 22571 | 1207 | 27327 | 653 | 23249 |
| 24-#11 | 3.71 | MA | 18266 | 4892 | 30874 | 3575 | 34274 | 2857 | 36053 | 2298 | 38442 | 1399 | 48069 | 751 | 41231 |
| 9L-5S | | MI | 10942 | 4892 | 19130 | 3395 | 20956 | 2705 | 21954 | 2130 | 23452 | 1200 | 28384 | 713 | 23658 |
| 24-#11 | 3.71 | MA | 17769 | 4892 | 30054 | 3574 | 33183 | 2869 | 34747 | 2309 | 36671 | 1407 | 45883 | 687 | 39825 |
| 10L-4S | | MI | 11211 | 4892 | 19596 | 3401 | 21542 | 2698 | 22651 | 2123 | 24415 | 1207 | 29521 | 755 | 24015 |
| 24-#11 | 3.71 | MA | 17264 | 4892 | 29245 | 3573 | 32109 | 2867 | 33403 | 2305 | 34809 | 1401 | 43651 | 633 | 38458 |
| 11L-3S | | MI | 11509 | 4892 | 20122 | 3394 | 22197 | 2705 | 23426 | 2130 | 25388 | 1200 | 30597 | 837 | 24386 |
| 24-#14 | 5.36 | MA | 19622 | 5479 | 34600 | 3945 | 38947 | 3143 | 41696 | 2465 | 46077 | 1363 | 58666 | 435 | 55357 |
| 9L-5S | | MI | 11880 | 5479 | 21712 | 3741 | 24051 | 2939 | 25628 | 2249 | 28399 | 1109 | 34664 | 389 | 32405 |

## RECTANGULAR TIED COLUMNS 24" x 44"

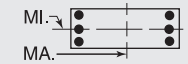
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.52 | MA | 19596 | 4301 | 31258 | 3173 | 34203 | 2576 | 35418 | 2129 | 36513 | 1476 | 43578 | 1373 | 21084 |
| 2E | | MI | 10330 | 4301 | 16862 | 2988 | 17768 | 2408 | 17954 | 1969 | 17881 | 1318 | 20647 | 1157 | 10734 |
| 6-#14 | 1.28 | MA | 19177 | 4213 | 30206 | 3137 | 32978 | 2551 | 33974 | 2118 | 34614 | 1494 | 41216 | 1407 | 18030 |
| 2L-3S | | MI | 9575 | 4213 | 15531 | 2964 | 16225 | 2417 | 16149 | 1992 | 15502 | 1373 | 17678 | 1102 | 9357 |
| 6-#14 | 1.28 | MA | 17906 | 4213 | 28296 | 3136 | 30543 | 2548 | 31013 | 2133 | 30603 | 1505 | 35819 | 1280 | 18035 |
| 3L-2S | | MI | 10176 | 4213 | 16444 | 2973 | 17359 | 2407 | 17500 | 1982 | 17288 | 1363 | 19976 | 1230 | 9278 |
| 6-#18 | 2.27 | MA | 21124 | 4585 | 34604 | 3350 | 38469 | 2704 | 40604 | 2209 | 43520 | 1457 | 52916 | 1328 | 31284 |
| 2L-3S | | MI | 9980 | 4585 | 16862 | 3145 | 17768 | 2544 | 17954 | 2049 | 17881 | 1286 | 20647 | 823 | 15686 |
| 6-#18 | 2.27 | MA | 18950 | 4585 | 31258 | 3346 | 34203 | 2732 | 35418 | 2233 | 36513 | 1475 | 43578 | 1100 | 31000 |
| 3L-2S | | MI | 10998 | 4585 | 18411 | 3162 | 19684 | 2526 | 20238 | 2031 | 20901 | 1268 | 24493 | 1051 | 15625 |
| 8-#11 | 1.18 | MA | 19005 | 4177 | 29765 | 3124 | 32476 | 2543 | 33386 | 2114 | 33827 | 1502 | 40256 | 1422 | 16773 |
| 2L-4S | | MI | 9378 | 4177 | 15075 | 2970 | 15729 | 2409 | 15581 | 1990 | 14809 | 1397 | 16993 | 1091 | 8777 |
| 8-#11 | 1.18 | MA | 18114 | 4177 | 28431 | 3123 | 30775 | 2541 | 31318 | 2125 | 31025 | 1510 | 36463 | 1334 | 16790 |
| 3E | | MI | 9688 | 4177 | 15601 | 2963 | 16384 | 2416 | 16357 | 1997 | 15781 | 1390 | 18068 | 1173 | 8722 |
| 8-#11 | 1.18 | MA | 17487 | 4177 | 27361 | 3137 | 29414 | 2553 | 29667 | 2122 | 28882 | 1518 | 33976 | 1245 | 16735 |
| 4L-2S | | MI | 10112 | 4177 | 16244 | 2969 | 17190 | 2409 | 17317 | 1990 | 17050 | 1383 | 19708 | 1261 | 8670 |
| 8-#14 | 1.70 | MA | 20067 | 4372 | 32116 | 3237 | 35414 | 2624 | 36935 | 2163 | 38625 | 1484 | 46613 | 1386 | 23864 |
| 2L-4S | | MI | 9537 | 4372 | 15694 | 3074 | 16436 | 2476 | 16409 | 2020 | 15919 | 1359 | 18467 | 934 | 12210 |
| 8-#14 | 1.70 | MA | 18808 | 4372 | 30206 | 3235 | 32978 | 2621 | 33974 | 2177 | 34614 | 1495 | 41216 | 1258 | 23817 |
| 3E | | MI | 9976 | 4372 | 16444 | 3064 | 17359 | 2486 | 17500 | 2030 | 17288 | 1349 | 19976 | 1050 | 12183 |
| 8-#14 | 1.70 | MA | 17922 | 4372 | 28673 | 3254 | 31028 | 2637 | 31607 | 2172 | 31541 | 1506 | 37680 | 1130 | 23557 |
| 4L-2S | | MI | 10572 | 4372 | 17357 | 3073 | 18493 | 2476 | 18852 | 2020 | 19074 | 1339 | 22274 | 1178 | 12122 |
| 8-#18 | 3.03 | MA | 22625 | 4869 | 37951 | 3527 | 42735 | 2833 | 45790 | 2289 | 50526 | 1439 | 62253 | 1282 | 41436 |
| 2L-4S | | MI | 9907 | 4869 | 17137 | 3337 | 18124 | 2645 | 18392 | 2094 | 18587 | 1254 | 21956 | 520 | 18819 |
| 8-#18 | 3.03 | MA | 20484 | 4869 | 34604 | 3524 | 38469 | 2861 | 40604 | 2313 | 43520 | 1456 | 52916 | 1055 | 41028 |
| 3E | | MI | 10652 | 4869 | 18411 | 3319 | 19684 | 2663 | 20238 | 2111 | 20901 | 1236 | 24493 | 717 | 20435 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

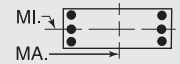



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.03 | MA | 18973 | 4869 | 31911 | 3555 | 35045 | 2853 | 36449 | 2301 | 38144 | 1474 | 46813 | 827 | 37612 |
| 4L-2S | | MI | 11660 | 4869 | 19960 | 3337 | 21601 | 2645 | 22523 | 2094 | 23920 | 1218 | 28339 | 944 | 20463 |
| 10-#11 | 1.48 | MA | 19632 | 4287 | 31100 | 3193 | 34177 | 2593 | 35454 | 2145 | 36628 | 1495 | 44049 | 1408 | 20850 |
| 2L-5S | | MI | 9384 | 4287 | 15252 | 3034 | 15949 | 2465 | 15844 | 2024 | 15115 | 1375 | 17496 | 1016 | 10628 |
| 10-#11 | 1.48 | MA | 18748 | 4287 | 29765 | 3193 | 32476 | 2591 | 33386 | 2156 | 33827 | 1503 | 40256 | 1320 | 20843 |
| 3L-4S | | MI | 9664 | 4287 | 15717 | 3040 | 16535 | 2458 | 16542 | 2017 | 16078 | 1381 | 18633 | 1057 | 10759 |
| 10-#11 | 1.48 | MA | 18126 | 4287 | 28696 | 3206 | 31116 | 2604 | 31735 | 2153 | 31683 | 1511 | 37768 | 1231 | 20758 |
| 4L-3S | | MI | 9973 | 4287 | 16244 | 3032 | 17190 | 2465 | 17317 | 2024 | 17050 | 1375 | 19708 | 1139 | 10719 |
| 10-#11 | 1.48 | MA | 17569 | 4287 | 27759 | 3205 | 29907 | 2602 | 30255 | 2164 | 29571 | 1506 | 35179 | 1186 | 20287 |
| 5L-2S | | MI | 10395 | 4287 | 16887 | 3038 | 17996 | 2458 | 18277 | 2017 | 18319 | 1368 | 21349 | 1227 | 10674 |
| 10-#14 | 2.13 | MA | 20946 | 4532 | 34027 | 3336 | 37850 | 2696 | 39896 | 2207 | 42637 | 1474 | 52010 | 1364 | 29677 |
| 2L-5S | | MI | 9543 | 4532 | 15944 | 3164 | 16746 | 2555 | 16779 | 2068 | 16441 | 1345 | 19172 | 821 | 14219 |
| 10-#14 | 2.13 | MA | 19699 | 4532 | 32116 | 3335 | 35414 | 2693 | 36935 | 2222 | 38625 | 1485 | 46613 | 1236 | 29587 |
| 3L-4S | | MI | 9938 | 4532 | 16607 | 3174 | 17571 | 2545 | 17760 | 2058 | 17705 | 1335 | 20765 | 881 | 14871 |
| 10-#14 | 2.13 | MA | 18822 | 4532 | 30583 | 3354 | 33464 | 2710 | 34568 | 2217 | 35553 | 1496 | 43077 | 1108 | 29277 |
| 4L-3S | | MI | 10373 | 4532 | 17357 | 3163 | 18493 | 2555 | 18852 | 2068 | 19074 | 1325 | 22274 | 997 | 14986 |
| 10-#14 | 2.13 | MA | 18037 | 4532 | 29239 | 3353 | 31731 | 2707 | 32446 | 2232 | 32524 | 1488 | 39386 | 1044 | 27532 |
| 5L-2S | | MI | 10966 | 4532 | 18270 | 3173 | 19627 | 2545 | 20203 | 2058 | 20860 | 1315 | 24572 | 1125 | 14944 |
| 10-#18 | 3.79 | MA | 21992 | 5153 | 37951 | 3701 | 42735 | 2989 | 45790 | 2393 | 50526 | 1438 | 62253 | 1010 | 51050 |
| 3L-4S | | MI | 10580 | 5153 | 18686 | 3511 | 20041 | 2763 | 20676 | 2156 | 21607 | 1204 | 25802 | 413 | 23251 |
| 10-#18 | 3.79 | MA | 20505 | 5153 | 35258 | 3733 | 39311 | 2982 | 41635 | 2381 | 45151 | 1455 | 56150 | 782 | 47281 |
| 4L-3S | | MI | 11316 | 5153 | 19960 | 3494 | 21601 | 2781 | 22523 | 2174 | 23920 | 1187 | 28339 | 610 | 25154 |
| 10-#18 | 3.79 | MA | 19175 | 5153 | 32895 | 3729 | 36265 | 3009 | 37905 | 2405 | 39849 | 1438 | 49739 | 673 | 44149 |
| 5L-2S | | MI | 12315 | 5153 | 21509 | 3511 | 23518 | 2763 | 24807 | 2156 | 26940 | 1169 | 32185 | 838 | 25268 |
| 12-#11 | 1.77 | MA | 20253 | 4398 | 32434 | 3262 | 35878 | 2643 | 37522 | 2177 | 39430 | 1488 | 47841 | 1394 | 24918 |
| 2L-6S | | MI | 9403 | 4398 | 15428 | 3111 | 16172 | 2507 | 16139 | 2058 | 15502 | 1366 | 18079 | 921 | 12234 |
| 12-#11 | 1.77 | MA | 19375 | 4398 | 31100 | 3262 | 34177 | 2642 | 35454 | 2187 | 36628 | 1496 | 44049 | 1305 | 24887 |
| 3L-5S | | MI | 9670 | 4398 | 15895 | 3103 | 16755 | 2514 | 16805 | 2052 | 16384 | 1359 | 19136 | 981 | 12484 |
| 12-#11 | 1.77 | MA | 18758 | 4398 | 30030 | 3275 | 32817 | 2654 | 33803 | 2184 | 34485 | 1504 | 41561 | 1217 | 24776 |
| 4E | | MI | 9948 | 4398 | 16360 | 3109 | 17341 | 2507 | 17502 | 2045 | 17346 | 1366 | 20274 | 1023 | 12727 |
| 12-#11 | 1.77 | MA | 18206 | 4398 | 29093 | 3275 | 31608 | 2652 | 32323 | 2195 | 32373 | 1499 | 38972 | 1172 | 24181 |
| 5L-3S | | MI | 10256 | 4398 | 16887 | 3101 | 17996 | 2514 | 18277 | 2052 | 18319 | 1359 | 21349 | 1105 | 12702 |
| 12-#11 | 1.77 | MA | 17680 | 4398 | 28210 | 3274 | 30407 | 2664 | 30858 | 2192 | 30433 | 1507 | 36503 | 1114 | 23369 |
| 6L-2S | | MI | 10675 | 4398 | 17529 | 3107 | 18802 | 2507 | 19238 | 2045 | 19588 | 1352 | 22990 | 1193 | 12665 |
| 12-#14 | 2.56 | MA | 20580 | 4692 | 34027 | 3435 | 37850 | 2765 | 39896 | 2267 | 42637 | 1475 | 52010 | 1214 | 35348 |
| 3L-5S | | MI | 9944 | 4692 | 16857 | 3264 | 17881 | 2624 | 18131 | 2106 | 18227 | 1320 | 21470 | 769 | 16859 |
| 12-#14 | 2.56 | MA | 19712 | 4692 | 32494 | 3454 | 35900 | 2782 | 37529 | 2262 | 39564 | 1486 | 48474 | 1086 | 34980 |
| 4E | | MI | 10336 | 4692 | 17520 | 3273 | 18705 | 2614 | 19112 | 2096 | 19491 | 1310 | 23063 | 829 | 17451 |
| 12-#14 | 2.56 | MA | 18936 | 4692 | 31150 | 3452 | 34166 | 2779 | 35406 | 2277 | 36535 | 1478 | 44783 | 1022 | 33129 |
| 5L-3S | | MI | 10768 | 4692 | 18270 | 3263 | 19627 | 2624 | 20203 | 2106 | 20860 | 1300 | 24572 | 944 | 17771 |
| 12-#14 | 2.56 | MA | 18195 | 4692 | 29882 | 3451 | 32444 | 2796 | 33305 | 2272 | 33753 | 1489 | 41272 | 938 | 31794 |
| 6L-2S | | MI | 11356 | 4692 | 19183 | 3273 | 20761 | 2614 | 21555 | 2096 | 22646 | 1290 | 26870 | 1072 | 17751 |
| 12-#18 | 4.55 | MA | 22013 | 5436 | 38604 | 3910 | 43578 | 3110 | 46822 | 2461 | 52157 | 1436 | 65487 | 737 | 56990 |
| 4E | | MI | 11245 | 5436 | 20235 | 3686 | 21957 | 2882 | 22961 | 2219 | 24626 | 1155 | 29648 | 307 | 27720 |
| 12-#18 | 4.55 | MA | 20704 | 5436 | 36242 | 3906 | 40531 | 3138 | 43091 | 2485 | 46856 | 1419 | 59076 | 628 | 53707 |
| 5L-3S | | MI | 11975 | 5436 | 21509 | 3668 | 23518 | 2900 | 24807 | 2236 | 26940 | 1137 | 32185 | 504 | 29613 |
| 12-#18 | 4.55 | MA | 19455 | 5436 | 34011 | 3902 | 37502 | 3131 | 39397 | 2474 | 41985 | 1436 | 53009 | 477 | 49724 |
| 6L-2S | | MI | 12964 | 5436 | 23058 | 3686 | 25435 | 2882 | 27092 | 2219 | 29960 | 1119 | 36031 | 731 | 30036 |
| 14-#11 | 2.07 | MA | 19997 | 4509 | 32434 | 3331 | 35878 | 2692 | 37522 | 2218 | 39430 | 1489 | 47841 | 1291 | 28925 |
| 3L-6S | | MI | 9689 | 4509 | 16071 | 3180 | 16978 | 2555 | 17099 | 2086 | 16771 | 1350 | 19720 | 887 | 14120 |
| 14-#11 | 2.07 | MA | 19385 | 4509 | 31364 | 3344 | 34518 | 2704 | 35871 | 2215 | 37287 | 1497 | 45354 | 1203 | 28792 |
| 4L-5S | | MI | 9954 | 4509 | 16538 | 3172 | 17561 | 2562 | 17765 | 2079 | 17653 | 1343 | 20777 | 947 | 14349 |
| 14-#11 | 2.07 | MA | 18838 | 4509 | 30428 | 3344 | 33309 | 2702 | 34391 | 2226 | 35175 | 1492 | 42764 | 1158 | 28086 |
| 5L-4S | | MI | 10231 | 4509 | 17003 | 3178 | 18147 | 2555 | 18462 | 2072 | 18615 | 1350 | 21915 | 989 | 14686 |
| 14-#11 | 2.07 | MA | 18316 | 4509 | 29544 | 3343 | 32108 | 2714 | 32926 | 2223 | 33235 | 1500 | 40296 | 1100 | 27310 |
| 6L-3S | | MI | 10537 | 4509 | 17529 | 3170 | 18802 | 2562 | 19238 | 2079 | 19588 | 1343 | 22990 | 1070 | 14675 |
| 14-#11 | 2.07 | MA | 17807 | 4509 | 28598 | 3357 | 30956 | 2712 | 31513 | 2234 | 31337 | 1509 | 37727 | 1013 | 26428 |
| 7L-2S | | MI | 10954 | 4509 | 18172 | 3176 | 19608 | 2555 | 20198 | 2072 | 20857 | 1337 | 24631 | 1159 | 14647 |

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

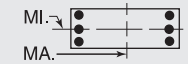
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.98 | MA | 20592 | 4851 | 34404 | 3553 | 38335 | 2854 | 40490 | 2307 | 43575 | 1477 | 53872 | 1064 | 40505 |
| 4L-5S | | MI | 10341 | 4851 | 17770 | 3364 | 19015 | 2693 | 19482 | 2144 | 20013 | 1296 | 23768 | 716 | 19509 |
| 14-#14 | 2.98 | MA | 19824 | 4851 | 33060 | 3552 | 36602 | 2851 | 38367 | 2322 | 40547 | 1468 | 50180 | 1001 | 38739 |
| 5L-4S | | MI | 10730 | 4851 | 18433 | 3373 | 19839 | 2683 | 20463 | 2134 | 21277 | 1286 | 25361 | 776 | 20050 |
| 14-#14 | 2.98 | MA | 19091 | 4851 | 31792 | 3551 | 34879 | 2868 | 36266 | 2317 | 37765 | 1479 | 46669 | 916 | 37317 |
| 6L-3S | | MI | 11159 | 4851 | 19183 | 3363 | 20761 | 2693 | 21555 | 2144 | 22646 | 1276 | 26870 | 892 | 20539 |
| 14-#14 | 2.98 | MA | 18377 | 4851 | 30435 | 3570 | 33225 | 2865 | 34239 | 2332 | 35042 | 1490 | 43015 | 790 | 35520 |
| 7L-2S | | MI | 11744 | 4851 | 20096 | 3372 | 21896 | 2683 | 22906 | 2134 | 24432 | 1266 | 29169 | 1020 | 20546 |
| 14-#18 | 5.30 | MA | 22211 | 5720 | 39588 | 4083 | 44798 | 3267 | 48277 | 2565 | 53863 | 1400 | 68414 | 583 | 63297 |
| 5L-4S | | MI | 11906 | 5720 | 21784 | 3861 | 23874 | 3001 | 25245 | 2281 | 27646 | 1105 | 33494 | 200 | 32217 |
| 14-#18 | 5.30 | MA | 20981 | 5720 | 37357 | 4080 | 41769 | 3259 | 44583 | 2554 | 48991 | 1418 | 62346 | 432 | 59462 |
| 6L-3S | | MI | 12628 | 5720 | 23058 | 3843 | 25435 | 3018 | 27092 | 2299 | 29960 | 1087 | 36031 | 397 | 33939 |
| 14-#18 | 5.30 | MA | 19781 | 5720 | 34971 | 4111 | 38859 | 3287 | 41018 | 2578 | 44224 | 1435 | 56028 | 207 | 54681 |
| 7L-2S | | MI | 13609 | 5720 | 24608 | 3861 | 27351 | 3001 | 29376 | 2281 | 32980 | 1070 | 39877 | 625 | 34785 |
| 16-#11 | 2.36 | MA | 20007 | 4619 | 32699 | 3413 | 36219 | 2754 | 37939 | 2247 | 40088 | 1491 | 49146 | 1189 | 32805 |
| 4L-6S | | MI | 9972 | 4619 | 16714 | 3249 | 17784 | 2604 | 18060 | 2113 | 18040 | 1335 | 21361 | 853 | 16010 |
| 16-#11 | 2.36 | MA | 19464 | 4619 | 31762 | 3413 | 35011 | 2752 | 36459 | 2257 | 37976 | 1485 | 46557 | 1144 | 32002 |
| 5E | | MI | 10236 | 4619 | 17181 | 3241 | 18367 | 2611 | 18725 | 2106 | 18921 | 1328 | 22418 | 913 | 16222 |
| 16-#11 | 2.36 | MA | 18946 | 4619 | 30878 | 3412 | 33810 | 2764 | 34994 | 2254 | 36037 | 1493 | 44088 | 1086 | 31256 |
| 6L-4S | | MI | 10512 | 4619 | 17646 | 3247 | 18953 | 2604 | 19422 | 2099 | 19884 | 1335 | 23556 | 955 | 16634 |
| 16-#11 | 2.36 | MA | 18441 | 4619 | 29932 | 3426 | 32657 | 2762 | 33581 | 2265 | 34139 | 1502 | 41520 | 998 | 30319 |
| 7L-3S | | MI | 10816 | 4619 | 18172 | 3239 | 19608 | 2611 | 20198 | 2106 | 20857 | 1328 | 24631 | 1036 | 16642 |
| 16-#11 | 2.36 | MA | 17943 | 4619 | 29065 | 3425 | 31493 | 2775 | 32197 | 2276 | 32151 | 1496 | 39100 | 947 | 29341 |
| 8L-2S | | MI | 11232 | 4619 | 18815 | 3245 | 20414 | 2604 | 21158 | 2099 | 22125 | 1321 | 26272 | 1125 | 16622 |
| 16-#14 | 3.41 | MA | 20703 | 5011 | 34971 | 3652 | 39038 | 2924 | 41328 | 2367 | 44558 | 1458 | 55577 | 979 | 44361 |
| 5E | | MI | 10735 | 5011 | 18683 | 3463 | 20149 | 2762 | 20833 | 2182 | 21798 | 1272 | 26066 | 663 | 22167 |
| 16-#14 | 3.41 | MA | 19978 | 5011 | 33703 | 3651 | 37315 | 2940 | 39227 | 2362 | 41776 | 1469 | 52066 | 894 | 42853 |
| 6L-4S | | MI | 11122 | 5011 | 19346 | 3473 | 20973 | 2752 | 21814 | 2172 | 23063 | 1262 | 27660 | 723 | 22664 |
| 16-#14 | 3.41 | MA | 19271 | 5011 | 32346 | 3669 | 35661 | 2937 | 37200 | 2377 | 39053 | 1480 | 48412 | 768 | 41114 |
| 7L-3S | | MI | 11548 | 5011 | 20096 | 3462 | 21896 | 2762 | 22906 | 2182 | 24432 | 1252 | 29169 | 839 | 23297 |
| 16-#14 | 3.41 | MA | 18573 | 5011 | 31101 | 3668 | 33992 | 2954 | 35215 | 2392 | 36202 | 1471 | 44963 | 694 | 38968 |
| 8L-2S | | MI | 12130 | 5011 | 21009 | 3472 | 23030 | 2752 | 24257 | 2172 | 26217 | 1242 | 31467 | 967 | 23332 |
| 16-#18 | 6.06 | MA | 22487 | 6004 | 40704 | 4257 | 46035 | 3388 | 49769 | 2634 | 55998 | 1399 | 71683 | 387 | 69129 |
| 6L-4S | | MI | 12561 | 6004 | 23333 | 4035 | 25791 | 3119 | 27530 | 2344 | 30666 | 1055 | 37340 | 94 | 36735 |
| 16-#18 | 6.06 | MA | 21304 | 6004 | 38317 | 4288 | 43126 | 3416 | 46205 | 2658 | 51231 | 1417 | 65365 | 162 | 64150 |
| 7L-3S | | MI | 13327 | 6004 | 24608 | 4018 | 27351 | 3137 | 29376 | 2361 | 32980 | 1038 | 39877 | 291 | 38305 |
| 18-#11 | 2.66 | MA | 20085 | 4730 | 33096 | 3482 | 36712 | 2802 | 38527 | 2288 | 40778 | 1478 | 50350 | 1130 | 35925 |
| 5L-6S | | MI | 10255 | 4730 | 17357 | 3318 | 18590 | 2653 | 19020 | 2140 | 19308 | 1319 | 23002 | 819 | 17902 |
| 18-#11 | 2.66 | MA | 19571 | 4730 | 32213 | 3482 | 35511 | 2814 | 37062 | 2285 | 38838 | 1487 | 47881 | 1072 | 35207 |
| 6L-5S | | MI | 10517 | 4730 | 17823 | 3310 | 19173 | 2660 | 19686 | 2133 | 20190 | 1312 | 24059 | 879 | 18100 |
| 18-#11 | 2.66 | MA | 19070 | 4730 | 31267 | 3495 | 34358 | 2813 | 35649 | 2296 | 36940 | 1495 | 45313 | 984 | 34217 |
| 7L-4S | | MI | 10792 | 4730 | 18289 | 3316 | 19759 | 2653 | 20383 | 2126 | 21153 | 1319 | 25197 | 921 | 18551 |
| 18-#11 | 2.66 | MA | 18576 | 4730 | 30399 | 3494 | 33195 | 2825 | 34265 | 2307 | 34952 | 1489 | 42893 | 933 | 33267 |
| 8L-3S | | MI | 11094 | 4730 | 18815 | 3308 | 20414 | 2660 | 21158 | 2133 | 22125 | 1312 | 26272 | 1002 | 18603 |
| 18-#11 | 2.66 | MA | 18064 | 4730 | 29548 | 3494 | 32058 | 2823 | 32834 | 2304 | 33074 | 1498 | 40501 | 877 | 31974 |
| 9L-2S | | MI | 11508 | 4730 | 19458 | 3314 | 21220 | 2653 | 22118 | 2126 | 23394 | 1305 | 27912 | 1091 | 18591 |
| 18-#14 | 3.84 | MA | 20856 | 5170 | 35613 | 3750 | 39751 | 3013 | 42188 | 2407 | 45787 | 1459 | 57463 | 872 | 48402 |
| 6L-5S | | MI | 11127 | 5170 | 19596 | 3563 | 21283 | 2831 | 22185 | 2220 | 23584 | 1247 | 28364 | 611 | 24831 |
| 18-#14 | 3.84 | MA | 20156 | 5170 | 34256 | 3769 | 38097 | 3010 | 40161 | 2422 | 43065 | 1470 | 53809 | 746 | 46717 |
| 7L-4S | | MI | 11512 | 5170 | 20259 | 3573 | 22107 | 2821 | 23166 | 2210 | 24849 | 1237 | 29958 | 671 | 25291 |
| 18-#14 | 3.84 | MA | 19465 | 5170 | 33011 | 3768 | 36428 | 3026 | 38176 | 2437 | 40213 | 1461 | 50360 | 672 | 44523 |
| 8L-3S | | MI | 11935 | 5170 | 21009 | 3562 | 23030 | 2831 | 24257 | 2220 | 26217 | 1228 | 31467 | 786 | 26048 |
| 18-#14 | 3.84 | MA | 18749 | 5170 | 31694 | 3787 | 34797 | 3023 | 36122 | 2432 | 37519 | 1472 | 46958 | 591 | 42196 |
| 9L-2S | | MI | 12513 | 5170 | 21922 | 3572 | 24164 | 2821 | 25609 | 2210 | 28003 | 1218 | 33765 | 914 | 26104 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

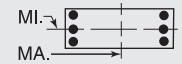
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 6.82 | MA | 22809 | 6287 | 41663 | 4466 | 47392 | 3544 | 51391 | 2737 | 58237 | 1398 | 74703 | 117 | 73850 |
| 7L-4S | | MI | 13275 | 6287 | 24882 | 4210 | 27708 | 3238 | 29814 | 2406 | 33685 | 1006 | 41186 | -13 | 41107 |
| 20-#11 | 2.95 | MA | 20191 | 4840 | 33547 | 3551 | 37212 | 2865 | 39130 | 2317 | 41640 | 1480 | 51674 | 1058 | 39163 |
| 6E | | MI | 10536 | 4840 | 18000 | 3387 | 19396 | 2702 | 19980 | 2168 | 20577 | 1304 | 24643 | 785 | 19738 |
| 20-#11 | 2.95 | MA | 19694 | 4840 | 32601 | 3564 | 36059 | 2863 | 37717 | 2327 | 39742 | 1488 | 49105 | 970 | 38121 |
| 7L-5S | | MI | 10797 | 4840 | 18466 | 3379 | 19979 | 2708 | 20646 | 2161 | 21459 | 1297 | 25700 | 845 | 19983 |
| 20-#11 | 2.95 | MA | 19204 | 4840 | 31734 | 3563 | 34896 | 2875 | 36333 | 2338 | 37754 | 1482 | 46686 | 919 | 37197 |
| 8L-4S | | MI | 11070 | 4840 | 18931 | 3385 | 20565 | 2702 | 21343 | 2154 | 22422 | 1304 | 26837 | 887 | 20403 |
| 20-#11 | 2.95 | MA | 18693 | 4840 | 30882 | 3563 | 33759 | 2873 | 34902 | 2335 | 35876 | 1491 | 44294 | 863 | 35872 |
| 9L-3S | | MI | 11371 | 4840 | 19458 | 3378 | 21220 | 2708 | 22118 | 2161 | 23394 | 1297 | 27912 | 968 | 20552 |
| 20-#11 | 2.95 | MA | 18144 | 4840 | 29952 | 3576 | 32611 | 2885 | 33527 | 2346 | 34012 | 1499 | 41974 | 799 | 34513 |
| 10L-2S | | MI | 11782 | 4840 | 20101 | 3383 | 22026 | 2702 | 23079 | 2154 | 24663 | 1290 | 29553 | 1057 | 20556 |
| 20-#14 | 4.26 | MA | 21033 | 5330 | 36166 | 3869 | 40532 | 3082 | 43122 | 2467 | 47076 | 1460 | 59207 | 724 | 52327 |
| 7L-5S | | MI | 11517 | 5330 | 20509 | 3663 | 22417 | 2900 | 23536 | 2258 | 25370 | 1223 | 30662 | 558 | 27493 |
| 20-#14 | 4.26 | MA | 20349 | 5330 | 34922 | 3868 | 38863 | 3099 | 41137 | 2482 | 44224 | 1451 | 55757 | 650 | 50087 |
| 8L-4S | | MI | 11899 | 5330 | 21172 | 3672 | 23241 | 2891 | 24517 | 2248 | 26634 | 1213 | 32256 | 618 | 27927 |
| 20-#14 | 4.26 | MA | 19634 | 5330 | 33604 | 3886 | 37232 | 3096 | 39083 | 2477 | 41530 | 1462 | 52355 | 569 | 47730 |
| 9L-3S | | MI | 12320 | 5330 | 21922 | 3662 | 24164 | 2900 | 25609 | 2258 | 28003 | 1203 | 33765 | 734 | 28794 |
| 22-#11 | 3.25 | MA | 20314 | 4951 | 33935 | 3633 | 37760 | 2913 | 39785 | 2359 | 42544 | 1481 | 52898 | 956 | 42031 |
| 7L-6S | | MI | 10815 | 4951 | 18642 | 3456 | 20202 | 2750 | 20940 | 2195 | 21846 | 1288 | 26283 | 751 | 21566 |
| 22-#11 | 3.25 | MA | 19827 | 4951 | 33068 | 3633 | 36597 | 2925 | 38401 | 2369 | 40556 | 1476 | 50478 | 905 | 41109 |
| 8L-5S | | MI | 11075 | 4951 | 19109 | 3449 | 20785 | 2757 | 21606 | 2188 | 22728 | 1281 | 27340 | 811 | 21868 |
| 22-#11 | 3.25 | MA | 19317 | 4951 | 32216 | 3632 | 35460 | 2923 | 36970 | 2366 | 38678 | 1484 | 48086 | 849 | 39775 |
| 9L-4S | | MI | 11346 | 4951 | 19574 | 3455 | 21371 | 2750 | 22303 | 2181 | 23691 | 1288 | 28478 | 852 | 22262 |
| 22-#11 | 3.25 | MA | 18775 | 4951 | 31287 | 3645 | 34312 | 2935 | 35595 | 2377 | 36814 | 1492 | 45767 | 785 | 38395 |
| 10L-3S | | MI | 11646 | 4951 | 20101 | 3447 | 22026 | 2757 | 23079 | 2188 | 24663 | 1281 | 29553 | 934 | 22498 |
| 22-#11 | 3.25 | MA | 18249 | 4951 | 30435 | 3645 | 33182 | 2933 | 34181 | 2374 | 34853 | 1487 | 43404 | 731 | 37044 |
| 11L-2S | | MI | 12056 | 4951 | 20743 | 3453 | 22832 | 2750 | 24039 | 2181 | 25932 | 1274 | 31194 | 1023 | 22517 |
| 22-#14 | 4.69 | MA | 21225 | 5489 | 36832 | 3967 | 41299 | 3171 | 44098 | 2526 | 48236 | 1441 | 61154 | 629 | 55658 |
| 8L-5S | | MI | 11905 | 5489 | 21422 | 3763 | 23551 | 2970 | 24887 | 2296 | 27156 | 1199 | 32960 | 505 | 30049 |
| 22-#14 | 4.69 | MA | 20512 | 5489 | 35515 | 3986 | 39668 | 3168 | 42044 | 2521 | 45541 | 1452 | 57752 | 547 | 53272 |
| 9L-4S | | MI | 12284 | 5489 | 22085 | 3772 | 24375 | 2960 | 25869 | 2286 | 28420 | 1189 | 34554 | 565 | 30571 |
| 24-#11 | 3.55 | MA | 20446 | 5062 | 34402 | 3702 | 38298 | 2975 | 40469 | 2400 | 43357 | 1469 | 54271 | 891 | 44989 |
| 8L-6S | | MI | 11093 | 5062 | 19285 | 3526 | 21008 | 2799 | 21901 | 2222 | 23115 | 1272 | 27924 | 717 | 23401 |
| 24-#11 | 3.55 | MA | 19937 | 5062 | 33551 | 3701 | 37161 | 2973 | 39038 | 2397 | 41479 | 1477 | 51879 | 835 | 43683 |
| 9L-5S | | MI | 11352 | 5062 | 19752 | 3518 | 21591 | 2806 | 22566 | 2215 | 23997 | 1265 | 28981 | 777 | 23757 |
| 24-#11 | 3.55 | MA | 19401 | 5062 | 32621 | 3715 | 36013 | 2985 | 37663 | 2408 | 39615 | 1485 | 49559 | 771 | 42280 |
| 10L-4S | | MI | 11622 | 5062 | 20217 | 3524 | 22177 | 2799 | 23264 | 2208 | 24959 | 1272 | 30119 | 818 | 24127 |
| 24-#11 | 3.55 | MA | 18878 | 5062 | 31770 | 3714 | 34883 | 2984 | 36249 | 2405 | 37655 | 1480 | 47196 | 717 | 40913 |
| 11L-3S | | MI | 11920 | 5062 | 20743 | 3516 | 22832 | 2806 | 24039 | 2215 | 25932 | 1265 | 31194 | 900 | 24441 |
| 24-#14 | 5.11 | MA | 21381 | 5649 | 37425 | 4086 | 42104 | 3240 | 45005 | 2566 | 49552 | 1443 | 63149 | 525 | 58820 |
| 9L-5S | | MI | 12290 | 5649 | 22335 | 3862 | 24685 | 3039 | 26239 | 2334 | 28942 | 1175 | 35258 | 452 | 32617 |

## RECTANGULAR TIED COLUMNS 24" x 46"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.45 | MA | 21310 | 4471 | 33849 | 3311 | 37043 | 2689 | 38321 | 2225 | 39431 | 1552 | 47066 | 1450 | 22164 |
| 2E | | MI | 10738 | 4471 | 17488 | 3108 | 18401 | 2506 | 18562 | 2053 | 18419 | 1382 | 21236 | 1219 | 10773 |
| 6-#14 | 1.22 | MA | 20863 | 4383 | 32736 | 3275 | 35746 | 2665 | 36792 | 2214 | 37380 | 1568 | 44537 | 1484 | 18941 |
| 2L-3S | | MI | 9982 | 4383 | 16154 | 3085 | 16859 | 2517 | 16760 | 2077 | 16045 | 1438 | 18273 | 1166 | 9390 |
| 6-#14 | 1.22 | MA | 19522 | 4383 | 30726 | 3274 | 33183 | 2662 | 33676 | 2229 | 33159 | 1580 | 38828 | 1356 | 18946 |
| 3L-2S | | MI | 10584 | 4383 | 17067 | 3095 | 17993 | 2507 | 18112 | 2067 | 17831 | 1429 | 20571 | 1293 | 9309 |
| 6-#18 | 2.17 | MA | 22929 | 4755 | 37373 | 3488 | 41535 | 2818 | 43782 | 2305 | 46830 | 1534 | 56957 | 1408 | 32904 |
| 2L-3S | | MI | 10388 | 4755 | 17488 | 3264 | 18401 | 2643 | 18562 | 2133 | 18419 | 1350 | 21236 | 885 | 15749 |
| 6-#18 | 2.17 | MA | 20633 | 4755 | 33849 | 3485 | 37043 | 2846 | 38321 | 2330 | 39431 | 1553 | 47066 | 1181 | 32620 |
| 3L-2S | | MI | 11408 | 4755 | 19037 | 3282 | 20318 | 2625 | 20847 | 2115 | 21439 | 1332 | 25082 | 1113 | 15672 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

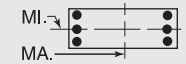
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.13 | MA | 20679 | 4346 | 32270 | 3262 | 35214 | 2657 | 36169 | 2211 | 36547 | 1576 | 43509 | 1498 | 17615 |
| 2L-4S | | MI | 9785 | 4346 | 15696 | 3093 | 16364 | 2510 | 16194 | 2076 | 15353 | 1463 | 17590 | 1155 | 8809 |
| 8-#11 | 1.13 | MA | 19740 | 4346 | 30866 | 3262 | 33425 | 2655 | 33994 | 2222 | 33600 | 1584 | 39500 | 1409 | 17633 |
| 3E | | MI | 10096 | 4346 | 16223 | 3085 | 17019 | 2517 | 16969 | 2083 | 16326 | 1456 | 18665 | 1236 | 8751 |
| 8-#11 | 1.13 | MA | 19080 | 4346 | 29743 | 3275 | 31996 | 2667 | 32259 | 2219 | 31347 | 1593 | 36868 | 1320 | 17577 |
| 4L-2S | | MI | 10520 | 4346 | 16865 | 3091 | 17825 | 2510 | 17929 | 2076 | 17594 | 1449 | 20306 | 1325 | 8698 |
| 8-#14 | 1.63 | MA | 21804 | 4542 | 34746 | 3374 | 38309 | 2737 | 39907 | 2259 | 41600 | 1558 | 50246 | 1463 | 25079 |
| 2L-4S | | MI | 9945 | 4542 | 16317 | 3195 | 17071 | 2576 | 17020 | 2105 | 16462 | 1424 | 19062 | 997 | 12262 |
| 8-#14 | 1.63 | MA | 20477 | 4542 | 32736 | 3374 | 35746 | 2735 | 36792 | 2274 | 37380 | 1570 | 44537 | 1335 | 25032 |
| 3E | | MI | 10384 | 4542 | 17067 | 3185 | 17993 | 2586 | 18112 | 2115 | 17831 | 1414 | 20571 | 1113 | 12223 |
| 8-#14 | 1.63 | MA | 19543 | 4542 | 31125 | 3393 | 33697 | 2752 | 34304 | 2270 | 34150 | 1582 | 40793 | 1207 | 24772 |
| 4L-2S | | MI | 10981 | 4542 | 17980 | 3195 | 19127 | 2576 | 19463 | 2105 | 19616 | 1404 | 22869 | 1241 | 12158 |
| 8-#18 | 2.90 | MA | 24519 | 5039 | 40896 | 3665 | 46027 | 2946 | 49243 | 2385 | 54228 | 1517 | 66849 | 1366 | 43596 |
| 2L-4S | | MI | 10314 | 5039 | 17762 | 3457 | 18757 | 2743 | 19000 | 2178 | 19125 | 1318 | 22545 | 582 | 19009 |
| 8-#18 | 2.90 | MA | 22258 | 5039 | 37373 | 3662 | 41535 | 2975 | 43782 | 2410 | 46830 | 1535 | 56957 | 1138 | 43188 |
| 3E | | MI | 11060 | 5039 | 19037 | 3439 | 20318 | 2761 | 20847 | 2195 | 21439 | 1301 | 25082 | 779 | 20508 |
| 8-#18 | 2.90 | MA | 20665 | 5039 | 34541 | 3695 | 37934 | 2969 | 39411 | 2400 | 41155 | 1553 | 50485 | 911 | 39842 |
| 4L-2S | | MI | 12070 | 5039 | 20586 | 3457 | 22234 | 2743 | 23131 | 2178 | 24459 | 1283 | 28928 | 1006 | 20516 |
| 10-#11 | 1.41 | MA | 21342 | 4457 | 33673 | 3331 | 37004 | 2707 | 38344 | 2242 | 39494 | 1569 | 47519 | 1485 | 21903 |
| 2L-5S | | MI | 9791 | 4457 | 15874 | 3156 | 16584 | 2566 | 16457 | 2110 | 15659 | 1440 | 18093 | 1079 | 10751 |
| 10-#11 | 1.41 | MA | 20410 | 4457 | 32270 | 3331 | 35214 | 2705 | 36169 | 2253 | 36547 | 1578 | 43509 | 1396 | 21896 |
| 3L-4S | | MI | 10072 | 4457 | 16339 | 3162 | 17170 | 2559 | 17154 | 2103 | 16622 | 1447 | 19231 | 1120 | 10795 |
| 10-#11 | 1.41 | MA | 19755 | 4457 | 31146 | 3344 | 33785 | 2718 | 34434 | 2250 | 34294 | 1586 | 40877 | 1307 | 21811 |
| 4L-3S | | MI | 10381 | 4457 | 16865 | 3154 | 17825 | 2566 | 17929 | 2110 | 17594 | 1440 | 20306 | 1202 | 10751 |
| 10-#11 | 1.41 | MA | 19170 | 4457 | 30162 | 3344 | 32516 | 2716 | 32880 | 2261 | 32076 | 1581 | 38144 | 1262 | 21417 |
| 5L-2S | | MI | 10803 | 4457 | 17508 | 3160 | 18631 | 2559 | 18890 | 2103 | 18863 | 1433 | 21947 | 1291 | 10705 |
| 10-#14 | 2.04 | MA | 22734 | 4702 | 36756 | 3474 | 40872 | 2810 | 43023 | 2304 | 45821 | 1548 | 55956 | 1443 | 31196 |
| 2L-5S | | MI | 9950 | 4702 | 16567 | 3286 | 17381 | 2655 | 17390 | 2153 | 16983 | 1410 | 19766 | 884 | 14338 |
| 10-#14 | 2.04 | MA | 21419 | 4702 | 34746 | 3473 | 38309 | 2807 | 39907 | 2319 | 41600 | 1560 | 50246 | 1315 | 31105 |
| 3L-4S | | MI | 10346 | 4702 | 17230 | 3295 | 18205 | 2645 | 18371 | 2143 | 18248 | 1400 | 21360 | 945 | 15010 |
| 10-#14 | 2.04 | MA | 20496 | 4702 | 33135 | 3493 | 36260 | 2824 | 37420 | 2315 | 38371 | 1572 | 46502 | 1187 | 30796 |
| 4L-3S | | MI | 10782 | 4702 | 17980 | 3285 | 19127 | 2655 | 19463 | 2153 | 19616 | 1390 | 22869 | 1060 | 15030 |
| 10-#14 | 2.04 | MA | 19669 | 4702 | 31723 | 3492 | 34439 | 2822 | 35190 | 2330 | 35189 | 1564 | 42604 | 1123 | 29068 |
| 5L-2S | | MI | 11375 | 4702 | 18893 | 3294 | 20262 | 2645 | 20814 | 2143 | 21402 | 1380 | 25167 | 1188 | 14984 |
| 10-#18 | 3.62 | MA | 23854 | 5322 | 40896 | 3840 | 46027 | 3104 | 49243 | 2490 | 54228 | 1517 | 66849 | 1096 | 53750 |
| 3L-4S | | MI | 10987 | 5322 | 19311 | 3631 | 20674 | 2862 | 21285 | 2240 | 22145 | 1269 | 26391 | 475 | 23438 |
| 10-#18 | 3.62 | MA | 22287 | 5322 | 38065 | 3872 | 42426 | 3097 | 44872 | 2480 | 48554 | 1535 | 60376 | 869 | 50034 |
| 4L-3S | | MI | 11726 | 5322 | 20586 | 3614 | 22234 | 2880 | 23131 | 2258 | 24459 | 1251 | 28928 | 672 | 25237 |
| 10-#18 | 3.62 | MA | 20885 | 5322 | 35581 | 3869 | 39224 | 3126 | 40951 | 2505 | 42959 | 1518 | 53597 | 758 | 46951 |
| 5L-2S | | MI | 12726 | 5322 | 22135 | 3631 | 24151 | 2862 | 25416 | 2240 | 27478 | 1233 | 32774 | 900 | 25330 |
| 12-#11 | 1.70 | MA | 22000 | 4568 | 35077 | 3400 | 38793 | 2757 | 40520 | 2273 | 42441 | 1562 | 51528 | 1472 | 26182 |
| 2L-6S | | MI | 9810 | 4568 | 16050 | 3233 | 16806 | 2607 | 16752 | 2144 | 16046 | 1432 | 18677 | 985 | 12322 |
| 12-#11 | 1.70 | MA | 21074 | 4568 | 33673 | 3400 | 37004 | 2755 | 38344 | 2284 | 39494 | 1571 | 47519 | 1383 | 26151 |
| 3L-5S | | MI | 10077 | 4568 | 16516 | 3225 | 17390 | 2614 | 17417 | 2137 | 16928 | 1425 | 19734 | 1045 | 12578 |
| 12-#11 | 1.70 | MA | 20424 | 4568 | 32550 | 3414 | 35574 | 2768 | 36610 | 2281 | 37241 | 1579 | 44886 | 1294 | 26040 |
| 4E | | MI | 10356 | 4568 | 16982 | 3231 | 17976 | 2607 | 18114 | 2130 | 17891 | 1432 | 20872 | 1086 | 12768 |
| 12-#11 | 1.70 | MA | 19843 | 4568 | 31566 | 3413 | 34305 | 2766 | 35055 | 2293 | 35023 | 1574 | 42154 | 1249 | 25515 |
| 5L-3S | | MI | 10664 | 4568 | 17508 | 3223 | 18631 | 2614 | 18890 | 2137 | 18863 | 1425 | 21947 | 1168 | 12738 |
| 12-#11 | 1.70 | MA | 19290 | 4568 | 30638 | 3413 | 33044 | 2779 | 33516 | 2290 | 32985 | 1583 | 39543 | 1191 | 24628 |
| 6L-2S | | MI | 11084 | 4568 | 18151 | 3229 | 19437 | 2607 | 19850 | 2130 | 20132 | 1418 | 23588 | 1257 | 12699 |
| 12-#14 | 2.45 | MA | 22351 | 4861 | 36756 | 3573 | 40872 | 2879 | 43023 | 2364 | 45821 | 1550 | 55956 | 1294 | 37171 |
| 3L-5S | | MI | 10351 | 4861 | 17480 | 3385 | 18515 | 2724 | 18742 | 2191 | 18769 | 1386 | 22065 | 832 | 16977 |
| 12-#14 | 2.45 | MA | 21437 | 4861 | 35145 | 3592 | 38822 | 2897 | 40535 | 2360 | 42592 | 1562 | 52211 | 1166 | 36819 |
| 4E | | MI | 10744 | 4861 | 18143 | 3395 | 19339 | 2714 | 19723 | 2181 | 20033 | 1376 | 23658 | 892 | 17588 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

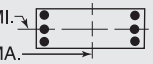


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 2.45 | MA | 20620 | 4861 | 33733 | 3592 | 37002 | 2894 | 38305 | 2375 | 39409 | 1554 | 48313 | 1102 | 34961 |
| 5L-3S | | MI | 11177 | 4861 | 18893 | 3385 | 20262 | 2724 | 20814 | 2191 | 21402 | 1366 | 25167 | 1007 | 17822 |
| 12-#14 | 2.45 | MA | 19840 | 4861 | 32402 | 3591 | 35192 | 2911 | 36098 | 2371 | 36486 | 1566 | 44597 | 1018 | 33694 |
| 6L-2S | | MI | 11766 | 4861 | 19806 | 3394 | 21396 | 2714 | 22166 | 2181 | 23188 | 1356 | 27465 | 1135 | 17793 |
| 12-#18 | 4.35 | MA | 23884 | 5606 | 41588 | 4049 | 46919 | 3226 | 50334 | 2560 | 55953 | 1518 | 70268 | 826 | 60268 |
| 4E | | MI | 11653 | 5606 | 20860 | 3806 | 22591 | 2981 | 23569 | 2303 | 25164 | 1219 | 30237 | 369 | 27905 |
| 12-#18 | 4.35 | MA | 22504 | 5606 | 39105 | 4046 | 43716 | 3254 | 46412 | 2585 | 50358 | 1501 | 63489 | 716 | 57036 |
| 5L-3S | | MI | 12385 | 5606 | 22135 | 3788 | 24151 | 2998 | 25416 | 2320 | 27478 | 1201 | 32774 | 566 | 29861 |
| 12-#18 | 4.35 | MA | 21188 | 5606 | 36761 | 4043 | 40532 | 3248 | 42529 | 2575 | 45217 | 1519 | 57057 | 566 | 52682 |
| 6L-2S | | MI | 13377 | 5606 | 23684 | 3806 | 26068 | 2981 | 27700 | 2303 | 30498 | 1184 | 36620 | 793 | 30103 |
| 14-#11 | 1.98 | MA | 21731 | 4678 | 35077 | 3469 | 38793 | 2806 | 40520 | 2315 | 42441 | 1564 | 51528 | 1370 | 30400 |
| 3L-6S | | MI | 10096 | 4678 | 16693 | 3302 | 17612 | 2656 | 17712 | 2171 | 17315 | 1416 | 20318 | 951 | 14209 |
| 14-#11 | 1.98 | MA | 21087 | 4678 | 33953 | 3483 | 37364 | 2818 | 38785 | 2313 | 40188 | 1573 | 48896 | 1281 | 30266 |
| 4L-5S | | MI | 10362 | 4678 | 17159 | 3294 | 18196 | 2663 | 18378 | 2164 | 18197 | 1409 | 21375 | 1011 | 14444 |
| 14-#11 | 1.98 | MA | 20511 | 4678 | 32969 | 3482 | 36095 | 2816 | 37230 | 2324 | 37970 | 1568 | 46163 | 1236 | 29625 |
| 5L-4S | | MI | 10639 | 4678 | 17625 | 3300 | 18782 | 2656 | 19075 | 2157 | 19160 | 1416 | 22512 | 1052 | 14732 |
| 14-#11 | 1.98 | MA | 19962 | 4678 | 32041 | 3482 | 34833 | 2829 | 35692 | 2321 | 35932 | 1576 | 43552 | 1178 | 28775 |
| 6L-3S | | MI | 10945 | 4678 | 18151 | 3292 | 19437 | 2663 | 19850 | 2164 | 20132 | 1409 | 23588 | 1134 | 14714 |
| 14-#11 | 1.98 | MA | 19426 | 4678 | 31048 | 3496 | 33623 | 2827 | 34208 | 2332 | 33939 | 1585 | 40836 | 1091 | 27941 |
| 7L-2S | | MI | 11364 | 4678 | 18794 | 3298 | 20243 | 2656 | 20810 | 2157 | 21401 | 1402 | 25228 | 1223 | 14683 |
| 14-#14 | 2.85 | MA | 22368 | 5021 | 37155 | 3692 | 41385 | 2969 | 43651 | 2405 | 46812 | 1552 | 57921 | 1146 | 42813 |
| 4L-5S | | MI | 10749 | 5021 | 18393 | 3485 | 19649 | 2793 | 20093 | 2229 | 20555 | 1361 | 24363 | 779 | 19628 |
| 14-#14 | 2.85 | MA | 21559 | 5021 | 35743 | 3691 | 39564 | 2966 | 41421 | 2420 | 43630 | 1544 | 54022 | 1082 | 40869 |
| 5L-4S | | MI | 11139 | 5021 | 19056 | 3495 | 20473 | 2783 | 21074 | 2219 | 21819 | 1351 | 25956 | 839 | 20186 |
| 14-#14 | 2.85 | MA | 20788 | 5021 | 34412 | 3690 | 37755 | 2984 | 39213 | 2416 | 40707 | 1556 | 50306 | 998 | 39513 |
| 6L-3S | | MI | 11569 | 5021 | 19806 | 3484 | 21396 | 2793 | 22166 | 2229 | 23188 | 1341 | 27465 | 955 | 20594 |
| 14-#14 | 2.85 | MA | 20036 | 5021 | 32986 | 3710 | 36017 | 2981 | 37084 | 2431 | 37847 | 1568 | 46440 | 872 | 37553 |
| 7L-2S | | MI | 12155 | 5021 | 20719 | 3494 | 22530 | 2783 | 23517 | 2219 | 24974 | 1331 | 29763 | 1083 | 20592 |
| 14-#18 | 5.07 | MA | 24099 | 5890 | 42629 | 4224 | 48208 | 3383 | 51873 | 2665 | 57757 | 1483 | 73380 | 674 | 67152 |
| 5L-4S | | MI | 12314 | 5890 | 22410 | 3981 | 24507 | 3099 | 25854 | 2365 | 28184 | 1169 | 34083 | 263 | 32400 |
| 14-#18 | 5.07 | MA | 22803 | 5890 | 40285 | 4221 | 45025 | 3376 | 47990 | 2655 | 52615 | 1501 | 66949 | 524 | 62949 |
| 6L-3S | | MI | 13040 | 5890 | 23684 | 3963 | 26068 | 3117 | 27700 | 2383 | 30498 | 1152 | 36620 | 459 | 34182 |
| 14-#18 | 5.07 | MA | 21538 | 5890 | 37777 | 4253 | 41968 | 3405 | 44243 | 2680 | 47584 | 1519 | 60254 | 299 | 58065 |
| 7L-2S | | MI | 14023 | 5890 | 25233 | 3981 | 27985 | 3099 | 29984 | 2365 | 33518 | 1134 | 40466 | 687 | 34857 |
| 16-#11 | 2.26 | MA | 21744 | 4789 | 35357 | 3552 | 39153 | 2868 | 40960 | 2344 | 43135 | 1566 | 52905 | 1268 | 34490 |
| 4L-6S | | MI | 10380 | 4789 | 17335 | 3371 | 18418 | 2705 | 18672 | 2199 | 18584 | 1400 | 21959 | 917 | 16100 |
| 16-#11 | 2.26 | MA | 21173 | 4789 | 34373 | 3552 | 37884 | 2867 | 39405 | 2355 | 40916 | 1561 | 50172 | 1223 | 33745 |
| 5E | | MI | 10644 | 4789 | 17802 | 3364 | 19002 | 2712 | 19338 | 2192 | 19466 | 1394 | 23016 | 977 | 16317 |
| 16-#11 | 2.26 | MA | 20628 | 4789 | 33445 | 3551 | 36623 | 2879 | 37867 | 2352 | 38879 | 1569 | 47561 | 1165 | 32928 |
| 6L-4S | | MI | 10921 | 4789 | 18267 | 3369 | 19588 | 2705 | 20035 | 2185 | 20428 | 1400 | 24153 | 1018 | 16684 |
| 16-#11 | 2.26 | MA | 20097 | 4789 | 32452 | 3565 | 35412 | 2878 | 36383 | 2363 | 36886 | 1578 | 44846 | 1078 | 32037 |
| 7L-3S | | MI | 11225 | 4789 | 18794 | 3362 | 20243 | 2712 | 20810 | 2192 | 21401 | 1394 | 25228 | 1100 | 16683 |
| 16-#11 | 2.26 | MA | 19573 | 4789 | 31541 | 3565 | 34190 | 2890 | 34930 | 2375 | 34798 | 1573 | 42291 | 1026 | 30973 |
| 8L-2S | | MI | 11642 | 4789 | 19437 | 3368 | 21049 | 2705 | 21771 | 2185 | 22670 | 1387 | 26869 | 1189 | 16660 |
| 16-#14 | 3.26 | MA | 22489 | 5180 | 37754 | 3791 | 42127 | 3039 | 44536 | 2465 | 47851 | 1534 | 59731 | 1061 | 46788 |
| 5E | | MI | 11144 | 5180 | 19306 | 3585 | 20783 | 2862 | 21445 | 2267 | 22341 | 1337 | 26661 | 726 | 22286 |
| 16-#14 | 3.26 | MA | 21726 | 5180 | 36422 | 3790 | 40317 | 3056 | 42329 | 2461 | 44928 | 1546 | 56015 | 977 | 45346 |
| 6L-4S | | MI | 11531 | 5180 | 19969 | 3594 | 21607 | 2852 | 22426 | 2257 | 23605 | 1327 | 28254 | 787 | 22799 |
| 16-#14 | 3.26 | MA | 20982 | 5180 | 34997 | 3809 | 38580 | 3053 | 40199 | 2476 | 42068 | 1558 | 52149 | 851 | 43445 |
| 7L-3S | | MI | 11959 | 5180 | 20719 | 3584 | 22530 | 2862 | 23517 | 2267 | 24974 | 1317 | 29763 | 902 | 23356 |
| 16-#14 | 3.26 | MA | 20247 | 5180 | 33689 | 3809 | 36827 | 3071 | 38115 | 2492 | 39072 | 1550 | 48506 | 777 | 41293 |
| 8L-2S | | MI | 12541 | 5180 | 21632 | 3594 | 23664 | 2852 | 24869 | 2257 | 26760 | 1307 | 32061 | 1030 | 23383 |
| 16-#18 | 5.80 | MA | 24397 | 6173 | 43808 | 4398 | 49517 | 3505 | 53451 | 2735 | 60014 | 1483 | 76840 | 481 | 73237 |
| 6L-4S | | MI | 12971 | 6173 | 23959 | 4155 | 26424 | 3218 | 28138 | 2428 | 31204 | 1120 | 37929 | 156 | 36917 |
| 16-#18 | 5.80 | MA | 23150 | 6173 | 41300 | 4430 | 46460 | 3534 | 49705 | 2760 | 54983 | 1501 | 70146 | 256 | 68268 |
| 7L-3S | | MI | 13690 | 6173 | 25233 | 4138 | 27985 | 3235 | 29984 | 2445 | 33518 | 1102 | 40466 | 353 | 38545 |
| 16-#18 | 5.80 | MA | 21921 | 6173 | 38999 | 4427 | 43375 | 3527 | 46036 | 2785 | 49713 | 1484 | 63812 | 127 | 62914 |
| 8L-2S | | MI | 14665 | 6173 | 26782 | 4155 | 29901 | 3218 | 32269 | 2428 | 36537 | 1084 | 44312 | 580 | 39596 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis



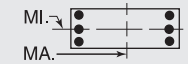

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.54 | MA | 21830 | 4900 | 35776 | 3621 | 39673 | 2917 | 41581 | 2386 | 43863 | 1554 | 54181 | 1210 | 37874 |
| 5L-6S | | MI | 10662 | 4900 | 17978 | 3441 | 19224 | 2754 | 19632 | 2226 | 19853 | 1385 | 23599 | 882 | 17993 |
| 18-#11 | 2.54 | MA | 21289 | 4900 | 34848 | 3621 | 38412 | 2929 | 40042 | 2383 | 41826 | 1563 | 51571 | 1152 | 37087 |
| 6L-5S | | MI | 10926 | 4900 | 18445 | 3433 | 19808 | 2760 | 20298 | 2219 | 20735 | 1378 | 24656 | 943 | 18195 |
| 18-#11 | 2.54 | MA | 20762 | 4900 | 33855 | 3634 | 37201 | 2928 | 38558 | 2395 | 39833 | 1571 | 48855 | 1065 | 36140 |
| 7L-4S | | MI | 11201 | 4900 | 18910 | 3439 | 20394 | 2754 | 20995 | 2212 | 21697 | 1385 | 25794 | 984 | 18630 |
| 18-#11 | 2.54 | MA | 20242 | 4900 | 32944 | 3634 | 35980 | 2940 | 37106 | 2406 | 37745 | 1566 | 46300 | 1012 | 35105 |
| 8L-3S | | MI | 11504 | 4900 | 19437 | 3431 | 21049 | 2760 | 21771 | 2219 | 22670 | 1378 | 26869 | 1066 | 18646 |
| 18-#11 | 2.54 | MA | 19696 | 4900 | 32050 | 3634 | 34786 | 2939 | 35603 | 2403 | 35773 | 1575 | 43771 | 956 | 33825 |
| 9L-2S | | MI | 11918 | 4900 | 20079 | 3437 | 21855 | 2754 | 22731 | 2212 | 23939 | 1371 | 28510 | 1155 | 18631 |
| 18-#14 | 3.67 | MA | 22655 | 5340 | 38432 | 3890 | 42880 | 3128 | 45444 | 2506 | 49149 | 1536 | 61725 | 957 | 51191 |
| 6L-5S | | MI | 11536 | 5340 | 20219 | 3685 | 21917 | 2931 | 22796 | 2305 | 24126 | 1313 | 28959 | 674 | 24951 |
| 18-#14 | 3.67 | MA | 21918 | 5340 | 37007 | 3909 | 41143 | 3126 | 43315 | 2521 | 46289 | 1548 | 57859 | 831 | 49346 |
| 7L-4S | | MI | 11921 | 5340 | 20882 | 3694 | 22741 | 2921 | 23777 | 2295 | 25391 | 1303 | 30552 | 734 | 25425 |
| 18-#14 | 3.67 | MA | 21191 | 5340 | 35700 | 3908 | 39390 | 3143 | 41230 | 2536 | 43293 | 1540 | 54215 | 756 | 47147 |
| 8L-3S | | MI | 12346 | 5340 | 21632 | 3684 | 23664 | 2931 | 24869 | 2305 | 26760 | 1293 | 32061 | 849 | 26111 |
| 18-#14 | 3.67 | MA | 20426 | 5340 | 34416 | 3907 | 37677 | 3140 | 39073 | 2532 | 40463 | 1552 | 50615 | 675 | 44799 |
| 9L-2S | | MI | 12925 | 5340 | 22545 | 3693 | 24798 | 2921 | 26220 | 2295 | 28546 | 1283 | 34359 | 977 | 26157 |
| 18-#18 | 6.52 | MA | 24742 | 6457 | 44824 | 4608 | 50952 | 3662 | 55166 | 2840 | 62381 | 1484 | 80037 | 214 | 78286 |
| 7L-4S | | MI | 13689 | 6457 | 25508 | 4330 | 28341 | 3336 | 30422 | 2490 | 34224 | 1070 | 41775 | 50 | 41450 |
| 18-#18 | 6.52 | MA | 23530 | 6457 | 42523 | 4605 | 47867 | 3656 | 51497 | 2865 | 57111 | 1467 | 73703 | 85 | 73088 |
| 8L-3S | | MI | 14380 | 6457 | 26782 | 4312 | 29901 | 3354 | 32269 | 2508 | 36537 | 1052 | 44312 | 246 | 42940 |
| 20-#11 | 2.83 | MA | 21945 | 5010 | 36252 | 3690 | 40201 | 2979 | 42217 | 2415 | 44773 | 1556 | 55580 | 1139 | 41250 |
| 6E | | MI | 10944 | 5010 | 18621 | 3510 | 20030 | 2802 | 20593 | 2253 | 21122 | 1369 | 25240 | 848 | 19888 |
| 20-#11 | 2.83 | MA | 21422 | 5010 | 35259 | 3703 | 38991 | 2978 | 40733 | 2426 | 42780 | 1564 | 52864 | 1052 | 40250 |
| 7L-5S | | MI | 11206 | 5010 | 19088 | 3502 | 20614 | 2809 | 21258 | 2246 | 22003 | 1362 | 26297 | 909 | 20078 |
| 20-#11 | 2.83 | MA | 20906 | 5010 | 34348 | 3703 | 37769 | 2990 | 39281 | 2437 | 40692 | 1559 | 50310 | 999 | 39242 |
| 8L-4S | | MI | 11479 | 5010 | 19553 | 3508 | 21200 | 2802 | 21956 | 2239 | 22966 | 1369 | 27435 | 950 | 20513 |
| 20-#11 | 2.83 | MA | 20361 | 5010 | 33454 | 3703 | 36576 | 2989 | 37778 | 2434 | 38720 | 1568 | 47780 | 943 | 37930 |
| 9L-3S | | MI | 11781 | 5010 | 20079 | 3500 | 21855 | 2809 | 22731 | 2246 | 23939 | 1362 | 28510 | 1032 | 20600 |
| 20-#11 | 2.83 | MA | 19782 | 5010 | 32478 | 3716 | 35370 | 3001 | 36334 | 2445 | 36762 | 1577 | 45326 | 880 | 36580 |
| 10L-2S | | MI | 12193 | 5010 | 20722 | 3506 | 22661 | 2802 | 23691 | 2239 | 25207 | 1355 | 30151 | 1121 | 20598 |
| 20-#14 | 4.08 | MA | 22845 | 5500 | 39017 | 4009 | 43706 | 3198 | 46430 | 2566 | 50509 | 1538 | 63568 | 810 | 55254 |
| 7L-5S | | MI | 11926 | 5500 | 21132 | 3784 | 23051 | 3000 | 24147 | 2343 | 25912 | 1288 | 31257 | 621 | 27621 |
| 20-#14 | 4.08 | MA | 22125 | 5500 | 37710 | 4008 | 41953 | 3215 | 44346 | 2581 | 47514 | 1530 | 59924 | 736 | 53008 |
| 8L-4S | | MI | 12309 | 5500 | 21795 | 3794 | 23876 | 2991 | 25128 | 2333 | 27177 | 1278 | 32850 | 681 | 28061 |
| 20-#14 | 4.08 | MA | 21362 | 5500 | 36427 | 4007 | 40240 | 3213 | 42189 | 2577 | 44684 | 1542 | 56324 | 655 | 50632 |
| 9L-3S | | MI | 12731 | 5500 | 22545 | 3784 | 24798 | 3000 | 26220 | 2343 | 28546 | 1269 | 34359 | 797 | 28860 |
| 20-#14 | 4.08 | MA | 20580 | 5500 | 35026 | 4026 | 38509 | 3230 | 40117 | 2592 | 41875 | 1554 | 52832 | 563 | 48275 |
| 10L-2S | | MI | 13307 | 5500 | 23458 | 3793 | 25932 | 2991 | 27571 | 2333 | 30331 | 1259 | 36657 | 925 | 28925 |
| 20-#18 | 7.25 | MA | 25120 | 6741 | 46046 | 4782 | 52360 | 3784 | 56958 | 2945 | 64510 | 1449 | 83595 | 43 | 83277 |
| 8L-4S | | MI | 14331 | 6741 | 27057 | 4504 | 30258 | 3455 | 32707 | 2553 | 37243 | 1021 | 45621 | -57 | 45240 |
| 22-#11 | 3.11 | MA | 22077 | 5121 | 36662 | 3772 | 40780 | 3028 | 42909 | 2457 | 45727 | 1558 | 56873 | 1039 | 44366 |
| 7L-6S | | MI | 11223 | 5121 | 19264 | 3579 | 20837 | 2851 | 21553 | 2280 | 22390 | 1354 | 26881 | 814 | 21716 |
| 22-#11 | 3.11 | MA | 21565 | 5121 | 35751 | 3772 | 39559 | 3040 | 41456 | 2468 | 43639 | 1553 | 54319 | 986 | 43384 |
| 8L-5S | | MI | 11484 | 5121 | 19730 | 3571 | 21420 | 2858 | 22219 | 2273 | 23272 | 1347 | 27938 | 875 | 21964 |
| 22-#11 | 3.11 | MA | 21021 | 5121 | 34857 | 3772 | 38365 | 3039 | 39953 | 2465 | 41667 | 1561 | 51789 | 930 | 42039 |
| 9L-4S | | MI | 11756 | 5121 | 20196 | 3577 | 22006 | 2851 | 22916 | 2267 | 24235 | 1354 | 29076 | 916 | 22372 |
| 22-#11 | 3.11 | MA | 20449 | 5121 | 33881 | 3785 | 37159 | 3051 | 38510 | 2477 | 39709 | 1570 | 49335 | 867 | 40668 |
| 10L-3S | | MI | 12056 | 5121 | 20722 | 3569 | 22661 | 2858 | 23691 | 2273 | 25207 | 1347 | 30151 | 998 | 22549 |
| 22-#11 | 3.11 | MA | 19895 | 5121 | 32988 | 3785 | 35973 | 3050 | 37024 | 2474 | 37650 | 1565 | 46841 | 812 | 39264 |
| 11L-2S | | MI | 12467 | 5121 | 21365 | 3575 | 23467 | 2851 | 24651 | 2267 | 26476 | 1340 | 31792 | 1086 | 22561 |
| 22-#14 | 4.48 | MA | 23051 | 5659 | 39720 | 4108 | 44516 | 3288 | 47461 | 2626 | 51734 | 1520 | 65634 | 715 | 58878 |
| 8L-5S | | MI | 12314 | 5659 | 22045 | 3884 | 24186 | 3070 | 25499 | 2381 | 27698 | 1264 | 33555 | 568 | 30260 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

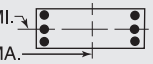
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 4.48 | MA | 22290 | 5659 | 38437 | 4107 | 42803 | 3285 | 45304 | 2622 | 48904 | 1532 | 62033 | 634 | 56472 |
| 9L-4S | | MI | 12695 | 5659 | 22708 | 3894 | 25010 | 3060 | 26480 | 2371 | 28963 | 1254 | 35148 | 628 | 30704 |
| 22-#14 | 4.48 | MA | 21514 | 5659 | 37036 | 4126 | 41072 | 3302 | 43233 | 2637 | 46095 | 1544 | 58542 | 543 | 54093 |
| 10L-3S | | MI | 13115 | 5659 | 23458 | 3883 | 25932 | 3070 | 27571 | 2381 | 30331 | 1244 | 36657 | 744 | 31604 |
| 24-#11 | 3.39 | MA | 22219 | 5232 | 37155 | 3841 | 41348 | 3090 | 43631 | 2499 | 46586 | 1546 | 58328 | 973 | 47530 |
| 8L-6S | | MI | 11502 | 5232 | 19907 | 3648 | 21643 | 2900 | 22513 | 2308 | 23659 | 1338 | 28522 | 780 | 23550 |
| 24-#11 | 3.39 | MA | 21676 | 5232 | 36261 | 3841 | 40154 | 3089 | 42128 | 2497 | 44613 | 1554 | 55799 | 917 | 46154 |
| 9L-5S | | MI | 11761 | 5232 | 20373 | 3640 | 22226 | 2906 | 23179 | 2301 | 24541 | 1331 | 29579 | 841 | 23853 |
| 24-#11 | 3.39 | MA | 21110 | 5232 | 35285 | 3855 | 38948 | 3101 | 40685 | 2508 | 42656 | 1563 | 53345 | 854 | 44761 |
| 10L-4S | | MI | 12032 | 5232 | 20838 | 3646 | 22812 | 2900 | 23876 | 2294 | 25504 | 1338 | 30716 | 882 | 24236 |
| 24-#11 | 3.39 | MA | 20560 | 5232 | 34391 | 3854 | 37762 | 3100 | 39199 | 2505 | 40597 | 1558 | 50850 | 799 | 43380 |
| 11L-3S | | MI | 12331 | 5232 | 21365 | 3638 | 23467 | 2906 | 24651 | 2301 | 26476 | 1331 | 31792 | 964 | 24494 |
| 24-#11 | 3.39 | MA | 20019 | 5232 | 33430 | 3868 | 36564 | 3112 | 37759 | 2516 | 38643 | 1567 | 48107 | 724 | 41738 |
| 12L-2S | | MI | 12740 | 5232 | 22008 | 3644 | 24273 | 2900 | 25612 | 2294 | 27745 | 1324 | 33432 | 1052 | 24516 |
| 24-#14 | 4.89 | MA | 23210 | 5819 | 40447 | 4207 | 45365 | 3357 | 48420 | 2667 | 53125 | 1522 | 67743 | 614 | 62319 |
| 9L-5S | | MI | 12701 | 5819 | 22958 | 3984 | 25320 | 3139 | 26850 | 2419 | 29484 | 1240 | 35853 | 516 | 32825 |
| 24-#14 | 4.89 | MA | 22440 | 5819 | 39046 | 4226 | 43635 | 3375 | 46348 | 2682 | 50316 | 1534 | 64251 | 523 | 59917 |
| 10L-4S | | MI | 13079 | 5819 | 23621 | 3993 | 26144 | 3129 | 27831 | 2409 | 30748 | 1230 | 37447 | 576 | 33355 |

## RECTANGULAR TIED COLUMNS 24" x 48"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.39 | MA | 23092 | 4641 | 36537 | 3449 | 39988 | 2803 | 41328 | 2322 | 42407 | 1626 | 50662 | 1527 | 23244 |
| 2E | | MI | 11146 | 4641 | 18113 | 3227 | 19034 | 2605 | 19171 | 2136 | 18957 | 1447 | 21824 | 1282 | 10812 |
| 6-#14 | 1.17 | MA | 22617 | 4552 | 35363 | 3413 | 38620 | 2778 | 39715 | 2310 | 40242 | 1642 | 47967 | 1559 | 19853 |
| 2L-3S | | MI | 10390 | 4552 | 16777 | 3207 | 17494 | 2617 | 17371 | 2162 | 16587 | 1504 | 18867 | 1229 | 9422 |
| 6-#14 | 1.17 | MA | 21207 | 4552 | 33253 | 3412 | 35930 | 2776 | 36445 | 2326 | 35812 | 1655 | 41945 | 1431 | 19857 |
| 3L-2S | | MI | 10992 | 4552 | 17690 | 3216 | 18628 | 2607 | 18723 | 2152 | 18373 | 1494 | 21165 | 1357 | 9340 |
| 6-#18 | 2.08 | MA | 24802 | 4925 | 40238 | 3626 | 44706 | 2931 | 47064 | 2402 | 50178 | 1609 | 61108 | 1488 | 34524 |
| 2L-3S | | MI | 10795 | 4925 | 18113 | 3384 | 19034 | 2741 | 19171 | 2216 | 18957 | 1415 | 21824 | 948 | 15807 |
| 6-#18 | 2.08 | MA | 22385 | 4925 | 36537 | 3624 | 39988 | 2961 | 41328 | 2428 | 42407 | 1628 | 50662 | 1260 | 34240 |
| 3L-2S | | MI | 11817 | 4925 | 19662 | 3402 | 20951 | 2724 | 21455 | 2199 | 21977 | 1397 | 25670 | 1175 | 15718 |
| 8-#11 | 1.08 | MA | 22421 | 4516 | 34871 | 3400 | 38059 | 2770 | 39058 | 2307 | 39363 | 1650 | 46871 | 1573 | 18458 |
| 2L-4S | | MI | 10192 | 4516 | 16318 | 3215 | 16998 | 2611 | 16806 | 2161 | 15897 | 1529 | 18188 | 1218 | 8839 |
| 8-#11 | 1.08 | MA | 21434 | 4516 | 33398 | 3400 | 36181 | 2769 | 36776 | 2319 | 36271 | 1659 | 42645 | 1484 | 18475 |
| 3E | | MI | 10504 | 4516 | 16844 | 3207 | 17654 | 2618 | 17582 | 2168 | 16870 | 1522 | 19263 | 1300 | 8779 |
| 8-#11 | 1.08 | MA | 20741 | 4516 | 32220 | 3414 | 34683 | 2782 | 34957 | 2316 | 33910 | 1668 | 39869 | 1396 | 18419 |
| 4L-2S | | MI | 10928 | 4516 | 17487 | 3213 | 18460 | 2611 | 18542 | 2161 | 18139 | 1515 | 20904 | 1389 | 8725 |
| 8-#14 | 1.56 | MA | 23610 | 4712 | 37473 | 3512 | 41310 | 2851 | 42985 | 2355 | 44672 | 1632 | 53988 | 1540 | 26294 |
| 2L-4S | | MI | 10352 | 4712 | 16940 | 3317 | 17705 | 2676 | 17631 | 2190 | 17004 | 1489 | 19656 | 1060 | 12309 |
| 8-#14 | 1.56 | MA | 22214 | 4712 | 35363 | 3512 | 38620 | 2849 | 39715 | 2371 | 40242 | 1645 | 47967 | 1412 | 26247 |
| 3E | | MI | 10792 | 4712 | 17690 | 3307 | 18628 | 2686 | 18723 | 2200 | 18373 | 1479 | 21165 | 1176 | 12261 |
| 8-#14 | 1.56 | MA | 21233 | 4712 | 33673 | 3531 | 36471 | 2866 | 37107 | 2367 | 36855 | 1657 | 44014 | 1284 | 25987 |
| 4L-2S | | MI | 11390 | 4712 | 18603 | 3316 | 19762 | 2676 | 20074 | 2190 | 20159 | 1470 | 23464 | 1304 | 12193 |
| 8-#18 | 2.78 | MA | 26482 | 5208 | 43939 | 3803 | 49425 | 3060 | 52800 | 2481 | 57948 | 1591 | 71554 | 1448 | 45756 |
| 2L-4S | | MI | 10721 | 5208 | 18388 | 3577 | 19391 | 2842 | 19609 | 2261 | 19663 | 1383 | 23133 | 644 | 19195 |
| 8-#18 | 2.78 | MA | 24100 | 5208 | 40238 | 3801 | 44706 | 3089 | 47064 | 2508 | 50178 | 1610 | 61108 | 1221 | 45348 |
| 3E | | MI | 11468 | 5208 | 19662 | 3559 | 20951 | 2860 | 21455 | 2279 | 21977 | 1365 | 25670 | 841 | 20579 |
| 8-#18 | 2.78 | MA | 22425 | 5208 | 37267 | 3834 | 40928 | 3084 | 42479 | 2499 | 44224 | 1630 | 54266 | 993 | 42092 |
| 4L-2S | | MI | 12480 | 5208 | 21212 | 3577 | 22868 | 2842 | 23740 | 2261 | 24997 | 1347 | 29516 | 1069 | 20569 |
| 10-#11 | 1.35 | MA | 23121 | 4627 | 36344 | 3469 | 39936 | 2820 | 41340 | 2338 | 42455 | 1643 | 51097 | 1561 | 22956 |
| 2L-5S | | MI | 10198 | 4627 | 16495 | 3278 | 17219 | 2666 | 17070 | 2195 | 16204 | 1506 | 18691 | 1143 | 10843 |
| 10-#11 | 1.35 | MA | 22140 | 4627 | 34871 | 3469 | 38059 | 2819 | 39058 | 2350 | 39363 | 1652 | 46871 | 1472 | 22949 |
| 3L-4S | | MI | 10479 | 4627 | 16960 | 3284 | 17804 | 2659 | 17767 | 2188 | 17166 | 1513 | 19828 | 1184 | 10831 |
| 10-#11 | 1.35 | MA | 21453 | 4627 | 33693 | 3483 | 36560 | 2832 | 37239 | 2347 | 37002 | 1661 | 44095 | 1383 | 22864 |
| 4L-3S | | MI | 10789 | 4627 | 17487 | 3277 | 18460 | 2666 | 18542 | 2195 | 18139 | 1506 | 20904 | 1266 | 10783 |
| 10-#11 | 1.35 | MA | 20839 | 4627 | 32662 | 3483 | 35230 | 2831 | 35610 | 2359 | 34676 | 1657 | 41218 | 1338 | 22556 |
| 5L-2S | | MI | 11212 | 4627 | 18130 | 3282 | 19266 | 2659 | 19502 | 2188 | 19408 | 1499 | 22544 | 1354 | 10735 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



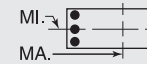

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.95 | MA | 24592 | 4871 | 39583 | 3612 | 44000 | 2923 | 46255 | 2400 | 49102 | 1622 | 60010 | 1521 | 32715 |
| 2L-5S | | MI | 10357 | 4871 | 17190 | 3407 | 18015 | 2755 | 18002 | 2238 | 17525 | 1475 | 20361 | 948 | 14454 |
| 10-#14 | 1.95 | MA | 23208 | 4871 | 37473 | 3612 | 41310 | 2921 | 42985 | 2416 | 44672 | 1635 | 53988 | 1393 | 32624 |
| 3L-4S | | MI | 10753 | 4871 | 17853 | 3417 | 18839 | 2745 | 18983 | 2228 | 18790 | 1465 | 21954 | 1008 | 15086 |
| 10-#14 | 1.95 | MA | 22238 | 4871 | 35783 | 3631 | 39161 | 2939 | 40377 | 2412 | 41285 | 1647 | 50036 | 1265 | 32315 |
| 4L-3S | | MI | 11190 | 4871 | 18603 | 3406 | 19762 | 2755 | 20074 | 2238 | 20159 | 1455 | 23464 | 1123 | 15073 |
| 10-#14 | 1.95 | MA | 21370 | 4871 | 34303 | 3631 | 37252 | 2936 | 38039 | 2428 | 37949 | 1640 | 45930 | 1201 | 30614 |
| 5L-2S | | MI | 11784 | 4871 | 19516 | 3416 | 20896 | 2745 | 21426 | 2228 | 21945 | 1445 | 25762 | 1251 | 15022 |
| 10-#18 | 3.47 | MA | 25786 | 5492 | 43939 | 3978 | 49425 | 3218 | 52800 | 2587 | 57948 | 1593 | 71554 | 1181 | 56450 |
| 3L-4S | | MI | 11394 | 5492 | 19937 | 3751 | 21307 | 2961 | 21893 | 2324 | 22683 | 1333 | 26979 | 538 | 23622 |
| 10-#18 | 3.47 | MA | 24138 | 5492 | 40968 | 4011 | 45647 | 3212 | 48215 | 2578 | 51995 | 1612 | 64712 | 954 | 52810 |
| 4L-3S | | MI | 12135 | 5492 | 21212 | 3734 | 22868 | 2978 | 23740 | 2341 | 24997 | 1315 | 29516 | 735 | 25316 |
| 10-#18 | 3.47 | MA | 22664 | 5492 | 38364 | 4009 | 42288 | 3242 | 44102 | 2605 | 46127 | 1596 | 57565 | 842 | 49776 |
| 5L-2S | | MI | 13137 | 5492 | 22761 | 3751 | 24785 | 2961 | 26024 | 2324 | 28017 | 1298 | 33363 | 962 | 25386 |
| 12-#11 | 1.63 | MA | 23814 | 4737 | 37816 | 3538 | 41814 | 2870 | 43623 | 2369 | 45547 | 1636 | 55323 | 1549 | 27445 |
| 2L-6S | | MI | 10217 | 4737 | 16671 | 3355 | 17441 | 2708 | 17364 | 2229 | 16591 | 1497 | 19274 | 1048 | 12408 |
| 12-#11 | 1.63 | MA | 22840 | 4737 | 36344 | 3538 | 39936 | 2869 | 41340 | 2381 | 42455 | 1645 | 51097 | 1460 | 27414 |
| 3L-5S | | MI | 10484 | 4737 | 17138 | 3348 | 18025 | 2715 | 18030 | 2223 | 17472 | 1490 | 20331 | 1109 | 12670 |
| 12-#11 | 1.63 | MA | 22158 | 4737 | 35166 | 3552 | 38438 | 2882 | 39522 | 2378 | 40094 | 1654 | 48321 | 1371 | 27304 |
| 4E | | MI | 10764 | 4737 | 17603 | 3354 | 18610 | 2708 | 18727 | 2216 | 18435 | 1497 | 21469 | 1150 | 12808 |
| 12-#11 | 1.63 | MA | 21549 | 4737 | 34135 | 3552 | 37108 | 2881 | 37893 | 2390 | 37769 | 1650 | 45444 | 1326 | 26858 |
| 5L-3S | | MI | 11072 | 4737 | 18130 | 3346 | 19266 | 2715 | 19502 | 2223 | 19408 | 1490 | 22544 | 1232 | 12773 |
| 12-#11 | 1.63 | MA | 20968 | 4737 | 33163 | 3552 | 35786 | 2893 | 36280 | 2388 | 35634 | 1659 | 42691 | 1268 | 25893 |
| 6L-2S | | MI | 11493 | 4737 | 18772 | 3352 | 20072 | 2708 | 20463 | 2216 | 20676 | 1484 | 24185 | 1320 | 12732 |
| 12-#14 | 2.34 | MA | 24191 | 5031 | 39583 | 3711 | 44000 | 2993 | 46255 | 2461 | 49102 | 1625 | 60010 | 1374 | 38993 |
| 3L-5S | | MI | 10758 | 5031 | 18103 | 3507 | 19149 | 2824 | 19353 | 2276 | 19311 | 1451 | 22659 | 895 | 17093 |
| 12-#14 | 2.34 | MA | 23231 | 5031 | 37893 | 3731 | 41851 | 3011 | 43647 | 2457 | 45716 | 1637 | 56058 | 1246 | 38641 |
| 4E | | MI | 11152 | 5031 | 18766 | 3516 | 19973 | 2814 | 20334 | 2266 | 20576 | 1441 | 24253 | 955 | 17722 |
| 12-#14 | 2.34 | MA | 22372 | 5031 | 36413 | 3731 | 39942 | 3009 | 41309 | 2473 | 42380 | 1630 | 51952 | 1182 | 36804 |
| 5L-3S | | MI | 11586 | 5031 | 19516 | 3506 | 20896 | 2824 | 21426 | 2276 | 21945 | 1431 | 25762 | 1071 | 17869 |
| 12-#14 | 2.34 | MA | 21554 | 5031 | 35018 | 3730 | 38046 | 3027 | 38995 | 2469 | 39316 | 1643 | 48031 | 1098 | 35593 |
| 6L-2S | | MI | 12176 | 5031 | 20429 | 3516 | 22030 | 2814 | 22777 | 2266 | 23730 | 1421 | 28060 | 1199 | 17835 |
| 12-#18 | 4.17 | MA | 25824 | 5776 | 44669 | 4189 | 50365 | 3341 | 53951 | 2658 | 59766 | 1595 | 75158 | 914 | 63568 |
| 4E | | MI | 12061 | 5776 | 21486 | 3926 | 23224 | 3079 | 24178 | 2386 | 25703 | 1283 | 30826 | 431 | 28087 |
| 12-#18 | 4.17 | MA | 24373 | 5776 | 42065 | 4187 | 47007 | 3371 | 49838 | 2685 | 53898 | 1579 | 68011 | 802 | 60405 |
| 5L-3S | | MI | 12795 | 5776 | 22761 | 3908 | 24785 | 3097 | 26024 | 2404 | 28017 | 1266 | 33363 | 628 | 30031 |
| 12-#18 | 4.17 | MA | 22989 | 5776 | 39608 | 4184 | 43668 | 3365 | 45766 | 2676 | 48506 | 1598 | 61216 | 653 | 55668 |
| 6L-2S | | MI | 13789 | 5776 | 24310 | 3926 | 26701 | 3079 | 28308 | 2386 | 31036 | 1248 | 37209 | 856 | 30169 |
| 14-#11 | 1.90 | MA | 23534 | 4848 | 37816 | 3607 | 41814 | 2919 | 43623 | 2412 | 45547 | 1638 | 55323 | 1448 | 31874 |
| 3L-6S | | MI | 10503 | 4848 | 17314 | 3425 | 18247 | 2757 | 18324 | 2257 | 17859 | 1482 | 20915 | 1014 | 14295 |
| 14-#11 | 1.90 | MA | 22857 | 4848 | 36638 | 3621 | 40315 | 2932 | 41804 | 2410 | 43186 | 1648 | 52547 | 1359 | 31740 |
| 4L-5S | | MI | 10769 | 4848 | 17781 | 3417 | 18831 | 2764 | 18990 | 2250 | 18741 | 1475 | 21972 | 1074 | 14536 |
| 14-#11 | 1.90 | MA | 22252 | 4848 | 35607 | 3621 | 38985 | 2931 | 40175 | 2421 | 40861 | 1643 | 49670 | 1314 | 31173 |
| 5L-4S | | MI | 11047 | 4848 | 18246 | 3423 | 19416 | 2757 | 19687 | 2243 | 19704 | 1482 | 23110 | 1116 | 14775 |
| 14-#11 | 1.90 | MA | 21676 | 4848 | 34635 | 3621 | 37664 | 2943 | 38563 | 2419 | 38726 | 1652 | 46917 | 1256 | 30246 |
| 6L-3S | | MI | 11354 | 4848 | 18772 | 3415 | 20072 | 2764 | 20463 | 2250 | 20676 | 1475 | 24185 | 1198 | 14752 |
| 14-#11 | 1.90 | MA | 21114 | 4848 | 33595 | 3635 | 36395 | 2942 | 37008 | 2430 | 36638 | 1661 | 44054 | 1168 | 29466 |
| 7L-2S | | MI | 11773 | 4848 | 19415 | 3421 | 20878 | 2757 | 21423 | 2243 | 21945 | 1468 | 25826 | 1286 | 14718 |
| 14-#14 | 2.73 | MA | 24213 | 5191 | 40003 | 3831 | 44541 | 3083 | 46917 | 2502 | 50146 | 1628 | 62079 | 1227 | 44967 |
| 4L-5S | | MI | 11156 | 5191 | 19016 | 3607 | 20283 | 2893 | 20704 | 2314 | 21097 | 1427 | 24957 | 842 | 19744 |
| 14-#14 | 2.73 | MA | 23363 | 5191 | 38523 | 3830 | 42632 | 3081 | 44579 | 2518 | 46810 | 1620 | 57973 | 1162 | 43008 |
| 5L-4S | | MI | 11547 | 5191 | 19679 | 3616 | 21108 | 2883 | 21685 | 2304 | 22362 | 1417 | 26551 | 902 | 20319 |
| 14-#14 | 2.73 | MA | 22554 | 5191 | 37128 | 3830 | 40736 | 3099 | 42265 | 2514 | 43746 | 1633 | 54052 | 1078 | 41731 |
| 6L-3S | | MI | 11978 | 5191 | 20429 | 3606 | 22030 | 2893 | 22777 | 2314 | 23730 | 1407 | 28060 | 1018 | 20648 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

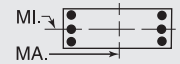


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.73 | MA | 21764 | 5191 | 35634 | 3849 | 38915 | 3097 | 40034 | 2530 | 40749 | 1645 | 49974 | 952 | 39602 |
| 7L-2S | | MI | 12565 | 5191 | 21342 | 3615 | 23164 | 2883 | 24128 | 2304 | 25516 | 1397 | 30358 | 1146 | 20636 |
| 14-#18 | 4.86 | MA | 26057 | 6059 | 45766 | 4364 | 51725 | 3499 | 55574 | 2764 | 61668 | 1561 | 78457 | 763 | 71048 |
| 5L-4S | | MI | 12723 | 6059 | 23035 | 4101 | 25141 | 3198 | 26462 | 2449 | 28722 | 1234 | 34672 | 325 | 32580 |
| 14-#18 | 4.86 | MA | 24694 | 6059 | 43309 | 4362 | 48387 | 3494 | 51502 | 2755 | 56277 | 1581 | 71662 | 613 | 66466 |
| 6L-3S | | MI | 13451 | 6059 | 24310 | 4083 | 26701 | 3216 | 28308 | 2466 | 31036 | 1216 | 37209 | 522 | 34422 |
| 14-#18 | 4.86 | MA | 23364 | 6059 | 40679 | 4395 | 45182 | 3523 | 47574 | 2782 | 51001 | 1600 | 64590 | 388 | 61490 |
| 7L-2S | | MI | 14436 | 6059 | 25859 | 4101 | 28618 | 3198 | 30593 | 2449 | 34056 | 1198 | 41055 | 749 | 34927 |
| 16-#11 | 2.17 | MA | 23550 | 4959 | 38111 | 3690 | 42193 | 2982 | 44087 | 2441 | 46278 | 1641 | 56773 | 1347 | 36175 |
| 4L-6S | | MI | 10787 | 4959 | 17957 | 3494 | 19053 | 2805 | 19285 | 2284 | 19128 | 1466 | 22556 | 980 | 16187 |
| 16-#11 | 2.17 | MA | 22950 | 4959 | 37080 | 3690 | 40863 | 2981 | 42457 | 2452 | 43953 | 1636 | 53896 | 1302 | 35497 |
| 5E | | MI | 11052 | 4959 | 18423 | 3486 | 19637 | 2812 | 19950 | 2277 | 20010 | 1459 | 23613 | 1040 | 16409 |
| 16-#11 | 2.17 | MA | 22379 | 4959 | 36108 | 3690 | 39541 | 2994 | 40845 | 2450 | 41818 | 1645 | 51143 | 1244 | 34606 |
| 6L-4S | | MI | 11329 | 4959 | 18889 | 3492 | 20222 | 2805 | 20647 | 2270 | 20973 | 1466 | 24751 | 1082 | 16733 |
| 16-#11 | 2.17 | MA | 21821 | 4959 | 35067 | 3704 | 38273 | 2992 | 39291 | 2462 | 39730 | 1655 | 48280 | 1156 | 33768 |
| 7L-3S | | MI | 11634 | 4959 | 19415 | 3484 | 20878 | 2812 | 21423 | 2277 | 21945 | 1459 | 25826 | 1163 | 16723 |
| 16-#11 | 2.17 | MA | 21271 | 4959 | 34114 | 3704 | 36993 | 3005 | 37769 | 2473 | 37542 | 1650 | 45591 | 1104 | 32614 |
| 8L-2S | | MI | 12051 | 4959 | 20058 | 3490 | 21684 | 2805 | 22383 | 2270 | 23214 | 1452 | 27467 | 1252 | 16697 |
| 16-#14 | 3.13 | MA | 24344 | 5350 | 40633 | 3930 | 45322 | 3153 | 47849 | 2563 | 51240 | 1610 | 63995 | 1143 | 49225 |
| 5E | | MI | 11552 | 5350 | 19929 | 3706 | 21418 | 2962 | 22056 | 2352 | 22883 | 1402 | 27255 | 789 | 22402 |
| 16-#14 | 3.13 | MA | 23543 | 5350 | 39238 | 3930 | 43425 | 3171 | 45535 | 2559 | 48176 | 1623 | 60074 | 1059 | 47861 |
| 6L-4S | | MI | 11940 | 5350 | 20592 | 3716 | 22242 | 2952 | 23037 | 2342 | 24147 | 1392 | 28849 | 850 | 22931 |
| 16-#14 | 3.13 | MA | 22761 | 5350 | 37744 | 3949 | 41605 | 3169 | 43304 | 2575 | 45179 | 1635 | 55996 | 933 | 45792 |
| 7L-3S | | MI | 12369 | 5350 | 21342 | 3706 | 23164 | 2962 | 24128 | 2352 | 25516 | 1382 | 30358 | 965 | 23414 |
| 16-#14 | 3.13 | MA | 21990 | 5350 | 36375 | 3949 | 39768 | 3187 | 41120 | 2591 | 42039 | 1628 | 52158 | 858 | 43644 |
| 8L-2S | | MI | 12952 | 5350 | 22255 | 3715 | 24298 | 2952 | 25480 | 2342 | 27302 | 1372 | 32656 | 1093 | 23428 |
| 16-#18 | 5.56 | MA | 26376 | 6343 | 47010 | 4539 | 53105 | 3622 | 57238 | 2835 | 64048 | 1563 | 82108 | 574 | 77284 |
| 6L-4S | | MI | 13380 | 6343 | 24584 | 4275 | 27058 | 3316 | 28746 | 2511 | 31742 | 1184 | 38518 | 218 | 37095 |
| 16-#18 | 5.56 | MA | 25066 | 6343 | 44380 | 4572 | 49900 | 3652 | 53310 | 2861 | 58772 | 1582 | 75036 | 349 | 72225 |
| 7L-3S | | MI | 14102 | 6343 | 25859 | 4257 | 28618 | 3334 | 30593 | 2529 | 34056 | 1166 | 41055 | 415 | 38780 |
| 16-#18 | 5.56 | MA | 23772 | 6343 | 41968 | 4570 | 46665 | 3646 | 49464 | 2888 | 53246 | 1567 | 68358 | 218 | 66734 |
| 8L-2S | | MI | 15079 | 6343 | 27408 | 4275 | 30535 | 3316 | 32877 | 2511 | 37076 | 1149 | 44901 | 643 | 39671 |
| 18-#11 | 2.44 | MA | 23643 | 5069 | 38553 | 3759 | 42740 | 3031 | 44740 | 2483 | 47045 | 1629 | 58122 | 1290 | 39831 |
| 5L-6S | | MI | 11070 | 5069 | 18600 | 3563 | 19859 | 2854 | 20245 | 2311 | 20397 | 1451 | 24197 | 946 | 18081 |
| 18-#11 | 2.44 | MA | 23076 | 5069 | 37581 | 3759 | 41419 | 3044 | 43128 | 2481 | 44910 | 1638 | 55369 | 1231 | 38972 |
| 6L-5S | | MI | 11334 | 5069 | 19066 | 3555 | 20443 | 2861 | 20911 | 2304 | 21279 | 1444 | 25254 | 1006 | 18287 |
| 18-#11 | 2.44 | MA | 22522 | 5069 | 36540 | 3773 | 40151 | 3043 | 41573 | 2493 | 42822 | 1648 | 52506 | 1144 | 38078 |
| 7L-4S | | MI | 11609 | 5069 | 19532 | 3561 | 21028 | 2854 | 21608 | 2297 | 22241 | 1451 | 26392 | 1048 | 18682 |
| 18-#11 | 2.44 | MA | 21977 | 5069 | 35586 | 3773 | 38871 | 3055 | 40051 | 2504 | 40634 | 1643 | 49817 | 1091 | 36954 |
| 8L-3S | | MI | 11913 | 5069 | 20058 | 3553 | 21684 | 2861 | 22383 | 2304 | 23214 | 1444 | 27467 | 1129 | 18689 |
| 18-#11 | 2.44 | MA | 21384 | 5069 | 34650 | 3773 | 37620 | 3054 | 38476 | 2502 | 38568 | 1652 | 47150 | 1035 | 35693 |
| 9L-2S | | MI | 12328 | 5069 | 20701 | 3559 | 22490 | 2854 | 23343 | 2297 | 24483 | 1437 | 29108 | 1218 | 18671 |
| 18-#14 | 3.52 | MA | 24522 | 5510 | 41348 | 4029 | 46115 | 3243 | 48805 | 2604 | 52607 | 1613 | 66096 | 1040 | 54002 |
| 6L-5S | | MI | 11945 | 5510 | 20842 | 3806 | 22552 | 3031 | 23407 | 2390 | 24669 | 1378 | 29553 | 737 | 25068 |
| 18-#14 | 3.52 | MA | 23748 | 5510 | 39854 | 4049 | 44295 | 3241 | 46574 | 2620 | 49609 | 1625 | 62017 | 914 | 51991 |
| 7L-4S | | MI | 12331 | 5510 | 21505 | 3816 | 23376 | 3021 | 24388 | 2380 | 25933 | 1368 | 31147 | 797 | 25556 |
| 18-#14 | 3.52 | MA | 22985 | 5510 | 38485 | 4048 | 42458 | 3259 | 44390 | 2636 | 46469 | 1618 | 58180 | 839 | 49796 |
| 8L-3S | | MI | 12757 | 5510 | 22255 | 3805 | 24298 | 3031 | 25480 | 2390 | 27302 | 1358 | 32656 | 913 | 26172 |
| 18-#14 | 3.52 | MA | 22171 | 5510 | 37140 | 4048 | 40663 | 3257 | 42129 | 2632 | 43504 | 1631 | 54381 | 758 | 47435 |
| 9L-2S | | MI | 13337 | 5510 | 23168 | 3815 | 25433 | 3021 | 26831 | 2380 | 29088 | 1348 | 34954 | 1040 | 26210 |
| 18-#18 | 6.25 | MA | 26746 | 6627 | 48081 | 4749 | 54618 | 3780 | 59046 | 2941 | 66543 | 1565 | 85482 | 309 | 82977 |
| 7L-4S | | MI | 14103 | 6627 | 26133 | 4450 | 28974 | 3435 | 31031 | 2574 | 34762 | 1135 | 42364 | 112 | 41628 |
| 18-#18 | 6.25 | MA | 25470 | 6627 | 45669 | 4747 | 51384 | 3775 | 55199 | 2968 | 61017 | 1549 | 78804 | 179 | 77442 |
| 8L-3S | | MI | 14798 | 6627 | 27408 | 4432 | 30535 | 3453 | 32877 | 2591 | 37076 | 1117 | 44901 | 309 | 43173 |
| 20-#11 | 2.71 | MA | 23767 | 5180 | 39053 | 3829 | 43296 | 3094 | 45410 | 2512 | 48002 | 1632 | 59595 | 1219 | 43342 |
| 6E | | MI | 11352 | 5180 | 19243 | 3632 | 20665 | 2903 | 21205 | 2339 | 21666 | 1435 | 25838 | 912 | 19977 |
| 20-#11 | 2.71 | MA | 23218 | 5180 | 38013 | 3842 | 42028 | 3093 | 43855 | 2524 | 45914 | 1641 | 56732 | 1132 | 42394 |
| 7L-5S | | MI | 11614 | 5180 | 19709 | 3624 | 21249 | 2910 | 21871 | 2332 | 22548 | 1428 | 26895 | 972 | 20171 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



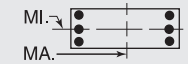

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.71 | MA | 22676 | 5180 | 37059 | 3842 | 40748 | 3105 | 42333 | 2535 | 43726 | 1636 | 54043 | 1079 | 41298 |
| 8L-4S | | MI | 11888 | 5180 | 20174 | 3630 | 21834 | 2903 | 22568 | 2325 | 23510 | 1435 | 28032 | 1014 | 20621 |
| 20-#11 | 2.71 | MA | 22098 | 5180 | 36122 | 3842 | 39498 | 3104 | 40759 | 2533 | 41660 | 1646 | 51376 | 1023 | 40004 |
| 9L-3S | | MI | 12191 | 5180 | 20701 | 3622 | 22490 | 2910 | 23343 | 2332 | 24483 | 1428 | 29108 | 1095 | 20650 |
| 20-#11 | 2.71 | MA | 21489 | 5180 | 35100 | 3856 | 38235 | 3117 | 39247 | 2545 | 39609 | 1655 | 48787 | 960 | 38670 |
| 10L-2S | | MI | 12604 | 5180 | 21344 | 3628 | 23296 | 2903 | 24304 | 2325 | 25752 | 1421 | 30748 | 1184 | 20639 |
| 20-#14 | 3.91 | MA | 24726 | 5669 | 41964 | 4149 | 46985 | 3314 | 49844 | 2665 | 54039 | 1615 | 68039 | 895 | 58198 |
| 7L-5S | | MI | 12335 | 5669 | 21755 | 3906 | 23686 | 3100 | 24758 | 2428 | 26455 | 1354 | 31852 | 684 | 27738 |
| 20-#14 | 3.91 | MA | 23970 | 5669 | 40594 | 4148 | 45148 | 3331 | 47660 | 2681 | 50900 | 1608 | 64201 | 820 | 55955 |
| 8L-4S | | MI | 12719 | 5669 | 22418 | 3915 | 24510 | 3091 | 25740 | 2418 | 27719 | 1344 | 33445 | 744 | 28192 |
| 20-#14 | 3.91 | MA | 23159 | 5669 | 39250 | 4148 | 43353 | 3329 | 45399 | 2677 | 47934 | 1621 | 60402 | 739 | 53567 |
| 9L-3S | | MI | 13143 | 5669 | 23168 | 3905 | 25433 | 3100 | 26831 | 2428 | 29088 | 1334 | 34954 | 860 | 28924 |
| 20-#14 | 3.91 | MA | 22336 | 5669 | 37782 | 4167 | 41540 | 3347 | 43229 | 2693 | 44990 | 1633 | 56717 | 648 | 51151 |
| 10L-2S | | MI | 13720 | 5669 | 24081 | 3915 | 26567 | 3091 | 28182 | 2418 | 30874 | 1324 | 37252 | 988 | 28980 |
| 20-#18 | 6.94 | MA | 27149 | 6911 | 49370 | 4924 | 56102 | 3903 | 60935 | 3047 | 68788 | 1531 | 89250 | 139 | 88164 |
| 8L-4S | | MI | 14746 | 6911 | 27682 | 4624 | 30891 | 3554 | 33315 | 2636 | 37782 | 1085 | 46210 | 5 | 46174 |
| 22-#11 | 2.98 | MA | 23908 | 5291 | 39485 | 3911 | 43906 | 3143 | 46138 | 2555 | 49006 | 1634 | 60958 | 1120 | 46715 |
| 7L-6S | | MI | 11632 | 5291 | 19885 | 3701 | 21471 | 2952 | 22165 | 2366 | 22935 | 1419 | 27478 | 878 | 21863 |
| 22-#11 | 2.98 | MA | 23371 | 5291 | 38531 | 3911 | 42626 | 3156 | 44616 | 2566 | 46818 | 1629 | 58269 | 1067 | 45647 |
| 8L-5S | | MI | 11893 | 5291 | 20352 | 3693 | 22055 | 2958 | 22831 | 2359 | 23816 | 1412 | 28536 | 938 | 22057 |
| 22-#11 | 2.98 | MA | 22794 | 5291 | 37595 | 3911 | 41375 | 3154 | 43041 | 2564 | 44752 | 1639 | 55601 | 1011 | 44321 |
| 9L-4S | | MI | 12166 | 5291 | 20817 | 3699 | 22640 | 2952 | 23528 | 2352 | 24779 | 1419 | 29673 | 980 | 22480 |
| 22-#11 | 2.98 | MA | 22191 | 5291 | 36573 | 3925 | 40112 | 3167 | 41529 | 2576 | 42701 | 1648 | 53013 | 948 | 42965 |
| 10L-3S | | MI | 12467 | 5291 | 21344 | 3691 | 23296 | 2958 | 24304 | 2359 | 25752 | 1412 | 30748 | 1061 | 22599 |
| 22-#11 | 2.98 | MA | 21609 | 5291 | 35636 | 3925 | 38869 | 3166 | 39973 | 2573 | 40544 | 1643 | 50387 | 892 | 41444 |
| 11L-2S | | MI | 12879 | 5291 | 21986 | 3697 | 24102 | 2952 | 25264 | 2352 | 27021 | 1406 | 32389 | 1150 | 22603 |
| 22-#14 | 4.30 | MA | 24947 | 5829 | 42704 | 4248 | 47838 | 3404 | 50930 | 2726 | 55330 | 1598 | 70223 | 801 | 62123 |
| 8L-5S | | MI | 12724 | 5829 | 22668 | 4006 | 24820 | 3170 | 26110 | 2466 | 28240 | 1329 | 34150 | 631 | 30412 |
| 22-#14 | 4.30 | MA | 24137 | 5829 | 41360 | 4247 | 46043 | 3402 | 48669 | 2722 | 52364 | 1611 | 66424 | 720 | 59706 |
| 9L-4S | | MI | 13106 | 5829 | 23331 | 4015 | 25644 | 3160 | 27091 | 2456 | 29505 | 1319 | 35743 | 692 | 30835 |
| 22-#14 | 4.30 | MA | 23322 | 5829 | 39892 | 4267 | 44230 | 3419 | 46499 | 2738 | 49421 | 1623 | 62739 | 629 | 57304 |
| 10L-3S | | MI | 13527 | 5829 | 24081 | 4005 | 26567 | 3170 | 28182 | 2466 | 30874 | 1310 | 37252 | 807 | 31671 |
| 24-#11 | 3.25 | MA | 24061 | 5401 | 40004 | 3981 | 44503 | 3206 | 46898 | 2598 | 49910 | 1622 | 62495 | 1055 | 50000 |
| 8L-6S | | MI | 11911 | 5401 | 20528 | 3770 | 22277 | 3000 | 23126 | 2393 | 24204 | 1404 | 29119 | 844 | 23695 |
| 24-#11 | 3.25 | MA | 23484 | 5401 | 39068 | 3981 | 43253 | 3205 | 45324 | 2595 | 47844 | 1632 | 59827 | 999 | 48642 |
| 9L-5S | | MI | 12171 | 5401 | 20995 | 3763 | 22861 | 3007 | 23792 | 2386 | 25085 | 1397 | 30176 | 904 | 23947 |
| 24-#11 | 3.25 | MA | 22888 | 5401 | 38045 | 3994 | 41990 | 3217 | 43811 | 2607 | 45793 | 1641 | 57239 | 936 | 47265 |
| 10L-4S | | MI | 12442 | 5401 | 21460 | 3768 | 23446 | 3000 | 24489 | 2379 | 26048 | 1404 | 31314 | 945 | 24344 |
| 24-#11 | 3.25 | MA | 22310 | 5401 | 37109 | 3994 | 40747 | 3216 | 42255 | 2605 | 43636 | 1636 | 54613 | 880 | 45768 |
| 11L-3S | | MI | 12742 | 5401 | 21986 | 3761 | 24102 | 3007 | 25264 | 2386 | 27021 | 1397 | 32389 | 1027 | 24546 |
| 24-#11 | 3.25 | MA | 21742 | 5401 | 36102 | 4008 | 39492 | 3229 | 40746 | 2616 | 41589 | 1646 | 51721 | 806 | 44116 |
| 12L-2S | | MI | 13152 | 5401 | 22629 | 3767 | 24908 | 3000 | 26224 | 2379 | 28289 | 1390 | 34030 | 1116 | 24564 |
| 24-#14 | 4.69 | MA | 25107 | 5989 | 43470 | 4347 | 48733 | 3474 | 51939 | 2767 | 56794 | 1601 | 72446 | 701 | 65852 |
| 9L-5S | | MI | 13111 | 5989 | 23581 | 4105 | 25954 | 3239 | 27461 | 2504 | 30026 | 1305 | 36448 | 579 | 33030 |
| 24-#14 | 4.69 | MA | 24298 | 5989 | 42002 | 4367 | 46920 | 3492 | 49769 | 2783 | 53851 | 1613 | 68760 | 610 | 63428 |
| 10L-4S | | MI | 13491 | 5989 | 24244 | 4115 | 26778 | 3229 | 28442 | 2494 | 31291 | 1295 | 38041 | 639 | 33485 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

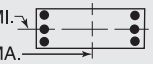
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.38 | MA | 7180 | 2722 | 11583 | 1948 | 12408 | 1581 | 12608 | 1302 | 12620 | 893 | 14742 | 812 | 7030 |
| 2L-3S | | MI | 6712 | 2722 | 10871 | 1943 | 11503 | 1588 | 11530 | 1309 | 11196 | 900 | 12888 | 723 | 7073 |
| 6-#14 | 2.00 | MA | 7567 | 2869 | 12508 | 2029 | 13518 | 1635 | 13918 | 1329 | 14348 | 864 | 16954 | 756 | 9870 |
| 2L-3S | | MI | 6909 | 2869 | 11495 | 2021 | 12241 | 1645 | 12397 | 1339 | 12339 | 874 | 14349 | 628 | 9892 |
| 6-#18 | 3.55 | MA | 8485 | 3241 | 14762 | 2240 | 16182 | 1772 | 17070 | 1394 | 18509 | 785 | 22222 | 601 | 16768 |
| 2L-3S | | MI | 7375 | 3241 | 13011 | 2223 | 14013 | 1790 | 14486 | 1412 | 15094 | 803 | 17835 | 373 | 16260 |
| 8-#11 | 1.85 | MA | 7495 | 2833 | 12295 | 2017 | 13313 | 1631 | 13686 | 1331 | 14044 | 879 | 16596 | 781 | 9228 |
| 2L-4S | | MI | 6693 | 2833 | 11002 | 2021 | 11673 | 1631 | 11738 | 1331 | 11529 | 893 | 13531 | 609 | 9211 |
| 8-#14 | 2.66 | MA | 8005 | 3029 | 13520 | 2128 | 14794 | 1706 | 15438 | 1369 | 16357 | 843 | 19559 | 709 | 12975 |
| 2L-4S | | MI | 6881 | 3029 | 11679 | 2132 | 12480 | 1706 | 12690 | 1369 | 12808 | 863 | 15249 | 462 | 12136 |
| 8-#18 | 4.73 | MA | 9214 | 3525 | 16512 | 2418 | 18350 | 1894 | 19654 | 1461 | 21923 | 741 | 26610 | 505 | 22068 |
| 2L-4S | | MI | 7324 | 3525 | 13323 | 2418 | 14418 | 1894 | 14983 | 1461 | 15892 | 776 | 19339 | 73 | 18888 |
| 10-#11 | 2.31 | MA | 7806 | 2944 | 13007 | 2086 | 14218 | 1681 | 14763 | 1359 | 15468 | 865 | 18450 | 751 | 11413 |
| 2L-5S | | MI | 6709 | 2944 | 11201 | 2085 | 11920 | 1688 | 12033 | 1366 | 11873 | 872 | 14099 | 537 | 10678 |
| 10-#11 | 2.31 | MA | 7345 | 2944 | 12295 | 2081 | 13313 | 1688 | 13686 | 1366 | 14044 | 872 | 16596 | 662 | 11418 |
| 3L-4S | | MI | 7011 | 2944 | 11714 | 2090 | 12578 | 1681 | 12816 | 1359 | 12952 | 879 | 15385 | 578 | 11213 |
| 10-#14 | 3.33 | MA | 8438 | 3188 | 14533 | 2228 | 16070 | 1777 | 16959 | 1409 | 18366 | 821 | 22163 | 662 | 16062 |
| 2L-5S | | MI | 6903 | 3188 | 11960 | 2224 | 12829 | 1787 | 13107 | 1419 | 13293 | 831 | 16048 | 355 | 14251 |
| 10-#14 | 3.33 | MA | 7794 | 3188 | 13520 | 2220 | 14794 | 1787 | 15438 | 1419 | 16357 | 831 | 19559 | 534 | 15993 |
| 3L-4S | | MI | 7326 | 3188 | 12692 | 2232 | 13756 | 1777 | 14211 | 1409 | 14817 | 841 | 17854 | 415 | 15001 |
| 10-#18 | 5.92 | MA | 8857 | 3809 | 16512 | 2578 | 18350 | 2034 | 19654 | 1545 | 21923 | 715 | 26610 | 182 | 25730 |
| 3L-4S | | MI | 8072 | 3809 | 15074 | 2596 | 16586 | 2016 | 17567 | 1528 | 19306 | 732 | 23727 | -22 | 23617 |

## RECTANGULAR TIED COLUMNS 26" x 28"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.24 | MA | 8219 | 2893 | 13170 | 2078 | 14081 | 1690 | 14261 | 1397 | 14162 | 971 | 16492 | 890 | 7346 |
| 2E | | MI | 7603 | 2893 | 12223 | 2062 | 12987 | 1674 | 13117 | 1382 | 12979 | 957 | 15052 | 873 | 6771 |
| 4-#18 | 2.20 | MA | 8915 | 3142 | 14848 | 2212 | 16076 | 1779 | 16611 | 1439 | 17259 | 919 | 20445 | 792 | 12495 |
| 2E | | MI | 8225 | 3142 | 13743 | 2195 | 14758 | 1758 | 15203 | 1419 | 15730 | 900 | 18532 | 764 | 11464 |
| 6-#11 | 1.29 | MA | 8280 | 2906 | 13263 | 2097 | 14237 | 1705 | 14487 | 1410 | 14464 | 978 | 16914 | 898 | 7661 |
| 2L-3S | | MI | 7190 | 2906 | 11598 | 2076 | 12249 | 1698 | 12251 | 1402 | 11839 | 972 | 13594 | 793 | 7108 |
| 6-#11 | 1.29 | MA | 7765 | 2906 | 12482 | 2093 | 13241 | 1712 | 13291 | 1417 | 12884 | 985 | 14846 | 810 | 7705 |
| 3L-2S | | MI | 7660 | 2906 | 12310 | 2081 | 13154 | 1691 | 13329 | 1395 | 13262 | 965 | 15448 | 881 | 7061 |
| 6-#14 | 1.85 | MA | 8712 | 3053 | 14282 | 2178 | 15500 | 1763 | 15952 | 1439 | 16394 | 951 | 19405 | 848 | 10781 |
| 2L-3S | | MI | 7388 | 3053 | 12223 | 2154 | 12987 | 1755 | 13117 | 1432 | 12979 | 946 | 15052 | 697 | 9946 |
| 6-#14 | 1.85 | MA | 7987 | 3053 | 13170 | 2171 | 14081 | 1773 | 14261 | 1448 | 14162 | 961 | 16492 | 720 | 10803 |
| 3L-2S | | MI | 8048 | 3053 | 13236 | 2162 | 14263 | 1745 | 14638 | 1422 | 14988 | 936 | 17657 | 825 | 9909 |
| 6-#18 | 3.30 | MA | 9741 | 3425 | 16776 | 2390 | 18497 | 1904 | 19495 | 1509 | 21070 | 879 | 25377 | 706 | 18388 |
| 2L-3S | | MI | 7854 | 3425 | 13743 | 2354 | 14758 | 1898 | 15203 | 1504 | 15730 | 873 | 18532 | 441 | 16628 |
| 6-#18 | 3.30 | MA | 8514 | 3425 | 14848 | 2375 | 16076 | 1922 | 16611 | 1527 | 17259 | 897 | 20445 | 478 | 18163 |
| 3L-2S | | MI | 8968 | 3425 | 15493 | 2372 | 16926 | 1880 | 17787 | 1486 | 19145 | 856 | 22919 | 669 | 16830 |
| 8-#11 | 1.71 | MA | 8629 | 3017 | 14044 | 2166 | 15233 | 1755 | 15682 | 1440 | 16043 | 966 | 18982 | 871 | 10070 |
| 2L-4S | | MI | 7171 | 3017 | 11729 | 2154 | 12419 | 1741 | 12459 | 1424 | 12171 | 965 | 14237 | 678 | 9281 |
| 8-#11 | 1.71 | MA | 8118 | 3017 | 13263 | 2162 | 14237 | 1763 | 14487 | 1446 | 14464 | 972 | 16914 | 782 | 10096 |
| 3E | | MI | 7509 | 3017 | 12310 | 2146 | 13154 | 1748 | 13329 | 1431 | 13262 | 958 | 15448 | 762 | 9294 |
| 8-#11 | 1.71 | MA | 7749 | 3017 | 12628 | 2172 | 13429 | 1756 | 13522 | 1440 | 13253 | 979 | 15566 | 696 | 10063 |
| 4L-2S | | MI | 7975 | 3017 | 13022 | 2151 | 14059 | 1741 | 14407 | 1424 | 14686 | 951 | 17302 | 851 | 9263 |
| 8-#14 | 2.47 | MA | 9199 | 3213 | 15395 | 2278 | 16918 | 1835 | 17642 | 1480 | 18627 | 932 | 22317 | 805 | 14190 |
| 2L-4S | | MI | 7359 | 3213 | 12408 | 2265 | 13225 | 1816 | 13410 | 1462 | 13448 | 934 | 15952 | 531 | 12337 |
| 8-#14 | 2.47 | MA | 8482 | 3213 | 14282 | 2271 | 15500 | 1845 | 15952 | 1490 | 16394 | 942 | 19405 | 677 | 14164 |
| 3E | | MI | 7834 | 3213 | 13236 | 2253 | 14263 | 1826 | 14638 | 1472 | 14988 | 924 | 17657 | 650 | 13012 |
| 8-#14 | 2.47 | MA | 7963 | 3213 | 13376 | 2284 | 14347 | 1835 | 14588 | 1480 | 14683 | 952 | 17504 | 555 | 13422 |
| 4L-2S | | MI | 8487 | 3213 | 14249 | 2262 | 15539 | 1816 | 16158 | 1462 | 16997 | 914 | 20262 | 778 | 13020 |
| 8-#18 | 4.40 | MA | 10553 | 3709 | 18703 | 2567 | 20918 | 2029 | 22379 | 1579 | 24881 | 840 | 30309 | 619 | 24228 |
| 2L-4S | | MI | 7800 | 3709 | 14055 | 2550 | 15162 | 2002 | 15700 | 1553 | 16528 | 847 | 20036 | 142 | 19156 |
| 8-#18 | 4.40 | MA | 9346 | 3709 | 16776 | 2552 | 18497 | 2047 | 19495 | 1597 | 21070 | 858 | 25377 | 392 | 23433 |
| 3E | | MI | 8602 | 3709 | 15493 | 2532 | 16926 | 2020 | 17787 | 1570 | 19145 | 829 | 22919 | 346 | 21316 |

## RECTANGULAR TIED COLUMNS 26" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

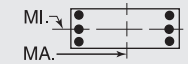
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 4.40 | MA | 8471 | 3709 | 15198 | 2573 | 16528 | 2029 | 17166 | 1579 | 18148 | 875 | 22147 | 182 | 20924 |
| 4L-2S | | MI | 9700 | 3709 | 17244 | 2549 | 19095 | 2002 | 20371 | 1553 | 22559 | 812 | 27307 | 573 | 22138 |
| 10-#11 | 2.14 | MA | 8974 | 3127 | 14825 | 2235 | 16229 | 1805 | 16878 | 1469 | 17622 | 953 | 21049 | 843 | 12466 |
| 2L-5S | | MI | 7187 | 3127 | 11928 | 2219 | 12666 | 1798 | 12755 | 1460 | 12515 | 944 | 14806 | 607 | 10816 |
| 10-#11 | 2.14 | MA | 8467 | 3127 | 14044 | 2231 | 15233 | 1813 | 15682 | 1476 | 16043 | 960 | 18982 | 755 | 12471 |
| 3L-4S | | MI | 7490 | 3127 | 12441 | 2224 | 13323 | 1791 | 13537 | 1453 | 13595 | 951 | 16091 | 648 | 11376 |
| 10-#11 | 2.14 | MA | 8102 | 3127 | 13409 | 2241 | 14425 | 1807 | 14718 | 1469 | 14832 | 967 | 17634 | 669 | 12380 |
| 4L-3S | | MI | 7825 | 3127 | 13022 | 2215 | 14059 | 1798 | 14407 | 1460 | 14686 | 944 | 17302 | 732 | 11468 |
| 10-#11 | 2.14 | MA | 7772 | 3127 | 12849 | 2237 | 13704 | 1814 | 13850 | 1476 | 13635 | 960 | 16200 | 628 | 11734 |
| 5L-2S | | MI | 8287 | 3127 | 13734 | 2220 | 14963 | 1791 | 15484 | 1453 | 16110 | 937 | 19156 | 820 | 11451 |
| 10-#14 | 3.09 | MA | 9680 | 3372 | 16507 | 2378 | 18336 | 1907 | 19332 | 1522 | 20860 | 913 | 25229 | 762 | 17581 |
| 2L-5S | | MI | 7379 | 3372 | 12689 | 2357 | 13574 | 1897 | 13827 | 1512 | 13933 | 903 | 16751 | 425 | 14569 |
| 10-#14 | 3.09 | MA | 8970 | 3372 | 15395 | 2371 | 16918 | 1917 | 17642 | 1532 | 18627 | 923 | 22317 | 634 | 17512 |
| 3L-4S | | MI | 7804 | 3372 | 13420 | 2365 | 14502 | 1887 | 14931 | 1502 | 15457 | 913 | 18557 | 484 | 15197 |
| 10-#14 | 3.09 | MA | 8457 | 3372 | 14488 | 2384 | 15766 | 1907 | 16278 | 1522 | 16915 | 933 | 20416 | 512 | 16573 |
| 4L-3S | | MI | 8275 | 3372 | 14249 | 2353 | 15539 | 1897 | 16158 | 1512 | 16997 | 903 | 20262 | 603 | 16063 |
| 10-#14 | 3.09 | MA | 7995 | 3372 | 13688 | 2377 | 14735 | 1917 | 15051 | 1532 | 15223 | 923 | 18396 | 454 | 15840 |
| 5L-2S | | MI | 8921 | 3372 | 15261 | 2361 | 16816 | 1887 | 17679 | 1502 | 19006 | 893 | 22866 | 731 | 16114 |
| 10-#18 | 5.49 | MA | 10165 | 3993 | 18703 | 2730 | 20918 | 2172 | 22379 | 1667 | 24881 | 818 | 30309 | 305 | 28703 |
| 3L-4S | | MI | 8550 | 3993 | 15805 | 2727 | 17331 | 2124 | 18284 | 1619 | 19942 | 803 | 24424 | 46 | 24129 |
| 10-#18 | 5.49 | MA | 9303 | 3993 | 17125 | 2750 | 18949 | 2154 | 20051 | 1650 | 21959 | 836 | 27079 | 95 | 26419 |
| 4L-3S | | MI | 9340 | 3993 | 17244 | 2709 | 19095 | 2142 | 20371 | 1637 | 22559 | 785 | 27307 | 250 | 26078 |
| 12-#11 | 2.57 | MA | 9317 | 3238 | 15606 | 2304 | 17224 | 1855 | 18073 | 1499 | 19201 | 941 | 23117 | 816 | 14852 |
| 2L-6S | | MI | 7218 | 3238 | 12155 | 2283 | 12916 | 1841 | 13085 | 1495 | 12949 | 937 | 15463 | 516 | 12397 |
| 12-#11 | 2.57 | MA | 8814 | 3238 | 14825 | 2300 | 16229 | 1863 | 16878 | 1506 | 17622 | 948 | 21049 | 727 | 14835 |
| 3L-5S | | MI | 7505 | 3238 | 12640 | 2288 | 13571 | 1848 | 13832 | 1488 | 13939 | 930 | 16660 | 576 | 12877 |
| 12-#11 | 2.57 | MA | 8451 | 3238 | 14190 | 2310 | 15421 | 1857 | 15913 | 1499 | 16411 | 955 | 19702 | 641 | 14597 |
| 4E | | MI | 7805 | 3238 | 13153 | 2293 | 14228 | 1841 | 14615 | 1481 | 15018 | 937 | 17945 | 617 | 13393 |
| 12-#11 | 2.57 | MA | 8124 | 3238 | 13630 | 2306 | 14700 | 1864 | 15045 | 1506 | 15214 | 948 | 18268 | 601 | 13998 |
| 5L-3S | | MI | 8138 | 3238 | 13734 | 2284 | 14963 | 1848 | 15484 | 1488 | 16110 | 930 | 19156 | 701 | 13625 |
| 12-#11 | 2.57 | MA | 7812 | 3238 | 13100 | 2302 | 13982 | 1858 | 14216 | 1513 | 14117 | 955 | 16931 | 541 | 13467 |
| 6L-2S | | MI | 8596 | 3238 | 14446 | 2289 | 15868 | 1841 | 16562 | 1481 | 17534 | 924 | 21010 | 790 | 13631 |
| 12-#14 | 3.71 | MA | 9453 | 3532 | 16507 | 2471 | 18336 | 1990 | 19332 | 1574 | 20860 | 904 | 25229 | 592 | 20850 |
| 3L-5S | | MI | 7825 | 3532 | 13701 | 2457 | 14851 | 1967 | 15347 | 1552 | 15942 | 881 | 19356 | 377 | 17354 |
| 12-#14 | 3.71 | MA | 8946 | 3532 | 15601 | 2484 | 17184 | 1980 | 17968 | 1564 | 19148 | 914 | 23328 | 470 | 19746 |
| 4E | | MI | 8245 | 3532 | 14433 | 2465 | 15778 | 1957 | 16451 | 1542 | 17466 | 891 | 21162 | 437 | 18079 |
| 12-#14 | 3.71 | MA | 8488 | 3532 | 14801 | 2477 | 16154 | 1990 | 16741 | 1574 | 17455 | 904 | 21309 | 411 | 18960 |
| 5L-3S | | MI | 8711 | 3532 | 15261 | 2453 | 16816 | 1967 | 17679 | 1552 | 19006 | 881 | 22866 | 556 | 19103 |
| 12-#14 | 3.71 | MA | 8051 | 3532 | 14044 | 2470 | 15128 | 1980 | 15569 | 1584 | 15904 | 914 | 19428 | 325 | 17722 |
| 6L-2S | | MI | 9352 | 3532 | 16274 | 2461 | 18092 | 1957 | 19199 | 1542 | 21015 | 871 | 25471 | 684 | 19188 |
| 12-#18 | 6.59 | MA | 10125 | 4276 | 19053 | 2927 | 21370 | 2280 | 22935 | 1720 | 25770 | 796 | 32011 | 9 | 31948 |
| 4E | | MI | 9290 | 4276 | 17556 | 2904 | 19499 | 2247 | 20868 | 1686 | 23357 | 759 | 28811 | -49 | 28524 |
| 14-#11 | 3.00 | MA | 9157 | 3349 | 15606 | 2369 | 17224 | 1913 | 18073 | 1536 | 19201 | 936 | 23117 | 700 | 17193 |
| 3L-6S | | MI | 7535 | 3349 | 12867 | 2352 | 13821 | 1891 | 14163 | 1524 | 14373 | 924 | 17317 | 486 | 14404 |
| 14-#11 | 3.00 | MA | 8798 | 3349 | 14971 | 2379 | 16417 | 1907 | 17109 | 1529 | 17990 | 942 | 21770 | 614 | 16828 |
| 4L-5S | | MI | 7820 | 3349 | 13352 | 2357 | 14475 | 1898 | 14910 | 1517 | 15363 | 917 | 18513 | 546 | 14946 |
| 14-#11 | 3.00 | MA | 8473 | 3349 | 14411 | 2375 | 15696 | 1914 | 16241 | 1536 | 16793 | 936 | 20336 | 573 | 16270 |
| 5L-4S | | MI | 8118 | 3349 | 13865 | 2362 | 15133 | 1891 | 15692 | 1510 | 16442 | 924 | 19799 | 587 | 15424 |
| 14-#11 | 3.00 | MA | 8163 | 3349 | 13881 | 2371 | 14978 | 1908 | 15412 | 1543 | 15696 | 942 | 18999 | 514 | 15678 |
| 6L-3S | | MI | 8448 | 3349 | 14446 | 2353 | 15868 | 1898 | 16562 | 1517 | 17534 | 917 | 21010 | 671 | 15776 |
| 14-#11 | 3.00 | MA | 7861 | 3349 | 13315 | 2380 | 14287 | 1916 | 14550 | 1536 | 14622 | 949 | 17737 | 447 | 15077 |
| 7L-2S | | MI | 8904 | 3349 | 15158 | 2358 | 16773 | 1891 | 17640 | 1510 | 18958 | 910 | 22864 | 759 | 15803 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

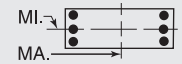
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 4.33 | MA | 9430 | 3691 | 16713 | 2583 | 18602 | 2052 | 19658 | 1606 | 21380 | 894 | 26241 | 427 | 22938 |
| 4L-5S | | MI | 8266 | 3691 | 14714 | 2557 | 16127 | 2038 | 16868 | 1592 | 17951 | 860 | 21960 | 330 | 20160 |
| 14-#14 | 4.33 | MA | 8977 | 3691 | 15913 | 2577 | 17572 | 2062 | 18431 | 1616 | 19688 | 885 | 24221 | 368 | 22058 |
| 5L-4S | | MI | 8682 | 3691 | 15446 | 2565 | 17054 | 2028 | 17972 | 1582 | 19475 | 869 | 23766 | 389 | 20979 |
| 14-#14 | 4.33 | MA | 8544 | 3691 | 15156 | 2570 | 16546 | 2052 | 17259 | 1626 | 18136 | 894 | 22340 | 282 | 20887 |
| 6L-3S | | MI | 9143 | 3691 | 16274 | 2553 | 18092 | 2038 | 19199 | 1592 | 21015 | 860 | 25471 | 509 | 22137 |
| 16-#11 | 3.43 | MA | 9141 | 3459 | 15752 | 2448 | 17413 | 1957 | 18304 | 1559 | 19569 | 930 | 23837 | 586 | 19071 |
| 4L-6S | | MI | 7850 | 3459 | 13579 | 2421 | 14726 | 1941 | 15241 | 1552 | 15797 | 910 | 19171 | 455 | 16422 |
| 16-#11 | 3.43 | MA | 8819 | 3459 | 15192 | 2444 | 16691 | 1965 | 17437 | 1566 | 18372 | 923 | 22404 | 546 | 18550 |
| 5E | | MI | 8133 | 3459 | 14064 | 2426 | 15380 | 1947 | 15988 | 1546 | 16786 | 903 | 20367 | 515 | 17021 |
| 16-#11 | 3.43 | MA | 8512 | 3459 | 14662 | 2440 | 15973 | 1958 | 16607 | 1573 | 17275 | 930 | 21067 | 486 | 17899 |
| 6L-4S | | MI | 8429 | 3459 | 14577 | 2431 | 16038 | 1941 | 16770 | 1539 | 17866 | 910 | 21653 | 556 | 17466 |
| 16-#11 | 3.43 | MA | 8212 | 3459 | 14096 | 2449 | 15283 | 1966 | 15746 | 1566 | 16201 | 937 | 19805 | 419 | 17294 |
| 7L-3S | | MI | 8756 | 3459 | 15158 | 2422 | 16773 | 1947 | 17640 | 1546 | 18958 | 903 | 22864 | 640 | 17923 |
| 16-#14 | 4.95 | MA | 9461 | 3851 | 17026 | 2676 | 18990 | 2134 | 20121 | 1658 | 21920 | 865 | 27133 | 326 | 25174 |
| 5E | | MI | 8703 | 3851 | 15727 | 2656 | 17403 | 2109 | 18388 | 1632 | 19960 | 838 | 24565 | 283 | 22984 |
| 16-#14 | 4.95 | MA | 9032 | 3851 | 16269 | 2670 | 17964 | 2125 | 18949 | 1668 | 20369 | 875 | 25253 | 239 | 24065 |
| 6L-4S | | MI | 9115 | 3851 | 16459 | 2664 | 18331 | 2099 | 19492 | 1622 | 21483 | 848 | 26371 | 342 | 23893 |
| 18-#11 | 3.86 | MA | 9163 | 3570 | 15973 | 2513 | 17687 | 2015 | 18632 | 1595 | 19952 | 911 | 24471 | 518 | 20834 |
| 5L-6S | | MI | 8163 | 3570 | 14291 | 2490 | 15630 | 1990 | 16318 | 1581 | 17221 | 896 | 21025 | 425 | 18448 |
| 18-#11 | 3.86 | MA | 8858 | 3570 | 15444 | 2509 | 16969 | 2009 | 17803 | 1602 | 18854 | 918 | 23134 | 459 | 20129 |
| 6L-5S | | MI | 8443 | 3570 | 14776 | 2495 | 16285 | 1997 | 17066 | 1574 | 18210 | 889 | 22221 | 485 | 19101 |
| 18-#11 | 3.86 | MA | 8560 | 3570 | 14877 | 2519 | 16279 | 2016 | 16941 | 1595 | 17780 | 925 | 21873 | 392 | 19484 |
| 7L-4S | | MI | 8737 | 3570 | 15289 | 2500 | 16942 | 1990 | 17848 | 1567 | 19290 | 896 | 23507 | 525 | 19517 |
| 18-#14 | 5.56 | MA | 9516 | 4011 | 17381 | 2769 | 19383 | 2197 | 20639 | 1709 | 22601 | 856 | 28165 | 197 | 27237 |
| 6L-5S | | MI | 9136 | 4010 | 16740 | 2756 | 18680 | 2180 | 19909 | 1672 | 21969 | 817 | 27169 | 236 | 25824 |
| 20-#11 | 4.29 | MA | 9201 | 3681 | 16225 | 2578 | 17965 | 2059 | 18999 | 1632 | 20433 | 906 | 25202 | 431 | 22366 |
| 6E | | MI | 8473 | 3681 | 15003 | 2559 | 16535 | 2040 | 17396 | 1610 | 18644 | 882 | 22878 | 394 | 20481 |
| 20-#11 | 4.29 | MA | 8906 | 3681 | 15658 | 2588 | 17275 | 2066 | 18137 | 1625 | 19359 | 912 | 23940 | 364 | 21684 |
| 7L-5S | | MI | 8752 | 3681 | 15488 | 2564 | 17190 | 2047 | 18143 | 1603 | 19634 | 875 | 24075 | 454 | 21185 |
| 22-#11 | 4.71 | MA | 9249 | 3791 | 16439 | 2657 | 18270 | 2116 | 19332 | 1655 | 20938 | 900 | 26008 | 337 | 23890 |
| 7L-6S | | MI | 8782 | 3791 | 15715 | 2629 | 17440 | 2090 | 18474 | 1638 | 20068 | 868 | 24732 | 364 | 22522 |

## RECTANGULAR TIED COLUMNS 26" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.15 | MA | 9388 | 3077 | 14949 | 2228 | 16006 | 1813 | 16240 | 1504 | 16090 | 1055 | 18754 | 976 | 7953 |
| 2E | | MI | 8082 | 3077 | 12952 | 2195 | 13732 | 1783 | 13837 | 1475 | 13619 | 1029 | 15756 | 942 | 6803 |
| 4-#18 | 2.05 | MA | 10161 | 3326 | 16789 | 2362 | 18254 | 1907 | 18851 | 1549 | 19530 | 1007 | 23177 | 885 | 13575 |
| 2E | | MI | 8706 | 3326 | 14475 | 2326 | 15502 | 1866 | 15920 | 1511 | 16366 | 970 | 19228 | 833 | 11512 |
| 6-#11 | 1.20 | MA | 9454 | 3090 | 15047 | 2246 | 16171 | 1828 | 16480 | 1517 | 16412 | 1062 | 19205 | 984 | 8293 |
| 2L-3S | | MI | 7669 | 3090 | 12324 | 2210 | 12995 | 1808 | 12972 | 1496 | 12481 | 1044 | 14301 | 862 | 7141 |
| 6-#11 | 1.20 | MA | 8891 | 3090 | 14197 | 2243 | 15087 | 1836 | 15167 | 1524 | 14677 | 1069 | 16922 | 895 | 8336 |
| 3L-2S | | MI | 8139 | 3090 | 13036 | 2215 | 13899 | 1801 | 14050 | 1489 | 13905 | 1037 | 16155 | 951 | 7091 |
| 6-#14 | 1.73 | MA | 9932 | 3237 | 16162 | 2328 | 17552 | 1886 | 18100 | 1547 | 18547 | 1038 | 21975 | 937 | 11692 |
| 2L-3S | | MI | 7866 | 3237 | 12952 | 2287 | 13732 | 1864 | 13837 | 1525 | 13619 | 1017 | 15756 | 767 | 9994 |
| 6-#14 | 1.73 | MA | 9139 | 3237 | 14949 | 2322 | 16006 | 1897 | 16240 | 1557 | 16090 | 1048 | 18754 | 809 | 11714 |
| 3L-2S | | MI | 8528 | 3237 | 13964 | 2295 | 15008 | 1854 | 15357 | 1515 | 15628 | 1007 | 18360 | 894 | 9947 |
| 6-#18 | 3.08 | MA | 11072 | 3609 | 18894 | 2539 | 20928 | 2035 | 22036 | 1623 | 23738 | 971 | 28656 | 807 | 20008 |
| 2L-3S | | MI | 8332 | 3609 | 14475 | 2486 | 15502 | 2006 | 15920 | 1595 | 16366 | 944 | 19228 | 509 | 16756 |
| 6-#18 | 3.08 | MA | 9729 | 3609 | 16789 | 2526 | 18254 | 2052 | 18851 | 1640 | 19530 | 989 | 23177 | 579 | 19783 |
| 3L-2S | | MI | 9450 | 3609 | 16225 | 2503 | 17671 | 1988 | 18504 | 1578 | 19780 | 926 | 23616 | 737 | 16885 |
| 8-#11 | 1.60 | MA | 9838 | 3201 | 15898 | 2316 | 17255 | 1878 | 17794 | 1548 | 18147 | 1051 | 21487 | 959 | 10912 |
| 2L-4S | | MI | 7649 | 3201 | 12456 | 2288 | 13164 | 1851 | 13180 | 1518 | 12813 | 1037 | 14943 | 748 | 9336 |
| 8-#11 | 1.60 | MA | 9280 | 3201 | 15047 | 2312 | 16171 | 1886 | 16480 | 1555 | 16412 | 1058 | 19205 | 870 | 10938 |
| 3E | | MI | 7988 | 3201 | 13036 | 2279 | 13899 | 1858 | 14050 | 1524 | 13905 | 1030 | 16155 | 832 | 9333 |

## RECTANGULAR TIED COLUMNS 26" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

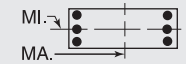
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.60 | MA | 8879 | 3201 | 14358 | 2322 | 15295 | 1881 | 15421 | 1548 | 15082 | 1065 | 17720 | 782 | 10905 |
| 4L-2S | | MI | 8455 | 3201 | 13748 | 2284 | 14804 | 1851 | 15128 | 1518 | 15328 | 1023 | 18008 | 920 | 9297 |
| 8-#14 | 2.31 | MA | 10468 | 3396 | 17374 | 2427 | 19097 | 1958 | 19960 | 1591 | 21004 | 1020 | 25196 | 898 | 15405 |
| 2L-4S | | MI | 7837 | 3396 | 13136 | 2398 | 13971 | 1925 | 14130 | 1555 | 14088 | 1006 | 16655 | 600 | 12530 |
| 8-#14 | 2.31 | MA | 9684 | 3396 | 16162 | 2422 | 17552 | 1969 | 18100 | 1601 | 18547 | 1030 | 21975 | 770 | 15379 |
| 3E | | MI | 8313 | 3396 | 13964 | 2387 | 15008 | 1935 | 15357 | 1565 | 15628 | 996 | 18360 | 719 | 13071 |
| 8-#14 | 2.31 | MA | 9120 | 3396 | 15177 | 2436 | 16300 | 1961 | 16600 | 1591 | 16663 | 1040 | 19877 | 645 | 14729 |
| 4L-2S | | MI | 8968 | 3396 | 14977 | 2395 | 16285 | 1925 | 16878 | 1555 | 17637 | 986 | 20965 | 847 | 13063 |
| 8-#18 | 4.10 | MA | 11969 | 3893 | 20999 | 2717 | 23602 | 2162 | 25222 | 1696 | 27947 | 936 | 34134 | 728 | 26388 |
| 2L-4S | | MI | 8277 | 3893 | 14787 | 2681 | 15907 | 2110 | 16417 | 1645 | 17163 | 918 | 20733 | 210 | 19414 |
| 8-#18 | 4.10 | MA | 10647 | 3893 | 18894 | 2704 | 20928 | 2180 | 22036 | 1714 | 23738 | 954 | 28656 | 501 | 25965 |
| 3E | | MI | 9082 | 3893 | 16225 | 2663 | 17671 | 2128 | 18504 | 1662 | 19780 | 900 | 23616 | 414 | 21664 |
| 8-#18 | 4.10 | MA | 9693 | 3893 | 17176 | 2726 | 18755 | 2162 | 19465 | 1696 | 20512 | 971 | 25076 | 285 | 22989 |
| 4L-2S | | MI | 10185 | 3893 | 17975 | 2681 | 19839 | 2110 | 21088 | 1645 | 23195 | 882 | 28004 | 641 | 22206 |
| 10-#11 | 2.00 | MA | 10218 | 3311 | 16748 | 2385 | 18339 | 1928 | 19107 | 1579 | 19882 | 1040 | 23769 | 934 | 13519 |
| 2L-5S | | MI | 7664 | 3311 | 12655 | 2352 | 13412 | 1908 | 13476 | 1553 | 13157 | 1016 | 15512 | 676 | 10949 |
| 10-#11 | 2.00 | MA | 9664 | 3311 | 15898 | 2381 | 17255 | 1937 | 17794 | 1586 | 18147 | 1047 | 21487 | 845 | 13524 |
| 3L-4S | | MI | 7968 | 3311 | 13167 | 2357 | 14069 | 1901 | 14258 | 1546 | 14237 | 1023 | 16797 | 717 | 11485 |
| 10-#11 | 2.00 | MA | 9267 | 3311 | 15208 | 2392 | 16379 | 1931 | 16734 | 1579 | 16817 | 1054 | 20003 | 757 | 13461 |
| 4L-3S | | MI | 8305 | 3311 | 13748 | 2349 | 14804 | 1908 | 15128 | 1553 | 15328 | 1016 | 18008 | 801 | 11511 |
| 10-#11 | 2.00 | MA | 8909 | 3311 | 14601 | 2388 | 15596 | 1940 | 15781 | 1586 | 15502 | 1047 | 18420 | 717 | 12801 |
| 5L-2S | | MI | 8768 | 3311 | 14460 | 2354 | 15709 | 1901 | 16206 | 1546 | 16752 | 1009 | 19862 | 890 | 11489 |
| 10-#14 | 2.88 | MA | 10998 | 3556 | 18586 | 2527 | 20643 | 2030 | 21820 | 1634 | 23461 | 1003 | 28417 | 860 | 19100 |
| 2L-5S | | MI | 7856 | 3556 | 13417 | 2490 | 14320 | 2006 | 14547 | 1605 | 14573 | 974 | 17454 | 494 | 14738 |
| 10-#14 | 2.88 | MA | 10222 | 3556 | 17374 | 2521 | 19097 | 2042 | 19960 | 1644 | 21004 | 1013 | 25196 | 732 | 19030 |
| 3L-4S | | MI | 8283 | 3556 | 14149 | 2498 | 15247 | 1996 | 15650 | 1595 | 16097 | 984 | 19260 | 553 | 15386 |
| 10-#14 | 2.88 | MA | 9664 | 3556 | 16389 | 2535 | 17845 | 2033 | 18460 | 1634 | 19120 | 1023 | 23098 | 607 | 18167 |
| 4L-3S | | MI | 8755 | 3556 | 14977 | 2486 | 16285 | 2006 | 16878 | 1605 | 17637 | 974 | 20965 | 672 | 16129 |
| 10-#14 | 2.88 | MA | 9161 | 3556 | 15521 | 2530 | 16727 | 2044 | 17110 | 1644 | 17258 | 1013 | 20865 | 549 | 17301 |
| 5L-2S | | MI | 9404 | 3556 | 15990 | 2494 | 17561 | 1996 | 18398 | 1595 | 19646 | 964 | 23569 | 800 | 16161 |
| 10-#18 | 5.13 | MA | 11550 | 4177 | 20999 | 2881 | 23602 | 2308 | 25222 | 1787 | 27947 | 918 | 34134 | 422 | 31737 |
| 3L-4S | | MI | 9028 | 4177 | 16537 | 2858 | 18075 | 2233 | 19001 | 1711 | 20578 | 874 | 25121 | 114 | 24383 |
| 10-#18 | 5.13 | MA | 10611 | 4177 | 19281 | 2904 | 21429 | 2290 | 22651 | 1769 | 24720 | 936 | 30555 | 207 | 29001 |
| 4L-3S | | MI | 9822 | 4177 | 17975 | 2840 | 19839 | 2250 | 21088 | 1729 | 23195 | 856 | 28004 | 318 | 26417 |
| 10-#18 | 5.13 | MA | 9766 | 4177 | 17766 | 2891 | 19486 | 2308 | 20339 | 1787 | 21529 | 918 | 26756 | 102 | 26216 |
| 5L-2S | | MI | 10910 | 4177 | 19726 | 2858 | 22007 | 2233 | 23672 | 1711 | 26610 | 838 | 32391 | 546 | 27494 |
| 12-#11 | 2.40 | MA | 10595 | 3422 | 17598 | 2454 | 19423 | 1978 | 20421 | 1609 | 21616 | 1029 | 26051 | 909 | 16116 |
| 2L-6S | | MI | 7695 | 3422 | 12881 | 2417 | 13662 | 1951 | 13806 | 1589 | 13592 | 1009 | 16169 | 586 | 12613 |
| 12-#11 | 2.40 | MA | 10045 | 3422 | 16748 | 2450 | 18339 | 1987 | 19107 | 1616 | 19882 | 1036 | 23769 | 820 | 16098 |
| 3L-5S | | MI | 7983 | 3422 | 13367 | 2422 | 14316 | 1958 | 14553 | 1582 | 14581 | 1002 | 17366 | 646 | 13009 |
| 12-#11 | 2.40 | MA | 9651 | 3422 | 16058 | 2461 | 17463 | 1981 | 18048 | 1609 | 18551 | 1043 | 22285 | 732 | 15980 |
| 4E | | MI | 8285 | 3422 | 13879 | 2427 | 14974 | 1951 | 15336 | 1575 | 15661 | 1009 | 18651 | 687 | 13548 |
| 12-#11 | 2.40 | MA | 9296 | 3422 | 15451 | 2457 | 16680 | 1990 | 17094 | 1616 | 17237 | 1036 | 20702 | 692 | 15268 |
| 5L-3S | | MI | 8618 | 3422 | 14460 | 2418 | 15709 | 1958 | 16206 | 1582 | 16752 | 1002 | 19862 | 771 | 13675 |
| 12-#11 | 2.40 | MA | 8957 | 3422 | 14877 | 2454 | 15902 | 1984 | 16183 | 1623 | 16031 | 1043 | 19225 | 633 | 14785 |
| 6L-2S | | MI | 9078 | 3422 | 15172 | 2423 | 16614 | 1951 | 17283 | 1575 | 18176 | 995 | 21716 | 859 | 13671 |
| 12-#14 | 3.46 | MA | 10754 | 3716 | 18586 | 2621 | 20643 | 2114 | 21820 | 1687 | 23461 | 996 | 28417 | 693 | 22672 |
| 3L-5S | | MI | 8302 | 3716 | 14430 | 2590 | 15596 | 2077 | 16067 | 1645 | 16582 | 953 | 20059 | 446 | 17658 |
| 12-#14 | 3.46 | MA | 10202 | 3716 | 17601 | 2635 | 19391 | 2105 | 20320 | 1678 | 21577 | 1006 | 26320 | 568 | 21629 |
| 4E | | MI | 8725 | 3716 | 15162 | 2598 | 16523 | 2067 | 17171 | 1635 | 18106 | 962 | 21865 | 506 | 18266 |
| 12-#14 | 3.46 | MA | 9704 | 3716 | 16733 | 2629 | 18272 | 2117 | 18970 | 1687 | 19715 | 996 | 24086 | 510 | 20825 |
| 5L-3S | | MI | 9192 | 3716 | 15990 | 2586 | 17561 | 2077 | 18398 | 1645 | 19646 | 953 | 23569 | 625 | 19175 |
| 12-#14 | 3.46 | MA | 9230 | 3716 | 15912 | 2624 | 17159 | 2108 | 17680 | 1697 | 18007 | 1006 | 22003 | 424 | 19464 |
| 6L-2S | | MI | 9836 | 3716 | 17003 | 2594 | 18837 | 2067 | 19919 | 1635 | 21655 | 943 | 26174 | 753 | 19243 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 30"

Short columns – no sidesway
Bending on major or minor axis

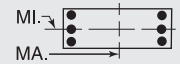


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 6.15 | MA | 11517 | 4460 | 21387 | 3081 | 24103 | 2418 | 25836 | 1843 | 28928 | 900 | 36033 | 128 | 35048 |
| 4E | | MI | 9769 | 4460 | 18287 | 3036 | 20243 | 2355 | 21584 | 1778 | 23992 | 829 | 29508 | 19 | 29385 |
| 12-#18 | 6.15 | MA | 10684 | 4460 | 19871 | 3068 | 22160 | 2436 | 23524 | 1860 | 25738 | 883 | 32235 | 24 | 32104 |
| 5L-3S | | MI | 10553 | 4460 | 19726 | 3018 | 22007 | 2372 | 23672 | 1796 | 26610 | 812 | 32391 | 223 | 31229 |
| 14-#11 | 2.80 | MA | 10423 | 3533 | 17598 | 2519 | 19423 | 2037 | 20421 | 1647 | 21616 | 1025 | 26051 | 795 | 18667 |
| 3L-6S | | MI | 8013 | 3533 | 13593 | 2486 | 14566 | 2001 | 14884 | 1617 | 15015 | 995 | 18023 | 555 | 14617 |
| 14-#11 | 2.80 | MA | 10032 | 3533 | 16908 | 2530 | 18547 | 2031 | 19361 | 1640 | 20286 | 1032 | 24567 | 707 | 18410 |
| 4L-5S | | MI | 8299 | 3533 | 14079 | 2491 | 15221 | 2008 | 15631 | 1610 | 16005 | 989 | 19220 | 615 | 15078 |
| 14-#11 | 2.80 | MA | 9680 | 3533 | 16301 | 2526 | 17764 | 2040 | 18408 | 1647 | 18972 | 1025 | 22984 | 667 | 17743 |
| 5L-4S | | MI | 8598 | 3533 | 14591 | 2496 | 15878 | 2001 | 16414 | 1604 | 17084 | 995 | 20505 | 656 | 15577 |
| 14-#11 | 2.80 | MA | 9344 | 3533 | 15727 | 2523 | 16986 | 2035 | 17497 | 1654 | 17766 | 1032 | 21507 | 608 | 17197 |
| 6L-3S | | MI | 8929 | 3533 | 15172 | 2487 | 16614 | 2008 | 17283 | 1610 | 18176 | 989 | 21716 | 740 | 15831 |
| 14-#11 | 2.80 | MA | 9015 | 3533 | 15113 | 2533 | 16237 | 2043 | 16551 | 1647 | 16586 | 1039 | 20118 | 540 | 16491 |
| 7L-2S | | MI | 9386 | 3533 | 15884 | 2492 | 17518 | 2001 | 18361 | 1604 | 19600 | 982 | 23570 | 829 | 15847 |
| 14-#14 | 4.04 | MA | 10734 | 3875 | 18813 | 2735 | 20936 | 2178 | 22180 | 1721 | 24033 | 989 | 29541 | 529 | 25110 |
| 4L-5S | | MI | 8744 | 3875 | 15443 | 2690 | 16872 | 2148 | 17588 | 1685 | 18591 | 931 | 22663 | 399 | 20459 |
| 14-#14 | 4.04 | MA | 10242 | 3875 | 17945 | 2729 | 19818 | 2189 | 20830 | 1731 | 22172 | 979 | 27307 | 471 | 24305 |
| 5L-4S | | MI | 9163 | 3875 | 16174 | 2698 | 17800 | 2138 | 18691 | 1675 | 20115 | 941 | 24469 | 458 | 21163 |
| 14-#14 | 4.04 | MA | 9772 | 3875 | 17124 | 2723 | 18704 | 2180 | 19540 | 1741 | 20464 | 989 | 25224 | 385 | 22920 |
| 6L-3S | | MI | 9626 | 3875 | 17003 | 2686 | 18837 | 2148 | 19919 | 1685 | 21655 | 931 | 26174 | 578 | 22214 |
| 14-#18 | 7.18 | MA | 11590 | 4744 | 21976 | 3245 | 24834 | 2563 | 26710 | 1934 | 29946 | 847 | 37713 | -55 | 37375 |
| 5L-4S | | MI | 10504 | 4744 | 20038 | 3213 | 22412 | 2477 | 24168 | 1845 | 27407 | 785 | 33896 | -77 | 33410 |
| 16-#11 | 3.20 | MA | 10410 | 3643 | 17759 | 2599 | 19631 | 2082 | 20675 | 1671 | 22021 | 1021 | 26849 | 682 | 20853 |
| 4L-6S | | MI | 8328 | 3643 | 14305 | 2555 | 15471 | 2051 | 15962 | 1646 | 16439 | 982 | 19877 | 525 | 16632 |
| 16-#11 | 3.20 | MA | 10060 | 3643 | 17152 | 2596 | 18848 | 2090 | 19722 | 1678 | 20707 | 1014 | 25267 | 642 | 20226 |
| 5E | | MI | 8612 | 3643 | 14791 | 2560 | 16126 | 2058 | 16709 | 1639 | 17429 | 975 | 21074 | 585 | 17153 |
| 16-#11 | 3.20 | MA | 9727 | 3643 | 16578 | 2592 | 18070 | 2085 | 18811 | 1685 | 19501 | 1021 | 23789 | 583 | 19619 |
| 6L-4S | | MI | 8910 | 3643 | 15303 | 2565 | 16783 | 2051 | 17491 | 1632 | 18508 | 982 | 22359 | 625 | 17617 |
| 16-#11 | 3.20 | MA | 9401 | 3643 | 15964 | 2602 | 17321 | 2093 | 17864 | 1678 | 18321 | 1028 | 22400 | 515 | 18945 |
| 7L-3S | | MI | 9238 | 3643 | 15884 | 2556 | 17518 | 2058 | 18361 | 1639 | 19600 | 975 | 23570 | 710 | 17981 |
| 16-#14 | 4.62 | MA | 10774 | 4035 | 19157 | 2829 | 21363 | 2261 | 22690 | 1774 | 24628 | 961 | 30528 | 433 | 27709 |
| 5E | | MI | 9182 | 4035 | 16455 | 2789 | 18148 | 2219 | 19108 | 1725 | 20600 | 909 | 25268 | 352 | 23278 |
| 16-#14 | 4.62 | MA | 10309 | 4035 | 18336 | 2823 | 20250 | 2253 | 21400 | 1784 | 22921 | 971 | 28445 | 347 | 26390 |
| 6L-4S | | MI | 9597 | 4035 | 17187 | 2797 | 19076 | 2209 | 20212 | 1715 | 22124 | 919 | 27074 | 411 | 24075 |
| 18-#11 | 3.60 | MA | 10438 | 3754 | 18002 | 2665 | 19932 | 2140 | 21035 | 1709 | 22441 | 1003 | 27549 | 617 | 22715 |
| 5L-6S | | MI | 8641 | 3754 | 15017 | 2624 | 16376 | 2101 | 17039 | 1675 | 17863 | 968 | 21731 | 494 | 18656 |
| 18-#11 | 3.60 | MA | 10107 | 3754 | 17428 | 2661 | 19154 | 2135 | 20124 | 1716 | 21236 | 1010 | 26071 | 558 | 22050 |
| 6L-5S | | MI | 8924 | 3754 | 15503 | 2629 | 17031 | 2107 | 17787 | 1668 | 18852 | 961 | 22927 | 554 | 19232 |
| 18-#11 | 3.60 | MA | 9784 | 3754 | 16814 | 2672 | 18405 | 2143 | 19178 | 1709 | 20056 | 1017 | 24683 | 490 | 21406 |
| 7L-4S | | MI | 9219 | 3754 | 16015 | 2634 | 17688 | 2101 | 18569 | 1661 | 19932 | 968 | 24213 | 595 | 19666 |
| 18-#14 | 5.19 | MA | 10841 | 4194 | 19549 | 2923 | 21795 | 2325 | 23260 | 1828 | 25378 | 954 | 31666 | 308 | 29872 |
| 6L-5S | | MI | 9617 | 4194 | 17468 | 2889 | 19425 | 2289 | 20629 | 1765 | 22609 | 888 | 27872 | 305 | 26113 |
| 20-#11 | 4.00 | MA | 10485 | 3865 | 18278 | 2730 | 20238 | 2185 | 21438 | 1746 | 22970 | 999 | 28354 | 533 | 24489 |
| 6E | | MI | 8953 | 3865 | 15729 | 2693 | 17281 | 2150 | 18117 | 1703 | 19287 | 954 | 23585 | 464 | 20687 |
| 20-#11 | 4.00 | MA | 10164 | 3865 | 17664 | 2741 | 19489 | 2193 | 20491 | 1740 | 21790 | 1006 | 26965 | 465 | 23842 |
| 7L-5S | | MI | 9233 | 3865 | 16215 | 2698 | 17935 | 2157 | 18865 | 1696 | 20276 | 947 | 24781 | 524 | 21316 |
| 22-#11 | 4.40 | MA | 10541 | 3975 | 18514 | 2810 | 20573 | 2244 | 21805 | 1770 | 23525 | 995 | 29247 | 440 | 26250 |
| 7L-6S | | MI | 9262 | 3975 | 16441 | 2762 | 18186 | 2200 | 19195 | 1732 | 20710 | 940 | 25439 | 433 | 22725 |

## RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis



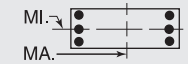

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.08 | MA | 10632 | 3261 | 16834 | 2377 | 18045 | 1936 | 18333 | 1611 | 18124 | 1138 | 21135 | 1060 | 8561 |
| 2E | | MI | 8561 | 3261 | 13680 | 2328 | 14477 | 1893 | 14557 | 1568 | 14259 | 1100 | 16459 | 1011 | 6834 |
| 4-#18 | 1.92 | MA | 11482 | 3509 | 18835 | 2511 | 20511 | 2031 | 21206 | 1659 | 21908 | 1094 | 26030 | 976 | 14655 |
| 2E | | MI | 9186 | 3509 | 15206 | 2457 | 16247 | 1974 | 16637 | 1603 | 17001 | 1041 | 19925 | 901 | 11559 |
| 6-#11 | 1.13 | MA | 10702 | 3274 | 16936 | 2396 | 18220 | 1951 | 18568 | 1623 | 18466 | 1146 | 21614 | 1068 | 8925 |
| 2L-3S | | MI | 8147 | 3274 | 13051 | 2344 | 13740 | 1918 | 13693 | 1589 | 13123 | 1116 | 15007 | 932 | 7172 |
| 6-#11 | 1.13 | MA | 10092 | 3274 | 16017 | 2393 | 17048 | 1960 | 17143 | 1630 | 16575 | 1152 | 19117 | 979 | 8968 |
| 3L-2S | | MI | 8618 | 3274 | 13763 | 2349 | 14645 | 1912 | 14771 | 1582 | 14547 | 1109 | 16861 | 1020 | 7120 |
| 6-#14 | 1.62 | MA | 11226 | 3421 | 18146 | 2477 | 19718 | 2009 | 20364 | 1656 | 20805 | 1123 | 24666 | 1025 | 12603 |
| 2L-3S | | MI | 8345 | 3421 | 13680 | 2420 | 14477 | 1974 | 14557 | 1618 | 14259 | 1089 | 16459 | 836 | 10039 |
| 6-#14 | 1.62 | MA | 10365 | 3421 | 16834 | 2472 | 18045 | 2021 | 18333 | 1666 | 18124 | 1133 | 21135 | 897 | 12626 |
| 3L-2S | | MI | 9008 | 3421 | 14693 | 2428 | 15754 | 1964 | 16077 | 1608 | 16268 | 1079 | 19063 | 964 | 9985 |
| 6-#18 | 2.88 | MA | 12480 | 3793 | 21117 | 2689 | 23421 | 2160 | 24694 | 1735 | 26514 | 1062 | 32057 | 904 | 21628 |
| 2L-3S | | MI | 8811 | 3793 | 15206 | 2617 | 16247 | 2114 | 16637 | 1687 | 17001 | 1015 | 19925 | 578 | 16850 |
| 6-#18 | 2.88 | MA | 11019 | 3793 | 18835 | 2678 | 20511 | 2179 | 21206 | 1753 | 21908 | 1080 | 26030 | 677 | 21403 |
| 3L-2S | | MI | 9933 | 3793 | 16957 | 2635 | 18415 | 2096 | 19221 | 1670 | 20416 | 997 | 24313 | 805 | 16940 |
| 8-#11 | 1.50 | MA | 11121 | 3385 | 17856 | 2465 | 19392 | 2001 | 19993 | 1654 | 20357 | 1136 | 24111 | 1045 | 11755 |
| 2L-4S | | MI | 8127 | 3385 | 13182 | 2422 | 13910 | 1961 | 13901 | 1611 | 13455 | 1109 | 15650 | 817 | 9387 |
| 8-#11 | 1.50 | MA | 10516 | 3385 | 16936 | 2462 | 18220 | 2010 | 18568 | 1661 | 18466 | 1143 | 21614 | 956 | 11781 |
| 3E | | MI | 8467 | 3385 | 13763 | 2413 | 14645 | 1968 | 14771 | 1618 | 14547 | 1102 | 16861 | 901 | 9370 |
| 8-#11 | 1.50 | MA | 10083 | 3385 | 16192 | 2473 | 17274 | 2005 | 17420 | 1655 | 17016 | 1149 | 19991 | 868 | 11748 |
| 4L-2S | | MI | 8934 | 3385 | 14475 | 2418 | 15550 | 1961 | 15849 | 1611 | 15971 | 1095 | 18715 | 990 | 9330 |
| 8-#14 | 2.16 | MA | 11813 | 3580 | 19458 | 2577 | 21391 | 2081 | 22394 | 1700 | 23486 | 1107 | 28196 | 989 | 16620 |
| 2L-4S | | MI | 8314 | 3580 | 13864 | 2531 | 14716 | 2035 | 14850 | 1648 | 14728 | 1077 | 17359 | 669 | 12717 |
| 8-#14 | 2.16 | MA | 10961 | 3580 | 18146 | 2572 | 19718 | 2093 | 20364 | 1710 | 20805 | 1117 | 24666 | 861 | 16594 |
| 3E | | MI | 8793 | 3580 | 14693 | 2520 | 15754 | 2045 | 16077 | 1658 | 16268 | 1067 | 19063 | 788 | 13126 |
| 8-#14 | 2.16 | MA | 10350 | 3580 | 17082 | 2587 | 18366 | 2086 | 18726 | 1700 | 18749 | 1127 | 22370 | 734 | 16057 |
| 4L-2S | | MI | 9449 | 3580 | 15705 | 2528 | 17030 | 2035 | 17598 | 1648 | 18277 | 1057 | 21668 | 916 | 13105 |
| 8-#18 | 3.85 | MA | 13462 | 4077 | 23399 | 2866 | 26331 | 2289 | 28181 | 1811 | 31121 | 1030 | 38083 | 833 | 28548 |
| 2L-4S | | MI | 8754 | 4077 | 15518 | 2813 | 16651 | 2219 | 17134 | 1736 | 17799 | 988 | 21430 | 278 | 19665 |
| 8-#18 | 3.85 | MA | 12023 | 4077 | 21117 | 2855 | 23421 | 2308 | 24694 | 1829 | 26514 | 1047 | 32057 | 605 | 28204 |
| 3E | | MI | 9562 | 4077 | 16957 | 2795 | 18415 | 2236 | 19221 | 1754 | 20416 | 971 | 24313 | 482 | 22003 |
| 8-#18 | 3.85 | MA | 10990 | 4077 | 19260 | 2879 | 21061 | 2291 | 21880 | 1811 | 22982 | 1065 | 28128 | 385 | 25083 |
| 4L-2S | | MI | 10669 | 4077 | 18707 | 2812 | 20583 | 2219 | 21805 | 1736 | 23831 | 953 | 28701 | 710 | 22272 |
| 10-#11 | 1.87 | MA | 11536 | 3495 | 18775 | 2534 | 20564 | 2051 | 21418 | 1685 | 22247 | 1126 | 26608 | 1022 | 14572 |
| 2L-5S | | MI | 8142 | 3495 | 13382 | 2486 | 14157 | 2018 | 14197 | 1647 | 13800 | 1088 | 16218 | 746 | 11077 |
| 10-#11 | 1.87 | MA | 10936 | 3495 | 17856 | 2531 | 19392 | 2060 | 19993 | 1692 | 20357 | 1133 | 24111 | 934 | 14577 |
| 3L-4S | | MI | 8447 | 3495 | 13894 | 2491 | 14815 | 2011 | 14979 | 1640 | 14879 | 1095 | 17504 | 787 | 11542 |
| 10-#11 | 1.87 | MA | 10506 | 3495 | 17112 | 2542 | 18446 | 2056 | 18845 | 1686 | 18907 | 1140 | 22488 | 845 | 14514 |
| 4L-3S | | MI | 8784 | 3495 | 14475 | 2482 | 15550 | 2018 | 15849 | 1647 | 15971 | 1088 | 18715 | 871 | 11553 |
| 10-#11 | 1.87 | MA | 10120 | 3495 | 16458 | 2539 | 17603 | 2065 | 17813 | 1693 | 17475 | 1133 | 20758 | 805 | 13879 |
| 5L-2S | | MI | 9248 | 3495 | 15187 | 2487 | 16455 | 2011 | 16927 | 1640 | 17394 | 1081 | 20569 | 959 | 11525 |
| 10-#14 | 2.70 | MA | 12392 | 3740 | 20770 | 2676 | 23063 | 2153 | 24424 | 1745 | 26168 | 1092 | 31727 | 954 | 20619 |
| 2L-5S | | MI | 8333 | 3740 | 14146 | 2623 | 15065 | 2115 | 15266 | 1698 | 15213 | 1045 | 18157 | 563 | 14900 |
| 10-#14 | 2.70 | MA | 11549 | 3740 | 19458 | 2672 | 21391 | 2166 | 22394 | 1755 | 23486 | 1102 | 28196 | 826 | 20549 |
| 3L-4S | | MI | 8762 | 3740 | 14877 | 2631 | 15992 | 2106 | 16370 | 1688 | 16737 | 1055 | 19963 | 622 | 15570 |
| 10-#14 | 2.70 | MA | 10945 | 3740 | 18394 | 2687 | 20039 | 2158 | 20757 | 1745 | 21430 | 1112 | 25901 | 699 | 19783 |
| 4L-3S | | MI | 9235 | 3740 | 15705 | 2619 | 17030 | 2115 | 17598 | 1698 | 18277 | 1045 | 21668 | 741 | 16191 |
| 10-#14 | 2.70 | MA | 10402 | 3740 | 17458 | 2682 | 18832 | 2170 | 19283 | 1755 | 19399 | 1102 | 23453 | 642 | 18775 |
| 5L-2S | | MI | 9886 | 3740 | 16718 | 2627 | 18306 | 2106 | 19118 | 1688 | 20286 | 1036 | 24272 | 869 | 16208 |
| 10-#18 | 4.81 | MA | 13012 | 4361 | 23399 | 3032 | 26331 | 2436 | 28181 | 1904 | 31121 | 1015 | 38083 | 533 | 34829 |
| 3L-4S | | MI | 9506 | 4361 | 17269 | 2990 | 18819 | 2341 | 19717 | 1803 | 21214 | 944 | 25818 | 182 | 24628 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis

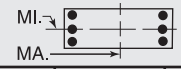


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 4.81 | MA | 11995 | 4361 | 21542 | 3057 | 23971 | 2420 | 25367 | 1887 | 27588 | 1033 | 34154 | 313 | 31612 |
| 4L-3S | | MI | 10304 | 4361 | 18707 | 2972 | 20583 | 2358 | 21805 | 1821 | 23831 | 926 | 28701 | 387 | 26747 |
| 10-#18 | 4.81 | MA | 11080 | 4361 | 19905 | 3046 | 21862 | 2439 | 22836 | 1904 | 24097 | 1015 | 29975 | 210 | 28772 |
| 5L-2S | | MI | 11396 | 4361 | 20457 | 2989 | 22752 | 2341 | 24388 | 1803 | 27245 | 909 | 33088 | 614 | 27567 |
| 12-#11 | 2.25 | MA | 11948 | 3606 | 19695 | 2603 | 21736 | 2101 | 22843 | 1716 | 24138 | 1116 | 29106 | 1000 | 17380 |
| 2L-6S | | MI | 8172 | 3606 | 13608 | 2550 | 14407 | 2061 | 14527 | 1682 | 14234 | 1081 | 16875 | 655 | 12823 |
| 12-#11 | 2.25 | MA | 11352 | 3606 | 18775 | 2600 | 20564 | 2110 | 21418 | 1723 | 22247 | 1123 | 26608 | 911 | 17362 |
| 3L-5S | | MI | 8461 | 3606 | 14094 | 2555 | 15062 | 2068 | 15275 | 1675 | 15223 | 1074 | 18072 | 715 | 13136 |
| 12-#11 | 2.25 | MA | 10926 | 3606 | 18031 | 2611 | 19619 | 2106 | 20270 | 1717 | 20797 | 1130 | 24985 | 822 | 17275 |
| 4E | | MI | 8764 | 3606 | 14606 | 2560 | 15719 | 2061 | 16057 | 1668 | 16303 | 1081 | 19357 | 756 | 13688 |
| 12-#11 | 2.25 | MA | 10542 | 3606 | 17377 | 2608 | 18775 | 2115 | 19238 | 1724 | 19365 | 1123 | 23256 | 782 | 16548 |
| 5L-3S | | MI | 9098 | 3606 | 15187 | 2552 | 16455 | 2068 | 16927 | 1675 | 17394 | 1074 | 20569 | 840 | 13725 |
| 12-#11 | 2.25 | MA | 10177 | 3606 | 16759 | 2606 | 17936 | 2110 | 18251 | 1732 | 18051 | 1130 | 21637 | 723 | 16120 |
| 6L-2S | | MI | 9559 | 3606 | 15899 | 2557 | 17359 | 2061 | 18004 | 1668 | 18818 | 1067 | 22422 | 929 | 13711 |
| 12-#14 | 3.25 | MA | 12130 | 3899 | 20770 | 2771 | 23063 | 2238 | 24424 | 1800 | 26168 | 1086 | 31727 | 791 | 24495 |
| 3L-5S | | MI | 8780 | 3899 | 15158 | 2723 | 16341 | 2186 | 16787 | 1738 | 17222 | 1024 | 20762 | 515 | 17833 |
| 12-#14 | 3.25 | MA | 11533 | 3899 | 19706 | 2786 | 21711 | 2230 | 22787 | 1790 | 24111 | 1096 | 29432 | 664 | 23534 |
| 4E | | MI | 9205 | 3899 | 15890 | 2731 | 17269 | 2176 | 17891 | 1728 | 18746 | 1034 | 22568 | 575 | 18447 |
| 12-#14 | 3.25 | MA | 10996 | 3899 | 18770 | 2782 | 20505 | 2243 | 21314 | 1800 | 22080 | 1086 | 26983 | 606 | 22593 |
| 5L-3S | | MI | 9674 | 3899 | 16718 | 2719 | 18306 | 2186 | 19118 | 1738 | 20286 | 1024 | 24272 | 694 | 19243 |
| 12-#14 | 3.25 | MA | 10483 | 3899 | 17885 | 2777 | 19305 | 2235 | 19905 | 1810 | 20217 | 1096 | 24697 | 521 | 21233 |
| 6L-2S | | MI | 10319 | 3899 | 17731 | 2727 | 19582 | 2176 | 20639 | 1728 | 22295 | 1014 | 26877 | 822 | 19296 |
| 12-#18 | 5.77 | MA | 12985 | 4644 | 23825 | 3234 | 26881 | 2548 | 28855 | 1963 | 32195 | 1001 | 40181 | 242 | 38179 |
| 4E | | MI | 10249 | 4644 | 19019 | 3167 | 20988 | 2463 | 22301 | 1870 | 24628 | 900 | 30205 | 87 | 29626 |
| 12-#18 | 5.77 | MA | 12084 | 4644 | 22188 | 3223 | 24771 | 2568 | 26323 | 1980 | 28704 | 983 | 36002 | 138 | 35178 |
| 5L-3S | | MI | 11037 | 4644 | 20457 | 3149 | 22752 | 2481 | 24388 | 1888 | 27245 | 882 | 33088 | 291 | 31552 |
| 14-#11 | 2.63 | MA | 11764 | 3716 | 19695 | 2669 | 21736 | 2160 | 22843 | 1754 | 24138 | 1113 | 29106 | 888 | 20141 |
| 3L-6S | | MI | 8490 | 3716 | 14320 | 2620 | 15312 | 2111 | 15605 | 1711 | 15658 | 1067 | 18729 | 625 | 14824 |
| 14-#11 | 2.63 | MA | 11341 | 3716 | 18951 | 2680 | 20791 | 2156 | 21695 | 1748 | 22688 | 1120 | 27482 | 799 | 20011 |
| 4L-5S | | MI | 8778 | 3716 | 14805 | 2625 | 15967 | 2118 | 16352 | 1704 | 16647 | 1060 | 19926 | 685 | 15204 |
| 14-#11 | 2.63 | MA | 10961 | 3716 | 18296 | 2678 | 19947 | 2165 | 20663 | 1755 | 21256 | 1113 | 25753 | 759 | 19227 |
| 5L-4S | | MI | 9078 | 3716 | 15318 | 2630 | 16624 | 2111 | 17135 | 1697 | 17727 | 1067 | 21211 | 726 | 15725 |
| 14-#11 | 2.63 | MA | 10598 | 3716 | 17678 | 2675 | 19108 | 2160 | 19676 | 1763 | 19942 | 1120 | 24134 | 700 | 18739 |
| 6L-3S | | MI | 9410 | 3716 | 15899 | 2621 | 17359 | 2118 | 18004 | 1704 | 18818 | 1060 | 22422 | 810 | 15883 |
| 14-#11 | 2.63 | MA | 10244 | 3716 | 17016 | 2686 | 18302 | 2170 | 18652 | 1757 | 18656 | 1127 | 22447 | 612 | 17922 |
| 7L-2S | | MI | 9869 | 3716 | 16611 | 2626 | 18264 | 2111 | 19082 | 1697 | 20242 | 1054 | 24276 | 898 | 15889 |
| 14-#14 | 3.79 | MA | 12114 | 4059 | 21018 | 2886 | 23384 | 2303 | 24817 | 1834 | 26793 | 1081 | 32962 | 628 | 27305 |
| 4L-5S | | MI | 9223 | 4059 | 16171 | 2823 | 17617 | 2257 | 18307 | 1778 | 19231 | 1002 | 23366 | 468 | 20749 |
| 14-#14 | 3.79 | MA | 11583 | 4059 | 20082 | 2881 | 22178 | 2315 | 23344 | 1844 | 24762 | 1071 | 30514 | 571 | 26423 |
| 5L-4S | | MI | 9643 | 4059 | 16903 | 2831 | 18545 | 2247 | 19411 | 1768 | 20755 | 1012 | 25172 | 528 | 21342 |
| 14-#14 | 3.79 | MA | 11075 | 4059 | 19197 | 2877 | 20977 | 2308 | 21936 | 1854 | 22898 | 1081 | 28228 | 485 | 24982 |
| 6L-3S | | MI | 10109 | 4059 | 17731 | 2819 | 19582 | 2257 | 20639 | 1778 | 22295 | 1002 | 26877 | 647 | 22287 |
| 14-#14 | 3.79 | MA | 10580 | 4059 | 18250 | 2892 | 19823 | 2320 | 20473 | 1844 | 21074 | 1091 | 26080 | 387 | 23602 |
| 7L-2S | | MI | 10749 | 4059 | 18744 | 2827 | 20859 | 2247 | 22159 | 1768 | 24304 | 993 | 29482 | 775 | 22368 |
| 14-#18 | 6.73 | MA | 13075 | 4928 | 24470 | 3400 | 27681 | 2696 | 29811 | 2056 | 33310 | 951 | 42029 | 66 | 41619 |
| 5L-4S | | MI | 10985 | 4928 | 20769 | 3344 | 23156 | 2585 | 24885 | 1937 | 28043 | 856 | 34593 | -9 | 34536 |
| 16-#11 | 3.00 | MA | 11754 | 3827 | 19870 | 2750 | 21963 | 2206 | 23120 | 1779 | 24578 | 1110 | 29979 | 777 | 22654 |
| 4L-6S | | MI | 8806 | 3827 | 15032 | 2689 | 16217 | 2161 | 16683 | 1739 | 17081 | 1054 | 20583 | 594 | 16836 |
| 16-#11 | 3.00 | MA | 11377 | 3827 | 19216 | 2747 | 21120 | 2215 | 22088 | 1787 | 23147 | 1103 | 28250 | 737 | 21914 |
| 5E | | MI | 9092 | 3827 | 15517 | 2694 | 16872 | 2168 | 17430 | 1733 | 18071 | 1047 | 21780 | 654 | 17279 |
| 16-#11 | 3.00 | MA | 11017 | 3827 | 18597 | 2744 | 20281 | 2210 | 21101 | 1794 | 21832 | 1110 | 26631 | 677 | 21362 |
| 6L-4S | | MI | 9390 | 3827 | 16030 | 2699 | 17529 | 2161 | 18212 | 1726 | 19150 | 1054 | 23065 | 695 | 17764 |
| 16-#11 | 3.00 | MA | 10665 | 3827 | 17936 | 2755 | 19474 | 2220 | 20077 | 1788 | 20546 | 1117 | 24944 | 589 | 20580 |
| 7L-3S | | MI | 9720 | 3827 | 16611 | 2690 | 18264 | 2168 | 19082 | 1733 | 20242 | 1047 | 24276 | 779 | 18037 |
| 16-#11 | 3.00 | MA | 10319 | 3827 | 17328 | 2752 | 18661 | 2215 | 19110 | 1795 | 19276 | 1124 | 23329 | 542 | 19716 |
| 8L-2S | | MI | 10176 | 3827 | 17323 | 2695 | 19169 | 2161 | 20160 | 1726 | 21666 | 1040 | 26130 | 868 | 18061 |
| 16-#14 | 4.33 | MA | 12164 | 4219 | 21394 | 2981 | 23850 | 2387 | 25374 | 1889 | 27443 | 1055 | 34044 | 536 | 30263 |
| 5E | | MI | 9662 | 4219 | 17184 | 2922 | 18894 | 2328 | 19828 | 1818 | 21240 | 981 | 25971 | 421 | 23564 |

## RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 4.33 | MA | 11662 | 4219 | 20509 | 2976 | 22650 | 2380 | 23966 | 1899 | 25579 | 1065 | 31758 | 450 | 28744 |
| 6L-4S | | MI | 10079 | 4219 | 17915 | 2930 | 19821 | 2318 | 20932 | 1808 | 22764 | 991 | 27777 | 480 | 24251 |
| 16-#14 | 4.33 | MA | 11172 | 4219 | 19562 | 2991 | 21496 | 2392 | 22503 | 1889 | 23755 | 1075 | 29611 | 351 | 27311 |
| 7L-3S | | MI | 10540 | 4219 | 18744 | 2919 | 20859 | 2328 | 22159 | 1818 | 24304 | 981 | 29482 | 599 | 25324 |
| 18-#11 | 3.37 | MA | 11789 | 3938 | 20135 | 2816 | 22292 | 2265 | 23513 | 1818 | 25037 | 1093 | 30747 | 714 | 24607 |
| 5L-6S | | MI | 9120 | 3938 | 15744 | 2758 | 17122 | 2211 | 17761 | 1768 | 18505 | 1040 | 22437 | 564 | 18857 |
| 18-#11 | 3.37 | MA | 11432 | 3938 | 19517 | 2813 | 21453 | 2261 | 22526 | 1825 | 23723 | 1100 | 29128 | 655 | 23995 |
| 6L-5S | | MI | 9404 | 3938 | 16229 | 2763 | 17776 | 2218 | 18508 | 1761 | 19495 | 1033 | 23634 | 624 | 19359 |
| 18-#11 | 3.37 | MA | 11083 | 3938 | 18855 | 2824 | 20646 | 2270 | 21502 | 1819 | 22437 | 1107 | 27441 | 566 | 23245 |
| 7L-4S | | MI | 9700 | 3938 | 16742 | 2768 | 18434 | 2211 | 19290 | 1754 | 20574 | 1040 | 24919 | 664 | 19812 |
| 18-#11 | 3.37 | MA | 10740 | 3938 | 18248 | 2821 | 19833 | 2265 | 20534 | 1826 | 21167 | 1114 | 25826 | 519 | 22344 |
| 8L-3S | | MI | 10028 | 3938 | 17323 | 2759 | 19169 | 2218 | 20160 | 1761 | 21666 | 1033 | 26130 | 749 | 20186 |
| 18-#14 | 4.87 | MA | 12243 | 4378 | 21821 | 3076 | 24323 | 2452 | 25996 | 1944 | 28260 | 1050 | 35289 | 415 | 32518 |
| 6L-5S | | MI | 10097 | 4378 | 18197 | 3022 | 20170 | 2399 | 21348 | 1858 | 23249 | 959 | 28576 | 374 | 26395 |
| 18-#14 | 4.87 | MA | 11758 | 4378 | 20874 | 3091 | 23169 | 2465 | 24534 | 1934 | 26437 | 1060 | 33141 | 316 | 31032 |
| 7L-4S | | MI | 10511 | 4378 | 18928 | 3030 | 21097 | 2389 | 22452 | 1848 | 24773 | 969 | 30382 | 433 | 27172 |
| 20-#11 | 3.75 | MA | 11843 | 4048 | 20436 | 2882 | 22625 | 2311 | 23951 | 1856 | 25614 | 1090 | 31626 | 632 | 26636 |
| 6E | | MI | 9432 | 4048 | 16456 | 2827 | 18026 | 2261 | 18838 | 1797 | 19929 | 1026 | 24291 | 533 | 20887 |
| 20-#11 | 3.75 | MA | 11498 | 4048 | 19775 | 2893 | 21819 | 2320 | 22927 | 1850 | 24328 | 1097 | 29938 | 544 | 25915 |
| 7L-5S | | MI | 9714 | 4048 | 16941 | 2832 | 18681 | 2267 | 19586 | 1790 | 20918 | 1019 | 25488 | 593 | 21443 |
| 20-#11 | 3.75 | MA | 11157 | 4048 | 19167 | 2890 | 21005 | 2315 | 21959 | 1857 | 23058 | 1104 | 28323 | 497 | 24979 |
| 8L-4S | | MI | 10008 | 4048 | 17454 | 2837 | 19338 | 2261 | 20368 | 1783 | 21998 | 1026 | 26773 | 634 | 21867 |
| 20-#14 | 5.41 | MA | 12338 | 4538 | 22186 | 3191 | 24841 | 2537 | 26564 | 1978 | 29118 | 1044 | 36672 | 280 | 34764 |
| 7L-5S | | MI | 10530 | 4538 | 19209 | 3122 | 21446 | 2470 | 22869 | 1898 | 25258 | 938 | 31180 | 327 | 29240 |
| 22-#11 | 4.13 | MA | 11909 | 4159 | 20694 | 2962 | 22991 | 2370 | 24352 | 1881 | 26218 | 1087 | 32435 | 521 | 28591 |
| 7L-6S | | MI | 9742 | 4159 | 17168 | 2896 | 18931 | 2310 | 19916 | 1825 | 21353 | 1012 | 26145 | 503 | 22923 |
| 22-#11 | 4.13 | MA | 11571 | 4159 | 20086 | 2959 | 22177 | 2365 | 23384 | 1888 | 24948 | 1094 | 30821 | 474 | 27620 |
| 8L-5S | | MI | 10022 | 4159 | 17653 | 2901 | 19586 | 2317 | 20663 | 1818 | 22342 | 1005 | 27341 | 563 | 23530 |
| 24-#11 | 4.50 | MA | 11982 | 4270 | 21006 | 3028 | 23349 | 2416 | 24809 | 1920 | 26839 | 1084 | 33318 | 451 | 30267 |
| 8L-6S | | MI | 10050 | 4270 | 17880 | 2965 | 19836 | 2360 | 20994 | 1854 | 22776 | 998 | 27999 | 472 | 24965 |

## RECTANGULAR TIED COLUMNS 26" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.02 | MA | 11950 | 3445 | 18823 | 2527 | 20199 | 2059 | 20515 | 1716 | 20263 | 1222 | 23635 | 1144 | 9168 |
| 2E | | MI | 9040 | 3445 | 14408 | 2461 | 15223 | 2002 | 15276 | 1661 | 14899 | 1172 | 17162 | 1080 | 6864 |
| 4-#18 | 1.81 | MA | 12877 | 3693 | 20985 | 2661 | 22864 | 2154 | 23676 | 1768 | 24391 | 1180 | 29003 | 1066 | 15735 |
| 2E | | MI | 9666 | 3693 | 15938 | 2589 | 16991 | 2082 | 17354 | 1695 | 17637 | 1112 | 20622 | 969 | 11604 |
| 6-#11 | 1.06 | MA | 12024 | 3458 | 18930 | 2545 | 20383 | 2074 | 20757 | 1727 | 20625 | 1229 | 24142 | 1151 | 9557 |
| 2L-3S | | MI | 8626 | 3458 | 13778 | 2478 | 14486 | 2029 | 14415 | 1683 | 13765 | 1188 | 15713 | 1001 | 7202 |
| 6-#11 | 1.06 | MA | 11366 | 3458 | 17941 | 2543 | 19123 | 2083 | 19224 | 1735 | 18578 | 1236 | 21430 | 1062 | 9600 |
| 3L-2S | | MI | 9097 | 3458 | 14490 | 2483 | 15391 | 2022 | 15492 | 1676 | 15189 | 1181 | 17567 | 1090 | 7148 |
| 6-#14 | 1.53 | MA | 12595 | 3605 | 20234 | 2626 | 21999 | 2131 | 22703 | 1761 | 23169 | 1208 | 27475 | 1111 | 13515 |
| 2L-3S | | MI | 8823 | 3605 | 14408 | 2553 | 15223 | 2083 | 15276 | 1711 | 14899 | 1160 | 17162 | 905 | 10082 |
| 6-#14 | 1.53 | MA | 11666 | 3605 | 18823 | 2622 | 20199 | 2145 | 20515 | 1772 | 20263 | 1218 | 23635 | 983 | 13537 |
| 3L-2S | | MI | 9487 | 3605 | 15421 | 2561 | 16499 | 2073 | 16797 | 1701 | 16908 | 1150 | 19766 | 1033 | 10021 |
| 6-#18 | 2.71 | MA | 13963 | 3977 | 23445 | 2838 | 26000 | 2283 | 27466 | 1846 | 29396 | 1151 | 35579 | 1000 | 23248 |
| 2L-3S | | MI | 9290 | 3977 | 15938 | 2749 | 16991 | 2222 | 17354 | 1779 | 17637 | 1085 | 20622 | 646 | 16938 |
| 6-#18 | 2.71 | MA | 12384 | 3977 | 20985 | 2829 | 22864 | 2304 | 23676 | 1864 | 24391 | 1169 | 29003 | 772 | 23023 |
| 3L-2S | | MI | 10414 | 3977 | 17688 | 2766 | 19159 | 2204 | 19938 | 1761 | 21052 | 1068 | 25010 | 873 | 16994 |
| 8-#11 | 1.41 | MA | 12479 | 3568 | 19919 | 2614 | 21643 | 2124 | 22289 | 1758 | 22672 | 1220 | 26855 | 1130 | 12597 |
| 2L-4S | | MI | 8606 | 3568 | 13909 | 2556 | 14656 | 2071 | 14622 | 1705 | 14098 | 1181 | 16356 | 887 | 9433 |
| 8-#11 | 1.41 | MA | 11826 | 3568 | 18930 | 2612 | 20383 | 2134 | 20757 | 1766 | 20625 | 1227 | 24142 | 1042 | 12623 |
| 3E | | MI | 8946 | 3568 | 14490 | 2547 | 15391 | 2078 | 15492 | 1712 | 15189 | 1174 | 17567 | 971 | 9406 |
| 8-#11 | 1.41 | MA | 11360 | 3568 | 18132 | 2623 | 19368 | 2130 | 19525 | 1761 | 19055 | 1234 | 22375 | 953 | 12590 |
| 4L-2S | | MI | 9414 | 3568 | 15202 | 2552 | 16296 | 2071 | 16570 | 1705 | 16613 | 1167 | 19421 | 1059 | 9362 |

## RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

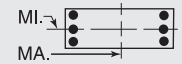
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.04 | MA | 13232 | 3764 | 21646 | 2726 | 23799 | 2204 | 24891 | 1806 | 26075 | 1194 | 31316 | 1079 | 17835 |
| 2L-4S | | MI | 8792 | 3764 | 14593 | 2664 | 15461 | 2144 | 15569 | 1741 | 15368 | 1148 | 18062 | 738 | 12899 |
| 8-#14 | 2.04 | MA | 12312 | 3764 | 20234 | 2722 | 21999 | 2217 | 22703 | 1817 | 23169 | 1204 | 27475 | 951 | 17809 |
| 3E | | MI | 9272 | 3764 | 15421 | 2653 | 16499 | 2154 | 16797 | 1751 | 16908 | 1138 | 19766 | 857 | 13179 |
| 8-#14 | 2.04 | MA | 11656 | 3764 | 19092 | 2738 | 20547 | 2211 | 20942 | 1808 | 20940 | 1213 | 24977 | 823 | 17406 |
| 4L-2S | | MI | 9930 | 3764 | 16434 | 2661 | 17775 | 2144 | 18317 | 1741 | 18917 | 1129 | 22371 | 985 | 13146 |
| 8-#18 | 3.62 | MA | 15031 | 4261 | 25904 | 3015 | 29136 | 2411 | 31256 | 1924 | 34402 | 1122 | 42155 | 934 | 30708 |
| 2L-4S | | MI | 9230 | 4261 | 16250 | 2944 | 17395 | 2327 | 17850 | 1828 | 18435 | 1059 | 22127 | 346 | 19908 |
| 8-#18 | 3.62 | MA | 13475 | 4261 | 23445 | 3006 | 26000 | 2432 | 27466 | 1942 | 29396 | 1139 | 35579 | 706 | 30364 |
| 3E | | MI | 10042 | 4261 | 17688 | 2926 | 19159 | 2344 | 19938 | 1846 | 21052 | 1041 | 25010 | 550 | 22170 |
| 8-#18 | 3.62 | MA | 12362 | 4261 | 21448 | 3032 | 23462 | 2418 | 24410 | 1924 | 25558 | 1157 | 31300 | 482 | 27203 |
| 4L-2S | | MI | 11152 | 4261 | 19439 | 2943 | 21328 | 2327 | 22521 | 1828 | 24466 | 1023 | 29397 | 778 | 22337 |
| 10-#11 | 1.76 | MA | 12929 | 3679 | 20907 | 2683 | 22904 | 2174 | 23821 | 1789 | 24718 | 1211 | 29567 | 1110 | 15625 |
| 2L-5S | | MI | 8620 | 3679 | 14108 | 2620 | 14903 | 2128 | 14918 | 1740 | 14442 | 1160 | 16924 | 815 | 11201 |
| 10-#11 | 1.76 | MA | 12281 | 3679 | 19919 | 2681 | 21643 | 2184 | 22289 | 1797 | 22672 | 1218 | 26855 | 1021 | 15630 |
| 3L-4S | | MI | 8925 | 3679 | 14621 | 2625 | 15560 | 2121 | 15700 | 1733 | 15521 | 1167 | 18210 | 856 | 11595 |
| 10-#11 | 1.76 | MA | 11820 | 3679 | 19120 | 2693 | 20628 | 2180 | 21057 | 1792 | 21102 | 1225 | 25088 | 932 | 15567 |
| 4L-3S | | MI | 9263 | 3679 | 15202 | 2616 | 16296 | 2128 | 16570 | 1740 | 16613 | 1160 | 19421 | 940 | 11593 |
| 10-#11 | 1.76 | MA | 11405 | 3679 | 18419 | 2690 | 19724 | 2189 | 19950 | 1800 | 19552 | 1218 | 23215 | 891 | 14968 |
| 5L-2S | | MI | 9728 | 3679 | 15914 | 2621 | 17200 | 2121 | 17648 | 1733 | 18037 | 1153 | 21275 | 1029 | 11561 |
| 10-#14 | 2.55 | MA | 13861 | 3924 | 23058 | 2826 | 25598 | 2276 | 27079 | 1851 | 28981 | 1180 | 35157 | 1046 | 22137 |
| 2L-5S | | MI | 8811 | 3924 | 14874 | 2756 | 15810 | 2225 | 15986 | 1791 | 15853 | 1117 | 18860 | 632 | 15056 |
| 10-#14 | 2.55 | MA | 12950 | 3924 | 21646 | 2822 | 23799 | 2289 | 24891 | 1862 | 26075 | 1189 | 31316 | 918 | 22068 |
| 3L-4S | | MI | 9240 | 3924 | 15606 | 2764 | 16738 | 2215 | 17090 | 1781 | 17377 | 1127 | 20666 | 691 | 15749 |
| 10-#14 | 2.55 | MA | 12301 | 3924 | 20504 | 2838 | 22347 | 2283 | 23130 | 1852 | 23846 | 1199 | 28818 | 790 | 21421 |
| 4L-3S | | MI | 9715 | 3924 | 16434 | 2752 | 17775 | 2225 | 18317 | 1791 | 18917 | 1117 | 22371 | 810 | 16250 |
| 10-#14 | 2.55 | MA | 11717 | 3924 | 19500 | 2834 | 21053 | 2296 | 21545 | 1863 | 21645 | 1189 | 26160 | 732 | 20261 |
| 5L-2S | | MI | 10368 | 3924 | 17447 | 2760 | 19051 | 2215 | 19838 | 1781 | 20926 | 1107 | 24976 | 938 | 16253 |
| 10-#18 | 4.52 | MA | 14550 | 4544 | 25904 | 3183 | 29136 | 2561 | 31256 | 2020 | 34402 | 1110 | 42155 | 640 | 37697 |
| 3L-4S | | MI | 9984 | 4544 | 18000 | 3121 | 19564 | 2449 | 20434 | 1895 | 21849 | 1015 | 26514 | 251 | 24867 |
| 10-#18 | 4.52 | MA | 13454 | 4544 | 23908 | 3209 | 26598 | 2547 | 28199 | 2003 | 30563 | 1128 | 37876 | 416 | 34252 |
| 4L-3S | | MI | 10785 | 4544 | 19439 | 3103 | 21328 | 2466 | 22521 | 1913 | 24466 | 997 | 29397 | 455 | 27070 |
| 10-#18 | 4.52 | MA | 12470 | 4544 | 22150 | 3200 | 24332 | 2568 | 25449 | 2020 | 26771 | 1110 | 33316 | 314 | 31377 |
| 5L-2S | | MI | 11882 | 4544 | 21189 | 3121 | 23496 | 2449 | 25105 | 1895 | 27881 | 979 | 33785 | 682 | 27638 |
| 12-#11 | 2.12 | MA | 13376 | 3790 | 21896 | 2753 | 24164 | 2224 | 25353 | 1820 | 26765 | 1202 | 32280 | 1089 | 18643 |
| 2L-6S | | MI | 8649 | 3790 | 14335 | 2684 | 15153 | 2171 | 15248 | 1776 | 14876 | 1153 | 17581 | 725 | 12980 |
| 12-#11 | 2.12 | MA | 12732 | 3790 | 20907 | 2750 | 22904 | 2234 | 23821 | 1828 | 24718 | 1209 | 29567 | 1000 | 18626 |
| 3L-5S | | MI | 8939 | 3790 | 14820 | 2689 | 15808 | 2178 | 15996 | 1769 | 15866 | 1146 | 18778 | 785 | 13259 |
| 12-#11 | 2.12 | MA | 12274 | 3790 | 20109 | 2762 | 21889 | 2230 | 22589 | 1823 | 23148 | 1216 | 27800 | 911 | 18539 |
| 4E | | MI | 9243 | 3790 | 15333 | 2694 | 16465 | 2171 | 16778 | 1762 | 16945 | 1153 | 20064 | 826 | 13746 |
| 12-#11 | 2.12 | MA | 11863 | 3790 | 19407 | 2759 | 20985 | 2240 | 21482 | 1831 | 21599 | 1209 | 25928 | 870 | 17840 |
| 5L-3S | | MI | 9578 | 3790 | 15914 | 2685 | 17200 | 2178 | 17648 | 1769 | 18037 | 1146 | 21275 | 910 | 13769 |
| 12-#11 | 2.12 | MA | 11470 | 3790 | 18745 | 2757 | 20085 | 2236 | 20386 | 1825 | 20176 | 1216 | 24168 | 811 | 17352 |
| 6L-2S | | MI | 10040 | 3790 | 16626 | 2690 | 18105 | 2171 | 18726 | 1762 | 19460 | 1139 | 23129 | 998 | 13749 |
| 12-#14 | 3.05 | MA | 13581 | 4083 | 23058 | 2922 | 25598 | 2362 | 27079 | 1906 | 28981 | 1175 | 35157 | 886 | 26317 |
| 3L-5S | | MI | 9258 | 4083 | 15887 | 2856 | 17086 | 2296 | 17507 | 1831 | 17862 | 1095 | 21465 | 585 | 17988 |
| 12-#14 | 3.05 | MA | 12939 | 4083 | 21916 | 2937 | 24147 | 2355 | 25318 | 1897 | 26752 | 1185 | 32659 | 758 | 25461 |
| 4E | | MI | 9684 | 4083 | 16618 | 2864 | 18014 | 2286 | 18610 | 1821 | 19386 | 1105 | 23271 | 644 | 18622 |
| 12-#14 | 3.05 | MA | 12362 | 4083 | 20912 | 2933 | 22852 | 2369 | 23733 | 1908 | 24551 | 1175 | 30000 | 700 | 24375 |
| 5L-3S | | MI | 10155 | 4083 | 17447 | 2852 | 19051 | 2296 | 19838 | 1831 | 20926 | 1095 | 24976 | 763 | 19308 |
| 12-#14 | 3.05 | MA | 11810 | 4083 | 19963 | 2929 | 21565 | 2362 | 22220 | 1919 | 22531 | 1185 | 27511 | 615 | 23028 |
| 6L-2S | | MI | 10802 | 4083 | 18459 | 2860 | 20328 | 2286 | 21358 | 1821 | 22935 | 1085 | 27580 | 891 | 19347 |
| 12-#18 | 5.43 | MA | 14530 | 4828 | 26368 | 3387 | 29734 | 2675 | 31989 | 2081 | 35568 | 1099 | 44452 | 350 | 41338 |
| 4E | | MI | 10728 | 4828 | 19751 | 3299 | 21732 | 2571 | 23018 | 1962 | 25264 | 971 | 30902 | 155 | 29861 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

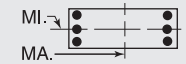
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 5.43 | MA | 13561 | 4828 | 24609 | 3377 | 27468 | 2696 | 29239 | 2098 | 31776 | 1081 | 39892 | 248 | 38303 |
| 5L-3S | | MI | 11520 | 4828 | 21189 | 3281 | 23496 | 2589 | 25105 | 1979 | 27881 | 953 | 33785 | 359 | 31868 |
| 14-#11 | 2.47 | MA | 13179 | 3900 | 21896 | 2819 | 24164 | 2284 | 25353 | 1860 | 26765 | 1200 | 32280 | 979 | 21615 |
| 3L-6S | | MI | 8968 | 3900 | 15047 | 2753 | 16058 | 2221 | 16326 | 1804 | 16300 | 1139 | 19435 | 694 | 15025 |
| 14-#11 | 2.47 | MA | 12725 | 3900 | 21097 | 2831 | 23149 | 2280 | 24122 | 1854 | 25195 | 1207 | 30512 | 890 | 21507 |
| 4L-5S | | MI | 9256 | 3900 | 15532 | 2758 | 16712 | 2228 | 17073 | 1797 | 17289 | 1132 | 20632 | 754 | 15326 |
| 14-#11 | 2.47 | MA | 12317 | 3900 | 20396 | 2828 | 22245 | 2290 | 23014 | 1862 | 23646 | 1200 | 28640 | 849 | 20722 |
| 5L-4S | | MI | 9558 | 3900 | 16045 | 2763 | 17370 | 2221 | 17856 | 1791 | 18369 | 1139 | 21918 | 795 | 15869 |
| 14-#11 | 2.47 | MA | 11928 | 3900 | 19733 | 2826 | 21346 | 2286 | 21918 | 1856 | 22223 | 1207 | 26880 | 790 | 20259 |
| 6L-3S | | MI | 9891 | 3900 | 16626 | 2755 | 18105 | 2228 | 18726 | 1797 | 19460 | 1132 | 23129 | 879 | 15933 |
| 14-#11 | 2.47 | MA | 11548 | 3900 | 19024 | 2838 | 20481 | 2296 | 20859 | 1865 | 20830 | 1214 | 25046 | 702 | 19370 |
| 7L-2S | | MI | 10350 | 3900 | 17338 | 2760 | 19010 | 2221 | 19803 | 1791 | 20884 | 1125 | 24983 | 968 | 15930 |
| 14-#14 | 3.56 | MA | 13570 | 4243 | 23327 | 3037 | 25947 | 2428 | 27506 | 1942 | 29658 | 1171 | 36499 | 726 | 29522 |
| 4L-5S | | MI | 9701 | 4243 | 16899 | 2956 | 18363 | 2367 | 19027 | 1871 | 19871 | 1074 | 24069 | 537 | 20930 |
| 14-#14 | 3.56 | MA | 12999 | 4243 | 22323 | 3033 | 24652 | 2441 | 25921 | 1953 | 27458 | 1161 | 33841 | 668 | 28500 |
| 5L-4S | | MI | 10124 | 4243 | 17631 | 2964 | 19290 | 2357 | 20131 | 1861 | 21395 | 1084 | 25875 | 597 | 21515 |
| 14-#14 | 3.56 | MA | 12453 | 4243 | 21374 | 3029 | 23365 | 2434 | 24408 | 1964 | 25437 | 1171 | 31351 | 582 | 27070 |
| 6L-3S | | MI | 10591 | 4243 | 18459 | 2952 | 20328 | 2367 | 21358 | 1871 | 22935 | 1074 | 27580 | 716 | 22356 |
| 14-#14 | 3.56 | MA | 11921 | 4243 | 20359 | 3045 | 22127 | 2448 | 22836 | 1955 | 23460 | 1181 | 28755 | 455 | 25693 |
| 7L-2S | | MI | 11233 | 4243 | 19472 | 2960 | 21604 | 2357 | 22879 | 1861 | 24944 | 1064 | 30185 | 844 | 22423 |
| 14-#18 | 6.33 | MA | 14637 | 5112 | 27069 | 3554 | 30604 | 2825 | 33029 | 2177 | 36782 | 1052 | 46468 | 182 | 45262 |
| 5L-4S | | MI | 11466 | 5112 | 21501 | 3476 | 23900 | 2693 | 25602 | 2028 | 28679 | 927 | 35290 | 60 | 34883 |
| 16-#11 | 2.82 | MA | 13172 | 4011 | 22086 | 2900 | 24409 | 2330 | 25654 | 1885 | 27242 | 1198 | 33225 | 869 | 24472 |
| 4L-6S | | MI | 9285 | 4011 | 15759 | 2823 | 16963 | 2271 | 17404 | 1833 | 17724 | 1125 | 21289 | 664 | 17034 |
| 16-#11 | 2.82 | MA | 12767 | 4011 | 21385 | 2898 | 23505 | 2340 | 24547 | 1893 | 25692 | 1191 | 31353 | 829 | 23613 |
| 5E | | MI | 9571 | 4011 | 16244 | 2828 | 17617 | 2278 | 18151 | 1826 | 18713 | 1119 | 22486 | 724 | 17400 |
| 16-#11 | 2.82 | MA | 12381 | 4011 | 20722 | 2895 | 22606 | 2336 | 23450 | 1888 | 24269 | 1198 | 29593 | 770 | 23129 |
| 6L-4S | | MI | 9870 | 4011 | 16757 | 2833 | 18275 | 2271 | 18934 | 1819 | 19793 | 1125 | 23771 | 764 | 17906 |
| 16-#11 | 2.82 | MA | 12004 | 4011 | 20013 | 2907 | 21742 | 2346 | 22391 | 1896 | 22877 | 1205 | 27759 | 682 | 22231 |
| 7L-3S | | MI | 10202 | 4011 | 17338 | 2824 | 19010 | 2278 | 19803 | 1826 | 20884 | 1119 | 24983 | 849 | 18090 |
| 16-#11 | 2.82 | MA | 11632 | 4011 | 19362 | 2904 | 20870 | 2342 | 21354 | 1904 | 21418 | 1198 | 26010 | 634 | 21384 |
| 8L-2S | | MI | 10658 | 4011 | 18050 | 2829 | 19915 | 2271 | 20881 | 1819 | 22308 | 1112 | 26836 | 937 | 18104 |
| 16-#14 | 4.07 | MA | 13629 | 4403 | 23735 | 3133 | 26452 | 2513 | 28109 | 1998 | 30364 | 1147 | 37682 | 635 | 32635 |
| 5E | | MI | 10141 | 4403 | 17912 | 3055 | 19639 | 2437 | 20548 | 1911 | 21880 | 1052 | 26674 | 490 | 23842 |
| 16-#14 | 4.07 | MA | 13090 | 4403 | 22786 | 3129 | 25165 | 2507 | 26595 | 2009 | 28344 | 1157 | 35192 | 550 | 31126 |
| 6L-4S | | MI | 10560 | 4403 | 18644 | 3063 | 20566 | 2428 | 21651 | 1901 | 23404 | 1062 | 28480 | 549 | 24423 |
| 16-#14 | 4.07 | MA | 12563 | 4403 | 21771 | 3145 | 23927 | 2520 | 25023 | 2000 | 26367 | 1167 | 32596 | 423 | 29695 |
| 7L-3S | | MI | 11023 | 4403 | 19472 | 3052 | 21604 | 2437 | 22879 | 1911 | 24944 | 1052 | 30185 | 669 | 25398 |
| 18-#11 | 3.18 | MA | 13214 | 4122 | 22373 | 2967 | 24766 | 2390 | 26079 | 1924 | 27739 | 1182 | 34065 | 808 | 26510 |
| 5L-6S | | MI | 9599 | 4122 | 16471 | 2892 | 17867 | 2321 | 18482 | 1862 | 19147 | 1112 | 23143 | 633 | 19053 |
| 18-#11 | 3.18 | MA | 12831 | 4122 | 21710 | 2964 | 23866 | 2386 | 24982 | 1919 | 26316 | 1189 | 32305 | 749 | 25963 |
| 6L-5S | | MI | 9884 | 4122 | 16956 | 2897 | 18522 | 2328 | 19229 | 1855 | 20137 | 1105 | 24340 | 693 | 19480 |
| 18-#11 | 3.18 | MA | 12457 | 4122 | 21001 | 2976 | 23002 | 2396 | 23923 | 1927 | 24924 | 1196 | 30471 | 661 | 25100 |
| 7L-4S | | MI | 10181 | 4122 | 17469 | 2902 | 19179 | 2321 | 20011 | 1848 | 21216 | 1112 | 25625 | 734 | 19953 |
| 18-#11 | 3.18 | MA | 12088 | 4122 | 20350 | 2974 | 22130 | 2392 | 22887 | 1935 | 23464 | 1189 | 28723 | 613 | 24215 |
| 8L-3S | | MI | 10510 | 4122 | 18050 | 2893 | 19915 | 2328 | 20881 | 1855 | 22308 | 1105 | 26836 | 818 | 20242 |
| 18-#14 | 4.58 | MA | 13720 | 4562 | 24198 | 3229 | 26964 | 2579 | 28783 | 2054 | 31250 | 1143 | 39032 | 518 | 35193 |
| 6L-5S | | MI | 10578 | 4562 | 18925 | 3155 | 20915 | 2508 | 22068 | 1951 | 23889 | 1031 | 29279 | 443 | 26669 |
| 18-#14 | 4.58 | MA | 13199 | 4562 | 23183 | 3244 | 25727 | 2592 | 27211 | 2045 | 29273 | 1153 | 36437 | 391 | 33709 |
| 7L-4S | | MI | 10993 | 4562 | 19657 | 3163 | 21843 | 2498 | 23172 | 1941 | 25413 | 1041 | 31085 | 502 | 27342 |
| 20-#11 | 3.53 | MA | 13277 | 4232 | 22699 | 3034 | 25127 | 2436 | 26514 | 1950 | 28363 | 1180 | 35018 | 728 | 28806 |
| 6E | | MI | 9911 | 4232 | 17183 | 2961 | 18772 | 2371 | 19559 | 1890 | 20571 | 1098 | 24997 | 603 | 21080 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

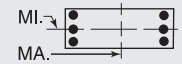
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.53 | MA | 12906 | 4232 | 21990 | 3045 | 24262 | 2446 | 25456 | 1958 | 26970 | 1187 | 33184 | 640 | 27975 |
| 7L-5S | | MI | 10194 | 4232 | 17668 | 2966 | 19427 | 2378 | 20307 | 1883 | 21561 | 1091 | 26194 | 663 | 21564 |
| 20-#11 | 3.53 | MA | 12540 | 4232 | 21339 | 3043 | 23390 | 2442 | 24419 | 1966 | 25511 | 1180 | 31435 | 592 | 27054 |
| 8L-4S | | MI | 10490 | 4232 | 18181 | 2971 | 20084 | 2371 | 21089 | 1876 | 22640 | 1098 | 27479 | 703 | 22007 |
| 20-#14 | 5.09 | MA | 13828 | 4722 | 24594 | 3344 | 27527 | 2665 | 29399 | 2090 | 32179 | 1139 | 40277 | 358 | 37735 |
| 7L-5S | | MI | 11011 | 4722 | 19938 | 3255 | 22192 | 2579 | 23589 | 1991 | 25898 | 1009 | 31883 | 396 | 29511 |
| 22-#11 | 3.88 | MA | 13352 | 4343 | 22979 | 3114 | 25523 | 2496 | 26988 | 1989 | 29017 | 1178 | 35896 | 619 | 30856 |
| 7L-6S | | MI | 10222 | 4343 | 17895 | 3030 | 19677 | 2420 | 20637 | 1919 | 21995 | 1084 | 26851 | 572 | 23115 |
| 22-#11 | 3.88 | MA | 12989 | 4343 | 22328 | 3112 | 24651 | 2492 | 25951 | 1997 | 27558 | 1171 | 34148 | 571 | 29899 |
| 8L-5S | | MI | 10503 | 4343 | 18380 | 3035 | 20332 | 2427 | 21385 | 1912 | 22984 | 1077 | 28048 | 632 | 23652 |
| 24-#11 | 4.24 | MA | 13434 | 4454 | 23316 | 3181 | 25911 | 2542 | 27483 | 2028 | 29604 | 1162 | 36860 | 550 | 32749 |
| 8L-6S | | MI | 10531 | 4454 | 18607 | 3099 | 20582 | 2470 | 21715 | 1948 | 23419 | 1070 | 28705 | 542 | 25155 |

## RECTANGULAR TIED COLUMNS 26" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.71 | MA | 14347 | 3877 | 23240 | 2810 | 25331 | 2277 | 26250 | 1875 | 26980 | 1266 | 32095 | 1153 | 16815 |
| 2E | | MI | 10146 | 3877 | 16669 | 2720 | 17735 | 2190 | 18071 | 1787 | 18273 | 1182 | 21319 | 1037 | 11648 |
| 6-#11 | 1.00 | MA | 13420 | 3642 | 21028 | 2695 | 22660 | 2197 | 23059 | 1831 | 22889 | 1311 | 26789 | 1234 | 10189 |
| 2L-3S | | MI | 9104 | 3642 | 14505 | 2612 | 15232 | 2139 | 15136 | 1776 | 14408 | 1259 | 16419 | 1071 | 7231 |
| 6-#11 | 1.00 | MA | 12714 | 3642 | 19970 | 2693 | 21312 | 2207 | 21420 | 1840 | 20686 | 1318 | 23860 | 1145 | 10232 |
| 3L-2S | | MI | 9576 | 3642 | 15217 | 2617 | 16136 | 2132 | 16213 | 1770 | 15831 | 1253 | 18273 | 1159 | 7176 |
| 6-#14 | 1.44 | MA | 14038 | 3788 | 22427 | 2776 | 24394 | 2254 | 25148 | 1865 | 25637 | 1292 | 30404 | 1196 | 14426 |
| 2L-3S | | MI | 9302 | 3788 | 15137 | 2686 | 15968 | 2193 | 15996 | 1804 | 15539 | 1231 | 17865 | 974 | 10122 |
| 6-#14 | 1.44 | MA | 13040 | 3788 | 20916 | 2772 | 22467 | 2269 | 22805 | 1877 | 22506 | 1302 | 26252 | 1068 | 14448 |
| 3L-2S | | MI | 9967 | 3788 | 16150 | 2694 | 17244 | 2183 | 17517 | 1794 | 17548 | 1221 | 20469 | 1102 | 10056 |
| 6-#18 | 2.56 | MA | 15522 | 4161 | 25877 | 2987 | 28693 | 2406 | 30337 | 1955 | 32385 | 1239 | 39222 | 1093 | 24868 |
| 2L-3S | | MI | 9769 | 4161 | 16669 | 2880 | 17735 | 2330 | 18071 | 1871 | 18273 | 1156 | 21319 | 714 | 17020 |
| 6-#18 | 2.56 | MA | 13823 | 4161 | 23240 | 2979 | 25331 | 2428 | 26250 | 1973 | 26980 | 1257 | 32095 | 865 | 24643 |
| 3L-2S | | MI | 10896 | 4161 | 18420 | 2898 | 19904 | 2313 | 20654 | 1853 | 21688 | 1138 | 25707 | 942 | 17046 |
| 8-#11 | 1.33 | MA | 13911 | 3752 | 22086 | 2764 | 24009 | 2247 | 24699 | 1862 | 25092 | 1303 | 29717 | 1215 | 13440 |
| 2L-4S | | MI | 9084 | 3752 | 14636 | 2690 | 15401 | 2182 | 15344 | 1798 | 14740 | 1252 | 17062 | 956 | 9475 |
| 8-#11 | 1.33 | MA | 13210 | 3752 | 21028 | 2762 | 22660 | 2257 | 23059 | 1871 | 22889 | 1310 | 26789 | 1126 | 13465 |
| 3E | | MI | 9424 | 3752 | 15217 | 2681 | 16136 | 2188 | 16213 | 1805 | 15831 | 1246 | 18273 | 1040 | 9440 |
| 8-#11 | 1.33 | MA | 12712 | 3752 | 20176 | 2774 | 21576 | 2254 | 21744 | 1866 | 21199 | 1317 | 24878 | 1037 | 13433 |
| 4L-2S | | MI | 9893 | 3752 | 15928 | 2686 | 17041 | 2182 | 17291 | 1798 | 17255 | 1239 | 20127 | 1129 | 9394 |
| 8-#14 | 1.92 | MA | 14725 | 3948 | 23939 | 2875 | 26321 | 2327 | 27490 | 1910 | 28769 | 1279 | 34555 | 1167 | 19050 |
| 2L-4S | | MI | 9270 | 3948 | 15321 | 2798 | 16207 | 2254 | 16289 | 1834 | 16008 | 1220 | 18765 | 807 | 13076 |
| 8-#14 | 1.92 | MA | 13738 | 3948 | 22427 | 2872 | 24394 | 2341 | 25148 | 1922 | 25637 | 1289 | 30404 | 1039 | 19024 |
| 3E | | MI | 9751 | 3948 | 16150 | 2786 | 17244 | 2263 | 17517 | 1844 | 17548 | 1210 | 20469 | 927 | 13227 |
| 8-#14 | 1.92 | MA | 13035 | 3948 | 21207 | 2889 | 22842 | 2335 | 23265 | 1914 | 23236 | 1299 | 27699 | 911 | 18774 |
| 4L-2S | | MI | 10410 | 3948 | 17162 | 2794 | 18520 | 2254 | 19037 | 1834 | 19557 | 1200 | 23074 | 1055 | 13186 |
| 8-#18 | 3.42 | MA | 16677 | 4445 | 28514 | 3165 | 32055 | 2534 | 34424 | 2035 | 37790 | 1212 | 46349 | 1032 | 32868 |
| 2L-4S | | MI | 9708 | 4445 | 16981 | 3075 | 18140 | 2435 | 18567 | 1920 | 19071 | 1129 | 22824 | 414 | 20145 |
| 8-#18 | 3.42 | MA | 15003 | 4445 | 25877 | 3157 | 28693 | 2557 | 30337 | 2053 | 32385 | 1230 | 39222 | 804 | 32524 |
| 3E | | MI | 10522 | 4445 | 18420 | 3057 | 19904 | 2452 | 20654 | 1938 | 21688 | 1112 | 25707 | 619 | 22264 |
| 8-#18 | 3.42 | MA | 13810 | 4445 | 23741 | 3184 | 25978 | 2544 | 27042 | 2036 | 28239 | 1248 | 34591 | 577 | 29350 |
| 4L-2S | | MI | 11636 | 4445 | 20170 | 3075 | 22072 | 2435 | 23238 | 1920 | 25102 | 1094 | 30094 | 846 | 22399 |
| 10-#11 | 1.67 | MA | 14396 | 3863 | 23144 | 2833 | 25357 | 2297 | 26338 | 1894 | 27294 | 1295 | 32645 | 1196 | 16678 |
| 2L-5S | | MI | 9098 | 3863 | 14835 | 2754 | 15649 | 2238 | 15639 | 1834 | 15084 | 1232 | 17630 | 885 | 11320 |
| 10-#11 | 1.67 | MA | 13701 | 3863 | 22086 | 2831 | 24009 | 2307 | 24699 | 1902 | 25092 | 1302 | 29717 | 1107 | 16683 |
| 3L-4S | | MI | 9404 | 3863 | 15348 | 2759 | 16306 | 2231 | 16421 | 1827 | 16164 | 1239 | 18916 | 926 | 11645 |
| 10-#11 | 1.67 | MA | 13207 | 3863 | 21233 | 2843 | 22925 | 2304 | 23383 | 1897 | 23402 | 1309 | 27806 | 1018 | 16620 |
| 4L-3S | | MI | 9742 | 3863 | 15928 | 2750 | 17041 | 2238 | 17291 | 1834 | 17255 | 1232 | 20127 | 1010 | 11631 |
| 10-#11 | 1.67 | MA | 12764 | 3863 | 20485 | 2841 | 21960 | 2314 | 22202 | 1906 | 21734 | 1302 | 25790 | 976 | 16067 |
| 5L-2S | | MI | 10208 | 3863 | 16640 | 2755 | 17946 | 2231 | 18369 | 1827 | 18679 | 1225 | 21981 | 1098 | 11596 |

## RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

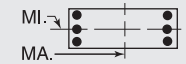
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.40 | MA | 15405 | 4108 | 25450 | 2975 | 28248 | 2399 | 29833 | 1955 | 31900 | 1266 | 38706 | 1137 | 23656 |
| 2L-5S | | MI | 9288 | 4108 | 15602 | 2889 | 16555 | 2334 | 16706 | 1884 | 16493 | 1188 | 19563 | 701 | 15206 |
| 10-#14 | 2.40 | MA | 14427 | 4108 | 23939 | 2972 | 26321 | 2413 | 27490 | 1967 | 28769 | 1276 | 34555 | 1009 | 23587 |
| 3L-4S | | MI | 9719 | 4108 | 16334 | 2897 | 17483 | 2324 | 17810 | 1874 | 18017 | 1198 | 21369 | 760 | 15922 |
| 10-#14 | 2.40 | MA | 13731 | 4108 | 22719 | 2988 | 24769 | 2408 | 25608 | 1959 | 26367 | 1286 | 31850 | 881 | 23078 |
| 4L-3S | | MI | 10195 | 4108 | 17162 | 2885 | 18520 | 2334 | 19037 | 1884 | 19557 | 1188 | 23074 | 879 | 16306 |
| 10-#14 | 2.40 | MA | 13107 | 4108 | 21646 | 2985 | 23387 | 2422 | 23915 | 1971 | 23996 | 1276 | 28985 | 822 | 21760 |
| 5L-2S | | MI | 10849 | 4108 | 18175 | 2893 | 19797 | 2324 | 20558 | 1874 | 21566 | 1178 | 25679 | 1007 | 16297 |
| 10-#18 | 4.27 | MA | 16164 | 4728 | 28514 | 3334 | 32055 | 2686 | 34424 | 2133 | 37790 | 1204 | 46349 | 744 | 40397 |
| 3L-4S | | MI | 10462 | 4728 | 18732 | 3253 | 20308 | 2557 | 21151 | 1987 | 22485 | 1085 | 27211 | 319 | 25099 |
| 10-#18 | 4.27 | MA | 14989 | 4728 | 26378 | 3361 | 29340 | 2673 | 31129 | 2116 | 33644 | 1221 | 41718 | 516 | 36918 |
| 4L-3S | | MI | 11267 | 4728 | 20170 | 3235 | 22072 | 2575 | 23238 | 2004 | 25102 | 1068 | 30094 | 523 | 27386 |
| 10-#18 | 4.27 | MA | 13935 | 4728 | 24499 | 3353 | 26918 | 2696 | 28165 | 2134 | 29551 | 1204 | 36776 | 415 | 34030 |
| 5L-2S | | MI | 12367 | 4728 | 21921 | 3252 | 24240 | 2557 | 25822 | 1987 | 28517 | 1050 | 34482 | 751 | 27707 |
| 12-#11 | 2.00 | MA | 14878 | 3974 | 24201 | 2902 | 26706 | 2347 | 27977 | 1925 | 29497 | 1287 | 35573 | 1176 | 19907 |
| 2L-6S | | MI | 9126 | 3974 | 15062 | 2818 | 15899 | 2281 | 15969 | 1869 | 15518 | 1225 | 18288 | 794 | 13093 |
| 12-#11 | 2.00 | MA | 14187 | 3974 | 23144 | 2900 | 25357 | 2357 | 26338 | 1934 | 27294 | 1294 | 32645 | 1088 | 19889 |
| 3L-5S | | MI | 9417 | 3974 | 15547 | 2823 | 16553 | 2288 | 16717 | 1862 | 16508 | 1218 | 19484 | 854 | 13377 |
| 12-#11 | 2.00 | MA | 13698 | 3974 | 22291 | 2912 | 24273 | 2354 | 25023 | 1929 | 25604 | 1301 | 30734 | 999 | 19802 |
| 4E | | MI | 9722 | 3974 | 16060 | 2828 | 17211 | 2281 | 17499 | 1855 | 17587 | 1225 | 20770 | 895 | 13801 |
| 12-#11 | 2.00 | MA | 13258 | 3974 | 21543 | 2910 | 23308 | 2364 | 23841 | 1937 | 23937 | 1294 | 28718 | 957 | 19142 |
| 5L-3S | | MI | 10058 | 3974 | 16640 | 2819 | 17946 | 2288 | 18369 | 1862 | 18679 | 1218 | 21981 | 979 | 13811 |
| 12-#11 | 2.00 | MA | 12838 | 3974 | 20836 | 2908 | 22349 | 2361 | 22671 | 1932 | 22406 | 1301 | 26817 | 898 | 18590 |
| 6L-2S | | MI | 10521 | 3974 | 17352 | 2824 | 18851 | 2281 | 19447 | 1855 | 20103 | 1211 | 23835 | 1068 | 13787 |
| 12-#14 | 2.88 | MA | 15108 | 4267 | 25450 | 3072 | 28248 | 2486 | 29833 | 2012 | 31900 | 1263 | 38706 | 979 | 28140 |
| 3L-5S | | MI | 9736 | 4267 | 16615 | 2989 | 17832 | 2405 | 18226 | 1924 | 18502 | 1167 | 22168 | 654 | 18137 |
| 12-#14 | 2.88 | MA | 14420 | 4267 | 24230 | 3088 | 26696 | 2480 | 27950 | 2004 | 29498 | 1273 | 36001 | 851 | 27408 |
| 4E | | MI | 10163 | 4267 | 17347 | 2997 | 18759 | 2395 | 19330 | 1914 | 20026 | 1177 | 23974 | 713 | 18793 |
| 12-#14 | 2.88 | MA | 13802 | 4267 | 23158 | 3085 | 25314 | 2494 | 26258 | 2016 | 27128 | 1263 | 33137 | 792 | 26168 |
| 5L-3S | | MI | 10636 | 4267 | 18175 | 2985 | 19797 | 2405 | 20558 | 1924 | 21566 | 1167 | 25679 | 832 | 19370 |
| 12-#14 | 2.88 | MA | 13213 | 4267 | 22145 | 3082 | 23940 | 2488 | 24582 | 2008 | 24951 | 1273 | 30443 | 707 | 24849 |
| 6L-2S | | MI | 11285 | 4267 | 19188 | 2993 | 21073 | 2395 | 22078 | 1914 | 23575 | 1157 | 28283 | 960 | 19394 |
| 12-#18 | 5.13 | MA | 16152 | 5012 | 29015 | 3539 | 32702 | 2802 | 35216 | 2196 | 39049 | 1195 | 48845 | 455 | 44525 |
| 4E | | MI | 11208 | 5012 | 20482 | 3430 | 22476 | 2679 | 23735 | 2053 | 25900 | 1041 | 31599 | 223 | 30090 |
| 12-#18 | 5.13 | MA | 15113 | 5012 | 27136 | 3531 | 30280 | 2824 | 32252 | 2214 | 34956 | 1177 | 43903 | 354 | 41476 |
| 5L-3S | | MI | 12003 | 5012 | 21921 | 3412 | 24240 | 2697 | 25822 | 2071 | 28517 | 1024 | 34482 | 428 | 32176 |
| 12-#18 | 5.13 | MA | 14123 | 5012 | 25359 | 3523 | 27870 | 2812 | 29419 | 2232 | 31199 | 1195 | 39286 | 202 | 38298 |
| 6L-2S | | MI | 13092 | 5012 | 23671 | 3429 | 26409 | 2679 | 28406 | 2053 | 31931 | 1006 | 38870 | 655 | 32993 |
| 14-#11 | 2.33 | MA | 14670 | 4084 | 24201 | 2969 | 26706 | 2407 | 27977 | 1965 | 29497 | 1286 | 35573 | 1068 | 23090 |
| 3L-6S | | MI | 9446 | 4084 | 15774 | 2887 | 16803 | 2331 | 17047 | 1898 | 16942 | 1211 | 20142 | 764 | 15179 |
| 14-#11 | 2.33 | MA | 14184 | 4084 | 23349 | 2981 | 25622 | 2404 | 26662 | 1960 | 27807 | 1293 | 33662 | 980 | 22981 |
| 4L-5S | | MI | 9735 | 4084 | 16259 | 2892 | 17458 | 2338 | 17795 | 1891 | 17932 | 1204 | 21338 | 824 | 15444 |
| 14-#11 | 2.33 | MA | 13747 | 4084 | 22600 | 2979 | 24657 | 2414 | 25480 | 1968 | 26140 | 1286 | 31646 | 938 | 22227 |
| 5L-4S | | MI | 10037 | 4084 | 16771 | 2897 | 18116 | 2331 | 18577 | 1884 | 19011 | 1211 | 22624 | 865 | 15951 |
| 14-#11 | 2.33 | MA | 13331 | 4084 | 21893 | 2977 | 23697 | 2411 | 24310 | 1964 | 24609 | 1293 | 29745 | 879 | 21703 |
| 6L-3S | | MI | 10371 | 4084 | 17352 | 2888 | 18851 | 2338 | 19447 | 1891 | 20103 | 1204 | 23835 | 949 | 15983 |
| 14-#11 | 2.33 | MA | 12925 | 4084 | 21137 | 2989 | 22775 | 2421 | 23180 | 1972 | 23110 | 1300 | 27765 | 791 | 20833 |
| 7L-2S | | MI | 10832 | 4084 | 18064 | 2893 | 19756 | 2331 | 20524 | 1884 | 21526 | 1197 | 25689 | 1037 | 15970 |
| 14-#14 | 3.37 | MA | 15100 | 4427 | 25741 | 3188 | 28623 | 2552 | 30293 | 2049 | 32629 | 1261 | 40152 | 821 | 31760 |
| 4L-5S | | MI | 10180 | 4427 | 17628 | 3089 | 19108 | 2476 | 19747 | 1964 | 20511 | 1145 | 24773 | 606 | 21079 |
| 14-#14 | 3.37 | MA | 14489 | 4427 | 24669 | 3185 | 27241 | 2566 | 28601 | 2061 | 30259 | 1251 | 37288 | 762 | 30589 |
| 5L-4S | | MI | 10604 | 4427 | 18360 | 3097 | 20035 | 2466 | 20851 | 1954 | 22035 | 1155 | 26579 | 666 | 21684 |
| 14-#14 | 3.37 | MA | 13906 | 4427 | 23657 | 3181 | 25867 | 2561 | 26924 | 2053 | 28082 | 1261 | 34594 | 677 | 29185 |
| 6L-3S | | MI | 11072 | 4427 | 19188 | 3085 | 21073 | 2476 | 22078 | 1964 | 23575 | 1145 | 28283 | 785 | 22423 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis

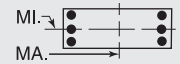



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 3.37 | MA | 13337 | 4427 | 22573 | 3198 | 24546 | 2575 | 25306 | 2064 | 25952 | 1271 | 31787 | 550 | 27822 |
| 7L-2S | | MI | 11717 | 4427 | 20201 | 3093 | 22349 | 2466 | 23599 | 1954 | 25584 | 1135 | 30888 | 913 | 22477 |
| 14-#18 | 5.98 | MA | 16276 | 5296 | 29773 | 3708 | 33642 | 2953 | 36339 | 2293 | 40360 | 1150 | 51030 | 293 | 48956 |
| 5L-4S | | MI | 11946 | 5296 | 22233 | 3607 | 24645 | 2801 | 26319 | 2120 | 29314 | 997 | 35987 | 128 | 35109 |
| 14-#18 | 5.98 | MA | 15300 | 5296 | 27996 | 3700 | 31232 | 2940 | 33506 | 2312 | 36603 | 1168 | 46413 | 141 | 45691 |
| 6L-3S | | MI | 12733 | 5296 | 23671 | 3589 | 26409 | 2819 | 28406 | 2138 | 31931 | 979 | 38870 | 332 | 37017 |
| 16-#11 | 2.67 | MA | 14666 | 4195 | 24406 | 3050 | 26971 | 2454 | 28301 | 1991 | 30010 | 1285 | 36590 | 961 | 26157 |
| 4L-6S | | MI | 9763 | 4195 | 16485 | 2956 | 17708 | 2381 | 18125 | 1927 | 18366 | 1197 | 21995 | 733 | 17227 |
| 16-#11 | 2.67 | MA | 14233 | 4195 | 23658 | 3048 | 26005 | 2465 | 27120 | 2000 | 28343 | 1278 | 34574 | 919 | 25322 |
| 5E | | MI | 10050 | 4195 | 16971 | 2961 | 18363 | 2388 | 18872 | 1920 | 19355 | 1190 | 23192 | 793 | 17518 |
| 16-#11 | 2.67 | MA | 13820 | 4195 | 22951 | 3047 | 25046 | 2461 | 25949 | 1995 | 26812 | 1285 | 32673 | 860 | 24821 |
| 6L-4S | | MI | 10350 | 4195 | 17483 | 2966 | 19020 | 2381 | 19655 | 1913 | 20435 | 1197 | 24478 | 834 | 18044 |
| 16-#11 | 2.67 | MA | 13417 | 4195 | 22195 | 3058 | 24124 | 2471 | 24820 | 2003 | 25313 | 1292 | 30693 | 772 | 23899 |
| 7L-3S | | MI | 10683 | 4195 | 18064 | 2958 | 19756 | 2388 | 20524 | 1920 | 21526 | 1190 | 25689 | 918 | 18142 |
| 16-#11 | 2.67 | MA | 13020 | 4195 | 21500 | 3057 | 23193 | 2468 | 23713 | 2012 | 23742 | 1285 | 28810 | 723 | 23076 |
| 8L-2S | | MI | 11141 | 4195 | 18776 | 2963 | 20660 | 2381 | 21602 | 1913 | 22950 | 1183 | 27543 | 1007 | 18147 |
| 16-#14 | 3.85 | MA | 15170 | 4586 | 26181 | 3284 | 29168 | 2639 | 30943 | 2105 | 33390 | 1238 | 41439 | 732 | 35021 |
| 5E | | MI | 10621 | 4586 | 18641 | 3188 | 20384 | 2547 | 21267 | 2004 | 22520 | 1124 | 27377 | 559 | 24030 |
| 16-#14 | 3.85 | MA | 14592 | 4586 | 25168 | 3281 | 27794 | 2633 | 29267 | 2097 | 31214 | 1248 | 38745 | 647 | 33534 |
| 6L-4S | | MI | 11041 | 4586 | 19372 | 3196 | 21312 | 2537 | 22371 | 1994 | 24044 | 1134 | 29183 | 618 | 24590 |
| 16-#14 | 3.85 | MA | 14029 | 4586 | 24084 | 3298 | 26473 | 2647 | 27649 | 2109 | 29083 | 1258 | 35939 | 520 | 32118 |
| 7L-3S | | MI | 11506 | 4586 | 20201 | 3185 | 22349 | 2547 | 23599 | 2004 | 25584 | 1124 | 30888 | 738 | 25469 |
| 16-#14 | 3.85 | MA | 13474 | 4586 | 23089 | 3294 | 25140 | 2642 | 26064 | 2121 | 26850 | 1248 | 33264 | 451 | 30446 |
| 8L-2S | | MI | 12146 | 4586 | 21213 | 3193 | 23626 | 2537 | 25119 | 1994 | 27593 | 1114 | 33492 | 866 | 25547 |
| 16-#18 | 6.84 | MA | 16462 | 5579 | 30633 | 3877 | 34594 | 3069 | 37593 | 2391 | 42008 | 1141 | 53540 | 80 | 53112 |
| 6L-4S | | MI | 12679 | 5579 | 23983 | 3785 | 26813 | 2923 | 28902 | 2187 | 32729 | 953 | 40374 | 32 | 40149 |
| 18-#11 | 3.00 | MA | 14715 | 4306 | 24716 | 3118 | 27354 | 2515 | 28759 | 2031 | 30546 | 1270 | 37502 | 900 | 28424 |
| 5L-6S | | MI | 10078 | 4306 | 17197 | 3026 | 18613 | 2431 | 19203 | 1955 | 19790 | 1183 | 23849 | 703 | 19243 |
| 18-#11 | 3.00 | MA | 14305 | 4306 | 24009 | 3116 | 26394 | 2511 | 27589 | 2026 | 29015 | 1277 | 35601 | 841 | 27944 |
| 6L-5S | | MI | 10363 | 4306 | 17683 | 3031 | 19268 | 2438 | 19950 | 1948 | 20779 | 1177 | 25046 | 763 | 19598 |
| 18-#11 | 3.00 | MA | 13905 | 4306 | 23252 | 3128 | 25472 | 2522 | 26459 | 2035 | 27516 | 1284 | 33621 | 753 | 26972 |
| 7L-4S | | MI | 10662 | 4306 | 18195 | 3036 | 19925 | 2431 | 20732 | 1941 | 21859 | 1183 | 26332 | 803 | 20090 |
| 18-#11 | 3.00 | MA | 13511 | 4306 | 22558 | 3126 | 24542 | 2518 | 25353 | 2043 | 25945 | 1277 | 31738 | 704 | 26112 |
| 8L-3S | | MI | 10992 | 4306 | 18776 | 3027 | 20660 | 2438 | 21602 | 1948 | 22950 | 1177 | 27543 | 888 | 20296 |
| 18-#11 | 3.00 | MA | 13120 | 4306 | 21823 | 3138 | 23632 | 2528 | 24208 | 2038 | 24462 | 1284 | 29896 | 647 | 25145 |
| 9L-2S | | MI | 11447 | 4306 | 19488 | 3032 | 21565 | 2431 | 22680 | 1941 | 24374 | 1170 | 29397 | 976 | 20319 |
| 18-#14 | 4.33 | MA | 15272 | 4746 | 26679 | 3381 | 29721 | 2705 | 31609 | 2142 | 34345 | 1235 | 42897 | 617 | 37895 |
| 6L-5S | | MI | 11058 | 4746 | 19653 | 3288 | 21661 | 2618 | 22788 | 2044 | 24529 | 1102 | 29982 | 512 | 26938 |
| 18-#14 | 4.33 | MA | 14715 | 4746 | 25596 | 3397 | 28400 | 2720 | 29991 | 2154 | 32214 | 1245 | 40090 | 491 | 36426 |
| 7L-4S | | MI | 11475 | 4746 | 20385 | 3296 | 22588 | 2608 | 23892 | 2034 | 26053 | 1112 | 31788 | 571 | 27508 |
| 18-#14 | 4.33 | MA | 14165 | 4746 | 24601 | 3394 | 27067 | 2714 | 28406 | 2166 | 29982 | 1235 | 37415 | 421 | 34805 |
| 8L-3S | | MI | 11937 | 4746 | 21213 | 3284 | 23626 | 2618 | 25119 | 2044 | 27593 | 1102 | 33492 | 690 | 28510 |
| 20-#11 | 3.33 | MA | 14786 | 4416 | 25067 | 3185 | 27743 | 2561 | 29228 | 2057 | 31217 | 1269 | 38529 | 822 | 31000 |
| 6E | | MI | 10391 | 4416 | 17909 | 3095 | 19518 | 2481 | 20281 | 1984 | 21213 | 1170 | 25703 | 672 | 21269 |
| 20-#11 | 3.33 | MA | 14389 | 4416 | 24310 | 3197 | 26821 | 2572 | 28098 | 2066 | 29719 | 1276 | 36549 | 734 | 30052 |
| 7L-5S | | MI | 10675 | 4416 | 18395 | 3100 | 20172 | 2488 | 21028 | 1977 | 22203 | 1163 | 26900 | 732 | 21682 |
| 20-#11 | 3.33 | MA | 13998 | 4416 | 23616 | 3195 | 25890 | 2568 | 26992 | 2075 | 28148 | 1269 | 34666 | 685 | 29155 |
| 8L-4S | | MI | 10971 | 4416 | 18907 | 3105 | 20830 | 2481 | 21810 | 1970 | 23282 | 1170 | 28185 | 773 | 22144 |
| 20-#11 | 3.33 | MA | 13610 | 4416 | 22881 | 3207 | 24981 | 2579 | 25848 | 2070 | 26665 | 1276 | 32824 | 628 | 28215 |
| 9L-3S | | MI | 11300 | 4416 | 19488 | 3096 | 21565 | 2488 | 22680 | 1977 | 24374 | 1163 | 29397 | 857 | 22447 |
| 20-#14 | 4.81 | MA | 15394 | 4906 | 27107 | 3497 | 30327 | 2792 | 32334 | 2199 | 35346 | 1232 | 44241 | 461 | 40746 |
| 7L-5S | | MI | 11492 | 4906 | 20666 | 3388 | 22937 | 2689 | 24308 | 2084 | 26538 | 1081 | 32586 | 465 | 29776 |
| 20-#14 | 4.81 | MA | 14849 | 4906 | 26112 | 3494 | 28994 | 2786 | 30749 | 2211 | 33113 | 1222 | 41566 | 391 | 39173 |
| 8L-4S | | MI | 11907 | 4906 | 21398 | 3396 | 23864 | 2679 | 25412 | 2074 | 28062 | 1091 | 34392 | 524 | 30436 |
| 22-#11 | 3.67 | MA | 14870 | 4527 | 25368 | 3266 | 28169 | 2622 | 29738 | 2097 | 31922 | 1268 | 39477 | 715 | 33137 |
| 7L-6S | | MI | 10702 | 4527 | 18621 | 3164 | 20423 | 2531 | 21358 | 2012 | 22637 | 1156 | 27557 | 642 | 23301 |

## RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.67 | MA | 14482 | 4527 | 24674 | 3264 | 27239 | 2618 | 28631 | 2106 | 30351 | 1261 | 37594 | 666 | 32204 |
| 8L-5S | | MI | 10984 | 4527 | 19107 | 3169 | 21077 | 2538 | 22106 | 2006 | 23627 | 1149 | 28754 | 702 | 23770 |
| 22-#11 | 3.67 | MA | 14097 | 4527 | 23939 | 3276 | 26330 | 2629 | 27487 | 2101 | 28867 | 1268 | 35752 | 609 | 31285 |
| 9L-4S | | MI | 11279 | 4527 | 19619 | 3174 | 21735 | 2531 | 22888 | 1999 | 24706 | 1156 | 30039 | 742 | 24204 |
| 22-#14 | 5.29 | MA | 15528 | 5065 | 27624 | 3594 | 30921 | 2859 | 33091 | 2256 | 36244 | 1210 | 45717 | 361 | 43467 |
| 8L-5S | | MI | 11924 | 5065 | 21679 | 3488 | 24213 | 2759 | 25829 | 2124 | 28547 | 1059 | 35191 | 417 | 32627 |
| 24-#11 | 4.00 | MA | 14962 | 4637 | 25731 | 3333 | 28587 | 2669 | 30271 | 2137 | 32554 | 1253 | 40522 | 647 | 35258 |
| 8L-6S | | MI | 11012 | 4637 | 19333 | 3233 | 21327 | 2580 | 22436 | 2041 | 24061 | 1142 | 29411 | 611 | 25340 |
| 24-#11 | 4.00 | MA | 14580 | 4637 | 24997 | 3345 | 27678 | 2679 | 29126 | 2132 | 31070 | 1259 | 38680 | 590 | 34314 |
| 9L-5S | | MI | 11292 | 4637 | 19819 | 3238 | 21982 | 2587 | 23183 | 2034 | 25050 | 1135 | 30608 | 671 | 25861 |

## RECTANGULAR TIED COLUMNS 26" x 38"

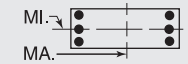
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.62 | MA | 15892 | 4061 | 25599 | 2959 | 27912 | 2400 | 28893 | 1980 | 29674 | 1350 | 35306 | 1240 | 17895 |
| 2E | | MI | 10625 | 4061 | 17401 | 2852 | 18480 | 2299 | 18788 | 1878 | 18909 | 1253 | 22016 | 1105 | 11691 |
| 6-#14 | 1.37 | MA | 15555 | 3972 | 24725 | 2925 | 26903 | 2377 | 27706 | 1970 | 28211 | 1375 | 33451 | 1281 | 15337 |
| 2L-3S | | MI | 9780 | 3972 | 15865 | 2819 | 16713 | 2302 | 16716 | 1897 | 16179 | 1303 | 18568 | 1043 | 10161 |
| 6-#14 | 1.37 | MA | 14489 | 3972 | 23114 | 2922 | 24849 | 2392 | 25209 | 1982 | 24855 | 1385 | 28988 | 1153 | 15359 |
| 3L-2S | | MI | 10446 | 3972 | 16878 | 2827 | 17989 | 2292 | 18236 | 1887 | 18188 | 1293 | 21173 | 1171 | 10090 |
| 6-#18 | 2.43 | MA | 17156 | 4345 | 28414 | 3137 | 31500 | 2529 | 33254 | 2060 | 35479 | 1326 | 42985 | 1184 | 26488 |
| 2L-3S | | MI | 10247 | 4345 | 17401 | 3012 | 18480 | 2438 | 18788 | 1963 | 18909 | 1226 | 22016 | 782 | 17097 |
| 6-#18 | 2.43 | MA | 15337 | 4345 | 25599 | 3130 | 27912 | 2553 | 28893 | 2080 | 29674 | 1344 | 35306 | 956 | 26263 |
| 3L-2S | | MI | 11377 | 4345 | 19151 | 3029 | 20648 | 2421 | 21371 | 1945 | 22323 | 1209 | 26404 | 1010 | 17098 |
| 8-#11 | 1.26 | MA | 15416 | 3936 | 24358 | 2913 | 26489 | 2370 | 27223 | 1967 | 27616 | 1387 | 32697 | 1298 | 14282 |
| 2L-4S | | MI | 9562 | 3936 | 15362 | 2824 | 16147 | 2292 | 16065 | 1892 | 15382 | 1324 | 17768 | 1026 | 9514 |
| 8-#11 | 1.26 | MA | 14668 | 3936 | 23231 | 2912 | 25052 | 2380 | 25476 | 1976 | 25257 | 1394 | 29553 | 1210 | 14308 |
| 3E | | MI | 9903 | 3936 | 15943 | 2815 | 16882 | 2299 | 16935 | 1899 | 16474 | 1317 | 18979 | 1110 | 9472 |
| 8-#11 | 1.26 | MA | 14138 | 3936 | 22324 | 2924 | 23899 | 2377 | 24077 | 1972 | 23447 | 1400 | 27498 | 1121 | 14275 |
| 4L-2S | | MI | 10373 | 3936 | 16655 | 2820 | 17787 | 2292 | 18012 | 1892 | 17897 | 1311 | 20833 | 1198 | 9424 |
| 8-#14 | 1.82 | MA | 16293 | 4132 | 26336 | 3025 | 28957 | 2450 | 30203 | 2015 | 31568 | 1364 | 37913 | 1253 | 20265 |
| 2L-4S | | MI | 9748 | 4132 | 16050 | 2931 | 16952 | 2363 | 17009 | 1927 | 16648 | 1291 | 19468 | 876 | 13248 |
| 8-#14 | 1.82 | MA | 15238 | 4132 | 24725 | 3022 | 26903 | 2465 | 27706 | 2027 | 28211 | 1374 | 33451 | 1125 | 20239 |
| 3E | | MI | 10230 | 4132 | 16878 | 2919 | 17989 | 2373 | 18236 | 1937 | 18188 | 1281 | 21173 | 996 | 13272 |
| 8-#14 | 1.82 | MA | 14488 | 4132 | 23426 | 3039 | 25252 | 2460 | 25702 | 2020 | 25636 | 1384 | 30538 | 997 | 20032 |
| 4L-2S | | MI | 10890 | 4132 | 17891 | 2927 | 19266 | 2363 | 19757 | 1927 | 20197 | 1271 | 23777 | 1124 | 13225 |
| 8-#18 | 3.24 | MA | 18398 | 4628 | 31228 | 3314 | 35088 | 2657 | 37616 | 2140 | 41284 | 1302 | 50663 | 1128 | 35028 |
| 2L-4S | | MI | 10185 | 4628 | 17713 | 3207 | 18884 | 2543 | 19284 | 2012 | 19706 | 1200 | 23521 | 483 | 20376 |
| 8-#18 | 3.24 | MA | 16606 | 4628 | 28414 | 3307 | 31500 | 2681 | 33254 | 2159 | 35479 | 1319 | 42985 | 900 | 34684 |
| 3E | | MI | 11002 | 4628 | 19151 | 3189 | 20648 | 2561 | 21371 | 2030 | 22323 | 1182 | 26404 | 687 | 22353 |
| 8-#18 | 3.24 | MA | 15332 | 4628 | 26138 | 3336 | 28608 | 2670 | 29745 | 2144 | 31026 | 1337 | 37988 | 673 | 31523 |
| 4L-2S | | MI | 12118 | 4628 | 20902 | 3206 | 22816 | 2543 | 23955 | 2012 | 25738 | 1165 | 30791 | 914 | 22457 |
| 10-#11 | 1.58 | MA | 15938 | 4047 | 25485 | 2982 | 27926 | 2420 | 28969 | 1998 | 29976 | 1379 | 35841 | 1281 | 17731 |
| 2L-5S | | MI | 9575 | 4047 | 15562 | 2888 | 16394 | 2348 | 16360 | 1927 | 15726 | 1304 | 18337 | 954 | 11436 |
| 10-#11 | 1.58 | MA | 15195 | 4047 | 24358 | 2981 | 26489 | 2431 | 27223 | 2007 | 27616 | 1386 | 32697 | 1192 | 17736 |
| 3L-4S | | MI | 9882 | 4047 | 16074 | 2893 | 17052 | 2342 | 17142 | 1920 | 16806 | 1311 | 19622 | 995 | 11691 |
| 10-#11 | 1.58 | MA | 14669 | 4047 | 23451 | 2993 | 25336 | 2428 | 25823 | 2003 | 25806 | 1393 | 30642 | 1103 | 17673 |
| 4L-3S | | MI | 10222 | 4047 | 16655 | 2884 | 17787 | 2348 | 18012 | 1927 | 17897 | 1304 | 20833 | 1079 | 11668 |
| 10-#11 | 1.58 | MA | 14197 | 4047 | 22655 | 2992 | 24310 | 2438 | 24567 | 2012 | 24021 | 1386 | 28483 | 1061 | 17176 |
| 5L-2S | | MI | 10688 | 4047 | 17367 | 2889 | 18692 | 2342 | 19090 | 1920 | 19321 | 1297 | 22687 | 1168 | 11630 |
| 10-#14 | 2.28 | MA | 17023 | 4292 | 27947 | 3125 | 31011 | 2522 | 32700 | 2059 | 34925 | 1352 | 42375 | 1226 | 25175 |
| 2L-5S | | MI | 9765 | 4292 | 16331 | 3022 | 17301 | 2444 | 17425 | 1977 | 17133 | 1260 | 20266 | 770 | 15352 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis

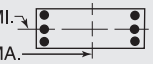



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.28 | MA | 15977 | 4292 | 26336 | 3122 | 28957 | 2537 | 30203 | 2072 | 31568 | 1362 | 37913 | 1098 | 25105 |
| 3L-4S | | MI | 10197 | 4292 | 17062 | 3030 | 18228 | 2434 | 18529 | 1967 | 18657 | 1270 | 22072 | 829 | 16091 |
| 10-#14 | 2.28 | MA | 15236 | 4292 | 25038 | 3139 | 27306 | 2532 | 28200 | 2065 | 28993 | 1372 | 35001 | 970 | 24755 |
| 4L-3S | | MI | 10675 | 4292 | 17891 | 3018 | 19266 | 2444 | 19757 | 1977 | 20197 | 1260 | 23777 | 948 | 16360 |
| 10-#14 | 2.28 | MA | 14571 | 4292 | 23898 | 3136 | 25836 | 2547 | 26400 | 2078 | 26453 | 1362 | 31930 | 910 | 23270 |
| 5L-2S | | MI | 11331 | 4292 | 18903 | 3026 | 20542 | 2434 | 21277 | 1967 | 22206 | 1250 | 26382 | 1076 | 16339 |
| 10-#18 | 4.05 | MA | 17854 | 4912 | 31228 | 3485 | 35088 | 2810 | 37616 | 2239 | 41284 | 1295 | 50663 | 844 | 43097 |
| 3L-4S | | MI | 10940 | 4912 | 19463 | 3384 | 21052 | 2665 | 21868 | 2079 | 23121 | 1156 | 27908 | 387 | 25326 |
| 10-#18 | 4.05 | MA | 16600 | 4912 | 28953 | 3513 | 32196 | 2799 | 34107 | 2224 | 36831 | 1313 | 45666 | 616 | 39611 |
| 4L-3S | | MI | 11748 | 4912 | 20902 | 3366 | 22816 | 2683 | 23955 | 2096 | 25738 | 1138 | 30791 | 591 | 27586 |
| 10-#18 | 4.05 | MA | 15475 | 4912 | 26953 | 3506 | 29618 | 2823 | 30950 | 2244 | 32436 | 1295 | 40357 | 513 | 36729 |
| 5L-2S | | MI | 12852 | 4912 | 22652 | 3384 | 24985 | 2665 | 26539 | 2079 | 29153 | 1120 | 35179 | 819 | 27775 |
| 12-#11 | 1.89 | MA | 16455 | 4157 | 26612 | 3051 | 29362 | 2470 | 30716 | 2029 | 32335 | 1372 | 38985 | 1263 | 21170 |
| 2L-6S | | MI | 9604 | 4157 | 15788 | 2952 | 16644 | 2391 | 16691 | 1963 | 16160 | 1297 | 18994 | 864 | 13201 |
| 12-#11 | 1.89 | MA | 15717 | 4157 | 25485 | 3050 | 27926 | 2481 | 28969 | 2039 | 29976 | 1379 | 35841 | 1174 | 21153 |
| 3L-5S | | MI | 9896 | 4157 | 16274 | 2957 | 17299 | 2398 | 17438 | 1956 | 17150 | 1290 | 20191 | 924 | 13492 |
| 12-#11 | 1.89 | MA | 15195 | 4157 | 24578 | 3062 | 26773 | 2478 | 27570 | 2034 | 28166 | 1386 | 33786 | 1085 | 21066 |
| 4E | | MI | 10201 | 4157 | 16786 | 2962 | 17956 | 2391 | 18220 | 1949 | 18230 | 1297 | 21476 | 965 | 13853 |
| 12-#11 | 1.89 | MA | 14727 | 4157 | 23782 | 3061 | 25747 | 2489 | 26314 | 2044 | 26381 | 1379 | 31627 | 1043 | 20454 |
| 5L-3S | | MI | 10538 | 4157 | 17367 | 2953 | 18692 | 2398 | 19090 | 1956 | 19321 | 1290 | 22687 | 1049 | 13851 |
| 12-#11 | 1.89 | MA | 14280 | 4157 | 23031 | 3059 | 24726 | 2486 | 25070 | 2039 | 24740 | 1386 | 29584 | 984 | 19835 |
| 6L-2S | | MI | 11002 | 4157 | 18079 | 2958 | 19596 | 2391 | 20168 | 1949 | 20745 | 1283 | 24541 | 1137 | 13823 |
| 12-#14 | 2.73 | MA | 16709 | 4451 | 27947 | 3222 | 31011 | 2609 | 32700 | 2117 | 34925 | 1351 | 42375 | 1070 | 29962 |
| 3L-5S | | MI | 10214 | 4451 | 17344 | 3122 | 18577 | 2515 | 18946 | 2017 | 19142 | 1238 | 22871 | 723 | 18282 |
| 12-#14 | 2.73 | MA | 15975 | 4451 | 26649 | 3239 | 29360 | 2604 | 30697 | 2110 | 32350 | 1361 | 39463 | 942 | 29376 |
| 4E | | MI | 10643 | 4451 | 18075 | 3130 | 19504 | 2505 | 20050 | 2007 | 20666 | 1248 | 24677 | 782 | 18959 |
| 12-#14 | 2.73 | MA | 15317 | 4451 | 25509 | 3236 | 27891 | 2619 | 28897 | 2123 | 29809 | 1351 | 36392 | 882 | 27974 |
| 5L-3S | | MI | 11116 | 4451 | 18903 | 3118 | 20542 | 2515 | 21277 | 2017 | 22206 | 1238 | 26382 | 901 | 19429 |
| 12-#14 | 2.73 | MA | 14689 | 4451 | 24432 | 3233 | 26429 | 2614 | 27114 | 2116 | 27476 | 1361 | 33494 | 797 | 26696 |
| 6L-2S | | MI | 11767 | 4451 | 19916 | 3126 | 21818 | 2505 | 22798 | 2007 | 24215 | 1228 | 28986 | 1029 | 19440 |
| 12-#18 | 4.86 | MA | 17849 | 5196 | 31767 | 3691 | 35784 | 2927 | 38468 | 2303 | 42636 | 1289 | 53345 | 560 | 47739 |
| 4E | | MI | 11687 | 5196 | 21214 | 3561 | 23221 | 2787 | 24452 | 2145 | 26536 | 1112 | 32296 | 292 | 30313 |
| 12-#18 | 4.86 | MA | 16741 | 5196 | 29767 | 3684 | 33206 | 2952 | 35312 | 2323 | 38241 | 1271 | 48035 | 457 | 44697 |
| 5L-3S | | MI | 12486 | 5196 | 22652 | 3543 | 24985 | 2805 | 26539 | 2163 | 29153 | 1094 | 35179 | 496 | 32479 |
| 12-#18 | 4.86 | MA | 15684 | 5196 | 27877 | 3677 | 30641 | 2941 | 32185 | 2308 | 34206 | 1289 | 43056 | 305 | 41457 |
| 6L-2S | | MI | 13579 | 5196 | 24403 | 3561 | 27153 | 2787 | 29123 | 2145 | 32567 | 1076 | 39566 | 723 | 33066 |
| 14-#11 | 2.21 | MA | 16234 | 4268 | 26612 | 3119 | 29362 | 2531 | 30716 | 2070 | 32335 | 1372 | 38985 | 1157 | 24564 |
| 3L-6S | | MI | 9923 | 4268 | 16500 | 3021 | 17549 | 2441 | 17768 | 1991 | 17584 | 1283 | 20848 | 833 | 15288 |
| 14-#11 | 2.21 | MA | 15716 | 4268 | 25705 | 3131 | 28209 | 2528 | 29316 | 2065 | 30525 | 1378 | 36930 | 1068 | 24455 |
| 4L-5S | | MI | 10213 | 4268 | 16986 | 3026 | 18204 | 2448 | 18516 | 1985 | 18574 | 1276 | 22044 | 893 | 15558 |
| 14-#11 | 2.21 | MA | 15252 | 4268 | 24909 | 3130 | 27183 | 2539 | 28060 | 2075 | 28740 | 1372 | 34771 | 1025 | 23743 |
| 5L-4S | | MI | 10517 | 4268 | 17498 | 3031 | 18861 | 2441 | 19298 | 1978 | 19653 | 1283 | 23330 | 934 | 16007 |
| 14-#11 | 2.21 | MA | 14809 | 4268 | 24158 | 3128 | 26163 | 2536 | 26816 | 2070 | 27100 | 1378 | 32728 | 967 | 23155 |
| 6L-3S | | MI | 10852 | 4268 | 18079 | 3022 | 19596 | 2448 | 20168 | 1985 | 20745 | 1276 | 24541 | 1018 | 16026 |
| 14-#11 | 2.21 | MA | 14376 | 4268 | 23354 | 3141 | 25183 | 2547 | 25616 | 2080 | 25494 | 1385 | 30601 | 879 | 22313 |
| 7L-2S | | MI | 11313 | 4268 | 18791 | 3027 | 20501 | 2441 | 21246 | 1978 | 22169 | 1269 | 26395 | 1107 | 16009 |
| 14-#14 | 3.19 | MA | 16706 | 4611 | 28260 | 3339 | 31415 | 2677 | 33194 | 2155 | 35706 | 1349 | 43925 | 915 | 34018 |
| 4L-5S | | MI | 10659 | 4611 | 18356 | 3222 | 19853 | 2586 | 20466 | 2057 | 21151 | 1217 | 25476 | 675 | 21224 |
| 14-#14 | 3.19 | MA | 16055 | 4611 | 27120 | 3336 | 29945 | 2692 | 31394 | 2168 | 33166 | 1339 | 40854 | 855 | 32691 |
| 5L-4S | | MI | 11084 | 4611 | 19088 | 3230 | 20781 | 2576 | 21570 | 2047 | 22675 | 1227 | 27282 | 735 | 21848 |
| 14-#14 | 3.19 | MA | 15433 | 4611 | 26043 | 3333 | 28483 | 2687 | 29611 | 2160 | 30832 | 1349 | 37956 | 770 | 31325 |
| 6L-3S | | MI | 11554 | 4611 | 19916 | 3218 | 21818 | 2586 | 22798 | 2057 | 24215 | 1217 | 28986 | 854 | 22487 |
| 14-#14 | 3.19 | MA | 14827 | 4611 | 24891 | 3350 | 27079 | 2702 | 27891 | 2173 | 28549 | 1359 | 34938 | 643 | 29941 |
| 7L-2S | | MI | 12200 | 4611 | 20929 | 3226 | 23095 | 2576 | 24318 | 2047 | 26224 | 1207 | 31591 | 982 | 22529 |
| 14-#18 | 5.67 | MA | 17990 | 5480 | 32581 | 3861 | 36794 | 3080 | 39674 | 2403 | 44046 | 1247 | 55714 | 400 | 52699 |
| 5L-4S | | MI | 12427 | 5480 | 22964 | 3739 | 25389 | 2909 | 27035 | 2212 | 29950 | 1068 | 36684 | 196 | 35329 |
| 14-#18 | 5.67 | MA | 16949 | 5480 | 30691 | 3854 | 34229 | 3069 | 36547 | 2388 | 40010 | 1264 | 50735 | 249 | 49375 |
| 6L-3S | | MI | 13218 | 5480 | 24403 | 3721 | 27153 | 2927 | 29123 | 2230 | 32567 | 1050 | 39566 | 400 | 37314 |

## RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis



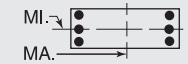

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.53 | MA | 16234 | 4379 | 26832 | 3201 | 29646 | 2578 | 31063 | 2096 | 32884 | 1371 | 40074 | 1050 | 27841 |
| 4L-6S | | MI | 10241 | 4379 | 17212 | 3090 | 18454 | 2491 | 18846 | 2020 | 19008 | 1269 | 22702 | 803 | 17379 |
| 16-#11 | 2.53 | MA | 15773 | 4379 | 26036 | 3199 | 28620 | 2589 | 29807 | 2106 | 31099 | 1364 | 37915 | 1008 | 27041 |
| 5E | | MI | 10529 | 4379 | 17698 | 3095 | 19109 | 2498 | 19593 | 2013 | 19998 | 1262 | 23898 | 863 | 17632 |
| 16-#11 | 2.53 | MA | 15333 | 4379 | 25285 | 3198 | 27600 | 2586 | 28563 | 2101 | 29459 | 1371 | 35872 | 949 | 26479 |
| 6L-4S | | MI | 10830 | 4379 | 18210 | 3100 | 19766 | 2491 | 20376 | 2006 | 21077 | 1269 | 25184 | 903 | 18155 |
| 16-#11 | 2.53 | MA | 14904 | 4379 | 24481 | 3210 | 26620 | 2597 | 27362 | 2111 | 27854 | 1378 | 33745 | 861 | 25583 |
| 7L-3S | | MI | 11164 | 4379 | 18791 | 3091 | 20501 | 2498 | 21246 | 2013 | 22169 | 1262 | 26395 | 988 | 18191 |
| 16-#11 | 2.53 | MA | 14481 | 4379 | 23743 | 3208 | 25631 | 2594 | 26186 | 2120 | 26172 | 1371 | 31728 | 811 | 24794 |
| 8L-2S | | MI | 11623 | 4379 | 19503 | 3096 | 21406 | 2491 | 22323 | 2006 | 23592 | 1255 | 28249 | 1076 | 18188 |
| 16-#14 | 3.64 | MA | 16785 | 4770 | 28731 | 3436 | 31999 | 2764 | 33891 | 2213 | 36523 | 1328 | 45316 | 827 | 37419 |
| 5E | | MI | 11100 | 4770 | 19369 | 3321 | 21130 | 2656 | 21987 | 2097 | 23160 | 1195 | 28080 | 628 | 24174 |
| 16-#14 | 3.64 | MA | 16170 | 4770 | 27655 | 3433 | 30537 | 2759 | 32108 | 2205 | 34189 | 1337 | 42419 | 742 | 35968 |
| 6L-4S | | MI | 11522 | 4770 | 20101 | 3330 | 22057 | 2646 | 23091 | 2087 | 24684 | 1205 | 29886 | 688 | 24752 |
| 16-#14 | 3.64 | MA | 15570 | 4770 | 26503 | 3450 | 29133 | 2774 | 30388 | 2218 | 31905 | 1347 | 39400 | 615 | 34579 |
| 7L-3S | | MI | 11989 | 4770 | 20929 | 3318 | 23095 | 2656 | 24318 | 2097 | 26224 | 1195 | 31591 | 807 | 25537 |
| 16-#14 | 3.64 | MA | 14978 | 4770 | 25445 | 3447 | 27716 | 2769 | 28703 | 2231 | 29512 | 1337 | 36532 | 545 | 32708 |
| 8L-2S | | MI | 12630 | 4770 | 21942 | 3326 | 24371 | 2646 | 25839 | 2087 | 28233 | 1185 | 34196 | 935 | 25603 |
| 16-#18 | 6.48 | MA | 18197 | 5763 | 33506 | 4032 | 37817 | 3198 | 40909 | 2467 | 45815 | 1240 | 58413 | 193 | 57321 |
| 6L-4S | | MI | 13161 | 5763 | 24715 | 3916 | 27557 | 3032 | 29619 | 2279 | 33365 | 1024 | 41071 | 101 | 40367 |
| 18-#11 | 2.84 | MA | 16290 | 4489 | 27163 | 3268 | 30057 | 2639 | 31553 | 2137 | 33458 | 1357 | 41059 | 990 | 30348 |
| 5L-6S | | MI | 10556 | 4489 | 17924 | 3160 | 19359 | 2541 | 19924 | 2049 | 20432 | 1255 | 24555 | 772 | 19429 |
| 18-#11 | 2.84 | MA | 15853 | 4489 | 26412 | 3267 | 29037 | 2636 | 30309 | 2132 | 31818 | 1364 | 39016 | 931 | 29808 |
| 6L-5S | | MI | 10843 | 4489 | 18409 | 3164 | 20013 | 2548 | 20671 | 2042 | 21421 | 1248 | 25752 | 832 | 19712 |
| 18-#11 | 2.84 | MA | 15428 | 4489 | 25608 | 3279 | 28057 | 2647 | 29109 | 2142 | 30213 | 1371 | 36889 | 844 | 28861 |
| 7L-4S | | MI | 11142 | 4489 | 18922 | 3169 | 20671 | 2541 | 21454 | 2035 | 22501 | 1255 | 27038 | 873 | 20224 |
| 18-#11 | 2.84 | MA | 15008 | 4489 | 24870 | 3278 | 27068 | 2644 | 27933 | 2151 | 28531 | 1364 | 34872 | 794 | 28034 |
| 8L-3S | | MI | 11474 | 4489 | 19503 | 3161 | 21406 | 2548 | 22323 | 2042 | 23592 | 1248 | 28249 | 957 | 20349 |
| 18-#11 | 2.84 | MA | 14592 | 4489 | 24090 | 3290 | 26102 | 2655 | 26717 | 2147 | 26942 | 1371 | 32893 | 737 | 26953 |
| 9L-2S | | MI | 11930 | 4489 | 20215 | 3166 | 22311 | 2541 | 23401 | 2035 | 25016 | 1242 | 30103 | 1046 | 20362 |
| 18-#14 | 4.10 | MA | 16900 | 4930 | 29266 | 3533 | 32591 | 2831 | 34606 | 2250 | 37546 | 1326 | 46881 | 715 | 40624 |
| 6L-5S | | MI | 11538 | 4930 | 20382 | 3421 | 22406 | 2727 | 23507 | 2137 | 25169 | 1174 | 30685 | 581 | 27131 |
| 18-#14 | 4.10 | MA | 16306 | 4930 | 28114 | 3550 | 31187 | 2846 | 32885 | 2263 | 35262 | 1336 | 43863 | 588 | 39182 |
| 7L-4S | | MI | 11957 | 4930 | 21113 | 3429 | 23333 | 2717 | 24611 | 2127 | 26693 | 1184 | 32491 | 640 | 27669 |
| 18-#14 | 4.10 | MA | 15720 | 4930 | 27056 | 3547 | 29770 | 2841 | 31200 | 2276 | 32869 | 1326 | 40994 | 517 | 37363 |
| 8L-3S | | MI | 12420 | 4930 | 21942 | 3417 | 24371 | 2727 | 25839 | 2137 | 28233 | 1174 | 34196 | 759 | 28581 |
| 20-#11 | 3.16 | MA | 16370 | 4600 | 27539 | 3336 | 30473 | 2686 | 32056 | 2164 | 34177 | 1357 | 42160 | 914 | 33141 |
| 6E | | MI | 10870 | 4600 | 18636 | 3229 | 20263 | 2591 | 21002 | 2077 | 21856 | 1242 | 26409 | 742 | 21452 |
| 20-#11 | 3.16 | MA | 15947 | 4600 | 26735 | 3348 | 29494 | 2697 | 30855 | 2173 | 32572 | 1363 | 40033 | 826 | 32145 |
| 7L-5S | | MI | 11155 | 4600 | 19121 | 3234 | 20918 | 2598 | 21749 | 2070 | 22845 | 1235 | 27606 | 802 | 21796 |
| 20-#11 | 3.16 | MA | 15531 | 4600 | 25997 | 3347 | 28505 | 2694 | 29679 | 2182 | 30891 | 1357 | 38016 | 776 | 31281 |
| 8L-4S | | MI | 11453 | 4600 | 19634 | 3239 | 21575 | 2591 | 22531 | 2064 | 23925 | 1242 | 28892 | 842 | 22276 |
| 20-#11 | 3.16 | MA | 15118 | 4600 | 25217 | 3359 | 27539 | 2705 | 28463 | 2178 | 29302 | 1363 | 36037 | 720 | 30228 |
| 9L-3S | | MI | 11782 | 4600 | 20215 | 3230 | 22311 | 2598 | 23401 | 2070 | 25016 | 1235 | 30103 | 927 | 22502 |
| 20-#11 | 3.16 | MA | 14669 | 4600 | 24483 | 3357 | 26562 | 2702 | 27295 | 2187 | 27725 | 1370 | 34119 | 656 | 28996 |
| 10L-2S | | MI | 12236 | 4600 | 20927 | 3235 | 23215 | 2591 | 24479 | 2064 | 26440 | 1228 | 31957 | 1015 | 22528 |
| 20-#14 | 4.55 | MA | 17035 | 5089 | 29725 | 3650 | 33241 | 2919 | 35382 | 2308 | 38618 | 1324 | 48325 | 560 | 43796 |
| 7L-5S | | MI | 11973 | 5089 | 21394 | 3521 | 23682 | 2798 | 25028 | 2177 | 27178 | 1152 | 33289 | 534 | 30035 |
| 20-#14 | 4.55 | MA | 16454 | 5089 | 28667 | 3647 | 31824 | 2914 | 33697 | 2321 | 36225 | 1314 | 45456 | 490 | 42028 |
| 8L-4S | | MI | 12389 | 5089 | 22126 | 3529 | 24610 | 2788 | 26132 | 2167 | 28702 | 1162 | 35095 | 593 | 30596 |
| 22-#11 | 3.47 | MA | 16463 | 4711 | 27862 | 3417 | 30930 | 2747 | 32602 | 2204 | 34931 | 1356 | 43177 | 808 | 35435 |
| 7L-6S | | MI | 11182 | 4711 | 19348 | 3298 | 21168 | 2641 | 22079 | 2106 | 23279 | 1228 | 28263 | 711 | 23483 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

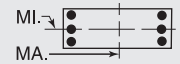
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.47 | MA | 16049 | 4711 | 27124 | 3416 | 29942 | 2744 | 31426 | 2214 | 33250 | 1349 | 41160 | 758 | 34534 |
| 8L-5S | | MI | 11465 | 4711 | 19833 | 3303 | 21823 | 2648 | 22827 | 2099 | 24269 | 1221 | 29460 | 771 | 23884 |
| 22-#11 | 3.47 | MA | 15639 | 4711 | 26344 | 3428 | 28975 | 2755 | 30210 | 2209 | 31661 | 1356 | 39181 | 702 | 33509 |
| 9L-4S | | MI | 11761 | 4711 | 20346 | 3308 | 22480 | 2641 | 23609 | 2092 | 25348 | 1228 | 30745 | 812 | 24336 |
| 22-#11 | 3.47 | MA | 15192 | 4711 | 25609 | 3427 | 27999 | 2752 | 29041 | 2219 | 30084 | 1363 | 37262 | 638 | 32253 |
| 10L-3S | | MI | 12089 | 4711 | 20927 | 3299 | 23215 | 2648 | 24479 | 2099 | 26440 | 1221 | 31957 | 896 | 24652 |
| 22-#14 | 5.01 | MA | 17182 | 5249 | 30279 | 3747 | 33878 | 2986 | 36194 | 2366 | 39582 | 1303 | 49918 | 462 | 46700 |
| 8L-5S | | MI | 12406 | 5249 | 22407 | 3621 | 24959 | 2869 | 26548 | 2217 | 29187 | 1131 | 35894 | 487 | 32883 |
| 24-#11 | 3.79 | MA | 16565 | 4821 | 28251 | 3485 | 31378 | 2794 | 33172 | 2245 | 35609 | 1342 | 44304 | 741 | 37793 |
| 8L-6S | | MI | 11492 | 4821 | 20060 | 3367 | 22073 | 2691 | 23157 | 2135 | 24703 | 1214 | 30117 | 681 | 25521 |
| 24-#11 | 3.79 | MA | 16155 | 4821 | 27470 | 3497 | 30412 | 2805 | 31956 | 2240 | 34020 | 1349 | 42325 | 684 | 36793 |
| 9L-5S | | MI | 11774 | 4821 | 20545 | 3372 | 22728 | 2697 | 23905 | 2128 | 25693 | 1207 | 31314 | 741 | 25975 |
| 24-#11 | 3.79 | MA | 15710 | 4821 | 26736 | 3496 | 29436 | 2802 | 30788 | 2250 | 32443 | 1356 | 40406 | 621 | 35515 |
| 10L-4S | | MI | 12068 | 4821 | 21058 | 3377 | 23385 | 2691 | 24687 | 2121 | 26772 | 1214 | 32599 | 781 | 26402 |

## RECTANGULAR TIED COLUMNS 26" x 40"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.54 | MA | 17510 | 4245 | 28063 | 3109 | 30608 | 2523 | 31649 | 2084 | 32474 | 1435 | 38637 | 1326 | 18975 |
| 2E | | MI | 11105 | 4245 | 18132 | 2983 | 19224 | 2407 | 19504 | 1970 | 19545 | 1323 | 22713 | 1174 | 11733 |
| 6-#14 | 1.30 | MA | 17146 | 4156 | 27127 | 3075 | 29527 | 2500 | 30378 | 2074 | 30890 | 1459 | 36616 | 1365 | 16248 |
| 2L-3S | | MI | 10259 | 4156 | 16594 | 2952 | 17458 | 2412 | 17435 | 1989 | 16820 | 1374 | 19271 | 1112 | 10198 |
| 6-#14 | 1.30 | MA | 16011 | 4156 | 25416 | 3072 | 27346 | 2516 | 27727 | 2088 | 27308 | 1469 | 31842 | 1237 | 16271 |
| 3L-2S | | MI | 10925 | 4156 | 17606 | 2960 | 18735 | 2402 | 18956 | 1980 | 18828 | 1364 | 21876 | 1240 | 10124 |
| 6-#18 | 2.31 | MA | 18864 | 4529 | 31055 | 3286 | 34422 | 2652 | 36286 | 2164 | 38679 | 1412 | 46868 | 1274 | 28108 |
| 2L-3S | | MI | 10726 | 4529 | 18132 | 3143 | 19224 | 2547 | 19504 | 2055 | 19545 | 1297 | 22713 | 851 | 17170 |
| 6-#18 | 2.31 | MA | 16925 | 4529 | 28063 | 3281 | 30608 | 2677 | 31649 | 2186 | 32474 | 1430 | 38637 | 1046 | 27883 |
| 3L-2S | | MI | 11857 | 4529 | 19883 | 3160 | 21392 | 2529 | 22088 | 2037 | 22959 | 1279 | 27100 | 1078 | 17148 |
| 8-#11 | 1.20 | MA | 16996 | 4120 | 26734 | 3062 | 29083 | 2492 | 29861 | 2071 | 30229 | 1469 | 35795 | 1381 | 15124 |
| 2L-4S | | MI | 10040 | 4120 | 16089 | 2958 | 16893 | 2402 | 16786 | 1985 | 16024 | 1396 | 18474 | 1095 | 9551 |
| 8-#11 | 1.20 | MA | 16200 | 4120 | 25538 | 3061 | 27558 | 2504 | 28007 | 2081 | 27717 | 1476 | 32435 | 1292 | 15150 |
| 3E | | MI | 10382 | 4120 | 16670 | 2949 | 17628 | 2409 | 17656 | 1992 | 17116 | 1389 | 19686 | 1179 | 9504 |
| 8-#11 | 1.20 | MA | 15637 | 4120 | 24577 | 3074 | 26336 | 2501 | 26524 | 2077 | 25792 | 1483 | 30236 | 1204 | 15117 |
| 4L-2S | | MI | 10852 | 4120 | 17382 | 2954 | 18533 | 2402 | 18733 | 1985 | 18540 | 1382 | 21539 | 1268 | 9454 |
| 8-#14 | 1.73 | MA | 17936 | 4316 | 28838 | 3174 | 31708 | 2573 | 33030 | 2119 | 34472 | 1448 | 41390 | 1339 | 21480 |
| 2L-4S | | MI | 10226 | 4316 | 16778 | 3064 | 17697 | 2472 | 17728 | 2020 | 17288 | 1363 | 20171 | 946 | 13311 |
| 8-#14 | 1.73 | MA | 16812 | 4316 | 27127 | 3172 | 29527 | 2588 | 30378 | 2133 | 30890 | 1458 | 36616 | 1211 | 21454 |
| 3E | | MI | 10709 | 4316 | 17606 | 3052 | 18735 | 2482 | 18956 | 2030 | 18828 | 1353 | 21876 | 1065 | 13316 |
| 8-#14 | 1.73 | MA | 16016 | 4316 | 25750 | 3190 | 27776 | 2584 | 28254 | 2126 | 28142 | 1468 | 33496 | 1083 | 21247 |
| 4L-2S | | MI | 11370 | 4316 | 18619 | 3060 | 20011 | 2472 | 20476 | 2020 | 20837 | 1343 | 24480 | 1193 | 13263 |
| 8-#18 | 3.08 | MA | 20194 | 4812 | 34047 | 3464 | 38236 | 2780 | 40923 | 2244 | 44884 | 1390 | 55099 | 1221 | 37188 |
| 2L-4S | | MI | 10662 | 4812 | 18444 | 3338 | 19628 | 2651 | 20001 | 2104 | 20342 | 1271 | 24217 | 551 | 20601 |
| 8-#18 | 3.08 | MA | 18283 | 4812 | 31055 | 3458 | 34422 | 2806 | 36286 | 2265 | 38679 | 1408 | 46868 | 994 | 36844 |
| 3E | | MI | 11482 | 4812 | 19883 | 3320 | 21392 | 2669 | 22088 | 2121 | 22959 | 1253 | 27100 | 755 | 22438 |
| 8-#18 | 3.08 | MA | 16928 | 4812 | 28641 | 3488 | 31352 | 2796 | 32561 | 2251 | 33919 | 1426 | 41503 | 766 | 33720 |
| 4L-2S | | MI | 12601 | 4812 | 21633 | 3338 | 23561 | 2651 | 24672 | 2104 | 26374 | 1235 | 31488 | 983 | 22514 |
| 10-#11 | 1.50 | MA | 17554 | 4231 | 27930 | 3132 | 30608 | 2543 | 31714 | 2102 | 32740 | 1462 | 39155 | 1365 | 18784 |
| 2L-5S | | MI | 10053 | 4231 | 16288 | 3022 | 17140 | 2459 | 17081 | 2021 | 16368 | 1376 | 19043 | 1024 | 11548 |
| 10-#11 | 1.50 | MA | 16763 | 4231 | 26734 | 3131 | 29083 | 2554 | 29861 | 2112 | 30229 | 1469 | 35795 | 1276 | 18789 |
| 3L-4S | | MI | 10361 | 4231 | 16801 | 3027 | 17797 | 2452 | 17864 | 2014 | 17448 | 1382 | 20328 | 1065 | 11733 |
| 10-#11 | 1.50 | MA | 16204 | 4231 | 25773 | 3143 | 27861 | 2551 | 28377 | 2108 | 28303 | 1476 | 33596 | 1187 | 18726 |
| 4L-3S | | MI | 10701 | 4231 | 17382 | 3018 | 18533 | 2459 | 18733 | 2021 | 18540 | 1376 | 21539 | 1149 | 11704 |
| 10-#11 | 1.50 | MA | 15703 | 4231 | 24931 | 3142 | 26774 | 2563 | 27047 | 2118 | 26404 | 1469 | 31294 | 1144 | 18294 |
| 5L-2S | | MI | 11168 | 4231 | 18094 | 3023 | 19437 | 2452 | 19811 | 2014 | 19963 | 1369 | 23393 | 1237 | 11663 |
| 10-#14 | 2.16 | MA | 18716 | 4475 | 30549 | 3274 | 33890 | 2645 | 35682 | 2164 | 38054 | 1438 | 46163 | 1314 | 26694 |
| 2L-5S | | MI | 10243 | 4475 | 17059 | 3155 | 18046 | 2553 | 18145 | 2070 | 17773 | 1331 | 20970 | 839 | 15493 |
| 10-#14 | 2.16 | MA | 17602 | 4475 | 28838 | 3272 | 31708 | 2660 | 33030 | 2177 | 34472 | 1448 | 41390 | 1186 | 26624 |
| 3L-4S | | MI | 10676 | 4475 | 17791 | 3163 | 18973 | 2543 | 19249 | 2060 | 19297 | 1341 | 22776 | 898 | 16256 |

## RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

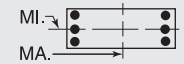
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.16 | MA | 16815 | 4475 | 27461 | 3290 | 29958 | 2656 | 30905 | 2171 | 31724 | 1458 | 38270 | 1058 | 26368 |
| 4L-3S | | MI | 11155 | 4475 | 18619 | 3151 | 20011 | 2553 | 20476 | 2070 | 20837 | 1331 | 24480 | 1017 | 16412 |
| 10-#14 | 2.16 | MA | 16109 | 4475 | 26253 | 3287 | 28400 | 2672 | 28998 | 2185 | 29014 | 1448 | 34992 | 996 | 24792 |
| 5L-2S | | MI | 11811 | 4475 | 19632 | 3160 | 21287 | 2543 | 21997 | 2060 | 22846 | 1321 | 27085 | 1145 | 16381 |
| 10-#18 | 3.85 | MA | 19620 | 5096 | 34047 | 3635 | 38236 | 2934 | 40923 | 2345 | 44884 | 1386 | 55099 | 942 | 45797 |
| 3L-4S | | MI | 11418 | 5096 | 20195 | 3516 | 21797 | 2773 | 22585 | 2170 | 23757 | 1226 | 28605 | 455 | 25547 |
| 10-#18 | 3.85 | MA | 18285 | 5096 | 31632 | 3665 | 35166 | 2924 | 37198 | 2331 | 40124 | 1403 | 49733 | 714 | 42329 |
| 4L-3S | | MI | 12229 | 5096 | 21633 | 3498 | 23561 | 2791 | 24672 | 2188 | 26374 | 1209 | 31488 | 660 | 27679 |
| 10-#18 | 3.85 | MA | 17089 | 5096 | 29511 | 3659 | 32432 | 2950 | 33850 | 2353 | 35427 | 1386 | 44057 | 609 | 39472 |
| 5L-2S | | MI | 13336 | 5096 | 23384 | 3515 | 25729 | 2773 | 27256 | 2170 | 29788 | 1191 | 35876 | 887 | 27841 |
| 12-#11 | 1.80 | MA | 18106 | 4341 | 29126 | 3201 | 32133 | 2593 | 33568 | 2134 | 35251 | 1455 | 42515 | 1349 | 22434 |
| 2L-6S | | MI | 10081 | 4341 | 16515 | 3086 | 17390 | 2502 | 17412 | 2056 | 16803 | 1369 | 19700 | 933 | 13305 |
| 12-#11 | 1.80 | MA | 17321 | 4341 | 27930 | 3200 | 30608 | 2604 | 31714 | 2143 | 32740 | 1462 | 39155 | 1260 | 22416 |
| 3L-5S | | MI | 10374 | 4341 | 17000 | 3091 | 18045 | 2508 | 18159 | 2049 | 17792 | 1362 | 20897 | 993 | 13603 |
| 12-#11 | 1.80 | MA | 16766 | 4341 | 26969 | 3212 | 29386 | 2602 | 30231 | 2140 | 30814 | 1469 | 36956 | 1171 | 22330 |
| 4E | | MI | 10679 | 4341 | 17513 | 3096 | 18702 | 2502 | 18941 | 2043 | 18872 | 1369 | 22182 | 1034 | 13902 |
| 12-#11 | 1.80 | MA | 16270 | 4341 | 26127 | 3211 | 28299 | 2613 | 28900 | 2149 | 28916 | 1462 | 34654 | 1128 | 21775 |
| 5L-3S | | MI | 11017 | 4341 | 18094 | 3087 | 19437 | 2508 | 19811 | 2049 | 19963 | 1362 | 23393 | 1118 | 13890 |
| 12-#11 | 1.80 | MA | 15796 | 4341 | 25331 | 3210 | 27219 | 2610 | 27583 | 2146 | 27171 | 1470 | 32469 | 1069 | 21087 |
| 6L-2S | | MI | 11482 | 4341 | 18806 | 3092 | 20342 | 2502 | 20889 | 2043 | 21387 | 1355 | 25247 | 1207 | 13859 |
| 12-#14 | 2.60 | MA | 18384 | 4635 | 30549 | 3372 | 33890 | 2733 | 35682 | 2222 | 38054 | 1437 | 46163 | 1160 | 31785 |
| 3L-5S | | MI | 10692 | 4635 | 18072 | 3255 | 19322 | 2624 | 19666 | 2110 | 19782 | 1310 | 23574 | 792 | 18422 |
| 12-#14 | 2.60 | MA | 17605 | 4635 | 29172 | 3389 | 32139 | 2729 | 33557 | 2216 | 35306 | 1447 | 43043 | 1032 | 31362 |
| 4E | | MI | 11122 | 4635 | 18804 | 3263 | 20250 | 2614 | 20769 | 2100 | 21306 | 1320 | 25380 | 851 | 19122 |
| 12-#14 | 2.60 | MA | 16906 | 4635 | 27964 | 3387 | 30581 | 2744 | 31650 | 2229 | 32596 | 1437 | 39766 | 971 | 29791 |
| 5L-3S | | MI | 11597 | 4635 | 19632 | 3251 | 21287 | 2624 | 21997 | 2110 | 22846 | 1310 | 27085 | 970 | 19486 |
| 12-#14 | 2.60 | MA | 16240 | 4635 | 26824 | 3385 | 29032 | 2740 | 29761 | 2223 | 30105 | 1447 | 36664 | 886 | 28566 |
| 6L-2S | | MI | 12249 | 4635 | 20645 | 3259 | 22564 | 2614 | 23517 | 2100 | 24855 | 1300 | 29689 | 1098 | 19485 |
| 12-#18 | 4.62 | MA | 19622 | 5380 | 34624 | 3842 | 38980 | 3053 | 41834 | 2411 | 46329 | 1381 | 57964 | 662 | 50979 |
| 4E | | MI | 12167 | 5380 | 21945 | 3693 | 23965 | 2895 | 25169 | 2237 | 27171 | 1182 | 32993 | 360 | 30531 |
| 12-#18 | 4.62 | MA | 18444 | 5380 | 32503 | 3836 | 36246 | 3079 | 38487 | 2432 | 41632 | 1363 | 52288 | 556 | 47964 |
| 5L-3S | | MI | 12968 | 5380 | 23384 | 3675 | 25729 | 2913 | 27256 | 2255 | 29788 | 1165 | 35876 | 564 | 32775 |
| 12-#18 | 4.62 | MA | 17321 | 5380 | 30499 | 3831 | 33527 | 3069 | 35171 | 2418 | 37318 | 1381 | 46946 | 405 | 44565 |
| 6L-2S | | MI | 14064 | 5380 | 25134 | 3692 | 27898 | 2895 | 29840 | 2237 | 33203 | 1147 | 40263 | 792 | 33138 |
| 14-#11 | 2.10 | MA | 17874 | 4452 | 29126 | 3269 | 32133 | 2654 | 33568 | 2175 | 35251 | 1455 | 42515 | 1244 | 26038 |
| 3L-6S | | MI | 10401 | 4452 | 17227 | 3155 | 18295 | 2551 | 18489 | 2085 | 18226 | 1355 | 21554 | 903 | 15393 |
| 14-#11 | 2.10 | MA | 17323 | 4452 | 28165 | 3281 | 30911 | 2652 | 32085 | 2171 | 33326 | 1462 | 40316 | 1155 | 25929 |
| 4L-5S | | MI | 10692 | 4452 | 17712 | 3160 | 18949 | 2558 | 19237 | 2078 | 19216 | 1348 | 22751 | 963 | 15669 |
| 14-#11 | 2.10 | MA | 16831 | 4452 | 27323 | 3280 | 29824 | 2663 | 30754 | 2181 | 31427 | 1456 | 38014 | 1112 | 25268 |
| 5L-4S | | MI | 10996 | 4452 | 18225 | 3165 | 19607 | 2551 | 20019 | 2071 | 20296 | 1355 | 24036 | 1004 | 16060 |
| 14-#11 | 2.10 | MA | 16361 | 4452 | 26527 | 3279 | 28744 | 2660 | 29436 | 2177 | 29682 | 1463 | 35829 | 1053 | 24612 |
| 6L-3S | | MI | 11332 | 4452 | 18806 | 3156 | 20342 | 2558 | 20889 | 2078 | 21387 | 1348 | 25247 | 1088 | 16069 |
| 14-#11 | 2.10 | MA | 15902 | 4452 | 25676 | 3292 | 27706 | 2672 | 28165 | 2187 | 27975 | 1470 | 33555 | 965 | 23807 |
| 7L-2S | | MI | 11794 | 4452 | 19518 | 3161 | 21247 | 2551 | 21967 | 2071 | 22811 | 1341 | 27101 | 1176 | 16047 |
| 14-#14 | 3.03 | MA | 18386 | 4795 | 30883 | 3489 | 34320 | 2801 | 36209 | 2261 | 38888 | 1436 | 47817 | 1007 | 36296 |
| 4L-5S | | MI | 11137 | 4795 | 19085 | 3355 | 20599 | 2695 | 21186 | 2150 | 21791 | 1288 | 26179 | 745 | 21364 |
| 14-#14 | 3.03 | MA | 17695 | 4795 | 29675 | 3487 | 32763 | 2817 | 34301 | 2274 | 36178 | 1427 | 44539 | 945 | 34804 |
| 5L-4S | | MI | 11564 | 4795 | 19816 | 3363 | 21526 | 2685 | 22290 | 2140 | 23315 | 1298 | 27985 | 804 | 22008 |
| 14-#14 | 3.03 | MA | 17035 | 4795 | 28535 | 3485 | 31214 | 2812 | 32413 | 2268 | 33688 | 1436 | 41437 | 861 | 33490 |
| 6L-3S | | MI | 12035 | 4795 | 20645 | 3351 | 22564 | 2695 | 23517 | 2150 | 24855 | 1288 | 29689 | 923 | 22548 |
| 14-#14 | 3.03 | MA | 16392 | 4795 | 27314 | 3503 | 29726 | 2828 | 30590 | 2282 | 31250 | 1446 | 38207 | 734 | 31952 |
| 7L-2S | | MI | 12683 | 4795 | 21657 | 3359 | 23840 | 2685 | 25038 | 2140 | 26864 | 1278 | 32294 | 1051 | 22580 |
| 14-#18 | 5.38 | MA | 19781 | 5663 | 35495 | 4014 | 40060 | 3207 | 43123 | 2512 | 47837 | 1341 | 60519 | 504 | 56488 |
| 5L-4S | | MI | 12908 | 5663 | 23696 | 3870 | 26133 | 3017 | 27752 | 2304 | 30586 | 1138 | 37380 | 264 | 35544 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis

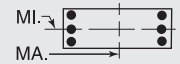


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 5.38 | MA | 18673 | 5663 | 33491 | 4008 | 37341 | 3197 | 39807 | 2498 | 43523 | 1359 | 55177 | 353 | 53122 |
| 6L-3S | | MI | 13701 | 5663 | 25134 | 3852 | 27898 | 3035 | 29840 | 2322 | 33203 | 1121 | 40263 | 469 | 37604 |
| 16-#11 | 2.40 | MA | 17876 | 4563 | 29361 | 3351 | 32436 | 2702 | 33939 | 2202 | 35837 | 1455 | 43676 | 1138 | 29526 |
| 4L-6S | | MI | 10719 | 4563 | 17939 | 3224 | 19200 | 2601 | 19567 | 2114 | 19650 | 1341 | 23408 | 872 | 17485 |
| 16-#11 | 2.40 | MA | 17387 | 4563 | 28519 | 3350 | 31349 | 2713 | 32608 | 2212 | 33938 | 1449 | 41374 | 1095 | 28771 |
| 5E | | MI | 11008 | 4563 | 18424 | 3229 | 19854 | 2608 | 20315 | 2107 | 20640 | 1334 | 24604 | 932 | 17743 |
| 16-#11 | 2.40 | MA | 16921 | 4563 | 27723 | 3348 | 30268 | 2711 | 31290 | 2208 | 32194 | 1456 | 39189 | 1037 | 28143 |
| 6L-4S | | MI | 11310 | 4563 | 18937 | 3234 | 20512 | 2601 | 21097 | 2100 | 21719 | 1341 | 25890 | 973 | 18212 |
| 16-#11 | 2.40 | MA | 16466 | 4563 | 26872 | 3361 | 29231 | 2722 | 30019 | 2218 | 30486 | 1463 | 36915 | 949 | 27282 |
| 7L-3S | | MI | 11644 | 4563 | 19518 | 3225 | 21247 | 2608 | 21967 | 2107 | 22811 | 1334 | 27101 | 1057 | 18241 |
| 16-#11 | 2.40 | MA | 16017 | 4563 | 26091 | 3360 | 28184 | 2719 | 28774 | 2228 | 28698 | 1456 | 34764 | 899 | 26446 |
| 8L-2S | | MI | 12104 | 4563 | 20230 | 3230 | 22152 | 2601 | 23044 | 2100 | 24235 | 1327 | 28955 | 1146 | 18228 |
| 16-#14 | 3.46 | MA | 18476 | 4954 | 31386 | 3587 | 34944 | 2889 | 36953 | 2319 | 39760 | 1416 | 49313 | 920 | 39829 |
| 5E | | MI | 11579 | 4954 | 20097 | 3455 | 21875 | 2766 | 22707 | 2190 | 23800 | 1267 | 28783 | 697 | 24314 |
| 16-#14 | 3.46 | MA | 17823 | 4954 | 30246 | 3585 | 33395 | 2885 | 35064 | 2313 | 37270 | 1426 | 46211 | 835 | 38427 |
| 6L-4S | | MI | 12003 | 4954 | 20829 | 3463 | 22802 | 2756 | 23810 | 2180 | 25324 | 1277 | 30589 | 757 | 24911 |
| 16-#14 | 3.46 | MA | 17185 | 4954 | 29025 | 3602 | 31908 | 2900 | 33242 | 2326 | 34832 | 1436 | 42981 | 709 | 36944 |
| 7L-3S | | MI | 12471 | 4954 | 21657 | 3451 | 23840 | 2766 | 25038 | 2190 | 26864 | 1267 | 32294 | 876 | 25603 |
| 16-#14 | 3.46 | MA | 16557 | 4954 | 27906 | 3600 | 30407 | 2896 | 31457 | 2340 | 32279 | 1426 | 39919 | 637 | 34998 |
| 8L-2S | | MI | 13114 | 4954 | 22670 | 3459 | 25116 | 2756 | 26558 | 2180 | 28873 | 1257 | 34899 | 1004 | 25657 |
| 16-#18 | 6.15 | MA | 20009 | 5947 | 36483 | 4185 | 41155 | 3326 | 44444 | 2578 | 49728 | 1337 | 63408 | 301 | 61593 |
| 6L-4S | | MI | 13643 | 5947 | 25446 | 4047 | 28302 | 3140 | 30336 | 2371 | 34001 | 1094 | 41768 | 169 | 40580 |
| 18-#11 | 2.70 | MA | 17939 | 4673 | 29715 | 3419 | 32874 | 2763 | 34461 | 2243 | 36450 | 1442 | 44734 | 1079 | 32282 |
| 5L-6S | | MI | 11035 | 4673 | 18651 | 3293 | 20104 | 2651 | 20645 | 2142 | 21074 | 1327 | 25262 | 842 | 19580 |
| 18-#11 | 2.70 | MA | 17476 | 4673 | 28919 | 3418 | 31793 | 2761 | 33144 | 2239 | 34705 | 1449 | 42549 | 1020 | 31679 |
| 6L-5S | | MI | 11323 | 4673 | 19136 | 3298 | 20759 | 2658 | 21392 | 2135 | 22064 | 1320 | 26458 | 902 | 19823 |
| 18-#11 | 2.70 | MA | 17025 | 4673 | 28068 | 3430 | 30756 | 2772 | 31872 | 2249 | 32997 | 1456 | 40275 | 933 | 30765 |
| 7L-4S | | MI | 11623 | 4673 | 19649 | 3303 | 21416 | 2651 | 22175 | 2128 | 23143 | 1327 | 27744 | 942 | 20354 |
| 18-#11 | 2.70 | MA | 16579 | 4673 | 27287 | 3429 | 29709 | 2770 | 30627 | 2259 | 31209 | 1449 | 38124 | 882 | 29954 |
| 8L-3S | | MI | 11955 | 4673 | 20230 | 3294 | 22152 | 2658 | 23044 | 2135 | 24235 | 1320 | 28955 | 1027 | 20400 |
| 18-#11 | 2.70 | MA | 16134 | 4673 | 26461 | 3442 | 28686 | 2781 | 29339 | 2255 | 29519 | 1457 | 36008 | 826 | 28781 |
| 9L-2S | | MI | 12413 | 4673 | 20942 | 3299 | 23056 | 2651 | 24122 | 2128 | 25658 | 1313 | 30809 | 1115 | 20404 |
| 18-#14 | 3.89 | MA | 18603 | 5114 | 31957 | 3684 | 35576 | 2957 | 37716 | 2358 | 40852 | 1415 | 50984 | 810 | 43377 |
| 6L-5S | | MI | 12018 | 5114 | 21110 | 3554 | 23151 | 2837 | 24227 | 2230 | 25809 | 1245 | 31388 | 650 | 27271 |
| 18-#14 | 3.89 | MA | 17972 | 5114 | 30736 | 3702 | 34089 | 2973 | 35893 | 2371 | 38414 | 1425 | 47754 | 683 | 41945 |
| 7L-4S | | MI | 12439 | 5114 | 21842 | 3562 | 24079 | 2827 | 25331 | 2220 | 27333 | 1255 | 33194 | 709 | 27826 |
| 18-#14 | 3.89 | MA | 17349 | 5114 | 29616 | 3700 | 32588 | 2968 | 34108 | 2385 | 35861 | 1415 | 44692 | 612 | 39950 |
| 8L-3S | | MI | 12903 | 5114 | 22670 | 3550 | 25116 | 2837 | 26558 | 2230 | 28873 | 1245 | 34899 | 829 | 28651 |
| 18-#14 | 3.89 | MA | 16728 | 5114 | 28431 | 3718 | 31121 | 2984 | 32262 | 2379 | 33449 | 1425 | 41687 | 530 | 37847 |
| 9L-2S | | MI | 13543 | 5114 | 23683 | 3558 | 26392 | 2827 | 28079 | 2220 | 30882 | 1235 | 37503 | 957 | 28727 |
| 20-#11 | 3.00 | MA | 18028 | 4784 | 30115 | 3487 | 33318 | 2811 | 34997 | 2270 | 37216 | 1442 | 45909 | 1004 | 35219 |
| 6E | | MI | 11349 | 4784 | 19363 | 3363 | 21009 | 2701 | 21723 | 2171 | 22498 | 1313 | 27116 | 811 | 21631 |
| 20-#11 | 3.00 | MA | 17580 | 4784 | 29264 | 3499 | 32281 | 2822 | 33726 | 2280 | 35509 | 1449 | 43635 | 916 | 34254 |
| 7L-5S | | MI | 11635 | 4784 | 19848 | 3367 | 21664 | 2708 | 22470 | 2164 | 23487 | 1307 | 28312 | 871 | 21907 |
| 20-#11 | 3.00 | MA | 17138 | 4784 | 28483 | 3498 | 31234 | 2820 | 32481 | 2290 | 33720 | 1442 | 41484 | 866 | 33431 |
| 8L-4S | | MI | 11934 | 4784 | 20361 | 3372 | 22321 | 2701 | 23252 | 2157 | 24567 | 1313 | 29598 | 912 | 22406 |
| 20-#11 | 3.00 | MA | 16693 | 4784 | 27657 | 3511 | 30211 | 2831 | 31193 | 2286 | 32030 | 1450 | 39368 | 810 | 32262 |
| 9L-3S | | MI | 12264 | 4784 | 20942 | 3364 | 23056 | 2708 | 24122 | 2164 | 25658 | 1307 | 30809 | 996 | 22556 |
| 20-#11 | 3.00 | MA | 16202 | 4784 | 26880 | 3510 | 29177 | 2828 | 29956 | 2296 | 30353 | 1457 | 37316 | 746 | 31030 |
| 10L-2S | | MI | 12719 | 4784 | 21654 | 3369 | 23961 | 2701 | 25200 | 2157 | 27082 | 1300 | 32663 | 1085 | 22576 |
| 20-#14 | 4.33 | MA | 18751 | 5273 | 32447 | 3802 | 36270 | 3045 | 38545 | 2416 | 41997 | 1415 | 52528 | 658 | 46883 |
| 7L-5S | | MI | 12454 | 5273 | 22123 | 3654 | 24428 | 2908 | 25748 | 2270 | 27818 | 1224 | 33993 | 603 | 30234 |
| 20-#14 | 4.33 | MA | 18134 | 5273 | 31327 | 3800 | 34769 | 3041 | 36760 | 2430 | 39443 | 1405 | 49466 | 586 | 44911 |
| 8L-4S | | MI | 12872 | 5273 | 22855 | 3662 | 25355 | 2898 | 26851 | 2260 | 29342 | 1234 | 35799 | 662 | 30753 |
| 20-#14 | 4.33 | MA | 17514 | 5273 | 30142 | 3817 | 33302 | 3056 | 34914 | 2423 | 37031 | 1415 | 46461 | 505 | 42776 |
| 9L-3S | | MI | 13334 | 5273 | 23683 | 3650 | 26392 | 2908 | 28079 | 2270 | 30882 | 1224 | 37503 | 781 | 31693 |

## RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

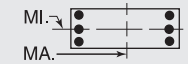
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.30 | MA | 18130 | 4895 | 30460 | 3569 | 33806 | 2872 | 35580 | 2311 | 38020 | 1442 | 46995 | 900 | 37749 |
| 7L-6S | | MI | 11662 | 4895 | 20075 | 3432 | 21914 | 2751 | 22801 | 2200 | 23922 | 1300 | 28969 | 781 | 23661 |
| 22-#11 | 3.30 | MA | 17692 | 4895 | 29679 | 3567 | 32759 | 2870 | 34335 | 2321 | 36232 | 1436 | 44844 | 850 | 36889 |
| 8L-5S | | MI | 11946 | 4895 | 20560 | 3437 | 22569 | 2758 | 23548 | 2193 | 24911 | 1293 | 30166 | 841 | 23995 |
| 22-#11 | 3.30 | MA | 17248 | 4895 | 28853 | 3580 | 31736 | 2881 | 33047 | 2317 | 34542 | 1443 | 42728 | 793 | 35748 |
| 9L-4S | | MI | 12243 | 4895 | 21073 | 3442 | 23226 | 2751 | 24330 | 2186 | 25991 | 1300 | 31452 | 881 | 24465 |
| 22-#11 | 3.30 | MA | 16773 | 4895 | 28076 | 3579 | 30702 | 2879 | 31810 | 2327 | 32865 | 1450 | 40676 | 730 | 34492 |
| 10L-3S | | MI | 12571 | 4895 | 21654 | 3433 | 23961 | 2758 | 25200 | 2193 | 27082 | 1293 | 32663 | 966 | 24708 |
| 22-#14 | 4.76 | MA | 18912 | 5433 | 33038 | 3899 | 36950 | 3113 | 39412 | 2475 | 43026 | 1394 | 54239 | 561 | 49881 |
| 8L-5S | | MI | 12888 | 5433 | 23136 | 3754 | 25704 | 2978 | 27268 | 2310 | 29827 | 1202 | 36597 | 556 | 33133 |
| 22-#14 | 4.76 | MA | 18294 | 5433 | 31853 | 3917 | 35483 | 3129 | 37565 | 2468 | 40613 | 1404 | 51234 | 479 | 47714 |
| 9L-4S | | MI | 13303 | 5433 | 23867 | 3762 | 26631 | 2968 | 28372 | 2300 | 31351 | 1212 | 38403 | 615 | 33688 |
| 24-#11 | 3.60 | MA | 18242 | 5005 | 30875 | 3637 | 34283 | 2920 | 36188 | 2352 | 38743 | 1429 | 48204 | 833 | 40353 |
| 8L-6S | | MI | 11972 | 5005 | 20787 | 3501 | 22819 | 2801 | 23878 | 2228 | 25345 | 1286 | 30823 | 750 | 25697 |
| 24-#11 | 3.60 | MA | 17799 | 5005 | 30049 | 3649 | 33260 | 2931 | 34900 | 2348 | 37053 | 1436 | 46088 | 777 | 39238 |
| 9L-5S | | MI | 12255 | 5005 | 21272 | 3506 | 23473 | 2808 | 24626 | 2221 | 26335 | 1279 | 32020 | 810 | 26087 |
| 24-#11 | 3.60 | MA | 17327 | 5005 | 29272 | 3648 | 32227 | 2929 | 33663 | 2358 | 35376 | 1443 | 44036 | 713 | 37960 |
| 10L-4S | | MI | 12551 | 5005 | 21785 | 3511 | 24131 | 2801 | 25408 | 2214 | 27414 | 1286 | 33306 | 851 | 26530 |
| 24-#14 | 5.19 | MA | 19067 | 5592 | 33564 | 4017 | 37665 | 3201 | 40217 | 2513 | 44195 | 1394 | 56008 | 454 | 52658 |
| 9L-5S | | MI | 13319 | 5592 | 24148 | 3853 | 26980 | 3049 | 28789 | 2350 | 31836 | 1181 | 39202 | 508 | 35990 |

## RECTANGULAR TIED COLUMNS 26" x 42"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.47 | MA | 19204 | 4429 | 30632 | 3258 | 33418 | 2646 | 34520 | 2189 | 35378 | 1519 | 42086 | 1411 | 20055 |
| 2E | | MI | 11584 | 4429 | 18864 | 3114 | 19968 | 2515 | 20221 | 2062 | 20180 | 1394 | 23410 | 1242 | 11774 |
| 6-#14 | 1.24 | MA | 18812 | 4340 | 29634 | 3224 | 32265 | 2623 | 33164 | 2178 | 33656 | 1541 | 39900 | 1448 | 17160 |
| 2L-3S | | MI | 10737 | 4340 | 17322 | 3085 | 18204 | 2521 | 18155 | 2082 | 17460 | 1446 | 19974 | 1181 | 10234 |
| 6-#14 | 1.24 | MA | 17607 | 4340 | 27823 | 3222 | 29957 | 2639 | 30358 | 2193 | 29854 | 1551 | 34814 | 1320 | 17182 |
| 3L-2S | | MI | 11405 | 4340 | 18335 | 3093 | 19480 | 2511 | 19676 | 2073 | 19469 | 1436 | 22579 | 1309 | 10157 |
| 6-#18 | 2.20 | MA | 20648 | 4712 | 33801 | 3436 | 37458 | 2775 | 39432 | 2268 | 41984 | 1498 | 50870 | 1362 | 29728 |
| 2L-3S | | MI | 11204 | 4712 | 18864 | 3274 | 19968 | 2655 | 20221 | 2146 | 20180 | 1368 | 23410 | 919 | 17240 |
| 6-#18 | 2.20 | MA | 18587 | 4712 | 30632 | 3431 | 33418 | 2801 | 34520 | 2291 | 35378 | 1516 | 42086 | 1135 | 29503 |
| 3L-2S | | MI | 12338 | 4712 | 20614 | 3292 | 22137 | 2637 | 22805 | 2129 | 23595 | 1350 | 27797 | 1146 | 17197 |
| 8-#11 | 1.14 | MA | 18650 | 4304 | 29215 | 3212 | 31792 | 2615 | 32613 | 2176 | 32918 | 1549 | 39012 | 1464 | 15967 |
| 2L-4S | | MI | 10518 | 4304 | 16816 | 3091 | 17638 | 2512 | 17507 | 2079 | 16666 | 1468 | 19181 | 1165 | 9586 |
| 8-#11 | 1.14 | MA | 17806 | 4304 | 27950 | 3211 | 30179 | 2613 | 30652 | 2186 | 30262 | 1557 | 35436 | 1375 | 15993 |
| 3E | | MI | 10860 | 4304 | 17397 | 3083 | 18374 | 2519 | 18377 | 2086 | 17758 | 1461 | 20392 | 1249 | 9535 |
| 8-#11 | 1.14 | MA | 17210 | 4304 | 26935 | 3224 | 28888 | 2625 | 29085 | 2183 | 28227 | 1564 | 33092 | 1286 | 15960 |
| 4L-2S | | MI | 11331 | 4304 | 18109 | 3088 | 19278 | 2512 | 19455 | 2079 | 19182 | 1454 | 22246 | 1337 | 9484 |
| 8-#14 | 1.65 | MA | 19653 | 4500 | 31445 | 3324 | 34574 | 2695 | 35971 | 2223 | 37458 | 1531 | 44985 | 1424 | 22695 |
| 2L-4S | | MI | 10704 | 4500 | 17507 | 3197 | 18442 | 2582 | 18448 | 2113 | 17928 | 1434 | 20874 | 1015 | 13370 |
| 8-#14 | 1.65 | MA | 18460 | 4500 | 29634 | 3322 | 32265 | 2712 | 33164 | 2238 | 33656 | 1541 | 39900 | 1296 | 22669 |
| 3E | | MI | 11188 | 4500 | 18335 | 3185 | 19480 | 2592 | 19676 | 2123 | 19469 | 1424 | 22579 | 1134 | 13358 |
| 8-#14 | 1.65 | MA | 17617 | 4500 | 28179 | 3340 | 30415 | 2708 | 30919 | 2232 | 30741 | 1551 | 36572 | 1168 | 22462 |
| 4L-2S | | MI | 11850 | 4500 | 19348 | 3193 | 20756 | 2582 | 21196 | 2113 | 21477 | 1414 | 25183 | 1262 | 13301 |
| 8-#18 | 2.93 | MA | 22066 | 4996 | 36970 | 3613 | 41498 | 2903 | 44343 | 2348 | 48590 | 1478 | 59654 | 1314 | 39348 |
| 2L-4S | | MI | 11139 | 4996 | 19176 | 3470 | 20373 | 2759 | 20718 | 2196 | 20978 | 1341 | 24914 | 619 | 20821 |
| 8-#18 | 2.93 | MA | 20035 | 4996 | 33801 | 3608 | 37458 | 2930 | 39432 | 2371 | 41984 | 1496 | 50870 | 1086 | 39004 |
| 3E | | MI | 11961 | 4996 | 20614 | 3452 | 22137 | 2777 | 22805 | 2213 | 23595 | 1323 | 27797 | 823 | 22518 |
| 8-#18 | 2.93 | MA | 18599 | 4996 | 31247 | 3639 | 34211 | 2921 | 35492 | 2359 | 36916 | 1513 | 45136 | 859 | 35941 |
| 4L-2S | | MI | 13083 | 4996 | 22365 | 3469 | 24305 | 2759 | 25389 | 2196 | 27009 | 1306 | 32185 | 1051 | 22569 |
| 10-#11 | 1.43 | MA | 19243 | 4415 | 30481 | 3281 | 33405 | 2666 | 34573 | 2207 | 35575 | 1542 | 42588 | 1448 | 19837 |
| 2L-5S | | MI | 10531 | 4415 | 17015 | 3156 | 17886 | 2569 | 17802 | 2114 | 17011 | 1447 | 19749 | 1093 | 11657 |
| 10-#11 | 1.43 | MA | 18405 | 4415 | 29215 | 3280 | 31792 | 2663 | 32613 | 2217 | 32918 | 1550 | 39012 | 1360 | 19842 |
| 3L-4S | | MI | 10839 | 4415 | 17528 | 3161 | 18543 | 2562 | 18585 | 2107 | 18090 | 1454 | 21034 | 1134 | 11773 |
| 10-#11 | 1.43 | MA | 17814 | 4415 | 28200 | 3293 | 30501 | 2675 | 31046 | 2214 | 30883 | 1557 | 36669 | 1271 | 19779 |
| 4L-3S | | MI | 11179 | 4415 | 18109 | 3152 | 19278 | 2569 | 19455 | 2114 | 19182 | 1447 | 22246 | 1218 | 11738 |

## RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

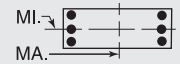
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.43 | MA | 17284 | 4415 | 27310 | 3292 | 29353 | 2673 | 29640 | 2224 | 28878 | 1551 | 34223 | 1227 | 19422 |
| 5L-2S | | MI | 11647 | 4415 | 18821 | 3157 | 20183 | 2562 | 20532 | 2107 | 20606 | 1441 | 24099 | 1307 | 11695 |
| 10-#14 | 2.06 | MA | 20484 | 4659 | 33256 | 3423 | 36882 | 2768 | 38777 | 2268 | 41260 | 1521 | 50070 | 1400 | 28212 |
| 2L-5S | | MI | 10720 | 4659 | 17788 | 3288 | 18791 | 2663 | 18865 | 2163 | 18414 | 1403 | 21673 | 908 | 15629 |
| 10-#14 | 2.06 | MA | 19302 | 4659 | 31445 | 3422 | 34574 | 2784 | 35971 | 2283 | 37458 | 1531 | 44985 | 1272 | 28143 |
| 3L-4S | | MI | 11155 | 4659 | 18519 | 3296 | 19719 | 2653 | 19969 | 2153 | 19937 | 1413 | 23479 | 967 | 16416 |
| 10-#14 | 2.06 | MA | 18468 | 4659 | 29990 | 3440 | 32723 | 2780 | 33725 | 2277 | 34542 | 1541 | 41657 | 1145 | 27887 |
| 4L-3S | | MI | 11634 | 4659 | 19348 | 3285 | 20756 | 2663 | 21196 | 2163 | 21477 | 1403 | 25183 | 1087 | 16459 |
| 10-#14 | 2.06 | MA | 17721 | 4659 | 28714 | 3438 | 31078 | 2797 | 31710 | 2291 | 31668 | 1532 | 38173 | 1082 | 26326 |
| 5L-2S | | MI | 12292 | 4659 | 20360 | 3293 | 22033 | 2653 | 22717 | 2153 | 23486 | 1393 | 27788 | 1215 | 16423 |
| 10-#18 | 3.66 | MA | 21460 | 5280 | 36970 | 3786 | 41498 | 3058 | 44343 | 2451 | 48590 | 1475 | 59654 | 1038 | 48497 |
| 3L-4S | | MI | 11897 | 5280 | 20926 | 3647 | 22541 | 2881 | 23302 | 2262 | 24392 | 1297 | 29302 | 524 | 25763 |
| 10-#18 | 3.66 | MA | 20046 | 5280 | 34416 | 3816 | 38251 | 3050 | 40403 | 2438 | 43522 | 1493 | 53920 | 810 | 45072 |
| 4L-3S | | MI | 12710 | 5280 | 22365 | 3629 | 24305 | 2899 | 25389 | 2280 | 27009 | 1279 | 32185 | 728 | 27769 |
| 10-#18 | 3.66 | MA | 18778 | 5280 | 32174 | 3812 | 35361 | 3077 | 36864 | 2461 | 38523 | 1475 | 47876 | 703 | 42259 |
| 5L-2S | | MI | 13820 | 5280 | 24115 | 3646 | 26474 | 2881 | 27973 | 2262 | 30424 | 1262 | 36573 | 955 | 27905 |
| 12-#11 | 1.71 | MA | 19831 | 4525 | 31746 | 3350 | 35018 | 2716 | 36534 | 2238 | 38231 | 1535 | 46164 | 1433 | 23698 |
| 2L-6S | | MI | 10559 | 4525 | 17242 | 3220 | 18136 | 2612 | 18133 | 2150 | 17445 | 1441 | 20406 | 1003 | 13406 |
| 12-#11 | 1.71 | MA | 18998 | 4525 | 30481 | 3349 | 33405 | 2714 | 34573 | 2248 | 35575 | 1543 | 42588 | 1345 | 23680 |
| 3L-5S | | MI | 10852 | 4525 | 17727 | 3225 | 18790 | 2619 | 18880 | 2143 | 18434 | 1434 | 21603 | 1063 | 13712 |
| 12-#11 | 1.71 | MA | 18412 | 4525 | 29465 | 3362 | 32114 | 2725 | 33006 | 2245 | 33540 | 1550 | 40245 | 1256 | 23593 |
| 4E | | MI | 11158 | 4525 | 18240 | 3230 | 19448 | 2612 | 19662 | 2136 | 19514 | 1441 | 22888 | 1104 | 13949 |
| 12-#11 | 1.71 | MA | 17886 | 4525 | 28575 | 3362 | 30966 | 2723 | 31601 | 2255 | 31535 | 1544 | 37799 | 1212 | 23107 |
| 5L-3S | | MI | 11497 | 4525 | 18821 | 3221 | 20183 | 2619 | 20532 | 2143 | 20606 | 1434 | 24099 | 1188 | 13929 |
| 12-#11 | 1.71 | MA | 17385 | 4525 | 27736 | 3361 | 29825 | 2735 | 30210 | 2252 | 29692 | 1552 | 35473 | 1154 | 22345 |
| 6L-2S | | MI | 11962 | 4525 | 19532 | 3226 | 21088 | 2612 | 21610 | 2136 | 22029 | 1427 | 25953 | 1276 | 13894 |
| 12-#14 | 2.47 | MA | 20135 | 4819 | 33256 | 3521 | 36882 | 2856 | 38777 | 2327 | 41260 | 1521 | 50070 | 1249 | 33607 |
| 3L-5S | | MI | 11170 | 4819 | 18800 | 3388 | 20068 | 2734 | 20385 | 2203 | 20422 | 1381 | 24277 | 861 | 18559 |
| 12-#14 | 2.47 | MA | 19309 | 4819 | 31800 | 3540 | 35032 | 2853 | 36532 | 2322 | 38344 | 1532 | 46742 | 1121 | 33309 |
| 4E | | MI | 11601 | 4819 | 19532 | 3396 | 20995 | 2724 | 21489 | 2193 | 21946 | 1391 | 26083 | 920 | 19280 |
| 12-#14 | 2.47 | MA | 18570 | 4819 | 30525 | 3538 | 33386 | 2869 | 34516 | 2336 | 35470 | 1522 | 43258 | 1059 | 31620 |
| 5L-3S | | MI | 12077 | 4819 | 20360 | 3384 | 22033 | 2734 | 22717 | 2203 | 23486 | 1381 | 27788 | 1039 | 19541 |
| 12-#14 | 2.47 | MA | 17864 | 4819 | 29320 | 3536 | 31751 | 2865 | 32521 | 2330 | 32828 | 1532 | 39951 | 974 | 30460 |
| 6L-2S | | MI | 12730 | 4819 | 21373 | 3392 | 23309 | 2724 | 24237 | 2193 | 25495 | 1371 | 30393 | 1167 | 19530 |
| 12-#18 | 4.40 | MA | 21471 | 5564 | 37585 | 3994 | 42292 | 3178 | 45315 | 2518 | 50128 | 1472 | 62704 | 762 | 54244 |
| 4E | | MI | 12646 | 5564 | 22677 | 3824 | 24709 | 3003 | 25885 | 2329 | 27807 | 1253 | 33690 | 428 | 30744 |
| 12-#18 | 4.40 | MA | 20222 | 5564 | 35343 | 3989 | 39401 | 3205 | 41775 | 2541 | 45129 | 1455 | 56660 | 654 | 51275 |
| 5L-3S | | MI | 13450 | 5564 | 24115 | 3806 | 26474 | 3021 | 27973 | 2347 | 30424 | 1235 | 36573 | 632 | 33002 |
| 12-#18 | 4.40 | MA | 19032 | 5564 | 33226 | 3984 | 36527 | 3197 | 38270 | 2529 | 40536 | 1472 | 50956 | 503 | 47514 |
| 6L-2S | | MI | 14550 | 5564 | 25866 | 3824 | 28642 | 3003 | 30556 | 2329 | 33839 | 1218 | 40960 | 860 | 33207 |
| 14-#11 | 2.00 | MA | 19587 | 4636 | 31746 | 3419 | 35018 | 2764 | 36534 | 2279 | 38231 | 1536 | 46164 | 1329 | 27512 |
| 3L-6S | | MI | 10879 | 4636 | 17954 | 3289 | 19041 | 2662 | 19211 | 2179 | 18869 | 1427 | 22260 | 972 | 15494 |
| 14-#11 | 2.00 | MA | 19005 | 4636 | 30730 | 3432 | 33727 | 2775 | 34967 | 2276 | 36196 | 1544 | 43821 | 1241 | 27404 |
| 4L-5S | | MI | 11171 | 4636 | 18439 | 3294 | 19695 | 2668 | 19958 | 2172 | 19858 | 1420 | 23457 | 1032 | 15777 |
| 14-#11 | 2.00 | MA | 18483 | 4636 | 29841 | 3431 | 32579 | 2773 | 33562 | 2286 | 34191 | 1538 | 41375 | 1197 | 26803 |
| 5L-4S | | MI | 11475 | 4636 | 18952 | 3299 | 20353 | 2662 | 20740 | 2165 | 20938 | 1427 | 24742 | 1073 | 16111 |
| 14-#11 | 2.00 | MA | 17986 | 4636 | 29001 | 3430 | 31438 | 2785 | 32170 | 2283 | 32349 | 1545 | 39049 | 1139 | 26076 |
| 6L-3S | | MI | 11812 | 4636 | 19532 | 3290 | 21088 | 2668 | 21610 | 2172 | 22029 | 1420 | 25953 | 1157 | 16110 |
| 14-#11 | 2.00 | MA | 17501 | 4636 | 28103 | 3443 | 30343 | 2783 | 30828 | 2293 | 30546 | 1553 | 36628 | 1051 | 25316 |
| 7L-2S | | MI | 12275 | 4636 | 20244 | 3295 | 21993 | 2662 | 22688 | 2165 | 23453 | 1413 | 27807 | 1246 | 16084 |
| 14-#14 | 2.88 | MA | 20141 | 4978 | 33611 | 3639 | 37340 | 2925 | 39338 | 2367 | 42146 | 1522 | 51828 | 1097 | 38593 |
| 4L-5S | | MI | 11616 | 4978 | 19813 | 3488 | 21344 | 2804 | 21906 | 2243 | 22431 | 1360 | 26882 | 814 | 21500 |
| 14-#14 | 2.88 | MA | 19409 | 4978 | 32335 | 3638 | 35695 | 2941 | 37323 | 2381 | 39272 | 1512 | 48343 | 1035 | 36929 |
| 5L-4S | | MI | 12044 | 4978 | 20545 | 3496 | 22271 | 2794 | 23010 | 2233 | 23955 | 1370 | 28688 | 873 | 22165 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis



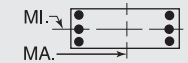

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.88 | MA | 18711 | 4978 | 31131 | 3636 | 34059 | 2938 | 35328 | 2375 | 36630 | 1522 | 45037 | 951 | 35678 |
| 6L-3S | | MI | 12516 | 4978 | 21373 | 3484 | 23309 | 2804 | 24237 | 2243 | 25495 | 1360 | 30393 | 992 | 22608 |
| 14-#14 | 2.88 | MA | 18030 | 4978 | 29842 | 3654 | 32488 | 2954 | 33403 | 2390 | 34045 | 1533 | 41595 | 824 | 33981 |
| 7L-2S | | MI | 13166 | 4978 | 22386 | 3492 | 24585 | 2794 | 25758 | 2233 | 27504 | 1350 | 32997 | 1120 | 22626 |
| 14-#18 | 5.13 | MA | 21647 | 5847 | 38512 | 4166 | 43441 | 3334 | 46687 | 2621 | 51734 | 1434 | 65444 | 606 | 60323 |
| 5L-4S | | MI | 13388 | 5847 | 24427 | 4002 | 26878 | 3126 | 28469 | 2396 | 31222 | 1209 | 38077 | 333 | 35754 |
| 14-#18 | 5.13 | MA | 20473 | 5847 | 36395 | 4161 | 40567 | 3325 | 43182 | 2608 | 47142 | 1452 | 59739 | 455 | 56708 |
| 6L-3S | | MI | 14185 | 5847 | 25866 | 3984 | 28642 | 3143 | 30556 | 2413 | 33839 | 1191 | 40960 | 537 | 37889 |
| 14-#18 | 5.13 | MA | 19329 | 5847 | 34130 | 4192 | 37806 | 3352 | 39799 | 2631 | 42648 | 1470 | 53798 | 230 | 52285 |
| 7L-2S | | MI | 15274 | 5847 | 27616 | 4001 | 30810 | 3126 | 33140 | 2396 | 37253 | 1173 | 45348 | 764 | 38492 |
| 16-#11 | 2.29 | MA | 19593 | 4746 | 31996 | 3501 | 35340 | 2826 | 36928 | 2307 | 38853 | 1537 | 47397 | 1226 | 31211 |
| 4L-6S | | MI | 11197 | 4746 | 18666 | 3358 | 19945 | 2711 | 20288 | 2207 | 20292 | 1413 | 24114 | 942 | 17587 |
| 16-#11 | 2.29 | MA | 19075 | 4746 | 31106 | 3500 | 34192 | 2823 | 35523 | 2318 | 36848 | 1531 | 44952 | 1182 | 30510 |
| 5E | | MI | 11487 | 4746 | 19151 | 3363 | 20600 | 2718 | 21036 | 2200 | 21282 | 1406 | 25311 | 1002 | 17851 |
| 16-#11 | 2.29 | MA | 18582 | 4746 | 30266 | 3499 | 33051 | 2835 | 34131 | 2314 | 35005 | 1538 | 42625 | 1123 | 29814 |
| 6L-4S | | MI | 11790 | 4746 | 19664 | 3368 | 21257 | 2711 | 21818 | 2193 | 22362 | 1413 | 26596 | 1042 | 18266 |
| 16-#11 | 2.29 | MA | 18101 | 4746 | 29368 | 3512 | 31956 | 2833 | 32789 | 2324 | 33203 | 1546 | 40204 | 1036 | 28996 |
| 7L-3S | | MI | 12125 | 4746 | 20244 | 3359 | 21993 | 2718 | 22688 | 2200 | 23453 | 1406 | 27807 | 1127 | 18284 |
| 16-#11 | 2.29 | MA | 17626 | 4746 | 28544 | 3511 | 30851 | 2845 | 31475 | 2335 | 31314 | 1540 | 37918 | 985 | 28075 |
| 8L-2S | | MI | 12586 | 4746 | 20956 | 3364 | 22897 | 2711 | 23766 | 2193 | 24877 | 1399 | 29661 | 1215 | 18268 |
| 16-#14 | 3.30 | MA | 20241 | 5138 | 34146 | 3738 | 38003 | 3014 | 40129 | 2426 | 43074 | 1502 | 53428 | 1011 | 42250 |
| 5E | | MI | 12059 | 5138 | 20826 | 3588 | 22620 | 2875 | 23426 | 2283 | 24440 | 1338 | 29486 | 766 | 24450 |
| 16-#14 | 3.30 | MA | 19550 | 5138 | 32942 | 3736 | 36367 | 3010 | 38134 | 2420 | 40432 | 1512 | 50122 | 927 | 40911 |
| 6L-4S | | MI | 12483 | 5138 | 21557 | 3596 | 23548 | 2865 | 24530 | 2273 | 25964 | 1348 | 31292 | 826 | 25066 |
| 16-#14 | 3.30 | MA | 18875 | 5138 | 31653 | 3754 | 34797 | 3026 | 36209 | 2434 | 37847 | 1523 | 46680 | 800 | 39270 |
| 7L-3S | | MI | 12953 | 5138 | 22386 | 3584 | 24585 | 2875 | 25758 | 2283 | 27504 | 1338 | 32997 | 945 | 25666 |
| 16-#14 | 3.30 | MA | 18210 | 5138 | 30471 | 3753 | 33212 | 3023 | 34324 | 2449 | 35139 | 1513 | 43424 | 728 | 37316 |
| 8L-2S | | MI | 13598 | 5138 | 23398 | 3592 | 25861 | 2865 | 27278 | 2273 | 29513 | 1328 | 35602 | 1073 | 25710 |
| 16-#18 | 5.86 | MA | 21896 | 6131 | 39564 | 4339 | 44607 | 3454 | 48093 | 2688 | 53748 | 1432 | 68523 | 406 | 65924 |
| 6L-4S | | MI | 14125 | 6131 | 26178 | 4179 | 29046 | 3248 | 31053 | 2462 | 34636 | 1165 | 42465 | 237 | 40788 |
| 16-#18 | 5.86 | MA | 20768 | 6131 | 37299 | 4369 | 41846 | 3480 | 44710 | 2711 | 49253 | 1449 | 62582 | 181 | 61412 |
| 7L-3S | | MI | 14914 | 6131 | 27616 | 4161 | 30810 | 3265 | 33140 | 2480 | 37253 | 1147 | 45348 | 441 | 42755 |
| 18-#11 | 2.57 | MA | 19663 | 4857 | 32371 | 3569 | 35805 | 2874 | 37483 | 2349 | 39504 | 1524 | 48528 | 1167 | 34226 |
| 5L-6S | | MI | 11514 | 4857 | 19378 | 3427 | 20850 | 2761 | 21366 | 2236 | 21716 | 1399 | 25968 | 911 | 19683 |
| 18-#11 | 2.57 | MA | 19174 | 4857 | 31531 | 3568 | 34665 | 2885 | 36092 | 2345 | 37662 | 1532 | 46201 | 1108 | 33557 |
| 6L-5S | | MI | 11802 | 4857 | 19863 | 3432 | 21505 | 2768 | 22113 | 2229 | 22706 | 1392 | 27165 | 971 | 19930 |
| 18-#11 | 2.57 | MA | 18696 | 4857 | 30633 | 3581 | 33569 | 2883 | 34750 | 2356 | 35859 | 1539 | 43780 | 1021 | 32684 |
| 7L-4S | | MI | 12103 | 4857 | 20376 | 3437 | 22162 | 2761 | 22896 | 2222 | 23785 | 1399 | 28450 | 1012 | 20416 |
| 18-#11 | 2.57 | MA | 18225 | 4857 | 29809 | 3580 | 32464 | 2895 | 33436 | 2366 | 33971 | 1533 | 41495 | 970 | 31790 |
| 8L-3S | | MI | 12436 | 4857 | 20956 | 3428 | 22897 | 2768 | 23766 | 2229 | 24877 | 1392 | 29661 | 1096 | 20449 |
| 18-#11 | 2.57 | MA | 17746 | 4857 | 28937 | 3593 | 31384 | 2893 | 32076 | 2363 | 32187 | 1541 | 39241 | 913 | 30628 |
| 9L-2S | | MI | 12895 | 4857 | 21668 | 3433 | 23802 | 2761 | 24843 | 2222 | 26301 | 1385 | 31515 | 1185 | 20446 |
| 18-#14 | 3.71 | MA | 20380 | 5298 | 34752 | 3836 | 38676 | 3082 | 40940 | 2465 | 44234 | 1502 | 55207 | 903 | 46156 |
| 6L-5S | | MI | 12498 | 5298 | 21839 | 3687 | 23897 | 2946 | 24947 | 2323 | 26449 | 1317 | 32091 | 719 | 27407 |
| 18-#14 | 3.71 | MA | 19712 | 5298 | 33464 | 3854 | 37105 | 3098 | 39015 | 2479 | 41649 | 1513 | 51765 | 777 | 44568 |
| 7L-4S | | MI | 12920 | 5298 | 22570 | 3695 | 24824 | 2936 | 26051 | 2313 | 27973 | 1327 | 33897 | 778 | 27980 |
| 18-#14 | 3.71 | MA | 19054 | 5298 | 32281 | 3852 | 35520 | 3095 | 37131 | 2494 | 38941 | 1503 | 48509 | 704 | 42565 |
| 8L-3S | | MI | 13386 | 5298 | 23398 | 3683 | 25861 | 2946 | 27278 | 2323 | 29513 | 1317 | 35602 | 898 | 28717 |
| 18-#14 | 3.71 | MA | 18384 | 5298 | 31030 | 3871 | 33971 | 3111 | 35181 | 2488 | 36382 | 1513 | 45306 | 623 | 40439 |
| 9L-2S | | MI | 14027 | 5298 | 24411 | 3692 | 27138 | 2936 | 28799 | 2313 | 31522 | 1307 | 38206 | 1026 | 28782 |
| 18-#18 | 6.59 | MA | 22189 | 6415 | 40468 | 4547 | 45886 | 3609 | 49622 | 2791 | 55859 | 1429 | 71365 | 133 | 70559 |
| 7L-4S | | MI | 14856 | 6415 | 27928 | 4356 | 31215 | 3370 | 33637 | 2529 | 38051 | 1121 | 46853 | 142 | 45840 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

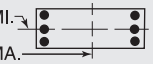
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.86 | MA | 19760 | 4968 | 32797 | 3637 | 36278 | 2935 | 38053 | 2376 | 40318 | 1525 | 49778 | 1093 | 37304 |
| 6E | | MI | 11828 | 4968 | 20090 | 3496 | 21755 | 2811 | 22444 | 2264 | 23140 | 1385 | 27822 | 881 | 21781 |
| 20-#11 | 2.86 | MA | 19286 | 4968 | 31898 | 3650 | 35182 | 2933 | 36711 | 2387 | 38516 | 1532 | 47356 | 1006 | 36378 |
| 7L-5S | | MI | 12115 | 4968 | 20575 | 3501 | 22409 | 2818 | 23191 | 2258 | 24130 | 1378 | 29018 | 941 | 22015 |
| 20-#11 | 2.86 | MA | 18819 | 4968 | 31074 | 3650 | 34077 | 2945 | 35397 | 2397 | 36627 | 1526 | 45071 | 955 | 35510 |
| 8L-4S | | MI | 12414 | 4968 | 21087 | 3506 | 23067 | 2811 | 23974 | 2251 | 25209 | 1385 | 30304 | 981 | 22532 |
| 20-#11 | 2.86 | MA | 18341 | 4968 | 30202 | 3663 | 32997 | 2943 | 34037 | 2394 | 34843 | 1534 | 42817 | 898 | 34314 |
| 9L-3S | | MI | 12746 | 4968 | 21668 | 3497 | 23802 | 2818 | 24843 | 2258 | 26301 | 1378 | 31515 | 1066 | 22607 |
| 20-#11 | 2.86 | MA | 17819 | 4968 | 29382 | 3662 | 31906 | 2955 | 32731 | 2404 | 33073 | 1542 | 40631 | 835 | 33090 |
| 10L-2S | | MI | 13202 | 4968 | 22380 | 3502 | 24707 | 2811 | 25921 | 2251 | 27724 | 1372 | 33369 | 1154 | 22620 |
| 20-#14 | 4.12 | MA | 20541 | 5457 | 35274 | 3954 | 39414 | 3171 | 41822 | 2524 | 45451 | 1503 | 56850 | 753 | 49875 |
| 7L-5S | | MI | 12935 | 5457 | 22851 | 3787 | 25173 | 3017 | 26467 | 2363 | 28458 | 1295 | 34696 | 672 | 30370 |
| 20-#14 | 4.12 | MA | 19889 | 5457 | 34092 | 3952 | 37829 | 3167 | 39937 | 2539 | 42743 | 1493 | 53595 | 681 | 47823 |
| 8L-4S | | MI | 13354 | 5457 | 23583 | 3795 | 26100 | 3007 | 27571 | 2353 | 29982 | 1305 | 36502 | 731 | 30905 |
| 20-#14 | 4.12 | MA | 19221 | 5457 | 32841 | 3970 | 36280 | 3183 | 37987 | 2533 | 40184 | 1503 | 50391 | 599 | 45666 |
| 9L-3S | | MI | 13817 | 5457 | 24411 | 3783 | 27138 | 3017 | 28799 | 2363 | 31522 | 1295 | 38206 | 850 | 31763 |
| 22-#11 | 3.14 | MA | 19872 | 5078 | 33163 | 3720 | 36795 | 2983 | 38672 | 2418 | 41172 | 1525 | 50933 | 990 | 40078 |
| 7L-6S | | MI | 12141 | 5078 | 20801 | 3566 | 22660 | 2861 | 23522 | 2293 | 24564 | 1372 | 29676 | 850 | 23834 |
| 22-#11 | 3.14 | MA | 19408 | 5078 | 32339 | 3719 | 35690 | 2995 | 37357 | 2428 | 39284 | 1519 | 48647 | 939 | 39235 |
| 8L-5S | | MI | 12426 | 5078 | 21287 | 3570 | 23314 | 2868 | 24269 | 2286 | 25553 | 1365 | 30872 | 910 | 24103 |
| 22-#11 | 3.14 | MA | 18931 | 5078 | 31467 | 3732 | 34610 | 2993 | 35998 | 2425 | 37500 | 1527 | 46393 | 883 | 38006 |
| 9L-4S | | MI | 12724 | 5078 | 21799 | 3575 | 23972 | 2861 | 25051 | 2279 | 26633 | 1372 | 32158 | 951 | 24591 |
| 22-#11 | 3.14 | MA | 18415 | 5078 | 30647 | 3731 | 33519 | 3005 | 34692 | 2435 | 35729 | 1535 | 44207 | 820 | 36759 |
| 10L-3S | | MI | 13054 | 5078 | 22380 | 3567 | 24707 | 2868 | 25921 | 2286 | 27724 | 1365 | 33369 | 1035 | 24762 |
| 22-#11 | 3.14 | MA | 17914 | 5078 | 29838 | 3730 | 32445 | 3003 | 33348 | 2432 | 33867 | 1529 | 41976 | 766 | 35536 |
| 11L-2S | | MI | 13508 | 5078 | 23092 | 3572 | 25612 | 2861 | 26999 | 2279 | 29148 | 1358 | 35223 | 1124 | 24786 |
| 22-#14 | 4.53 | MA | 20717 | 5617 | 35903 | 4052 | 40137 | 3239 | 42743 | 2583 | 46545 | 1483 | 58680 | 657 | 53090 |
| 8L-5S | | MI | 13369 | 5617 | 23864 | 3887 | 26449 | 3088 | 27988 | 2403 | 30467 | 1274 | 37300 | 625 | 33337 |
| 22-#14 | 4.53 | MA | 20051 | 5617 | 34652 | 4070 | 38588 | 3256 | 40793 | 2578 | 43986 | 1493 | 55477 | 576 | 50901 |
| 9L-4S | | MI | 13786 | 5617 | 24596 | 3895 | 27377 | 3078 | 29092 | 2393 | 31991 | 1284 | 39106 | 684 | 33840 |
| 24-#11 | 3.43 | MA | 19994 | 5189 | 33604 | 3788 | 37303 | 3045 | 39318 | 2459 | 41940 | 1513 | 52223 | 924 | 42937 |
| 8L-6S | | MI | 12453 | 5189 | 21513 | 3635 | 23564 | 2911 | 24599 | 2322 | 25988 | 1358 | 31530 | 820 | 25869 |
| 24-#11 | 3.43 | MA | 19518 | 5189 | 32732 | 3801 | 36223 | 3043 | 37959 | 2456 | 40156 | 1520 | 49969 | 868 | 41702 |
| 9L-5S | | MI | 12736 | 5189 | 21999 | 3640 | 24219 | 2918 | 25347 | 2315 | 26977 | 1351 | 32726 | 880 | 26195 |
| 24-#11 | 3.43 | MA | 19018 | 5189 | 31912 | 3800 | 35132 | 3055 | 36653 | 2466 | 38386 | 1528 | 47783 | 805 | 40432 |
| 10L-4S | | MI | 13033 | 5189 | 22511 | 3645 | 24876 | 2911 | 26129 | 2308 | 28057 | 1358 | 34012 | 920 | 26655 |
| 24-#11 | 3.43 | MA | 18509 | 5189 | 31103 | 3799 | 34058 | 3053 | 35309 | 2463 | 36524 | 1522 | 45552 | 751 | 39192 |
| 11L-3S | | MI | 13360 | 5189 | 23092 | 3636 | 25612 | 2918 | 26999 | 2315 | 29148 | 1351 | 35223 | 1005 | 26913 |
| 24-#14 | 4.95 | MA | 20874 | 5776 | 36462 | 4170 | 40897 | 3328 | 43599 | 2623 | 47788 | 1483 | 60562 | 552 | 56143 |
| 9L-5S | | MI | 13801 | 5776 | 24877 | 3987 | 27725 | 3159 | 29508 | 2443 | 32476 | 1252 | 39905 | 577 | 36233 |

## RECTANGULAR TIED COLUMNS 26" x 44"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.40 | MA | 20971 | 4613 | 33305 | 3408 | 36342 | 2769 | 37505 | 2293 | 38388 | 1602 | 45653 | 1495 | 21135 |
| 2E | | MI | 12063 | 4613 | 19596 | 3246 | 20713 | 2623 | 20938 | 2154 | 20816 | 1465 | 24107 | 1310 | 11814 |
| 6-#14 | 1.18 | MA | 20551 | 4524 | 32246 | 3373 | 35118 | 2746 | 36065 | 2283 | 36496 | 1621 | 43301 | 1530 | 18071 |
| 2L-3S | | MI | 11215 | 4524 | 18050 | 3218 | 18949 | 2630 | 18875 | 2175 | 18100 | 1517 | 20677 | 1250 | 10268 |
| 6-#14 | 1.18 | MA | 19277 | 4524 | 30335 | 3372 | 32682 | 2743 | 33104 | 2298 | 32484 | 1632 | 37904 | 1402 | 18093 |
| 3L-2S | | MI | 11884 | 4524 | 19063 | 3226 | 20225 | 2620 | 20395 | 2165 | 20109 | 1507 | 23282 | 1378 | 10189 |
| 6-#18 | 2.10 | MA | 22506 | 4896 | 36651 | 3585 | 40608 | 2897 | 42691 | 2373 | 45395 | 1583 | 54991 | 1450 | 31348 |
| 2L-3S | | MI | 11683 | 4896 | 19596 | 3406 | 20713 | 2763 | 20938 | 2238 | 20816 | 1438 | 24107 | 987 | 17306 |
| 6-#18 | 2.10 | MA | 20323 | 4896 | 33305 | 3581 | 36342 | 2925 | 37505 | 2397 | 38388 | 1601 | 45653 | 1222 | 31123 |
| 3L-2S | | MI | 12818 | 4896 | 21346 | 3423 | 22881 | 2745 | 23522 | 2221 | 24231 | 1420 | 28494 | 1215 | 17245 |
| 8-#11 | 1.09 | MA | 20378 | 4488 | 31801 | 3361 | 34615 | 2738 | 35478 | 2280 | 35712 | 1629 | 42346 | 1546 | 16809 |
| 2L-4S | | MI | 10996 | 4488 | 17542 | 3225 | 18384 | 2622 | 18228 | 2172 | 17309 | 1540 | 19887 | 1234 | 9620 |
| 8-#11 | 1.09 | MA | 19485 | 4488 | 30467 | 3361 | 32914 | 2737 | 33410 | 2291 | 32910 | 1637 | 38554 | 1457 | 16835 |
| 3E | | MI | 11339 | 4488 | 18123 | 3216 | 19119 | 2629 | 19098 | 2179 | 18400 | 1533 | 21098 | 1318 | 9564 |

## RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

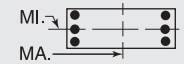
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.09 | MA | 18857 | 4488 | 29397 | 3374 | 31554 | 2749 | 31760 | 2288 | 30767 | 1646 | 36066 | 1368 | 16802 |
| 4L-2S | | MI | 11810 | 4488 | 18835 | 3221 | 20024 | 2622 | 20176 | 2172 | 19824 | 1526 | 22952 | 1407 | 9512 |
| 8-#14 | 1.57 | MA | 21444 | 4684 | 34156 | 3473 | 37553 | 2818 | 39026 | 2328 | 40507 | 1611 | 48699 | 1508 | 23910 |
| 2L-4S | | MI | 11182 | 4684 | 18235 | 3330 | 19188 | 2691 | 19168 | 2206 | 18569 | 1506 | 21577 | 1084 | 13425 |
| 8-#14 | 1.57 | MA | 20182 | 4684 | 32246 | 3472 | 35118 | 2815 | 36065 | 2343 | 36496 | 1622 | 43301 | 1380 | 23884 |
| 3E | | MI | 11666 | 4684 | 19063 | 3318 | 20225 | 2701 | 20395 | 2215 | 20109 | 1496 | 23282 | 1203 | 13398 |
| 8-#14 | 1.57 | MA | 19292 | 4684 | 30712 | 3491 | 33168 | 2832 | 33698 | 2338 | 33423 | 1633 | 39765 | 1252 | 23677 |
| 4L-2S | | MI | 12330 | 4684 | 20076 | 3326 | 21502 | 2691 | 21916 | 2206 | 22117 | 1486 | 25886 | 1331 | 13337 |
| 8-#18 | 2.80 | MA | 24013 | 5180 | 39998 | 3762 | 44875 | 3026 | 47878 | 2453 | 52401 | 1565 | 64328 | 1404 | 41508 |
| 2L-4S | | MI | 11617 | 5180 | 19908 | 3601 | 21117 | 2867 | 21435 | 2287 | 21614 | 1412 | 25611 | 687 | 21036 |
| 8-#18 | 2.80 | MA | 21862 | 5180 | 36651 | 3759 | 40608 | 3054 | 42691 | 2477 | 45395 | 1582 | 54991 | 1177 | 41164 |
| 3E | | MI | 12441 | 5180 | 21346 | 3583 | 22881 | 2885 | 23522 | 2305 | 24231 | 1394 | 28494 | 892 | 22595 |
| 8-#18 | 2.80 | MA | 20344 | 5180 | 33959 | 3790 | 37184 | 3046 | 38536 | 2466 | 40019 | 1600 | 48888 | 949 | 38186 |
| 4L-2S | | MI | 13565 | 5180 | 23096 | 3601 | 25050 | 2867 | 26106 | 2287 | 27645 | 1376 | 32882 | 1119 | 22623 |
| 10-#11 | 1.36 | MA | 21007 | 4598 | 33135 | 3430 | 36316 | 2788 | 37546 | 2311 | 38513 | 1622 | 46139 | 1531 | 20890 |
| 2L-5S | | MI | 11009 | 4598 | 17742 | 3289 | 18631 | 2679 | 18523 | 2208 | 17653 | 1519 | 20455 | 1163 | 11763 |
| 10-#11 | 1.36 | MA | 20121 | 4598 | 31801 | 3430 | 34615 | 2787 | 35478 | 2322 | 35712 | 1630 | 42346 | 1443 | 20895 |
| 3L-4S | | MI | 11318 | 4598 | 18254 | 3294 | 19289 | 2672 | 19306 | 2201 | 18732 | 1526 | 21741 | 1204 | 11812 |
| 10-#11 | 1.36 | MA | 19497 | 4598 | 30731 | 3443 | 33255 | 2799 | 33828 | 2319 | 33568 | 1639 | 39859 | 1354 | 20832 |
| 4L-3S | | MI | 11658 | 4598 | 18835 | 3286 | 20024 | 2679 | 20176 | 2208 | 19824 | 1519 | 22952 | 1288 | 11772 |
| 10-#11 | 1.36 | MA | 18938 | 4598 | 29795 | 3443 | 32046 | 2797 | 32347 | 2330 | 31456 | 1633 | 37269 | 1310 | 20559 |
| 5L-2S | | MI | 12127 | 4598 | 19547 | 3291 | 20929 | 2672 | 21253 | 2201 | 21248 | 1512 | 24806 | 1376 | 11727 |
| 10-#14 | 1.97 | MA | 22326 | 4843 | 36066 | 3573 | 39989 | 2891 | 41986 | 2373 | 44518 | 1601 | 54096 | 1486 | 29731 |
| 2L-5S | | MI | 11198 | 4843 | 18516 | 3421 | 19537 | 2772 | 19585 | 2256 | 19054 | 1474 | 22376 | 977 | 15763 |
| 10-#14 | 1.97 | MA | 21075 | 4843 | 34156 | 3572 | 37553 | 2888 | 39026 | 2388 | 40507 | 1612 | 48699 | 1358 | 29662 |
| 3L-4S | | MI | 11633 | 4843 | 19248 | 3429 | 20464 | 2762 | 20688 | 2246 | 20577 | 1484 | 24182 | 1036 | 16489 |
| 10-#14 | 1.97 | MA | 20195 | 4843 | 32623 | 3590 | 35603 | 2904 | 36659 | 2383 | 37434 | 1623 | 45163 | 1230 | 29405 |
| 4L-3S | | MI | 12114 | 4843 | 20076 | 3418 | 21502 | 2772 | 21916 | 2256 | 22117 | 1474 | 25886 | 1156 | 16504 |
| 10-#14 | 1.97 | MA | 19406 | 4843 | 31279 | 3589 | 33870 | 2901 | 34536 | 2397 | 34406 | 1615 | 41471 | 1167 | 27870 |
| 5L-2S | | MI | 12773 | 4843 | 21089 | 3426 | 22778 | 2762 | 23436 | 2246 | 24126 | 1464 | 28491 | 1284 | 16463 |
| 10-#18 | 3.50 | MA | 23376 | 5464 | 39998 | 3936 | 44875 | 3182 | 47878 | 2557 | 52401 | 1564 | 64328 | 1132 | 51197 |
| 3L-4S | | MI | 12375 | 5464 | 21658 | 3778 | 23285 | 2989 | 24018 | 2354 | 25028 | 1368 | 29999 | 592 | 25974 |
| 10-#18 | 3.50 | MA | 21881 | 5464 | 37305 | 3967 | 41451 | 3175 | 43722 | 2545 | 47026 | 1581 | 58225 | 904 | 47839 |
| 4L-3S | | MI | 13190 | 5464 | 23096 | 3760 | 25050 | 3007 | 26106 | 2372 | 27645 | 1350 | 32882 | 796 | 27854 |
| 10-#18 | 3.50 | MA | 20542 | 5464 | 34942 | 3964 | 38404 | 3203 | 39992 | 2569 | 41724 | 1564 | 51814 | 795 | 45088 |
| 5L-2S | | MI | 14303 | 5464 | 24847 | 3778 | 27218 | 2989 | 28689 | 2354 | 31060 | 1332 | 37269 | 1024 | 27968 |
| 12-#11 | 1.64 | MA | 21631 | 4709 | 34470 | 3500 | 38017 | 2839 | 39614 | 2342 | 41315 | 1615 | 49932 | 1517 | 24961 |
| 2L-6S | | MI | 11036 | 4709 | 17968 | 3354 | 18881 | 2722 | 18854 | 2243 | 18087 | 1512 | 21112 | 1072 | 13504 |
| 12-#11 | 1.64 | MA | 20750 | 4709 | 33135 | 3499 | 36316 | 2837 | 37546 | 2353 | 38513 | 1624 | 46139 | 1429 | 24944 |
| 3L-5S | | MI | 11330 | 4709 | 18454 | 3359 | 19536 | 2729 | 19601 | 2237 | 19077 | 1506 | 22309 | 1132 | 13817 |
| 12-#11 | 1.64 | MA | 20131 | 4709 | 32066 | 3512 | 34956 | 2849 | 35896 | 2350 | 36370 | 1632 | 43651 | 1340 | 24857 |
| 4E | | MI | 11637 | 4709 | 18966 | 3364 | 20193 | 2722 | 20384 | 2230 | 20156 | 1512 | 23595 | 1173 | 13991 |
| 12-#11 | 1.64 | MA | 19577 | 4709 | 31129 | 3512 | 33748 | 2847 | 34415 | 2361 | 34258 | 1626 | 41062 | 1296 | 24447 |
| 5L-3S | | MI | 11976 | 4709 | 19547 | 3355 | 20929 | 2729 | 21253 | 2237 | 21248 | 1506 | 24806 | 1257 | 13965 |
| 12-#11 | 1.64 | MA | 19049 | 4709 | 30245 | 3511 | 32547 | 2859 | 32951 | 2358 | 32318 | 1635 | 38593 | 1237 | 23609 |
| 6L-2S | | MI | 12442 | 4709 | 20259 | 3360 | 21833 | 2722 | 22331 | 2230 | 22672 | 1499 | 26660 | 1346 | 13928 |
| 12-#14 | 2.36 | MA | 21959 | 5003 | 36066 | 3671 | 39989 | 2960 | 41986 | 2432 | 44518 | 1602 | 54096 | 1336 | 35430 |
| 3L-5S | | MI | 11648 | 5003 | 19529 | 3521 | 20813 | 2843 | 21105 | 2296 | 21063 | 1453 | 24980 | 930 | 18691 |
| 12-#14 | 2.36 | MA | 21088 | 5003 | 34533 | 3690 | 38039 | 2977 | 39620 | 2427 | 41446 | 1613 | 50560 | 1208 | 35131 |
| 4E | | MI | 12080 | 5003 | 20260 | 3529 | 21740 | 2833 | 22209 | 2286 | 22586 | 1463 | 26786 | 989 | 19435 |
| 12-#14 | 2.36 | MA | 20307 | 5003 | 33189 | 3689 | 36306 | 2974 | 37497 | 2442 | 38417 | 1605 | 46868 | 1145 | 33460 |
| 5L-3S | | MI | 12557 | 5003 | 21089 | 3517 | 22778 | 2843 | 23436 | 2296 | 24126 | 1453 | 28491 | 1108 | 19594 |
| 12-#14 | 2.36 | MA | 19563 | 5003 | 31921 | 3688 | 34583 | 2990 | 35396 | 2437 | 35635 | 1616 | 43357 | 1061 | 32377 |
| 6L-2S | | MI | 13212 | 5003 | 22101 | 3525 | 24054 | 2833 | 24957 | 2286 | 26135 | 1443 | 31096 | 1236 | 19573 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis

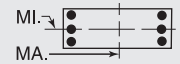



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 4.20 | MA | 23395 | 5747 | 40651 | 4145 | 45717 | 3303 | 48909 | 2625 | 54032 | 1563 | 67563 | 859 | 57534 |
| 4E | | MI | 13125 | 5747 | 23408 | 3956 | 25454 | 3112 | 26602 | 2421 | 28443 | 1323 | 34386 | 496 | 30952 |
| 12-#18 | 4.20 | MA | 22076 | 5747 | 38289 | 4141 | 42670 | 3331 | 45178 | 2649 | 48731 | 1545 | 61151 | 750 | 54629 |
| 5L-3S | | MI | 13932 | 5747 | 24847 | 3938 | 27218 | 3129 | 28689 | 2439 | 31060 | 1306 | 37269 | 701 | 33095 |
| 12-#18 | 4.20 | MA | 20818 | 5747 | 36058 | 4137 | 39641 | 3324 | 41484 | 2638 | 43860 | 1563 | 55084 | 599 | 50493 |
| 6L-2S | | MI | 15035 | 5747 | 26597 | 3955 | 29386 | 3112 | 31273 | 2421 | 34474 | 1288 | 41657 | 928 | 33276 |
| 14-#11 | 1.91 | MA | 21375 | 4820 | 34470 | 3568 | 38017 | 2887 | 39614 | 2384 | 41315 | 1617 | 49932 | 1415 | 28986 |
| 3L-6S | | MI | 11357 | 4820 | 18680 | 3423 | 19786 | 2772 | 19932 | 2272 | 19511 | 1499 | 22966 | 1042 | 15592 |
| 14-#11 | 1.91 | MA | 20760 | 4820 | 33400 | 3582 | 36657 | 2899 | 37964 | 2381 | 39172 | 1625 | 47444 | 1326 | 28878 |
| 4L-5S | | MI | 11649 | 4820 | 19166 | 3428 | 20441 | 2779 | 20679 | 2265 | 20500 | 1492 | 24163 | 1102 | 15882 |
| 14-#11 | 1.91 | MA | 20210 | 4820 | 32463 | 3581 | 35449 | 2897 | 36484 | 2392 | 37060 | 1619 | 44855 | 1282 | 28348 |
| 5L-4S | | MI | 11954 | 4820 | 19678 | 3433 | 21098 | 2772 | 21461 | 2258 | 21580 | 1499 | 25448 | 1143 | 16160 |
| 14-#11 | 1.91 | MA | 19686 | 4820 | 31580 | 3581 | 34248 | 2909 | 35019 | 2389 | 35120 | 1628 | 42386 | 1223 | 27547 |
| 6L-3S | | MI | 12291 | 4820 | 20259 | 3424 | 21833 | 2779 | 22331 | 2265 | 22672 | 1492 | 26660 | 1227 | 16150 |
| 14-#11 | 1.91 | MA | 19175 | 4820 | 30634 | 3594 | 33095 | 2908 | 33605 | 2400 | 33222 | 1636 | 39818 | 1136 | 26840 |
| 7L-2S | | MI | 12755 | 4820 | 20971 | 3429 | 22738 | 2772 | 23409 | 2258 | 24095 | 1485 | 28513 | 1315 | 16121 |
| 14-#14 | 2.75 | MA | 21971 | 5162 | 36444 | 3790 | 40475 | 3049 | 42581 | 2472 | 45457 | 1603 | 55957 | 1186 | 40856 |
| 4L-5S | | MI | 12094 | 5162 | 20542 | 3621 | 22089 | 2914 | 22626 | 2336 | 23071 | 1431 | 27585 | 883 | 21632 |
| 14-#14 | 2.75 | MA | 21198 | 5162 | 35100 | 3789 | 38741 | 3046 | 40458 | 2487 | 42428 | 1595 | 52265 | 1123 | 39066 |
| 5L-4S | | MI | 12523 | 5162 | 21273 | 3629 | 23017 | 2904 | 23729 | 2326 | 24595 | 1441 | 29391 | 942 | 22318 |
| 14-#14 | 2.75 | MA | 20462 | 5162 | 33832 | 3787 | 37019 | 3063 | 38357 | 2482 | 39646 | 1606 | 48754 | 1039 | 37890 |
| 6L-3S | | MI | 12997 | 5162 | 22101 | 3617 | 24054 | 2914 | 24957 | 2336 | 26135 | 1431 | 31096 | 1061 | 22665 |
| 14-#14 | 2.75 | MA | 19743 | 5162 | 32475 | 3806 | 35365 | 3060 | 36330 | 2497 | 36924 | 1617 | 45100 | 913 | 36027 |
| 7L-2S | | MI | 13648 | 5162 | 23114 | 3625 | 25330 | 2904 | 26477 | 2326 | 28144 | 1421 | 33700 | 1189 | 22672 |
| 14-#18 | 4.90 | MA | 23588 | 6031 | 41635 | 4318 | 46937 | 3460 | 50364 | 2729 | 55738 | 1526 | 70489 | 705 | 64202 |
| 5L-4S | | MI | 13869 | 6031 | 25159 | 4133 | 27622 | 3234 | 29186 | 2488 | 31857 | 1279 | 38774 | 401 | 35960 |
| 14-#18 | 4.90 | MA | 22349 | 6031 | 39405 | 4314 | 43908 | 3452 | 46670 | 2718 | 50866 | 1544 | 64421 | 554 | 60216 |
| 6L-3S | | MI | 14668 | 6031 | 26597 | 4115 | 29386 | 3251 | 31273 | 2505 | 34474 | 1262 | 41657 | 605 | 38169 |
| 14-#18 | 4.90 | MA | 21139 | 6031 | 37018 | 4346 | 40999 | 3480 | 43106 | 2742 | 46099 | 1562 | 58103 | 329 | 55700 |
| 7L-2S | | MI | 15761 | 6031 | 28348 | 4132 | 31555 | 3234 | 33857 | 2488 | 37889 | 1244 | 46045 | 833 | 38565 |
| 16-#11 | 2.18 | MA | 21384 | 4930 | 34734 | 3651 | 38358 | 2949 | 40032 | 2412 | 41973 | 1618 | 51237 | 1312 | 32896 |
| 4L-6S | | MI | 11676 | 4930 | 19392 | 3492 | 20691 | 2822 | 21009 | 2301 | 20935 | 1485 | 24820 | 1011 | 17686 |
| 16-#11 | 2.18 | MA | 20838 | 4930 | 33798 | 3650 | 37150 | 2947 | 38552 | 2423 | 39861 | 1613 | 48648 | 1268 | 32259 |
| 5E | | MI | 11966 | 4930 | 19878 | 3497 | 21346 | 2828 | 21757 | 2294 | 21924 | 1478 | 26017 | 1071 | 17955 |
| 16-#11 | 2.18 | MA | 20318 | 4930 | 32914 | 3650 | 35949 | 2959 | 37087 | 2420 | 37922 | 1621 | 46179 | 1209 | 31491 |
| 6L-4S | | MI | 12270 | 4930 | 20390 | 3502 | 22003 | 2822 | 22539 | 2287 | 23004 | 1485 | 27302 | 1112 | 18319 |
| 16-#11 | 2.18 | MA | 19811 | 4930 | 31968 | 3663 | 34796 | 2958 | 35674 | 2431 | 36024 | 1629 | 43610 | 1122 | 30725 |
| 7L-3S | | MI | 12605 | 4930 | 20971 | 3493 | 22738 | 2828 | 23409 | 2294 | 24095 | 1478 | 28513 | 1196 | 18327 |
| 16-#11 | 2.18 | MA | 19310 | 4930 | 31101 | 3662 | 33633 | 2970 | 34290 | 2442 | 34036 | 1624 | 41191 | 1070 | 29716 |
| 8L-2S | | MI | 13067 | 4930 | 21683 | 3498 | 23643 | 2822 | 24487 | 2287 | 25519 | 1471 | 30367 | 1285 | 18307 |
| 16-#14 | 3.15 | MA | 22080 | 5322 | 37010 | 3888 | 41177 | 3118 | 43419 | 2532 | 46440 | 1585 | 57663 | 1101 | 44683 |
| 5E | | MI | 12538 | 5322 | 21554 | 3721 | 23366 | 2985 | 24146 | 2376 | 25080 | 1410 | 30190 | 835 | 24582 |
| 16-#14 | 3.15 | MA | 21351 | 5322 | 35742 | 3887 | 39454 | 3135 | 41318 | 2527 | 43658 | 1596 | 54151 | 1017 | 43418 |
| 6L-4S | | MI | 12964 | 5322 | 22286 | 3729 | 24293 | 2975 | 25250 | 2366 | 26604 | 1420 | 31996 | 895 | 25217 |
| 16-#14 | 3.15 | MA | 20639 | 5322 | 34385 | 3906 | 37800 | 3132 | 39291 | 2542 | 40935 | 1607 | 50498 | 891 | 41613 |
| 7L-3S | | MI | 13434 | 5322 | 23114 | 3717 | 25330 | 2985 | 26477 | 2376 | 28144 | 1410 | 33700 | 1014 | 25727 |
| 16-#14 | 3.15 | MA | 19938 | 5322 | 33140 | 3905 | 36131 | 3149 | 37306 | 2557 | 38083 | 1598 | 47048 | 817 | 39662 |
| 8L-2S | | MI | 14081 | 5322 | 24127 | 3725 | 26607 | 2975 | 27998 | 2366 | 30153 | 1400 | 36305 | 1142 | 25762 |
| 16-#18 | 5.59 | MA | 23859 | 6315 | 42751 | 4492 | 48174 | 3581 | 51857 | 2798 | 57873 | 1525 | 73759 | 509 | 69961 |
| 6L-4S | | MI | 14606 | 6315 | 26909 | 4310 | 29791 | 3356 | 31770 | 2554 | 35272 | 1235 | 43162 | 305 | 40992 |
| 16-#18 | 5.59 | MA | 22667 | 6315 | 40364 | 4523 | 45265 | 3609 | 48292 | 2822 | 53105 | 1543 | 67441 | 284 | 65356 |
| 7L-3S | | MI | 15398 | 6315 | 28348 | 4292 | 31555 | 3374 | 33857 | 2572 | 37889 | 1218 | 46045 | 510 | 43030 |
| 18-#11 | 2.45 | MA | 21461 | 5041 | 35132 | 3719 | 38851 | 2998 | 40620 | 2454 | 42663 | 1606 | 52440 | 1253 | 36179 |
| 5L-6S | | MI | 11992 | 5041 | 20104 | 3561 | 21596 | 2871 | 22087 | 2329 | 22358 | 1471 | 26674 | 981 | 19782 |
| 18-#11 | 2.45 | MA | 20945 | 5041 | 34248 | 3719 | 37650 | 3010 | 39155 | 2451 | 40723 | 1614 | 49972 | 1195 | 35441 |
| 6L-5S | | MI | 12281 | 5041 | 20590 | 3566 | 22250 | 2878 | 22835 | 2322 | 23348 | 1464 | 27871 | 1041 | 20035 |
| 18-#11 | 2.45 | MA | 20441 | 5041 | 33302 | 3732 | 36497 | 3008 | 37742 | 2462 | 38825 | 1622 | 47403 | 1108 | 34617 |
| 7L-4S | | MI | 12583 | 5041 | 21102 | 3571 | 22908 | 2871 | 23617 | 2316 | 24428 | 1471 | 29156 | 1081 | 20472 |

## RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis

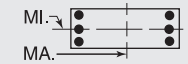



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.45 | MA | 19945 | 5041 | 32435 | 3732 | 35334 | 3020 | 36358 | 2473 | 36837 | 1617 | 44983 | 1056 | 33638 |
| 8L-3S | | MI | 12917 | 5041 | 21683 | 3562 | 23643 | 2878 | 24487 | 2322 | 25519 | 1464 | 30367 | 1166 | 20498 |
| 18-#11 | 2.45 | MA | 19432 | 5041 | 31583 | 3731 | 34197 | 3018 | 34927 | 2470 | 34959 | 1625 | 42591 | 1000 | 32493 |
| 9L-2S | | MI | 13376 | 5041 | 22395 | 3567 | 24548 | 2871 | 25564 | 2316 | 26943 | 1457 | 32221 | 1254 | 20487 |
| 18-#14 | 3.54 | MA | 22232 | 5481 | 37653 | 3987 | 41890 | 3207 | 44279 | 2572 | 47669 | 1586 | 59549 | 995 | 48959 |
| 6L-5S | | MI | 12978 | 5481 | 22567 | 3820 | 24642 | 3056 | 25667 | 2416 | 27089 | 1388 | 32794 | 788 | 27539 |
| 18-#14 | 3.54 | MA | 21527 | 5481 | 36296 | 4006 | 40236 | 3204 | 42252 | 2587 | 44946 | 1597 | 55895 | 869 | 47209 |
| 7L-4S | | MI | 13401 | 5481 | 23299 | 3828 | 25569 | 3046 | 26770 | 2406 | 28613 | 1398 | 34600 | 848 | 28131 |
| 18-#14 | 3.54 | MA | 20832 | 5481 | 35051 | 4004 | 38567 | 3221 | 40267 | 2602 | 42095 | 1588 | 52445 | 795 | 45208 |
| 8L-3S | | MI | 13869 | 5481 | 24127 | 3817 | 26607 | 3056 | 27998 | 2416 | 30153 | 1388 | 36305 | 967 | 28782 |
| 18-#14 | 3.54 | MA | 20115 | 5481 | 33734 | 4023 | 36936 | 3218 | 38213 | 2597 | 39400 | 1599 | 49043 | 714 | 43067 |
| 9L-2S | | MI | 14512 | 5481 | 25140 | 3825 | 27883 | 3046 | 29518 | 2406 | 32162 | 1378 | 38909 | 1095 | 28837 |
| 18-#18 | 6.29 | MA | 24176 | 6599 | 43710 | 4701 | 49531 | 3737 | 53478 | 2902 | 60112 | 1524 | 76778 | 239 | 75032 |
| 7L-4S | | MI | 15339 | 6599 | 28660 | 4488 | 31959 | 3478 | 34354 | 2621 | 38687 | 1191 | 47549 | 210 | 46043 |
| 20-#11 | 2.73 | MA | 21567 | 5152 | 35583 | 3788 | 39351 | 3060 | 41223 | 2482 | 43525 | 1607 | 53764 | 1181 | 39395 |
| 6E | | MI | 12308 | 5152 | 20816 | 3630 | 22500 | 2921 | 23165 | 2358 | 23782 | 1457 | 28528 | 950 | 21881 |
| 20-#11 | 2.73 | MA | 21067 | 5152 | 34637 | 3801 | 38198 | 3058 | 39810 | 2493 | 41627 | 1615 | 51196 | 1094 | 38517 |
| 7L-5S | | MI | 12595 | 5152 | 21302 | 3635 | 23155 | 2928 | 23912 | 2351 | 24772 | 1450 | 29725 | 1010 | 22119 |
| 20-#11 | 2.73 | MA | 20574 | 5152 | 33769 | 3801 | 37035 | 3070 | 38426 | 2504 | 39639 | 1610 | 48776 | 1042 | 37564 |
| 8L-4S | | MI | 12895 | 5152 | 21814 | 3640 | 23813 | 2921 | 24695 | 2344 | 25851 | 1457 | 31010 | 1051 | 22621 |
| 20-#11 | 2.73 | MA | 20063 | 5152 | 32918 | 3800 | 35898 | 3068 | 36995 | 2501 | 37761 | 1618 | 46384 | 986 | 36385 |
| 9L-3S | | MI | 13227 | 5152 | 22395 | 3631 | 24548 | 2928 | 25564 | 2351 | 26943 | 1450 | 32221 | 1135 | 22658 |
| 20-#11 | 2.73 | MA | 19511 | 5152 | 31988 | 3814 | 34750 | 3080 | 35620 | 2512 | 35897 | 1626 | 44064 | 923 | 35175 |
| 10L-2S | | MI | 13685 | 5152 | 23107 | 3636 | 25453 | 2921 | 26642 | 2344 | 28367 | 1443 | 34075 | 1224 | 22662 |
| 20-#14 | 3.93 | MA | 22407 | 5641 | 38206 | 4105 | 42672 | 3277 | 45212 | 2632 | 48958 | 1587 | 61292 | 847 | 52814 |
| 7L-5S | | MI | 13416 | 5641 | 23580 | 3920 | 25918 | 3126 | 27187 | 2456 | 29098 | 1367 | 35399 | 741 | 30502 |
| 20-#14 | 3.93 | MA | 21719 | 5641 | 36961 | 4104 | 41003 | 3293 | 43228 | 2647 | 46106 | 1578 | 57842 | 773 | 50763 |
| 8L-4S | | MI | 13836 | 5641 | 24311 | 3928 | 26845 | 3116 | 28291 | 2446 | 30622 | 1377 | 37205 | 800 | 31055 |
| 20-#14 | 3.93 | MA | 21002 | 5641 | 35644 | 4123 | 39372 | 3290 | 41174 | 2642 | 43412 | 1589 | 54441 | 692 | 48592 |
| 9L-3S | | MI | 14301 | 5641 | 25140 | 3916 | 27883 | 3126 | 29518 | 2456 | 32162 | 1367 | 38909 | 919 | 31831 |
| 22-#11 | 3.00 | MA | 21689 | 5262 | 35971 | 3870 | 39900 | 3108 | 41878 | 2524 | 44429 | 1608 | 54989 | 1080 | 42422 |
| 7L-6S | | MI | 12621 | 5262 | 21528 | 3699 | 23405 | 2971 | 24243 | 2387 | 25206 | 1443 | 30382 | 920 | 23982 |
| 22-#11 | 3.00 | MA | 21199 | 5262 | 35104 | 3870 | 38736 | 3120 | 40494 | 2535 | 42441 | 1603 | 52569 | 1028 | 41495 |
| 8L-5S | | MI | 12907 | 5262 | 22013 | 3704 | 24060 | 2978 | 24990 | 2380 | 26196 | 1437 | 31579 | 980 | 24208 |
| 22-#11 | 3.00 | MA | 20689 | 5262 | 34252 | 3869 | 37599 | 3118 | 39063 | 2532 | 40563 | 1611 | 50177 | 972 | 40283 |
| 9L-4S | | MI | 13206 | 5262 | 22526 | 3709 | 24717 | 2971 | 25772 | 2373 | 27275 | 1443 | 32864 | 1020 | 24714 |
| 22-#11 | 3.00 | MA | 20143 | 5262 | 33322 | 3883 | 36451 | 3130 | 37688 | 2543 | 38699 | 1620 | 47857 | 908 | 39050 |
| 10L-3S | | MI | 13536 | 5262 | 23107 | 3700 | 25453 | 2978 | 26642 | 2380 | 28367 | 1437 | 34075 | 1105 | 24814 |
| 22-#11 | 3.00 | MA | 19614 | 5262 | 32471 | 3882 | 35321 | 3129 | 36273 | 2540 | 36738 | 1614 | 45494 | 854 | 37713 |
| 11L-2S | | MI | 13991 | 5262 | 23819 | 3705 | 26357 | 2971 | 27720 | 2373 | 29790 | 1430 | 35929 | 1193 | 24834 |
| 22-#14 | 4.33 | MA | 22597 | 5801 | 38872 | 4204 | 43438 | 3366 | 46189 | 2692 | 50117 | 1568 | 63239 | 751 | 56327 |
| 8L-5S | | MI | 13851 | 5801 | 24592 | 4020 | 27194 | 3197 | 28708 | 2496 | 31107 | 1345 | 38003 | 694 | 33470 |
| 22-#14 | 4.33 | MA | 21883 | 5801 | 37554 | 4223 | 41807 | 3363 | 44135 | 2687 | 47423 | 1579 | 59838 | 670 | 54125 |
| 9L-4S | | MI | 14269 | 5801 | 25324 | 4028 | 28122 | 3187 | 29811 | 2486 | 32631 | 1355 | 39809 | 753 | 33988 |
| 24-#11 | 3.27 | MA | 21820 | 5373 | 36438 | 3939 | 40437 | 3170 | 42562 | 2566 | 45242 | 1596 | 56361 | 1014 | 45430 |
| 8L-6S | | MI | 12933 | 5373 | 22240 | 3769 | 24310 | 3021 | 25321 | 2415 | 26630 | 1430 | 32236 | 889 | 26037 |
| 24-#11 | 3.27 | MA | 21310 | 5373 | 35586 | 3939 | 39301 | 3169 | 41131 | 2563 | 43364 | 1604 | 53970 | 958 | 44186 |
| 9L-5S | | MI | 13217 | 5373 | 22725 | 3774 | 24965 | 3028 | 26068 | 2408 | 27619 | 1423 | 33432 | 949 | 26300 |
| 24-#11 | 3.27 | MA | 20770 | 5373 | 34657 | 3952 | 38152 | 3181 | 39756 | 2574 | 41500 | 1613 | 51650 | 894 | 42930 |
| 10L-4S | | MI | 13514 | 5373 | 23238 | 3778 | 25622 | 3021 | 26850 | 2401 | 28699 | 1430 | 34718 | 990 | 26778 |
| 24-#11 | 3.27 | MA | 20245 | 5373 | 33805 | 3951 | 37022 | 3179 | 38341 | 2571 | 39540 | 1607 | 49287 | 840 | 41616 |
| 11L-3S | | MI | 13843 | 5373 | 23819 | 3770 | 26357 | 3028 | 27720 | 2408 | 29790 | 1423 | 35929 | 1074 | 26968 |
| 24-#14 | 4.72 | MA | 22756 | 5960 | 39465 | 4322 | 44243 | 3435 | 47096 | 2732 | 51434 | 1570 | 65235 | 648 | 59665 |
| 9L-5S | | MI | 14283 | 5960 | 25605 | 4120 | 28471 | 3268 | 30228 | 2536 | 33116 | 1324 | 40608 | 647 | 36442 |

## RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

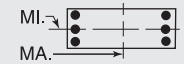
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.34 | MA | 22812 | 4796 | 36083 | 3557 | 39381 | 2892 | 40604 | 2397 | 41484 | 1684 | 49339 | 1578 | 22215 |
| 2E | | MI | 12542 | 4796 | 20327 | 3377 | 21457 | 2731 | 21655 | 2246 | 21452 | 1535 | 24803 | 1378 | 11853 |
| 6-#14 | 1.13 | MA | 22364 | 4708 | 34962 | 3523 | 38084 | 2869 | 39079 | 2387 | 39440 | 1701 | 46821 | 1612 | 18982 |
| 2L-3S | | MI | 11694 | 4708 | 18779 | 3351 | 19694 | 2740 | 19595 | 2268 | 18740 | 1589 | 21380 | 1319 | 10302 |
| 6-#14 | 1.13 | MA | 21021 | 4708 | 32951 | 3522 | 35522 | 2866 | 35963 | 2403 | 35219 | 1713 | 41112 | 1484 | 19004 |
| 3L-2S | | MI | 12363 | 4708 | 19792 | 3359 | 20971 | 2730 | 21115 | 2258 | 20749 | 1579 | 23985 | 1447 | 10220 |
| 6-#18 | 2.01 | MA | 24438 | 5080 | 39606 | 3734 | 43873 | 3020 | 46065 | 2477 | 48883 | 1667 | 59231 | 1536 | 32968 |
| 2L-3S | | MI | 12161 | 5080 | 20327 | 3537 | 21457 | 2871 | 21655 | 2330 | 21452 | 1509 | 24803 | 1055 | 17369 |
| 6-#18 | 2.01 | MA | 22134 | 5080 | 36083 | 3731 | 39381 | 3049 | 40604 | 2503 | 41484 | 1685 | 49339 | 1309 | 32743 |
| 3L-2S | | MI | 13299 | 5080 | 22078 | 3555 | 23625 | 2853 | 24239 | 2312 | 24866 | 1491 | 29191 | 1283 | 17292 |
| 8-#11 | 1.04 | MA | 22180 | 4672 | 34491 | 3511 | 37552 | 2861 | 38458 | 2384 | 38610 | 1709 | 45799 | 1627 | 17652 |
| 2L-4S | | MI | 11474 | 4672 | 18269 | 3359 | 19130 | 2732 | 18949 | 2266 | 17951 | 1612 | 20593 | 1304 | 9651 |
| 8-#11 | 1.04 | MA | 21239 | 4672 | 33088 | 3510 | 35763 | 2860 | 36283 | 2396 | 35663 | 1718 | 41789 | 1538 | 17677 |
| 3E | | MI | 11817 | 4672 | 18850 | 3350 | 19865 | 2739 | 19819 | 2273 | 19042 | 1605 | 21804 | 1388 | 9593 |
| 8-#11 | 1.04 | MA | 20577 | 4672 | 31964 | 3524 | 34334 | 2872 | 34548 | 2393 | 33411 | 1727 | 39157 | 1450 | 17645 |
| 4L-2S | | MI | 12289 | 4672 | 19562 | 3355 | 20770 | 2732 | 20897 | 2266 | 20466 | 1598 | 23658 | 1476 | 9540 |
| 8-#14 | 1.51 | MA | 23309 | 4867 | 36972 | 3622 | 40647 | 2941 | 42194 | 2432 | 43660 | 1691 | 52530 | 1592 | 25125 |
| 2L-4S | | MI | 11660 | 4867 | 18963 | 3463 | 19933 | 2801 | 19888 | 2299 | 19209 | 1577 | 22280 | 1153 | 13477 |
| 8-#14 | 1.51 | MA | 21978 | 4867 | 34962 | 3622 | 38084 | 2939 | 39079 | 2448 | 39440 | 1703 | 46821 | 1464 | 25099 |
| 3E | | MI | 12145 | 4867 | 19792 | 3451 | 20971 | 2811 | 21115 | 2308 | 20749 | 1567 | 23985 | 1272 | 13438 |
| 8-#14 | 1.51 | MA | 21041 | 4867 | 33350 | 3641 | 36035 | 2956 | 36591 | 2443 | 36210 | 1715 | 43077 | 1336 | 24892 |
| 4L-2S | | MI | 12810 | 4867 | 20804 | 3459 | 22247 | 2801 | 22636 | 2299 | 22758 | 1557 | 26590 | 1400 | 13373 |
| 8-#18 | 2.68 | MA | 26035 | 5364 | 43130 | 3912 | 48365 | 3149 | 51526 | 2557 | 56281 | 1649 | 69122 | 1494 | 43668 |
| 2L-4S | | MI | 12094 | 5364 | 20639 | 3732 | 21861 | 2975 | 22151 | 2379 | 22249 | 1482 | 26308 | 756 | 21246 |
| 8-#18 | 2.68 | MA | 23764 | 5364 | 39606 | 3909 | 43873 | 3178 | 46065 | 2582 | 48883 | 1667 | 59231 | 1266 | 43324 |
| 3E | | MI | 12920 | 5364 | 22078 | 3715 | 23625 | 2993 | 24239 | 2397 | 24866 | 1465 | 29191 | 960 | 22668 |
| 8-#18 | 2.68 | MA | 22163 | 5364 | 36775 | 3941 | 40272 | 3171 | 41695 | 2572 | 43208 | 1685 | 52758 | 1039 | 40453 |
| 4L-2S | | MI | 14046 | 5364 | 23828 | 3732 | 25794 | 2975 | 26822 | 2379 | 28281 | 1447 | 33579 | 1187 | 22676 |
| 10-#11 | 1.30 | MA | 22845 | 4782 | 35895 | 3580 | 39342 | 2911 | 40633 | 2416 | 41557 | 1702 | 49808 | 1614 | 21943 |
| 2L-5S | | MI | 11487 | 4782 | 18468 | 3423 | 19377 | 2789 | 19245 | 2301 | 18295 | 1591 | 21161 | 1232 | 11871 |
| 10-#11 | 1.30 | MA | 21910 | 4782 | 34491 | 3580 | 37552 | 2910 | 38458 | 2427 | 38610 | 1711 | 45799 | 1525 | 21948 |
| 3L-4S | | MI | 11796 | 4782 | 18981 | 3428 | 20034 | 2782 | 20027 | 2295 | 19375 | 1598 | 22447 | 1273 | 11848 |
| 10-#11 | 1.30 | MA | 21254 | 4782 | 33367 | 3593 | 36123 | 2922 | 36724 | 2424 | 36358 | 1720 | 43167 | 1437 | 21885 |
| 4L-3S | | MI | 12137 | 4782 | 19562 | 3419 | 20770 | 2789 | 20897 | 2301 | 20466 | 1591 | 23658 | 1357 | 11804 |
| 10-#11 | 1.30 | MA | 20666 | 4782 | 32384 | 3593 | 34854 | 2921 | 35169 | 2435 | 34139 | 1715 | 40434 | 1392 | 21702 |
| 5L-2S | | MI | 12606 | 4782 | 20274 | 3424 | 21674 | 2782 | 21975 | 2295 | 21890 | 1584 | 25512 | 1446 | 11758 |
| 10-#14 | 1.88 | MA | 24243 | 5027 | 38982 | 3722 | 43210 | 3014 | 45310 | 2477 | 47881 | 1681 | 58240 | 1571 | 31250 |
| 2L-5S | | MI | 11675 | 5027 | 19244 | 3554 | 20282 | 2882 | 20304 | 2349 | 19694 | 1546 | 23079 | 1046 | 15892 |
| 10-#14 | 1.88 | MA | 22923 | 5027 | 36972 | 3721 | 40647 | 3011 | 42194 | 2493 | 43660 | 1693 | 52530 | 1443 | 31180 |
| 3L-4S | | MI | 12111 | 5027 | 19976 | 3562 | 21209 | 2872 | 21408 | 2339 | 21218 | 1556 | 24885 | 1106 | 16548 |
| 10-#14 | 1.88 | MA | 21996 | 5027 | 35360 | 3741 | 38598 | 3028 | 39707 | 2488 | 40431 | 1705 | 48786 | 1315 | 30924 |
| 4L-3S | | MI | 12593 | 5027 | 20804 | 3551 | 22247 | 2882 | 22636 | 2349 | 22758 | 1546 | 26590 | 1225 | 16549 |
| 10-#14 | 1.88 | MA | 21166 | 5027 | 33949 | 3740 | 36777 | 3026 | 37477 | 2504 | 37248 | 1697 | 44888 | 1252 | 29425 |
| 5L-2S | | MI | 13253 | 5027 | 21817 | 3559 | 23523 | 2872 | 24156 | 2339 | 24766 | 1536 | 29194 | 1353 | 16502 |
| 10-#18 | 3.34 | MA | 25367 | 5648 | 43130 | 4086 | 48365 | 3306 | 51526 | 2662 | 56281 | 1650 | 69122 | 1224 | 53897 |
| 3L-4S | | MI | 12853 | 5648 | 22390 | 3910 | 24030 | 3098 | 24735 | 2446 | 25664 | 1438 | 30696 | 660 | 26181 |
| 10-#18 | 3.34 | MA | 23791 | 5648 | 40298 | 4118 | 44764 | 3300 | 47156 | 2652 | 50607 | 1668 | 62650 | 997 | 50630 |
| 4L-3S | | MI | 13671 | 5648 | 23828 | 3892 | 25794 | 3115 | 26822 | 2464 | 28281 | 1420 | 33579 | 864 | 27937 |
| 10-#18 | 3.34 | MA | 22380 | 5648 | 37815 | 4115 | 41562 | 3329 | 43234 | 2677 | 45012 | 1650 | 55871 | 886 | 47760 |
| 5L-2S | | MI | 14786 | 5648 | 25578 | 3909 | 27962 | 3098 | 29406 | 2446 | 31696 | 1403 | 37966 | 1092 | 28030 |
| 12-#11 | 1.57 | MA | 23505 | 4893 | 37298 | 3649 | 41131 | 2961 | 42809 | 2447 | 44504 | 1695 | 53817 | 1601 | 26225 |
| 2L-6S | | MI | 11514 | 4893 | 18695 | 3487 | 19627 | 2832 | 19575 | 2337 | 18729 | 1584 | 21819 | 1142 | 13598 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

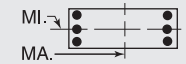
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.57 | MA | 22576 | 4893 | 35895 | 3649 | 39342 | 2960 | 40633 | 2458 | 41557 | 1704 | 49808 | 1512 | 26207 |
| 3L-5S | | MI | 11808 | 4893 | 19180 | 3492 | 20282 | 2839 | 20322 | 2330 | 19719 | 1577 | 23015 | 1202 | 13920 |
| 12-#11 | 1.57 | MA | 21924 | 4893 | 34771 | 3662 | 37913 | 2972 | 38899 | 2455 | 39304 | 1713 | 47176 | 1423 | 26120 |
| 4E | | MI | 12116 | 4893 | 19693 | 3497 | 20939 | 2832 | 21105 | 2323 | 20798 | 1584 | 24301 | 1243 | 14032 |
| 12-#11 | 1.57 | MA | 21342 | 4893 | 33787 | 3662 | 36643 | 2971 | 37344 | 2466 | 37086 | 1708 | 44443 | 1379 | 25797 |
| 5L-3S | | MI | 12455 | 4893 | 20274 | 3489 | 21674 | 2839 | 21975 | 2330 | 21890 | 1577 | 25512 | 1327 | 14001 |
| 12-#11 | 1.57 | MA | 20786 | 4893 | 32859 | 3662 | 35382 | 2983 | 35806 | 2464 | 35049 | 1717 | 41832 | 1320 | 24879 |
| 6L-2S | | MI | 12922 | 4893 | 20986 | 3494 | 22579 | 2832 | 23052 | 2323 | 23314 | 1571 | 27366 | 1415 | 13962 |
| 12-#14 | 2.26 | MA | 23858 | 5187 | 38982 | 3821 | 43210 | 3083 | 45310 | 2537 | 47881 | 1683 | 58240 | 1423 | 37252 |
| 3L-5S | | MI | 12126 | 5187 | 20257 | 3654 | 21558 | 2952 | 21825 | 2389 | 21703 | 1524 | 25683 | 999 | 18820 |
| 12-#14 | 2.26 | MA | 22940 | 5187 | 37370 | 3840 | 41161 | 3101 | 42822 | 2533 | 44651 | 1695 | 54496 | 1295 | 36954 |
| 4E | | MI | 12559 | 5187 | 20989 | 3662 | 22486 | 2943 | 22929 | 2379 | 23226 | 1534 | 27489 | 1058 | 19587 |
| 12-#14 | 2.26 | MA | 22119 | 5187 | 35959 | 3839 | 39340 | 3098 | 40592 | 2549 | 41469 | 1687 | 50597 | 1231 | 35311 |
| 5L-3S | | MI | 13037 | 5187 | 21817 | 3650 | 23523 | 2952 | 24156 | 2389 | 24766 | 1524 | 29194 | 1177 | 19645 |
| 12-#14 | 2.26 | MA | 21336 | 5187 | 34627 | 3839 | 37530 | 3115 | 38385 | 2544 | 38546 | 1699 | 46881 | 1147 | 34175 |
| 6L-2S | | MI | 13693 | 5187 | 22830 | 3658 | 24799 | 2943 | 25677 | 2379 | 26775 | 1514 | 31799 | 1305 | 19616 |
| 12-#18 | 4.01 | MA | 25393 | 5931 | 43822 | 4296 | 49257 | 3428 | 52617 | 2732 | 58005 | 1650 | 72541 | 954 | 60848 |
| 4E | | MI | 13605 | 5931 | 24140 | 4087 | 26198 | 3220 | 27319 | 2513 | 29079 | 1394 | 35083 | 565 | 31156 |
| 12-#18 | 4.01 | MA | 24003 | 5931 | 41339 | 4293 | 46054 | 3457 | 48695 | 2757 | 52411 | 1633 | 65762 | 844 | 58026 |
| 5L-3S | | MI | 14414 | 5931 | 25578 | 4069 | 27962 | 3237 | 29406 | 2530 | 31696 | 1376 | 37966 | 769 | 33185 |
| 12-#18 | 4.01 | MA | 22678 | 5931 | 38995 | 4290 | 42871 | 3451 | 44812 | 2747 | 47270 | 1651 | 59331 | 694 | 53502 |
| 6L-2S | | MI | 15519 | 5931 | 27329 | 4087 | 30131 | 3220 | 31990 | 2513 | 35110 | 1359 | 42354 | 996 | 33343 |
| 14-#11 | 1.83 | MA | 23236 | 5004 | 37298 | 3718 | 41131 | 3010 | 42809 | 2489 | 44504 | 1697 | 53817 | 1499 | 30461 |
| 3L-6S | | MI | 11835 | 5004 | 19407 | 3557 | 20532 | 2882 | 20653 | 2366 | 20153 | 1571 | 23672 | 1111 | 15687 |
| 14-#11 | 1.83 | MA | 22589 | 5004 | 36174 | 3731 | 39702 | 3023 | 41074 | 2486 | 42251 | 1706 | 51185 | 1410 | 30352 |
| 4L-5S | | MI | 12128 | 5004 | 19892 | 3562 | 21187 | 2889 | 21400 | 2359 | 21143 | 1564 | 24869 | 1171 | 15985 |
| 14-#11 | 1.83 | MA | 22011 | 5004 | 35191 | 3731 | 38433 | 3021 | 39519 | 2498 | 40033 | 1701 | 48452 | 1366 | 29902 |
| 5L-4S | | MI | 12433 | 5004 | 20405 | 3567 | 21844 | 2882 | 22182 | 2352 | 22222 | 1571 | 26155 | 1212 | 16206 |
| 14-#11 | 1.83 | MA | 21460 | 5004 | 34263 | 3731 | 37171 | 3034 | 37981 | 2495 | 37995 | 1710 | 45841 | 1307 | 29023 |
| 6L-3S | | MI | 12771 | 5004 | 20986 | 3558 | 22579 | 2889 | 23052 | 2359 | 23314 | 1564 | 27366 | 1296 | 16188 |
| 14-#11 | 1.83 | MA | 20922 | 5004 | 33269 | 3745 | 35961 | 3032 | 36497 | 2506 | 36002 | 1719 | 43126 | 1220 | 28378 |
| 7L-2S | | MI | 13236 | 5004 | 21698 | 3563 | 23484 | 2882 | 24130 | 2352 | 24738 | 1557 | 29220 | 1385 | 16157 |
| 14-#14 | 2.63 | MA | 23875 | 5346 | 39381 | 3940 | 43723 | 3173 | 45938 | 2578 | 48872 | 1685 | 60205 | 1275 | 42982 |
| 4L-5S | | MI | 12573 | 5346 | 21270 | 3754 | 22834 | 3023 | 23345 | 2429 | 23712 | 1503 | 28288 | 952 | 21760 |
| 14-#14 | 2.63 | MA | 23061 | 5346 | 37969 | 3939 | 41902 | 3170 | 43708 | 2593 | 45690 | 1677 | 56306 | 1211 | 41213 |
| 5L-4S | | MI | 13003 | 5346 | 22002 | 3762 | 23762 | 3013 | 24449 | 2419 | 25235 | 1513 | 30094 | 1011 | 22468 |
| 14-#14 | 2.63 | MA | 22286 | 5346 | 36637 | 3938 | 40093 | 3188 | 41500 | 2589 | 42767 | 1689 | 52590 | 1127 | 40121 |
| 6L-3S | | MI | 13478 | 5346 | 22830 | 3750 | 24799 | 3023 | 25677 | 2429 | 26775 | 1503 | 31799 | 1130 | 22721 |
| 14-#14 | 2.63 | MA | 21530 | 5346 | 35212 | 3958 | 38356 | 3185 | 39371 | 2604 | 39907 | 1701 | 48724 | 1000 | 38090 |
| 7L-2S | | MI | 14130 | 5346 | 23843 | 3758 | 26076 | 3013 | 27197 | 2419 | 28784 | 1493 | 34403 | 1258 | 22718 |
| 14-#18 | 4.68 | MA | 25605 | 6215 | 44862 | 4470 | 50547 | 3586 | 54156 | 2837 | 59809 | 1615 | 75654 | 802 | 68125 |
| 5L-4S | | MI | 14349 | 6215 | 25890 | 4264 | 28367 | 3342 | 29903 | 2579 | 32493 | 1350 | 39471 | 469 | 36162 |
| 14-#18 | 4.68 | MA | 24299 | 6215 | 42518 | 4467 | 47363 | 3579 | 50273 | 2827 | 54668 | 1633 | 69222 | 651 | 63755 |
| 6L-3S | | MI | 15151 | 6215 | 27329 | 4246 | 30131 | 3360 | 31990 | 2597 | 35110 | 1332 | 42354 | 673 | 38419 |
| 14-#18 | 4.68 | MA | 23024 | 6215 | 40010 | 4499 | 44306 | 3608 | 46527 | 2852 | 49637 | 1651 | 62528 | 427 | 59157 |
| 7L-2S | | MI | 16247 | 6215 | 29079 | 4264 | 32299 | 3342 | 34574 | 2579 | 38525 | 1315 | 46742 | 901 | 38637 |
| 16-#11 | 2.09 | MA | 23249 | 5114 | 37578 | 3801 | 41491 | 3073 | 43249 | 2518 | 45198 | 1699 | 55194 | 1397 | 34581 |
| 4L-6S | | MI | 12154 | 5114 | 20119 | 3626 | 21437 | 2932 | 21731 | 2394 | 21577 | 1557 | 25526 | 1081 | 17781 |
| 16-#11 | 2.09 | MA | 22675 | 5114 | 36594 | 3800 | 40222 | 3071 | 41695 | 2529 | 42980 | 1694 | 52461 | 1352 | 34018 |
| 5E | | MI | 12445 | 5114 | 20604 | 3631 | 22091 | 2939 | 22478 | 2387 | 22566 | 1550 | 26723 | 1141 | 18058 |
| 16-#11 | 2.09 | MA | 22128 | 5114 | 35666 | 3800 | 38961 | 3084 | 40156 | 2526 | 40942 | 1703 | 49851 | 1294 | 33174 |
| 6L-4S | | MI | 12749 | 5114 | 21117 | 3636 | 22749 | 2932 | 23260 | 2380 | 23646 | 1557 | 28009 | 1181 | 18369 |
| 16-#11 | 2.09 | MA | 21594 | 5114 | 34673 | 3814 | 37750 | 3082 | 38672 | 2537 | 38949 | 1712 | 47135 | 1207 | 32468 |
| 7L-3S | | MI | 13085 | 5114 | 21698 | 3627 | 23484 | 2939 | 24130 | 2387 | 24738 | 1550 | 29220 | 1266 | 18368 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis

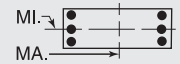


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.09 | MA | 21068 | 5114 | 33762 | 3813 | 36529 | 3095 | 37219 | 2548 | 36861 | 1707 | 44581 | 1155 | 31368 |
| 8L-2S | | MI | 13548 | 5114 | 22410 | 3632 | 24389 | 2932 | 25208 | 2380 | 26161 | 1543 | 31074 | 1354 | 18345 |
| 16-#14 | 3.01 | MA | 23995 | 5506 | 39979 | 4039 | 44465 | 3243 | 46823 | 2638 | 49911 | 1667 | 62016 | 1190 | 47127 |
| 5E | | MI | 13017 | 5506 | 22283 | 3854 | 24111 | 3094 | 24866 | 2469 | 25720 | 1481 | 30893 | 905 | 24710 |
| 16-#14 | 3.01 | MA | 23227 | 5506 | 38647 | 4038 | 42656 | 3260 | 44616 | 2634 | 46988 | 1679 | 58300 | 1106 | 45949 |
| 6L-4S | | MI | 13444 | 5506 | 23014 | 3862 | 25038 | 3084 | 25970 | 2459 | 27244 | 1491 | 32699 | 964 | 25366 |
| 16-#14 | 3.01 | MA | 22478 | 5506 | 37222 | 4057 | 40918 | 3257 | 42486 | 2649 | 44128 | 1691 | 54433 | 980 | 43974 |
| 7L-3S | | MI | 13916 | 5506 | 23843 | 3850 | 26076 | 3094 | 27197 | 2469 | 28784 | 1481 | 34403 | 1083 | 25786 |
| 16-#14 | 3.01 | MA | 21739 | 5506 | 35915 | 4056 | 39165 | 3275 | 40402 | 2665 | 41132 | 1683 | 50790 | 906 | 42034 |
| 8L-2S | | MI | 14564 | 5506 | 24855 | 3858 | 27352 | 3084 | 28718 | 2459 | 30793 | 1471 | 37008 | 1211 | 25813 |
| 16-#18 | 5.35 | MA | 25898 | 6499 | 46042 | 4644 | 51855 | 3708 | 55734 | 2907 | 62067 | 1616 | 79114 | 609 | 74028 |
| 6L-4S | | MI | 15088 | 6499 | 27641 | 4442 | 30535 | 3464 | 32487 | 2646 | 35908 | 1306 | 43859 | 374 | 41192 |
| 16-#18 | 5.35 | MA | 24641 | 6499 | 43534 | 4677 | 48798 | 3737 | 51988 | 2932 | 57035 | 1634 | 72419 | 384 | 69344 |
| 7L-3S | | MI | 15883 | 6499 | 29079 | 4424 | 32299 | 3482 | 34574 | 2664 | 38525 | 1288 | 46742 | 578 | 43301 |
| 16-#18 | 5.35 | MA | 23401 | 6499 | 41232 | 4674 | 45713 | 3730 | 48319 | 2957 | 51765 | 1617 | 66085 | 255 | 64247 |
| 8L-2S | | MI | 16969 | 6499 | 30830 | 4441 | 34467 | 3464 | 37158 | 2646 | 41939 | 1271 | 51129 | 805 | 43916 |
| 18-#11 | 2.35 | MA | 23334 | 5225 | 37998 | 3870 | 42011 | 3121 | 43870 | 2560 | 45927 | 1687 | 56471 | 1339 | 38142 |
| 5L-6S | | MI | 12471 | 5225 | 20831 | 3695 | 22341 | 2981 | 22808 | 2423 | 23001 | 1543 | 27380 | 1050 | 19879 |
| 18-#11 | 2.35 | MA | 22791 | 5225 | 37070 | 3869 | 40750 | 3134 | 42331 | 2557 | 43889 | 1696 | 53860 | 1281 | 37331 |
| 6L-5S | | MI | 12761 | 5225 | 21316 | 3700 | 22996 | 2988 | 23556 | 2416 | 23990 | 1536 | 28577 | 1110 | 20137 |
| 18-#11 | 2.35 | MA | 22261 | 5225 | 36076 | 3883 | 39540 | 3132 | 40847 | 2568 | 41896 | 1705 | 51144 | 1194 | 36566 |
| 7L-4S | | MI | 13063 | 5225 | 21829 | 3705 | 23653 | 2981 | 24338 | 2409 | 25070 | 1543 | 29862 | 1151 | 20525 |
| 18-#11 | 2.35 | MA | 21738 | 5225 | 35166 | 3883 | 38318 | 3145 | 39395 | 2580 | 39808 | 1700 | 48590 | 1142 | 35496 |
| 8L-3S | | MI | 13397 | 5225 | 22410 | 3696 | 24389 | 2988 | 25208 | 2416 | 26161 | 1536 | 31074 | 1235 | 20542 |
| 18-#11 | 2.35 | MA | 21180 | 5225 | 34272 | 3882 | 37124 | 3143 | 37892 | 2577 | 37836 | 1709 | 46060 | 1086 | 34376 |
| 9L-2S | | MI | 13858 | 5225 | 23122 | 3701 | 25293 | 2981 | 26286 | 2409 | 27585 | 1529 | 32927 | 1324 | 20527 |
| 18-#14 | 3.39 | MA | 24159 | 5665 | 40657 | 4138 | 45218 | 3332 | 47731 | 2679 | 51208 | 1669 | 64009 | 1086 | 51785 |
| 6L-5S | | MI | 13458 | 5665 | 23295 | 3953 | 25387 | 3165 | 26386 | 2509 | 27729 | 1460 | 33497 | 857 | 27668 |
| 18-#14 | 3.39 | MA | 23417 | 5665 | 39232 | 4157 | 43481 | 3330 | 45602 | 2694 | 48348 | 1681 | 60143 | 959 | 49868 |
| 7L-4S | | MI | 13882 | 5665 | 24027 | 3961 | 26314 | 3155 | 27490 | 2499 | 29253 | 1469 | 35303 | 917 | 28278 |
| 18-#14 | 3.39 | MA | 22685 | 5665 | 37925 | 4156 | 41728 | 3347 | 43517 | 2710 | 45353 | 1673 | 56499 | 885 | 47878 |
| 8L-3S | | MI | 14351 | 5665 | 24855 | 3950 | 27352 | 3165 | 28718 | 2509 | 30793 | 1460 | 37008 | 1036 | 28845 |
| 18-#14 | 3.39 | MA | 21919 | 5665 | 36642 | 4155 | 40015 | 3344 | 41360 | 2705 | 42523 | 1685 | 52899 | 804 | 45731 |
| 9L-2S | | MI | 14995 | 5665 | 25868 | 3958 | 28628 | 3155 | 30238 | 2499 | 32802 | 1450 | 39613 | 1164 | 28891 |
| 18-#18 | 6.02 | MA | 26238 | 6782 | 47057 | 4854 | 53291 | 3865 | 57449 | 3012 | 64434 | 1616 | 82311 | 342 | 79550 |
| 7L-4S | | MI | 15822 | 6782 | 29391 | 4619 | 32703 | 3586 | 35070 | 2713 | 39322 | 1262 | 48246 | 278 | 46241 |
| 18-#18 | 6.02 | MA | 25014 | 6782 | 44756 | 4851 | 50205 | 3859 | 53780 | 3037 | 59164 | 1599 | 75977 | 213 | 74405 |
| 8L-3S | | MI | 16610 | 6782 | 30830 | 4601 | 34467 | 3604 | 37158 | 2731 | 41939 | 1244 | 51129 | 482 | 48194 |
| 20-#11 | 2.61 | MA | 23449 | 5336 | 38473 | 3938 | 42539 | 3184 | 44506 | 2588 | 46836 | 1689 | 57869 | 1268 | 41492 |
| 6E | | MI | 12787 | 5336 | 21543 | 3764 | 23246 | 3031 | 23886 | 2452 | 24424 | 1529 | 29234 | 1020 | 21978 |
| 20-#11 | 2.61 | MA | 22923 | 5336 | 37480 | 3952 | 41329 | 3183 | 43022 | 2600 | 44843 | 1698 | 55154 | 1181 | 40670 |
| 7L-5S | | MI | 13075 | 5336 | 22028 | 3769 | 23901 | 3038 | 24633 | 2445 | 25414 | 1522 | 30431 | 1080 | 22222 |
| 20-#11 | 2.61 | MA | 22404 | 5336 | 36569 | 3952 | 40107 | 3195 | 41570 | 2611 | 42755 | 1693 | 52599 | 1129 | 39629 |
| 8L-4S | | MI | 13376 | 5336 | 22541 | 3774 | 24558 | 3031 | 25416 | 2438 | 26494 | 1529 | 31716 | 1120 | 22677 |
| 20-#11 | 2.61 | MA | 21859 | 5336 | 35675 | 3952 | 38914 | 3193 | 40067 | 2608 | 40783 | 1702 | 50070 | 1073 | 38475 |
| 9L-3S | | MI | 13708 | 5336 | 23122 | 3765 | 25293 | 3038 | 26286 | 2445 | 27585 | 1522 | 32927 | 1205 | 22706 |
| 20-#11 | 2.61 | MA | 21276 | 5336 | 34699 | 3965 | 37708 | 3206 | 38623 | 2619 | 38825 | 1711 | 47616 | 1009 | 37286 |
| 10L-2S | | MI | 14167 | 5336 | 23834 | 3770 | 26198 | 3031 | 27363 | 2438 | 29009 | 1515 | 34781 | 1293 | 22704 |
| 20-#14 | 3.76 | MA | 24347 | 5825 | 41242 | 4257 | 46044 | 3402 | 48717 | 2739 | 52569 | 1671 | 65852 | 939 | 55770 |
| 7L-5S | | MI | 13896 | 5825 | 24308 | 4053 | 26663 | 3236 | 27907 | 2549 | 29738 | 1438 | 36102 | 810 | 30631 |
| 20-#14 | 3.76 | MA | 23622 | 5825 | 39935 | 4256 | 44291 | 3419 | 46633 | 2755 | 49573 | 1663 | 62208 | 865 | 53731 |
| 8L-4S | | MI | 14318 | 5825 | 25040 | 4061 | 27591 | 3226 | 29011 | 2539 | 31262 | 1448 | 37908 | 869 | 31201 |
| 20-#14 | 3.76 | MA | 22858 | 5825 | 38652 | 4255 | 42578 | 3417 | 44476 | 2750 | 46743 | 1675 | 58608 | 784 | 51555 |
| 9L-3S | | MI | 14784 | 5825 | 25868 | 4049 | 28628 | 3236 | 30238 | 2549 | 32802 | 1438 | 39613 | 989 | 31897 |
| 20-#14 | 3.76 | MA | 22071 | 5825 | 37251 | 4274 | 40847 | 3434 | 42404 | 2766 | 43934 | 1687 | 55116 | 692 | 49244 |
| 10L-2S | | MI | 15425 | 5825 | 26881 | 4057 | 29905 | 3226 | 31759 | 2539 | 34811 | 1428 | 42217 | 1117 | 31962 |
| 20-#18 | 6.69 | MA | 26610 | 7066 | 48280 | 5028 | 54698 | 3987 | 59241 | 3117 | 66563 | 1581 | 85868 | 171 | 84579 |
| 8L-4S | | MI | 16551 | 7066 | 31142 | 4796 | 34872 | 3708 | 37654 | 2780 | 42737 | 1218 | 52634 | 183 | 51306 |

## RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.87 | MA | 23580 | 5446 | 38883 | 4021 | 43118 | 3233 | 45198 | 2631 | 47790 | 1691 | 59163 | 1168 | 44781 |
| 7L-6S | | MI | 13100 | 5446 | 22255 | 3833 | 24151 | 3081 | 24964 | 2480 | 25848 | 1515 | 31088 | 989 | 24080 |
| 22-#11 | 2.87 | MA | 23065 | 5446 | 37973 | 4021 | 41897 | 3245 | 43745 | 2642 | 45702 | 1686 | 56608 | 1116 | 43767 |
| 8L-5S | | MI | 13387 | 5446 | 22740 | 3838 | 24806 | 3088 | 25711 | 2473 | 26838 | 1508 | 32285 | 1049 | 24311 |
| 22-#11 | 2.87 | MA | 22520 | 5446 | 37079 | 4021 | 40703 | 3244 | 42242 | 2639 | 43730 | 1695 | 54079 | 1060 | 42579 |
| 9L-4S | | MI | 13687 | 5446 | 23253 | 3843 | 25463 | 3081 | 26494 | 2466 | 27917 | 1515 | 33570 | 1090 | 24825 |
| 22-#11 | 2.87 | MA | 21944 | 5446 | 36103 | 4034 | 39497 | 3256 | 40799 | 2650 | 41772 | 1704 | 51625 | 996 | 41368 |
| 10L-3S | | MI | 14018 | 5446 | 23834 | 3834 | 26198 | 3088 | 27363 | 2473 | 29009 | 1508 | 34781 | 1174 | 24866 |
| 22-#11 | 2.87 | MA | 21388 | 5446 | 35209 | 4034 | 38311 | 3255 | 39313 | 2648 | 39714 | 1699 | 49130 | 941 | 39912 |
| 11L-2S | | MI | 14474 | 5446 | 24546 | 3839 | 27103 | 3081 | 28441 | 2466 | 30433 | 1502 | 36635 | 1263 | 24877 |
| 22-#14 | 4.14 | MA | 24552 | 5985 | 41945 | 4356 | 46854 | 3492 | 49748 | 2800 | 53794 | 1653 | 67918 | 844 | 59592 |
| 8L-5S | | MI | 14332 | 5985 | 25321 | 4153 | 27940 | 3307 | 29427 | 2589 | 31747 | 1416 | 38706 | 763 | 33600 |
| 22-#14 | 4.14 | MA | 23789 | 5985 | 40662 | 4355 | 45141 | 3489 | 47591 | 2795 | 50964 | 1665 | 64317 | 763 | 57386 |
| 9L-4S | | MI | 14751 | 5985 | 26053 | 4161 | 28867 | 3297 | 30531 | 2579 | 33271 | 1426 | 40512 | 822 | 34134 |
| 22-#14 | 4.14 | MA | 23008 | 5985 | 39261 | 4374 | 43410 | 3506 | 45520 | 2811 | 48155 | 1677 | 60826 | 672 | 55116 |
| 10L-3S | | MI | 15214 | 5985 | 26881 | 4149 | 29905 | 3307 | 31759 | 2589 | 34811 | 1416 | 42217 | 941 | 34945 |
| 24-#11 | 3.13 | MA | 23721 | 5557 | 39376 | 4090 | 43686 | 3295 | 45920 | 2673 | 48649 | 1679 | 60618 | 1102 | 47909 |
| 8L-6S | | MI | 13413 | 5557 | 22967 | 3902 | 25056 | 3131 | 26042 | 2509 | 27272 | 1502 | 32942 | 959 | 26184 |
| 24-#11 | 3.13 | MA | 23178 | 5557 | 38482 | 4090 | 42492 | 3294 | 44417 | 2670 | 46677 | 1688 | 58088 | 1046 | 46688 |
| 9L-5S | | MI | 13698 | 5557 | 23452 | 3907 | 25710 | 3138 | 26789 | 2502 | 28262 | 1495 | 34139 | 1019 | 26403 |
| 24-#11 | 3.13 | MA | 22607 | 5557 | 37506 | 4103 | 41287 | 3306 | 42974 | 2682 | 44719 | 1697 | 55634 | 983 | 45454 |
| 10L-4S | | MI | 13996 | 5557 | 23965 | 3912 | 26368 | 3131 | 27571 | 2495 | 29341 | 1502 | 35424 | 1059 | 26898 |
| 24-#11 | 3.13 | MA | 22054 | 5557 | 36612 | 4103 | 40100 | 3305 | 41488 | 2679 | 42660 | 1692 | 53140 | 928 | 44022 |
| 11L-3S | | MI | 14326 | 5557 | 24546 | 3904 | 27103 | 3138 | 28441 | 2502 | 30433 | 1495 | 36635 | 1144 | 27021 |
| 24-#11 | 3.13 | MA | 21511 | 5557 | 35651 | 4117 | 38902 | 3317 | 40048 | 2690 | 40706 | 1701 | 50396 | 854 | 42517 |
| 12L-2S | | MI | 14780 | 5557 | 25258 | 3908 | 28008 | 3131 | 29519 | 2495 | 31856 | 1488 | 38489 | 1232 | 27043 |
| 24-#14 | 4.52 | MA | 24712 | 6144 | 42672 | 4455 | 47704 | 3561 | 50707 | 2840 | 55185 | 1655 | 70027 | 743 | 63224 |
| 9L-5S | | MI | 14765 | 6144 | 26334 | 4253 | 29216 | 3378 | 30948 | 2629 | 33756 | 1395 | 41311 | 716 | 36572 |
| 24-#14 | 4.52 | MA | 23937 | 6144 | 41271 | 4474 | 45973 | 3579 | 48635 | 2856 | 52376 | 1667 | 66535 | 651 | 60994 |
| 10L-4S | | MI | 15182 | 6144 | 27065 | 4261 | 30143 | 3368 | 32052 | 2619 | 35280 | 1405 | 43117 | 775 | 37074 |

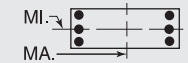
## RECTANGULAR TIED COLUMNS 26" x 48"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.28 | MA | 24728 | 4980 | 38965 | 3706 | 42534 | 3015 | 43816 | 2502 | 44645 | 1765 | 53143 | 1661 | 23295 |
| 2E | | MI | 13021 | 4980 | 21059 | 3509 | 22201 | 2839 | 22372 | 2338 | 22088 | 1606 | 25500 | 1447 | 11892 |
| 6-#14 | 1.08 | MA | 24251 | 4892 | 37782 | 3672 | 41166 | 2992 | 42207 | 2492 | 42488 | 1782 | 50459 | 1694 | 19893 |
| 2L-3S | | MI | 12172 | 4892 | 19507 | 3484 | 20440 | 2849 | 20314 | 2361 | 19380 | 1660 | 22083 | 1388 | 10334 |
| 6-#14 | 1.08 | MA | 22838 | 4892 | 35672 | 3672 | 38476 | 2990 | 38937 | 2508 | 38058 | 1794 | 44437 | 1566 | 19916 |
| 3L-2S | | MI | 12842 | 4892 | 20520 | 3492 | 21716 | 2839 | 21835 | 2351 | 21389 | 1650 | 24688 | 1516 | 10251 |
| 6-#18 | 1.92 | MA | 26445 | 5264 | 42666 | 3884 | 47252 | 3143 | 49552 | 2582 | 52416 | 1747 | 63589 | 1622 | 34588 |
| 2L-3S | | MI | 12640 | 5264 | 21059 | 3669 | 22201 | 2979 | 22372 | 2422 | 22088 | 1579 | 25500 | 1124 | 17427 |
| 6-#18 | 1.92 | MA | 24019 | 5264 | 38965 | 3882 | 42534 | 3173 | 43816 | 2608 | 44645 | 1767 | 53143 | 1394 | 34363 |
| 3L-2S | | MI | 13779 | 5264 | 22809 | 3686 | 24370 | 2961 | 24955 | 2404 | 25502 | 1562 | 29888 | 1351 | 17338 |
| 8-#11 | 1.00 | MA | 24055 | 4856 | 37286 | 3660 | 40604 | 2984 | 41552 | 2489 | 41613 | 1789 | 49369 | 1708 | 18494 |
| 2L-4S | | MI | 11952 | 4856 | 18996 | 3493 | 19875 | 2842 | 19670 | 2359 | 18593 | 1684 | 21299 | 1373 | 9682 |
| 8-#11 | 1.00 | MA | 23066 | 4856 | 35813 | 3660 | 38727 | 2983 | 39270 | 2500 | 38520 | 1799 | 45143 | 1619 | 18520 |
| 3E | | MI | 12296 | 4856 | 19577 | 3484 | 20611 | 2849 | 20540 | 2366 | 19685 | 1677 | 22510 | 1457 | 9621 |
| 8-#11 | 1.00 | MA | 22371 | 4856 | 34635 | 3674 | 37228 | 2996 | 37451 | 2498 | 36159 | 1808 | 42366 | 1531 | 18487 |
| 4L-2S | | MI | 12768 | 4856 | 20289 | 3489 | 21515 | 2842 | 21618 | 2359 | 21108 | 1670 | 24364 | 1546 | 9568 |
| 8-#14 | 1.44 | MA | 25248 | 5051 | 39892 | 3772 | 43856 | 3064 | 45477 | 2537 | 46918 | 1772 | 56480 | 1675 | 26340 |
| 2L-4S | | MI | 12138 | 5051 | 19692 | 3596 | 20678 | 2910 | 20607 | 2391 | 19849 | 1649 | 22983 | 1222 | 13524 |
| 8-#14 | 1.44 | MA | 23847 | 5051 | 37782 | 3771 | 41166 | 3062 | 42207 | 2553 | 42488 | 1784 | 50459 | 1547 | 26314 |
| 3E | | MI | 12624 | 5051 | 20520 | 3584 | 21716 | 2920 | 21835 | 2401 | 21389 | 1639 | 24688 | 1341 | 13476 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

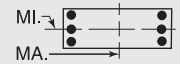



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.44 | MA | 22864 | 5051 | 36092 | 3791 | 39017 | 3080 | 39599 | 2549 | 39101 | 1797 | 46506 | 1419 | 26107 |
| 4L-2S | | MI | 13289 | 5051 | 21533 | 3592 | 22992 | 2910 | 23355 | 2391 | 23398 | 1629 | 27293 | 1469 | 13408 |
| 8-#18 | 2.56 | MA | 28132 | 5548 | 46367 | 4061 | 51971 | 3272 | 55288 | 2662 | 60187 | 1729 | 74035 | 1582 | 45828 |
| 2L-4S | | MI | 12572 | 5548 | 21371 | 3864 | 22606 | 3083 | 22868 | 2471 | 22885 | 1553 | 27005 | 824 | 21453 |
| 8-#18 | 2.56 | MA | 25740 | 5548 | 42666 | 4059 | 47252 | 3302 | 49552 | 2688 | 52416 | 1749 | 63589 | 1355 | 45484 |
| 3E | | MI | 13400 | 5548 | 22809 | 3846 | 24370 | 3101 | 24955 | 2489 | 25502 | 1535 | 29888 | 1028 | 22739 |
| 8-#18 | 2.56 | MA | 24057 | 5548 | 39695 | 4092 | 43474 | 3296 | 44967 | 2679 | 46463 | 1768 | 56747 | 1127 | 42743 |
| 4L-2S | | MI | 14527 | 5548 | 24560 | 3863 | 26538 | 3083 | 27539 | 2471 | 28917 | 1517 | 34276 | 1256 | 22729 |
| 10-#11 | 1.25 | MA | 24757 | 4966 | 38759 | 3729 | 42482 | 3034 | 43834 | 2520 | 44705 | 1783 | 53595 | 1696 | 22996 |
| 2L-5S | | MI | 11965 | 4966 | 19195 | 3557 | 20123 | 2899 | 19966 | 2395 | 18937 | 1663 | 21868 | 1302 | 11914 |
| 10-#11 | 1.25 | MA | 23774 | 4966 | 37286 | 3729 | 40604 | 3033 | 41552 | 2532 | 41613 | 1792 | 49369 | 1607 | 23001 |
| 3L-4S | | MI | 12274 | 4966 | 19708 | 3562 | 20780 | 2892 | 20748 | 2388 | 20017 | 1670 | 23153 | 1343 | 11884 |
| 10-#11 | 1.25 | MA | 23085 | 4966 | 36108 | 3743 | 39106 | 3046 | 39733 | 2529 | 39251 | 1801 | 46592 | 1519 | 22938 |
| 4L-3S | | MI | 12616 | 4966 | 20289 | 3553 | 21515 | 2899 | 21618 | 2395 | 21108 | 1663 | 24364 | 1427 | 11836 |
| 10-#11 | 1.25 | MA | 22468 | 4966 | 35077 | 3743 | 37776 | 3045 | 38104 | 2541 | 36926 | 1797 | 43716 | 1473 | 22755 |
| 5L-2S | | MI | 13085 | 4966 | 21001 | 3558 | 22420 | 2892 | 22696 | 2388 | 22532 | 1656 | 26218 | 1515 | 11788 |
| 10-#14 | 1.80 | MA | 26234 | 5211 | 42002 | 3872 | 46546 | 3136 | 48747 | 2581 | 51348 | 1762 | 62502 | 1656 | 32769 |
| 2L-5S | | MI | 12153 | 5211 | 19973 | 3687 | 21027 | 2991 | 21024 | 2441 | 20334 | 1617 | 23782 | 1115 | 16018 |
| 10-#14 | 1.80 | MA | 24845 | 5211 | 39892 | 3871 | 43856 | 3134 | 45477 | 2597 | 46918 | 1774 | 56480 | 1528 | 32699 |
| 3L-4S | | MI | 12590 | 5211 | 20705 | 3695 | 21955 | 2981 | 22128 | 2432 | 21858 | 1627 | 25588 | 1175 | 16605 |
| 10-#14 | 1.80 | MA | 23871 | 5211 | 38202 | 3891 | 41707 | 3152 | 42869 | 2594 | 43531 | 1787 | 52528 | 1400 | 32443 |
| 4L-3S | | MI | 13072 | 5211 | 21533 | 3684 | 22992 | 2991 | 23355 | 2441 | 23398 | 1617 | 27293 | 1294 | 16592 |
| 10-#14 | 1.80 | MA | 23000 | 5211 | 36723 | 3890 | 39798 | 3150 | 40531 | 2610 | 40195 | 1779 | 48422 | 1335 | 30991 |
| 5L-2S | | MI | 13733 | 5211 | 22545 | 3692 | 24268 | 2981 | 24876 | 2432 | 25407 | 1607 | 29897 | 1422 | 16541 |
| 10-#18 | 3.21 | MA | 27433 | 5831 | 46367 | 4236 | 51971 | 3430 | 55288 | 2768 | 60187 | 1731 | 74035 | 1315 | 56597 |
| 3L-4S | | MI | 13332 | 5831 | 23121 | 4041 | 24774 | 3206 | 25452 | 2538 | 26300 | 1509 | 31393 | 728 | 26384 |
| 10-#18 | 3.21 | MA | 25775 | 5831 | 43396 | 4269 | 48193 | 3424 | 50703 | 2759 | 54234 | 1751 | 67193 | 1088 | 53443 |
| 4L-3S | | MI | 14151 | 5831 | 24560 | 4023 | 26538 | 3223 | 27539 | 2555 | 28917 | 1491 | 34276 | 933 | 28016 |
| 10-#18 | 3.21 | MA | 24292 | 5831 | 40792 | 4267 | 44834 | 3454 | 46590 | 2785 | 48365 | 1735 | 60046 | 976 | 50321 |
| 5L-2S | | MI | 15268 | 5831 | 26310 | 4041 | 28707 | 3206 | 30123 | 2538 | 32331 | 1473 | 38663 | 1160 | 28086 |
| 12-#11 | 1.50 | MA | 25453 | 5077 | 40231 | 3798 | 44359 | 3084 | 46117 | 2551 | 47797 | 1776 | 57821 | 1684 | 27488 |
| 2L-6S | | MI | 11992 | 5077 | 19422 | 3621 | 20373 | 2942 | 20296 | 2430 | 19372 | 1656 | 22525 | 1211 | 13690 |
| 12-#11 | 1.50 | MA | 24476 | 5077 | 38759 | 3798 | 42482 | 3083 | 43834 | 2563 | 44705 | 1785 | 53595 | 1595 | 27471 |
| 3L-5S | | MI | 12286 | 5077 | 19907 | 3626 | 21027 | 2949 | 21043 | 2424 | 20361 | 1649 | 23721 | 1271 | 14020 |
| 12-#11 | 1.50 | MA | 23791 | 5077 | 37581 | 3812 | 40983 | 3096 | 42016 | 2560 | 42343 | 1794 | 50818 | 1506 | 27384 |
| 4E | | MI | 12594 | 5077 | 20420 | 3631 | 21685 | 2942 | 21826 | 2417 | 21441 | 1656 | 25007 | 1312 | 14071 |
| 12-#11 | 1.50 | MA | 23180 | 5077 | 36550 | 3812 | 39653 | 3095 | 40387 | 2572 | 40018 | 1790 | 47941 | 1461 | 27156 |
| 5L-3S | | MI | 12934 | 5077 | 21001 | 3622 | 22420 | 2949 | 22696 | 2424 | 22532 | 1649 | 26218 | 1396 | 14036 |
| 12-#11 | 1.50 | MA | 22597 | 5077 | 35578 | 3812 | 38332 | 3107 | 38775 | 2570 | 37883 | 1799 | 45188 | 1403 | 26155 |
| 6L-2S | | MI | 13402 | 5077 | 21713 | 3627 | 23325 | 2942 | 23773 | 2417 | 23956 | 1642 | 28072 | 1485 | 13995 |
| 12-#14 | 2.16 | MA | 25832 | 5370 | 42002 | 3971 | 46546 | 3207 | 48747 | 2642 | 51348 | 1764 | 62502 | 1509 | 39075 |
| 3L-5S | | MI | 12604 | 5370 | 20986 | 3787 | 22303 | 3062 | 22545 | 2482 | 22343 | 1596 | 26387 | 1068 | 18946 |
| 12-#14 | 2.16 | MA | 24867 | 5370 | 40312 | 3990 | 44397 | 3224 | 46139 | 2638 | 47962 | 1777 | 58549 | 1381 | 38776 |
| 4E | | MI | 13038 | 5370 | 21717 | 3795 | 23231 | 3052 | 23648 | 2472 | 23867 | 1605 | 28193 | 1127 | 19667 |
| 12-#14 | 2.16 | MA | 24005 | 5370 | 38833 | 3990 | 42488 | 3222 | 43801 | 2655 | 44625 | 1769 | 54444 | 1316 | 37173 |
| 5L-3S | | MI | 13517 | 5370 | 22545 | 3783 | 24268 | 3062 | 24876 | 2482 | 25407 | 1596 | 29897 | 1247 | 19691 |
| 12-#14 | 2.16 | MA | 23182 | 5370 | 37437 | 3990 | 40591 | 3240 | 41487 | 2651 | 41562 | 1782 | 50523 | 1232 | 35944 |
| 6L-2S | | MI | 14174 | 5370 | 23558 | 3791 | 25545 | 3052 | 26396 | 2472 | 27415 | 1586 | 32502 | 1375 | 19658 |
| 12-#18 | 3.85 | MA | 27467 | 6115 | 47097 | 4447 | 52911 | 3553 | 56439 | 2838 | 62004 | 1733 | 77639 | 1048 | 64186 |
| 4E | | MI | 14084 | 6115 | 24872 | 4219 | 26943 | 3328 | 28036 | 2605 | 29714 | 1465 | 35780 | 633 | 31356 |
| 12-#18 | 3.85 | MA | 26006 | 6115 | 44493 | 4444 | 49552 | 3583 | 52326 | 2865 | 56136 | 1717 | 70492 | 936 | 61217 |
| 5L-3S | | MI | 14895 | 6115 | 26310 | 4201 | 28707 | 3345 | 30123 | 2622 | 32331 | 1447 | 38663 | 837 | 33271 |
| 12-#18 | 3.85 | MA | 24613 | 6115 | 42036 | 4442 | 46214 | 3577 | 48254 | 2856 | 50745 | 1737 | 63697 | 786 | 56541 |
| 6L-2S | | MI | 16003 | 6115 | 28060 | 4218 | 30875 | 3328 | 32707 | 2605 | 35746 | 1429 | 43051 | 1065 | 33409 |
| 14-#11 | 1.75 | MA | 25172 | 5187 | 40231 | 3868 | 44359 | 3133 | 46117 | 2594 | 47797 | 1778 | 57821 | 1583 | 31935 |
| 3L-6S | | MI | 12313 | 5187 | 20134 | 3690 | 21278 | 2992 | 21374 | 2459 | 20795 | 1642 | 24379 | 1181 | 15780 |
| 14-#11 | 1.75 | MA | 24493 | 5187 | 39053 | 3881 | 42861 | 3146 | 44298 | 2592 | 45436 | 1787 | 55044 | 1494 | 31826 |
| 4L-5S | | MI | 12606 | 5187 | 20619 | 3695 | 21932 | 2999 | 22121 | 2452 | 21785 | 1635 | 25575 | 1241 | 16085 |

## RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

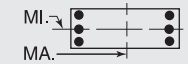



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.75 | MA | 23885 | 5187 | 38022 | 3881 | 41531 | 3145 | 42669 | 2603 | 43110 | 1783 | 52167 | 1449 | 31465 |
| 5L-4S | | MI | 12912 | 5187 | 21132 | 3700 | 22590 | 2992 | 22904 | 2445 | 22864 | 1642 | 26861 | 1282 | 16249 |
| 14-#11 | 1.75 | MA | 23307 | 5187 | 37050 | 3881 | 40209 | 3158 | 41057 | 2601 | 40976 | 1792 | 49414 | 1391 | 30506 |
| 6L-3S | | MI | 13250 | 5187 | 21713 | 3692 | 23325 | 2999 | 23773 | 2452 | 23956 | 1635 | 28072 | 1366 | 16226 |
| 14-#11 | 1.75 | MA | 22743 | 5187 | 36010 | 3895 | 38941 | 3156 | 39502 | 2612 | 38887 | 1801 | 46551 | 1303 | 29878 |
| 7L-2S | | MI | 13716 | 5187 | 22425 | 3697 | 24230 | 2992 | 24851 | 2445 | 25380 | 1629 | 29926 | 1454 | 16192 |
| 14-#14 | 2.52 | MA | 25853 | 5530 | 42422 | 4090 | 47087 | 3297 | 49409 | 2683 | 52392 | 1767 | 64571 | 1362 | 45108 |
| 4L-5S | | MI | 13052 | 5530 | 21998 | 3887 | 23580 | 3133 | 24065 | 2522 | 24352 | 1574 | 28991 | 1021 | 21886 |
| 14-#14 | 2.52 | MA | 24999 | 5530 | 40943 | 4090 | 45178 | 3295 | 47071 | 2699 | 49056 | 1760 | 60465 | 1297 | 43371 |
| 5L-4S | | MI | 13483 | 5530 | 22730 | 3895 | 24507 | 3123 | 25169 | 2512 | 25875 | 1584 | 30797 | 1080 | 22614 |
| 14-#14 | 2.52 | MA | 24185 | 5530 | 39547 | 4089 | 43281 | 3312 | 44757 | 2696 | 45992 | 1772 | 56544 | 1213 | 42189 |
| 6L-3S | | MI | 13958 | 5530 | 23558 | 3883 | 25545 | 3133 | 26396 | 2522 | 27415 | 1574 | 32502 | 1199 | 22774 |
| 14-#14 | 2.52 | MA | 23390 | 5530 | 38054 | 4109 | 41461 | 3310 | 42526 | 2712 | 42995 | 1785 | 52466 | 1087 | 40169 |
| 7L-2S | | MI | 14611 | 5530 | 24571 | 3891 | 26821 | 3123 | 27917 | 2512 | 29424 | 1564 | 35106 | 1327 | 22763 |
| 14-#18 | 4.49 | MA | 27696 | 6399 | 48194 | 4622 | 54271 | 3711 | 58062 | 2945 | 63907 | 1699 | 80938 | 897 | 72089 |
| 5L-4S | | MI | 14830 | 6399 | 26622 | 4396 | 29111 | 3450 | 30620 | 2671 | 33129 | 1421 | 40168 | 537 | 36360 |
| 14-#18 | 4.49 | MA | 26323 | 6399 | 45737 | 4619 | 50933 | 3706 | 53990 | 2935 | 58516 | 1719 | 74143 | 747 | 67323 |
| 6L-3S | | MI | 15634 | 6399 | 28060 | 4378 | 30875 | 3468 | 32707 | 2689 | 35746 | 1403 | 43051 | 742 | 38512 |
| 14-#18 | 4.49 | MA | 24983 | 6399 | 43107 | 4653 | 47727 | 3735 | 50062 | 2962 | 53240 | 1738 | 67071 | 522 | 62658 |
| 7L-2S | | MI | 16732 | 6399 | 29811 | 4395 | 33043 | 3450 | 35291 | 2671 | 39161 | 1385 | 47439 | 969 | 38707 |
| 16-#11 | 2.00 | MA | 25188 | 5298 | 40526 | 3950 | 44739 | 3196 | 46581 | 2623 | 48528 | 1780 | 59270 | 1482 | 36265 |
| 4L-6S | | MI | 12632 | 5298 | 20846 | 3760 | 22182 | 3042 | 22452 | 2488 | 22219 | 1629 | 26233 | 1150 | 17874 |
| 16-#11 | 2.00 | MA | 24586 | 5298 | 39495 | 3950 | 43408 | 3195 | 44951 | 2634 | 46202 | 1776 | 56393 | 1437 | 35785 |
| 5E | | MI | 12924 | 5298 | 21331 | 3765 | 22837 | 3049 | 23199 | 2481 | 23209 | 1622 | 27429 | 1210 | 18157 |
| 16-#11 | 2.00 | MA | 24011 | 5298 | 38523 | 3950 | 42087 | 3208 | 43339 | 2632 | 44068 | 1785 | 53640 | 1379 | 34863 |
| 6L-4S | | MI | 13228 | 5298 | 21844 | 3770 | 23494 | 3042 | 23981 | 2474 | 24288 | 1629 | 28715 | 1251 | 18417 |
| 16-#11 | 2.00 | MA | 23451 | 5298 | 37482 | 3964 | 40819 | 3207 | 41785 | 2643 | 41979 | 1794 | 50777 | 1291 | 34225 |
| 7L-3S | | MI | 13565 | 5298 | 22425 | 3761 | 24230 | 3049 | 24851 | 2481 | 25380 | 1622 | 29926 | 1335 | 18408 |
| 16-#11 | 2.00 | MA | 22899 | 5298 | 36529 | 3964 | 39539 | 3219 | 40263 | 2655 | 39791 | 1790 | 48088 | 1239 | 33031 |
| 8L-2S | | MI | 14028 | 5298 | 23137 | 3766 | 25134 | 3042 | 25929 | 2474 | 26804 | 1615 | 31780 | 1424 | 18382 |
| 16-#14 | 2.88 | MA | 25983 | 5690 | 43053 | 4189 | 47868 | 3367 | 50341 | 2744 | 53486 | 1750 | 66487 | 1278 | 49582 |
| 5E | | MI | 13496 | 5690 | 23011 | 3987 | 24856 | 3204 | 25586 | 2562 | 26361 | 1553 | 31596 | 974 | 24836 |
| 16-#14 | 2.88 | MA | 25177 | 5690 | 41657 | 4189 | 45971 | 3385 | 48028 | 2740 | 50422 | 1762 | 62566 | 1194 | 48442 |
| 6L-4S | | MI | 13924 | 5690 | 23743 | 3995 | 25783 | 3194 | 26689 | 2552 | 27884 | 1562 | 33402 | 1033 | 25511 |
| 16-#14 | 2.88 | MA | 24390 | 5690 | 40163 | 4209 | 44151 | 3382 | 45796 | 2756 | 47425 | 1775 | 58487 | 1068 | 46351 |
| 7L-3S | | MI | 14397 | 5690 | 24571 | 3983 | 26821 | 3204 | 27917 | 2562 | 29424 | 1553 | 35106 | 1152 | 25844 |
| 16-#14 | 2.88 | MA | 23615 | 5690 | 38794 | 4208 | 42314 | 3400 | 43612 | 2772 | 44285 | 1767 | 54650 | 993 | 44431 |
| 8L-2S | | MI | 15046 | 5690 | 25584 | 3991 | 28097 | 3194 | 29437 | 2552 | 31433 | 1543 | 37711 | 1280 | 25858 |
| 16-#18 | 5.13 | MA | 28011 | 6683 | 49438 | 4797 | 55651 | 3834 | 59726 | 3015 | 66287 | 1701 | 84589 | 707 | 78126 |
| 6L-4S | | MI | 15569 | 6683 | 28372 | 4573 | 31279 | 3572 | 33203 | 2738 | 36544 | 1376 | 44556 | 442 | 41388 |
| 16-#18 | 5.13 | MA | 26690 | 6683 | 46808 | 4830 | 52446 | 3864 | 55798 | 3042 | 61011 | 1721 | 77517 | 483 | 73376 |
| 7L-3S | | MI | 16367 | 6683 | 29811 | 4555 | 33043 | 3590 | 35291 | 2756 | 39161 | 1359 | 47439 | 646 | 43566 |
| 16-#18 | 5.13 | MA | 25386 | 6683 | 44396 | 4828 | 49211 | 3858 | 51952 | 3068 | 55485 | 1705 | 70838 | 352 | 68163 |
| 8L-2S | | MI | 17456 | 6683 | 31561 | 4573 | 35212 | 3572 | 37874 | 2738 | 42575 | 1341 | 51826 | 874 | 43991 |
| 18-#11 | 2.25 | MA | 25280 | 5409 | 40968 | 4020 | 45286 | 3245 | 47234 | 2665 | 49295 | 1769 | 60619 | 1425 | 40114 |
| 5L-6S | | MI | 12950 | 5409 | 21558 | 3829 | 23087 | 3092 | 23529 | 2516 | 23643 | 1615 | 28086 | 1120 | 19972 |
| 18-#11 | 2.25 | MA | 24710 | 5409 | 39996 | 4020 | 43965 | 3258 | 45622 | 2663 | 47160 | 1778 | 57866 | 1367 | 39227 |
| 6L-5S | | MI | 13240 | 5409 | 22043 | 3834 | 23742 | 3099 | 24277 | 2510 | 24632 | 1608 | 29283 | 1180 | 20237 |
| 18-#11 | 2.25 | MA | 24154 | 5409 | 38955 | 4033 | 42696 | 3257 | 44067 | 2675 | 45071 | 1787 | 55003 | 1279 | 38528 |
| 7L-4S | | MI | 13543 | 5409 | 22556 | 3839 | 24399 | 3092 | 25059 | 2503 | 25712 | 1615 | 30569 | 1220 | 20577 |
| 18-#11 | 2.25 | MA | 23606 | 5409 | 38001 | 4033 | 41416 | 3269 | 42545 | 2686 | 42884 | 1783 | 52314 | 1227 | 37365 |
| 8L-3S | | MI | 13878 | 5409 | 23137 | 3830 | 25134 | 3099 | 25929 | 2510 | 26804 | 1608 | 31780 | 1305 | 20584 |
| 18-#11 | 2.25 | MA | 23012 | 5409 | 37065 | 4033 | 40166 | 3268 | 40970 | 2684 | 40817 | 1792 | 49647 | 1171 | 36277 |
| 9L-2S | | MI | 14339 | 5409 | 23848 | 3835 | 26039 | 3092 | 27007 | 2503 | 28227 | 1601 | 33634 | 1393 | 20566 |
| 18-#14 | 3.25 | MA | 26160 | 5849 | 43767 | 4289 | 48661 | 3457 | 51298 | 2785 | 54852 | 1752 | 68587 | 1175 | 54634 |
| 6L-5S | | MI | 13938 | 5849 | 24024 | 4086 | 26132 | 3274 | 27106 | 2602 | 28369 | 1531 | 34200 | 926 | 27793 |
| 18-#14 | 3.25 | MA | 25381 | 5849 | 42273 | 4308 | 46841 | 3455 | 49066 | 2801 | 51855 | 1765 | 64509 | 1049 | 52543 |
| 7L-4S | | MI | 14363 | 5849 | 24755 | 4094 | 27060 | 3265 | 28210 | 2592 | 29893 | 1541 | 36006 | 986 | 28422 |


## RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

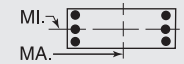


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 3.25 | MA | 24612 | 5849 | 40904 | 4308 | 45004 | 3473 | 46882 | 2817 | 48715 | 1757 | 60671 | 974 | 50574 |
| 8L-3S | | MI | 14833 | 5849 | 25584 | 4083 | 28097 | 3274 | 29437 | 2602 | 31433 | 1531 | 37711 | 1105 | 28906 |
| 18-#14 | 3.25 | MA | 23798 | 5849 | 39560 | 4307 | 43209 | 3470 | 44621 | 2813 | 45750 | 1770 | 56872 | 893 | 48430 |
| 9L-2S | | MI | 15479 | 5849 | 26596 | 4091 | 29374 | 3265 | 30958 | 2592 | 33442 | 1521 | 40316 | 1233 | 28944 |
| 18-#18 | 5.77 | MA | 28375 | 6966 | 50509 | 5007 | 57164 | 3992 | 61534 | 3121 | 68782 | 1703 | 87963 | 443 | 84113 |
| 7L-4S | | MI | 16304 | 6966 | 30123 | 4750 | 33448 | 3694 | 35787 | 2805 | 39958 | 1332 | 48943 | 346 | 46436 |
| 18-#18 | 5.77 | MA | 27089 | 6966 | 48097 | 5005 | 53930 | 3987 | 57687 | 3148 | 63256 | 1687 | 81284 | 313 | 78854 |
| 8L-3S | | MI | 17095 | 6966 | 31561 | 4733 | 35212 | 3712 | 37874 | 2822 | 42575 | 1315 | 51826 | 550 | 48456 |
| 20-#11 | 2.50 | MA | 25404 | 5519 | 41468 | 4089 | 45842 | 3308 | 47904 | 2694 | 50252 | 1771 | 62092 | 1354 | 43595 |
| 6E | | MI | 13266 | 5519 | 22270 | 3898 | 23992 | 3141 | 24607 | 2545 | 25067 | 1601 | 29940 | 1089 | 22073 |
| 20-#11 | 2.50 | MA | 24852 | 5519 | 40428 | 4103 | 44574 | 3307 | 46349 | 2706 | 48164 | 1781 | 59229 | 1267 | 42838 |
| 7L-5S | | MI | 13554 | 5519 | 22755 | 3903 | 24646 | 3148 | 25355 | 2538 | 26056 | 1594 | 31137 | 1149 | 22322 |
| 20-#11 | 2.50 | MA | 24308 | 5519 | 39474 | 4103 | 43294 | 3320 | 44828 | 2717 | 45976 | 1776 | 56540 | 1214 | 41705 |
| 8L-4S | | MI | 13856 | 5519 | 23268 | 3908 | 25304 | 3141 | 26137 | 2531 | 27136 | 1601 | 32423 | 1190 | 22731 |
| 20-#11 | 2.50 | MA | 23717 | 5519 | 38538 | 4103 | 42044 | 3318 | 43253 | 2715 | 43909 | 1785 | 53873 | 1158 | 40582 |
| 9L-3S | | MI | 14189 | 5519 | 23848 | 3899 | 26039 | 3148 | 27007 | 2538 | 28227 | 1594 | 33634 | 1274 | 22756 |
| 20-#11 | 2.50 | MA | 23116 | 5519 | 37515 | 4116 | 40780 | 3331 | 41741 | 2726 | 41859 | 1795 | 51285 | 1095 | 39345 |
| 10L-2S | | MI | 14649 | 5519 | 24560 | 3904 | 26944 | 3141 | 28084 | 2531 | 29651 | 1587 | 35488 | 1363 | 22745 |
| 20-#14 | 3.61 | MA | 26362 | 6009 | 44383 | 4408 | 49531 | 3527 | 52336 | 2846 | 56285 | 1755 | 70531 | 1030 | 58743 |
| 7L-5S | | MI | 14377 | 6009 | 25037 | 4186 | 27409 | 3345 | 28627 | 2642 | 30378 | 1509 | 36805 | 879 | 30757 |
| 20-#14 | 3.61 | MA | 25601 | 6009 | 43014 | 4408 | 47694 | 3545 | 50152 | 2862 | 53146 | 1747 | 66693 | 955 | 56724 |
| 8L-4S | | MI | 14799 | 6009 | 25768 | 4194 | 28336 | 3335 | 29730 | 2632 | 31902 | 1519 | 38611 | 938 | 31345 |
| 20-#14 | 3.61 | MA | 24788 | 6009 | 41669 | 4407 | 45899 | 3543 | 47891 | 2858 | 50180 | 1760 | 62894 | 874 | 54552 |
| 9L-3S | | MI | 15267 | 6009 | 26596 | 4182 | 29374 | 3345 | 30958 | 2642 | 33442 | 1509 | 40316 | 1058 | 31962 |
| 20-#14 | 3.61 | MA | 23961 | 6009 | 40202 | 4427 | 44085 | 3560 | 45721 | 2874 | 47236 | 1773 | 59209 | 783 | 52047 |
| 10L-2S | | MI | 15909 | 6009 | 27609 | 4190 | 30650 | 3335 | 32478 | 2632 | 35451 | 1500 | 42920 | 1186 | 32017 |
| 20-#18 | 6.41 | MA | 28772 | 7250 | 51798 | 5182 | 58648 | 4115 | 63423 | 3228 | 71027 | 1670 | 91730 | 273 | 89561 |
| 8L-4S | | MI | 17034 | 7250 | 31873 | 4928 | 35616 | 3816 | 38371 | 2871 | 43373 | 1288 | 53331 | 251 | 51499 |
| 22-#11 | 2.75 | MA | 25545 | 5630 | 41900 | 4172 | 46451 | 3357 | 48632 | 2737 | 51256 | 1774 | 63455 | 1255 | 47155 |
| 7L-6S | | MI | 13580 | 5630 | 22982 | 3967 | 24897 | 3191 | 25685 | 2574 | 26490 | 1587 | 31794 | 1059 | 24176 |
| 22-#11 | 2.75 | MA | 25004 | 5630 | 40947 | 4172 | 45171 | 3370 | 47110 | 2748 | 49068 | 1769 | 60766 | 1202 | 46050 |
| 8L-5S | | MI | 13867 | 5630 | 23467 | 3972 | 25551 | 3198 | 26432 | 2567 | 27480 | 1580 | 32991 | 1119 | 24411 |
| 22-#11 | 2.75 | MA | 24426 | 5630 | 40010 | 4172 | 43921 | 3369 | 45535 | 2746 | 47002 | 1778 | 58099 | 1146 | 44893 |
| 9L-4S | | MI | 14167 | 5630 | 23980 | 3977 | 26209 | 3191 | 27215 | 2560 | 28560 | 1587 | 34276 | 1159 | 24882 |
| 22-#11 | 2.75 | MA | 23820 | 5630 | 38988 | 4186 | 42658 | 3381 | 44023 | 2758 | 44951 | 1788 | 55511 | 1083 | 43680 |
| 10L-3S | | MI | 14499 | 5630 | 24560 | 3968 | 26944 | 3198 | 28084 | 2567 | 29651 | 1580 | 35488 | 1244 | 24915 |
| 22-#11 | 2.75 | MA | 23235 | 5630 | 38052 | 4186 | 41415 | 3380 | 42467 | 2755 | 42794 | 1783 | 52884 | 1028 | 42132 |
| 11L-2S | | MI | 14957 | 5630 | 25272 | 3973 | 27849 | 3191 | 29162 | 2560 | 31075 | 1573 | 37341 | 1332 | 24920 |
| 22-#14 | 3.97 | MA | 26581 | 6168 | 45124 | 4507 | 50384 | 3617 | 53422 | 2907 | 57576 | 1738 | 72715 | 936 | 62883 |
| 8L-5S | | MI | 14813 | 6168 | 26049 | 4286 | 28685 | 3416 | 30147 | 2682 | 32387 | 1488 | 39410 | 832 | 33726 |
| 22-#14 | 3.97 | MA | 25770 | 6168 | 43779 | 4507 | 48589 | 3615 | 51161 | 2903 | 54610 | 1750 | 68916 | 855 | 60682 |
| 9L-4S | | MI | 15233 | 6168 | 26781 | 4294 | 29612 | 3406 | 31251 | 2672 | 33911 | 1498 | 41216 | 891 | 34277 |
| 22-#14 | 3.97 | MA | 24949 | 6168 | 42311 | 4526 | 46775 | 3633 | 48991 | 2919 | 51666 | 1763 | 65231 | 764 | 58218 |
| 10L-3S | | MI | 15698 | 6168 | 27609 | 4282 | 30650 | 3416 | 32478 | 2682 | 35451 | 1488 | 42920 | 1010 | 35012 |
| 24-#11 | 3.00 | MA | 25696 | 5741 | 42419 | 4241 | 47049 | 3420 | 49392 | 2779 | 52160 | 1762 | 64992 | 1190 | 50399 |
| 8L-6S | | MI | 13893 | 5741 | 23694 | 4036 | 25801 | 3241 | 26763 | 2602 | 27914 | 1573 | 33648 | 1028 | 26280 |
| 24-#11 | 3.00 | MA | 25119 | 5741 | 41483 | 4241 | 45799 | 3419 | 47818 | 2777 | 50094 | 1771 | 62325 | 1134 | 49208 |
| 9L-5S | | MI | 14179 | 5741 | 24179 | 4041 | 26456 | 3248 | 27510 | 2595 | 28904 | 1566 | 34845 | 1088 | 26503 |
| 24-#11 | 3.00 | MA | 24519 | 5741 | 40460 | 4255 | 44535 | 3431 | 46305 | 2789 | 48043 | 1781 | 59737 | 1071 | 47980 |
| 10L-4S | | MI | 14477 | 5741 | 24691 | 4046 | 27113 | 3241 | 28292 | 2589 | 29983 | 1573 | 36130 | 1129 | 27015 |
| 24-#11 | 3.00 | MA | 23938 | 5741 | 39524 | 4255 | 43292 | 3430 | 44749 | 2786 | 45886 | 1776 | 57110 | 1015 | 46450 |
| 11L-3S | | MI | 14808 | 5741 | 25272 | 4037 | 27849 | 3248 | 29162 | 2595 | 31075 | 1566 | 37341 | 1213 | 27073 |
| 24-#11 | 3.00 | MA | 23367 | 5741 | 38517 | 4269 | 42038 | 3443 | 43240 | 2798 | 43838 | 1785 | 54219 | 941 | 44945 |
| 12L-2S | | MI | 15263 | 5741 | 25984 | 4042 | 28753 | 3241 | 30240 | 2589 | 32499 | 1560 | 39195 | 1302 | 27092 |
| 24-#14 | 4.33 | MA | 26744 | 6328 | 45889 | 4607 | 51279 | 3687 | 54431 | 2948 | 59040 | 1740 | 74937 | 836 | 66818 |
| 9L-5S | | MI | 15247 | 6328 | 27062 | 4386 | 29961 | 3487 | 31668 | 2722 | 34396 | 1466 | 42014 | 785 | 36698 |
| 24-#14 | 4.33 | MA | 25929 | 6328 | 44421 | 4626 | 49465 | 3705 | 52261 | 2964 | 56097 | 1753 | 71252 | 744 | 64396 |
| 10L-4S | | MI | 15665 | 6328 | 27794 | 4394 | 30889 | 3477 | 32771 | 2712 | 35920 | 1476 | 43820 | 844 | 37216 |

## RECTANGULAR TIED COLUMNS 28" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.19 | MA | 8836 | 3104 | 14103 | 2242 | 15102 | 1824 | 15325 | 1511 | 15212 | 1056 | 17738 | 974 | 7692 |
| 2L-3S | | MI | 8319 | 3104 | 13322 | 2238 | 14106 | 1832 | 14130 | 1518 | 13633 | 1063 | 15670 | 885 | 7740 |
| 6-#14 | 1.72 | MA | 9269 | 3251 | 15124 | 2323 | 16365 | 1882 | 16789 | 1540 | 17140 | 1029 | 20225 | 923 | 10820 |
| 2L-3S | | MI | 8542 | 3251 | 14012 | 2316 | 14946 | 1892 | 15098 | 1549 | 14908 | 1039 | 17313 | 795 | 10857 |
| 6-#18 | 3.06 | MA | 10301 | 3623 | 17621 | 2533 | 19361 | 2022 | 20329 | 1609 | 21811 | 956 | 26191 | 780 | 18450 |
| 2L-3S | | MI | 9070 | 3623 | 15694 | 2518 | 16940 | 2039 | 17445 | 1627 | 18000 | 974 | 21259 | 552 | 18274 |
| 8-#11 | 1.59 | MA | 9186 | 3215 | 14884 | 2311 | 16098 | 1875 | 16521 | 1541 | 16791 | 1044 | 19806 | 946 | 10105 |
| 2L-4S | | MI | 8303 | 3215 | 13468 | 2317 | 14295 | 1876 | 14361 | 1541 | 14001 | 1057 | 16390 | 772 | 10124 |
| 8-#14 | 2.30 | MA | 9758 | 3411 | 16237 | 2422 | 17783 | 1954 | 18479 | 1581 | 19373 | 1010 | 23137 | 880 | 14235 |
| 2L-4S | | MI | 8517 | 3411 | 14217 | 2429 | 15212 | 1954 | 15425 | 1581 | 15429 | 1030 | 18324 | 630 | 13643 |
| 8-#18 | 4.08 | MA | 11116 | 3907 | 19549 | 2710 | 21782 | 2147 | 23213 | 1679 | 25622 | 917 | 31123 | 694 | 24298 |
| 2L-4S | | MI | 9024 | 3907 | 16043 | 2716 | 17393 | 2147 | 18000 | 1679 | 18890 | 952 | 22960 | 256 | 21219 |
| 10-#11 | 1.99 | MA | 9532 | 3325 | 15665 | 2381 | 17094 | 1925 | 17716 | 1571 | 18370 | 1031 | 21873 | 919 | 12504 |
| 2L-5S | | MI | 8326 | 3325 | 13689 | 2382 | 14569 | 1934 | 14688 | 1578 | 14383 | 1038 | 17024 | 704 | 11884 |
| 10-#11 | 1.99 | MA | 9024 | 3325 | 14884 | 2376 | 16098 | 1932 | 16521 | 1578 | 16791 | 1038 | 19806 | 830 | 12521 |
| 3L-4S | | MI | 8657 | 3325 | 14249 | 2386 | 15291 | 1926 | 15556 | 1571 | 15580 | 1045 | 18458 | 744 | 12476 |
| 10-#14 | 2.87 | MA | 10241 | 3570 | 17349 | 2522 | 19201 | 2026 | 20169 | 1623 | 21606 | 991 | 26050 | 837 | 17633 |
| 2L-5S | | MI | 8548 | 3570 | 14530 | 2522 | 15600 | 2036 | 15888 | 1633 | 15969 | 1001 | 19217 | 529 | 16031 |
| 10-#14 | 2.87 | MA | 9528 | 3570 | 16237 | 2515 | 17783 | 2036 | 18479 | 1633 | 19373 | 1001 | 23137 | 709 | 17582 |
| 3L-4S | | MI | 9013 | 3570 | 15330 | 2528 | 16631 | 2026 | 17115 | 1623 | 17661 | 1011 | 21236 | 587 | 16789 |
| 10-#18 | 5.10 | MA | 10725 | 4191 | 19549 | 2872 | 21782 | 2290 | 23213 | 1767 | 25622 | 895 | 31123 | 380 | 29095 |
| 3L-4S | | MI | 9858 | 4191 | 17971 | 2893 | 19813 | 2272 | 20885 | 1750 | 22701 | 913 | 27892 | 169 | 26707 |

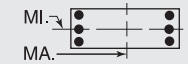
## RECTANGULAR TIED COLUMNS 28" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.07 | MA | 10026 | 3289 | 15913 | 2384 | 17000 | 1942 | 17203 | 1613 | 16950 | 1139 | 19701 | 1057 | 7986 |
| 2E | | MI | 9330 | 3289 | 14854 | 2367 | 15811 | 1928 | 15935 | 1599 | 15654 | 1126 | 18133 | 1040 | 7411 |
| 4-#18 | 1.90 | MA | 10801 | 3538 | 17757 | 2516 | 19247 | 2034 | 19811 | 1657 | 20385 | 1090 | 24117 | 965 | 13624 |
| 2E | | MI | 10030 | 3538 | 16539 | 2498 | 17804 | 2014 | 18279 | 1639 | 18742 | 1072 | 22073 | 940 | 12592 |
| 6-#11 | 1.11 | MA | 10092 | 3302 | 16009 | 2403 | 17165 | 1957 | 17445 | 1627 | 17274 | 1146 | 20155 | 1065 | 8324 |
| 2L-3S | | MI | 8874 | 3302 | 14162 | 2383 | 14972 | 1952 | 14968 | 1620 | 14381 | 1141 | 16494 | 961 | 7773 |
| 6-#11 | 1.11 | MA | 9528 | 3302 | 15158 | 2400 | 16081 | 1965 | 16131 | 1634 | 15540 | 1153 | 17873 | 976 | 8371 |
| 3L-2S | | MI | 9391 | 3302 | 14943 | 2388 | 15967 | 1944 | 16164 | 1613 | 15960 | 1134 | 18562 | 1049 | 7723 |
| 6-#14 | 1.61 | MA | 10571 | 3449 | 17125 | 2484 | 18545 | 2014 | 19063 | 1656 | 19407 | 1121 | 22922 | 1018 | 11732 |
| 2L-3S | | MI | 9097 | 3449 | 14854 | 2460 | 15811 | 2011 | 15935 | 1650 | 15654 | 1117 | 18133 | 870 | 10906 |
| 6-#14 | 1.61 | MA | 9776 | 3449 | 15913 | 2478 | 17000 | 2025 | 17203 | 1666 | 16950 | 1131 | 19701 | 890 | 11768 |
| 3L-2S | | MI | 9826 | 3449 | 15966 | 2467 | 17230 | 2001 | 17626 | 1641 | 17886 | 1107 | 21046 | 998 | 10859 |
| 6-#18 | 2.86 | MA | 11715 | 3821 | 19862 | 2694 | 21921 | 2162 | 22996 | 1731 | 24593 | 1054 | 29596 | 887 | 20070 |
| 2L-3S | | MI | 9625 | 3821 | 16539 | 2661 | 17804 | 2157 | 18279 | 1727 | 18742 | 1051 | 22073 | 627 | 18376 |
| 6-#18 | 2.86 | MA | 10367 | 3821 | 17757 | 2681 | 19247 | 2179 | 19811 | 1748 | 20385 | 1072 | 24117 | 659 | 19894 |
| 3L-2S | | MI | 10860 | 3821 | 18467 | 2676 | 20225 | 2139 | 21163 | 1709 | 22552 | 1033 | 27005 | 854 | 18505 |
| 8-#11 | 1.49 | MA | 10477 | 3413 | 16859 | 2472 | 18249 | 2007 | 18758 | 1658 | 19009 | 1135 | 22438 | 1040 | 10948 |
| 2L-4S | | MI | 8858 | 3413 | 14308 | 2462 | 15160 | 1996 | 15199 | 1643 | 14749 | 1135 | 17214 | 847 | 10179 |
| 8-#11 | 1.49 | MA | 9917 | 3413 | 16009 | 2469 | 17165 | 2015 | 17445 | 1664 | 17274 | 1142 | 20155 | 951 | 10979 |
| 3E | | MI | 9229 | 3413 | 14943 | 2453 | 15967 | 2002 | 16164 | 1650 | 15960 | 1129 | 18562 | 933 | 10176 |
| 8-#11 | 1.49 | MA | 9515 | 3413 | 15319 | 2479 | 16288 | 2010 | 16385 | 1658 | 15944 | 1149 | 18671 | 864 | 10966 |
| 4L-2S | | MI | 9742 | 3413 | 15724 | 2457 | 16963 | 1994 | 17359 | 1643 | 17539 | 1122 | 20629 | 1022 | 10139 |
| 8-#14 | 2.14 | MA | 11109 | 3609 | 18337 | 2583 | 20091 | 2086 | 20923 | 1700 | 21864 | 1104 | 26143 | 979 | 15450 |
| 2L-4S | | MI | 9072 | 3609 | 15059 | 2573 | 16077 | 2073 | 16262 | 1682 | 16174 | 1107 | 19145 | 705 | 13857 |
| 8-#14 | 2.14 | MA | 10323 | 3609 | 17125 | 2578 | 18545 | 2098 | 19063 | 1710 | 19407 | 1114 | 22922 | 851 | 15442 |
| 3E | | MI | 9594 | 3609 | 15966 | 2560 | 17230 | 2083 | 17626 | 1692 | 17886 | 1097 | 21046 | 827 | 14286 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis

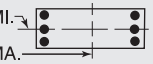



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.14 | MA | 9756 | 3609 | 16140 | 2592 | 17293 | 2089 | 17563 | 1700 | 17523 | 1124 | 20824 | 726 | 14972 |
| 4L-2S | | MI | 10316 | 3609 | 17079 | 2567 | 18648 | 2073 | 19316 | 1682 | 20119 | 1087 | 23958 | 955 | 14278 |
| 8-#18 | 3.81 | MA | 12615 | 4105 | 21967 | 2871 | 24595 | 2289 | 26182 | 1804 | 28802 | 1019 | 35074 | 808 | 26458 |
| 2L-4S | | MI | 9577 | 4105 | 16889 | 2858 | 18257 | 2264 | 18834 | 1779 | 19631 | 1029 | 23774 | 330 | 21504 |
| 8-#18 | 3.81 | MA | 11287 | 4105 | 19862 | 2858 | 21921 | 2307 | 22996 | 1822 | 24593 | 1036 | 29596 | 581 | 26169 |
| 3E | | MI | 10461 | 4105 | 18467 | 2838 | 20225 | 2282 | 21163 | 1797 | 22552 | 1011 | 27005 | 540 | 24124 |
| 8-#18 | 3.81 | MA | 10328 | 4105 | 18144 | 2881 | 19748 | 2289 | 20425 | 1804 | 21367 | 1054 | 26016 | 365 | 23313 |
| 4L-2S | | MI | 11678 | 4105 | 20395 | 2853 | 22646 | 2264 | 24047 | 1779 | 26363 | 993 | 31937 | 768 | 24366 |
| 10-#11 | 1.86 | MA | 10858 | 3523 | 17709 | 2541 | 19333 | 2057 | 20072 | 1688 | 20744 | 1124 | 24720 | 1015 | 13557 |
| 2L-5S | | MI | 8880 | 3523 | 14529 | 2527 | 15435 | 2053 | 15527 | 1679 | 15131 | 1116 | 17848 | 779 | 12029 |
| 10-#11 | 1.86 | MA | 10303 | 3523 | 16859 | 2538 | 18249 | 2066 | 18758 | 1695 | 19009 | 1131 | 22438 | 926 | 13574 |
| 3L-4S | | MI | 9212 | 3523 | 15089 | 2531 | 16156 | 2046 | 16395 | 1672 | 16328 | 1123 | 19282 | 820 | 12538 |
| 10-#11 | 1.86 | MA | 9904 | 3523 | 16169 | 2548 | 17372 | 2060 | 17699 | 1688 | 17679 | 1138 | 20953 | 839 | 13529 |
| 4L-3S | | MI | 9580 | 3523 | 15724 | 2522 | 16963 | 2052 | 17359 | 1679 | 17539 | 1116 | 20629 | 906 | 12564 |
| 10-#11 | 1.86 | MA | 9545 | 3523 | 15562 | 2545 | 16590 | 2069 | 16746 | 1695 | 16365 | 1131 | 19371 | 799 | 12964 |
| 5L-2S | | MI | 10090 | 3523 | 16505 | 2526 | 17959 | 2044 | 18555 | 1672 | 19118 | 1109 | 22697 | 994 | 12542 |
| 10-#14 | 2.68 | MA | 11641 | 3768 | 19550 | 2683 | 21636 | 2159 | 22783 | 1743 | 24320 | 1087 | 29365 | 941 | 19152 |
| 2L-5S | | MI | 9101 | 3768 | 15372 | 2666 | 16465 | 2155 | 16725 | 1734 | 16715 | 1078 | 20038 | 604 | 16214 |
| 10-#14 | 2.68 | MA | 10862 | 3768 | 18337 | 2677 | 20091 | 2170 | 20923 | 1753 | 21864 | 1097 | 26143 | 813 | 19100 |
| 3L-4S | | MI | 9568 | 3768 | 16172 | 2673 | 17496 | 2145 | 17952 | 1724 | 18407 | 1088 | 22057 | 662 | 16998 |
| 10-#14 | 2.68 | MA | 10302 | 3768 | 17352 | 2691 | 18839 | 2161 | 19423 | 1743 | 19980 | 1107 | 24046 | 688 | 18405 |
| 4L-3S | | MI | 10085 | 3768 | 17079 | 2660 | 18648 | 2155 | 19316 | 1734 | 20119 | 1078 | 23958 | 785 | 17647 |
| 10-#14 | 2.68 | MA | 9796 | 3768 | 16484 | 2686 | 17720 | 2173 | 18073 | 1753 | 18118 | 1097 | 21812 | 630 | 17507 |
| 5L-2S | | MI | 10800 | 3768 | 18191 | 2667 | 20066 | 2145 | 21006 | 1724 | 22351 | 1068 | 26870 | 913 | 17680 |
| 10-#18 | 4.76 | MA | 12193 | 4389 | 21967 | 3035 | 24595 | 2435 | 26182 | 1895 | 28802 | 1001 | 35074 | 502 | 32176 |
| 3L-4S | | MI | 10413 | 4389 | 18816 | 3036 | 20678 | 2390 | 21719 | 1850 | 23442 | 989 | 28706 | 244 | 26986 |
| 10-#18 | 4.76 | MA | 11248 | 4389 | 20249 | 3058 | 22422 | 2417 | 23611 | 1877 | 25575 | 1019 | 31495 | 287 | 29317 |
| 4L-3S | | MI | 11284 | 4389 | 20395 | 3015 | 22646 | 2407 | 24047 | 1867 | 26363 | 972 | 31937 | 454 | 29477 |
| 10-#18 | 4.76 | MA | 10398 | 4389 | 18733 | 3045 | 20479 | 2435 | 21299 | 1895 | 22384 | 1001 | 27696 | 182 | 26715 |
| 5L-2S | | MI | 12486 | 4389 | 22322 | 3030 | 25067 | 2390 | 26932 | 1850 | 30174 | 954 | 36869 | 681 | 30194 |
| 12-#11 | 2.23 | MA | 11236 | 3634 | 18559 | 2611 | 20417 | 2107 | 21385 | 1719 | 22479 | 1113 | 27002 | 990 | 16158 |
| 2L-6S | | MI | 8918 | 3634 | 14780 | 2592 | 15712 | 2097 | 15893 | 1716 | 15613 | 1111 | 18579 | 692 | 13954 |
| 12-#11 | 2.23 | MA | 10685 | 3634 | 17709 | 2607 | 19333 | 2116 | 20072 | 1726 | 20744 | 1120 | 24720 | 901 | 16152 |
| 3L-5S | | MI | 9233 | 3634 | 15310 | 2596 | 16430 | 2103 | 16722 | 1709 | 16711 | 1104 | 19916 | 752 | 14290 |
| 12-#11 | 2.23 | MA | 10289 | 3634 | 17019 | 2617 | 18456 | 2110 | 19012 | 1719 | 19413 | 1127 | 23235 | 814 | 16085 |
| 4E | | MI | 9563 | 3634 | 15870 | 2601 | 17152 | 2096 | 17590 | 1702 | 17907 | 1111 | 21350 | 792 | 14889 |
| 12-#11 | 2.23 | MA | 9933 | 3634 | 16412 | 2614 | 17674 | 2119 | 18059 | 1726 | 18099 | 1120 | 21653 | 774 | 15429 |
| 5L-3S | | MI | 9928 | 3634 | 16505 | 2591 | 17959 | 2102 | 18555 | 1709 | 19118 | 1104 | 22697 | 878 | 14939 |
| 12-#11 | 2.23 | MA | 9592 | 3634 | 15838 | 2611 | 16895 | 2113 | 17148 | 1733 | 16893 | 1127 | 20175 | 714 | 15052 |
| 6L-2S | | MI | 10434 | 3634 | 17286 | 2595 | 18955 | 2094 | 19750 | 1702 | 20697 | 1097 | 24765 | 967 | 14935 |
| 12-#14 | 3.21 | MA | 12168 | 3928 | 20762 | 2783 | 23182 | 2231 | 24644 | 1787 | 26777 | 1070 | 32586 | 902 | 22833 |
| 2L-6S | | MI | 9155 | 3928 | 15727 | 2759 | 16858 | 2218 | 17243 | 1786 | 17395 | 1069 | 21069 | 475 | 18306 |
| 12-#14 | 3.21 | MA | 11396 | 3928 | 19550 | 2777 | 21636 | 2242 | 22783 | 1797 | 24320 | 1080 | 29365 | 774 | 22748 |
| 3L-5S | | MI | 9597 | 3928 | 16485 | 2766 | 17884 | 2228 | 18415 | 1776 | 18947 | 1059 | 22950 | 561 | 19440 |
| 12-#14 | 3.21 | MA | 10841 | 3928 | 18564 | 2791 | 20384 | 2234 | 21283 | 1787 | 22436 | 1090 | 27267 | 649 | 21862 |
| 4E | | MI | 10059 | 3928 | 17284 | 2773 | 18914 | 2218 | 19642 | 1766 | 20640 | 1069 | 24969 | 620 | 20164 |
| 12-#14 | 3.21 | MA | 10341 | 3928 | 17696 | 2785 | 19266 | 2245 | 19933 | 1797 | 20575 | 1080 | 25033 | 591 | 21029 |
| 5L-3S | | MI | 10571 | 3928 | 18191 | 2760 | 20066 | 2228 | 21006 | 1776 | 22351 | 1059 | 26870 | 742 | 20998 |
| 12-#14 | 3.21 | MA | 9864 | 3928 | 16875 | 2780 | 18152 | 2236 | 18643 | 1806 | 18867 | 1090 | 22950 | 505 | 19790 |
| 6L-2S | | MI | 11280 | 3928 | 19304 | 2766 | 21485 | 2218 | 22696 | 1766 | 24584 | 1049 | 29783 | 870 | 21065 |
| 12-#18 | 5.71 | MA | 12156 | 4673 | 22354 | 3235 | 25096 | 2545 | 26796 | 1951 | 29783 | 983 | 36973 | 208 | 35358 |
| 4E | | MI | 11238 | 4673 | 20744 | 3213 | 23099 | 2515 | 24603 | 1920 | 27253 | 950 | 33638 | 157 | 32504 |
| 12-#18 | 5.71 | MA | 11318 | 4673 | 20838 | 3222 | 23153 | 2563 | 24484 | 1968 | 26593 | 965 | 33175 | 104 | 32593 |
| 5L-3S | | MI | 12099 | 4673 | 22322 | 3193 | 25067 | 2532 | 26932 | 1937 | 30174 | 932 | 36869 | 368 | 34788 |
| 14-#11 | 2.60 | MA | 11612 | 3745 | 19410 | 2680 | 21501 | 2157 | 22699 | 1750 | 24213 | 1102 | 29284 | 965 | 18752 |
| 2L-7S | | MI | 8966 | 3745 | 14995 | 2671 | 16018 | 2155 | 16227 | 1739 | 16118 | 1105 | 19385 | 598 | 15511 |
| 14-#11 | 2.60 | MA | 11064 | 3745 | 18559 | 2676 | 20417 | 2166 | 21385 | 1757 | 22479 | 1109 | 27002 | 876 | 18725 |
| 3L-6S | | MI | 9271 | 3745 | 15561 | 2661 | 16708 | 2147 | 17089 | 1746 | 17192 | 1099 | 20647 | 665 | 16158 |

## RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

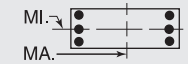
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.60 | MA | 10671 | 3745 | 17870 | 2687 | 19540 | 2160 | 20326 | 1750 | 21148 | 1116 | 25518 | 789 | 18601 |
| 4L-5S | | MI | 9584 | 3745 | 16091 | 2666 | 17426 | 2154 | 17918 | 1739 | 18290 | 1092 | 21984 | 724 | 16561 |
| 14-#11 | 2.60 | MA | 10318 | 3745 | 17263 | 2683 | 18758 | 2169 | 19373 | 1757 | 19834 | 1109 | 23935 | 749 | 17903 |
| 5L-4S | | MI | 9911 | 3745 | 16651 | 2670 | 18148 | 2146 | 18786 | 1732 | 19486 | 1099 | 23417 | 764 | 17171 |
| 14-#11 | 2.60 | MA | 9980 | 3745 | 16689 | 2680 | 17980 | 2164 | 18462 | 1764 | 18628 | 1116 | 22458 | 689 | 17465 |
| 6L-3S | | MI | 10274 | 3745 | 17286 | 2660 | 18955 | 2152 | 19750 | 1739 | 20697 | 1092 | 24765 | 851 | 17305 |
| 14-#11 | 2.60 | MA | 9650 | 3745 | 16075 | 2690 | 17231 | 2172 | 17515 | 1757 | 17448 | 1123 | 21069 | 621 | 16732 |
| 7L-2S | | MI | 10777 | 3745 | 18067 | 2664 | 19951 | 2145 | 20946 | 1732 | 22276 | 1085 | 26833 | 939 | 17321 |
| 14-#14 | 3.75 | MA | 11924 | 4087 | 20762 | 2877 | 23182 | 2315 | 24644 | 1840 | 26777 | 1062 | 32586 | 735 | 26389 |
| 3L-6S | | MI | 9650 | 4087 | 16840 | 2859 | 18276 | 2290 | 18933 | 1828 | 19628 | 1050 | 23981 | 432 | 21461 |
| 14-#14 | 3.75 | MA | 11375 | 4087 | 19777 | 2891 | 21930 | 2306 | 23143 | 1830 | 24893 | 1072 | 30488 | 610 | 25339 |
| 4L-5S | | MI | 10088 | 4087 | 17597 | 2866 | 19302 | 2300 | 20105 | 1818 | 21180 | 1040 | 25862 | 518 | 22678 |
| 14-#14 | 3.75 | MA | 10880 | 4087 | 18909 | 2885 | 20811 | 2317 | 21793 | 1840 | 23031 | 1062 | 28254 | 552 | 24562 |
| 5L-4S | | MI | 10545 | 4087 | 18397 | 2872 | 20332 | 2290 | 21332 | 1808 | 22872 | 1050 | 27882 | 577 | 23349 |
| 14-#14 | 3.75 | MA | 10407 | 4087 | 18088 | 2879 | 19698 | 2309 | 20503 | 1850 | 21324 | 1072 | 26171 | 467 | 23241 |
| 6L-3S | | MI | 11053 | 4087 | 19304 | 2859 | 21485 | 2300 | 22696 | 1818 | 24584 | 1040 | 29783 | 699 | 24340 |
| 14-#18 | 6.67 | MA | 12227 | 4956 | 22943 | 3400 | 25827 | 2690 | 27670 | 2042 | 30801 | 930 | 38653 | 25 | 38507 |
| 5L-4S | | MI | 12055 | 4956 | 22672 | 3390 | 25519 | 2640 | 27487 | 1990 | 31064 | 910 | 38570 | 71 | 38050 |
| 16-#11 | 2.97 | MA | 11440 | 3855 | 19410 | 2745 | 21501 | 2216 | 22699 | 1788 | 24213 | 1098 | 29284 | 852 | 21292 |
| 3L-7S | | MI | 9319 | 3855 | 15776 | 2740 | 17014 | 2205 | 17423 | 1769 | 17697 | 1093 | 21453 | 570 | 17756 |
| 16-#11 | 2.97 | MA | 11050 | 3855 | 18720 | 2756 | 20624 | 2211 | 21640 | 1781 | 22883 | 1105 | 27800 | 764 | 21041 |
| 4L-6S | | MI | 9622 | 3855 | 16342 | 2731 | 17704 | 2198 | 18284 | 1776 | 18771 | 1086 | 22714 | 637 | 18372 |
| 16-#11 | 2.97 | MA | 10699 | 3855 | 18113 | 2752 | 19842 | 2219 | 20686 | 1788 | 21569 | 1098 | 26217 | 724 | 20385 |
| 5E | | MI | 9932 | 3855 | 16872 | 2735 | 18422 | 2204 | 19113 | 1769 | 19869 | 1079 | 24051 | 697 | 18838 |
| 16-#11 | 2.97 | MA | 10364 | 3855 | 17539 | 2749 | 19064 | 2214 | 19775 | 1794 | 20363 | 1105 | 24740 | 664 | 19883 |
| 6L-4S | | MI | 10257 | 3855 | 17432 | 2739 | 19143 | 2196 | 19981 | 1762 | 21065 | 1086 | 25485 | 737 | 19409 |
| 16-#11 | 2.97 | MA | 10037 | 3855 | 16925 | 2759 | 18315 | 2222 | 18829 | 1788 | 19183 | 1112 | 23351 | 596 | 19183 |
| 7L-3S | | MI | 10617 | 3855 | 18067 | 2729 | 19951 | 2202 | 20946 | 1769 | 22276 | 1079 | 26833 | 823 | 19666 |
| 16-#14 | 4.29 | MA | 11904 | 4247 | 20989 | 2991 | 23475 | 2378 | 25003 | 1873 | 27350 | 1055 | 33709 | 572 | 28832 |
| 4L-6S | | MI | 10141 | 4247 | 17952 | 2959 | 19694 | 2362 | 20623 | 1870 | 21861 | 1031 | 26894 | 390 | 24631 |
| 16-#14 | 4.29 | MA | 11414 | 4247 | 20121 | 2985 | 22357 | 2390 | 23653 | 1883 | 25488 | 1045 | 31475 | 514 | 28085 |
| 5E | | MI | 10574 | 4247 | 18709 | 2965 | 20720 | 2372 | 21795 | 1860 | 23412 | 1021 | 28775 | 476 | 25841 |
| 16-#14 | 4.29 | MA | 10946 | 4247 | 19300 | 2979 | 21243 | 2381 | 22363 | 1893 | 23781 | 1055 | 29392 | 428 | 26706 |
| 6L-4S | | MI | 11028 | 4247 | 19509 | 2972 | 21751 | 2362 | 23022 | 1850 | 25105 | 1031 | 30794 | 534 | 26550 |
| 18-#11 | 3.34 | MA | 11426 | 3966 | 19570 | 2825 | 21708 | 2261 | 22953 | 1811 | 24618 | 1094 | 30082 | 739 | 23492 |
| 4L-7S | | MI | 9668 | 3966 | 16557 | 2809 | 18009 | 2255 | 18618 | 1799 | 19276 | 1081 | 23520 | 543 | 20009 |
| 18-#11 | 3.34 | MA | 11078 | 3966 | 18963 | 2821 | 20926 | 2269 | 22000 | 1818 | 23304 | 1087 | 28500 | 699 | 22872 |
| 5L-6S | | MI | 9969 | 3966 | 17123 | 2800 | 18700 | 2248 | 19480 | 1805 | 20350 | 1074 | 24782 | 609 | 20596 |
| 18-#11 | 3.34 | MA | 10745 | 3966 | 18389 | 2818 | 20148 | 2264 | 21089 | 1825 | 22098 | 1094 | 27022 | 640 | 22311 |
| 6L-5S | | MI | 10277 | 3966 | 17653 | 2804 | 19418 | 2254 | 20309 | 1799 | 21448 | 1067 | 26119 | 669 | 21122 |
| 18-#11 | 3.34 | MA | 10421 | 3966 | 17775 | 2828 | 19399 | 2272 | 20142 | 1818 | 20918 | 1101 | 25633 | 571 | 21641 |
| 7L-4S | | MI | 10600 | 3966 | 18213 | 2808 | 20139 | 2246 | 21177 | 1792 | 22645 | 1074 | 27553 | 709 | 21658 |
| 18-#14 | 4.82 | MA | 11943 | 4407 | 21333 | 3085 | 23902 | 2462 | 25513 | 1927 | 27945 | 1028 | 34696 | 475 | 31499 |
| 5L-6S | | MI | 10627 | 4407 | 19065 | 3058 | 21113 | 2435 | 22313 | 1911 | 24093 | 1011 | 29806 | 347 | 27812 |
| 18-#14 | 4.82 | MA | 11480 | 4407 | 20512 | 3079 | 22789 | 2453 | 24223 | 1937 | 26237 | 1038 | 32613 | 389 | 30183 |
| 6L-5S | | MI | 11056 | 4407 | 19822 | 3065 | 22139 | 2445 | 23485 | 1902 | 25645 | 1001 | 31687 | 433 | 28962 |
| 20-#11 | 3.71 | MA | 11454 | 4077 | 19813 | 2891 | 22010 | 2319 | 23313 | 1849 | 25038 | 1076 | 30782 | 674 | 25365 |
| 5L-7S | | MI | 10015 | 4077 | 17338 | 2878 | 19005 | 2305 | 19814 | 1828 | 20855 | 1069 | 25588 | 515 | 22268 |
| 20-#11 | 3.71 | MA | 11124 | 4077 | 19239 | 2887 | 21232 | 2314 | 22402 | 1856 | 23832 | 1083 | 29304 | 615 | 24746 |
| 6E | | MI | 10314 | 4077 | 17905 | 2869 | 19696 | 2298 | 20675 | 1835 | 21929 | 1062 | 26850 | 582 | 22828 |
| 20-#11 | 3.71 | MA | 10801 | 4077 | 18625 | 2897 | 20483 | 2322 | 21456 | 1849 | 22652 | 1090 | 27915 | 546 | 24105 |
| 7L-5S | | MI | 10620 | 4077 | 18434 | 2873 | 20414 | 2304 | 21505 | 1828 | 23027 | 1055 | 28187 | 642 | 23410 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

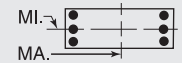
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 5.36 | MA | 12009 | 4566 | 21724 | 3179 | 24334 | 2526 | 26083 | 1980 | 28694 | 1021 | 35834 | 350 | 33671 |
| 6E | | MI | 11109 | 4566 | 20177 | 3158 | 22531 | 2507 | 24004 | 1953 | 26326 | 992 | 32718 | 304 | 31004 |
| 22-#11 | 4.09 | MA | 11500 | 4187 | 20090 | 2956 | 22316 | 2364 | 23716 | 1887 | 25567 | 1072 | 31586 | 590 | 27189 |
| 6L-7S | | MI | 10360 | 4187 | 18119 | 2948 | 20001 | 2356 | 21009 | 1858 | 22434 | 1056 | 27656 | 488 | 24517 |
| 22-#11 | 4.09 | MA | 11180 | 4187 | 19476 | 2967 | 21567 | 2373 | 22770 | 1880 | 24387 | 1079 | 30198 | 521 | 26574 |
| 7L-6S | | MI | 10657 | 4187 | 18686 | 2938 | 20692 | 2348 | 21871 | 1865 | 23508 | 1049 | 28918 | 554 | 25067 |
| 24-#11 | 4.46 | MA | 11555 | 4298 | 20326 | 3036 | 22651 | 2423 | 24083 | 1911 | 26122 | 1068 | 32480 | 496 | 29013 |
| 7E | | MI | 10703 | 4298 | 18900 | 3017 | 20997 | 2406 | 22205 | 1888 | 24014 | 1044 | 29724 | 460 | 26723 |

## RECTANGULAR TIED COLUMNS 28" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.00 | MA | 11358 | 3487 | 17927 | 2545 | 19176 | 2074 | 19431 | 1728 | 19106 | 1228 | 22218 | 1147 | 8594 |
| 2E | | MI | 9886 | 3487 | 15696 | 2512 | 16676 | 2047 | 16772 | 1700 | 16400 | 1203 | 18954 | 1115 | 7441 |
| 4-#18 | 1.79 | MA | 12209 | 3736 | 19932 | 2677 | 21642 | 2168 | 22301 | 1775 | 22884 | 1183 | 27105 | 1062 | 14704 |
| 2E | | MI | 10586 | 3736 | 17385 | 2641 | 18668 | 2132 | 19113 | 1738 | 19483 | 1149 | 22887 | 1015 | 12639 |
| 6-#11 | 1.04 | MA | 11428 | 3500 | 18027 | 2564 | 19351 | 2089 | 19667 | 1740 | 19450 | 1236 | 22701 | 1155 | 8956 |
| 2L-3S | | MI | 9429 | 3500 | 15002 | 2529 | 15837 | 2071 | 15806 | 1721 | 15129 | 1219 | 17318 | 1036 | 7804 |
| 6-#11 | 1.04 | MA | 10816 | 3500 | 17108 | 2561 | 18179 | 2098 | 18242 | 1748 | 17560 | 1243 | 20203 | 1067 | 9003 |
| 3L-2S | | MI | 9947 | 3500 | 15783 | 2533 | 16833 | 2064 | 17002 | 1714 | 16708 | 1212 | 19386 | 1125 | 7752 |
| 6-#14 | 1.51 | MA | 11953 | 3647 | 19239 | 2644 | 20849 | 2146 | 21462 | 1773 | 21787 | 1213 | 25748 | 1112 | 12643 |
| 2L-3S | | MI | 9652 | 3647 | 15696 | 2605 | 16676 | 2129 | 16772 | 1751 | 16400 | 1194 | 18954 | 945 | 10951 |
| 6-#14 | 1.51 | MA | 11091 | 3647 | 17927 | 2640 | 19176 | 2159 | 19431 | 1783 | 19106 | 1223 | 22218 | 984 | 12680 |
| 3L-2S | | MI | 10382 | 3647 | 16808 | 2612 | 18095 | 2119 | 18463 | 1742 | 18632 | 1184 | 21866 | 1073 | 10896 |
| 6-#18 | 2.68 | MA | 13211 | 4019 | 22215 | 2854 | 24551 | 2296 | 25788 | 1851 | 27491 | 1151 | 33132 | 991 | 21690 |
| 2L-3S | | MI | 10181 | 4019 | 17385 | 2804 | 18668 | 2274 | 19113 | 1826 | 19483 | 1127 | 22887 | 701 | 18470 |
| 6-#18 | 2.68 | MA | 11745 | 4019 | 19932 | 2844 | 21642 | 2316 | 22301 | 1868 | 22884 | 1169 | 27105 | 763 | 21514 |
| 3L-2S | | MI | 11419 | 4019 | 19312 | 2819 | 21089 | 2257 | 21997 | 1809 | 23294 | 1110 | 27819 | 928 | 18560 |
| 8-#11 | 1.39 | MA | 11848 | 3611 | 18946 | 2633 | 20523 | 2139 | 21092 | 1771 | 21341 | 1226 | 25198 | 1133 | 11790 |
| 2L-4S | | MI | 9413 | 3611 | 15148 | 2608 | 16025 | 2115 | 16038 | 1744 | 15497 | 1214 | 18038 | 923 | 10229 |
| 8-#11 | 1.39 | MA | 11241 | 3611 | 18027 | 2630 | 19351 | 2148 | 19667 | 1779 | 19450 | 1233 | 22701 | 1044 | 11822 |
| 3E | | MI | 9784 | 3611 | 15783 | 2598 | 16833 | 2121 | 17002 | 1751 | 16708 | 1207 | 19386 | 1009 | 10213 |
| 8-#11 | 1.39 | MA | 10807 | 3611 | 17283 | 2641 | 18405 | 2144 | 18520 | 1772 | 18000 | 1240 | 21077 | 955 | 11809 |
| 4L-2S | | MI | 10298 | 3611 | 16564 | 2602 | 17829 | 2114 | 18198 | 1744 | 18287 | 1200 | 21453 | 1097 | 10172 |
| 8-#14 | 2.01 | MA | 12542 | 3807 | 20551 | 2744 | 22521 | 2219 | 23492 | 1818 | 24468 | 1197 | 29279 | 1076 | 16665 |
| 2L-4S | | MI | 9626 | 3807 | 15901 | 2718 | 16942 | 2192 | 17099 | 1783 | 16920 | 1185 | 19965 | 780 | 14064 |
| 8-#14 | 2.01 | MA | 11687 | 3807 | 19239 | 2739 | 20849 | 2231 | 21462 | 1827 | 21787 | 1207 | 25748 | 948 | 16657 |
| 3E | | MI | 10150 | 3807 | 16808 | 2705 | 18095 | 2202 | 18463 | 1793 | 18632 | 1175 | 21866 | 902 | 14341 |
| 8-#14 | 2.01 | MA | 11075 | 3807 | 18175 | 2754 | 19497 | 2224 | 19824 | 1818 | 19730 | 1217 | 23453 | 821 | 16323 |
| 4L-2S | | MI | 10873 | 3807 | 17921 | 2711 | 19513 | 2192 | 20153 | 1783 | 20865 | 1165 | 24779 | 1030 | 14320 |
| 8-#18 | 3.57 | MA | 14197 | 4303 | 24497 | 3032 | 27461 | 2425 | 29276 | 1927 | 32097 | 1119 | 39158 | 919 | 28618 |
| 2L-4S | | MI | 10130 | 4303 | 17734 | 3001 | 19121 | 2382 | 19668 | 1879 | 20372 | 1105 | 24588 | 404 | 21781 |
| 8-#18 | 3.57 | MA | 12752 | 4303 | 22215 | 3021 | 24551 | 2444 | 25788 | 1944 | 27491 | 1136 | 33132 | 691 | 28329 |
| 3E | | MI | 11018 | 4303 | 19312 | 2981 | 21089 | 2400 | 21997 | 1897 | 23294 | 1088 | 27819 | 614 | 24230 |
| 8-#18 | 3.57 | MA | 11714 | 4303 | 20358 | 3045 | 22191 | 2428 | 22975 | 1927 | 23958 | 1154 | 29203 | 471 | 25436 |
| 4L-2S | | MI | 12240 | 4303 | 21240 | 2996 | 23510 | 2382 | 24881 | 1879 | 27105 | 1070 | 32751 | 842 | 24432 |
| 10-#11 | 1.74 | MA | 12265 | 3721 | 19866 | 2702 | 21695 | 2189 | 22517 | 1802 | 23231 | 1216 | 27695 | 1110 | 14610 |
| 2L-5S | | MI | 9434 | 3721 | 15369 | 2673 | 16300 | 2173 | 16365 | 1781 | 15880 | 1194 | 18672 | 855 | 12168 |
| 10-#11 | 1.74 | MA | 11662 | 3721 | 18946 | 2700 | 20523 | 2199 | 21092 | 1810 | 21341 | 1223 | 25198 | 1021 | 14627 |
| 3L-4S | | MI | 9767 | 3721 | 15929 | 2677 | 17021 | 2165 | 17233 | 1774 | 17076 | 1201 | 20106 | 895 | 12595 |
| 10-#11 | 1.74 | MA | 11231 | 3721 | 18202 | 2710 | 19577 | 2194 | 19945 | 1803 | 19891 | 1230 | 23574 | 932 | 14582 |
| 4L-3S | | MI | 10136 | 3721 | 16564 | 2667 | 17829 | 2172 | 18198 | 1781 | 18287 | 1194 | 21453 | 981 | 12606 |
| 10-#11 | 1.74 | MA | 10844 | 3721 | 17548 | 2708 | 18734 | 2203 | 18912 | 1811 | 18459 | 1223 | 21845 | 892 | 14055 |
| 5L-2S | | MI | 10647 | 3721 | 17345 | 2671 | 18825 | 2164 | 19393 | 1774 | 19866 | 1187 | 23521 | 1070 | 12578 |
| 10-#14 | 2.51 | MA | 13123 | 3966 | 21863 | 2844 | 24194 | 2291 | 25522 | 1862 | 27149 | 1182 | 32809 | 1041 | 20670 |
| 2L-5S | | MI | 9655 | 3966 | 16214 | 2811 | 17330 | 2274 | 17562 | 1835 | 17460 | 1156 | 20858 | 679 | 16389 |

## RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

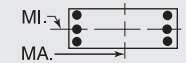
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.51 | MA | 12277 | 3966 | 20551 | 2839 | 22521 | 2303 | 23492 | 1872 | 24468 | 1192 | 29279 | 913 | 20619 |
| 3L-4S | | MI | 10123 | 3966 | 17014 | 2818 | 18361 | 2264 | 18789 | 1825 | 19153 | 1166 | 22878 | 737 | 17201 |
| 10-#14 | 2.51 | MA | 11671 | 3966 | 19487 | 2854 | 21170 | 2296 | 21855 | 1862 | 22412 | 1202 | 26984 | 786 | 20043 |
| 4L-3S | | MI | 10642 | 3966 | 17921 | 2804 | 19513 | 2274 | 20153 | 1835 | 20865 | 1156 | 24779 | 860 | 17710 |
| 10-#14 | 2.51 | MA | 11125 | 3966 | 18551 | 2849 | 19963 | 2308 | 20381 | 1872 | 20381 | 1192 | 24535 | 729 | 18996 |
| 5L-2S | | MI | 11359 | 3966 | 19033 | 2811 | 20931 | 2264 | 21843 | 1825 | 23097 | 1146 | 27691 | 988 | 17726 |
| 10-#18 | 4.46 | MA | 13744 | 4587 | 24497 | 3198 | 27461 | 2573 | 29276 | 2020 | 32097 | 1104 | 39158 | 620 | 35132 |
| 3L-4S | | MI | 10968 | 4587 | 19662 | 3179 | 21542 | 2507 | 22553 | 1949 | 24183 | 1066 | 29520 | 318 | 27257 |
| 10-#18 | 4.46 | MA | 12721 | 4587 | 22640 | 3223 | 25101 | 2556 | 26462 | 2003 | 28565 | 1122 | 35229 | 400 | 31957 |
| 4L-3S | | MI | 11844 | 4587 | 21240 | 3158 | 23510 | 2525 | 24881 | 1967 | 27105 | 1048 | 32751 | 528 | 29849 |
| 10-#18 | 4.46 | MA | 11800 | 4587 | 21003 | 3212 | 22992 | 2575 | 23931 | 2020 | 25074 | 1104 | 31050 | 296 | 29324 |
| 5L-2S | | MI | 13050 | 4587 | 23168 | 3173 | 25931 | 2507 | 27766 | 1949 | 30915 | 1031 | 37683 | 756 | 30267 |
| 12-#11 | 2.09 | MA | 12677 | 3832 | 20785 | 2772 | 22867 | 2240 | 23942 | 1834 | 25122 | 1206 | 30192 | 1087 | 17421 |
| 2L-6S | | MI | 9472 | 3832 | 15620 | 2738 | 16578 | 2217 | 16732 | 1818 | 16361 | 1189 | 19403 | 768 | 14097 |
| 12-#11 | 2.09 | MA | 12079 | 3832 | 19866 | 2769 | 21695 | 2249 | 22517 | 1841 | 23231 | 1213 | 27695 | 998 | 17416 |
| 3L-5S | | MI | 9788 | 3832 | 16150 | 2742 | 17296 | 2223 | 17561 | 1811 | 17459 | 1182 | 20740 | 827 | 14428 |
| 12-#11 | 2.09 | MA | 11652 | 3832 | 19122 | 2780 | 20750 | 2244 | 21370 | 1835 | 21781 | 1220 | 26071 | 910 | 17349 |
| 4E | | MI | 10119 | 3832 | 16710 | 2746 | 18017 | 2215 | 18429 | 1804 | 18655 | 1189 | 22174 | 867 | 14952 |
| 12-#11 | 2.09 | MA | 11267 | 3832 | 18468 | 2777 | 19906 | 2253 | 20337 | 1842 | 20350 | 1213 | 24342 | 870 | 16722 |
| 5L-3S | | MI | 10485 | 3832 | 17345 | 2736 | 18825 | 2222 | 19393 | 1811 | 19866 | 1182 | 23521 | 954 | 14989 |
| 12-#11 | 2.09 | MA | 10900 | 3832 | 17849 | 2774 | 19067 | 2249 | 19351 | 1849 | 19035 | 1220 | 22723 | 810 | 16286 |
| 6L-2S | | MI | 10993 | 3832 | 18126 | 2740 | 19820 | 2214 | 20589 | 1804 | 21445 | 1175 | 25589 | 1042 | 14974 |
| 12-#14 | 3.01 | MA | 13699 | 4126 | 23175 | 2944 | 25867 | 2363 | 27553 | 1907 | 29831 | 1166 | 36340 | 1006 | 24656 |
| 2L-6S | | MI | 9708 | 4126 | 16569 | 2904 | 17723 | 2337 | 18080 | 1887 | 18141 | 1147 | 21890 | 550 | 18584 |
| 12-#14 | 3.01 | MA | 12860 | 4126 | 21863 | 2939 | 24194 | 2376 | 25522 | 1917 | 27149 | 1176 | 32809 | 878 | 24571 |
| 3L-5S | | MI | 10151 | 4126 | 17326 | 2910 | 18749 | 2347 | 19252 | 1877 | 19693 | 1137 | 23770 | 636 | 19614 |
| 12-#14 | 3.01 | MA | 12260 | 4126 | 20799 | 2954 | 22842 | 2368 | 23885 | 1907 | 25093 | 1186 | 30514 | 751 | 23788 |
| 4E | | MI | 10615 | 4126 | 18126 | 2917 | 19779 | 2337 | 20479 | 1867 | 21386 | 1147 | 25790 | 695 | 20363 |
| 12-#14 | 3.01 | MA | 11720 | 4126 | 19863 | 2949 | 21636 | 2381 | 22411 | 1917 | 23062 | 1176 | 28066 | 693 | 22812 |
| 5L-3S | | MI | 11129 | 4126 | 19033 | 2904 | 20931 | 2346 | 21843 | 1877 | 23097 | 1137 | 27691 | 817 | 21066 |
| 12-#14 | 3.01 | MA | 11205 | 4126 | 18978 | 2944 | 20435 | 2373 | 21003 | 1927 | 21198 | 1186 | 25780 | 608 | 21590 |
| 6L-2S | | MI | 11841 | 4126 | 20146 | 2911 | 22350 | 2336 | 23533 | 1867 | 25330 | 1127 | 30603 | 945 | 21118 |
| 12-#18 | 5.36 | MA | 13714 | 4871 | 24922 | 3400 | 28011 | 2685 | 29950 | 2079 | 33171 | 1090 | 41256 | 328 | 38516 |
| 4E | | MI | 11795 | 4871 | 21590 | 3356 | 23963 | 2632 | 25437 | 2020 | 27994 | 1027 | 34452 | 231 | 32770 |
| 12-#18 | 5.36 | MA | 12807 | 4871 | 23285 | 3389 | 25902 | 2704 | 27418 | 2096 | 29680 | 1072 | 37077 | 224 | 35719 |
| 5L-3S | | MI | 12660 | 4871 | 23168 | 3336 | 25931 | 2650 | 27766 | 2037 | 30915 | 1009 | 37683 | 442 | 35152 |
| 14-#11 | 2.44 | MA | 13087 | 3943 | 21705 | 2841 | 24040 | 2290 | 25367 | 1865 | 27013 | 1196 | 32689 | 1064 | 20226 |
| 2L-7S | | MI | 9519 | 3943 | 15835 | 2816 | 16883 | 2275 | 17066 | 1841 | 16866 | 1184 | 20209 | 673 | 15715 |
| 14-#11 | 2.44 | MA | 12493 | 3943 | 20785 | 2838 | 22867 | 2299 | 23942 | 1872 | 25122 | 1203 | 30192 | 975 | 20199 |
| 3L-6S | | MI | 9826 | 3943 | 16401 | 2807 | 17574 | 2267 | 17927 | 1847 | 17940 | 1177 | 21471 | 740 | 16387 |
| 14-#11 | 2.44 | MA | 12069 | 3943 | 20041 | 2849 | 21922 | 2294 | 22794 | 1866 | 23672 | 1210 | 28568 | 887 | 20111 |
| 4L-5S | | MI | 10139 | 3943 | 16931 | 2811 | 18292 | 2273 | 18756 | 1841 | 19038 | 1170 | 22807 | 800 | 16697 |
| 14-#11 | 2.44 | MA | 11687 | 3943 | 19387 | 2846 | 21078 | 2303 | 21762 | 1873 | 22240 | 1203 | 26839 | 847 | 19399 |
| 5L-4S | | MI | 10468 | 3943 | 17491 | 2815 | 19013 | 2266 | 19624 | 1834 | 20235 | 1177 | 24241 | 840 | 17302 |
| 14-#11 | 2.44 | MA | 11323 | 3943 | 18769 | 2843 | 20239 | 2299 | 20776 | 1881 | 20926 | 1210 | 25221 | 788 | 18986 |
| 6L-3S | | MI | 10831 | 3943 | 18126 | 2805 | 19820 | 2272 | 20589 | 1841 | 21445 | 1170 | 25589 | 926 | 17357 |
| 14-#11 | 2.44 | MA | 10967 | 3943 | 18107 | 2854 | 19433 | 2308 | 19752 | 1874 | 19640 | 1217 | 23533 | 699 | 18183 |
| 7L-2S | | MI | 11336 | 3943 | 18907 | 2810 | 20816 | 2264 | 21784 | 1834 | 23025 | 1163 | 27657 | 1015 | 17363 |
| 14-#14 | 3.52 | MA | 13438 | 4285 | 23175 | 3039 | 25867 | 2448 | 27553 | 1961 | 29831 | 1161 | 36340 | 842 | 28516 |
| 3L-6S | | MI | 10204 | 4285 | 17682 | 3003 | 19141 | 2409 | 19770 | 1929 | 20374 | 1127 | 24802 | 507 | 21735 |
| 14-#14 | 3.52 | MA | 12843 | 4285 | 22111 | 3054 | 24515 | 2441 | 25915 | 1952 | 27774 | 1171 | 34045 | 715 | 27554 |
| 4L-5S | | MI | 10643 | 4285 | 18439 | 3010 | 20167 | 2419 | 20942 | 1919 | 21926 | 1117 | 26683 | 594 | 22851 |
| 14-#14 | 3.52 | MA | 12309 | 4285 | 21175 | 3049 | 23309 | 2453 | 24442 | 1961 | 25743 | 1161 | 31596 | 658 | 26640 |
| 5L-4S | | MI | 11103 | 4285 | 19239 | 3017 | 21197 | 2409 | 22169 | 1909 | 23618 | 1127 | 28702 | 652 | 23545 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis

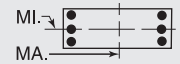


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 3.52 | MA | 11799 | 4285 | 20290 | 3044 | 22108 | 2445 | 23034 | 1971 | 23880 | 1171 | 29310 | 572 | 25333 |
| 6L-3S | | MI | 11612 | 4285 | 20146 | 3004 | 22350 | 2419 | 23533 | 1919 | 25330 | 1117 | 30603 | 774 | 24413 |
| 14-#14 | 3.52 | MA | 11301 | 4285 | 19343 | 3059 | 20954 | 2458 | 21571 | 1961 | 22056 | 1181 | 27163 | 473 | 24080 |
| 7L-2S | | MI | 12318 | 4285 | 21258 | 3011 | 23768 | 2409 | 25223 | 1909 | 27562 | 1107 | 33516 | 902 | 24494 |
| 14-#18 | 6.25 | MA | 13801 | 5154 | 25568 | 3566 | 28811 | 2833 | 30906 | 2172 | 34287 | 1040 | 43104 | 153 | 42149 |
| 5L-4S | | MI | 12614 | 5154 | 23517 | 3533 | 26384 | 2757 | 28321 | 2090 | 31805 | 987 | 39384 | 145 | 38311 |
| 16-#11 | 2.79 | MA | 12903 | 4053 | 21705 | 2907 | 24040 | 2349 | 25367 | 1903 | 27013 | 1193 | 32689 | 953 | 22977 |
| 3L-7S | | MI | 9872 | 4053 | 16616 | 2886 | 17879 | 2325 | 18261 | 1870 | 18445 | 1171 | 22276 | 646 | 17959 |
| 16-#11 | 2.79 | MA | 12482 | 4053 | 20961 | 2918 | 23094 | 2344 | 24219 | 1897 | 25563 | 1200 | 31065 | 864 | 22859 |
| 4L-6S | | MI | 10176 | 4053 | 17182 | 2876 | 18569 | 2317 | 19123 | 1877 | 19519 | 1164 | 23538 | 712 | 18598 |
| 16-#11 | 2.79 | MA | 12103 | 4053 | 20306 | 2915 | 22251 | 2354 | 23187 | 1904 | 24131 | 1193 | 29336 | 824 | 22084 |
| 5E | | MI | 10488 | 4053 | 17712 | 2880 | 19287 | 2323 | 19952 | 1870 | 20617 | 1157 | 24875 | 772 | 18974 |
| 16-#11 | 2.79 | MA | 11742 | 4053 | 19688 | 2912 | 21412 | 2349 | 22201 | 1912 | 22817 | 1200 | 27718 | 765 | 21652 |
| 6L-4S | | MI | 10814 | 4053 | 18272 | 2884 | 20009 | 2316 | 20820 | 1863 | 21814 | 1164 | 26309 | 812 | 19570 |
| 16-#11 | 2.79 | MA | 11389 | 4053 | 19026 | 2923 | 20605 | 2358 | 21176 | 1905 | 21530 | 1207 | 26030 | 677 | 20838 |
| 7L-3S | | MI | 11175 | 4053 | 18907 | 2875 | 20816 | 2322 | 21784 | 1870 | 23025 | 1157 | 27657 | 898 | 19722 |
| 16-#11 | 2.79 | MA | 11041 | 4053 | 18419 | 2920 | 19792 | 2354 | 20209 | 1913 | 20260 | 1214 | 24416 | 630 | 20071 |
| 8L-2S | | MI | 11677 | 4053 | 19688 | 2879 | 21812 | 2314 | 22980 | 1863 | 24604 | 1151 | 29724 | 987 | 19746 |
| 16-#14 | 4.02 | MA | 13421 | 4445 | 23423 | 3153 | 26188 | 2513 | 27946 | 1996 | 30456 | 1155 | 37575 | 680 | 31338 |
| 4L-6S | | MI | 10695 | 4445 | 18794 | 3103 | 20559 | 2481 | 21460 | 1971 | 22606 | 1108 | 27714 | 465 | 24901 |
| 16-#14 | 4.02 | MA | 12892 | 4445 | 22487 | 3149 | 24981 | 2525 | 26472 | 2006 | 28425 | 1145 | 35127 | 623 | 30477 |
| 5E | | MI | 11130 | 4445 | 19551 | 3110 | 21585 | 2491 | 22632 | 1961 | 24158 | 1098 | 29595 | 551 | 26096 |
| 16-#14 | 4.02 | MA | 12387 | 4445 | 21602 | 3144 | 23781 | 2518 | 25064 | 2016 | 26561 | 1155 | 32841 | 537 | 29090 |
| 6L-4S | | MI | 11586 | 4445 | 20351 | 3117 | 22616 | 2481 | 23859 | 1951 | 25851 | 1108 | 31615 | 609 | 26743 |
| 16-#14 | 4.02 | MA | 11894 | 4445 | 20655 | 3159 | 22627 | 2530 | 23601 | 2006 | 24737 | 1165 | 30693 | 438 | 27782 |
| 7L-3S | | MI | 12092 | 4445 | 21258 | 3104 | 23768 | 2491 | 25223 | 1961 | 27562 | 1098 | 33516 | 732 | 27754 |
| 18-#11 | 3.13 | MA | 12893 | 4164 | 21880 | 2987 | 24266 | 2395 | 25644 | 1928 | 27453 | 1190 | 33563 | 841 | 25510 |
| 4L-7S | | MI | 10222 | 4164 | 17397 | 2955 | 18875 | 2375 | 19457 | 1900 | 20024 | 1159 | 24344 | 618 | 20210 |
| 18-#11 | 3.13 | MA | 12517 | 4164 | 21226 | 2984 | 23423 | 2404 | 24612 | 1935 | 26021 | 1183 | 31833 | 801 | 24776 |
| 5L-6S | | MI | 10525 | 4164 | 17963 | 2945 | 19565 | 2367 | 20318 | 1907 | 21098 | 1152 | 25606 | 685 | 20819 |
| 18-#11 | 3.13 | MA | 12158 | 4164 | 20607 | 2981 | 22584 | 2399 | 23626 | 1943 | 24707 | 1190 | 30215 | 742 | 24280 |
| 6L-5S | | MI | 10834 | 4164 | 18493 | 2949 | 20283 | 2373 | 21147 | 1900 | 22196 | 1145 | 26943 | 745 | 21257 |
| 18-#11 | 3.13 | MA | 11808 | 4164 | 19946 | 2992 | 21778 | 2408 | 22601 | 1936 | 23421 | 1197 | 28527 | 654 | 23499 |
| 7L-4S | | MI | 11158 | 4164 | 19053 | 2953 | 21005 | 2366 | 22015 | 1893 | 23393 | 1152 | 28377 | 785 | 21817 |
| 18-#11 | 3.13 | MA | 11462 | 4164 | 19338 | 2989 | 20964 | 2404 | 21634 | 1944 | 22151 | 1204 | 26913 | 607 | 22695 |
| 8L-3S | | MI | 11517 | 4164 | 19688 | 2944 | 21812 | 2372 | 22980 | 1900 | 24604 | 1145 | 29724 | 871 | 22081 |
| 18-#14 | 4.52 | MA | 13470 | 4605 | 23799 | 3248 | 26654 | 2598 | 28502 | 2051 | 31106 | 1130 | 38658 | 587 | 34323 |
| 5L-6S | | MI | 11182 | 4605 | 19907 | 3203 | 21978 | 2554 | 23150 | 2012 | 24839 | 1089 | 30627 | 422 | 28078 |
| 18-#14 | 4.52 | MA | 12969 | 4605 | 22914 | 3244 | 25453 | 2590 | 27094 | 2061 | 29242 | 1140 | 36371 | 502 | 32859 |
| 6L-5S | | MI | 11614 | 4605 | 20664 | 3210 | 23004 | 2563 | 24322 | 2003 | 26391 | 1079 | 32508 | 508 | 29277 |
| 18-#14 | 4.52 | MA | 12481 | 4605 | 21967 | 3259 | 24300 | 2602 | 25632 | 2051 | 27418 | 1150 | 34224 | 403 | 31497 |
| 7L-4S | | MI | 12066 | 4605 | 21464 | 3216 | 24034 | 2553 | 25549 | 1993 | 28083 | 1089 | 34527 | 567 | 29954 |
| 20-#11 | 3.48 | MA | 12927 | 4275 | 22145 | 3053 | 24595 | 2454 | 26037 | 1967 | 27912 | 1174 | 34330 | 778 | 27473 |
| 5L-7S | | MI | 10570 | 4275 | 18178 | 3024 | 19871 | 2425 | 20652 | 1930 | 21604 | 1147 | 26412 | 591 | 22467 |
| 20-#11 | 3.48 | MA | 12571 | 4275 | 21527 | 3050 | 23756 | 2449 | 25051 | 1974 | 26598 | 1180 | 32712 | 719 | 26918 |
| 6E | | MI | 10871 | 4275 | 18745 | 3014 | 20561 | 2417 | 21514 | 1937 | 22678 | 1140 | 27674 | 657 | 23048 |
| 20-#11 | 3.48 | MA | 12223 | 4275 | 20865 | 3061 | 22950 | 2458 | 24026 | 1968 | 25312 | 1187 | 31024 | 631 | 26167 |
| 7L-5S | | MI | 11178 | 4275 | 19274 | 3018 | 21279 | 2424 | 22343 | 1930 | 23775 | 1133 | 29011 | 717 | 23545 |
| 20-#11 | 3.48 | MA | 11880 | 4275 | 20258 | 3058 | 22136 | 2454 | 23059 | 1975 | 24042 | 1194 | 29410 | 584 | 25326 |
| 8L-4S | | MI | 11500 | 4275 | 19834 | 3023 | 22001 | 2416 | 23211 | 1923 | 24972 | 1140 | 30445 | 757 | 24073 |
| 20-#14 | 5.02 | MA | 13547 | 4764 | 24226 | 3343 | 27126 | 2662 | 29125 | 2105 | 31923 | 1124 | 39902 | 466 | 36639 |
| 6E | | MI | 11666 | 4764 | 21019 | 3303 | 23396 | 2626 | 24841 | 2054 | 27072 | 1070 | 33539 | 379 | 31267 |
| 20-#14 | 5.02 | MA | 13063 | 4764 | 23279 | 3358 | 25972 | 2675 | 27662 | 2095 | 30100 | 1134 | 37754 | 367 | 35223 |
| 7L-5S | | MI | 12094 | 4764 | 21776 | 3309 | 24422 | 2636 | 26013 | 2044 | 28623 | 1060 | 35420 | 466 | 32408 |
| 22-#11 | 3.83 | MA | 12981 | 4385 | 22446 | 3120 | 24928 | 2499 | 26476 | 2005 | 28488 | 1171 | 35209 | 696 | 29562 |
| 6L-7S | | MI | 10916 | 4385 | 18959 | 3093 | 20866 | 2475 | 21848 | 1960 | 23183 | 1134 | 28480 | 563 | 24729 |

## RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

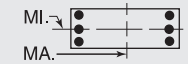
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.83 | MA | 12636 | 4385 | 21785 | 3131 | 24122 | 2509 | 25451 | 1999 | 27202 | 1177 | 33521 | 608 | 28840 |
| 7L-6S | | MI | 11214 | 4385 | 19526 | 3083 | 21557 | 2468 | 22709 | 1967 | 24257 | 1127 | 29742 | 630 | 25285 |
| 22-#11 | 3.83 | MA | 12295 | 4385 | 21177 | 3128 | 23308 | 2504 | 24484 | 2006 | 25932 | 1184 | 31907 | 561 | 27963 |
| 8L-5S | | MI | 11520 | 4385 | 20055 | 3088 | 22275 | 2474 | 23539 | 1960 | 25354 | 1121 | 31078 | 690 | 25837 |
| 22-#14 | 5.52 | MA | 13641 | 4924 | 24591 | 3458 | 27645 | 2747 | 29692 | 2140 | 32781 | 1118 | 41285 | 332 | 38960 |
| 7L-6S | | MI | 12146 | 4924 | 22132 | 3402 | 24814 | 2698 | 26531 | 2096 | 29304 | 1051 | 36451 | 337 | 34465 |
| 24-#11 | 4.18 | MA | 13045 | 4496 | 22704 | 3200 | 25294 | 2559 | 26876 | 2030 | 29093 | 1168 | 36019 | 586 | 31519 |
| 7E | | MI | 11260 | 4496 | 19740 | 3162 | 21862 | 2525 | 23043 | 1990 | 24762 | 1122 | 30547 | 536 | 26996 |
| 24-#11 | 4.18 | MA | 12708 | 4496 | 22096 | 3197 | 24480 | 2554 | 25909 | 2037 | 27823 | 1174 | 34404 | 539 | 30607 |
| 8L-6S | | MI | 11556 | 4496 | 20307 | 3153 | 22553 | 2518 | 23905 | 1996 | 25836 | 1115 | 31809 | 602 | 27528 |

## RECTANGULAR TIED COLUMNS 28" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.68 | MA | 13698 | 3934 | 22221 | 2838 | 24140 | 2300 | 24915 | 1892 | 25497 | 1275 | 30222 | 1158 | 15784 |
| 2E | | MI | 11143 | 3934 | 18230 | 2784 | 19532 | 2249 | 19947 | 1838 | 20224 | 1226 | 23701 | 1089 | 12684 |
| 6-#14 | 1.42 | MA | 13416 | 3845 | 21465 | 2805 | 23276 | 2279 | 23945 | 1886 | 24280 | 1304 | 28702 | 1204 | 13554 |
| 2L-3S | | MI | 10207 | 3845 | 16538 | 2749 | 17541 | 2248 | 17609 | 1852 | 17145 | 1272 | 19775 | 1020 | 10993 |
| 6-#14 | 1.42 | MA | 12484 | 3845 | 20053 | 2801 | 21476 | 2292 | 21757 | 1897 | 21374 | 1314 | 24862 | 1076 | 13591 |
| 3L-2S | | MI | 10939 | 3845 | 17650 | 2756 | 18960 | 2238 | 19300 | 1843 | 19378 | 1262 | 22687 | 1148 | 10932 |
| 6-#18 | 2.52 | MA | 14789 | 4217 | 24681 | 3015 | 27276 | 2429 | 28704 | 1970 | 30503 | 1246 | 36798 | 1092 | 23310 |
| 2L-3S | | MI | 10736 | 4217 | 18230 | 2947 | 19532 | 2392 | 19947 | 1926 | 20224 | 1204 | 23701 | 775 | 18558 |
| 6-#18 | 2.52 | MA | 13203 | 4217 | 22221 | 3006 | 24140 | 2450 | 24915 | 1988 | 25497 | 1264 | 30222 | 864 | 23134 |
| 3L-2S | | MI | 11978 | 4217 | 20158 | 2961 | 21953 | 2374 | 22831 | 1909 | 24035 | 1186 | 28633 | 1002 | 18614 |
| 8-#11 | 1.31 | MA | 13299 | 3809 | 21147 | 2794 | 22920 | 2272 | 23532 | 1884 | 23786 | 1316 | 28086 | 1224 | 12632 |
| 2L-4S | | MI | 9967 | 3809 | 15987 | 2753 | 16891 | 2235 | 16876 | 1846 | 16245 | 1292 | 18862 | 998 | 10276 |
| 8-#11 | 1.31 | MA | 12645 | 3809 | 20158 | 2792 | 21660 | 2281 | 22000 | 1892 | 21739 | 1323 | 25373 | 1135 | 12664 |
| 3E | | MI | 10339 | 3809 | 16623 | 2743 | 17698 | 2241 | 17840 | 1853 | 17456 | 1285 | 20209 | 1084 | 10248 |
| 8-#11 | 1.31 | MA | 12178 | 3809 | 19360 | 2803 | 20645 | 2277 | 20768 | 1886 | 20169 | 1330 | 23606 | 1046 | 12651 |
| 4L-2S | | MI | 10854 | 3809 | 17404 | 2747 | 18694 | 2233 | 19036 | 1846 | 19035 | 1278 | 22277 | 1173 | 10205 |
| 8-#14 | 1.89 | MA | 14054 | 4005 | 22877 | 2905 | 25075 | 2351 | 26133 | 1931 | 27186 | 1290 | 32543 | 1172 | 17880 |
| 2L-4S | | MI | 10181 | 4005 | 16743 | 2862 | 17807 | 2311 | 17936 | 1884 | 17666 | 1263 | 20786 | 855 | 14264 |
| 8-#14 | 1.89 | MA | 13132 | 4005 | 21465 | 2901 | 23276 | 2364 | 23945 | 1942 | 24280 | 1300 | 28702 | 1044 | 17872 |
| 3E | | MI | 10706 | 4005 | 17650 | 2849 | 18960 | 2321 | 19300 | 1894 | 19378 | 1253 | 22687 | 977 | 14394 |
| 8-#14 | 1.89 | MA | 12474 | 4005 | 20323 | 2917 | 21824 | 2358 | 22183 | 1933 | 22051 | 1310 | 26204 | 916 | 17695 |
| 4L-2S | | MI | 11431 | 4005 | 18762 | 2856 | 20378 | 2311 | 20990 | 1884 | 21611 | 1243 | 25599 | 1105 | 14361 |
| 8-#18 | 3.36 | MA | 15861 | 4501 | 27140 | 3193 | 30412 | 2557 | 32494 | 2048 | 35508 | 1217 | 43374 | 1026 | 30778 |
| 2L-4S | | MI | 10684 | 4501 | 18580 | 3144 | 19985 | 2499 | 20502 | 1979 | 21114 | 1182 | 25402 | 478 | 22049 |
| 8-#18 | 3.36 | MA | 14298 | 4501 | 24681 | 3183 | 27276 | 2578 | 28704 | 2066 | 30503 | 1235 | 36798 | 798 | 30489 |
| 3E | | MI | 11575 | 4501 | 20158 | 3124 | 21953 | 2517 | 22831 | 1997 | 24035 | 1165 | 28633 | 689 | 24330 |
| 8-#18 | 3.36 | MA | 13180 | 4501 | 22684 | 3209 | 24738 | 2564 | 25648 | 2048 | 26664 | 1252 | 32519 | 574 | 27588 |
| 4L-2S | | MI | 12801 | 4501 | 22086 | 3139 | 24374 | 2499 | 25715 | 1979 | 27846 | 1147 | 33565 | 916 | 24497 |
| 10-#11 | 1.64 | MA | 13751 | 3920 | 22135 | 2863 | 24181 | 2322 | 25064 | 1915 | 25832 | 1307 | 30798 | 1203 | 15663 |
| 2L-5S | | MI | 9988 | 3920 | 16209 | 2818 | 17165 | 2292 | 17204 | 1883 | 16628 | 1272 | 19496 | 930 | 12302 |
| 10-#11 | 1.64 | MA | 13101 | 3920 | 21147 | 2861 | 22920 | 2332 | 23532 | 1923 | 23786 | 1314 | 28086 | 1114 | 15680 |
| 3L-4S | | MI | 10322 | 3920 | 16769 | 2822 | 17887 | 2285 | 18072 | 1876 | 17824 | 1279 | 20930 | 970 | 12648 |
| 10-#11 | 1.64 | MA | 12638 | 3920 | 20348 | 2872 | 21906 | 2328 | 22300 | 1917 | 22216 | 1321 | 26319 | 1025 | 15635 |
| 4L-3S | | MI | 10692 | 3920 | 17404 | 2812 | 18694 | 2291 | 19036 | 1883 | 19035 | 1272 | 22277 | 1057 | 12646 |
| 10-#11 | 1.64 | MA | 12222 | 3920 | 19647 | 2870 | 21001 | 2337 | 21193 | 1926 | 20666 | 1314 | 24446 | 984 | 15157 |
| 5L-2S | | MI | 11204 | 3920 | 18185 | 2817 | 19690 | 2283 | 20232 | 1876 | 20614 | 1265 | 24345 | 1145 | 12614 |
| 10-#14 | 2.36 | MA | 14686 | 4164 | 24288 | 3005 | 26875 | 2423 | 28321 | 1976 | 30093 | 1276 | 36384 | 1139 | 22189 |
| 2L-5S | | MI | 10209 | 4164 | 17056 | 2955 | 18195 | 2393 | 18399 | 1936 | 18206 | 1233 | 21679 | 754 | 16558 |
| 10-#14 | 2.36 | MA | 13772 | 4164 | 22877 | 3001 | 25075 | 2437 | 26133 | 1987 | 27186 | 1286 | 32543 | 1011 | 22138 |
| 3L-4S | | MI | 10679 | 4164 | 17856 | 2962 | 19226 | 2383 | 19626 | 1926 | 19899 | 1243 | 23698 | 812 | 17397 |
| 10-#14 | 2.36 | MA | 13120 | 4164 | 21735 | 3017 | 23624 | 2430 | 24371 | 1978 | 24957 | 1296 | 30045 | 883 | 21703 |
| 4L-3S | | MI | 11199 | 4164 | 18762 | 2949 | 20378 | 2393 | 20990 | 1936 | 21611 | 1233 | 25599 | 935 | 17769 |
| 10-#14 | 2.36 | MA | 12534 | 4164 | 20731 | 3013 | 22330 | 2444 | 22787 | 1988 | 22757 | 1286 | 27387 | 825 | 20498 |
| 5L-2S | | MI | 11918 | 4164 | 19875 | 2956 | 21796 | 2383 | 22680 | 1926 | 23843 | 1223 | 28512 | 1063 | 17771 |

## RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

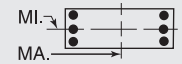
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 4.20 | MA | 15376 | 4785 | 27140 | 3361 | 30412 | 2707 | 32494 | 2144 | 35508 | 1206 | 43374 | 732 | 37832 |
| 3L-4S | | MI | 11523 | 4785 | 20508 | 3322 | 22406 | 2625 | 23387 | 2049 | 24925 | 1143 | 30334 | 392 | 27520 |
| 10-#18 | 4.20 | MA | 14274 | 4785 | 25144 | 3387 | 27874 | 2693 | 29438 | 2126 | 31669 | 1223 | 39095 | 508 | 34626 |
| 4L-3S | | MI | 12402 | 4785 | 22086 | 3301 | 24374 | 2642 | 25715 | 2067 | 27846 | 1125 | 33565 | 602 | 30084 |
| 10-#18 | 4.20 | MA | 13284 | 4785 | 23385 | 3377 | 25609 | 2714 | 26687 | 2144 | 27877 | 1206 | 34535 | 406 | 31985 |
| 5L-2S | | MI | 13614 | 4785 | 24013 | 3316 | 26795 | 2625 | 28600 | 2049 | 31657 | 1107 | 38497 | 830 | 30338 |
| 12-#11 | 1.97 | MA | 14199 | 4030 | 23124 | 2932 | 25441 | 2372 | 26596 | 1946 | 27879 | 1298 | 33511 | 1182 | 18685 |
| 2L-6S | | MI | 10026 | 4030 | 16460 | 2883 | 17443 | 2336 | 17570 | 1919 | 17109 | 1267 | 20227 | 843 | 14223 |
| 12-#11 | 1.97 | MA | 13554 | 4030 | 22135 | 2930 | 24181 | 2382 | 25064 | 1954 | 25832 | 1305 | 30798 | 1093 | 18679 |
| 3L-5S | | MI | 10343 | 4030 | 16990 | 2887 | 18161 | 2343 | 18399 | 1912 | 18207 | 1260 | 21564 | 903 | 14561 |
| 12-#11 | 1.97 | MA | 13094 | 4030 | 21337 | 2942 | 23166 | 2378 | 23832 | 1949 | 24262 | 1312 | 29031 | 1005 | 18612 |
| 4E | | MI | 10674 | 4030 | 17550 | 2891 | 18882 | 2335 | 19267 | 1905 | 19404 | 1267 | 22997 | 943 | 15010 |
| 12-#11 | 1.97 | MA | 12681 | 4030 | 20635 | 2939 | 22262 | 2388 | 22725 | 1957 | 22713 | 1305 | 27159 | 964 | 18026 |
| 5L-3S | | MI | 11042 | 4030 | 18185 | 2882 | 19690 | 2341 | 20232 | 1912 | 20614 | 1260 | 24345 | 1029 | 15032 |
| 12-#11 | 1.97 | MA | 12287 | 4030 | 19973 | 2937 | 21362 | 2384 | 21629 | 1951 | 21290 | 1312 | 25399 | 905 | 17527 |
| 6L-2S | | MI | 11550 | 4030 | 18966 | 2886 | 20686 | 2334 | 21427 | 1905 | 22194 | 1253 | 26413 | 1118 | 15013 |
| 12-#14 | 2.84 | MA | 15311 | 4324 | 25700 | 3105 | 28675 | 2496 | 30508 | 2021 | 32999 | 1262 | 40224 | 1107 | 26478 |
| 2L-6S | | MI | 10261 | 4324 | 17411 | 3048 | 18588 | 2456 | 18917 | 1988 | 18887 | 1224 | 22710 | 625 | 18854 |
| 12-#14 | 2.84 | MA | 14405 | 4324 | 24288 | 3101 | 26875 | 2509 | 28321 | 2032 | 30093 | 1272 | 36384 | 979 | 26393 |
| 3L-5S | | MI | 10706 | 4324 | 18168 | 3055 | 19614 | 2465 | 20089 | 1978 | 20439 | 1214 | 24591 | 711 | 19782 |
| 12-#14 | 2.84 | MA | 13760 | 4324 | 23146 | 3116 | 25424 | 2503 | 26559 | 2022 | 27864 | 1282 | 33886 | 851 | 25737 |
| 4E | | MI | 11172 | 4324 | 18968 | 3062 | 20644 | 2455 | 21316 | 1968 | 22131 | 1224 | 26611 | 770 | 20556 |
| 12-#14 | 2.84 | MA | 13180 | 4324 | 22142 | 3112 | 24129 | 2516 | 24975 | 2033 | 25663 | 1272 | 31228 | 793 | 24608 |
| 5L-3S | | MI | 11687 | 4324 | 19875 | 3049 | 21796 | 2465 | 22680 | 1978 | 23843 | 1214 | 28512 | 892 | 21130 |
| 12-#14 | 2.84 | MA | 12626 | 4324 | 21193 | 3108 | 22842 | 2509 | 23461 | 2044 | 23643 | 1282 | 28738 | 708 | 23417 |
| 6L-2S | | MI | 12401 | 4324 | 20987 | 3055 | 23215 | 2455 | 24370 | 1968 | 26076 | 1204 | 31424 | 1020 | 21170 |
| 12-#18 | 5.04 | MA | 15354 | 5069 | 27603 | 3564 | 31010 | 2821 | 33228 | 2205 | 36675 | 1194 | 45671 | 443 | 41704 |
| 4E | | MI | 12352 | 5069 | 22435 | 3499 | 24827 | 2750 | 26271 | 2120 | 28735 | 1103 | 35266 | 306 | 33028 |
| 12-#18 | 5.04 | MA | 14377 | 5069 | 25845 | 3554 | 28745 | 2842 | 30477 | 2222 | 32883 | 1176 | 41111 | 340 | 38898 |
| 5L-3S | | MI | 13221 | 5069 | 24013 | 3478 | 26795 | 2768 | 28600 | 2137 | 31657 | 1086 | 38497 | 516 | 35507 |
| 14-#11 | 2.29 | MA | 14643 | 4141 | 24112 | 3002 | 26701 | 2422 | 28128 | 1977 | 29926 | 1290 | 36223 | 1161 | 21700 |
| 2L-7S | | MI | 10072 | 4141 | 16675 | 2962 | 17748 | 2394 | 17904 | 1942 | 17614 | 1262 | 21033 | 749 | 15913 |
| 14-#11 | 2.29 | MA | 14002 | 4141 | 23124 | 2999 | 25441 | 2432 | 26596 | 1985 | 27879 | 1296 | 33511 | 1072 | 21673 |
| 3L-6S | | MI | 10380 | 4141 | 17241 | 2952 | 18439 | 2387 | 18766 | 1949 | 18688 | 1255 | 22294 | 815 | 16513 |
| 14-#11 | 2.29 | MA | 13546 | 4141 | 22325 | 3011 | 24426 | 2428 | 25365 | 1980 | 26309 | 1303 | 31744 | 984 | 21585 |
| 4L-5S | | MI | 10695 | 4141 | 17771 | 2956 | 19157 | 2393 | 19595 | 1942 | 19786 | 1248 | 23631 | 875 | 16829 |
| 14-#11 | 2.29 | MA | 13137 | 4141 | 21624 | 3008 | 23522 | 2438 | 24258 | 1988 | 24760 | 1296 | 29871 | 943 | 20906 |
| 5L-4S | | MI | 11024 | 4141 | 18331 | 2960 | 19878 | 2385 | 20463 | 1935 | 20983 | 1255 | 25065 | 915 | 17365 |
| 14-#11 | 2.29 | MA | 12745 | 4141 | 20961 | 3006 | 22623 | 2434 | 23161 | 1982 | 23337 | 1303 | 28111 | 884 | 20433 |
| 6L-3S | | MI | 11389 | 4141 | 18966 | 2951 | 20686 | 2391 | 21427 | 1942 | 22194 | 1248 | 26413 | 1001 | 17407 |
| 14-#11 | 2.29 | MA | 12364 | 4141 | 20252 | 3017 | 21759 | 2444 | 22102 | 1990 | 21945 | 1310 | 26278 | 796 | 19651 |
| 7L-2S | | MI | 11894 | 4141 | 19747 | 2955 | 21682 | 2384 | 22623 | 1935 | 23773 | 1241 | 28480 | 1090 | 17404 |
| 14-#14 | 3.31 | MA | 15032 | 4483 | 25700 | 3200 | 28675 | 2581 | 30508 | 2076 | 32999 | 1258 | 40224 | 947 | 30642 |
| 3L-6S | | MI | 10757 | 4483 | 18524 | 3148 | 20006 | 2528 | 20607 | 2030 | 21120 | 1205 | 25622 | 582 | 22001 |
| 14-#14 | 3.31 | MA | 14393 | 4483 | 24558 | 3216 | 27223 | 2575 | 28747 | 2067 | 30770 | 1267 | 37726 | 819 | 29793 |
| 4L-5S | | MI | 11198 | 4483 | 19281 | 3155 | 21032 | 2538 | 21779 | 2020 | 22671 | 1195 | 27503 | 669 | 23017 |
| 14-#14 | 3.31 | MA | 13819 | 4483 | 23554 | 3212 | 25929 | 2588 | 27163 | 2078 | 28569 | 1258 | 35068 | 761 | 28731 |
| 5L-4S | | MI | 11660 | 4483 | 20081 | 3162 | 22062 | 2528 | 23006 | 2010 | 24364 | 1205 | 29523 | 727 | 23736 |
| 14-#14 | 3.31 | MA | 13270 | 4483 | 22605 | 3208 | 24642 | 2582 | 25649 | 2089 | 26549 | 1267 | 32578 | 675 | 27452 |
| 6L-3S | | MI | 12172 | 4483 | 20987 | 3148 | 23215 | 2538 | 24370 | 2020 | 26076 | 1195 | 31424 | 849 | 24483 |
| 14-#14 | 3.31 | MA | 12735 | 4483 | 21590 | 3224 | 23404 | 2595 | 24077 | 2080 | 24572 | 1277 | 29983 | 548 | 26217 |
| 7L-2S | | MI | 12880 | 4483 | 22100 | 3155 | 24633 | 2528 | 26060 | 2010 | 28308 | 1185 | 34336 | 977 | 24549 |
| 14-#18 | 5.88 | MA | 15457 | 5352 | 28305 | 3732 | 31881 | 2971 | 34267 | 2301 | 37888 | 1147 | 47687 | 274 | 45846 |
| 5L-4S | | MI | 13172 | 5352 | 24363 | 3676 | 27248 | 2875 | 29155 | 2190 | 32546 | 1064 | 40198 | 219 | 38565 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

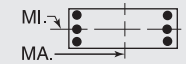
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.62 | MA | 14447 | 4251 | 24112 | 3068 | 26701 | 2482 | 28128 | 2016 | 29926 | 1287 | 36223 | 1052 | 24662 |
| 3L-7S | | MI | 10426 | 4251 | 17456 | 3031 | 18744 | 2444 | 19100 | 1972 | 19193 | 1249 | 23100 | 721 | 18155 |
| 16-#11 | 2.62 | MA | 13995 | 4251 | 23314 | 3080 | 25687 | 2478 | 26897 | 2011 | 28356 | 1294 | 34456 | 963 | 24555 |
| 4L-6S | | MI | 10731 | 4251 | 18022 | 3021 | 19435 | 2437 | 19961 | 1979 | 20267 | 1242 | 24362 | 788 | 18807 |
| 16-#11 | 2.62 | MA | 13588 | 4251 | 22613 | 3077 | 24782 | 2488 | 25790 | 2019 | 26806 | 1287 | 32584 | 922 | 23794 |
| 5E | | MI | 11044 | 4251 | 18552 | 3025 | 20153 | 2443 | 20790 | 1972 | 21365 | 1235 | 25699 | 848 | 19106 |
| 16-#11 | 2.62 | MA | 13200 | 4251 | 21950 | 3075 | 23883 | 2484 | 24693 | 2013 | 25384 | 1294 | 30824 | 863 | 23344 |
| 6L-4S | | MI | 11371 | 4251 | 19112 | 3030 | 20874 | 2435 | 21658 | 1965 | 22562 | 1242 | 27133 | 888 | 19716 |
| 16-#11 | 2.62 | MA | 12821 | 4251 | 21241 | 3087 | 23019 | 2494 | 23634 | 2021 | 23991 | 1301 | 28990 | 775 | 22510 |
| 7L-3S | | MI | 11733 | 4251 | 19747 | 3020 | 21682 | 2442 | 22623 | 1972 | 23773 | 1235 | 28480 | 974 | 19775 |
| 16-#11 | 2.62 | MA | 12448 | 4251 | 20590 | 3084 | 22147 | 2490 | 22597 | 2030 | 22532 | 1294 | 27242 | 727 | 21771 |
| 8L-2S | | MI | 12236 | 4251 | 20528 | 3024 | 22677 | 2434 | 23818 | 1965 | 25352 | 1229 | 30548 | 1063 | 19789 |
| 16-#14 | 3.78 | MA | 15020 | 4643 | 25970 | 3316 | 29023 | 2647 | 30935 | 2112 | 33676 | 1253 | 41567 | 786 | 33866 |
| 4L-6S | | MI | 11249 | 4643 | 19636 | 3248 | 21424 | 2600 | 22297 | 2072 | 23352 | 1186 | 28535 | 540 | 25163 |
| 16-#14 | 3.78 | MA | 14451 | 4643 | 24966 | 3312 | 27729 | 2661 | 29351 | 2123 | 31475 | 1243 | 38909 | 728 | 32864 |
| 5E | | MI | 11687 | 4643 | 20393 | 3254 | 22450 | 2610 | 23469 | 2062 | 24904 | 1176 | 30416 | 626 | 26262 |
| 16-#14 | 3.78 | MA | 13908 | 4643 | 24017 | 3308 | 26441 | 2654 | 27837 | 2134 | 29455 | 1253 | 36419 | 643 | 31502 |
| 6L-4S | | MI | 12145 | 4643 | 21193 | 3261 | 23481 | 2600 | 24696 | 2052 | 26597 | 1186 | 32435 | 684 | 26931 |
| 16-#14 | 3.78 | MA | 13379 | 4643 | 23002 | 3324 | 25204 | 2667 | 26265 | 2125 | 27478 | 1263 | 33823 | 516 | 30212 |
| 7L-3S | | MI | 12652 | 4643 | 22100 | 3248 | 24633 | 2610 | 26060 | 2062 | 28308 | 1176 | 34336 | 807 | 27828 |
| 18-#11 | 2.95 | MA | 14440 | 4362 | 24303 | 3149 | 26947 | 2528 | 28429 | 2042 | 30403 | 1285 | 37168 | 942 | 27522 |
| 4L-7S | | MI | 10777 | 4362 | 18237 | 3100 | 19740 | 2494 | 20295 | 2002 | 20773 | 1237 | 25168 | 694 | 20404 |
| 18-#11 | 2.95 | MA | 14036 | 4362 | 23601 | 3147 | 26043 | 2538 | 27322 | 2050 | 28853 | 1279 | 35296 | 901 | 26690 |
| 5L-6S | | MI | 11080 | 4362 | 18803 | 3090 | 20431 | 2487 | 21157 | 2009 | 21847 | 1230 | 26430 | 760 | 21035 |
| 18-#11 | 2.95 | MA | 13651 | 4362 | 22939 | 3144 | 25143 | 2534 | 26225 | 2044 | 27430 | 1285 | 33536 | 842 | 26260 |
| 6L-5S | | MI | 11391 | 4362 | 19333 | 3095 | 21149 | 2493 | 21986 | 2002 | 22944 | 1223 | 27767 | 820 | 21388 |
| 18-#11 | 2.95 | MA | 13275 | 4362 | 22230 | 3156 | 24279 | 2544 | 25167 | 2053 | 26038 | 1292 | 31702 | 754 | 25375 |
| 7L-4S | | MI | 11716 | 4362 | 19893 | 3099 | 21870 | 2485 | 22854 | 1995 | 24141 | 1230 | 29201 | 860 | 21972 |
| 18-#11 | 2.95 | MA | 12904 | 4362 | 21579 | 3153 | 23407 | 2540 | 24130 | 2061 | 24578 | 1285 | 29954 | 706 | 24598 |
| 8L-3S | | MI | 12076 | 4362 | 20528 | 3089 | 22677 | 2492 | 23818 | 2002 | 25352 | 1223 | 30548 | 946 | 22137 |
| 18-#14 | 4.25 | MA | 15078 | 4803 | 26377 | 3412 | 29529 | 2733 | 31539 | 2168 | 34381 | 1229 | 42749 | 696 | 37006 |
| 5L-6S | | MI | 11737 | 4803 | 20749 | 3347 | 22843 | 2672 | 23987 | 2113 | 25585 | 1167 | 31447 | 497 | 28337 |
| 18-#14 | 4.25 | MA | 14540 | 4803 | 25428 | 3408 | 28241 | 2726 | 30025 | 2179 | 32361 | 1239 | 40260 | 611 | 35564 |
| 6L-5S | | MI | 12172 | 4803 | 21506 | 3354 | 23869 | 2682 | 25159 | 2104 | 27137 | 1157 | 33328 | 583 | 29513 |
| 18-#14 | 4.25 | MA | 14016 | 4803 | 24413 | 3423 | 27004 | 2740 | 28453 | 2170 | 30384 | 1249 | 37664 | 483 | 34219 |
| 7L-4S | | MI | 12626 | 4803 | 22306 | 3361 | 24899 | 2672 | 26386 | 2094 | 28829 | 1167 | 35348 | 642 | 30140 |
| 20-#11 | 3.28 | MA | 14481 | 4473 | 24590 | 3216 | 27303 | 2588 | 28854 | 2081 | 30900 | 1270 | 38009 | 880 | 29592 |
| 5L-7S | | MI | 11125 | 4473 | 19018 | 3169 | 20736 | 2545 | 21491 | 2032 | 22352 | 1225 | 27236 | 666 | 22659 |
| 20-#11 | 3.28 | MA | 14099 | 4473 | 23927 | 3213 | 26404 | 2584 | 27757 | 2076 | 29477 | 1277 | 36249 | 821 | 29113 |
| 6E | | MI | 11427 | 4473 | 19585 | 3160 | 21426 | 2537 | 22352 | 2038 | 23426 | 1218 | 28498 | 733 | 23262 |
| 20-#11 | 3.28 | MA | 13725 | 4473 | 23218 | 3225 | 25540 | 2594 | 26699 | 2084 | 28085 | 1283 | 34415 | 733 | 28247 |
| 7L-5S | | MI | 11735 | 4473 | 20114 | 3164 | 22144 | 2543 | 23182 | 2032 | 24523 | 1211 | 29835 | 793 | 23676 |
| 20-#11 | 3.28 | MA | 13357 | 4473 | 22567 | 3223 | 24667 | 2590 | 25662 | 2092 | 26625 | 1277 | 32666 | 685 | 27432 |
| 8L-4S | | MI | 12058 | 4473 | 20674 | 3168 | 22866 | 2536 | 24049 | 2025 | 25720 | 1218 | 31268 | 833 | 24226 |
| 20-#14 | 4.73 | MA | 15167 | 4962 | 26840 | 3507 | 30041 | 2799 | 32213 | 2224 | 35267 | 1225 | 44100 | 578 | 39637 |
| 6E | | MI | 12222 | 4962 | 21861 | 3447 | 24261 | 2745 | 25678 | 2155 | 27817 | 1147 | 34360 | 454 | 31523 |
| 20-#14 | 4.73 | MA | 14647 | 4962 | 25825 | 3523 | 28804 | 2812 | 30641 | 2215 | 33290 | 1235 | 41505 | 451 | 38238 |
| 7L-5S | | MI | 12653 | 4962 | 22618 | 3454 | 25287 | 2755 | 26850 | 2145 | 29369 | 1137 | 36240 | 541 | 32711 |
| 22-#11 | 3.61 | MA | 14543 | 4583 | 24916 | 3283 | 27664 | 2634 | 29289 | 2107 | 31524 | 1268 | 38961 | 800 | 31960 |
| 6L-7S | | MI | 11472 | 4583 | 19799 | 3238 | 21732 | 2595 | 22686 | 2061 | 23931 | 1212 | 29304 | 639 | 24920 |
| 22-#11 | 3.61 | MA | 14173 | 4583 | 24207 | 3294 | 26800 | 2644 | 28231 | 2115 | 30131 | 1274 | 37127 | 712 | 31125 |
| 7L-6S | | MI | 11771 | 4583 | 20366 | 3229 | 22422 | 2587 | 23548 | 2068 | 25005 | 1206 | 30565 | 705 | 25496 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

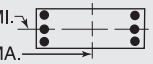
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.61 | MA | 13807 | 4583 | 23556 | 3292 | 25928 | 2640 | 27194 | 2123 | 28672 | 1268 | 35379 | 664 | 30273 |
| 8L-5S | | MI | 12078 | 4583 | 20895 | 3233 | 23140 | 2593 | 24377 | 2061 | 26102 | 1199 | 31902 | 765 | 25968 |
| 22-#14 | 5.20 | MA | 15274 | 5122 | 27237 | 3623 | 30604 | 2884 | 32829 | 2260 | 36197 | 1221 | 45345 | 419 | 42268 |
| 7L-6S | | MI | 12704 | 5122 | 22974 | 3547 | 25679 | 2817 | 27368 | 2197 | 30050 | 1128 | 37272 | 412 | 34718 |
| 24-#11 | 3.93 | MA | 14617 | 4694 | 25195 | 3363 | 28060 | 2694 | 29763 | 2146 | 32178 | 1266 | 39840 | 692 | 34007 |
| 7E | | MI | 11816 | 4694 | 20580 | 3307 | 22728 | 2645 | 23882 | 2091 | 25510 | 1200 | 31371 | 611 | 27185 |
| 24-#11 | 3.93 | MA | 14254 | 4694 | 24544 | 3361 | 27188 | 2690 | 28726 | 2154 | 30718 | 1259 | 38091 | 643 | 33119 |
| 8L-6S | | MI | 12114 | 4694 | 21147 | 3298 | 23418 | 2637 | 24744 | 2098 | 26584 | 1193 | 32633 | 678 | 27737 |

## RECTANGULAR TIED COLUMNS 28" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.59 | MA | 15268 | 4132 | 24622 | 2999 | 26762 | 2433 | 27640 | 2007 | 28224 | 1367 | 33467 | 1251 | 16864 |
| 2E | | MI | 11699 | 4132 | 19076 | 2927 | 20397 | 2367 | 20781 | 1938 | 20965 | 1303 | 24515 | 1163 | 12728 |
| 6-#14 | 1.34 | MA | 14958 | 4043 | 23804 | 2966 | 25826 | 2411 | 26541 | 1998 | 26887 | 1394 | 31784 | 1295 | 14465 |
| 2L-3S | | MI | 10762 | 4043 | 17379 | 2894 | 18406 | 2367 | 18446 | 1953 | 17891 | 1349 | 20595 | 1095 | 11034 |
| 6-#14 | 1.34 | MA | 13958 | 4043 | 22292 | 2963 | 23899 | 2425 | 24199 | 2010 | 23756 | 1404 | 27633 | 1167 | 14502 |
| 3L-2S | | MI | 11495 | 4043 | 18492 | 2901 | 19825 | 2357 | 20137 | 1943 | 20124 | 1340 | 23507 | 1223 | 10967 |
| 6-#18 | 2.38 | MA | 16447 | 4415 | 27259 | 3176 | 30124 | 2561 | 31727 | 2087 | 33629 | 1340 | 40594 | 1191 | 24930 |
| 2L-3S | | MI | 11291 | 4415 | 19076 | 3089 | 20397 | 2510 | 20781 | 2026 | 20965 | 1281 | 24515 | 849 | 18640 |
| 6-#18 | 2.38 | MA | 14742 | 4415 | 24622 | 3168 | 26762 | 2584 | 27640 | 2105 | 28224 | 1358 | 33467 | 963 | 24754 |
| 3L-2S | | MI | 12536 | 4415 | 21004 | 3104 | 22818 | 2492 | 23665 | 2008 | 24776 | 1263 | 29447 | 1077 | 18666 |
| 8-#11 | 1.24 | MA | 14830 | 4007 | 23459 | 2955 | 25441 | 2404 | 26094 | 1996 | 26344 | 1406 | 31102 | 1314 | 13475 |
| 2L-4S | | MI | 10522 | 4007 | 16827 | 2898 | 17756 | 2354 | 17714 | 1947 | 16994 | 1370 | 19686 | 1073 | 10318 |
| 8-#11 | 1.24 | MA | 14128 | 4007 | 22402 | 2953 | 24092 | 2414 | 24455 | 2005 | 24141 | 1413 | 28173 | 1225 | 13506 |
| 3E | | MI | 10894 | 4007 | 17463 | 2889 | 18563 | 2361 | 18679 | 1954 | 18204 | 1363 | 21033 | 1160 | 10282 |
| 8-#11 | 1.24 | MA | 13629 | 4007 | 21549 | 2965 | 23008 | 2411 | 23140 | 2000 | 22451 | 1420 | 26263 | 1137 | 13493 |
| 4L-2S | | MI | 11410 | 4007 | 18244 | 2893 | 19559 | 2353 | 19874 | 1947 | 19784 | 1356 | 23101 | 1248 | 10236 |
| 8-#14 | 1.79 | MA | 15647 | 4203 | 25315 | 3066 | 27753 | 2483 | 28884 | 2043 | 30018 | 1381 | 35936 | 1266 | 19095 |
| 2L-4S | | MI | 10735 | 4203 | 17585 | 3007 | 18672 | 2430 | 18773 | 1985 | 18412 | 1340 | 21606 | 930 | 14396 |
| 8-#14 | 1.79 | MA | 14657 | 4203 | 23804 | 3063 | 25826 | 2498 | 26541 | 2055 | 26887 | 1391 | 31784 | 1138 | 19087 |
| 3E | | MI | 11261 | 4203 | 18492 | 2994 | 19825 | 2440 | 20137 | 1995 | 20124 | 1330 | 23507 | 1052 | 14442 |
| 8-#14 | 1.79 | MA | 13952 | 4203 | 22583 | 3079 | 24274 | 2492 | 24659 | 2047 | 24485 | 1401 | 29079 | 1010 | 18923 |
| 4L-2S | | MI | 11988 | 4203 | 19604 | 3001 | 21243 | 2430 | 21827 | 1985 | 22357 | 1320 | 26420 | 1180 | 14401 |
| 8-#18 | 3.17 | MA | 17606 | 4699 | 29896 | 3354 | 33486 | 2690 | 35814 | 2167 | 39033 | 1314 | 47721 | 1130 | 32938 |
| 2L-4S | | MI | 11238 | 4699 | 19425 | 3287 | 20849 | 2617 | 21336 | 2079 | 21855 | 1259 | 26216 | 553 | 22311 |
| 8-#18 | 3.17 | MA | 15925 | 4699 | 27259 | 3346 | 30124 | 2712 | 31727 | 2185 | 33629 | 1332 | 40594 | 902 | 32649 |
| 3E | | MI | 12132 | 4699 | 21004 | 3267 | 22818 | 2635 | 23665 | 2096 | 24776 | 1241 | 29447 | 763 | 24424 |
| 8-#18 | 3.17 | MA | 14726 | 4699 | 25123 | 3373 | 27409 | 2700 | 28433 | 2168 | 29483 | 1349 | 35964 | 675 | 29767 |
| 4L-2S | | MI | 13361 | 4699 | 22931 | 3282 | 25238 | 2617 | 26549 | 2079 | 28587 | 1224 | 34379 | 990 | 24559 |
| 10-#11 | 1.55 | MA | 15318 | 4118 | 24517 | 3024 | 26789 | 2454 | 27734 | 2027 | 28547 | 1398 | 34030 | 1295 | 16716 |
| 2L-5S | | MI | 10543 | 4118 | 17049 | 2963 | 18031 | 2412 | 18042 | 1984 | 17376 | 1350 | 20320 | 1006 | 12432 |
| 10-#11 | 1.55 | MA | 14620 | 4118 | 23459 | 3022 | 25441 | 2465 | 26094 | 2036 | 26344 | 1405 | 31102 | 1206 | 16733 |
| 3L-4S | | MI | 10877 | 4118 | 17609 | 2967 | 18752 | 2404 | 18910 | 1977 | 18573 | 1357 | 21754 | 1046 | 12698 |
| 10-#11 | 1.55 | MA | 14125 | 4118 | 22607 | 3034 | 24357 | 2461 | 24779 | 2031 | 24654 | 1412 | 29191 | 1117 | 16688 |
| 4L-3S | | MI | 11248 | 4118 | 18244 | 2958 | 19559 | 2411 | 19874 | 1984 | 19784 | 1350 | 23101 | 1132 | 12684 |
| 10-#11 | 1.55 | MA | 13680 | 4118 | 21858 | 3032 | 23392 | 2471 | 23597 | 2040 | 22987 | 1405 | 27175 | 1076 | 16269 |
| 5L-2S | | MI | 11760 | 4118 | 19025 | 2962 | 20555 | 2403 | 21070 | 1977 | 21363 | 1344 | 25169 | 1221 | 12649 |
| 10-#14 | 2.23 | MA | 16329 | 4362 | 26827 | 3166 | 29679 | 2556 | 31226 | 2088 | 33150 | 1369 | 40087 | 1236 | 23708 |
| 2L-5S | | MI | 10762 | 4362 | 17898 | 3100 | 19060 | 2512 | 19236 | 2037 | 18952 | 1311 | 22499 | 829 | 16721 |
| 10-#14 | 2.23 | MA | 15348 | 4362 | 25315 | 3162 | 27753 | 2570 | 28884 | 2100 | 30018 | 1379 | 35936 | 1108 | 23657 |
| 3L-4S | | MI | 11234 | 4362 | 18698 | 3107 | 20091 | 2502 | 20463 | 2027 | 20645 | 1321 | 24519 | 887 | 17589 |
| 10-#14 | 2.23 | MA | 14650 | 4362 | 24095 | 3179 | 26201 | 2564 | 27001 | 2092 | 27616 | 1388 | 33231 | 980 | 23384 |
| 4L-3S | | MI | 11755 | 4362 | 19604 | 3093 | 21243 | 2512 | 21827 | 2037 | 22357 | 1311 | 26420 | 1010 | 17825 |
| 10-#14 | 2.23 | MA | 14023 | 4362 | 23023 | 3176 | 24819 | 2578 | 25309 | 2104 | 25246 | 1379 | 30366 | 921 | 22013 |
| 5L-2S | | MI | 12476 | 4362 | 20717 | 3100 | 22661 | 2502 | 23517 | 2027 | 24589 | 1301 | 29332 | 1138 | 17815 |
| 10-#18 | 3.97 | MA | 17091 | 4983 | 29896 | 3523 | 33486 | 2841 | 35814 | 2265 | 39033 | 1305 | 47721 | 842 | 40532 |
| 3L-4S | | MI | 12078 | 4983 | 21353 | 3465 | 23270 | 2742 | 24221 | 2149 | 25666 | 1220 | 31148 | 466 | 27776 |

## RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis



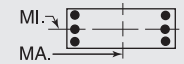

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.97 | MA | 15909 | 4983 | 27760 | 3550 | 30771 | 2828 | 32520 | 2248 | 34888 | 1323 | 43091 | 614 | 37324 |
| 4L-3S | | MI | 12961 | 4983 | 22931 | 3444 | 25238 | 2760 | 26549 | 2167 | 28587 | 1202 | 34379 | 676 | 30187 |
| 10-#18 | 3.97 | MA | 14848 | 4983 | 25881 | 3542 | 28349 | 2851 | 29555 | 2266 | 30795 | 1305 | 38149 | 513 | 34695 |
| 5L-2S | | MI | 14176 | 4983 | 24859 | 3459 | 27659 | 2742 | 29434 | 2149 | 32398 | 1184 | 39311 | 904 | 30407 |
| 12-#11 | 1.86 | MA | 15801 | 4228 | 25575 | 3093 | 28138 | 2504 | 29373 | 2058 | 30750 | 1390 | 36958 | 1276 | 19949 |
| 2L-6S | | MI | 10580 | 4228 | 17300 | 3028 | 18308 | 2456 | 18409 | 2021 | 17857 | 1345 | 21051 | 918 | 14343 |
| 12-#11 | 1.86 | MA | 15108 | 4228 | 24517 | 3091 | 26789 | 2515 | 27734 | 2067 | 28547 | 1397 | 34030 | 1187 | 19943 |
| 3L-5S | | MI | 10898 | 4228 | 17830 | 3032 | 19026 | 2462 | 19238 | 2014 | 18955 | 1338 | 22388 | 978 | 14689 |
| 12-#11 | 1.86 | MA | 14617 | 4228 | 23665 | 3103 | 25705 | 2511 | 26418 | 2062 | 26857 | 1404 | 32119 | 1098 | 19876 |
| 4E | | MI | 11230 | 4228 | 18390 | 3037 | 19748 | 2455 | 20106 | 2007 | 20152 | 1345 | 23821 | 1018 | 15065 |
| 12-#11 | 1.86 | MA | 14175 | 4228 | 22916 | 3101 | 24740 | 2522 | 25236 | 2071 | 25190 | 1397 | 30103 | 1056 | 19341 |
| 5L-3S | | MI | 11598 | 4228 | 19025 | 3027 | 20555 | 2461 | 21070 | 2014 | 21363 | 1338 | 25169 | 1104 | 15074 |
| 12-#11 | 1.86 | MA | 13754 | 4228 | 22209 | 3100 | 23781 | 2518 | 24066 | 2066 | 23658 | 1404 | 28202 | 998 | 18775 |
| 6L-2S | | MI | 12108 | 4228 | 19806 | 3031 | 21551 | 2453 | 22266 | 2007 | 22942 | 1331 | 27237 | 1193 | 15050 |
| 12-#14 | 2.68 | MA | 17004 | 4522 | 28338 | 3265 | 31606 | 2628 | 33569 | 2133 | 36281 | 1356 | 44238 | 1206 | 28301 |
| 2L-6S | | MI | 10814 | 4522 | 18253 | 3193 | 19453 | 2574 | 19754 | 2089 | 19633 | 1302 | 23531 | 700 | 19116 |
| 12-#14 | 2.68 | MA | 16031 | 4522 | 26827 | 3262 | 29679 | 2642 | 31226 | 2145 | 33150 | 1366 | 40087 | 1078 | 28216 |
| 3L-5S | | MI | 11260 | 4522 | 19010 | 3200 | 20479 | 2584 | 20926 | 2079 | 21185 | 1292 | 25412 | 786 | 19943 |
| 12-#14 | 2.68 | MA | 15340 | 4522 | 25606 | 3279 | 28128 | 2637 | 29344 | 2137 | 30748 | 1376 | 37382 | 950 | 27707 |
| 4E | | MI | 11728 | 4522 | 19810 | 3206 | 21509 | 2574 | 22153 | 2069 | 22877 | 1302 | 27431 | 845 | 20744 |
| 12-#14 | 2.68 | MA | 14720 | 4522 | 24534 | 3275 | 26746 | 2651 | 27652 | 2149 | 28377 | 1366 | 34517 | 891 | 26418 |
| 5L-3S | | MI | 12245 | 4522 | 20717 | 3193 | 22661 | 2584 | 23517 | 2079 | 24589 | 1292 | 29332 | 967 | 21192 |
| 12-#14 | 2.68 | MA | 14127 | 4522 | 23521 | 3272 | 25371 | 2645 | 25976 | 2141 | 26200 | 1376 | 31824 | 806 | 25271 |
| 6L-2S | | MI | 12960 | 4522 | 21829 | 3200 | 24080 | 2574 | 25207 | 2069 | 26822 | 1282 | 32244 | 1095 | 21216 |
| 12-#18 | 4.76 | MA | 17075 | 5267 | 30397 | 3728 | 34133 | 2957 | 36607 | 2328 | 40293 | 1296 | 50218 | 554 | 44921 |
| 4E | | MI | 12909 | 5267 | 23281 | 3642 | 25691 | 2867 | 27105 | 2219 | 29477 | 1180 | 36080 | 380 | 33279 |
| 12-#18 | 4.76 | MA | 16030 | 5267 | 28518 | 3720 | 31711 | 2980 | 33642 | 2346 | 36200 | 1278 | 45276 | 452 | 42128 |
| 5L-3S | | MI | 13781 | 5267 | 24859 | 3621 | 27659 | 2885 | 29434 | 2237 | 32398 | 1162 | 39311 | 590 | 35854 |
| 12-#18 | 4.76 | MA | 15032 | 5267 | 26741 | 3712 | 29301 | 2967 | 30809 | 2364 | 32442 | 1296 | 40658 | 300 | 39154 |
| 6L-2S | | MI | 14983 | 5267 | 26787 | 3636 | 30080 | 2867 | 32318 | 2219 | 36209 | 1145 | 44243 | 818 | 36233 |
| 14-#11 | 2.17 | MA | 16280 | 4339 | 26633 | 3162 | 29486 | 2554 | 31012 | 2090 | 32953 | 1382 | 39886 | 1257 | 23174 |
| 2L-7S | | MI | 10626 | 4339 | 17515 | 3107 | 18614 | 2514 | 18743 | 2044 | 18363 | 1340 | 21856 | 824 | 16105 |
| 14-#11 | 2.17 | MA | 15592 | 4339 | 25575 | 3161 | 28138 | 2565 | 29373 | 2098 | 30750 | 1389 | 36958 | 1168 | 23147 |
| 3L-6S | | MI | 10934 | 4339 | 18081 | 3097 | 19304 | 2506 | 19604 | 2051 | 19437 | 1333 | 23118 | 891 | 16634 |
| 14-#11 | 2.17 | MA | 15104 | 4339 | 24722 | 3172 | 27054 | 2561 | 28057 | 2093 | 29060 | 1396 | 35047 | 1079 | 23059 |
| 4L-5S | | MI | 11250 | 4339 | 18611 | 3102 | 20022 | 2512 | 20433 | 2044 | 20534 | 1326 | 24455 | 951 | 16957 |
| 14-#11 | 2.17 | MA | 14666 | 4339 | 23974 | 3171 | 26089 | 2572 | 26876 | 2102 | 27393 | 1389 | 33031 | 1037 | 22424 |
| 5L-4S | | MI | 11580 | 4339 | 19171 | 3106 | 20744 | 2505 | 21301 | 2037 | 21731 | 1333 | 25889 | 991 | 17425 |
| 14-#11 | 2.17 | MA | 14248 | 4339 | 23267 | 3169 | 25129 | 2568 | 25705 | 2097 | 25861 | 1396 | 31130 | 978 | 21887 |
| 6L-3S | | MI | 11946 | 4339 | 19806 | 3096 | 21551 | 2511 | 22266 | 2044 | 22942 | 1326 | 27237 | 1077 | 17457 |
| 14-#11 | 2.17 | MA | 13840 | 4339 | 22510 | 3181 | 24207 | 2579 | 24576 | 2106 | 24362 | 1403 | 29149 | 891 | 21137 |
| 7L-2S | | MI | 12453 | 4339 | 20587 | 3100 | 22547 | 2503 | 23461 | 2037 | 24521 | 1319 | 29304 | 1166 | 17444 |
| 14-#14 | 3.13 | MA | 16708 | 4681 | 28338 | 3362 | 31606 | 2715 | 33569 | 2190 | 36281 | 1353 | 44238 | 1048 | 32768 |
| 3L-6S | | MI | 11311 | 4681 | 19366 | 3292 | 20871 | 2647 | 21444 | 2131 | 21866 | 1283 | 26443 | 657 | 22260 |
| 14-#14 | 3.13 | MA | 16023 | 4681 | 27118 | 3378 | 30055 | 2709 | 31686 | 2182 | 33879 | 1363 | 41533 | 920 | 32053 |
| 4L-5S | | MI | 11754 | 4681 | 20123 | 3299 | 21897 | 2657 | 22616 | 2121 | 23417 | 1273 | 28324 | 744 | 23178 |
| 14-#14 | 3.13 | MA | 15409 | 4681 | 26046 | 3375 | 28673 | 2723 | 29994 | 2194 | 31509 | 1353 | 38669 | 861 | 30836 |
| 5L-4S | | MI | 12217 | 4681 | 20923 | 3306 | 22927 | 2647 | 23843 | 2111 | 25110 | 1283 | 30343 | 802 | 23921 |
| 14-#14 | 3.13 | MA | 14823 | 4681 | 25033 | 3372 | 27298 | 2717 | 28318 | 2186 | 29332 | 1363 | 35975 | 776 | 29599 |
| 6L-3S | | MI | 12730 | 4681 | 21829 | 3293 | 24080 | 2657 | 25207 | 2121 | 26822 | 1273 | 32244 | 924 | 24549 |
| 14-#14 | 3.13 | MA | 14250 | 4681 | 23949 | 3388 | 25978 | 2732 | 26700 | 2198 | 27201 | 1373 | 33168 | 649 | 28323 |
| 7L-2S | | MI | 13441 | 4681 | 22942 | 3300 | 25498 | 2647 | 26897 | 2111 | 29054 | 1263 | 35157 | 1052 | 24603 |
| 14-#18 | 5.56 | MA | 17196 | 5550 | 31155 | 3897 | 35073 | 3108 | 37729 | 2425 | 41604 | 1252 | 52402 | 391 | 49595 |
| 5L-4S | | MI | 13731 | 5550 | 25209 | 3819 | 28112 | 2993 | 29989 | 2290 | 33288 | 1141 | 41012 | 294 | 38813 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis

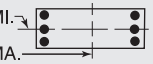


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 5.56 | MA | 16212 | 5550 | 29378 | 3889 | 32663 | 3096 | 34896 | 2444 | 37847 | 1269 | 47785 | 239 | 46535 |
| 6L-3S | | MI | 14594 | 5550 | 26787 | 3799 | 30080 | 3010 | 32318 | 2307 | 36209 | 1123 | 44243 | 504 | 41193 |
| 16-#11 | 2.48 | MA | 16072 | 4449 | 26633 | 3230 | 29486 | 2615 | 31012 | 2129 | 32953 | 1381 | 39886 | 1149 | 26347 |
| 3L-7S | | MI | 10980 | 4449 | 18296 | 3176 | 19610 | 2564 | 19938 | 2073 | 19942 | 1327 | 23924 | 797 | 18344 |
| 16-#11 | 2.48 | MA | 15588 | 4449 | 25780 | 3242 | 28402 | 2612 | 29697 | 2125 | 31263 | 1388 | 37975 | 1060 | 26239 |
| 4L-6S | | MI | 11286 | 4449 | 18862 | 3167 | 20300 | 2556 | 20800 | 2080 | 21016 | 1320 | 25186 | 863 | 18929 |
| 16-#11 | 2.48 | MA | 15153 | 4449 | 25031 | 3240 | 27437 | 2622 | 28515 | 2133 | 29595 | 1381 | 35959 | 1018 | 25516 |
| 5E | | MI | 11600 | 4449 | 19392 | 3171 | 21018 | 2562 | 21629 | 2073 | 22113 | 1314 | 26523 | 923 | 19233 |
| 16-#11 | 2.48 | MA | 14738 | 4449 | 24325 | 3238 | 26478 | 2618 | 27345 | 2128 | 28064 | 1388 | 34058 | 959 | 25005 |
| 6L-4S | | MI | 11928 | 4449 | 19952 | 3175 | 21739 | 2555 | 22497 | 2067 | 23310 | 1320 | 27957 | 963 | 19779 |
| 16-#11 | 2.48 | MA | 14333 | 4449 | 23568 | 3250 | 25556 | 2629 | 26215 | 2137 | 26565 | 1394 | 32078 | 871 | 24199 |
| 7L-3S | | MI | 12291 | 4449 | 20587 | 3165 | 22547 | 2561 | 23461 | 2073 | 24521 | 1314 | 29304 | 1049 | 19826 |
| 16-#11 | 2.48 | MA | 13934 | 4449 | 22874 | 3248 | 24625 | 2625 | 25109 | 2146 | 24995 | 1388 | 30195 | 823 | 23497 |
| 8L-2S | | MI | 12795 | 4449 | 21368 | 3169 | 23543 | 2553 | 24657 | 2067 | 26100 | 1307 | 31372 | 1138 | 19831 |
| 16-#14 | 3.57 | MA | 16700 | 4841 | 28629 | 3478 | 31982 | 2781 | 34029 | 2227 | 37010 | 1350 | 45684 | 890 | 36417 |
| 4L-6S | | MI | 11804 | 4841 | 20478 | 3392 | 22289 | 2719 | 23134 | 2173 | 24098 | 1263 | 29355 | 615 | 25418 |
| 16-#14 | 3.57 | MA | 16091 | 4841 | 27557 | 3475 | 30600 | 2795 | 32337 | 2239 | 34640 | 1340 | 42820 | 831 | 35265 |
| 5E | | MI | 12243 | 4841 | 21235 | 3399 | 23315 | 2729 | 24306 | 2163 | 25650 | 1253 | 31236 | 701 | 26422 |
| 16-#14 | 3.57 | MA | 15511 | 4841 | 26544 | 3472 | 29225 | 2790 | 30661 | 2231 | 32463 | 1350 | 40126 | 746 | 33942 |
| 6L-4S | | MI | 12703 | 4841 | 22035 | 3406 | 24346 | 2719 | 25533 | 2153 | 27342 | 1263 | 33256 | 760 | 27114 |
| 16-#14 | 3.57 | MA | 14944 | 4841 | 25461 | 3488 | 27905 | 2804 | 29043 | 2242 | 30333 | 1360 | 37319 | 619 | 32682 |
| 7L-3S | | MI | 13212 | 4841 | 22942 | 3393 | 25498 | 2729 | 26897 | 2163 | 29054 | 1253 | 35157 | 882 | 27899 |
| 16-#14 | 3.57 | MA | 14386 | 4841 | 24466 | 3485 | 26572 | 2798 | 27458 | 2254 | 28100 | 1350 | 34644 | 550 | 30947 |
| 8L-2S | | MI | 13917 | 4841 | 24054 | 3400 | 26916 | 2719 | 28587 | 2153 | 31287 | 1243 | 38069 | 1010 | 27977 |
| 16-#18 | 6.35 | MA | 17377 | 5834 | 32015 | 4066 | 36025 | 3224 | 38983 | 2523 | 43252 | 1243 | 54912 | 178 | 53943 |
| 6L-4S | | MI | 14545 | 5834 | 27136 | 3996 | 30533 | 3118 | 32873 | 2360 | 37099 | 1101 | 45944 | 207 | 44371 |
| 18-#11 | 2.79 | MA | 16067 | 4560 | 26838 | 3311 | 29751 | 2662 | 31336 | 2156 | 33465 | 1380 | 40903 | 1041 | 29417 |
| 4L-7S | | MI | 11331 | 4560 | 19077 | 3245 | 20605 | 2614 | 21134 | 2103 | 21521 | 1315 | 25992 | 769 | 20592 |
| 18-#11 | 2.79 | MA | 15636 | 4560 | 26089 | 3309 | 28786 | 2672 | 30154 | 2164 | 31798 | 1373 | 38887 | 999 | 28616 |
| 5L-6S | | MI | 11635 | 4560 | 19643 | 3236 | 21296 | 2606 | 21995 | 2110 | 22595 | 1308 | 27254 | 836 | 21227 |
| 18-#11 | 2.79 | MA | 15224 | 4560 | 25382 | 3307 | 27826 | 2669 | 28984 | 2159 | 30267 | 1380 | 36986 | 940 | 28126 |
| 6L-5S | | MI | 11947 | 4560 | 20173 | 3240 | 22014 | 2613 | 22824 | 2103 | 23692 | 1301 | 28591 | 896 | 21515 |
| 18-#11 | 2.79 | MA | 14822 | 4560 | 24626 | 3319 | 26904 | 2679 | 27854 | 2168 | 28768 | 1386 | 35006 | 852 | 27268 |
| 7L-4S | | MI | 12273 | 4560 | 20733 | 3244 | 22735 | 2605 | 23692 | 2096 | 24889 | 1308 | 30025 | 936 | 22122 |
| 18-#11 | 2.79 | MA | 14426 | 4560 | 23932 | 3317 | 25974 | 2676 | 26748 | 2177 | 27198 | 1380 | 33123 | 803 | 26527 |
| 8L-3S | | MI | 12635 | 4560 | 21368 | 3234 | 23543 | 2611 | 24657 | 2103 | 26100 | 1301 | 31372 | 1022 | 22192 |
| 18-#11 | 2.79 | MA | 14034 | 4560 | 23197 | 3329 | 25064 | 2686 | 25604 | 2172 | 25714 | 1386 | 31281 | 747 | 25526 |
| 9L-2S | | MI | 13136 | 4560 | 22149 | 3239 | 24539 | 2604 | 25852 | 2096 | 27679 | 1294 | 33440 | 1111 | 22214 |
| 18-#14 | 4.02 | MA | 16768 | 5001 | 29069 | 3575 | 32527 | 2868 | 34679 | 2283 | 37771 | 1328 | 46971 | 801 | 39703 |
| 5L-6S | | MI | 12293 | 5001 | 21591 | 3492 | 23708 | 2791 | 24825 | 2214 | 26331 | 1244 | 32268 | 572 | 28589 |
| 18-#14 | 4.02 | MA | 16193 | 5001 | 28056 | 3571 | 31152 | 2862 | 33003 | 2275 | 35594 | 1338 | 44277 | 716 | 38297 |
| 6L-5S | | MI | 12729 | 5001 | 22348 | 3499 | 24734 | 2801 | 25996 | 2205 | 27883 | 1234 | 34149 | 658 | 29673 |
| 18-#14 | 4.02 | MA | 15631 | 5001 | 26972 | 3588 | 29832 | 2876 | 31385 | 2287 | 33464 | 1347 | 41471 | 589 | 36983 |
| 7L-4S | | MI | 13185 | 5001 | 23148 | 3506 | 25764 | 2791 | 27223 | 2195 | 29575 | 1244 | 36168 | 717 | 30321 |
| 18-#14 | 4.02 | MA | 15078 | 5001 | 25977 | 3585 | 28499 | 2871 | 29800 | 2299 | 31231 | 1338 | 38796 | 520 | 35300 |
| 8L-3S | | MI | 13691 | 5001 | 24054 | 3492 | 26916 | 2801 | 28587 | 2205 | 31287 | 1234 | 38069 | 839 | 31243 |
| 20-#11 | 3.10 | MA | 16116 | 4671 | 27147 | 3378 | 30134 | 2722 | 31794 | 2196 | 34001 | 1365 | 41815 | 980 | 31722 |
| 5L-7S | | MI | 11680 | 4671 | 19858 | 3315 | 21601 | 2664 | 22329 | 2133 | 23100 | 1303 | 28060 | 742 | 22845 |
| 20-#11 | 3.10 | MA | 15707 | 4671 | 26440 | 3376 | 29175 | 2719 | 30623 | 2191 | 32470 | 1371 | 39914 | 921 | 31252 |
| 6E | | MI | 11983 | 4671 | 20424 | 3305 | 22292 | 2657 | 23191 | 2140 | 24174 | 1296 | 29322 | 808 | 23470 |
| 20-#11 | 3.10 | MA | 15308 | 4671 | 25684 | 3388 | 28253 | 2729 | 29494 | 2199 | 30971 | 1378 | 37934 | 833 | 30344 |
| 7L-5S | | MI | 12293 | 4671 | 20954 | 3309 | 23010 | 2663 | 24020 | 2133 | 25271 | 1289 | 30659 | 868 | 23802 |
| 20-#11 | 3.10 | MA | 14915 | 4671 | 24989 | 3386 | 27322 | 2726 | 28387 | 2208 | 29400 | 1371 | 36051 | 784 | 29565 |
| 8L-4S | | MI | 12617 | 4671 | 21514 | 3313 | 23731 | 2655 | 24888 | 2126 | 26468 | 1296 | 32092 | 908 | 24375 |
| 20-#11 | 3.10 | MA | 14525 | 4671 | 24255 | 3398 | 26413 | 2736 | 27243 | 2203 | 27917 | 1378 | 34209 | 728 | 28591 |
| 9L-3S | | MI | 12976 | 4671 | 22149 | 3304 | 24539 | 2661 | 25852 | 2133 | 27679 | 1289 | 33440 | 994 | 24553 |
| 20-#14 | 4.46 | MA | 16869 | 5160 | 29567 | 3671 | 33079 | 2934 | 35346 | 2320 | 38726 | 1325 | 48429 | 687 | 42664 |
| 6E | | MI | 12779 | 5160 | 22703 | 3592 | 25126 | 2864 | 26515 | 2256 | 28563 | 1225 | 35180 | 529 | 31772 |

## RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 4.46 | MA | 16312 | 5160 | 28484 | 3688 | 31759 | 2949 | 33728 | 2332 | 36595 | 1335 | 45622 | 560 | 41296 |
| 7L-5S | | MI | 13211 | 5160 | 23460 | 3599 | 26152 | 2874 | 27687 | 2246 | 30115 | 1215 | 37061 | 616 | 32931 |
| 20-#14 | 4.46 | MA | 15764 | 5160 | 27489 | 3684 | 30426 | 2943 | 32143 | 2344 | 34362 | 1325 | 42947 | 490 | 39662 |
| 8L-4S | | MI | 13664 | 5160 | 24260 | 3605 | 27182 | 2864 | 28913 | 2236 | 31808 | 1225 | 39080 | 674 | 33539 |
| 22-#11 | 3.40 | MA | 16186 | 4781 | 27498 | 3445 | 30523 | 2769 | 32263 | 2222 | 34673 | 1363 | 42842 | 902 | 34381 |
| 6L-7S | | MI | 12027 | 4781 | 20639 | 3384 | 22597 | 2714 | 23525 | 2163 | 24679 | 1290 | 30127 | 714 | 25105 |
| 22-#11 | 3.40 | MA | 15790 | 4781 | 26741 | 3457 | 29601 | 2779 | 31133 | 2231 | 33174 | 1370 | 40862 | 814 | 33426 |
| 7L-6S | | MI | 12328 | 4781 | 21206 | 3374 | 23288 | 2707 | 24386 | 2170 | 25753 | 1284 | 31389 | 781 | 25702 |
| 22-#11 | 3.40 | MA | 15400 | 4781 | 26047 | 3455 | 28671 | 2776 | 30027 | 2239 | 31603 | 1363 | 38979 | 765 | 32609 |
| 8L-5S | | MI | 12636 | 4781 | 21735 | 3378 | 24006 | 2713 | 25216 | 2163 | 26851 | 1277 | 32726 | 840 | 26094 |
| 22-#11 | 3.40 | MA | 15013 | 4781 | 25312 | 3467 | 27761 | 2786 | 28882 | 2234 | 30120 | 1370 | 37137 | 708 | 31662 |
| 9L-4S | | MI | 12958 | 4781 | 22295 | 3382 | 24727 | 2705 | 26083 | 2156 | 28047 | 1284 | 34160 | 881 | 26636 |
| 22-#14 | 4.91 | MA | 16988 | 5320 | 29995 | 3787 | 33686 | 3021 | 36070 | 2377 | 39727 | 1322 | 49773 | 530 | 45619 |
| 7L-6S | | MI | 13261 | 5320 | 23816 | 3691 | 26544 | 2936 | 28205 | 2298 | 30796 | 1206 | 38092 | 487 | 34964 |
| 22-#14 | 4.91 | MA | 16445 | 5320 | 29000 | 3784 | 32353 | 3015 | 34485 | 2389 | 37494 | 1312 | 47098 | 460 | 44033 |
| 8L-5S | | MI | 13690 | 5320 | 24573 | 3698 | 27570 | 2946 | 29377 | 2288 | 32348 | 1196 | 39973 | 573 | 36144 |
| 24-#11 | 3.71 | MA | 16269 | 4892 | 27799 | 3526 | 30950 | 2829 | 32772 | 2262 | 35377 | 1362 | 43790 | 795 | 36513 |
| 7E | | MI | 12372 | 4892 | 21420 | 3453 | 23593 | 2764 | 24720 | 2193 | 26258 | 1278 | 32195 | 687 | 27369 |
| 24-#11 | 3.71 | MA | 15881 | 4892 | 27105 | 3524 | 30019 | 2826 | 31666 | 2270 | 33806 | 1355 | 41907 | 746 | 35660 |
| 8L-6S | | MI | 12671 | 4892 | 21987 | 3443 | 24283 | 2757 | 25582 | 2200 | 27332 | 1271 | 33457 | 753 | 27941 |
| 24-#11 | 3.71 | MA | 15497 | 4892 | 26370 | 3536 | 29110 | 2836 | 30522 | 2265 | 32323 | 1362 | 40065 | 689 | 34737 |
| 9L-5S | | MI | 12978 | 4892 | 22516 | 3447 | 25002 | 2763 | 26411 | 2193 | 28430 | 1264 | 34794 | 813 | 28389 |
| 24-#14 | 5.36 | MA | 17120 | 5479 | 30512 | 3884 | 34280 | 3088 | 36828 | 2434 | 40625 | 1299 | 51249 | 431 | 48411 |
| 8L-6S | | MI | 13740 | 5479 | 24928 | 3791 | 27963 | 3008 | 29895 | 2340 | 33029 | 1187 | 41005 | 444 | 38165 |

## RECTANGULAR TIED COLUMNS 28" x 38"

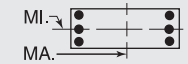
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.50 | MA | 16917 | 4330 | 27135 | 3160 | 29507 | 2565 | 30444 | 2120 | 31064 | 1458 | 36841 | 1344 | 17944 |
| 2E | | MI | 12255 | 4330 | 19921 | 3070 | 21261 | 2484 | 21615 | 2038 | 21707 | 1379 | 25329 | 1237 | 12771 |
| 6-#14 | 1.27 | MA | 16580 | 4241 | 26255 | 3127 | 28499 | 2543 | 29261 | 2111 | 29607 | 1484 | 34994 | 1386 | 15377 |
| 2L-3S | | MI | 11317 | 4241 | 18221 | 3039 | 19271 | 2486 | 19284 | 2054 | 18637 | 1427 | 21416 | 1170 | 11072 |
| 6-#14 | 1.27 | MA | 15511 | 4241 | 24644 | 3124 | 26444 | 2558 | 26764 | 2124 | 26250 | 1494 | 30532 | 1258 | 15413 |
| 3L-2S | | MI | 12051 | 4241 | 19334 | 3045 | 20690 | 2476 | 20974 | 2044 | 20870 | 1417 | 24328 | 1298 | 11002 |
| 6-#18 | 2.26 | MA | 18186 | 4613 | 29950 | 3337 | 33095 | 2694 | 34806 | 2200 | 36869 | 1434 | 44520 | 1288 | 26550 |
| 2L-3S | | MI | 11847 | 4613 | 19921 | 3232 | 21261 | 2627 | 21615 | 2126 | 21707 | 1358 | 25329 | 923 | 18717 |
| 6-#18 | 2.26 | MA | 16361 | 4613 | 27135 | 3330 | 29507 | 2718 | 30444 | 2220 | 31064 | 1451 | 36841 | 1060 | 26374 |
| 3L-2S | | MI | 13094 | 4613 | 21849 | 3247 | 23682 | 2609 | 24499 | 2108 | 25518 | 1340 | 30261 | 1151 | 18718 |
| 8-#11 | 1.17 | MA | 16441 | 4205 | 25885 | 3116 | 28084 | 2536 | 28779 | 2109 | 29015 | 1496 | 34245 | 1404 | 14317 |
| 2L-4S | | MI | 11076 | 4205 | 17667 | 3044 | 18621 | 2474 | 18553 | 2049 | 17742 | 1448 | 20510 | 1149 | 10357 |
| 8-#11 | 1.17 | MA | 15691 | 4205 | 24758 | 3114 | 26648 | 2547 | 27033 | 2118 | 26656 | 1502 | 31101 | 1315 | 14349 |
| 3E | | MI | 11450 | 4205 | 18303 | 3034 | 19429 | 2480 | 19517 | 2056 | 18953 | 1441 | 21857 | 1235 | 10315 |
| 8-#11 | 1.17 | MA | 15159 | 4205 | 23851 | 3127 | 25495 | 2544 | 25634 | 2114 | 24846 | 1509 | 29046 | 1226 | 14336 |
| 4L-2S | | MI | 11966 | 4205 | 19084 | 3038 | 20425 | 2472 | 20713 | 2049 | 20532 | 1434 | 23925 | 1324 | 10267 |
| 8-#14 | 1.69 | MA | 17321 | 4401 | 27866 | 3227 | 30553 | 2616 | 31758 | 2156 | 32963 | 1472 | 39456 | 1358 | 20310 |
| 2L-4S | | MI | 11289 | 4401 | 18427 | 3151 | 19537 | 2549 | 19610 | 2086 | 19158 | 1418 | 22427 | 1005 | 14463 |
| 8-#14 | 1.69 | MA | 16262 | 4401 | 26255 | 3224 | 28499 | 2631 | 29261 | 2168 | 29607 | 1482 | 34994 | 1230 | 20302 |
| 3E | | MI | 11817 | 4401 | 19334 | 3138 | 20690 | 2558 | 20974 | 2096 | 20870 | 1408 | 24328 | 1127 | 14487 |
| 8-#14 | 1.69 | MA | 15510 | 4401 | 24957 | 3241 | 26848 | 2626 | 27257 | 2161 | 27032 | 1492 | 32082 | 1102 | 20138 |
| 4L-2S | | MI | 12545 | 4401 | 20446 | 3145 | 22108 | 2548 | 22664 | 2086 | 23102 | 1398 | 27240 | 1255 | 14440 |
| 8-#18 | 3.01 | MA | 19433 | 4897 | 32764 | 3514 | 36683 | 2822 | 39168 | 2280 | 42673 | 1409 | 52198 | 1232 | 35098 |
| 2L-4S | | MI | 11791 | 4897 | 20271 | 3430 | 21713 | 2735 | 22171 | 2179 | 22596 | 1336 | 27030 | 627 | 22565 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis

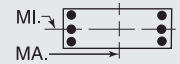



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.01 | MA | 17633 | 4897 | 29950 | 3508 | 33095 | 2846 | 34806 | 2299 | 36869 | 1427 | 44520 | 1004 | 34809 |
| 3E | | MI | 12688 | 4897 | 21849 | 3410 | 23682 | 2752 | 24499 | 2196 | 25518 | 1318 | 30261 | 837 | 24513 |
| 8-#18 | 3.01 | MA | 16353 | 4897 | 27675 | 3536 | 30203 | 2835 | 31296 | 2284 | 32416 | 1445 | 39523 | 777 | 31972 |
| 4L-2S | | MI | 13921 | 4897 | 23777 | 3425 | 26103 | 2735 | 27383 | 2179 | 29329 | 1300 | 35193 | 1065 | 24617 |
| 10-#11 | 1.47 | MA | 16964 | 4316 | 27012 | 3185 | 29521 | 2587 | 30526 | 2140 | 31374 | 1488 | 37389 | 1386 | 17769 |
| 2L-5S | | MI | 11097 | 4316 | 17889 | 3109 | 18896 | 2532 | 18881 | 2086 | 18124 | 1428 | 21144 | 1081 | 12557 |
| 10-#11 | 1.47 | MA | 16219 | 4316 | 25885 | 3184 | 28084 | 2597 | 28779 | 2149 | 29015 | 1495 | 34245 | 1297 | 17786 |
| 3L-4S | | MI | 11432 | 4316 | 18449 | 3113 | 19617 | 2524 | 19748 | 2079 | 19321 | 1435 | 22577 | 1121 | 12744 |
| 10-#11 | 1.47 | MA | 15691 | 4316 | 24978 | 3196 | 26931 | 2594 | 27380 | 2145 | 27205 | 1502 | 32190 | 1208 | 17741 |
| 4L-3S | | MI | 11803 | 4316 | 19084 | 3103 | 20425 | 2530 | 20713 | 2086 | 20532 | 1428 | 23925 | 1207 | 12721 |
| 10-#11 | 1.47 | MA | 15218 | 4316 | 24182 | 3194 | 25905 | 2605 | 26124 | 2154 | 25420 | 1495 | 30031 | 1166 | 17392 |
| 5L-2S | | MI | 12317 | 4316 | 19865 | 3107 | 21421 | 2523 | 21908 | 2079 | 22111 | 1422 | 25993 | 1296 | 12683 |
| 10-#14 | 2.11 | MA | 18053 | 4560 | 29478 | 3327 | 32607 | 2688 | 34255 | 2201 | 36320 | 1461 | 43919 | 1331 | 25227 |
| 2L-5S | | MI | 11316 | 4560 | 18740 | 3244 | 19925 | 2631 | 20073 | 2138 | 19698 | 1389 | 23320 | 904 | 16878 |
| 10-#14 | 2.11 | MA | 17004 | 4560 | 27866 | 3324 | 30553 | 2703 | 31758 | 2213 | 32963 | 1471 | 39456 | 1203 | 25175 |
| 3L-4S | | MI | 11789 | 4560 | 19540 | 3251 | 20956 | 2621 | 21300 | 2128 | 21391 | 1399 | 25339 | 962 | 17775 |
| 10-#14 | 2.11 | MA | 16260 | 4560 | 26568 | 3341 | 28902 | 2698 | 29754 | 2206 | 30388 | 1481 | 36544 | 1075 | 24964 |
| 4L-3S | | MI | 12312 | 4560 | 20446 | 3238 | 22108 | 2631 | 22664 | 2138 | 23102 | 1389 | 27240 | 1085 | 17879 |
| 10-#14 | 2.11 | MA | 15592 | 4560 | 25428 | 3338 | 27432 | 2713 | 27955 | 2219 | 27848 | 1471 | 33473 | 1014 | 23540 |
| 5L-2S | | MI | 13034 | 4560 | 21559 | 3245 | 23526 | 2621 | 24354 | 2128 | 25335 | 1379 | 30153 | 1213 | 17858 |
| 10-#18 | 3.76 | MA | 18886 | 5181 | 32764 | 3685 | 36683 | 2975 | 39168 | 2379 | 42673 | 1403 | 52198 | 948 | 43232 |
| 3L-4S | | MI | 12633 | 5181 | 22199 | 3607 | 24134 | 2860 | 25055 | 2249 | 26407 | 1296 | 31962 | 540 | 28025 |
| 10-#18 | 3.76 | MA | 17625 | 5181 | 30489 | 3714 | 33791 | 2964 | 35658 | 2364 | 38221 | 1421 | 47201 | 720 | 40048 |
| 4L-3S | | MI | 13519 | 5181 | 23777 | 3587 | 26103 | 2877 | 27383 | 2267 | 29329 | 1279 | 35193 | 751 | 30286 |
| 10-#18 | 3.76 | MA | 16493 | 5181 | 28489 | 3707 | 31213 | 2988 | 32502 | 2384 | 33826 | 1403 | 41891 | 617 | 37453 |
| 5L-2S | | MI | 14738 | 5181 | 25705 | 3602 | 28524 | 2860 | 30268 | 2249 | 33139 | 1261 | 40125 | 978 | 30475 |
| 12-#11 | 1.76 | MA | 17483 | 4426 | 28138 | 3254 | 30958 | 2637 | 32272 | 2171 | 33733 | 1481 | 40532 | 1368 | 21212 |
| 2L-6S | | MI | 11134 | 4426 | 18140 | 3174 | 19174 | 2576 | 19247 | 2122 | 18606 | 1423 | 21874 | 994 | 14459 |
| 12-#11 | 1.76 | MA | 16743 | 4426 | 27012 | 3253 | 29521 | 2648 | 30526 | 2180 | 31374 | 1488 | 37389 | 1280 | 21206 |
| 3L-5S | | MI | 11452 | 4426 | 18670 | 3178 | 19892 | 2582 | 20076 | 2115 | 19703 | 1416 | 23211 | 1054 | 14813 |
| 12-#11 | 1.76 | MA | 16219 | 4426 | 26105 | 3265 | 28368 | 2645 | 29127 | 2176 | 29564 | 1495 | 35334 | 1191 | 21139 |
| 4E | | MI | 11785 | 4426 | 19230 | 3182 | 20613 | 2574 | 20944 | 2109 | 20900 | 1423 | 24645 | 1094 | 15117 |
| 12-#11 | 1.76 | MA | 15749 | 4426 | 25309 | 3264 | 27342 | 2655 | 27870 | 2185 | 27779 | 1488 | 33175 | 1148 | 20666 |
| 5L-3S | | MI | 12154 | 4426 | 19865 | 3172 | 21421 | 2580 | 21908 | 2115 | 22111 | 1416 | 25993 | 1180 | 15115 |
| 12-#11 | 1.76 | MA | 15301 | 4426 | 24558 | 3262 | 26322 | 2653 | 26626 | 2181 | 26139 | 1495 | 31132 | 1090 | 20030 |
| 6L-2S | | MI | 12665 | 4426 | 20646 | 3176 | 22416 | 2573 | 23104 | 2109 | 23690 | 1409 | 28060 | 1269 | 15087 |
| 12-#14 | 2.54 | MA | 18778 | 4720 | 31089 | 3426 | 34661 | 2760 | 36752 | 2246 | 39677 | 1449 | 48381 | 1303 | 30123 |
| 2L-6S | | MI | 11367 | 4720 | 19095 | 3337 | 20318 | 2693 | 20591 | 2190 | 20379 | 1379 | 24351 | 775 | 19372 |
| 12-#14 | 2.54 | MA | 17737 | 4720 | 29478 | 3424 | 32607 | 2775 | 34255 | 2258 | 36320 | 1459 | 43919 | 1175 | 30038 |
| 3L-5S | | MI | 11815 | 4720 | 19852 | 3344 | 21344 | 2703 | 21763 | 2180 | 21931 | 1369 | 26232 | 861 | 20100 |
| 12-#14 | 2.54 | MA | 17001 | 4720 | 28179 | 3441 | 30956 | 2770 | 32252 | 2251 | 33745 | 1469 | 41006 | 1047 | 29698 |
| 4E | | MI | 12284 | 4720 | 20652 | 3351 | 22374 | 2693 | 22990 | 2170 | 23623 | 1379 | 28252 | 920 | 20927 |
| 12-#14 | 2.54 | MA | 16340 | 4720 | 27039 | 3438 | 29486 | 2785 | 30452 | 2264 | 31205 | 1459 | 37935 | 987 | 28240 |
| 5L-3S | | MI | 12802 | 4720 | 21559 | 3338 | 23526 | 2703 | 24354 | 2180 | 25335 | 1369 | 30153 | 1042 | 21251 |
| 12-#14 | 2.54 | MA | 15709 | 4720 | 25962 | 3435 | 28024 | 2781 | 28669 | 2257 | 28871 | 1469 | 35038 | 902 | 27151 |
| 6L-2S | | MI | 13519 | 4720 | 22671 | 3345 | 24945 | 2693 | 26044 | 2170 | 27568 | 1360 | 33065 | 1170 | 21263 |
| 12-#18 | 4.51 | MA | 18878 | 5465 | 33303 | 3891 | 37379 | 3092 | 40020 | 2444 | 44026 | 1396 | 54879 | 664 | 48166 |
| 4E | | MI | 13465 | 5465 | 24126 | 3785 | 26555 | 2985 | 27939 | 2319 | 30218 | 1257 | 36894 | 454 | 33524 |
| 12-#18 | 4.51 | MA | 17763 | 5465 | 31303 | 3884 | 34801 | 3117 | 36864 | 2463 | 39631 | 1379 | 49570 | 561 | 45406 |
| 5L-3S | | MI | 14341 | 5465 | 25705 | 3764 | 28524 | 3003 | 30268 | 2337 | 33139 | 1239 | 40125 | 664 | 36044 |
| 12-#18 | 4.51 | MA | 16699 | 5465 | 29413 | 3877 | 32236 | 3105 | 33736 | 2448 | 35595 | 1396 | 44591 | 409 | 42248 |
| 6L-2S | | MI | 15548 | 5465 | 27632 | 3779 | 30944 | 2985 | 33152 | 2319 | 36950 | 1221 | 45057 | 892 | 36306 |
| 14-#11 | 2.05 | MA | 17997 | 4537 | 29265 | 3323 | 32395 | 2687 | 34019 | 2202 | 36093 | 1474 | 43676 | 1351 | 24649 |
| 2L-7S | | MI | 11179 | 4537 | 18355 | 3252 | 19479 | 2633 | 19581 | 2145 | 19111 | 1418 | 22680 | 900 | 16291 |
| 14-#11 | 2.05 | MA | 17262 | 4537 | 28138 | 3322 | 30958 | 2698 | 32272 | 2211 | 33733 | 1480 | 40532 | 1262 | 24621 |
| 3L-6S | | MI | 11488 | 4537 | 18921 | 3243 | 20170 | 2626 | 20443 | 2152 | 20185 | 1411 | 23942 | 966 | 16750 |
| 14-#11 | 2.05 | MA | 16742 | 4537 | 27232 | 3334 | 29805 | 2695 | 30873 | 2207 | 31923 | 1487 | 38478 | 1173 | 24534 |
| 4L-5S | | MI | 11805 | 4537 | 19451 | 3247 | 20888 | 2632 | 21272 | 2145 | 21282 | 1404 | 25279 | 1026 | 17080 |

## RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

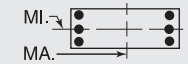
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.05 | MA | 16275 | 4537 | 26436 | 3333 | 28779 | 2706 | 29617 | 2216 | 30138 | 1480 | 36319 | 1131 | 23952 |
| 5L-4S | | MI | 12136 | 4537 | 20011 | 3251 | 21609 | 2624 | 22140 | 2138 | 22479 | 1411 | 26713 | 1066 | 17481 |
| 14-#11 | 2.05 | MA | 15831 | 4537 | 25685 | 3331 | 27759 | 2703 | 28373 | 2212 | 28498 | 1487 | 34276 | 1072 | 23348 |
| 6L-3S | | MI | 12503 | 4537 | 20646 | 3241 | 22416 | 2631 | 23104 | 2145 | 23690 | 1404 | 28060 | 1152 | 17501 |
| 14-#11 | 2.05 | MA | 15396 | 4537 | 24881 | 3343 | 26779 | 2713 | 27172 | 2221 | 26893 | 1494 | 32149 | 984 | 22638 |
| 7L-2S | | MI | 13011 | 4537 | 21427 | 3246 | 23412 | 2623 | 24300 | 2138 | 25269 | 1397 | 30128 | 1241 | 17483 |
| 14-#14 | 2.96 | MA | 18464 | 4879 | 31089 | 3523 | 34661 | 2848 | 36752 | 2303 | 39677 | 1448 | 48381 | 1148 | 34894 |
| 3L-6S | | MI | 11865 | 4879 | 20208 | 3437 | 21736 | 2766 | 22281 | 2232 | 22612 | 1360 | 27264 | 732 | 22512 |
| 14-#14 | 2.96 | MA | 17734 | 4879 | 29790 | 3541 | 33010 | 2843 | 34749 | 2296 | 37102 | 1458 | 45468 | 1020 | 34334 |
| 4L-5S | | MI | 12309 | 4879 | 20965 | 3444 | 22762 | 2776 | 23453 | 2222 | 24163 | 1350 | 29145 | 819 | 23333 |
| 14-#14 | 2.96 | MA | 17079 | 4879 | 28650 | 3538 | 31540 | 2858 | 32949 | 2309 | 34561 | 1448 | 42397 | 959 | 32953 |
| 5L-4S | | MI | 12774 | 4879 | 21765 | 3451 | 23792 | 2766 | 24680 | 2212 | 25856 | 1360 | 31164 | 877 | 24101 |
| 14-#14 | 2.96 | MA | 16455 | 4879 | 27573 | 3535 | 30078 | 2853 | 31166 | 2302 | 32228 | 1458 | 39500 | 875 | 31773 |
| 6L-3S | | MI | 13289 | 4879 | 22671 | 3438 | 24945 | 2775 | 26044 | 2222 | 27568 | 1350 | 33065 | 999 | 24613 |
| 14-#14 | 2.96 | MA | 15845 | 4879 | 26421 | 3552 | 28674 | 2868 | 29446 | 2314 | 29944 | 1467 | 36481 | 748 | 30343 |
| 7L-2S | | MI | 14001 | 4879 | 23784 | 3444 | 26363 | 2765 | 27734 | 2212 | 29800 | 1340 | 35977 | 1127 | 24655 |
| 14-#18 | 5.26 | MA | 19016 | 5748 | 34118 | 4061 | 38389 | 3245 | 41225 | 2543 | 45435 | 1354 | 57248 | 504 | 53395 |
| 5L-4S | | MI | 14289 | 5748 | 26054 | 3962 | 28976 | 3110 | 30823 | 2390 | 34029 | 1217 | 41826 | 368 | 39055 |
| 14-#18 | 5.26 | MA | 17967 | 5748 | 32228 | 4055 | 35824 | 3234 | 38098 | 2528 | 41400 | 1372 | 52269 | 353 | 50298 |
| 6L-3S | | MI | 15156 | 5748 | 27632 | 3942 | 30944 | 3128 | 33152 | 2407 | 36950 | 1200 | 45057 | 578 | 41525 |
| 16-#11 | 2.35 | MA | 17777 | 4647 | 29265 | 3391 | 32395 | 2748 | 34019 | 2242 | 36093 | 1473 | 43676 | 1244 | 28031 |
| 3L-7S | | MI | 11534 | 4647 | 19136 | 3322 | 20475 | 2683 | 20777 | 2175 | 20690 | 1405 | 24748 | 872 | 18528 |
| 16-#11 | 2.35 | MA | 17261 | 4647 | 28359 | 3403 | 31241 | 2745 | 32620 | 2238 | 34283 | 1480 | 41622 | 1155 | 27924 |
| 4L-6S | | MI | 11841 | 4647 | 19702 | 3312 | 21165 | 2676 | 21638 | 2182 | 21764 | 1398 | 26010 | 939 | 19046 |
| 16-#11 | 2.35 | MA | 16798 | 4647 | 27563 | 3402 | 30215 | 2756 | 31363 | 2247 | 32498 | 1473 | 39463 | 1113 | 27248 |
| 5E | | MI | 12155 | 4647 | 20232 | 3316 | 21883 | 2682 | 22467 | 2175 | 22861 | 1392 | 27347 | 999 | 19356 |
| 16-#11 | 2.35 | MA | 16356 | 4647 | 26812 | 3400 | 29195 | 2753 | 30119 | 2243 | 30857 | 1480 | 37420 | 1054 | 26672 |
| 6L-4S | | MI | 12484 | 4647 | 20792 | 3320 | 22605 | 2674 | 23335 | 2168 | 24058 | 1398 | 28781 | 1039 | 19839 |
| 16-#11 | 2.35 | MA | 15925 | 4647 | 26008 | 3413 | 28216 | 2764 | 28919 | 2252 | 29252 | 1487 | 35293 | 966 | 25904 |
| 7L-3S | | MI | 12849 | 4647 | 21427 | 3311 | 23412 | 2681 | 24300 | 2175 | 25269 | 1392 | 30128 | 1125 | 19876 |
| 16-#11 | 2.35 | MA | 15500 | 4647 | 25270 | 3411 | 27227 | 2761 | 27743 | 2262 | 27570 | 1480 | 33276 | 917 | 25128 |
| 8L-2S | | MI | 13354 | 4647 | 22208 | 3315 | 24408 | 2673 | 25495 | 2168 | 26848 | 1385 | 32196 | 1214 | 19873 |
| 16-#14 | 3.38 | MA | 18461 | 5039 | 31401 | 3640 | 35064 | 2915 | 37246 | 2341 | 40458 | 1446 | 49931 | 992 | 38989 |
| 4L-6S | | MI | 12358 | 5039 | 21320 | 3537 | 23154 | 2838 | 23971 | 2274 | 24844 | 1341 | 30176 | 690 | 25666 |
| 16-#14 | 3.38 | MA | 17812 | 5039 | 30261 | 3638 | 33594 | 2930 | 35446 | 2354 | 37918 | 1436 | 46860 | 932 | 37678 |
| 5E | | MI | 12799 | 5039 | 22077 | 3544 | 24180 | 2848 | 25143 | 2264 | 26396 | 1331 | 32057 | 776 | 26577 |
| 16-#14 | 3.38 | MA | 17194 | 5039 | 29185 | 3635 | 32133 | 2925 | 33663 | 2347 | 35584 | 1446 | 43962 | 847 | 36409 |
| 6L-4S | | MI | 13261 | 5039 | 22877 | 3550 | 25211 | 2838 | 26370 | 2254 | 28088 | 1341 | 34076 | 835 | 27293 |
| 16-#14 | 3.38 | MA | 16590 | 5039 | 28033 | 3652 | 30728 | 2940 | 31943 | 2359 | 33301 | 1456 | 40944 | 720 | 35032 |
| 7L-3S | | MI | 13772 | 5039 | 23784 | 3537 | 26363 | 2848 | 27734 | 2264 | 29800 | 1331 | 35977 | 957 | 27967 |
| 16-#14 | 3.38 | MA | 15995 | 5039 | 26975 | 3649 | 29311 | 2935 | 30258 | 2372 | 30908 | 1446 | 38075 | 650 | 33250 |
| 8L-2S | | MI | 14479 | 5039 | 24896 | 3544 | 27781 | 2838 | 29424 | 2254 | 32033 | 1321 | 38890 | 1085 | 28033 |
| 16-#18 | 6.02 | MA | 19219 | 6032 | 35042 | 4232 | 39412 | 3363 | 42460 | 2607 | 47205 | 1348 | 59948 | 297 | 58230 |
| 6L-4S | | MI | 15105 | 6032 | 27982 | 4139 | 31397 | 3235 | 33707 | 2460 | 37840 | 1178 | 46758 | 281 | 44609 |
| 18-#11 | 2.64 | MA | 17776 | 4758 | 29485 | 3472 | 32678 | 2795 | 34366 | 2269 | 36642 | 1473 | 44765 | 1138 | 31313 |
| 4L-7S | | MI | 11885 | 4758 | 19917 | 3391 | 21471 | 2734 | 21972 | 2205 | 22269 | 1393 | 26816 | 845 | 20774 |
| 18-#11 | 2.64 | MA | 17316 | 4758 | 28690 | 3471 | 31652 | 2806 | 33110 | 2279 | 34857 | 1466 | 42607 | 1095 | 30552 |
| 5L-6S | | MI | 12191 | 4758 | 20483 | 3381 | 22161 | 2726 | 22834 | 2212 | 23343 | 1386 | 28078 | 911 | 21345 |
| 18-#11 | 2.64 | MA | 16878 | 4758 | 27939 | 3470 | 30632 | 2803 | 31866 | 2274 | 33217 | 1473 | 40564 | 1037 | 30000 |
| 6L-5S | | MI | 12504 | 4758 | 21013 | 3385 | 22879 | 2732 | 23663 | 2205 | 24441 | 1379 | 29415 | 971 | 21637 |
| 18-#11 | 2.64 | MA | 16450 | 4758 | 27135 | 3482 | 29652 | 2814 | 30665 | 2284 | 31611 | 1480 | 38436 | 949 | 29178 |
| 7L-4S | | MI | 12831 | 4758 | 21573 | 3389 | 23601 | 2725 | 24531 | 2198 | 25637 | 1386 | 30848 | 1011 | 22193 |
| 18-#11 | 2.64 | MA | 16028 | 4758 | 26397 | 3480 | 28664 | 2811 | 29490 | 2293 | 29930 | 1473 | 36420 | 899 | 28428 |
| 8L-3S | | MI | 13193 | 4758 | 22208 | 3380 | 24408 | 2731 | 25495 | 2205 | 26848 | 1379 | 32196 | 1097 | 22244 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis

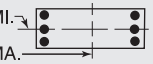



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.64 | MA | 15610 | 4758 | 25617 | 3493 | 27697 | 2822 | 28273 | 2289 | 28341 | 1480 | 34441 | 843 | 27362 |
| 9L-2S | | MI | 13696 | 4758 | 22989 | 3384 | 25404 | 2723 | 26691 | 2198 | 28427 | 1372 | 34264 | 1186 | 22257 |
| 18-#14 | 3.81 | MA | 18538 | 5199 | 31873 | 3737 | 35648 | 3002 | 37943 | 2399 | 41275 | 1424 | 51322 | 904 | 42412 |
| 5L-6S | | MI | 12848 | 5199 | 22433 | 3637 | 24573 | 2910 | 25662 | 2315 | 27077 | 1322 | 33088 | 647 | 28835 |
| 18-#14 | 3.81 | MA | 17926 | 5199 | 30796 | 3735 | 34187 | 2997 | 36161 | 2391 | 38941 | 1434 | 48424 | 820 | 41058 |
| 6L-5S | | MI | 13286 | 5199 | 23190 | 3643 | 25599 | 2920 | 26833 | 2306 | 28628 | 1312 | 34969 | 733 | 29828 |
| 18-#14 | 3.81 | MA | 17328 | 5199 | 29644 | 3752 | 32783 | 3012 | 34440 | 2404 | 36657 | 1444 | 45406 | 693 | 39731 |
| 7L-4S | | MI | 13744 | 5199 | 23989 | 3650 | 26629 | 2910 | 28060 | 2296 | 30321 | 1322 | 36989 | 792 | 30498 |
| 18-#14 | 3.81 | MA | 16738 | 5199 | 28586 | 3749 | 31366 | 3008 | 32755 | 2417 | 34264 | 1434 | 42537 | 622 | 37898 |
| 8L-3S | | MI | 14251 | 5199 | 24896 | 3637 | 27781 | 2920 | 29424 | 2306 | 32033 | 1312 | 38890 | 914 | 31315 |
| 20-#11 | 2.93 | MA | 17831 | 4869 | 29817 | 3540 | 33089 | 2856 | 34856 | 2310 | 37216 | 1459 | 45751 | 1078 | 33863 |
| 5L-7S | | MI | 12235 | 4869 | 20698 | 3460 | 22467 | 2784 | 23168 | 2235 | 23848 | 1381 | 28884 | 817 | 23026 |
| 20-#11 | 2.93 | MA | 17396 | 4869 | 29066 | 3539 | 32069 | 2853 | 33612 | 2305 | 35576 | 1465 | 43708 | 1019 | 33332 |
| 6E | | MI | 12539 | 4869 | 21264 | 3450 | 23157 | 2776 | 24029 | 2242 | 24922 | 1374 | 30145 | 884 | 23647 |
| 20-#11 | 2.93 | MA | 16971 | 4869 | 28262 | 3551 | 31089 | 2864 | 32412 | 2315 | 33971 | 1472 | 41580 | 931 | 32458 |
| 7L-5S | | MI | 12850 | 4869 | 21794 | 3454 | 23875 | 2782 | 24858 | 2235 | 26020 | 1367 | 31482 | 943 | 23925 |
| 20-#11 | 2.93 | MA | 16552 | 4869 | 27524 | 3549 | 30100 | 2861 | 31236 | 2324 | 32289 | 1465 | 39564 | 881 | 31724 |
| 8L-4S | | MI | 13175 | 4869 | 22354 | 3459 | 24596 | 2775 | 25726 | 2228 | 27216 | 1374 | 32916 | 984 | 24520 |
| 20-#11 | 2.93 | MA | 16137 | 4869 | 26744 | 3562 | 29134 | 2872 | 30020 | 2320 | 30700 | 1472 | 37584 | 825 | 30633 |
| 9L-3S | | MI | 13535 | 4869 | 22989 | 3449 | 25404 | 2781 | 26691 | 2235 | 28427 | 1367 | 34264 | 1070 | 24608 |
| 20-#11 | 2.93 | MA | 15688 | 4869 | 26009 | 3560 | 28158 | 2869 | 28852 | 2329 | 29123 | 1479 | 35666 | 761 | 29513 |
| 10L-2S | | MI | 14035 | 4869 | 23770 | 3453 | 26400 | 2773 | 27886 | 2228 | 30006 | 1360 | 36332 | 1159 | 24634 |
| 20-#14 | 4.23 | MA | 18651 | 5358 | 32407 | 3834 | 36241 | 3070 | 38658 | 2436 | 42298 | 1423 | 52886 | 792 | 45719 |
| 6E | | MI | 13335 | 5358 | 23545 | 3736 | 25991 | 2983 | 27352 | 2357 | 29309 | 1303 | 36001 | 604 | 32014 |
| 20-#14 | 4.23 | MA | 18059 | 5358 | 31255 | 3852 | 34837 | 3085 | 36937 | 2449 | 40014 | 1433 | 49868 | 665 | 44393 |
| 7L-5S | | MI | 13769 | 5358 | 24302 | 3743 | 27017 | 2993 | 28524 | 2347 | 30861 | 1293 | 37882 | 691 | 33085 |
| 20-#14 | 4.23 | MA | 17474 | 5358 | 30198 | 3849 | 33420 | 3080 | 35252 | 2462 | 37621 | 1423 | 47000 | 595 | 42556 |
| 8L-4S | | MI | 14224 | 5358 | 25102 | 3750 | 28047 | 2983 | 29750 | 2337 | 32554 | 1303 | 39901 | 749 | 33714 |
| 22-#11 | 3.23 | MA | 17910 | 4979 | 30192 | 3608 | 33505 | 2903 | 35359 | 2336 | 37935 | 1458 | 46852 | 1001 | 36668 |
| 6L-7S | | MI | 12583 | 4979 | 21479 | 3529 | 23462 | 2834 | 24363 | 2264 | 25427 | 1369 | 30951 | 790 | 25284 |
| 22-#11 | 3.23 | MA | 17488 | 4979 | 29389 | 3620 | 32526 | 2914 | 34158 | 2346 | 36330 | 1465 | 44724 | 913 | 35745 |
| 7L-6S | | MI | 12885 | 4979 | 22046 | 3519 | 24153 | 2826 | 25225 | 2271 | 26501 | 1362 | 32213 | 856 | 25903 |
| 22-#11 | 3.23 | MA | 17072 | 4979 | 28651 | 3619 | 31537 | 2911 | 32983 | 2355 | 34648 | 1458 | 42708 | 864 | 34973 |
| 8L-5S | | MI | 13194 | 4979 | 22575 | 3524 | 24871 | 2832 | 26054 | 2264 | 27599 | 1355 | 33550 | 916 | 26216 |
| 22-#11 | 3.23 | MA | 16660 | 4979 | 27871 | 3631 | 30571 | 2922 | 31766 | 2351 | 33059 | 1465 | 40728 | 807 | 33909 |
| 9L-4S | | MI | 13517 | 4979 | 23135 | 3528 | 25592 | 2825 | 26922 | 2258 | 28795 | 1362 | 34984 | 956 | 26780 |
| 22-#11 | 3.23 | MA | 16212 | 4979 | 27136 | 3629 | 29595 | 2919 | 30598 | 2360 | 31482 | 1472 | 38810 | 744 | 32765 |
| 10L-3S | | MI | 13876 | 4979 | 23770 | 3518 | 26400 | 2831 | 27886 | 2264 | 30006 | 1355 | 36332 | 1042 | 26969 |
| 22-#14 | 4.65 | MA | 18784 | 5518 | 32866 | 3951 | 36891 | 3157 | 39434 | 2494 | 43371 | 1421 | 54330 | 638 | 49010 |
| 7L-6S | | MI | 13818 | 5518 | 24657 | 3836 | 27409 | 3055 | 29042 | 2399 | 31542 | 1283 | 38913 | 562 | 35204 |
| 22-#14 | 4.65 | MA | 18205 | 5518 | 31809 | 3949 | 35474 | 3152 | 37749 | 2507 | 40978 | 1411 | 51462 | 567 | 47222 |
| 8L-5S | | MI | 14250 | 5518 | 25415 | 3843 | 28435 | 3065 | 30214 | 2389 | 33094 | 1273 | 40794 | 648 | 36348 |
| 24-#11 | 3.52 | MA | 18002 | 5090 | 30515 | 3689 | 33962 | 2964 | 35905 | 2377 | 38689 | 1458 | 47868 | 896 | 39037 |
| 7E | | MI | 12929 | 5090 | 22260 | 3598 | 24458 | 2884 | 25559 | 2294 | 27006 | 1356 | 33019 | 762 | 27547 |
| 24-#11 | 3.52 | MA | 17589 | 5090 | 29778 | 3688 | 32974 | 2961 | 34729 | 2386 | 37007 | 1451 | 45851 | 846 | 38227 |
| 8L-6S | | MI | 13229 | 5090 | 22827 | 3589 | 25149 | 2876 | 26420 | 2301 | 28080 | 1349 | 34281 | 829 | 28140 |
| 24-#11 | 3.52 | MA | 17179 | 5090 | 28997 | 3700 | 32008 | 2972 | 33513 | 2382 | 35419 | 1458 | 43872 | 790 | 37189 |
| 9L-5S | | MI | 13536 | 5090 | 23356 | 3593 | 25867 | 2883 | 27250 | 2294 | 29178 | 1342 | 35618 | 888 | 28512 |
| 24-#11 | 3.52 | MA | 16732 | 5090 | 28263 | 3699 | 31031 | 2969 | 32345 | 2391 | 33842 | 1465 | 41954 | 726 | 36022 |
| 10L-4S | | MI | 13858 | 5090 | 23916 | 3597 | 26588 | 2875 | 28117 | 2287 | 30375 | 1349 | 37052 | 929 | 29046 |
| 24-#14 | 5.08 | MA | 18929 | 5677 | 33420 | 4048 | 37528 | 3224 | 40247 | 2552 | 44334 | 1400 | 55924 | 540 | 51896 |
| 8L-6S | | MI | 14299 | 5677 | 25770 | 3936 | 28828 | 3127 | 30732 | 2441 | 33774 | 1264 | 41825 | 519 | 38403 |

## RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

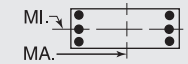
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.43 | MA | 18647 | 4528 | 29762 | 3321 | 32375 | 2697 | 33371 | 2232 | 34017 | 1548 | 40343 | 1436 | 19024 |
| 2E | | MI | 12811 | 4528 | 20767 | 3213 | 22125 | 2602 | 22449 | 2138 | 22448 | 1456 | 26143 | 1311 | 12813 |
| 6-#14 | 1.21 | MA | 18282 | 4439 | 28819 | 3288 | 31295 | 2676 | 32103 | 2223 | 32440 | 1573 | 38331 | 1475 | 16288 |
| 2L-3S | | MI | 11872 | 4439 | 19063 | 3183 | 20136 | 2605 | 20121 | 2155 | 19383 | 1505 | 22236 | 1245 | 11110 |
| 6-#14 | 1.21 | MA | 17144 | 4439 | 27108 | 3286 | 29114 | 2691 | 29451 | 2237 | 28858 | 1583 | 33557 | 1347 | 16325 |
| 3L-2S | | MI | 12606 | 4439 | 20176 | 3190 | 21555 | 2595 | 21811 | 2145 | 21616 | 1495 | 25149 | 1373 | 11035 |
| 6-#18 | 2.14 | MA | 20005 | 4811 | 32753 | 3498 | 36189 | 2826 | 38007 | 2312 | 40222 | 1526 | 48574 | 1384 | 28170 |
| 2L-3S | | MI | 12402 | 4811 | 20767 | 3375 | 22125 | 2745 | 22449 | 2226 | 22448 | 1434 | 26143 | 998 | 18790 |
| 6-#18 | 2.14 | MA | 18059 | 4811 | 29762 | 3492 | 32375 | 2851 | 33371 | 2334 | 34017 | 1544 | 40343 | 1156 | 27994 |
| 3L-2S | | MI | 13651 | 4811 | 22695 | 3390 | 24546 | 2727 | 25333 | 2208 | 26259 | 1417 | 31075 | 1225 | 18768 |
| 8-#11 | 1.11 | MA | 18131 | 4403 | 28423 | 3277 | 30851 | 2669 | 31587 | 2221 | 31781 | 1584 | 37515 | 1492 | 15160 |
| 2L-4S | | MI | 11631 | 4403 | 18507 | 3189 | 19487 | 2593 | 19391 | 2151 | 18490 | 1526 | 21334 | 1224 | 10394 |
| 8-#11 | 1.11 | MA | 17333 | 4403 | 27227 | 3276 | 29326 | 2680 | 29734 | 2231 | 29270 | 1591 | 34155 | 1404 | 15191 |
| 3E | | MI | 12005 | 4403 | 19143 | 3179 | 20294 | 2600 | 20356 | 2157 | 19701 | 1519 | 22681 | 1310 | 10346 |
| 8-#11 | 1.11 | MA | 16769 | 4403 | 26266 | 3288 | 28104 | 2678 | 28250 | 2227 | 27344 | 1598 | 31956 | 1315 | 15178 |
| 4L-2S | | MI | 12522 | 4403 | 19924 | 3184 | 21290 | 2592 | 21551 | 2151 | 21280 | 1512 | 24749 | 1399 | 10297 |
| 8-#14 | 1.61 | MA | 19074 | 4599 | 30530 | 3388 | 33476 | 2748 | 34755 | 2268 | 36022 | 1563 | 43105 | 1450 | 21525 |
| 2L-4S | | MI | 11844 | 4599 | 19269 | 3296 | 20402 | 2667 | 20447 | 2187 | 19904 | 1495 | 23248 | 1080 | 14526 |
| 8-#14 | 1.61 | MA | 17946 | 4599 | 28819 | 3386 | 31295 | 2764 | 32103 | 2282 | 32440 | 1573 | 38331 | 1322 | 21517 |
| 3E | | MI | 12372 | 4599 | 20176 | 3283 | 21555 | 2677 | 21811 | 2197 | 21616 | 1485 | 25149 | 1202 | 14531 |
| 8-#14 | 1.61 | MA | 17148 | 4599 | 27442 | 3403 | 29544 | 2760 | 29979 | 2275 | 29691 | 1583 | 35211 | 1194 | 21353 |
| 4L-2S | | MI | 13101 | 4599 | 21288 | 3290 | 22973 | 2667 | 23501 | 2187 | 23848 | 1476 | 28061 | 1330 | 14478 |
| 8-#18 | 2.86 | MA | 21341 | 5095 | 35745 | 3675 | 40004 | 2954 | 42644 | 2392 | 46427 | 1504 | 56804 | 1332 | 37258 |
| 2L-4S | | MI | 12345 | 5095 | 21117 | 3573 | 22577 | 2852 | 23005 | 2279 | 23338 | 1412 | 27844 | 701 | 22814 |
| 8-#18 | 2.86 | MA | 19422 | 5095 | 32753 | 3670 | 36189 | 2980 | 38007 | 2413 | 40222 | 1522 | 48574 | 1104 | 36969 |
| 3E | | MI | 13245 | 5095 | 22695 | 3553 | 24546 | 2870 | 25333 | 2296 | 26259 | 1395 | 31075 | 911 | 24598 |
| 8-#18 | 2.86 | MA | 18060 | 5095 | 30339 | 3699 | 33120 | 2970 | 34282 | 2399 | 35462 | 1539 | 43208 | 876 | 34203 |
| 4L-2S | | MI | 14480 | 5095 | 24622 | 3568 | 26967 | 2852 | 28218 | 2279 | 30070 | 1377 | 36007 | 1139 | 24674 |
| 10-#11 | 1.39 | MA | 18690 | 4514 | 29619 | 3346 | 32376 | 2719 | 33441 | 2252 | 34293 | 1577 | 40875 | 1476 | 18822 |
| 2L-5S | | MI | 11651 | 4514 | 18729 | 3254 | 19761 | 2651 | 19719 | 2187 | 18872 | 1507 | 21968 | 1157 | 12679 |
| 10-#11 | 1.39 | MA | 17897 | 4514 | 28423 | 3345 | 30851 | 2730 | 31587 | 2262 | 31781 | 1584 | 37515 | 1387 | 18839 |
| 3L-4S | | MI | 11987 | 4514 | 19288 | 3258 | 20483 | 2644 | 20587 | 2180 | 20069 | 1513 | 23401 | 1197 | 12786 |
| 10-#11 | 1.39 | MA | 17337 | 4514 | 27462 | 3357 | 29629 | 2728 | 30104 | 2258 | 29856 | 1591 | 35316 | 1299 | 18794 |
| 4L-3S | | MI | 12359 | 4514 | 19924 | 3249 | 21290 | 2650 | 21551 | 2187 | 21280 | 1507 | 24749 | 1283 | 12757 |
| 10-#11 | 1.39 | MA | 16835 | 4514 | 26619 | 3356 | 28542 | 2739 | 28773 | 2268 | 27957 | 1584 | 33014 | 1255 | 18524 |
| 5L-2S | | MI | 12873 | 4514 | 20705 | 3253 | 22286 | 2642 | 22747 | 2180 | 22859 | 1500 | 26817 | 1372 | 12716 |
| 10-#14 | 2.01 | MA | 19857 | 4758 | 32241 | 3487 | 35657 | 2820 | 37406 | 2313 | 39604 | 1552 | 47878 | 1425 | 26745 |
| 2L-5S | | MI | 11870 | 4758 | 19582 | 3389 | 20790 | 2750 | 20910 | 2239 | 20444 | 1466 | 24140 | 979 | 17031 |
| 10-#14 | 2.01 | MA | 18739 | 4758 | 30530 | 3485 | 33476 | 2836 | 34755 | 2327 | 36022 | 1562 | 43105 | 1297 | 26694 |
| 3L-4S | | MI | 12344 | 4758 | 20381 | 3396 | 21821 | 2740 | 22137 | 2229 | 22137 | 1476 | 26160 | 1038 | 17880 |
| 10-#14 | 2.01 | MA | 17949 | 4758 | 29153 | 3503 | 31726 | 2832 | 32630 | 2320 | 33274 | 1572 | 39985 | 1169 | 26482 |
| 4L-3S | | MI | 12868 | 4758 | 21288 | 3383 | 22973 | 2750 | 23501 | 2239 | 23848 | 1466 | 28061 | 1160 | 17931 |
| 10-#14 | 2.01 | MA | 17240 | 4758 | 27945 | 3501 | 30168 | 2848 | 30723 | 2334 | 30563 | 1562 | 36707 | 1107 | 25079 |
| 5L-2S | | MI | 13592 | 4758 | 22401 | 3389 | 24391 | 2740 | 25191 | 2229 | 26081 | 1456 | 30973 | 1288 | 17900 |
| 10-#18 | 3.57 | MA | 20763 | 5379 | 35745 | 3847 | 40004 | 3109 | 42644 | 2493 | 46427 | 1499 | 56804 | 1052 | 45932 |
| 3L-4S | | MI | 13188 | 5379 | 23044 | 3750 | 24998 | 2977 | 25889 | 2349 | 27149 | 1373 | 32776 | 615 | 28268 |
| 10-#18 | 3.57 | MA | 19421 | 5379 | 33331 | 3877 | 36934 | 3099 | 38919 | 2479 | 41667 | 1517 | 51439 | 824 | 42799 |
| 4L-3S | | MI | 14077 | 5379 | 24622 | 3730 | 26967 | 2995 | 28218 | 2367 | 30070 | 1355 | 36007 | 825 | 30379 |
| 10-#18 | 3.57 | MA | 18218 | 5379 | 31210 | 3871 | 34200 | 3124 | 35571 | 2501 | 36970 | 1499 | 45763 | 719 | 40257 |
| 5L-2S | | MI | 15300 | 5379 | 26550 | 3745 | 29388 | 2977 | 31102 | 2349 | 33881 | 1338 | 40939 | 1052 | 30541 |
| 12-#11 | 1.67 | MA | 19244 | 4624 | 30815 | 3415 | 33901 | 2769 | 35295 | 2283 | 36804 | 1570 | 44235 | 1460 | 22476 |
| 2L-6S | | MI | 11688 | 4624 | 18980 | 3319 | 20039 | 2695 | 20086 | 2224 | 19354 | 1501 | 22698 | 1069 | 14571 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis

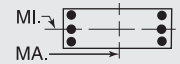


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.67 | MA | 18457 | 4624 | 29619 | 3414 | 32376 | 2780 | 33441 | 2293 | 34293 | 1577 | 40875 | 1371 | 22470 |
| 3L-5S | | MI | 12007 | 4624 | 19510 | 3323 | 20757 | 2701 | 20915 | 2217 | 20451 | 1494 | 24035 | 1129 | 14934 |
| 12-#11 | 1.67 | MA | 17901 | 4624 | 28658 | 3427 | 31154 | 2778 | 31958 | 2289 | 32367 | 1584 | 38676 | 1282 | 22403 |
| 4E | | MI | 12341 | 4624 | 20070 | 3327 | 21478 | 2694 | 21782 | 2210 | 21648 | 1501 | 25469 | 1169 | 15166 |
| 12-#11 | 1.67 | MA | 17402 | 4624 | 27815 | 3426 | 30067 | 2789 | 30627 | 2299 | 30468 | 1577 | 36374 | 1239 | 22001 |
| 5L-3S | | MI | 12710 | 4624 | 20705 | 3318 | 22286 | 2700 | 22747 | 2217 | 22859 | 1494 | 26817 | 1255 | 15154 |
| 12-#11 | 1.67 | MA | 16927 | 4624 | 27020 | 3424 | 28987 | 2787 | 29309 | 2295 | 28724 | 1585 | 34189 | 1181 | 21292 |
| 6L-2S | | MI | 13222 | 4624 | 21486 | 3322 | 23282 | 2692 | 23943 | 2210 | 24438 | 1487 | 28884 | 1344 | 15123 |
| 12-#14 | 2.41 | MA | 20632 | 4918 | 33952 | 3587 | 37839 | 2893 | 40058 | 2358 | 43186 | 1542 | 52652 | 1399 | 31946 |
| 2L-6S | | MI | 11920 | 4918 | 19937 | 3482 | 21183 | 2812 | 21428 | 2291 | 21125 | 1457 | 25172 | 850 | 19622 |
| 12-#14 | 2.41 | MA | 19524 | 4918 | 32241 | 3585 | 35657 | 2908 | 37406 | 2371 | 39604 | 1552 | 47878 | 1271 | 31861 |
| 3L-5S | | MI | 12369 | 4918 | 20694 | 3489 | 22209 | 2822 | 22600 | 2281 | 22677 | 1447 | 27053 | 936 | 20251 |
| 12-#14 | 2.41 | MA | 18741 | 4918 | 30864 | 3603 | 33907 | 2904 | 35282 | 2365 | 36856 | 1562 | 44758 | 1143 | 31608 |
| 4E | | MI | 12839 | 4918 | 21494 | 3495 | 23239 | 2812 | 23827 | 2271 | 24369 | 1457 | 29072 | 995 | 21106 |
| 12-#14 | 2.41 | MA | 18039 | 4918 | 29656 | 3601 | 32349 | 2920 | 33375 | 2379 | 34145 | 1552 | 41481 | 1082 | 30074 |
| 5L-3S | | MI | 13360 | 4918 | 22401 | 3482 | 24391 | 2822 | 25191 | 2281 | 26081 | 1447 | 30973 | 1117 | 21308 |
| 12-#14 | 2.41 | MA | 17370 | 4918 | 28516 | 3599 | 30800 | 2916 | 31486 | 2372 | 31655 | 1562 | 38379 | 997 | 29056 |
| 6L-2S | | MI | 14078 | 4918 | 23513 | 3489 | 25810 | 2812 | 26881 | 2271 | 28314 | 1437 | 33886 | 1245 | 21308 |
| 12-#18 | 4.29 | MA | 20763 | 5663 | 36322 | 4054 | 40748 | 3227 | 43556 | 2559 | 47872 | 1495 | 59670 | 772 | 51438 |
| 4E | | MI | 14022 | 5663 | 24972 | 3928 | 27419 | 3103 | 28773 | 2419 | 30959 | 1334 | 37708 | 528 | 33764 |
| 12-#18 | 4.29 | MA | 19577 | 5663 | 34201 | 4048 | 38014 | 3253 | 40208 | 2580 | 43175 | 1477 | 53993 | 666 | 48733 |
| 5L-3S | | MI | 14901 | 5663 | 26550 | 3907 | 29388 | 3120 | 31102 | 2437 | 33881 | 1316 | 40939 | 739 | 36145 |
| 12-#18 | 4.29 | MA | 18446 | 5663 | 32198 | 4043 | 35294 | 3243 | 36892 | 2567 | 38862 | 1495 | 48652 | 515 | 45212 |
| 6L-2S | | MI | 16111 | 5663 | 28478 | 3922 | 31809 | 3103 | 33986 | 2419 | 37692 | 1298 | 45871 | 966 | 36378 |
| 14-#11 | 1.95 | MA | 19794 | 4735 | 32011 | 3484 | 35426 | 2819 | 37148 | 2314 | 39315 | 1563 | 47595 | 1444 | 26123 |
| 2L-7S | | MI | 11733 | 4735 | 19195 | 3398 | 20344 | 2753 | 20419 | 2247 | 19859 | 1496 | 23504 | 975 | 16472 |
| 14-#11 | 1.95 | MA | 19012 | 4735 | 30815 | 3483 | 33901 | 2830 | 35295 | 2324 | 36804 | 1570 | 44235 | 1355 | 26096 |
| 3L-6S | | MI | 12043 | 4735 | 19761 | 3388 | 21035 | 2745 | 21281 | 2254 | 20933 | 1489 | 24766 | 1042 | 16862 |
| 14-#11 | 1.95 | MA | 18459 | 4735 | 29854 | 3496 | 32679 | 2828 | 33811 | 2320 | 34878 | 1577 | 42036 | 1266 | 26008 |
| 4L-5S | | MI | 12360 | 4735 | 20291 | 3392 | 21753 | 2751 | 22110 | 2247 | 22030 | 1482 | 26103 | 1102 | 17200 |
| 14-#11 | 1.95 | MA | 17965 | 4735 | 29011 | 3495 | 31592 | 2839 | 32481 | 2330 | 32980 | 1571 | 39734 | 1223 | 25491 |
| 5L-4S | | MI | 12692 | 4735 | 20851 | 3396 | 22474 | 2744 | 22978 | 2240 | 23227 | 1489 | 27537 | 1142 | 17534 |
| 14-#11 | 1.95 | MA | 17493 | 4735 | 28216 | 3494 | 30512 | 2837 | 31163 | 2326 | 31235 | 1578 | 37549 | 1164 | 24816 |
| 6L-3S | | MI | 13059 | 4735 | 21486 | 3387 | 23282 | 2750 | 23943 | 2247 | 24438 | 1482 | 28884 | 1228 | 17543 |
| 14-#11 | 1.95 | MA | 17032 | 4735 | 27364 | 3506 | 29474 | 2848 | 29891 | 2336 | 29527 | 1585 | 35275 | 1077 | 24155 |
| 7L-2S | | MI | 13568 | 4735 | 22267 | 3391 | 24278 | 2742 | 25138 | 2240 | 26017 | 1475 | 30952 | 1317 | 17521 |
| 14-#14 | 2.81 | MA | 20301 | 5077 | 33952 | 3685 | 37839 | 2981 | 40058 | 2416 | 43186 | 1541 | 52652 | 1246 | 37021 |
| 3L-6S | | MI | 12418 | 5077 | 21049 | 3582 | 22601 | 2885 | 23118 | 2333 | 23357 | 1438 | 28084 | 807 | 22757 |
| 14-#14 | 2.81 | MA | 19525 | 5077 | 32575 | 3703 | 36088 | 2976 | 37934 | 2410 | 40438 | 1551 | 49532 | 1118 | 36636 |
| 4L-5S | | MI | 12864 | 5077 | 21807 | 3588 | 23627 | 2894 | 24290 | 2323 | 24909 | 1428 | 29965 | 894 | 23484 |
| 14-#14 | 2.81 | MA | 18830 | 5077 | 31367 | 3700 | 34530 | 2992 | 36026 | 2424 | 37728 | 1541 | 46254 | 1056 | 35082 |
| 5L-4S | | MI | 13331 | 5077 | 22606 | 3595 | 24657 | 2884 | 25517 | 2313 | 26602 | 1438 | 31985 | 952 | 24277 |
| 14-#14 | 2.81 | MA | 18167 | 5077 | 30227 | 3698 | 32982 | 2988 | 34137 | 2417 | 35237 | 1551 | 43152 | 972 | 33972 |
| 6L-3S | | MI | 13847 | 5077 | 23513 | 3582 | 25810 | 2894 | 26881 | 2323 | 28314 | 1428 | 33886 | 1074 | 24675 |
| 14-#14 | 2.81 | MA | 17520 | 5077 | 29006 | 3716 | 31494 | 3004 | 32315 | 2431 | 32800 | 1561 | 39922 | 845 | 32381 |
| 7L-2S | | MI | 14561 | 5077 | 24626 | 3589 | 27228 | 2884 | 28571 | 2313 | 30546 | 1418 | 36798 | 1202 | 24706 |
| 14-#18 | 5.00 | MA | 20918 | 5946 | 37193 | 4226 | 41828 | 3381 | 44845 | 2660 | 49380 | 1455 | 62224 | 614 | 57244 |
| 5L-4S | | MI | 14847 | 5946 | 26900 | 4105 | 29840 | 3228 | 31657 | 2489 | 34770 | 1294 | 42640 | 442 | 39290 |
| 14-#18 | 5.00 | MA | 19802 | 5946 | 35189 | 4220 | 39108 | 3372 | 41528 | 2646 | 45067 | 1473 | 56883 | 463 | 53866 |
| 6L-3S | | MI | 15717 | 5946 | 28478 | 4085 | 31809 | 3245 | 33986 | 2507 | 37692 | 1276 | 45871 | 652 | 41851 |
| 16-#11 | 2.23 | MA | 19562 | 4846 | 32011 | 3552 | 35426 | 2881 | 37148 | 2355 | 39315 | 1563 | 47595 | 1338 | 29716 |
| 3L-7S | | MI | 12087 | 4846 | 19976 | 3467 | 21340 | 2803 | 21615 | 2277 | 21438 | 1483 | 25572 | 948 | 18707 |
| 16-#11 | 2.23 | MA | 19014 | 4846 | 31050 | 3565 | 34204 | 2878 | 35665 | 2352 | 37390 | 1570 | 45396 | 1250 | 29609 |
| 4L-6S | | MI | 12396 | 4846 | 20542 | 3457 | 22031 | 2795 | 22477 | 2283 | 22512 | 1477 | 26834 | 1014 | 19158 |
| 16-#11 | 2.23 | MA | 18523 | 4846 | 30207 | 3564 | 33117 | 2889 | 34334 | 2361 | 35491 | 1564 | 43094 | 1206 | 28991 |
| 5E | | MI | 12711 | 4846 | 21072 | 3461 | 22749 | 2802 | 23306 | 2277 | 23610 | 1470 | 28171 | 1074 | 19475 |
| 16-#11 | 2.23 | MA | 18054 | 4846 | 29412 | 3563 | 32036 | 2887 | 33016 | 2358 | 33746 | 1571 | 40909 | 1148 | 28346 |
| 6L-4S | | MI | 13041 | 4846 | 21632 | 3466 | 23470 | 2794 | 24174 | 2270 | 24806 | 1477 | 29605 | 1114 | 19896 |

## RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

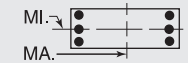
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.23 | MA | 17597 | 4846 | 28561 | 3575 | 30999 | 2898 | 31745 | 2367 | 32039 | 1578 | 38635 | 1060 | 27625 |
| 7L-3S | | MI | 13406 | 4846 | 22267 | 3456 | 24278 | 2800 | 25138 | 2277 | 26017 | 1470 | 30952 | 1200 | 19925 |
| 16-#11 | 2.23 | MA | 17146 | 4846 | 27780 | 3574 | 29952 | 2896 | 30500 | 2377 | 30250 | 1571 | 36484 | 1010 | 26765 |
| 8L-2S | | MI | 13913 | 4846 | 23048 | 3460 | 25273 | 2793 | 26334 | 2270 | 27596 | 1463 | 33020 | 1289 | 19913 |
| 16-#14 | 3.21 | MA | 20302 | 5237 | 34286 | 3802 | 38269 | 3049 | 40585 | 2455 | 44020 | 1541 | 54305 | 1092 | 41582 |
| 4L-6S | | MI | 12913 | 5237 | 22162 | 3681 | 24019 | 2957 | 24808 | 2375 | 25590 | 1419 | 30997 | 765 | 25909 |
| 16-#14 | 3.21 | MA | 19613 | 5237 | 33078 | 3800 | 36712 | 3064 | 38678 | 2468 | 41310 | 1531 | 51028 | 1031 | 40103 |
| 5E | | MI | 13356 | 5237 | 22919 | 3688 | 25045 | 2967 | 25980 | 2365 | 27142 | 1409 | 32877 | 851 | 26727 |
| 16-#14 | 3.21 | MA | 18957 | 5237 | 31938 | 3798 | 35163 | 3060 | 36789 | 2462 | 38819 | 1541 | 47926 | 946 | 38902 |
| 6L-4S | | MI | 13818 | 5237 | 23719 | 3695 | 26076 | 2957 | 27207 | 2355 | 28834 | 1419 | 34897 | 910 | 27467 |
| 16-#14 | 3.21 | MA | 18316 | 5237 | 30717 | 3816 | 33676 | 3076 | 34966 | 2476 | 36382 | 1551 | 44696 | 820 | 37367 |
| 7L-3S | | MI | 14331 | 5237 | 24626 | 3682 | 27228 | 2967 | 28571 | 2365 | 30546 | 1409 | 36798 | 1032 | 28033 |
| 16-#14 | 3.21 | MA | 17684 | 5237 | 29597 | 3814 | 32174 | 3072 | 33182 | 2489 | 33829 | 1541 | 41634 | 748 | 35581 |
| 8L-2S | | MI | 15040 | 5237 | 25738 | 3689 | 28646 | 2957 | 30261 | 2355 | 32779 | 1399 | 39710 | 1160 | 28087 |
| 16-#18 | 5.71 | MA | 21142 | 6230 | 38181 | 4397 | 42923 | 3500 | 46165 | 2726 | 51272 | 1451 | 65114 | 411 | 62543 |
| 6L-4S | | MI | 15665 | 6230 | 28827 | 4282 | 32261 | 3353 | 34542 | 2560 | 38581 | 1255 | 47572 | 356 | 44842 |
| 18-#11 | 2.51 | MA | 19564 | 4956 | 32246 | 3634 | 35729 | 2928 | 37519 | 2383 | 39901 | 1563 | 48756 | 1233 | 33208 |
| 4L-7S | | MI | 12440 | 4956 | 20757 | 3536 | 22336 | 2853 | 22811 | 2306 | 23017 | 1471 | 27640 | 920 | 20951 |
| 18-#11 | 2.51 | MA | 19076 | 4956 | 31403 | 3633 | 34642 | 2940 | 36188 | 2393 | 38002 | 1557 | 46454 | 1190 | 32499 |
| 5L-6S | | MI | 12746 | 4956 | 21323 | 3526 | 23027 | 2846 | 23672 | 2313 | 24091 | 1464 | 28902 | 987 | 21458 |
| 18-#11 | 2.51 | MA | 18611 | 4956 | 30608 | 3632 | 33561 | 2937 | 34870 | 2389 | 36258 | 1564 | 44269 | 1132 | 31880 |
| 6L-5S | | MI | 13060 | 4956 | 21853 | 3531 | 23745 | 2852 | 24501 | 2306 | 25189 | 1457 | 30239 | 1046 | 21757 |
| 18-#11 | 2.51 | MA | 18158 | 4956 | 29757 | 3645 | 32524 | 2948 | 33599 | 2399 | 34550 | 1571 | 41995 | 1044 | 31103 |
| 7L-4S | | MI | 13388 | 4956 | 22413 | 3535 | 24466 | 2844 | 25369 | 2300 | 26385 | 1464 | 31672 | 1087 | 22254 |
| 18-#11 | 2.51 | MA | 17710 | 4956 | 28976 | 3643 | 31477 | 2946 | 32354 | 2409 | 32762 | 1564 | 39844 | 994 | 30270 |
| 8L-3S | | MI | 13751 | 4956 | 23048 | 3525 | 25273 | 2850 | 26334 | 2306 | 27596 | 1457 | 33020 | 1173 | 22295 |
| 18-#11 | 2.51 | MA | 17264 | 4956 | 28149 | 3656 | 30454 | 2957 | 31066 | 2405 | 31072 | 1572 | 37727 | 937 | 29219 |
| 9L-2S | | MI | 14255 | 4956 | 23829 | 3529 | 26269 | 2843 | 27529 | 2300 | 29175 | 1450 | 35088 | 1262 | 22300 |
| 18-#14 | 3.62 | MA | 20390 | 5397 | 34789 | 3900 | 38893 | 3137 | 41330 | 2513 | 44892 | 1520 | 55801 | 1005 | 45134 |
| 5L-6S | | MI | 13404 | 5397 | 23274 | 3781 | 25438 | 3029 | 26499 | 2416 | 27823 | 1399 | 33909 | 722 | 29074 |
| 18-#14 | 3.62 | MA | 19739 | 5397 | 33649 | 3898 | 37344 | 3133 | 39441 | 2507 | 42401 | 1530 | 52699 | 921 | 43845 |
| 6L-5S | | MI | 13843 | 5397 | 24032 | 3788 | 26464 | 3039 | 27671 | 2407 | 29374 | 1389 | 35790 | 808 | 29978 |
| 18-#14 | 3.62 | MA | 19104 | 5397 | 32428 | 3916 | 35857 | 3148 | 37618 | 2521 | 39964 | 1540 | 49469 | 794 | 42362 |
| 7L-4S | | MI | 14303 | 5397 | 24831 | 3795 | 27494 | 3029 | 28897 | 2397 | 31067 | 1399 | 37809 | 867 | 30670 |
| 18-#14 | 3.62 | MA | 18478 | 5397 | 31308 | 3913 | 34356 | 3144 | 35833 | 2534 | 37411 | 1530 | 46407 | 722 | 40526 |
| 8L-3S | | MI | 14812 | 5397 | 25738 | 3782 | 28646 | 3039 | 30261 | 2407 | 32779 | 1389 | 39710 | 989 | 31384 |
| 18-#14 | 3.62 | MA | 17856 | 5397 | 30123 | 3931 | 32889 | 3160 | 33987 | 2528 | 34998 | 1540 | 43402 | 641 | 38576 |
| 9L-2S | | MI | 15516 | 5397 | 26851 | 3788 | 30065 | 3029 | 31951 | 2397 | 35011 | 1380 | 42623 | 1117 | 31460 |
| 20-#11 | 2.79 | MA | 19626 | 5067 | 32599 | 3702 | 36167 | 2990 | 38042 | 2424 | 40514 | 1550 | 49814 | 1174 | 36014 |
| 5L-7S | | MI | 12790 | 5067 | 21538 | 3605 | 23332 | 2903 | 24006 | 2336 | 24596 | 1459 | 29708 | 893 | 23202 |
| 20-#11 | 2.79 | MA | 19164 | 5067 | 31804 | 3701 | 35086 | 2987 | 36724 | 2420 | 38769 | 1557 | 47629 | 1115 | 35420 |
| 6E | | MI | 13095 | 5067 | 22104 | 3596 | 24022 | 2896 | 24868 | 2343 | 25670 | 1452 | 30969 | 959 | 23760 |
| 20-#11 | 2.79 | MA | 18714 | 5067 | 30953 | 3714 | 34049 | 2998 | 35452 | 2430 | 37061 | 1564 | 45355 | 1028 | 34588 |
| 7L-5S | | MI | 13407 | 5067 | 22634 | 3600 | 24740 | 2902 | 25697 | 2336 | 26768 | 1445 | 32306 | 1019 | 24044 |
| 20-#11 | 2.79 | MA | 18270 | 5067 | 30172 | 3713 | 33002 | 2996 | 34208 | 2440 | 35273 | 1558 | 43204 | 977 | 33780 |
| 8L-4S | | MI | 13733 | 5067 | 23194 | 3604 | 25462 | 2894 | 26565 | 2329 | 27965 | 1452 | 33740 | 1059 | 24607 |
| 20-#11 | 2.79 | MA | 17825 | 5067 | 29345 | 3725 | 31979 | 3007 | 32920 | 2436 | 33583 | 1565 | 41087 | 921 | 32695 |
| 9L-3S | | MI | 14094 | 5067 | 23829 | 3594 | 26269 | 2901 | 27529 | 2336 | 29175 | 1445 | 35088 | 1145 | 24662 |
| 20-#11 | 2.79 | MA | 17331 | 5067 | 28568 | 3724 | 30945 | 3005 | 31682 | 2446 | 31906 | 1572 | 39035 | 857 | 31653 |
| 10L-2S | | MI | 14596 | 5067 | 24610 | 3598 | 27265 | 2893 | 28725 | 2329 | 30755 | 1438 | 37155 | 1234 | 24682 |
| 20-#14 | 4.02 | MA | 20515 | 5556 | 35360 | 3998 | 39526 | 3205 | 42092 | 2552 | 45984 | 1520 | 57473 | 895 | 48800 |
| 6E | | MI | 13891 | 5556 | 24387 | 3881 | 26856 | 3102 | 28189 | 2458 | 30055 | 1380 | 36821 | 679 | 32251 |
| 20-#14 | 4.02 | MA | 19886 | 5556 | 34139 | 4015 | 38038 | 3221 | 40270 | 2565 | 43546 | 1529 | 54243 | 769 | 47366 |
| 7L-5S | | MI | 14327 | 5556 | 25144 | 3888 | 27882 | 3111 | 29361 | 2448 | 31607 | 1370 | 38702 | 766 | 33235 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

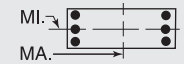
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 4.02 | MA | 19265 | 5556 | 33019 | 4013 | 36537 | 3216 | 38485 | 2579 | 40993 | 1520 | 51181 | 697 | 45480 |
| 8L-4S | | MI | 14784 | 5556 | 25944 | 3894 | 28912 | 3101 | 30587 | 2438 | 33299 | 1380 | 40722 | 824 | 33885 |
| 20-#14 | 4.02 | MA | 18644 | 5556 | 31834 | 4031 | 35070 | 3232 | 36638 | 2573 | 38580 | 1529 | 48176 | 615 | 43498 |
| 9L-3S | | MI | 15289 | 5556 | 26851 | 3881 | 30065 | 3111 | 31951 | 2448 | 35011 | 1370 | 42623 | 947 | 34731 |
| 22-#11 | 3.06 | MA | 19714 | 5177 | 33000 | 3770 | 36611 | 3037 | 38578 | 2451 | 41280 | 1550 | 50989 | 1099 | 38963 |
| 6L-7S | | MI | 13138 | 5177 | 22319 | 3674 | 24328 | 2953 | 25202 | 2366 | 26175 | 1447 | 31775 | 865 | 25458 |
| 22-#11 | 3.06 | MA | 19266 | 5177 | 32149 | 3783 | 35574 | 3049 | 37306 | 2461 | 39573 | 1557 | 48715 | 1011 | 38080 |
| 7L-6S | | MI | 13441 | 5177 | 22886 | 3665 | 25018 | 2946 | 26063 | 2373 | 27249 | 1440 | 33037 | 932 | 26065 |
| 22-#11 | 3.06 | MA | 18825 | 5177 | 31368 | 3782 | 34527 | 3046 | 36061 | 2471 | 37784 | 1551 | 46564 | 961 | 37295 |
| 8L-5S | | MI | 13751 | 5177 | 23415 | 3669 | 25736 | 2952 | 26892 | 2366 | 28347 | 1433 | 34374 | 991 | 26335 |
| 22-#11 | 3.06 | MA | 18381 | 5177 | 30541 | 3794 | 33504 | 3057 | 34773 | 2467 | 36094 | 1558 | 44447 | 905 | 36176 |
| 9L-4S | | MI | 14076 | 5177 | 23975 | 3673 | 26458 | 2944 | 27760 | 2359 | 29544 | 1440 | 35808 | 1032 | 26920 |
| 22-#11 | 3.06 | MA | 17903 | 5177 | 29764 | 3793 | 32470 | 3055 | 33536 | 2477 | 34417 | 1565 | 42395 | 841 | 35043 |
| 10L-3S | | MI | 14435 | 5177 | 24610 | 3663 | 27265 | 2951 | 28725 | 2366 | 30755 | 1433 | 37155 | 1118 | 27024 |
| 22-#14 | 4.42 | MA | 20661 | 5716 | 35850 | 4115 | 40220 | 3293 | 42921 | 2610 | 47128 | 1519 | 59017 | 743 | 52378 |
| 7L-6S | | MI | 14376 | 5716 | 25499 | 3981 | 28274 | 3174 | 29879 | 2500 | 32288 | 1361 | 39734 | 637 | 35439 |
| 22-#14 | 4.42 | MA | 20046 | 5716 | 34730 | 4113 | 38718 | 3289 | 41137 | 2624 | 44575 | 1509 | 55955 | 672 | 50443 |
| 8L-5S | | MI | 14809 | 5716 | 26256 | 3987 | 29300 | 3184 | 31051 | 2490 | 33839 | 1351 | 41615 | 723 | 36498 |
| 22-#14 | 4.42 | MA | 19426 | 5716 | 33545 | 4131 | 37251 | 3304 | 39290 | 2618 | 42163 | 1519 | 52949 | 590 | 48428 |
| 9L-4S | | MI | 15262 | 5716 | 27056 | 3994 | 30331 | 3174 | 32278 | 2480 | 35532 | 1361 | 43634 | 782 | 37110 |
| 24-#11 | 3.34 | MA | 19815 | 5288 | 33345 | 3852 | 37098 | 3099 | 39160 | 2492 | 42084 | 1550 | 52075 | 995 | 41577 |
| 7E | | MI | 13485 | 5288 | 23100 | 3744 | 25324 | 3004 | 26397 | 2396 | 27754 | 1434 | 33843 | 838 | 27720 |
| 24-#11 | 3.34 | MA | 19377 | 5288 | 32564 | 3851 | 36051 | 3096 | 37915 | 2502 | 40296 | 1544 | 49924 | 945 | 40814 |
| 8L-6S | | MI | 13786 | 5288 | 23667 | 3734 | 26014 | 2996 | 27259 | 2403 | 28828 | 1427 | 35105 | 904 | 28334 |
| 24-#11 | 3.34 | MA | 18934 | 5288 | 31737 | 3864 | 35028 | 3108 | 36627 | 2498 | 38606 | 1551 | 47807 | 888 | 39662 |
| 9L-5S | | MI | 14095 | 5288 | 24196 | 3738 | 26732 | 3002 | 28088 | 2396 | 29926 | 1420 | 36442 | 964 | 28630 |
| 24-#11 | 3.34 | MA | 18459 | 5288 | 30960 | 3862 | 33995 | 3105 | 35390 | 2508 | 36928 | 1558 | 45755 | 825 | 38506 |
| 10L-4S | | MI | 14417 | 5288 | 24756 | 3742 | 27454 | 2995 | 28956 | 2389 | 31123 | 1427 | 37876 | 1004 | 29186 |
| 24-#14 | 4.82 | MA | 20820 | 5875 | 36441 | 4213 | 40900 | 3361 | 43788 | 2669 | 48157 | 1498 | 60728 | 646 | 55413 |
| 8L-6S | | MI | 14857 | 5875 | 26612 | 4080 | 29693 | 3246 | 31569 | 2542 | 34520 | 1342 | 42646 | 594 | 38635 |
| 24-#14 | 4.82 | MA | 20202 | 5875 | 35256 | 4230 | 39433 | 3377 | 41942 | 2662 | 45745 | 1508 | 57723 | 565 | 53365 |
| 9L-5S | | MI | 15287 | 5875 | 27369 | 4087 | 30719 | 3256 | 32741 | 2532 | 36072 | 1332 | 44527 | 681 | 39765 |

## RECTANGULAR TIED COLUMNS 28" x 42"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.36 | MA | 20456 | 4726 | 32501 | 3482 | 35367 | 2830 | 36420 | 2345 | 37083 | 1639 | 43972 | 1527 | 20104 |
| 2E | | MI | 13367 | 4726 | 21613 | 3356 | 22989 | 2719 | 23283 | 2238 | 23189 | 1533 | 26957 | 1386 | 12854 |
| 6-#14 | 1.15 | MA | 20063 | 4637 | 31496 | 3449 | 34214 | 2808 | 35068 | 2336 | 35368 | 1662 | 41795 | 1565 | 17199 |
| 2L-3S | | MI | 12427 | 4637 | 19905 | 3328 | 21001 | 2724 | 20958 | 2256 | 20129 | 1582 | 23057 | 1320 | 11145 |
| 6-#14 | 1.15 | MA | 18856 | 4637 | 29685 | 3447 | 31906 | 2824 | 32262 | 2350 | 31566 | 1672 | 36710 | 1437 | 17236 |
| 3L-2S | | MI | 13162 | 4637 | 21018 | 3334 | 22420 | 2714 | 22648 | 2246 | 22362 | 1572 | 25969 | 1448 | 11068 |
| 6-#18 | 2.04 | MA | 21905 | 5009 | 35670 | 3659 | 39407 | 2958 | 41331 | 2425 | 43689 | 1618 | 52756 | 1478 | 29790 |
| 2L-3S | | MI | 12957 | 5009 | 21613 | 3518 | 22989 | 2862 | 23283 | 2326 | 23189 | 1511 | 26957 | 1072 | 18860 |
| 6-#18 | 2.04 | MA | 19838 | 5009 | 32501 | 3654 | 35367 | 2985 | 36420 | 2447 | 37083 | 1636 | 43972 | 1251 | 29614 |
| 3L-2S | | MI | 14209 | 5009 | 23540 | 3533 | 25410 | 2845 | 26167 | 2308 | 27000 | 1493 | 31889 | 1299 | 18817 |
| 8-#11 | 1.06 | MA | 19901 | 4601 | 31073 | 3438 | 33741 | 2801 | 34518 | 2333 | 34633 | 1670 | 40912 | 1581 | 16002 |
| 2L-4S | | MI | 12185 | 4601 | 19347 | 3334 | 20352 | 2713 | 20230 | 2252 | 19238 | 1604 | 22158 | 1300 | 10429 |
| 8-#11 | 1.06 | MA | 19055 | 4601 | 29808 | 3437 | 32128 | 2799 | 32557 | 2344 | 31976 | 1678 | 37336 | 1492 | 16034 |
| 3E | | MI | 12560 | 4601 | 19983 | 3325 | 21159 | 2719 | 21194 | 2259 | 20449 | 1597 | 23505 | 1386 | 10377 |
| 8-#11 | 1.06 | MA | 18458 | 4601 | 28793 | 3450 | 30837 | 2811 | 30990 | 2340 | 29942 | 1686 | 34993 | 1403 | 16021 |
| 4L-2S | | MI | 13077 | 4601 | 20764 | 3329 | 22155 | 2712 | 22390 | 2252 | 22028 | 1590 | 25573 | 1475 | 10326 |
| 8-#14 | 1.53 | MA | 20907 | 4797 | 33307 | 3549 | 36523 | 2880 | 37874 | 2381 | 39170 | 1652 | 46881 | 1541 | 22740 |
| 2L-4S | | MI | 12398 | 4797 | 20111 | 3440 | 21267 | 2786 | 21284 | 2288 | 20650 | 1573 | 24068 | 1155 | 14585 |
| 8-#14 | 1.53 | MA | 19710 | 4797 | 31496 | 3547 | 34214 | 2897 | 35068 | 2395 | 35368 | 1662 | 41795 | 1413 | 22732 |
| 3E | | MI | 12928 | 4797 | 21018 | 3427 | 22420 | 2796 | 22648 | 2298 | 22362 | 1563 | 25969 | 1277 | 14573 |
| 8-#14 | 1.53 | MA | 18865 | 4797 | 30041 | 3565 | 32364 | 2893 | 32822 | 2389 | 32452 | 1672 | 38468 | 1285 | 22568 |
| 4L-2S | | MI | 13658 | 4797 | 22130 | 3434 | 23838 | 2786 | 24338 | 2288 | 24594 | 1553 | 28882 | 1405 | 14516 |

## RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

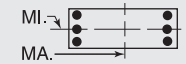
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 2.72 | MA | 23330 | 5293 | 38839 | 3836 | 43447 | 3087 | 46243 | 2504 | 50295 | 1598 | 61540 | 1430 | 39418 |
| 2L-4S | | MI | 12899 | 5293 | 21962 | 3716 | 23442 | 2970 | 23839 | 2378 | 24079 | 1489 | 28658 | 775 | 23056 |
| 8-#18 | 2.72 | MA | 21291 | 5293 | 35670 | 3832 | 39407 | 3114 | 41331 | 2527 | 43689 | 1615 | 52756 | 1202 | 39129 |
| 3E | | MI | 13801 | 5293 | 23540 | 3695 | 25410 | 2987 | 26167 | 2396 | 27000 | 1472 | 31889 | 985 | 24678 |
| 8-#18 | 2.72 | MA | 19847 | 5293 | 33116 | 3862 | 36160 | 3105 | 37391 | 2515 | 38622 | 1633 | 47022 | 975 | 36459 |
| 4L-2S | | MI | 15039 | 5293 | 25468 | 3710 | 27831 | 2970 | 29052 | 2378 | 30811 | 1454 | 36821 | 1213 | 24729 |
| 10-#11 | 1.33 | MA | 20496 | 4712 | 32339 | 3507 | 35354 | 2851 | 36479 | 2365 | 37289 | 1663 | 44489 | 1566 | 19875 |
| 2L-5S | | MI | 12205 | 4712 | 19569 | 3399 | 20627 | 2771 | 20558 | 2289 | 19620 | 1585 | 22791 | 1232 | 12798 |
| 10-#11 | 1.33 | MA | 19656 | 4712 | 31073 | 3506 | 33741 | 2849 | 34518 | 2375 | 34633 | 1671 | 40912 | 1477 | 19892 |
| 3L-4S | | MI | 12542 | 4712 | 20128 | 3403 | 21348 | 2763 | 21425 | 2282 | 20817 | 1591 | 24225 | 1272 | 12826 |
| 10-#11 | 1.33 | MA | 19063 | 4712 | 30058 | 3519 | 32450 | 2861 | 32951 | 2372 | 32598 | 1679 | 38569 | 1388 | 19847 |
| 4L-3S | | MI | 12914 | 4712 | 20764 | 3394 | 22155 | 2769 | 22390 | 2289 | 22028 | 1585 | 25573 | 1358 | 12791 |
| 10-#11 | 1.33 | MA | 18532 | 4712 | 29168 | 3518 | 31302 | 2859 | 31545 | 2382 | 30593 | 1673 | 36123 | 1344 | 19667 |
| 5L-2S | | MI | 13429 | 4712 | 21545 | 3398 | 23151 | 2762 | 23585 | 2282 | 23607 | 1578 | 27641 | 1447 | 12748 |
| 10-#14 | 1.91 | MA | 21741 | 4956 | 35117 | 3648 | 38831 | 2953 | 40681 | 2425 | 42971 | 1642 | 51966 | 1517 | 28264 |
| 2L-5S | | MI | 12424 | 4956 | 20424 | 3533 | 21655 | 2869 | 21747 | 2340 | 21190 | 1544 | 24961 | 1054 | 17180 |
| 10-#14 | 1.91 | MA | 20555 | 4956 | 33307 | 3647 | 36523 | 2969 | 37874 | 2440 | 39170 | 1652 | 46881 | 1389 | 28213 |
| 3L-4S | | MI | 12899 | 4956 | 21223 | 3540 | 22686 | 2859 | 22974 | 2330 | 22882 | 1554 | 26980 | 1113 | 17946 |
| 10-#14 | 1.91 | MA | 19718 | 4956 | 31851 | 3665 | 34672 | 2965 | 35629 | 2434 | 36254 | 1662 | 43553 | 1261 | 28001 |
| 4L-3S | | MI | 13424 | 4956 | 22130 | 3527 | 23838 | 2869 | 24338 | 2340 | 24594 | 1544 | 28882 | 1235 | 17978 |
| 10-#14 | 1.91 | MA | 18968 | 4956 | 30576 | 3663 | 33027 | 2982 | 33614 | 2448 | 33379 | 1653 | 40068 | 1199 | 26630 |
| 5L-2S | | MI | 14149 | 4956 | 23243 | 3534 | 25256 | 2859 | 26028 | 2330 | 26827 | 1534 | 31794 | 1363 | 17941 |
| 10-#18 | 3.40 | MA | 22721 | 5577 | 38839 | 4009 | 43447 | 3242 | 46243 | 2607 | 50295 | 1595 | 61540 | 1154 | 48632 |
| 3L-4S | | MI | 13743 | 5577 | 23890 | 3893 | 25863 | 3095 | 26723 | 2449 | 27890 | 1450 | 33590 | 689 | 28506 |
| 10-#18 | 3.40 | MA | 21298 | 5577 | 36285 | 4040 | 40200 | 3234 | 42303 | 2595 | 45227 | 1613 | 55806 | 926 | 45576 |
| 4L-3S | | MI | 14635 | 5577 | 25468 | 3873 | 27831 | 3113 | 29052 | 2466 | 30811 | 1432 | 36821 | 899 | 30469 |
| 10-#18 | 3.40 | MA | 20024 | 5577 | 34043 | 4035 | 37310 | 3260 | 38764 | 2617 | 40228 | 1595 | 49762 | 819 | 43106 |
| 5L-2S | | MI | 15861 | 5577 | 27396 | 3888 | 30252 | 3095 | 31936 | 2449 | 34622 | 1414 | 41753 | 1127 | 30605 |
| 12-#11 | 1.59 | MA | 21086 | 4822 | 33604 | 3576 | 36967 | 2901 | 38440 | 2396 | 39946 | 1656 | 48065 | 1551 | 23739 |
| 2L-6S | | MI | 12242 | 4822 | 19820 | 3464 | 20904 | 2815 | 20924 | 2325 | 20102 | 1579 | 23522 | 1145 | 14679 |
| 12-#11 | 1.59 | MA | 20251 | 4822 | 32339 | 3575 | 35354 | 2899 | 36479 | 2406 | 37289 | 1664 | 44489 | 1462 | 23734 |
| 3L-5S | | MI | 12561 | 4822 | 20350 | 3468 | 21622 | 2821 | 21753 | 2319 | 21200 | 1572 | 24859 | 1205 | 15052 |
| 12-#11 | 1.59 | MA | 19662 | 4822 | 31323 | 3588 | 34063 | 2911 | 34912 | 2403 | 35255 | 1672 | 42145 | 1373 | 23667 |
| 4E | | MI | 12896 | 4822 | 20910 | 3473 | 22344 | 2813 | 22621 | 2312 | 22396 | 1579 | 26293 | 1245 | 15212 |
| 12-#11 | 1.59 | MA | 19135 | 4822 | 30433 | 3587 | 32915 | 2909 | 33506 | 2413 | 33249 | 1666 | 39700 | 1329 | 23347 |
| 5L-3S | | MI | 13266 | 4822 | 21545 | 3463 | 23151 | 2820 | 23585 | 2319 | 23607 | 1572 | 27641 | 1331 | 15192 |
| 12-#11 | 1.59 | MA | 18632 | 4822 | 29594 | 3587 | 31775 | 2921 | 32115 | 2410 | 31407 | 1673 | 37373 | 1271 | 22561 |
| 6L-2S | | MI | 13778 | 4822 | 22326 | 3467 | 24147 | 2812 | 24781 | 2312 | 25186 | 1565 | 29708 | 1420 | 15158 |
| 12-#14 | 2.30 | MA | 22567 | 5116 | 36928 | 3748 | 41140 | 3025 | 43487 | 2470 | 46773 | 1632 | 57051 | 1494 | 33768 |
| 2L-6S | | MI | 12473 | 5116 | 20779 | 3626 | 22048 | 2931 | 22265 | 2392 | 21871 | 1535 | 25992 | 925 | 19865 |
| 12-#14 | 2.30 | MA | 21391 | 5116 | 35117 | 3746 | 38831 | 3041 | 40681 | 2485 | 42971 | 1642 | 51966 | 1366 | 33683 |
| 3L-5S | | MI | 12924 | 5116 | 21536 | 3633 | 23074 | 2941 | 23437 | 2382 | 23423 | 1525 | 27873 | 1011 | 20398 |
| 12-#14 | 2.30 | MA | 20562 | 5116 | 33662 | 3765 | 36981 | 3038 | 38435 | 2479 | 40056 | 1652 | 48638 | 1238 | 33430 |
| 4E | | MI | 13395 | 5116 | 22336 | 3640 | 24104 | 2931 | 24664 | 2372 | 25115 | 1535 | 29893 | 1070 | 21280 |
| 12-#14 | 2.30 | MA | 19819 | 5116 | 32386 | 3763 | 35335 | 3054 | 36420 | 2493 | 37181 | 1643 | 45153 | 1175 | 31920 |
| 5L-3S | | MI | 13917 | 5116 | 23243 | 3627 | 25256 | 2941 | 26028 | 2382 | 26827 | 1525 | 31794 | 1192 | 21363 |
| 12-#14 | 2.30 | MA | 19111 | 5116 | 31182 | 3761 | 33700 | 3050 | 34425 | 2488 | 34540 | 1653 | 41847 | 1091 | 30948 |
| 6L-2S | | MI | 14637 | 5116 | 24355 | 3634 | 26675 | 2931 | 27718 | 2372 | 29059 | 1515 | 34706 | 1320 | 21352 |
| 12-#18 | 4.08 | MA | 22728 | 5861 | 39454 | 4217 | 44241 | 3362 | 47214 | 2674 | 51833 | 1592 | 64590 | 878 | 54736 |
| 4E | | MI | 14578 | 5861 | 25818 | 4071 | 28283 | 3220 | 29607 | 2519 | 31701 | 1410 | 38522 | 602 | 33997 |
| 12-#18 | 4.08 | MA | 21472 | 5861 | 37212 | 4212 | 41350 | 3389 | 43675 | 2697 | 46834 | 1575 | 58546 | 770 | 52106 |
| 5L-3S | | MI | 15460 | 5861 | 27396 | 4050 | 30252 | 3238 | 31936 | 2537 | 34622 | 1393 | 41753 | 813 | 36242 |
| 12-#18 | 4.08 | MA | 20274 | 5861 | 35095 | 4208 | 38476 | 3380 | 40170 | 2685 | 42242 | 1592 | 52842 | 619 | 48208 |
| 6L-2S | | MI | 16674 | 5861 | 29323 | 4065 | 32673 | 3220 | 34820 | 2519 | 38433 | 1375 | 46685 | 1040 | 36447 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis

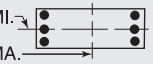


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.86 | MA | 21672 | 4933 | 34869 | 3645 | 38580 | 2952 | 40400 | 2427 | 42602 | 1649 | 51641 | 1535 | 27597 |
| 2L-7S | | MI | 12286 | 4933 | 20034 | 3543 | 21210 | 2872 | 21258 | 2348 | 20607 | 1574 | 24328 | 1051 | 16648 |
| 14-#11 | 1.86 | MA | 20841 | 4933 | 33604 | 3644 | 36967 | 2949 | 38440 | 2437 | 39946 | 1657 | 48065 | 1447 | 27570 |
| 3L-6S | | MI | 12597 | 4933 | 20601 | 3533 | 21900 | 2865 | 22120 | 2355 | 21681 | 1567 | 25590 | 1117 | 16970 |
| 14-#11 | 1.86 | MA | 20257 | 4933 | 32588 | 3657 | 35676 | 2961 | 36873 | 2434 | 37911 | 1665 | 45722 | 1358 | 27482 |
| 4L-5S | | MI | 12915 | 4933 | 21131 | 3538 | 22618 | 2871 | 22949 | 2348 | 22779 | 1560 | 26927 | 1177 | 17317 |
| 14-#11 | 1.86 | MA | 19734 | 4933 | 31699 | 3657 | 34528 | 2959 | 35467 | 2444 | 35906 | 1659 | 43276 | 1314 | 27040 |
| 5L-4S | | MI | 13248 | 4933 | 21691 | 3542 | 23340 | 2863 | 23816 | 2341 | 23975 | 1567 | 28361 | 1217 | 17585 |
| 14-#11 | 1.86 | MA | 19235 | 4933 | 30859 | 3656 | 33388 | 2971 | 34076 | 2441 | 34064 | 1667 | 40949 | 1256 | 26290 |
| 6L-3S | | MI | 13616 | 4933 | 22326 | 3532 | 24147 | 2870 | 24781 | 2348 | 25186 | 1560 | 29708 | 1303 | 17584 |
| 14-#11 | 1.86 | MA | 18748 | 4933 | 29961 | 3669 | 32293 | 2969 | 32733 | 2451 | 32261 | 1674 | 38528 | 1168 | 25687 |
| 7L-2S | | MI | 14126 | 4933 | 23107 | 3536 | 25143 | 2862 | 25977 | 2341 | 26765 | 1553 | 31776 | 1392 | 17559 |
| 14-#14 | 2.68 | MA | 22218 | 5275 | 36928 | 3846 | 41140 | 3114 | 43487 | 2530 | 46773 | 1632 | 57051 | 1342 | 39147 |
| 3L-6S | | MI | 12972 | 5275 | 21891 | 3726 | 23466 | 3003 | 23955 | 2434 | 24103 | 1515 | 28905 | 882 | 22998 |
| 14-#14 | 2.68 | MA | 21397 | 5275 | 35473 | 3864 | 39289 | 3110 | 41241 | 2524 | 43858 | 1642 | 53723 | 1214 | 38857 |
| 4L-5S | | MI | 13420 | 5275 | 22648 | 3733 | 24492 | 3013 | 25127 | 2424 | 25655 | 1505 | 30786 | 969 | 23631 |
| 14-#14 | 2.68 | MA | 20661 | 5275 | 34197 | 3863 | 37644 | 3126 | 39226 | 2538 | 40983 | 1633 | 50239 | 1152 | 37224 |
| 5L-4S | | MI | 13887 | 5275 | 23448 | 3740 | 25522 | 3003 | 26354 | 2414 | 27348 | 1515 | 32805 | 1027 | 24449 |
| 14-#14 | 2.68 | MA | 19960 | 5275 | 32993 | 3861 | 36008 | 3123 | 37231 | 2533 | 38342 | 1643 | 46932 | 1067 | 36195 |
| 6L-3S | | MI | 14405 | 5275 | 24355 | 3727 | 26675 | 3013 | 27718 | 2424 | 29059 | 1505 | 34706 | 1150 | 24734 |
| 14-#14 | 2.68 | MA | 19275 | 5275 | 31704 | 3879 | 34437 | 3139 | 35306 | 2547 | 35757 | 1653 | 43490 | 941 | 34437 |
| 7L-2S | | MI | 15120 | 5275 | 25468 | 3733 | 28093 | 3003 | 29408 | 2414 | 31292 | 1496 | 37619 | 1278 | 24752 |
| 14-#18 | 4.76 | MA | 22901 | 6144 | 40381 | 4390 | 45390 | 3517 | 48587 | 2777 | 53440 | 1554 | 67330 | 722 | 61139 |
| 5L-4S | | MI | 15405 | 6144 | 27745 | 4248 | 30704 | 3345 | 32491 | 2589 | 35512 | 1371 | 43454 | 516 | 39521 |
| 14-#18 | 4.76 | MA | 21719 | 6144 | 38264 | 4385 | 42516 | 3509 | 45081 | 2764 | 48847 | 1572 | 61625 | 571 | 57389 |
| 6L-3S | | MI | 16278 | 6144 | 29323 | 4227 | 32673 | 3363 | 34820 | 2607 | 38433 | 1353 | 46685 | 726 | 42003 |
| 14-#18 | 4.76 | MA | 20566 | 6144 | 35999 | 4416 | 39755 | 3536 | 41699 | 2787 | 44353 | 1590 | 55684 | 346 | 53205 |
| 7L-2S | | MI | 17481 | 6144 | 31251 | 4242 | 35094 | 3345 | 37704 | 2589 | 42244 | 1335 | 51616 | 954 | 42272 |
| 16-#11 | 2.12 | MA | 21427 | 5044 | 34869 | 3713 | 38580 | 3000 | 40400 | 2468 | 42602 | 1650 | 51641 | 1432 | 31401 |
| 3L-7S | | MI | 12641 | 5044 | 20816 | 3612 | 22206 | 2923 | 22453 | 2378 | 22186 | 1562 | 26396 | 1023 | 18881 |
| 16-#11 | 2.12 | MA | 20847 | 5044 | 33854 | 3726 | 37289 | 3011 | 38833 | 2465 | 40568 | 1658 | 49298 | 1343 | 31294 |
| 4L-6S | | MI | 12950 | 5044 | 21382 | 3603 | 22896 | 2915 | 23315 | 2385 | 23260 | 1555 | 27658 | 1090 | 19266 |
| 16-#11 | 2.12 | MA | 20327 | 5044 | 32964 | 3726 | 36141 | 3009 | 37428 | 2475 | 38562 | 1652 | 46852 | 1299 | 30743 |
| 5E | | MI | 13267 | 5044 | 21912 | 3607 | 23614 | 2921 | 24144 | 2378 | 24358 | 1548 | 28995 | 1149 | 19591 |
| 16-#11 | 2.12 | MA | 19832 | 5044 | 32124 | 3725 | 35001 | 3021 | 36037 | 2472 | 36720 | 1660 | 44526 | 1241 | 30026 |
| 6L-4S | | MI | 13597 | 5044 | 22472 | 3611 | 24335 | 2914 | 25012 | 2371 | 25554 | 1555 | 30429 | 1190 | 19951 |
| 16-#11 | 2.12 | MA | 19349 | 5044 | 31226 | 3738 | 33906 | 3019 | 34694 | 2482 | 34917 | 1667 | 42104 | 1153 | 29362 |
| 7L-3S | | MI | 13963 | 5044 | 23107 | 3601 | 25143 | 2920 | 25977 | 2378 | 26765 | 1548 | 31776 | 1276 | 19969 |
| 16-#11 | 2.12 | MA | 18872 | 5044 | 30402 | 3737 | 32800 | 3030 | 33380 | 2493 | 33029 | 1661 | 39819 | 1102 | 28413 |
| 8L-2S | | MI | 14471 | 5044 | 23888 | 3605 | 26139 | 2912 | 27172 | 2371 | 28344 | 1541 | 33844 | 1365 | 19953 |
| 16-#14 | 3.06 | MA | 22224 | 5435 | 37283 | 3964 | 41598 | 3182 | 44048 | 2569 | 47660 | 1632 | 58809 | 1190 | 44195 |
| 4L-6S | | MI | 13468 | 5435 | 23004 | 3826 | 24884 | 3076 | 25645 | 2476 | 26336 | 1496 | 31817 | 840 | 26146 |
| 16-#14 | 3.06 | MA | 21495 | 5435 | 36008 | 3963 | 39952 | 3199 | 42033 | 2583 | 44785 | 1623 | 55324 | 1128 | 42541 |
| 5E | | MI | 13912 | 5435 | 23761 | 3833 | 25910 | 3086 | 26817 | 2466 | 27888 | 1486 | 33698 | 926 | 26873 |
| 16-#14 | 3.06 | MA | 20800 | 5435 | 34803 | 3961 | 38317 | 3195 | 40038 | 2577 | 42144 | 1633 | 52017 | 1044 | 41420 |
| 6L-4S | | MI | 14376 | 5435 | 24561 | 3839 | 26941 | 3076 | 28044 | 2456 | 29580 | 1496 | 35718 | 985 | 27636 |
| 16-#14 | 3.06 | MA | 20122 | 5435 | 33515 | 3979 | 36746 | 3211 | 38113 | 2592 | 39558 | 1643 | 48576 | 917 | 39720 |
| 7L-3S | | MI | 14890 | 5435 | 25468 | 3826 | 28093 | 3086 | 29408 | 2466 | 31292 | 1486 | 37619 | 1107 | 28096 |
| 16-#14 | 3.06 | MA | 19454 | 5435 | 32332 | 3978 | 35161 | 3208 | 36228 | 2606 | 36851 | 1634 | 45320 | 845 | 37942 |
| 8L-2S | | MI | 15601 | 5435 | 26580 | 3833 | 29511 | 3076 | 31098 | 2456 | 33525 | 1476 | 40531 | 1235 | 28140 |
| 16-#18 | 5.44 | MA | 23146 | 6428 | 41433 | 4562 | 46556 | 3637 | 49993 | 2844 | 55453 | 1552 | 70409 | 522 | 66594 |
| 6L-4S | | MI | 16224 | 6428 | 29673 | 4425 | 33125 | 3471 | 35376 | 2660 | 39323 | 1331 | 48386 | 430 | 45070 |
| 16-#18 | 5.44 | MA | 22009 | 6428 | 39168 | 4593 | 43795 | 3664 | 46610 | 2867 | 50959 | 1569 | 64468 | 297 | 62318 |
| 7L-3S | | MI | 17089 | 6428 | 31251 | 4405 | 35094 | 3488 | 37704 | 2677 | 42244 | 1314 | 51616 | 640 | 47535 |
| 18-#11 | 2.39 | MA | 21433 | 5154 | 35119 | 3796 | 38902 | 3061 | 40794 | 2496 | 43224 | 1651 | 52874 | 1328 | 35103 |
| 4L-7S | | MI | 12994 | 5154 | 21597 | 3681 | 23201 | 2973 | 23649 | 2408 | 23765 | 1549 | 28464 | 996 | 21124 |
| 18-#11 | 2.39 | MA | 20917 | 5154 | 34229 | 3795 | 37754 | 3059 | 39389 | 2506 | 41219 | 1645 | 50429 | 1284 | 34456 |
| 5L-6S | | MI | 13301 | 5154 | 22163 | 3672 | 23892 | 2965 | 24511 | 2415 | 24839 | 1542 | 29726 | 1062 | 21567 |

## RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis



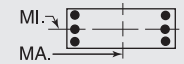

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.39 | MA | 20425 | 5154 | 33389 | 3794 | 36614 | 3071 | 37997 | 2503 | 39377 | 1653 | 48102 | 1226 | 33768 |
| 6L-5S | | MI | 13616 | 5154 | 22693 | 3676 | 24610 | 2971 | 25340 | 2408 | 25937 | 1535 | 31062 | 1122 | 21872 |
| 18-#11 | 2.39 | MA | 19945 | 5154 | 32491 | 3807 | 35519 | 3069 | 36655 | 2513 | 37574 | 1661 | 45681 | 1138 | 33045 |
| 7L-4S | | MI | 13945 | 5154 | 23253 | 3680 | 25331 | 2964 | 26208 | 2401 | 27134 | 1542 | 32496 | 1162 | 22312 |
| 18-#11 | 2.39 | MA | 19472 | 5154 | 31667 | 3806 | 34413 | 3081 | 35341 | 2524 | 35686 | 1654 | 43395 | 1087 | 32125 |
| 8L-3S | | MI | 14309 | 5154 | 23888 | 3670 | 26139 | 2970 | 27172 | 2408 | 28344 | 1535 | 33844 | 1248 | 22344 |
| 18-#11 | 2.39 | MA | 18992 | 5154 | 30795 | 3819 | 33333 | 3078 | 33981 | 2520 | 33902 | 1662 | 41141 | 1031 | 31095 |
| 9L-2S | | MI | 14814 | 5154 | 24669 | 3675 | 27135 | 2962 | 28368 | 2401 | 29924 | 1529 | 35912 | 1337 | 22341 |
| 18-#14 | 3.44 | MA | 22322 | 5595 | 37818 | 4062 | 42261 | 3271 | 44839 | 2628 | 48587 | 1613 | 60409 | 1105 | 47868 |
| 5L-6S | | MI | 13959 | 5595 | 24116 | 3926 | 26303 | 3148 | 27336 | 2517 | 28569 | 1477 | 34729 | 797 | 29308 |
| 18-#14 | 3.44 | MA | 21633 | 5595 | 36614 | 4061 | 40625 | 3267 | 42844 | 2622 | 45945 | 1623 | 57103 | 1020 | 46658 |
| 6L-5S | | MI | 14400 | 5595 | 24873 | 3932 | 27329 | 3158 | 28508 | 2508 | 30120 | 1467 | 36610 | 883 | 30124 |
| 18-#14 | 3.44 | MA | 20961 | 5595 | 35325 | 4079 | 39054 | 3284 | 40919 | 2637 | 43360 | 1633 | 53661 | 894 | 45013 |
| 7L-4S | | MI | 14861 | 5595 | 25673 | 3939 | 28359 | 3148 | 29734 | 2498 | 31813 | 1477 | 38630 | 942 | 30838 |
| 18-#14 | 3.44 | MA | 20299 | 5595 | 34143 | 4077 | 37469 | 3280 | 39034 | 2651 | 40653 | 1624 | 50405 | 821 | 43183 |
| 8L-3S | | MI | 15372 | 5595 | 26580 | 3926 | 29511 | 3158 | 31098 | 2508 | 33525 | 1467 | 40531 | 1064 | 31451 |
| 18-#14 | 3.44 | MA | 19628 | 5595 | 32892 | 4095 | 35920 | 3296 | 37084 | 2645 | 38094 | 1634 | 47202 | 740 | 41224 |
| 9L-2S | | MI | 16078 | 5595 | 27693 | 3933 | 30930 | 3148 | 32788 | 2498 | 35757 | 1457 | 43443 | 1192 | 31516 |
| 18-#18 | 6.12 | MA | 23435 | 6712 | 42337 | 4770 | 47835 | 3793 | 51521 | 2947 | 57564 | 1549 | 73251 | 249 | 71452 |
| 7L-4S | | MI | 17038 | 6712 | 31601 | 4603 | 35546 | 3596 | 38260 | 2730 | 43133 | 1292 | 53318 | 343 | 50639 |
| 20-#11 | 2.65 | MA | 21502 | 5265 | 35494 | 3864 | 39367 | 3109 | 41350 | 2538 | 43875 | 1638 | 54005 | 1269 | 38176 |
| 5L-7S | | MI | 13345 | 5265 | 22378 | 3751 | 24197 | 3023 | 24845 | 2438 | 25344 | 1537 | 30531 | 968 | 23373 |
| 20-#11 | 2.65 | MA | 21014 | 5265 | 34655 | 3863 | 38227 | 3121 | 39958 | 2534 | 42033 | 1646 | 51678 | 1210 | 37514 |
| 6E | | MI | 13651 | 5265 | 22944 | 3741 | 24888 | 3015 | 25706 | 2445 | 26418 | 1530 | 31793 | 1035 | 23870 |
| 20-#11 | 2.65 | MA | 20537 | 5265 | 33756 | 3876 | 37132 | 3119 | 38616 | 2545 | 40230 | 1654 | 49257 | 1123 | 36735 |
| 7L-5S | | MI | 13963 | 5265 | 23474 | 3745 | 25606 | 3021 | 26535 | 2438 | 27516 | 1523 | 33130 | 1094 | 24159 |
| 20-#11 | 2.65 | MA | 20067 | 5265 | 32932 | 3875 | 36026 | 3131 | 37302 | 2555 | 38342 | 1648 | 46971 | 1072 | 35841 |
| 8L-4S | | MI | 14290 | 5265 | 24034 | 3749 | 26327 | 3014 | 27403 | 2431 | 28713 | 1530 | 34564 | 1135 | 24668 |
| 20-#11 | 2.65 | MA | 19589 | 5265 | 32060 | 3888 | 34946 | 3129 | 35942 | 2551 | 36558 | 1655 | 44717 | 1016 | 34777 |
| 9L-3S | | MI | 14653 | 5265 | 24669 | 3740 | 27135 | 3020 | 28368 | 2438 | 29924 | 1523 | 35912 | 1221 | 24713 |
| 20-#11 | 2.65 | MA | 19064 | 5265 | 31240 | 3888 | 33855 | 3140 | 34636 | 2562 | 34787 | 1663 | 42531 | 952 | 33758 |
| 10L-2S | | MI | 15155 | 5265 | 25450 | 3744 | 28130 | 3012 | 29563 | 2431 | 31503 | 1516 | 37979 | 1310 | 24726 |
| 20-#14 | 3.83 | MA | 22459 | 5754 | 38425 | 4160 | 42934 | 3340 | 45650 | 2667 | 49747 | 1613 | 62188 | 996 | 51907 |
| 6E | | MI | 14447 | 5754 | 25229 | 4025 | 27721 | 3220 | 29026 | 2559 | 30801 | 1458 | 37642 | 755 | 32483 |
| 20-#14 | 3.83 | MA | 21793 | 5754 | 37136 | 4179 | 41363 | 3356 | 43725 | 2681 | 47162 | 1623 | 58746 | 870 | 50314 |
| 7L-5S | | MI | 14885 | 5754 | 25986 | 4032 | 28747 | 3230 | 30198 | 2549 | 32353 | 1448 | 39523 | 841 | 33381 |
| 20-#14 | 3.83 | MA | 21137 | 5754 | 35954 | 4177 | 39778 | 3352 | 41840 | 2696 | 44455 | 1614 | 55490 | 797 | 48434 |
| 8L-4S | | MI | 15343 | 5754 | 26786 | 4039 | 29777 | 3220 | 31424 | 2539 | 34045 | 1458 | 41542 | 899 | 34052 |
| 20-#14 | 3.83 | MA | 20468 | 5754 | 34703 | 4195 | 38229 | 3369 | 39890 | 2690 | 41896 | 1624 | 52287 | 716 | 46443 |
| 9L-3S | | MI | 15851 | 5754 | 27693 | 4026 | 30930 | 3230 | 32788 | 2549 | 35757 | 1448 | 43443 | 1022 | 34801 |
| 22-#11 | 2.92 | MA | 21598 | 5375 | 35920 | 3932 | 39840 | 3171 | 41919 | 2565 | 44690 | 1639 | 55254 | 1195 | 41264 |
| 6L-7S | | MI | 13694 | 5375 | 23159 | 3820 | 25193 | 3073 | 26040 | 2468 | 26924 | 1525 | 32599 | 941 | 25628 |
| 22-#11 | 2.92 | MA | 21125 | 5375 | 35021 | 3945 | 38745 | 3169 | 40577 | 2576 | 42887 | 1647 | 52833 | 1108 | 40431 |
| 7L-6S | | MI | 13998 | 5375 | 23725 | 3810 | 25884 | 3065 | 26902 | 2474 | 27998 | 1518 | 33861 | 1007 | 26176 |
| 22-#11 | 2.92 | MA | 20658 | 5375 | 34197 | 3945 | 37639 | 3181 | 39263 | 2586 | 40999 | 1641 | 50548 | 1057 | 39562 |
| 8L-5S | | MI | 14309 | 5375 | 24255 | 3814 | 26602 | 3072 | 27731 | 2468 | 29095 | 1511 | 35198 | 1067 | 26451 |
| 22-#11 | 2.92 | MA | 20181 | 5375 | 33325 | 3958 | 36560 | 3179 | 37903 | 2583 | 39215 | 1648 | 48294 | 1000 | 38464 |
| 9L-4S | | MI | 14634 | 5375 | 24815 | 3818 | 27323 | 3064 | 28599 | 2461 | 30292 | 1518 | 36632 | 1107 | 27021 |
| 22-#11 | 2.92 | MA | 19662 | 5375 | 32505 | 3957 | 35468 | 3190 | 36597 | 2593 | 37444 | 1656 | 46108 | 937 | 37419 |
| 10L-3S | | MI | 14995 | 5375 | 25450 | 3809 | 28130 | 3070 | 29563 | 2468 | 31503 | 1511 | 37979 | 1193 | 27079 |
| 22-#11 | 2.92 | MA | 19158 | 5375 | 31696 | 3956 | 34395 | 3188 | 35253 | 2590 | 35582 | 1650 | 43876 | 883 | 36086 |
| 11L-2S | | MI | 15495 | 5375 | 26231 | 3813 | 29126 | 3063 | 30759 | 2461 | 33082 | 1504 | 40047 | 1282 | 27102 |
| 22-#14 | 4.21 | MA | 22618 | 5914 | 38947 | 4278 | 43671 | 3428 | 46531 | 2726 | 50964 | 1614 | 63831 | 846 | 55622 |
| 7L-6S | | MI | 14933 | 5914 | 26341 | 4125 | 29139 | 3293 | 30716 | 2601 | 33034 | 1439 | 40554 | 712 | 35668 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 4.21 | MA | 21967 | 5914 | 37764 | 4277 | 42086 | 3425 | 44647 | 2741 | 48256 | 1604 | 60576 | 774 | 53693 |
| 8L-5S | | MI | 15368 | 5914 | 27098 | 4132 | 30165 | 3303 | 31888 | 2591 | 34585 | 1429 | 42435 | 798 | 36644 |
| 22-#14 | 4.21 | MA | 21300 | 5914 | 36513 | 4295 | 40537 | 3441 | 42697 | 2735 | 45698 | 1614 | 57372 | 692 | 51670 |
| 9L-4S | | MI | 15823 | 5914 | 27898 | 4139 | 31196 | 3293 | 33115 | 2581 | 36278 | 1439 | 44455 | 857 | 37276 |
| 24-#11 | 3.18 | MA | 21709 | 5486 | 36286 | 4014 | 40358 | 3219 | 42538 | 2607 | 45544 | 1640 | 56409 | 1093 | 44133 |
| 7E | | MI | 14041 | 5486 | 23940 | 3889 | 26189 | 3123 | 27236 | 2497 | 28503 | 1512 | 34667 | 913 | 27889 |
| 24-#11 | 3.18 | MA | 21246 | 5486 | 35462 | 4014 | 39252 | 3231 | 41224 | 2617 | 43655 | 1634 | 54124 | 1042 | 43288 |
| 8L-6S | | MI | 14343 | 5486 | 24507 | 3879 | 26879 | 3116 | 28097 | 2504 | 29577 | 1505 | 35929 | 980 | 28484 |
| 24-#11 | 3.18 | MA | 20769 | 5486 | 34590 | 4027 | 38173 | 3229 | 39864 | 2614 | 41871 | 1642 | 51870 | 985 | 42156 |
| 9L-5S | | MI | 14653 | 5486 | 25036 | 3883 | 27598 | 3122 | 28926 | 2497 | 30674 | 1499 | 37266 | 1039 | 28746 |
| 24-#11 | 3.18 | MA | 20266 | 5486 | 33770 | 4026 | 37081 | 3241 | 38558 | 2624 | 40101 | 1649 | 49684 | 922 | 41018 |
| 10L-4S | | MI | 14976 | 5486 | 25596 | 3888 | 28319 | 3114 | 29794 | 2490 | 31871 | 1505 | 38700 | 1080 | 29322 |
| 24-#11 | 3.18 | MA | 19755 | 5486 | 32961 | 4025 | 36008 | 3238 | 37214 | 2621 | 38238 | 1643 | 47453 | 868 | 39777 |
| 11L-3S | | MI | 15335 | 5486 | 26231 | 3878 | 29126 | 3120 | 30759 | 2497 | 33082 | 1499 | 40047 | 1166 | 29440 |
| 24-#14 | 4.59 | MA | 22792 | 6073 | 39575 | 4376 | 44395 | 3497 | 47453 | 2786 | 52058 | 1594 | 65661 | 750 | 58960 |
| 8L-6S | | MI | 15415 | 6073 | 27454 | 4225 | 30558 | 3365 | 32406 | 2643 | 35266 | 1419 | 43467 | 669 | 38862 |
| 24-#14 | 4.59 | MA | 22125 | 6073 | 38324 | 4395 | 42846 | 3513 | 45503 | 2780 | 49500 | 1604 | 62458 | 669 | 56904 |
| 9L-5S | | MI | 15847 | 6073 | 28211 | 4232 | 31584 | 3375 | 33578 | 2633 | 36818 | 1409 | 45347 | 756 | 39911 |

## RECTANGULAR TIED COLUMNS 28" x 44"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.30 | MA | 22345 | 4924 | 35352 | 3643 | 38481 | 2962 | 39592 | 2457 | 40263 | 1728 | 47729 | 1617 | 21184 |
| 2E | | MI | 13923 | 4924 | 22458 | 3499 | 23853 | 2837 | 24117 | 2338 | 23931 | 1610 | 27770 | 1460 | 12894 |
| 6-#14 | 1.10 | MA | 21924 | 4835 | 34285 | 3610 | 37257 | 2941 | 38156 | 2448 | 38377 | 1748 | 45387 | 1653 | 18110 |
| 2L-3S | | MI | 12981 | 4835 | 20747 | 3472 | 21866 | 2843 | 21795 | 2357 | 20875 | 1660 | 23877 | 1395 | 11180 |
| 6-#14 | 1.10 | MA | 20648 | 4835 | 32375 | 3609 | 34821 | 2937 | 35195 | 2463 | 34366 | 1759 | 39990 | 1525 | 18147 |
| 3L-2S | | MI | 13717 | 4835 | 21860 | 3479 | 23285 | 2833 | 23485 | 2347 | 23108 | 1650 | 26790 | 1523 | 11100 |
| 6-#18 | 1.95 | MA | 23885 | 5207 | 38698 | 3820 | 42747 | 3091 | 44778 | 2537 | 47270 | 1710 | 57066 | 1572 | 31410 |
| 2L-3S | | MI | 13512 | 5207 | 22458 | 3661 | 23853 | 2980 | 24117 | 2426 | 23931 | 1588 | 27770 | 1146 | 18926 |
| 6-#18 | 1.95 | MA | 21696 | 5207 | 35352 | 3816 | 38481 | 3118 | 39592 | 2561 | 40263 | 1727 | 47729 | 1344 | 31234 |
| 3L-2S | | MI | 14766 | 5207 | 24386 | 3676 | 26274 | 2962 | 27001 | 2408 | 27742 | 1570 | 32702 | 1373 | 18865 |
| 8-#11 | 1.01 | MA | 21751 | 4799 | 33837 | 3599 | 36754 | 2934 | 37571 | 2446 | 37597 | 1756 | 44437 | 1669 | 16844 |
| 2L-4S | | MI | 12740 | 4799 | 20187 | 3480 | 21217 | 2833 | 21068 | 2354 | 19986 | 1682 | 22981 | 1375 | 10462 |
| 8-#11 | 1.01 | MA | 20856 | 4799 | 32502 | 3598 | 35053 | 2932 | 35503 | 2457 | 34795 | 1765 | 40644 | 1580 | 16876 |
| 3E | | MI | 13115 | 4799 | 20823 | 3470 | 22025 | 2839 | 22033 | 2361 | 21197 | 1675 | 24329 | 1461 | 10407 |
| 8-#11 | 1.01 | MA | 20226 | 4799 | 31433 | 3611 | 33693 | 2944 | 33852 | 2454 | 32651 | 1773 | 38156 | 1491 | 16863 |
| 4L-2S | | MI | 13633 | 4799 | 21604 | 3474 | 23021 | 2831 | 23228 | 2354 | 22776 | 1668 | 26397 | 1550 | 10355 |
| 8-#14 | 1.46 | MA | 22820 | 4995 | 36196 | 3710 | 39692 | 3013 | 41116 | 2493 | 42389 | 1738 | 50784 | 1631 | 23955 |
| 2L-4S | | MI | 12953 | 4995 | 20953 | 3585 | 22132 | 2905 | 22121 | 2389 | 21396 | 1651 | 24889 | 1230 | 14640 |
| 8-#14 | 1.46 | MA | 21554 | 4995 | 34285 | 3708 | 37257 | 3010 | 38156 | 2508 | 38377 | 1749 | 45387 | 1503 | 23947 |
| 3E | | MI | 13483 | 4995 | 21860 | 3572 | 23285 | 2915 | 23485 | 2399 | 23108 | 1641 | 26790 | 1352 | 14613 |
| 8-#14 | 1.46 | MA | 20662 | 4995 | 32752 | 3727 | 35307 | 3027 | 35789 | 2503 | 35305 | 1760 | 41851 | 1375 | 23783 |
| 4L-2S | | MI | 14214 | 4995 | 22972 | 3579 | 24703 | 2905 | 25175 | 2389 | 25340 | 1631 | 29702 | 1480 | 14552 |
| 8-#18 | 2.60 | MA | 25399 | 5491 | 42045 | 3997 | 47014 | 3219 | 49965 | 2617 | 54276 | 1691 | 66404 | 1526 | 41578 |
| 2L-4S | | MI | 13453 | 5491 | 22808 | 3859 | 24306 | 3087 | 24673 | 2478 | 24820 | 1566 | 29472 | 849 | 23293 |
| 8-#18 | 2.60 | MA | 23240 | 5491 | 38698 | 3993 | 42747 | 3247 | 44778 | 2641 | 47270 | 1709 | 57066 | 1299 | 41289 |
| 3E | | MI | 14357 | 5491 | 24386 | 3838 | 26274 | 3105 | 27001 | 2496 | 27742 | 1548 | 32702 | 1060 | 24755 |
| 8-#18 | 2.60 | MA | 21715 | 5491 | 36006 | 4025 | 39324 | 3239 | 40623 | 2630 | 41894 | 1726 | 50963 | 1071 | 38739 |
| 4L-2S | | MI | 15598 | 5491 | 26314 | 3853 | 28695 | 3087 | 29886 | 2478 | 31553 | 1531 | 37634 | 1287 | 24783 |
| 10-#11 | 1.27 | MA | 22382 | 4910 | 35171 | 3668 | 38455 | 2984 | 39639 | 2477 | 40398 | 1750 | 48229 | 1655 | 20928 |
| 2L-5S | | MI | 12760 | 4910 | 20409 | 3545 | 21492 | 2890 | 21396 | 2390 | 20369 | 1663 | 23615 | 1308 | 12876 |
| 10-#11 | 1.27 | MA | 21493 | 4910 | 33837 | 3667 | 36754 | 2982 | 37571 | 2488 | 37597 | 1758 | 44437 | 1566 | 20945 |
| 3L-4S | | MI | 13097 | 4910 | 20968 | 3549 | 22213 | 2883 | 22264 | 2383 | 21565 | 1670 | 25049 | 1348 | 12865 |
| 10-#11 | 1.27 | MA | 20868 | 4910 | 32767 | 3680 | 35394 | 2994 | 35920 | 2485 | 35453 | 1766 | 41949 | 1477 | 20900 |
| 4L-3S | | MI | 13469 | 4910 | 21604 | 3539 | 23021 | 2889 | 23228 | 2390 | 22776 | 1663 | 26397 | 1434 | 12825 |
| 10-#11 | 1.27 | MA | 20308 | 4910 | 31830 | 3680 | 34186 | 2992 | 34440 | 2496 | 33341 | 1761 | 39360 | 1433 | 20753 |
| 5L-2S | | MI | 13985 | 4910 | 22385 | 3543 | 24016 | 2881 | 24424 | 2383 | 24355 | 1656 | 28464 | 1523 | 12780 |

## RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

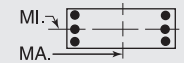
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.83 | MA | 23705 | 5154 | 38106 | 3809 | 42128 | 3085 | 44077 | 2538 | 46400 | 1728 | 56181 | 1609 | 29783 |
| 2L-5S | | MI | 12978 | 5154 | 21265 | 3678 | 22520 | 2988 | 22584 | 2441 | 21936 | 1622 | 25782 | 1129 | 17324 |
| 10-#14 | 1.83 | MA | 22451 | 5154 | 36196 | 3808 | 39692 | 3082 | 41116 | 2553 | 42389 | 1739 | 50784 | 1481 | 29732 |
| 3L-4S | | MI | 13454 | 5154 | 22065 | 3685 | 23551 | 2978 | 23811 | 2431 | 23628 | 1631 | 27801 | 1188 | 18008 |
| 10-#14 | 1.83 | MA | 21567 | 5154 | 34662 | 3827 | 37743 | 3099 | 38750 | 2548 | 39316 | 1750 | 47248 | 1353 | 29520 |
| 4L-3S | | MI | 13980 | 5154 | 22972 | 3672 | 24703 | 2988 | 25175 | 2441 | 25340 | 1622 | 29702 | 1310 | 18023 |
| 10-#14 | 1.83 | MA | 20776 | 5154 | 33318 | 3826 | 36009 | 3096 | 36627 | 2563 | 36288 | 1742 | 43556 | 1290 | 28193 |
| 5L-2S | | MI | 14706 | 5154 | 24085 | 3678 | 26121 | 2978 | 26865 | 2431 | 27573 | 1612 | 32614 | 1438 | 17982 |
| 10-#18 | 3.25 | MA | 24759 | 5775 | 42045 | 4171 | 47014 | 3376 | 49965 | 2721 | 54276 | 1690 | 66404 | 1254 | 51332 |
| 3L-4S | | MI | 14298 | 5775 | 24735 | 4036 | 26727 | 3213 | 27557 | 2549 | 28631 | 1527 | 34404 | 763 | 28738 |
| 10-#18 | 3.25 | MA | 23256 | 5775 | 39352 | 4202 | 43590 | 3368 | 45810 | 2709 | 48901 | 1707 | 60301 | 1026 | 48378 |
| 4L-3S | | MI | 15193 | 5775 | 26314 | 4016 | 28695 | 3230 | 29886 | 2566 | 31553 | 1509 | 37634 | 973 | 30554 |
| 10-#18 | 3.25 | MA | 21909 | 5775 | 36989 | 4198 | 40543 | 3396 | 42079 | 2734 | 43599 | 1690 | 53889 | 917 | 45681 |
| 5L-2S | | MI | 16421 | 5775 | 28241 | 4031 | 31116 | 3213 | 32770 | 2549 | 35363 | 1491 | 42566 | 1201 | 30668 |
| 12-#11 | 1.52 | MA | 23008 | 5020 | 36505 | 3737 | 40157 | 3034 | 41707 | 2508 | 43200 | 1743 | 52022 | 1641 | 25003 |
| 2L-6S | | MI | 12796 | 5020 | 20660 | 3610 | 21770 | 2934 | 21763 | 2427 | 20850 | 1657 | 24346 | 1220 | 14783 |
| 12-#11 | 1.52 | MA | 22124 | 5020 | 35171 | 3736 | 38455 | 3032 | 39639 | 2519 | 40398 | 1751 | 48229 | 1552 | 24997 |
| 3L-5S | | MI | 13116 | 5020 | 21190 | 3614 | 22488 | 2940 | 22592 | 2420 | 21948 | 1650 | 25683 | 1280 | 15166 |
| 12-#11 | 1.52 | MA | 21503 | 5020 | 34101 | 3750 | 37095 | 3044 | 37988 | 2516 | 38255 | 1759 | 45742 | 1463 | 24930 |
| 4E | | MI | 13451 | 5020 | 21750 | 3618 | 23209 | 2933 | 23459 | 2413 | 23144 | 1657 | 27117 | 1320 | 15255 |
| 12-#11 | 1.52 | MA | 20948 | 5020 | 33165 | 3749 | 35887 | 3042 | 36508 | 2527 | 36143 | 1754 | 43153 | 1419 | 24702 |
| 5L-3S | | MI | 13822 | 5020 | 22385 | 3608 | 24016 | 2939 | 24424 | 2420 | 24355 | 1650 | 28464 | 1406 | 15229 |
| 12-#11 | 1.52 | MA | 20418 | 5020 | 32281 | 3749 | 34686 | 3054 | 35043 | 2524 | 34203 | 1762 | 40684 | 1361 | 23836 |
| 6L-2S | | MI | 14335 | 5020 | 23166 | 3613 | 25012 | 2931 | 25619 | 2413 | 25934 | 1643 | 30532 | 1495 | 15192 |
| 12-#14 | 2.19 | MA | 24582 | 5314 | 40016 | 3909 | 44564 | 3157 | 47038 | 2583 | 50411 | 1718 | 61578 | 1587 | 35591 |
| 2L-6S | | MI | 13027 | 5314 | 21621 | 3771 | 22913 | 3050 | 23102 | 2493 | 22617 | 1612 | 26813 | 1000 | 20099 |
| 12-#14 | 2.19 | MA | 23338 | 5314 | 38106 | 3908 | 42128 | 3154 | 44077 | 2598 | 46400 | 1729 | 56181 | 1459 | 35506 |
| 3L-5S | | MI | 13479 | 5314 | 22378 | 3778 | 23939 | 3060 | 24274 | 2483 | 24168 | 1602 | 28694 | 1086 | 20542 |
| 12-#14 | 2.19 | MA | 22462 | 5314 | 36573 | 3927 | 40178 | 3171 | 41711 | 2593 | 43327 | 1740 | 52645 | 1331 | 35253 |
| 4E | | MI | 13951 | 5314 | 23178 | 3784 | 24969 | 3050 | 25501 | 2473 | 25861 | 1612 | 30713 | 1145 | 21363 |
| 12-#14 | 2.19 | MA | 21678 | 5314 | 35229 | 3925 | 38445 | 3168 | 39588 | 2608 | 40299 | 1732 | 48954 | 1268 | 33777 |
| 5L-3S | | MI | 14473 | 5314 | 24085 | 3771 | 26121 | 3060 | 26865 | 2483 | 27573 | 1602 | 32614 | 1267 | 21416 |
| 12-#14 | 2.19 | MA | 20931 | 5314 | 33961 | 3924 | 36722 | 3185 | 37487 | 2603 | 37517 | 1743 | 45442 | 1184 | 32716 |
| 6L-2S | | MI | 15195 | 5314 | 25197 | 3778 | 27540 | 3050 | 28555 | 2473 | 29805 | 1592 | 35527 | 1395 | 21396 |
| 12-#18 | 3.90 | MA | 24775 | 6059 | 42698 | 4380 | 47856 | 3497 | 50996 | 2789 | 55907 | 1689 | 69638 | 981 | 58060 |
| 4E | | MI | 15134 | 6059 | 26663 | 4213 | 29148 | 3338 | 30441 | 2619 | 32442 | 1487 | 39336 | 677 | 34226 |
| 12-#18 | 3.90 | MA | 23447 | 6059 | 40336 | 4376 | 44810 | 3524 | 47265 | 2813 | 50606 | 1671 | 63227 | 872 | 55507 |
| 5L-3S | | MI | 16019 | 6059 | 28241 | 4193 | 31116 | 3355 | 32770 | 2637 | 35363 | 1469 | 42566 | 887 | 36335 |
| 12-#18 | 3.90 | MA | 22182 | 6059 | 38105 | 4372 | 41781 | 3517 | 43571 | 2802 | 45735 | 1689 | 57159 | 721 | 51235 |
| 6L-2S | | MI | 17236 | 6059 | 30169 | 4208 | 33537 | 3338 | 35654 | 2619 | 39174 | 1452 | 47498 | 1114 | 36516 |
| 14-#11 | 1.77 | MA | 23629 | 5131 | 37840 | 3806 | 41858 | 3084 | 43775 | 2539 | 46002 | 1736 | 55815 | 1627 | 29071 |
| 2L-7S | | MI | 12840 | 5131 | 20874 | 3688 | 22075 | 2992 | 22096 | 2450 | 21355 | 1652 | 25152 | 1126 | 16819 |
| 14-#11 | 1.77 | MA | 22751 | 5131 | 36505 | 3806 | 40157 | 3082 | 41707 | 2550 | 43200 | 1744 | 52022 | 1538 | 29044 |
| 3L-6S | | MI | 13151 | 5131 | 21441 | 3679 | 22765 | 2984 | 22958 | 2457 | 22429 | 1645 | 26414 | 1193 | 17075 |
| 14-#11 | 1.77 | MA | 22134 | 5131 | 35436 | 3819 | 38796 | 3094 | 40056 | 2547 | 41057 | 1752 | 49535 | 1449 | 28956 |
| 4L-5S | | MI | 13470 | 5131 | 21971 | 3683 | 23484 | 2991 | 23787 | 2450 | 23527 | 1638 | 27751 | 1252 | 17431 |
| 14-#11 | 1.77 | MA | 21582 | 5131 | 34499 | 3818 | 37588 | 3092 | 38576 | 2558 | 38945 | 1747 | 46945 | 1405 | 28599 |
| 5L-4S | | MI | 13803 | 5131 | 22531 | 3687 | 24205 | 2983 | 24655 | 2443 | 24724 | 1645 | 29185 | 1293 | 17634 |
| 14-#11 | 1.77 | MA | 21056 | 5131 | 33615 | 3818 | 36387 | 3105 | 37111 | 2555 | 37005 | 1755 | 44477 | 1346 | 27771 |
| 6L-3S | | MI | 14172 | 5131 | 23166 | 3678 | 25012 | 2989 | 25619 | 2450 | 25934 | 1638 | 30532 | 1379 | 17624 |
| 14-#11 | 1.77 | MA | 20543 | 5131 | 32669 | 3831 | 35234 | 3103 | 35698 | 2566 | 35107 | 1763 | 41908 | 1259 | 27230 |
| 7L-2S | | MI | 14683 | 5131 | 23947 | 3682 | 26008 | 2982 | 26815 | 2443 | 27514 | 1631 | 32600 | 1468 | 17595 |
| 14-#14 | 2.56 | MA | 24216 | 5473 | 40016 | 4008 | 44564 | 3227 | 47038 | 2643 | 50411 | 1719 | 61578 | 1437 | 41273 |
| 3L-6S | | MI | 13527 | 5473 | 22733 | 3871 | 24331 | 3122 | 24792 | 2535 | 24849 | 1593 | 29725 | 957 | 23232 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

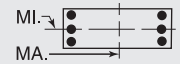



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.56 | MA | 23348 | 5473 | 38483 | 4026 | 42614 | 3244 | 44672 | 2638 | 47339 | 1730 | 58042 | 1309 | 40983 |
| 4L-5S | | MI | 13975 | 5473 | 23490 | 3877 | 25357 | 3132 | 25964 | 2525 | 26401 | 1583 | 31606 | 1044 | 23773 |
| 14-#14 | 2.56 | MA | 22572 | 5473 | 37139 | 4025 | 40881 | 3240 | 42549 | 2653 | 44310 | 1722 | 54351 | 1246 | 39377 |
| 5L-4S | | MI | 14444 | 5473 | 24290 | 3884 | 26387 | 3122 | 27191 | 2515 | 28094 | 1593 | 33626 | 1102 | 24617 |
| 14-#14 | 2.56 | MA | 21832 | 5473 | 35871 | 4024 | 39158 | 3257 | 40448 | 2648 | 41528 | 1733 | 50840 | 1162 | 38359 |
| 6L-3S | | MI | 14963 | 5473 | 25197 | 3871 | 27540 | 3132 | 28555 | 2525 | 29805 | 1583 | 35527 | 1225 | 24791 |
| 14-#14 | 2.56 | MA | 21110 | 5473 | 34514 | 4043 | 37504 | 3254 | 38421 | 2662 | 38805 | 1744 | 47186 | 1035 | 36512 |
| 7L-2S | | MI | 15679 | 5473 | 26309 | 3878 | 28958 | 3122 | 30245 | 2515 | 32038 | 1573 | 38439 | 1353 | 24799 |
| 14-#18 | 4.55 | MA | 24965 | 6342 | 43682 | 4553 | 49076 | 3653 | 52452 | 2893 | 57613 | 1652 | 72564 | 826 | 65081 |
| 5L-4S | | MI | 15962 | 6342 | 28591 | 4391 | 31569 | 3463 | 33325 | 2689 | 36253 | 1448 | 44268 | 590 | 39746 |
| 14-#18 | 4.55 | MA | 23717 | 6342 | 41452 | 4549 | 46047 | 3646 | 48757 | 2882 | 52741 | 1670 | 66497 | 676 | 60945 |
| 6L-3S | | MI | 16839 | 6342 | 30169 | 4370 | 33537 | 3481 | 35654 | 2707 | 39174 | 1430 | 47498 | 801 | 42103 |
| 14-#18 | 4.55 | MA | 22498 | 6342 | 39065 | 4581 | 43138 | 3673 | 45193 | 2906 | 47974 | 1688 | 60179 | 451 | 56688 |
| 7L-2S | | MI | 18045 | 6342 | 32097 | 4385 | 35958 | 3463 | 38538 | 2689 | 42985 | 1412 | 52430 | 1028 | 42345 |
| 16-#11 | 2.03 | MA | 23373 | 5242 | 37840 | 3875 | 41858 | 3132 | 43775 | 2581 | 46002 | 1737 | 55815 | 1524 | 33086 |
| 3L-7S | | MI | 13196 | 5242 | 21656 | 3758 | 23071 | 3042 | 23292 | 2480 | 22934 | 1640 | 27220 | 1099 | 19051 |
| 16-#11 | 2.03 | MA | 22760 | 5242 | 36770 | 3888 | 40498 | 3144 | 42124 | 2578 | 43858 | 1745 | 53327 | 1435 | 32979 |
| 4L-6S | | MI | 13505 | 5242 | 22222 | 3748 | 23761 | 3035 | 24154 | 2487 | 24008 | 1633 | 28482 | 1165 | 19371 |
| 16-#11 | 2.03 | MA | 22212 | 5242 | 35833 | 3887 | 39289 | 3143 | 40644 | 2589 | 41746 | 1740 | 50738 | 1391 | 32506 |
| 5E | | MI | 13822 | 5242 | 22752 | 3752 | 24479 | 3041 | 24983 | 2480 | 25106 | 1626 | 29819 | 1225 | 19704 |
| 16-#11 | 2.03 | MA | 21690 | 5242 | 34950 | 3887 | 38088 | 3155 | 39179 | 2586 | 39807 | 1748 | 48269 | 1332 | 31713 |
| 6L-4S | | MI | 14153 | 5242 | 23312 | 3756 | 25201 | 3033 | 25850 | 2473 | 26303 | 1633 | 31252 | 1265 | 20003 |
| 16-#11 | 2.03 | MA | 21180 | 5242 | 34004 | 3900 | 36935 | 3153 | 37766 | 2597 | 37909 | 1757 | 45701 | 1245 | 31114 |
| 7L-3S | | MI | 14520 | 5242 | 23947 | 3747 | 26008 | 3039 | 26815 | 2480 | 27514 | 1626 | 32600 | 1351 | 20011 |
| 16-#11 | 2.03 | MA | 20678 | 5242 | 33136 | 3900 | 35772 | 3165 | 36383 | 2608 | 35921 | 1751 | 43281 | 1193 | 30073 |
| 8L-2S | | MI | 15029 | 5242 | 24728 | 3751 | 27004 | 3032 | 28011 | 2473 | 29093 | 1619 | 34668 | 1440 | 19992 |
| 16-#14 | 2.92 | MA | 24226 | 5633 | 40394 | 4126 | 45050 | 3316 | 47633 | 2682 | 51350 | 1721 | 63440 | 1287 | 46712 |
| 4L-6S | | MI | 14022 | 5633 | 23846 | 3970 | 25749 | 3195 | 26482 | 2577 | 27082 | 1574 | 32638 | 915 | 26378 |
| 16-#14 | 2.92 | MA | 23457 | 5633 | 39050 | 4125 | 43316 | 3313 | 45510 | 2697 | 48321 | 1712 | 59748 | 1224 | 44990 |
| 5E | | MI | 14468 | 5633 | 24603 | 3977 | 26775 | 3205 | 27654 | 2567 | 28634 | 1564 | 34519 | 1001 | 27015 |
| 16-#14 | 2.92 | MA | 22724 | 5633 | 37782 | 4124 | 41594 | 3330 | 43409 | 2692 | 45539 | 1723 | 56237 | 1140 | 43963 |
| 6L-4S | | MI | 14933 | 5633 | 25403 | 3984 | 27806 | 3195 | 28881 | 2557 | 30326 | 1574 | 36538 | 1060 | 27803 |
| 16-#14 | 2.92 | MA | 22008 | 5633 | 36425 | 4142 | 39940 | 3326 | 41382 | 2707 | 42817 | 1734 | 52583 | 1014 | 42092 |
| 7L-3S | | MI | 15449 | 5633 | 26309 | 3971 | 28958 | 3204 | 30245 | 2567 | 32038 | 1564 | 38439 | 1182 | 28157 |
| 16-#14 | 2.92 | MA | 21303 | 5633 | 35180 | 4141 | 38271 | 3343 | 39397 | 2722 | 39965 | 1725 | 49133 | 940 | 40331 |
| 8L-2S | | MI | 16161 | 5633 | 27422 | 3978 | 30376 | 3194 | 31935 | 2557 | 34270 | 1554 | 41351 | 1310 | 28192 |
| 16-#18 | 5.19 | MA | 25232 | 6626 | 44798 | 4727 | 50313 | 3774 | 53944 | 2962 | 59748 | 1651 | 75834 | 631 | 70677 |
| 6L-4S | | MI | 16783 | 6626 | 30519 | 4568 | 33989 | 3588 | 36210 | 2759 | 40064 | 1408 | 49200 | 504 | 45293 |
| 16-#18 | 5.19 | MA | 24030 | 6626 | 42411 | 4758 | 47404 | 3802 | 50379 | 2986 | 54980 | 1669 | 69516 | 406 | 66331 |
| 7L-3S | | MI | 17652 | 6626 | 32097 | 4548 | 35958 | 3606 | 38538 | 2777 | 42985 | 1390 | 52430 | 714 | 47843 |
| 18-#11 | 2.28 | MA | 23381 | 5352 | 38104 | 3957 | 42199 | 3195 | 44192 | 2609 | 46660 | 1739 | 57120 | 1421 | 36999 |
| 4L-7S | | MI | 13549 | 5352 | 22437 | 3827 | 24067 | 3092 | 24487 | 2510 | 24513 | 1627 | 29288 | 1071 | 21292 |
| 18-#11 | 2.28 | MA | 22837 | 5352 | 37168 | 3957 | 40990 | 3193 | 42712 | 2620 | 44548 | 1733 | 54531 | 1377 | 36423 |
| 5L-6S | | MI | 13857 | 5352 | 23003 | 3817 | 24757 | 3085 | 25349 | 2516 | 25587 | 1620 | 30549 | 1138 | 21672 |
| 18-#11 | 2.28 | MA | 22318 | 5352 | 36284 | 3956 | 39789 | 3205 | 41247 | 2617 | 42608 | 1741 | 52062 | 1318 | 35661 |
| 6L-5S | | MI | 14172 | 5352 | 23533 | 3821 | 25475 | 3091 | 26178 | 2510 | 26685 | 1613 | 31886 | 1197 | 21985 |
| 18-#11 | 2.28 | MA | 21812 | 5352 | 35338 | 3969 | 38636 | 3203 | 39834 | 2628 | 40710 | 1750 | 49494 | 1231 | 35002 |
| 7L-4S | | MI | 14502 | 5352 | 24093 | 3825 | 26197 | 3083 | 27046 | 2503 | 27882 | 1620 | 33320 | 1238 | 22367 |
| 18-#11 | 2.28 | MA | 21313 | 5352 | 34471 | 3969 | 37473 | 3215 | 38451 | 2639 | 38722 | 1744 | 47074 | 1179 | 33991 |
| 8L-3S | | MI | 14867 | 5352 | 24728 | 3816 | 27004 | 3090 | 28011 | 2510 | 29093 | 1613 | 34668 | 1324 | 22394 |
| 18-#11 | 2.28 | MA | 20790 | 5352 | 33619 | 3968 | 36336 | 3213 | 37020 | 2636 | 36844 | 1752 | 44682 | 1123 | 32991 |
| 9L-2S | | MI | 15373 | 5352 | 25509 | 3820 | 28000 | 3082 | 29206 | 2503 | 30672 | 1607 | 36735 | 1413 | 22382 |
| 18-#14 | 3.29 | MA | 24334 | 5793 | 40960 | 4225 | 45752 | 3385 | 48471 | 2742 | 52333 | 1702 | 65145 | 1202 | 50614 |
| 5L-6S | | MI | 14515 | 5793 | 24958 | 4070 | 27168 | 3267 | 28173 | 2618 | 29314 | 1555 | 35550 | 872 | 29537 |
| 18-#14 | 3.29 | MA | 23608 | 5793 | 39692 | 4223 | 44029 | 3402 | 46370 | 2737 | 49551 | 1713 | 61634 | 1118 | 49495 |
| 6L-5S | | MI | 14957 | 5793 | 25715 | 4077 | 28194 | 3277 | 29345 | 2608 | 30866 | 1545 | 37431 | 959 | 30266 |
| 18-#14 | 3.29 | MA | 22899 | 5793 | 38335 | 4242 | 42375 | 3399 | 44343 | 2752 | 46828 | 1724 | 57980 | 992 | 47681 |
| 7L-4S | | MI | 15419 | 5793 | 26515 | 4084 | 29224 | 3267 | 30571 | 2599 | 32559 | 1555 | 39450 | 1017 | 31003 |

## RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

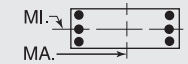



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 3.29 | MA | 22199 | 5793 | 37090 | 4241 | 40706 | 3416 | 42358 | 2767 | 43976 | 1715 | 54530 | 918 | 45869 |
| 8L-3S | | MI | 15931 | 5793 | 27422 | 4071 | 30376 | 3277 | 31935 | 2608 | 34270 | 1545 | 41351 | 1139 | 31516 |
| 18-#14 | 3.29 | MA | 21481 | 5793 | 35773 | 4260 | 39075 | 3412 | 40304 | 2762 | 41282 | 1726 | 51129 | 837 | 43910 |
| 9L-2S | | MI | 16640 | 5793 | 28534 | 4077 | 31795 | 3267 | 33625 | 2599 | 36503 | 1535 | 44264 | 1267 | 31571 |
| 18-#18 | 5.84 | MA | 25544 | 6910 | 45757 | 4935 | 51670 | 3930 | 55565 | 3066 | 61987 | 1650 | 78853 | 361 | 75993 |
| 7L-4S | | MI | 17598 | 6910 | 32446 | 4745 | 36410 | 3713 | 39094 | 2830 | 43875 | 1369 | 54132 | 418 | 50860 |
| 20-#11 | 2.53 | MA | 23458 | 5463 | 38502 | 4026 | 42692 | 3243 | 44780 | 2651 | 47350 | 1726 | 58323 | 1363 | 40348 |
| 5L-7S | | MI | 13900 | 5463 | 23218 | 3896 | 25063 | 3142 | 25683 | 2539 | 26093 | 1615 | 31355 | 1044 | 23540 |
| 20-#11 | 2.53 | MA | 22943 | 5463 | 37618 | 4025 | 41491 | 3255 | 43315 | 2648 | 45410 | 1734 | 55855 | 1304 | 39614 |
| 6E | | MI | 14206 | 5463 | 23784 | 3886 | 25753 | 3135 | 26545 | 2546 | 27167 | 1608 | 32617 | 1110 | 23976 |
| 20-#11 | 2.53 | MA | 22440 | 5463 | 36672 | 4039 | 40338 | 3253 | 41902 | 2659 | 43512 | 1743 | 53286 | 1217 | 38896 |
| 7L-5S | | MI | 14520 | 5463 | 24314 | 3890 | 26471 | 3141 | 27374 | 2539 | 28264 | 1601 | 33954 | 1170 | 24272 |
| 20-#11 | 2.53 | MA | 21945 | 5463 | 35805 | 4038 | 39174 | 3265 | 40519 | 2670 | 41524 | 1737 | 50866 | 1165 | 37913 |
| 8L-4S | | MI | 14848 | 5463 | 24874 | 3895 | 27192 | 3133 | 28242 | 2532 | 29461 | 1608 | 35388 | 1210 | 24727 |
| 20-#11 | 2.53 | MA | 21432 | 5463 | 34953 | 4038 | 38038 | 3263 | 39088 | 2667 | 39646 | 1746 | 48475 | 1109 | 36878 |
| 9L-3S | | MI | 15211 | 5463 | 25509 | 3885 | 28000 | 3140 | 29206 | 2539 | 30672 | 1601 | 36735 | 1296 | 24764 |
| 20-#11 | 2.53 | MA | 20878 | 5463 | 34024 | 4051 | 36889 | 3276 | 37713 | 2678 | 37782 | 1754 | 46155 | 1046 | 35797 |
| 10L-2S | | MI | 15715 | 5463 | 26290 | 3889 | 28996 | 3132 | 30402 | 2532 | 32251 | 1594 | 38803 | 1385 | 24768 |
| 20-#14 | 3.65 | MA | 24484 | 5952 | 41603 | 4323 | 46465 | 3474 | 49330 | 2782 | 53562 | 1703 | 67031 | 1096 | 55040 |
| 6E | | MI | 15004 | 5952 | 26071 | 4170 | 28586 | 3339 | 29863 | 2660 | 31547 | 1535 | 38462 | 830 | 32709 |
| 20-#14 | 3.65 | MA | 23781 | 5952 | 40246 | 4342 | 44811 | 3471 | 47303 | 2797 | 50839 | 1714 | 63377 | 970 | 53279 |
| 7L-5S | | MI | 15443 | 5952 | 26828 | 4177 | 29612 | 3349 | 31035 | 2650 | 33099 | 1525 | 40343 | 916 | 33523 |
| 20-#14 | 3.65 | MA | 23088 | 5952 | 39001 | 4341 | 43142 | 3488 | 45319 | 2812 | 47988 | 1705 | 59928 | 896 | 51417 |
| 8L-4S | | MI | 15902 | 5952 | 27628 | 4183 | 30642 | 3339 | 32261 | 2640 | 34791 | 1535 | 42363 | 974 | 34215 |
| 20-#14 | 3.65 | MA | 22371 | 5952 | 37684 | 4359 | 41511 | 3485 | 43265 | 2807 | 45293 | 1716 | 56526 | 815 | 49427 |
| 9L-3S | | MI | 16411 | 5952 | 28534 | 4170 | 31795 | 3349 | 33625 | 2650 | 36503 | 1525 | 44264 | 1097 | 34869 |
| 22-#11 | 2.79 | MA | 23563 | 5573 | 38953 | 4094 | 43192 | 3305 | 45383 | 2679 | 48212 | 1728 | 59647 | 1290 | 43571 |
| 6L-7S | | MI | 14249 | 5573 | 23999 | 3965 | 26058 | 3193 | 26879 | 2569 | 27672 | 1603 | 33423 | 1016 | 25794 |
| 22-#11 | 2.79 | MA | 23064 | 5573 | 38007 | 4108 | 42039 | 3303 | 43970 | 2690 | 46314 | 1736 | 57079 | 1203 | 42798 |
| 7L-6S | | MI | 14554 | 5573 | 24565 | 3955 | 26749 | 3185 | 27740 | 2576 | 28746 | 1596 | 34685 | 1083 | 26283 |
| 22-#11 | 2.79 | MA | 22571 | 5573 | 37139 | 4107 | 40875 | 3315 | 42587 | 2701 | 44326 | 1730 | 54659 | 1151 | 41841 |
| 8L-5S | | MI | 14866 | 5573 | 25095 | 3960 | 27467 | 3191 | 28569 | 2569 | 29843 | 1589 | 36022 | 1142 | 26563 |
| 22-#11 | 2.79 | MA | 22060 | 5573 | 36288 | 4107 | 39739 | 3314 | 41156 | 2698 | 42448 | 1739 | 52267 | 1095 | 40771 |
| 9L-4S | | MI | 15192 | 5573 | 25655 | 3964 | 28188 | 3184 | 29437 | 2562 | 31040 | 1596 | 37456 | 1183 | 27082 |
| 22-#11 | 2.79 | MA | 21511 | 5573 | 35358 | 4120 | 38590 | 3326 | 39781 | 2709 | 40584 | 1747 | 49947 | 1032 | 39713 |
| 10L-3S | | MI | 15554 | 5573 | 26290 | 3954 | 28996 | 3190 | 30402 | 2569 | 32251 | 1589 | 38803 | 1269 | 27131 |
| 22-#11 | 2.79 | MA | 20980 | 5573 | 34507 | 4119 | 37460 | 3324 | 38366 | 2706 | 38623 | 1742 | 47584 | 977 | 38300 |
| 11L-2S | | MI | 16055 | 5573 | 27071 | 3958 | 29992 | 3182 | 31597 | 2562 | 33830 | 1582 | 40871 | 1357 | 27151 |
| 22-#14 | 4.02 | MA | 24656 | 6112 | 42156 | 4442 | 47247 | 3543 | 50264 | 2842 | 54851 | 1704 | 68774 | 948 | 58886 |
| 7L-6S | | MI | 15490 | 6112 | 27183 | 4270 | 30004 | 3412 | 31553 | 2702 | 33780 | 1516 | 41375 | 787 | 35892 |
| 22-#14 | 4.02 | MA | 23970 | 6112 | 40911 | 4440 | 45577 | 3560 | 48280 | 2857 | 51999 | 1695 | 65325 | 874 | 56973 |
| 8L-5S | | MI | 15926 | 6112 | 27940 | 4276 | 31030 | 3422 | 32725 | 2692 | 35331 | 1506 | 43256 | 873 | 36785 |
| 22-#14 | 4.02 | MA | 23254 | 6112 | 39594 | 4459 | 43946 | 3557 | 46226 | 2852 | 49304 | 1706 | 61923 | 793 | 54951 |
| 9L-4S | | MI | 16383 | 6112 | 28740 | 4283 | 32061 | 3412 | 33952 | 2682 | 37024 | 1516 | 45275 | 932 | 37438 |
| 24-#11 | 3.04 | MA | 23683 | 5684 | 39341 | 4177 | 43740 | 3353 | 46038 | 2721 | 49116 | 1729 | 60872 | 1189 | 46705 |
| 7E | | MI | 14597 | 5684 | 24780 | 4034 | 27054 | 3243 | 28074 | 2599 | 29251 | 1590 | 35491 | 988 | 28054 |
| 24-#11 | 3.04 | MA | 23194 | 5684 | 38474 | 4176 | 42577 | 3366 | 44655 | 2732 | 47127 | 1723 | 58452 | 1137 | 45773 |
| 8L-6S | | MI | 14900 | 5684 | 25347 | 4025 | 27745 | 3235 | 28936 | 2606 | 30325 | 1583 | 36753 | 1055 | 28591 |
| 24-#11 | 3.04 | MA | 22684 | 5684 | 37622 | 4176 | 41440 | 3364 | 43224 | 2729 | 45249 | 1732 | 56060 | 1081 | 44669 |
| 9L-5S | | MI | 15210 | 5684 | 25876 | 4029 | 28463 | 3241 | 29765 | 2599 | 31422 | 1577 | 38090 | 1115 | 28859 |
| 24-#11 | 3.04 | MA | 22140 | 5684 | 36692 | 4189 | 40291 | 3376 | 41849 | 2740 | 43385 | 1740 | 53740 | 1018 | 43628 |
| 10L-4S | | MI | 15535 | 5684 | 26436 | 4033 | 29184 | 3234 | 30633 | 2592 | 32619 | 1583 | 39523 | 1155 | 29435 |
| 24-#11 | 3.04 | MA | 21612 | 5684 | 35841 | 4189 | 39161 | 3374 | 40434 | 2737 | 41425 | 1735 | 51377 | 963 | 42197 |
| 11L-3S | | MI | 15895 | 5684 | 27071 | 4023 | 29992 | 3240 | 31597 | 2599 | 33830 | 1577 | 40871 | 1241 | 29495 |
| 24-#14 | 4.38 | MA | 24844 | 6271 | 42822 | 4540 | 48013 | 3633 | 51240 | 2902 | 56010 | 1685 | 70722 | 852 | 62536 |
| 8L-6S | | MI | 15973 | 6271 | 28296 | 4369 | 31423 | 3484 | 33243 | 2744 | 36012 | 1497 | 44287 | 744 | 39084 |
| 24-#14 | 4.38 | MA | 24130 | 6271 | 41504 | 4559 | 46382 | 3629 | 49187 | 2897 | 53316 | 1697 | 67320 | 771 | 60483 |
| 9L-5S | | MI | 16407 | 6271 | 29053 | 4376 | 32449 | 3494 | 34415 | 2734 | 37564 | 1487 | 46168 | 831 | 40053 |

## RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

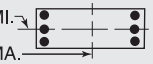
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.24 | MA | 24314 | 5122 | 38316 | 3803 | 41719 | 3094 | 42887 | 2570 | 43537 | 1817 | 51613 | 1706 | 22264 |
| 2E | | MI | 14479 | 5122 | 23304 | 3642 | 24717 | 2955 | 24951 | 2438 | 24672 | 1686 | 28584 | 1534 | 12933 |
| 6-#14 | 1.05 | MA | 23865 | 5033 | 37187 | 3771 | 40423 | 3073 | 41366 | 2561 | 41499 | 1834 | 49105 | 1741 | 19022 |
| 2L-3S | | MI | 13536 | 5033 | 21589 | 3617 | 22731 | 2962 | 22632 | 2458 | 21621 | 1738 | 24698 | 1470 | 11213 |
| 6-#14 | 1.05 | MA | 22519 | 5033 | 35177 | 3770 | 37860 | 3070 | 38251 | 2576 | 37279 | 1846 | 43396 | 1613 | 19058 |
| 3L-2S | | MI | 14273 | 5033 | 22701 | 3623 | 24150 | 2952 | 24322 | 2448 | 23853 | 1728 | 27610 | 1598 | 11131 |
| 6-#18 | 1.86 | MA | 25945 | 5406 | 41840 | 3981 | 46211 | 3223 | 48348 | 2649 | 50935 | 1799 | 61504 | 1664 | 33030 |
| 2L-3S | | MI | 14067 | 5406 | 23304 | 3804 | 24717 | 3097 | 24951 | 2526 | 24672 | 1665 | 28584 | 1220 | 18989 |
| 6-#18 | 1.86 | MA | 23634 | 5406 | 38316 | 3978 | 41719 | 3252 | 42887 | 2675 | 43537 | 1817 | 51613 | 1436 | 32854 |
| 3L-2S | | MI | 15323 | 5406 | 25231 | 3819 | 27138 | 3080 | 27835 | 2508 | 28483 | 1647 | 33516 | 1448 | 18912 |
| 8-#14 | 1.40 | MA | 24812 | 5193 | 39197 | 3870 | 42985 | 3145 | 44481 | 2605 | 45720 | 1825 | 54814 | 1721 | 25170 |
| 2L-4S | | MI | 13507 | 5193 | 21795 | 3730 | 22997 | 3024 | 22958 | 2490 | 22142 | 1728 | 25709 | 1305 | 14692 |
| 8-#14 | 1.40 | MA | 23478 | 5193 | 37187 | 3870 | 40423 | 3143 | 41366 | 2621 | 41499 | 1836 | 49105 | 1593 | 25162 |
| 3E | | MI | 14038 | 5193 | 22701 | 3716 | 24150 | 3034 | 24322 | 2500 | 23853 | 1718 | 27610 | 1428 | 14653 |
| 8-#14 | 1.40 | MA | 22538 | 5193 | 35576 | 3889 | 38373 | 3160 | 38879 | 2616 | 38270 | 1848 | 45361 | 1465 | 24998 |
| 4L-2S | | MI | 14770 | 5193 | 23814 | 3723 | 25568 | 3024 | 26012 | 2490 | 26086 | 1708 | 30523 | 1556 | 14588 |
| 8-#18 | 2.48 | MA | 27549 | 5689 | 45364 | 4158 | 50704 | 3352 | 53809 | 2729 | 58334 | 1781 | 71396 | 1622 | 43738 |
| 2L-4S | | MI | 14007 | 5689 | 23653 | 4002 | 25170 | 3205 | 25507 | 2578 | 25562 | 1643 | 30286 | 924 | 23525 |
| 8-#18 | 2.48 | MA | 25269 | 5689 | 41840 | 4155 | 46211 | 3380 | 48348 | 2755 | 50935 | 1800 | 61504 | 1394 | 43449 |
| 3E | | MI | 14913 | 5689 | 25231 | 3981 | 27138 | 3223 | 27835 | 2596 | 28483 | 1625 | 33516 | 1134 | 24828 |
| 8-#18 | 2.48 | MA | 23662 | 5689 | 39008 | 4187 | 42610 | 3374 | 43978 | 2744 | 45261 | 1818 | 55032 | 1167 | 41043 |
| 4L-2S | | MI | 16156 | 5689 | 27159 | 3996 | 29559 | 3205 | 30720 | 2578 | 32294 | 1607 | 38448 | 1361 | 24836 |
| 10-#11 | 1.21 | MA | 24347 | 5108 | 38116 | 3829 | 41680 | 3116 | 42922 | 2589 | 43620 | 1836 | 52097 | 1743 | 21981 |
| 2L-5S | | MI | 13314 | 5108 | 21249 | 3690 | 22357 | 3010 | 22235 | 2492 | 21117 | 1741 | 24439 | 1383 | 12924 |
| 10-#11 | 1.21 | MA | 23410 | 5108 | 36713 | 3828 | 39891 | 3115 | 40747 | 2601 | 40673 | 1845 | 48088 | 1654 | 21998 |
| 3L-4S | | MI | 13651 | 5108 | 21808 | 3694 | 23079 | 3002 | 23102 | 2485 | 22313 | 1748 | 25873 | 1423 | 12901 |
| 10-#11 | 1.21 | MA | 22752 | 5108 | 35589 | 3842 | 38461 | 3127 | 39013 | 2598 | 38421 | 1854 | 45456 | 1566 | 21953 |
| 4L-3S | | MI | 14025 | 5108 | 22444 | 3685 | 23886 | 3009 | 24067 | 2492 | 23524 | 1741 | 27221 | 1509 | 12857 |
| 10-#11 | 1.21 | MA | 22163 | 5108 | 34605 | 3842 | 37192 | 3126 | 37458 | 2609 | 36202 | 1849 | 42723 | 1521 | 21806 |
| 5L-2S | | MI | 14541 | 5108 | 23225 | 3689 | 24882 | 3001 | 25262 | 2485 | 25103 | 1734 | 29288 | 1598 | 12811 |
| 10-#14 | 1.75 | MA | 25750 | 5352 | 41207 | 3970 | 45548 | 3218 | 47597 | 2650 | 49941 | 1815 | 60524 | 1700 | 31302 |
| 2L-5S | | MI | 13532 | 5352 | 22107 | 3822 | 23385 | 3107 | 23421 | 2542 | 22682 | 1699 | 26602 | 1204 | 17464 |
| 10-#14 | 1.75 | MA | 24426 | 5352 | 39197 | 3969 | 42985 | 3215 | 44481 | 2666 | 45720 | 1826 | 54814 | 1572 | 31250 |
| 3L-4S | | MI | 14009 | 5352 | 22907 | 3829 | 24416 | 3097 | 24648 | 2532 | 24374 | 1709 | 28622 | 1263 | 18067 |
| 10-#14 | 1.75 | MA | 23496 | 5352 | 37586 | 3988 | 40936 | 3232 | 41994 | 2661 | 42490 | 1838 | 51070 | 1444 | 31039 |
| 4L-3S | | MI | 14536 | 5352 | 23814 | 3816 | 25568 | 3106 | 26012 | 2542 | 26086 | 1699 | 30523 | 1385 | 18068 |
| 10-#14 | 1.75 | MA | 22663 | 5352 | 36174 | 3988 | 39115 | 3230 | 39764 | 2677 | 39308 | 1830 | 47172 | 1380 | 29766 |
| 5L-2S | | MI | 15263 | 5352 | 24926 | 3823 | 26986 | 3096 | 27702 | 2532 | 28319 | 1689 | 33435 | 1513 | 18021 |
| 10-#18 | 3.11 | MA | 26878 | 5973 | 45364 | 4332 | 50704 | 3509 | 53809 | 2834 | 58334 | 1782 | 71396 | 1352 | 54032 |
| 3L-4S | | MI | 14854 | 5973 | 25581 | 4179 | 27591 | 3330 | 28391 | 2648 | 29373 | 1603 | 35218 | 837 | 28966 |
| 10-#18 | 3.11 | MA | 25293 | 5973 | 42532 | 4365 | 47103 | 3502 | 49439 | 2824 | 52660 | 1800 | 64923 | 1125 | 51204 |
| 4L-3S | | MI | 15750 | 5973 | 27159 | 4159 | 29559 | 3348 | 30720 | 2666 | 32294 | 1586 | 38448 | 1047 | 30637 |
| 10-#18 | 3.11 | MA | 23875 | 5973 | 40048 | 4362 | 43900 | 3531 | 45517 | 2849 | 47065 | 1783 | 58144 | 1014 | 48253 |
| 5L-2S | | MI | 16981 | 5973 | 29087 | 4174 | 31980 | 3330 | 33604 | 2648 | 36105 | 1568 | 43380 | 1275 | 30730 |
| 12-#11 | 1.45 | MA | 25009 | 5218 | 39520 | 3898 | 43469 | 3166 | 45098 | 2621 | 46567 | 1829 | 56106 | 1730 | 26267 |
| 2L-6S | | MI | 13350 | 5218 | 21500 | 3755 | 22635 | 3054 | 22601 | 2529 | 21598 | 1735 | 25170 | 1296 | 14884 |
| 12-#11 | 1.45 | MA | 24078 | 5218 | 38116 | 3898 | 41680 | 3165 | 42922 | 2632 | 43620 | 1838 | 52097 | 1641 | 26261 |
| 3L-5S | | MI | 13671 | 5218 | 22030 | 3759 | 23353 | 3060 | 23430 | 2522 | 22696 | 1728 | 26507 | 1355 | 15278 |
| 12-#11 | 1.45 | MA | 23424 | 5218 | 36992 | 3911 | 40251 | 3177 | 41188 | 2629 | 41368 | 1847 | 49465 | 1553 | 26194 |
| 4E | | MI | 14006 | 5218 | 22589 | 3763 | 24074 | 3052 | 24298 | 2515 | 23893 | 1735 | 27941 | 1396 | 15295 |
| 12-#11 | 1.45 | MA | 22840 | 5218 | 36008 | 3911 | 38981 | 3176 | 39633 | 2640 | 39149 | 1842 | 46732 | 1508 | 26022 |
| 5L-3S | | MI | 14378 | 5218 | 23225 | 3754 | 24882 | 3059 | 25262 | 2522 | 25103 | 1728 | 29288 | 1482 | 15265 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

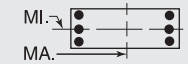
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.45 | MA | 22282 | 5218 | 35080 | 3911 | 37720 | 3188 | 38095 | 2638 | 37112 | 1850 | 44121 | 1450 | 25117 |
| 6L-2S | | MI | 14891 | 5218 | 24006 | 3758 | 25878 | 3051 | 26458 | 2515 | 26683 | 1722 | 31356 | 1571 | 15226 |
| 12-#14 | 2.10 | MA | 26678 | 5512 | 43218 | 4070 | 48111 | 3290 | 50712 | 2695 | 54162 | 1805 | 66233 | 1680 | 37413 |
| 2L-6S | | MI | 13581 | 5512 | 22463 | 3915 | 23778 | 3169 | 23939 | 2594 | 23363 | 1690 | 27634 | 1075 | 20233 |
| 12-#14 | 2.10 | MA | 25364 | 5512 | 41207 | 4069 | 45548 | 3287 | 47597 | 2711 | 49941 | 1816 | 60524 | 1552 | 37328 |
| 3L-5S | | MI | 14033 | 5512 | 23220 | 3922 | 24804 | 3179 | 25111 | 2584 | 24914 | 1680 | 29515 | 1161 | 20681 |
| 12-#14 | 2.10 | MA | 24442 | 5512 | 39596 | 4088 | 43499 | 3305 | 45109 | 2706 | 46711 | 1828 | 56780 | 1424 | 37075 |
| 4E | | MI | 14506 | 5512 | 24020 | 3929 | 25834 | 3169 | 26338 | 2574 | 26607 | 1690 | 31534 | 1220 | 21428 |
| 12-#14 | 2.10 | MA | 23618 | 5512 | 38184 | 4087 | 41678 | 3302 | 42879 | 2722 | 43529 | 1820 | 52881 | 1360 | 35646 |
| 5L-3S | | MI | 15030 | 5512 | 24926 | 3916 | 26986 | 3179 | 27702 | 2584 | 28319 | 1680 | 33435 | 1342 | 21467 |
| 12-#14 | 2.10 | MA | 22831 | 5512 | 36852 | 4087 | 39868 | 3319 | 40672 | 2717 | 40606 | 1832 | 49165 | 1276 | 34491 |
| 6L-2S | | MI | 15752 | 5512 | 26039 | 3923 | 28405 | 3169 | 29392 | 2574 | 30551 | 1670 | 36347 | 1470 | 21438 |
| 12-#18 | 3.73 | MA | 26902 | 6257 | 46055 | 4542 | 51595 | 3631 | 54900 | 2904 | 60058 | 1782 | 74815 | 1082 | 61409 |
| 4E | | MI | 15691 | 6257 | 27509 | 4356 | 30012 | 3455 | 31275 | 2719 | 33183 | 1564 | 40150 | 751 | 34450 |
| 12-#18 | 3.73 | MA | 25503 | 6257 | 43572 | 4539 | 48392 | 3660 | 50978 | 2929 | 54464 | 1765 | 68036 | 972 | 58609 |
| 5L-3S | | MI | 16578 | 6257 | 29087 | 4336 | 31980 | 3473 | 33604 | 2736 | 36105 | 1546 | 43380 | 961 | 36425 |
| 12-#18 | 3.73 | MA | 24170 | 6257 | 41228 | 4536 | 45209 | 3653 | 47095 | 2919 | 49323 | 1783 | 61605 | 822 | 54294 |
| 6L-2S | | MI | 17798 | 6257 | 31015 | 4351 | 34401 | 3455 | 36488 | 2719 | 39916 | 1528 | 48312 | 1189 | 36583 |
| 14-#11 | 1.70 | MA | 25666 | 5329 | 40923 | 3967 | 45259 | 3216 | 47273 | 2652 | 49514 | 1822 | 60116 | 1717 | 30545 |
| 2L-7S | | MI | 13394 | 5329 | 21714 | 3834 | 22940 | 3112 | 22935 | 2552 | 22103 | 1730 | 25976 | 1202 | 16965 |
| 14-#11 | 1.70 | MA | 24740 | 5329 | 39520 | 3967 | 43469 | 3215 | 45098 | 2663 | 46567 | 1831 | 56106 | 1628 | 30518 |
| 3L-6S | | MI | 13706 | 5329 | 22281 | 3824 | 23631 | 3104 | 23797 | 2558 | 23177 | 1723 | 27238 | 1268 | 17176 |
| 14-#11 | 1.70 | MA | 24091 | 5329 | 38396 | 3980 | 42040 | 3227 | 43363 | 2660 | 44315 | 1840 | 53474 | 1540 | 30430 |
| 4L-5S | | MI | 14025 | 5329 | 22811 | 3828 | 24349 | 3110 | 24626 | 2552 | 24275 | 1716 | 28575 | 1328 | 17541 |
| 14-#11 | 1.70 | MA | 23510 | 5329 | 37412 | 3980 | 40771 | 3226 | 41808 | 2671 | 42096 | 1835 | 50742 | 1495 | 30167 |
| 5L-4S | | MI | 14359 | 5329 | 23371 | 3832 | 25070 | 3103 | 25493 | 2545 | 25472 | 1723 | 30009 | 1368 | 17680 |
| 14-#11 | 1.70 | MA | 22957 | 5329 | 36484 | 3980 | 39509 | 3238 | 40270 | 2669 | 40059 | 1844 | 48131 | 1437 | 29258 |
| 6L-3S | | MI | 14728 | 5329 | 24006 | 3823 | 25878 | 3109 | 26458 | 2552 | 26683 | 1716 | 31356 | 1454 | 17663 |
| 14-#11 | 1.70 | MA | 22417 | 5329 | 35491 | 3993 | 38299 | 3237 | 38786 | 2680 | 38066 | 1852 | 45415 | 1349 | 28675 |
| 7L-2S | | MI | 15240 | 5329 | 24787 | 3827 | 26874 | 3101 | 27653 | 2545 | 28262 | 1709 | 33424 | 1543 | 17631 |
| 14-#14 | 2.45 | MA | 26294 | 5671 | 43218 | 4169 | 48111 | 3360 | 50712 | 2756 | 54162 | 1807 | 66233 | 1531 | 43399 |
| 3L-6S | | MI | 14081 | 5671 | 23575 | 4015 | 25196 | 3241 | 25629 | 2636 | 25595 | 1671 | 30546 | 1033 | 23462 |
| 14-#14 | 2.45 | MA | 25380 | 5671 | 41606 | 4188 | 46062 | 3377 | 48225 | 2751 | 50932 | 1818 | 62489 | 1403 | 43110 |
| 4L-5S | | MI | 14530 | 5671 | 24332 | 4022 | 26222 | 3251 | 26801 | 2626 | 27147 | 1661 | 32427 | 1119 | 23912 |
| 14-#14 | 2.45 | MA | 24563 | 5671 | 40194 | 4187 | 44241 | 3374 | 45995 | 2767 | 47750 | 1810 | 58590 | 1339 | 41542 |
| 5L-4S | | MI | 15000 | 5671 | 25132 | 4029 | 27252 | 3241 | 28028 | 2616 | 28839 | 1671 | 34446 | 1177 | 24779 |
| 14-#14 | 2.45 | MA | 23784 | 5671 | 38863 | 4186 | 42431 | 3392 | 43787 | 2762 | 44827 | 1822 | 54874 | 1255 | 40433 |
| 6L-3S | | MI | 15520 | 5671 | 26039 | 4016 | 28405 | 3251 | 29392 | 2626 | 30551 | 1661 | 36347 | 1300 | 24847 |
| 14-#14 | 2.45 | MA | 23024 | 5671 | 37437 | 4205 | 40694 | 3389 | 41658 | 2778 | 41967 | 1834 | 51008 | 1129 | 38604 |
| 7L-2S | | MI | 16238 | 5671 | 27151 | 4022 | 29823 | 3241 | 31082 | 2616 | 32784 | 1651 | 39260 | 1428 | 24844 |
| 14-#18 | 4.35 | MA | 27110 | 6540 | 47096 | 4716 | 52885 | 3788 | 56439 | 3009 | 61862 | 1747 | 77927 | 929 | 68986 |
| 5L-4S | | MI | 16520 | 6540 | 29436 | 4534 | 32433 | 3580 | 34159 | 2789 | 36994 | 1524 | 45082 | 665 | 39967 |
| 14-#18 | 4.35 | MA | 25795 | 6540 | 44752 | 4713 | 49701 | 3782 | 52556 | 2999 | 56721 | 1766 | 71496 | 779 | 64532 |
| 6L-3S | | MI | 17399 | 6540 | 31015 | 4513 | 34401 | 3598 | 36488 | 2807 | 39916 | 1507 | 48312 | 875 | 42199 |
| 14-#18 | 4.35 | MA | 24511 | 6540 | 42244 | 4746 | 46644 | 3811 | 48810 | 3024 | 51690 | 1784 | 64801 | 554 | 60217 |
| 7L-2S | | MI | 18609 | 6540 | 32942 | 4528 | 36822 | 3580 | 39372 | 2789 | 43726 | 1489 | 53244 | 1102 | 42417 |
| 16-#11 | 1.94 | MA | 25398 | 5440 | 40923 | 4036 | 45259 | 3265 | 47273 | 2694 | 49514 | 1824 | 60116 | 1615 | 34771 |
| 3L-7S | | MI | 13750 | 5440 | 22496 | 3903 | 23936 | 3162 | 24130 | 2581 | 23683 | 1718 | 28044 | 1174 | 19217 |
| 16-#11 | 1.94 | MA | 24753 | 5440 | 39799 | 4049 | 43829 | 3277 | 45538 | 2691 | 47262 | 1833 | 57484 | 1527 | 34663 |
| 4L-6S | | MI | 14060 | 5440 | 23062 | 3893 | 24627 | 3154 | 24992 | 2588 | 24757 | 1711 | 29306 | 1241 | 19473 |
| 16-#11 | 1.94 | MA | 24176 | 5440 | 38815 | 4049 | 42560 | 3276 | 43984 | 2703 | 45043 | 1828 | 54751 | 1482 | 34279 |
| 5E | | MI | 14378 | 5440 | 23592 | 3897 | 25345 | 3160 | 25821 | 2581 | 25854 | 1704 | 30642 | 1300 | 19815 |
| 16-#11 | 1.94 | MA | 23627 | 5440 | 37887 | 4049 | 41299 | 3288 | 42445 | 2700 | 43006 | 1837 | 52140 | 1423 | 33407 |
| 6L-4S | | MI | 14710 | 5440 | 24152 | 3902 | 26066 | 3153 | 26689 | 2574 | 27051 | 1711 | 32076 | 1341 | 20054 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.94 | MA | 23091 | 5440 | 36894 | 4062 | 40088 | 3287 | 40961 | 2711 | 41012 | 1845 | 49424 | 1336 | 32841 |
| 7L-3S | | MI | 15077 | 5440 | 24787 | 3892 | 26874 | 3159 | 27653 | 2581 | 28262 | 1704 | 33424 | 1427 | 20053 |
| 16-#11 | 1.94 | MA | 22562 | 5440 | 35984 | 4062 | 38867 | 3299 | 39508 | 2722 | 38924 | 1840 | 46870 | 1284 | 31745 |
| 8L-2S | | MI | 15586 | 5440 | 25568 | 3896 | 27869 | 3151 | 28849 | 2574 | 29841 | 1697 | 35492 | 1516 | 20030 |
| 16-#14 | 2.80 | MA | 26309 | 5831 | 43616 | 4288 | 48624 | 3449 | 51340 | 2796 | 55153 | 1808 | 68198 | 1383 | 49142 |
| 4L-6S | | MI | 14577 | 5831 | 24688 | 4115 | 26614 | 3314 | 27319 | 2678 | 27828 | 1651 | 33458 | 990 | 26604 |
| 16-#14 | 2.80 | MA | 25499 | 5831 | 42205 | 4287 | 46803 | 3447 | 49110 | 2812 | 51970 | 1800 | 64300 | 1319 | 47451 |
| 5E | | MI | 15023 | 5831 | 25445 | 4122 | 27640 | 3323 | 28491 | 2668 | 29379 | 1642 | 35339 | 1076 | 27154 |
| 16-#14 | 2.80 | MA | 24727 | 5831 | 40873 | 4286 | 44994 | 3464 | 46903 | 2807 | 49047 | 1812 | 60584 | 1235 | 46384 |
| 6L-4S | | MI | 15490 | 5831 | 26245 | 4128 | 28671 | 3313 | 29718 | 2658 | 31072 | 1651 | 37359 | 1135 | 27965 |
| 16-#14 | 2.80 | MA | 23974 | 5831 | 39447 | 4305 | 43257 | 3461 | 44773 | 2823 | 46188 | 1824 | 56717 | 1109 | 44481 |
| 7L-3S | | MI | 16007 | 5831 | 27151 | 4115 | 29823 | 3323 | 31082 | 2668 | 32784 | 1642 | 39260 | 1257 | 28216 |
| 16-#14 | 2.80 | MA | 23232 | 5831 | 38140 | 4304 | 41503 | 3479 | 42689 | 2838 | 43192 | 1816 | 53074 | 1034 | 42748 |
| 8L-2S | | MI | 16721 | 5831 | 28264 | 4122 | 31241 | 3313 | 32772 | 2658 | 35016 | 1632 | 42172 | 1385 | 28243 |
| 16-#18 | 4.97 | MA | 27399 | 6824 | 48275 | 4891 | 54193 | 3910 | 58017 | 3079 | 64120 | 1748 | 81388 | 737 | 74792 |
| 6L-4S | | MI | 17342 | 6824 | 31364 | 4711 | 34854 | 3706 | 37044 | 2859 | 40805 | 1485 | 50014 | 578 | 45511 |
| 16-#18 | 4.97 | MA | 26132 | 6824 | 45767 | 4923 | 51136 | 3939 | 54271 | 3104 | 59088 | 1766 | 74693 | 512 | 70389 |
| 7L-3S | | MI | 18214 | 6824 | 32942 | 4691 | 36822 | 3723 | 39372 | 2877 | 43726 | 1467 | 53244 | 788 | 47963 |
| 16-#18 | 4.97 | MA | 24883 | 6824 | 43466 | 4920 | 48051 | 3933 | 50602 | 3129 | 53818 | 1749 | 68359 | 383 | 65544 |
| 8L-2S | | MI | 19413 | 6824 | 34870 | 4706 | 39243 | 3706 | 42257 | 2859 | 47537 | 1450 | 58176 | 1016 | 48236 |
| 18-#11 | 2.18 | MA | 25410 | 5550 | 41203 | 4119 | 45619 | 3328 | 47713 | 2723 | 50209 | 1826 | 61493 | 1513 | 38894 |
| 4L-7S | | MI | 14103 | 5550 | 23277 | 3972 | 24932 | 3212 | 25326 | 2611 | 25262 | 1705 | 30111 | 1147 | 21456 |
| 18-#11 | 2.18 | MA | 24837 | 5550 | 40219 | 4118 | 44349 | 3326 | 46159 | 2734 | 47990 | 1821 | 58760 | 1469 | 38400 |
| 5L-6S | | MI | 14412 | 5550 | 23843 | 3962 | 25623 | 3204 | 26188 | 2618 | 26336 | 1698 | 31373 | 1213 | 21775 |
| 18-#11 | 2.18 | MA | 24292 | 5550 | 39291 | 4118 | 43088 | 3338 | 44620 | 2731 | 45953 | 1830 | 56149 | 1410 | 37561 |
| 6L-5S | | MI | 14728 | 5550 | 24373 | 3967 | 26341 | 3210 | 27017 | 2611 | 27433 | 1692 | 32710 | 1273 | 22095 |
| 18-#11 | 2.18 | MA | 23759 | 5550 | 38298 | 4132 | 41878 | 3337 | 43136 | 2742 | 43959 | 1839 | 53434 | 1323 | 36974 |
| 7L-4S | | MI | 15058 | 5550 | 24933 | 3971 | 27062 | 3203 | 27884 | 2604 | 28630 | 1698 | 34144 | 1313 | 22421 |
| 18-#11 | 2.18 | MA | 23235 | 5550 | 37387 | 4131 | 40656 | 3349 | 41684 | 2753 | 41871 | 1834 | 50879 | 1271 | 35868 |
| 8L-3S | | MI | 15424 | 5550 | 25568 | 3961 | 27869 | 3209 | 28849 | 2611 | 29841 | 1692 | 35492 | 1399 | 22437 |
| 18-#11 | 2.18 | MA | 22675 | 5550 | 36493 | 4131 | 39462 | 3348 | 40181 | 2751 | 39899 | 1842 | 48350 | 1215 | 34905 |
| 9L-2S | | MI | 15931 | 5550 | 26349 | 3965 | 28865 | 3201 | 30045 | 2604 | 31420 | 1685 | 37559 | 1488 | 22422 |
| 18-#14 | 3.14 | MA | 26427 | 5991 | 44215 | 4387 | 49366 | 3519 | 52226 | 2856 | 56191 | 1790 | 70009 | 1299 | 53371 |
| 5L-6S | | MI | 15070 | 5991 | 25800 | 4215 | 28033 | 3386 | 29010 | 2719 | 30060 | 1632 | 36371 | 947 | 29761 |
| 18-#14 | 3.14 | MA | 25662 | 5991 | 42883 | 4386 | 47557 | 3536 | 50018 | 2852 | 53268 | 1802 | 66293 | 1214 | 52341 |
| 6L-5S | | MI | 15513 | 5991 | 26557 | 4221 | 29059 | 3396 | 30182 | 2709 | 31612 | 1622 | 38252 | 1034 | 30404 |
| 18-#14 | 3.14 | MA | 24916 | 5991 | 41458 | 4405 | 45819 | 3534 | 47889 | 2868 | 50408 | 1814 | 62427 | 1088 | 50368 |
| 7L-4S | | MI | 15977 | 5991 | 27357 | 4228 | 30089 | 3386 | 31408 | 2700 | 33305 | 1632 | 40271 | 1092 | 31164 |
| 18-#14 | 3.14 | MA | 24180 | 5991 | 40151 | 4404 | 44066 | 3551 | 45804 | 2883 | 47413 | 1806 | 58783 | 1014 | 48583 |
| 8L-3S | | MI | 16491 | 5991 | 28264 | 4215 | 31241 | 3396 | 32772 | 2709 | 35016 | 1622 | 42172 | 1214 | 31579 |
| 18-#14 | 3.14 | MA | 23413 | 5991 | 38867 | 4403 | 42353 | 3548 | 43647 | 2879 | 44582 | 1818 | 55183 | 933 | 46571 |
| 9L-2S | | MI | 17201 | 5991 | 29376 | 4222 | 32660 | 3386 | 34462 | 2700 | 37249 | 1612 | 45084 | 1342 | 31625 |
| 18-#18 | 5.59 | MA | 27734 | 7108 | 49291 | 5100 | 55629 | 4068 | 59732 | 3184 | 66487 | 1748 | 84584 | 470 | 80581 |
| 7L-4S | | MI | 18159 | 7108 | 33292 | 4888 | 37275 | 3831 | 39928 | 2930 | 44616 | 1445 | 54946 | 492 | 51077 |
| 18-#18 | 5.59 | MA | 26501 | 7108 | 46990 | 5097 | 52543 | 4061 | 56064 | 3209 | 61217 | 1731 | 78250 | 341 | 75687 |
| 8L-3S | | MI | 19022 | 7108 | 34870 | 4868 | 39243 | 3849 | 42257 | 2947 | 47537 | 1428 | 58176 | 702 | 53538 |
| 20-#11 | 2.42 | MA | 25493 | 5661 | 41622 | 4187 | 46139 | 3376 | 48334 | 2765 | 50937 | 1814 | 62769 | 1456 | 42529 |
| 5L-7S | | MI | 14455 | 5661 | 24058 | 4041 | 25928 | 3262 | 26521 | 2641 | 26841 | 1693 | 32179 | 1119 | 23702 |
| 20-#11 | 2.42 | MA | 24952 | 5661 | 40694 | 4187 | 44878 | 3389 | 46795 | 2762 | 48900 | 1823 | 60159 | 1397 | 41721 |
| 6E | | MI | 14762 | 5661 | 24624 | 4032 | 26618 | 3254 | 27383 | 2648 | 27915 | 1686 | 33441 | 1186 | 24079 |
| 20-#11 | 2.42 | MA | 24423 | 5661 | 39701 | 4201 | 43667 | 3387 | 45312 | 2773 | 46906 | 1832 | 57443 | 1310 | 41073 |
| 7L-5S | | MI | 15076 | 5661 | 25154 | 4036 | 27336 | 3261 | 28212 | 2641 | 29012 | 1679 | 34778 | 1245 | 24382 |
| 20-#11 | 2.42 | MA | 23902 | 5661 | 38791 | 4201 | 42445 | 3400 | 43859 | 2785 | 44818 | 1827 | 54888 | 1258 | 39998 |
| 8L-4S | | MI | 15405 | 5661 | 25714 | 4040 | 28058 | 3253 | 29080 | 2634 | 30209 | 1686 | 36212 | 1286 | 24783 |
| 20-#11 | 2.42 | MA | 23346 | 5661 | 37897 | 4200 | 41252 | 3398 | 42356 | 2782 | 42846 | 1835 | 52359 | 1202 | 38999 |
| 9L-3S | | MI | 15769 | 5661 | 26349 | 4030 | 28865 | 3259 | 30045 | 2641 | 31420 | 1679 | 37559 | 1372 | 24812 |
| 20-#11 | 2.42 | MA | 22771 | 5661 | 36920 | 4214 | 40046 | 3410 | 40912 | 2793 | 40889 | 1844 | 49905 | 1138 | 37822 |
| 10L-2S | | MI | 16274 | 5661 | 27130 | 4034 | 29861 | 3252 | 31240 | 2634 | 32999 | 1672 | 39627 | 1460 | 24810 |

## RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

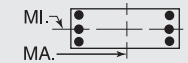
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 3.49 | MA | 26589 | 6150 | 44893 | 4486 | 50119 | 3609 | 53134 | 2897 | 57489 | 1792 | 72002 | 1194 | 58197 |
| 6E | | MI | 15560 | 6150 | 26913 | 4314 | 29451 | 3458 | 30700 | 2761 | 32293 | 1613 | 39283 | 905 | 32931 |
| 20-#14 | 3.49 | MA | 25849 | 6150 | 43468 | 4505 | 48382 | 3606 | 51004 | 2912 | 54629 | 1804 | 68136 | 1068 | 56264 |
| 7L-5S | | MI | 16000 | 6150 | 27670 | 4321 | 30477 | 3468 | 31872 | 2751 | 33845 | 1603 | 41164 | 991 | 33661 |
| 20-#14 | 3.49 | MA | 25120 | 6150 | 42161 | 4504 | 46629 | 3623 | 48920 | 2928 | 51633 | 1796 | 64492 | 993 | 54428 |
| 8L-4S | | MI | 16461 | 6150 | 28470 | 4328 | 31507 | 3458 | 33098 | 2741 | 35537 | 1613 | 43183 | 1049 | 34375 |
| 20-#14 | 3.49 | MA | 24354 | 6150 | 40877 | 4503 | 44916 | 3621 | 46763 | 2924 | 48803 | 1808 | 60892 | 912 | 52448 |
| 9L-3S | | MI | 16971 | 6150 | 29376 | 4315 | 32660 | 3468 | 34462 | 2751 | 37249 | 1603 | 45084 | 1172 | 34935 |
| 20-#14 | 3.49 | MA | 23563 | 6150 | 39476 | 4522 | 43185 | 3638 | 44691 | 2939 | 45994 | 1820 | 57400 | 821 | 50056 |
| 10L-2S | | MI | 17677 | 6150 | 30489 | 4322 | 34078 | 3458 | 36152 | 2741 | 39482 | 1593 | 47997 | 1300 | 35000 |
| 20-#18 | 6.21 | MA | 28101 | 7391 | 50513 | 5275 | 57036 | 4190 | 61525 | 3289 | 68615 | 1713 | 88142 | 299 | 85847 |
| 8L-4S | | MI | 18969 | 7391 | 35220 | 5066 | 39695 | 3956 | 42812 | 3000 | 48427 | 1406 | 59878 | 406 | 56659 |
| 22-#11 | 2.66 | MA | 25607 | 5771 | 42098 | 4256 | 46667 | 3439 | 48971 | 2793 | 51846 | 1816 | 64168 | 1384 | 45885 |
| 6L-7S | | MI | 14805 | 5771 | 24839 | 4110 | 26924 | 3312 | 27717 | 2671 | 28420 | 1681 | 34247 | 1091 | 25956 |
| 22-#11 | 2.66 | MA | 25082 | 5771 | 41105 | 4270 | 45456 | 3437 | 47487 | 2805 | 49853 | 1825 | 61452 | 1297 | 45180 |
| 7L-6S | | MI | 15110 | 5771 | 25405 | 4101 | 27614 | 3305 | 28579 | 2678 | 29494 | 1674 | 35509 | 1158 | 26386 |
| 22-#11 | 2.66 | MA | 24564 | 5771 | 40194 | 4270 | 44235 | 3450 | 46034 | 2816 | 47765 | 1820 | 58898 | 1245 | 44132 |
| 8L-5S | | MI | 15423 | 5771 | 25935 | 4105 | 28332 | 3311 | 29408 | 2671 | 30591 | 1667 | 36846 | 1218 | 26673 |
| 22-#11 | 2.66 | MA | 24019 | 5771 | 39300 | 4269 | 43041 | 3448 | 44531 | 2813 | 45793 | 1829 | 56368 | 1189 | 43097 |
| 9L-4S | | MI | 15750 | 5771 | 26495 | 4109 | 29054 | 3303 | 30276 | 2664 | 31788 | 1674 | 38280 | 1258 | 27142 |
| 22-#11 | 2.66 | MA | 23440 | 5771 | 38324 | 4283 | 41835 | 3461 | 43088 | 2824 | 43836 | 1837 | 53914 | 1125 | 41944 |
| 10L-3S | | MI | 16112 | 5771 | 27130 | 4099 | 29861 | 3309 | 31240 | 2671 | 32999 | 1667 | 39627 | 1344 | 27182 |
| 22-#11 | 2.66 | MA | 22881 | 5771 | 37430 | 4283 | 40649 | 3459 | 41602 | 2822 | 41777 | 1832 | 51420 | 1070 | 40536 |
| 11L-2S | | MI | 16615 | 5771 | 27911 | 4104 | 30857 | 3302 | 32436 | 2664 | 34578 | 1660 | 41695 | 1433 | 27194 |
| 22-#14 | 3.84 | MA | 26775 | 6310 | 45478 | 4604 | 50945 | 3678 | 54120 | 2957 | 58850 | 1794 | 73845 | 1047 | 62167 |
| 7L-6S | | MI | 16046 | 6310 | 28025 | 4414 | 30869 | 3531 | 32390 | 2803 | 34525 | 1594 | 42195 | 862 | 36111 |
| 22-#14 | 3.84 | MA | 26052 | 6310 | 44171 | 4604 | 49192 | 3696 | 52035 | 2973 | 55854 | 1786 | 70202 | 973 | 60281 |
| 8L-5S | | MI | 16484 | 6310 | 28782 | 4421 | 31895 | 3540 | 33562 | 2793 | 36077 | 1584 | 44076 | 948 | 36924 |
| 22-#14 | 3.84 | MA | 25288 | 6310 | 42888 | 4603 | 47479 | 3693 | 49878 | 2968 | 53024 | 1798 | 66602 | 892 | 58270 |
| 9L-4S | | MI | 16942 | 6310 | 29582 | 4428 | 32926 | 3530 | 34789 | 2783 | 37770 | 1594 | 46096 | 1007 | 37596 |
| 22-#14 | 3.84 | MA | 24502 | 6310 | 41487 | 4622 | 45748 | 3710 | 47807 | 2984 | 50215 | 1810 | 63110 | 801 | 55920 |
| 10L-3S | | MI | 17450 | 6310 | 30489 | 4415 | 34078 | 3540 | 36152 | 2793 | 39482 | 1584 | 47997 | 1129 | 38286 |
| 24-#11 | 2.91 | MA | 25737 | 5882 | 42508 | 4339 | 47246 | 3487 | 49662 | 2836 | 52800 | 1818 | 65461 | 1284 | 49292 |
| 7E | | MI | 15153 | 5882 | 25620 | 4180 | 27920 | 3362 | 28913 | 2700 | 29999 | 1668 | 36315 | 1064 | 28214 |
| 24-#11 | 2.91 | MA | 25223 | 5882 | 41598 | 4339 | 46024 | 3500 | 48209 | 2847 | 50712 | 1813 | 62907 | 1232 | 48270 |
| 8L-6S | | MI | 15457 | 5882 | 26187 | 4170 | 28610 | 3355 | 29774 | 2707 | 31073 | 1662 | 37577 | 1131 | 28696 |
| 24-#11 | 2.91 | MA | 24678 | 5882 | 40704 | 4339 | 44831 | 3498 | 46706 | 2844 | 48740 | 1822 | 60377 | 1176 | 47201 |
| 9L-5S | | MI | 15768 | 5882 | 26716 | 4174 | 29328 | 3361 | 30603 | 2700 | 32171 | 1655 | 38914 | 1190 | 28969 |
| 24-#11 | 2.91 | MA | 24105 | 5882 | 39727 | 4352 | 43625 | 3511 | 45263 | 2855 | 46783 | 1830 | 57923 | 1112 | 46071 |
| 10L-4S | | MI | 16094 | 5882 | 27276 | 4178 | 30050 | 3353 | 31471 | 2694 | 33367 | 1662 | 40347 | 1231 | 29497 |
| 24-#11 | 2.91 | MA | 23549 | 5882 | 38834 | 4352 | 42438 | 3509 | 43777 | 2853 | 44724 | 1825 | 55429 | 1057 | 44640 |
| 11L-3S | | MI | 16454 | 5882 | 27911 | 4169 | 30857 | 3360 | 32436 | 2700 | 34578 | 1655 | 41695 | 1317 | 29548 |
| 24-#11 | 2.91 | MA | 23003 | 5882 | 37873 | 4365 | 41240 | 3522 | 42337 | 2864 | 42769 | 1834 | 52685 | 983 | 43268 |
| 12L-2S | | MI | 16955 | 5882 | 28692 | 4173 | 31853 | 3352 | 33631 | 2694 | 36157 | 1648 | 43763 | 1405 | 29571 |
| 24-#14 | 4.19 | MA | 26977 | 6469 | 46181 | 4703 | 51755 | 3768 | 55151 | 3018 | 60075 | 1776 | 75911 | 952 | 66142 |
| 8L-6S | | MI | 16530 | 6469 | 29138 | 4514 | 32288 | 3603 | 34080 | 2845 | 36758 | 1575 | 45108 | 819 | 39302 |
| 24-#14 | 4.19 | MA | 26214 | 6469 | 44898 | 4703 | 50042 | 3765 | 52994 | 3013 | 57245 | 1788 | 72311 | 871 | 64100 |
| 9L-5S | | MI | 16966 | 6469 | 29895 | 4521 | 33314 | 3613 | 35252 | 2835 | 38310 | 1565 | 46989 | 906 | 40191 |
| 24-#14 | 4.19 | MA | 25434 | 6469 | 43497 | 4722 | 48311 | 3783 | 50922 | 3029 | 54436 | 1800 | 68819 | 780 | 61791 |
| 10L-4S | | MI | 17421 | 6469 | 30695 | 4527 | 34344 | 3603 | 36479 | 2825 | 40002 | 1575 | 49008 | 964 | 40827 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis

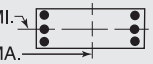



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.19 | MA | 26363 | 5320 | 41393 | 3964 | 45080 | 3227 | 46304 | 2682 | 46884 | 1903 | 55624 | 1795 | 23344 |
| 2E | | MI | 15034 | 5320 | 24149 | 3785 | 25582 | 3072 | 25785 | 2537 | 25413 | 1763 | 29398 | 1608 | 12972 |
| 6-#14 | 1.00 | MA | 25885 | 5231 | 40202 | 3932 | 43711 | 3205 | 44699 | 2673 | 44734 | 1921 | 52950 | 1829 | 19933 |
| 2L-3S | | MI | 14091 | 5231 | 22431 | 3761 | 23596 | 3081 | 23469 | 2559 | 22367 | 1815 | 25519 | 1545 | 11245 |
| 6-#14 | 1.00 | MA | 24469 | 5231 | 38092 | 3931 | 41022 | 3203 | 41429 | 2689 | 40304 | 1933 | 46929 | 1701 | 19970 |
| 3L-2S | | MI | 14828 | 5231 | 23543 | 3768 | 25015 | 3071 | 25159 | 2549 | 24599 | 1805 | 28431 | 1673 | 11162 |
| 6-#18 | 1.79 | MA | 28085 | 5604 | 45094 | 4142 | 49798 | 3355 | 52040 | 2762 | 54655 | 1885 | 66070 | 1756 | 34650 |
| 2L-3S | | MI | 14622 | 5604 | 24149 | 3947 | 25582 | 3215 | 25785 | 2625 | 25413 | 1741 | 29398 | 1294 | 19047 |
| 6-#18 | 1.79 | MA | 25652 | 5604 | 41393 | 4139 | 45080 | 3385 | 46304 | 2788 | 46884 | 1905 | 55624 | 1528 | 34474 |
| 3L-2S | | MI | 15880 | 5604 | 26077 | 3962 | 28002 | 3197 | 28669 | 2608 | 29224 | 1724 | 34330 | 1522 | 18958 |
| 8-#14 | 1.34 | MA | 26885 | 5391 | 42311 | 4031 | 46401 | 3278 | 47969 | 2718 | 49164 | 1911 | 58972 | 1810 | 26385 |
| 2L-4S | | MI | 14062 | 5391 | 22637 | 3874 | 23862 | 3143 | 23795 | 2591 | 22888 | 1806 | 26530 | 1380 | 14739 |
| 8-#14 | 1.34 | MA | 25481 | 5391 | 40202 | 4031 | 43711 | 3275 | 44699 | 2734 | 44734 | 1923 | 52950 | 1682 | 26377 |
| 3E | | MI | 14593 | 5391 | 23543 | 3861 | 25015 | 3153 | 25159 | 2601 | 24599 | 1796 | 28431 | 1503 | 14691 |
| 8-#14 | 1.34 | MA | 24494 | 5391 | 38512 | 4050 | 41562 | 3293 | 42091 | 2730 | 41347 | 1936 | 48998 | 1554 | 26213 |
| 4L-2S | | MI | 15326 | 5391 | 24656 | 3868 | 26433 | 3143 | 26849 | 2591 | 26832 | 1786 | 31343 | 1631 | 14623 |
| 8-#18 | 2.38 | MA | 29780 | 5887 | 48795 | 4319 | 54517 | 3484 | 57776 | 2842 | 62426 | 1868 | 76516 | 1716 | 45898 |
| 2L-4S | | MI | 14562 | 5887 | 24499 | 4145 | 26034 | 3322 | 26341 | 2678 | 26303 | 1719 | 31100 | 998 | 23752 |
| 8-#18 | 2.38 | MA | 27378 | 5887 | 45094 | 4317 | 49798 | 3514 | 52040 | 2868 | 54655 | 1887 | 66070 | 1489 | 45609 |
| 3E | | MI | 15469 | 5887 | 26077 | 4124 | 28002 | 3340 | 28669 | 2696 | 29224 | 1702 | 34330 | 1208 | 24899 |
| 8-#18 | 2.38 | MA | 25688 | 5887 | 42123 | 4350 | 46020 | 3508 | 47455 | 2859 | 48701 | 1907 | 59228 | 1261 | 43370 |
| 4L-2S | | MI | 16715 | 5887 | 28005 | 4139 | 30423 | 3322 | 31554 | 2678 | 33035 | 1684 | 39262 | 1436 | 24889 |
| 10-#11 | 1.16 | MA | 26392 | 5306 | 41174 | 3989 | 45027 | 3248 | 46328 | 2702 | 46954 | 1922 | 56092 | 1831 | 23034 |
| 2L-5S | | MI | 13868 | 5306 | 22088 | 3835 | 23223 | 3130 | 23073 | 2593 | 21865 | 1819 | 25263 | 1458 | 12967 |
| 10-#11 | 1.16 | MA | 25407 | 5306 | 39701 | 3989 | 43150 | 3247 | 44046 | 2713 | 43862 | 1932 | 51866 | 1742 | 23051 |
| 3L-4S | | MI | 14206 | 5306 | 22648 | 3840 | 23944 | 3122 | 23941 | 2587 | 23062 | 1826 | 26697 | 1499 | 12937 |
| 10-#11 | 1.16 | MA | 24716 | 5306 | 38523 | 4003 | 41652 | 3260 | 42227 | 2711 | 41501 | 1941 | 49089 | 1654 | 23006 |
| 4L-3S | | MI | 14580 | 5306 | 23284 | 3830 | 24751 | 3128 | 24905 | 2593 | 24273 | 1819 | 28044 | 1585 | 12889 |
| 10-#11 | 1.16 | MA | 24098 | 5306 | 37492 | 4003 | 40322 | 3259 | 40598 | 2723 | 39176 | 1936 | 46213 | 1608 | 22859 |
| 5L-2S | | MI | 15097 | 5306 | 24065 | 3834 | 25747 | 3121 | 26101 | 2587 | 25852 | 1812 | 30112 | 1674 | 12841 |
| 10-#14 | 1.67 | MA | 27874 | 5550 | 44421 | 4131 | 49091 | 3350 | 51239 | 2763 | 53594 | 1901 | 64994 | 1791 | 32820 |
| 2L-5S | | MI | 14086 | 5550 | 22949 | 3967 | 24250 | 3225 | 24258 | 2643 | 23428 | 1777 | 27423 | 1279 | 17602 |
| 10-#14 | 1.67 | MA | 26481 | 5550 | 42311 | 4131 | 46401 | 3348 | 47969 | 2779 | 49164 | 1914 | 58972 | 1663 | 32769 |
| 3L-4S | | MI | 14564 | 5550 | 23749 | 3974 | 25281 | 3215 | 25485 | 2633 | 25120 | 1787 | 29442 | 1338 | 18123 |
| 10-#14 | 1.67 | MA | 25504 | 5550 | 40622 | 4150 | 44252 | 3366 | 45361 | 2775 | 45777 | 1926 | 55020 | 1535 | 32557 |
| 4L-3S | | MI | 15092 | 5550 | 24656 | 3961 | 26433 | 3225 | 26849 | 2643 | 26832 | 1777 | 31343 | 1460 | 18111 |
| 10-#14 | 1.67 | MA | 24629 | 5550 | 39142 | 4150 | 42344 | 3363 | 43023 | 2791 | 42441 | 1919 | 50914 | 1470 | 31351 |
| 5L-2S | | MI | 15820 | 5550 | 25768 | 3967 | 27851 | 3215 | 28539 | 2633 | 29065 | 1767 | 34256 | 1588 | 18060 |
| 10-#18 | 2.98 | MA | 29077 | 6171 | 48795 | 4494 | 54517 | 3642 | 57776 | 2948 | 62426 | 1870 | 76516 | 1449 | 56732 |
| 3L-4S | | MI | 15409 | 6171 | 26427 | 4322 | 28455 | 3448 | 29225 | 2748 | 30114 | 1680 | 36032 | 911 | 29189 |
| 10-#18 | 2.98 | MA | 27411 | 6171 | 45824 | 4527 | 50738 | 3637 | 53191 | 2939 | 56472 | 1889 | 69674 | 1222 | 54054 |
| 4L-3S | | MI | 16307 | 6171 | 28005 | 4302 | 30423 | 3465 | 31554 | 2766 | 33035 | 1662 | 39262 | 1122 | 30716 |
| 10-#18 | 2.98 | MA | 25920 | 6171 | 43220 | 4525 | 47380 | 3666 | 49078 | 2965 | 50604 | 1873 | 62527 | 1110 | 50840 |
| 5L-2S | | MI | 17541 | 6171 | 29932 | 4316 | 32844 | 3448 | 34438 | 2748 | 36846 | 1645 | 44194 | 1349 | 30786 |
| 12-#11 | 1.39 | MA | 27090 | 5416 | 42646 | 4059 | 46905 | 3299 | 48611 | 2733 | 50046 | 1915 | 60318 | 1819 | 27530 |
| 2L-6S | | MI | 13904 | 5416 | 22340 | 3900 | 23500 | 3173 | 23439 | 2630 | 22346 | 1813 | 25994 | 1371 | 14982 |
| 12-#11 | 1.39 | MA | 26111 | 5416 | 41174 | 4059 | 45027 | 3297 | 46328 | 2745 | 46954 | 1925 | 56092 | 1730 | 27524 |
| 3L-5S | | MI | 14225 | 5416 | 22870 | 3905 | 24218 | 3180 | 24269 | 2623 | 23444 | 1806 | 27331 | 1431 | 15344 |
| 12-#11 | 1.39 | MA | 25424 | 5416 | 39996 | 4072 | 43529 | 3310 | 44510 | 2742 | 44593 | 1934 | 53315 | 1642 | 27457 |
| 4E | | MI | 14561 | 5416 | 23429 | 3909 | 24940 | 3172 | 25136 | 2616 | 24641 | 1813 | 28765 | 1471 | 15335 |
| 12-#11 | 1.39 | MA | 24811 | 5416 | 38965 | 4072 | 42199 | 3309 | 42881 | 2754 | 42268 | 1929 | 50439 | 1596 | 27286 |
| 5L-3S | | MI | 14933 | 5416 | 24065 | 3899 | 25747 | 3178 | 26101 | 2623 | 25852 | 1806 | 30112 | 1557 | 15300 |
| 12-#11 | 1.39 | MA | 24226 | 5416 | 37993 | 4072 | 40878 | 3322 | 41269 | 2752 | 40133 | 1939 | 47686 | 1538 | 26405 |
| 6L-2S | | MI | 15448 | 5416 | 24846 | 3903 | 26743 | 3171 | 27296 | 2616 | 27431 | 1800 | 32180 | 1646 | 15259 |
| 12-#14 | 2.01 | MA | 28853 | 5710 | 46531 | 4231 | 51781 | 3422 | 54509 | 2808 | 58024 | 1891 | 71015 | 1771 | 39236 |
| 2L-6S | | MI | 14134 | 5710 | 23305 | 4060 | 24643 | 3288 | 24776 | 2695 | 24108 | 1768 | 28454 | 1150 | 20362 |

## RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

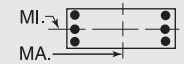
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 2.01 | MA | 27471 | 5710 | 44421 | 4230 | 49091 | 3420 | 51239 | 2824 | 53594 | 1904 | 64994 | 1644 | 39151 |
| 3L-5S | | MI | 14588 | 5710 | 24062 | 4067 | 25669 | 3298 | 25948 | 2685 | 25660 | 1758 | 30335 | 1237 | 20817 |
| 12-#14 | 2.01 | MA | 26503 | 5710 | 42732 | 4250 | 46942 | 3438 | 48631 | 2820 | 50208 | 1916 | 61041 | 1516 | 38898 |
| 4E | | MI | 15062 | 5710 | 24862 | 4074 | 26699 | 3288 | 27175 | 2675 | 27353 | 1768 | 32355 | 1295 | 21490 |
| 12-#14 | 2.01 | MA | 25637 | 5710 | 41252 | 4249 | 45034 | 3436 | 46293 | 2836 | 46871 | 1909 | 56935 | 1451 | 37526 |
| 5L-3S | | MI | 15586 | 5710 | 25768 | 4060 | 27851 | 3298 | 28539 | 2685 | 29065 | 1758 | 34256 | 1417 | 21514 |
| 12-#14 | 2.01 | MA | 24811 | 5710 | 39857 | 4249 | 43137 | 3453 | 43980 | 2832 | 43808 | 1921 | 53014 | 1367 | 36274 |
| 6L-2S | | MI | 16310 | 5710 | 26881 | 4067 | 29270 | 3288 | 30229 | 2675 | 31297 | 1748 | 37168 | 1545 | 21480 |
| 12-#18 | 3.57 | MA | 29109 | 6455 | 49525 | 4704 | 55457 | 3765 | 58927 | 3019 | 64243 | 1871 | 80119 | 1182 | 64782 |
| 4E | | MI | 16247 | 6455 | 28354 | 4499 | 30876 | 3573 | 32109 | 2819 | 33925 | 1641 | 40964 | 825 | 34669 |
| 12-#18 | 3.57 | MA | 27639 | 6455 | 46921 | 4702 | 52098 | 3795 | 54814 | 3045 | 58375 | 1856 | 72973 | 1070 | 61727 |
| 5L-3S | | MI | 17137 | 6455 | 29932 | 4479 | 32844 | 3591 | 34438 | 2836 | 36846 | 1623 | 44194 | 1035 | 36511 |
| 12-#18 | 3.57 | MA | 26238 | 6455 | 44464 | 4700 | 48760 | 3789 | 50742 | 3036 | 52984 | 1875 | 66178 | 920 | 57383 |
| 6L-2S | | MI | 18360 | 6455 | 31860 | 4494 | 35265 | 3573 | 37322 | 2819 | 40657 | 1605 | 49126 | 1263 | 36649 |
| 14-#11 | 1.63 | MA | 27783 | 5527 | 44119 | 4128 | 48783 | 3349 | 50893 | 2764 | 53138 | 1909 | 64544 | 1807 | 32020 |
| 2L-7S | | MI | 13948 | 5527 | 22554 | 3979 | 23806 | 3231 | 23773 | 2653 | 22852 | 1808 | 26800 | 1277 | 17063 |
| 14-#11 | 1.63 | MA | 26809 | 5527 | 42646 | 4128 | 46905 | 3348 | 48611 | 2776 | 50046 | 1918 | 60318 | 1718 | 31992 |
| 3L-6S | | MI | 14260 | 5527 | 23121 | 3970 | 24496 | 3224 | 24635 | 2660 | 23926 | 1801 | 28062 | 1344 | 17274 |
| 14-#11 | 1.63 | MA | 26127 | 5527 | 41468 | 4142 | 45407 | 3360 | 46792 | 2773 | 47685 | 1927 | 57541 | 1629 | 31905 |
| 4L-5S | | MI | 14580 | 5527 | 23651 | 3974 | 25214 | 3230 | 25464 | 2653 | 25023 | 1794 | 29399 | 1403 | 17650 |
| 14-#11 | 1.63 | MA | 25518 | 5527 | 40437 | 4142 | 44077 | 3359 | 45163 | 2785 | 45360 | 1923 | 54665 | 1584 | 31711 |
| 5L-4S | | MI | 14914 | 5527 | 24211 | 3978 | 25936 | 3222 | 26332 | 2646 | 26220 | 1801 | 30832 | 1444 | 17723 |
| 14-#11 | 1.63 | MA | 24938 | 5527 | 39465 | 4142 | 42755 | 3372 | 43551 | 2783 | 43225 | 1932 | 51912 | 1526 | 30752 |
| 6L-3S | | MI | 15284 | 5527 | 24846 | 3968 | 26743 | 3228 | 27296 | 2653 | 27431 | 1794 | 32180 | 1530 | 17700 |
| 14-#11 | 1.63 | MA | 24371 | 5527 | 38425 | 4155 | 41487 | 3371 | 41996 | 2794 | 41137 | 1941 | 49049 | 1439 | 30123 |
| 7L-2S | | MI | 15797 | 5527 | 25627 | 3972 | 27739 | 3221 | 28492 | 2646 | 29010 | 1787 | 34248 | 1618 | 17667 |
| 14-#14 | 2.34 | MA | 28452 | 5869 | 46531 | 4330 | 51781 | 3492 | 54509 | 2869 | 58024 | 1894 | 71015 | 1624 | 45526 |
| 3L-6S | | MI | 14635 | 5869 | 24417 | 4160 | 26061 | 3360 | 26466 | 2737 | 26341 | 1748 | 31367 | 1108 | 23623 |
| 14-#14 | 2.34 | MA | 27492 | 5870 | 44842 | 4350 | 49632 | 3510 | 51901 | 2865 | 54638 | 1906 | 67063 | 1496 | 45236 |
| 4L-5S | | MI | 15085 | 5870 | 25174 | 4166 | 27087 | 3370 | 27638 | 2727 | 27893 | 1738 | 33247 | 1194 | 24047 |
| 14-#14 | 2.34 | MA | 26634 | 5869 | 43362 | 4349 | 47724 | 3508 | 49563 | 2881 | 51302 | 1899 | 62957 | 1432 | 43718 |
| 5L-4S | | MI | 15556 | 5870 | 25974 | 4173 | 28117 | 3360 | 28865 | 2717 | 29585 | 1748 | 35267 | 1252 | 24846 |
| 14-#14 | 2.34 | MA | 25816 | 5869 | 41967 | 4349 | 45827 | 3526 | 47250 | 2877 | 48238 | 1911 | 59036 | 1348 | 42515 |
| 6L-3S | | MI | 16077 | 5870 | 26881 | 4160 | 29270 | 3370 | 30229 | 2727 | 31297 | 1738 | 37168 | 1375 | 24901 |
| 14-#14 | 2.34 | MA | 25018 | 5869 | 40473 | 4368 | 44007 | 3524 | 45018 | 2893 | 45241 | 1924 | 54958 | 1222 | 40714 |
| 7L-2S | | MI | 16797 | 5869 | 27993 | 4167 | 30688 | 3360 | 31919 | 2717 | 33530 | 1728 | 40080 | 1503 | 24889 |
| 14-#18 | 4.17 | MA | 29335 | 6738 | 50622 | 4879 | 56817 | 3923 | 60550 | 3125 | 66146 | 1838 | 83419 | 1031 | 72634 |
| 5L-4S | | MI | 17077 | 6738 | 30282 | 4677 | 33297 | 3698 | 34993 | 2889 | 37736 | 1601 | 45896 | 739 | 40184 |
| 14-#18 | 4.17 | MA | 27953 | 6738 | 48165 | 4877 | 53479 | 3918 | 56478 | 3116 | 60755 | 1857 | 76624 | 881 | 68150 |
| 6L-3S | | MI | 17959 | 6738 | 31860 | 4656 | 35265 | 3716 | 37322 | 2907 | 40657 | 1583 | 49126 | 949 | 42292 |
| 14-#18 | 4.17 | MA | 26604 | 6738 | 45535 | 4910 | 50273 | 3947 | 52550 | 3142 | 55479 | 1877 | 69552 | 656 | 63790 |
| 7L-2S | | MI | 19172 | 6738 | 33788 | 4671 | 37686 | 3698 | 40206 | 2889 | 44468 | 1566 | 54058 | 1177 | 42487 |
| 16-#11 | 1.86 | MA | 27503 | 5638 | 44119 | 4197 | 48783 | 3398 | 50893 | 2807 | 53138 | 1911 | 64544 | 1706 | 36455 |
| 3L-7S | | MI | 14304 | 5638 | 23336 | 4048 | 24802 | 3281 | 24969 | 2683 | 24431 | 1796 | 28868 | 1250 | 19371 |
| 16-#11 | 1.86 | MA | 26825 | 5638 | 42941 | 4211 | 47284 | 3410 | 49075 | 2805 | 50777 | 1920 | 61767 | 1617 | 36348 |
| 4L-6S | | MI | 14615 | 5638 | 23902 | 4039 | 25492 | 3274 | 25831 | 2690 | 25505 | 1789 | 30129 | 1316 | 19572 |
| 16-#11 | 1.86 | MA | 26220 | 5638 | 41910 | 4211 | 45954 | 3409 | 47445 | 2816 | 48452 | 1916 | 58891 | 1572 | 36060 |
| 5E | | MI | 14933 | 5638 | 24432 | 4043 | 26210 | 3280 | 26660 | 2683 | 26602 | 1782 | 31466 | 1376 | 19922 |
| 16-#11 | 1.86 | MA | 25644 | 5638 | 40938 | 4211 | 44633 | 3422 | 45833 | 2814 | 46317 | 1925 | 56138 | 1514 | 35107 |
| 6L-4S | | MI | 15266 | 5638 | 24992 | 4047 | 26931 | 3272 | 27527 | 2676 | 27799 | 1789 | 32900 | 1416 | 20102 |
| 16-#11 | 1.86 | MA | 25081 | 5638 | 39897 | 4225 | 43364 | 3421 | 44279 | 2825 | 44229 | 1934 | 53275 | 1426 | 34497 |
| 7L-3S | | MI | 15634 | 5638 | 25627 | 4037 | 27739 | 3279 | 28492 | 2683 | 29010 | 1782 | 34248 | 1502 | 20093 |
| 16-#11 | 1.86 | MA | 24527 | 5638 | 38944 | 4225 | 42085 | 3433 | 42757 | 2837 | 42041 | 1930 | 50586 | 1374 | 33427 |
| 8L-2S | | MI | 16144 | 5638 | 26408 | 4042 | 28735 | 3271 | 29687 | 2676 | 30589 | 1775 | 36315 | 1591 | 20067 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis

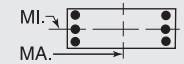



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.68 | MA | 28472 | 6029 | 46951 | 4449 | 52322 | 3582 | 55171 | 2910 | 59068 | 1896 | 73084 | 1477 | 51572 |
| 4L-6S | | MI | 15132 | 6029 | 25530 | 4259 | 27479 | 3432 | 28156 | 2779 | 28574 | 1729 | 34279 | 1065 | 26827 |
| 16-#14 | 2.68 | MA | 27621 | 6029 | 45472 | 4449 | 50414 | 3580 | 52833 | 2926 | 55732 | 1889 | 68979 | 1413 | 49923 |
| 5E | | MI | 15579 | 6029 | 26287 | 4266 | 28505 | 3442 | 29328 | 2769 | 30125 | 1719 | 36160 | 1151 | 27288 |
| 16-#14 | 2.68 | MA | 26811 | 6029 | 44077 | 4448 | 48517 | 3598 | 50520 | 2922 | 52668 | 1901 | 65058 | 1329 | 48765 |
| 6L-4S | | MI | 16047 | 6029 | 27087 | 4273 | 29536 | 3432 | 30555 | 2759 | 31818 | 1729 | 38179 | 1210 | 28125 |
| 16-#14 | 2.68 | MA | 26020 | 6029 | 42583 | 4468 | 46697 | 3596 | 48288 | 2938 | 49671 | 1914 | 60979 | 1203 | 46888 |
| 7L-3S | | MI | 16565 | 6029 | 27993 | 4260 | 30688 | 3442 | 31919 | 2769 | 33530 | 1719 | 40080 | 1332 | 28274 |
| 16-#14 | 2.68 | MA | 25240 | 6029 | 41213 | 4468 | 44860 | 3614 | 46104 | 2954 | 46531 | 1907 | 57142 | 1128 | 45191 |
| 8L-2S | | MI | 17280 | 6029 | 29106 | 4267 | 32106 | 3432 | 33609 | 2759 | 35762 | 1709 | 42993 | 1460 | 28288 |
| 16-#18 | 4.76 | MA | 29646 | 7022 | 51866 | 5055 | 58197 | 4046 | 62214 | 3195 | 68526 | 1840 | 87069 | 841 | 78939 |
| 6L-4S | | MI | 17901 | 7022 | 32210 | 4854 | 35718 | 3823 | 37878 | 2959 | 41546 | 1562 | 50828 | 652 | 45726 |
| 16-#18 | 4.76 | MA | 28315 | 7022 | 49236 | 5088 | 54992 | 4076 | 58286 | 3222 | 63250 | 1859 | 79998 | 617 | 74493 |
| 7L-3S | | MI | 18775 | 7022 | 33788 | 4834 | 37686 | 3841 | 40206 | 2977 | 44468 | 1544 | 54058 | 863 | 48061 |
| 16-#18 | 4.76 | MA | 27002 | 7022 | 46824 | 5085 | 51757 | 4070 | 54440 | 3248 | 57724 | 1843 | 73319 | 486 | 69552 |
| 8L-2S | | MI | 19978 | 7022 | 35716 | 4848 | 40107 | 3823 | 43091 | 2959 | 48279 | 1526 | 58990 | 1090 | 48311 |
| 18-#11 | 2.09 | MA | 27518 | 5748 | 44414 | 4280 | 49162 | 3460 | 51357 | 2836 | 53869 | 1913 | 65993 | 1605 | 40790 |
| 4L-7S | | MI | 14658 | 5748 | 24117 | 4117 | 25797 | 3331 | 26164 | 2713 | 26010 | 1783 | 30935 | 1222 | 21616 |
| 18-#11 | 2.09 | MA | 26917 | 5748 | 43383 | 4280 | 47832 | 3459 | 49728 | 2847 | 51544 | 1909 | 63117 | 1560 | 40386 |
| 5L-6S | | MI | 14967 | 5748 | 24683 | 4108 | 26488 | 3324 | 27026 | 2720 | 27084 | 1776 | 32197 | 1289 | 21874 |
| 18-#11 | 2.09 | MA | 26344 | 5748 | 42411 | 4280 | 46510 | 3472 | 48116 | 2845 | 49409 | 1918 | 60364 | 1502 | 39468 |
| 6L-5S | | MI | 15284 | 5748 | 25213 | 4112 | 27206 | 3330 | 27855 | 2713 | 28181 | 1770 | 33534 | 1348 | 22203 |
| 18-#11 | 2.09 | MA | 25786 | 5748 | 41370 | 4294 | 45242 | 3471 | 46561 | 2856 | 47321 | 1927 | 57501 | 1414 | 38875 |
| 7L-4S | | MI | 15615 | 5748 | 25773 | 4116 | 27927 | 3322 | 28723 | 2706 | 29378 | 1776 | 34968 | 1389 | 22472 |
| 18-#11 | 2.09 | MA | 25235 | 5748 | 40416 | 4294 | 43962 | 3484 | 45039 | 2868 | 45133 | 1923 | 54812 | 1362 | 37757 |
| 8L-3S | | MI | 15981 | 5748 | 26408 | 4107 | 28735 | 3329 | 29687 | 2713 | 30589 | 1770 | 36315 | 1475 | 22480 |
| 18-#11 | 2.09 | MA | 24640 | 5748 | 39480 | 4294 | 42712 | 3482 | 43464 | 2866 | 43067 | 1932 | 52144 | 1306 | 36838 |
| 9L-2S | | MI | 16489 | 5748 | 27189 | 4111 | 29731 | 3321 | 30883 | 2706 | 32168 | 1763 | 38383 | 1563 | 22461 |
| 18-#14 | 3.01 | MA | 28600 | 6189 | 47582 | 4549 | 53104 | 3653 | 56103 | 2971 | 60162 | 1879 | 75000 | 1394 | 56140 |
| 5L-6S | | MI | 15625 | 6189 | 26642 | 4359 | 28898 | 3505 | 29847 | 2820 | 30806 | 1710 | 37191 | 1022 | 29981 |
| 18-#14 | 3.01 | MA | 27797 | 6189 | 46186 | 4548 | 51207 | 3670 | 53790 | 2967 | 57098 | 1892 | 71079 | 1310 | 55022 |
| 6L-5S | | MI | 16070 | 6189 | 27399 | 4366 | 29924 | 3515 | 31019 | 2810 | 32358 | 1700 | 39072 | 1109 | 30539 |
| 18-#14 | 3.01 | MA | 27013 | 6189 | 44693 | 4568 | 49387 | 3668 | 51558 | 2983 | 54101 | 1904 | 67001 | 1184 | 53072 |
| 7L-4S | | MI | 16535 | 6189 | 28199 | 4373 | 30954 | 3505 | 32245 | 2801 | 34050 | 1710 | 41092 | 1167 | 31322 |
| 18-#14 | 3.01 | MA | 26241 | 6189 | 43323 | 4567 | 47550 | 3686 | 49374 | 2999 | 50961 | 1897 | 63163 | 1109 | 51324 |
| 8L-3S | | MI | 17050 | 6189 | 29106 | 4360 | 32106 | 3515 | 33609 | 2810 | 35762 | 1700 | 42993 | 1289 | 31640 |
| 18-#14 | 3.01 | MA | 25425 | 6189 | 41979 | 4567 | 45755 | 3684 | 47113 | 2995 | 47995 | 1909 | 59364 | 1028 | 49221 |
| 9L-2S | | MI | 17761 | 6189 | 30218 | 4366 | 33525 | 3505 | 35299 | 2801 | 37995 | 1690 | 45905 | 1417 | 31677 |
| 18-#18 | 5.36 | MA | 30006 | 7306 | 52937 | 5265 | 59710 | 4205 | 64022 | 3302 | 71021 | 1842 | 90444 | 577 | 85215 |
| 7L-4S | | MI | 18719 | 7306 | 34138 | 5031 | 38139 | 3948 | 40762 | 3030 | 45357 | 1522 | 55760 | 566 | 51289 |
| 18-#18 | 5.36 | MA | 28709 | 7306 | 50525 | 5263 | 56476 | 4199 | 60176 | 3328 | 65495 | 1826 | 83765 | 447 | 80228 |
| 8L-3S | | MI | 19585 | 7306 | 35716 | 5011 | 40107 | 3966 | 43091 | 3047 | 48279 | 1505 | 58990 | 776 | 53822 |
| 20-#11 | 2.32 | MA | 27609 | 5859 | 44855 | 4349 | 49709 | 3509 | 52010 | 2878 | 54636 | 1902 | 67343 | 1548 | 44720 |
| 5L-7S | | MI | 15010 | 5859 | 24898 | 4187 | 26793 | 3382 | 27360 | 2742 | 27589 | 1771 | 33003 | 1194 | 23862 |
| 20-#11 | 2.32 | MA | 27040 | 5859 | 43883 | 4349 | 48388 | 3522 | 50398 | 2876 | 52501 | 1911 | 64590 | 1490 | 43834 |
| 6E | | MI | 15318 | 5859 | 25464 | 4177 | 27484 | 3374 | 28222 | 2749 | 28663 | 1764 | 34265 | 1261 | 24179 |
| 20-#11 | 2.32 | MA | 26486 | 5859 | 42843 | 4363 | 47119 | 3521 | 48843 | 2888 | 50413 | 1920 | 61727 | 1402 | 43256 |
| 7L-5S | | MI | 15633 | 5859 | 25994 | 4181 | 28202 | 3380 | 29051 | 2742 | 29760 | 1757 | 35602 | 1321 | 24489 |
| 20-#11 | 2.32 | MA | 25939 | 5859 | 41889 | 4363 | 45840 | 3534 | 47322 | 2899 | 48225 | 1916 | 59038 | 1350 | 42093 |
| 8L-4S | | MI | 15962 | 5859 | 26554 | 4185 | 28923 | 3373 | 29919 | 2736 | 30957 | 1764 | 37036 | 1361 | 24837 |
| 20-#11 | 2.32 | MA | 25347 | 5859 | 40953 | 4363 | 44589 | 3533 | 45747 | 2897 | 46159 | 1925 | 56370 | 1294 | 41138 |
| 9L-3S | | MI | 16327 | 5859 | 27189 | 4176 | 29731 | 3379 | 30883 | 2742 | 32168 | 1757 | 38383 | 1447 | 24862 |
| 20-#11 | 2.32 | MA | 24743 | 5859 | 39930 | 4377 | 43326 | 3545 | 44235 | 2908 | 44108 | 1934 | 53782 | 1230 | 39862 |
| 10L-2S | | MI | 16832 | 5859 | 27970 | 4180 | 30726 | 3371 | 32079 | 2736 | 33747 | 1750 | 40451 | 1536 | 24851 |
| 20-#14 | 3.35 | MA | 28775 | 6348 | 48296 | 4648 | 53897 | 3743 | 57060 | 3012 | 61529 | 1882 | 77101 | 1291 | 61284 |
| 6E | | MI | 16116 | 6348 | 27755 | 4459 | 30316 | 3577 | 31537 | 2862 | 33039 | 1691 | 40104 | 980 | 33148 |
| 20-#14 | 3.35 | MA | 27998 | 6348 | 46803 | 4667 | 52077 | 3741 | 54828 | 3028 | 58531 | 1894 | 73022 | 1164 | 59265 |
| 7L-5S | | MI | 16558 | 6348 | 28512 | 4466 | 31342 | 3587 | 32709 | 2852 | 34591 | 1681 | 41985 | 1066 | 33796 |

## RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

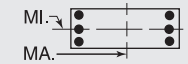
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 3.35 | MA | 27232 | 6348 | 45433 | 4667 | 50240 | 3758 | 52644 | 3044 | 55392 | 1887 | 69185 | 1089 | 57466 |
| 8L-4S | | MI | 17020 | 6348 | 29312 | 4472 | 32372 | 3577 | 33935 | 2842 | 36283 | 1691 | 44004 | 1125 | 34531 |
| 20-#14 | 3.35 | MA | 26418 | 6348 | 44089 | 4667 | 48445 | 3756 | 50383 | 3040 | 52426 | 1899 | 65386 | 1009 | 55408 |
| 9L-3S | | MI | 17531 | 6348 | 30218 | 4459 | 33525 | 3587 | 35299 | 2852 | 37995 | 1681 | 45905 | 1247 | 34999 |
| 20-#14 | 3.35 | MA | 25558 | 6348 | 42621 | 4686 | 46631 | 3774 | 48213 | 3056 | 49482 | 1912 | 61701 | 917 | 52911 |
| 10L-2S | | MI | 18239 | 6348 | 31331 | 4466 | 34943 | 3577 | 36989 | 2842 | 40227 | 1671 | 48817 | 1375 | 35055 |
| 20-#18 | 5.95 | MA | 30398 | 7590 | 54226 | 5440 | 61194 | 4328 | 65911 | 3408 | 73265 | 1808 | 94211 | 407 | 90920 |
| 8L-4S | | MI | 19531 | 7590 | 36065 | 5209 | 40560 | 4074 | 43646 | 3100 | 49168 | 1483 | 60692 | 480 | 56870 |
| 22-#11 | 2.55 | MA | 27732 | 5970 | 45356 | 4418 | 50265 | 3572 | 52681 | 2907 | 55594 | 1904 | 68815 | 1477 | 48205 |
| 6L-7S | | MI | 15360 | 5970 | 25679 | 4256 | 27789 | 3432 | 28556 | 2772 | 29168 | 1759 | 35071 | 1167 | 26114 |
| 22-#11 | 2.55 | MA | 27181 | 5970 | 44315 | 4432 | 48997 | 3571 | 51126 | 2919 | 53505 | 1913 | 65953 | 1390 | 47577 |
| 7L-6S | | MI | 15666 | 5970 | 26245 | 4246 | 28480 | 3424 | 29417 | 2779 | 30242 | 1752 | 36333 | 1234 | 26487 |
| 22-#11 | 2.55 | MA | 26637 | 5970 | 43362 | 4432 | 47717 | 3584 | 49604 | 2930 | 51317 | 1909 | 63263 | 1337 | 46434 |
| 8L-5S | | MI | 15980 | 5970 | 26775 | 4250 | 29198 | 3430 | 30246 | 2772 | 31340 | 1745 | 37670 | 1293 | 26781 |
| 22-#11 | 2.55 | MA | 26049 | 5970 | 42425 | 4432 | 46467 | 3583 | 48029 | 2928 | 49251 | 1918 | 60596 | 1281 | 45442 |
| 9L-4S | | MI | 16308 | 5970 | 27335 | 4254 | 29919 | 3423 | 31114 | 2765 | 32536 | 1752 | 39103 | 1334 | 27199 |
| 22-#11 | 2.55 | MA | 25449 | 5970 | 41403 | 4446 | 45204 | 3595 | 46517 | 2939 | 47200 | 1927 | 58008 | 1218 | 44192 |
| 10L-3S | | MI | 16671 | 5970 | 27970 | 4245 | 30726 | 3429 | 32079 | 2772 | 33747 | 1745 | 40451 | 1420 | 27232 |
| 22-#11 | 2.55 | MA | 24861 | 5970 | 40467 | 4446 | 43961 | 3594 | 44961 | 2937 | 45043 | 1923 | 55382 | 1163 | 42794 |
| 11L-2S | | MI | 17174 | 5970 | 28751 | 4249 | 31722 | 3421 | 33274 | 2765 | 35326 | 1738 | 42519 | 1508 | 27237 |
| 22-#14 | 3.68 | MA | 28974 | 6508 | 48913 | 4767 | 54767 | 3813 | 58098 | 3072 | 62962 | 1884 | 79044 | 1145 | 65467 |
| 7L-6S | | MI | 16603 | 6508 | 28867 | 4559 | 31734 | 3649 | 33227 | 2904 | 35271 | 1671 | 43016 | 937 | 36327 |
| 22-#14 | 3.68 | MA | 28215 | 6508 | 47543 | 4767 | 52930 | 3831 | 55914 | 3088 | 59822 | 1877 | 75206 | 1070 | 63617 |
| 8L-5S | | MI | 17042 | 6508 | 29624 | 4565 | 32760 | 3659 | 34399 | 2894 | 36823 | 1662 | 44897 | 1023 | 37058 |
| 22-#14 | 3.68 | MA | 27403 | 6508 | 46199 | 4766 | 51135 | 3828 | 53653 | 3085 | 56856 | 1889 | 71408 | 990 | 61532 |
| 9L-4S | | MI | 17502 | 6508 | 30424 | 4572 | 33791 | 3649 | 35626 | 2884 | 38516 | 1671 | 46916 | 1082 | 37752 |
| 22-#14 | 3.68 | MA | 26577 | 6508 | 44731 | 4786 | 49321 | 3846 | 51483 | 3101 | 53912 | 1902 | 67722 | 898 | 59074 |
| 10L-3S | | MI | 18011 | 6508 | 31331 | 4559 | 34943 | 3659 | 36989 | 2894 | 40227 | 1662 | 48817 | 1204 | 38353 |
| 24-#11 | 2.79 | MA | 27871 | 6080 | 45788 | 4501 | 50875 | 3621 | 53408 | 2950 | 56597 | 1907 | 70179 | 1378 | 51894 |
| 7E | | MI | 15709 | 6080 | 26460 | 4325 | 28785 | 3482 | 29751 | 2802 | 30747 | 1746 | 37139 | 1139 | 28371 |
| 24-#11 | 2.79 | MA | 27331 | 6080 | 44834 | 4501 | 49595 | 3634 | 51886 | 2961 | 54410 | 1902 | 67489 | 1325 | 50779 |
| 8L-6S | | MI | 16013 | 6080 | 27026 | 4315 | 29475 | 3474 | 30613 | 2809 | 31821 | 1740 | 38400 | 1206 | 28797 |
| 24-#11 | 2.79 | MA | 26753 | 6080 | 43898 | 4501 | 48344 | 3633 | 50312 | 2959 | 52343 | 1911 | 64822 | 1269 | 49752 |
| 9L-5S | | MI | 16325 | 6080 | 27556 | 4319 | 30193 | 3480 | 31442 | 2802 | 32919 | 1733 | 39737 | 1266 | 29076 |
| 24-#11 | 2.79 | MA | 26149 | 6080 | 42875 | 4515 | 47081 | 3645 | 48799 | 2971 | 50293 | 1921 | 62234 | 1206 | 48525 |
| 10L-4S | | MI | 16652 | 6080 | 28116 | 4324 | 30915 | 3473 | 32310 | 2795 | 34115 | 1740 | 41171 | 1306 | 29556 |
| 24-#11 | 2.79 | MA | 25566 | 6080 | 41939 | 4515 | 45838 | 3644 | 47243 | 2968 | 48135 | 1916 | 59608 | 1151 | 47105 |
| 11L-3S | | MI | 17013 | 6080 | 28751 | 4314 | 31722 | 3479 | 33274 | 2802 | 35326 | 1733 | 42519 | 1392 | 29600 |
| 24-#11 | 2.79 | MA | 24992 | 6080 | 40933 | 4529 | 44583 | 3657 | 45735 | 2980 | 46088 | 1925 | 56716 | 1076 | 45743 |
| 12L-2S | | MI | 17515 | 6080 | 29532 | 4318 | 32718 | 3471 | 34470 | 2795 | 36905 | 1726 | 44586 | 1481 | 29619 |
| 24-#14 | 4.02 | MA | 29190 | 6667 | 49653 | 4867 | 55619 | 3903 | 59184 | 3133 | 64252 | 1867 | 81228 | 1051 | 69775 |
| 8L-6S | | MI | 17088 | 6667 | 29980 | 4658 | 33153 | 3722 | 34917 | 2946 | 37504 | 1652 | 45928 | 894 | 39515 |
| 24-#14 | 4.02 | MA | 28380 | 6667 | 48309 | 4866 | 53825 | 3901 | 56924 | 3129 | 61286 | 1879 | 77429 | 970 | 67734 |
| 9L-5S | | MI | 17525 | 6667 | 30737 | 4665 | 34179 | 3732 | 36089 | 2936 | 39056 | 1642 | 47809 | 981 | 40326 |
| 24-#14 | 4.02 | MA | 27560 | 6667 | 46841 | 4886 | 52011 | 3919 | 54753 | 3146 | 58343 | 1892 | 73744 | 879 | 65243 |
| 10L-4S | | MI | 17981 | 6667 | 31536 | 4672 | 35209 | 3722 | 37316 | 2926 | 40748 | 1652 | 49829 | 1039 | 40981 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

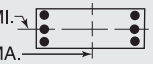
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.04 | MA | 10730 | 3514 | 16970 | 2560 | 18159 | 2086 | 18409 | 1736 | 18137 | 1230 | 21106 | 1147 | 8354 |
| 2L-3S | | MI | 10165 | 3514 | 16120 | 2557 | 17075 | 2094 | 17096 | 1743 | 16402 | 1237 | 18824 | 1058 | 8404 |
| 6-#14 | 1.50 | MA | 11210 | 3661 | 18089 | 2640 | 19539 | 2142 | 20026 | 1766 | 20267 | 1205 | 23870 | 1099 | 11770 |
| 2L-3S | | MI | 10414 | 3661 | 16876 | 2634 | 17993 | 2154 | 18166 | 1775 | 17810 | 1215 | 20648 | 971 | 11817 |
| 6-#18 | 2.67 | MA | 12357 | 4034 | 20829 | 2848 | 22914 | 2289 | 23956 | 1838 | 25448 | 1137 | 30536 | 967 | 20125 |
| 2L-3S | | MI | 11005 | 4034 | 18724 | 2835 | 20239 | 2306 | 20771 | 1856 | 21240 | 1155 | 25057 | 739 | 19996 |
| 8-#11 | 1.39 | MA | 11116 | 3625 | 17820 | 2629 | 19243 | 2136 | 19723 | 1767 | 19871 | 1219 | 23388 | 1122 | 10982 |
| 2L-4S | | MI | 10152 | 3625 | 16280 | 2636 | 17282 | 2139 | 17350 | 1767 | 16806 | 1233 | 19622 | 945 | 11021 |
| 8-#14 | 2.00 | MA | 11750 | 3821 | 19301 | 2739 | 21084 | 2215 | 21886 | 1809 | 22723 | 1188 | 27091 | 1060 | 15493 |
| 2L-4S | | MI | 10393 | 3821 | 17103 | 2748 | 18287 | 2217 | 18526 | 1809 | 18383 | 1208 | 21772 | 807 | 15207 |
| 8-#18 | 3.56 | MA | 13261 | 4317 | 22934 | 3025 | 25588 | 2416 | 27142 | 1912 | 29656 | 1102 | 36014 | 888 | 26526 |
| 2L-4S | | MI | 10964 | 4317 | 19112 | 3035 | 20740 | 2416 | 21385 | 1912 | 22222 | 1137 | 26956 | 445 | 23626 |
| 10-#11 | 1.73 | MA | 11498 | 3736 | 18670 | 2698 | 20327 | 2186 | 21036 | 1798 | 21606 | 1208 | 25670 | 1097 | 13595 |
| 2L-5S | | MI | 10181 | 3736 | 16523 | 2702 | 17584 | 2198 | 17710 | 1805 | 17227 | 1215 | 20321 | 880 | 13120 |
| 10-#11 | 1.73 | MA | 10941 | 3736 | 17820 | 2695 | 19243 | 2195 | 19723 | 1805 | 19871 | 1215 | 23388 | 1008 | 13617 |
| 3L-4S | | MI | 10541 | 3736 | 17131 | 2705 | 18366 | 2189 | 18663 | 1798 | 18541 | 1222 | 21904 | 920 | 13591 |
| 10-#14 | 2.50 | MA | 12284 | 3980 | 20513 | 2839 | 22630 | 2287 | 23747 | 1852 | 25180 | 1171 | 30312 | 1022 | 19199 |
| 2L-5S | | MI | 10432 | 3980 | 17448 | 2842 | 18714 | 2301 | 19036 | 1862 | 18978 | 1181 | 22759 | 711 | 17704 |
| 10-#14 | 2.50 | MA | 11502 | 3980 | 19301 | 2833 | 21084 | 2298 | 21886 | 1862 | 22723 | 1181 | 27091 | 894 | 19166 |
| 3L-4S | | MI | 10939 | 3980 | 18316 | 2847 | 19832 | 2290 | 20386 | 1852 | 20839 | 1191 | 24993 | 769 | 18634 |
| 10-#18 | 4.44 | MA | 14152 | 4601 | 25039 | 3203 | 28262 | 2544 | 30327 | 1985 | 33865 | 1066 | 41493 | 810 | 32894 |
| 2L-5S | | MI | 11031 | 4601 | 19701 | 3200 | 21472 | 2562 | 22259 | 2003 | 23239 | 1084 | 28636 | 262 | 27201 |
| 10-#18 | 4.44 | MA | 12836 | 4601 | 22934 | 3190 | 25588 | 2562 | 27142 | 2003 | 29656 | 1084 | 36014 | 582 | 32557 |
| 3L-4S | | MI | 11886 | 4601 | 21217 | 3212 | 23415 | 2544 | 24571 | 1985 | 26430 | 1102 | 32435 | 367 | 29623 |

## RECTANGULAR TIED COLUMNS 30" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.67 | MA | 12937 | 3962 | 21030 | 2843 | 22772 | 2304 | 23395 | 1891 | 23861 | 1272 | 28180 | 1149 | 14752 |
| 2E | | MI | 12079 | 3962 | 19692 | 2825 | 21232 | 2288 | 21731 | 1873 | 22095 | 1256 | 25997 | 1126 | 13719 |
| 6-#14 | 1.41 | MA | 12680 | 3873 | 20332 | 2812 | 21980 | 2284 | 22560 | 1890 | 22768 | 1303 | 26831 | 1199 | 12681 |
| 2L-3S | | MI | 11051 | 3873 | 17840 | 2790 | 18987 | 2282 | 19129 | 1884 | 18670 | 1299 | 21596 | 1052 | 11862 |
| 6-#14 | 1.41 | MA | 11816 | 3873 | 19020 | 2807 | 20307 | 2297 | 20529 | 1900 | 20087 | 1313 | 23300 | 1071 | 12728 |
| 3L-2S | | MI | 11849 | 3873 | 19052 | 2796 | 20532 | 2271 | 20989 | 1875 | 21126 | 1289 | 24817 | 1180 | 11807 |
| 6-#18 | 2.50 | MA | 13942 | 4246 | 23313 | 3020 | 25682 | 2433 | 26883 | 1967 | 28467 | 1240 | 34207 | 1077 | 21745 |
| 2L-3S | | MI | 11643 | 4246 | 19692 | 2990 | 21232 | 2433 | 21731 | 1964 | 22095 | 1238 | 25997 | 820 | 20090 |
| 6-#18 | 2.50 | MA | 12471 | 4246 | 21030 | 3009 | 22772 | 2452 | 23395 | 1984 | 23861 | 1258 | 28180 | 849 | 21616 |
| 3L-2S | | MI | 12999 | 4246 | 21797 | 3002 | 23906 | 2416 | 24916 | 1946 | 26303 | 1220 | 31476 | 1047 | 20180 |
| 8-#11 | 1.30 | MA | 12575 | 3837 | 20037 | 2802 | 21654 | 2278 | 22192 | 1889 | 22325 | 1316 | 26284 | 1220 | 11824 |
| 2L-4S | | MI | 10789 | 3837 | 17242 | 2793 | 18276 | 2268 | 18314 | 1877 | 17668 | 1317 | 20572 | 1026 | 11072 |
| 8-#11 | 1.30 | MA | 11967 | 3837 | 19118 | 2799 | 20482 | 2287 | 20767 | 1896 | 20434 | 1323 | 23787 | 1131 | 11860 |
| 3E | | MI | 11192 | 3837 | 17931 | 2783 | 19153 | 2273 | 19374 | 1884 | 18999 | 1311 | 22057 | 1114 | 11055 |
| 8-#11 | 1.30 | MA | 11531 | 3837 | 18374 | 2810 | 19536 | 2282 | 19619 | 1890 | 18984 | 1330 | 22163 | 1042 | 11864 |
| 4L-2S | | MI | 11754 | 3837 | 18781 | 2786 | 20237 | 2265 | 20687 | 1877 | 20733 | 1304 | 24339 | 1203 | 11015 |
| 8-#14 | 1.88 | MA | 13270 | 4033 | 21644 | 2912 | 23652 | 2357 | 24590 | 1935 | 25450 | 1287 | 30361 | 1163 | 16708 |
| 2L-4S | | MI | 11029 | 4033 | 18067 | 2904 | 19280 | 2346 | 19489 | 1918 | 19242 | 1292 | 22719 | 888 | 15434 |
| 8-#14 | 1.88 | MA | 12414 | 4033 | 20332 | 2907 | 21980 | 2369 | 22560 | 1945 | 22768 | 1297 | 26831 | 1035 | 16716 |
| 3E | | MI | 11599 | 4033 | 19052 | 2890 | 20532 | 2354 | 20989 | 1928 | 21126 | 1282 | 24817 | 1013 | 15556 |
| 8-#14 | 1.88 | MA | 11799 | 4033 | 19268 | 2922 | 20628 | 2361 | 20922 | 1935 | 20712 | 1307 | 24536 | 908 | 16579 |
| 4L-2S | | MI | 12390 | 4033 | 20264 | 2895 | 22078 | 2343 | 22850 | 1918 | 23583 | 1272 | 28038 | 1141 | 15535 |
| 8-#18 | 3.33 | MA | 14931 | 4529 | 25595 | 3198 | 28591 | 2562 | 30370 | 2043 | 33074 | 1208 | 40233 | 1005 | 28686 |
| 2L-4S | | MI | 11600 | 4529 | 20079 | 3189 | 21733 | 2543 | 22345 | 2020 | 23077 | 1220 | 27896 | 526 | 23930 |
| 8-#18 | 3.33 | MA | 13480 | 4529 | 23313 | 3187 | 25682 | 2581 | 26883 | 2060 | 28467 | 1226 | 34207 | 777 | 28444 |
| 3E | | MI | 12567 | 4529 | 21797 | 3167 | 23906 | 2561 | 24916 | 2037 | 26303 | 1202 | 31476 | 741 | 26390 |
| 8-#18 | 3.33 | MA | 12437 | 4529 | 21455 | 3211 | 23321 | 2564 | 24069 | 2043 | 24935 | 1243 | 30278 | 557 | 25778 |
| 4L-2S | | MI | 13905 | 4529 | 23902 | 3180 | 26581 | 2543 | 28102 | 2020 | 30511 | 1185 | 36954 | 969 | 26592 |

## RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

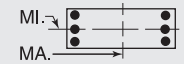
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.63 | MA | 12992 | 3948 | 20956 | 2871 | 22826 | 2328 | 23616 | 1920 | 24216 | 1307 | 28781 | 1197 | 14648 |
| 2L-5S | | MI | 10817 | 3948 | 17485 | 2859 | 18578 | 2327 | 18675 | 1914 | 18089 | 1299 | 21272 | 962 | 13271 |
| 10-#11 | 1.63 | MA | 12388 | 3948 | 20037 | 2868 | 21654 | 2337 | 22192 | 1927 | 22325 | 1313 | 26284 | 1108 | 14670 |
| 3L-4S | | MI | 11179 | 3948 | 18092 | 2862 | 19360 | 2318 | 19628 | 1907 | 19403 | 1306 | 22855 | 1002 | 13648 |
| 10-#11 | 1.63 | MA | 11956 | 3948 | 19293 | 2879 | 20708 | 2332 | 21044 | 1921 | 20875 | 1320 | 24660 | 1020 | 14644 |
| 4L-3S | | MI | 11580 | 3948 | 18781 | 2852 | 20237 | 2324 | 20687 | 1914 | 20733 | 1299 | 24339 | 1089 | 13659 |
| 10-#11 | 1.63 | MA | 11568 | 3948 | 18639 | 2876 | 19865 | 2342 | 20012 | 1928 | 19443 | 1313 | 22931 | 980 | 14223 |
| 5L-2S | | MI | 12137 | 3948 | 19632 | 2855 | 21321 | 2315 | 22001 | 1907 | 22468 | 1293 | 26621 | 1178 | 13631 |
| 10-#14 | 2.34 | MA | 13854 | 4193 | 22956 | 3011 | 25325 | 2429 | 26620 | 1979 | 28131 | 1272 | 33892 | 1128 | 20718 |
| 2L-5S | | MI | 11068 | 4193 | 18411 | 2998 | 19707 | 2429 | 19999 | 1971 | 19837 | 1264 | 23706 | 792 | 17893 |
| 10-#14 | 2.34 | MA | 13005 | 4192 | 21644 | 3007 | 23652 | 2441 | 24590 | 1989 | 25450 | 1282 | 30361 | 1000 | 20685 |
| 3L-4S | | MI | 11577 | 4193 | 19279 | 3004 | 20826 | 2418 | 21349 | 1961 | 21699 | 1274 | 25940 | 850 | 18856 |
| 10-#14 | 2.34 | MA | 12396 | 4192 | 20580 | 3022 | 22300 | 2434 | 22953 | 1979 | 23393 | 1292 | 28066 | 873 | 20293 |
| 4L-3S | | MI | 12141 | 4193 | 20264 | 2989 | 22078 | 2427 | 22850 | 1971 | 23583 | 1264 | 28038 | 975 | 19228 |
| 10-#14 | 2.34 | MA | 11849 | 4192 | 19644 | 3017 | 21094 | 2446 | 21479 | 1989 | 21362 | 1282 | 25618 | 816 | 19208 |
| 5L-2S | | MI | 12925 | 4193 | 21477 | 2995 | 23623 | 2415 | 24710 | 1961 | 26040 | 1254 | 31259 | 1103 | 19245 |
| 10-#18 | 4.17 | MA | 15907 | 4813 | 27877 | 3375 | 31501 | 2690 | 33858 | 2119 | 37680 | 1176 | 46260 | 933 | 35594 |
| 2L-5S | | MI | 11664 | 4813 | 20668 | 3354 | 22464 | 2689 | 23219 | 2111 | 24094 | 1167 | 29576 | 343 | 27675 |
| 10-#18 | 4.17 | MA | 14475 | 4813 | 25595 | 3364 | 28591 | 2709 | 30370 | 2136 | 33074 | 1193 | 40233 | 706 | 35257 |
| 3L-4S | | MI | 12524 | 4813 | 22184 | 3367 | 24407 | 2671 | 25531 | 2093 | 27285 | 1184 | 33375 | 447 | 29919 |
| 10-#18 | 4.17 | MA | 13447 | 4813 | 23738 | 3388 | 26231 | 2693 | 27557 | 2119 | 29541 | 1211 | 36304 | 486 | 32291 |
| 4L-3S | | MI | 13478 | 4813 | 23902 | 3344 | 26581 | 2689 | 28102 | 2111 | 30511 | 1167 | 36954 | 663 | 32674 |
| 10-#18 | 4.17 | MA | 12521 | 4813 | 22101 | 3377 | 24122 | 2712 | 25025 | 2136 | 26050 | 1193 | 32125 | 382 | 29862 |
| 5L-2S | | MI | 14800 | 4813 | 26007 | 3357 | 29255 | 2671 | 31287 | 2093 | 34720 | 1149 | 42433 | 890 | 32967 |
| 12-#11 | 1.95 | MA | 13407 | 4058 | 21876 | 2940 | 23998 | 2378 | 25041 | 1951 | 26106 | 1297 | 31278 | 1174 | 17462 |
| 2L-6S | | MI | 10864 | 4058 | 17761 | 2924 | 18883 | 2371 | 19077 | 1952 | 18618 | 1295 | 22077 | 877 | 15340 |
| 12-#11 | 1.95 | MA | 12807 | 4058 | 20956 | 2937 | 22826 | 2387 | 23616 | 1959 | 24216 | 1304 | 28781 | 1086 | 17466 |
| 3L-5S | | MI | 11207 | 4058 | 18335 | 2928 | 19662 | 2377 | 19988 | 1945 | 19824 | 1288 | 23554 | 937 | 15732 |
| 12-#11 | 1.95 | MA | 12378 | 4058 | 20212 | 2948 | 21881 | 2383 | 22469 | 1952 | 22765 | 1310 | 27158 | 997 | 17416 |
| 4E | | MI | 11565 | 4058 | 18942 | 2931 | 20444 | 2368 | 20942 | 1938 | 21138 | 1295 | 25137 | 977 | 16215 |
| 12-#11 | 1.95 | MA | 11992 | 4058 | 19558 | 2945 | 21037 | 2392 | 21437 | 1960 | 21334 | 1304 | 25428 | 957 | 16888 |
| 5L-3S | | MI | 11964 | 4058 | 19632 | 2921 | 21321 | 2374 | 22001 | 1945 | 22468 | 1288 | 26621 | 1064 | 16252 |
| 12-#11 | 1.95 | MA | 11623 | 4058 | 18940 | 2942 | 20198 | 2387 | 20450 | 1967 | 20020 | 1310 | 23810 | 898 | 16443 |
| 6L-2S | | MI | 12518 | 4058 | 20482 | 2924 | 22405 | 2365 | 23314 | 1938 | 24203 | 1282 | 28903 | 1153 | 16238 |
| 12-#14 | 2.81 | MA | 14431 | 4352 | 24268 | 3111 | 26998 | 2501 | 28651 | 2024 | 30812 | 1256 | 37423 | 1093 | 24710 |
| 2L-6S | | MI | 11133 | 4352 | 18802 | 3092 | 20139 | 2493 | 20569 | 2025 | 20587 | 1257 | 24844 | 667 | 20411 |
| 12-#14 | 2.81 | MA | 13590 | 4352 | 22956 | 3106 | 25325 | 2514 | 26620 | 2034 | 28131 | 1266 | 33892 | 965 | 24643 |
| 3L-5S | | MI | 11615 | 4352 | 19623 | 3098 | 21253 | 2502 | 21859 | 2015 | 22294 | 1247 | 26927 | 753 | 21411 |
| 12-#14 | 2.81 | MA | 12987 | 4352 | 21892 | 3121 | 23973 | 2506 | 24983 | 2024 | 26075 | 1276 | 31597 | 838 | 24034 |
| 4E | | MI | 12119 | 4352 | 20491 | 3103 | 22371 | 2490 | 23209 | 2005 | 24156 | 1257 | 29161 | 811 | 22305 |
| 12-#14 | 2.81 | MA | 12445 | 4352 | 20956 | 3117 | 22767 | 2518 | 23509 | 2034 | 24044 | 1266 | 29149 | 780 | 23021 |
| 5L-3S | | MI | 12678 | 4352 | 21477 | 3089 | 23623 | 2499 | 24710 | 2015 | 26040 | 1247 | 31259 | 936 | 22888 |
| 12-#14 | 2.81 | MA | 11927 | 4352 | 20071 | 3112 | 21566 | 2511 | 22101 | 2044 | 22180 | 1276 | 26862 | 695 | 21935 |
| 6L-2S | | MI | 13455 | 4352 | 22689 | 3095 | 25169 | 2488 | 26570 | 2005 | 28497 | 1237 | 34480 | 1064 | 22941 |
| 12-#18 | 5.00 | MA | 15457 | 5097 | 27877 | 3541 | 31501 | 2838 | 33858 | 2212 | 37680 | 1161 | 46260 | 634 | 42062 |
| 3L-5S | | MI | 12587 | 5097 | 22773 | 3531 | 25139 | 2817 | 26404 | 2184 | 28302 | 1131 | 35055 | 264 | 33534 |
| 12-#18 | 5.00 | MA | 14443 | 5097 | 26020 | 3566 | 29141 | 2821 | 31044 | 2195 | 34148 | 1179 | 42331 | 414 | 38842 |
| 4E | | MI | 13436 | 5097 | 24289 | 3544 | 27082 | 2799 | 28716 | 2166 | 31493 | 1149 | 38853 | 369 | 35948 |
| 12-#18 | 5.00 | MA | 13530 | 5097 | 24383 | 3555 | 27032 | 2841 | 28513 | 2212 | 30657 | 1161 | 38152 | 310 | 36246 |
| 5L-3S | | MI | 14378 | 5097 | 26007 | 3522 | 29255 | 2817 | 31287 | 2184 | 34720 | 1131 | 42433 | 584 | 38821 |
| 14-#11 | 2.27 | MA | 13818 | 4169 | 22795 | 3009 | 25171 | 2428 | 26466 | 1982 | 27997 | 1287 | 33775 | 1152 | 20269 |
| 2L-7S | | MI | 10920 | 4169 | 17997 | 3004 | 19219 | 2430 | 19444 | 1976 | 19173 | 1291 | 22970 | 784 | 17186 |
| 14-#11 | 2.27 | MA | 13221 | 4169 | 21876 | 3006 | 23998 | 2437 | 25041 | 1990 | 26106 | 1294 | 31278 | 1063 | 20254 |
| 3L-6S | | MI | 11253 | 4169 | 18611 | 2993 | 19967 | 2422 | 20391 | 1983 | 20353 | 1284 | 24359 | 852 | 17835 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis

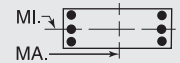



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.27 | MA | 12796 | 4169 | 21132 | 3017 | 23053 | 2433 | 23894 | 1983 | 24656 | 1301 | 29655 | 974 | 20183 |
| 4L-5S | | MI | 11593 | 4169 | 19185 | 2997 | 20746 | 2427 | 21302 | 1976 | 21558 | 1277 | 25836 | 912 | 18203 |
| 14-#11 | 2.27 | MA | 12413 | 4169 | 20478 | 3014 | 22209 | 2442 | 22862 | 1991 | 23224 | 1294 | 27925 | 934 | 19563 |
| 5L-4S | | MI | 11949 | 4169 | 19792 | 3000 | 21528 | 2419 | 22255 | 1969 | 22872 | 1284 | 27419 | 952 | 18777 |
| 14-#11 | 2.27 | MA | 12047 | 4169 | 19859 | 3011 | 21370 | 2437 | 21875 | 1998 | 21910 | 1301 | 26307 | 875 | 19143 |
| 6L-3S | | MI | 12344 | 4169 | 20482 | 2990 | 22405 | 2424 | 23314 | 1976 | 24203 | 1277 | 28903 | 1039 | 18832 |
| 14-#11 | 2.27 | MA | 11690 | 4169 | 19198 | 3022 | 20564 | 2446 | 20851 | 1992 | 20624 | 1307 | 24619 | 787 | 18434 |
| 7L-2S | | MI | 12895 | 4169 | 21332 | 2993 | 23489 | 2415 | 24628 | 1969 | 25938 | 1271 | 31185 | 1128 | 18837 |
| 14-#14 | 3.28 | MA | 14169 | 4512 | 24268 | 3206 | 26998 | 2586 | 28651 | 2079 | 30812 | 1251 | 37423 | 929 | 28593 |
| 3L-6S | | MI | 11679 | 4512 | 20014 | 3192 | 21685 | 2565 | 22429 | 2068 | 23043 | 1240 | 28065 | 629 | 23853 |
| 14-#14 | 3.28 | MA | 13572 | 4512 | 23204 | 3221 | 25646 | 2578 | 27013 | 2069 | 28756 | 1261 | 35127 | 802 | 27796 |
| 4L-5S | | MI | 12156 | 4512 | 20836 | 3197 | 22798 | 2574 | 23719 | 2058 | 24751 | 1230 | 30148 | 714 | 24941 |
| 14-#14 | 3.28 | MA | 13035 | 4512 | 22268 | 3216 | 24439 | 2591 | 25540 | 2079 | 26725 | 1251 | 32679 | 745 | 26847 |
| 5L-4S | | MI | 12655 | 4512 | 21704 | 3203 | 23917 | 2563 | 25069 | 2048 | 26613 | 1240 | 32382 | 772 | 25775 |
| 14-#14 | 3.28 | MA | 12522 | 4512 | 21383 | 3212 | 23239 | 2583 | 24131 | 2088 | 24861 | 1261 | 30393 | 659 | 25672 |
| 6L-3S | | MI | 13210 | 4512 | 22689 | 3189 | 25169 | 2571 | 26570 | 2058 | 28497 | 1230 | 34480 | 897 | 26539 |
| 14-#14 | 3.28 | MA | 12022 | 4512 | 20436 | 3227 | 22085 | 2596 | 22669 | 2079 | 23037 | 1271 | 28245 | 560 | 24544 |
| 7L-2S | | MI | 13981 | 4512 | 23901 | 3195 | 26714 | 2560 | 28430 | 2048 | 30953 | 1220 | 37701 | 1025 | 26620 |
| 14-#18 | 5.83 | MA | 15427 | 5381 | 28302 | 3743 | 32051 | 2950 | 34532 | 2271 | 38754 | 1147 | 48358 | 342 | 45425 |
| 4L-5S | | MI | 13500 | 5381 | 24878 | 3709 | 27813 | 2944 | 29590 | 2257 | 32511 | 1096 | 40533 | 186 | 39429 |
| 14-#18 | 5.83 | MA | 14526 | 5381 | 26665 | 3732 | 29942 | 2969 | 32000 | 2288 | 35263 | 1129 | 44179 | 239 | 42666 |
| 5L-4S | | MI | 14338 | 5381 | 26394 | 3721 | 29756 | 2927 | 31902 | 2240 | 35701 | 1113 | 44332 | 290 | 42006 |
| 16-#11 | 2.60 | MA | 13633 | 4280 | 22795 | 3075 | 25171 | 2488 | 26466 | 2021 | 27997 | 1284 | 33775 | 1040 | 23035 |
| 3L-7S | | MI | 11308 | 4280 | 18847 | 3073 | 20303 | 2480 | 20758 | 2007 | 20907 | 1280 | 25252 | 759 | 19632 |
| 16-#11 | 2.60 | MA | 13210 | 4280 | 22051 | 3086 | 24225 | 2483 | 25319 | 2014 | 26547 | 1291 | 32152 | 951 | 22947 |
| 4L-6S | | MI | 11638 | 4280 | 19461 | 3063 | 21051 | 2472 | 21704 | 2014 | 22087 | 1273 | 26641 | 827 | 20334 |
| 16-#11 | 2.60 | MA | 12830 | 4280 | 21397 | 3083 | 23382 | 2492 | 24287 | 2022 | 25115 | 1284 | 30423 | 911 | 22247 |
| 5E | | MI | 11976 | 4280 | 20035 | 3066 | 21830 | 2477 | 22615 | 2007 | 23293 | 1266 | 28119 | 887 | 20683 |
| 16-#11 | 2.60 | MA | 12467 | 4280 | 20779 | 3080 | 22543 | 2487 | 23300 | 2029 | 23801 | 1291 | 28804 | 852 | 21848 |
| 6L-4S | | MI | 12330 | 4280 | 20643 | 3069 | 22612 | 2469 | 23569 | 2000 | 24607 | 1273 | 29701 | 927 | 21333 |
| 16-#11 | 2.60 | MA | 12112 | 4280 | 20117 | 3091 | 21736 | 2497 | 22276 | 2023 | 22515 | 1298 | 27116 | 764 | 21085 |
| 7L-3S | | MI | 12723 | 4280 | 21332 | 3059 | 23489 | 2474 | 24628 | 2007 | 25938 | 1266 | 31185 | 1014 | 21406 |
| 16-#11 | 2.60 | MA | 11763 | 4280 | 19509 | 3089 | 20923 | 2492 | 21308 | 2030 | 21245 | 1304 | 25502 | 717 | 20415 |
| 8L-2S | | MI | 13270 | 4280 | 22182 | 3063 | 24573 | 2466 | 25942 | 2000 | 27672 | 1260 | 33468 | 1103 | 21431 |
| 16-#14 | 3.75 | MA | 14152 | 4671 | 24516 | 3321 | 27318 | 2651 | 29044 | 2113 | 31437 | 1245 | 38658 | 767 | 31575 |
| 4L-6S | | MI | 12219 | 4671 | 21227 | 3291 | 23230 | 2638 | 24289 | 2111 | 25500 | 1223 | 31286 | 590 | 27309 |
| 16-#14 | 3.75 | MA | 13620 | 4671 | 23580 | 3316 | 26112 | 2663 | 27570 | 2123 | 29406 | 1235 | 36210 | 710 | 30683 |
| 5E | | MI | 12692 | 4671 | 22048 | 3297 | 24344 | 2646 | 25579 | 2101 | 27208 | 1213 | 33369 | 676 | 28481 |
| 16-#14 | 3.75 | MA | 13112 | 4671 | 22695 | 3311 | 24912 | 2656 | 26162 | 2133 | 27542 | 1245 | 33923 | 624 | 29424 |
| 6L-4S | | MI | 13187 | 4671 | 22916 | 3303 | 25462 | 2635 | 26929 | 2091 | 29069 | 1223 | 35603 | 734 | 29262 |
| 16-#14 | 3.75 | MA | 12616 | 4671 | 21748 | 3326 | 23758 | 2668 | 24699 | 2123 | 25719 | 1255 | 31776 | 525 | 28239 |
| 7L-3S | | MI | 13737 | 4671 | 23901 | 3289 | 26714 | 2644 | 28430 | 2101 | 30953 | 1213 | 37701 | 858 | 30184 |
| 16-#18 | 6.67 | MA | 15512 | 5664 | 28948 | 3909 | 32851 | 3098 | 35488 | 2364 | 39870 | 1097 | 50205 | 167 | 49117 |
| 5E | | MI | 14404 | 5664 | 26984 | 3886 | 30487 | 3072 | 32775 | 2331 | 36719 | 1060 | 46012 | 107 | 45356 |
| 18-#11 | 2.92 | MA | 13622 | 4390 | 22971 | 3155 | 25397 | 2533 | 26744 | 2046 | 28437 | 1281 | 34649 | 929 | 25705 |
| 4L-7S | | MI | 11694 | 4390 | 19698 | 3142 | 21387 | 2530 | 22072 | 2038 | 22642 | 1269 | 27534 | 734 | 22085 |
| 18-#11 | 2.92 | MA | 13244 | 4390 | 22316 | 3153 | 24554 | 2542 | 25711 | 2053 | 27006 | 1274 | 32920 | 889 | 24937 |
| 5L-6S | | MI | 12021 | 4390 | 20312 | 3132 | 22135 | 2522 | 23018 | 2044 | 23822 | 1262 | 28923 | 802 | 22808 |
| 18-#11 | 2.92 | MA | 12884 | 4390 | 21698 | 3150 | 23715 | 2538 | 24725 | 2060 | 25691 | 1281 | 31301 | 829 | 24556 |
| 6L-5S | | MI | 12357 | 4390 | 20886 | 3135 | 22914 | 2527 | 23929 | 2038 | 25028 | 1255 | 30401 | 862 | 23169 |
| 18-#11 | 2.92 | MA | 12532 | 4390 | 21037 | 3161 | 22909 | 2547 | 23701 | 2054 | 24405 | 1288 | 29614 | 741 | 23744 |
| 7L-4S | | MI | 12708 | 4390 | 21493 | 3139 | 23696 | 2519 | 24882 | 2031 | 26342 | 1262 | 31983 | 902 | 23845 |
| 18-#11 | 2.92 | MA | 12185 | 4390 | 20429 | 3158 | 22095 | 2542 | 22733 | 2061 | 23135 | 1295 | 27999 | 694 | 23035 |
| 8L-3S | | MI | 13098 | 4390 | 22182 | 3128 | 24573 | 2524 | 25942 | 2038 | 27672 | 1255 | 33468 | 989 | 23976 |
| 18-#14 | 4.22 | MA | 14199 | 4831 | 24892 | 3416 | 27785 | 2735 | 29600 | 2168 | 32088 | 1220 | 39740 | 674 | 34527 |
| 5L-6S | | MI | 12756 | 4831 | 22439 | 3391 | 24776 | 2710 | 26149 | 2155 | 27957 | 1205 | 34507 | 551 | 30777 |
| 18-#14 | 4.22 | MA | 13696 | 4831 | 24007 | 3411 | 26584 | 2728 | 28192 | 2178 | 30224 | 1230 | 37454 | 589 | 33189 |
| 6L-5S | | MI | 13225 | 4831 | 23260 | 3397 | 25889 | 2719 | 27439 | 2145 | 29664 | 1196 | 36590 | 637 | 32028 |

## RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 4.22 | MA | 13204 | 4831 | 23060 | 3426 | 25430 | 2740 | 26730 | 2168 | 28400 | 1240 | 35306 | 490 | 31948 |
| 7L-4S | | MI | 13715 | 4831 | 24128 | 3402 | 27008 | 2707 | 28789 | 2135 | 31526 | 1205 | 38824 | 695 | 32762 |
| 20-#11 | 3.25 | MA | 13656 | 4501 | 23236 | 3222 | 25726 | 2592 | 27136 | 2084 | 28896 | 1264 | 35417 | 866 | 27634 |
| 5L-7S | | MI | 12076 | 4501 | 20548 | 3211 | 22471 | 2580 | 23385 | 2068 | 24377 | 1258 | 29817 | 709 | 24545 |
| 20-#11 | 3.25 | MA | 13298 | 4501 | 22617 | 3219 | 24887 | 2588 | 26150 | 2092 | 27582 | 1271 | 33798 | 807 | 27190 |
| 6E | | MI | 12402 | 4501 | 21162 | 3201 | 23219 | 2572 | 24331 | 2075 | 25557 | 1251 | 31205 | 777 | 25238 |
| 20-#11 | 3.25 | MA | 12948 | 4501 | 21956 | 3230 | 24081 | 2597 | 25126 | 2085 | 26296 | 1278 | 32111 | 719 | 26410 |
| 7L-5S | | MI | 12735 | 4501 | 21736 | 3204 | 23998 | 2577 | 25242 | 2068 | 26763 | 1244 | 32683 | 837 | 25661 |
| 20-#11 | 3.25 | MA | 12604 | 4501 | 21348 | 3227 | 23267 | 2592 | 24158 | 2093 | 25026 | 1285 | 30496 | 671 | 25662 |
| 8L-4S | | MI | 13084 | 4501 | 22343 | 3208 | 24780 | 2569 | 26196 | 2061 | 28077 | 1251 | 34266 | 877 | 26301 |
| 20-#14 | 4.69 | MA | 14275 | 4990 | 25319 | 3511 | 28257 | 2800 | 30223 | 2222 | 32905 | 1214 | 40984 | 553 | 36965 |
| 6E | | MI | 13288 | 4990 | 23651 | 3491 | 26321 | 2782 | 28009 | 2198 | 30414 | 1188 | 37728 | 512 | 34257 |
| 20-#14 | 4.69 | MA | 13788 | 4990 | 24372 | 3526 | 27103 | 2813 | 28760 | 2213 | 31081 | 1224 | 38837 | 454 | 35669 |
| 7L-5S | | MI | 13753 | 4990 | 24472 | 3496 | 27435 | 2791 | 29299 | 2188 | 32121 | 1178 | 39811 | 598 | 35582 |
| 22-#11 | 3.57 | MA | 13709 | 4612 | 23537 | 3288 | 26059 | 2638 | 27575 | 2123 | 29473 | 1261 | 36295 | 784 | 29832 |
| 6L-7S | | MI | 12456 | 4612 | 21398 | 3280 | 23555 | 2631 | 24699 | 2099 | 26112 | 1247 | 32099 | 684 | 27011 |
| 22-#11 | 3.57 | MA | 13362 | 4612 | 22875 | 3299 | 25253 | 2647 | 26551 | 2116 | 28187 | 1268 | 34608 | 696 | 29081 |
| 7L-6S | | MI | 12779 | 4612 | 22012 | 3270 | 24303 | 2622 | 25645 | 2106 | 27292 | 1240 | 33488 | 752 | 27675 |
| 22-#11 | 3.57 | MA | 13020 | 4612 | 22268 | 3296 | 24439 | 2642 | 25583 | 2124 | 26916 | 1275 | 32993 | 649 | 28296 |
| 8L-5S | | MI | 13111 | 4612 | 22586 | 3273 | 25082 | 2628 | 26556 | 2099 | 28497 | 1233 | 34965 | 812 | 28157 |
| 22-#14 | 5.16 | MA | 14367 | 5150 | 25684 | 3626 | 28776 | 2885 | 30790 | 2257 | 33763 | 1208 | 42368 | 419 | 39400 |
| 7L-6S | | MI | 13816 | 5150 | 24863 | 3591 | 27867 | 2855 | 29869 | 2241 | 32870 | 1171 | 40949 | 474 | 37747 |
| 24-#11 | 3.90 | MA | 13773 | 4722 | 23795 | 3368 | 26425 | 2697 | 27976 | 2147 | 30077 | 1258 | 37105 | 673 | 31757 |
| 7E | | MI | 12834 | 4722 | 22248 | 3349 | 24639 | 2681 | 26012 | 2130 | 27846 | 1236 | 34381 | 659 | 29481 |
| 24-#11 | 3.90 | MA | 13433 | 4722 | 23187 | 3365 | 25611 | 2693 | 27008 | 2155 | 28807 | 1265 | 35490 | 626 | 30935 |
| 8L-6S | | MI | 13155 | 4722 | 22862 | 3339 | 25387 | 2672 | 26959 | 2137 | 29026 | 1229 | 35770 | 727 | 30119 |

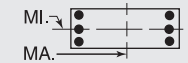
## RECTANGULAR TIED COLUMNS 30" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.57 | MA | 14519 | 4174 | 23457 | 3015 | 25417 | 2446 | 26153 | 2016 | 26603 | 1371 | 31441 | 1250 | 15832 |
| 2E | | MI | 12718 | 4174 | 20659 | 2980 | 22225 | 2415 | 22691 | 1981 | 22950 | 1339 | 26937 | 1206 | 13764 |
| 6-#14 | 1.32 | MA | 14236 | 4085 | 22696 | 2984 | 24552 | 2426 | 25186 | 2011 | 25392 | 1400 | 29930 | 1297 | 13592 |
| 2L-3S | | MI | 11688 | 4085 | 18803 | 2946 | 19980 | 2410 | 20092 | 1994 | 19529 | 1383 | 22543 | 1133 | 11904 |
| 6-#14 | 1.32 | MA | 13303 | 4085 | 21284 | 2980 | 22753 | 2439 | 22998 | 2022 | 22486 | 1410 | 26089 | 1169 | 13639 |
| 3L-2S | | MI | 12487 | 4085 | 20016 | 2952 | 21526 | 2399 | 21953 | 1984 | 21986 | 1373 | 25764 | 1261 | 11843 |
| 6-#18 | 2.35 | MA | 15613 | 4458 | 25916 | 3193 | 28552 | 2575 | 29943 | 2094 | 31609 | 1341 | 38017 | 1184 | 23365 |
| 2L-3S | | MI | 12280 | 4458 | 20659 | 3144 | 22225 | 2560 | 22691 | 2072 | 22950 | 1321 | 26937 | 900 | 20178 |
| 6-#18 | 2.35 | MA | 14023 | 4458 | 23457 | 3183 | 25417 | 2596 | 26153 | 2112 | 26603 | 1359 | 31441 | 956 | 23236 |
| 3L-2S | | MI | 13640 | 4458 | 22765 | 3157 | 24899 | 2543 | 25876 | 2054 | 27158 | 1303 | 32416 | 1127 | 20234 |
| 8-#11 | 1.22 | MA | 14119 | 4049 | 22375 | 2974 | 24197 | 2420 | 24775 | 2009 | 24900 | 1413 | 29317 | 1317 | 12667 |
| 2L-4S | | MI | 11425 | 4049 | 18203 | 2950 | 19270 | 2397 | 19279 | 1986 | 18530 | 1402 | 21523 | 1108 | 11118 |
| 8-#11 | 1.22 | MA | 13464 | 4049 | 21386 | 2972 | 22937 | 2429 | 23243 | 2018 | 22853 | 1420 | 26605 | 1228 | 12703 |
| 3E | | MI | 11830 | 4049 | 18892 | 2939 | 20146 | 2402 | 20338 | 1993 | 19861 | 1395 | 23007 | 1196 | 11091 |
| 8-#11 | 1.22 | MA | 12996 | 4049 | 20588 | 2983 | 21922 | 2425 | 22011 | 2012 | 21283 | 1427 | 24837 | 1140 | 12706 |
| 4L-2S | | MI | 12392 | 4049 | 19743 | 2943 | 21230 | 2394 | 21652 | 1986 | 21596 | 1388 | 25289 | 1284 | 11047 |
| 8-#14 | 1.76 | MA | 14877 | 4245 | 24107 | 3084 | 26352 | 2498 | 27374 | 2056 | 28298 | 1386 | 33770 | 1265 | 17923 |
| 2L-4S | | MI | 11666 | 4245 | 19030 | 3060 | 20274 | 2474 | 20452 | 2027 | 20102 | 1375 | 23666 | 970 | 15539 |
| 8-#14 | 1.76 | MA | 13952 | 4245 | 22696 | 3080 | 24552 | 2512 | 25186 | 2067 | 25392 | 1396 | 29930 | 1137 | 17931 |
| 3E | | MI | 12237 | 4245 | 20016 | 3046 | 21526 | 2483 | 21953 | 2037 | 21986 | 1365 | 25764 | 1094 | 15609 |
| 8-#14 | 1.76 | MA | 13291 | 4245 | 21554 | 3096 | 23101 | 2505 | 23425 | 2058 | 23163 | 1406 | 27432 | 1009 | 17804 |
| 4L-2S | | MI | 13030 | 4245 | 21228 | 3051 | 23071 | 2471 | 23813 | 2027 | 24443 | 1356 | 28985 | 1222 | 15576 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis

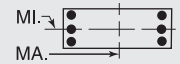



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.14 | MA | 16689 | 4742 | 28376 | 3370 | 31688 | 2703 | 33733 | 2172 | 36614 | 1312 | 44594 | 1118 | 30846 |
| 2L-4S | | MI | 12235 | 4742 | 21047 | 3344 | 22726 | 2670 | 23305 | 2128 | 23932 | 1303 | 28836 | 606 | 24224 |
| 8-#18 | 3.14 | MA | 15121 | 4742 | 25916 | 3361 | 28552 | 2724 | 29943 | 2190 | 31609 | 1330 | 38017 | 890 | 30604 |
| 3E | | MI | 13206 | 4742 | 22765 | 3321 | 24899 | 2688 | 25876 | 2145 | 27158 | 1285 | 32416 | 821 | 26490 |
| 8-#18 | 3.14 | MA | 13997 | 4742 | 23920 | 3387 | 26015 | 2710 | 26886 | 2172 | 27770 | 1348 | 33738 | 666 | 27960 |
| 4L-2S | | MI | 14549 | 4742 | 24870 | 3334 | 27573 | 2670 | 29062 | 2128 | 31366 | 1268 | 37894 | 1049 | 26657 |
| 10-#11 | 1.53 | MA | 14572 | 4160 | 23363 | 3043 | 25458 | 2470 | 26307 | 2041 | 26947 | 1404 | 32029 | 1296 | 15701 |
| 2L-5S | | MI | 11454 | 4160 | 18446 | 3015 | 19571 | 2456 | 19639 | 2024 | 18951 | 1384 | 22223 | 1043 | 13416 |
| 10-#11 | 1.53 | MA | 13921 | 4160 | 22375 | 3041 | 24197 | 2480 | 24775 | 2049 | 24900 | 1411 | 29317 | 1208 | 15723 |
| 3L-4S | | MI | 11816 | 4160 | 19053 | 3019 | 20354 | 2447 | 20593 | 2017 | 20265 | 1391 | 23805 | 1083 | 13701 |
| 10-#11 | 1.53 | MA | 13457 | 4160 | 21576 | 3052 | 23183 | 2476 | 23543 | 2043 | 23330 | 1418 | 27550 | 1119 | 15697 |
| 4L-3S | | MI | 12218 | 4160 | 19743 | 3009 | 21230 | 2453 | 21652 | 2024 | 21596 | 1384 | 25289 | 1171 | 13699 |
| 10-#11 | 1.53 | MA | 13039 | 4160 | 20875 | 3050 | 22278 | 2485 | 22436 | 2051 | 21781 | 1411 | 25678 | 1078 | 15338 |
| 5L-2S | | MI | 12777 | 4160 | 20593 | 3012 | 22314 | 2444 | 22966 | 2017 | 23330 | 1377 | 27572 | 1259 | 13667 |
| 10-#14 | 2.21 | MA | 15510 | 4405 | 25519 | 3184 | 28152 | 2571 | 29562 | 2101 | 31204 | 1372 | 37611 | 1232 | 22236 |
| 2L-5S | | MI | 11704 | 4405 | 19375 | 3154 | 20701 | 2558 | 20962 | 2080 | 20697 | 1348 | 24653 | 873 | 18075 |
| 10-#14 | 2.21 | MA | 14594 | 4405 | 24107 | 3180 | 26352 | 2584 | 27374 | 2112 | 28298 | 1382 | 33770 | 1104 | 22204 |
| 3L-4S | | MI | 12214 | 4405 | 20243 | 3160 | 21819 | 2546 | 22312 | 2070 | 22559 | 1358 | 26887 | 931 | 19072 |
| 10-#14 | 2.21 | MA | 13940 | 4405 | 22965 | 3196 | 24901 | 2577 | 25613 | 2103 | 26069 | 1392 | 31272 | 976 | 21975 |
| 4L-3S | | MI | 12780 | 4405 | 21228 | 3145 | 23071 | 2555 | 23813 | 2080 | 24443 | 1348 | 28985 | 1056 | 19287 |
| 10-#14 | 2.21 | MA | 13351 | 4405 | 21961 | 3192 | 23606 | 2591 | 24028 | 2114 | 23868 | 1382 | 28614 | 918 | 20725 |
| 5L-2S | | MI | 13566 | 4405 | 22440 | 3151 | 24617 | 2544 | 25673 | 2070 | 26900 | 1338 | 32206 | 1184 | 19290 |
| 10-#18 | 3.92 | MA | 17750 | 5025 | 30836 | 3547 | 34824 | 2832 | 37522 | 2250 | 41619 | 1283 | 51170 | 1052 | 38294 |
| 2L-5S | | MI | 12297 | 5025 | 21636 | 3508 | 23457 | 2816 | 24179 | 2219 | 24949 | 1250 | 30516 | 423 | 28138 |
| 10-#18 | 3.92 | MA | 16202 | 5025 | 28376 | 3538 | 31688 | 2853 | 33733 | 2268 | 36614 | 1301 | 44594 | 824 | 37957 |
| 3L-4S | | MI | 13161 | 5025 | 23152 | 3521 | 25400 | 2798 | 26491 | 2201 | 28140 | 1267 | 34315 | 527 | 30207 |
| 10-#18 | 3.92 | MA | 15094 | 5025 | 26379 | 3564 | 29151 | 2839 | 30676 | 2250 | 32776 | 1318 | 40314 | 601 | 34989 |
| 4L-3S | | MI | 14120 | 5025 | 24870 | 3499 | 27573 | 2816 | 29062 | 2219 | 31366 | 1250 | 37894 | 743 | 32784 |
| 10-#18 | 3.92 | MA | 14098 | 5025 | 24621 | 3555 | 26885 | 2860 | 27925 | 2268 | 28983 | 1301 | 35754 | 498 | 32576 |
| 5L-2S | | MI | 15446 | 5025 | 26975 | 3511 | 30247 | 2798 | 32247 | 2201 | 35575 | 1232 | 43373 | 970 | 33038 |
| 12-#11 | 1.84 | MA | 15022 | 4271 | 24352 | 3112 | 26718 | 2520 | 27839 | 2072 | 28993 | 1395 | 34742 | 1275 | 18726 |
| 2L-6S | | MI | 11500 | 4271 | 18722 | 3081 | 19877 | 2501 | 20042 | 2062 | 19480 | 1380 | 23027 | 959 | 15474 |
| 12-#11 | 1.84 | MA | 14375 | 4271 | 23363 | 3110 | 25458 | 2530 | 26307 | 2080 | 26947 | 1402 | 32029 | 1187 | 18730 |
| 3L-5S | | MI | 11844 | 4271 | 19296 | 3085 | 20655 | 2506 | 20953 | 2055 | 20686 | 1373 | 24505 | 1018 | 15875 |
| 12-#11 | 1.84 | MA | 13914 | 4271 | 22565 | 3121 | 24443 | 2526 | 25076 | 2074 | 25377 | 1409 | 30262 | 1098 | 18680 |
| 4E | | MI | 12203 | 4271 | 19903 | 3088 | 21438 | 2497 | 21906 | 2048 | 22000 | 1380 | 26087 | 1058 | 16274 |
| 12-#11 | 1.84 | MA | 13500 | 4271 | 21863 | 3119 | 23539 | 2536 | 23969 | 2082 | 23827 | 1402 | 28390 | 1057 | 18204 |
| 5L-3S | | MI | 12602 | 4271 | 20593 | 3078 | 22314 | 2503 | 22966 | 2055 | 23330 | 1373 | 27572 | 1146 | 16296 |
| 12-#11 | 1.84 | MA | 13104 | 4271 | 21201 | 3117 | 22639 | 2532 | 22872 | 2077 | 22405 | 1409 | 26630 | 998 | 17693 |
| 6L-2S | | MI | 13158 | 4271 | 21443 | 3081 | 23398 | 2494 | 24279 | 2048 | 25065 | 1366 | 29854 | 1235 | 16276 |
| 12-#14 | 2.65 | MA | 16137 | 4564 | 26931 | 3284 | 29952 | 2643 | 31750 | 2146 | 34110 | 1358 | 41451 | 1200 | 26533 |
| 2L-6S | | MI | 11768 | 4564 | 19766 | 3248 | 21133 | 2621 | 21532 | 2134 | 21446 | 1341 | 25791 | 748 | 20708 |
| 12-#14 | 2.65 | MA | 15229 | 4564 | 25519 | 3280 | 28152 | 2656 | 29562 | 2157 | 31204 | 1368 | 37611 | 1072 | 26465 |
| 3L-5S | | MI | 12251 | 4564 | 20587 | 3254 | 22246 | 2630 | 22822 | 2124 | 23154 | 1331 | 27874 | 834 | 21591 |
| 12-#14 | 2.65 | MA | 14581 | 4564 | 24377 | 3295 | 26700 | 2650 | 27801 | 2148 | 28975 | 1378 | 35113 | 944 | 26004 |
| 4E | | MI | 12757 | 4564 | 21455 | 3259 | 23365 | 2619 | 24172 | 2114 | 25016 | 1341 | 30108 | 892 | 22517 |
| 12-#14 | 2.65 | MA | 13998 | 4564 | 23373 | 3291 | 25406 | 2663 | 26216 | 2158 | 26775 | 1368 | 32455 | 886 | 24832 |
| 5L-3S | | MI | 13318 | 4564 | 22440 | 3245 | 24617 | 2627 | 25673 | 2124 | 26900 | 1331 | 32206 | 1017 | 22953 |
| 12-#14 | 2.65 | MA | 13442 | 4564 | 22424 | 3287 | 24119 | 2657 | 24703 | 2169 | 24754 | 1378 | 29965 | 801 | 23793 |
| 6L-2S | | MI | 14098 | 4564 | 23652 | 3251 | 26162 | 2616 | 27533 | 2114 | 29356 | 1321 | 35427 | 1145 | 22992 |
| 12-#18 | 4.71 | MA | 17269 | 5309 | 30836 | 3715 | 34824 | 2981 | 37522 | 2346 | 41619 | 1272 | 51170 | 759 | 45302 |
| 3L-5S | | MI | 13223 | 5309 | 23741 | 3686 | 26131 | 2944 | 27364 | 2292 | 29157 | 1214 | 35995 | 344 | 33987 |
| 12-#18 | 4.71 | MA | 16177 | 5309 | 28839 | 3741 | 32287 | 2967 | 34466 | 2329 | 37781 | 1289 | 46890 | 535 | 42058 |
| 4E | | MI | 14076 | 5309 | 25257 | 3699 | 28074 | 2926 | 29676 | 2274 | 32348 | 1232 | 39793 | 449 | 36230 |
| 12-#18 | 4.71 | MA | 15195 | 5309 | 27081 | 3732 | 30021 | 2988 | 31715 | 2346 | 33989 | 1272 | 42330 | 432 | 39477 |
| 5L-3S | | MI | 15022 | 5309 | 26975 | 3676 | 30247 | 2944 | 32247 | 2292 | 35575 | 1214 | 43373 | 664 | 39066 |
| 14-#11 | 2.14 | MA | 15468 | 4381 | 25340 | 3181 | 27979 | 2570 | 29371 | 2103 | 31040 | 1386 | 37454 | 1255 | 21743 |
| 2L-7S | | MI | 11556 | 4381 | 18958 | 3161 | 20212 | 2559 | 20409 | 2086 | 20035 | 1376 | 23921 | 866 | 17402 |

## RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

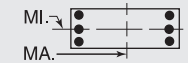
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.14 | MA | 14825 | 4381 | 24352 | 3179 | 26718 | 2580 | 27839 | 2111 | 28993 | 1393 | 34742 | 1166 | 21728 |
| 3L-6S | | MI | 11889 | 4381 | 19572 | 3150 | 20961 | 2551 | 21355 | 2092 | 21215 | 1369 | 25309 | 934 | 17969 |
| 14-#11 | 2.14 | MA | 14367 | 4381 | 23553 | 3190 | 25703 | 2576 | 26608 | 2105 | 27423 | 1400 | 32975 | 1077 | 21658 |
| 4L-5S | | MI | 12230 | 4381 | 20146 | 3154 | 21739 | 2556 | 22266 | 2086 | 22421 | 1362 | 26787 | 993 | 18345 |
| 14-#11 | 2.14 | MA | 13956 | 4381 | 22852 | 3188 | 24799 | 2586 | 25501 | 2113 | 25874 | 1393 | 31102 | 1036 | 21082 |
| 5L-4S | | MI | 12588 | 4381 | 20754 | 3157 | 22522 | 2548 | 23220 | 2079 | 23735 | 1369 | 28370 | 1033 | 18840 |
| 14-#11 | 2.14 | MA | 13563 | 4381 | 22189 | 3186 | 23900 | 2582 | 24404 | 2108 | 24451 | 1400 | 29343 | 977 | 20598 |
| 6L-3S | | MI | 12984 | 4381 | 21443 | 3147 | 23398 | 2553 | 24279 | 2086 | 25065 | 1362 | 29854 | 1121 | 18882 |
| 14-#11 | 2.14 | MA | 13180 | 4381 | 21480 | 3197 | 23036 | 2591 | 23345 | 2116 | 23059 | 1407 | 27509 | 889 | 19923 |
| 7L-2S | | MI | 13537 | 4381 | 22293 | 3150 | 24482 | 2544 | 25593 | 2079 | 26800 | 1355 | 32136 | 1210 | 18878 |
| 14-#14 | 3.09 | MA | 15858 | 4724 | 26931 | 3379 | 29952 | 2729 | 31750 | 2201 | 34110 | 1354 | 41451 | 1039 | 30719 |
| 3L-6S | | MI | 12315 | 4724 | 20978 | 3348 | 22678 | 2694 | 23392 | 2177 | 23903 | 1324 | 29012 | 710 | 24145 |
| 14-#14 | 3.09 | MA | 15216 | 4724 | 25789 | 3395 | 28500 | 2722 | 29989 | 2192 | 31881 | 1364 | 38953 | 911 | 30055 |
| 4L-5S | | MI | 12794 | 4724 | 21799 | 3353 | 23792 | 2702 | 24682 | 2167 | 25611 | 1314 | 31095 | 795 | 25120 |
| 14-#14 | 3.09 | MA | 14638 | 4724 | 24785 | 3391 | 27206 | 2735 | 28404 | 2203 | 29681 | 1354 | 36295 | 854 | 28953 |
| 5L-4S | | MI | 13295 | 4724 | 22667 | 3359 | 24910 | 2691 | 26032 | 2157 | 27472 | 1324 | 33329 | 853 | 25983 |
| 14-#14 | 3.09 | MA | 14088 | 4724 | 23836 | 3387 | 25918 | 2729 | 26891 | 2214 | 27660 | 1364 | 33806 | 768 | 27822 |
| 6L-3S | | MI | 13852 | 4724 | 23652 | 3345 | 26162 | 2700 | 27533 | 2167 | 29356 | 1314 | 35427 | 978 | 26609 |
| 14-#14 | 3.09 | MA | 13550 | 4724 | 22821 | 3403 | 24681 | 2742 | 25319 | 2205 | 25683 | 1374 | 31210 | 641 | 26658 |
| 7L-2S | | MI | 14626 | 4724 | 24864 | 3351 | 27708 | 2688 | 29393 | 2157 | 31813 | 1304 | 38648 | 1106 | 26675 |
| 14-#18 | 5.49 | MA | 17246 | 5593 | 31299 | 3919 | 35423 | 3096 | 38256 | 2407 | 42786 | 1260 | 53467 | 469 | 49160 |
| 4L-5S | | MI | 14137 | 5593 | 25846 | 3863 | 28805 | 3071 | 30550 | 2365 | 33365 | 1179 | 41473 | 266 | 39874 |
| 14-#18 | 5.49 | MA | 16277 | 5593 | 29541 | 3909 | 33157 | 3117 | 35505 | 2425 | 38994 | 1242 | 48906 | 366 | 46414 |
| 5L-4S | | MI | 14980 | 5593 | 27362 | 3876 | 30748 | 3054 | 32862 | 2348 | 36556 | 1196 | 45272 | 370 | 42284 |
| 16-#11 | 2.45 | MA | 15271 | 4492 | 25340 | 3248 | 27979 | 2630 | 29371 | 2142 | 31040 | 1384 | 37454 | 1145 | 24720 |
| 3L-7S | | MI | 11944 | 4492 | 19809 | 3230 | 21296 | 2609 | 21723 | 2116 | 21769 | 1364 | 26203 | 841 | 19845 |
| 16-#11 | 2.45 | MA | 14817 | 4492 | 24542 | 3260 | 26964 | 2626 | 28140 | 2136 | 29470 | 1391 | 35687 | 1056 | 24631 |
| 4L-6S | | MI | 12275 | 4492 | 20423 | 3219 | 22045 | 2601 | 22669 | 2123 | 22949 | 1358 | 27592 | 909 | 20469 |
| 16-#11 | 2.45 | MA | 14408 | 4492 | 23841 | 3257 | 26059 | 2636 | 27033 | 2145 | 27921 | 1384 | 33815 | 1015 | 23969 |
| 5E | | MI | 12615 | 4492 | 20997 | 3223 | 22823 | 2606 | 23580 | 2116 | 24155 | 1351 | 29069 | 968 | 20824 |
| 16-#11 | 2.45 | MA | 14019 | 4492 | 23178 | 3255 | 25160 | 2632 | 25936 | 2139 | 26498 | 1391 | 32055 | 956 | 23509 |
| 6L-4S | | MI | 12969 | 4492 | 21604 | 3226 | 23606 | 2598 | 24533 | 2109 | 25469 | 1358 | 30652 | 1008 | 21401 |
| 16-#11 | 2.45 | MA | 13638 | 4492 | 22469 | 3266 | 24296 | 2642 | 24877 | 2147 | 25105 | 1398 | 30221 | 868 | 22777 |
| 7L-3S | | MI | 13363 | 4492 | 22293 | 3216 | 24482 | 2603 | 25593 | 2116 | 26800 | 1351 | 32136 | 1096 | 21460 |
| 16-#11 | 2.45 | MA | 13263 | 4492 | 21818 | 3264 | 23424 | 2638 | 23841 | 2155 | 23646 | 1391 | 28473 | 820 | 22145 |
| 8L-2S | | MI | 13913 | 4492 | 23144 | 3219 | 25566 | 2595 | 26906 | 2109 | 28535 | 1344 | 34418 | 1185 | 21474 |
| 16-#14 | 3.53 | MA | 15845 | 4883 | 27201 | 3495 | 30300 | 2794 | 32176 | 2237 | 34787 | 1350 | 42794 | 879 | 34124 |
| 4L-6S | | MI | 12856 | 4883 | 22190 | 3447 | 24224 | 2766 | 25252 | 2220 | 26360 | 1306 | 32233 | 671 | 27597 |
| 16-#14 | 3.53 | MA | 15273 | 4883 | 26196 | 3491 | 29006 | 2808 | 30592 | 2248 | 32587 | 1340 | 40136 | 821 | 33084 |
| 5E | | MI | 13331 | 4883 | 23011 | 3453 | 25337 | 2775 | 26542 | 2210 | 28067 | 1297 | 34316 | 757 | 28658 |
| 16-#14 | 3.53 | MA | 14727 | 4883 | 25247 | 3487 | 27718 | 2801 | 29078 | 2259 | 30567 | 1350 | 37646 | 736 | 31866 |
| 6L-4S | | MI | 13829 | 4883 | 23879 | 3459 | 26456 | 2763 | 27892 | 2200 | 29929 | 1306 | 36550 | 815 | 29467 |
| 16-#14 | 3.53 | MA | 14195 | 4883 | 24232 | 3503 | 26481 | 2815 | 27506 | 2250 | 28590 | 1360 | 35050 | 609 | 30714 |
| 7L-3S | | MI | 14381 | 4883 | 24864 | 3445 | 27708 | 2772 | 29393 | 2210 | 31813 | 1297 | 38648 | 939 | 30258 |
| 16-#18 | 6.27 | MA | 17347 | 5876 | 32000 | 4087 | 36293 | 3245 | 39295 | 2503 | 43999 | 1213 | 55483 | 300 | 53383 |
| 5E | | MI | 15043 | 5876 | 27951 | 4040 | 31480 | 3199 | 33735 | 2439 | 37574 | 1143 | 46952 | 187 | 45793 |
| 18-#11 | 2.75 | MA | 15263 | 4603 | 25531 | 3329 | 28224 | 2676 | 29672 | 2168 | 31517 | 1382 | 38400 | 1035 | 27602 |
| 4L-7S | | MI | 12330 | 4603 | 20659 | 3299 | 22380 | 2659 | 23036 | 2147 | 23504 | 1353 | 28485 | 816 | 22296 |
| 18-#11 | 2.75 | MA | 14858 | 4603 | 24829 | 3326 | 27320 | 2686 | 28565 | 2176 | 29967 | 1375 | 36527 | 994 | 26863 |
| 5L-6S | | MI | 12659 | 4603 | 21273 | 3289 | 23129 | 2651 | 23982 | 2154 | 24684 | 1347 | 29874 | 884 | 22972 |
| 18-#11 | 2.75 | MA | 14471 | 4603 | 24167 | 3324 | 26420 | 2682 | 27468 | 2170 | 28545 | 1382 | 34767 | 935 | 26424 |
| 6L-5S | | MI | 12996 | 4603 | 21847 | 3292 | 23907 | 2656 | 24893 | 2147 | 25890 | 1340 | 31351 | 943 | 23310 |
| 18-#11 | 2.75 | MA | 14093 | 4603 | 23458 | 3336 | 25556 | 2692 | 26410 | 2178 | 27152 | 1389 | 32934 | 847 | 25639 |
| 7L-4S | | MI | 13349 | 4603 | 22454 | 3295 | 24690 | 2648 | 25847 | 2140 | 27204 | 1347 | 32934 | 983 | 23958 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

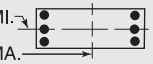
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.75 | MA | 13721 | 4603 | 22807 | 3333 | 24684 | 2688 | 25373 | 2186 | 25693 | 1382 | 31185 | 799 | 24968 |
| 8L-3S | | MI | 13740 | 4603 | 23144 | 3285 | 25566 | 2653 | 26906 | 2147 | 28535 | 1340 | 34418 | 1071 | 24033 |
| 18-#14 | 3.97 | MA | 15902 | 5043 | 27608 | 3591 | 30806 | 2880 | 32780 | 2293 | 35493 | 1326 | 43977 | 789 | 37224 |
| 5L-6S | | MI | 13394 | 5043 | 23402 | 3547 | 25769 | 2838 | 27112 | 2264 | 28817 | 1289 | 35454 | 632 | 31062 |
| 18-#14 | 3.97 | MA | 15361 | 5043 | 26659 | 3587 | 29518 | 2874 | 31266 | 2304 | 33473 | 1336 | 41487 | 703 | 35923 |
| 6L-5S | | MI | 13865 | 5043 | 24224 | 3553 | 26883 | 2847 | 28402 | 2254 | 30524 | 1279 | 37537 | 718 | 32205 |
| 18-#14 | 3.97 | MA | 14833 | 5043 | 25644 | 3602 | 28281 | 2887 | 29694 | 2295 | 31496 | 1345 | 38891 | 576 | 34715 |
| 7L-4S | | MI | 14358 | 5043 | 25092 | 3559 | 28001 | 2836 | 29752 | 2244 | 32386 | 1289 | 39771 | 776 | 32965 |
| 20-#11 | 3.06 | MA | 15304 | 4713 | 25818 | 3396 | 28580 | 2736 | 30097 | 2207 | 32014 | 1366 | 39240 | 974 | 29764 |
| 5L-7S | | MI | 12713 | 4713 | 21509 | 3368 | 23464 | 2710 | 24350 | 2178 | 25239 | 1342 | 30767 | 791 | 24754 |
| 20-#11 | 3.06 | MA | 14920 | 4713 | 25155 | 3393 | 27681 | 2732 | 29000 | 2201 | 30591 | 1373 | 37480 | 915 | 29343 |
| 6E | | MI | 13040 | 4713 | 22123 | 3358 | 24213 | 2701 | 25296 | 2185 | 26419 | 1336 | 32156 | 859 | 25472 |
| 20-#11 | 3.06 | MA | 14544 | 4713 | 24446 | 3405 | 26817 | 2742 | 27942 | 2209 | 29199 | 1380 | 35646 | 827 | 28508 |
| 7L-5S | | MI | 13375 | 4713 | 22697 | 3361 | 24991 | 2706 | 26207 | 2178 | 27625 | 1329 | 33634 | 918 | 25801 |
| 20-#11 | 3.06 | MA | 14175 | 4713 | 23795 | 3402 | 25945 | 2738 | 26905 | 2217 | 27739 | 1373 | 33898 | 779 | 27798 |
| 8L-4S | | MI | 13725 | 4713 | 23304 | 3365 | 25774 | 2698 | 27160 | 2171 | 28939 | 1336 | 35216 | 958 | 26468 |
| 20-#14 | 4.41 | MA | 15989 | 5203 | 28071 | 3686 | 31318 | 2946 | 33454 | 2349 | 36379 | 1321 | 45327 | 671 | 39991 |
| 6E | | MI | 13927 | 5203 | 24615 | 3647 | 27315 | 2911 | 28972 | 2307 | 31273 | 1272 | 38675 | 593 | 34538 |
| 20-#14 | 4.41 | MA | 15466 | 5203 | 27056 | 3702 | 30081 | 2959 | 31882 | 2340 | 34402 | 1331 | 42732 | 544 | 38727 |
| 7L-5S | | MI | 14394 | 5203 | 25436 | 3653 | 28428 | 2919 | 30262 | 2297 | 32981 | 1262 | 40759 | 679 | 35758 |
| 22-#11 | 3.36 | MA | 15365 | 4824 | 26144 | 3462 | 28941 | 2782 | 30533 | 2232 | 32638 | 1364 | 40192 | 894 | 32253 |
| 6L-7S | | MI | 13094 | 4824 | 22359 | 3437 | 24549 | 2760 | 25663 | 2209 | 26974 | 1331 | 33049 | 766 | 27218 |
| 22-#11 | 3.36 | MA | 14993 | 4824 | 25435 | 3474 | 28077 | 2792 | 29474 | 2240 | 31246 | 1371 | 38358 | 806 | 31383 |
| 7L-6S | | MI | 13419 | 4824 | 22973 | 3427 | 25297 | 2751 | 26610 | 2216 | 28154 | 1325 | 34438 | 834 | 27907 |
| 22-#11 | 3.36 | MA | 14626 | 4824 | 24784 | 3471 | 27205 | 2788 | 28437 | 2249 | 29786 | 1364 | 36610 | 758 | 30635 |
| 8L-5S | | MI | 13752 | 4824 | 23548 | 3430 | 26075 | 2757 | 27521 | 2209 | 29360 | 1318 | 35916 | 893 | 28297 |
| 22-#14 | 4.85 | MA | 16094 | 5362 | 28467 | 3802 | 31880 | 3032 | 34070 | 2385 | 37308 | 1317 | 46572 | 512 | 42751 |
| 7L-6S | | MI | 14456 | 5362 | 25827 | 3747 | 28860 | 2983 | 30833 | 2350 | 33730 | 1255 | 41896 | 555 | 38024 |
| 24-#11 | 3.67 | MA | 15438 | 4934 | 26423 | 3543 | 29337 | 2842 | 31006 | 2272 | 33292 | 1362 | 41071 | 785 | 34264 |
| 7E | | MI | 13473 | 4934 | 23210 | 3506 | 25633 | 2810 | 26977 | 2239 | 28708 | 1320 | 35332 | 741 | 29687 |
| 24-#11 | 3.67 | MA | 15074 | 4934 | 25772 | 3541 | 28465 | 2838 | 29969 | 2280 | 31833 | 1355 | 39322 | 737 | 33477 |
| 8L-6S | | MI | 13796 | 4934 | 23824 | 3496 | 26381 | 2801 | 27923 | 2246 | 29888 | 1314 | 36720 | 809 | 30349 |

## RECTANGULAR TIED COLUMNS 30" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.48 | MA | 16188 | 4386 | 26004 | 3188 | 28193 | 2588 | 29031 | 2139 | 29468 | 1468 | 34840 | 1350 | 16912 |
| 2E | | MI | 13357 | 4386 | 21627 | 3134 | 23218 | 2542 | 23651 | 2089 | 23805 | 1422 | 27877 | 1286 | 13808 |
| 6-#14 | 1.25 | MA | 15877 | 4298 | 25180 | 3157 | 27257 | 2568 | 27935 | 2132 | 28136 | 1496 | 33165 | 1394 | 14504 |
| 2L-3S | | MI | 12325 | 4298 | 19767 | 3102 | 20974 | 2539 | 21055 | 2103 | 20389 | 1466 | 23490 | 1214 | 11945 |
| 6-#14 | 1.25 | MA | 14876 | 4298 | 23669 | 3153 | 25330 | 2582 | 25593 | 2143 | 25005 | 1506 | 29014 | 1266 | 14551 |
| 3L-2S | | MI | 13125 | 4298 | 20979 | 3108 | 22519 | 2527 | 22916 | 2093 | 22846 | 1457 | 26711 | 1342 | 11878 |
| 6-#18 | 2.22 | MA | 17371 | 4670 | 28641 | 3365 | 31555 | 2717 | 33118 | 2219 | 34872 | 1442 | 41967 | 1289 | 24985 |
| 2L-3S | | MI | 12918 | 4670 | 21627 | 3298 | 23218 | 2687 | 23651 | 2180 | 23805 | 1404 | 27877 | 980 | 20260 |
| 6-#18 | 2.22 | MA | 15661 | 4670 | 26004 | 3357 | 28193 | 2739 | 29031 | 2237 | 29468 | 1460 | 34840 | 1061 | 24856 |
| 3L-2S | | MI | 14281 | 4670 | 23732 | 3311 | 25892 | 2670 | 26836 | 2162 | 28013 | 1386 | 33356 | 1208 | 20286 |
| 8-#11 | 1.16 | MA | 15749 | 4261 | 24833 | 3146 | 26873 | 2561 | 27490 | 2130 | 27596 | 1509 | 32486 | 1413 | 13509 |
| 2L-4S | | MI | 12062 | 4261 | 19164 | 3107 | 20263 | 2526 | 20244 | 2096 | 19393 | 1486 | 22474 | 1189 | 11160 |
| 8-#11 | 1.16 | MA | 15046 | 4261 | 23775 | 3144 | 25524 | 2572 | 25850 | 2139 | 25393 | 1516 | 29558 | 1325 | 13545 |
| 3E | | MI | 12467 | 4261 | 19854 | 3096 | 21140 | 2532 | 21303 | 2103 | 20723 | 1479 | 23958 | 1277 | 11125 |
| 8-#11 | 1.16 | MA | 14546 | 4261 | 22923 | 3156 | 24440 | 2568 | 24535 | 2134 | 23703 | 1523 | 27648 | 1236 | 13548 |
| 4L-2S | | MI | 13030 | 4261 | 20704 | 3100 | 22224 | 2523 | 22617 | 2096 | 22458 | 1472 | 26240 | 1366 | 11079 |
| 8-#14 | 1.67 | MA | 16569 | 4457 | 26692 | 3256 | 29184 | 2640 | 30278 | 2176 | 31268 | 1484 | 37316 | 1364 | 19138 |
| 2L-4S | | MI | 12302 | 4457 | 19994 | 3216 | 21267 | 2602 | 21415 | 2136 | 20962 | 1459 | 24613 | 1051 | 15611 |
| 8-#14 | 1.67 | MA | 15576 | 4457 | 25180 | 3253 | 27257 | 2654 | 27935 | 2188 | 28136 | 1494 | 33165 | 1236 | 19146 |
| 3E | | MI | 12875 | 4457 | 20979 | 3202 | 22519 | 2611 | 22916 | 2146 | 22846 | 1449 | 26711 | 1175 | 15657 |

## RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

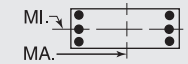
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.67 | MA | 14869 | 4457 | 23960 | 3270 | 25706 | 2649 | 26053 | 2180 | 25735 | 1504 | 30460 | 1109 | 19019 |
| 4L-2S | | MI | 13669 | 4457 | 22191 | 3207 | 24065 | 2600 | 24776 | 2136 | 25303 | 1439 | 29932 | 1303 | 15616 |
| 8-#18 | 2.96 | MA | 18534 | 4954 | 31278 | 3542 | 34917 | 2845 | 37205 | 2299 | 40277 | 1415 | 49094 | 1228 | 33006 |
| 2L-4S | | MI | 12871 | 4954 | 22014 | 3498 | 23719 | 2798 | 24265 | 2235 | 24787 | 1386 | 29776 | 686 | 24511 |
| 8-#18 | 2.96 | MA | 16847 | 4954 | 28641 | 3534 | 31555 | 2868 | 33118 | 2317 | 34872 | 1433 | 41967 | 1000 | 32764 |
| 3E | | MI | 13846 | 4954 | 23732 | 3476 | 25892 | 2815 | 26836 | 2253 | 28013 | 1368 | 33356 | 901 | 26584 |
| 8-#18 | 2.96 | MA | 15643 | 4954 | 26505 | 3562 | 28840 | 2855 | 29823 | 2300 | 30727 | 1451 | 37336 | 773 | 30169 |
| 4L-2S | | MI | 15192 | 4954 | 25837 | 3489 | 28566 | 2798 | 30022 | 2235 | 32221 | 1350 | 38834 | 1129 | 26719 |
| 10-#11 | 1.44 | MA | 16238 | 4372 | 25891 | 3215 | 28221 | 2612 | 29129 | 2161 | 29799 | 1501 | 35415 | 1394 | 16754 |
| 2L-5S | | MI | 12090 | 4372 | 19407 | 3172 | 20565 | 2585 | 20604 | 2134 | 19813 | 1468 | 23173 | 1125 | 13556 |
| 10-#11 | 1.44 | MA | 15539 | 4372 | 24833 | 3214 | 26873 | 2622 | 27490 | 2170 | 27596 | 1508 | 32486 | 1305 | 16776 |
| 3L-4S | | MI | 12453 | 4372 | 20014 | 3176 | 21347 | 2576 | 21557 | 2127 | 21127 | 1475 | 24756 | 1164 | 13751 |
| 10-#11 | 1.44 | MA | 15043 | 4372 | 23980 | 3225 | 25789 | 2619 | 26174 | 2165 | 25906 | 1515 | 30576 | 1217 | 16750 |
| 4L-3S | | MI | 12856 | 4372 | 20704 | 3165 | 22224 | 2582 | 22617 | 2134 | 22458 | 1468 | 26240 | 1252 | 13737 |
| 10-#11 | 1.44 | MA | 14597 | 4372 | 23232 | 3224 | 24824 | 2629 | 24993 | 2174 | 24239 | 1508 | 28560 | 1175 | 16463 |
| 5L-2S | | MI | 13415 | 4372 | 21554 | 3169 | 23308 | 2573 | 23930 | 2127 | 24192 | 1461 | 28522 | 1341 | 13702 |
| 10-#14 | 2.08 | MA | 17253 | 4617 | 28203 | 3356 | 31111 | 2712 | 32620 | 2221 | 34399 | 1471 | 41468 | 1335 | 23755 |
| 2L-5S | | MI | 12340 | 4617 | 20338 | 3310 | 21694 | 2686 | 21925 | 2189 | 21557 | 1432 | 25600 | 954 | 18251 |
| 10-#14 | 2.08 | MA | 16269 | 4617 | 26692 | 3353 | 29184 | 2727 | 30278 | 2233 | 31268 | 1481 | 37316 | 1207 | 23722 |
| 3L-4S | | MI | 12852 | 4617 | 21206 | 3316 | 22813 | 2675 | 23275 | 2179 | 23419 | 1442 | 27834 | 1012 | 19253 |
| 10-#14 | 2.08 | MA | 15568 | 4617 | 25471 | 3369 | 27633 | 2721 | 28395 | 2225 | 28866 | 1491 | 34611 | 1079 | 23548 |
| 4L-3S | | MI | 13419 | 4617 | 22191 | 3301 | 24065 | 2683 | 24776 | 2189 | 25303 | 1432 | 29932 | 1137 | 19344 |
| 10-#14 | 2.08 | MA | 14939 | 4617 | 24399 | 3366 | 26251 | 2735 | 26703 | 2237 | 26495 | 1481 | 31747 | 1019 | 22256 |
| 5L-2S | | MI | 14207 | 4617 | 23403 | 3307 | 25610 | 2672 | 26636 | 2179 | 27759 | 1422 | 33153 | 1265 | 19334 |
| 10-#18 | 3.70 | MA | 19682 | 5237 | 33915 | 3720 | 38279 | 2974 | 41292 | 2379 | 45682 | 1389 | 56220 | 1167 | 40994 |
| 2L-5S | | MI | 12931 | 5237 | 22604 | 3663 | 24450 | 2943 | 25139 | 2326 | 25804 | 1333 | 31456 | 503 | 28590 |
| 10-#18 | 3.70 | MA | 18016 | 5237 | 31278 | 3712 | 34917 | 2996 | 37205 | 2397 | 40277 | 1406 | 49094 | 940 | 40657 |
| 3L-4S | | MI | 13799 | 5237 | 24120 | 3676 | 26393 | 2925 | 27451 | 2309 | 28995 | 1350 | 35255 | 607 | 30487 |
| 10-#18 | 3.70 | MA | 16829 | 5237 | 29142 | 3739 | 32202 | 2984 | 33910 | 2380 | 36132 | 1424 | 44463 | 712 | 37716 |
| 4L-3S | | MI | 14761 | 5237 | 25837 | 3653 | 28566 | 2943 | 30022 | 2326 | 32221 | 1333 | 38834 | 823 | 32887 |
| 10-#18 | 3.70 | MA | 15762 | 5237 | 27263 | 3731 | 29780 | 3006 | 30946 | 2398 | 32039 | 1406 | 39521 | 611 | 35341 |
| 5L-2S | | MI | 16092 | 5237 | 27942 | 3666 | 31240 | 2925 | 33207 | 2309 | 36429 | 1315 | 44313 | 1050 | 33107 |
| 12-#11 | 1.73 | MA | 16723 | 4483 | 26948 | 3285 | 29570 | 2662 | 30768 | 2192 | 32002 | 1493 | 38343 | 1375 | 19989 |
| 2L-6S | | MI | 12136 | 4483 | 19683 | 3238 | 20871 | 2630 | 21006 | 2171 | 20342 | 1464 | 23978 | 1040 | 15603 |
| 12-#11 | 1.73 | MA | 16028 | 4483 | 25891 | 3283 | 28221 | 2672 | 29129 | 2201 | 29799 | 1500 | 35415 | 1286 | 19993 |
| 3L-5S | | MI | 12480 | 4483 | 20258 | 3241 | 21649 | 2635 | 21917 | 2164 | 21548 | 1457 | 25455 | 1100 | 16014 |
| 12-#11 | 1.73 | MA | 15535 | 4483 | 25038 | 3295 | 27137 | 2669 | 27814 | 2196 | 28109 | 1506 | 33504 | 1198 | 19943 |
| 4E | | MI | 12841 | 4483 | 20865 | 3245 | 22432 | 2626 | 22871 | 2157 | 22862 | 1464 | 27038 | 1139 | 16328 |
| 12-#11 | 1.73 | MA | 15093 | 4483 | 24289 | 3293 | 26172 | 2679 | 26632 | 2205 | 26442 | 1500 | 31488 | 1156 | 19532 |
| 5L-3S | | MI | 13241 | 4483 | 21554 | 3235 | 23308 | 2632 | 23930 | 2164 | 24192 | 1457 | 28522 | 1227 | 16338 |
| 12-#11 | 1.73 | MA | 14670 | 4483 | 23583 | 3291 | 25212 | 2676 | 25462 | 2200 | 24910 | 1506 | 29587 | 1097 | 18951 |
| 6L-2S | | MI | 13798 | 4483 | 22404 | 3238 | 24392 | 2623 | 25244 | 2157 | 25927 | 1450 | 30804 | 1316 | 16314 |
| 12-#14 | 2.50 | MA | 17930 | 4776 | 29714 | 3456 | 33038 | 2785 | 34963 | 2266 | 37530 | 1458 | 45619 | 1305 | 28355 |
| 2L-6S | | MI | 12403 | 4776 | 20729 | 3404 | 22126 | 2750 | 22495 | 2243 | 22306 | 1425 | 26738 | 829 | 20997 |
| 12-#14 | 2.50 | MA | 16954 | 4776 | 28203 | 3453 | 31111 | 2799 | 32620 | 2278 | 34399 | 1468 | 41468 | 1177 | 28288 |
| 3L-5S | | MI | 12888 | 4776 | 21550 | 3410 | 23240 | 2758 | 23785 | 2233 | 24014 | 1415 | 28821 | 915 | 21765 |
| 12-#14 | 2.50 | MA | 16260 | 4776 | 26983 | 3469 | 29560 | 2793 | 30738 | 2270 | 31997 | 1478 | 38763 | 1049 | 27996 |
| 4E | | MI | 13396 | 4776 | 22418 | 3415 | 24358 | 2747 | 25135 | 2223 | 25875 | 1425 | 31055 | 973 | 22723 |
| 12-#14 | 2.50 | MA | 15637 | 4776 | 25911 | 3466 | 28178 | 2808 | 29046 | 2282 | 29627 | 1468 | 35898 | 990 | 26657 |
| 5L-3S | | MI | 13958 | 4776 | 23403 | 3401 | 25610 | 2756 | 26636 | 2233 | 27759 | 1415 | 33153 | 1098 | 23015 |
| 12-#14 | 2.50 | MA | 15043 | 4776 | 24898 | 3463 | 26803 | 2802 | 27369 | 2274 | 27450 | 1478 | 33205 | 905 | 25679 |
| 6L-2S | | MI | 14740 | 4776 | 24616 | 3407 | 27156 | 2744 | 28496 | 2223 | 30216 | 1405 | 36374 | 1226 | 23039 |
| 12-#18 | 4.44 | MA | 19170 | 5521 | 33915 | 3889 | 38279 | 3125 | 41292 | 2477 | 45682 | 1380 | 56220 | 879 | 48542 |
| 3L-5S | | MI | 13858 | 5521 | 24709 | 3840 | 27124 | 3071 | 28324 | 2400 | 30012 | 1297 | 36935 | 424 | 34431 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis

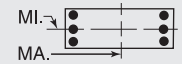



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 4.44 | MA | 17998 | 5521 | 31779 | 3916 | 35564 | 3112 | 37997 | 2460 | 41537 | 1397 | 51590 | 652 | 45304 |
| 4E | | MI | 14715 | 5521 | 26225 | 3853 | 29067 | 3053 | 30636 | 2382 | 33203 | 1315 | 40733 | 529 | 36505 |
| 12-#18 | 4.44 | MA | 16946 | 5521 | 29900 | 3908 | 33142 | 3135 | 35033 | 2478 | 37443 | 1380 | 46648 | 550 | 42761 |
| 5L-3S | | MI | 15666 | 5521 | 27942 | 3830 | 31240 | 3071 | 33207 | 2400 | 36429 | 1297 | 44313 | 744 | 39177 |
| 12-#18 | 4.44 | MA | 15943 | 5521 | 28123 | 3900 | 30733 | 3122 | 32200 | 2496 | 33686 | 1397 | 42031 | 398 | 39857 |
| 6L-2S | | MI | 16982 | 5521 | 30047 | 3843 | 33914 | 3053 | 36393 | 2382 | 40638 | 1279 | 49791 | 972 | 39473 |
| 14-#11 | 2.02 | MA | 17204 | 4593 | 28006 | 3354 | 30918 | 2712 | 32408 | 2223 | 34205 | 1485 | 41271 | 1356 | 23218 |
| 2L-7S | | MI | 12191 | 4593 | 19920 | 3317 | 21206 | 2688 | 21374 | 2195 | 20897 | 1460 | 24871 | 947 | 17611 |
| 14-#11 | 2.02 | MA | 16514 | 4593 | 26948 | 3352 | 29570 | 2722 | 30768 | 2232 | 32002 | 1492 | 38343 | 1267 | 23202 |
| 3L-6S | | MI | 12525 | 4593 | 20534 | 3307 | 21955 | 2680 | 22320 | 2202 | 22077 | 1453 | 26260 | 1015 | 18098 |
| 14-#11 | 2.02 | MA | 16024 | 4593 | 26096 | 3364 | 28486 | 2719 | 29453 | 2227 | 30312 | 1498 | 36432 | 1178 | 23132 |
| 4L-5S | | MI | 12868 | 4593 | 21108 | 3311 | 22733 | 2685 | 23231 | 2195 | 23283 | 1446 | 27738 | 1075 | 18483 |
| 14-#11 | 2.02 | MA | 15584 | 4593 | 25347 | 3362 | 27521 | 2729 | 28271 | 2236 | 28645 | 1492 | 34416 | 1137 | 22612 |
| 5L-4S | | MI | 13226 | 4593 | 21715 | 3314 | 23516 | 2677 | 24184 | 2188 | 24597 | 1453 | 29320 | 1114 | 18899 |
| 14-#11 | 2.02 | MA | 15165 | 4593 | 24640 | 3360 | 26561 | 2726 | 27101 | 2231 | 27113 | 1498 | 32515 | 1078 | 22062 |
| 6L-3S | | MI | 13624 | 4593 | 22404 | 3304 | 24392 | 2682 | 25244 | 2195 | 25927 | 1446 | 30804 | 1202 | 18931 |
| 14-#11 | 2.02 | MA | 14756 | 4593 | 23884 | 3372 | 25639 | 2736 | 25971 | 2240 | 25615 | 1505 | 30534 | 990 | 21428 |
| 7L-2S | | MI | 14177 | 4593 | 23255 | 3307 | 25476 | 2674 | 26557 | 2188 | 27662 | 1439 | 33087 | 1291 | 18918 |
| 14-#14 | 2.92 | MA | 17633 | 4936 | 29714 | 3552 | 33038 | 2871 | 34963 | 2323 | 37530 | 1455 | 45619 | 1147 | 32845 |
| 3L-6S | | MI | 12951 | 4936 | 21941 | 3504 | 23672 | 2822 | 24355 | 2286 | 24763 | 1407 | 29959 | 791 | 24429 |
| 14-#14 | 2.92 | MA | 16945 | 4936 | 28494 | 3569 | 31487 | 2866 | 33080 | 2315 | 35128 | 1465 | 42914 | 1019 | 32336 |
| 4L-5S | | MI | 13431 | 4936 | 22763 | 3509 | 24785 | 2831 | 25645 | 2276 | 26470 | 1398 | 32042 | 876 | 25293 |
| 14-#14 | 2.92 | MA | 16328 | 4936 | 27422 | 3566 | 30105 | 2880 | 31388 | 2327 | 32758 | 1455 | 40049 | 960 | 31072 |
| 5L-4S | | MI | 13935 | 4936 | 23631 | 3515 | 25903 | 2819 | 26995 | 2266 | 28332 | 1407 | 34276 | 934 | 26186 |
| 14-#14 | 2.92 | MA | 15739 | 4936 | 26409 | 3562 | 28730 | 2874 | 29712 | 2319 | 30581 | 1465 | 37356 | 875 | 30000 |
| 6L-3S | | MI | 14493 | 4936 | 24616 | 3501 | 27156 | 2828 | 28496 | 2276 | 30216 | 1398 | 36374 | 1059 | 26676 |
| 14-#14 | 2.92 | MA | 15164 | 4936 | 25326 | 3579 | 27409 | 2888 | 28094 | 2331 | 28451 | 1475 | 34549 | 748 | 28683 |
| 7L-2S | | MI | 15269 | 4936 | 25828 | 3507 | 28701 | 2817 | 30356 | 2266 | 32673 | 1388 | 39595 | 1187 | 26729 |
| 14-#18 | 5.19 | MA | 19153 | 5805 | 34416 | 4094 | 38926 | 3241 | 42084 | 2539 | 46942 | 1371 | 58717 | 591 | 52926 |
| 4L-5S | | MI | 14774 | 5805 | 26814 | 4017 | 29798 | 3198 | 31510 | 2473 | 34220 | 1262 | 42413 | 346 | 40309 |
| 14-#18 | 5.19 | MA | 18115 | 5805 | 32537 | 4086 | 36504 | 3264 | 39120 | 2557 | 42848 | 1353 | 53775 | 489 | 50217 |
| 5L-4S | | MI | 15622 | 5805 | 28330 | 4030 | 31741 | 3181 | 33822 | 2455 | 37411 | 1279 | 46212 | 450 | 42555 |
| 14-#18 | 5.19 | MA | 17125 | 5805 | 30760 | 4078 | 34095 | 3251 | 36287 | 2575 | 39091 | 1371 | 49158 | 337 | 47358 |
| 6L-3S | | MI | 16562 | 5805 | 30047 | 4008 | 33914 | 3198 | 36393 | 2473 | 40638 | 1262 | 49791 | 666 | 45442 |
| 16-#11 | 2.31 | MA | 16995 | 4704 | 28006 | 3421 | 30918 | 2772 | 32408 | 2263 | 34205 | 1483 | 41271 | 1248 | 26405 |
| 3L-7S | | MI | 12580 | 4704 | 20770 | 3387 | 22290 | 2738 | 22687 | 2226 | 22632 | 1449 | 27153 | 922 | 20052 |
| 16-#11 | 2.31 | MA | 16509 | 4704 | 27153 | 3433 | 29834 | 2769 | 31092 | 2258 | 32515 | 1490 | 39360 | 1159 | 26316 |
| 4L-6S | | MI | 12912 | 4704 | 21384 | 3376 | 23039 | 2730 | 23633 | 2233 | 23812 | 1442 | 28542 | 990 | 20598 |
| 16-#11 | 2.31 | MA | 16072 | 4704 | 26405 | 3431 | 28869 | 2779 | 29911 | 2267 | 30848 | 1483 | 37344 | 1117 | 25702 |
| 5E | | MI | 13253 | 4704 | 21958 | 3380 | 23817 | 2735 | 24544 | 2226 | 25017 | 1435 | 30020 | 1050 | 20961 |
| 16-#11 | 2.31 | MA | 15656 | 4704 | 25698 | 3429 | 27909 | 2776 | 28740 | 2262 | 29316 | 1490 | 35443 | 1059 | 25178 |
| 6L-4S | | MI | 13609 | 4704 | 22565 | 3383 | 24600 | 2727 | 25498 | 2219 | 26332 | 1442 | 31602 | 1089 | 21464 |
| 16-#11 | 2.31 | MA | 15250 | 4704 | 24942 | 3441 | 26988 | 2786 | 27611 | 2271 | 27817 | 1497 | 33462 | 971 | 24486 |
| 7L-3S | | MI | 14004 | 4704 | 23255 | 3373 | 25476 | 2732 | 26557 | 2226 | 27662 | 1435 | 33087 | 1177 | 21511 |
| 16-#11 | 2.31 | MA | 14849 | 4704 | 24247 | 3439 | 26057 | 2783 | 26504 | 2280 | 26247 | 1490 | 31580 | 922 | 23774 |
| 8L-2S | | MI | 14554 | 4704 | 24105 | 3376 | 26560 | 2724 | 27871 | 2219 | 29397 | 1428 | 35369 | 1266 | 21516 |
| 16-#14 | 3.33 | MA | 17624 | 5096 | 30006 | 3669 | 33414 | 2938 | 35423 | 2360 | 38260 | 1453 | 47065 | 989 | 36695 |
| 4L-6S | | MI | 13493 | 5096 | 23154 | 3603 | 25217 | 2894 | 26215 | 2329 | 27220 | 1390 | 33180 | 752 | 27877 |
| 16-#14 | 3.33 | MA | 17013 | 5096 | 28934 | 3665 | 32032 | 2952 | 33731 | 2372 | 35889 | 1443 | 44201 | 930 | 35498 |
| 5E | | MI | 13970 | 5096 | 23975 | 3609 | 26331 | 2903 | 27505 | 2319 | 28927 | 1380 | 35263 | 838 | 28830 |
| 16-#14 | 3.33 | MA | 16429 | 5096 | 27921 | 3662 | 30657 | 2947 | 32054 | 2364 | 33713 | 1453 | 41507 | 845 | 34337 |
| 6L-4S | | MI | 14469 | 5096 | 24843 | 3615 | 27449 | 2892 | 28855 | 2309 | 30789 | 1390 | 37497 | 896 | 29667 |
| 16-#14 | 3.33 | MA | 15859 | 5096 | 26837 | 3679 | 29336 | 2961 | 30436 | 2376 | 31582 | 1463 | 38700 | 718 | 33072 |
| 7L-3S | | MI | 15023 | 5096 | 25828 | 3601 | 28701 | 2900 | 30356 | 2319 | 32673 | 1380 | 39595 | 1020 | 30329 |
| 16-#14 | 3.33 | MA | 15298 | 5096 | 25842 | 3675 | 28003 | 2955 | 28852 | 2387 | 29349 | 1453 | 36025 | 649 | 31432 |
| 8L-2S | | MI | 15794 | 5096 | 27040 | 3606 | 30247 | 2889 | 32216 | 2309 | 35130 | 1370 | 42816 | 1148 | 30407 |
| 16-#18 | 5.93 | MA | 19271 | 6089 | 35174 | 4263 | 39866 | 3392 | 43207 | 2637 | 48253 | 1327 | 60902 | 429 | 57705 |
| 5E | | MI | 15682 | 6089 | 28919 | 4195 | 32472 | 3326 | 34695 | 2546 | 38429 | 1226 | 47892 | 267 | 46221 |

## RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

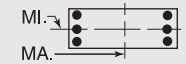
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 5.93 | MA | 18294 | 6089 | 33397 | 4255 | 37457 | 3380 | 40374 | 2655 | 44496 | 1344 | 56284 | 277 | 54754 |
| 6L-4S | | MI | 16520 | 6089 | 30435 | 4208 | 34415 | 3309 | 37007 | 2529 | 41619 | 1244 | 51690 | 372 | 48630 |
| 18-#11 | 2.60 | MA | 16990 | 4815 | 28211 | 3502 | 31183 | 2819 | 32732 | 2289 | 34718 | 1482 | 42288 | 1140 | 29498 |
| 4L-7S | | MI | 12967 | 4815 | 21620 | 3456 | 23374 | 2788 | 24001 | 2257 | 24366 | 1438 | 29436 | 897 | 22501 |
| 18-#11 | 2.60 | MA | 16557 | 4815 | 27463 | 3500 | 30218 | 2829 | 31550 | 2298 | 33051 | 1475 | 40272 | 1098 | 28800 |
| 5L-6S | | MI | 13297 | 4815 | 22234 | 3445 | 24123 | 2780 | 24947 | 2264 | 25546 | 1431 | 30824 | 965 | 23101 |
| 18-#11 | 2.60 | MA | 16143 | 4815 | 26756 | 3498 | 29258 | 2826 | 30380 | 2293 | 31519 | 1482 | 38371 | 1039 | 28300 |
| 6L-5S | | MI | 13635 | 4815 | 22808 | 3449 | 24901 | 2785 | 25858 | 2257 | 26752 | 1424 | 32302 | 1025 | 23445 |
| 18-#11 | 2.60 | MA | 15740 | 4815 | 25999 | 3510 | 28336 | 2836 | 29250 | 2302 | 30020 | 1489 | 36391 | 952 | 27552 |
| 7L-4S | | MI | 13989 | 4815 | 23415 | 3452 | 25684 | 2777 | 26811 | 2250 | 28066 | 1431 | 33885 | 1064 | 24025 |
| 18-#11 | 2.60 | MA | 15342 | 4815 | 25305 | 3508 | 27406 | 2833 | 28144 | 2311 | 28450 | 1482 | 34508 | 903 | 26865 |
| 8L-3S | | MI | 14381 | 4815 | 24105 | 3442 | 26560 | 2782 | 27871 | 2257 | 29397 | 1424 | 35369 | 1152 | 24087 |
| 18-#11 | 2.60 | MA | 14947 | 4815 | 24570 | 3520 | 26496 | 2843 | 26999 | 2306 | 26966 | 1489 | 32666 | 846 | 25892 |
| 9L-2S | | MI | 14929 | 4815 | 24955 | 3445 | 27644 | 2774 | 29184 | 2250 | 31131 | 1417 | 37651 | 1241 | 24109 |
| 18-#14 | 3.75 | MA | 17691 | 5255 | 30445 | 3765 | 33959 | 3024 | 36073 | 2417 | 39021 | 1430 | 48352 | 900 | 39934 |
| 5L-6S | | MI | 14032 | 5255 | 24366 | 3703 | 26763 | 2967 | 28075 | 2373 | 29676 | 1373 | 36401 | 713 | 31338 |
| 18-#14 | 3.75 | MA | 17113 | 5255 | 29432 | 3762 | 32584 | 3019 | 34397 | 2409 | 36844 | 1440 | 45658 | 815 | 38687 |
| 6L-5S | | MI | 14505 | 5255 | 25187 | 3709 | 27876 | 2975 | 29365 | 2363 | 31384 | 1363 | 38485 | 799 | 32376 |
| 18-#14 | 3.75 | MA | 16548 | 5255 | 28349 | 3778 | 31263 | 3033 | 32779 | 2420 | 34713 | 1450 | 42851 | 688 | 37470 |
| 7L-4S | | MI | 15000 | 5255 | 26055 | 3715 | 28994 | 2964 | 30716 | 2353 | 33246 | 1373 | 40718 | 857 | 33163 |
| 18-#14 | 3.75 | MA | 15992 | 5255 | 27354 | 3775 | 29930 | 3027 | 31194 | 2432 | 32481 | 1440 | 40176 | 619 | 35779 |
| 8L-3S | | MI | 15550 | 5255 | 27040 | 3700 | 30247 | 2973 | 32216 | 2363 | 35130 | 1363 | 42816 | 982 | 33977 |
| 18-#18 | 6.67 | MA | 19450 | 6372 | 36034 | 4432 | 40819 | 3508 | 44461 | 2735 | 49901 | 1318 | 63411 | 216 | 62177 |
| 6L-5S | | MI | 16581 | 6372 | 31024 | 4372 | 35146 | 3454 | 37881 | 2620 | 42637 | 1191 | 53370 | 189 | 52161 |
| 20-#11 | 2.89 | MA | 17038 | 4925 | 28520 | 3569 | 31566 | 2880 | 33189 | 2329 | 35254 | 1467 | 43200 | 1079 | 31905 |
| 5L-7S | | MI | 13351 | 4925 | 22470 | 3525 | 24458 | 2839 | 25314 | 2288 | 26101 | 1427 | 31718 | 872 | 24956 |
| 20-#11 | 2.89 | MA | 16627 | 4925 | 27813 | 3567 | 30607 | 2876 | 32019 | 2324 | 33722 | 1474 | 41299 | 1020 | 31425 |
| 6E | | MI | 13679 | 4925 | 23084 | 3515 | 25207 | 2830 | 26261 | 2294 | 27281 | 1420 | 33107 | 940 | 25609 |
| 20-#11 | 2.89 | MA | 16226 | 4925 | 27057 | 3579 | 29685 | 2886 | 30889 | 2333 | 32223 | 1481 | 39319 | 932 | 30625 |
| 7L-5S | | MI | 14015 | 4925 | 23659 | 3518 | 25985 | 2835 | 27172 | 2288 | 28487 | 1413 | 34584 | 1000 | 25936 |
| 20-#11 | 2.89 | MA | 15831 | 4925 | 26363 | 3577 | 28754 | 2883 | 29783 | 2342 | 30653 | 1474 | 37436 | 884 | 29961 |
| 8L-4S | | MI | 14366 | 4925 | 24266 | 3521 | 26768 | 2827 | 28125 | 2281 | 29801 | 1420 | 36167 | 1039 | 26583 |
| 20-#11 | 2.89 | MA | 15440 | 4925 | 25628 | 3589 | 27845 | 2893 | 28639 | 2337 | 29169 | 1481 | 35594 | 827 | 28953 |
| 9L-3S | | MI | 14757 | 4925 | 24955 | 3511 | 27644 | 2832 | 29184 | 2288 | 31131 | 1413 | 37651 | 1127 | 26659 |
| 20-#14 | 4.17 | MA | 17791 | 5415 | 30944 | 3862 | 34511 | 3091 | 36740 | 2453 | 39975 | 1427 | 49809 | 785 | 43048 |
| 6E | | MI | 14566 | 5415 | 25578 | 3803 | 28308 | 3039 | 29936 | 2416 | 32133 | 1356 | 39622 | 674 | 34811 |
| 20-#14 | 4.17 | MA | 17231 | 5415 | 29860 | 3878 | 33190 | 3105 | 35121 | 2465 | 37845 | 1437 | 47003 | 659 | 41829 |
| 7L-5S | | MI | 15036 | 5415 | 26399 | 3809 | 29422 | 3048 | 31225 | 2406 | 33841 | 1346 | 41706 | 760 | 35929 |
| 20-#14 | 4.17 | MA | 16680 | 5415 | 28865 | 3875 | 31857 | 3100 | 33537 | 2477 | 35612 | 1427 | 44328 | 589 | 40135 |
| 8L-4S | | MI | 15527 | 5415 | 27267 | 3814 | 30540 | 3036 | 32576 | 2396 | 35702 | 1356 | 43939 | 818 | 36671 |
| 22-#11 | 3.18 | MA | 17108 | 5036 | 28871 | 3637 | 31955 | 2926 | 33658 | 2355 | 35925 | 1466 | 44227 | 1001 | 34554 |
| 6L-7S | | MI | 13732 | 5036 | 23321 | 3594 | 25542 | 2889 | 26628 | 2318 | 27836 | 1416 | 34000 | 847 | 27418 |
| 22-#11 | 3.18 | MA | 16710 | 5036 | 28115 | 3649 | 31033 | 2937 | 32529 | 2364 | 34426 | 1473 | 42247 | 913 | 33704 |
| 7L-6S | | MI | 14058 | 5036 | 23935 | 3584 | 26291 | 2880 | 27574 | 2325 | 29016 | 1409 | 35389 | 915 | 28118 |
| 22-#11 | 3.18 | MA | 16317 | 5036 | 27420 | 3647 | 30103 | 2933 | 31422 | 2373 | 32856 | 1466 | 40364 | 864 | 33002 |
| 8L-5S | | MI | 14392 | 5036 | 24509 | 3587 | 27069 | 2886 | 28485 | 2318 | 30222 | 1402 | 36866 | 975 | 28432 |
| 22-#11 | 3.18 | MA | 15928 | 5036 | 26686 | 3659 | 29193 | 2944 | 30278 | 2368 | 31372 | 1473 | 38522 | 808 | 32020 |
| 9L-4S | | MI | 14742 | 5036 | 25116 | 3591 | 27852 | 2877 | 29439 | 2311 | 31536 | 1409 | 38449 | 1015 | 29091 |
| 22-#14 | 4.58 | MA | 17909 | 5574 | 31371 | 3978 | 35117 | 3178 | 37464 | 2510 | 40976 | 1424 | 51154 | 629 | 46146 |
| 7L-6S | | MI | 15097 | 5574 | 26790 | 3903 | 29854 | 3111 | 31796 | 2459 | 34590 | 1339 | 42843 | 636 | 38294 |
| 22-#14 | 4.58 | MA | 17362 | 5574 | 30376 | 3975 | 33784 | 3172 | 35879 | 2522 | 38743 | 1414 | 48479 | 559 | 44500 |
| 8L-5S | | MI | 15563 | 5574 | 27611 | 3908 | 30967 | 3120 | 33086 | 2449 | 36297 | 1329 | 44927 | 722 | 39487 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

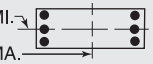
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 3.47 | MA | 17190 | 5147 | 29172 | 3718 | 32382 | 2987 | 34168 | 2395 | 36629 | 1465 | 45175 | 894 | 36789 |
| 7E | | MI | 14112 | 5147 | 24171 | 3663 | 26626 | 2939 | 27941 | 2349 | 29571 | 1405 | 36282 | 822 | 29886 |
| 24-#11 | 3.47 | MA | 16800 | 5147 | 28478 | 3716 | 31451 | 2983 | 33062 | 2404 | 35059 | 1458 | 43292 | 845 | 36048 |
| 8L-6S | | MI | 14436 | 5147 | 24785 | 3653 | 27375 | 2930 | 28888 | 2356 | 30751 | 1398 | 37671 | 890 | 30573 |
| 24-#11 | 3.47 | MA | 16414 | 5147 | 27744 | 3728 | 30542 | 2994 | 31917 | 2399 | 33575 | 1465 | 41450 | 789 | 35092 |
| 9L-5S | | MI | 14768 | 5147 | 25359 | 3656 | 28153 | 2936 | 29799 | 2349 | 31956 | 1391 | 39149 | 950 | 30931 |
| 24-#14 | 5.00 | MA | 18039 | 5734 | 31888 | 4074 | 35711 | 3244 | 38222 | 2567 | 41874 | 1402 | 52630 | 529 | 48873 |
| 8L-6S | | MI | 15624 | 5734 | 28003 | 4002 | 31399 | 3184 | 33656 | 2503 | 37047 | 1321 | 46064 | 597 | 41787 |

## RECTANGULAR TIED COLUMNS 30" x 38"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.40 | MA | 17942 | 4598 | 28672 | 3360 | 31102 | 2730 | 31996 | 2260 | 32453 | 1566 | 38376 | 1448 | 17992 |
| 2E | | MI | 13995 | 4598 | 22595 | 3288 | 24210 | 2669 | 24611 | 2197 | 24660 | 1504 | 28817 | 1366 | 13851 |
| 6-#14 | 1.18 | MA | 17604 | 4510 | 27785 | 3329 | 30094 | 2710 | 30816 | 2252 | 31002 | 1592 | 36537 | 1491 | 15415 |
| 2L-3S | | MI | 12962 | 4510 | 20730 | 3258 | 21967 | 2667 | 22019 | 2212 | 21249 | 1550 | 24437 | 1295 | 11984 |
| 6-#14 | 1.18 | MA | 16533 | 4510 | 26174 | 3326 | 28040 | 2725 | 28319 | 2265 | 27646 | 1602 | 32075 | 1363 | 15462 |
| 3L-2S | | MI | 13764 | 4510 | 21943 | 3264 | 23513 | 2656 | 23879 | 2202 | 23706 | 1540 | 27658 | 1423 | 11913 |
| 6-#18 | 2.11 | MA | 19215 | 4882 | 31486 | 3538 | 34690 | 2858 | 36357 | 2340 | 38258 | 1541 | 46054 | 1392 | 26605 |
| 2L-3S | | MI | 13555 | 4882 | 22595 | 3453 | 24210 | 2814 | 24611 | 2288 | 24660 | 1487 | 28817 | 1060 | 20337 |
| 6-#18 | 2.11 | MA | 17384 | 4882 | 28672 | 3531 | 31102 | 2883 | 31996 | 2360 | 32453 | 1559 | 38376 | 1164 | 26476 |
| 3L-2S | | MI | 14921 | 4882 | 24700 | 3466 | 26885 | 2797 | 27796 | 2270 | 28868 | 1469 | 34296 | 1288 | 20338 |
| 8-#11 | 1.09 | MA | 17465 | 4474 | 27412 | 3319 | 29680 | 2703 | 30336 | 2250 | 30413 | 1604 | 35792 | 1509 | 14351 |
| 2L-4S | | MI | 12698 | 4474 | 20125 | 3263 | 21257 | 2655 | 21208 | 2205 | 20255 | 1570 | 23424 | 1271 | 11199 |
| 8-#11 | 1.09 | MA | 16714 | 4474 | 26285 | 3317 | 28243 | 2714 | 28590 | 2260 | 28054 | 1611 | 32648 | 1420 | 14388 |
| 3E | | MI | 13104 | 4474 | 20815 | 3253 | 22134 | 2661 | 22268 | 2212 | 21585 | 1563 | 24908 | 1359 | 11157 |
| 8-#11 | 1.09 | MA | 16181 | 4474 | 25378 | 3330 | 27090 | 2711 | 27190 | 2255 | 26244 | 1618 | 30594 | 1331 | 14391 |
| 4L-2S | | MI | 13668 | 4474 | 21665 | 3257 | 23218 | 2652 | 23581 | 2205 | 23320 | 1556 | 27191 | 1447 | 11109 |
| 8-#14 | 1.58 | MA | 18347 | 4669 | 29396 | 3429 | 32148 | 2782 | 33313 | 2297 | 34359 | 1581 | 41000 | 1463 | 20353 |
| 2L-4S | | MI | 12939 | 4669 | 20957 | 3372 | 22261 | 2731 | 22378 | 2245 | 21822 | 1543 | 25560 | 1132 | 15678 |
| 8-#14 | 1.58 | MA | 17286 | 4669 | 27785 | 3426 | 30094 | 2797 | 30816 | 2310 | 31002 | 1591 | 36537 | 1335 | 20361 |
| 3E | | MI | 13513 | 4669 | 21943 | 3358 | 23513 | 2739 | 23879 | 2255 | 23706 | 1533 | 27658 | 1256 | 15702 |
| 8-#14 | 1.58 | MA | 16532 | 4669 | 26487 | 3443 | 28443 | 2792 | 28812 | 2302 | 28427 | 1601 | 33625 | 1207 | 20234 |
| 4L-2S | | MI | 14308 | 4669 | 23155 | 3363 | 25058 | 2728 | 25739 | 2245 | 26162 | 1523 | 30879 | 1384 | 15655 |
| 8-#18 | 2.81 | MA | 20467 | 5166 | 34300 | 3715 | 38278 | 2987 | 40719 | 2420 | 44063 | 1517 | 53733 | 1336 | 35166 |
| 2L-4S | | MI | 13508 | 5166 | 22982 | 3653 | 24711 | 2925 | 25225 | 2343 | 25641 | 1469 | 30716 | 766 | 24790 |
| 8-#18 | 2.81 | MA | 18660 | 5166 | 31486 | 3708 | 34690 | 3011 | 36357 | 2439 | 38258 | 1535 | 46054 | 1108 | 34924 |
| 3E | | MI | 14485 | 5166 | 24700 | 3630 | 26885 | 2942 | 27796 | 2361 | 28868 | 1451 | 34296 | 982 | 26673 |
| 8-#18 | 2.81 | MA | 17375 | 5166 | 29211 | 3737 | 31798 | 3000 | 32848 | 2424 | 33806 | 1552 | 41057 | 881 | 32406 |
| 4L-2S | | MI | 15835 | 5166 | 26805 | 3643 | 29559 | 2925 | 30982 | 2343 | 33076 | 1433 | 39774 | 1209 | 26777 |
| 10-#11 | 1.37 | MA | 17989 | 4584 | 28539 | 3388 | 31117 | 2753 | 32083 | 2281 | 32773 | 1597 | 38936 | 1491 | 17807 |
| 2L-5S | | MI | 12726 | 4584 | 20369 | 3329 | 21559 | 2714 | 21568 | 2243 | 20675 | 1552 | 24124 | 1206 | 13693 |
| 10-#11 | 1.37 | MA | 17243 | 4584 | 27412 | 3386 | 29680 | 2764 | 30336 | 2291 | 30413 | 1604 | 35792 | 1402 | 17829 |
| 3L-4S | | MI | 13090 | 4584 | 20976 | 3333 | 22341 | 2705 | 22522 | 2236 | 21989 | 1559 | 25706 | 1246 | 13797 |
| 10-#11 | 1.37 | MA | 16714 | 4584 | 26505 | 3399 | 28527 | 2761 | 28937 | 2286 | 28603 | 1611 | 33738 | 1314 | 17803 |
| 4L-3S | | MI | 13493 | 4584 | 21665 | 3322 | 23218 | 2711 | 23581 | 2243 | 23320 | 1552 | 27191 | 1334 | 13774 |
| 10-#11 | 1.37 | MA | 16239 | 4584 | 25709 | 3397 | 27501 | 2772 | 27680 | 2296 | 26818 | 1604 | 31579 | 1271 | 17599 |
| 5L-2S | | MI | 14054 | 4584 | 22515 | 3326 | 24302 | 2702 | 24895 | 2236 | 25055 | 1545 | 29473 | 1422 | 13736 |
| 10-#14 | 1.97 | MA | 19082 | 4829 | 31008 | 3529 | 34202 | 2854 | 35810 | 2342 | 37716 | 1569 | 45462 | 1436 | 25274 |
| 2L-5S | | MI | 12976 | 4829 | 21302 | 3466 | 22688 | 2814 | 22888 | 2298 | 22417 | 1516 | 26547 | 1035 | 18421 |
| 10-#14 | 1.97 | MA | 18029 | 4829 | 29396 | 3526 | 32148 | 2869 | 33313 | 2355 | 34359 | 1579 | 41000 | 1308 | 25241 |
| 3L-4S | | MI | 13489 | 4829 | 22170 | 3472 | 23806 | 2803 | 24238 | 2288 | 24278 | 1526 | 28781 | 1093 | 19328 |
| 10-#14 | 1.97 | MA | 17283 | 4829 | 28098 | 3543 | 30497 | 2864 | 31309 | 2347 | 31784 | 1589 | 38087 | 1180 | 25067 |
| 4L-3S | | MI | 14058 | 4829 | 23155 | 3457 | 25058 | 2812 | 25739 | 2298 | 26162 | 1516 | 30879 | 1218 | 19398 |
| 10-#14 | 1.97 | MA | 16613 | 4829 | 26958 | 3540 | 29027 | 2879 | 29510 | 2360 | 29244 | 1579 | 35016 | 1119 | 23799 |
| 5L-2S | | MI | 14847 | 4829 | 24367 | 3463 | 26604 | 2800 | 27599 | 2288 | 28619 | 1506 | 34100 | 1346 | 19377 |
| 10-#18 | 3.51 | MA | 21701 | 5450 | 37115 | 3892 | 41866 | 3116 | 45081 | 2499 | 49868 | 1493 | 61411 | 1280 | 43694 |
| 2L-5S | | MI | 13566 | 5450 | 23571 | 3817 | 25443 | 3070 | 26099 | 2434 | 26659 | 1416 | 32396 | 583 | 29032 |

## RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis



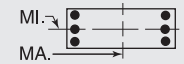

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.51 | MA | 19917 | 5450 | 34300 | 3885 | 38278 | 3140 | 40719 | 2519 | 44063 | 1510 | 53733 | 1052 | 43357 |
| 3L-4S | | MI | 14437 | 5450 | 25087 | 3830 | 27386 | 3052 | 28411 | 2417 | 29850 | 1433 | 36195 | 688 | 30761 |
| 10-#18 | 3.51 | MA | 18650 | 5450 | 32025 | 3914 | 35386 | 3129 | 37210 | 2504 | 39610 | 1528 | 48736 | 824 | 40471 |
| 4L-3S | | MI | 15402 | 5450 | 26805 | 3807 | 29559 | 3070 | 30982 | 2434 | 33076 | 1416 | 39774 | 903 | 32986 |
| 10-#18 | 3.51 | MA | 17512 | 5450 | 30025 | 3907 | 32808 | 3153 | 34053 | 2524 | 35215 | 1510 | 43426 | 721 | 38156 |
| 5L-2S | | MI | 16737 | 5450 | 28910 | 3820 | 32233 | 3052 | 34167 | 2417 | 37284 | 1398 | 45253 | 1131 | 33175 |
| 12-#11 | 1.64 | MA | 18510 | 4695 | 29665 | 3457 | 32553 | 2804 | 33829 | 2313 | 35132 | 1590 | 42080 | 1474 | 21253 |
| 2L-6S | | MI | 12772 | 4695 | 20645 | 3395 | 21864 | 2759 | 21971 | 2281 | 21204 | 1548 | 24928 | 1122 | 15726 |
| 12-#11 | 1.64 | MA | 17768 | 4695 | 28539 | 3456 | 31117 | 2814 | 32083 | 2322 | 32773 | 1597 | 38936 | 1385 | 21257 |
| 3L-5S | | MI | 13117 | 4695 | 21219 | 3398 | 22643 | 2764 | 22882 | 2274 | 22410 | 1541 | 26406 | 1181 | 16148 |
| 12-#11 | 1.64 | MA | 17242 | 4695 | 27632 | 3468 | 29964 | 2811 | 30683 | 2318 | 30963 | 1604 | 36881 | 1296 | 21207 |
| 4E | | MI | 13479 | 4695 | 21826 | 3402 | 23425 | 2755 | 23835 | 2267 | 23724 | 1548 | 27989 | 1221 | 16380 |
| 12-#11 | 1.64 | MA | 16771 | 4695 | 26836 | 3466 | 28938 | 2822 | 29427 | 2327 | 29178 | 1597 | 34723 | 1254 | 20870 |
| 5L-3S | | MI | 13879 | 4695 | 22515 | 3391 | 24302 | 2761 | 24895 | 2274 | 25055 | 1541 | 29473 | 1309 | 16378 |
| 12-#11 | 1.64 | MA | 16321 | 4695 | 26085 | 3465 | 27918 | 2819 | 28183 | 2323 | 27537 | 1604 | 32680 | 1195 | 20216 |
| 6L-2S | | MI | 14437 | 4695 | 23366 | 3395 | 25386 | 2752 | 26208 | 2267 | 26789 | 1534 | 31755 | 1397 | 16351 |
| 12-#14 | 2.37 | MA | 19809 | 4989 | 32619 | 3628 | 36257 | 2927 | 38307 | 2387 | 41072 | 1558 | 49924 | 1408 | 30178 |
| 2L-6S | | MI | 13038 | 4989 | 21693 | 3560 | 23120 | 2878 | 23458 | 2352 | 23166 | 1509 | 27685 | 910 | 21279 |
| 12-#14 | 2.37 | MA | 18765 | 4989 | 31008 | 3626 | 34202 | 2942 | 35810 | 2399 | 37716 | 1568 | 45462 | 1280 | 30110 |
| 3L-5S | | MI | 13525 | 4989 | 22514 | 3566 | 24233 | 2887 | 24748 | 2342 | 24873 | 1499 | 29768 | 996 | 21934 |
| 12-#14 | 2.37 | MA | 18026 | 4989 | 29709 | 3643 | 32551 | 2937 | 33807 | 2392 | 35141 | 1578 | 42550 | 1152 | 29896 |
| 4E | | MI | 14034 | 4989 | 23382 | 3571 | 25351 | 2875 | 26098 | 2332 | 26735 | 1509 | 32002 | 1054 | 22923 |
| 12-#14 | 2.37 | MA | 17362 | 4989 | 28569 | 3640 | 31081 | 2952 | 32007 | 2405 | 32600 | 1568 | 39479 | 1092 | 28494 |
| 5L-3S | | MI | 14598 | 4989 | 24367 | 3557 | 26604 | 2884 | 27599 | 2342 | 28619 | 1499 | 34100 | 1179 | 23074 |
| 12-#14 | 2.37 | MA | 16729 | 4989 | 27492 | 3637 | 29620 | 2947 | 30224 | 2398 | 30267 | 1578 | 36581 | 1007 | 27591 |
| 6L-2S | | MI | 15382 | 4989 | 25579 | 3563 | 28149 | 2873 | 29459 | 2332 | 31076 | 1489 | 37321 | 1307 | 23085 |
| 12-#18 | 4.21 | MA | 21157 | 5733 | 37115 | 4063 | 41866 | 3268 | 45081 | 2599 | 49868 | 1486 | 61411 | 996 | 51782 |
| 3L-5S | | MI | 14494 | 5733 | 25676 | 3995 | 28117 | 3198 | 29284 | 2508 | 30867 | 1380 | 37875 | 505 | 34865 |
| 12-#18 | 4.21 | MA | 19907 | 5733 | 34840 | 4091 | 38974 | 3257 | 41571 | 2584 | 45415 | 1504 | 56414 | 768 | 48579 |
| 4E | | MI | 15354 | 5733 | 27192 | 4007 | 30060 | 3180 | 31596 | 2490 | 34058 | 1398 | 41673 | 609 | 36773 |
| 12-#18 | 4.21 | MA | 18785 | 5733 | 32839 | 4085 | 36396 | 3281 | 38415 | 2603 | 41020 | 1486 | 51104 | 665 | 46096 |
| 5L-3S | | MI | 16309 | 5733 | 28910 | 3985 | 32233 | 3198 | 34167 | 2508 | 37284 | 1380 | 45253 | 825 | 39284 |
| 12-#18 | 4.21 | MA | 17715 | 5733 | 30949 | 4078 | 33831 | 3270 | 35288 | 2588 | 36985 | 1504 | 46125 | 513 | 42830 |
| 6L-2S | | MI | 17630 | 5733 | 31015 | 3998 | 34907 | 3180 | 37353 | 2490 | 41493 | 1362 | 50731 | 1052 | 39546 |
| 14-#11 | 1.92 | MA | 19026 | 4806 | 30792 | 3526 | 33990 | 2854 | 35576 | 2344 | 37491 | 1582 | 45224 | 1456 | 24692 |
| 2L-7S | | MI | 12827 | 4806 | 20881 | 3474 | 22200 | 2817 | 22338 | 2305 | 21759 | 1544 | 25822 | 1028 | 17813 |
| 14-#11 | 1.92 | MA | 18288 | 4806 | 29665 | 3525 | 32553 | 2865 | 33829 | 2353 | 35132 | 1589 | 42080 | 1367 | 24676 |
| 3L-6S | | MI | 13162 | 4806 | 21495 | 3464 | 22948 | 2809 | 23284 | 2312 | 22939 | 1537 | 27211 | 1097 | 18221 |
| 14-#11 | 1.92 | MA | 17767 | 4806 | 28759 | 3537 | 31400 | 2862 | 32430 | 2349 | 33322 | 1596 | 40025 | 1278 | 24606 |
| 4L-5S | | MI | 13505 | 4806 | 22069 | 3467 | 23727 | 2814 | 24195 | 2305 | 24145 | 1530 | 28688 | 1156 | 18616 |
| 14-#11 | 1.92 | MA | 17299 | 4806 | 27963 | 3535 | 30374 | 2872 | 31173 | 2358 | 31537 | 1589 | 37867 | 1236 | 24153 |
| 5L-4S | | MI | 13864 | 4806 | 22676 | 3471 | 24509 | 2806 | 25149 | 2298 | 25459 | 1537 | 30271 | 1196 | 18955 |
| 14-#11 | 1.92 | MA | 16852 | 4806 | 27212 | 3534 | 29354 | 2869 | 29929 | 2354 | 29897 | 1596 | 35824 | 1177 | 23532 |
| 6L-3S | | MI | 14263 | 4806 | 23366 | 3461 | 25386 | 2811 | 26208 | 2305 | 26789 | 1530 | 31755 | 1284 | 18975 |
| 14-#11 | 1.92 | MA | 16417 | 4806 | 26408 | 3546 | 28375 | 2880 | 28729 | 2363 | 28291 | 1603 | 33696 | 1089 | 22951 |
| 7L-2S | | MI | 14818 | 4806 | 24216 | 3464 | 26470 | 2803 | 27522 | 2298 | 28524 | 1523 | 34037 | 1372 | 18957 |
| 14-#14 | 2.76 | MA | 19495 | 5148 | 32619 | 3725 | 36257 | 3014 | 38307 | 2444 | 41072 | 1556 | 49924 | 1253 | 34971 |
| 3L-6S | | MI | 13587 | 5148 | 22905 | 3660 | 24665 | 2950 | 25318 | 2395 | 25623 | 1491 | 30906 | 872 | 24706 |
| 14-#14 | 2.76 | MA | 18761 | 5148 | 31320 | 3743 | 34605 | 3009 | 36304 | 2437 | 38497 | 1566 | 47012 | 1125 | 34639 |
| 4L-5S | | MI | 14069 | 5148 | 23726 | 3665 | 25779 | 2959 | 26608 | 2385 | 27330 | 1481 | 32990 | 957 | 25460 |
| 14-#14 | 2.76 | MA | 18104 | 5148 | 30180 | 3740 | 33136 | 3024 | 34504 | 2450 | 35957 | 1556 | 43941 | 1064 | 33204 |
| 5L-4S | | MI | 14574 | 5148 | 24594 | 3671 | 26897 | 2948 | 27958 | 2375 | 29192 | 1491 | 35223 | 1015 | 26383 |
| 14-#14 | 2.76 | MA | 17476 | 5148 | 29104 | 3737 | 31674 | 3019 | 32721 | 2443 | 33623 | 1566 | 41043 | 980 | 32206 |
| 6L-3S | | MI | 15134 | 5148 | 25579 | 3657 | 28149 | 2956 | 29459 | 2385 | 31076 | 1481 | 37321 | 1140 | 26739 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis

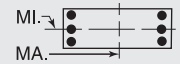


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.76 | MA | 16864 | 5148 | 27952 | 3754 | 30270 | 3034 | 31001 | 2456 | 31340 | 1576 | 38025 | 853 | 30728 |
| 7L-2S | | MI | 15912 | 5148 | 26791 | 3663 | 29695 | 2945 | 31319 | 2375 | 33533 | 1471 | 40542 | 1268 | 26782 |
| 14-#18 | 4.91 | MA | 21149 | 6017 | 37654 | 4269 | 42562 | 3386 | 45933 | 2663 | 51220 | 1480 | 64093 | 712 | 56721 |
| 4L-5S | | MI | 15412 | 6017 | 27781 | 4172 | 30791 | 3326 | 32470 | 2581 | 35075 | 1345 | 43353 | 426 | 40735 |
| 14-#18 | 4.91 | MA | 20041 | 6017 | 35654 | 4262 | 39984 | 3410 | 42777 | 2683 | 46825 | 1462 | 58783 | 608 | 54072 |
| 5L-4S | | MI | 16263 | 6017 | 29297 | 4185 | 32734 | 3308 | 34782 | 2563 | 38266 | 1362 | 47152 | 531 | 42818 |
| 14-#18 | 4.91 | MA | 18985 | 6017 | 33764 | 4255 | 37419 | 3399 | 39650 | 2668 | 42790 | 1480 | 53804 | 457 | 50948 |
| 6L-3S | | MI | 17207 | 6017 | 31015 | 4162 | 34907 | 3326 | 37353 | 2581 | 41493 | 1345 | 50731 | 746 | 45571 |
| 16-#11 | 2.19 | MA | 18805 | 4916 | 30792 | 3594 | 33990 | 2915 | 35576 | 2384 | 37491 | 1582 | 45224 | 1350 | 28090 |
| 3L-7S | | MI | 13216 | 4916 | 21731 | 3543 | 23284 | 2867 | 23652 | 2336 | 23494 | 1533 | 28104 | 1003 | 20252 |
| 16-#11 | 2.19 | MA | 18287 | 4916 | 29885 | 3606 | 32837 | 2912 | 34176 | 2380 | 35681 | 1589 | 43169 | 1261 | 28001 |
| 4L-6S | | MI | 13549 | 4916 | 22345 | 3533 | 24032 | 2859 | 24598 | 2342 | 24674 | 1526 | 29493 | 1072 | 20721 |
| 16-#11 | 2.19 | MA | 17822 | 4916 | 29090 | 3605 | 31811 | 2923 | 32920 | 2389 | 33896 | 1582 | 41011 | 1218 | 27447 |
| 5E | | MI | 13891 | 4916 | 22919 | 3537 | 24811 | 2864 | 25509 | 2336 | 25880 | 1519 | 30970 | 1131 | 21093 |
| 16-#11 | 2.19 | MA | 17379 | 4916 | 28339 | 3603 | 30791 | 2920 | 31676 | 2385 | 32256 | 1589 | 38968 | 1160 | 26854 |
| 6L-4S | | MI | 14248 | 4916 | 23526 | 3540 | 25593 | 2856 | 26462 | 2329 | 27194 | 1526 | 32553 | 1171 | 21524 |
| 16-#11 | 2.19 | MA | 16946 | 4916 | 27535 | 3615 | 29811 | 2930 | 30475 | 2394 | 30650 | 1596 | 36840 | 1072 | 26213 |
| 7L-3S | | MI | 14644 | 4916 | 24216 | 3530 | 26470 | 2861 | 27522 | 2336 | 28524 | 1519 | 34037 | 1259 | 21561 |
| 16-#11 | 2.19 | MA | 16520 | 4916 | 26797 | 3614 | 28823 | 2928 | 29300 | 2404 | 28969 | 1589 | 34824 | 1022 | 25415 |
| 8L-2S | | MI | 15196 | 4916 | 25066 | 3533 | 27554 | 2853 | 28835 | 2329 | 30259 | 1512 | 36319 | 1347 | 21558 |
| 16-#14 | 3.16 | MA | 19490 | 5308 | 32931 | 3842 | 36660 | 3081 | 38801 | 2482 | 41854 | 1554 | 51474 | 1097 | 39289 |
| 4L-6S | | MI | 14130 | 5308 | 24117 | 3759 | 26211 | 3023 | 27178 | 2438 | 28079 | 1474 | 34127 | 833 | 28150 |
| 16-#14 | 3.16 | MA | 18839 | 5308 | 31791 | 3840 | 35190 | 3096 | 37001 | 2495 | 39314 | 1544 | 48403 | 1037 | 37926 |
| 5E | | MI | 14609 | 5308 | 24938 | 3765 | 27324 | 3031 | 28468 | 2428 | 29787 | 1464 | 36211 | 919 | 28996 |
| 16-#14 | 3.16 | MA | 18217 | 5308 | 30715 | 3837 | 33728 | 3091 | 35218 | 2488 | 36980 | 1554 | 45505 | 952 | 36835 |
| 6L-4S | | MI | 15110 | 5308 | 25806 | 3771 | 28442 | 3020 | 29819 | 2418 | 31649 | 1474 | 38444 | 977 | 29862 |
| 16-#14 | 3.16 | MA | 17610 | 5308 | 29563 | 3854 | 32324 | 3106 | 33498 | 2500 | 34696 | 1564 | 42487 | 825 | 35413 |
| 7L-3S | | MI | 15666 | 5308 | 26791 | 3757 | 29695 | 3029 | 31319 | 2428 | 33533 | 1464 | 40542 | 1102 | 30397 |
| 16-#14 | 3.16 | MA | 17012 | 5308 | 28505 | 3851 | 30907 | 3101 | 31813 | 2513 | 32303 | 1554 | 39619 | 755 | 33774 |
| 8L-2S | | MI | 16439 | 5308 | 28004 | 3762 | 31240 | 3017 | 33179 | 2418 | 35989 | 1454 | 43763 | 1229 | 30463 |
| 16-#18 | 5.61 | MA | 21283 | 6301 | 38468 | 4439 | 43572 | 3539 | 47139 | 2763 | 52630 | 1438 | 66461 | 552 | 62080 |
| 5E | | MI | 16321 | 6301 | 29886 | 4349 | 33465 | 3453 | 35655 | 2654 | 39284 | 1309 | 48832 | 348 | 46640 |
| 16-#18 | 5.61 | MA | 20241 | 6301 | 36578 | 4432 | 41007 | 3527 | 44012 | 2747 | 48594 | 1455 | 61482 | 401 | 59088 |
| 6L-4S | | MI | 17163 | 6301 | 31402 | 4362 | 35408 | 3436 | 37967 | 2637 | 42474 | 1327 | 52630 | 452 | 48890 |
| 18-#11 | 2.46 | MA | 18804 | 5027 | 31012 | 3675 | 34274 | 2962 | 35923 | 2411 | 38040 | 1582 | 46313 | 1243 | 31393 |
| 4L-7S | | MI | 13603 | 5027 | 22581 | 3613 | 24368 | 2917 | 24965 | 2366 | 25229 | 1522 | 30386 | 978 | 22699 |
| 18-#11 | 2.46 | MA | 18342 | 5027 | 30217 | 3674 | 33248 | 2973 | 34666 | 2420 | 36255 | 1575 | 44154 | 1201 | 30748 |
| 5L-6S | | MI | 13934 | 5027 | 23195 | 3602 | 25116 | 2909 | 25912 | 2373 | 26408 | 1515 | 31775 | 1047 | 23225 |
| 18-#11 | 2.46 | MA | 17902 | 5027 | 29466 | 3672 | 32228 | 2970 | 33422 | 2416 | 34615 | 1582 | 42112 | 1142 | 30182 |
| 6L-5S | | MI | 14274 | 5027 | 23770 | 3606 | 25895 | 2914 | 26823 | 2366 | 27614 | 1508 | 33253 | 1106 | 23577 |
| 18-#11 | 2.46 | MA | 17472 | 5027 | 28662 | 3685 | 31248 | 2981 | 32222 | 2425 | 33010 | 1589 | 39984 | 1054 | 29483 |
| 7L-4S | | MI | 14629 | 5027 | 24377 | 3609 | 26677 | 2906 | 27776 | 2359 | 28928 | 1515 | 34835 | 1146 | 24089 |
| 18-#11 | 2.46 | MA | 17049 | 5027 | 27924 | 3683 | 30259 | 2978 | 31046 | 2435 | 31328 | 1582 | 37968 | 1004 | 28712 |
| 8L-3S | | MI | 15022 | 5027 | 25066 | 3599 | 27554 | 2911 | 28835 | 2366 | 30259 | 1508 | 36319 | 1234 | 24140 |
| 18-#11 | 2.46 | MA | 16629 | 5027 | 27144 | 3695 | 29293 | 2989 | 29830 | 2430 | 29739 | 1589 | 35988 | 948 | 27756 |
| 9L-2S | | MI | 15571 | 5027 | 25917 | 3602 | 28638 | 2903 | 30149 | 2359 | 31994 | 1501 | 38602 | 1322 | 24153 |
| 18-#14 | 3.55 | MA | 19567 | 5467 | 33403 | 3939 | 37244 | 3169 | 39498 | 2540 | 42670 | 1533 | 52865 | 1009 | 42657 |
| 5L-6S | | MI | 14670 | 5467 | 25329 | 3859 | 27756 | 3095 | 29039 | 2482 | 30536 | 1457 | 37348 | 794 | 31608 |
| 18-#14 | 3.55 | MA | 18951 | 5467 | 32326 | 3937 | 35782 | 3164 | 37716 | 2533 | 40337 | 1543 | 49968 | 924 | 41478 |
| 6L-5S | | MI | 15145 | 5467 | 26150 | 3865 | 28870 | 3104 | 30328 | 2472 | 32244 | 1447 | 39432 | 880 | 32542 |
| 18-#14 | 3.55 | MA | 18350 | 5467 | 31174 | 3954 | 34378 | 3179 | 35995 | 2545 | 38053 | 1553 | 46949 | 798 | 40107 |
| 7L-4S | | MI | 15642 | 5467 | 27018 | 3871 | 29988 | 3092 | 31679 | 2462 | 34105 | 1457 | 41665 | 938 | 33355 |
| 18-#14 | 3.55 | MA | 17757 | 5467 | 30116 | 3951 | 32961 | 3174 | 34310 | 2558 | 35660 | 1543 | 44081 | 727 | 38415 |
| 8L-3S | | MI | 16194 | 5467 | 28004 | 3856 | 31240 | 3101 | 33179 | 2472 | 35989 | 1447 | 43763 | 1063 | 34049 |
| 18-#18 | 6.32 | MA | 21483 | 6584 | 39392 | 4610 | 44595 | 3656 | 48373 | 2827 | 54399 | 1431 | 69161 | 345 | 67063 |
| 6L-5S | | MI | 17222 | 6584 | 31991 | 4526 | 36139 | 3581 | 38841 | 2728 | 43492 | 1274 | 54310 | 269 | 52573 |
| 20-#11 | 2.74 | MA | 18858 | 5138 | 31344 | 3743 | 34684 | 3023 | 36413 | 2451 | 38614 | 1567 | 47298 | 1183 | 34057 |
| 5L-7S | | MI | 13988 | 5138 | 23432 | 3682 | 25452 | 2968 | 26279 | 2397 | 26963 | 1511 | 32668 | 953 | 25153 |

## RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.74 | MA | 18421 | 5138 | 30592 | 3741 | 33664 | 3020 | 35169 | 2447 | 36974 | 1574 | 45255 | 1124 | 33514 |
| 6E | | MI | 14317 | 5138 | 24046 | 3671 | 26200 | 2959 | 27225 | 2404 | 28143 | 1504 | 34057 | 1022 | 25733 |
| 20-#11 | 2.74 | MA | 17994 | 5138 | 29789 | 3754 | 32685 | 3031 | 33968 | 2456 | 35369 | 1581 | 43128 | 1036 | 32759 |
| 7L-5S | | MI | 14654 | 5138 | 24620 | 3675 | 26979 | 2964 | 28136 | 2397 | 29349 | 1497 | 35535 | 1081 | 26067 |
| 20-#11 | 2.74 | MA | 17574 | 5138 | 29051 | 3752 | 31696 | 3028 | 32793 | 2466 | 33687 | 1574 | 41111 | 987 | 32013 |
| 8L-4S | | MI | 15007 | 5138 | 25227 | 3678 | 27761 | 2956 | 29090 | 2390 | 30663 | 1504 | 37117 | 1121 | 26649 |
| 20-#11 | 2.74 | MA | 17157 | 5138 | 28271 | 3765 | 30730 | 3039 | 31577 | 2461 | 32098 | 1581 | 39132 | 930 | 31022 |
| 9L-3S | | MI | 15399 | 5138 | 25917 | 3668 | 28638 | 2961 | 30149 | 2397 | 31994 | 1497 | 38602 | 1209 | 26714 |
| 20-#11 | 2.74 | MA | 16696 | 5138 | 27536 | 3763 | 29753 | 3036 | 30408 | 2471 | 30521 | 1588 | 37214 | 867 | 30074 |
| 10L-2S | | MI | 15945 | 5138 | 26767 | 3671 | 29722 | 2953 | 31462 | 2390 | 33728 | 1490 | 40884 | 1297 | 26740 |
| 20-#14 | 3.95 | MA | 19679 | 5627 | 33937 | 4036 | 37836 | 3236 | 40213 | 2577 | 43693 | 1531 | 54430 | 897 | 46133 |
| 6E | | MI | 15205 | 5627 | 26542 | 3959 | 29302 | 3167 | 30899 | 2525 | 32993 | 1440 | 40569 | 755 | 35077 |
| 20-#14 | 3.95 | MA | 19083 | 5627 | 32785 | 4054 | 36432 | 3251 | 38492 | 2590 | 41409 | 1541 | 51412 | 770 | 44809 |
| 7L-5S | | MI | 15677 | 5627 | 27363 | 3965 | 30415 | 3176 | 32189 | 2515 | 34700 | 1430 | 42653 | 841 | 36094 |
| 20-#14 | 3.95 | MA | 18495 | 5627 | 31728 | 4051 | 35015 | 3246 | 36807 | 2603 | 39016 | 1531 | 48543 | 700 | 43067 |
| 8L-4S | | MI | 16170 | 5627 | 28231 | 3970 | 31533 | 3165 | 33539 | 2505 | 36562 | 1440 | 44886 | 899 | 36861 |
| 22-#11 | 3.01 | MA | 18937 | 5248 | 31719 | 3811 | 35101 | 3070 | 36915 | 2478 | 39334 | 1567 | 48399 | 1107 | 36849 |
| 6L-7S | | MI | 14370 | 5248 | 24282 | 3751 | 26536 | 3018 | 27592 | 2428 | 28698 | 1500 | 34951 | 928 | 27613 |
| 22-#11 | 3.01 | MA | 18513 | 5248 | 30916 | 3823 | 34121 | 3081 | 35715 | 2488 | 37728 | 1574 | 46272 | 1019 | 36043 |
| 7L-6S | | MI | 14697 | 5248 | 24896 | 3741 | 27284 | 3009 | 28539 | 2435 | 29878 | 1493 | 36339 | 997 | 28243 |
| 22-#11 | 3.01 | MA | 18095 | 5248 | 30178 | 3821 | 33133 | 3078 | 34539 | 2497 | 36047 | 1567 | 44255 | 969 | 35320 |
| 8L-5S | | MI | 15033 | 5248 | 25470 | 3744 | 28063 | 3015 | 29450 | 2428 | 31084 | 1486 | 37817 | 1056 | 28562 |
| 22-#11 | 3.01 | MA | 17681 | 5248 | 29397 | 3834 | 32166 | 3089 | 33323 | 2493 | 34458 | 1574 | 42276 | 913 | 34294 |
| 9L-4S | | MI | 15384 | 5248 | 26077 | 3747 | 28845 | 3006 | 30403 | 2421 | 32398 | 1493 | 39400 | 1096 | 29207 |
| 22-#11 | 3.01 | MA | 17232 | 5248 | 28663 | 3832 | 31190 | 3086 | 32155 | 2502 | 32881 | 1581 | 40358 | 849 | 33320 |
| 10L-3S | | MI | 15773 | 5248 | 26767 | 3737 | 29722 | 3012 | 31462 | 2428 | 33728 | 1486 | 40884 | 1184 | 29285 |
| 22-#14 | 4.34 | MA | 19810 | 5787 | 34396 | 4153 | 38486 | 3323 | 40989 | 2635 | 44766 | 1530 | 55874 | 743 | 49520 |
| 7L-6S | | MI | 15737 | 5787 | 27754 | 4059 | 30847 | 3240 | 32759 | 2568 | 35450 | 1422 | 43790 | 717 | 38558 |
| 22-#14 | 4.34 | MA | 19227 | 5787 | 33339 | 4151 | 37069 | 3318 | 39304 | 2648 | 42373 | 1520 | 53005 | 672 | 47727 |
| 8L-5S | | MI | 16205 | 5787 | 28575 | 4064 | 31961 | 3248 | 34049 | 2558 | 37157 | 1412 | 45874 | 803 | 39652 |
| 24-#11 | 3.28 | MA | 19028 | 5359 | 32042 | 3892 | 35558 | 3131 | 37461 | 2519 | 40087 | 1567 | 49416 | 1001 | 39332 |
| 7E | | MI | 14750 | 5359 | 25132 | 3820 | 27620 | 3068 | 28906 | 2459 | 30433 | 1489 | 37233 | 904 | 30079 |
| 24-#11 | 3.28 | MA | 18613 | 5359 | 31305 | 3891 | 34569 | 3128 | 36286 | 2528 | 38406 | 1560 | 47399 | 951 | 38630 |
| 8L-6S | | MI | 15076 | 5359 | 25746 | 3810 | 28368 | 3059 | 29852 | 2466 | 31613 | 1482 | 38622 | 972 | 30756 |
| 24-#11 | 3.28 | MA | 18202 | 5359 | 30524 | 3903 | 33603 | 3139 | 35070 | 2524 | 36817 | 1567 | 45420 | 895 | 37571 |
| 9L-5S | | MI | 15409 | 5359 | 26320 | 3813 | 29147 | 3065 | 30763 | 2459 | 32819 | 1475 | 40099 | 1031 | 31062 |
| 24-#11 | 3.28 | MA | 17753 | 5359 | 29790 | 3901 | 32627 | 3136 | 33901 | 2533 | 35240 | 1573 | 43502 | 831 | 36512 |
| 10L-4S | | MI | 15758 | 5359 | 26927 | 3817 | 29929 | 3056 | 31717 | 2452 | 34133 | 1482 | 41682 | 1071 | 31714 |
| 24-#14 | 4.74 | MA | 19954 | 5946 | 34950 | 4250 | 39123 | 3391 | 41802 | 2693 | 45730 | 1508 | 57467 | 645 | 52396 |
| 8L-6S | | MI | 16266 | 5946 | 28966 | 4158 | 32393 | 3312 | 34619 | 2612 | 37906 | 1405 | 47011 | 678 | 42047 |

## RECTANGULAR TIED COLUMNS 30" x 40"

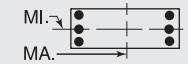
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.33 | MA | 19782 | 4811 | 31460 | 3533 | 34143 | 2872 | 35092 | 2380 | 35560 | 1662 | 42048 | 1546 | 19072 |
| 2E | | MI | 14633 | 4811 | 23562 | 3443 | 25203 | 2796 | 25571 | 2305 | 25515 | 1587 | 29757 | 1446 | 13893 |
| 6-#14 | 1.13 | MA | 19416 | 4722 | 30511 | 3501 | 33063 | 2851 | 33828 | 2372 | 33989 | 1688 | 40046 | 1586 | 16326 |
| 2L-3S | | MI | 13599 | 4722 | 21694 | 3414 | 22961 | 2795 | 22982 | 2321 | 22109 | 1634 | 25384 | 1376 | 12021 |
| 6-#14 | 1.13 | MA | 18276 | 4722 | 28800 | 3499 | 30881 | 2867 | 31176 | 2386 | 30407 | 1698 | 35273 | 1458 | 16373 |
| 3L-2S | | MI | 14401 | 4722 | 22906 | 3420 | 24506 | 2784 | 24842 | 2311 | 24565 | 1624 | 28605 | 1504 | 11946 |
| 6-#18 | 2.00 | MA | 21145 | 5094 | 34452 | 3710 | 37957 | 3000 | 39729 | 2460 | 41765 | 1640 | 50279 | 1494 | 28225 |
| 2L-3S | | MI | 14193 | 5094 | 23562 | 3607 | 25203 | 2941 | 25571 | 2396 | 25515 | 1570 | 29757 | 1140 | 20410 |
| 6-#18 | 2.00 | MA | 19193 | 5094 | 31460 | 3704 | 34143 | 3026 | 35092 | 2482 | 35560 | 1658 | 42048 | 1266 | 28096 |
| 3L-2S | | MI | 15561 | 5094 | 25667 | 3620 | 27877 | 2924 | 28756 | 2378 | 29723 | 1552 | 35236 | 1368 | 20388 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis

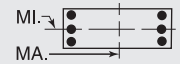



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.04 | MA | 19266 | 4686 | 30111 | 3491 | 32619 | 2845 | 33314 | 2371 | 33334 | 1699 | 39235 | 1604 | 15194 |
| 2L-4S | | MI | 13335 | 4686 | 21087 | 3420 | 22251 | 2784 | 22173 | 2315 | 21117 | 1654 | 24375 | 1352 | 11236 |
| 8-#11 | 1.04 | MA | 18466 | 4686 | 28915 | 3490 | 31094 | 2856 | 31460 | 2381 | 30823 | 1706 | 35875 | 1515 | 15230 |
| 3E | | MI | 13741 | 4686 | 21776 | 3410 | 23128 | 2790 | 23232 | 2322 | 22447 | 1647 | 25859 | 1440 | 11189 |
| 8-#11 | 1.04 | MA | 17901 | 4686 | 27954 | 3503 | 29872 | 2854 | 29977 | 2377 | 28897 | 1713 | 33676 | 1426 | 15233 |
| 4L-2S | | MI | 14306 | 4686 | 22627 | 3413 | 24212 | 2781 | 24546 | 2315 | 24182 | 1641 | 28141 | 1529 | 11139 |
| 8-#14 | 1.50 | MA | 20211 | 4882 | 32222 | 3601 | 35244 | 2924 | 36480 | 2417 | 37571 | 1678 | 44820 | 1561 | 21568 |
| 2L-4S | | MI | 13576 | 4882 | 21921 | 3528 | 23254 | 2859 | 23341 | 2354 | 22681 | 1627 | 26507 | 1213 | 15741 |
| 8-#14 | 1.50 | MA | 19081 | 4882 | 30511 | 3599 | 33063 | 2939 | 33828 | 2431 | 33989 | 1687 | 40046 | 1433 | 21576 |
| 3E | | MI | 14150 | 4882 | 22906 | 3514 | 24506 | 2868 | 24842 | 2364 | 24565 | 1617 | 28605 | 1337 | 15746 |
| 8-#14 | 1.50 | MA | 18280 | 4882 | 29134 | 3617 | 31312 | 2935 | 31703 | 2425 | 31241 | 1697 | 36926 | 1305 | 21449 |
| 4L-2S | | MI | 14947 | 4882 | 24118 | 3519 | 26052 | 2856 | 26702 | 2354 | 27022 | 1607 | 31826 | 1465 | 15693 |
| 8-#18 | 2.67 | MA | 22486 | 5378 | 37444 | 3887 | 41771 | 3129 | 44365 | 2540 | 47970 | 1618 | 58510 | 1442 | 37326 |
| 2L-4S | | MI | 14144 | 5378 | 23950 | 3807 | 25704 | 3052 | 26185 | 2451 | 26496 | 1552 | 31656 | 846 | 25062 |
| 8-#18 | 2.67 | MA | 20560 | 5378 | 34452 | 3882 | 37957 | 3154 | 39729 | 2561 | 41765 | 1635 | 50279 | 1214 | 37084 |
| 3E | | MI | 15124 | 5378 | 25667 | 3785 | 27877 | 3069 | 28756 | 2469 | 29723 | 1534 | 35236 | 1062 | 26758 |
| 8-#18 | 2.67 | MA | 19193 | 5378 | 32037 | 3911 | 34887 | 3145 | 36004 | 2547 | 37006 | 1653 | 44914 | 986 | 34670 |
| 4L-2S | | MI | 16477 | 5378 | 27772 | 3797 | 30552 | 3052 | 31942 | 2451 | 33931 | 1516 | 40714 | 1289 | 26834 |
| 10-#11 | 1.30 | MA | 19826 | 4796 | 31307 | 3560 | 34144 | 2895 | 35168 | 2402 | 35845 | 1692 | 42595 | 1587 | 18860 |
| 2L-5S | | MI | 13363 | 4796 | 21330 | 3486 | 22553 | 2843 | 22533 | 2353 | 21538 | 1636 | 25074 | 1287 | 13824 |
| 10-#11 | 1.30 | MA | 19032 | 4796 | 30111 | 3559 | 32619 | 2907 | 33314 | 2412 | 33334 | 1699 | 39235 | 1499 | 18882 |
| 3L-4S | | MI | 13727 | 4796 | 21937 | 3489 | 23335 | 2834 | 23486 | 2346 | 22852 | 1643 | 26657 | 1327 | 13839 |
| 10-#11 | 1.30 | MA | 18470 | 4796 | 29150 | 3572 | 31397 | 2904 | 31831 | 2408 | 31408 | 1706 | 37036 | 1410 | 18856 |
| 4L-3S | | MI | 14131 | 4796 | 22627 | 3479 | 24212 | 2840 | 24546 | 2353 | 24182 | 1636 | 28141 | 1415 | 13810 |
| 10-#11 | 1.30 | MA | 17967 | 4796 | 28307 | 3571 | 30310 | 2915 | 30500 | 2418 | 29510 | 1699 | 34733 | 1367 | 18740 |
| 5L-2S | | MI | 14692 | 4796 | 23477 | 3483 | 25296 | 2831 | 25859 | 2346 | 25917 | 1630 | 30423 | 1504 | 13769 |
| 10-#14 | 1.88 | MA | 20997 | 5041 | 33933 | 3701 | 37425 | 2996 | 39131 | 2462 | 41153 | 1667 | 49593 | 1535 | 26793 |
| 2L-5S | | MI | 13612 | 5041 | 22265 | 3622 | 23681 | 2943 | 23851 | 2407 | 23276 | 1600 | 27495 | 1116 | 18586 |
| 10-#14 | 1.88 | MA | 19876 | 5041 | 32222 | 3699 | 35244 | 3012 | 36480 | 2476 | 37571 | 1677 | 44820 | 1407 | 26760 |
| 3L-4S | | MI | 14126 | 5041 | 23133 | 3628 | 24799 | 2931 | 25201 | 2397 | 25138 | 1610 | 29728 | 1174 | 19398 |
| 10-#14 | 1.88 | MA | 19083 | 5041 | 30845 | 3717 | 33493 | 3007 | 34355 | 2469 | 34823 | 1687 | 41700 | 1279 | 26586 |
| 4L-3S | | MI | 14696 | 5041 | 24118 | 3613 | 26052 | 2940 | 26702 | 2407 | 27022 | 1600 | 31826 | 1299 | 19449 |
| 10-#14 | 1.88 | MA | 18371 | 5041 | 29637 | 3714 | 31936 | 3023 | 32448 | 2483 | 32113 | 1677 | 38422 | 1218 | 25355 |
| 5L-2S | | MI | 15487 | 5041 | 25330 | 3619 | 27597 | 2929 | 28562 | 2397 | 29479 | 1590 | 35047 | 1427 | 19419 |
| 10-#18 | 3.33 | MA | 23807 | 5662 | 40435 | 4065 | 45585 | 3257 | 49002 | 2620 | 54175 | 1596 | 66741 | 1389 | 46394 |
| 2L-5S | | MI | 14200 | 5662 | 24539 | 3972 | 26435 | 3197 | 27059 | 2542 | 27514 | 1498 | 33336 | 663 | 29465 |
| 10-#18 | 3.33 | MA | 21905 | 5662 | 37444 | 4059 | 41771 | 3283 | 44365 | 2641 | 47970 | 1613 | 58510 | 1162 | 46057 |
| 3L-4S | | MI | 15074 | 5662 | 26055 | 3984 | 28378 | 3179 | 29371 | 2525 | 30705 | 1516 | 37135 | 768 | 31027 |
| 10-#18 | 3.33 | MA | 20557 | 5662 | 35029 | 4089 | 38702 | 3273 | 40640 | 2627 | 43211 | 1631 | 53145 | 934 | 43254 |
| 4L-3S | | MI | 16043 | 5662 | 27772 | 3962 | 30552 | 3197 | 31942 | 2542 | 33931 | 1498 | 40714 | 983 | 33079 |
| 10-#18 | 3.33 | MA | 19348 | 5662 | 32908 | 4083 | 35967 | 3299 | 37293 | 2649 | 38514 | 1613 | 47468 | 829 | 40982 |
| 5L-2S | | MI | 17381 | 5662 | 29877 | 3975 | 33226 | 3179 | 35127 | 2525 | 38139 | 1481 | 46193 | 1211 | 33241 |
| 12-#11 | 1.56 | MA | 20382 | 4907 | 32503 | 3629 | 35669 | 2945 | 37021 | 2433 | 38357 | 1685 | 45955 | 1571 | 22516 |
| 2L-6S | | MI | 13408 | 4907 | 21606 | 3552 | 22858 | 2888 | 22935 | 2390 | 22066 | 1632 | 25879 | 1203 | 15845 |
| 12-#11 | 1.56 | MA | 19592 | 4907 | 31307 | 3628 | 34144 | 2957 | 35168 | 2443 | 35845 | 1692 | 42595 | 1482 | 22521 |
| 3L-5S | | MI | 13754 | 4907 | 22180 | 3555 | 23637 | 2893 | 23846 | 2384 | 23272 | 1625 | 27357 | 1262 | 16279 |
| 12-#11 | 1.56 | MA | 19035 | 4907 | 30346 | 3641 | 32922 | 2954 | 33684 | 2439 | 33919 | 1699 | 40396 | 1394 | 22471 |
| 4E | | MI | 14116 | 4907 | 22787 | 3559 | 24419 | 2885 | 24800 | 2377 | 24586 | 1632 | 28939 | 1302 | 16429 |
| 12-#11 | 1.56 | MA | 18535 | 4907 | 29503 | 3640 | 31835 | 2965 | 32353 | 2449 | 32021 | 1693 | 38093 | 1350 | 22219 |
| 5L-3S | | MI | 14518 | 4907 | 23477 | 3548 | 25296 | 2890 | 25859 | 2384 | 25917 | 1625 | 30423 | 1390 | 16418 |
| 12-#11 | 1.56 | MA | 18058 | 4907 | 28708 | 3639 | 30755 | 2963 | 31036 | 2445 | 30276 | 1700 | 35909 | 1292 | 21487 |
| 6L-2S | | MI | 15076 | 4907 | 24327 | 3552 | 26380 | 2881 | 27173 | 2377 | 27651 | 1619 | 32706 | 1479 | 16386 |
| 12-#14 | 2.25 | MA | 21775 | 5201 | 35644 | 3801 | 39607 | 3068 | 41783 | 2507 | 44736 | 1656 | 54367 | 1510 | 32000 |
| 2L-6S | | MI | 13674 | 5201 | 22656 | 3716 | 24113 | 3006 | 24421 | 2461 | 24026 | 1592 | 28632 | 991 | 21553 |
| 12-#14 | 2.25 | MA | 20663 | 5201 | 33933 | 3799 | 37425 | 3084 | 39131 | 2521 | 41153 | 1666 | 49593 | 1382 | 31933 |
| 3L-5S | | MI | 14162 | 5201 | 23477 | 3722 | 25227 | 3015 | 25711 | 2451 | 25733 | 1582 | 30716 | 1077 | 22097 |
| 12-#14 | 2.25 | MA | 19877 | 5201 | 32556 | 3816 | 35675 | 3080 | 37007 | 2514 | 38405 | 1676 | 46473 | 1254 | 31718 |
| 4E | | MI | 14672 | 5201 | 24345 | 3727 | 26345 | 3004 | 27061 | 2441 | 27595 | 1592 | 32949 | 1135 | 23045 |

## RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis



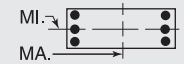

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 2.25 | MA | 19172 | 5201 | 31348 | 3814 | 34117 | 3095 | 35099 | 2528 | 35695 | 1666 | 43196 | 1193 | 30344 |
| 5L-3S | | MI | 15238 | 5201 | 25330 | 3713 | 27597 | 3012 | 28562 | 2451 | 29479 | 1582 | 35047 | 1260 | 23131 |
| 12-#14 | 2.25 | MA | 18500 | 5201 | 30208 | 3812 | 32568 | 3091 | 33211 | 2522 | 33204 | 1676 | 40094 | 1108 | 29449 |
| 6L-2S | | MI | 16023 | 5201 | 26543 | 3719 | 29143 | 3001 | 30422 | 2441 | 31936 | 1572 | 38268 | 1388 | 23130 |
| 12-#18 | 4.00 | MA | 23233 | 5945 | 40435 | 4236 | 45585 | 3411 | 49002 | 2721 | 54175 | 1591 | 66741 | 1110 | 55022 |
| 3L-5S | | MI | 15130 | 5945 | 26644 | 4149 | 29109 | 3325 | 30244 | 2616 | 31722 | 1463 | 38815 | 585 | 35289 |
| 12-#18 | 4.00 | MA | 21903 | 5945 | 38021 | 4266 | 42516 | 3402 | 45277 | 2707 | 49416 | 1609 | 61376 | 882 | 51882 |
| 4E | | MI | 15994 | 5945 | 28160 | 4162 | 31052 | 3307 | 32556 | 2598 | 34913 | 1481 | 42613 | 689 | 37035 |
| 12-#18 | 4.00 | MA | 20710 | 5945 | 35900 | 4260 | 39781 | 3427 | 41929 | 2729 | 44719 | 1591 | 55699 | 776 | 49481 |
| 5L-3S | | MI | 16951 | 5945 | 29877 | 4139 | 33226 | 3325 | 35127 | 2616 | 38139 | 1463 | 46193 | 905 | 39385 |
| 12-#18 | 4.00 | MA | 19572 | 5945 | 33896 | 4255 | 37062 | 3417 | 38613 | 2715 | 40405 | 1609 | 50358 | 625 | 45838 |
| 6L-2S | | MI | 18277 | 5945 | 31983 | 4152 | 35900 | 3307 | 38313 | 2598 | 42347 | 1445 | 51671 | 1132 | 39618 |
| 14-#11 | 1.82 | MA | 20934 | 5018 | 33699 | 3699 | 37194 | 2996 | 38875 | 2464 | 40868 | 1678 | 49315 | 1555 | 26166 |
| 2L-7S | | MI | 13462 | 5018 | 21842 | 3631 | 23194 | 2946 | 23303 | 2414 | 22621 | 1628 | 26772 | 1110 | 18010 |
| 14-#11 | 1.82 | MA | 20149 | 5018 | 32503 | 3697 | 35669 | 3007 | 37021 | 2474 | 38357 | 1685 | 45955 | 1466 | 26150 |
| 3L-6S | | MI | 13798 | 5018 | 22456 | 3621 | 23942 | 2938 | 24249 | 2421 | 23801 | 1621 | 28161 | 1178 | 18340 |
| 14-#11 | 1.82 | MA | 19595 | 5018 | 31542 | 3710 | 34447 | 3004 | 35538 | 2470 | 36431 | 1692 | 43756 | 1377 | 26080 |
| 4L-5S | | MI | 14142 | 5018 | 23030 | 3624 | 24721 | 2943 | 25160 | 2414 | 25007 | 1614 | 29639 | 1237 | 18745 |
| 14-#11 | 1.82 | MA | 19098 | 5018 | 30700 | 3709 | 33360 | 3016 | 34207 | 2480 | 34532 | 1686 | 41453 | 1334 | 25705 |
| 5L-4S | | MI | 14502 | 5018 | 23637 | 3628 | 25503 | 2935 | 26113 | 2407 | 26321 | 1621 | 31221 | 1277 | 19009 |
| 14-#11 | 1.82 | MA | 18625 | 5018 | 29904 | 3708 | 32280 | 3013 | 32889 | 2476 | 32787 | 1693 | 39269 | 1276 | 25009 |
| 6L-3S | | MI | 14902 | 5018 | 24327 | 3617 | 26380 | 2940 | 27173 | 2414 | 27651 | 1614 | 32706 | 1365 | 19017 |
| 14-#11 | 1.82 | MA | 18163 | 5018 | 29053 | 3720 | 31242 | 3024 | 31618 | 2486 | 31080 | 1700 | 36995 | 1188 | 24490 |
| 7L-2S | | MI | 15458 | 5018 | 25177 | 3621 | 27464 | 2932 | 28486 | 2407 | 29386 | 1608 | 34988 | 1454 | 18995 |
| 14-#14 | 2.63 | MA | 21442 | 5360 | 35644 | 3898 | 39607 | 3156 | 41783 | 2566 | 44736 | 1656 | 54367 | 1356 | 37098 |
| 3L-6S | | MI | 14223 | 5360 | 23868 | 3816 | 25659 | 3079 | 26281 | 2504 | 26482 | 1575 | 31853 | 953 | 24977 |
| 14-#14 | 2.63 | MA | 20663 | 5360 | 34267 | 3916 | 37856 | 3152 | 39658 | 2559 | 41987 | 1666 | 51247 | 1229 | 36847 |
| 4L-5S | | MI | 14707 | 5360 | 24689 | 3821 | 26772 | 3087 | 27571 | 2494 | 28190 | 1565 | 33937 | 1039 | 25622 |
| 14-#14 | 2.63 | MA | 19965 | 5360 | 33059 | 3914 | 36298 | 3168 | 37751 | 2573 | 39277 | 1656 | 47969 | 1167 | 35349 |
| 5L-4S | | MI | 15213 | 5360 | 25557 | 3827 | 27890 | 3076 | 28922 | 2484 | 30052 | 1575 | 36170 | 1096 | 26576 |
| 14-#14 | 2.63 | MA | 19299 | 5360 | 31919 | 3912 | 34750 | 3164 | 35862 | 2566 | 36787 | 1666 | 44867 | 1083 | 34438 |
| 6L-3S | | MI | 15775 | 5360 | 26543 | 3813 | 29143 | 3085 | 30422 | 2494 | 31936 | 1565 | 38268 | 1221 | 26801 |
| 14-#14 | 2.63 | MA | 18649 | 5360 | 30698 | 3930 | 33262 | 3179 | 34040 | 2580 | 34349 | 1676 | 41637 | 956 | 32793 |
| 7L-2S | | MI | 16555 | 5360 | 27755 | 3819 | 30688 | 3073 | 32282 | 2484 | 34392 | 1555 | 41489 | 1349 | 26833 |
| 14-#18 | 4.67 | MA | 23231 | 6229 | 41012 | 4443 | 46330 | 3530 | 49914 | 2787 | 55621 | 1587 | 69607 | 830 | 60545 |
| 4L-5S | | MI | 16049 | 6229 | 28749 | 4326 | 31784 | 3453 | 33430 | 2689 | 35930 | 1427 | 44293 | 506 | 41153 |
| 14-#18 | 4.67 | MA | 22054 | 6229 | 38892 | 4438 | 43596 | 3556 | 46566 | 2808 | 50924 | 1569 | 63930 | 724 | 57978 |
| 5L-4S | | MI | 16904 | 6229 | 30265 | 4339 | 33727 | 3435 | 35742 | 2671 | 39121 | 1445 | 48092 | 611 | 43076 |
| 14-#18 | 4.67 | MA | 20932 | 6229 | 36888 | 4432 | 40876 | 3546 | 43250 | 2794 | 46610 | 1587 | 58589 | 573 | 54481 |
| 6L-3S | | MI | 17852 | 6229 | 31983 | 4316 | 35900 | 3453 | 38313 | 2689 | 42347 | 1427 | 51671 | 826 | 45679 |
| 16-#11 | 2.08 | MA | 20701 | 5128 | 33699 | 3767 | 37194 | 3057 | 38875 | 2505 | 40868 | 1678 | 49315 | 1450 | 29775 |
| 3L-7S | | MI | 13852 | 5128 | 22692 | 3700 | 24278 | 2996 | 24616 | 2445 | 24356 | 1617 | 29055 | 1085 | 20447 |
| 16-#11 | 2.08 | MA | 20151 | 5128 | 32738 | 3779 | 35972 | 3054 | 37392 | 2501 | 38942 | 1685 | 47116 | 1361 | 29686 |
| 4L-6S | | MI | 14186 | 5128 | 23307 | 3690 | 25026 | 2988 | 25563 | 2452 | 25536 | 1610 | 30443 | 1153 | 20840 |
| 16-#11 | 2.08 | MA | 19658 | 5128 | 31896 | 3778 | 34885 | 3066 | 36061 | 2511 | 37043 | 1679 | 44813 | 1318 | 29202 |
| 5E | | MI | 14529 | 5128 | 23881 | 3693 | 25805 | 2993 | 26474 | 2445 | 26742 | 1603 | 31921 | 1212 | 21221 |
| 16-#11 | 2.08 | MA | 19188 | 5128 | 31100 | 3777 | 33804 | 3063 | 34743 | 2507 | 35299 | 1686 | 42629 | 1259 | 28538 |
| 6L-4S | | MI | 14886 | 5128 | 24488 | 3697 | 26587 | 2985 | 27427 | 2438 | 28056 | 1610 | 33504 | 1252 | 21581 |
| 16-#11 | 2.08 | MA | 18729 | 5128 | 30249 | 3790 | 32767 | 3075 | 33472 | 2517 | 33591 | 1693 | 40355 | 1172 | 27956 |
| 7L-3S | | MI | 15283 | 5128 | 25177 | 3687 | 27464 | 2990 | 28486 | 2445 | 29386 | 1603 | 34988 | 1340 | 21610 |
| 16-#11 | 2.08 | MA | 18276 | 5128 | 29468 | 3789 | 31720 | 3072 | 32227 | 2527 | 31803 | 1686 | 38203 | 1121 | 27070 |
| 8L-2S | | MI | 15836 | 5128 | 26028 | 3690 | 28548 | 2982 | 29800 | 2438 | 31121 | 1596 | 37270 | 1429 | 21598 |
| 16-#14 | 3.00 | MA | 21443 | 5520 | 35978 | 4016 | 40037 | 3224 | 42310 | 2604 | 45569 | 1655 | 56020 | 1203 | 41904 |
| 4L-6S | | MI | 14767 | 5520 | 25081 | 3915 | 27204 | 3151 | 28142 | 2547 | 28939 | 1558 | 35074 | 914 | 28417 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis

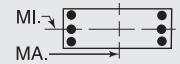



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.00 | MA | 20751 | 5520 | 34770 | 4014 | 38480 | 3240 | 40403 | 2618 | 42859 | 1645 | 52743 | 1142 | 40366 |
| 5E | | MI | 15247 | 5520 | 25902 | 3921 | 28318 | 3160 | 29431 | 2537 | 30647 | 1548 | 37158 | 1000 | 29158 |
| 16-#14 | 3.00 | MA | 20091 | 5520 | 33630 | 4012 | 36931 | 3236 | 38514 | 2611 | 40369 | 1655 | 49641 | 1057 | 39361 |
| 6L-4S | | MI | 15750 | 5520 | 26770 | 3927 | 29436 | 3148 | 30782 | 2527 | 32508 | 1558 | 39391 | 1058 | 30052 |
| 16-#14 | 3.00 | MA | 19447 | 5520 | 32409 | 4029 | 35443 | 3251 | 36691 | 2625 | 37931 | 1665 | 46411 | 930 | 37773 |
| 7L-3S | | MI | 16308 | 5520 | 27755 | 3913 | 30688 | 3157 | 32282 | 2537 | 34392 | 1548 | 41489 | 1183 | 30463 |
| 16-#14 | 3.00 | MA | 18812 | 5520 | 31289 | 4027 | 33942 | 3247 | 34906 | 2638 | 35378 | 1655 | 43349 | 859 | 36145 |
| 8L-2S | | MI | 17083 | 5520 | 28967 | 3918 | 32234 | 3146 | 34142 | 2527 | 36849 | 1538 | 44710 | 1310 | 30517 |
| 16-#18 | 5.33 | MA | 23383 | 6513 | 41883 | 4615 | 47410 | 3684 | 51202 | 2888 | 57129 | 1547 | 72161 | 672 | 66507 |
| 5E | | MI | 16960 | 6513 | 30854 | 4504 | 34458 | 3580 | 36615 | 2762 | 40138 | 1392 | 49772 | 428 | 47050 |
| 16-#18 | 5.33 | MA | 22275 | 6513 | 39880 | 4609 | 44690 | 3675 | 47886 | 2874 | 52815 | 1564 | 66819 | 521 | 63147 |
| 6L-4S | | MI | 17806 | 6513 | 32370 | 4516 | 36401 | 3563 | 38927 | 2745 | 43329 | 1410 | 53570 | 532 | 49144 |
| 18-#11 | 2.34 | MA | 20703 | 5239 | 33934 | 3848 | 37496 | 3105 | 39245 | 2532 | 41453 | 1679 | 50476 | 1345 | 33289 |
| 4L-7S | | MI | 14240 | 5239 | 23543 | 3769 | 25362 | 3046 | 25930 | 2476 | 26091 | 1606 | 31337 | 1060 | 22892 |
| 18-#11 | 2.34 | MA | 20213 | 5239 | 33092 | 3847 | 36410 | 3116 | 37915 | 2542 | 39555 | 1672 | 48173 | 1301 | 32707 |
| 5L-6S | | MI | 14572 | 5239 | 24157 | 3759 | 26110 | 3038 | 26876 | 2483 | 27271 | 1599 | 32726 | 1128 | 23345 |
| 18-#11 | 2.34 | MA | 19746 | 5239 | 32296 | 3846 | 35329 | 3113 | 36597 | 2538 | 37810 | 1679 | 45989 | 1243 | 32071 |
| 6L-5S | | MI | 14912 | 5239 | 24731 | 3763 | 26889 | 3043 | 27787 | 2476 | 28476 | 1592 | 34203 | 1188 | 23705 |
| 18-#11 | 2.34 | MA | 19290 | 5239 | 31445 | 3859 | 34292 | 3125 | 35325 | 2548 | 36103 | 1686 | 43715 | 1155 | 31430 |
| 7L-4S | | MI | 15268 | 5239 | 25338 | 3766 | 27671 | 3035 | 28741 | 2469 | 29791 | 1599 | 35786 | 1227 | 24149 |
| 18-#11 | 2.34 | MA | 18841 | 5239 | 30664 | 3858 | 33245 | 3122 | 34081 | 2558 | 34314 | 1680 | 41563 | 1105 | 30572 |
| 8L-3S | | MI | 15663 | 5239 | 26028 | 3756 | 28548 | 3040 | 29800 | 2476 | 31121 | 1592 | 37270 | 1315 | 24190 |
| 18-#11 | 2.34 | MA | 18395 | 5239 | 29838 | 3870 | 32222 | 3133 | 32793 | 2554 | 32624 | 1687 | 39447 | 1048 | 29641 |
| 9L-2S | | MI | 16213 | 5239 | 26878 | 3759 | 29632 | 3032 | 31113 | 2469 | 32856 | 1585 | 39552 | 1404 | 24195 |
| 18-#14 | 3.38 | MA | 21529 | 5679 | 36481 | 4113 | 40661 | 3312 | 43054 | 2663 | 46441 | 1635 | 57516 | 1116 | 45394 |
| 5L-6S | | MI | 15307 | 5679 | 26293 | 4015 | 28750 | 3223 | 30002 | 2591 | 31396 | 1541 | 38295 | 875 | 31871 |
| 18-#14 | 3.38 | MA | 20875 | 5679 | 35341 | 4111 | 39112 | 3308 | 41166 | 2656 | 43951 | 1645 | 54414 | 1032 | 44297 |
| 6L-5S | | MI | 15784 | 5679 | 27114 | 4021 | 29863 | 3232 | 31292 | 2581 | 33103 | 1531 | 40379 | 961 | 32702 |
| 18-#14 | 3.38 | MA | 20237 | 5679 | 34120 | 4129 | 37625 | 3324 | 39343 | 2670 | 41514 | 1655 | 51184 | 905 | 42763 |
| 7L-4S | | MI | 16283 | 5679 | 27982 | 4027 | 30981 | 3221 | 32642 | 2571 | 34965 | 1541 | 42612 | 1019 | 33543 |
| 18-#14 | 3.38 | MA | 19608 | 5679 | 33000 | 4127 | 36124 | 3320 | 37558 | 2683 | 38960 | 1645 | 48122 | 833 | 41083 |
| 8L-3S | | MI | 16837 | 5679 | 28967 | 4012 | 32234 | 3229 | 34142 | 2581 | 36849 | 1531 | 44710 | 1144 | 34118 |
| 18-#14 | 3.38 | MA | 18984 | 5679 | 31815 | 4145 | 34657 | 3335 | 35712 | 2677 | 36548 | 1655 | 45117 | 752 | 39284 |
| 9L-2S | | MI | 17607 | 5679 | 30179 | 4018 | 33779 | 3218 | 36002 | 2571 | 39306 | 1521 | 47931 | 1272 | 34194 |
| 18-#18 | 6.00 | MA | 23604 | 6797 | 42871 | 4787 | 48504 | 3803 | 52523 | 2954 | 59020 | 1542 | 75050 | 469 | 71834 |
| 6L-5S | | MI | 17863 | 6797 | 32959 | 4681 | 37132 | 3708 | 39801 | 2836 | 44347 | 1356 | 55250 | 349 | 52977 |
| 20-#11 | 2.60 | MA | 20765 | 5350 | 34288 | 3916 | 37935 | 3166 | 39768 | 2573 | 42066 | 1665 | 51533 | 1285 | 36221 |
| 5L-7S | | MI | 14625 | 5350 | 24393 | 3839 | 26446 | 3097 | 27243 | 2507 | 27825 | 1595 | 33619 | 1035 | 25344 |
| 20-#11 | 2.60 | MA | 20301 | 5350 | 33492 | 3915 | 36854 | 3164 | 38450 | 2570 | 40321 | 1672 | 49349 | 1227 | 35610 |
| 6E | | MI | 14955 | 5350 | 25007 | 3828 | 27194 | 3088 | 28190 | 2514 | 29005 | 1588 | 35008 | 1103 | 25853 |
| 20-#11 | 2.60 | MA | 19848 | 5350 | 32641 | 3928 | 35817 | 3175 | 37179 | 2579 | 38614 | 1679 | 47075 | 1139 | 34911 |
| 7L-5S | | MI | 15294 | 5350 | 25581 | 3832 | 27973 | 3094 | 29101 | 2507 | 30211 | 1581 | 36485 | 1163 | 26195 |
| 20-#11 | 2.60 | MA | 19402 | 5350 | 31860 | 3927 | 34770 | 3172 | 35934 | 2589 | 36826 | 1673 | 44923 | 1088 | 34079 |
| 8L-4S | | MI | 15647 | 5350 | 26188 | 3835 | 28755 | 3085 | 30054 | 2500 | 31525 | 1588 | 38068 | 1202 | 26713 |
| 20-#11 | 2.60 | MA | 18956 | 5350 | 31034 | 3939 | 33747 | 3184 | 34646 | 2586 | 35136 | 1680 | 42807 | 1032 | 33112 |
| 9L-3S | | MI | 16040 | 5350 | 26878 | 3825 | 29632 | 3090 | 31113 | 2507 | 32856 | 1581 | 39552 | 1290 | 26768 |
| 20-#11 | 2.60 | MA | 18460 | 5350 | 30257 | 3938 | 32713 | 3181 | 33409 | 2595 | 33458 | 1687 | 40755 | 969 | 32188 |
| 10L-2S | | MI | 16588 | 5350 | 27728 | 3828 | 30716 | 3082 | 32427 | 2500 | 34590 | 1574 | 41834 | 1379 | 26788 |
| 20-#14 | 3.75 | MA | 21653 | 5839 | 37051 | 4211 | 41294 | 3380 | 43817 | 2701 | 47533 | 1634 | 59188 | 1006 | 49246 |
| 6E | | MI | 15844 | 5839 | 27505 | 4115 | 30295 | 3296 | 31862 | 2634 | 33853 | 1523 | 41516 | 836 | 35337 |
| 20-#14 | 3.75 | MA | 21021 | 5839 | 35831 | 4229 | 39806 | 3396 | 41995 | 2715 | 45096 | 1644 | 55958 | 880 | 47762 |
| 7L-5S | | MI | 16317 | 5839 | 28326 | 4121 | 31409 | 3304 | 33152 | 2624 | 35560 | 1513 | 43600 | 922 | 36254 |
| 20-#14 | 3.75 | MA | 20397 | 5839 | 34711 | 4227 | 38305 | 3392 | 40210 | 2728 | 42542 | 1634 | 52896 | 808 | 46030 |
| 8L-4S | | MI | 16813 | 5839 | 29194 | 4126 | 32527 | 3293 | 34502 | 2614 | 37422 | 1523 | 45833 | 980 | 37047 |
| 20-#14 | 3.75 | MA | 19775 | 5839 | 33526 | 4244 | 36838 | 3408 | 38363 | 2722 | 40130 | 1644 | 49891 | 726 | 44198 |
| 9L-3S | | MI | 17363 | 5839 | 30179 | 4112 | 33779 | 3302 | 36002 | 2624 | 39306 | 1513 | 47931 | 1105 | 37768 |
| 22-#11 | 2.86 | MA | 20852 | 5460 | 34688 | 3984 | 38379 | 3214 | 40304 | 2601 | 42833 | 1665 | 52709 | 1210 | 39152 |
| 6L-7S | | MI | 15008 | 5460 | 25243 | 3908 | 27530 | 3147 | 28557 | 2537 | 29560 | 1584 | 35901 | 1010 | 27803 |

## RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

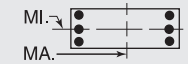
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.86 | MA | 20402 | 5460 | 33837 | 3997 | 37342 | 3225 | 39033 | 2611 | 41125 | 1672 | 50435 | 1123 | 38398 |
| 7L-6S | | MI | 15337 | 5460 | 25857 | 3897 | 28278 | 3138 | 29503 | 2544 | 30740 | 1577 | 37290 | 1078 | 28364 |
| 22-#11 | 2.86 | MA | 19959 | 5460 | 33056 | 3996 | 36295 | 3222 | 37788 | 2621 | 39337 | 1666 | 48283 | 1072 | 37591 |
| 8L-5S | | MI | 15673 | 5460 | 26431 | 3901 | 29057 | 3144 | 30414 | 2537 | 31946 | 1570 | 38768 | 1138 | 28690 |
| 22-#11 | 2.86 | MA | 19514 | 5460 | 32230 | 4009 | 35272 | 3234 | 36500 | 2617 | 37647 | 1673 | 46167 | 1016 | 36589 |
| 9L-4S | | MI | 16025 | 5460 | 27038 | 3904 | 29839 | 3135 | 31368 | 2531 | 33260 | 1577 | 40350 | 1177 | 29274 |
| 22-#11 | 2.86 | MA | 19023 | 5460 | 31453 | 4008 | 34238 | 3231 | 35263 | 2627 | 35970 | 1680 | 44115 | 952 | 35640 |
| 10L-3S | | MI | 16416 | 5460 | 27728 | 3894 | 30716 | 3141 | 32427 | 2537 | 34590 | 1570 | 41834 | 1265 | 29341 |
| 22-#14 | 4.13 | MA | 21798 | 5999 | 37542 | 4328 | 41987 | 3468 | 44646 | 2760 | 48678 | 1634 | 60732 | 854 | 52770 |
| 7L-6S | | MI | 16377 | 5999 | 28717 | 4215 | 31841 | 3368 | 33722 | 2677 | 36309 | 1506 | 44737 | 798 | 38815 |
| 22-#14 | 4.13 | MA | 21179 | 5999 | 36422 | 4326 | 40486 | 3464 | 42861 | 2773 | 46125 | 1624 | 57670 | 782 | 50986 |
| 8L-5S | | MI | 16847 | 5999 | 29538 | 4220 | 32954 | 3377 | 35012 | 2667 | 38017 | 1496 | 46821 | 884 | 39812 |
| 22-#14 | 4.13 | MA | 20559 | 5999 | 35237 | 4344 | 39019 | 3480 | 41015 | 2767 | 43712 | 1634 | 54664 | 701 | 49120 |
| 9L-4S | | MI | 17339 | 5999 | 30406 | 4226 | 34072 | 3365 | 36362 | 2658 | 39879 | 1506 | 49054 | 942 | 40562 |
| 24-#11 | 3.12 | MA | 20953 | 5571 | 35033 | 4066 | 38866 | 3275 | 40886 | 2642 | 43637 | 1665 | 53795 | 1106 | 41892 |
| 7E | | MI | 15389 | 5571 | 26093 | 3977 | 28614 | 3197 | 29870 | 2568 | 31295 | 1573 | 38183 | 985 | 30267 |
| 24-#11 | 3.12 | MA | 20512 | 5571 | 34252 | 4065 | 37819 | 3273 | 39642 | 2652 | 41848 | 1659 | 51643 | 1056 | 41108 |
| 8L-6S | | MI | 15716 | 5571 | 26708 | 3967 | 29362 | 3188 | 30817 | 2575 | 32475 | 1566 | 39572 | 1053 | 30877 |
| 24-#11 | 3.12 | MA | 20068 | 5571 | 33426 | 4078 | 36796 | 3284 | 38354 | 2648 | 40158 | 1666 | 49527 | 999 | 40071 |
| 9L-5S | | MI | 16050 | 5571 | 27282 | 3970 | 30141 | 3194 | 31728 | 2568 | 33681 | 1559 | 41050 | 1113 | 31189 |
| 24-#11 | 3.12 | MA | 19591 | 5571 | 32649 | 4077 | 35763 | 3281 | 37116 | 2658 | 38481 | 1673 | 47475 | 936 | 39095 |
| 10L-4S | | MI | 16400 | 5571 | 27889 | 3973 | 30923 | 3185 | 32681 | 2561 | 34995 | 1566 | 42632 | 1152 | 31832 |
| 24-#14 | 4.50 | MA | 21956 | 6158 | 38133 | 4426 | 42668 | 3537 | 45513 | 2818 | 49707 | 1613 | 62443 | 757 | 55951 |
| 8L-6S | | MI | 16907 | 6158 | 29929 | 4314 | 33386 | 3440 | 35582 | 2721 | 38766 | 1489 | 47959 | 759 | 42302 |
| 24-#14 | 4.50 | MA | 21336 | 6158 | 36948 | 4444 | 41201 | 3552 | 43667 | 2812 | 47294 | 1623 | 59438 | 675 | 54051 |
| 9L-5S | | MI | 17374 | 6158 | 30751 | 4320 | 34500 | 3449 | 36872 | 2711 | 40474 | 1479 | 50042 | 845 | 43375 |

## RECTANGULAR TIED COLUMNS 30" x 42"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.27 | MA | 21708 | 5023 | 34369 | 3705 | 37316 | 3013 | 38320 | 2501 | 38789 | 1758 | 45858 | 1643 | 20152 |
| 2E | | MI | 15271 | 5023 | 24530 | 3597 | 26196 | 2923 | 26531 | 2412 | 26369 | 1670 | 30697 | 1527 | 13934 |
| 6-#14 | 1.07 | MA | 21314 | 4934 | 33358 | 3674 | 36163 | 2993 | 36972 | 2493 | 37079 | 1782 | 43691 | 1681 | 17237 |
| 2L-3S | | MI | 14236 | 4934 | 22657 | 3570 | 23954 | 2924 | 23945 | 2430 | 22968 | 1718 | 26331 | 1457 | 12056 |
| 6-#14 | 1.07 | MA | 20105 | 4934 | 31547 | 3672 | 33855 | 3010 | 34165 | 2507 | 33277 | 1793 | 38606 | 1553 | 17284 |
| 3L-2S | | MI | 15039 | 4934 | 23869 | 3576 | 25500 | 2913 | 25805 | 2420 | 25425 | 1708 | 29552 | 1585 | 11979 |
| 6-#18 | 1.90 | MA | 23162 | 5306 | 37538 | 3882 | 41356 | 3142 | 43231 | 2581 | 45394 | 1738 | 54642 | 1594 | 29845 |
| 2L-3S | | MI | 14830 | 5306 | 24530 | 3762 | 26196 | 3069 | 26531 | 2504 | 26369 | 1652 | 30697 | 1221 | 20480 |
| 6-#18 | 1.90 | MA | 21088 | 5306 | 34369 | 3878 | 37316 | 3169 | 38320 | 2603 | 38789 | 1756 | 45858 | 1367 | 29716 |
| 3L-2S | | MI | 16201 | 5306 | 26635 | 3774 | 28870 | 3051 | 29716 | 2486 | 30578 | 1635 | 36176 | 1448 | 20437 |
| 8-#14 | 1.43 | MA | 22160 | 5094 | 35168 | 3774 | 38472 | 3066 | 39778 | 2538 | 40881 | 1773 | 48776 | 1658 | 22783 |
| 2L-4S | | MI | 14212 | 5094 | 22884 | 3684 | 24247 | 2988 | 24304 | 2463 | 23541 | 1711 | 27454 | 1294 | 15800 |
| 8-#14 | 1.43 | MA | 20961 | 5094 | 33358 | 3772 | 36163 | 3082 | 36972 | 2552 | 37079 | 1783 | 43691 | 1530 | 22791 |
| 3E | | MI | 14788 | 5094 | 23869 | 3670 | 25500 | 2996 | 25805 | 2473 | 25425 | 1701 | 29552 | 1418 | 15788 |
| 8-#14 | 1.43 | MA | 20113 | 5094 | 31902 | 3790 | 34313 | 3078 | 34726 | 2546 | 34164 | 1793 | 40363 | 1402 | 22664 |
| 4L-2S | | MI | 15586 | 5094 | 25082 | 3675 | 27045 | 2985 | 27665 | 2463 | 27882 | 1691 | 32773 | 1546 | 15731 |
| 8-#18 | 2.54 | MA | 24591 | 5590 | 40707 | 4060 | 45396 | 3271 | 48143 | 2660 | 52000 | 1718 | 63426 | 1546 | 39486 |
| 2L-4S | | MI | 14780 | 5590 | 24917 | 3961 | 26697 | 3179 | 27145 | 2559 | 27351 | 1635 | 32596 | 927 | 25328 |
| 8-#18 | 2.54 | MA | 22545 | 5590 | 37538 | 4055 | 41356 | 3297 | 43231 | 2683 | 45394 | 1735 | 54642 | 1318 | 39244 |
| 3E | | MI | 15762 | 5590 | 26635 | 3939 | 28870 | 3196 | 29716 | 2577 | 30578 | 1617 | 36176 | 1142 | 26838 |
| 8-#18 | 2.54 | MA | 21096 | 5590 | 34985 | 4086 | 38109 | 3289 | 39291 | 2671 | 40327 | 1753 | 48908 | 1091 | 36959 |
| 4L-2S | | MI | 17118 | 5590 | 28740 | 3952 | 31544 | 3179 | 32902 | 2559 | 34786 | 1599 | 41654 | 1370 | 26889 |
| 10-#11 | 1.24 | MA | 21748 | 5009 | 34197 | 3733 | 37303 | 3037 | 38384 | 2522 | 39004 | 1784 | 46389 | 1683 | 19913 |
| 2L-5S | | MI | 13999 | 5009 | 22291 | 3643 | 23546 | 2972 | 23498 | 2462 | 22400 | 1721 | 26025 | 1369 | 13878 |
| 10-#11 | 1.24 | MA | 20906 | 5009 | 32931 | 3732 | 35690 | 3035 | 36423 | 2533 | 36348 | 1792 | 42813 | 1594 | 19935 |
| 3L-4S | | MI | 14364 | 5009 | 22898 | 3646 | 24329 | 2963 | 24451 | 2455 | 23714 | 1728 | 27608 | 1409 | 13879 |
| 10-#11 | 1.24 | MA | 20312 | 5009 | 31916 | 3745 | 34399 | 3047 | 34856 | 2529 | 34313 | 1800 | 40470 | 1505 | 19909 |
| 4L-3S | | MI | 14768 | 5009 | 23588 | 3636 | 25205 | 2969 | 25510 | 2462 | 25044 | 1721 | 29092 | 1496 | 13844 |

## RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

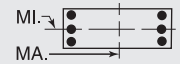
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.24 | MA | 19779 | 5009 | 31026 | 3744 | 33252 | 3045 | 33451 | 2540 | 32308 | 1794 | 38024 | 1462 | 19793 |
| 5L-2S | | MI | 15331 | 5009 | 24438 | 3639 | 26289 | 2960 | 26824 | 2455 | 26779 | 1714 | 31374 | 1585 | 13801 |
| 10-#14 | 1.79 | MA | 22997 | 5253 | 36979 | 3873 | 40780 | 3138 | 42584 | 2583 | 44683 | 1763 | 53862 | 1634 | 28311 |
| 2L-5S | | MI | 14248 | 5253 | 23228 | 3778 | 24675 | 3071 | 24814 | 2516 | 24136 | 1683 | 28442 | 1197 | 18747 |
| 10-#14 | 1.79 | MA | 21808 | 5253 | 35168 | 3872 | 38472 | 3154 | 39778 | 2597 | 40881 | 1773 | 48776 | 1506 | 28279 |
| 3L-4S | | MI | 14763 | 5253 | 24096 | 3784 | 25793 | 3060 | 26164 | 2506 | 25998 | 1693 | 30675 | 1255 | 19464 |
| 10-#14 | 1.79 | MA | 20968 | 5253 | 33713 | 3890 | 36622 | 3151 | 37532 | 2591 | 37966 | 1783 | 45448 | 1378 | 28105 |
| 4L-3S | | MI | 15335 | 5253 | 25082 | 3769 | 27045 | 3068 | 27665 | 2516 | 27882 | 1683 | 32773 | 1380 | 19496 |
| 10-#14 | 1.79 | MA | 20215 | 5253 | 32437 | 3888 | 34976 | 3167 | 35517 | 2606 | 35091 | 1774 | 41964 | 1316 | 26923 |
| 5L-2S | | MI | 16127 | 5253 | 26294 | 3775 | 28591 | 3057 | 29525 | 2506 | 30339 | 1673 | 35994 | 1508 | 19460 |
| 10-#18 | 3.17 | MA | 26001 | 5874 | 43876 | 4237 | 49436 | 3399 | 53054 | 2740 | 58606 | 1697 | 72210 | 1497 | 49094 |
| 2L-5S | | MI | 14835 | 5874 | 25506 | 4126 | 27428 | 3324 | 28018 | 2650 | 28369 | 1581 | 34276 | 743 | 29890 |
| 10-#18 | 3.17 | MA | 23980 | 5874 | 40707 | 4232 | 45396 | 3426 | 48143 | 2763 | 52000 | 1715 | 63426 | 1270 | 48757 |
| 3L-4S | | MI | 15712 | 5874 | 27022 | 4139 | 29371 | 3306 | 30331 | 2632 | 31559 | 1599 | 38075 | 848 | 31287 |
| 10-#18 | 3.17 | MA | 22551 | 5874 | 38154 | 4263 | 42149 | 3417 | 44203 | 2751 | 46932 | 1733 | 57692 | 1042 | 46063 |
| 4L-3S | | MI | 16683 | 5874 | 28740 | 4116 | 31544 | 3324 | 32902 | 2650 | 34786 | 1581 | 41654 | 1063 | 33169 |
| 10-#18 | 3.17 | MA | 21270 | 5874 | 35912 | 4258 | 39259 | 3444 | 40664 | 2773 | 41933 | 1715 | 51648 | 935 | 43547 |
| 5L-2S | | MI | 18025 | 5874 | 30845 | 4129 | 34218 | 3306 | 36087 | 2632 | 38994 | 1564 | 47133 | 1291 | 33305 |
| 12-#11 | 1.49 | MA | 22340 | 5119 | 35462 | 3802 | 38916 | 3087 | 40345 | 2553 | 41661 | 1777 | 49965 | 1668 | 23780 |
| 2L-6S | | MI | 14044 | 5119 | 22567 | 3708 | 23852 | 3017 | 23900 | 2500 | 22929 | 1717 | 26830 | 1284 | 15960 |
| 12-#11 | 1.49 | MA | 21503 | 5119 | 34197 | 3801 | 37303 | 3085 | 38384 | 2564 | 39004 | 1785 | 46389 | 1579 | 23784 |
| 3L-5S | | MI | 14391 | 5119 | 23141 | 3712 | 24630 | 3022 | 24811 | 2493 | 24134 | 1710 | 28307 | 1344 | 16406 |
| 12-#11 | 1.49 | MA | 20912 | 5119 | 33181 | 3814 | 36012 | 3097 | 36817 | 2560 | 36969 | 1793 | 44046 | 1490 | 23734 |
| 4E | | MI | 14753 | 5119 | 23748 | 3715 | 25413 | 3014 | 25764 | 2486 | 25448 | 1717 | 29890 | 1384 | 16476 |
| 12-#11 | 1.49 | MA | 20384 | 5119 | 32292 | 3813 | 34865 | 3095 | 35412 | 2571 | 34964 | 1787 | 41600 | 1447 | 23578 |
| 5L-3S | | MI | 15156 | 5119 | 24438 | 3705 | 26289 | 3019 | 26824 | 2493 | 26779 | 1710 | 31374 | 1472 | 16456 |
| 12-#11 | 1.49 | MA | 19880 | 5119 | 31452 | 3812 | 33724 | 3106 | 34020 | 2567 | 33122 | 1795 | 39274 | 1388 | 22766 |
| 6L-2S | | MI | 15715 | 5119 | 25288 | 3709 | 27373 | 3010 | 28137 | 2486 | 28514 | 1703 | 33656 | 1560 | 16421 |
| 12-#14 | 2.14 | MA | 23826 | 5413 | 38790 | 3973 | 43089 | 3210 | 45390 | 2628 | 48485 | 1753 | 58947 | 1610 | 33823 |
| 2L-6S | | MI | 14309 | 5413 | 23620 | 3872 | 25107 | 3135 | 25384 | 2570 | 24885 | 1676 | 29579 | 1072 | 21737 |
| 12-#14 | 2.14 | MA | 22646 | 5413 | 36979 | 3971 | 40780 | 3226 | 42584 | 2642 | 44683 | 1763 | 53862 | 1482 | 33755 |
| 3L-5S | | MI | 14798 | 5413 | 24441 | 3878 | 26220 | 3143 | 26674 | 2560 | 26593 | 1666 | 31663 | 1158 | 22256 |
| 12-#14 | 2.14 | MA | 21814 | 5413 | 35524 | 3990 | 38930 | 3223 | 40339 | 2636 | 41767 | 1773 | 50534 | 1355 | 33541 |
| 4E | | MI | 15310 | 5413 | 25309 | 3883 | 27338 | 3132 | 28025 | 2550 | 28455 | 1676 | 33896 | 1216 | 23117 |
| 12-#14 | 2.14 | MA | 21068 | 5413 | 34248 | 3988 | 37285 | 3239 | 38324 | 2650 | 38893 | 1764 | 47049 | 1292 | 32207 |
| 5L-3S | | MI | 15877 | 5413 | 26294 | 3869 | 28591 | 3141 | 29525 | 2560 | 30339 | 1666 | 35994 | 1341 | 23186 |
| 12-#14 | 2.14 | MA | 20357 | 5413 | 33044 | 3986 | 35649 | 3235 | 36328 | 2645 | 36251 | 1774 | 43743 | 1208 | 31221 |
| 6L-2S | | MI | 16664 | 5413 | 27506 | 3875 | 30136 | 3129 | 31385 | 2550 | 32795 | 1656 | 39215 | 1469 | 23175 |
| 12-#18 | 3.81 | MA | 25395 | 6158 | 43876 | 4410 | 49436 | 3554 | 53054 | 2843 | 58606 | 1695 | 72210 | 1221 | 58262 |
| 3L-5S | | MI | 15766 | 6158 | 27611 | 4303 | 30102 | 3452 | 31204 | 2724 | 32577 | 1546 | 39755 | 665 | 35706 |
| 12-#18 | 3.81 | MA | 23985 | 6158 | 41323 | 4440 | 46190 | 3546 | 49114 | 2830 | 53538 | 1712 | 66476 | 994 | 55212 |
| 4E | | MI | 16633 | 6158 | 29127 | 4316 | 32045 | 3434 | 33516 | 2706 | 35768 | 1564 | 43553 | 769 | 37290 |
| 12-#18 | 3.81 | MA | 22722 | 6158 | 39081 | 4436 | 43299 | 3573 | 45575 | 2853 | 48539 | 1695 | 60432 | 886 | 52837 |
| 5L-3S | | MI | 17594 | 6158 | 30845 | 4294 | 34218 | 3452 | 36087 | 2724 | 38994 | 1546 | 47133 | 985 | 39482 |
| 12-#18 | 3.81 | MA | 21516 | 6158 | 36964 | 4431 | 40425 | 3564 | 42070 | 2841 | 43947 | 1712 | 54728 | 735 | 48879 |
| 6L-2S | | MI | 18923 | 6158 | 32950 | 4306 | 36893 | 3434 | 39273 | 2706 | 43202 | 1528 | 52611 | 1212 | 39687 |
| 14-#11 | 1.73 | MA | 22928 | 5230 | 36727 | 3871 | 40529 | 3137 | 42306 | 2585 | 44317 | 1771 | 53542 | 1653 | 27640 |
| 2L-7S | | MI | 14098 | 5230 | 22803 | 3788 | 24188 | 3075 | 24267 | 2524 | 23483 | 1712 | 27723 | 1191 | 18202 |
| 14-#11 | 1.73 | MA | 22095 | 5230 | 35462 | 3870 | 38916 | 3135 | 40345 | 2595 | 41661 | 1778 | 49965 | 1564 | 27625 |
| 3L-6S | | MI | 14435 | 5230 | 23418 | 3778 | 24936 | 3067 | 25214 | 2531 | 24663 | 1706 | 29112 | 1260 | 18455 |
| 14-#11 | 1.73 | MA | 21508 | 5230 | 34447 | 3883 | 37625 | 3147 | 38778 | 2592 | 39626 | 1786 | 47622 | 1475 | 27554 |
| 4L-5S | | MI | 14780 | 5230 | 23992 | 3781 | 25715 | 3072 | 26125 | 2524 | 25869 | 1699 | 30589 | 1319 | 18871 |
| 14-#11 | 1.73 | MA | 20984 | 5230 | 33557 | 3882 | 36478 | 3145 | 37372 | 2602 | 37621 | 1780 | 45177 | 1431 | 27267 |
| 5L-4S | | MI | 15140 | 5230 | 24599 | 3785 | 26497 | 3064 | 27078 | 2517 | 27183 | 1706 | 32172 | 1359 | 19059 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

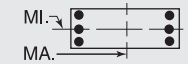
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.73 | MA | 20483 | 5230 | 32717 | 3882 | 35337 | 3156 | 35981 | 2599 | 35778 | 1788 | 42850 | 1373 | 26494 |
| 6L-3S | | MI | 15541 | 5230 | 25288 | 3774 | 27373 | 3069 | 28137 | 2524 | 28514 | 1699 | 33656 | 1447 | 19058 |
| 14-#11 | 1.73 | MA | 19994 | 5230 | 31819 | 3895 | 34242 | 3154 | 34639 | 2609 | 33976 | 1796 | 40429 | 1285 | 25997 |
| 7L-2S | | MI | 16097 | 5230 | 26139 | 3778 | 28457 | 3061 | 29451 | 2517 | 30248 | 1692 | 35938 | 1535 | 19033 |
| 14-#14 | 2.50 | MA | 23476 | 5572 | 38790 | 4071 | 43089 | 3299 | 45390 | 2687 | 48485 | 1753 | 58947 | 1459 | 39224 |
| 3L-6S | | MI | 14859 | 5572 | 24832 | 3972 | 26652 | 3207 | 27245 | 2613 | 27342 | 1659 | 32800 | 1034 | 25240 |
| 14-#14 | 2.50 | MA | 22651 | 5572 | 37335 | 4089 | 41239 | 3295 | 43145 | 2681 | 45569 | 1763 | 55619 | 1331 | 38974 |
| 4L-5S | | MI | 15344 | 5572 | 25653 | 3977 | 27766 | 3216 | 28534 | 2603 | 29050 | 1649 | 34884 | 1120 | 25779 |
| 14-#14 | 2.50 | MA | 21913 | 5572 | 36059 | 4088 | 39593 | 3311 | 41130 | 2695 | 42695 | 1754 | 52134 | 1269 | 37507 |
| 5L-4S | | MI | 15852 | 5572 | 26521 | 3983 | 28884 | 3204 | 29885 | 2593 | 30911 | 1659 | 37117 | 1177 | 26761 |
| 14-#14 | 2.50 | MA | 21208 | 5572 | 34854 | 4086 | 37957 | 3308 | 39135 | 2690 | 40053 | 1764 | 48828 | 1184 | 36564 |
| 6L-3S | | MI | 16415 | 5572 | 27506 | 3969 | 30136 | 3213 | 31385 | 2603 | 32795 | 1649 | 39215 | 1302 | 26860 |
| 14-#14 | 2.50 | MA | 20520 | 5572 | 33566 | 4104 | 36387 | 3324 | 37210 | 2704 | 37468 | 1774 | 45386 | 1058 | 34876 |
| 7L-2S | | MI | 17197 | 5572 | 28718 | 3975 | 31682 | 3202 | 33245 | 2593 | 35252 | 1639 | 42436 | 1430 | 26879 |
| 14-#18 | 4.44 | MA | 25401 | 6441 | 44492 | 4618 | 50230 | 3674 | 54026 | 2910 | 60144 | 1692 | 75260 | 945 | 64397 |
| 4L-5S | | MI | 16686 | 6441 | 29717 | 4481 | 32776 | 3580 | 34390 | 2797 | 36785 | 1510 | 45233 | 586 | 41562 |
| 14-#18 | 4.44 | MA | 24154 | 6441 | 42250 | 4613 | 47339 | 3701 | 50486 | 2933 | 55145 | 1674 | 69216 | 838 | 61933 |
| 5L-4S | | MI | 17545 | 6441 | 31232 | 4493 | 34719 | 3562 | 36702 | 2779 | 39976 | 1528 | 49032 | 691 | 43327 |
| 14-#18 | 4.44 | MA | 22965 | 6441 | 40133 | 4608 | 44465 | 3693 | 46981 | 2921 | 50552 | 1692 | 63511 | 687 | 58049 |
| 6L-3S | | MI | 18496 | 6441 | 32950 | 4471 | 36893 | 3580 | 39273 | 2797 | 43202 | 1510 | 52611 | 906 | 45783 |
| 14-#18 | 4.44 | MA | 21805 | 6441 | 37868 | 4639 | 41704 | 3719 | 43598 | 2943 | 46058 | 1710 | 57570 | 462 | 54099 |
| 7L-2S | | MI | 19813 | 6441 | 35055 | 4484 | 39567 | 3562 | 42458 | 2779 | 47411 | 1493 | 58090 | 1134 | 46052 |
| 16-#11 | 1.98 | MA | 22683 | 5341 | 36727 | 3939 | 40529 | 3185 | 42306 | 2626 | 44317 | 1771 | 53542 | 1549 | 31459 |
| 3L-7S | | MI | 14489 | 5341 | 23654 | 3857 | 25272 | 3125 | 25581 | 2555 | 25218 | 1701 | 30005 | 1166 | 20636 |
| 16-#11 | 1.98 | MA | 22100 | 5341 | 35712 | 3952 | 39238 | 3197 | 40739 | 2623 | 42282 | 1779 | 51198 | 1460 | 31371 |
| 4L-6S | | MI | 14823 | 5341 | 24268 | 3847 | 26020 | 3117 | 26527 | 2562 | 26398 | 1695 | 31394 | 1235 | 20956 |
| 16-#11 | 1.98 | MA | 21579 | 5341 | 34822 | 3951 | 38091 | 3195 | 39333 | 2633 | 40277 | 1773 | 48753 | 1416 | 30967 |
| 5E | | MI | 15166 | 5341 | 24842 | 3850 | 26799 | 3122 | 27438 | 2555 | 27604 | 1688 | 32872 | 1294 | 21346 |
| 16-#11 | 1.98 | MA | 21082 | 5341 | 33982 | 3951 | 36950 | 3207 | 37942 | 2630 | 38435 | 1781 | 46426 | 1358 | 30228 |
| 6L-4S | | MI | 15525 | 5341 | 25449 | 3854 | 27581 | 3114 | 28392 | 2548 | 28918 | 1695 | 34454 | 1334 | 21636 |
| 16-#11 | 1.98 | MA | 20597 | 5341 | 33084 | 3964 | 35855 | 3205 | 36600 | 2640 | 36632 | 1789 | 44005 | 1270 | 29715 |
| 7L-3S | | MI | 15923 | 5341 | 26139 | 3843 | 28457 | 3119 | 29451 | 2555 | 30248 | 1688 | 35938 | 1422 | 21654 |
| 16-#11 | 1.98 | MA | 20118 | 5341 | 32260 | 3963 | 34750 | 3216 | 35285 | 2650 | 34744 | 1783 | 41719 | 1219 | 28736 |
| 8L-2S | | MI | 16477 | 5341 | 26989 | 3847 | 29541 | 3111 | 30764 | 2548 | 31983 | 1681 | 38221 | 1510 | 21638 |
| 16-#14 | 2.86 | MA | 23481 | 5732 | 39145 | 4189 | 43547 | 3367 | 45951 | 2726 | 49371 | 1753 | 60704 | 1307 | 44404 |
| 4L-6S | | MI | 15404 | 5732 | 26044 | 4071 | 28198 | 3279 | 29105 | 2656 | 29799 | 1642 | 36021 | 995 | 28677 |
| 16-#14 | 2.86 | MA | 22749 | 5732 | 37869 | 4188 | 41902 | 3384 | 43936 | 2740 | 46497 | 1744 | 57220 | 1245 | 42819 |
| 5E | | MI | 15886 | 5732 | 26865 | 4077 | 29311 | 3288 | 30395 | 2646 | 31506 | 1632 | 38105 | 1081 | 29314 |
| 16-#14 | 2.86 | MA | 22051 | 5732 | 36665 | 4186 | 40266 | 3380 | 41941 | 2735 | 43855 | 1754 | 53913 | 1161 | 41912 |
| 6L-4S | | MI | 16390 | 5732 | 27733 | 4083 | 30429 | 3277 | 31745 | 2636 | 33368 | 1642 | 40338 | 1139 | 30237 |
| 16-#14 | 2.86 | MA | 21369 | 5732 | 35376 | 4204 | 38695 | 3396 | 40016 | 2749 | 41270 | 1764 | 50471 | 1034 | 40153 |
| 7L-3S | | MI | 16949 | 5732 | 28718 | 4069 | 31682 | 3285 | 33245 | 2646 | 35252 | 1632 | 42436 | 1264 | 30526 |
| 16-#14 | 2.86 | MA | 20697 | 5732 | 34194 | 4202 | 37110 | 3393 | 38131 | 2763 | 38562 | 1755 | 47216 | 961 | 38547 |
| 8L-2S | | MI | 17726 | 5732 | 29931 | 4074 | 33227 | 3274 | 35105 | 2636 | 37709 | 1622 | 45657 | 1392 | 30570 |
| 16-#18 | 5.08 | MA | 25570 | 6725 | 45419 | 4790 | 51380 | 3830 | 55398 | 3013 | 61750 | 1654 | 78000 | 789 | 70984 |
| 5E | | MI | 17599 | 6725 | 31822 | 4658 | 35451 | 3707 | 37575 | 2870 | 40993 | 1475 | 50712 | 508 | 47453 |
| 16-#18 | 5.08 | MA | 24397 | 6725 | 43302 | 4786 | 48505 | 3821 | 51893 | 3000 | 57158 | 1672 | 72295 | 638 | 67242 |
| 6L-4S | | MI | 18448 | 6725 | 33337 | 4671 | 37394 | 3690 | 39887 | 2852 | 44184 | 1493 | 54510 | 612 | 49392 |
| 16-#18 | 5.08 | MA | 23251 | 6725 | 41037 | 4816 | 45744 | 3848 | 48510 | 3023 | 52664 | 1689 | 66354 | 413 | 63199 |
| 7L-3S | | MI | 19390 | 6725 | 35055 | 4648 | 39567 | 3707 | 42458 | 2870 | 47411 | 1475 | 58090 | 828 | 52075 |
| 18-#11 | 2.23 | MA | 22688 | 5451 | 36977 | 4021 | 40851 | 3247 | 42700 | 2654 | 44939 | 1772 | 54775 | 1445 | 35184 |
| 4L-7S | | MI | 14877 | 5451 | 24504 | 3926 | 26356 | 3175 | 26894 | 2586 | 26953 | 1690 | 32287 | 1141 | 23079 |
| 18-#11 | 2.23 | MA | 22170 | 5451 | 36087 | 4021 | 39704 | 3245 | 41294 | 2664 | 42934 | 1766 | 52329 | 1401 | 34677 |
| 5L-6S | | MI | 15210 | 5451 | 25118 | 3916 | 27104 | 3167 | 27841 | 2592 | 28133 | 1684 | 33676 | 1210 | 23460 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis

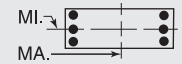


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.23 | MA | 21676 | 5451 | 35248 | 4020 | 38563 | 3257 | 39903 | 2661 | 41091 | 1774 | 50002 | 1343 | 33968 |
| 6L-5S | | MI | 15551 | 5451 | 25692 | 3919 | 27883 | 3172 | 28752 | 2586 | 29339 | 1677 | 35154 | 1269 | 23829 |
| 18-#11 | 2.23 | MA | 21194 | 5451 | 34349 | 4033 | 37468 | 3255 | 38560 | 2671 | 39289 | 1782 | 47581 | 1255 | 33393 |
| 7L-4S | | MI | 15907 | 5451 | 26299 | 3923 | 28665 | 3164 | 29705 | 2579 | 30653 | 1684 | 36736 | 1309 | 24207 |
| 18-#11 | 2.23 | MA | 20719 | 5451 | 33525 | 4032 | 36363 | 3266 | 37246 | 2682 | 37400 | 1776 | 45296 | 1204 | 32444 |
| 8L-3S | | MI | 16303 | 5451 | 26989 | 3913 | 29541 | 3169 | 30764 | 2586 | 31983 | 1677 | 38221 | 1397 | 24240 |
| 18-#11 | 2.23 | MA | 20239 | 5451 | 32653 | 4045 | 35283 | 3264 | 35887 | 2678 | 35616 | 1784 | 43042 | 1148 | 31546 |
| 9L-2S | | MI | 16855 | 5451 | 27839 | 3916 | 30626 | 3161 | 32078 | 2579 | 33718 | 1670 | 40503 | 1485 | 24237 |
| 18-#14 | 3.21 | MA | 23578 | 5892 | 39680 | 4287 | 44210 | 3456 | 46742 | 2785 | 50299 | 1734 | 62305 | 1221 | 48143 |
| 5L-6S | | MI | 15945 | 5892 | 27256 | 4171 | 29743 | 3352 | 30965 | 2700 | 32256 | 1624 | 39242 | 956 | 32128 |
| 18-#14 | 3.21 | MA | 22886 | 5892 | 38476 | 4286 | 42574 | 3452 | 44747 | 2780 | 47657 | 1744 | 58998 | 1137 | 47143 |
| 6L-5S | | MI | 16424 | 5892 | 28077 | 4177 | 30857 | 3360 | 32255 | 2690 | 33963 | 1614 | 41326 | 1042 | 32858 |
| 18-#14 | 3.21 | MA | 22211 | 5892 | 37187 | 4304 | 41004 | 3469 | 42822 | 2794 | 45072 | 1754 | 55557 | 1010 | 45440 |
| 7L-4S | | MI | 16924 | 5892 | 28945 | 4183 | 31975 | 3349 | 33605 | 2680 | 35825 | 1624 | 43559 | 1100 | 33726 |
| 18-#14 | 3.21 | MA | 21545 | 5892 | 36005 | 4302 | 39419 | 3465 | 40938 | 2808 | 42364 | 1745 | 52301 | 938 | 43781 |
| 8L-3S | | MI | 17480 | 5892 | 29931 | 4168 | 33227 | 3358 | 35105 | 2690 | 37709 | 1614 | 45657 | 1225 | 34185 |
| 18-#14 | 3.21 | MA | 20873 | 5892 | 34754 | 4320 | 37870 | 3481 | 38988 | 2802 | 39806 | 1755 | 49097 | 856 | 42107 |
| 9L-2S | | MI | 18252 | 5892 | 31143 | 4174 | 34773 | 3346 | 36965 | 2680 | 40166 | 1605 | 48878 | 1353 | 34250 |
| 18-#18 | 5.71 | MA | 25812 | 7009 | 46471 | 4963 | 52545 | 3950 | 56804 | 3080 | 63764 | 1651 | 81079 | 590 | 76455 |
| 6L-5S | | MI | 18503 | 7009 | 33927 | 4835 | 38125 | 3835 | 40761 | 2944 | 45202 | 1439 | 56190 | 429 | 53373 |
| 18-#18 | 5.71 | MA | 24681 | 7009 | 44206 | 4994 | 49785 | 3976 | 53421 | 3103 | 59269 | 1669 | 75137 | 365 | 72320 |
| 7L-4S | | MI | 19345 | 7009 | 35443 | 4848 | 40068 | 3817 | 43073 | 2926 | 48392 | 1457 | 59989 | 534 | 55479 |
| 20-#11 | 2.48 | MA | 22757 | 5562 | 37352 | 4090 | 41317 | 3295 | 43255 | 2695 | 45590 | 1759 | 55905 | 1386 | 38395 |
| 5L-7S | | MI | 15262 | 5562 | 25354 | 3995 | 27440 | 3226 | 28208 | 2616 | 28688 | 1679 | 34570 | 1116 | 25530 |
| 20-#11 | 2.48 | MA | 22266 | 5562 | 36513 | 4089 | 40176 | 3307 | 41864 | 2692 | 43748 | 1767 | 53579 | 1328 | 37713 |
| 6E | | MI | 15594 | 5562 | 25968 | 3985 | 28188 | 3217 | 29154 | 2623 | 29868 | 1672 | 35958 | 1185 | 25969 |
| 20-#11 | 2.48 | MA | 21788 | 5562 | 35614 | 4102 | 39081 | 3305 | 40521 | 2702 | 41945 | 1775 | 51157 | 1240 | 37078 |
| 7L-5S | | MI | 15933 | 5562 | 26542 | 3989 | 28967 | 3223 | 30065 | 2616 | 31073 | 1666 | 37436 | 1244 | 26319 |
| 20-#11 | 2.48 | MA | 21316 | 5562 | 34790 | 4101 | 37976 | 3316 | 39207 | 2713 | 40057 | 1769 | 48872 | 1189 | 36157 |
| 8L-4S | | MI | 16288 | 5562 | 27149 | 3992 | 29749 | 3214 | 31019 | 2609 | 32387 | 1672 | 39019 | 1284 | 26774 |
| 20-#11 | 2.48 | MA | 20837 | 5562 | 33918 | 4114 | 36896 | 3314 | 37848 | 2709 | 38273 | 1777 | 46618 | 1133 | 35222 |
| 9L-3S | | MI | 16681 | 5562 | 27839 | 3982 | 30626 | 3219 | 32078 | 2616 | 33718 | 1666 | 40503 | 1372 | 26819 |
| 20-#11 | 2.48 | MA | 20310 | 5562 | 33098 | 4113 | 35805 | 3326 | 36542 | 2720 | 36502 | 1784 | 44432 | 1069 | 34206 |
| 10L-2S | | MI | 17230 | 5562 | 28689 | 3985 | 31710 | 3211 | 33392 | 2609 | 35453 | 1659 | 42785 | 1460 | 26832 |
| 20-#14 | 3.57 | MA | 23714 | 6051 | 40286 | 4385 | 44883 | 3525 | 47554 | 2824 | 51459 | 1734 | 64084 | 1113 | 52386 |
| 6E | | MI | 16483 | 6051 | 28468 | 4271 | 31289 | 3424 | 32825 | 2743 | 34712 | 1607 | 42464 | 917 | 35591 |
| 20-#14 | 3.57 | MA | 23045 | 6051 | 38998 | 4404 | 43312 | 3541 | 45629 | 2839 | 48874 | 1744 | 60642 | 987 | 50735 |
| 7L-5S | | MI | 16958 | 6051 | 29290 | 4277 | 32402 | 3433 | 34115 | 2733 | 36420 | 1597 | 44547 | 1003 | 36410 |
| 20-#14 | 3.57 | MA | 22384 | 6051 | 37815 | 4402 | 41727 | 3537 | 43744 | 2853 | 46166 | 1735 | 57386 | 914 | 49024 |
| 8L-4S | | MI | 17455 | 6051 | 30158 | 4282 | 33520 | 3421 | 35465 | 2723 | 38282 | 1607 | 46780 | 1061 | 37229 |
| 20-#14 | 3.57 | MA | 21715 | 6051 | 36564 | 4420 | 40178 | 3554 | 41794 | 2847 | 43608 | 1745 | 54183 | 833 | 47197 |
| 9L-3S | | MI | 18007 | 6051 | 31143 | 4268 | 34773 | 3430 | 36965 | 2733 | 40166 | 1597 | 48878 | 1186 | 37838 |
| 20-#18 | 6.35 | MA | 26095 | 7292 | 47375 | 5171 | 53825 | 4105 | 58333 | 3183 | 65875 | 1648 | 83921 | 316 | 81460 |
| 7L-5S | | MI | 19401 | 7292 | 36032 | 5013 | 40799 | 3963 | 43946 | 3017 | 49410 | 1404 | 61669 | 351 | 59321 |
| 22-#11 | 2.72 | MA | 22853 | 5672 | 37778 | 4158 | 41789 | 3357 | 43824 | 2723 | 46404 | 1760 | 57155 | 1313 | 41462 |
| 6L-7S | | MI | 15646 | 5672 | 26204 | 4065 | 28524 | 3276 | 29522 | 2647 | 30422 | 1668 | 36852 | 1091 | 27987 |
| 22-#11 | 2.72 | MA | 22377 | 5672 | 36879 | 4171 | 40694 | 3355 | 42482 | 2733 | 44602 | 1768 | 54734 | 1225 | 40770 |
| 7L-6S | | MI | 15975 | 5672 | 26819 | 4054 | 29272 | 3267 | 30468 | 2654 | 31602 | 1661 | 38241 | 1160 | 28480 |
| 22-#11 | 2.72 | MA | 21908 | 5672 | 36055 | 4170 | 39589 | 3367 | 41168 | 2744 | 42713 | 1762 | 52448 | 1174 | 39875 |
| 8L-5S | | MI | 16313 | 5672 | 27393 | 4058 | 30051 | 3273 | 31379 | 2647 | 32808 | 1655 | 39718 | 1219 | 28813 |
| 22-#11 | 2.72 | MA | 21430 | 5672 | 35183 | 4183 | 38509 | 3365 | 39808 | 2740 | 40929 | 1770 | 50194 | 1118 | 38905 |
| 9L-4S | | MI | 16666 | 5672 | 28000 | 4061 | 30833 | 3264 | 32332 | 2640 | 34122 | 1661 | 41301 | 1259 | 29338 |
| 22-#11 | 2.72 | MA | 20908 | 5672 | 34363 | 4183 | 37418 | 3376 | 38502 | 2751 | 39159 | 1777 | 48008 | 1054 | 37911 |
| 10L-3S | | MI | 17057 | 5672 | 28689 | 4051 | 31710 | 3270 | 33392 | 2647 | 35453 | 1655 | 42785 | 1347 | 29395 |
| 22-#11 | 2.72 | MA | 20403 | 5672 | 33554 | 4182 | 36344 | 3374 | 37158 | 2747 | 37297 | 1771 | 45777 | 1000 | 36616 |
| 11L-2S | | MI | 17604 | 5672 | 29540 | 4054 | 32794 | 3261 | 34705 | 2640 | 37187 | 1648 | 45067 | 1435 | 29419 |
| 22-#14 | 3.93 | MA | 23872 | 6211 | 40808 | 4503 | 45621 | 3613 | 48435 | 2884 | 52676 | 1734 | 65727 | 963 | 56039 |
| 7L-6S | | MI | 17017 | 6211 | 29681 | 4371 | 32834 | 3496 | 34685 | 2786 | 37169 | 1590 | 45685 | 879 | 39066 |

## RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 3.93 | MA | 23217 | 6211 | 39626 | 4502 | 44035 | 3610 | 46550 | 2898 | 49968 | 1725 | 62471 | 891 | 54277 |
| 8L-5S | | MI | 17489 | 6211 | 30502 | 4376 | 33948 | 3505 | 35975 | 2777 | 38877 | 1580 | 47768 | 965 | 39968 |
| 22-#14 | 3.93 | MA | 22549 | 6211 | 38375 | 4520 | 42486 | 3626 | 44600 | 2892 | 47409 | 1735 | 59268 | 809 | 52416 |
| 9L-4S | | MI | 17983 | 6211 | 31370 | 4382 | 35066 | 3494 | 37325 | 2767 | 40738 | 1590 | 50001 | 1023 | 40742 |
| 24-#11 | 2.97 | MA | 22963 | 5783 | 38145 | 4240 | 42307 | 3405 | 44443 | 2765 | 47258 | 1761 | 58310 | 1210 | 44469 |
| 7E | | MI | 16027 | 5783 | 27055 | 4134 | 29608 | 3326 | 30835 | 2678 | 32157 | 1657 | 39134 | 1066 | 30450 |
| 24-#11 | 2.97 | MA | 22497 | 5783 | 37320 | 4239 | 41202 | 3417 | 43129 | 2775 | 45370 | 1755 | 56025 | 1159 | 43598 |
| 8L-6S | | MI | 16355 | 5783 | 27669 | 4123 | 30356 | 3317 | 31781 | 2685 | 33337 | 1650 | 40523 | 1135 | 30994 |
| 24-#11 | 2.97 | MA | 22020 | 5783 | 36448 | 4252 | 40122 | 3415 | 41769 | 2772 | 43586 | 1763 | 53770 | 1103 | 42592 |
| 9L-5S | | MI | 16691 | 5783 | 28243 | 4127 | 31135 | 3323 | 32692 | 2678 | 34543 | 1644 | 42000 | 1194 | 31312 |
| 24-#11 | 2.97 | MA | 21503 | 5783 | 35628 | 4252 | 39031 | 3426 | 40463 | 2782 | 41815 | 1771 | 51585 | 1039 | 41620 |
| 10L-4S | | MI | 17042 | 5783 | 28850 | 4130 | 31917 | 3314 | 33646 | 2671 | 35857 | 1650 | 43583 | 1234 | 31898 |
| 24-#11 | 2.97 | MA | 21000 | 5783 | 34819 | 4251 | 37957 | 3424 | 39119 | 2778 | 39953 | 1765 | 49353 | 985 | 40302 |
| 11L-3S | | MI | 17432 | 5783 | 29540 | 4120 | 32794 | 3320 | 34705 | 2678 | 37187 | 1644 | 45067 | 1322 | 31967 |
| 24-#14 | 4.29 | MA | 24044 | 6370 | 41437 | 4601 | 46344 | 3682 | 49356 | 2943 | 53770 | 1715 | 67557 | 867 | 59537 |
| 8L-6S | | MI | 17547 | 6370 | 30893 | 4470 | 34380 | 3569 | 36545 | 2830 | 39626 | 1573 | 48906 | 840 | 42550 |
| 24-#14 | 4.29 | MA | 23377 | 6370 | 40186 | 4620 | 44795 | 3698 | 47406 | 2937 | 51211 | 1725 | 64353 | 786 | 57644 |
| 9L-5S | | MI | 18016 | 6370 | 31714 | 4476 | 35493 | 3577 | 37835 | 2820 | 41333 | 1563 | 50989 | 926 | 43530 |

## RECTANGULAR TIED COLUMNS 30" x 44"

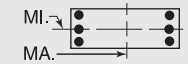
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.21 | MA | 23719 | 5235 | 37399 | 3877 | 40620 | 3155 | 41679 | 2621 | 42138 | 1854 | 49804 | 1739 | 21232 |
| 2E | | MI | 15909 | 5235 | 25498 | 3752 | 27189 | 3050 | 27491 | 2520 | 27224 | 1753 | 31637 | 1607 | 13974 |
| 6-#14 | 1.02 | MA | 23297 | 5146 | 36325 | 3846 | 39396 | 3135 | 40247 | 2613 | 40259 | 1875 | 47472 | 1776 | 18149 |
| 2L-3S | | MI | 14873 | 5146 | 23621 | 3726 | 24948 | 3052 | 24908 | 2539 | 23828 | 1802 | 27278 | 1538 | 12091 |
| 6-#14 | 1.02 | MA | 22018 | 5146 | 34414 | 3845 | 36960 | 3132 | 37286 | 2628 | 36248 | 1886 | 42075 | 1648 | 18196 |
| 3L-2S | | MI | 15677 | 5146 | 24833 | 3732 | 26493 | 3041 | 26768 | 2529 | 26285 | 1792 | 30499 | 1666 | 12011 |
| 6-#18 | 1.82 | MA | 25264 | 5519 | 40746 | 4055 | 44887 | 3284 | 46865 | 2701 | 49144 | 1836 | 59141 | 1693 | 31465 |
| 2L-3S | | MI | 15467 | 5519 | 25498 | 3916 | 27189 | 3196 | 27491 | 2611 | 27224 | 1735 | 31637 | 1301 | 20546 |
| 6-#18 | 1.82 | MA | 23068 | 5519 | 37399 | 4051 | 40620 | 3312 | 41679 | 2725 | 42138 | 1853 | 49804 | 1466 | 31336 |
| 3L-2S | | MI | 16840 | 5519 | 27603 | 3929 | 29863 | 3178 | 30676 | 2594 | 31433 | 1718 | 37116 | 1528 | 20485 |
| 8-#14 | 1.36 | MA | 24195 | 5306 | 38235 | 3946 | 41832 | 3207 | 43207 | 2658 | 44270 | 1865 | 52869 | 1754 | 23998 |
| 2L-4S | | MI | 14849 | 5306 | 23848 | 3840 | 25241 | 3116 | 25267 | 2572 | 24401 | 1794 | 28401 | 1375 | 15855 |
| 8-#14 | 1.36 | MA | 22927 | 5306 | 36325 | 3945 | 39396 | 3204 | 40247 | 2673 | 40259 | 1876 | 47472 | 1626 | 24006 |
| 3E | | MI | 15425 | 5306 | 24833 | 3826 | 26493 | 3124 | 26768 | 2582 | 26285 | 1784 | 30499 | 1499 | 15828 |
| 8-#14 | 1.36 | MA | 22032 | 5306 | 34791 | 3963 | 37446 | 3221 | 37880 | 2668 | 37186 | 1887 | 43936 | 1498 | 23879 |
| 4L-2S | | MI | 16224 | 5306 | 26045 | 3831 | 28039 | 3113 | 28628 | 2572 | 28742 | 1774 | 33720 | 1627 | 15767 |
| 8-#18 | 2.42 | MA | 26783 | 5802 | 44092 | 4232 | 49153 | 3412 | 52052 | 2781 | 56151 | 1817 | 68479 | 1648 | 41646 |
| 2L-4S | | MI | 15416 | 5802 | 25885 | 4116 | 27690 | 3306 | 28105 | 2667 | 28206 | 1718 | 33536 | 1007 | 25588 |
| 8-#18 | 2.42 | MA | 24616 | 5802 | 40746 | 4228 | 44887 | 3440 | 46865 | 2805 | 49144 | 1835 | 59141 | 1421 | 41404 |
| 3E | | MI | 16401 | 5802 | 27603 | 4093 | 29863 | 3323 | 30676 | 2685 | 31433 | 1700 | 37116 | 1222 | 26915 |
| 8-#18 | 2.42 | MA | 23085 | 5802 | 38053 | 4260 | 41463 | 3433 | 42710 | 2794 | 43769 | 1852 | 53038 | 1193 | 39274 |
| 4L-2S | | MI | 17760 | 5802 | 29708 | 4106 | 32537 | 3306 | 33862 | 2667 | 35641 | 1682 | 42594 | 1450 | 26943 |
| 10-#11 | 1.18 | MA | 23756 | 5221 | 37207 | 3905 | 40595 | 3179 | 41732 | 2643 | 42283 | 1877 | 50320 | 1778 | 20966 |
| 2L-5S | | MI | 14635 | 5221 | 23252 | 3800 | 24540 | 3101 | 24462 | 2572 | 23262 | 1805 | 26976 | 1450 | 13929 |
| 10-#11 | 1.18 | MA | 22865 | 5221 | 35872 | 3904 | 38893 | 3177 | 39664 | 2654 | 39482 | 1885 | 46527 | 1689 | 20988 |
| 3L-4S | | MI | 15001 | 5221 | 23859 | 3803 | 25323 | 3092 | 25415 | 2565 | 24576 | 1812 | 28558 | 1490 | 13918 |
| 10-#11 | 1.18 | MA | 22238 | 5221 | 34803 | 3918 | 37533 | 3189 | 38013 | 2651 | 37338 | 1894 | 44040 | 1600 | 20962 |
| 4L-3S | | MI | 15406 | 5221 | 24549 | 3793 | 26199 | 3098 | 26475 | 2572 | 25906 | 1805 | 30042 | 1578 | 13878 |
| 10-#11 | 1.18 | MA | 21677 | 5221 | 33866 | 3917 | 36325 | 3187 | 36533 | 2661 | 35226 | 1888 | 41450 | 1556 | 20846 |
| 5L-2S | | MI | 15969 | 5221 | 25399 | 3796 | 27283 | 3089 | 27788 | 2565 | 27641 | 1798 | 32325 | 1667 | 13833 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis

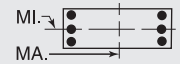



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.70 | MA | 25084 | 5465 | 40146 | 4046 | 44267 | 3280 | 46168 | 2703 | 48282 | 1855 | 58266 | 1732 | 29830 |
| 2L-5S | | MI | 14884 | 5465 | 24192 | 3934 | 25668 | 3199 | 25777 | 2625 | 24996 | 1767 | 29389 | 1278 | 18903 |
| 10-#14 | 1.70 | MA | 23825 | 5465 | 38235 | 4045 | 41832 | 3277 | 43207 | 2718 | 44270 | 1866 | 52869 | 1604 | 29797 |
| 3L-4S | | MI | 15401 | 5465 | 25060 | 3940 | 26786 | 3188 | 27128 | 2615 | 26858 | 1777 | 31622 | 1336 | 19527 |
| 10-#14 | 1.70 | MA | 22939 | 5465 | 36702 | 4063 | 39882 | 3293 | 40841 | 2713 | 41198 | 1877 | 49333 | 1476 | 29623 |
| 4L-3S | | MI | 15973 | 5465 | 26045 | 3926 | 28039 | 3197 | 28628 | 2625 | 28742 | 1767 | 33720 | 1461 | 19542 |
| 10-#14 | 1.70 | MA | 22145 | 5465 | 35358 | 4062 | 38149 | 3290 | 38718 | 2728 | 38169 | 1869 | 45642 | 1413 | 28503 |
| 5L-2S | | MI | 16766 | 5465 | 27257 | 3931 | 29584 | 3186 | 30488 | 2615 | 31198 | 1757 | 36941 | 1589 | 19500 |
| 10-#18 | 3.03 | MA | 28282 | 6086 | 47438 | 4409 | 53419 | 3541 | 57238 | 2861 | 63158 | 1798 | 77816 | 1603 | 51794 |
| 2L-5S | | MI | 15470 | 6086 | 26474 | 4280 | 28421 | 3451 | 28978 | 2758 | 29224 | 1664 | 35216 | 824 | 30171 |
| 10-#18 | 3.03 | MA | 26141 | 6086 | 44092 | 4406 | 49153 | 3569 | 52052 | 2885 | 56151 | 1816 | 68479 | 1376 | 51457 |
| 3L-4S | | MI | 16349 | 6086 | 27990 | 4293 | 30364 | 3433 | 31291 | 2740 | 32414 | 1682 | 39015 | 928 | 31542 |
| 10-#18 | 3.03 | MA | 24630 | 6086 | 41399 | 4437 | 45729 | 3561 | 47897 | 2874 | 50776 | 1834 | 62376 | 1148 | 48899 |
| 4L-3S | | MI | 17323 | 6086 | 29708 | 4271 | 32537 | 3451 | 33862 | 2758 | 35641 | 1664 | 42594 | 1144 | 33254 |
| 10-#18 | 3.03 | MA | 23277 | 6086 | 39037 | 4433 | 42683 | 3589 | 44166 | 2898 | 45474 | 1816 | 55965 | 1039 | 46128 |
| 5L-2S | | MI | 18668 | 6086 | 31813 | 4283 | 35211 | 3433 | 37047 | 2740 | 39849 | 1647 | 48073 | 1371 | 33368 |
| 12-#11 | 1.42 | MA | 24384 | 5331 | 38541 | 3974 | 42296 | 3229 | 43800 | 2674 | 45085 | 1870 | 54112 | 1764 | 25044 |
| 2L-6S | | MI | 14680 | 5331 | 23529 | 3865 | 24846 | 3146 | 24865 | 2610 | 23791 | 1801 | 27780 | 1366 | 16072 |
| 12-#11 | 1.42 | MA | 23498 | 5331 | 37207 | 3974 | 40595 | 3227 | 41732 | 2685 | 42283 | 1878 | 50320 | 1675 | 25048 |
| 3L-5S | | MI | 15027 | 5331 | 24103 | 3869 | 25624 | 3151 | 25776 | 2603 | 24997 | 1794 | 29258 | 1425 | 16505 |
| 12-#11 | 1.42 | MA | 22875 | 5331 | 36137 | 3987 | 39234 | 3239 | 40081 | 2682 | 40140 | 1887 | 47832 | 1586 | 24998 |
| 4E | | MI | 15391 | 5331 | 24710 | 3872 | 26407 | 3143 | 26729 | 2596 | 26311 | 1801 | 30840 | 1465 | 16518 |
| 12-#11 | 1.42 | MA | 22318 | 5331 | 35200 | 3986 | 38026 | 3238 | 38601 | 2693 | 38028 | 1881 | 45243 | 1542 | 24857 |
| 5L-3S | | MI | 15794 | 5331 | 25399 | 3862 | 27283 | 3148 | 27788 | 2603 | 27641 | 1794 | 32325 | 1553 | 16493 |
| 12-#11 | 1.42 | MA | 21787 | 5331 | 34317 | 3986 | 36825 | 3250 | 37136 | 2690 | 36088 | 1889 | 42774 | 1484 | 24051 |
| 6L-2S | | MI | 16354 | 5331 | 26250 | 3865 | 28367 | 3139 | 29102 | 2596 | 29376 | 1787 | 34607 | 1642 | 16456 |
| 12-#14 | 2.05 | MA | 25964 | 5625 | 42056 | 4145 | 46703 | 3352 | 49129 | 2748 | 52293 | 1845 | 63664 | 1710 | 35645 |
| 2L-6S | | MI | 14945 | 5625 | 24583 | 4028 | 26100 | 3263 | 26348 | 2679 | 25745 | 1760 | 30526 | 1153 | 21884 |
| 12-#14 | 2.05 | MA | 24715 | 5625 | 40146 | 4144 | 44267 | 3349 | 46168 | 2763 | 48282 | 1856 | 58266 | 1582 | 35578 |
| 3L-5S | | MI | 15435 | 5625 | 25404 | 4034 | 27214 | 3272 | 27637 | 2669 | 27453 | 1750 | 32610 | 1239 | 22410 |
| 12-#14 | 2.05 | MA | 23836 | 5625 | 38612 | 4163 | 42318 | 3366 | 43802 | 2758 | 45209 | 1867 | 54731 | 1454 | 35363 |
| 4E | | MI | 15948 | 5625 | 26272 | 4039 | 28332 | 3261 | 28988 | 2659 | 29314 | 1760 | 34843 | 1297 | 23185 |
| 12-#14 | 2.05 | MA | 23050 | 5625 | 37268 | 4162 | 40584 | 3363 | 41679 | 2773 | 42180 | 1859 | 51039 | 1391 | 34081 |
| 5L-3S | | MI | 16516 | 5625 | 27257 | 4025 | 29584 | 3269 | 30488 | 2669 | 31198 | 1750 | 36941 | 1422 | 23239 |
| 12-#14 | 2.05 | MA | 22300 | 5625 | 36000 | 4161 | 38862 | 3379 | 39578 | 2768 | 39398 | 1870 | 47528 | 1307 | 33001 |
| 6L-2S | | MI | 17305 | 5625 | 28470 | 4031 | 31130 | 3258 | 32348 | 2659 | 33655 | 1740 | 40162 | 1550 | 23218 |
| 12-#18 | 3.64 | MA | 27644 | 6370 | 47438 | 4583 | 53419 | 3697 | 57238 | 2965 | 63158 | 1797 | 77816 | 1330 | 61502 |
| 3L-5S | | MI | 16402 | 6370 | 28579 | 4458 | 31095 | 3579 | 32164 | 2831 | 33432 | 1629 | 40695 | 745 | 36114 |
| 12-#18 | 3.64 | MA | 26154 | 6370 | 44745 | 4614 | 49995 | 3690 | 53083 | 2953 | 57782 | 1815 | 71713 | 1103 | 58568 |
| 4E | | MI | 17272 | 6370 | 30095 | 4471 | 33038 | 3561 | 34476 | 2814 | 36623 | 1647 | 44493 | 850 | 37540 |
| 12-#18 | 3.64 | MA | 24819 | 6370 | 42383 | 4611 | 46949 | 3718 | 49352 | 2978 | 52481 | 1797 | 65302 | 994 | 55947 |
| 5L-3S | | MI | 18236 | 6370 | 31813 | 4448 | 35211 | 3579 | 37047 | 2831 | 39849 | 1629 | 48073 | 1065 | 39575 |
| 12-#18 | 3.64 | MA | 23546 | 6370 | 40152 | 4607 | 43920 | 3710 | 45658 | 2966 | 47610 | 1815 | 59234 | 843 | 51953 |
| 6L-2S | | MI | 19568 | 6370 | 33918 | 4461 | 37885 | 3561 | 40233 | 2814 | 44057 | 1611 | 53551 | 1293 | 39756 |
| 14-#11 | 1.65 | MA | 25007 | 5442 | 39875 | 4043 | 43997 | 3279 | 45868 | 2705 | 47887 | 1863 | 57905 | 1750 | 29114 |
| 2L-7S | | MI | 14734 | 5442 | 23765 | 3945 | 25181 | 3204 | 25232 | 2634 | 24345 | 1797 | 28674 | 1273 | 18317 |
| 14-#11 | 1.65 | MA | 24126 | 5442 | 38541 | 4043 | 42296 | 3277 | 43800 | 2716 | 45085 | 1871 | 54112 | 1661 | 29099 |
| 3L-6S | | MI | 15071 | 5442 | 24379 | 3934 | 25930 | 3196 | 26178 | 2640 | 25525 | 1790 | 30062 | 1341 | 18566 |
| 14-#11 | 1.65 | MA | 23507 | 5442 | 37471 | 4056 | 40936 | 3289 | 42149 | 2713 | 42942 | 1880 | 51625 | 1572 | 29029 |
| 4L-5S | | MI | 15417 | 5442 | 24953 | 3938 | 26708 | 3201 | 27089 | 2634 | 26731 | 1783 | 31540 | 1400 | 18994 |
| 14-#11 | 1.65 | MA | 22954 | 5442 | 36535 | 4056 | 39727 | 3288 | 40669 | 2724 | 40830 | 1874 | 49036 | 1528 | 28840 |
| 5L-4S | | MI | 15778 | 5442 | 25560 | 3941 | 27491 | 3193 | 28043 | 2627 | 28045 | 1790 | 33123 | 1440 | 19108 |
| 14-#11 | 1.65 | MA | 22426 | 5442 | 35651 | 4055 | 38526 | 3300 | 39204 | 2721 | 38890 | 1883 | 46567 | 1470 | 27985 |
| 6L-3S | | MI | 16179 | 5442 | 26250 | 3931 | 28367 | 3198 | 29102 | 2634 | 29376 | 1783 | 34607 | 1528 | 19098 |
| 14-#11 | 1.65 | MA | 21911 | 5442 | 34705 | 4068 | 37373 | 3298 | 37791 | 2731 | 36992 | 1891 | 43999 | 1382 | 27444 |
| 7L-2S | | MI | 16737 | 5442 | 27100 | 3934 | 29451 | 3190 | 30415 | 2627 | 31111 | 1776 | 36889 | 1617 | 19070 |
| 14-#14 | 2.39 | MA | 25596 | 5785 | 42056 | 4244 | 46703 | 3421 | 49129 | 2808 | 52293 | 1846 | 63664 | 1560 | 41350 |
| 3L-6S | | MI | 15495 | 5785 | 25795 | 4128 | 27646 | 3336 | 28208 | 2722 | 28202 | 1743 | 33747 | 1115 | 25439 |

## RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis



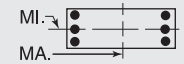

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.39 | MA | 24725 | 5785 | 40523 | 4263 | 44753 | 3438 | 46763 | 2803 | 49220 | 1857 | 60128 | 1432 | 41100 |
| 4L-5S | | MI | 15982 | 5785 | 26616 | 4133 | 28759 | 3344 | 29498 | 2712 | 29909 | 1733 | 35831 | 1201 | 25933 |
| 14-#14 | 2.39 | MA | 23945 | 5785 | 39179 | 4262 | 43020 | 3435 | 44640 | 2818 | 46192 | 1849 | 56436 | 1369 | 39676 |
| 5L-4S | | MI | 16491 | 5785 | 27484 | 4139 | 29877 | 3333 | 30848 | 2702 | 31771 | 1743 | 38064 | 1258 | 26835 |
| 14-#14 | 2.39 | MA | 23202 | 5785 | 37911 | 4260 | 41297 | 3452 | 42539 | 2813 | 43410 | 1860 | 52925 | 1285 | 38642 |
| 6L-3S | | MI | 17055 | 5785 | 28470 | 4125 | 31130 | 3341 | 32348 | 2712 | 33655 | 1733 | 40162 | 1383 | 26917 |
| 14-#14 | 2.39 | MA | 22477 | 5785 | 36554 | 4279 | 39643 | 3449 | 40512 | 2828 | 40687 | 1871 | 49271 | 1158 | 36979 |
| 7L-2S | | MI | 17839 | 5785 | 29682 | 4131 | 32675 | 3330 | 34208 | 2702 | 36112 | 1723 | 43383 | 1511 | 26925 |
| 14-#18 | 4.24 | MA | 27658 | 6654 | 48092 | 4792 | 54262 | 3818 | 58269 | 3033 | 64789 | 1796 | 81051 | 1058 | 68276 |
| 4L-5S | | MI | 17324 | 6654 | 30684 | 4635 | 33769 | 3707 | 35350 | 2905 | 37640 | 1593 | 46173 | 667 | 41964 |
| 14-#18 | 4.24 | MA | 26341 | 6654 | 45729 | 4788 | 51215 | 3846 | 54539 | 3057 | 59488 | 1778 | 74639 | 948 | 65786 |
| 5L-4S | | MI | 18185 | 6654 | 32200 | 4648 | 35712 | 3689 | 37662 | 2887 | 40831 | 1611 | 49972 | 771 | 43574 |
| 14-#18 | 4.24 | MA | 25085 | 6654 | 43499 | 4784 | 48186 | 3839 | 50845 | 3046 | 54616 | 1796 | 68572 | 798 | 61650 |
| 6L-3S | | MI | 19140 | 6654 | 33918 | 4625 | 37885 | 3707 | 40233 | 2905 | 44057 | 1593 | 53551 | 987 | 45883 |
| 14-#18 | 4.24 | MA | 23859 | 6654 | 41112 | 4816 | 45277 | 3867 | 47280 | 3070 | 49849 | 1814 | 62254 | 573 | 57650 |
| 7L-2S | | MI | 20460 | 6654 | 36023 | 4638 | 40559 | 3689 | 43418 | 2887 | 48266 | 1576 | 59030 | 1214 | 46125 |
| 16-#11 | 1.89 | MA | 24750 | 5553 | 39875 | 4112 | 43997 | 3328 | 45868 | 2747 | 47887 | 1865 | 57905 | 1647 | 33144 |
| 3L-7S | | MI | 15125 | 5553 | 24615 | 4014 | 26265 | 3254 | 26545 | 2664 | 26080 | 1786 | 30956 | 1248 | 20821 |
| 16-#11 | 1.89 | MA | 24135 | 5553 | 38806 | 4125 | 42637 | 3340 | 44217 | 2744 | 45743 | 1873 | 55418 | 1558 | 33055 |
| 4L-6S | | MI | 15460 | 5553 | 25229 | 4004 | 27014 | 3246 | 27492 | 2671 | 27260 | 1779 | 32345 | 1316 | 21067 |
| 16-#11 | 1.89 | MA | 23585 | 5553 | 37869 | 4125 | 41428 | 3338 | 42737 | 2755 | 43631 | 1867 | 52828 | 1514 | 32743 |
| 5E | | MI | 15804 | 5553 | 25803 | 4007 | 27792 | 3251 | 28403 | 2664 | 28466 | 1772 | 33822 | 1375 | 21468 |
| 16-#11 | 1.89 | MA | 23061 | 5553 | 36985 | 4124 | 40227 | 3350 | 41272 | 2752 | 41692 | 1876 | 50360 | 1456 | 31925 |
| 6L-4S | | MI | 16163 | 5553 | 26410 | 4011 | 28575 | 3243 | 29356 | 2657 | 29780 | 1779 | 35405 | 1415 | 21688 |
| 16-#11 | 1.89 | MA | 22550 | 5553 | 36039 | 4138 | 39075 | 3348 | 39859 | 2763 | 39794 | 1884 | 47791 | 1368 | 31402 |
| 7L-3S | | MI | 16562 | 5553 | 27100 | 4000 | 29451 | 3248 | 30415 | 2664 | 31111 | 1772 | 36889 | 1503 | 21696 |
| 16-#11 | 1.89 | MA | 22045 | 5553 | 35172 | 4137 | 37911 | 3360 | 38476 | 2773 | 37806 | 1879 | 45371 | 1316 | 30415 |
| 8L-2S | | MI | 17117 | 5553 | 27950 | 4004 | 30535 | 3240 | 31729 | 2657 | 32845 | 1765 | 39171 | 1592 | 21676 |
| 16-#14 | 2.73 | MA | 25606 | 5944 | 42433 | 4362 | 47189 | 3510 | 49724 | 2848 | 53232 | 1848 | 65525 | 1410 | 46834 |
| 4L-6S | | MI | 16041 | 5944 | 27008 | 4227 | 29191 | 3408 | 30068 | 2765 | 30659 | 1725 | 36968 | 1076 | 28931 |
| 16-#14 | 2.73 | MA | 24833 | 5944 | 41089 | 4361 | 45456 | 3507 | 47601 | 2863 | 50203 | 1839 | 61833 | 1347 | 45285 |
| 5E | | MI | 16524 | 5944 | 27829 | 4233 | 30305 | 3416 | 31358 | 2755 | 32366 | 1715 | 39052 | 1162 | 29467 |
| 16-#14 | 2.73 | MA | 24096 | 5944 | 39821 | 4360 | 43733 | 3524 | 45500 | 2858 | 47421 | 1850 | 58322 | 1263 | 44291 |
| 6L-4S | | MI | 17030 | 5944 | 28697 | 4239 | 31423 | 3405 | 32708 | 2746 | 34228 | 1725 | 41285 | 1220 | 30419 |
| 16-#14 | 2.73 | MA | 23377 | 5944 | 38464 | 4379 | 42079 | 3521 | 43473 | 2873 | 44698 | 1861 | 54668 | 1136 | 42552 |
| 7L-3S | | MI | 17590 | 5944 | 29682 | 4225 | 32675 | 3414 | 34208 | 2755 | 36112 | 1715 | 43383 | 1345 | 30587 |
| 16-#14 | 2.73 | MA | 22668 | 5944 | 37220 | 4378 | 40410 | 3538 | 41488 | 2887 | 41847 | 1852 | 51219 | 1063 | 40978 |
| 8L-2S | | MI | 18369 | 5944 | 30894 | 4230 | 34221 | 3402 | 36068 | 2746 | 38569 | 1706 | 46604 | 1473 | 30622 |
| 16-#18 | 4.85 | MA | 27845 | 6937 | 49075 | 4965 | 55481 | 3975 | 59725 | 3137 | 66494 | 1760 | 83977 | 903 | 75509 |
| 5E | | MI | 18238 | 6937 | 32789 | 4812 | 36443 | 3834 | 38535 | 2978 | 41848 | 1558 | 51652 | 588 | 47848 |
| 16-#18 | 4.85 | MA | 26605 | 6937 | 46845 | 4961 | 52452 | 3967 | 56031 | 3126 | 61623 | 1777 | 77909 | 753 | 71370 |
| 6L-4S | | MI | 19091 | 6937 | 34305 | 4825 | 38386 | 3817 | 40847 | 2960 | 45039 | 1575 | 55450 | 693 | 49635 |
| 16-#18 | 4.85 | MA | 25395 | 6937 | 44458 | 4993 | 49543 | 3995 | 52466 | 3150 | 56855 | 1795 | 71591 | 528 | 67278 |
| 7L-3S | | MI | 20036 | 6937 | 36023 | 4803 | 40559 | 3834 | 43418 | 2978 | 48266 | 1558 | 59030 | 908 | 52181 |
| 18-#11 | 2.13 | MA | 24758 | 5663 | 40140 | 4194 | 44338 | 3390 | 46285 | 2775 | 48545 | 1866 | 59210 | 1544 | 37079 |
| 4L-7S | | MI | 15513 | 5663 | 25465 | 4083 | 27349 | 3305 | 27859 | 2695 | 27815 | 1775 | 33238 | 1223 | 23262 |
| 18-#11 | 2.13 | MA | 24212 | 5663 | 39203 | 4194 | 43130 | 3388 | 44805 | 2786 | 46433 | 1860 | 56621 | 1500 | 36657 |
| 5L-6S | | MI | 15847 | 5663 | 26079 | 4073 | 28098 | 3296 | 28805 | 2702 | 28995 | 1768 | 34627 | 1291 | 23572 |
| 18-#11 | 2.13 | MA | 23691 | 5663 | 38320 | 4193 | 41929 | 3400 | 43340 | 2783 | 44493 | 1869 | 54152 | 1442 | 35871 |
| 6L-5S | | MI | 16189 | 5663 | 26653 | 4076 | 28876 | 3301 | 29716 | 2695 | 30201 | 1761 | 36104 | 1350 | 23951 |
| 18-#11 | 2.13 | MA | 23183 | 5663 | 37374 | 4207 | 40776 | 3398 | 41927 | 2794 | 42595 | 1877 | 51584 | 1354 | 35363 |
| 7L-4S | | MI | 16546 | 5663 | 27260 | 4080 | 29659 | 3293 | 30670 | 2688 | 31515 | 1768 | 37687 | 1390 | 24263 |
| 18-#11 | 2.13 | MA | 22682 | 5663 | 36506 | 4206 | 39612 | 3410 | 40544 | 2805 | 40607 | 1872 | 49164 | 1302 | 34328 |
| 8L-3S | | MI | 16943 | 5663 | 27950 | 4069 | 30535 | 3298 | 31729 | 2695 | 32845 | 1761 | 39171 | 1478 | 24289 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis

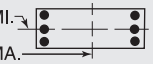



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.13 | MA | 22158 | 5663 | 35655 | 4206 | 38476 | 3409 | 39112 | 2802 | 38729 | 1880 | 46772 | 1246 | 33471 |
| 9L-2S | | MI | 17496 | 5663 | 28800 | 4073 | 31619 | 3290 | 33043 | 2688 | 34580 | 1754 | 41453 | 1567 | 24278 |
| 18-#14 | 3.07 | MA | 25713 | 6104 | 43000 | 4461 | 47891 | 3580 | 50562 | 2908 | 54214 | 1829 | 67231 | 1325 | 50905 |
| 5L-6S | | MI | 16583 | 6104 | 28220 | 4327 | 30737 | 3480 | 31928 | 2809 | 33115 | 1708 | 40190 | 1037 | 32379 |
| 18-#14 | 3.07 | MA | 24983 | 6104 | 41732 | 4460 | 46169 | 3596 | 48461 | 2903 | 51432 | 1840 | 63719 | 1241 | 49947 |
| 6L-5S | | MI | 17063 | 6104 | 29041 | 4333 | 31850 | 3489 | 33218 | 2799 | 34823 | 1698 | 42273 | 1123 | 33010 |
| 18-#14 | 3.07 | MA | 24270 | 6104 | 40375 | 4479 | 44515 | 3593 | 46433 | 2917 | 48710 | 1851 | 60065 | 1114 | 48135 |
| 7L-4S | | MI | 17565 | 6104 | 29909 | 4339 | 32968 | 3477 | 34568 | 2789 | 36685 | 1708 | 44506 | 1181 | 33906 |
| 18-#14 | 3.07 | MA | 23567 | 6104 | 39130 | 4477 | 42845 | 3610 | 44449 | 2932 | 45858 | 1842 | 56616 | 1041 | 46509 |
| 8L-3S | | MI | 18122 | 6104 | 30894 | 4324 | 34221 | 3486 | 36068 | 2799 | 38569 | 1698 | 46604 | 1306 | 34250 |
| 18-#14 | 3.07 | MA | 22847 | 6104 | 37813 | 4496 | 41214 | 3607 | 42395 | 2927 | 43164 | 1853 | 53214 | 960 | 44675 |
| 9L-2S | | MI | 18896 | 6104 | 32106 | 4330 | 35766 | 3475 | 37928 | 2789 | 41025 | 1688 | 49825 | 1434 | 34305 |
| 18-#18 | 5.45 | MA | 28108 | 7221 | 50191 | 5139 | 56719 | 4096 | 61217 | 3206 | 68629 | 1759 | 87247 | 708 | 81111 |
| 6L-5S | | MI | 19144 | 7221 | 34894 | 4990 | 39117 | 3962 | 41721 | 3051 | 46056 | 1522 | 57130 | 510 | 53762 |
| 18-#18 | 5.45 | MA | 26913 | 7221 | 47805 | 5170 | 53810 | 4124 | 57652 | 3230 | 63862 | 1776 | 80929 | 483 | 76927 |
| 7L-4S | | MI | 19989 | 7221 | 36410 | 5002 | 41060 | 3944 | 44033 | 3034 | 49247 | 1540 | 60929 | 614 | 55719 |
| 20-#11 | 2.36 | MA | 24835 | 5774 | 40538 | 4263 | 44831 | 3438 | 46873 | 2817 | 49235 | 1854 | 60414 | 1486 | 40579 |
| 5L-7S | | MI | 15900 | 5774 | 26315 | 4152 | 28433 | 3355 | 29173 | 2726 | 29550 | 1764 | 35520 | 1198 | 25711 |
| 20-#11 | 2.36 | MA | 24317 | 5774 | 39654 | 4263 | 43630 | 3450 | 45408 | 2814 | 47295 | 1862 | 57945 | 1428 | 39823 |
| 6E | | MI | 16232 | 5774 | 26930 | 4142 | 29182 | 3346 | 30119 | 2733 | 30730 | 1757 | 36909 | 1266 | 26081 |
| 20-#11 | 2.36 | MA | 23813 | 5774 | 38708 | 4276 | 42477 | 3448 | 43995 | 2825 | 45397 | 1870 | 55377 | 1340 | 39262 |
| 7L-5S | | MI | 16572 | 5774 | 27504 | 4145 | 29960 | 3352 | 31030 | 2726 | 31936 | 1750 | 38387 | 1325 | 26440 |
| 20-#11 | 2.36 | MA | 23315 | 5774 | 37841 | 4275 | 41314 | 3460 | 42612 | 2836 | 43409 | 1865 | 52957 | 1288 | 38247 |
| 8L-4S | | MI | 16927 | 5774 | 28111 | 4149 | 30743 | 3343 | 31983 | 2719 | 33250 | 1757 | 39969 | 1365 | 26833 |
| 20-#11 | 2.36 | MA | 22802 | 5774 | 36989 | 4275 | 40177 | 3459 | 41180 | 2833 | 41531 | 1873 | 50565 | 1232 | 37353 |
| 9L-3S | | MI | 17322 | 5774 | 28800 | 4138 | 31619 | 3348 | 33043 | 2726 | 34580 | 1750 | 41453 | 1453 | 26870 |
| 20-#11 | 2.36 | MA | 22245 | 5774 | 36059 | 4288 | 39028 | 3471 | 39806 | 2843 | 39667 | 1881 | 48245 | 1169 | 36240 |
| 10L-2S | | MI | 17872 | 5774 | 29651 | 4142 | 32703 | 3340 | 34356 | 2719 | 36315 | 1743 | 43736 | 1542 | 26874 |
| 20-#14 | 3.41 | MA | 25862 | 6263 | 43642 | 4560 | 48604 | 3669 | 51421 | 2947 | 55444 | 1830 | 69117 | 1219 | 55552 |
| 6E | | MI | 17121 | 6263 | 29432 | 4427 | 32282 | 3552 | 33788 | 2852 | 35572 | 1691 | 43411 | 998 | 35840 |
| 20-#14 | 3.41 | MA | 25155 | 6263 | 42285 | 4578 | 46950 | 3666 | 49394 | 2962 | 52721 | 1841 | 65463 | 1092 | 53728 |
| 7L-5S | | MI | 17598 | 6263 | 30253 | 4433 | 33396 | 3561 | 35078 | 2842 | 37280 | 1681 | 45494 | 1084 | 36561 |
| 20-#14 | 3.41 | MA | 24458 | 6263 | 41040 | 4577 | 45281 | 3682 | 47410 | 2977 | 49869 | 1832 | 62013 | 1019 | 52049 |
| 8L-4S | | MI | 18097 | 6263 | 31121 | 4438 | 34514 | 3550 | 36428 | 2832 | 39141 | 1691 | 47728 | 1142 | 37406 |
| 20-#14 | 3.41 | MA | 23740 | 6263 | 39723 | 4596 | 43650 | 3679 | 45356 | 2972 | 47175 | 1843 | 58611 | 938 | 50258 |
| 9L-3S | | MI | 18650 | 6263 | 32106 | 4424 | 35766 | 3558 | 37928 | 2842 | 41025 | 1681 | 49825 | 1267 | 37906 |
| 20-#18 | 6.06 | MA | 28415 | 7505 | 51151 | 5348 | 58076 | 4252 | 62839 | 3310 | 70869 | 1758 | 90266 | 437 | 86595 |
| 7L-5S | | MI | 20043 | 7505 | 36999 | 5167 | 41792 | 4090 | 44906 | 3125 | 50265 | 1487 | 62609 | 431 | 59704 |
| 22-#11 | 2.60 | MA | 24939 | 5885 | 40988 | 4332 | 45331 | 3500 | 47476 | 2845 | 50097 | 1855 | 61738 | 1414 | 43778 |
| 6L-7S | | MI | 16284 | 5885 | 27166 | 4221 | 29517 | 3405 | 30486 | 2757 | 31284 | 1753 | 37803 | 1173 | 28167 |
| 22-#11 | 2.60 | MA | 24438 | 5885 | 40042 | 4345 | 44178 | 3499 | 46063 | 2856 | 48199 | 1863 | 59169 | 1326 | 43159 |
| 7L-6S | | MI | 16614 | 5885 | 27780 | 4211 | 30266 | 3396 | 31432 | 2764 | 32464 | 1746 | 39191 | 1241 | 28593 |
| 22-#11 | 2.60 | MA | 23943 | 5885 | 39175 | 4344 | 43015 | 3511 | 44680 | 2867 | 46211 | 1858 | 56749 | 1274 | 42172 |
| 8L-5S | | MI | 16952 | 5885 | 28354 | 4214 | 31044 | 3402 | 32343 | 2757 | 33670 | 1739 | 40669 | 1300 | 28934 |
| 22-#11 | 2.60 | MA | 23431 | 5885 | 38323 | 4344 | 41878 | 3509 | 43248 | 2864 | 44333 | 1866 | 54358 | 1218 | 41241 |
| 9L-4S | | MI | 17306 | 5885 | 28961 | 4218 | 31827 | 3393 | 33297 | 2750 | 34984 | 1746 | 42251 | 1340 | 29399 |
| 22-#11 | 2.60 | MA | 22880 | 5885 | 37394 | 4357 | 40729 | 3521 | 41874 | 2875 | 42468 | 1874 | 52038 | 1155 | 40152 |
| 10L-3S | | MI | 17699 | 5885 | 29651 | 4208 | 32703 | 3399 | 34356 | 2757 | 36315 | 1739 | 43736 | 1428 | 29448 |
| 22-#11 | 2.60 | MA | 22346 | 5885 | 36542 | 4357 | 39599 | 3519 | 40459 | 2872 | 40508 | 1869 | 49675 | 1100 | 38864 |
| 11L-2S | | MI | 18247 | 5885 | 30501 | 4211 | 33787 | 3390 | 35670 | 2750 | 38050 | 1732 | 46018 | 1517 | 29467 |
| 22-#14 | 3.75 | MA | 26033 | 6423 | 44196 | 4678 | 49386 | 3738 | 52355 | 3007 | 56732 | 1831 | 70860 | 1070 | 59328 |
| 7L-6S | | MI | 17656 | 6423 | 30644 | 4527 | 33828 | 3625 | 35648 | 2895 | 38029 | 1674 | 46632 | 960 | 39312 |
| 22-#14 | 3.75 | MA | 25342 | 6423 | 42951 | 4677 | 47717 | 3755 | 50370 | 3022 | 53881 | 1822 | 67410 | 997 | 57597 |
| 8L-5S | | MI | 18130 | 6423 | 31465 | 4532 | 34941 | 3633 | 36938 | 2886 | 39736 | 1664 | 48715 | 1046 | 40119 |
| 22-#14 | 3.75 | MA | 24625 | 6423 | 41634 | 4695 | 46086 | 3752 | 48317 | 3017 | 51186 | 1833 | 64008 | 916 | 55753 |
| 9L-4S | | MI | 18626 | 6423 | 32333 | 4538 | 36059 | 3622 | 38288 | 2876 | 41598 | 1674 | 50949 | 1104 | 40918 |
| 24-#11 | 2.84 | MA | 25059 | 5995 | 41377 | 4414 | 45879 | 3549 | 48131 | 2887 | 51001 | 1856 | 62962 | 1312 | 47062 |
| 7E | | MI | 16666 | 5995 | 28016 | 4291 | 30601 | 3455 | 31800 | 2787 | 33019 | 1742 | 40085 | 1148 | 30629 |

## RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.84 | MA | 24568 | 5995 | 40509 | 4414 | 44716 | 3561 | 46748 | 2898 | 49012 | 1851 | 60542 | 1260 | 46101 |
| 8L-6S | | MI | 16994 | 5995 | 28630 | 4280 | 31350 | 3447 | 32746 | 2794 | 34199 | 1735 | 41474 | 1216 | 31108 |
| 24-#11 | 2.84 | MA | 24057 | 5995 | 39658 | 4413 | 43579 | 3559 | 45316 | 2895 | 47134 | 1859 | 58150 | 1204 | 45134 |
| 9L-5S | | MI | 17331 | 5995 | 29204 | 4284 | 32128 | 3452 | 33657 | 2787 | 35405 | 1728 | 42951 | 1275 | 31433 |
| 24-#11 | 2.84 | MA | 23510 | 5995 | 38728 | 4426 | 42431 | 3571 | 43942 | 2906 | 45270 | 1868 | 55831 | 1141 | 44068 |
| 10L-4S | | MI | 17683 | 5995 | 29811 | 4287 | 32911 | 3443 | 34610 | 2781 | 36719 | 1735 | 44534 | 1315 | 31962 |
| 24-#11 | 2.84 | MA | 22979 | 5995 | 37877 | 4426 | 41301 | 3569 | 42527 | 2903 | 43310 | 1862 | 53468 | 1086 | 42757 |
| 11L-3S | | MI | 18074 | 5995 | 30501 | 4277 | 33787 | 3449 | 35670 | 2787 | 38050 | 1728 | 46018 | 1403 | 32022 |
| 24-#14 | 4.09 | MA | 26219 | 6583 | 44861 | 4777 | 50152 | 3827 | 53331 | 3067 | 57892 | 1812 | 72807 | 975 | 63154 |
| 8L-6S | | MI | 18188 | 6583 | 31856 | 4626 | 35373 | 3697 | 37508 | 2939 | 40486 | 1657 | 49853 | 921 | 42794 |
| 24-#14 | 4.09 | MA | 25504 | 6583 | 43544 | 4795 | 48521 | 3824 | 51278 | 3062 | 55197 | 1824 | 69406 | 894 | 61277 |
| 9L-5S | | MI | 18659 | 6583 | 32678 | 4632 | 36486 | 3706 | 38798 | 2929 | 42193 | 1647 | 51936 | 1007 | 43681 |

## RECTANGULAR TIED COLUMNS 30" x 46"

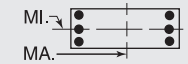
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.16 | MA | 25815 | 5447 | 40550 | 4050 | 44057 | 3297 | 45170 | 2742 | 45590 | 1949 | 53886 | 1834 | 22312 |
| 2E | | MI | 16547 | 5447 | 26465 | 3906 | 28181 | 3177 | 28451 | 2628 | 28079 | 1836 | 32577 | 1687 | 14013 |
| 6-#18 | 1.74 | MA | 27451 | 5731 | 44073 | 4227 | 48549 | 3426 | 50631 | 2822 | 52988 | 1931 | 63778 | 1792 | 33085 |
| 2L-3S | | MI | 16105 | 5731 | 26465 | 4070 | 28181 | 3323 | 28451 | 2719 | 28079 | 1818 | 32577 | 1381 | 20609 |
| 6-#18 | 1.74 | MA | 25134 | 5731 | 40550 | 4224 | 44057 | 3454 | 45170 | 2847 | 45590 | 1950 | 53886 | 1564 | 32956 |
| 3L-2S | | MI | 17480 | 5731 | 28570 | 4083 | 30856 | 3305 | 31636 | 2702 | 32287 | 1801 | 38056 | 1608 | 20532 |
| 8-#14 | 1.30 | MA | 26315 | 5518 | 41423 | 4118 | 45324 | 3349 | 46769 | 2779 | 47780 | 1958 | 57098 | 1849 | 25213 |
| 2L-4S | | MI | 15485 | 5518 | 24811 | 3996 | 26234 | 3244 | 26231 | 2681 | 25261 | 1878 | 29348 | 1456 | 15907 |
| 8-#14 | 1.30 | MA | 24977 | 5518 | 39413 | 4118 | 42761 | 3347 | 43653 | 2794 | 43559 | 1970 | 51389 | 1721 | 25221 |
| 3E | | MI | 16063 | 5518 | 25796 | 3982 | 27487 | 3253 | 27731 | 2691 | 27145 | 1868 | 31446 | 1580 | 15868 |
| 8-#14 | 1.30 | MA | 24036 | 5518 | 37801 | 4137 | 40711 | 3364 | 41166 | 2790 | 40329 | 1981 | 47645 | 1593 | 25094 |
| 4L-2S | | MI | 16862 | 5518 | 27009 | 3988 | 29032 | 3242 | 29591 | 2681 | 29601 | 1858 | 34667 | 1708 | 15803 |
| 8-#18 | 2.32 | MA | 29061 | 6015 | 47597 | 4404 | 53042 | 3554 | 56092 | 2901 | 60387 | 1914 | 73669 | 1750 | 43806 |
| 2L-4S | | MI | 16053 | 6015 | 26853 | 4270 | 28682 | 3433 | 29065 | 2775 | 29061 | 1800 | 34476 | 1087 | 25843 |
| 8-#18 | 2.32 | MA | 26773 | 6015 | 44073 | 4401 | 48549 | 3583 | 50631 | 2927 | 52988 | 1932 | 63778 | 1522 | 43564 |
| 3E | | MI | 17039 | 6015 | 28570 | 4248 | 30856 | 3450 | 31636 | 2793 | 32287 | 1783 | 38056 | 1302 | 26988 |
| 8-#18 | 2.32 | MA | 25160 | 6015 | 41242 | 4434 | 44948 | 3576 | 46261 | 2917 | 47314 | 1950 | 57305 | 1295 | 41613 |
| 4L-2S | | MI | 18401 | 6015 | 30675 | 4261 | 33530 | 3433 | 34822 | 2775 | 36496 | 1765 | 43534 | 1530 | 26996 |
| 10-#11 | 1.13 | MA | 25849 | 5433 | 40337 | 4077 | 44018 | 3321 | 45212 | 2763 | 45683 | 1970 | 54387 | 1872 | 22019 |
| 2L-5S | | MI | 15272 | 5433 | 24214 | 3956 | 25534 | 3230 | 25427 | 2682 | 24124 | 1889 | 27926 | 1532 | 13977 |
| 10-#11 | 1.13 | MA | 24910 | 5433 | 38934 | 4077 | 42229 | 3319 | 43036 | 2774 | 42736 | 1978 | 50377 | 1784 | 22041 |
| 3L-4S | | MI | 15638 | 5433 | 24821 | 3960 | 26316 | 3221 | 26380 | 2675 | 25438 | 1896 | 29509 | 1572 | 13954 |
| 10-#11 | 1.13 | MA | 24250 | 5433 | 37810 | 4091 | 40799 | 3332 | 41302 | 2772 | 40484 | 1987 | 47745 | 1695 | 22015 |
| 4L-3S | | MI | 16043 | 5433 | 25510 | 3950 | 27193 | 3227 | 27439 | 2682 | 26768 | 1889 | 30993 | 1659 | 13910 |
| 10-#11 | 1.13 | MA | 23660 | 5433 | 36826 | 4090 | 39530 | 3330 | 39747 | 2783 | 38265 | 1982 | 45012 | 1650 | 21899 |
| 5L-2S | | MI | 16607 | 5433 | 26361 | 3953 | 28277 | 3218 | 28753 | 2675 | 28503 | 1882 | 33275 | 1748 | 13864 |
| 10-#14 | 1.63 | MA | 27255 | 5678 | 43433 | 4218 | 47886 | 3422 | 49884 | 2824 | 52001 | 1948 | 62808 | 1829 | 31349 |
| 2L-5S | | MI | 15520 | 5678 | 25155 | 4090 | 26662 | 3328 | 26740 | 2734 | 25856 | 1851 | 30336 | 1359 | 19055 |
| 10-#14 | 1.63 | MA | 25928 | 5678 | 41423 | 4217 | 45324 | 3419 | 46769 | 2839 | 47780 | 1960 | 57098 | 1701 | 31316 |
| 3L-4S | | MI | 16038 | 5678 | 26023 | 4096 | 27780 | 3317 | 28091 | 2724 | 27717 | 1861 | 32569 | 1417 | 19586 |
| 10-#14 | 1.63 | MA | 24995 | 5678 | 39811 | 4236 | 43274 | 3436 | 44281 | 2835 | 44550 | 1971 | 53354 | 1573 | 31142 |
| 4L-3S | | MI | 16611 | 5678 | 27009 | 4082 | 29032 | 3325 | 29591 | 2734 | 29601 | 1851 | 34667 | 1542 | 19586 |
| 10-#14 | 1.63 | MA | 24159 | 5678 | 38399 | 4236 | 41453 | 3434 | 42051 | 2850 | 41368 | 1963 | 49456 | 1509 | 30094 |
| 5L-2S | | MI | 17406 | 5678 | 28221 | 4087 | 30578 | 3314 | 31451 | 2724 | 32058 | 1841 | 37888 | 1670 | 19540 |
| 10-#18 | 2.90 | MA | 30649 | 6298 | 51121 | 4582 | 57534 | 3683 | 61553 | 2981 | 67785 | 1896 | 83561 | 1707 | 54494 |
| 2L-5S | | MI | 16105 | 6298 | 27442 | 4435 | 29414 | 3578 | 29938 | 2866 | 30078 | 1747 | 36156 | 904 | 30391 |
| 10-#18 | 2.90 | MA | 28388 | 6298 | 47597 | 4579 | 53042 | 3712 | 56092 | 3006 | 60387 | 1914 | 73669 | 1480 | 54157 |
| 3L-4S | | MI | 16987 | 6298 | 28958 | 4448 | 31357 | 3560 | 32251 | 2848 | 33269 | 1765 | 39955 | 1008 | 31791 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis

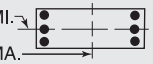



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 2.90 | MA | 26796 | 6298 | 44765 | 4611 | 49441 | 3705 | 51722 | 2996 | 54713 | 1932 | 67197 | 1252 | 51759 |
| 4L-3S | | MI | 17963 | 6298 | 30675 | 4425 | 33530 | 3578 | 34822 | 2866 | 36496 | 1747 | 43534 | 1224 | 33337 |
| 10-#18 | 2.90 | MA | 25370 | 6298 | 42282 | 4608 | 46238 | 3734 | 47800 | 3022 | 49118 | 1915 | 60418 | 1142 | 48724 |
| 5L-2S | | MI | 19311 | 6298 | 32780 | 4438 | 36204 | 3560 | 38007 | 2848 | 40704 | 1730 | 49013 | 1451 | 33430 |
| 12-#11 | 1.36 | MA | 26513 | 5544 | 41741 | 4147 | 45807 | 3371 | 47387 | 2794 | 48630 | 1963 | 58396 | 1859 | 26307 |
| 2L-6S | | MI | 15316 | 5544 | 24490 | 4022 | 25839 | 3275 | 25829 | 2719 | 24653 | 1885 | 28731 | 1447 | 16180 |
| 12-#11 | 1.36 | MA | 25579 | 5544 | 40337 | 4146 | 44018 | 3369 | 45212 | 2806 | 45683 | 1971 | 54387 | 1771 | 26311 |
| 3L-5S | | MI | 15664 | 5544 | 25064 | 4026 | 26618 | 3280 | 26740 | 2712 | 25859 | 1878 | 30208 | 1507 | 16558 |
| 12-#11 | 1.36 | MA | 24924 | 5544 | 39214 | 4160 | 42589 | 3382 | 43477 | 2803 | 43431 | 1980 | 51755 | 1682 | 26261 |
| 4E | | MI | 16028 | 5544 | 25671 | 4029 | 27400 | 3272 | 27694 | 2705 | 27173 | 1885 | 31791 | 1547 | 16559 |
| 12-#11 | 1.36 | MA | 24337 | 5544 | 38230 | 4160 | 41319 | 3380 | 41922 | 2814 | 41212 | 1975 | 49022 | 1637 | 26121 |
| 5L-3S | | MI | 16432 | 5544 | 26361 | 4019 | 28277 | 3277 | 28753 | 2712 | 28503 | 1878 | 33275 | 1634 | 16529 |
| 12-#11 | 1.36 | MA | 23779 | 5544 | 37302 | 4159 | 40058 | 3393 | 40384 | 2812 | 39175 | 1984 | 46411 | 1579 | 25343 |
| 6L-2S | | MI | 16993 | 5544 | 27211 | 4022 | 29361 | 3269 | 30066 | 2705 | 30238 | 1871 | 35557 | 1723 | 16489 |
| 12-#14 | 1.96 | MA | 28187 | 5837 | 45443 | 4318 | 50449 | 3494 | 52999 | 2868 | 56221 | 1938 | 68517 | 1808 | 37468 |
| 2L-6S | | MI | 15581 | 5837 | 25547 | 4184 | 27094 | 3392 | 27311 | 2788 | 26605 | 1844 | 31473 | 1234 | 22027 |
| 12-#14 | 1.96 | MA | 26869 | 5837 | 43433 | 4317 | 47886 | 3491 | 49884 | 2884 | 52001 | 1950 | 62808 | 1680 | 37400 |
| 3L-5S | | MI | 16072 | 5837 | 26368 | 4190 | 28207 | 3400 | 28601 | 2778 | 28312 | 1834 | 33557 | 1320 | 22560 |
| 12-#14 | 1.96 | MA | 25944 | 5837 | 41821 | 4336 | 45837 | 3509 | 47397 | 2880 | 48771 | 1962 | 59064 | 1553 | 37186 |
| 4E | | MI | 16586 | 5837 | 27236 | 4195 | 29325 | 3389 | 29951 | 2768 | 30174 | 1844 | 35790 | 1378 | 23250 |
| 12-#14 | 1.96 | MA | 25116 | 5837 | 40410 | 4335 | 44016 | 3506 | 45166 | 2895 | 45589 | 1953 | 55165 | 1489 | 35968 |
| 5L-3S | | MI | 17155 | 5837 | 28221 | 4181 | 30578 | 3397 | 31451 | 2778 | 32058 | 1834 | 37888 | 1503 | 23290 |
| 12-#14 | 1.96 | MA | 24327 | 5837 | 39078 | 4335 | 42206 | 3523 | 42959 | 2891 | 42666 | 1965 | 51449 | 1405 | 34790 |
| 6L-2S | | MI | 17945 | 5837 | 29433 | 4187 | 32123 | 3386 | 33311 | 2768 | 34515 | 1824 | 41109 | 1631 | 23261 |
| 12-#18 | 3.48 | MA | 29980 | 6582 | 51121 | 4756 | 57534 | 3840 | 61553 | 3086 | 67785 | 1896 | 83561 | 1438 | 64742 |
| 3L-5S | | MI | 17038 | 6582 | 29547 | 4612 | 32088 | 3706 | 33124 | 2939 | 34287 | 1712 | 41635 | 825 | 36496 |
| 12-#18 | 3.48 | MA | 28409 | 6582 | 48289 | 4788 | 53933 | 3834 | 57183 | 3076 | 62111 | 1915 | 77088 | 1210 | 61951 |
| 4E | | MI | 17911 | 6582 | 31063 | 4625 | 34031 | 3688 | 35436 | 2922 | 37478 | 1729 | 45433 | 930 | 37785 |
| 12-#18 | 3.48 | MA | 27003 | 6582 | 45806 | 4785 | 50731 | 3862 | 53261 | 3101 | 56517 | 1897 | 70309 | 1100 | 59072 |
| 5L-3S | | MI | 18877 | 6582 | 32780 | 4602 | 36204 | 3706 | 38007 | 2939 | 40704 | 1712 | 49013 | 1145 | 39665 |
| 12-#18 | 3.48 | MA | 25662 | 6582 | 43462 | 4782 | 47547 | 3856 | 49378 | 3091 | 51375 | 1916 | 63878 | 949 | 55060 |
| 6L-2S | | MI | 20213 | 6582 | 34885 | 4615 | 38878 | 3688 | 41193 | 2922 | 44912 | 1694 | 54491 | 1373 | 39823 |
| 14-#11 | 1.58 | MA | 27172 | 5654 | 43144 | 4216 | 47597 | 3421 | 49562 | 2826 | 51577 | 1956 | 62405 | 1846 | 30589 |
| 2L-7S | | MI | 15370 | 5654 | 24726 | 4102 | 26175 | 3333 | 26196 | 2743 | 25208 | 1881 | 29624 | 1354 | 18424 |
| 14-#11 | 1.58 | MA | 26243 | 5654 | 41741 | 4215 | 45807 | 3420 | 47387 | 2837 | 48630 | 1965 | 58396 | 1757 | 30573 |
| 3L-6S | | MI | 15708 | 5654 | 25340 | 4091 | 26924 | 3325 | 27143 | 2750 | 26388 | 1874 | 31013 | 1422 | 18674 |
| 14-#11 | 1.58 | MA | 25592 | 5654 | 40617 | 4229 | 44378 | 3432 | 45652 | 2834 | 46378 | 1973 | 55764 | 1669 | 30503 |
| 4L-5S | | MI | 16054 | 5654 | 25914 | 4095 | 27702 | 3330 | 28054 | 2743 | 27593 | 1867 | 32491 | 1482 | 19114 |
| 14-#11 | 1.58 | MA | 25010 | 5654 | 39633 | 4229 | 43109 | 3430 | 44097 | 2845 | 44159 | 1968 | 53031 | 1624 | 30340 |
| 5L-4S | | MI | 16416 | 5654 | 26521 | 4098 | 28484 | 3322 | 29007 | 2736 | 28908 | 1874 | 34073 | 1522 | 19155 |
| 14-#11 | 1.58 | MA | 24455 | 5654 | 38705 | 4229 | 41848 | 3443 | 42559 | 2843 | 42122 | 1977 | 50420 | 1566 | 29482 |
| 6L-3S | | MI | 16818 | 5654 | 27211 | 4088 | 29361 | 3327 | 30066 | 2743 | 30238 | 1867 | 35557 | 1609 | 19137 |
| 14-#11 | 1.58 | MA | 23913 | 5654 | 37712 | 4242 | 40637 | 3441 | 41075 | 2854 | 40129 | 1986 | 47704 | 1478 | 28896 |
| 7L-2S | | MI | 17376 | 5654 | 28061 | 4091 | 30445 | 3319 | 31380 | 2736 | 31973 | 1860 | 37840 | 1698 | 19106 |
| 14-#14 | 2.28 | MA | 27802 | 5997 | 45443 | 4417 | 50449 | 3564 | 52999 | 2929 | 56221 | 1940 | 68517 | 1660 | 43476 |
| 3L-6S | | MI | 16131 | 5997 | 26759 | 4284 | 28639 | 3464 | 29171 | 2831 | 29062 | 1826 | 34695 | 1196 | 25582 |
| 14-#14 | 2.28 | MA | 26884 | 5997 | 43831 | 4436 | 48400 | 3581 | 50512 | 2924 | 52992 | 1952 | 64773 | 1532 | 43226 |
| 4L-5S | | MI | 16619 | 5997 | 27580 | 4289 | 29753 | 3472 | 30461 | 2821 | 30769 | 1817 | 36778 | 1282 | 26082 |
| 14-#14 | 2.28 | MA | 26064 | 5997 | 42420 | 4435 | 46579 | 3578 | 48282 | 2940 | 49809 | 1944 | 60874 | 1468 | 41858 |
| 5L-4S | | MI | 17129 | 5997 | 28448 | 4295 | 30871 | 3461 | 31811 | 2811 | 32631 | 1826 | 39011 | 1339 | 26905 |
| 14-#14 | 2.28 | MA | 25282 | 5997 | 41088 | 4434 | 44769 | 3596 | 46074 | 2936 | 46887 | 1955 | 57158 | 1384 | 40729 |
| 6L-3S | | MI | 17695 | 5997 | 29433 | 4281 | 32123 | 3470 | 33311 | 2821 | 34515 | 1817 | 41109 | 1464 | 26973 |
| 14-#14 | 2.28 | MA | 24519 | 5997 | 39663 | 4453 | 43032 | 3593 | 43945 | 2951 | 44027 | 1967 | 53292 | 1258 | 39099 |
| 7L-2S | | MI | 18480 | 5997 | 30645 | 4287 | 33669 | 3459 | 35171 | 2811 | 36972 | 1807 | 44330 | 1592 | 26970 |
| 14-#18 | 4.06 | MA | 30002 | 6866 | 51812 | 4966 | 58425 | 3962 | 62644 | 3156 | 69510 | 1897 | 86980 | 1168 | 72180 |
| 4L-5S | | MI | 17961 | 6866 | 31652 | 4789 | 34762 | 3834 | 36310 | 3013 | 38495 | 1676 | 47113 | 747 | 42358 |
| 14-#18 | 4.06 | MA | 28614 | 6866 | 49329 | 4963 | 55223 | 3991 | 58722 | 3181 | 63915 | 1880 | 80201 | 1057 | 69442 |
| 5L-4S | | MI | 18826 | 6866 | 33168 | 4802 | 36705 | 3816 | 38622 | 2995 | 41686 | 1694 | 50912 | 851 | 43815 |

## RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis



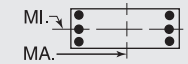

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 4.06 | MA | 27291 | 6866 | 46985 | 4960 | 52039 | 3984 | 54839 | 3171 | 58774 | 1898 | 73770 | 907 | 65284 |
| 6L-3S | | MI | 19783 | 6866 | 34885 | 4780 | 38878 | 3834 | 41193 | 3013 | 44912 | 1676 | 54491 | 1067 | 45979 |
| 14-#18 | 4.06 | MA | 26000 | 6866 | 44477 | 4992 | 48982 | 4013 | 51093 | 3196 | 53743 | 1916 | 67075 | 682 | 61247 |
| 7L-2S | | MI | 21107 | 6866 | 36990 | 4793 | 41552 | 3816 | 44378 | 2995 | 49120 | 1659 | 59970 | 1294 | 46197 |
| 16-#11 | 1.81 | MA | 26903 | 5765 | 43144 | 4285 | 47597 | 3470 | 49562 | 2868 | 51577 | 1958 | 62405 | 1744 | 34829 |
| 3L-7S | | MI | 15761 | 5765 | 25576 | 4171 | 27259 | 3383 | 27510 | 2774 | 26942 | 1870 | 31907 | 1329 | 20936 |
| 16-#11 | 1.81 | MA | 26255 | 5765 | 42021 | 4298 | 46167 | 3482 | 47827 | 2865 | 49325 | 1966 | 59773 | 1656 | 34740 |
| 4L-6S | | MI | 16097 | 5765 | 26190 | 4160 | 28008 | 3375 | 28456 | 2781 | 28122 | 1863 | 33295 | 1397 | 21175 |
| 16-#11 | 1.81 | MA | 25677 | 5765 | 41037 | 4298 | 44898 | 3481 | 46273 | 2876 | 47106 | 1961 | 57040 | 1611 | 34530 |
| 5E | | MI | 16442 | 5765 | 26764 | 4164 | 28786 | 3380 | 29367 | 2774 | 29328 | 1856 | 34773 | 1457 | 21587 |
| 16-#11 | 1.81 | MA | 25126 | 5765 | 40109 | 4298 | 43637 | 3493 | 44734 | 2874 | 45069 | 1970 | 54429 | 1553 | 33628 |
| 6L-4S | | MI | 16802 | 5765 | 27371 | 4167 | 29568 | 3372 | 30321 | 2767 | 30642 | 1863 | 36355 | 1497 | 21739 |
| 16-#11 | 1.81 | MA | 24588 | 5765 | 39116 | 4311 | 42426 | 3492 | 43250 | 2885 | 43076 | 1979 | 51714 | 1465 | 33061 |
| 7L-3S | | MI | 17201 | 5765 | 28061 | 4157 | 30445 | 3377 | 31380 | 2774 | 31973 | 1856 | 37840 | 1584 | 21738 |
| 16-#11 | 1.81 | MA | 24057 | 5765 | 38205 | 4311 | 41205 | 3504 | 41797 | 2896 | 40988 | 1974 | 49159 | 1413 | 32105 |
| 8L-2S | | MI | 17757 | 5765 | 28911 | 4160 | 31529 | 3369 | 32694 | 2767 | 33707 | 1849 | 40122 | 1673 | 21714 |
| 16-#14 | 2.61 | MA | 27816 | 6156 | 45842 | 4536 | 50962 | 3653 | 53628 | 2969 | 57212 | 1942 | 70482 | 1512 | 49264 |
| 4L-6S | | MI | 16678 | 6156 | 27971 | 4383 | 30185 | 3536 | 31031 | 2874 | 31518 | 1809 | 37916 | 1157 | 29143 |
| 16-#14 | 2.61 | MA | 27003 | 6156 | 44430 | 4535 | 49142 | 3651 | 51397 | 2985 | 54030 | 1934 | 66584 | 1448 | 47762 |
| 5E | | MI | 17162 | 6156 | 28792 | 4389 | 31298 | 3545 | 32321 | 2864 | 33226 | 1799 | 39999 | 1243 | 29615 |
| 16-#14 | 2.61 | MA | 26228 | 6156 | 43098 | 4534 | 47332 | 3668 | 49190 | 2980 | 51107 | 1945 | 62868 | 1364 | 46677 |
| 6L-4S | | MI | 17669 | 6156 | 29660 | 4395 | 32416 | 3534 | 33671 | 2855 | 35088 | 1809 | 42233 | 1301 | 30552 |
| 16-#14 | 2.61 | MA | 25471 | 6156 | 41673 | 4553 | 45595 | 3665 | 47061 | 2996 | 48247 | 1957 | 59002 | 1237 | 44969 |
| 7L-3S | | MI | 18231 | 6156 | 30645 | 4381 | 33669 | 3542 | 35171 | 2864 | 36972 | 1799 | 44330 | 1426 | 30646 |
| 16-#14 | 2.61 | MA | 24725 | 6156 | 40366 | 4552 | 43842 | 3683 | 44976 | 3011 | 45252 | 1949 | 55358 | 1163 | 43438 |
| 8L-2S | | MI | 19012 | 6156 | 31857 | 4386 | 35214 | 3531 | 37031 | 2855 | 39428 | 1789 | 47551 | 1554 | 30673 |
| 16-#18 | 4.64 | MA | 30206 | 7149 | 52853 | 5140 | 59715 | 4120 | 64184 | 3261 | 71314 | 1862 | 90092 | 1015 | 79830 |
| 5E | | MI | 18877 | 7149 | 33757 | 4967 | 37436 | 3961 | 39495 | 3086 | 42703 | 1641 | 52592 | 668 | 48236 |
| 16-#18 | 4.64 | MA | 28900 | 7149 | 50509 | 5137 | 56532 | 4113 | 60301 | 3251 | 66173 | 1880 | 83661 | 865 | 75532 |
| 6L-4S | | MI | 19733 | 7149 | 35273 | 4980 | 39379 | 3944 | 41807 | 3068 | 45894 | 1658 | 56390 | 773 | 49873 |
| 16-#18 | 4.64 | MA | 27625 | 7149 | 48001 | 5169 | 53474 | 4142 | 56554 | 3276 | 61141 | 1898 | 76966 | 640 | 71405 |
| 7L-3S | | MI | 20681 | 7149 | 36990 | 4957 | 41552 | 3961 | 44378 | 3086 | 49120 | 1641 | 59970 | 988 | 52283 |
| 16-#18 | 4.64 | MA | 26367 | 7149 | 45699 | 5166 | 50389 | 4135 | 52886 | 3302 | 55871 | 1881 | 70633 | 511 | 66808 |
| 8L-2S | | MI | 21995 | 7149 | 39095 | 4970 | 44226 | 3944 | 47564 | 3068 | 53329 | 1623 | 65448 | 1216 | 52556 |
| 18-#11 | 2.03 | MA | 26914 | 5876 | 43424 | 4367 | 47957 | 3532 | 50002 | 2896 | 52272 | 1960 | 63782 | 1643 | 38975 |
| 4L-7S | | MI | 16150 | 5876 | 26427 | 4240 | 28343 | 3434 | 28824 | 2805 | 28677 | 1859 | 34189 | 1304 | 23441 |
| 18-#11 | 2.03 | MA | 26340 | 5876 | 42440 | 4367 | 46687 | 3531 | 48448 | 2908 | 50053 | 1955 | 61049 | 1598 | 38647 |
| 5L-6S | | MI | 16484 | 5876 | 27041 | 4230 | 29092 | 3425 | 29770 | 2812 | 29857 | 1852 | 35578 | 1372 | 23681 |
| 18-#11 | 2.03 | MA | 25792 | 5876 | 41512 | 4367 | 45426 | 3543 | 46909 | 2905 | 48016 | 1963 | 58439 | 1540 | 37781 |
| 6L-5S | | MI | 16827 | 5876 | 27615 | 4233 | 29870 | 3430 | 30681 | 2805 | 31063 | 1845 | 37055 | 1432 | 24069 |
| 18-#11 | 2.03 | MA | 25258 | 5876 | 40519 | 4380 | 44216 | 3542 | 45425 | 2916 | 46023 | 1972 | 55723 | 1452 | 37230 |
| 7L-4S | | MI | 17185 | 5876 | 28222 | 4236 | 30652 | 3422 | 31634 | 2798 | 32377 | 1852 | 38638 | 1472 | 24316 |
| 18-#11 | 2.03 | MA | 24731 | 5876 | 39608 | 4380 | 42994 | 3554 | 43973 | 2927 | 43935 | 1967 | 53168 | 1400 | 36225 |
| 8L-3S | | MI | 17583 | 5876 | 28911 | 4226 | 31529 | 3427 | 32694 | 2805 | 33707 | 1845 | 40122 | 1559 | 24333 |
| 18-#11 | 2.03 | MA | 24170 | 5876 | 38714 | 4380 | 41801 | 3553 | 42470 | 2925 | 41962 | 1976 | 50639 | 1344 | 35401 |
| 9L-2S | | MI | 18136 | 5876 | 29762 | 4230 | 32613 | 3419 | 34007 | 2798 | 35442 | 1838 | 42404 | 1648 | 24318 |
| 18-#14 | 2.93 | MA | 27934 | 6316 | 46440 | 4635 | 51704 | 3723 | 54513 | 3030 | 58251 | 1924 | 72293 | 1427 | 53678 |
| 5L-6S | | MI | 17221 | 6316 | 29183 | 4483 | 31730 | 3609 | 32891 | 2918 | 33975 | 1792 | 41137 | 1118 | 32625 |
| 18-#14 | 2.93 | MA | 27165 | 6316 | 45108 | 4634 | 49895 | 3740 | 52305 | 3025 | 55328 | 1936 | 68577 | 1343 | 52632 |
| 6L-5S | | MI | 17702 | 6316 | 30004 | 4489 | 32844 | 3617 | 34181 | 2908 | 35683 | 1782 | 43220 | 1204 | 33158 |
| 18-#14 | 2.93 | MA | 26415 | 6316 | 43683 | 4653 | 48157 | 3738 | 50176 | 3041 | 52468 | 1947 | 64711 | 1217 | 50849 |
| 7L-4S | | MI | 18205 | 6316 | 30872 | 4495 | 33962 | 3606 | 35531 | 2898 | 37544 | 1792 | 45454 | 1262 | 34081 |
| 18-#14 | 2.93 | MA | 25675 | 6316 | 42376 | 4652 | 46404 | 3755 | 48091 | 3056 | 49472 | 1939 | 61067 | 1143 | 49265 |
| 8L-3S | | MI | 18764 | 6316 | 31857 | 4481 | 35214 | 3614 | 37031 | 2908 | 39428 | 1782 | 47551 | 1387 | 34312 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis

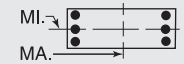



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.93 | MA | 24907 | 6316 | 41093 | 4651 | 44691 | 3752 | 45935 | 3052 | 46642 | 1951 | 57467 | 1062 | 47266 |
| 9L-2S | | MI | 19540 | 6316 | 33070 | 4486 | 36760 | 3603 | 38891 | 2898 | 41885 | 1772 | 50773 | 1515 | 34358 |
| 18-#18 | 5.22 | MA | 30491 | 7433 | 54033 | 5314 | 61024 | 4242 | 65762 | 3331 | 73571 | 1862 | 93553 | 823 | 85800 |
| 6L-5S | | MI | 19784 | 7433 | 35862 | 5144 | 40110 | 4089 | 42681 | 3159 | 46911 | 1605 | 58070 | 590 | 54145 |
| 18-#18 | 5.22 | MA | 29231 | 7433 | 51524 | 5347 | 57967 | 4270 | 62015 | 3356 | 68540 | 1881 | 86858 | 598 | 81583 |
| 7L-4S | | MI | 20633 | 7433 | 37378 | 5157 | 42053 | 4071 | 44993 | 3142 | 50102 | 1623 | 61869 | 694 | 55955 |
| 18-#18 | 5.22 | MA | 27989 | 7433 | 49223 | 5344 | 54882 | 4264 | 58347 | 3381 | 63270 | 1863 | 80524 | 469 | 76937 |
| 8L-3S | | MI | 21573 | 7433 | 39095 | 5134 | 44226 | 4089 | 47564 | 3159 | 53329 | 1605 | 65448 | 910 | 58578 |
| 20-#11 | 2.26 | MA | 26998 | 5986 | 43844 | 4436 | 48477 | 3581 | 50623 | 2939 | 53000 | 1948 | 65059 | 1585 | 42774 |
| 5L-7S | | MI | 16537 | 5986 | 27277 | 4309 | 29427 | 3484 | 30137 | 2835 | 30412 | 1848 | 36471 | 1279 | 25888 |
| 20-#11 | 2.26 | MA | 26454 | 5986 | 42916 | 4436 | 47216 | 3593 | 49084 | 2936 | 50963 | 1956 | 62448 | 1527 | 41939 |
| 6E | | MI | 16870 | 5986 | 27891 | 4299 | 30176 | 3475 | 31083 | 2842 | 31592 | 1841 | 37860 | 1347 | 26190 |
| 20-#11 | 2.26 | MA | 25923 | 5986 | 41923 | 4450 | 46005 | 3592 | 47601 | 2947 | 48970 | 1965 | 59732 | 1439 | 41403 |
| 7L-5S | | MI | 17210 | 5986 | 28465 | 4302 | 30954 | 3481 | 31994 | 2835 | 32798 | 1834 | 39337 | 1407 | 26557 |
| 20-#11 | 2.26 | MA | 25400 | 5986 | 41012 | 4449 | 44783 | 3604 | 46148 | 2958 | 46882 | 1960 | 57178 | 1387 | 40350 |
| 8L-4S | | MI | 17567 | 5986 | 29072 | 4306 | 31736 | 3472 | 32948 | 2829 | 34112 | 1841 | 40920 | 1447 | 26889 |
| 20-#11 | 2.26 | MA | 24843 | 5986 | 40118 | 4449 | 43590 | 3603 | 44645 | 2956 | 44909 | 1969 | 54648 | 1331 | 39503 |
| 9L-3S | | MI | 17962 | 5986 | 29762 | 4295 | 32613 | 3478 | 34007 | 2835 | 35442 | 1834 | 42404 | 1534 | 26918 |
| 20-#11 | 2.26 | MA | 24265 | 5986 | 39142 | 4463 | 42384 | 3615 | 43201 | 2967 | 42952 | 1978 | 52194 | 1268 | 38291 |
| 10L-2S | | MI | 18514 | 5986 | 30612 | 4299 | 33697 | 3469 | 35321 | 2829 | 37177 | 1827 | 44686 | 1623 | 26916 |
| 20-#14 | 3.26 | MA | 28095 | 6476 | 47119 | 4734 | 52458 | 3813 | 55421 | 3070 | 59549 | 1926 | 74286 | 1323 | 58593 |
| 6E | | MI | 17760 | 6476 | 30395 | 4583 | 33276 | 3681 | 34751 | 2961 | 36432 | 1775 | 44358 | 1079 | 36083 |
| 20-#14 | 3.26 | MA | 27351 | 6476 | 45693 | 4753 | 50720 | 3810 | 53292 | 3086 | 56689 | 1937 | 70420 | 1196 | 56739 |
| 7L-5S | | MI | 18238 | 6476 | 31217 | 4589 | 34389 | 3689 | 36041 | 2951 | 38139 | 1765 | 46441 | 1165 | 36709 |
| 20-#14 | 3.26 | MA | 26618 | 6476 | 44386 | 4752 | 48967 | 3827 | 51207 | 3101 | 53693 | 1929 | 66777 | 1122 | 55102 |
| 8L-4S | | MI | 18738 | 6476 | 32085 | 4594 | 35507 | 3678 | 37391 | 2941 | 40001 | 1775 | 48675 | 1223 | 37580 |
| 20-#14 | 3.26 | MA | 25851 | 6476 | 43103 | 4751 | 47254 | 3825 | 49050 | 3097 | 50863 | 1941 | 63176 | 1041 | 53147 |
| 9L-3S | | MI | 19293 | 6476 | 33070 | 4580 | 36760 | 3687 | 38891 | 2951 | 41885 | 1765 | 50773 | 1348 | 37972 |
| 20-#14 | 3.26 | MA | 25030 | 6476 | 41702 | 4770 | 45524 | 3842 | 46978 | 3112 | 48054 | 1953 | 59685 | 950 | 50841 |
| 10L-2S | | MI | 20065 | 6476 | 34282 | 4586 | 38305 | 3675 | 40751 | 2941 | 44342 | 1755 | 53994 | 1476 | 38037 |
| 20-#18 | 5.80 | MA | 30821 | 7717 | 55048 | 5524 | 62459 | 4399 | 67476 | 3436 | 75938 | 1863 | 96749 | 556 | 91779 |
| 7L-5S | | MI | 20685 | 7717 | 37967 | 5321 | 42784 | 4217 | 45866 | 3233 | 51120 | 1570 | 63549 | 511 | 60081 |
| 20-#18 | 5.80 | MA | 29594 | 7717 | 52747 | 5521 | 59374 | 4392 | 63808 | 3461 | 70668 | 1846 | 90415 | 427 | 87083 |
| 8L-4S | | MI | 21526 | 7717 | 39483 | 5334 | 44727 | 4199 | 48178 | 3215 | 54310 | 1587 | 67347 | 616 | 62055 |
| 22-#11 | 2.49 | MA | 27111 | 6097 | 44319 | 4505 | 49005 | 3643 | 51260 | 2967 | 53910 | 1950 | 66457 | 1513 | 46102 |
| 6L-7S | | MI | 16921 | 6097 | 28127 | 4378 | 30511 | 3534 | 31451 | 2866 | 32147 | 1837 | 38753 | 1254 | 28342 |
| 22-#11 | 2.49 | MA | 26584 | 6097 | 43326 | 4519 | 47794 | 3642 | 49776 | 2978 | 51917 | 1958 | 63742 | 1426 | 45563 |
| 7L-6S | | MI | 17253 | 6097 | 28741 | 4368 | 31260 | 3525 | 32397 | 2873 | 33327 | 1830 | 40142 | 1322 | 28703 |
| 22-#11 | 2.49 | MA | 26064 | 6097 | 42415 | 4518 | 46573 | 3654 | 48323 | 2990 | 49829 | 1953 | 61187 | 1374 | 44481 |
| 8L-5S | | MI | 17592 | 6097 | 29315 | 4371 | 32038 | 3531 | 33308 | 2866 | 34532 | 1823 | 41620 | 1382 | 29051 |
| 22-#11 | 2.49 | MA | 25518 | 6097 | 41521 | 4518 | 45379 | 3653 | 46820 | 2987 | 47856 | 1962 | 58657 | 1318 | 43597 |
| 9L-4S | | MI | 17946 | 6097 | 29922 | 4375 | 32820 | 3522 | 34261 | 2859 | 35847 | 1830 | 43202 | 1422 | 29458 |
| 22-#11 | 2.49 | MA | 24936 | 6097 | 40545 | 4532 | 44173 | 3665 | 45377 | 2998 | 45899 | 1971 | 56203 | 1255 | 42409 |
| 10L-3S | | MI | 18340 | 6097 | 30612 | 4364 | 33697 | 3528 | 35321 | 2866 | 37177 | 1823 | 44686 | 1509 | 29499 |
| 22-#11 | 2.49 | MA | 24375 | 6097 | 39652 | 4532 | 42987 | 3664 | 43891 | 2995 | 43840 | 1966 | 53709 | 1200 | 41136 |
| 11L-2S | | MI | 18889 | 6097 | 31462 | 4368 | 34781 | 3519 | 36634 | 2859 | 38912 | 1816 | 46969 | 1598 | 29511 |
| 22-#14 | 3.59 | MA | 28280 | 6635 | 47703 | 4852 | 53283 | 3882 | 56407 | 3131 | 60910 | 1928 | 76129 | 1176 | 62637 |
| 7L-6S | | MI | 18296 | 6635 | 31608 | 4683 | 34821 | 3753 | 36611 | 3005 | 38889 | 1758 | 47579 | 1041 | 39552 |
| 22-#14 | 3.59 | MA | 27552 | 6635 | 46396 | 4852 | 51530 | 3900 | 54322 | 3146 | 57914 | 1919 | 72486 | 1102 | 60947 |
| 8L-5S | | MI | 18771 | 6635 | 32429 | 4688 | 35934 | 3762 | 37901 | 2995 | 40596 | 1748 | 49662 | 1127 | 40266 |
| 22-#14 | 3.59 | MA | 26787 | 6635 | 45113 | 4851 | 49817 | 3897 | 52165 | 3142 | 55084 | 1931 | 68886 | 1021 | 59035 |
| 9L-4S | | MI | 19268 | 6635 | 33297 | 4694 | 37053 | 3750 | 39251 | 2985 | 42458 | 1758 | 51896 | 1185 | 41090 |
| 22-#14 | 3.59 | MA | 25997 | 6635 | 43712 | 4870 | 48086 | 3914 | 50094 | 3157 | 52275 | 1943 | 65394 | 929 | 56698 |
| 10L-3S | | MI | 19820 | 6635 | 34282 | 4680 | 38305 | 3759 | 40751 | 2995 | 44342 | 1748 | 53994 | 1309 | 41627 |
| 22-#18 | 6.38 | MA | 31182 | 8001 | 56270 | 5698 | 63866 | 4521 | 69269 | 3541 | 78067 | 1828 | 100307 | 384 | 97245 |
| 8L-5S | | MI | 21580 | 8001 | 40072 | 5499 | 45459 | 4345 | 49052 | 3306 | 55328 | 1534 | 69027 | 433 | 66041 |
| 24-#11 | 2.71 | MA | 27241 | 6207 | 44730 | 4588 | 49584 | 3692 | 51951 | 3009 | 54863 | 1951 | 67751 | 1413 | 49671 |
| 7E | | MI | 17304 | 6207 | 28977 | 4447 | 31595 | 3584 | 32764 | 2897 | 33881 | 1826 | 41035 | 1229 | 30803 |

## RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.71 | MA | 26724 | 6207 | 43819 | 4588 | 48362 | 3704 | 50498 | 3021 | 52775 | 1946 | 65196 | 1361 | 48616 |
| 8L-6S | | MI | 17634 | 6207 | 29591 | 4437 | 32344 | 3576 | 33711 | 2904 | 35061 | 1819 | 42424 | 1297 | 31217 |
| 24-#11 | 2.71 | MA | 26179 | 6207 | 42925 | 4587 | 47169 | 3703 | 48995 | 3018 | 50803 | 1955 | 62667 | 1305 | 47695 |
| 9L-5S | | MI | 17971 | 6207 | 30165 | 4440 | 33122 | 3581 | 34622 | 2897 | 36267 | 1812 | 43902 | 1357 | 31550 |
| 24-#11 | 2.71 | MA | 25602 | 6207 | 41949 | 4601 | 45963 | 3715 | 47552 | 3029 | 48846 | 1964 | 60213 | 1242 | 46532 |
| 10L-4S | | MI | 18324 | 6207 | 30773 | 4444 | 33905 | 3572 | 35575 | 2890 | 37581 | 1819 | 45484 | 1397 | 32024 |
| 24-#11 | 2.71 | MA | 25044 | 6207 | 41055 | 4601 | 44776 | 3714 | 46066 | 3027 | 46787 | 1959 | 57718 | 1186 | 45236 |
| 11L-3S | | MI | 18716 | 6207 | 31462 | 4434 | 34781 | 3578 | 36634 | 2897 | 38912 | 1812 | 46969 | 1485 | 32076 |
| 24-#11 | 2.71 | MA | 24495 | 6207 | 40094 | 4614 | 43578 | 3726 | 44626 | 3038 | 44832 | 1968 | 54975 | 1112 | 43994 |
| 12L-2S | | MI | 19263 | 6207 | 32312 | 4437 | 35865 | 3569 | 37948 | 2890 | 40646 | 1805 | 49251 | 1573 | 32098 |
| 24-#14 | 3.91 | MA | 28480 | 6795 | 48407 | 4951 | 54093 | 3972 | 57438 | 3191 | 62135 | 1910 | 78195 | 1081 | 66801 |
| 8L-6S | | MI | 18829 | 6795 | 32820 | 4782 | 36367 | 3825 | 38471 | 3048 | 41345 | 1740 | 50800 | 1002 | 43032 |
| 24-#14 | 3.91 | MA | 27716 | 6795 | 47123 | 4951 | 52380 | 3969 | 55281 | 3187 | 59304 | 1921 | 74595 | 1000 | 64870 |
| 9L-5S | | MI | 19301 | 6795 | 33641 | 4788 | 37480 | 3834 | 39761 | 3038 | 43053 | 1730 | 52883 | 1088 | 43829 |
| 24-#14 | 3.91 | MA | 26932 | 6795 | 45722 | 4970 | 50649 | 3987 | 53209 | 3202 | 56496 | 1933 | 71103 | 909 | 62561 |
| 10L-4S | | MI | 19795 | 6795 | 34509 | 4794 | 38598 | 3823 | 41111 | 3028 | 44915 | 1740 | 55117 | 1146 | 44611 |

## RECTANGULAR TIED COLUMNS 30" x 48"

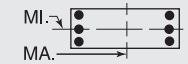
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.11 | MA | 27997 | 5659 | 43821 | 4222 | 47626 | 3439 | 48792 | 2862 | 49123 | 2042 | 58105 | 1929 | 23392 |
| 2E | | MI | 17185 | 5659 | 27433 | 4060 | 29174 | 3304 | 29411 | 2736 | 28934 | 1919 | 33517 | 1767 | 14052 |
| 6-#18 | 1.67 | MA | 29725 | 5943 | 47522 | 4399 | 52344 | 3567 | 54528 | 2942 | 56894 | 2024 | 68551 | 1890 | 34705 |
| 2L-3S | | MI | 16742 | 5943 | 27433 | 4225 | 29174 | 3450 | 29411 | 2827 | 28934 | 1901 | 33517 | 1461 | 20667 |
| 6-#18 | 1.67 | MA | 27285 | 5943 | 43821 | 4397 | 47626 | 3597 | 48792 | 2968 | 49123 | 2043 | 58105 | 1662 | 34576 |
| 3L-2S | | MI | 18119 | 5943 | 29538 | 4238 | 31848 | 3432 | 32596 | 2810 | 33142 | 1884 | 38996 | 1689 | 20578 |
| 8-#14 | 1.25 | MA | 28521 | 5730 | 44731 | 4291 | 48947 | 3491 | 50461 | 2899 | 51410 | 2050 | 61464 | 1944 | 26428 |
| 2L-4S | | MI | 16122 | 5730 | 25775 | 4152 | 27228 | 3373 | 27194 | 2790 | 26120 | 1962 | 30295 | 1537 | 15954 |
| 8-#14 | 1.25 | MA | 27113 | 5730 | 42621 | 4290 | 46257 | 3489 | 47191 | 2915 | 46980 | 2063 | 55442 | 1816 | 26436 |
| 3E | | MI | 16700 | 5730 | 26760 | 4138 | 28480 | 3381 | 28694 | 2800 | 28004 | 1952 | 32393 | 1661 | 15906 |
| 8-#14 | 1.25 | MA | 26125 | 5730 | 40931 | 4310 | 44108 | 3507 | 44583 | 2911 | 43593 | 2075 | 51490 | 1688 | 26309 |
| 4L-2S | | MI | 17501 | 5730 | 27972 | 4144 | 30026 | 3370 | 30554 | 2790 | 30461 | 1942 | 35614 | 1789 | 15838 |
| 8-#18 | 2.22 | MA | 31426 | 6227 | 51223 | 4577 | 57062 | 3696 | 60264 | 3022 | 64665 | 2006 | 78997 | 1850 | 45966 |
| 2L-4S | | MI | 16689 | 6227 | 27820 | 4425 | 29675 | 3560 | 30025 | 2883 | 29916 | 1883 | 35416 | 1167 | 26092 |
| 8-#18 | 2.22 | MA | 29016 | 6227 | 47522 | 4575 | 52344 | 3726 | 54528 | 3048 | 56894 | 2026 | 68551 | 1623 | 45724 |
| 3E | | MI | 17678 | 6227 | 29538 | 4402 | 31848 | 3577 | 32596 | 2901 | 33142 | 1866 | 38996 | 1383 | 27059 |
| 8-#18 | 2.22 | MA | 27319 | 6227 | 44551 | 4608 | 48566 | 3720 | 49943 | 3039 | 50940 | 2045 | 61708 | 1395 | 43976 |
| 4L-2S | | MI | 19041 | 6227 | 31643 | 4415 | 34522 | 3560 | 35782 | 2883 | 37351 | 1848 | 44474 | 1610 | 27049 |
| 10-#11 | 1.08 | MA | 28027 | 5645 | 43589 | 4250 | 47573 | 3462 | 48822 | 2884 | 49204 | 2062 | 58589 | 1966 | 23072 |
| 2L-5S | | MI | 15908 | 5645 | 25175 | 4113 | 26528 | 3359 | 26391 | 2791 | 24986 | 1973 | 28877 | 1613 | 14020 |
| 10-#11 | 1.08 | MA | 27039 | 5645 | 42116 | 4250 | 45696 | 3461 | 46540 | 2895 | 46112 | 2071 | 54363 | 1878 | 23094 |
| 3L-4S | | MI | 16275 | 5645 | 25782 | 4117 | 27310 | 3350 | 27345 | 2784 | 26300 | 1980 | 30459 | 1653 | 13990 |
| 10-#11 | 1.08 | MA | 26347 | 5645 | 40938 | 4264 | 44197 | 3474 | 44722 | 2893 | 43750 | 2081 | 51587 | 1789 | 23068 |
| 4L-3S | | MI | 16681 | 5645 | 26472 | 4106 | 28187 | 3356 | 28404 | 2791 | 27631 | 1973 | 31944 | 1741 | 13942 |
| 10-#11 | 1.08 | MA | 25728 | 5645 | 39907 | 4264 | 42867 | 3473 | 43092 | 2905 | 41425 | 2076 | 48710 | 1744 | 22952 |
| 5L-2S | | MI | 17245 | 5645 | 27322 | 4110 | 29271 | 3347 | 29718 | 2784 | 29365 | 1966 | 34226 | 1830 | 13894 |
| 10-#14 | 1.56 | MA | 29513 | 5890 | 46841 | 4390 | 51637 | 3563 | 53731 | 2944 | 55840 | 2040 | 67485 | 1925 | 32868 |
| 2L-5S | | MI | 16157 | 5890 | 26119 | 4246 | 27655 | 3456 | 27704 | 2843 | 26715 | 1935 | 31283 | 1440 | 19203 |
| 10-#14 | 1.56 | MA | 28116 | 5890 | 44731 | 4390 | 48947 | 3561 | 50461 | 2960 | 51410 | 2053 | 61464 | 1797 | 32835 |
| 3L-4S | | MI | 16675 | 5890 | 26987 | 4252 | 28773 | 3445 | 29054 | 2833 | 28577 | 1945 | 33516 | 1498 | 19642 |
| 10-#14 | 1.56 | MA | 27136 | 5890 | 43041 | 4410 | 46798 | 3579 | 47853 | 2956 | 48023 | 2065 | 57511 | 1669 | 32661 |
| 4L-3S | | MI | 17249 | 5890 | 27972 | 4238 | 30026 | 3454 | 30554 | 2843 | 30461 | 1935 | 35614 | 1623 | 19629 |
| 10-#14 | 1.56 | MA | 26259 | 5890 | 41562 | 4409 | 44890 | 3577 | 45515 | 2972 | 44687 | 2058 | 53406 | 1605 | 31696 |
| 5L-2S | | MI | 18045 | 5890 | 29184 | 4243 | 31571 | 3442 | 32414 | 2833 | 32918 | 1925 | 38835 | 1751 | 19579 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 2.78 | MA | 33102 | 6510 | 54924 | 4754 | 61781 | 3825 | 66000 | 3102 | 72435 | 1989 | 89443 | 1811 | 57194 |
| 2L-5S | | MI | 16740 | 6510 | 28409 | 4589 | 30406 | 3705 | 30898 | 2974 | 30933 | 1830 | 37096 | 984 | 30606 |
| 10-#18 | 2.78 | MA | 30721 | 6510 | 51223 | 4752 | 57062 | 3854 | 60264 | 3128 | 64665 | 2008 | 78997 | 1583 | 56857 |
| 3L-4S | | MI | 17624 | 6510 | 29925 | 4602 | 32349 | 3687 | 33211 | 2956 | 34124 | 1848 | 40895 | 1089 | 32035 |
| 10-#18 | 2.78 | MA | 29047 | 6510 | 48252 | 4785 | 53284 | 3849 | 55679 | 3119 | 58711 | 2028 | 72154 | 1356 | 54644 |
| 4L-3S | | MI | 18603 | 6510 | 31643 | 4579 | 34522 | 3705 | 35782 | 2974 | 37351 | 1830 | 44474 | 1304 | 33416 |
| 10-#18 | 2.78 | MA | 27549 | 6510 | 45648 | 4783 | 49926 | 3878 | 51566 | 3145 | 52843 | 2012 | 65008 | 1244 | 51336 |
| 5L-2S | | MI | 19954 | 6510 | 33748 | 4592 | 37197 | 3687 | 38967 | 2956 | 41559 | 1813 | 49953 | 1532 | 33486 |
| 12-#11 | 1.30 | MA | 28727 | 5756 | 45061 | 4319 | 49451 | 3513 | 51105 | 2915 | 52296 | 2055 | 62815 | 1954 | 27571 |
| 2L-6S | | MI | 15952 | 5756 | 25451 | 4179 | 26833 | 3404 | 26794 | 2829 | 25515 | 1969 | 29682 | 1529 | 16285 |
| 12-#11 | 1.30 | MA | 27745 | 5756 | 43589 | 4319 | 47573 | 3512 | 48822 | 2926 | 49204 | 2064 | 58589 | 1865 | 27575 |
| 3L-5S | | MI | 16301 | 5756 | 26025 | 4182 | 27612 | 3409 | 27705 | 2822 | 26721 | 1962 | 31159 | 1588 | 16608 |
| 12-#11 | 1.30 | MA | 27057 | 5756 | 42411 | 4333 | 46075 | 3524 | 47004 | 2924 | 46843 | 2074 | 55813 | 1777 | 27525 |
| 4E | | MI | 16665 | 5756 | 26632 | 4186 | 28394 | 3401 | 28658 | 2815 | 28035 | 1969 | 32742 | 1628 | 16598 |
| 12-#11 | 1.30 | MA | 26442 | 5756 | 41380 | 4333 | 44745 | 3523 | 45375 | 2936 | 44517 | 2069 | 52936 | 1731 | 27384 |
| 5L-3S | | MI | 17069 | 5756 | 27322 | 4176 | 29271 | 3406 | 29718 | 2822 | 29365 | 1962 | 34226 | 1716 | 16564 |
| 12-#11 | 1.30 | MA | 25856 | 5756 | 40408 | 4333 | 43423 | 3536 | 43763 | 2933 | 42382 | 2078 | 50183 | 1673 | 26642 |
| 6L-2S | | MI | 17631 | 5756 | 28172 | 4179 | 30355 | 3398 | 31031 | 2815 | 31100 | 1955 | 36508 | 1805 | 16522 |
| 12-#14 | 1.88 | MA | 30495 | 6049 | 48951 | 4490 | 54327 | 3636 | 57001 | 2989 | 60270 | 2030 | 73507 | 1906 | 39290 |
| 2L-6S | | MI | 16217 | 6049 | 26510 | 4340 | 28087 | 3520 | 28274 | 2897 | 27465 | 1927 | 32421 | 1315 | 22165 |
| 12-#14 | 1.88 | MA | 29109 | 6049 | 46841 | 4490 | 51637 | 3634 | 53731 | 3005 | 55840 | 2043 | 67485 | 1778 | 39223 |
| 3L-5S | | MI | 16709 | 6049 | 27331 | 4346 | 29201 | 3529 | 29564 | 2887 | 29172 | 1918 | 34504 | 1401 | 22707 |
| 12-#14 | 1.88 | MA | 28137 | 6049 | 45151 | 4509 | 49488 | 3651 | 51123 | 3001 | 52454 | 2055 | 63533 | 1650 | 39008 |
| 4E | | MI | 17223 | 6049 | 28199 | 4351 | 30319 | 3517 | 30914 | 2877 | 31034 | 1927 | 36737 | 1459 | 23312 |
| 12-#14 | 1.88 | MA | 27268 | 6049 | 43672 | 4509 | 47580 | 3649 | 48785 | 3017 | 49117 | 2048 | 59427 | 1586 | 37865 |
| 5L-3S | | MI | 17794 | 6049 | 29184 | 4337 | 31571 | 3526 | 32414 | 2887 | 32918 | 1918 | 38835 | 1584 | 23336 |
| 12-#14 | 1.88 | MA | 26440 | 6049 | 42276 | 4508 | 45683 | 3667 | 46472 | 3013 | 46054 | 2061 | 55506 | 1502 | 36585 |
| 6L-2S | | MI | 18585 | 6049 | 30397 | 4343 | 33117 | 3515 | 34274 | 2877 | 35375 | 1908 | 42056 | 1712 | 23303 |
| 12-#18 | 3.33 | MA | 32403 | 6794 | 54924 | 4929 | 61781 | 3983 | 66000 | 3208 | 72435 | 1990 | 89443 | 1544 | 67982 |
| 3L-5S | | MI | 17674 | 6794 | 30514 | 4767 | 33080 | 3833 | 34084 | 3047 | 35142 | 1795 | 42575 | 905 | 36709 |
| 12-#18 | 3.33 | MA | 30750 | 6794 | 51953 | 4962 | 58003 | 3977 | 61415 | 3199 | 66482 | 2010 | 82600 | 1316 | 65358 |
| 4E | | MI | 18549 | 6794 | 32030 | 4779 | 35023 | 3815 | 36396 | 3030 | 38332 | 1812 | 46373 | 1010 | 38025 |
| 12-#18 | 3.33 | MA | 29273 | 6794 | 49349 | 4960 | 54644 | 4007 | 57302 | 3225 | 60614 | 1994 | 75453 | 1204 | 62213 |
| 5L-3S | | MI | 19519 | 6794 | 33748 | 4757 | 37197 | 3833 | 38967 | 3047 | 41559 | 1795 | 49953 | 1225 | 39751 |
| 12-#18 | 3.33 | MA | 27864 | 6794 | 46892 | 4958 | 51306 | 4001 | 53230 | 3216 | 55223 | 2014 | 68658 | 1054 | 58197 |
| 6L-2S | | MI | 20858 | 6794 | 35853 | 4770 | 39871 | 3815 | 42153 | 3030 | 45767 | 1777 | 55431 | 1453 | 39889 |
| 14-#11 | 1.52 | MA | 29422 | 5866 | 46534 | 4388 | 51328 | 3563 | 53387 | 2946 | 55388 | 2048 | 67041 | 1942 | 32063 |
| 2L-7S | | MI | 16006 | 5866 | 25687 | 4258 | 27169 | 3462 | 27161 | 2853 | 26070 | 1965 | 30575 | 1436 | 18527 |
| 14-#11 | 1.52 | MA | 28445 | 5866 | 45061 | 4388 | 49451 | 3562 | 51105 | 2958 | 52296 | 2058 | 62815 | 1853 | 32047 |
| 3L-6S | | MI | 16344 | 5866 | 26301 | 4248 | 27917 | 3454 | 28107 | 2860 | 27250 | 1958 | 31964 | 1504 | 18779 |
| 14-#11 | 1.52 | MA | 27761 | 5866 | 43883 | 4402 | 47952 | 3574 | 49286 | 2955 | 49935 | 2067 | 60039 | 1765 | 31977 |
| 4L-5S | | MI | 16691 | 5866 | 26875 | 4252 | 28696 | 3459 | 29018 | 2853 | 28456 | 1951 | 33441 | 1563 | 19185 |
| 14-#11 | 1.52 | MA | 27150 | 5866 | 42852 | 4402 | 46622 | 3573 | 47657 | 2967 | 47609 | 2062 | 57162 | 1719 | 31814 |
| 5L-4S | | MI | 17054 | 5866 | 27482 | 4255 | 29478 | 3451 | 29972 | 2846 | 29770 | 1958 | 35024 | 1603 | 19197 |
| 14-#11 | 1.52 | MA | 26568 | 5866 | 41880 | 4402 | 45301 | 3586 | 46045 | 2965 | 45475 | 2072 | 54409 | 1661 | 30986 |
| 6L-3S | | MI | 17456 | 5866 | 28172 | 4245 | 30355 | 3456 | 31031 | 2853 | 31100 | 1951 | 36508 | 1691 | 19175 |
| 14-#11 | 1.52 | MA | 26000 | 5866 | 40840 | 4416 | 44033 | 3585 | 44490 | 2976 | 43386 | 2081 | 51546 | 1574 | 30353 |
| 7L-2S | | MI | 18015 | 5866 | 29022 | 4248 | 31439 | 3448 | 32345 | 2846 | 32835 | 1944 | 38790 | 1780 | 19141 |
| 14-#14 | 2.19 | MA | 30093 | 6209 | 48951 | 4590 | 54327 | 3706 | 57001 | 3050 | 60270 | 2033 | 73507 | 1759 | 45603 |
| 3L-6S | | MI | 16768 | 6209 | 27722 | 4440 | 29633 | 3592 | 30134 | 2940 | 29921 | 1910 | 35642 | 1277 | 25720 |
| 14-#14 | 2.19 | MA | 29129 | 6209 | 47261 | 4609 | 52178 | 3724 | 54393 | 3046 | 56884 | 2046 | 69555 | 1631 | 45352 |
| 4L-5S | | MI | 17257 | 6209 | 28543 | 4445 | 30746 | 3601 | 31424 | 2930 | 31629 | 1900 | 37725 | 1363 | 26227 |
| 14-#14 | 2.19 | MA | 28268 | 6209 | 45781 | 4609 | 50270 | 3721 | 52055 | 3062 | 53548 | 2038 | 65449 | 1567 | 44051 |
| 5L-4S | | MI | 17768 | 6209 | 29411 | 4451 | 31864 | 3590 | 32774 | 2920 | 33491 | 1910 | 39959 | 1420 | 26972 |
| 14-#14 | 2.19 | MA | 27447 | 6209 | 44386 | 4608 | 48373 | 3739 | 49742 | 3058 | 50484 | 2051 | 61528 | 1483 | 42824 |
| 6L-3S | | MI | 18335 | 6209 | 30397 | 4437 | 33117 | 3598 | 34274 | 2930 | 35375 | 1900 | 42056 | 1545 | 27027 |
| 14-#14 | 2.19 | MA | 26646 | 6209 | 42892 | 4628 | 46553 | 3737 | 47510 | 3074 | 47487 | 2063 | 57449 | 1356 | 41237 |
| 7L-2S | | MI | 19121 | 6209 | 31609 | 4443 | 34662 | 3587 | 36134 | 2920 | 37831 | 1890 | 45278 | 1673 | 27015 |

## RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

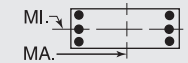
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.89 | MA | 32433 | 7078 | 55654 | 5140 | 62721 | 4106 | 67151 | 3279 | 74253 | 1992 | 93046 | 1276 | 76111 |
| 4L-5S | | MI | 18599 | 7078 | 32619 | 4944 | 35755 | 3961 | 37269 | 3121 | 39350 | 1759 | 48053 | 827 | 42745 |
| 14-#18 | 3.89 | MA | 30974 | 7078 | 53050 | 5137 | 59363 | 4136 | 63038 | 3305 | 68385 | 1976 | 85899 | 1164 | 73113 |
| 5L-4S | | MI | 19466 | 7078 | 34135 | 4957 | 37698 | 3943 | 39582 | 3103 | 42541 | 1777 | 51852 | 931 | 44051 |
| 14-#18 | 3.89 | MA | 29583 | 7078 | 50593 | 5135 | 56024 | 4130 | 58966 | 3296 | 62993 | 1996 | 79104 | 1015 | 68950 |
| 6L-3S | | MI | 20426 | 7078 | 35853 | 4934 | 39871 | 3961 | 42153 | 3121 | 45767 | 1759 | 55431 | 1147 | 46072 |
| 14-#18 | 3.89 | MA | 28226 | 7078 | 47963 | 5168 | 52819 | 4160 | 55038 | 3322 | 57718 | 2015 | 72033 | 790 | 64891 |
| 7L-2S | | MI | 21754 | 7078 | 37958 | 4947 | 42545 | 3943 | 45338 | 3103 | 49975 | 1741 | 60910 | 1374 | 46267 |
| 16-#11 | 1.73 | MA | 29141 | 5977 | 46534 | 4457 | 51328 | 3612 | 53387 | 2989 | 55388 | 2051 | 67041 | 1841 | 36514 |
| 3L-7S | | MI | 16397 | 5977 | 26538 | 4328 | 28253 | 3512 | 28475 | 2884 | 27805 | 1954 | 32857 | 1411 | 21040 |
| 16-#11 | 1.73 | MA | 28461 | 5977 | 45356 | 4471 | 49830 | 3624 | 51569 | 2986 | 53027 | 2060 | 64265 | 1752 | 36425 |
| 4L-6S | | MI | 16734 | 5977 | 27152 | 4317 | 29001 | 3504 | 29421 | 2890 | 28985 | 1947 | 34246 | 1479 | 21280 |
| 16-#11 | 1.73 | MA | 27854 | 5977 | 44325 | 4471 | 48500 | 3623 | 49940 | 2998 | 50702 | 2055 | 61388 | 1707 | 36243 |
| 5E | | MI | 17079 | 5977 | 27726 | 4321 | 29780 | 3509 | 30332 | 2884 | 30190 | 1940 | 35724 | 1538 | 21703 |
| 16-#11 | 1.73 | MA | 27276 | 5977 | 43353 | 4471 | 47178 | 3636 | 48327 | 2996 | 48567 | 2065 | 58635 | 1649 | 35339 |
| 6L-4S | | MI | 17440 | 5977 | 28333 | 4324 | 30562 | 3501 | 31285 | 2877 | 31504 | 1947 | 37306 | 1578 | 21787 |
| 16-#11 | 1.73 | MA | 26711 | 5977 | 42312 | 4485 | 45910 | 3635 | 46773 | 3007 | 46478 | 2074 | 55772 | 1562 | 34726 |
| 7L-3S | | MI | 17840 | 5977 | 29022 | 4314 | 31439 | 3506 | 32345 | 2884 | 32835 | 1940 | 38790 | 1666 | 21778 |
| 16-#11 | 1.73 | MA | 26155 | 5977 | 41359 | 4485 | 44630 | 3648 | 45251 | 3019 | 44291 | 2069 | 53083 | 1509 | 33807 |
| 8L-2S | | MI | 18397 | 5977 | 29873 | 4317 | 32523 | 3498 | 33658 | 2877 | 34570 | 1933 | 41073 | 1755 | 21752 |
| 16-#14 | 2.50 | MA | 30113 | 6369 | 49371 | 4709 | 54868 | 3796 | 57663 | 3091 | 61314 | 2036 | 75576 | 1612 | 51694 |
| 4L-6S | | MI | 17315 | 6369 | 28934 | 4539 | 31178 | 3665 | 31994 | 2983 | 32378 | 1893 | 38863 | 1238 | 29282 |
| 16-#14 | 2.50 | MA | 29258 | 6369 | 47891 | 4708 | 52960 | 3794 | 55325 | 3107 | 57978 | 2028 | 71471 | 1548 | 50251 |
| 5E | | MI | 17801 | 6369 | 29756 | 4545 | 32291 | 3673 | 33284 | 2974 | 34086 | 1883 | 40946 | 1324 | 29760 |
| 16-#14 | 2.50 | MA | 28444 | 6369 | 46496 | 4708 | 51063 | 3812 | 53012 | 3103 | 54914 | 2041 | 67550 | 1464 | 49070 |
| 6L-4S | | MI | 18309 | 6369 | 30624 | 4551 | 33410 | 3662 | 34634 | 2964 | 35947 | 1893 | 43180 | 1382 | 30624 |
| 16-#14 | 2.50 | MA | 27650 | 6369 | 45002 | 4727 | 49242 | 3809 | 50780 | 3119 | 51917 | 2053 | 63471 | 1337 | 47404 |
| 7L-3S | | MI | 18872 | 6369 | 31609 | 4537 | 34662 | 3670 | 36134 | 2974 | 37831 | 1883 | 45278 | 1507 | 30704 |
| 16-#14 | 2.50 | MA | 26867 | 6369 | 43633 | 4727 | 47405 | 3827 | 48596 | 3135 | 48777 | 2046 | 59633 | 1262 | 45867 |
| 8L-2S | | MI | 19654 | 6369 | 32821 | 4543 | 36208 | 3659 | 37994 | 2964 | 40288 | 1873 | 48499 | 1635 | 30718 |
| 16-#18 | 4.44 | MA | 32655 | 7362 | 56751 | 5315 | 64081 | 4264 | 68774 | 3385 | 76156 | 1959 | 96345 | 1125 | 84031 |
| 5E | | MI | 19515 | 7362 | 34724 | 5121 | 38429 | 4088 | 40455 | 3194 | 43558 | 1724 | 53532 | 748 | 48617 |
| 16-#18 | 4.44 | MA | 31281 | 7362 | 54294 | 5312 | 60743 | 4258 | 64702 | 3376 | 70764 | 1978 | 89550 | 975 | 79726 |
| 6L-4S | | MI | 20374 | 7362 | 36240 | 5134 | 40372 | 4071 | 42767 | 3176 | 46749 | 1741 | 57330 | 853 | 50106 |
| 16-#18 | 4.44 | MA | 29941 | 7362 | 51664 | 5345 | 57538 | 4288 | 60774 | 3402 | 65489 | 1998 | 82479 | 750 | 75579 |
| 7L-3S | | MI | 21326 | 7362 | 37958 | 5111 | 42545 | 4088 | 45338 | 3194 | 49975 | 1724 | 60910 | 1068 | 52381 |
| 16-#18 | 4.44 | MA | 28619 | 7362 | 49252 | 5343 | 54303 | 4282 | 56928 | 3428 | 59962 | 1982 | 75800 | 620 | 70906 |
| 8L-2S | | MI | 22643 | 7362 | 40063 | 5124 | 45219 | 4071 | 48524 | 3176 | 54184 | 1706 | 66388 | 1296 | 52631 |
| 18-#11 | 1.95 | MA | 29156 | 6088 | 46829 | 4540 | 51707 | 3675 | 53851 | 3018 | 56119 | 2053 | 68491 | 1740 | 40870 |
| 4L-7S | | MI | 16787 | 6088 | 27388 | 4397 | 29337 | 3563 | 29788 | 2914 | 29539 | 1943 | 35139 | 1386 | 23557 |
| 18-#11 | 1.95 | MA | 28553 | 6088 | 45798 | 4540 | 50377 | 3673 | 52222 | 3029 | 53794 | 2048 | 65614 | 1695 | 40647 |
| 5L-6S | | MI | 17122 | 6088 | 28002 | 4386 | 30085 | 3554 | 30734 | 2921 | 30719 | 1936 | 36528 | 1454 | 23786 |
| 18-#11 | 1.95 | MA | 27978 | 6088 | 44826 | 4540 | 49056 | 3686 | 50610 | 3027 | 51659 | 2058 | 62861 | 1637 | 39697 |
| 6L-5S | | MI | 17465 | 6088 | 28576 | 4390 | 30864 | 3559 | 31645 | 2914 | 31925 | 1929 | 38006 | 1513 | 24184 |
| 18-#11 | 1.95 | MA | 27418 | 6088 | 43785 | 4554 | 47788 | 3685 | 49055 | 3038 | 49570 | 2067 | 59998 | 1549 | 39103 |
| 7L-4S | | MI | 17824 | 6088 | 29183 | 4393 | 31646 | 3551 | 32599 | 2907 | 33239 | 1936 | 39588 | 1553 | 24368 |
| 18-#11 | 1.95 | MA | 26865 | 6088 | 42831 | 4554 | 46508 | 3698 | 47533 | 3050 | 47383 | 2062 | 57309 | 1497 | 38133 |
| 8L-3S | | MI | 18222 | 6088 | 29873 | 4383 | 32523 | 3556 | 33658 | 2914 | 34570 | 1929 | 41073 | 1641 | 24375 |
| 18-#11 | 1.95 | MA | 26268 | 6088 | 41895 | 4554 | 45258 | 3697 | 45958 | 3048 | 45316 | 2072 | 54641 | 1441 | 37242 |
| 9L-2S | | MI | 18777 | 6088 | 30723 | 4386 | 33607 | 3548 | 34972 | 2907 | 36304 | 1922 | 43355 | 1730 | 24357 |
| 18-#14 | 2.81 | MA | 30240 | 6528 | 50001 | 4808 | 55650 | 3866 | 58595 | 3152 | 62408 | 2018 | 77492 | 1528 | 56464 |
| 5L-6S | | MI | 17858 | 6528 | 30147 | 4639 | 32724 | 3737 | 33854 | 3027 | 34835 | 1876 | 42084 | 1199 | 32849 |
| 18-#14 | 2.81 | MA | 29433 | 6528 | 48606 | 4808 | 53753 | 3884 | 56282 | 3148 | 59344 | 2031 | 73571 | 1444 | 55325 |
| 6L-5S | | MI | 18341 | 6528 | 30968 | 4645 | 33837 | 3745 | 35144 | 3017 | 36542 | 1866 | 44167 | 1285 | 33303 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis

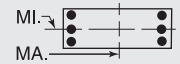


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.81 | MA | 28646 | 6528 | 47112 | 4827 | 51932 | 3882 | 54050 | 3164 | 56347 | 2043 | 69493 | 1318 | 53582 |
| 7L-4S | | MI | 18846 | 6528 | 31836 | 4651 | 34955 | 3734 | 36494 | 3007 | 38404 | 1876 | 46401 | 1343 | 34253 |
| 18-#14 | 2.81 | MA | 27869 | 6528 | 45743 | 4827 | 50095 | 3899 | 51866 | 3180 | 53207 | 2036 | 65655 | 1243 | 52050 |
| 8L-3S | | MI | 19405 | 6528 | 32821 | 4637 | 36208 | 3743 | 37994 | 3017 | 40288 | 1866 | 48499 | 1468 | 34373 |
| 18-#14 | 2.81 | MA | 27052 | 6528 | 44398 | 4826 | 48301 | 3897 | 49605 | 3176 | 50241 | 2049 | 61856 | 1162 | 49880 |
| 9L-2S | | MI | 20183 | 6528 | 34033 | 4642 | 37753 | 3732 | 39854 | 3007 | 42745 | 1856 | 51720 | 1596 | 34411 |
| 18-#18 | 5.00 | MA | 32961 | 7645 | 57995 | 5490 | 65461 | 4387 | 70438 | 3455 | 78535 | 1961 | 99996 | 936 | 90523 |
| 6L-5S | | MI | 20425 | 7645 | 36829 | 5298 | 41103 | 4216 | 43641 | 3267 | 47766 | 1688 | 59010 | 670 | 54520 |
| 18-#18 | 5.00 | MA | 31637 | 7645 | 55365 | 5523 | 62256 | 4417 | 66510 | 3482 | 73259 | 1980 | 92925 | 711 | 86286 |
| 7L-4S | | MI | 21276 | 7645 | 38345 | 5311 | 43046 | 4198 | 45953 | 3250 | 50957 | 1706 | 62809 | 774 | 56185 |
| 18-#18 | 5.00 | MA | 30331 | 7645 | 52953 | 5521 | 59022 | 4411 | 62664 | 3508 | 67733 | 1964 | 86246 | 580 | 81567 |
| 8L-3S | | MI | 22220 | 7645 | 40063 | 5289 | 45219 | 4216 | 48524 | 3267 | 54184 | 1688 | 66388 | 990 | 58682 |
| 20-#11 | 2.17 | MA | 29247 | 6198 | 47270 | 4609 | 52255 | 3724 | 54504 | 3060 | 56886 | 2042 | 69840 | 1683 | 44978 |
| 5L-7S | | MI | 17174 | 6198 | 28238 | 4466 | 30421 | 3613 | 31102 | 2945 | 31274 | 1932 | 37422 | 1361 | 26061 |
| 20-#11 | 2.17 | MA | 28676 | 6198 | 46298 | 4609 | 50933 | 3736 | 52892 | 3058 | 54751 | 2051 | 67087 | 1625 | 44062 |
| 6E | | MI | 17507 | 6198 | 28852 | 4456 | 31169 | 3604 | 32048 | 2952 | 32454 | 1925 | 38810 | 1429 | 26296 |
| 20-#11 | 2.17 | MA | 28119 | 6198 | 45258 | 4623 | 49665 | 3735 | 51337 | 3069 | 52663 | 2060 | 64224 | 1537 | 43483 |
| 7L-5S | | MI | 17849 | 6198 | 29426 | 4459 | 31948 | 3610 | 32959 | 2945 | 33660 | 1918 | 40288 | 1488 | 26672 |
| 20-#11 | 2.17 | MA | 27570 | 6198 | 44304 | 4623 | 48385 | 3748 | 49816 | 3081 | 50475 | 2056 | 61535 | 1485 | 42464 |
| 8L-4S | | MI | 18206 | 6198 | 30033 | 4462 | 32730 | 3601 | 33912 | 2938 | 34974 | 1925 | 41870 | 1528 | 26943 |
| 20-#11 | 2.17 | MA | 26977 | 6198 | 43368 | 4623 | 47135 | 3747 | 48241 | 3079 | 48408 | 2065 | 58867 | 1429 | 41595 |
| 9L-3S | | MI | 18603 | 6198 | 30723 | 4452 | 33607 | 3607 | 34972 | 2945 | 36304 | 1918 | 43355 | 1616 | 26968 |
| 20-#11 | 2.17 | MA | 26371 | 6198 | 42345 | 4637 | 45872 | 3759 | 46729 | 3090 | 46358 | 2074 | 56279 | 1366 | 40357 |
| 10L-2S | | MI | 19155 | 6198 | 31573 | 4456 | 34691 | 3598 | 36285 | 2938 | 38039 | 1911 | 45637 | 1705 | 26957 |
| 20-#14 | 3.13 | MA | 30414 | 6688 | 50716 | 4907 | 56443 | 3956 | 59552 | 3193 | 63775 | 2021 | 79593 | 1425 | 61585 |
| 6E | | MI | 18398 | 6688 | 31359 | 4739 | 34269 | 3809 | 35714 | 3070 | 37292 | 1859 | 45305 | 1160 | 36321 |
| 20-#14 | 3.13 | MA | 29633 | 6688 | 49222 | 4927 | 54622 | 3954 | 57320 | 3209 | 60777 | 2033 | 75514 | 1299 | 59768 |
| 7L-5S | | MI | 18878 | 6688 | 32180 | 4745 | 35382 | 3818 | 37004 | 3060 | 38999 | 1849 | 47388 | 1246 | 36853 |
| 20-#14 | 3.13 | MA | 28863 | 6688 | 47853 | 4926 | 52785 | 3972 | 55136 | 3225 | 57637 | 2026 | 71677 | 1224 | 58184 |
| 8L-4S | | MI | 19380 | 6688 | 33048 | 4750 | 36501 | 3807 | 38354 | 3050 | 40861 | 1859 | 49622 | 1304 | 37750 |
| 20-#14 | 3.13 | MA | 28048 | 6688 | 46508 | 4926 | 50991 | 3970 | 52876 | 3221 | 54672 | 2039 | 67878 | 1143 | 56059 |
| 9L-3S | | MI | 19936 | 6688 | 34033 | 4736 | 37753 | 3815 | 39854 | 3060 | 42745 | 1849 | 51720 | 1429 | 38037 |
| 20-#14 | 3.13 | MA | 27184 | 6688 | 45040 | 4946 | 49177 | 3987 | 50705 | 3237 | 51728 | 2051 | 64193 | 1052 | 53747 |
| 10L-2S | | MI | 20710 | 6688 | 35245 | 4742 | 39299 | 3804 | 41715 | 3050 | 45202 | 1839 | 54941 | 1557 | 38092 |
| 20-#18 | 5.56 | MA | 33315 | 7929 | 59066 | 5700 | 66975 | 4545 | 72246 | 3562 | 81030 | 1962 | 103371 | 671 | 97012 |
| 7L-5S | | MI | 21327 | 7929 | 38935 | 5476 | 43777 | 4344 | 46826 | 3341 | 51974 | 1653 | 64489 | 591 | 60451 |
| 20-#18 | 5.56 | MA | 32024 | 7929 | 56654 | 5698 | 63740 | 4540 | 68399 | 3588 | 75504 | 1947 | 96692 | 541 | 92245 |
| 8L-4S | | MI | 22171 | 7929 | 40450 | 5489 | 45720 | 4326 | 49138 | 3323 | 55165 | 1670 | 68287 | 696 | 62284 |
| 22-#11 | 2.38 | MA | 29369 | 6309 | 47771 | 4678 | 52811 | 3786 | 55175 | 3089 | 57843 | 2044 | 71313 | 1613 | 48431 |
| 6L-7S | | MI | 17559 | 6309 | 29088 | 4535 | 31505 | 3663 | 32415 | 2976 | 33009 | 1921 | 39704 | 1336 | 28514 |
| 22-#11 | 2.38 | MA | 28816 | 6309 | 46730 | 4692 | 51543 | 3785 | 53620 | 3101 | 55755 | 2053 | 68450 | 1525 | 47867 |
| 7L-6S | | MI | 17891 | 6309 | 29702 | 4525 | 32253 | 3654 | 33362 | 2983 | 34189 | 1914 | 41093 | 1404 | 28809 |
| 22-#11 | 2.38 | MA | 28270 | 6309 | 45777 | 4692 | 50263 | 3798 | 52098 | 3112 | 53567 | 2049 | 65761 | 1473 | 46801 |
| 8L-5S | | MI | 18231 | 6309 | 30276 | 4528 | 33032 | 3660 | 34273 | 2976 | 35395 | 1907 | 42570 | 1463 | 29166 |
| 22-#11 | 2.38 | MA | 27681 | 6309 | 44840 | 4692 | 49013 | 3797 | 50523 | 3110 | 51501 | 2058 | 63093 | 1417 | 45952 |
| 9L-4S | | MI | 18587 | 6309 | 30884 | 4532 | 33814 | 3651 | 35226 | 2969 | 36709 | 1914 | 44153 | 1503 | 29515 |
| 22-#11 | 2.38 | MA | 27078 | 6309 | 43818 | 4706 | 47749 | 3809 | 49011 | 3121 | 49450 | 2067 | 60505 | 1353 | 44682 |
| 10L-3S | | MI | 18981 | 6309 | 31573 | 4521 | 34691 | 3657 | 36285 | 2976 | 38039 | 1907 | 45637 | 1591 | 29549 |
| 22-#11 | 2.38 | MA | 26488 | 6309 | 42882 | 4706 | 46506 | 3808 | 47455 | 3119 | 47293 | 2063 | 57879 | 1298 | 43431 |
| 11L-2S | | MI | 19531 | 6309 | 32423 | 4525 | 35775 | 3648 | 37599 | 2969 | 39774 | 1900 | 47919 | 1680 | 29553 |
| 22-#14 | 3.44 | MA | 30613 | 6847 | 51332 | 5027 | 57312 | 4026 | 60590 | 3254 | 65207 | 2024 | 81536 | 1280 | 65963 |
| 7L-6S | | MI | 18935 | 6847 | 32571 | 4839 | 35815 | 3882 | 37574 | 3114 | 39748 | 1841 | 48526 | 1122 | 39788 |
| 22-#14 | 3.44 | MA | 29849 | 6847 | 49963 | 5026 | 55475 | 4044 | 58406 | 3270 | 62068 | 2016 | 77698 | 1205 | 64326 |
| 8L-5S | | MI | 19412 | 6847 | 33392 | 4844 | 36928 | 3890 | 38864 | 3104 | 41456 | 1831 | 50609 | 1208 | 40410 |
| 22-#14 | 3.44 | MA | 29035 | 6847 | 48618 | 5026 | 53681 | 4042 | 56146 | 3266 | 59102 | 2029 | 73899 | 1124 | 62246 |
| 9L-4S | | MI | 19910 | 6847 | 34260 | 4850 | 38046 | 3879 | 40214 | 3094 | 43318 | 1841 | 52843 | 1266 | 41259 |
| 22-#14 | 3.44 | MA | 28182 | 6847 | 47150 | 5045 | 51867 | 4060 | 53975 | 3282 | 56158 | 2041 | 70214 | 1033 | 59902 |
| 10L-3S | | MI | 20464 | 6847 | 35245 | 4836 | 39299 | 3887 | 41715 | 3104 | 45202 | 1831 | 54941 | 1390 | 41694 |

## RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 22-#18 | 6.11 | MA | 33700 | 8213 | 60355 | 5875 | 68458 | 4668 | 74135 | 3668 | 83275 | 1929 | 107138 | 501 | 102938 |
| 8L-5S | | MI | 22224 | 8213 | 41040 | 5653 | 46451 | 4472 | 50012 | 3414 | 56183 | 1617 | 69967 | 513 | 66406 |
| 24-#11 | 2.60 | MA | 29508 | 6420 | 48203 | 4761 | 53420 | 3835 | 55902 | 3132 | 58847 | 2046 | 72676 | 1513 | 52253 |
| 7E | | MI | 17942 | 6420 | 29939 | 4604 | 32589 | 3713 | 33729 | 3007 | 34744 | 1910 | 41986 | 1311 | 30973 |
| 24-#11 | 2.60 | MA | 28966 | 6420 | 47249 | 4761 | 52140 | 3848 | 54380 | 3143 | 56659 | 2042 | 69987 | 1460 | 51143 |
| 8L-6S | | MI | 18273 | 6420 | 30553 | 4594 | 33337 | 3705 | 34675 | 3014 | 35923 | 1903 | 43375 | 1379 | 31324 |
| 24-#11 | 2.60 | MA | 28380 | 6420 | 46313 | 4761 | 50890 | 3847 | 52806 | 3141 | 54593 | 2051 | 67319 | 1404 | 50277 |
| 9L-5S | | MI | 18611 | 6420 | 31127 | 4597 | 34116 | 3710 | 35586 | 3007 | 37129 | 1896 | 44852 | 1438 | 31665 |
| 24-#11 | 2.60 | MA | 27780 | 6420 | 45290 | 4775 | 49627 | 3860 | 51293 | 3152 | 52542 | 2060 | 64731 | 1341 | 49012 |
| 10L-4S | | MI | 18965 | 6420 | 31734 | 4601 | 34898 | 3701 | 36540 | 3000 | 38443 | 1903 | 46435 | 1478 | 32083 |
| 24-#11 | 2.60 | MA | 27194 | 6420 | 44354 | 4775 | 48384 | 3858 | 49737 | 3150 | 50385 | 2056 | 62105 | 1286 | 47737 |
| 11L-3S | | MI | 19358 | 6420 | 32423 | 4590 | 35775 | 3707 | 37599 | 3007 | 39774 | 1896 | 47919 | 1566 | 32127 |
| 24-#11 | 2.60 | MA | 26618 | 6420 | 43348 | 4789 | 47129 | 3871 | 48229 | 3162 | 48337 | 2065 | 59213 | 1211 | 46430 |
| 12L-2S | | MI | 19906 | 6420 | 33274 | 4594 | 36859 | 3698 | 38912 | 3000 | 41509 | 1889 | 50201 | 1655 | 32146 |
| 24-#14 | 3.75 | MA | 30827 | 7007 | 52072 | 5126 | 58165 | 4116 | 61676 | 3315 | 66498 | 2006 | 83720 | 1186 | 70477 |
| 8L-6S | | MI | 19469 | 7007 | 33783 | 4938 | 37360 | 3954 | 39434 | 3157 | 42205 | 1824 | 51747 | 1083 | 43265 |
| 24-#14 | 3.75 | MA | 30015 | 7007 | 50728 | 5126 | 56370 | 4114 | 59416 | 3311 | 63532 | 2019 | 79921 | 1105 | 68439 |
| 9L-5S | | MI | 19943 | 7007 | 34604 | 4944 | 38473 | 3962 | 40724 | 3147 | 43913 | 1814 | 53830 | 1169 | 43973 |
| 24-#14 | 3.75 | MA | 29190 | 7007 | 49260 | 5145 | 54557 | 4132 | 57245 | 3327 | 60589 | 2031 | 76236 | 1014 | 66063 |
| 10L-4S | | MI | 20438 | 7007 | 35472 | 4950 | 39592 | 3951 | 42074 | 3137 | 45774 | 1824 | 56064 | 1227 | 44778 |

## RECTANGULAR TIED COLUMNS 32" x 32"

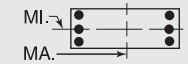
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#14 | 1.32 | MA | 13407 | 4100 | 21425 | 2979 | 23110 | 2422 | 23657 | 2007 | 23750 | 1393 | 27914 | 1286 | 12718 |
| 2L-3S | | MI | 12541 | 4100 | 20113 | 2975 | 21438 | 2434 | 21627 | 2017 | 21069 | 1403 | 24383 | 1158 | 12773 |
| 6-#18 | 2.34 | MA | 14672 | 4472 | 24410 | 3186 | 26812 | 2569 | 27978 | 2083 | 29444 | 1329 | 35282 | 1163 | 21800 |
| 2L-3S | | MI | 13197 | 4472 | 22128 | 3175 | 23902 | 2589 | 24490 | 2100 | 24837 | 1347 | 29255 | 935 | 21710 |
| 8-#11 | 1.22 | MA | 13301 | 4063 | 21128 | 2970 | 22785 | 2416 | 23291 | 2007 | 23309 | 1407 | 27370 | 1307 | 11857 |
| 2L-4S | | MI | 12256 | 4063 | 19464 | 2978 | 20667 | 2421 | 20719 | 2008 | 19968 | 1421 | 23250 | 1130 | 11914 |
| 8-#14 | 1.76 | MA | 13998 | 4259 | 22737 | 3079 | 24783 | 2494 | 25688 | 2052 | 26431 | 1377 | 31444 | 1250 | 16750 |
| 2L-4S | | MI | 12524 | 4259 | 20361 | 3089 | 21758 | 2499 | 22020 | 2052 | 21694 | 1397 | 25618 | 995 | 16675 |
| 8-#18 | 3.13 | MA | 15664 | 4756 | 26693 | 3364 | 29722 | 2698 | 31465 | 2159 | 34050 | 1297 | 41309 | 1091 | 28752 |
| 2L-4S | | MI | 13161 | 4756 | 22553 | 3377 | 24451 | 2701 | 25164 | 2159 | 25912 | 1332 | 31353 | 644 | 26110 |
| 10-#11 | 1.52 | MA | 13720 | 4174 | 22047 | 3039 | 23957 | 2466 | 24716 | 2038 | 25200 | 1397 | 29868 | 1285 | 14684 |
| 2L-5S | | MI | 12292 | 4174 | 19729 | 3044 | 20996 | 2480 | 21111 | 2046 | 20427 | 1404 | 24018 | 1067 | 14386 |
| 10-#11 | 1.52 | MA | 13115 | 4174 | 21128 | 3036 | 22785 | 2476 | 23291 | 2045 | 23309 | 1404 | 27370 | 1196 | 14712 |
| 3L-4S | | MI | 12681 | 4174 | 20384 | 3047 | 21839 | 2471 | 22143 | 2039 | 21859 | 1411 | 25747 | 1107 | 14701 |
| 10-#14 | 2.20 | MA | 14583 | 4419 | 24049 | 3179 | 26456 | 2567 | 27718 | 2096 | 29113 | 1362 | 34975 | 1215 | 20764 |
| 2L-5S | | MI | 12572 | 4419 | 20737 | 3184 | 22225 | 2584 | 22577 | 2106 | 22344 | 1372 | 26701 | 903 | 19411 |
| 10-#14 | 2.20 | MA | 13732 | 4419 | 22737 | 3174 | 24783 | 2579 | 25688 | 2106 | 26431 | 1372 | 31444 | 1087 | 20747 |
| 3L-4S | | MI | 13122 | 4419 | 21673 | 3189 | 23431 | 2572 | 24050 | 2096 | 24375 | 1382 | 29149 | 960 | 20536 |
| 10-#18 | 3.91 | MA | 16643 | 5039 | 28975 | 3541 | 32631 | 2827 | 34953 | 2235 | 38657 | 1265 | 47335 | 1019 | 35667 |
| 2L-5S | | MI | 13242 | 5039 | 23198 | 3543 | 25252 | 2848 | 26120 | 2252 | 27027 | 1283 | 33201 | 468 | 30386 |
| 10-#18 | 3.91 | MA | 15206 | 5039 | 26693 | 3530 | 29722 | 2846 | 31465 | 2252 | 34050 | 1283 | 41309 | 792 | 35374 |
| 3L-4S | | MI | 14173 | 5039 | 24835 | 3554 | 27361 | 2829 | 28651 | 2235 | 30518 | 1300 | 37380 | 572 | 32614 |

## RECTANGULAR TIED COLUMNS 32" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#18 | 1.47 | MA | 15340 | 4415 | 24692 | 3193 | 26693 | 2592 | 27391 | 2140 | 27710 | 1466 | 32660 | 1342 | 15879 |
| 2E | | MI | 14391 | 4415 | 23226 | 3175 | 25032 | 2577 | 25585 | 2123 | 25814 | 1450 | 30330 | 1321 | 14844 |
| 6-#14 | 1.24 | MA | 15056 | 4326 | 23926 | 3163 | 25829 | 2573 | 26428 | 2136 | 26503 | 1496 | 31157 | 1390 | 13630 |
| 2L-3S | | MI | 13265 | 4326 | 21206 | 3142 | 22569 | 2572 | 22725 | 2134 | 22050 | 1493 | 25466 | 1245 | 12816 |
| 6-#14 | 1.24 | MA | 14121 | 4326 | 22515 | 3159 | 24030 | 2587 | 24240 | 2147 | 23597 | 1506 | 27316 | 1262 | 13684 |
| 3L-2S | | MI | 14133 | 4326 | 22518 | 3147 | 24241 | 2560 | 24755 | 2124 | 24732 | 1483 | 28996 | 1373 | 12755 |
| 6-#18 | 2.21 | MA | 16437 | 4698 | 27152 | 3370 | 29829 | 2721 | 31181 | 2218 | 32715 | 1437 | 39237 | 1276 | 23420 |
| 2L-3S | | MI | 13922 | 4698 | 23226 | 3341 | 25032 | 2725 | 25585 | 2216 | 25814 | 1436 | 30330 | 1021 | 21798 |

## RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

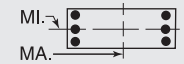
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#18 | 2.21 | MA | 14842 | 4698 | 24692 | 3361 | 26693 | 2742 | 27391 | 2236 | 27710 | 1454 | 32660 | 1048 | 23330 |
| 3L-2S | | MI | 15401 | 4698 | 25508 | 3352 | 27942 | 2706 | 29072 | 2199 | 30420 | 1418 | 36357 | 1249 | 21854 |
| 8-#11 | 1.15 | MA | 14939 | 4290 | 23603 | 3154 | 25475 | 2568 | 26018 | 2135 | 26014 | 1509 | 30548 | 1410 | 12700 |
| 2L-4S | | MI | 12980 | 4290 | 20555 | 3146 | 21798 | 2559 | 21818 | 2125 | 20953 | 1511 | 24336 | 1217 | 11961 |
| 8-#11 | 1.15 | MA | 14282 | 4290 | 22614 | 3151 | 24214 | 2577 | 24486 | 2143 | 23968 | 1516 | 27836 | 1322 | 12740 |
| 3E | | MI | 13417 | 4290 | 21299 | 3135 | 22744 | 2564 | 22965 | 2132 | 22403 | 1504 | 25960 | 1306 | 11933 |
| 8-#11 | 1.15 | MA | 13814 | 4290 | 21816 | 3163 | 23199 | 2573 | 23254 | 2138 | 22398 | 1523 | 26069 | 1233 | 12757 |
| 4L-2S | | MI | 14027 | 4290 | 22218 | 3138 | 23916 | 2555 | 24390 | 2124 | 24293 | 1497 | 28457 | 1395 | 11890 |
| 8-#14 | 1.65 | MA | 15698 | 4486 | 25338 | 3263 | 27629 | 2646 | 28616 | 2181 | 29410 | 1482 | 34997 | 1358 | 17965 |
| 2L-4S | | MI | 13248 | 4486 | 21454 | 3257 | 22889 | 2637 | 23118 | 2169 | 22675 | 1487 | 26701 | 1082 | 16754 |
| 8-#14 | 1.65 | MA | 14772 | 4486 | 23926 | 3259 | 25829 | 2659 | 26428 | 2192 | 26503 | 1492 | 31157 | 1230 | 17986 |
| 3E | | MI | 13865 | 4486 | 22518 | 3242 | 24241 | 2645 | 24755 | 2179 | 24732 | 1477 | 28996 | 1209 | 16824 |
| 8-#14 | 1.65 | MA | 14109 | 4486 | 22784 | 3275 | 24378 | 2652 | 24666 | 2183 | 24274 | 1502 | 28659 | 1102 | 17890 |
| 4L-2S | | MI | 14726 | 4486 | 23830 | 3247 | 25914 | 2632 | 26786 | 2169 | 27413 | 1467 | 32527 | 1337 | 16791 |
| 8-#18 | 2.94 | MA | 17516 | 4982 | 29612 | 3547 | 32965 | 2849 | 34971 | 2296 | 37720 | 1408 | 45813 | 1210 | 30912 |
| 2L-4S | | MI | 13885 | 4982 | 23651 | 3543 | 25581 | 2837 | 26259 | 2275 | 26888 | 1421 | 32428 | 730 | 26431 |
| 8-#18 | 2.94 | MA | 15942 | 4982 | 27152 | 3538 | 29829 | 2870 | 31181 | 2314 | 32715 | 1425 | 39237 | 982 | 30710 |
| 3E | | MI | 14936 | 4982 | 25508 | 3519 | 27942 | 2854 | 29072 | 2292 | 30420 | 1404 | 36357 | 950 | 28650 |
| 8-#18 | 2.94 | MA | 14814 | 4982 | 25156 | 3564 | 27291 | 2856 | 28124 | 2296 | 28876 | 1443 | 34957 | 759 | 28320 |
| 4L-2S | | MI | 16396 | 4982 | 27790 | 3530 | 30852 | 2834 | 32560 | 2275 | 35027 | 1386 | 42384 | 1177 | 28817 |
| 10-#11 | 1.43 | MA | 15393 | 4400 | 24591 | 3223 | 26735 | 2618 | 27550 | 2166 | 28061 | 1501 | 33261 | 1390 | 15737 |
| 2L-5S | | MI | 13016 | 4400 | 20820 | 3213 | 22127 | 2619 | 22211 | 2164 | 21412 | 1494 | 25104 | 1154 | 14542 |
| 10-#11 | 1.43 | MA | 14741 | 4400 | 23603 | 3221 | 25475 | 2628 | 26018 | 2174 | 26014 | 1507 | 30548 | 1301 | 15765 |
| 3L-4S | | MI | 13406 | 4400 | 21474 | 3215 | 22970 | 2609 | 23243 | 2156 | 22843 | 1501 | 26833 | 1194 | 14754 |
| 10-#11 | 1.43 | MA | 14275 | 4400 | 22804 | 3232 | 24460 | 2624 | 24787 | 2169 | 24444 | 1514 | 28781 | 1212 | 15754 |
| 4L-3S | | MI | 13840 | 4400 | 22218 | 3204 | 23916 | 2614 | 24390 | 2163 | 24293 | 1494 | 28457 | 1283 | 14752 |
| 10-#11 | 1.43 | MA | 13857 | 4400 | 22103 | 3230 | 23555 | 2633 | 23679 | 2177 | 22895 | 1507 | 26909 | 1171 | 15512 |
| 5L-2S | | MI | 14447 | 4400 | 23138 | 3207 | 25088 | 2605 | 25815 | 2155 | 26184 | 1487 | 30954 | 1372 | 14720 |
| 10-#14 | 2.07 | MA | 16334 | 4645 | 26750 | 3363 | 29429 | 2718 | 30804 | 2226 | 32316 | 1468 | 38838 | 1325 | 22283 |
| 2L-5S | | MI | 13296 | 4645 | 21830 | 3352 | 23356 | 2722 | 23675 | 2223 | 23326 | 1462 | 27783 | 990 | 19607 |
| 10-#14 | 2.07 | MA | 15415 | 4645 | 25338 | 3359 | 27629 | 2731 | 28616 | 2237 | 29410 | 1478 | 34997 | 1197 | 22266 |
| 3L-4S | | MI | 13847 | 4645 | 22766 | 3357 | 24562 | 2709 | 25148 | 2213 | 25357 | 1472 | 30232 | 1047 | 20692 |
| 10-#14 | 2.07 | MA | 14759 | 4645 | 24196 | 3375 | 26177 | 2725 | 26854 | 2228 | 27180 | 1488 | 32499 | 1069 | 22124 |
| 4L-3S | | MI | 14459 | 4645 | 23830 | 3342 | 25914 | 2717 | 26786 | 2223 | 27413 | 1462 | 32527 | 1174 | 20806 |
| 10-#14 | 2.07 | MA | 14168 | 4645 | 23192 | 3371 | 24883 | 2738 | 25270 | 2239 | 24980 | 1478 | 29841 | 1011 | 20943 |
| 5L-2S | | MI | 15313 | 4645 | 25142 | 3346 | 27586 | 2704 | 28816 | 2213 | 30094 | 1452 | 36057 | 1302 | 20809 |
| 10-#18 | 3.68 | MA | 18581 | 5266 | 32072 | 3725 | 36101 | 2978 | 38761 | 2374 | 42726 | 1378 | 52389 | 1144 | 38367 |
| 2L-5S | | MI | 13964 | 5266 | 24296 | 3709 | 26382 | 2985 | 27215 | 2368 | 28003 | 1372 | 34276 | 555 | 30897 |
| 10-#18 | 3.68 | MA | 17027 | 5266 | 29612 | 3715 | 32965 | 2999 | 34971 | 2392 | 37720 | 1396 | 45813 | 917 | 38074 |
| 3L-4S | | MI | 14898 | 5266 | 25933 | 3720 | 28491 | 2966 | 29746 | 2350 | 31494 | 1389 | 38455 | 658 | 32928 |
| 10-#18 | 3.68 | MA | 15914 | 5266 | 27615 | 3741 | 30427 | 2984 | 31914 | 2374 | 33882 | 1414 | 41533 | 693 | 35340 |
| 4L-3S | | MI | 15936 | 5266 | 27790 | 3696 | 30852 | 2982 | 32560 | 2368 | 35027 | 1372 | 42384 | 878 | 35484 |
| 10-#18 | 3.68 | MA | 14913 | 5266 | 25857 | 3732 | 28161 | 3006 | 29163 | 2392 | 30090 | 1396 | 36973 | 590 | 33152 |
| 5L-2S | | MI | 17379 | 5266 | 30073 | 3707 | 33762 | 2963 | 36047 | 2350 | 39633 | 1354 | 48410 | 1105 | 35738 |
| 12-#11 | 1.72 | MA | 15844 | 4511 | 25580 | 3292 | 27995 | 2668 | 29082 | 2197 | 30108 | 1492 | 35973 | 1369 | 18765 |
| 2L-6S | | MI | 13070 | 4511 | 21121 | 3279 | 22460 | 2664 | 22649 | 2202 | 21988 | 1491 | 25983 | 1073 | 16734 |
| 12-#11 | 1.72 | MA | 15195 | 4511 | 24591 | 3290 | 26735 | 2678 | 27550 | 2205 | 28061 | 1498 | 33261 | 1280 | 18780 |
| 3L-5S | | MI | 13441 | 4511 | 21739 | 3282 | 23299 | 2669 | 23636 | 2195 | 23302 | 1484 | 27601 | 1132 | 17202 |
| 12-#11 | 1.72 | MA | 14733 | 4511 | 23793 | 3301 | 25720 | 2674 | 26319 | 2200 | 26491 | 1505 | 31493 | 1191 | 18742 |
| 4E | | MI | 13829 | 4511 | 22394 | 3285 | 24143 | 2660 | 24668 | 2187 | 24734 | 1491 | 29330 | 1172 | 17537 |
| 12-#11 | 1.72 | MA | 14318 | 4511 | 23092 | 3299 | 24816 | 2683 | 25212 | 2208 | 24942 | 1498 | 29621 | 1150 | 18376 |
| 5L-3S | | MI | 14260 | 4511 | 23138 | 3274 | 25088 | 2664 | 25815 | 2194 | 26184 | 1484 | 30954 | 1260 | 17560 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis



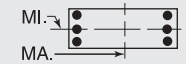

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.72 | MA | 13921 | 4511 | 22429 | 3296 | 23916 | 2679 | 24115 | 2202 | 23519 | 1505 | 27861 | 1091 | 17851 |
| 6L-2S | | MI | 14863 | 4511 | 24057 | 3277 | 26261 | 2655 | 27240 | 2186 | 28075 | 1477 | 33451 | 1349 | 17540 |
| 12-#14 | 2.48 | MA | 16963 | 4805 | 28161 | 3463 | 31229 | 2790 | 32991 | 2271 | 35222 | 1454 | 42679 | 1293 | 26586 |
| 2L-6S | | MI | 13373 | 4805 | 22257 | 3447 | 23828 | 2787 | 24297 | 2278 | 24143 | 1456 | 29027 | 869 | 22595 |
| 12-#14 | 2.48 | MA | 16052 | 4805 | 26750 | 3459 | 29429 | 2804 | 30804 | 2282 | 32316 | 1464 | 38838 | 1165 | 26533 |
| 3L-5S | | MI | 13894 | 4805 | 23142 | 3452 | 25028 | 2794 | 25705 | 2268 | 26007 | 1446 | 31314 | 954 | 23416 |
| 12-#14 | 2.48 | MA | 15401 | 4805 | 25608 | 3474 | 27977 | 2797 | 29042 | 2273 | 30087 | 1474 | 36340 | 1037 | 26262 |
| 4E | | MI | 14441 | 4805 | 24078 | 3456 | 26235 | 2782 | 27179 | 2258 | 28038 | 1456 | 33762 | 1012 | 24503 |
| 12-#14 | 2.48 | MA | 14816 | 4805 | 24604 | 3470 | 26683 | 2810 | 27458 | 2284 | 27886 | 1464 | 33682 | 979 | 25047 |
| 5L-3S | | MI | 15047 | 4805 | 25142 | 3441 | 27586 | 2789 | 28816 | 2268 | 30094 | 1446 | 36057 | 1139 | 24775 |
| 12-#14 | 2.48 | MA | 14258 | 4805 | 23655 | 3466 | 25395 | 2804 | 25944 | 2294 | 25866 | 1474 | 31192 | 894 | 24158 |
| 6L-2S | | MI | 15894 | 4805 | 26454 | 3446 | 29259 | 2777 | 30846 | 2258 | 32776 | 1436 | 39588 | 1267 | 24815 |
| 12-#18 | 4.41 | MA | 18098 | 5549 | 32072 | 3893 | 36101 | 3127 | 38761 | 2470 | 42726 | 1367 | 52389 | 851 | 45427 |
| 3L-5S | | MI | 14977 | 5549 | 26578 | 3887 | 29292 | 3114 | 30702 | 2444 | 32610 | 1340 | 40302 | 483 | 37261 |
| 12-#18 | 4.41 | MA | 16999 | 5549 | 30075 | 3919 | 33563 | 3113 | 35704 | 2453 | 38887 | 1385 | 48110 | 627 | 42402 |
| 4E | | MI | 15899 | 5549 | 28215 | 3898 | 31401 | 3094 | 33234 | 2426 | 36101 | 1357 | 44481 | 586 | 39466 |
| 12-#18 | 4.41 | MA | 16012 | 5549 | 28317 | 3909 | 31297 | 3134 | 32953 | 2470 | 35095 | 1367 | 43550 | 524 | 40042 |
| 5L-3S | | MI | 16924 | 5549 | 30073 | 3873 | 33762 | 3111 | 36047 | 2444 | 39633 | 1340 | 48410 | 806 | 42306 |
| 14-#11 | 2.01 | MA | 16291 | 4622 | 26568 | 3361 | 29256 | 2718 | 30614 | 2228 | 32154 | 1483 | 38685 | 1348 | 21785 |
| 2L-7S | | MI | 13136 | 4622 | 21379 | 3359 | 22826 | 2723 | 23050 | 2227 | 22592 | 1488 | 26792 | 962 | 18910 |
| 14-#11 | 2.01 | MA | 15646 | 4622 | 25580 | 3359 | 27995 | 2728 | 29082 | 2237 | 30108 | 1490 | 35973 | 1259 | 21780 |
| 3L-6S | | MI | 13495 | 4622 | 22041 | 3348 | 23633 | 2714 | 24074 | 2233 | 23879 | 1481 | 28480 | 1050 | 19434 |
| 14-#11 | 2.01 | MA | 15187 | 4622 | 24781 | 3370 | 26980 | 2724 | 27851 | 2231 | 28538 | 1496 | 34206 | 1170 | 21725 |
| 4L-5S | | MI | 13864 | 4622 | 22659 | 3351 | 24471 | 2719 | 25060 | 2226 | 25193 | 1474 | 30098 | 1109 | 19874 |
| 14-#11 | 2.01 | MA | 14775 | 4622 | 24080 | 3368 | 26076 | 2734 | 26744 | 2239 | 26988 | 1490 | 32334 | 1129 | 21252 |
| 5L-4S | | MI | 14249 | 4622 | 23313 | 3354 | 25315 | 2710 | 26093 | 2219 | 26624 | 1481 | 31827 | 1149 | 20314 |
| 14-#11 | 2.01 | MA | 14381 | 4622 | 23417 | 3366 | 25177 | 2730 | 25647 | 2233 | 25565 | 1496 | 30574 | 1071 | 20756 |
| 6L-3S | | MI | 14677 | 4622 | 24057 | 3343 | 26261 | 2714 | 27240 | 2225 | 28075 | 1474 | 33451 | 1238 | 20356 |
| 14-#11 | 2.01 | MA | 13996 | 4622 | 22708 | 3377 | 24313 | 2739 | 24588 | 2242 | 24173 | 1503 | 28740 | 983 | 20184 |
| 7L-2S | | MI | 15276 | 4622 | 24977 | 3346 | 27433 | 2705 | 28665 | 2218 | 29965 | 1468 | 35948 | 1326 | 20352 |
| 14-#14 | 2.90 | MA | 17587 | 4964 | 29573 | 3562 | 33029 | 2863 | 35179 | 2316 | 38128 | 1440 | 46519 | 1260 | 30873 |
| 2L-7S | | MI | 13465 | 4964 | 22622 | 3562 | 24347 | 2871 | 24865 | 2313 | 25001 | 1450 | 30411 | 734 | 25242 |
| 14-#14 | 2.90 | MA | 16682 | 4964 | 28161 | 3558 | 31229 | 2876 | 32991 | 2327 | 35222 | 1450 | 42679 | 1132 | 30792 |
| 3L-6S | | MI | 13970 | 4964 | 23569 | 3547 | 25500 | 2859 | 26327 | 2323 | 26824 | 1441 | 32558 | 833 | 26321 |
| 14-#14 | 2.90 | MA | 16038 | 4964 | 27020 | 3574 | 29777 | 2869 | 31230 | 2318 | 32993 | 1460 | 40181 | 1004 | 30308 |
| 4L-5S | | MI | 14487 | 4964 | 24454 | 3551 | 26701 | 2866 | 27735 | 2313 | 28688 | 1431 | 34844 | 919 | 27238 |
| 14-#14 | 2.90 | MA | 15458 | 4964 | 26015 | 3570 | 28483 | 2883 | 29646 | 2328 | 30792 | 1450 | 37523 | 946 | 29165 |
| 5L-4S | | MI | 15028 | 4964 | 25390 | 3556 | 27907 | 2854 | 29209 | 2303 | 30719 | 1441 | 37293 | 976 | 28257 |
| 14-#14 | 2.90 | MA | 14905 | 4964 | 25066 | 3566 | 27195 | 2876 | 28132 | 2339 | 28772 | 1460 | 35033 | 861 | 28181 |
| 6L-3S | | MI | 15630 | 4964 | 26454 | 3541 | 29259 | 2861 | 30846 | 2313 | 32776 | 1431 | 39588 | 1103 | 28735 |
| 14-#14 | 2.90 | MA | 14365 | 4964 | 24051 | 3582 | 25958 | 2890 | 26560 | 2330 | 26795 | 1470 | 32437 | 734 | 26981 |
| 7L-2S | | MI | 16470 | 4964 | 27766 | 3546 | 30932 | 2849 | 32877 | 2303 | 35457 | 1421 | 43118 | 1231 | 28802 |
| 14-#18 | 5.15 | MA | 18072 | 5833 | 32535 | 4096 | 36699 | 3242 | 39494 | 2531 | 43892 | 1355 | 54686 | 561 | 49497 |
| 4L-5S | | MI | 15977 | 5833 | 28861 | 4064 | 32202 | 3242 | 34190 | 2520 | 37216 | 1307 | 46329 | 411 | 43662 |
| 14-#18 | 5.15 | MA | 17097 | 5833 | 30776 | 4087 | 34433 | 3263 | 36743 | 2549 | 40100 | 1338 | 50126 | 458 | 46968 |
| 5L-4S | | MI | 16888 | 5833 | 30498 | 4075 | 34311 | 3223 | 36721 | 2502 | 40707 | 1325 | 50508 | 514 | 46038 |
| 16-#11 | 2.29 | MA | 16735 | 4732 | 27557 | 3430 | 30516 | 2768 | 32147 | 2260 | 34201 | 1474 | 41398 | 1327 | 24800 |
| 2L-8S | | MI | 13208 | 4732 | 21691 | 3425 | 23185 | 2769 | 23507 | 2266 | 23213 | 1485 | 27675 | 892 | 20974 |
| 16-#11 | 2.29 | MA | 16094 | 4732 | 26568 | 3428 | 29256 | 2778 | 30614 | 2268 | 32154 | 1481 | 38685 | 1238 | 24776 |
| 3L-7S | | MI | 13560 | 4732 | 22298 | 3428 | 23998 | 2774 | 24475 | 2258 | 24483 | 1478 | 29289 | 939 | 21555 |
| 16-#11 | 2.29 | MA | 15638 | 4732 | 25770 | 3439 | 28241 | 2774 | 29383 | 2262 | 30584 | 1488 | 36918 | 1150 | 24703 |
| 4L-6S | | MI | 13917 | 4732 | 22960 | 3417 | 24805 | 2764 | 25499 | 2265 | 25769 | 1471 | 30977 | 1027 | 22138 |
| 16-#11 | 2.29 | MA | 15228 | 4732 | 25069 | 3437 | 27336 | 2784 | 28276 | 2270 | 29035 | 1481 | 35046 | 1109 | 24137 |
| 5E | | MI | 14283 | 4732 | 23578 | 3420 | 25644 | 2769 | 26485 | 2257 | 27083 | 1465 | 32595 | 1086 | 22555 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis

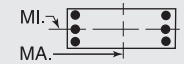



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.29 | MA | 14837 | 4732 | 24406 | 3435 | 26437 | 2780 | 27179 | 2265 | 27612 | 1488 | 33286 | 1050 | 23666 |
| 6L-4S | | MI | 14666 | 4732 | 24233 | 3423 | 26487 | 2760 | 27518 | 2250 | 28515 | 1471 | 34325 | 1126 | 23085 |
| 16-#11 | 2.29 | MA | 14455 | 4732 | 23697 | 3446 | 25573 | 2790 | 26121 | 2273 | 26220 | 1494 | 31452 | 962 | 23035 |
| 7L-3S | | MI | 15091 | 4732 | 24977 | 3412 | 27433 | 2765 | 28665 | 2256 | 29965 | 1465 | 35948 | 1215 | 23145 |
| 16-#11 | 2.29 | MA | 14079 | 4732 | 23046 | 3444 | 24701 | 2786 | 25084 | 2281 | 24760 | 1488 | 29704 | 914 | 22388 |
| 8L-2S | | MI | 15687 | 4732 | 25896 | 3415 | 28605 | 2755 | 30090 | 2249 | 31856 | 1458 | 38445 | 1304 | 23159 |
| 16-#14 | 3.31 | MA | 17308 | 5124 | 29573 | 3658 | 33029 | 2948 | 35179 | 2371 | 38128 | 1436 | 46519 | 1100 | 35044 |
| 3L-7S | | MI | 14061 | 5124 | 23934 | 3661 | 26019 | 2944 | 26895 | 2357 | 27682 | 1435 | 33941 | 699 | 29033 |
| 16-#14 | 3.31 | MA | 16669 | 5124 | 28431 | 3674 | 31577 | 2942 | 33418 | 2362 | 35899 | 1446 | 44021 | 972 | 34373 |
| 4L-6S | | MI | 14561 | 5124 | 24881 | 3646 | 27173 | 2931 | 28358 | 2367 | 29506 | 1425 | 36089 | 798 | 30064 |
| 16-#14 | 3.31 | MA | 16094 | 5124 | 27427 | 3670 | 30283 | 2955 | 31834 | 2373 | 33698 | 1436 | 41363 | 914 | 33294 |
| 5E | | MI | 15074 | 5124 | 25766 | 3651 | 28374 | 2939 | 29766 | 2357 | 31370 | 1415 | 38375 | 884 | 31071 |
| 16-#14 | 3.31 | MA | 15546 | 5124 | 26478 | 3666 | 28995 | 2949 | 30320 | 2384 | 31678 | 1446 | 38873 | 829 | 32219 |
| 6L-4S | | MI | 15611 | 5124 | 26702 | 3656 | 29580 | 2926 | 31239 | 2347 | 33401 | 1425 | 40823 | 941 | 32029 |
| 16-#14 | 3.31 | MA | 15011 | 5124 | 25463 | 3682 | 27758 | 2962 | 28748 | 2375 | 29701 | 1456 | 36278 | 702 | 31070 |
| 7L-3S | | MI | 16208 | 5124 | 27766 | 3641 | 30932 | 2934 | 32877 | 2357 | 35457 | 1415 | 43118 | 1068 | 32688 |
| 16-#18 | 5.88 | MA | 18170 | 6117 | 33236 | 4264 | 37569 | 3391 | 40533 | 2627 | 45106 | 1309 | 56702 | 392 | 53927 |
| 5E | | MI | 16967 | 6117 | 31143 | 4241 | 35112 | 3371 | 37677 | 2596 | 41823 | 1275 | 52356 | 339 | 50095 |
| 18-#11 | 2.58 | MA | 16539 | 4843 | 27557 | 3497 | 30516 | 2828 | 32147 | 2299 | 34201 | 1472 | 41398 | 1217 | 27767 |
| 3L-8S | | MI | 13631 | 4843 | 22610 | 3494 | 24357 | 2819 | 24932 | 2297 | 25104 | 1475 | 30172 | 869 | 23650 |
| 18-#11 | 2.58 | MA | 16086 | 4843 | 26759 | 3509 | 29501 | 2824 | 30915 | 2293 | 32631 | 1479 | 39631 | 1129 | 27678 |
| 4L-7S | | MI | 13981 | 4843 | 23218 | 3497 | 25171 | 2824 | 25900 | 2289 | 26374 | 1468 | 31786 | 916 | 24209 |
| 18-#11 | 2.58 | MA | 15679 | 4843 | 26057 | 3506 | 28597 | 2834 | 29808 | 2301 | 31082 | 1472 | 37758 | 1088 | 27030 |
| 5L-6S | | MI | 14336 | 4843 | 23879 | 3486 | 25977 | 2815 | 26924 | 2296 | 27660 | 1462 | 33474 | 1004 | 24848 |
| 18-#11 | 2.58 | MA | 15290 | 4843 | 25395 | 3504 | 27697 | 2830 | 28711 | 2296 | 29659 | 1479 | 35999 | 1029 | 26581 |
| 6L-5S | | MI | 14699 | 4843 | 24498 | 3489 | 26816 | 2819 | 27910 | 2288 | 28974 | 1455 | 35092 | 1063 | 25244 |
| 18-#11 | 2.58 | MA | 14911 | 4843 | 24686 | 3515 | 26833 | 2840 | 27653 | 2304 | 28266 | 1485 | 34165 | 941 | 25894 |
| 7L-4S | | MI | 15080 | 4843 | 25152 | 3492 | 27659 | 2810 | 28943 | 2281 | 30406 | 1462 | 36822 | 1103 | 25853 |
| 18-#11 | 2.58 | MA | 14537 | 4843 | 24035 | 3513 | 25961 | 2836 | 26616 | 2312 | 26807 | 1479 | 32416 | 893 | 25271 |
| 8L-3S | | MI | 15503 | 4843 | 25896 | 3481 | 28605 | 2815 | 30090 | 2287 | 31856 | 1455 | 38445 | 1192 | 25928 |
| 18-#14 | 3.72 | MA | 17294 | 5283 | 29843 | 3774 | 33377 | 3014 | 35606 | 2407 | 38805 | 1432 | 47862 | 940 | 38454 |
| 4L-7S | | MI | 14652 | 5283 | 25246 | 3761 | 27692 | 3016 | 28925 | 2402 | 30363 | 1419 | 37472 | 664 | 32816 |
| 18-#14 | 3.72 | MA | 16725 | 5283 | 28839 | 3770 | 32083 | 3027 | 34022 | 2418 | 36605 | 1422 | 45204 | 882 | 37433 |
| 5L-6S | | MI | 15148 | 5283 | 26193 | 3746 | 28846 | 3004 | 30388 | 2412 | 32187 | 1409 | 39619 | 763 | 33819 |
| 18-#14 | 3.72 | MA | 16181 | 5283 | 27890 | 3766 | 30795 | 3021 | 32508 | 2429 | 34584 | 1432 | 42714 | 796 | 36271 |
| 6L-5S | | MI | 15657 | 5283 | 27078 | 3751 | 30046 | 3011 | 31796 | 2402 | 34051 | 1400 | 41905 | 848 | 34912 |
| 18-#14 | 3.72 | MA | 15651 | 5283 | 26875 | 3781 | 29558 | 3034 | 30936 | 2420 | 32607 | 1442 | 40118 | 669 | 35169 |
| 7L-4S | | MI | 16189 | 5283 | 28014 | 3756 | 31253 | 2999 | 33270 | 2392 | 36082 | 1409 | 44354 | 906 | 35816 |
| 20-#11 | 2.87 | MA | 16531 | 4954 | 27747 | 3578 | 30761 | 2874 | 32447 | 2324 | 34678 | 1470 | 42343 | 1108 | 30650 |
| 4L-8S | | MI | 14052 | 4954 | 23530 | 3563 | 25529 | 2869 | 26357 | 2328 | 26994 | 1465 | 32669 | 846 | 26303 |
| 20-#11 | 2.87 | MA | 16126 | 4954 | 27046 | 3575 | 29857 | 2884 | 31340 | 2332 | 33128 | 1463 | 40471 | 1067 | 29929 |
| 5L-7S | | MI | 14399 | 4954 | 24137 | 3566 | 26343 | 2874 | 27325 | 2320 | 28264 | 1459 | 34283 | 893 | 26870 |
| 20-#11 | 2.87 | MA | 15740 | 4954 | 26383 | 3573 | 28958 | 2880 | 30243 | 2327 | 31705 | 1470 | 38711 | 1008 | 29500 |
| 6E | | MI | 14752 | 4954 | 24799 | 3555 | 27149 | 2865 | 28349 | 2327 | 29550 | 1452 | 35971 | 981 | 27560 |
| 20-#11 | 2.87 | MA | 15364 | 4954 | 25674 | 3585 | 28094 | 2890 | 29185 | 2335 | 30313 | 1477 | 36877 | 920 | 28761 |
| 7L-5S | | MI | 15113 | 4954 | 25417 | 3558 | 27988 | 2869 | 29335 | 2319 | 30865 | 1445 | 37590 | 1041 | 27938 |
| 20-#11 | 2.87 | MA | 14992 | 4954 | 25023 | 3582 | 27222 | 2886 | 28148 | 2343 | 28854 | 1470 | 35129 | 872 | 28152 |
| 8L-4S | | MI | 15491 | 4954 | 26071 | 3561 | 28831 | 2860 | 30368 | 2312 | 32296 | 1452 | 39319 | 1081 | 28618 |
| 20-#14 | 4.14 | MA | 17350 | 5443 | 30251 | 3869 | 33882 | 3100 | 36209 | 2463 | 39511 | 1408 | 49044 | 849 | 41578 |
| 5L-7S | | MI | 15238 | 5443 | 26558 | 3861 | 29365 | 3088 | 30956 | 2447 | 33044 | 1404 | 41002 | 628 | 36525 |
| 20-#14 | 4.14 | MA | 16811 | 5443 | 29302 | 3865 | 32595 | 3093 | 34696 | 2474 | 37491 | 1418 | 46555 | 764 | 40335 |
| 6E | | MI | 15731 | 5443 | 27505 | 3846 | 30518 | 3076 | 32418 | 2457 | 34868 | 1394 | 43150 | 727 | 37587 |
| 20-#14 | 4.14 | MA | 16285 | 5443 | 28286 | 3881 | 31357 | 3107 | 33124 | 2465 | 35514 | 1428 | 43959 | 637 | 39203 |
| 7L-5S | | MI | 16235 | 5443 | 28390 | 3851 | 31719 | 3083 | 33827 | 2447 | 36732 | 1384 | 45436 | 813 | 38761 |
| 22-#11 | 3.15 | MA | 16571 | 5064 | 28034 | 3645 | 31118 | 2934 | 32872 | 2364 | 35175 | 1454 | 43183 | 1046 | 32834 |
| 5L-8S | | MI | 14469 | 5064 | 24449 | 3633 | 26701 | 2919 | 27782 | 2359 | 28885 | 1456 | 35166 | 824 | 28930 |
| 22-#11 | 3.15 | MA | 16187 | 5064 | 27372 | 3642 | 30218 | 2930 | 31776 | 2358 | 33752 | 1461 | 41423 | 987 | 32422 |
| 6L-7S | | MI | 14815 | 5064 | 25057 | 3636 | 27515 | 2924 | 28750 | 2352 | 30155 | 1449 | 36781 | 871 | 29536 |

## RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.15 | MA | 15813 | 5064 | 26663 | 3654 | 29354 | 2940 | 30717 | 2366 | 32360 | 1468 | 39590 | 899 | 31633 |
| 7L-6S | | MI | 15165 | 5064 | 25718 | 3625 | 28321 | 2915 | 29774 | 2358 | 31441 | 1442 | 38468 | 959 | 30276 |
| 22-#11 | 3.15 | MA | 15444 | 5064 | 26012 | 3651 | 28482 | 2936 | 29680 | 2374 | 30900 | 1461 | 37841 | 851 | 30985 |
| 8L-5S | | MI | 15524 | 5064 | 26337 | 3627 | 29160 | 2919 | 30760 | 2351 | 32755 | 1435 | 40087 | 1018 | 30638 |
| 22-#14 | 4.55 | MA | 17437 | 5603 | 30713 | 3965 | 34395 | 3166 | 36884 | 2519 | 40397 | 1404 | 50395 | 732 | 44409 |
| 6L-7S | | MI | 15820 | 5603 | 27870 | 3961 | 31037 | 3161 | 32986 | 2491 | 35726 | 1388 | 44533 | 593 | 40246 |
| 22-#14 | 4.55 | MA | 16915 | 5603 | 29698 | 3981 | 33157 | 3179 | 35312 | 2510 | 38420 | 1414 | 47800 | 605 | 43221 |
| 7L-6S | | MI | 16309 | 5603 | 28817 | 3946 | 32191 | 3148 | 34449 | 2501 | 37550 | 1378 | 46680 | 692 | 41365 |
| 24-#11 | 3.44 | MA | 16632 | 5175 | 28360 | 3711 | 31479 | 2980 | 33308 | 2389 | 35799 | 1452 | 44136 | 966 | 35347 |
| 6L-8S | | MI | 14885 | 5175 | 25368 | 3702 | 27873 | 2970 | 29207 | 2390 | 30775 | 1446 | 37663 | 801 | 31563 |
| 24-#11 | 3.44 | MA | 16260 | 5175 | 27651 | 3723 | 30614 | 2990 | 32249 | 2397 | 34406 | 1459 | 42302 | 878 | 34511 |
| 7E | | MI | 15228 | 5175 | 25976 | 3705 | 28687 | 2974 | 30175 | 2383 | 32045 | 1439 | 39278 | 848 | 32208 |
| 24-#11 | 3.44 | MA | 15893 | 5175 | 27000 | 3720 | 29742 | 2986 | 31212 | 2405 | 32947 | 1452 | 40554 | 830 | 33824 |
| 8L-6S | | MI | 15576 | 5175 | 26638 | 3694 | 29493 | 2965 | 31199 | 2389 | 33332 | 1432 | 40965 | 936 | 32989 |
| 24-#14 | 4.96 | MA | 17540 | 5762 | 31110 | 4081 | 34957 | 3251 | 37500 | 2555 | 41326 | 1399 | 51640 | 572 | 47249 |
| 7E | | MI | 16398 | 5762 | 29182 | 4060 | 32710 | 3233 | 35016 | 2536 | 38407 | 1373 | 48063 | 558 | 43978 |

## RECTANGULAR TIED COLUMNS 32" x 36"

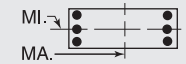
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.39 | MA | 17108 | 4641 | 27386 | 3377 | 29625 | 2743 | 30421 | 2271 | 30712 | 1570 | 36212 | 1448 | 16959 |
| 2E | | MI | 15117 | 4641 | 24323 | 3341 | 26162 | 2714 | 26680 | 2239 | 26790 | 1539 | 31405 | 1407 | 14888 |
| 6-#14 | 1.17 | MA | 16797 | 4552 | 26556 | 3347 | 28689 | 2725 | 29329 | 2265 | 29386 | 1599 | 34546 | 1493 | 14541 |
| 2L-3S | | MI | 13990 | 4552 | 22299 | 3310 | 23699 | 2710 | 23823 | 2251 | 23032 | 1583 | 26548 | 1332 | 12856 |
| 6-#14 | 1.17 | MA | 15793 | 4552 | 25045 | 3344 | 26762 | 2739 | 26987 | 2276 | 26255 | 1609 | 30395 | 1365 | 14596 |
| 3L-2S | | MI | 14859 | 4552 | 23611 | 3315 | 25372 | 2698 | 25853 | 2241 | 25713 | 1573 | 30079 | 1460 | 12790 |
| 6-#18 | 2.08 | MA | 18294 | 4925 | 30023 | 3554 | 32987 | 2872 | 34508 | 2351 | 36116 | 1543 | 43339 | 1387 | 25040 |
| 2L-3S | | MI | 14648 | 4925 | 24323 | 3507 | 26162 | 2861 | 26680 | 2332 | 26790 | 1525 | 31405 | 1108 | 21880 |
| 6-#18 | 2.08 | MA | 16579 | 4925 | 27386 | 3546 | 29625 | 2895 | 30421 | 2369 | 30712 | 1561 | 36212 | 1159 | 24950 |
| 3L-2S | | MI | 16130 | 4925 | 26606 | 3518 | 29072 | 2842 | 30167 | 2315 | 31397 | 1507 | 37432 | 1335 | 21906 |
| 8-#11 | 1.08 | MA | 16668 | 4516 | 26206 | 3338 | 28305 | 2719 | 28885 | 2264 | 28848 | 1612 | 33871 | 1513 | 13542 |
| 2L-4S | | MI | 13704 | 4516 | 21646 | 3315 | 22929 | 2698 | 22917 | 2243 | 21937 | 1601 | 25422 | 1305 | 12002 |
| 8-#11 | 1.08 | MA | 15964 | 4516 | 25149 | 3336 | 26956 | 2729 | 27246 | 2272 | 26646 | 1618 | 30943 | 1424 | 13582 |
| 3E | | MI | 14142 | 4516 | 22389 | 3304 | 23875 | 2702 | 24065 | 2249 | 23387 | 1594 | 27046 | 1393 | 11967 |
| 8-#11 | 1.08 | MA | 15463 | 4516 | 24296 | 3348 | 25872 | 2726 | 25931 | 2267 | 24956 | 1625 | 29033 | 1335 | 13599 |
| 4L-2S | | MI | 14753 | 4516 | 23309 | 3307 | 25047 | 2693 | 25490 | 2242 | 25277 | 1588 | 29543 | 1482 | 11921 |
| 8-#14 | 1.56 | MA | 17490 | 4712 | 28068 | 3447 | 30616 | 2797 | 31672 | 2310 | 32517 | 1586 | 38697 | 1463 | 19180 |
| 2L-4S | | MI | 13972 | 4712 | 22547 | 3425 | 24020 | 2775 | 24216 | 2286 | 23657 | 1577 | 27784 | 1169 | 16826 |
| 8-#14 | 1.56 | MA | 16495 | 4712 | 26556 | 3444 | 28689 | 2811 | 29329 | 2321 | 29386 | 1596 | 34546 | 1335 | 19201 |
| 3E | | MI | 14591 | 4712 | 23611 | 3409 | 25372 | 2782 | 25853 | 2296 | 25713 | 1567 | 30079 | 1296 | 16872 |
| 8-#14 | 1.56 | MA | 15786 | 4712 | 25336 | 3460 | 27138 | 2805 | 27447 | 2313 | 26984 | 1606 | 31841 | 1207 | 19105 |
| 4L-2S | | MI | 15453 | 4712 | 24923 | 3414 | 27045 | 2770 | 27884 | 2286 | 28395 | 1557 | 33609 | 1424 | 16831 |
| 8-#18 | 2.78 | MA | 19462 | 5208 | 32660 | 3731 | 36349 | 3001 | 38595 | 2431 | 41521 | 1517 | 50466 | 1326 | 33072 |
| 2L-4S | | MI | 14609 | 5208 | 24748 | 3709 | 26712 | 2974 | 27353 | 2390 | 27865 | 1511 | 33503 | 816 | 26744 |
| 8-#18 | 2.78 | MA | 17769 | 5208 | 30023 | 3723 | 32987 | 3023 | 34508 | 2449 | 36116 | 1534 | 43339 | 1099 | 32870 |
| 3E | | MI | 15664 | 5208 | 26606 | 3684 | 29072 | 2990 | 30167 | 2408 | 31397 | 1493 | 37432 | 1036 | 28744 |
| 8-#18 | 2.78 | MA | 16560 | 5208 | 27887 | 3751 | 30272 | 3011 | 31214 | 2432 | 31971 | 1552 | 38709 | 871 | 30559 |
| 4L-2S | | MI | 17128 | 5208 | 28888 | 3695 | 31982 | 2971 | 33654 | 2390 | 36003 | 1475 | 43459 | 1263 | 28879 |
| 10-#11 | 1.35 | MA | 17158 | 4627 | 27264 | 3407 | 29653 | 2769 | 30525 | 2295 | 31051 | 1604 | 36799 | 1494 | 16790 |
| 2L-5S | | MI | 13740 | 4627 | 21911 | 3381 | 23258 | 2757 | 23310 | 2281 | 22396 | 1585 | 26190 | 1242 | 14694 |
| 10-#11 | 1.35 | MA | 16458 | 4627 | 26206 | 3405 | 28305 | 2779 | 28885 | 2303 | 28848 | 1610 | 33871 | 1405 | 16818 |
| 3L-4S | | MI | 14131 | 4627 | 22565 | 3384 | 24101 | 2748 | 24342 | 2274 | 23827 | 1591 | 27920 | 1282 | 14804 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis

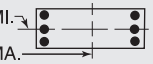



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.35 | MA | 15960 | 4627 | 25354 | 3417 | 27221 | 2776 | 27570 | 2298 | 27158 | 1617 | 31961 | 1316 | 16807 |
| 4L-3S | | MI | 14566 | 4627 | 23309 | 3373 | 25047 | 2753 | 25490 | 2280 | 25277 | 1585 | 29543 | 1371 | 14790 |
| 10-#11 | 1.35 | MA | 15513 | 4627 | 24605 | 3415 | 26256 | 2786 | 26388 | 2307 | 25491 | 1610 | 29945 | 1274 | 16650 |
| 5L-2S | | MI | 15173 | 4627 | 24228 | 3376 | 26219 | 2743 | 26915 | 2273 | 27168 | 1578 | 32040 | 1459 | 14755 |
| 10-#14 | 1.95 | MA | 18176 | 4871 | 29579 | 3547 | 32543 | 2869 | 34014 | 2354 | 35649 | 1573 | 42848 | 1434 | 23801 |
| 2L-5S | | MI | 14020 | 4871 | 22923 | 3519 | 24486 | 2860 | 24773 | 2340 | 24307 | 1552 | 28866 | 1077 | 19796 |
| 10-#14 | 1.95 | MA | 17189 | 4871 | 28068 | 3543 | 30616 | 2883 | 31672 | 2366 | 32517 | 1583 | 38697 | 1306 | 23785 |
| 3L-4S | | MI | 14573 | 4871 | 23859 | 3524 | 25693 | 2847 | 26246 | 2330 | 26338 | 1562 | 31314 | 1134 | 20772 |
| 10-#14 | 1.95 | MA | 16487 | 4871 | 26848 | 3560 | 29065 | 2878 | 29789 | 2358 | 30115 | 1593 | 35992 | 1178 | 23643 |
| 4L-3S | | MI | 15186 | 4871 | 24923 | 3509 | 27045 | 2855 | 27884 | 2340 | 28395 | 1552 | 33609 | 1261 | 20862 |
| 10-#14 | 1.95 | MA | 15855 | 4871 | 25776 | 3557 | 27683 | 2892 | 28097 | 2370 | 27745 | 1583 | 33128 | 1118 | 22489 |
| 5L-2S | | MI | 16041 | 4871 | 26235 | 3514 | 28717 | 2842 | 29914 | 2330 | 31076 | 1542 | 37140 | 1389 | 20853 |
| 10-#18 | 3.47 | MA | 20613 | 5492 | 35297 | 3909 | 39711 | 3129 | 42682 | 2511 | 46926 | 1490 | 57593 | 1265 | 41067 |
| 2L-5S | | MI | 14686 | 5492 | 25394 | 3875 | 27512 | 3121 | 28310 | 2484 | 28980 | 1461 | 35351 | 641 | 31397 |
| 10-#18 | 3.47 | MA | 18941 | 5492 | 32660 | 3901 | 36349 | 3152 | 38595 | 2529 | 41521 | 1508 | 50466 | 1038 | 40774 |
| 3L-4S | | MI | 15624 | 5492 | 27031 | 3886 | 29621 | 3102 | 30841 | 2466 | 32471 | 1478 | 39530 | 744 | 33234 |
| 10-#18 | 3.47 | MA | 17748 | 5492 | 30524 | 3928 | 33634 | 3139 | 35301 | 2512 | 37376 | 1525 | 45836 | 810 | 38096 |
| 4L-3S | | MI | 16666 | 5492 | 28888 | 3862 | 31982 | 3119 | 33654 | 2484 | 36003 | 1461 | 43459 | 964 | 35587 |
| 10-#18 | 3.47 | MA | 16676 | 5492 | 28645 | 3920 | 31212 | 3162 | 32336 | 2530 | 33282 | 1508 | 40893 | 709 | 35971 |
| 5L-2S | | MI | 18113 | 5492 | 31170 | 3873 | 34892 | 3100 | 37142 | 2466 | 40610 | 1443 | 49485 | 1192 | 35807 |
| 12-#11 | 1.63 | MA | 17644 | 4737 | 28322 | 3476 | 31002 | 2819 | 32164 | 2326 | 33254 | 1595 | 39727 | 1474 | 20029 |
| 2L-6S | | MI | 13794 | 4737 | 22212 | 3447 | 23591 | 2803 | 23749 | 2320 | 22972 | 1582 | 27069 | 1160 | 16871 |
| 12-#11 | 1.63 | MA | 16948 | 4737 | 27264 | 3474 | 29653 | 2829 | 30525 | 2335 | 31051 | 1602 | 36799 | 1386 | 20043 |
| 3L-5S | | MI | 14166 | 4737 | 22830 | 3450 | 24430 | 2807 | 24735 | 2313 | 24286 | 1575 | 28687 | 1219 | 17352 |
| 12-#11 | 1.63 | MA | 16454 | 4737 | 26411 | 3486 | 28569 | 2826 | 29209 | 2330 | 29361 | 1609 | 34889 | 1297 | 20006 |
| 4E | | MI | 14555 | 4737 | 23484 | 3453 | 25274 | 2798 | 25767 | 2305 | 25718 | 1582 | 30417 | 1259 | 17592 |
| 12-#11 | 1.63 | MA | 16010 | 4737 | 25663 | 3484 | 27604 | 2836 | 28027 | 2338 | 27694 | 1602 | 32873 | 1255 | 19716 |
| 5L-3S | | MI | 14987 | 4737 | 24228 | 3442 | 26219 | 2803 | 26915 | 2311 | 27168 | 1575 | 32040 | 1348 | 17602 |
| 12-#11 | 1.63 | MA | 15586 | 4737 | 24956 | 3482 | 26644 | 2833 | 26857 | 2333 | 26163 | 1609 | 30972 | 1196 | 19118 |
| 6L-2S | | MI | 15591 | 4737 | 25148 | 3445 | 27392 | 2794 | 28340 | 2304 | 29059 | 1568 | 34537 | 1437 | 17578 |
| 12-#14 | 2.34 | MA | 18856 | 5031 | 31091 | 3646 | 34470 | 2941 | 36357 | 2399 | 38780 | 1560 | 47000 | 1404 | 28408 |
| 2L-6S | | MI | 14096 | 5031 | 23350 | 3614 | 24959 | 2924 | 25395 | 2395 | 25125 | 1546 | 30110 | 956 | 22911 |
| 12-#14 | 2.34 | MA | 17876 | 5031 | 29579 | 3643 | 32543 | 2956 | 34014 | 2411 | 35649 | 1570 | 42848 | 1276 | 28356 |
| 3L-5S | | MI | 14619 | 5031 | 24235 | 3619 | 26159 | 2932 | 26803 | 2385 | 26989 | 1536 | 32396 | 1041 | 23603 |
| 12-#14 | 2.34 | MA | 17180 | 5031 | 28359 | 3660 | 30992 | 2950 | 32132 | 2403 | 33247 | 1580 | 40143 | 1148 | 28174 |
| 4E | | MI | 15167 | 5031 | 25171 | 3624 | 27365 | 2919 | 28277 | 2375 | 29020 | 1546 | 34845 | 1099 | 24710 |
| 12-#14 | 2.34 | MA | 16555 | 5031 | 27287 | 3656 | 29610 | 2964 | 30440 | 2415 | 30876 | 1570 | 37279 | 1089 | 26887 |
| 5L-3S | | MI | 15775 | 5031 | 26235 | 3609 | 28717 | 2927 | 29914 | 2385 | 31076 | 1536 | 37140 | 1226 | 24837 |
| 12-#14 | 2.34 | MA | 15958 | 5031 | 26274 | 3653 | 28235 | 2959 | 28763 | 2407 | 28699 | 1580 | 34585 | 1004 | 26074 |
| 6L-2S | | MI | 16624 | 5031 | 27547 | 3614 | 30390 | 2915 | 31944 | 2375 | 33757 | 1526 | 40670 | 1354 | 24861 |
| 12-#18 | 4.17 | MA | 20098 | 5776 | 35297 | 4078 | 39711 | 3280 | 42682 | 2609 | 46926 | 1481 | 57593 | 977 | 48667 |
| 3L-5S | | MI | 15700 | 5776 | 27676 | 4052 | 30422 | 3250 | 31797 | 2560 | 33586 | 1429 | 41377 | 569 | 37751 |
| 12-#18 | 4.17 | MA | 18921 | 5776 | 33161 | 4105 | 36996 | 3268 | 39388 | 2592 | 42781 | 1499 | 52962 | 750 | 45676 |
| 4E | | MI | 16627 | 5776 | 29313 | 4063 | 32531 | 3231 | 34328 | 2542 | 37077 | 1446 | 45557 | 672 | 39766 |
| 12-#18 | 4.17 | MA | 17863 | 5776 | 31282 | 4097 | 34574 | 3290 | 36423 | 2610 | 38687 | 1481 | 48020 | 648 | 43379 |
| 5L-3S | | MI | 17656 | 5776 | 31170 | 4039 | 34892 | 3247 | 37142 | 2560 | 40610 | 1429 | 49485 | 892 | 42417 |
| 12-#18 | 4.17 | MA | 16854 | 5776 | 29505 | 4089 | 32164 | 3278 | 33590 | 2628 | 34930 | 1499 | 43403 | 496 | 40380 |
| 6L-2S | | MI | 19088 | 5776 | 33453 | 4050 | 37801 | 3228 | 40629 | 2542 | 45216 | 1411 | 55512 | 1120 | 42713 |
| 14-#11 | 1.90 | MA | 18127 | 4848 | 29379 | 3545 | 32350 | 2869 | 33803 | 2357 | 35457 | 1587 | 42656 | 1455 | 23260 |
| 2L-7S | | MI | 13859 | 4848 | 22470 | 3527 | 23957 | 2862 | 24149 | 2345 | 23577 | 1579 | 27878 | 1049 | 19136 |
| 14-#11 | 1.90 | MA | 17435 | 4848 | 28322 | 3543 | 31002 | 2880 | 32164 | 2366 | 33254 | 1594 | 39727 | 1367 | 23254 |
| 3L-6S | | MI | 14220 | 4848 | 23131 | 3516 | 24764 | 2853 | 25174 | 2351 | 24863 | 1572 | 29566 | 1137 | 19570 |
| 14-#11 | 1.90 | MA | 16944 | 4848 | 27469 | 3555 | 29918 | 2876 | 30848 | 2361 | 31564 | 1601 | 37817 | 1278 | 23199 |
| 4L-5S | | MI | 14589 | 4848 | 23750 | 3519 | 25603 | 2857 | 26160 | 2344 | 26177 | 1565 | 31185 | 1196 | 20022 |
| 14-#11 | 1.90 | MA | 16503 | 4848 | 26721 | 3553 | 28953 | 2887 | 29667 | 2370 | 29897 | 1594 | 35801 | 1236 | 22794 |
| 5L-4S | | MI | 14975 | 4848 | 24404 | 3522 | 26446 | 2848 | 27192 | 2336 | 27609 | 1572 | 32914 | 1236 | 20373 |
| 14-#11 | 1.90 | MA | 16082 | 4848 | 26014 | 3551 | 27993 | 2883 | 28496 | 2365 | 28366 | 1601 | 33900 | 1177 | 22228 |
| 6L-3S | | MI | 15405 | 4848 | 25148 | 3511 | 27392 | 2853 | 28340 | 2343 | 29059 | 1565 | 34537 | 1325 | 20405 |

## RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

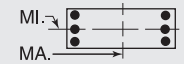
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.90 | MA | 15671 | 4848 | 25257 | 3563 | 27071 | 2893 | 27367 | 2373 | 26867 | 1608 | 31919 | 1089 | 21710 |
| 7L-2S | | MI | 16005 | 4848 | 26067 | 3514 | 28564 | 2844 | 29765 | 2335 | 30949 | 1558 | 37035 | 1414 | 20392 |
| 14-#14 | 2.73 | MA | 19529 | 5191 | 32602 | 3746 | 36397 | 3014 | 38699 | 2444 | 41911 | 1548 | 51151 | 1374 | 32999 |
| 2L-7S | | MI | 14187 | 5191 | 23715 | 3729 | 25477 | 3009 | 25963 | 2430 | 25982 | 1540 | 31493 | 821 | 25522 |
| 14-#14 | 2.73 | MA | 18557 | 5191 | 31091 | 3743 | 34470 | 3028 | 36357 | 2456 | 38780 | 1558 | 47000 | 1246 | 32918 |
| 3L-6S | | MI | 14694 | 5191 | 24662 | 3714 | 26631 | 2997 | 27425 | 2440 | 27806 | 1531 | 33641 | 920 | 26632 |
| 14-#14 | 2.73 | MA | 17867 | 5191 | 29871 | 3759 | 32919 | 3022 | 34474 | 2448 | 36378 | 1568 | 44295 | 1118 | 32611 |
| 4L-5S | | MI | 15213 | 5191 | 25547 | 3719 | 27832 | 3004 | 28833 | 2430 | 29670 | 1521 | 35927 | 1006 | 27423 |
| 14-#14 | 2.73 | MA | 17247 | 5191 | 28799 | 3756 | 31537 | 3037 | 32782 | 2460 | 34008 | 1558 | 41430 | 1059 | 31299 |
| 5L-4S | | MI | 15756 | 5191 | 26483 | 3724 | 29038 | 2992 | 30307 | 2420 | 31701 | 1531 | 38375 | 1063 | 28477 |
| 14-#14 | 2.73 | MA | 16656 | 5191 | 27786 | 3753 | 30162 | 3031 | 31106 | 2452 | 31831 | 1568 | 38737 | 974 | 30389 |
| 6L-3S | | MI | 16360 | 5191 | 27547 | 3709 | 30390 | 2999 | 31944 | 2430 | 33757 | 1521 | 40670 | 1190 | 28802 |
| 14-#14 | 2.73 | MA | 16078 | 5191 | 26702 | 3769 | 28841 | 3045 | 29488 | 2464 | 29700 | 1578 | 35930 | 847 | 29030 |
| 7L-2S | | MI | 17203 | 5191 | 28859 | 3713 | 32063 | 2987 | 33975 | 2420 | 36439 | 1511 | 44201 | 1318 | 28855 |
| 14-#18 | 4.86 | MA | 20079 | 6059 | 35798 | 4283 | 40358 | 3396 | 43475 | 2671 | 48185 | 1472 | 60089 | 689 | 53290 |
| 4L-5S | | MI | 16703 | 6059 | 29958 | 4230 | 33332 | 3379 | 35284 | 2636 | 38193 | 1396 | 47404 | 497 | 44143 |
| 14-#18 | 4.86 | MA | 19035 | 6059 | 33919 | 4275 | 37936 | 3419 | 40510 | 2689 | 44092 | 1455 | 55147 | 587 | 50823 |
| 5L-4S | | MI | 17619 | 6059 | 31596 | 4241 | 35441 | 3359 | 37816 | 2618 | 41684 | 1414 | 51583 | 601 | 46332 |
| 14-#18 | 4.86 | MA | 18039 | 6059 | 32142 | 4267 | 35526 | 3406 | 37677 | 2707 | 40335 | 1472 | 50530 | 435 | 47963 |
| 6L-3S | | MI | 18636 | 6059 | 33453 | 4216 | 37801 | 3376 | 40629 | 2636 | 45216 | 1396 | 55512 | 820 | 49238 |
| 16-#11 | 2.17 | MA | 18606 | 4959 | 30437 | 3614 | 33699 | 2919 | 35443 | 2388 | 37660 | 1579 | 45584 | 1436 | 26485 |
| 2L-8S | | MI | 13931 | 4959 | 22781 | 3594 | 24316 | 2907 | 24607 | 2383 | 24197 | 1576 | 28761 | 979 | 21183 |
| 16-#11 | 2.17 | MA | 17918 | 4959 | 29379 | 3612 | 32350 | 2930 | 33803 | 2397 | 35457 | 1586 | 42656 | 1347 | 26461 |
| 3L-7S | | MI | 14284 | 4959 | 23389 | 3596 | 25129 | 2912 | 25574 | 2376 | 25467 | 1569 | 30376 | 1026 | 21779 |
| 16-#11 | 2.17 | MA | 17430 | 4959 | 28527 | 3624 | 31266 | 2926 | 32488 | 2392 | 33767 | 1593 | 40745 | 1259 | 26388 |
| 4L-6S | | MI | 14642 | 4959 | 24051 | 3585 | 25936 | 2903 | 26599 | 2382 | 26753 | 1562 | 32063 | 1114 | 22275 |
| 16-#11 | 2.17 | MA | 16992 | 4959 | 27778 | 3622 | 30301 | 2937 | 31306 | 2401 | 32100 | 1586 | 38729 | 1217 | 25881 |
| 5E | | MI | 15009 | 4959 | 24669 | 3588 | 26775 | 2908 | 27585 | 2375 | 28068 | 1555 | 33682 | 1174 | 22702 |
| 16-#11 | 2.17 | MA | 16574 | 4959 | 27071 | 3620 | 29341 | 2933 | 30136 | 2396 | 30569 | 1593 | 36828 | 1158 | 25344 |
| 6L-4S | | MI | 15393 | 4959 | 25323 | 3591 | 27618 | 2898 | 28617 | 2367 | 29499 | 1562 | 35411 | 1214 | 23149 |
| 16-#11 | 2.17 | MA | 16166 | 4959 | 26315 | 3632 | 28419 | 2944 | 29006 | 2405 | 29070 | 1600 | 34847 | 1070 | 24764 |
| 7L-3S | | MI | 15820 | 4959 | 26067 | 3580 | 28564 | 2903 | 29765 | 2374 | 30949 | 1555 | 37035 | 1302 | 23196 |
| 16-#11 | 2.17 | MA | 15764 | 4959 | 25621 | 3630 | 27489 | 2940 | 27900 | 2413 | 27499 | 1593 | 32965 | 1021 | 24032 |
| 8L-2S | | MI | 16417 | 4959 | 26987 | 3583 | 29736 | 2894 | 31190 | 2366 | 32840 | 1548 | 39532 | 1391 | 23201 |
| 16-#14 | 3.13 | MA | 19232 | 5350 | 32602 | 3843 | 36397 | 3100 | 38699 | 2501 | 41911 | 1545 | 51151 | 1216 | 37474 |
| 3L-7S | | MI | 14784 | 5350 | 25027 | 3829 | 27150 | 3081 | 27993 | 2474 | 28664 | 1525 | 35024 | 786 | 29309 |
| 16-#14 | 3.13 | MA | 18548 | 5350 | 31382 | 3859 | 34846 | 3095 | 36817 | 2493 | 39509 | 1555 | 48446 | 1088 | 36965 |
| 4L-6S | | MI | 15286 | 5350 | 25974 | 3814 | 28304 | 3069 | 29456 | 2484 | 30487 | 1515 | 37171 | 885 | 30370 |
| 16-#14 | 3.13 | MA | 17933 | 5350 | 30310 | 3856 | 33464 | 3109 | 35125 | 2505 | 37139 | 1545 | 45581 | 1029 | 35723 |
| 5E | | MI | 15801 | 5350 | 26859 | 3819 | 29504 | 3077 | 30864 | 2474 | 32351 | 1505 | 39458 | 971 | 31254 |
| 16-#14 | 3.13 | MA | 17347 | 5350 | 29297 | 3853 | 32089 | 3103 | 33448 | 2497 | 34962 | 1555 | 42888 | 944 | 34720 |
| 6L-4S | | MI | 16340 | 5350 | 27795 | 3823 | 30711 | 3064 | 32337 | 2464 | 34382 | 1515 | 41906 | 1028 | 32246 |
| 16-#14 | 3.13 | MA | 16775 | 5350 | 28213 | 3869 | 30768 | 3117 | 31830 | 2509 | 32832 | 1565 | 40081 | 817 | 33414 |
| 7L-3S | | MI | 16939 | 5350 | 28859 | 3808 | 32063 | 3072 | 33975 | 2474 | 36439 | 1505 | 44201 | 1155 | 32759 |
| 16-#14 | 3.13 | MA | 16211 | 5350 | 27219 | 3866 | 29435 | 3112 | 30245 | 2521 | 30599 | 1555 | 37406 | 748 | 31903 |
| 8L-2S | | MI | 17776 | 5350 | 30171 | 3813 | 33735 | 3059 | 36005 | 2464 | 39120 | 1495 | 47731 | 1283 | 32837 |
| 16-#18 | 5.56 | MA | 20194 | 6343 | 36556 | 4452 | 41298 | 3548 | 44597 | 2769 | 49497 | 1428 | 62274 | 527 | 58300 |
| 5E | | MI | 17695 | 6343 | 32241 | 4407 | 36242 | 3507 | 38772 | 2712 | 42799 | 1364 | 53431 | 425 | 50568 |
| 16-#18 | 5.56 | MA | 19210 | 6343 | 34779 | 4444 | 38888 | 3535 | 41764 | 2787 | 45740 | 1446 | 57657 | 375 | 55547 |
| 6L-4S | | MI | 18601 | 6343 | 33878 | 4418 | 38351 | 3488 | 41303 | 2694 | 46290 | 1382 | 57610 | 529 | 52925 |
| 18-#11 | 2.44 | MA | 18397 | 5069 | 30437 | 3682 | 33699 | 2980 | 35443 | 2428 | 37660 | 1578 | 45584 | 1328 | 29663 |
| 3L-8S | | MI | 14354 | 5069 | 23701 | 3663 | 25488 | 2958 | 26032 | 2414 | 26088 | 1566 | 31258 | 956 | 23858 |
| 18-#11 | 2.44 | MA | 17913 | 5069 | 29585 | 3693 | 32615 | 2976 | 34127 | 2423 | 35970 | 1585 | 43673 | 1239 | 29573 |
| 4L-7S | | MI | 14705 | 5069 | 24308 | 3666 | 26302 | 2962 | 26999 | 2407 | 27358 | 1559 | 32873 | 1003 | 24430 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis

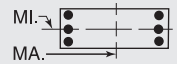



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.44 | MA | 17477 | 5069 | 28836 | 3692 | 31650 | 2987 | 32945 | 2432 | 34303 | 1578 | 41657 | 1198 | 28978 |
| 5L-6S | | MI | 15061 | 5069 | 24970 | 3655 | 27108 | 2953 | 28024 | 2413 | 28644 | 1552 | 34560 | 1092 | 24984 |
| 18-#11 | 2.44 | MA | 17062 | 5069 | 28129 | 3690 | 30690 | 2983 | 31775 | 2427 | 32771 | 1585 | 39756 | 1139 | 28465 |
| 6L-5S | | MI | 15426 | 5069 | 25588 | 3657 | 27947 | 2958 | 29010 | 2406 | 29958 | 1545 | 36179 | 1151 | 25389 |
| 18-#11 | 2.44 | MA | 16657 | 5069 | 27373 | 3702 | 29768 | 2994 | 30645 | 2436 | 31273 | 1592 | 37775 | 1051 | 27827 |
| 7L-4S | | MI | 15808 | 5069 | 26243 | 3660 | 28790 | 2949 | 30042 | 2398 | 31390 | 1552 | 37908 | 1191 | 25920 |
| 18-#11 | 2.44 | MA | 16258 | 5069 | 26678 | 3700 | 28838 | 2990 | 29539 | 2444 | 29702 | 1585 | 35893 | 1002 | 27121 |
| 8L-3S | | MI | 16232 | 5069 | 26987 | 3649 | 29736 | 2953 | 31190 | 2405 | 32840 | 1545 | 39532 | 1280 | 25983 |
| 18-#11 | 2.44 | MA | 15862 | 5069 | 25944 | 3712 | 27928 | 3001 | 28395 | 2439 | 28219 | 1592 | 34051 | 945 | 26246 |
| 9L-2S | | MI | 16826 | 5069 | 27906 | 3652 | 30908 | 2944 | 32615 | 2397 | 34731 | 1538 | 42029 | 1368 | 26005 |
| 18-#14 | 3.52 | MA | 19223 | 5510 | 32893 | 3959 | 36773 | 3167 | 39159 | 2538 | 42640 | 1542 | 52597 | 1058 | 41336 |
| 4L-7S | | MI | 15376 | 5510 | 26339 | 3929 | 28823 | 3154 | 30023 | 2519 | 31345 | 1509 | 38554 | 751 | 33107 |
| 18-#14 | 3.52 | MA | 18614 | 5510 | 31821 | 3956 | 35390 | 3181 | 37467 | 2550 | 40270 | 1532 | 49733 | 999 | 40156 |
| 5L-6S | | MI | 15874 | 5510 | 27286 | 3914 | 29977 | 3141 | 31486 | 2529 | 33169 | 1499 | 40702 | 850 | 34122 |
| 18-#14 | 3.52 | MA | 18032 | 5510 | 30809 | 3952 | 34016 | 3176 | 35791 | 2542 | 38093 | 1542 | 47039 | 914 | 39064 |
| 6L-5S | | MI | 16385 | 5510 | 28171 | 3918 | 31177 | 3149 | 32894 | 2519 | 35032 | 1490 | 42988 | 935 | 35095 |
| 18-#14 | 3.52 | MA | 17465 | 5510 | 29725 | 3969 | 32695 | 3190 | 34173 | 2554 | 35963 | 1552 | 44232 | 787 | 37808 |
| 7L-4S | | MI | 16920 | 5510 | 29107 | 3923 | 32383 | 3136 | 34368 | 2509 | 37063 | 1499 | 45436 | 992 | 36031 |
| 18-#14 | 3.52 | MA | 16906 | 5510 | 28730 | 3966 | 31362 | 3184 | 32588 | 2565 | 33730 | 1542 | 41557 | 718 | 36243 |
| 8L-3S | | MI | 17514 | 5510 | 30171 | 3908 | 33735 | 3144 | 36005 | 2519 | 39120 | 1490 | 47731 | 1120 | 36711 |
| 18-#18 | 6.25 | MA | 20369 | 6627 | 37416 | 4621 | 42250 | 3664 | 45851 | 2867 | 51145 | 1419 | 64784 | 314 | 62959 |
| 6L-5S | | MI | 18679 | 6627 | 34523 | 4584 | 39152 | 3636 | 42259 | 2788 | 47406 | 1332 | 59458 | 354 | 57022 |
| 20-#11 | 2.71 | MA | 18392 | 5180 | 30642 | 3763 | 33963 | 3027 | 35766 | 2454 | 38173 | 1577 | 46601 | 1220 | 32756 |
| 4L-8S | | MI | 14776 | 5180 | 24620 | 3732 | 26660 | 3008 | 27457 | 2445 | 27978 | 1556 | 33755 | 934 | 26538 |
| 20-#11 | 2.71 | MA | 17960 | 5180 | 29894 | 3761 | 32998 | 3037 | 34585 | 2463 | 36506 | 1570 | 44585 | 1178 | 32081 |
| 5L-7S | | MI | 15124 | 5180 | 25228 | 3735 | 27474 | 3012 | 28424 | 2438 | 29248 | 1549 | 35370 | 981 | 27089 |
| 20-#11 | 2.71 | MA | 17547 | 5180 | 29187 | 3759 | 32038 | 3034 | 33414 | 2458 | 34974 | 1577 | 42684 | 1120 | 31590 |
| 6E | | MI | 15478 | 5180 | 25889 | 3724 | 28280 | 3003 | 29449 | 2444 | 30535 | 1542 | 37057 | 1069 | 27697 |
| 20-#11 | 2.71 | MA | 17145 | 5180 | 28430 | 3771 | 31117 | 3044 | 32285 | 2467 | 33476 | 1584 | 40704 | 1032 | 30897 |
| 7L-5S | | MI | 15841 | 5180 | 26508 | 3727 | 29119 | 3008 | 30435 | 2437 | 31849 | 1535 | 38676 | 1128 | 28083 |
| 20-#11 | 2.71 | MA | 16748 | 5180 | 27736 | 3769 | 30186 | 3040 | 31178 | 2476 | 31905 | 1577 | 38821 | 983 | 30214 |
| 8L-4S | | MI | 16220 | 5180 | 27162 | 3730 | 29962 | 2999 | 31467 | 2430 | 33280 | 1542 | 40405 | 1168 | 28689 |
| 20-#11 | 2.71 | MA | 16355 | 5180 | 27002 | 3781 | 29277 | 3051 | 30034 | 2471 | 30421 | 1584 | 36979 | 926 | 29303 |
| 9L-3S | | MI | 16642 | 5180 | 27906 | 3719 | 30908 | 3003 | 32615 | 2436 | 34731 | 1535 | 42029 | 1257 | 28765 |
| 20-#14 | 3.91 | MA | 19289 | 5669 | 33333 | 4055 | 37317 | 3254 | 39810 | 2595 | 43401 | 1519 | 53884 | 969 | 44598 |
| 5L-7S | | MI | 15963 | 5669 | 27651 | 4028 | 30495 | 3226 | 32054 | 2564 | 34026 | 1494 | 42085 | 715 | 36913 |
| 20-#14 | 3.91 | MA | 18712 | 5669 | 32320 | 4052 | 35943 | 3248 | 38133 | 2587 | 41225 | 1529 | 51190 | 884 | 43420 |
| 6E | | MI | 16458 | 5669 | 28598 | 4013 | 31649 | 3214 | 33516 | 2574 | 35850 | 1484 | 44232 | 814 | 37885 |
| 20-#14 | 3.91 | MA | 18150 | 5669 | 31236 | 4069 | 34622 | 3262 | 36515 | 2598 | 39094 | 1539 | 48383 | 757 | 42211 |
| 7L-5S | | MI | 16965 | 5669 | 29483 | 4018 | 32850 | 3221 | 34924 | 2564 | 37714 | 1474 | 46519 | 900 | 38943 |
| 20-#14 | 3.91 | MA | 17595 | 5669 | 30241 | 4065 | 33289 | 3256 | 34930 | 2610 | 36861 | 1529 | 45708 | 688 | 40594 |
| 8L-4S | | MI | 17496 | 5669 | 30419 | 4023 | 34056 | 3209 | 36398 | 2554 | 39745 | 1484 | 48967 | 957 | 39829 |
| 22-#11 | 2.98 | MA | 18439 | 5291 | 30952 | 3830 | 34347 | 3087 | 36224 | 2494 | 38709 | 1562 | 47513 | 1159 | 35190 |
| 5L-8S | | MI | 15194 | 5291 | 25540 | 3801 | 27832 | 3058 | 28882 | 2477 | 29869 | 1546 | 36252 | 911 | 29223 |
| 22-#11 | 2.98 | MA | 18029 | 5291 | 30245 | 3828 | 33387 | 3084 | 35054 | 2489 | 37177 | 1569 | 45612 | 1101 | 34718 |
| 6L-7S | | MI | 15541 | 5291 | 26147 | 3804 | 28646 | 3062 | 29849 | 2469 | 31139 | 1539 | 37867 | 958 | 29753 |
| 22-#11 | 2.98 | MA | 17630 | 5291 | 29488 | 3840 | 32465 | 3094 | 33924 | 2498 | 35678 | 1576 | 43632 | 1013 | 33973 |
| 7L-6S | | MI | 15892 | 5291 | 26809 | 3793 | 29452 | 3053 | 30873 | 2476 | 32425 | 1532 | 39555 | 1046 | 30413 |
| 22-#11 | 2.98 | MA | 17235 | 5291 | 28794 | 3838 | 31535 | 3091 | 32818 | 2507 | 34108 | 1569 | 41749 | 964 | 33313 |
| 8L-5S | | MI | 16253 | 5291 | 27427 | 3796 | 30291 | 3058 | 31860 | 2468 | 33739 | 1525 | 41173 | 1105 | 30782 |
| 22-#11 | 2.98 | MA | 16844 | 5291 | 28059 | 3850 | 30625 | 3101 | 31673 | 2502 | 32624 | 1576 | 39907 | 907 | 32367 |
| 9L-4S | | MI | 16630 | 5291 | 28081 | 3799 | 31135 | 3049 | 32892 | 2461 | 35171 | 1532 | 42902 | 1145 | 31454 |
| 22-#14 | 4.30 | MA | 19387 | 5829 | 33831 | 4152 | 37870 | 3320 | 40476 | 2631 | 44356 | 1517 | 55341 | 855 | 47787 |
| 6L-7S | | MI | 16547 | 5829 | 28963 | 4128 | 32168 | 3298 | 34084 | 2608 | 36707 | 1478 | 45615 | 680 | 40654 |
| 22-#14 | 4.30 | MA | 18829 | 5829 | 32748 | 4168 | 36549 | 3334 | 38858 | 2643 | 42226 | 1527 | 52535 | 728 | 46621 |
| 7L-6S | | MI | 17038 | 5829 | 29910 | 4113 | 33322 | 3286 | 35547 | 2618 | 38531 | 1468 | 47763 | 779 | 41660 |
| 22-#14 | 4.30 | MA | 18279 | 5829 | 31753 | 4165 | 35216 | 3329 | 37273 | 2655 | 39993 | 1517 | 49859 | 658 | 44953 |
| 8L-5S | | MI | 17541 | 5829 | 30795 | 4118 | 34522 | 3293 | 36955 | 2608 | 40395 | 1458 | 50049 | 864 | 42797 |

## RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 3.25 | MA | 18509 | 5401 | 31302 | 3897 | 34735 | 3134 | 36693 | 2520 | 39380 | 1561 | 48540 | 1081 | 37850 |
| 6L-8S | | MI | 15610 | 5401 | 26459 | 3870 | 29004 | 3108 | 30307 | 2508 | 31760 | 1536 | 38750 | 888 | 31864 |
| 24-#11 | 3.25 | MA | 18111 | 5401 | 30546 | 3909 | 33814 | 3144 | 35563 | 2529 | 37881 | 1568 | 46560 | 993 | 37055 |
| 7E | | MI | 15955 | 5401 | 27067 | 3873 | 29818 | 3113 | 31274 | 2500 | 33030 | 1529 | 40364 | 935 | 32424 |
| 24-#11 | 3.25 | MA | 17719 | 5401 | 29852 | 3907 | 32883 | 3141 | 34457 | 2538 | 36311 | 1561 | 44677 | 945 | 36415 |
| 8L-6S | | MI | 16304 | 5401 | 27728 | 3862 | 30624 | 3103 | 32298 | 2507 | 34316 | 1522 | 42052 | 1023 | 33132 |
| 24-#11 | 3.25 | MA | 17331 | 5401 | 29117 | 3919 | 31974 | 3151 | 33313 | 2533 | 34827 | 1568 | 42835 | 888 | 35435 |
| 9L-5S | | MI | 16663 | 5401 | 28347 | 3865 | 31463 | 3108 | 33285 | 2499 | 35630 | 1515 | 43670 | 1082 | 33486 |
| 24-#14 | 4.69 | MA | 19504 | 5989 | 34259 | 4268 | 38476 | 3407 | 41200 | 2688 | 45357 | 1514 | 56686 | 698 | 50980 |
| 7E | | MI | 17126 | 5989 | 30275 | 4228 | 33841 | 3371 | 36114 | 2653 | 39389 | 1463 | 49146 | 645 | 44381 |
| 24-#14 | 4.69 | MA | 18958 | 5989 | 33264 | 4265 | 37143 | 3401 | 39615 | 2700 | 43124 | 1504 | 54011 | 628 | 49321 |
| 8L-6S | | MI | 17614 | 5989 | 31222 | 4213 | 34994 | 3358 | 37577 | 2663 | 41213 | 1453 | 51293 | 744 | 45444 |

## RECTANGULAR TIED COLUMNS 32" x 38"

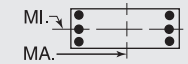
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.32 | MA | 18967 | 4867 | 30208 | 3561 | 32697 | 2895 | 33547 | 2400 | 33843 | 1673 | 39910 | 1552 | 18039 |
| 2E | | MI | 15843 | 4867 | 25421 | 3507 | 27292 | 2850 | 27774 | 2355 | 27767 | 1629 | 32481 | 1493 | 14931 |
| 6-#14 | 1.11 | MA | 18628 | 4779 | 29315 | 3531 | 31689 | 2876 | 32371 | 2393 | 32398 | 1701 | 38081 | 1596 | 15452 |
| 2L-3S | | MI | 14715 | 4779 | 23392 | 3477 | 24830 | 2848 | 24921 | 2368 | 24014 | 1673 | 27631 | 1419 | 12895 |
| 6-#14 | 1.11 | MA | 17556 | 4779 | 27704 | 3528 | 29635 | 2891 | 29874 | 2406 | 29041 | 1711 | 33619 | 1468 | 15507 |
| 3L-2S | | MI | 15585 | 4779 | 24704 | 3482 | 26503 | 2835 | 26951 | 2358 | 26695 | 1663 | 31161 | 1547 | 12824 |
| 6-#18 | 1.97 | MA | 20243 | 5151 | 33022 | 3738 | 36285 | 3023 | 37909 | 2480 | 39648 | 1649 | 47589 | 1496 | 26660 |
| 2L-3S | | MI | 15373 | 5151 | 25421 | 3673 | 27292 | 2998 | 27774 | 2448 | 27767 | 1614 | 32481 | 1194 | 21957 |
| 6-#18 | 1.97 | MA | 18408 | 5151 | 30208 | 3731 | 32697 | 3047 | 33547 | 2500 | 33843 | 1667 | 39910 | 1268 | 26570 |
| 3L-2S | | MI | 16858 | 5151 | 27703 | 3684 | 30202 | 2979 | 31262 | 2430 | 32373 | 1596 | 38507 | 1421 | 21958 |
| 8-#11 | 1.03 | MA | 18489 | 4742 | 28939 | 3522 | 31276 | 2870 | 31893 | 2392 | 31812 | 1713 | 37340 | 1614 | 14385 |
| 2L-4S | | MI | 14429 | 4742 | 22736 | 3483 | 24060 | 2836 | 24017 | 2360 | 22921 | 1692 | 26509 | 1392 | 12042 |
| 8-#11 | 1.03 | MA | 17736 | 4742 | 27812 | 3520 | 29839 | 2881 | 30146 | 2401 | 29452 | 1720 | 34196 | 1525 | 14425 |
| 3E | | MI | 14867 | 4742 | 23480 | 3472 | 25006 | 2841 | 25164 | 2367 | 24371 | 1685 | 28132 | 1481 | 12000 |
| 8-#11 | 1.03 | MA | 17202 | 4742 | 26905 | 3532 | 28686 | 2878 | 28747 | 2397 | 27642 | 1727 | 32141 | 1437 | 14441 |
| 4L-2S | | MI | 15479 | 4742 | 24400 | 3475 | 26178 | 2832 | 26589 | 2359 | 26262 | 1678 | 30630 | 1570 | 11952 |
| 8-#14 | 1.48 | MA | 19373 | 4938 | 30927 | 3631 | 33744 | 2948 | 34868 | 2438 | 35754 | 1689 | 42543 | 1568 | 20395 |
| 2L-4S | | MI | 14697 | 4938 | 23640 | 3592 | 25151 | 2913 | 25314 | 2403 | 24639 | 1667 | 28866 | 1256 | 16893 |
| 8-#14 | 1.48 | MA | 18309 | 4938 | 29315 | 3628 | 31689 | 2963 | 32371 | 2451 | 32398 | 1699 | 38081 | 1440 | 20416 |
| 3E | | MI | 15317 | 4938 | 24704 | 3577 | 26503 | 2920 | 26951 | 2413 | 26695 | 1657 | 31161 | 1383 | 16917 |
| 8-#14 | 1.48 | MA | 17554 | 4938 | 28017 | 3645 | 30038 | 2958 | 30367 | 2444 | 29823 | 1709 | 35168 | 1312 | 20320 |
| 4L-2S | | MI | 16180 | 4938 | 26016 | 3582 | 28175 | 2908 | 28981 | 2403 | 29376 | 1647 | 34692 | 1511 | 16870 |
| 8-#18 | 2.63 | MA | 21499 | 5435 | 35837 | 3915 | 39873 | 3152 | 42271 | 2560 | 45452 | 1625 | 55267 | 1440 | 35232 |
| 2L-4S | | MI | 15333 | 5435 | 25846 | 3875 | 27842 | 3110 | 28448 | 2506 | 28841 | 1600 | 34578 | 902 | 27049 |
| 8-#18 | 2.63 | MA | 19687 | 5435 | 33022 | 3908 | 36285 | 3176 | 37909 | 2579 | 39648 | 1642 | 47589 | 1212 | 35030 |
| 3E | | MI | 16391 | 5435 | 27703 | 3850 | 30202 | 3127 | 31262 | 2524 | 32373 | 1582 | 38507 | 1122 | 28833 |
| 8-#18 | 2.63 | MA | 18397 | 5435 | 30747 | 3937 | 33393 | 3165 | 34399 | 2564 | 35195 | 1660 | 42592 | 985 | 32827 |
| 4L-2S | | MI | 17859 | 5435 | 29986 | 3861 | 33112 | 3107 | 34749 | 2506 | 36980 | 1564 | 44534 | 1349 | 28937 |
| 10-#11 | 1.28 | MA | 19014 | 4853 | 30066 | 3591 | 32712 | 2920 | 33639 | 2423 | 34171 | 1706 | 40484 | 1597 | 17843 |
| 2L-5S | | MI | 14464 | 4853 | 23001 | 3549 | 24389 | 2896 | 24409 | 2399 | 23380 | 1675 | 27277 | 1329 | 14819 |
| 10-#11 | 1.28 | MA | 18266 | 4853 | 28939 | 3589 | 31276 | 2931 | 31893 | 2433 | 31812 | 1713 | 37340 | 1508 | 17871 |
| 3L-4S | | MI | 14856 | 4853 | 23656 | 3552 | 25232 | 2886 | 25442 | 2392 | 24812 | 1682 | 29006 | 1369 | 14850 |
| 10-#11 | 1.28 | MA | 17736 | 4853 | 28032 | 3601 | 30122 | 2928 | 30493 | 2428 | 30002 | 1720 | 35285 | 1419 | 17860 |
| 4L-3S | | MI | 15292 | 4853 | 24400 | 3541 | 26178 | 2891 | 26589 | 2398 | 26262 | 1675 | 30630 | 1458 | 14827 |
| 10-#11 | 1.28 | MA | 17260 | 4853 | 27236 | 3600 | 29097 | 2939 | 29237 | 2438 | 28217 | 1713 | 33127 | 1377 | 17771 |
| 5L-2S | | MI | 15900 | 4853 | 25319 | 3544 | 27350 | 2882 | 28014 | 2391 | 28152 | 1668 | 33127 | 1547 | 14789 |
| 10-#14 | 1.85 | MA | 20110 | 5098 | 32538 | 3731 | 35798 | 3020 | 37365 | 2483 | 39111 | 1678 | 47005 | 1541 | 25320 |
| 2L-5S | | MI | 14744 | 5098 | 24016 | 3687 | 25617 | 2997 | 25871 | 2457 | 25289 | 1642 | 29949 | 1164 | 19980 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis

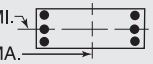



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.85 | MA | 19055 | 5098 | 30927 | 3728 | 33744 | 3035 | 34868 | 2496 | 35754 | 1688 | 42543 | 1413 | 25303 |
| 3L-4S | | MI | 15298 | 5098 | 24952 | 3692 | 26823 | 2985 | 27344 | 2447 | 27320 | 1652 | 32397 | 1221 | 20847 |
| 10-#14 | 1.85 | MA | 18306 | 5098 | 29628 | 3745 | 32093 | 3031 | 32864 | 2489 | 33179 | 1698 | 39631 | 1285 | 25161 |
| 4L-3S | | MI | 15913 | 5098 | 26016 | 3677 | 28175 | 2992 | 28981 | 2457 | 29376 | 1642 | 34692 | 1348 | 20916 |
| 10-#14 | 1.85 | MA | 17634 | 5098 | 28488 | 3742 | 30623 | 3045 | 31065 | 2501 | 30639 | 1688 | 36560 | 1224 | 24048 |
| 5L-2S | | MI | 16770 | 5098 | 27328 | 3682 | 29848 | 2980 | 31012 | 2447 | 32058 | 1632 | 38223 | 1476 | 20896 |
| 10-#18 | 3.29 | MA | 22738 | 5718 | 38651 | 4093 | 43461 | 3280 | 46632 | 2639 | 51257 | 1600 | 62946 | 1384 | 43767 |
| 2L-5S | | MI | 15408 | 5718 | 26491 | 4041 | 28642 | 3258 | 29404 | 2600 | 29956 | 1550 | 36426 | 727 | 31885 |
| 10-#18 | 3.29 | MA | 20948 | 5718 | 35837 | 4086 | 39873 | 3305 | 42271 | 2659 | 45452 | 1618 | 55267 | 1156 | 43474 |
| 3L-4S | | MI | 16350 | 5718 | 28128 | 4052 | 30752 | 3239 | 31936 | 2582 | 33448 | 1568 | 40605 | 830 | 33532 |
| 10-#18 | 3.29 | MA | 19675 | 5718 | 33561 | 4114 | 36981 | 3293 | 38761 | 2644 | 41000 | 1636 | 50270 | 929 | 40881 |
| 4L-3S | | MI | 17395 | 5718 | 29986 | 4028 | 33112 | 3255 | 34749 | 2600 | 36980 | 1550 | 44534 | 1050 | 35686 |
| 10-#18 | 3.29 | MA | 18531 | 5718 | 31561 | 4108 | 34403 | 3318 | 35605 | 2664 | 36605 | 1618 | 44961 | 825 | 38796 |
| 5L-2S | | MI | 18847 | 5718 | 32268 | 4039 | 36022 | 3236 | 38237 | 2582 | 41586 | 1532 | 50561 | 1278 | 35875 |
| 12-#11 | 1.54 | MA | 19536 | 4964 | 31192 | 3660 | 34149 | 2970 | 35386 | 2454 | 36530 | 1699 | 43628 | 1579 | 21292 |
| 2L-6S | | MI | 14518 | 4964 | 23302 | 3615 | 24722 | 2941 | 24848 | 2438 | 23956 | 1672 | 28155 | 1247 | 17002 |
| 12-#11 | 1.54 | MA | 18792 | 4964 | 30066 | 3658 | 32712 | 2981 | 33639 | 2464 | 34171 | 1706 | 40484 | 1490 | 21307 |
| 3L-5S | | MI | 14890 | 4964 | 23921 | 3618 | 25561 | 2946 | 25834 | 2430 | 25270 | 1665 | 29774 | 1307 | 17497 |
| 12-#11 | 1.54 | MA | 18266 | 4964 | 29159 | 3671 | 31559 | 2978 | 32240 | 2459 | 32361 | 1713 | 38429 | 1401 | 21270 |
| 4E | | MI | 15280 | 4964 | 24575 | 3621 | 26405 | 2937 | 26867 | 2423 | 26702 | 1672 | 31503 | 1347 | 17644 |
| 12-#11 | 1.54 | MA | 17793 | 4964 | 28363 | 3669 | 30533 | 2989 | 30984 | 2469 | 30576 | 1706 | 36270 | 1359 | 21066 |
| 5L-3S | | MI | 15713 | 4964 | 25319 | 3610 | 27350 | 2941 | 28014 | 2429 | 28152 | 1665 | 33127 | 1435 | 17642 |
| 12-#11 | 1.54 | MA | 17342 | 4964 | 27612 | 3668 | 29513 | 2986 | 29740 | 2464 | 28936 | 1713 | 34228 | 1300 | 20392 |
| 6L-2S | | MI | 16318 | 4964 | 26238 | 3613 | 28523 | 2932 | 29439 | 2422 | 30043 | 1658 | 35624 | 1524 | 17614 |
| 12-#14 | 2.22 | MA | 20840 | 5257 | 34149 | 3830 | 37852 | 3093 | 39862 | 2528 | 42468 | 1666 | 51468 | 1513 | 30231 |
| 2L-6S | | MI | 14819 | 5257 | 24443 | 3782 | 26089 | 3062 | 26493 | 2512 | 26106 | 1636 | 31193 | 1043 | 23195 |
| 12-#14 | 2.22 | MA | 19793 | 5257 | 32538 | 3828 | 35798 | 3108 | 37365 | 2541 | 39111 | 1676 | 47005 | 1385 | 30178 |
| 3L-5S | | MI | 15344 | 5257 | 25328 | 3787 | 27290 | 3070 | 27901 | 2502 | 27970 | 1626 | 33479 | 1128 | 23784 |
| 12-#14 | 2.22 | MA | 19051 | 5257 | 31239 | 3845 | 34147 | 3103 | 35362 | 2533 | 36536 | 1686 | 44093 | 1257 | 29997 |
| 4E | | MI | 15893 | 5257 | 26264 | 3792 | 28496 | 3057 | 29375 | 2492 | 30001 | 1636 | 35927 | 1185 | 24791 |
| 12-#14 | 2.22 | MA | 18384 | 5257 | 30099 | 3842 | 32677 | 3118 | 33562 | 2546 | 33996 | 1676 | 41022 | 1197 | 28739 |
| 5L-3S | | MI | 16503 | 5257 | 27328 | 3776 | 29848 | 3065 | 31012 | 2502 | 32058 | 1626 | 38223 | 1313 | 24896 |
| 12-#14 | 2.22 | MA | 17749 | 5257 | 29023 | 3839 | 31215 | 3113 | 31779 | 2539 | 31662 | 1686 | 38124 | 1112 | 27920 |
| 6L-2S | | MI | 17354 | 5257 | 28640 | 3781 | 31521 | 3052 | 33042 | 2492 | 34739 | 1616 | 41753 | 1441 | 24908 |
| 12-#18 | 3.95 | MA | 22192 | 6002 | 38651 | 4263 | 43461 | 3433 | 46632 | 2739 | 51257 | 1594 | 62946 | 1100 | 51907 |
| 3L-5S | | MI | 16424 | 6002 | 28774 | 4218 | 31552 | 3386 | 32892 | 2676 | 34563 | 1518 | 42453 | 655 | 38230 |
| 12-#18 | 3.95 | MA | 20935 | 6002 | 36376 | 4292 | 40569 | 3422 | 43123 | 2724 | 46805 | 1611 | 57949 | 872 | 48980 |
| 4E | | MI | 17355 | 6002 | 30411 | 4229 | 33661 | 3367 | 35423 | 2658 | 38054 | 1535 | 46632 | 758 | 40058 |
| 12-#18 | 3.95 | MA | 19807 | 6002 | 34376 | 4285 | 37991 | 3446 | 39967 | 2743 | 42410 | 1594 | 52639 | 769 | 46768 |
| 5L-3S | | MI | 18388 | 6002 | 32268 | 4205 | 36022 | 3384 | 38237 | 2676 | 41586 | 1518 | 50561 | 978 | 42524 |
| 12-#18 | 3.95 | MA | 18731 | 6002 | 32486 | 4278 | 35426 | 3435 | 36839 | 2728 | 38375 | 1611 | 47660 | 617 | 43394 |
| 6L-2S | | MI | 19825 | 6002 | 34550 | 4216 | 38932 | 3365 | 41724 | 2658 | 46193 | 1500 | 56587 | 1206 | 42786 |
| 14-#11 | 1.80 | MA | 20054 | 5074 | 32319 | 3729 | 35586 | 3021 | 37132 | 2485 | 38889 | 1691 | 46772 | 1561 | 24734 |
| 2L-7S | | MI | 14582 | 5074 | 23560 | 3696 | 25088 | 3000 | 25249 | 2462 | 24561 | 1669 | 28965 | 1136 | 19356 |
| 14-#11 | 1.80 | MA | 19314 | 5074 | 31192 | 3727 | 34149 | 3031 | 35386 | 2495 | 36530 | 1698 | 43628 | 1472 | 24728 |
| 3L-6S | | MI | 14944 | 5074 | 24222 | 3685 | 25895 | 2991 | 26273 | 2469 | 25847 | 1662 | 30652 | 1225 | 19701 |
| 14-#11 | 1.80 | MA | 18791 | 5074 | 30286 | 3740 | 32996 | 3028 | 33986 | 2490 | 34720 | 1705 | 41573 | 1384 | 24673 |
| 4L-5S | | MI | 15314 | 5074 | 24840 | 3688 | 26734 | 2996 | 27259 | 2461 | 27161 | 1655 | 32271 | 1284 | 20165 |
| 14-#11 | 1.80 | MA | 18322 | 5074 | 29490 | 3738 | 31970 | 3039 | 32730 | 2500 | 32935 | 1698 | 39414 | 1341 | 24347 |
| 5L-4S | | MI | 15701 | 5074 | 25494 | 3690 | 27577 | 2987 | 28292 | 2454 | 28593 | 1662 | 34000 | 1324 | 20429 |
| 14-#11 | 1.80 | MA | 17874 | 5074 | 28739 | 3737 | 30950 | 3036 | 31486 | 2495 | 31295 | 1705 | 37371 | 1283 | 23707 |
| 6L-3S | | MI | 16132 | 5074 | 26238 | 3679 | 28523 | 2991 | 29439 | 2460 | 30043 | 1655 | 35624 | 1412 | 20449 |
| 14-#11 | 1.80 | MA | 17437 | 5074 | 27935 | 3749 | 29970 | 3047 | 30286 | 2505 | 29690 | 1712 | 35244 | 1195 | 23253 |
| 7L-2S | | MI | 16734 | 5074 | 27158 | 3682 | 29695 | 2982 | 30864 | 2453 | 31933 | 1648 | 38121 | 1501 | 20431 |
| 14-#14 | 2.59 | MA | 21563 | 5417 | 35760 | 3930 | 39906 | 3165 | 42359 | 2573 | 45824 | 1655 | 55930 | 1486 | 35125 |
| 2L-7S | | MI | 14909 | 5417 | 24808 | 3897 | 26608 | 3147 | 27060 | 2547 | 26964 | 1630 | 32576 | 908 | 25793 |
| 14-#14 | 2.59 | MA | 20524 | 5417 | 34149 | 3927 | 37852 | 3180 | 39862 | 2585 | 42468 | 1665 | 51468 | 1358 | 35044 |
| 3L-6S | | MI | 15418 | 5417 | 25755 | 3882 | 27762 | 3135 | 28523 | 2557 | 28788 | 1620 | 34723 | 1007 | 26935 |

## RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis



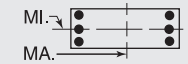

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.59 | MA | 19788 | 5417 | 32850 | 3945 | 36201 | 3175 | 37859 | 2578 | 39893 | 1674 | 48555 | 1230 | 34828 |
| 4L-5S | | MI | 15938 | 5417 | 26640 | 3886 | 28962 | 3142 | 29931 | 2547 | 30652 | 1611 | 37010 | 1093 | 27602 |
| 14-#14 | 2.59 | MA | 19128 | 5417 | 31710 | 3942 | 34731 | 3190 | 36059 | 2591 | 37352 | 1665 | 45484 | 1169 | 33446 |
| 5L-4S | | MI | 16483 | 5417 | 27576 | 3891 | 30169 | 3130 | 31405 | 2537 | 32683 | 1620 | 39458 | 1150 | 28692 |
| 14-#14 | 2.59 | MA | 18498 | 5417 | 30634 | 3939 | 33269 | 3185 | 34276 | 2584 | 35019 | 1674 | 42587 | 1084 | 32625 |
| 6L-3S | | MI | 17089 | 5417 | 28640 | 3876 | 31521 | 3137 | 33042 | 2547 | 34739 | 1611 | 41753 | 1277 | 28866 |
| 14-#14 | 2.59 | MA | 17883 | 5417 | 29482 | 3956 | 31865 | 3200 | 32556 | 2597 | 32735 | 1684 | 39568 | 958 | 31100 |
| 7L-2S | | MI | 17934 | 5417 | 29952 | 3881 | 33193 | 3125 | 35073 | 2537 | 37420 | 1601 | 45284 | 1405 | 28908 |
| 14-#18 | 4.61 | MA | 22180 | 6286 | 39190 | 4469 | 44157 | 3551 | 47485 | 2803 | 52609 | 1587 | 65627 | 816 | 57114 |
| 4L-5S | | MI | 17429 | 6286 | 31056 | 4396 | 34462 | 3515 | 36379 | 2752 | 39169 | 1486 | 48479 | 583 | 44613 |
| 14-#18 | 4.61 | MA | 21067 | 6286 | 37190 | 4462 | 41579 | 3575 | 44328 | 2823 | 48214 | 1570 | 60318 | 712 | 54732 |
| 5L-4S | | MI | 18349 | 6286 | 32693 | 4407 | 36571 | 3496 | 38911 | 2734 | 42660 | 1503 | 52658 | 687 | 46619 |
| 14-#18 | 4.61 | MA | 20004 | 6286 | 35300 | 4455 | 39014 | 3564 | 41201 | 2808 | 44179 | 1587 | 55338 | 561 | 51502 |
| 6L-3S | | MI | 19371 | 6286 | 34550 | 4382 | 38932 | 3512 | 41724 | 2752 | 46193 | 1486 | 56587 | 907 | 49351 |
| 16-#11 | 2.05 | MA | 20568 | 5185 | 33446 | 3798 | 37022 | 3071 | 38879 | 2517 | 41249 | 1684 | 49916 | 1544 | 28170 |
| 2L-8S | | MI | 14653 | 5185 | 23872 | 3762 | 25447 | 3046 | 25706 | 2501 | 25181 | 1666 | 29847 | 1067 | 21385 |
| 16-#11 | 2.05 | MA | 19833 | 5185 | 32319 | 3797 | 35586 | 3082 | 37132 | 2526 | 38889 | 1691 | 46772 | 1455 | 28146 |
| 3L-7S | | MI | 15008 | 5185 | 24480 | 3765 | 26260 | 3051 | 26674 | 2493 | 26451 | 1659 | 31462 | 1114 | 21997 |
| 16-#11 | 2.05 | MA | 19313 | 5185 | 31412 | 3809 | 34433 | 3079 | 35733 | 2522 | 37079 | 1698 | 44717 | 1366 | 28073 |
| 4L-6S | | MI | 15367 | 5185 | 25141 | 3754 | 27067 | 3041 | 27698 | 2500 | 27737 | 1652 | 33150 | 1202 | 22406 |
| 16-#11 | 2.05 | MA | 18847 | 5185 | 30617 | 3807 | 33407 | 3089 | 34477 | 2531 | 35294 | 1691 | 42558 | 1324 | 27638 |
| 5E | | MI | 15735 | 5185 | 25760 | 3757 | 27906 | 3046 | 28684 | 2492 | 29052 | 1645 | 34768 | 1261 | 22844 |
| 16-#11 | 2.05 | MA | 18402 | 5185 | 29866 | 3806 | 32386 | 3086 | 33233 | 2527 | 33654 | 1698 | 40515 | 1265 | 27029 |
| 6L-4S | | MI | 16120 | 5185 | 26414 | 3760 | 28749 | 3037 | 29717 | 2485 | 30483 | 1652 | 36497 | 1301 | 23209 |
| 16-#11 | 2.05 | MA | 17968 | 5185 | 29062 | 3818 | 31407 | 3097 | 32032 | 2536 | 32049 | 1705 | 38388 | 1177 | 26511 |
| 7L-3S | | MI | 16548 | 5185 | 27158 | 3749 | 29695 | 3041 | 30864 | 2491 | 31933 | 1645 | 38121 | 1390 | 23245 |
| 16-#11 | 2.05 | MA | 17540 | 5185 | 28324 | 3817 | 30418 | 3094 | 30856 | 2545 | 30367 | 1698 | 36371 | 1127 | 25690 |
| 8L-2S | | MI | 17146 | 5185 | 28077 | 3751 | 30867 | 3032 | 32289 | 2484 | 33824 | 1638 | 40618 | 1478 | 23242 |
| 16-#14 | 2.96 | MA | 21249 | 5576 | 35760 | 4027 | 39906 | 3252 | 42359 | 2630 | 45824 | 1653 | 55930 | 1330 | 39904 |
| 3L-7S | | MI | 15507 | 5576 | 26120 | 3996 | 28281 | 3219 | 29091 | 2591 | 29645 | 1615 | 36106 | 873 | 29577 |
| 16-#14 | 2.96 | MA | 20519 | 5576 | 34462 | 4044 | 38255 | 3247 | 40356 | 2623 | 43249 | 1663 | 53017 | 1202 | 39580 |
| 4L-6S | | MI | 16011 | 5576 | 27067 | 3981 | 29435 | 3207 | 30553 | 2601 | 31469 | 1605 | 38254 | 972 | 30669 |
| 16-#14 | 2.96 | MA | 19865 | 5576 | 33322 | 4042 | 36785 | 3262 | 38556 | 2636 | 40709 | 1653 | 49946 | 1142 | 38164 |
| 5E | | MI | 16528 | 5576 | 27952 | 3986 | 30635 | 3214 | 31962 | 2591 | 33333 | 1595 | 40540 | 1057 | 31432 |
| 16-#14 | 2.96 | MA | 19240 | 5576 | 32245 | 4039 | 35323 | 3258 | 36773 | 2629 | 38375 | 1663 | 47049 | 1057 | 37249 |
| 6L-4S | | MI | 17069 | 5576 | 28888 | 3991 | 31841 | 3202 | 33435 | 2581 | 35364 | 1605 | 42988 | 1115 | 32458 |
| 16-#14 | 2.96 | MA | 18631 | 5576 | 31093 | 4056 | 33919 | 3272 | 35053 | 2642 | 36092 | 1673 | 44030 | 930 | 35779 |
| 7L-3S | | MI | 17670 | 5576 | 29952 | 3976 | 33193 | 3209 | 35073 | 2591 | 37420 | 1595 | 45284 | 1242 | 32827 |
| 16-#14 | 2.96 | MA | 18030 | 5576 | 30035 | 4053 | 32502 | 3268 | 33368 | 2654 | 33699 | 1663 | 41162 | 859 | 34282 |
| 8L-2S | | MI | 18509 | 5576 | 31264 | 3981 | 34866 | 3197 | 37103 | 2581 | 40101 | 1585 | 48814 | 1370 | 32893 |
| 16-#18 | 5.26 | MA | 22312 | 6569 | 40004 | 4640 | 45167 | 3703 | 48690 | 2903 | 54019 | 1545 | 67996 | 656 | 62728 |
| 5E | | MI | 18423 | 6569 | 33338 | 4573 | 37372 | 3644 | 39867 | 2828 | 43776 | 1453 | 54506 | 511 | 51031 |
| 16-#18 | 5.26 | MA | 21263 | 6569 | 38114 | 4633 | 42602 | 3692 | 45563 | 2887 | 49984 | 1563 | 63017 | 505 | 59633 |
| 6L-4S | | MI | 19333 | 6569 | 34976 | 4584 | 39481 | 3625 | 42398 | 2810 | 47267 | 1471 | 58685 | 615 | 53208 |
| 18-#11 | 2.31 | MA | 20348 | 5296 | 33446 | 3866 | 37022 | 3132 | 38879 | 2557 | 41249 | 1684 | 49916 | 1437 | 31558 |
| 3L-8S | | MI | 15078 | 5296 | 24791 | 3831 | 26619 | 3096 | 27131 | 2532 | 27072 | 1656 | 32345 | 1044 | 24058 |
| 18-#11 | 2.31 | MA | 19831 | 5296 | 32539 | 3878 | 35869 | 3129 | 37479 | 2553 | 39439 | 1691 | 47861 | 1348 | 31469 |
| 4L-7S | | MI | 15430 | 5296 | 25399 | 3834 | 27433 | 3101 | 28099 | 2525 | 28342 | 1649 | 33959 | 1091 | 24645 |
| 18-#11 | 2.31 | MA | 19368 | 5296 | 31744 | 3877 | 34843 | 3140 | 36223 | 2562 | 37654 | 1684 | 45702 | 1306 | 30937 |
| 5L-6S | | MI | 15787 | 5296 | 26061 | 3823 | 28239 | 3092 | 29123 | 2531 | 29628 | 1642 | 35647 | 1179 | 25115 |
| 18-#11 | 2.31 | MA | 18926 | 5296 | 30993 | 3875 | 33823 | 3137 | 34979 | 2558 | 36013 | 1691 | 43659 | 1247 | 30355 |
| 6L-5S | | MI | 16153 | 5296 | 26679 | 3826 | 29078 | 3096 | 30109 | 2524 | 30942 | 1635 | 37265 | 1238 | 25530 |
| 18-#11 | 2.31 | MA | 18495 | 5296 | 30189 | 3887 | 32844 | 3147 | 33779 | 2567 | 34408 | 1697 | 41532 | 1159 | 29777 |
| 7L-4S | | MI | 16536 | 5296 | 27333 | 3829 | 29921 | 3087 | 31142 | 2516 | 32374 | 1642 | 38994 | 1278 | 25984 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis

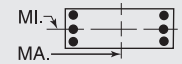


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.31 | MA | 18069 | 5296 | 29451 | 3886 | 31855 | 3145 | 32603 | 2576 | 32727 | 1691 | 39515 | 1110 | 28984 |
| 8L-3S | | MI | 16961 | 5296 | 28077 | 3818 | 30867 | 3092 | 32289 | 2522 | 33824 | 1635 | 40618 | 1367 | 26035 |
| 18-#11 | 2.31 | MA | 17648 | 5296 | 28671 | 3898 | 30889 | 3155 | 31387 | 2572 | 31138 | 1697 | 37536 | 1053 | 28136 |
| 9L-2S | | MI | 17557 | 5296 | 28997 | 3821 | 32039 | 3082 | 33714 | 2515 | 35715 | 1629 | 43115 | 1456 | 26048 |
| 18-#14 | 3.33 | MA | 21244 | 5736 | 36073 | 4144 | 40309 | 3320 | 42853 | 2668 | 46606 | 1651 | 57480 | 1175 | 44242 |
| 4L-7S | | MI | 16100 | 5736 | 27432 | 4096 | 29953 | 3292 | 31121 | 2636 | 32326 | 1599 | 39637 | 838 | 33372 |
| 18-#14 | 3.33 | MA | 20595 | 5736 | 34933 | 4141 | 38839 | 3335 | 41053 | 2681 | 44066 | 1641 | 54409 | 1114 | 42894 |
| 5L-6S | | MI | 16601 | 5736 | 28379 | 4081 | 31107 | 3279 | 32584 | 2646 | 34150 | 1589 | 41784 | 937 | 34416 |
| 18-#14 | 3.33 | MA | 19976 | 5736 | 33856 | 4139 | 37378 | 3330 | 39270 | 2674 | 41732 | 1651 | 51511 | 1029 | 41886 |
| 6L-5S | | MI | 17113 | 5736 | 29264 | 4086 | 32308 | 3287 | 33992 | 2636 | 36014 | 1579 | 44071 | 1022 | 35272 |
| 18-#14 | 3.33 | MA | 19372 | 5736 | 32704 | 4156 | 35973 | 3345 | 37550 | 2686 | 39448 | 1661 | 48493 | 903 | 40469 |
| 7L-4S | | MI | 17650 | 5736 | 30200 | 4091 | 33514 | 3274 | 35466 | 2626 | 38045 | 1589 | 46519 | 1079 | 36240 |
| 18-#14 | 3.33 | MA | 18776 | 5736 | 31647 | 4153 | 34556 | 3340 | 35865 | 2699 | 37055 | 1651 | 45624 | 832 | 38917 |
| 8L-3S | | MI | 18247 | 5736 | 31264 | 4076 | 34866 | 3282 | 37103 | 2636 | 40101 | 1579 | 48814 | 1207 | 36783 |
| 18-#18 | 5.92 | MA | 22508 | 6853 | 40929 | 4810 | 46190 | 3821 | 49925 | 2967 | 55789 | 1539 | 70695 | 449 | 67784 |
| 6L-5S | | MI | 19408 | 6853 | 35621 | 4750 | 40282 | 3772 | 43354 | 2904 | 48382 | 1421 | 60533 | 440 | 57477 |
| 20-#11 | 2.57 | MA | 20346 | 5406 | 33666 | 3947 | 37306 | 3179 | 39226 | 2584 | 41798 | 1683 | 51005 | 1331 | 34862 |
| 4L-8S | | MI | 15500 | 5406 | 25711 | 3900 | 27791 | 3146 | 28556 | 2563 | 28963 | 1646 | 34842 | 1021 | 26737 |
| 20-#11 | 2.57 | MA | 19885 | 5406 | 32871 | 3946 | 36280 | 3190 | 37970 | 2593 | 40013 | 1676 | 48846 | 1288 | 34245 |
| 5L-7S | | MI | 15850 | 5406 | 26318 | 3903 | 28605 | 3151 | 29524 | 2556 | 30233 | 1639 | 36456 | 1068 | 27301 |
| 20-#11 | 2.57 | MA | 19446 | 5406 | 32119 | 3944 | 35260 | 3187 | 36726 | 2589 | 38373 | 1683 | 46803 | 1230 | 33687 |
| 6E | | MI | 16205 | 5406 | 26980 | 3892 | 29411 | 3142 | 30548 | 2562 | 31519 | 1632 | 38144 | 1156 | 27828 |
| 20-#11 | 2.57 | MA | 19018 | 5406 | 31316 | 3957 | 34280 | 3198 | 35525 | 2598 | 36767 | 1690 | 44676 | 1142 | 33050 |
| 7L-5S | | MI | 16568 | 5406 | 27598 | 3895 | 30250 | 3146 | 31534 | 2555 | 32833 | 1626 | 39762 | 1215 | 28224 |
| 20-#11 | 2.57 | MA | 18595 | 5406 | 30578 | 3955 | 33291 | 3195 | 34349 | 2608 | 35086 | 1683 | 42659 | 1092 | 32283 |
| 8L-4S | | MI | 16949 | 5406 | 28253 | 3898 | 31093 | 3137 | 32567 | 2547 | 34265 | 1632 | 41492 | 1255 | 28755 |
| 20-#11 | 2.57 | MA | 18177 | 5406 | 29798 | 3967 | 32325 | 3206 | 33133 | 2603 | 33497 | 1690 | 40680 | 1036 | 31398 |
| 9L-3S | | MI | 17372 | 5406 | 28997 | 3887 | 32039 | 3142 | 33714 | 2554 | 35715 | 1626 | 43115 | 1344 | 28820 |
| 20-#11 | 2.57 | MA | 17715 | 5406 | 29063 | 3966 | 31349 | 3203 | 31965 | 2613 | 31920 | 1697 | 38762 | 972 | 30542 |
| 10L-2S | | MI | 17965 | 5406 | 29916 | 3890 | 33211 | 3133 | 35139 | 2546 | 37605 | 1619 | 45612 | 1433 | 28846 |
| 20-#14 | 3.70 | MA | 21320 | 5896 | 36544 | 4241 | 40893 | 3407 | 43550 | 2726 | 47422 | 1630 | 58871 | 1087 | 47632 |
| 5L-7S | | MI | 16689 | 5896 | 28744 | 4196 | 31626 | 3364 | 33152 | 2681 | 35008 | 1584 | 43168 | 802 | 37175 |
| 20-#14 | 3.70 | MA | 20706 | 5896 | 35467 | 4238 | 39432 | 3402 | 41768 | 2719 | 45089 | 1640 | 55973 | 1002 | 46535 |
| 6E | | MI | 17185 | 5896 | 29691 | 4181 | 32780 | 3351 | 34614 | 2691 | 36832 | 1574 | 45315 | 901 | 38176 |
| 20-#14 | 3.70 | MA | 20107 | 5896 | 34315 | 4256 | 38028 | 3417 | 40047 | 2731 | 42805 | 1650 | 52955 | 875 | 45167 |
| 7L-5S | | MI | 17694 | 5896 | 30576 | 4186 | 33980 | 3359 | 36022 | 2681 | 38695 | 1564 | 47601 | 987 | 39119 |
| 20-#14 | 3.70 | MA | 19516 | 5896 | 33258 | 4253 | 36611 | 3412 | 38362 | 2744 | 40412 | 1640 | 50086 | 804 | 43563 |
| 8L-4S | | MI | 18227 | 5896 | 31512 | 4190 | 35187 | 3347 | 37496 | 2671 | 40726 | 1574 | 50049 | 1044 | 40036 |
| 22-#11 | 2.82 | MA | 20400 | 5517 | 33997 | 4015 | 37717 | 3240 | 39716 | 2624 | 42372 | 1669 | 51990 | 1271 | 37558 |
| 5L-8S | | MI | 15919 | 5517 | 26630 | 3969 | 28963 | 3196 | 29981 | 2594 | 30853 | 1636 | 37339 | 998 | 29421 |
| 22-#11 | 2.82 | MA | 19963 | 5517 | 33246 | 4013 | 36697 | 3237 | 38472 | 2620 | 40732 | 1676 | 49947 | 1212 | 37022 |
| 6L-7S | | MI | 16267 | 5517 | 27238 | 3972 | 29777 | 3201 | 30949 | 2587 | 32123 | 1629 | 38953 | 1045 | 29964 |
| 22-#11 | 2.82 | MA | 19538 | 5517 | 32442 | 4026 | 35717 | 3248 | 37272 | 2629 | 39127 | 1683 | 47820 | 1124 | 36330 |
| 7L-6S | | MI | 16620 | 5517 | 27899 | 3961 | 30583 | 3192 | 31973 | 2593 | 33409 | 1623 | 40641 | 1133 | 30545 |
| 22-#11 | 2.82 | MA | 19118 | 5517 | 31705 | 4024 | 34728 | 3245 | 36096 | 2639 | 37445 | 1676 | 45803 | 1074 | 35587 |
| 8L-5S | | MI | 16981 | 5517 | 28518 | 3964 | 31422 | 3196 | 32959 | 2586 | 34724 | 1616 | 42259 | 1193 | 30922 |
| 22-#11 | 2.82 | MA | 18702 | 5517 | 30924 | 4037 | 33762 | 3256 | 34880 | 2634 | 35856 | 1683 | 43824 | 1018 | 34666 |
| 9L-4S | | MI | 17360 | 5517 | 29172 | 3967 | 32266 | 3187 | 33992 | 2578 | 36155 | 1623 | 43989 | 1233 | 31524 |
| 22-#11 | 2.82 | MA | 18243 | 5517 | 30190 | 4035 | 32786 | 3253 | 33711 | 2644 | 34279 | 1690 | 41906 | 954 | 33797 |
| 10L-3S | | MI | 17781 | 5517 | 29916 | 3956 | 33211 | 3192 | 35139 | 2585 | 37605 | 1616 | 45612 | 1321 | 31602 |
| 22-#14 | 4.07 | MA | 21430 | 6055 | 37078 | 4338 | 41486 | 3474 | 44265 | 2764 | 48445 | 1628 | 60435 | 974 | 51195 |
| 6L-7S | | MI | 17273 | 6055 | 30056 | 4296 | 33299 | 3436 | 35182 | 2725 | 37689 | 1568 | 46698 | 767 | 40987 |
| 22-#14 | 4.07 | MA | 20836 | 6055 | 35926 | 4355 | 40082 | 3489 | 42544 | 2776 | 46162 | 1638 | 57417 | 848 | 49873 |
| 7L-6S | | MI | 17766 | 6055 | 31003 | 4281 | 34453 | 3424 | 36644 | 2735 | 39513 | 1558 | 48845 | 866 | 41947 |
| 22-#14 | 4.07 | MA | 20250 | 6055 | 34869 | 4353 | 38665 | 3485 | 40859 | 2789 | 43769 | 1628 | 54549 | 777 | 48217 |
| 8L-5S | | MI | 18272 | 6055 | 31888 | 4285 | 35653 | 3431 | 38053 | 2725 | 41377 | 1548 | 51132 | 951 | 42973 |
| 24-#11 | 3.08 | MA | 20477 | 5628 | 34373 | 4083 | 38133 | 3287 | 40219 | 2651 | 43091 | 1669 | 53091 | 1194 | 40360 |
| 6L-8S | | MI | 16336 | 5628 | 27550 | 4038 | 30135 | 3246 | 31406 | 2625 | 32744 | 1626 | 39836 | 976 | 32108 |

## RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 3.08 | MA | 20054 | 5628 | 33569 | 4095 | 37154 | 3298 | 39018 | 2660 | 41486 | 1676 | 50964 | 1106 | 39616 |
| 7E | | MI | 16682 | 5628 | 28157 | 4041 | 30949 | 3251 | 32374 | 2618 | 34014 | 1620 | 41450 | 1023 | 32633 |
| 24-#11 | 3.08 | MA | 19637 | 5628 | 32832 | 4093 | 36165 | 3295 | 37842 | 2670 | 39804 | 1669 | 48947 | 1057 | 38895 |
| 8L-6S | | MI | 17033 | 5628 | 28819 | 4030 | 31755 | 3242 | 33398 | 2624 | 35300 | 1613 | 43138 | 1111 | 33264 |
| 24-#11 | 3.08 | MA | 19224 | 5628 | 32051 | 4106 | 35199 | 3306 | 36626 | 2665 | 38215 | 1676 | 46968 | 1000 | 37939 |
| 9L-5S | | MI | 17392 | 5628 | 29437 | 4033 | 32594 | 3247 | 34384 | 2617 | 36614 | 1606 | 44757 | 1170 | 33626 |
| 24-#11 | 3.08 | MA | 18775 | 5628 | 31317 | 4104 | 34222 | 3303 | 35458 | 2675 | 36638 | 1682 | 45050 | 937 | 37043 |
| 10L-4S | | MI | 17769 | 5628 | 30091 | 4036 | 33438 | 3237 | 35416 | 2610 | 38046 | 1613 | 46486 | 1210 | 34290 |
| 24-#14 | 4.44 | MA | 21560 | 6215 | 37538 | 4455 | 42136 | 3562 | 45041 | 2821 | 49518 | 1627 | 61879 | 820 | 54587 |
| 7E | | MI | 17854 | 6215 | 31368 | 4395 | 34971 | 3509 | 37212 | 2770 | 40370 | 1553 | 50229 | 732 | 44775 |
| 24-#14 | 4.44 | MA | 20978 | 6215 | 36480 | 4452 | 40719 | 3557 | 43357 | 2834 | 47125 | 1617 | 59011 | 749 | 52880 |
| 8L-6S | | MI | 18343 | 6215 | 32315 | 4380 | 36125 | 3496 | 38675 | 2780 | 42194 | 1543 | 52376 | 831 | 45728 |

## RECTANGULAR TIED COLUMNS 32" x 40"

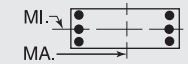
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.25 | MA | 20918 | 5094 | 33159 | 3744 | 35911 | 3046 | 36813 | 2528 | 37104 | 1776 | 43754 | 1656 | 19119 |
| 2E | | MI | 16569 | 5094 | 26519 | 3673 | 28422 | 2987 | 28869 | 2470 | 28743 | 1718 | 33556 | 1579 | 14973 |
| 6-#14 | 1.05 | MA | 20551 | 5005 | 32203 | 3715 | 34831 | 3027 | 35553 | 2522 | 35539 | 1803 | 41761 | 1697 | 16363 |
| 2L-3S | | MI | 15440 | 5005 | 24485 | 3645 | 25961 | 2986 | 26019 | 2485 | 24995 | 1763 | 28714 | 1506 | 12932 |
| 6-#14 | 1.05 | MA | 19409 | 5005 | 30492 | 3713 | 32649 | 3043 | 32901 | 2535 | 31957 | 1813 | 36988 | 1569 | 16418 |
| 3L-2S | | MI | 16311 | 5005 | 25797 | 3650 | 27634 | 2973 | 28049 | 2475 | 27677 | 1753 | 32244 | 1634 | 12858 |
| 6-#18 | 1.88 | MA | 22284 | 5377 | 36150 | 3922 | 39725 | 3174 | 41450 | 2608 | 43309 | 1754 | 51985 | 1604 | 28280 |
| 2L-3S | | MI | 16098 | 5377 | 26519 | 3839 | 28422 | 3134 | 28869 | 2564 | 28743 | 1703 | 33556 | 1280 | 22030 |
| 6-#18 | 1.88 | MA | 20327 | 5377 | 33159 | 3916 | 35911 | 3200 | 36813 | 2630 | 37104 | 1771 | 43754 | 1376 | 28190 |
| 3L-2S | | MI | 17586 | 5377 | 28801 | 3850 | 31332 | 3115 | 32356 | 2546 | 33350 | 1685 | 39582 | 1507 | 22008 |
| 8-#14 | 1.41 | MA | 21347 | 5164 | 33914 | 3815 | 37012 | 3099 | 38204 | 2567 | 39121 | 1792 | 46535 | 1672 | 21610 |
| 2L-4S | | MI | 15421 | 5164 | 24734 | 3760 | 26282 | 3050 | 26412 | 2520 | 25620 | 1757 | 29949 | 1343 | 16956 |
| 8-#14 | 1.41 | MA | 20215 | 5164 | 32203 | 3813 | 34831 | 3115 | 35553 | 2580 | 35539 | 1802 | 41761 | 1544 | 21631 |
| 3E | | MI | 16042 | 5164 | 25797 | 3744 | 27634 | 3058 | 28049 | 2530 | 27677 | 1747 | 32244 | 1470 | 16961 |
| 8-#14 | 1.41 | MA | 19412 | 5164 | 30826 | 3830 | 33080 | 3111 | 33428 | 2574 | 32790 | 1812 | 38641 | 1416 | 21535 |
| 4L-2S | | MI | 16907 | 5164 | 27109 | 3749 | 29306 | 3046 | 30079 | 2520 | 30358 | 1737 | 35775 | 1598 | 16908 |
| 8-#18 | 2.50 | MA | 23629 | 5661 | 39142 | 4099 | 43539 | 3303 | 46086 | 2688 | 49514 | 1732 | 60216 | 1552 | 37392 |
| 2L-4S | | MI | 16057 | 5661 | 26944 | 4041 | 28972 | 3247 | 29543 | 2622 | 29818 | 1689 | 35653 | 988 | 27346 |
| 8-#18 | 2.50 | MA | 21697 | 5661 | 36150 | 4093 | 39725 | 3329 | 41450 | 2709 | 43309 | 1749 | 51985 | 1324 | 37190 |
| 3E | | MI | 17118 | 5661 | 28801 | 4016 | 31332 | 3263 | 32356 | 2640 | 33350 | 1671 | 39582 | 1208 | 28918 |
| 8-#18 | 2.50 | MA | 20325 | 5661 | 33736 | 4123 | 36655 | 3319 | 37725 | 2696 | 38549 | 1767 | 46620 | 1096 | 35122 |
| 4L-2S | | MI | 18589 | 5661 | 31083 | 4027 | 34242 | 3244 | 35844 | 2622 | 37956 | 1653 | 45609 | 1436 | 28994 |
| 10-#11 | 1.22 | MA | 20962 | 5079 | 32996 | 3775 | 35912 | 3072 | 36894 | 2552 | 37398 | 1807 | 44314 | 1699 | 18896 |
| 2L-5S | | MI | 15188 | 5079 | 24092 | 3718 | 25520 | 3034 | 25509 | 2517 | 24364 | 1765 | 28363 | 1417 | 14877 |
| 10-#11 | 1.22 | MA | 20166 | 5079 | 31800 | 3773 | 34387 | 3083 | 35041 | 2562 | 34886 | 1814 | 40954 | 1610 | 18924 |
| 3L-4S | | MI | 15581 | 5079 | 24746 | 3720 | 26364 | 3025 | 26541 | 2509 | 25796 | 1772 | 30092 | 1457 | 14892 |
| 10-#11 | 1.22 | MA | 19603 | 5079 | 30839 | 3786 | 33165 | 3080 | 33557 | 2558 | 32961 | 1821 | 38755 | 1521 | 18913 |
| 4L-3S | | MI | 16017 | 5079 | 25490 | 3709 | 27309 | 3030 | 27689 | 2516 | 27246 | 1765 | 31716 | 1545 | 14863 |
| 10-#11 | 1.22 | MA | 19098 | 5079 | 29996 | 3785 | 32078 | 3092 | 32226 | 2568 | 31062 | 1815 | 36453 | 1478 | 18824 |
| 5L-2S | | MI | 16626 | 5079 | 26410 | 3712 | 28481 | 3020 | 29114 | 2508 | 29136 | 1759 | 34213 | 1634 | 14822 |
| 10-#14 | 1.76 | MA | 22135 | 5324 | 35625 | 3914 | 39193 | 3172 | 40856 | 2611 | 42703 | 1782 | 51308 | 1646 | 26839 |
| 2L-5S | | MI | 15468 | 5324 | 25109 | 3854 | 26748 | 3135 | 26968 | 2574 | 26271 | 1732 | 31031 | 1250 | 20157 |
| 10-#14 | 1.76 | MA | 21012 | 5324 | 33914 | 3912 | 37012 | 3187 | 38204 | 2625 | 39121 | 1792 | 46535 | 1518 | 26822 |
| 3L-4S | | MI | 16023 | 5324 | 26046 | 3859 | 27954 | 3123 | 28442 | 2565 | 28302 | 1741 | 33479 | 1308 | 20917 |
| 10-#14 | 1.76 | MA | 20216 | 5324 | 32537 | 3930 | 35261 | 3183 | 36080 | 2619 | 36373 | 1802 | 43415 | 1390 | 26680 |
| 4L-3S | | MI | 16639 | 5324 | 27109 | 3844 | 29306 | 3130 | 30079 | 2574 | 30358 | 1732 | 35775 | 1435 | 20968 |
| 10-#14 | 1.76 | MA | 19503 | 5324 | 31329 | 3928 | 33704 | 3199 | 34173 | 2632 | 33662 | 1792 | 40137 | 1329 | 25620 |
| 5L-2S | | MI | 17498 | 5324 | 28421 | 3849 | 30979 | 3118 | 32110 | 2565 | 33039 | 1722 | 39305 | 1563 | 20938 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis

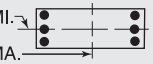



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.13 | MA | 24956 | 5945 | 42134 | 4276 | 47353 | 3432 | 50723 | 2768 | 55719 | 1709 | 68447 | 1499 | 46467 |
| 2L-5S | | MI | 16131 | 5945 | 27589 | 4207 | 29773 | 3394 | 30499 | 2716 | 30933 | 1639 | 37501 | 813 | 32281 |
| 10-#18 | 3.13 | MA | 23047 | 5945 | 39142 | 4271 | 43539 | 3457 | 46086 | 2789 | 49514 | 1727 | 60216 | 1272 | 46174 |
| 3L-4S | | MI | 17076 | 5945 | 29226 | 4218 | 31882 | 3375 | 33030 | 2698 | 34424 | 1657 | 41680 | 916 | 33822 |
| 10-#18 | 3.13 | MA | 21693 | 5945 | 36728 | 4300 | 40469 | 3447 | 42362 | 2775 | 44754 | 1745 | 54851 | 1044 | 43695 |
| 4L-3S | | MI | 18124 | 5945 | 31083 | 4194 | 34242 | 3392 | 35844 | 2716 | 37956 | 1639 | 45609 | 1136 | 35779 |
| 10-#18 | 3.13 | MA | 20478 | 5945 | 34607 | 4295 | 37735 | 3473 | 39014 | 2797 | 40057 | 1727 | 49174 | 939 | 41366 |
| 5L-2S | | MI | 19580 | 5945 | 33366 | 4205 | 37152 | 3372 | 39331 | 2698 | 42563 | 1621 | 51636 | 1364 | 35941 |
| 12-#11 | 1.46 | MA | 21519 | 5190 | 34192 | 3844 | 37437 | 3122 | 38748 | 2583 | 39909 | 1800 | 47674 | 1682 | 22556 |
| 2L-6S | | MI | 15242 | 5190 | 24393 | 3784 | 25853 | 3080 | 25948 | 2555 | 24940 | 1762 | 29242 | 1335 | 17129 |
| 12-#11 | 1.46 | MA | 20728 | 5190 | 32996 | 3843 | 35912 | 3133 | 36894 | 2593 | 37398 | 1807 | 44314 | 1594 | 22570 |
| 3L-5S | | MI | 15615 | 5190 | 25011 | 3787 | 26692 | 3084 | 26934 | 2548 | 26255 | 1756 | 30860 | 1394 | 17638 |
| 12-#11 | 1.46 | MA | 20168 | 5190 | 32035 | 3855 | 34690 | 3130 | 35411 | 2589 | 35472 | 1814 | 42115 | 1505 | 22533 |
| 4E | | MI | 16006 | 5190 | 25666 | 3790 | 27536 | 3075 | 27966 | 2540 | 27686 | 1762 | 32589 | 1434 | 17693 |
| 12-#11 | 1.46 | MA | 19667 | 5190 | 31192 | 3854 | 33603 | 3142 | 34080 | 2599 | 33573 | 1808 | 39813 | 1462 | 22419 |
| 5L-3S | | MI | 16439 | 5190 | 26410 | 3779 | 28481 | 3080 | 29114 | 2547 | 29136 | 1756 | 34213 | 1523 | 17681 |
| 12-#11 | 1.46 | MA | 19189 | 5190 | 30397 | 3853 | 32523 | 3139 | 32762 | 2595 | 31829 | 1815 | 37628 | 1403 | 21674 |
| 6L-2S | | MI | 17045 | 5190 | 27329 | 3782 | 29654 | 3071 | 30539 | 2539 | 31027 | 1749 | 36710 | 1611 | 17650 |
| 12-#14 | 2.11 | MA | 22916 | 5484 | 37336 | 4014 | 41375 | 3244 | 43508 | 2656 | 46285 | 1771 | 56082 | 1621 | 32053 |
| 2L-6S | | MI | 15542 | 5484 | 25536 | 3949 | 27220 | 3200 | 27591 | 2629 | 27088 | 1726 | 32275 | 1130 | 23363 |
| 12-#14 | 2.11 | MA | 21801 | 5484 | 35625 | 4012 | 39193 | 3260 | 40856 | 2670 | 42703 | 1781 | 51308 | 1493 | 32001 |
| 3L-5S | | MI | 16068 | 5484 | 26421 | 3954 | 28421 | 3208 | 28999 | 2619 | 28952 | 1716 | 34562 | 1215 | 23959 |
| 12-#14 | 2.11 | MA | 21012 | 5484 | 34248 | 4030 | 37443 | 3255 | 38732 | 2663 | 39955 | 1791 | 48188 | 1365 | 31819 |
| 4E | | MI | 16619 | 5484 | 27357 | 3959 | 29627 | 3195 | 30472 | 2609 | 30983 | 1726 | 37010 | 1272 | 24867 |
| 12-#14 | 2.11 | MA | 20305 | 5484 | 33040 | 4028 | 35885 | 3271 | 36824 | 2677 | 37244 | 1781 | 44911 | 1303 | 30605 |
| 5L-3S | | MI | 17231 | 5484 | 28421 | 3944 | 30979 | 3203 | 32110 | 2619 | 33039 | 1716 | 39305 | 1400 | 24953 |
| 12-#14 | 2.11 | MA | 19631 | 5484 | 31900 | 4026 | 34336 | 3267 | 34935 | 2671 | 34754 | 1791 | 41809 | 1219 | 29696 |
| 6L-2S | | MI | 18084 | 5484 | 29733 | 3949 | 32651 | 3190 | 34140 | 2609 | 35721 | 1706 | 42836 | 1528 | 24953 |
| 12-#18 | 3.75 | MA | 24379 | 6228 | 42134 | 4448 | 47353 | 3586 | 50723 | 2869 | 55719 | 1705 | 68447 | 1220 | 55147 |
| 3L-5S | | MI | 17148 | 6228 | 29871 | 4384 | 32682 | 3523 | 33986 | 2792 | 35539 | 1607 | 43528 | 741 | 38699 |
| 12-#18 | 3.75 | MA | 23042 | 6228 | 39719 | 4478 | 44283 | 3576 | 46998 | 2855 | 50959 | 1723 | 63082 | 992 | 52312 |
| 4E | | MI | 18082 | 6228 | 31509 | 4395 | 34792 | 3504 | 36518 | 2774 | 39030 | 1624 | 47707 | 845 | 40343 |
| 12-#18 | 3.75 | MA | 21843 | 6228 | 37598 | 4472 | 41549 | 3601 | 43650 | 2877 | 46262 | 1705 | 57405 | 886 | 50121 |
| 5L-3S | | MI | 19119 | 6228 | 33366 | 4371 | 37152 | 3520 | 39331 | 2792 | 42563 | 1607 | 51636 | 1065 | 42625 |
| 12-#18 | 3.75 | MA | 20700 | 6228 | 35595 | 4466 | 38830 | 3592 | 40334 | 2863 | 41948 | 1723 | 52064 | 735 | 46445 |
| 6L-2S | | MI | 20561 | 6228 | 35648 | 4382 | 40062 | 3501 | 42819 | 2774 | 47169 | 1589 | 57662 | 1292 | 42858 |
| 14-#11 | 1.71 | MA | 22073 | 5301 | 35388 | 3913 | 38962 | 3172 | 40602 | 2614 | 42420 | 1793 | 51034 | 1666 | 26208 |
| 2L-7S | | MI | 15306 | 5301 | 24651 | 3864 | 26219 | 3139 | 26348 | 2580 | 25545 | 1759 | 30051 | 1224 | 19539 |
| 14-#11 | 1.71 | MA | 21285 | 5301 | 34192 | 3912 | 37437 | 3183 | 38748 | 2624 | 39909 | 1800 | 47674 | 1577 | 26203 |
| 3L-6S | | MI | 15668 | 5301 | 25312 | 3853 | 27026 | 3130 | 27373 | 2586 | 26831 | 1753 | 31739 | 1312 | 19827 |
| 14-#11 | 1.71 | MA | 20730 | 5301 | 33231 | 3924 | 36215 | 3181 | 37265 | 2620 | 37983 | 1807 | 45475 | 1489 | 26148 |
| 4L-5S | | MI | 16039 | 5301 | 25931 | 3856 | 27865 | 3134 | 28359 | 2579 | 28145 | 1746 | 33357 | 1371 | 20305 |
| 14-#11 | 1.71 | MA | 20232 | 5301 | 32388 | 3923 | 35128 | 3192 | 35934 | 2630 | 36085 | 1801 | 43173 | 1445 | 25911 |
| 5L-4S | | MI | 16427 | 5301 | 26585 | 3859 | 28708 | 3125 | 29391 | 2571 | 29577 | 1753 | 35087 | 1411 | 20483 |
| 14-#11 | 1.71 | MA | 19757 | 5301 | 31593 | 3922 | 34048 | 3189 | 34616 | 2626 | 34340 | 1808 | 40988 | 1387 | 25194 |
| 6L-3S | | MI | 16859 | 5301 | 27329 | 3848 | 29654 | 3130 | 30539 | 2578 | 31027 | 1746 | 36710 | 1500 | 20491 |
| 14-#11 | 1.71 | MA | 19294 | 5301 | 30741 | 3935 | 33010 | 3201 | 33345 | 2636 | 32633 | 1815 | 38714 | 1299 | 24740 |
| 7L-2S | | MI | 17462 | 5301 | 28248 | 3851 | 30826 | 3121 | 31964 | 2570 | 32918 | 1739 | 39207 | 1589 | 20470 |
| 14-#14 | 2.46 | MA | 23690 | 5643 | 39047 | 4114 | 43556 | 3316 | 46160 | 2701 | 49867 | 1761 | 60855 | 1595 | 37252 |
| 2L-7S | | MI | 15632 | 5643 | 25902 | 4064 | 27739 | 3285 | 28158 | 2664 | 27945 | 1720 | 33659 | 995 | 26056 |
| 14-#14 | 2.46 | MA | 22583 | 5643 | 37336 | 4112 | 41375 | 3332 | 43508 | 2715 | 46285 | 1770 | 56082 | 1467 | 37171 |
| 3L-6S | | MI | 16142 | 5643 | 26848 | 4049 | 28893 | 3272 | 29621 | 2674 | 29769 | 1710 | 35806 | 1094 | 27214 |
| 14-#14 | 2.46 | MA | 21801 | 5643 | 35959 | 4130 | 39624 | 3328 | 41383 | 2708 | 43537 | 1780 | 52962 | 1339 | 36954 |
| 4L-5S | | MI | 16664 | 5643 | 27733 | 4054 | 30093 | 3280 | 31029 | 2664 | 31633 | 1700 | 38092 | 1180 | 27776 |
| 14-#14 | 2.46 | MA | 21100 | 5643 | 34751 | 4127 | 38066 | 3343 | 39476 | 2722 | 40827 | 1770 | 49684 | 1278 | 35606 |
| 5L-4S | | MI | 17211 | 5643 | 28669 | 4059 | 31300 | 3267 | 32503 | 2654 | 33664 | 1710 | 40540 | 1237 | 28810 |
| 14-#14 | 2.46 | MA | 20431 | 5643 | 33611 | 4125 | 36518 | 3339 | 37587 | 2716 | 38336 | 1780 | 46582 | 1193 | 34738 |
| 6L-3S | | MI | 17818 | 5643 | 29733 | 4044 | 32651 | 3275 | 34140 | 2664 | 35721 | 1700 | 42836 | 1364 | 28927 |

## RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis



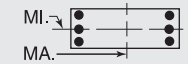

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.46 | MA | 19779 | 5643 | 32390 | 4143 | 35030 | 3355 | 35764 | 2729 | 35899 | 1790 | 43352 | 1067 | 33190 |
| 7L-2S | | MI | 18665 | 5643 | 31045 | 4049 | 34324 | 3263 | 36170 | 2654 | 38402 | 1691 | 46366 | 1492 | 28959 |
| 14-#18 | 4.38 | MA | 24375 | 6512 | 42711 | 4655 | 48098 | 3705 | 51635 | 2935 | 57164 | 1700 | 71312 | 940 | 60967 |
| 4L-5S | | MI | 18154 | 6512 | 32154 | 4562 | 35592 | 3652 | 37474 | 2868 | 40146 | 1575 | 49554 | 669 | 45074 |
| 14-#18 | 4.38 | MA | 23191 | 6512 | 40590 | 4649 | 45363 | 3730 | 48287 | 2956 | 52467 | 1683 | 65636 | 834 | 58694 |
| 5L-4S | | MI | 19078 | 6512 | 33791 | 4573 | 37701 | 3632 | 40005 | 2850 | 43637 | 1592 | 53733 | 773 | 46899 |
| 14-#18 | 4.38 | MA | 22062 | 6512 | 38586 | 4644 | 42644 | 3720 | 44971 | 2942 | 48153 | 1700 | 60294 | 683 | 55077 |
| 6L-3S | | MI | 20104 | 6512 | 35648 | 4548 | 40062 | 3649 | 42819 | 2868 | 47169 | 1575 | 57662 | 993 | 49459 |
| 16-#11 | 1.95 | MA | 22622 | 5411 | 36584 | 3982 | 40487 | 3222 | 42455 | 2645 | 44932 | 1786 | 54394 | 1650 | 29855 |
| 2L-8S | | MI | 15376 | 5411 | 24963 | 3930 | 26578 | 3184 | 26806 | 2618 | 26165 | 1756 | 30934 | 1154 | 21580 |
| 16-#11 | 1.95 | MA | 21839 | 5411 | 35388 | 3981 | 38962 | 3233 | 40602 | 2655 | 42420 | 1793 | 51034 | 1561 | 29830 |
| 3L-7S | | MI | 15732 | 5411 | 25570 | 3933 | 27391 | 3189 | 27773 | 2611 | 27436 | 1750 | 32548 | 1201 | 22208 |
| 16-#11 | 1.95 | MA | 21287 | 5411 | 34427 | 3994 | 37740 | 3231 | 39118 | 2651 | 40495 | 1801 | 48835 | 1472 | 29757 |
| 4L-6S | | MI | 16092 | 5411 | 26232 | 3922 | 28198 | 3180 | 28798 | 2617 | 28722 | 1743 | 34236 | 1289 | 22532 |
| 16-#11 | 1.95 | MA | 20793 | 5411 | 33584 | 3992 | 36653 | 3242 | 37787 | 2661 | 38596 | 1794 | 46533 | 1429 | 29405 |
| 5E | | MI | 16460 | 5411 | 26850 | 3925 | 29037 | 3185 | 29784 | 2610 | 30036 | 1736 | 35854 | 1348 | 22982 |
| 16-#11 | 1.95 | MA | 20321 | 5411 | 32789 | 3991 | 35572 | 3240 | 36470 | 2657 | 36851 | 1801 | 44348 | 1371 | 28721 |
| 6L-4S | | MI | 16847 | 5411 | 27504 | 3928 | 29880 | 3175 | 30816 | 2603 | 31468 | 1743 | 37584 | 1388 | 23266 |
| 16-#11 | 1.95 | MA | 19860 | 5411 | 31937 | 4004 | 34535 | 3251 | 35198 | 2667 | 35144 | 1808 | 42074 | 1283 | 28274 |
| 7L-3S | | MI | 17275 | 5411 | 28248 | 3917 | 30826 | 3180 | 31964 | 2609 | 32918 | 1736 | 39207 | 1477 | 23295 |
| 16-#11 | 1.95 | MA | 19406 | 5411 | 31157 | 4003 | 33488 | 3248 | 33953 | 2677 | 33356 | 1802 | 39923 | 1232 | 27362 |
| 8L-2S | | MI | 17875 | 5411 | 29168 | 3920 | 31998 | 3171 | 33389 | 2602 | 34808 | 1729 | 41704 | 1566 | 23283 |
| 16-#14 | 2.81 | MA | 23358 | 5803 | 39047 | 4212 | 43556 | 3404 | 46160 | 2760 | 49867 | 1760 | 60855 | 1442 | 42334 |
| 3L-7S | | MI | 16230 | 5803 | 27213 | 4164 | 29412 | 3357 | 30189 | 2708 | 30627 | 1705 | 37189 | 960 | 29837 |
| 16-#14 | 2.81 | MA | 22582 | 5803 | 37670 | 4229 | 41805 | 3400 | 44035 | 2753 | 47119 | 1770 | 57736 | 1314 | 42087 |
| 4L-6S | | MI | 16736 | 5803 | 28160 | 4149 | 30565 | 3345 | 31651 | 2718 | 32451 | 1695 | 39336 | 1059 | 30960 |
| 16-#14 | 2.81 | MA | 21888 | 5803 | 36462 | 4227 | 40248 | 3416 | 42128 | 2767 | 44409 | 1760 | 54458 | 1253 | 40619 |
| 5E | | MI | 17255 | 5803 | 29045 | 4154 | 31766 | 3352 | 33060 | 2708 | 34314 | 1685 | 41623 | 1144 | 31605 |
| 16-#14 | 2.81 | MA | 21225 | 5803 | 35321 | 4225 | 38699 | 3411 | 40239 | 2760 | 41918 | 1770 | 51356 | 1168 | 39788 |
| 6L-4S | | MI | 17797 | 5803 | 29981 | 4159 | 32972 | 3340 | 34533 | 2699 | 36345 | 1695 | 44071 | 1202 | 32665 |
| 16-#14 | 2.81 | MA | 20578 | 5803 | 34101 | 4243 | 37211 | 3427 | 38416 | 2774 | 39481 | 1780 | 48126 | 1041 | 38165 |
| 7L-3S | | MI | 18400 | 5803 | 31045 | 4143 | 34324 | 3347 | 36170 | 2708 | 38402 | 1685 | 46366 | 1329 | 32893 |
| 16-#14 | 2.81 | MA | 19940 | 5803 | 32981 | 4241 | 35710 | 3423 | 36631 | 2788 | 36928 | 1770 | 45064 | 970 | 36692 |
| 8L-2S | | MI | 19242 | 5803 | 32357 | 4148 | 35997 | 3335 | 38201 | 2699 | 41083 | 1675 | 49897 | 1457 | 32947 |
| 16-#18 | 5.00 | MA | 24524 | 6796 | 43582 | 4827 | 49177 | 3859 | 52924 | 3036 | 58672 | 1660 | 73867 | 782 | 67210 |
| 5E | | MI | 19151 | 6796 | 34436 | 4739 | 38502 | 3780 | 40961 | 2944 | 44752 | 1543 | 55581 | 598 | 51484 |
| 16-#18 | 5.00 | MA | 23408 | 6796 | 41578 | 4821 | 46458 | 3849 | 49608 | 3022 | 54359 | 1678 | 68525 | 631 | 63733 |
| 6L-4S | | MI | 20065 | 6796 | 36073 | 4750 | 40611 | 3761 | 43493 | 2926 | 48243 | 1560 | 59760 | 701 | 53484 |
| 18-#11 | 2.19 | MA | 22390 | 5522 | 36584 | 4050 | 40487 | 3283 | 42455 | 2686 | 44932 | 1786 | 54394 | 1545 | 33453 |
| 3L-8S | | MI | 15801 | 5522 | 25882 | 3999 | 27750 | 3235 | 28231 | 2650 | 28056 | 1747 | 33431 | 1131 | 24252 |
| 18-#11 | 2.19 | MA | 21841 | 5522 | 35623 | 4063 | 39264 | 3281 | 40972 | 2682 | 43006 | 1794 | 52195 | 1456 | 33364 |
| 4L-7S | | MI | 16154 | 5522 | 26490 | 4002 | 28564 | 3239 | 29198 | 2642 | 29326 | 1740 | 35045 | 1178 | 24854 |
| 18-#11 | 2.19 | MA | 21349 | 5522 | 34780 | 4062 | 38178 | 3292 | 39641 | 2692 | 41107 | 1787 | 49893 | 1413 | 32908 |
| 5L-6S | | MI | 16513 | 5522 | 27151 | 3991 | 29370 | 3230 | 30222 | 2649 | 30612 | 1733 | 36733 | 1266 | 25241 |
| 18-#11 | 2.19 | MA | 20881 | 5522 | 33985 | 4060 | 37097 | 3290 | 38323 | 2688 | 39363 | 1794 | 47708 | 1354 | 32254 |
| 6L-5S | | MI | 16879 | 5522 | 27770 | 3994 | 30209 | 3235 | 31209 | 2641 | 31927 | 1726 | 38352 | 1326 | 25668 |
| 18-#11 | 2.19 | MA | 20423 | 5522 | 33133 | 4073 | 36060 | 3301 | 37052 | 2698 | 37655 | 1801 | 45434 | 1266 | 31744 |
| 7L-4S | | MI | 17263 | 5522 | 28424 | 3997 | 31052 | 3225 | 32241 | 2634 | 33358 | 1733 | 40081 | 1366 | 26045 |
| 18-#11 | 2.19 | MA | 19972 | 5522 | 32353 | 4072 | 35013 | 3298 | 35807 | 2708 | 35867 | 1795 | 43283 | 1216 | 30861 |
| 8L-3S | | MI | 17690 | 5522 | 29168 | 3986 | 31998 | 3230 | 33389 | 2640 | 34808 | 1726 | 41704 | 1454 | 26086 |
| 18-#11 | 2.19 | MA | 19525 | 5522 | 31526 | 4085 | 33990 | 3310 | 34519 | 2704 | 34177 | 1802 | 41167 | 1160 | 30048 |
| 9L-2S | | MI | 18287 | 5522 | 30087 | 3989 | 33170 | 3221 | 34814 | 2633 | 36699 | 1719 | 44202 | 1543 | 26091 |
| 18-#14 | 3.16 | MA | 23358 | 5962 | 39381 | 4329 | 43987 | 3472 | 46687 | 2798 | 50701 | 1759 | 62509 | 1288 | 47169 |
| 4L-7S | | MI | 16824 | 5962 | 28525 | 4264 | 31084 | 3429 | 32219 | 2753 | 33308 | 1689 | 40720 | 925 | 33629 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis

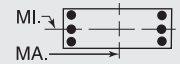



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 3.16 | MA | 22669 | 5962 | 38173 | 4327 | 42429 | 3488 | 44779 | 2812 | 47991 | 1749 | 59231 | 1227 | 45644 |
| 5L-6S | | MI | 17327 | 5962 | 29472 | 4249 | 32238 | 3417 | 33682 | 2763 | 35132 | 1679 | 42867 | 1024 | 34704 |
| 18-#14 | 3.16 | MA | 22011 | 5962 | 37032 | 4325 | 40880 | 3484 | 42890 | 2805 | 45500 | 1759 | 56129 | 1142 | 44736 |
| 6L-5S | | MI | 17841 | 5962 | 30357 | 4253 | 33439 | 3424 | 35090 | 2753 | 36996 | 1669 | 45153 | 1109 | 35443 |
| 18-#14 | 3.16 | MA | 21370 | 5962 | 35812 | 4342 | 39393 | 3499 | 41068 | 2819 | 43063 | 1769 | 52899 | 1016 | 43150 |
| 7L-4S | | MI | 18380 | 5962 | 31293 | 4258 | 34645 | 3412 | 36563 | 2743 | 39027 | 1679 | 47601 | 1166 | 36444 |
| 18-#14 | 3.16 | MA | 20738 | 5962 | 34692 | 4340 | 37892 | 3495 | 39283 | 2832 | 40510 | 1759 | 49837 | 944 | 41623 |
| 8L-3S | | MI | 18978 | 5962 | 32357 | 4243 | 35997 | 3420 | 38201 | 2753 | 41083 | 1669 | 49897 | 1294 | 36852 |
| 18-#14 | 3.16 | MA | 20111 | 5962 | 33507 | 4358 | 36425 | 3511 | 37436 | 2826 | 38097 | 1769 | 46832 | 863 | 40061 |
| 9L-2S | | MI | 19815 | 5962 | 33669 | 4248 | 37669 | 3407 | 40231 | 2743 | 43764 | 1659 | 53427 | 1422 | 36928 |
| 18-#18 | 5.63 | MA | 24741 | 7079 | 44570 | 4998 | 50272 | 3977 | 54244 | 3102 | 60564 | 1656 | 76756 | 579 | 72411 |
| 6L-5S | | MI | 20138 | 7079 | 36719 | 4916 | 41412 | 3909 | 44449 | 3020 | 49359 | 1510 | 61608 | 526 | 57924 |
| 20-#11 | 2.44 | MA | 22391 | 5633 | 36819 | 4132 | 40789 | 3331 | 42826 | 2713 | 45517 | 1787 | 55555 | 1440 | 36968 |
| 4L-8S | | MI | 16224 | 5633 | 26801 | 4068 | 28922 | 3285 | 29656 | 2681 | 29947 | 1737 | 35928 | 1108 | 26930 |
| 20-#11 | 2.44 | MA | 21902 | 5633 | 35976 | 4131 | 39703 | 3342 | 41495 | 2723 | 43619 | 1780 | 53253 | 1396 | 36420 |
| 5L-7S | | MI | 16575 | 5633 | 27409 | 4071 | 29736 | 3289 | 30623 | 2673 | 31217 | 1730 | 37543 | 1156 | 27508 |
| 20-#11 | 2.44 | MA | 21437 | 5633 | 35181 | 4130 | 38622 | 3340 | 40177 | 2719 | 41874 | 1787 | 51068 | 1338 | 35791 |
| 6E | | MI | 16931 | 5633 | 28071 | 4060 | 30542 | 3280 | 31647 | 2680 | 32503 | 1723 | 39230 | 1244 | 27955 |
| 20-#11 | 2.44 | MA | 20982 | 5633 | 34330 | 4142 | 37585 | 3351 | 38906 | 2729 | 40167 | 1794 | 48794 | 1250 | 35222 |
| 7L-5S | | MI | 17296 | 5633 | 28689 | 4063 | 31381 | 3285 | 32634 | 2672 | 33817 | 1716 | 40849 | 1303 | 28360 |
| 20-#11 | 2.44 | MA | 20534 | 5633 | 33549 | 4141 | 36538 | 3349 | 37661 | 2739 | 38378 | 1788 | 46643 | 1200 | 34365 |
| 8L-4S | | MI | 17677 | 5633 | 29343 | 4066 | 32224 | 3276 | 33666 | 2665 | 35249 | 1723 | 42578 | 1343 | 28819 |
| 20-#11 | 2.44 | MA | 20088 | 5633 | 32722 | 4154 | 35515 | 3360 | 36373 | 2735 | 36688 | 1795 | 44527 | 1143 | 33515 |
| 9L-3S | | MI | 18102 | 5633 | 30087 | 4055 | 33170 | 3280 | 34814 | 2671 | 36699 | 1716 | 44202 | 1432 | 28874 |
| 20-#11 | 2.44 | MA | 19590 | 5633 | 31945 | 4153 | 34481 | 3357 | 35136 | 2745 | 35011 | 1802 | 42475 | 1080 | 32566 |
| 10L-2S | | MI | 18696 | 5633 | 31007 | 4058 | 34342 | 3271 | 36239 | 2664 | 38589 | 1709 | 46699 | 1520 | 28894 |
| 20-#14 | 3.52 | MA | 23443 | 6122 | 39884 | 4427 | 44610 | 3560 | 47431 | 2857 | 51573 | 1739 | 64005 | 1202 | 50678 |
| 5L-7S | | MI | 17414 | 6122 | 29837 | 4363 | 32757 | 3502 | 34249 | 2798 | 35989 | 1674 | 44250 | 889 | 37430 |
| 20-#14 | 3.52 | MA | 22791 | 6122 | 38743 | 4424 | 43061 | 3556 | 45542 | 2850 | 49083 | 1749 | 60903 | 1117 | 49678 |
| 6E | | MI | 17913 | 6122 | 30784 | 4348 | 33911 | 3489 | 35712 | 2808 | 37813 | 1664 | 46397 | 988 | 38460 |
| 20-#14 | 3.52 | MA | 22155 | 6122 | 37523 | 4442 | 41574 | 3572 | 43719 | 2864 | 46645 | 1759 | 57673 | 990 | 48144 |
| 7L-5S | | MI | 18423 | 6122 | 31669 | 4353 | 35111 | 3497 | 37120 | 2798 | 39677 | 1654 | 48684 | 1074 | 39290 |
| 20-#14 | 3.52 | MA | 21528 | 6122 | 36403 | 4440 | 40073 | 3568 | 41935 | 2877 | 44092 | 1749 | 54611 | 919 | 46564 |
| 8L-4S | | MI | 18958 | 6122 | 32605 | 4358 | 36318 | 3484 | 38594 | 2788 | 41708 | 1664 | 51132 | 1131 | 40237 |
| 20-#14 | 3.52 | MA | 20906 | 6122 | 35218 | 4458 | 38606 | 3583 | 40088 | 2871 | 41679 | 1759 | 51606 | 837 | 44993 |
| 9L-3S | | MI | 19553 | 6122 | 33669 | 4343 | 37669 | 3492 | 40231 | 2798 | 43764 | 1654 | 53427 | 1258 | 40806 |
| 22-#11 | 2.68 | MA | 22452 | 5743 | 37172 | 4200 | 41227 | 3392 | 43348 | 2754 | 46130 | 1773 | 56613 | 1380 | 39937 |
| 5L-8S | | MI | 16644 | 5743 | 27721 | 4138 | 30094 | 3335 | 31081 | 2712 | 31837 | 1727 | 38425 | 1086 | 29612 |
| 22-#11 | 2.68 | MA | 21989 | 5743 | 36377 | 4199 | 40147 | 3390 | 42031 | 2750 | 44385 | 1780 | 54428 | 1322 | 39333 |
| 6L-7S | | MI | 16993 | 5743 | 28328 | 4141 | 30908 | 3339 | 32048 | 2704 | 33107 | 1720 | 40040 | 1133 | 30169 |
| 22-#11 | 2.68 | MA | 21538 | 5743 | 35526 | 4211 | 39110 | 3401 | 40759 | 2760 | 42678 | 1787 | 52154 | 1234 | 38706 |
| 7L-6S | | MI | 17347 | 5743 | 28990 | 4130 | 31714 | 3330 | 33072 | 2711 | 34393 | 1713 | 41727 | 1221 | 30671 |
| 22-#11 | 2.68 | MA | 21092 | 5743 | 34745 | 4210 | 38063 | 3399 | 39514 | 2770 | 40889 | 1781 | 50003 | 1183 | 37875 |
| 8L-5S | | MI | 17709 | 5743 | 29608 | 4132 | 32553 | 3335 | 34059 | 2703 | 35708 | 1706 | 43346 | 1280 | 31058 |
| 22-#11 | 2.68 | MA | 20647 | 5743 | 33918 | 4223 | 37040 | 3410 | 38227 | 2766 | 39200 | 1788 | 47887 | 1127 | 36988 |
| 9L-4S | | MI | 18089 | 5743 | 30263 | 4135 | 33397 | 3326 | 35091 | 2696 | 37139 | 1713 | 45075 | 1320 | 31590 |
| 22-#11 | 2.68 | MA | 20153 | 5743 | 33141 | 4222 | 36006 | 3408 | 36989 | 2776 | 37522 | 1795 | 45835 | 1064 | 36062 |
| 10L-3S | | MI | 18511 | 5743 | 31007 | 4124 | 34342 | 3330 | 36239 | 2702 | 38589 | 1706 | 46699 | 1409 | 31658 |
| 22-#14 | 3.87 | MA | 23566 | 6282 | 40454 | 4524 | 45243 | 3628 | 48194 | 2895 | 52665 | 1738 | 65677 | 1092 | 54632 |
| 6L-7S | | MI | 17999 | 6282 | 31149 | 4463 | 34429 | 3574 | 36280 | 2843 | 38671 | 1658 | 47781 | 854 | 41239 |
| 22-#14 | 3.87 | MA | 22935 | 6282 | 39234 | 4542 | 43755 | 3644 | 46371 | 2909 | 50227 | 1748 | 62447 | 965 | 53147 |
| 7L-6S | | MI | 18495 | 6282 | 32096 | 4448 | 35583 | 3562 | 37742 | 2852 | 40495 | 1648 | 49928 | 953 | 42228 |
| 22-#14 | 3.87 | MA | 22313 | 6282 | 38114 | 4540 | 42254 | 3640 | 44586 | 2922 | 47674 | 1738 | 59385 | 893 | 51514 |
| 8L-5S | | MI | 19002 | 6282 | 32981 | 4453 | 36784 | 3569 | 39151 | 2843 | 42358 | 1638 | 52214 | 1038 | 43143 |
| 22-#14 | 3.87 | MA | 21691 | 6282 | 36929 | 4558 | 40787 | 3655 | 42740 | 2916 | 45262 | 1748 | 56379 | 812 | 49794 |
| 9L-4S | | MI | 19533 | 6282 | 33917 | 4458 | 37990 | 3557 | 40624 | 2833 | 44389 | 1648 | 54663 | 1096 | 44042 |
| 24-#11 | 2.92 | MA | 22538 | 5854 | 37573 | 4268 | 41672 | 3440 | 43884 | 2782 | 46897 | 1773 | 57788 | 1305 | 42878 |
| 6L-8S | | MI | 17061 | 5854 | 28640 | 4207 | 31266 | 3385 | 32505 | 2743 | 33728 | 1717 | 40922 | 1063 | 32299 |

## RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.92 | MA | 22089 | 5854 | 36722 | 4281 | 40634 | 3451 | 42613 | 2792 | 45189 | 1781 | 55514 | 1218 | 42196 |
| 7E | | MI | 17408 | 5854 | 29248 | 4210 | 32080 | 3390 | 33473 | 2736 | 34998 | 1710 | 42537 | 1110 | 32836 |
| 24-#11 | 2.92 | MA | 21647 | 5854 | 35941 | 4279 | 39587 | 3449 | 41368 | 2801 | 43401 | 1774 | 53363 | 1167 | 41389 |
| 8L-6S | | MI | 17760 | 5854 | 29909 | 4199 | 32887 | 3380 | 34497 | 2742 | 36284 | 1703 | 44224 | 1198 | 33391 |
| 24-#11 | 2.92 | MA | 21203 | 5854 | 35114 | 4292 | 38564 | 3460 | 40080 | 2798 | 41711 | 1781 | 51247 | 1111 | 40466 |
| 9L-5S | | MI | 18121 | 5854 | 30528 | 4202 | 33725 | 3385 | 35484 | 2735 | 37598 | 1696 | 45843 | 1257 | 33761 |
| 24-#11 | 2.92 | MA | 20713 | 5854 | 34337 | 4291 | 37531 | 3458 | 38843 | 2807 | 40034 | 1788 | 49195 | 1047 | 39561 |
| 10L-4S | | MI | 18499 | 5854 | 31182 | 4204 | 34569 | 3376 | 36516 | 2727 | 39030 | 1703 | 47572 | 1297 | 34359 |
| 24-#14 | 4.22 | MA | 23709 | 6441 | 40945 | 4642 | 45937 | 3716 | 49023 | 2954 | 53809 | 1738 | 67220 | 939 | 58157 |
| 7E | | MI | 18581 | 6441 | 32461 | 4563 | 36102 | 3646 | 38310 | 2887 | 41352 | 1643 | 51311 | 819 | 45056 |
| 24-#14 | 4.22 | MA | 23091 | 6441 | 39825 | 4640 | 44436 | 3712 | 47238 | 2967 | 51256 | 1728 | 64158 | 868 | 56472 |
| 8L-6S | | MI | 19073 | 6441 | 33408 | 4548 | 37256 | 3634 | 39773 | 2897 | 43176 | 1633 | 53459 | 918 | 46006 |
| 24-#14 | 4.22 | MA | 22471 | 6441 | 38640 | 4657 | 42969 | 3728 | 45391 | 2961 | 48844 | 1738 | 61153 | 786 | 54718 |
| 9L-5S | | MI | 19577 | 6441 | 34293 | 4553 | 38456 | 3641 | 41181 | 2887 | 45040 | 1623 | 55745 | 1003 | 47002 |

## RECTANGULAR TIED COLUMNS 32" x 42"

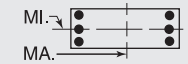
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.19 | MA | 22959 | 5320 | 36238 | 3928 | 39265 | 3197 | 40220 | 2657 | 40494 | 1878 | 47744 | 1759 | 20199 |
| 2E | | MI | 17295 | 5320 | 27616 | 3838 | 29552 | 3123 | 29964 | 2586 | 29720 | 1807 | 34631 | 1665 | 15014 |
| 6-#14 | 1.00 | MA | 22565 | 5231 | 35219 | 3899 | 38113 | 3178 | 38875 | 2650 | 38791 | 1903 | 45587 | 1798 | 17275 |
| 2L-3S | | MI | 16164 | 5231 | 25578 | 3812 | 27092 | 3123 | 27117 | 2602 | 25977 | 1853 | 29796 | 1593 | 12968 |
| 6-#14 | 1.00 | MA | 21353 | 5231 | 33409 | 3897 | 35804 | 3195 | 36069 | 2664 | 34989 | 1914 | 40501 | 1670 | 17329 |
| 3L-2S | | MI | 17036 | 5231 | 26890 | 3817 | 28764 | 3111 | 29147 | 2592 | 28658 | 1843 | 33327 | 1721 | 12890 |
| 6-#18 | 1.79 | MA | 24417 | 5604 | 39407 | 4106 | 43305 | 3326 | 45131 | 2737 | 47099 | 1858 | 56528 | 1710 | 29900 |
| 2L-3S | | MI | 16823 | 5604 | 27616 | 4005 | 29552 | 3271 | 29964 | 2680 | 29720 | 1792 | 34631 | 1366 | 22100 |
| 6-#18 | 1.79 | MA | 22338 | 5604 | 36238 | 4101 | 39265 | 3353 | 40220 | 2760 | 40494 | 1876 | 47744 | 1483 | 29810 |
| 3L-2S | | MI | 18314 | 5604 | 29899 | 4016 | 32462 | 3252 | 33451 | 2662 | 34326 | 1775 | 40657 | 1594 | 22057 |
| 8-#14 | 1.34 | MA | 23413 | 5391 | 37030 | 3999 | 40421 | 3251 | 41681 | 2695 | 42593 | 1893 | 50672 | 1775 | 22825 |
| 2L-4S | | MI | 16145 | 5391 | 25827 | 3927 | 27412 | 3188 | 27510 | 2637 | 26602 | 1847 | 31031 | 1430 | 17015 |
| 8-#14 | 1.34 | MA | 22211 | 5391 | 35219 | 3997 | 38113 | 3267 | 38875 | 2709 | 38791 | 1904 | 45587 | 1647 | 22846 |
| 3E | | MI | 16768 | 5391 | 26890 | 3912 | 28764 | 3196 | 29147 | 2647 | 28658 | 1837 | 33327 | 1557 | 17003 |
| 8-#14 | 1.34 | MA | 21362 | 5391 | 33764 | 4015 | 36262 | 3263 | 36630 | 2704 | 35875 | 1914 | 42259 | 1519 | 22750 |
| 4L-2S | | MI | 17634 | 5391 | 28202 | 3917 | 30437 | 3183 | 31177 | 2637 | 31340 | 1827 | 36857 | 1685 | 16946 |
| 8-#18 | 2.38 | MA | 25852 | 5887 | 42576 | 4283 | 47345 | 3454 | 50043 | 2817 | 53705 | 1838 | 65312 | 1662 | 39552 |
| 2L-4S | | MI | 16781 | 5887 | 28041 | 4206 | 30102 | 3383 | 30638 | 2738 | 30794 | 1778 | 36729 | 1074 | 27637 |
| 8-#18 | 2.38 | MA | 23799 | 5887 | 39407 | 4278 | 43305 | 3481 | 45131 | 2839 | 47099 | 1855 | 56528 | 1434 | 39350 |
| 3E | | MI | 17844 | 5887 | 29899 | 4182 | 32462 | 3399 | 33451 | 2756 | 34326 | 1760 | 40657 | 1294 | 28998 |
| 8-#18 | 2.38 | MA | 22344 | 5887 | 36854 | 4309 | 40058 | 3472 | 41191 | 2827 | 42032 | 1873 | 50794 | 1207 | 37444 |
| 4L-2S | | MI | 19319 | 5887 | 32181 | 4193 | 35372 | 3380 | 36939 | 2738 | 38933 | 1742 | 46684 | 1522 | 29049 |
| 10-#11 | 1.16 | MA | 23000 | 5306 | 36055 | 3958 | 39253 | 3223 | 40289 | 2680 | 40719 | 1906 | 48290 | 1800 | 19949 |
| 2L-5S | | MI | 15912 | 5306 | 25183 | 3886 | 26651 | 3173 | 26608 | 2634 | 25348 | 1856 | 29449 | 1504 | 14931 |
| 10-#11 | 1.16 | MA | 22156 | 5306 | 34789 | 3958 | 37640 | 3221 | 38329 | 2691 | 38062 | 1913 | 44713 | 1711 | 19977 |
| 3L-4S | | MI | 16306 | 5306 | 25837 | 3889 | 27495 | 3163 | 27641 | 2627 | 26780 | 1863 | 31179 | 1544 | 14932 |
| 10-#11 | 1.16 | MA | 21560 | 5306 | 33774 | 3971 | 36348 | 3232 | 36761 | 2687 | 36028 | 1921 | 42370 | 1623 | 19966 |
| 4L-3S | | MI | 16742 | 5306 | 26581 | 3878 | 28440 | 3168 | 28788 | 2633 | 28230 | 1856 | 32802 | 1633 | 14897 |
| 10-#11 | 1.16 | MA | 21027 | 5306 | 32884 | 3970 | 35201 | 3230 | 35356 | 2697 | 34022 | 1915 | 39924 | 1579 | 19877 |
| 5L-2S | | MI | 17352 | 5306 | 27500 | 3881 | 29612 | 3159 | 30213 | 2626 | 30121 | 1849 | 35299 | 1722 | 14854 |
| 10-#14 | 1.67 | MA | 24252 | 5550 | 38841 | 4098 | 42730 | 3323 | 44488 | 2740 | 46395 | 1883 | 55757 | 1751 | 28358 |
| 2L-5S | | MI | 16192 | 5550 | 26202 | 4022 | 27879 | 3273 | 28066 | 2692 | 27252 | 1822 | 32114 | 1337 | 20330 |
| 10-#14 | 1.67 | MA | 23060 | 5550 | 37030 | 4097 | 40421 | 3339 | 41681 | 2754 | 42593 | 1894 | 50672 | 1623 | 28341 |
| 3L-4S | | MI | 16748 | 5550 | 27139 | 4027 | 29085 | 3261 | 29540 | 2682 | 29283 | 1831 | 34562 | 1395 | 20983 |
| 10-#14 | 1.67 | MA | 22218 | 5550 | 35575 | 4115 | 38571 | 3336 | 39436 | 2749 | 39677 | 1904 | 47344 | 1495 | 28199 |
| 4L-3S | | MI | 17365 | 5550 | 28202 | 4012 | 30437 | 3268 | 31177 | 2692 | 31340 | 1822 | 36857 | 1522 | 21015 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis

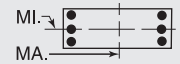



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.67 | MA | 21463 | 5550 | 34299 | 4113 | 36925 | 3352 | 37421 | 2763 | 36803 | 1894 | 43860 | 1433 | 27204 |
| 5L-2S | | MI | 18225 | 5550 | 29514 | 4017 | 32110 | 3256 | 33208 | 2682 | 34021 | 1812 | 40388 | 1650 | 20979 |
| 10-#18 | 2.98 | MA | 27267 | 6171 | 45745 | 4460 | 51385 | 3583 | 54954 | 2896 | 60311 | 1817 | 74096 | 1613 | 49167 |
| 2L-5S | | MI | 16854 | 6171 | 28687 | 4373 | 30903 | 3531 | 31594 | 2832 | 31909 | 1728 | 38576 | 899 | 32531 |
| 10-#18 | 2.98 | MA | 25238 | 6171 | 42576 | 4456 | 47345 | 3610 | 50043 | 2919 | 53705 | 1835 | 65312 | 1386 | 48874 |
| 3L-4S | | MI | 17801 | 6171 | 30324 | 4384 | 33012 | 3512 | 34125 | 2814 | 35401 | 1746 | 42755 | 1002 | 34106 |
| 10-#18 | 2.98 | MA | 23803 | 6171 | 40023 | 4486 | 44098 | 3601 | 46103 | 2907 | 48638 | 1853 | 59578 | 1158 | 46536 |
| 4L-3S | | MI | 18853 | 6171 | 32181 | 4359 | 35372 | 3528 | 36939 | 2832 | 38933 | 1728 | 46684 | 1222 | 35869 |
| 10-#18 | 2.98 | MA | 22516 | 6171 | 37781 | 4482 | 41208 | 3628 | 42563 | 2930 | 43639 | 1835 | 53534 | 1051 | 43953 |
| 5L-2S | | MI | 20312 | 6171 | 34463 | 4370 | 38282 | 3509 | 40426 | 2814 | 43539 | 1710 | 52711 | 1450 | 36005 |
| 12-#11 | 1.39 | MA | 23593 | 5416 | 37320 | 4028 | 40866 | 3273 | 42250 | 2711 | 43375 | 1899 | 51866 | 1785 | 23820 |
| 2L-6S | | MI | 15966 | 5416 | 25484 | 3952 | 26984 | 3218 | 27047 | 2673 | 25925 | 1853 | 30328 | 1422 | 17251 |
| 12-#11 | 1.39 | MA | 22754 | 5416 | 36055 | 4027 | 39253 | 3271 | 40289 | 2722 | 40719 | 1906 | 48290 | 1696 | 23834 |
| 3L-5S | | MI | 16340 | 5416 | 26102 | 3955 | 27823 | 3223 | 28033 | 2665 | 27239 | 1846 | 31947 | 1481 | 17713 |
| 12-#11 | 1.39 | MA | 22162 | 5416 | 35039 | 4040 | 37961 | 3283 | 38722 | 2718 | 38684 | 1914 | 45946 | 1608 | 23797 |
| 4E | | MI | 16731 | 5416 | 26756 | 3958 | 28667 | 3214 | 29066 | 2658 | 28670 | 1853 | 33676 | 1521 | 17739 |
| 12-#11 | 1.39 | MA | 21632 | 5416 | 34150 | 4039 | 36814 | 3280 | 37317 | 2729 | 36679 | 1908 | 43501 | 1564 | 23683 |
| 5L-3S | | MI | 17165 | 5416 | 27500 | 3947 | 29612 | 3218 | 30213 | 2664 | 30121 | 1846 | 35299 | 1610 | 17719 |
| 12-#11 | 1.39 | MA | 21127 | 5416 | 33310 | 4038 | 35673 | 3292 | 35925 | 2725 | 34837 | 1916 | 41174 | 1505 | 22962 |
| 6L-2S | | MI | 17772 | 5416 | 28420 | 3950 | 30785 | 3209 | 31638 | 2657 | 32011 | 1839 | 37797 | 1699 | 17685 |
| 12-#14 | 2.01 | MA | 25084 | 5710 | 40651 | 4198 | 45038 | 3395 | 47294 | 2785 | 50197 | 1873 | 60842 | 1727 | 33876 |
| 2L-6S | | MI | 16265 | 5710 | 26629 | 4117 | 28351 | 3338 | 28689 | 2746 | 28070 | 1816 | 33358 | 1217 | 23525 |
| 12-#14 | 2.01 | MA | 23900 | 5710 | 38841 | 4196 | 42730 | 3412 | 44488 | 2799 | 46395 | 1884 | 55757 | 1599 | 33823 |
| 3L-5S | | MI | 16793 | 5710 | 27514 | 4122 | 29551 | 3345 | 30097 | 2736 | 29934 | 1806 | 35644 | 1302 | 24130 |
| 12-#14 | 2.01 | MA | 23065 | 5710 | 37386 | 4215 | 40879 | 3408 | 42242 | 2793 | 43479 | 1894 | 52429 | 1471 | 33642 |
| 4E | | MI | 17345 | 5710 | 28451 | 4127 | 30758 | 3333 | 31570 | 2726 | 31964 | 1816 | 38093 | 1359 | 24939 |
| 12-#14 | 2.01 | MA | 22317 | 5710 | 36110 | 4213 | 39234 | 3424 | 40227 | 2808 | 40604 | 1884 | 48945 | 1409 | 32483 |
| 5L-3S | | MI | 17958 | 5710 | 29514 | 4111 | 32110 | 3340 | 33208 | 2736 | 34021 | 1806 | 40388 | 1487 | 25008 |
| 12-#14 | 2.01 | MA | 21604 | 5710 | 34905 | 4211 | 37598 | 3421 | 38232 | 2802 | 37963 | 1895 | 45638 | 1325 | 31480 |
| 6L-2S | | MI | 18813 | 5710 | 30826 | 4116 | 33782 | 3328 | 35238 | 2726 | 36702 | 1796 | 43918 | 1615 | 24997 |
| 12-#18 | 3.57 | MA | 26658 | 6455 | 45745 | 4633 | 51385 | 3738 | 54954 | 2999 | 60311 | 1815 | 74096 | 1337 | 58387 |
| 3L-5S | | MI | 17872 | 6455 | 30969 | 4550 | 33812 | 3659 | 35081 | 2908 | 36516 | 1696 | 44603 | 827 | 39159 |
| 12-#18 | 3.57 | MA | 25241 | 6455 | 43192 | 4664 | 48139 | 3730 | 51014 | 2986 | 55243 | 1832 | 68362 | 1110 | 55673 |
| 4E | | MI | 18810 | 6455 | 32606 | 4561 | 35922 | 3640 | 37612 | 2890 | 40007 | 1714 | 48782 | 931 | 40621 |
| 12-#18 | 3.57 | MA | 23971 | 6455 | 40950 | 4659 | 45248 | 3756 | 47475 | 3009 | 50244 | 1815 | 62318 | 1002 | 53236 |
| 5L-3S | | MI | 19850 | 6455 | 34463 | 4537 | 38282 | 3657 | 40426 | 2908 | 43539 | 1696 | 52711 | 1151 | 42722 |
| 12-#18 | 3.57 | MA | 22760 | 6455 | 38833 | 4654 | 42374 | 3748 | 43970 | 2997 | 45652 | 1832 | 56614 | 851 | 49530 |
| 6L-2S | | MI | 21296 | 6455 | 36746 | 4548 | 41192 | 3638 | 43914 | 2890 | 48146 | 1678 | 58737 | 1378 | 42927 |
| 14-#11 | 1.63 | MA | 24182 | 5527 | 38585 | 4097 | 42479 | 3323 | 44211 | 2742 | 46032 | 1892 | 55442 | 1770 | 27682 |
| 2L-7S | | MI | 16029 | 5527 | 25741 | 4032 | 27350 | 3277 | 27448 | 2698 | 26529 | 1850 | 31138 | 1311 | 19660 |
| 14-#11 | 1.63 | MA | 23348 | 5527 | 37320 | 4096 | 40866 | 3321 | 42250 | 2753 | 43375 | 1900 | 51866 | 1681 | 27677 |
| 3L-6S | | MI | 16392 | 5527 | 26403 | 4021 | 28157 | 3268 | 28472 | 2704 | 27815 | 1843 | 32825 | 1399 | 19949 |
| 14-#11 | 1.63 | MA | 22760 | 5527 | 36305 | 4109 | 39574 | 3333 | 40683 | 2749 | 41341 | 1907 | 49523 | 1592 | 27622 |
| 4L-5S | | MI | 16764 | 5527 | 27021 | 4024 | 28996 | 3273 | 29458 | 2697 | 29129 | 1836 | 34444 | 1459 | 20440 |
| 14-#11 | 1.63 | MA | 22233 | 5527 | 35415 | 4108 | 38427 | 3331 | 39278 | 2760 | 39335 | 1901 | 47077 | 1549 | 27486 |
| 5L-4S | | MI | 17153 | 5527 | 27676 | 4027 | 29839 | 3264 | 30491 | 2689 | 30561 | 1843 | 36173 | 1499 | 20534 |
| 14-#11 | 1.63 | MA | 21731 | 5527 | 34575 | 4107 | 37286 | 3342 | 37886 | 2756 | 37493 | 1909 | 44750 | 1490 | 26688 |
| 6L-3S | | MI | 17585 | 5527 | 28420 | 4016 | 30785 | 3268 | 31638 | 2695 | 32011 | 1836 | 37797 | 1587 | 20532 |
| 14-#11 | 1.63 | MA | 21241 | 5527 | 33677 | 4120 | 36191 | 3340 | 36544 | 2767 | 35690 | 1917 | 42329 | 1403 | 26190 |
| 7L-2S | | MI | 18189 | 5527 | 29339 | 4019 | 31957 | 3259 | 33063 | 2688 | 33902 | 1829 | 40294 | 1676 | 20507 |
| 14-#14 | 2.34 | MA | 25908 | 5870 | 42462 | 4298 | 47347 | 3468 | 50100 | 2830 | 53998 | 1864 | 65928 | 1704 | 39378 |
| 2L-7S | | MI | 16355 | 5869 | 26995 | 4232 | 28870 | 3423 | 29256 | 2781 | 28927 | 1810 | 34741 | 1082 | 26312 |
| 14-#14 | 2.34 | MA | 24733 | 5870 | 40651 | 4296 | 45038 | 3484 | 47294 | 2844 | 50197 | 1874 | 60842 | 1576 | 39297 |
| 3L-6S | | MI | 16866 | 5870 | 27941 | 4217 | 30024 | 3410 | 30719 | 2791 | 30751 | 1800 | 36889 | 1181 | 27375 |
| 14-#14 | 2.34 | MA | 23905 | 5869 | 39196 | 4314 | 43188 | 3480 | 45048 | 2838 | 47281 | 1884 | 57515 | 1448 | 39081 |
| 4L-5S | | MI | 17389 | 5870 | 28826 | 4221 | 31224 | 3418 | 32127 | 2781 | 32615 | 1790 | 39175 | 1267 | 27945 |
| 14-#14 | 2.34 | MA | 23164 | 5869 | 37920 | 4313 | 41542 | 3496 | 43033 | 2853 | 44406 | 1874 | 54030 | 1385 | 37779 |
| 5L-4S | | MI | 17937 | 5870 | 29762 | 4226 | 32430 | 3405 | 33601 | 2771 | 34646 | 1800 | 41623 | 1324 | 28887 |

## RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

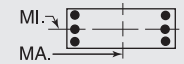
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.34 | MA | 22456 | 5869 | 36716 | 4311 | 39907 | 3493 | 41038 | 2847 | 41765 | 1885 | 50724 | 1301 | 36821 |
| 6L-3S | | MI | 18546 | 5869 | 30826 | 4211 | 33782 | 3413 | 35238 | 2781 | 36702 | 1790 | 43918 | 1451 | 28986 |
| 14-#14 | 2.34 | MA | 21766 | 5869 | 35427 | 4329 | 38336 | 3509 | 39113 | 2861 | 39180 | 1895 | 47282 | 1175 | 35299 |
| 7L-2S | | MI | 19395 | 5869 | 32138 | 4216 | 35455 | 3400 | 37268 | 2771 | 39383 | 1781 | 47449 | 1579 | 29005 |
| 14-#18 | 4.17 | MA | 26662 | 6738 | 46360 | 4841 | 52179 | 3858 | 55925 | 3066 | 61849 | 1812 | 77146 | 1061 | 64848 |
| 4L-5S | | MI | 18880 | 6738 | 33251 | 4727 | 36722 | 3788 | 38569 | 2984 | 41122 | 1664 | 50630 | 756 | 45526 |
| 14-#18 | 4.17 | MA | 25408 | 6738 | 44119 | 4836 | 49288 | 3885 | 52386 | 3089 | 56850 | 1794 | 71102 | 954 | 62540 |
| 5L-4S | | MI | 19808 | 6738 | 34889 | 4738 | 38832 | 3769 | 41100 | 2966 | 44613 | 1681 | 54809 | 859 | 47172 |
| 14-#18 | 4.17 | MA | 24212 | 6738 | 42002 | 4832 | 46414 | 3876 | 48881 | 3077 | 52258 | 1812 | 65397 | 803 | 58688 |
| 6L-3S | | MI | 20837 | 6738 | 36746 | 4714 | 41192 | 3785 | 43914 | 2984 | 48146 | 1664 | 58737 | 1079 | 49563 |
| 14-#18 | 4.17 | MA | 23045 | 6738 | 39736 | 4862 | 43653 | 3903 | 45498 | 3099 | 47763 | 1830 | 59456 | 578 | 54970 |
| 7L-2S | | MI | 22270 | 6738 | 39028 | 4725 | 44102 | 3766 | 47401 | 2966 | 52752 | 1646 | 64764 | 1306 | 49832 |
| 16-#11 | 1.86 | MA | 24768 | 5638 | 39850 | 4166 | 44092 | 3373 | 46172 | 2774 | 48688 | 1885 | 59018 | 1755 | 31539 |
| 2L-8S | | MI | 16100 | 5638 | 26053 | 4098 | 27709 | 3323 | 27905 | 2736 | 27150 | 1847 | 32020 | 1241 | 21770 |
| 16-#11 | 1.86 | MA | 23937 | 5638 | 38585 | 4165 | 42479 | 3371 | 44211 | 2784 | 46032 | 1893 | 55442 | 1666 | 31515 |
| 3L-7S | | MI | 16456 | 5638 | 26661 | 4101 | 28523 | 3328 | 28873 | 2729 | 28420 | 1840 | 33635 | 1288 | 22377 |
| 16-#11 | 1.86 | MA | 23353 | 5638 | 37570 | 4178 | 41187 | 3383 | 42644 | 2780 | 43997 | 1900 | 53099 | 1577 | 31442 |
| 4L-6S | | MI | 16816 | 5638 | 27322 | 4090 | 29329 | 3318 | 29897 | 2735 | 29706 | 1833 | 35322 | 1377 | 22654 |
| 16-#11 | 1.86 | MA | 22830 | 5638 | 36680 | 4177 | 40040 | 3381 | 41239 | 2791 | 41992 | 1894 | 50653 | 1534 | 31183 |
| 5E | | MI | 17186 | 5638 | 27941 | 4093 | 30168 | 3323 | 30883 | 2728 | 31020 | 1826 | 36941 | 1436 | 23116 |
| 16-#11 | 1.86 | MA | 22331 | 5638 | 35840 | 4176 | 38899 | 3392 | 39847 | 2787 | 40150 | 1902 | 48327 | 1475 | 30420 |
| 6L-4S | | MI | 17573 | 5638 | 28595 | 4096 | 31011 | 3314 | 31916 | 2720 | 32452 | 1833 | 38670 | 1476 | 23321 |
| 16-#11 | 1.86 | MA | 21844 | 5638 | 34942 | 4189 | 37804 | 3390 | 38505 | 2798 | 38347 | 1910 | 45905 | 1388 | 29939 |
| 7L-3S | | MI | 18003 | 5638 | 29339 | 4085 | 31957 | 3318 | 33063 | 2727 | 33902 | 1826 | 40294 | 1564 | 23339 |
| 16-#11 | 1.86 | MA | 21364 | 5638 | 34118 | 4189 | 36699 | 3402 | 37191 | 2808 | 36459 | 1904 | 43620 | 1336 | 29046 |
| 8L-2S | | MI | 18604 | 5638 | 30258 | 4088 | 33129 | 3309 | 34488 | 2719 | 35792 | 1819 | 42791 | 1653 | 23322 |
| 16-#14 | 2.68 | MA | 25559 | 6029 | 42462 | 4396 | 47347 | 3556 | 50100 | 2889 | 53998 | 1864 | 65928 | 1552 | 44764 |
| 3L-7S | | MI | 16954 | 6029 | 28307 | 4331 | 30542 | 3495 | 31287 | 2826 | 31608 | 1795 | 38272 | 1047 | 30090 |
| 16-#14 | 2.68 | MA | 24738 | 6029 | 41007 | 4414 | 45496 | 3553 | 47855 | 2883 | 51083 | 1874 | 62600 | 1424 | 44517 |
| 4L-6S | | MI | 17461 | 6029 | 29253 | 4316 | 31696 | 3482 | 32749 | 2836 | 33432 | 1785 | 40419 | 1146 | 31232 |
| 16-#14 | 2.68 | MA | 24002 | 6029 | 39731 | 4413 | 43851 | 3569 | 45840 | 2897 | 48208 | 1864 | 59115 | 1362 | 43088 |
| 5E | | MI | 17981 | 6029 | 30138 | 4321 | 32897 | 3490 | 34157 | 2826 | 35296 | 1775 | 42705 | 1231 | 31773 |
| 16-#14 | 2.68 | MA | 23301 | 6029 | 38527 | 4411 | 42215 | 3565 | 43845 | 2892 | 45567 | 1875 | 55809 | 1277 | 42169 |
| 6L-4S | | MI | 18525 | 6029 | 31074 | 4326 | 34103 | 3478 | 35631 | 2816 | 37327 | 1785 | 45154 | 1289 | 32829 |
| 16-#14 | 2.68 | MA | 22617 | 6029 | 37238 | 4429 | 40644 | 3581 | 41920 | 2906 | 42982 | 1885 | 52367 | 1151 | 40570 |
| 7L-3S | | MI | 19130 | 6029 | 32138 | 4311 | 35455 | 3485 | 37268 | 2826 | 39383 | 1775 | 47449 | 1416 | 32956 |
| 16-#14 | 2.68 | MA | 21942 | 6029 | 36056 | 4427 | 39059 | 3578 | 40035 | 2920 | 40274 | 1875 | 49111 | 1078 | 39134 |
| 8L-2S | | MI | 19974 | 6029 | 33450 | 4316 | 37128 | 3473 | 39299 | 2816 | 42065 | 1765 | 50979 | 1544 | 33000 |
| 16-#18 | 4.76 | MA | 26828 | 7022 | 47288 | 5014 | 53329 | 4014 | 57298 | 3169 | 63456 | 1774 | 79886 | 905 | 71743 |
| 5E | | MI | 19878 | 7022 | 35534 | 4905 | 39632 | 3917 | 42056 | 3060 | 45729 | 1632 | 56656 | 684 | 51928 |
| 16-#18 | 4.76 | MA | 25647 | 7022 | 45171 | 5009 | 50454 | 4005 | 53793 | 3156 | 58863 | 1792 | 74181 | 754 | 67870 |
| 6L-4S | | MI | 20796 | 7022 | 37171 | 4916 | 41741 | 3897 | 44587 | 3042 | 49220 | 1649 | 60835 | 787 | 53753 |
| 16-#18 | 4.76 | MA | 24494 | 7022 | 42905 | 5040 | 47693 | 4032 | 50410 | 3179 | 54369 | 1809 | 68240 | 529 | 64058 |
| 7L-3S | | MI | 21816 | 7022 | 39028 | 4891 | 44102 | 3914 | 47401 | 3060 | 52752 | 1632 | 64764 | 1007 | 56395 |
| 18-#11 | 2.09 | MA | 24523 | 5748 | 39850 | 4234 | 44092 | 3421 | 46172 | 2815 | 48688 | 1886 | 59018 | 1651 | 35349 |
| 3L-8S | | MI | 16525 | 5748 | 26973 | 4168 | 28881 | 3373 | 29330 | 2767 | 29040 | 1837 | 34517 | 1219 | 24440 |
| 18-#11 | 2.09 | MA | 23942 | 5748 | 38835 | 4247 | 42800 | 3433 | 44605 | 2812 | 46654 | 1894 | 56675 | 1562 | 35259 |
| 4L-7S | | MI | 16879 | 5748 | 27580 | 4171 | 29695 | 3378 | 30298 | 2760 | 30310 | 1830 | 36132 | 1266 | 25058 |
| 18-#11 | 2.09 | MA | 23422 | 5748 | 37945 | 4246 | 41653 | 3431 | 43199 | 2822 | 44648 | 1888 | 54230 | 1518 | 34890 |
| 5L-6S | | MI | 17238 | 5748 | 28242 | 4160 | 30501 | 3369 | 31322 | 2766 | 31596 | 1823 | 37819 | 1354 | 25364 |
| 18-#11 | 2.09 | MA | 22927 | 5748 | 37106 | 4246 | 40512 | 3443 | 41808 | 2819 | 42806 | 1895 | 51903 | 1460 | 34159 |
| 6L-5S | | MI | 17606 | 5748 | 28860 | 4162 | 31340 | 3373 | 32308 | 2759 | 32911 | 1816 | 39438 | 1413 | 25801 |
| 18-#11 | 2.09 | MA | 22443 | 5748 | 36207 | 4259 | 39417 | 3440 | 40466 | 2829 | 41003 | 1903 | 49482 | 1372 | 33693 |
| 7L-4S | | MI | 17990 | 5748 | 29514 | 4165 | 32183 | 3364 | 33341 | 2751 | 34342 | 1823 | 41167 | 1453 | 26103 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis

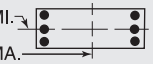


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.09 | MA | 21966 | 5748 | 35383 | 4258 | 38312 | 3452 | 39152 | 2839 | 39115 | 1897 | 47196 | 1321 | 32750 |
| 8L-3S | | MI | 18418 | 5748 | 30258 | 4154 | 33129 | 3369 | 34488 | 2758 | 35792 | 1816 | 42791 | 1542 | 26135 |
| 18-#11 | 2.09 | MA | 21476 | 5748 | 34511 | 4271 | 37232 | 3450 | 37792 | 2836 | 37331 | 1905 | 44942 | 1265 | 31981 |
| 9L-2S | | MI | 19016 | 5748 | 31178 | 4157 | 34301 | 3359 | 35913 | 2750 | 37683 | 1809 | 45288 | 1630 | 26132 |
| 18-#14 | 3.01 | MA | 25563 | 6189 | 42818 | 4514 | 47805 | 3625 | 50661 | 2928 | 54885 | 1864 | 67685 | 1400 | 49950 |
| 4L-7S | | MI | 17549 | 6189 | 29619 | 4431 | 32215 | 3567 | 33317 | 2870 | 34290 | 1779 | 41802 | 1012 | 33879 |
| 18-#14 | 3.01 | MA | 24834 | 6189 | 41542 | 4512 | 46159 | 3641 | 48646 | 2942 | 52010 | 1855 | 64201 | 1338 | 48408 |
| 5L-6S | | MI | 18052 | 6189 | 30565 | 4416 | 33369 | 3555 | 34780 | 2880 | 36114 | 1769 | 43950 | 1111 | 34984 |
| 18-#14 | 3.01 | MA | 24138 | 6189 | 40337 | 4511 | 44524 | 3637 | 46651 | 2937 | 49369 | 1865 | 60894 | 1254 | 47524 |
| 6L-5S | | MI | 18569 | 6189 | 31450 | 4421 | 34569 | 3562 | 36188 | 2870 | 37977 | 1759 | 46236 | 1196 | 35610 |
| 18-#14 | 3.01 | MA | 23460 | 6189 | 39049 | 4529 | 42953 | 3654 | 44726 | 2951 | 46784 | 1875 | 57452 | 1127 | 45851 |
| 7L-4S | | MI | 19109 | 6189 | 32386 | 4426 | 35776 | 3550 | 37661 | 2860 | 40008 | 1769 | 48684 | 1253 | 36644 |
| 18-#14 | 3.01 | MA | 22791 | 6189 | 37866 | 4527 | 41368 | 3650 | 42841 | 2965 | 44076 | 1865 | 54196 | 1055 | 44361 |
| 8L-3S | | MI | 19709 | 6189 | 33450 | 4411 | 37128 | 3557 | 39299 | 2870 | 42065 | 1759 | 50979 | 1381 | 36919 |
| 18-#14 | 3.01 | MA | 22118 | 6189 | 36615 | 4545 | 39819 | 3666 | 40891 | 2960 | 41517 | 1876 | 50993 | 973 | 42638 |
| 9L-2S | | MI | 20548 | 6189 | 34762 | 4416 | 38800 | 3545 | 41329 | 2860 | 44746 | 1749 | 54510 | 1509 | 36984 |
| 18-#18 | 5.36 | MA | 27066 | 7306 | 48340 | 5186 | 54494 | 4133 | 58704 | 3236 | 65469 | 1771 | 82965 | 706 | 77074 |
| 6L-5S | | MI | 20868 | 7306 | 37816 | 5082 | 42542 | 4045 | 45543 | 3136 | 50335 | 1600 | 62683 | 612 | 58361 |
| 18-#18 | 5.36 | MA | 25927 | 7306 | 46074 | 5217 | 51734 | 4160 | 55321 | 3259 | 60975 | 1789 | 77023 | 481 | 73167 |
| 7L-4S | | MI | 21777 | 7306 | 39453 | 5093 | 44651 | 4026 | 48075 | 3118 | 53826 | 1617 | 66862 | 715 | 60358 |
| 20-#11 | 2.32 | MA | 24527 | 5859 | 40100 | 4316 | 44414 | 3483 | 46566 | 2843 | 49310 | 1887 | 60252 | 1547 | 39074 |
| 4L-8S | | MI | 16948 | 5859 | 27892 | 4237 | 30053 | 3423 | 30755 | 2798 | 30931 | 1827 | 37014 | 1196 | 27116 |
| 20-#11 | 2.32 | MA | 24011 | 5859 | 39210 | 4316 | 43266 | 3481 | 45160 | 2853 | 47305 | 1881 | 57806 | 1503 | 38605 |
| 5L-7S | | MI | 17300 | 5859 | 28500 | 4240 | 30867 | 3428 | 31723 | 2791 | 32201 | 1820 | 38629 | 1243 | 27710 |
| 20-#11 | 2.32 | MA | 23518 | 5859 | 38371 | 4315 | 42125 | 3493 | 43769 | 2850 | 45463 | 1888 | 55479 | 1445 | 37903 |
| 6E | | MI | 17657 | 5859 | 29161 | 4229 | 31673 | 3419 | 32747 | 2797 | 33487 | 1813 | 40317 | 1331 | 28077 |
| 20-#11 | 2.32 | MA | 23038 | 5859 | 37472 | 4328 | 41030 | 3491 | 42427 | 2860 | 43660 | 1896 | 53058 | 1357 | 37410 |
| 7L-5S | | MI | 18023 | 5859 | 29780 | 4232 | 32512 | 3423 | 33733 | 2790 | 34801 | 1806 | 41935 | 1390 | 28493 |
| 20-#11 | 2.32 | MA | 22564 | 5859 | 36648 | 4327 | 39925 | 3502 | 41113 | 2870 | 41772 | 1890 | 50772 | 1306 | 36460 |
| 8L-4S | | MI | 18405 | 5859 | 30434 | 4235 | 33355 | 3414 | 34765 | 2782 | 36233 | 1813 | 43664 | 1430 | 28880 |
| 20-#11 | 2.32 | MA | 22084 | 5859 | 35776 | 4340 | 38845 | 3500 | 39753 | 2867 | 39988 | 1898 | 48518 | 1250 | 35653 |
| 9L-3S | | MI | 18831 | 5859 | 31178 | 4224 | 34301 | 3419 | 35913 | 2789 | 37683 | 1806 | 45288 | 1519 | 28925 |
| 20-#11 | 2.32 | MA | 21555 | 5859 | 34956 | 4339 | 37754 | 3512 | 38447 | 2877 | 38217 | 1906 | 46332 | 1187 | 34608 |
| 10L-2S | | MI | 19426 | 5859 | 32097 | 4226 | 35473 | 3410 | 37338 | 2781 | 39574 | 1799 | 47785 | 1608 | 28938 |
| 20-#14 | 3.35 | MA | 25659 | 6348 | 43352 | 4612 | 48468 | 3713 | 51452 | 2987 | 55812 | 1845 | 69286 | 1315 | 53738 |
| 5L-7S | | MI | 18139 | 6348 | 30930 | 4531 | 33888 | 3640 | 35347 | 2915 | 36971 | 1764 | 45333 | 976 | 37678 |
| 20-#14 | 3.35 | MA | 24969 | 6348 | 42148 | 4610 | 46832 | 3710 | 49457 | 2982 | 53171 | 1855 | 65979 | 1230 | 52850 |
| 6E | | MI | 18640 | 6348 | 31877 | 4516 | 35041 | 3627 | 36810 | 2925 | 38795 | 1754 | 47480 | 1075 | 38737 |
| 20-#14 | 3.35 | MA | 24296 | 6348 | 40859 | 4629 | 45261 | 3726 | 47532 | 2996 | 50585 | 1865 | 62538 | 1104 | 51142 |
| 7L-5S | | MI | 19152 | 6348 | 32762 | 4521 | 36242 | 3635 | 38218 | 2915 | 40659 | 1744 | 49766 | 1161 | 39456 |
| 20-#14 | 3.35 | MA | 23632 | 6348 | 39677 | 4627 | 43676 | 3722 | 45647 | 3010 | 47878 | 1856 | 59282 | 1031 | 49597 |
| 8L-4S | | MI | 19689 | 6348 | 33698 | 4526 | 37448 | 3622 | 39692 | 2905 | 42690 | 1754 | 52215 | 1218 | 40435 |
| 20-#14 | 3.35 | MA | 22962 | 6348 | 38426 | 4645 | 42127 | 3739 | 43697 | 3005 | 45319 | 1866 | 56078 | 950 | 47918 |
| 9L-3S | | MI | 20285 | 6348 | 34762 | 4510 | 38800 | 3630 | 41329 | 2915 | 44746 | 1744 | 54510 | 1345 | 40876 |
| 20-#18 | 5.95 | MA | 27346 | 7590 | 49243 | 5394 | 55774 | 4289 | 60232 | 3339 | 67580 | 1768 | 85807 | 432 | 82295 |
| 7L-5S | | MI | 21849 | 7590 | 40099 | 5259 | 45452 | 4174 | 49031 | 3212 | 54942 | 1567 | 68710 | 540 | 64821 |
| 22-#11 | 2.55 | MA | 24596 | 5970 | 40476 | 4385 | 44879 | 3531 | 47121 | 2884 | 49961 | 1874 | 61382 | 1488 | 42328 |
| 5L-8S | | MI | 17368 | 5970 | 28811 | 4306 | 31225 | 3473 | 32180 | 2829 | 32821 | 1817 | 39512 | 1173 | 29797 |
| 22-#11 | 2.55 | MA | 24106 | 5970 | 39636 | 4384 | 43738 | 3543 | 45730 | 2881 | 48119 | 1881 | 59055 | 1430 | 41651 |
| 6L-7S | | MI | 17719 | 5970 | 29419 | 4309 | 32039 | 3478 | 33147 | 2822 | 34092 | 1810 | 41126 | 1220 | 30369 |
| 22-#11 | 2.55 | MA | 23629 | 5970 | 38737 | 4397 | 42643 | 3541 | 44388 | 2891 | 46317 | 1889 | 56634 | 1342 | 41098 |
| 7L-6S | | MI | 18074 | 5970 | 30081 | 4298 | 32845 | 3469 | 34172 | 2828 | 35378 | 1803 | 42814 | 1308 | 30794 |
| 22-#11 | 2.55 | MA | 23158 | 5970 | 37913 | 4396 | 41538 | 3552 | 43073 | 2902 | 44428 | 1883 | 54349 | 1291 | 40176 |
| 8L-5S | | MI | 18437 | 5970 | 30699 | 4301 | 33684 | 3473 | 35158 | 2821 | 36692 | 1796 | 44432 | 1367 | 31190 |
| 22-#11 | 2.55 | MA | 22679 | 5970 | 37041 | 4409 | 40458 | 3550 | 41714 | 2898 | 42644 | 1891 | 52095 | 1235 | 39331 |
| 9L-4S | | MI | 18818 | 5970 | 31353 | 4304 | 34528 | 3464 | 36190 | 2814 | 38124 | 1803 | 46161 | 1407 | 31654 |
| 22-#11 | 2.55 | MA | 22155 | 5970 | 36221 | 4408 | 39367 | 3562 | 40408 | 2909 | 40874 | 1899 | 49909 | 1171 | 38309 |
| 10L-3S | | MI | 19241 | 5970 | 32097 | 4293 | 35473 | 3469 | 37338 | 2820 | 39574 | 1796 | 47785 | 1496 | 31712 |

## RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.55 | MA | 21648 | 5970 | 35412 | 4407 | 38293 | 3560 | 39064 | 2905 | 39011 | 1893 | 47677 | 1117 | 37128 |
| 11L-2S | | MI | 19834 | 5970 | 33017 | 4296 | 36646 | 3460 | 38763 | 2813 | 41464 | 1790 | 50282 | 1585 | 31736 |
| 22-#14 | 3.68 | MA | 25794 | 6508 | 43959 | 4710 | 49141 | 3782 | 52263 | 3027 | 56972 | 1845 | 71065 | 1206 | 58097 |
| 6L-7S | | MI | 18726 | 6508 | 32242 | 4631 | 35560 | 3712 | 37378 | 2960 | 39652 | 1748 | 48863 | 941 | 41485 |
| 22-#14 | 3.68 | MA | 25126 | 6508 | 42670 | 4728 | 47570 | 3798 | 50338 | 3041 | 54387 | 1855 | 67623 | 1080 | 56441 |
| 7L-6S | | MI | 19223 | 6508 | 33189 | 4616 | 36714 | 3699 | 38840 | 2970 | 41476 | 1738 | 51011 | 1040 | 42502 |
| 22-#14 | 3.68 | MA | 24467 | 6508 | 41488 | 4727 | 45985 | 3795 | 48454 | 3055 | 51680 | 1846 | 64367 | 1007 | 54843 |
| 8L-5S | | MI | 19732 | 6508 | 34074 | 4620 | 37915 | 3707 | 40248 | 2960 | 43340 | 1728 | 53297 | 1125 | 43308 |
| 22-#14 | 3.68 | MA | 23798 | 6508 | 40237 | 4745 | 44436 | 3811 | 46504 | 3049 | 49121 | 1856 | 61164 | 926 | 53204 |
| 9L-4S | | MI | 20265 | 6508 | 35010 | 4625 | 39121 | 3695 | 41722 | 2950 | 45371 | 1738 | 55745 | 1183 | 44238 |
| 24-#11 | 2.79 | MA | 24691 | 6080 | 40901 | 4453 | 45351 | 3593 | 47691 | 2912 | 50776 | 1875 | 62632 | 1415 | 45403 |
| 6L-8S | | MI | 17787 | 6080 | 29731 | 4375 | 32397 | 3523 | 33605 | 2861 | 34712 | 1807 | 42009 | 1150 | 32483 |
| 24-#11 | 2.79 | MA | 24216 | 6080 | 40003 | 4466 | 44256 | 3591 | 46348 | 2922 | 48973 | 1882 | 60211 | 1327 | 44793 |
| 7E | | MI | 18135 | 6080 | 30339 | 4378 | 33211 | 3528 | 34572 | 2853 | 35982 | 1800 | 43623 | 1197 | 33034 |
| 24-#11 | 2.79 | MA | 23748 | 6080 | 39178 | 4465 | 43151 | 3603 | 45034 | 2933 | 47085 | 1876 | 57925 | 1276 | 43896 |
| 8L-6S | | MI | 18488 | 6080 | 31000 | 4367 | 34018 | 3519 | 35597 | 2860 | 37268 | 1793 | 45311 | 1285 | 33514 |
| 24-#11 | 2.79 | MA | 23270 | 6080 | 38306 | 4478 | 42071 | 3600 | 43675 | 2929 | 45301 | 1884 | 55671 | 1220 | 43014 |
| 9L-5S | | MI | 18850 | 6080 | 31618 | 4370 | 34857 | 3524 | 36583 | 2852 | 38583 | 1787 | 46929 | 1345 | 33893 |
| 24-#11 | 2.79 | MA | 22751 | 6080 | 37486 | 4477 | 40980 | 3612 | 42369 | 2940 | 43530 | 1892 | 53485 | 1156 | 42015 |
| 10L-4S | | MI | 19229 | 6080 | 32273 | 4373 | 35700 | 3514 | 37615 | 2845 | 40014 | 1793 | 48659 | 1385 | 34426 |
| 24-#11 | 2.79 | MA | 22246 | 6080 | 36677 | 4477 | 39906 | 3610 | 41025 | 2936 | 41668 | 1886 | 51254 | 1102 | 40810 |
| 11L-3S | | MI | 19650 | 6080 | 33017 | 4362 | 36646 | 3519 | 38763 | 2851 | 41464 | 1787 | 50282 | 1473 | 34495 |
| 24-#14 | 4.02 | MA | 25950 | 6667 | 44481 | 4828 | 49878 | 3871 | 53145 | 3086 | 58189 | 1845 | 72708 | 1056 | 61748 |
| 7E | | MI | 19309 | 6667 | 33554 | 4730 | 37233 | 3784 | 39408 | 3004 | 42334 | 1733 | 52394 | 906 | 45300 |
| 24-#14 | 4.02 | MA | 25296 | 6667 | 43298 | 4826 | 48293 | 3867 | 51260 | 3100 | 55481 | 1836 | 69452 | 984 | 60097 |
| 8L-6S | | MI | 19802 | 6667 | 34501 | 4715 | 38387 | 3772 | 40871 | 3014 | 44157 | 1723 | 54541 | 1004 | 46277 |
| 24-#14 | 4.02 | MA | 24628 | 6667 | 42047 | 4845 | 46744 | 3883 | 49310 | 3094 | 52923 | 1846 | 66249 | 902 | 58476 |
| 9L-5S | | MI | 20308 | 6667 | 35386 | 4720 | 39587 | 3779 | 42279 | 3004 | 46021 | 1713 | 56827 | 1090 | 47167 |

## RECTANGULAR TIED COLUMNS 32" x 44"

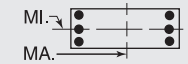
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.14 | MA | 25092 | 5546 | 39446 | 4112 | 42760 | 3348 | 43766 | 2785 | 44013 | 1981 | 51879 | 1861 | 21279 |
| 2E | | MI | 18021 | 5546 | 28714 | 4004 | 30683 | 3260 | 31058 | 2702 | 30696 | 1896 | 35706 | 1751 | 15054 |
| 6-#18 | 1.70 | MA | 26641 | 5830 | 42793 | 4290 | 47026 | 3477 | 48953 | 2865 | 51019 | 1962 | 61217 | 1815 | 31520 |
| 2L-3S | | MI | 17548 | 5830 | 28714 | 4171 | 30683 | 3407 | 31058 | 2796 | 30696 | 1881 | 35706 | 1452 | 22166 |
| 6-#18 | 1.70 | MA | 24440 | 5830 | 39446 | 4286 | 42760 | 3505 | 43766 | 2889 | 44013 | 1979 | 51879 | 1588 | 31430 |
| 3L-2S | | MI | 19041 | 5830 | 30996 | 4182 | 33592 | 3388 | 34546 | 2778 | 35303 | 1864 | 41733 | 1680 | 22105 |
| 8-#14 | 1.28 | MA | 25569 | 5617 | 40275 | 4182 | 43971 | 3402 | 45298 | 2823 | 46152 | 1992 | 54955 | 1877 | 24040 |
| 2L-4S | | MI | 16870 | 5617 | 26920 | 4095 | 28543 | 3326 | 28608 | 2754 | 27584 | 1937 | 32114 | 1517 | 17070 |
| 8-#14 | 1.28 | MA | 24299 | 5617 | 38364 | 4181 | 41535 | 3399 | 42337 | 2838 | 42141 | 2003 | 49557 | 1749 | 24061 |
| 3E | | MI | 17493 | 5617 | 27983 | 4080 | 29895 | 3334 | 30245 | 2764 | 29640 | 1927 | 34409 | 1644 | 17043 |
| 8-#14 | 1.28 | MA | 23402 | 5617 | 36831 | 4200 | 39586 | 3416 | 39971 | 2833 | 39068 | 2014 | 46022 | 1621 | 23965 |
| 4L-2S | | MI | 18360 | 5617 | 29295 | 4084 | 31568 | 3321 | 32275 | 2754 | 32321 | 1917 | 37940 | 1772 | 16982 |
| 8-#18 | 2.27 | MA | 28166 | 6114 | 46139 | 4467 | 51292 | 3606 | 54139 | 2945 | 58026 | 1943 | 70554 | 1770 | 41712 |
| 2L-4S | | MI | 17505 | 6114 | 29139 | 4372 | 31232 | 3520 | 31732 | 2854 | 31771 | 1867 | 37804 | 1160 | 27920 |
| 8-#18 | 2.27 | MA | 25992 | 6114 | 42793 | 4463 | 47026 | 3633 | 48953 | 2969 | 51019 | 1961 | 61217 | 1543 | 41510 |
| 3E | | MI | 18571 | 6114 | 30996 | 4348 | 33592 | 3536 | 34546 | 2872 | 35303 | 1849 | 41733 | 1380 | 29075 |
| 8-#18 | 2.27 | MA | 24455 | 6114 | 40100 | 4495 | 43602 | 3626 | 44797 | 2958 | 45644 | 1978 | 55114 | 1315 | 39791 |
| 4L-2S | | MI | 20049 | 6114 | 33279 | 4359 | 36502 | 3517 | 38033 | 2854 | 39909 | 1832 | 47759 | 1608 | 29103 |
| 10-#11 | 1.11 | MA | 25129 | 5532 | 39242 | 4142 | 42734 | 3374 | 43825 | 2809 | 44168 | 2004 | 52410 | 1901 | 21002 |
| 2L-5S | | MI | 16636 | 5532 | 26273 | 4054 | 27782 | 3311 | 27708 | 2752 | 26332 | 1946 | 30536 | 1591 | 14982 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis

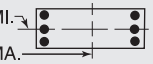



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.11 | MA | 24237 | 5532 | 37908 | 4142 | 41033 | 3372 | 41757 | 2819 | 41367 | 2013 | 48617 | 1812 | 21030 |
| 3L-4S | | MI | 17030 | 5532 | 26927 | 4057 | 28626 | 3302 | 28740 | 2744 | 27764 | 1953 | 32265 | 1631 | 14971 |
| 10-#11 | 1.11 | MA | 23609 | 5532 | 36838 | 4155 | 39673 | 3384 | 40106 | 2816 | 39223 | 2021 | 46130 | 1724 | 21019 |
| 4L-3S | | MI | 17468 | 5532 | 27671 | 4046 | 29571 | 3307 | 29888 | 2751 | 29214 | 1946 | 33889 | 1720 | 14931 |
| 10-#11 | 1.11 | MA | 23046 | 5532 | 35902 | 4155 | 38464 | 3383 | 38626 | 2827 | 37111 | 2016 | 43541 | 1679 | 20930 |
| 5L-2S | | MI | 18078 | 5532 | 28591 | 4049 | 30743 | 3297 | 31313 | 2743 | 31105 | 1939 | 36386 | 1809 | 14886 |
| 10-#14 | 1.60 | MA | 26461 | 5777 | 42185 | 4282 | 46407 | 3474 | 48259 | 2868 | 50163 | 1982 | 60352 | 1855 | 29876 |
| 2L-5S | | MI | 16916 | 5777 | 27296 | 4189 | 29009 | 3411 | 29164 | 2809 | 28234 | 1911 | 33196 | 1424 | 20498 |
| 10-#14 | 1.60 | MA | 25199 | 5777 | 40275 | 4281 | 43971 | 3471 | 45298 | 2883 | 46152 | 1993 | 54955 | 1727 | 29860 |
| 3L-4S | | MI | 17473 | 5777 | 28232 | 4194 | 30216 | 3398 | 30638 | 2799 | 30265 | 1921 | 35645 | 1482 | 21045 |
| 10-#14 | 1.60 | MA | 24310 | 5777 | 38741 | 4300 | 42021 | 3488 | 42932 | 2878 | 43079 | 2004 | 51419 | 1599 | 29718 |
| 4L-3S | | MI | 18091 | 5777 | 29295 | 4179 | 31568 | 3406 | 32275 | 2809 | 32321 | 1911 | 37940 | 1609 | 21061 |
| 10-#14 | 1.60 | MA | 23514 | 5777 | 37398 | 4299 | 40288 | 3485 | 40809 | 2893 | 40051 | 1996 | 47727 | 1536 | 28801 |
| 5L-2S | | MI | 18953 | 5777 | 30607 | 4184 | 33240 | 3394 | 34306 | 2799 | 35002 | 1902 | 41470 | 1737 | 21019 |
| 10-#18 | 2.84 | MA | 29670 | 6397 | 49485 | 4644 | 55558 | 3734 | 59325 | 3025 | 65033 | 1924 | 79891 | 1725 | 51867 |
| 2L-5S | | MI | 17576 | 6397 | 29784 | 4539 | 32033 | 3667 | 32688 | 2948 | 32886 | 1817 | 39651 | 985 | 32775 |
| 10-#18 | 2.84 | MA | 27521 | 6397 | 46139 | 4640 | 51292 | 3762 | 54139 | 3049 | 58026 | 1942 | 70554 | 1497 | 51574 |
| 3L-4S | | MI | 18527 | 6397 | 31422 | 4550 | 34142 | 3648 | 35220 | 2930 | 36377 | 1835 | 43830 | 1089 | 34383 |
| 10-#18 | 2.84 | MA | 26004 | 6397 | 43446 | 4672 | 47868 | 3754 | 49984 | 3038 | 52651 | 1960 | 64451 | 1270 | 49403 |
| 4L-3S | | MI | 19581 | 6397 | 33279 | 4525 | 36502 | 3665 | 38033 | 2948 | 39909 | 1817 | 47759 | 1309 | 35954 |
| 10-#18 | 2.84 | MA | 24645 | 6397 | 41084 | 4668 | 44822 | 3782 | 46253 | 3062 | 47349 | 1942 | 58040 | 1161 | 46557 |
| 5L-2S | | MI | 21044 | 6397 | 35561 | 4536 | 39412 | 3645 | 41521 | 2930 | 44516 | 1799 | 53786 | 1536 | 36068 |
| 12-#11 | 1.33 | MA | 25759 | 5643 | 40577 | 4211 | 44435 | 3424 | 45893 | 2840 | 46970 | 1997 | 56203 | 1887 | 25083 |
| 2L-6S | | MI | 16690 | 5643 | 26574 | 4120 | 28115 | 3357 | 28146 | 2790 | 26909 | 1943 | 31414 | 1510 | 17370 |
| 12-#11 | 1.33 | MA | 24871 | 5643 | 39242 | 4211 | 42734 | 3422 | 43825 | 2851 | 44168 | 2006 | 52410 | 1798 | 25098 |
| 3L-5S | | MI | 17064 | 5643 | 27193 | 4123 | 28954 | 3361 | 29133 | 2783 | 28223 | 1936 | 33033 | 1569 | 17769 |
| 12-#11 | 1.33 | MA | 24247 | 5643 | 38173 | 4224 | 41374 | 3435 | 42174 | 2848 | 42025 | 2014 | 49923 | 1710 | 25060 |
| 4E | | MI | 17456 | 5643 | 27847 | 4126 | 29798 | 3352 | 30165 | 2776 | 29655 | 1943 | 34762 | 1609 | 17782 |
| 12-#11 | 1.33 | MA | 23688 | 5643 | 37236 | 4224 | 40165 | 3433 | 40694 | 2858 | 39913 | 2009 | 47333 | 1665 | 24946 |
| 5L-3S | | MI | 17891 | 5643 | 28591 | 4115 | 30743 | 3357 | 31313 | 2782 | 31105 | 1936 | 36386 | 1697 | 17756 |
| 12-#11 | 1.33 | MA | 23156 | 5643 | 36352 | 4223 | 38964 | 3445 | 39229 | 2855 | 37973 | 2017 | 44865 | 1607 | 24258 |
| 6L-2S | | MI | 18499 | 5643 | 29510 | 4118 | 31916 | 3347 | 32738 | 2775 | 32995 | 1929 | 38883 | 1786 | 17719 |
| 12-#14 | 1.92 | MA | 27343 | 5936 | 44096 | 4382 | 48842 | 3547 | 51220 | 2913 | 54175 | 1972 | 65749 | 1833 | 35698 |
| 2L-6S | | MI | 16989 | 5936 | 27722 | 4284 | 29482 | 3476 | 29786 | 2863 | 29051 | 1906 | 34441 | 1304 | 23681 |
| 12-#14 | 1.92 | MA | 26091 | 5936 | 42185 | 4381 | 46407 | 3543 | 48259 | 2928 | 50163 | 1983 | 60352 | 1705 | 35646 |
| 3L-5S | | MI | 17518 | 5936 | 28608 | 4289 | 30682 | 3483 | 31195 | 2853 | 30915 | 1896 | 36727 | 1389 | 24296 |
| 12-#14 | 1.92 | MA | 25210 | 5936 | 40652 | 4399 | 44457 | 3560 | 45893 | 2923 | 47091 | 1994 | 56816 | 1577 | 35464 |
| 4E | | MI | 18071 | 5936 | 29544 | 4294 | 31888 | 3471 | 32668 | 2843 | 32946 | 1906 | 39175 | 1446 | 25008 |
| 12-#14 | 1.92 | MA | 24421 | 5936 | 39308 | 4398 | 42724 | 3557 | 43770 | 2938 | 44062 | 1986 | 53124 | 1514 | 34374 |
| 5L-3S | | MI | 18685 | 5936 | 30607 | 4279 | 33240 | 3478 | 34306 | 2853 | 35002 | 1896 | 41470 | 1574 | 25061 |
| 12-#14 | 1.92 | MA | 23668 | 5936 | 38040 | 4397 | 41001 | 3574 | 41669 | 2933 | 41280 | 1997 | 49613 | 1429 | 33273 |
| 6L-2S | | MI | 19541 | 5936 | 31919 | 4284 | 34913 | 3466 | 36336 | 2843 | 37684 | 1886 | 45001 | 1702 | 25041 |
| 12-#18 | 3.41 | MA | 29030 | 6681 | 49485 | 4818 | 55558 | 3891 | 59325 | 3129 | 65033 | 1923 | 79891 | 1452 | 61627 |
| 3L-5S | | MI | 18597 | 6681 | 32067 | 4716 | 34943 | 3796 | 36176 | 3024 | 37492 | 1785 | 45678 | 913 | 39404 |
| 12-#18 | 3.41 | MA | 27532 | 6681 | 46793 | 4849 | 52134 | 3883 | 55170 | 3118 | 59657 | 1941 | 73789 | 1225 | 59061 |
| 4E | | MI | 19537 | 6681 | 33704 | 4727 | 37052 | 3777 | 38707 | 3006 | 40984 | 1803 | 49857 | 1017 | 40893 |
| 12-#18 | 3.41 | MA | 26191 | 6681 | 44430 | 4845 | 49088 | 3911 | 51440 | 3142 | 54356 | 1923 | 67377 | 1116 | 56368 |
| 5L-3S | | MI | 20580 | 6681 | 35561 | 4703 | 39412 | 3793 | 41521 | 3024 | 44516 | 1785 | 53786 | 1237 | 42815 |
| 12-#18 | 3.41 | MA | 24912 | 6681 | 42200 | 4842 | 46059 | 3903 | 47745 | 3130 | 49485 | 1941 | 61310 | 965 | 52649 |
| 6L-2S | | MI | 22030 | 6681 | 37843 | 4714 | 42322 | 3774 | 45008 | 3006 | 49122 | 1767 | 59813 | 1464 | 42996 |
| 14-#11 | 1.55 | MA | 26384 | 5753 | 41911 | 4281 | 46136 | 3474 | 47961 | 2871 | 49772 | 1991 | 59996 | 1873 | 29156 |
| 2L-7S | | MI | 16753 | 5753 | 26832 | 4201 | 28481 | 3416 | 28547 | 2815 | 27513 | 1940 | 32224 | 1399 | 19777 |
| 14-#11 | 1.55 | MA | 25501 | 5753 | 40577 | 4280 | 44435 | 3473 | 45893 | 2882 | 46970 | 1999 | 56203 | 1784 | 29151 |
| 3L-6S | | MI | 17117 | 5753 | 27494 | 4190 | 29288 | 3407 | 29571 | 2822 | 28799 | 1933 | 33912 | 1487 | 20068 |
| 14-#11 | 1.55 | MA | 24881 | 5753 | 39507 | 4293 | 43075 | 3485 | 44242 | 2879 | 44827 | 2007 | 53715 | 1696 | 29096 |
| 4L-5S | | MI | 17489 | 5753 | 28112 | 4192 | 30127 | 3411 | 30558 | 2814 | 30114 | 1926 | 35530 | 1546 | 20548 |
| 14-#11 | 1.55 | MA | 24325 | 5753 | 38570 | 4293 | 41866 | 3483 | 42762 | 2889 | 42715 | 2002 | 51126 | 1651 | 28960 |
| 5L-4S | | MI | 17879 | 5753 | 28766 | 4195 | 30970 | 3402 | 31590 | 2807 | 31545 | 1933 | 37259 | 1586 | 20582 |

## RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

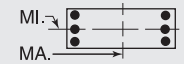
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.55 | MA | 23796 | 5753 | 37687 | 4292 | 40665 | 3495 | 41297 | 2886 | 40775 | 2010 | 48657 | 1593 | 28188 |
| 6L-3S | | MI | 18312 | 5753 | 29510 | 4184 | 31916 | 3407 | 32738 | 2813 | 32995 | 1926 | 38883 | 1675 | 20572 |
| 14-#11 | 1.55 | MA | 23280 | 5753 | 36741 | 4306 | 39513 | 3493 | 39884 | 2897 | 38877 | 2018 | 46089 | 1505 | 27645 |
| 7L-2S | | MI | 18917 | 5753 | 30430 | 4187 | 33088 | 3398 | 34163 | 2806 | 34886 | 1920 | 41380 | 1763 | 20544 |
| 14-#14 | 2.24 | MA | 28219 | 6096 | 46006 | 4482 | 51278 | 3619 | 54181 | 2958 | 58186 | 1962 | 71146 | 1811 | 41504 |
| 2L-7S | | MI | 17077 | 6096 | 28088 | 4399 | 30000 | 3560 | 30354 | 2898 | 29909 | 1900 | 35824 | 1169 | 26562 |
| 14-#14 | 2.24 | MA | 26975 | 6096 | 44096 | 4480 | 48842 | 3616 | 51220 | 2973 | 54175 | 1973 | 65749 | 1683 | 41423 |
| 3L-6S | | MI | 17590 | 6096 | 29034 | 4384 | 31154 | 3548 | 31817 | 2908 | 31733 | 1890 | 37971 | 1268 | 27531 |
| 14-#14 | 2.24 | MA | 26101 | 6096 | 42562 | 4499 | 46892 | 3633 | 48854 | 2968 | 51102 | 1984 | 62213 | 1555 | 41207 |
| 4L-5S | | MI | 18115 | 6096 | 29919 | 4389 | 32355 | 3555 | 33225 | 2898 | 33596 | 1880 | 40257 | 1354 | 28109 |
| 14-#14 | 2.24 | MA | 25318 | 6096 | 41218 | 4498 | 45159 | 3630 | 46731 | 2983 | 48073 | 1976 | 58522 | 1492 | 39964 |
| 5L-4S | | MI | 18664 | 6096 | 30856 | 4394 | 33561 | 3543 | 34699 | 2888 | 35627 | 1890 | 42706 | 1411 | 28961 |
| 14-#14 | 2.24 | MA | 24572 | 6096 | 39950 | 4497 | 43437 | 3646 | 44630 | 2978 | 45291 | 1987 | 55010 | 1407 | 38911 |
| 6L-3S | | MI | 19274 | 6096 | 31919 | 4379 | 34913 | 3551 | 36336 | 2898 | 37684 | 1880 | 45001 | 1538 | 29044 |
| 14-#14 | 2.24 | MA | 23844 | 6096 | 38593 | 4515 | 41783 | 3643 | 42603 | 2993 | 42569 | 1998 | 51357 | 1281 | 37428 |
| 7L-2S | | MI | 20125 | 6096 | 33231 | 4384 | 36586 | 3538 | 38366 | 2888 | 40365 | 1870 | 48531 | 1666 | 29051 |
| 14-#18 | 3.98 | MA | 29042 | 6965 | 50139 | 5027 | 56401 | 4012 | 60356 | 3197 | 66664 | 1922 | 83126 | 1180 | 68758 |
| 4L-5S | | MI | 19606 | 6965 | 34349 | 4893 | 37852 | 3924 | 39663 | 3100 | 42099 | 1753 | 51705 | 842 | 45970 |
| 14-#18 | 3.98 | MA | 27717 | 6965 | 47776 | 5023 | 53354 | 4039 | 56626 | 3221 | 61363 | 1905 | 76715 | 1070 | 66201 |
| 5L-4S | | MI | 20537 | 6965 | 35986 | 4904 | 39962 | 3905 | 42195 | 3082 | 45590 | 1771 | 55884 | 945 | 47440 |
| 14-#18 | 3.98 | MA | 26454 | 6965 | 45546 | 5019 | 50325 | 4032 | 52932 | 3210 | 56491 | 1922 | 70647 | 920 | 62334 |
| 6L-3S | | MI | 21570 | 6965 | 37843 | 4880 | 42322 | 3922 | 45008 | 3100 | 49122 | 1753 | 59813 | 1165 | 49663 |
| 14-#18 | 3.98 | MA | 25221 | 6965 | 43159 | 5051 | 47416 | 4060 | 49367 | 3234 | 51724 | 1940 | 64329 | 695 | 58586 |
| 7L-2S | | MI | 23006 | 6965 | 40126 | 4891 | 45232 | 3903 | 48496 | 3082 | 53729 | 1735 | 65839 | 1393 | 49905 |
| 16-#11 | 1.77 | MA | 27005 | 5864 | 43245 | 4350 | 47838 | 3524 | 50029 | 2902 | 52574 | 1984 | 63788 | 1859 | 33224 |
| 2L-8S | | MI | 16823 | 5864 | 27144 | 4267 | 28840 | 3461 | 29005 | 2854 | 28134 | 1937 | 33107 | 1329 | 21954 |
| 16-#11 | 1.77 | MA | 26126 | 5864 | 41911 | 4349 | 46136 | 3523 | 47961 | 2913 | 49772 | 1992 | 59996 | 1770 | 33200 |
| 3L-7S | | MI | 17180 | 5864 | 27751 | 4270 | 29654 | 3466 | 29972 | 2846 | 29404 | 1930 | 34721 | 1376 | 22495 |
| 16-#11 | 1.77 | MA | 25510 | 5864 | 40841 | 4363 | 44776 | 3535 | 46310 | 2910 | 47628 | 2000 | 57508 | 1682 | 33127 |
| 4L-6S | | MI | 17541 | 5864 | 28413 | 4259 | 30460 | 3457 | 30996 | 2853 | 30690 | 1923 | 36409 | 1464 | 22772 |
| 16-#11 | 1.77 | MA | 24958 | 5864 | 39905 | 4362 | 43568 | 3533 | 44830 | 2921 | 45516 | 1995 | 54919 | 1637 | 32972 |
| 5E | | MI | 17912 | 5864 | 29031 | 4262 | 31299 | 3461 | 31983 | 2845 | 32004 | 1917 | 38027 | 1523 | 23247 |
| 16-#11 | 1.77 | MA | 24432 | 5864 | 39021 | 4362 | 42367 | 3545 | 43365 | 2918 | 43577 | 2003 | 52450 | 1579 | 32127 |
| 6L-4S | | MI | 18299 | 5864 | 29686 | 4265 | 32142 | 3452 | 33015 | 2838 | 33436 | 1923 | 39756 | 1563 | 23373 |
| 16-#11 | 1.77 | MA | 23919 | 5864 | 38075 | 4375 | 41214 | 3543 | 41952 | 2928 | 41679 | 2011 | 49882 | 1491 | 31602 |
| 7L-3S | | MI | 18730 | 5864 | 30430 | 4254 | 33088 | 3457 | 34163 | 2844 | 34886 | 1917 | 41380 | 1652 | 23381 |
| 16-#11 | 1.77 | MA | 23413 | 5864 | 37208 | 4374 | 40050 | 3555 | 40568 | 2939 | 39691 | 2006 | 47462 | 1440 | 30742 |
| 8L-2S | | MI | 19332 | 5864 | 31349 | 4256 | 34260 | 3448 | 35587 | 2837 | 36777 | 1910 | 43877 | 1741 | 23361 |
| 16-#14 | 2.56 | MA | 27852 | 6255 | 46006 | 4580 | 51278 | 3688 | 54181 | 3018 | 58186 | 1963 | 71146 | 1661 | 47194 |
| 3L-7S | | MI | 17677 | 6255 | 29400 | 4499 | 31673 | 3633 | 32385 | 2943 | 32590 | 1885 | 39354 | 1134 | 30337 |
| 16-#14 | 2.56 | MA | 26984 | 6255 | 44473 | 4599 | 49328 | 3705 | 51814 | 3013 | 55113 | 1975 | 67610 | 1533 | 46947 |
| 4L-6S | | MI | 18186 | 6255 | 30346 | 4484 | 32827 | 3620 | 33847 | 2953 | 34414 | 1875 | 41502 | 1233 | 31389 |
| 16-#14 | 2.56 | MA | 26208 | 6255 | 43129 | 4598 | 47595 | 3702 | 49692 | 3028 | 52085 | 1966 | 63919 | 1470 | 45568 |
| 5E | | MI | 18708 | 6255 | 31231 | 4489 | 34027 | 3628 | 35255 | 2943 | 36278 | 1865 | 43788 | 1318 | 31936 |
| 16-#14 | 2.56 | MA | 25469 | 6255 | 41861 | 4597 | 45872 | 3719 | 47591 | 3023 | 49303 | 1977 | 60408 | 1385 | 44558 |
| 6L-4S | | MI | 19253 | 6255 | 32168 | 4494 | 35234 | 3615 | 36729 | 2933 | 38309 | 1875 | 46236 | 1376 | 32908 |
| 16-#14 | 2.56 | MA | 24747 | 6255 | 40504 | 4615 | 44218 | 3716 | 45563 | 3038 | 46580 | 1988 | 56754 | 1259 | 42995 |
| 7L-3S | | MI | 19859 | 6255 | 33231 | 4478 | 36586 | 3623 | 38366 | 2943 | 40365 | 1865 | 48531 | 1503 | 33017 |
| 16-#14 | 2.56 | MA | 24035 | 6255 | 39259 | 4614 | 42549 | 3732 | 43579 | 3053 | 43728 | 1979 | 53304 | 1186 | 41606 |
| 8L-2S | | MI | 20705 | 6255 | 34543 | 4483 | 38258 | 3610 | 40397 | 2933 | 43046 | 1855 | 52062 | 1631 | 33052 |
| 16-#18 | 4.55 | MA | 29225 | 7248 | 51123 | 5200 | 57621 | 4168 | 61812 | 3301 | 68369 | 1886 | 86052 | 1025 | 76053 |
| 5E | | MI | 20606 | 7248 | 36632 | 5071 | 40762 | 4053 | 43151 | 3176 | 46705 | 1721 | 57731 | 770 | 52364 |
| 16-#18 | 4.55 | MA | 27978 | 7248 | 48892 | 5196 | 54592 | 4161 | 58118 | 3290 | 63498 | 1904 | 79985 | 875 | 72043 |
| 6L-4S | | MI | 21527 | 7248 | 38269 | 5082 | 42872 | 4034 | 45682 | 3158 | 50196 | 1738 | 61910 | 873 | 54017 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis

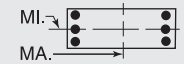


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 4.55 | MA | 26760 | 7248 | 46505 | 5228 | 51683 | 4188 | 54553 | 3314 | 58730 | 1921 | 73667 | 650 | 68201 |
| 7L-3S | | MI | 22551 | 7248 | 40126 | 5057 | 45232 | 4050 | 48496 | 3176 | 53729 | 1721 | 65839 | 1093 | 56501 |
| 18-#11 | 1.99 | MA | 26748 | 5975 | 43245 | 4418 | 47838 | 3573 | 50029 | 2944 | 52574 | 1985 | 63788 | 1756 | 37244 |
| 3L-8S | | MI | 17249 | 5975 | 28063 | 4336 | 30012 | 3512 | 30430 | 2885 | 30024 | 1927 | 35604 | 1306 | 24623 |
| 18-#11 | 1.99 | MA | 26135 | 5975 | 42176 | 4432 | 46477 | 3585 | 48378 | 2941 | 50430 | 1993 | 61301 | 1667 | 37155 |
| 4L-7S | | MI | 17603 | 5975 | 28671 | 4339 | 30826 | 3516 | 31397 | 2877 | 31294 | 1920 | 37218 | 1353 | 25215 |
| 18-#11 | 1.99 | MA | 25586 | 5975 | 41239 | 4431 | 45269 | 3583 | 46898 | 2952 | 48318 | 1988 | 58712 | 1623 | 36883 |
| 5L-6S | | MI | 17963 | 5975 | 29332 | 4328 | 31632 | 3507 | 32421 | 2884 | 32581 | 1914 | 38906 | 1441 | 25482 |
| 18-#11 | 1.99 | MA | 25064 | 5975 | 40355 | 4431 | 44068 | 3595 | 45433 | 2949 | 46378 | 1996 | 56243 | 1565 | 36072 |
| 6L-5S | | MI | 18332 | 5975 | 29951 | 4331 | 32471 | 3512 | 33408 | 2876 | 33895 | 1907 | 40524 | 1500 | 25931 |
| 18-#11 | 1.99 | MA | 24554 | 5975 | 39409 | 4444 | 42915 | 3593 | 44020 | 2960 | 44480 | 2005 | 53674 | 1477 | 35563 |
| 7L-4S | | MI | 18717 | 5975 | 30605 | 4334 | 33314 | 3502 | 34440 | 2869 | 35326 | 1914 | 42254 | 1540 | 26158 |
| 18-#11 | 1.99 | MA | 24051 | 5975 | 38542 | 4443 | 41752 | 3606 | 42637 | 2970 | 42492 | 1999 | 51254 | 1426 | 34652 |
| 8L-3S | | MI | 19146 | 5975 | 31349 | 4323 | 34260 | 3507 | 35587 | 2875 | 36777 | 1907 | 43877 | 1629 | 26184 |
| 18-#11 | 1.99 | MA | 23526 | 5975 | 37690 | 4443 | 40615 | 3604 | 41205 | 2967 | 40614 | 2007 | 48863 | 1370 | 33881 |
| 9L-2S | | MI | 19745 | 5975 | 32268 | 4326 | 35432 | 3498 | 37012 | 2868 | 38667 | 1900 | 46374 | 1718 | 26173 |
| 18-#14 | 2.88 | MA | 27861 | 6415 | 46383 | 4699 | 51764 | 3777 | 54775 | 3058 | 59125 | 1965 | 73007 | 1511 | 52684 |
| 4L-7S | | MI | 18273 | 6415 | 30712 | 4599 | 33346 | 3705 | 34415 | 2987 | 35271 | 1869 | 42885 | 1099 | 34123 |
| 18-#14 | 2.88 | MA | 27091 | 6415 | 45039 | 4697 | 50031 | 3774 | 52653 | 3073 | 56096 | 1956 | 69316 | 1448 | 51185 |
| 5L-6S | | MI | 18778 | 6415 | 31658 | 4584 | 34500 | 3693 | 35877 | 2997 | 37095 | 1859 | 45032 | 1197 | 35252 |
| 18-#14 | 2.88 | MA | 26357 | 6415 | 43771 | 4696 | 48308 | 3791 | 50551 | 3068 | 53314 | 1967 | 65805 | 1363 | 50212 |
| 6L-5S | | MI | 19296 | 6415 | 32543 | 4588 | 35700 | 3700 | 37286 | 2987 | 38959 | 1849 | 47319 | 1283 | 35772 |
| 18-#14 | 2.88 | MA | 25641 | 6415 | 42414 | 4715 | 46654 | 3788 | 48524 | 3083 | 50591 | 1978 | 62151 | 1237 | 48573 |
| 7L-4S | | MI | 19838 | 6415 | 33479 | 4593 | 36906 | 3688 | 38759 | 2977 | 40990 | 1859 | 49767 | 1340 | 36838 |
| 18-#14 | 2.88 | MA | 24935 | 6415 | 41170 | 4714 | 44985 | 3805 | 46540 | 3098 | 47740 | 1969 | 58701 | 1164 | 47128 |
| 8L-3S | | MI | 20440 | 6415 | 34543 | 4578 | 38258 | 3695 | 40397 | 2987 | 43046 | 1849 | 52062 | 1468 | 36983 |
| 18-#14 | 2.88 | MA | 24214 | 6415 | 39852 | 4732 | 43354 | 3802 | 44486 | 3093 | 45045 | 1980 | 55299 | 1082 | 45240 |
| 9L-2S | | MI | 21281 | 6415 | 35855 | 4583 | 39931 | 3683 | 42427 | 2977 | 45728 | 1839 | 55592 | 1595 | 37039 |
| 18-#18 | 5.11 | MA | 29485 | 7532 | 52238 | 5374 | 58858 | 4289 | 63304 | 3370 | 70504 | 1885 | 89322 | 830 | 81773 |
| 6L-5S | | MI | 21597 | 7532 | 38914 | 5248 | 43672 | 4182 | 46638 | 3252 | 51312 | 1689 | 63758 | 698 | 58790 |
| 18-#18 | 5.11 | MA | 28282 | 7532 | 49852 | 5405 | 55949 | 4317 | 59739 | 3394 | 65737 | 1903 | 83004 | 604 | 77838 |
| 7L-4S | | MI | 22510 | 7532 | 40551 | 5259 | 45781 | 4163 | 49170 | 3234 | 54803 | 1706 | 67937 | 801 | 60618 |
| 20-#11 | 2.22 | MA | 26756 | 6085 | 43510 | 4501 | 48178 | 3635 | 50446 | 2972 | 53232 | 1987 | 65093 | 1653 | 41180 |
| 4L-8S | | MI | 17672 | 6085 | 28983 | 4405 | 31184 | 3562 | 31854 | 2916 | 31915 | 1917 | 38101 | 1283 | 27297 |
| 20-#11 | 2.22 | MA | 26211 | 6085 | 42573 | 4500 | 46970 | 3633 | 48966 | 2983 | 51120 | 1981 | 62504 | 1609 | 40802 |
| 5L-7S | | MI | 18025 | 6085 | 29590 | 4408 | 31998 | 3566 | 32822 | 2909 | 33185 | 1911 | 39715 | 1330 | 27906 |
| 20-#11 | 2.22 | MA | 25691 | 6085 | 41690 | 4500 | 45769 | 3645 | 47501 | 2980 | 49180 | 1989 | 60035 | 1551 | 40022 |
| 6E | | MI | 18383 | 6085 | 30252 | 4397 | 32804 | 3557 | 33846 | 2915 | 34471 | 1904 | 41403 | 1418 | 28196 |
| 20-#11 | 2.22 | MA | 25185 | 6085 | 40744 | 4513 | 44616 | 3644 | 46088 | 2991 | 47282 | 1998 | 57467 | 1463 | 39527 |
| 7L-5S | | MI | 18749 | 6085 | 30870 | 4400 | 33643 | 3562 | 34833 | 2908 | 35785 | 1897 | 43021 | 1478 | 28622 |
| 20-#11 | 2.22 | MA | 24685 | 6085 | 39876 | 4513 | 43453 | 3656 | 44705 | 3001 | 45294 | 1992 | 55047 | 1412 | 38568 |
| 8L-4S | | MI | 19133 | 6085 | 31525 | 4403 | 34486 | 3553 | 35865 | 2900 | 37217 | 1904 | 44751 | 1518 | 28939 |
| 20-#11 | 2.22 | MA | 24163 | 6085 | 39025 | 4512 | 42316 | 3654 | 43273 | 2998 | 43416 | 2000 | 52655 | 1356 | 37812 |
| 9L-3S | | MI | 19560 | 6085 | 32268 | 4392 | 35432 | 3557 | 37012 | 2907 | 38667 | 1897 | 46374 | 1606 | 28976 |
| 20-#11 | 2.22 | MA | 23612 | 6085 | 38095 | 4525 | 41168 | 3666 | 41898 | 3009 | 41552 | 2009 | 50336 | 1292 | 36667 |
| 10L-2S | | MI | 20156 | 6085 | 33188 | 4395 | 36604 | 3548 | 38437 | 2899 | 40558 | 1890 | 48871 | 1695 | 28980 |
| 20-#14 | 3.20 | MA | 27966 | 6575 | 46950 | 4797 | 52466 | 3846 | 55614 | 3118 | 60107 | 1946 | 74713 | 1426 | 56811 |
| 5L-7S | | MI | 18864 | 6575 | 32024 | 4698 | 35018 | 3777 | 36445 | 3032 | 37953 | 1854 | 46415 | 1063 | 37920 |
| 20-#14 | 3.20 | MA | 27239 | 6575 | 45682 | 4796 | 50743 | 3863 | 53512 | 3113 | 57325 | 1957 | 71202 | 1342 | 55873 |
| 6E | | MI | 19366 | 6575 | 32970 | 4683 | 36172 | 3765 | 37908 | 3042 | 39777 | 1844 | 48563 | 1162 | 39008 |
| 20-#14 | 3.20 | MA | 26528 | 6575 | 44325 | 4815 | 49089 | 3860 | 51485 | 3128 | 54603 | 1968 | 67548 | 1215 | 54160 |
| 7L-5S | | MI | 19881 | 6575 | 33855 | 4688 | 37373 | 3772 | 39316 | 3032 | 41640 | 1834 | 50849 | 1248 | 39617 |
| 20-#14 | 3.20 | MA | 25828 | 6575 | 43080 | 4814 | 47420 | 3877 | 49501 | 3142 | 51751 | 1959 | 64098 | 1142 | 52661 |
| 8L-4S | | MI | 20419 | 6575 | 34791 | 4693 | 38579 | 3760 | 40790 | 3022 | 43671 | 1844 | 53297 | 1305 | 40627 |
| 20-#14 | 3.20 | MA | 25109 | 6575 | 41763 | 4832 | 45789 | 3874 | 47447 | 3138 | 49057 | 1970 | 60697 | 1060 | 50817 |
| 9L-3S | | MI | 21017 | 6575 | 35855 | 4678 | 39931 | 3768 | 42427 | 3032 | 45728 | 1834 | 55592 | 1432 | 40944 |
| 20-#18 | 5.68 | MA | 29788 | 7816 | 53198 | 5583 | 60215 | 4445 | 64926 | 3474 | 72744 | 1884 | 92341 | 559 | 87493 |
| 7L-5S | | MI | 22581 | 7816 | 41196 | 5425 | 46582 | 4310 | 50126 | 3328 | 55918 | 1656 | 69785 | 626 | 65244 |

## RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.44 | MA | 26831 | 6196 | 43908 | 4569 | 48671 | 3683 | 51034 | 3014 | 53922 | 1974 | 66297 | 1595 | 44729 |
| 5L-8S | | MI | 18093 | 6196 | 29902 | 4474 | 32356 | 3612 | 33279 | 2947 | 33806 | 1908 | 40598 | 1261 | 29977 |
| 22-#11 | 2.44 | MA | 26315 | 6196 | 43024 | 4569 | 47470 | 3696 | 49569 | 3011 | 51982 | 1982 | 63828 | 1537 | 43976 |
| 6L-7S | | MI | 18444 | 6196 | 30510 | 4477 | 33170 | 3616 | 34247 | 2940 | 35076 | 1901 | 42212 | 1308 | 30563 |
| 22-#11 | 2.44 | MA | 25811 | 6196 | 42078 | 4582 | 46317 | 3694 | 48156 | 3022 | 50084 | 1991 | 61260 | 1449 | 43494 |
| 7L-6S | | MI | 18800 | 6196 | 31171 | 4466 | 33976 | 3607 | 35271 | 2946 | 36362 | 1894 | 43900 | 1396 | 30913 |
| 22-#11 | 2.44 | MA | 25315 | 6196 | 41211 | 4582 | 45154 | 3706 | 46773 | 3033 | 48096 | 1985 | 58840 | 1398 | 42489 |
| 8L-5S | | MI | 19165 | 6196 | 31790 | 4469 | 34815 | 3612 | 36258 | 2939 | 37676 | 1887 | 45519 | 1455 | 31319 |
| 22-#11 | 2.44 | MA | 24802 | 6196 | 40359 | 4581 | 44017 | 3704 | 45341 | 3030 | 46217 | 1994 | 56448 | 1341 | 41695 |
| 9L-4S | | MI | 19547 | 6196 | 32444 | 4472 | 35659 | 3603 | 37290 | 2931 | 39108 | 1894 | 47248 | 1495 | 31716 |
| 22-#11 | 2.44 | MA | 24248 | 6196 | 39429 | 4595 | 42869 | 3716 | 43967 | 3040 | 44353 | 2002 | 54128 | 1278 | 40574 |
| 10L-3S | | MI | 19971 | 6196 | 33188 | 4461 | 36604 | 3607 | 38437 | 2938 | 40558 | 1887 | 48871 | 1584 | 31764 |
| 22-#11 | 2.44 | MA | 23713 | 6196 | 38578 | 4594 | 41739 | 3714 | 42552 | 3037 | 42393 | 1996 | 51765 | 1224 | 39410 |
| 11L-2S | | MI | 20565 | 6196 | 34107 | 4464 | 37777 | 3598 | 39862 | 2930 | 42448 | 1880 | 51369 | 1672 | 31784 |
| 22-#14 | 3.52 | MA | 28113 | 6734 | 47592 | 4896 | 53179 | 3936 | 56473 | 3158 | 61337 | 1947 | 76599 | 1320 | 61538 |
| 6L-7S | | MI | 19452 | 6734 | 33336 | 4798 | 36691 | 3850 | 38476 | 3077 | 40634 | 1838 | 49946 | 1028 | 41725 |
| 22-#14 | 3.52 | MA | 27409 | 6734 | 46235 | 4914 | 51525 | 3933 | 54446 | 3172 | 58614 | 1958 | 72945 | 1193 | 59755 |
| 7L-6S | | MI | 19951 | 6734 | 34282 | 4783 | 37845 | 3837 | 39938 | 3087 | 42458 | 1828 | 52093 | 1127 | 42770 |
| 22-#14 | 3.52 | MA | 26714 | 6734 | 44990 | 4913 | 49856 | 3949 | 52461 | 3187 | 55762 | 1949 | 69495 | 1120 | 58203 |
| 8L-5S | | MI | 20462 | 6734 | 35167 | 4788 | 39045 | 3845 | 41346 | 3077 | 44322 | 1818 | 54380 | 1212 | 43470 |
| 22-#14 | 3.52 | MA | 25996 | 6734 | 43673 | 4932 | 48225 | 3946 | 50408 | 3182 | 53068 | 1960 | 66094 | 1039 | 56401 |
| 9L-4S | | MI | 20997 | 6734 | 36103 | 4793 | 40252 | 3832 | 42820 | 3067 | 46353 | 1828 | 56828 | 1270 | 44428 |
| 24-#11 | 2.66 | MA | 26935 | 6306 | 44358 | 4638 | 49171 | 3746 | 51637 | 3042 | 54784 | 1976 | 67621 | 1523 | 47935 |
| 6L-8S | | MI | 18512 | 6306 | 30821 | 4543 | 33529 | 3662 | 34704 | 2978 | 35696 | 1898 | 43095 | 1238 | 32662 |
| 24-#11 | 2.66 | MA | 26434 | 6306 | 43412 | 4651 | 48019 | 3744 | 50224 | 3053 | 52886 | 1984 | 65053 | 1435 | 47407 |
| 7E | | MI | 18861 | 6306 | 31429 | 4546 | 34342 | 3667 | 35672 | 2971 | 36966 | 1891 | 44710 | 1285 | 33227 |
| 24-#11 | 2.66 | MA | 25941 | 6306 | 42545 | 4651 | 46855 | 3756 | 48841 | 3064 | 50897 | 1978 | 62633 | 1384 | 46415 |
| 8L-6S | | MI | 19216 | 6306 | 32091 | 4535 | 35149 | 3657 | 36696 | 2977 | 38252 | 1884 | 46397 | 1373 | 33633 |
| 24-#11 | 2.66 | MA | 25429 | 6306 | 41693 | 4650 | 45718 | 3754 | 47409 | 3061 | 49019 | 1987 | 60241 | 1327 | 45583 |
| 9L-5S | | MI | 19578 | 6306 | 32709 | 4538 | 35988 | 3662 | 37682 | 2970 | 39567 | 1877 | 48016 | 1432 | 34021 |
| 24-#11 | 2.66 | MA | 24880 | 6306 | 40764 | 4664 | 44570 | 3766 | 46035 | 3072 | 47155 | 1995 | 57921 | 1264 | 44486 |
| 10L-4S | | MI | 19958 | 6306 | 33363 | 4541 | 36831 | 3653 | 38715 | 2962 | 40998 | 1884 | 49745 | 1472 | 34490 |
| 24-#11 | 2.66 | MA | 24347 | 6306 | 39912 | 4663 | 43440 | 3764 | 44620 | 3069 | 45195 | 1989 | 55558 | 1210 | 43298 |
| 11L-3S | | MI | 20381 | 6306 | 34107 | 4530 | 37777 | 3658 | 39862 | 2969 | 42448 | 1877 | 51369 | 1561 | 34549 |
| 24-#14 | 3.84 | MA | 28283 | 6894 | 48146 | 5014 | 53961 | 4005 | 57407 | 3217 | 62625 | 1948 | 78342 | 1171 | 65359 |
| 7E | | MI | 20036 | 6894 | 34647 | 4898 | 38364 | 3922 | 40506 | 3121 | 43315 | 1823 | 53476 | 993 | 45537 |
| 24-#14 | 3.84 | MA | 27594 | 6894 | 46901 | 5013 | 52292 | 4022 | 55422 | 3232 | 59774 | 1939 | 74893 | 1098 | 63753 |
| 8L-6S | | MI | 20532 | 6894 | 35594 | 4883 | 39518 | 3910 | 41969 | 3131 | 45139 | 1813 | 55624 | 1091 | 46542 |
| 24-#14 | 3.84 | MA | 26877 | 6894 | 45583 | 5032 | 50661 | 4019 | 53369 | 3227 | 57079 | 1951 | 71491 | 1017 | 61992 |
| 9L-5S | | MI | 21039 | 6894 | 36479 | 4888 | 40718 | 3917 | 43377 | 3121 | 47003 | 1803 | 57910 | 1177 | 47328 |

## RECTANGULAR TIED COLUMNS 32" x 46"

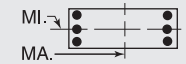
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.09 | MA | 27316 | 5772 | 42783 | 4296 | 46395 | 3500 | 47453 | 2914 | 47643 | 2081 | 56160 | 1962 | 22359 |
| 2E | | MI | 18747 | 5772 | 29812 | 4170 | 31813 | 3396 | 32153 | 2818 | 31673 | 1985 | 36781 | 1838 | 15093 |
| 6-#18 | 1.63 | MA | 28957 | 6056 | 46307 | 4473 | 50888 | 3628 | 52914 | 2994 | 55041 | 2064 | 66051 | 1920 | 33140 |
| 2L-3S | | MI | 18274 | 6056 | 29812 | 4337 | 31813 | 3544 | 32153 | 2912 | 31673 | 1970 | 36781 | 1538 | 22229 |
| 6-#18 | 1.63 | MA | 26634 | 6056 | 42783 | 4470 | 46395 | 3657 | 47453 | 3019 | 47643 | 2082 | 56160 | 1692 | 33050 |
| 3L-2S | | MI | 19769 | 6056 | 32094 | 4348 | 34723 | 3525 | 35641 | 2894 | 36279 | 1953 | 42808 | 1766 | 22152 |
| 8-#14 | 1.22 | MA | 27817 | 5843 | 43648 | 4366 | 47662 | 3553 | 49056 | 2952 | 49840 | 2091 | 59383 | 1978 | 25255 |
| 2L-4S | | MI | 17594 | 5843 | 28013 | 4262 | 29674 | 3464 | 29705 | 2871 | 28565 | 2027 | 33197 | 1604 | 17122 |
| 8-#14 | 1.22 | MA | 26477 | 5843 | 41638 | 4366 | 45099 | 3551 | 45940 | 2967 | 45619 | 2103 | 53673 | 1850 | 25276 |
| 3E | | MI | 18218 | 5843 | 29076 | 4247 | 31026 | 3471 | 31343 | 2881 | 30622 | 2017 | 35492 | 1731 | 17083 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis

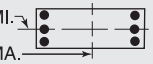



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.22 | MA | 25533 | 5843 | 40026 | 4385 | 43049 | 3568 | 43453 | 2963 | 42389 | 2115 | 49929 | 1722 | 25180 |
| 4L-2S | | MI | 19086 | 5843 | 30388 | 4252 | 32698 | 3459 | 33373 | 2871 | 33303 | 2007 | 39023 | 1859 | 17018 |
| 8-#18 | 2.17 | MA | 30572 | 6340 | 49831 | 4651 | 55380 | 3757 | 58375 | 3074 | 62440 | 2046 | 75943 | 1878 | 43872 |
| 2L-4S | | MI | 18230 | 6340 | 30237 | 4538 | 32362 | 3656 | 32827 | 2970 | 32747 | 1956 | 38879 | 1247 | 28198 |
| 8-#18 | 2.17 | MA | 28277 | 6340 | 46307 | 4648 | 50888 | 3786 | 52914 | 3099 | 55041 | 2064 | 66051 | 1650 | 43670 |
| 3E | | MI | 19297 | 6340 | 32094 | 4514 | 34723 | 3672 | 35641 | 2988 | 36279 | 1938 | 42808 | 1467 | 29148 |
| 8-#18 | 2.17 | MA | 26657 | 6340 | 43475 | 4680 | 47287 | 3779 | 48544 | 3089 | 49367 | 2082 | 59579 | 1423 | 42165 |
| 4L-2S | | MI | 20778 | 6340 | 34376 | 4525 | 37632 | 3653 | 39128 | 2970 | 40886 | 1921 | 48834 | 1694 | 29156 |
| 10-#11 | 1.06 | MA | 27350 | 5758 | 42559 | 4326 | 46356 | 3525 | 47501 | 2937 | 47747 | 2103 | 56676 | 2001 | 22055 |
| 2L-5S | | MI | 17360 | 5758 | 27364 | 4223 | 28913 | 3450 | 28807 | 2870 | 27317 | 2037 | 31622 | 1679 | 15030 |
| 10-#11 | 1.06 | MA | 26409 | 5758 | 41155 | 4326 | 44567 | 3524 | 45325 | 2948 | 44800 | 2112 | 52667 | 1913 | 22083 |
| 3L-4S | | MI | 17755 | 5758 | 28018 | 4225 | 29757 | 3440 | 29840 | 2862 | 28748 | 2043 | 33351 | 1719 | 15007 |
| 10-#11 | 1.06 | MA | 25748 | 5758 | 40031 | 4339 | 43137 | 3536 | 43591 | 2946 | 42547 | 2121 | 50035 | 1824 | 22072 |
| 4L-3S | | MI | 18193 | 5758 | 28762 | 4214 | 30702 | 3445 | 30987 | 2868 | 30198 | 2037 | 34975 | 1808 | 14963 |
| 10-#11 | 1.06 | MA | 25157 | 5758 | 39048 | 4339 | 41868 | 3535 | 42036 | 2957 | 40329 | 2116 | 47302 | 1779 | 21983 |
| 5L-2S | | MI | 18804 | 5758 | 29681 | 4217 | 31875 | 3436 | 32412 | 2861 | 32089 | 2030 | 37472 | 1896 | 14917 |
| 10-#14 | 1.53 | MA | 28760 | 6003 | 45658 | 4466 | 50225 | 3626 | 52171 | 2997 | 54060 | 2081 | 65092 | 1958 | 31395 |
| 2L-5S | | MI | 17639 | 6003 | 28389 | 4357 | 30140 | 3549 | 30262 | 2926 | 29215 | 2001 | 34279 | 1511 | 20662 |
| 10-#14 | 1.53 | MA | 27430 | 6003 | 43648 | 4465 | 47662 | 3623 | 49056 | 3012 | 49840 | 2093 | 59383 | 1830 | 31378 |
| 3L-4S | | MI | 18198 | 6003 | 29325 | 4362 | 31347 | 3536 | 31736 | 2916 | 31246 | 2011 | 36727 | 1569 | 21105 |
| 10-#14 | 1.53 | MA | 26494 | 6003 | 42037 | 4484 | 45612 | 3640 | 46568 | 3008 | 46610 | 2105 | 55638 | 1702 | 31236 |
| 4L-3S | | MI | 18817 | 6003 | 30388 | 4347 | 32698 | 3544 | 33373 | 2926 | 33303 | 2001 | 39023 | 1696 | 21105 |
| 10-#14 | 1.53 | MA | 25656 | 6003 | 40625 | 4484 | 43791 | 3638 | 44338 | 3023 | 43428 | 2097 | 51740 | 1638 | 30409 |
| 5L-2S | | MI | 19680 | 6003 | 31700 | 4352 | 34371 | 3531 | 35403 | 2916 | 35984 | 1991 | 42553 | 1824 | 21059 |
| 10-#18 | 2.72 | MA | 32165 | 6624 | 53354 | 4828 | 59872 | 3885 | 63837 | 3153 | 69838 | 2028 | 85834 | 1835 | 54567 |
| 2L-5S | | MI | 18299 | 6624 | 30882 | 4705 | 33163 | 3804 | 33783 | 3064 | 33862 | 1906 | 40726 | 1071 | 33011 |
| 10-#18 | 2.72 | MA | 29896 | 6624 | 49831 | 4825 | 55380 | 3914 | 58375 | 3179 | 62440 | 2046 | 75943 | 1608 | 54274 |
| 3L-4S | | MI | 19252 | 6624 | 32519 | 4716 | 35272 | 3785 | 36314 | 3046 | 37354 | 1924 | 44905 | 1175 | 34655 |
| 10-#18 | 2.72 | MA | 28298 | 6624 | 46999 | 4857 | 51779 | 3908 | 54005 | 3169 | 56765 | 2065 | 69470 | 1380 | 52297 |
| 4L-3S | | MI | 20309 | 6624 | 34376 | 4691 | 37632 | 3801 | 39128 | 3064 | 40886 | 1906 | 48834 | 1395 | 36037 |
| 10-#18 | 2.72 | MA | 26866 | 6624 | 44515 | 4854 | 48576 | 3937 | 50083 | 3194 | 51171 | 2047 | 62691 | 1270 | 49176 |
| 5L-2S | | MI | 21775 | 6624 | 36659 | 4702 | 40542 | 3782 | 42615 | 3046 | 45492 | 1889 | 54861 | 1622 | 36130 |
| 12-#11 | 1.27 | MA | 28015 | 5869 | 43962 | 4395 | 48145 | 3575 | 49676 | 2968 | 50694 | 2096 | 60685 | 1988 | 26347 |
| 2L-6S | | MI | 17413 | 5869 | 27665 | 4289 | 29246 | 3495 | 29246 | 2908 | 27893 | 2034 | 32501 | 1597 | 17485 |
| 12-#11 | 1.27 | MA | 27080 | 5869 | 42559 | 4395 | 46356 | 3574 | 47501 | 2979 | 47747 | 2105 | 56676 | 1900 | 26361 |
| 3L-5S | | MI | 17789 | 5869 | 28283 | 4292 | 30085 | 3500 | 30232 | 2901 | 29207 | 2027 | 34119 | 1656 | 17821 |
| 12-#11 | 1.27 | MA | 26423 | 5869 | 41435 | 4409 | 44927 | 3586 | 45766 | 2977 | 45494 | 2114 | 54044 | 1811 | 26324 |
| 4E | | MI | 18181 | 5869 | 28937 | 4295 | 30929 | 3491 | 31265 | 2893 | 30639 | 2034 | 35849 | 1696 | 17823 |
| 12-#11 | 1.27 | MA | 25835 | 5869 | 40451 | 4408 | 43658 | 3585 | 44211 | 2988 | 43276 | 2109 | 51311 | 1766 | 26210 |
| 5L-3S | | MI | 18617 | 5869 | 29681 | 4284 | 31875 | 3495 | 32412 | 2900 | 32089 | 2027 | 37472 | 1785 | 17792 |
| 12-#11 | 1.27 | MA | 25275 | 5869 | 39523 | 4408 | 42396 | 3597 | 42673 | 2985 | 41238 | 2118 | 48700 | 1708 | 25560 |
| 6L-2S | | MI | 19225 | 5869 | 30601 | 4286 | 33047 | 3486 | 33837 | 2892 | 33980 | 2020 | 39969 | 1874 | 17753 |
| 12-#14 | 1.83 | MA | 29694 | 6163 | 47668 | 4566 | 52787 | 3698 | 55287 | 3042 | 58281 | 2071 | 70801 | 1937 | 37521 |
| 2L-6S | | MI | 17712 | 6163 | 28816 | 4452 | 30612 | 3613 | 30884 | 2980 | 30033 | 1996 | 35523 | 1390 | 23832 |
| 12-#14 | 1.83 | MA | 28373 | 6163 | 45658 | 4565 | 50225 | 3695 | 52171 | 3057 | 54060 | 2083 | 65092 | 1809 | 37468 |
| 3L-5S | | MI | 18242 | 6163 | 29701 | 4457 | 31813 | 3621 | 32293 | 2970 | 31897 | 1986 | 37810 | 1476 | 24457 |
| 12-#14 | 1.83 | MA | 27445 | 6163 | 44047 | 4584 | 48175 | 3713 | 49684 | 3053 | 50831 | 2095 | 61348 | 1681 | 37287 |
| 4E | | MI | 18797 | 6163 | 30637 | 4462 | 33019 | 3609 | 33766 | 2960 | 33928 | 1996 | 40258 | 1533 | 25073 |
| 12-#14 | 1.83 | MA | 26615 | 6163 | 42635 | 4583 | 46354 | 3710 | 47454 | 3068 | 47648 | 2087 | 57449 | 1617 | 36277 |
| 5L-3S | | MI | 19412 | 6163 | 31700 | 4447 | 34371 | 3616 | 35403 | 2970 | 35984 | 1986 | 42553 | 1661 | 25112 |
| 12-#14 | 1.83 | MA | 25823 | 6163 | 41303 | 4583 | 44544 | 3727 | 45246 | 3064 | 44726 | 2099 | 53733 | 1533 | 35073 |
| 6L-2S | | MI | 20269 | 6163 | 33012 | 4451 | 36044 | 3604 | 37434 | 2960 | 38665 | 1976 | 46084 | 1788 | 25083 |
| 12-#18 | 3.26 | MA | 31494 | 6907 | 53354 | 5002 | 59872 | 4043 | 63837 | 3258 | 69838 | 2029 | 85834 | 1566 | 64867 |
| 3L-5S | | MI | 19321 | 6907 | 33164 | 4882 | 36073 | 3932 | 37271 | 3140 | 38469 | 1874 | 46753 | 1000 | 39638 |
| 12-#18 | 3.26 | MA | 29915 | 6907 | 50522 | 5035 | 56271 | 4036 | 59466 | 3248 | 64164 | 2047 | 79362 | 1338 | 62476 |
| 4E | | MI | 20264 | 6907 | 34802 | 4893 | 38182 | 3913 | 39802 | 3122 | 41960 | 1892 | 50932 | 1103 | 41159 |
| 12-#18 | 3.26 | MA | 28503 | 6907 | 48039 | 5032 | 53069 | 4065 | 55545 | 3274 | 58569 | 2030 | 72583 | 1227 | 59516 |
| 5L-3S | | MI | 21310 | 6907 | 36659 | 4869 | 40542 | 3930 | 42615 | 3140 | 45492 | 1874 | 54861 | 1323 | 42905 |

## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

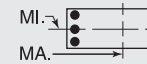
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 3.26 | MA | 27155 | 6907 | 45695 | 5029 | 49885 | 4059 | 51662 | 3263 | 53428 | 2048 | 66152 | 1077 | 55802 |
| 6L-2S | | MI | 22763 | 6907 | 38941 | 4880 | 43452 | 3910 | 46103 | 3122 | 50099 | 1856 | 60888 | 1550 | 43063 |
| 14-#11 | 1.48 | MA | 28676 | 5980 | 45366 | 4464 | 49935 | 3626 | 51851 | 2999 | 53640 | 2089 | 64694 | 1975 | 30631 |
| 2L-7S | | MI | 17477 | 5980 | 27923 | 4369 | 29612 | 3554 | 29647 | 2933 | 28497 | 2031 | 33310 | 1486 | 19889 |
| 14-#11 | 1.48 | MA | 27745 | 5980 | 43962 | 4464 | 48145 | 3624 | 49676 | 3011 | 50694 | 2098 | 60685 | 1887 | 30625 |
| 3L-6S | | MI | 17841 | 5980 | 28584 | 4358 | 30419 | 3545 | 30671 | 2939 | 29784 | 2024 | 34998 | 1574 | 20183 |
| 14-#11 | 1.48 | MA | 27092 | 5980 | 42838 | 4478 | 46716 | 3637 | 47941 | 3008 | 48441 | 2107 | 58053 | 1798 | 30570 |
| 4L-5S | | MI | 18214 | 5980 | 29203 | 4361 | 31258 | 3550 | 31657 | 2932 | 31098 | 2017 | 36616 | 1633 | 20605 |
| 14-#11 | 1.48 | MA | 26508 | 5980 | 41855 | 4478 | 45447 | 3635 | 46386 | 3019 | 46222 | 2102 | 55320 | 1753 | 30434 |
| 5L-4S | | MI | 18605 | 5980 | 29857 | 4364 | 32101 | 3541 | 32690 | 2924 | 32529 | 2024 | 38346 | 1673 | 20629 |
| 14-#11 | 1.48 | MA | 25952 | 5980 | 40927 | 4477 | 44186 | 3647 | 44848 | 3016 | 44185 | 2111 | 52709 | 1695 | 29696 |
| 6L-3S | | MI | 19038 | 5980 | 30601 | 4353 | 33047 | 3545 | 33837 | 2931 | 33980 | 2017 | 39969 | 1762 | 20611 |
| 14-#11 | 1.48 | MA | 25409 | 5980 | 39933 | 4491 | 42975 | 3646 | 43364 | 3028 | 42192 | 2120 | 49994 | 1607 | 29105 |
| 7L-2S | | MI | 19644 | 5980 | 31520 | 4356 | 34219 | 3536 | 35262 | 2923 | 35870 | 2010 | 42466 | 1851 | 20580 |
| 14-#14 | 2.14 | MA | 30621 | 6322 | 49679 | 4666 | 55350 | 3770 | 58402 | 3087 | 62502 | 2061 | 76510 | 1917 | 43630 |
| 2L-7S | | MI | 17800 | 6322 | 29181 | 4567 | 31131 | 3698 | 31452 | 3015 | 30890 | 1990 | 36906 | 1256 | 26806 |
| 14-#14 | 2.14 | MA | 29309 | 6322 | 47668 | 4665 | 52787 | 3768 | 55287 | 3102 | 58281 | 2073 | 70801 | 1789 | 43549 |
| 3L-6S | | MI | 18314 | 6322 | 30127 | 4552 | 32285 | 3686 | 32915 | 3025 | 32714 | 1980 | 39054 | 1355 | 27682 |
| 14-#14 | 2.14 | MA | 28388 | 6322 | 46057 | 4684 | 50738 | 3785 | 52799 | 3098 | 55051 | 2085 | 67057 | 1661 | 43333 |
| 4L-5S | | MI | 18840 | 6322 | 31013 | 4557 | 33486 | 3693 | 34323 | 3015 | 34578 | 1970 | 41340 | 1441 | 28270 |
| 14-#14 | 2.14 | MA | 27564 | 6322 | 44645 | 4683 | 48917 | 3782 | 50569 | 3113 | 51869 | 2077 | 63158 | 1597 | 42162 |
| 5L-4S | | MI | 19391 | 6322 | 31949 | 4561 | 34692 | 3681 | 35796 | 3005 | 36609 | 1980 | 43788 | 1498 | 29031 |
| 14-#14 | 2.14 | MA | 26779 | 6322 | 43314 | 4682 | 47107 | 3800 | 48362 | 3109 | 48946 | 2089 | 59442 | 1513 | 41010 |
| 6L-3S | | MI | 20002 | 6322 | 33012 | 4546 | 36044 | 3688 | 37434 | 3015 | 38665 | 1970 | 46084 | 1625 | 29099 |
| 14-#14 | 2.14 | MA | 26013 | 6322 | 41888 | 4701 | 45370 | 3797 | 46232 | 3124 | 46086 | 2100 | 55576 | 1387 | 39576 |
| 7L-2S | | MI | 20854 | 6322 | 34324 | 4551 | 37716 | 3676 | 39464 | 3005 | 41347 | 1960 | 49614 | 1753 | 29097 |
| 14-#18 | 3.80 | MA | 31514 | 7191 | 54046 | 5212 | 60764 | 4165 | 64927 | 3328 | 71563 | 2029 | 89253 | 1296 | 72694 |
| 4L-5S | | MI | 20332 | 7191 | 35447 | 5059 | 38983 | 4061 | 40758 | 3216 | 43075 | 1842 | 52780 | 928 | 46286 |
| 14-#18 | 3.80 | MA | 30118 | 7191 | 51563 | 5209 | 57561 | 4194 | 61006 | 3353 | 65968 | 2012 | 82474 | 1185 | 69878 |
| 5L-4S | | MI | 21265 | 7191 | 37084 | 5070 | 41092 | 4042 | 43289 | 3198 | 46567 | 1860 | 56959 | 1031 | 47702 |
| 14-#18 | 3.80 | MA | 28788 | 7191 | 49219 | 5206 | 54377 | 4187 | 57123 | 3343 | 60827 | 2030 | 76043 | 1035 | 66014 |
| 6L-3S | | MI | 22302 | 7191 | 38941 | 5046 | 43452 | 4058 | 46103 | 3216 | 50099 | 1842 | 60888 | 1251 | 49759 |
| 14-#18 | 3.80 | MA | 27489 | 7191 | 46711 | 5238 | 51320 | 4216 | 53376 | 3369 | 55795 | 2048 | 69348 | 810 | 62250 |
| 7L-2S | | MI | 23742 | 7191 | 41224 | 5057 | 46362 | 4039 | 49590 | 3198 | 54705 | 1824 | 66914 | 1479 | 49977 |
| 16-#11 | 1.70 | MA | 29333 | 6090 | 46769 | 4534 | 51724 | 3676 | 54026 | 3031 | 56587 | 2082 | 68704 | 1962 | 34909 |
| 2L-8S | | MI | 17546 | 6090 | 28234 | 4435 | 29971 | 3600 | 30104 | 2971 | 29118 | 2028 | 34193 | 1416 | 22133 |
| 16-#11 | 1.70 | MA | 28407 | 6090 | 45366 | 4533 | 49935 | 3674 | 51851 | 3042 | 53640 | 2091 | 64694 | 1874 | 34885 |
| 3L-7S | | MI | 17904 | 6090 | 28842 | 4438 | 30785 | 3604 | 31072 | 2964 | 30388 | 2021 | 35807 | 1463 | 22608 |
| 16-#11 | 1.70 | MA | 27758 | 6090 | 44242 | 4547 | 48505 | 3687 | 50116 | 3039 | 51388 | 2100 | 62062 | 1785 | 34812 |
| 4L-6S | | MI | 18266 | 6090 | 29504 | 4427 | 31591 | 3595 | 32096 | 2970 | 31674 | 2014 | 37495 | 1551 | 22887 |
| 16-#11 | 1.70 | MA | 27177 | 6090 | 43258 | 4547 | 47236 | 3685 | 48562 | 3050 | 49169 | 2095 | 59330 | 1740 | 34657 |
| 5E | | MI | 18637 | 6090 | 30122 | 4430 | 32430 | 3600 | 33082 | 2963 | 32988 | 2007 | 39114 | 1611 | 23375 |
| 16-#11 | 1.70 | MA | 26624 | 6090 | 42330 | 4546 | 45975 | 3698 | 47023 | 3048 | 47132 | 2104 | 56719 | 1682 | 33840 |
| 6L-4S | | MI | 19026 | 6090 | 30776 | 4433 | 33273 | 3591 | 34114 | 2955 | 34420 | 2014 | 40843 | 1651 | 23423 |
| 16-#11 | 1.70 | MA | 26085 | 6090 | 41337 | 4560 | 44764 | 3696 | 45539 | 3059 | 45139 | 2113 | 54003 | 1594 | 33269 |
| 7L-3S | | MI | 19457 | 6090 | 31520 | 4422 | 34219 | 3595 | 35262 | 2962 | 35870 | 2007 | 42466 | 1739 | 23422 |
| 16-#11 | 1.70 | MA | 25553 | 6090 | 40426 | 4560 | 43543 | 3709 | 44087 | 3070 | 43051 | 2108 | 51449 | 1542 | 32451 |
| 8L-2S | | MI | 20060 | 6090 | 32440 | 4425 | 35391 | 3586 | 36687 | 2954 | 37761 | 2000 | 44964 | 1828 | 23399 |
| 16-#14 | 2.45 | MA | 30236 | 6482 | 49679 | 4765 | 55350 | 3840 | 58402 | 3147 | 62502 | 2063 | 76510 | 1768 | 49624 |
| 3L-7S | | MI | 18401 | 6482 | 30493 | 4666 | 32804 | 3770 | 33482 | 3060 | 33572 | 1975 | 40437 | 1221 | 30578 |
| 16-#14 | 2.45 | MA | 29323 | 6482 | 48067 | 4784 | 53301 | 3857 | 55915 | 3143 | 59272 | 2075 | 72766 | 1640 | 49377 |
| 4L-6S | | MI | 18911 | 6482 | 31439 | 4651 | 33958 | 3758 | 34945 | 3070 | 35396 | 1965 | 42584 | 1320 | 31540 |
| 16-#14 | 2.45 | MA | 28506 | 6482 | 46655 | 4783 | 51480 | 3855 | 53684 | 3158 | 56090 | 2067 | 68868 | 1576 | 48062 |
| 5E | | MI | 19434 | 6482 | 32325 | 4656 | 35158 | 3766 | 36353 | 3060 | 37259 | 1955 | 44871 | 1405 | 32095 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis

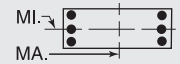



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.45 | MA | 27727 | 6482 | 45324 | 4782 | 49670 | 3872 | 51477 | 3154 | 53167 | 2079 | 65152 | 1492 | 46956 |
| 6L-4S | | MI | 19981 | 6482 | 33261 | 4661 | 36365 | 3753 | 37827 | 3050 | 39290 | 1965 | 47319 | 1463 | 32982 |
| 16-#14 | 2.45 | MA | 26968 | 6482 | 43898 | 4801 | 47933 | 3869 | 49348 | 3169 | 50307 | 2091 | 61286 | 1366 | 45439 |
| 7L-3S | | MI | 20588 | 6482 | 34324 | 4646 | 37716 | 3761 | 39464 | 3060 | 41347 | 1955 | 49614 | 1590 | 33076 |
| 16-#14 | 2.45 | MA | 26219 | 6482 | 42591 | 4800 | 46180 | 3887 | 47263 | 3185 | 47311 | 2082 | 57642 | 1292 | 43988 |
| 8L-2S | | MI | 21436 | 6482 | 35636 | 4651 | 39389 | 3748 | 41494 | 3050 | 44028 | 1945 | 53145 | 1718 | 33103 |
| 16-#18 | 4.35 | MA | 31715 | 7475 | 55086 | 5386 | 62053 | 4322 | 66467 | 3433 | 73366 | 1994 | 92366 | 1143 | 80260 |
| 5E | | MI | 21333 | 7475 | 37729 | 5237 | 41892 | 4190 | 44245 | 3292 | 47682 | 1810 | 58806 | 856 | 52793 |
| 16-#18 | 4.35 | MA | 30401 | 7475 | 52742 | 5383 | 58870 | 4316 | 62584 | 3423 | 68225 | 2012 | 85935 | 993 | 76249 |
| 6L-4S | | MI | 22258 | 7475 | 39366 | 5248 | 44002 | 4170 | 46777 | 3274 | 51173 | 1828 | 62985 | 959 | 54275 |
| 16-#18 | 4.35 | MA | 29118 | 7475 | 50234 | 5416 | 55813 | 4345 | 58837 | 3448 | 63194 | 2031 | 79240 | 768 | 72394 |
| 7L-3S | | MI | 23285 | 7475 | 41224 | 5223 | 46362 | 4187 | 49590 | 3292 | 54705 | 1810 | 66914 | 1179 | 56603 |
| 16-#18 | 4.35 | MA | 27853 | 7475 | 47933 | 5413 | 52727 | 4338 | 55169 | 3474 | 57924 | 2013 | 72906 | 639 | 68041 |
| 8L-2S | | MI | 24714 | 7475 | 43506 | 5234 | 49272 | 4168 | 53078 | 3274 | 59312 | 1792 | 72941 | 1407 | 56876 |
| 18-#11 | 1.91 | MA | 29064 | 6201 | 46769 | 4603 | 51724 | 3724 | 54026 | 3073 | 56587 | 2084 | 68704 | 1861 | 39140 |
| 3L-8S | | MI | 17972 | 6201 | 29154 | 4504 | 31143 | 3650 | 31529 | 3002 | 31009 | 2018 | 36690 | 1393 | 24800 |
| 18-#11 | 1.91 | MA | 28418 | 6201 | 45645 | 4616 | 50295 | 3737 | 52291 | 3070 | 54335 | 2093 | 66072 | 1772 | 39050 |
| 4L-7S | | MI | 18328 | 6201 | 29762 | 4507 | 31957 | 3655 | 32496 | 2995 | 32279 | 2011 | 38305 | 1441 | 25329 |
| 18-#11 | 1.91 | MA | 27842 | 6201 | 44662 | 4616 | 49026 | 3735 | 50737 | 3081 | 52116 | 2088 | 63339 | 1727 | 38877 |
| 5L-6S | | MI | 18689 | 6201 | 30423 | 4496 | 32763 | 3645 | 33521 | 3001 | 33565 | 2004 | 39992 | 1529 | 25597 |
| 18-#11 | 1.91 | MA | 27292 | 6201 | 43734 | 4616 | 47764 | 3748 | 49198 | 3079 | 50079 | 2097 | 60728 | 1669 | 37991 |
| 6L-5S | | MI | 19058 | 6201 | 31041 | 4499 | 33602 | 3650 | 34507 | 2994 | 34879 | 1997 | 41611 | 1588 | 26058 |
| 18-#11 | 1.91 | MA | 26756 | 6201 | 42740 | 4629 | 46554 | 3746 | 47714 | 3090 | 48086 | 2106 | 58012 | 1581 | 37438 |
| 7L-4S | | MI | 19444 | 6201 | 31696 | 4502 | 34445 | 3641 | 35539 | 2987 | 36311 | 2004 | 43340 | 1628 | 26212 |
| 18-#11 | 1.91 | MA | 26227 | 6201 | 41830 | 4629 | 45332 | 3759 | 46262 | 3101 | 45998 | 2101 | 55458 | 1529 | 36566 |
| 8L-3S | | MI | 19874 | 6201 | 32440 | 4491 | 35391 | 3646 | 36687 | 2993 | 37761 | 1997 | 44964 | 1717 | 26228 |
| 18-#11 | 1.91 | MA | 25666 | 6201 | 40936 | 4629 | 44139 | 3757 | 44759 | 3098 | 44026 | 2110 | 52928 | 1473 | 35728 |
| 9L-2S | | MI | 20474 | 6201 | 33359 | 4494 | 36563 | 3636 | 38112 | 2986 | 39651 | 1990 | 47461 | 1805 | 26213 |
| 18-#14 | 2.75 | MA | 30250 | 6641 | 50077 | 4883 | 55863 | 3930 | 59030 | 3188 | 63493 | 2065 | 78476 | 1620 | 55418 |
| 4L-7S | | MI | 18997 | 6641 | 31805 | 4766 | 34477 | 3843 | 35513 | 3104 | 36253 | 1959 | 43968 | 1186 | 34362 |
| 18-#14 | 2.75 | MA | 29439 | 6641 | 48666 | 4883 | 54043 | 3927 | 56800 | 3203 | 60311 | 2057 | 74577 | 1556 | 53974 |
| 5L-6S | | MI | 19504 | 6641 | 32751 | 4751 | 35630 | 3830 | 36975 | 3114 | 38077 | 1949 | 46115 | 1284 | 35403 |
| 18-#14 | 2.75 | MA | 28667 | 6641 | 47334 | 4882 | 52233 | 3944 | 54592 | 3199 | 57388 | 2069 | 70861 | 1472 | 52909 |
| 6L-5S | | MI | 20023 | 6641 | 33636 | 4756 | 36831 | 3838 | 38384 | 3104 | 39941 | 1939 | 48401 | 1370 | 35931 |
| 18-#14 | 2.75 | MA | 27914 | 6641 | 45909 | 4901 | 50496 | 3942 | 52463 | 3214 | 54528 | 2081 | 66995 | 1346 | 51313 |
| 7L-4S | | MI | 20567 | 6641 | 34573 | 4761 | 38037 | 3826 | 39857 | 3094 | 41972 | 1949 | 50849 | 1427 | 36928 |
| 18-#14 | 2.75 | MA | 27171 | 6641 | 44601 | 4900 | 48743 | 3959 | 50379 | 3230 | 51532 | 2073 | 63351 | 1271 | 49904 |
| 8L-3S | | MI | 21170 | 6641 | 35636 | 4746 | 39389 | 3833 | 41494 | 3104 | 44028 | 1939 | 53145 | 1554 | 37046 |
| 18-#14 | 2.75 | MA | 26402 | 6641 | 43318 | 4899 | 47030 | 3956 | 48222 | 3225 | 48702 | 2084 | 59751 | 1190 | 47866 |
| 9L-2S | | MI | 22013 | 6641 | 36948 | 4751 | 41062 | 3821 | 43525 | 3094 | 46709 | 1929 | 56675 | 1682 | 37092 |
| 18-#18 | 4.89 | MA | 31997 | 7758 | 56266 | 5561 | 63362 | 4444 | 68045 | 3503 | 75624 | 1995 | 95826 | 951 | 86506 |
| 6L-5S | | MI | 22326 | 7758 | 40012 | 5414 | 44802 | 4318 | 47733 | 3367 | 52288 | 1778 | 64833 | 784 | 59212 |
| 18-#18 | 4.89 | MA | 30729 | 7758 | 53758 | 5593 | 60305 | 4473 | 64298 | 3528 | 70592 | 2013 | 89131 | 726 | 82559 |
| 7L-4S | | MI | 23243 | 7758 | 41649 | 5425 | 46912 | 4299 | 50264 | 3350 | 55779 | 1795 | 69012 | 888 | 60874 |
| 18-#18 | 4.89 | MA | 29479 | 7758 | 51457 | 5590 | 57220 | 4467 | 60630 | 3553 | 65323 | 1996 | 82798 | 597 | 78157 |
| 8L-3S | | MI | 24260 | 7758 | 43506 | 5400 | 49272 | 4315 | 53078 | 3367 | 59312 | 1778 | 72941 | 1108 | 63438 |
| 20-#11 | 2.12 | MA | 29075 | 6311 | 47049 | 4685 | 52084 | 3787 | 54467 | 3101 | 57282 | 2086 | 70081 | 1759 | 43286 |
| 4L-8S | | MI | 18396 | 6311 | 30073 | 4573 | 32315 | 3700 | 32954 | 3034 | 32899 | 2008 | 39187 | 1371 | 27474 |
| 20-#11 | 2.12 | MA | 28502 | 6311 | 46065 | 4685 | 50815 | 3786 | 52912 | 3112 | 55063 | 2081 | 67348 | 1714 | 43009 |
| 5L-7S | | MI | 18750 | 6311 | 30681 | 4576 | 33129 | 3705 | 33921 | 3026 | 34169 | 2001 | 40802 | 1418 | 28053 |
| 20-#11 | 2.12 | MA | 27956 | 6311 | 45137 | 4685 | 49554 | 3798 | 51373 | 3110 | 53026 | 2090 | 64737 | 1656 | 42147 |
| 6E | | MI | 19109 | 6311 | 31342 | 4565 | 33935 | 3696 | 34946 | 3033 | 35455 | 1994 | 42489 | 1506 | 28311 |
| 20-#11 | 2.12 | MA | 27423 | 6311 | 44144 | 4698 | 48343 | 3796 | 49890 | 3121 | 51033 | 2099 | 62022 | 1568 | 41610 |
| 7L-5S | | MI | 19476 | 6311 | 31961 | 4568 | 34774 | 3700 | 35932 | 3025 | 36770 | 1987 | 44108 | 1565 | 28748 |
| 20-#11 | 2.12 | MA | 26897 | 6311 | 43233 | 4698 | 47122 | 3809 | 48437 | 3132 | 48945 | 2094 | 59467 | 1516 | 40688 |
| 8L-4S | | MI | 19861 | 6311 | 32615 | 4571 | 35618 | 3691 | 36964 | 3018 | 38201 | 1994 | 45837 | 1605 | 28995 |
| 20-#11 | 2.12 | MA | 26339 | 6311 | 42339 | 4698 | 45928 | 3807 | 46934 | 3130 | 46973 | 2103 | 56938 | 1460 | 39871 |
| 9L-3S | | MI | 20288 | 6311 | 33359 | 4560 | 36563 | 3696 | 38112 | 3024 | 39651 | 1987 | 47461 | 1694 | 29024 |

## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

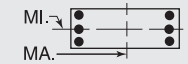
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.12 | MA | 25760 | 6311 | 41363 | 4711 | 44722 | 3820 | 45490 | 3141 | 45015 | 2111 | 54484 | 1397 | 38742 |
| 10L-2S | | MI | 20886 | 6311 | 34279 | 4563 | 37735 | 3687 | 39537 | 3017 | 41542 | 1980 | 49958 | 1782 | 29022 |
| 20-#14 | 3.06 | MA | 30366 | 6801 | 50676 | 4982 | 56605 | 3999 | 59915 | 3248 | 64531 | 2047 | 80286 | 1536 | 59897 |
| 5L-7S | | MI | 19589 | 6801 | 33117 | 4866 | 36149 | 3915 | 37543 | 3149 | 38934 | 1944 | 47498 | 1150 | 38155 |
| 20-#14 | 3.06 | MA | 29600 | 6801 | 49344 | 4982 | 54796 | 4017 | 57708 | 3244 | 61609 | 2059 | 76570 | 1451 | 58868 |
| 6E | | MI | 20093 | 6801 | 34063 | 4851 | 37303 | 3903 | 39006 | 3159 | 40758 | 1934 | 49645 | 1249 | 39272 |
| 20-#14 | 3.06 | MA | 28852 | 6801 | 47919 | 5001 | 53058 | 4014 | 55579 | 3259 | 58749 | 2071 | 72704 | 1325 | 57197 |
| 7L-5S | | MI | 20609 | 6801 | 34948 | 4856 | 38503 | 3910 | 40414 | 3149 | 42622 | 1924 | 51932 | 1335 | 39775 |
| 20-#14 | 3.06 | MA | 28115 | 6801 | 46612 | 5000 | 51305 | 4031 | 53494 | 3274 | 55753 | 2063 | 69061 | 1251 | 55755 |
| 8L-4S | | MI | 21149 | 6801 | 35884 | 4861 | 39710 | 3898 | 41888 | 3139 | 44653 | 1934 | 54380 | 1392 | 40816 |
| 20-#14 | 3.06 | MA | 27348 | 6801 | 45328 | 4999 | 49592 | 4029 | 51337 | 3270 | 52923 | 2074 | 65460 | 1170 | 53741 |
| 9L-3S | | MI | 21749 | 6801 | 36948 | 4845 | 41062 | 3905 | 43525 | 3149 | 46709 | 1924 | 56675 | 1519 | 41010 |
| 20-#14 | 3.06 | MA | 26523 | 6801 | 43927 | 5018 | 47862 | 4046 | 49266 | 3286 | 50114 | 2086 | 61969 | 1078 | 51603 |
| 10L-2S | | MI | 22587 | 6801 | 38260 | 4850 | 42734 | 3893 | 45555 | 3139 | 49391 | 1914 | 60206 | 1647 | 41075 |
| 20-#18 | 5.43 | MA | 32323 | 8042 | 57281 | 5770 | 64797 | 4602 | 69759 | 3608 | 77991 | 1995 | 99023 | 684 | 92742 |
| 7L-5S | | MI | 23312 | 8042 | 42294 | 5591 | 47712 | 4447 | 51220 | 3443 | 56895 | 1746 | 70860 | 712 | 65660 |
| 20-#18 | 5.43 | MA | 31087 | 8042 | 54980 | 5767 | 61712 | 4595 | 66091 | 3633 | 72721 | 1978 | 92689 | 555 | 88290 |
| 8L-4S | | MI | 24220 | 8042 | 43931 | 5602 | 49821 | 4428 | 53752 | 3426 | 60386 | 1763 | 75039 | 816 | 67493 |
| 22-#11 | 2.33 | MA | 29158 | 6422 | 47469 | 4754 | 52604 | 3836 | 55087 | 3144 | 58010 | 2074 | 71357 | 1701 | 47140 |
| 5L-8S | | MI | 18818 | 6422 | 30993 | 4643 | 33487 | 3750 | 34379 | 3065 | 34790 | 1998 | 41684 | 1348 | 30153 |
| 22-#11 | 2.33 | MA | 28615 | 6422 | 46541 | 4754 | 51343 | 3848 | 53549 | 3141 | 55973 | 2083 | 68746 | 1643 | 46309 |
| 6L-7S | | MI | 19170 | 6422 | 31600 | 4645 | 34301 | 3755 | 35346 | 3057 | 36060 | 1991 | 43299 | 1395 | 30753 |
| 22-#11 | 2.33 | MA | 28085 | 6422 | 45547 | 4767 | 50132 | 3847 | 52065 | 3152 | 53980 | 2092 | 66031 | 1555 | 45785 |
| 7L-6S | | MI | 19527 | 6422 | 32262 | 4635 | 35107 | 3746 | 36371 | 3064 | 37346 | 1984 | 44986 | 1483 | 31028 |
| 22-#11 | 2.33 | MA | 27563 | 6422 | 44637 | 4767 | 48911 | 3859 | 50612 | 3163 | 51892 | 2087 | 63476 | 1503 | 44815 |
| 8L-5S | | MI | 19892 | 6422 | 32880 | 4637 | 35946 | 3750 | 37357 | 3056 | 38660 | 1977 | 46605 | 1542 | 31445 |
| 22-#11 | 2.33 | MA | 27008 | 6422 | 43743 | 4767 | 47717 | 3858 | 49109 | 3161 | 49919 | 2096 | 60947 | 1447 | 44018 |
| 9L-4S | | MI | 20275 | 6422 | 33535 | 4640 | 36790 | 3741 | 38389 | 3049 | 40092 | 1984 | 48334 | 1582 | 31775 |
| 22-#11 | 2.33 | MA | 26432 | 6422 | 42767 | 4781 | 46511 | 3870 | 47666 | 3172 | 47962 | 2105 | 58493 | 1384 | 42856 |
| 10L-3S | | MI | 20701 | 6422 | 34279 | 4629 | 37735 | 3746 | 39537 | 3055 | 41542 | 1977 | 49958 | 1671 | 31815 |
| 22-#11 | 2.33 | MA | 25869 | 6422 | 41873 | 4780 | 45325 | 3869 | 46180 | 3169 | 45903 | 2100 | 55998 | 1329 | 41716 |
| 11L-2S | | MI | 21296 | 6422 | 35198 | 4632 | 38908 | 3737 | 40962 | 3048 | 43433 | 1970 | 52455 | 1760 | 31827 |
| 22-#14 | 3.36 | MA | 30525 | 6960 | 51354 | 5081 | 57358 | 4089 | 60823 | 3288 | 65829 | 2049 | 82280 | 1431 | 64833 |
| 6L-7S | | MI | 20178 | 6960 | 34429 | 4966 | 37822 | 3987 | 39573 | 3194 | 41616 | 1928 | 51029 | 1115 | 41958 |
| 22-#14 | 3.36 | MA | 29784 | 6960 | 49929 | 5100 | 55621 | 4086 | 58694 | 3304 | 62969 | 2061 | 78414 | 1305 | 63089 |
| 7L-6S | | MI | 20678 | 6960 | 35375 | 4951 | 38976 | 3975 | 41036 | 3204 | 43439 | 1918 | 53176 | 1214 | 43033 |
| 22-#14 | 3.36 | MA | 29052 | 6960 | 48622 | 5100 | 53868 | 4104 | 56609 | 3319 | 59974 | 2053 | 74770 | 1230 | 61594 |
| 8L-5S | | MI | 21191 | 6960 | 36260 | 4955 | 40176 | 3983 | 42444 | 3194 | 45303 | 1908 | 55462 | 1299 | 43627 |
| 22-#14 | 3.36 | MA | 28286 | 6960 | 47339 | 5099 | 52155 | 4101 | 54453 | 3315 | 57143 | 2065 | 71170 | 1149 | 59623 |
| 9L-4S | | MI | 21728 | 6960 | 37196 | 4960 | 41382 | 3970 | 43918 | 3184 | 47334 | 1918 | 57910 | 1357 | 44615 |
| 22-#14 | 3.36 | MA | 27471 | 6960 | 45938 | 5118 | 50425 | 4118 | 52381 | 3330 | 54335 | 2076 | 67678 | 1058 | 57452 |
| 10L-3S | | MI | 22324 | 6960 | 38260 | 4945 | 42734 | 3978 | 45555 | 3194 | 49391 | 1908 | 60206 | 1484 | 44969 |
| 22-#18 | 5.98 | MA | 32680 | 8326 | 58504 | 5945 | 66204 | 4724 | 71552 | 3713 | 80120 | 1960 | 102580 | 512 | 98439 |
| 8L-5S | | MI | 24290 | 8326 | 44576 | 5769 | 50622 | 4575 | 54708 | 3519 | 61501 | 1713 | 76886 | 641 | 72132 |
| 24-#11 | 2.54 | MA | 29270 | 6533 | 47944 | 4823 | 53132 | 3898 | 55724 | 3172 | 58920 | 2076 | 72756 | 1630 | 50474 |
| 6L-8S | | MI | 19237 | 6533 | 31912 | 4712 | 34660 | 3800 | 35804 | 3096 | 36680 | 1988 | 44181 | 1325 | 32836 |
| 24-#11 | 2.54 | MA | 28744 | 6533 | 46951 | 4837 | 51922 | 3897 | 54240 | 3183 | 56927 | 2085 | 70040 | 1542 | 49963 |
| 7E | | MI | 19588 | 6533 | 32520 | 4715 | 35473 | 3805 | 36771 | 3088 | 37950 | 1981 | 45796 | 1372 | 33415 |
| 24-#11 | 2.54 | MA | 28225 | 6533 | 46040 | 4836 | 50700 | 3909 | 52787 | 3194 | 54839 | 2080 | 67486 | 1490 | 48948 |
| 8L-6S | | MI | 19943 | 6533 | 33181 | 4704 | 36280 | 3796 | 37796 | 3095 | 39237 | 1974 | 47484 | 1460 | 33749 |
| 24-#11 | 2.54 | MA | 27679 | 6533 | 45146 | 4836 | 49507 | 3908 | 51284 | 3192 | 52866 | 2089 | 64956 | 1434 | 48168 |
| 9L-5S | | MI | 20307 | 6533 | 33800 | 4707 | 37119 | 3801 | 38782 | 3087 | 40551 | 1967 | 49102 | 1519 | 34146 |
| 24-#11 | 2.54 | MA | 27100 | 6533 | 44170 | 4850 | 48301 | 3920 | 49841 | 3203 | 50909 | 2098 | 62502 | 1371 | 46975 |
| 10L-4S | | MI | 20688 | 6533 | 34454 | 4709 | 37962 | 3791 | 39814 | 3080 | 41982 | 1974 | 50831 | 1559 | 34551 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.54 | MA | 26539 | 6533 | 43276 | 4849 | 47114 | 3919 | 48355 | 3200 | 48850 | 2093 | 60008 | 1316 | 45811 |
| 11L-3S | | MI | 21111 | 6533 | 35198 | 4699 | 38908 | 3796 | 40962 | 3086 | 43433 | 1967 | 52455 | 1648 | 34603 |
| 24-#11 | 2.54 | MA | 25989 | 6533 | 42315 | 4863 | 45916 | 3931 | 46915 | 3212 | 46896 | 2101 | 57264 | 1241 | 44572 |
| 12L-2S | | MI | 21704 | 6533 | 36117 | 4701 | 40080 | 3787 | 42387 | 3079 | 45323 | 1960 | 54952 | 1737 | 34625 |
| 24-#14 | 3.67 | MA | 30708 | 7120 | 51939 | 5200 | 58184 | 4159 | 61810 | 3349 | 67190 | 2051 | 84123 | 1284 | 68990 |
| 7E | | MI | 20763 | 7120 | 35741 | 5065 | 39494 | 4060 | 41604 | 3238 | 44297 | 1913 | 54559 | 1080 | 45769 |
| 24-#14 | 3.67 | MA | 29983 | 7120 | 50632 | 5199 | 56431 | 4176 | 59725 | 3364 | 64194 | 2043 | 80479 | 1210 | 67440 |
| 8L-6S | | MI | 21260 | 7120 | 36687 | 5050 | 40648 | 4047 | 43066 | 3248 | 46121 | 1903 | 56706 | 1178 | 46802 |
| 24-#14 | 3.67 | MA | 29218 | 7120 | 49349 | 5199 | 54718 | 4173 | 57568 | 3360 | 61364 | 2055 | 76879 | 1129 | 65511 |
| 9L-5S | | MI | 21770 | 7120 | 37572 | 5055 | 41849 | 4055 | 44475 | 3238 | 47985 | 1893 | 58993 | 1264 | 47484 |
| 24-#14 | 3.67 | MA | 28429 | 7120 | 47948 | 5218 | 52987 | 4191 | 55497 | 3375 | 58555 | 2066 | 73387 | 1038 | 63308 |
| 10L-4S | | MI | 22303 | 7120 | 38508 | 5060 | 43055 | 4042 | 45948 | 3228 | 50016 | 1903 | 61441 | 1321 | 48425 |

## RECTANGULAR TIED COLUMNS 32" x 48"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.04 | MA | 29631 | 5999 | 46249 | 4480 | 50172 | 3651 | 51281 | 3042 | 51362 | 2180 | 60586 | 2063 | 23439 |
| 2E | | MI | 19472 | 5999 | 30909 | 4336 | 32943 | 3533 | 33248 | 2934 | 32649 | 2074 | 37856 | 1924 | 15132 |
| 6-#18 | 1.56 | MA | 31363 | 6282 | 49950 | 4657 | 54890 | 3780 | 57016 | 3122 | 59132 | 2162 | 71032 | 2023 | 34760 |
| 2L-3S | | MI | 18999 | 6282 | 30909 | 4502 | 32943 | 3680 | 33248 | 3028 | 32649 | 2060 | 37856 | 1624 | 22287 |
| 6-#18 | 1.56 | MA | 28918 | 6282 | 46249 | 4655 | 50172 | 3809 | 51281 | 3149 | 51362 | 2182 | 60586 | 1796 | 34670 |
| 3L-2S | | MI | 20496 | 6282 | 33192 | 4513 | 35853 | 3661 | 36735 | 3010 | 37256 | 2042 | 43883 | 1852 | 22198 |
| 8-#14 | 1.17 | MA | 30156 | 6070 | 47150 | 4550 | 51493 | 3704 | 52953 | 3080 | 53656 | 2190 | 63956 | 2079 | 26470 |
| 2L-4S | | MI | 18318 | 6070 | 29106 | 4430 | 30805 | 3602 | 30803 | 2988 | 29547 | 2117 | 34279 | 1691 | 17169 |
| 8-#14 | 1.17 | MA | 28746 | 6070 | 45040 | 4550 | 48803 | 3702 | 49683 | 3096 | 49226 | 2202 | 57934 | 1951 | 26491 |
| 3E | | MI | 18943 | 6070 | 30169 | 4415 | 32157 | 3609 | 32441 | 2998 | 31603 | 2107 | 36575 | 1818 | 17121 |
| 8-#14 | 1.17 | MA | 27755 | 6070 | 43351 | 4569 | 46654 | 3720 | 47075 | 3093 | 45839 | 2215 | 53982 | 1823 | 26395 |
| 4L-2S | | MI | 19812 | 6070 | 31481 | 4419 | 33829 | 3597 | 34471 | 2988 | 34284 | 2097 | 40105 | 1946 | 17053 |
| 8-#18 | 2.08 | MA | 33070 | 6566 | 53651 | 4835 | 59608 | 3908 | 62752 | 3202 | 66903 | 2145 | 81478 | 1984 | 46032 |
| 2L-4S | | MI | 18954 | 6566 | 31335 | 4704 | 33492 | 3793 | 33922 | 3086 | 33724 | 2045 | 39954 | 1333 | 28470 |
| 8-#18 | 2.08 | MA | 30653 | 6566 | 49950 | 4832 | 54890 | 3938 | 57016 | 3228 | 59132 | 2164 | 71032 | 1756 | 45830 |
| 3E | | MI | 20024 | 6566 | 33192 | 4680 | 35853 | 3809 | 36735 | 3104 | 37256 | 2027 | 43883 | 1553 | 29219 |
| 8-#18 | 2.08 | MA | 28951 | 6566 | 46979 | 4865 | 51112 | 3932 | 52431 | 3219 | 53179 | 2184 | 64189 | 1529 | 44562 |
| 4L-2S | | MI | 21506 | 6566 | 35474 | 4691 | 38763 | 3790 | 40223 | 3086 | 41862 | 2010 | 49909 | 1780 | 29209 |
| 10-#11 | 1.02 | MA | 29661 | 5985 | 46004 | 4510 | 50119 | 3677 | 51316 | 3066 | 51453 | 2202 | 61087 | 2101 | 23108 |
| 2L-5S | | MI | 18084 | 5985 | 28454 | 4391 | 30044 | 3588 | 29907 | 2987 | 28301 | 2127 | 32709 | 1766 | 15073 |
| 10-#11 | 1.02 | MA | 28672 | 5985 | 44531 | 4510 | 48241 | 3675 | 49034 | 3077 | 48361 | 2211 | 56861 | 2013 | 23136 |
| 3L-4S | | MI | 18479 | 5985 | 29109 | 4394 | 30888 | 3579 | 30939 | 2980 | 29732 | 2134 | 34438 | 1806 | 15043 |
| 10-#11 | 1.02 | MA | 27978 | 5985 | 43353 | 4524 | 46743 | 3688 | 47216 | 3075 | 46000 | 2220 | 54084 | 1924 | 23125 |
| 4L-3S | | MI | 18918 | 5985 | 29853 | 4383 | 31833 | 3583 | 32087 | 2986 | 31182 | 2127 | 36061 | 1895 | 14995 |
| 10-#11 | 1.02 | MA | 27357 | 5985 | 42322 | 4524 | 45413 | 3687 | 45586 | 3086 | 43675 | 2216 | 51207 | 1879 | 23036 |
| 5L-2S | | MI | 19530 | 5985 | 30772 | 4386 | 33006 | 3574 | 33512 | 2979 | 33073 | 2120 | 38559 | 1984 | 14947 |
| 10-#14 | 1.46 | MA | 31151 | 6229 | 49260 | 4650 | 54183 | 3777 | 56223 | 3125 | 58086 | 2180 | 69977 | 2060 | 32914 |
| 2L-5S | | MI | 18363 | 6229 | 29482 | 4525 | 31271 | 3686 | 31360 | 3043 | 30197 | 2091 | 35362 | 1598 | 20822 |
| 10-#14 | 1.46 | MA | 29751 | 6229 | 47150 | 4650 | 51493 | 3775 | 52953 | 3141 | 53656 | 2192 | 63956 | 1932 | 32897 |
| 3L-4S | | MI | 18923 | 6229 | 30418 | 4529 | 32477 | 3674 | 32834 | 3033 | 32228 | 2101 | 37810 | 1656 | 21161 |
| 10-#14 | 1.46 | MA | 28768 | 6229 | 45461 | 4669 | 49344 | 3792 | 50345 | 3137 | 50269 | 2205 | 60003 | 1804 | 32755 |
| 4L-3S | | MI | 19543 | 6229 | 31481 | 4514 | 33829 | 3682 | 34471 | 3043 | 34284 | 2091 | 40105 | 1783 | 21148 |
| 10-#14 | 1.46 | MA | 27889 | 6229 | 43981 | 4669 | 47435 | 3790 | 48007 | 3154 | 46933 | 2197 | 55897 | 1739 | 32029 |
| 5L-2S | | MI | 20407 | 6229 | 32793 | 4519 | 35502 | 3669 | 36501 | 3033 | 36966 | 2081 | 43636 | 1911 | 21097 |
| 10-#18 | 2.60 | MA | 34753 | 6850 | 57352 | 5012 | 64327 | 4037 | 68488 | 3282 | 74674 | 2127 | 91924 | 1944 | 57267 |
| 2L-5S | | MI | 19023 | 6850 | 31980 | 4870 | 34293 | 3940 | 34878 | 3180 | 34839 | 1995 | 41802 | 1157 | 33241 |
| 10-#18 | 2.60 | MA | 32363 | 6850 | 53651 | 5010 | 59608 | 4066 | 62752 | 3308 | 66903 | 2147 | 81478 | 1717 | 56974 |
| 3L-4S | | MI | 19978 | 6850 | 33617 | 4881 | 36402 | 3921 | 37409 | 3162 | 38330 | 2013 | 45981 | 1261 | 34921 |
| 10-#18 | 2.60 | MA | 30682 | 6850 | 50680 | 5043 | 55830 | 4061 | 58167 | 3299 | 60950 | 2166 | 74635 | 1489 | 55216 |
| 4L-3S | | MI | 21037 | 6850 | 35474 | 4857 | 38763 | 3937 | 40223 | 3180 | 41862 | 1995 | 49909 | 1481 | 36116 |
| 10-#18 | 2.60 | MA | 29178 | 6850 | 48076 | 5041 | 52472 | 4090 | 54054 | 3325 | 55082 | 2150 | 67488 | 1377 | 51811 |
| 5L-2S | | MI | 22506 | 6850 | 37756 | 4868 | 41672 | 3918 | 43710 | 3162 | 46469 | 1978 | 55936 | 1708 | 36186 |

## RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

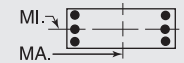
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.22 | MA | 30362 | 6095 | 47476 | 4579 | 51996 | 3727 | 53599 | 3097 | 54545 | 2195 | 65313 | 2089 | 27610 |
| 2L-6S | | MI | 18137 | 6095 | 28755 | 4457 | 30378 | 3634 | 30345 | 3026 | 28877 | 2124 | 33587 | 1684 | 17597 |
| 12-#11 | 1.22 | MA | 29379 | 6095 | 46004 | 4579 | 50119 | 3726 | 51316 | 3108 | 51453 | 2204 | 61087 | 2001 | 27625 |
| 3L-5S | | MI | 18513 | 6095 | 29374 | 4460 | 31216 | 3638 | 31332 | 3018 | 30191 | 2117 | 35206 | 1744 | 17871 |
| 12-#11 | 1.22 | MA | 28689 | 6095 | 44826 | 4593 | 48621 | 3738 | 49498 | 3106 | 49092 | 2213 | 58310 | 1912 | 27588 |
| 4E | | MI | 18906 | 6095 | 30028 | 4463 | 32060 | 3629 | 32364 | 3011 | 31623 | 2124 | 36935 | 1784 | 17862 |
| 12-#11 | 1.22 | MA | 28073 | 6095 | 43795 | 4593 | 47291 | 3737 | 47869 | 3118 | 46767 | 2209 | 55433 | 1867 | 27474 |
| 5L-3S | | MI | 19342 | 6095 | 30772 | 4452 | 33006 | 3634 | 33512 | 3017 | 33073 | 2117 | 38559 | 1872 | 17827 |
| 12-#11 | 1.22 | MA | 27485 | 6095 | 42823 | 4593 | 45969 | 3750 | 46257 | 3115 | 44632 | 2218 | 52680 | 1808 | 26869 |
| 6L-2S | | MI | 19951 | 6095 | 31691 | 4455 | 34178 | 3624 | 34936 | 3010 | 34964 | 2110 | 41056 | 1961 | 17786 |
| 12-#14 | 1.76 | MA | 32137 | 6389 | 51370 | 4750 | 56873 | 3849 | 59493 | 3170 | 62516 | 2170 | 75999 | 2041 | 39343 |
| 2L-6S | | MI | 18436 | 6389 | 29909 | 4619 | 31743 | 3751 | 31982 | 3097 | 31015 | 2086 | 36606 | 1477 | 23978 |
| 12-#14 | 1.76 | MA | 30747 | 6389 | 49260 | 4749 | 54183 | 3847 | 56223 | 3186 | 58086 | 2182 | 69977 | 1913 | 39291 |
| 3L-5S | | MI | 18967 | 6389 | 30794 | 4624 | 32944 | 3759 | 33390 | 3087 | 32878 | 2076 | 38892 | 1563 | 24615 |
| 12-#14 | 1.76 | MA | 29772 | 6389 | 47570 | 4769 | 52034 | 3865 | 53615 | 3182 | 54699 | 2195 | 66025 | 1785 | 39109 |
| 4E | | MI | 19522 | 6389 | 31730 | 4629 | 34150 | 3746 | 34864 | 3077 | 34909 | 2086 | 41340 | 1620 | 25135 |
| 12-#14 | 1.76 | MA | 28900 | 6389 | 46091 | 4768 | 50125 | 3863 | 51277 | 3198 | 51363 | 2187 | 61919 | 1720 | 38192 |
| 5L-3S | | MI | 20139 | 6389 | 32793 | 4614 | 35502 | 3754 | 36501 | 3087 | 36966 | 2076 | 43636 | 1747 | 25159 |
| 12-#14 | 1.76 | MA | 28069 | 6389 | 44696 | 4768 | 48229 | 3880 | 48964 | 3195 | 48300 | 2200 | 57998 | 1636 | 36882 |
| 6L-2S | | MI | 20997 | 6389 | 34105 | 4619 | 37175 | 3741 | 38532 | 3077 | 39647 | 2066 | 47166 | 1875 | 25125 |
| 12-#18 | 3.13 | MA | 34050 | 7134 | 57352 | 5187 | 64327 | 4195 | 68488 | 3388 | 74674 | 2129 | 91924 | 1677 | 68107 |
| 3L-5S | | MI | 20045 | 7134 | 34262 | 5048 | 37203 | 4069 | 38365 | 3256 | 39445 | 1963 | 47828 | 1086 | 39865 |
| 12-#18 | 3.13 | MA | 32391 | 7134 | 54381 | 5220 | 60549 | 4189 | 63903 | 3379 | 68721 | 2148 | 85081 | 1450 | 65917 |
| 4E | | MI | 20991 | 7134 | 35899 | 5059 | 39312 | 4050 | 40897 | 3238 | 42937 | 1981 | 52007 | 1189 | 41421 |
| 12-#18 | 3.13 | MA | 30906 | 7134 | 51777 | 5218 | 57190 | 4219 | 59790 | 3405 | 62853 | 2133 | 77934 | 1338 | 62680 |
| 5L-3S | | MI | 22040 | 7134 | 37756 | 5034 | 41672 | 4066 | 43710 | 3256 | 46469 | 1963 | 55936 | 1409 | 42991 |
| 12-#18 | 3.13 | MA | 29490 | 7134 | 49320 | 5216 | 53852 | 4213 | 55718 | 3396 | 57461 | 2152 | 71139 | 1188 | 58987 |
| 6L-2S | | MI | 23496 | 7134 | 40039 | 5045 | 44582 | 4047 | 47198 | 3238 | 51075 | 1945 | 61963 | 1637 | 43129 |
| 14-#11 | 1.42 | MA | 31060 | 6206 | 48949 | 4648 | 53874 | 3777 | 55881 | 3128 | 57638 | 2188 | 69539 | 2077 | 32105 |
| 2L-7S | | MI | 18200 | 6206 | 29013 | 4537 | 30743 | 3693 | 30746 | 3050 | 29482 | 2121 | 34397 | 1573 | 19998 |
| 14-#11 | 1.42 | MA | 30081 | 6206 | 47476 | 4648 | 51996 | 3776 | 53599 | 3139 | 54545 | 2197 | 65313 | 1988 | 32099 |
| 3L-6S | | MI | 18565 | 6206 | 29675 | 4526 | 31550 | 3684 | 31770 | 3057 | 30768 | 2114 | 36084 | 1662 | 20294 |
| 14-#11 | 1.42 | MA | 29395 | 6206 | 46298 | 4662 | 50498 | 3788 | 51780 | 3137 | 52184 | 2207 | 62536 | 1900 | 32044 |
| 4L-5S | | MI | 18939 | 6206 | 30293 | 4529 | 32389 | 3688 | 32757 | 3049 | 32082 | 2107 | 37703 | 1721 | 20660 |
| 14-#11 | 1.42 | MA | 28782 | 6206 | 45267 | 4662 | 49168 | 3787 | 50151 | 3149 | 49859 | 2202 | 59659 | 1854 | 31909 |
| 5L-4S | | MI | 19330 | 6206 | 30948 | 4532 | 33232 | 3679 | 33789 | 3042 | 33514 | 2114 | 39432 | 1761 | 20672 |
| 14-#11 | 1.42 | MA | 28199 | 6206 | 44295 | 4662 | 47847 | 3800 | 48539 | 3146 | 47724 | 2211 | 56906 | 1796 | 31210 |
| 6L-3S | | MI | 19764 | 6206 | 31691 | 4521 | 34178 | 3684 | 34936 | 3048 | 34964 | 2107 | 41056 | 1849 | 20649 |
| 14-#11 | 1.42 | MA | 27629 | 6206 | 43255 | 4676 | 46578 | 3799 | 46984 | 3158 | 45636 | 2221 | 54043 | 1709 | 30570 |
| 7L-2S | | MI | 20371 | 6206 | 32611 | 4524 | 35350 | 3675 | 36361 | 3041 | 36854 | 2100 | 43553 | 1938 | 20615 |
| 14-#14 | 2.05 | MA | 33114 | 6548 | 53480 | 4849 | 59563 | 3921 | 62763 | 3215 | 66946 | 2160 | 82021 | 2022 | 45757 |
| 2L-7S | | MI | 18523 | 6548 | 30274 | 4734 | 32262 | 3836 | 32550 | 3132 | 31872 | 2080 | 37989 | 1343 | 27044 |
| 14-#14 | 2.05 | MA | 31734 | 6548 | 51370 | 4849 | 56873 | 3919 | 59493 | 3231 | 62516 | 2172 | 75999 | 1894 | 45676 |
| 3L-6S | | MI | 19038 | 6548 | 31221 | 4719 | 33416 | 3824 | 34013 | 3142 | 33696 | 2070 | 40136 | 1442 | 27828 |
| 14-#14 | 2.05 | MA | 30766 | 6548 | 49680 | 4868 | 54724 | 3937 | 56885 | 3227 | 59130 | 2185 | 72046 | 1766 | 45459 |
| 4L-5S | | MI | 19565 | 6548 | 32106 | 4724 | 34616 | 3831 | 35421 | 3132 | 35560 | 2060 | 42423 | 1528 | 28426 |
| 14-#14 | 2.05 | MA | 29902 | 6548 | 48201 | 4868 | 52815 | 3935 | 54547 | 3243 | 55793 | 2178 | 67941 | 1701 | 44372 |
| 5L-4S | | MI | 20117 | 6548 | 33042 | 4729 | 35823 | 3819 | 36894 | 3122 | 37591 | 2070 | 44871 | 1585 | 29098 |
| 14-#14 | 2.05 | MA | 29078 | 6548 | 46805 | 4868 | 50919 | 3953 | 52234 | 3239 | 52730 | 2190 | 64020 | 1617 | 43117 |
| 6L-3S | | MI | 20730 | 6548 | 34105 | 4714 | 37175 | 3826 | 38532 | 3132 | 39647 | 2060 | 47166 | 1712 | 29153 |
| 14-#14 | 2.05 | MA | 28273 | 6548 | 45312 | 4887 | 49098 | 3950 | 50002 | 3255 | 49733 | 2203 | 59941 | 1491 | 41742 |
| 7L-2S | | MI | 21584 | 6548 | 35417 | 4719 | 38847 | 3814 | 40562 | 3122 | 42328 | 2050 | 50697 | 1840 | 29141 |
| 14-#18 | 3.65 | MA | 34078 | 7417 | 58082 | 5397 | 65267 | 4318 | 69639 | 3459 | 76492 | 2131 | 95527 | 1410 | 76657 |
| 4L-5S | | MI | 21057 | 7417 | 36545 | 5225 | 40113 | 4197 | 41853 | 3332 | 44052 | 1931 | 53855 | 1014 | 46512 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

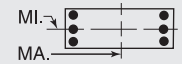



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.65 | MA | 32611 | 7417 | 55478 | 5395 | 61909 | 4348 | 65526 | 3485 | 70623 | 2115 | 88380 | 1298 | 73571 |
| 5L-4S | | MI | 21994 | 7417 | 38182 | 5236 | 42222 | 4178 | 44384 | 3314 | 47543 | 1949 | 58034 | 1117 | 47959 |
| 14-#18 | 3.65 | MA | 31213 | 7417 | 53021 | 5393 | 58570 | 4342 | 61454 | 3476 | 65232 | 2134 | 81585 | 1149 | 69726 |
| 6L-3S | | MI | 23033 | 7417 | 40039 | 5212 | 44582 | 4195 | 47198 | 3332 | 51075 | 1931 | 61963 | 1337 | 49852 |
| 14-#18 | 3.65 | MA | 29849 | 7417 | 50391 | 5426 | 55365 | 4372 | 57526 | 3502 | 59956 | 2154 | 74514 | 924 | 65962 |
| 7L-2S | | MI | 24477 | 7417 | 42321 | 5223 | 47492 | 4176 | 50685 | 3314 | 55682 | 1913 | 67989 | 1565 | 50047 |
| 16-#11 | 1.63 | MA | 31752 | 6316 | 50422 | 4717 | 55751 | 3827 | 58164 | 3159 | 60730 | 2181 | 73764 | 2065 | 36594 |
| 2L-8S | | MI | 18270 | 6316 | 29325 | 4603 | 31102 | 3738 | 31203 | 3089 | 30102 | 2118 | 35279 | 1504 | 22308 |
| 16-#11 | 1.63 | MA | 30778 | 6316 | 48949 | 4717 | 53874 | 3826 | 55881 | 3171 | 57638 | 2190 | 69539 | 1976 | 36570 |
| 3L-7S | | MI | 18628 | 6316 | 29933 | 4606 | 31916 | 3743 | 32171 | 3082 | 31372 | 2111 | 36894 | 1551 | 22717 |
| 16-#11 | 1.63 | MA | 30097 | 6316 | 47771 | 4731 | 52376 | 3839 | 54063 | 3168 | 55276 | 2200 | 66762 | 1888 | 36497 |
| 4L-6S | | MI | 18991 | 6316 | 30594 | 4595 | 32722 | 3734 | 33195 | 3088 | 32658 | 2104 | 38581 | 1639 | 22998 |
| 16-#11 | 1.63 | MA | 29488 | 6316 | 46740 | 4731 | 51046 | 3837 | 52434 | 3180 | 52951 | 2195 | 63885 | 1842 | 36342 |
| 5E | | MI | 19363 | 6316 | 31213 | 4598 | 33561 | 3738 | 34182 | 3081 | 33973 | 2097 | 40200 | 1698 | 23441 |
| 16-#11 | 1.63 | MA | 28907 | 6316 | 45768 | 4731 | 49724 | 3850 | 50821 | 3178 | 50816 | 2204 | 61132 | 1784 | 35560 |
| 6L-4S | | MI | 19752 | 6316 | 31867 | 4601 | 34404 | 3729 | 35214 | 3073 | 35404 | 2104 | 41929 | 1738 | 23472 |
| 16-#11 | 1.63 | MA | 28341 | 6316 | 44727 | 4745 | 48456 | 3849 | 49267 | 3189 | 48728 | 2214 | 58269 | 1697 | 34942 |
| 7L-3S | | MI | 20184 | 6316 | 32611 | 4590 | 35350 | 3734 | 36361 | 3080 | 36854 | 2097 | 43553 | 1827 | 23463 |
| 16-#11 | 1.63 | MA | 27783 | 6316 | 43774 | 4745 | 47176 | 3862 | 47745 | 3201 | 46540 | 2209 | 55580 | 1644 | 34171 |
| 8L-2S | | MI | 20788 | 6316 | 33530 | 4593 | 36522 | 3725 | 37786 | 3072 | 38745 | 2090 | 46050 | 1915 | 23437 |
| 16-#14 | 2.34 | MA | 32712 | 6708 | 53480 | 4949 | 59563 | 3992 | 62763 | 3276 | 66946 | 2162 | 82021 | 1875 | 52054 |
| 3L-7S | | MI | 19125 | 6708 | 31586 | 4834 | 33935 | 3908 | 34580 | 3177 | 34553 | 2065 | 41520 | 1308 | 30813 |
| 16-#14 | 2.34 | MA | 31752 | 6708 | 51790 | 4968 | 57414 | 4009 | 60155 | 3272 | 63560 | 2175 | 78068 | 1747 | 51807 |
| 4L-6S | | MI | 19636 | 6708 | 32533 | 4819 | 35089 | 3896 | 36043 | 3187 | 36377 | 2055 | 43667 | 1407 | 31686 |
| 16-#14 | 2.34 | MA | 30895 | 6708 | 50311 | 4968 | 55505 | 4007 | 57817 | 3288 | 60224 | 2168 | 73962 | 1682 | 50567 |
| 5E | | MI | 20160 | 6708 | 33418 | 4824 | 36289 | 3903 | 37451 | 3177 | 38241 | 2045 | 45953 | 1492 | 32250 |
| 16-#14 | 2.34 | MA | 30077 | 6708 | 48915 | 4967 | 53609 | 4025 | 55504 | 3284 | 57160 | 2180 | 70041 | 1598 | 49361 |
| 6L-4S | | MI | 20708 | 6708 | 34354 | 4829 | 37495 | 3891 | 38925 | 3167 | 40272 | 2055 | 48401 | 1550 | 33054 |
| 16-#14 | 2.34 | MA | 29280 | 6708 | 47422 | 4987 | 51788 | 4023 | 53272 | 3300 | 54163 | 2193 | 65963 | 1472 | 47902 |
| 7L-3S | | MI | 21317 | 6708 | 35417 | 4814 | 38847 | 3899 | 40562 | 3177 | 42328 | 2045 | 50697 | 1677 | 33134 |
| 16-#14 | 2.34 | MA | 28493 | 6708 | 46052 | 4986 | 49951 | 4041 | 51088 | 3316 | 51023 | 2185 | 62125 | 1397 | 46329 |
| 8L-2S | | MI | 22166 | 6708 | 36729 | 4818 | 40520 | 3886 | 42592 | 3167 | 45010 | 2035 | 54227 | 1805 | 33148 |
| 16-#18 | 4.17 | MA | 34298 | 7701 | 59179 | 5572 | 66627 | 4476 | 71262 | 3565 | 78394 | 2097 | 98826 | 1259 | 84483 |
| 5E | | MI | 22060 | 7701 | 38827 | 5402 | 43023 | 4326 | 45340 | 3407 | 48658 | 1899 | 59882 | 942 | 53175 |
| 16-#18 | 4.17 | MA | 32916 | 7701 | 56722 | 5570 | 63289 | 4471 | 67190 | 3556 | 73003 | 2117 | 92031 | 1109 | 80490 |
| 6L-4S | | MI | 22988 | 7701 | 40464 | 5413 | 45132 | 4307 | 47871 | 3390 | 52149 | 1917 | 64061 | 1046 | 54528 |
| 16-#18 | 4.17 | MA | 31568 | 7701 | 54092 | 5603 | 60084 | 4500 | 63262 | 3582 | 67727 | 2136 | 84960 | 884 | 76636 |
| 7L-3S | | MI | 24018 | 7701 | 42321 | 5389 | 47492 | 4323 | 50685 | 3407 | 55682 | 1899 | 67989 | 1266 | 56701 |
| 16-#18 | 4.17 | MA | 30238 | 7701 | 51680 | 5601 | 56849 | 4495 | 59416 | 3608 | 62201 | 2120 | 78281 | 754 | 72212 |
| 8L-2S | | MI | 25451 | 7701 | 44604 | 5400 | 50402 | 4304 | 54173 | 3390 | 60288 | 1881 | 74016 | 1493 | 56951 |
| 18-#11 | 1.83 | MA | 31471 | 6427 | 50422 | 4787 | 55751 | 3876 | 58164 | 3202 | 60730 | 2184 | 73764 | 1964 | 41035 |
| 3L-8S | | MI | 18696 | 6427 | 30245 | 4673 | 32274 | 3788 | 32628 | 3120 | 31993 | 2108 | 37776 | 1481 | 24973 |
| 18-#11 | 1.83 | MA | 30793 | 6427 | 49244 | 4800 | 54253 | 3889 | 56345 | 3199 | 58368 | 2193 | 70988 | 1875 | 40946 |
| 4L-7S | | MI | 19052 | 6427 | 30852 | 4676 | 33088 | 3793 | 33596 | 3113 | 33263 | 2101 | 39391 | 1528 | 25439 |
| 18-#11 | 1.83 | MA | 30188 | 6427 | 48213 | 4800 | 52923 | 3888 | 54716 | 3211 | 56043 | 2188 | 68111 | 1830 | 40773 |
| 5L-6S | | MI | 19414 | 6427 | 31514 | 4665 | 33894 | 3784 | 34620 | 3119 | 34549 | 2094 | 41079 | 1616 | 25708 |
| 18-#11 | 1.83 | MA | 29611 | 6427 | 47241 | 4800 | 51602 | 3900 | 53104 | 3209 | 53908 | 2198 | 65358 | 1772 | 39917 |
| 6L-5S | | MI | 19784 | 6427 | 32132 | 4667 | 34733 | 3789 | 35607 | 3112 | 35863 | 2087 | 42697 | 1675 | 26181 |
| 18-#11 | 1.83 | MA | 29049 | 6427 | 46200 | 4814 | 50333 | 3899 | 51549 | 3220 | 51820 | 2207 | 62495 | 1685 | 39318 |
| 7L-4S | | MI | 20171 | 6427 | 32786 | 4670 | 35576 | 3779 | 36639 | 3104 | 37295 | 2094 | 44426 | 1715 | 26263 |
| 18-#11 | 1.83 | MA | 28494 | 6427 | 45246 | 4814 | 49054 | 3912 | 50027 | 3232 | 49632 | 2202 | 59806 | 1632 | 38493 |
| 8L-3S | | MI | 20601 | 6427 | 33530 | 4659 | 36522 | 3784 | 37786 | 3111 | 38745 | 2087 | 46050 | 1804 | 26271 |
| 18-#11 | 1.83 | MA | 27897 | 6427 | 44310 | 4814 | 47803 | 3911 | 48452 | 3229 | 47566 | 2211 | 57139 | 1576 | 37585 |
| 9L-2S | | MI | 21203 | 6427 | 34450 | 4662 | 37694 | 3775 | 39211 | 3103 | 40636 | 2081 | 48547 | 1893 | 26252 |
| 18-#14 | 2.64 | MA | 32731 | 6868 | 53900 | 5068 | 60104 | 4082 | 63425 | 3317 | 67990 | 2165 | 84090 | 1728 | 58151 |
| 4L-7S | | MI | 19722 | 6868 | 32898 | 4934 | 35607 | 3981 | 36611 | 3221 | 37235 | 2049 | 45050 | 1273 | 34594 |
| 18-#14 | 2.64 | MA | 31880 | 6868 | 52421 | 5068 | 58195 | 4080 | 61087 | 3333 | 64654 | 2158 | 79984 | 1663 | 56775 |
| 5L-6S | | MI | 20230 | 6868 | 33844 | 4919 | 36761 | 3968 | 38073 | 3231 | 39058 | 2039 | 47197 | 1371 | 35550 |

## RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

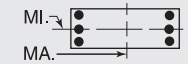



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.64 | MA | 31069 | 6868 | 51025 | 5067 | 56299 | 4097 | 58774 | 3329 | 61590 | 2170 | 76063 | 1579 | 55613 |
| 6L-5S | | MI | 20750 | 6868 | 34730 | 4924 | 37962 | 3976 | 39481 | 3221 | 40922 | 2029 | 49484 | 1457 | 36085 |
| 18-#14 | 2.64 | MA | 30278 | 6868 | 49532 | 5087 | 54478 | 4095 | 56542 | 3345 | 58593 | 2183 | 71984 | 1453 | 54073 |
| 7L-4S | | MI | 21295 | 6868 | 35666 | 4928 | 39168 | 3963 | 40955 | 3211 | 42953 | 2039 | 51932 | 1514 | 37004 |
| 18-#14 | 2.64 | MA | 29498 | 6868 | 48162 | 5086 | 52641 | 4113 | 54358 | 3361 | 55453 | 2175 | 68147 | 1378 | 52543 |
| 8L-3S | | MI | 21900 | 6868 | 36729 | 4913 | 40520 | 3971 | 42592 | 3221 | 45010 | 2029 | 54227 | 1641 | 37107 |
| 18-#14 | 2.64 | MA | 28680 | 6868 | 46818 | 5086 | 50846 | 4111 | 52098 | 3357 | 52487 | 2188 | 64348 | 1297 | 50516 |
| 9L-2S | | MI | 22745 | 6868 | 38041 | 4918 | 42193 | 3958 | 44623 | 3211 | 47691 | 2019 | 57758 | 1769 | 37145 |
| 18-#18 | 4.69 | MA | 34601 | 7985 | 60422 | 5748 | 68007 | 4599 | 72926 | 3636 | 80774 | 2099 | 102477 | 1070 | 91274 |
| 6L-5S | | MI | 23055 | 7985 | 41109 | 5580 | 45932 | 4455 | 48828 | 3483 | 53265 | 1867 | 65908 | 870 | 59627 |
| 18-#18 | 4.69 | MA | 33268 | 7985 | 57793 | 5781 | 64802 | 4629 | 68998 | 3662 | 75498 | 2119 | 95405 | 845 | 87329 |
| 7L-4S | | MI | 23975 | 7985 | 42746 | 5591 | 48042 | 4435 | 51359 | 3466 | 56756 | 1884 | 70087 | 974 | 61124 |
| 18-#18 | 4.69 | MA | 31954 | 7985 | 55381 | 5778 | 61568 | 4623 | 65152 | 3688 | 69972 | 2103 | 88727 | 714 | 82874 |
| 8L-3S | | MI | 24996 | 7985 | 44604 | 5566 | 50402 | 4452 | 54173 | 3483 | 60288 | 1867 | 74016 | 1194 | 63542 |
| 20-#11 | 2.03 | MA | 31486 | 6538 | 50716 | 4870 | 56131 | 3939 | 58628 | 3231 | 61461 | 2186 | 75214 | 1863 | 45392 |
| 4L-8S | | MI | 19120 | 6538 | 31164 | 4742 | 33446 | 3839 | 34053 | 3151 | 33883 | 2098 | 40274 | 1458 | 27646 |
| 20-#11 | 2.03 | MA | 30884 | 6538 | 49685 | 4870 | 54801 | 3938 | 56998 | 3242 | 59135 | 2181 | 72337 | 1818 | 45203 |
| 5L-7S | | MI | 19475 | 6538 | 31772 | 4745 | 34260 | 3843 | 35021 | 3144 | 35153 | 2091 | 41888 | 1505 | 28164 |
| 20-#11 | 2.03 | MA | 30311 | 6538 | 48713 | 4870 | 53479 | 3950 | 55386 | 3240 | 57001 | 2191 | 69584 | 1760 | 44280 |
| 6E | | MI | 19835 | 6538 | 32433 | 4734 | 35066 | 3834 | 36045 | 3150 | 36440 | 2084 | 43576 | 1593 | 28422 |
| 20-#11 | 2.03 | MA | 29752 | 6538 | 47673 | 4883 | 52211 | 3949 | 53831 | 3251 | 54912 | 2200 | 66721 | 1672 | 43698 |
| 7L-5S | | MI | 20203 | 6538 | 33052 | 4737 | 35905 | 3839 | 37031 | 3143 | 37754 | 2078 | 45194 | 1652 | 28871 |
| 20-#11 | 2.03 | MA | 29201 | 6538 | 46719 | 4883 | 50931 | 3962 | 52310 | 3263 | 52724 | 2195 | 64032 | 1620 | 42821 |
| 8L-4S | | MI | 20588 | 6538 | 33706 | 4739 | 36749 | 3830 | 38064 | 3135 | 39185 | 2084 | 46923 | 1692 | 29049 |
| 20-#11 | 2.03 | MA | 28607 | 6538 | 45783 | 4883 | 49681 | 3961 | 50735 | 3261 | 50658 | 2205 | 61365 | 1564 | 41935 |
| 9L-3S | | MI | 21016 | 6538 | 34450 | 4729 | 37694 | 3834 | 39211 | 3142 | 40636 | 2078 | 48547 | 1781 | 29074 |
| 20-#11 | 2.03 | MA | 27999 | 6538 | 44760 | 4897 | 48417 | 3973 | 49223 | 3272 | 48607 | 2214 | 58777 | 1501 | 40834 |
| 10L-2S | | MI | 21615 | 6538 | 35369 | 4731 | 38866 | 3825 | 40636 | 3134 | 42526 | 2071 | 51044 | 1870 | 29063 |
| 20-#14 | 2.93 | MA | 32857 | 7027 | 54531 | 5167 | 60885 | 4152 | 64357 | 3378 | 69084 | 2148 | 86006 | 1644 | 62994 |
| 5L-7S | | MI | 20315 | 7027 | 34210 | 5033 | 37280 | 4053 | 38641 | 3266 | 39916 | 2034 | 48581 | 1237 | 38386 |
| 20-#14 | 2.93 | MA | 32052 | 7027 | 53135 | 5167 | 58989 | 4170 | 62044 | 3374 | 66021 | 2160 | 82085 | 1560 | 61871 |
| 6E | | MI | 20820 | 7027 | 35156 | 5018 | 38434 | 4041 | 40104 | 3276 | 41740 | 2024 | 50728 | 1336 | 39419 |
| 20-#14 | 2.93 | MA | 31268 | 7027 | 51642 | 5186 | 57168 | 4167 | 59812 | 3390 | 63023 | 2173 | 78006 | 1434 | 60253 |
| 7L-5S | | MI | 21337 | 7027 | 36041 | 5023 | 39634 | 4048 | 41512 | 3266 | 43604 | 2014 | 53014 | 1422 | 39929 |
| 20-#14 | 2.93 | MA | 30494 | 7027 | 50272 | 5186 | 55331 | 4185 | 57628 | 3406 | 59883 | 2165 | 74168 | 1359 | 58764 |
| 8L-4S | | MI | 21878 | 7027 | 36978 | 5028 | 40841 | 4036 | 42985 | 3256 | 45635 | 2024 | 55463 | 1479 | 40948 |
| 20-#14 | 2.93 | MA | 29678 | 7027 | 48928 | 5186 | 53536 | 4183 | 55368 | 3402 | 56918 | 2178 | 70370 | 1278 | 56688 |
| 9L-3S | | MI | 22480 | 7027 | 38041 | 5013 | 42193 | 4043 | 44623 | 3266 | 47691 | 2014 | 57758 | 1606 | 41074 |
| 20-#14 | 2.93 | MA | 28809 | 7027 | 47460 | 5205 | 51723 | 4201 | 53197 | 3418 | 53974 | 2191 | 66684 | 1187 | 54557 |
| 10L-2S | | MI | 23320 | 7027 | 39353 | 5018 | 43865 | 4031 | 46653 | 3256 | 50372 | 2004 | 61288 | 1734 | 41130 |
| 20-#18 | 5.21 | MA | 34951 | 8268 | 61494 | 5958 | 69520 | 4757 | 74734 | 3742 | 83269 | 2101 | 105851 | 805 | 98042 |
| 7L-5S | | MI | 24042 | 8268 | 43392 | 5757 | 48842 | 4583 | 52315 | 3559 | 57871 | 1835 | 71935 | 799 | 66068 |
| 20-#18 | 5.21 | MA | 33651 | 8268 | 59082 | 5956 | 66286 | 4752 | 70888 | 3768 | 77743 | 2085 | 99173 | 675 | 93538 |
| 8L-4S | | MI | 24954 | 8268 | 45029 | 5768 | 50952 | 4564 | 54846 | 3542 | 61362 | 1852 | 76114 | 902 | 67740 |
| 22-#11 | 2.23 | MA | 31576 | 6648 | 51158 | 4939 | 56678 | 3988 | 59281 | 3273 | 62227 | 2174 | 76563 | 1806 | 49562 |
| 5L-8S | | MI | 19543 | 6648 | 32083 | 4811 | 34618 | 3889 | 35478 | 3182 | 35774 | 2088 | 42771 | 1435 | 30323 |
| 22-#11 | 2.23 | MA | 31006 | 6648 | 50186 | 4939 | 55357 | 4001 | 57669 | 3271 | 60093 | 2184 | 73810 | 1748 | 48648 |
| 6L-7S | | MI | 19895 | 6648 | 32691 | 4814 | 35432 | 3893 | 36446 | 3175 | 37044 | 2081 | 44385 | 1482 | 30891 |
| 22-#11 | 2.23 | MA | 30450 | 6648 | 49145 | 4953 | 54088 | 3999 | 56114 | 3282 | 58004 | 2193 | 70947 | 1660 | 48081 |
| 7L-6S | | MI | 20253 | 6648 | 33353 | 4803 | 36238 | 3884 | 37470 | 3181 | 38330 | 2075 | 46073 | 1570 | 31140 |
| 22-#11 | 2.23 | MA | 29902 | 6648 | 48192 | 4953 | 52809 | 4012 | 54592 | 3294 | 55817 | 2188 | 68258 | 1608 | 47154 |
| 8L-5S | | MI | 20620 | 6648 | 33971 | 4806 | 37077 | 3889 | 38456 | 3174 | 39644 | 2068 | 47691 | 1630 | 31567 |
| 22-#11 | 2.23 | MA | 29312 | 6648 | 47255 | 4953 | 51558 | 4011 | 53017 | 3292 | 53750 | 2198 | 65591 | 1552 | 46289 |
| 9L-4S | | MI | 21003 | 6648 | 34625 | 4809 | 37921 | 3880 | 39489 | 3167 | 41076 | 2075 | 49421 | 1670 | 31832 |
| 22-#11 | 2.23 | MA | 28707 | 6648 | 46233 | 4966 | 50295 | 4024 | 51505 | 3303 | 51699 | 2207 | 63003 | 1489 | 45154 |
| 10L-3S | | MI | 21429 | 6648 | 35369 | 4798 | 38866 | 3884 | 40636 | 3173 | 42526 | 2068 | 51044 | 1758 | 31865 |
| 22-#11 | 2.23 | MA | 28115 | 6648 | 45297 | 4966 | 49052 | 4022 | 49949 | 3301 | 49542 | 2202 | 60376 | 1433 | 44115 |
| 11L-2S | | MI | 22026 | 6648 | 36289 | 4801 | 40039 | 3875 | 42061 | 3165 | 44417 | 2061 | 53541 | 1847 | 31870 |

## RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

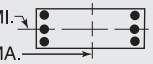
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 3.22 | MA | 33029 | 7187 | 55245 | 5267 | 61679 | 4242 | 65314 | 3419 | 70451 | 2150 | 88106 | 1541 | 68136 |
| 6L-7S | | MI | 20904 | 7187 | 35522 | 5133 | 38953 | 4125 | 40671 | 3311 | 42597 | 2018 | 52111 | 1202 | 42187 |
| 22-#14 | 3.22 | MA | 32250 | 7187 | 53751 | 5286 | 59858 | 4240 | 63082 | 3435 | 67453 | 2163 | 84028 | 1415 | 66442 |
| 7L-6S | | MI | 21406 | 7187 | 36468 | 5118 | 40106 | 4113 | 42134 | 3321 | 44421 | 2008 | 54258 | 1301 | 43290 |
| 22-#14 | 3.22 | MA | 31482 | 7187 | 52382 | 5286 | 58021 | 4258 | 60898 | 3451 | 64314 | 2156 | 80190 | 1340 | 64991 |
| 8L-5S | | MI | 21920 | 7187 | 37353 | 5123 | 41307 | 4120 | 43542 | 3311 | 46285 | 1998 | 56545 | 1386 | 43780 |
| 22-#14 | 3.22 | MA | 30668 | 7187 | 51038 | 5285 | 56226 | 4255 | 58638 | 3447 | 61348 | 2168 | 76391 | 1259 | 62868 |
| 9L-4S | | MI | 22458 | 7187 | 38290 | 5128 | 42513 | 4108 | 45016 | 3301 | 48316 | 2008 | 58993 | 1444 | 44798 |
| 22-#14 | 3.22 | MA | 29809 | 7187 | 49570 | 5305 | 54413 | 4273 | 56467 | 3463 | 58404 | 2181 | 72706 | 1168 | 60704 |
| 10L-3S | | MI | 23056 | 7187 | 39353 | 5113 | 43865 | 4115 | 46653 | 3311 | 50372 | 1998 | 61288 | 1571 | 45036 |
| 22-#18 | 5.73 | MA | 35333 | 8552 | 62782 | 6133 | 71004 | 4880 | 76623 | 3848 | 85514 | 2067 | 109619 | 635 | 104217 |
| 8L-5S | | MI | 25023 | 8552 | 45674 | 5934 | 51752 | 4712 | 55802 | 3635 | 62478 | 1803 | 77962 | 727 | 72535 |
| 24-#11 | 2.44 | MA | 31697 | 6759 | 51659 | 5008 | 57234 | 4051 | 59951 | 3302 | 63185 | 2177 | 78036 | 1736 | 53020 |
| 6L-8S | | MI | 19962 | 6759 | 33003 | 4880 | 35791 | 3939 | 36903 | 3213 | 37665 | 2078 | 45268 | 1413 | 33006 |
| 24-#11 | 2.44 | MA | 31145 | 6759 | 50618 | 5022 | 55966 | 4050 | 58396 | 3314 | 61096 | 2186 | 75173 | 1648 | 52467 |
| 7E | | MI | 20314 | 6759 | 33610 | 4883 | 36604 | 3944 | 37871 | 3206 | 38935 | 2072 | 46882 | 1460 | 33600 |
| 24-#11 | 2.44 | MA | 30600 | 6759 | 49664 | 5022 | 54686 | 4062 | 56874 | 3325 | 58909 | 2182 | 72484 | 1595 | 51492 |
| 8L-6S | | MI | 20670 | 6759 | 34272 | 4872 | 37411 | 3934 | 38895 | 3212 | 40221 | 2065 | 48570 | 1548 | 33861 |
| 24-#11 | 2.44 | MA | 30013 | 6759 | 48728 | 5022 | 53436 | 4061 | 55300 | 3323 | 56842 | 2191 | 69817 | 1540 | 50647 |
| 9L-5S | | MI | 21035 | 6759 | 34890 | 4875 | 38250 | 3939 | 39881 | 3205 | 41535 | 2058 | 50188 | 1607 | 34269 |
| 24-#11 | 2.44 | MA | 29411 | 6759 | 47705 | 5036 | 52173 | 4074 | 53787 | 3334 | 54792 | 2200 | 67228 | 1476 | 49479 |
| 10L-4S | | MI | 21416 | 6759 | 35545 | 4878 | 39093 | 3930 | 40914 | 3198 | 42967 | 2065 | 51918 | 1647 | 34611 |
| 24-#11 | 2.44 | MA | 28822 | 6759 | 46769 | 5036 | 50930 | 4073 | 52231 | 3332 | 52634 | 2196 | 64602 | 1421 | 48347 |
| 11L-3S | | MI | 21841 | 6759 | 36289 | 4867 | 40039 | 3934 | 42061 | 3204 | 44417 | 2058 | 53541 | 1736 | 34655 |
| 24-#11 | 2.44 | MA | 28244 | 6759 | 45763 | 5049 | 49675 | 4085 | 50723 | 3344 | 50587 | 2205 | 61710 | 1346 | 47005 |
| 12L-2S | | MI | 22435 | 6759 | 37208 | 4870 | 41211 | 3925 | 43486 | 3197 | 46307 | 2051 | 56038 | 1824 | 34673 |
| 24-#14 | 3.52 | MA | 33226 | 7346 | 55861 | 5386 | 62548 | 4312 | 66352 | 3480 | 71884 | 2153 | 90049 | 1396 | 72640 |
| 7E | | MI | 21490 | 7346 | 36834 | 5233 | 40625 | 4198 | 42702 | 3355 | 45279 | 2003 | 55642 | 1167 | 45996 |
| 24-#14 | 3.52 | MA | 32463 | 7346 | 54492 | 5385 | 60711 | 4330 | 64168 | 3496 | 68744 | 2146 | 86212 | 1321 | 71158 |
| 8L-6S | | MI | 21989 | 7346 | 37780 | 5218 | 41779 | 4185 | 44164 | 3365 | 47102 | 1993 | 57789 | 1265 | 47057 |
| 24-#14 | 3.52 | MA | 31650 | 7346 | 53148 | 5385 | 58916 | 4328 | 61908 | 3492 | 65778 | 2158 | 82413 | 1240 | 69055 |
| 9L-5S | | MI | 22500 | 7346 | 38665 | 5223 | 42980 | 4193 | 45572 | 3355 | 48966 | 1983 | 60075 | 1351 | 47637 |
| 24-#14 | 3.52 | MA | 30802 | 7346 | 51680 | 5404 | 57103 | 4345 | 59737 | 3508 | 62834 | 2171 | 78728 | 1149 | 66858 |
| 10L-4S | | MI | 23035 | 7346 | 39601 | 5228 | 44186 | 4180 | 47046 | 3345 | 50997 | 1993 | 62524 | 1408 | 48607 |

## RECTANGULAR TIED COLUMNS 34" x 34"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#14 | 1.17 | MA | 15876 | 4566 | 25157 | 3342 | 27106 | 2721 | 27669 | 2261 | 27615 | 1592 | 32384 | 1483 | 13666 |
| 2L-3S | | MI | 14940 | 4566 | 23745 | 3338 | 25306 | 2734 | 25481 | 2272 | 24709 | 1602 | 28543 | 1355 | 13727 |
| 6-#18 | 2.08 | MA | 17260 | 4939 | 28388 | 3548 | 31105 | 2867 | 32419 | 2342 | 33821 | 1532 | 40456 | 1368 | 23474 |
| 2L-3S | | MI | 15661 | 4939 | 25928 | 3538 | 27969 | 2888 | 28629 | 2360 | 28816 | 1550 | 33880 | 1141 | 23418 |
| 8-#11 | 1.08 | MA | 15759 | 4530 | 24831 | 3334 | 26752 | 2716 | 27261 | 2261 | 27128 | 1606 | 31779 | 1504 | 12732 |
| 2L-4S | | MI | 14631 | 4530 | 23044 | 3343 | 24476 | 2721 | 24497 | 2263 | 23512 | 1620 | 27300 | 1326 | 12803 |
| 8-#14 | 1.56 | MA | 16520 | 4726 | 26569 | 3442 | 28906 | 2793 | 29857 | 2306 | 30521 | 1578 | 36225 | 1451 | 18006 |
| 2L-4S | | MI | 14927 | 4726 | 24015 | 3454 | 25655 | 2800 | 25908 | 2308 | 25386 | 1598 | 29886 | 1195 | 17969 |
| 8-#18 | 2.77 | MA | 18343 | 5222 | 30848 | 3725 | 34241 | 2995 | 36209 | 2420 | 38826 | 1503 | 47032 | 1302 | 30977 |
| 2L-4S | | MI | 15632 | 5222 | 26391 | 3741 | 28567 | 3002 | 29362 | 2420 | 29983 | 1538 | 36176 | 851 | 28669 |
| 10-#11 | 1.35 | MA | 16214 | 4641 | 25819 | 3403 | 28012 | 2766 | 28793 | 2292 | 29175 | 1597 | 34492 | 1483 | 15773 |
| 2L-5S | | MI | 14674 | 4641 | 23331 | 3409 | 24833 | 2781 | 24923 | 2303 | 24009 | 1604 | 28140 | 1265 | 15681 |
| 10-#11 | 1.35 | MA | 15560 | 4641 | 24831 | 3400 | 26752 | 2775 | 27261 | 2300 | 27128 | 1604 | 31779 | 1394 | 15805 |
| 3L-4S | | MI | 15094 | 4641 | 24032 | 3412 | 25737 | 2771 | 26030 | 2294 | 25558 | 1611 | 30012 | 1306 | 15807 |
| 10-#14 | 1.95 | MA | 17157 | 4886 | 27980 | 3542 | 30706 | 2865 | 32045 | 2351 | 33427 | 1564 | 40065 | 1418 | 22328 |
| 2L-5S | | MI | 14986 | 4886 | 24423 | 3550 | 26160 | 2885 | 26511 | 2364 | 26091 | 1574 | 31068 | 1104 | 21154 |
| 10-#14 | 1.95 | MA | 16236 | 4886 | 26569 | 3538 | 28906 | 2879 | 29857 | 2362 | 30521 | 1574 | 36225 | 1290 | 22325 |
| 3L-4S | | MI | 15578 | 4886 | 25427 | 3554 | 27454 | 2872 | 28096 | 2353 | 28292 | 1584 | 33727 | 1162 | 22211 |
| 10-#18 | 3.46 | MA | 19411 | 5506 | 33307 | 3902 | 37377 | 3124 | 39999 | 2498 | 43832 | 1474 | 53608 | 1236 | 38438 |
| 2L-5S | | MI | 15729 | 5506 | 27093 | 3909 | 29438 | 3151 | 30401 | 2516 | 31196 | 1491 | 38193 | 682 | 33714 |
| 10-#18 | 3.46 | MA | 17851 | 5506 | 30848 | 3893 | 34241 | 3145 | 36209 | 2516 | 38826 | 1491 | 47032 | 1009 | 38184 |
| 3L-4S | | MI | 16734 | 5506 | 28851 | 3919 | 31703 | 3130 | 33152 | 2498 | 34988 | 1509 | 42753 | 785 | 35681 |

## RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

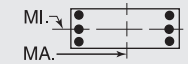
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.31 | MA | 18027 | 4895 | 28768 | 3566 | 31056 | 2899 | 31812 | 2403 | 31955 | 1671 | 37585 | 1546 | 17004 |
| 2E | | MI | 16980 | 4895 | 27164 | 3548 | 29245 | 2884 | 29867 | 2388 | 29922 | 1656 | 35099 | 1526 | 15968 |
| 6-#14 | 1.10 | MA | 17715 | 4807 | 27933 | 3538 | 30121 | 2881 | 30723 | 2398 | 30635 | 1701 | 35927 | 1592 | 14577 |
| 2L-3S | | MI | 15758 | 4807 | 24976 | 3517 | 26583 | 2881 | 26723 | 2397 | 25820 | 1698 | 29771 | 1448 | 13767 |
| 6-#14 | 1.10 | MA | 16710 | 4807 | 26421 | 3534 | 28194 | 2895 | 28380 | 2410 | 27504 | 1711 | 31776 | 1464 | 14638 |
| 3L-2S | | MI | 16695 | 4807 | 26388 | 3521 | 28383 | 2868 | 28911 | 2386 | 28726 | 1688 | 33611 | 1576 | 13701 |
| 6-#18 | 1.96 | MA | 19217 | 5179 | 31405 | 3743 | 34418 | 3027 | 35898 | 2483 | 37360 | 1645 | 44711 | 1485 | 25094 |
| 2L-3S | | MI | 16480 | 5179 | 27164 | 3716 | 29245 | 3034 | 29867 | 2484 | 29922 | 1645 | 35099 | 1233 | 23500 |
| 6-#18 | 1.96 | MA | 17498 | 5179 | 28768 | 3735 | 31056 | 3050 | 31812 | 2501 | 31955 | 1662 | 37585 | 1257 | 25038 |
| 3L-2S | | MI | 18082 | 5179 | 29624 | 3725 | 32381 | 3013 | 33657 | 2466 | 34927 | 1627 | 41675 | 1460 | 23526 |
| 8-#11 | 1.02 | MA | 17587 | 4771 | 27580 | 3529 | 29737 | 2876 | 30281 | 2397 | 30101 | 1714 | 35256 | 1612 | 13574 |
| 2L-4S | | MI | 15449 | 4771 | 24272 | 3522 | 25753 | 2869 | 25741 | 2389 | 24626 | 1716 | 28531 | 1420 | 12845 |
| 8-#11 | 1.02 | MA | 16881 | 4771 | 26522 | 3527 | 28388 | 2887 | 28641 | 2406 | 27898 | 1721 | 32328 | 1523 | 13618 |
| 3E | | MI | 15919 | 4771 | 25070 | 3511 | 26768 | 2873 | 26972 | 2395 | 26196 | 1709 | 30298 | 1508 | 12809 |
| 8-#11 | 1.02 | MA | 16379 | 4771 | 25669 | 3539 | 27304 | 2883 | 27326 | 2401 | 26208 | 1728 | 30417 | 1435 | 13645 |
| 4L-2S | | MI | 16578 | 4771 | 26059 | 3513 | 28029 | 2863 | 28504 | 2386 | 28243 | 1703 | 33010 | 1597 | 12763 |
| 8-#14 | 1.47 | MA | 18410 | 4966 | 29444 | 3637 | 32048 | 2954 | 33065 | 2443 | 33767 | 1688 | 40078 | 1562 | 19221 |
| 2L-4S | | MI | 15745 | 4966 | 25246 | 3633 | 26931 | 2947 | 27149 | 2433 | 26497 | 1694 | 31113 | 1287 | 18041 |
| 8-#14 | 1.47 | MA | 17413 | 4966 | 27933 | 3634 | 30121 | 2968 | 30723 | 2455 | 30635 | 1698 | 35927 | 1434 | 19254 |
| 3E | | MI | 16410 | 4966 | 26388 | 3617 | 28383 | 2953 | 28911 | 2442 | 28726 | 1684 | 33611 | 1415 | 18087 |
| 8-#14 | 1.47 | MA | 16703 | 4966 | 26713 | 3651 | 28569 | 2962 | 28840 | 2446 | 28234 | 1708 | 33222 | 1306 | 19184 |
| 4L-2S | | MI | 17340 | 4966 | 27799 | 3621 | 30183 | 2940 | 31099 | 2431 | 31633 | 1674 | 37452 | 1543 | 18046 |
| 8-#18 | 2.61 | MA | 20388 | 5463 | 34042 | 3920 | 37780 | 3156 | 39985 | 2563 | 42765 | 1618 | 51838 | 1424 | 33137 |
| 2L-4S | | MI | 16450 | 5463 | 27627 | 3919 | 29844 | 3148 | 30600 | 2544 | 31089 | 1633 | 37396 | 943 | 29010 |
| 8-#18 | 2.61 | MA | 18690 | 5463 | 31405 | 3912 | 34418 | 3179 | 35898 | 2581 | 37360 | 1636 | 44711 | 1197 | 32970 |
| 3E | | MI | 17585 | 5463 | 29624 | 3893 | 32381 | 3162 | 33657 | 2562 | 34927 | 1616 | 41675 | 1167 | 30904 |
| 8-#18 | 2.61 | MA | 17477 | 5463 | 29269 | 3940 | 31703 | 3166 | 32604 | 2564 | 33215 | 1653 | 40081 | 969 | 30938 |
| 4L-2S | | MI | 19168 | 5463 | 32083 | 3902 | 35517 | 3141 | 37447 | 2544 | 39933 | 1598 | 48251 | 1394 | 31039 |
| 10-#11 | 1.27 | MA | 18078 | 4881 | 28637 | 3598 | 31085 | 2926 | 31920 | 2428 | 32304 | 1706 | 38184 | 1593 | 16826 |
| 2L-5S | | MI | 15492 | 4881 | 24559 | 3589 | 26110 | 2929 | 26166 | 2428 | 25123 | 1701 | 29371 | 1358 | 15809 |
| 10-#11 | 1.27 | MA | 17376 | 4881 | 27580 | 3596 | 29737 | 2937 | 30281 | 2437 | 30101 | 1713 | 35256 | 1504 | 16858 |
| 3L-4S | | MI | 15912 | 4881 | 25260 | 3592 | 27014 | 2919 | 27273 | 2420 | 26673 | 1707 | 31243 | 1399 | 15857 |
| 10-#11 | 1.27 | MA | 16878 | 4881 | 26727 | 3608 | 28653 | 2933 | 28965 | 2432 | 28411 | 1720 | 33346 | 1415 | 16860 |
| 4L-3S | | MI | 16379 | 4881 | 26059 | 3580 | 28029 | 2923 | 28504 | 2426 | 28243 | 1701 | 33010 | 1488 | 15843 |
| 10-#11 | 1.27 | MA | 16430 | 4881 | 25979 | 3606 | 27687 | 2944 | 27784 | 2441 | 26744 | 1713 | 31330 | 1374 | 16793 |
| 5L-2S | | MI | 17034 | 4881 | 27047 | 3583 | 29289 | 2914 | 30036 | 2417 | 30289 | 1694 | 35723 | 1576 | 15808 |
| 10-#14 | 1.84 | MA | 19098 | 5126 | 30956 | 3737 | 33975 | 3026 | 35408 | 2488 | 36898 | 1676 | 44229 | 1532 | 23846 |
| 2L-5S | | MI | 15803 | 5126 | 25653 | 3729 | 27437 | 3033 | 27753 | 2489 | 27203 | 1670 | 32296 | 1197 | 21357 |
| 10-#14 | 1.84 | MA | 18109 | 5126 | 29444 | 3734 | 32048 | 3040 | 33065 | 2499 | 33767 | 1685 | 40078 | 1405 | 23844 |
| 3L-4S | | MI | 16396 | 5126 | 26658 | 3733 | 28731 | 3019 | 29337 | 2478 | 29404 | 1680 | 34954 | 1255 | 22291 |
| 10-#14 | 1.84 | MA | 17405 | 5126 | 28224 | 3750 | 30496 | 3034 | 31183 | 2491 | 31365 | 1695 | 37373 | 1277 | 23729 |
| 4L-3S | | MI | 17056 | 5126 | 27799 | 3717 | 30183 | 3026 | 31099 | 2487 | 31633 | 1670 | 37452 | 1383 | 22381 |
| 10-#14 | 1.84 | MA | 16772 | 5126 | 27152 | 3747 | 29114 | 3049 | 29491 | 2503 | 28995 | 1685 | 34508 | 1217 | 22714 |
| 5L-2S | | MI | 17979 | 5126 | 29211 | 3721 | 31983 | 3012 | 33286 | 2476 | 34539 | 1660 | 41292 | 1511 | 22372 |
| 10-#18 | 3.27 | MA | 21543 | 5747 | 36679 | 4098 | 41142 | 3284 | 44072 | 2643 | 48170 | 1592 | 58965 | 1363 | 41138 |
| 2L-5S | | MI | 16544 | 5747 | 28329 | 4087 | 30714 | 3297 | 31640 | 2640 | 32302 | 1587 | 39412 | 774 | 34262 |
| 10-#18 | 3.27 | MA | 19865 | 5747 | 34042 | 4090 | 37780 | 3307 | 39985 | 2661 | 42765 | 1609 | 51838 | 1136 | 40884 |
| 3L-4S | | MI | 17554 | 5747 | 30087 | 4096 | 32980 | 3276 | 34390 | 2622 | 36094 | 1604 | 43972 | 877 | 36013 |
| 10-#18 | 3.27 | MA | 18668 | 5747 | 31906 | 4117 | 35065 | 3295 | 36691 | 2644 | 38620 | 1627 | 47208 | 909 | 38465 |
| 4L-3S | | MI | 18675 | 5747 | 32083 | 4070 | 35517 | 3291 | 37447 | 2640 | 39933 | 1587 | 48251 | 1101 | 38287 |
| 10-#18 | 3.27 | MA | 17591 | 5747 | 30027 | 4109 | 32643 | 3317 | 33726 | 2662 | 34526 | 1609 | 42266 | 807 | 36570 |
| 5L-2S | | MI | 20240 | 5747 | 34543 | 4080 | 38653 | 3270 | 41237 | 2622 | 44938 | 1569 | 54828 | 1328 | 38507 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.53 | MA | 18565 | 4992 | 29695 | 3667 | 32434 | 2977 | 33559 | 2459 | 34507 | 1698 | 41112 | 1574 | 20067 |
| 2L-6S | | MI | 15555 | 4992 | 24885 | 3656 | 26471 | 2975 | 26601 | 2454 | 25747 | 1699 | 30324 | 1278 | 18147 |
| 12-#11 | 1.53 | MA | 17868 | 4992 | 28637 | 3665 | 31085 | 2987 | 31920 | 2468 | 32304 | 1705 | 38184 | 1485 | 20087 |
| 3L-5S | | MI | 15954 | 4992 | 25548 | 3658 | 27370 | 2979 | 27698 | 2459 | 27170 | 1692 | 32083 | 1337 | 18703 |
| 12-#11 | 1.53 | MA | 17372 | 4992 | 27785 | 3677 | 30001 | 2983 | 30605 | 2463 | 30614 | 1712 | 36274 | 1396 | 20064 |
| 4E | | MI | 16371 | 4992 | 26249 | 3661 | 28274 | 2970 | 28805 | 2451 | 28719 | 1699 | 33956 | 1378 | 18856 |
| 12-#11 | 1.53 | MA | 16927 | 4992 | 27036 | 3675 | 29036 | 2994 | 29423 | 2472 | 28947 | 1705 | 34258 | 1354 | 19893 |
| 5L-3S | | MI | 16836 | 4992 | 27047 | 3649 | 29289 | 2974 | 30036 | 2457 | 30289 | 1692 | 35723 | 1467 | 18865 |
| 12-#11 | 1.53 | MA | 16502 | 4992 | 26329 | 3673 | 28076 | 2990 | 28253 | 2467 | 27415 | 1712 | 32357 | 1296 | 19278 |
| 6L-2S | | MI | 17487 | 4992 | 28036 | 3652 | 30549 | 2964 | 31568 | 2449 | 32336 | 1685 | 38435 | 1556 | 18841 |
| 12-#14 | 2.21 | MA | 19780 | 5286 | 32467 | 3837 | 35902 | 3098 | 37751 | 2532 | 40029 | 1663 | 48380 | 1503 | 28460 |
| 2L-6S | | MI | 15891 | 5286 | 26116 | 3824 | 27949 | 3098 | 28427 | 2545 | 28089 | 1666 | 33647 | 1079 | 24790 |
| 12-#14 | 2.21 | MA | 18798 | 5286 | 30956 | 3834 | 33975 | 3112 | 35408 | 2544 | 36898 | 1673 | 44229 | 1375 | 28420 |
| 3L-5S | | MI | 16453 | 5286 | 27065 | 3828 | 29237 | 3105 | 29941 | 2534 | 30109 | 1656 | 36136 | 1165 | 25455 |
| 12-#14 | 2.21 | MA | 18100 | 5286 | 29736 | 3850 | 32423 | 3107 | 33526 | 2536 | 34496 | 1683 | 41524 | 1247 | 28268 |
| 4E | | MI | 17041 | 5286 | 28069 | 3832 | 30531 | 3092 | 31525 | 2523 | 32310 | 1666 | 38794 | 1223 | 26532 |
| 12-#14 | 2.21 | MA | 17472 | 5286 | 28663 | 3847 | 31041 | 3121 | 31833 | 2548 | 32126 | 1673 | 38660 | 1188 | 27108 |
| 5L-3S | | MI | 17696 | 5286 | 29211 | 3817 | 31983 | 3098 | 33286 | 2532 | 34539 | 1656 | 41292 | 1351 | 26660 |
| 12-#14 | 2.21 | MA | 16873 | 5286 | 27651 | 3844 | 29667 | 3115 | 30157 | 2540 | 29949 | 1683 | 35966 | 1102 | 26366 |
| 6L-2S | | MI | 18612 | 5286 | 30623 | 3821 | 33783 | 3085 | 35474 | 2521 | 37445 | 1646 | 45133 | 1479 | 26684 |
| 12-#18 | 3.92 | MA | 21026 | 6030 | 36679 | 4267 | 41142 | 3436 | 44072 | 2741 | 48170 | 1583 | 58965 | 1075 | 48786 |
| 3L-5S | | MI | 17647 | 6030 | 30788 | 4264 | 33850 | 3426 | 35430 | 2718 | 37307 | 1557 | 45988 | 709 | 41131 |
| 12-#18 | 3.92 | MA | 19843 | 6030 | 34543 | 4294 | 38427 | 3423 | 40778 | 2724 | 44024 | 1600 | 54335 | 848 | 46037 |
| 4E | | MI | 18644 | 6030 | 32547 | 4273 | 36116 | 3405 | 38180 | 2701 | 41099 | 1575 | 50548 | 811 | 43061 |
| 12-#18 | 3.92 | MA | 18780 | 6030 | 32664 | 4286 | 36005 | 3446 | 37813 | 2742 | 39931 | 1583 | 49393 | 746 | 43981 |
| 5L-3S | | MI | 19752 | 6030 | 34543 | 4247 | 38653 | 3419 | 41237 | 2718 | 44938 | 1557 | 54828 | 1035 | 45657 |
| 12-#18 | 3.92 | MA | 17766 | 6030 | 30887 | 4278 | 33595 | 3433 | 34981 | 2760 | 36174 | 1600 | 44776 | 594 | 40888 |
| 6L-2S | | MI | 21300 | 6030 | 37003 | 4257 | 41789 | 3398 | 45027 | 2701 | 49943 | 1540 | 61404 | 1262 | 45953 |
| 14-#11 | 1.78 | MA | 19049 | 5103 | 30753 | 3736 | 33782 | 3027 | 35199 | 2491 | 36709 | 1690 | 44040 | 1555 | 23301 |
| 2L-7S | | MI | 15630 | 5103 | 25164 | 3737 | 26867 | 3035 | 27075 | 2493 | 26401 | 1696 | 31202 | 1169 | 20682 |
| 14-#11 | 1.78 | MA | 18355 | 5103 | 29695 | 3735 | 32434 | 3037 | 33559 | 2499 | 34507 | 1697 | 41112 | 1466 | 23304 |
| 3L-6S | | MI | 16016 | 5103 | 25873 | 3725 | 27731 | 3025 | 28133 | 2485 | 27794 | 1690 | 33036 | 1257 | 21051 |
| 14-#11 | 1.78 | MA | 17863 | 5103 | 28843 | 3746 | 31350 | 3034 | 32244 | 2494 | 32817 | 1704 | 39202 | 1377 | 23262 |
| 4L-5S | | MI | 16412 | 5103 | 26536 | 3728 | 28630 | 3029 | 29230 | 2490 | 29217 | 1683 | 34796 | 1316 | 21574 |
| 14-#11 | 1.78 | MA | 17421 | 5103 | 28094 | 3745 | 30385 | 3044 | 31062 | 2503 | 31149 | 1697 | 37186 | 1335 | 22969 |
| 5L-4S | | MI | 16827 | 5103 | 27238 | 3730 | 29534 | 3020 | 30337 | 2482 | 30766 | 1690 | 36668 | 1357 | 21847 |
| 14-#11 | 1.78 | MA | 16999 | 5103 | 27387 | 3743 | 29425 | 3040 | 29892 | 2498 | 29618 | 1704 | 35285 | 1276 | 22387 |
| 6L-3S | | MI | 17289 | 5103 | 28036 | 3719 | 30549 | 3024 | 31568 | 2488 | 32336 | 1683 | 38435 | 1446 | 21880 |
| 14-#11 | 1.78 | MA | 16587 | 5103 | 26631 | 3755 | 28503 | 3051 | 28762 | 2507 | 28119 | 1711 | 33304 | 1189 | 21982 |
| 7L-2S | | MI | 17936 | 5103 | 29024 | 3721 | 31810 | 3014 | 33101 | 2480 | 34383 | 1676 | 41148 | 1535 | 21866 |
| 14-#14 | 2.57 | MA | 20456 | 5445 | 33979 | 3937 | 37829 | 3171 | 40093 | 2577 | 43161 | 1650 | 52532 | 1473 | 33054 |
| 2L-7S | | MI | 15996 | 5445 | 26513 | 3940 | 28512 | 3184 | 29043 | 2580 | 29018 | 1662 | 34891 | 920 | 27594 |
| 14-#14 | 2.57 | MA | 19481 | 5445 | 32467 | 3933 | 35902 | 3185 | 37751 | 2589 | 40029 | 1660 | 48380 | 1345 | 32988 |
| 3L-6S | | MI | 16540 | 5445 | 27528 | 3924 | 29749 | 3171 | 30615 | 2589 | 30995 | 1652 | 37487 | 1047 | 28867 |
| 14-#14 | 2.57 | MA | 18788 | 5445 | 31247 | 3950 | 34350 | 3179 | 35868 | 2581 | 37627 | 1670 | 45675 | 1217 | 32801 |
| 4L-5S | | MI | 17097 | 5445 | 28477 | 3928 | 31037 | 3177 | 32129 | 2579 | 33015 | 1642 | 39977 | 1132 | 29568 |
| 14-#14 | 2.57 | MA | 18166 | 5445 | 30175 | 3947 | 32968 | 3193 | 34176 | 2593 | 35257 | 1660 | 42811 | 1158 | 31517 |
| 5L-4S | | MI | 17681 | 5445 | 29481 | 3932 | 32331 | 3164 | 33713 | 2568 | 35216 | 1652 | 42635 | 1190 | 30767 |
| 14-#14 | 2.57 | MA | 17572 | 5445 | 29162 | 3943 | 31594 | 3188 | 32500 | 2585 | 33080 | 1670 | 40117 | 1073 | 30766 |
| 6L-3S | | MI | 18330 | 5445 | 30623 | 3916 | 33783 | 3170 | 35474 | 2577 | 37445 | 1642 | 45133 | 1318 | 30928 |
| 14-#14 | 2.57 | MA | 16993 | 5445 | 28078 | 3960 | 30273 | 3202 | 30882 | 2597 | 30950 | 1680 | 37311 | 946 | 29365 |
| 7L-2S | | MI | 19240 | 5445 | 32035 | 3920 | 35582 | 3157 | 37662 | 2566 | 40351 | 1632 | 48974 | 1446 | 30982 |
| 14-#18 | 4.58 | MA | 21005 | 6314 | 37180 | 4472 | 41789 | 3552 | 44865 | 2803 | 49429 | 1574 | 61462 | 787 | 53644 |
| 4L-5S | | MI | 18736 | 6314 | 33248 | 4441 | 36986 | 3555 | 39219 | 2796 | 42313 | 1528 | 52564 | 643 | 48038 |
| 14-#18 | 4.58 | MA | 19955 | 6314 | 35301 | 4464 | 39367 | 3574 | 41900 | 2821 | 45336 | 1556 | 56520 | 685 | 51415 |
| 5L-4S | | MI | 19722 | 6314 | 35006 | 4451 | 39251 | 3534 | 41970 | 2779 | 46105 | 1546 | 57124 | 745 | 50144 |
| 14-#18 | 4.58 | MA | 18953 | 6314 | 33524 | 4456 | 36957 | 3562 | 39068 | 2839 | 41579 | 1574 | 51902 | 533 | 48461 |
| 6L-3S | | MI | 20817 | 6314 | 37003 | 4425 | 41789 | 3548 | 45027 | 2796 | 49943 | 1528 | 61404 | 969 | 53018 |

## RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

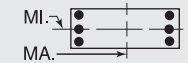
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.04 | MA | 19530 | 5213 | 31811 | 3806 | 35131 | 3077 | 36838 | 2522 | 38912 | 1682 | 46969 | 1535 | 26528 |
| 2L-8S | | MI | 15711 | 5213 | 25502 | 3803 | 27255 | 3081 | 27570 | 2532 | 26989 | 1681 | 32166 | 1100 | 22844 |
| 16-#11 | 2.04 | MA | 18840 | 5213 | 30753 | 3804 | 33782 | 3087 | 35199 | 2531 | 36709 | 1689 | 44040 | 1447 | 26514 |
| 3L-7S | | MI | 16090 | 5213 | 26153 | 3806 | 28127 | 3085 | 28607 | 2524 | 28448 | 1688 | 33915 | 1148 | 23527 |
| 16-#11 | 2.04 | MA | 18350 | 5213 | 29900 | 3816 | 32698 | 3084 | 33883 | 2526 | 35019 | 1696 | 42130 | 1358 | 26455 |
| 4L-6S | | MI | 16474 | 5213 | 26862 | 3794 | 28991 | 3076 | 29665 | 2516 | 29841 | 1681 | 35748 | 1236 | 23960 |
| 16-#11 | 2.04 | MA | 17911 | 5213 | 29152 | 3814 | 31733 | 3094 | 32702 | 2534 | 33352 | 1689 | 40114 | 1316 | 26055 |
| 5E | | MI | 16868 | 5213 | 27525 | 3797 | 29891 | 3080 | 30762 | 2522 | 31263 | 1674 | 37508 | 1295 | 24456 |
| 16-#11 | 2.04 | MA | 17492 | 5213 | 28445 | 3812 | 30773 | 3091 | 31531 | 2529 | 31821 | 1696 | 38213 | 1257 | 25502 |
| 6L-4S | | MI | 17280 | 5213 | 28226 | 3799 | 30795 | 3070 | 31869 | 2513 | 32813 | 1681 | 39381 | 1336 | 24834 |
| 16-#11 | 2.04 | MA | 17082 | 5213 | 27688 | 3824 | 29851 | 3101 | 30402 | 2538 | 30322 | 1703 | 36232 | 1169 | 25033 |
| 7L-3S | | MI | 17739 | 5213 | 29024 | 3788 | 31810 | 3074 | 33101 | 2519 | 34383 | 1674 | 41148 | 1425 | 24881 |
| 16-#11 | 2.04 | MA | 16679 | 5213 | 26994 | 3822 | 28921 | 3098 | 29295 | 2547 | 28752 | 1696 | 34350 | 1121 | 24281 |
| 8L-2S | | MI | 18383 | 5213 | 30013 | 3790 | 33070 | 3064 | 34633 | 2511 | 36429 | 1667 | 43860 | 1514 | 24886 |
| 16-#14 | 2.94 | MA | 20158 | 5605 | 33979 | 4033 | 37829 | 3257 | 40093 | 2634 | 43161 | 1647 | 52532 | 1315 | 37548 |
| 3L-7S | | MI | 16644 | 5605 | 27924 | 4040 | 30312 | 3256 | 31231 | 2625 | 31924 | 1648 | 38732 | 888 | 31675 |
| 16-#14 | 2.94 | MA | 19471 | 5605 | 32758 | 4050 | 36277 | 3251 | 38211 | 2626 | 40759 | 1657 | 49827 | 1187 | 37227 |
| 4L-6S | | MI | 17183 | 5605 | 28940 | 4024 | 31549 | 3243 | 32803 | 2634 | 33901 | 1638 | 41328 | 1015 | 32896 |
| 16-#14 | 2.94 | MA | 18854 | 5605 | 31686 | 4046 | 34895 | 3266 | 36518 | 2638 | 38388 | 1647 | 46962 | 1128 | 35939 |
| 5E | | MI | 17736 | 5605 | 29889 | 4028 | 32836 | 3250 | 34317 | 2623 | 35922 | 1628 | 43818 | 1100 | 33694 |
| 16-#14 | 2.94 | MA | 18265 | 5605 | 30674 | 4043 | 33521 | 3260 | 34842 | 2630 | 36212 | 1657 | 44269 | 1043 | 35091 |
| 6L-4S | | MI | 18315 | 5605 | 30893 | 4032 | 34131 | 3236 | 35901 | 2613 | 38122 | 1638 | 46476 | 1158 | 34852 |
| 16-#14 | 2.94 | MA | 17691 | 5605 | 29590 | 4060 | 32200 | 3274 | 33224 | 2642 | 34081 | 1667 | 41462 | 916 | 33745 |
| 7L-3S | | MI | 18959 | 5605 | 32035 | 4016 | 35582 | 3243 | 37662 | 2622 | 40351 | 1628 | 48974 | 1286 | 35189 |
| 16-#14 | 2.94 | MA | 17124 | 5605 | 28595 | 4056 | 30867 | 3268 | 31639 | 2654 | 31848 | 1657 | 38787 | 847 | 32359 |
| 8L-2S | | MI | 19863 | 5605 | 33446 | 4020 | 37382 | 3229 | 39850 | 2611 | 43257 | 1618 | 52814 | 1414 | 35267 |
| 16-#18 | 5.23 | MA | 21117 | 6598 | 37938 | 4641 | 42729 | 3703 | 45987 | 2901 | 50741 | 1530 | 63647 | 625 | 58881 |
| 5E | | MI | 19814 | 6598 | 35708 | 4619 | 40122 | 3683 | 43009 | 2875 | 47318 | 1499 | 59140 | 577 | 54978 |
| 16-#18 | 5.23 | MA | 20127 | 6598 | 36161 | 4633 | 40319 | 3690 | 43155 | 2919 | 46984 | 1547 | 59029 | 473 | 56059 |
| 6L-4S | | MI | 20789 | 6598 | 37466 | 4628 | 42387 | 3662 | 45760 | 2857 | 51110 | 1517 | 63701 | 679 | 57256 |
| 18-#11 | 2.29 | MA | 19321 | 5324 | 31811 | 3873 | 35131 | 3137 | 36838 | 2562 | 38912 | 1681 | 46969 | 1428 | 29719 |
| 3L-8S | | MI | 16171 | 5324 | 26491 | 3873 | 28515 | 3132 | 29102 | 2563 | 29035 | 1672 | 34879 | 1080 | 25723 |
| 18-#11 | 2.29 | MA | 18834 | 5324 | 30958 | 3885 | 34047 | 3134 | 35523 | 2557 | 37222 | 1688 | 45058 | 1339 | 29644 |
| 4L-7S | | MI | 16547 | 5324 | 27142 | 3875 | 29387 | 3136 | 30139 | 2555 | 30495 | 1679 | 36627 | 1128 | 26380 |
| 18-#11 | 2.29 | MA | 18398 | 5324 | 30210 | 3883 | 33082 | 3144 | 34341 | 2566 | 35555 | 1681 | 43042 | 1297 | 29149 |
| 5L-6S | | MI | 16929 | 5324 | 27851 | 3864 | 30252 | 3126 | 31198 | 2547 | 31887 | 1672 | 38461 | 1216 | 26875 |
| 18-#11 | 2.29 | MA | 17981 | 5324 | 29503 | 3881 | 32122 | 3141 | 33171 | 2561 | 34024 | 1688 | 41141 | 1238 | 28622 |
| 6L-5S | | MI | 17320 | 5324 | 28513 | 3866 | 31151 | 3130 | 32294 | 2553 | 33310 | 1665 | 40221 | 1275 | 27346 |
| 18-#11 | 2.29 | MA | 17574 | 5324 | 28746 | 3893 | 31200 | 3151 | 32041 | 2569 | 32525 | 1695 | 39160 | 1150 | 28092 |
| 7L-4S | | MI | 17730 | 5324 | 29215 | 3868 | 32055 | 3120 | 33401 | 2545 | 34859 | 1672 | 42093 | 1315 | 27816 |
| 18-#11 | 2.29 | MA | 17173 | 5324 | 28052 | 3891 | 30269 | 3148 | 30935 | 2578 | 30954 | 1688 | 37278 | 1101 | 27367 |
| 8L-3S | | MI | 18186 | 5324 | 30013 | 3857 | 33070 | 3124 | 34633 | 2550 | 36429 | 1665 | 43860 | 1404 | 27878 |
| 18-#11 | 2.29 | MA | 16776 | 5324 | 27317 | 3903 | 29360 | 3158 | 29790 | 2573 | 29471 | 1695 | 35436 | 1045 | 26588 |
| 9L-2S | | MI | 18827 | 5324 | 31001 | 3859 | 34330 | 3114 | 36165 | 2542 | 38476 | 1658 | 46573 | 1493 | 27900 |
| 18-#14 | 3.31 | MA | 20148 | 5764 | 34270 | 4149 | 38204 | 3324 | 40553 | 2671 | 43890 | 1644 | 53978 | 1157 | 41594 |
| 4L-7S | | MI | 17286 | 5764 | 29336 | 4140 | 32111 | 3329 | 33419 | 2670 | 34830 | 1634 | 42573 | 855 | 35767 |
| 18-#14 | 3.31 | MA | 19536 | 5764 | 33198 | 4146 | 36822 | 3338 | 38861 | 2683 | 41520 | 1635 | 51113 | 1098 | 40371 |
| 5L-6S | | MI | 17821 | 5764 | 30351 | 4124 | 33349 | 3315 | 34991 | 2679 | 36807 | 1624 | 45168 | 982 | 36938 |
| 18-#14 | 3.31 | MA | 18952 | 5764 | 32185 | 4143 | 35448 | 3332 | 37185 | 2675 | 39343 | 1644 | 48420 | 1013 | 39430 |
| 6L-5S | | MI | 18370 | 5764 | 31300 | 4128 | 34636 | 3322 | 36504 | 2668 | 38828 | 1614 | 47658 | 1068 | 37829 |
| 18-#14 | 3.31 | MA | 18382 | 5764 | 31101 | 4159 | 34127 | 3346 | 35567 | 2687 | 37213 | 1654 | 45613 | 886 | 38135 |
| 7L-4S | | MI | 18944 | 5764 | 32304 | 4132 | 35931 | 3309 | 38089 | 2658 | 41028 | 1624 | 50316 | 1126 | 38926 |
| 18-#14 | 3.31 | MA | 17820 | 5764 | 30106 | 4156 | 32794 | 3341 | 33982 | 2699 | 34980 | 1644 | 42938 | 817 | 36694 |
| 8L-3S | | MI | 19584 | 5764 | 33446 | 4116 | 37382 | 3315 | 39850 | 2667 | 43257 | 1614 | 52814 | 1253 | 39445 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis

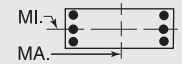



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 5.88 | MA | 21289 | 6881 | 38798 | 4810 | 43681 | 3819 | 47242 | 2999 | 52388 | 1521 | 66156 | 412 | 63678 |
| 6L-5S | | MI | 20883 | 6881 | 38168 | 4796 | 43258 | 3812 | 46799 | 2953 | 52323 | 1470 | 65717 | 511 | 61948 |
| 20-#11 | 2.55 | MA | 19315 | 5435 | 32016 | 3954 | 35395 | 3184 | 37162 | 2588 | 39425 | 1680 | 47986 | 1320 | 32830 |
| 4L-8S | | MI | 16627 | 5435 | 27479 | 3942 | 29776 | 3182 | 30634 | 2594 | 31082 | 1663 | 37591 | 1059 | 28608 |
| 20-#11 | 2.55 | MA | 18881 | 5435 | 31267 | 3952 | 34430 | 3194 | 35980 | 2597 | 37758 | 1673 | 45970 | 1278 | 32251 |
| 5L-7S | | MI | 17001 | 5435 | 28130 | 3944 | 30648 | 3186 | 31671 | 2586 | 32541 | 1670 | 39339 | 1107 | 29241 |
| 20-#11 | 2.55 | MA | 18467 | 5435 | 30560 | 3950 | 33470 | 3191 | 34810 | 2592 | 36227 | 1680 | 44069 | 1219 | 31747 |
| 6E | | MI | 17381 | 5435 | 28839 | 3933 | 31512 | 3176 | 32730 | 2578 | 33934 | 1663 | 41173 | 1195 | 29794 |
| 20-#11 | 2.55 | MA | 18063 | 5435 | 29804 | 3962 | 32548 | 3201 | 33680 | 2600 | 34728 | 1687 | 42088 | 1131 | 31159 |
| 7L-5S | | MI | 17770 | 5435 | 29502 | 3935 | 32411 | 3180 | 33826 | 2584 | 35357 | 1656 | 42933 | 1254 | 30243 |
| 20-#11 | 2.55 | MA | 17665 | 5435 | 29110 | 3960 | 31618 | 3198 | 32574 | 2609 | 33157 | 1680 | 40206 | 1082 | 30458 |
| 8L-4S | | MI | 18177 | 5435 | 30203 | 3937 | 33316 | 3170 | 34933 | 2576 | 36906 | 1663 | 44805 | 1295 | 30795 |
| 20-#11 | 2.55 | MA | 17270 | 5435 | 28375 | 3972 | 30709 | 3208 | 31430 | 2604 | 31674 | 1687 | 38364 | 1026 | 29642 |
| 9L-3S | | MI | 18631 | 5435 | 31001 | 3926 | 34330 | 3174 | 36165 | 2581 | 38476 | 1656 | 46573 | 1383 | 30871 |
| 20-#14 | 3.68 | MA | 20213 | 5924 | 34709 | 4246 | 38749 | 3410 | 41203 | 2728 | 44651 | 1622 | 55265 | 1068 | 44811 |
| 5L-7S | | MI | 17923 | 5924 | 30748 | 4239 | 33911 | 3401 | 35607 | 2715 | 37737 | 1620 | 46413 | 823 | 39868 |
| 20-#14 | 3.68 | MA | 19634 | 5924 | 33696 | 4243 | 37375 | 3405 | 39527 | 2720 | 42474 | 1632 | 52571 | 983 | 43782 |
| 6E | | MI | 18455 | 5924 | 31763 | 4223 | 35148 | 3388 | 37179 | 2724 | 39714 | 1610 | 49009 | 950 | 40993 |
| 20-#14 | 3.68 | MA | 19068 | 5924 | 32613 | 4259 | 36054 | 3419 | 37909 | 2732 | 40344 | 1642 | 49764 | 856 | 42533 |
| 7L-5S | | MI | 18999 | 5924 | 32712 | 4227 | 36436 | 3394 | 38692 | 2713 | 41734 | 1600 | 51499 | 1035 | 41972 |
| 20-#14 | 3.68 | MA | 18511 | 5924 | 31618 | 4256 | 34721 | 3413 | 36324 | 2743 | 38111 | 1632 | 47089 | 787 | 41039 |
| 8L-4S | | MI | 19569 | 5924 | 33716 | 4231 | 37730 | 3381 | 40277 | 2702 | 43934 | 1610 | 54157 | 1093 | 43014 |
| 22-#11 | 2.80 | MA | 19362 | 5545 | 32325 | 4021 | 35779 | 3244 | 37620 | 2628 | 39961 | 1665 | 48898 | 1259 | 35359 |
| 5L-8S | | MI | 17081 | 5545 | 28468 | 4011 | 31036 | 3232 | 32166 | 2626 | 33129 | 1654 | 40303 | 1038 | 31498 |
| 22-#11 | 2.80 | MA | 18951 | 5545 | 31618 | 4019 | 34819 | 3241 | 36449 | 2623 | 38430 | 1672 | 46997 | 1200 | 34876 |
| 6L-7S | | MI | 17453 | 5545 | 29119 | 4013 | 31908 | 3236 | 33203 | 2617 | 34588 | 1661 | 42052 | 1086 | 32109 |
| 22-#11 | 2.80 | MA | 18549 | 5545 | 30862 | 4031 | 33897 | 3251 | 35320 | 2632 | 36931 | 1679 | 45016 | 1112 | 34232 |
| 7L-6S | | MI | 17830 | 5545 | 29828 | 4002 | 32772 | 3226 | 34262 | 2609 | 35981 | 1654 | 43886 | 1174 | 32716 |
| 22-#11 | 2.80 | MA | 18153 | 5545 | 30167 | 4029 | 32967 | 3248 | 34213 | 2640 | 35360 | 1672 | 43134 | 1063 | 33555 |
| 8L-5S | | MI | 18217 | 5545 | 30490 | 4004 | 33672 | 3230 | 35358 | 2615 | 37403 | 1647 | 45646 | 1233 | 33146 |
| 22-#11 | 2.80 | MA | 17760 | 5545 | 29433 | 4041 | 32057 | 3258 | 33069 | 2635 | 33877 | 1679 | 41292 | 1006 | 32702 |
| 9L-4S | | MI | 18622 | 5545 | 31192 | 4007 | 34576 | 3220 | 36466 | 2607 | 38953 | 1654 | 47518 | 1274 | 33771 |
| 22-#14 | 4.04 | MA | 20310 | 6084 | 35208 | 4342 | 39302 | 3477 | 41870 | 2765 | 45605 | 1619 | 56722 | 953 | 48144 |
| 6L-7S | | MI | 18556 | 6084 | 32159 | 4339 | 35711 | 3473 | 37795 | 2760 | 40643 | 1606 | 50254 | 790 | 43977 |
| 22-#14 | 4.04 | MA | 19749 | 6084 | 34124 | 4359 | 37981 | 3491 | 40252 | 2776 | 43475 | 1629 | 53915 | 827 | 46941 |
| 7L-6S | | MI | 19083 | 6084 | 33175 | 4323 | 36948 | 3460 | 39367 | 2769 | 42620 | 1596 | 52850 | 918 | 45059 |
| 22-#14 | 4.04 | MA | 19196 | 6084 | 33129 | 4356 | 36648 | 3485 | 38667 | 2788 | 41242 | 1619 | 51240 | 757 | 45394 |
| 8L-5S | | MI | 19624 | 6084 | 34124 | 4327 | 38236 | 3467 | 40880 | 2758 | 44640 | 1586 | 55339 | 1003 | 46123 |
| 24-#11 | 3.06 | MA | 19431 | 5656 | 32676 | 4088 | 36167 | 3291 | 38088 | 2654 | 40632 | 1664 | 49925 | 1181 | 38007 |
| 6L-8S | | MI | 17532 | 5656 | 29456 | 4080 | 32296 | 3282 | 33698 | 2657 | 35175 | 1645 | 43016 | 1017 | 34392 |
| 24-#11 | 3.06 | MA | 19032 | 5656 | 31919 | 4100 | 35245 | 3302 | 36959 | 2663 | 39134 | 1670 | 47945 | 1093 | 37312 |
| 7E | | MI | 17902 | 5656 | 30107 | 4082 | 33169 | 3286 | 34735 | 2649 | 36635 | 1652 | 44764 | 1065 | 34982 |
| 24-#11 | 3.06 | MA | 18638 | 5656 | 31225 | 4098 | 34315 | 3298 | 35853 | 2672 | 37563 | 1664 | 46062 | 1044 | 36655 |
| 8L-6S | | MI | 18277 | 5656 | 30816 | 4071 | 34033 | 3276 | 35794 | 2640 | 38027 | 1645 | 46598 | 1153 | 35641 |
| 24-#11 | 3.06 | MA | 18248 | 5656 | 30490 | 4110 | 33406 | 3308 | 34708 | 2667 | 36080 | 1670 | 44220 | 987 | 35767 |
| 9L-5S | | MI | 18661 | 5656 | 31479 | 4073 | 34932 | 3280 | 36891 | 2646 | 39450 | 1638 | 48358 | 1212 | 36054 |
| 24-#14 | 4.41 | MA | 20426 | 6243 | 35636 | 4459 | 39908 | 3563 | 42594 | 2821 | 46606 | 1616 | 58067 | 797 | 51355 |
| 7E | | MI | 19185 | 6243 | 33571 | 4439 | 37511 | 3546 | 39983 | 2805 | 43549 | 1592 | 54094 | 758 | 48093 |
| 24-#14 | 4.41 | MA | 19877 | 6243 | 34641 | 4455 | 38575 | 3558 | 41009 | 2833 | 44373 | 1606 | 55391 | 727 | 49757 |
| 8L-6S | | MI | 19708 | 6243 | 34586 | 4423 | 38748 | 3532 | 41555 | 2814 | 45526 | 1582 | 56690 | 885 | 49135 |

## RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

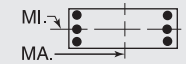
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.24 | MA | 19992 | 5136 | 31744 | 3761 | 34292 | 3060 | 35098 | 2540 | 35233 | 1781 | 41445 | 1656 | 18084 |
| 2E | | MI | 17800 | 5136 | 28400 | 3725 | 30522 | 3030 | 31105 | 2512 | 31028 | 1752 | 36318 | 1618 | 16011 |
| 6-#14 | 1.04 | MA | 19652 | 5047 | 30845 | 3733 | 33285 | 3042 | 33926 | 2534 | 33793 | 1809 | 39624 | 1700 | 15488 |
| 2L-3S | | MI | 16576 | 5047 | 26207 | 3696 | 27860 | 3028 | 27964 | 2522 | 26932 | 1794 | 30998 | 1541 | 13806 |
| 6-#14 | 1.04 | MA | 18578 | 5047 | 29234 | 3730 | 31231 | 3057 | 31429 | 2547 | 30437 | 1819 | 35162 | 1572 | 15549 |
| 3L-2S | | MI | 17515 | 5047 | 27618 | 3700 | 29660 | 3015 | 30152 | 2511 | 29838 | 1784 | 34838 | 1669 | 13735 |
| 6-#18 | 1.86 | MA | 21271 | 5420 | 34558 | 3938 | 37880 | 3188 | 39460 | 2620 | 41037 | 1757 | 49123 | 1600 | 26714 |
| 2L-3S | | MI | 17299 | 5420 | 28400 | 3893 | 30522 | 3180 | 31105 | 2608 | 31028 | 1740 | 36318 | 1325 | 23577 |
| 6-#18 | 1.86 | MA | 19431 | 5420 | 31744 | 3932 | 34292 | 3212 | 35098 | 2640 | 35233 | 1774 | 41445 | 1373 | 26658 |
| 3L-2S | | MI | 18905 | 5420 | 30860 | 3902 | 33658 | 3158 | 34895 | 2590 | 36033 | 1723 | 42894 | 1552 | 23578 |
| 8-#14 | 1.39 | MA | 20398 | 5207 | 32457 | 3833 | 35339 | 3114 | 36423 | 2579 | 37150 | 1798 | 44086 | 1673 | 20436 |
| 2L-4S | | MI | 16563 | 5207 | 26477 | 3812 | 28208 | 3094 | 28391 | 2558 | 27609 | 1790 | 32340 | 1380 | 18108 |
| 8-#14 | 1.39 | MA | 19333 | 5207 | 30845 | 3830 | 33285 | 3129 | 33926 | 2592 | 33793 | 1808 | 39624 | 1545 | 20469 |
| 3E | | MI | 17229 | 5207 | 27618 | 3796 | 29660 | 3101 | 30152 | 2567 | 29838 | 1780 | 34838 | 1508 | 18132 |
| 8-#14 | 1.39 | MA | 18575 | 5207 | 29547 | 3847 | 31634 | 3124 | 31922 | 2585 | 31218 | 1818 | 36712 | 1417 | 20399 |
| 4L-2S | | MI | 18161 | 5207 | 29030 | 3800 | 31460 | 3087 | 32340 | 2556 | 32744 | 1770 | 38679 | 1636 | 18085 |
| 8-#18 | 2.48 | MA | 22531 | 5703 | 37373 | 4116 | 41468 | 3317 | 43822 | 2700 | 46842 | 1732 | 56802 | 1544 | 35297 |
| 2L-4S | | MI | 17267 | 5703 | 28863 | 4096 | 31120 | 3294 | 31839 | 2668 | 32195 | 1729 | 38615 | 1035 | 29341 |
| 8-#18 | 2.48 | MA | 20713 | 5703 | 34558 | 4109 | 37880 | 3341 | 39460 | 2719 | 41037 | 1750 | 49123 | 1316 | 35130 |
| 3E | | MI | 18406 | 5703 | 30860 | 4070 | 33658 | 3308 | 34895 | 2686 | 36033 | 1711 | 42894 | 1259 | 30993 |
| 8-#18 | 2.48 | MA | 19418 | 5703 | 32283 | 4137 | 34988 | 3330 | 35951 | 2704 | 36585 | 1768 | 44126 | 1089 | 33235 |
| 4L-2S | | MI | 19993 | 5703 | 33319 | 4080 | 36794 | 3287 | 38685 | 2668 | 41039 | 1693 | 49471 | 1486 | 31097 |
| 10-#11 | 1.21 | MA | 20039 | 5122 | 31592 | 3793 | 34308 | 3087 | 35196 | 2565 | 35569 | 1815 | 42032 | 1702 | 17879 |
| 2L-5S | | MI | 16309 | 5122 | 25787 | 3769 | 27387 | 3077 | 27409 | 2554 | 26238 | 1797 | 30602 | 1451 | 15872 |
| 10-#11 | 1.21 | MA | 19290 | 5122 | 30466 | 3792 | 32871 | 3098 | 33449 | 2574 | 33210 | 1822 | 38888 | 1613 | 17911 |
| 3L-4S | | MI | 16730 | 5122 | 26488 | 3771 | 28291 | 3067 | 28516 | 2546 | 27787 | 1804 | 32474 | 1492 | 15903 |
| 10-#11 | 1.21 | MA | 18758 | 5122 | 29559 | 3804 | 31718 | 3095 | 32050 | 2570 | 31400 | 1829 | 36833 | 1524 | 17913 |
| 4L-3S | | MI | 17198 | 5122 | 27287 | 3760 | 29306 | 3071 | 29747 | 2551 | 29357 | 1797 | 34242 | 1581 | 15880 |
| 10-#11 | 1.21 | MA | 18282 | 5122 | 28763 | 3803 | 30692 | 3106 | 30794 | 2579 | 29615 | 1822 | 34674 | 1482 | 17846 |
| 5L-2S | | MI | 17854 | 5122 | 28275 | 3762 | 30566 | 3062 | 31279 | 2543 | 31404 | 1790 | 36954 | 1670 | 15842 |
| 10-#14 | 1.74 | MA | 21137 | 5366 | 34068 | 3933 | 37393 | 3187 | 38920 | 2624 | 40507 | 1786 | 48549 | 1645 | 25365 |
| 2L-5S | | MI | 16620 | 5366 | 26884 | 3908 | 28714 | 3180 | 28994 | 2614 | 28315 | 1766 | 33523 | 1290 | 21553 |
| 10-#14 | 1.74 | MA | 20080 | 5366 | 32457 | 3930 | 35339 | 3202 | 36423 | 2637 | 37150 | 1796 | 44086 | 1517 | 25362 |
| 3L-4S | | MI | 17215 | 5366 | 27888 | 3912 | 30008 | 3167 | 30579 | 2603 | 30515 | 1776 | 36181 | 1348 | 22366 |
| 10-#14 | 1.74 | MA | 19329 | 5366 | 31158 | 3947 | 33688 | 3197 | 34419 | 2630 | 34575 | 1806 | 41174 | 1389 | 25248 |
| 4L-3S | | MI | 17876 | 5366 | 29030 | 3896 | 31460 | 3173 | 32340 | 2612 | 32744 | 1766 | 38679 | 1476 | 22435 |
| 10-#14 | 1.74 | MA | 18655 | 5366 | 30018 | 3944 | 32218 | 3212 | 32620 | 2642 | 32035 | 1796 | 38103 | 1329 | 24288 |
| 5L-2S | | MI | 18801 | 5366 | 30442 | 3900 | 33260 | 3160 | 34528 | 2601 | 35650 | 1756 | 42520 | 1604 | 22414 |
| 10-#18 | 3.10 | MA | 23774 | 5987 | 40187 | 4293 | 45057 | 3445 | 48184 | 2779 | 52647 | 1708 | 64480 | 1488 | 43838 |
| 2L-5S | | MI | 17360 | 5987 | 29565 | 4264 | 31990 | 3443 | 32878 | 2764 | 33408 | 1682 | 40631 | 867 | 34596 |
| 10-#18 | 3.10 | MA | 21977 | 5987 | 37373 | 4286 | 41468 | 3469 | 43822 | 2799 | 46842 | 1726 | 56802 | 1260 | 43584 |
| 3L-4S | | MI | 18373 | 5987 | 31323 | 4274 | 34256 | 3422 | 35629 | 2746 | 37200 | 1700 | 45191 | 969 | 36336 |
| 10-#18 | 3.10 | MA | 20699 | 5987 | 35098 | 4315 | 38576 | 3458 | 40312 | 2784 | 42390 | 1743 | 51805 | 1033 | 41279 |
| 4L-3S | | MI | 19498 | 5987 | 33319 | 4248 | 36794 | 3437 | 38685 | 2764 | 41039 | 1682 | 49471 | 1193 | 38386 |
| 10-#18 | 3.10 | MA | 19551 | 5987 | 33098 | 4308 | 35998 | 3482 | 37156 | 2804 | 37995 | 1726 | 46495 | 929 | 39144 |
| 5L-2S | | MI | 21068 | 5987 | 35779 | 4257 | 39930 | 3416 | 42475 | 2746 | 46044 | 1664 | 56047 | 1420 | 38575 |
| 12-#11 | 1.45 | MA | 20562 | 5232 | 32719 | 3863 | 35744 | 3137 | 36942 | 2596 | 37929 | 1808 | 45176 | 1684 | 21331 |
| 2L-6S | | MI | 16372 | 5232 | 26113 | 3836 | 27748 | 3123 | 27844 | 2579 | 26861 | 1795 | 31555 | 1371 | 18287 |
| 12-#11 | 1.45 | MA | 19817 | 5232 | 31592 | 3861 | 34308 | 3148 | 35196 | 2605 | 35569 | 1815 | 42032 | 1595 | 21350 |
| 3L-5S | | MI | 16772 | 5232 | 26776 | 3838 | 28647 | 3127 | 28941 | 2585 | 28284 | 1788 | 33315 | 1430 | 18853 |
| 12-#11 | 1.45 | MA | 19289 | 5232 | 30686 | 3873 | 33155 | 3145 | 33797 | 2601 | 33759 | 1821 | 39977 | 1507 | 21328 |
| 4E | | MI | 17190 | 5232 | 27477 | 3841 | 29551 | 3117 | 30048 | 2577 | 29834 | 1795 | 35187 | 1471 | 18907 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis

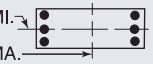



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.45 | MA | 18815 | 5232 | 29890 | 3872 | 32129 | 3156 | 32540 | 2610 | 31974 | 1815 | 37818 | 1464 | 21237 |
| 5L-3S | | MI | 17655 | 5232 | 28275 | 3829 | 30566 | 3121 | 31279 | 2582 | 31404 | 1788 | 36954 | 1560 | 18906 |
| 12-#11 | 1.45 | MA | 18363 | 5232 | 29139 | 3870 | 31109 | 3153 | 31296 | 2606 | 30334 | 1821 | 35775 | 1405 | 20561 |
| 6L-2S | | MI | 18308 | 5232 | 29264 | 3832 | 31826 | 3112 | 32812 | 2574 | 33450 | 1781 | 39666 | 1649 | 18878 |
| 12-#14 | 2.09 | MA | 21869 | 5526 | 35679 | 4032 | 39447 | 3259 | 41417 | 2669 | 43863 | 1775 | 53011 | 1618 | 30282 |
| 2L-6S | | MI | 16708 | 5526 | 27347 | 4003 | 29226 | 3246 | 29669 | 2670 | 29201 | 1762 | 34874 | 1172 | 24975 |
| 12-#14 | 2.09 | MA | 20820 | 5526 | 34068 | 4030 | 37393 | 3274 | 38920 | 2682 | 40507 | 1785 | 48549 | 1490 | 30243 |
| 3L-5S | | MI | 17271 | 5526 | 28296 | 4007 | 30514 | 3252 | 31182 | 2659 | 31221 | 1752 | 37363 | 1258 | 25649 |
| 12-#14 | 2.09 | MA | 20075 | 5526 | 32769 | 4047 | 35742 | 3269 | 36916 | 2675 | 37932 | 1795 | 45636 | 1362 | 30090 |
| 4E | | MI | 17861 | 5526 | 29300 | 4011 | 31808 | 3239 | 32767 | 2648 | 33421 | 1762 | 40022 | 1316 | 26613 |
| 12-#14 | 2.09 | MA | 19407 | 5526 | 31629 | 4044 | 34272 | 3284 | 35117 | 2687 | 35391 | 1785 | 42565 | 1302 | 28975 |
| 5L-3S | | MI | 18517 | 5526 | 30442 | 3996 | 33260 | 3245 | 34528 | 2657 | 35650 | 1752 | 42520 | 1444 | 26719 |
| 12-#14 | 2.09 | MA | 18769 | 5526 | 30553 | 4041 | 32811 | 3279 | 33334 | 2680 | 33058 | 1795 | 39668 | 1217 | 28144 |
| 6L-2S | | MI | 19436 | 5526 | 31854 | 4000 | 35059 | 3232 | 36716 | 2646 | 38557 | 1742 | 46360 | 1572 | 26730 |
| 12-#18 | 3.72 | MA | 23225 | 6271 | 40187 | 4463 | 45057 | 3598 | 48184 | 2879 | 52647 | 1701 | 64480 | 1204 | 52026 |
| 3L-5S | | MI | 18465 | 6271 | 32024 | 4441 | 35126 | 3572 | 36668 | 2842 | 38413 | 1653 | 47207 | 801 | 41657 |
| 12-#18 | 3.72 | MA | 21963 | 6271 | 37912 | 4492 | 42164 | 3587 | 44674 | 2864 | 48194 | 1719 | 59483 | 976 | 49369 |
| 4E | | MI | 19465 | 6271 | 33782 | 4451 | 37392 | 3551 | 39419 | 2824 | 42206 | 1670 | 51767 | 903 | 43377 |
| 12-#18 | 3.72 | MA | 20829 | 6271 | 35912 | 4485 | 39586 | 3611 | 41518 | 2883 | 43799 | 1701 | 54174 | 873 | 47365 |
| 5L-3S | | MI | 20578 | 6271 | 35779 | 4425 | 39930 | 3565 | 42475 | 2842 | 46044 | 1653 | 56047 | 1127 | 45764 |
| 12-#18 | 3.72 | MA | 19748 | 6271 | 34022 | 4479 | 37021 | 3600 | 38391 | 2868 | 39764 | 1719 | 49195 | 721 | 43943 |
| 6L-2S | | MI | 22132 | 6271 | 38239 | 4434 | 43066 | 3544 | 46265 | 2824 | 51049 | 1635 | 62623 | 1354 | 46026 |
| 14-#11 | 1.69 | MA | 21081 | 5343 | 33846 | 3932 | 37181 | 3187 | 38689 | 2627 | 40288 | 1800 | 48320 | 1667 | 24775 |
| 2L-7S | | MI | 16446 | 5343 | 26392 | 3917 | 28144 | 3183 | 28318 | 2619 | 27516 | 1793 | 32433 | 1263 | 20860 |
| 14-#11 | 1.69 | MA | 20340 | 5343 | 32719 | 3930 | 35744 | 3198 | 36942 | 2637 | 37929 | 1807 | 45176 | 1578 | 24778 |
| 3L-6S | | MI | 16834 | 5343 | 27101 | 3905 | 29008 | 3173 | 29376 | 2610 | 28908 | 1786 | 34267 | 1351 | 21189 |
| 14-#11 | 1.69 | MA | 19815 | 5343 | 31813 | 3943 | 34591 | 3195 | 35543 | 2632 | 36119 | 1814 | 43121 | 1489 | 24736 |
| 4L-5S | | MI | 17231 | 5343 | 27764 | 3907 | 29907 | 3177 | 30473 | 2616 | 30331 | 1779 | 36027 | 1410 | 21728 |
| 14-#11 | 1.69 | MA | 19345 | 5343 | 31017 | 3941 | 33565 | 3206 | 34287 | 2642 | 34334 | 1807 | 40962 | 1446 | 24534 |
| 5L-4S | | MI | 17647 | 5343 | 28466 | 3910 | 30812 | 3168 | 31580 | 2608 | 31880 | 1786 | 37899 | 1451 | 21904 |
| 14-#11 | 1.69 | MA | 18896 | 5343 | 30266 | 3940 | 32545 | 3203 | 33043 | 2637 | 32693 | 1814 | 38919 | 1388 | 23875 |
| 6L-3S | | MI | 18109 | 5343 | 29264 | 3898 | 31826 | 3172 | 32812 | 2614 | 33450 | 1779 | 39666 | 1539 | 21923 |
| 14-#11 | 1.69 | MA | 18457 | 5343 | 29462 | 3952 | 31566 | 3214 | 31842 | 2646 | 31088 | 1821 | 36792 | 1300 | 23463 |
| 7L-2S | | MI | 18758 | 5343 | 30252 | 3901 | 33087 | 3162 | 34344 | 2605 | 35497 | 1772 | 42379 | 1628 | 21906 |
| 14-#14 | 2.44 | MA | 22595 | 5686 | 37290 | 4132 | 41502 | 3331 | 43914 | 2714 | 47220 | 1763 | 57473 | 1590 | 35180 |
| 2L-7S | | MI | 16812 | 5686 | 27743 | 4119 | 29789 | 3331 | 30284 | 2706 | 30130 | 1758 | 36119 | 1013 | 27887 |
| 14-#14 | 2.44 | MA | 21553 | 5686 | 35679 | 4129 | 39447 | 3346 | 41417 | 2727 | 43863 | 1773 | 53011 | 1462 | 35114 |
| 3L-6S | | MI | 17357 | 5686 | 28759 | 4103 | 31026 | 3318 | 31856 | 2715 | 32107 | 1748 | 38714 | 1140 | 29122 |
| 14-#14 | 2.44 | MA | 20814 | 5686 | 34381 | 4147 | 37796 | 3341 | 39414 | 2719 | 41288 | 1783 | 50099 | 1334 | 34927 |
| 4L-5S | | MI | 17917 | 5686 | 29708 | 4107 | 32313 | 3325 | 33370 | 2704 | 34127 | 1738 | 41204 | 1225 | 29760 |
| 14-#14 | 2.44 | MA | 20152 | 5686 | 33240 | 4144 | 36326 | 3356 | 37614 | 2732 | 38748 | 1773 | 47028 | 1274 | 33678 |
| 5L-4S | | MI | 18502 | 5686 | 30712 | 4111 | 33608 | 3311 | 34955 | 2693 | 36327 | 1748 | 43862 | 1283 | 30854 |
| 14-#14 | 2.44 | MA | 19519 | 5686 | 32164 | 4141 | 34865 | 3351 | 35831 | 2725 | 36414 | 1783 | 44130 | 1189 | 32887 |
| 6L-3S | | MI | 19153 | 5686 | 31854 | 4095 | 35059 | 3318 | 36716 | 2702 | 38557 | 1738 | 46360 | 1411 | 30992 |
| 14-#14 | 2.44 | MA | 18902 | 5686 | 31012 | 4158 | 33461 | 3366 | 34111 | 2738 | 34131 | 1793 | 41112 | 1063 | 31459 |
| 7L-2S | | MI | 20065 | 5686 | 33265 | 4099 | 36859 | 3304 | 38904 | 2691 | 41463 | 1728 | 50201 | 1539 | 31034 |
| 14-#18 | 4.33 | MA | 23211 | 6554 | 40726 | 4669 | 45752 | 3715 | 49036 | 2943 | 53999 | 1695 | 67162 | 920 | 57495 |
| 4L-5S | | MI | 19556 | 6554 | 34484 | 4619 | 38262 | 3700 | 40458 | 2920 | 43419 | 1624 | 53783 | 735 | 48555 |
| 14-#18 | 4.33 | MA | 22092 | 6554 | 38726 | 4663 | 43174 | 3740 | 45880 | 2963 | 49604 | 1677 | 61852 | 816 | 55376 |
| 5L-4S | | MI | 20546 | 6554 | 36242 | 4628 | 40528 | 3679 | 43208 | 2903 | 47211 | 1641 | 58344 | 837 | 50455 |
| 14-#18 | 4.33 | MA | 21024 | 6554 | 36836 | 4656 | 40609 | 3728 | 42753 | 2948 | 45569 | 1695 | 56873 | 665 | 52040 |
| 6L-3S | | MI | 21646 | 6554 | 38239 | 4602 | 43066 | 3694 | 46265 | 2920 | 51049 | 1624 | 62623 | 1061 | 53131 |
| 16-#11 | 1.93 | MA | 21597 | 5454 | 34973 | 4001 | 38618 | 3238 | 40435 | 2658 | 42647 | 1793 | 51464 | 1649 | 28213 |
| 2L-8S | | MI | 16527 | 5454 | 26730 | 3983 | 28532 | 3229 | 28813 | 2658 | 28103 | 1777 | 33397 | 1194 | 23061 |
| 16-#11 | 1.93 | MA | 20860 | 5454 | 33846 | 3999 | 37181 | 3248 | 38689 | 2668 | 40288 | 1800 | 48320 | 1560 | 28199 |
| 3L-7S | | MI | 16907 | 5454 | 27381 | 3986 | 29404 | 3233 | 29850 | 2650 | 29562 | 1784 | 35146 | 1242 | 23761 |
| 16-#11 | 1.93 | MA | 20338 | 5454 | 32939 | 4012 | 36028 | 3245 | 37290 | 2663 | 38478 | 1807 | 46265 | 1471 | 28140 |
| 4L-6S | | MI | 17293 | 5454 | 28090 | 3974 | 30268 | 3224 | 30908 | 2642 | 30955 | 1777 | 36980 | 1330 | 24099 |

## RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

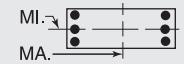
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.93 | MA | 19871 | 5454 | 32144 | 4010 | 35002 | 3256 | 36033 | 2673 | 36693 | 1800 | 44106 | 1429 | 27822 |
| 5E | | MI | 17687 | 5454 | 28753 | 3977 | 31168 | 3228 | 32005 | 2647 | 32378 | 1770 | 38739 | 1389 | 24608 |
| 16-#11 | 1.93 | MA | 19424 | 5454 | 31393 | 4009 | 33982 | 3253 | 34789 | 2668 | 35053 | 1807 | 42063 | 1370 | 27195 |
| 6L-4S | | MI | 18101 | 5454 | 29454 | 3979 | 32072 | 3218 | 33112 | 2639 | 33927 | 1777 | 40612 | 1430 | 24894 |
| 16-#11 | 1.93 | MA | 18989 | 5454 | 30589 | 4021 | 33002 | 3264 | 33589 | 2678 | 33447 | 1814 | 39936 | 1282 | 26798 |
| 7L-3S | | MI | 18561 | 5454 | 30252 | 3967 | 33087 | 3222 | 34344 | 2645 | 35497 | 1770 | 42379 | 1518 | 24930 |
| 16-#11 | 1.93 | MA | 18559 | 5454 | 29851 | 4020 | 32014 | 3261 | 32413 | 2687 | 31766 | 1807 | 37919 | 1233 | 25955 |
| 8L-2S | | MI | 19206 | 5454 | 31241 | 3970 | 34347 | 3212 | 35876 | 2637 | 37544 | 1763 | 45091 | 1607 | 24927 |
| 16-#14 | 2.79 | MA | 22280 | 5845 | 37290 | 4229 | 41502 | 3419 | 43914 | 2772 | 47220 | 1761 | 57473 | 1435 | 39978 |
| 3L-7S | | MI | 17460 | 5845 | 29155 | 4219 | 31588 | 3404 | 32472 | 2750 | 33036 | 1744 | 39959 | 981 | 31964 |
| 16-#14 | 2.79 | MA | 21547 | 5845 | 35992 | 4246 | 39851 | 3414 | 41911 | 2764 | 44645 | 1771 | 54561 | 1307 | 39761 |
| 4L-6S | | MI | 18002 | 5845 | 30170 | 4203 | 32826 | 3390 | 34044 | 2759 | 35013 | 1734 | 42555 | 1108 | 33221 |
| 16-#14 | 2.79 | MA | 20890 | 5845 | 34852 | 4244 | 38381 | 3429 | 40111 | 2777 | 42105 | 1761 | 51490 | 1247 | 38394 |
| 5E | | MI | 18557 | 5845 | 31119 | 4207 | 34113 | 3397 | 35558 | 2749 | 37033 | 1724 | 45045 | 1193 | 33884 |
| 16-#14 | 2.79 | MA | 20263 | 5845 | 33775 | 4241 | 36919 | 3424 | 38328 | 2770 | 39771 | 1771 | 48592 | 1162 | 37638 |
| 6L-4S | | MI | 19138 | 5845 | 32123 | 4211 | 35408 | 3384 | 37142 | 2738 | 39234 | 1734 | 47703 | 1251 | 35081 |
| 16-#14 | 2.79 | MA | 19651 | 5845 | 32623 | 4258 | 35515 | 3439 | 36608 | 2783 | 37487 | 1781 | 45574 | 1035 | 36133 |
| 7L-3S | | MI | 19784 | 5845 | 33265 | 4195 | 36859 | 3390 | 38904 | 2747 | 41463 | 1724 | 50201 | 1379 | 35257 |
| 16-#14 | 2.79 | MA | 19048 | 5845 | 31566 | 4255 | 34098 | 3434 | 34923 | 2795 | 35094 | 1771 | 42705 | 964 | 34775 |
| 8L-2S | | MI | 20690 | 5845 | 34677 | 4199 | 38659 | 3377 | 41092 | 2736 | 44369 | 1714 | 54041 | 1507 | 35323 |
| 16-#18 | 4.95 | MA | 23341 | 6838 | 41541 | 4840 | 46762 | 3868 | 50242 | 3043 | 55409 | 1653 | 69531 | 760 | 63361 |
| 5E | | MI | 20637 | 6838 | 36944 | 4796 | 41398 | 3829 | 44248 | 2999 | 48424 | 1594 | 60360 | 669 | 55487 |
| 16-#18 | 4.95 | MA | 22285 | 6838 | 39650 | 4833 | 44197 | 3857 | 47114 | 3028 | 51374 | 1671 | 64552 | 609 | 60162 |
| 6L-4S | | MI | 21616 | 6838 | 38702 | 4805 | 43664 | 3808 | 46998 | 2981 | 52216 | 1612 | 64920 | 771 | 57561 |
| 18-#11 | 2.17 | MA | 21376 | 5564 | 34973 | 4069 | 38618 | 3299 | 40435 | 2699 | 42647 | 1793 | 51464 | 1542 | 31614 |
| 3L-8S | | MI | 16988 | 5564 | 27719 | 4052 | 29792 | 3279 | 30345 | 2689 | 30150 | 1768 | 36110 | 1173 | 25938 |
| 18-#11 | 2.17 | MA | 20858 | 5564 | 34066 | 4081 | 37465 | 3296 | 39036 | 2694 | 40837 | 1799 | 49409 | 1454 | 31539 |
| 4L-7S | | MI | 17365 | 5564 | 28370 | 4055 | 30665 | 3283 | 31382 | 2681 | 31609 | 1775 | 37858 | 1221 | 26612 |
| 18-#11 | 2.17 | MA | 20393 | 5564 | 33271 | 4079 | 36439 | 3306 | 37780 | 2704 | 39052 | 1793 | 47250 | 1411 | 31120 |
| 5L-6S | | MI | 17748 | 5564 | 29079 | 4043 | 31529 | 3274 | 32441 | 2673 | 33001 | 1768 | 39692 | 1309 | 27013 |
| 18-#11 | 2.17 | MA | 19949 | 5564 | 32519 | 4078 | 35419 | 3303 | 36536 | 2699 | 37412 | 1799 | 45207 | 1353 | 30522 |
| 6L-5S | | MI | 18141 | 5564 | 29741 | 4046 | 32428 | 3278 | 33537 | 2678 | 34424 | 1761 | 41452 | 1368 | 27497 |
| 18-#11 | 2.17 | MA | 19517 | 5564 | 31716 | 4090 | 34439 | 3314 | 35335 | 2709 | 35807 | 1806 | 43080 | 1265 | 30061 |
| 7L-4S | | MI | 18552 | 5564 | 30443 | 4048 | 33332 | 3268 | 34644 | 2670 | 35974 | 1768 | 43324 | 1409 | 27879 |
| 18-#11 | 2.17 | MA | 19090 | 5564 | 30978 | 4089 | 33450 | 3311 | 34160 | 2718 | 34125 | 1799 | 41063 | 1215 | 29246 |
| 8L-3S | | MI | 19009 | 5564 | 31241 | 4037 | 34347 | 3272 | 35876 | 2676 | 37544 | 1761 | 45091 | 1498 | 27930 |
| 18-#11 | 2.17 | MA | 18667 | 5564 | 30198 | 4101 | 32484 | 3322 | 32943 | 2714 | 32536 | 1806 | 39084 | 1159 | 28504 |
| 9L-2S | | MI | 19651 | 5564 | 32230 | 4039 | 35607 | 3262 | 37408 | 2668 | 39590 | 1755 | 47804 | 1586 | 27944 |
| 18-#14 | 3.13 | MA | 22275 | 6005 | 37603 | 4346 | 41905 | 3486 | 44408 | 2809 | 48001 | 1760 | 59023 | 1279 | 44520 |
| 4L-7S | | MI | 18104 | 6005 | 30567 | 4319 | 33388 | 3476 | 34660 | 2795 | 35942 | 1730 | 43800 | 948 | 36053 |
| 18-#14 | 3.13 | MA | 21623 | 6005 | 36463 | 4343 | 40435 | 3501 | 42608 | 2822 | 45461 | 1750 | 55952 | 1219 | 43121 |
| 5L-6S | | MI | 18641 | 6005 | 31582 | 4303 | 34626 | 3463 | 36232 | 2804 | 37919 | 1720 | 46396 | 1075 | 37259 |
| 18-#14 | 3.13 | MA | 21001 | 6005 | 35386 | 4341 | 38973 | 3496 | 40825 | 2815 | 43128 | 1760 | 53054 | 1134 | 42281 |
| 6L-5S | | MI | 19192 | 6005 | 32531 | 4307 | 35913 | 3469 | 37746 | 2793 | 39939 | 1710 | 48885 | 1161 | 38018 |
| 18-#14 | 3.13 | MA | 20394 | 6005 | 34234 | 4358 | 37569 | 3511 | 39105 | 2828 | 40844 | 1770 | 50036 | 1008 | 40818 |
| 7L-4S | | MI | 19768 | 6005 | 33535 | 4311 | 37207 | 3456 | 39330 | 2783 | 42140 | 1720 | 51543 | 1218 | 39152 |
| 18-#14 | 3.13 | MA | 19795 | 6005 | 33177 | 4355 | 36152 | 3506 | 37420 | 2840 | 38451 | 1760 | 47168 | 937 | 39404 |
| 8L-3S | | MI | 20410 | 6005 | 34677 | 4295 | 38659 | 3462 | 41092 | 2792 | 44369 | 1710 | 54041 | 1346 | 39516 |
| 18-#18 | 5.57 | MA | 23534 | 7122 | 42465 | 5010 | 47785 | 3986 | 51476 | 3107 | 57178 | 1646 | 72230 | 553 | 68305 |
| 6L-5S | | MI | 21707 | 7122 | 39403 | 4973 | 44534 | 3958 | 48037 | 3077 | 53429 | 1565 | 66936 | 603 | 62448 |
| 20-#11 | 2.41 | MA | 21374 | 5675 | 35193 | 4150 | 38901 | 3346 | 40783 | 2726 | 43196 | 1792 | 52553 | 1436 | 34936 |
| 4L-8S | | MI | 17445 | 5675 | 28707 | 4122 | 31053 | 3330 | 31877 | 2720 | 32196 | 1759 | 38822 | 1152 | 28821 |
| 20-#11 | 2.41 | MA | 20912 | 5675 | 34398 | 4149 | 37875 | 3357 | 39526 | 2735 | 41411 | 1785 | 50394 | 1393 | 34426 |
| 5L-7S | | MI | 17820 | 5675 | 29358 | 4124 | 31925 | 3334 | 32914 | 2712 | 33656 | 1766 | 40571 | 1200 | 29471 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis

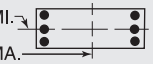



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.41 | MA | 20471 | 5675 | 33646 | 4147 | 36855 | 3354 | 38282 | 2730 | 39771 | 1792 | 48351 | 1335 | 33852 |
| 6E | | MI | 18201 | 5675 | 30067 | 4113 | 32789 | 3324 | 33973 | 2704 | 35048 | 1759 | 42404 | 1288 | 29932 |
| 20-#11 | 2.41 | MA | 20041 | 5675 | 32843 | 4159 | 35876 | 3364 | 37082 | 2740 | 38166 | 1799 | 46224 | 1247 | 33332 |
| 7L-5S | | MI | 18591 | 5675 | 30730 | 4115 | 33688 | 3328 | 35069 | 2709 | 36471 | 1752 | 44164 | 1347 | 30393 |
| 20-#11 | 2.41 | MA | 19617 | 5675 | 32105 | 4158 | 34887 | 3362 | 35906 | 2749 | 36484 | 1792 | 44207 | 1197 | 32542 |
| 8L-4S | | MI | 19000 | 5675 | 31431 | 4117 | 34593 | 3318 | 36176 | 2701 | 38020 | 1759 | 46037 | 1388 | 30861 |
| 20-#11 | 2.41 | MA | 19197 | 5675 | 31324 | 4170 | 33921 | 3372 | 34690 | 2745 | 34895 | 1799 | 42228 | 1141 | 31762 |
| 9L-3S | | MI | 19455 | 5675 | 32230 | 4106 | 35607 | 3322 | 37408 | 2707 | 39590 | 1752 | 47804 | 1477 | 30926 |
| 20-#11 | 2.41 | MA | 18734 | 5675 | 30590 | 4169 | 32945 | 3369 | 33522 | 2754 | 33318 | 1806 | 40310 | 1077 | 30884 |
| 10L-2S | | MI | 20094 | 5675 | 33218 | 4108 | 36868 | 3312 | 38940 | 2699 | 41637 | 1746 | 50516 | 1565 | 30952 |
| 20-#14 | 3.48 | MA | 22350 | 6164 | 38074 | 4443 | 42489 | 3573 | 45105 | 2867 | 48818 | 1738 | 60414 | 1192 | 47857 |
| 5L-7S | | MI | 18742 | 6164 | 31978 | 4418 | 35188 | 3548 | 36848 | 2840 | 38848 | 1716 | 47640 | 916 | 40150 |
| 20-#14 | 3.48 | MA | 21733 | 6164 | 36997 | 4440 | 41027 | 3568 | 43323 | 2860 | 46484 | 1748 | 57517 | 1107 | 46925 |
| 6E | | MI | 19276 | 6164 | 32994 | 4402 | 36425 | 3535 | 38420 | 2849 | 40825 | 1706 | 50236 | 1043 | 41309 |
| 20-#14 | 3.48 | MA | 21130 | 6164 | 35845 | 4458 | 39623 | 3583 | 41602 | 2873 | 44200 | 1758 | 54498 | 980 | 45513 |
| 7L-5S | | MI | 19822 | 6164 | 33943 | 4406 | 37713 | 3542 | 39934 | 2838 | 42845 | 1696 | 52726 | 1128 | 42160 |
| 20-#14 | 3.48 | MA | 20537 | 6164 | 34788 | 4455 | 38206 | 3578 | 39917 | 2885 | 41807 | 1748 | 51630 | 909 | 44044 |
| 8L-4S | | MI | 20395 | 6164 | 34947 | 4410 | 39007 | 3528 | 41518 | 2828 | 45046 | 1706 | 55384 | 1186 | 43237 |
| 22-#11 | 2.66 | MA | 21428 | 5786 | 35524 | 4218 | 39312 | 3407 | 41273 | 2766 | 43771 | 1778 | 53538 | 1376 | 37738 |
| 5L-8S | | MI | 17899 | 5786 | 29696 | 4191 | 32313 | 3380 | 33409 | 2751 | 34243 | 1750 | 41535 | 1131 | 31709 |
| 22-#11 | 2.66 | MA | 20990 | 5786 | 34773 | 4216 | 38292 | 3404 | 40029 | 2762 | 42130 | 1785 | 51495 | 1317 | 37187 |
| 6L-7S | | MI | 18273 | 5786 | 30347 | 4193 | 33185 | 3384 | 34446 | 2743 | 35702 | 1757 | 43283 | 1179 | 32336 |
| 22-#11 | 2.66 | MA | 20562 | 5786 | 33969 | 4229 | 37312 | 3415 | 38828 | 2771 | 40525 | 1792 | 49368 | 1229 | 36609 |
| 7L-6S | | MI | 18651 | 5786 | 31056 | 4182 | 34049 | 3374 | 35505 | 2735 | 37095 | 1750 | 45117 | 1267 | 32854 |
| 22-#11 | 2.66 | MA | 20141 | 5786 | 33232 | 4227 | 36324 | 3412 | 37653 | 2780 | 38843 | 1785 | 47351 | 1180 | 35844 |
| 8L-5S | | MI | 19039 | 5786 | 31718 | 4184 | 34949 | 3378 | 36602 | 2741 | 38518 | 1744 | 46877 | 1326 | 33295 |
| 22-#11 | 2.66 | MA | 19723 | 5786 | 32451 | 4239 | 35357 | 3423 | 36436 | 2776 | 37255 | 1792 | 45372 | 1123 | 35026 |
| 9L-4S | | MI | 19445 | 5786 | 32420 | 4186 | 35853 | 3368 | 37709 | 2732 | 40067 | 1750 | 48749 | 1367 | 33840 |
| 22-#11 | 2.66 | MA | 19263 | 5786 | 31717 | 4238 | 34381 | 3420 | 35268 | 2785 | 35678 | 1799 | 43454 | 1060 | 34171 |
| 10L-3S | | MI | 19898 | 5786 | 33218 | 4175 | 36868 | 3372 | 38940 | 2738 | 41637 | 1744 | 50516 | 1456 | 33918 |
| 22-#14 | 3.83 | MA | 22459 | 6324 | 38609 | 4540 | 43081 | 3641 | 45820 | 2905 | 49841 | 1737 | 61979 | 1079 | 51580 |
| 6L-7S | | MI | 19376 | 6324 | 33390 | 4518 | 36988 | 3621 | 39036 | 2885 | 41754 | 1702 | 51481 | 883 | 44256 |
| 22-#14 | 3.83 | MA | 21861 | 6324 | 37457 | 4557 | 41677 | 3656 | 44099 | 2917 | 47557 | 1747 | 58961 | 952 | 50215 |
| 7L-6S | | MI | 19906 | 6324 | 34405 | 4502 | 38225 | 3607 | 40608 | 2894 | 43731 | 1692 | 54077 | 1010 | 45372 |
| 22-#14 | 3.83 | MA | 21272 | 6324 | 36399 | 4555 | 40260 | 3651 | 42414 | 2930 | 45164 | 1737 | 56092 | 882 | 48693 |
| 8L-5S | | MI | 20449 | 6324 | 35354 | 4506 | 39513 | 3614 | 42122 | 2883 | 45752 | 1682 | 56567 | 1096 | 46309 |
| 24-#11 | 2.90 | MA | 21505 | 5896 | 35900 | 4285 | 39729 | 3454 | 41775 | 2793 | 44490 | 1778 | 54639 | 1300 | 40525 |
| 6L-8S | | MI | 18351 | 5896 | 30684 | 4260 | 33574 | 3430 | 34941 | 2782 | 36290 | 1742 | 44247 | 1110 | 34602 |
| 24-#11 | 2.90 | MA | 21080 | 5896 | 35096 | 4298 | 38749 | 3465 | 40575 | 2802 | 42884 | 1784 | 52512 | 1212 | 39892 |
| 7E | | MI | 18722 | 5896 | 31335 | 4262 | 34446 | 3434 | 35978 | 2774 | 37749 | 1748 | 45995 | 1158 | 35208 |
| 24-#11 | 2.90 | MA | 20661 | 5896 | 34359 | 4296 | 37760 | 3462 | 39399 | 2812 | 41203 | 1778 | 50495 | 1162 | 39150 |
| 8L-6S | | MI | 19099 | 5896 | 32044 | 4251 | 35310 | 3424 | 37037 | 2766 | 39141 | 1742 | 47829 | 1246 | 35780 |
| 24-#11 | 2.90 | MA | 20246 | 5896 | 33578 | 4308 | 36794 | 3473 | 38183 | 2807 | 39614 | 1784 | 48516 | 1106 | 38296 |
| 9L-5S | | MI | 19485 | 5896 | 32707 | 4253 | 36209 | 3428 | 38134 | 2772 | 40564 | 1735 | 49589 | 1305 | 36203 |
| 24-#11 | 2.90 | MA | 19797 | 5896 | 32844 | 4307 | 35818 | 3470 | 37015 | 2817 | 38037 | 1791 | 46597 | 1042 | 37461 |
| 10L-4S | | MI | 19889 | 5896 | 33408 | 4256 | 37113 | 3418 | 39241 | 2764 | 42114 | 1742 | 51461 | 1346 | 36817 |
| 24-#14 | 4.18 | MA | 22587 | 6484 | 39068 | 4657 | 43731 | 3728 | 46596 | 2962 | 50914 | 1735 | 63423 | 925 | 54925 |
| 7E | | MI | 20006 | 6484 | 34802 | 4618 | 38788 | 3693 | 41224 | 2930 | 44661 | 1688 | 55322 | 851 | 48370 |
| 24-#14 | 4.18 | MA | 22003 | 6484 | 38010 | 4654 | 42314 | 3723 | 44911 | 2975 | 48521 | 1725 | 60554 | 854 | 53351 |
| 8L-6S | | MI | 20532 | 6484 | 35817 | 4602 | 40025 | 3680 | 42796 | 2939 | 46638 | 1678 | 57917 | 978 | 49444 |

## RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

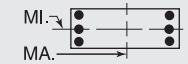
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.18 | MA | 22053 | 5376 | 34857 | 3956 | 37678 | 3220 | 38534 | 2676 | 38647 | 1890 | 45460 | 1766 | 19164 |
| 2E | | MI | 18620 | 5376 | 29636 | 3902 | 31798 | 3176 | 32344 | 2636 | 32134 | 1847 | 37537 | 1710 | 16053 |
| 6-#18 | 1.76 | MA | 23423 | 5660 | 37849 | 4134 | 41492 | 3349 | 43171 | 2756 | 44852 | 1868 | 53691 | 1714 | 28334 |
| 2L-3S | | MI | 18118 | 5660 | 29636 | 4070 | 31798 | 3325 | 32344 | 2731 | 32134 | 1835 | 37537 | 1417 | 23650 |
| 6-#18 | 1.76 | MA | 21461 | 5660 | 34857 | 4128 | 37678 | 3374 | 38534 | 2778 | 38647 | 1885 | 45460 | 1486 | 28278 |
| 3L-2S | | MI | 19726 | 5660 | 32095 | 4080 | 34934 | 3304 | 36134 | 2714 | 37140 | 1818 | 44114 | 1644 | 23628 |
| 8-#14 | 1.32 | MA | 22483 | 5447 | 35606 | 4028 | 38780 | 3275 | 39929 | 2716 | 40670 | 1907 | 48250 | 1783 | 21651 |
| 2L-4S | | MI | 17380 | 5447 | 27707 | 3991 | 29485 | 3241 | 29632 | 2683 | 28721 | 1886 | 33568 | 1473 | 18171 |
| 8-#14 | 1.32 | MA | 21348 | 5447 | 33895 | 4026 | 36599 | 3291 | 37278 | 2729 | 37088 | 1917 | 43476 | 1655 | 21684 |
| 3E | | MI | 18048 | 5447 | 28849 | 3975 | 30937 | 3248 | 31394 | 2692 | 30950 | 1876 | 36066 | 1601 | 18176 |
| 8-#14 | 1.32 | MA | 20544 | 5447 | 32518 | 4044 | 34848 | 3286 | 35153 | 2723 | 34340 | 1927 | 40356 | 1527 | 21614 |
| 4L-2S | | MI | 18981 | 5447 | 30261 | 3979 | 32737 | 3235 | 33582 | 2681 | 33856 | 1867 | 39906 | 1729 | 18123 |
| 8-#18 | 2.35 | MA | 24772 | 5944 | 40840 | 4311 | 45307 | 3477 | 47808 | 2836 | 51057 | 1845 | 61922 | 1662 | 37457 |
| 2L-4S | | MI | 18085 | 5944 | 30099 | 4274 | 32396 | 3440 | 33077 | 2792 | 33301 | 1824 | 39834 | 1127 | 29664 |
| 8-#18 | 2.35 | MA | 22834 | 5944 | 37849 | 4305 | 41492 | 3503 | 43171 | 2858 | 44852 | 1863 | 53691 | 1434 | 37290 |
| 3E | | MI | 19227 | 5944 | 32095 | 4248 | 34934 | 3454 | 36134 | 2810 | 37140 | 1806 | 44114 | 1351 | 31078 |
| 8-#18 | 2.35 | MA | 21457 | 5944 | 35434 | 4335 | 38423 | 3493 | 39446 | 2844 | 40092 | 1881 | 48326 | 1206 | 35561 |
| 4L-2S | | MI | 20818 | 5944 | 34555 | 4257 | 38070 | 3433 | 39924 | 2792 | 42145 | 1789 | 50690 | 1578 | 31154 |
| 10-#11 | 1.15 | MA | 22097 | 5362 | 34684 | 3989 | 37680 | 3248 | 38621 | 2701 | 38950 | 1922 | 46034 | 1810 | 18932 |
| 2L-5S | | MI | 17127 | 5362 | 27015 | 3949 | 28664 | 3225 | 28652 | 2679 | 27352 | 1894 | 31833 | 1545 | 15930 |
| 10-#11 | 1.15 | MA | 21299 | 5362 | 33488 | 3988 | 36155 | 3259 | 36767 | 2711 | 36439 | 1929 | 42674 | 1721 | 18964 |
| 3L-4S | | MI | 17548 | 5362 | 27716 | 3951 | 29568 | 3215 | 29759 | 2671 | 28901 | 1901 | 33706 | 1586 | 15945 |
| 10-#11 | 1.15 | MA | 20735 | 5362 | 32527 | 4000 | 34933 | 3257 | 35284 | 2707 | 34513 | 1936 | 40475 | 1632 | 18966 |
| 4L-3S | | MI | 18017 | 5362 | 28515 | 3940 | 30583 | 3219 | 30990 | 2677 | 30471 | 1894 | 35473 | 1674 | 15916 |
| 10-#11 | 1.15 | MA | 20230 | 5362 | 31684 | 3999 | 33846 | 3268 | 33953 | 2717 | 32615 | 1930 | 38173 | 1589 | 18899 |
| 5L-2S | | MI | 18674 | 5362 | 29503 | 3942 | 31843 | 3209 | 32522 | 2669 | 32518 | 1887 | 38185 | 1763 | 15875 |
| 10-#14 | 1.65 | MA | 23273 | 5607 | 37317 | 4128 | 40961 | 3347 | 42581 | 2761 | 44252 | 1896 | 53023 | 1757 | 26884 |
| 2L-5S | | MI | 17437 | 5607 | 28115 | 4087 | 29991 | 3327 | 30236 | 2739 | 29426 | 1862 | 34750 | 1383 | 21744 |
| 10-#14 | 1.65 | MA | 22147 | 5607 | 35606 | 4126 | 38780 | 3363 | 39929 | 2774 | 40670 | 1906 | 48250 | 1629 | 26881 |
| 3L-4S | | MI | 18034 | 5607 | 29119 | 4091 | 31285 | 3314 | 31820 | 2728 | 31627 | 1872 | 37408 | 1441 | 22436 |
| 10-#14 | 1.65 | MA | 21350 | 5607 | 34229 | 4144 | 37029 | 3359 | 37805 | 2768 | 37922 | 1916 | 45130 | 1501 | 26767 |
| 4L-3S | | MI | 18696 | 5607 | 30261 | 4075 | 32737 | 3320 | 33582 | 2737 | 33856 | 1862 | 39906 | 1569 | 22487 |
| 10-#14 | 1.65 | MA | 20634 | 5607 | 33021 | 4141 | 35472 | 3374 | 35897 | 2781 | 35212 | 1906 | 41852 | 1440 | 25875 |
| 5L-2S | | MI | 19623 | 5607 | 31673 | 4079 | 34536 | 3307 | 35769 | 2726 | 36762 | 1852 | 43747 | 1697 | 22456 |
| 10-#18 | 2.94 | MA | 26103 | 6228 | 43832 | 4488 | 49121 | 3606 | 52444 | 2916 | 57262 | 1823 | 70153 | 1609 | 46538 |
| 2L-5S | | MI | 18176 | 6228 | 30800 | 4442 | 33267 | 3589 | 34116 | 2888 | 34514 | 1777 | 41850 | 959 | 34872 |
| 10-#18 | 2.94 | MA | 24187 | 6228 | 40840 | 4483 | 45307 | 3631 | 47808 | 2937 | 51057 | 1841 | 61922 | 1382 | 46284 |
| 3L-4S | | MI | 19193 | 6228 | 32559 | 4451 | 35532 | 3568 | 36867 | 2870 | 38306 | 1795 | 46410 | 1061 | 36652 |
| 10-#18 | 2.94 | MA | 22828 | 6228 | 38426 | 4512 | 42237 | 3622 | 44083 | 2923 | 46297 | 1859 | 56557 | 1154 | 44123 |
| 4L-3S | | MI | 20321 | 6228 | 34555 | 4425 | 38070 | 3583 | 39924 | 2888 | 42145 | 1777 | 50690 | 1285 | 38479 |
| 10-#18 | 2.94 | MA | 21608 | 6228 | 36305 | 4507 | 39503 | 3647 | 40735 | 2945 | 41600 | 1841 | 50880 | 1049 | 41735 |
| 5L-2S | | MI | 21895 | 6228 | 37015 | 4434 | 41206 | 3562 | 43713 | 2870 | 47150 | 1759 | 57266 | 1513 | 38641 |
| 12-#11 | 1.38 | MA | 22656 | 5473 | 35880 | 4058 | 39205 | 3298 | 40474 | 2733 | 41462 | 1915 | 49394 | 1794 | 22594 |
| 2L-6S | | MI | 17190 | 5473 | 27341 | 4016 | 29025 | 3271 | 29087 | 2705 | 27976 | 1892 | 32786 | 1465 | 18421 |
| 12-#11 | 1.38 | MA | 21862 | 5473 | 34684 | 4057 | 37680 | 3309 | 38621 | 2742 | 38950 | 1922 | 46034 | 1705 | 22614 |
| 3L-5S | | MI | 17590 | 5473 | 28004 | 4018 | 29924 | 3275 | 30184 | 2711 | 29398 | 1885 | 34546 | 1524 | 18917 |
| 12-#11 | 1.38 | MA | 21302 | 5473 | 33723 | 4070 | 36458 | 3307 | 37138 | 2739 | 37025 | 1929 | 43835 | 1616 | 22592 |
| 4E | | MI | 18009 | 5473 | 28705 | 4020 | 30828 | 3265 | 31291 | 2702 | 30948 | 1892 | 36418 | 1565 | 18957 |
| 12-#11 | 1.38 | MA | 20800 | 5473 | 32880 | 4068 | 35371 | 3318 | 35807 | 2748 | 35126 | 1923 | 41533 | 1573 | 22500 |
| 5L-3S | | MI | 18475 | 5473 | 29503 | 4009 | 31843 | 3269 | 32522 | 2708 | 32518 | 1885 | 38185 | 1654 | 18945 |
| 12-#11 | 1.38 | MA | 20320 | 5473 | 32085 | 4067 | 34291 | 3316 | 34489 | 2745 | 33381 | 1930 | 39348 | 1514 | 21852 |
| 6L-2S | | MI | 19128 | 5473 | 30492 | 4011 | 33104 | 3260 | 34055 | 2700 | 34564 | 1878 | 40898 | 1742 | 18914 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis

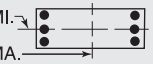


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 1.99 | MA | 24056 | 5766 | 39028 | 4228 | 43143 | 3420 | 45233 | 2805 | 47835 | 1886 | 57797 | 1732 | 32105 |
| 2L-6S | | MI | 17524 | 5766 | 28578 | 4182 | 30503 | 3393 | 30910 | 2795 | 30312 | 1858 | 36101 | 1265 | 25153 |
| 12-#14 | 1.99 | MA | 22938 | 5766 | 37317 | 4226 | 40961 | 3435 | 42581 | 2819 | 44252 | 1896 | 53023 | 1604 | 32065 |
| 3L-5S | | MI | 18089 | 5766 | 29527 | 4186 | 31791 | 3400 | 32424 | 2784 | 32332 | 1848 | 38591 | 1351 | 25837 |
| 12-#14 | 1.99 | MA | 22147 | 5766 | 35940 | 4243 | 39211 | 3431 | 40457 | 2813 | 41504 | 1906 | 49903 | 1476 | 31913 |
| 4E | | MI | 18681 | 5766 | 30531 | 4190 | 33085 | 3386 | 34008 | 2773 | 34533 | 1858 | 41249 | 1409 | 26690 |
| 12-#14 | 1.99 | MA | 21438 | 5766 | 34732 | 4241 | 37653 | 3447 | 38549 | 2826 | 38794 | 1896 | 46626 | 1414 | 30856 |
| 5L-3S | | MI | 19338 | 5766 | 31673 | 4175 | 34536 | 3393 | 35769 | 2782 | 36762 | 1848 | 43747 | 1537 | 26776 |
| 12-#14 | 1.99 | MA | 20762 | 5766 | 33591 | 4239 | 36104 | 3442 | 36660 | 2820 | 36304 | 1906 | 43524 | 1330 | 29932 |
| 6L-2S | | MI | 20259 | 5766 | 33084 | 4179 | 36336 | 3379 | 37957 | 2771 | 39668 | 1838 | 47587 | 1665 | 26775 |
| 12-#18 | 3.53 | MA | 25523 | 6511 | 43832 | 4660 | 49121 | 3760 | 52444 | 3017 | 57262 | 1819 | 70153 | 1330 | 55266 |
| 3L-5S | | MI | 19282 | 6511 | 33260 | 4619 | 36403 | 3718 | 37906 | 2966 | 39520 | 1748 | 48426 | 893 | 42030 |
| 12-#18 | 3.53 | MA | 24181 | 6511 | 41418 | 4690 | 46051 | 3750 | 48719 | 3003 | 52502 | 1836 | 64787 | 1102 | 52730 |
| 4E | | MI | 20287 | 6511 | 35018 | 4628 | 38668 | 3697 | 40657 | 2948 | 43312 | 1766 | 52987 | 995 | 43686 |
| 12-#18 | 3.53 | MA | 22976 | 6511 | 39297 | 4684 | 43317 | 3776 | 45372 | 3025 | 47806 | 1819 | 59111 | 997 | 50484 |
| 5L-3S | | MI | 21403 | 6511 | 37015 | 4602 | 41206 | 3711 | 43713 | 2966 | 47150 | 1748 | 57266 | 1219 | 45865 |
| 12-#18 | 3.53 | MA | 21827 | 6511 | 37293 | 4678 | 40597 | 3766 | 42056 | 3011 | 43492 | 1836 | 53769 | 845 | 47035 |
| 6L-2S | | MI | 22962 | 6511 | 39475 | 4612 | 44342 | 3690 | 47503 | 2948 | 52156 | 1730 | 63842 | 1447 | 46098 |
| 14-#11 | 1.61 | MA | 23210 | 5583 | 37076 | 4127 | 40730 | 3348 | 42328 | 2764 | 43973 | 1908 | 52754 | 1777 | 26249 |
| 2L-7S | | MI | 17263 | 5583 | 27620 | 4096 | 29421 | 3331 | 29561 | 2744 | 28630 | 1890 | 33664 | 1356 | 20993 |
| 14-#11 | 1.61 | MA | 22422 | 5583 | 35880 | 4126 | 39205 | 3359 | 40474 | 2774 | 41462 | 1915 | 49394 | 1689 | 26253 |
| 3L-6S | | MI | 17652 | 5583 | 28329 | 4085 | 30285 | 3321 | 30619 | 2736 | 30022 | 1883 | 35498 | 1444 | 21323 |
| 14-#11 | 1.61 | MA | 21865 | 5583 | 34919 | 4139 | 37983 | 3357 | 38991 | 2770 | 39536 | 1922 | 47195 | 1600 | 26211 |
| 4L-5S | | MI | 18050 | 5583 | 28992 | 4087 | 31184 | 3325 | 31716 | 2742 | 31445 | 1876 | 37258 | 1503 | 21877 |
| 14-#11 | 1.61 | MA | 21365 | 5583 | 34076 | 4138 | 36896 | 3368 | 37660 | 2780 | 37637 | 1916 | 44893 | 1557 | 26098 |
| 5L-4S | | MI | 18466 | 5583 | 29694 | 4090 | 32089 | 3316 | 32823 | 2734 | 32994 | 1883 | 39130 | 1544 | 21957 |
| 14-#11 | 1.61 | MA | 20889 | 5583 | 33281 | 4136 | 35816 | 3366 | 36343 | 2776 | 35893 | 1923 | 42708 | 1498 | 25371 |
| 6L-3S | | MI | 18930 | 5583 | 30492 | 4078 | 33104 | 3320 | 34055 | 2739 | 34564 | 1876 | 40898 | 1633 | 21965 |
| 14-#11 | 1.61 | MA | 20424 | 5583 | 32430 | 4149 | 34778 | 3377 | 35071 | 2786 | 34185 | 1930 | 40434 | 1410 | 24915 |
| 7L-2S | | MI | 19580 | 5583 | 31480 | 4081 | 34364 | 3310 | 35587 | 2731 | 36611 | 1869 | 43610 | 1721 | 21944 |
| 14-#14 | 2.32 | MA | 24833 | 5926 | 40739 | 4327 | 45324 | 3492 | 47884 | 2850 | 51417 | 1875 | 62570 | 1706 | 37307 |
| 2L-7S | | MI | 17628 | 5926 | 28974 | 4298 | 31065 | 3479 | 31526 | 2831 | 31241 | 1854 | 37346 | 1106 | 28171 |
| 14-#14 | 2.32 | MA | 23722 | 5926 | 39028 | 4325 | 43143 | 3508 | 45233 | 2864 | 47835 | 1885 | 57797 | 1578 | 37240 |
| 3L-6S | | MI | 18175 | 5926 | 29989 | 4282 | 32303 | 3465 | 33098 | 2840 | 33218 | 1844 | 39942 | 1233 | 29299 |
| 14-#14 | 2.32 | MA | 22938 | 5926 | 37651 | 4343 | 41392 | 3503 | 43108 | 2858 | 45086 | 1895 | 54677 | 1450 | 37054 |
| 4L-5S | | MI | 18736 | 5926 | 30938 | 4286 | 33590 | 3472 | 34612 | 2829 | 35238 | 1834 | 42431 | 1318 | 29946 |
| 14-#14 | 2.32 | MA | 22235 | 5926 | 36443 | 4341 | 39834 | 3519 | 41201 | 2871 | 42376 | 1885 | 51399 | 1389 | 35853 |
| 5L-4S | | MI | 19323 | 5926 | 31942 | 4290 | 34885 | 3458 | 36196 | 2818 | 37439 | 1844 | 45089 | 1376 | 30936 |
| 14-#14 | 2.32 | MA | 21564 | 5926 | 35302 | 4339 | 38285 | 3515 | 39312 | 2865 | 39886 | 1895 | 48297 | 1304 | 34972 |
| 6L-3S | | MI | 19976 | 5926 | 33084 | 4274 | 36336 | 3465 | 37957 | 2827 | 39668 | 1834 | 47587 | 1504 | 31053 |
| 14-#14 | 2.32 | MA | 20909 | 5926 | 34082 | 4356 | 36798 | 3530 | 37489 | 2878 | 37448 | 1905 | 45067 | 1178 | 33573 |
| 7L-2S | | MI | 20890 | 5926 | 34496 | 4278 | 38136 | 3452 | 40145 | 2816 | 42574 | 1824 | 51428 | 1632 | 31085 |
| 14-#18 | 4.12 | MA | 25517 | 6795 | 44409 | 4867 | 49865 | 3879 | 53356 | 3083 | 58707 | 1814 | 73018 | 1050 | 61376 |
| 4L-5S | | MI | 20376 | 6795 | 35720 | 4796 | 39538 | 3846 | 41696 | 3044 | 44525 | 1719 | 55003 | 827 | 49061 |
| 14-#18 | 4.12 | MA | 24327 | 6795 | 42288 | 4861 | 47131 | 3904 | 50008 | 3104 | 54011 | 1796 | 67342 | 944 | 59254 |
| 5L-4S | | MI | 21370 | 6795 | 37478 | 4806 | 41804 | 3825 | 44447 | 3027 | 48317 | 1736 | 59563 | 929 | 50758 |
| 14-#18 | 4.12 | MA | 23193 | 6795 | 40285 | 4856 | 44411 | 3895 | 46692 | 3091 | 49697 | 1814 | 62000 | 793 | 55657 |
| 6L-3S | | MI | 22474 | 6795 | 39475 | 4780 | 44342 | 3840 | 47503 | 3044 | 52156 | 1719 | 63842 | 1153 | 53239 |
| 16-#11 | 1.84 | MA | 23762 | 5694 | 38272 | 4196 | 42255 | 3398 | 44182 | 2795 | 46484 | 1901 | 56114 | 1761 | 29898 |
| 2L-8S | | MI | 17344 | 5694 | 27958 | 4163 | 29809 | 3377 | 30056 | 2784 | 29217 | 1874 | 34628 | 1287 | 23270 |
| 16-#11 | 1.84 | MA | 22977 | 5694 | 37076 | 4195 | 40730 | 3410 | 42328 | 2805 | 43973 | 1908 | 52754 | 1672 | 29884 |
| 3L-7S | | MI | 17725 | 5694 | 28609 | 4165 | 30681 | 3381 | 31093 | 2775 | 30677 | 1881 | 36377 | 1335 | 23916 |
| 16-#11 | 1.84 | MA | 22423 | 5694 | 36115 | 4208 | 39508 | 3407 | 40845 | 2801 | 42047 | 1916 | 50555 | 1584 | 29825 |
| 4L-6S | | MI | 18111 | 5694 | 29318 | 4154 | 31545 | 3371 | 32152 | 2767 | 32069 | 1874 | 38211 | 1423 | 24232 |
| 16-#11 | 1.84 | MA | 21927 | 5694 | 35272 | 4207 | 38421 | 3418 | 39514 | 2811 | 40149 | 1909 | 48253 | 1540 | 29602 |
| 5E | | MI | 18507 | 5694 | 29981 | 4156 | 32445 | 3375 | 33248 | 2773 | 33492 | 1867 | 39971 | 1482 | 24756 |
| 16-#11 | 1.84 | MA | 21454 | 5694 | 34477 | 4206 | 37340 | 3416 | 38196 | 2807 | 38404 | 1916 | 46068 | 1482 | 28896 |
| 6L-4S | | MI | 18921 | 5694 | 30682 | 4159 | 33349 | 3366 | 34355 | 2765 | 35041 | 1874 | 41843 | 1523 | 24951 |

## RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

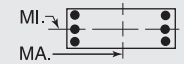
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.84 | MA | 20992 | 5694 | 33626 | 4218 | 36303 | 3427 | 36925 | 2817 | 36696 | 1923 | 43794 | 1394 | 28457 |
| 7L-3S | | MI | 19382 | 5694 | 31480 | 4147 | 34364 | 3370 | 35587 | 2770 | 36611 | 1867 | 43610 | 1612 | 24980 |
| 16-#11 | 1.84 | MA | 20537 | 5694 | 32845 | 4217 | 35256 | 3425 | 35680 | 2827 | 34908 | 1917 | 41643 | 1344 | 27643 |
| 8L-2S | | MI | 20029 | 5694 | 32469 | 4150 | 35624 | 3360 | 37119 | 2762 | 38658 | 1860 | 46322 | 1701 | 24968 |
| 16-#14 | 2.65 | MA | 24500 | 6086 | 40739 | 4425 | 45324 | 3580 | 47884 | 2909 | 51417 | 1875 | 62570 | 1553 | 42408 |
| 3L-7S | | MI | 18277 | 6086 | 30386 | 4398 | 32865 | 3551 | 33714 | 2875 | 34147 | 1840 | 41186 | 1074 | 32245 |
| 16-#14 | 2.65 | MA | 23722 | 6086 | 39362 | 4443 | 43573 | 3576 | 45760 | 2902 | 48669 | 1885 | 59451 | 1425 | 42191 |
| 4L-6S | | MI | 18820 | 6086 | 31401 | 4382 | 34103 | 3538 | 35286 | 2885 | 36124 | 1830 | 43782 | 1201 | 33453 |
| 16-#14 | 2.65 | MA | 23024 | 6086 | 38154 | 4441 | 42016 | 3591 | 43852 | 2916 | 45958 | 1875 | 56173 | 1363 | 40864 |
| 5E | | MI | 19377 | 6086 | 32350 | 4386 | 35390 | 3544 | 36800 | 2874 | 38145 | 1820 | 46272 | 1286 | 34068 |
| 16-#14 | 2.65 | MA | 22359 | 6086 | 37013 | 4438 | 40467 | 3587 | 41964 | 2910 | 43468 | 1885 | 53071 | 1279 | 40021 |
| 6L-4S | | MI | 19960 | 6086 | 33354 | 4390 | 36684 | 3531 | 38384 | 2863 | 40345 | 1830 | 48930 | 1344 | 35177 |
| 16-#14 | 2.65 | MA | 21709 | 6086 | 35793 | 4456 | 38979 | 3603 | 40141 | 2923 | 41030 | 1894 | 49841 | 1152 | 38543 |
| 7L-3S | | MI | 20608 | 6086 | 34496 | 4374 | 38136 | 3537 | 40145 | 2872 | 42574 | 1820 | 51428 | 1472 | 35323 |
| 16-#14 | 2.65 | MA | 21069 | 6086 | 34673 | 4454 | 37478 | 3599 | 38356 | 2937 | 38477 | 1885 | 46779 | 1080 | 37223 |
| 8L-2S | | MI | 21517 | 6086 | 35908 | 4378 | 39936 | 3524 | 42333 | 2861 | 45480 | 1810 | 55269 | 1600 | 35377 |
| 16-#18 | 4.71 | MA | 25664 | 7079 | 45280 | 5039 | 50945 | 4033 | 54645 | 3184 | 60216 | 1774 | 75573 | 892 | 67896 |
| 5E | | MI | 21459 | 7079 | 38179 | 4973 | 42674 | 3975 | 45486 | 3123 | 49530 | 1690 | 61579 | 761 | 55984 |
| 16-#18 | 4.71 | MA | 24542 | 7079 | 43277 | 5033 | 48225 | 4023 | 51329 | 3170 | 55902 | 1792 | 70231 | 741 | 64303 |
| 6L-4S | | MI | 22442 | 7079 | 39938 | 4983 | 44940 | 3954 | 48237 | 3105 | 53322 | 1707 | 66139 | 863 | 57860 |
| 18-#11 | 2.06 | MA | 23529 | 5805 | 38272 | 4264 | 42255 | 3460 | 44182 | 2836 | 46484 | 1902 | 56114 | 1656 | 33510 |
| 3L-8S | | MI | 17805 | 5805 | 28947 | 4232 | 31070 | 3427 | 31588 | 2815 | 31264 | 1865 | 37341 | 1266 | 26146 |
| 18-#11 | 2.06 | MA | 22978 | 5805 | 37311 | 4277 | 41032 | 3457 | 42699 | 2832 | 44559 | 1909 | 53915 | 1567 | 33435 |
| 4L-7S | | MI | 18183 | 5805 | 29598 | 4235 | 31942 | 3431 | 32625 | 2807 | 32723 | 1872 | 39089 | 1314 | 26838 |
| 18-#11 | 2.06 | MA | 22485 | 5805 | 36469 | 4276 | 39946 | 3468 | 41368 | 2842 | 42660 | 1902 | 51613 | 1524 | 33103 |
| 5L-6S | | MI | 18567 | 5805 | 30307 | 4223 | 32806 | 3422 | 33684 | 2798 | 34116 | 1865 | 40923 | 1402 | 27147 |
| 18-#11 | 2.06 | MA | 22015 | 5805 | 35673 | 4275 | 38865 | 3466 | 40050 | 2838 | 40915 | 1909 | 49428 | 1465 | 32428 |
| 6L-5S | | MI | 18961 | 5805 | 30969 | 4226 | 33705 | 3426 | 34780 | 2804 | 35538 | 1858 | 42683 | 1461 | 27644 |
| 18-#11 | 2.06 | MA | 21556 | 5805 | 34822 | 4287 | 37828 | 3477 | 38779 | 2848 | 39208 | 1916 | 47154 | 1378 | 32003 |
| 7L-4S | | MI | 19373 | 5805 | 31671 | 4228 | 34609 | 3416 | 35887 | 2796 | 37088 | 1865 | 44555 | 1502 | 27940 |
| 18-#11 | 2.06 | MA | 21103 | 5805 | 34041 | 4286 | 36781 | 3475 | 37534 | 2858 | 37419 | 1910 | 45003 | 1327 | 31139 |
| 8L-3S | | MI | 19831 | 5805 | 32469 | 4216 | 35624 | 3420 | 37119 | 2801 | 38658 | 1858 | 46322 | 1591 | 27981 |
| 18-#11 | 2.06 | MA | 20655 | 5805 | 33215 | 4299 | 35758 | 3486 | 36246 | 2854 | 35729 | 1917 | 42886 | 1271 | 30442 |
| 9L-2S | | MI | 20475 | 5805 | 33458 | 4219 | 36885 | 3410 | 38651 | 2793 | 40704 | 1851 | 49035 | 1680 | 27986 |
| 18-#14 | 2.98 | MA | 24499 | 6245 | 41073 | 4543 | 45755 | 3648 | 48412 | 2947 | 52251 | 1874 | 64224 | 1399 | 47325 |
| 4L-7S | | MI | 18922 | 6245 | 31797 | 4498 | 34665 | 3623 | 35902 | 2920 | 37054 | 1826 | 45027 | 1041 | 36330 |
| 18-#14 | 2.98 | MA | 23807 | 6245 | 39865 | 4540 | 44197 | 3664 | 46504 | 2961 | 49540 | 1864 | 60946 | 1338 | 45886 |
| 5L-6S | | MI | 19461 | 6245 | 32813 | 4482 | 35902 | 3610 | 37474 | 2929 | 39031 | 1816 | 47623 | 1168 | 37571 |
| 18-#14 | 2.98 | MA | 23147 | 6245 | 38724 | 4538 | 42648 | 3659 | 44615 | 2955 | 47050 | 1874 | 57844 | 1253 | 45076 |
| 6L-5S | | MI | 20013 | 6245 | 33762 | 4486 | 37190 | 3616 | 38987 | 2919 | 41051 | 1806 | 50113 | 1253 | 38201 |
| 18-#14 | 2.98 | MA | 22503 | 6245 | 37504 | 4556 | 41161 | 3675 | 42793 | 2968 | 44613 | 1884 | 54615 | 1127 | 43523 |
| 7L-4S | | MI | 20592 | 6245 | 34766 | 4490 | 38484 | 3603 | 40572 | 2908 | 43251 | 1816 | 52771 | 1311 | 39373 |
| 18-#14 | 2.98 | MA | 21868 | 6245 | 36384 | 4554 | 39660 | 3671 | 41008 | 2982 | 42059 | 1874 | 51552 | 1055 | 42148 |
| 8L-3S | | MI | 21236 | 6245 | 35908 | 4474 | 39936 | 3610 | 42333 | 2917 | 45480 | 1806 | 55269 | 1439 | 39586 |
| 18-#14 | 2.98 | MA | 21238 | 6245 | 35199 | 4572 | 38193 | 3686 | 39161 | 2975 | 39647 | 1884 | 48547 | 973 | 40542 |
| 9L-2S | | MI | 22139 | 6245 | 37319 | 4478 | 41736 | 3596 | 44521 | 2906 | 48387 | 1796 | 59109 | 1567 | 39662 |
| 18-#18 | 5.29 | MA | 25878 | 7362 | 46268 | 5210 | 52040 | 4152 | 55965 | 3250 | 62107 | 1770 | 78462 | 689 | 72971 |
| 6L-5S | | MI | 22532 | 7362 | 40639 | 5151 | 45810 | 4104 | 49276 | 3201 | 54536 | 1660 | 68155 | 695 | 62938 |
| 20-#11 | 2.29 | MA | 23530 | 5915 | 38507 | 4346 | 42557 | 3507 | 44552 | 2863 | 47070 | 1902 | 57275 | 1551 | 37042 |
| 4L-8S | | MI | 18262 | 5915 | 29935 | 4301 | 32330 | 3478 | 33120 | 2846 | 33310 | 1856 | 40053 | 1245 | 29027 |
| 20-#11 | 2.29 | MA | 23040 | 5915 | 37665 | 4345 | 41471 | 3519 | 43221 | 2873 | 45171 | 1895 | 54973 | 1508 | 36612 |
| 5L-7S | | MI | 18639 | 5915 | 30586 | 4304 | 33202 | 3482 | 34157 | 2838 | 34770 | 1863 | 41802 | 1293 | 29694 |
| 20-#11 | 2.29 | MA | 22572 | 5915 | 36869 | 4344 | 40390 | 3516 | 41904 | 2869 | 43427 | 1902 | 52788 | 1449 | 35965 |
| 6E | | MI | 19021 | 5915 | 31295 | 4292 | 34066 | 3472 | 35216 | 2829 | 36162 | 1856 | 43636 | 1381 | 30065 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.29 | MA | 22116 | 5915 | 36018 | 4357 | 39353 | 3527 | 40632 | 2879 | 41719 | 1909 | 50514 | 1361 | 35522 |
| 7L-5S | | MI | 19412 | 5915 | 31958 | 4295 | 34965 | 3476 | 36313 | 2835 | 37585 | 1849 | 45395 | 1440 | 30539 |
| 20-#11 | 2.29 | MA | 21666 | 5915 | 35237 | 4355 | 38306 | 3525 | 39387 | 2889 | 39931 | 1903 | 48363 | 1311 | 34640 |
| 8L-4S | | MI | 19822 | 5915 | 32659 | 4297 | 35870 | 3466 | 37420 | 2827 | 39134 | 1856 | 47268 | 1481 | 30925 |
| 20-#11 | 2.29 | MA | 21220 | 5915 | 34411 | 4368 | 37283 | 3536 | 38099 | 2885 | 38241 | 1910 | 46246 | 1255 | 33905 |
| 9L-3S | | MI | 20278 | 5915 | 33458 | 4286 | 36885 | 3470 | 38651 | 2833 | 40704 | 1849 | 49035 | 1570 | 30980 |
| 20-#11 | 2.29 | MA | 20719 | 5915 | 33634 | 4367 | 36249 | 3534 | 36862 | 2895 | 36564 | 1917 | 44194 | 1191 | 32931 |
| 10L-2S | | MI | 20919 | 5915 | 34446 | 4288 | 38145 | 3460 | 40183 | 2824 | 42751 | 1842 | 51747 | 1659 | 31000 |
| 20-#14 | 3.31 | MA | 24584 | 6405 | 41576 | 4640 | 46378 | 3736 | 49156 | 3006 | 53122 | 1854 | 65720 | 1312 | 50918 |
| 5L-7S | | MI | 19561 | 6405 | 33209 | 4597 | 36465 | 3696 | 38090 | 2965 | 39960 | 1812 | 48868 | 1009 | 40425 |
| 20-#14 | 3.31 | MA | 23929 | 6405 | 40435 | 4638 | 44829 | 3732 | 47267 | 2999 | 50632 | 1863 | 62618 | 1228 | 50098 |
| 6E | | MI | 20097 | 6405 | 34224 | 4581 | 37702 | 3682 | 39662 | 2974 | 41937 | 1802 | 51463 | 1136 | 41618 |
| 20-#14 | 3.31 | MA | 23290 | 6405 | 39215 | 4656 | 43342 | 3747 | 45444 | 3013 | 48195 | 1873 | 59388 | 1101 | 48513 |
| 7L-5S | | MI | 20645 | 6405 | 35173 | 4585 | 38990 | 3689 | 41175 | 2963 | 43957 | 1792 | 53953 | 1221 | 42342 |
| 20-#14 | 3.31 | MA | 22660 | 6405 | 38095 | 4654 | 41841 | 3743 | 43659 | 3027 | 45641 | 1863 | 56326 | 1030 | 47082 |
| 8L-4S | | MI | 21220 | 6405 | 36177 | 4589 | 40284 | 3675 | 42760 | 2953 | 46158 | 1802 | 56611 | 1279 | 43456 |
| 20-#14 | 3.31 | MA | 22035 | 6405 | 36910 | 4671 | 40374 | 3759 | 41813 | 3020 | 43229 | 1873 | 53321 | 948 | 45519 |
| 9L-3S | | MI | 21859 | 6405 | 37319 | 4574 | 41736 | 3682 | 44521 | 2962 | 48387 | 1792 | 59109 | 1407 | 43843 |
| 22-#11 | 2.52 | MA | 23591 | 6026 | 38861 | 4414 | 42995 | 3569 | 45075 | 2904 | 47683 | 1888 | 58333 | 1491 | 40128 |
| 5L-8S | | MI | 18718 | 6026 | 30924 | 4371 | 33590 | 3528 | 34652 | 2877 | 35357 | 1847 | 42766 | 1225 | 31914 |
| 22-#11 | 2.52 | MA | 23126 | 6026 | 38065 | 4413 | 41915 | 3566 | 43757 | 2900 | 45938 | 1895 | 56148 | 1433 | 39506 |
| 6L-7S | | MI | 19092 | 6026 | 31575 | 4373 | 34462 | 3532 | 35689 | 2869 | 36817 | 1854 | 44514 | 1273 | 32557 |
| 22-#11 | 2.52 | MA | 22673 | 6026 | 37214 | 4426 | 40878 | 3578 | 42486 | 2910 | 44230 | 1903 | 53874 | 1345 | 39003 |
| 7L-6S | | MI | 19472 | 6026 | 32284 | 4362 | 35326 | 3522 | 36748 | 2861 | 38209 | 1847 | 46348 | 1361 | 32988 |
| 22-#11 | 2.52 | MA | 22226 | 6026 | 36433 | 4425 | 39831 | 3575 | 41241 | 2920 | 42442 | 1896 | 51723 | 1295 | 38148 |
| 8L-5S | | MI | 19861 | 6026 | 32946 | 4364 | 36226 | 3526 | 37845 | 2866 | 39632 | 1840 | 48108 | 1420 | 33440 |
| 22-#11 | 2.52 | MA | 21780 | 6026 | 35607 | 4437 | 38807 | 3586 | 39953 | 2916 | 40752 | 1903 | 49606 | 1238 | 37374 |
| 9L-4S | | MI | 20269 | 6026 | 33648 | 4366 | 37130 | 3516 | 38952 | 2858 | 41181 | 1847 | 49980 | 1461 | 33907 |
| 22-#11 | 2.52 | MA | 21284 | 6026 | 34830 | 4436 | 37774 | 3584 | 38716 | 2926 | 39075 | 1910 | 47554 | 1175 | 36423 |
| 10L-3S | | MI | 20722 | 6026 | 34446 | 4355 | 38145 | 3520 | 40183 | 2864 | 42751 | 1840 | 51747 | 1549 | 33974 |
| 22-#14 | 3.64 | MA | 24706 | 6564 | 42146 | 4738 | 47011 | 3804 | 49919 | 3044 | 54214 | 1853 | 67392 | 1202 | 55047 |
| 6L-7S | | MI | 20197 | 6564 | 34621 | 4697 | 38265 | 3768 | 40278 | 3010 | 42866 | 1798 | 52708 | 976 | 44528 |
| 22-#14 | 3.64 | MA | 24071 | 6564 | 40926 | 4755 | 45523 | 3820 | 48096 | 3058 | 51777 | 1863 | 64162 | 1076 | 53512 |
| 7L-6S | | MI | 20728 | 6564 | 35636 | 4681 | 39502 | 3755 | 41850 | 3019 | 44843 | 1788 | 55304 | 1103 | 45677 |
| 22-#14 | 3.64 | MA | 23446 | 6564 | 39806 | 4753 | 44022 | 3815 | 46311 | 3071 | 49224 | 1853 | 61100 | 1004 | 52026 |
| 8L-5S | | MI | 21273 | 6564 | 36585 | 4685 | 40790 | 3761 | 43363 | 3008 | 46863 | 1778 | 57794 | 1189 | 46490 |
| 22-#14 | 3.64 | MA | 22824 | 6564 | 38621 | 4771 | 42555 | 3831 | 44465 | 3065 | 46811 | 1863 | 58095 | 923 | 50503 |
| 9L-4S | | MI | 21844 | 6564 | 37589 | 4689 | 42084 | 3748 | 44948 | 2998 | 49064 | 1788 | 60452 | 1247 | 47551 |
| 24-#11 | 2.75 | MA | 23677 | 6137 | 39261 | 4482 | 43440 | 3616 | 45611 | 2931 | 48449 | 1889 | 59508 | 1416 | 43051 |
| 6L-8S | | MI | 19170 | 6137 | 31912 | 4440 | 34851 | 3578 | 36185 | 2908 | 37404 | 1838 | 45478 | 1204 | 34805 |
| 24-#11 | 2.75 | MA | 23226 | 6137 | 38410 | 4495 | 42402 | 3628 | 44340 | 2941 | 46742 | 1896 | 57234 | 1329 | 42490 |
| 7E | | MI | 19543 | 6137 | 32563 | 4442 | 35723 | 3582 | 37221 | 2900 | 38863 | 1845 | 47227 | 1252 | 35427 |
| 24-#11 | 2.75 | MA | 22782 | 6137 | 37629 | 4494 | 41355 | 3625 | 43095 | 2951 | 44953 | 1889 | 55083 | 1278 | 41659 |
| 8L-6S | | MI | 19920 | 6137 | 33272 | 4431 | 36587 | 3572 | 38280 | 2892 | 40256 | 1838 | 49060 | 1340 | 35913 |
| 24-#11 | 2.75 | MA | 22337 | 6137 | 36803 | 4506 | 40332 | 3636 | 41807 | 2947 | 43263 | 1896 | 52966 | 1222 | 40848 |
| 9L-5S | | MI | 20308 | 6137 | 33935 | 4433 | 37486 | 3576 | 39377 | 2897 | 41678 | 1831 | 50820 | 1399 | 36347 |
| 24-#11 | 2.75 | MA | 21845 | 6137 | 36026 | 4505 | 39299 | 3634 | 40570 | 2957 | 41586 | 1903 | 50914 | 1158 | 39919 |
| 10L-4S | | MI | 20713 | 6137 | 34636 | 4435 | 38390 | 3566 | 40484 | 2889 | 43228 | 1838 | 52693 | 1440 | 36886 |
| 24-#14 | 3.97 | MA | 24847 | 6724 | 42637 | 4855 | 47705 | 3892 | 50748 | 3103 | 55359 | 1852 | 68935 | 1050 | 58518 |
| 7E | | MI | 20828 | 6724 | 36033 | 4797 | 40065 | 3840 | 42466 | 3055 | 45772 | 1784 | 56549 | 944 | 48639 |
| 24-#14 | 3.97 | MA | 24227 | 6724 | 41517 | 4853 | 46203 | 3888 | 48963 | 3116 | 52806 | 1842 | 65873 | 979 | 56979 |
| 8L-6S | | MI | 21356 | 6724 | 37048 | 4781 | 41302 | 3827 | 44038 | 3064 | 47749 | 1774 | 59145 | 1071 | 49746 |
| 24-#14 | 3.97 | MA | 23606 | 6724 | 40332 | 4871 | 44736 | 3903 | 47116 | 3110 | 50393 | 1852 | 62868 | 897 | 55473 |
| 9L-5S | | MI | 21897 | 6724 | 37997 | 4785 | 42589 | 3833 | 45551 | 3053 | 49769 | 1764 | 61634 | 1156 | 50645 |

## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

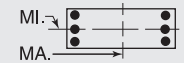
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.12 | MA | 24210 | 5617 | 38107 | 4152 | 41214 | 3381 | 42119 | 2813 | 42199 | 1998 | 49630 | 1875 | 20244 |
| 2E | | MI | 19439 | 5617 | 30872 | 4080 | 33074 | 3322 | 33582 | 2760 | 33240 | 1942 | 38757 | 1802 | 16094 |
| 6-#18 | 1.68 | MA | 25672 | 5901 | 41276 | 4329 | 45254 | 3510 | 47031 | 2893 | 48805 | 1978 | 58414 | 1826 | 29954 |
| 2L-3S | | MI | 18937 | 5901 | 30872 | 4248 | 33074 | 3471 | 33582 | 2855 | 33240 | 1931 | 38757 | 1509 | 23720 |
| 6-#18 | 1.68 | MA | 23588 | 5901 | 38107 | 4324 | 41214 | 3536 | 42119 | 2916 | 42199 | 1996 | 49630 | 1599 | 29898 |
| 3L-2S | | MI | 20548 | 5901 | 33331 | 4257 | 36210 | 3450 | 37372 | 2838 | 38246 | 1913 | 45333 | 1736 | 23677 |
| 8-#14 | 1.26 | MA | 24665 | 5688 | 38892 | 4224 | 42370 | 3436 | 43585 | 2852 | 44304 | 2014 | 52568 | 1891 | 22866 |
| 2L-4S | | MI | 18198 | 5688 | 28938 | 4170 | 30762 | 3389 | 30874 | 2808 | 29832 | 1983 | 34795 | 1566 | 18230 |
| 8-#14 | 1.26 | MA | 23461 | 5688 | 37081 | 4222 | 40062 | 3452 | 40779 | 2866 | 40502 | 2024 | 47482 | 1763 | 22899 |
| 3E | | MI | 18867 | 5688 | 30080 | 4154 | 32214 | 3395 | 32635 | 2817 | 32061 | 1973 | 37293 | 1694 | 18218 |
| 8-#14 | 1.26 | MA | 22610 | 5688 | 35626 | 4240 | 38212 | 3448 | 38533 | 2861 | 37587 | 2035 | 44155 | 1635 | 22829 |
| 4L-2S | | MI | 19801 | 5688 | 31492 | 4158 | 34013 | 3382 | 34823 | 2806 | 34967 | 1963 | 41133 | 1822 | 18161 |
| 8-#18 | 2.24 | MA | 27111 | 6184 | 44445 | 4506 | 49294 | 3638 | 51942 | 2973 | 55410 | 1958 | 67198 | 1778 | 39617 |
| 2L-4S | | MI | 18903 | 6184 | 31335 | 4451 | 33673 | 3586 | 34315 | 2916 | 34407 | 1919 | 41053 | 1219 | 29979 |
| 8-#18 | 2.24 | MA | 25052 | 6184 | 41276 | 4502 | 45254 | 3665 | 47031 | 2995 | 48805 | 1975 | 58414 | 1550 | 39450 |
| 3E | | MI | 20047 | 6184 | 33331 | 4425 | 36210 | 3600 | 37372 | 2934 | 38246 | 1902 | 45333 | 1443 | 31158 |
| 8-#18 | 2.24 | MA | 23593 | 6184 | 38722 | 4532 | 42007 | 3656 | 43091 | 2983 | 43737 | 1993 | 52680 | 1323 | 37914 |
| 4L-2S | | MI | 21641 | 6184 | 35791 | 4434 | 39346 | 3579 | 41162 | 2916 | 43251 | 1884 | 51909 | 1671 | 31209 |
| 10-#11 | 1.09 | MA | 24251 | 5603 | 37913 | 4184 | 41202 | 3409 | 42195 | 2838 | 42434 | 2027 | 50190 | 1917 | 19985 |
| 2L-5S | | MI | 17944 | 5603 | 28243 | 4129 | 29941 | 3373 | 29895 | 2805 | 28466 | 1990 | 33064 | 1638 | 15984 |
| 10-#11 | 1.09 | MA | 23406 | 5603 | 36648 | 4183 | 39589 | 3406 | 40234 | 2848 | 39777 | 2035 | 46614 | 1829 | 20017 |
| 3L-4S | | MI | 18367 | 5603 | 28944 | 4131 | 30845 | 3363 | 31002 | 2797 | 30015 | 1997 | 34937 | 1679 | 15985 |
| 10-#11 | 1.09 | MA | 22809 | 5603 | 35632 | 4196 | 38298 | 3418 | 38667 | 2845 | 37742 | 2042 | 44271 | 1740 | 20019 |
| 4L-3S | | MI | 18836 | 5603 | 29743 | 4120 | 31860 | 3367 | 32233 | 2803 | 31585 | 1990 | 36704 | 1768 | 15950 |
| 10-#11 | 1.09 | MA | 22275 | 5603 | 34742 | 4196 | 37150 | 3416 | 37261 | 2855 | 35737 | 2036 | 41825 | 1696 | 19952 |
| 5L-2S | | MI | 19493 | 5603 | 30731 | 4122 | 33120 | 3357 | 33766 | 2794 | 33632 | 1983 | 39416 | 1856 | 15907 |
| 10-#14 | 1.58 | MA | 25507 | 5847 | 40702 | 4323 | 44679 | 3508 | 46391 | 2897 | 48106 | 2004 | 57653 | 1868 | 28403 |
| 2L-5S | | MI | 18255 | 5847 | 29346 | 4266 | 31268 | 3474 | 31477 | 2864 | 30538 | 1959 | 35977 | 1476 | 21930 |
| 10-#14 | 1.58 | MA | 24312 | 5847 | 38892 | 4322 | 42370 | 3524 | 43585 | 2911 | 44304 | 2014 | 52568 | 1740 | 28400 |
| 3L-4S | | MI | 18852 | 5847 | 30350 | 4270 | 32562 | 3461 | 33062 | 2853 | 32738 | 1968 | 38635 | 1534 | 22502 |
| 10-#14 | 1.58 | MA | 23467 | 5847 | 37437 | 4340 | 40520 | 3521 | 41339 | 2906 | 41389 | 2025 | 49240 | 1612 | 28286 |
| 4L-3S | | MI | 19516 | 5847 | 31492 | 4254 | 34013 | 3468 | 34823 | 2862 | 34967 | 1959 | 41133 | 1662 | 22534 |
| 10-#14 | 1.58 | MA | 22711 | 5847 | 36161 | 4338 | 38875 | 3537 | 39324 | 2920 | 38514 | 2015 | 45755 | 1549 | 27475 |
| 5L-2S | | MI | 20444 | 5847 | 32903 | 4258 | 35813 | 3454 | 37011 | 2851 | 37873 | 1949 | 44974 | 1790 | 22498 |
| 10-#18 | 2.80 | MA | 28531 | 6468 | 47614 | 4684 | 53334 | 3767 | 56854 | 3052 | 62016 | 1937 | 75982 | 1729 | 49238 |
| 2L-5S | | MI | 18993 | 6468 | 32036 | 4619 | 34543 | 3735 | 35354 | 3012 | 35621 | 1872 | 43070 | 1051 | 35140 |
| 10-#18 | 2.80 | MA | 26495 | 6468 | 44445 | 4679 | 49294 | 3793 | 51942 | 3075 | 55410 | 1955 | 67198 | 1502 | 48984 |
| 3L-4S | | MI | 20012 | 6468 | 33794 | 4628 | 36809 | 3714 | 38105 | 2994 | 39413 | 1890 | 47630 | 1153 | 36960 |
| 10-#18 | 2.80 | MA | 25054 | 6468 | 41891 | 4710 | 46047 | 3785 | 48002 | 3063 | 50343 | 1973 | 61464 | 1274 | 46994 |
| 4L-3S | | MI | 21144 | 6468 | 35791 | 4602 | 39346 | 3729 | 41162 | 3012 | 43251 | 1872 | 51909 | 1377 | 38569 |
| 10-#18 | 2.80 | MA | 23762 | 6468 | 39650 | 4705 | 43157 | 3812 | 44463 | 3086 | 45344 | 1955 | 55420 | 1166 | 44344 |
| 5L-2S | | MI | 22722 | 6468 | 38251 | 4612 | 42482 | 3708 | 44952 | 2994 | 48256 | 1855 | 58485 | 1605 | 38705 |
| 12-#11 | 1.31 | MA | 24846 | 5713 | 39178 | 4253 | 42815 | 3459 | 44156 | 2869 | 45090 | 2020 | 53766 | 1902 | 23858 |
| 2L-6S | | MI | 18007 | 5713 | 28569 | 4196 | 30302 | 3419 | 30330 | 2831 | 29090 | 1988 | 34017 | 1558 | 18551 |
| 12-#11 | 1.31 | MA | 24005 | 5713 | 37913 | 4253 | 41202 | 3457 | 42195 | 2879 | 42434 | 2028 | 50190 | 1814 | 23878 |
| 3L-5S | | MI | 18408 | 5713 | 29232 | 4198 | 31201 | 3423 | 31427 | 2836 | 30513 | 1981 | 35777 | 1617 | 18976 |
| 12-#11 | 1.31 | MA | 23412 | 5713 | 36897 | 4266 | 39911 | 3468 | 40628 | 2876 | 40399 | 2036 | 47847 | 1725 | 23855 |
| 4E | | MI | 18828 | 5713 | 29933 | 4200 | 32105 | 3413 | 32534 | 2828 | 32062 | 1988 | 37649 | 1658 | 19003 |
| 12-#11 | 1.31 | MA | 22881 | 5713 | 36008 | 4265 | 38763 | 3466 | 39222 | 2886 | 38394 | 2029 | 45401 | 1681 | 23764 |
| 5L-3S | | MI | 19294 | 5713 | 30731 | 4189 | 33120 | 3417 | 33766 | 2834 | 33632 | 1981 | 39416 | 1747 | 18983 |
| 12-#11 | 1.31 | MA | 22374 | 5713 | 35168 | 4264 | 37622 | 3478 | 37831 | 2883 | 36551 | 2037 | 43075 | 1623 | 23150 |
| 6L-2S | | MI | 19949 | 5713 | 31720 | 4191 | 34381 | 3408 | 35298 | 2826 | 35679 | 1974 | 42129 | 1836 | 18949 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

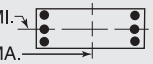


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 1.89 | MA | 26341 | 6007 | 42513 | 4423 | 46987 | 3580 | 49197 | 2942 | 51908 | 1994 | 62738 | 1844 | 33927 |
| 2L-6S | | MI | 18341 | 6007 | 29808 | 4361 | 31780 | 3540 | 32152 | 2920 | 31424 | 1954 | 37328 | 1358 | 25324 |
| 12-#14 | 1.89 | MA | 25154 | 6007 | 40702 | 4421 | 44679 | 3597 | 46391 | 2956 | 48106 | 2005 | 57653 | 1716 | 33888 |
| 3L-5S | | MI | 18907 | 6007 | 30757 | 4365 | 33067 | 3547 | 33665 | 2909 | 33444 | 1945 | 39818 | 1444 | 26020 |
| 12-#14 | 1.89 | MA | 24317 | 6007 | 39247 | 4440 | 42829 | 3593 | 44146 | 2951 | 45191 | 2015 | 54325 | 1588 | 33735 |
| 4E | | MI | 19500 | 6007 | 31761 | 4369 | 34362 | 3533 | 35250 | 2898 | 35644 | 1954 | 42476 | 1502 | 26762 |
| 12-#14 | 1.89 | MA | 23566 | 6007 | 37971 | 4438 | 41183 | 3609 | 42131 | 2965 | 42316 | 2005 | 50840 | 1526 | 32750 |
| 5L-3S | | MI | 20159 | 6007 | 32903 | 4354 | 35813 | 3540 | 37011 | 2907 | 37873 | 1945 | 44974 | 1630 | 26831 |
| 12-#14 | 1.89 | MA | 22851 | 6007 | 36767 | 4436 | 39547 | 3606 | 40135 | 2959 | 39675 | 2015 | 47534 | 1441 | 31727 |
| 6L-2S | | MI | 21082 | 6007 | 34315 | 4358 | 37613 | 3527 | 39199 | 2896 | 40780 | 1935 | 48815 | 1758 | 26820 |
| 12-#18 | 3.36 | MA | 27920 | 6752 | 47614 | 4856 | 53334 | 3922 | 56854 | 3155 | 62016 | 1935 | 75982 | 1453 | 58506 |
| 3L-5S | | MI | 20100 | 6752 | 34496 | 4796 | 37679 | 3864 | 39144 | 3090 | 40626 | 1843 | 49646 | 985 | 42295 |
| 12-#18 | 3.36 | MA | 26496 | 6752 | 45060 | 4887 | 50088 | 3913 | 52914 | 3143 | 56948 | 1952 | 70248 | 1226 | 56121 |
| 4E | | MI | 21108 | 6752 | 36254 | 4806 | 39944 | 3843 | 41895 | 3072 | 44418 | 1861 | 54206 | 1087 | 43988 |
| 12-#18 | 3.36 | MA | 25221 | 6752 | 42819 | 4882 | 47197 | 3940 | 49375 | 3165 | 51949 | 1935 | 64204 | 1118 | 53620 |
| 5L-3S | | MI | 22228 | 6752 | 38251 | 4780 | 42482 | 3857 | 44952 | 3090 | 48256 | 1843 | 58485 | 1311 | 45962 |
| 12-#18 | 3.36 | MA | 24004 | 6752 | 40702 | 4878 | 44323 | 3932 | 45869 | 3153 | 47357 | 1952 | 58500 | 967 | 50163 |
| 6L-2S | | MI | 23791 | 6752 | 40710 | 4789 | 45618 | 3836 | 48742 | 3072 | 53262 | 1826 | 65061 | 1539 | 46167 |
| 14-#11 | 1.53 | MA | 25437 | 5824 | 40443 | 4322 | 44428 | 3509 | 46116 | 2900 | 47747 | 2013 | 57343 | 1887 | 27723 |
| 2L-7S | | MI | 18080 | 5824 | 28849 | 4276 | 30698 | 3479 | 30804 | 2870 | 29744 | 1986 | 34896 | 1449 | 21121 |
| 14-#11 | 1.53 | MA | 24600 | 5824 | 39178 | 4322 | 42815 | 3507 | 44156 | 2911 | 45090 | 2021 | 53766 | 1798 | 27727 |
| 3L-6S | | MI | 18470 | 5824 | 29558 | 4265 | 31562 | 3469 | 31863 | 2862 | 31137 | 1979 | 36730 | 1537 | 21453 |
| 14-#11 | 1.53 | MA | 24011 | 5824 | 38163 | 4335 | 41524 | 3518 | 42589 | 2907 | 43055 | 2029 | 51423 | 1710 | 27685 |
| 4L-5S | | MI | 18868 | 5824 | 30220 | 4267 | 32461 | 3473 | 32959 | 2867 | 32559 | 1972 | 38489 | 1596 | 21962 |
| 14-#11 | 1.53 | MA | 23483 | 5824 | 37273 | 4334 | 40376 | 3516 | 41183 | 2918 | 41050 | 2023 | 48978 | 1666 | 27572 |
| 5L-4S | | MI | 19286 | 5824 | 30922 | 4269 | 33366 | 3463 | 34066 | 2859 | 34109 | 1979 | 40362 | 1637 | 22008 |
| 14-#11 | 1.53 | MA | 22979 | 5824 | 36433 | 4333 | 39235 | 3528 | 39792 | 2914 | 39208 | 2030 | 46651 | 1607 | 26874 |
| 6L-3S | | MI | 19750 | 5824 | 31720 | 4258 | 34381 | 3467 | 35298 | 2865 | 35679 | 1972 | 42129 | 1726 | 22006 |
| 14-#11 | 1.53 | MA | 22488 | 5824 | 35535 | 4346 | 38140 | 3526 | 38449 | 2924 | 37405 | 2038 | 44230 | 1520 | 26373 |
| 7L-2S | | MI | 20401 | 5824 | 32708 | 4260 | 35641 | 3458 | 36830 | 2857 | 37725 | 1966 | 44841 | 1815 | 21981 |
| 14-#14 | 2.21 | MA | 27168 | 6167 | 44324 | 4523 | 49296 | 3653 | 52004 | 2987 | 55710 | 1984 | 67823 | 1820 | 39433 |
| 2L-7S | | MI | 18444 | 6167 | 30205 | 4477 | 32342 | 3626 | 32767 | 2956 | 32353 | 1950 | 38573 | 1199 | 28447 |
| 14-#14 | 2.21 | MA | 25989 | 6167 | 42513 | 4521 | 46987 | 3669 | 49197 | 3001 | 51908 | 1995 | 62738 | 1692 | 39366 |
| 3L-6S | | MI | 18993 | 6167 | 31220 | 4461 | 33580 | 3613 | 34339 | 2965 | 34330 | 1940 | 41169 | 1326 | 29470 |
| 14-#14 | 2.21 | MA | 25158 | 6167 | 41058 | 4539 | 45137 | 3665 | 46952 | 2996 | 48992 | 2005 | 59410 | 1565 | 39180 |
| 4L-5S | | MI | 19555 | 6167 | 32169 | 4465 | 34867 | 3619 | 35853 | 2954 | 36350 | 1930 | 43658 | 1411 | 30127 |
| 14-#14 | 2.21 | MA | 24414 | 6167 | 39782 | 4538 | 43492 | 3682 | 44937 | 3010 | 46118 | 1995 | 55926 | 1502 | 38041 |
| 5L-4S | | MI | 20143 | 6167 | 33173 | 4469 | 36161 | 3606 | 37437 | 2943 | 38551 | 1940 | 46317 | 1469 | 31014 |
| 14-#14 | 2.21 | MA | 23705 | 6167 | 38578 | 4536 | 41856 | 3678 | 42942 | 3004 | 43476 | 2006 | 52619 | 1418 | 37066 |
| 6L-3S | | MI | 20798 | 6167 | 34315 | 4453 | 37613 | 3612 | 39199 | 2952 | 40780 | 1930 | 48815 | 1597 | 31113 |
| 14-#14 | 2.21 | MA | 23012 | 6167 | 37289 | 4554 | 40285 | 3694 | 41017 | 3018 | 40891 | 2016 | 49177 | 1291 | 35708 |
| 7L-2S | | MI | 21714 | 6167 | 35727 | 4457 | 39413 | 3599 | 41387 | 2941 | 43686 | 1921 | 52655 | 1725 | 31131 |
| 14-#18 | 3.92 | MA | 27921 | 7035 | 48229 | 5064 | 54128 | 4042 | 57825 | 3222 | 63554 | 1932 | 79032 | 1177 | 65287 |
| 4L-5S | | MI | 21196 | 7035 | 36956 | 4974 | 40815 | 3992 | 42934 | 3168 | 45631 | 1814 | 56222 | 919 | 49471 |
| 14-#18 | 3.92 | MA | 26661 | 7035 | 45987 | 5060 | 51237 | 4069 | 54286 | 3245 | 58555 | 1914 | 72988 | 1069 | 62918 |
| 5L-4S | | MI | 22193 | 7035 | 38714 | 4983 | 43080 | 3971 | 45685 | 3151 | 49423 | 1832 | 60782 | 1021 | 51055 |
| 14-#18 | 3.92 | MA | 25459 | 7035 | 43870 | 5055 | 48363 | 4060 | 50781 | 3233 | 53963 | 1932 | 67283 | 919 | 59310 |
| 6L-3S | | MI | 23302 | 7035 | 40710 | 4957 | 45618 | 3986 | 48742 | 3168 | 53262 | 1814 | 65061 | 1245 | 53343 |
| 14-#18 | 3.92 | MA | 24286 | 7035 | 41605 | 5086 | 45602 | 4087 | 47398 | 3256 | 49468 | 1950 | 61342 | 693 | 55819 |
| 7L-2S | | MI | 24850 | 7035 | 43170 | 4966 | 48754 | 3965 | 52531 | 3151 | 58267 | 1796 | 71638 | 1473 | 53612 |
| 16-#11 | 1.75 | MA | 26024 | 5935 | 41708 | 4392 | 46041 | 3559 | 48077 | 2931 | 50403 | 2006 | 60919 | 1872 | 31583 |
| 2L-8S | | MI | 18160 | 5935 | 29186 | 4343 | 31086 | 3525 | 31299 | 2909 | 30331 | 1970 | 35860 | 1380 | 23473 |
| 16-#11 | 1.75 | MA | 25191 | 5935 | 40443 | 4391 | 44428 | 3557 | 46116 | 2942 | 47747 | 2014 | 57343 | 1783 | 31569 |
| 3L-7S | | MI | 18542 | 5935 | 29837 | 4345 | 31958 | 3529 | 32336 | 2901 | 31791 | 1977 | 37608 | 1429 | 24044 |
| 16-#11 | 1.75 | MA | 24605 | 5935 | 39428 | 4404 | 43137 | 3569 | 44549 | 2938 | 45712 | 2022 | 54999 | 1695 | 31509 |
| 4L-6S | | MI | 18929 | 5935 | 30546 | 4334 | 32822 | 3519 | 33395 | 2893 | 33183 | 1970 | 39442 | 1517 | 24361 |
| 16-#11 | 1.75 | MA | 24080 | 5935 | 38538 | 4403 | 41989 | 3566 | 43144 | 2949 | 43707 | 2016 | 52554 | 1651 | 31378 |
| 5E | | MI | 19326 | 5935 | 31209 | 4336 | 33722 | 3523 | 34491 | 2899 | 34606 | 1963 | 41202 | 1575 | 24900 |

## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

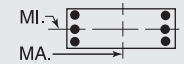
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.75 | MA | 23580 | 5935 | 37698 | 4402 | 40848 | 3578 | 41753 | 2945 | 41864 | 2023 | 50227 | 1592 | 30605 |
| 6L-4S | | MI | 19741 | 5935 | 31910 | 4339 | 34626 | 3514 | 35598 | 2890 | 36155 | 1970 | 43074 | 1616 | 25006 |
| 16-#11 | 1.75 | MA | 23092 | 5935 | 36800 | 4415 | 39753 | 3576 | 40410 | 2956 | 40062 | 2031 | 47806 | 1505 | 30122 |
| 7L-3S | | MI | 20203 | 5935 | 32708 | 4327 | 35641 | 3518 | 36830 | 2896 | 37725 | 1963 | 44841 | 1705 | 25023 |
| 16-#11 | 1.75 | MA | 22611 | 5935 | 35976 | 4414 | 38648 | 3588 | 39096 | 2966 | 38173 | 2025 | 45520 | 1454 | 29344 |
| 8L-2S | | MI | 20851 | 5935 | 33697 | 4329 | 36901 | 3508 | 38362 | 2888 | 39772 | 1957 | 47554 | 1794 | 25007 |
| 16-#14 | 2.52 | MA | 26818 | 6326 | 44324 | 4621 | 49296 | 3741 | 52004 | 3046 | 55710 | 1985 | 67823 | 1669 | 44838 |
| 3L-7S | | MI | 19094 | 6326 | 31616 | 4577 | 34142 | 3698 | 34955 | 3001 | 35259 | 1936 | 42414 | 1166 | 32518 |
| 16-#14 | 2.52 | MA | 25993 | 6326 | 42869 | 4639 | 47446 | 3738 | 49758 | 3040 | 52794 | 1995 | 64496 | 1541 | 44621 |
| 4L-6S | | MI | 19639 | 6326 | 32632 | 4561 | 35379 | 3685 | 36527 | 3010 | 37236 | 1926 | 45009 | 1294 | 33624 |
| 16-#14 | 2.52 | MA | 25255 | 6326 | 41593 | 4637 | 45800 | 3754 | 47743 | 3055 | 49920 | 1985 | 61011 | 1479 | 43346 |
| 5E | | MI | 20197 | 6326 | 33581 | 4565 | 36667 | 3691 | 38041 | 2999 | 39256 | 1916 | 47499 | 1379 | 34247 |
| 16-#14 | 2.52 | MA | 24551 | 6326 | 40388 | 4636 | 44164 | 3750 | 45748 | 3049 | 47278 | 1996 | 57705 | 1394 | 42412 |
| 6L-4S | | MI | 20782 | 6326 | 34585 | 4569 | 37961 | 3678 | 39625 | 2988 | 41457 | 1926 | 50157 | 1437 | 35259 |
| 16-#14 | 2.52 | MA | 23864 | 6326 | 39100 | 4654 | 42594 | 3767 | 43823 | 3063 | 44693 | 2006 | 54263 | 1268 | 40973 |
| 7L-3S | | MI | 21431 | 6326 | 35727 | 4553 | 39413 | 3685 | 41387 | 2997 | 43686 | 1916 | 52655 | 1565 | 35386 |
| 16-#14 | 2.52 | MA | 23187 | 6326 | 37917 | 4652 | 41008 | 3763 | 41938 | 3078 | 41985 | 1996 | 51007 | 1195 | 39703 |
| 8L-2S | | MI | 22342 | 6326 | 37138 | 4557 | 41213 | 3671 | 43575 | 2986 | 46592 | 1906 | 56496 | 1693 | 35430 |
| 16-#18 | 4.48 | MA | 28085 | 7319 | 49156 | 5237 | 55278 | 4197 | 59198 | 3325 | 65161 | 1894 | 81772 | 1021 | 72235 |
| 5E | | MI | 22280 | 7319 | 39415 | 5151 | 43951 | 4121 | 46724 | 3247 | 50637 | 1785 | 62798 | 853 | 56472 |
| 16-#18 | 4.48 | MA | 26897 | 7319 | 47039 | 5232 | 52403 | 4189 | 55692 | 3313 | 60568 | 1911 | 76067 | 870 | 68481 |
| 6L-4S | | MI | 23268 | 7319 | 41173 | 5160 | 46216 | 4100 | 49475 | 3229 | 54429 | 1803 | 67358 | 955 | 58152 |
| 16-#18 | 4.48 | MA | 25738 | 7319 | 44774 | 5263 | 49642 | 4215 | 52309 | 3335 | 56074 | 1929 | 70126 | 645 | 64895 |
| 7L-3S | | MI | 24365 | 7319 | 43170 | 5134 | 48754 | 4114 | 52531 | 3247 | 58267 | 1785 | 71638 | 1179 | 60715 |
| 18-#11 | 1.97 | MA | 25778 | 6045 | 41708 | 4460 | 46041 | 3607 | 48077 | 2973 | 50403 | 2007 | 60919 | 1768 | 35405 |
| 3L-8S | | MI | 18622 | 6045 | 30175 | 4412 | 32347 | 3575 | 32831 | 2940 | 32378 | 1961 | 38572 | 1360 | 26347 |
| 18-#11 | 1.97 | MA | 25196 | 6045 | 40693 | 4473 | 44750 | 3619 | 46510 | 2969 | 48369 | 2015 | 58576 | 1679 | 35330 |
| 4L-7S | | MI | 19001 | 6045 | 30826 | 4414 | 33219 | 3579 | 33868 | 2932 | 33837 | 1968 | 40320 | 1408 | 26970 |
| 18-#11 | 1.97 | MA | 24674 | 6045 | 39803 | 4472 | 43602 | 3617 | 45105 | 2980 | 46363 | 2009 | 56130 | 1636 | 35096 |
| 5L-6S | | MI | 19386 | 6045 | 31535 | 4403 | 34083 | 3570 | 34927 | 2924 | 35230 | 1961 | 42154 | 1496 | 27276 |
| 18-#11 | 1.97 | MA | 24177 | 6045 | 38964 | 4471 | 42461 | 3628 | 43713 | 2976 | 44521 | 2017 | 53803 | 1577 | 34342 |
| 6L-5S | | MI | 19781 | 6045 | 32197 | 4405 | 34982 | 3574 | 36023 | 2930 | 36653 | 1955 | 43914 | 1555 | 27786 |
| 18-#11 | 1.97 | MA | 23692 | 6045 | 38065 | 4484 | 41366 | 3626 | 42371 | 2987 | 42718 | 2024 | 51382 | 1490 | 33875 |
| 7L-4S | | MI | 20194 | 6045 | 32899 | 4408 | 35886 | 3564 | 37131 | 2922 | 38202 | 1961 | 45786 | 1596 | 27998 |
| 18-#11 | 1.97 | MA | 23214 | 6045 | 37241 | 4484 | 40261 | 3638 | 41057 | 2997 | 40830 | 2018 | 49097 | 1439 | 33045 |
| 8L-3S | | MI | 20653 | 6045 | 33697 | 4396 | 36901 | 3568 | 38362 | 2927 | 39772 | 1955 | 47554 | 1684 | 28030 |
| 18-#11 | 1.97 | MA | 22723 | 6045 | 36369 | 4497 | 39181 | 3636 | 39697 | 2994 | 39046 | 2026 | 46843 | 1382 | 32327 |
| 9L-2S | | MI | 21299 | 6045 | 34686 | 4399 | 38162 | 3558 | 39894 | 2919 | 41819 | 1948 | 50266 | 1773 | 28028 |
| 18-#14 | 2.84 | MA | 26821 | 6486 | 44679 | 4739 | 49754 | 3810 | 52564 | 3085 | 56596 | 1985 | 69581 | 1517 | 50059 |
| 4L-7S | | MI | 19740 | 6486 | 33028 | 4677 | 35942 | 3771 | 37143 | 3045 | 38165 | 1922 | 46254 | 1134 | 36600 |
| 18-#14 | 2.84 | MA | 26089 | 6486 | 43403 | 4737 | 48109 | 3826 | 50549 | 3100 | 53722 | 1975 | 66096 | 1455 | 48664 |
| 5L-6S | | MI | 20281 | 6486 | 34043 | 4661 | 37179 | 3757 | 38715 | 3055 | 40142 | 1912 | 48850 | 1261 | 37784 |
| 18-#14 | 2.84 | MA | 25390 | 6486 | 42199 | 4736 | 46473 | 3823 | 48554 | 3094 | 51080 | 1986 | 62790 | 1371 | 47766 |
| 6L-5S | | MI | 20835 | 6486 | 34992 | 4665 | 38467 | 3764 | 40229 | 3044 | 42162 | 1902 | 51340 | 1346 | 38378 |
| 18-#14 | 2.84 | MA | 24709 | 6486 | 40910 | 4754 | 44902 | 3839 | 46629 | 3108 | 48495 | 1996 | 59348 | 1244 | 46249 |
| 7L-4S | | MI | 21415 | 6486 | 35996 | 4669 | 39761 | 3750 | 41813 | 3033 | 44363 | 1912 | 53998 | 1404 | 39500 |
| 18-#14 | 2.84 | MA | 24037 | 6486 | 39728 | 4752 | 43317 | 3835 | 44745 | 3122 | 45787 | 1986 | 56092 | 1171 | 44923 |
| 8L-3S | | MI | 22061 | 6486 | 37138 | 4653 | 41213 | 3757 | 43575 | 3042 | 46592 | 1902 | 56496 | 1532 | 39652 |
| 18-#14 | 2.84 | MA | 23364 | 6486 | 38477 | 4770 | 41768 | 3851 | 42795 | 3117 | 43229 | 1997 | 52889 | 1090 | 43152 |
| 9L-2S | | MI | 22966 | 6486 | 38550 | 4657 | 43013 | 3744 | 45763 | 3031 | 49498 | 1892 | 60336 | 1660 | 39717 |
| 18-#18 | 5.04 | MA | 28321 | 7603 | 50208 | 5410 | 56443 | 4317 | 60604 | 3392 | 67174 | 1891 | 84851 | 822 | 77675 |
| 6L-5S | | MI | 23356 | 7603 | 41875 | 5328 | 47087 | 4249 | 50514 | 3325 | 55642 | 1756 | 69374 | 787 | 63419 |
| 18-#18 | 5.04 | MA | 27175 | 7603 | 47943 | 5440 | 53683 | 4344 | 57221 | 3415 | 62680 | 1909 | 78909 | 596 | 73992 |
| 7L-4S | | MI | 24333 | 7603 | 43633 | 5338 | 49352 | 4228 | 53265 | 3307 | 59434 | 1773 | 73935 | 890 | 65275 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

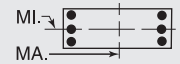


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.18 | MA | 25783 | 6156 | 41958 | 4542 | 46363 | 3669 | 48471 | 3001 | 51025 | 2008 | 62152 | 1664 | 39148 |
| 4L-8S | | MI | 19080 | 6156 | 31163 | 4481 | 33607 | 3626 | 34363 | 2971 | 34425 | 1953 | 41284 | 1339 | 29227 |
| 20-#11 | 2.18 | MA | 25264 | 6156 | 41068 | 4541 | 45215 | 3667 | 47066 | 3011 | 49020 | 2002 | 59706 | 1621 | 38809 |
| 5L-7S | | MI | 19458 | 6156 | 31814 | 4484 | 34479 | 3630 | 35400 | 2963 | 35884 | 1959 | 43033 | 1387 | 29899 |
| 20-#11 | 2.18 | MA | 24770 | 6156 | 40229 | 4541 | 44074 | 3678 | 45674 | 3007 | 47177 | 2010 | 57380 | 1562 | 38085 |
| 6E | | MI | 19841 | 6156 | 32523 | 4472 | 35343 | 3620 | 36459 | 2955 | 37277 | 1953 | 44867 | 1475 | 30194 |
| 20-#11 | 2.18 | MA | 24288 | 6156 | 39330 | 4554 | 42979 | 3676 | 44332 | 3018 | 45375 | 2017 | 54958 | 1475 | 37632 |
| 7L-5S | | MI | 20233 | 6156 | 33186 | 4475 | 36243 | 3624 | 37556 | 2961 | 38699 | 1946 | 46627 | 1534 | 30681 |
| 20-#11 | 2.18 | MA | 23812 | 6156 | 38506 | 4553 | 41874 | 3688 | 43018 | 3028 | 43486 | 2011 | 52673 | 1423 | 36752 |
| 8L-4S | | MI | 20644 | 6156 | 33887 | 4477 | 37147 | 3614 | 38663 | 2953 | 40249 | 1953 | 48499 | 1575 | 30986 |
| 20-#11 | 2.18 | MA | 23332 | 6156 | 37634 | 4566 | 40794 | 3686 | 41658 | 3025 | 41702 | 2019 | 50419 | 1367 | 36053 |
| 9L-3S | | MI | 21101 | 6156 | 34686 | 4465 | 38162 | 3618 | 39894 | 2958 | 41819 | 1946 | 50266 | 1663 | 31031 |
| 20-#11 | 2.18 | MA | 22801 | 6156 | 36814 | 4565 | 39703 | 3698 | 40352 | 3035 | 39932 | 2027 | 48233 | 1304 | 34996 |
| 10L-2S | | MI | 21743 | 6156 | 35674 | 4468 | 39422 | 3608 | 41426 | 2950 | 43865 | 1939 | 52978 | 1752 | 31044 |
| 20-#14 | 3.15 | MA | 26916 | 6645 | 45214 | 4837 | 50417 | 3899 | 53356 | 3144 | 57524 | 1965 | 71181 | 1431 | 53991 |
| 5L-7S | | MI | 20380 | 6645 | 34440 | 4776 | 37742 | 3843 | 39331 | 3090 | 41071 | 1908 | 50095 | 1102 | 40692 |
| 20-#14 | 3.15 | MA | 26223 | 6645 | 44010 | 4835 | 48781 | 3895 | 51361 | 3139 | 54882 | 1976 | 67875 | 1347 | 53126 |
| 6E | | MI | 20918 | 6645 | 35455 | 4760 | 38979 | 3830 | 40903 | 3099 | 43048 | 1898 | 52691 | 1229 | 41920 |
| 20-#14 | 3.15 | MA | 25547 | 6645 | 42721 | 4854 | 47211 | 3911 | 49436 | 3153 | 52297 | 1986 | 64433 | 1220 | 51535 |
| 7L-5S | | MI | 21468 | 6645 | 36404 | 4764 | 40267 | 3836 | 42417 | 3089 | 45069 | 1888 | 55180 | 1314 | 42519 |
| 20-#14 | 3.15 | MA | 24880 | 6645 | 41539 | 4852 | 45625 | 3908 | 47551 | 3167 | 49589 | 1976 | 61177 | 1148 | 50153 |
| 8L-4S | | MI | 22044 | 6645 | 37408 | 4768 | 41561 | 3823 | 44001 | 3078 | 47269 | 1898 | 57838 | 1372 | 43669 |
| 20-#14 | 3.15 | MA | 24209 | 6645 | 40288 | 4870 | 44076 | 3924 | 45601 | 3162 | 47031 | 1987 | 57974 | 1066 | 48425 |
| 9L-3S | | MI | 22686 | 6645 | 38550 | 4753 | 43013 | 3829 | 45763 | 3087 | 49498 | 1888 | 60336 | 1500 | 43913 |
| 20-#18 | 5.60 | MA | 28597 | 7887 | 51112 | 5618 | 57723 | 4473 | 62132 | 3495 | 69285 | 1888 | 87693 | 548 | 83110 |
| 7L-5S | | MI | 24422 | 7887 | 44335 | 5505 | 50223 | 4378 | 54304 | 3403 | 60647 | 1727 | 75951 | 721 | 70392 |
| 22-#11 | 2.40 | MA | 25851 | 6267 | 42334 | 4611 | 46828 | 3717 | 49026 | 3042 | 51676 | 1995 | 63283 | 1605 | 42529 |
| 5L-8S | | MI | 19536 | 6267 | 32152 | 4550 | 34867 | 3676 | 35896 | 3003 | 36471 | 1944 | 43997 | 1318 | 32112 |
| 22-#11 | 2.40 | MA | 25360 | 6267 | 41494 | 4610 | 45687 | 3729 | 47635 | 3039 | 49834 | 2003 | 60956 | 1547 | 41833 |
| 6L-7S | | MI | 19912 | 6267 | 32803 | 4553 | 35739 | 3680 | 36932 | 2994 | 37931 | 1950 | 45745 | 1366 | 32772 |
| 22-#11 | 2.40 | MA | 24880 | 6267 | 40595 | 4623 | 44592 | 3726 | 46293 | 3049 | 48031 | 2011 | 58535 | 1459 | 41391 |
| 7L-6S | | MI | 20292 | 6267 | 33512 | 4541 | 36604 | 3670 | 37991 | 2986 | 39323 | 1944 | 47579 | 1454 | 33117 |
| 22-#11 | 2.40 | MA | 24408 | 6267 | 39771 | 4622 | 43487 | 3738 | 44979 | 3059 | 46143 | 2004 | 56249 | 1408 | 40465 |
| 8L-5S | | MI | 20683 | 6267 | 34174 | 4544 | 37503 | 3674 | 39088 | 2992 | 40746 | 1937 | 49339 | 1513 | 33581 |
| 22-#11 | 2.40 | MA | 23928 | 6267 | 38899 | 4635 | 42407 | 3736 | 43619 | 3056 | 44359 | 2012 | 53995 | 1352 | 39743 |
| 9L-4S | | MI | 21091 | 6267 | 34876 | 4546 | 38407 | 3664 | 40195 | 2984 | 42295 | 1944 | 51211 | 1554 | 33971 |
| 22-#11 | 2.40 | MA | 23402 | 6267 | 38079 | 4634 | 41316 | 3748 | 42313 | 3066 | 42588 | 2020 | 51809 | 1289 | 38693 |
| 10L-3S | | MI | 21546 | 6267 | 35674 | 4535 | 39422 | 3668 | 41426 | 2989 | 43865 | 1937 | 52978 | 1643 | 34028 |
| 22-#11 | 2.40 | MA | 22893 | 6267 | 37270 | 4633 | 40242 | 3746 | 40969 | 3063 | 40726 | 2014 | 49578 | 1235 | 37682 |
| 11L-2S | | MI | 22186 | 6267 | 36663 | 4537 | 40682 | 3658 | 42958 | 2981 | 45912 | 1930 | 55691 | 1731 | 34052 |
| 22-#14 | 3.47 | MA | 27050 | 6805 | 45821 | 4935 | 51090 | 3967 | 54167 | 3184 | 58684 | 1966 | 72960 | 1323 | 58492 |
| 6L-7S | | MI | 21017 | 6805 | 35852 | 4876 | 39542 | 3915 | 41519 | 3135 | 43977 | 1894 | 53935 | 1069 | 44793 |
| 22-#14 | 3.47 | MA | 26379 | 6805 | 44532 | 4953 | 49519 | 3983 | 52242 | 3198 | 56099 | 1976 | 69518 | 1197 | 56830 |
| 7L-6S | | MI | 21550 | 6805 | 36867 | 4860 | 40779 | 3902 | 43091 | 3144 | 45954 | 1884 | 56531 | 1196 | 45975 |
| 22-#14 | 3.47 | MA | 25717 | 6805 | 43349 | 4952 | 47934 | 3980 | 50357 | 3212 | 53391 | 1966 | 66263 | 1124 | 55393 |
| 8L-5S | | MI | 22097 | 6805 | 37816 | 4864 | 42067 | 3908 | 44605 | 3133 | 47975 | 1874 | 59021 | 1282 | 46666 |
| 22-#14 | 3.47 | MA | 25047 | 6805 | 42098 | 4970 | 46385 | 3996 | 48407 | 3207 | 50833 | 1977 | 63059 | 1043 | 53707 |
| 9L-4S | | MI | 22670 | 6805 | 38820 | 4868 | 43361 | 3895 | 46189 | 3123 | 50175 | 1884 | 61679 | 1340 | 47762 |
| 24-#11 | 2.62 | MA | 25946 | 6377 | 42759 | 4679 | 47300 | 3779 | 49596 | 3070 | 52491 | 1996 | 64532 | 1532 | 45584 |
| 6L-8S | | MI | 19989 | 6377 | 33140 | 4620 | 36128 | 3726 | 37428 | 3034 | 38518 | 1935 | 46709 | 1297 | 35002 |
| 24-#11 | 2.62 | MA | 25469 | 6377 | 41861 | 4692 | 46205 | 3777 | 48254 | 3080 | 50688 | 2004 | 62111 | 1444 | 45107 |
| 7E | | MI | 20363 | 6377 | 33791 | 4622 | 37000 | 3730 | 38465 | 3026 | 39977 | 1942 | 48458 | 1345 | 35640 |
| 24-#11 | 2.62 | MA | 24999 | 6377 | 41037 | 4691 | 45100 | 3788 | 46940 | 3090 | 48800 | 1998 | 59826 | 1393 | 44182 |
| 8L-6S | | MI | 20742 | 6377 | 34500 | 4610 | 37864 | 3720 | 39523 | 3017 | 41370 | 1935 | 50292 | 1433 | 36043 |
| 24-#11 | 2.62 | MA | 24521 | 6377 | 40164 | 4704 | 44020 | 3786 | 45580 | 3087 | 47015 | 2005 | 57571 | 1337 | 43422 |
| 9L-5S | | MI | 21130 | 6377 | 35163 | 4613 | 38763 | 3724 | 40620 | 3023 | 42793 | 1928 | 52051 | 1492 | 36487 |
| 24-#11 | 2.62 | MA | 23999 | 6377 | 39344 | 4703 | 42929 | 3798 | 44274 | 3097 | 45245 | 2013 | 55386 | 1274 | 42396 |
| 10L-4S | | MI | 21537 | 6377 | 35864 | 4615 | 39667 | 3714 | 41727 | 3015 | 44342 | 1935 | 53924 | 1533 | 36953 |

## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.62 | MA | 23493 | 6377 | 38535 | 4702 | 41855 | 3796 | 42930 | 3094 | 43383 | 2007 | 53154 | 1220 | 41301 |
| 11L-3S | | MI | 21990 | 6377 | 36663 | 4604 | 40682 | 3718 | 42958 | 3021 | 45912 | 1928 | 55691 | 1622 | 37022 |
| 24-#14 | 3.78 | MA | 27205 | 6964 | 46342 | 5053 | 51827 | 4056 | 55048 | 3243 | 59901 | 1966 | 74604 | 1173 | 62132 |
| 7E | | MI | 21649 | 6964 | 37263 | 4976 | 41341 | 3988 | 43707 | 3180 | 46884 | 1880 | 57776 | 1037 | 48901 |
| 24-#14 | 3.78 | MA | 26548 | 6964 | 45160 | 5051 | 50242 | 4052 | 53163 | 3257 | 57193 | 1956 | 71348 | 1101 | 60641 |
| 8L-6S | | MI | 22179 | 6964 | 38278 | 4960 | 42579 | 3974 | 45279 | 3189 | 48861 | 1870 | 60372 | 1164 | 50041 |
| 24-#14 | 3.78 | MA | 25880 | 6964 | 43909 | 5070 | 48693 | 4068 | 51213 | 3252 | 54634 | 1967 | 68145 | 1019 | 58995 |
| 9L-5S | | MI | 22723 | 6964 | 39227 | 4964 | 43866 | 3981 | 46793 | 3178 | 50881 | 1860 | 62862 | 1249 | 50820 |

## RECTANGULAR TIED COLUMNS 34" x 44"

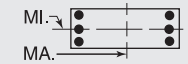
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.07 | MA | 26465 | 5857 | 41493 | 4347 | 44899 | 3542 | 45853 | 2950 | 45888 | 2107 | 53954 | 1983 | 21324 |
| 2E | | MI | 20259 | 5857 | 32107 | 4257 | 34351 | 3468 | 34820 | 2884 | 34347 | 2037 | 39976 | 1894 | 16134 |
| 6-#18 | 1.60 | MA | 28018 | 6141 | 44840 | 4524 | 49165 | 3670 | 51040 | 3029 | 52894 | 2088 | 63292 | 1937 | 31574 |
| 2L-3S | | MI | 19755 | 6141 | 32107 | 4425 | 34351 | 3617 | 34820 | 2979 | 34347 | 2026 | 39976 | 1601 | 23786 |
| 6-#18 | 1.60 | MA | 25812 | 6141 | 41493 | 4521 | 44899 | 3698 | 45853 | 3053 | 45888 | 2106 | 53954 | 1710 | 31518 |
| 3L-2S | | MI | 21369 | 6141 | 34567 | 4434 | 37487 | 3596 | 38610 | 2962 | 39352 | 2008 | 46552 | 1829 | 23725 |
| 8-#14 | 1.20 | MA | 26943 | 5928 | 42314 | 4419 | 46110 | 3596 | 47389 | 2989 | 48034 | 2119 | 57040 | 1999 | 24081 |
| 2L-4S | | MI | 19016 | 5928 | 30169 | 4349 | 32039 | 3536 | 32115 | 2933 | 30944 | 2079 | 36022 | 1659 | 18285 |
| 8-#14 | 1.20 | MA | 25670 | 5928 | 40404 | 4418 | 43675 | 3593 | 44428 | 3004 | 44022 | 2130 | 51643 | 1871 | 24114 |
| 3E | | MI | 19686 | 5928 | 31311 | 4333 | 33491 | 3543 | 33877 | 2942 | 33173 | 2069 | 38520 | 1787 | 18258 |
| 8-#14 | 1.20 | MA | 24772 | 5928 | 38871 | 4436 | 41725 | 3610 | 42062 | 2999 | 40950 | 2141 | 48107 | 1743 | 24044 |
| 4L-2S | | MI | 20621 | 5928 | 32722 | 4337 | 35290 | 3529 | 36065 | 2932 | 36079 | 2059 | 42361 | 1915 | 18197 |
| 8-#18 | 2.14 | MA | 29547 | 6425 | 48186 | 4702 | 53431 | 3799 | 56226 | 3109 | 59901 | 2069 | 72629 | 1892 | 41777 |
| 2L-4S | | MI | 19720 | 6425 | 32570 | 4628 | 34949 | 3732 | 35553 | 3040 | 35513 | 2015 | 42273 | 1311 | 30288 |
| 8-#18 | 2.14 | MA | 27367 | 6425 | 44840 | 4698 | 49165 | 3827 | 51040 | 3133 | 52894 | 2087 | 63292 | 1665 | 41610 |
| 3E | | MI | 20867 | 6425 | 34567 | 4602 | 37487 | 3746 | 38610 | 3058 | 39352 | 1997 | 46552 | 1535 | 31235 |
| 8-#18 | 2.14 | MA | 25826 | 6425 | 42147 | 4729 | 45741 | 3819 | 46885 | 3122 | 47519 | 2105 | 57189 | 1437 | 40294 |
| 4L-2S | | MI | 22465 | 6425 | 37027 | 4612 | 40623 | 3725 | 42400 | 3040 | 44357 | 1979 | 53128 | 1763 | 31263 |
| 10-#11 | 1.04 | MA | 26502 | 5843 | 41278 | 4380 | 44873 | 3569 | 45918 | 2974 | 46053 | 2132 | 54501 | 2024 | 21038 |
| 2L-5S | | MI | 18762 | 5843 | 29471 | 4309 | 31218 | 3521 | 31138 | 2931 | 29580 | 2087 | 34296 | 1731 | 16035 |
| 10-#11 | 1.04 | MA | 25609 | 5843 | 39944 | 4379 | 43172 | 3568 | 43850 | 2985 | 43252 | 2140 | 50708 | 1936 | 21070 |
| 3L-4S | | MI | 19185 | 5843 | 30172 | 4311 | 32122 | 3511 | 32245 | 2923 | 31130 | 2094 | 36168 | 1772 | 16024 |
| 10-#11 | 1.04 | MA | 24979 | 5843 | 38874 | 4392 | 41812 | 3580 | 42199 | 2982 | 41108 | 2148 | 48220 | 1847 | 21072 |
| 4L-3S | | MI | 19655 | 5843 | 30971 | 4299 | 33137 | 3515 | 33477 | 2928 | 32699 | 2087 | 37935 | 1861 | 15984 |
| 10-#11 | 1.04 | MA | 24416 | 5843 | 37937 | 4392 | 40603 | 3578 | 40719 | 2993 | 38996 | 2143 | 45631 | 1802 | 21005 |
| 5L-2S | | MI | 20313 | 5843 | 31959 | 4302 | 34397 | 3505 | 35009 | 2920 | 34746 | 2080 | 40647 | 1950 | 15939 |
| 10-#14 | 1.50 | MA | 27837 | 6088 | 44225 | 4519 | 48546 | 3669 | 50350 | 3034 | 52045 | 2109 | 62437 | 1977 | 29921 |
| 2L-5S | | MI | 19072 | 6088 | 30576 | 4445 | 32544 | 3622 | 32719 | 2989 | 31649 | 2055 | 37204 | 1569 | 22110 |
| 10-#14 | 1.50 | MA | 26573 | 6088 | 42314 | 4517 | 46110 | 3666 | 47389 | 3049 | 48034 | 2120 | 57040 | 1849 | 29919 |
| 3L-4S | | MI | 19671 | 6088 | 31580 | 4449 | 33839 | 3608 | 34303 | 2978 | 33850 | 2065 | 39863 | 1627 | 22564 |
| 10-#14 | 1.50 | MA | 25682 | 6088 | 40781 | 4536 | 44160 | 3683 | 45023 | 3044 | 44961 | 2131 | 53504 | 1721 | 29804 |
| 4L-3S | | MI | 20336 | 6088 | 32722 | 4433 | 35290 | 3615 | 36065 | 2987 | 36079 | 2055 | 42361 | 1755 | 22579 |
| 10-#14 | 1.50 | MA | 24883 | 6088 | 39437 | 4535 | 42427 | 3679 | 42900 | 3058 | 41933 | 2123 | 49813 | 1658 | 29088 |
| 5L-2S | | MI | 21265 | 6088 | 34134 | 4437 | 37090 | 3602 | 38252 | 2976 | 38985 | 2045 | 46201 | 1883 | 22538 |
| 10-#18 | 2.67 | MA | 31056 | 6708 | 51532 | 4879 | 57698 | 3927 | 61412 | 3189 | 66908 | 2050 | 81967 | 1847 | 51938 |
| 2L-5S | | MI | 19809 | 6708 | 33272 | 4796 | 35819 | 3881 | 36592 | 3136 | 36727 | 1968 | 44289 | 1143 | 35400 |
| 10-#18 | 2.67 | MA | 28900 | 6708 | 48186 | 4875 | 53431 | 3955 | 56226 | 3213 | 59901 | 2068 | 72629 | 1619 | 51684 |
| 3L-4S | | MI | 20831 | 6708 | 35030 | 4806 | 38085 | 3860 | 39343 | 3118 | 40519 | 1985 | 48849 | 1245 | 37261 |
| 10-#18 | 2.67 | MA | 27378 | 6708 | 45493 | 4907 | 50007 | 3948 | 52071 | 3202 | 54526 | 2086 | 66526 | 1392 | 49893 |
| 4L-3S | | MI | 21966 | 6708 | 37027 | 4780 | 40623 | 3874 | 42400 | 3136 | 44357 | 1968 | 53128 | 1469 | 38654 |
| 10-#18 | 2.67 | MA | 26014 | 6708 | 43131 | 4903 | 46961 | 3976 | 48340 | 3226 | 49224 | 2068 | 60115 | 1283 | 46969 |
| 5L-2S | | MI | 23548 | 6708 | 39486 | 4789 | 43759 | 3853 | 46190 | 3118 | 49363 | 1950 | 59704 | 1697 | 38768 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis

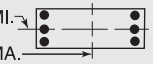



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.25 | MA | 27133 | 5954 | 42612 | 4449 | 46574 | 3619 | 47986 | 3006 | 48855 | 2125 | 58293 | 2010 | 25122 |
| 2L-6S | | MI | 18824 | 5954 | 29797 | 4375 | 31579 | 3567 | 31573 | 2956 | 30204 | 2085 | 35248 | 1652 | 18678 |
| 12-#11 | 1.25 | MA | 26244 | 5954 | 41278 | 4448 | 44873 | 3618 | 45918 | 3016 | 46053 | 2133 | 54501 | 1922 | 25141 |
| 3L-5S | | MI | 19226 | 5954 | 30460 | 4378 | 32478 | 3571 | 32670 | 2962 | 31627 | 2078 | 37008 | 1711 | 19032 |
| 12-#11 | 1.25 | MA | 25618 | 5954 | 40208 | 4461 | 43513 | 3630 | 44267 | 3013 | 43910 | 2142 | 52013 | 1833 | 25119 |
| 4E | | MI | 19646 | 5954 | 31161 | 4380 | 33382 | 3561 | 33777 | 2954 | 33176 | 2085 | 38880 | 1752 | 19045 |
| 12-#11 | 1.25 | MA | 25058 | 5954 | 39272 | 4461 | 42305 | 3628 | 42787 | 3024 | 41798 | 2136 | 49424 | 1788 | 25028 |
| 5L-3S | | MI | 20114 | 5954 | 31959 | 4369 | 34397 | 3565 | 35009 | 2959 | 34746 | 2078 | 40647 | 1840 | 19020 |
| 12-#11 | 1.25 | MA | 24525 | 5954 | 38388 | 4460 | 41104 | 3640 | 41322 | 3021 | 39858 | 2144 | 46955 | 1730 | 24455 |
| 6L-2S | | MI | 20769 | 5954 | 32948 | 4371 | 35658 | 3555 | 36541 | 2951 | 36793 | 2071 | 43360 | 1929 | 18983 |
| 12-#14 | 1.80 | MA | 28722 | 6247 | 46135 | 4618 | 50982 | 3741 | 53311 | 3079 | 56056 | 2099 | 67834 | 1955 | 35750 |
| 2L-6S | | MI | 19158 | 6247 | 31039 | 4540 | 33057 | 3688 | 33393 | 3045 | 32535 | 2051 | 38555 | 1451 | 25489 |
| 12-#14 | 1.80 | MA | 27467 | 6247 | 44225 | 4617 | 48546 | 3738 | 50350 | 3093 | 52045 | 2110 | 62437 | 1828 | 35710 |
| 3L-5S | | MI | 19726 | 6247 | 31988 | 4544 | 34344 | 3694 | 34907 | 3034 | 34555 | 2041 | 41045 | 1537 | 26198 |
| 12-#14 | 1.80 | MA | 26583 | 6247 | 42691 | 4636 | 46596 | 3755 | 47984 | 3088 | 48972 | 2121 | 58901 | 1700 | 35558 |
| 4E | | MI | 20320 | 6247 | 32992 | 4548 | 35639 | 3681 | 36491 | 3023 | 36756 | 2051 | 43703 | 1594 | 26830 |
| 12-#14 | 1.80 | MA | 25791 | 6247 | 41348 | 4635 | 44863 | 3752 | 45861 | 3103 | 45944 | 2113 | 55210 | 1636 | 34656 |
| 5L-3S | | MI | 20980 | 6247 | 34134 | 4533 | 37090 | 3687 | 38252 | 3032 | 38985 | 2041 | 46201 | 1722 | 26884 |
| 12-#14 | 1.80 | MA | 25037 | 6247 | 40080 | 4634 | 43140 | 3769 | 43760 | 3098 | 43162 | 2124 | 51699 | 1552 | 33532 |
| 6L-2S | | MI | 21904 | 6247 | 35546 | 4537 | 38890 | 3674 | 40440 | 3021 | 41891 | 2031 | 50042 | 1850 | 26863 |
| 12-#18 | 3.21 | MA | 30414 | 6992 | 51532 | 5053 | 57698 | 4084 | 61412 | 3293 | 66908 | 2049 | 81967 | 1574 | 61746 |
| 3L-5S | | MI | 20918 | 6992 | 35732 | 4974 | 38955 | 4010 | 40382 | 3214 | 41732 | 1938 | 50865 | 1077 | 42552 |
| 12-#18 | 3.21 | MA | 28910 | 6992 | 48840 | 5084 | 54274 | 4076 | 57257 | 3282 | 61532 | 2067 | 75864 | 1347 | 59540 |
| 4E | | MI | 21929 | 6992 | 37490 | 4983 | 41221 | 3989 | 43133 | 3196 | 45524 | 1956 | 55425 | 1179 | 44283 |
| 12-#18 | 3.21 | MA | 27563 | 6992 | 46477 | 5080 | 51227 | 4104 | 53527 | 3306 | 56231 | 2049 | 69453 | 1238 | 56773 |
| 5L-3S | | MI | 23053 | 6992 | 39486 | 4957 | 43759 | 4003 | 46190 | 3214 | 49363 | 1938 | 59704 | 1403 | 46055 |
| 12-#18 | 3.21 | MA | 26278 | 6992 | 44247 | 5077 | 48198 | 4097 | 49833 | 3294 | 51360 | 2067 | 63385 | 1087 | 53326 |
| 6L-2S | | MI | 24620 | 6992 | 41946 | 4966 | 46894 | 3982 | 49980 | 3196 | 54368 | 1921 | 66281 | 1631 | 46236 |
| 14-#11 | 1.46 | MA | 27760 | 6064 | 43947 | 4518 | 48276 | 3670 | 50054 | 3037 | 51657 | 2118 | 62086 | 1996 | 29197 |
| 2L-7S | | MI | 18897 | 6064 | 30077 | 4456 | 31975 | 3627 | 32047 | 2996 | 30858 | 2083 | 36127 | 1543 | 21243 |
| 14-#11 | 1.46 | MA | 26875 | 6064 | 42612 | 4517 | 46574 | 3668 | 47986 | 3047 | 48855 | 2126 | 58293 | 1907 | 29201 |
| 3L-6S | | MI | 19287 | 6064 | 30786 | 4445 | 32839 | 3617 | 33106 | 2987 | 32251 | 2076 | 37961 | 1631 | 21578 |
| 14-#11 | 1.46 | MA | 26253 | 6064 | 41543 | 4531 | 45214 | 3680 | 46335 | 3044 | 46712 | 2135 | 55806 | 1819 | 29159 |
| 4L-5S | | MI | 19687 | 6064 | 31448 | 4447 | 33739 | 3621 | 34202 | 2993 | 33674 | 2069 | 39720 | 1690 | 22022 |
| 14-#11 | 1.46 | MA | 25697 | 6064 | 40606 | 4530 | 44006 | 3678 | 44855 | 3055 | 44600 | 2129 | 53217 | 1774 | 29046 |
| 5L-4S | | MI | 20105 | 6064 | 32150 | 4449 | 34643 | 3611 | 35309 | 2985 | 35223 | 2076 | 41593 | 1731 | 22057 |
| 14-#11 | 1.46 | MA | 25166 | 6064 | 39722 | 4530 | 42805 | 3690 | 43390 | 3052 | 42660 | 2137 | 50748 | 1716 | 28384 |
| 6L-3S | | MI | 20570 | 6064 | 32948 | 4438 | 35658 | 3615 | 36541 | 2991 | 36793 | 2069 | 43360 | 1819 | 22046 |
| 14-#11 | 1.46 | MA | 24648 | 6064 | 38776 | 4543 | 41652 | 3688 | 41977 | 3063 | 40762 | 2146 | 48179 | 1629 | 27835 |
| 7L-2S | | MI | 21222 | 6064 | 33936 | 4440 | 36918 | 3606 | 38073 | 2982 | 38840 | 2062 | 46072 | 1908 | 22018 |
| 14-#14 | 2.11 | MA | 29600 | 6407 | 48046 | 4718 | 53417 | 3813 | 56272 | 3123 | 60068 | 2089 | 73231 | 1934 | 41559 |
| 2L-7S | | MI | 19260 | 6407 | 31435 | 4656 | 33619 | 3773 | 34009 | 3081 | 33464 | 2046 | 39800 | 1292 | 28717 |
| 14-#14 | 2.11 | MA | 28353 | 6407 | 46135 | 4717 | 50982 | 3810 | 53311 | 3138 | 56056 | 2100 | 67834 | 1806 | 41493 |
| 3L-6S | | MI | 19810 | 6407 | 32451 | 4640 | 34857 | 3760 | 35581 | 3090 | 35441 | 2037 | 42396 | 1419 | 29635 |
| 14-#14 | 2.11 | MA | 27476 | 6407 | 44602 | 4736 | 49032 | 3827 | 50945 | 3133 | 52984 | 2111 | 64298 | 1678 | 41306 |
| 4L-5S | | MI | 20374 | 6407 | 33400 | 4644 | 36144 | 3766 | 37095 | 3079 | 37462 | 2027 | 44886 | 1504 | 30303 |
| 14-#14 | 2.11 | MA | 26691 | 6407 | 43258 | 4734 | 47299 | 3824 | 48822 | 3148 | 49955 | 2103 | 60607 | 1614 | 40242 |
| 5L-4S | | MI | 20964 | 6407 | 34404 | 4648 | 37438 | 3753 | 38679 | 3068 | 39662 | 2037 | 47544 | 1562 | 31087 |
| 14-#14 | 2.11 | MA | 25942 | 6407 | 41990 | 4733 | 45576 | 3841 | 46721 | 3143 | 47173 | 2114 | 57096 | 1530 | 39168 |
| 6L-3S | | MI | 21620 | 6407 | 35546 | 4632 | 38890 | 3760 | 40440 | 3077 | 41891 | 2027 | 50042 | 1690 | 31170 |
| 14-#14 | 2.11 | MA | 25212 | 6407 | 40633 | 4752 | 43922 | 3838 | 44694 | 3158 | 44450 | 2125 | 53442 | 1404 | 37863 |
| 7L-2S | | MI | 22538 | 6407 | 36957 | 4636 | 40690 | 3746 | 42628 | 3066 | 44797 | 2017 | 53882 | 1818 | 31177 |
| 14-#18 | 3.74 | MA | 30424 | 7276 | 52186 | 5261 | 58540 | 4205 | 62443 | 3361 | 68539 | 2048 | 85201 | 1301 | 69226 |
| 4L-5S | | MI | 22015 | 7276 | 38191 | 5151 | 42091 | 4138 | 44172 | 3292 | 46737 | 1909 | 57441 | 1011 | 49726 |
| 14-#18 | 3.74 | MA | 29092 | 7276 | 49823 | 5258 | 55493 | 4233 | 58713 | 3386 | 63238 | 2031 | 78790 | 1192 | 66600 |
| 5L-4S | | MI | 23016 | 7276 | 39950 | 5160 | 44357 | 4117 | 46923 | 3275 | 50529 | 1927 | 62001 | 1113 | 51345 |
| 14-#18 | 3.74 | MA | 27823 | 7276 | 47593 | 5254 | 52464 | 4225 | 55019 | 3374 | 58366 | 2048 | 72722 | 1042 | 62999 |
| 6L-3S | | MI | 24128 | 7276 | 41946 | 5134 | 46894 | 4132 | 49980 | 3292 | 54368 | 1909 | 66281 | 1337 | 53443 |
| 14-#18 | 3.74 | MA | 26584 | 7276 | 45206 | 5285 | 49555 | 4253 | 51454 | 3398 | 53599 | 2066 | 66404 | 817 | 59498 |
| 7L-2S | | MI | 25682 | 7276 | 44406 | 5144 | 50030 | 4111 | 53770 | 3275 | 59373 | 1892 | 72857 | 1565 | 53685 |

## RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis



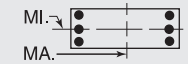

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.67 | MA | 28382 | 6175 | 45281 | 4587 | 49977 | 3720 | 52122 | 3068 | 54459 | 2111 | 65879 | 1982 | 33268 |
| 2L-8S | | MI | 18977 | 6175 | 30414 | 4523 | 32363 | 3673 | 32542 | 3035 | 31445 | 2067 | 37091 | 1474 | 23671 |
| 16-#11 | 1.67 | MA | 27502 | 6175 | 43947 | 4587 | 48276 | 3718 | 50054 | 3079 | 51657 | 2119 | 62086 | 1893 | 33253 |
| 3L-7S | | MI | 19360 | 6175 | 31065 | 4525 | 33235 | 3677 | 33579 | 3027 | 32905 | 2074 | 38839 | 1522 | 24167 |
| 16-#11 | 1.67 | MA | 26884 | 6175 | 42877 | 4600 | 46915 | 3730 | 48403 | 3076 | 49513 | 2128 | 59598 | 1805 | 33194 |
| 4L-6S | | MI | 19748 | 6175 | 31774 | 4514 | 34100 | 3667 | 34638 | 3019 | 34297 | 2067 | 40673 | 1610 | 24487 |
| 16-#11 | 1.67 | MA | 26331 | 6175 | 41940 | 4599 | 45707 | 3728 | 46923 | 3086 | 47401 | 2122 | 57009 | 1760 | 33063 |
| 5E | | MI | 20145 | 6175 | 32437 | 4516 | 34999 | 3671 | 35734 | 3024 | 35720 | 2060 | 42433 | 1669 | 25007 |
| 16-#11 | 1.67 | MA | 25803 | 6175 | 41057 | 4599 | 44506 | 3740 | 45458 | 3083 | 45462 | 2131 | 54541 | 1702 | 32320 |
| 6L-4S | | MI | 20561 | 6175 | 33138 | 4518 | 35903 | 3662 | 36841 | 3016 | 37270 | 2067 | 44305 | 1710 | 25058 |
| 16-#11 | 1.67 | MA | 25289 | 6175 | 40111 | 4612 | 43353 | 3739 | 44045 | 3094 | 43564 | 2139 | 51972 | 1615 | 31792 |
| 7L-3S | | MI | 21024 | 6175 | 33936 | 4507 | 36918 | 3666 | 38073 | 3022 | 38840 | 2060 | 46072 | 1799 | 25066 |
| 16-#11 | 1.67 | MA | 24781 | 6175 | 39243 | 4612 | 42190 | 3751 | 42661 | 3105 | 41575 | 2133 | 49552 | 1563 | 31057 |
| 8L-2S | | MI | 21673 | 6175 | 34925 | 4509 | 38178 | 3656 | 39605 | 3014 | 40886 | 2053 | 48785 | 1887 | 25046 |
| 16-#14 | 2.41 | MA | 29233 | 6567 | 48046 | 4817 | 53417 | 3883 | 56272 | 3183 | 60068 | 2090 | 73231 | 1784 | 47268 |
| 3L-7S | | MI | 19911 | 6567 | 32847 | 4756 | 35419 | 3846 | 36197 | 3126 | 36370 | 2032 | 43641 | 1259 | 32784 |
| 16-#14 | 2.41 | MA | 28362 | 6567 | 46512 | 4835 | 51467 | 3899 | 53905 | 3178 | 56995 | 2102 | 69696 | 1656 | 47051 |
| 4L-6S | | MI | 20457 | 6567 | 33862 | 4740 | 36656 | 3832 | 37769 | 3135 | 38348 | 2022 | 46237 | 1386 | 33788 |
| 16-#14 | 2.41 | MA | 27583 | 6567 | 45168 | 4834 | 49734 | 3896 | 51783 | 3193 | 53966 | 2093 | 66004 | 1592 | 45842 |
| 5E | | MI | 21017 | 6567 | 34811 | 4744 | 37944 | 3839 | 39283 | 3124 | 40368 | 2013 | 48726 | 1472 | 34422 |
| 16-#14 | 2.41 | MA | 26840 | 6567 | 43900 | 4833 | 48011 | 3913 | 49682 | 3188 | 51184 | 2104 | 62493 | 1508 | 44813 |
| 6L-4S | | MI | 21603 | 6567 | 35815 | 4748 | 39238 | 3825 | 40867 | 3113 | 42568 | 2022 | 51384 | 1530 | 35338 |
| 16-#14 | 2.41 | MA | 26116 | 6567 | 42543 | 4852 | 46357 | 3910 | 47654 | 3203 | 48462 | 2115 | 58839 | 1382 | 43424 |
| 7L-3S | | MI | 22255 | 6567 | 36957 | 4732 | 40690 | 3832 | 42628 | 3122 | 44797 | 2013 | 53882 | 1658 | 35447 |
| 16-#14 | 2.41 | MA | 25401 | 6567 | 41299 | 4851 | 44688 | 3927 | 45670 | 3218 | 45610 | 2106 | 55389 | 1308 | 42063 |
| 8L-2S | | MI | 23168 | 6567 | 38369 | 4736 | 42490 | 3818 | 44816 | 3111 | 47704 | 2003 | 57723 | 1786 | 35482 |
| 16-#18 | 4.28 | MA | 30605 | 7560 | 53170 | 5435 | 59760 | 4361 | 63899 | 3465 | 70244 | 2012 | 88127 | 1147 | 76446 |
| 5E | | MI | 23102 | 7560 | 40651 | 5328 | 45227 | 4267 | 47962 | 3370 | 51743 | 1880 | 64017 | 945 | 56918 |
| 16-#18 | 4.28 | MA | 29351 | 7560 | 50939 | 5431 | 56731 | 4354 | 60205 | 3454 | 65373 | 2030 | 82060 | 997 | 72696 |
| 6L-4S | | MI | 24093 | 7560 | 42409 | 5338 | 47493 | 4246 | 50713 | 3353 | 55535 | 1898 | 68578 | 1048 | 58437 |
| 16-#18 | 4.28 | MA | 28126 | 7560 | 48552 | 5463 | 53822 | 4382 | 56640 | 3478 | 60605 | 2047 | 75742 | 772 | 69101 |
| 7L-3S | | MI | 25195 | 7560 | 44406 | 5312 | 50030 | 4260 | 53770 | 3370 | 59373 | 1880 | 72857 | 1271 | 60821 |
| 18-#11 | 1.88 | MA | 28125 | 6286 | 45281 | 4656 | 49977 | 3768 | 52122 | 3110 | 54459 | 2113 | 65879 | 1879 | 37301 |
| 3L-8S | | MI | 19439 | 6286 | 31403 | 4592 | 33624 | 3723 | 34074 | 3066 | 33492 | 2058 | 39803 | 1453 | 26543 |
| 18-#11 | 1.88 | MA | 27510 | 6286 | 44211 | 4669 | 48617 | 3780 | 50471 | 3107 | 52315 | 2121 | 63391 | 1791 | 37226 |
| 4L-7S | | MI | 19819 | 6286 | 32054 | 4594 | 34496 | 3727 | 35111 | 3058 | 34952 | 2065 | 41552 | 1501 | 27094 |
| 18-#11 | 1.88 | MA | 26960 | 6286 | 43275 | 4668 | 47408 | 3778 | 48991 | 3118 | 50203 | 2115 | 60802 | 1746 | 37077 |
| 5L-6S | | MI | 20205 | 6286 | 32763 | 4583 | 35360 | 3718 | 36170 | 3050 | 36344 | 2058 | 43386 | 1589 | 27401 |
| 18-#11 | 1.88 | MA | 26436 | 6286 | 42391 | 4668 | 46207 | 3790 | 47526 | 3115 | 48263 | 2124 | 58333 | 1688 | 36264 |
| 6L-5S | | MI | 20600 | 6286 | 33425 | 4585 | 36259 | 3722 | 37267 | 3055 | 37767 | 2051 | 45145 | 1648 | 27925 |
| 18-#11 | 1.88 | MA | 25925 | 6286 | 41445 | 4681 | 45054 | 3789 | 46113 | 3125 | 46365 | 2132 | 55765 | 1600 | 35752 |
| 7L-4S | | MI | 21014 | 6286 | 34127 | 4588 | 37163 | 3712 | 38374 | 3047 | 39316 | 2058 | 47018 | 1689 | 28054 |
| 18-#11 | 1.88 | MA | 25420 | 6286 | 40578 | 4681 | 43891 | 3801 | 44729 | 3136 | 44377 | 2126 | 53345 | 1549 | 34964 |
| 8L-3S | | MI | 21475 | 6286 | 34925 | 4576 | 38178 | 3716 | 39605 | 3053 | 40886 | 2051 | 48785 | 1778 | 28080 |
| 18-#11 | 1.88 | MA | 24894 | 6286 | 39726 | 4680 | 42754 | 3799 | 43298 | 3133 | 42499 | 2135 | 50953 | 1493 | 34179 |
| 9L-2S | | MI | 22121 | 6286 | 35914 | 4578 | 39439 | 3706 | 41137 | 3045 | 42933 | 2044 | 51497 | 1866 | 28068 |
| 18-#14 | 2.71 | MA | 29241 | 6726 | 48423 | 4935 | 53903 | 3972 | 56866 | 3223 | 61006 | 2092 | 75093 | 1634 | 52793 |
| 4L-7S | | MI | 20557 | 6726 | 34259 | 4856 | 37219 | 3918 | 38385 | 3171 | 39277 | 2018 | 47481 | 1227 | 36863 |
| 18-#14 | 2.71 | MA | 28468 | 6726 | 47079 | 4934 | 52170 | 3969 | 54744 | 3238 | 57978 | 2083 | 71401 | 1571 | 51455 |
| 5L-6S | | MI | 21100 | 6726 | 35274 | 4840 | 38456 | 3904 | 39957 | 3180 | 41254 | 2008 | 50077 | 1354 | 37949 |
| 18-#14 | 2.71 | MA | 27731 | 6726 | 45811 | 4933 | 50447 | 3985 | 52642 | 3233 | 55196 | 2094 | 67890 | 1486 | 50465 |
| 6L-5S | | MI | 21656 | 6726 | 36223 | 4844 | 39744 | 3911 | 41470 | 3169 | 43274 | 1999 | 52567 | 1439 | 38552 |
| 18-#14 | 2.71 | MA | 27012 | 6726 | 44454 | 4951 | 48793 | 3982 | 50615 | 3248 | 52473 | 2105 | 64236 | 1360 | 48996 |
| 7L-4S | | MI | 22238 | 6726 | 37227 | 4848 | 41038 | 3898 | 43055 | 3158 | 45474 | 2008 | 55225 | 1497 | 39583 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis

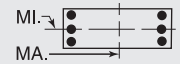



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.71 | MA | 26303 | 6726 | 43209 | 4950 | 47124 | 3999 | 48631 | 3263 | 49621 | 2096 | 60787 | 1286 | 47675 |
| 8L-3S | | MI | 22885 | 6726 | 38369 | 4832 | 42490 | 3904 | 44816 | 3167 | 47704 | 1999 | 57723 | 1625 | 39717 |
| 18-#14 | 2.71 | MA | 25582 | 6726 | 41892 | 4969 | 45493 | 3996 | 46577 | 3258 | 46927 | 2107 | 57385 | 1205 | 45787 |
| 9L-2S | | MI | 23793 | 6726 | 39781 | 4836 | 44289 | 3891 | 47004 | 3156 | 50610 | 1989 | 61564 | 1753 | 39772 |
| 18-#18 | 4.81 | MA | 30862 | 7843 | 54286 | 5608 | 60997 | 4482 | 65391 | 3534 | 72379 | 2011 | 91397 | 952 | 82416 |
| 6L-5S | | MI | 24179 | 7843 | 43111 | 5506 | 48363 | 4395 | 51752 | 3449 | 56748 | 1851 | 70594 | 879 | 63890 |
| 18-#18 | 4.81 | MA | 29652 | 7843 | 51899 | 5640 | 58088 | 4510 | 61827 | 3558 | 67612 | 2029 | 85079 | 726 | 78726 |
| 7L-4S | | MI | 25161 | 7843 | 44869 | 5515 | 50629 | 4374 | 54503 | 3431 | 60540 | 1869 | 75154 | 982 | 65556 |
| 20-#11 | 2.09 | MA | 28133 | 6396 | 45546 | 4738 | 50318 | 3830 | 52539 | 3138 | 55117 | 2114 | 67184 | 1777 | 41254 |
| 4L-8S | | MI | 19898 | 6396 | 32391 | 4661 | 34884 | 3773 | 35606 | 3097 | 35539 | 2049 | 42516 | 1432 | 29421 |
| 20-#11 | 2.09 | MA | 27586 | 6396 | 44609 | 4738 | 49109 | 3829 | 51059 | 3149 | 53005 | 2108 | 64595 | 1732 | 41018 |
| 5L-7S | | MI | 20276 | 6396 | 33042 | 4663 | 35756 | 3777 | 36643 | 3089 | 36998 | 2056 | 44264 | 1480 | 30024 |
| 20-#11 | 2.09 | MA | 27065 | 6396 | 43725 | 4737 | 47908 | 3841 | 49594 | 3146 | 51065 | 2117 | 62126 | 1674 | 40213 |
| 6E | | MI | 20660 | 6396 | 33751 | 4652 | 36620 | 3768 | 37702 | 3081 | 38391 | 2049 | 46098 | 1568 | 30319 |
| 20-#11 | 2.09 | MA | 26557 | 6396 | 42779 | 4750 | 46755 | 3839 | 48181 | 3156 | 49167 | 2125 | 59558 | 1586 | 39716 |
| 7L-5S | | MI | 21053 | 6396 | 34414 | 4654 | 37520 | 3772 | 38799 | 3086 | 39814 | 2042 | 47858 | 1627 | 30819 |
| 20-#11 | 2.09 | MA | 26055 | 6396 | 41912 | 4750 | 45592 | 3851 | 46797 | 3167 | 47179 | 2120 | 57138 | 1535 | 38877 |
| 8L-4S | | MI | 21465 | 6396 | 35115 | 4657 | 38424 | 3762 | 39906 | 3078 | 41363 | 2049 | 49730 | 1668 | 31045 |
| 20-#11 | 2.09 | MA | 25532 | 6396 | 41060 | 4749 | 44455 | 3849 | 45366 | 3164 | 45301 | 2128 | 54746 | 1479 | 38112 |
| 9L-3S | | MI | 21923 | 6396 | 35914 | 4645 | 39439 | 3766 | 41137 | 3084 | 42933 | 2042 | 51497 | 1757 | 31082 |
| 20-#11 | 2.09 | MA | 24980 | 6396 | 40131 | 4763 | 43307 | 3861 | 43991 | 3175 | 43437 | 2136 | 52426 | 1415 | 37078 |
| 10L-2S | | MI | 22567 | 6396 | 36902 | 4648 | 40699 | 3756 | 42669 | 3076 | 44980 | 2035 | 54210 | 1846 | 31086 |
| 20-#14 | 3.01 | MA | 29346 | 6886 | 48989 | 5034 | 54605 | 4041 | 57705 | 3283 | 61989 | 2073 | 76798 | 1549 | 57078 |
| 5L-7S | | MI | 21199 | 6886 | 35671 | 4955 | 39019 | 3990 | 40573 | 3215 | 42183 | 2004 | 51322 | 1195 | 40952 |
| 20-#14 | 3.01 | MA | 28615 | 6886 | 47721 | 5032 | 52883 | 4058 | 55603 | 3278 | 59207 | 2084 | 73287 | 1464 | 56124 |
| 6E | | MI | 21738 | 6886 | 36686 | 4939 | 40256 | 3977 | 42145 | 3225 | 44160 | 1994 | 53918 | 1322 | 42114 |
| 20-#14 | 3.01 | MA | 27902 | 6886 | 46364 | 5051 | 51229 | 4055 | 53576 | 3293 | 56484 | 2095 | 69633 | 1338 | 54578 |
| 7L-5S | | MI | 22290 | 6886 | 37635 | 4943 | 41544 | 3983 | 43658 | 3214 | 46180 | 1984 | 56407 | 1407 | 42691 |
| 20-#14 | 3.01 | MA | 27198 | 6886 | 45120 | 5050 | 49560 | 4072 | 51591 | 3308 | 53633 | 2086 | 66184 | 1264 | 53256 |
| 8L-4S | | MI | 22869 | 6886 | 38639 | 4947 | 42838 | 3970 | 45243 | 3203 | 48381 | 1994 | 59066 | 1465 | 43824 |
| 20-#14 | 3.01 | MA | 26478 | 6886 | 43802 | 5069 | 47929 | 4068 | 49538 | 3303 | 50938 | 2097 | 62782 | 1183 | 51358 |
| 9L-3S | | MI | 23512 | 6886 | 39781 | 4932 | 44289 | 3976 | 47004 | 3212 | 50610 | 1984 | 61564 | 1593 | 43981 |
| 20-#18 | 5.35 | MA | 31162 | 8127 | 55245 | 5817 | 62354 | 4639 | 67013 | 3638 | 74619 | 2010 | 94417 | 681 | 88370 |
| 7L-5S | | MI | 25248 | 8127 | 45570 | 5683 | 51499 | 4524 | 55542 | 3527 | 61753 | 1822 | 77170 | 813 | 70857 |
| 22-#11 | 2.29 | MA | 28208 | 6507 | 45943 | 4807 | 50810 | 3879 | 53127 | 3180 | 55807 | 2102 | 68387 | 1718 | 44942 |
| 5L-8S | | MI | 20354 | 6507 | 33380 | 4730 | 36144 | 3824 | 37139 | 3128 | 37586 | 2040 | 45228 | 1411 | 32305 |
| 22-#11 | 2.29 | MA | 27690 | 6507 | 45060 | 4806 | 49609 | 3891 | 51662 | 3177 | 53867 | 2110 | 65919 | 1660 | 44166 |
| 6L-7S | | MI | 20731 | 6507 | 34031 | 4733 | 37016 | 3828 | 38176 | 3120 | 39045 | 2047 | 46976 | 1459 | 32956 |
| 22-#11 | 2.29 | MA | 27185 | 6507 | 44114 | 4820 | 48457 | 3889 | 50249 | 3188 | 51969 | 2118 | 63350 | 1572 | 43684 |
| 7L-6S | | MI | 21113 | 6507 | 34740 | 4721 | 37881 | 3818 | 39234 | 3112 | 40437 | 2040 | 48810 | 1547 | 33242 |
| 22-#11 | 2.29 | MA | 26686 | 6507 | 43246 | 4819 | 47293 | 3901 | 48865 | 3198 | 49981 | 2113 | 60930 | 1521 | 42795 |
| 8L-5S | | MI | 21504 | 6507 | 35402 | 4723 | 38780 | 3822 | 40331 | 3118 | 41860 | 2033 | 50570 | 1606 | 33719 |
| 22-#11 | 2.29 | MA | 26166 | 6507 | 42395 | 4819 | 46156 | 3899 | 47434 | 3195 | 48102 | 2121 | 58539 | 1465 | 42050 |
| 9L-4S | | MI | 21914 | 6507 | 36104 | 4726 | 39684 | 3812 | 41438 | 3109 | 43410 | 2040 | 52442 | 1647 | 34032 |
| 22-#11 | 2.29 | MA | 25617 | 6507 | 41465 | 4832 | 45008 | 3911 | 46059 | 3206 | 46238 | 2129 | 56219 | 1401 | 40982 |
| 10L-3S | | MI | 22370 | 6507 | 36902 | 4714 | 40699 | 3816 | 42669 | 3115 | 44980 | 2033 | 54210 | 1736 | 34081 |
| 22-#11 | 2.29 | MA | 25080 | 6507 | 40614 | 4831 | 43878 | 3910 | 44644 | 3203 | 44278 | 2124 | 53856 | 1347 | 40000 |
| 11L-2S | | MI | 23011 | 6507 | 37891 | 4717 | 41959 | 3806 | 44201 | 3107 | 47026 | 2026 | 56922 | 1825 | 34100 |
| 22-#14 | 3.31 | MA | 29492 | 7045 | 49632 | 5132 | 55318 | 4130 | 58564 | 3323 | 63218 | 2074 | 78684 | 1442 | 61789 |
| 6L-7S | | MI | 21837 | 7045 | 37082 | 5055 | 40818 | 4062 | 42761 | 3260 | 45089 | 1990 | 55163 | 1162 | 45051 |
| 22-#14 | 3.31 | MA | 28784 | 7045 | 48275 | 5151 | 53664 | 4127 | 56537 | 3338 | 60496 | 2085 | 75031 | 1316 | 60168 |
| 7L-6S | | MI | 22372 | 7045 | 38097 | 5039 | 42056 | 4049 | 44333 | 3269 | 47066 | 1980 | 57758 | 1289 | 46266 |
| 22-#14 | 3.31 | MA | 28086 | 7045 | 47030 | 5150 | 51995 | 4144 | 54552 | 3353 | 57644 | 2076 | 71581 | 1242 | 58791 |
| 8L-5S | | MI | 22921 | 7045 | 39046 | 5043 | 43343 | 4056 | 45846 | 3259 | 49086 | 1970 | 60248 | 1375 | 46837 |
| 22-#14 | 3.31 | MA | 27368 | 7045 | 45713 | 5168 | 50364 | 4141 | 52499 | 3348 | 54949 | 2087 | 68179 | 1161 | 56936 |
| 9L-4S | | MI | 23496 | 7045 | 40051 | 5047 | 44638 | 4042 | 47431 | 3248 | 51287 | 1980 | 62906 | 1433 | 47968 |
| 24-#11 | 2.50 | MA | 28312 | 6618 | 46394 | 4875 | 51311 | 3941 | 53730 | 3208 | 56669 | 2103 | 69711 | 1646 | 48124 |
| 6L-8S | | MI | 20808 | 6618 | 34368 | 4799 | 37405 | 3874 | 38671 | 3159 | 39632 | 2031 | 47940 | 1390 | 35193 |

## RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.50 | MA | 27809 | 6618 | 45448 | 4889 | 50158 | 3939 | 52317 | 3219 | 54771 | 2111 | 67143 | 1558 | 47653 |
| 7E | | MI | 21183 | 6618 | 35019 | 4802 | 38277 | 3878 | 39708 | 3151 | 41092 | 2038 | 49689 | 1438 | 35848 |
| 24-#11 | 2.50 | MA | 27314 | 6618 | 44581 | 4888 | 48994 | 3951 | 50933 | 3230 | 52782 | 2106 | 64723 | 1507 | 46718 |
| 8L-6S | | MI | 21563 | 6618 | 35728 | 4790 | 39141 | 3868 | 40766 | 3143 | 42484 | 2031 | 51523 | 1526 | 36168 |
| 24-#11 | 2.50 | MA | 26801 | 6618 | 43729 | 4888 | 47858 | 3949 | 49502 | 3227 | 50904 | 2114 | 62331 | 1451 | 45991 |
| 9L-5S | | MI | 21952 | 6618 | 36391 | 4793 | 40040 | 3872 | 41863 | 3149 | 43907 | 2024 | 53283 | 1585 | 36624 |
| 24-#11 | 2.50 | MA | 26250 | 6618 | 42799 | 4901 | 46709 | 3961 | 48127 | 3237 | 49040 | 2122 | 60011 | 1387 | 44890 |
| 10L-4S | | MI | 22360 | 6618 | 37092 | 4795 | 40945 | 3862 | 42970 | 3141 | 45456 | 2031 | 55155 | 1626 | 37017 |
| 24-#11 | 2.50 | MA | 25715 | 6618 | 41948 | 4900 | 45579 | 3960 | 46713 | 3234 | 47080 | 2117 | 57648 | 1333 | 43882 |
| 11L-3S | | MI | 22814 | 6618 | 37891 | 4784 | 41959 | 3866 | 44201 | 3146 | 47026 | 2024 | 56922 | 1715 | 37077 |
| 24-#14 | 3.61 | MA | 29661 | 7205 | 50185 | 5251 | 56100 | 4199 | 59498 | 3383 | 64507 | 2075 | 80428 | 1294 | 65767 |
| 7E | | MI | 22470 | 7205 | 38494 | 5155 | 42618 | 4135 | 44949 | 3305 | 47995 | 1976 | 59003 | 1130 | 49157 |
| 24-#14 | 3.61 | MA | 28968 | 7205 | 48940 | 5249 | 54431 | 4216 | 57513 | 3398 | 61655 | 2066 | 76978 | 1220 | 64335 |
| 8L-6S | | MI | 23003 | 7205 | 39509 | 5139 | 43856 | 4121 | 46521 | 3314 | 49972 | 1966 | 61599 | 1257 | 50329 |
| 24-#14 | 3.61 | MA | 28251 | 7205 | 47623 | 5268 | 52800 | 4213 | 55460 | 3393 | 58961 | 2077 | 73576 | 1139 | 62521 |
| 9L-5S | | MI | 23548 | 7205 | 40458 | 5143 | 45143 | 4128 | 48034 | 3303 | 51992 | 1956 | 64089 | 1342 | 50991 |

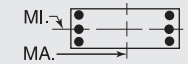
## RECTANGULAR TIED COLUMNS 34" x 46"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.02 | MA | 28816 | 6098 | 45017 | 4542 | 48733 | 3702 | 49736 | 3086 | 49695 | 2214 | 58433 | 2090 | 22404 |
| 2E | | MI | 21078 | 6098 | 33343 | 4435 | 35627 | 3614 | 36058 | 3007 | 35453 | 2133 | 41195 | 1987 | 16173 |
| 6-#18 | 1.53 | MA | 30461 | 6381 | 48540 | 4720 | 53226 | 3831 | 55198 | 3166 | 57094 | 2196 | 68325 | 2048 | 33194 |
| 2L-3S | | MI | 20574 | 6381 | 33343 | 4602 | 35627 | 3763 | 36058 | 3103 | 35453 | 2121 | 41195 | 1693 | 23849 |
| 6-#18 | 1.53 | MA | 28133 | 6381 | 45017 | 4717 | 48733 | 3860 | 49736 | 3191 | 49695 | 2214 | 58433 | 1820 | 33138 |
| 3L-2S | | MI | 22190 | 6381 | 35803 | 4612 | 38763 | 3742 | 39848 | 3086 | 40458 | 2104 | 47771 | 1921 | 23772 |
| 8-#14 | 1.15 | MA | 29318 | 6169 | 45874 | 4614 | 50000 | 3757 | 51343 | 3125 | 51899 | 2224 | 61667 | 2107 | 25296 |
| 2L-4S | | MI | 19834 | 6169 | 31399 | 4528 | 33316 | 3683 | 33357 | 3058 | 32055 | 2175 | 37249 | 1752 | 18337 |
| 8-#14 | 1.15 | MA | 27976 | 6169 | 43863 | 4614 | 47437 | 3755 | 48227 | 3141 | 47679 | 2236 | 55957 | 1979 | 25329 |
| 3E | | MI | 20504 | 6169 | 32541 | 4512 | 34767 | 3690 | 35118 | 3068 | 34284 | 2165 | 39747 | 1880 | 18298 |
| 8-#14 | 1.15 | MA | 27030 | 6169 | 42252 | 4633 | 45388 | 3772 | 45740 | 3136 | 44449 | 2248 | 52213 | 1851 | 25259 |
| 4L-2S | | MI | 21441 | 6169 | 33953 | 4516 | 36567 | 3676 | 37306 | 3057 | 37190 | 2155 | 43588 | 2008 | 18233 |
| 8-#18 | 2.05 | MA | 32081 | 6665 | 52064 | 4897 | 57718 | 3960 | 60659 | 3246 | 64493 | 2178 | 78216 | 2006 | 43937 |
| 2L-4S | | MI | 20538 | 6665 | 33806 | 4806 | 36225 | 3877 | 36791 | 3164 | 36620 | 2110 | 43492 | 1403 | 30589 |
| 8-#18 | 2.05 | MA | 29779 | 6665 | 48540 | 4894 | 53226 | 3988 | 55198 | 3271 | 57094 | 2196 | 68325 | 1778 | 43770 |
| 3E | | MI | 21688 | 6665 | 35803 | 4780 | 38763 | 3892 | 39848 | 3182 | 40458 | 2092 | 47771 | 1627 | 31308 |
| 8-#18 | 2.05 | MA | 28155 | 6665 | 45709 | 4926 | 49625 | 3982 | 50827 | 3261 | 51420 | 2215 | 61852 | 1550 | 42700 |
| 4L-2S | | MI | 23287 | 6665 | 38263 | 4789 | 41899 | 3871 | 43638 | 3164 | 45464 | 2074 | 54348 | 1855 | 31316 |
| 10-#14 | 1.44 | MA | 30264 | 6328 | 47884 | 4714 | 52563 | 3830 | 54458 | 3170 | 56120 | 2214 | 67376 | 2086 | 31440 |
| 2L-5S | | MI | 19889 | 6328 | 31807 | 4624 | 33821 | 3769 | 33960 | 3114 | 32761 | 2151 | 38432 | 1662 | 22286 |
| 10-#14 | 1.44 | MA | 28931 | 6328 | 45874 | 4713 | 50000 | 3827 | 51343 | 3186 | 51899 | 2226 | 61667 | 1958 | 31437 |
| 3L-4S | | MI | 20489 | 6328 | 32811 | 4628 | 35116 | 3756 | 35545 | 3103 | 34961 | 2161 | 41090 | 1720 | 22623 |
| 10-#14 | 1.44 | MA | 27993 | 6328 | 44262 | 4732 | 47950 | 3844 | 48855 | 3181 | 48670 | 2238 | 57923 | 1830 | 31323 |
| 4L-3S | | MI | 21155 | 6328 | 33953 | 4612 | 36567 | 3762 | 37306 | 3112 | 37190 | 2151 | 43588 | 1848 | 22624 |
| 10-#14 | 1.44 | MA | 27153 | 6328 | 42850 | 4732 | 46129 | 3842 | 46625 | 3197 | 45487 | 2230 | 54024 | 1767 | 30713 |
| 5L-2S | | MI | 22086 | 6328 | 35365 | 4616 | 38367 | 3749 | 39494 | 3102 | 40097 | 2141 | 47428 | 1976 | 22577 |
| 10-#18 | 2.56 | MA | 33680 | 6949 | 55588 | 5074 | 62210 | 4088 | 66120 | 3325 | 71891 | 2161 | 88108 | 1963 | 54638 |
| 2L-5S | | MI | 20626 | 6949 | 34508 | 4974 | 37096 | 4027 | 37831 | 3260 | 37833 | 2063 | 45508 | 1235 | 35653 |
| 10-#18 | 2.56 | MA | 31403 | 6949 | 52064 | 5071 | 57718 | 4117 | 60659 | 3351 | 64493 | 2179 | 78216 | 1736 | 54384 |
| 3L-4S | | MI | 21650 | 6949 | 36266 | 4983 | 39361 | 4006 | 40581 | 3242 | 41625 | 2081 | 50068 | 1337 | 37556 |
| 10-#18 | 2.56 | MA | 29799 | 6949 | 49232 | 5104 | 54117 | 4110 | 56288 | 3341 | 58818 | 2197 | 71744 | 1508 | 52819 |
| 4L-3S | | MI | 22788 | 6949 | 38263 | 4957 | 41899 | 4020 | 43638 | 3260 | 45464 | 2063 | 54348 | 1561 | 38737 |
| 10-#18 | 2.56 | MA | 28362 | 6949 | 46749 | 5101 | 50915 | 4139 | 52367 | 3366 | 53224 | 2180 | 64965 | 1398 | 49611 |
| 5L-2S | | MI | 24373 | 6949 | 40722 | 4967 | 45035 | 3999 | 47428 | 3242 | 50469 | 2045 | 60924 | 1789 | 38830 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis

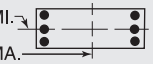



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.20 | MA | 29517 | 6194 | 46184 | 4644 | 50483 | 3780 | 51965 | 3142 | 52757 | 2230 | 62975 | 2118 | 26385 |
| 2L-6S | | MI | 19641 | 6194 | 31025 | 4555 | 32856 | 3715 | 32817 | 3082 | 31318 | 2181 | 36479 | 1745 | 18800 |
| 12-#11 | 1.20 | MA | 28580 | 6194 | 44780 | 4644 | 48694 | 3779 | 49790 | 3153 | 49810 | 2239 | 58965 | 2029 | 26405 |
| 3L-5S | | MI | 20044 | 6194 | 31688 | 4558 | 33755 | 3719 | 33913 | 3088 | 32741 | 2174 | 38239 | 1804 | 19085 |
| 12-#11 | 1.20 | MA | 27921 | 6194 | 43656 | 4657 | 47265 | 3791 | 48055 | 3151 | 47557 | 2247 | 56333 | 1940 | 26382 |
| 4E | | MI | 20465 | 6194 | 32389 | 4560 | 34659 | 3709 | 35020 | 3079 | 34290 | 2181 | 40111 | 1845 | 19086 |
| 12-#11 | 1.20 | MA | 27333 | 6194 | 42672 | 4657 | 45996 | 3790 | 46500 | 3162 | 45339 | 2242 | 53600 | 1895 | 26291 |
| 5L-3S | | MI | 20933 | 6194 | 33187 | 4548 | 35674 | 3713 | 36252 | 3085 | 35860 | 2174 | 41879 | 1934 | 19056 |
| 12-#11 | 1.20 | MA | 26771 | 6194 | 41744 | 4657 | 44734 | 3802 | 44962 | 3159 | 43302 | 2251 | 50989 | 1837 | 25768 |
| 6L-2S | | MI | 21589 | 6194 | 34176 | 4551 | 36935 | 3703 | 37784 | 3077 | 37907 | 2168 | 44591 | 2022 | 19017 |
| 12-#14 | 1.73 | MA | 31201 | 6488 | 49894 | 4814 | 55125 | 3902 | 57574 | 3215 | 60341 | 2204 | 73085 | 2066 | 37572 |
| 2L-6S | | MI | 19975 | 6488 | 32270 | 4719 | 34334 | 3835 | 34635 | 3170 | 33647 | 2147 | 39782 | 1544 | 25649 |
| 12-#14 | 1.73 | MA | 29877 | 6488 | 47884 | 4813 | 52563 | 3899 | 54458 | 3231 | 56120 | 2216 | 67376 | 1938 | 37533 |
| 3L-5S | | MI | 20544 | 6488 | 33219 | 4723 | 35621 | 3841 | 36148 | 3159 | 35667 | 2137 | 42272 | 1630 | 26372 |
| 12-#14 | 1.73 | MA | 28946 | 6488 | 46272 | 4832 | 50513 | 3917 | 51971 | 3226 | 52891 | 2228 | 63632 | 1810 | 37380 |
| 4E | | MI | 21139 | 6488 | 34223 | 4727 | 36915 | 3828 | 37733 | 3148 | 37868 | 2147 | 44930 | 1687 | 26895 |
| 12-#14 | 1.73 | MA | 28113 | 6488 | 44861 | 4831 | 48692 | 3914 | 49741 | 3242 | 49708 | 2220 | 59733 | 1746 | 36575 |
| 5L-3S | | MI | 21800 | 6488 | 35365 | 4712 | 38367 | 3834 | 39494 | 3157 | 40097 | 2137 | 47428 | 1815 | 26935 |
| 12-#14 | 1.73 | MA | 27319 | 6488 | 43529 | 4831 | 46883 | 3931 | 47533 | 3237 | 46785 | 2232 | 56017 | 1662 | 35344 |
| 6L-2S | | MI | 22726 | 6488 | 36776 | 4716 | 40167 | 3821 | 41682 | 3146 | 43003 | 2127 | 51269 | 1943 | 26906 |
| 12-#18 | 3.07 | MA | 33006 | 7233 | 55588 | 5249 | 62210 | 4245 | 66120 | 3431 | 71891 | 2161 | 88108 | 1694 | 64986 |
| 3L-5S | | MI | 21736 | 7233 | 36968 | 5151 | 40231 | 4156 | 41620 | 3338 | 42838 | 2034 | 52084 | 1169 | 42802 |
| 12-#18 | 3.07 | MA | 31421 | 7233 | 52756 | 5281 | 58609 | 4239 | 61750 | 3420 | 66217 | 2179 | 81635 | 1466 | 62986 |
| 4E | | MI | 22750 | 7233 | 38726 | 5160 | 42497 | 4135 | 44371 | 3320 | 46630 | 2051 | 56644 | 1271 | 44572 |
| 12-#18 | 3.07 | MA | 30002 | 7233 | 50273 | 5278 | 55407 | 4268 | 57828 | 3446 | 60622 | 2162 | 74856 | 1355 | 59942 |
| 5L-3S | | MI | 23877 | 7233 | 40722 | 5134 | 45035 | 4149 | 47428 | 3338 | 50469 | 2034 | 60924 | 1495 | 46145 |
| 12-#18 | 3.07 | MA | 28649 | 7233 | 47929 | 5275 | 52223 | 4261 | 53945 | 3436 | 55481 | 2180 | 68425 | 1205 | 56523 |
| 6L-2S | | MI | 25447 | 7233 | 43182 | 5144 | 48171 | 4128 | 51218 | 3320 | 55474 | 2016 | 67500 | 1723 | 46303 |
| 14-#11 | 1.40 | MA | 30180 | 6305 | 47587 | 4713 | 52273 | 3830 | 54140 | 3173 | 55704 | 2223 | 66984 | 2105 | 30672 |
| 2L-7S | | MI | 19714 | 6305 | 31305 | 4636 | 33252 | 3775 | 33290 | 3121 | 31973 | 2179 | 37358 | 1636 | 21361 |
| 14-#11 | 1.40 | MA | 29247 | 6305 | 46184 | 4713 | 50483 | 3829 | 51965 | 3184 | 52757 | 2232 | 62975 | 2016 | 30675 |
| 3L-6S | | MI | 20105 | 6305 | 32014 | 4624 | 34116 | 3765 | 34349 | 3113 | 33365 | 2172 | 39192 | 1724 | 21700 |
| 14-#11 | 1.40 | MA | 28592 | 6305 | 45060 | 4727 | 49054 | 3841 | 50230 | 3182 | 50504 | 2241 | 60342 | 1927 | 30633 |
| 4L-5S | | MI | 20505 | 6305 | 32676 | 4627 | 35016 | 3769 | 35445 | 3119 | 34788 | 2166 | 40952 | 1783 | 22080 |
| 14-#11 | 1.40 | MA | 28007 | 6305 | 44076 | 4726 | 47785 | 3840 | 48675 | 3193 | 48286 | 2236 | 57610 | 1882 | 30521 |
| 5L-4S | | MI | 20924 | 6305 | 33378 | 4629 | 35920 | 3759 | 36552 | 3111 | 36337 | 2172 | 42824 | 1824 | 22103 |
| 14-#11 | 1.40 | MA | 27449 | 6305 | 43148 | 4726 | 46524 | 3852 | 47137 | 3190 | 46248 | 2244 | 54999 | 1824 | 29901 |
| 6L-3S | | MI | 21390 | 6305 | 34176 | 4618 | 36935 | 3763 | 37784 | 3116 | 37907 | 2166 | 44591 | 1913 | 22085 |
| 14-#11 | 1.40 | MA | 26905 | 6305 | 42155 | 4740 | 45313 | 3851 | 45653 | 3202 | 44255 | 2253 | 52283 | 1737 | 29303 |
| 7L-2S | | MI | 22043 | 6305 | 35164 | 4620 | 38195 | 3754 | 39316 | 3108 | 39954 | 2159 | 47303 | 2002 | 22054 |
| 14-#14 | 2.01 | MA | 32130 | 6647 | 51904 | 4914 | 57688 | 3974 | 60689 | 3260 | 64562 | 2194 | 78795 | 2046 | 43685 |
| 2L-7S | | MI | 20076 | 6647 | 32666 | 4835 | 34896 | 3920 | 35250 | 3206 | 34576 | 2143 | 41027 | 1385 | 28980 |
| 14-#14 | 2.01 | MA | 30815 | 6647 | 49894 | 4913 | 55125 | 3972 | 57574 | 3275 | 60341 | 2206 | 73085 | 1918 | 43619 |
| 3L-6S | | MI | 20628 | 6647 | 33681 | 4819 | 36133 | 3907 | 36822 | 3215 | 36553 | 2133 | 43623 | 1512 | 29794 |
| 14-#14 | 2.01 | MA | 29891 | 6647 | 48282 | 4932 | 53076 | 3989 | 55086 | 3271 | 57111 | 2218 | 69341 | 1790 | 43432 |
| 4L-5S | | MI | 21193 | 6647 | 34630 | 4823 | 37421 | 3914 | 38336 | 3204 | 38573 | 2123 | 46113 | 1597 | 30475 |
| 14-#14 | 2.01 | MA | 29065 | 6647 | 46871 | 4931 | 51255 | 3986 | 52856 | 3287 | 53929 | 2210 | 65443 | 1726 | 42456 |
| 5L-4S | | MI | 21784 | 6647 | 35634 | 4827 | 38715 | 3900 | 39920 | 3193 | 40774 | 2133 | 48771 | 1655 | 31158 |
| 14-#14 | 2.01 | MA | 28277 | 6647 | 45539 | 4930 | 49445 | 4004 | 50649 | 3282 | 51006 | 2222 | 61727 | 1642 | 41278 |
| 6L-3S | | MI | 22441 | 6647 | 36776 | 4811 | 40167 | 3907 | 41682 | 3202 | 43003 | 2123 | 51269 | 1783 | 31226 |
| 14-#14 | 2.01 | MA | 27508 | 6647 | 44114 | 4949 | 47708 | 4001 | 48519 | 3298 | 48146 | 2234 | 57860 | 1515 | 40037 |
| 7L-2S | | MI | 23361 | 6647 | 38188 | 4815 | 41967 | 3893 | 43870 | 3191 | 45909 | 2113 | 55110 | 1911 | 31223 |
| 14-#18 | 3.58 | MA | 33024 | 7516 | 56279 | 5458 | 63102 | 4368 | 67211 | 3500 | 73615 | 2162 | 91527 | 1424 | 73194 |
| 4L-5S | | MI | 22835 | 7516 | 39427 | 5328 | 43367 | 4284 | 45410 | 3416 | 47844 | 2005 | 58660 | 1103 | 49974 |
| 14-#18 | 3.58 | MA | 31622 | 7516 | 53796 | 5455 | 59899 | 4396 | 63289 | 3526 | 68021 | 2144 | 84748 | 1313 | 70298 |
| 5L-4S | | MI | 23839 | 7516 | 41185 | 5338 | 45633 | 4263 | 48161 | 3399 | 51636 | 2022 | 63221 | 1206 | 51628 |
| 14-#18 | 3.58 | MA | 30285 | 7516 | 51452 | 5452 | 56716 | 4390 | 59406 | 3515 | 62880 | 2162 | 78317 | 1163 | 66722 |
| 6L-3S | | MI | 24955 | 7516 | 43182 | 5312 | 48171 | 4278 | 51218 | 3416 | 55474 | 2005 | 67500 | 1429 | 53539 |
| 14-#18 | 3.58 | MA | 28980 | 7516 | 48944 | 5485 | 53658 | 4419 | 55659 | 3541 | 57848 | 2181 | 71622 | 938 | 63228 |
| 7L-2S | | MI | 26512 | 7516 | 45642 | 5321 | 51307 | 4257 | 55008 | 3399 | 60480 | 1987 | 74076 | 1657 | 53757 |

## RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

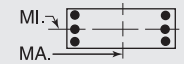
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.60 | MA | 30838 | 6415 | 48991 | 4782 | 54062 | 3880 | 56315 | 3204 | 58651 | 2216 | 70993 | 2091 | 34952 |
| 2L-8S | | MI | 19794 | 6415 | 31642 | 4703 | 33640 | 3821 | 33785 | 3161 | 32560 | 2164 | 38322 | 1567 | 23863 |
| 16-#11 | 1.60 | MA | 29910 | 6415 | 47587 | 4782 | 52273 | 3879 | 54140 | 3216 | 55704 | 2225 | 66984 | 2003 | 34938 |
| 3L-7S | | MI | 20177 | 6415 | 32293 | 4705 | 34512 | 3825 | 34822 | 3152 | 34019 | 2170 | 40070 | 1615 | 24285 |
| 16-#11 | 1.60 | MA | 29259 | 6415 | 46463 | 4796 | 50844 | 3891 | 52405 | 3213 | 53451 | 2234 | 64352 | 1914 | 34879 |
| 4L-6S | | MI | 20566 | 6415 | 33002 | 4694 | 35377 | 3815 | 35881 | 3144 | 35412 | 2164 | 41904 | 1703 | 24608 |
| 16-#11 | 1.60 | MA | 28677 | 6415 | 45479 | 4795 | 49574 | 3890 | 50851 | 3224 | 51233 | 2229 | 61619 | 1869 | 34747 |
| 5E | | MI | 20964 | 6415 | 33665 | 4696 | 36276 | 3819 | 36978 | 3150 | 36834 | 2157 | 43664 | 1762 | 25068 |
| 16-#11 | 1.60 | MA | 28123 | 6415 | 44551 | 4795 | 48313 | 3902 | 49312 | 3221 | 49195 | 2237 | 59008 | 1811 | 34043 |
| 6L-4S | | MI | 21381 | 6415 | 34366 | 4698 | 37180 | 3810 | 38085 | 3142 | 38384 | 2164 | 45536 | 1803 | 25108 |
| 16-#11 | 1.60 | MA | 27582 | 6415 | 43558 | 4809 | 47102 | 3901 | 47828 | 3233 | 47202 | 2246 | 56292 | 1724 | 33467 |
| 7L-3S | | MI | 21844 | 6415 | 35164 | 4687 | 38195 | 3814 | 39316 | 3147 | 39954 | 2157 | 47303 | 1892 | 25107 |
| 16-#11 | 1.60 | MA | 27048 | 6415 | 42648 | 4809 | 45881 | 3913 | 46376 | 3244 | 45114 | 2241 | 53738 | 1671 | 32784 |
| 8L-2S | | MI | 22495 | 6415 | 36153 | 4689 | 39455 | 3804 | 40848 | 3139 | 42000 | 2150 | 50016 | 1981 | 25084 |
| 16-#14 | 2.30 | MA | 31745 | 6807 | 51904 | 5012 | 57688 | 4044 | 60689 | 3320 | 64562 | 2196 | 78795 | 1897 | 49698 |
| 3L-7S | | MI | 20728 | 6807 | 34078 | 4935 | 36696 | 3993 | 37438 | 3251 | 37482 | 2129 | 44868 | 1352 | 33044 |
| 16-#14 | 2.30 | MA | 30828 | 6807 | 50293 | 5032 | 55639 | 4061 | 58202 | 3316 | 61332 | 2208 | 75050 | 1769 | 49481 |
| 4L-6S | | MI | 21276 | 6807 | 35093 | 4919 | 37933 | 3979 | 39010 | 3260 | 39459 | 2119 | 47464 | 1479 | 33948 |
| 16-#14 | 2.30 | MA | 30008 | 6807 | 48881 | 5031 | 53818 | 4059 | 55972 | 3331 | 58150 | 2200 | 71152 | 1705 | 48351 |
| 5E | | MI | 21837 | 6807 | 36042 | 4923 | 39221 | 3986 | 40524 | 3249 | 41479 | 2109 | 49953 | 1565 | 34592 |
| 16-#14 | 2.30 | MA | 29227 | 6807 | 47549 | 5030 | 52008 | 4076 | 53764 | 3327 | 55227 | 2212 | 67436 | 1621 | 47221 |
| 6L-4S | | MI | 22424 | 6807 | 37046 | 4927 | 40515 | 3973 | 42108 | 3238 | 43680 | 2119 | 52612 | 1623 | 35412 |
| 16-#14 | 2.30 | MA | 28464 | 6807 | 46124 | 5049 | 50271 | 4073 | 51635 | 3342 | 52367 | 2224 | 63570 | 1495 | 45894 |
| 7L-3S | | MI | 23077 | 6807 | 38188 | 4911 | 41967 | 3979 | 43870 | 3247 | 45909 | 2109 | 55110 | 1751 | 35506 |
| 16-#14 | 2.30 | MA | 27713 | 6807 | 44817 | 5048 | 48518 | 4091 | 49550 | 3358 | 49371 | 2216 | 59926 | 1421 | 44411 |
| 8L-2S | | MI | 23992 | 6807 | 39600 | 4915 | 43767 | 3966 | 46058 | 3236 | 48815 | 2099 | 58950 | 1879 | 35533 |
| 16-#18 | 4.09 | MA | 33223 | 7800 | 57320 | 5633 | 64392 | 4525 | 68750 | 3605 | 75419 | 2127 | 94639 | 1271 | 80674 |
| 5E | | MI | 23924 | 7800 | 41887 | 5506 | 46503 | 4413 | 49200 | 3494 | 52849 | 1975 | 65237 | 1037 | 57163 |
| 16-#18 | 4.09 | MA | 31902 | 7800 | 54976 | 5630 | 61208 | 4518 | 64867 | 3595 | 70278 | 2145 | 88208 | 1121 | 76947 |
| 6L-4S | | MI | 24918 | 7800 | 43645 | 5515 | 48769 | 4392 | 51951 | 3477 | 56641 | 1993 | 69797 | 1140 | 58717 |
| 16-#18 | 4.09 | MA | 30612 | 7800 | 52468 | 5662 | 58151 | 4547 | 61120 | 3621 | 65247 | 2163 | 81513 | 896 | 73359 |
| 7L-3S | | MI | 26024 | 7800 | 45642 | 5489 | 51307 | 4406 | 55008 | 3494 | 60480 | 1975 | 74076 | 1364 | 60923 |
| 16-#18 | 4.09 | MA | 29340 | 7800 | 50166 | 5659 | 55066 | 4541 | 57452 | 3646 | 59977 | 2146 | 75180 | 767 | 69178 |
| 8L-2S | | MI | 27568 | 7800 | 48101 | 5498 | 54443 | 4385 | 58798 | 3477 | 65485 | 1958 | 80652 | 1591 | 61196 |
| 18-#11 | 1.80 | MA | 30569 | 6526 | 48991 | 4851 | 54062 | 3929 | 56315 | 3247 | 58651 | 2218 | 70993 | 1990 | 39196 |
| 3L-8S | | MI | 20256 | 6526 | 32631 | 4772 | 34901 | 3871 | 35317 | 3192 | 34606 | 2155 | 41034 | 1546 | 26733 |
| 18-#11 | 1.80 | MA | 29922 | 6526 | 47867 | 4865 | 52633 | 3942 | 54580 | 3244 | 56398 | 2227 | 68361 | 1901 | 39121 |
| 4L-7S | | MI | 20637 | 6526 | 33282 | 4774 | 35773 | 3875 | 36354 | 3183 | 36066 | 2161 | 42783 | 1594 | 27213 |
| 18-#11 | 1.80 | MA | 29343 | 6526 | 46883 | 4865 | 51364 | 3940 | 53026 | 3255 | 54180 | 2222 | 65628 | 1856 | 38972 |
| 5L-6S | | MI | 21024 | 6526 | 33991 | 4763 | 36637 | 3865 | 37413 | 3175 | 37458 | 2155 | 44617 | 1682 | 27522 |
| 18-#11 | 1.80 | MA | 28792 | 6526 | 45955 | 4864 | 50102 | 3952 | 51487 | 3253 | 52142 | 2231 | 63017 | 1798 | 38192 |
| 6L-5S | | MI | 21420 | 6526 | 34653 | 4765 | 37536 | 3869 | 38510 | 3181 | 38881 | 2148 | 46376 | 1741 | 28052 |
| 18-#11 | 1.80 | MA | 28254 | 6526 | 44962 | 4878 | 48892 | 3951 | 50003 | 3264 | 50149 | 2239 | 60302 | 1710 | 37635 |
| 7L-4S | | MI | 21835 | 6526 | 35355 | 4767 | 38441 | 3860 | 39617 | 3173 | 40430 | 2155 | 48249 | 1782 | 28107 |
| 18-#11 | 1.80 | MA | 27724 | 6526 | 44051 | 4878 | 47670 | 3963 | 48551 | 3275 | 48061 | 2234 | 57747 | 1658 | 36896 |
| 8L-3S | | MI | 22296 | 6526 | 36153 | 4756 | 39455 | 3864 | 40848 | 3178 | 42000 | 2148 | 50016 | 1871 | 28123 |
| 18-#11 | 1.80 | MA | 27162 | 6526 | 43157 | 4877 | 46477 | 3962 | 47048 | 3272 | 46089 | 2243 | 55218 | 1602 | 36041 |
| 9L-2S | | MI | 22944 | 6526 | 37142 | 4758 | 40716 | 3854 | 42380 | 3170 | 44047 | 2141 | 52728 | 1960 | 28108 |
| 18-#14 | 2.59 | MA | 31758 | 6967 | 52303 | 5131 | 58202 | 4134 | 61317 | 3361 | 65553 | 2198 | 80760 | 1749 | 55527 |
| 4L-7S | | MI | 21375 | 6967 | 35490 | 5035 | 38496 | 4065 | 39626 | 3296 | 40388 | 2115 | 48709 | 1320 | 37120 |
| 18-#14 | 2.59 | MA | 30944 | 6967 | 50891 | 5131 | 56381 | 4131 | 59087 | 3376 | 62370 | 2190 | 76861 | 1685 | 54259 |
| 5L-6S | | MI | 21919 | 6967 | 36505 | 5019 | 39733 | 4052 | 41198 | 3305 | 42365 | 2105 | 51304 | 1447 | 38108 |
| 18-#14 | 2.59 | MA | 30169 | 6967 | 49559 | 5130 | 54571 | 4148 | 56880 | 3372 | 59448 | 2202 | 73145 | 1601 | 53172 |
| 6L-5S | | MI | 22477 | 6967 | 37454 | 5023 | 41021 | 4058 | 42712 | 3294 | 44385 | 2095 | 53794 | 1532 | 38720 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis

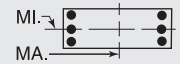


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.59 | MA | 29413 | 6967 | 48134 | 5149 | 52834 | 4146 | 54750 | 3387 | 56588 | 2214 | 69279 | 1474 | 51762 |
| 7L-4S | | MI | 23060 | 6967 | 38458 | 5027 | 42315 | 4045 | 44296 | 3283 | 46586 | 2105 | 56452 | 1590 | 39662 |
| 18-#14 | 2.59 | MA | 28667 | 6967 | 46827 | 5148 | 51081 | 4163 | 52666 | 3403 | 53592 | 2206 | 65635 | 1400 | 50321 |
| 8L-3S | | MI | 23709 | 6967 | 39600 | 5011 | 43767 | 4051 | 46058 | 3292 | 48815 | 2095 | 58950 | 1718 | 39780 |
| 18-#14 | 2.59 | MA | 27897 | 6967 | 45544 | 5147 | 49368 | 4160 | 50509 | 3398 | 50762 | 2218 | 62035 | 1319 | 48447 |
| 9L-2S | | MI | 24619 | 6967 | 41011 | 5015 | 45566 | 4038 | 48246 | 3281 | 51721 | 2085 | 62791 | 1846 | 39826 |
| 18-#18 | 4.60 | MA | 33502 | 8084 | 58500 | 5807 | 65700 | 4647 | 70328 | 3675 | 77677 | 2127 | 98100 | 1079 | 87193 |
| 6L-5S | | MI | 25003 | 8084 | 44347 | 5683 | 49639 | 4541 | 52990 | 3573 | 57854 | 1946 | 71813 | 971 | 64353 |
| 18-#18 | 4.60 | MA | 32227 | 8084 | 55991 | 5839 | 62643 | 4676 | 66582 | 3700 | 72645 | 2145 | 91405 | 854 | 83511 |
| 7L-4S | | MI | 25988 | 8084 | 46105 | 5692 | 51905 | 4520 | 55741 | 3555 | 61646 | 1964 | 76373 | 1074 | 65832 |
| 18-#18 | 4.60 | MA | 30969 | 8084 | 53690 | 5836 | 59558 | 4669 | 62913 | 3726 | 67375 | 2128 | 85071 | 725 | 79348 |
| 8L-3S | | MI | 27084 | 8084 | 48101 | 5666 | 54443 | 4535 | 58798 | 3573 | 65485 | 1946 | 80652 | 1298 | 68298 |
| 20-#11 | 1.99 | MA | 30580 | 6637 | 49270 | 4934 | 54422 | 3992 | 56756 | 3275 | 59345 | 2220 | 72370 | 1888 | 43360 |
| 4L-8S | | MI | 20715 | 6637 | 33619 | 4841 | 36161 | 3921 | 36850 | 3223 | 36653 | 2146 | 43747 | 1526 | 29610 |
| 20-#11 | 1.99 | MA | 30005 | 6637 | 48286 | 4934 | 53153 | 3990 | 55201 | 3286 | 57127 | 2215 | 69637 | 1843 | 43195 |
| 5L-7S | | MI | 21095 | 6637 | 34270 | 4843 | 37033 | 3925 | 37886 | 3215 | 38113 | 2153 | 45495 | 1574 | 30144 |
| 20-#11 | 1.99 | MA | 29457 | 6637 | 47358 | 4934 | 51892 | 4003 | 53662 | 3284 | 55089 | 2224 | 67027 | 1785 | 42347 |
| 6E | | MI | 21480 | 6637 | 34979 | 4832 | 37897 | 3916 | 38945 | 3206 | 39505 | 2146 | 47329 | 1662 | 30441 |
| 20-#11 | 1.99 | MA | 28922 | 6637 | 46365 | 4947 | 50681 | 4001 | 52179 | 3295 | 53096 | 2232 | 64311 | 1697 | 41806 |
| 7L-5S | | MI | 21874 | 6637 | 35642 | 4834 | 38797 | 3920 | 40042 | 3212 | 40928 | 2139 | 49089 | 1721 | 30953 |
| 20-#11 | 1.99 | MA | 28395 | 6637 | 45455 | 4947 | 49460 | 4014 | 50726 | 3306 | 51008 | 2227 | 61756 | 1645 | 41014 |
| 8L-4S | | MI | 22286 | 6637 | 36343 | 4837 | 39701 | 3910 | 41149 | 3204 | 42477 | 2146 | 50961 | 1761 | 31101 |
| 20-#11 | 1.99 | MA | 27836 | 6637 | 44561 | 4947 | 48266 | 4012 | 49223 | 3303 | 49036 | 2236 | 59227 | 1589 | 40181 |
| 9L-3S | | MI | 22746 | 6637 | 37142 | 4825 | 40716 | 3914 | 42380 | 3210 | 44047 | 2139 | 52728 | 1850 | 31130 |
| 20-#11 | 1.99 | MA | 27255 | 6637 | 43584 | 4960 | 47060 | 4024 | 47779 | 3315 | 47078 | 2245 | 56773 | 1526 | 39177 |
| 10L-2S | | MI | 23391 | 6637 | 38130 | 4827 | 41976 | 3904 | 43912 | 3201 | 46094 | 2132 | 55441 | 1939 | 31128 |
| 20-#14 | 2.88 | MA | 31874 | 7126 | 52901 | 5230 | 58944 | 4203 | 62202 | 3421 | 66591 | 2180 | 82570 | 1664 | 60178 |
| 5L-7S | | MI | 22018 | 7126 | 36901 | 5134 | 40295 | 4137 | 41814 | 3341 | 43294 | 2100 | 52549 | 1288 | 41206 |
| 20-#14 | 2.88 | MA | 31104 | 7126 | 51570 | 5229 | 57134 | 4221 | 59995 | 3417 | 63668 | 2192 | 78854 | 1580 | 59130 |
| 6E | | MI | 22559 | 7126 | 37916 | 5118 | 41533 | 4124 | 43386 | 3350 | 45271 | 2091 | 55145 | 1415 | 42274 |
| 20-#14 | 2.88 | MA | 30353 | 7126 | 50144 | 5249 | 55397 | 4218 | 57866 | 3432 | 60808 | 2204 | 74988 | 1454 | 57640 |
| 7L-5S | | MI | 23112 | 7126 | 38865 | 5122 | 42820 | 4131 | 44900 | 3339 | 47292 | 2081 | 57635 | 1500 | 42859 |
| 20-#14 | 2.88 | MA | 29613 | 7126 | 48837 | 5248 | 53644 | 4235 | 55781 | 3448 | 57813 | 2196 | 71345 | 1380 | 56239 |
| 8L-4S | | MI | 23692 | 7126 | 39870 | 5126 | 44115 | 4117 | 46484 | 3328 | 49492 | 2091 | 60293 | 1558 | 43906 |
| 20-#14 | 2.88 | MA | 28845 | 7126 | 47554 | 5247 | 51931 | 4233 | 53624 | 3443 | 54982 | 2208 | 67744 | 1299 | 54315 |
| 9L-3S | | MI | 24337 | 7126 | 41011 | 5111 | 45566 | 4124 | 48246 | 3337 | 51721 | 2081 | 62791 | 1686 | 44047 |
| 20-#14 | 2.88 | MA | 28016 | 7126 | 46153 | 5266 | 50200 | 4250 | 51553 | 3459 | 52174 | 2219 | 64253 | 1207 | 52342 |
| 10L-2S | | MI | 25242 | 7126 | 42423 | 5115 | 47366 | 4110 | 50434 | 3326 | 54627 | 2071 | 66631 | 1814 | 44112 |
| 20-#18 | 5.12 | MA | 33825 | 8367 | 59515 | 6017 | 67135 | 4804 | 72043 | 3780 | 80044 | 2128 | 101296 | 811 | 93682 |
| 7L-5S | | MI | 26074 | 8367 | 46806 | 5860 | 52775 | 4670 | 56780 | 3651 | 62860 | 1917 | 78389 | 905 | 71313 |
| 20-#18 | 5.12 | MA | 32581 | 8367 | 57214 | 6014 | 64050 | 4798 | 68374 | 3805 | 74774 | 2110 | 94963 | 682 | 89469 |
| 8L-4S | | MI | 27050 | 8367 | 48564 | 5870 | 55041 | 4649 | 59531 | 3633 | 66652 | 1935 | 82949 | 1008 | 72970 |
| 22-#11 | 2.19 | MA | 30663 | 6747 | 49690 | 5003 | 54942 | 4040 | 57376 | 3317 | 60073 | 2208 | 73647 | 1830 | 47366 |
| 5L-8S | | MI | 21172 | 6747 | 34608 | 4910 | 37421 | 3972 | 38382 | 3254 | 38700 | 2137 | 46459 | 1505 | 32492 |
| 22-#11 | 2.19 | MA | 30118 | 6747 | 48762 | 5003 | 53681 | 4053 | 55838 | 3315 | 58036 | 2217 | 71036 | 1772 | 46507 |
| 6L-7S | | MI | 21550 | 6747 | 35259 | 4912 | 38294 | 3976 | 39419 | 3246 | 40159 | 2144 | 48208 | 1553 | 33077 |
| 22-#11 | 2.19 | MA | 29586 | 6747 | 47769 | 5016 | 52471 | 4051 | 54354 | 3326 | 56043 | 2226 | 68320 | 1684 | 45981 |
| 7L-6S | | MI | 21933 | 6747 | 35968 | 4901 | 39158 | 3966 | 40477 | 3238 | 41552 | 2137 | 50042 | 1641 | 33363 |
| 22-#11 | 2.19 | MA | 29062 | 6747 | 46858 | 5016 | 51249 | 4064 | 52901 | 3337 | 53955 | 2221 | 65766 | 1632 | 45138 |
| 8L-5S | | MI | 22325 | 6747 | 36630 | 4903 | 40057 | 3970 | 41574 | 3243 | 42974 | 2130 | 51801 | 1700 | 33853 |
| 22-#11 | 2.19 | MA | 28506 | 6747 | 45964 | 5016 | 50055 | 4062 | 51398 | 3335 | 51983 | 2229 | 63236 | 1576 | 44326 |
| 9L-4S | | MI | 22736 | 6747 | 37332 | 4906 | 40961 | 3960 | 42681 | 3235 | 44524 | 2137 | 53674 | 1741 | 34091 |
| 22-#11 | 2.19 | MA | 27928 | 6747 | 44988 | 5029 | 48850 | 4075 | 49955 | 3346 | 50025 | 2238 | 60782 | 1513 | 43287 |
| 10L-3S | | MI | 23193 | 6747 | 38130 | 4894 | 41976 | 3964 | 43912 | 3241 | 46094 | 2130 | 55441 | 1829 | 34132 |
| 22-#11 | 2.19 | MA | 27363 | 6747 | 44094 | 5029 | 47663 | 4073 | 48469 | 3343 | 47967 | 2233 | 58288 | 1458 | 42316 |
| 11L-2S | | MI | 23835 | 6747 | 39119 | 4897 | 43236 | 3954 | 45445 | 3233 | 48140 | 2123 | 58153 | 1918 | 34144 |
| 22-#14 | 3.16 | MA | 32032 | 7286 | 53580 | 5329 | 59697 | 4293 | 63110 | 3462 | 67889 | 2182 | 84564 | 1560 | 65094 |
| 6L-7S | | MI | 22657 | 7286 | 38313 | 5234 | 42095 | 4210 | 44002 | 3385 | 46201 | 2086 | 56390 | 1255 | 45302 |

## RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 3.16 | MA | 31287 | 7286 | 52154 | 5348 | 57959 | 4290 | 60981 | 3477 | 65029 | 2194 | 80698 | 1433 | 63527 |
| 7L-6S | | MI | 23194 | 7286 | 39328 | 5218 | 43333 | 4196 | 45574 | 3394 | 48178 | 2076 | 58986 | 1382 | 46444 |
| 22-#14 | 3.16 | MA | 30552 | 7286 | 50847 | 5348 | 56206 | 4308 | 58897 | 3493 | 62033 | 2186 | 77054 | 1359 | 62163 |
| 8L-5S | | MI | 23744 | 7286 | 40277 | 5222 | 44620 | 4203 | 47088 | 3384 | 50198 | 2067 | 61475 | 1468 | 47004 |
| 22-#14 | 3.16 | MA | 29785 | 7286 | 49564 | 5347 | 54493 | 4305 | 56740 | 3488 | 59203 | 2198 | 73454 | 1278 | 60191 |
| 9L-4S | | MI | 24321 | 7286 | 41281 | 5226 | 45914 | 4190 | 48672 | 3373 | 52398 | 2076 | 64133 | 1525 | 48148 |
| 22-#14 | 3.16 | MA | 28966 | 7286 | 48163 | 5366 | 52763 | 4322 | 54668 | 3504 | 56394 | 2210 | 69962 | 1187 | 58184 |
| 10L-3S | | MI | 24962 | 7286 | 42423 | 5210 | 47366 | 4196 | 50434 | 3382 | 54627 | 2067 | 66631 | 1653 | 48310 |
| 22-#18 | 5.63 | MA | 34178 | 8651 | 60737 | 6191 | 68543 | 4926 | 73835 | 3885 | 82172 | 2093 | 104854 | 640 | 99605 |
| 8L-5S | | MI | 27137 | 8651 | 49266 | 6038 | 55911 | 4798 | 60570 | 3729 | 67865 | 1888 | 84965 | 839 | 78299 |
| 24-#11 | 2.39 | MA | 30775 | 6858 | 50165 | 5072 | 55470 | 4103 | 58013 | 3346 | 60983 | 2210 | 75045 | 1759 | 50672 |
| 6L-8S | | MI | 21627 | 6858 | 35596 | 4979 | 38682 | 4022 | 39914 | 3285 | 40746 | 2128 | 49172 | 1484 | 35380 |
| 24-#11 | 2.39 | MA | 30246 | 6858 | 49172 | 5085 | 54260 | 4101 | 56529 | 3357 | 58990 | 2219 | 72329 | 1671 | 50159 |
| 7E | | MI | 22003 | 6858 | 36247 | 4982 | 39554 | 4026 | 40951 | 3277 | 42206 | 2135 | 50920 | 1532 | 36011 |
| 24-#11 | 2.39 | MA | 29725 | 6858 | 48262 | 5085 | 53038 | 4114 | 55076 | 3368 | 56902 | 2214 | 69775 | 1619 | 49267 |
| 8L-6S | | MI | 22384 | 6858 | 36956 | 4970 | 40418 | 4016 | 42009 | 3269 | 43598 | 2128 | 52754 | 1620 | 36290 |
| 24-#11 | 2.39 | MA | 29173 | 6858 | 47368 | 5085 | 51845 | 4112 | 53573 | 3366 | 54930 | 2222 | 67245 | 1563 | 48474 |
| 9L-5S | | MI | 22774 | 6858 | 37619 | 4972 | 41317 | 4020 | 43106 | 3274 | 45021 | 2121 | 54514 | 1679 | 36757 |
| 24-#11 | 2.39 | MA | 28597 | 6858 | 46391 | 5098 | 50639 | 4125 | 52130 | 3377 | 52972 | 2231 | 64791 | 1500 | 47402 |
| 10L-4S | | MI | 23183 | 6858 | 38320 | 4975 | 42222 | 4010 | 44213 | 3266 | 46570 | 2128 | 56386 | 1720 | 37078 |
| 24-#11 | 2.39 | MA | 28035 | 6858 | 45498 | 5098 | 49452 | 4123 | 50644 | 3374 | 50913 | 2226 | 62297 | 1445 | 46431 |
| 11L-3S | | MI | 23638 | 6858 | 39119 | 4963 | 43236 | 4014 | 45445 | 3272 | 48140 | 2121 | 58153 | 1809 | 37130 |
| 24-#11 | 2.39 | MA | 27482 | 6858 | 44537 | 5112 | 48254 | 4136 | 49204 | 3385 | 48959 | 2235 | 59553 | 1370 | 45096 |
| 12L-2S | | MI | 24278 | 6858 | 40107 | 4966 | 44497 | 4004 | 46977 | 3264 | 50187 | 2114 | 60866 | 1897 | 37152 |
| 24-#14 | 3.45 | MA | 32214 | 7445 | 54165 | 5448 | 60522 | 4363 | 64097 | 3522 | 69250 | 2184 | 86407 | 1413 | 69423 |
| 7E | | MI | 23291 | 7445 | 39725 | 5334 | 43895 | 4282 | 46190 | 3430 | 49107 | 2072 | 60230 | 1223 | 49406 |
| 24-#14 | 3.45 | MA | 31485 | 7445 | 52857 | 5447 | 58769 | 4380 | 62012 | 3538 | 66254 | 2176 | 82763 | 1339 | 68061 |
| 8L-6S | | MI | 23825 | 7445 | 40740 | 5318 | 45132 | 4269 | 47762 | 3439 | 51084 | 2062 | 62826 | 1350 | 50611 |
| 24-#14 | 3.45 | MA | 30719 | 7445 | 51574 | 5446 | 57056 | 4377 | 59855 | 3533 | 63424 | 2188 | 79163 | 1258 | 66074 |
| 9L-5S | | MI | 24372 | 7445 | 41689 | 5322 | 46420 | 4275 | 49276 | 3429 | 53104 | 2053 | 65316 | 1435 | 51157 |
| 24-#14 | 3.45 | MA | 29927 | 7445 | 50173 | 5466 | 55326 | 4395 | 57784 | 3549 | 60615 | 2200 | 75671 | 1166 | 64033 |
| 10L-4S | | MI | 24945 | 7445 | 42693 | 5326 | 47714 | 4262 | 50860 | 3418 | 55305 | 2062 | 67974 | 1493 | 52270 |

## RECTANGULAR TIED COLUMNS 34" x 48"

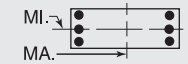
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.47 | MA | 33001 | 6622 | 52378 | 4915 | 57436 | 3992 | 59504 | 3302 | 61371 | 2301 | 73512 | 2157 | 34814 |
| 2L-3S | | MI | 21392 | 6622 | 34579 | 4780 | 36903 | 3909 | 37296 | 3227 | 36559 | 2217 | 42414 | 1785 | 23907 |
| 6-#18 | 1.47 | MA | 30550 | 6622 | 48677 | 4913 | 52717 | 4021 | 53769 | 3329 | 53600 | 2320 | 63067 | 1930 | 34758 |
| 3L-2S | | MI | 23010 | 6622 | 37039 | 4789 | 40039 | 3888 | 41086 | 3210 | 41564 | 2199 | 48991 | 2013 | 23818 |
| 8-#14 | 1.10 | MA | 31790 | 6409 | 49570 | 4810 | 54039 | 3918 | 55445 | 3262 | 55902 | 2329 | 66447 | 2214 | 26511 |
| 2L-4S | | MI | 20651 | 6409 | 32630 | 4707 | 34593 | 3831 | 34598 | 3184 | 33167 | 2271 | 38476 | 1845 | 18384 |
| 8-#14 | 1.10 | MA | 30378 | 6409 | 47460 | 4809 | 51349 | 3916 | 52175 | 3278 | 51472 | 2341 | 60426 | 2086 | 26544 |
| 3E | | MI | 21323 | 6409 | 33772 | 4691 | 36044 | 3837 | 36360 | 3193 | 35396 | 2261 | 40974 | 1973 | 18336 |
| 8-#14 | 1.10 | MA | 29385 | 6409 | 45770 | 4829 | 49200 | 3934 | 49567 | 3274 | 48085 | 2354 | 56473 | 1958 | 26474 |
| 4L-2S | | MI | 22260 | 6409 | 35184 | 4695 | 37844 | 3824 | 38548 | 3182 | 38302 | 2251 | 44815 | 2101 | 18268 |
| 8-#18 | 1.96 | MA | 34712 | 6906 | 56079 | 5092 | 62154 | 4120 | 65240 | 3382 | 69142 | 2283 | 83958 | 2118 | 46097 |
| 2L-4S | | MI | 21356 | 6906 | 35042 | 4983 | 37502 | 4023 | 38030 | 3288 | 37726 | 2205 | 44711 | 1495 | 30885 |
| 8-#18 | 1.96 | MA | 32289 | 6906 | 52378 | 5090 | 57436 | 4150 | 59504 | 3409 | 61371 | 2303 | 73512 | 1890 | 45930 |
| 3E | | MI | 22507 | 6906 | 37039 | 4957 | 40039 | 4038 | 41086 | 3306 | 41564 | 2187 | 48991 | 1719 | 31379 |
| 8-#18 | 1.96 | MA | 30582 | 6906 | 49407 | 5123 | 53658 | 4144 | 54919 | 3399 | 55418 | 2322 | 66670 | 1663 | 45132 |
| 4L-2S | | MI | 24110 | 6906 | 39498 | 4967 | 43175 | 4017 | 44876 | 3288 | 46570 | 2170 | 55567 | 1947 | 31369 |
| 10-#14 | 1.38 | MA | 32788 | 6569 | 51680 | 4909 | 56729 | 3990 | 58715 | 3307 | 60332 | 2319 | 72469 | 2195 | 32959 |
| 2L-5S | | MI | 20707 | 6569 | 33038 | 4803 | 35098 | 3916 | 35202 | 3239 | 33872 | 2247 | 39659 | 1755 | 22458 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis

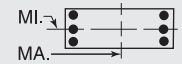



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.38 | MA | 31385 | 6569 | 49570 | 4909 | 54039 | 3988 | 55445 | 3323 | 55902 | 2332 | 66447 | 2067 | 32956 |
| 3L-4S | | MI | 21307 | 6569 | 34042 | 4807 | 36392 | 3903 | 36786 | 3228 | 36073 | 2257 | 42317 | 1813 | 22680 |
| 10-#14 | 1.38 | MA | 30400 | 6569 | 47880 | 4928 | 51890 | 4006 | 52837 | 3319 | 52515 | 2344 | 62495 | 1939 | 32842 |
| 4L-3S | | MI | 21974 | 6569 | 35184 | 4791 | 37844 | 3909 | 38548 | 3238 | 38302 | 2247 | 44815 | 1941 | 22667 |
| 10-#14 | 1.38 | MA | 29519 | 6569 | 46400 | 4928 | 49981 | 4004 | 50499 | 3335 | 49179 | 2337 | 58389 | 1874 | 32351 |
| 5L-2S | | MI | 22906 | 6569 | 36595 | 4795 | 39644 | 3896 | 40735 | 3227 | 41208 | 2237 | 48656 | 2069 | 22616 |
| 10-#18 | 2.45 | MA | 36401 | 7189 | 59780 | 5270 | 66873 | 4249 | 70976 | 3462 | 76913 | 2266 | 94404 | 2078 | 57338 |
| 2L-5S | | MI | 21442 | 7189 | 35744 | 5151 | 38372 | 4173 | 39069 | 3384 | 38939 | 2158 | 46727 | 1327 | 35899 |
| 10-#18 | 2.45 | MA | 34003 | 7189 | 56079 | 5267 | 62154 | 4279 | 65240 | 3488 | 69142 | 2285 | 83958 | 1851 | 57084 |
| 3L-4S | | MI | 22469 | 7189 | 37502 | 5160 | 40637 | 4152 | 41820 | 3366 | 42731 | 2176 | 51287 | 1430 | 37845 |
| 10-#18 | 2.45 | MA | 32317 | 7189 | 53108 | 5301 | 58376 | 4273 | 60655 | 3479 | 63189 | 2305 | 77116 | 1623 | 55771 |
| 4L-3S | | MI | 23610 | 7189 | 39498 | 5135 | 43175 | 4166 | 44876 | 3384 | 46570 | 2158 | 55567 | 1653 | 38816 |
| 10-#18 | 2.45 | MA | 30807 | 7189 | 50504 | 5298 | 55018 | 4303 | 56542 | 3506 | 57320 | 2289 | 69969 | 1511 | 52268 |
| 5L-2S | | MI | 25198 | 7189 | 41958 | 5144 | 46311 | 4145 | 48666 | 3366 | 51575 | 2141 | 62143 | 1881 | 38886 |
| 12-#11 | 1.15 | MA | 31998 | 6435 | 49891 | 4839 | 54542 | 3941 | 56093 | 3279 | 56795 | 2335 | 67810 | 2224 | 27649 |
| 2L-6S | | MI | 20459 | 6435 | 32253 | 4735 | 34133 | 3863 | 34060 | 3208 | 32432 | 2278 | 37711 | 1838 | 18919 |
| 12-#11 | 1.15 | MA | 31012 | 6435 | 48419 | 4839 | 52665 | 3940 | 53811 | 3290 | 53703 | 2344 | 63584 | 2136 | 27668 |
| 3L-5S | | MI | 20862 | 6435 | 32916 | 4737 | 35032 | 3867 | 35156 | 3213 | 33855 | 2271 | 39470 | 1897 | 19135 |
| 12-#11 | 1.15 | MA | 30321 | 6435 | 47241 | 4853 | 51166 | 3952 | 51992 | 3288 | 51342 | 2353 | 60807 | 2047 | 27646 |
| 4E | | MI | 21283 | 6435 | 33617 | 4740 | 35937 | 3857 | 36263 | 3205 | 35405 | 2278 | 41343 | 1938 | 19126 |
| 12-#11 | 1.15 | MA | 29703 | 6435 | 46210 | 4853 | 49836 | 3951 | 50363 | 3299 | 49016 | 2349 | 57931 | 2002 | 27555 |
| 5L-3S | | MI | 21752 | 6435 | 34415 | 4728 | 36951 | 3861 | 37495 | 3211 | 36975 | 2271 | 43110 | 2027 | 19091 |
| 12-#11 | 1.15 | MA | 29114 | 6435 | 45238 | 4853 | 48515 | 3964 | 48751 | 3297 | 46882 | 2358 | 55178 | 1944 | 27087 |
| 6L-2S | | MI | 22409 | 6435 | 35404 | 4731 | 38212 | 3851 | 39027 | 3203 | 39021 | 2264 | 45822 | 2116 | 19050 |
| 12-#14 | 1.65 | MA | 33776 | 6728 | 53790 | 5009 | 59419 | 4063 | 61985 | 3352 | 64762 | 2309 | 78491 | 2176 | 39395 |
| 2L-6S | | MI | 20792 | 6728 | 33500 | 4898 | 35610 | 3982 | 35876 | 3295 | 34758 | 2243 | 41010 | 1637 | 25804 |
| 12-#14 | 1.65 | MA | 32383 | 6728 | 51680 | 5009 | 56729 | 4060 | 58715 | 3368 | 60332 | 2322 | 72469 | 2048 | 39355 |
| 3L-5S | | MI | 21362 | 6728 | 34449 | 4902 | 36898 | 3989 | 37390 | 3284 | 36779 | 2233 | 43499 | 1722 | 26541 |
| 12-#14 | 1.65 | MA | 31406 | 6728 | 49990 | 5028 | 54580 | 4078 | 56107 | 3364 | 56945 | 2334 | 68517 | 1920 | 39203 |
| 4E | | MI | 21958 | 6728 | 35453 | 4906 | 38192 | 3975 | 38974 | 3273 | 38979 | 2243 | 46158 | 1780 | 26957 |
| 12-#14 | 1.65 | MA | 30531 | 6728 | 48510 | 5028 | 52671 | 4076 | 53769 | 3380 | 53609 | 2327 | 64411 | 1855 | 38507 |
| 5L-3S | | MI | 22621 | 6728 | 36595 | 4891 | 39644 | 3982 | 40735 | 3282 | 41208 | 2233 | 48656 | 1908 | 26981 |
| 12-#14 | 1.65 | MA | 29698 | 6728 | 47115 | 5027 | 50775 | 4094 | 51456 | 3376 | 50546 | 2339 | 60490 | 1771 | 37165 |
| 6L-2S | | MI | 23547 | 6728 | 38007 | 4895 | 41444 | 3968 | 42923 | 3272 | 44114 | 2223 | 52496 | 2036 | 26948 |
| 12-#18 | 2.94 | MA | 35697 | 7473 | 59780 | 5445 | 66873 | 4407 | 70976 | 3568 | 76913 | 2267 | 94404 | 1811 | 68226 |
| 3L-5S | | MI | 22554 | 7473 | 38203 | 5328 | 41508 | 4302 | 42859 | 3462 | 43944 | 2129 | 53303 | 1261 | 43045 |
| 12-#18 | 2.94 | MA | 34030 | 7473 | 56809 | 5478 | 63095 | 4401 | 66391 | 3559 | 70959 | 2287 | 87562 | 1584 | 66459 |
| 4E | | MI | 23571 | 7473 | 39962 | 5338 | 43773 | 4281 | 45609 | 3444 | 47736 | 2147 | 57864 | 1364 | 44855 |
| 12-#18 | 2.94 | MA | 32539 | 7473 | 54205 | 5476 | 59736 | 4431 | 62278 | 3585 | 65091 | 2271 | 80415 | 1472 | 63128 |
| 5L-3S | | MI | 24700 | 7473 | 41958 | 5312 | 46311 | 4295 | 48666 | 3462 | 51575 | 2129 | 62143 | 1587 | 46231 |
| 12-#18 | 2.94 | MA | 31117 | 7473 | 51748 | 5473 | 56398 | 4426 | 58206 | 3576 | 59700 | 2291 | 73620 | 1322 | 59754 |
| 6L-2S | | MI | 26275 | 7473 | 44418 | 5321 | 49447 | 4274 | 52456 | 3444 | 56580 | 2111 | 68719 | 1815 | 46369 |
| 14-#11 | 1.34 | MA | 32696 | 6545 | 51364 | 4909 | 56420 | 3991 | 58375 | 3310 | 59887 | 2328 | 72036 | 2212 | 32146 |
| 2L-7S | | MI | 20531 | 6545 | 32533 | 4816 | 34529 | 3923 | 34533 | 3247 | 33087 | 2276 | 38589 | 1729 | 21475 |
| 14-#11 | 1.34 | MA | 31716 | 6545 | 49891 | 4909 | 54542 | 3990 | 56093 | 3321 | 56795 | 2337 | 67810 | 2124 | 32149 |
| 3L-6S | | MI | 20923 | 6545 | 33242 | 4804 | 35393 | 3913 | 35592 | 3239 | 34479 | 2269 | 40423 | 1817 | 21819 |
| 14-#11 | 1.34 | MA | 31028 | 6545 | 48713 | 4922 | 53044 | 4003 | 54274 | 3319 | 54434 | 2346 | 65033 | 2035 | 32107 |
| 4L-5S | | MI | 21323 | 6545 | 33904 | 4807 | 36293 | 3917 | 36688 | 3244 | 35902 | 2262 | 42183 | 1876 | 22134 |
| 14-#11 | 1.34 | MA | 30414 | 6545 | 47683 | 4922 | 51714 | 4001 | 52645 | 3331 | 52108 | 2342 | 62157 | 1990 | 31995 |
| 5L-4S | | MI | 21743 | 6545 | 34606 | 4809 | 37197 | 3907 | 37796 | 3236 | 37451 | 2269 | 44055 | 1917 | 22146 |
| 14-#11 | 1.34 | MA | 29829 | 6545 | 46710 | 4922 | 50392 | 4014 | 51033 | 3328 | 49974 | 2351 | 59404 | 1931 | 31426 |
| 6L-3S | | MI | 22209 | 6545 | 35404 | 4797 | 38212 | 3911 | 39027 | 3242 | 39021 | 2262 | 45822 | 2006 | 22123 |
| 14-#11 | 1.34 | MA | 29258 | 6545 | 45670 | 4936 | 49124 | 4013 | 49478 | 3340 | 47885 | 2360 | 56541 | 1844 | 30775 |
| 7L-2S | | MI | 22863 | 6545 | 36392 | 4800 | 39472 | 3902 | 40559 | 3234 | 41068 | 2255 | 48535 | 2095 | 22089 |
| 14-#14 | 1.93 | MA | 34757 | 6888 | 55899 | 5109 | 62109 | 4135 | 65255 | 3396 | 69192 | 2299 | 84512 | 2157 | 45812 |
| 2L-7S | | MI | 20893 | 6888 | 33897 | 5014 | 36173 | 4068 | 36492 | 3331 | 35687 | 2239 | 42255 | 1478 | 29237 |
| 14-#14 | 1.93 | MA | 33373 | 6888 | 53790 | 5108 | 59419 | 4133 | 61985 | 3412 | 64762 | 2312 | 78491 | 2029 | 45745 |
| 3L-6S | | MI | 21446 | 6888 | 34912 | 4998 | 37410 | 4054 | 38064 | 3340 | 37664 | 2229 | 44850 | 1605 | 29949 |

## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

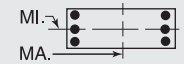
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 1.93 | MA | 32402 | 6888 | 52100 | 5128 | 57270 | 4150 | 59377 | 3409 | 61376 | 2324 | 74538 | 1901 | 45559 |
| 4L-5S | | MI | 22011 | 6888 | 35861 | 5002 | 38698 | 4061 | 39578 | 3329 | 39685 | 2219 | 47340 | 1690 | 30642 |
| 14-#14 | 1.93 | MA | 31535 | 6888 | 50620 | 5128 | 55361 | 4148 | 57039 | 3425 | 58039 | 2317 | 70433 | 1836 | 44682 |
| 5L-4S | | MI | 22604 | 6888 | 36865 | 5006 | 39992 | 4048 | 41162 | 3318 | 41885 | 2229 | 49998 | 1748 | 31225 |
| 14-#14 | 1.93 | MA | 30708 | 6888 | 49225 | 5127 | 53465 | 4166 | 54726 | 3421 | 54976 | 2329 | 66512 | 1752 | 43397 |
| 6L-3S | | MI | 23262 | 6888 | 38007 | 4990 | 41444 | 4054 | 42923 | 3327 | 44114 | 2219 | 52496 | 1876 | 31279 |
| 14-#14 | 1.93 | MA | 29902 | 6888 | 47731 | 5147 | 51644 | 4164 | 52494 | 3437 | 51979 | 2342 | 62433 | 1626 | 42230 |
| 7L-2S | | MI | 24184 | 6888 | 39419 | 4994 | 43244 | 4041 | 45111 | 3316 | 47020 | 2209 | 56337 | 2004 | 31268 |
| 14-#18 | 3.43 | MA | 35722 | 7757 | 60510 | 5655 | 67813 | 4530 | 72127 | 3639 | 78730 | 2269 | 98008 | 1544 | 77188 |
| 4L-5S | | MI | 23655 | 7757 | 40663 | 5506 | 44644 | 4430 | 46649 | 3540 | 48950 | 2100 | 59880 | 1195 | 50215 |
| 14-#18 | 3.43 | MA | 34249 | 7757 | 57906 | 5653 | 64455 | 4560 | 68014 | 3665 | 72862 | 2253 | 90861 | 1432 | 74013 |
| 5L-4S | | MI | 24662 | 7757 | 42421 | 5515 | 46909 | 4409 | 49399 | 3522 | 52742 | 2118 | 64440 | 1298 | 51907 |
| 14-#18 | 3.43 | MA | 32844 | 7757 | 55449 | 5651 | 61116 | 4554 | 63942 | 3656 | 67471 | 2273 | 84066 | 1282 | 70480 |
| 6L-3S | | MI | 25781 | 7757 | 44418 | 5489 | 49447 | 4423 | 52456 | 3540 | 56580 | 2100 | 68719 | 1522 | 53632 |
| 14-#18 | 3.43 | MA | 31473 | 7757 | 52819 | 5684 | 57911 | 4584 | 60014 | 3682 | 62195 | 2292 | 76994 | 1058 | 67007 |
| 7L-2S | | MI | 27342 | 7757 | 46877 | 5499 | 52583 | 4402 | 56246 | 3522 | 61586 | 2082 | 75295 | 1749 | 53827 |
| 16-#11 | 1.53 | MA | 33391 | 6656 | 52837 | 4978 | 58297 | 4041 | 60658 | 3341 | 62979 | 2321 | 76262 | 2200 | 36637 |
| 2L-8S | | MI | 20611 | 6656 | 32870 | 4882 | 34917 | 3969 | 35028 | 3286 | 33674 | 2260 | 39553 | 1661 | 24050 |
| 16-#11 | 1.53 | MA | 32415 | 6656 | 51364 | 4978 | 56420 | 4040 | 58375 | 3352 | 59887 | 2330 | 72036 | 2111 | 36623 |
| 3L-7S | | MI | 20995 | 6656 | 33521 | 4885 | 35790 | 3973 | 36065 | 3278 | 35133 | 2267 | 41301 | 1709 | 24400 |
| 16-#11 | 1.53 | MA | 31731 | 6656 | 50186 | 4992 | 54921 | 4053 | 56557 | 3350 | 57526 | 2339 | 69259 | 2023 | 36564 |
| 4L-6S | | MI | 21384 | 6656 | 34230 | 4873 | 36654 | 3963 | 37124 | 3270 | 36526 | 2260 | 43135 | 1797 | 24726 |
| 16-#11 | 1.53 | MA | 31121 | 6656 | 49155 | 4992 | 53591 | 4052 | 54928 | 3362 | 55201 | 2335 | 66383 | 1977 | 36432 |
| 5E | | MI | 21783 | 6656 | 34893 | 4876 | 37553 | 3967 | 38221 | 3275 | 37949 | 2253 | 44895 | 1856 | 25126 |
| 16-#11 | 1.53 | MA | 30539 | 6656 | 48183 | 4992 | 52270 | 4064 | 53315 | 3359 | 53066 | 2344 | 63630 | 1919 | 35773 |
| 6L-4S | | MI | 22200 | 6656 | 35594 | 4878 | 38457 | 3957 | 39328 | 3267 | 39498 | 2260 | 46767 | 1897 | 25157 |
| 16-#11 | 1.53 | MA | 29971 | 6656 | 47143 | 5005 | 51002 | 4063 | 51761 | 3371 | 50977 | 2353 | 60767 | 1832 | 35146 |
| 7L-3S | | MI | 22665 | 6656 | 36392 | 4867 | 39472 | 3961 | 40559 | 3273 | 41068 | 2253 | 48535 | 1985 | 25147 |
| 16-#11 | 1.53 | MA | 29412 | 6656 | 46189 | 5005 | 49722 | 4076 | 50239 | 3382 | 48790 | 2349 | 58078 | 1779 | 34522 |
| 8L-2S | | MI | 23316 | 6656 | 37381 | 4869 | 40732 | 3952 | 42091 | 3265 | 43115 | 2246 | 51247 | 2074 | 25121 |
| 16-#14 | 2.21 | MA | 34354 | 7047 | 55899 | 5208 | 62109 | 4205 | 65255 | 3457 | 69192 | 2302 | 84512 | 2009 | 52128 |
| 3L-7S | | MI | 21545 | 7047 | 35309 | 5114 | 37973 | 4140 | 38680 | 3376 | 38594 | 2225 | 46095 | 1445 | 33297 |
| 16-#14 | 2.21 | MA | 33391 | 7047 | 54210 | 5228 | 59960 | 4223 | 62647 | 3453 | 65806 | 2314 | 80560 | 1882 | 51911 |
| 4L-6S | | MI | 22094 | 7047 | 36324 | 5098 | 39210 | 4127 | 40252 | 3385 | 40571 | 2215 | 48691 | 1572 | 34102 |
| 16-#14 | 2.21 | MA | 32530 | 7047 | 52730 | 5227 | 58051 | 4221 | 60309 | 3470 | 62470 | 2307 | 76454 | 1817 | 50872 |
| 5E | | MI | 22657 | 7047 | 37273 | 5102 | 40498 | 4133 | 41765 | 3374 | 42591 | 2205 | 51181 | 1658 | 34758 |
| 16-#14 | 2.21 | MA | 31710 | 7047 | 51335 | 5227 | 56155 | 4238 | 57996 | 3466 | 59406 | 2319 | 72533 | 1733 | 49638 |
| 6L-4S | | MI | 23245 | 7047 | 38277 | 5106 | 41792 | 4120 | 43350 | 3363 | 44791 | 2215 | 53839 | 1716 | 35484 |
| 16-#14 | 2.21 | MA | 30910 | 7047 | 49841 | 5246 | 54334 | 4236 | 55764 | 3482 | 56409 | 2332 | 68455 | 1607 | 48383 |
| 7L-3S | | MI | 23900 | 7047 | 39419 | 5090 | 43244 | 4126 | 45111 | 3372 | 47020 | 2205 | 56337 | 1844 | 35564 |
| 16-#14 | 2.21 | MA | 30121 | 7047 | 48472 | 5246 | 52497 | 4254 | 53580 | 3498 | 53269 | 2325 | 64617 | 1532 | 46773 |
| 8L-2S | | MI | 24816 | 7047 | 40830 | 5094 | 45043 | 4113 | 47299 | 3361 | 49927 | 2195 | 60177 | 1972 | 35578 |
| 16-#18 | 3.92 | MA | 35940 | 8040 | 61607 | 5830 | 69173 | 4688 | 73750 | 3745 | 80633 | 2236 | 101307 | 1393 | 84918 |
| 5E | | MI | 24745 | 8040 | 43123 | 5683 | 47780 | 4559 | 50439 | 3618 | 53955 | 2071 | 66456 | 1129 | 57403 |
| 16-#18 | 3.92 | MA | 34551 | 8040 | 59149 | 5828 | 65835 | 4683 | 69678 | 3736 | 75242 | 2255 | 94512 | 1243 | 81231 |
| 6L-4S | | MI | 25743 | 8040 | 44881 | 5692 | 50045 | 4538 | 53189 | 3601 | 57747 | 2088 | 71016 | 1232 | 58991 |
| 16-#18 | 3.92 | MA | 33196 | 8040 | 56520 | 5861 | 62630 | 4712 | 65750 | 3762 | 69966 | 2275 | 87440 | 1018 | 77666 |
| 7L-3S | | MI | 26852 | 8040 | 46877 | 5666 | 52583 | 4552 | 56246 | 3618 | 61586 | 2071 | 75295 | 1456 | 61021 |
| 16-#18 | 3.92 | MA | 31859 | 8040 | 54108 | 5859 | 59395 | 4707 | 61904 | 3789 | 64440 | 2259 | 80762 | 888 | 73303 |
| 8L-2S | | MI | 28400 | 8040 | 49337 | 5676 | 55719 | 4531 | 60036 | 3601 | 66591 | 2053 | 81872 | 1683 | 61271 |
| 18-#11 | 1.72 | MA | 33110 | 6767 | 52837 | 5047 | 58297 | 4090 | 60658 | 3384 | 62979 | 2323 | 76262 | 2099 | 41091 |
| 3L-8S | | MI | 21073 | 6767 | 33859 | 4952 | 36178 | 4019 | 36561 | 3317 | 35721 | 2251 | 42265 | 1640 | 26918 |
| 18-#11 | 1.72 | MA | 32430 | 6767 | 51659 | 5061 | 56799 | 4103 | 58839 | 3381 | 60618 | 2333 | 73485 | 2011 | 41016 |
| 4L-7S | | MI | 21455 | 6767 | 34510 | 4954 | 37050 | 4023 | 37597 | 3309 | 37180 | 2258 | 44014 | 1688 | 27328 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis

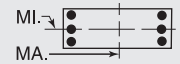


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.72 | MA | 31823 | 6767 | 50628 | 5061 | 55469 | 4102 | 57210 | 3393 | 58293 | 2328 | 70609 | 1965 | 40868 |
| 5L-6S | | MI | 21843 | 6767 | 35219 | 4942 | 37914 | 4013 | 38656 | 3301 | 38573 | 2251 | 45848 | 1776 | 27640 |
| 18-#11 | 1.72 | MA | 31244 | 6767 | 49656 | 5061 | 54147 | 4114 | 55598 | 3391 | 56158 | 2337 | 67855 | 1907 | 40128 |
| 6L-5S | | MI | 22239 | 6767 | 35881 | 4945 | 38813 | 4017 | 39753 | 3307 | 39995 | 2244 | 47608 | 1835 | 28114 |
| 18-#11 | 1.72 | MA | 30680 | 6767 | 48615 | 5075 | 52879 | 4113 | 54043 | 3402 | 54070 | 2347 | 64993 | 1820 | 39522 |
| 7L-4S | | MI | 22655 | 6767 | 36583 | 4947 | 39718 | 4008 | 40860 | 3298 | 41545 | 2251 | 49480 | 1876 | 28159 |
| 18-#11 | 1.72 | MA | 30124 | 6767 | 47661 | 5075 | 51599 | 4126 | 52521 | 3414 | 51882 | 2342 | 62303 | 1767 | 38840 |
| 8L-3S | | MI | 23117 | 6767 | 37381 | 4936 | 40732 | 4012 | 42091 | 3304 | 43115 | 2244 | 51247 | 1964 | 28166 |
| 18-#11 | 1.72 | MA | 29526 | 6767 | 46725 | 5075 | 50349 | 4125 | 50946 | 3411 | 49815 | 2351 | 59636 | 1711 | 37913 |
| 9L-2S | | MI | 23766 | 6767 | 38370 | 4938 | 41993 | 4002 | 43623 | 3296 | 45161 | 2237 | 53959 | 2053 | 28148 |
| 18-#14 | 2.48 | MA | 34372 | 7207 | 56320 | 5327 | 62650 | 4295 | 65917 | 3498 | 70236 | 2304 | 86582 | 1862 | 58260 |
| 4L-7S | | MI | 22193 | 7207 | 36720 | 5214 | 39773 | 4212 | 40868 | 3421 | 41500 | 2211 | 49936 | 1413 | 37371 |
| 18-#14 | 2.48 | MA | 33518 | 7207 | 54840 | 5327 | 60741 | 4293 | 63579 | 3514 | 66900 | 2297 | 82476 | 1798 | 57076 |
| 5L-6S | | MI | 22739 | 7207 | 37735 | 5198 | 41010 | 4199 | 42440 | 3430 | 43477 | 2201 | 52531 | 1540 | 38262 |
| 18-#14 | 2.48 | MA | 32704 | 7207 | 53445 | 5327 | 58845 | 4311 | 61266 | 3511 | 63836 | 2310 | 78555 | 1714 | 55888 |
| 6L-5S | | MI | 23297 | 7207 | 38684 | 5202 | 42297 | 4206 | 43953 | 3419 | 45497 | 2191 | 55021 | 1625 | 38885 |
| 18-#14 | 2.48 | MA | 31910 | 7207 | 51951 | 5346 | 57024 | 4309 | 59034 | 3527 | 60839 | 2322 | 74476 | 1588 | 54548 |
| 7L-4S | | MI | 23883 | 7207 | 39689 | 5206 | 43592 | 4192 | 45538 | 3408 | 47698 | 2201 | 57679 | 1683 | 39737 |
| 18-#14 | 2.48 | MA | 31127 | 7207 | 50582 | 5346 | 55187 | 4326 | 56850 | 3543 | 57699 | 2315 | 70639 | 1513 | 52982 |
| 8L-3S | | MI | 24533 | 7207 | 40830 | 5190 | 45043 | 4199 | 47299 | 3417 | 49927 | 2191 | 60177 | 1811 | 39841 |
| 18-#14 | 2.48 | MA | 30291 | 7207 | 49237 | 5345 | 53392 | 4324 | 54590 | 3539 | 54733 | 2327 | 66840 | 1432 | 51131 |
| 9L-2S | | MI | 25445 | 7207 | 42242 | 5194 | 46843 | 4185 | 49487 | 3406 | 52833 | 2181 | 64018 | 1939 | 39879 |
| 18-#18 | 4.41 | MA | 36240 | 8324 | 62850 | 6005 | 70553 | 4811 | 75414 | 3816 | 83013 | 2237 | 104958 | 1203 | 92004 |
| 6L-5S | | MI | 25826 | 8324 | 45582 | 5860 | 50916 | 4687 | 54228 | 3697 | 58960 | 2042 | 73032 | 1063 | 64606 |
| 18-#18 | 4.41 | MA | 34900 | 8324 | 60221 | 6038 | 67348 | 4841 | 71486 | 3842 | 77737 | 2257 | 97886 | 979 | 88347 |
| 7L-4S | | MI | 26815 | 8324 | 47341 | 5870 | 53181 | 4666 | 56979 | 3679 | 62752 | 2059 | 77592 | 1166 | 66102 |
| 18-#18 | 4.41 | MA | 33578 | 8324 | 57809 | 6036 | 64113 | 4835 | 67640 | 3868 | 72211 | 2241 | 91208 | 848 | 83922 |
| 8L-3S | | MI | 27914 | 8324 | 49337 | 5844 | 55719 | 4681 | 60036 | 3697 | 66591 | 2042 | 81872 | 1390 | 68402 |
| 20-#11 | 1.91 | MA | 33124 | 6877 | 53131 | 5130 | 58676 | 4153 | 61122 | 3412 | 63710 | 2326 | 77711 | 1998 | 45466 |
| 4L-8S | | MI | 21533 | 6877 | 34847 | 5021 | 37438 | 4069 | 38093 | 3348 | 37767 | 2242 | 44978 | 1619 | 29794 |
| 20-#11 | 1.91 | MA | 32520 | 6877 | 52100 | 5130 | 57346 | 4152 | 59492 | 3424 | 61385 | 2321 | 74835 | 1953 | 45301 |
| 5L-7S | | MI | 21913 | 6877 | 35498 | 5023 | 38310 | 4073 | 39130 | 3340 | 39227 | 2249 | 46726 | 1667 | 30259 |
| 20-#11 | 1.91 | MA | 31945 | 6877 | 51128 | 5130 | 56025 | 4164 | 57880 | 3422 | 59250 | 2330 | 72081 | 1895 | 44489 |
| 6E | | MI | 22299 | 6877 | 36207 | 5012 | 39174 | 4064 | 40188 | 3332 | 40619 | 2242 | 48560 | 1755 | 30559 |
| 20-#11 | 1.91 | MA | 31384 | 6877 | 50088 | 5144 | 54757 | 4163 | 56326 | 3433 | 57162 | 2340 | 69218 | 1808 | 43901 |
| 7L-5S | | MI | 22694 | 6877 | 36870 | 5014 | 40074 | 4068 | 41285 | 3338 | 42042 | 2235 | 50320 | 1814 | 31085 |
| 20-#11 | 1.91 | MA | 30831 | 6877 | 49134 | 5144 | 53477 | 4176 | 54804 | 3445 | 54974 | 2335 | 66529 | 1755 | 43164 |
| 8L-4S | | MI | 23107 | 6877 | 37571 | 5016 | 40978 | 4058 | 42392 | 3330 | 43591 | 2242 | 52192 | 1855 | 31155 |
| 20-#11 | 1.91 | MA | 30237 | 6877 | 48198 | 5144 | 52226 | 4175 | 53229 | 3442 | 52908 | 2344 | 63862 | 1699 | 42260 |
| 9L-3S | | MI | 23568 | 6877 | 38370 | 5005 | 41993 | 4062 | 43623 | 3335 | 45161 | 2235 | 53959 | 1944 | 31180 |
| 20-#11 | 1.91 | MA | 29627 | 6877 | 47175 | 5157 | 50963 | 4188 | 51717 | 3454 | 50857 | 2354 | 61274 | 1636 | 41294 |
| 10L-2S | | MI | 24214 | 6877 | 39358 | 5007 | 43253 | 4052 | 45156 | 3327 | 47208 | 2228 | 56672 | 2032 | 31169 |
| 20-#14 | 2.76 | MA | 34498 | 7367 | 56950 | 5427 | 63431 | 4365 | 66849 | 3559 | 71330 | 2287 | 88497 | 1779 | 63291 |
| 5L-7S | | MI | 22837 | 7367 | 38132 | 5313 | 41572 | 4285 | 43056 | 3466 | 44406 | 2197 | 53776 | 1381 | 41455 |
| 20-#14 | 2.76 | MA | 33690 | 7367 | 55555 | 5426 | 61535 | 4383 | 64536 | 3555 | 68266 | 2300 | 84576 | 1695 | 62145 |
| 6E | | MI | 23379 | 7367 | 39147 | 5297 | 42810 | 4271 | 44628 | 3475 | 46383 | 2187 | 56372 | 1508 | 42428 |
| 20-#14 | 2.76 | MA | 32902 | 7367 | 54061 | 5446 | 59714 | 4381 | 62304 | 3571 | 65269 | 2312 | 80498 | 1569 | 60722 |
| 7L-5S | | MI | 23934 | 7367 | 40096 | 5301 | 44097 | 4278 | 46141 | 3464 | 48403 | 2177 | 58862 | 1593 | 43022 |
| 20-#14 | 2.76 | MA | 32125 | 7367 | 52692 | 5445 | 57877 | 4399 | 60120 | 3587 | 62129 | 2305 | 76660 | 1494 | 59198 |
| 8L-4S | | MI | 24516 | 7367 | 41100 | 5305 | 45392 | 4264 | 47726 | 3453 | 50604 | 2187 | 61520 | 1651 | 43986 |
| 20-#14 | 2.76 | MA | 31308 | 7367 | 51347 | 5445 | 56082 | 4397 | 57860 | 3584 | 59164 | 2317 | 72861 | 1413 | 57297 |
| 9L-3S | | MI | 25162 | 7367 | 42242 | 5290 | 46843 | 4271 | 49487 | 3462 | 52833 | 2177 | 64018 | 1779 | 44112 |
| 20-#14 | 2.76 | MA | 30436 | 7367 | 49879 | 5464 | 54269 | 4414 | 55689 | 3600 | 56220 | 2330 | 69176 | 1321 | 55343 |
| 10L-2S | | MI | 26069 | 7367 | 43654 | 5294 | 48643 | 4258 | 51675 | 3451 | 55739 | 2167 | 67859 | 1907 | 44167 |
| 20-#18 | 4.90 | MA | 36587 | 8608 | 63922 | 6216 | 72066 | 4970 | 77222 | 3922 | 85508 | 2239 | 108332 | 939 | 99046 |
| 7L-5S | | MI | 26899 | 8608 | 48042 | 6038 | 54051 | 4816 | 58018 | 3775 | 63966 | 2012 | 79608 | 997 | 71761 |
| 20-#18 | 4.90 | MA | 35280 | 8608 | 61510 | 6214 | 68832 | 4964 | 73376 | 3948 | 79982 | 2223 | 101654 | 809 | 94731 |
| 8L-4S | | MI | 27879 | 8608 | 49800 | 6047 | 56317 | 4795 | 60769 | 3757 | 67758 | 2030 | 84169 | 1100 | 73237 |

## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

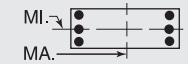
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.10 | MA | 33214 | 6988 | 53573 | 5199 | 59224 | 4202 | 61775 | 3455 | 64477 | 2314 | 79060 | 1941 | 49733 |
| 5L-8S | | MI | 21991 | 6988 | 35836 | 5090 | 38698 | 4119 | 39625 | 3380 | 39814 | 2233 | 47690 | 1598 | 32675 |
| 22-#11 | 2.10 | MA | 32642 | 6988 | 52601 | 5199 | 57902 | 4215 | 60163 | 3453 | 62342 | 2323 | 76307 | 1883 | 48855 |
| 6L-7S | | MI | 22369 | 6988 | 36487 | 5092 | 39571 | 4123 | 40662 | 3371 | 41273 | 2240 | 49439 | 1646 | 33193 |
| 22-#11 | 2.10 | MA | 32085 | 6988 | 51560 | 5213 | 56634 | 4214 | 58608 | 3464 | 60254 | 2333 | 73444 | 1795 | 48284 |
| 7L-6S | | MI | 22753 | 6988 | 37196 | 5081 | 40435 | 4114 | 41720 | 3363 | 42666 | 2233 | 51273 | 1734 | 33482 |
| 22-#11 | 2.10 | MA | 31535 | 6988 | 50607 | 5213 | 55354 | 4226 | 57086 | 3476 | 58066 | 2328 | 70755 | 1743 | 47493 |
| 8L-5S | | MI | 23146 | 6988 | 37859 | 5083 | 41334 | 4118 | 42817 | 3369 | 44089 | 2226 | 53032 | 1793 | 33984 |
| 22-#11 | 2.10 | MA | 30943 | 6988 | 49670 | 5213 | 54104 | 4225 | 55511 | 3474 | 56000 | 2337 | 68088 | 1687 | 46612 |
| 9L-4S | | MI | 23558 | 6988 | 38560 | 5085 | 42238 | 4108 | 43924 | 3361 | 45638 | 2233 | 54905 | 1834 | 34148 |
| 22-#11 | 2.10 | MA | 30336 | 6988 | 48648 | 5227 | 52841 | 4238 | 53999 | 3485 | 53949 | 2347 | 65500 | 1624 | 45610 |
| 10L-3S | | MI | 24016 | 6988 | 39358 | 5074 | 43253 | 4112 | 45156 | 3366 | 47208 | 2226 | 56672 | 1923 | 34182 |
| 22-#11 | 2.10 | MA | 29743 | 6988 | 47712 | 5227 | 51598 | 4237 | 52443 | 3483 | 51792 | 2342 | 62874 | 1568 | 44559 |
| 11L-2S | | MI | 24659 | 6988 | 40347 | 5076 | 44514 | 4102 | 46688 | 3358 | 49255 | 2220 | 59384 | 2011 | 34186 |
| 22-#14 | 3.03 | MA | 34669 | 7526 | 57664 | 5526 | 64225 | 4455 | 67806 | 3600 | 72697 | 2290 | 90598 | 1676 | 68407 |
| 6L-7S | | MI | 23477 | 7526 | 39544 | 5413 | 43372 | 4357 | 45244 | 3511 | 47312 | 2183 | 57617 | 1348 | 45548 |
| 22-#14 | 3.03 | MA | 33887 | 7526 | 56171 | 5546 | 62404 | 4453 | 65574 | 3616 | 69699 | 2302 | 86520 | 1550 | 66906 |
| 7L-6S | | MI | 24015 | 7526 | 40559 | 5397 | 44610 | 4344 | 46816 | 3520 | 49289 | 2173 | 60213 | 1475 | 46599 |
| 22-#14 | 3.03 | MA | 33116 | 7526 | 54801 | 5545 | 60567 | 4471 | 63390 | 3632 | 66560 | 2295 | 82682 | 1474 | 65421 |
| 8L-5S | | MI | 24567 | 7526 | 41508 | 5401 | 45897 | 4350 | 48329 | 3509 | 51309 | 2163 | 62702 | 1560 | 47168 |
| 22-#14 | 3.03 | MA | 32300 | 7526 | 53457 | 5545 | 58772 | 4469 | 61130 | 3628 | 63594 | 2307 | 78883 | 1394 | 63471 |
| 9L-4S | | MI | 25145 | 7526 | 42512 | 5405 | 47191 | 4337 | 49914 | 3498 | 53510 | 2173 | 65361 | 1618 | 48230 |
| 22-#14 | 3.03 | MA | 31438 | 7526 | 51989 | 5564 | 56959 | 4487 | 58959 | 3645 | 60650 | 2320 | 75198 | 1302 | 61483 |
| 10L-3S | | MI | 25788 | 7526 | 43654 | 5389 | 48643 | 4343 | 51675 | 3507 | 55739 | 2163 | 67859 | 1746 | 48377 |
| 22-#18 | 5.39 | MA | 36965 | 8892 | 65210 | 6391 | 73550 | 5092 | 79111 | 4028 | 87753 | 2206 | 112100 | 769 | 105468 |
| 8L-5S | | MI | 27964 | 8892 | 50502 | 6215 | 57187 | 4944 | 61808 | 3853 | 68971 | 1983 | 86185 | 932 | 78741 |
| 24-#11 | 2.29 | MA | 33335 | 7099 | 54074 | 5268 | 59780 | 4265 | 62445 | 3484 | 65434 | 2317 | 80533 | 1871 | 53226 |
| 6L-8S | | MI | 22446 | 7099 | 36824 | 5159 | 39959 | 4170 | 41157 | 3411 | 41861 | 2224 | 50403 | 1577 | 35561 |
| 24-#11 | 2.29 | MA | 32781 | 7099 | 53033 | 5282 | 58512 | 4264 | 60890 | 3495 | 63346 | 2326 | 77670 | 1783 | 52669 |
| 7E | | MI | 22823 | 7099 | 37475 | 5161 | 40831 | 4174 | 42194 | 3403 | 43320 | 2231 | 52151 | 1625 | 36129 |
| 24-#11 | 2.29 | MA | 32234 | 7099 | 52079 | 5282 | 57232 | 4276 | 59368 | 3507 | 61158 | 2321 | 74981 | 1731 | 51829 |
| 8L-6S | | MI | 23205 | 7099 | 38184 | 5150 | 41695 | 4164 | 43252 | 3394 | 44713 | 2224 | 53985 | 1713 | 36408 |
| 24-#11 | 2.29 | MA | 31645 | 7099 | 51143 | 5282 | 55982 | 4275 | 57794 | 3505 | 59092 | 2331 | 72314 | 1675 | 50967 |
| 9L-5S | | MI | 23596 | 7099 | 38847 | 5152 | 42594 | 4168 | 44349 | 3400 | 46135 | 2217 | 55745 | 1772 | 36888 |
| 24-#11 | 2.29 | MA | 31041 | 7099 | 50120 | 5296 | 54718 | 4288 | 56282 | 3516 | 57041 | 2340 | 69726 | 1612 | 49930 |
| 10L-4S | | MI | 24006 | 7099 | 39548 | 5155 | 43499 | 4158 | 45456 | 3392 | 47685 | 2224 | 57617 | 1813 | 37138 |
| 24-#11 | 2.29 | MA | 30451 | 7099 | 49184 | 5296 | 53475 | 4287 | 54725 | 3514 | 54884 | 2335 | 67100 | 1556 | 48899 |
| 11L-3S | | MI | 24462 | 7099 | 40347 | 5143 | 44514 | 4162 | 46688 | 3398 | 49255 | 2217 | 59384 | 1902 | 37182 |
| 24-#11 | 2.29 | MA | 29871 | 7099 | 48178 | 5310 | 52220 | 4299 | 53217 | 3525 | 52836 | 2345 | 64208 | 1482 | 47559 |
| 12L-2S | | MI | 25103 | 7099 | 41335 | 5146 | 45774 | 4152 | 48220 | 3389 | 51301 | 2211 | 62097 | 1991 | 37200 |
| 24-#14 | 3.31 | MA | 34865 | 7686 | 58281 | 5645 | 65094 | 4526 | 68845 | 3661 | 74130 | 2292 | 92541 | 1530 | 73098 |
| 7E | | MI | 24112 | 7686 | 40955 | 5513 | 45172 | 4429 | 47432 | 3555 | 50218 | 2169 | 61458 | 1316 | 49650 |
| 24-#14 | 3.31 | MA | 34099 | 7686 | 56911 | 5645 | 63257 | 4543 | 66660 | 3677 | 70990 | 2285 | 88704 | 1455 | 71650 |
| 8L-6S | | MI | 24648 | 7686 | 41971 | 5497 | 46409 | 4416 | 49004 | 3564 | 52195 | 2159 | 64053 | 1443 | 50773 |
| 24-#14 | 3.31 | MA | 33285 | 7686 | 55567 | 5644 | 61462 | 4541 | 64400 | 3673 | 68024 | 2297 | 84905 | 1375 | 69651 |
| 9L-5S | | MI | 25197 | 7686 | 42920 | 5501 | 47697 | 4423 | 50517 | 3554 | 54216 | 2149 | 66543 | 1528 | 51320 |
| 24-#14 | 3.31 | MA | 32432 | 7686 | 54099 | 5664 | 59649 | 4559 | 62229 | 3689 | 65080 | 2310 | 81219 | 1283 | 67630 |
| 10L-4S | | MI | 25771 | 7686 | 43924 | 5505 | 48991 | 4409 | 52102 | 3543 | 56416 | 2159 | 69201 | 1586 | 52466 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.04 | MA | 18634 | 5061 | 29309 | 3728 | 31553 | 3038 | 32117 | 2531 | 31885 | 1803 | 37308 | 1691 | 14612 |
| 2L-3S | | MI | 17628 | 5061 | 27798 | 3725 | 29626 | 3052 | 29774 | 2543 | 28754 | 1813 | 33156 | 1563 | 14679 |
| 6-#18 | 1.85 | MA | 20139 | 5434 | 32787 | 3932 | 35849 | 3183 | 37289 | 2615 | 38604 | 1746 | 46084 | 1583 | 25146 |
| 2L-3S | | MI | 18416 | 5434 | 30150 | 3924 | 32487 | 3205 | 33202 | 2633 | 33199 | 1764 | 38957 | 1355 | 25120 |
| 8-#14 | 1.39 | MA | 19331 | 5221 | 30821 | 3828 | 33480 | 3110 | 34459 | 2576 | 35016 | 1791 | 41459 | 1661 | 19261 |
| 2L-4S | | MI | 17620 | 5221 | 28089 | 3841 | 30001 | 3119 | 30234 | 2580 | 29483 | 1810 | 34603 | 1405 | 19256 |
| 8-#18 | 2.47 | MA | 21313 | 5718 | 35424 | 4109 | 39211 | 3311 | 41376 | 2695 | 44009 | 1720 | 53211 | 1522 | 33199 |
| 2L-4S | | MI | 18393 | 5718 | 30651 | 4128 | 33134 | 3321 | 33995 | 2696 | 34459 | 1755 | 41453 | 1067 | 31306 |
| 10-#11 | 1.20 | MA | 18997 | 5136 | 30011 | 3789 | 32517 | 3084 | 33316 | 2562 | 33556 | 1809 | 39569 | 1692 | 16861 |
| 2L-5S | | MI | 17346 | 5136 | 27352 | 3798 | 29119 | 3101 | 29179 | 2575 | 27996 | 1816 | 32715 | 1473 | 16862 |
| 10-#11 | 1.20 | MA | 18295 | 5136 | 28953 | 3788 | 31168 | 3094 | 31676 | 2571 | 31353 | 1816 | 36641 | 1603 | 16896 |
| 3L-4S | | MI | 17795 | 5136 | 28101 | 3799 | 30085 | 3091 | 30361 | 2566 | 29663 | 1823 | 34730 | 1515 | 16910 |
| 10-#14 | 1.74 | MA | 20020 | 5381 | 32332 | 3928 | 35407 | 3183 | 36802 | 2621 | 38148 | 1778 | 45610 | 1631 | 23890 |
| 2L-5S | | MI | 17688 | 5381 | 28528 | 3938 | 30546 | 3205 | 30885 | 2636 | 30244 | 1788 | 35889 | 1316 | 22931 |
| 10-#14 | 1.74 | MA | 19029 | 5381 | 30821 | 3924 | 33480 | 3197 | 34459 | 2633 | 35016 | 1788 | 41459 | 1503 | 23900 |
| 3L-4S | | MI | 18323 | 5381 | 29600 | 3941 | 31928 | 3191 | 32577 | 2624 | 32614 | 1798 | 38754 | 1375 | 23810 |
| 10-#18 | 3.09 | MA | 22472 | 6001 | 38061 | 4286 | 42573 | 3440 | 45463 | 2775 | 49414 | 1693 | 60338 | 1461 | 41207 |
| 2L-5S | | MI | 18506 | 6001 | 31409 | 4298 | 34074 | 3473 | 35117 | 2794 | 35770 | 1711 | 43638 | 905 | 36885 |
| 10-#18 | 3.09 | MA | 20789 | 6001 | 35424 | 4278 | 39211 | 3463 | 41376 | 2793 | 44009 | 1711 | 53211 | 1234 | 40987 |
| 3L-4S | | MI | 19587 | 6001 | 33288 | 4306 | 36496 | 3450 | 38082 | 2776 | 39864 | 1728 | 48580 | 1007 | 38824 |

## RECTANGULAR TIED COLUMNS 36" x 38"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.17 | MA | 21016 | 5405 | 33280 | 3961 | 35887 | 3224 | 36650 | 2680 | 36622 | 1888 | 42979 | 1760 | 18128 |
| 2E | | MI | 19866 | 5405 | 31532 | 3943 | 33919 | 3210 | 34592 | 2667 | 34443 | 1874 | 40329 | 1742 | 17091 |
| 6-#18 | 1.75 | MA | 22298 | 5688 | 36095 | 4139 | 39475 | 3353 | 41012 | 2760 | 42427 | 1864 | 50658 | 1704 | 26766 |
| 2L-3S | | MI | 19334 | 5688 | 31532 | 4113 | 33919 | 3361 | 34592 | 2765 | 34443 | 1865 | 40329 | 1454 | 25197 |
| 6-#18 | 1.75 | MA | 20454 | 5688 | 33280 | 4132 | 35887 | 3377 | 36650 | 2780 | 36622 | 1882 | 42979 | 1477 | 26740 |
| 3L-2S | | MI | 21060 | 5688 | 34169 | 4121 | 37281 | 3338 | 38679 | 2747 | 39848 | 1848 | 47456 | 1681 | 25198 |
| 8-#14 | 1.32 | MA | 21423 | 5476 | 33987 | 4035 | 36935 | 3280 | 37978 | 2720 | 38545 | 1906 | 45630 | 1778 | 20476 |
| 2L-4S | | MI | 18537 | 5476 | 29465 | 4032 | 31433 | 3276 | 31628 | 2713 | 30733 | 1913 | 35983 | 1504 | 19323 |
| 8-#14 | 1.32 | MA | 20356 | 5476 | 32376 | 4032 | 34880 | 3295 | 35481 | 2733 | 35189 | 1916 | 41168 | 1650 | 20517 |
| 3E | | MI | 19250 | 5476 | 30686 | 4015 | 32984 | 3281 | 33511 | 2721 | 33135 | 1903 | 38688 | 1632 | 19347 |
| 8-#14 | 1.32 | MA | 19597 | 5476 | 31077 | 4049 | 33229 | 3291 | 33477 | 2726 | 32614 | 1926 | 38255 | 1522 | 20471 |
| 4L-2S | | MI | 20250 | 5476 | 32197 | 4018 | 34911 | 3267 | 35853 | 2709 | 36266 | 1893 | 42840 | 1760 | 19300 |
| 8-#18 | 2.34 | MA | 23561 | 5972 | 38909 | 4316 | 43064 | 3481 | 45374 | 2840 | 48232 | 1840 | 58336 | 1648 | 35359 |
| 2L-4S | | MI | 19310 | 5972 | 32033 | 4317 | 34565 | 3477 | 35385 | 2828 | 35703 | 1856 | 42826 | 1165 | 31664 |
| 8-#18 | 2.34 | MA | 21739 | 5972 | 36095 | 4309 | 39475 | 3506 | 41012 | 2859 | 42427 | 1858 | 50658 | 1420 | 35224 |
| 3E | | MI | 20531 | 5972 | 34169 | 4290 | 37281 | 3489 | 38679 | 2845 | 39848 | 1839 | 47456 | 1393 | 33153 |
| 8-#18 | 2.34 | MA | 20440 | 5972 | 33819 | 4338 | 36583 | 3495 | 37502 | 2844 | 37974 | 1875 | 45661 | 1193 | 33632 |
| 4L-2S | | MI | 22237 | 5972 | 36806 | 4298 | 40643 | 3467 | 42766 | 2827 | 45253 | 1821 | 54583 | 1620 | 33257 |
| 10-#11 | 1.14 | MA | 21063 | 5390 | 33119 | 3996 | 35903 | 3254 | 36753 | 2707 | 36968 | 1924 | 43580 | 1807 | 17914 |
| 2L-5S | | MI | 18263 | 5390 | 28726 | 3989 | 30551 | 3258 | 30575 | 2708 | 29248 | 1919 | 34100 | 1572 | 16925 |
| 10-#11 | 1.14 | MA | 20313 | 5390 | 31993 | 3995 | 34467 | 3265 | 35006 | 2716 | 34609 | 1931 | 40436 | 1718 | 17949 |
| 3L-4S | | MI | 18712 | 5390 | 29474 | 3991 | 31516 | 3248 | 31756 | 2700 | 30915 | 1926 | 36115 | 1614 | 16956 |
| 10-#11 | 1.14 | MA | 19780 | 5390 | 31086 | 4007 | 33314 | 3262 | 33607 | 2712 | 32799 | 1938 | 38381 | 1630 | 17963 |
| 4L-3S | | MI | 19213 | 5390 | 30327 | 3979 | 32600 | 3252 | 33072 | 2705 | 32605 | 1919 | 38026 | 1703 | 16933 |
| 10-#11 | 1.14 | MA | 19303 | 5390 | 30290 | 4006 | 32288 | 3273 | 32350 | 2721 | 31014 | 1931 | 36222 | 1587 | 17915 |
| 5L-2S | | MI | 19917 | 5390 | 31384 | 3981 | 33949 | 3241 | 34711 | 2696 | 34808 | 1912 | 40954 | 1792 | 16895 |
| 10-#14 | 1.64 | MA | 22164 | 5635 | 35598 | 4135 | 38989 | 3353 | 40475 | 2765 | 41902 | 1895 | 50092 | 1750 | 25409 |
| 2L-5S | | MI | 18604 | 5635 | 29905 | 4128 | 31978 | 3362 | 32279 | 2769 | 31494 | 1890 | 37270 | 1415 | 23142 |
| 10-#14 | 1.64 | MA | 21104 | 5635 | 33987 | 4132 | 36935 | 3368 | 37978 | 2778 | 38545 | 1905 | 45630 | 1622 | 25419 |
| 3L-4S | | MI | 19241 | 5635 | 30977 | 4131 | 33360 | 3348 | 33971 | 2758 | 33864 | 1900 | 40135 | 1474 | 23885 |
| 10-#14 | 1.64 | MA | 20352 | 5635 | 32688 | 4149 | 35284 | 3363 | 35974 | 2771 | 35970 | 1915 | 42717 | 1494 | 25328 |
| 4L-3S | | MI | 19948 | 5635 | 32197 | 4115 | 34911 | 3354 | 35853 | 2766 | 36266 | 1890 | 42840 | 1602 | 23954 |

## RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

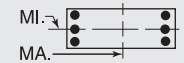
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.64 | MA | 19676 | 5635 | 31548 | 4146 | 33814 | 3378 | 34175 | 2784 | 33430 | 1905 | 39646 | 1434 | 24520 |
| 5L-2S | | MI | 20942 | 5635 | 33709 | 4118 | 36838 | 3339 | 38196 | 2754 | 39397 | 1880 | 46991 | 1730 | 23933 |
| 10-#18 | 2.92 | MA | 24808 | 6256 | 41723 | 4493 | 46652 | 3610 | 49735 | 2919 | 54036 | 1816 | 66015 | 1592 | 43907 |
| 2L-5S | | MI | 19421 | 6256 | 32791 | 4487 | 35506 | 3628 | 36507 | 2926 | 37014 | 1812 | 45011 | 1003 | 37190 |
| 10-#18 | 2.92 | MA | 23006 | 6256 | 38909 | 4487 | 43064 | 3634 | 45374 | 2939 | 48232 | 1833 | 58336 | 1364 | 43687 |
| 3L-4S | | MI | 20506 | 6256 | 34670 | 4495 | 37927 | 3605 | 39472 | 2908 | 41107 | 1830 | 49953 | 1105 | 39174 |
| 10-#18 | 2.92 | MA | 21723 | 6256 | 36634 | 4515 | 40171 | 3623 | 41864 | 2924 | 43779 | 1851 | 53339 | 1137 | 41666 |
| 4L-3S | | MI | 21711 | 6256 | 36806 | 4467 | 40643 | 3618 | 42766 | 2925 | 45253 | 1812 | 54583 | 1332 | 41086 |
| 10-#18 | 2.92 | MA | 20571 | 6256 | 34634 | 4508 | 37593 | 3647 | 38708 | 2944 | 39384 | 1833 | 48030 | 1033 | 39479 |
| 5L-2S | | MI | 23400 | 6256 | 39443 | 4475 | 44005 | 3595 | 46853 | 2907 | 50658 | 1794 | 61710 | 1560 | 41275 |
| 12-#11 | 1.37 | MA | 21587 | 5501 | 34246 | 4065 | 37340 | 3304 | 38499 | 2738 | 39327 | 1917 | 46724 | 1789 | 21368 |
| 2L-6S | | MI | 18335 | 5501 | 29076 | 4056 | 30940 | 3305 | 31044 | 2735 | 29920 | 1917 | 35127 | 1494 | 19579 |
| 12-#11 | 1.37 | MA | 20841 | 5501 | 33119 | 4064 | 35903 | 3315 | 36753 | 2747 | 36968 | 1923 | 43580 | 1701 | 21392 |
| 3L-5S | | MI | 18761 | 5501 | 29783 | 4058 | 31900 | 3309 | 32214 | 2739 | 31451 | 1911 | 37028 | 1553 | 20116 |
| 12-#11 | 1.37 | MA | 20312 | 5501 | 32213 | 4076 | 34750 | 3312 | 35353 | 2743 | 35158 | 1930 | 41525 | 1612 | 21383 |
| 4E | | MI | 19208 | 5501 | 30532 | 4060 | 32865 | 3298 | 33396 | 2731 | 33118 | 1917 | 39043 | 1595 | 20171 |
| 12-#11 | 1.37 | MA | 19837 | 5501 | 31417 | 4075 | 33724 | 3323 | 34097 | 2752 | 33373 | 1923 | 39366 | 1569 | 21311 |
| 5L-3S | | MI | 19706 | 5501 | 31384 | 4048 | 33949 | 3302 | 34711 | 2736 | 34808 | 1911 | 40954 | 1684 | 20169 |
| 12-#11 | 1.37 | MA | 19384 | 5501 | 30666 | 4073 | 32704 | 3320 | 32853 | 2748 | 31733 | 1930 | 37323 | 1511 | 20724 |
| 6L-2S | | MI | 20406 | 5501 | 32442 | 4050 | 35297 | 3291 | 36350 | 2727 | 37011 | 1904 | 43882 | 1772 | 20141 |
| 12-#14 | 1.97 | MA | 22898 | 5795 | 37209 | 4234 | 41043 | 3425 | 42972 | 2810 | 45259 | 1883 | 54554 | 1723 | 30329 |
| 2L-6S | | MI | 18705 | 5795 | 30403 | 4225 | 32530 | 3429 | 32945 | 2806 | 32448 | 1887 | 38728 | 1300 | 26765 |
| 12-#14 | 1.97 | MA | 21846 | 5795 | 35598 | 4232 | 38989 | 3440 | 40475 | 2823 | 41902 | 1893 | 50092 | 1595 | 30305 |
| 3L-5S | | MI | 19307 | 5795 | 31416 | 4228 | 33905 | 3434 | 34621 | 2814 | 34625 | 1877 | 41421 | 1385 | 27530 |
| 12-#14 | 1.97 | MA | 21099 | 5795 | 34299 | 4249 | 37338 | 3435 | 38471 | 2816 | 39327 | 1903 | 47180 | 1467 | 30177 |
| 4E | | MI | 19938 | 5795 | 32488 | 4231 | 35287 | 3420 | 36313 | 2803 | 36995 | 1887 | 44286 | 1445 | 28436 |
| 12-#14 | 1.97 | MA | 20429 | 5795 | 33159 | 4246 | 35868 | 3450 | 36672 | 2828 | 36787 | 1893 | 44109 | 1406 | 29204 |
| 5L-3S | | MI | 20640 | 5795 | 33709 | 4215 | 36838 | 3426 | 38196 | 2811 | 39397 | 1877 | 46991 | 1573 | 28541 |
| 12-#14 | 1.97 | MA | 19789 | 5795 | 32083 | 4243 | 34406 | 3445 | 34889 | 2821 | 34453 | 1903 | 41211 | 1322 | 28359 |
| 6L-2S | | MI | 21627 | 5795 | 35220 | 4218 | 38765 | 3412 | 40538 | 2799 | 42528 | 1867 | 51142 | 1701 | 28553 |
| 12-#18 | 3.51 | MA | 26041 | 6540 | 44538 | 4671 | 50240 | 3739 | 54097 | 2999 | 59841 | 1791 | 73693 | 1535 | 52433 |
| 2L-6S | | MI | 19592 | 6540 | 33651 | 4656 | 36458 | 3744 | 37761 | 3024 | 38662 | 1803 | 47520 | 790 | 41863 |
| 12-#18 | 3.51 | MA | 24257 | 6540 | 41723 | 4664 | 46652 | 3763 | 49735 | 3019 | 54036 | 1809 | 66015 | 1308 | 52137 |
| 3L-5S | | MI | 20615 | 6540 | 35428 | 4664 | 38868 | 3757 | 40594 | 3006 | 42419 | 1786 | 52138 | 942 | 44876 |
| 12-#18 | 3.51 | MA | 22990 | 6540 | 39448 | 4692 | 43759 | 3752 | 46226 | 3004 | 49584 | 1827 | 61018 | 1080 | 49747 |
| 4E | | MI | 21686 | 6540 | 37307 | 4672 | 41289 | 3734 | 43559 | 2987 | 46512 | 1803 | 57080 | 1044 | 46731 |
| 12-#18 | 3.51 | MA | 21852 | 6540 | 37448 | 4686 | 41181 | 3776 | 43069 | 3023 | 45189 | 1809 | 55708 | 977 | 47695 |
| 5L-3S | | MI | 22878 | 6540 | 39443 | 4645 | 44005 | 3747 | 46853 | 3005 | 50658 | 1786 | 61710 | 1271 | 49004 |
| 12-#18 | 3.51 | MA | 20765 | 6540 | 35558 | 4679 | 38616 | 3765 | 39942 | 3008 | 41154 | 1827 | 50729 | 825 | 44476 |
| 6L-2S | | MI | 24550 | 6540 | 42080 | 4653 | 47367 | 3724 | 50940 | 2987 | 56062 | 1768 | 68837 | 1499 | 49266 |
| 14-#11 | 1.60 | MA | 22108 | 5612 | 35373 | 4135 | 38777 | 3354 | 40246 | 2769 | 41686 | 1909 | 49867 | 1772 | 24815 |
| 2L-7S | | MI | 18418 | 5612 | 29378 | 4137 | 31367 | 3366 | 31553 | 2774 | 30624 | 1916 | 36074 | 1387 | 22315 |
| 14-#11 | 1.60 | MA | 21365 | 5612 | 34246 | 4133 | 37340 | 3365 | 38499 | 2778 | 39327 | 1916 | 46724 | 1683 | 24828 |
| 3L-6S | | MI | 18832 | 5612 | 30134 | 4125 | 32289 | 3355 | 32683 | 2766 | 32123 | 1909 | 38055 | 1475 | 22686 |
| 14-#11 | 1.60 | MA | 20839 | 5612 | 33339 | 4145 | 36187 | 3362 | 37100 | 2774 | 37517 | 1923 | 44669 | 1594 | 24796 |
| 4L-5S | | MI | 19257 | 5612 | 30841 | 4127 | 33248 | 3359 | 33853 | 2771 | 33654 | 1902 | 39956 | 1534 | 23303 |
| 14-#11 | 1.60 | MA | 20367 | 5612 | 32544 | 4144 | 35161 | 3373 | 35843 | 2783 | 35732 | 1916 | 42510 | 1552 | 24703 |
| 5L-4S | | MI | 19701 | 5612 | 31590 | 4129 | 34213 | 3348 | 35035 | 2762 | 35321 | 1909 | 41971 | 1576 | 23378 |
| 14-#11 | 1.60 | MA | 19917 | 5612 | 31793 | 4142 | 34141 | 3370 | 34599 | 2779 | 34092 | 1923 | 40467 | 1493 | 24036 |
| 6L-3S | | MI | 20196 | 5612 | 32442 | 4117 | 35297 | 3352 | 36350 | 2767 | 37011 | 1902 | 43882 | 1665 | 23397 |
| 14-#11 | 1.60 | MA | 19478 | 5612 | 30989 | 4155 | 33161 | 3381 | 33399 | 2788 | 32487 | 1930 | 38340 | 1405 | 23623 |
| 7L-2S | | MI | 20892 | 5612 | 33500 | 4119 | 36646 | 3341 | 37990 | 2758 | 39214 | 1896 | 46810 | 1753 | 23380 |
| 14-#14 | 2.30 | MA | 23626 | 5954 | 38820 | 4334 | 43097 | 3497 | 45469 | 2855 | 48615 | 1872 | 59017 | 1695 | 35234 |
| 2L-7S | | MI | 18822 | 5954 | 30831 | 4341 | 33136 | 3515 | 33669 | 2863 | 33449 | 1884 | 40072 | 1144 | 30004 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis

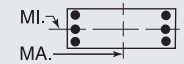



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.30 | MA | 22581 | 5954 | 37209 | 4331 | 41043 | 3512 | 42972 | 2868 | 45259 | 1881 | 54554 | 1567 | 35181 |
| 3L-6S | | MI | 19406 | 5954 | 31915 | 4324 | 34457 | 3501 | 35287 | 2851 | 35579 | 1875 | 42879 | 1271 | 31209 |
| 14-#14 | 2.30 | MA | 21840 | 5954 | 35911 | 4349 | 39392 | 3507 | 40969 | 2861 | 42684 | 1891 | 51642 | 1439 | 35020 |
| 4L-5S | | MI | 20003 | 5954 | 32928 | 4328 | 35832 | 3507 | 36964 | 2859 | 37756 | 1865 | 45572 | 1356 | 31933 |
| 14-#14 | 2.30 | MA | 21175 | 5954 | 34771 | 4346 | 37922 | 3522 | 39169 | 2873 | 40143 | 1881 | 48571 | 1379 | 33903 |
| 5L-4S | | MI | 20629 | 5954 | 34000 | 4331 | 37214 | 3493 | 38656 | 2847 | 40126 | 1875 | 48437 | 1415 | 32981 |
| 14-#14 | 2.30 | MA | 20541 | 5954 | 33694 | 4343 | 36460 | 3518 | 37386 | 2866 | 37810 | 1891 | 45673 | 1294 | 33100 |
| 6L-3S | | MI | 21326 | 5954 | 35220 | 4314 | 38765 | 3498 | 40538 | 2855 | 42528 | 1865 | 51142 | 1543 | 33118 |
| 14-#14 | 2.30 | MA | 19922 | 5954 | 32542 | 4360 | 35056 | 3533 | 35666 | 2879 | 35526 | 1901 | 42655 | 1167 | 31806 |
| 7L-2S | | MI | 22306 | 5954 | 36731 | 4318 | 40692 | 3484 | 42881 | 2844 | 45660 | 1855 | 55293 | 1671 | 33160 |
| 14-#18 | 4.09 | MA | 25495 | 6823 | 44538 | 4841 | 50240 | 3891 | 54097 | 3099 | 59841 | 1785 | 73693 | 1252 | 60578 |
| 3L-6S | | MI | 20783 | 6823 | 36288 | 4833 | 39820 | 3873 | 41848 | 3103 | 44067 | 1777 | 54647 | 730 | 49420 |
| 14-#18 | 4.09 | MA | 24242 | 6823 | 42262 | 4870 | 47347 | 3880 | 50588 | 3083 | 55389 | 1802 | 68696 | 1024 | 57866 |
| 4L-5S | | MI | 21794 | 6823 | 38065 | 4841 | 42230 | 3885 | 44681 | 3085 | 47824 | 1759 | 59264 | 882 | 52558 |
| 14-#18 | 4.09 | MA | 23117 | 6823 | 40262 | 4863 | 44769 | 3904 | 47431 | 3103 | 50994 | 1785 | 63387 | 921 | 55934 |
| 5L-4S | | MI | 22854 | 6823 | 39944 | 4849 | 44651 | 3862 | 47646 | 3067 | 51917 | 1777 | 64207 | 983 | 54325 |
| 14-#18 | 4.09 | MA | 22044 | 6823 | 38372 | 4856 | 42204 | 3893 | 44304 | 3088 | 46958 | 1802 | 58408 | 769 | 52564 |
| 6L-3S | | MI | 24033 | 6823 | 42080 | 4822 | 47367 | 3875 | 50940 | 3085 | 56062 | 1759 | 68837 | 1210 | 56911 |
| 16-#11 | 1.82 | MA | 22625 | 5722 | 36500 | 4204 | 40213 | 3404 | 41992 | 2800 | 44046 | 1902 | 53011 | 1754 | 28255 |
| 2L-8S | | MI | 18509 | 5722 | 29741 | 4204 | 31785 | 3412 | 32086 | 2814 | 31256 | 1901 | 37120 | 1319 | 24751 |
| 16-#11 | 1.82 | MA | 21886 | 5722 | 35373 | 4202 | 38777 | 3415 | 40246 | 2809 | 41686 | 1909 | 49867 | 1665 | 28250 |
| 3L-7S | | MI | 18915 | 5722 | 30435 | 4206 | 32715 | 3416 | 33193 | 2806 | 32827 | 1908 | 39002 | 1368 | 25444 |
| 16-#11 | 1.82 | MA | 21363 | 5722 | 34466 | 4215 | 37624 | 3412 | 38846 | 2805 | 39876 | 1916 | 47813 | 1577 | 28203 |
| 4L-6S | | MI | 19327 | 5722 | 31192 | 4194 | 33637 | 3405 | 34322 | 2797 | 34325 | 1901 | 40983 | 1456 | 25800 |
| 16-#11 | 1.82 | MA | 20894 | 5722 | 33671 | 4213 | 36598 | 3423 | 37590 | 2814 | 38091 | 1909 | 45654 | 1534 | 28001 |
| 5E | | MI | 19748 | 5722 | 31899 | 4196 | 34597 | 3409 | 35493 | 2802 | 35857 | 1894 | 42884 | 1515 | 26385 |
| 16-#11 | 1.82 | MA | 20447 | 5722 | 32920 | 4212 | 35578 | 3420 | 36346 | 2810 | 36451 | 1916 | 43611 | 1475 | 27356 |
| 6L-4S | | MI | 20190 | 5722 | 32647 | 4198 | 35562 | 3399 | 36674 | 2793 | 37524 | 1901 | 44900 | 1557 | 26578 |
| 16-#11 | 1.82 | MA | 20010 | 5722 | 32116 | 4224 | 34598 | 3431 | 35145 | 2819 | 34846 | 1923 | 41484 | 1388 | 26958 |
| 7L-3S | | MI | 20682 | 5722 | 33500 | 4186 | 36646 | 3402 | 37990 | 2798 | 39214 | 1894 | 46810 | 1645 | 26615 |
| 16-#11 | 1.82 | MA | 19579 | 5722 | 31378 | 4222 | 33609 | 3428 | 33970 | 2829 | 33164 | 1916 | 39467 | 1338 | 26210 |
| 8L-2S | | MI | 21375 | 5722 | 34558 | 4188 | 37994 | 3392 | 39629 | 2789 | 41417 | 1888 | 49738 | 1734 | 26612 |
| 16-#14 | 2.63 | MA | 24349 | 6114 | 40432 | 4434 | 45151 | 3570 | 47966 | 2900 | 51972 | 1860 | 63479 | 1668 | 40127 |
| 2L-8S | | MI | 18952 | 6114 | 31348 | 4437 | 33730 | 3582 | 34427 | 2920 | 34347 | 1862 | 41548 | 1044 | 33236 |
| 16-#14 | 2.63 | MA | 23310 | 6114 | 38820 | 4431 | 43097 | 3585 | 45469 | 2913 | 48615 | 1870 | 59017 | 1540 | 40049 |
| 3L-7S | | MI | 19522 | 6114 | 32343 | 4441 | 35063 | 3588 | 36012 | 2908 | 36580 | 1872 | 44223 | 1114 | 34375 |
| 16-#14 | 2.63 | MA | 22575 | 6114 | 37522 | 4448 | 41446 | 3580 | 43466 | 2906 | 46040 | 1880 | 56104 | 1412 | 39859 |
| 4L-6S | | MI | 20101 | 6114 | 33426 | 4424 | 36384 | 3573 | 37630 | 2896 | 38711 | 1862 | 47030 | 1241 | 35660 |
| 16-#14 | 2.63 | MA | 21916 | 6114 | 36382 | 4446 | 39976 | 3595 | 41666 | 2918 | 43500 | 1870 | 53033 | 1351 | 38617 |
| 5E | | MI | 20694 | 6114 | 34439 | 4427 | 37759 | 3579 | 39306 | 2904 | 40887 | 1852 | 49724 | 1326 | 36351 |
| 16-#14 | 2.63 | MA | 21286 | 6114 | 35305 | 4443 | 38514 | 3590 | 39883 | 2911 | 41166 | 1880 | 50136 | 1267 | 37850 |
| 6L-4S | | MI | 21315 | 6114 | 35511 | 4431 | 39141 | 3565 | 40998 | 2892 | 43258 | 1862 | 52588 | 1385 | 37520 |
| 16-#14 | 2.63 | MA | 20672 | 6114 | 34153 | 4460 | 37110 | 3605 | 38163 | 2924 | 38883 | 1890 | 47117 | 1140 | 36476 |
| 7L-3S | | MI | 22007 | 6114 | 36731 | 4414 | 40692 | 3571 | 42881 | 2900 | 45660 | 1852 | 55293 | 1513 | 37687 |
| 16-#14 | 2.63 | MA | 20066 | 6114 | 33096 | 4457 | 35693 | 3600 | 36478 | 2937 | 36490 | 1880 | 44249 | 1069 | 35255 |
| 8L-2S | | MI | 22981 | 6114 | 38243 | 4417 | 42619 | 3556 | 45223 | 2888 | 48791 | 1842 | 59444 | 1641 | 37753 |
| 16-#18 | 4.68 | MA | 25481 | 7107 | 45077 | 5047 | 50935 | 4009 | 54949 | 3163 | 61193 | 1778 | 76375 | 968 | 66017 |
| 4L-6S | | MI | 21961 | 7107 | 38925 | 5011 | 43182 | 4001 | 45935 | 3183 | 49471 | 1750 | 61774 | 669 | 57002 |
| 16-#18 | 4.68 | MA | 24369 | 7107 | 43077 | 5040 | 48357 | 4033 | 51793 | 3183 | 56798 | 1760 | 71065 | 864 | 63979 |
| 5E | | MI | 22961 | 7107 | 40702 | 5019 | 45592 | 4014 | 48768 | 3165 | 53228 | 1732 | 66391 | 821 | 60005 |
| 16-#18 | 4.68 | MA | 23308 | 7107 | 41187 | 5034 | 45792 | 4022 | 48666 | 3168 | 52763 | 1778 | 66086 | 713 | 60677 |
| 6L-4S | | MI | 24009 | 7107 | 42581 | 5027 | 48013 | 3991 | 51733 | 3147 | 57322 | 1750 | 71333 | 922 | 61950 |
| 18-#11 | 2.05 | MA | 23139 | 5833 | 37627 | 4273 | 41650 | 3455 | 43739 | 2831 | 46405 | 1895 | 56155 | 1736 | 31691 |
| 2L-9S | | MI | 18606 | 5833 | 30064 | 4285 | 32224 | 3473 | 32581 | 2841 | 31976 | 1900 | 38206 | 1243 | 27242 |
| 18-#11 | 2.05 | MA | 22404 | 5833 | 36500 | 4271 | 40213 | 3465 | 41992 | 2841 | 44046 | 1901 | 53011 | 1648 | 31669 |
| 3L-8S | | MI | 19005 | 5833 | 30799 | 4274 | 33133 | 3462 | 33726 | 2846 | 33459 | 1893 | 40048 | 1300 | 27833 |
| 18-#11 | 2.05 | MA | 21884 | 5833 | 35593 | 4284 | 39060 | 3462 | 40593 | 2836 | 42236 | 1908 | 50957 | 1559 | 31607 |
| 4L-7S | | MI | 19409 | 5833 | 31493 | 4275 | 34064 | 3466 | 34832 | 2837 | 35030 | 1900 | 41930 | 1349 | 28575 |

## RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

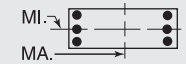
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.05 | MA | 21418 | 5833 | 34798 | 4282 | 38034 | 3473 | 39336 | 2845 | 40451 | 1901 | 48798 | 1516 | 31297 |
| 5L-6S | | MI | 19818 | 5833 | 32250 | 4264 | 34986 | 3456 | 35962 | 2828 | 36528 | 1893 | 43911 | 1437 | 28920 |
| 18-#11 | 2.05 | MA | 20973 | 5833 | 34046 | 4281 | 37014 | 3470 | 38092 | 2841 | 38810 | 1908 | 46755 | 1458 | 30681 |
| 6L-5S | | MI | 20237 | 5833 | 32956 | 4265 | 35945 | 3459 | 37132 | 2833 | 38060 | 1886 | 45812 | 1496 | 29477 |
| 18-#11 | 2.05 | MA | 20539 | 5833 | 33243 | 4293 | 36035 | 3481 | 36892 | 2850 | 37205 | 1915 | 44628 | 1370 | 30297 |
| 7L-4S | | MI | 20676 | 5833 | 33705 | 4267 | 36910 | 3449 | 38314 | 2824 | 39727 | 1893 | 47828 | 1537 | 29775 |
| 18-#11 | 2.05 | MA | 20111 | 5833 | 32505 | 4292 | 35046 | 3478 | 35716 | 2860 | 35523 | 1908 | 42611 | 1320 | 29498 |
| 8L-3S | | MI | 21166 | 5833 | 34558 | 4255 | 37994 | 3452 | 39629 | 2829 | 41417 | 1886 | 49738 | 1626 | 29826 |
| 18-#11 | 2.05 | MA | 19687 | 5833 | 31725 | 4304 | 34080 | 3489 | 34500 | 2855 | 33935 | 1915 | 40632 | 1264 | 28861 |
| 9L-2S | | MI | 21855 | 5833 | 35615 | 4257 | 39343 | 3442 | 41268 | 2820 | 43620 | 1879 | 52666 | 1715 | 29839 |
| 18-#14 | 2.96 | MA | 24034 | 6274 | 40432 | 4531 | 45151 | 3657 | 47966 | 2958 | 51972 | 1858 | 63479 | 1512 | 44912 |
| 3L-8S | | MI | 19650 | 6274 | 32859 | 4537 | 35657 | 3654 | 36769 | 2965 | 37479 | 1849 | 45699 | 1015 | 37561 |
| 18-#14 | 2.96 | MA | 23304 | 6274 | 39133 | 4548 | 43500 | 3652 | 45963 | 2950 | 49397 | 1868 | 60566 | 1384 | 44694 |
| 4L-7S | | MI | 20216 | 6274 | 33854 | 4540 | 36990 | 3660 | 38354 | 2953 | 39712 | 1859 | 48374 | 1084 | 38757 |
| 18-#14 | 2.96 | MA | 22650 | 6274 | 37993 | 4545 | 42030 | 3667 | 44163 | 2963 | 46857 | 1858 | 57495 | 1324 | 43342 |
| 5L-6S | | MI | 20791 | 6274 | 34938 | 4524 | 38311 | 3646 | 39972 | 2941 | 41842 | 1849 | 51181 | 1211 | 40118 |
| 18-#14 | 2.96 | MA | 22025 | 6274 | 36916 | 4543 | 40568 | 3662 | 42380 | 2956 | 44523 | 1868 | 54598 | 1239 | 42606 |
| 6L-5S | | MI | 21379 | 6274 | 35951 | 4527 | 39686 | 3651 | 41649 | 2949 | 44019 | 1839 | 53875 | 1296 | 40779 |
| 18-#14 | 2.96 | MA | 21416 | 6274 | 35764 | 4560 | 39164 | 3677 | 40660 | 2969 | 42239 | 1878 | 51579 | 1112 | 41157 |
| 7L-4S | | MI | 21996 | 6274 | 37023 | 4530 | 41068 | 3637 | 43341 | 2937 | 46389 | 1849 | 56739 | 1355 | 42056 |
| 18-#14 | 2.96 | MA | 20815 | 6274 | 34707 | 4557 | 37747 | 3672 | 38975 | 2982 | 39846 | 1868 | 48711 | 1042 | 39878 |
| 8L-3S | | MI | 22683 | 6274 | 38243 | 4514 | 42619 | 3643 | 45223 | 2945 | 48791 | 1839 | 59444 | 1483 | 42250 |
| 18-#18 | 5.26 | MA | 25609 | 7391 | 45891 | 5218 | 51945 | 4162 | 56155 | 3263 | 62603 | 1736 | 78744 | 808 | 71984 |
| 5L-6S | | MI | 23128 | 7391 | 41562 | 5188 | 46544 | 4130 | 50022 | 3263 | 54876 | 1724 | 68901 | 608 | 64607 |
| 18-#18 | 5.26 | MA | 24559 | 7391 | 44001 | 5211 | 49381 | 4150 | 53028 | 3247 | 58568 | 1754 | 73765 | 657 | 68813 |
| 6L-5S | | MI | 24118 | 7391 | 43339 | 5196 | 48954 | 4142 | 52855 | 3245 | 58633 | 1706 | 73518 | 760 | 67483 |
| 20-#11 | 2.28 | MA | 22918 | 5944 | 37627 | 4341 | 41650 | 3516 | 43739 | 2872 | 46405 | 1894 | 56155 | 1630 | 35083 |
| 3L-9S | | MI | 19101 | 5944 | 31122 | 4355 | 33572 | 3523 | 34221 | 2872 | 34178 | 1892 | 41134 | 1224 | 30289 |
| 20-#11 | 2.28 | MA | 22401 | 5944 | 36720 | 4353 | 40497 | 3513 | 42339 | 2867 | 44595 | 1901 | 54100 | 1541 | 35007 |
| 4L-8S | | MI | 19498 | 5944 | 31857 | 4343 | 34482 | 3513 | 35365 | 2877 | 35662 | 1885 | 42976 | 1281 | 30920 |
| 20-#11 | 2.28 | MA | 21938 | 5944 | 35924 | 4351 | 39471 | 3523 | 41083 | 2877 | 42810 | 1894 | 51942 | 1499 | 34601 |
| 5L-7S | | MI | 19899 | 5944 | 32551 | 4345 | 35412 | 3516 | 36471 | 2868 | 37232 | 1892 | 44858 | 1330 | 31660 |
| 20-#11 | 2.28 | MA | 21496 | 5944 | 35173 | 4350 | 38451 | 3520 | 39839 | 2872 | 41170 | 1901 | 49899 | 1440 | 34011 |
| 6E | | MI | 20306 | 5944 | 33307 | 4333 | 36334 | 3506 | 37601 | 2859 | 38731 | 1885 | 46839 | 1418 | 32044 |
| 20-#11 | 2.28 | MA | 21064 | 5944 | 34370 | 4362 | 37471 | 3531 | 38638 | 2882 | 39564 | 1908 | 47772 | 1352 | 33604 |
| 7L-5S | | MI | 20723 | 5944 | 34014 | 4335 | 37294 | 3509 | 38771 | 2864 | 40263 | 1878 | 48740 | 1476 | 32576 |
| 20-#11 | 2.28 | MA | 20639 | 5944 | 33632 | 4361 | 36483 | 3528 | 37463 | 2891 | 37883 | 1901 | 45755 | 1303 | 32793 |
| 8L-4S | | MI | 21160 | 5944 | 34763 | 4336 | 38259 | 3499 | 39953 | 2855 | 41930 | 1885 | 50756 | 1518 | 32967 |
| 20-#11 | 2.28 | MA | 20217 | 5944 | 32851 | 4373 | 35516 | 3539 | 36247 | 2887 | 36294 | 1908 | 43776 | 1246 | 32115 |
| 9L-3S | | MI | 21646 | 5944 | 35615 | 4325 | 39343 | 3502 | 41268 | 2860 | 43620 | 1878 | 52666 | 1607 | 33032 |
| 20-#11 | 2.28 | MA | 19754 | 5944 | 32117 | 4372 | 34540 | 3536 | 35078 | 2896 | 34717 | 1915 | 41857 | 1182 | 31215 |
| 10L-2S | | MI | 22333 | 5944 | 36673 | 4326 | 40691 | 3492 | 42908 | 2851 | 45823 | 1871 | 55595 | 1696 | 33058 |
| 20-#14 | 3.29 | MA | 24028 | 6433 | 40744 | 4648 | 45554 | 3724 | 48460 | 2995 | 52754 | 1857 | 65029 | 1357 | 49459 |
| 4L-8S | | MI | 20343 | 6433 | 34371 | 4637 | 37584 | 3727 | 39112 | 3010 | 40610 | 1836 | 49851 | 985 | 41896 |
| 20-#14 | 3.29 | MA | 23379 | 6433 | 39604 | 4645 | 44084 | 3739 | 46660 | 3008 | 50213 | 1847 | 61958 | 1296 | 48076 |
| 5L-7S | | MI | 20905 | 6433 | 35366 | 4640 | 38917 | 3732 | 40697 | 2998 | 42843 | 1846 | 52526 | 1054 | 43149 |
| 20-#14 | 3.29 | MA | 22759 | 6433 | 38528 | 4642 | 42623 | 3735 | 44878 | 3001 | 47880 | 1857 | 59060 | 1212 | 47305 |
| 6E | | MI | 21476 | 6433 | 36449 | 4624 | 40238 | 3718 | 42315 | 2986 | 44973 | 1836 | 55333 | 1181 | 44476 |
| 20-#14 | 3.29 | MA | 22154 | 6433 | 37375 | 4660 | 41218 | 3749 | 43157 | 3014 | 45596 | 1867 | 56042 | 1085 | 45847 |
| 7L-5S | | MI | 22060 | 6433 | 37462 | 4627 | 41613 | 3724 | 43991 | 2994 | 47150 | 1826 | 58026 | 1266 | 45216 |
| 20-#14 | 3.29 | MA | 21558 | 6433 | 36318 | 4657 | 39801 | 3745 | 41472 | 3026 | 43203 | 1857 | 53173 | 1014 | 44512 |
| 8L-4S | | MI | 22672 | 6433 | 38534 | 4630 | 42995 | 3709 | 45683 | 2982 | 49520 | 1836 | 60891 | 1325 | 46465 |
| 20-#18 | 5.85 | MA | 25799 | 7674 | 46815 | 5388 | 52969 | 4279 | 57390 | 3327 | 64373 | 1730 | 81443 | 600 | 76967 |
| 6E | | MI | 24285 | 7674 | 44199 | 5365 | 49906 | 4258 | 54109 | 3343 | 60281 | 1697 | 76028 | 547 | 72231 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

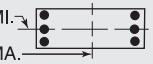
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.51 | MA | 22916 | 6054 | 37847 | 4422 | 41934 | 3563 | 44086 | 2898 | 46954 | 1894 | 57244 | 1524 | 38404 |
| 4L-9S | | MI | 19593 | 6054 | 32180 | 4424 | 34921 | 3573 | 35860 | 2903 | 36381 | 1884 | 44062 | 1205 | 33343 |
| 22-#11 | 2.51 | MA | 22455 | 6054 | 37051 | 4421 | 40908 | 3574 | 42829 | 2908 | 45169 | 1887 | 55086 | 1481 | 37912 |
| 5L-8S | | MI | 19988 | 6054 | 32914 | 4412 | 35830 | 3563 | 37004 | 2908 | 37865 | 1877 | 45904 | 1262 | 34013 |
| 22-#11 | 2.51 | MA | 22015 | 6054 | 36300 | 4419 | 39888 | 3571 | 41585 | 2903 | 43529 | 1894 | 53043 | 1422 | 37346 |
| 6L-7S | | MI | 20387 | 6054 | 33609 | 4414 | 36761 | 3566 | 38111 | 2899 | 39435 | 1884 | 47786 | 1311 | 34728 |
| 22-#11 | 2.51 | MA | 21586 | 6054 | 35496 | 4431 | 38908 | 3581 | 40385 | 2913 | 41923 | 1901 | 50915 | 1335 | 36878 |
| 7L-6S | | MI | 20792 | 6054 | 34365 | 4402 | 37683 | 3556 | 39240 | 2890 | 40934 | 1877 | 49767 | 1399 | 35172 |
| 22-#11 | 2.51 | MA | 21163 | 6054 | 34759 | 4430 | 37919 | 3579 | 39209 | 2922 | 40242 | 1894 | 48899 | 1285 | 36092 |
| 8L-5S | | MI | 21206 | 6054 | 35072 | 4404 | 38642 | 3559 | 40411 | 2895 | 42466 | 1870 | 51668 | 1457 | 35681 |
| 22-#11 | 2.51 | MA | 20744 | 6054 | 33978 | 4442 | 36953 | 3589 | 37993 | 2918 | 38653 | 1901 | 46920 | 1228 | 35376 |
| 9L-4S | | MI | 21640 | 6054 | 35820 | 4406 | 39608 | 3549 | 41592 | 2886 | 44133 | 1877 | 53684 | 1499 | 36157 |
| 22-#11 | 2.51 | MA | 20283 | 6054 | 33244 | 4441 | 35977 | 3586 | 36825 | 2927 | 37076 | 1908 | 45001 | 1165 | 34498 |
| 10L-3S | | MI | 22124 | 6054 | 36673 | 4394 | 40691 | 3552 | 42908 | 2891 | 45823 | 1870 | 55595 | 1588 | 36235 |
| 22-#14 | 3.62 | MA | 24102 | 6593 | 41215 | 4745 | 46138 | 3812 | 49157 | 3053 | 53570 | 1835 | 66420 | 1269 | 52818 |
| 5L-8S | | MI | 21031 | 6593 | 35882 | 4737 | 39511 | 3799 | 41454 | 3055 | 43741 | 1824 | 54002 | 955 | 46240 |
| 22-#14 | 3.62 | MA | 23487 | 6593 | 40139 | 4742 | 44677 | 3807 | 47375 | 3046 | 51236 | 1845 | 63522 | 1184 | 51955 |
| 6L-7S | | MI | 21590 | 6593 | 36877 | 4740 | 40844 | 3805 | 43039 | 3043 | 45974 | 1834 | 56677 | 1024 | 47550 |
| 22-#14 | 3.62 | MA | 22887 | 6593 | 38987 | 4759 | 43273 | 3822 | 45654 | 3059 | 48953 | 1855 | 60504 | 1057 | 50546 |
| 7L-6S | | MI | 22156 | 6593 | 37961 | 4723 | 42165 | 3790 | 44657 | 3031 | 48104 | 1824 | 59484 | 1151 | 48830 |
| 22-#14 | 3.62 | MA | 22295 | 6593 | 37929 | 4757 | 41856 | 3817 | 43969 | 3071 | 46560 | 1845 | 57635 | 987 | 49156 |
| 8L-5S | | MI | 22736 | 6593 | 38973 | 4727 | 43540 | 3796 | 46334 | 3039 | 50281 | 1814 | 62177 | 1236 | 49661 |
| 24-#11 | 2.74 | MA | 22969 | 6165 | 38178 | 4490 | 42344 | 3624 | 44576 | 2939 | 47528 | 1880 | 58230 | 1463 | 41228 |
| 5L-9S | | MI | 20082 | 6165 | 33237 | 4493 | 36269 | 3623 | 37499 | 2934 | 38584 | 1876 | 46990 | 1186 | 36402 |
| 24-#11 | 2.74 | MA | 22532 | 6165 | 37427 | 4488 | 41324 | 3621 | 43332 | 2934 | 45888 | 1886 | 56187 | 1405 | 40684 |
| 6L-8S | | MI | 20475 | 6165 | 33972 | 4481 | 37179 | 3613 | 38644 | 2939 | 40068 | 1869 | 48832 | 1243 | 37110 |
| 24-#11 | 2.74 | MA | 22105 | 6165 | 36623 | 4500 | 40345 | 3632 | 42131 | 2944 | 44283 | 1893 | 54059 | 1317 | 40159 |
| 7E | | MI | 20872 | 6165 | 34666 | 4483 | 38109 | 3616 | 39750 | 2930 | 41638 | 1876 | 50714 | 1291 | 37803 |
| 24-#11 | 2.74 | MA | 21685 | 6165 | 35886 | 4499 | 39356 | 3629 | 40956 | 2953 | 42601 | 1886 | 52043 | 1267 | 39396 |
| 8L-6S | | MI | 21274 | 6165 | 35423 | 4471 | 39031 | 3606 | 40879 | 2921 | 43137 | 1869 | 52695 | 1379 | 38304 |
| 24-#11 | 2.74 | MA | 21268 | 6165 | 35105 | 4511 | 38390 | 3639 | 39740 | 2949 | 41012 | 1893 | 50063 | 1211 | 38642 |
| 9L-5S | | MI | 21686 | 6165 | 36130 | 4473 | 39991 | 3609 | 42050 | 2926 | 44669 | 1862 | 54596 | 1438 | 38793 |
| 24-#11 | 2.74 | MA | 20810 | 6165 | 34371 | 4510 | 37413 | 3637 | 38571 | 2958 | 39435 | 1900 | 48145 | 1147 | 37786 |
| 10L-4S | | MI | 22118 | 6165 | 36878 | 4475 | 40956 | 3599 | 43232 | 2917 | 46336 | 1869 | 56612 | 1480 | 39344 |
| 24-#14 | 3.95 | MA | 24211 | 6752 | 41750 | 4842 | 46731 | 3879 | 49872 | 3091 | 54593 | 1834 | 67984 | 1157 | 56617 |
| 6L-8S | | MI | 21715 | 6752 | 37393 | 4836 | 41438 | 3871 | 43797 | 3099 | 46872 | 1811 | 58153 | 925 | 50594 |
| 24-#14 | 3.95 | MA | 23615 | 6752 | 40598 | 4859 | 45327 | 3894 | 48151 | 3103 | 52309 | 1843 | 64966 | 1030 | 55253 |
| 7E | | MI | 22269 | 6752 | 38388 | 4840 | 42771 | 3877 | 45382 | 3088 | 49105 | 1821 | 60828 | 995 | 51958 |
| 24-#14 | 3.95 | MA | 23027 | 6752 | 39540 | 4856 | 43910 | 3889 | 46466 | 3116 | 49916 | 1834 | 62098 | 959 | 53809 |
| 8L-6S | | MI | 22831 | 6752 | 39472 | 4823 | 44092 | 3863 | 47000 | 3076 | 51236 | 1811 | 63635 | 1121 | 53194 |

## RECTANGULAR TIED COLUMNS 36" x 40"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.11 | MA | 23187 | 5659 | 36556 | 4168 | 39446 | 3395 | 40256 | 2825 | 40190 | 2004 | 47166 | 1876 | 19208 |
| 2E | | MI | 20784 | 5659 | 32914 | 4132 | 35350 | 3365 | 35983 | 2799 | 35687 | 1976 | 41702 | 1840 | 17133 |
| 6-#18 | 1.67 | MA | 24560 | 5943 | 39547 | 4346 | 43260 | 3523 | 44892 | 2904 | 46396 | 1981 | 55397 | 1824 | 28386 |
| 2L-3S | | MI | 20252 | 5943 | 32914 | 4302 | 35350 | 3516 | 35983 | 2897 | 35687 | 1967 | 41702 | 1552 | 25270 |
| 6-#18 | 1.67 | MA | 22595 | 5943 | 36556 | 4340 | 39446 | 3549 | 40256 | 2926 | 40190 | 1999 | 47166 | 1596 | 28360 |
| 3L-2S | | MI | 21981 | 5943 | 35551 | 4310 | 38712 | 3494 | 40070 | 2879 | 41092 | 1949 | 48829 | 1779 | 25248 |
| 8-#14 | 1.25 | MA | 23619 | 5730 | 37298 | 4242 | 40548 | 3451 | 41654 | 2865 | 42220 | 2021 | 49965 | 1893 | 21691 |
| 2L-4S | | MI | 19453 | 5730 | 30842 | 4222 | 32865 | 3432 | 33022 | 2846 | 31982 | 2015 | 37364 | 1603 | 19386 |
| 8-#14 | 1.25 | MA | 22482 | 5730 | 35587 | 4240 | 38367 | 3466 | 39003 | 2878 | 38638 | 2031 | 45191 | 1765 | 21732 |
| 3E | | MI | 20168 | 5730 | 32062 | 4206 | 34416 | 3438 | 34904 | 2854 | 34384 | 2005 | 40069 | 1731 | 19391 |
| 8-#14 | 1.25 | MA | 21676 | 5730 | 34210 | 4257 | 36616 | 3462 | 36878 | 2872 | 35890 | 2041 | 42071 | 1637 | 21686 |
| 4L-2S | | MI | 21170 | 5730 | 33573 | 4209 | 36343 | 3424 | 37247 | 2842 | 37515 | 1995 | 44220 | 1859 | 19338 |
| 8-#18 | 2.22 | MA | 25913 | 6227 | 42539 | 4523 | 47074 | 3652 | 49529 | 2984 | 52601 | 1959 | 63627 | 1772 | 37519 |
| 2L-4S | | MI | 20227 | 6227 | 33415 | 4506 | 35997 | 3632 | 36775 | 2960 | 36947 | 1958 | 44198 | 1264 | 32014 |

## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

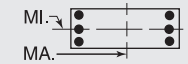
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 2.22 | MA | 23970 | 6227 | 39547 | 4517 | 43260 | 3677 | 44892 | 3006 | 46396 | 1977 | 55397 | 1544 | 37384 |
| 3E | | MI | 21451 | 6227 | 35551 | 4479 | 38712 | 3645 | 40070 | 2977 | 41092 | 1940 | 48829 | 1491 | 33238 |
| 8-#18 | 2.22 | MA | 22589 | 6227 | 37133 | 4547 | 40190 | 3667 | 41167 | 2992 | 41636 | 1995 | 50031 | 1316 | 35988 |
| 4L-2S | | MI | 23161 | 6227 | 38188 | 4487 | 42074 | 3622 | 44157 | 2959 | 46497 | 1922 | 55956 | 1718 | 33314 |
| 10-#11 | 1.08 | MA | 23231 | 5645 | 36373 | 4203 | 39448 | 3424 | 40347 | 2851 | 40503 | 2037 | 47753 | 1921 | 18967 |
| 2L-5S | | MI | 19179 | 5645 | 30099 | 4180 | 31983 | 3416 | 31970 | 2842 | 30501 | 2021 | 35485 | 1672 | 16983 |
| 10-#11 | 1.08 | MA | 22433 | 5645 | 35177 | 4202 | 37923 | 3435 | 38494 | 2861 | 37992 | 2044 | 44393 | 1832 | 19002 |
| 3L-4S | | MI | 19630 | 5645 | 30848 | 4182 | 32948 | 3405 | 33152 | 2833 | 32168 | 2028 | 37500 | 1713 | 16998 |
| 10-#11 | 1.08 | MA | 21868 | 5645 | 34216 | 4215 | 36701 | 3433 | 37011 | 2857 | 36066 | 2051 | 42195 | 1744 | 19016 |
| 4L-3S | | MI | 20131 | 5645 | 31700 | 4170 | 34032 | 3409 | 34467 | 2838 | 33858 | 2021 | 39411 | 1802 | 16969 |
| 10-#11 | 1.08 | MA | 21361 | 5645 | 33373 | 4214 | 35614 | 3444 | 35680 | 2867 | 34167 | 2045 | 39892 | 1701 | 18968 |
| 5L-2S | | MI | 20835 | 5645 | 32758 | 4172 | 35381 | 3399 | 36107 | 2829 | 36061 | 2014 | 42339 | 1891 | 16928 |
| 10-#14 | 1.56 | MA | 24411 | 5890 | 39009 | 4341 | 42729 | 3523 | 44306 | 2910 | 45802 | 2011 | 54738 | 1868 | 26928 |
| 2L-5S | | MI | 19521 | 5890 | 31281 | 4319 | 33410 | 3519 | 33672 | 2903 | 32743 | 1992 | 38651 | 1514 | 23346 |
| 10-#14 | 1.56 | MA | 23282 | 5890 | 37298 | 4339 | 40548 | 3539 | 41654 | 2923 | 42220 | 2021 | 49965 | 1740 | 26937 |
| 3L-4S | | MI | 20158 | 5890 | 32353 | 4322 | 34792 | 3505 | 35365 | 2891 | 35113 | 2002 | 41515 | 1573 | 23955 |
| 10-#14 | 1.56 | MA | 22483 | 5890 | 35921 | 4357 | 38797 | 3534 | 39530 | 2917 | 39472 | 2031 | 46845 | 1612 | 26847 |
| 4L-3S | | MI | 20867 | 5890 | 33573 | 4305 | 36343 | 3510 | 37247 | 2899 | 37515 | 1992 | 44220 | 1701 | 24006 |
| 10-#14 | 1.56 | MA | 21766 | 5890 | 34713 | 4355 | 37239 | 3550 | 37622 | 2931 | 36761 | 2021 | 43567 | 1551 | 26122 |
| 5L-2S | | MI | 21862 | 5890 | 35085 | 4309 | 38270 | 3496 | 39590 | 2887 | 40647 | 1982 | 48372 | 1829 | 23975 |
| 10-#18 | 2.78 | MA | 27249 | 6510 | 45531 | 4700 | 50888 | 3780 | 54166 | 3064 | 58806 | 1937 | 71858 | 1719 | 46607 |
| 2L-5S | | MI | 20337 | 6510 | 34173 | 4676 | 36937 | 3783 | 37898 | 3058 | 38258 | 1914 | 46383 | 1101 | 37484 |
| 10-#18 | 2.78 | MA | 25327 | 6510 | 42539 | 4694 | 47074 | 3806 | 49529 | 3085 | 52601 | 1955 | 63627 | 1492 | 46387 |
| 3L-4S | | MI | 21424 | 6510 | 36052 | 4684 | 39359 | 3761 | 40862 | 3040 | 42351 | 1931 | 51325 | 1203 | 39515 |
| 10-#18 | 2.78 | MA | 23963 | 6510 | 40125 | 4724 | 44005 | 3796 | 45804 | 3071 | 47841 | 1972 | 58262 | 1264 | 44539 |
| 4L-3S | | MI | 22634 | 6510 | 38188 | 4656 | 42074 | 3773 | 44157 | 3057 | 46497 | 1914 | 55956 | 1430 | 41179 |
| 10-#18 | 2.78 | MA | 22739 | 6510 | 38004 | 4718 | 41270 | 3822 | 42456 | 3093 | 43144 | 1955 | 52586 | 1159 | 42090 |
| 5L-2S | | MI | 24327 | 6510 | 40825 | 4664 | 45436 | 3751 | 48244 | 3039 | 51901 | 1896 | 63082 | 1658 | 41341 |
| 12-#11 | 1.30 | MA | 23791 | 5756 | 37569 | 4272 | 40973 | 3474 | 42201 | 2882 | 43014 | 2030 | 51113 | 1905 | 22632 |
| 2L-6S | | MI | 19251 | 5756 | 30450 | 4247 | 32372 | 3463 | 32439 | 2868 | 31172 | 2020 | 36512 | 1594 | 19722 |
| 12-#11 | 1.30 | MA | 22997 | 5756 | 36373 | 4271 | 39448 | 3486 | 40347 | 2892 | 40503 | 2037 | 47753 | 1816 | 22656 |
| 3L-5S | | MI | 19678 | 5756 | 31157 | 4249 | 33332 | 3466 | 33609 | 2873 | 32703 | 2013 | 38413 | 1652 | 20180 |
| 12-#11 | 1.30 | MA | 22435 | 5756 | 35412 | 4284 | 38226 | 3483 | 38864 | 2888 | 38577 | 2044 | 45555 | 1727 | 22646 |
| 4E | | MI | 20126 | 5756 | 31905 | 4251 | 34297 | 3456 | 34791 | 2864 | 34371 | 2020 | 40428 | 1694 | 20220 |
| 12-#11 | 1.30 | MA | 21932 | 5756 | 34569 | 4283 | 37139 | 3494 | 37533 | 2898 | 36679 | 2038 | 43252 | 1684 | 22575 |
| 5L-3S | | MI | 20625 | 5756 | 32758 | 4239 | 35381 | 3459 | 36107 | 2869 | 36061 | 2013 | 42339 | 1783 | 20208 |
| 12-#11 | 1.30 | MA | 21452 | 5756 | 33774 | 4282 | 36059 | 3492 | 36216 | 2894 | 34934 | 2045 | 41068 | 1626 | 22023 |
| 6L-2S | | MI | 21326 | 5756 | 33816 | 4241 | 36729 | 3449 | 37746 | 2861 | 38263 | 2006 | 45267 | 1872 | 20177 |
| 12-#14 | 1.88 | MA | 25196 | 6049 | 40720 | 4441 | 44910 | 3595 | 46958 | 2955 | 49384 | 2000 | 59512 | 1842 | 32151 |
| 2L-6S | | MI | 19620 | 6049 | 31780 | 4415 | 33962 | 3585 | 34339 | 2939 | 33697 | 1990 | 40108 | 1399 | 26952 |
| 12-#14 | 1.88 | MA | 24075 | 6049 | 39009 | 4439 | 42729 | 3611 | 44306 | 2968 | 45802 | 2010 | 54738 | 1714 | 32127 |
| 3L-5S | | MI | 20224 | 6049 | 32793 | 4418 | 35337 | 3591 | 36015 | 2947 | 35874 | 1980 | 42802 | 1484 | 27731 |
| 12-#14 | 1.88 | MA | 23282 | 6049 | 37632 | 4457 | 40979 | 3607 | 42181 | 2962 | 43054 | 2020 | 51618 | 1587 | 32000 |
| 4E | | MI | 20857 | 6049 | 33865 | 4422 | 36719 | 3577 | 37707 | 2936 | 38245 | 1990 | 45667 | 1543 | 28512 |
| 12-#14 | 1.88 | MA | 22571 | 6049 | 36424 | 4455 | 39421 | 3622 | 40274 | 2975 | 40343 | 2010 | 48341 | 1525 | 31099 |
| 5L-3S | | MI | 21561 | 6049 | 35085 | 4405 | 38270 | 3583 | 39590 | 2944 | 40647 | 1980 | 48372 | 1671 | 28598 |
| 12-#14 | 1.88 | MA | 21892 | 6049 | 35283 | 4452 | 37872 | 3618 | 38385 | 2969 | 37853 | 2020 | 45239 | 1441 | 30157 |
| 6L-2S | | MI | 22549 | 6049 | 36596 | 4408 | 40197 | 3568 | 41932 | 2932 | 43778 | 1970 | 52523 | 1799 | 28598 |
| 12-#18 | 3.33 | MA | 28569 | 6794 | 48522 | 4877 | 54702 | 3909 | 58802 | 3144 | 65011 | 1915 | 80089 | 1667 | 55673 |
| 2L-6S | | MI | 20505 | 6794 | 35033 | 4845 | 37889 | 3899 | 39152 | 3156 | 39906 | 1905 | 48893 | 888 | 42333 |
| 12-#18 | 3.33 | MA | 26667 | 6794 | 45531 | 4872 | 50888 | 3934 | 54166 | 3165 | 58806 | 1932 | 71858 | 1440 | 55377 |
| 3L-5S | | MI | 21532 | 6794 | 36810 | 4853 | 40299 | 3912 | 41985 | 3138 | 43663 | 1887 | 53510 | 1040 | 45167 |
| 12-#18 | 3.33 | MA | 25319 | 6794 | 43116 | 4901 | 47819 | 3925 | 50441 | 3151 | 54046 | 1950 | 66493 | 1212 | 53137 |
| 4E | | MI | 22607 | 6794 | 38689 | 4861 | 42721 | 3889 | 44949 | 3119 | 47756 | 1905 | 58452 | 1142 | 47065 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis

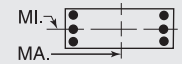



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 3.33 | MA | 24109 | 6794 | 40995 | 4896 | 45084 | 3950 | 47093 | 3173 | 49349 | 1932 | 60817 | 1107 | 50834 |
| 5L-3S | | MI | 23804 | 6794 | 40825 | 4834 | 45436 | 3902 | 48244 | 3137 | 51901 | 1887 | 63082 | 1369 | 49105 |
| 12-#18 | 3.33 | MA | 22955 | 6794 | 38992 | 4890 | 42365 | 3940 | 43777 | 3159 | 45035 | 1950 | 55475 | 955 | 47609 |
| 6L-2S | | MI | 25480 | 6794 | 43462 | 4842 | 48798 | 3879 | 52331 | 3119 | 57306 | 1869 | 70209 | 1597 | 49338 |
| 14-#11 | 1.52 | MA | 24348 | 5866 | 38765 | 4341 | 42498 | 3524 | 44055 | 2913 | 45526 | 2023 | 54473 | 1889 | 26289 |
| 2L-7S | | MI | 19334 | 5866 | 30751 | 4328 | 32799 | 3523 | 32949 | 2908 | 31876 | 2019 | 37459 | 1487 | 22454 |
| 14-#11 | 1.52 | MA | 23557 | 5866 | 37569 | 4340 | 40973 | 3536 | 42201 | 2923 | 43014 | 2030 | 51113 | 1800 | 26302 |
| 3L-6S | | MI | 19749 | 5866 | 31508 | 4317 | 33721 | 3513 | 34078 | 2899 | 33375 | 2012 | 39440 | 1574 | 22828 |
| 14-#11 | 1.52 | MA | 22999 | 5866 | 36608 | 4353 | 39751 | 3533 | 40718 | 2919 | 41089 | 2038 | 48915 | 1711 | 26270 |
| 4L-5S | | MI | 20174 | 5866 | 32214 | 4318 | 34680 | 3516 | 35249 | 2904 | 34906 | 2005 | 41341 | 1633 | 23371 |
| 14-#11 | 1.52 | MA | 22499 | 5866 | 35765 | 4352 | 38664 | 3544 | 39387 | 2929 | 39190 | 2031 | 46612 | 1668 | 26177 |
| 5L-4S | | MI | 20619 | 5866 | 32963 | 4320 | 35645 | 3506 | 36430 | 2896 | 36574 | 2012 | 43356 | 1675 | 23431 |
| 14-#11 | 1.52 | MA | 22021 | 5866 | 34970 | 4351 | 37584 | 3542 | 38069 | 2925 | 37445 | 2038 | 44428 | 1609 | 25540 |
| 6L-3S | | MI | 21115 | 5866 | 33816 | 4308 | 36729 | 3509 | 37746 | 2900 | 38263 | 2005 | 45267 | 1764 | 23440 |
| 14-#11 | 1.52 | MA | 21555 | 5866 | 34118 | 4363 | 36546 | 3553 | 36798 | 2935 | 35738 | 2045 | 42153 | 1522 | 25082 |
| 7L-2S | | MI | 21813 | 5866 | 34873 | 4310 | 38078 | 3499 | 39385 | 2892 | 40466 | 1998 | 48195 | 1853 | 23418 |
| 14-#14 | 2.19 | MA | 25975 | 6209 | 42430 | 4541 | 47092 | 3668 | 49609 | 3000 | 52966 | 1990 | 64286 | 1817 | 37360 |
| 2L-7S | | MI | 19738 | 6209 | 32208 | 4531 | 34568 | 3672 | 35063 | 2996 | 34698 | 1987 | 41453 | 1243 | 30310 |
| 14-#14 | 2.19 | MA | 24861 | 6209 | 40720 | 4539 | 44910 | 3683 | 46958 | 3013 | 49384 | 2000 | 59512 | 1689 | 37307 |
| 3L-6S | | MI | 20323 | 6209 | 33291 | 4515 | 35889 | 3658 | 36681 | 2984 | 36829 | 1977 | 44260 | 1369 | 31395 |
| 14-#14 | 2.19 | MA | 24074 | 6209 | 39343 | 4557 | 43160 | 3679 | 44833 | 3007 | 46636 | 2010 | 56392 | 1561 | 37146 |
| 4L-5S | | MI | 20922 | 6209 | 34304 | 4518 | 37264 | 3663 | 38357 | 2992 | 39006 | 1967 | 46953 | 1454 | 32132 |
| 14-#14 | 2.19 | MA | 23369 | 6209 | 38135 | 4554 | 41602 | 3695 | 42926 | 3020 | 43926 | 2000 | 53114 | 1500 | 36092 |
| 5L-4S | | MI | 21550 | 6209 | 35376 | 4521 | 38646 | 3649 | 40050 | 2981 | 41376 | 1977 | 49818 | 1514 | 33062 |
| 14-#14 | 2.19 | MA | 22696 | 6209 | 36994 | 4552 | 40053 | 3690 | 41037 | 3014 | 41435 | 2010 | 50012 | 1415 | 35196 |
| 6L-3S | | MI | 22248 | 6209 | 36596 | 4505 | 40197 | 3655 | 41932 | 2989 | 43778 | 1967 | 52523 | 1642 | 33180 |
| 14-#14 | 2.19 | MA | 22039 | 6209 | 35774 | 4570 | 38566 | 3706 | 39214 | 3028 | 38998 | 2020 | 46782 | 1288 | 33945 |
| 7L-2S | | MI | 23231 | 6209 | 38108 | 4508 | 42124 | 3641 | 44275 | 2977 | 46909 | 1957 | 56674 | 1770 | 33211 |
| 14-#18 | 3.89 | MA | 27992 | 7078 | 48522 | 5049 | 54702 | 4063 | 58802 | 3245 | 65011 | 1910 | 80089 | 1388 | 64358 |
| 3L-6S | | MI | 21698 | 7078 | 37670 | 5022 | 41251 | 4028 | 43239 | 3235 | 45310 | 1878 | 56020 | 828 | 49882 |
| 14-#18 | 3.89 | MA | 26659 | 7078 | 46108 | 5079 | 51633 | 4053 | 55077 | 3231 | 60251 | 1928 | 74724 | 1160 | 61775 |
| 4L-5S | | MI | 22714 | 7078 | 39447 | 5030 | 43661 | 4041 | 46072 | 3217 | 49068 | 1860 | 60637 | 980 | 52871 |
| 14-#18 | 3.89 | MA | 25464 | 7078 | 43987 | 5073 | 48899 | 4079 | 51730 | 3253 | 55554 | 1910 | 69047 | 1054 | 59599 |
| 5L-4S | | MI | 23777 | 7078 | 41326 | 5038 | 46083 | 4018 | 49036 | 3199 | 53161 | 1878 | 65579 | 1081 | 54652 |
| 14-#18 | 3.89 | MA | 24323 | 7078 | 41983 | 5067 | 46179 | 4069 | 48413 | 3239 | 51240 | 1928 | 63706 | 903 | 56221 |
| 6L-3S | | MI | 24961 | 7078 | 43462 | 5011 | 48798 | 4031 | 52331 | 3217 | 57306 | 1860 | 70209 | 1309 | 57019 |
| 16-#11 | 1.73 | MA | 24900 | 5977 | 39961 | 4411 | 44023 | 3575 | 45908 | 2945 | 48037 | 2016 | 57833 | 1872 | 29940 |
| 2L-8S | | MI | 19425 | 5977 | 31115 | 4396 | 33217 | 3570 | 33482 | 2948 | 32508 | 2004 | 38505 | 1419 | 24975 |
| 16-#11 | 1.73 | MA | 24114 | 5977 | 38765 | 4409 | 42498 | 3586 | 44055 | 2954 | 45526 | 2024 | 54473 | 1784 | 29935 |
| 3L-7S | | MI | 19832 | 5977 | 31809 | 4398 | 34147 | 3573 | 34588 | 2939 | 34079 | 2011 | 40387 | 1467 | 25583 |
| 16-#11 | 1.73 | MA | 23559 | 5977 | 37804 | 4422 | 41276 | 3583 | 42572 | 2951 | 43600 | 2031 | 52275 | 1695 | 29888 |
| 4L-6S | | MI | 20244 | 5977 | 32565 | 4386 | 35069 | 3563 | 35718 | 2930 | 35578 | 2004 | 42368 | 1555 | 25941 |
| 16-#11 | 1.73 | MA | 23061 | 5977 | 36961 | 4421 | 40189 | 3595 | 41241 | 2960 | 41701 | 2024 | 49972 | 1652 | 29777 |
| 5E | | MI | 20667 | 5977 | 33272 | 4388 | 36029 | 3566 | 36888 | 2935 | 37109 | 1997 | 44269 | 1614 | 26543 |
| 16-#11 | 1.73 | MA | 22587 | 5977 | 36166 | 4420 | 39108 | 3592 | 39923 | 2957 | 39957 | 2031 | 47788 | 1593 | 29065 |
| 6L-4S | | MI | 21110 | 5977 | 34021 | 4390 | 36994 | 3556 | 38070 | 2927 | 38776 | 2004 | 46284 | 1656 | 26636 |
| 16-#11 | 1.73 | MA | 22124 | 5977 | 35314 | 4433 | 38071 | 3603 | 38652 | 2966 | 38249 | 2038 | 45513 | 1505 | 28624 |
| 7L-3S | | MI | 21603 | 5977 | 34873 | 4378 | 38078 | 3559 | 39385 | 2932 | 40466 | 1997 | 48195 | 1745 | 26664 |
| 16-#11 | 1.73 | MA | 21667 | 5977 | 34534 | 4431 | 37024 | 3601 | 37407 | 2976 | 36461 | 2032 | 43362 | 1455 | 27914 |
| 8L-2S | | MI | 22297 | 5977 | 35931 | 4379 | 39426 | 3549 | 41024 | 2923 | 42669 | 1990 | 51123 | 1833 | 26652 |
| 16-#14 | 2.50 | MA | 26747 | 6369 | 44141 | 4641 | 49273 | 3740 | 52261 | 3044 | 56548 | 1979 | 69059 | 1792 | 42557 |
| 2L-8S | | MI | 19866 | 6369 | 32724 | 4628 | 35162 | 3739 | 35821 | 3053 | 35597 | 1964 | 42929 | 1143 | 33658 |
| 16-#14 | 2.50 | MA | 25641 | 6369 | 42430 | 4639 | 47092 | 3756 | 49609 | 3058 | 52966 | 1989 | 64286 | 1664 | 42479 |
| 3L-7S | | MI | 20438 | 6369 | 33719 | 4631 | 36495 | 3744 | 37406 | 3041 | 37830 | 1974 | 45604 | 1213 | 34677 |
| 16-#14 | 2.50 | MA | 24860 | 6369 | 41054 | 4656 | 45341 | 3751 | 47485 | 3052 | 50218 | 1999 | 61166 | 1536 | 42289 |
| 4L-6S | | MI | 21019 | 6369 | 34803 | 4615 | 37816 | 3730 | 39024 | 3029 | 39960 | 1964 | 48411 | 1340 | 35846 |
| 16-#14 | 2.50 | MA | 24160 | 6369 | 39846 | 4654 | 43783 | 3767 | 45577 | 3065 | 47508 | 1989 | 57888 | 1474 | 41100 |
| 5E | | MI | 21614 | 6369 | 35815 | 4618 | 39191 | 3736 | 40700 | 3037 | 42137 | 1954 | 51104 | 1425 | 36547 |

## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

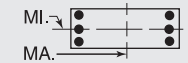
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.50 | MA | 23492 | 6369 | 38705 | 4652 | 42235 | 3763 | 43688 | 3059 | 45017 | 1999 | 54786 | 1390 | 40243 |
| 6L-4S | | MI | 22237 | 6369 | 36888 | 4621 | 40573 | 3722 | 42392 | 3025 | 44507 | 1964 | 53969 | 1484 | 37607 |
| 16-#14 | 2.50 | MA | 22840 | 6369 | 37485 | 4670 | 40747 | 3778 | 41866 | 3072 | 42580 | 2009 | 51556 | 1263 | 38909 |
| 7L-3S | | MI | 22931 | 6369 | 38108 | 4605 | 42124 | 3727 | 44275 | 3033 | 46909 | 1954 | 56674 | 1612 | 37753 |
| 16-#14 | 2.50 | MA | 22198 | 6369 | 36365 | 4668 | 39246 | 3774 | 40081 | 3086 | 40027 | 1999 | 48494 | 1191 | 37739 |
| 8L-2S | | MI | 23907 | 6369 | 39619 | 4608 | 44051 | 3713 | 46617 | 3022 | 50040 | 1944 | 60825 | 1740 | 37807 |
| 16-#18 | 4.44 | MA | 27985 | 7362 | 49099 | 5256 | 55447 | 4182 | 59714 | 3311 | 66456 | 1906 | 82955 | 1108 | 70445 |
| 4L-6S | | MI | 22879 | 7362 | 40307 | 5199 | 44613 | 4156 | 47326 | 3315 | 50715 | 1852 | 63146 | 767 | 57457 |
| 16-#18 | 4.44 | MA | 26803 | 7362 | 46979 | 5250 | 52713 | 4207 | 56366 | 3332 | 61759 | 1888 | 77278 | 1002 | 68383 |
| 5E | | MI | 23883 | 7362 | 42084 | 5207 | 47023 | 4169 | 50159 | 3297 | 54472 | 1834 | 67764 | 919 | 60549 |
| 16-#18 | 4.44 | MA | 25676 | 7362 | 44975 | 5245 | 49993 | 4197 | 53050 | 3318 | 57445 | 1906 | 71937 | 851 | 64858 |
| 6L-4S | | MI | 24936 | 7362 | 43963 | 5215 | 49445 | 4146 | 53123 | 3279 | 58566 | 1852 | 72706 | 1020 | 62272 |
| 18-#11 | 1.95 | MA | 25450 | 6088 | 41157 | 4480 | 45547 | 3625 | 47762 | 2976 | 50548 | 2009 | 61193 | 1856 | 33587 |
| 2L-9S | | MI | 19521 | 6088 | 31438 | 4477 | 33656 | 3630 | 33977 | 2974 | 33228 | 2003 | 39591 | 1343 | 27501 |
| 18-#11 | 1.95 | MA | 24667 | 6088 | 39961 | 4479 | 44023 | 3636 | 45908 | 2986 | 48037 | 2017 | 57833 | 1767 | 33564 |
| 3L-8S | | MI | 19922 | 6088 | 32172 | 4465 | 34565 | 3620 | 35121 | 2979 | 34711 | 1996 | 41433 | 1399 | 28054 |
| 18-#11 | 1.95 | MA | 24115 | 6088 | 39000 | 4491 | 42800 | 3633 | 44425 | 2982 | 46111 | 2024 | 55635 | 1678 | 33502 |
| 4L-7S | | MI | 20326 | 6088 | 32867 | 4467 | 35496 | 3623 | 36227 | 2970 | 36282 | 2003 | 43315 | 1448 | 28716 |
| 18-#11 | 1.95 | MA | 23620 | 6088 | 38157 | 4490 | 41714 | 3645 | 43094 | 2992 | 44213 | 2017 | 53332 | 1635 | 33291 |
| 5L-6S | | MI | 20736 | 6088 | 33623 | 4455 | 36418 | 3613 | 37357 | 2962 | 37781 | 1996 | 45296 | 1536 | 29060 |
| 18-#11 | 1.95 | MA | 23149 | 6088 | 37362 | 4489 | 40633 | 3642 | 41777 | 2988 | 42468 | 2024 | 51148 | 1577 | 32596 |
| 6L-5S | | MI | 21157 | 6088 | 34330 | 4457 | 37377 | 3616 | 38527 | 2967 | 39312 | 1989 | 47197 | 1595 | 29633 |
| 18-#11 | 1.95 | MA | 22689 | 6088 | 36510 | 4502 | 39596 | 3654 | 40505 | 2998 | 40760 | 2031 | 48873 | 1489 | 32170 |
| 7L-4S | | MI | 21597 | 6088 | 35078 | 4459 | 38342 | 3606 | 39709 | 2958 | 40979 | 1996 | 49213 | 1637 | 29835 |
| 18-#11 | 1.95 | MA | 22235 | 6088 | 35730 | 4501 | 38549 | 3651 | 39260 | 3008 | 38972 | 2025 | 46722 | 1439 | 31407 |
| 8L-3S | | MI | 22087 | 6088 | 35931 | 4447 | 39426 | 3609 | 41024 | 2963 | 42669 | 1989 | 51123 | 1726 | 29877 |
| 18-#11 | 1.95 | MA | 21775 | 6088 | 34903 | 4513 | 37526 | 3662 | 37972 | 3004 | 37282 | 2032 | 44606 | 1382 | 30743 |
| 9L-2S | | MI | 22779 | 6088 | 36989 | 4449 | 40775 | 3599 | 42664 | 2954 | 44872 | 1982 | 54051 | 1814 | 29881 |
| 18-#14 | 2.81 | MA | 26415 | 6528 | 44141 | 4738 | 49273 | 3828 | 52261 | 3103 | 56548 | 1979 | 69059 | 1638 | 47646 |
| 3L-8S | | MI | 20565 | 6528 | 34235 | 4728 | 37089 | 3811 | 38163 | 3098 | 38728 | 1951 | 47080 | 1113 | 37978 |
| 18-#14 | 2.81 | MA | 25640 | 6528 | 42765 | 4756 | 47522 | 3824 | 50136 | 3097 | 53800 | 1989 | 65939 | 1510 | 47428 |
| 4L-7S | | MI | 21134 | 6528 | 35230 | 4731 | 38422 | 3817 | 39748 | 3086 | 40961 | 1961 | 49755 | 1183 | 39055 |
| 18-#14 | 2.81 | MA | 24945 | 6528 | 41557 | 4754 | 45965 | 3839 | 48229 | 3110 | 51090 | 1979 | 62661 | 1449 | 46119 |
| 5L-6S | | MI | 21710 | 6528 | 36314 | 4714 | 39743 | 3802 | 41366 | 3074 | 43091 | 1951 | 52562 | 1310 | 40304 |
| 18-#14 | 2.81 | MA | 24282 | 6528 | 40416 | 4752 | 44416 | 3835 | 46340 | 3104 | 48599 | 1989 | 59559 | 1364 | 45298 |
| 6L-5S | | MI | 22301 | 6528 | 37327 | 4718 | 41118 | 3808 | 43042 | 3082 | 45268 | 1941 | 55256 | 1395 | 40974 |
| 18-#14 | 2.81 | MA | 23636 | 6528 | 39196 | 4769 | 42929 | 3851 | 44518 | 3117 | 46162 | 1999 | 56330 | 1238 | 43885 |
| 7L-4S | | MI | 22919 | 6528 | 38399 | 4721 | 42500 | 3794 | 44735 | 3070 | 47639 | 1951 | 58120 | 1454 | 42148 |
| 18-#14 | 2.81 | MA | 22998 | 6528 | 38076 | 4767 | 41427 | 3846 | 42733 | 3131 | 43609 | 1989 | 53267 | 1166 | 42658 |
| 8L-3S | | MI | 23608 | 6528 | 39619 | 4704 | 44051 | 3800 | 46617 | 3078 | 50040 | 1941 | 60825 | 1582 | 42319 |
| 18-#14 | 2.81 | MA | 22366 | 6528 | 36891 | 4785 | 39960 | 3862 | 40886 | 3125 | 41196 | 1999 | 50262 | 1084 | 41009 |
| 9L-2S | | MI | 24579 | 6528 | 41131 | 4708 | 45978 | 3785 | 48960 | 3066 | 53172 | 1931 | 64976 | 1710 | 42395 |
| 18-#18 | 5.00 | MA | 28130 | 7645 | 49970 | 5428 | 56527 | 4336 | 61003 | 3412 | 67964 | 1866 | 85509 | 950 | 77090 |
| 5L-6S | | MI | 24048 | 7645 | 42944 | 5377 | 47975 | 4285 | 51413 | 3395 | 56120 | 1825 | 70273 | 706 | 65055 |
| 18-#18 | 5.00 | MA | 27015 | 7645 | 47967 | 5422 | 53807 | 4326 | 57687 | 3398 | 63650 | 1883 | 80168 | 799 | 73517 |
| 6L-5S | | MI | 25042 | 7645 | 44721 | 5385 | 50385 | 4298 | 54246 | 3377 | 59877 | 1807 | 74891 | 858 | 68018 |
| 20-#11 | 2.17 | MA | 25217 | 6198 | 41157 | 4548 | 45547 | 3686 | 47762 | 3017 | 50548 | 2010 | 61193 | 1751 | 37189 |
| 3L-9S | | MI | 20017 | 6198 | 32495 | 4546 | 35004 | 3680 | 35616 | 3005 | 35431 | 1995 | 42519 | 1324 | 30600 |
| 20-#11 | 2.17 | MA | 24668 | 6198 | 40196 | 4560 | 44325 | 3684 | 46279 | 3013 | 48622 | 2017 | 58995 | 1662 | 37113 |
| 4L-8S | | MI | 20415 | 6198 | 33230 | 4534 | 35914 | 3670 | 36760 | 3010 | 36914 | 1988 | 44361 | 1380 | 31140 |
| 20-#11 | 2.17 | MA | 24176 | 6198 | 39353 | 4559 | 43238 | 3695 | 44948 | 3023 | 46724 | 2010 | 56692 | 1619 | 36798 |
| 5L-7S | | MI | 20817 | 6198 | 33924 | 4536 | 36844 | 3673 | 37867 | 3002 | 38485 | 1995 | 46243 | 1429 | 31851 |
| 20-#11 | 2.17 | MA | 23707 | 6198 | 38558 | 4558 | 42158 | 3692 | 43630 | 3019 | 44979 | 2017 | 54508 | 1560 | 36132 |
| 6E | | MI | 21225 | 6198 | 34681 | 4524 | 37766 | 3663 | 38996 | 2993 | 39984 | 1988 | 48224 | 1517 | 32185 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis

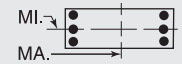



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.17 | MA | 23250 | 6198 | 37706 | 4571 | 41121 | 3704 | 42359 | 3029 | 43272 | 2025 | 52233 | 1473 | 35719 |
| 7L-5S | | MI | 21643 | 6198 | 35388 | 4526 | 38726 | 3667 | 40167 | 2998 | 41515 | 1981 | 50125 | 1576 | 32731 |
| 20-#11 | 2.17 | MA | 22798 | 6198 | 36926 | 4570 | 40074 | 3701 | 41114 | 3039 | 41483 | 2018 | 50082 | 1422 | 34906 |
| 8L-4S | | MI | 22081 | 6198 | 36136 | 4528 | 39691 | 3656 | 41348 | 2989 | 43182 | 1988 | 52141 | 1618 | 33031 |
| 20-#11 | 2.17 | MA | 22351 | 6198 | 36099 | 4582 | 39051 | 3712 | 39826 | 3035 | 39793 | 2025 | 47966 | 1366 | 34261 |
| 9L-3S | | MI | 22569 | 6198 | 36989 | 4516 | 40775 | 3660 | 42664 | 2994 | 44872 | 1981 | 54051 | 1706 | 33086 |
| 20-#11 | 2.17 | MA | 21849 | 6198 | 35322 | 4581 | 38017 | 3710 | 38589 | 3045 | 38116 | 2032 | 45914 | 1302 | 33283 |
| 10L-2S | | MI | 23257 | 6198 | 38046 | 4518 | 42123 | 3649 | 44303 | 2985 | 47075 | 1974 | 56979 | 1795 | 33106 |
| 20-#14 | 3.13 | MA | 26414 | 6688 | 44476 | 4856 | 49704 | 3896 | 52788 | 3141 | 57382 | 1978 | 70713 | 1485 | 52564 |
| 4L-8S | | MI | 21260 | 6688 | 35747 | 4827 | 39016 | 3883 | 40506 | 3143 | 41859 | 1939 | 51231 | 1084 | 42308 |
| 20-#14 | 3.13 | MA | 25724 | 6688 | 43268 | 4854 | 48146 | 3912 | 50881 | 3155 | 54672 | 1968 | 67435 | 1423 | 51149 |
| 5L-7S | | MI | 21824 | 6688 | 36742 | 4831 | 40349 | 3889 | 42091 | 3131 | 44092 | 1949 | 53906 | 1153 | 43444 |
| 20-#14 | 3.13 | MA | 25066 | 6688 | 42127 | 4851 | 46597 | 3907 | 48992 | 3149 | 52182 | 1978 | 64333 | 1339 | 50358 |
| 6E | | MI | 22396 | 6688 | 37826 | 4814 | 41670 | 3875 | 43709 | 3119 | 46223 | 1939 | 56713 | 1280 | 44767 |
| 20-#14 | 3.13 | MA | 24425 | 6688 | 40907 | 4869 | 45110 | 3923 | 47169 | 3162 | 49744 | 1988 | 61103 | 1212 | 48871 |
| 7L-5S | | MI | 22983 | 6688 | 38838 | 4817 | 43045 | 3880 | 45385 | 3127 | 48399 | 1929 | 59407 | 1365 | 45409 |
| 20-#14 | 3.13 | MA | 23792 | 6688 | 39787 | 4867 | 43609 | 3919 | 45384 | 3176 | 47191 | 1978 | 58041 | 1140 | 47586 |
| 8L-4S | | MI | 23597 | 6688 | 39910 | 4821 | 44427 | 3866 | 47077 | 3115 | 50770 | 1939 | 62271 | 1424 | 46685 |
| 20-#14 | 3.13 | MA | 23164 | 6688 | 38602 | 4885 | 42142 | 3934 | 43538 | 3169 | 44779 | 1988 | 55036 | 1059 | 45980 |
| 9L-3S | | MI | 24282 | 6688 | 41131 | 4804 | 45978 | 3872 | 48960 | 3123 | 53172 | 1929 | 64976 | 1552 | 46881 |
| 20-#18 | 5.56 | MA | 28341 | 7929 | 50958 | 5599 | 57621 | 4455 | 62323 | 3478 | 69855 | 1861 | 88399 | 747 | 82196 |
| 6E | | MI | 25207 | 7929 | 45581 | 5554 | 51337 | 4414 | 55500 | 3475 | 61525 | 1798 | 77400 | 645 | 72672 |
| 22-#11 | 2.38 | MA | 25218 | 6309 | 41392 | 4630 | 45850 | 3734 | 48133 | 3044 | 51134 | 2010 | 62355 | 1646 | 40720 |
| 4L-9S | | MI | 20509 | 6309 | 33553 | 4615 | 36353 | 3731 | 37255 | 3036 | 37634 | 1987 | 45447 | 1304 | 33650 |
| 22-#11 | 2.38 | MA | 24729 | 6309 | 40549 | 4628 | 44763 | 3745 | 46802 | 3054 | 49235 | 2003 | 60052 | 1603 | 40312 |
| 5L-8S | | MI | 20906 | 6309 | 34288 | 4603 | 37262 | 3720 | 38400 | 3041 | 39117 | 1980 | 47289 | 1361 | 34231 |
| 22-#11 | 2.38 | MA | 24262 | 6309 | 39754 | 4627 | 43683 | 3743 | 45484 | 3050 | 47490 | 2010 | 57868 | 1544 | 39673 |
| 6L-7S | | MI | 21306 | 6309 | 34982 | 4605 | 38193 | 3724 | 39506 | 3033 | 40688 | 1987 | 49171 | 1410 | 34966 |
| 22-#11 | 2.38 | MA | 23807 | 6309 | 38903 | 4640 | 42646 | 3754 | 44213 | 3060 | 45783 | 2018 | 55593 | 1456 | 39271 |
| 7L-6S | | MI | 21712 | 6309 | 35738 | 4593 | 39115 | 3713 | 40636 | 3024 | 42186 | 1980 | 51152 | 1498 | 35313 |
| 22-#11 | 2.38 | MA | 23359 | 6309 | 38122 | 4639 | 41599 | 3751 | 42968 | 3070 | 43995 | 2011 | 53442 | 1406 | 38411 |
| 8L-5S | | MI | 22127 | 6309 | 36445 | 4595 | 40074 | 3717 | 41806 | 3029 | 43718 | 1973 | 53053 | 1557 | 35836 |
| 22-#11 | 2.38 | MA | 22913 | 6309 | 37295 | 4652 | 40575 | 3763 | 41680 | 3066 | 42305 | 2018 | 51326 | 1350 | 37748 |
| 9L-4S | | MI | 22563 | 6309 | 37194 | 4597 | 41039 | 3706 | 42988 | 3020 | 45385 | 1980 | 55069 | 1598 | 36224 |
| 22-#11 | 2.38 | MA | 22415 | 6309 | 36518 | 4650 | 39542 | 3760 | 40443 | 3076 | 40627 | 2025 | 49274 | 1286 | 36772 |
| 10L-3S | | MI | 23048 | 6309 | 38046 | 4585 | 42123 | 3710 | 44303 | 3025 | 47075 | 1973 | 56979 | 1687 | 36291 |
| 22-#14 | 3.44 | MA | 26498 | 6847 | 44978 | 4953 | 50327 | 3984 | 53532 | 3200 | 58254 | 1958 | 72209 | 1398 | 56187 |
| 5L-8S | | MI | 21949 | 6847 | 37258 | 4927 | 40943 | 3956 | 42848 | 3188 | 44991 | 1926 | 55383 | 1054 | 46648 |
| 22-#14 | 3.44 | MA | 25845 | 6847 | 43838 | 4951 | 48779 | 3980 | 51644 | 3194 | 55764 | 1968 | 69107 | 1313 | 55424 |
| 6L-7S | | MI | 22509 | 6847 | 38253 | 4930 | 42276 | 3961 | 44433 | 3176 | 47224 | 1936 | 58058 | 1123 | 47842 |
| 22-#14 | 3.44 | MA | 25208 | 6847 | 42618 | 4969 | 47291 | 3995 | 49821 | 3207 | 53326 | 1977 | 65877 | 1187 | 53865 |
| 7L-6S | | MI | 23078 | 6847 | 39337 | 4914 | 43597 | 3947 | 46051 | 3164 | 49354 | 1926 | 60865 | 1250 | 49160 |
| 22-#14 | 3.44 | MA | 24580 | 6847 | 41498 | 4967 | 45790 | 3991 | 48036 | 3221 | 50773 | 1968 | 62815 | 1115 | 52525 |
| 8L-5S | | MI | 23660 | 6847 | 40350 | 4917 | 44971 | 3953 | 47728 | 3172 | 51531 | 1916 | 63558 | 1335 | 49853 |
| 22-#14 | 3.44 | MA | 23957 | 6847 | 40313 | 4985 | 44323 | 4007 | 46189 | 3214 | 48361 | 1977 | 59810 | 1033 | 50959 |
| 9L-4S | | MI | 24270 | 6847 | 41422 | 4920 | 46354 | 3939 | 49420 | 3160 | 53901 | 1926 | 66423 | 1394 | 51086 |
| 24-#11 | 2.60 | MA | 25278 | 6420 | 41745 | 4698 | 46288 | 3795 | 48655 | 3085 | 51746 | 1996 | 63412 | 1586 | 43833 |
| 5L-9S | | MI | 20999 | 6420 | 34611 | 4684 | 37701 | 3781 | 38895 | 3068 | 39837 | 1979 | 48375 | 1285 | 36706 |
| 24-#11 | 2.60 | MA | 24814 | 6420 | 40950 | 4696 | 45208 | 3793 | 47338 | 3081 | 50002 | 2004 | 61228 | 1528 | 43217 |
| 6L-8S | | MI | 21394 | 6420 | 35345 | 4672 | 38611 | 3770 | 40039 | 3073 | 41320 | 1972 | 50217 | 1342 | 37327 |
| 24-#11 | 2.60 | MA | 24362 | 6420 | 40099 | 4709 | 44170 | 3804 | 46066 | 3091 | 48294 | 2011 | 58953 | 1440 | 42776 |
| 7E | | MI | 21792 | 6420 | 36040 | 4674 | 39541 | 3774 | 41145 | 3064 | 42891 | 1979 | 52099 | 1391 | 38038 |
| 24-#11 | 2.60 | MA | 23916 | 6420 | 39318 | 4708 | 43123 | 3801 | 44821 | 3101 | 46506 | 2004 | 56802 | 1390 | 41920 |
| 8L-6S | | MI | 22195 | 6420 | 36796 | 4662 | 40463 | 3763 | 42275 | 3055 | 44389 | 1972 | 54080 | 1479 | 38444 |
| 24-#11 | 2.60 | MA | 23471 | 6420 | 38491 | 4721 | 42100 | 3813 | 43533 | 3097 | 44816 | 2011 | 54686 | 1333 | 41219 |
| 9L-5S | | MI | 22609 | 6420 | 37503 | 4664 | 41423 | 3767 | 43445 | 3060 | 45921 | 1965 | 55981 | 1537 | 38946 |
| 24-#11 | 2.60 | MA | 22977 | 6420 | 37714 | 4720 | 41067 | 3810 | 42296 | 3107 | 43139 | 2018 | 52634 | 1270 | 40265 |
| 10L-4S | | MI | 23042 | 6420 | 38252 | 4666 | 42388 | 3756 | 44627 | 3051 | 47588 | 1972 | 57997 | 1579 | 39414 |

## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#14 | 3.75 | MA | 26618 | 7007 | 45549 | 5051 | 50960 | 4052 | 54295 | 3238 | 59346 | 1957 | 73880 | 1288 | 60404 |
| 6L-8S | | MI | 22634 | 7007 | 38770 | 5027 | 42870 | 4028 | 45191 | 3233 | 48122 | 1913 | 59534 | 1024 | 50997 |
| 24-#14 | 3.75 | MA | 25986 | 7007 | 44329 | 5069 | 49473 | 4068 | 52473 | 3252 | 56908 | 1967 | 70650 | 1161 | 58868 |
| 7E | | MI | 23190 | 7007 | 39765 | 5030 | 44203 | 4034 | 46776 | 3221 | 50355 | 1923 | 62209 | 1094 | 52247 |
| 24-#14 | 3.75 | MA | 25362 | 7007 | 43209 | 5067 | 47971 | 4063 | 50688 | 3266 | 54355 | 1957 | 67588 | 1089 | 57472 |
| 8L-6S | | MI | 23755 | 7007 | 40848 | 5014 | 45524 | 4019 | 48394 | 3209 | 52485 | 1913 | 65016 | 1220 | 53521 |
| 24-#14 | 3.75 | MA | 24740 | 7007 | 42024 | 5084 | 46504 | 4079 | 48841 | 3259 | 51943 | 1967 | 64583 | 1008 | 55946 |
| 9L-5S | | MI | 24333 | 7007 | 41861 | 5017 | 46898 | 4025 | 50070 | 3217 | 54662 | 1903 | 67709 | 1305 | 54303 |

## RECTANGULAR TIED COLUMNS 36" x 42"

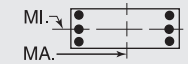
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.06 | MA | 25461 | 5914 | 39976 | 4375 | 43163 | 3565 | 44019 | 2969 | 43904 | 2118 | 51516 | 1991 | 20288 |
| 2E | | MI | 21703 | 5914 | 34296 | 4321 | 36781 | 3520 | 37373 | 2931 | 36931 | 2077 | 43074 | 1938 | 17174 |
| 6-#18 | 1.59 | MA | 26926 | 6198 | 43145 | 4552 | 47203 | 3693 | 48931 | 3049 | 50510 | 2098 | 60300 | 1942 | 30006 |
| 2L-3S | | MI | 21170 | 6198 | 34296 | 4490 | 36781 | 3672 | 37373 | 3029 | 36931 | 2068 | 43074 | 1650 | 25340 |
| 6-#18 | 1.59 | MA | 24838 | 6198 | 39976 | 4548 | 43163 | 3720 | 44019 | 3072 | 43904 | 2116 | 51516 | 1714 | 29980 |
| 3L-2S | | MI | 22902 | 6198 | 36933 | 4498 | 40143 | 3649 | 41460 | 3011 | 42336 | 2050 | 50201 | 1877 | 25297 |
| 8-#14 | 1.19 | MA | 25917 | 5985 | 40753 | 4449 | 44320 | 3621 | 45488 | 3009 | 46016 | 2135 | 54463 | 2008 | 22906 |
| 2L-4S | | MI | 20370 | 5985 | 32218 | 4413 | 34296 | 3589 | 34416 | 2979 | 33232 | 2117 | 38745 | 1702 | 19445 |
| 8-#14 | 1.19 | MA | 24711 | 5985 | 38943 | 4447 | 42011 | 3637 | 42682 | 3024 | 42214 | 2145 | 49378 | 1880 | 22947 |
| 3E | | MI | 21086 | 5985 | 33438 | 4396 | 35848 | 3595 | 36298 | 2987 | 35634 | 2107 | 41450 | 1830 | 19433 |
| 8-#14 | 1.19 | MA | 23858 | 5985 | 37488 | 4465 | 40161 | 3633 | 40437 | 3018 | 39298 | 2156 | 46050 | 1752 | 22901 |
| 4L-2S | | MI | 22089 | 5985 | 34950 | 4399 | 37775 | 3580 | 38641 | 2975 | 38765 | 2097 | 45601 | 1958 | 19376 |
| 8-#18 | 2.12 | MA | 28369 | 6481 | 46314 | 4730 | 51243 | 3822 | 53842 | 3129 | 57115 | 2078 | 69084 | 1894 | 39679 |
| 2L-4S | | MI | 21144 | 6481 | 34797 | 4695 | 37428 | 3788 | 38166 | 3092 | 38190 | 2059 | 45571 | 1362 | 32355 |
| 8-#18 | 2.12 | MA | 26305 | 6481 | 43145 | 4725 | 47203 | 3849 | 48931 | 3152 | 50510 | 2095 | 60300 | 1666 | 39544 |
| 3E | | MI | 22370 | 6481 | 36933 | 4668 | 40143 | 3800 | 41460 | 3109 | 42336 | 2042 | 50201 | 1589 | 33318 |
| 8-#18 | 2.12 | MA | 24841 | 6481 | 40591 | 4756 | 43956 | 3840 | 44991 | 3139 | 45442 | 2113 | 54566 | 1438 | 38371 |
| 4L-2S | | MI | 24084 | 6481 | 39570 | 4676 | 43505 | 3777 | 45547 | 3091 | 47740 | 2024 | 57328 | 1816 | 33369 |
| 10-#11 | 1.03 | MA | 25502 | 5900 | 39771 | 4410 | 43151 | 3594 | 44100 | 2996 | 44148 | 2148 | 52091 | 2035 | 20020 |
| 2L-5S | | MI | 20096 | 5900 | 31472 | 4371 | 33415 | 3573 | 33366 | 2976 | 31753 | 2124 | 36870 | 1771 | 17037 |
| 10-#11 | 1.03 | MA | 24655 | 5900 | 38506 | 4409 | 41538 | 3592 | 42139 | 3006 | 41492 | 2156 | 48514 | 1946 | 20055 |
| 3L-4S | | MI | 20547 | 5900 | 32221 | 4373 | 34380 | 3563 | 34547 | 2967 | 33420 | 2131 | 38885 | 1813 | 17038 |
| 10-#11 | 1.03 | MA | 24058 | 5900 | 37490 | 4422 | 40247 | 3604 | 40572 | 3003 | 39457 | 2164 | 46171 | 1857 | 20069 |
| 4L-3S | | MI | 21049 | 5900 | 33074 | 4361 | 35464 | 3566 | 35863 | 2972 | 35110 | 2124 | 40796 | 1902 | 17003 |
| 10-#11 | 1.03 | MA | 23522 | 5900 | 36600 | 4421 | 39099 | 3602 | 39167 | 3013 | 37452 | 2158 | 43725 | 1813 | 20021 |
| 5L-2S | | MI | 21754 | 5900 | 34131 | 4363 | 36813 | 3556 | 37502 | 2963 | 37313 | 2117 | 43724 | 1990 | 16960 |
| 10-#14 | 1.49 | MA | 26760 | 6144 | 42564 | 4548 | 46628 | 3693 | 48295 | 3054 | 49818 | 2125 | 59549 | 1985 | 28447 |
| 2L-5S | | MI | 20437 | 6144 | 32658 | 4509 | 34841 | 3676 | 35066 | 3036 | 33993 | 2095 | 40032 | 1613 | 23545 |
| 10-#14 | 1.49 | MA | 25563 | 6144 | 40753 | 4547 | 44320 | 3709 | 45488 | 3069 | 46016 | 2135 | 54463 | 1857 | 28456 |
| 3L-4S | | MI | 21076 | 6144 | 33730 | 4512 | 36223 | 3661 | 36758 | 3024 | 36363 | 2105 | 42896 | 1672 | 24021 |
| 10-#14 | 1.49 | MA | 24717 | 6144 | 39298 | 4565 | 42469 | 3706 | 43243 | 3063 | 43100 | 2146 | 51136 | 1729 | 28366 |
| 4L-3S | | MI | 21786 | 6144 | 34950 | 4496 | 37775 | 3667 | 38641 | 3032 | 38765 | 2095 | 45601 | 1800 | 24053 |
| 10-#14 | 1.49 | MA | 23958 | 6144 | 38022 | 4563 | 40824 | 3722 | 41228 | 3077 | 40226 | 2136 | 47651 | 1666 | 27738 |
| 5L-2S | | MI | 22783 | 6144 | 36461 | 4499 | 39702 | 3653 | 40983 | 3020 | 41896 | 2085 | 49752 | 1928 | 24016 |
| 10-#18 | 2.65 | MA | 29793 | 6765 | 49483 | 4907 | 55283 | 3950 | 58754 | 3209 | 63721 | 2057 | 77868 | 1845 | 49307 |
| 2L-5S | | MI | 21252 | 6765 | 35555 | 4864 | 38368 | 3939 | 39288 | 3190 | 39502 | 2015 | 47755 | 1199 | 37769 |
| 10-#18 | 2.65 | MA | 27751 | 6765 | 46314 | 4902 | 51243 | 3977 | 53842 | 3231 | 57115 | 2075 | 69084 | 1617 | 49087 |
| 3L-4S | | MI | 22343 | 6765 | 37434 | 4872 | 40790 | 3916 | 42253 | 3172 | 43595 | 2033 | 52698 | 1301 | 39849 |
| 10-#18 | 2.65 | MA | 26306 | 6765 | 43760 | 4933 | 47996 | 3969 | 49902 | 3219 | 52048 | 2093 | 63350 | 1390 | 47440 |
| 4L-3S | | MI | 23556 | 6765 | 39570 | 4845 | 43505 | 3929 | 45547 | 3189 | 47740 | 2015 | 57328 | 1528 | 41269 |
| 10-#18 | 2.65 | MA | 25009 | 6765 | 41518 | 4928 | 45106 | 3995 | 46363 | 3242 | 47049 | 2075 | 57306 | 1282 | 44720 |
| 5L-2S | | MI | 25253 | 6765 | 42207 | 4853 | 46867 | 3906 | 49634 | 3171 | 53145 | 1997 | 64455 | 1756 | 41405 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis

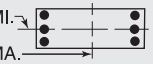



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.24 | MA | 26098 | 6010 | 41036 | 4479 | 44764 | 3644 | 46061 | 3027 | 46805 | 2141 | 55667 | 2020 | 23896 |
| 2L-6S | | MI | 20167 | 6010 | 31823 | 4439 | 33804 | 3620 | 33835 | 3002 | 32424 | 2123 | 37897 | 1693 | 19860 |
| 12-#11 | 1.24 | MA | 25256 | 6010 | 39771 | 4478 | 43151 | 3642 | 44100 | 3037 | 44148 | 2149 | 52091 | 1931 | 23920 |
| 3L-5S | | MI | 20595 | 6010 | 32530 | 4441 | 34764 | 3623 | 35005 | 3007 | 33956 | 2116 | 39798 | 1752 | 20240 |
| 12-#11 | 1.24 | MA | 24661 | 6010 | 38755 | 4491 | 41860 | 3654 | 42533 | 3034 | 42114 | 2157 | 49747 | 1842 | 23910 |
| 4E | | MI | 21044 | 6010 | 33279 | 4443 | 35729 | 3613 | 36187 | 2998 | 35623 | 2123 | 41813 | 1794 | 20267 |
| 12-#11 | 1.24 | MA | 24129 | 6010 | 37866 | 4491 | 40712 | 3652 | 41127 | 3044 | 40108 | 2151 | 47302 | 1798 | 23838 |
| 5L-3S | | MI | 21543 | 6010 | 34131 | 4431 | 36813 | 3616 | 37502 | 3003 | 37313 | 2116 | 43724 | 1882 | 20247 |
| 12-#11 | 1.24 | MA | 23622 | 6010 | 37026 | 4490 | 39572 | 3664 | 39736 | 3041 | 38266 | 2158 | 44975 | 1740 | 23331 |
| 6L-2S | | MI | 22245 | 6010 | 35189 | 4433 | 38161 | 3606 | 39141 | 2994 | 39516 | 2109 | 46652 | 1971 | 20212 |
| 12-#14 | 1.79 | MA | 27597 | 6304 | 44375 | 4648 | 48937 | 3765 | 51101 | 3099 | 53620 | 2115 | 64634 | 1961 | 33974 |
| 2L-6S | | MI | 20536 | 6304 | 33156 | 4606 | 35394 | 3742 | 35733 | 3073 | 34947 | 2092 | 41489 | 1498 | 27133 |
| 12-#14 | 1.79 | MA | 26407 | 6304 | 42564 | 4646 | 46628 | 3782 | 48295 | 3113 | 49818 | 2125 | 59549 | 1833 | 33950 |
| 3L-5S | | MI | 21142 | 6304 | 34169 | 4609 | 36768 | 3748 | 37409 | 3081 | 37124 | 2082 | 44183 | 1583 | 27926 |
| 12-#14 | 1.79 | MA | 25568 | 6304 | 41109 | 4665 | 44778 | 3778 | 46049 | 3108 | 46902 | 2136 | 56221 | 1705 | 33822 |
| 4E | | MI | 21776 | 6304 | 35241 | 4612 | 38150 | 3734 | 39101 | 3069 | 39494 | 2092 | 47047 | 1642 | 28584 |
| 12-#14 | 1.79 | MA | 24815 | 6304 | 39833 | 4663 | 43132 | 3794 | 44034 | 3122 | 44028 | 2126 | 52736 | 1643 | 33007 |
| 5L-3S | | MI | 22481 | 6304 | 36461 | 4596 | 39702 | 3739 | 40983 | 3077 | 41896 | 2082 | 49752 | 1770 | 28653 |
| 12-#14 | 1.79 | MA | 24098 | 6304 | 38629 | 4661 | 41497 | 3791 | 42039 | 3116 | 41386 | 2136 | 49430 | 1558 | 31964 |
| 6L-2S | | MI | 23471 | 6304 | 37973 | 4599 | 41629 | 3725 | 43326 | 3065 | 45027 | 2072 | 53904 | 1898 | 28642 |
| 12-#18 | 3.17 | MA | 31201 | 7049 | 52652 | 5084 | 59324 | 4079 | 63665 | 3288 | 70327 | 2037 | 86651 | 1797 | 58913 |
| 2L-6S | | MI | 21419 | 7049 | 36415 | 5034 | 39320 | 4055 | 40542 | 3288 | 41150 | 2006 | 50265 | 987 | 42792 |
| 12-#18 | 3.17 | MA | 29180 | 7049 | 49483 | 5080 | 55283 | 4106 | 58754 | 3311 | 63721 | 2055 | 77868 | 1569 | 58617 |
| 3L-5S | | MI | 22449 | 7049 | 38192 | 5042 | 41730 | 4067 | 43375 | 3270 | 44907 | 1988 | 54882 | 1138 | 45448 |
| 12-#18 | 3.17 | MA | 27751 | 7049 | 46929 | 5110 | 52037 | 4097 | 54814 | 3299 | 58654 | 2072 | 72134 | 1341 | 56557 |
| 4E | | MI | 23528 | 7049 | 40071 | 5050 | 44152 | 4045 | 46340 | 3251 | 49000 | 2006 | 59824 | 1240 | 47391 |
| 12-#18 | 3.17 | MA | 26470 | 7049 | 44687 | 5106 | 49146 | 4124 | 51274 | 3321 | 53655 | 2055 | 66090 | 1234 | 53990 |
| 5L-3S | | MI | 24728 | 7049 | 42207 | 5022 | 46867 | 4057 | 49634 | 3269 | 53145 | 1988 | 64455 | 1467 | 49202 |
| 12-#18 | 3.17 | MA | 25248 | 7049 | 42570 | 5101 | 46272 | 4115 | 47769 | 3309 | 49062 | 2072 | 60386 | 1083 | 50778 |
| 6L-2S | | MI | 26409 | 7049 | 44844 | 5030 | 50229 | 4035 | 53721 | 3251 | 58550 | 1971 | 71582 | 1695 | 49407 |
| 14-#11 | 1.44 | MA | 26690 | 6121 | 42301 | 4548 | 46377 | 3695 | 48022 | 3058 | 49461 | 2134 | 59243 | 2004 | 27763 |
| 2L-7S | | MI | 20250 | 6121 | 32125 | 4520 | 34231 | 3680 | 34344 | 3042 | 33128 | 2122 | 38844 | 1586 | 22588 |
| 14-#11 | 1.44 | MA | 25852 | 6121 | 41036 | 4547 | 44764 | 3692 | 46061 | 3068 | 46805 | 2142 | 55667 | 1916 | 27776 |
| 3L-6S | | MI | 20666 | 6121 | 32881 | 4508 | 35152 | 3670 | 35474 | 3033 | 34627 | 2115 | 40825 | 1674 | 22965 |
| 14-#11 | 1.44 | MA | 25261 | 6121 | 40021 | 4560 | 43473 | 3704 | 44494 | 3065 | 44770 | 2150 | 53324 | 1827 | 27744 |
| 4L-5S | | MI | 21092 | 6121 | 33588 | 4510 | 36112 | 3673 | 36644 | 3038 | 36159 | 2108 | 42726 | 1733 | 23436 |
| 14-#11 | 1.44 | MA | 24732 | 6121 | 39131 | 4560 | 42325 | 3702 | 43088 | 3075 | 42765 | 2144 | 50878 | 1783 | 27652 |
| 5L-4S | | MI | 21538 | 6121 | 34336 | 4512 | 37077 | 3663 | 37826 | 3029 | 37826 | 2115 | 44741 | 1774 | 23482 |
| 14-#11 | 1.44 | MA | 24227 | 6121 | 38291 | 4559 | 41185 | 3714 | 41697 | 3072 | 40923 | 2152 | 48551 | 1725 | 27052 |
| 6L-3S | | MI | 22035 | 6121 | 35189 | 4500 | 38161 | 3667 | 39141 | 3034 | 39516 | 2108 | 46652 | 1863 | 23481 |
| 14-#11 | 1.44 | MA | 23735 | 6121 | 37393 | 4572 | 40089 | 3712 | 40355 | 3082 | 39120 | 2159 | 46130 | 1637 | 26547 |
| 7L-2S | | MI | 22733 | 6121 | 36247 | 4502 | 39510 | 3656 | 40781 | 3025 | 41719 | 2101 | 49580 | 1952 | 23455 |
| 14-#14 | 2.08 | MA | 28426 | 6464 | 46185 | 4748 | 51245 | 3838 | 53907 | 3144 | 57422 | 2105 | 69719 | 1937 | 39487 |
| 2L-7S | | MI | 20653 | 6464 | 33584 | 4722 | 36000 | 3829 | 36457 | 3129 | 35948 | 2089 | 42834 | 1341 | 30607 |
| 14-#14 | 2.08 | MA | 27245 | 6464 | 44375 | 4746 | 48937 | 3854 | 51101 | 3158 | 53620 | 2115 | 64634 | 1809 | 39433 |
| 3L-6S | | MI | 21239 | 6464 | 34668 | 4705 | 37321 | 3815 | 38075 | 3117 | 38078 | 2079 | 45640 | 1468 | 31575 |
| 14-#14 | 2.08 | MA | 26411 | 6464 | 42920 | 4764 | 47086 | 3850 | 48855 | 3153 | 50704 | 2126 | 61306 | 1681 | 39272 |
| 4L-5S | | MI | 21840 | 6464 | 35680 | 4709 | 38695 | 3820 | 39751 | 3126 | 40255 | 2069 | 48334 | 1553 | 32325 |
| 14-#14 | 2.08 | MA | 25665 | 6464 | 41644 | 4763 | 45441 | 3867 | 46840 | 3167 | 47830 | 2116 | 57821 | 1619 | 38295 |
| 5L-4S | | MI | 22469 | 6464 | 36753 | 4712 | 40077 | 3806 | 41443 | 3114 | 42625 | 2079 | 51198 | 1613 | 33140 |
| 14-#14 | 2.08 | MA | 24953 | 6464 | 40440 | 4761 | 43805 | 3863 | 44845 | 3161 | 45188 | 2126 | 54515 | 1535 | 37300 |
| 6L-3S | | MI | 23170 | 6464 | 37973 | 4695 | 41629 | 3812 | 43326 | 3122 | 45027 | 2069 | 53904 | 1741 | 33239 |
| 14-#14 | 2.08 | MA | 24258 | 6464 | 39151 | 4779 | 42234 | 3879 | 42920 | 3176 | 42603 | 2137 | 51073 | 1408 | 36104 |
| 7L-2S | | MI | 24154 | 6464 | 39484 | 4699 | 43556 | 3797 | 45668 | 3110 | 48159 | 2059 | 58055 | 1869 | 33257 |
| 14-#18 | 3.70 | MA | 30593 | 7332 | 52652 | 5257 | 59324 | 4234 | 63665 | 3391 | 70327 | 2034 | 86651 | 1520 | 68138 |
| 3L-6S | | MI | 22614 | 7332 | 39052 | 5211 | 42682 | 4183 | 44629 | 3367 | 46554 | 1980 | 57392 | 926 | 50333 |
| 14-#18 | 3.70 | MA | 29180 | 7332 | 50098 | 5288 | 56077 | 4226 | 59725 | 3378 | 65259 | 2052 | 80918 | 1293 | 65714 |
| 4L-5S | | MI | 23633 | 7332 | 40829 | 5219 | 45092 | 4196 | 47462 | 3349 | 50311 | 1962 | 62009 | 1078 | 53150 |
| 14-#18 | 3.70 | MA | 27914 | 7332 | 47856 | 5283 | 53186 | 4252 | 56186 | 3401 | 60260 | 2034 | 74874 | 1185 | 63283 |
| 5L-4S | | MI | 24701 | 7332 | 42708 | 5227 | 47514 | 4173 | 50427 | 3331 | 54405 | 1980 | 66951 | 1179 | 54973 |

## RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

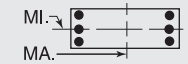
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.70 | MA | 26706 | 7332 | 45739 | 5278 | 50312 | 4244 | 52681 | 3389 | 55668 | 2052 | 69169 | 1035 | 59915 |
| 6L-3S | | MI | 25889 | 7332 | 44844 | 5200 | 50229 | 4186 | 53721 | 3349 | 58550 | 1962 | 71582 | 1407 | 57123 |
| 14-#18 | 3.70 | MA | 25528 | 7332 | 43474 | 5309 | 47551 | 4271 | 49298 | 3412 | 51173 | 2069 | 63228 | 809 | 56649 |
| 7L-2S | | MI | 27554 | 7332 | 47481 | 5208 | 53591 | 4163 | 57808 | 3330 | 63955 | 1944 | 78709 | 1634 | 57392 |
| 16-#11 | 1.65 | MA | 27279 | 6232 | 43566 | 4617 | 47990 | 3745 | 49983 | 3089 | 52118 | 2127 | 62819 | 1989 | 31625 |
| 2L-8S | | MI | 20341 | 6232 | 32488 | 4587 | 34649 | 3727 | 34877 | 3082 | 33761 | 2107 | 39890 | 1518 | 25192 |
| 16-#11 | 1.65 | MA | 26444 | 6232 | 42301 | 4617 | 46377 | 3743 | 48022 | 3099 | 49461 | 2135 | 59243 | 1901 | 31620 |
| 3L-7S | | MI | 20748 | 6232 | 33182 | 4589 | 35579 | 3731 | 35984 | 3073 | 35331 | 2114 | 41772 | 1567 | 25717 |
| 16-#11 | 1.65 | MA | 25857 | 6232 | 41286 | 4630 | 45086 | 3754 | 46455 | 3096 | 47427 | 2143 | 56900 | 1812 | 31573 |
| 4L-6S | | MI | 21162 | 6232 | 33939 | 4577 | 36501 | 3720 | 37113 | 3064 | 36830 | 2107 | 43753 | 1655 | 26078 |
| 16-#11 | 1.65 | MA | 25331 | 6232 | 40396 | 4629 | 43938 | 3752 | 45049 | 3106 | 45421 | 2137 | 54454 | 1768 | 31462 |
| 5E | | MI | 21585 | 6232 | 34646 | 4579 | 37461 | 3724 | 38284 | 3069 | 38362 | 2100 | 45654 | 1713 | 26627 |
| 16-#11 | 1.65 | MA | 24829 | 6232 | 39556 | 4628 | 42798 | 3764 | 43658 | 3103 | 43579 | 2145 | 52128 | 1710 | 30782 |
| 6L-4S | | MI | 22029 | 6232 | 35394 | 4581 | 38426 | 3713 | 39465 | 3060 | 40029 | 2107 | 47669 | 1755 | 26690 |
| 16-#11 | 1.65 | MA | 24340 | 6232 | 38658 | 4641 | 41702 | 3762 | 42316 | 3113 | 41776 | 2152 | 49706 | 1622 | 30296 |
| 7L-3S | | MI | 22523 | 6232 | 36247 | 4569 | 39510 | 3717 | 40781 | 3065 | 41719 | 2100 | 49580 | 1844 | 26708 |
| 16-#11 | 1.65 | MA | 23857 | 6232 | 37834 | 4640 | 40597 | 3773 | 41001 | 3124 | 39888 | 2146 | 47421 | 1571 | 29631 |
| 8L-2S | | MI | 23219 | 6232 | 37304 | 4571 | 40858 | 3706 | 42420 | 3056 | 43922 | 2093 | 52508 | 1933 | 26692 |
| 16-#14 | 2.38 | MA | 29250 | 6623 | 47996 | 4848 | 53553 | 3910 | 56713 | 3189 | 61223 | 2095 | 74804 | 1914 | 44987 |
| 2L-8S | | MI | 20780 | 6623 | 34100 | 4818 | 36594 | 3895 | 37215 | 3186 | 36846 | 2066 | 44310 | 1242 | 33991 |
| 16-#14 | 2.38 | MA | 28075 | 6623 | 46185 | 4846 | 51245 | 3926 | 53907 | 3203 | 57422 | 2105 | 69719 | 1786 | 44909 |
| 3L-7S | | MI | 21355 | 6623 | 35095 | 4822 | 37927 | 3901 | 38799 | 3174 | 39079 | 2076 | 46985 | 1312 | 34970 |
| 16-#14 | 2.38 | MA | 27248 | 6623 | 44730 | 4864 | 49395 | 3923 | 51662 | 3198 | 54506 | 2116 | 66391 | 1658 | 44719 |
| 4L-6S | | MI | 21937 | 6623 | 36179 | 4805 | 39248 | 3887 | 40418 | 3162 | 41210 | 2066 | 49792 | 1439 | 36026 |
| 16-#14 | 2.38 | MA | 26507 | 6623 | 43454 | 4862 | 47749 | 3939 | 49647 | 3212 | 51631 | 2106 | 62907 | 1595 | 43597 |
| 5E | | MI | 22533 | 6623 | 37192 | 4808 | 40622 | 3893 | 42094 | 3170 | 43386 | 2056 | 52485 | 1524 | 36738 |
| 16-#14 | 2.38 | MA | 25801 | 6623 | 42250 | 4861 | 46113 | 3935 | 47652 | 3206 | 48990 | 2116 | 59600 | 1511 | 42645 |
| 6L-4S | | MI | 23158 | 6623 | 38264 | 4812 | 42004 | 3878 | 43786 | 3159 | 45757 | 2066 | 55350 | 1583 | 37689 |
| 16-#14 | 2.38 | MA | 25112 | 6623 | 40961 | 4879 | 44543 | 3952 | 45727 | 3221 | 46405 | 2127 | 56158 | 1385 | 41364 |
| 7L-3S | | MI | 23854 | 6623 | 39484 | 4795 | 43556 | 3884 | 45668 | 3167 | 48159 | 2056 | 58055 | 1711 | 37816 |
| 16-#14 | 2.38 | MA | 24432 | 6623 | 39779 | 4877 | 42958 | 3948 | 43842 | 3235 | 43697 | 2117 | 52903 | 1312 | 40096 |
| 8L-2S | | MI | 24832 | 6623 | 40996 | 4798 | 45483 | 3870 | 48011 | 3155 | 51290 | 2047 | 62206 | 1839 | 37860 |
| 16-#18 | 4.23 | MA | 30594 | 7616 | 53267 | 5465 | 60117 | 4354 | 64636 | 3458 | 71865 | 2031 | 89701 | 1244 | 74904 |
| 4L-6S | | MI | 23796 | 7616 | 41689 | 5388 | 46044 | 4312 | 48716 | 3447 | 51959 | 1953 | 64519 | 865 | 57901 |
| 16-#18 | 4.23 | MA | 29342 | 7616 | 51025 | 5460 | 57227 | 4381 | 61097 | 3481 | 66866 | 2014 | 83658 | 1137 | 72595 |
| 5E | | MI | 24805 | 7616 | 43466 | 5396 | 48454 | 4325 | 51549 | 3429 | 55716 | 1935 | 69136 | 1017 | 60870 |
| 16-#18 | 4.23 | MA | 28148 | 7616 | 48908 | 5456 | 54352 | 4372 | 57592 | 3469 | 62274 | 2031 | 77953 | 986 | 69076 |
| 6L-4S | | MI | 25862 | 7616 | 45345 | 5404 | 50876 | 4302 | 54514 | 3411 | 59810 | 1953 | 74078 | 1119 | 62587 |
| 16-#18 | 4.23 | MA | 26983 | 7616 | 46643 | 5486 | 51591 | 4399 | 54209 | 3491 | 57779 | 2049 | 72012 | 761 | 65713 |
| 7L-3S | | MI | 27038 | 7616 | 47481 | 5377 | 53591 | 4314 | 57808 | 3428 | 63955 | 1935 | 78709 | 1346 | 65035 |
| 18-#11 | 1.86 | MA | 27864 | 6342 | 44832 | 4687 | 49603 | 3795 | 51943 | 3120 | 54774 | 2121 | 66396 | 1974 | 35482 |
| 2L-9S | | MI | 20436 | 6342 | 32811 | 4668 | 35088 | 3788 | 35372 | 3108 | 34480 | 2106 | 40976 | 1442 | 27708 |
| 18-#11 | 1.86 | MA | 27033 | 6342 | 43566 | 4686 | 47990 | 3793 | 49983 | 3131 | 52118 | 2128 | 62819 | 1885 | 35460 |
| 3L-8S | | MI | 20838 | 6342 | 33546 | 4656 | 35997 | 3777 | 36517 | 3113 | 35964 | 2099 | 42818 | 1499 | 28270 |
| 18-#11 | 1.86 | MA | 26449 | 6342 | 42551 | 4699 | 46699 | 3804 | 48416 | 3127 | 50083 | 2136 | 60476 | 1797 | 35397 |
| 4L-7S | | MI | 21243 | 6342 | 34240 | 4658 | 36928 | 3781 | 37623 | 3104 | 37534 | 2106 | 44700 | 1548 | 28850 |
| 18-#11 | 1.86 | MA | 25926 | 6342 | 41661 | 4698 | 45551 | 3802 | 47010 | 3138 | 48078 | 2130 | 58031 | 1753 | 35269 |
| 5L-6S | | MI | 21654 | 6342 | 34996 | 4646 | 37849 | 3770 | 38753 | 3095 | 39033 | 2099 | 46681 | 1636 | 29197 |
| 18-#11 | 1.86 | MA | 25427 | 6342 | 40822 | 4697 | 44411 | 3814 | 45619 | 3134 | 46236 | 2138 | 55704 | 1694 | 34518 |
| 6L-5S | | MI | 22076 | 6342 | 35703 | 4648 | 38809 | 3774 | 39923 | 3100 | 40564 | 2092 | 48582 | 1694 | 29785 |
| 18-#11 | 1.86 | MA | 24941 | 6342 | 39923 | 4710 | 43315 | 3812 | 44276 | 3144 | 44433 | 2146 | 53283 | 1607 | 34049 |
| 7L-4S | | MI | 22517 | 6342 | 36452 | 4650 | 39774 | 3763 | 41105 | 3091 | 42232 | 2099 | 50597 | 1736 | 29893 |
| 18-#11 | 1.86 | MA | 24461 | 6342 | 39099 | 4709 | 42210 | 3824 | 42962 | 3155 | 42545 | 2140 | 50997 | 1556 | 33329 |
| 8L-3S | | MI | 23009 | 6342 | 37304 | 4638 | 40858 | 3767 | 42420 | 3096 | 43922 | 2092 | 52508 | 1825 | 29926 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis

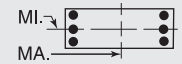



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.86 | MA | 23970 | 6342 | 38227 | 4722 | 41130 | 3821 | 41603 | 3151 | 40761 | 2147 | 48743 | 1500 | 32599 |
| 9L-2S | | MI | 23701 | 6342 | 38362 | 4640 | 42207 | 3757 | 44059 | 3088 | 46124 | 2085 | 55436 | 1914 | 29923 |
| 18-#14 | 2.68 | MA | 28900 | 6783 | 47996 | 4946 | 53553 | 3999 | 56713 | 3248 | 61223 | 2096 | 74804 | 1762 | 50380 |
| 3L-8S | | MI | 21481 | 6783 | 35612 | 4918 | 38521 | 3968 | 39557 | 3231 | 39978 | 2054 | 48461 | 1212 | 38385 |
| 18-#14 | 2.68 | MA | 28078 | 6783 | 46541 | 4964 | 51703 | 3995 | 54468 | 3243 | 58308 | 2106 | 71477 | 1634 | 50161 |
| 4L-7S | | MI | 22051 | 6783 | 36607 | 4921 | 39854 | 3973 | 41142 | 3219 | 42211 | 2064 | 51136 | 1282 | 39346 |
| 18-#14 | 2.68 | MA | 27343 | 6783 | 45265 | 4962 | 50058 | 4011 | 52453 | 3257 | 55433 | 2096 | 67992 | 1572 | 48911 |
| 5L-6S | | MI | 22629 | 6783 | 37691 | 4905 | 41175 | 3959 | 42760 | 3207 | 44341 | 2054 | 53943 | 1409 | 40483 |
| 18-#14 | 2.68 | MA | 26642 | 6783 | 44061 | 4961 | 48422 | 4008 | 50458 | 3251 | 52792 | 2106 | 64685 | 1487 | 47998 |
| 6L-5S | | MI | 23221 | 6783 | 38703 | 4908 | 42549 | 3965 | 44436 | 3215 | 46518 | 2044 | 56636 | 1494 | 41163 |
| 18-#14 | 2.68 | MA | 25958 | 6783 | 42772 | 4979 | 46851 | 4024 | 48533 | 3265 | 50207 | 2117 | 61244 | 1361 | 46635 |
| 7L-4S | | MI | 23842 | 6783 | 39775 | 4911 | 43931 | 3951 | 46128 | 3203 | 48888 | 2054 | 59501 | 1553 | 42234 |
| 18-#14 | 2.68 | MA | 25283 | 6783 | 41590 | 4977 | 45266 | 4020 | 46648 | 3280 | 47499 | 2107 | 57988 | 1288 | 45406 |
| 8L-3S | | MI | 24533 | 6783 | 40996 | 4895 | 45483 | 3956 | 48011 | 3211 | 51290 | 2044 | 62206 | 1681 | 42386 |
| 18-#14 | 2.68 | MA | 24610 | 6783 | 40339 | 4995 | 43717 | 4037 | 44698 | 3274 | 44940 | 2117 | 54785 | 1207 | 43650 |
| 9L-2S | | MI | 25506 | 6783 | 42507 | 4898 | 47410 | 3942 | 50353 | 3200 | 54421 | 2034 | 66357 | 1809 | 42451 |
| 18-#18 | 4.76 | MA | 30756 | 7900 | 54194 | 5638 | 61267 | 4510 | 66009 | 3561 | 73472 | 1993 | 92442 | 1088 | 81924 |
| 5L-6S | | MI | 24968 | 7900 | 44326 | 5566 | 49406 | 4440 | 52803 | 3527 | 57364 | 1926 | 71646 | 804 | 65492 |
| 18-#18 | 4.76 | MA | 29574 | 7900 | 52077 | 5633 | 58392 | 4501 | 62504 | 3548 | 68879 | 2011 | 86737 | 938 | 78261 |
| 6L-5S | | MI | 25966 | 7900 | 46103 | 5574 | 51816 | 4453 | 55636 | 3509 | 61121 | 1909 | 76263 | 956 | 68543 |
| 18-#18 | 4.76 | MA | 28422 | 7900 | 49812 | 5664 | 55632 | 4528 | 59121 | 3571 | 64385 | 2029 | 80796 | 712 | 74799 |
| 7L-4S | | MI | 27013 | 7900 | 47982 | 5582 | 54238 | 4430 | 58601 | 3491 | 65214 | 1926 | 81205 | 1058 | 70228 |
| 20-#11 | 2.06 | MA | 27619 | 6453 | 44832 | 4755 | 49603 | 3843 | 51943 | 3162 | 54774 | 2121 | 66396 | 1870 | 39295 |
| 3L-9S | | MI | 20932 | 6453 | 33869 | 4737 | 36436 | 3838 | 37012 | 3139 | 36683 | 2098 | 43904 | 1423 | 30810 |
| 20-#11 | 2.06 | MA | 27037 | 6453 | 43816 | 4768 | 48312 | 3855 | 50376 | 3158 | 52740 | 2129 | 64053 | 1782 | 39219 |
| 4L-8S | | MI | 21332 | 6453 | 34603 | 4725 | 37346 | 3827 | 38156 | 3144 | 38167 | 2091 | 45746 | 1480 | 31353 |
| 20-#11 | 2.06 | MA | 26517 | 6453 | 42926 | 4767 | 47164 | 3852 | 48971 | 3169 | 50734 | 2123 | 61607 | 1738 | 39006 |
| 5L-7S | | MI | 21735 | 6453 | 35298 | 4727 | 38276 | 3831 | 39262 | 3135 | 39737 | 2098 | 47628 | 1528 | 31986 |
| 20-#11 | 2.06 | MA | 26022 | 6453 | 42087 | 4766 | 46024 | 3864 | 47580 | 3165 | 48892 | 2131 | 59280 | 1679 | 38260 |
| 6E | | MI | 22144 | 6453 | 36054 | 4715 | 39198 | 3820 | 40392 | 3126 | 41236 | 2091 | 49609 | 1616 | 32321 |
| 20-#11 | 2.06 | MA | 25538 | 6453 | 41188 | 4779 | 44928 | 3862 | 46237 | 3176 | 47090 | 2139 | 56859 | 1592 | 37805 |
| 7L-5S | | MI | 22563 | 6453 | 36761 | 4717 | 40158 | 3824 | 41562 | 3131 | 42767 | 2084 | 51510 | 1675 | 32882 |
| 20-#11 | 2.06 | MA | 25061 | 6453 | 40364 | 4779 | 43823 | 3874 | 44923 | 3186 | 45201 | 2133 | 54574 | 1541 | 37033 |
| 8L-4S | | MI | 23002 | 6453 | 37510 | 4719 | 41123 | 3814 | 42744 | 3123 | 44434 | 2091 | 53526 | 1717 | 33092 |
| 20-#11 | 2.06 | MA | 24573 | 6453 | 39492 | 4792 | 42743 | 3872 | 43563 | 3183 | 43417 | 2140 | 52319 | 1484 | 36323 |
| 9L-3S | | MI | 23491 | 6453 | 38362 | 4707 | 42207 | 3817 | 44059 | 3128 | 46124 | 2084 | 55436 | 1806 | 33137 |
| 20-#11 | 2.06 | MA | 24048 | 6453 | 38672 | 4791 | 41652 | 3883 | 42258 | 3193 | 41647 | 2148 | 50134 | 1421 | 35370 |
| 10L-2S | | MI | 24181 | 6453 | 39420 | 4709 | 43555 | 3807 | 45699 | 3119 | 48327 | 2077 | 58364 | 1894 | 33150 |
| 20-#14 | 2.98 | MA | 28903 | 6942 | 48352 | 5064 | 54012 | 4067 | 57274 | 3287 | 62110 | 2096 | 76562 | 1610 | 55602 |
| 4L-8S | | MI | 22176 | 6942 | 37123 | 5018 | 40448 | 4040 | 41900 | 3276 | 43109 | 2041 | 52612 | 1183 | 42710 |
| 20-#14 | 2.98 | MA | 28173 | 6942 | 47076 | 5062 | 52366 | 4084 | 55259 | 3302 | 59235 | 2086 | 73077 | 1548 | 54236 |
| 5L-7S | | MI | 22742 | 6942 | 38118 | 5021 | 41781 | 4046 | 43485 | 3264 | 45342 | 2051 | 55287 | 1252 | 43731 |
| 20-#14 | 2.98 | MA | 27477 | 6942 | 45872 | 5060 | 50730 | 4080 | 53264 | 3296 | 56594 | 2097 | 69771 | 1464 | 53357 |
| 6E | | MI | 23316 | 6942 | 39202 | 5005 | 43102 | 4031 | 45103 | 3252 | 47472 | 2041 | 58094 | 1379 | 44946 |
| 20-#14 | 2.98 | MA | 26798 | 6942 | 44583 | 5079 | 49160 | 4096 | 51339 | 3310 | 54009 | 2107 | 66329 | 1337 | 51916 |
| 7L-5S | | MI | 23905 | 6942 | 40215 | 5008 | 44476 | 4037 | 46779 | 3260 | 49649 | 2031 | 60788 | 1464 | 45597 |
| 20-#14 | 2.98 | MA | 26129 | 6942 | 43401 | 5077 | 47575 | 4093 | 49454 | 3325 | 51301 | 2097 | 63073 | 1265 | 50694 |
| 8L-4S | | MI | 24521 | 6942 | 41287 | 5011 | 45858 | 4023 | 48471 | 3248 | 52019 | 2041 | 63652 | 1523 | 46775 |
| 20-#14 | 2.98 | MA | 25456 | 6942 | 42149 | 5095 | 46026 | 4109 | 47504 | 3319 | 48742 | 2107 | 59870 | 1183 | 48918 |
| 9L-3S | | MI | 25208 | 6942 | 42507 | 4995 | 47410 | 4029 | 50353 | 3256 | 54421 | 2031 | 66357 | 1651 | 46951 |
| 20-#18 | 5.29 | MA | 30988 | 8184 | 55246 | 5810 | 62433 | 4630 | 67415 | 3628 | 75485 | 1991 | 95521 | 889 | 87465 |
| 6E | | MI | 26129 | 8184 | 46963 | 5743 | 52768 | 4569 | 56890 | 3607 | 62769 | 1900 | 78773 | 743 | 73104 |
| 20-#18 | 5.29 | MA | 29848 | 8184 | 52981 | 5841 | 59672 | 4656 | 64032 | 3651 | 70990 | 2008 | 89579 | 664 | 83906 |
| 7L-5S | | MI | 27118 | 8184 | 48740 | 5751 | 55178 | 4582 | 59723 | 3589 | 66526 | 1882 | 83390 | 895 | 76032 |
| 22-#11 | 2.27 | MA | 27623 | 6564 | 45081 | 4837 | 49925 | 3905 | 52337 | 3189 | 55396 | 2122 | 67629 | 1766 | 43037 |
| 4L-9S | | MI | 21426 | 6564 | 34927 | 4806 | 37785 | 3888 | 38651 | 3170 | 38886 | 2089 | 46832 | 1404 | 33916 |
| 22-#11 | 2.27 | MA | 27105 | 6564 | 44192 | 4836 | 48777 | 3903 | 50932 | 3200 | 53391 | 2116 | 65183 | 1723 | 42725 |
| 5L-8S | | MI | 21823 | 6564 | 35661 | 4794 | 38694 | 3878 | 39795 | 3175 | 40369 | 2083 | 48674 | 1460 | 34443 |

## RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

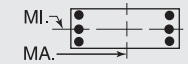
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.27 | MA | 26612 | 6564 | 43352 | 4835 | 47637 | 3914 | 49540 | 3196 | 51549 | 2124 | 62856 | 1664 | 42007 |
| 6L-7S | | MI | 22225 | 6564 | 36355 | 4796 | 39625 | 3881 | 40902 | 3166 | 41940 | 2089 | 50556 | 1509 | 35124 |
| 22-#11 | 2.27 | MA | 26131 | 6564 | 42453 | 4848 | 46541 | 3912 | 48198 | 3207 | 49746 | 2132 | 60435 | 1577 | 41565 |
| 7L-6S | | MI | 22631 | 6564 | 37112 | 4784 | 40547 | 3871 | 42031 | 3158 | 43439 | 2083 | 52537 | 1597 | 35449 |
| 22-#11 | 2.27 | MA | 25657 | 6564 | 41629 | 4848 | 45436 | 3924 | 46884 | 3217 | 47858 | 2126 | 58150 | 1526 | 40743 |
| 8L-5S | | MI | 23048 | 6564 | 37819 | 4786 | 41506 | 3874 | 43202 | 3163 | 44970 | 2076 | 54438 | 1656 | 35986 |
| 22-#11 | 2.27 | MA | 25177 | 6564 | 40757 | 4861 | 44356 | 3922 | 45524 | 3214 | 46074 | 2133 | 55896 | 1469 | 40052 |
| 9L-4S | | MI | 23485 | 6564 | 38567 | 4788 | 42471 | 3864 | 44383 | 3154 | 46637 | 2083 | 56454 | 1698 | 36287 |
| 22-#11 | 2.27 | MA | 24649 | 6564 | 39937 | 4860 | 43265 | 3933 | 44218 | 3224 | 44303 | 2141 | 53710 | 1406 | 39064 |
| 10L-3S | | MI | 23972 | 6564 | 39420 | 4776 | 43555 | 3867 | 45699 | 3159 | 48327 | 2076 | 58364 | 1787 | 36345 |
| 22-#11 | 2.27 | MA | 24138 | 6564 | 39128 | 4859 | 42192 | 3931 | 42874 | 3221 | 42441 | 2135 | 51478 | 1352 | 38161 |
| 11L-2S | | MI | 24659 | 6564 | 40478 | 4778 | 44904 | 3857 | 47338 | 3150 | 50530 | 2069 | 61292 | 1875 | 36369 |
| 22-#14 | 3.27 | MA | 28997 | 7102 | 48886 | 5162 | 54675 | 4156 | 58065 | 3347 | 63037 | 2076 | 78162 | 1525 | 59570 |
| 5L-8S | | MI | 22867 | 7102 | 38635 | 5118 | 42375 | 4112 | 44242 | 3321 | 46240 | 2028 | 56763 | 1153 | 47046 |
| 22-#14 | 3.27 | MA | 28306 | 7102 | 47682 | 5160 | 53039 | 4152 | 56070 | 3341 | 60396 | 2087 | 74856 | 1440 | 58722 |
| 6L-7S | | MI | 23429 | 7102 | 39630 | 5121 | 43708 | 4118 | 45827 | 3309 | 48473 | 2038 | 59438 | 1222 | 48126 |
| 22-#14 | 3.27 | MA | 27632 | 7102 | 46393 | 5178 | 51468 | 4169 | 54145 | 3355 | 57810 | 2097 | 71414 | 1314 | 57206 |
| 7L-6S | | MI | 23999 | 7102 | 40713 | 5104 | 45029 | 4104 | 47445 | 3297 | 50603 | 2028 | 62245 | 1349 | 49414 |
| 22-#14 | 3.27 | MA | 26967 | 7102 | 45211 | 5177 | 49883 | 4165 | 52261 | 3369 | 55103 | 2087 | 68158 | 1241 | 55928 |
| 8L-5S | | MI | 24584 | 7102 | 41726 | 5108 | 46403 | 4109 | 49121 | 3305 | 52780 | 2018 | 64939 | 1434 | 50040 |
| 22-#14 | 3.27 | MA | 26296 | 7102 | 43960 | 5195 | 48334 | 4181 | 50311 | 3364 | 52544 | 2097 | 64955 | 1160 | 54194 |
| 9L-4S | | MI | 25196 | 7102 | 42798 | 5111 | 47785 | 4095 | 50814 | 3293 | 55151 | 2028 | 67803 | 1493 | 51313 |
| 22-#18 | 5.82 | MA | 31261 | 8467 | 56150 | 6018 | 63712 | 4785 | 68944 | 3731 | 77596 | 1988 | 98363 | 615 | 93032 |
| 7L-6S | | MI | 27281 | 8467 | 49600 | 5920 | 56130 | 4698 | 60977 | 3687 | 68174 | 1873 | 85900 | 683 | 80734 |
| 24-#11 | 2.48 | MA | 27690 | 6674 | 45457 | 4905 | 50390 | 3953 | 52893 | 3231 | 56048 | 2109 | 68759 | 1708 | 46450 |
| 5L-9S | | MI | 21917 | 6674 | 35984 | 4876 | 39133 | 3938 | 40290 | 3201 | 41089 | 2081 | 49760 | 1385 | 37003 |
| 24-#11 | 2.48 | MA | 27200 | 6674 | 44617 | 4905 | 49250 | 3964 | 51501 | 3228 | 54205 | 2117 | 66433 | 1649 | 45758 |
| 6L-8S | | MI | 22312 | 6674 | 36719 | 4864 | 40043 | 3928 | 41435 | 3206 | 42572 | 2075 | 51602 | 1441 | 37537 |
| 24-#11 | 2.48 | MA | 26721 | 6674 | 43719 | 4918 | 48155 | 3962 | 50159 | 3238 | 52403 | 2125 | 64012 | 1561 | 45327 |
| 7E | | MI | 22711 | 6674 | 37413 | 4866 | 40973 | 3931 | 42541 | 3197 | 44143 | 2081 | 53484 | 1490 | 38265 |
| 24-#11 | 2.48 | MA | 26250 | 6674 | 42895 | 4917 | 47049 | 3974 | 48845 | 3248 | 50514 | 2119 | 61726 | 1510 | 44459 |
| 8L-6S | | MI | 23116 | 6674 | 38170 | 4854 | 41895 | 3921 | 43670 | 3189 | 45642 | 2075 | 55465 | 1578 | 38580 |
| 24-#11 | 2.48 | MA | 25771 | 6674 | 42022 | 4930 | 45969 | 3972 | 47485 | 3245 | 48730 | 2127 | 59472 | 1454 | 43785 |
| 9L-5S | | MI | 23531 | 6674 | 38877 | 4856 | 42855 | 3924 | 44841 | 3194 | 47173 | 2068 | 57366 | 1637 | 39095 |
| 24-#11 | 2.48 | MA | 25247 | 6674 | 41202 | 4929 | 44878 | 3984 | 46179 | 3255 | 46960 | 2134 | 57286 | 1391 | 42764 |
| 10L-4S | | MI | 23965 | 6674 | 39625 | 4857 | 43820 | 3914 | 46023 | 3185 | 48840 | 2075 | 59382 | 1679 | 39480 |
| 24-#11 | 2.48 | MA | 24739 | 6674 | 40393 | 4928 | 43805 | 3981 | 44835 | 3252 | 45097 | 2128 | 55055 | 1337 | 41833 |
| 11L-3S | | MI | 24450 | 6674 | 40478 | 4846 | 44904 | 3917 | 47338 | 3190 | 50530 | 2068 | 61292 | 1767 | 39549 |
| 24-#14 | 3.57 | MA | 29130 | 7261 | 49493 | 5260 | 55347 | 4225 | 58877 | 3386 | 64197 | 2077 | 79941 | 1416 | 64091 |
| 6L-8S | | MI | 23553 | 7261 | 40146 | 5217 | 44302 | 4185 | 46585 | 3366 | 49371 | 2015 | 60915 | 1123 | 51392 |
| 24-#14 | 3.57 | MA | 28460 | 7261 | 48204 | 5278 | 53777 | 4241 | 56952 | 3400 | 61612 | 2087 | 76499 | 1290 | 62505 |
| 7E | | MI | 24111 | 7261 | 41141 | 5221 | 45635 | 4190 | 48170 | 3354 | 51604 | 2025 | 63590 | 1192 | 52529 |
| 24-#14 | 3.57 | MA | 27800 | 7261 | 47022 | 5276 | 52192 | 4237 | 55067 | 3414 | 58905 | 2077 | 73244 | 1217 | 61170 |
| 8L-6S | | MI | 24678 | 7261 | 42225 | 5204 | 46956 | 4176 | 49788 | 3342 | 53735 | 2015 | 66397 | 1319 | 53840 |
| 24-#14 | 3.57 | MA | 27131 | 7261 | 45771 | 5295 | 50643 | 4253 | 53117 | 3409 | 56346 | 2088 | 70040 | 1136 | 59477 |
| 9L-5S | | MI | 25259 | 7261 | 43238 | 5207 | 48330 | 4182 | 51464 | 3350 | 55912 | 2006 | 69090 | 1404 | 54489 |

## RECTANGULAR TIED COLUMNS 36" x 44"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.01 | MA | 27837 | 6168 | 43541 | 4582 | 47038 | 3735 | 47941 | 3114 | 47763 | 2233 | 56030 | 2105 | 21368 |
| 2E | | MI | 22621 | 6168 | 35678 | 4510 | 38212 | 3676 | 38764 | 3063 | 38175 | 2178 | 44447 | 2036 | 17214 |
| 6-#18 | 1.52 | MA | 29394 | 6452 | 46887 | 4759 | 51304 | 3863 | 53127 | 3193 | 54769 | 2214 | 65367 | 2059 | 31626 |
| 2L-3S | | MI | 22087 | 6452 | 35678 | 4679 | 38212 | 3827 | 38764 | 3161 | 38175 | 2170 | 44447 | 1748 | 25406 |
| 6-#18 | 1.52 | MA | 27184 | 6452 | 43541 | 4755 | 47038 | 3891 | 47941 | 3218 | 47763 | 2232 | 56030 | 1832 | 31600 |
| 3L-2S | | MI | 23822 | 6452 | 38315 | 4687 | 41574 | 3804 | 42851 | 3143 | 43580 | 2152 | 51573 | 1975 | 25345 |
| 8-#14 | 1.14 | MA | 28317 | 6239 | 44354 | 4655 | 48250 | 3791 | 49480 | 3154 | 49915 | 2246 | 59125 | 2122 | 24121 |
| 2L-4S | | MI | 21287 | 6239 | 33595 | 4603 | 35728 | 3746 | 35810 | 3112 | 34481 | 2220 | 40126 | 1801 | 19500 |

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

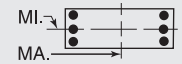
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.14 | MA | 27042 | 6239 | 42443 | 4654 | 45814 | 3788 | 46519 | 3169 | 45904 | 2257 | 53728 | 1994 | 24162 |
| 3E | | MI | 22004 | 6239 | 34815 | 4587 | 37280 | 3751 | 37692 | 3120 | 36883 | 2210 | 42831 | 1929 | 19473 |
| 8-#14 | 1.14 | MA | 26142 | 6239 | 40910 | 4673 | 43864 | 3805 | 44153 | 3164 | 42831 | 2268 | 50192 | 1866 | 24116 |
| 4L-2S | | MI | 23008 | 6239 | 36326 | 4590 | 39207 | 3737 | 40035 | 3108 | 40014 | 2200 | 46982 | 2057 | 19412 |
| 8-#18 | 2.02 | MA | 30927 | 6736 | 50233 | 4937 | 55571 | 3992 | 58313 | 3273 | 61776 | 2195 | 74705 | 2014 | 41839 |
| 2L-4S | | MI | 22061 | 6736 | 36179 | 4884 | 38859 | 3943 | 39556 | 3224 | 39434 | 2161 | 46943 | 1460 | 32689 |
| 8-#18 | 2.02 | MA | 28742 | 6736 | 46887 | 4933 | 51304 | 4020 | 53127 | 3297 | 54769 | 2213 | 65367 | 1787 | 41704 |
| 3E | | MI | 23290 | 6736 | 38315 | 4857 | 41574 | 3956 | 42851 | 3241 | 43580 | 2143 | 51573 | 1687 | 33395 |
| 8-#18 | 2.02 | MA | 27196 | 6736 | 44194 | 4964 | 47880 | 4012 | 48972 | 3286 | 49394 | 2231 | 59264 | 1559 | 40783 |
| 4L-2S | | MI | 25007 | 6736 | 40952 | 4865 | 44936 | 3933 | 46938 | 3223 | 48984 | 2125 | 58700 | 1915 | 33423 |
| 10-#14 | 1.42 | MA | 29212 | 6399 | 46264 | 4755 | 50685 | 3863 | 52441 | 3199 | 53927 | 2236 | 64523 | 2100 | 29965 |
| 2L-5S | | MI | 21354 | 6399 | 34034 | 4700 | 36273 | 3832 | 36460 | 3169 | 35242 | 2197 | 41412 | 1712 | 23738 |
| 10-#14 | 1.42 | MA | 27946 | 6399 | 44354 | 4754 | 48250 | 3860 | 49480 | 3214 | 49915 | 2247 | 59125 | 1972 | 29975 |
| 3L-4S | | MI | 21994 | 6399 | 35106 | 4703 | 37655 | 3818 | 38152 | 3157 | 37612 | 2207 | 44277 | 1771 | 24083 |
| 10-#14 | 1.42 | MA | 27053 | 6399 | 42821 | 4773 | 46300 | 3877 | 47114 | 3209 | 46843 | 2258 | 55590 | 1844 | 29885 |
| 4L-3S | | MI | 22705 | 6399 | 36326 | 4686 | 39207 | 3824 | 40035 | 3165 | 40014 | 2197 | 46982 | 1899 | 24098 |
| 10-#14 | 1.42 | MA | 26253 | 6399 | 41477 | 4771 | 44567 | 3874 | 44991 | 3224 | 43814 | 2250 | 51898 | 1781 | 29367 |
| 5L-2S | | MI | 23703 | 6399 | 37838 | 4690 | 41134 | 3810 | 42377 | 3153 | 43146 | 2187 | 51133 | 2027 | 24057 |
| 10-#18 | 2.53 | MA | 32441 | 7020 | 53579 | 5114 | 59837 | 4121 | 63499 | 3353 | 68783 | 2177 | 84042 | 1969 | 52007 |
| 2L-5S | | MI | 22168 | 7020 | 36937 | 5053 | 39799 | 4094 | 40679 | 3322 | 40746 | 2116 | 49128 | 1297 | 38046 |
| 10-#18 | 2.53 | MA | 30279 | 7020 | 50233 | 5110 | 55571 | 4148 | 58313 | 3377 | 61776 | 2194 | 74705 | 1741 | 51787 |
| 3L-4S | | MI | 23262 | 7020 | 38816 | 5061 | 42221 | 4072 | 43643 | 3304 | 44839 | 2134 | 54070 | 1399 | 40174 |
| 10-#18 | 2.53 | MA | 28751 | 7020 | 47540 | 5142 | 52147 | 4141 | 54158 | 3366 | 56401 | 2212 | 68602 | 1514 | 50370 |
| 4L-3S | | MI | 24478 | 7020 | 40952 | 5034 | 44936 | 4084 | 46938 | 3321 | 48984 | 2116 | 58700 | 1626 | 41354 |
| 10-#18 | 2.53 | MA | 27382 | 7020 | 45178 | 5138 | 49100 | 4169 | 50427 | 3390 | 51099 | 2194 | 62190 | 1405 | 47366 |
| 5L-2S | | MI | 26179 | 7020 | 43589 | 5042 | 48298 | 4061 | 51025 | 3303 | 54389 | 2099 | 65827 | 1854 | 41468 |
| 12-#11 | 1.18 | MA | 28507 | 6265 | 44648 | 4686 | 48714 | 3815 | 50078 | 3171 | 50740 | 2252 | 60384 | 2133 | 25159 |
| 2L-6S | | MI | 21084 | 6265 | 33197 | 4630 | 35236 | 3777 | 35230 | 3136 | 33677 | 2226 | 39282 | 1792 | 19994 |
| 12-#11 | 1.18 | MA | 27616 | 6265 | 43314 | 4685 | 47012 | 3813 | 48010 | 3182 | 47938 | 2261 | 56591 | 2045 | 25183 |
| 3L-5S | | MI | 21512 | 6265 | 33904 | 4632 | 36196 | 3781 | 36400 | 3141 | 35208 | 2219 | 41183 | 1851 | 20296 |
| 12-#11 | 1.18 | MA | 26990 | 6265 | 42244 | 4699 | 45652 | 3825 | 46360 | 3179 | 45795 | 2269 | 54103 | 1956 | 25174 |
| 4E | | MI | 21962 | 6265 | 34652 | 4634 | 37161 | 3770 | 37582 | 3132 | 36875 | 2226 | 43198 | 1893 | 20309 |
| 12-#11 | 1.18 | MA | 26429 | 6265 | 41307 | 4698 | 44444 | 3823 | 44879 | 3190 | 43683 | 2263 | 51514 | 1912 | 25102 |
| 5L-3S | | MI | 22462 | 6265 | 35505 | 4622 | 38245 | 3774 | 38898 | 3137 | 38565 | 2219 | 45109 | 1982 | 20283 |
| 12-#11 | 1.18 | MA | 25894 | 6265 | 40424 | 4698 | 43243 | 3835 | 43414 | 3187 | 41743 | 2272 | 49046 | 1853 | 24646 |
| 6L-2S | | MI | 23165 | 6265 | 36562 | 4624 | 39593 | 3763 | 40537 | 3128 | 40768 | 2212 | 48037 | 2070 | 20246 |
| 12-#14 | 1.70 | MA | 30100 | 6559 | 48175 | 4855 | 53121 | 3936 | 55402 | 3244 | 57938 | 2226 | 69920 | 2078 | 35796 |
| 2L-6S | | MI | 21452 | 6559 | 34533 | 4796 | 36825 | 3899 | 37126 | 3206 | 36196 | 2194 | 42870 | 1597 | 27307 |
| 12-#14 | 1.70 | MA | 28842 | 6559 | 46264 | 4854 | 50685 | 3933 | 52441 | 3259 | 53927 | 2237 | 64523 | 1950 | 35772 |
| 3L-5S | | MI | 22059 | 6559 | 35545 | 4799 | 38200 | 3905 | 38803 | 3214 | 38373 | 2184 | 45564 | 1682 | 28117 |
| 12-#14 | 1.70 | MA | 27956 | 6559 | 44731 | 4872 | 48735 | 3949 | 50075 | 3254 | 50854 | 2248 | 60987 | 1822 | 35645 |
| 4E | | MI | 22694 | 6559 | 36617 | 4803 | 39582 | 3890 | 40495 | 3202 | 40744 | 2194 | 48428 | 1741 | 28653 |
| 12-#14 | 1.70 | MA | 27162 | 6559 | 43387 | 4871 | 47002 | 3946 | 47952 | 3269 | 47825 | 2240 | 57295 | 1759 | 34929 |
| 5L-3S | | MI | 23401 | 6559 | 37838 | 4786 | 41134 | 3896 | 42377 | 3210 | 43146 | 2184 | 51133 | 1869 | 28706 |
| 12-#14 | 1.70 | MA | 26405 | 6559 | 42119 | 4870 | 45279 | 3963 | 45851 | 3264 | 45043 | 2251 | 53784 | 1675 | 33779 |
| 6L-2S | | MI | 24393 | 6559 | 39349 | 4789 | 43061 | 3882 | 44720 | 3198 | 46277 | 2174 | 55284 | 1997 | 28686 |
| 12-#18 | 3.03 | MA | 33938 | 7303 | 56926 | 5291 | 64103 | 4249 | 68686 | 3433 | 75789 | 2158 | 93379 | 1924 | 62153 |
| 2L-6S | | MI | 22333 | 7303 | 37797 | 5223 | 40752 | 4210 | 41933 | 3420 | 42393 | 2108 | 51638 | 1085 | 43241 |
| 12-#18 | 3.03 | MA | 31797 | 7303 | 53579 | 5287 | 59837 | 4277 | 63499 | 3457 | 68783 | 2176 | 84042 | 1696 | 61857 |
| 3L-5S | | MI | 23366 | 7303 | 39574 | 5231 | 43161 | 4223 | 44766 | 3402 | 46150 | 2090 | 56255 | 1237 | 45722 |
| 12-#18 | 3.03 | MA | 30287 | 7303 | 50887 | 5319 | 56413 | 4269 | 59344 | 3446 | 63407 | 2193 | 77939 | 1469 | 60005 |
| 4E | | MI | 24449 | 7303 | 41453 | 5239 | 45583 | 4200 | 47730 | 3383 | 50244 | 2108 | 61197 | 1338 | 47710 |
| 12-#18 | 3.03 | MA | 28934 | 7303 | 48524 | 5315 | 53366 | 4297 | 55614 | 3470 | 58106 | 2176 | 71528 | 1359 | 57163 |
| 5L-3S | | MI | 25652 | 7303 | 43589 | 5211 | 48298 | 4213 | 51025 | 3401 | 54389 | 2090 | 65827 | 1565 | 49295 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

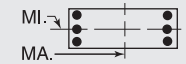
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 3.03 | MA | 27644 | 7303 | 46294 | 5311 | 50337 | 4290 | 51920 | 3459 | 53235 | 2193 | 65460 | 1209 | 53984 |
| 6L-2S | | MI | 27338 | 7303 | 46226 | 5219 | 51660 | 4190 | 55112 | 3383 | 59794 | 2072 | 72954 | 1793 | 49476 |
| 14-#11 | 1.38 | MA | 29135 | 6376 | 45982 | 4755 | 50415 | 3865 | 52146 | 3203 | 53542 | 2245 | 64176 | 2119 | 29237 |
| 2L-7S | | MI | 21166 | 6376 | 33498 | 4711 | 35662 | 3838 | 35740 | 3176 | 34381 | 2225 | 40229 | 1685 | 22716 |
| 14-#11 | 1.38 | MA | 28249 | 6376 | 44648 | 4755 | 48714 | 3863 | 50078 | 3213 | 50740 | 2254 | 60384 | 2031 | 29251 |
| 3L-6S | | MI | 21583 | 6376 | 34254 | 4699 | 36584 | 3827 | 36869 | 3167 | 35879 | 2218 | 42210 | 1773 | 23098 |
| 14-#11 | 1.38 | MA | 27626 | 6376 | 43578 | 4768 | 47353 | 3875 | 48428 | 3210 | 48597 | 2262 | 57896 | 1942 | 29218 |
| 4L-5S | | MI | 22009 | 6376 | 34961 | 4701 | 37544 | 3831 | 38040 | 3172 | 37411 | 2211 | 44111 | 1832 | 23496 |
| 14-#11 | 1.38 | MA | 27068 | 6376 | 42642 | 4767 | 46145 | 3873 | 46947 | 3221 | 46485 | 2257 | 55307 | 1898 | 29126 |
| 5L-4S | | MI | 22456 | 6376 | 35710 | 4703 | 38509 | 3821 | 39221 | 3163 | 39078 | 2218 | 46126 | 1874 | 23531 |
| 14-#11 | 1.38 | MA | 26536 | 6376 | 41758 | 4767 | 44944 | 3885 | 45483 | 3218 | 44545 | 2265 | 52838 | 1839 | 28572 |
| 6L-3S | | MI | 22954 | 6376 | 36562 | 4691 | 39593 | 3824 | 40537 | 3168 | 40768 | 2211 | 48037 | 1963 | 23521 |
| 14-#11 | 1.38 | MA | 26017 | 6376 | 40812 | 4780 | 43791 | 3884 | 44069 | 3229 | 42647 | 2273 | 50270 | 1752 | 28016 |
| 7L-2S | | MI | 23654 | 6376 | 37620 | 4693 | 40942 | 3814 | 42176 | 3159 | 42971 | 2204 | 50965 | 2051 | 23492 |
| 14-#14 | 1.99 | MA | 30981 | 6718 | 50085 | 4955 | 55557 | 4008 | 58363 | 3289 | 61949 | 2216 | 75317 | 2056 | 41613 |
| 2L-7S | | MI | 21568 | 6718 | 34960 | 4912 | 37432 | 3985 | 37851 | 3262 | 37197 | 2191 | 44214 | 1440 | 30897 |
| 14-#14 | 1.99 | MA | 29731 | 6718 | 48175 | 4953 | 53121 | 4005 | 55402 | 3304 | 57938 | 2227 | 69920 | 1928 | 41559 |
| 3L-6S | | MI | 22156 | 6718 | 36044 | 4896 | 38752 | 3971 | 39469 | 3251 | 39328 | 2181 | 47021 | 1567 | 31749 |
| 14-#14 | 1.99 | MA | 28851 | 6718 | 46641 | 4972 | 51171 | 4022 | 53035 | 3299 | 54865 | 2238 | 66384 | 1800 | 41399 |
| 4L-5S | | MI | 22758 | 6718 | 37057 | 4899 | 40127 | 3977 | 41145 | 3259 | 41505 | 2172 | 49715 | 1652 | 32513 |
| 14-#14 | 1.99 | MA | 28063 | 6718 | 45298 | 4971 | 49438 | 4019 | 50913 | 3313 | 51837 | 2230 | 62692 | 1737 | 40511 |
| 5L-4S | | MI | 23389 | 6718 | 38129 | 4902 | 41509 | 3963 | 42837 | 3247 | 43875 | 2181 | 52579 | 1711 | 33214 |
| 14-#14 | 1.99 | MA | 27313 | 6718 | 44030 | 4970 | 47715 | 4035 | 48812 | 3308 | 49055 | 2241 | 59181 | 1653 | 39413 |
| 6L-3S | | MI | 24091 | 6718 | 39349 | 4886 | 43061 | 3968 | 44720 | 3255 | 46277 | 2172 | 55284 | 1839 | 33296 |
| 14-#14 | 1.99 | MA | 26580 | 6718 | 42673 | 4988 | 46061 | 4032 | 46784 | 3323 | 46332 | 2252 | 55527 | 1527 | 38284 |
| 7L-2S | | MI | 25077 | 6718 | 40861 | 4889 | 44988 | 3954 | 47062 | 3243 | 49408 | 2162 | 59435 | 1967 | 33304 |
| 14-#18 | 3.54 | MA | 33298 | 7587 | 56926 | 5465 | 64103 | 4406 | 68686 | 3537 | 75789 | 2157 | 93379 | 1651 | 71918 |
| 3L-6S | | MI | 23529 | 7587 | 40434 | 5400 | 44114 | 4339 | 46020 | 3499 | 47798 | 2081 | 58764 | 1024 | 50775 |
| 14-#18 | 3.54 | MA | 31805 | 7587 | 54233 | 5496 | 60679 | 4398 | 64531 | 3526 | 70414 | 2175 | 87276 | 1423 | 69682 |
| 4L-5S | | MI | 24552 | 7587 | 42211 | 5408 | 46523 | 4351 | 48853 | 3481 | 51555 | 2063 | 63382 | 1176 | 53420 |
| 14-#18 | 3.54 | MA | 30468 | 7587 | 51871 | 5492 | 57633 | 4426 | 60800 | 3550 | 65112 | 2157 | 80865 | 1314 | 66984 |
| 5L-4S | | MI | 25624 | 7587 | 44090 | 5416 | 48945 | 4329 | 51817 | 3463 | 55649 | 2081 | 68324 | 1277 | 55286 |
| 14-#18 | 3.54 | MA | 29192 | 7587 | 49640 | 5489 | 54604 | 4418 | 57106 | 3538 | 60241 | 2175 | 74798 | 1164 | 63645 |
| 6L-3S | | MI | 26815 | 7587 | 46226 | 5389 | 51660 | 4341 | 55112 | 3481 | 59794 | 2063 | 72954 | 1505 | 57223 |
| 14-#18 | 3.54 | MA | 27948 | 7587 | 47253 | 5520 | 51695 | 4446 | 53541 | 3563 | 55474 | 2192 | 68480 | 939 | 60389 |
| 7L-2S | | MI | 28486 | 7587 | 48863 | 5397 | 55022 | 4319 | 59199 | 3462 | 65199 | 2046 | 80081 | 1732 | 57465 |
| 16-#11 | 1.58 | MA | 29760 | 6486 | 47317 | 4824 | 52116 | 3915 | 54215 | 3234 | 56344 | 2239 | 67969 | 2105 | 33310 |
| 2L-8S | | MI | 21256 | 6486 | 33861 | 4778 | 36081 | 3885 | 36273 | 3215 | 35013 | 2210 | 41275 | 1617 | 25404 |
| 16-#11 | 1.58 | MA | 28877 | 6486 | 45982 | 4824 | 50415 | 3913 | 52146 | 3244 | 53542 | 2247 | 64176 | 2017 | 33305 |
| 3L-7S | | MI | 21665 | 6486 | 34556 | 4780 | 37011 | 3888 | 37379 | 3207 | 36584 | 2216 | 43157 | 1666 | 25846 |
| 16-#11 | 1.58 | MA | 28257 | 6486 | 44913 | 4837 | 49055 | 3925 | 50496 | 3241 | 51398 | 2255 | 61689 | 1928 | 33258 |
| 4L-6S | | MI | 22079 | 6486 | 35312 | 4768 | 37933 | 3878 | 38509 | 3198 | 38082 | 2210 | 45138 | 1754 | 26210 |
| 16-#11 | 1.58 | MA | 27703 | 6486 | 43976 | 4837 | 47846 | 3923 | 49016 | 3252 | 49286 | 2250 | 59100 | 1884 | 33146 |
| 5E | | MI | 22503 | 6486 | 36019 | 4770 | 38893 | 3881 | 39679 | 3203 | 39614 | 2203 | 47039 | 1813 | 26691 |
| 16-#11 | 1.58 | MA | 27174 | 6486 | 43092 | 4836 | 46645 | 3935 | 47551 | 3249 | 47347 | 2258 | 56631 | 1825 | 32507 |
| 6L-4S | | MI | 22948 | 6486 | 36768 | 4772 | 39858 | 3871 | 40861 | 3194 | 41281 | 2210 | 49054 | 1855 | 26743 |
| 16-#11 | 1.58 | MA | 26658 | 6486 | 42146 | 4849 | 45492 | 3934 | 46137 | 3260 | 45449 | 2266 | 54063 | 1738 | 31972 |
| 7L-3S | | MI | 23443 | 6486 | 37620 | 4760 | 40942 | 3874 | 42176 | 3199 | 42971 | 2203 | 50965 | 1943 | 26751 |
| 16-#11 | 1.58 | MA | 26149 | 6486 | 41279 | 4849 | 44329 | 3946 | 44754 | 3271 | 43460 | 2261 | 51643 | 1686 | 31362 |
| 8L-2S | | MI | 24140 | 6486 | 38678 | 4762 | 42290 | 3864 | 43815 | 3190 | 45174 | 2196 | 53893 | 2032 | 26731 |
| 16-#14 | 2.27 | MA | 31855 | 6878 | 51995 | 5054 | 57992 | 4080 | 61324 | 3334 | 65961 | 2206 | 80714 | 2034 | 47417 |
| 2L-8S | | MI | 21695 | 6878 | 35477 | 5009 | 38026 | 4052 | 38608 | 3319 | 38096 | 2169 | 45691 | 1341 | 34259 |
| 16-#14 | 2.27 | MA | 30612 | 6878 | 50085 | 5053 | 55557 | 4077 | 58363 | 3348 | 61949 | 2217 | 75317 | 1906 | 47339 |
| 3L-7S | | MI | 22271 | 6878 | 36472 | 5012 | 39359 | 4058 | 40193 | 3307 | 40329 | 2179 | 48366 | 1411 | 35257 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis

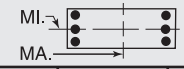


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.27 | MA | 29739 | 6878 | 48552 | 5072 | 53607 | 4094 | 55996 | 3343 | 58877 | 2229 | 71781 | 1778 | 47149 |
| 4L-6S | | MI | 22855 | 6878 | 37555 | 4996 | 40679 | 4044 | 41811 | 3296 | 42459 | 2169 | 51172 | 1537 | 36199 |
| 16-#14 | 2.27 | MA | 28957 | 6878 | 47208 | 5071 | 51873 | 4091 | 53874 | 3358 | 55848 | 2220 | 68089 | 1715 | 46107 |
| 5E | | MI | 23453 | 6878 | 38568 | 4999 | 42054 | 4049 | 43488 | 3304 | 44636 | 2159 | 53866 | 1622 | 36924 |
| 16-#14 | 2.27 | MA | 28212 | 6878 | 45940 | 5069 | 50151 | 4108 | 51772 | 3353 | 53066 | 2231 | 64578 | 1631 | 45056 |
| 6L-4S | | MI | 24079 | 6878 | 39640 | 5002 | 43436 | 4035 | 45180 | 3292 | 47006 | 2169 | 56730 | 1682 | 37768 |
| 16-#14 | 2.27 | MA | 27485 | 6878 | 44583 | 5088 | 48497 | 4105 | 49745 | 3368 | 50343 | 2242 | 60924 | 1505 | 43839 |
| 7L-3S | | MI | 24776 | 6878 | 40861 | 4986 | 44988 | 4041 | 47062 | 3300 | 49408 | 2159 | 59435 | 1810 | 37877 |
| 16-#14 | 2.27 | MA | 26768 | 6878 | 43338 | 5087 | 46828 | 4121 | 47761 | 3383 | 47492 | 2233 | 57475 | 1431 | 42449 |
| 8L-2S | | MI | 25757 | 6878 | 42372 | 4989 | 46914 | 4026 | 49405 | 3288 | 52539 | 2149 | 63587 | 1938 | 37912 |
| 16-#18 | 4.04 | MA | 33307 | 7871 | 57579 | 5674 | 64945 | 4527 | 69717 | 3605 | 77420 | 2156 | 96614 | 1378 | 79393 |
| 4L-6S | | MI | 24714 | 7871 | 43071 | 5577 | 47476 | 4467 | 50107 | 3579 | 53203 | 2054 | 65891 | 963 | 58336 |
| 16-#18 | 4.04 | MA | 31984 | 7871 | 55217 | 5670 | 61899 | 4554 | 65986 | 3629 | 72119 | 2138 | 90203 | 1269 | 76825 |
| 5E | | MI | 25726 | 7871 | 44848 | 5585 | 49885 | 4480 | 52940 | 3561 | 56960 | 2037 | 70509 | 1115 | 61138 |
| 16-#18 | 4.04 | MA | 30723 | 7871 | 52986 | 5666 | 58870 | 4547 | 62292 | 3618 | 67248 | 2156 | 84135 | 1119 | 73332 |
| 6L-4S | | MI | 26787 | 7871 | 46727 | 5593 | 52307 | 4457 | 55904 | 3543 | 61053 | 2054 | 75451 | 1217 | 62895 |
| 16-#18 | 4.04 | MA | 29493 | 7871 | 50600 | 5698 | 55961 | 4575 | 58727 | 3642 | 62480 | 2173 | 77817 | 894 | 69980 |
| 7L-3S | | MI | 27968 | 7871 | 48863 | 5566 | 55022 | 4470 | 59199 | 3560 | 65199 | 2037 | 80081 | 1444 | 65141 |
| 18-#11 | 1.77 | MA | 30380 | 6597 | 48651 | 4893 | 53817 | 3965 | 56283 | 3265 | 59145 | 2232 | 71762 | 2091 | 37377 |
| 2L-9S | | MI | 21351 | 6597 | 34185 | 4859 | 36520 | 3945 | 36768 | 3242 | 35732 | 2208 | 42361 | 1541 | 27908 |
| 18-#11 | 1.77 | MA | 29502 | 6597 | 47317 | 4893 | 52116 | 3963 | 54215 | 3276 | 56344 | 2240 | 67969 | 2003 | 37355 |
| 3L-8S | | MI | 21754 | 6597 | 34919 | 4847 | 37429 | 3935 | 37912 | 3247 | 37216 | 2201 | 44203 | 1598 | 28479 |
| 18-#11 | 1.77 | MA | 28885 | 6597 | 46247 | 4906 | 50756 | 3975 | 52564 | 3273 | 54200 | 2248 | 65482 | 1914 | 37293 |
| 4L-7S | | MI | 22160 | 6597 | 35614 | 4849 | 38359 | 3938 | 39018 | 3238 | 38786 | 2208 | 46085 | 1647 | 28979 |
| 18-#11 | 1.77 | MA | 28334 | 6597 | 45310 | 4906 | 49547 | 3974 | 51084 | 3283 | 52088 | 2243 | 62892 | 1870 | 37164 |
| 5L-6S | | MI | 22572 | 6597 | 36370 | 4837 | 39281 | 3928 | 40148 | 3229 | 40285 | 2201 | 48066 | 1735 | 29329 |
| 18-#11 | 1.77 | MA | 27808 | 6597 | 44427 | 4905 | 48346 | 3986 | 49619 | 3280 | 50148 | 2251 | 60424 | 1811 | 36448 |
| 6L-5S | | MI | 22995 | 6597 | 37077 | 4839 | 40241 | 3931 | 41318 | 3234 | 41817 | 2195 | 49967 | 1794 | 29882 |
| 18-#11 | 1.77 | MA | 27295 | 6597 | 43481 | 4919 | 47193 | 3984 | 48206 | 3291 | 48250 | 2259 | 57855 | 1724 | 35933 |
| 7L-4S | | MI | 23437 | 6597 | 37825 | 4841 | 41206 | 3921 | 42500 | 3225 | 43484 | 2201 | 51982 | 1835 | 29949 |
| 18-#11 | 1.77 | MA | 26789 | 6597 | 42613 | 4918 | 46030 | 3996 | 46822 | 3302 | 46262 | 2254 | 55435 | 1672 | 35265 |
| 8L-3S | | MI | 23929 | 6597 | 38678 | 4829 | 42290 | 3924 | 43815 | 3230 | 45174 | 2195 | 53893 | 1924 | 29975 |
| 18-#11 | 1.77 | MA | 26263 | 6597 | 41762 | 4917 | 44893 | 3994 | 45391 | 3299 | 44384 | 2262 | 53044 | 1616 | 34465 |
| 9L-2S | | MI | 24623 | 6597 | 39736 | 4831 | 43639 | 3914 | 45455 | 3221 | 47377 | 2188 | 56821 | 2013 | 29964 |
| 18-#14 | 2.56 | MA | 31488 | 7037 | 51995 | 5153 | 57992 | 4150 | 61324 | 3393 | 65961 | 2207 | 80714 | 1884 | 53113 |
| 3L-8S | | MI | 22396 | 7037 | 36988 | 5109 | 39953 | 4124 | 40951 | 3364 | 41227 | 2156 | 49842 | 1311 | 38668 |
| 18-#14 | 2.56 | MA | 30620 | 7037 | 50462 | 5172 | 56042 | 4166 | 58957 | 3388 | 62888 | 2219 | 77178 | 1756 | 52895 |
| 4L-7S | | MI | 22968 | 7037 | 37983 | 5112 | 41286 | 4130 | 42536 | 3352 | 43460 | 2166 | 52517 | 1381 | 39628 |
| 18-#14 | 2.56 | MA | 29844 | 7037 | 49118 | 5170 | 54309 | 4163 | 56835 | 3403 | 59859 | 2210 | 73487 | 1693 | 51716 |
| 5L-6S | | MI | 23548 | 7037 | 39067 | 5095 | 42606 | 4116 | 44154 | 3340 | 45590 | 2156 | 55324 | 1508 | 40656 |
| 18-#14 | 2.56 | MA | 29105 | 7037 | 47850 | 5169 | 52586 | 4180 | 54733 | 3398 | 57077 | 2221 | 69975 | 1609 | 50707 |
| 6L-5S | | MI | 24142 | 7037 | 40080 | 5099 | 43981 | 4122 | 45830 | 3348 | 47767 | 2146 | 58017 | 1593 | 41347 |
| 18-#14 | 2.56 | MA | 28383 | 7037 | 46493 | 5188 | 50932 | 4177 | 52706 | 3413 | 54355 | 2232 | 66322 | 1483 | 49406 |
| 7L-4S | | MI | 24764 | 7037 | 41152 | 5102 | 45363 | 4107 | 47522 | 3337 | 50138 | 2156 | 60882 | 1652 | 42317 |
| 18-#14 | 2.56 | MA | 27672 | 7037 | 45249 | 5187 | 49263 | 4194 | 50721 | 3428 | 51503 | 2223 | 62872 | 1409 | 48057 |
| 8L-3S | | MI | 25457 | 7037 | 42372 | 5085 | 46914 | 4113 | 49405 | 3345 | 52539 | 2146 | 63587 | 1780 | 42451 |
| 18-#14 | 2.56 | MA | 26950 | 7037 | 43931 | 5205 | 47632 | 4191 | 48668 | 3423 | 48809 | 2234 | 59470 | 1328 | 46317 |
| 9L-2S | | MI | 26432 | 7037 | 43883 | 5089 | 48841 | 4099 | 51747 | 3333 | 55671 | 2136 | 67738 | 1908 | 42506 |
| 18-#18 | 4.55 | MA | 33486 | 8154 | 58563 | 5847 | 66165 | 4683 | 71173 | 3709 | 79126 | 2119 | 99540 | 1224 | 86683 |
| 5L-6S | | MI | 25887 | 8154 | 45708 | 5755 | 50838 | 4596 | 54194 | 3659 | 58608 | 2028 | 73018 | 902 | 65920 |
| 18-#18 | 4.55 | MA | 32239 | 8154 | 56333 | 5843 | 63136 | 4675 | 67478 | 3698 | 74254 | 2137 | 93473 | 1073 | 83042 |
| 6L-5S | | MI | 26890 | 8154 | 47485 | 5763 | 53247 | 4608 | 57027 | 3641 | 62365 | 2010 | 77635 | 1054 | 68871 |
| 18-#18 | 4.55 | MA | 31022 | 8154 | 53946 | 5875 | 60227 | 4703 | 63914 | 3722 | 69487 | 2155 | 87155 | 848 | 79593 |
| 7L-4S | | MI | 27941 | 8154 | 49364 | 5771 | 55669 | 4586 | 59991 | 3623 | 66458 | 2028 | 82577 | 1156 | 70532 |
| 20-#11 | 1.97 | MA | 30123 | 6708 | 48651 | 4962 | 53817 | 4013 | 56283 | 3307 | 59145 | 2233 | 71762 | 1989 | 41401 |
| 3L-9S | | MI | 21848 | 6708 | 35242 | 4929 | 37868 | 3995 | 38407 | 3273 | 37935 | 2200 | 45289 | 1522 | 31009 |
| 20-#11 | 1.97 | MA | 29510 | 6708 | 47581 | 4975 | 52457 | 4025 | 54632 | 3304 | 57002 | 2241 | 69274 | 1900 | 41325 |
| 4L-8S | | MI | 22249 | 6708 | 35977 | 4917 | 38778 | 3985 | 39551 | 3278 | 39419 | 2193 | 47131 | 1579 | 31561 |

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

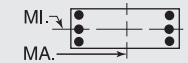
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.97 | MA | 28961 | 6708 | 46645 | 4975 | 51249 | 4024 | 53152 | 3314 | 54890 | 2236 | 66685 | 1855 | 41181 |
| 5L-7S | | MI | 22653 | 6708 | 36671 | 4919 | 39708 | 3988 | 40658 | 3269 | 40989 | 2200 | 49013 | 1628 | 32116 |
| 20-#11 | 1.97 | MA | 28438 | 6708 | 45761 | 4974 | 50048 | 4036 | 51687 | 3311 | 52950 | 2244 | 64216 | 1797 | 40396 |
| 6E | | MI | 23063 | 6708 | 37428 | 4907 | 40630 | 3978 | 41787 | 3260 | 42488 | 2193 | 50994 | 1716 | 32452 |
| 20-#11 | 1.97 | MA | 27928 | 6708 | 44815 | 4988 | 48895 | 4034 | 50274 | 3322 | 51052 | 2252 | 61648 | 1710 | 39896 |
| 7L-5S | | MI | 23483 | 6708 | 38135 | 4909 | 41590 | 3981 | 42958 | 3265 | 44020 | 2186 | 52895 | 1774 | 33029 |
| 20-#11 | 1.97 | MA | 27425 | 6708 | 43948 | 4987 | 47731 | 4046 | 48890 | 3333 | 49064 | 2247 | 59228 | 1658 | 39174 |
| 8L-4S | | MI | 23923 | 6708 | 38883 | 4910 | 42555 | 3971 | 44139 | 3256 | 45687 | 2193 | 54910 | 1816 | 33151 |
| 20-#11 | 1.97 | MA | 26902 | 6708 | 43096 | 4987 | 46595 | 4044 | 47459 | 3330 | 47186 | 2255 | 56836 | 1602 | 38396 |
| 9L-3S | | MI | 24413 | 6708 | 39736 | 4899 | 43639 | 3974 | 45455 | 3261 | 47377 | 2186 | 56821 | 1905 | 33188 |
| 20-#11 | 1.97 | MA | 26348 | 6708 | 42166 | 5000 | 45446 | 4056 | 46084 | 3341 | 45322 | 2264 | 54516 | 1539 | 37475 |
| 10L-2S | | MI | 25104 | 6708 | 40793 | 4900 | 44987 | 3964 | 47094 | 3252 | 49580 | 2180 | 59749 | 1994 | 33192 |
| 20-#14 | 2.84 | MA | 31495 | 7197 | 52373 | 5271 | 58478 | 4239 | 61918 | 3433 | 66899 | 2209 | 82575 | 1734 | 58639 |
| 4L-8S | | MI | 23093 | 7197 | 38500 | 5208 | 41880 | 4197 | 43293 | 3409 | 44358 | 2143 | 53993 | 1282 | 43084 |
| 20-#14 | 2.84 | MA | 30725 | 7197 | 51029 | 5270 | 56745 | 4236 | 59795 | 3448 | 63871 | 2200 | 78884 | 1671 | 57337 |
| 5L-7S | | MI | 23660 | 7197 | 39495 | 5212 | 43213 | 4202 | 44878 | 3397 | 46591 | 2153 | 56668 | 1351 | 44011 |
| 20-#14 | 2.84 | MA | 29991 | 7197 | 49761 | 5269 | 55022 | 4252 | 57694 | 3443 | 61089 | 2211 | 75373 | 1587 | 56365 |
| 6E | | MI | 24237 | 7197 | 40578 | 5195 | 44533 | 4188 | 46496 | 3385 | 48722 | 2143 | 59475 | 1478 | 45119 |
| 20-#14 | 2.84 | MA | 29275 | 7197 | 48404 | 5288 | 53368 | 4249 | 55667 | 3458 | 58366 | 2222 | 71719 | 1461 | 54982 |
| 7L-5S | | MI | 24827 | 7197 | 41591 | 5198 | 45908 | 4194 | 48173 | 3393 | 50898 | 2133 | 62168 | 1563 | 45781 |
| 20-#14 | 2.84 | MA | 28568 | 7197 | 47159 | 5286 | 51699 | 4266 | 53682 | 3473 | 55514 | 2213 | 68269 | 1387 | 53673 |
| 8L-4S | | MI | 25445 | 7197 | 42663 | 5202 | 47290 | 4180 | 49865 | 3381 | 53269 | 2143 | 65033 | 1622 | 46861 |
| 20-#14 | 2.84 | MA | 27848 | 7197 | 45842 | 5305 | 50068 | 4263 | 51629 | 3468 | 52820 | 2224 | 64867 | 1306 | 51882 |
| 9L-3S | | MI | 26134 | 7197 | 43883 | 5185 | 48841 | 4185 | 51747 | 3389 | 55671 | 2133 | 67738 | 1750 | 47019 |
| 20-#18 | 5.05 | MA | 33740 | 8438 | 59679 | 6021 | 67402 | 4804 | 72665 | 3778 | 81261 | 2118 | 102810 | 1028 | 92772 |
| 6E | | MI | 27051 | 8438 | 48345 | 5932 | 54200 | 4724 | 58281 | 3739 | 64013 | 2001 | 80145 | 842 | 73526 |
| 20-#18 | 5.05 | MA | 32535 | 8438 | 57292 | 6052 | 64493 | 4832 | 69100 | 3802 | 76494 | 2136 | 96492 | 803 | 89226 |
| 7L-5S | | MI | 28045 | 8438 | 50122 | 5940 | 56609 | 4737 | 61114 | 3721 | 67770 | 1984 | 84762 | 993 | 76540 |
| 22-#11 | 2.17 | MA | 30130 | 6818 | 48916 | 5045 | 54158 | 4076 | 56700 | 3335 | 59804 | 2234 | 73067 | 1886 | 45354 |
| 4L-9S | | MI | 22342 | 6818 | 36300 | 4998 | 39217 | 4045 | 40046 | 3304 | 40138 | 2192 | 48217 | 1503 | 34114 |
| 22-#11 | 2.17 | MA | 29585 | 6818 | 47979 | 5044 | 52950 | 4074 | 55220 | 3346 | 57692 | 2229 | 70478 | 1841 | 45149 |
| 5L-8S | | MI | 22741 | 6818 | 37035 | 4986 | 40126 | 4035 | 41191 | 3309 | 41622 | 2185 | 50059 | 1560 | 34648 |
| 22-#11 | 2.17 | MA | 29065 | 6818 | 47095 | 5044 | 51749 | 4086 | 53755 | 3343 | 55752 | 2237 | 68009 | 1783 | 44349 |
| 6L-7S | | MI | 23143 | 6818 | 37729 | 4988 | 41057 | 4038 | 42297 | 3300 | 43192 | 2192 | 51941 | 1609 | 35255 |
| 22-#11 | 2.17 | MA | 28558 | 6818 | 46149 | 5057 | 50596 | 4084 | 52342 | 3353 | 53854 | 2246 | 65441 | 1696 | 43864 |
| 7L-6S | | MI | 23551 | 6818 | 38485 | 4976 | 41978 | 4028 | 43427 | 3291 | 44691 | 2185 | 53922 | 1697 | 35580 |
| 22-#11 | 2.17 | MA | 28058 | 6818 | 45282 | 5056 | 49432 | 4096 | 50958 | 3364 | 51866 | 2240 | 63021 | 1644 | 43090 |
| 8L-5S | | MI | 23969 | 6818 | 39192 | 4978 | 42938 | 4031 | 44597 | 3296 | 46223 | 2178 | 55823 | 1755 | 36132 |
| 22-#11 | 2.17 | MA | 27537 | 6818 | 44430 | 5056 | 48296 | 4094 | 49527 | 3361 | 49987 | 2248 | 60629 | 1588 | 42332 |
| 9L-4S | | MI | 24407 | 6818 | 39941 | 4980 | 43903 | 4021 | 45779 | 3287 | 47890 | 2185 | 57838 | 1797 | 36349 |
| 22-#11 | 2.17 | MA | 26986 | 6818 | 43501 | 5069 | 47147 | 4106 | 48152 | 3372 | 48123 | 2257 | 58309 | 1525 | 41375 |
| 10L-3S | | MI | 24895 | 6818 | 40793 | 4968 | 44987 | 4025 | 47094 | 3292 | 49580 | 2178 | 59749 | 1886 | 36397 |
| 22-#11 | 2.17 | MA | 26447 | 6818 | 42649 | 5069 | 46017 | 4105 | 46737 | 3369 | 46163 | 2251 | 55946 | 1470 | 40464 |
| 11L-2S | | MI | 25583 | 6818 | 41851 | 4970 | 46336 | 4014 | 48733 | 3284 | 51783 | 2172 | 62677 | 1975 | 36417 |
| 22-#14 | 3.13 | MA | 31600 | 7356 | 52939 | 5370 | 59180 | 4308 | 62756 | 3493 | 67882 | 2190 | 84281 | 1649 | 62967 |
| 5L-8S | | MI | 23784 | 7356 | 40011 | 5308 | 43807 | 4269 | 45636 | 3454 | 47490 | 2131 | 58144 | 1252 | 47436 |
| 22-#14 | 3.13 | MA | 30871 | 7356 | 51671 | 5369 | 57458 | 4325 | 60655 | 3488 | 65100 | 2201 | 80770 | 1565 | 62028 |
| 6L-7S | | MI | 24348 | 7356 | 41006 | 5311 | 45140 | 4275 | 47221 | 3442 | 49723 | 2140 | 60819 | 1321 | 48403 |
| 22-#14 | 3.13 | MA | 30159 | 7356 | 50314 | 5387 | 55804 | 4322 | 58628 | 3503 | 62377 | 2212 | 77116 | 1439 | 60568 |
| 7L-6S | | MI | 24921 | 7356 | 42090 | 5295 | 46460 | 4261 | 48839 | 3430 | 51853 | 2131 | 63626 | 1448 | 49587 |
| 22-#14 | 3.13 | MA | 29458 | 7356 | 49070 | 5386 | 54135 | 4338 | 56643 | 3518 | 59526 | 2203 | 73666 | 1365 | 59295 |
| 8L-5S | | MI | 25507 | 7356 | 43103 | 5298 | 47835 | 4266 | 50515 | 3438 | 54030 | 2121 | 66320 | 1533 | 50222 |
| 22-#14 | 3.13 | MA | 28739 | 7356 | 47752 | 5405 | 52504 | 4335 | 54590 | 3513 | 56831 | 2214 | 70265 | 1284 | 57455 |
| 9L-4S | | MI | 26122 | 7356 | 44175 | 5301 | 49217 | 4252 | 52207 | 3426 | 56400 | 2131 | 69184 | 1592 | 51403 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

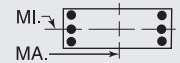
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#18 | 5.56 | MA | 34036 | 8722 | 60638 | 6230 | 68760 | 4960 | 74286 | 3882 | 83500 | 2117 | 105829 | 758 | 98877 |
| 7L-6S | | MI | 28206 | 8722 | 50982 | 6109 | 57562 | 4853 | 62368 | 3819 | 69417 | 1975 | 87272 | 781 | 81151 |
| 24-#11 | 2.36 | MA | 30205 | 6929 | 49313 | 5113 | 54651 | 4124 | 57288 | 3377 | 60493 | 2222 | 74270 | 1827 | 49078 |
| 5L-9S | | MI | 22834 | 6929 | 37358 | 5067 | 40565 | 4095 | 41686 | 3335 | 42341 | 2184 | 51145 | 1484 | 37222 |
| 24-#11 | 2.36 | MA | 29688 | 6929 | 48430 | 5113 | 53450 | 4136 | 55823 | 3374 | 58553 | 2230 | 71802 | 1769 | 48306 |
| 6L-8S | | MI | 23230 | 6929 | 38092 | 5055 | 41475 | 4085 | 42830 | 3340 | 43825 | 2177 | 52987 | 1541 | 37741 |
| 24-#11 | 2.36 | MA | 29184 | 6929 | 47484 | 5126 | 52297 | 4134 | 54410 | 3385 | 56656 | 2239 | 69233 | 1682 | 47833 |
| 7E | | MI | 23631 | 6929 | 38787 | 5057 | 42405 | 4089 | 43936 | 3331 | 45395 | 2184 | 54869 | 1589 | 38396 |
| 24-#11 | 2.36 | MA | 28686 | 6929 | 46616 | 5125 | 51134 | 4146 | 53026 | 3395 | 54667 | 2233 | 66813 | 1630 | 47010 |
| 8L-6S | | MI | 24037 | 6929 | 39543 | 5045 | 43327 | 4078 | 45066 | 3322 | 46894 | 2177 | 56850 | 1677 | 38712 |
| 24-#11 | 2.36 | MA | 28174 | 6929 | 45765 | 5125 | 49997 | 4145 | 51595 | 3392 | 52789 | 2242 | 64422 | 1574 | 46271 |
| 9L-5S | | MI | 24452 | 6929 | 40250 | 5047 | 44287 | 4082 | 46236 | 3327 | 48425 | 2170 | 58751 | 1736 | 39241 |
| 24-#11 | 2.36 | MA | 27620 | 6929 | 44835 | 5138 | 48848 | 4157 | 50220 | 3403 | 50925 | 2250 | 62102 | 1510 | 45280 |
| 10L-4S | | MI | 24888 | 6929 | 40999 | 5049 | 45252 | 4071 | 47418 | 3319 | 50093 | 2177 | 60767 | 1778 | 39544 |
| 24-#11 | 2.36 | MA | 27084 | 6929 | 43984 | 5138 | 47718 | 4155 | 48805 | 3400 | 48965 | 2244 | 59739 | 1456 | 44387 |
| 11L-3S | | MI | 25374 | 6929 | 41851 | 5037 | 46336 | 4075 | 48733 | 3324 | 51783 | 2170 | 62677 | 1867 | 39604 |
| 24-#14 | 3.41 | MA | 31744 | 7516 | 53582 | 5468 | 59893 | 4397 | 63616 | 3533 | 69111 | 2191 | 86167 | 1543 | 67697 |
| 6L-8S | | MI | 24471 | 7516 | 41523 | 5408 | 45734 | 4341 | 47979 | 3499 | 50621 | 2118 | 62295 | 1222 | 51777 |
| 24-#14 | 3.41 | MA | 31038 | 7516 | 52225 | 5487 | 58239 | 4394 | 61589 | 3548 | 66389 | 2202 | 82513 | 1417 | 66163 |
| 7E | | MI | 25032 | 7516 | 42518 | 5411 | 47067 | 4347 | 49563 | 3487 | 52854 | 2128 | 64970 | 1291 | 52803 |
| 24-#14 | 3.41 | MA | 30342 | 7516 | 50980 | 5486 | 56570 | 4411 | 59604 | 3563 | 63537 | 2193 | 79063 | 1343 | 64901 |
| 8L-6S | | MI | 25601 | 7516 | 43601 | 5395 | 48387 | 4333 | 51181 | 3475 | 54984 | 2118 | 67777 | 1418 | 54059 |
| 24-#14 | 3.41 | MA | 29624 | 7516 | 49663 | 5505 | 54939 | 4408 | 57551 | 3558 | 60842 | 2204 | 75662 | 1262 | 63035 |
| 9L-5S | | MI | 26184 | 7516 | 44614 | 5398 | 49762 | 4339 | 52858 | 3483 | 57161 | 2108 | 70471 | 1503 | 54670 |

## RECTANGULAR TIED COLUMNS 36" x 46"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.45 | MA | 31964 | 6707 | 50774 | 4966 | 55564 | 4034 | 57481 | 3338 | 59147 | 2328 | 70598 | 2176 | 33246 |
| 2L-3S | | MI | 23005 | 6707 | 37060 | 4868 | 39644 | 3982 | 40154 | 3293 | 39419 | 2271 | 45819 | 1846 | 25469 |
| 6-#18 | 1.45 | MA | 29632 | 6707 | 47250 | 4963 | 51072 | 4062 | 52020 | 3363 | 51748 | 2346 | 60707 | 1948 | 33220 |
| 3L-2S | | MI | 24742 | 6707 | 39697 | 4876 | 43006 | 3960 | 44241 | 3275 | 44823 | 2253 | 52946 | 2073 | 25392 |
| 8-#14 | 1.09 | MA | 30819 | 6494 | 48099 | 4862 | 52338 | 3961 | 53630 | 3299 | 53959 | 2357 | 63951 | 2236 | 25336 |
| 2L-4S | | MI | 22204 | 6494 | 34971 | 4794 | 37160 | 3902 | 37204 | 3245 | 35731 | 2322 | 41506 | 1900 | 19552 |
| 8-#14 | 1.09 | MA | 29475 | 6494 | 46089 | 4861 | 49775 | 3959 | 50514 | 3314 | 49738 | 2369 | 58241 | 2108 | 25377 |
| 3E | | MI | 22921 | 6494 | 36191 | 4777 | 38711 | 3908 | 39086 | 3253 | 38133 | 2312 | 44211 | 2028 | 19513 |
| 8-#14 | 1.09 | MA | 28527 | 6494 | 44477 | 4881 | 47726 | 3976 | 48027 | 3310 | 46509 | 2381 | 54497 | 1980 | 25331 |
| 4L-2S | | MI | 23927 | 6494 | 37703 | 4780 | 40638 | 3894 | 41429 | 3241 | 41264 | 2302 | 48363 | 2156 | 19448 |
| 8-#18 | 1.93 | MA | 33589 | 6990 | 54298 | 5143 | 60056 | 4162 | 62942 | 3418 | 66545 | 2311 | 80490 | 2133 | 43999 |
| 2L-4S | | MI | 22978 | 6990 | 37561 | 5073 | 40291 | 4098 | 40947 | 3356 | 40678 | 2262 | 48315 | 1558 | 33016 |
| 8-#18 | 1.93 | MA | 31282 | 6990 | 50774 | 5140 | 55564 | 4191 | 57481 | 3443 | 59147 | 2329 | 70598 | 1906 | 43864 |
| 3E | | MI | 24209 | 6990 | 39697 | 5046 | 43006 | 4111 | 44241 | 3373 | 44823 | 2244 | 52946 | 1785 | 33468 |
| 8-#18 | 1.93 | MA | 29653 | 6990 | 47942 | 5173 | 51963 | 4184 | 53111 | 3433 | 53473 | 2347 | 64126 | 1678 | 43221 |
| 4L-2S | | MI | 25930 | 6990 | 42334 | 5054 | 46368 | 4088 | 48328 | 3355 | 50228 | 2227 | 60073 | 2013 | 33476 |
| 10-#14 | 1.36 | MA | 31767 | 6654 | 50109 | 4962 | 54901 | 4034 | 56745 | 3343 | 58180 | 2347 | 69660 | 2215 | 31484 |
| 2L-5S | | MI | 22270 | 6654 | 35410 | 4890 | 37705 | 3989 | 37854 | 3302 | 36492 | 2299 | 42793 | 1811 | 23927 |
| 10-#14 | 1.36 | MA | 30431 | 6654 | 48099 | 4961 | 52338 | 4031 | 53630 | 3359 | 53959 | 2359 | 63951 | 2087 | 31494 |
| 3L-4S | | MI | 22911 | 6654 | 36482 | 4893 | 39087 | 3975 | 39546 | 3290 | 38862 | 2309 | 45658 | 1870 | 24142 |
| 10-#14 | 1.36 | MA | 29491 | 6654 | 46488 | 4980 | 50289 | 4048 | 51143 | 3354 | 50730 | 2371 | 60207 | 1959 | 31403 |
| 4L-3S | | MI | 23624 | 6654 | 37703 | 4877 | 40638 | 3980 | 41429 | 3298 | 41264 | 2299 | 48363 | 1998 | 24143 |
| 10-#14 | 1.36 | MA | 28649 | 6654 | 45076 | 4980 | 48468 | 4046 | 48912 | 3370 | 47547 | 2363 | 56308 | 1895 | 31008 |
| 5L-2S | | MI | 24623 | 6654 | 39214 | 4880 | 42565 | 3966 | 43771 | 3286 | 44395 | 2289 | 52514 | 2126 | 24096 |
| 10-#18 | 2.42 | MA | 35193 | 7274 | 57821 | 5321 | 64549 | 4291 | 68403 | 3498 | 73944 | 2293 | 90381 | 2091 | 54707 |
| 2L-5S | | MI | 23083 | 7274 | 38319 | 5242 | 41231 | 4250 | 42069 | 3454 | 41990 | 2218 | 50500 | 1395 | 38316 |
| 10-#18 | 2.42 | MA | 32909 | 7274 | 54298 | 5318 | 60056 | 4320 | 62942 | 3523 | 66545 | 2311 | 80490 | 1864 | 54487 |
| 3L-4S | | MI | 24180 | 7274 | 40198 | 5250 | 43653 | 4227 | 45034 | 3436 | 46083 | 2236 | 55442 | 1497 | 40493 |
| 10-#18 | 2.42 | MA | 31300 | 7274 | 51466 | 5350 | 56455 | 4313 | 58572 | 3513 | 60871 | 2329 | 74017 | 1636 | 53327 |
| 4L-3S | | MI | 25399 | 7274 | 42334 | 5223 | 46368 | 4240 | 48328 | 3453 | 50228 | 2218 | 60073 | 1724 | 41437 |

## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

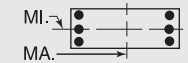
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 2.42 | MA | 29858 | 7274 | 48982 | 5347 | 53253 | 4342 | 54650 | 3538 | 55277 | 2312 | 67238 | 1526 | 50029 |
| 5L-2S | | MI | 27103 | 7274 | 44971 | 5231 | 49730 | 4217 | 52415 | 3435 | 55633 | 2200 | 67200 | 1952 | 41530 |
| 12-#11 | 1.13 | MA | 31018 | 6520 | 48405 | 4893 | 52822 | 3985 | 54254 | 3316 | 54820 | 2363 | 65264 | 2247 | 26423 |
| 2L-6S | | MI | 22000 | 6520 | 34570 | 4821 | 36668 | 3935 | 36626 | 3269 | 34929 | 2328 | 40667 | 1892 | 20124 |
| 12-#11 | 1.13 | MA | 30080 | 6520 | 47001 | 4893 | 51032 | 3983 | 52079 | 3327 | 51873 | 2372 | 61255 | 2158 | 26447 |
| 3L-5S | | MI | 22429 | 6520 | 35277 | 4823 | 37627 | 3938 | 37796 | 3274 | 36460 | 2322 | 42568 | 1950 | 20349 |
| 12-#11 | 1.13 | MA | 29420 | 6520 | 45878 | 4906 | 49603 | 3996 | 50344 | 3324 | 49621 | 2381 | 58623 | 2069 | 26437 |
| 4E | | MI | 22879 | 6520 | 36026 | 4825 | 38593 | 3928 | 38978 | 3265 | 38128 | 2328 | 44583 | 1992 | 20350 |
| 12-#11 | 1.13 | MA | 28830 | 6520 | 44894 | 4906 | 48334 | 3994 | 48789 | 3336 | 47402 | 2376 | 55890 | 2024 | 26366 |
| 5L-3S | | MI | 23380 | 6520 | 36878 | 4813 | 39677 | 3931 | 40293 | 3270 | 39817 | 2322 | 46494 | 2081 | 20319 |
| 12-#11 | 1.13 | MA | 28268 | 6520 | 43966 | 4906 | 47072 | 4007 | 47251 | 3333 | 45365 | 2385 | 53279 | 1966 | 25968 |
| 6L-2S | | MI | 24084 | 6520 | 37936 | 4815 | 41025 | 3921 | 41932 | 3262 | 42020 | 2315 | 49422 | 2170 | 20280 |
| 12-#14 | 1.63 | MA | 32706 | 6813 | 52119 | 5062 | 57464 | 4106 | 59861 | 3388 | 62401 | 2337 | 75369 | 2195 | 37619 |
| 2L-6S | | MI | 22368 | 6813 | 35909 | 4987 | 38257 | 4056 | 38520 | 3339 | 37446 | 2296 | 44251 | 1696 | 27476 |
| 12-#14 | 1.63 | MA | 31379 | 6813 | 50109 | 5061 | 54901 | 4103 | 56745 | 3404 | 58180 | 2349 | 69660 | 2067 | 37595 |
| 3L-5S | | MI | 22976 | 6813 | 36922 | 4990 | 39632 | 4061 | 40196 | 3347 | 39623 | 2287 | 46944 | 1781 | 28302 |
| 12-#14 | 1.63 | MA | 30446 | 6813 | 48498 | 5080 | 52851 | 4121 | 54258 | 3399 | 54950 | 2361 | 65916 | 1939 | 37467 |
| 4E | | MI | 23612 | 6813 | 37994 | 4993 | 41014 | 4047 | 41889 | 3335 | 41993 | 2296 | 49809 | 1840 | 28718 |
| 12-#14 | 1.63 | MA | 29611 | 6813 | 47086 | 5079 | 51030 | 4118 | 52028 | 3415 | 51768 | 2353 | 62017 | 1875 | 36864 |
| 5L-3S | | MI | 24320 | 6813 | 39214 | 4977 | 42565 | 4053 | 43771 | 3343 | 44395 | 2287 | 52514 | 1968 | 28757 |
| 12-#14 | 1.63 | MA | 28815 | 6813 | 45754 | 5078 | 49221 | 4135 | 49820 | 3410 | 48845 | 2365 | 58301 | 1791 | 35604 |
| 6L-2S | | MI | 25314 | 6813 | 40726 | 4980 | 44492 | 4039 | 46114 | 3331 | 47526 | 2277 | 56665 | 2096 | 28728 |
| 12-#18 | 2.90 | MA | 36778 | 7558 | 61345 | 5498 | 69041 | 4419 | 73864 | 3577 | 81343 | 2275 | 100273 | 2049 | 65393 |
| 2L-6S | | MI | 23247 | 7558 | 39179 | 5411 | 42183 | 4366 | 43323 | 3552 | 43637 | 2209 | 53010 | 1183 | 43681 |
| 12-#18 | 2.90 | MA | 34517 | 7558 | 57821 | 5495 | 64549 | 4448 | 68403 | 3603 | 73944 | 2293 | 90381 | 1821 | 65097 |
| 3L-5S | | MI | 24284 | 7558 | 40956 | 5419 | 44593 | 4378 | 46156 | 3534 | 47394 | 2191 | 57627 | 1335 | 45988 |
| 12-#18 | 2.90 | MA | 32926 | 7558 | 54989 | 5527 | 60948 | 4442 | 64033 | 3593 | 68270 | 2311 | 83909 | 1594 | 63482 |
| 4E | | MI | 25369 | 7558 | 42835 | 5427 | 47015 | 4355 | 49121 | 3515 | 51488 | 2209 | 62569 | 1436 | 48022 |
| 12-#18 | 2.90 | MA | 31501 | 7558 | 52506 | 5524 | 57745 | 4470 | 60111 | 3618 | 62675 | 2294 | 77130 | 1483 | 60354 |
| 5L-3S | | MI | 26576 | 7558 | 44971 | 5400 | 49730 | 4368 | 52415 | 3533 | 55633 | 2191 | 67200 | 1664 | 49385 |
| 12-#18 | 2.90 | MA | 30143 | 7558 | 50162 | 5521 | 54561 | 4464 | 56228 | 3608 | 57534 | 2312 | 70699 | 1333 | 57224 |
| 6L-2S | | MI | 28265 | 7558 | 47608 | 5408 | 53092 | 4345 | 56502 | 3515 | 61038 | 2174 | 74327 | 1891 | 49543 |
| 14-#11 | 1.32 | MA | 31683 | 6630 | 49808 | 4962 | 54611 | 4035 | 56429 | 3347 | 57767 | 2357 | 69273 | 2234 | 30712 |
| 2L-7S | | MI | 22083 | 6630 | 34872 | 4902 | 37094 | 3995 | 37135 | 3309 | 35633 | 2327 | 41614 | 1785 | 22840 |
| 14-#11 | 1.32 | MA | 30748 | 6630 | 48405 | 4962 | 52822 | 4034 | 54254 | 3358 | 54820 | 2365 | 65264 | 2145 | 30725 |
| 3L-6S | | MI | 22500 | 6630 | 35628 | 4890 | 38016 | 3985 | 38265 | 3300 | 37132 | 2320 | 43595 | 1873 | 23227 |
| 14-#11 | 1.32 | MA | 30092 | 6630 | 47281 | 4975 | 51392 | 4046 | 52519 | 3356 | 52568 | 2374 | 62632 | 2056 | 30693 |
| 4L-5S | | MI | 22927 | 6630 | 36335 | 4892 | 38976 | 3988 | 39435 | 3305 | 38663 | 2313 | 45496 | 1931 | 23554 |
| 14-#11 | 1.32 | MA | 29506 | 6630 | 46297 | 4975 | 50123 | 4044 | 50964 | 3367 | 50349 | 2369 | 59899 | 2011 | 30600 |
| 5L-4S | | MI | 23374 | 6630 | 37083 | 4894 | 39941 | 3978 | 40617 | 3297 | 40330 | 2320 | 47511 | 1973 | 23577 |
| 14-#11 | 1.32 | MA | 28946 | 6630 | 45369 | 4975 | 48862 | 4057 | 49426 | 3364 | 48312 | 2378 | 57288 | 1953 | 30099 |
| 6L-3S | | MI | 23873 | 6630 | 37936 | 4882 | 41025 | 3981 | 41932 | 3302 | 42020 | 2313 | 49422 | 2062 | 23559 |
| 14-#11 | 1.32 | MA | 28401 | 6630 | 44376 | 4988 | 47651 | 4055 | 47942 | 3375 | 46319 | 2387 | 54572 | 1866 | 29491 |
| 7L-2S | | MI | 24573 | 6630 | 38994 | 4884 | 42374 | 3971 | 43572 | 3293 | 44223 | 2307 | 52350 | 2151 | 23528 |
| 14-#14 | 1.90 | MA | 33638 | 6973 | 54130 | 5161 | 60026 | 4178 | 62976 | 3433 | 66621 | 2327 | 81079 | 2174 | 43739 |
| 2L-7S | | MI | 22484 | 6973 | 36337 | 5103 | 38863 | 4142 | 39245 | 3396 | 38447 | 2294 | 45595 | 1539 | 31180 |
| 14-#14 | 1.90 | MA | 32320 | 6973 | 52119 | 5161 | 57464 | 4176 | 59861 | 3449 | 62401 | 2339 | 75369 | 2046 | 43686 |
| 3L-6S | | MI | 23073 | 6973 | 37420 | 5086 | 40184 | 4128 | 40863 | 3384 | 40577 | 2284 | 48402 | 1666 | 31917 |
| 14-#14 | 1.90 | MA | 31393 | 6973 | 50508 | 5180 | 55414 | 4193 | 57373 | 3444 | 59171 | 2351 | 71625 | 1918 | 43525 |
| 4L-5S | | MI | 23676 | 6973 | 38433 | 5090 | 41559 | 4134 | 42539 | 3392 | 42754 | 2274 | 51096 | 1751 | 32696 |
| 14-#14 | 1.90 | MA | 30565 | 6973 | 49096 | 5179 | 53593 | 4190 | 55143 | 3460 | 55989 | 2343 | 67727 | 1854 | 42740 |
| 5L-4S | | MI | 24309 | 6973 | 39505 | 5093 | 42941 | 4119 | 44231 | 3380 | 45124 | 2284 | 53960 | 1810 | 33284 |
| 14-#14 | 1.90 | MA | 29775 | 6973 | 47765 | 5178 | 51784 | 4208 | 52936 | 3455 | 53066 | 2355 | 64011 | 1770 | 41535 |
| 6L-3S | | MI | 25012 | 6973 | 40726 | 5076 | 44492 | 4125 | 46114 | 3388 | 47526 | 2274 | 56665 | 1938 | 33352 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis

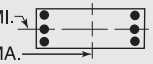


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 1.90 | MA | 29004 | 6973 | 46339 | 5197 | 50046 | 4205 | 50807 | 3471 | 50206 | 2367 | 60145 | 1644 | 40484 |
| 7L-2S | | MI | 26000 | 6973 | 42237 | 5080 | 46419 | 4111 | 48456 | 3376 | 50658 | 2264 | 60816 | 2066 | 33349 |
| 14-#18 | 3.38 | MA | 36108 | 7842 | 61345 | 5672 | 69041 | 4577 | 73864 | 3683 | 81343 | 2276 | 100273 | 1779 | 75698 |
| 3L-6S | | MI | 24445 | 7842 | 41816 | 5589 | 45545 | 4494 | 47410 | 3631 | 49042 | 2182 | 60137 | 1122 | 51207 |
| 14-#18 | 3.38 | MA | 34533 | 7842 | 58513 | 5705 | 65440 | 4570 | 69494 | 3672 | 75668 | 2294 | 93800 | 1552 | 73679 |
| 4L-5S | | MI | 25471 | 7842 | 43593 | 5597 | 47955 | 4507 | 50243 | 3613 | 52799 | 2165 | 64754 | 1274 | 53684 |
| 14-#18 | 3.38 | MA | 33125 | 7842 | 56030 | 5702 | 62237 | 4599 | 65572 | 3698 | 70074 | 2277 | 87021 | 1441 | 70703 |
| 5L-4S | | MI | 26546 | 7842 | 45472 | 5605 | 50377 | 4484 | 53208 | 3595 | 56893 | 2182 | 69696 | 1375 | 55592 |
| 14-#18 | 3.38 | MA | 31782 | 7842 | 53686 | 5699 | 59054 | 4592 | 61689 | 3688 | 64933 | 2295 | 80590 | 1291 | 67412 |
| 6L-3S | | MI | 27742 | 7842 | 47608 | 5577 | 53092 | 4497 | 56502 | 3613 | 61038 | 2165 | 74327 | 1603 | 57319 |
| 14-#18 | 3.38 | MA | 30471 | 7842 | 51178 | 5731 | 55997 | 4621 | 57943 | 3713 | 59901 | 2313 | 73896 | 1066 | 64182 |
| 7L-2S | | MI | 29417 | 7842 | 50245 | 5585 | 56454 | 4474 | 60589 | 3594 | 66443 | 2147 | 81453 | 1830 | 57537 |
| 16-#11 | 1.51 | MA | 32343 | 6741 | 51212 | 5031 | 56400 | 4085 | 58604 | 3378 | 60714 | 2350 | 73282 | 2221 | 34995 |
| 2L-8S | | MI | 22172 | 6741 | 35235 | 4970 | 37512 | 4042 | 37668 | 3349 | 36265 | 2312 | 42660 | 1717 | 25609 |
| 16-#11 | 1.51 | MA | 31413 | 6741 | 49808 | 5031 | 54611 | 4084 | 56429 | 3389 | 57767 | 2358 | 69273 | 2132 | 34990 |
| 3L-7S | | MI | 22581 | 6741 | 35929 | 4972 | 38443 | 4045 | 38775 | 3340 | 37836 | 2319 | 44542 | 1765 | 25970 |
| 16-#11 | 1.51 | MA | 30760 | 6741 | 48685 | 5044 | 53182 | 4096 | 54694 | 3387 | 55515 | 2367 | 66641 | 2043 | 34942 |
| 4L-6S | | MI | 22996 | 6741 | 36686 | 4960 | 39365 | 4035 | 39904 | 3332 | 39335 | 2312 | 46523 | 1853 | 26339 |
| 16-#11 | 1.51 | MA | 30177 | 6741 | 47701 | 5044 | 51912 | 4095 | 53140 | 3398 | 53296 | 2362 | 63908 | 1998 | 34831 |
| 5E | | MI | 23422 | 6741 | 37393 | 4962 | 40325 | 4038 | 41075 | 3337 | 40866 | 2305 | 48424 | 1912 | 26753 |
| 16-#11 | 1.51 | MA | 29621 | 6741 | 46773 | 5044 | 50651 | 4107 | 51601 | 3395 | 51259 | 2371 | 61297 | 1940 | 34239 |
| 6L-4S | | MI | 23867 | 6741 | 38141 | 4963 | 41290 | 4028 | 42256 | 3328 | 42533 | 2312 | 50439 | 1954 | 26793 |
| 16-#11 | 1.51 | MA | 29079 | 6741 | 45780 | 5058 | 49441 | 4106 | 50117 | 3406 | 49265 | 2380 | 58582 | 1853 | 33654 |
| 7L-3S | | MI | 24363 | 6741 | 38994 | 4952 | 42374 | 4032 | 43572 | 3333 | 44223 | 2305 | 52350 | 2043 | 26792 |
| 16-#11 | 1.51 | MA | 28544 | 6741 | 44869 | 5057 | 48219 | 4118 | 48665 | 3418 | 47177 | 2375 | 56027 | 1801 | 33105 |
| 8L-2S | | MI | 25061 | 6741 | 40051 | 4953 | 43722 | 4021 | 45211 | 3324 | 46426 | 2298 | 55278 | 2131 | 26769 |
| 16-#14 | 2.17 | MA | 34563 | 7132 | 56140 | 5261 | 62589 | 4250 | 66092 | 3478 | 70842 | 2317 | 86788 | 2154 | 49847 |
| 2L-8S | | MI | 22610 | 7132 | 36853 | 5199 | 39457 | 4209 | 40002 | 3452 | 39345 | 2271 | 47071 | 1440 | 34519 |
| 16-#14 | 2.17 | MA | 33253 | 7132 | 54130 | 5260 | 60026 | 4248 | 62976 | 3494 | 66621 | 2329 | 81079 | 2026 | 49769 |
| 3L-7S | | MI | 23187 | 7132 | 37848 | 5203 | 40790 | 4215 | 41587 | 3440 | 41578 | 2281 | 49746 | 1509 | 35536 |
| 16-#14 | 2.17 | MA | 32333 | 7132 | 52518 | 5280 | 57977 | 4265 | 60489 | 3489 | 63392 | 2341 | 77335 | 1898 | 49579 |
| 4L-6S | | MI | 23772 | 7132 | 38932 | 5186 | 42111 | 4200 | 43205 | 3429 | 43709 | 2271 | 52553 | 1636 | 36367 |
| 16-#14 | 2.17 | MA | 31510 | 7132 | 51106 | 5279 | 56156 | 4263 | 58259 | 3505 | 60210 | 2333 | 73436 | 1834 | 48631 |
| 5E | | MI | 24372 | 7132 | 39945 | 5189 | 43486 | 4206 | 44882 | 3437 | 45885 | 2261 | 55247 | 1721 | 37106 |
| 16-#14 | 2.17 | MA | 30726 | 7132 | 49775 | 5278 | 54346 | 4280 | 56051 | 3500 | 57287 | 2345 | 69720 | 1750 | 47476 |
| 6L-4S | | MI | 25000 | 7132 | 41017 | 5193 | 44868 | 4192 | 46574 | 3425 | 48256 | 2271 | 58111 | 1781 | 37842 |
| 16-#14 | 2.17 | MA | 29961 | 7132 | 48349 | 5297 | 52609 | 4277 | 53922 | 3516 | 54427 | 2357 | 65854 | 1624 | 46335 |
| 7L-3S | | MI | 25699 | 7132 | 42237 | 5176 | 46419 | 4197 | 48456 | 3433 | 50658 | 2261 | 60816 | 1909 | 37936 |
| 16-#14 | 2.17 | MA | 29207 | 7132 | 47042 | 5296 | 50856 | 4295 | 51837 | 3531 | 51431 | 2349 | 62210 | 1549 | 44817 |
| 8L-2S | | MI | 26681 | 7132 | 43748 | 5179 | 48346 | 4183 | 50799 | 3421 | 53789 | 2251 | 64967 | 2037 | 37963 |
| 16-#18 | 3.86 | MA | 36124 | 8125 | 62037 | 5882 | 69932 | 4699 | 74955 | 3752 | 83067 | 2276 | 103692 | 1509 | 83912 |
| 4L-6S | | MI | 25631 | 8125 | 44453 | 5766 | 48907 | 4623 | 51497 | 3711 | 54447 | 2156 | 67264 | 1061 | 58761 |
| 16-#18 | 3.86 | MA | 34731 | 8125 | 59553 | 5879 | 66730 | 4728 | 71033 | 3778 | 77472 | 2259 | 96913 | 1399 | 81073 |
| 5E | | MI | 26648 | 8125 | 46230 | 5774 | 51317 | 4635 | 54330 | 3693 | 58204 | 2138 | 71881 | 1213 | 61399 |
| 16-#18 | 3.86 | MA | 33403 | 8125 | 57209 | 5876 | 63546 | 4721 | 67150 | 3767 | 72331 | 2277 | 90482 | 1249 | 77625 |
| 6L-4S | | MI | 27712 | 8125 | 48109 | 5782 | 53739 | 4613 | 57295 | 3675 | 62297 | 2156 | 76823 | 1315 | 63197 |
| 16-#18 | 3.86 | MA | 32107 | 8125 | 54701 | 5908 | 60489 | 4750 | 63404 | 3793 | 67300 | 2295 | 83787 | 1024 | 74300 |
| 7L-3S | | MI | 28897 | 8125 | 50245 | 5755 | 56454 | 4625 | 60589 | 3692 | 66443 | 2138 | 81453 | 1542 | 65243 |
| 16-#18 | 3.86 | MA | 30829 | 8125 | 52400 | 5905 | 57404 | 4743 | 59735 | 3818 | 62030 | 2278 | 77453 | 895 | 70178 |
| 8L-2S | | MI | 30558 | 8125 | 52882 | 5763 | 59816 | 4603 | 64676 | 3674 | 71847 | 2120 | 88580 | 1770 | 65516 |
| 18-#11 | 1.70 | MA | 32999 | 6851 | 52615 | 5100 | 58190 | 4135 | 60779 | 3409 | 63661 | 2343 | 77292 | 2208 | 39273 |
| 2L-9S | | MI | 22267 | 6851 | 35558 | 5051 | 37952 | 4102 | 38163 | 3375 | 36985 | 2311 | 43746 | 1641 | 28101 |
| 18-#11 | 1.70 | MA | 32073 | 6851 | 51212 | 5100 | 56400 | 4134 | 58604 | 3420 | 60714 | 2352 | 73282 | 2119 | 39250 |
| 3L-8S | | MI | 22670 | 6851 | 36293 | 5039 | 38861 | 4092 | 39308 | 3380 | 38468 | 2304 | 45588 | 1697 | 28682 |
| 18-#11 | 1.70 | MA | 31424 | 6851 | 50088 | 5114 | 54971 | 4146 | 56870 | 3418 | 58462 | 2360 | 70650 | 2030 | 39188 |
| 4L-7S | | MI | 23077 | 6851 | 36987 | 5041 | 39791 | 4095 | 40414 | 3371 | 40039 | 2311 | 47470 | 1746 | 29104 |
| 18-#11 | 1.70 | MA | 30844 | 6851 | 49104 | 5113 | 53702 | 4145 | 55315 | 3429 | 56243 | 2355 | 67917 | 1985 | 39060 |
| 5L-6S | | MI | 23490 | 6851 | 37743 | 5029 | 40713 | 4085 | 41544 | 3363 | 41538 | 2304 | 49451 | 1834 | 29457 |

## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

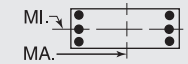
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.70 | MA | 30291 | 6851 | 48176 | 5113 | 52440 | 4157 | 53776 | 3426 | 54206 | 2364 | 65307 | 1927 | 38386 |
| 6L-5S | | MI | 23913 | 6851 | 38450 | 5031 | 41673 | 4089 | 42714 | 3368 | 43069 | 2297 | 51352 | 1893 | 29947 |
| 18-#11 | 1.70 | MA | 29752 | 6851 | 47183 | 5127 | 51230 | 4156 | 52292 | 3438 | 52212 | 2373 | 62591 | 1840 | 37822 |
| 7L-4S | | MI | 24357 | 6851 | 39199 | 5033 | 42638 | 4078 | 43896 | 3359 | 44736 | 2304 | 53367 | 1935 | 30002 |
| 18-#11 | 1.70 | MA | 29220 | 6851 | 46272 | 5126 | 50008 | 4168 | 50840 | 3449 | 50124 | 2368 | 60037 | 1787 | 37213 |
| 8L-3S | | MI | 24850 | 6851 | 40051 | 5021 | 43722 | 4082 | 45211 | 3364 | 46426 | 2297 | 55278 | 2024 | 30019 |
| 18-#11 | 1.70 | MA | 28658 | 6851 | 45378 | 5126 | 48815 | 4167 | 49337 | 3446 | 48152 | 2377 | 57507 | 1731 | 36342 |
| 9L-2S | | MI | 25545 | 6851 | 41109 | 5023 | 45071 | 4071 | 46850 | 3355 | 48629 | 2290 | 58206 | 2112 | 30004 |
| 18-#14 | 2.45 | MA | 34179 | 7292 | 56140 | 5360 | 62589 | 4320 | 66092 | 3538 | 70842 | 2319 | 86788 | 2005 | 55847 |
| 3L-8S | | MI | 23312 | 7292 | 38365 | 5299 | 41384 | 4281 | 42345 | 3497 | 42477 | 2258 | 51222 | 1410 | 38926 |
| 18-#14 | 2.45 | MA | 33265 | 7292 | 54528 | 5379 | 60540 | 4338 | 63604 | 3534 | 67613 | 2331 | 83044 | 1877 | 55629 |
| 4L-7S | | MI | 23885 | 7292 | 39360 | 5302 | 42717 | 4287 | 43930 | 3485 | 44710 | 2268 | 53898 | 1480 | 39904 |
| 18-#14 | 2.45 | MA | 32449 | 7292 | 53117 | 5378 | 58719 | 4335 | 61374 | 3550 | 64430 | 2323 | 79145 | 1813 | 54535 |
| 5L-6S | | MI | 24467 | 7292 | 40443 | 5286 | 44038 | 4273 | 45548 | 3474 | 46840 | 2258 | 56704 | 1607 | 40823 |
| 18-#14 | 2.45 | MA | 31670 | 7292 | 51785 | 5378 | 56909 | 4352 | 59167 | 3545 | 61507 | 2335 | 75429 | 1729 | 53425 |
| 6L-5S | | MI | 25062 | 7292 | 41456 | 5289 | 45413 | 4278 | 47224 | 3482 | 49017 | 2248 | 59398 | 1692 | 41527 |
| 18-#14 | 2.45 | MA | 30911 | 7292 | 50359 | 5397 | 55172 | 4350 | 57037 | 3561 | 58647 | 2347 | 71563 | 1603 | 52197 |
| 7L-4S | | MI | 25686 | 7292 | 42528 | 5292 | 46795 | 4264 | 48916 | 3470 | 51387 | 2258 | 62262 | 1751 | 42395 |
| 18-#14 | 2.45 | MA | 30162 | 7292 | 49052 | 5396 | 53419 | 4367 | 54953 | 3576 | 55652 | 2339 | 67920 | 1529 | 50723 |
| 8L-3S | | MI | 26381 | 7292 | 43748 | 5276 | 48346 | 4270 | 50799 | 3478 | 53789 | 2248 | 64967 | 1879 | 42514 |
| 18-#14 | 2.45 | MA | 29392 | 7292 | 47769 | 5395 | 51706 | 4364 | 52796 | 3572 | 52822 | 2351 | 64319 | 1448 | 49010 |
| 9L-2S | | MI | 27358 | 7292 | 45260 | 5279 | 50273 | 4256 | 53141 | 3466 | 56920 | 2238 | 69119 | 2007 | 42560 |
| 18-#18 | 4.35 | MA | 36321 | 8409 | 63077 | 6056 | 71222 | 4856 | 76494 | 3857 | 84871 | 2241 | 106804 | 1357 | 91460 |
| 5L-6S | | MI | 26807 | 8409 | 47090 | 5943 | 52269 | 4751 | 55584 | 3791 | 59852 | 2129 | 74391 | 1000 | 66340 |
| 18-#18 | 4.35 | MA | 35007 | 8409 | 60733 | 6053 | 68038 | 4850 | 72611 | 3847 | 79730 | 2259 | 100373 | 1206 | 87861 |
| 6L-5S | | MI | 27814 | 8409 | 48867 | 5951 | 54679 | 4764 | 58417 | 3773 | 63609 | 2112 | 79008 | 1152 | 69130 |
| 18-#18 | 4.35 | MA | 33725 | 8409 | 58225 | 6086 | 64981 | 4878 | 68865 | 3872 | 74698 | 2278 | 93679 | 982 | 84440 |
| 7L-4S | | MI | 28869 | 8409 | 50746 | 5959 | 57101 | 4741 | 61382 | 3755 | 67702 | 2129 | 83950 | 1254 | 70829 |
| 18-#18 | 4.35 | MA | 32461 | 8409 | 55924 | 6083 | 61896 | 4872 | 65196 | 3898 | 69428 | 2260 | 87345 | 853 | 80268 |
| 8L-3S | | MI | 30043 | 8409 | 52882 | 5932 | 59816 | 4754 | 64676 | 3772 | 71847 | 2112 | 88580 | 1481 | 73158 |
| 20-#11 | 1.88 | MA | 32730 | 6962 | 52615 | 5169 | 58190 | 4184 | 60779 | 3452 | 63661 | 2345 | 77292 | 2106 | 43507 |
| 3L-9S | | MI | 22764 | 6962 | 36616 | 5120 | 39300 | 4153 | 39803 | 3406 | 39188 | 2303 | 46674 | 1622 | 31201 |
| 20-#11 | 1.88 | MA | 32084 | 6962 | 51492 | 5183 | 56760 | 4196 | 59045 | 3449 | 61408 | 2353 | 74660 | 2017 | 43431 |
| 4L-8S | | MI | 23166 | 6962 | 37350 | 5108 | 40209 | 4142 | 40947 | 3411 | 40671 | 2296 | 48516 | 1678 | 31762 |
| 20-#11 | 1.88 | MA | 31507 | 6962 | 50508 | 5183 | 55491 | 4195 | 57490 | 3460 | 59190 | 2348 | 71927 | 1972 | 43287 |
| 5L-7S | | MI | 23571 | 6962 | 38045 | 5110 | 41140 | 4146 | 42053 | 3403 | 42242 | 2303 | 50398 | 1727 | 32241 |
| 20-#11 | 1.88 | MA | 30958 | 6962 | 49580 | 5182 | 54230 | 4207 | 55952 | 3458 | 57153 | 2357 | 69316 | 1914 | 42539 |
| 6E | | MI | 23982 | 6962 | 38801 | 5098 | 42062 | 4135 | 43183 | 3394 | 43740 | 2296 | 52379 | 1815 | 32580 |
| 20-#11 | 1.88 | MA | 30421 | 6962 | 48586 | 5196 | 53019 | 4206 | 54468 | 3469 | 55159 | 2366 | 66600 | 1827 | 41993 |
| 7L-5S | | MI | 24403 | 6962 | 39508 | 5100 | 43022 | 4139 | 44353 | 3399 | 45272 | 2289 | 54280 | 1874 | 33138 |
| 20-#11 | 1.88 | MA | 29893 | 6962 | 47676 | 5196 | 51798 | 4218 | 53015 | 3480 | 53071 | 2361 | 64046 | 1774 | 41328 |
| 8L-4S | | MI | 24844 | 6962 | 40257 | 5102 | 43987 | 4128 | 45535 | 3390 | 46939 | 2296 | 56295 | 1916 | 33207 |
| 20-#11 | 1.88 | MA | 29333 | 6962 | 46782 | 5195 | 50604 | 4217 | 51512 | 3477 | 51099 | 2370 | 61516 | 1718 | 40479 |
| 9L-3S | | MI | 25335 | 6962 | 41109 | 5090 | 45071 | 4132 | 46850 | 3395 | 48629 | 2289 | 58206 | 2004 | 33236 |
| 20-#11 | 1.88 | MA | 28750 | 6962 | 45806 | 5209 | 49398 | 4229 | 50068 | 3488 | 49142 | 2379 | 59062 | 1655 | 39598 |
| 10L-2S | | MI | 26027 | 6962 | 42167 | 5092 | 46419 | 4121 | 48490 | 3386 | 50832 | 2282 | 61134 | 2093 | 33234 |
| 20-#14 | 2.72 | MA | 34191 | 7451 | 56538 | 5479 | 63103 | 4410 | 66720 | 3579 | 71833 | 2321 | 88753 | 1857 | 61677 |
| 4L-8S | | MI | 24009 | 7451 | 39876 | 5399 | 43311 | 4353 | 44687 | 3542 | 45608 | 2246 | 55374 | 1380 | 43340 |
| 20-#14 | 2.72 | MA | 33380 | 7451 | 55127 | 5478 | 61282 | 4407 | 64490 | 3594 | 68651 | 2313 | 84855 | 1793 | 60451 |
| 5L-7S | | MI | 24579 | 7451 | 40871 | 5402 | 44644 | 4359 | 46272 | 3530 | 47841 | 2255 | 58049 | 1450 | 44284 |
| 20-#14 | 2.72 | MA | 32608 | 7451 | 53795 | 5477 | 59472 | 4425 | 62282 | 3590 | 65728 | 2325 | 81139 | 1709 | 59381 |
| 6E | | MI | 25156 | 7451 | 41955 | 5386 | 45965 | 4345 | 47890 | 3518 | 49971 | 2246 | 60856 | 1577 | 45286 |
| 20-#14 | 2.72 | MA | 31854 | 7451 | 52370 | 5497 | 57735 | 4422 | 60153 | 3606 | 62868 | 2337 | 77272 | 1583 | 58069 |
| 7L-5S | | MI | 25748 | 7451 | 42968 | 5389 | 47340 | 4351 | 49567 | 3526 | 52148 | 2236 | 63549 | 1662 | 45959 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis

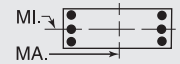


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.72 | MA | 31111 | 7451 | 51063 | 5496 | 55982 | 4439 | 58068 | 3621 | 59872 | 2329 | 73629 | 1508 | 56637 |
| 8L-4S | | MI | 26368 | 7451 | 44040 | 5392 | 48722 | 4336 | 51259 | 3515 | 54518 | 2246 | 66414 | 1721 | 46944 |
| 20-#14 | 2.72 | MA | 30341 | 7451 | 49779 | 5495 | 54269 | 4437 | 55911 | 3617 | 57042 | 2341 | 70029 | 1427 | 54872 |
| 9L-3S | | MI | 27059 | 7451 | 45260 | 5376 | 50273 | 4342 | 53141 | 3523 | 56920 | 2236 | 69119 | 1849 | 47085 |
| 20-#14 | 2.72 | MA | 29510 | 7451 | 48378 | 5514 | 52538 | 4454 | 53840 | 3632 | 54233 | 2353 | 66537 | 1336 | 53061 |
| 10L-2S | | MI | 28031 | 7451 | 46771 | 5379 | 52200 | 4328 | 55484 | 3511 | 60052 | 2226 | 73270 | 1977 | 47150 |
| 20-#18 | 4.83 | MA | 36596 | 8693 | 64257 | 6231 | 72531 | 4978 | 78072 | 3927 | 87128 | 2242 | 110265 | 1164 | 98117 |
| 6E | | MI | 27973 | 8693 | 49727 | 6121 | 55631 | 4880 | 59671 | 3871 | 65256 | 2103 | 81517 | 940 | 73940 |
| 20-#18 | 4.83 | MA | 35327 | 8693 | 61748 | 6263 | 69474 | 5007 | 74326 | 3952 | 82097 | 2260 | 103570 | 939 | 94600 |
| 7L-5S | | MI | 28970 | 8693 | 51504 | 6129 | 58041 | 4892 | 62504 | 3853 | 69014 | 2085 | 86135 | 1092 | 76875 |
| 20-#18 | 4.83 | MA | 34076 | 8693 | 59447 | 6260 | 66388 | 5000 | 70657 | 3978 | 76827 | 2243 | 97236 | 810 | 90536 |
| 8L-4S | | MI | 30016 | 8693 | 53383 | 6137 | 60463 | 4870 | 65469 | 3835 | 73107 | 2103 | 91077 | 1193 | 78485 |
| 22-#11 | 2.07 | MA | 32741 | 7073 | 52895 | 5252 | 58550 | 4246 | 61220 | 3480 | 64355 | 2347 | 78669 | 2004 | 47670 |
| 4L-9S | | MI | 23259 | 7073 | 37674 | 5189 | 40649 | 4203 | 41442 | 3438 | 41391 | 2295 | 49602 | 1602 | 34305 |
| 22-#11 | 2.07 | MA | 32167 | 7073 | 51911 | 5252 | 57280 | 4245 | 59665 | 3491 | 62137 | 2342 | 75936 | 1959 | 47512 |
| 5L-8S | | MI | 23658 | 7073 | 38408 | 5177 | 41558 | 4192 | 42586 | 3443 | 42874 | 2288 | 51444 | 1659 | 34848 |
| 22-#11 | 2.07 | MA | 31620 | 7073 | 50983 | 5251 | 56019 | 4257 | 58127 | 3489 | 60099 | 2350 | 73325 | 1901 | 46698 |
| 6L-7S | | MI | 24062 | 7073 | 39102 | 5179 | 42488 | 4196 | 43693 | 3434 | 44445 | 2295 | 53326 | 1708 | 35380 |
| 22-#11 | 2.07 | MA | 31087 | 7073 | 49990 | 5265 | 54809 | 4256 | 56643 | 3500 | 58106 | 2359 | 70610 | 1814 | 46168 |
| 7L-6S | | MI | 24470 | 7073 | 39859 | 5167 | 43410 | 4185 | 44822 | 3425 | 45943 | 2288 | 55307 | 1796 | 35708 |
| 22-#11 | 2.07 | MA | 30561 | 7073 | 49079 | 5265 | 53587 | 4268 | 55190 | 3511 | 56018 | 2354 | 68055 | 1761 | 45449 |
| 8L-5S | | MI | 24889 | 7073 | 40566 | 5169 | 44370 | 4189 | 45993 | 3430 | 47475 | 2281 | 57208 | 1855 | 36275 |
| 22-#11 | 2.07 | MA | 30004 | 7073 | 48185 | 5265 | 52393 | 4267 | 53687 | 3508 | 54046 | 2363 | 65526 | 1705 | 44621 |
| 9L-4S | | MI | 25328 | 7073 | 41314 | 5171 | 45335 | 4179 | 47174 | 3421 | 49142 | 2288 | 59223 | 1896 | 36408 |
| 22-#11 | 2.07 | MA | 29425 | 7073 | 47209 | 5278 | 51188 | 4279 | 52244 | 3520 | 52089 | 2372 | 63072 | 1642 | 43704 |
| 10L-3S | | MI | 25817 | 7073 | 42167 | 5159 | 46419 | 4182 | 48490 | 3426 | 50832 | 2281 | 61134 | 1985 | 36449 |
| 22-#11 | 2.07 | MA | 28858 | 7073 | 46316 | 5278 | 50001 | 4278 | 50758 | 3517 | 50030 | 2367 | 60577 | 1587 | 42713 |
| 11L-2S | | MI | 26507 | 7073 | 43225 | 5161 | 47768 | 4172 | 50129 | 3417 | 53035 | 2274 | 64062 | 2074 | 36460 |
| 22-#14 | 2.99 | MA | 34306 | 7611 | 57137 | 5578 | 63844 | 4480 | 67605 | 3639 | 72872 | 2303 | 90564 | 1773 | 66377 |
| 5L-8S | | MI | 24702 | 7611 | 41388 | 5499 | 45238 | 4426 | 47030 | 3587 | 48739 | 2233 | 59525 | 1351 | 47761 |
| 22-#14 | 2.99 | MA | 33538 | 7611 | 55805 | 5577 | 62035 | 4497 | 65398 | 3635 | 69949 | 2315 | 86848 | 1688 | 65344 |
| 6L-7S | | MI | 25268 | 7611 | 42383 | 5502 | 46571 | 4431 | 48615 | 3575 | 50972 | 2243 | 62200 | 1420 | 48673 |
| 22-#14 | 2.99 | MA | 32790 | 7611 | 54380 | 5596 | 60298 | 4494 | 63268 | 3650 | 67089 | 2327 | 82982 | 1562 | 63952 |
| 7L-6S | | MI | 25842 | 7611 | 43466 | 5485 | 47892 | 4417 | 50233 | 3563 | 53102 | 2233 | 65007 | 1547 | 49754 |
| 22-#14 | 2.99 | MA | 32052 | 7611 | 53073 | 5596 | 58544 | 4512 | 61184 | 3666 | 64093 | 2319 | 79338 | 1488 | 62557 |
| 8L-5S | | MI | 26430 | 7611 | 44479 | 5489 | 49267 | 4423 | 51909 | 3571 | 55279 | 2223 | 67700 | 1632 | 50399 |
| 22-#14 | 2.99 | MA | 31284 | 7611 | 51790 | 5595 | 56832 | 4509 | 59027 | 3662 | 61263 | 2331 | 75738 | 1407 | 60742 |
| 9L-4S | | MI | 27046 | 7611 | 45551 | 5492 | 50649 | 4409 | 53601 | 3559 | 57650 | 2233 | 70565 | 1691 | 51489 |
| 22-#14 | 2.99 | MA | 30461 | 7611 | 50389 | 5614 | 55101 | 4526 | 56955 | 3677 | 58454 | 2343 | 72246 | 1316 | 58896 |
| 10L-3S | | MI | 27733 | 7611 | 46771 | 5475 | 52200 | 4414 | 55484 | 3568 | 60052 | 2223 | 73270 | 1819 | 51651 |
| 22-#18 | 5.31 | MA | 36915 | 8976 | 65272 | 6440 | 73966 | 5136 | 79787 | 4032 | 89495 | 2242 | 113461 | 897 | 104778 |
| 7L-6S | | MI | 29130 | 8976 | 52364 | 6298 | 58993 | 5008 | 63758 | 3951 | 70661 | 2076 | 88644 | 879 | 81559 |
| 22-#18 | 5.31 | MA | 35677 | 8976 | 62971 | 6437 | 70881 | 5129 | 76118 | 4057 | 84225 | 2225 | 107128 | 768 | 100747 |
| 8L-5S | | MI | 30119 | 8976 | 54141 | 6306 | 61403 | 5021 | 66591 | 3933 | 74418 | 2058 | 93262 | 1031 | 84538 |
| 24-#11 | 2.26 | MA | 32823 | 7183 | 53315 | 5321 | 59070 | 4295 | 61841 | 3522 | 65084 | 2335 | 79945 | 1946 | 51717 |
| 5L-9S | | MI | 23751 | 7183 | 38731 | 5258 | 41997 | 4253 | 43081 | 3469 | 43593 | 2287 | 52530 | 1583 | 37413 |
| 24-#11 | 2.26 | MA | 32279 | 7183 | 52387 | 5321 | 57809 | 4308 | 60302 | 3520 | 63046 | 2343 | 77334 | 1888 | 50862 |
| 6L-8S | | MI | 24149 | 7183 | 39466 | 5246 | 42907 | 4242 | 44226 | 3474 | 45077 | 2280 | 54372 | 1640 | 37940 |
| 24-#11 | 2.26 | MA | 31749 | 7183 | 51393 | 5334 | 56598 | 4306 | 58818 | 3531 | 61053 | 2352 | 74619 | 1800 | 50345 |
| 7E | | MI | 24550 | 7183 | 40160 | 5248 | 43837 | 4246 | 45332 | 3465 | 46647 | 2287 | 56254 | 1689 | 38522 |
| 24-#11 | 2.26 | MA | 31226 | 7183 | 50483 | 5334 | 55376 | 4318 | 57365 | 3542 | 58965 | 2347 | 72064 | 1748 | 49575 |
| 8L-6S | | MI | 24957 | 7183 | 40917 | 5236 | 44759 | 4236 | 46461 | 3456 | 48146 | 2280 | 58235 | 1777 | 38840 |
| 24-#11 | 2.26 | MA | 30672 | 7183 | 49589 | 5334 | 54183 | 4317 | 55862 | 3540 | 56993 | 2356 | 69535 | 1692 | 48767 |
| 9L-5S | | MI | 25374 | 7183 | 41623 | 5238 | 45719 | 4239 | 47632 | 3461 | 49678 | 2273 | 60136 | 1835 | 39383 |
| 24-#11 | 2.26 | MA | 30095 | 7183 | 48613 | 5347 | 52977 | 4329 | 54419 | 3551 | 55036 | 2365 | 67081 | 1629 | 47815 |
| 10L-4S | | MI | 25811 | 7183 | 42372 | 5240 | 46684 | 4229 | 48814 | 3452 | 51345 | 2280 | 62151 | 1877 | 39606 |
| 24-#11 | 2.26 | MA | 29531 | 7183 | 47719 | 5347 | 51790 | 4328 | 52933 | 3548 | 52977 | 2360 | 64586 | 1574 | 46843 |
| 11L-3S | | MI | 26298 | 7183 | 43225 | 5228 | 47768 | 4232 | 50129 | 3457 | 53035 | 2273 | 64062 | 1966 | 39657 |

## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.26 | MA | 28976 | 7183 | 46758 | 5361 | 50592 | 4340 | 51493 | 3559 | 51022 | 2369 | 61843 | 1499 | 45603 |
| 12L-2S | | MI | 26984 | 7183 | 44282 | 5230 | 49116 | 4222 | 51768 | 3448 | 55238 | 2266 | 66990 | 2055 | 39679 |
| 24-#14 | 3.26 | MA | 34463 | 7771 | 57815 | 5677 | 64598 | 4569 | 68513 | 3680 | 74170 | 2305 | 92557 | 1668 | 71311 |
| 6L-8S | | MI | 25390 | 7771 | 42899 | 5598 | 47165 | 4498 | 49372 | 3632 | 51871 | 2220 | 63676 | 1321 | 52154 |
| 24-#14 | 3.26 | MA | 33720 | 7771 | 56390 | 5696 | 62860 | 4567 | 66384 | 3695 | 71310 | 2317 | 88691 | 1542 | 69842 |
| 7E | | MI | 25953 | 7771 | 43894 | 5602 | 48498 | 4504 | 50957 | 3620 | 54103 | 2230 | 66351 | 1390 | 53071 |
| 24-#14 | 3.26 | MA | 32987 | 7771 | 55083 | 5695 | 61107 | 4584 | 64299 | 3711 | 68314 | 2309 | 85047 | 1467 | 68484 |
| 8L-6S | | MI | 26523 | 7771 | 44978 | 5585 | 49819 | 4490 | 52575 | 3608 | 56234 | 2220 | 69158 | 1517 | 54227 |
| 24-#14 | 3.26 | MA | 32220 | 7771 | 53800 | 5694 | 59394 | 4581 | 62142 | 3706 | 65484 | 2321 | 81447 | 1386 | 66619 |
| 9L-5S | | MI | 27108 | 7771 | 45990 | 5588 | 51194 | 4495 | 54252 | 3616 | 58411 | 2210 | 71852 | 1602 | 54847 |
| 24-#14 | 3.26 | MA | 31406 | 7771 | 52399 | 5714 | 57664 | 4599 | 60071 | 3722 | 62675 | 2333 | 77955 | 1295 | 64739 |
| 10L-4S | | MI | 27721 | 7771 | 47063 | 5592 | 52576 | 4481 | 55944 | 3604 | 60781 | 2220 | 74716 | 1661 | 56031 |
| 24-#18 | 5.80 | MA | 37264 | 9260 | 66494 | 6615 | 75373 | 5258 | 81580 | 4137 | 91624 | 2207 | 117019 | 726 | 110887 |
| 8L-6S | | MI | 30278 | 9260 | 55001 | 6475 | 62355 | 5137 | 67845 | 4030 | 76066 | 2050 | 95771 | 818 | 89195 |

## RECTANGULAR TIED COLUMNS 36" x 48"

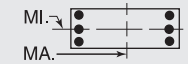
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.39 | MA | 34638 | 6961 | 54806 | 5173 | 59982 | 4204 | 61992 | 3483 | 63610 | 2439 | 75993 | 2291 | 34866 |
| 2L-3S | | MI | 23923 | 6961 | 38442 | 5057 | 41075 | 4138 | 41545 | 3425 | 40663 | 2372 | 47191 | 1944 | 25527 |
| 6-#18 | 1.39 | MA | 32182 | 6961 | 51105 | 5171 | 55263 | 4234 | 56257 | 3509 | 55839 | 2459 | 65547 | 2064 | 34840 |
| 3L-2S | | MI | 25662 | 6961 | 41079 | 5065 | 44437 | 4115 | 45632 | 3407 | 46067 | 2355 | 54318 | 2171 | 25438 |
| 8-#14 | 1.04 | MA | 33424 | 6749 | 51989 | 5069 | 56585 | 4131 | 57937 | 3443 | 58148 | 2468 | 68939 | 2349 | 26551 |
| 2L-4S | | MI | 23121 | 6749 | 36347 | 4984 | 38592 | 4059 | 38597 | 3378 | 36980 | 2424 | 42887 | 1999 | 19599 |
| 8-#14 | 1.04 | MA | 32010 | 6749 | 49879 | 5069 | 53895 | 4129 | 54667 | 3459 | 53718 | 2481 | 62918 | 2221 | 26592 |
| 3E | | MI | 23839 | 6749 | 37568 | 4968 | 40143 | 4065 | 40480 | 3386 | 39382 | 2414 | 45592 | 2127 | 19551 |
| 8-#14 | 1.04 | MA | 31015 | 6749 | 48190 | 5088 | 51746 | 4147 | 52059 | 3455 | 50331 | 2493 | 58965 | 2093 | 26546 |
| 4L-2S | | MI | 24846 | 6749 | 39079 | 4971 | 42070 | 4051 | 42822 | 3374 | 42513 | 2404 | 49743 | 2255 | 19483 |
| 8-#18 | 1.85 | MA | 36354 | 7245 | 58507 | 5350 | 64700 | 4332 | 67728 | 3562 | 71381 | 2422 | 86439 | 2252 | 46159 |
| 2L-4S | | MI | 23894 | 7245 | 38943 | 5262 | 41722 | 4254 | 42337 | 3488 | 41922 | 2364 | 49688 | 1656 | 33280 |
| 8-#18 | 1.85 | MA | 33924 | 7245 | 54806 | 5348 | 59982 | 4362 | 61992 | 3589 | 63610 | 2441 | 75993 | 2024 | 46024 |
| 3E | | MI | 25128 | 7245 | 41079 | 5234 | 44437 | 4266 | 45632 | 3505 | 46067 | 2346 | 54318 | 1883 | 33539 |
| 8-#18 | 1.85 | MA | 32212 | 7245 | 51835 | 5381 | 56204 | 4356 | 57407 | 3580 | 57656 | 2461 | 69151 | 1797 | 45410 |
| 4L-2S | | MI | 26851 | 7245 | 43716 | 5242 | 47799 | 4244 | 49719 | 3487 | 51472 | 2328 | 61445 | 2111 | 33529 |
| 10-#14 | 1.30 | MA | 34424 | 6908 | 54099 | 5169 | 59275 | 4204 | 61207 | 3488 | 62578 | 2458 | 74961 | 2329 | 33003 |
| 2L-5S | | MI | 23187 | 6908 | 36787 | 5081 | 39137 | 4146 | 39248 | 3435 | 37741 | 2402 | 44174 | 1910 | 24111 |
| 10-#14 | 1.30 | MA | 33019 | 6908 | 51989 | 5168 | 56585 | 4202 | 57937 | 3504 | 58148 | 2471 | 68939 | 2201 | 33012 |
| 3L-4S | | MI | 23828 | 6908 | 37859 | 5084 | 40519 | 4132 | 40940 | 3423 | 40111 | 2412 | 47038 | 1969 | 24198 |
| 10-#14 | 1.30 | MA | 32032 | 6908 | 50299 | 5188 | 54436 | 4219 | 55329 | 3500 | 54761 | 2483 | 64987 | 2073 | 32922 |
| 4L-3S | | MI | 24542 | 6908 | 39079 | 5067 | 42070 | 4137 | 42822 | 3431 | 42513 | 2402 | 49743 | 2097 | 24186 |
| 10-#14 | 1.30 | MA | 31148 | 6908 | 48820 | 5187 | 52527 | 4217 | 52991 | 3516 | 51425 | 2476 | 60881 | 2009 | 32652 |
| 5L-2S | | MI | 25543 | 6908 | 40590 | 5071 | 43997 | 4123 | 45165 | 3419 | 45645 | 2392 | 53895 | 2225 | 24135 |
| 10-#18 | 2.31 | MA | 38048 | 7529 | 62208 | 5528 | 69419 | 4461 | 73464 | 3642 | 79152 | 2404 | 96885 | 2212 | 57407 |
| 2L-5S | | MI | 23999 | 7529 | 39701 | 5431 | 42662 | 4405 | 43460 | 3586 | 43233 | 2319 | 51873 | 1493 | 38578 |
| 10-#18 | 2.31 | MA | 35643 | 7529 | 58507 | 5525 | 64700 | 4491 | 67728 | 3668 | 71381 | 2423 | 86439 | 1985 | 57187 |
| 3L-4S | | MI | 25098 | 7529 | 41580 | 5439 | 45084 | 4382 | 46424 | 3568 | 47327 | 2337 | 56815 | 1595 | 40806 |
| 10-#18 | 2.31 | MA | 33951 | 7529 | 55536 | 5558 | 60922 | 4485 | 63143 | 3659 | 65427 | 2443 | 79597 | 1757 | 56311 |
| 4L-3S | | MI | 26320 | 7529 | 43716 | 5412 | 47799 | 4395 | 49719 | 3585 | 51472 | 2319 | 61445 | 1822 | 41516 |
| 10-#18 | 2.31 | MA | 32437 | 7529 | 52932 | 5556 | 57564 | 4515 | 59030 | 3686 | 59559 | 2427 | 72450 | 1645 | 52709 |
| 5L-2S | | MI | 28028 | 7529 | 46353 | 5420 | 51161 | 4372 | 53806 | 3567 | 56877 | 2302 | 68572 | 2050 | 41586 |
| 12-#11 | 1.08 | MA | 33632 | 6774 | 52306 | 5100 | 57088 | 4155 | 58587 | 3460 | 59045 | 2475 | 70307 | 2360 | 27686 |
| 2L-6S | | MI | 22916 | 6774 | 35944 | 5013 | 38100 | 4092 | 38021 | 3403 | 36181 | 2431 | 42051 | 1991 | 20251 |
| 12-#11 | 1.08 | MA | 32645 | 6774 | 50834 | 5100 | 55210 | 4154 | 56305 | 3472 | 55952 | 2484 | 66081 | 2271 | 27710 |
| 3L-5S | | MI | 23346 | 6774 | 36651 | 5015 | 39059 | 4096 | 39191 | 3408 | 37713 | 2424 | 43953 | 2050 | 20399 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

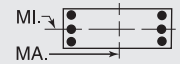



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.08 | MA | 31953 | 6774 | 49656 | 5113 | 53712 | 4167 | 54486 | 3470 | 53591 | 2493 | 63305 | 2182 | 27701 |
| 4E | | MI | 23797 | 6774 | 37399 | 5016 | 40024 | 4085 | 40373 | 3399 | 39380 | 2431 | 45968 | 2092 | 20389 |
| 12-#11 | 1.08 | MA | 31334 | 6774 | 48625 | 5114 | 52382 | 4165 | 52857 | 3481 | 51266 | 2488 | 60428 | 2137 | 27629 |
| 5L-3S | | MI | 24298 | 6774 | 38252 | 5005 | 41108 | 4089 | 41689 | 3404 | 41070 | 2424 | 47879 | 2180 | 20354 |
| 12-#11 | 1.08 | MA | 30744 | 6774 | 47653 | 5114 | 51060 | 4178 | 51245 | 3479 | 49131 | 2498 | 57675 | 2079 | 27297 |
| 6L-2S | | MI | 25003 | 6774 | 39309 | 5006 | 42457 | 4078 | 43328 | 3395 | 43273 | 2417 | 50807 | 2269 | 20313 |
| 12-#14 | 1.56 | MA | 35415 | 7068 | 56209 | 5269 | 61965 | 4276 | 64477 | 3533 | 67008 | 2448 | 80983 | 2310 | 39441 |
| 2L-6S | | MI | 23284 | 7068 | 37285 | 5177 | 39689 | 4212 | 39914 | 3472 | 38696 | 2399 | 45632 | 1795 | 27640 |
| 12-#14 | 1.56 | MA | 34019 | 7068 | 54099 | 5268 | 59275 | 4274 | 61207 | 3549 | 62578 | 2461 | 74961 | 2182 | 39417 |
| 3L-5S | | MI | 23893 | 7068 | 38298 | 5180 | 41064 | 4218 | 41590 | 3480 | 40872 | 2389 | 48325 | 1880 | 28483 |
| 12-#14 | 1.56 | MA | 33039 | 7068 | 52409 | 5288 | 57126 | 4292 | 58599 | 3545 | 59191 | 2473 | 71009 | 2054 | 39290 |
| 4E | | MI | 24531 | 7068 | 39370 | 5184 | 42446 | 4204 | 43282 | 3468 | 43243 | 2399 | 51190 | 1939 | 28780 |
| 12-#14 | 1.56 | MA | 32162 | 7068 | 50930 | 5287 | 55217 | 4289 | 56261 | 3561 | 55855 | 2466 | 66903 | 1990 | 38812 |
| 5L-3S | | MI | 25240 | 7068 | 40590 | 5167 | 43997 | 4210 | 45165 | 3476 | 45645 | 2389 | 53895 | 2067 | 28804 |
| 12-#14 | 1.56 | MA | 31327 | 7068 | 49534 | 5287 | 53320 | 4307 | 53948 | 3557 | 52792 | 2479 | 62982 | 1906 | 37436 |
| 6L-2S | | MI | 26235 | 7068 | 42102 | 5170 | 45924 | 4195 | 47507 | 3464 | 48776 | 2379 | 58046 | 2195 | 28770 |
| 12-#18 | 2.78 | MA | 39723 | 7812 | 65909 | 5705 | 74137 | 4590 | 79200 | 3722 | 86923 | 2386 | 107331 | 2173 | 68633 |
| 2L-6S | | MI | 24162 | 7812 | 40561 | 5600 | 43614 | 4521 | 44714 | 3684 | 44881 | 2310 | 54382 | 1281 | 44111 |
| 12-#18 | 2.78 | MA | 37341 | 7812 | 62208 | 5703 | 69419 | 4619 | 73464 | 3748 | 79152 | 2406 | 96885 | 1945 | 68337 |
| 3L-5S | | MI | 25201 | 7812 | 42338 | 5608 | 46024 | 4534 | 47547 | 3665 | 48638 | 2293 | 59000 | 1433 | 46247 |
| 12-#18 | 2.78 | MA | 35668 | 7812 | 59237 | 5736 | 65641 | 4614 | 68879 | 3739 | 73198 | 2425 | 90043 | 1718 | 66987 |
| 4E | | MI | 26289 | 7812 | 44217 | 5616 | 48446 | 4511 | 50511 | 3647 | 52732 | 2310 | 63942 | 1534 | 48328 |
| 12-#18 | 2.78 | MA | 34171 | 7812 | 56633 | 5733 | 62282 | 4643 | 64766 | 3766 | 67330 | 2409 | 82896 | 1606 | 63561 |
| 5L-3S | | MI | 27499 | 7812 | 46353 | 5589 | 51161 | 4524 | 53806 | 3665 | 56877 | 2293 | 68572 | 1762 | 49471 |
| 12-#18 | 2.78 | MA | 32744 | 7812 | 54176 | 5731 | 58944 | 4638 | 60694 | 3757 | 61939 | 2429 | 76101 | 1456 | 60499 |
| 6L-2S | | MI | 29192 | 7812 | 48990 | 5597 | 54523 | 4501 | 57893 | 3647 | 62282 | 2275 | 75699 | 1989 | 49609 |
| 14-#11 | 1.26 | MA | 34332 | 6885 | 53779 | 5169 | 58965 | 4205 | 60869 | 3492 | 62137 | 2468 | 74533 | 2347 | 32186 |
| 2L-7S | | MI | 22999 | 6885 | 36245 | 5094 | 38526 | 4153 | 38531 | 3443 | 36885 | 2430 | 42999 | 1884 | 22959 |
| 14-#11 | 1.26 | MA | 33350 | 6885 | 52306 | 5169 | 57088 | 4204 | 58587 | 3503 | 59045 | 2477 | 70307 | 2259 | 32199 |
| 3L-6S | | MI | 23416 | 6885 | 37001 | 5082 | 39448 | 4142 | 39660 | 3434 | 38384 | 2423 | 44980 | 1972 | 23353 |
| 14-#11 | 1.26 | MA | 32661 | 6885 | 51128 | 5183 | 55590 | 4217 | 56768 | 3501 | 56683 | 2486 | 67531 | 2170 | 32167 |
| 4L-5S | | MI | 23844 | 6885 | 37708 | 5084 | 40408 | 4146 | 40831 | 3439 | 39916 | 2416 | 46881 | 2031 | 23608 |
| 14-#11 | 1.26 | MA | 32046 | 6885 | 50098 | 5183 | 54259 | 4216 | 55139 | 3512 | 54358 | 2482 | 64654 | 2125 | 32074 |
| 5L-4S | | MI | 24293 | 6885 | 38457 | 5086 | 41373 | 4135 | 42012 | 3430 | 41583 | 2423 | 48896 | 2072 | 23620 |
| 14-#11 | 1.26 | MA | 31459 | 6885 | 49125 | 5183 | 52938 | 4228 | 53527 | 3510 | 52223 | 2491 | 61901 | 2067 | 31633 |
| 6L-3S | | MI | 24791 | 6885 | 39309 | 5074 | 42457 | 4139 | 43328 | 3435 | 43273 | 2416 | 50807 | 2161 | 23597 |
| 14-#11 | 1.26 | MA | 30887 | 6885 | 48085 | 5196 | 51670 | 4227 | 51972 | 3522 | 50135 | 2500 | 59038 | 1979 | 30971 |
| 7L-2S | | MI | 25493 | 6885 | 40367 | 5076 | 43805 | 4128 | 44967 | 3426 | 45476 | 2409 | 53735 | 2250 | 23563 |
| 14-#14 | 1.82 | MA | 36399 | 7227 | 58319 | 5368 | 64655 | 4348 | 67748 | 3578 | 71438 | 2438 | 87004 | 2291 | 45865 |
| 2L-7S | | MI | 23399 | 7227 | 37713 | 5293 | 40295 | 4299 | 40638 | 3529 | 39696 | 2396 | 46976 | 1638 | 31456 |
| 14-#14 | 1.82 | MA | 35011 | 7227 | 56209 | 5368 | 61965 | 4346 | 64477 | 3594 | 67008 | 2451 | 80983 | 2163 | 45812 |
| 3L-6S | | MI | 23990 | 7227 | 38797 | 5277 | 41616 | 4285 | 42257 | 3517 | 41827 | 2386 | 49783 | 1765 | 32080 |
| 14-#14 | 1.82 | MA | 34038 | 7227 | 54519 | 5387 | 59816 | 4364 | 61869 | 3590 | 63622 | 2464 | 77030 | 2035 | 45651 |
| 4L-5S | | MI | 24594 | 7227 | 39810 | 5280 | 42991 | 4290 | 43933 | 3525 | 44004 | 2376 | 52476 | 1850 | 32875 |
| 14-#14 | 1.82 | MA | 33168 | 7227 | 53040 | 5387 | 57907 | 4362 | 59531 | 3606 | 60285 | 2456 | 72924 | 1971 | 44981 |
| 5L-4S | | MI | 25228 | 7227 | 40882 | 5283 | 44373 | 4276 | 45625 | 3513 | 46374 | 2386 | 55341 | 1909 | 33351 |
| 14-#14 | 1.82 | MA | 32339 | 7227 | 51644 | 5387 | 56010 | 4380 | 57218 | 3602 | 57222 | 2469 | 69003 | 1887 | 43665 |
| 6L-3S | | MI | 25932 | 7227 | 42102 | 5267 | 45924 | 4282 | 47507 | 3521 | 48776 | 2376 | 58046 | 2037 | 33406 |
| 14-#14 | 1.82 | MA | 31530 | 7227 | 50151 | 5406 | 54190 | 4377 | 54986 | 3618 | 54225 | 2481 | 64925 | 1761 | 42703 |
| 7L-2S | | MI | 26922 | 7227 | 43613 | 5270 | 47851 | 4268 | 49850 | 3509 | 51907 | 2366 | 62197 | 2165 | 33394 |
| 14-#18 | 3.24 | MA | 39021 | 8096 | 65909 | 5880 | 74137 | 4748 | 79200 | 3828 | 86923 | 2388 | 107331 | 1906 | 79478 |
| 3L-6S | | MI | 25361 | 8096 | 43198 | 5778 | 46976 | 4649 | 48801 | 3763 | 50286 | 2284 | 61509 | 1220 | 51631 |
| 14-#18 | 3.24 | MA | 37366 | 8096 | 62938 | 5913 | 70359 | 4742 | 74615 | 3819 | 80969 | 2408 | 100489 | 1678 | 77704 |
| 4L-5S | | MI | 26390 | 8096 | 44975 | 5786 | 49386 | 4662 | 51634 | 3745 | 54043 | 2266 | 66126 | 1372 | 53940 |
| 14-#18 | 3.24 | MA | 35885 | 8096 | 60334 | 5911 | 67000 | 4772 | 70502 | 3845 | 75101 | 2392 | 93342 | 1566 | 74438 |
| 5L-4S | | MI | 27468 | 8096 | 46854 | 5794 | 51808 | 4639 | 54598 | 3727 | 58136 | 2284 | 71069 | 1474 | 55893 |
| 14-#18 | 3.24 | MA | 34474 | 8096 | 57876 | 5909 | 63662 | 4766 | 66430 | 3836 | 69710 | 2411 | 86547 | 1416 | 71214 |
| 6L-3S | | MI | 28667 | 8096 | 48990 | 5766 | 54523 | 4652 | 57893 | 3745 | 62282 | 2266 | 75699 | 1701 | 57412 |
| 14-#18 | 3.24 | MA | 33097 | 8096 | 55247 | 5942 | 60457 | 4796 | 62502 | 3863 | 64434 | 2431 | 79475 | 1192 | 67865 |
| 7L-2S | | MI | 30346 | 8096 | 51627 | 5774 | 57885 | 4629 | 61980 | 3726 | 67686 | 2248 | 82826 | 1928 | 57607 |

## RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

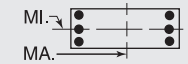
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.44 | MA | 35029 | 6995 | 55252 | 5238 | 60843 | 4255 | 63152 | 3523 | 65229 | 2461 | 78759 | 2335 | 36679 |
| 2L-8S | | MI | 23088 | 6995 | 36608 | 5161 | 38944 | 4199 | 39064 | 3483 | 37518 | 2415 | 44045 | 1816 | 25810 |
| 16-#11 | 1.44 | MA | 34051 | 6995 | 53779 | 5238 | 58965 | 4254 | 60869 | 3534 | 62137 | 2470 | 74533 | 2247 | 36674 |
| 3L-7S | | MI | 23498 | 6995 | 37303 | 5163 | 39875 | 4203 | 40170 | 3474 | 39088 | 2422 | 45927 | 1865 | 26089 |
| 16-#11 | 1.44 | MA | 33366 | 6995 | 52601 | 5252 | 57467 | 4267 | 59051 | 3532 | 59775 | 2479 | 71757 | 2158 | 36627 |
| 4L-6S | | MI | 23914 | 6995 | 38059 | 5151 | 40797 | 4192 | 41300 | 3465 | 40587 | 2415 | 47908 | 1953 | 26464 |
| 16-#11 | 1.44 | MA | 32753 | 6995 | 51570 | 5252 | 56137 | 4266 | 57422 | 3544 | 57450 | 2475 | 68880 | 2112 | 36516 |
| 5E | | MI | 24340 | 6995 | 38766 | 5153 | 41756 | 4196 | 42470 | 3470 | 42118 | 2408 | 49809 | 2011 | 26811 |
| 16-#11 | 1.44 | MA | 32170 | 6995 | 50598 | 5252 | 54815 | 4278 | 55809 | 3541 | 55315 | 2484 | 66127 | 2054 | 35978 |
| 6L-4S | | MI | 24786 | 6995 | 39515 | 5155 | 42722 | 4185 | 43652 | 3461 | 43786 | 2415 | 51824 | 2053 | 26841 |
| 16-#11 | 1.44 | MA | 31601 | 6995 | 49558 | 5266 | 53547 | 4277 | 54255 | 3553 | 53227 | 2493 | 63264 | 1967 | 35341 |
| 7L-3S | | MI | 25282 | 6995 | 40367 | 5143 | 43805 | 4189 | 44967 | 3466 | 45476 | 2408 | 53735 | 2142 | 26832 |
| 16-#11 | 1.44 | MA | 31040 | 6995 | 48604 | 5266 | 52267 | 4290 | 52733 | 3564 | 51039 | 2489 | 60575 | 1914 | 34861 |
| 8L-2S | | MI | 25981 | 6995 | 41425 | 5145 | 45154 | 4179 | 46606 | 3458 | 47678 | 2401 | 56663 | 2231 | 26806 |
| 16-#14 | 2.08 | MA | 37375 | 7387 | 60429 | 5468 | 67345 | 4421 | 71018 | 3623 | 75869 | 2428 | 93026 | 2272 | 52277 |
| 2L-8S | | MI | 23525 | 7387 | 38230 | 5390 | 40889 | 4366 | 41396 | 3585 | 40595 | 2373 | 48452 | 1539 | 34772 |
| 16-#14 | 2.08 | MA | 35996 | 7387 | 58319 | 5468 | 64655 | 4419 | 67748 | 3639 | 71438 | 2441 | 87004 | 2144 | 52199 |
| 3L-7S | | MI | 24103 | 7387 | 39225 | 5393 | 42222 | 4371 | 42981 | 3574 | 42828 | 2383 | 51127 | 1608 | 35809 |
| 16-#14 | 2.08 | MA | 35029 | 7387 | 56629 | 5487 | 62506 | 4436 | 65139 | 3635 | 68052 | 2454 | 83052 | 2016 | 52009 |
| 4L-6S | | MI | 24690 | 7387 | 40308 | 5377 | 43543 | 4357 | 44599 | 3562 | 44958 | 2373 | 53934 | 1735 | 36529 |
| 16-#14 | 2.08 | MA | 34166 | 7387 | 55150 | 5487 | 60597 | 4434 | 62801 | 3651 | 64716 | 2446 | 78946 | 1952 | 51167 |
| 5E | | MI | 25291 | 7387 | 41321 | 5380 | 44918 | 4363 | 46275 | 3570 | 47135 | 2363 | 56628 | 1820 | 37283 |
| 16-#14 | 2.08 | MA | 33343 | 7387 | 53754 | 5486 | 58700 | 4452 | 60488 | 3647 | 61652 | 2459 | 75025 | 1868 | 49904 |
| 6L-4S | | MI | 25920 | 7387 | 42393 | 5383 | 46300 | 4348 | 47967 | 3558 | 49505 | 2373 | 59492 | 1880 | 37914 |
| 16-#14 | 2.08 | MA | 32540 | 7387 | 52261 | 5506 | 56880 | 4450 | 58256 | 3663 | 58655 | 2471 | 70947 | 1742 | 48850 |
| 7L-3S | | MI | 26620 | 7387 | 43613 | 5367 | 47851 | 4354 | 49850 | 3566 | 51907 | 2363 | 62197 | 2007 | 37994 |
| 16-#14 | 2.08 | MA | 31748 | 7387 | 50891 | 5505 | 55043 | 4467 | 56072 | 3679 | 55515 | 2464 | 67109 | 1666 | 47200 |
| 8L-2S | | MI | 27605 | 7387 | 45125 | 5370 | 49778 | 4340 | 52192 | 3554 | 55038 | 2353 | 66348 | 2135 | 38008 |
| 16-#18 | 3.70 | MA | 39045 | 8380 | 66639 | 6090 | 75077 | 4871 | 80351 | 3899 | 88740 | 2390 | 110935 | 1639 | 88458 |
| 4L-6S | | MI | 26549 | 8380 | 45835 | 5955 | 50338 | 4778 | 52888 | 3843 | 55691 | 2257 | 68636 | 1159 | 59178 |
| 16-#18 | 3.70 | MA | 37581 | 8380 | 64035 | 6088 | 71719 | 4900 | 76238 | 3925 | 82872 | 2374 | 103788 | 1527 | 85337 |
| 5E | | MI | 27569 | 8380 | 47612 | 5963 | 52748 | 4791 | 55721 | 3825 | 59448 | 2240 | 73253 | 1311 | 61653 |
| 16-#18 | 3.70 | MA | 36185 | 8380 | 61577 | 6086 | 68381 | 4895 | 72166 | 3916 | 77481 | 2394 | 96993 | 1377 | 81953 |
| 6L-4S | | MI | 28637 | 8380 | 49491 | 5971 | 55170 | 4768 | 58685 | 3807 | 63541 | 2257 | 78195 | 1413 | 63492 |
| 16-#18 | 3.70 | MA | 34824 | 8380 | 58948 | 6119 | 65175 | 4924 | 68238 | 3942 | 72205 | 2413 | 89921 | 1152 | 78672 |
| 7L-3S | | MI | 29825 | 8380 | 51627 | 5944 | 57885 | 4781 | 61980 | 3824 | 67686 | 2240 | 82826 | 1640 | 65341 |
| 16-#18 | 3.70 | MA | 33480 | 8380 | 56536 | 6117 | 61941 | 4919 | 64392 | 3969 | 66679 | 2397 | 83243 | 1022 | 74189 |
| 8L-2S | | MI | 31491 | 8380 | 54264 | 5952 | 61247 | 4758 | 66067 | 3806 | 73091 | 2222 | 89953 | 1868 | 65591 |
| 18-#11 | 1.63 | MA | 35721 | 7106 | 56724 | 5307 | 62720 | 4305 | 65434 | 3554 | 68321 | 2454 | 82985 | 2323 | 41168 |
| 2L-9S | | MI | 23182 | 7106 | 36932 | 5242 | 39383 | 4260 | 39559 | 3509 | 38237 | 2414 | 45131 | 1740 | 28289 |
| 18-#11 | 1.63 | MA | 34747 | 7106 | 55252 | 5307 | 60843 | 4304 | 63152 | 3565 | 65229 | 2463 | 78759 | 2234 | 41146 |
| 3L-8S | | MI | 23587 | 7106 | 37666 | 5230 | 40293 | 4249 | 40703 | 3514 | 39721 | 2407 | 46973 | 1797 | 28881 |
| 18-#11 | 1.63 | MA | 34066 | 7106 | 54074 | 5321 | 59345 | 4317 | 61333 | 3563 | 62868 | 2472 | 75982 | 2146 | 41084 |
| 4L-7S | | MI | 23995 | 7106 | 38360 | 5232 | 41223 | 4253 | 41809 | 3505 | 41291 | 2414 | 48855 | 1846 | 29224 |
| 18-#11 | 1.63 | MA | 33457 | 7106 | 53043 | 5321 | 58015 | 4316 | 59704 | 3575 | 60542 | 2468 | 73106 | 2100 | 40955 |
| 5L-6S | | MI | 24408 | 7106 | 39117 | 5220 | 42145 | 4243 | 42939 | 3496 | 42790 | 2407 | 50836 | 1934 | 29581 |
| 18-#11 | 1.63 | MA | 32877 | 7106 | 52071 | 5321 | 56693 | 4328 | 58092 | 3572 | 58408 | 2477 | 70353 | 2042 | 40331 |
| 6L-5S | | MI | 24832 | 7106 | 39824 | 5222 | 43105 | 4246 | 44109 | 3501 | 44321 | 2400 | 52737 | 1992 | 30009 |
| 18-#11 | 1.63 | MA | 32311 | 7106 | 51030 | 5335 | 55425 | 4327 | 56537 | 3584 | 56319 | 2486 | 67490 | 1955 | 39716 |
| 7L-4S | | MI | 25276 | 7106 | 40572 | 5224 | 44070 | 4236 | 45291 | 3493 | 45989 | 2407 | 54752 | 2034 | 30054 |
| 18-#11 | 1.63 | MA | 31753 | 7106 | 50076 | 5335 | 54145 | 4340 | 55015 | 3595 | 54131 | 2482 | 64801 | 1902 | 39175 |
| 8L-3S | | MI | 25770 | 7106 | 41425 | 5212 | 45154 | 4239 | 46606 | 3498 | 47678 | 2400 | 56663 | 2123 | 30061 |
| 18-#11 | 1.63 | MA | 31155 | 7106 | 49140 | 5335 | 52895 | 4339 | 53441 | 3593 | 52065 | 2491 | 62133 | 1846 | 38228 |
| 9L-2S | | MI | 26466 | 7106 | 42483 | 5214 | 46503 | 4229 | 48246 | 3489 | 49881 | 2393 | 59591 | 2212 | 30043 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

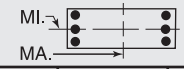


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.34 | MA | 36973 | 7547 | 60429 | 5567 | 67345 | 4491 | 71018 | 3684 | 75869 | 2431 | 93026 | 2125 | 58581 |
| 3L-8S | | MI | 24228 | 7547 | 39741 | 5490 | 42816 | 4438 | 43739 | 3630 | 43726 | 2361 | 52603 | 1509 | 39176 |
| 18-#14 | 2.34 | MA | 36013 | 7547 | 58739 | 5587 | 65196 | 4509 | 68409 | 3680 | 72482 | 2444 | 89073 | 1997 | 58363 |
| 4L-7S | | MI | 24802 | 7546 | 40736 | 5493 | 44149 | 4444 | 45324 | 3619 | 45959 | 2371 | 55278 | 1579 | 40174 |
| 18-#14 | 2.34 | MA | 35156 | 7546 | 57260 | 5586 | 63287 | 4506 | 66072 | 3696 | 69146 | 2436 | 84968 | 1933 | 57367 |
| 5L-6S | | MI | 25385 | 7546 | 41820 | 5476 | 45470 | 4429 | 46942 | 3607 | 48089 | 2361 | 58085 | 1705 | 40986 |
| 18-#14 | 2.34 | MA | 34339 | 7547 | 55864 | 5586 | 61390 | 4524 | 63758 | 3692 | 66082 | 2449 | 81047 | 1849 | 56151 |
| 6L-5S | | MI | 25982 | 7547 | 42832 | 5480 | 46845 | 4435 | 48618 | 3615 | 50266 | 2351 | 60779 | 1790 | 41703 |
| 18-#14 | 2.34 | MA | 33542 | 7547 | 54370 | 5606 | 59570 | 4522 | 61526 | 3708 | 63085 | 2461 | 76968 | 1722 | 55008 |
| 7L-4S | | MI | 26608 | 7547 | 43905 | 5483 | 48227 | 4421 | 50310 | 3603 | 52637 | 2361 | 63643 | 1850 | 42471 |
| 18-#14 | 2.34 | MA | 32756 | 7547 | 53001 | 5605 | 57733 | 4540 | 59342 | 3724 | 59945 | 2454 | 73130 | 1647 | 53404 |
| 8L-3S | | MI | 27304 | 7547 | 45125 | 5466 | 49778 | 4426 | 52192 | 3611 | 55038 | 2351 | 66348 | 1978 | 42575 |
| 18-#14 | 2.34 | MA | 31918 | 7546 | 51657 | 5605 | 55938 | 4538 | 57082 | 3720 | 56979 | 2467 | 69332 | 1567 | 51728 |
| 9L-2S | | MI | 28283 | 7546 | 46636 | 5470 | 51705 | 4412 | 54535 | 3599 | 58170 | 2341 | 70499 | 2106 | 42612 |
| 18-#18 | 4.17 | MA | 39260 | 8664 | 67735 | 6265 | 76437 | 5029 | 81974 | 4005 | 90643 | 2356 | 114234 | 1487 | 96254 |
| 5L-6S | | MI | 27726 | 8664 | 48472 | 6132 | 53700 | 4907 | 56975 | 3923 | 61096 | 2231 | 75763 | 1098 | 66751 |
| 18-#18 | 4.17 | MA | 37879 | 8664 | 65278 | 6263 | 73099 | 5023 | 77902 | 3996 | 85251 | 2376 | 107439 | 1337 | 92715 |
| 6L-5S | | MI | 28737 | 8664 | 50249 | 6140 | 56110 | 4919 | 59807 | 3905 | 64853 | 2213 | 80380 | 1250 | 69383 |
| 18-#18 | 4.17 | MA | 36532 | 8664 | 62649 | 6296 | 69894 | 5053 | 73974 | 4022 | 79976 | 2395 | 100367 | 1113 | 89340 |
| 7L-4S | | MI | 29795 | 8664 | 52128 | 6148 | 58532 | 4897 | 62772 | 3887 | 68946 | 2231 | 85322 | 1352 | 71120 |
| 18-#18 | 4.17 | MA | 35203 | 8664 | 60237 | 6294 | 66659 | 5047 | 70128 | 4049 | 74450 | 2380 | 93689 | 982 | 84964 |
| 8L-3S | | MI | 30973 | 8664 | 54264 | 6121 | 61247 | 4909 | 66067 | 3904 | 73091 | 2213 | 89953 | 1579 | 73262 |
| 20-#11 | 1.81 | MA | 35440 | 7217 | 56724 | 5376 | 62720 | 4354 | 65434 | 3597 | 68321 | 2456 | 82985 | 2222 | 45613 |
| 3L-9S | | MI | 23680 | 7217 | 37989 | 5311 | 40732 | 4310 | 41198 | 3540 | 40440 | 2406 | 48059 | 1721 | 31388 |
| 20-#11 | 1.81 | MA | 34762 | 7217 | 55546 | 5390 | 61222 | 4367 | 63616 | 3594 | 65960 | 2465 | 80208 | 2133 | 45537 |
| 4L-8S | | MI | 24082 | 7217 | 38724 | 5299 | 41641 | 4300 | 42342 | 3545 | 41923 | 2399 | 49901 | 1778 | 31959 |
| 20-#11 | 1.81 | MA | 34156 | 7217 | 54516 | 5390 | 59892 | 4366 | 61986 | 3606 | 63634 | 2461 | 77332 | 2088 | 45393 |
| 5L-7S | | MI | 24488 | 7217 | 39418 | 5301 | 42572 | 4303 | 43449 | 3536 | 43494 | 2406 | 51783 | 1826 | 32361 |
| 20-#11 | 1.81 | MA | 33579 | 7217 | 53543 | 5390 | 58571 | 4379 | 60374 | 3604 | 61500 | 2470 | 74579 | 2030 | 44690 |
| 6E | | MI | 24900 | 7217 | 40175 | 5289 | 43494 | 4293 | 44578 | 3527 | 44993 | 2399 | 53764 | 1914 | 32705 |
| 20-#11 | 1.81 | MA | 33017 | 7217 | 52503 | 5404 | 57302 | 4377 | 58820 | 3615 | 59411 | 2479 | 71716 | 1943 | 44094 |
| 7L-5S | | MI | 25322 | 7217 | 40881 | 5291 | 44453 | 4296 | 45749 | 3532 | 46524 | 2392 | 55665 | 1973 | 33203 |
| 20-#11 | 1.81 | MA | 32462 | 7217 | 51549 | 5404 | 56022 | 4390 | 57298 | 3627 | 57223 | 2475 | 69027 | 1890 | 43495 |
| 8L-4S | | MI | 25764 | 7217 | 41630 | 5293 | 45419 | 4286 | 46930 | 3524 | 48191 | 2399 | 57680 | 2015 | 33261 |
| 20-#11 | 1.81 | MA | 31866 | 7217 | 50613 | 5404 | 54772 | 4389 | 55723 | 3624 | 55157 | 2484 | 66359 | 1834 | 42572 |
| 9L-3S | | MI | 26256 | 7217 | 42483 | 5281 | 46503 | 4289 | 48246 | 3529 | 49881 | 2392 | 59591 | 2104 | 33286 |
| 20-#11 | 1.81 | MA | 31255 | 7217 | 49590 | 5418 | 53509 | 4402 | 54211 | 3636 | 53106 | 2493 | 63771 | 1771 | 41738 |
| 10L-2S | | MI | 26949 | 7217 | 43540 | 5283 | 47851 | 4279 | 49885 | 3520 | 52084 | 2385 | 62519 | 2192 | 33275 |
| 20-#14 | 2.60 | MA | 36990 | 7706 | 60849 | 5687 | 67886 | 4581 | 71679 | 3725 | 76912 | 2434 | 95095 | 1978 | 64714 |
| 4L-8S | | MI | 24926 | 7706 | 41252 | 5589 | 44743 | 4510 | 46081 | 3675 | 46857 | 2348 | 56754 | 1479 | 43589 |
| 20-#14 | 2.60 | MA | 36138 | 7706 | 59369 | 5686 | 65977 | 4579 | 69342 | 3741 | 73576 | 2426 | 90989 | 1913 | 63578 |
| 5L-7S | | MI | 25497 | 7706 | 42247 | 5593 | 46076 | 4516 | 47666 | 3663 | 49090 | 2358 | 59430 | 1549 | 44551 |
| 20-#14 | 2.60 | MA | 35327 | 7706 | 57974 | 5686 | 64080 | 4597 | 67028 | 3737 | 70512 | 2439 | 87068 | 1830 | 62406 |
| 6E | | MI | 26076 | 7706 | 43331 | 5576 | 47397 | 4502 | 49284 | 3652 | 51221 | 2348 | 62236 | 1676 | 45449 |
| 20-#14 | 2.60 | MA | 34536 | 7706 | 56480 | 5705 | 62260 | 4594 | 64797 | 3753 | 67515 | 2451 | 82990 | 1703 | 61177 |
| 7L-5S | | MI | 26669 | 7706 | 44344 | 5579 | 48772 | 4507 | 50960 | 3660 | 53398 | 2338 | 64930 | 1761 | 46133 |
| 20-#14 | 2.60 | MA | 33756 | 7706 | 55111 | 5705 | 60423 | 4612 | 62612 | 3769 | 64375 | 2444 | 79152 | 1628 | 59616 |
| 8L-4S | | MI | 27291 | 7706 | 45416 | 5583 | 50154 | 4493 | 52653 | 3648 | 55768 | 2348 | 67794 | 1820 | 47023 |
| 20-#14 | 2.60 | MA | 32938 | 7706 | 53767 | 5704 | 58628 | 4610 | 60352 | 3765 | 61409 | 2457 | 75353 | 1547 | 57887 |
| 9L-3S | | MI | 27983 | 7706 | 46636 | 5566 | 51705 | 4499 | 54535 | 3656 | 58170 | 2338 | 70499 | 1948 | 47149 |
| 20-#14 | 2.60 | MA | 32062 | 7706 | 52299 | 5724 | 56815 | 4628 | 58181 | 3781 | 58466 | 2469 | 71668 | 1456 | 56173 |
| 10L-2S | | MI | 28958 | 7706 | 48148 | 5569 | 53632 | 4485 | 56878 | 3644 | 61301 | 2328 | 74651 | 2076 | 47205 |
| 20-#18 | 4.63 | MA | 39556 | 8947 | 68979 | 6441 | 77817 | 5152 | 83638 | 4076 | 93022 | 2358 | 117885 | 1298 | 103498 |
| 6E | | MI | 28894 | 8947 | 51109 | 6310 | 57062 | 5035 | 61062 | 4003 | 66500 | 2204 | 82890 | 1038 | 74345 |
| 20-#18 | 4.63 | MA | 38223 | 8947 | 66350 | 6474 | 74612 | 5182 | 79710 | 4102 | 87747 | 2378 | 110813 | 1073 | 100027 |
| 7L-5S | | MI | 29896 | 8947 | 52886 | 6318 | 59472 | 5048 | 63894 | 3985 | 70257 | 2186 | 87507 | 1190 | 77126 |
| 20-#18 | 4.63 | MA | 36908 | 8947 | 63937 | 6471 | 71378 | 5176 | 75864 | 4128 | 82220 | 2362 | 104135 | 943 | 95755 |
| 8L-4S | | MI | 30945 | 8947 | 54765 | 6326 | 61894 | 5025 | 66859 | 3967 | 74351 | 2204 | 92449 | 1291 | 78773 |

## RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

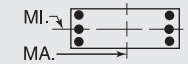



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.99 | MA | 35454 | 7327 | 57019 | 5459 | 63100 | 4417 | 65898 | 3625 | 69052 | 2459 | 84434 | 2121 | 49987 |
| 4L-9S | | MI | 24175 | 7327 | 39047 | 5380 | 42081 | 4360 | 42837 | 3571 | 42643 | 2398 | 50987 | 1702 | 34491 |
| 22-#11 | 1.99 | MA | 34852 | 7327 | 55988 | 5459 | 61770 | 4416 | 64269 | 3637 | 66727 | 2454 | 81558 | 2076 | 49828 |
| 5L-8S | | MI | 24576 | 7327 | 39782 | 5368 | 42990 | 4350 | 43982 | 3576 | 44126 | 2391 | 52829 | 1758 | 35044 |
| 22-#11 | 1.99 | MA | 34278 | 7327 | 55016 | 5459 | 60448 | 4429 | 62657 | 3635 | 64592 | 2463 | 78805 | 2018 | 49055 |
| 6L-7S | | MI | 24980 | 7327 | 40476 | 5370 | 43920 | 4353 | 45088 | 3567 | 45697 | 2398 | 54711 | 1807 | 35502 |
| 22-#11 | 1.99 | MA | 33718 | 7327 | 53976 | 5473 | 59180 | 4428 | 61102 | 3646 | 62503 | 2473 | 75942 | 1931 | 48477 |
| 7L-6S | | MI | 25390 | 7327 | 41232 | 5358 | 44842 | 4343 | 46218 | 3559 | 47196 | 2391 | 56692 | 1895 | 35832 |
| 22-#11 | 1.99 | MA | 33167 | 7327 | 53022 | 5473 | 57900 | 4440 | 59580 | 3658 | 60316 | 2468 | 73253 | 1878 | 47822 |
| 8L-5S | | MI | 25810 | 7327 | 41939 | 5360 | 45802 | 4346 | 47388 | 3564 | 48727 | 2384 | 58593 | 1954 | 36394 |
| 22-#11 | 1.99 | MA | 32574 | 7327 | 52085 | 5473 | 56650 | 4439 | 58005 | 3655 | 58249 | 2477 | 70585 | 1822 | 46921 |
| 9L-4S | | MI | 26249 | 7327 | 42688 | 5362 | 46767 | 4336 | 48570 | 3555 | 50394 | 2391 | 60608 | 1996 | 36465 |
| 22-#11 | 1.99 | MA | 31966 | 7327 | 51063 | 5487 | 55386 | 4452 | 56493 | 3667 | 56199 | 2486 | 67997 | 1759 | 46050 |
| 10L-3S | | MI | 26739 | 7327 | 43540 | 5350 | 47851 | 4339 | 49885 | 3560 | 52084 | 2384 | 62519 | 2085 | 36498 |
| 22-#11 | 1.99 | MA | 31371 | 7327 | 50127 | 5487 | 54143 | 4451 | 54937 | 3665 | 54041 | 2482 | 65371 | 1703 | 44977 |
| 11L-2S | | MI | 27430 | 7327 | 44598 | 5352 | 49200 | 4329 | 51524 | 3551 | 54287 | 2377 | 65447 | 2173 | 36503 |
| 22-#14 | 2.86 | MA | 37115 | 7866 | 61479 | 5786 | 68667 | 4651 | 72612 | 3786 | 78006 | 2416 | 97011 | 1894 | 69800 |
| 5L-8S | | MI | 25619 | 7866 | 42764 | 5689 | 46670 | 4583 | 48424 | 3720 | 49989 | 2335 | 60906 | 1450 | 48008 |
| 22-#14 | 2.86 | MA | 36309 | 7866 | 60084 | 5786 | 66770 | 4669 | 70298 | 3782 | 74943 | 2429 | 93090 | 1810 | 68667 |
| 6L-7S | | MI | 26187 | 7866 | 43759 | 5692 | 48003 | 4588 | 50009 | 3708 | 52222 | 2345 | 63581 | 1519 | 48937 |
| 22-#14 | 2.86 | MA | 35523 | 7866 | 58590 | 5805 | 64950 | 4667 | 68067 | 3798 | 71945 | 2442 | 89011 | 1684 | 67355 |
| 7L-6S | | MI | 26763 | 7866 | 44843 | 5676 | 49324 | 4574 | 51627 | 3696 | 54352 | 2335 | 66388 | 1646 | 49917 |
| 22-#14 | 2.86 | MA | 34749 | 7866 | 57221 | 5805 | 63113 | 4684 | 65882 | 3814 | 68806 | 2434 | 85174 | 1609 | 65835 |
| 8L-5S | | MI | 27353 | 7866 | 45855 | 5679 | 50699 | 4580 | 53303 | 3704 | 56529 | 2325 | 69081 | 1731 | 50573 |
| 22-#14 | 2.86 | MA | 33932 | 7866 | 55876 | 5804 | 61318 | 4682 | 63622 | 3810 | 65840 | 2447 | 81375 | 1528 | 64055 |
| 9L-4S | | MI | 27971 | 7866 | 46927 | 5682 | 52081 | 4565 | 54995 | 3693 | 58899 | 2335 | 71946 | 1790 | 51572 |
| 22-#14 | 2.86 | MA | 33066 | 7866 | 54409 | 5824 | 59505 | 4700 | 61451 | 3826 | 62896 | 2459 | 77690 | 1437 | 62241 |
| 10L-3S | | MI | 28659 | 7866 | 48148 | 5666 | 53632 | 4571 | 56878 | 3701 | 61301 | 2325 | 74651 | 1918 | 51718 |
| 22-#18 | 5.09 | MA | 39899 | 9231 | 70050 | 6651 | 79331 | 5310 | 85446 | 4182 | 95517 | 2360 | 121259 | 1034 | 110733 |
| 7L-6S | | MI | 30053 | 9231 | 53746 | 6487 | 60424 | 5164 | 65149 | 4083 | 71905 | 2178 | 90017 | 977 | 81959 |
| 22-#18 | 5.09 | MA | 38598 | 9231 | 67638 | 6649 | 76096 | 5305 | 81600 | 4208 | 89991 | 2344 | 114581 | 903 | 106412 |
| 8L-5S | | MI | 31046 | 9231 | 55523 | 6495 | 62834 | 5176 | 67981 | 4065 | 75662 | 2160 | 94634 | 1129 | 84880 |
| 24-#11 | 2.17 | MA | 35543 | 7438 | 57461 | 5528 | 63647 | 4466 | 66551 | 3668 | 69819 | 2447 | 85784 | 2064 | 54263 |
| 5L-9S | | MI | 24668 | 7438 | 40105 | 5449 | 43429 | 4410 | 44477 | 3602 | 44846 | 2390 | 53915 | 1683 | 37598 |
| 24-#11 | 2.17 | MA | 34973 | 7438 | 56489 | 5528 | 62326 | 4479 | 64939 | 3666 | 67684 | 2456 | 83031 | 2006 | 53425 |
| 6L-8S | | MI | 25067 | 7438 | 40839 | 5438 | 44338 | 4400 | 45621 | 3607 | 46329 | 2383 | 55757 | 1739 | 38134 |
| 24-#11 | 2.17 | MA | 34416 | 7438 | 55448 | 5542 | 61057 | 4478 | 63384 | 3677 | 65596 | 2466 | 80168 | 1918 | 52862 |
| 7E | | MI | 25469 | 7438 | 41534 | 5439 | 45269 | 4403 | 46727 | 3599 | 47900 | 2390 | 57639 | 1788 | 38644 |
| 24-#11 | 2.17 | MA | 33867 | 7438 | 54494 | 5542 | 59778 | 4490 | 61862 | 3689 | 63408 | 2461 | 77479 | 1866 | 52153 |
| 8L-6S | | MI | 25877 | 7438 | 42290 | 5428 | 46191 | 4393 | 47857 | 3590 | 49399 | 2383 | 59620 | 1876 | 38964 |
| 24-#11 | 2.17 | MA | 33278 | 7438 | 53558 | 5542 | 58527 | 4489 | 60288 | 3687 | 61341 | 2470 | 74811 | 1810 | 51274 |
| 9L-5S | | MI | 26295 | 7438 | 42997 | 5429 | 47150 | 4396 | 49027 | 3595 | 50930 | 2376 | 61521 | 1935 | 39521 |
| 24-#11 | 2.17 | MA | 32672 | 7438 | 52535 | 5556 | 57264 | 4502 | 58776 | 3698 | 59291 | 2480 | 72223 | 1747 | 50367 |
| 10L-4S | | MI | 26733 | 7438 | 43745 | 5431 | 48116 | 4386 | 50209 | 3586 | 52597 | 2383 | 63536 | 1977 | 39665 |
| 24-#11 | 2.17 | MA | 32080 | 7438 | 51599 | 5556 | 56021 | 4501 | 57219 | 3696 | 57134 | 2475 | 69597 | 1691 | 49314 |
| 11L-3S | | MI | 27221 | 7438 | 44598 | 5419 | 49200 | 4389 | 51524 | 3591 | 54287 | 2376 | 65447 | 2065 | 39709 |
| 24-#11 | 2.17 | MA | 31498 | 7438 | 50593 | 5570 | 54766 | 4513 | 55711 | 3707 | 55086 | 2484 | 66705 | 1617 | 48095 |
| 12L-2S | | MI | 27909 | 7438 | 45656 | 5421 | 50548 | 4379 | 53164 | 3582 | 56490 | 2369 | 68375 | 2154 | 39728 |
| 24-#14 | 3.13 | MA | 37284 | 8025 | 62194 | 5885 | 69460 | 4741 | 73568 | 3827 | 79373 | 2419 | 99111 | 1791 | 74934 |
| 6L-8S | | MI | 26309 | 8025 | 44275 | 5789 | 48597 | 4655 | 50766 | 3765 | 53120 | 2322 | 65057 | 1420 | 52434 |
| 24-#14 | 3.13 | MA | 36504 | 8025 | 60700 | 5905 | 67640 | 4739 | 71337 | 3843 | 76375 | 2432 | 95033 | 1665 | 73542 |
| 7E | | MI | 26873 | 8025 | 45270 | 5792 | 49930 | 4661 | 52351 | 3753 | 55353 | 2332 | 67732 | 1489 | 53333 |
| 24-#14 | 3.13 | MA | 35735 | 8025 | 59331 | 5904 | 65803 | 4757 | 69152 | 3859 | 73236 | 2424 | 91195 | 1590 | 72060 |
| 8L-6S | | MI | 27445 | 8025 | 46354 | 5776 | 51251 | 4646 | 53969 | 3741 | 57483 | 2322 | 70539 | 1616 | 54389 |
| 24-#14 | 3.13 | MA | 34920 | 8025 | 57986 | 5904 | 64008 | 4755 | 66892 | 3855 | 70270 | 2437 | 87396 | 1509 | 70229 |
| 9L-5S | | MI | 28032 | 8025 | 47367 | 5779 | 52625 | 4652 | 55645 | 3749 | 59660 | 2312 | 73232 | 1701 | 55019 |
| 24-#14 | 3.13 | MA | 34062 | 8025 | 56518 | 5923 | 62195 | 4772 | 64721 | 3871 | 67326 | 2449 | 83711 | 1418 | 68381 |
| 10L-4S | | MI | 28646 | 8025 | 48439 | 5782 | 54008 | 4638 | 57338 | 3738 | 62030 | 2322 | 76097 | 1760 | 56117 |
| 24-#18 | 5.56 | MA | 40273 | 9515 | 71339 | 6826 | 80815 | 5433 | 87335 | 4288 | 97762 | 2327 | 125027 | 864 | 117237 |
| 8L-6S | | MI | 31204 | 9515 | 56383 | 6664 | 63786 | 5292 | 69236 | 4162 | 77310 | 2151 | 97144 | 916 | 89591 |

## RECTANGULAR TIED COLUMNS 38" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.66 | MA | 23324 | 5957 | 37631 | 4339 | 41071 | 3518 | 42563 | 2900 | 43816 | 1972 | 52192 | 1808 | 26818 |
| 2L-3S | | MI | 21477 | 5957 | 34817 | 4332 | 37482 | 3542 | 38201 | 2920 | 38012 | 1989 | 44514 | 1581 | 26817 |
| 8-#14 | 1.25 | MA | 22448 | 5744 | 35517 | 4237 | 38530 | 3447 | 39533 | 2861 | 39941 | 2015 | 47173 | 1883 | 20515 |
| 2L-4S | | MI | 20618 | 5744 | 32607 | 4251 | 34825 | 3457 | 35032 | 2867 | 34009 | 2035 | 39799 | 1627 | 20538 |
| 8-#18 | 2.22 | MA | 24591 | 6241 | 40445 | 4516 | 44659 | 3646 | 46925 | 2980 | 49621 | 1947 | 59871 | 1752 | 35417 |
| 2L-4S | | MI | 21462 | 6241 | 35356 | 4538 | 38178 | 3659 | 39054 | 2984 | 39364 | 1983 | 47195 | 1297 | 34019 |
| 10-#11 | 1.08 | MA | 22087 | 5659 | 34646 | 4199 | 37499 | 3421 | 38309 | 2848 | 38366 | 2033 | 45127 | 1912 | 17948 |
| 2L-5S | | MI | 20324 | 5659 | 31817 | 4208 | 33883 | 3440 | 33907 | 2863 | 32412 | 2040 | 37770 | 1692 | 17978 |
| 10-#11 | 1.08 | MA | 21336 | 5659 | 33519 | 4198 | 36062 | 3432 | 36563 | 2858 | 36007 | 2040 | 41984 | 1824 | 17986 |
| 3L-4S | | MI | 20803 | 5659 | 32613 | 4210 | 34909 | 3429 | 35163 | 2853 | 34197 | 2047 | 39929 | 1735 | 18009 |
| 10-#14 | 1.56 | MA | 23190 | 5904 | 37128 | 4337 | 40584 | 3519 | 42030 | 2906 | 43298 | 2003 | 51635 | 1855 | 25452 |
| 2L-5S | | MI | 20697 | 5904 | 33078 | 4348 | 35409 | 3544 | 35730 | 2925 | 34826 | 2013 | 41190 | 1539 | 24745 |
| 10-#14 | 1.56 | MA | 22128 | 5904 | 35517 | 4334 | 38530 | 3534 | 39533 | 2919 | 39941 | 2013 | 47173 | 1727 | 25473 |
| 3L-4S | | MI | 21374 | 5904 | 34218 | 4351 | 36879 | 3529 | 37529 | 2912 | 37366 | 2023 | 44261 | 1599 | 25403 |
| 10-#18 | 2.77 | MA | 25842 | 6525 | 43260 | 4694 | 48247 | 3775 | 51287 | 3059 | 55426 | 1923 | 67549 | 1696 | 43975 |
| 2L-5S | | MI | 21591 | 6525 | 36170 | 4709 | 39188 | 3812 | 40259 | 3084 | 40774 | 1941 | 49564 | 1137 | 39802 |
| 10-#18 | 2.77 | MA | 24034 | 6525 | 40445 | 4687 | 44659 | 3799 | 46925 | 3079 | 49621 | 1941 | 59871 | 1468 | 43786 |
| 3L-4S | | MI | 22747 | 6525 | 38170 | 4715 | 41766 | 3788 | 43415 | 3064 | 45169 | 1959 | 54874 | 1241 | 42044 |

## RECTANGULAR TIED COLUMNS 38" x 40"

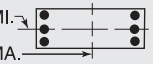
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.05 | MA | 24321 | 5942 | 38254 | 4380 | 41214 | 3569 | 41977 | 2973 | 41734 | 2117 | 48872 | 1986 | 19251 |
| 2E | | MI | 23063 | 5942 | 36353 | 4362 | 39078 | 3554 | 39753 | 2960 | 39401 | 2104 | 46049 | 1968 | 18213 |
| 6-#18 | 1.58 | MA | 25697 | 6226 | 41246 | 4557 | 45028 | 3697 | 46614 | 3052 | 47939 | 2095 | 57102 | 1934 | 28438 |
| 2L-3S | | MI | 22500 | 6226 | 36353 | 4533 | 39078 | 3707 | 39753 | 3060 | 39401 | 2097 | 46049 | 1685 | 26890 |
| 6-#18 | 1.58 | MA | 23728 | 6226 | 38254 | 4552 | 41214 | 3723 | 41977 | 3074 | 41734 | 2113 | 48872 | 1706 | 28437 |
| 3L-2S | | MI | 24350 | 6226 | 39167 | 4539 | 42666 | 3683 | 44115 | 3040 | 45206 | 2079 | 53727 | 1912 | 26868 |
| 8-#14 | 1.18 | MA | 24754 | 6013 | 38990 | 4455 | 42316 | 3626 | 43379 | 3014 | 43769 | 2136 | 51680 | 2004 | 21730 |
| 2L-4S | | MI | 21640 | 6013 | 34137 | 4453 | 36420 | 3623 | 36587 | 3008 | 35405 | 2143 | 41342 | 1732 | 20601 |
| 8-#14 | 1.18 | MA | 23615 | 6013 | 37279 | 4453 | 40134 | 3642 | 40727 | 3028 | 40187 | 2146 | 46906 | 1876 | 21777 |
| 3E | | MI | 22401 | 6013 | 35436 | 4436 | 38071 | 3628 | 38591 | 3015 | 37980 | 2133 | 44254 | 1860 | 20606 |
| 8-#14 | 1.18 | MA | 22808 | 6013 | 35902 | 4471 | 38384 | 3638 | 38603 | 3021 | 37439 | 2156 | 43786 | 1748 | 21753 |
| 4L-2S | | MI | 23472 | 6013 | 37047 | 4439 | 40125 | 3613 | 41088 | 3003 | 41336 | 2123 | 48717 | 1988 | 20553 |
| 8-#18 | 2.11 | MA | 27054 | 6510 | 44237 | 4735 | 48842 | 3826 | 51250 | 3132 | 54144 | 2073 | 65333 | 1882 | 37577 |
| 2L-4S | | MI | 22483 | 6510 | 36892 | 4739 | 39773 | 3824 | 40605 | 3124 | 40754 | 2090 | 48730 | 1401 | 34396 |
| 8-#18 | 2.11 | MA | 25106 | 6510 | 41246 | 4729 | 45028 | 3852 | 46614 | 3154 | 47939 | 2091 | 57102 | 1654 | 37473 |
| 3E | | MI | 23789 | 6510 | 39167 | 4710 | 42666 | 3835 | 44115 | 3139 | 45206 | 2073 | 53727 | 1628 | 35398 |
| 8-#18 | 2.11 | MA | 23722 | 6510 | 38831 | 4759 | 41958 | 3842 | 42889 | 3140 | 43179 | 2108 | 51737 | 1426 | 36403 |
| 4L-2S | | MI | 25620 | 6510 | 41981 | 4717 | 46254 | 3811 | 48476 | 3120 | 51011 | 2055 | 61406 | 1856 | 35474 |
| 10-#11 | 1.03 | MA | 24366 | 5928 | 38061 | 4417 | 41216 | 3600 | 42074 | 3001 | 42056 | 2152 | 49473 | 2033 | 19001 |
| 2L-5S | | MI | 21345 | 5928 | 33344 | 4411 | 35479 | 3606 | 35464 | 3004 | 33810 | 2149 | 39318 | 1798 | 18036 |
| 10-#11 | 1.03 | MA | 23566 | 5928 | 36865 | 4416 | 39691 | 3612 | 40220 | 3011 | 39544 | 2159 | 46113 | 1944 | 19039 |
| 3L-4S | | MI | 21824 | 5928 | 34140 | 4413 | 36505 | 3596 | 36720 | 2995 | 35595 | 2155 | 41476 | 1840 | 18051 |
| 10-#11 | 1.03 | MA | 23000 | 5928 | 35904 | 4429 | 38469 | 3609 | 38737 | 3007 | 37618 | 2166 | 43914 | 1855 | 19062 |
| 4L-3S | | MI | 22358 | 5928 | 35046 | 4400 | 37658 | 3598 | 38119 | 2999 | 37405 | 2149 | 43531 | 1929 | 18022 |
| 10-#11 | 1.03 | MA | 22493 | 5928 | 35061 | 4428 | 37382 | 3620 | 37406 | 3017 | 35720 | 2160 | 41612 | 1812 | 19031 |
| 5L-2S | | MI | 23111 | 5928 | 36173 | 4402 | 39094 | 3588 | 39866 | 2990 | 39765 | 2142 | 46675 | 2018 | 17981 |
| 10-#14 | 1.48 | MA | 25548 | 6173 | 40700 | 4555 | 44497 | 3699 | 46031 | 3059 | 47351 | 2126 | 56453 | 1979 | 26971 |
| 2L-5S | | MI | 21718 | 6173 | 34608 | 4550 | 37004 | 3710 | 37284 | 3066 | 36221 | 2122 | 42733 | 1644 | 24963 |
| 10-#14 | 1.48 | MA | 24417 | 6173 | 38990 | 4553 | 42316 | 3714 | 43379 | 3072 | 43769 | 2136 | 51680 | 1851 | 26991 |
| 3L-4S | | MI | 22397 | 6173 | 35748 | 4553 | 38474 | 3695 | 39084 | 3053 | 38761 | 2132 | 45804 | 1704 | 25473 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

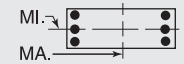
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.48 | MA | 23616 | 6173 | 37613 | 4571 | 40565 | 3710 | 41255 | 3066 | 41021 | 2145 | 48560 | 1723 | 26922 |
| 4L-3S | | MI | 23152 | 6173 | 37047 | 4536 | 40125 | 3700 | 41088 | 3060 | 41336 | 2122 | 48717 | 1832 | 25524 |
| 10-#14 | 1.48 | MA | 22897 | 6173 | 36405 | 4568 | 39007 | 3726 | 39347 | 3080 | 38311 | 2136 | 45282 | 1661 | 26362 |
| 5L-2S | | MI | 24216 | 6173 | 38658 | 4539 | 42180 | 3685 | 43585 | 3048 | 44693 | 2112 | 53179 | 1960 | 25494 |
| 10-#18 | 2.63 | MA | 28393 | 6793 | 47229 | 4912 | 52656 | 3955 | 55887 | 3212 | 60349 | 2051 | 73564 | 1829 | 46675 |
| 2L-5S | | MI | 22611 | 6793 | 37706 | 4909 | 40783 | 3977 | 41811 | 3224 | 42163 | 2048 | 51099 | 1241 | 40115 |
| 10-#18 | 2.63 | MA | 26466 | 6793 | 44237 | 4906 | 48842 | 3980 | 51250 | 3233 | 54144 | 2068 | 65333 | 1602 | 46486 |
| 3L-4S | | MI | 23771 | 6793 | 39706 | 4916 | 43361 | 3953 | 44967 | 3204 | 46558 | 2066 | 56409 | 1345 | 42412 |
| 10-#18 | 2.63 | MA | 25098 | 6793 | 41823 | 4936 | 45772 | 3970 | 47525 | 3220 | 49384 | 2086 | 59968 | 1374 | 44944 |
| 4L-3S | | MI | 25062 | 6793 | 41981 | 4887 | 46254 | 3964 | 48476 | 3219 | 51011 | 2048 | 61406 | 1572 | 43879 |
| 10-#18 | 2.63 | MA | 23869 | 6793 | 39702 | 4930 | 43038 | 3996 | 44178 | 3241 | 44687 | 2068 | 54292 | 1269 | 42433 |
| 5L-2S | | MI | 26874 | 6793 | 44796 | 4894 | 49842 | 3940 | 52838 | 3199 | 56816 | 2031 | 69084 | 1800 | 44041 |
| 12-#11 | 1.23 | MA | 24927 | 6039 | 39257 | 4487 | 42741 | 3651 | 43928 | 3032 | 44567 | 2145 | 52833 | 2016 | 22669 |
| 2L-6S | | MI | 21426 | 6039 | 33720 | 4479 | 35895 | 3654 | 35966 | 3031 | 34529 | 2148 | 40419 | 1721 | 21031 |
| 12-#11 | 1.23 | MA | 24131 | 6039 | 38061 | 4485 | 41216 | 3662 | 42074 | 3042 | 42056 | 2152 | 49473 | 1927 | 22696 |
| 3L-5S | | MI | 21881 | 6039 | 34471 | 4480 | 36915 | 3657 | 37210 | 3036 | 36170 | 2141 | 42462 | 1780 | 21444 |
| 12-#11 | 1.23 | MA | 23569 | 6039 | 37100 | 4498 | 39994 | 3659 | 40591 | 3038 | 40130 | 2160 | 47274 | 1839 | 22698 |
| 4E | | MI | 22357 | 6039 | 35266 | 4482 | 37941 | 3646 | 38467 | 3026 | 37955 | 2148 | 44620 | 1823 | 21484 |
| 12-#11 | 1.23 | MA | 23064 | 6039 | 36257 | 4497 | 38907 | 3671 | 39260 | 3048 | 38231 | 2153 | 44972 | 1795 | 22644 |
| 5L-3S | | MI | 22888 | 6039 | 36173 | 4470 | 39094 | 3649 | 39866 | 3031 | 39765 | 2141 | 46675 | 1911 | 21472 |
| 12-#11 | 1.23 | MA | 22583 | 6039 | 35462 | 4496 | 37827 | 3668 | 37942 | 3044 | 36486 | 2160 | 42787 | 1737 | 22189 |
| 6L-2S | | MI | 23637 | 6039 | 37300 | 4471 | 40531 | 3638 | 41612 | 3021 | 42124 | 2134 | 49819 | 2000 | 21441 |
| 12-#14 | 1.78 | MA | 26335 | 6332 | 42411 | 4655 | 46678 | 3771 | 48682 | 3104 | 50934 | 2115 | 61227 | 1953 | 32198 |
| 2L-6S | | MI | 21831 | 6332 | 35143 | 4647 | 37597 | 3778 | 37999 | 3104 | 37244 | 2120 | 44298 | 1531 | 28762 |
| 12-#14 | 1.78 | MA | 25212 | 6332 | 40700 | 4653 | 44497 | 3787 | 46031 | 3117 | 47351 | 2125 | 56453 | 1825 | 32186 |
| 3L-5S | | MI | 22473 | 6332 | 36220 | 4650 | 39059 | 3783 | 39782 | 3111 | 39578 | 2110 | 47195 | 1616 | 29639 |
| 12-#14 | 1.78 | MA | 24417 | 6332 | 39324 | 4670 | 42746 | 3782 | 43906 | 3111 | 44603 | 2135 | 53333 | 1697 | 32081 |
| 4E | | MI | 23147 | 6332 | 37360 | 4653 | 40529 | 3768 | 41581 | 3098 | 42118 | 2120 | 50266 | 1677 | 30335 |
| 12-#14 | 1.78 | MA | 23704 | 6332 | 38116 | 4668 | 41189 | 3798 | 41999 | 3125 | 41893 | 2125 | 50056 | 1636 | 31334 |
| 5L-3S | | MI | 23897 | 6332 | 38658 | 4636 | 42180 | 3772 | 43585 | 3105 | 44693 | 2110 | 53179 | 1805 | 30421 |
| 12-#14 | 1.78 | MA | 23023 | 6332 | 36975 | 4666 | 39640 | 3794 | 40110 | 3118 | 39403 | 2135 | 46954 | 1551 | 30373 |
| 6L-2S | | MI | 24954 | 6332 | 40269 | 4638 | 44234 | 3757 | 46082 | 3092 | 48050 | 2100 | 57641 | 1933 | 30420 |
| 12-#18 | 3.16 | MA | 29718 | 7077 | 50221 | 5089 | 56470 | 4083 | 60523 | 3292 | 66554 | 2028 | 81795 | 1777 | 55746 |
| 2L-6S | | MI | 22802 | 7077 | 38630 | 5080 | 41806 | 4094 | 43045 | 3288 | 43933 | 2042 | 53798 | 1033 | 45503 |
| 12-#18 | 3.16 | MA | 27809 | 7077 | 47229 | 5084 | 52656 | 4109 | 55887 | 3313 | 60349 | 2046 | 73564 | 1550 | 55484 |
| 3L-5S | | MI | 23896 | 7077 | 40520 | 5086 | 44371 | 4106 | 46172 | 3303 | 47968 | 2024 | 58777 | 1185 | 48323 |
| 12-#18 | 3.16 | MA | 26456 | 7077 | 44815 | 5113 | 49586 | 4099 | 52162 | 3299 | 55589 | 2064 | 68199 | 1322 | 53533 |
| 4E | | MI | 25043 | 7077 | 42521 | 5093 | 46949 | 4081 | 49329 | 3284 | 52363 | 2042 | 64087 | 1288 | 50476 |
| 12-#18 | 3.16 | MA | 25242 | 7077 | 42694 | 5108 | 46852 | 4124 | 48814 | 3321 | 50892 | 2046 | 62522 | 1217 | 51171 |
| 5L-3S | | MI | 26320 | 7077 | 44796 | 5065 | 49842 | 4093 | 52838 | 3299 | 56816 | 2024 | 69084 | 1516 | 52345 |
| 12-#18 | 3.16 | MA | 24084 | 7077 | 40690 | 5102 | 44132 | 4115 | 45498 | 3307 | 46579 | 2064 | 57181 | 1065 | 48168 |
| 6L-2S | | MI | 28115 | 7077 | 47610 | 5071 | 53430 | 4068 | 57200 | 3279 | 62620 | 2007 | 76762 | 1744 | 52578 |
| 14-#11 | 1.44 | MA | 25484 | 6149 | 40453 | 4556 | 44266 | 3701 | 45781 | 3063 | 47078 | 2138 | 56193 | 2000 | 26328 |
| 2L-7S | | MI | 21519 | 6149 | 34043 | 4560 | 36352 | 3715 | 36512 | 3072 | 35283 | 2148 | 41435 | 1616 | 23921 |
| 14-#11 | 1.44 | MA | 24693 | 6149 | 39257 | 4555 | 42741 | 3712 | 43928 | 3073 | 44567 | 2146 | 52833 | 1911 | 26346 |
| 3L-6S | | MI | 21960 | 6149 | 34847 | 4548 | 37332 | 3704 | 37713 | 3062 | 36889 | 2141 | 43563 | 1704 | 24341 |
| 14-#11 | 1.44 | MA | 24133 | 6149 | 38296 | 4567 | 41519 | 3709 | 42445 | 3069 | 42641 | 2153 | 50634 | 1822 | 26326 |
| 4L-5S | | MI | 22413 | 6149 | 35598 | 4550 | 38352 | 3707 | 38957 | 3067 | 38529 | 2134 | 45606 | 1762 | 24846 |
| 14-#11 | 1.44 | MA | 23632 | 6149 | 37453 | 4566 | 40432 | 3721 | 41114 | 3079 | 40742 | 2146 | 48332 | 1779 | 26251 |
| 5L-4S | | MI | 22886 | 6149 | 36393 | 4551 | 39378 | 3696 | 40213 | 3057 | 40314 | 2141 | 47764 | 1805 | 24905 |
| 14-#11 | 1.44 | MA | 23153 | 6149 | 36658 | 4565 | 39352 | 3718 | 39796 | 3075 | 38998 | 2153 | 46147 | 1721 | 25704 |
| 6L-3S | | MI | 23414 | 6149 | 37300 | 4539 | 40531 | 3699 | 41612 | 3062 | 42124 | 2134 | 49819 | 1894 | 24914 |
| 14-#11 | 1.44 | MA | 22686 | 6149 | 35807 | 4578 | 38314 | 3730 | 38525 | 3085 | 37290 | 2160 | 43873 | 1633 | 25241 |
| 7L-2S | | MI | 24160 | 6149 | 38427 | 4540 | 41968 | 3688 | 43359 | 3052 | 44483 | 2127 | 52963 | 1982 | 24892 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis

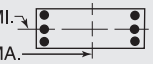



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.07 | MA | 27116 | 6492 | 44122 | 4754 | 48860 | 3843 | 51334 | 3149 | 54516 | 2104 | 66001 | 1928 | 37413 |
| 2L-7S | | MI | 21961 | 6492 | 35602 | 4764 | 38247 | 3865 | 38776 | 3161 | 38317 | 2118 | 45742 | 1377 | 32471 |
| 14-#14 | 2.07 | MA | 26000 | 6492 | 42411 | 4752 | 46678 | 3859 | 48682 | 3162 | 50934 | 2114 | 61227 | 1800 | 37371 |
| 3L-6S | | MI | 22584 | 6492 | 36754 | 4747 | 39651 | 3850 | 40496 | 3149 | 40601 | 2108 | 48760 | 1504 | 33501 |
| 14-#14 | 2.07 | MA | 25210 | 6492 | 41035 | 4770 | 44928 | 3855 | 46558 | 3156 | 48185 | 2124 | 58107 | 1672 | 37233 |
| 4L-5S | | MI | 23222 | 6492 | 37831 | 4750 | 41113 | 3855 | 42279 | 3156 | 42934 | 2098 | 51658 | 1589 | 34333 |
| 14-#14 | 2.07 | MA | 24503 | 6492 | 39827 | 4768 | 43370 | 3870 | 44650 | 3169 | 45475 | 2114 | 54829 | 1611 | 36324 |
| 5L-4S | | MI | 23891 | 6492 | 38971 | 4753 | 42583 | 3840 | 44078 | 3143 | 45475 | 2108 | 54729 | 1649 | 35189 |
| 14-#14 | 2.07 | MA | 23828 | 6492 | 38686 | 4766 | 41821 | 3866 | 42762 | 3163 | 42985 | 2124 | 51727 | 1526 | 35410 |
| 6L-3S | | MI | 24636 | 6492 | 40269 | 4735 | 44234 | 3845 | 46082 | 3150 | 48050 | 2098 | 57641 | 1777 | 35306 |
| 14-#14 | 2.07 | MA | 23169 | 6492 | 37466 | 4783 | 40334 | 3882 | 40939 | 3177 | 40547 | 2134 | 48497 | 1399 | 34305 |
| 7L-2S | | MI | 25686 | 6492 | 41881 | 4738 | 46288 | 3830 | 48579 | 3137 | 51406 | 2088 | 62103 | 1905 | 35338 |
| 14-#18 | 3.68 | MA | 29138 | 7361 | 50221 | 5261 | 56470 | 4237 | 60523 | 3393 | 66554 | 2024 | 81795 | 1498 | 64471 |
| 3L-6S | | MI | 24084 | 7361 | 41445 | 5257 | 45395 | 4223 | 47407 | 3368 | 49738 | 2018 | 61477 | 977 | 53574 |
| 14-#18 | 3.68 | MA | 27800 | 7361 | 47806 | 5291 | 53401 | 4227 | 56799 | 3379 | 61794 | 2042 | 76430 | 1270 | 62163 |
| 4L-5S | | MI | 25167 | 7361 | 43335 | 5264 | 47959 | 4234 | 50534 | 3383 | 53773 | 2000 | 66456 | 1129 | 56553 |
| 14-#18 | 3.68 | MA | 26599 | 7361 | 45685 | 5285 | 50666 | 4253 | 53451 | 3401 | 57097 | 2024 | 70753 | 1164 | 59933 |
| 5L-4S | | MI | 26301 | 7361 | 45335 | 5270 | 50537 | 4210 | 53690 | 3363 | 58168 | 2018 | 71765 | 1232 | 58581 |
| 14-#18 | 3.68 | MA | 25454 | 7361 | 43682 | 5279 | 47947 | 4243 | 50135 | 3387 | 52784 | 2042 | 65412 | 1013 | 56770 |
| 6L-3S | | MI | 27564 | 7361 | 47610 | 5242 | 53430 | 4221 | 57200 | 3379 | 62620 | 2000 | 76762 | 1460 | 60799 |
| 16-#11 | 1.64 | MA | 26039 | 6260 | 41649 | 4625 | 45791 | 3751 | 47635 | 3094 | 49589 | 2131 | 59553 | 1984 | 29982 |
| 2L-8S | | MI | 21620 | 6260 | 34432 | 4628 | 36800 | 3762 | 37083 | 3112 | 35961 | 2134 | 42563 | 1549 | 26695 |
| 16-#11 | 1.64 | MA | 25250 | 6260 | 40453 | 4624 | 44266 | 3762 | 45781 | 3104 | 47078 | 2139 | 56193 | 1895 | 29985 |
| 3L-7S | | MI | 22053 | 6260 | 35170 | 4629 | 37789 | 3765 | 38259 | 3103 | 37643 | 2140 | 44579 | 1598 | 27256 |
| 16-#11 | 1.64 | MA | 24694 | 6260 | 39492 | 4636 | 43044 | 3760 | 44298 | 3100 | 45152 | 2146 | 53994 | 1806 | 29948 |
| 4L-6S | | MI | 22491 | 6260 | 35973 | 4617 | 38769 | 3754 | 39459 | 3093 | 39248 | 2134 | 46707 | 1686 | 27659 |
| 16-#11 | 1.64 | MA | 24195 | 6260 | 38649 | 4635 | 41957 | 3771 | 42967 | 3110 | 43254 | 2139 | 51692 | 1763 | 29855 |
| 5E | | MI | 22941 | 6260 | 36725 | 4619 | 39789 | 3757 | 40703 | 3098 | 40888 | 2127 | 48749 | 1745 | 28243 |
| 16-#11 | 1.64 | MA | 23720 | 6260 | 37854 | 4634 | 40876 | 3768 | 41650 | 3106 | 41509 | 2146 | 49507 | 1704 | 29227 |
| 6L-4S | | MI | 23412 | 6260 | 37520 | 4620 | 40815 | 3746 | 41960 | 3088 | 42673 | 2134 | 50908 | 1787 | 28320 |
| 16-#11 | 1.64 | MA | 23255 | 6260 | 37003 | 4647 | 39839 | 3780 | 40378 | 3116 | 39802 | 2153 | 47233 | 1617 | 28783 |
| 7L-3S | | MI | 23938 | 6260 | 38427 | 4608 | 41968 | 3749 | 43359 | 3093 | 44483 | 2127 | 52963 | 1876 | 28349 |
| 16-#11 | 1.64 | MA | 22798 | 6260 | 36222 | 4646 | 38792 | 3777 | 39133 | 3126 | 38013 | 2147 | 45082 | 1566 | 28176 |
| 8L-2S | | MI | 24680 | 6260 | 39554 | 4609 | 43404 | 3738 | 45105 | 3083 | 46842 | 2120 | 56107 | 1965 | 28337 |
| 16-#14 | 2.37 | MA | 27891 | 6651 | 45833 | 4854 | 51041 | 3916 | 53986 | 3194 | 58098 | 2094 | 70774 | 1902 | 42613 |
| 2L-8S | | MI | 22104 | 6651 | 36156 | 4861 | 38884 | 3932 | 39588 | 3219 | 39281 | 2097 | 47335 | 1279 | 36055 |
| 16-#14 | 2.37 | MA | 26782 | 6651 | 44122 | 4852 | 48860 | 3931 | 51334 | 3207 | 54516 | 2104 | 66001 | 1774 | 42547 |
| 3L-7S | | MI | 22714 | 6651 | 37213 | 4864 | 40301 | 3937 | 41273 | 3206 | 41674 | 2107 | 50204 | 1350 | 37132 |
| 16-#14 | 2.37 | MA | 25998 | 6651 | 42746 | 4870 | 47109 | 3927 | 49210 | 3201 | 51768 | 2114 | 62881 | 1646 | 42380 |
| 4L-6S | | MI | 23332 | 6651 | 38365 | 4847 | 41705 | 3922 | 42993 | 3193 | 43957 | 2097 | 53222 | 1476 | 38249 |
| 16-#14 | 2.37 | MA | 25296 | 6651 | 41538 | 4868 | 45551 | 3943 | 47302 | 3214 | 49057 | 2104 | 59603 | 1585 | 41329 |
| 5E | | MI | 23965 | 6651 | 39442 | 4850 | 43167 | 3927 | 44776 | 3201 | 46291 | 2087 | 56120 | 1561 | 39042 |
| 16-#14 | 2.37 | MA | 24626 | 6651 | 40397 | 4865 | 44003 | 3938 | 45413 | 3208 | 46567 | 2114 | 56501 | 1500 | 40456 |
| 6L-4S | | MI | 24629 | 6651 | 40582 | 4852 | 44637 | 3912 | 46576 | 3188 | 48831 | 2097 | 59191 | 1622 | 40037 |
| 16-#14 | 2.37 | MA | 23972 | 6651 | 39177 | 4883 | 42515 | 3954 | 43591 | 3222 | 44129 | 2124 | 53271 | 1374 | 39265 |
| 7L-3S | | MI | 25369 | 6651 | 41881 | 4835 | 46288 | 3917 | 48579 | 3195 | 51406 | 2087 | 62103 | 1750 | 40183 |
| 16-#14 | 2.37 | MA | 23327 | 6651 | 38057 | 4881 | 41014 | 3950 | 41806 | 3235 | 41576 | 2114 | 50209 | 1302 | 38092 |
| 8L-2S | | MI | 26413 | 6651 | 43492 | 4838 | 48342 | 3902 | 51076 | 3182 | 54763 | 2077 | 66565 | 1878 | 40237 |
| 16-#18 | 4.21 | MA | 29130 | 7644 | 50798 | 5468 | 57215 | 4356 | 61435 | 3459 | 67999 | 2019 | 84661 | 1218 | 70826 |
| 4L-6S | | MI | 25353 | 7644 | 44259 | 5434 | 48983 | 4352 | 51769 | 3448 | 55542 | 1993 | 69155 | 921 | 61671 |
| 16-#18 | 4.21 | MA | 27942 | 7644 | 48677 | 5462 | 54480 | 4382 | 58087 | 3480 | 63302 | 2002 | 78984 | 1112 | 68713 |
| 5E | | MI | 26424 | 7644 | 46149 | 5441 | 51547 | 4363 | 54896 | 3463 | 59578 | 1976 | 74134 | 1072 | 64803 |
| 16-#18 | 4.21 | MA | 26810 | 7644 | 46673 | 5457 | 51761 | 4372 | 54771 | 3466 | 58989 | 2019 | 73643 | 961 | 65398 |
| 6L-4S | | MI | 27547 | 7644 | 48149 | 5448 | 54126 | 4339 | 58052 | 3443 | 63973 | 1993 | 79444 | 1176 | 66718 |
| 18-#11 | 1.85 | MA | 26590 | 6371 | 42845 | 4694 | 47315 | 3801 | 49489 | 3125 | 52101 | 2125 | 62913 | 1967 | 33630 |
| 2L-9S | | MI | 21726 | 6371 | 34778 | 4709 | 37271 | 3823 | 37613 | 3139 | 36731 | 2133 | 43727 | 1474 | 29360 |
| 18-#11 | 1.85 | MA | 25805 | 6371 | 41649 | 4693 | 45791 | 3812 | 47635 | 3135 | 49589 | 2132 | 59553 | 1878 | 33617 |
| 3L-8S | | MI | 22153 | 6371 | 35559 | 4697 | 38237 | 3812 | 38830 | 3143 | 38320 | 2126 | 45706 | 1531 | 29979 |

## RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

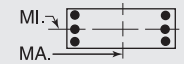
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.85 | MA | 25251 | 6371 | 40688 | 4706 | 44568 | 3810 | 46152 | 3131 | 47664 | 2139 | 57354 | 1790 | 33566 |
| 4L-7S | | MI | 22583 | 6371 | 36297 | 4699 | 39226 | 3815 | 40005 | 3134 | 40002 | 2133 | 47723 | 1581 | 30596 |
| 18-#11 | 1.85 | MA | 24756 | 6371 | 39845 | 4704 | 43482 | 3821 | 44821 | 3141 | 45765 | 2132 | 55052 | 1747 | 33456 |
| 5L-6S | | MI | 23019 | 6371 | 37100 | 4686 | 40205 | 3804 | 41206 | 3125 | 41607 | 2126 | 49850 | 1668 | 30983 |
| 18-#11 | 1.85 | MA | 24283 | 6371 | 39050 | 4703 | 42401 | 3819 | 43503 | 3137 | 44020 | 2139 | 52867 | 1688 | 32757 |
| 6L-5S | | MI | 23466 | 6371 | 37851 | 4688 | 41225 | 3807 | 42450 | 3129 | 43247 | 2119 | 51893 | 1727 | 31635 |
| 18-#11 | 1.85 | MA | 23821 | 6371 | 38199 | 4716 | 41364 | 3830 | 42232 | 3147 | 42313 | 2147 | 50593 | 1600 | 32329 |
| 7L-4S | | MI | 23935 | 6371 | 38647 | 4689 | 42251 | 3796 | 43706 | 3120 | 45032 | 2126 | 54052 | 1770 | 31731 |
| 18-#11 | 1.85 | MA | 23366 | 6371 | 37418 | 4715 | 40317 | 3827 | 40987 | 3157 | 40525 | 2140 | 48442 | 1550 | 31666 |
| 8L-3S | | MI | 24458 | 6371 | 39554 | 4677 | 43404 | 3799 | 45105 | 3124 | 46842 | 2119 | 56107 | 1858 | 31772 |
| 18-#11 | 1.85 | MA | 22905 | 6371 | 36592 | 4728 | 39294 | 3839 | 39699 | 3153 | 38835 | 2147 | 46325 | 1494 | 30992 |
| 9L-2S | | MI | 25196 | 6371 | 40681 | 4678 | 44841 | 3788 | 46852 | 3115 | 49202 | 2112 | 59251 | 1947 | 31777 |
| 18-#14 | 2.66 | MA | 27558 | 6811 | 45833 | 4952 | 51041 | 4004 | 53986 | 3252 | 58098 | 2093 | 70774 | 1749 | 47718 |
| 3L-8S | | MI | 22855 | 6811 | 37767 | 4961 | 40938 | 4005 | 42085 | 3264 | 42637 | 2085 | 51798 | 1252 | 40765 |
| 18-#14 | 2.66 | MA | 26780 | 6811 | 44456 | 4969 | 49290 | 3999 | 51861 | 3246 | 55350 | 2103 | 67654 | 1621 | 47524 |
| 4L-7S | | MI | 23460 | 6811 | 38824 | 4964 | 42355 | 4010 | 43770 | 3251 | 45030 | 2095 | 54666 | 1322 | 41805 |
| 18-#14 | 2.66 | MA | 26082 | 6811 | 43248 | 4967 | 47733 | 4015 | 49954 | 3259 | 52639 | 2093 | 64376 | 1560 | 46346 |
| 5L-6S | | MI | 24074 | 6811 | 39977 | 4947 | 43759 | 3995 | 45490 | 3238 | 47314 | 2085 | 57685 | 1449 | 43004 |
| 18-#14 | 2.66 | MA | 25417 | 6811 | 42108 | 4965 | 46184 | 4011 | 48065 | 3253 | 50149 | 2103 | 61275 | 1475 | 45510 |
| 6L-5S | | MI | 24703 | 6811 | 41053 | 4949 | 45221 | 3999 | 47273 | 3245 | 49648 | 2075 | 60582 | 1534 | 43762 |
| 18-#14 | 2.66 | MA | 24768 | 6811 | 40888 | 4983 | 44696 | 4026 | 46242 | 3266 | 47712 | 2113 | 58045 | 1348 | 44236 |
| 7L-4S | | MI | 25362 | 6811 | 42193 | 4952 | 46691 | 3984 | 49073 | 3233 | 52188 | 2085 | 63653 | 1594 | 44881 |
| 18-#14 | 2.66 | MA | 24128 | 6811 | 39768 | 4981 | 43195 | 4022 | 44457 | 3280 | 45158 | 2103 | 54982 | 1277 | 43102 |
| 8L-3S | | MI | 26096 | 6811 | 43492 | 4935 | 48342 | 3989 | 51076 | 3240 | 54763 | 2075 | 66565 | 1722 | 45053 |
| 18-#14 | 2.66 | MA | 23494 | 6811 | 38583 | 4999 | 41728 | 4038 | 42611 | 3274 | 42746 | 2113 | 51977 | 1195 | 41461 |
| 9L-2S | | MI | 27134 | 6811 | 45103 | 4938 | 50396 | 3974 | 53573 | 3227 | 58120 | 2065 | 71028 | 1850 | 45129 |
| 18-#18 | 4.74 | MA | 29272 | 7928 | 51669 | 5640 | 58294 | 4510 | 62724 | 3560 | 69507 | 1980 | 87215 | 1060 | 77509 |
| 5L-6S | | MI | 26610 | 7928 | 47073 | 5612 | 52571 | 4480 | 56131 | 3527 | 61347 | 1969 | 76834 | 865 | 69791 |
| 18-#18 | 4.74 | MA | 28151 | 7928 | 49665 | 5634 | 55575 | 4500 | 59408 | 3546 | 65194 | 1997 | 81873 | 909 | 74049 |
| 6L-5S | | MI | 27670 | 7928 | 48963 | 5618 | 55135 | 4491 | 59258 | 3543 | 65382 | 1951 | 81813 | 1016 | 73068 |
| 20-#11 | 2.05 | MA | 27137 | 6481 | 44041 | 4763 | 48840 | 3851 | 51342 | 3157 | 54612 | 2118 | 66273 | 1951 | 37270 |
| 2L-10S | | MI | 21794 | 6481 | 35171 | 4777 | 37731 | 3870 | 38192 | 3179 | 37514 | 2133 | 44953 | 1393 | 31845 |
| 20-#11 | 2.05 | MA | 26356 | 6481 | 42845 | 4762 | 47315 | 3862 | 49489 | 3166 | 52101 | 2125 | 62913 | 1862 | 37244 |
| 3L-9S | | MI | 22258 | 6481 | 35905 | 4779 | 38707 | 3873 | 39360 | 3170 | 39091 | 2126 | 46871 | 1457 | 32669 |
| 20-#11 | 2.05 | MA | 25806 | 6481 | 41884 | 4775 | 46093 | 3860 | 48006 | 3163 | 50175 | 2132 | 60714 | 1773 | 37179 |
| 4L-8S | | MI | 22682 | 6481 | 36686 | 4766 | 39674 | 3862 | 40576 | 3174 | 40679 | 2119 | 48850 | 1513 | 33268 |
| 20-#11 | 2.05 | MA | 25312 | 6481 | 41042 | 4774 | 45006 | 3871 | 46675 | 3172 | 48276 | 2125 | 58412 | 1730 | 36978 |
| 5L-7S | | MI | 23110 | 6481 | 37423 | 4768 | 40662 | 3865 | 41752 | 3165 | 42361 | 2126 | 50867 | 1563 | 33938 |
| 20-#11 | 2.05 | MA | 24842 | 6481 | 40246 | 4772 | 43926 | 3869 | 45357 | 3169 | 46532 | 2132 | 56227 | 1672 | 36293 |
| 6E | | MI | 23544 | 6481 | 38227 | 4755 | 41642 | 3854 | 42952 | 3156 | 43966 | 2119 | 52994 | 1651 | 34312 |
| 20-#11 | 2.05 | MA | 24383 | 6481 | 39395 | 4785 | 42889 | 3880 | 44086 | 3178 | 44824 | 2140 | 53953 | 1584 | 35878 |
| 7L-5S | | MI | 23989 | 6481 | 38978 | 4757 | 42662 | 3857 | 44196 | 3160 | 45607 | 2112 | 55037 | 1709 | 34936 |
| 20-#11 | 2.05 | MA | 23931 | 6481 | 38614 | 4784 | 41842 | 3877 | 42841 | 3188 | 43036 | 2133 | 51802 | 1534 | 35163 |
| 8L-4S | | MI | 24455 | 6481 | 39774 | 4758 | 43688 | 3846 | 45453 | 3151 | 47392 | 2119 | 57196 | 1752 | 35137 |
| 20-#11 | 2.05 | MA | 23482 | 6481 | 37788 | 4797 | 40819 | 3889 | 41553 | 3185 | 41346 | 2140 | 49685 | 1477 | 34508 |
| 9L-3S | | MI | 24975 | 6481 | 40681 | 4746 | 44841 | 3849 | 46852 | 3155 | 49202 | 2112 | 59251 | 1841 | 35192 |
| 20-#11 | 2.05 | MA | 22980 | 6481 | 37011 | 4796 | 39785 | 3886 | 40316 | 3194 | 39669 | 2147 | 47633 | 1414 | 33624 |
| 10L-2S | | MI | 25710 | 6481 | 41808 | 4748 | 46278 | 3838 | 48598 | 3146 | 51561 | 2105 | 62395 | 1929 | 35212 |
| 20-#14 | 2.96 | MA | 27556 | 6971 | 46167 | 5069 | 51472 | 4072 | 54513 | 3291 | 58932 | 2093 | 72428 | 1596 | 52665 |
| 4L-8S | | MI | 23600 | 6971 | 39378 | 5061 | 42992 | 4077 | 44582 | 3309 | 45994 | 2074 | 56260 | 1224 | 45414 |
| 20-#14 | 2.96 | MA | 26863 | 6971 | 44959 | 5067 | 49914 | 4087 | 52606 | 3304 | 56222 | 2083 | 69150 | 1534 | 51373 |
| 5L-7S | | MI | 24201 | 6971 | 40436 | 5064 | 44409 | 4082 | 46267 | 3296 | 48387 | 2084 | 59128 | 1295 | 46488 |
| 20-#14 | 2.96 | MA | 26203 | 6971 | 43819 | 5065 | 48365 | 4083 | 50717 | 3298 | 53731 | 2093 | 66048 | 1450 | 50570 |
| 6E | | MI | 24811 | 6971 | 41588 | 5046 | 45813 | 4067 | 47987 | 3283 | 50671 | 2074 | 62147 | 1421 | 47765 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis

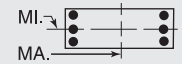


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.96 | MA | 25559 | 6971 | 42599 | 5083 | 46878 | 4099 | 48894 | 3311 | 51294 | 2103 | 62818 | 1323 | 49218 |
| 7L-5S | | MI | 25435 | 6971 | 42664 | 5049 | 47275 | 4072 | 49770 | 3290 | 53004 | 2064 | 65044 | 1506 | 48492 |
| 20-#14 | 2.96 | MA | 24924 | 6971 | 41479 | 5081 | 45377 | 4094 | 47109 | 3325 | 48740 | 2093 | 59756 | 1251 | 48078 |
| 8L-4S | | MI | 26089 | 6971 | 43804 | 5052 | 48745 | 4057 | 51570 | 3278 | 55544 | 2074 | 68115 | 1567 | 49722 |
| 20-#14 | 2.96 | MA | 24294 | 6971 | 40294 | 5098 | 43910 | 4110 | 45263 | 3319 | 46328 | 2103 | 56751 | 1170 | 46428 |
| 9L-3S | | MI | 26819 | 6971 | 45103 | 5035 | 50396 | 4062 | 53573 | 3285 | 58120 | 2064 | 71028 | 1695 | 49918 |
| 20-#18 | 5.26 | MA | 29481 | 8212 | 52657 | 5811 | 59389 | 4629 | 64045 | 3626 | 71399 | 1975 | 90104 | 857 | 82721 |
| 6E | | MI | 27855 | 8212 | 49888 | 5789 | 56159 | 4609 | 60492 | 3607 | 67152 | 1945 | 84512 | 808 | 77931 |
| 22-#11 | 2.26 | MA | 26905 | 6592 | 44041 | 4831 | 48840 | 3913 | 51342 | 3198 | 54612 | 2118 | 66273 | 1846 | 40868 |
| 3L-10S | | MI | 22324 | 6592 | 36298 | 4846 | 39168 | 3920 | 39938 | 3211 | 39873 | 2125 | 48097 | 1375 | 35122 |
| 22-#11 | 2.26 | MA | 26357 | 6592 | 43080 | 4844 | 47618 | 3910 | 49859 | 3194 | 52686 | 2125 | 64074 | 1757 | 40790 |
| 4L-9S | | MI | 22786 | 6592 | 37032 | 4848 | 40144 | 3923 | 41106 | 3201 | 41450 | 2118 | 50015 | 1439 | 35982 |
| 22-#11 | 2.26 | MA | 25866 | 6592 | 42238 | 4843 | 46531 | 3921 | 48528 | 3204 | 50788 | 2118 | 61772 | 1714 | 40491 |
| 5L-8S | | MI | 23208 | 6592 | 37813 | 4835 | 41110 | 3912 | 42323 | 3206 | 43039 | 2112 | 51994 | 1496 | 36564 |
| 22-#11 | 2.26 | MA | 25398 | 6592 | 41442 | 4842 | 45451 | 3919 | 47211 | 3200 | 49043 | 2126 | 59587 | 1655 | 39833 |
| 6L-7S | | MI | 23634 | 6592 | 38550 | 4837 | 42099 | 3915 | 43498 | 3196 | 44720 | 2118 | 54011 | 1545 | 37283 |
| 22-#11 | 2.26 | MA | 24942 | 6592 | 40591 | 4854 | 44414 | 3930 | 45939 | 3210 | 47336 | 2133 | 57313 | 1568 | 39430 |
| 7L-6S | | MI | 24066 | 6592 | 39354 | 4825 | 43079 | 3904 | 44699 | 3187 | 46326 | 2112 | 56138 | 1633 | 37646 |
| 22-#11 | 2.26 | MA | 24492 | 6592 | 39810 | 4853 | 43367 | 3928 | 44694 | 3220 | 45547 | 2126 | 55162 | 1517 | 38665 |
| 8L-5S | | MI | 24508 | 6592 | 40105 | 4826 | 44099 | 3907 | 45943 | 3191 | 47966 | 2105 | 58181 | 1692 | 38244 |
| 22-#11 | 2.26 | MA | 24046 | 6592 | 38984 | 4866 | 42343 | 3939 | 43406 | 3216 | 43857 | 2133 | 53045 | 1461 | 38029 |
| 9L-4S | | MI | 24972 | 6592 | 40901 | 4828 | 45125 | 3896 | 47199 | 3182 | 49751 | 2112 | 60340 | 1734 | 38540 |
| 22-#11 | 2.26 | MA | 23546 | 6592 | 38207 | 4865 | 41310 | 3936 | 42169 | 3226 | 42180 | 2140 | 50993 | 1397 | 37110 |
| 10L-3S | | MI | 25489 | 6592 | 41808 | 4815 | 46278 | 3899 | 48598 | 3186 | 51561 | 2105 | 62395 | 1823 | 38607 |
| 22-#14 | 3.26 | MA | 27639 | 7130 | 46670 | 5167 | 52095 | 4160 | 55257 | 3349 | 59804 | 2072 | 73924 | 1509 | 56409 |
| 5L-8S | | MI | 24340 | 7130 | 40989 | 5161 | 45046 | 4149 | 47079 | 3354 | 49350 | 2062 | 60722 | 1196 | 50048 |
| 22-#14 | 3.26 | MA | 26984 | 7130 | 45530 | 5165 | 50547 | 4155 | 53368 | 3343 | 57313 | 2082 | 70822 | 1424 | 55635 |
| 6L-7S | | MI | 24937 | 7130 | 42047 | 5163 | 46464 | 4154 | 48764 | 3341 | 51744 | 2072 | 63591 | 1267 | 51180 |
| 22-#14 | 3.26 | MA | 26344 | 7130 | 44310 | 5182 | 49059 | 4171 | 51546 | 3356 | 54876 | 2092 | 67592 | 1297 | 54208 |
| 7L-6S | | MI | 25542 | 7130 | 43199 | 5146 | 47868 | 4139 | 50485 | 3328 | 54027 | 2062 | 66609 | 1394 | 52531 |
| 22-#14 | 3.26 | MA | 25713 | 7130 | 43190 | 5180 | 47558 | 4167 | 49761 | 3370 | 52323 | 2082 | 64530 | 1226 | 53011 |
| 8L-5S | | MI | 26162 | 7130 | 44276 | 5149 | 49329 | 4144 | 52267 | 3335 | 56361 | 2052 | 69507 | 1479 | 53231 |
| 22-#14 | 3.26 | MA | 25088 | 7130 | 42005 | 5198 | 46091 | 4182 | 47914 | 3363 | 49910 | 2092 | 61525 | 1144 | 51403 |
| 9L-4S | | MI | 26813 | 7130 | 45416 | 5152 | 50799 | 4129 | 54067 | 3323 | 58901 | 2062 | 72578 | 1539 | 54560 |
| 24-#11 | 2.46 | MA | 26905 | 6702 | 44276 | 4913 | 49143 | 3960 | 51713 | 3225 | 55198 | 2118 | 67434 | 1741 | 44399 |
| 4L-10S | | MI | 22852 | 6702 | 37425 | 4915 | 40605 | 3970 | 41685 | 3242 | 42232 | 2118 | 51241 | 1358 | 38405 |
| 24-#11 | 2.46 | MA | 26417 | 6702 | 43434 | 4912 | 48056 | 3971 | 50382 | 3235 | 53299 | 2112 | 65132 | 1698 | 44010 |
| 5L-9S | | MI | 23312 | 6702 | 38159 | 4917 | 41581 | 3973 | 42853 | 3232 | 43809 | 2111 | 53159 | 1421 | 39299 |
| 24-#11 | 2.46 | MA | 25952 | 6702 | 42638 | 4911 | 46976 | 3969 | 49064 | 3231 | 51554 | 2119 | 62947 | 1639 | 43377 |
| 6L-8S | | MI | 23732 | 6702 | 38940 | 4905 | 42547 | 3962 | 44069 | 3237 | 45398 | 2104 | 55138 | 1478 | 39865 |
| 24-#11 | 2.46 | MA | 25498 | 6702 | 41787 | 4923 | 45938 | 3980 | 47793 | 3241 | 49847 | 2126 | 60673 | 1551 | 42985 |
| 7E | | MI | 24155 | 6702 | 39677 | 4906 | 43536 | 3965 | 45245 | 3227 | 47080 | 2111 | 57155 | 1528 | 40631 |
| 24-#11 | 2.46 | MA | 25050 | 6702 | 41006 | 4922 | 44891 | 3978 | 46548 | 3251 | 48059 | 2119 | 58522 | 1501 | 42173 |
| 8L-6S | | MI | 24585 | 6702 | 40481 | 4894 | 44515 | 3954 | 46445 | 3218 | 48685 | 2104 | 59282 | 1615 | 40984 |
| 24-#11 | 2.46 | MA | 24604 | 6702 | 40180 | 4935 | 43868 | 3989 | 45260 | 3247 | 46369 | 2126 | 56405 | 1445 | 41553 |
| 9L-5S | | MI | 25025 | 6702 | 41232 | 4895 | 45536 | 3957 | 47689 | 3222 | 50325 | 2097 | 61325 | 1674 | 41558 |
| 24-#11 | 2.46 | MA | 24109 | 6702 | 39403 | 4934 | 42835 | 3987 | 44023 | 3257 | 44691 | 2133 | 54353 | 1381 | 40600 |
| 10L-4S | | MI | 25486 | 6702 | 42028 | 4897 | 46561 | 3947 | 48946 | 3213 | 52110 | 2104 | 63484 | 1717 | 41941 |
| 24-#14 | 3.55 | MA | 27759 | 7290 | 47241 | 5264 | 52728 | 4228 | 56020 | 3388 | 60895 | 2072 | 75595 | 1399 | 60705 |
| 6L-8S | | MI | 25075 | 7290 | 42601 | 5260 | 47101 | 4222 | 49576 | 3399 | 52707 | 2050 | 65184 | 1169 | 54691 |
| 24-#14 | 3.55 | MA | 27124 | 7290 | 46020 | 5282 | 51240 | 4243 | 54197 | 3401 | 58458 | 2082 | 72365 | 1272 | 59207 |
| 7E | | MI | 25668 | 7290 | 43658 | 5263 | 48518 | 4226 | 51261 | 3386 | 55100 | 2060 | 68053 | 1240 | 55881 |
| 24-#14 | 3.55 | MA | 26497 | 7290 | 44901 | 5280 | 49739 | 4239 | 52413 | 3415 | 55905 | 2072 | 69303 | 1200 | 57953 |
| 8L-6S | | MI | 26269 | 7290 | 44810 | 5246 | 49922 | 4212 | 52982 | 3373 | 57384 | 2050 | 71071 | 1366 | 57302 |
| 24-#14 | 3.55 | MA | 25875 | 7290 | 43716 | 5298 | 48272 | 4255 | 50566 | 3408 | 53492 | 2082 | 66298 | 1119 | 56385 |
| 9L-5S | | MI | 26885 | 7290 | 45887 | 5249 | 51384 | 4216 | 54764 | 3380 | 59717 | 2041 | 73969 | 1451 | 57978 |

## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

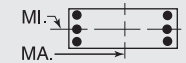
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.00 | MA | 26711 | 6211 | 41844 | 4598 | 45112 | 3748 | 45919 | 3125 | 45609 | 2238 | 53402 | 2106 | 20331 |
| 2E | | MI | 24086 | 6211 | 37889 | 4562 | 40673 | 3719 | 41304 | 3100 | 40791 | 2211 | 47583 | 2072 | 18254 |
| 6-#18 | 1.50 | MA | 28179 | 6495 | 45013 | 4776 | 49152 | 3877 | 50830 | 3205 | 52215 | 2218 | 62186 | 2058 | 30058 |
| 2L-3S | | MI | 23522 | 6495 | 37889 | 4733 | 40673 | 3872 | 41304 | 3200 | 40791 | 2205 | 47583 | 1789 | 26960 |
| 6-#18 | 1.50 | MA | 26088 | 6495 | 41844 | 4771 | 45112 | 3904 | 45919 | 3228 | 45609 | 2236 | 53402 | 1830 | 30057 |
| 3L-2S | | MI | 25376 | 6495 | 40703 | 4740 | 44261 | 3847 | 45666 | 3180 | 46596 | 2187 | 55262 | 2016 | 26917 |
| 8-#14 | 1.13 | MA | 27168 | 6282 | 42615 | 4674 | 46269 | 3806 | 47392 | 3167 | 47727 | 2256 | 56359 | 2125 | 22945 |
| 2L-4S | | MI | 22662 | 6282 | 35667 | 4655 | 38016 | 3789 | 38142 | 3149 | 36800 | 2252 | 42885 | 1836 | 20660 |
| 8-#14 | 1.13 | MA | 25960 | 6282 | 40804 | 4672 | 43960 | 3822 | 44586 | 3181 | 43926 | 2266 | 51274 | 1997 | 22992 |
| 3E | | MI | 23424 | 6282 | 36966 | 4638 | 39667 | 3794 | 40146 | 3157 | 39375 | 2242 | 45798 | 1964 | 20648 |
| 8-#14 | 1.13 | MA | 25106 | 6282 | 39349 | 4690 | 42110 | 3819 | 42340 | 3175 | 41010 | 2276 | 47946 | 1869 | 22968 |
| 4L-2S | | MI | 24496 | 6282 | 38577 | 4641 | 41721 | 3779 | 42643 | 3144 | 42732 | 2232 | 50260 | 2092 | 20591 |
| 8-#18 | 2.01 | MA | 29626 | 6778 | 48182 | 4953 | 53192 | 4006 | 55742 | 3285 | 58821 | 2198 | 70970 | 2009 | 39737 |
| 2L-4S | | MI | 23505 | 6778 | 38428 | 4939 | 41368 | 3989 | 42157 | 3264 | 42143 | 2198 | 50265 | 1505 | 34764 |
| 8-#18 | 2.01 | MA | 27557 | 6778 | 45013 | 4948 | 49152 | 4032 | 50830 | 3308 | 52215 | 2215 | 62186 | 1782 | 39633 |
| 3E | | MI | 24814 | 6778 | 40703 | 4910 | 44261 | 4000 | 45666 | 3280 | 46596 | 2180 | 55262 | 1732 | 35478 |
| 8-#18 | 2.01 | MA | 26090 | 6778 | 42460 | 4979 | 45905 | 4024 | 46890 | 3295 | 47147 | 2233 | 56452 | 1554 | 38817 |
| 4L-2S | | MI | 26648 | 6778 | 43518 | 4917 | 47849 | 3976 | 50028 | 3260 | 52400 | 2163 | 62940 | 1960 | 35529 |
| 10-#14 | 1.41 | MA | 28013 | 6441 | 44426 | 4773 | 48577 | 3878 | 50198 | 3212 | 51529 | 2246 | 61444 | 2101 | 28489 |
| 2L-5S | | MI | 22739 | 6441 | 36139 | 4752 | 38600 | 3876 | 38839 | 3207 | 37617 | 2230 | 44277 | 1749 | 25175 |
| 10-#14 | 1.41 | MA | 26814 | 6441 | 42615 | 4772 | 46269 | 3895 | 47392 | 3226 | 47727 | 2256 | 56359 | 1973 | 28510 |
| 3L-4S | | MI | 23419 | 6441 | 37279 | 4755 | 40070 | 3861 | 40639 | 3194 | 40157 | 2240 | 47348 | 1809 | 25539 |
| 10-#14 | 1.41 | MA | 25966 | 6441 | 41160 | 4790 | 44418 | 3891 | 45146 | 3220 | 44812 | 2266 | 53031 | 1845 | 28441 |
| 4L-3S | | MI | 24176 | 6441 | 38577 | 4738 | 41721 | 3866 | 42643 | 3201 | 42732 | 2230 | 50260 | 1937 | 25571 |
| 10-#14 | 1.41 | MA | 25206 | 6441 | 39884 | 4788 | 42773 | 3907 | 43131 | 3234 | 41937 | 2257 | 49547 | 1783 | 27992 |
| 5L-2S | | MI | 25242 | 6441 | 40188 | 4741 | 43775 | 3851 | 45140 | 3189 | 46089 | 2220 | 54722 | 2065 | 25535 |
| 10-#18 | 2.51 | MA | 31054 | 7062 | 51351 | 5130 | 57232 | 4134 | 60653 | 3365 | 65426 | 2177 | 79754 | 1961 | 49375 |
| 2L-5S | | MI | 23631 | 7062 | 39242 | 5109 | 42378 | 4142 | 43362 | 3364 | 43553 | 2156 | 52633 | 1345 | 40419 |
| 10-#18 | 2.51 | MA | 29007 | 7062 | 48182 | 5126 | 53192 | 4161 | 55742 | 3387 | 58821 | 2195 | 70970 | 1733 | 49186 |
| 3L-4S | | MI | 24795 | 7062 | 41242 | 5116 | 44956 | 4118 | 46518 | 3344 | 47948 | 2174 | 57943 | 1449 | 42771 |
| 10-#18 | 2.51 | MA | 27557 | 7062 | 45629 | 5156 | 49945 | 4152 | 51802 | 3375 | 53753 | 2213 | 65236 | 1506 | 47874 |
| 4L-3S | | MI | 26089 | 7062 | 43518 | 5088 | 47849 | 4129 | 50028 | 3359 | 52400 | 2156 | 62940 | 1676 | 43969 |
| 10-#18 | 2.51 | MA | 26256 | 7062 | 43387 | 5152 | 47055 | 4179 | 48263 | 3398 | 48754 | 2195 | 59192 | 1398 | 45083 |
| 5L-2S | | MI | 27906 | 7062 | 46332 | 5094 | 51437 | 4105 | 54390 | 3339 | 58205 | 2138 | 70619 | 1904 | 44105 |
| 12-#11 | 1.17 | MA | 27350 | 6307 | 42894 | 4705 | 46713 | 3830 | 47966 | 3185 | 48520 | 2263 | 57567 | 2137 | 23932 |
| 2L-6S | | MI | 22447 | 6307 | 35247 | 4682 | 37491 | 3820 | 37523 | 3173 | 35928 | 2257 | 41966 | 1827 | 21177 |
| 12-#11 | 1.17 | MA | 26506 | 6307 | 41629 | 4704 | 45100 | 3828 | 46005 | 3195 | 45863 | 2270 | 53991 | 2048 | 23960 |
| 3L-5S | | MI | 22902 | 6307 | 35998 | 4683 | 38511 | 3823 | 38767 | 3177 | 37568 | 2250 | 44009 | 1885 | 21504 |
| 12-#11 | 1.17 | MA | 25911 | 6307 | 40614 | 4717 | 43809 | 3840 | 44438 | 3192 | 43828 | 2278 | 51648 | 1959 | 23962 |
| 4E | | MI | 23380 | 6307 | 36793 | 4685 | 39537 | 3813 | 40023 | 3168 | 39353 | 2257 | 46168 | 1928 | 21530 |
| 12-#11 | 1.17 | MA | 25378 | 6307 | 39724 | 4716 | 42661 | 3838 | 43033 | 3202 | 41823 | 2272 | 49202 | 1915 | 23907 |
| 5L-3S | | MI | 23911 | 6307 | 37700 | 4672 | 40690 | 3815 | 41423 | 3172 | 41163 | 2250 | 48223 | 2017 | 21510 |
| 12-#11 | 1.17 | MA | 24869 | 6307 | 38884 | 4716 | 41521 | 3849 | 41641 | 3199 | 39981 | 2280 | 46876 | 1857 | 23505 |
| 6L-2S | | MI | 24661 | 6307 | 38827 | 4674 | 42127 | 3805 | 43169 | 3163 | 43522 | 2243 | 51367 | 2105 | 21476 |
| 12-#14 | 1.69 | MA | 28852 | 6601 | 46236 | 4873 | 50886 | 3951 | 53004 | 3256 | 55331 | 2236 | 66530 | 2078 | 34020 |
| 2L-6S | | MI | 22851 | 6601 | 36673 | 4849 | 39192 | 3944 | 39554 | 3245 | 38640 | 2228 | 45841 | 1636 | 28952 |
| 12-#14 | 1.69 | MA | 27660 | 6601 | 44426 | 4871 | 48577 | 3967 | 50198 | 3271 | 51529 | 2246 | 61444 | 1950 | 34009 |
| 3L-5S | | MI | 23495 | 6601 | 37750 | 4852 | 40654 | 3949 | 41337 | 3252 | 40973 | 2218 | 48739 | 1721 | 29848 |
| 12-#14 | 1.69 | MA | 26818 | 6601 | 42971 | 4890 | 46727 | 3963 | 47953 | 3265 | 48614 | 2256 | 58116 | 1822 | 33903 |
| 4E | | MI | 24170 | 6601 | 38890 | 4855 | 42124 | 3934 | 43136 | 3239 | 43514 | 2228 | 51810 | 1781 | 30407 |
| 12-#14 | 1.69 | MA | 26064 | 6601 | 41695 | 4888 | 45081 | 3979 | 45938 | 3279 | 45739 | 2247 | 54632 | 1759 | 33257 |
| 5L-3S | | MI | 24922 | 6601 | 40188 | 4838 | 43775 | 3939 | 45140 | 3246 | 46089 | 2218 | 54722 | 1909 | 30476 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

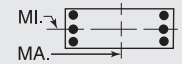



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 1.69 | MA | 25345 | 6601 | 40491 | 4886 | 43446 | 3976 | 43942 | 3274 | 43098 | 2257 | 51325 | 1675 | 32190 |
| 6L-2S | | MI | 25981 | 6601 | 41800 | 4840 | 45829 | 3924 | 47637 | 3234 | 49445 | 2209 | 59184 | 2037 | 30465 |
| 12-#18 | 3.01 | MA | 32467 | 7346 | 54520 | 5308 | 61273 | 4263 | 65565 | 3444 | 72032 | 2157 | 88537 | 1912 | 58986 |
| 2L-6S | | MI | 23820 | 7346 | 40167 | 5280 | 43402 | 4259 | 44597 | 3428 | 45322 | 2149 | 55333 | 1137 | 45999 |
| 12-#18 | 3.01 | MA | 30439 | 7346 | 51351 | 5303 | 57232 | 4289 | 60653 | 3467 | 65426 | 2174 | 79754 | 1685 | 58724 |
| 3L-5S | | MI | 24919 | 7346 | 42057 | 5287 | 45966 | 4270 | 47724 | 3443 | 49358 | 2132 | 60312 | 1289 | 48622 |
| 12-#18 | 3.01 | MA | 29005 | 7346 | 48798 | 5334 | 53986 | 4281 | 56713 | 3455 | 60359 | 2192 | 74020 | 1457 | 56981 |
| 4E | | MI | 26069 | 7346 | 44057 | 5294 | 48544 | 4246 | 50880 | 3424 | 53753 | 2149 | 65622 | 1393 | 50828 |
| 12-#18 | 3.01 | MA | 27720 | 7346 | 46556 | 5329 | 51095 | 4308 | 53174 | 3478 | 55360 | 2174 | 67976 | 1350 | 54347 |
| 5L-3S | | MI | 27350 | 7346 | 46332 | 5265 | 51437 | 4257 | 54390 | 3439 | 58205 | 2132 | 70619 | 1620 | 52442 |
| 12-#18 | 3.01 | MA | 26493 | 7346 | 44439 | 5324 | 48221 | 4299 | 49669 | 3465 | 50767 | 2192 | 62272 | 1199 | 51378 |
| 6L-2S | | MI | 29150 | 7346 | 49146 | 5272 | 55025 | 4233 | 58752 | 3419 | 64010 | 2114 | 78297 | 1848 | 52647 |
| 14-#11 | 1.37 | MA | 27943 | 6418 | 44159 | 4774 | 48326 | 3880 | 49927 | 3216 | 51176 | 2256 | 61144 | 2122 | 27802 |
| 2L-7S | | MI | 22540 | 6418 | 35570 | 4763 | 37948 | 3881 | 38069 | 3213 | 36682 | 2257 | 42983 | 1721 | 24061 |
| 14-#11 | 1.37 | MA | 27103 | 6418 | 42894 | 4773 | 46713 | 3878 | 47966 | 3226 | 48520 | 2263 | 57567 | 2033 | 27820 |
| 3L-6S | | MI | 22982 | 6418 | 36374 | 4751 | 38928 | 3871 | 39269 | 3204 | 38287 | 2250 | 45110 | 1809 | 24486 |
| 14-#11 | 1.37 | MA | 26511 | 6418 | 41879 | 4786 | 45422 | 3890 | 46399 | 3223 | 46485 | 2271 | 55224 | 1944 | 27800 |
| 4L-5S | | MI | 23435 | 6418 | 37125 | 4752 | 39948 | 3874 | 40513 | 3208 | 39927 | 2243 | 47153 | 1868 | 24910 |
| 14-#11 | 1.37 | MA | 25981 | 6418 | 40989 | 4785 | 44274 | 3888 | 44994 | 3233 | 44480 | 2265 | 52779 | 1900 | 27725 |
| 5L-4S | | MI | 23910 | 6418 | 37920 | 4754 | 40974 | 3863 | 41770 | 3199 | 41712 | 2250 | 49312 | 1910 | 24956 |
| 14-#11 | 1.37 | MA | 25476 | 6418 | 40149 | 4785 | 43134 | 3899 | 43602 | 3230 | 42637 | 2273 | 50452 | 1842 | 27225 |
| 6L-3S | | MI | 24439 | 6418 | 38827 | 4742 | 42127 | 3866 | 43169 | 3203 | 43522 | 2243 | 51367 | 1999 | 24955 |
| 14-#11 | 1.37 | MA | 24982 | 6418 | 39251 | 4798 | 42039 | 3897 | 42260 | 3240 | 40835 | 2281 | 48031 | 1754 | 26713 |
| 7L-2S | | MI | 25185 | 6418 | 39954 | 4743 | 43563 | 3855 | 44916 | 3194 | 45882 | 2236 | 54511 | 2088 | 24930 |
| 14-#14 | 1.97 | MA | 29684 | 6761 | 48047 | 4973 | 53194 | 4023 | 55811 | 3301 | 59133 | 2226 | 71615 | 2054 | 39539 |
| 2L-7S | | MI | 22982 | 6761 | 37132 | 4966 | 39842 | 4031 | 40331 | 3302 | 39713 | 2227 | 47285 | 1482 | 32790 |
| 14-#14 | 1.97 | MA | 28499 | 6761 | 46236 | 4971 | 50886 | 4039 | 53004 | 3316 | 55331 | 2236 | 66530 | 1926 | 39497 |
| 3L-6S | | MI | 23606 | 6761 | 38284 | 4949 | 41246 | 4016 | 42051 | 3290 | 41996 | 2217 | 50303 | 1609 | 33690 |
| 14-#14 | 1.97 | MA | 27664 | 6761 | 44781 | 4989 | 49035 | 4036 | 50759 | 3310 | 52416 | 2247 | 63202 | 1798 | 39359 |
| 4L-5S | | MI | 24245 | 6761 | 39361 | 4952 | 42708 | 4021 | 43834 | 3297 | 44330 | 2207 | 53201 | 1694 | 34539 |
| 14-#14 | 1.97 | MA | 26915 | 6761 | 43505 | 4988 | 47390 | 4052 | 48744 | 3324 | 49541 | 2237 | 59717 | 1736 | 38541 |
| 5L-4S | | MI | 24916 | 6761 | 40501 | 4955 | 44178 | 4006 | 45633 | 3284 | 46870 | 2217 | 56272 | 1754 | 35266 |
| 14-#14 | 1.97 | MA | 26201 | 6761 | 42301 | 4986 | 45754 | 4048 | 46749 | 3319 | 46900 | 2247 | 56411 | 1651 | 37525 |
| 6L-3S | | MI | 25662 | 6761 | 41800 | 4937 | 45829 | 4011 | 47637 | 3291 | 49445 | 2207 | 59184 | 1882 | 35365 |
| 14-#14 | 1.97 | MA | 25504 | 6761 | 41012 | 5004 | 44184 | 4064 | 44824 | 3333 | 44314 | 2257 | 52969 | 1525 | 36489 |
| 7L-2S | | MI | 26715 | 6761 | 43411 | 4940 | 47883 | 3996 | 50134 | 3278 | 52802 | 2197 | 63647 | 2010 | 35384 |
| 14-#18 | 3.51 | MA | 31857 | 7629 | 54520 | 5480 | 61273 | 4418 | 65565 | 3547 | 72032 | 2154 | 88537 | 1636 | 68251 |
| 3L-6S | | MI | 25105 | 7629 | 42981 | 5457 | 46990 | 4388 | 48958 | 3508 | 51127 | 2125 | 63011 | 1081 | 54061 |
| 14-#18 | 3.51 | MA | 30438 | 7629 | 51967 | 5511 | 58026 | 4409 | 61625 | 3535 | 66964 | 2172 | 82804 | 1409 | 66130 |
| 4L-5S | | MI | 26191 | 7629 | 44871 | 5464 | 49554 | 4399 | 52086 | 3523 | 55162 | 2108 | 67990 | 1233 | 56849 |
| 14-#18 | 3.51 | MA | 29166 | 7629 | 49725 | 5506 | 55135 | 4436 | 58086 | 3557 | 61965 | 2154 | 76760 | 1301 | 63635 |
| 5L-4S | | MI | 27330 | 7629 | 46871 | 5471 | 52133 | 4375 | 55242 | 3503 | 59557 | 2125 | 73300 | 1336 | 58926 |
| 14-#18 | 3.51 | MA | 27954 | 7629 | 47608 | 5502 | 52261 | 4428 | 54580 | 3545 | 57373 | 2172 | 71055 | 1151 | 60504 |
| 6L-3S | | MI | 28598 | 7629 | 49146 | 5442 | 55025 | 4386 | 58752 | 3519 | 64010 | 2108 | 78297 | 1564 | 60903 |
| 14-#18 | 3.51 | MA | 26770 | 7629 | 45343 | 5532 | 49500 | 4454 | 51198 | 3568 | 52879 | 2189 | 65114 | 925 | 57459 |
| 7L-2S | | MI | 30381 | 7629 | 51961 | 5449 | 58613 | 4362 | 63113 | 3499 | 69815 | 2090 | 85975 | 1791 | 61172 |
| 16-#11 | 1.56 | MA | 28533 | 6529 | 45424 | 4843 | 49939 | 3930 | 51888 | 3247 | 53833 | 2249 | 64720 | 2107 | 31666 |
| 2L-8S | | MI | 22640 | 6529 | 35959 | 4831 | 38396 | 3929 | 38640 | 3254 | 37359 | 2242 | 44110 | 1654 | 26927 |
| 16-#11 | 1.56 | MA | 27697 | 6529 | 44159 | 4842 | 48326 | 3928 | 49927 | 3257 | 51176 | 2256 | 61144 | 2018 | 31669 |
| 3L-7S | | MI | 23074 | 6529 | 36697 | 4832 | 39385 | 3932 | 39815 | 3245 | 39041 | 2249 | 46127 | 1704 | 27396 |
| 16-#11 | 1.56 | MA | 27108 | 6529 | 43144 | 4855 | 47035 | 3940 | 48360 | 3254 | 49142 | 2264 | 58801 | 1929 | 31633 |
| 4L-6S | | MI | 23514 | 6529 | 37500 | 4820 | 40364 | 3921 | 41016 | 3235 | 40646 | 2242 | 48254 | 1791 | 27803 |
| 16-#11 | 1.56 | MA | 26581 | 6529 | 42254 | 4855 | 45887 | 3938 | 46955 | 3264 | 47136 | 2258 | 56355 | 1885 | 31540 |
| 5E | | MI | 23964 | 6529 | 38252 | 4821 | 41384 | 3924 | 42260 | 3240 | 42287 | 2236 | 50297 | 1850 | 28311 |
| 16-#11 | 1.56 | MA | 26078 | 6529 | 41415 | 4854 | 44747 | 3950 | 45563 | 3261 | 45294 | 2266 | 54028 | 1827 | 30953 |
| 6L-4S | | MI | 24436 | 6529 | 39047 | 4823 | 42410 | 3913 | 43516 | 3230 | 44072 | 2242 | 52456 | 1893 | 28375 |
| 16-#11 | 1.56 | MA | 25588 | 6529 | 40516 | 4867 | 43652 | 3948 | 44221 | 3271 | 43491 | 2274 | 51607 | 1739 | 30461 |
| 7L-3S | | MI | 24963 | 6529 | 39954 | 4811 | 43563 | 3916 | 44916 | 3235 | 45882 | 2236 | 54511 | 1981 | 28393 |

## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

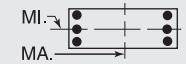
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.56 | MA | 25104 | 6529 | 39692 | 4866 | 42546 | 3959 | 42907 | 3282 | 41603 | 2268 | 49321 | 1688 | 29909 |
| 8L-2S | | MI | 25706 | 6529 | 41081 | 4812 | 45000 | 3905 | 46662 | 3225 | 48241 | 2229 | 57655 | 2070 | 28377 |
| 16-#14 | 2.26 | MA | 30509 | 6920 | 49858 | 5072 | 55503 | 4095 | 58617 | 3346 | 62935 | 2216 | 76700 | 2030 | 45043 |
| 2L-8S | | MI | 23124 | 6920 | 37686 | 5063 | 40479 | 4098 | 41143 | 3360 | 40676 | 2205 | 48879 | 1384 | 36349 |
| 16-#14 | 2.26 | MA | 29332 | 6920 | 48047 | 5071 | 53194 | 4111 | 55811 | 3360 | 59133 | 2226 | 71615 | 1902 | 44977 |
| 3L-7S | | MI | 23735 | 6920 | 38743 | 5066 | 41897 | 4103 | 42828 | 3347 | 43069 | 2215 | 51747 | 1455 | 37447 |
| 16-#14 | 2.26 | MA | 28502 | 6920 | 46592 | 5089 | 51344 | 4108 | 53565 | 3355 | 56218 | 2237 | 68287 | 1775 | 44810 |
| 4L-6S | | MI | 24355 | 6920 | 39895 | 5049 | 43301 | 4088 | 44548 | 3335 | 45353 | 2205 | 54766 | 1581 | 38438 |
| 16-#14 | 2.26 | MA | 27759 | 6920 | 45316 | 5087 | 49698 | 4124 | 51550 | 3369 | 53343 | 2227 | 64802 | 1712 | 43839 |
| 5E | | MI | 24990 | 6920 | 40972 | 5052 | 44762 | 4093 | 46331 | 3342 | 47687 | 2195 | 57663 | 1666 | 39245 |
| 16-#14 | 2.26 | MA | 27051 | 6920 | 44112 | 5086 | 48063 | 4120 | 49555 | 3363 | 50701 | 2237 | 61496 | 1628 | 42869 |
| 6L-4S | | MI | 25655 | 6920 | 42112 | 5054 | 46232 | 4078 | 48131 | 3329 | 50227 | 2205 | 60734 | 1726 | 40119 |
| 16-#14 | 2.26 | MA | 26359 | 6920 | 42823 | 5104 | 46492 | 4137 | 47630 | 3378 | 48116 | 2247 | 58054 | 1501 | 41743 |
| 7L-3S | | MI | 26397 | 6920 | 43411 | 5037 | 47883 | 4083 | 50134 | 3336 | 52802 | 2195 | 63647 | 1854 | 40246 |
| 16-#14 | 2.26 | MA | 25677 | 6920 | 41641 | 5102 | 44907 | 4133 | 45745 | 3392 | 45409 | 2238 | 54798 | 1429 | 40448 |
| 8L-2S | | MI | 27443 | 6920 | 45022 | 5040 | 49937 | 4068 | 52631 | 3323 | 56158 | 2185 | 68109 | 1982 | 40290 |
| 16-#18 | 4.01 | MA | 31856 | 7913 | 55136 | 5688 | 62066 | 4538 | 66536 | 3614 | 73570 | 2151 | 91587 | 1360 | 75312 |
| 4L-6S | | MI | 26376 | 7913 | 45795 | 5635 | 50578 | 4516 | 53320 | 3588 | 56932 | 2101 | 70690 | 1025 | 62150 |
| 16-#18 | 4.01 | MA | 30598 | 7913 | 52894 | 5684 | 59176 | 4565 | 62997 | 3637 | 68571 | 2134 | 85544 | 1253 | 72943 |
| 5E | | MI | 27451 | 7913 | 47685 | 5641 | 53142 | 4528 | 56447 | 3603 | 60967 | 2083 | 75669 | 1176 | 65095 |
| 16-#18 | 4.01 | MA | 29398 | 7913 | 50777 | 5679 | 56301 | 4556 | 59492 | 3625 | 63979 | 2151 | 79839 | 1102 | 69656 |
| 6L-4S | | MI | 28578 | 7913 | 49685 | 5648 | 55721 | 4503 | 59604 | 3583 | 65362 | 2101 | 80978 | 1280 | 67057 |
| 16-#18 | 4.01 | MA | 28228 | 7913 | 48512 | 5710 | 53540 | 4583 | 56109 | 3647 | 59484 | 2169 | 73898 | 877 | 66513 |
| 7L-3S | | MI | 29834 | 7913 | 51961 | 5620 | 58613 | 4515 | 63113 | 3599 | 69815 | 2083 | 85975 | 1508 | 69355 |
| 18-#11 | 1.76 | MA | 29120 | 6639 | 46690 | 4912 | 51552 | 3981 | 53849 | 3278 | 56489 | 2242 | 68296 | 2091 | 35525 |
| 2L-9S | | MI | 22746 | 6639 | 36305 | 4912 | 38866 | 3990 | 39170 | 3281 | 38130 | 2242 | 45275 | 1580 | 29579 |
| 18-#11 | 1.76 | MA | 28287 | 6639 | 45424 | 4912 | 49939 | 3979 | 51888 | 3288 | 53833 | 2250 | 64720 | 2003 | 35512 |
| 3L-8S | | MI | 23174 | 6639 | 37086 | 4900 | 39833 | 3979 | 40386 | 3285 | 39719 | 2235 | 47254 | 1636 | 30208 |
| 18-#11 | 1.76 | MA | 27702 | 6639 | 44409 | 4925 | 48648 | 3990 | 50321 | 3285 | 51798 | 2257 | 62377 | 1914 | 35461 |
| 4L-7S | | MI | 23605 | 6639 | 37823 | 4901 | 40821 | 3982 | 41562 | 3276 | 41400 | 2242 | 49271 | 1686 | 30736 |
| 18-#11 | 1.76 | MA | 27177 | 6639 | 43519 | 4924 | 47501 | 3988 | 48915 | 3295 | 49793 | 2251 | 59931 | 1870 | 35351 |
| 5L-6S | | MI | 24042 | 6639 | 38627 | 4889 | 41801 | 3971 | 42762 | 3266 | 43006 | 2235 | 51398 | 1774 | 31126 |
| 18-#11 | 1.76 | MA | 26677 | 6639 | 42680 | 4923 | 46360 | 4000 | 47524 | 3292 | 47950 | 2259 | 57604 | 1812 | 34688 |
| 6L-5S | | MI | 24490 | 6639 | 39378 | 4891 | 42821 | 3974 | 44006 | 3271 | 44646 | 2228 | 53441 | 1832 | 31709 |
| 18-#11 | 1.76 | MA | 26189 | 6639 | 41781 | 4936 | 45265 | 3998 | 46182 | 3302 | 46148 | 2267 | 55183 | 1724 | 34214 |
| 7L-4S | | MI | 24960 | 6639 | 40174 | 4892 | 43847 | 3963 | 45263 | 3261 | 46431 | 2235 | 55600 | 1875 | 31789 |
| 18-#11 | 1.76 | MA | 25708 | 6639 | 40957 | 4935 | 44159 | 4009 | 44868 | 3313 | 44259 | 2261 | 52898 | 1673 | 33604 |
| 8L-3S | | MI | 25484 | 6639 | 41081 | 4880 | 45000 | 3966 | 46662 | 3266 | 48241 | 2228 | 57655 | 1964 | 31821 |
| 18-#11 | 1.76 | MA | 25217 | 6639 | 40085 | 4948 | 43080 | 4007 | 43508 | 3309 | 42475 | 2269 | 50644 | 1617 | 32860 |
| 9L-2S | | MI | 26224 | 6639 | 42208 | 4881 | 46437 | 3955 | 48409 | 3256 | 50600 | 2221 | 60799 | 2052 | 31818 |
| 18-#14 | 2.54 | MA | 30159 | 7080 | 49858 | 5171 | 55503 | 4184 | 58617 | 3405 | 62935 | 2216 | 76700 | 1879 | 50451 |
| 3L-8S | | MI | 23875 | 7080 | 39297 | 5163 | 42534 | 4171 | 43640 | 3405 | 44033 | 2194 | 53341 | 1356 | 41056 |
| 18-#14 | 2.54 | MA | 29335 | 7080 | 48403 | 5189 | 53652 | 4180 | 56371 | 3400 | 60019 | 2227 | 73372 | 1751 | 50258 |
| 4L-7S | | MI | 24482 | 7080 | 40355 | 5166 | 43951 | 4176 | 45325 | 3392 | 46426 | 2204 | 56210 | 1427 | 42116 |
| 18-#14 | 2.54 | MA | 28597 | 7080 | 47127 | 5187 | 52007 | 4196 | 54356 | 3414 | 57145 | 2217 | 69888 | 1689 | 49151 |
| 5L-6S | | MI | 25098 | 7080 | 41507 | 5149 | 45355 | 4161 | 47045 | 3379 | 48710 | 2194 | 59228 | 1554 | 43192 |
| 18-#14 | 2.54 | MA | 27894 | 7080 | 45923 | 5186 | 50371 | 4193 | 52361 | 3408 | 54503 | 2227 | 66581 | 1604 | 48220 |
| 6L-5S | | MI | 25729 | 7080 | 42583 | 5151 | 46816 | 4166 | 48828 | 3387 | 51043 | 2184 | 62125 | 1639 | 43963 |
| 18-#14 | 2.54 | MA | 27207 | 7080 | 44634 | 5204 | 48800 | 4209 | 50436 | 3423 | 51918 | 2238 | 63139 | 1478 | 47009 |
| 7L-4S | | MI | 26390 | 7080 | 43723 | 5154 | 48286 | 4151 | 50628 | 3374 | 53583 | 2194 | 65197 | 1699 | 44968 |
| 18-#14 | 2.54 | MA | 26530 | 7080 | 43452 | 5202 | 47215 | 4205 | 48552 | 3437 | 49211 | 2228 | 59884 | 1405 | 45755 |
| 8L-3S | | MI | 27126 | 7080 | 45022 | 5137 | 49937 | 4156 | 52631 | 3381 | 56158 | 2184 | 68109 | 1827 | 45120 |
| 18-#14 | 2.54 | MA | 25856 | 7080 | 42200 | 5220 | 45666 | 4222 | 46602 | 3431 | 46652 | 2238 | 56680 | 1324 | 44133 |
| 9L-2S | | MI | 28167 | 7080 | 46633 | 5140 | 51992 | 4141 | 55128 | 3368 | 59515 | 2174 | 72571 | 1955 | 45185 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

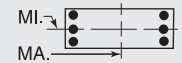



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 4.51 | MA | 32015 | 8197 | 56063 | 5861 | 63216 | 4693 | 67909 | 3717 | 75177 | 2113 | 94328 | 1204 | 82268 |
| 5L-6S | | MI | 27635 | 8197 | 48610 | 5812 | 54166 | 4645 | 57682 | 3667 | 62737 | 2077 | 78368 | 969 | 70263 |
| 18-#18 | 4.51 | MA | 30828 | 8197 | 53946 | 5856 | 60341 | 4685 | 64403 | 3704 | 70584 | 2131 | 88623 | 1054 | 78831 |
| 6L-5S | | MI | 28700 | 8197 | 50500 | 5819 | 56730 | 4656 | 60809 | 3683 | 66772 | 2059 | 83347 | 1120 | 73358 |
| 18-#18 | 4.51 | MA | 29670 | 8197 | 51681 | 5887 | 57581 | 4711 | 61020 | 3727 | 66090 | 2149 | 82682 | 828 | 75588 |
| 7L-4S | | MI | 29816 | 8197 | 52500 | 5825 | 59309 | 4632 | 63966 | 3663 | 71167 | 2077 | 88657 | 1224 | 75217 |
| 20-#11 | 1.95 | MA | 29703 | 6750 | 47955 | 4982 | 53165 | 4031 | 55810 | 3309 | 59146 | 2235 | 71873 | 2076 | 39376 |
| 2L-10S | | MI | 22814 | 6750 | 36698 | 4980 | 39327 | 4037 | 39748 | 3321 | 38912 | 2242 | 46501 | 1498 | 32146 |
| 20-#11 | 1.95 | MA | 28874 | 6750 | 46690 | 4981 | 51552 | 4029 | 53849 | 3319 | 56489 | 2243 | 68296 | 1988 | 39350 |
| 3L-9S | | MI | 23278 | 6750 | 37432 | 4981 | 40303 | 4040 | 40917 | 3312 | 40489 | 2235 | 48419 | 1562 | 32886 |
| 20-#11 | 1.95 | MA | 28291 | 6750 | 45674 | 4994 | 50261 | 4040 | 52282 | 3316 | 54455 | 2250 | 65953 | 1899 | 39285 |
| 4L-8S | | MI | 23704 | 6750 | 38213 | 4969 | 41269 | 4029 | 42133 | 3316 | 42078 | 2228 | 50398 | 1619 | 33496 |
| 20-#11 | 1.95 | MA | 27770 | 6750 | 44784 | 4993 | 49114 | 4038 | 50876 | 3326 | 52449 | 2244 | 63507 | 1855 | 39160 |
| 5L-7S | | MI | 24133 | 6750 | 38950 | 4971 | 42258 | 4032 | 43308 | 3307 | 43760 | 2235 | 52415 | 1668 | 34079 |
| 20-#11 | 1.95 | MA | 27273 | 6750 | 43945 | 4992 | 47973 | 4050 | 49485 | 3323 | 50607 | 2252 | 61181 | 1797 | 38429 |
| 6E | | MI | 24568 | 6750 | 39754 | 4958 | 43238 | 4021 | 44509 | 3297 | 45365 | 2228 | 54542 | 1756 | 34455 |
| 20-#11 | 1.95 | MA | 26787 | 6750 | 43046 | 5005 | 46878 | 4048 | 48143 | 3333 | 48804 | 2260 | 58760 | 1709 | 37971 |
| 7L-5S | | MI | 25014 | 6750 | 40505 | 4960 | 44258 | 4024 | 45753 | 3302 | 47005 | 2221 | 56585 | 1815 | 35097 |
| 20-#11 | 1.95 | MA | 26309 | 6750 | 42222 | 5004 | 45772 | 4059 | 46828 | 3344 | 46916 | 2254 | 56474 | 1658 | 37306 |
| 8L-4S | | MI | 25481 | 6750 | 41301 | 4961 | 45284 | 4013 | 47009 | 3292 | 48790 | 2228 | 58744 | 1857 | 35198 |
| 20-#11 | 1.95 | MA | 25820 | 6750 | 41350 | 5017 | 44693 | 4057 | 45469 | 3340 | 45132 | 2262 | 54220 | 1602 | 36583 |
| 9L-3S | | MI | 26002 | 6750 | 42208 | 4949 | 46437 | 4016 | 48409 | 3297 | 50600 | 2221 | 60799 | 1946 | 35243 |
| 20-#11 | 1.95 | MA | 25294 | 6750 | 40530 | 5017 | 43601 | 4069 | 44163 | 3351 | 43361 | 2269 | 52034 | 1538 | 35733 |
| 10L-2S | | MI | 26739 | 6750 | 43335 | 4950 | 47873 | 4005 | 50155 | 3287 | 52959 | 2214 | 63943 | 2035 | 35256 |
| 20-#14 | 2.82 | MA | 30162 | 7239 | 50213 | 5289 | 55961 | 4252 | 59178 | 3445 | 63821 | 2217 | 78457 | 1727 | 55702 |
| 4L-8S | | MI | 24622 | 7239 | 40908 | 5263 | 44588 | 4243 | 46137 | 3450 | 47389 | 2182 | 57803 | 1329 | 45771 |
| 20-#14 | 2.82 | MA | 29429 | 7239 | 48937 | 5287 | 54315 | 4269 | 57163 | 3459 | 60947 | 2207 | 74973 | 1665 | 54473 |
| 5L-7S | | MI | 25225 | 7239 | 41966 | 5266 | 46005 | 4248 | 47822 | 3437 | 49782 | 2192 | 60672 | 1400 | 46795 |
| 20-#14 | 2.82 | MA | 28730 | 7239 | 47733 | 5285 | 52680 | 4265 | 55168 | 3453 | 58305 | 2217 | 71666 | 1581 | 53578 |
| 6E | | MI | 25836 | 7239 | 43118 | 5248 | 47409 | 4233 | 49542 | 3424 | 52066 | 2182 | 63690 | 1526 | 47953 |
| 20-#14 | 2.82 | MA | 28049 | 7239 | 46445 | 5304 | 51109 | 4281 | 53243 | 3468 | 55720 | 2228 | 68225 | 1454 | 52286 |
| 7L-5S | | MI | 26462 | 7239 | 44194 | 5251 | 48871 | 4238 | 51325 | 3432 | 54400 | 2172 | 66588 | 1611 | 48692 |
| 20-#14 | 2.82 | MA | 27377 | 7239 | 45262 | 5302 | 49524 | 4278 | 51358 | 3482 | 53012 | 2218 | 64969 | 1381 | 51070 |
| 8L-4S | | MI | 27119 | 7239 | 45335 | 5254 | 50341 | 4223 | 53125 | 3419 | 56940 | 2182 | 69659 | 1671 | 49813 |
| 20-#14 | 2.82 | MA | 26704 | 7239 | 44011 | 5320 | 47975 | 4294 | 49408 | 3476 | 50454 | 2228 | 61765 | 1300 | 49396 |
| 9L-3S | | MI | 27851 | 7239 | 46633 | 5237 | 51992 | 4228 | 55128 | 3426 | 59515 | 2172 | 72571 | 1799 | 49988 |
| 20-#18 | 5.01 | MA | 32245 | 8481 | 57115 | 6034 | 64382 | 4813 | 69315 | 3784 | 77190 | 2111 | 97407 | 1005 | 88027 |
| 6E | | MI | 28883 | 8481 | 51424 | 5989 | 57754 | 4774 | 62044 | 3747 | 68541 | 2052 | 86047 | 913 | 78397 |
| 20-#18 | 5.01 | MA | 31099 | 8481 | 54850 | 6064 | 61621 | 4840 | 65932 | 3807 | 72696 | 2128 | 91465 | 780 | 84685 |
| 7L-5S | | MI | 29938 | 8481 | 53314 | 5996 | 60319 | 4785 | 65171 | 3763 | 72577 | 2035 | 91026 | 1064 | 81634 |
| 22-#11 | 2.15 | MA | 29458 | 6861 | 47955 | 5050 | 53165 | 4079 | 55810 | 3351 | 59146 | 2236 | 71873 | 1972 | 43185 |
| 3L-10S | | MI | 23345 | 6861 | 37825 | 5049 | 40763 | 4087 | 41495 | 3352 | 41271 | 2234 | 49645 | 1481 | 35421 |
| 22-#11 | 2.15 | MA | 28878 | 6861 | 46939 | 5063 | 51874 | 4090 | 54243 | 3347 | 57111 | 2244 | 69529 | 1884 | 43107 |
| 4L-9S | | MI | 23808 | 6861 | 38559 | 5051 | 41740 | 4090 | 42663 | 3343 | 42848 | 2227 | 51563 | 1544 | 36198 |
| 22-#11 | 2.15 | MA | 28359 | 6861 | 46050 | 5062 | 50727 | 4088 | 52837 | 3358 | 55106 | 2238 | 67084 | 1840 | 42914 |
| 5L-8S | | MI | 24231 | 6861 | 39340 | 5038 | 42706 | 4079 | 43879 | 3347 | 44437 | 2220 | 53542 | 1601 | 36789 |
| 22-#11 | 2.15 | MA | 27865 | 6861 | 45210 | 5061 | 49586 | 4100 | 51446 | 3354 | 53264 | 2245 | 64757 | 1781 | 42175 |
| 6L-7S | | MI | 24658 | 6861 | 40077 | 5040 | 43695 | 4082 | 45055 | 3338 | 46119 | 2227 | 55559 | 1651 | 37424 |
| 22-#11 | 2.15 | MA | 27382 | 6861 | 44312 | 5074 | 48491 | 4098 | 50103 | 3365 | 51461 | 2253 | 62336 | 1694 | 41730 |
| 7L-6S | | MI | 25091 | 6861 | 40881 | 5027 | 44674 | 4071 | 46255 | 3329 | 47724 | 2220 | 57686 | 1738 | 37789 |
| 22-#11 | 2.15 | MA | 26906 | 6861 | 43487 | 5073 | 47386 | 4110 | 48789 | 3375 | 49573 | 2247 | 60050 | 1643 | 41013 |
| 8L-5S | | MI | 25534 | 6861 | 41632 | 5029 | 45694 | 4074 | 47499 | 3333 | 49364 | 2214 | 59729 | 1797 | 38404 |
| 22-#11 | 2.15 | MA | 26426 | 6861 | 42615 | 5086 | 46306 | 4108 | 47430 | 3371 | 47788 | 2255 | 57796 | 1587 | 40310 |
| 9L-4S | | MI | 25999 | 6861 | 42428 | 5030 | 46720 | 4063 | 48756 | 3324 | 51149 | 2220 | 61888 | 1840 | 38604 |
| 22-#11 | 2.15 | MA | 25896 | 6861 | 41795 | 5086 | 45214 | 4119 | 46124 | 3382 | 46018 | 2262 | 55610 | 1523 | 39424 |
| 10L-3S | | MI | 26518 | 6861 | 43335 | 5018 | 47873 | 4066 | 50155 | 3328 | 52959 | 2214 | 63943 | 1928 | 38662 |
| 22-#11 | 2.15 | MA | 25384 | 6861 | 40986 | 5085 | 44141 | 4117 | 44780 | 3378 | 44156 | 2256 | 53379 | 1469 | 38574 |
| 11L-2S | | MI | 27252 | 6861 | 44461 | 5020 | 49310 | 4055 | 51902 | 3319 | 55319 | 2207 | 67086 | 2017 | 38685 |

## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 3.10 | MA | 30255 | 7399 | 50748 | 5387 | 56624 | 4341 | 59969 | 3504 | 64749 | 2197 | 80058 | 1641 | 59805 |
| 5L-8S | | MI | 25363 | 7399 | 42520 | 5363 | 46642 | 4315 | 48634 | 3495 | 50746 | 2171 | 62266 | 1301 | 50478 |
| 22-#14 | 3.10 | MA | 29561 | 7399 | 49544 | 5385 | 54988 | 4337 | 57974 | 3498 | 62107 | 2207 | 76752 | 1557 | 58942 |
| 6L-7S | | MI | 25962 | 7399 | 43577 | 5365 | 48059 | 4320 | 50319 | 3482 | 53139 | 2180 | 65134 | 1372 | 51484 |
| 22-#14 | 3.10 | MA | 28885 | 7399 | 48255 | 5403 | 53417 | 4354 | 56049 | 3512 | 59522 | 2218 | 73310 | 1430 | 57572 |
| 7L-6S | | MI | 26569 | 7399 | 44729 | 5348 | 49463 | 4305 | 52040 | 3469 | 55423 | 2171 | 68152 | 1499 | 52719 |
| 22-#14 | 3.10 | MA | 28217 | 7399 | 47073 | 5402 | 51832 | 4350 | 54164 | 3527 | 56814 | 2208 | 70054 | 1358 | 56391 |
| 8L-5S | | MI | 27191 | 7399 | 45806 | 5351 | 50925 | 4310 | 53822 | 3476 | 57756 | 2161 | 71050 | 1584 | 53430 |
| 22-#14 | 3.10 | MA | 27546 | 7399 | 45822 | 5420 | 50283 | 4366 | 52214 | 3521 | 54256 | 2218 | 66851 | 1276 | 54667 |
| 9L-4S | | MI | 27844 | 7399 | 46946 | 5353 | 52395 | 4295 | 55622 | 3464 | 60297 | 2171 | 74121 | 1644 | 54654 |
| 22-#18 | 5.51 | MA | 32515 | 8764 | 58019 | 6242 | 65661 | 4969 | 70843 | 3887 | 79301 | 2108 | 100249 | 731 | 93800 |
| 7L-6S | | MI | 30122 | 8764 | 54238 | 6167 | 61342 | 4902 | 66406 | 3827 | 74346 | 2028 | 93725 | 856 | 86549 |
| 24-#11 | 2.35 | MA | 29462 | 6971 | 48205 | 5132 | 53487 | 4141 | 56203 | 3378 | 59768 | 2237 | 73106 | 1869 | 46926 |
| 4L-10S | | MI | 23874 | 6971 | 38952 | 5118 | 42200 | 4137 | 43241 | 3383 | 43631 | 2227 | 52789 | 1463 | 38701 |
| 24-#11 | 2.35 | MA | 28945 | 6971 | 47315 | 5131 | 52340 | 4139 | 54798 | 3389 | 57762 | 2231 | 70660 | 1825 | 46638 |
| 5L-9S | | MI | 24334 | 6971 | 39686 | 5120 | 43176 | 4140 | 44410 | 3374 | 45208 | 2220 | 54707 | 1527 | 39514 |
| 24-#11 | 2.35 | MA | 28453 | 6971 | 46475 | 5130 | 51199 | 4150 | 53407 | 3385 | 55920 | 2238 | 68333 | 1766 | 45925 |
| 6L-8S | | MI | 24755 | 6971 | 40466 | 5107 | 44143 | 4129 | 45626 | 3378 | 46796 | 2213 | 56686 | 1583 | 40088 |
| 24-#11 | 2.35 | MA | 27974 | 6971 | 45577 | 5143 | 50104 | 4148 | 52064 | 3396 | 54117 | 2246 | 65912 | 1679 | 45492 |
| 7E | | MI | 25180 | 6971 | 41204 | 5109 | 45131 | 4132 | 46801 | 3369 | 48478 | 2220 | 58703 | 1633 | 40772 |
| 24-#11 | 2.35 | MA | 27500 | 6971 | 44753 | 5143 | 48999 | 4160 | 50750 | 3406 | 52229 | 2240 | 63627 | 1628 | 44726 |
| 8L-6S | | MI | 25611 | 6971 | 42008 | 5097 | 46111 | 4121 | 48002 | 3360 | 50083 | 2213 | 60830 | 1721 | 41126 |
| 24-#11 | 2.35 | MA | 27021 | 6971 | 43880 | 5156 | 47919 | 4158 | 49390 | 3403 | 50445 | 2248 | 61372 | 1571 | 44041 |
| 9L-5S | | MI | 26052 | 6971 | 42759 | 5098 | 47131 | 4124 | 49246 | 3364 | 51724 | 2206 | 62873 | 1779 | 41717 |
| 24-#11 | 2.35 | MA | 26495 | 6971 | 43060 | 5155 | 46828 | 4169 | 48085 | 3413 | 48674 | 2256 | 59187 | 1508 | 43120 |
| 10L-4S | | MI | 26515 | 6971 | 43555 | 5100 | 48157 | 4113 | 50502 | 3355 | 53509 | 2213 | 65032 | 1822 | 42007 |
| 24-#11 | 2.35 | MA | 25986 | 6971 | 42251 | 5154 | 45754 | 4167 | 46741 | 3410 | 46812 | 2250 | 56955 | 1454 | 42288 |
| 11L-3S | | MI | 27031 | 6971 | 44461 | 5087 | 49310 | 4116 | 51902 | 3359 | 55319 | 2206 | 67086 | 1911 | 42076 |
| 24-#14 | 3.38 | MA | 30387 | 7559 | 51355 | 5485 | 57297 | 4410 | 60780 | 3543 | 65909 | 2197 | 81837 | 1533 | 64311 |
| 6L-8S | | MI | 26099 | 7559 | 44131 | 5462 | 48696 | 4388 | 51131 | 3540 | 54103 | 2159 | 66728 | 1274 | 55116 |
| 24-#14 | 3.38 | MA | 29715 | 7559 | 50066 | 5503 | 55726 | 4426 | 58855 | 3557 | 63324 | 2208 | 78395 | 1407 | 62866 |
| 7E | | MI | 26694 | 7559 | 45188 | 5465 | 50113 | 4393 | 52816 | 3527 | 56496 | 2169 | 69596 | 1344 | 56182 |
| 24-#14 | 3.38 | MA | 29052 | 7559 | 48884 | 5501 | 54141 | 4422 | 56970 | 3572 | 60616 | 2198 | 75139 | 1334 | 61686 |
| 8L-6S | | MI | 27298 | 7559 | 46340 | 5448 | 51517 | 4378 | 54537 | 3514 | 58779 | 2159 | 72615 | 1471 | 57489 |
| 24-#14 | 3.38 | MA | 28382 | 7559 | 47632 | 5520 | 52592 | 4439 | 55020 | 3566 | 58058 | 2208 | 71936 | 1253 | 59945 |
| 9L-5S | | MI | 27916 | 7559 | 47417 | 5451 | 52979 | 4383 | 56319 | 3521 | 61113 | 2149 | 75512 | 1556 | 58175 |

## RECTANGULAR TIED COLUMNS 38" x 44"

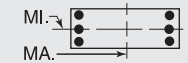
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.44 | MA | 30769 | 6763 | 48934 | 4994 | 53443 | 4057 | 55214 | 3358 | 56644 | 2340 | 67442 | 2181 | 31678 |
| 2L-3S | | MI | 24545 | 6763 | 39425 | 4933 | 42268 | 4037 | 42856 | 3340 | 42181 | 2312 | 49118 | 1893 | 27026 |
| 6-#18 | 1.44 | MA | 28555 | 6763 | 45588 | 4990 | 49177 | 4084 | 50028 | 3382 | 49638 | 2358 | 58105 | 1954 | 31677 |
| 3L-2S | | MI | 26401 | 6763 | 42239 | 4940 | 45856 | 4012 | 47218 | 3320 | 47985 | 2295 | 56796 | 2120 | 26965 |
| 8-#14 | 1.08 | MA | 29690 | 6551 | 46393 | 4892 | 50389 | 3986 | 51571 | 3319 | 51797 | 2373 | 61211 | 2245 | 24160 |
| 2L-4S | | MI | 23683 | 6551 | 37198 | 4857 | 39611 | 3955 | 39697 | 3291 | 38196 | 2360 | 44429 | 1941 | 20715 |
| 8-#14 | 1.08 | MA | 28413 | 6551 | 44483 | 4891 | 47953 | 3982 | 48610 | 3334 | 47786 | 2384 | 55814 | 2117 | 24207 |
| 3E | | MI | 24447 | 6551 | 38496 | 4840 | 41262 | 3960 | 41701 | 3298 | 40771 | 2350 | 47341 | 2069 | 20688 |
| 8-#14 | 1.08 | MA | 27511 | 6551 | 42950 | 4909 | 46003 | 3999 | 46244 | 3329 | 44713 | 2395 | 52278 | 1989 | 24183 |
| 4L-2S | | MI | 25520 | 6551 | 40107 | 4843 | 43316 | 3945 | 44198 | 3285 | 44127 | 2340 | 51803 | 2197 | 20627 |
| 8-#18 | 1.91 | MA | 32307 | 7047 | 52280 | 5171 | 57710 | 4185 | 60400 | 3437 | 63651 | 2321 | 76780 | 2136 | 41897 |
| 2L-4S | | MI | 24527 | 7047 | 39964 | 5139 | 42963 | 4154 | 43708 | 3404 | 43533 | 2306 | 51799 | 1609 | 35124 |
| 8-#18 | 1.91 | MA | 30116 | 7047 | 48934 | 5168 | 53443 | 4213 | 55214 | 3461 | 56644 | 2339 | 67442 | 1909 | 41793 |
| 3E | | MI | 25838 | 7047 | 42239 | 5111 | 45856 | 4165 | 47218 | 3420 | 47985 | 2288 | 56796 | 1837 | 35555 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis

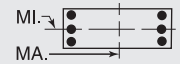



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.91 | MA | 28566 | 7047 | 46241 | 5199 | 50019 | 4206 | 51059 | 3450 | 51269 | 2357 | 61339 | 1681 | 41256 |
| 4L-2S | | MI | 27676 | 7047 | 45054 | 5117 | 49444 | 4141 | 51579 | 3400 | 53790 | 2270 | 64475 | 2064 | 35583 |
| 10-#14 | 1.35 | MA | 30587 | 6710 | 48304 | 4992 | 52825 | 4058 | 54532 | 3364 | 55808 | 2363 | 66608 | 2223 | 30008 |
| 2L-5S | | MI | 23760 | 6710 | 37669 | 4954 | 40195 | 4043 | 40394 | 3348 | 39012 | 2339 | 45820 | 1853 | 25382 |
| 10-#14 | 1.35 | MA | 29319 | 6710 | 46393 | 4990 | 50389 | 4055 | 51571 | 3379 | 51797 | 2374 | 61211 | 2095 | 30029 |
| 3L-4S | | MI | 24442 | 6710 | 38809 | 4957 | 41665 | 4028 | 42194 | 3335 | 41552 | 2348 | 48891 | 1914 | 25602 |
| 10-#14 | 1.35 | MA | 28424 | 6710 | 44860 | 5009 | 48439 | 4072 | 49205 | 3374 | 48724 | 2385 | 57675 | 1967 | 29960 |
| 4L-3S | | MI | 25200 | 6710 | 40107 | 4940 | 43316 | 4032 | 44198 | 3343 | 44127 | 2339 | 51803 | 2042 | 25617 |
| 10-#14 | 1.35 | MA | 27622 | 6710 | 43516 | 5008 | 46706 | 4068 | 47082 | 3389 | 45696 | 2377 | 53983 | 1904 | 29636 |
| 5L-2S | | MI | 26267 | 6710 | 41718 | 4943 | 45370 | 4018 | 46695 | 3330 | 47484 | 2329 | 56266 | 2170 | 25575 |
| 10-#18 | 2.39 | MA | 33825 | 7331 | 55627 | 5349 | 61976 | 4314 | 65586 | 3517 | 70658 | 2303 | 86117 | 2091 | 52075 |
| 2L-5S | | MI | 24652 | 7331 | 40779 | 5310 | 43973 | 4307 | 44914 | 3504 | 44943 | 2264 | 54168 | 1449 | 40713 |
| 10-#18 | 2.39 | MA | 31657 | 7331 | 52280 | 5345 | 57710 | 4342 | 60400 | 3541 | 63651 | 2320 | 76780 | 1863 | 51886 |
| 3L-4S | | MI | 25818 | 7331 | 42779 | 5317 | 46551 | 4282 | 48070 | 3484 | 49338 | 2281 | 59478 | 1553 | 43122 |
| 10-#18 | 2.39 | MA | 30124 | 7331 | 49588 | 5376 | 54286 | 4334 | 56245 | 3530 | 58276 | 2338 | 70677 | 1636 | 50834 |
| 4L-3S | | MI | 27116 | 7331 | 45054 | 5288 | 49444 | 4294 | 51579 | 3499 | 53790 | 2264 | 64475 | 1780 | 44054 |
| 10-#18 | 2.39 | MA | 28751 | 7331 | 47225 | 5373 | 51239 | 4362 | 52515 | 3554 | 52974 | 2320 | 64266 | 1527 | 47750 |
| 5L-2S | | MI | 28937 | 7331 | 47868 | 5295 | 53032 | 4269 | 55941 | 3480 | 59595 | 2246 | 72153 | 2008 | 44168 |
| 12-#11 | 1.12 | MA | 29881 | 6576 | 46684 | 4923 | 50853 | 4010 | 52171 | 3337 | 52625 | 2380 | 62474 | 2257 | 25196 |
| 2L-6S | | MI | 23468 | 6576 | 36774 | 4884 | 39086 | 3987 | 39080 | 3315 | 37326 | 2366 | 43514 | 1932 | 21319 |
| 12-#11 | 1.12 | MA | 28989 | 6576 | 45349 | 4923 | 49152 | 4008 | 50103 | 3348 | 49823 | 2388 | 58681 | 2168 | 25224 |
| 3L-5S | | MI | 23924 | 6576 | 37525 | 4886 | 40107 | 3990 | 40324 | 3319 | 38966 | 2359 | 45557 | 1991 | 21560 |
| 12-#11 | 1.12 | MA | 28361 | 6576 | 44280 | 4936 | 47791 | 4020 | 48452 | 3345 | 47680 | 2396 | 56194 | 2079 | 25225 |
| 4E | | MI | 24402 | 6576 | 38320 | 4887 | 41132 | 3979 | 41580 | 3310 | 40752 | 2366 | 47716 | 2033 | 21573 |
| 12-#11 | 1.12 | MA | 27799 | 6576 | 43343 | 4936 | 46583 | 4018 | 46972 | 3356 | 45568 | 2391 | 53605 | 2035 | 25171 |
| 5L-3S | | MI | 24935 | 6576 | 39227 | 4875 | 42286 | 3982 | 42979 | 3314 | 42562 | 2359 | 49771 | 2122 | 21547 |
| 12-#11 | 1.12 | MA | 27263 | 6576 | 42459 | 4935 | 45382 | 4030 | 45507 | 3353 | 43628 | 2399 | 51136 | 1977 | 24829 |
| 6L-2S | | MI | 25685 | 6576 | 40354 | 4877 | 43722 | 3971 | 44726 | 3305 | 44921 | 2352 | 52915 | 2211 | 21510 |
| 12-#14 | 1.61 | MA | 31477 | 6870 | 50214 | 5091 | 55260 | 4130 | 57493 | 3409 | 59820 | 2353 | 72005 | 2201 | 35843 |
| 2L-6S | | MI | 23872 | 6870 | 38203 | 5051 | 40788 | 4110 | 41109 | 3386 | 40035 | 2337 | 47385 | 1741 | 29136 |
| 12-#14 | 1.61 | MA | 30217 | 6870 | 48304 | 5090 | 52825 | 4127 | 54532 | 3424 | 55808 | 2364 | 66608 | 2073 | 35831 |
| 3L-5S | | MI | 24517 | 6870 | 39280 | 5054 | 42249 | 4115 | 42892 | 3393 | 42369 | 2327 | 50282 | 1826 | 30051 |
| 12-#14 | 1.61 | MA | 29328 | 6870 | 46770 | 5109 | 50875 | 4144 | 52166 | 3419 | 52736 | 2375 | 63072 | 1945 | 35726 |
| 4E | | MI | 25194 | 6870 | 40420 | 5057 | 43719 | 4100 | 44691 | 3380 | 44909 | 2337 | 53353 | 1886 | 30475 |
| 12-#14 | 1.61 | MA | 28533 | 6870 | 45427 | 5108 | 49141 | 4141 | 50043 | 3434 | 49707 | 2367 | 59380 | 1882 | 35194 |
| 5L-3S | | MI | 25947 | 6870 | 41718 | 5040 | 45370 | 4105 | 46695 | 3387 | 47484 | 2327 | 56266 | 2014 | 30529 |
| 12-#14 | 1.61 | MA | 27774 | 6870 | 44159 | 5106 | 47419 | 4158 | 47942 | 3429 | 46925 | 2378 | 55869 | 1798 | 34017 |
| 6L-2S | | MI | 27008 | 6870 | 43330 | 5042 | 47425 | 4090 | 49192 | 3375 | 50841 | 2317 | 60728 | 2142 | 30508 |
| 12-#18 | 2.87 | MA | 35326 | 7614 | 58973 | 5526 | 66242 | 4442 | 70773 | 3597 | 77664 | 2284 | 95455 | 2046 | 62226 |
| 2L-6S | | MI | 24839 | 7614 | 41703 | 5480 | 44997 | 4424 | 46148 | 3568 | 46712 | 2257 | 56867 | 1241 | 46483 |
| 12-#18 | 2.87 | MA | 33179 | 7614 | 55627 | 5522 | 61976 | 4470 | 65586 | 3621 | 70658 | 2302 | 86117 | 1818 | 61964 |
| 3L-5S | | MI | 25941 | 7614 | 43593 | 5487 | 47561 | 4435 | 49275 | 3583 | 50747 | 2239 | 61847 | 1393 | 48912 |
| 12-#18 | 2.87 | MA | 31663 | 7614 | 52934 | 5554 | 58552 | 4463 | 61431 | 3610 | 65282 | 2319 | 80014 | 1591 | 60459 |
| 4E | | MI | 27095 | 7614 | 45593 | 5494 | 50140 | 4411 | 52432 | 3564 | 55142 | 2257 | 67156 | 1497 | 51171 |
| 12-#18 | 2.87 | MA | 30306 | 7614 | 50571 | 5550 | 55506 | 4491 | 57701 | 3634 | 59981 | 2302 | 73603 | 1481 | 57540 |
| 5L-3S | | MI | 28379 | 7614 | 47868 | 5465 | 53032 | 4422 | 55941 | 3579 | 59595 | 2239 | 72153 | 1724 | 52535 |
| 12-#18 | 2.87 | MA | 29011 | 7614 | 48341 | 5546 | 52477 | 4483 | 54007 | 3623 | 55110 | 2319 | 67536 | 1331 | 54625 |
| 6L-2S | | MI | 30184 | 7614 | 50682 | 5472 | 56620 | 4398 | 60303 | 3559 | 65399 | 2222 | 79832 | 1952 | 52716 |
| 14-#11 | 1.31 | MA | 30510 | 6687 | 48018 | 4992 | 52554 | 4060 | 54239 | 3368 | 55427 | 2373 | 66267 | 2243 | 29277 |
| 2L-7S | | MI | 23561 | 6687 | 37097 | 4966 | 39543 | 4048 | 39626 | 3355 | 38080 | 2366 | 44531 | 1827 | 24195 |
| 14-#11 | 1.31 | MA | 29622 | 6687 | 46684 | 4992 | 50853 | 4058 | 52171 | 3379 | 52625 | 2381 | 62474 | 2154 | 29294 |
| 3L-6S | | MI | 24004 | 6687 | 37900 | 4954 | 40523 | 4037 | 40826 | 3346 | 39685 | 2359 | 46658 | 1914 | 24627 |
| 14-#11 | 1.31 | MA | 28998 | 6687 | 45614 | 5005 | 49493 | 4070 | 50520 | 3376 | 50482 | 2389 | 59987 | 2065 | 29275 |
| 4L-5S | | MI | 24457 | 6687 | 38652 | 4955 | 41543 | 4040 | 42070 | 3350 | 41326 | 2352 | 48701 | 1973 | 24971 |
| 14-#11 | 1.31 | MA | 28439 | 6687 | 44677 | 5005 | 48284 | 4069 | 49040 | 3387 | 48370 | 2384 | 57397 | 2021 | 29200 |
| 5L-4S | | MI | 24933 | 6687 | 39447 | 4957 | 42569 | 4030 | 43326 | 3341 | 43111 | 2359 | 50860 | 2016 | 25005 |
| 14-#11 | 1.31 | MA | 27906 | 6687 | 43794 | 5004 | 47083 | 4081 | 47575 | 3384 | 46430 | 2392 | 54929 | 1962 | 28753 |
| 6L-3S | | MI | 25463 | 6687 | 40354 | 4944 | 43722 | 4032 | 44726 | 3345 | 44921 | 2352 | 52915 | 2104 | 24995 |

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis

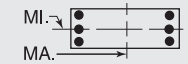



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.31 | MA | 27386 | 6687 | 42848 | 5017 | 45930 | 4079 | 46162 | 3395 | 44532 | 2401 | 52360 | 1875 | 28189 |
| 7L-2S | | MI | 26210 | 6687 | 41481 | 4946 | 45159 | 4022 | 46472 | 3336 | 47280 | 2345 | 56059 | 2193 | 24966 |
| 14-#14 | 1.88 | MA | 32360 | 7029 | 52125 | 5191 | 57696 | 4203 | 60454 | 3454 | 63831 | 2343 | 77402 | 2179 | 41665 |
| 2L-7S | | MI | 24002 | 7029 | 38662 | 5168 | 41438 | 4197 | 41886 | 3444 | 41108 | 2335 | 48829 | 1587 | 33101 |
| 14-#14 | 1.88 | MA | 31107 | 7029 | 50214 | 5190 | 55260 | 4199 | 57493 | 3469 | 59820 | 2354 | 72005 | 2051 | 41623 |
| 3L-6S | | MI | 24627 | 7029 | 39814 | 5151 | 42842 | 4182 | 43606 | 3431 | 43392 | 2325 | 51847 | 1714 | 33873 |
| 14-#14 | 1.88 | MA | 30225 | 7029 | 48681 | 5209 | 53310 | 4216 | 55126 | 3464 | 56747 | 2365 | 68469 | 1923 | 41486 |
| 4L-5S | | MI | 25268 | 7029 | 40891 | 5154 | 44304 | 4187 | 45389 | 3438 | 45725 | 2315 | 54744 | 1798 | 34739 |
| 14-#14 | 1.88 | MA | 29436 | 7029 | 47337 | 5207 | 51577 | 4213 | 53004 | 3479 | 53718 | 2357 | 64778 | 1860 | 40771 |
| 5L-4S | | MI | 25940 | 7029 | 42031 | 5157 | 45774 | 4172 | 47188 | 3425 | 48266 | 2325 | 57815 | 1859 | 35340 |
| 14-#14 | 1.88 | MA | 28683 | 7029 | 46069 | 5206 | 49854 | 4230 | 50903 | 3474 | 50936 | 2368 | 61267 | 1776 | 39649 |
| 6L-3S | | MI | 26688 | 7029 | 43330 | 5139 | 47425 | 4177 | 49192 | 3432 | 50841 | 2315 | 60728 | 1987 | 35422 |
| 14-#14 | 1.88 | MA | 27948 | 7029 | 44712 | 5225 | 48200 | 4227 | 48875 | 3489 | 48214 | 2379 | 57613 | 1649 | 38693 |
| 7L-2S | | MI | 27743 | 7029 | 44941 | 5142 | 49479 | 4162 | 51689 | 3420 | 54197 | 2305 | 65190 | 2115 | 35430 |
| 14-#18 | 3.35 | MA | 34685 | 7898 | 58973 | 5700 | 66242 | 4599 | 70773 | 3701 | 77664 | 2283 | 95455 | 1773 | 72031 |
| 3L-6S | | MI | 26126 | 7898 | 44517 | 5658 | 48585 | 4553 | 50510 | 3648 | 52517 | 2233 | 64546 | 1185 | 54537 |
| 14-#18 | 3.35 | MA | 33185 | 7898 | 56280 | 5731 | 62818 | 4591 | 66618 | 3690 | 72289 | 2301 | 89352 | 1545 | 70126 |
| 4L-5S | | MI | 27216 | 7898 | 46407 | 5664 | 51149 | 4564 | 53637 | 3663 | 56552 | 2215 | 69525 | 1337 | 57136 |
| 14-#18 | 3.35 | MA | 31842 | 7898 | 53918 | 5727 | 59772 | 4619 | 62887 | 3714 | 66987 | 2283 | 82941 | 1436 | 67356 |
| 5L-4S | | MI | 28358 | 7898 | 48407 | 5671 | 53728 | 4540 | 56793 | 3643 | 60947 | 2233 | 74835 | 1440 | 59263 |
| 14-#18 | 3.35 | MA | 30562 | 7898 | 51687 | 5724 | 56743 | 4612 | 59193 | 3703 | 62116 | 2301 | 76873 | 1286 | 64275 |
| 6L-3S | | MI | 29630 | 7898 | 50682 | 5643 | 56620 | 4551 | 60303 | 3659 | 65399 | 2215 | 79832 | 1668 | 61003 |
| 14-#18 | 3.35 | MA | 29312 | 7898 | 49300 | 5755 | 53834 | 4639 | 55628 | 3727 | 57349 | 2318 | 70555 | 1061 | 61260 |
| 7L-2S | | MI | 31419 | 7898 | 53497 | 5649 | 60208 | 4527 | 64665 | 3639 | 71204 | 2197 | 87510 | 1895 | 61245 |
| 16-#11 | 1.49 | MA | 31136 | 6797 | 49352 | 5062 | 54255 | 4110 | 56307 | 3399 | 58229 | 2366 | 70060 | 2229 | 33351 |
| 2L-8S | | MI | 23661 | 6797 | 37486 | 5034 | 39991 | 4095 | 40197 | 3396 | 38758 | 2351 | 45658 | 1759 | 27152 |
| 16-#11 | 1.49 | MA | 30252 | 6797 | 48018 | 5061 | 52554 | 4108 | 54239 | 3410 | 55427 | 2374 | 66267 | 2140 | 33354 |
| 3L-7S | | MI | 24095 | 6797 | 38224 | 5035 | 40980 | 4098 | 41372 | 3386 | 40439 | 2358 | 47675 | 1809 | 27531 |
| 16-#11 | 1.49 | MA | 29631 | 6797 | 46948 | 5074 | 51194 | 4120 | 52588 | 3407 | 53283 | 2383 | 63779 | 2051 | 33318 |
| 4L-6S | | MI | 24536 | 6797 | 39027 | 5023 | 41960 | 4088 | 42573 | 3377 | 42045 | 2351 | 49802 | 1897 | 27943 |
| 16-#11 | 1.49 | MA | 29075 | 6797 | 46012 | 5074 | 49985 | 4119 | 51108 | 3418 | 51171 | 2377 | 61190 | 2007 | 33224 |
| 5E | | MI | 24987 | 6797 | 39778 | 5024 | 42980 | 4091 | 43817 | 3381 | 43685 | 2344 | 51845 | 1955 | 28376 |
| 16-#11 | 1.49 | MA | 28545 | 6797 | 45128 | 5073 | 48784 | 4131 | 49643 | 3415 | 49232 | 2385 | 58721 | 1948 | 32686 |
| 6L-4S | | MI | 25460 | 6797 | 40574 | 5026 | 44006 | 4080 | 45073 | 3372 | 45470 | 2351 | 54004 | 1998 | 28427 |
| 16-#11 | 1.49 | MA | 28028 | 6797 | 44182 | 5087 | 47632 | 4129 | 48230 | 3426 | 47334 | 2394 | 56153 | 1861 | 32145 |
| 7L-3S | | MI | 25988 | 6797 | 41481 | 5013 | 45159 | 4083 | 46472 | 3376 | 47280 | 2344 | 56059 | 2087 | 28435 |
| 16-#11 | 1.49 | MA | 27518 | 6797 | 43315 | 5086 | 46468 | 4141 | 46847 | 3437 | 45345 | 2388 | 53733 | 1809 | 31656 |
| 8L-2S | | MI | 26732 | 6797 | 42608 | 5015 | 46596 | 4072 | 48219 | 3367 | 49639 | 2338 | 59202 | 2175 | 28416 |
| 16-#14 | 2.15 | MA | 33237 | 7189 | 54035 | 5291 | 60131 | 4275 | 63415 | 3499 | 67842 | 2333 | 82799 | 2157 | 47473 |
| 2L-8S | | MI | 24143 | 7189 | 39216 | 5265 | 42075 | 4265 | 42698 | 3501 | 42072 | 2314 | 50422 | 1489 | 36634 |
| 16-#14 | 2.15 | MA | 31991 | 7189 | 52125 | 5290 | 57696 | 4272 | 60454 | 3514 | 63831 | 2344 | 77402 | 2029 | 47407 |
| 3L-7S | | MI | 24756 | 7189 | 40274 | 5268 | 43492 | 4270 | 44383 | 3488 | 44465 | 2324 | 53291 | 1559 | 37754 |
| 16-#14 | 2.15 | MA | 31115 | 7189 | 50591 | 5308 | 55746 | 4289 | 58087 | 3509 | 60758 | 2356 | 73866 | 1901 | 47240 |
| 4L-6S | | MI | 25377 | 7189 | 41426 | 5251 | 44896 | 4255 | 46103 | 3476 | 46748 | 2314 | 56309 | 1686 | 38620 |
| 16-#14 | 2.15 | MA | 30331 | 7189 | 49248 | 5307 | 54013 | 4285 | 55965 | 3524 | 57730 | 2347 | 70175 | 1838 | 46364 |
| 5E | | MI | 26014 | 7189 | 42502 | 5254 | 46358 | 4260 | 47886 | 3483 | 49082 | 2304 | 59207 | 1771 | 39443 |
| 16-#14 | 2.15 | MA | 29584 | 7189 | 47980 | 5306 | 52290 | 4302 | 53863 | 3519 | 54948 | 2358 | 66664 | 1754 | 45290 |
| 6L-4S | | MI | 26681 | 7189 | 43642 | 5256 | 47828 | 4245 | 49686 | 3470 | 51622 | 2314 | 62278 | 1831 | 40198 |
| 16-#14 | 2.15 | MA | 28855 | 7189 | 46623 | 5325 | 50636 | 4299 | 51836 | 3534 | 52225 | 2369 | 63010 | 1627 | 44242 |
| 7L-3S | | MI | 27425 | 7189 | 44941 | 5239 | 49479 | 4249 | 51689 | 3477 | 54197 | 2304 | 65190 | 1959 | 40307 |
| 16-#14 | 2.15 | MA | 28135 | 7189 | 45378 | 5323 | 48967 | 4316 | 49852 | 3548 | 49373 | 2360 | 59560 | 1554 | 42821 |
| 8L-2S | | MI | 28473 | 7189 | 46552 | 5242 | 51533 | 4234 | 54186 | 3465 | 57554 | 2294 | 69652 | 2087 | 40342 |
| 16-#18 | 3.83 | MA | 34691 | 8182 | 59626 | 5908 | 67085 | 4720 | 71804 | 3770 | 79295 | 2282 | 98689 | 1500 | 79829 |
| 4L-6S | | MI | 27399 | 8182 | 47331 | 5835 | 52173 | 4681 | 54872 | 3728 | 58322 | 2209 | 72224 | 1129 | 62619 |
| 16-#18 | 3.83 | MA | 33363 | 8182 | 57264 | 5905 | 64038 | 4748 | 68073 | 3794 | 73994 | 2264 | 92278 | 1391 | 77192 |
| 5E | | MI | 28478 | 8182 | 49222 | 5842 | 54737 | 4692 | 57999 | 3743 | 62357 | 2191 | 77203 | 1280 | 65380 |
| 16-#18 | 3.83 | MA | 32096 | 8182 | 55033 | 5901 | 61009 | 4740 | 64379 | 3782 | 69123 | 2282 | 86210 | 1241 | 73952 |
| 6L-4S | | MI | 29609 | 8182 | 51222 | 5849 | 57316 | 4668 | 61155 | 3723 | 66752 | 2209 | 82513 | 1384 | 67389 |
| 16-#18 | 3.83 | MA | 30860 | 8182 | 52647 | 5932 | 58100 | 4768 | 60815 | 3806 | 64355 | 2300 | 79892 | 1016 | 70839 |
| 7L-3S | | MI | 30869 | 8182 | 53497 | 5820 | 60208 | 4679 | 64665 | 3739 | 71204 | 2191 | 87510 | 1612 | 69461 |

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

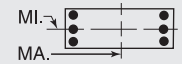
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.68 | MA | 31758 | 6908 | 50687 | 5131 | 55956 | 4160 | 58375 | 3431 | 61030 | 2359 | 73852 | 2215 | 37421 |
| 2L-9S | | MI | 23758 | 6908 | 37832 | 5115 | 40462 | 4156 | 40727 | 3422 | 39528 | 2351 | 46823 | 1685 | 29790 |
| 18-#11 | 1.68 | MA | 30878 | 6908 | 49352 | 5130 | 54255 | 4159 | 56307 | 3441 | 58229 | 2367 | 70060 | 2126 | 37407 |
| 3L-8S | | MI | 24195 | 6908 | 38613 | 5103 | 41428 | 4146 | 41943 | 3427 | 41117 | 2344 | 48802 | 1742 | 30431 |
| 18-#11 | 1.68 | MA | 30260 | 6908 | 48283 | 5144 | 52895 | 4171 | 54656 | 3438 | 56085 | 2376 | 67572 | 2037 | 37356 |
| 4L-7S | | MI | 24627 | 6908 | 39350 | 5104 | 42417 | 4149 | 43119 | 3417 | 42799 | 2351 | 50819 | 1791 | 30870 |
| 18-#11 | 1.68 | MA | 29707 | 6908 | 47346 | 5143 | 51687 | 4169 | 53176 | 3449 | 53973 | 2370 | 64983 | 1993 | 37246 |
| 5L-6S | | MI | 25065 | 6908 | 40154 | 5092 | 43396 | 4138 | 44319 | 3408 | 44404 | 2344 | 52946 | 1879 | 31266 |
| 18-#11 | 1.68 | MA | 29180 | 6908 | 46462 | 5143 | 50486 | 4181 | 51711 | 3446 | 52033 | 2379 | 62514 | 1934 | 36627 |
| 6L-5S | | MI | 25514 | 6908 | 40905 | 5093 | 44417 | 4141 | 45563 | 3412 | 46044 | 2337 | 54989 | 1938 | 31778 |
| 18-#11 | 1.68 | MA | 28666 | 6908 | 45516 | 5156 | 49333 | 4179 | 50298 | 3457 | 50135 | 2387 | 59946 | 1847 | 36105 |
| 7L-4S | | MI | 25985 | 6908 | 41701 | 5095 | 45443 | 4130 | 46819 | 3403 | 47829 | 2344 | 57148 | 1980 | 31844 |
| 18-#11 | 1.68 | MA | 28159 | 6908 | 44649 | 5155 | 48169 | 4191 | 48915 | 3468 | 48147 | 2381 | 57526 | 1795 | 35556 |
| 8L-3S | | MI | 26510 | 6908 | 42608 | 5083 | 46596 | 4133 | 48219 | 3407 | 49639 | 2337 | 59202 | 2069 | 31871 |
| 18-#11 | 1.68 | MA | 27631 | 6908 | 43797 | 5155 | 47033 | 4189 | 47483 | 3465 | 46269 | 2390 | 55134 | 1739 | 34740 |
| 9L-2S | | MI | 27251 | 6908 | 43735 | 5084 | 48032 | 4122 | 49965 | 3398 | 51998 | 2330 | 62346 | 2158 | 31859 |
| 18-#14 | 2.42 | MA | 32869 | 7348 | 54035 | 5389 | 60131 | 4344 | 63415 | 3559 | 67842 | 2334 | 82799 | 2007 | 53185 |
| 3L-8S | | MI | 24896 | 7348 | 40827 | 5365 | 44129 | 4337 | 45195 | 3546 | 45428 | 2302 | 54884 | 1461 | 41339 |
| 18-#14 | 2.42 | MA | 31999 | 7348 | 52502 | 5408 | 58182 | 4361 | 61048 | 3554 | 64770 | 2346 | 79264 | 1879 | 52991 |
| 4L-7S | | MI | 25504 | 7348 | 41885 | 5368 | 45546 | 4342 | 46880 | 3533 | 47821 | 2312 | 57753 | 1532 | 42419 |
| 18-#14 | 2.42 | MA | 31220 | 7348 | 51158 | 5407 | 56448 | 4358 | 58926 | 3569 | 61741 | 2337 | 75572 | 1816 | 51970 |
| 5L-6S | | MI | 26122 | 7348 | 43037 | 5351 | 46950 | 4327 | 48600 | 3521 | 50105 | 2302 | 60771 | 1659 | 43374 |
| 18-#14 | 2.42 | MA | 30478 | 7348 | 49890 | 5406 | 54726 | 4375 | 56824 | 3564 | 58959 | 2348 | 72061 | 1732 | 50940 |
| 6L-5S | | MI | 26754 | 7348 | 44113 | 5353 | 48412 | 4332 | 50383 | 3528 | 52439 | 2292 | 63669 | 1743 | 44159 |
| 18-#14 | 2.42 | MA | 29754 | 7348 | 48533 | 5424 | 53072 | 4371 | 54797 | 3578 | 56236 | 2359 | 68407 | 1605 | 49803 |
| 7L-4S | | MI | 27417 | 7348 | 45253 | 5356 | 49882 | 4317 | 52183 | 3515 | 54979 | 2302 | 66740 | 1804 | 45050 |
| 18-#14 | 2.42 | MA | 29040 | 7348 | 47288 | 5423 | 51403 | 4388 | 52812 | 3593 | 53385 | 2350 | 64957 | 1532 | 48425 |
| 8L-3S | | MI | 28156 | 7348 | 46552 | 5339 | 51533 | 4322 | 54186 | 3522 | 57554 | 2292 | 69652 | 1932 | 45185 |
| 18-#14 | 2.42 | MA | 28317 | 7348 | 45971 | 5442 | 49772 | 4385 | 50759 | 3588 | 50690 | 2361 | 61556 | 1451 | 46832 |
| 9L-2S | | MI | 29199 | 7348 | 48163 | 5342 | 53587 | 4307 | 56683 | 3509 | 60910 | 2282 | 74114 | 2060 | 45240 |
| 18-#18 | 4.31 | MA | 34869 | 8466 | 60610 | 6082 | 68304 | 4876 | 73260 | 3873 | 81001 | 2246 | 101615 | 1346 | 87046 |
| 5L-6S | | MI | 28660 | 8466 | 50146 | 6012 | 55761 | 4810 | 59234 | 3807 | 64126 | 2184 | 79903 | 1073 | 70725 |
| 18-#18 | 4.31 | MA | 33615 | 8466 | 58380 | 6078 | 65275 | 4869 | 69566 | 3862 | 76129 | 2263 | 95548 | 1195 | 83653 |
| 6L-5S | | MI | 29729 | 8466 | 52036 | 6019 | 58326 | 4821 | 62361 | 3823 | 68161 | 2167 | 84882 | 1224 | 73640 |
| 18-#18 | 4.31 | MA | 32392 | 8466 | 55993 | 6110 | 62366 | 4897 | 66001 | 3886 | 71362 | 2281 | 89230 | 970 | 80441 |
| 7L-4S | | MI | 30850 | 8466 | 54036 | 6026 | 60904 | 4797 | 65517 | 3803 | 72556 | 2184 | 90192 | 1328 | 75544 |
| 20-#11 | 1.87 | MA | 32377 | 7019 | 52021 | 5200 | 57658 | 4210 | 60443 | 3462 | 63832 | 2352 | 77645 | 2201 | 41482 |
| 2L-10S | | MI | 23834 | 7019 | 38225 | 5183 | 40922 | 4204 | 41305 | 3463 | 40310 | 2351 | 48049 | 1604 | 32439 |
| 20-#11 | 1.87 | MA | 31501 | 7019 | 50687 | 5199 | 55956 | 4209 | 58375 | 3472 | 61030 | 2360 | 73852 | 2112 | 41456 |
| 3L-9S | | MI | 24299 | 7019 | 38959 | 5184 | 41899 | 4207 | 42473 | 3453 | 41887 | 2344 | 49967 | 1667 | 33096 |
| 20-#11 | 1.87 | MA | 30886 | 7019 | 49617 | 5213 | 54596 | 4221 | 56724 | 3470 | 58887 | 2369 | 71365 | 2023 | 41391 |
| 4L-8S | | MI | 24725 | 7019 | 39740 | 5172 | 42865 | 4196 | 43690 | 3458 | 43476 | 2337 | 51946 | 1724 | 33716 |
| 20-#11 | 1.87 | MA | 30335 | 7019 | 48680 | 5212 | 53388 | 4219 | 55244 | 3480 | 56775 | 2363 | 68775 | 1979 | 41266 |
| 5L-7S | | MI | 25155 | 7019 | 40477 | 5173 | 43853 | 4199 | 44865 | 3448 | 45158 | 2344 | 53963 | 1774 | 34214 |
| 20-#11 | 1.87 | MA | 29811 | 7019 | 47797 | 5212 | 52187 | 4231 | 53779 | 3477 | 54835 | 2372 | 66307 | 1920 | 40573 |
| 6E | | MI | 25591 | 7019 | 41281 | 5161 | 44833 | 4188 | 46066 | 3439 | 46763 | 2337 | 56090 | 1861 | 34594 |
| 20-#11 | 1.87 | MA | 29300 | 7019 | 46851 | 5225 | 51034 | 4229 | 52366 | 3488 | 52937 | 2380 | 63738 | 1833 | 40068 |
| 7L-5S | | MI | 26038 | 7019 | 42032 | 5163 | 45853 | 4191 | 47310 | 3443 | 48403 | 2330 | 58133 | 1920 | 35176 |
| 20-#11 | 1.87 | MA | 28796 | 7019 | 45983 | 5224 | 49871 | 4241 | 50983 | 3499 | 50949 | 2374 | 61318 | 1781 | 39462 |
| 8L-4S | | MI | 26507 | 7019 | 42828 | 5164 | 46879 | 4180 | 48566 | 3434 | 50188 | 2337 | 60292 | 1963 | 35257 |
| 20-#11 | 1.87 | MA | 28271 | 7019 | 45132 | 5224 | 48734 | 4240 | 49552 | 3496 | 49071 | 2383 | 58927 | 1725 | 38669 |
| 9L-3S | | MI | 27029 | 7019 | 43735 | 5152 | 48032 | 4183 | 49965 | 3439 | 51998 | 2330 | 62346 | 2051 | 35294 |
| 20-#11 | 1.87 | MA | 27716 | 7019 | 44202 | 5237 | 47585 | 4252 | 48177 | 3507 | 47207 | 2391 | 56607 | 1662 | 37860 |
| 10L-2S | | MI | 27767 | 7019 | 44862 | 5153 | 49469 | 4172 | 51712 | 3429 | 54358 | 2323 | 65490 | 2140 | 35298 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

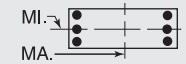
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.69 | MA | 32876 | 7508 | 54412 | 5508 | 60617 | 4433 | 64009 | 3599 | 68781 | 2336 | 84661 | 1857 | 58740 |
| 4L-8S | | MI | 25643 | 7508 | 42438 | 5465 | 46183 | 4409 | 47692 | 3591 | 48785 | 2291 | 59347 | 1434 | 46051 |
| 20-#14 | 2.69 | MA | 32103 | 7508 | 53068 | 5507 | 58884 | 4430 | 61886 | 3613 | 65752 | 2327 | 80969 | 1794 | 57587 |
| 5L-7S | | MI | 26248 | 7508 | 43496 | 5468 | 47600 | 4414 | 49377 | 3578 | 51178 | 2301 | 62215 | 1504 | 47095 |
| 20-#14 | 2.69 | MA | 31366 | 7508 | 51800 | 5505 | 57161 | 4447 | 59785 | 3608 | 62970 | 2338 | 77458 | 1710 | 56596 |
| 6E | | MI | 26861 | 7508 | 44648 | 5450 | 49004 | 4399 | 51097 | 3566 | 53462 | 2291 | 65234 | 1631 | 48134 |
| 20-#14 | 2.69 | MA | 30647 | 7508 | 50443 | 5524 | 55507 | 4444 | 57758 | 3623 | 60248 | 2349 | 73804 | 1583 | 55375 |
| 7L-5S | | MI | 27489 | 7508 | 45725 | 5453 | 50466 | 4404 | 52880 | 3573 | 55795 | 2281 | 68131 | 1716 | 48887 |
| 20-#14 | 2.69 | MA | 29938 | 7508 | 49199 | 5523 | 53838 | 4461 | 55773 | 3638 | 57396 | 2340 | 70354 | 1510 | 54037 |
| 8L-4S | | MI | 28148 | 7508 | 46865 | 5456 | 51936 | 4389 | 54680 | 3560 | 58335 | 2291 | 71202 | 1776 | 49899 |
| 20-#14 | 2.69 | MA | 29217 | 7508 | 47881 | 5542 | 52207 | 4458 | 53720 | 3633 | 54702 | 2351 | 66953 | 1429 | 52391 |
| 9L-3S | | MI | 28882 | 7508 | 48163 | 5439 | 53587 | 4394 | 56683 | 3567 | 60910 | 2281 | 74114 | 1904 | 50056 |
| 20-#18 | 4.78 | MA | 35120 | 8749 | 61726 | 6255 | 69542 | 4997 | 74752 | 3942 | 83136 | 2244 | 104885 | 1150 | 93374 |
| 6E | | MI | 29911 | 8749 | 52960 | 6190 | 59349 | 4938 | 63595 | 3887 | 69931 | 2160 | 87581 | 1017 | 78852 |
| 20-#18 | 4.78 | MA | 33909 | 8749 | 59339 | 6287 | 66633 | 5025 | 71187 | 3966 | 78369 | 2262 | 98567 | 925 | 90063 |
| 7L-5S | | MI | 30970 | 8749 | 54850 | 6196 | 61914 | 4950 | 66723 | 3903 | 73966 | 2142 | 92560 | 1168 | 81914 |
| 22-#11 | 2.05 | MA | 32120 | 7129 | 52021 | 5269 | 57658 | 4259 | 60443 | 3504 | 63832 | 2354 | 77645 | 2098 | 45501 |
| 3L-10S | | MI | 24366 | 7129 | 39352 | 5252 | 42359 | 4254 | 43051 | 3494 | 42670 | 2343 | 51192 | 1586 | 35712 |
| 22-#11 | 2.05 | MA | 31508 | 7129 | 50951 | 5282 | 56297 | 4271 | 58792 | 3501 | 61689 | 2362 | 75157 | 2009 | 45423 |
| 4L-9S | | MI | 24829 | 7129 | 40086 | 5253 | 43335 | 4257 | 44220 | 3485 | 44247 | 2336 | 53111 | 1650 | 36407 |
| 22-#11 | 2.05 | MA | 30961 | 7129 | 50015 | 5281 | 55089 | 4269 | 57312 | 3511 | 59577 | 2356 | 72568 | 1965 | 45284 |
| 5L-8S | | MI | 25253 | 7129 | 40867 | 5241 | 44301 | 4246 | 45436 | 3489 | 45836 | 2329 | 55090 | 1706 | 37008 |
| 22-#11 | 2.05 | MA | 30439 | 7129 | 49131 | 5281 | 53888 | 4281 | 55847 | 3508 | 57637 | 2365 | 70099 | 1906 | 44525 |
| 6L-7S | | MI | 25681 | 7129 | 41604 | 5243 | 45290 | 4249 | 46612 | 3480 | 47517 | 2336 | 57107 | 1756 | 37560 |
| 22-#11 | 2.05 | MA | 29930 | 7129 | 48185 | 5294 | 52735 | 4279 | 54434 | 3519 | 55739 | 2373 | 67531 | 1819 | 44035 |
| 7L-6S | | MI | 26115 | 7129 | 42408 | 5230 | 46270 | 4238 | 47812 | 3470 | 49122 | 2329 | 59234 | 1844 | 37927 |
| 22-#11 | 2.05 | MA | 29429 | 7129 | 47318 | 5294 | 51572 | 4291 | 53051 | 3530 | 53751 | 2368 | 65111 | 1767 | 43375 |
| 8L-5S | | MI | 26560 | 7129 | 43159 | 5232 | 47290 | 4241 | 49056 | 3475 | 50763 | 2323 | 61277 | 1902 | 38559 |
| 22-#11 | 2.05 | MA | 28907 | 7129 | 46466 | 5293 | 50435 | 4290 | 51620 | 3527 | 51872 | 2376 | 62719 | 1711 | 42602 |
| 9L-4S | | MI | 27026 | 7129 | 43955 | 5233 | 48316 | 4230 | 50312 | 3465 | 52548 | 2329 | 63436 | 1945 | 38665 |
| 22-#11 | 2.05 | MA | 28355 | 7129 | 45536 | 5306 | 49286 | 4302 | 50245 | 3538 | 50008 | 2384 | 60399 | 1648 | 41757 |
| 10L-3S | | MI | 27546 | 7129 | 44862 | 5221 | 49469 | 4233 | 51712 | 3470 | 54358 | 2323 | 65490 | 2034 | 38714 |
| 22-#11 | 2.05 | MA | 27814 | 7129 | 44685 | 5306 | 48156 | 4300 | 48830 | 3535 | 48048 | 2379 | 58036 | 1593 | 40828 |
| 11L-2S | | MI | 28281 | 7129 | 45988 | 5222 | 50906 | 4222 | 53458 | 3460 | 56717 | 2316 | 68634 | 2122 | 38734 |
| 22-#14 | 2.96 | MA | 32980 | 7668 | 54979 | 5606 | 61320 | 4502 | 64847 | 3658 | 69764 | 2317 | 86366 | 1772 | 63215 |
| 5L-8S | | MI | 26386 | 7668 | 44050 | 5565 | 48237 | 4482 | 50189 | 3636 | 52141 | 2279 | 63809 | 1406 | 50771 |
| 22-#14 | 2.96 | MA | 32248 | 7668 | 53711 | 5605 | 59597 | 4519 | 62746 | 3653 | 66982 | 2328 | 82855 | 1688 | 62258 |
| 6L-7S | | MI | 26986 | 7668 | 45107 | 5567 | 49654 | 4487 | 51874 | 3623 | 54535 | 2289 | 66677 | 1477 | 51781 |
| 22-#14 | 2.96 | MA | 31534 | 7668 | 52354 | 5624 | 57943 | 4516 | 60719 | 3668 | 64259 | 2339 | 79201 | 1562 | 60957 |
| 7L-6S | | MI | 27596 | 7668 | 46259 | 5550 | 51059 | 4472 | 53595 | 3610 | 56818 | 2279 | 69696 | 1604 | 52900 |
| 22-#14 | 2.96 | MA | 30830 | 7668 | 51109 | 5623 | 56274 | 4533 | 58734 | 3683 | 61407 | 2330 | 75752 | 1488 | 59656 |
| 8L-5S | | MI | 28220 | 7668 | 47336 | 5553 | 52520 | 4476 | 55377 | 3618 | 59152 | 2269 | 72593 | 1688 | 53623 |
| 22-#14 | 2.96 | MA | 30110 | 7668 | 49792 | 5641 | 54643 | 4530 | 56681 | 3678 | 58713 | 2341 | 72350 | 1407 | 57959 |
| 9L-4S | | MI | 28875 | 7668 | 48476 | 5555 | 53990 | 4461 | 57177 | 3605 | 61692 | 2279 | 75664 | 1749 | 54744 |
| 22-#18 | 5.26 | MA | 35413 | 9033 | 62686 | 6464 | 70899 | 5154 | 76373 | 4046 | 85375 | 2243 | 107905 | 880 | 99704 |
| 7L-6S | | MI | 31152 | 9033 | 55774 | 6367 | 62937 | 5067 | 67957 | 3967 | 75736 | 2136 | 95260 | 960 | 86999 |
| 24-#11 | 2.24 | MA | 32127 | 7240 | 52286 | 5351 | 57999 | 4321 | 60861 | 3532 | 64490 | 2355 | 78950 | 1995 | 49453 |
| 4L-10S | | MI | 24895 | 7240 | 40479 | 5321 | 43796 | 4304 | 44798 | 3525 | 45029 | 2336 | 54336 | 1568 | 38989 |
| 24-#11 | 2.24 | MA | 31583 | 7240 | 51349 | 5350 | 56790 | 4319 | 59380 | 3543 | 62378 | 2350 | 76361 | 1951 | 49276 |
| 5L-9S | | MI | 25356 | 7240 | 41213 | 5323 | 44772 | 4307 | 45966 | 3516 | 46606 | 2329 | 56255 | 1632 | 39721 |
| 24-#11 | 2.24 | MA | 31064 | 7240 | 50465 | 5350 | 55589 | 4331 | 57915 | 3540 | 60438 | 2358 | 73892 | 1892 | 48481 |
| 6L-8S | | MI | 25778 | 7240 | 41993 | 5310 | 45738 | 4296 | 47182 | 3520 | 48195 | 2322 | 58234 | 1689 | 40305 |
| 24-#11 | 2.24 | MA | 30558 | 7240 | 49519 | 5363 | 54436 | 4330 | 56502 | 3550 | 58541 | 2366 | 71324 | 1805 | 48005 |
| 7E | | MI | 26204 | 7240 | 42731 | 5312 | 46727 | 4299 | 48358 | 3511 | 49876 | 2329 | 60250 | 1738 | 40908 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

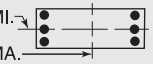
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.24 | MA | 30059 | 7240 | 48652 | 5363 | 53273 | 4342 | 55119 | 3561 | 56552 | 2361 | 68904 | 1753 | 47293 |
| 8L-6S | | MI | 26636 | 7240 | 43535 | 5299 | 47707 | 4288 | 49559 | 3501 | 51482 | 2322 | 62378 | 1826 | 41264 |
| 24-#11 | 2.24 | MA | 29540 | 7240 | 47800 | 5362 | 52136 | 4340 | 53688 | 3558 | 54674 | 2369 | 66512 | 1697 | 46540 |
| 9L-5S | | MI | 27079 | 7240 | 44286 | 5301 | 48727 | 4291 | 50803 | 3506 | 53122 | 2315 | 64421 | 1885 | 41871 |
| 24-#11 | 2.24 | MA | 28990 | 7240 | 46871 | 5376 | 50988 | 4352 | 52313 | 3569 | 52810 | 2377 | 64192 | 1634 | 45658 |
| 10L-4S | | MI | 27543 | 7240 | 45082 | 5302 | 49753 | 4280 | 52059 | 3496 | 54907 | 2322 | 66579 | 1927 | 42071 |
| 24-#11 | 2.24 | MA | 28452 | 7240 | 46019 | 5375 | 49857 | 4350 | 50898 | 3566 | 50850 | 2372 | 61829 | 1579 | 44748 |
| 11L-3S | | MI | 28060 | 7240 | 45988 | 5290 | 50906 | 4283 | 53458 | 3501 | 56717 | 2315 | 68634 | 2016 | 42131 |
| 24-#14 | 3.23 | MA | 33124 | 7827 | 55621 | 5705 | 62033 | 4592 | 65707 | 3698 | 70993 | 2318 | 88252 | 1666 | 67926 |
| 6L-8S | | MI | 27123 | 7827 | 45661 | 5664 | 50291 | 4554 | 52686 | 3681 | 55498 | 2267 | 68271 | 1379 | 55497 |
| 24-#14 | 3.23 | MA | 32415 | 7827 | 54264 | 5724 | 60379 | 4588 | 63680 | 3713 | 68270 | 2329 | 84598 | 1540 | 66547 |
| 7E | | MI | 27720 | 7827 | 46718 | 5667 | 51709 | 4559 | 54371 | 3668 | 57891 | 2277 | 71140 | 1449 | 56475 |
| 24-#14 | 3.23 | MA | 31716 | 7827 | 53020 | 5722 | 58709 | 4605 | 61695 | 3728 | 65419 | 2320 | 81149 | 1466 | 65282 |
| 8L-6S | | MI | 28326 | 7827 | 47870 | 5650 | 53113 | 4544 | 56092 | 3655 | 60175 | 2267 | 74158 | 1576 | 57671 |
| 24-#14 | 3.23 | MA | 30997 | 7827 | 51702 | 5741 | 57078 | 4602 | 59642 | 3723 | 62724 | 2331 | 77747 | 1385 | 63534 |
| 9L-5S | | MI | 28946 | 7827 | 48947 | 5653 | 54574 | 4549 | 57874 | 3662 | 62508 | 2257 | 77056 | 1661 | 58366 |

## RECTANGULAR TIED COLUMNS 38" x 46"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.37 | MA | 33467 | 7032 | 53007 | 5212 | 57902 | 4236 | 59764 | 3510 | 61200 | 2461 | 72872 | 2304 | 33298 |
| 2L-3S | | MI | 25567 | 7032 | 40961 | 5134 | 43863 | 4201 | 44407 | 3480 | 43570 | 2420 | 50652 | 1997 | 27089 |
| 6-#18 | 1.37 | MA | 31130 | 7032 | 49484 | 5209 | 53410 | 4265 | 54303 | 3535 | 53801 | 2479 | 62980 | 2076 | 33297 |
| 3L-2S | | MI | 27426 | 7032 | 43776 | 5141 | 47451 | 4177 | 48769 | 3460 | 49375 | 2402 | 58331 | 2224 | 27012 |
| 8-#14 | 1.03 | MA | 32320 | 6819 | 50325 | 5110 | 54676 | 4165 | 55917 | 3472 | 56019 | 2490 | 66235 | 2364 | 25375 |
| 2L-4S | | MI | 24705 | 6819 | 38728 | 5059 | 41207 | 4121 | 41252 | 3432 | 39591 | 2469 | 45972 | 2046 | 20767 |
| 8-#14 | 1.03 | MA | 30973 | 6819 | 48314 | 5109 | 52113 | 4163 | 52802 | 3487 | 51798 | 2502 | 60526 | 2236 | 25422 |
| 3E | | MI | 25469 | 6819 | 40026 | 5042 | 42858 | 4126 | 43256 | 3439 | 42166 | 2459 | 48885 | 2174 | 20728 |
| 8-#14 | 1.03 | MA | 30024 | 6819 | 46703 | 5129 | 50064 | 4180 | 50314 | 3483 | 48569 | 2514 | 56781 | 2108 | 25398 |
| 4L-2S | | MI | 26544 | 6819 | 41637 | 5045 | 44912 | 4111 | 45753 | 3426 | 45523 | 2449 | 53347 | 2302 | 20663 |
| 8-#18 | 1.83 | MA | 35096 | 7316 | 56531 | 5390 | 62394 | 4365 | 65225 | 3590 | 68598 | 2443 | 82763 | 2261 | 44057 |
| 2L-4S | | MI | 25548 | 7316 | 41500 | 5340 | 44558 | 4319 | 45259 | 3544 | 44922 | 2413 | 53334 | 1713 | 35325 |
| 8-#18 | 1.83 | MA | 32784 | 7316 | 53007 | 5387 | 57902 | 4394 | 59764 | 3615 | 61200 | 2461 | 72872 | 2034 | 43953 |
| 3E | | MI | 26862 | 7316 | 43776 | 5311 | 47451 | 4330 | 48769 | 3560 | 49375 | 2396 | 58331 | 1941 | 35629 |
| 8-#18 | 1.83 | MA | 31151 | 7316 | 50176 | 5419 | 54301 | 4387 | 55394 | 3605 | 55525 | 2479 | 66399 | 1806 | 43416 |
| 4L-2S | | MI | 28704 | 7316 | 46590 | 5318 | 51039 | 4306 | 53131 | 3540 | 55180 | 2378 | 66009 | 2168 | 35636 |
| 10-#14 | 1.29 | MA | 33269 | 6979 | 52335 | 5210 | 57239 | 4238 | 59032 | 3517 | 60240 | 2480 | 71944 | 2344 | 31527 |
| 2L-5S | | MI | 24782 | 6979 | 39199 | 5156 | 41791 | 4209 | 41949 | 3489 | 40408 | 2447 | 47363 | 1958 | 25552 |
| 10-#14 | 1.29 | MA | 31931 | 6979 | 50325 | 5209 | 54676 | 4235 | 55917 | 3532 | 56019 | 2492 | 66235 | 2216 | 31548 |
| 3L-4S | | MI | 25464 | 6979 | 40339 | 5159 | 43261 | 4194 | 43749 | 3477 | 42948 | 2457 | 50434 | 2019 | 25661 |
| 10-#14 | 1.29 | MA | 30989 | 6979 | 48713 | 5228 | 52627 | 4252 | 53430 | 3528 | 52789 | 2504 | 62491 | 2088 | 31478 |
| 4L-3S | | MI | 26223 | 6979 | 41637 | 5142 | 44912 | 4199 | 45753 | 3484 | 45523 | 2447 | 53347 | 2147 | 25661 |
| 10-#14 | 1.29 | MA | 30146 | 6979 | 47301 | 5227 | 50806 | 4250 | 51199 | 3543 | 49607 | 2496 | 58592 | 2024 | 31249 |
| 5L-2S | | MI | 27292 | 6979 | 43249 | 5145 | 46966 | 4184 | 48250 | 3471 | 48880 | 2437 | 57809 | 2275 | 25615 |
| 10-#18 | 2.29 | MA | 36705 | 7599 | 60055 | 5567 | 66887 | 4493 | 70686 | 3670 | 75997 | 2425 | 92655 | 2219 | 54775 |
| 2L-5S | | MI | 25672 | 7599 | 42315 | 5510 | 45568 | 4472 | 46465 | 3644 | 46332 | 2371 | 55703 | 1553 | 41000 |
| 10-#18 | 2.29 | MA | 34415 | 7599 | 56531 | 5564 | 62394 | 4522 | 65225 | 3695 | 68598 | 2443 | 82763 | 1992 | 54586 |
| 3L-4S | | MI | 26842 | 7599 | 44315 | 5517 | 48147 | 4447 | 49621 | 3624 | 50727 | 2389 | 61012 | 1657 | 43466 |
| 10-#18 | 2.29 | MA | 32801 | 7599 | 53699 | 5596 | 58793 | 4516 | 60855 | 3685 | 62924 | 2461 | 76291 | 1764 | 53821 |
| 4L-3S | | MI | 28142 | 7599 | 46590 | 5488 | 51039 | 4458 | 53131 | 3639 | 55180 | 2371 | 66009 | 1884 | 44137 |
| 10-#18 | 2.29 | MA | 31354 | 7599 | 51216 | 5593 | 55591 | 4545 | 56933 | 3710 | 57329 | 2444 | 69512 | 1653 | 50434 |
| 5L-2S | | MI | 29967 | 7599 | 49404 | 5495 | 54627 | 4434 | 57493 | 3620 | 60984 | 2354 | 73688 | 2112 | 44230 |
| 12-#11 | 1.07 | MA | 32519 | 6845 | 50626 | 5142 | 55160 | 4189 | 56543 | 3490 | 56883 | 2497 | 67553 | 2376 | 26459 |
| 2L-6S | | MI | 24489 | 6845 | 38301 | 5087 | 40682 | 4154 | 40636 | 3456 | 38725 | 2475 | 45062 | 2037 | 21457 |
| 12-#11 | 1.07 | MA | 31579 | 6845 | 49223 | 5141 | 53370 | 4188 | 54368 | 3501 | 53936 | 2506 | 63544 | 2287 | 26487 |
| 3L-5S | | MI | 24946 | 6845 | 39052 | 5089 | 41702 | 4157 | 41880 | 3461 | 40365 | 2468 | 47105 | 2096 | 21612 |
| 12-#11 | 1.07 | MA | 30918 | 6845 | 48099 | 5155 | 51941 | 4200 | 52633 | 3498 | 51684 | 2515 | 60912 | 2198 | 26489 |
| 4E | | MI | 25424 | 6845 | 39847 | 5090 | 42728 | 4146 | 43137 | 3451 | 42150 | 2475 | 49264 | 2139 | 21613 |

## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

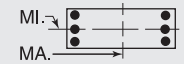
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.07 | MA | 30327 | 6845 | 47115 | 5155 | 50672 | 4199 | 51078 | 3510 | 49465 | 2510 | 58179 | 2154 | 26434 |
| 5L-3S | | MI | 25958 | 6845 | 40754 | 5078 | 43881 | 4149 | 44536 | 3456 | 43960 | 2468 | 51319 | 2227 | 21583 |
| 12-#11 | 1.07 | MA | 29764 | 6845 | 46187 | 5154 | 49411 | 4211 | 49540 | 3507 | 47428 | 2518 | 55568 | 2095 | 26161 |
| 6L-2S | | MI | 26709 | 6845 | 41881 | 5079 | 45318 | 4138 | 46282 | 3446 | 46319 | 2461 | 54462 | 2316 | 21544 |
| 12-#14 | 1.54 | MA | 34211 | 7138 | 54345 | 5310 | 59802 | 4310 | 62148 | 3562 | 64461 | 2470 | 77653 | 2323 | 37665 |
| 2L-6S | | MI | 24893 | 7138 | 39733 | 5253 | 42383 | 4276 | 42664 | 3527 | 41431 | 2445 | 48928 | 1846 | 29314 |
| 12-#14 | 1.54 | MA | 32881 | 7138 | 52335 | 5309 | 57239 | 4307 | 59032 | 3577 | 60240 | 2482 | 71944 | 2195 | 37654 |
| 3L-5S | | MI | 25539 | 7138 | 40810 | 5256 | 43845 | 4281 | 44446 | 3534 | 43764 | 2435 | 51826 | 1931 | 30249 |
| 12-#14 | 1.54 | MA | 31946 | 7138 | 50723 | 5328 | 55190 | 4325 | 56545 | 3573 | 57010 | 2494 | 68200 | 2068 | 37548 |
| 4E | | MI | 26217 | 7138 | 41950 | 5259 | 45315 | 4266 | 46246 | 3521 | 46304 | 2445 | 54897 | 1991 | 30540 |
| 12-#14 | 1.54 | MA | 31109 | 7138 | 49312 | 5327 | 53369 | 4322 | 54315 | 3588 | 53828 | 2486 | 64301 | 2004 | 37144 |
| 5L-3S | | MI | 26971 | 7138 | 43249 | 5242 | 46966 | 4271 | 48250 | 3529 | 48880 | 2435 | 57809 | 2119 | 30580 |
| 12-#14 | 1.54 | MA | 30311 | 7138 | 47980 | 5326 | 51559 | 4339 | 52107 | 3584 | 50905 | 2498 | 60585 | 1920 | 35853 |
| 6L-2S | | MI | 28034 | 7138 | 44860 | 5244 | 49020 | 4256 | 50747 | 3516 | 52236 | 2425 | 62271 | 2247 | 30551 |
| 12-#18 | 2.75 | MA | 38295 | 7883 | 63578 | 5744 | 71379 | 4622 | 76147 | 3750 | 83395 | 2407 | 102546 | 2177 | 65466 |
| 2L-6S | | MI | 25858 | 7883 | 43239 | 5681 | 46592 | 4589 | 47700 | 3708 | 48102 | 2365 | 58402 | 1345 | 46958 |
| 12-#18 | 2.75 | MA | 36027 | 7883 | 60055 | 5741 | 66887 | 4651 | 70686 | 3775 | 75997 | 2426 | 92655 | 1949 | 65204 |
| 3L-5S | | MI | 26963 | 7883 | 45129 | 5688 | 49156 | 4600 | 50827 | 3724 | 52137 | 2347 | 63381 | 1497 | 49195 |
| 12-#18 | 2.75 | MA | 34430 | 7883 | 57223 | 5774 | 63286 | 4644 | 66316 | 3765 | 70322 | 2444 | 86182 | 1722 | 63965 |
| 4E | | MI | 28120 | 7883 | 47129 | 5694 | 51735 | 4576 | 53983 | 3704 | 56532 | 2365 | 68691 | 1601 | 51508 |
| 12-#18 | 2.75 | MA | 33001 | 7883 | 54740 | 5771 | 60083 | 4673 | 62394 | 3790 | 64728 | 2427 | 79403 | 1611 | 60751 |
| 5L-3S | | MI | 29408 | 7883 | 49404 | 5666 | 54627 | 4587 | 57493 | 3719 | 60984 | 2347 | 73688 | 1828 | 52625 |
| 12-#18 | 2.75 | MA | 31637 | 7883 | 52396 | 5768 | 56900 | 4667 | 58511 | 3780 | 59587 | 2445 | 72972 | 1461 | 57908 |
| 6L-2S | | MI | 31217 | 7883 | 52219 | 5672 | 58215 | 4563 | 61854 | 3699 | 66789 | 2329 | 81366 | 2056 | 52783 |
| 14-#11 | 1.25 | MA | 33185 | 6955 | 52030 | 5211 | 56949 | 4240 | 58718 | 3521 | 59830 | 2490 | 71562 | 2363 | 30751 |
| 2L-7S | | MI | 24581 | 6955 | 38624 | 5169 | 41139 | 4215 | 41182 | 3497 | 39479 | 2474 | 46079 | 1932 | 24325 |
| 14-#11 | 1.25 | MA | 32249 | 6955 | 50626 | 5211 | 55160 | 4238 | 56543 | 3532 | 56883 | 2499 | 67553 | 2274 | 30768 |
| 3L-6S | | MI | 25025 | 6955 | 39427 | 5156 | 42119 | 4204 | 42383 | 3487 | 41084 | 2468 | 48206 | 2020 | 24763 |
| 14-#11 | 1.25 | MA | 31592 | 6955 | 49502 | 5224 | 53730 | 4251 | 54808 | 3529 | 54631 | 2508 | 64921 | 2185 | 30749 |
| 4L-5S | | MI | 25480 | 6955 | 40179 | 5158 | 43139 | 4207 | 43627 | 3492 | 42724 | 2461 | 50249 | 2078 | 25028 |
| 14-#11 | 1.25 | MA | 31004 | 6955 | 48519 | 5224 | 52461 | 4249 | 53253 | 3541 | 52412 | 2503 | 62188 | 2141 | 30674 |
| 5L-4S | | MI | 25956 | 6955 | 40974 | 5159 | 44165 | 4196 | 44883 | 3482 | 44509 | 2468 | 52408 | 2121 | 25051 |
| 14-#11 | 1.25 | MA | 30444 | 6955 | 47591 | 5224 | 51200 | 4261 | 51715 | 3538 | 50375 | 2512 | 59577 | 2082 | 30289 |
| 6L-3S | | MI | 26486 | 6955 | 41881 | 5147 | 45318 | 4199 | 46282 | 3487 | 46319 | 2461 | 54462 | 2210 | 25034 |
| 14-#11 | 1.25 | MA | 29897 | 6955 | 46597 | 5237 | 49989 | 4260 | 50231 | 3549 | 48382 | 2520 | 56862 | 1995 | 29671 |
| 7L-2S | | MI | 27235 | 6955 | 43008 | 5149 | 46754 | 4188 | 48029 | 3477 | 48678 | 2454 | 57606 | 2298 | 25002 |
| 14-#14 | 1.80 | MA | 35146 | 7298 | 56355 | 5409 | 62365 | 4382 | 65263 | 3606 | 68681 | 2460 | 83363 | 2303 | 43792 |
| 2L-7S | | MI | 25022 | 7298 | 40192 | 5370 | 43033 | 4363 | 43441 | 3585 | 42504 | 2444 | 50372 | 1692 | 33405 |
| 14-#14 | 1.80 | MA | 33824 | 7298 | 54345 | 5409 | 59802 | 4380 | 62148 | 3622 | 64461 | 2472 | 77653 | 2175 | 43749 |
| 3L-6S | | MI | 25649 | 7298 | 41345 | 5353 | 44437 | 4348 | 45161 | 3572 | 44787 | 2434 | 53390 | 1819 | 34050 |
| 14-#14 | 1.80 | MA | 32895 | 7298 | 52733 | 5428 | 57752 | 4397 | 59661 | 3618 | 61231 | 2484 | 73909 | 2047 | 43612 |
| 4L-5S | | MI | 26291 | 7298 | 42421 | 5356 | 45899 | 4353 | 46944 | 3579 | 47121 | 2424 | 56288 | 1903 | 34935 |
| 14-#14 | 1.80 | MA | 32064 | 7298 | 51322 | 5427 | 55931 | 4394 | 57430 | 3633 | 58049 | 2476 | 70011 | 1983 | 43015 |
| 5L-4S | | MI | 26964 | 7298 | 43561 | 5359 | 47369 | 4338 | 48743 | 3566 | 49661 | 2434 | 59359 | 1964 | 35410 |
| 14-#14 | 1.80 | MA | 31272 | 7298 | 49990 | 5426 | 54122 | 4412 | 55223 | 3629 | 55126 | 2488 | 66295 | 1899 | 41782 |
| 6L-3S | | MI | 27714 | 7298 | 44860 | 5341 | 49020 | 4343 | 50747 | 3574 | 52236 | 2424 | 62271 | 2092 | 35478 |
| 14-#14 | 1.80 | MA | 30499 | 7298 | 48565 | 5445 | 52384 | 4409 | 53094 | 3644 | 52266 | 2500 | 62429 | 1773 | 40917 |
| 7L-2S | | MI | 28770 | 7298 | 46471 | 5344 | 51074 | 4328 | 53244 | 3561 | 55593 | 2414 | 66733 | 2220 | 35475 |
| 14-#18 | 3.20 | MA | 37622 | 8167 | 63578 | 5919 | 71379 | 4779 | 76147 | 3855 | 83395 | 2408 | 102546 | 1907 | 75811 |
| 3L-6S | | MI | 27147 | 8167 | 46053 | 5858 | 50180 | 4718 | 52061 | 3788 | 53906 | 2340 | 66081 | 1289 | 55004 |
| 14-#18 | 3.20 | MA | 36042 | 8167 | 60746 | 5951 | 67778 | 4773 | 71777 | 3845 | 77721 | 2426 | 96074 | 1680 | 74152 |
| 4L-5S | | MI | 28240 | 8167 | 47943 | 5865 | 52744 | 4729 | 55189 | 3803 | 57942 | 2323 | 71060 | 1441 | 57415 |
| 14-#18 | 3.20 | MA | 34628 | 8167 | 58263 | 5948 | 64576 | 4802 | 67855 | 3870 | 72126 | 2409 | 89295 | 1569 | 71094 |
| 5L-4S | | MI | 29386 | 8167 | 49943 | 5872 | 55323 | 4704 | 58345 | 3783 | 62337 | 2340 | 76369 | 1544 | 59593 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

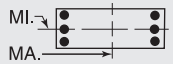


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.20 | MA | 33279 | 8167 | 55919 | 5945 | 61392 | 4795 | 63972 | 3860 | 66985 | 2427 | 82864 | 1419 | 68084 |
| 6L-3S | | MI | 30662 | 8167 | 52219 | 5843 | 58215 | 4716 | 61854 | 3799 | 66789 | 2323 | 81366 | 1772 | 61099 |
| 14-#18 | 3.20 | MA | 31963 | 8167 | 53411 | 5977 | 58335 | 4824 | 60226 | 3885 | 61954 | 2445 | 76169 | 1194 | 64935 |
| 7L-2S | | MI | 32455 | 8167 | 55033 | 5850 | 61803 | 4691 | 66216 | 3779 | 72594 | 2305 | 89045 | 1999 | 61317 |
| 16-#11 | 1.43 | MA | 33847 | 7066 | 53433 | 5280 | 58738 | 4290 | 60893 | 3552 | 62777 | 2483 | 75572 | 2350 | 35036 |
| 2L-8S | | MI | 24681 | 7066 | 39013 | 5236 | 41587 | 4262 | 41753 | 3537 | 40156 | 2460 | 47206 | 1864 | 27362 |
| 16-#11 | 1.43 | MA | 32915 | 7066 | 52030 | 5280 | 56949 | 4288 | 58718 | 3563 | 59830 | 2492 | 71562 | 2261 | 35039 |
| 3L-7S | | MI | 25117 | 7066 | 39750 | 5238 | 42576 | 4265 | 42929 | 3528 | 41838 | 2467 | 49223 | 1914 | 27660 |
| 16-#11 | 1.43 | MA | 32261 | 7066 | 50906 | 5293 | 55520 | 4301 | 56983 | 3561 | 57578 | 2501 | 68930 | 2172 | 35003 |
| 4L-6S | | MI | 25558 | 7066 | 40554 | 5226 | 43555 | 4254 | 44129 | 3519 | 43443 | 2460 | 51350 | 2002 | 28078 |
| 16-#11 | 1.43 | MA | 31676 | 7066 | 49922 | 5293 | 54250 | 4299 | 55429 | 3572 | 55359 | 2496 | 66198 | 2128 | 34909 |
| 5E | | MI | 26010 | 7066 | 41305 | 5227 | 44575 | 4257 | 45373 | 3523 | 45083 | 2453 | 53393 | 2061 | 28438 |
| 16-#11 | 1.43 | MA | 31119 | 7066 | 48994 | 5293 | 52989 | 4312 | 53890 | 3569 | 53322 | 2505 | 63587 | 2069 | 34427 |
| 6L-4S | | MI | 26484 | 7066 | 42101 | 5229 | 45601 | 4247 | 46630 | 3514 | 46868 | 2460 | 55552 | 2103 | 28478 |
| 16-#11 | 1.43 | MA | 30576 | 7066 | 48001 | 5306 | 51779 | 4310 | 52406 | 3580 | 51329 | 2513 | 60871 | 1982 | 33833 |
| 7L-3S | | MI | 27012 | 7066 | 43008 | 5216 | 46754 | 4249 | 48029 | 3518 | 48678 | 2453 | 57606 | 2192 | 28477 |
| 16-#11 | 1.43 | MA | 30040 | 7066 | 47090 | 5306 | 50557 | 4323 | 50954 | 3591 | 49241 | 2508 | 58317 | 1930 | 33395 |
| 8L-2S | | MI | 27758 | 7066 | 44135 | 5218 | 48191 | 4239 | 49775 | 3509 | 51038 | 2446 | 60750 | 2281 | 28454 |
| 16-#14 | 2.06 | MA | 36073 | 7458 | 58365 | 5509 | 64927 | 4454 | 68379 | 3651 | 72902 | 2451 | 89072 | 2283 | 49903 |
| 2L-8S | | MI | 25163 | 7458 | 40746 | 5467 | 43670 | 4431 | 44253 | 3642 | 43467 | 2422 | 51966 | 1594 | 36911 |
| 16-#14 | 2.06 | MA | 34759 | 7458 | 56355 | 5508 | 62365 | 4452 | 65263 | 3667 | 68681 | 2462 | 83363 | 2155 | 49837 |
| 3L-7S | | MI | 25777 | 7458 | 41804 | 5470 | 45087 | 4436 | 45938 | 3630 | 45860 | 2432 | 54834 | 1664 | 38053 |
| 16-#14 | 2.06 | MA | 33837 | 7458 | 54744 | 5527 | 60315 | 4469 | 62776 | 3662 | 65452 | 2474 | 79619 | 2027 | 49670 |
| 4L-6S | | MI | 26400 | 7458 | 42956 | 5453 | 46491 | 4421 | 47658 | 3617 | 48144 | 2422 | 57852 | 1791 | 38796 |
| 16-#14 | 2.06 | MA | 33012 | 7458 | 53332 | 5527 | 58494 | 4467 | 60546 | 3678 | 62269 | 2466 | 75720 | 1963 | 48902 |
| 5E | | MI | 27038 | 7458 | 44032 | 5456 | 47953 | 4426 | 49441 | 3624 | 50477 | 2412 | 60750 | 1876 | 39636 |
| 16-#14 | 2.06 | MA | 32225 | 7458 | 52000 | 5526 | 56685 | 4484 | 58338 | 3674 | 59346 | 2478 | 72004 | 1879 | 47720 |
| 6L-4S | | MI | 27707 | 7458 | 45172 | 5458 | 49423 | 4411 | 51241 | 3611 | 53018 | 2422 | 63821 | 1936 | 40272 |
| 16-#14 | 2.06 | MA | 31458 | 7458 | 50575 | 5545 | 54947 | 4481 | 56209 | 3689 | 56487 | 2490 | 68138 | 1752 | 46762 |
| 7L-3S | | MI | 28452 | 7458 | 46471 | 5441 | 51074 | 4416 | 53244 | 3618 | 55593 | 2412 | 66733 | 2064 | 40366 |
| 16-#14 | 2.06 | MA | 30701 | 7458 | 49268 | 5544 | 53194 | 4499 | 54124 | 3705 | 53491 | 2482 | 64494 | 1678 | 45209 |
| 8L-2S | | MI | 29502 | 7458 | 48082 | 5444 | 53128 | 4401 | 55741 | 3606 | 58949 | 2402 | 71196 | 2192 | 40393 |
| 16-#18 | 3.66 | MA | 37637 | 8451 | 64270 | 6128 | 72270 | 4901 | 77238 | 3924 | 85120 | 2408 | 105965 | 1637 | 84376 |
| 4L-6S | | MI | 28422 | 8451 | 48868 | 6035 | 53768 | 4846 | 56423 | 3868 | 59711 | 2316 | 73759 | 1233 | 63078 |
| 16-#18 | 3.66 | MA | 36237 | 8451 | 61787 | 6125 | 69068 | 4930 | 73316 | 3950 | 79525 | 2391 | 99186 | 1527 | 81459 |
| 5E | | MI | 29505 | 8451 | 50758 | 6042 | 56333 | 4857 | 59550 | 3883 | 63746 | 2298 | 78738 | 1385 | 65656 |
| 16-#18 | 3.66 | MA | 34903 | 8451 | 59443 | 6122 | 65884 | 4924 | 69433 | 3940 | 74384 | 2409 | 92755 | 1377 | 78286 |
| 6L-4S | | MI | 30640 | 8451 | 52758 | 6049 | 58911 | 4833 | 62707 | 3863 | 68141 | 2316 | 84048 | 1488 | 67713 |
| 16-#18 | 3.66 | MA | 33602 | 8451 | 56935 | 6155 | 62827 | 4953 | 65687 | 3965 | 69352 | 2427 | 86061 | 1152 | 75220 |
| 7L-3S | | MI | 31904 | 8451 | 55033 | 6020 | 61803 | 4844 | 66216 | 3879 | 72594 | 2298 | 89045 | 1716 | 69563 |
| 16-#18 | 3.66 | MA | 32318 | 8451 | 54633 | 6152 | 59742 | 4946 | 62018 | 3990 | 64083 | 2410 | 79727 | 1023 | 70990 |
| 8L-2S | | MI | 33683 | 8451 | 57847 | 6027 | 65391 | 4820 | 70578 | 3859 | 78398 | 2281 | 96723 | 1943 | 69836 |
| 18-#11 | 1.61 | MA | 34505 | 7177 | 54837 | 5349 | 60528 | 4340 | 63068 | 3583 | 65724 | 2476 | 79581 | 2337 | 39316 |
| 2L-9S | | MI | 24778 | 7177 | 39359 | 5318 | 42057 | 4323 | 42283 | 3564 | 40927 | 2460 | 48371 | 1790 | 29995 |
| 18-#11 | 1.61 | MA | 33577 | 7177 | 53433 | 5349 | 58738 | 4338 | 60893 | 3594 | 62777 | 2485 | 75572 | 2248 | 39303 |
| 3L-8S | | MI | 25216 | 7177 | 40140 | 5306 | 43024 | 4312 | 43500 | 3568 | 42515 | 2453 | 50350 | 1847 | 30648 |
| 18-#11 | 1.61 | MA | 32926 | 7177 | 52309 | 5362 | 57309 | 4351 | 59159 | 3592 | 60525 | 2494 | 72940 | 2159 | 39252 |
| 4L-7S | | MI | 25649 | 7177 | 40877 | 5307 | 44012 | 4315 | 44675 | 3559 | 44197 | 2460 | 52367 | 1897 | 31000 |
| 18-#11 | 1.61 | MA | 32345 | 7177 | 51325 | 5362 | 56040 | 4349 | 57604 | 3603 | 58306 | 2489 | 70207 | 2114 | 39142 |
| 5L-6S | | MI | 26088 | 7177 | 41681 | 5295 | 44992 | 4305 | 45876 | 3550 | 45802 | 2453 | 54494 | 1984 | 31401 |
| 18-#11 | 1.61 | MA | 31791 | 7177 | 50398 | 5362 | 54779 | 4362 | 56065 | 3600 | 56269 | 2498 | 67596 | 2056 | 38573 |
| 6L-5S | | MI | 26538 | 7177 | 42432 | 5296 | 46012 | 4307 | 47120 | 3554 | 47443 | 2446 | 56537 | 2043 | 31843 |
| 18-#11 | 1.61 | MA | 31250 | 7177 | 49404 | 5375 | 53568 | 4360 | 54581 | 3611 | 54276 | 2507 | 64880 | 1969 | 38000 |
| 7L-4S | | MI | 27009 | 7177 | 43228 | 5298 | 47038 | 4297 | 48376 | 3545 | 49228 | 2453 | 58695 | 2086 | 31898 |
| 18-#11 | 1.61 | MA | 30717 | 7177 | 48494 | 5375 | 52346 | 4373 | 53129 | 3623 | 52188 | 2502 | 62326 | 1917 | 37521 |
| 8L-3S | | MI | 27535 | 7177 | 44135 | 5285 | 48191 | 4300 | 49775 | 3549 | 51038 | 2446 | 60750 | 2174 | 31914 |
| 18-#11 | 1.61 | MA | 30153 | 7177 | 47600 | 5375 | 51153 | 4371 | 51626 | 3620 | 50215 | 2510 | 59796 | 1861 | 36630 |
| 9L-2S | | MI | 28278 | 7177 | 45262 | 5287 | 49628 | 4289 | 51522 | 3540 | 53397 | 2439 | 63894 | 2263 | 31899 |

## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

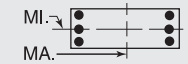



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.32 | MA | 35688 | 7617 | 58365 | 5608 | 64927 | 4524 | 68379 | 3712 | 72902 | 2452 | 89072 | 2134 | 55919 |
| 3L-8S | | MI | 25916 | 7617 | 42357 | 5567 | 45724 | 4503 | 46750 | 3687 | 46824 | 2411 | 56428 | 1566 | 41613 |
| 18-#14 | 2.32 | MA | 34772 | 7617 | 56754 | 5627 | 62878 | 4541 | 65891 | 3707 | 69672 | 2464 | 85328 | 2006 | 55725 |
| 4L-7S | | MI | 26526 | 7617 | 43415 | 5570 | 47142 | 4508 | 48435 | 3675 | 49217 | 2421 | 59296 | 1637 | 42715 |
| 18-#14 | 2.32 | MA | 33952 | 7617 | 55342 | 5626 | 61057 | 4539 | 63661 | 3723 | 66490 | 2456 | 81429 | 1942 | 54803 |
| 5L-6S | | MI | 27145 | 7617 | 44567 | 5553 | 48546 | 4493 | 50155 | 3662 | 51501 | 2411 | 62315 | 1764 | 43550 |
| 18-#14 | 2.32 | MA | 33171 | 7617 | 54010 | 5626 | 59247 | 4556 | 61454 | 3718 | 63567 | 2468 | 77713 | 1858 | 53668 |
| 6L-5S | | MI | 27779 | 7617 | 45644 | 5555 | 50007 | 4498 | 51938 | 3669 | 53834 | 2401 | 65212 | 1848 | 44351 |
| 18-#14 | 2.32 | MA | 32410 | 7617 | 52585 | 5645 | 57510 | 4554 | 59325 | 3734 | 60707 | 2480 | 73847 | 1732 | 52619 |
| 7L-4S | | MI | 28444 | 7617 | 46784 | 5558 | 51477 | 4483 | 53738 | 3656 | 56374 | 2411 | 68283 | 1909 | 45129 |
| 18-#14 | 2.32 | MA | 31658 | 7617 | 51278 | 5644 | 55757 | 4571 | 57240 | 3749 | 57711 | 2472 | 70204 | 1658 | 51111 |
| 8L-3S | | MI | 29185 | 7617 | 48082 | 5541 | 53128 | 4488 | 55741 | 3663 | 58949 | 2401 | 71196 | 2037 | 45247 |
| 18-#14 | 2.32 | MA | 30872 | 7617 | 49995 | 5643 | 54044 | 4568 | 55083 | 3745 | 54881 | 2484 | 66603 | 1577 | 49557 |
| 9L-2S | | MI | 30230 | 7617 | 49693 | 5543 | 55182 | 4473 | 58238 | 3651 | 62306 | 2391 | 75658 | 2165 | 45293 |
| 18-#18 | 4.12 | MA | 37832 | 8734 | 65310 | 6303 | 73560 | 5059 | 78777 | 4029 | 86924 | 2374 | 109078 | 1484 | 91841 |
| 5L-6S | | MI | 29685 | 8734 | 51682 | 6213 | 57356 | 4975 | 60785 | 3947 | 65516 | 2292 | 81437 | 1177 | 71177 |
| 18-#18 | 4.12 | MA | 36511 | 8734 | 62967 | 6300 | 70377 | 5052 | 74894 | 4019 | 81782 | 2392 | 102647 | 1334 | 88512 |
| 6L-5S | | MI | 30758 | 8734 | 53572 | 6219 | 59921 | 4986 | 63912 | 3963 | 69551 | 2274 | 86417 | 1328 | 73914 |
| 18-#18 | 4.12 | MA | 35223 | 8734 | 60458 | 6332 | 67319 | 5081 | 71148 | 4045 | 76751 | 2410 | 95952 | 1110 | 85349 |
| 7L-4S | | MI | 31883 | 8734 | 55572 | 6226 | 62499 | 4962 | 67068 | 3943 | 73946 | 2292 | 91726 | 1432 | 75863 |
| 18-#18 | 4.12 | MA | 33953 | 8734 | 58157 | 6329 | 64234 | 5075 | 67480 | 4070 | 71481 | 2393 | 89618 | 980 | 81225 |
| 8L-3S | | MI | 33136 | 8734 | 57847 | 6198 | 65391 | 4973 | 70578 | 3959 | 78398 | 2274 | 96723 | 1659 | 78018 |
| 20-#11 | 1.78 | MA | 35159 | 7287 | 56240 | 5418 | 62317 | 4390 | 65244 | 3614 | 68671 | 2469 | 83590 | 2324 | 43588 |
| 2L-10S | | MI | 24854 | 7287 | 39752 | 5386 | 42518 | 4370 | 42862 | 3605 | 41709 | 2459 | 49596 | 1709 | 32725 |
| 20-#11 | 1.78 | MA | 34235 | 7287 | 54837 | 5418 | 60528 | 4389 | 63068 | 3625 | 65724 | 2478 | 79581 | 2235 | 43562 |
| 3L-9S | | MI | 25320 | 7287 | 40486 | 5387 | 43494 | 4373 | 44030 | 3595 | 43286 | 2453 | 51515 | 1773 | 33300 |
| 20-#11 | 1.78 | MA | 33588 | 7287 | 53713 | 5432 | 59098 | 4401 | 61334 | 3623 | 63472 | 2487 | 76949 | 2146 | 43497 |
| 4L-8S | | MI | 25747 | 7287 | 41267 | 5375 | 44460 | 4363 | 45246 | 3600 | 44875 | 2446 | 53494 | 1829 | 33931 |
| 20-#11 | 1.78 | MA | 33009 | 7287 | 52729 | 5431 | 57829 | 4400 | 59779 | 3634 | 61253 | 2482 | 74216 | 2101 | 43372 |
| 5L-7S | | MI | 26178 | 7287 | 42004 | 5376 | 45449 | 4366 | 46422 | 3590 | 46556 | 2453 | 55510 | 1879 | 34344 |
| 20-#11 | 1.78 | MA | 32458 | 7287 | 51801 | 5431 | 56568 | 4412 | 58241 | 3631 | 59216 | 2491 | 71605 | 2043 | 42725 |
| 6E | | MI | 26615 | 7287 | 42808 | 5364 | 46429 | 4355 | 47622 | 3581 | 48162 | 2446 | 57638 | 1967 | 34729 |
| 20-#11 | 1.78 | MA | 31920 | 7287 | 50808 | 5445 | 55357 | 4410 | 56757 | 3643 | 57223 | 2500 | 68890 | 1956 | 42171 |
| 7L-5S | | MI | 27063 | 7287 | 43559 | 5365 | 47449 | 4358 | 48866 | 3585 | 49802 | 2439 | 59681 | 2025 | 35244 |
| 20-#11 | 1.78 | MA | 31390 | 7287 | 49897 | 5444 | 54136 | 4423 | 55304 | 3654 | 55135 | 2495 | 66335 | 1904 | 41633 |
| 8L-4S | | MI | 27532 | 7287 | 44355 | 5367 | 48475 | 4347 | 50123 | 3576 | 51587 | 2446 | 61839 | 2068 | 35313 |
| 20-#11 | 1.78 | MA | 30830 | 7287 | 49003 | 5444 | 52942 | 4421 | 53801 | 3651 | 53162 | 2503 | 63806 | 1848 | 40766 |
| 9L-3S | | MI | 28056 | 7287 | 45262 | 5355 | 49628 | 4350 | 51522 | 3580 | 53397 | 2439 | 63894 | 2157 | 35342 |
| 20-#11 | 1.78 | MA | 30246 | 7287 | 48027 | 5458 | 51736 | 4434 | 52357 | 3662 | 51205 | 2512 | 61352 | 1784 | 40006 |
| 10L-2S | | MI | 28795 | 7287 | 46389 | 5356 | 51065 | 4339 | 53268 | 3571 | 55756 | 2432 | 67038 | 2245 | 35340 |
| 20-#14 | 2.57 | MA | 35700 | 7777 | 58764 | 5727 | 65441 | 4614 | 69007 | 3752 | 73893 | 2454 | 91037 | 1986 | 61777 |
| 4L-8S | | MI | 26665 | 7777 | 43969 | 5667 | 47779 | 4575 | 49247 | 3732 | 50180 | 2399 | 60890 | 1539 | 46323 |
| 20-#14 | 2.57 | MA | 34886 | 7777 | 57352 | 5726 | 63620 | 4611 | 66777 | 3768 | 70711 | 2446 | 87139 | 1922 | 60715 |
| 5L-7S | | MI | 27271 | 7777 | 45026 | 5670 | 49196 | 4580 | 50932 | 3719 | 52573 | 2409 | 63759 | 1609 | 47387 |
| 20-#14 | 2.57 | MA | 34111 | 7777 | 56020 | 5725 | 61810 | 4629 | 64569 | 3763 | 67788 | 2458 | 83423 | 1838 | 59622 |
| 6E | | MI | 27886 | 7777 | 46178 | 5652 | 50600 | 4565 | 52652 | 3707 | 54857 | 2399 | 66777 | 1736 | 48310 |
| 20-#14 | 2.57 | MA | 33354 | 7777 | 54595 | 5745 | 60073 | 4626 | 62440 | 3779 | 64928 | 2470 | 79557 | 1711 | 58486 |
| 7L-5S | | MI | 28516 | 7777 | 47255 | 5655 | 52062 | 4570 | 54435 | 3714 | 57191 | 2389 | 69674 | 1821 | 49076 |
| 20-#14 | 2.57 | MA | 32608 | 7777 | 53288 | 5744 | 58320 | 4643 | 60355 | 3794 | 61932 | 2462 | 75913 | 1637 | 57021 |
| 8L-4S | | MI | 29177 | 7777 | 48395 | 5658 | 53531 | 4555 | 56235 | 3701 | 59731 | 2399 | 72746 | 1881 | 49981 |
| 20-#14 | 2.57 | MA | 31838 | 7777 | 52005 | 5743 | 56607 | 4641 | 58198 | 3790 | 59102 | 2474 | 72313 | 1556 | 55413 |
| 9L-3S | | MI | 29913 | 7777 | 49693 | 5641 | 55182 | 4560 | 58238 | 3708 | 62306 | 2389 | 75658 | 2009 | 50122 |
| 20-#14 | 2.57 | MA | 31004 | 7777 | 50604 | 5762 | 54876 | 4658 | 56127 | 3805 | 56293 | 2486 | 68821 | 1465 | 53798 |
| 10L-2S | | MI | 30952 | 7777 | 51304 | 5643 | 57237 | 4545 | 60735 | 3695 | 65663 | 2379 | 80120 | 2137 | 50187 |
| 20-#18 | 4.58 | MA | 38105 | 9018 | 66490 | 6477 | 74869 | 5181 | 80355 | 4099 | 89181 | 2374 | 112538 | 1292 | 98758 |
| 6E | | MI | 30938 | 9018 | 54496 | 6390 | 60944 | 5103 | 65147 | 4027 | 71321 | 2268 | 89116 | 1121 | 79298 |
| 20-#18 | 4.58 | MA | 36829 | 9018 | 63982 | 6509 | 71812 | 5210 | 76609 | 4124 | 84150 | 2392 | 105844 | 1067 | 95497 |
| 7L-5S | | MI | 32002 | 9018 | 56386 | 6397 | 63509 | 5114 | 68274 | 4043 | 75356 | 2250 | 94095 | 1272 | 82186 |
| 20-#18 | 4.58 | MA | 35572 | 9018 | 61681 | 6506 | 68727 | 5203 | 72941 | 4150 | 78880 | 2375 | 99510 | 938 | 91475 |
| 8L-4S | | MI | 33117 | 9018 | 58386 | 6404 | 66087 | 5090 | 71430 | 4023 | 79751 | 2268 | 99405 | 1376 | 84038 |

## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

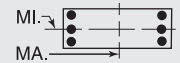
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.96 | MA | 34891 | 7398 | 56240 | 5487 | 62317 | 4439 | 65244 | 3657 | 68671 | 2471 | 83590 | 2222 | 47818 |
| 3L-10S | | MI | 25387 | 7398 | 40879 | 5455 | 43955 | 4421 | 44608 | 3636 | 44068 | 2452 | 52740 | 1691 | 35995 |
| 22-#11 | 1.96 | MA | 34246 | 7398 | 55116 | 5501 | 60888 | 4451 | 63509 | 3654 | 66419 | 2480 | 80958 | 2133 | 47740 |
| 4L-9S | | MI | 25850 | 7398 | 41613 | 5456 | 44931 | 4424 | 45776 | 3626 | 45645 | 2445 | 54658 | 1755 | 36609 |
| 22-#11 | 1.96 | MA | 33670 | 7398 | 54132 | 5500 | 59619 | 4450 | 61954 | 3665 | 64200 | 2475 | 78225 | 2088 | 47600 |
| 5L-8S | | MI | 26275 | 7398 | 42394 | 5444 | 45897 | 4413 | 46993 | 3631 | 47234 | 2438 | 56638 | 1811 | 37221 |
| 22-#11 | 1.96 | MA | 33122 | 7398 | 53205 | 5500 | 58357 | 4462 | 60416 | 3663 | 62163 | 2484 | 75615 | 2030 | 46882 |
| 6L-7S | | MI | 26704 | 7398 | 43131 | 5445 | 46886 | 4416 | 48168 | 3621 | 48916 | 2445 | 58654 | 1861 | 37690 |
| 22-#11 | 1.96 | MA | 32587 | 7398 | 52211 | 5514 | 57147 | 4461 | 58932 | 3674 | 60169 | 2493 | 72899 | 1943 | 46346 |
| 7L-6S | | MI | 27139 | 7398 | 43935 | 5433 | 47865 | 4405 | 49369 | 3612 | 50521 | 2438 | 60782 | 1949 | 38062 |
| 22-#11 | 1.96 | MA | 32060 | 7398 | 51301 | 5514 | 55925 | 4473 | 57479 | 3685 | 58082 | 2488 | 70344 | 1891 | 45750 |
| 8L-5S | | MI | 27585 | 7398 | 44686 | 5435 | 48885 | 4408 | 50613 | 3616 | 52161 | 2431 | 62825 | 2008 | 38642 |
| 22-#11 | 1.96 | MA | 31502 | 7398 | 50407 | 5513 | 54732 | 4472 | 55976 | 3682 | 56109 | 2497 | 67815 | 1835 | 44905 |
| 9L-4S | | MI | 28052 | 7398 | 45482 | 5436 | 49911 | 4397 | 51869 | 3607 | 53946 | 2438 | 64983 | 2050 | 38725 |
| 22-#11 | 1.96 | MA | 30921 | 7398 | 49431 | 5527 | 53526 | 4484 | 54533 | 3693 | 54152 | 2505 | 65361 | 1771 | 44108 |
| 10L-3S | | MI | 28573 | 7398 | 46389 | 5424 | 51065 | 4400 | 53268 | 3611 | 55756 | 2431 | 67038 | 2139 | 38765 |
| 22-#11 | 1.96 | MA | 30353 | 7398 | 48537 | 5527 | 52339 | 4483 | 53047 | 3691 | 52093 | 2500 | 62866 | 1716 | 43096 |
| 11L-2S | | MI | 29310 | 7398 | 47515 | 5425 | 52501 | 4389 | 55015 | 3602 | 58115 | 2425 | 70182 | 2228 | 38777 |
| 22-#14 | 2.83 | MA | 35814 | 7936 | 59362 | 5826 | 66183 | 4684 | 69892 | 3813 | 74932 | 2436 | 92848 | 1901 | 66638 |
| 5L-8S | | MI | 27408 | 7936 | 45580 | 5767 | 49833 | 4648 | 51744 | 3777 | 53537 | 2387 | 65352 | 1511 | 51040 |
| 22-#14 | 2.83 | MA | 35044 | 7936 | 58031 | 5825 | 64373 | 4701 | 67685 | 3808 | 72009 | 2448 | 89132 | 1817 | 65583 |
| 6L-7S | | MI | 28011 | 7936 | 46637 | 5769 | 51250 | 4653 | 53429 | 3764 | 55930 | 2397 | 68221 | 1582 | 52070 |
| 22-#14 | 2.83 | MA | 34292 | 7936 | 56605 | 5844 | 62636 | 4698 | 65555 | 3824 | 69149 | 2460 | 85266 | 1691 | 64363 |
| 7L-6S | | MI | 28622 | 7936 | 47789 | 5752 | 52654 | 4638 | 55149 | 3752 | 58214 | 2387 | 71239 | 1709 | 53076 |
| 22-#14 | 2.83 | MA | 33552 | 7936 | 55298 | 5843 | 60883 | 4716 | 63471 | 3839 | 66153 | 2452 | 81622 | 1617 | 62937 |
| 8L-5S | | MI | 29248 | 7936 | 48866 | 5755 | 54116 | 4643 | 56932 | 3759 | 60547 | 2378 | 74137 | 1793 | 53811 |
| 22-#14 | 2.83 | MA | 32783 | 7936 | 54015 | 5843 | 59170 | 4713 | 61314 | 3835 | 63323 | 2464 | 78022 | 1536 | 61277 |
| 9L-4S | | MI | 29905 | 7936 | 50006 | 5757 | 55586 | 4628 | 58732 | 3746 | 63088 | 2387 | 77208 | 1854 | 54830 |
| 22-#14 | 2.83 | MA | 31957 | 7936 | 52614 | 5862 | 57439 | 4730 | 59242 | 3850 | 60514 | 2476 | 74530 | 1444 | 59697 |
| 10L-3S | | MI | 30637 | 7936 | 51304 | 5740 | 57237 | 4633 | 60735 | 3753 | 65663 | 2378 | 80120 | 1982 | 54992 |
| 22-#18 | 5.03 | MA | 38421 | 9302 | 67506 | 6687 | 76304 | 5338 | 82070 | 4204 | 91548 | 2374 | 115735 | 1025 | 105665 |
| 7L-6S | | MI | 32182 | 9302 | 57311 | 6567 | 64532 | 5232 | 69509 | 4107 | 77125 | 2243 | 96794 | 1064 | 87439 |
| 22-#18 | 5.03 | MA | 37176 | 9302 | 65204 | 6684 | 73219 | 5332 | 78402 | 4230 | 86278 | 2357 | 109401 | 896 | 101604 |
| 8L-5S | | MI | 33236 | 9302 | 59201 | 6574 | 67097 | 5243 | 72636 | 4123 | 81161 | 2226 | 101773 | 1216 | 90470 |
| 24-#11 | 2.14 | MA | 34901 | 7509 | 56520 | 5570 | 62677 | 4501 | 65684 | 3685 | 69366 | 2473 | 84968 | 2120 | 51980 |
| 4L-10S | | MI | 25917 | 7509 | 42006 | 5524 | 45391 | 4471 | 46355 | 3667 | 46427 | 2445 | 55884 | 1674 | 39270 |
| 24-#11 | 2.14 | MA | 34328 | 7509 | 55536 | 5570 | 61408 | 4500 | 64130 | 3696 | 67147 | 2468 | 82235 | 2075 | 51827 |
| 5L-9S | | MI | 26378 | 7509 | 42740 | 5525 | 46367 | 4474 | 47523 | 3657 | 48004 | 2438 | 57802 | 1737 | 39923 |
| 24-#11 | 2.14 | MA | 33782 | 7509 | 54608 | 5569 | 60147 | 4512 | 62591 | 3694 | 65110 | 2477 | 79624 | 2017 | 51045 |
| 6L-8S | | MI | 26801 | 7509 | 43520 | 5513 | 47334 | 4463 | 48739 | 3662 | 49593 | 2431 | 59781 | 1794 | 40517 |
| 24-#11 | 2.14 | MA | 33250 | 7509 | 53615 | 5583 | 58936 | 4511 | 61107 | 3705 | 63116 | 2486 | 76908 | 1930 | 50523 |
| 7E | | MI | 27228 | 7509 | 44258 | 5515 | 48322 | 4466 | 49915 | 3652 | 51275 | 2438 | 61798 | 1844 | 41039 |
| 24-#11 | 2.14 | MA | 32725 | 7509 | 52704 | 5583 | 57714 | 4523 | 59654 | 3716 | 61028 | 2481 | 74354 | 1878 | 49874 |
| 8L-6S | | MI | 27661 | 7509 | 45062 | 5502 | 49302 | 4455 | 51115 | 3643 | 52880 | 2431 | 63925 | 1931 | 41399 |
| 24-#11 | 2.14 | MA | 32171 | 7509 | 51810 | 5582 | 56521 | 4522 | 58151 | 3713 | 59056 | 2490 | 71824 | 1822 | 49049 |
| 9L-5S | | MI | 28105 | 7509 | 45813 | 5504 | 50322 | 4458 | 52359 | 3647 | 54520 | 2424 | 65968 | 1990 | 42022 |
| 24-#11 | 2.14 | MA | 31592 | 7509 | 50834 | 5596 | 55315 | 4534 | 56708 | 3725 | 57099 | 2498 | 69370 | 1758 | 48215 |
| 10L-4S | | MI | 28570 | 7509 | 46609 | 5505 | 51348 | 4447 | 53616 | 3638 | 56305 | 2431 | 68127 | 2033 | 42133 |
| 24-#11 | 2.14 | MA | 31026 | 7509 | 49940 | 5596 | 54128 | 4533 | 55222 | 3722 | 55040 | 2493 | 66876 | 1703 | 47223 |
| 11L-3S | | MI | 29089 | 7509 | 47515 | 5493 | 52501 | 4450 | 55015 | 3642 | 58115 | 2424 | 70182 | 2121 | 42184 |
| 24-#11 | 2.14 | MA | 30470 | 7509 | 48979 | 5609 | 52930 | 4545 | 53782 | 3733 | 53085 | 2502 | 64132 | 1629 | 46094 |
| 12L-2S | | MI | 29823 | 7509 | 48642 | 5494 | 53938 | 4439 | 56761 | 3633 | 60475 | 2417 | 73326 | 2210 | 42207 |
| 24-#14 | 3.09 | MA | 35971 | 8096 | 60041 | 5925 | 66936 | 4773 | 70800 | 3853 | 76229 | 2438 | 94841 | 1797 | 71550 |
| 6L-8S | | MI | 28147 | 8096 | 47191 | 5866 | 51887 | 4720 | 54241 | 3822 | 56894 | 2376 | 69815 | 1484 | 55764 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#14 | 3.09 | MA | 35224 | 8096 | 58615 | 5944 | 65199 | 4771 | 68671 | 3869 | 73369 | 2450 | 90975 | 1671 | 70250 |
| 7E | | MI | 28746 | 8096 | 48248 | 5869 | 53304 | 4725 | 55926 | 3809 | 59287 | 2386 | 72683 | 1554 | 56762 |
| 24-#14 | 3.09 | MA | 34489 | 8096 | 57308 | 5943 | 63445 | 4788 | 66586 | 3884 | 70374 | 2442 | 87332 | 1596 | 68861 |
| 8L-6S | | MI | 29354 | 8096 | 49400 | 5852 | 54708 | 4710 | 57647 | 3796 | 61570 | 2376 | 75701 | 1681 | 57846 |
| 24-#14 | 3.09 | MA | 33721 | 8096 | 56025 | 5942 | 61733 | 4785 | 64429 | 3880 | 67544 | 2454 | 83731 | 1515 | 67149 |
| 9L-5S | | MI | 29976 | 8096 | 50477 | 5855 | 56170 | 4715 | 59429 | 3804 | 63904 | 2366 | 78599 | 1766 | 58554 |
| 24-#14 | 3.09 | MA | 32903 | 8096 | 54624 | 5962 | 60002 | 4803 | 62358 | 3895 | 64735 | 2466 | 80239 | 1424 | 65426 |
| 10L-4S | | MI | 30629 | 8096 | 51617 | 5857 | 57640 | 4700 | 61229 | 3791 | 66444 | 2376 | 81670 | 1826 | 59676 |
| 24-#18 | 5.49 | MA | 38767 | 9585 | 68728 | 6861 | 77711 | 5460 | 83863 | 4309 | 93677 | 2340 | 119293 | 854 | 111890 |
| 8L-6S | | MI | 33416 | 9585 | 60125 | 6745 | 68120 | 5360 | 73870 | 4187 | 82930 | 2219 | 104473 | 1008 | 95598 |

## RECTANGULAR TIED COLUMNS 38" x 48"

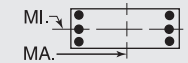
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.32 | MA | 36274 | 7301 | 57234 | 5431 | 62528 | 4416 | 64481 | 3663 | 65849 | 2578 | 78474 | 2425 | 34918 |
| 2L-3S | | MI | 26590 | 7301 | 42498 | 5334 | 45458 | 4366 | 45959 | 3620 | 44960 | 2527 | 52187 | 2101 | 27147 |
| 6-#18 | 1.32 | MA | 33814 | 7301 | 53533 | 5429 | 57809 | 4446 | 58745 | 3689 | 58078 | 2597 | 68028 | 2198 | 34917 |
| 3L-2S | | MI | 28451 | 7301 | 45312 | 5341 | 49046 | 4342 | 50321 | 3600 | 50764 | 2510 | 59865 | 2328 | 27058 |
| 8-#18 | 1.75 | MA | 37994 | 7585 | 60935 | 5608 | 67246 | 4544 | 70216 | 3743 | 73620 | 2560 | 88920 | 2386 | 46217 |
| 2L-4S | | MI | 26570 | 7585 | 43037 | 5540 | 46154 | 4484 | 46811 | 3684 | 46312 | 2521 | 54868 | 1817 | 35440 |
| 8-#18 | 1.75 | MA | 35559 | 7585 | 57234 | 5606 | 62528 | 4574 | 64481 | 3769 | 65849 | 2580 | 78474 | 2158 | 46113 |
| 3E | | MI | 27886 | 7585 | 45312 | 5511 | 49046 | 4495 | 50321 | 3700 | 50764 | 2503 | 59865 | 2045 | 35699 |
| 8-#18 | 1.75 | MA | 33843 | 7585 | 54263 | 5639 | 58750 | 4569 | 59895 | 3760 | 59895 | 2599 | 71632 | 1931 | 45576 |
| 4L-2S | | MI | 29731 | 7585 | 48126 | 5518 | 52634 | 4471 | 54682 | 3680 | 56569 | 2485 | 67544 | 2272 | 35689 |
| 10-#14 | 1.23 | MA | 36060 | 7248 | 56518 | 5428 | 61821 | 4417 | 63699 | 3669 | 64824 | 2598 | 77453 | 2464 | 33046 |
| 2L-5S | | MI | 25803 | 7248 | 40729 | 5358 | 43386 | 4375 | 43504 | 3630 | 41803 | 2555 | 48907 | 2063 | 25631 |
| 10-#14 | 1.23 | MA | 34652 | 7248 | 54409 | 5428 | 59131 | 4415 | 60429 | 3685 | 60394 | 2610 | 71431 | 2336 | 33066 |
| 3L-4S | | MI | 26486 | 7248 | 41869 | 5361 | 44856 | 4360 | 45304 | 3618 | 44343 | 2565 | 51978 | 2124 | 25717 |
| 10-#14 | 1.23 | MA | 33663 | 7248 | 52719 | 5447 | 56982 | 4433 | 57821 | 3681 | 57007 | 2623 | 67479 | 2208 | 32997 |
| 4L-3S | | MI | 27246 | 7248 | 43167 | 5344 | 46507 | 4365 | 47308 | 3625 | 46918 | 2555 | 54890 | 2252 | 25704 |
| 10-#14 | 1.23 | MA | 32778 | 7248 | 51239 | 5447 | 55073 | 4431 | 55483 | 3697 | 53671 | 2615 | 63373 | 2144 | 32768 |
| 5L-2S | | MI | 28316 | 7248 | 44779 | 5347 | 48561 | 4350 | 49805 | 3612 | 50275 | 2546 | 59352 | 2380 | 25654 |
| 10-#18 | 2.19 | MA | 39693 | 7868 | 64636 | 5785 | 71965 | 4673 | 75952 | 3822 | 81390 | 2542 | 99366 | 2346 | 57475 |
| 2L-5S | | MI | 26693 | 7868 | 43851 | 5711 | 47163 | 4636 | 48016 | 3784 | 47722 | 2479 | 57237 | 1657 | 41279 |
| 10-#18 | 2.19 | MA | 37282 | 7868 | 60935 | 5783 | 67246 | 4703 | 70216 | 3849 | 73620 | 2562 | 88920 | 2119 | 57286 |
| 3L-4S | | MI | 27865 | 7868 | 45851 | 5717 | 49742 | 4612 | 51173 | 3764 | 52117 | 2497 | 62547 | 1761 | 43802 |
| 10-#18 | 2.19 | MA | 35585 | 7868 | 57964 | 5816 | 63468 | 4697 | 65631 | 3840 | 67666 | 2581 | 82078 | 1891 | 56652 |
| 4L-3S | | MI | 29168 | 7868 | 48126 | 5689 | 52634 | 4623 | 54682 | 3779 | 56569 | 2479 | 67544 | 1988 | 44216 |
| 10-#18 | 2.19 | MA | 34066 | 7868 | 55360 | 5814 | 60110 | 4727 | 61518 | 3866 | 61798 | 2566 | 74931 | 1779 | 53136 |
| 5L-2S | | MI | 30996 | 7868 | 50941 | 5696 | 56222 | 4599 | 59044 | 3760 | 62374 | 2461 | 75222 | 2216 | 44286 |
| 12-#11 | 1.03 | MA | 35266 | 7114 | 54722 | 5360 | 59633 | 4369 | 61081 | 3642 | 61294 | 2614 | 72804 | 2495 | 27723 |
| 2L-6S | | MI | 25510 | 7114 | 39827 | 5290 | 42278 | 4321 | 42193 | 3598 | 40123 | 2584 | 46610 | 2143 | 21591 |
| 12-#11 | 1.03 | MA | 34277 | 7114 | 53249 | 5360 | 57756 | 4368 | 58799 | 3654 | 58202 | 2624 | 68578 | 2406 | 27751 |
| 3L-5S | | MI | 25968 | 7114 | 40579 | 5292 | 43298 | 4324 | 43437 | 3602 | 41763 | 2577 | 48653 | 2201 | 21662 |
| 12-#11 | 1.03 | MA | 33584 | 7114 | 52071 | 5374 | 56258 | 4381 | 56980 | 3652 | 55841 | 2633 | 65802 | 2317 | 27753 |
| 4E | | MI | 26447 | 7114 | 41374 | 5293 | 44324 | 4313 | 44693 | 3593 | 43548 | 2584 | 50812 | 2244 | 21653 |
| 12-#11 | 1.03 | MA | 32964 | 7114 | 51040 | 5374 | 54928 | 4380 | 55351 | 3663 | 53515 | 2628 | 62925 | 2272 | 27698 |
| 5L-3S | | MI | 26981 | 7114 | 42281 | 5281 | 45477 | 4316 | 46093 | 3597 | 45358 | 2577 | 52866 | 2333 | 21618 |
| 12-#11 | 1.03 | MA | 32373 | 7114 | 50068 | 5374 | 53606 | 4392 | 53739 | 3661 | 51381 | 2638 | 60172 | 2214 | 27499 |
| 6L-2S | | MI | 27733 | 7114 | 43408 | 5282 | 46913 | 4305 | 47839 | 3588 | 47718 | 2570 | 56010 | 2421 | 21577 |
| 12-#14 | 1.48 | MA | 37053 | 7407 | 58628 | 5528 | 64511 | 4489 | 66970 | 3714 | 69254 | 2588 | 83474 | 2445 | 39488 |
| 2L-6S | | MI | 25913 | 7407 | 41263 | 5455 | 43979 | 4442 | 44219 | 3668 | 42826 | 2554 | 50471 | 1951 | 29487 |
| 12-#14 | 1.48 | MA | 35654 | 7407 | 56518 | 5528 | 61821 | 4487 | 63699 | 3730 | 64824 | 2600 | 77453 | 2317 | 39476 |
| 3L-5S | | MI | 26561 | 7407 | 42340 | 5458 | 45440 | 4447 | 46001 | 3675 | 45160 | 2544 | 53369 | 2036 | 30442 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

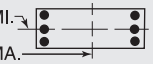



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 1.48 | MA | 34672 | 7407 | 54829 | 5547 | 59672 | 4505 | 61091 | 3726 | 61437 | 2613 | 73500 | 2189 | 39371 |
| 4E | | MI | 27240 | 7407 | 43480 | 5461 | 46910 | 4432 | 47801 | 3663 | 47700 | 2554 | 56440 | 2096 | 30602 |
| 12-#14 | 1.48 | MA | 33794 | 7407 | 53349 | 5547 | 57763 | 4503 | 58753 | 3742 | 58101 | 2605 | 69395 | 2125 | 39103 |
| 5L-3S | | MI | 27996 | 7407 | 44779 | 5444 | 48561 | 4437 | 49805 | 3670 | 50275 | 2544 | 59352 | 2224 | 30626 |
| 12-#14 | 1.48 | MA | 32956 | 7407 | 51954 | 5546 | 55866 | 4521 | 56440 | 3738 | 55038 | 2618 | 65474 | 2041 | 37697 |
| 6L-2S | | MI | 29059 | 7407 | 46390 | 5446 | 50615 | 4422 | 52302 | 3657 | 53632 | 2534 | 63815 | 2352 | 30593 |
| 12-#18 | 2.63 | MA | 41373 | 8152 | 68336 | 5963 | 76683 | 4802 | 81688 | 3902 | 89161 | 2525 | 109812 | 2307 | 68706 |
| 2L-6S | | MI | 26878 | 8152 | 44775 | 5881 | 48187 | 4754 | 49251 | 3848 | 49491 | 2472 | 59937 | 1449 | 47422 |
| 12-#18 | 2.63 | MA | 38985 | 8152 | 64636 | 5960 | 71965 | 4831 | 75952 | 3928 | 81390 | 2544 | 99366 | 2079 | 68444 |
| 3L-5S | | MI | 27985 | 8152 | 46665 | 5888 | 50751 | 4765 | 52378 | 3864 | 53527 | 2455 | 64916 | 1601 | 49470 |
| 12-#18 | 2.63 | MA | 37306 | 8152 | 61665 | 5994 | 68186 | 4826 | 71367 | 3919 | 75437 | 2564 | 92524 | 1852 | 67500 |
| 4E | | MI | 29146 | 8152 | 48665 | 5895 | 53330 | 4741 | 55534 | 3844 | 57921 | 2472 | 70225 | 1705 | 51837 |
| 12-#18 | 2.63 | MA | 35804 | 8152 | 59061 | 5991 | 64828 | 4855 | 67254 | 3946 | 69569 | 2548 | 85377 | 1739 | 63980 |
| 5L-3S | | MI | 30436 | 8152 | 50941 | 5866 | 56222 | 4752 | 59044 | 3859 | 62374 | 2455 | 75222 | 1932 | 52711 |
| 12-#18 | 2.63 | MA | 34371 | 8152 | 56603 | 5989 | 61490 | 4850 | 63182 | 3937 | 64178 | 2567 | 78582 | 1590 | 61226 |
| 6L-2S | | MI | 32249 | 8152 | 53755 | 5873 | 59810 | 4728 | 63406 | 3839 | 68179 | 2437 | 82901 | 2160 | 52849 |
| 14-#11 | 1.20 | MA | 35968 | 7224 | 56194 | 5429 | 61511 | 4419 | 63363 | 3673 | 64386 | 2607 | 77030 | 2483 | 32225 |
| 2L-7S | | MI | 25602 | 7224 | 40151 | 5372 | 42735 | 4382 | 42739 | 3639 | 40877 | 2583 | 47626 | 2037 | 24450 |
| 14-#11 | 1.20 | MA | 34984 | 7224 | 54722 | 5429 | 59633 | 4418 | 61081 | 3685 | 61294 | 2617 | 72804 | 2394 | 32243 |
| 3L-6S | | MI | 26047 | 7224 | 40954 | 5359 | 43714 | 4371 | 43939 | 3629 | 42482 | 2577 | 49754 | 2125 | 24896 |
| 14-#11 | 1.20 | MA | 34294 | 7224 | 53544 | 5443 | 58135 | 4431 | 59262 | 3683 | 58933 | 2626 | 70028 | 2305 | 32223 |
| 4L-5S | | MI | 26502 | 7224 | 41705 | 5361 | 44734 | 4374 | 45184 | 3634 | 44123 | 2570 | 51797 | 2184 | 25082 |
| 14-#11 | 1.20 | MA | 33677 | 7224 | 52513 | 5443 | 56805 | 4430 | 57633 | 3694 | 56608 | 2621 | 67151 | 2260 | 32148 |
| 5L-4S | | MI | 26979 | 7224 | 42501 | 5362 | 45760 | 4363 | 46440 | 3624 | 45908 | 2577 | 53955 | 2226 | 25094 |
| 14-#11 | 1.20 | MA | 33089 | 7224 | 51540 | 5443 | 55484 | 4442 | 56021 | 3692 | 54473 | 2631 | 64398 | 2202 | 31833 |
| 6L-3S | | MI | 27510 | 7224 | 43408 | 5350 | 46913 | 4366 | 47839 | 3629 | 47718 | 2570 | 56010 | 2315 | 25071 |
| 14-#11 | 1.20 | MA | 32516 | 7224 | 50500 | 5457 | 54215 | 4441 | 54466 | 3704 | 52384 | 2640 | 61535 | 2114 | 31159 |
| 7L-2S | | MI | 28259 | 7224 | 44535 | 5351 | 48350 | 4355 | 49586 | 3619 | 50077 | 2563 | 59154 | 2404 | 25038 |
| 14-#14 | 1.73 | MA | 38039 | 7567 | 60738 | 5628 | 67200 | 4562 | 70240 | 3759 | 73684 | 2578 | 89496 | 2426 | 45918 |
| 2L-7S | | MI | 26042 | 7567 | 41723 | 5572 | 44629 | 4530 | 44996 | 3726 | 43899 | 2552 | 51915 | 1797 | 33657 |
| 14-#14 | 1.73 | MA | 36649 | 7567 | 58628 | 5627 | 64511 | 4560 | 66970 | 3775 | 69254 | 2590 | 83474 | 2298 | 45876 |
| 3L-6S | | MI | 26671 | 7567 | 42875 | 5555 | 46033 | 4515 | 46716 | 3713 | 46183 | 2542 | 54934 | 1923 | 34222 |
| 14-#14 | 1.73 | MA | 35673 | 7567 | 56939 | 5647 | 62361 | 4577 | 64361 | 3771 | 65867 | 2603 | 79522 | 2170 | 45738 |
| 4L-5S | | MI | 27314 | 7567 | 43951 | 5558 | 47495 | 4520 | 48499 | 3720 | 48516 | 2532 | 57831 | 2008 | 35125 |
| 14-#14 | 1.73 | MA | 34801 | 7567 | 55459 | 5646 | 60453 | 4575 | 62024 | 3787 | 62531 | 2596 | 75416 | 2105 | 45272 |
| 5L-4S | | MI | 27989 | 7567 | 45091 | 5561 | 48964 | 4505 | 50298 | 3708 | 51057 | 2542 | 60902 | 2069 | 35477 |
| 14-#14 | 1.73 | MA | 33970 | 7567 | 54064 | 5646 | 58556 | 4593 | 59710 | 3783 | 59468 | 2608 | 71495 | 2021 | 43923 |
| 6L-3S | | MI | 28740 | 7567 | 46390 | 5543 | 50615 | 4509 | 52302 | 3715 | 53632 | 2532 | 63815 | 2197 | 35532 |
| 14-#14 | 1.73 | MA | 33158 | 7567 | 52570 | 5665 | 56736 | 4591 | 57478 | 3799 | 56471 | 2621 | 67417 | 1895 | 43050 |
| 7L-2S | | MI | 29798 | 7567 | 48001 | 5546 | 52670 | 4495 | 54799 | 3702 | 56988 | 2522 | 68277 | 2325 | 35520 |
| 14-#18 | 3.07 | MA | 40669 | 8436 | 68336 | 6138 | 76683 | 4960 | 81688 | 4008 | 89161 | 2527 | 109812 | 2040 | 79591 |
| 3L-6S | | MI | 28167 | 8436 | 47590 | 6058 | 51775 | 4882 | 53613 | 3928 | 55296 | 2448 | 67615 | 1393 | 55461 |
| 14-#18 | 3.07 | MA | 39008 | 8436 | 65366 | 6171 | 72905 | 4954 | 77103 | 3999 | 83208 | 2546 | 102970 | 1812 | 78207 |
| 4L-5S | | MI | 29264 | 8436 | 49480 | 6065 | 54340 | 4894 | 56740 | 3943 | 59331 | 2430 | 72594 | 1545 | 57687 |
| 14-#18 | 3.07 | MA | 37522 | 8436 | 62762 | 6169 | 69546 | 4984 | 72990 | 4026 | 77340 | 2530 | 95823 | 1700 | 74850 |
| 5L-4S | | MI | 30413 | 8436 | 51480 | 6072 | 56918 | 4869 | 59896 | 3924 | 63726 | 2448 | 77904 | 1648 | 59916 |
| 14-#18 | 3.07 | MA | 36105 | 8436 | 60304 | 6166 | 66208 | 4978 | 68918 | 4017 | 71948 | 2550 | 89028 | 1550 | 71928 |
| 6L-3S | | MI | 31693 | 8436 | 53755 | 6043 | 59810 | 4880 | 63406 | 3939 | 68179 | 2430 | 82901 | 1876 | 61192 |
| 14-#18 | 3.07 | MA | 34722 | 8436 | 57675 | 6200 | 63003 | 5008 | 64990 | 4043 | 66673 | 2569 | 81956 | 1325 | 68502 |
| 7L-2S | | MI | 33490 | 8436 | 56569 | 6050 | 63398 | 4856 | 67768 | 3919 | 73983 | 2413 | 90579 | 2103 | 61387 |
| 16-#11 | 1.37 | MA | 36666 | 7335 | 57667 | 5498 | 63389 | 4469 | 65646 | 3705 | 67478 | 2601 | 81256 | 2470 | 36721 |
| 2L-8S | | MI | 25702 | 7335 | 40540 | 5439 | 43183 | 4429 | 43310 | 3679 | 41555 | 2569 | 48754 | 1970 | 27490 |
| 16-#11 | 1.37 | MA | 35686 | 7335 | 56194 | 5498 | 61511 | 4468 | 63363 | 3716 | 64386 | 2610 | 77030 | 2382 | 36724 |
| 3L-7S | | MI | 26138 | 7335 | 41277 | 5441 | 44171 | 4432 | 44485 | 3670 | 43236 | 2576 | 50770 | 2020 | 27786 |
| 16-#11 | 1.37 | MA | 34999 | 7335 | 55016 | 5512 | 60013 | 4481 | 61545 | 3714 | 62025 | 2619 | 74254 | 2293 | 36687 |
| 4L-6S | | MI | 26580 | 7335 | 42081 | 5428 | 45151 | 4421 | 45686 | 3660 | 44842 | 2569 | 52898 | 2107 | 28211 |
| 16-#11 | 1.37 | MA | 34386 | 7335 | 53985 | 5512 | 58683 | 4480 | 59916 | 3725 | 59700 | 2614 | 71377 | 2248 | 36594 |
| 5E | | MI | 27033 | 7335 | 42832 | 5430 | 46171 | 4424 | 46930 | 3665 | 46482 | 2562 | 54941 | 2166 | 28496 |

## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

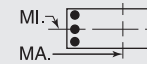
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.37 | MA | 33801 | 7335 | 53013 | 5512 | 57361 | 4492 | 58304 | 3723 | 57565 | 2624 | 68624 | 2190 | 36175 |
| 6L-4S | | MI | 27508 | 7335 | 43628 | 5431 | 47197 | 4413 | 48186 | 3655 | 48267 | 2569 | 57099 | 2208 | 28526 |
| 16-#11 | 1.37 | MA | 33231 | 7335 | 51973 | 5526 | 56093 | 4491 | 56749 | 3735 | 55477 | 2633 | 65761 | 2102 | 35527 |
| 7L-3S | | MI | 28037 | 7335 | 44535 | 5419 | 48350 | 4416 | 49586 | 3660 | 50077 | 2562 | 59154 | 2297 | 28517 |
| 16-#11 | 1.37 | MA | 32669 | 7335 | 51019 | 5526 | 54813 | 4504 | 55227 | 3746 | 53289 | 2628 | 63072 | 2050 | 35057 |
| 8L-2S | | MI | 28783 | 7335 | 45662 | 5421 | 49787 | 4405 | 51332 | 3650 | 52436 | 2555 | 62298 | 2386 | 28491 |
| 16-#14 | 1.97 | MA | 39018 | 7726 | 62848 | 5728 | 69890 | 4634 | 73510 | 3804 | 78115 | 2568 | 95518 | 2407 | 52333 |
| 2L-8S | | MI | 26182 | 7726 | 42276 | 5669 | 45266 | 4597 | 45808 | 3784 | 44863 | 2531 | 53509 | 1699 | 37180 |
| 16-#14 | 1.97 | MA | 37636 | 7726 | 60738 | 5727 | 67200 | 4632 | 70240 | 3820 | 73684 | 2580 | 89496 | 2279 | 52267 |
| 3L-7S | | MI | 26798 | 7726 | 43334 | 5672 | 46683 | 4602 | 47493 | 3771 | 47256 | 2541 | 56378 | 1769 | 38346 |
| 16-#14 | 1.97 | MA | 36666 | 7726 | 59049 | 5747 | 65051 | 4650 | 67631 | 3816 | 70298 | 2593 | 85544 | 2151 | 52100 |
| 4L-6S | | MI | 27422 | 7726 | 44486 | 5655 | 48087 | 4587 | 49213 | 3758 | 49539 | 2531 | 59396 | 1896 | 38967 |
| 16-#14 | 1.97 | MA | 35800 | 7726 | 57569 | 5746 | 63143 | 4648 | 65294 | 3832 | 66962 | 2586 | 81438 | 2086 | 51453 |
| 5E | | MI | 28062 | 7726 | 45562 | 5658 | 49549 | 4592 | 50996 | 3765 | 51873 | 2521 | 62293 | 1981 | 39825 |
| 16-#14 | 1.97 | MA | 34975 | 7726 | 56174 | 5746 | 61246 | 4665 | 62980 | 3828 | 63898 | 2598 | 77517 | 2002 | 50159 |
| 6L-4S | | MI | 28732 | 7726 | 46702 | 5660 | 51019 | 4577 | 52795 | 3752 | 54413 | 2531 | 65364 | 2041 | 40344 |
| 16-#14 | 1.97 | MA | 34170 | 7726 | 54680 | 5765 | 59426 | 4663 | 60748 | 3844 | 60901 | 2611 | 73438 | 1876 | 49302 |
| 7L-3S | | MI | 29479 | 7726 | 48001 | 5643 | 52670 | 4582 | 54799 | 3760 | 56988 | 2521 | 68277 | 2169 | 40424 |
| 16-#14 | 1.97 | MA | 33376 | 7726 | 53311 | 5765 | 57589 | 4681 | 58564 | 3860 | 57761 | 2603 | 69601 | 1801 | 47613 |
| 8L-2S | | MI | 30531 | 7726 | 49612 | 5646 | 54724 | 4567 | 57296 | 3747 | 60345 | 2511 | 72739 | 2297 | 40438 |
| 16-#18 | 3.51 | MA | 40692 | 8719 | 69066 | 6348 | 77623 | 5083 | 82839 | 4079 | 90979 | 2528 | 113416 | 1772 | 88952 |
| 4L-6S | | MI | 29445 | 8719 | 50404 | 6236 | 55363 | 5011 | 57975 | 4008 | 61101 | 2424 | 75294 | 1337 | 63528 |
| 16-#18 | 3.51 | MA | 39221 | 8719 | 66462 | 6346 | 74265 | 5113 | 78726 | 4105 | 85111 | 2513 | 106269 | 1660 | 85743 |
| 5E | | MI | 30531 | 8719 | 52294 | 6243 | 57928 | 5022 | 61102 | 4023 | 65136 | 2406 | 80273 | 1489 | 65925 |
| 16-#18 | 3.51 | MA | 37820 | 8719 | 64005 | 6344 | 70927 | 5107 | 74654 | 4096 | 79719 | 2532 | 99474 | 1511 | 82656 |
| 6L-4S | | MI | 31670 | 8719 | 54294 | 6249 | 60506 | 4998 | 64258 | 4003 | 69531 | 2424 | 85582 | 1592 | 68031 |
| 16-#18 | 3.51 | MA | 36452 | 8719 | 61376 | 6377 | 67721 | 5137 | 70726 | 4123 | 74444 | 2552 | 92402 | 1286 | 79340 |
| 7L-3S | | MI | 32938 | 8719 | 56569 | 6221 | 63398 | 5009 | 67768 | 4019 | 73983 | 2406 | 90579 | 1820 | 69661 |
| 16-#18 | 3.51 | MA | 35103 | 8719 | 58964 | 6375 | 64487 | 5131 | 66880 | 4149 | 68917 | 2536 | 85724 | 1155 | 75053 |
| 8L-2S | | MI | 34722 | 8719 | 59384 | 6227 | 66986 | 4985 | 72130 | 3999 | 79788 | 2388 | 98258 | 2047 | 69911 |
| 18-#11 | 1.54 | MA | 37360 | 7445 | 59139 | 5567 | 65266 | 4520 | 67928 | 3736 | 70570 | 2594 | 85482 | 2458 | 41211 |
| 2L-9S | | MI | 25798 | 7445 | 40886 | 5521 | 43653 | 4490 | 43840 | 3706 | 42325 | 2569 | 49918 | 1896 | 30194 |
| 18-#11 | 1.54 | MA | 36384 | 7445 | 57667 | 5567 | 63389 | 4518 | 65646 | 3747 | 67478 | 2603 | 81256 | 2370 | 41198 |
| 3L-8S | | MI | 26237 | 7445 | 41667 | 5508 | 44619 | 4479 | 45056 | 3710 | 43914 | 2562 | 51898 | 1952 | 30838 |
| 18-#11 | 1.54 | MA | 35701 | 7445 | 56489 | 5581 | 61890 | 4531 | 63827 | 3745 | 65117 | 2612 | 78480 | 2281 | 41147 |
| 4L-7S | | MI | 26670 | 7445 | 42404 | 5510 | 45608 | 4482 | 46232 | 3701 | 45596 | 2569 | 53914 | 2002 | 31126 |
| 18-#11 | 1.54 | MA | 35091 | 7445 | 55458 | 5581 | 60560 | 4530 | 62198 | 3757 | 62792 | 2608 | 75603 | 2235 | 41037 |
| 5L-6S | | MI | 27111 | 7445 | 43208 | 5498 | 46588 | 4471 | 47432 | 3691 | 47201 | 2562 | 56042 | 2090 | 31532 |
| 18-#11 | 1.54 | MA | 34509 | 7445 | 54486 | 5581 | 59239 | 4543 | 60586 | 3754 | 60657 | 2617 | 72850 | 2177 | 40526 |
| 6L-5S | | MI | 27561 | 7445 | 43959 | 5499 | 47608 | 4474 | 48677 | 3696 | 48841 | 2555 | 58084 | 2148 | 31904 |
| 18-#11 | 1.54 | MA | 33942 | 7445 | 53445 | 5595 | 57970 | 4541 | 59031 | 3766 | 58569 | 2626 | 69987 | 2090 | 39901 |
| 7L-4S | | MI | 28034 | 7445 | 44755 | 5501 | 48634 | 4464 | 49933 | 3686 | 50626 | 2562 | 60243 | 2191 | 31949 |
| 18-#11 | 1.54 | MA | 33383 | 7445 | 52491 | 5595 | 56691 | 4554 | 57509 | 3777 | 56381 | 2622 | 67298 | 2037 | 39442 |
| 8L-3S | | MI | 28560 | 7445 | 45662 | 5488 | 49787 | 4466 | 51332 | 3691 | 52436 | 2555 | 62298 | 2280 | 31957 |
| 18-#11 | 1.54 | MA | 32784 | 7445 | 51555 | 5595 | 55440 | 4553 | 55935 | 3775 | 54314 | 2631 | 64631 | 1981 | 38531 |
| 9L-2S | | MI | 29304 | 7445 | 46789 | 5490 | 51223 | 4456 | 53079 | 3681 | 54795 | 2548 | 65442 | 2368 | 31938 |
| 18-#14 | 2.22 | MA | 38616 | 7886 | 62848 | 5827 | 69890 | 4704 | 73510 | 3865 | 78115 | 2570 | 95518 | 2260 | 58653 |
| 3L-8S | | MI | 26937 | 7886 | 43888 | 5769 | 47320 | 4669 | 48305 | 3828 | 48219 | 2519 | 57971 | 1671 | 41879 |
| 18-#14 | 2.22 | MA | 37653 | 7886 | 61158 | 5846 | 67741 | 4722 | 70901 | 3861 | 74728 | 2583 | 91565 | 2132 | 58459 |
| 4L-7S | | MI | 27548 | 7886 | 44945 | 5772 | 48737 | 4674 | 49990 | 3816 | 50612 | 2529 | 60840 | 1742 | 43004 |
| 18-#14 | 2.22 | MA | 36792 | 7886 | 59679 | 5846 | 65833 | 4720 | 68564 | 3877 | 71392 | 2576 | 87459 | 2067 | 57649 |
| 5L-6S | | MI | 28169 | 7886 | 46097 | 5755 | 50141 | 4659 | 51710 | 3803 | 52896 | 2519 | 63858 | 1868 | 43720 |
| 18-#14 | 2.22 | MA | 35973 | 7886 | 58284 | 5845 | 63936 | 4738 | 66250 | 3873 | 68328 | 2588 | 83538 | 1983 | 56405 |
| 6L-5S | | MI | 28804 | 7886 | 47174 | 5757 | 51603 | 4664 | 53493 | 3810 | 55230 | 2509 | 66756 | 1953 | 44537 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

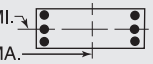


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.22 | MA | 35173 | 7886 | 56790 | 5865 | 62116 | 4735 | 64019 | 3889 | 65331 | 2601 | 79460 | 1857 | 55455 |
| 7L-4S | | MI | 29471 | 7886 | 48314 | 5760 | 53073 | 4649 | 55293 | 3797 | 57770 | 2519 | 69827 | 2014 | 45205 |
| 18-#14 | 2.22 | MA | 34385 | 7886 | 55420 | 5865 | 60279 | 4753 | 61834 | 3905 | 62191 | 2593 | 75622 | 1782 | 53813 |
| 8L-3S | | MI | 30213 | 7886 | 49612 | 5743 | 54724 | 4654 | 57296 | 3804 | 60345 | 2509 | 72739 | 2142 | 45308 |
| 18-#14 | 2.22 | MA | 33546 | 7886 | 54076 | 5864 | 58484 | 4751 | 59574 | 3901 | 59225 | 2606 | 71823 | 1701 | 52307 |
| 9L-2S | | MI | 31260 | 7886 | 51223 | 5745 | 56778 | 4639 | 59793 | 3792 | 63701 | 2499 | 77201 | 2270 | 45346 |
| 18-#18 | 3.95 | MA | 40905 | 9003 | 70163 | 6523 | 78983 | 5241 | 84462 | 4185 | 92881 | 2495 | 116715 | 1621 | 96654 |
| 5L-6S | | MI | 30710 | 9003 | 53218 | 6413 | 58951 | 5140 | 62336 | 4087 | 66905 | 2400 | 82972 | 1281 | 71621 |
| 18-#18 | 3.95 | MA | 39517 | 9003 | 67706 | 6521 | 75645 | 5235 | 80390 | 4176 | 87490 | 2514 | 109920 | 1471 | 93408 |
| 6L-5S | | MI | 31787 | 9003 | 55108 | 6420 | 61516 | 5151 | 65464 | 4103 | 70941 | 2382 | 87951 | 1432 | 74181 |
| 18-#18 | 3.95 | MA | 38164 | 9003 | 65077 | 6554 | 72440 | 5265 | 76462 | 4202 | 82214 | 2534 | 102848 | 1246 | 90196 |
| 7L-4S | | MI | 32916 | 9003 | 57108 | 6427 | 64094 | 5126 | 68620 | 4083 | 75336 | 2400 | 93261 | 1536 | 76176 |
| 18-#18 | 3.95 | MA | 36829 | 9003 | 62664 | 6552 | 69205 | 5260 | 72616 | 4229 | 76688 | 2518 | 96170 | 1116 | 85817 |
| 8L-3S | | MI | 34173 | 9003 | 59384 | 6398 | 66986 | 5138 | 72130 | 4099 | 79788 | 2382 | 98258 | 1764 | 78122 |
| 20-#11 | 1.71 | MA | 38050 | 7556 | 60612 | 5637 | 67144 | 4570 | 70211 | 3767 | 73663 | 2587 | 89708 | 2446 | 45694 |
| 2L-10S | | MI | 25874 | 7556 | 41279 | 5588 | 44113 | 4537 | 44418 | 3746 | 43107 | 2568 | 51144 | 1814 | 33004 |
| 20-#11 | 1.71 | MA | 37079 | 7556 | 59139 | 5637 | 65266 | 4569 | 67928 | 3778 | 70570 | 2596 | 85482 | 2357 | 45668 |
| 3L-9S | | MI | 26334 | 7556 | 42013 | 5590 | 45090 | 4540 | 45587 | 3737 | 44684 | 2561 | 53062 | 1878 | 33497 |
| 20-#11 | 1.71 | MA | 36399 | 7556 | 57961 | 5650 | 63768 | 4581 | 66110 | 3776 | 68209 | 2605 | 82706 | 2269 | 45603 |
| 4L-8S | | MI | 26769 | 7556 | 42794 | 5578 | 46056 | 4529 | 46803 | 3741 | 46273 | 2555 | 55041 | 1934 | 34141 |
| 20-#11 | 1.71 | MA | 35791 | 7556 | 56931 | 5650 | 62438 | 4580 | 64480 | 3788 | 65884 | 2601 | 79829 | 2223 | 45478 |
| 5L-7S | | MI | 27200 | 7556 | 43531 | 5579 | 47045 | 4532 | 47978 | 3732 | 47955 | 2561 | 57058 | 1984 | 34470 |
| 20-#11 | 1.71 | MA | 35213 | 7556 | 55958 | 5650 | 61116 | 4593 | 62868 | 3785 | 63749 | 2610 | 77076 | 2165 | 44884 |
| 6E | | MI | 27638 | 7556 | 44335 | 5567 | 48024 | 4522 | 49179 | 3723 | 49560 | 2555 | 59185 | 2072 | 34860 |
| 20-#11 | 1.71 | MA | 34649 | 7556 | 54918 | 5664 | 59848 | 4592 | 61314 | 3797 | 61661 | 2619 | 74213 | 2078 | 44279 |
| 7L-5S | | MI | 28087 | 7556 | 45086 | 5568 | 49044 | 4524 | 50423 | 3727 | 51200 | 2548 | 61228 | 2131 | 35309 |
| 20-#11 | 1.71 | MA | 34093 | 7556 | 53964 | 5664 | 58568 | 4604 | 59792 | 3808 | 59473 | 2615 | 71524 | 2025 | 43816 |
| 8L-4S | | MI | 28557 | 7556 | 45882 | 5570 | 50070 | 4514 | 51679 | 3718 | 52985 | 2555 | 63387 | 2173 | 35367 |
| 20-#11 | 1.71 | MA | 33496 | 7556 | 53028 | 5664 | 57318 | 4603 | 58217 | 3806 | 57407 | 2624 | 68857 | 1969 | 42873 |
| 9L-3S | | MI | 29082 | 7556 | 46789 | 5557 | 51223 | 4517 | 53079 | 3722 | 54795 | 2548 | 65442 | 2262 | 35392 |
| 20-#11 | 1.71 | MA | 32884 | 7556 | 52005 | 5678 | 56055 | 4616 | 56705 | 3818 | 55356 | 2633 | 66268 | 1906 | 42148 |
| 10L-2S | | MI | 29823 | 7556 | 47915 | 5559 | 52660 | 4506 | 54825 | 3713 | 57155 | 2541 | 68586 | 2351 | 35381 |
| 20-#14 | 2.47 | MA | 38632 | 8046 | 63268 | 5946 | 70431 | 4794 | 74171 | 3906 | 79158 | 2573 | 97587 | 2113 | 64815 |
| 4L-8S | | MI | 27686 | 8046 | 45499 | 5869 | 49374 | 4742 | 50802 | 3873 | 51576 | 2508 | 62433 | 1644 | 46587 |
| 20-#14 | 2.47 | MA | 37778 | 8046 | 61789 | 5946 | 68523 | 4792 | 71834 | 3922 | 75822 | 2566 | 93481 | 2048 | 63857 |
| 5L-7S | | MI | 28294 | 8046 | 46556 | 5872 | 50791 | 4747 | 52487 | 3861 | 53969 | 2517 | 65302 | 1714 | 47673 |
| 20-#14 | 2.47 | MA | 36964 | 8046 | 60393 | 5945 | 66626 | 4810 | 69520 | 3918 | 72758 | 2578 | 89560 | 1964 | 62658 |
| 6E | | MI | 28911 | 8046 | 47708 | 5854 | 52195 | 4732 | 54207 | 3848 | 56253 | 2508 | 68320 | 1841 | 48480 |
| 20-#14 | 2.47 | MA | 36170 | 8046 | 58900 | 5965 | 64806 | 4808 | 67289 | 3934 | 69761 | 2591 | 85482 | 1838 | 61618 |
| 7L-5S | | MI | 29542 | 8046 | 48785 | 5857 | 53657 | 4736 | 55990 | 3855 | 58586 | 2498 | 71218 | 1926 | 49261 |
| 20-#14 | 2.47 | MA | 35387 | 8046 | 57530 | 5964 | 62969 | 4826 | 65104 | 3950 | 66621 | 2583 | 81644 | 1763 | 60020 |
| 8L-4S | | MI | 30204 | 8046 | 49925 | 5860 | 55127 | 4722 | 57790 | 3842 | 61126 | 2508 | 74289 | 1986 | 50061 |
| 20-#14 | 2.47 | MA | 34554 | 8046 | 56186 | 5964 | 61174 | 4823 | 62844 | 3946 | 63655 | 2596 | 77845 | 1682 | 58461 |
| 9L-3S | | MI | 30943 | 8046 | 51223 | 5843 | 56778 | 4726 | 59793 | 3849 | 63701 | 2498 | 77201 | 2114 | 50187 |
| 20-#14 | 2.47 | MA | 33689 | 8046 | 54718 | 5983 | 59360 | 4841 | 60673 | 3962 | 60712 | 2609 | 74160 | 1591 | 56710 |
| 10L-2S | | MI | 31984 | 8046 | 52835 | 5845 | 58832 | 4711 | 62290 | 3837 | 67058 | 2488 | 81663 | 2242 | 50242 |
| 20-#18 | 4.39 | MA | 41199 | 9287 | 71407 | 6698 | 80363 | 5364 | 86126 | 4256 | 95261 | 2497 | 120366 | 1432 | 104181 |
| 6E | | MI | 31966 | 9287 | 56033 | 6590 | 62539 | 5268 | 66698 | 4167 | 72710 | 2375 | 90651 | 1225 | 79736 |
| 20-#18 | 4.39 | MA | 39859 | 9287 | 68777 | 6731 | 77158 | 5394 | 82198 | 4282 | 89985 | 2516 | 113294 | 1207 | 100986 |
| 7L-5S | | MI | 33033 | 9287 | 57923 | 6597 | 65104 | 5279 | 69825 | 4183 | 76745 | 2358 | 95630 | 1376 | 82451 |
| 20-#18 | 4.39 | MA | 38537 | 9287 | 66365 | 6729 | 73924 | 5388 | 78352 | 4309 | 84459 | 2500 | 106616 | 1076 | 96597 |
| 8L-4S | | MI | 34152 | 9287 | 59923 | 6604 | 67682 | 5255 | 72982 | 4163 | 81140 | 2375 | 100939 | 1480 | 84347 |
| 22-#11 | 1.88 | MA | 37769 | 7667 | 60612 | 5706 | 67144 | 4619 | 70211 | 3810 | 73663 | 2589 | 89708 | 2345 | 50135 |
| 3L-10S | | MI | 26408 | 7667 | 42406 | 5657 | 45550 | 4587 | 46165 | 3777 | 45467 | 2561 | 54288 | 1797 | 36271 |
| 22-#11 | 1.88 | MA | 37093 | 7667 | 59434 | 5720 | 65645 | 4631 | 68392 | 3807 | 71301 | 2598 | 86932 | 2256 | 50057 |
| 4L-9S | | MI | 26872 | 7667 | 43140 | 5659 | 46526 | 4590 | 47333 | 3768 | 47044 | 2554 | 56206 | 1860 | 36806 |
| 22-#11 | 1.88 | MA | 36488 | 7667 | 58403 | 5720 | 64315 | 4630 | 66763 | 3819 | 68976 | 2594 | 84055 | 2211 | 49917 |
| 5L-8S | | MI | 27298 | 7667 | 43920 | 5647 | 47493 | 4580 | 48549 | 3772 | 48632 | 2547 | 58185 | 1917 | 37429 |

## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

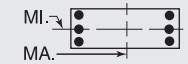



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.88 | MA | 35913 | 7667 | 57431 | 5720 | 62994 | 4643 | 65151 | 3817 | 66841 | 2603 | 81302 | 2153 | 49248 |
| 6L-7S | | MI | 27728 | 7667 | 44658 | 5648 | 48481 | 4583 | 49725 | 3763 | 50314 | 2554 | 60202 | 1967 | 37817 |
| 22-#11 | 1.88 | MA | 35352 | 7667 | 56391 | 5733 | 61725 | 4642 | 63596 | 3828 | 64753 | 2612 | 78439 | 2066 | 48661 |
| 7L-6S | | MI | 28163 | 7667 | 45462 | 5636 | 49461 | 4572 | 50925 | 3754 | 51919 | 2547 | 62329 | 2054 | 38192 |
| 22-#11 | 1.88 | MA | 34798 | 7667 | 55437 | 5733 | 60446 | 4654 | 62074 | 3840 | 62565 | 2608 | 75750 | 2013 | 48139 |
| 8L-5S | | MI | 28610 | 7667 | 46213 | 5637 | 50481 | 4575 | 52169 | 3758 | 53560 | 2540 | 64372 | 2113 | 38710 |
| 22-#11 | 1.88 | MA | 34205 | 7667 | 54500 | 5733 | 59195 | 4653 | 60499 | 3837 | 60499 | 2617 | 73083 | 1957 | 47219 |
| 9L-4S | | MI | 29078 | 7667 | 47009 | 5639 | 51507 | 4564 | 53426 | 3749 | 55345 | 2547 | 66531 | 2156 | 38782 |
| 22-#11 | 1.88 | MA | 33595 | 7667 | 53478 | 5747 | 57932 | 4666 | 58987 | 3849 | 58448 | 2626 | 70494 | 1894 | 46477 |
| 10L-3S | | MI | 29600 | 7667 | 47915 | 5627 | 52660 | 4567 | 54825 | 3753 | 57155 | 2540 | 68586 | 2244 | 38815 |
| 22-#11 | 1.88 | MA | 32999 | 7667 | 52542 | 5747 | 56689 | 4665 | 57431 | 3847 | 56291 | 2622 | 67868 | 1838 | 45380 |
| 11L-2S | | MI | 30339 | 7667 | 49042 | 5628 | 54097 | 4556 | 56572 | 3744 | 59514 | 2533 | 71730 | 2333 | 38820 |
| 22-#14 | 2.71 | MA | 38757 | 8205 | 63899 | 6045 | 71213 | 4865 | 75104 | 3967 | 80252 | 2556 | 99503 | 2029 | 70076 |
| 5L-8S | | MI | 28431 | 8205 | 47110 | 5969 | 51428 | 4814 | 53299 | 3918 | 54932 | 2496 | 66896 | 1616 | 51303 |
| 22-#14 | 2.71 | MA | 37948 | 8205 | 62503 | 6045 | 69316 | 4882 | 72790 | 3963 | 77189 | 2568 | 95582 | 1945 | 68917 |
| 6L-7S | | MI | 29035 | 8205 | 48167 | 5971 | 52845 | 4819 | 54984 | 3905 | 57326 | 2506 | 69764 | 1687 | 52353 |
| 22-#14 | 2.71 | MA | 37159 | 8205 | 61010 | 6064 | 67496 | 4880 | 70559 | 3979 | 74191 | 2581 | 91503 | 1819 | 67791 |
| 7L-6S | | MI | 29648 | 8205 | 49319 | 5954 | 54249 | 4804 | 56704 | 3893 | 59609 | 2496 | 72783 | 1813 | 53246 |
| 22-#14 | 2.71 | MA | 36382 | 8205 | 59640 | 6064 | 65659 | 4898 | 68374 | 3995 | 71051 | 2574 | 87666 | 1744 | 66235 |
| 8L-5S | | MI | 30276 | 8205 | 50396 | 5957 | 55711 | 4809 | 58487 | 3900 | 61943 | 2486 | 75680 | 1898 | 53995 |
| 22-#14 | 2.71 | MA | 35564 | 8205 | 58296 | 6064 | 63864 | 4896 | 66114 | 3991 | 68086 | 2586 | 83867 | 1663 | 64622 |
| 9L-4S | | MI | 30934 | 8205 | 51536 | 5959 | 57181 | 4794 | 60287 | 3887 | 64483 | 2496 | 78751 | 1959 | 54913 |
| 22-#14 | 2.71 | MA | 34695 | 8205 | 56828 | 6083 | 62050 | 4913 | 63943 | 4007 | 65142 | 2599 | 80181 | 1572 | 62907 |
| 10L-3S | | MI | 31668 | 8205 | 52835 | 5942 | 58832 | 4799 | 62290 | 3894 | 67058 | 2486 | 81663 | 2087 | 55059 |
| 22-#18 | 4.82 | MA | 41540 | 9570 | 72478 | 6909 | 81877 | 5522 | 87934 | 4362 | 97756 | 2499 | 123740 | 1167 | 111680 |
| 7L-6S | | MI | 33211 | 9570 | 58847 | 6768 | 66127 | 5397 | 71060 | 4247 | 78515 | 2351 | 98329 | 1168 | 87871 |
| 22-#18 | 4.82 | MA | 40231 | 9570 | 70066 | 6907 | 78642 | 5517 | 84088 | 4388 | 92230 | 2483 | 117062 | 1037 | 107392 |
| 8L-5S | | MI | 34270 | 9570 | 60737 | 6774 | 68692 | 5408 | 74187 | 4263 | 82550 | 2333 | 103308 | 1320 | 90734 |
| 24-#11 | 2.05 | MA | 37783 | 7777 | 60907 | 5789 | 67523 | 4681 | 70674 | 3838 | 74394 | 2591 | 91158 | 2244 | 54507 |
| 4L-10S | | MI | 26938 | 7777 | 43533 | 5727 | 46987 | 4638 | 47911 | 3809 | 47826 | 2554 | 57432 | 1779 | 39544 |
| 24-#11 | 2.05 | MA | 37182 | 7777 | 59876 | 5789 | 66193 | 4680 | 69045 | 3850 | 72068 | 2587 | 88281 | 2199 | 54354 |
| 5L-9S | | MI | 27400 | 7777 | 44267 | 5728 | 47963 | 4641 | 49080 | 3799 | 49403 | 2547 | 59350 | 1843 | 40118 |
| 24-#11 | 2.05 | MA | 36609 | 7777 | 58904 | 5789 | 64871 | 4693 | 67433 | 3848 | 69933 | 2596 | 85528 | 2141 | 53616 |
| 6L-8S | | MI | 27824 | 7777 | 45047 | 5716 | 48929 | 4630 | 50296 | 3804 | 50992 | 2540 | 61329 | 1899 | 40723 |
| 24-#11 | 2.05 | MA | 36051 | 7777 | 57863 | 5802 | 63603 | 4692 | 65878 | 3859 | 67845 | 2605 | 82665 | 2054 | 53046 |
| 7E | | MI | 28252 | 7777 | 45785 | 5717 | 49918 | 4633 | 51471 | 3794 | 52673 | 2547 | 63346 | 1949 | 41166 |
| 24-#11 | 2.05 | MA | 35500 | 7777 | 56909 | 5803 | 62323 | 4705 | 64357 | 3871 | 65657 | 2601 | 79976 | 2001 | 52468 |
| 8L-6S | | MI | 28686 | 7777 | 46589 | 5705 | 50898 | 4622 | 52672 | 3785 | 54279 | 2540 | 65473 | 2037 | 41529 |
| 24-#11 | 2.05 | MA | 34910 | 7777 | 55973 | 5803 | 61073 | 4703 | 62782 | 3868 | 63591 | 2610 | 77309 | 1945 | 51570 |
| 9L-5S | | MI | 29131 | 7777 | 47340 | 5707 | 51918 | 4625 | 53916 | 3789 | 55919 | 2533 | 67516 | 2095 | 42109 |
| 24-#11 | 2.05 | MA | 34302 | 7777 | 54950 | 5816 | 59810 | 4716 | 61270 | 3880 | 61540 | 2619 | 74720 | 1882 | 50790 |
| 10L-4S | | MI | 29597 | 7777 | 48136 | 5708 | 52944 | 4614 | 55172 | 3780 | 57704 | 2540 | 69675 | 2138 | 42192 |
| 24-#11 | 2.05 | MA | 33709 | 7777 | 54014 | 5816 | 58567 | 4715 | 59713 | 3878 | 59383 | 2615 | 72094 | 1826 | 49713 |
| 11L-3S | | MI | 30117 | 7777 | 49042 | 5696 | 54097 | 4617 | 56572 | 3784 | 59514 | 2533 | 71730 | 2227 | 42236 |
| 24-#11 | 2.05 | MA | 33125 | 7777 | 53008 | 5830 | 57312 | 4728 | 58205 | 3889 | 57335 | 2624 | 69202 | 1752 | 48615 |
| 12L-2S | | MI | 30852 | 7777 | 50169 | 5697 | 55533 | 4606 | 58318 | 3775 | 61873 | 2526 | 74874 | 2315 | 42255 |
| 24-#14 | 2.96 | MA | 38926 | 8365 | 64613 | 6145 | 72006 | 4955 | 76060 | 4008 | 81619 | 2558 | 101603 | 1926 | 75183 |
| 6L-8S | | MI | 29171 | 8365 | 48721 | 6068 | 53482 | 4886 | 55796 | 3963 | 58289 | 2484 | 71358 | 1588 | 56025 |
| 24-#14 | 2.96 | MA | 38142 | 8365 | 63120 | 6164 | 70186 | 4952 | 73829 | 4024 | 78621 | 2571 | 97525 | 1800 | 73973 |
| 7E | | MI | 29772 | 8365 | 49779 | 6071 | 54899 | 4891 | 57481 | 3950 | 60682 | 2494 | 74226 | 1659 | 57042 |
| 24-#14 | 2.96 | MA | 37370 | 8365 | 61750 | 6164 | 68349 | 4970 | 71644 | 4040 | 75482 | 2564 | 93687 | 1725 | 72456 |
| 8L-6S | | MI | 30381 | 8365 | 50931 | 6054 | 56304 | 4876 | 59202 | 3938 | 62966 | 2484 | 77245 | 1786 | 58016 |
| 24-#14 | 2.96 | MA | 36554 | 8365 | 60406 | 6163 | 66554 | 4968 | 69384 | 4036 | 72516 | 2576 | 89888 | 1644 | 70791 |
| 9L-5S | | MI | 31005 | 8365 | 52007 | 6057 | 57765 | 4881 | 60984 | 3945 | 65299 | 2474 | 80142 | 1871 | 58736 |
| 24-#14 | 2.96 | MA | 35693 | 8365 | 58938 | 6183 | 64740 | 4986 | 67213 | 4052 | 69572 | 2589 | 86203 | 1553 | 69111 |
| 10L-4S | | MI | 31660 | 8365 | 53147 | 6059 | 59235 | 4866 | 62784 | 3932 | 67840 | 2484 | 83213 | 1931 | 59762 |
| 24-#18 | 5.26 | MA | 41910 | 9854 | 73767 | 7084 | 83361 | 5645 | 89823 | 4468 | 100001 | 2465 | 127507 | 997 | 118201 |
| 8L-6S | | MI | 34448 | 9854 | 61661 | 6945 | 69715 | 5525 | 75422 | 4327 | 84320 | 2327 | 106007 | 1112 | 96024 |

## RECTANGULAR TIED COLUMNS 40" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.50 | MA | 26834 | 6509 | 42944 | 4769 | 46795 | 3872 | 48335 | 3200 | 49482 | 2209 | 58808 | 2044 | 28488 |
| 2L-3S | | MI | 24861 | 6509 | 39953 | 4764 | 42981 | 3897 | 43698 | 3222 | 43277 | 2227 | 50577 | 1816 | 28510 |
| 8-#14 | 1.13 | MA | 25889 | 6296 | 40681 | 4669 | 44084 | 3802 | 45104 | 3163 | 45319 | 2251 | 53395 | 2115 | 21768 |
| 2L-4S | | MI | 23940 | 6296 | 37594 | 4684 | 40152 | 3813 | 40328 | 3170 | 38989 | 2271 | 45501 | 1859 | 21816 |
| 8-#18 | 2.00 | MA | 28194 | 6792 | 45936 | 4947 | 50609 | 4000 | 52971 | 3280 | 55687 | 2187 | 67039 | 1992 | 37634 |
| 2L-4S | | MI | 24854 | 6792 | 40530 | 4971 | 43726 | 4016 | 44610 | 3288 | 44722 | 2222 | 53443 | 1536 | 36809 |
| 10-#14 | 1.41 | MA | 26684 | 6456 | 42392 | 4768 | 46265 | 3874 | 47756 | 3208 | 48901 | 2240 | 58168 | 2090 | 27013 |
| 2L-5S | | MI | 24029 | 6456 | 38097 | 4782 | 40775 | 3901 | 41072 | 3229 | 39860 | 2250 | 46997 | 1772 | 26594 |
| 10-#14 | 1.41 | MA | 25552 | 6456 | 40681 | 4766 | 44084 | 3890 | 45104 | 3222 | 45319 | 2250 | 53395 | 1962 | 27043 |
| 3L-4S | | MI | 24749 | 6456 | 39305 | 4784 | 42333 | 3886 | 42979 | 3215 | 42571 | 2260 | 50275 | 1834 | 26992 |
| 10-#18 | 2.50 | MA | 29537 | 7076 | 48927 | 5124 | 54424 | 4129 | 57608 | 3360 | 61892 | 2164 | 75270 | 1939 | 46741 |
| 2L-5S | | MI | 25000 | 7076 | 41400 | 5142 | 44806 | 4170 | 45899 | 3389 | 46231 | 2182 | 55997 | 1379 | 42766 |
| 10-#18 | 2.50 | MA | 27604 | 7076 | 45936 | 5118 | 50609 | 4154 | 52971 | 3382 | 55687 | 2182 | 67039 | 1712 | 46579 |
| 3L-4S | | MI | 26232 | 7076 | 43521 | 5148 | 47540 | 4145 | 49247 | 3368 | 50927 | 2200 | 61674 | 1484 | 45339 |

## RECTANGULAR TIED COLUMNS 40" x 42"

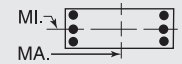
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.43 | MA | 29432 | 6792 | 46882 | 4999 | 51101 | 4061 | 52730 | 3361 | 53920 | 2338 | 64072 | 2174 | 30108 |
| 2L-3S | | MI | 25994 | 6792 | 41651 | 4975 | 44749 | 4072 | 45419 | 3370 | 44821 | 2340 | 52283 | 1926 | 28580 |
| 6-#18 | 1.43 | MA | 27337 | 6792 | 43713 | 4994 | 47061 | 4088 | 47819 | 3384 | 47314 | 2356 | 55288 | 1946 | 30130 |
| 3L-2S | | MI | 27970 | 6792 | 44643 | 4981 | 48563 | 4046 | 50056 | 3348 | 51026 | 2323 | 60514 | 2154 | 28537 |
| 8-#14 | 1.07 | MA | 28419 | 6579 | 44477 | 4898 | 48218 | 3991 | 49295 | 3324 | 49439 | 2377 | 58255 | 2242 | 22983 |
| 2L-4S | | MI | 25072 | 6579 | 39286 | 4898 | 41920 | 3989 | 42053 | 3320 | 40538 | 2385 | 47216 | 1970 | 21875 |
| 8-#14 | 1.07 | MA | 27209 | 6579 | 42666 | 4897 | 45909 | 4007 | 46489 | 3338 | 45637 | 2387 | 53169 | 2114 | 23036 |
| 3E | | MI | 25882 | 6579 | 40662 | 4880 | 43670 | 3993 | 44177 | 3326 | 43286 | 2375 | 50336 | 2098 | 21863 |
| 8-#14 | 1.07 | MA | 26354 | 6579 | 41211 | 4915 | 44059 | 4004 | 44244 | 3332 | 42722 | 2397 | 49842 | 1986 | 23031 |
| 4L-2S | | MI | 27023 | 6579 | 42373 | 4882 | 45852 | 3978 | 46829 | 3312 | 46868 | 2365 | 55110 | 2226 | 21806 |
| 8-#18 | 1.90 | MA | 30882 | 7075 | 50051 | 5176 | 55141 | 4189 | 57642 | 3441 | 60526 | 2317 | 72856 | 2125 | 39794 |
| 2L-4S | | MI | 25986 | 7075 | 42228 | 5182 | 45493 | 4190 | 46331 | 3436 | 46266 | 2336 | 55149 | 1647 | 37204 |
| 8-#18 | 1.90 | MA | 28809 | 7075 | 46882 | 5172 | 51101 | 4216 | 52730 | 3464 | 53920 | 2335 | 64072 | 1898 | 39718 |
| 3E | | MI | 27377 | 7075 | 44643 | 5153 | 48563 | 4200 | 50056 | 3450 | 51026 | 2318 | 60514 | 1874 | 37638 |
| 8-#18 | 1.90 | MA | 27338 | 7075 | 44329 | 5202 | 47854 | 4207 | 48790 | 3451 | 48853 | 2353 | 58338 | 1670 | 39250 |
| 4L-2S | | MI | 29333 | 7075 | 47634 | 5158 | 52377 | 4175 | 54693 | 3428 | 57231 | 2300 | 68745 | 2102 | 37689 |
| 10-#14 | 1.34 | MA | 29266 | 6738 | 46287 | 4998 | 50526 | 4063 | 52102 | 3369 | 53241 | 2367 | 63340 | 2218 | 28531 |
| 2L-5S | | MI | 25161 | 6738 | 39789 | 4995 | 42543 | 4077 | 42797 | 3378 | 41410 | 2365 | 48712 | 1883 | 26820 |
| 10-#14 | 1.34 | MA | 28064 | 6738 | 44477 | 4997 | 48218 | 4080 | 49295 | 3383 | 49439 | 2377 | 58255 | 2090 | 28562 |
| 3L-4S | | MI | 25882 | 6738 | 40997 | 4997 | 44101 | 4061 | 44704 | 3365 | 44120 | 2375 | 51990 | 1945 | 27058 |
| 10-#14 | 1.34 | MA | 27215 | 6738 | 43022 | 5015 | 46368 | 4076 | 47050 | 3377 | 46523 | 2387 | 54927 | 1962 | 28511 |
| 4L-3S | | MI | 26686 | 6738 | 42373 | 4980 | 45852 | 4066 | 46829 | 3371 | 46868 | 2365 | 55110 | 2072 | 27090 |
| 10-#14 | 1.34 | MA | 26453 | 6738 | 41746 | 5013 | 44722 | 4092 | 45035 | 3392 | 43649 | 2378 | 51442 | 1900 | 28239 |
| 5L-2S | | MI | 27820 | 6738 | 44084 | 4982 | 48033 | 4050 | 49480 | 3357 | 50451 | 2355 | 59883 | 2200 | 27054 |
| 10-#18 | 2.38 | MA | 32315 | 7359 | 53220 | 5354 | 59181 | 4318 | 62553 | 3521 | 67131 | 2297 | 81640 | 2077 | 49441 |
| 2L-5S | | MI | 26131 | 7359 | 43099 | 5354 | 46573 | 4344 | 47620 | 3537 | 47774 | 2296 | 57703 | 1489 | 43088 |
| 10-#18 | 2.38 | MA | 30262 | 7359 | 50051 | 5349 | 55141 | 4345 | 57642 | 3544 | 60526 | 2315 | 72856 | 1849 | 49279 |
| 3L-4S | | MI | 27366 | 7359 | 45220 | 5360 | 49308 | 4319 | 50968 | 3516 | 52471 | 2314 | 63380 | 1594 | 45725 |
| 10-#18 | 2.38 | MA | 28808 | 7359 | 47498 | 5380 | 51894 | 4336 | 53702 | 3531 | 55458 | 2332 | 67122 | 1622 | 48298 |
| 4L-3S | | MI | 28742 | 7359 | 47634 | 5330 | 52377 | 4329 | 54693 | 3530 | 57231 | 2296 | 68745 | 1822 | 46669 |
| 10-#18 | 2.38 | MA | 27503 | 7359 | 45256 | 5375 | 49004 | 4363 | 50163 | 3554 | 50459 | 2315 | 61078 | 1514 | 45434 |
| 5L-2S | | MI | 30679 | 7359 | 50626 | 5336 | 56191 | 4303 | 59329 | 3508 | 63436 | 2278 | 76976 | 2049 | 46805 |
| 12-#11 | 1.11 | MA | 28601 | 6604 | 44752 | 4931 | 48663 | 4016 | 49872 | 3342 | 50234 | 2384 | 59468 | 2254 | 23968 |
| 2L-6S | | MI | 24846 | 6604 | 38839 | 4924 | 41363 | 4021 | 41395 | 3344 | 39592 | 2390 | 46227 | 1960 | 22503 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

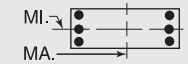
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.11 | MA | 27756 | 6604 | 43487 | 4930 | 47049 | 4014 | 47911 | 3353 | 47578 | 2392 | 55892 | 2165 | 23999 |
| 3L-5S | | MI | 25329 | 6604 | 39634 | 4926 | 42443 | 4023 | 42713 | 3347 | 41336 | 2383 | 48411 | 2018 | 22767 |
| 12-#11 | 1.11 | MA | 27160 | 6604 | 42472 | 4943 | 45758 | 4026 | 46344 | 3349 | 45543 | 2399 | 53548 | 2077 | 24011 |
| 4E | | MI | 25835 | 6604 | 40477 | 4927 | 43530 | 4012 | 44044 | 3338 | 43235 | 2390 | 50713 | 2061 | 22794 |
| 12-#11 | 1.11 | MA | 26626 | 6604 | 41582 | 4942 | 44611 | 4023 | 44938 | 3360 | 43538 | 2393 | 51103 | 2033 | 23971 |
| 5L-3S | | MI | 26399 | 6604 | 41438 | 4914 | 44752 | 4014 | 45527 | 3341 | 45161 | 2383 | 52912 | 2150 | 22774 |
| 12-#11 | 1.11 | MA | 26116 | 6604 | 40742 | 4941 | 43470 | 4035 | 43547 | 3356 | 41696 | 2401 | 48776 | 1974 | 23674 |
| 6L-2S | | MI | 27197 | 6604 | 42634 | 4915 | 46277 | 4003 | 47381 | 3332 | 47672 | 2375 | 56272 | 2239 | 22739 |
| 12-#14 | 1.61 | MA | 30106 | 6898 | 48098 | 5098 | 52835 | 4136 | 54908 | 3414 | 57043 | 2357 | 68425 | 2195 | 34065 |
| 2L-6S | | MI | 25285 | 6898 | 40359 | 5093 | 43176 | 4145 | 43560 | 3417 | 42502 | 2364 | 50384 | 1773 | 30781 |
| 12-#14 | 1.61 | MA | 28912 | 6898 | 46287 | 5096 | 50526 | 4152 | 52102 | 3428 | 53241 | 2367 | 63340 | 2067 | 34066 |
| 3L-5S | | MI | 25969 | 6898 | 41499 | 5095 | 44725 | 4149 | 45449 | 3423 | 44992 | 2354 | 53486 | 1858 | 31784 |
| 12-#14 | 1.61 | MA | 28069 | 6898 | 44832 | 5115 | 48676 | 4148 | 49856 | 3422 | 50325 | 2377 | 60012 | 1939 | 33980 |
| 4E | | MI | 26685 | 6898 | 42707 | 5097 | 46282 | 4134 | 47356 | 3409 | 47702 | 2364 | 56763 | 1919 | 32229 |
| 12-#14 | 1.61 | MA | 27313 | 6898 | 43556 | 5113 | 47031 | 4165 | 47841 | 3437 | 47451 | 2368 | 56528 | 1876 | 33500 |
| 5L-3S | | MI | 27483 | 6898 | 44084 | 5079 | 48033 | 4138 | 49480 | 3416 | 50451 | 2354 | 59883 | 2047 | 32298 |
| 12-#14 | 1.61 | MA | 26592 | 6898 | 42352 | 5111 | 45395 | 4161 | 45846 | 3431 | 44809 | 2378 | 53221 | 1792 | 32409 |
| 6L-2S | | MI | 28611 | 6898 | 45795 | 5082 | 50214 | 4122 | 52132 | 3402 | 54033 | 2344 | 64657 | 2175 | 32287 |
| 12-#18 | 2.86 | MA | 33731 | 7643 | 56389 | 5531 | 63222 | 4446 | 67465 | 3601 | 73737 | 2277 | 90423 | 2028 | 59058 |
| 2L-6S | | MI | 26342 | 7643 | 44087 | 5526 | 47668 | 4463 | 48941 | 3603 | 49665 | 2291 | 60593 | 1285 | 49246 |
| 12-#18 | 2.86 | MA | 31698 | 7643 | 53220 | 5526 | 59181 | 4473 | 62553 | 3623 | 67131 | 2294 | 81640 | 1801 | 58825 |
| 3L-5S | | MI | 27508 | 7643 | 46091 | 5531 | 50387 | 4473 | 52257 | 3617 | 53979 | 2274 | 65934 | 1437 | 51815 |
| 12-#18 | 2.86 | MA | 30259 | 7643 | 50667 | 5557 | 55935 | 4465 | 58613 | 3611 | 62064 | 2312 | 75906 | 1573 | 57395 |
| 4E | | MI | 28731 | 7643 | 48212 | 5537 | 53122 | 4447 | 55604 | 3595 | 58676 | 2291 | 71611 | 1542 | 54298 |
| 12-#18 | 2.86 | MA | 28969 | 7643 | 48425 | 5552 | 53044 | 4491 | 55074 | 3634 | 57065 | 2294 | 69862 | 1466 | 54693 |
| 5L-3S | | MI | 30092 | 7643 | 50626 | 5507 | 56191 | 4457 | 59329 | 3609 | 63436 | 2274 | 76976 | 1770 | 55682 |
| 12-#18 | 2.86 | MA | 27738 | 7643 | 46308 | 5548 | 50170 | 4483 | 51569 | 3621 | 52473 | 2312 | 64158 | 1315 | 51963 |
| 6L-2S | | MI | 32011 | 7643 | 53618 | 5513 | 60005 | 4432 | 63966 | 3588 | 69641 | 2256 | 85207 | 1997 | 55887 |
| 14-#11 | 1.30 | MA | 29196 | 6715 | 46017 | 5000 | 50276 | 4066 | 51832 | 3374 | 52891 | 2377 | 63044 | 2239 | 27841 |
| 2L-7S | | MI | 24948 | 6715 | 39184 | 5006 | 41850 | 4082 | 41978 | 3385 | 40395 | 2390 | 47312 | 1855 | 25539 |
| 14-#11 | 1.30 | MA | 28354 | 6715 | 44752 | 4999 | 48663 | 4064 | 49872 | 3384 | 50234 | 2385 | 59468 | 2150 | 27862 |
| 3L-6S | | MI | 25417 | 6715 | 40035 | 4994 | 42887 | 4071 | 43249 | 3375 | 42103 | 2383 | 49587 | 1943 | 26015 |
| 14-#11 | 1.30 | MA | 27761 | 6715 | 43737 | 5012 | 47371 | 4076 | 48304 | 3380 | 48200 | 2392 | 57125 | 2061 | 27854 |
| 4L-5S | | MI | 25897 | 6715 | 40830 | 4995 | 43968 | 4073 | 44567 | 3379 | 43848 | 2376 | 51771 | 2002 | 26384 |
| 14-#11 | 1.30 | MA | 27230 | 6715 | 42847 | 5011 | 46224 | 4074 | 46899 | 3391 | 46194 | 2386 | 54679 | 2018 | 27794 |
| 5L-4S | | MI | 26401 | 6715 | 41673 | 4996 | 45055 | 4062 | 45898 | 3369 | 45746 | 2383 | 54073 | 2045 | 26430 |
| 14-#11 | 1.30 | MA | 26724 | 6715 | 42007 | 5010 | 45083 | 4085 | 45508 | 3387 | 44352 | 2394 | 52352 | 1959 | 27392 |
| 6L-3S | | MI | 26962 | 6715 | 42634 | 4983 | 46277 | 4065 | 47381 | 3373 | 47672 | 2376 | 56272 | 2134 | 26429 |
| 14-#11 | 1.30 | MA | 26229 | 6715 | 41109 | 5023 | 43988 | 4083 | 44165 | 3398 | 42549 | 2402 | 49931 | 1872 | 26871 |
| 7L-2S | | MI | 27757 | 6715 | 43830 | 4984 | 47802 | 4053 | 49235 | 3363 | 50183 | 2369 | 59632 | 2222 | 26404 |
| 14-#14 | 1.88 | MA | 30940 | 7058 | 49909 | 5198 | 55143 | 4208 | 57714 | 3459 | 60845 | 2347 | 73510 | 2171 | 39590 |
| 2L-7S | | MI | 25430 | 7058 | 40850 | 5210 | 43870 | 4233 | 44389 | 3475 | 43646 | 2364 | 51927 | 1621 | 34997 |
| 14-#14 | 1.88 | MA | 29753 | 7058 | 48098 | 5196 | 52835 | 4224 | 54908 | 3473 | 57043 | 2357 | 68425 | 2043 | 39558 |
| 3L-6S | | MI | 26092 | 7058 | 42070 | 5193 | 45357 | 4217 | 46211 | 3462 | 46084 | 2354 | 55157 | 1748 | 35816 |
| 14-#14 | 1.88 | MA | 28916 | 7058 | 46643 | 5214 | 50985 | 4221 | 52662 | 3467 | 54127 | 2367 | 65097 | 1915 | 39441 |
| 4L-5S | | MI | 26770 | 7058 | 43210 | 5195 | 46906 | 4222 | 48100 | 3468 | 48574 | 2344 | 58259 | 1832 | 36768 |
| 14-#14 | 1.88 | MA | 28165 | 7058 | 45367 | 5213 | 49339 | 4237 | 50647 | 3481 | 51253 | 2358 | 61613 | 1853 | 38779 |
| 5L-4S | | MI | 27482 | 7058 | 44418 | 5197 | 48464 | 4206 | 50008 | 3454 | 51284 | 2354 | 61537 | 1894 | 37392 |
| 14-#14 | 1.88 | MA | 27449 | 7058 | 44163 | 5211 | 47703 | 4233 | 48652 | 3476 | 48611 | 2368 | 58306 | 1768 | 37742 |
| 6L-3S | | MI | 28275 | 7058 | 45795 | 5179 | 50214 | 4210 | 52132 | 3461 | 54033 | 2344 | 64657 | 2022 | 37491 |
| 14-#14 | 1.88 | MA | 26751 | 7058 | 42874 | 5229 | 46133 | 4249 | 46727 | 3490 | 46026 | 2378 | 54865 | 1642 | 36862 |
| 7L-2S | | MI | 29395 | 7058 | 47506 | 5181 | 52396 | 4195 | 54784 | 3447 | 57615 | 2334 | 69431 | 2150 | 37510 |
| 14-#18 | 3.33 | MA | 33119 | 7926 | 56389 | 5704 | 63222 | 4602 | 67465 | 3703 | 73737 | 2274 | 90423 | 1752 | 68359 |
| 3L-6S | | MI | 27717 | 7926 | 47079 | 5703 | 51482 | 4592 | 53577 | 3683 | 55870 | 2269 | 68823 | 1233 | 57830 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

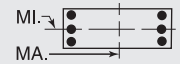


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.33 | MA | 31695 | 7926 | 53836 | 5734 | 59975 | 4593 | 63525 | 3691 | 68670 | 2292 | 84690 | 1525 | 66535 |
| 4L-5S | | MI | 28871 | 7926 | 49082 | 5709 | 54201 | 4602 | 56893 | 3697 | 60184 | 2252 | 74165 | 1384 | 60568 |
| 14-#18 | 3.33 | MA | 30419 | 7926 | 51594 | 5730 | 57084 | 4620 | 59985 | 3713 | 63671 | 2274 | 78646 | 1417 | 63976 |
| 5L-4S | | MI | 30080 | 7926 | 51203 | 5714 | 56936 | 4576 | 60241 | 3675 | 64881 | 2269 | 79841 | 1490 | 62912 |
| 14-#18 | 3.33 | MA | 29201 | 7926 | 49477 | 5725 | 54210 | 4611 | 56480 | 3701 | 59078 | 2292 | 72942 | 1267 | 61079 |
| 6L-3S | | MI | 31428 | 7926 | 53618 | 5685 | 60005 | 4586 | 63966 | 3689 | 69641 | 2252 | 85207 | 1718 | 64683 |
| 14-#18 | 3.33 | MA | 28013 | 7926 | 47211 | 5756 | 51449 | 4638 | 53097 | 3724 | 54584 | 2309 | 67000 | 1041 | 58253 |
| 7L-2S | | MI | 33330 | 7926 | 56609 | 5690 | 63820 | 4560 | 68603 | 3668 | 75846 | 2234 | 93437 | 1945 | 64952 |
| 16-#11 | 1.49 | MA | 29787 | 6826 | 47282 | 5069 | 51889 | 4116 | 53793 | 3405 | 55547 | 2370 | 66620 | 2224 | 31707 |
| 2L-8S | | MI | 25059 | 6826 | 39599 | 5074 | 42328 | 4130 | 42587 | 3426 | 41118 | 2377 | 48521 | 1789 | 28676 |
| 16-#11 | 1.49 | MA | 28949 | 6826 | 46017 | 5068 | 50276 | 4114 | 51832 | 3415 | 52891 | 2378 | 63044 | 2135 | 31719 |
| 3L-7S | | MI | 25519 | 6826 | 40380 | 5075 | 43375 | 4132 | 43831 | 3416 | 42907 | 2384 | 50672 | 1839 | 29081 |
| 16-#11 | 1.49 | MA | 28359 | 6826 | 45002 | 5081 | 48984 | 4126 | 50265 | 3412 | 50856 | 2385 | 60701 | 2046 | 31690 |
| 4L-6S | | MI | 25985 | 6826 | 41231 | 5063 | 44412 | 4121 | 45103 | 3406 | 44614 | 2376 | 52947 | 1927 | 29536 |
| 16-#11 | 1.49 | MA | 27831 | 6826 | 44112 | 5080 | 47837 | 4124 | 48860 | 3422 | 48851 | 2379 | 58255 | 2002 | 31613 |
| 5E | | MI | 26463 | 6826 | 42026 | 5064 | 45493 | 4124 | 46421 | 3410 | 46359 | 2369 | 55131 | 1985 | 29996 |
| 16-#11 | 1.49 | MA | 27327 | 6826 | 43273 | 5080 | 46696 | 4135 | 47468 | 3419 | 47009 | 2387 | 55929 | 1944 | 31118 |
| 6L-4S | | MI | 26963 | 6826 | 42869 | 5065 | 46580 | 4112 | 47751 | 3400 | 48258 | 2376 | 57433 | 2029 | 30060 |
| 16-#11 | 1.49 | MA | 26835 | 6826 | 42374 | 5093 | 45601 | 4133 | 46126 | 3429 | 45206 | 2395 | 53507 | 1856 | 30620 |
| 7L-3S | | MI | 27522 | 6826 | 43830 | 5052 | 47802 | 4115 | 49235 | 3404 | 50183 | 2369 | 59632 | 2117 | 30078 |
| 16-#11 | 1.49 | MA | 26351 | 6826 | 41550 | 5092 | 44496 | 4145 | 44812 | 3439 | 43318 | 2389 | 51222 | 1805 | 30179 |
| 8L-2S | | MI | 28313 | 6826 | 45026 | 5053 | 49327 | 4103 | 51088 | 3394 | 52695 | 2362 | 62992 | 2206 | 30062 |
| 16-#14 | 2.14 | MA | 31768 | 7217 | 51719 | 5297 | 57452 | 4280 | 60520 | 3503 | 64647 | 2337 | 78596 | 2147 | 45097 |
| 2L-8S | | MI | 25586 | 7217 | 41441 | 5308 | 44550 | 4301 | 45256 | 3533 | 44675 | 2343 | 53639 | 1524 | 38725 |
| 16-#14 | 2.14 | MA | 30588 | 7217 | 49909 | 5296 | 55143 | 4297 | 57714 | 3518 | 60845 | 2347 | 73510 | 2019 | 45043 |
| 3L-7S | | MI | 26235 | 7217 | 42560 | 5310 | 46051 | 4305 | 47040 | 3520 | 47229 | 2353 | 56701 | 1596 | 39947 |
| 16-#14 | 2.14 | MA | 29756 | 7217 | 48454 | 5314 | 53293 | 4293 | 55469 | 3512 | 57929 | 2357 | 70183 | 1891 | 44897 |
| 4L-6S | | MI | 26892 | 7217 | 43781 | 5292 | 47538 | 4290 | 48863 | 3506 | 49666 | 2343 | 59931 | 1722 | 40860 |
| 16-#14 | 2.14 | MA | 29011 | 7217 | 47178 | 5312 | 51648 | 4309 | 53454 | 3526 | 55055 | 2348 | 66698 | 1829 | 44075 |
| 5E | | MI | 27566 | 7217 | 44921 | 5295 | 49087 | 4294 | 50752 | 3513 | 52156 | 2333 | 63033 | 1807 | 41767 |
| 16-#14 | 2.14 | MA | 28300 | 7217 | 45974 | 5311 | 50012 | 4306 | 51459 | 3521 | 52413 | 2358 | 63392 | 1745 | 43084 |
| 6L-4S | | MI | 28272 | 7217 | 46129 | 5297 | 50645 | 4278 | 52659 | 3499 | 54867 | 2343 | 66311 | 1868 | 42549 |
| 16-#14 | 2.14 | MA | 27607 | 7217 | 44685 | 5329 | 48441 | 4322 | 49534 | 3535 | 49828 | 2368 | 59950 | 1618 | 42111 |
| 7L-3S | | MI | 29060 | 7217 | 47506 | 5279 | 52396 | 4282 | 54784 | 3506 | 57615 | 2333 | 69431 | 1996 | 42676 |
| 16-#14 | 2.14 | MA | 26923 | 7217 | 43503 | 5327 | 46856 | 4318 | 47649 | 3549 | 47120 | 2359 | 56694 | 1545 | 40789 |
| 8L-2S | | MI | 30174 | 7217 | 49217 | 5281 | 54577 | 4267 | 57436 | 3492 | 61197 | 2323 | 74204 | 2124 | 42720 |
| 16-#18 | 3.81 | MA | 33116 | 8210 | 57005 | 5912 | 64015 | 4722 | 68436 | 3770 | 75275 | 2271 | 93473 | 1476 | 75710 |
| 4L-6S | | MI | 29077 | 8210 | 50070 | 5880 | 55296 | 4720 | 58214 | 3763 | 62075 | 2247 | 77054 | 1181 | 66442 |
| 16-#18 | 3.81 | MA | 31853 | 8210 | 54763 | 5907 | 61125 | 4749 | 64897 | 3793 | 70276 | 2254 | 87430 | 1369 | 73280 |
| 5E | | MI | 30219 | 8210 | 52074 | 5886 | 58016 | 4730 | 61530 | 3776 | 66389 | 2229 | 82396 | 1332 | 69341 |
| 16-#18 | 3.81 | MA | 30649 | 8210 | 52646 | 5902 | 58250 | 4740 | 61392 | 3781 | 65684 | 2271 | 81725 | 1218 | 70222 |
| 6L-4S | | MI | 31417 | 8210 | 54195 | 5892 | 60750 | 4705 | 64878 | 3755 | 71086 | 2247 | 88072 | 1438 | 71562 |
| 16-#18 | 3.81 | MA | 29473 | 8210 | 50380 | 5933 | 55489 | 4767 | 58009 | 3804 | 61189 | 2289 | 75784 | 993 | 67295 |
| 7L-3S | | MI | 32752 | 8210 | 56609 | 5862 | 63820 | 4714 | 68603 | 3769 | 75846 | 2229 | 93437 | 1665 | 73675 |
| 18-#11 | 1.67 | MA | 30375 | 6936 | 48548 | 5138 | 53502 | 4166 | 55754 | 3436 | 58204 | 2363 | 70197 | 2209 | 35568 |
| 2L-9S | | MI | 25166 | 6936 | 39969 | 5156 | 42830 | 4191 | 43152 | 3453 | 41940 | 2377 | 49765 | 1716 | 31462 |
| 18-#11 | 1.67 | MA | 29541 | 6936 | 47282 | 5137 | 51889 | 4164 | 53793 | 3446 | 55547 | 2371 | 66620 | 2120 | 35563 |
| 3L-8S | | MI | 25629 | 6936 | 40795 | 5143 | 43853 | 4180 | 44440 | 3457 | 43630 | 2370 | 51881 | 1772 | 32161 |
| 18-#11 | 1.67 | MA | 28954 | 6936 | 46267 | 5150 | 50597 | 4176 | 52226 | 3443 | 53513 | 2379 | 64277 | 2031 | 35522 |
| 4L-7S | | MI | 26086 | 6936 | 41576 | 5145 | 44900 | 4182 | 45685 | 3447 | 45418 | 2377 | 54032 | 1823 | 32627 |
| 18-#11 | 1.67 | MA | 28428 | 6936 | 45377 | 5150 | 49450 | 4174 | 50821 | 3453 | 51507 | 2373 | 61832 | 1987 | 35428 |
| 5L-6S | | MI | 26550 | 6936 | 42427 | 5132 | 45937 | 4171 | 46956 | 3437 | 47126 | 2370 | 56307 | 1911 | 33065 |
| 18-#11 | 1.67 | MA | 27927 | 6936 | 44538 | 5149 | 48309 | 4186 | 49429 | 3450 | 49665 | 2380 | 59505 | 1929 | 34852 |
| 6L-5S | | MI | 27025 | 6936 | 43222 | 5133 | 47018 | 4174 | 48274 | 3441 | 48870 | 2362 | 58491 | 1969 | 33605 |
| 18-#11 | 1.67 | MA | 27438 | 6936 | 43639 | 5162 | 47214 | 4183 | 48087 | 3460 | 47863 | 2388 | 57084 | 1841 | 34372 |
| 7L-4S | | MI | 27523 | 6936 | 44065 | 5134 | 48104 | 4162 | 49605 | 3431 | 50769 | 2369 | 60793 | 2012 | 33684 |
| 18-#11 | 1.67 | MA | 26956 | 6936 | 42815 | 5161 | 46109 | 4195 | 46773 | 3470 | 45974 | 2382 | 54798 | 1790 | 33871 |
| 8L-3S | | MI | 28079 | 6936 | 45026 | 5122 | 49327 | 4165 | 51088 | 3435 | 52695 | 2362 | 62992 | 2101 | 33717 |

## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

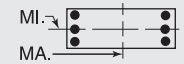



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.67 | MA | 26463 | 6936 | 41943 | 5174 | 45029 | 4193 | 45413 | 3467 | 44190 | 2390 | 52544 | 1734 | 33112 |
| 9L-2S | | MI | 28867 | 6936 | 46222 | 5123 | 50851 | 4154 | 52942 | 3425 | 55206 | 2355 | 66352 | 2190 | 33714 |
| 18-#14 | 2.41 | MA | 32591 | 7377 | 53530 | 5397 | 59760 | 4353 | 63327 | 3548 | 68448 | 2327 | 83681 | 2124 | 50597 |
| 2L-9S | | MI | 25751 | 7377 | 41967 | 5426 | 45264 | 4389 | 46061 | 3572 | 45845 | 2343 | 55407 | 1417 | 42331 |
| 18-#14 | 2.41 | MA | 31417 | 7377 | 51719 | 5396 | 57452 | 4369 | 60520 | 3563 | 64647 | 2337 | 78596 | 1996 | 50521 |
| 3L-8S | | MI | 26390 | 7377 | 43152 | 5408 | 46731 | 4373 | 47907 | 3578 | 48257 | 2333 | 58412 | 1498 | 43729 |
| 18-#14 | 2.41 | MA | 30591 | 7377 | 50264 | 5414 | 55602 | 4365 | 58275 | 3557 | 61731 | 2347 | 75268 | 1868 | 50349 |
| 4L-7S | | MI | 27034 | 7377 | 44271 | 5410 | 48232 | 4378 | 49692 | 3565 | 50811 | 2343 | 61475 | 1570 | 44910 |
| 18-#14 | 2.41 | MA | 29850 | 7377 | 48988 | 5412 | 53956 | 4381 | 56260 | 3571 | 58856 | 2338 | 71783 | 1805 | 49384 |
| 5L-6S | | MI | 27687 | 7377 | 45492 | 5392 | 49720 | 4362 | 51515 | 3551 | 53248 | 2333 | 64705 | 1697 | 45912 |
| 18-#14 | 2.41 | MA | 29145 | 7377 | 47784 | 5411 | 52320 | 4378 | 54265 | 3566 | 56215 | 2348 | 68477 | 1721 | 48434 |
| 6L-5S | | MI | 28356 | 7377 | 46632 | 5394 | 51269 | 4366 | 53404 | 3558 | 55738 | 2323 | 67806 | 1781 | 46779 |
| 18-#14 | 2.41 | MA | 28456 | 7377 | 46496 | 5429 | 50750 | 4394 | 52340 | 3580 | 53630 | 2358 | 65035 | 1595 | 47373 |
| 7L-4S | | MI | 29057 | 7377 | 47840 | 5396 | 52826 | 4351 | 55311 | 3544 | 58449 | 2333 | 71084 | 1843 | 47702 |
| 18-#14 | 2.41 | MA | 27777 | 7377 | 45313 | 5427 | 49165 | 4390 | 50455 | 3594 | 50922 | 2349 | 61779 | 1522 | 46092 |
| 8L-3S | | MI | 29840 | 7377 | 49217 | 5379 | 54577 | 4355 | 57436 | 3550 | 61197 | 2323 | 74204 | 1971 | 47854 |
| 18-#14 | 2.41 | MA | 27102 | 7377 | 44062 | 5445 | 47616 | 4407 | 48505 | 3588 | 48363 | 2359 | 58576 | 1441 | 44603 |
| 9L-2S | | MI | 30948 | 7377 | 50928 | 5381 | 56758 | 4339 | 60087 | 3537 | 64779 | 2313 | 78978 | 2099 | 47919 |
| 18-#18 | 4.29 | MA | 33274 | 8494 | 57932 | 6084 | 65165 | 4877 | 69808 | 3873 | 76882 | 2233 | 96214 | 1320 | 82601 |
| 5L-6S | | MI | 30424 | 8494 | 53062 | 6058 | 59110 | 4849 | 62850 | 3842 | 68280 | 2225 | 85285 | 1129 | 75077 |
| 18-#18 | 4.29 | MA | 32082 | 8494 | 55815 | 6080 | 62291 | 4868 | 66303 | 3861 | 72290 | 2251 | 90509 | 1170 | 79389 |
| 6L-5S | | MI | 31555 | 8494 | 55066 | 6063 | 61830 | 4859 | 66167 | 3856 | 72594 | 2207 | 90627 | 1280 | 78131 |
| 18-#18 | 4.29 | MA | 30918 | 8494 | 53549 | 6110 | 59530 | 4895 | 62920 | 3883 | 67795 | 2269 | 84568 | 944 | 76360 |
| 7L-4S | | MI | 32741 | 8494 | 57187 | 6069 | 64564 | 4833 | 69514 | 3835 | 77291 | 2225 | 96303 | 1386 | 80241 |
| 20-#11 | 1.86 | MA | 30960 | 7047 | 49813 | 5207 | 55115 | 4217 | 57715 | 3467 | 60861 | 2356 | 73773 | 2194 | 39424 |
| 2L-10S | | MI | 25241 | 7047 | 40387 | 5224 | 43321 | 4239 | 43769 | 3494 | 42774 | 2377 | 51073 | 1636 | 34276 |
| 20-#11 | 1.86 | MA | 30129 | 7047 | 48548 | 5207 | 53502 | 4214 | 55754 | 3477 | 58204 | 2364 | 70197 | 2105 | 39404 |
| 3L-9S | | MI | 25736 | 7047 | 41165 | 5225 | 44355 | 4241 | 45006 | 3484 | 44451 | 2370 | 53125 | 1700 | 34975 |
| 20-#11 | 1.86 | MA | 29545 | 7047 | 47532 | 5220 | 52210 | 4226 | 54187 | 3474 | 56169 | 2372 | 67854 | 2016 | 39349 |
| 4L-8S | | MI | 26195 | 7047 | 41991 | 5213 | 45378 | 4230 | 46294 | 3488 | 46141 | 2363 | 55241 | 1756 | 35653 |
| 20-#11 | 1.86 | MA | 29022 | 7047 | 46643 | 5219 | 51063 | 4224 | 52782 | 3484 | 54164 | 2366 | 65408 | 1972 | 39240 |
| 5L-7S | | MI | 26650 | 7047 | 42772 | 5214 | 46425 | 4233 | 47539 | 3478 | 47929 | 2370 | 57392 | 1807 | 36177 |
| 20-#11 | 1.86 | MA | 28523 | 7047 | 45803 | 5218 | 49922 | 4236 | 51390 | 3481 | 52322 | 2373 | 63081 | 1914 | 38592 |
| 6E | | MI | 27111 | 7047 | 43623 | 5201 | 47462 | 4221 | 48810 | 3468 | 49637 | 2363 | 59667 | 1894 | 36599 |
| 20-#11 | 1.86 | MA | 28037 | 7047 | 44904 | 5231 | 48827 | 4234 | 50048 | 3491 | 50519 | 2381 | 60660 | 1826 | 38129 |
| 7L-5S | | MI | 27584 | 7047 | 44418 | 5202 | 48542 | 4224 | 50128 | 3472 | 51382 | 2355 | 61851 | 1953 | 37210 |
| 20-#11 | 1.86 | MA | 27557 | 7047 | 44080 | 5230 | 47722 | 4245 | 48734 | 3502 | 48631 | 2375 | 58375 | 1775 | 37570 |
| 8L-4S | | MI | 28080 | 7047 | 45261 | 5203 | 49629 | 4213 | 51459 | 3462 | 53280 | 2362 | 64153 | 1996 | 37304 |
| 20-#11 | 1.86 | MA | 27068 | 7047 | 43208 | 5243 | 46642 | 4243 | 47374 | 3498 | 46847 | 2383 | 56120 | 1719 | 36833 |
| 9L-3S | | MI | 28633 | 7047 | 46222 | 5191 | 50851 | 4215 | 52942 | 3466 | 55206 | 2355 | 66352 | 2085 | 37349 |
| 20-#11 | 1.86 | MA | 26540 | 7047 | 42388 | 5242 | 45551 | 4255 | 46068 | 3509 | 45076 | 2391 | 53935 | 1655 | 36085 |
| 10L-2S | | MI | 29417 | 7047 | 47418 | 5192 | 52376 | 4204 | 54796 | 3456 | 57717 | 2348 | 69712 | 2173 | 37362 |
| 20-#14 | 2.68 | MA | 32241 | 7536 | 53530 | 5495 | 59760 | 4441 | 63327 | 3607 | 68448 | 2327 | 83681 | 1972 | 55993 |
| 3L-9S | | MI | 26553 | 7536 | 43677 | 5525 | 47446 | 4461 | 48712 | 3617 | 49427 | 2332 | 60181 | 1391 | 47288 |
| 20-#14 | 2.68 | MA | 31419 | 7536 | 52075 | 5514 | 57910 | 4438 | 61081 | 3602 | 65533 | 2337 | 80353 | 1844 | 55797 |
| 4L-8S | | MI | 27187 | 7536 | 44862 | 5508 | 48913 | 4446 | 50559 | 3623 | 51840 | 2322 | 63186 | 1473 | 48740 |
| 20-#14 | 2.68 | MA | 30684 | 7536 | 50799 | 5512 | 56265 | 4454 | 59066 | 3616 | 62658 | 2328 | 76869 | 1782 | 54704 |
| 5L-7S | | MI | 27827 | 7536 | 45982 | 5510 | 50414 | 4450 | 52344 | 3610 | 54393 | 2332 | 66248 | 1545 | 49883 |
| 20-#14 | 2.68 | MA | 29983 | 7536 | 49595 | 5510 | 54629 | 4450 | 57071 | 3610 | 60017 | 2338 | 73562 | 1697 | 53791 |
| 6E | | MI | 28476 | 7536 | 47203 | 5492 | 51901 | 4434 | 54166 | 3596 | 56830 | 2322 | 69478 | 1671 | 50970 |
| 20-#14 | 2.68 | MA | 29299 | 7536 | 48306 | 5528 | 53058 | 4466 | 55146 | 3625 | 57432 | 2348 | 70120 | 1571 | 52645 |
| 7L-5S | | MI | 29140 | 7536 | 48343 | 5494 | 53450 | 4439 | 56055 | 3603 | 59321 | 2312 | 72580 | 1756 | 51802 |
| 20-#14 | 2.68 | MA | 28625 | 7536 | 47124 | 5527 | 51473 | 4463 | 53261 | 3639 | 54724 | 2339 | 66864 | 1498 | 51403 |
| 8L-4S | | MI | 29837 | 7536 | 49551 | 5496 | 55008 | 4423 | 57963 | 3589 | 62031 | 2322 | 75858 | 1817 | 52850 |
| 20-#14 | 2.68 | MA | 27951 | 7536 | 45873 | 5545 | 49924 | 4479 | 51311 | 3633 | 52165 | 2349 | 63661 | 1417 | 49861 |
| 9L-3S | | MI | 30615 | 7536 | 50928 | 5478 | 56758 | 4427 | 60087 | 3595 | 64779 | 2312 | 78978 | 1945 | 53026 |
| 20-#18 | 4.76 | MA | 33502 | 8778 | 58984 | 6257 | 66331 | 4997 | 71215 | 3940 | 78895 | 2231 | 99293 | 1121 | 88577 |
| 6E | | MI | 31760 | 8778 | 56054 | 6235 | 62924 | 4977 | 67487 | 3922 | 74485 | 2203 | 93516 | 1077 | 83734 |
| 20-#18 | 4.76 | MA | 32350 | 8778 | 56718 | 6288 | 63570 | 5024 | 67832 | 3963 | 74401 | 2248 | 93351 | 896 | 85447 |
| 7L-5S | | MI | 32880 | 8778 | 58057 | 6241 | 65644 | 4987 | 70803 | 3936 | 78799 | 2185 | 98857 | 1228 | 86936 |


## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.04 | MA | 30714 | 7158 | 49813 | 5276 | 55115 | 4265 | 57715 | 3508 | 60861 | 2357 | 73773 | 2090 | 43241 |
| 3L-10S | | MI | 25808 | 7158 | 41583 | 5293 | 44846 | 4289 | 45622 | 3525 | 45285 | 2371 | 54433 | 1620 | 37756 |
| 22-#11 | 2.04 | MA | 30133 | 7158 | 48797 | 5289 | 53823 | 4276 | 56148 | 3505 | 58826 | 2365 | 71430 | 2001 | 43173 |
| 4L-9S | | MI | 26309 | 7158 | 42361 | 5294 | 45879 | 4292 | 46860 | 3515 | 46962 | 2363 | 56485 | 1683 | 38492 |
| 22-#11 | 2.04 | MA | 29613 | 7158 | 47908 | 5288 | 52676 | 4274 | 54742 | 3515 | 56821 | 2359 | 68984 | 1957 | 43050 |
| 5L-8S | | MI | 26758 | 7158 | 43187 | 5282 | 46903 | 4280 | 48148 | 3519 | 48652 | 2356 | 58601 | 1740 | 39151 |
| 22-#11 | 2.04 | MA | 29117 | 7158 | 47068 | 5287 | 51535 | 4286 | 53351 | 3512 | 54978 | 2367 | 66657 | 1899 | 42337 |
| 6L-7S | | MI | 27210 | 7158 | 43968 | 5283 | 47949 | 4283 | 49392 | 3509 | 50441 | 2363 | 60752 | 1790 | 39730 |
| 22-#11 | 2.04 | MA | 28633 | 7158 | 46170 | 5300 | 50440 | 4284 | 52009 | 3522 | 53176 | 2374 | 64236 | 1811 | 41889 |
| 7L-6S | | MI | 27670 | 7158 | 44819 | 5270 | 48987 | 4271 | 50664 | 3499 | 52148 | 2356 | 63027 | 1878 | 40138 |
| 22-#11 | 2.04 | MA | 28156 | 7158 | 45345 | 5299 | 49335 | 4295 | 50695 | 3533 | 51287 | 2368 | 61951 | 1760 | 41274 |
| 8L-5S | | MI | 28140 | 7158 | 45614 | 5271 | 50067 | 4274 | 51982 | 3503 | 53893 | 2349 | 65211 | 1936 | 40813 |
| 22-#11 | 2.04 | MA | 27669 | 7158 | 44473 | 5312 | 48255 | 4293 | 49335 | 3529 | 49503 | 2376 | 59697 | 1704 | 40558 |
| 9L-4S | | MI | 28633 | 7158 | 46457 | 5272 | 51154 | 4263 | 53312 | 3493 | 55792 | 2355 | 67513 | 1980 | 40921 |
| 22-#11 | 2.04 | MA | 27143 | 7158 | 43653 | 5311 | 47164 | 4305 | 48029 | 3540 | 47733 | 2384 | 57511 | 1640 | 39772 |
| 10L-3S | | MI | 29184 | 7158 | 47418 | 5260 | 52376 | 4265 | 54796 | 3497 | 57717 | 2348 | 69712 | 2068 | 40978 |
| 22-#11 | 2.04 | MA | 26630 | 7158 | 42844 | 5311 | 46090 | 4303 | 46685 | 3536 | 45870 | 2378 | 55279 | 1586 | 38907 |
| 11L-2S | | MI | 29965 | 7158 | 48614 | 5261 | 53901 | 4254 | 56649 | 3487 | 60229 | 2341 | 73072 | 2157 | 41002 |
| 22-#14 | 2.95 | MA | 32243 | 7696 | 53886 | 5613 | 60219 | 4510 | 63888 | 3647 | 69335 | 2328 | 85438 | 1820 | 61243 |
| 4L-9S | | MI | 27350 | 7696 | 45388 | 5625 | 49627 | 4534 | 51364 | 3662 | 53009 | 2321 | 64955 | 1366 | 52254 |
| 22-#14 | 2.95 | MA | 31512 | 7696 | 52610 | 5612 | 58573 | 4526 | 61872 | 3661 | 66460 | 2318 | 81954 | 1758 | 60033 |
| 5L-8S | | MI | 27980 | 7696 | 46573 | 5607 | 51094 | 4518 | 53211 | 3668 | 55422 | 2311 | 67960 | 1447 | 53759 |
| 22-#14 | 2.95 | MA | 30816 | 7696 | 51406 | 5610 | 56937 | 4522 | 59877 | 3655 | 63819 | 2328 | 78647 | 1674 | 59154 |
| 6L-7S | | MI | 28615 | 7696 | 47693 | 5609 | 52595 | 4522 | 54995 | 3655 | 57975 | 2321 | 71022 | 1519 | 54867 |
| 22-#14 | 2.95 | MA | 30137 | 7696 | 50117 | 5628 | 55367 | 4539 | 57952 | 3670 | 61234 | 2338 | 75206 | 1547 | 57927 |
| 7L-6S | | MI | 29260 | 7696 | 48914 | 5592 | 54082 | 4507 | 56818 | 3641 | 60412 | 2311 | 74252 | 1646 | 56034 |
| 22-#14 | 2.95 | MA | 29467 | 7696 | 48935 | 5627 | 53781 | 4535 | 56068 | 3684 | 58526 | 2329 | 71950 | 1475 | 56722 |
| 8L-5S | | MI | 29920 | 7696 | 50054 | 5594 | 55631 | 4511 | 58707 | 3647 | 62903 | 2302 | 77354 | 1730 | 56835 |
| 22-#14 | 2.95 | MA | 28795 | 7696 | 47683 | 5645 | 52232 | 4551 | 54118 | 3678 | 55967 | 2339 | 68746 | 1393 | 55127 |
| 9L-4S | | MI | 30613 | 7696 | 51262 | 5596 | 57189 | 4495 | 60614 | 3634 | 65613 | 2311 | 80631 | 1792 | 57996 |
| 22-#18 | 5.24 | MA | 33769 | 9061 | 59887 | 6465 | 67610 | 5152 | 72743 | 4043 | 81006 | 2228 | 102135 | 847 | 94553 |
| 7L-6S | | MI | 33085 | 9061 | 59045 | 6412 | 66738 | 5106 | 72124 | 4002 | 80690 | 2180 | 101747 | 1025 | 92410 |
| 24-#11 | 2.23 | MA | 30718 | 7268 | 50063 | 5358 | 55436 | 4326 | 58109 | 3536 | 61482 | 2358 | 75006 | 1986 | 46995 |
| 4L-10S | | MI | 26373 | 7268 | 42780 | 5362 | 46371 | 4339 | 47476 | 3556 | 47796 | 2364 | 57793 | 1604 | 41241 |
| 24-#11 | 2.23 | MA | 30200 | 7268 | 49173 | 5357 | 54289 | 4324 | 56703 | 3546 | 59477 | 2352 | 72560 | 1942 | 46820 |
| 5L-9S | | MI | 26872 | 7268 | 43557 | 5364 | 47404 | 4342 | 48713 | 3546 | 49474 | 2357 | 59845 | 1667 | 42014 |
| 24-#11 | 2.23 | MA | 29707 | 7268 | 48333 | 5356 | 53148 | 4336 | 55312 | 3543 | 57635 | 2360 | 70234 | 1884 | 46087 |
| 6L-8S | | MI | 27318 | 7268 | 44383 | 5351 | 48427 | 4330 | 50001 | 3550 | 51164 | 2349 | 61961 | 1723 | 42655 |
| 24-#11 | 2.23 | MA | 29225 | 7268 | 47435 | 5369 | 52053 | 4334 | 53970 | 3553 | 55832 | 2367 | 67813 | 1796 | 45651 |
| 7E | | MI | 27768 | 7268 | 45164 | 5352 | 49474 | 4333 | 51246 | 3540 | 52952 | 2356 | 64112 | 1774 | 43285 |
| 24-#11 | 2.23 | MA | 28751 | 7268 | 46611 | 5368 | 50948 | 4346 | 52655 | 3564 | 53944 | 2361 | 65527 | 1745 | 44985 |
| 8L-6S | | MI | 28225 | 7268 | 46015 | 5339 | 50512 | 4322 | 52517 | 3530 | 54660 | 2349 | 66387 | 1862 | 43681 |
| 24-#11 | 2.23 | MA | 28271 | 7268 | 45738 | 5381 | 49868 | 4343 | 51296 | 3560 | 52160 | 2369 | 63273 | 1689 | 44288 |
| 9L-5S | | MI | 28693 | 7268 | 46811 | 5341 | 51592 | 4324 | 53835 | 3534 | 56404 | 2342 | 68571 | 1920 | 44351 |
| 24-#11 | 2.23 | MA | 27743 | 7268 | 44918 | 5381 | 48777 | 4355 | 49990 | 3571 | 50389 | 2377 | 61087 | 1625 | 43465 |
| 10L-4S | | MI | 29184 | 7268 | 47653 | 5342 | 52679 | 4313 | 55166 | 3524 | 58303 | 2348 | 70873 | 1963 | 44534 |
| 24-#11 | 2.23 | MA | 27232 | 7268 | 44109 | 5380 | 47703 | 4353 | 48646 | 3567 | 48527 | 2371 | 58856 | 1571 | 42618 |
| 11L-3S | | MI | 29732 | 7268 | 48614 | 5329 | 53901 | 4315 | 56649 | 3528 | 60229 | 2341 | 73072 | 2052 | 44603 |
| 24-#14 | 3.21 | MA | 32335 | 7856 | 54421 | 5711 | 60882 | 4598 | 64679 | 3706 | 70262 | 2308 | 87039 | 1735 | 65371 |
| 5L-9S | | MI | 28141 | 7856 | 47099 | 5725 | 51808 | 4606 | 54016 | 3707 | 56591 | 2311 | 69728 | 1340 | 57227 |
| 24-#14 | 3.21 | MA | 31644 | 7856 | 53216 | 5710 | 59246 | 4595 | 62684 | 3700 | 67621 | 2318 | 83733 | 1650 | 64522 |
| 6L-8S | | MI | 28767 | 7856 | 48284 | 5707 | 53275 | 4590 | 55862 | 3713 | 59004 | 2301 | 72733 | 1422 | 58784 |
| 24-#14 | 3.21 | MA | 30969 | 7856 | 51928 | 5728 | 57675 | 4611 | 60759 | 3715 | 65035 | 2329 | 80291 | 1524 | 63218 |
| 7E | | MI | 29398 | 7856 | 49404 | 5709 | 54776 | 4595 | 57647 | 3700 | 61557 | 2311 | 75795 | 1494 | 59859 |
| 24-#14 | 3.21 | MA | 30304 | 7856 | 50745 | 5726 | 56090 | 4607 | 58874 | 3729 | 62328 | 2319 | 77035 | 1451 | 62047 |
| 8L-6S | | MI | 30038 | 7856 | 50625 | 5691 | 56264 | 4579 | 59470 | 3686 | 63994 | 2301 | 79025 | 1620 | 61103 |
| 24-#14 | 3.21 | MA | 29632 | 7856 | 49494 | 5745 | 54541 | 4624 | 56924 | 3723 | 59769 | 2329 | 73832 | 1370 | 60401 |
| 9L-5S | | MI | 30695 | 7856 | 51765 | 5694 | 57812 | 4583 | 61359 | 3692 | 66485 | 2291 | 82127 | 1705 | 61875 |

## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

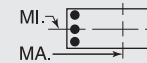
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.36 | MA | 32144 | 7074 | 50981 | 5229 | 55583 | 4250 | 57301 | 3522 | 58519 | 2466 | 69518 | 2303 | 31728 |
| 2L-3S | | MI | 27127 | 7074 | 43349 | 5187 | 46516 | 4246 | 47141 | 3518 | 46364 | 2454 | 53989 | 2036 | 28646 |
| 6-#18 | 1.36 | MA | 29926 | 7074 | 47635 | 5225 | 51316 | 4278 | 52115 | 3546 | 51513 | 2484 | 60180 | 2076 | 31750 |
| 3L-2S | | MI | 29106 | 7074 | 46341 | 5193 | 50331 | 4220 | 51777 | 3497 | 52569 | 2436 | 62220 | 2264 | 28585 |
| 8-#14 | 1.02 | MA | 31063 | 6862 | 48433 | 5128 | 52528 | 4180 | 53662 | 3484 | 53679 | 2500 | 63296 | 2368 | 24198 |
| 2L-4S | | MI | 26204 | 6862 | 40977 | 5111 | 43688 | 4165 | 43777 | 3469 | 42088 | 2500 | 48931 | 2081 | 21930 |
| 8-#14 | 1.02 | MA | 29784 | 6862 | 46523 | 5127 | 50093 | 4177 | 50701 | 3499 | 49667 | 2511 | 57899 | 2240 | 24251 |
| 3E | | MI | 27015 | 6862 | 42354 | 5093 | 45438 | 4169 | 45902 | 3475 | 44836 | 2490 | 52051 | 2209 | 21903 |
| 8-#14 | 1.02 | MA | 28881 | 6862 | 44989 | 5146 | 48143 | 4194 | 48335 | 3494 | 46595 | 2522 | 54363 | 2112 | 24246 |
| 4L-2S | | MI | 28157 | 6862 | 44065 | 5096 | 47620 | 4153 | 48554 | 3462 | 48418 | 2480 | 56825 | 2337 | 21842 |
| 8-#18 | 1.82 | MA | 33685 | 7358 | 54327 | 5406 | 59849 | 4378 | 62487 | 3601 | 65526 | 2448 | 78855 | 2258 | 41954 |
| 2L-4S | | MI | 27118 | 7358 | 43927 | 5394 | 47261 | 4365 | 48052 | 3584 | 47809 | 2450 | 56855 | 1757 | 37362 |
| 8-#18 | 1.82 | MA | 31490 | 7358 | 50981 | 5402 | 55583 | 4406 | 57301 | 3626 | 58519 | 2465 | 69518 | 2030 | 41878 |
| 3E | | MI | 28512 | 7358 | 46341 | 5365 | 50331 | 4374 | 51777 | 3598 | 52569 | 2432 | 62220 | 1984 | 37715 |
| 8-#18 | 1.82 | MA | 29936 | 7358 | 48288 | 5434 | 52159 | 4399 | 53146 | 3614 | 53144 | 2483 | 63415 | 1803 | 41410 |
| 4L-2S | | MI | 30471 | 7358 | 49333 | 5370 | 54145 | 4349 | 56414 | 3576 | 58774 | 2414 | 70451 | 2212 | 37743 |
| 10-#14 | 1.28 | MA | 31962 | 7021 | 50343 | 5228 | 54964 | 4252 | 56623 | 3529 | 57690 | 2490 | 68693 | 2346 | 30050 |
| 2L-5S | | MI | 26292 | 7021 | 41480 | 5209 | 44311 | 4253 | 44522 | 3527 | 42959 | 2479 | 50427 | 1994 | 26987 |
| 10-#14 | 1.28 | MA | 30691 | 7021 | 48433 | 5227 | 52528 | 4249 | 53662 | 3544 | 53679 | 2501 | 63296 | 2218 | 30081 |
| 3L-4S | | MI | 27015 | 7021 | 42688 | 5211 | 45869 | 4237 | 46429 | 3514 | 45670 | 2489 | 53705 | 2055 | 27120 |
| 10-#14 | 1.28 | MA | 29795 | 7021 | 46900 | 5246 | 50578 | 4266 | 51296 | 3539 | 50606 | 2512 | 59760 | 2090 | 30030 |
| 4L-3S | | MI | 27820 | 7021 | 44065 | 5193 | 47620 | 4241 | 48554 | 3520 | 48418 | 2479 | 56825 | 2183 | 27136 |
| 10-#14 | 1.28 | MA | 28991 | 7021 | 45556 | 5244 | 48845 | 4263 | 49173 | 3554 | 47577 | 2504 | 56069 | 2027 | 29836 |
| 5L-2S | | MI | 28956 | 7021 | 45776 | 5195 | 49801 | 4226 | 51205 | 3506 | 52000 | 2470 | 61598 | 2311 | 27094 |
| 10-#18 | 2.27 | MA | 35207 | 7642 | 57674 | 5584 | 64115 | 4507 | 67674 | 3681 | 72533 | 2429 | 88193 | 2213 | 52141 |
| 2L-5S | | MI | 27262 | 7642 | 44797 | 5566 | 48341 | 4519 | 49341 | 3685 | 49317 | 2410 | 59409 | 1599 | 43400 |
| 10-#18 | 2.27 | MA | 33034 | 7642 | 54327 | 5580 | 59849 | 4535 | 62487 | 3705 | 65526 | 2447 | 78855 | 1985 | 51979 |
| 3L-4S | | MI | 28501 | 7642 | 46918 | 5572 | 51075 | 4493 | 52689 | 3664 | 54014 | 2427 | 65085 | 1704 | 46103 |
| 10-#18 | 2.27 | MA | 31497 | 7642 | 51635 | 5611 | 56425 | 4527 | 58332 | 3694 | 60151 | 2464 | 72752 | 1758 | 51286 |
| 4L-3S | | MI | 29880 | 7642 | 49333 | 5542 | 54145 | 4503 | 56414 | 3678 | 58774 | 2410 | 70451 | 1932 | 46754 |
| 10-#18 | 2.27 | MA | 30120 | 7642 | 49272 | 5608 | 53378 | 4555 | 54602 | 3718 | 54849 | 2447 | 66341 | 1649 | 48122 |
| 5L-2S | | MI | 31821 | 7642 | 52324 | 5548 | 57959 | 4477 | 61051 | 3656 | 64979 | 2392 | 78681 | 2159 | 46868 |
| 12-#11 | 1.06 | MA | 31254 | 6887 | 48719 | 5161 | 52992 | 4205 | 54264 | 3503 | 54510 | 2507 | 64565 | 2380 | 25232 |
| 2L-6S | | MI | 25977 | 6887 | 40527 | 5139 | 43131 | 4197 | 43122 | 3493 | 41144 | 2505 | 47946 | 2071 | 22653 |
| 12-#11 | 1.06 | MA | 30360 | 6887 | 47385 | 5160 | 51291 | 4203 | 52196 | 3514 | 51708 | 2516 | 60772 | 2291 | 25263 |
| 3L-5S | | MI | 26461 | 6887 | 41323 | 5140 | 44211 | 4200 | 44440 | 3497 | 42889 | 2498 | 50131 | 2129 | 22823 |
| 12-#11 | 1.06 | MA | 29732 | 6887 | 46315 | 5173 | 49931 | 4215 | 50545 | 3511 | 49565 | 2524 | 58284 | 2202 | 25275 |
| 4E | | MI | 26967 | 6887 | 42166 | 5141 | 45298 | 4188 | 45771 | 3487 | 44788 | 2505 | 52433 | 2173 | 22836 |
| 12-#11 | 1.06 | MA | 29169 | 6887 | 45379 | 5173 | 48722 | 4214 | 49065 | 3522 | 47453 | 2518 | 55695 | 2158 | 25235 |
| 5L-3S | | MI | 27533 | 6887 | 43127 | 5128 | 46520 | 4191 | 47254 | 3491 | 46713 | 2498 | 54632 | 2261 | 22811 |
| 12-#11 | 1.06 | MA | 28632 | 6887 | 44495 | 5172 | 47521 | 4226 | 47600 | 3519 | 45513 | 2527 | 53226 | 2100 | 25007 |
| 6L-2S | | MI | 28332 | 6887 | 44323 | 5129 | 48045 | 4179 | 49108 | 3481 | 49225 | 2491 | 57992 | 2350 | 22774 |
| 12-#14 | 1.53 | MA | 32854 | 7181 | 52254 | 5328 | 57399 | 4325 | 59584 | 3574 | 61701 | 2480 | 74090 | 2324 | 35888 |
| 2L-6S | | MI | 26416 | 7181 | 42051 | 5306 | 44944 | 4321 | 45285 | 3566 | 44051 | 2479 | 52099 | 1884 | 30975 |
| 12-#14 | 1.53 | MA | 31591 | 7181 | 50343 | 5327 | 54964 | 4322 | 56623 | 3589 | 57690 | 2491 | 68693 | 2196 | 35888 |
| 3L-5S | | MI | 27101 | 7181 | 43191 | 5309 | 46493 | 4325 | 47173 | 3572 | 46542 | 2469 | 55201 | 1969 | 32001 |
| 12-#14 | 1.53 | MA | 30700 | 7181 | 48810 | 5345 | 53014 | 4338 | 54256 | 3584 | 54617 | 2502 | 65157 | 2068 | 35802 |
| 4E | | MI | 27819 | 7181 | 44399 | 5311 | 48050 | 4309 | 49081 | 3559 | 49252 | 2479 | 58478 | 2030 | 32298 |
| 12-#14 | 1.53 | MA | 29903 | 7181 | 47466 | 5344 | 51281 | 4335 | 52134 | 3599 | 51589 | 2494 | 61466 | 2005 | 35451 |
| 5L-3S | | MI | 28619 | 7181 | 45776 | 5293 | 49801 | 4313 | 51205 | 3565 | 52000 | 2469 | 61598 | 2158 | 32351 |
| 12-#14 | 1.53 | MA | 29143 | 7181 | 46198 | 5343 | 49558 | 4352 | 50033 | 3594 | 48807 | 2505 | 57955 | 1920 | 34247 |
| 6L-2S | | MI | 29748 | 7181 | 47487 | 5295 | 51982 | 4298 | 53857 | 3551 | 55582 | 2459 | 66372 | 2286 | 32331 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

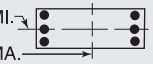



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 2.73 | MA | 36713 | 7926 | 61020 | 5761 | 68381 | 4636 | 72860 | 3761 | 79539 | 2410 | 97530 | 2168 | 62298 |
| 2L-6S | | MI | 27471 | 7926 | 45786 | 5738 | 49435 | 4637 | 50662 | 3751 | 51209 | 2405 | 62298 | 1395 | 49767 |
| 12-#18 | 2.73 | MA | 34560 | 7926 | 57674 | 5757 | 64115 | 4663 | 67674 | 3785 | 72533 | 2428 | 88193 | 1940 | 62065 |
| 3L-5S | | MI | 28641 | 7926 | 47789 | 5743 | 52155 | 4647 | 53978 | 3765 | 55522 | 2388 | 67640 | 1547 | 52123 |
| 12-#18 | 2.73 | MA | 33039 | 7926 | 54981 | 5789 | 60691 | 4656 | 63518 | 3774 | 67157 | 2445 | 82090 | 1713 | 60901 |
| 4E | | MI | 29867 | 7926 | 49910 | 5749 | 54889 | 4622 | 57326 | 3743 | 60219 | 2405 | 73316 | 1652 | 54667 |
| 12-#18 | 2.73 | MA | 31677 | 7926 | 52618 | 5785 | 57645 | 4684 | 59788 | 3798 | 61856 | 2428 | 75678 | 1603 | 57906 |
| 5L-3S | | MI | 31233 | 7926 | 52324 | 5719 | 57959 | 4632 | 61051 | 3757 | 64979 | 2387 | 78681 | 1880 | 55775 |
| 12-#18 | 2.73 | MA | 30378 | 7926 | 50388 | 5781 | 54616 | 4676 | 56094 | 3787 | 56985 | 2445 | 69611 | 1453 | 55250 |
| 6L-2S | | MI | 33157 | 7926 | 55316 | 5725 | 61773 | 4606 | 65687 | 3736 | 71184 | 2370 | 86912 | 2107 | 55956 |
| 14-#11 | 1.24 | MA | 31884 | 6998 | 50054 | 5230 | 54693 | 4255 | 56332 | 3534 | 57312 | 2500 | 68357 | 2366 | 29315 |
| 2L-7S | | MI | 26080 | 6998 | 40872 | 5221 | 43618 | 4258 | 43704 | 3534 | 41948 | 2506 | 49032 | 1967 | 25680 |
| 14-#11 | 1.24 | MA | 30995 | 6998 | 48719 | 5229 | 52992 | 4253 | 54264 | 3545 | 54510 | 2509 | 64565 | 2277 | 29336 |
| 3L-6S | | MI | 26549 | 6998 | 41723 | 5208 | 44655 | 4247 | 44976 | 3524 | 43656 | 2498 | 51306 | 2054 | 26164 |
| 14-#11 | 1.24 | MA | 30369 | 6998 | 47650 | 5242 | 51632 | 4265 | 52613 | 3542 | 52367 | 2517 | 62077 | 2188 | 29328 |
| 4L-5S | | MI | 27030 | 6998 | 42519 | 5209 | 45736 | 4250 | 46293 | 3528 | 45400 | 2491 | 53491 | 2113 | 26445 |
| 14-#11 | 1.24 | MA | 29809 | 6998 | 46713 | 5242 | 50423 | 4264 | 51133 | 3553 | 50255 | 2511 | 59488 | 2144 | 29268 |
| 5L-4S | | MI | 27534 | 6998 | 43362 | 5210 | 46823 | 4238 | 47624 | 3518 | 47299 | 2498 | 55793 | 2156 | 26479 |
| 14-#11 | 1.24 | MA | 29275 | 6998 | 45829 | 5241 | 49222 | 4276 | 49668 | 3550 | 48315 | 2520 | 57019 | 2086 | 28929 |
| 6L-3S | | MI | 28097 | 6998 | 44323 | 5197 | 48045 | 4241 | 49108 | 3522 | 49225 | 2491 | 57992 | 2245 | 26469 |
| 14-#11 | 1.24 | MA | 28754 | 6998 | 44883 | 5255 | 48070 | 4274 | 48255 | 3561 | 46417 | 2528 | 54451 | 1998 | 28355 |
| 7L-2S | | MI | 28892 | 6998 | 45519 | 5199 | 49570 | 4230 | 50961 | 3512 | 51736 | 2484 | 61352 | 2334 | 26441 |
| 14-#14 | 1.79 | MA | 33739 | 7340 | 54164 | 5428 | 59835 | 4397 | 62545 | 3619 | 65713 | 2470 | 79488 | 2302 | 41716 |
| 2L-7S | | MI | 26560 | 7340 | 42541 | 5424 | 45638 | 4409 | 46114 | 3624 | 45196 | 2478 | 53642 | 1732 | 35329 |
| 14-#14 | 1.79 | MA | 32483 | 7340 | 52254 | 5426 | 57399 | 4394 | 59584 | 3634 | 61701 | 2481 | 74090 | 2174 | 41685 |
| 3L-6S | | MI | 27224 | 7340 | 43762 | 5406 | 47125 | 4393 | 47936 | 3611 | 47633 | 2468 | 56872 | 1858 | 36008 |
| 14-#14 | 1.79 | MA | 31599 | 7340 | 50720 | 5445 | 55450 | 4411 | 57217 | 3629 | 58629 | 2492 | 70555 | 2046 | 41567 |
| 4L-5S | | MI | 27904 | 7340 | 44902 | 5408 | 48674 | 4397 | 49825 | 3617 | 50124 | 2458 | 59974 | 1943 | 36981 |
| 14-#14 | 1.79 | MA | 30807 | 7340 | 49377 | 5444 | 53716 | 4408 | 55095 | 3644 | 55600 | 2484 | 66863 | 1983 | 41024 |
| 5L-4S | | MI | 28617 | 7340 | 46110 | 5410 | 50232 | 4382 | 51732 | 3603 | 52834 | 2468 | 63252 | 2004 | 37466 |
| 14-#14 | 1.79 | MA | 30053 | 7340 | 48109 | 5443 | 51994 | 4424 | 52993 | 3639 | 52818 | 2495 | 63352 | 1899 | 39876 |
| 6L-3S | | MI | 29411 | 7340 | 47487 | 5393 | 51982 | 4386 | 53857 | 3610 | 55582 | 2458 | 66372 | 2132 | 37549 |
| 14-#14 | 1.79 | MA | 29316 | 7340 | 46752 | 5461 | 50340 | 4421 | 50966 | 3654 | 50095 | 2506 | 59698 | 1772 | 39090 |
| 7L-2S | | MI | 30534 | 7340 | 49198 | 5395 | 54164 | 4370 | 56509 | 3596 | 59164 | 2448 | 71146 | 2260 | 37556 |
| 14-#18 | 3.18 | MA | 36069 | 8209 | 61020 | 5934 | 68381 | 4792 | 72860 | 3865 | 79539 | 2409 | 97530 | 1895 | 72139 |
| 3L-6S | | MI | 28848 | 8209 | 48777 | 5915 | 53250 | 4766 | 55298 | 3831 | 57414 | 2383 | 70529 | 1343 | 58343 |
| 14-#18 | 3.18 | MA | 34565 | 8209 | 58327 | 5966 | 64958 | 4784 | 68705 | 3854 | 74164 | 2427 | 91427 | 1667 | 70559 |
| 4L-5S | | MI | 30006 | 8209 | 50781 | 5921 | 55969 | 4776 | 58615 | 3845 | 61727 | 2365 | 75871 | 1494 | 60872 |
| 14-#18 | 3.18 | MA | 33217 | 8209 | 55965 | 5962 | 61911 | 4812 | 64974 | 3878 | 68862 | 2409 | 85016 | 1558 | 67716 |
| 5L-4S | | MI | 31219 | 8209 | 52902 | 5926 | 58703 | 4750 | 61962 | 3823 | 66424 | 2383 | 81547 | 1600 | 63274 |
| 14-#18 | 3.18 | MA | 31932 | 8209 | 53734 | 5958 | 58882 | 4805 | 61280 | 3867 | 63991 | 2427 | 78948 | 1408 | 64890 |
| 6L-3S | | MI | 32572 | 8209 | 55316 | 5897 | 61773 | 4760 | 65687 | 3837 | 71184 | 2365 | 86912 | 1828 | 64783 |
| 14-#18 | 3.18 | MA | 30677 | 8209 | 51347 | 5990 | 55973 | 4833 | 57715 | 3891 | 59224 | 2444 | 72630 | 1183 | 61946 |
| 7L-2S | | MI | 34479 | 8209 | 58308 | 5902 | 65587 | 4735 | 70324 | 3816 | 77389 | 2348 | 95143 | 2055 | 65025 |
| 16-#11 | 1.42 | MA | 32512 | 7109 | 51388 | 5299 | 56395 | 4305 | 58400 | 3565 | 60114 | 2493 | 72150 | 2352 | 33392 |
| 2L-8S | | MI | 26190 | 7109 | 41287 | 5289 | 44096 | 4306 | 44313 | 3575 | 42671 | 2492 | 50241 | 1900 | 28890 |
| 16-#11 | 1.42 | MA | 31626 | 7109 | 50054 | 5298 | 54693 | 4304 | 56332 | 3576 | 57312 | 2502 | 68357 | 2263 | 33404 |
| 3L-7S | | MI | 26651 | 7109 | 42068 | 5290 | 45143 | 4309 | 45558 | 3565 | 44459 | 2499 | 52392 | 1950 | 29222 |
| 16-#11 | 1.42 | MA | 31003 | 7109 | 48984 | 5312 | 53333 | 4316 | 54681 | 3573 | 55168 | 2510 | 65870 | 2174 | 33375 |
| 4L-6S | | MI | 27118 | 7109 | 42919 | 5277 | 46180 | 4297 | 46829 | 3556 | 46167 | 2492 | 54666 | 2038 | 29684 |
| 16-#11 | 1.42 | MA | 30446 | 7109 | 48047 | 5311 | 52125 | 4314 | 53201 | 3584 | 53056 | 2505 | 63280 | 2130 | 33297 |
| 5E | | MI | 27596 | 7109 | 43715 | 5278 | 47261 | 4300 | 48147 | 3559 | 47911 | 2484 | 56851 | 2097 | 30061 |
| 16-#11 | 1.42 | MA | 29915 | 7109 | 47164 | 5311 | 50924 | 4326 | 51736 | 3581 | 51117 | 2513 | 60812 | 2072 | 32860 |
| 6L-4S | | MI | 28098 | 7109 | 44558 | 5279 | 48348 | 4289 | 49478 | 3550 | 49810 | 2491 | 59153 | 2140 | 30112 |
| 16-#11 | 1.42 | MA | 29397 | 7109 | 46218 | 5324 | 49771 | 4324 | 50323 | 3592 | 49219 | 2521 | 58243 | 1984 | 32310 |
| 7L-3S | | MI | 28658 | 7109 | 45519 | 5267 | 49570 | 4291 | 50961 | 3553 | 51736 | 2484 | 61352 | 2229 | 30120 |
| 16-#11 | 1.42 | MA | 28886 | 7109 | 45350 | 5323 | 48607 | 4336 | 48940 | 3602 | 47230 | 2516 | 55823 | 1933 | 31908 |
| 8L-2S | | MI | 29450 | 7109 | 46715 | 5268 | 51095 | 4280 | 52815 | 3544 | 54247 | 2477 | 64712 | 2317 | 30100 |

## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

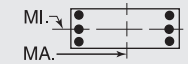
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.05 | MA | 34618 | 7500 | 56075 | 5527 | 62271 | 4469 | 65506 | 3664 | 69724 | 2460 | 84885 | 2280 | 47527 |
| 2L-8S | | MI | 26716 | 7500 | 43132 | 5522 | 46318 | 4477 | 46980 | 3683 | 46225 | 2458 | 55354 | 1635 | 39027 |
| 16-#14 | 2.05 | MA | 33369 | 7500 | 54164 | 5526 | 59835 | 4466 | 62545 | 3679 | 65713 | 2471 | 79488 | 2152 | 47473 |
| 3L-7S | | MI | 27366 | 7500 | 44252 | 5524 | 47819 | 4481 | 48765 | 3669 | 48778 | 2468 | 58416 | 1706 | 40275 |
| 16-#14 | 2.05 | MA | 32491 | 7500 | 52631 | 5545 | 57885 | 4483 | 60178 | 3674 | 62640 | 2482 | 75952 | 2024 | 47327 |
| 4L-6S | | MI | 28025 | 7500 | 45473 | 5506 | 49306 | 4465 | 50588 | 3656 | 51215 | 2458 | 61646 | 1833 | 41051 |
| 16-#14 | 2.05 | MA | 31705 | 7500 | 51287 | 5544 | 56152 | 4480 | 58056 | 3689 | 59611 | 2474 | 72260 | 1961 | 46613 |
| 5E | | MI | 28701 | 7500 | 46613 | 5508 | 50855 | 4470 | 52477 | 3662 | 53706 | 2448 | 64748 | 1918 | 41977 |
| 16-#14 | 2.05 | MA | 30955 | 7500 | 50019 | 5542 | 54429 | 4497 | 55954 | 3684 | 56829 | 2485 | 68749 | 1877 | 45515 |
| 6L-4S | | MI | 29409 | 7500 | 47821 | 5510 | 52413 | 4454 | 54384 | 3648 | 56416 | 2458 | 68026 | 1979 | 42628 |
| 16-#14 | 2.05 | MA | 30224 | 7500 | 48662 | 5561 | 52775 | 4494 | 53927 | 3699 | 54107 | 2496 | 65095 | 1750 | 44634 |
| 7L-3S | | MI | 30199 | 7500 | 49198 | 5492 | 54164 | 4458 | 56509 | 3655 | 59164 | 2448 | 71146 | 2107 | 42737 |
| 16-#14 | 2.05 | MA | 29503 | 7500 | 47417 | 5560 | 51106 | 4511 | 51942 | 3714 | 51255 | 2487 | 61645 | 1677 | 43180 |
| 8L-2S | | MI | 31315 | 7500 | 50909 | 5495 | 56345 | 4442 | 59160 | 3641 | 62746 | 2438 | 75919 | 2235 | 42772 |
| 16-#18 | 3.64 | MA | 36075 | 8493 | 61674 | 6143 | 69224 | 4913 | 73891 | 3934 | 81170 | 2408 | 100764 | 1622 | 80254 |
| 4L-6S | | MI | 30211 | 8493 | 51769 | 6092 | 57064 | 4895 | 59935 | 3911 | 63619 | 2361 | 78760 | 1291 | 66946 |
| 16-#18 | 3.64 | MA | 34741 | 8493 | 59311 | 6139 | 66177 | 4941 | 70160 | 3958 | 75869 | 2390 | 94353 | 1513 | 77547 |
| 5E | | MI | 31357 | 8493 | 53772 | 6098 | 59783 | 4904 | 63251 | 3925 | 67932 | 2343 | 84101 | 1442 | 69642 |
| 16-#18 | 3.64 | MA | 33469 | 8493 | 57081 | 6136 | 63148 | 4933 | 66466 | 3946 | 70998 | 2408 | 88286 | 1363 | 74557 |
| 6L-4S | | MI | 32559 | 8493 | 55893 | 6104 | 62518 | 4879 | 66599 | 3903 | 72629 | 2361 | 89778 | 1548 | 71917 |
| 16-#18 | 3.64 | MA | 32228 | 8493 | 54694 | 6167 | 60239 | 4961 | 62902 | 3971 | 66230 | 2426 | 81968 | 1137 | 71680 |
| 7L-3S | | MI | 33899 | 8493 | 58308 | 6074 | 65587 | 4889 | 70324 | 3917 | 77389 | 2343 | 95143 | 1775 | 73781 |
| 18-#11 | 1.60 | MA | 33135 | 7219 | 52722 | 5368 | 58096 | 4355 | 60468 | 3596 | 62915 | 2487 | 75943 | 2338 | 37463 |
| 2L-9S | | MI | 26296 | 7219 | 41657 | 5370 | 44598 | 4368 | 44879 | 3603 | 43492 | 2492 | 51484 | 1827 | 31685 |
| 18-#11 | 1.60 | MA | 32254 | 7219 | 51388 | 5368 | 56395 | 4354 | 58400 | 3607 | 60114 | 2495 | 72150 | 2249 | 37458 |
| 3L-8S | | MI | 26760 | 7219 | 42483 | 5358 | 45621 | 4356 | 46167 | 3607 | 45182 | 2485 | 53601 | 1884 | 32398 |
| 18-#11 | 1.60 | MA | 31634 | 7219 | 50318 | 5381 | 55034 | 4366 | 56749 | 3604 | 57970 | 2503 | 69662 | 2160 | 37417 |
| 4L-7S | | MI | 27218 | 7219 | 43264 | 5359 | 46668 | 4359 | 47412 | 3597 | 46971 | 2492 | 55752 | 1934 | 32768 |
| 18-#11 | 1.60 | MA | 31080 | 7219 | 49382 | 5380 | 53826 | 4364 | 55269 | 3615 | 55858 | 2498 | 67073 | 2116 | 37323 |
| 5L-6S | | MI | 27683 | 7219 | 44116 | 5346 | 47705 | 4347 | 48683 | 3587 | 48678 | 2485 | 58026 | 2022 | 33211 |
| 18-#11 | 1.60 | MA | 30551 | 7219 | 48498 | 5380 | 52625 | 4376 | 53804 | 3612 | 53918 | 2506 | 64604 | 2058 | 36799 |
| 6L-5S | | MI | 28159 | 7219 | 44911 | 5347 | 48786 | 4350 | 50001 | 3591 | 50423 | 2477 | 60211 | 2080 | 33673 |
| 18-#11 | 1.60 | MA | 30036 | 7219 | 47552 | 5393 | 51472 | 4374 | 52391 | 3623 | 52020 | 2514 | 62036 | 1970 | 36269 |
| 7L-4S | | MI | 28658 | 7219 | 45754 | 5348 | 49872 | 4339 | 51332 | 3581 | 52321 | 2484 | 62513 | 2124 | 33740 |
| 18-#11 | 1.60 | MA | 29528 | 7219 | 46685 | 5393 | 50309 | 4386 | 51008 | 3634 | 50032 | 2509 | 59616 | 1918 | 35838 |
| 8L-3S | | MI | 29215 | 7219 | 46715 | 5336 | 51095 | 4341 | 52815 | 3585 | 54247 | 2477 | 64712 | 2212 | 33766 |
| 18-#11 | 1.60 | MA | 29000 | 7219 | 45833 | 5392 | 49172 | 4385 | 49576 | 3631 | 48154 | 2517 | 57224 | 1862 | 35005 |
| 9L-2S | | MI | 30004 | 7219 | 47911 | 5337 | 52619 | 4330 | 54669 | 3575 | 56759 | 2470 | 68072 | 2301 | 33755 |
| 18-#14 | 2.30 | MA | 35491 | 7660 | 57985 | 5627 | 64706 | 4542 | 68466 | 3709 | 73735 | 2450 | 90282 | 2258 | 53330 |
| 2L-9S | | MI | 26881 | 7660 | 43658 | 5639 | 47032 | 4565 | 47786 | 3721 | 47394 | 2457 | 57122 | 1528 | 42749 |
| 18-#14 | 2.30 | MA | 34249 | 7660 | 56075 | 5626 | 62271 | 4539 | 65506 | 3724 | 69724 | 2461 | 84885 | 2130 | 53254 |
| 3L-8S | | MI | 27521 | 7660 | 44843 | 5621 | 48499 | 4549 | 49632 | 3728 | 49807 | 2447 | 60128 | 1609 | 44028 |
| 18-#14 | 2.30 | MA | 33377 | 7660 | 54541 | 5645 | 60321 | 4555 | 63139 | 3719 | 66651 | 2473 | 81349 | 2002 | 53083 |
| 4L-7S | | MI | 28166 | 7660 | 45963 | 5623 | 50000 | 4553 | 51417 | 3714 | 52360 | 2457 | 63190 | 1681 | 45234 |
| 18-#14 | 2.30 | MA | 32596 | 7660 | 53198 | 5643 | 58588 | 4552 | 61016 | 3734 | 63623 | 2464 | 77657 | 1939 | 52216 |
| 5L-6S | | MI | 28821 | 7660 | 47184 | 5606 | 51488 | 4538 | 53240 | 3700 | 54798 | 2447 | 66420 | 1808 | 46102 |
| 18-#14 | 2.30 | MA | 31851 | 7660 | 51930 | 5642 | 56865 | 4569 | 58915 | 3729 | 60841 | 2475 | 74146 | 1855 | 51163 |
| 6L-5S | | MI | 29492 | 7660 | 48324 | 5608 | 53036 | 4542 | 55128 | 3707 | 57288 | 2437 | 69521 | 1892 | 46987 |
| 18-#14 | 2.30 | MA | 31125 | 7660 | 50573 | 5661 | 55211 | 4566 | 56888 | 3744 | 58118 | 2486 | 70492 | 1728 | 50190 |
| 7L-4S | | MI | 30196 | 7660 | 49532 | 5610 | 54594 | 4526 | 57036 | 3693 | 59998 | 2447 | 72799 | 1954 | 47784 |
| 18-#14 | 2.30 | MA | 30409 | 7660 | 49328 | 5660 | 53542 | 4583 | 54903 | 3759 | 55266 | 2477 | 67043 | 1655 | 48781 |
| 8L-3S | | MI | 30980 | 7660 | 50909 | 5592 | 56345 | 4530 | 59160 | 3700 | 62746 | 2437 | 75919 | 2081 | 47918 |
| 18-#14 | 2.30 | MA | 29685 | 7660 | 48010 | 5678 | 51911 | 4580 | 52850 | 3754 | 52572 | 2488 | 63641 | 1574 | 47333 |
| 9L-2S | | MI | 32091 | 7660 | 52620 | 5594 | 58526 | 4515 | 61812 | 3686 | 66329 | 2427 | 80693 | 2209 | 47974 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

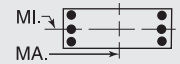



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 4.09 | MA | 36250 | 8777 | 62657 | 6317 | 70444 | 5069 | 75347 | 4038 | 82876 | 2372 | 103691 | 1468 | 87396 |
| 5L-6S | | MI | 31561 | 8777 | 54760 | 6270 | 60878 | 5023 | 64572 | 3990 | 69824 | 2339 | 86991 | 1239 | 75574 |
| 18-#18 | 4.09 | MA | 34991 | 8777 | 60427 | 6313 | 67415 | 5062 | 71653 | 4026 | 78004 | 2389 | 97623 | 1317 | 84248 |
| 6L-5S | | MI | 32696 | 8777 | 56764 | 6275 | 63597 | 5033 | 67888 | 4004 | 74137 | 2321 | 92332 | 1390 | 78429 |
| 18-#18 | 4.09 | MA | 33762 | 8777 | 58040 | 6345 | 64506 | 5090 | 68088 | 4050 | 73237 | 2407 | 91305 | 1092 | 81271 |
| 7L-4S | | MI | 33887 | 8777 | 58885 | 6281 | 66332 | 5007 | 71236 | 3983 | 78834 | 2339 | 98009 | 1496 | 80591 |
| 20-#11 | 1.77 | MA | 33756 | 7330 | 54057 | 5437 | 59797 | 4406 | 62536 | 3628 | 65717 | 2480 | 79735 | 2324 | 41530 |
| 2L-10S | | MI | 26371 | 7330 | 42076 | 5438 | 45089 | 4415 | 45495 | 3644 | 44326 | 2493 | 52792 | 1747 | 34589 |
| 20-#11 | 1.77 | MA | 32878 | 7330 | 52722 | 5437 | 58096 | 4404 | 60468 | 3638 | 62915 | 2488 | 75943 | 2235 | 41510 |
| 3L-9S | | MI | 26867 | 7330 | 42853 | 5440 | 46123 | 4418 | 46733 | 3634 | 46004 | 2485 | 54844 | 1811 | 35196 |
| 20-#11 | 1.77 | MA | 32261 | 7330 | 51653 | 5450 | 56735 | 4416 | 58817 | 3635 | 60772 | 2496 | 73455 | 2146 | 41455 |
| 4L-8S | | MI | 27327 | 7330 | 43679 | 5427 | 47146 | 4406 | 48020 | 3638 | 47694 | 2478 | 56961 | 1867 | 35888 |
| 20-#11 | 1.77 | MA | 31710 | 7330 | 50716 | 5449 | 55527 | 4414 | 57337 | 3646 | 58660 | 2491 | 70866 | 2102 | 41346 |
| 5L-7S | | MI | 27783 | 7330 | 44460 | 5428 | 48193 | 4409 | 49265 | 3628 | 49482 | 2485 | 59112 | 1918 | 36318 |
| 20-#11 | 1.77 | MA | 31184 | 7330 | 49832 | 5449 | 54326 | 4426 | 55872 | 3643 | 56720 | 2499 | 68397 | 2044 | 40744 |
| 6E | | MI | 28245 | 7330 | 45312 | 5415 | 49230 | 4398 | 50537 | 3618 | 51189 | 2478 | 61386 | 2005 | 36744 |
| 20-#11 | 1.77 | MA | 30671 | 7330 | 48886 | 5462 | 53173 | 4424 | 54459 | 3654 | 54822 | 2507 | 65829 | 1956 | 40233 |
| 7L-5S | | MI | 28719 | 7330 | 46107 | 5416 | 50310 | 4400 | 51854 | 3622 | 52934 | 2471 | 63571 | 2064 | 37282 |
| 20-#11 | 1.77 | MA | 30166 | 7330 | 48019 | 5462 | 52010 | 4436 | 53076 | 3665 | 52834 | 2502 | 63409 | 1904 | 39742 |
| 8L-4S | | MI | 29216 | 7330 | 46950 | 5418 | 51397 | 4389 | 53185 | 3612 | 54833 | 2477 | 65873 | 2107 | 37363 |
| 20-#11 | 1.77 | MA | 29640 | 7330 | 47167 | 5461 | 50873 | 4435 | 51644 | 3662 | 50956 | 2510 | 61017 | 1848 | 38932 |
| 9L-3S | | MI | 29770 | 7330 | 47911 | 5405 | 52619 | 4391 | 54669 | 3616 | 56759 | 2470 | 68072 | 2196 | 37400 |
| 20-#11 | 1.77 | MA | 29084 | 7330 | 46238 | 5474 | 49725 | 4447 | 50270 | 3672 | 49092 | 2518 | 58697 | 1785 | 38234 |
| 10L-2S | | MI | 30556 | 7330 | 49107 | 5406 | 54144 | 4380 | 56522 | 3606 | 59270 | 2463 | 71432 | 2285 | 37404 |
| 20-#14 | 2.56 | MA | 35124 | 7819 | 57985 | 5726 | 64706 | 4611 | 68466 | 3769 | 73735 | 2451 | 90282 | 2108 | 59031 |
| 3L-9S | | MI | 27684 | 7819 | 45369 | 5739 | 49213 | 4637 | 50437 | 3766 | 50977 | 2447 | 61896 | 1502 | 47702 |
| 20-#14 | 2.56 | MA | 34256 | 7819 | 56452 | 5744 | 62756 | 4628 | 66100 | 3764 | 70663 | 2463 | 86746 | 1980 | 58835 |
| 4L-8S | | MI | 28319 | 7819 | 46554 | 5721 | 50680 | 4621 | 52284 | 3772 | 53389 | 2437 | 64901 | 1584 | 49037 |
| 20-#14 | 2.56 | MA | 33481 | 7819 | 55108 | 5743 | 61023 | 4625 | 63977 | 3779 | 67634 | 2454 | 83055 | 1917 | 57831 |
| 5L-7S | | MI | 28961 | 7819 | 47674 | 5723 | 52182 | 4626 | 54069 | 3759 | 55942 | 2447 | 67963 | 1655 | 50204 |
| 20-#14 | 2.56 | MA | 32741 | 7819 | 53840 | 5742 | 59301 | 4641 | 61876 | 3774 | 64852 | 2465 | 79543 | 1833 | 56819 |
| 6E | | MI | 29612 | 7819 | 48895 | 5705 | 53669 | 4610 | 55891 | 3745 | 58380 | 2437 | 71193 | 1782 | 51160 |
| 20-#14 | 2.56 | MA | 32020 | 7819 | 52483 | 5761 | 57647 | 4638 | 59849 | 3789 | 62129 | 2476 | 75889 | 1706 | 55757 |
| 7L-5S | | MI | 30278 | 7819 | 50035 | 5708 | 55218 | 4614 | 57780 | 3752 | 60870 | 2427 | 74295 | 1867 | 52008 |
| 20-#14 | 2.56 | MA | 31308 | 7819 | 51238 | 5759 | 55977 | 4655 | 57864 | 3803 | 59278 | 2467 | 72440 | 1633 | 54389 |
| 8L-4S | | MI | 30977 | 7819 | 51243 | 5710 | 56775 | 4599 | 59688 | 3738 | 63580 | 2437 | 77573 | 1928 | 52936 |
| 20-#14 | 2.56 | MA | 30586 | 7819 | 49921 | 5778 | 54346 | 4652 | 55811 | 3798 | 56583 | 2478 | 69038 | 1552 | 52887 |
| 9L-3S | | MI | 31757 | 7819 | 52620 | 5692 | 58526 | 4603 | 61812 | 3745 | 66329 | 2427 | 80693 | 2056 | 53094 |
| 20-#18 | 4.55 | MA | 36499 | 9060 | 63773 | 6490 | 71681 | 5190 | 76839 | 4106 | 85011 | 2371 | 106960 | 1272 | 93961 |
| 6E | | MI | 32899 | 9060 | 57752 | 6447 | 64692 | 5152 | 69208 | 4070 | 76029 | 2316 | 95222 | 1187 | 84224 |
| 20-#18 | 4.55 | MA | 35283 | 9060 | 61386 | 6522 | 68772 | 5218 | 73274 | 4130 | 80244 | 2388 | 100642 | 1047 | 90882 |
| 7L-5S | | MI | 34024 | 9060 | 59756 | 6453 | 67412 | 5162 | 72524 | 4084 | 80342 | 2299 | 100563 | 1338 | 87231 |
| 22-#11 | 1.95 | MA | 33498 | 7440 | 54057 | 5506 | 59797 | 4454 | 62536 | 3669 | 65717 | 2481 | 79735 | 2221 | 45557 |
| 3L-10S | | MI | 26940 | 7440 | 43272 | 5508 | 46614 | 4465 | 47349 | 3675 | 46838 | 2486 | 56152 | 1731 | 38066 |
| 22-#11 | 1.95 | MA | 32885 | 7440 | 52987 | 5519 | 58437 | 4466 | 60885 | 3666 | 63574 | 2489 | 77248 | 2132 | 45490 |
| 4L-9S | | MI | 27435 | 7440 | 44049 | 5509 | 47647 | 4468 | 48586 | 3665 | 48515 | 2478 | 58204 | 1795 | 38713 |
| 22-#11 | 1.95 | MA | 32336 | 7440 | 52050 | 5519 | 57228 | 4464 | 59405 | 3677 | 61462 | 2484 | 74659 | 2088 | 45367 |
| 5L-8S | | MI | 27891 | 7440 | 44876 | 5496 | 48671 | 4457 | 49874 | 3669 | 50205 | 2471 | 60321 | 1851 | 39384 |
| 22-#11 | 1.95 | MA | 31813 | 7440 | 51167 | 5518 | 56027 | 4476 | 57940 | 3674 | 59522 | 2492 | 72190 | 2030 | 44695 |
| 6L-7S | | MI | 28344 | 7440 | 45656 | 5497 | 49717 | 4459 | 51119 | 3659 | 51993 | 2478 | 62472 | 1901 | 39871 |
| 22-#11 | 1.95 | MA | 31303 | 7440 | 50221 | 5531 | 54874 | 4475 | 56527 | 3685 | 57624 | 2500 | 69622 | 1942 | 44200 |
| 7L-6S | | MI | 28805 | 7440 | 46508 | 5485 | 50755 | 4448 | 52390 | 3649 | 53701 | 2471 | 64746 | 1989 | 40283 |
| 22-#11 | 1.95 | MA | 30800 | 7440 | 49353 | 5531 | 53711 | 4487 | 55144 | 3696 | 55636 | 2495 | 67202 | 1890 | 43651 |
| 8L-5S | | MI | 29276 | 7440 | 47303 | 5486 | 51835 | 4450 | 53708 | 3653 | 55445 | 2464 | 66931 | 2048 | 40888 |
| 22-#11 | 1.95 | MA | 30277 | 7440 | 48502 | 5530 | 52574 | 4485 | 53712 | 3693 | 53757 | 2503 | 64810 | 1834 | 42863 |
| 9L-4S | | MI | 29771 | 7440 | 48146 | 5487 | 52922 | 4439 | 55039 | 3643 | 57344 | 2470 | 69233 | 2091 | 40982 |
| 22-#11 | 1.95 | MA | 29724 | 7440 | 47572 | 5544 | 51426 | 4497 | 52338 | 3704 | 51893 | 2512 | 62490 | 1771 | 42127 |
| 10L-3S | | MI | 30323 | 7440 | 49107 | 5474 | 54144 | 4441 | 56522 | 3647 | 59270 | 2463 | 71432 | 2180 | 41031 |

## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.95 | MA | 29182 | 7440 | 46721 | 5543 | 50296 | 4495 | 50923 | 3701 | 49933 | 2506 | 60127 | 1716 | 41179 |
| 11L-2S | | MI | 31105 | 7440 | 50303 | 5475 | 55669 | 4430 | 58376 | 3637 | 61781 | 2456 | 74792 | 2268 | 41050 |
| 22-#14 | 2.81 | MA | 35130 | 7979 | 58362 | 5844 | 65192 | 4700 | 69061 | 3809 | 74674 | 2453 | 92143 | 1958 | 64584 |
| 4L-9S | | MI | 28481 | 7979 | 47080 | 5838 | 51395 | 4709 | 53089 | 3811 | 54559 | 2436 | 66670 | 1477 | 52664 |
| 22-#14 | 2.81 | MA | 34360 | 7979 | 57018 | 5843 | 63459 | 4697 | 66938 | 3824 | 71645 | 2444 | 88452 | 1895 | 63456 |
| 5L-8S | | MI | 29113 | 7979 | 48265 | 5821 | 52862 | 4694 | 54935 | 3817 | 56971 | 2426 | 69675 | 1558 | 54053 |
| 22-#14 | 2.81 | MA | 33625 | 7979 | 55750 | 5842 | 61736 | 4714 | 64837 | 3819 | 68863 | 2455 | 84941 | 1811 | 62480 |
| 6L-7S | | MI | 29750 | 7979 | 49385 | 5823 | 54363 | 4698 | 56720 | 3804 | 59524 | 2436 | 72737 | 1630 | 55183 |
| 22-#14 | 2.81 | MA | 32908 | 7979 | 54393 | 5860 | 60082 | 4711 | 62810 | 3833 | 66141 | 2466 | 81287 | 1684 | 61335 |
| 7L-6S | | MI | 30397 | 7979 | 50606 | 5805 | 55850 | 4682 | 58543 | 3790 | 61962 | 2426 | 75967 | 1757 | 56224 |
| 22-#14 | 2.81 | MA | 32202 | 7979 | 53149 | 5859 | 58413 | 4727 | 60825 | 3848 | 63289 | 2457 | 77837 | 1611 | 60005 |
| 8L-5S | | MI | 31059 | 7979 | 51746 | 5807 | 57399 | 4686 | 60432 | 3797 | 64452 | 2416 | 79069 | 1841 | 57039 |
| 22-#14 | 2.81 | MA | 31481 | 7979 | 51831 | 5878 | 56782 | 4724 | 58772 | 3843 | 60594 | 2468 | 74435 | 1530 | 58449 |
| 9L-4S | | MI | 31754 | 7979 | 52954 | 5809 | 58957 | 4671 | 62339 | 3783 | 67163 | 2426 | 82346 | 1903 | 58085 |
| 22-#18 | 5.00 | MA | 36790 | 9344 | 64733 | 6699 | 73038 | 5347 | 78460 | 4210 | 87250 | 2370 | 109980 | 1002 | 100514 |
| 7L-6S | | MI | 34227 | 9344 | 60744 | 6624 | 68506 | 5280 | 73845 | 4150 | 82234 | 2294 | 103452 | 1135 | 92893 |
| 24-#11 | 2.13 | MA | 33505 | 7551 | 54321 | 5588 | 60138 | 4516 | 62953 | 3698 | 66375 | 2482 | 81041 | 2118 | 49522 |
| 4L-10S | | MI | 27505 | 7551 | 44468 | 5577 | 48139 | 4515 | 49203 | 3706 | 49349 | 2479 | 59512 | 1715 | 41548 |
| 24-#11 | 2.13 | MA | 32959 | 7551 | 53385 | 5588 | 58929 | 4514 | 61473 | 3708 | 64263 | 2477 | 78451 | 2074 | 49386 |
| 5L-9S | | MI | 28004 | 7551 | 45245 | 5578 | 49172 | 4518 | 50440 | 3696 | 51026 | 2472 | 61564 | 1778 | 42233 |
| 24-#11 | 2.13 | MA | 32439 | 7551 | 52501 | 5587 | 57728 | 4526 | 60008 | 3705 | 62323 | 2485 | 75983 | 2016 | 48651 |
| 6L-8S | | MI | 28452 | 7551 | 46072 | 5565 | 50195 | 4507 | 51728 | 3700 | 52716 | 2464 | 63681 | 1835 | 42885 |
| 24-#11 | 2.13 | MA | 31931 | 7551 | 51555 | 5601 | 56576 | 4525 | 58595 | 3716 | 60425 | 2494 | 73414 | 1928 | 48170 |
| 7E | | MI | 28903 | 7551 | 46852 | 5566 | 51242 | 4509 | 52973 | 3690 | 54505 | 2471 | 65832 | 1885 | 43426 |
| 24-#11 | 2.13 | MA | 31431 | 7551 | 50688 | 5600 | 55412 | 4537 | 57212 | 3727 | 58437 | 2488 | 70994 | 1876 | 47567 |
| 8L-6S | | MI | 29361 | 7551 | 47704 | 5554 | 52280 | 4498 | 54244 | 3680 | 56212 | 2464 | 68106 | 1973 | 43826 |
| 24-#11 | 2.13 | MA | 30911 | 7551 | 49836 | 5600 | 54275 | 4535 | 55780 | 3724 | 56559 | 2496 | 68602 | 1820 | 46799 |
| 9L-5S | | MI | 29830 | 7551 | 48499 | 5555 | 53360 | 4500 | 55562 | 3684 | 57957 | 2457 | 70291 | 2031 | 44491 |
| 24-#11 | 2.13 | MA | 30360 | 7551 | 48906 | 5613 | 53127 | 4547 | 54406 | 3735 | 54695 | 2505 | 66283 | 1757 | 46025 |
| 10L-4S | | MI | 30323 | 7551 | 49342 | 5556 | 54447 | 4489 | 56893 | 3674 | 59855 | 2463 | 72593 | 2075 | 44598 |
| 24-#11 | 2.13 | MA | 29820 | 7551 | 48055 | 5612 | 51997 | 4545 | 52991 | 3732 | 52735 | 2499 | 63920 | 1702 | 45097 |
| 11L-3S | | MI | 30872 | 7551 | 50303 | 5543 | 55669 | 4492 | 58376 | 3678 | 61781 | 2456 | 74792 | 2163 | 44658 |
| 24-#14 | 3.07 | MA | 35233 | 8138 | 58929 | 5943 | 65895 | 4769 | 69899 | 3868 | 75657 | 2434 | 93849 | 1873 | 69089 |
| 5L-9S | | MI | 29274 | 8138 | 48791 | 5938 | 53576 | 4782 | 55741 | 3856 | 58141 | 2426 | 71443 | 1451 | 57633 |
| 24-#14 | 3.07 | MA | 34503 | 8138 | 57661 | 5941 | 64172 | 4786 | 67798 | 3863 | 72875 | 2445 | 90338 | 1789 | 68147 |
| 6L-8S | | MI | 29902 | 8138 | 49976 | 5920 | 55043 | 4766 | 57587 | 3862 | 60553 | 2416 | 74448 | 1533 | 59076 |
| 24-#14 | 3.07 | MA | 33791 | 8138 | 56304 | 5960 | 62518 | 4783 | 65771 | 3878 | 70152 | 2456 | 86684 | 1662 | 66921 |
| 7E | | MI | 30535 | 8138 | 51096 | 5923 | 56544 | 4770 | 59372 | 3849 | 63107 | 2426 | 77510 | 1605 | 60172 |
| 24-#14 | 3.07 | MA | 33089 | 8138 | 55059 | 5959 | 60849 | 4800 | 63786 | 3893 | 67300 | 2447 | 83234 | 1589 | 65628 |
| 8L-6S | | MI | 31178 | 8138 | 52317 | 5905 | 58032 | 4755 | 61195 | 3835 | 65544 | 2416 | 80740 | 1731 | 61292 |
| 24-#14 | 3.07 | MA | 32370 | 8138 | 53742 | 5978 | 59218 | 4797 | 61732 | 3888 | 64606 | 2458 | 79832 | 1508 | 64019 |
| 9L-5S | | MI | 31836 | 8138 | 53457 | 5907 | 59580 | 4759 | 63084 | 3842 | 68034 | 2406 | 83842 | 1816 | 62078 |

## RECTANGULAR TIED COLUMNS 40" x 46"

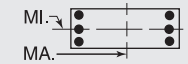
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.30 | MA | 34969 | 7357 | 55241 | 5459 | 60240 | 4439 | 62047 | 3682 | 63253 | 2593 | 75146 | 2431 | 33348 |
| 2L-3S | | MI | 28260 | 7357 | 45048 | 5399 | 48284 | 4420 | 48862 | 3666 | 47907 | 2568 | 55695 | 2146 | 28709 |
| 6-#18 | 1.30 | MA | 32629 | 7357 | 51717 | 5456 | 55748 | 4468 | 56586 | 3708 | 55854 | 2611 | 65254 | 2204 | 33370 |
| 3L-2S | | MI | 30241 | 7357 | 48040 | 5405 | 52098 | 4395 | 53499 | 3645 | 54112 | 2550 | 63926 | 2374 | 28632 |
| 8-#18 | 1.74 | MA | 36602 | 7641 | 58765 | 5636 | 64733 | 4568 | 67508 | 3762 | 70651 | 2575 | 85037 | 2389 | 44114 |
| 2L-4S | | MI | 28250 | 7641 | 45625 | 5606 | 49029 | 4539 | 49774 | 3732 | 49352 | 2563 | 58560 | 1867 | 37485 |
| 8-#18 | 1.74 | MA | 34285 | 7641 | 55241 | 5633 | 60240 | 4596 | 62047 | 3787 | 63253 | 2593 | 75146 | 2162 | 44038 |
| 3E | | MI | 29647 | 7641 | 48040 | 5576 | 52098 | 4549 | 53499 | 3746 | 54112 | 2546 | 63926 | 2094 | 37789 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

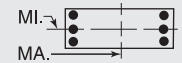



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.74 | MA | 32648 | 7641 | 52409 | 5665 | 56639 | 4590 | 57677 | 3777 | 57578 | 2611 | 68673 | 1934 | 43570 |
| 4L-2S | | MI | 31609 | 7641 | 51031 | 5582 | 55912 | 4523 | 58135 | 3724 | 60317 | 2528 | 72156 | 2322 | 37796 |
| 10-#14 | 1.22 | MA | 34771 | 7304 | 54560 | 5458 | 59577 | 4442 | 61320 | 3690 | 62300 | 2614 | 74228 | 2473 | 31569 |
| 2L-5S | | MI | 27424 | 7304 | 43172 | 5422 | 46079 | 4428 | 46247 | 3676 | 44509 | 2594 | 52142 | 2105 | 27071 |
| 10-#14 | 1.22 | MA | 33431 | 7304 | 52550 | 5457 | 57014 | 4439 | 58204 | 3705 | 58079 | 2625 | 68519 | 2345 | 31599 |
| 3L-4S | | MI | 28147 | 7304 | 44380 | 5424 | 47637 | 4413 | 48154 | 3663 | 47219 | 2604 | 55420 | 2166 | 27180 |
| 10-#14 | 1.22 | MA | 32488 | 7304 | 50938 | 5476 | 54965 | 4456 | 55717 | 3701 | 54849 | 2637 | 64775 | 2217 | 31548 |
| 4L-3S | | MI | 28954 | 7304 | 45757 | 5407 | 49387 | 4417 | 50278 | 3669 | 49967 | 2594 | 58540 | 2294 | 27180 |
| 10-#14 | 1.22 | MA | 31643 | 7304 | 49527 | 5475 | 53144 | 4454 | 53487 | 3717 | 51667 | 2629 | 60876 | 2153 | 31355 |
| 5L-2S | | MI | 30091 | 7304 | 47468 | 5409 | 51569 | 4401 | 52930 | 3656 | 53550 | 2584 | 63313 | 2422 | 27134 |
| 10-#18 | 2.17 | MA | 38215 | 7925 | 62288 | 5813 | 69225 | 4696 | 72969 | 3842 | 78050 | 2557 | 94928 | 2347 | 54841 |
| 2L-5S | | MI | 28393 | 7925 | 46496 | 5778 | 50108 | 4693 | 51063 | 3833 | 50861 | 2523 | 61115 | 1709 | 43705 |
| 10-#18 | 2.17 | MA | 35920 | 7925 | 58765 | 5810 | 64733 | 4725 | 67508 | 3867 | 70651 | 2576 | 85037 | 2119 | 54679 |
| 3L-4S | | MI | 29635 | 7925 | 48617 | 5783 | 52843 | 4667 | 54410 | 3812 | 55557 | 2541 | 66791 | 1814 | 46440 |
| 10-#18 | 2.17 | MA | 34301 | 7925 | 55933 | 5843 | 61131 | 4718 | 63138 | 3857 | 64977 | 2594 | 78565 | 1892 | 54115 |
| 4L-3S | | MI | 31017 | 7925 | 51031 | 5754 | 55912 | 4677 | 58135 | 3826 | 60317 | 2523 | 72156 | 2042 | 46837 |
| 10-#18 | 2.17 | MA | 32851 | 7925 | 53449 | 5840 | 57929 | 4747 | 59216 | 3882 | 59382 | 2577 | 71786 | 1781 | 50826 |
| 5L-2S | | MI | 32962 | 7925 | 54023 | 5759 | 59727 | 4652 | 62772 | 3804 | 66522 | 2506 | 80387 | 2269 | 46930 |
| 12-#11 | 1.02 | MA | 34020 | 7170 | 52847 | 5390 | 57498 | 4394 | 58832 | 3664 | 58947 | 2631 | 69843 | 2505 | 26495 |
| 2L-6S | | MI | 27109 | 7170 | 42216 | 5353 | 44899 | 4373 | 44849 | 3643 | 42697 | 2620 | 49666 | 2182 | 22799 |
| 12-#11 | 1.02 | MA | 33078 | 7170 | 51444 | 5390 | 55708 | 4393 | 56657 | 3675 | 56000 | 2639 | 65833 | 2416 | 26526 |
| 3L-5S | | MI | 27593 | 7170 | 43011 | 5354 | 45979 | 4376 | 46166 | 3647 | 44441 | 2613 | 51851 | 2241 | 22876 |
| 12-#11 | 1.02 | MA | 32417 | 7170 | 50320 | 5404 | 54279 | 4405 | 54922 | 3672 | 53747 | 2648 | 63201 | 2328 | 26538 |
| 4E | | MI | 28100 | 7170 | 43854 | 5355 | 47066 | 4365 | 47497 | 3637 | 46340 | 2620 | 54153 | 2284 | 22877 |
| 12-#11 | 1.02 | MA | 31825 | 7170 | 49336 | 5403 | 53010 | 4404 | 53367 | 3683 | 51529 | 2643 | 60468 | 2283 | 26498 |
| 5L-3S | | MI | 28666 | 7170 | 44815 | 5343 | 48288 | 4367 | 48980 | 3641 | 48266 | 2613 | 56352 | 2373 | 22847 |
| 12-#11 | 1.02 | MA | 31260 | 7170 | 48408 | 5403 | 51749 | 4416 | 51829 | 3681 | 49491 | 2652 | 57857 | 2225 | 26347 |
| 6L-2S | | MI | 29466 | 7170 | 46011 | 5344 | 49813 | 4356 | 50834 | 3631 | 50777 | 2606 | 59712 | 2461 | 22807 |
| 12-#14 | 1.47 | MA | 35715 | 7464 | 56570 | 5558 | 62140 | 4514 | 64435 | 3735 | 66520 | 2604 | 79937 | 2452 | 37710 |
| 2L-6S | | MI | 27548 | 7464 | 43743 | 5520 | 46712 | 4496 | 47009 | 3715 | 45601 | 2594 | 53814 | 1995 | 31163 |
| 12-#14 | 1.47 | MA | 34383 | 7464 | 54560 | 5557 | 59577 | 4511 | 61320 | 3750 | 62300 | 2615 | 74228 | 2324 | 37711 |
| 3L-5S | | MI | 28234 | 7464 | 44883 | 5522 | 48260 | 4501 | 48898 | 3721 | 48091 | 2584 | 56916 | 2079 | 32212 |
| 12-#14 | 1.47 | MA | 33446 | 7464 | 52949 | 5576 | 57528 | 4529 | 58832 | 3746 | 59070 | 2627 | 70484 | 2196 | 37625 |
| 4E | | MI | 28952 | 7464 | 46091 | 5524 | 49818 | 4485 | 50806 | 3708 | 50801 | 2594 | 60193 | 2141 | 32363 |
| 12-#14 | 1.47 | MA | 32607 | 7464 | 51537 | 5575 | 55707 | 4526 | 56602 | 3761 | 55888 | 2619 | 66586 | 2132 | 37393 |
| 5L-3S | | MI | 29754 | 7464 | 47468 | 5506 | 51569 | 4489 | 52930 | 3714 | 53550 | 2584 | 63313 | 2269 | 32402 |
| 12-#14 | 1.47 | MA | 31807 | 7464 | 50205 | 5574 | 53897 | 4543 | 54395 | 3757 | 52965 | 2631 | 62869 | 2048 | 36093 |
| 6L-2S | | MI | 30885 | 7464 | 49179 | 5509 | 53750 | 4473 | 55582 | 3701 | 57132 | 2574 | 68087 | 2397 | 32373 |
| 12-#18 | 2.61 | MA | 39810 | 8209 | 65812 | 5991 | 73717 | 4825 | 78430 | 3922 | 85448 | 2540 | 104820 | 2305 | 65538 |
| 2L-6S | | MI | 28601 | 8209 | 47484 | 5949 | 51203 | 4812 | 52383 | 3899 | 52752 | 2519 | 64004 | 1505 | 50277 |
| 12-#18 | 2.61 | MA | 37536 | 8209 | 62288 | 5988 | 69225 | 4853 | 72969 | 3947 | 78050 | 2558 | 94928 | 2077 | 65305 |
| 3L-5S | | MI | 29774 | 8209 | 49488 | 5955 | 53923 | 4822 | 55699 | 3913 | 57066 | 2501 | 69346 | 1657 | 52423 |
| 12-#18 | 2.61 | MA | 35934 | 8209 | 59456 | 6020 | 65624 | 4847 | 68599 | 3937 | 72375 | 2576 | 88456 | 1850 | 64437 |
| 4E | | MI | 31003 | 8209 | 51608 | 5961 | 56657 | 4796 | 59047 | 3892 | 61762 | 2519 | 75022 | 1762 | 55028 |
| 12-#18 | 2.61 | MA | 34500 | 8209 | 56973 | 6017 | 62421 | 4876 | 64677 | 3962 | 66781 | 2559 | 81677 | 1739 | 61137 |
| 5L-3S | | MI | 32372 | 8209 | 54023 | 5931 | 59727 | 4806 | 62772 | 3905 | 66522 | 2501 | 80387 | 1990 | 55865 |
| 12-#18 | 2.61 | MA | 33131 | 8209 | 54629 | 6014 | 59238 | 4869 | 60794 | 3952 | 61640 | 2577 | 75246 | 1589 | 58574 |
| 6L-2S | | MI | 34301 | 8209 | 57015 | 5937 | 63541 | 4780 | 67408 | 3884 | 72727 | 2484 | 88618 | 2217 | 56023 |
| 14-#11 | 1.19 | MA | 34687 | 7281 | 54251 | 5460 | 59287 | 4444 | 61007 | 3695 | 61893 | 2624 | 73852 | 2492 | 30789 |
| 2L-7S | | MI | 27211 | 7281 | 42561 | 5435 | 45386 | 4435 | 45431 | 3684 | 43501 | 2621 | 50752 | 2078 | 25816 |
| 14-#11 | 1.19 | MA | 33749 | 7281 | 52847 | 5459 | 57498 | 4443 | 58832 | 3706 | 58947 | 2633 | 69843 | 2403 | 30811 |
| 3L-6S | | MI | 27681 | 7281 | 43412 | 5422 | 46423 | 4423 | 46702 | 3674 | 45208 | 2614 | 53026 | 2166 | 26308 |
| 14-#11 | 1.19 | MA | 33091 | 7281 | 51724 | 5473 | 56068 | 4455 | 57097 | 3703 | 56694 | 2641 | 67211 | 2315 | 30802 |
| 4L-5S | | MI | 28163 | 7281 | 44207 | 5423 | 47504 | 4426 | 48020 | 3678 | 46953 | 2606 | 55211 | 2224 | 26502 |
| 14-#11 | 1.19 | MA | 32502 | 7281 | 50740 | 5473 | 54799 | 4454 | 55543 | 3714 | 54475 | 2636 | 64478 | 2270 | 30742 |
| 5L-4S | | MI | 28668 | 7281 | 45050 | 5424 | 48591 | 4415 | 49351 | 3668 | 48851 | 2613 | 57513 | 2267 | 26526 |
| 14-#11 | 1.19 | MA | 31941 | 7281 | 49812 | 5472 | 53538 | 4466 | 54004 | 3712 | 52438 | 2645 | 61867 | 2212 | 30474 |
| 6L-3S | | MI | 29231 | 7281 | 46011 | 5412 | 49813 | 4417 | 50834 | 3672 | 50777 | 2606 | 59712 | 2356 | 26508 |

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

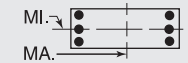
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.19 | MA | 31393 | 7281 | 48819 | 5486 | 52327 | 4465 | 52520 | 3723 | 50445 | 2654 | 59151 | 2124 | 29844 |
| 7L-2S | | MI | 30027 | 7281 | 47207 | 5413 | 51338 | 4406 | 52688 | 3662 | 53288 | 2599 | 63072 | 2445 | 26477 |
| 14-#14 | 1.71 | MA | 36652 | 7623 | 58581 | 5657 | 64703 | 4586 | 67551 | 3780 | 70741 | 2594 | 85647 | 2432 | 43843 |
| 2L-7S | | MI | 27691 | 7623 | 44233 | 5637 | 47406 | 4584 | 47838 | 3773 | 46745 | 2593 | 55357 | 1843 | 35569 |
| 14-#14 | 1.71 | MA | 35327 | 7623 | 56570 | 5657 | 62140 | 4584 | 64435 | 3795 | 66520 | 2606 | 79937 | 2304 | 43811 |
| 3L-6S | | MI | 28356 | 7623 | 45454 | 5620 | 48893 | 4569 | 49661 | 3760 | 49183 | 2583 | 58587 | 1969 | 36194 |
| 14-#14 | 1.71 | MA | 34396 | 7623 | 54959 | 5676 | 60090 | 4601 | 61948 | 3791 | 63291 | 2617 | 76193 | 2176 | 43694 |
| 4L-5S | | MI | 29037 | 7623 | 46594 | 5622 | 50442 | 4573 | 51550 | 3766 | 51673 | 2573 | 61689 | 2054 | 37189 |
| 14-#14 | 1.71 | MA | 33564 | 7623 | 53547 | 5675 | 58270 | 4598 | 59717 | 3806 | 60108 | 2609 | 72295 | 2112 | 43282 |
| 5L-4S | | MI | 29752 | 7623 | 47802 | 5624 | 51999 | 4557 | 53457 | 3753 | 54384 | 2583 | 64967 | 2115 | 37536 |
| 14-#14 | 1.71 | MA | 32769 | 7623 | 52215 | 5674 | 56460 | 4616 | 57510 | 3802 | 57185 | 2621 | 68579 | 2028 | 42019 |
| 6L-3S | | MI | 30548 | 7623 | 49179 | 5606 | 53750 | 4561 | 55582 | 3759 | 57132 | 2573 | 68087 | 2243 | 37604 |
| 14-#14 | 1.71 | MA | 31995 | 7623 | 50790 | 5693 | 54723 | 4613 | 55381 | 3817 | 54326 | 2633 | 64713 | 1902 | 41209 |
| 7L-2S | | MI | 31673 | 7623 | 50890 | 5608 | 55931 | 4546 | 58234 | 3745 | 60714 | 2563 | 72861 | 2371 | 37602 |
| 14-#18 | 3.04 | MA | 39135 | 8492 | 65812 | 6165 | 73717 | 4982 | 78430 | 4027 | 85448 | 2540 | 104820 | 2035 | 75919 |
| 3L-6S | | MI | 29980 | 8492 | 50476 | 6127 | 55017 | 4940 | 57020 | 3979 | 58957 | 2497 | 72235 | 1453 | 58844 |
| 14-#18 | 3.04 | MA | 37549 | 8492 | 62980 | 6197 | 70116 | 4976 | 74060 | 4017 | 79774 | 2558 | 98347 | 1808 | 74614 |
| 4L-5S | | MI | 31141 | 8492 | 52479 | 6132 | 57737 | 4950 | 60336 | 3993 | 63271 | 2479 | 77576 | 1604 | 61168 |
| 14-#18 | 3.04 | MA | 36130 | 8492 | 60497 | 6194 | 66914 | 5004 | 70138 | 4042 | 74179 | 2541 | 91569 | 1697 | 71473 |
| 5L-4S | | MI | 32358 | 8492 | 54600 | 6138 | 60471 | 4925 | 63684 | 3971 | 67968 | 2497 | 83253 | 1710 | 63628 |
| 14-#18 | 3.04 | MA | 34776 | 8492 | 58153 | 6191 | 63730 | 4998 | 66255 | 4032 | 69038 | 2559 | 85137 | 1547 | 68739 |
| 6L-3S | | MI | 33715 | 8492 | 57015 | 6108 | 63541 | 4934 | 67408 | 3985 | 72727 | 2479 | 88618 | 1938 | 64879 |
| 14-#18 | 3.04 | MA | 33455 | 8492 | 55645 | 6224 | 60673 | 5027 | 62509 | 4057 | 64007 | 2577 | 78443 | 1322 | 65519 |
| 7L-2S | | MI | 35627 | 8492 | 60006 | 6114 | 67355 | 4909 | 72045 | 3964 | 78932 | 2461 | 96849 | 2165 | 65097 |
| 16-#11 | 1.36 | MA | 35350 | 7391 | 55654 | 5529 | 61076 | 4494 | 63182 | 3726 | 64840 | 2617 | 77861 | 2479 | 35076 |
| 2L-8S | | MI | 27321 | 7391 | 42976 | 5503 | 45864 | 4482 | 46040 | 3725 | 44224 | 2607 | 51961 | 2011 | 29028 |
| 16-#11 | 1.36 | MA | 34417 | 7391 | 54251 | 5528 | 59287 | 4493 | 61007 | 3737 | 61893 | 2626 | 73852 | 2390 | 35088 |
| 3L-7S | | MI | 27782 | 7391 | 43757 | 5504 | 46911 | 4485 | 47285 | 3715 | 46012 | 2614 | 54112 | 2062 | 29357 |
| 16-#11 | 1.36 | MA | 33761 | 7391 | 53127 | 5542 | 57858 | 4505 | 59272 | 3734 | 59641 | 2634 | 71220 | 2302 | 35060 |
| 4L-6S | | MI | 28250 | 7391 | 44608 | 5491 | 47948 | 4474 | 48556 | 3705 | 47719 | 2607 | 56386 | 2149 | 29827 |
| 16-#11 | 1.36 | MA | 33175 | 7391 | 52143 | 5542 | 56589 | 4504 | 57718 | 3746 | 57422 | 2629 | 68487 | 2257 | 34982 |
| 5E | | MI | 28730 | 7391 | 45403 | 5492 | 49029 | 4476 | 49874 | 3709 | 49464 | 2599 | 58571 | 2208 | 30122 |
| 16-#11 | 1.36 | MA | 32617 | 7391 | 51215 | 5542 | 55327 | 4516 | 56179 | 3743 | 55385 | 2638 | 65876 | 2198 | 34609 |
| 6L-4S | | MI | 29232 | 7391 | 46246 | 5494 | 50116 | 4465 | 51205 | 3699 | 51363 | 2606 | 60873 | 2251 | 30163 |
| 16-#11 | 1.36 | MA | 32072 | 7391 | 50222 | 5555 | 54117 | 4515 | 54695 | 3754 | 53392 | 2647 | 63160 | 2111 | 34005 |
| 7L-3S | | MI | 29793 | 7391 | 47207 | 5481 | 51338 | 4467 | 52688 | 3703 | 53288 | 2599 | 63072 | 2340 | 30162 |
| 16-#11 | 1.36 | MA | 31535 | 7391 | 49312 | 5555 | 52895 | 4527 | 53243 | 3765 | 51304 | 2642 | 60606 | 2059 | 33572 |
| 8L-2S | | MI | 30586 | 7391 | 48403 | 5482 | 52863 | 4456 | 54542 | 3693 | 55800 | 2592 | 66432 | 2429 | 30138 |
| 16-#14 | 1.96 | MA | 37582 | 7783 | 60591 | 5757 | 67266 | 4658 | 70666 | 3825 | 74962 | 2584 | 91356 | 2411 | 49957 |
| 2L-8S | | MI | 27846 | 7783 | 44824 | 5735 | 48086 | 4652 | 48705 | 3832 | 47774 | 2572 | 57069 | 1746 | 39321 |
| 16-#14 | 1.96 | MA | 36265 | 7783 | 58581 | 5756 | 64703 | 4656 | 67551 | 3840 | 70741 | 2596 | 85647 | 2283 | 49903 |
| 3L-7S | | MI | 28498 | 7783 | 45944 | 5737 | 49587 | 4657 | 50490 | 3818 | 50328 | 2582 | 60131 | 1817 | 40595 |
| 16-#14 | 1.96 | MA | 35340 | 7783 | 56969 | 5775 | 62653 | 4673 | 65063 | 3836 | 67511 | 2607 | 81903 | 2155 | 49757 |
| 4L-6S | | MI | 29159 | 7783 | 47165 | 5719 | 51074 | 4641 | 52313 | 3805 | 52765 | 2572 | 63361 | 1944 | 41236 |
| 16-#14 | 1.96 | MA | 34513 | 7783 | 55557 | 5775 | 60832 | 4671 | 62833 | 3851 | 64329 | 2599 | 78004 | 2091 | 49165 |
| 5E | | MI | 29835 | 7783 | 48305 | 5722 | 52623 | 4645 | 54202 | 3811 | 55255 | 2562 | 66463 | 2028 | 42183 |
| 16-#14 | 1.96 | MA | 33724 | 7783 | 54226 | 5774 | 59023 | 4688 | 60625 | 3847 | 61406 | 2611 | 74288 | 2007 | 47956 |
| 6L-4S | | MI | 30545 | 7783 | 49513 | 5724 | 54181 | 4630 | 56109 | 3798 | 57966 | 2572 | 69741 | 2090 | 42702 |
| 16-#14 | 1.96 | MA | 32955 | 7783 | 52800 | 5793 | 57285 | 4685 | 58496 | 3862 | 58546 | 2623 | 70422 | 1881 | 47171 |
| 7L-3S | | MI | 31336 | 7783 | 50890 | 5706 | 55931 | 4634 | 58234 | 3804 | 60714 | 2562 | 72861 | 2218 | 42796 |
| 16-#14 | 1.96 | MA | 32196 | 7783 | 51493 | 5792 | 55532 | 4703 | 56412 | 3878 | 55551 | 2615 | 66778 | 1807 | 45589 |
| 8L-2S | | MI | 32455 | 7783 | 52601 | 5708 | 58113 | 4618 | 60885 | 3790 | 64296 | 2553 | 77634 | 2346 | 42823 |
| 16-#18 | 3.48 | MA | 39149 | 8776 | 66504 | 6375 | 74609 | 5104 | 79521 | 4097 | 87172 | 2541 | 108239 | 1765 | 84829 |
| 4L-6S | | MI | 31344 | 8776 | 53467 | 6304 | 58831 | 5069 | 61656 | 4059 | 65162 | 2475 | 80466 | 1401 | 67440 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

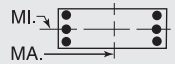


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 3.48 | MA | 37743 | 8776 | 64020 | 6372 | 71406 | 5133 | 75600 | 4122 | 81578 | 2524 | 101460 | 1655 | 81832 |
| 5E | | MI | 32495 | 8776 | 55471 | 6310 | 61551 | 5079 | 64972 | 4073 | 69476 | 2457 | 85807 | 1552 | 69934 |
| 16-#18 | 3.48 | MA | 36404 | 8776 | 61676 | 6369 | 68222 | 5126 | 71717 | 4112 | 76437 | 2542 | 95029 | 1505 | 78931 |
| 6L-4S | | MI | 33701 | 8776 | 57592 | 6315 | 64285 | 5053 | 68320 | 4051 | 74173 | 2475 | 91484 | 1658 | 72265 |
| 16-#18 | 3.48 | MA | 35097 | 8776 | 59168 | 6401 | 65165 | 5155 | 67970 | 4137 | 71405 | 2560 | 88334 | 1280 | 75820 |
| 7L-3S | | MI | 35045 | 8776 | 60006 | 6286 | 67355 | 5063 | 72045 | 4065 | 78932 | 2457 | 96849 | 1885 | 73883 |
| 16-#18 | 3.48 | MA | 33808 | 8776 | 56867 | 6398 | 62080 | 5149 | 64302 | 4162 | 66135 | 2543 | 82000 | 1151 | 71783 |
| 8L-2S | | MI | 36942 | 8776 | 62998 | 6291 | 71169 | 5037 | 76682 | 4044 | 85137 | 2439 | 105080 | 2113 | 74156 |
| 18-#11 | 1.53 | MA | 36010 | 7502 | 57058 | 5598 | 62866 | 4545 | 65358 | 3757 | 67787 | 2610 | 81870 | 2466 | 39358 |
| 2L-9S | | MI | 27426 | 7502 | 43346 | 5585 | 46366 | 4544 | 46605 | 3752 | 45045 | 2607 | 53204 | 1939 | 31902 |
| 18-#11 | 1.53 | MA | 35080 | 7502 | 55654 | 5598 | 61076 | 4543 | 63182 | 3768 | 64840 | 2619 | 77861 | 2377 | 39354 |
| 3L-8S | | MI | 27892 | 7502 | 44172 | 5572 | 47389 | 4533 | 47893 | 3756 | 46735 | 2600 | 55321 | 1995 | 32583 |
| 18-#11 | 1.53 | MA | 34428 | 7502 | 54531 | 5611 | 59647 | 4556 | 61448 | 3766 | 62588 | 2628 | 75229 | 2288 | 39312 |
| 4L-7S | | MI | 28351 | 7502 | 44953 | 5573 | 48436 | 4535 | 49138 | 3746 | 48523 | 2607 | 57472 | 2045 | 32903 |
| 18-#11 | 1.53 | MA | 33845 | 7502 | 53547 | 5611 | 58378 | 4554 | 59893 | 3777 | 60369 | 2623 | 72496 | 2244 | 39219 |
| 5L-6S | | MI | 28816 | 7502 | 45804 | 5561 | 49473 | 4524 | 50410 | 3736 | 50231 | 2600 | 59746 | 2133 | 33353 |
| 18-#11 | 1.53 | MA | 33290 | 7502 | 52619 | 5611 | 57117 | 4566 | 58354 | 3774 | 58332 | 2631 | 69885 | 2185 | 38753 |
| 6L-5S | | MI | 29293 | 7502 | 46599 | 5562 | 50554 | 4526 | 51727 | 3740 | 51975 | 2593 | 61931 | 2192 | 33738 |
| 18-#11 | 1.53 | MA | 32748 | 7502 | 51626 | 5624 | 55906 | 4565 | 56870 | 3785 | 56339 | 2640 | 67170 | 2098 | 38171 |
| 7L-4S | | MI | 29793 | 7502 | 47442 | 5563 | 51640 | 4515 | 53058 | 3730 | 53874 | 2599 | 64233 | 2235 | 33793 |
| 18-#11 | 1.53 | MA | 32213 | 7502 | 50715 | 5624 | 54684 | 4577 | 55418 | 3796 | 54251 | 2635 | 64615 | 2046 | 37748 |
| 8L-3S | | MI | 30352 | 7502 | 48403 | 5550 | 52863 | 4517 | 54542 | 3734 | 55800 | 2592 | 66432 | 2324 | 33810 |
| 18-#11 | 1.53 | MA | 31649 | 7502 | 49821 | 5624 | 53491 | 4576 | 53915 | 3794 | 52279 | 2644 | 62086 | 1990 | 36909 |
| 9L-2S | | MI | 31142 | 7502 | 49599 | 5551 | 54387 | 4506 | 56395 | 3724 | 58311 | 2585 | 69792 | 2412 | 33795 |
| 18-#14 | 2.20 | MA | 38506 | 7943 | 62601 | 5857 | 69828 | 4731 | 73781 | 3870 | 79183 | 2574 | 97065 | 2391 | 56064 |
| 2L-9S | | MI | 28010 | 7943 | 45350 | 5852 | 48800 | 4740 | 49510 | 3870 | 48944 | 2572 | 58837 | 1639 | 43158 |
| 18-#14 | 2.20 | MA | 37196 | 7943 | 60591 | 5856 | 67266 | 4728 | 70666 | 3885 | 74962 | 2586 | 91356 | 2263 | 55988 |
| 3L-8S | | MI | 28652 | 7943 | 46535 | 5835 | 50267 | 4725 | 51357 | 3877 | 51356 | 2562 | 61843 | 1720 | 44319 |
| 18-#14 | 2.20 | MA | 36277 | 7943 | 58979 | 5875 | 65216 | 4745 | 68179 | 3881 | 71732 | 2598 | 87612 | 2135 | 55816 |
| 4L-7S | | MI | 29299 | 7943 | 47655 | 5837 | 51768 | 4729 | 53142 | 3863 | 53910 | 2572 | 64905 | 1792 | 45550 |
| 18-#14 | 2.20 | MA | 35455 | 7943 | 57567 | 5874 | 63395 | 4743 | 65948 | 3896 | 68550 | 2589 | 83713 | 2071 | 55063 |
| 5L-6S | | MI | 29955 | 7943 | 48876 | 5819 | 53256 | 4713 | 54964 | 3850 | 56347 | 2562 | 68135 | 1918 | 46287 |
| 18-#14 | 2.20 | MA | 34672 | 7943 | 56236 | 5874 | 61585 | 4760 | 63741 | 3892 | 65627 | 2601 | 79997 | 1987 | 53902 |
| 6L-5S | | MI | 30628 | 7943 | 50016 | 5821 | 54804 | 4717 | 56853 | 3856 | 58837 | 2552 | 71237 | 2003 | 47190 |
| 18-#14 | 2.20 | MA | 33908 | 7943 | 54810 | 5893 | 59848 | 4758 | 61612 | 3907 | 62767 | 2613 | 76131 | 1861 | 53029 |
| 7L-4S | | MI | 31333 | 7943 | 51224 | 5823 | 56362 | 4702 | 58761 | 3842 | 61548 | 2562 | 74514 | 2064 | 47863 |
| 18-#14 | 2.20 | MA | 33155 | 7943 | 53503 | 5892 | 58095 | 4775 | 59527 | 3923 | 59771 | 2605 | 72488 | 1786 | 51486 |
| 8L-3S | | MI | 32120 | 7943 | 52601 | 5806 | 58113 | 4706 | 60885 | 3849 | 64296 | 2552 | 77634 | 2192 | 47981 |
| 18-#14 | 2.20 | MA | 32367 | 7943 | 52220 | 5891 | 56382 | 4772 | 57370 | 3918 | 56941 | 2617 | 68887 | 1705 | 50089 |
| 9L-2S | | MI | 33233 | 7943 | 54312 | 5808 | 60294 | 4690 | 63537 | 3835 | 67878 | 2542 | 82408 | 2320 | 48027 |
| 18-#18 | 3.91 | MA | 39342 | 9060 | 67544 | 6549 | 75898 | 5261 | 81061 | 4202 | 88976 | 2506 | 111351 | 1612 | 92210 |
| 5L-6S | | MI | 32697 | 9060 | 56459 | 6481 | 62645 | 5197 | 66293 | 4138 | 71367 | 2452 | 88697 | 1349 | 76060 |
| 18-#18 | 3.91 | MA | 38016 | 9060 | 65200 | 6546 | 72715 | 5255 | 77178 | 4192 | 83835 | 2524 | 104920 | 1462 | 89147 |
| 6L-5S | | MI | 33836 | 9060 | 58462 | 6487 | 65365 | 5207 | 69609 | 4152 | 75681 | 2435 | 94038 | 1500 | 78719 |
| 18-#18 | 3.91 | MA | 36722 | 9060 | 62692 | 6578 | 69658 | 5284 | 73431 | 4217 | 78804 | 2542 | 98226 | 1237 | 86138 |
| 7L-4S | | MI | 35031 | 9060 | 60583 | 6493 | 68099 | 5182 | 72957 | 4131 | 80378 | 2452 | 99715 | 1606 | 80933 |
| 18-#18 | 3.91 | MA | 35445 | 9060 | 60391 | 6575 | 66572 | 5277 | 69763 | 4242 | 73534 | 2525 | 91892 | 1108 | 82007 |
| 8L-3S | | MI | 36364 | 9060 | 62998 | 6463 | 71169 | 5192 | 76682 | 4145 | 85137 | 2435 | 105080 | 1833 | 82878 |
| 20-#11 | 1.70 | MA | 36666 | 7613 | 58461 | 5667 | 64655 | 4595 | 67533 | 3788 | 70734 | 2603 | 85880 | 2453 | 43636 |
| 2L-10S | | MI | 27502 | 7613 | 43764 | 5653 | 46857 | 4591 | 47222 | 3793 | 45879 | 2608 | 54512 | 1859 | 34878 |
| 20-#11 | 1.70 | MA | 35740 | 7613 | 57058 | 5667 | 62866 | 4593 | 65358 | 3799 | 67787 | 2612 | 81870 | 2364 | 43616 |
| 3L-9S | | MI | 27998 | 7613 | 44542 | 5654 | 47891 | 4594 | 48459 | 3784 | 47556 | 2600 | 56564 | 1922 | 35411 |
| 20-#11 | 1.70 | MA | 35091 | 7613 | 55934 | 5680 | 61436 | 4606 | 63623 | 3797 | 65535 | 2621 | 79238 | 2275 | 43561 |
| 4L-8S | | MI | 28459 | 7613 | 45368 | 5641 | 48914 | 4583 | 49747 | 3787 | 49246 | 2593 | 58681 | 1979 | 36117 |
| 20-#11 | 1.70 | MA | 34511 | 7613 | 54950 | 5680 | 60167 | 4604 | 62068 | 3808 | 63316 | 2616 | 76505 | 2231 | 43452 |
| 5L-7S | | MI | 28916 | 7613 | 46149 | 5642 | 49961 | 4585 | 50992 | 3777 | 51035 | 2600 | 60832 | 2029 | 36453 |
| 20-#11 | 1.70 | MA | 33958 | 7613 | 54022 | 5680 | 58906 | 4617 | 60530 | 3805 | 61279 | 2624 | 73895 | 2172 | 42904 |
| 6E | | MI | 29379 | 7613 | 47000 | 5630 | 50998 | 4574 | 52263 | 3768 | 52742 | 2593 | 63106 | 2117 | 36886 |

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

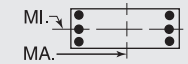
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.70 | MA | 33419 | 7613 | 53029 | 5693 | 57695 | 4615 | 59046 | 3816 | 59286 | 2633 | 71179 | 2085 | 42342 |
| 7L-5S | | MI | 29854 | 7613 | 47795 | 5631 | 52078 | 4576 | 53581 | 3771 | 54487 | 2586 | 65291 | 2175 | 37350 |
| 20-#11 | 1.70 | MA | 32888 | 7613 | 52119 | 5693 | 56474 | 4628 | 57593 | 3828 | 57198 | 2628 | 68624 | 2033 | 41927 |
| 8L-4S | | MI | 30352 | 7613 | 48638 | 5632 | 53165 | 4565 | 54912 | 3762 | 56385 | 2592 | 67593 | 2218 | 37419 |
| 20-#11 | 1.70 | MA | 32326 | 7613 | 51225 | 5693 | 55280 | 4626 | 56090 | 3825 | 55226 | 2637 | 66095 | 1977 | 41042 |
| 9L-3S | | MI | 30908 | 7613 | 49599 | 5619 | 54387 | 4568 | 56395 | 3765 | 58311 | 2585 | 69792 | 2307 | 37448 |
| 20-#11 | 1.70 | MA | 31741 | 7613 | 50248 | 5706 | 54074 | 4638 | 54647 | 3836 | 53268 | 2646 | 63641 | 1913 | 40365 |
| 10L-2S | | MI | 31695 | 7613 | 50795 | 5620 | 55912 | 4556 | 58249 | 3756 | 60822 | 2578 | 73152 | 2396 | 37446 |
| 20-#14 | 2.45 | MA | 38121 | 8102 | 62601 | 5956 | 69828 | 4801 | 73781 | 3930 | 79183 | 2576 | 97065 | 2242 | 62068 |
| 3L-9S | | MI | 28814 | 8102 | 47061 | 5952 | 50981 | 4813 | 52162 | 3915 | 52526 | 2561 | 63611 | 1613 | 48106 |
| 20-#14 | 2.45 | MA | 37208 | 8102 | 60989 | 5975 | 67779 | 4818 | 71294 | 3926 | 75953 | 2588 | 93321 | 2114 | 61872 |
| 4L-8S | | MI | 29451 | 8102 | 48246 | 5934 | 52448 | 4797 | 54009 | 3922 | 54939 | 2551 | 66616 | 1695 | 49325 |
| 20-#14 | 2.45 | MA | 36391 | 8102 | 59578 | 5974 | 65958 | 4815 | 69064 | 3941 | 72771 | 2580 | 89423 | 2051 | 60972 |
| 5L-7S | | MI | 30095 | 8102 | 49366 | 5937 | 53949 | 4801 | 55793 | 3908 | 57492 | 2561 | 69678 | 1766 | 50516 |
| 20-#14 | 2.45 | MA | 35613 | 8102 | 58246 | 5973 | 64148 | 4833 | 66856 | 3937 | 69848 | 2591 | 85707 | 1966 | 59855 |
| 6E | | MI | 30747 | 8102 | 50587 | 5919 | 55437 | 4786 | 57616 | 3895 | 59929 | 2551 | 72908 | 1893 | 51344 |
| 20-#14 | 2.45 | MA | 34854 | 8102 | 56821 | 5992 | 62411 | 4830 | 64727 | 3952 | 66988 | 2603 | 81841 | 1840 | 58892 |
| 7L-5S | | MI | 31416 | 8102 | 51727 | 5921 | 56986 | 4790 | 59505 | 3901 | 62420 | 2541 | 76010 | 1978 | 52209 |
| 20-#14 | 2.45 | MA | 34106 | 8102 | 55514 | 5992 | 60658 | 4847 | 62642 | 3968 | 63992 | 2595 | 78197 | 1766 | 57392 |
| 8L-4S | | MI | 32117 | 8102 | 52935 | 5923 | 58543 | 4774 | 61412 | 3887 | 65130 | 2551 | 79288 | 2039 | 53019 |
| 20-#14 | 2.45 | MA | 33335 | 8102 | 54230 | 5991 | 58945 | 4845 | 60486 | 3963 | 61162 | 2607 | 74597 | 1685 | 55939 |
| 9L-3S | | MI | 32899 | 8102 | 54312 | 5905 | 60294 | 4778 | 63537 | 3894 | 67878 | 2541 | 82408 | 2167 | 53160 |
| 20-#14 | 2.45 | MA | 32498 | 8102 | 52829 | 6010 | 57214 | 4862 | 58414 | 3979 | 58353 | 2619 | 71105 | 1593 | 54291 |
| 10L-2S | | MI | 34006 | 8102 | 56023 | 5908 | 62475 | 4763 | 66189 | 3880 | 71460 | 2531 | 87181 | 2295 | 53225 |
| 20-#18 | 4.35 | MA | 39613 | 9343 | 68724 | 6723 | 77207 | 5383 | 82639 | 4271 | 91234 | 2506 | 114812 | 1420 | 99385 |
| 6E | | MI | 34038 | 9343 | 59451 | 6659 | 66460 | 5326 | 70929 | 4218 | 77572 | 2430 | 96927 | 1297 | 84703 |
| 20-#18 | 4.35 | MA | 38331 | 9343 | 66215 | 6756 | 74150 | 5412 | 78892 | 4297 | 86202 | 2524 | 108117 | 1195 | 96375 |
| 7L-5S | | MI | 35167 | 9343 | 61454 | 6664 | 69179 | 5336 | 74246 | 4232 | 81886 | 2412 | 102269 | 1448 | 87518 |
| 20-#18 | 4.35 | MA | 37068 | 9343 | 63914 | 6753 | 71065 | 5406 | 75224 | 4322 | 80932 | 2507 | 101783 | 1066 | 92248 |
| 8L-4S | | MI | 36351 | 9343 | 63575 | 6670 | 71914 | 5310 | 77593 | 4211 | 86583 | 2430 | 107945 | 1554 | 89628 |
| 22-#11 | 1.87 | MA | 36397 | 7723 | 58461 | 5736 | 64655 | 4643 | 67533 | 3830 | 70734 | 2605 | 85880 | 2351 | 47874 |
| 3L-10S | | MI | 28071 | 7723 | 44960 | 5722 | 48382 | 4642 | 49076 | 3825 | 48390 | 2601 | 57872 | 1842 | 38368 |
| 22-#11 | 1.87 | MA | 35751 | 7723 | 57338 | 5749 | 63226 | 4656 | 65798 | 3828 | 68482 | 2614 | 83248 | 2262 | 47807 |
| 4L-9S | | MI | 28566 | 7723 | 45738 | 5723 | 49415 | 4644 | 50313 | 3815 | 50068 | 2594 | 59924 | 1906 | 38926 |
| 22-#11 | 1.87 | MA | 35173 | 7723 | 56354 | 5749 | 61957 | 4654 | 64243 | 3839 | 66263 | 2609 | 80515 | 2218 | 47684 |
| 5L-8S | | MI | 29024 | 7723 | 46564 | 5710 | 50438 | 4633 | 51601 | 3819 | 51757 | 2586 | 62041 | 1962 | 39610 |
| 22-#11 | 1.87 | MA | 34623 | 7723 | 55426 | 5749 | 60695 | 4667 | 62705 | 3836 | 64226 | 2618 | 77904 | 2159 | 47061 |
| 6L-7S | | MI | 29478 | 7723 | 47345 | 5711 | 51485 | 4635 | 52846 | 3809 | 53546 | 2593 | 64192 | 2013 | 40007 |
| 22-#11 | 1.87 | MA | 34087 | 7723 | 54433 | 5763 | 59485 | 4665 | 61221 | 3848 | 62233 | 2626 | 75188 | 2072 | 46516 |
| 7L-6S | | MI | 29939 | 7723 | 48196 | 5699 | 52523 | 4624 | 54117 | 3799 | 55253 | 2586 | 66466 | 2100 | 40424 |
| 22-#11 | 1.87 | MA | 33558 | 7723 | 53522 | 5762 | 58263 | 4678 | 59768 | 3859 | 60145 | 2621 | 72634 | 2020 | 46042 |
| 8L-5S | | MI | 30412 | 7723 | 48991 | 5700 | 53603 | 4627 | 55435 | 3803 | 56998 | 2579 | 68651 | 2159 | 40959 |
| 22-#11 | 1.87 | MA | 33000 | 7723 | 52628 | 5762 | 57070 | 4676 | 58265 | 3856 | 58172 | 2630 | 70104 | 1964 | 45179 |
| 9L-4S | | MI | 30908 | 7723 | 49834 | 5701 | 54690 | 4615 | 56766 | 3793 | 58897 | 2585 | 70953 | 2202 | 41041 |
| 22-#11 | 1.87 | MA | 32417 | 7723 | 51652 | 5776 | 55864 | 4689 | 56822 | 3867 | 56215 | 2639 | 67650 | 1900 | 44500 |
| 10L-3S | | MI | 31461 | 7723 | 50795 | 5688 | 55912 | 4618 | 58249 | 3797 | 60822 | 2578 | 73152 | 2291 | 41082 |
| 22-#11 | 1.87 | MA | 31848 | 7723 | 50758 | 5775 | 54677 | 4687 | 55336 | 3865 | 54156 | 2634 | 65156 | 1845 | 43467 |
| 11L-2S | | MI | 32245 | 7723 | 51991 | 5690 | 57437 | 4606 | 60103 | 3787 | 63334 | 2571 | 76512 | 2380 | 41094 |
| 22-#14 | 2.69 | MA | 38133 | 8262 | 62999 | 6075 | 70342 | 4890 | 74409 | 3970 | 80174 | 2578 | 99031 | 2094 | 67925 |
| 4L-9S | | MI | 29613 | 8262 | 48772 | 6052 | 53163 | 4885 | 54814 | 3960 | 56108 | 2551 | 68385 | 1588 | 53064 |
| 22-#14 | 2.69 | MA | 37321 | 8262 | 61588 | 6074 | 68521 | 4888 | 72179 | 3986 | 76991 | 2570 | 95132 | 2030 | 66893 |
| 5L-8S | | MI | 30246 | 8262 | 49957 | 6034 | 54630 | 4869 | 56660 | 3967 | 58521 | 2541 | 71390 | 1669 | 54339 |
| 22-#14 | 2.69 | MA | 36548 | 8262 | 60256 | 6073 | 66711 | 4905 | 69972 | 3982 | 74068 | 2581 | 91416 | 1946 | 65815 |
| 6L-7S | | MI | 30886 | 8262 | 51077 | 6036 | 56131 | 4874 | 58445 | 3953 | 61074 | 2551 | 74452 | 1741 | 55493 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

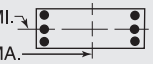
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 2.69 | MA | 35794 | 8262 | 58831 | 6092 | 64974 | 4902 | 67843 | 3997 | 71209 | 2593 | 87550 | 1820 | 64764 |
| 7L-6S | | MI | 31534 | 8262 | 52297 | 6019 | 57618 | 4858 | 60268 | 3939 | 63511 | 2541 | 77682 | 1867 | 56407 |
| 22-#14 | 2.69 | MA | 35051 | 8262 | 57524 | 6091 | 63221 | 4920 | 65758 | 4012 | 68213 | 2585 | 83906 | 1745 | 63305 |
| 8L-5S | | MI | 32198 | 8262 | 53438 | 6021 | 59167 | 4862 | 62157 | 3946 | 66002 | 2531 | 80784 | 1952 | 57239 |
| 22-#14 | 2.69 | MA | 34282 | 8262 | 56240 | 6091 | 61508 | 4917 | 63601 | 4008 | 65383 | 2597 | 80306 | 1664 | 61798 |
| 9L-4S | | MI | 32895 | 8262 | 54646 | 6023 | 60725 | 4846 | 64064 | 3932 | 68712 | 2541 | 84061 | 2013 | 58172 |
| 22-#14 | 2.69 | MA | 33452 | 8262 | 54839 | 6110 | 59777 | 4934 | 61530 | 4024 | 62574 | 2609 | 76814 | 1573 | 60185 |
| 10L-3S | | MI | 33673 | 8262 | 56023 | 6005 | 62475 | 4851 | 66189 | 3939 | 71460 | 2531 | 87181 | 2141 | 58334 |
| 22-#18 | 4.78 | MA | 39927 | 9627 | 69739 | 6933 | 78642 | 5541 | 84353 | 4376 | 93601 | 2507 | 118009 | 1153 | 106532 |
| 7L-6S | | MI | 35368 | 9627 | 62442 | 6836 | 70274 | 5455 | 75566 | 4298 | 83777 | 2408 | 105158 | 1245 | 93366 |
| 22-#18 | 4.78 | MA | 38675 | 9627 | 67438 | 6930 | 75557 | 5534 | 80685 | 4402 | 88331 | 2490 | 111675 | 1024 | 102504 |
| 8L-5S | | MI | 36488 | 9627 | 64446 | 6842 | 72993 | 5464 | 78882 | 4312 | 88091 | 2390 | 110500 | 1396 | 96331 |
| 24-#11 | 2.03 | MA | 36407 | 7834 | 58741 | 5819 | 65015 | 4706 | 67973 | 3859 | 71429 | 2607 | 87257 | 2249 | 52050 |
| 4L-10S | | MI | 28637 | 7834 | 46156 | 5791 | 49907 | 4692 | 50929 | 3856 | 50902 | 2594 | 61232 | 1826 | 41848 |
| 24-#11 | 2.03 | MA | 35832 | 7834 | 57757 | 5818 | 63746 | 4705 | 66419 | 3870 | 69210 | 2602 | 84524 | 2204 | 51913 |
| 5L-9S | | MI | 29137 | 7834 | 46934 | 5792 | 50940 | 4694 | 52166 | 3846 | 52579 | 2587 | 63284 | 1890 | 42445 |
| 24-#11 | 2.03 | MA | 35285 | 7834 | 56829 | 5818 | 62485 | 4717 | 64880 | 3868 | 67173 | 2611 | 81913 | 2146 | 51222 |
| 6L-8S | | MI | 29585 | 7834 | 47760 | 5780 | 51963 | 4683 | 53454 | 3850 | 54269 | 2580 | 65401 | 1946 | 43110 |
| 24-#11 | 2.03 | MA | 34751 | 7834 | 55836 | 5832 | 61274 | 4715 | 63396 | 3879 | 65180 | 2619 | 79198 | 2059 | 50694 |
| 7E | | MI | 30038 | 7834 | 48541 | 5781 | 53010 | 4685 | 54699 | 3840 | 56057 | 2586 | 67552 | 1996 | 43563 |
| 24-#11 | 2.03 | MA | 34225 | 7834 | 54926 | 5831 | 60053 | 4728 | 61943 | 3890 | 63092 | 2614 | 76643 | 2007 | 50163 |
| 8L-6S | | MI | 30497 | 7834 | 49392 | 5768 | 54048 | 4674 | 55971 | 3830 | 57765 | 2579 | 69826 | 2084 | 43967 |
| 24-#11 | 2.03 | MA | 33669 | 7834 | 54032 | 5831 | 58859 | 4726 | 60440 | 3887 | 61119 | 2623 | 74113 | 1951 | 49321 |
| 9L-5S | | MI | 30967 | 7834 | 50187 | 5769 | 55128 | 4677 | 57288 | 3834 | 59509 | 2572 | 72011 | 2143 | 44565 |
| 24-#11 | 2.03 | MA | 33089 | 7834 | 53055 | 5845 | 57653 | 4739 | 58997 | 3898 | 59162 | 2632 | 71659 | 1887 | 48603 |
| 10L-4S | | MI | 31461 | 7834 | 51030 | 5770 | 56215 | 4665 | 58619 | 3824 | 61408 | 2579 | 74313 | 2186 | 44660 |
| 24-#11 | 2.03 | MA | 32522 | 7834 | 52162 | 5845 | 56467 | 4737 | 57511 | 3896 | 57103 | 2627 | 69165 | 1832 | 47591 |
| 11L-3S | | MI | 32012 | 7834 | 51991 | 5758 | 57437 | 4668 | 60103 | 3828 | 63334 | 2571 | 76512 | 2275 | 44712 |
| 24-#11 | 2.03 | MA | 31965 | 7834 | 51201 | 5858 | 55269 | 4750 | 56071 | 3907 | 55149 | 2636 | 66421 | 1758 | 46626 |
| 12L-2S | | MI | 32793 | 7834 | 53187 | 5759 | 58962 | 4657 | 61956 | 3818 | 65845 | 2564 | 79872 | 2363 | 44734 |
| 24-#14 | 2.93 | MA | 38246 | 8421 | 63598 | 6174 | 71084 | 4960 | 75295 | 4031 | 81212 | 2560 | 100841 | 2010 | 72822 |
| 5L-9S | | MI | 30406 | 8421 | 50483 | 6152 | 55344 | 4957 | 57465 | 4005 | 59690 | 2540 | 73158 | 1562 | 58029 |
| 24-#14 | 2.93 | MA | 37478 | 8421 | 62266 | 6173 | 69274 | 4977 | 73087 | 4026 | 78289 | 2572 | 97125 | 1926 | 71780 |
| 6L-8S | | MI | 31036 | 8421 | 51668 | 6134 | 56811 | 4942 | 59312 | 4011 | 62103 | 2530 | 76163 | 1644 | 59359 |
| 24-#14 | 2.93 | MA | 36729 | 8421 | 60841 | 6192 | 67537 | 4975 | 70958 | 4042 | 75429 | 2583 | 93259 | 1799 | 70646 |
| 7E | | MI | 31672 | 8421 | 52788 | 6136 | 58312 | 4946 | 61097 | 3998 | 64656 | 2540 | 79225 | 1715 | 60478 |
| 24-#14 | 2.93 | MA | 35990 | 8421 | 59534 | 6191 | 65784 | 4992 | 68873 | 4057 | 72433 | 2575 | 89616 | 1725 | 69225 |
| 8L-6S | | MI | 32316 | 8421 | 54008 | 6118 | 59800 | 4930 | 62920 | 3984 | 67093 | 2530 | 82455 | 1842 | 61476 |
| 24-#14 | 2.93 | MA | 35222 | 8421 | 58251 | 6190 | 64071 | 4989 | 66716 | 4053 | 69603 | 2587 | 86015 | 1644 | 67665 |
| 9L-5S | | MI | 32977 | 8421 | 55149 | 6121 | 61348 | 4934 | 64808 | 3991 | 69584 | 2520 | 85557 | 1927 | 62276 |
| 24-#14 | 2.93 | MA | 34401 | 8421 | 56850 | 6209 | 62340 | 5007 | 64645 | 4068 | 66795 | 2599 | 82524 | 1553 | 66086 |
| 10L-4S | | MI | 33669 | 8421 | 56357 | 6123 | 62906 | 4919 | 66716 | 3977 | 72294 | 2530 | 88835 | 1988 | 63321 |
| 24-#18 | 5.22 | MA | 40270 | 9911 | 70961 | 7107 | 80049 | 5663 | 86146 | 4481 | 95730 | 2472 | 121566 | 982 | 112775 |
| 8L-6S | | MI | 36689 | 9911 | 65434 | 7013 | 74088 | 5583 | 80203 | 4378 | 89982 | 2386 | 113389 | 1193 | 102048 |

## RECTANGULAR TIED COLUMNS 40" x 48"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.25 | MA | 37909 | 7640 | 59662 | 5689 | 65074 | 4628 | 66969 | 3843 | 68087 | 2716 | 80955 | 2559 | 34968 |
| 2L-3S | | MI | 29393 | 7640 | 46746 | 5611 | 50052 | 4594 | 50583 | 3814 | 49451 | 2682 | 57401 | 2256 | 28767 |
| 6-#18 | 1.25 | MA | 35445 | 7640 | 55961 | 5686 | 60355 | 4658 | 61233 | 3869 | 60317 | 2736 | 70509 | 2331 | 34990 |
| 3L-2S | | MI | 31377 | 7640 | 49738 | 5617 | 53866 | 4569 | 55220 | 3793 | 55656 | 2664 | 65631 | 2484 | 28678 |
| 8-#18 | 1.67 | MA | 39633 | 7924 | 63363 | 5866 | 69792 | 4757 | 72704 | 3923 | 75858 | 2699 | 91401 | 2519 | 46274 |
| 2L-4S | | MI | 29382 | 7924 | 47324 | 5818 | 50796 | 4713 | 51495 | 3880 | 50896 | 2677 | 60266 | 1977 | 37600 |
| 8-#18 | 1.67 | MA | 37194 | 7924 | 59662 | 5864 | 65074 | 4786 | 66969 | 3949 | 68087 | 2718 | 80955 | 2292 | 46198 |
| 3E | | MI | 30781 | 7924 | 49738 | 5788 | 53866 | 4723 | 55220 | 3894 | 55656 | 2659 | 65631 | 2204 | 37859 |
| 8-#18 | 1.67 | MA | 35474 | 7924 | 56691 | 5897 | 61296 | 4781 | 62383 | 3940 | 62134 | 2738 | 74113 | 2064 | 45730 |
| 4L-2S | | MI | 32747 | 7924 | 52730 | 5794 | 57680 | 4697 | 59856 | 3872 | 61861 | 2642 | 73862 | 2432 | 37849 |

## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

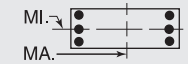
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.17 | MA | 37695 | 7587 | 58938 | 5688 | 64366 | 4631 | 66192 | 3851 | 67070 | 2737 | 79945 | 2599 | 33088 |
| 2L-5S | | MI | 28555 | 7587 | 44864 | 5636 | 47847 | 4604 | 47971 | 3826 | 46058 | 2709 | 53857 | 2216 | 27150 |
| 10-#14 | 1.17 | MA | 36285 | 7587 | 56828 | 5687 | 61676 | 4628 | 62922 | 3867 | 62640 | 2750 | 73923 | 2471 | 33118 |
| 3L-4S | | MI | 29280 | 7587 | 46072 | 5638 | 49405 | 4588 | 49879 | 3812 | 48769 | 2719 | 57135 | 2277 | 27236 |
| 10-#14 | 1.17 | MA | 35294 | 7587 | 55138 | 5707 | 59527 | 4646 | 60313 | 3863 | 59253 | 2762 | 69971 | 2343 | 33067 |
| 4L-3S | | MI | 30087 | 7587 | 47449 | 5620 | 51155 | 4592 | 52003 | 3818 | 51517 | 2709 | 60255 | 2405 | 27223 |
| 10-#14 | 1.17 | MA | 34408 | 7587 | 53659 | 5706 | 57619 | 4644 | 57975 | 3879 | 55917 | 2755 | 65865 | 2278 | 32874 |
| 5L-2S | | MI | 31226 | 7587 | 49160 | 5622 | 53337 | 4577 | 54655 | 3805 | 55099 | 2699 | 65028 | 2533 | 27172 |
| 10-#18 | 2.08 | MA | 41337 | 8208 | 67063 | 6043 | 74510 | 4885 | 78440 | 4003 | 83629 | 2681 | 101847 | 2480 | 57541 |
| 2L-5S | | MI | 29524 | 8208 | 48194 | 5990 | 51876 | 4867 | 52784 | 3981 | 52404 | 2637 | 62821 | 1819 | 44002 |
| 10-#18 | 2.08 | MA | 38920 | 8208 | 63363 | 6041 | 69792 | 4915 | 72704 | 4029 | 75858 | 2700 | 91401 | 2252 | 57379 |
| 3L-4S | | MI | 30768 | 8208 | 50315 | 5995 | 54610 | 4842 | 56132 | 3960 | 57101 | 2655 | 68497 | 1924 | 46565 |
| 10-#18 | 2.08 | MA | 37219 | 8208 | 60392 | 6074 | 66014 | 4909 | 68119 | 4020 | 69905 | 2720 | 84559 | 2025 | 56815 |
| 4L-3S | | MI | 32154 | 8208 | 52730 | 5966 | 57680 | 4852 | 59856 | 3974 | 61861 | 2637 | 73862 | 2152 | 46916 |
| 10-#18 | 2.08 | MA | 35695 | 8208 | 57788 | 6072 | 62655 | 4939 | 64006 | 4046 | 64037 | 2704 | 77412 | 1913 | 53549 |
| 5L-2S | | MI | 34102 | 8208 | 55721 | 5971 | 61494 | 4826 | 64493 | 3952 | 68066 | 2620 | 82093 | 2379 | 46986 |
| 12-#14 | 1.41 | MA | 38690 | 7747 | 61048 | 5787 | 67056 | 4703 | 69462 | 3895 | 71500 | 2727 | 85966 | 2580 | 39533 |
| 2L-6S | | MI | 28679 | 7747 | 45435 | 5733 | 48480 | 4672 | 48734 | 3864 | 47150 | 2708 | 55529 | 2106 | 31345 |
| 12-#14 | 1.41 | MA | 37289 | 7747 | 58938 | 5787 | 64366 | 4701 | 66192 | 3911 | 67070 | 2740 | 79945 | 2452 | 39533 |
| 3L-5S | | MI | 29366 | 7747 | 46575 | 5736 | 50028 | 4676 | 50623 | 3870 | 49641 | 2698 | 58631 | 2190 | 32302 |
| 12-#14 | 1.41 | MA | 36305 | 7747 | 57248 | 5807 | 62217 | 4719 | 63583 | 3908 | 63683 | 2752 | 75992 | 2324 | 39447 |
| 4E | | MI | 30086 | 7747 | 47783 | 5738 | 51586 | 4660 | 52531 | 3857 | 52351 | 2708 | 61909 | 2252 | 32425 |
| 12-#14 | 1.41 | MA | 35424 | 7747 | 55769 | 5806 | 60309 | 4716 | 61246 | 3924 | 60347 | 2745 | 71886 | 2259 | 39216 |
| 5L-3S | | MI | 30888 | 7747 | 49160 | 5720 | 53337 | 4665 | 54655 | 3863 | 55099 | 2698 | 65028 | 2380 | 32449 |
| 12-#14 | 1.41 | MA | 34585 | 7747 | 54373 | 5806 | 58412 | 4734 | 58932 | 3920 | 57284 | 2757 | 67965 | 2175 | 37949 |
| 6L-2S | | MI | 32021 | 7747 | 50871 | 5722 | 55518 | 4649 | 57307 | 3850 | 58681 | 2688 | 69802 | 2508 | 32415 |
| 12-#18 | 2.50 | MA | 43022 | 8491 | 70764 | 6221 | 79229 | 5014 | 84176 | 4082 | 91400 | 2663 | 112293 | 2440 | 68778 |
| 2L-6S | | MI | 29731 | 8491 | 49182 | 6161 | 52971 | 4986 | 54104 | 4047 | 54295 | 2633 | 65710 | 1615 | 50777 |
| 12-#18 | 2.50 | MA | 40627 | 8491 | 67063 | 6218 | 74510 | 5043 | 78440 | 4109 | 83629 | 2683 | 101847 | 2213 | 68545 |
| 3L-5S | | MI | 30907 | 8491 | 51186 | 6167 | 55690 | 4996 | 57420 | 4061 | 58609 | 2615 | 71051 | 1767 | 52715 |
| 12-#18 | 2.50 | MA | 38943 | 8491 | 64093 | 6251 | 70732 | 5038 | 73855 | 4100 | 77676 | 2702 | 95005 | 1985 | 67897 |
| 4E | | MI | 32139 | 8491 | 53307 | 6173 | 58425 | 4970 | 60768 | 4040 | 63306 | 2633 | 76728 | 1872 | 55382 |
| 12-#18 | 2.50 | MA | 37436 | 8491 | 61489 | 6249 | 67374 | 5068 | 69742 | 4126 | 71808 | 2686 | 87858 | 1873 | 64385 |
| 5L-3S | | MI | 33512 | 8491 | 55721 | 6143 | 61494 | 4980 | 64493 | 4054 | 68066 | 2615 | 82093 | 2100 | 55951 |
| 12-#18 | 2.50 | MA | 35999 | 8491 | 59031 | 6247 | 64036 | 5062 | 65670 | 4117 | 66416 | 2706 | 81063 | 1724 | 61935 |
| 6L-2S | | MI | 35444 | 8491 | 58713 | 6149 | 65308 | 4955 | 69130 | 4032 | 74271 | 2597 | 90324 | 2327 | 56089 |
| 14-#11 | 1.14 | MA | 37603 | 7564 | 58609 | 5689 | 64057 | 4633 | 65857 | 3855 | 66636 | 2747 | 79528 | 2618 | 32263 |
| 2L-7S | | MI | 28342 | 7564 | 44249 | 5649 | 47154 | 4611 | 47158 | 3834 | 45053 | 2736 | 52471 | 2189 | 25947 |
| 14-#11 | 1.14 | MA | 36617 | 7564 | 57137 | 5689 | 62179 | 4632 | 63575 | 3867 | 63544 | 2756 | 75302 | 2529 | 32285 |
| 3L-6S | | MI | 28813 | 7564 | 45100 | 5637 | 48191 | 4600 | 48429 | 3824 | 46761 | 2729 | 54745 | 2277 | 26449 |
| 14-#11 | 1.14 | MA | 35926 | 7564 | 55959 | 5703 | 60681 | 4645 | 61756 | 3865 | 61182 | 2766 | 72525 | 2440 | 32276 |
| 4L-5S | | MI | 29295 | 7564 | 45896 | 5638 | 49272 | 4602 | 49747 | 3828 | 48505 | 2721 | 56930 | 2336 | 26556 |
| 14-#11 | 1.14 | MA | 35308 | 7564 | 54928 | 5703 | 59351 | 4644 | 60127 | 3876 | 58857 | 2761 | 69649 | 2395 | 32217 |
| 5L-4S | | MI | 29801 | 7564 | 46738 | 5639 | 50359 | 4591 | 51078 | 3818 | 50404 | 2728 | 59232 | 2379 | 26568 |
| 14-#11 | 1.14 | MA | 34720 | 7564 | 53956 | 5703 | 58029 | 4656 | 58515 | 3874 | 56722 | 2770 | 66895 | 2337 | 32026 |
| 6L-3S | | MI | 30365 | 7564 | 47700 | 5626 | 51581 | 4594 | 52561 | 3822 | 52330 | 2721 | 61431 | 2467 | 26546 |
| 14-#11 | 1.14 | MA | 34145 | 7564 | 52915 | 5717 | 56761 | 4655 | 56960 | 3885 | 54634 | 2780 | 64033 | 2249 | 31338 |
| 7L-2S | | MI | 31162 | 7564 | 48896 | 5627 | 53106 | 4582 | 54414 | 3812 | 54841 | 2714 | 64791 | 2556 | 26512 |
| 14-#14 | 1.64 | MA | 39679 | 7906 | 63158 | 5887 | 69746 | 4775 | 72732 | 3940 | 75930 | 2717 | 91988 | 2561 | 45969 |
| 2L-7S | | MI | 28822 | 7906 | 45925 | 5851 | 49173 | 4760 | 49563 | 3923 | 48295 | 2708 | 57073 | 1954 | 35749 |
| 14-#14 | 1.64 | MA | 38285 | 7906 | 61048 | 5887 | 67056 | 4773 | 69462 | 3956 | 71500 | 2730 | 85966 | 2433 | 45937 |
| 3L-6S | | MI | 29488 | 7906 | 47146 | 5833 | 50661 | 4744 | 51386 | 3909 | 50732 | 2698 | 60302 | 2080 | 36375 |
| 14-#14 | 1.64 | MA | 37308 | 7906 | 59358 | 5906 | 64907 | 4791 | 66853 | 3953 | 68113 | 2742 | 82014 | 2305 | 45820 |
| 4L-5S | | MI | 30171 | 7906 | 48286 | 5835 | 52210 | 4748 | 53275 | 3915 | 53223 | 2688 | 63404 | 2165 | 37392 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis

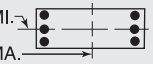


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 1.64 | MA | 36433 | 7906 | 57879 | 5906 | 62999 | 4789 | 64516 | 3969 | 64777 | 2735 | 77908 | 2240 | 45554 |
| 5L-4S | | MI | 30886 | 7906 | 49494 | 5837 | 53767 | 4733 | 55182 | 3902 | 55933 | 2698 | 66682 | 2226 | 37603 |
| 14-#14 | 1.64 | MA | 35600 | 7906 | 56483 | 5905 | 61102 | 4806 | 62202 | 3965 | 61714 | 2747 | 73987 | 2156 | 44172 |
| 6L-3S | | MI | 31684 | 7906 | 50871 | 5820 | 55518 | 4737 | 57307 | 3908 | 58681 | 2688 | 69802 | 2354 | 37658 |
| 14-#14 | 1.64 | MA | 34787 | 7906 | 54989 | 5925 | 59282 | 4804 | 59971 | 3981 | 58717 | 2760 | 69909 | 2030 | 43298 |
| 7L-2S | | MI | 32810 | 7906 | 52582 | 5822 | 57699 | 4721 | 59958 | 3895 | 62263 | 2678 | 74576 | 2482 | 37646 |
| 14-#18 | 2.92 | MA | 42316 | 8775 | 70764 | 6396 | 79229 | 5172 | 84176 | 4188 | 91400 | 2665 | 112293 | 2173 | 79699 |
| 3L-6S | | MI | 31111 | 8775 | 52174 | 6339 | 56785 | 5115 | 58741 | 4127 | 60500 | 2611 | 73941 | 1563 | 59336 |
| 14-#18 | 2.92 | MA | 40649 | 8775 | 67793 | 6429 | 75451 | 5166 | 79591 | 4179 | 85447 | 2685 | 105451 | 1946 | 78698 |
| 4L-5S | | MI | 32276 | 8775 | 54178 | 6344 | 59504 | 5124 | 62057 | 4141 | 64814 | 2593 | 79282 | 1714 | 61456 |
| 14-#18 | 2.92 | MA | 39157 | 8775 | 65190 | 6426 | 72092 | 5196 | 75478 | 4206 | 79578 | 2669 | 98304 | 1834 | 75249 |
| 5L-4S | | MI | 33497 | 8775 | 56299 | 6350 | 62239 | 5099 | 65405 | 4119 | 69511 | 2611 | 84959 | 1820 | 63975 |
| 14-#18 | 2.92 | MA | 37736 | 8775 | 62732 | 6424 | 68754 | 5190 | 71406 | 4197 | 74187 | 2688 | 91509 | 1684 | 72625 |
| 6L-3S | | MI | 34857 | 8775 | 58713 | 6320 | 65308 | 5109 | 69130 | 4133 | 74271 | 2593 | 90324 | 2048 | 64972 |
| 14-#18 | 2.92 | MA | 36348 | 8775 | 60103 | 6457 | 65549 | 5220 | 67478 | 4223 | 68911 | 2708 | 84437 | 1459 | 69120 |
| 7L-2S | | MI | 36774 | 8775 | 61705 | 6326 | 69122 | 5083 | 73766 | 4112 | 80476 | 2575 | 98555 | 2275 | 65167 |
| 16-#11 | 1.30 | MA | 38302 | 7674 | 60082 | 5759 | 65934 | 4684 | 68140 | 3886 | 69728 | 2740 | 83754 | 2606 | 36761 |
| 2L-8S | | MI | 28452 | 7674 | 44664 | 5717 | 47632 | 4659 | 47766 | 3875 | 45776 | 2722 | 53680 | 2123 | 29161 |
| 16-#11 | 1.30 | MA | 37321 | 7674 | 58609 | 5759 | 64057 | 4682 | 65857 | 3898 | 66636 | 2750 | 79528 | 2517 | 36773 |
| 3L-7S | | MI | 28914 | 7674 | 45445 | 5718 | 48679 | 4661 | 49011 | 3865 | 47565 | 2729 | 55831 | 2173 | 29488 |
| 16-#11 | 1.30 | MA | 36633 | 7674 | 57431 | 5772 | 62558 | 4695 | 64039 | 3896 | 64275 | 2759 | 76751 | 2428 | 36744 |
| 4L-6S | | MI | 29383 | 7674 | 46296 | 5706 | 49716 | 4650 | 50283 | 3855 | 49272 | 2722 | 58105 | 2261 | 29967 |
| 16-#11 | 1.30 | MA | 36018 | 7674 | 56400 | 5772 | 61228 | 4694 | 62410 | 3907 | 61949 | 2754 | 73875 | 2383 | 36667 |
| 5E | | MI | 29863 | 7674 | 47092 | 5707 | 50797 | 4652 | 51600 | 3859 | 51017 | 2715 | 60290 | 2319 | 30181 |
| 16-#11 | 1.30 | MA | 35432 | 7674 | 55428 | 5772 | 59907 | 4707 | 60798 | 3905 | 59814 | 2764 | 71121 | 2325 | 36367 |
| 6L-4S | | MI | 30366 | 7674 | 47935 | 5708 | 51884 | 4641 | 52931 | 3849 | 52915 | 2721 | 62592 | 2362 | 30211 |
| 16-#11 | 1.30 | MA | 34861 | 7674 | 54388 | 5786 | 58639 | 4705 | 59243 | 3917 | 57726 | 2773 | 68258 | 2237 | 35706 |
| 7L-3S | | MI | 30928 | 7674 | 48896 | 5695 | 53106 | 4644 | 54414 | 3853 | 54841 | 2714 | 64791 | 2451 | 30202 |
| 16-#11 | 1.30 | MA | 34291 | 7674 | 53434 | 5786 | 57359 | 4718 | 57721 | 3928 | 55538 | 2768 | 65569 | 2185 | 35239 |
| 8L-2S | | MI | 31722 | 7674 | 50092 | 5696 | 54630 | 4632 | 56268 | 3843 | 57352 | 2707 | 68151 | 2540 | 30176 |
| 16-#14 | 1.88 | MA | 40661 | 8066 | 65268 | 5987 | 72436 | 4848 | 76002 | 3985 | 80360 | 2707 | 98009 | 2542 | 52387 |
| 2L-8S | | MI | 28976 | 8066 | 46516 | 5948 | 49854 | 4828 | 50430 | 3981 | 49324 | 2687 | 58784 | 1856 | 39607 |
| 16-#14 | 1.88 | MA | 39275 | 8066 | 63158 | 5987 | 69746 | 4845 | 72732 | 4001 | 75930 | 2720 | 91988 | 2414 | 52333 |
| 3L-7S | | MI | 29629 | 8066 | 47636 | 5951 | 51355 | 4832 | 52215 | 3967 | 51877 | 2697 | 61846 | 1928 | 40813 |
| 16-#14 | 1.88 | MA | 38303 | 8066 | 61468 | 6006 | 67597 | 4863 | 70123 | 3997 | 72544 | 2732 | 88035 | 2286 | 52187 |
| 4L-6S | | MI | 30291 | 8066 | 48857 | 5933 | 52842 | 4817 | 54038 | 3954 | 54314 | 2687 | 65076 | 2055 | 41416 |
| 16-#14 | 1.88 | MA | 37435 | 8066 | 59988 | 6006 | 65689 | 4861 | 67786 | 4013 | 69207 | 2725 | 83930 | 2221 | 51731 |
| 5E | | MI | 30970 | 8066 | 49997 | 5935 | 54391 | 4821 | 55926 | 3960 | 56805 | 2677 | 68178 | 2139 | 42383 |
| 16-#14 | 1.88 | MA | 36607 | 8066 | 58593 | 6005 | 63792 | 4879 | 65472 | 4010 | 66144 | 2737 | 80009 | 2137 | 50406 |
| 6L-4S | | MI | 31681 | 8066 | 51205 | 5937 | 55949 | 4805 | 57834 | 3947 | 59515 | 2687 | 71456 | 2201 | 42774 |
| 16-#14 | 1.88 | MA | 35800 | 8066 | 57099 | 6025 | 61972 | 4877 | 63241 | 4026 | 63147 | 2750 | 75930 | 2011 | 49559 |
| 7L-3S | | MI | 32474 | 8066 | 52582 | 5919 | 57699 | 4809 | 59958 | 3953 | 62263 | 2677 | 74576 | 2329 | 42854 |
| 16-#14 | 1.88 | MA | 35003 | 8066 | 55730 | 6024 | 60135 | 4894 | 61056 | 4042 | 60007 | 2743 | 72092 | 1936 | 48013 |
| 8L-2S | | MI | 33595 | 8066 | 54293 | 5922 | 59881 | 4794 | 62610 | 3940 | 65845 | 2667 | 79349 | 2457 | 42868 |
| 16-#18 | 3.33 | MA | 42338 | 9059 | 71494 | 6606 | 80169 | 5295 | 85327 | 4259 | 93217 | 2667 | 115897 | 1906 | 89433 |
| 4L-6S | | MI | 32478 | 9059 | 55166 | 6516 | 60599 | 5243 | 63377 | 4207 | 66705 | 2588 | 82172 | 1511 | 67924 |
| 16-#18 | 3.33 | MA | 40861 | 9059 | 68890 | 6604 | 76811 | 5325 | 81214 | 4286 | 87349 | 2651 | 108750 | 1794 | 86136 |
| 5E | | MI | 33632 | 9059 | 57169 | 6522 | 63319 | 5253 | 66694 | 4221 | 71019 | 2571 | 87513 | 1662 | 70219 |
| 16-#18 | 3.33 | MA | 39454 | 9059 | 66433 | 6602 | 73472 | 5319 | 77142 | 4277 | 81958 | 2671 | 101955 | 1645 | 83343 |
| 6L-4S | | MI | 34842 | 9059 | 59290 | 6527 | 66053 | 5227 | 70041 | 4199 | 75716 | 2588 | 93190 | 1768 | 72606 |
| 16-#18 | 3.33 | MA | 38080 | 9059 | 63804 | 6635 | 70267 | 5349 | 73214 | 4303 | 76682 | 2690 | 94883 | 1420 | 79950 |
| 7L-3S | | MI | 36190 | 9059 | 61705 | 6498 | 69122 | 5237 | 73766 | 4213 | 80476 | 2571 | 98555 | 1995 | 73981 |
| 16-#18 | 3.33 | MA | 36726 | 9059 | 61391 | 6632 | 67033 | 5343 | 69368 | 4329 | 71156 | 2674 | 88205 | 1289 | 75896 |
| 8L-2S | | MI | 38092 | 9059 | 64696 | 6503 | 72937 | 5212 | 78403 | 4192 | 86681 | 2553 | 106786 | 2223 | 74231 |
| 18-#11 | 1.46 | MA | 38998 | 7785 | 61555 | 5828 | 67812 | 4734 | 70422 | 3918 | 72820 | 2733 | 87980 | 2593 | 41254 |
| 2L-9S | | MI | 28557 | 7785 | 45034 | 5799 | 48134 | 4720 | 48332 | 3902 | 46598 | 2722 | 54924 | 2050 | 32112 |
| 18-#11 | 1.46 | MA | 38020 | 7785 | 60082 | 5828 | 65934 | 4733 | 68140 | 3929 | 69728 | 2743 | 83754 | 2505 | 41249 |
| 3L-8S | | MI | 29023 | 7785 | 45860 | 5786 | 49157 | 4709 | 49620 | 3906 | 48287 | 2715 | 57040 | 2106 | 32717 |

## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

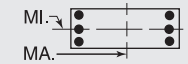
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.46 | MA | 37336 | 7785 | 58904 | 5841 | 64436 | 4745 | 66321 | 3927 | 67367 | 2752 | 80977 | 2416 | 41208 |
| 4L-7S | | MI | 29483 | 7785 | 46641 | 5787 | 50204 | 4711 | 50865 | 3896 | 50076 | 2722 | 59191 | 2157 | 33034 |
| 18-#11 | 1.46 | MA | 36724 | 7785 | 57873 | 5841 | 63106 | 4744 | 64692 | 3938 | 65041 | 2747 | 78100 | 2371 | 41114 |
| 5L-6S | | MI | 29949 | 7785 | 47492 | 5775 | 51241 | 4700 | 52136 | 3886 | 51783 | 2715 | 61465 | 2244 | 33492 |
| 18-#11 | 1.46 | MA | 36141 | 7785 | 56901 | 5842 | 61784 | 4757 | 63080 | 3936 | 62907 | 2757 | 75347 | 2313 | 40716 |
| 6L-5S | | MI | 30427 | 7785 | 48288 | 5776 | 52322 | 4703 | 53454 | 3890 | 53528 | 2708 | 63650 | 2303 | 33800 |
| 18-#11 | 1.46 | MA | 35573 | 7785 | 55860 | 5855 | 60516 | 4756 | 61525 | 3948 | 60818 | 2766 | 72484 | 2225 | 40079 |
| 7L-4S | | MI | 30928 | 7785 | 49131 | 5777 | 53408 | 4691 | 54785 | 3880 | 55427 | 2714 | 65952 | 2346 | 33845 |
| 18-#11 | 1.46 | MA | 35012 | 7785 | 54906 | 5855 | 59236 | 4768 | 60003 | 3959 | 58630 | 2761 | 69795 | 2172 | 39624 |
| 8L-3S | | MI | 31487 | 7785 | 50092 | 5764 | 54630 | 4694 | 56268 | 3884 | 57352 | 2707 | 68151 | 2435 | 33852 |
| 18-#11 | 1.46 | MA | 34412 | 7785 | 53970 | 5855 | 57986 | 4767 | 58429 | 3957 | 56564 | 2771 | 67128 | 2117 | 38823 |
| 9L-2S | | MI | 32279 | 7785 | 51288 | 5766 | 56155 | 4683 | 58122 | 3874 | 59864 | 2700 | 71511 | 2524 | 33834 |
| 18-#14 | 2.11 | MA | 41636 | 8225 | 67378 | 6087 | 75126 | 4920 | 79272 | 4030 | 84791 | 2697 | 104031 | 2523 | 58798 |
| 2L-9S | | MI | 29139 | 8225 | 47042 | 6066 | 50568 | 4916 | 51235 | 4020 | 50493 | 2686 | 60552 | 1749 | 43557 |
| 18-#14 | 2.11 | MA | 40257 | 8225 | 65268 | 6086 | 72436 | 4918 | 76002 | 4046 | 80360 | 2710 | 98009 | 2395 | 58722 |
| 3L-8S | | MI | 29783 | 8225 | 48227 | 6048 | 52035 | 4900 | 53082 | 4026 | 52906 | 2677 | 63558 | 1831 | 44602 |
| 18-#14 | 2.11 | MA | 39292 | 8225 | 63578 | 6106 | 70287 | 4935 | 73393 | 4042 | 76974 | 2722 | 94057 | 2267 | 58550 |
| 4L-7S | | MI | 30431 | 8225 | 49347 | 6050 | 53536 | 4905 | 54867 | 4012 | 55459 | 2686 | 66620 | 1903 | 45859 |
| 18-#14 | 2.11 | MA | 38429 | 8225 | 62098 | 6105 | 68379 | 4933 | 71056 | 4058 | 73638 | 2715 | 89951 | 2202 | 57923 |
| 5L-6S | | MI | 31090 | 8225 | 50567 | 6033 | 55024 | 4889 | 56689 | 3999 | 57897 | 2677 | 69850 | 2029 | 46466 |
| 18-#14 | 2.11 | MA | 37607 | 8225 | 60703 | 6105 | 66482 | 4951 | 68742 | 4054 | 70574 | 2728 | 86030 | 2118 | 56649 |
| 6L-5S | | MI | 31764 | 8225 | 51708 | 6035 | 56572 | 4893 | 58578 | 4005 | 60387 | 2667 | 72952 | 2114 | 47388 |
| 18-#14 | 2.11 | MA | 36805 | 8225 | 59209 | 6124 | 64662 | 4949 | 66511 | 4070 | 67577 | 2740 | 81952 | 1992 | 55826 |
| 7L-4S | | MI | 32471 | 8225 | 52916 | 6037 | 58130 | 4877 | 60486 | 3992 | 63097 | 2677 | 76229 | 2175 | 47939 |
| 18-#14 | 2.11 | MA | 36014 | 8225 | 57840 | 6124 | 62825 | 4967 | 64326 | 4086 | 64437 | 2733 | 78114 | 1917 | 54207 |
| 8L-3S | | MI | 33259 | 8225 | 54293 | 6019 | 59881 | 4882 | 62610 | 3998 | 65845 | 2667 | 79349 | 2303 | 48042 |
| 18-#14 | 2.11 | MA | 35175 | 8225 | 56495 | 6124 | 61030 | 4965 | 62066 | 4083 | 61471 | 2745 | 74315 | 1836 | 52871 |
| 9L-2S | | MI | 34374 | 8225 | 56004 | 6021 | 62062 | 4866 | 65262 | 3984 | 69428 | 2657 | 84123 | 2431 | 48080 |
| 18-#18 | 3.75 | MA | 42549 | 9343 | 72591 | 6781 | 81529 | 5453 | 86950 | 4365 | 95120 | 2633 | 119196 | 1755 | 97042 |
| 5L-6S | | MI | 33833 | 9343 | 58157 | 6693 | 64413 | 5372 | 68014 | 4287 | 72910 | 2566 | 90402 | 1459 | 76537 |
| 18-#18 | 3.75 | MA | 41155 | 9343 | 70134 | 6779 | 78191 | 5448 | 82878 | 4356 | 89729 | 2653 | 112401 | 1605 | 94084 |
| 6L-5S | | MI | 34976 | 9343 | 60161 | 6699 | 67133 | 5382 | 71330 | 4300 | 77224 | 2548 | 95744 | 1610 | 79001 |
| 18-#18 | 3.75 | MA | 39795 | 9343 | 67504 | 6812 | 74986 | 5477 | 78950 | 4383 | 84453 | 2672 | 105329 | 1380 | 90797 |
| 7L-4S | | MI | 36175 | 9343 | 62282 | 6705 | 69867 | 5356 | 74678 | 4279 | 81921 | 2566 | 101420 | 1716 | 81269 |
| 18-#18 | 3.75 | MA | 38455 | 9343 | 65092 | 6810 | 71751 | 5472 | 75104 | 4409 | 78927 | 2657 | 98650 | 1250 | 86649 |
| 8L-3S | | MI | 37512 | 9343 | 64696 | 6675 | 72937 | 5366 | 78403 | 4293 | 86681 | 2548 | 106786 | 1943 | 82982 |
| 20-#11 | 1.63 | MA | 39690 | 7896 | 63027 | 5897 | 69689 | 4784 | 72705 | 3949 | 75912 | 2726 | 92206 | 2581 | 45742 |
| 2L-10S | | MI | 28633 | 7896 | 45453 | 5867 | 48625 | 4768 | 48949 | 3943 | 47432 | 2723 | 56232 | 1970 | 35083 |
| 20-#11 | 1.63 | MA | 38716 | 7896 | 61555 | 5897 | 67812 | 4783 | 70422 | 3960 | 72820 | 2736 | 87980 | 2493 | 45722 |
| 3L-9S | | MI | 29129 | 7896 | 46230 | 5868 | 49659 | 4770 | 50186 | 3933 | 49109 | 2716 | 58284 | 2034 | 35620 |
| 20-#11 | 1.63 | MA | 38035 | 7896 | 60377 | 5911 | 66313 | 4795 | 68604 | 3958 | 70459 | 2745 | 85203 | 2404 | 45667 |
| 4L-8S | | MI | 29591 | 7896 | 47056 | 5856 | 50682 | 4759 | 51474 | 3937 | 50799 | 2708 | 60400 | 2090 | 36275 |
| 20-#11 | 1.63 | MA | 37426 | 7896 | 59346 | 5911 | 64983 | 4794 | 66974 | 3970 | 68133 | 2740 | 82326 | 2358 | 45558 |
| 5L-7S | | MI | 30049 | 7896 | 47837 | 5857 | 51729 | 4761 | 52719 | 3927 | 52587 | 2715 | 62551 | 2140 | 36585 |
| 20-#11 | 1.63 | MA | 36846 | 7896 | 58373 | 5911 | 63662 | 4807 | 65362 | 3967 | 65999 | 2750 | 79573 | 2300 | 45072 |
| 6E | | MI | 30513 | 7896 | 48689 | 5844 | 52766 | 4750 | 53990 | 3917 | 54295 | 2708 | 64825 | 2228 | 37024 |
| 20-#11 | 1.63 | MA | 36281 | 7896 | 57333 | 5924 | 62394 | 4806 | 63808 | 3979 | 63910 | 2759 | 76710 | 2213 | 44457 |
| 7L-5S | | MI | 30989 | 7896 | 49484 | 5845 | 53846 | 4753 | 55308 | 3921 | 56039 | 2701 | 67010 | 2287 | 37415 |
| 20-#11 | 1.63 | MA | 35723 | 7896 | 56379 | 5924 | 61114 | 4818 | 62286 | 3990 | 61723 | 2754 | 74021 | 2160 | 44011 |
| 8L-4S | | MI | 31488 | 7896 | 50327 | 5846 | 54933 | 4741 | 56639 | 3911 | 57938 | 2707 | 69312 | 2330 | 37473 |
| 20-#11 | 1.63 | MA | 35126 | 7896 | 55443 | 5924 | 59864 | 4817 | 60711 | 3988 | 59656 | 2764 | 71354 | 2104 | 43162 |
| 9L-3S | | MI | 32044 | 7896 | 51288 | 5834 | 56155 | 4744 | 58122 | 3915 | 59864 | 2700 | 71511 | 2418 | 37498 |
| 20-#11 | 1.63 | MA | 34512 | 7896 | 54420 | 5938 | 58600 | 4830 | 59199 | 4000 | 57605 | 2773 | 68766 | 2041 | 42431 |
| 10L-2S | | MI | 32833 | 7896 | 52484 | 5835 | 57680 | 4733 | 59975 | 3905 | 62375 | 2693 | 74871 | 2507 | 37487 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis

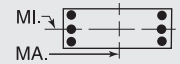



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.34 | MA | 41233 | 8385 | 67378 | 6186 | 75126 | 4990 | 79272 | 4091 | 84791 | 2700 | 104031 | 2375 | 65106 |
| 3L-9S | | MI | 29944 | 8385 | 48753 | 6166 | 52749 | 4988 | 53887 | 4064 | 54076 | 2676 | 65326 | 1724 | 48501 |
| 20-#14 | 2.34 | MA | 40274 | 8385 | 65688 | 6206 | 72977 | 5008 | 76663 | 4087 | 81404 | 2712 | 100079 | 2247 | 64910 |
| 4L-8S | | MI | 30583 | 8385 | 49938 | 6148 | 54216 | 4973 | 55733 | 4071 | 56488 | 2666 | 68331 | 1805 | 49605 |
| 20-#14 | 2.34 | MA | 39416 | 8385 | 64208 | 6205 | 71069 | 5006 | 74326 | 4103 | 78068 | 2705 | 95973 | 2183 | 64127 |
| 5L-7S | | MI | 31228 | 8385 | 51058 | 6150 | 55717 | 4977 | 57518 | 4057 | 59041 | 2676 | 71393 | 1877 | 50821 |
| 20-#14 | 2.34 | MA | 38600 | 8385 | 62813 | 6205 | 69172 | 5023 | 72012 | 4099 | 75004 | 2718 | 92052 | 2099 | 62900 |
| 6E | | MI | 31883 | 8385 | 52278 | 6132 | 57205 | 4961 | 59341 | 4044 | 61479 | 2666 | 74623 | 2004 | 51523 |
| 20-#14 | 2.34 | MA | 37803 | 8385 | 61319 | 6224 | 67352 | 5021 | 69781 | 4115 | 72007 | 2730 | 87973 | 1973 | 62047 |
| 7L-5S | | MI | 32553 | 8385 | 53419 | 6135 | 58754 | 4965 | 61230 | 4050 | 63969 | 2656 | 77725 | 2088 | 52406 |
| 20-#14 | 2.34 | MA | 37018 | 8385 | 59950 | 6224 | 65515 | 5039 | 67596 | 4131 | 68867 | 2723 | 84136 | 1898 | 60411 |
| 8L-4S | | MI | 33255 | 8385 | 54627 | 6137 | 60311 | 4950 | 63137 | 4037 | 66679 | 2666 | 81003 | 2150 | 53098 |
| 20-#14 | 2.34 | MA | 36184 | 8385 | 58605 | 6223 | 63720 | 5037 | 65336 | 4128 | 65901 | 2735 | 80337 | 1817 | 59018 |
| 9L-3S | | MI | 34039 | 8385 | 56004 | 6119 | 62062 | 4954 | 65262 | 4043 | 69428 | 2656 | 84123 | 2278 | 53224 |
| 20-#14 | 2.34 | MA | 35317 | 8385 | 57137 | 6243 | 61906 | 5055 | 63165 | 4144 | 62958 | 2748 | 76652 | 1726 | 57230 |
| 10L-2S | | MI | 35149 | 8385 | 57715 | 6121 | 64243 | 4938 | 67914 | 4029 | 73010 | 2646 | 88896 | 2406 | 53280 |
| 20-#18 | 4.17 | MA | 42841 | 9626 | 73835 | 6956 | 82909 | 5576 | 88614 | 4436 | 97500 | 2635 | 122847 | 1566 | 104847 |
| 6E | | MI | 35176 | 9626 | 61149 | 6871 | 68227 | 5500 | 72651 | 4366 | 79115 | 2544 | 98633 | 1407 | 85174 |
| 20-#18 | 4.17 | MA | 41495 | 9626 | 71205 | 6989 | 79704 | 5606 | 84686 | 4462 | 92224 | 2655 | 115775 | 1341 | 101659 |
| 7L-5S | | MI | 36310 | 9626 | 63153 | 6876 | 70947 | 5510 | 75967 | 4380 | 83429 | 2526 | 103975 | 1558 | 87798 |
| 20-#18 | 4.17 | MA | 40167 | 9626 | 68793 | 6987 | 76470 | 5600 | 80840 | 4489 | 86698 | 2639 | 109096 | 1210 | 97419 |
| 8L-4S | | MI | 37498 | 9626 | 65274 | 6882 | 73681 | 5485 | 79315 | 4359 | 88126 | 2544 | 109651 | 1664 | 89958 |
| 22-#11 | 1.79 | MA | 39409 | 8006 | 63027 | 5966 | 69689 | 4833 | 72705 | 3991 | 75912 | 2729 | 92206 | 2480 | 50190 |
| 3L-10S | | MI | 29202 | 8006 | 46649 | 5936 | 50150 | 4818 | 50802 | 3974 | 49943 | 2716 | 59592 | 1954 | 38610 |
| 22-#11 | 1.79 | MA | 38730 | 8006 | 61849 | 5980 | 68191 | 4845 | 70886 | 3989 | 73551 | 2738 | 89429 | 2392 | 50123 |
| 4L-9S | | MI | 29698 | 8006 | 47426 | 5937 | 51183 | 4820 | 52039 | 3964 | 51620 | 2709 | 61644 | 2017 | 39134 |
| 22-#11 | 1.79 | MA | 38125 | 8006 | 60818 | 5980 | 66861 | 4844 | 69257 | 4001 | 71226 | 2734 | 86552 | 2346 | 50000 |
| 5L-8S | | MI | 30156 | 8006 | 48252 | 5925 | 52206 | 4809 | 53327 | 3968 | 53310 | 2702 | 63760 | 2074 | 39831 |
| 22-#11 | 1.79 | MA | 37548 | 8006 | 59846 | 5980 | 65539 | 4857 | 67645 | 3998 | 69091 | 2743 | 83799 | 2288 | 49434 |
| 6L-7S | | MI | 30612 | 8006 | 49033 | 5926 | 53253 | 4812 | 54572 | 3958 | 55098 | 2708 | 65911 | 2124 | 40138 |
| 22-#11 | 1.79 | MA | 36985 | 8006 | 58806 | 5994 | 64271 | 4856 | 66090 | 4010 | 67002 | 2752 | 80936 | 2201 | 48838 |
| 7L-6S | | MI | 31074 | 8006 | 49885 | 5913 | 54291 | 4800 | 55844 | 3948 | 56806 | 2701 | 68185 | 2212 | 40562 |
| 22-#11 | 1.79 | MA | 36430 | 8006 | 57852 | 5994 | 62991 | 4869 | 64568 | 4021 | 64815 | 2748 | 78247 | 2148 | 48401 |
| 8L-5S | | MI | 31548 | 8006 | 50680 | 5914 | 55371 | 4803 | 57161 | 3952 | 58551 | 2694 | 70370 | 2270 | 41027 |
| 22-#11 | 1.79 | MA | 35836 | 8006 | 56915 | 5994 | 61741 | 4867 | 62993 | 4019 | 62748 | 2757 | 75580 | 2092 | 47506 |
| 9L-4S | | MI | 32044 | 8006 | 51523 | 5915 | 56458 | 4792 | 58492 | 3942 | 60449 | 2701 | 72672 | 2313 | 41098 |
| 22-#11 | 1.79 | MA | 35224 | 8006 | 55893 | 6007 | 60478 | 4880 | 61481 | 4031 | 60698 | 2766 | 72992 | 2029 | 46791 |
| 10L-3S | | MI | 32599 | 8006 | 52484 | 5903 | 57680 | 4794 | 59975 | 3946 | 62375 | 2693 | 74871 | 2402 | 41132 |
| 22-#11 | 1.79 | MA | 34627 | 8006 | 54957 | 6007 | 59235 | 4879 | 59925 | 4028 | 58540 | 2761 | 70366 | 1974 | 45770 |
| 11L-2S | | MI | 33384 | 8006 | 53680 | 5904 | 59205 | 4783 | 61829 | 3936 | 64886 | 2686 | 78231 | 2491 | 41136 |
| 22-#14 | 2.58 | MA | 41250 | 8545 | 67798 | 6305 | 75667 | 5080 | 79933 | 4132 | 85834 | 2702 | 106100 | 2228 | 71267 |
| 4L-9S | | MI | 30744 | 8545 | 50464 | 6265 | 54931 | 5061 | 56539 | 4109 | 57658 | 2665 | 70100 | 1698 | 53455 |
| 22-#14 | 2.58 | MA | 40398 | 8545 | 66318 | 6305 | 73759 | 5078 | 77596 | 4148 | 82498 | 2695 | 101995 | 2164 | 70343 |
| 5L-8S | | MI | 31379 | 8545 | 51649 | 6248 | 56398 | 5045 | 58385 | 4116 | 60070 | 2655 | 73105 | 1780 | 54617 |
| 22-#14 | 2.58 | MA | 39586 | 8545 | 64923 | 6304 | 71862 | 5096 | 75282 | 4144 | 79435 | 2708 | 98073 | 2080 | 69158 |
| 6L-7S | | MI | 32020 | 8545 | 52769 | 6250 | 57899 | 5049 | 60170 | 4102 | 62623 | 2665 | 76167 | 1852 | 55795 |
| 22-#14 | 2.58 | MA | 38795 | 8545 | 63429 | 6324 | 70042 | 5094 | 73051 | 4160 | 76437 | 2720 | 93995 | 1954 | 68215 |
| 7L-6S | | MI | 32671 | 8545 | 53989 | 6232 | 59386 | 5034 | 61993 | 4089 | 65061 | 2655 | 79397 | 1978 | 56585 |
| 22-#14 | 2.58 | MA | 38014 | 8545 | 62060 | 6323 | 68204 | 5111 | 70866 | 4176 | 73297 | 2713 | 90157 | 1879 | 66622 |
| 8L-5S | | MI | 33337 | 8545 | 55130 | 6234 | 60935 | 5038 | 63882 | 4095 | 67551 | 2646 | 82499 | 2063 | 57433 |
| 22-#14 | 2.58 | MA | 37196 | 8545 | 60715 | 6323 | 66410 | 5109 | 68606 | 4172 | 70332 | 2725 | 86358 | 1798 | 65174 |
| 9L-4S | | MI | 34036 | 8545 | 56338 | 6236 | 62493 | 5022 | 65789 | 4081 | 70262 | 2655 | 85776 | 2124 | 58254 |
| 22-#14 | 2.58 | MA | 36323 | 8545 | 59247 | 6343 | 64596 | 5127 | 66435 | 4188 | 67388 | 2738 | 82673 | 1707 | 63422 |
| 10L-3S | | MI | 34815 | 8545 | 57715 | 6219 | 64243 | 5026 | 67914 | 4088 | 73010 | 2646 | 88896 | 2252 | 58401 |
| 22-#18 | 4.58 | MA | 43179 | 9910 | 74906 | 7167 | 84423 | 5734 | 90422 | 4542 | 99995 | 2637 | 126221 | 1301 | 112536 |
| 7L-6S | | MI | 36509 | 9910 | 64141 | 7048 | 72041 | 5629 | 77287 | 4446 | 85320 | 2522 | 106864 | 1355 | 93831 |
| 22-#18 | 4.58 | MA | 41864 | 9910 | 72494 | 7164 | 81188 | 5729 | 86576 | 4569 | 94469 | 2621 | 119542 | 1171 | 108204 |
| 8L-5S | | MI | 37633 | 9910 | 66144 | 7054 | 74761 | 5639 | 80604 | 4460 | 89634 | 2504 | 112206 | 1506 | 96609 |

## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 1.95 | MA | 39423 | 8117 | 63322 | 6049 | 70069 | 4896 | 73168 | 4020 | 76643 | 2731 | 93655 | 2379 | 54577 |
| 4L-10S | | MI | 29769 | 8117 | 47845 | 6005 | 51675 | 4868 | 52656 | 4005 | 52454 | 2709 | 62952 | 1937 | 42140 |
| 24-#11 | 1.95 | MA | 38820 | 8117 | 62291 | 6049 | 68738 | 4894 | 71539 | 4032 | 74318 | 2727 | 90778 | 2334 | 54441 |
| 5L-9S | | MI | 30264 | 8117 | 48622 | 6006 | 52708 | 4871 | 53893 | 3996 | 54131 | 2702 | 65004 | 2001 | 42651 |
| 24-#11 | 1.95 | MA | 38245 | 8117 | 61319 | 6049 | 67417 | 4907 | 69927 | 4030 | 72183 | 2736 | 88025 | 2276 | 53801 |
| 6L-8S | | MI | 30719 | 8117 | 49449 | 5994 | 53731 | 4859 | 55181 | 3999 | 55821 | 2695 | 67120 | 2057 | 43329 |
| 24-#11 | 1.95 | MA | 37685 | 8117 | 60278 | 6063 | 66149 | 4906 | 68372 | 4041 | 70095 | 2745 | 85162 | 2189 | 53223 |
| 7E | | MI | 31172 | 8117 | 50229 | 5995 | 54778 | 4862 | 56426 | 3990 | 57610 | 2701 | 69271 | 2108 | 43695 |
| 24-#11 | 1.95 | MA | 37133 | 8117 | 59324 | 6063 | 64869 | 4919 | 66851 | 4053 | 67907 | 2741 | 82473 | 2136 | 52773 |
| 8L-6S | | MI | 31632 | 8117 | 51081 | 5982 | 55816 | 4850 | 57697 | 3980 | 59317 | 2694 | 71545 | 2195 | 44104 |
| 24-#11 | 1.95 | MA | 36542 | 8117 | 58388 | 6063 | 63619 | 4918 | 65276 | 4050 | 65840 | 2750 | 79806 | 2080 | 51855 |
| 9L-5S | | MI | 32104 | 8117 | 51876 | 5983 | 56896 | 4853 | 59015 | 3983 | 61062 | 2687 | 73730 | 2254 | 44636 |
| 24-#11 | 1.95 | MA | 35933 | 8117 | 57365 | 6077 | 62355 | 4930 | 63764 | 4062 | 63790 | 2759 | 77218 | 2017 | 51155 |
| 10L-4S | | MI | 32598 | 8117 | 52719 | 5985 | 57983 | 4842 | 60346 | 3974 | 62961 | 2694 | 76032 | 2297 | 44719 |
| 24-#11 | 1.95 | MA | 35338 | 8117 | 56429 | 6077 | 61112 | 4929 | 62207 | 4060 | 61633 | 2755 | 74592 | 1961 | 50100 |
| 11L-3S | | MI | 33150 | 8117 | 53680 | 5972 | 59205 | 4844 | 61829 | 3977 | 64886 | 2686 | 78231 | 2386 | 44763 |
| 24-#11 | 1.95 | MA | 34753 | 8117 | 55423 | 6090 | 59857 | 4942 | 60699 | 4071 | 59585 | 2764 | 71700 | 1887 | 49176 |
| 12L-2S | | MI | 33933 | 8117 | 54876 | 5973 | 60730 | 4833 | 63683 | 3968 | 67398 | 2679 | 81591 | 2475 | 44782 |
| 24-#14 | 2.81 | MA | 41373 | 8704 | 68428 | 6405 | 76449 | 5150 | 80866 | 4193 | 86928 | 2685 | 108016 | 2145 | 76568 |
| 5L-9S | | MI | 31539 | 8704 | 52175 | 6365 | 57112 | 5133 | 59190 | 4154 | 61240 | 2655 | 74873 | 1673 | 58417 |
| 24-#14 | 2.81 | MA | 40567 | 8704 | 67033 | 6404 | 74552 | 5168 | 78552 | 4189 | 83865 | 2698 | 104095 | 2061 | 75423 |
| 6L-8S | | MI | 32170 | 8704 | 53360 | 6347 | 58579 | 5117 | 61037 | 4161 | 63652 | 2645 | 77878 | 1755 | 59635 |
| 24-#14 | 2.81 | MA | 39780 | 8704 | 65539 | 6424 | 72732 | 5166 | 76321 | 4205 | 80867 | 2710 | 100017 | 1935 | 74393 |
| 7E | | MI | 32808 | 8704 | 54480 | 6350 | 60080 | 5121 | 62822 | 4147 | 66206 | 2655 | 80940 | 1826 | 60777 |
| 24-#14 | 2.81 | MA | 39005 | 8704 | 64170 | 6423 | 70894 | 5184 | 74136 | 4221 | 77728 | 2703 | 96179 | 1860 | 72839 |
| 8L-6S | | MI | 33454 | 8704 | 55700 | 6332 | 61567 | 5106 | 64644 | 4134 | 68643 | 2645 | 84170 | 1953 | 61654 |
| 24-#14 | 2.81 | MA | 38188 | 8704 | 62825 | 6423 | 69100 | 5182 | 71876 | 4217 | 74762 | 2716 | 92380 | 1779 | 71338 |
| 9L-5S | | MI | 34117 | 8704 | 56841 | 6334 | 63116 | 5110 | 66533 | 4140 | 71133 | 2635 | 87272 | 2037 | 62470 |
| 24-#14 | 2.81 | MA | 37323 | 8704 | 61357 | 6442 | 67286 | 5199 | 69705 | 4233 | 71818 | 2728 | 88695 | 1687 | 69621 |
| 10L-4S | | MI | 34811 | 8704 | 58049 | 6336 | 64674 | 5094 | 68441 | 4126 | 73844 | 2645 | 90550 | 2099 | 63407 |
| 24-#18 | 5.00 | MA | 43547 | 10194 | 76195 | 7342 | 85906 | 5857 | 92311 | 4648 | 102240 | 2604 | 129988 | 1131 | 119004 |
| 8L-6S | | MI | 37833 | 10194 | 67132 | 7225 | 75856 | 5758 | 81924 | 4526 | 91525 | 2499 | 115095 | 1303 | 102506 |

## RECTANGULAR TIED COLUMNS 42" x 42"

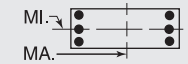
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.36 | MA | 30684 | 7089 | 48751 | 5222 | 53050 | 4245 | 54630 | 3517 | 55625 | 2458 | 65958 | 2290 | 30157 |
| 2L-3S | | MI | 28586 | 7089 | 45582 | 5218 | 49010 | 4271 | 49719 | 3540 | 49020 | 2475 | 57174 | 2062 | 30200 |
| 8-#14 | 1.02 | MA | 29669 | 6876 | 46338 | 5123 | 50167 | 4176 | 51199 | 3481 | 51151 | 2497 | 60150 | 2359 | 23021 |
| 2L-4S | | MI | 27602 | 6876 | 43073 | 5140 | 46008 | 4189 | 46147 | 3490 | 44433 | 2518 | 51737 | 2103 | 23090 |
| 8-#18 | 1.81 | MA | 32138 | 7372 | 51920 | 5400 | 57090 | 4373 | 59542 | 3597 | 62231 | 2437 | 74742 | 2241 | 39849 |
| 2L-4S | | MI | 28586 | 7372 | 46197 | 5426 | 49803 | 4391 | 50690 | 3607 | 50558 | 2473 | 60224 | 1786 | 39391 |
| 10-#14 | 1.28 | MA | 30518 | 7035 | 48149 | 5223 | 52476 | 4248 | 54005 | 3526 | 54952 | 2488 | 65236 | 2335 | 28573 |
| 2L-5S | | MI | 27701 | 7035 | 43607 | 5238 | 46671 | 4277 | 46938 | 3549 | 45360 | 2498 | 53338 | 2017 | 28415 |
| 10-#14 | 1.28 | MA | 29315 | 7035 | 46338 | 5222 | 50167 | 4265 | 51199 | 3540 | 51151 | 2498 | 60150 | 2207 | 28609 |
| 3L-4S | | MI | 28464 | 7035 | 44883 | 5240 | 48317 | 4261 | 48953 | 3535 | 48235 | 2508 | 56823 | 2079 | 28577 |
| 10-#18 | 2.27 | MA | 33574 | 7656 | 55089 | 5577 | 61130 | 4502 | 64453 | 3677 | 68837 | 2417 | 83526 | 2193 | 49505 |
| 2L-5S | | MI | 28750 | 7656 | 47125 | 5598 | 50953 | 4547 | 52062 | 3710 | 52164 | 2435 | 62964 | 1630 | 45776 |
| 10-#18 | 2.27 | MA | 31516 | 7656 | 51920 | 5572 | 57090 | 4528 | 59542 | 3700 | 62231 | 2435 | 74742 | 1965 | 49369 |
| 3L-4S | | MI | 30058 | 7656 | 49366 | 5603 | 53843 | 4520 | 55602 | 3687 | 57163 | 2452 | 69008 | 1738 | 48711 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis

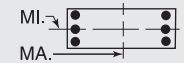



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.30 | MA | 33518 | 7386 | 53028 | 5464 | 57722 | 4443 | 59388 | 3686 | 60394 | 2592 | 71593 | 2425 | 31777 |
| 2L-3S | | MI | 29835 | 7386 | 47451 | 5441 | 50959 | 4455 | 51618 | 3696 | 50725 | 2595 | 59060 | 2178 | 30266 |
| 6-#18 | 1.30 | MA | 31297 | 7386 | 49682 | 5460 | 53456 | 4471 | 54202 | 3710 | 53388 | 2610 | 62256 | 2198 | 31820 |
| 3L-2S | | MI | 31936 | 7386 | 50620 | 5446 | 54999 | 4428 | 56530 | 3673 | 57330 | 2578 | 67844 | 2406 | 30205 |
| 8-#18 | 1.73 | MA | 35062 | 7669 | 56375 | 5641 | 61988 | 4572 | 64574 | 3766 | 67401 | 2574 | 80930 | 2380 | 42009 |
| 2L-4S | | MI | 29835 | 7669 | 48066 | 5649 | 51752 | 4575 | 52590 | 3763 | 52263 | 2593 | 62110 | 1902 | 39522 |
| 8-#18 | 1.73 | MA | 32863 | 7669 | 53028 | 5637 | 57722 | 4599 | 59388 | 3790 | 60394 | 2591 | 71593 | 2152 | 41958 |
| 3E | | MI | 31312 | 7669 | 50620 | 5618 | 54999 | 4584 | 56530 | 3776 | 57330 | 2575 | 67844 | 2130 | 39875 |
| 8-#18 | 1.73 | MA | 31306 | 7669 | 50335 | 5669 | 54298 | 4592 | 55233 | 3778 | 55019 | 2609 | 65490 | 1925 | 41551 |
| 4L-2S | | MI | 33392 | 7669 | 53789 | 5623 | 59039 | 4557 | 61441 | 3753 | 63936 | 2557 | 76628 | 2357 | 39903 |
| 10-#14 | 1.22 | MA | 33336 | 7332 | 52383 | 5465 | 57103 | 4447 | 58714 | 3695 | 59572 | 2617 | 70779 | 2469 | 30091 |
| 2L-5S | | MI | 28949 | 7332 | 45469 | 5463 | 48621 | 4462 | 48842 | 3706 | 47072 | 2619 | 55234 | 2134 | 28506 |
| 10-#14 | 1.22 | MA | 32063 | 7332 | 50473 | 5463 | 54667 | 4444 | 55753 | 3709 | 55560 | 2628 | 65381 | 2341 | 30128 |
| 3L-4S | | MI | 29713 | 7332 | 46745 | 5465 | 50266 | 4446 | 50857 | 3692 | 49947 | 2629 | 58718 | 2196 | 28639 |
| 10-#14 | 1.22 | MA | 31165 | 7332 | 48939 | 5482 | 52718 | 4461 | 53387 | 3705 | 52488 | 2639 | 61846 | 2213 | 30096 |
| 4L-3S | | MI | 30565 | 7332 | 48200 | 5447 | 52116 | 4450 | 53102 | 3697 | 52862 | 2619 | 62046 | 2324 | 28654 |
| 10-#14 | 1.22 | MA | 30361 | 7332 | 47595 | 5481 | 50984 | 4458 | 51264 | 3719 | 49459 | 2631 | 58154 | 2149 | 29934 |
| 5L-2S | | MI | 31770 | 7332 | 50011 | 5448 | 54425 | 4434 | 55909 | 3683 | 56664 | 2608 | 67131 | 2452 | 28613 |
| 10-#18 | 2.16 | MA | 36589 | 7953 | 59721 | 5818 | 66254 | 4700 | 69761 | 3845 | 74408 | 2555 | 90268 | 2335 | 52205 |
| 2L-5S | | MI | 29997 | 7953 | 48993 | 5822 | 52902 | 4730 | 53962 | 3866 | 53870 | 2555 | 64850 | 1746 | 46107 |
| 10-#18 | 2.16 | MA | 34410 | 7953 | 56375 | 5815 | 61988 | 4728 | 64574 | 3870 | 67401 | 2573 | 80930 | 2107 | 52069 |
| 3L-4S | | MI | 31309 | 7953 | 51235 | 5826 | 55792 | 4704 | 57501 | 3843 | 58868 | 2572 | 70894 | 1854 | 49008 |
| 10-#18 | 2.16 | MA | 32870 | 7953 | 53682 | 5846 | 58564 | 4721 | 60419 | 3858 | 62026 | 2590 | 74827 | 1880 | 51566 |
| 4L-3S | | MI | 32770 | 7953 | 53789 | 5796 | 59039 | 4712 | 61441 | 3856 | 63936 | 2555 | 76628 | 2081 | 49454 |
| 10-#18 | 2.16 | MA | 31489 | 7953 | 51319 | 5842 | 55518 | 4748 | 56689 | 3882 | 56724 | 2573 | 68416 | 1770 | 48482 |
| 5L-2S | | MI | 34832 | 7953 | 56958 | 5800 | 63079 | 4685 | 66353 | 3833 | 70542 | 2537 | 85412 | 2309 | 49568 |
| 12-#11 | 1.01 | MA | 32626 | 7198 | 50755 | 5398 | 55131 | 4400 | 56357 | 3669 | 56395 | 2635 | 66655 | 2503 | 25267 |
| 2L-6S | | MI | 28611 | 7198 | 44458 | 5393 | 47368 | 4407 | 47357 | 3672 | 45125 | 2644 | 52577 | 2209 | 23995 |
| 12-#11 | 1.01 | MA | 31732 | 7198 | 49421 | 5397 | 53430 | 4399 | 54289 | 3680 | 53593 | 2643 | 62862 | 2414 | 25301 |
| 3L-5S | | MI | 29122 | 7198 | 45298 | 5394 | 48509 | 4395 | 48749 | 3675 | 46967 | 2636 | 54904 | 2267 | 24087 |
| 12-#11 | 1.01 | MA | 31102 | 7198 | 48351 | 5411 | 52070 | 4411 | 52638 | 3677 | 51450 | 2651 | 60375 | 2326 | 25321 |
| 4E | | MI | 29658 | 7198 | 46188 | 5394 | 49657 | 4397 | 50154 | 3665 | 48973 | 2642 | 57350 | 2311 | 24100 |
| 12-#11 | 1.01 | MA | 30538 | 7198 | 47414 | 5410 | 50862 | 4409 | 51158 | 3687 | 49338 | 2646 | 57785 | 2281 | 25294 |
| 5L-3S | | MI | 30256 | 7198 | 47203 | 5381 | 50948 | 4385 | 51721 | 3668 | 51007 | 2634 | 59693 | 2400 | 24074 |
| 12-#11 | 1.01 | MA | 30001 | 7198 | 46531 | 5410 | 49661 | 4421 | 49693 | 3684 | 47398 | 2654 | 55317 | 2223 | 25179 |
| 6L-2S | | MI | 31103 | 7198 | 48468 | 5382 | 52561 | 4387 | 53682 | 3658 | 53664 | 2626 | 63269 | 2488 | 24037 |
| 12-#14 | 1.46 | MA | 34230 | 7492 | 54293 | 5564 | 59539 | 4519 | 61675 | 3739 | 63583 | 2607 | 76176 | 2447 | 35932 |
| 2L-6S | | MI | 29086 | 7492 | 46076 | 5561 | 49293 | 4531 | 49653 | 3745 | 48232 | 2620 | 57012 | 2025 | 32824 |
| 12-#14 | 1.46 | MA | 32964 | 7492 | 52383 | 5563 | 57103 | 4516 | 58714 | 3754 | 59572 | 2618 | 70779 | 2319 | 35943 |
| 3L-5S | | MI | 29810 | 7492 | 47280 | 5563 | 50929 | 4535 | 51648 | 3751 | 50874 | 2609 | 60319 | 2110 | 33949 |
| 12-#14 | 1.46 | MA | 32072 | 7492 | 50850 | 5582 | 55153 | 4533 | 56347 | 3749 | 56499 | 2629 | 67243 | 2191 | 35874 |
| 4E | | MI | 30569 | 7492 | 48556 | 5565 | 52575 | 4518 | 53663 | 3737 | 53748 | 2619 | 63804 | 2172 | 34120 |
| 12-#14 | 1.46 | MA | 31273 | 7492 | 49506 | 5581 | 53420 | 4530 | 54225 | 3764 | 53470 | 2621 | 63551 | 2128 | 35675 |
| 5L-3S | | MI | 31416 | 7492 | 50011 | 5546 | 54425 | 4522 | 55909 | 3742 | 56664 | 2609 | 67131 | 2300 | 34174 |
| 12-#14 | 1.46 | MA | 30512 | 7492 | 48238 | 5579 | 51697 | 4547 | 52124 | 3759 | 50688 | 2632 | 60040 | 2043 | 34468 |
| 6L-2S | | MI | 32614 | 7492 | 51821 | 5548 | 56733 | 4506 | 58715 | 3728 | 60466 | 2598 | 72217 | 2428 | 34153 |
| 12-#18 | 2.60 | MA | 38099 | 8237 | 63067 | 5996 | 70521 | 4829 | 74947 | 3925 | 81414 | 2536 | 99605 | 2289 | 62367 |
| 2L-6S | | MI | 30229 | 8237 | 50045 | 5994 | 54068 | 4850 | 55368 | 3933 | 55883 | 2552 | 67930 | 1547 | 53092 |
| 12-#18 | 2.60 | MA | 35940 | 8237 | 59721 | 5992 | 66254 | 4857 | 69761 | 3949 | 74408 | 2554 | 90268 | 2062 | 62162 |
| 3L-5S | | MI | 31468 | 8237 | 52162 | 5999 | 56942 | 4859 | 58874 | 3946 | 60475 | 2534 | 73634 | 1698 | 55354 |
| 12-#18 | 2.60 | MA | 34415 | 8237 | 57028 | 6023 | 62830 | 4849 | 65606 | 3938 | 69032 | 2572 | 84165 | 1834 | 61333 |
| 4E | | MI | 32766 | 8237 | 54404 | 6004 | 59833 | 4832 | 62413 | 3923 | 65474 | 2552 | 79678 | 1805 | 58195 |
| 12-#18 | 2.60 | MA | 33048 | 8237 | 54666 | 6020 | 59784 | 4877 | 61875 | 3962 | 63731 | 2554 | 77754 | 1725 | 58260 |
| 5L-3S | | MI | 34213 | 8237 | 56958 | 5973 | 63079 | 4841 | 66353 | 3936 | 70542 | 2534 | 85412 | 2033 | 59015 |
| 12-#18 | 2.60 | MA | 31745 | 8237 | 52435 | 6016 | 56755 | 4869 | 58181 | 3951 | 58860 | 2572 | 71686 | 1575 | 55860 |
| 6L-2S | | MI | 36257 | 8237 | 60127 | 5978 | 67120 | 4814 | 71264 | 3913 | 77147 | 2517 | 94195 | 2260 | 59196 |

## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

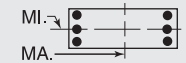
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.18 | MA | 33258 | 7309 | 52089 | 5467 | 56833 | 4450 | 58425 | 3700 | 59197 | 2628 | 70448 | 2489 | 29352 |
| 2L-7S | | MI | 28723 | 7309 | 44825 | 5475 | 47886 | 4455 | 47976 | 3713 | 45979 | 2644 | 53732 | 2106 | 27171 |
| 14-#11 | 1.18 | MA | 32368 | 7309 | 50755 | 5466 | 55131 | 4449 | 56357 | 3711 | 56395 | 2636 | 66655 | 2400 | 29377 |
| 3L-6S | | MI | 29220 | 7309 | 45723 | 5462 | 48981 | 4457 | 49318 | 3703 | 47782 | 2637 | 56153 | 2194 | 27710 |
| 14-#11 | 1.18 | MA | 31741 | 7309 | 49685 | 5480 | 53771 | 4461 | 54706 | 3708 | 54252 | 2644 | 64167 | 2312 | 29379 |
| 4L-5S | | MI | 29728 | 7309 | 46563 | 5463 | 50122 | 4445 | 50710 | 3706 | 49624 | 2629 | 58480 | 2252 | 27919 |
| 14-#11 | 1.18 | MA | 31180 | 7309 | 48749 | 5479 | 52563 | 4459 | 53226 | 3719 | 52140 | 2639 | 61578 | 2267 | 29333 |
| 5L-4S | | MI | 30261 | 7309 | 47453 | 5464 | 51270 | 4447 | 52115 | 3696 | 51629 | 2635 | 60926 | 2296 | 27953 |
| 14-#11 | 1.18 | MA | 30645 | 7309 | 47865 | 5479 | 51362 | 4471 | 51761 | 3716 | 50200 | 2647 | 59109 | 2209 | 29099 |
| 6L-3S | | MI | 30856 | 7309 | 48468 | 5451 | 52561 | 4436 | 53682 | 3699 | 53664 | 2627 | 63269 | 2385 | 27943 |
| 14-#11 | 1.18 | MA | 30123 | 7309 | 46919 | 5492 | 50209 | 4469 | 50348 | 3726 | 48302 | 2655 | 56541 | 2121 | 28514 |
| 7L-2S | | MI | 31699 | 7309 | 49733 | 5451 | 54174 | 4438 | 55643 | 3689 | 56320 | 2619 | 66845 | 2473 | 27915 |
| 14-#14 | 1.70 | MA | 35117 | 7652 | 56204 | 5664 | 61974 | 4592 | 64636 | 3784 | 67594 | 2597 | 81573 | 2425 | 41762 |
| 2L-7S | | MI | 29244 | 7652 | 46598 | 5679 | 50031 | 4620 | 50534 | 3804 | 49449 | 2620 | 58656 | 1875 | 37466 |
| 14-#14 | 1.70 | MA | 33859 | 7652 | 54293 | 5663 | 59539 | 4589 | 61675 | 3799 | 63583 | 2608 | 76176 | 2297 | 41744 |
| 3L-6S | | MI | 29946 | 7652 | 47886 | 5661 | 51602 | 4603 | 52459 | 3790 | 52034 | 2610 | 62098 | 2002 | 38153 |
| 14-#14 | 1.70 | MA | 32973 | 7652 | 52760 | 5682 | 57589 | 4605 | 59308 | 3794 | 60510 | 2619 | 72640 | 2169 | 41645 |
| 4L-5S | | MI | 30665 | 7652 | 49091 | 5663 | 53238 | 4607 | 54454 | 3796 | 54676 | 2599 | 65404 | 2086 | 39238 |
| 14-#14 | 1.70 | MA | 32179 | 7652 | 51416 | 5680 | 55856 | 4602 | 57186 | 3809 | 57482 | 2611 | 68948 | 2106 | 41270 |
| 5L-4S | | MI | 31419 | 7652 | 50366 | 5664 | 54883 | 4591 | 56469 | 3782 | 57550 | 2609 | 68889 | 2149 | 39592 |
| 14-#14 | 1.70 | MA | 31423 | 7652 | 50148 | 5679 | 54133 | 4619 | 55084 | 3804 | 54700 | 2622 | 65437 | 2021 | 40095 |
| 6L-3S | | MI | 32260 | 7652 | 51821 | 5646 | 56733 | 4594 | 58715 | 3787 | 60466 | 2599 | 72217 | 2277 | 39675 |
| 14-#14 | 1.70 | MA | 30684 | 7652 | 48791 | 5698 | 52479 | 4616 | 53057 | 3819 | 51977 | 2633 | 61783 | 1895 | 39347 |
| 7L-2S | | MI | 33451 | 7652 | 53632 | 5648 | 59042 | 4578 | 61521 | 3773 | 64268 | 2588 | 77302 | 2405 | 39682 |
| 14-#18 | 3.03 | MA | 39594 | 8521 | 66413 | 6173 | 74787 | 4957 | 80133 | 4005 | 88421 | 2518 | 108943 | 2244 | 72512 |
| 2L-7S | | MI | 30500 | 8521 | 50949 | 6202 | 55347 | 5006 | 56897 | 4036 | 57994 | 2549 | 70772 | 1273 | 59400 |
| 14-#18 | 3.03 | MA | 37453 | 8521 | 63067 | 6169 | 70521 | 4985 | 74947 | 4029 | 81414 | 2535 | 99605 | 2017 | 72243 |
| 3L-6S | | MI | 31697 | 8521 | 53214 | 6172 | 58108 | 4979 | 60280 | 4013 | 62488 | 2532 | 76714 | 1499 | 62190 |
| 14-#18 | 3.03 | MA | 35944 | 8521 | 60374 | 6201 | 67097 | 4978 | 70792 | 4018 | 76039 | 2553 | 93502 | 1789 | 70983 |
| 4L-5S | | MI | 32922 | 8521 | 55331 | 6176 | 60982 | 4987 | 63785 | 4026 | 67081 | 2514 | 82418 | 1649 | 64628 |
| 14-#18 | 3.03 | MA | 34591 | 8521 | 58012 | 6197 | 64050 | 5005 | 67061 | 4042 | 70737 | 2535 | 87091 | 1680 | 68065 |
| 5L-4S | | MI | 34207 | 8521 | 57573 | 6181 | 63873 | 4961 | 67324 | 4003 | 72080 | 2532 | 88462 | 1757 | 67319 |
| 14-#18 | 3.03 | MA | 33301 | 8521 | 55781 | 6193 | 61021 | 4998 | 63367 | 4031 | 65866 | 2553 | 81023 | 1530 | 65491 |
| 6L-3S | | MI | 35641 | 8521 | 60127 | 6150 | 67120 | 4969 | 71264 | 4015 | 77147 | 2514 | 94195 | 1984 | 68563 |
| 14-#18 | 3.03 | MA | 32042 | 8521 | 53395 | 6225 | 58112 | 5026 | 59803 | 4055 | 61099 | 2571 | 74705 | 1305 | 62483 |
| 7L-2S | | MI | 37667 | 8521 | 63296 | 6155 | 71160 | 4943 | 76176 | 3992 | 83753 | 2496 | 102979 | 2212 | 68805 |
| 16-#11 | 1.35 | MA | 33887 | 7420 | 53424 | 5536 | 58534 | 4501 | 60493 | 3731 | 61999 | 2621 | 74240 | 2475 | 33431 |
| 2L-8S | | MI | 28844 | 7420 | 45266 | 5543 | 48394 | 4516 | 48623 | 3755 | 46747 | 2631 | 55023 | 2040 | 30556 |
| 16-#11 | 1.35 | MA | 33000 | 7420 | 52089 | 5536 | 56833 | 4499 | 58425 | 3742 | 59197 | 2629 | 70448 | 2386 | 33447 |
| 3L-7S | | MI | 29331 | 7420 | 46090 | 5544 | 49499 | 4505 | 49937 | 3744 | 48636 | 2637 | 57308 | 2091 | 30918 |
| 16-#11 | 1.35 | MA | 32376 | 7420 | 51020 | 5549 | 55472 | 4511 | 56774 | 3739 | 57053 | 2637 | 67960 | 2298 | 33430 |
| 4L-6S | | MI | 29824 | 7420 | 46989 | 5531 | 50594 | 4507 | 51279 | 3734 | 50438 | 2630 | 59730 | 2179 | 31434 |
| 16-#11 | 1.35 | MA | 31818 | 7420 | 50083 | 5548 | 54264 | 4509 | 55294 | 3750 | 54941 | 2632 | 65371 | 2253 | 33366 |
| 5E | | MI | 30330 | 7420 | 47828 | 5532 | 51735 | 4495 | 52670 | 3738 | 52280 | 2622 | 62056 | 2237 | 31746 |
| 16-#11 | 1.35 | MA | 31286 | 7420 | 49199 | 5548 | 53063 | 4521 | 53829 | 3747 | 53002 | 2640 | 62902 | 2195 | 33028 |
| 6L-4S | | MI | 30861 | 7420 | 48718 | 5533 | 52883 | 4497 | 54076 | 3727 | 54286 | 2628 | 64502 | 2281 | 31797 |
| 16-#11 | 1.35 | MA | 30767 | 7420 | 48253 | 5561 | 51910 | 4519 | 52416 | 3757 | 51104 | 2649 | 60334 | 2107 | 32468 |
| 7L-3S | | MI | 31453 | 7420 | 49733 | 5520 | 54174 | 4486 | 55643 | 3731 | 56320 | 2620 | 66845 | 2369 | 31805 |
| 16-#11 | 1.35 | MA | 30255 | 7420 | 47386 | 5561 | 50747 | 4531 | 51032 | 3768 | 49115 | 2643 | 57914 | 2056 | 32070 |
| 8L-2S | | MI | 32293 | 7420 | 50999 | 5521 | 55787 | 4488 | 57604 | 3720 | 58977 | 2612 | 70421 | 2458 | 31785 |
| 16-#14 | 1.95 | MA | 35998 | 7811 | 58114 | 5764 | 64410 | 4664 | 67596 | 3829 | 71606 | 2587 | 86970 | 2403 | 47580 |
| 2L-8S | | MI | 29414 | 7811 | 47226 | 5777 | 50754 | 4688 | 51456 | 3864 | 50543 | 2600 | 60485 | 1779 | 41439 |
| 16-#14 | 1.95 | MA | 34747 | 7811 | 56204 | 5763 | 61974 | 4661 | 64636 | 3844 | 67594 | 2598 | 81573 | 2275 | 47536 |
| 3L-7S | | MI | 30102 | 7811 | 48408 | 5779 | 52340 | 4692 | 53341 | 3849 | 53251 | 2610 | 63741 | 1852 | 42820 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis

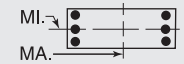


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 1.95 | MA | 33866 | 7811 | 54670 | 5781 | 60024 | 4678 | 62269 | 3839 | 64522 | 2609 | 78037 | 2147 | 47409 |
| 4L-6S | | MI | 30799 | 7811 | 49697 | 5761 | 53910 | 4676 | 55266 | 3835 | 55836 | 2600 | 67183 | 1978 | 43492 |
| 16-#14 | 1.95 | MA | 33078 | 7811 | 53327 | 5780 | 58291 | 4675 | 60147 | 3854 | 61493 | 2601 | 74346 | 2084 | 46856 |
| 5E | | MI | 31513 | 7811 | 50901 | 5762 | 55546 | 4679 | 57261 | 3841 | 58478 | 2589 | 70489 | 2063 | 44527 |
| 16-#14 | 1.95 | MA | 32327 | 7811 | 52059 | 5779 | 56569 | 4691 | 58045 | 3849 | 58711 | 2612 | 70834 | 1999 | 45733 |
| 6L-4S | | MI | 32262 | 7811 | 52177 | 5764 | 57192 | 4663 | 59276 | 3826 | 61352 | 2599 | 73974 | 2125 | 45058 |
| 16-#14 | 1.95 | MA | 31593 | 7811 | 50702 | 5798 | 54915 | 4688 | 56018 | 3864 | 55988 | 2623 | 67181 | 1873 | 45009 |
| 7L-3S | | MI | 33098 | 7811 | 53632 | 5746 | 59042 | 4667 | 61521 | 3832 | 64268 | 2589 | 77302 | 2253 | 45167 |
| 16-#14 | 1.95 | MA | 30870 | 7811 | 49457 | 5796 | 53245 | 4705 | 54033 | 3879 | 53137 | 2614 | 63731 | 1799 | 43529 |
| 8L-2S | | MI | 34283 | 7811 | 55443 | 5747 | 61350 | 4650 | 64327 | 3818 | 68070 | 2578 | 82387 | 2381 | 45202 |
| 16-#18 | 3.46 | MA | 38953 | 8804 | 66413 | 6347 | 74787 | 5114 | 80133 | 4109 | 88421 | 2516 | 108943 | 1972 | 82315 |
| 3L-7S | | MI | 31965 | 8804 | 54118 | 6380 | 59387 | 5134 | 61808 | 4116 | 64600 | 2529 | 79556 | 1225 | 68629 |
| 16-#18 | 3.46 | MA | 37457 | 8804 | 63721 | 6378 | 71363 | 5106 | 75978 | 4098 | 83045 | 2534 | 102840 | 1744 | 80669 |
| 4L-6S | | MI | 33149 | 8804 | 56383 | 6349 | 62148 | 5107 | 65191 | 4093 | 69094 | 2511 | 85497 | 1450 | 71316 |
| 16-#18 | 3.46 | MA | 36118 | 8804 | 61358 | 6374 | 68316 | 5134 | 72248 | 4122 | 77744 | 2516 | 96428 | 1635 | 77892 |
| 5E | | MI | 34363 | 8804 | 58500 | 6354 | 65023 | 5116 | 68696 | 4105 | 73687 | 2494 | 91202 | 1601 | 73924 |
| 16-#18 | 3.46 | MA | 34841 | 8804 | 59128 | 6371 | 65287 | 5127 | 68553 | 4111 | 72873 | 2534 | 90361 | 1484 | 75148 |
| 6L-4S | | MI | 35636 | 8804 | 60742 | 6358 | 67913 | 5089 | 72236 | 4083 | 78685 | 2511 | 97245 | 1708 | 76480 |
| 16-#18 | 3.46 | MA | 33595 | 8804 | 56741 | 6402 | 62378 | 5154 | 64989 | 4135 | 68105 | 2552 | 84043 | 1259 | 72247 |
| 7L-3S | | MI | 37055 | 8804 | 63296 | 6328 | 71160 | 5098 | 76176 | 4095 | 83753 | 2494 | 102979 | 1936 | 78101 |
| 18-#11 | 1.52 | MA | 34512 | 7530 | 54758 | 5605 | 60235 | 4551 | 62561 | 3762 | 64800 | 2614 | 78033 | 2461 | 37505 |
| 2L-9S | | MI | 28957 | 7530 | 45659 | 5626 | 48927 | 4565 | 49224 | 3783 | 47620 | 2632 | 56345 | 1969 | 33592 |
| 18-#11 | 1.52 | MA | 33628 | 7530 | 53424 | 5605 | 58534 | 4549 | 60493 | 3773 | 61999 | 2622 | 74240 | 2372 | 37507 |
| 3L-8S | | MI | 29451 | 7530 | 46531 | 5613 | 50007 | 4567 | 50584 | 3786 | 49404 | 2625 | 58599 | 2025 | 34317 |
| 18-#11 | 1.52 | MA | 33008 | 7530 | 52354 | 5618 | 57174 | 4561 | 58842 | 3770 | 59855 | 2631 | 71753 | 2283 | 37475 |
| 4L-7S | | MI | 29935 | 7530 | 47355 | 5613 | 51112 | 4555 | 51898 | 3776 | 51292 | 2631 | 60885 | 2076 | 34671 |
| 18-#11 | 1.52 | MA | 32452 | 7530 | 51417 | 5618 | 55965 | 4559 | 57362 | 3781 | 57743 | 2625 | 69164 | 2239 | 37395 |
| 5L-6S | | MI | 30426 | 7530 | 48254 | 5600 | 52207 | 4557 | 53240 | 3765 | 53095 | 2623 | 63306 | 2163 | 35165 |
| 18-#11 | 1.52 | MA | 31923 | 7530 | 50534 | 5617 | 54764 | 4571 | 55897 | 3778 | 55803 | 2633 | 66695 | 2181 | 36966 |
| 6L-5S | | MI | 30929 | 7530 | 49093 | 5601 | 53348 | 4545 | 54631 | 3769 | 54937 | 2615 | 65633 | 2222 | 35568 |
| 18-#11 | 1.52 | MA | 31406 | 7530 | 49588 | 5630 | 53611 | 4570 | 54484 | 3789 | 53905 | 2642 | 64127 | 2093 | 36428 |
| 7L-4S | | MI | 31457 | 7530 | 49983 | 5602 | 54496 | 4547 | 56037 | 3758 | 56942 | 2621 | 68078 | 2266 | 35635 |
| 18-#11 | 1.52 | MA | 30897 | 7530 | 48720 | 5630 | 52448 | 4582 | 53100 | 3799 | 51917 | 2636 | 61707 | 2042 | 36039 |
| 8L-3S | | MI | 32047 | 7530 | 50999 | 5589 | 55787 | 4536 | 57604 | 3762 | 58977 | 2613 | 70421 | 2354 | 35661 |
| 18-#11 | 1.52 | MA | 30368 | 7530 | 47869 | 5629 | 51311 | 4580 | 51669 | 3796 | 50039 | 2644 | 59315 | 1986 | 35262 |
| 9L-2S | | MI | 32883 | 7530 | 52264 | 5590 | 57400 | 4538 | 59565 | 3751 | 61634 | 2606 | 73998 | 2443 | 35650 |
| 18-#14 | 2.19 | MA | 36873 | 7971 | 60025 | 5864 | 66846 | 4736 | 70557 | 3874 | 75617 | 2577 | 92367 | 2381 | 53386 |
| 2L-9S | | MI | 29594 | 7971 | 47785 | 5895 | 51514 | 4777 | 52312 | 3903 | 51787 | 2601 | 62367 | 1674 | 45508 |
| 18-#14 | 2.19 | MA | 35629 | 7971 | 58114 | 5862 | 64410 | 4733 | 67596 | 3889 | 71606 | 2588 | 86970 | 2253 | 53321 |
| 3L-8S | | MI | 30271 | 7971 | 49037 | 5877 | 53063 | 4761 | 54262 | 3909 | 54345 | 2590 | 65571 | 1755 | 46735 |
| 18-#14 | 2.19 | MA | 34754 | 7971 | 56581 | 5881 | 62460 | 4750 | 65230 | 3884 | 68533 | 2600 | 83434 | 2125 | 53169 |
| 4L-7S | | MI | 30954 | 7971 | 50219 | 5879 | 54648 | 4764 | 56147 | 3894 | 57053 | 2600 | 68826 | 1828 | 48072 |
| 18-#14 | 2.19 | MA | 33971 | 7971 | 55237 | 5880 | 60727 | 4747 | 63107 | 3899 | 65504 | 2591 | 79743 | 2062 | 52456 |
| 5L-6S | | MI | 31646 | 7971 | 51508 | 5860 | 56219 | 4748 | 58072 | 3880 | 59638 | 2590 | 72268 | 1955 | 48840 |
| 18-#14 | 2.19 | MA | 33224 | 7971 | 53969 | 5879 | 59004 | 4764 | 61006 | 3894 | 62722 | 2602 | 76232 | 1977 | 51379 |
| 6L-5S | | MI | 32356 | 7971 | 52712 | 5862 | 57855 | 4752 | 60067 | 3886 | 62280 | 2579 | 75575 | 2039 | 49830 |
| 18-#14 | 2.19 | MA | 32496 | 7971 | 52612 | 5897 | 57350 | 4761 | 58979 | 3909 | 60000 | 2613 | 72578 | 1851 | 50567 |
| 7L-4S | | MI | 33100 | 7971 | 53988 | 5864 | 59500 | 4735 | 62082 | 3871 | 65154 | 2589 | 79059 | 2101 | 50518 |
| 18-#14 | 2.19 | MA | 31778 | 7971 | 51367 | 5896 | 55681 | 4777 | 56994 | 3924 | 57148 | 2604 | 69128 | 1777 | 49126 |
| 8L-3S | | MI | 33931 | 7971 | 55443 | 5846 | 61350 | 4739 | 64327 | 3877 | 68070 | 2579 | 82387 | 2229 | 50652 |
| 18-#14 | 2.19 | MA | 31040 | 7971 | 50050 | 5915 | 54050 | 4774 | 54941 | 3919 | 54454 | 2615 | 65726 | 1696 | 47820 |
| 9L-2S | | MI | 35110 | 7971 | 57254 | 5847 | 63659 | 4723 | 67134 | 3863 | 71872 | 2569 | 87472 | 2357 | 50707 |
| 18-#18 | 3.90 | MA | 38958 | 9088 | 67067 | 6555 | 75629 | 5235 | 81164 | 4178 | 90052 | 2515 | 112177 | 1699 | 90388 |
| 4L-7S | | MI | 33415 | 9088 | 57287 | 6557 | 63428 | 5263 | 66720 | 4196 | 71205 | 2509 | 88340 | 1176 | 77859 |
| 18-#18 | 3.90 | MA | 37631 | 9088 | 64704 | 6552 | 72583 | 5263 | 77434 | 4202 | 84751 | 2498 | 105766 | 1590 | 87737 |
| 5L-6S | | MI | 34588 | 9088 | 59552 | 6526 | 66189 | 5236 | 70103 | 4173 | 75700 | 2491 | 94281 | 1402 | 80466 |
| 18-#18 | 3.90 | MA | 36367 | 9088 | 62474 | 6548 | 69554 | 5255 | 73740 | 4190 | 79879 | 2515 | 99698 | 1439 | 84831 |
| 6L-5S | | MI | 35790 | 9088 | 61669 | 6531 | 69063 | 5245 | 73608 | 4185 | 80292 | 2473 | 99986 | 1552 | 83239 |
| 18-#18 | 3.90 | MA | 35133 | 9088 | 60087 | 6579 | 66645 | 5283 | 70175 | 4214 | 75112 | 2533 | 93380 | 1214 | 82029 |
| 7L-4S | | MI | 37051 | 9088 | 63911 | 6536 | 71953 | 5218 | 77147 | 4162 | 85291 | 2491 | 106029 | 1660 | 85672 |

## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis



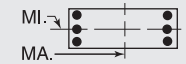

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.69 | MA | 35134 | 7641 | 56092 | 5674 | 61936 | 4601 | 64629 | 3793 | 67602 | 2607 | 81826 | 2447 | 41574 |
| 2L-10S | | MI | 29034 | 7641 | 46104 | 5694 | 49449 | 4626 | 49879 | 3824 | 48506 | 2633 | 57736 | 1890 | 36727 |
| 20-#11 | 1.69 | MA | 34254 | 7641 | 54758 | 5674 | 60235 | 4599 | 62561 | 3804 | 64800 | 2615 | 78033 | 2358 | 41561 |
| 3L-9S | | MI | 29563 | 7641 | 46924 | 5695 | 50540 | 4615 | 51185 | 3814 | 50276 | 2625 | 59921 | 1953 | 37308 |
| 20-#11 | 1.69 | MA | 33636 | 7641 | 53688 | 5687 | 58875 | 4611 | 60910 | 3801 | 62657 | 2624 | 75546 | 2269 | 41516 |
| 4L-8S | | MI | 30054 | 7641 | 47796 | 5682 | 51620 | 4617 | 52544 | 3817 | 52060 | 2618 | 62176 | 2010 | 38075 |
| 20-#11 | 1.69 | MA | 33083 | 7641 | 52752 | 5687 | 57666 | 4609 | 59430 | 3812 | 60545 | 2618 | 72956 | 2225 | 41422 |
| 5L-7S | | MI | 30536 | 7641 | 48620 | 5682 | 52725 | 4605 | 53859 | 3807 | 53949 | 2624 | 64461 | 2061 | 38428 |
| 20-#11 | 1.69 | MA | 32556 | 7641 | 51868 | 5686 | 56465 | 4621 | 57965 | 3809 | 58605 | 2626 | 70488 | 2167 | 40910 |
| 6E | | MI | 31024 | 7641 | 49519 | 5669 | 53821 | 4607 | 55201 | 3796 | 55751 | 2616 | 66882 | 2148 | 38904 |
| 20-#11 | 1.69 | MA | 32042 | 7641 | 50922 | 5700 | 55312 | 4620 | 56552 | 3820 | 56707 | 2635 | 67919 | 2079 | 40391 |
| 7L-5S | | MI | 31525 | 7641 | 50359 | 5670 | 54961 | 4596 | 56592 | 3800 | 57594 | 2608 | 69209 | 2207 | 39388 |
| 20-#11 | 1.69 | MA | 31536 | 7641 | 50055 | 5699 | 54149 | 4632 | 55169 | 3831 | 54719 | 2629 | 65499 | 2028 | 40011 |
| 8L-4S | | MI | 32050 | 7641 | 51248 | 5671 | 56109 | 4598 | 57998 | 3789 | 59599 | 2614 | 71655 | 2251 | 39469 |
| 20-#11 | 1.69 | MA | 31010 | 7641 | 49203 | 5698 | 53012 | 4630 | 53737 | 3828 | 52841 | 2638 | 63107 | 1972 | 39186 |
| 9L-3S | | MI | 32637 | 7641 | 52264 | 5658 | 57400 | 4586 | 59565 | 3793 | 61634 | 2606 | 73998 | 2339 | 39506 |
| 20-#11 | 1.69 | MA | 30452 | 7641 | 48273 | 5712 | 51864 | 4642 | 52362 | 3838 | 50977 | 2646 | 60788 | 1908 | 38557 |
| 10L-2S | | MI | 33471 | 7641 | 53529 | 5659 | 59013 | 4588 | 61526 | 3782 | 64290 | 2599 | 77574 | 2428 | 39510 |
| 20-#14 | 2.44 | MA | 36505 | 8130 | 60025 | 5962 | 66846 | 4805 | 70557 | 3934 | 75617 | 2578 | 92367 | 2231 | 59101 |
| 3L-9S | | MI | 30447 | 8130 | 49596 | 5995 | 53822 | 4849 | 55118 | 3948 | 55589 | 2591 | 67453 | 1651 | 50756 |
| 20-#14 | 2.44 | MA | 35636 | 8130 | 58491 | 5981 | 64896 | 4822 | 68191 | 3929 | 72544 | 2590 | 88831 | 2103 | 58925 |
| 4L-8S | | MI | 31121 | 8130 | 50847 | 5977 | 55371 | 4833 | 57068 | 3953 | 58147 | 2580 | 70656 | 1732 | 52040 |
| 20-#14 | 2.44 | MA | 34857 | 8130 | 57148 | 5980 | 63163 | 4819 | 66068 | 3944 | 69516 | 2581 | 85140 | 2040 | 58068 |
| 5L-7S | | MI | 31800 | 8130 | 52030 | 5978 | 56957 | 4837 | 58953 | 3939 | 60855 | 2590 | 73912 | 1805 | 53336 |
| 20-#14 | 2.44 | MA | 34116 | 8130 | 55880 | 5978 | 61440 | 4836 | 63967 | 3939 | 66734 | 2592 | 81629 | 1955 | 57033 |
| 6E | | MI | 32488 | 8130 | 53318 | 5960 | 58527 | 4820 | 60878 | 3925 | 63440 | 2580 | 77353 | 1931 | 54196 |
| 20-#14 | 2.44 | MA | 33392 | 8130 | 54522 | 5997 | 59786 | 4833 | 61940 | 3954 | 64011 | 2603 | 77975 | 1829 | 56129 |
| 7L-5S | | MI | 33193 | 8130 | 54523 | 5962 | 60163 | 4824 | 62873 | 3931 | 66081 | 2570 | 80660 | 2015 | 55146 |
| 20-#14 | 2.44 | MA | 32679 | 8130 | 53278 | 5996 | 58117 | 4850 | 59955 | 3969 | 61159 | 2594 | 74525 | 1756 | 54731 |
| 8L-4S | | MI | 33933 | 8130 | 55798 | 5963 | 61808 | 4808 | 64888 | 3916 | 68956 | 2579 | 84145 | 2078 | 55974 |
| 20-#14 | 2.44 | MA | 31956 | 8130 | 51960 | 6015 | 56486 | 4847 | 57902 | 3964 | 58465 | 2605 | 71124 | 1674 | 53369 |
| 9L-3S | | MI | 34759 | 8130 | 57254 | 5945 | 63659 | 4811 | 67134 | 3922 | 71872 | 2569 | 87472 | 2206 | 56131 |
| 20-#18 | 4.33 | MA | 39131 | 9372 | 68051 | 6729 | 76849 | 5391 | 82620 | 4281 | 91757 | 2479 | 115103 | 1544 | 97599 |
| 5L-7S | | MI | 34852 | 9372 | 60456 | 6734 | 67468 | 5391 | 71631 | 4275 | 77811 | 2488 | 97123 | 1128 | 86927 |
| 20-#18 | 4.33 | MA | 37879 | 9372 | 65820 | 6725 | 73820 | 5384 | 78926 | 4270 | 86886 | 2497 | 109036 | 1394 | 94535 |
| 6E | | MI | 36014 | 9372 | 62721 | 6704 | 70229 | 5365 | 75014 | 4253 | 82305 | 2470 | 103065 | 1353 | 89639 |
| 20-#18 | 4.33 | MA | 36656 | 9372 | 63433 | 6757 | 70911 | 5412 | 75361 | 4294 | 82119 | 2514 | 102718 | 1169 | 91685 |
| 7L-5S | | MI | 37206 | 9372 | 64838 | 6708 | 73103 | 5373 | 78519 | 4265 | 86898 | 2453 | 108769 | 1504 | 92569 |
| 22-#11 | 1.86 | MA | 35753 | 7752 | 57427 | 5744 | 63637 | 4651 | 66697 | 3824 | 70404 | 2600 | 85619 | 2433 | 45635 |
| 2L-11S | | MI | 29122 | 7752 | 46560 | 5762 | 49988 | 4674 | 50496 | 3852 | 49300 | 2620 | 59080 | 1821 | 39542 |
| 22-#11 | 1.86 | MA | 34876 | 7752 | 56092 | 5743 | 61936 | 4649 | 64629 | 3835 | 67602 | 2608 | 81826 | 2344 | 45611 |
| 3L-10S | | MI | 29638 | 7752 | 47369 | 5763 | 51062 | 4676 | 51840 | 3855 | 51162 | 2626 | 61312 | 1875 | 40441 |
| 22-#11 | 1.86 | MA | 34261 | 7752 | 55023 | 5756 | 60576 | 4661 | 62978 | 3832 | 65459 | 2617 | 79338 | 2255 | 45554 |
| 4L-9S | | MI | 30165 | 7752 | 48189 | 5764 | 52153 | 4665 | 53146 | 3845 | 52933 | 2619 | 63498 | 1938 | 41030 |
| 22-#11 | 1.86 | MA | 33711 | 7752 | 54086 | 5756 | 59367 | 4660 | 61498 | 3843 | 63346 | 2611 | 76749 | 2211 | 45446 |
| 5L-8S | | MI | 30654 | 7752 | 49062 | 5751 | 53233 | 4667 | 54505 | 3848 | 54717 | 2611 | 65752 | 1995 | 41775 |
| 22-#11 | 1.86 | MA | 33187 | 7752 | 53202 | 5755 | 58166 | 4672 | 60033 | 3840 | 61407 | 2620 | 74280 | 2153 | 44860 |
| 6L-7S | | MI | 31133 | 7752 | 49886 | 5752 | 54338 | 4655 | 55819 | 3838 | 56605 | 2617 | 68037 | 2046 | 42188 |
| 22-#11 | 1.86 | MA | 32675 | 7752 | 52256 | 5769 | 57014 | 4670 | 58620 | 3851 | 59509 | 2628 | 71712 | 2065 | 44358 |
| 7L-6S | | MI | 31620 | 7752 | 50784 | 5739 | 55434 | 4657 | 57162 | 3828 | 58408 | 2609 | 70459 | 2133 | 42647 |
| 22-#11 | 1.86 | MA | 32171 | 7752 | 51389 | 5768 | 55850 | 4682 | 57237 | 3862 | 57521 | 2622 | 69292 | 2014 | 43920 |
| 8L-5S | | MI | 32118 | 7752 | 51624 | 5739 | 56574 | 4646 | 58553 | 3831 | 60250 | 2601 | 72785 | 2192 | 43204 |
| 22-#11 | 1.86 | MA | 31648 | 7752 | 50537 | 5768 | 54713 | 4680 | 55805 | 3859 | 55642 | 2631 | 66900 | 1957 | 43116 |
| 9L-4S | | MI | 32641 | 7752 | 52514 | 5740 | 57722 | 4648 | 59959 | 3821 | 62255 | 2607 | 75231 | 2235 | 43299 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

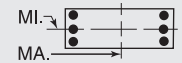
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.86 | MA | 31093 | 7752 | 49608 | 5781 | 53565 | 4692 | 54430 | 3869 | 53778 | 2639 | 64580 | 1894 | 42486 |
| 10L-3S | | MI | 33225 | 7752 | 53529 | 5727 | 59013 | 4636 | 61526 | 3824 | 64290 | 2600 | 77574 | 2324 | 43347 |
| 22-#11 | 1.86 | MA | 30550 | 7752 | 48756 | 5780 | 52435 | 4690 | 53016 | 3866 | 51818 | 2634 | 62217 | 1840 | 41519 |
| 11L-2S | | MI | 34056 | 7752 | 54794 | 5728 | 60626 | 4638 | 63486 | 3814 | 66947 | 2592 | 81150 | 2413 | 43367 |
| 22-#14 | 2.68 | MA | 36512 | 8290 | 60402 | 6080 | 67331 | 4895 | 71152 | 3974 | 76556 | 2580 | 94229 | 2081 | 64678 |
| 4L-9S | | MI | 31293 | 8290 | 51407 | 6095 | 56131 | 4922 | 57925 | 3993 | 59390 | 2581 | 72538 | 1627 | 56013 |
| 22-#14 | 2.68 | MA | 35738 | 8290 | 59058 | 6079 | 65598 | 4892 | 69029 | 3989 | 73527 | 2571 | 90537 | 2018 | 63690 |
| 5L-8S | | MI | 31966 | 8290 | 52658 | 6077 | 57680 | 4905 | 59875 | 3998 | 61949 | 2570 | 75741 | 1708 | 57353 |
| 22-#14 | 2.68 | MA | 35001 | 8290 | 57790 | 6078 | 63876 | 4908 | 66928 | 3984 | 70745 | 2582 | 87026 | 1933 | 62694 |
| 6L-7S | | MI | 32640 | 8290 | 53840 | 6078 | 59265 | 4909 | 61760 | 3984 | 64657 | 2580 | 78997 | 1781 | 58610 |
| 22-#14 | 2.68 | MA | 34282 | 8290 | 56433 | 6097 | 62222 | 4905 | 64901 | 3999 | 68022 | 2593 | 83372 | 1807 | 61702 |
| 7L-6S | | MI | 33324 | 8290 | 55129 | 6060 | 60836 | 4893 | 63684 | 3970 | 67242 | 2570 | 82439 | 1907 | 59557 |
| 22-#14 | 2.68 | MA | 33574 | 8290 | 55188 | 6096 | 60552 | 4922 | 62916 | 4014 | 65171 | 2584 | 79922 | 1734 | 60343 |
| 8L-5S | | MI | 34025 | 8290 | 56333 | 6062 | 62471 | 4896 | 65680 | 3975 | 69883 | 2560 | 85745 | 1992 | 60471 |
| 22-#14 | 2.68 | MA | 32852 | 8290 | 53871 | 6114 | 58921 | 4919 | 60863 | 4009 | 62476 | 2595 | 76521 | 1652 | 58927 |
| 9L-4S | | MI | 34760 | 8290 | 57609 | 6063 | 64117 | 4880 | 67695 | 3961 | 72758 | 2569 | 89230 | 2054 | 61427 |
| 22-#18 | 4.76 | MA | 39378 | 9655 | 69167 | 6903 | 78086 | 5512 | 84112 | 4350 | 93893 | 2478 | 118373 | 1349 | 104259 |
| 6L-7S | | MI | 36277 | 9655 | 63625 | 6912 | 71508 | 5520 | 76543 | 4355 | 84417 | 2468 | 105907 | 1079 | 96015 |
| 22-#18 | 4.76 | MA | 38167 | 9655 | 66780 | 6934 | 75177 | 5540 | 80548 | 4374 | 89125 | 2496 | 112055 | 1124 | 101307 |
| 7L-6S | | MI | 37429 | 9655 | 65890 | 6881 | 74269 | 5493 | 79926 | 4332 | 88911 | 2450 | 111849 | 1305 | 98831 |
| 24-#11 | 2.03 | MA | 35495 | 7862 | 57427 | 5812 | 63637 | 4699 | 66697 | 3866 | 70404 | 2602 | 85619 | 2330 | 49658 |
| 3L-11S | | MI | 29726 | 7862 | 47825 | 5831 | 51601 | 4725 | 52456 | 3883 | 51956 | 2613 | 62657 | 1806 | 43248 |
| 24-#11 | 2.03 | MA | 34883 | 7862 | 56357 | 5826 | 62277 | 4711 | 65046 | 3863 | 68260 | 2610 | 83131 | 2241 | 49589 |
| 4L-10S | | MI | 30239 | 7862 | 48634 | 5832 | 52675 | 4727 | 53801 | 3886 | 53819 | 2619 | 64888 | 1860 | 44128 |
| 24-#11 | 2.03 | MA | 34335 | 7862 | 55420 | 5825 | 61069 | 4710 | 63566 | 3874 | 66148 | 2604 | 80542 | 2197 | 49468 |
| 5L-9S | | MI | 30765 | 7862 | 49454 | 5833 | 53766 | 4715 | 55106 | 3876 | 55589 | 2612 | 67074 | 1923 | 44756 |
| 24-#11 | 2.03 | MA | 33814 | 7862 | 54537 | 5825 | 59868 | 4722 | 62101 | 3871 | 64208 | 2613 | 78073 | 2139 | 48815 |
| 6L-8S | | MI | 31251 | 7862 | 50327 | 5820 | 54846 | 4717 | 56466 | 3879 | 57373 | 2604 | 69328 | 1979 | 45481 |
| 24-#11 | 2.03 | MA | 33305 | 7862 | 53591 | 5838 | 58715 | 4720 | 60688 | 3882 | 62310 | 2621 | 75505 | 2051 | 48328 |
| 7E | | MI | 31728 | 7862 | 51151 | 5821 | 55951 | 4705 | 57780 | 3869 | 59262 | 2610 | 71614 | 2030 | 45950 |
| 24-#11 | 2.03 | MA | 32803 | 7862 | 52723 | 5837 | 57551 | 4732 | 59305 | 3893 | 60322 | 2615 | 73085 | 2000 | 47833 |
| 8L-6S | | MI | 32212 | 7862 | 52049 | 5808 | 57047 | 4707 | 59123 | 3859 | 61064 | 2602 | 74035 | 2118 | 46396 |
| 24-#11 | 2.03 | MA | 32282 | 7862 | 51872 | 5837 | 56415 | 4730 | 57873 | 3890 | 58444 | 2624 | 70693 | 1943 | 47049 |
| 9L-5S | | MI | 32708 | 7862 | 52889 | 5809 | 58187 | 4696 | 60514 | 3862 | 62907 | 2594 | 76361 | 2176 | 47019 |
| 24-#11 | 2.03 | MA | 31729 | 7862 | 50942 | 5850 | 55266 | 4742 | 56498 | 3901 | 56580 | 2632 | 68373 | 1880 | 46381 |
| 10L-4S | | MI | 33229 | 7862 | 53779 | 5809 | 59335 | 4698 | 61919 | 3852 | 64912 | 2600 | 78807 | 2220 | 47126 |
| 24-#11 | 2.03 | MA | 31189 | 7862 | 50091 | 5850 | 54136 | 4741 | 55084 | 3898 | 54620 | 2627 | 66010 | 1826 | 45434 |
| 11L-3S | | MI | 33810 | 7862 | 54794 | 5796 | 60626 | 4686 | 63486 | 3855 | 66947 | 2593 | 81150 | 2309 | 47185 |
| 24-#14 | 2.92 | MA | 36614 | 8450 | 60968 | 6179 | 68034 | 4964 | 71990 | 4034 | 77538 | 2561 | 95934 | 1996 | 69322 |
| 5L-9S | | MI | 32134 | 8450 | 53217 | 6195 | 58439 | 4994 | 60731 | 4038 | 63192 | 2571 | 77623 | 1603 | 61278 |
| 24-#14 | 2.92 | MA | 35882 | 8450 | 59700 | 6178 | 66311 | 4981 | 69889 | 4029 | 74756 | 2572 | 92423 | 1911 | 68360 |
| 6L-8S | | MI | 32806 | 8450 | 54469 | 6176 | 59988 | 4978 | 62681 | 4043 | 65751 | 2561 | 80826 | 1685 | 62673 |
| 24-#14 | 2.92 | MA | 35167 | 8450 | 58343 | 6197 | 64657 | 4978 | 67862 | 4044 | 72034 | 2583 | 88769 | 1785 | 67285 |
| 7E | | MI | 33476 | 8450 | 55651 | 6178 | 61574 | 4981 | 64566 | 4029 | 68459 | 2570 | 84082 | 1757 | 63894 |
| 24-#14 | 2.92 | MA | 34463 | 8450 | 57099 | 6195 | 62988 | 4994 | 65877 | 4059 | 69182 | 2574 | 85320 | 1712 | 65963 |
| 8L-6S | | MI | 34155 | 8450 | 56940 | 6160 | 63144 | 4965 | 66491 | 4015 | 71044 | 2560 | 87524 | 1884 | 64924 |
| 24-#14 | 2.92 | MA | 33743 | 8450 | 55781 | 6214 | 61357 | 4991 | 63823 | 4054 | 66487 | 2585 | 81918 | 1630 | 64492 |
| 9L-5S | | MI | 34852 | 8450 | 58144 | 6161 | 64780 | 4969 | 68486 | 4020 | 73685 | 2550 | 90830 | 1968 | 65806 |
| 24-#18 | 5.19 | MA | 39666 | 9939 | 70126 | 7111 | 79444 | 5669 | 85734 | 4454 | 96132 | 2477 | 121393 | 1079 | 110947 |
| 7E | | MI | 37692 | 9939 | 66794 | 7089 | 75548 | 5648 | 81454 | 4435 | 91022 | 2447 | 114691 | 1031 | 105122 |

## RECTANGULAR TIED COLUMNS 42" x 46"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.24 | MA | 36471 | 7683 | 57474 | 5705 | 62578 | 4642 | 64330 | 3854 | 65305 | 2725 | 77419 | 2559 | 33397 |
| 2L-3S | | MI | 31084 | 7683 | 49320 | 5664 | 52908 | 4639 | 53518 | 3852 | 52430 | 2715 | 60946 | 2294 | 30329 |
| 6-#18 | 1.24 | MA | 34127 | 7683 | 53951 | 5702 | 58086 | 4670 | 58869 | 3880 | 57907 | 2743 | 67528 | 2332 | 33440 |
| 3L-2S | | MI | 33188 | 7683 | 52488 | 5669 | 56948 | 4612 | 58430 | 3829 | 59035 | 2698 | 69730 | 2522 | 30252 |
| 8-#18 | 1.66 | MA | 38107 | 7966 | 60998 | 5882 | 67071 | 4770 | 69791 | 3934 | 72704 | 2707 | 87311 | 2517 | 44169 |
| 2L-4S | | MI | 31083 | 7966 | 49935 | 5872 | 53701 | 4759 | 54490 | 3919 | 53968 | 2713 | 63996 | 2018 | 39645 |

## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.66 | MA | 35786 | 7966 | 57474 | 5879 | 62578 | 4799 | 64330 | 3959 | 65305 | 2726 | 77419 | 2290 | 44118 |
| 3E | | MI | 32562 | 7966 | 52488 | 5842 | 56948 | 4767 | 58430 | 3932 | 59035 | 2695 | 69730 | 2246 | 39949 |
| 8-#18 | 1.66 | MA | 34146 | 7966 | 54643 | 5912 | 58977 | 4792 | 59960 | 3949 | 59631 | 2744 | 70947 | 2062 | 43711 |
| 4L-2S | | MI | 34647 | 7966 | 55657 | 5846 | 60988 | 4741 | 63341 | 3909 | 65641 | 2677 | 78514 | 2473 | 39956 |
| 10-#14 | 1.16 | MA | 36273 | 7629 | 56786 | 5706 | 61915 | 4646 | 63607 | 3863 | 64359 | 2747 | 76512 | 2601 | 31610 |
| 2L-5S | | MI | 30196 | 7629 | 47331 | 5688 | 50570 | 4647 | 50745 | 3863 | 48784 | 2740 | 57129 | 2250 | 28590 |
| 10-#14 | 1.16 | MA | 34931 | 7629 | 54775 | 5705 | 59352 | 4643 | 60491 | 3879 | 60139 | 2759 | 70803 | 2473 | 31646 |
| 3L-4S | | MI | 30961 | 7629 | 48607 | 5690 | 52215 | 4631 | 52760 | 3849 | 51658 | 2750 | 60614 | 2313 | 28698 |
| 10-#14 | 1.16 | MA | 33986 | 7629 | 53164 | 5724 | 57303 | 4660 | 58004 | 3874 | 56909 | 2770 | 67059 | 2345 | 31614 |
| 4L-3S | | MI | 31815 | 7629 | 50062 | 5672 | 54066 | 4635 | 55006 | 3855 | 54574 | 2739 | 63942 | 2441 | 28699 |
| 10-#14 | 1.16 | MA | 33139 | 7629 | 51752 | 5723 | 55482 | 4658 | 55774 | 3890 | 53727 | 2762 | 63160 | 2282 | 31453 |
| 5L-2S | | MI | 33021 | 7629 | 51873 | 5673 | 56374 | 4619 | 57812 | 3840 | 58376 | 2729 | 69027 | 2569 | 28652 |
| 10-#18 | 2.07 | MA | 39724 | 8250 | 64522 | 6060 | 71563 | 4899 | 75253 | 4014 | 80102 | 2690 | 97202 | 2475 | 54905 |
| 2L-5S | | MI | 31244 | 8250 | 50862 | 6045 | 54851 | 4914 | 55862 | 4022 | 55575 | 2675 | 66736 | 1862 | 46430 |
| 10-#18 | 2.07 | MA | 37424 | 8250 | 60998 | 6057 | 67071 | 4928 | 69791 | 4039 | 72704 | 2708 | 87311 | 2247 | 54769 |
| 3L-4S | | MI | 32559 | 8250 | 53104 | 6050 | 57741 | 4887 | 59401 | 3999 | 60574 | 2692 | 72780 | 1970 | 49140 |
| 10-#18 | 2.07 | MA | 35801 | 8250 | 58166 | 6089 | 63470 | 4921 | 65421 | 4029 | 67030 | 2726 | 80838 | 2020 | 54266 |
| 4L-3S | | MI | 34024 | 8250 | 55657 | 6019 | 60988 | 4896 | 63341 | 4012 | 65641 | 2675 | 78514 | 2197 | 49537 |
| 10-#18 | 2.07 | MA | 34347 | 8250 | 55683 | 6086 | 60267 | 4950 | 61499 | 4054 | 61435 | 2709 | 74059 | 1909 | 51207 |
| 5L-2S | | MI | 36090 | 8250 | 58826 | 6024 | 65028 | 4869 | 68253 | 3989 | 72247 | 2657 | 87298 | 2425 | 49630 |
| 12-#14 | 1.40 | MA | 37219 | 7789 | 58796 | 5806 | 64478 | 4718 | 66722 | 3908 | 68580 | 2737 | 82222 | 2581 | 37755 |
| 2L-6S | | MI | 30333 | 7789 | 47937 | 5786 | 51243 | 4716 | 51557 | 3903 | 49944 | 2740 | 58908 | 2142 | 33021 |
| 12-#14 | 1.40 | MA | 35884 | 7789 | 56786 | 5805 | 61915 | 4715 | 63607 | 3924 | 64359 | 2749 | 76512 | 2453 | 37766 |
| 3L-5S | | MI | 31058 | 7789 | 49142 | 5788 | 52878 | 4720 | 53552 | 3908 | 52585 | 2730 | 62215 | 2227 | 34040 |
| 12-#14 | 1.40 | MA | 34945 | 7789 | 55174 | 5824 | 59866 | 4733 | 61119 | 3919 | 61130 | 2761 | 72768 | 2325 | 37697 |
| 4E | | MI | 31819 | 7789 | 50417 | 5790 | 54524 | 4704 | 55567 | 3894 | 55460 | 2740 | 65699 | 2289 | 34185 |
| 12-#14 | 1.40 | MA | 34105 | 7789 | 53762 | 5823 | 58045 | 4730 | 58889 | 3935 | 57947 | 2752 | 68870 | 2261 | 37497 |
| 5L-3S | | MI | 32667 | 7789 | 51873 | 5771 | 56374 | 4707 | 57812 | 3900 | 58376 | 2729 | 69027 | 2417 | 34225 |
| 12-#14 | 1.40 | MA | 33304 | 7789 | 52431 | 5822 | 56235 | 4747 | 56682 | 3930 | 55025 | 2764 | 65154 | 2177 | 36325 |
| 6L-2S | | MI | 33867 | 7789 | 53683 | 5773 | 58683 | 4691 | 60618 | 3885 | 62178 | 2719 | 74112 | 2545 | 34196 |
| 12-#18 | 2.48 | MA | 41324 | 8534 | 68045 | 6237 | 76055 | 5027 | 80714 | 4094 | 87501 | 2672 | 107093 | 2433 | 65607 |
| 2L-6S | | MI | 31475 | 8534 | 51914 | 6218 | 56017 | 5034 | 57268 | 4089 | 57588 | 2672 | 69816 | 1663 | 53639 |
| 12-#18 | 2.48 | MA | 39044 | 8534 | 64522 | 6234 | 71563 | 5056 | 75253 | 4119 | 80102 | 2690 | 97202 | 2205 | 65402 |
| 3L-5S | | MI | 32717 | 8534 | 54031 | 6222 | 58891 | 5043 | 60773 | 4102 | 62180 | 2654 | 75520 | 1814 | 55672 |
| 12-#18 | 2.48 | MA | 37437 | 8534 | 61690 | 6266 | 67962 | 5050 | 70882 | 4109 | 74428 | 2708 | 90730 | 1978 | 64817 |
| 4E | | MI | 34018 | 8534 | 56273 | 6227 | 61782 | 5016 | 64313 | 4079 | 67179 | 2672 | 81564 | 1921 | 58582 |
| 12-#18 | 2.48 | MA | 35998 | 8534 | 59207 | 6263 | 64759 | 5078 | 66961 | 4134 | 68834 | 2691 | 83951 | 1867 | 61510 |
| 5L-3S | | MI | 35469 | 8534 | 58826 | 6196 | 65028 | 5025 | 68253 | 4092 | 72247 | 2654 | 87298 | 2149 | 59105 |
| 12-#18 | 2.48 | MA | 34626 | 8534 | 56863 | 6260 | 61576 | 5072 | 63078 | 4124 | 63692 | 2709 | 77519 | 1717 | 59225 |
| 6L-2S | | MI | 37518 | 8534 | 61995 | 6201 | 69069 | 4998 | 73164 | 4069 | 78852 | 2637 | 96081 | 2376 | 59263 |
| 14-#11 | 1.13 | MA | 36188 | 7606 | 56472 | 5708 | 61625 | 4649 | 63296 | 3869 | 63957 | 2757 | 76141 | 2621 | 30826 |
| 2L-7S | | MI | 29971 | 7606 | 46683 | 5701 | 49835 | 4640 | 49881 | 3871 | 47694 | 2766 | 55633 | 2223 | 27313 |
| 14-#11 | 1.13 | MA | 35249 | 7606 | 55069 | 5708 | 59836 | 4648 | 61121 | 3880 | 61010 | 2766 | 72132 | 2532 | 30852 |
| 3L-6S | | MI | 30467 | 7606 | 47582 | 5688 | 50931 | 4643 | 51224 | 3861 | 49497 | 2758 | 58054 | 2311 | 27862 |
| 14-#11 | 1.13 | MA | 34590 | 7606 | 53945 | 5722 | 58407 | 4660 | 59386 | 3877 | 58757 | 2775 | 69500 | 2444 | 30853 |
| 4L-5S | | MI | 30977 | 7606 | 48421 | 5689 | 52071 | 4631 | 52615 | 3864 | 51339 | 2750 | 60381 | 2369 | 27976 |
| 14-#11 | 1.13 | MA | 34000 | 7606 | 52961 | 5721 | 57137 | 4658 | 57832 | 3888 | 56539 | 2770 | 66767 | 2399 | 30807 |
| 5L-4S | | MI | 31510 | 7606 | 49311 | 5689 | 53219 | 4633 | 54020 | 3854 | 53344 | 2756 | 62826 | 2413 | 28000 |
| 14-#11 | 1.13 | MA | 33438 | 7606 | 52033 | 5721 | 55876 | 4671 | 56293 | 3886 | 54501 | 2779 | 64156 | 2341 | 30652 |
| 6L-3S | | MI | 32106 | 7606 | 50326 | 5676 | 54510 | 4621 | 55587 | 3857 | 55379 | 2748 | 65169 | 2502 | 27982 |
| 14-#11 | 1.13 | MA | 32889 | 7606 | 51040 | 5735 | 54665 | 4669 | 54809 | 3897 | 52508 | 2788 | 61441 | 2253 | 30010 |
| 7L-2S | | MI | 32951 | 7606 | 51591 | 5677 | 56123 | 4623 | 57548 | 3847 | 58035 | 2741 | 68746 | 2591 | 27951 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 42" x 46"

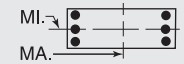
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 1.63 | MA | 38157 | 7949 | 60806 | 5905 | 67041 | 4790 | 69838 | 3953 | 72801 | 2727 | 87931 | 2561 | 43889 |
| 2L-7S | | MI | 30491 | 7949 | 48459 | 5904 | 51980 | 4805 | 52438 | 3962 | 51161 | 2741 | 60552 | 1992 | 37661 |
| 14-#14 | 1.63 | MA | 36830 | 7949 | 58796 | 5905 | 64478 | 4788 | 66722 | 3969 | 68580 | 2739 | 82222 | 2433 | 43870 |
| 3L-6S | | MI | 31194 | 7949 | 49748 | 5886 | 53551 | 4788 | 54363 | 3947 | 53746 | 2730 | 63993 | 2119 | 38349 |
| 14-#14 | 1.63 | MA | 35897 | 7949 | 57184 | 5924 | 62429 | 4805 | 64235 | 3964 | 65350 | 2751 | 78478 | 2305 | 43771 |
| 4L-5S | | MI | 31914 | 7949 | 50952 | 5888 | 55187 | 4792 | 56358 | 3953 | 56387 | 2720 | 67300 | 2203 | 39458 |
| 14-#14 | 1.63 | MA | 35063 | 7949 | 55773 | 5923 | 60608 | 4802 | 62005 | 3980 | 62168 | 2743 | 74579 | 2241 | 43538 |
| 5L-4S | | MI | 32670 | 7949 | 52228 | 5889 | 56832 | 4776 | 58373 | 3939 | 59262 | 2730 | 70784 | 2265 | 39663 |
| 14-#14 | 1.63 | MA | 34267 | 7949 | 54441 | 5922 | 58798 | 4820 | 59797 | 3975 | 59245 | 2754 | 70863 | 2157 | 42249 |
| 6L-3S | | MI | 33512 | 7949 | 53683 | 5871 | 58683 | 4779 | 60618 | 3944 | 62178 | 2720 | 74112 | 2393 | 39731 |
| 14-#14 | 1.63 | MA | 33490 | 7949 | 53016 | 5941 | 57061 | 4817 | 57668 | 3991 | 56385 | 2766 | 66997 | 2030 | 41438 |
| 7L-2S | | MI | 34706 | 7949 | 55494 | 5873 | 60991 | 4763 | 63425 | 3930 | 65979 | 2709 | 79197 | 2521 | 39728 |
| 14-#18 | 2.90 | MA | 42908 | 8818 | 71569 | 6414 | 80548 | 5156 | 86175 | 4174 | 94900 | 2654 | 116985 | 2390 | 76292 |
| 2L-7S | | MI | 31744 | 8818 | 52818 | 6426 | 57296 | 5189 | 58797 | 4192 | 59699 | 2669 | 72658 | 1389 | 59880 |
| 14-#18 | 2.90 | MA | 40647 | 8818 | 68045 | 6411 | 76055 | 5185 | 80714 | 4199 | 87501 | 2673 | 107093 | 2163 | 76023 |
| 3L-6S | | MI | 32944 | 8818 | 55083 | 6395 | 60057 | 5163 | 62180 | 4169 | 64194 | 2652 | 78600 | 1615 | 62728 |
| 14-#18 | 2.90 | MA | 39056 | 8818 | 65213 | 6444 | 72454 | 5178 | 76343 | 4189 | 81827 | 2691 | 100621 | 1935 | 75065 |
| 4L-5S | | MI | 34174 | 8818 | 57200 | 6400 | 62931 | 5171 | 65685 | 4182 | 68786 | 2634 | 84304 | 1765 | 64941 |
| 14-#18 | 2.90 | MA | 37632 | 8818 | 62730 | 6441 | 69252 | 5207 | 72422 | 4214 | 76232 | 2673 | 93842 | 1825 | 71841 |
| 5L-4S | | MI | 35463 | 8818 | 59442 | 6404 | 65822 | 5144 | 69224 | 4159 | 73785 | 2652 | 90348 | 1873 | 67698 |
| 14-#18 | 2.90 | MA | 36274 | 8818 | 60386 | 6438 | 66068 | 5200 | 68539 | 4204 | 71091 | 2692 | 87411 | 1675 | 69380 |
| 6L-3S | | MI | 36900 | 8818 | 61995 | 6374 | 69069 | 5153 | 73164 | 4171 | 78852 | 2634 | 96081 | 2100 | 68659 |
| 14-#18 | 2.90 | MA | 34948 | 8818 | 57878 | 6470 | 63011 | 5229 | 64792 | 4229 | 66060 | 2710 | 80716 | 1450 | 66088 |
| 7L-2S | | MI | 38932 | 8818 | 65164 | 6378 | 73109 | 5126 | 78075 | 4149 | 85458 | 2616 | 104865 | 2328 | 68877 |
| 16-#11 | 1.29 | MA | 36853 | 7717 | 57876 | 5777 | 63414 | 4699 | 65471 | 3900 | 66904 | 2750 | 80150 | 2608 | 35116 |
| 2L-8S | | MI | 30091 | 7717 | 47124 | 5769 | 50343 | 4702 | 50528 | 3913 | 48462 | 2753 | 56924 | 2157 | 30699 |
| 16-#11 | 1.29 | MA | 35918 | 7717 | 56472 | 5777 | 61625 | 4698 | 63296 | 3911 | 63957 | 2759 | 76141 | 2519 | 35132 |
| 3L-7S | | MI | 30579 | 7717 | 47948 | 5770 | 51449 | 4691 | 51842 | 3902 | 50350 | 2759 | 59209 | 2208 | 31060 |
| 16-#11 | 1.29 | MA | 35261 | 7717 | 55349 | 5791 | 60196 | 4710 | 61561 | 3908 | 61704 | 2768 | 73509 | 2431 | 35114 |
| 4L-6S | | MI | 31073 | 7717 | 48847 | 5757 | 52544 | 4693 | 53184 | 3892 | 52153 | 2751 | 61630 | 2296 | 31584 |
| 16-#11 | 1.29 | MA | 34674 | 7717 | 54365 | 5791 | 58927 | 4709 | 60007 | 3919 | 59486 | 2763 | 70776 | 2386 | 35051 |
| 5E | | MI | 31580 | 7717 | 49686 | 5758 | 53684 | 4681 | 54576 | 3895 | 53995 | 2743 | 63957 | 2354 | 31807 |
| 16-#11 | 1.29 | MA | 34115 | 7717 | 53437 | 5790 | 57665 | 4721 | 58468 | 3917 | 57448 | 2772 | 68165 | 2328 | 34786 |
| 6L-4S | | MI | 32111 | 7717 | 50576 | 5759 | 54832 | 4683 | 55981 | 3885 | 56001 | 2749 | 66403 | 2398 | 31847 |
| 16-#11 | 1.29 | MA | 33569 | 7717 | 52443 | 5804 | 56455 | 4720 | 56984 | 3928 | 55455 | 2781 | 65450 | 2240 | 34170 |
| 7L-3S | | MI | 32704 | 7717 | 51591 | 5746 | 56123 | 4671 | 57548 | 3888 | 58035 | 2742 | 68746 | 2487 | 31846 |
| 16-#11 | 1.29 | MA | 33031 | 7717 | 51533 | 5804 | 55233 | 4732 | 55532 | 3939 | 53367 | 2776 | 62895 | 2188 | 33740 |
| 8L-2S | | MI | 33545 | 7717 | 52857 | 5746 | 57736 | 4674 | 59509 | 3878 | 60692 | 2734 | 72322 | 2575 | 31823 |
| 16-#14 | 1.86 | MA | 39090 | 8108 | 62816 | 6005 | 69604 | 4862 | 72953 | 3998 | 77022 | 2717 | 93640 | 2540 | 50010 |
| 2L-8S | | MI | 30661 | 8108 | 49088 | 6002 | 52704 | 4873 | 53359 | 4021 | 52255 | 2721 | 62381 | 1896 | 41750 |
| 16-#14 | 1.86 | MA | 37770 | 8108 | 60806 | 6004 | 67041 | 4860 | 69838 | 4013 | 72801 | 2729 | 87931 | 2412 | 49966 |
| 3L-7S | | MI | 31350 | 8108 | 50270 | 6004 | 54289 | 4877 | 55244 | 4007 | 54963 | 2731 | 65637 | 1969 | 43024 |
| 16-#14 | 1.86 | MA | 36843 | 8108 | 59194 | 6023 | 64991 | 4877 | 67350 | 4009 | 69571 | 2741 | 84187 | 2284 | 49839 |
| 4L-6S | | MI | 32048 | 8108 | 51559 | 5986 | 55860 | 4861 | 57169 | 3992 | 57548 | 2721 | 69079 | 2095 | 43687 |
| 16-#14 | 1.86 | MA | 36014 | 8108 | 57783 | 6023 | 63171 | 4875 | 65120 | 4024 | 66389 | 2733 | 80288 | 2220 | 49421 |
| 5E | | MI | 32764 | 8108 | 52763 | 5987 | 57495 | 4864 | 59164 | 3998 | 60189 | 2710 | 72385 | 2179 | 44745 |
| 16-#14 | 1.86 | MA | 35223 | 8108 | 56451 | 6022 | 61361 | 4892 | 62913 | 4020 | 63466 | 2744 | 76572 | 2136 | 48184 |
| 6L-4S | | MI | 33515 | 8108 | 54039 | 5989 | 59141 | 4848 | 61179 | 3984 | 63064 | 2720 | 75870 | 2242 | 45132 |
| 16-#14 | 1.86 | MA | 34452 | 8108 | 55026 | 6041 | 59624 | 4889 | 60783 | 4036 | 60606 | 2756 | 72706 | 2010 | 47399 |
| 7L-3S | | MI | 34353 | 8108 | 55494 | 5971 | 60991 | 4852 | 63425 | 3989 | 65979 | 2710 | 79197 | 2370 | 45226 |
| 16-#14 | 1.86 | MA | 33691 | 8108 | 53719 | 6040 | 57871 | 4907 | 58699 | 4051 | 57610 | 2748 | 69062 | 1936 | 45956 |
| 8L-2S | | MI | 35540 | 8108 | 57305 | 5972 | 63299 | 4836 | 66231 | 3975 | 69781 | 2699 | 84283 | 2498 | 45253 |
| 16-#18 | 3.31 | MA | 42236 | 9101 | 71569 | 6589 | 80548 | 5313 | 86175 | 4279 | 94900 | 2655 | 116985 | 2121 | 86635 |
| 3L-7S | | MI | 33211 | 9101 | 55987 | 6603 | 61336 | 5318 | 63708 | 4272 | 66305 | 2649 | 81442 | 1341 | 69103 |
| 16-#18 | 3.31 | MA | 40659 | 9101 | 68737 | 6621 | 76947 | 5307 | 81804 | 4269 | 89225 | 2673 | 110513 | 1893 | 85271 |
| 4L-6S | | MI | 34399 | 9101 | 58252 | 6572 | 64097 | 5291 | 67091 | 4249 | 70799 | 2631 | 87383 | 1566 | 71845 |
| 16-#18 | 3.31 | MA | 39249 | 9101 | 66254 | 6618 | 73744 | 5336 | 77883 | 4294 | 83631 | 2656 | 103734 | 1783 | 82195 |
| 5E | | MI | 35617 | 9101 | 60369 | 6577 | 66972 | 5300 | 70596 | 4262 | 75392 | 2613 | 93088 | 1717 | 74233 |
| 16-#18 | 3.31 | MA | 37904 | 9101 | 63910 | 6615 | 70561 | 5329 | 74000 | 4284 | 78490 | 2674 | 97302 | 1632 | 79562 |
| 6L-4S | | MI | 36894 | 9101 | 62611 | 6582 | 69862 | 5273 | 74135 | 4239 | 80391 | 2631 | 99131 | 1824 | 76852 |

## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

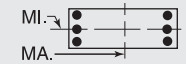
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 3.31 | MA | 36592 | 9101 | 61402 | 6647 | 67503 | 5358 | 70253 | 4309 | 73458 | 2692 | 90608 | 1408 | 76381 |
| 7L-3S | | MI | 38318 | 9101 | 61564 | 6551 | 73109 | 5282 | 78075 | 4251 | 85458 | 2613 | 104865 | 2052 | 78203 |
| 16-#18 | 3.31 | MA | 35298 | 9101 | 59101 | 6644 | 64418 | 5351 | 66585 | 4334 | 68188 | 2675 | 84274 | 1279 | 72558 |
| 8L-2S | | MI | 40335 | 9101 | 68333 | 6556 | 77149 | 5255 | 82987 | 4228 | 92064 | 2596 | 113649 | 2279 | 78476 |
| 18-#11 | 1.45 | MA | 37514 | 7827 | 59279 | 5847 | 65204 | 4749 | 67647 | 3931 | 69851 | 2744 | 84160 | 2595 | 39400 |
| 2L-9S | | MI | 30205 | 7827 | 47517 | 5851 | 50876 | 4750 | 51129 | 3940 | 49334 | 2754 | 58246 | 2086 | 33820 |
| 18-#11 | 1.45 | MA | 36582 | 7827 | 57876 | 5846 | 63414 | 4748 | 65471 | 3942 | 66904 | 2752 | 80150 | 2506 | 39403 |
| 3L-8S | | MI | 30698 | 7827 | 48389 | 5838 | 51956 | 4752 | 52489 | 3944 | 51119 | 2746 | 60500 | 2142 | 34461 |
| 18-#11 | 1.45 | MA | 35929 | 7827 | 56752 | 5860 | 61985 | 4760 | 63737 | 3939 | 64651 | 2761 | 77518 | 2418 | 39370 |
| 4L-7S | | MI | 31183 | 7827 | 49213 | 5839 | 53062 | 4741 | 53803 | 3933 | 53007 | 2752 | 62785 | 2193 | 34812 |
| 18-#11 | 1.45 | MA | 35345 | 7827 | 55768 | 5860 | 60716 | 4759 | 62182 | 3951 | 62433 | 2756 | 74786 | 2373 | 39291 |
| 5L-6S | | MI | 31675 | 7827 | 50112 | 5826 | 54157 | 4743 | 55145 | 3923 | 54810 | 2744 | 65206 | 2281 | 35315 |
| 18-#11 | 1.45 | MA | 34788 | 7827 | 54840 | 5859 | 59455 | 4771 | 60643 | 3948 | 60395 | 2765 | 72175 | 2315 | 38928 |
| 6L-5S | | MI | 32179 | 7827 | 50951 | 5827 | 55297 | 4731 | 56537 | 3926 | 56652 | 2736 | 67533 | 2339 | 35633 |
| 18-#11 | 1.45 | MA | 34245 | 7827 | 53847 | 5873 | 58244 | 4770 | 59160 | 3959 | 58402 | 2774 | 69459 | 2227 | 38336 |
| 7L-4S | | MI | 32708 | 7827 | 51841 | 5828 | 56445 | 4733 | 57942 | 3916 | 58657 | 2742 | 69979 | 2383 | 35689 |
| 18-#11 | 1.45 | MA | 33710 | 7827 | 52936 | 5873 | 57023 | 4782 | 57707 | 3970 | 56314 | 2769 | 66905 | 2175 | 37916 |
| 8L-3S | | MI | 33299 | 7827 | 52857 | 5815 | 57736 | 4722 | 59509 | 3919 | 60692 | 2735 | 72322 | 2472 | 35705 |
| 18-#11 | 1.45 | MA | 33145 | 7827 | 52042 | 5873 | 55829 | 4781 | 56204 | 3968 | 54342 | 2778 | 64375 | 2119 | 37178 |
| 9L-2S | | MI | 34137 | 7827 | 54122 | 5816 | 59349 | 4724 | 61470 | 3909 | 63348 | 2727 | 75898 | 2560 | 35690 |
| 18-#14 | 2.10 | MA | 40016 | 8268 | 64826 | 6105 | 72167 | 4935 | 76069 | 4043 | 81242 | 2707 | 99349 | 2520 | 56120 |
| 2L-9S | | MI | 30839 | 8268 | 49647 | 6120 | 53463 | 4962 | 54216 | 4060 | 53498 | 2721 | 64263 | 1791 | 45945 |
| 18-#14 | 2.10 | MA | 38703 | 8268 | 62816 | 6104 | 69604 | 4932 | 72953 | 4058 | 77022 | 2719 | 93640 | 2392 | 56055 |
| 3L-8S | | MI | 31518 | 8268 | 50898 | 6102 | 55012 | 4946 | 56166 | 4066 | 56057 | 2711 | 67466 | 1872 | 47043 |
| 18-#14 | 2.10 | MA | 37782 | 8268 | 61205 | 6123 | 67554 | 4949 | 70466 | 4054 | 73792 | 2731 | 89896 | 2264 | 55903 |
| 4L-7S | | MI | 32203 | 8268 | 52081 | 6104 | 56597 | 4949 | 58050 | 4051 | 58765 | 2721 | 70722 | 1945 | 48391 |
| 18-#14 | 2.10 | MA | 36958 | 8268 | 59793 | 6122 | 65733 | 4947 | 68235 | 4069 | 70610 | 2723 | 85998 | 2200 | 55315 |
| 5L-6S | | MI | 32897 | 8268 | 53369 | 6085 | 58168 | 4933 | 59975 | 4037 | 61350 | 2711 | 74164 | 2071 | 49034 |
| 18-#14 | 2.10 | MA | 36173 | 8268 | 58461 | 6122 | 63924 | 4964 | 66028 | 4065 | 67687 | 2735 | 82281 | 2116 | 54128 |
| 6L-5S | | MI | 33608 | 8268 | 54574 | 6087 | 59804 | 4937 | 61970 | 4043 | 63991 | 2700 | 77470 | 2156 | 50046 |
| 18-#14 | 2.10 | MA | 35406 | 8268 | 57036 | 6141 | 62186 | 4962 | 63899 | 4080 | 64827 | 2746 | 78415 | 1989 | 53365 |
| 7L-4S | | MI | 34354 | 8268 | 55849 | 6089 | 61449 | 4920 | 63985 | 4029 | 66866 | 2710 | 80955 | 2218 | 50597 |
| 18-#14 | 2.10 | MA | 34651 | 8268 | 55729 | 6140 | 60433 | 4979 | 61814 | 4096 | 61831 | 2738 | 74772 | 1915 | 51850 |
| 8L-3S | | MI | 35187 | 8268 | 57305 | 6070 | 63299 | 4924 | 66231 | 4034 | 69781 | 2700 | 84283 | 2346 | 50715 |
| 18-#14 | 2.10 | MA | 33862 | 8268 | 54446 | 6139 | 58720 | 4976 | 59657 | 4092 | 59001 | 2750 | 71172 | 1834 | 50607 |
| 9L-2S | | MI | 36368 | 8268 | 59115 | 6072 | 65608 | 4908 | 69037 | 4020 | 73583 | 2689 | 89368 | 2474 | 50761 |
| 18-#18 | 3.73 | MA | 42248 | 9385 | 72261 | 6798 | 81439 | 5435 | 87266 | 4348 | 96624 | 2655 | 120404 | 1851 | 95509 |
| 4L-7S | | MI | 34663 | 9385 | 59156 | 6780 | 65377 | 5446 | 68620 | 4352 | 72911 | 2628 | 90226 | 1292 | 78344 |
| 18-#18 | 3.73 | MA | 40851 | 9385 | 69777 | 6795 | 78237 | 5464 | 83344 | 4374 | 91029 | 2638 | 113625 | 1740 | 92569 |
| 5L-6S | | MI | 35841 | 9385 | 61421 | 6750 | 68138 | 5420 | 72003 | 4329 | 77405 | 2611 | 96167 | 1518 | 80988 |
| 18-#18 | 3.73 | MA | 39519 | 9385 | 67434 | 6792 | 75053 | 5458 | 79461 | 4364 | 85888 | 2656 | 107194 | 1590 | 89768 |
| 6L-5S | | MI | 37047 | 9385 | 63538 | 6754 | 71012 | 5428 | 75508 | 4341 | 81997 | 2593 | 101872 | 1668 | 83544 |
| 18-#18 | 3.73 | MA | 38220 | 9385 | 64925 | 6825 | 71996 | 5486 | 75714 | 4389 | 80857 | 2674 | 100499 | 1365 | 86691 |
| 7L-4S | | MI | 38313 | 9385 | 65780 | 6759 | 73902 | 5402 | 79047 | 4319 | 86996 | 2611 | 107915 | 1776 | 86039 |
| 18-#18 | 3.73 | MA | 36939 | 9385 | 62624 | 6822 | 68911 | 5480 | 72046 | 4414 | 75587 | 2657 | 94165 | 1236 | 82772 |
| 8L-3S | | MI | 39725 | 9385 | 68333 | 6728 | 77149 | 5410 | 82987 | 4331 | 92064 | 2593 | 113649 | 2003 | 87738 |
| 20-#11 | 1.61 | MA | 38171 | 7938 | 60683 | 5916 | 66993 | 4799 | 69822 | 3962 | 72797 | 2737 | 88169 | 2582 | 43680 |
| 2L-10S | | MI | 30280 | 7938 | 47962 | 5920 | 51398 | 4812 | 51784 | 3982 | 50220 | 2754 | 59636 | 2007 | 36949 |
| 20-#11 | 1.61 | MA | 37244 | 7938 | 59279 | 5916 | 65204 | 4798 | 67647 | 3973 | 69851 | 2745 | 84160 | 2493 | 43667 |
| 3L-9S | | MI | 30811 | 7938 | 48782 | 5920 | 52489 | 4800 | 53090 | 3971 | 51991 | 2747 | 61822 | 2071 | 37535 |
| 20-#11 | 1.61 | MA | 36593 | 7938 | 58156 | 5929 | 63775 | 4810 | 65912 | 3971 | 67598 | 2754 | 81528 | 2405 | 43622 |
| 4L-8S | | MI | 31302 | 7938 | 49654 | 5907 | 53569 | 4803 | 54450 | 3975 | 53775 | 2739 | 64076 | 2127 | 38226 |
| 20-#11 | 1.61 | MA | 36012 | 7938 | 57172 | 5929 | 62505 | 4809 | 64357 | 3982 | 65380 | 2749 | 78795 | 2360 | 43528 |
| 5L-7S | | MI | 31785 | 7938 | 50479 | 5908 | 54675 | 4791 | 55764 | 3965 | 55663 | 2745 | 66362 | 2178 | 38569 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

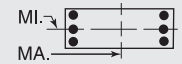



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.61 | MA | 35458 | 7938 | 56244 | 5929 | 61244 | 4821 | 62819 | 3979 | 63342 | 2758 | 76184 | 2302 | 43078 |
| 6E | | MI | 32274 | 7938 | 51377 | 5895 | 55770 | 4793 | 57106 | 3954 | 57466 | 2737 | 68783 | 2266 | 39052 |
| 20-#11 | 1.61 | MA | 34918 | 7938 | 55250 | 5942 | 60034 | 4820 | 61335 | 3990 | 61349 | 2767 | 73468 | 2214 | 42506 |
| 7L-5S | | MI | 32776 | 7938 | 52217 | 5896 | 56910 | 4781 | 58497 | 3958 | 59308 | 2729 | 71109 | 2324 | 39456 |
| 20-#11 | 1.61 | MA | 34385 | 7938 | 54340 | 5942 | 58812 | 4832 | 59882 | 4001 | 59261 | 2762 | 70914 | 2162 | 42096 |
| 8L-4S | | MI | 33303 | 7938 | 53106 | 5897 | 58058 | 4783 | 59903 | 3947 | 61314 | 2735 | 73555 | 2368 | 39525 |
| 20-#11 | 1.61 | MA | 33823 | 7938 | 53446 | 5942 | 57618 | 4831 | 58379 | 3999 | 57289 | 2771 | 68384 | 2106 | 41309 |
| 9L-3S | | MI | 33891 | 7938 | 54122 | 5884 | 59349 | 4772 | 61470 | 3951 | 63348 | 2728 | 75898 | 2456 | 39554 |
| 20-#11 | 1.61 | MA | 33237 | 7938 | 52470 | 5955 | 56412 | 4843 | 56936 | 4010 | 55331 | 2779 | 65930 | 2043 | 40626 |
| 10L-2S | | MI | 34726 | 7938 | 55387 | 5885 | 60962 | 4774 | 63431 | 3940 | 66005 | 2720 | 79475 | 2545 | 39552 |
| 20-#14 | 2.33 | MA | 39631 | 8427 | 64826 | 6204 | 72167 | 5005 | 76069 | 4103 | 81242 | 2709 | 99349 | 2371 | 62138 |
| 3L-9S | | MI | 31694 | 8427 | 51458 | 6220 | 55772 | 5034 | 57022 | 4105 | 57300 | 2712 | 69348 | 1767 | 51188 |
| 20-#14 | 2.33 | MA | 38715 | 8427 | 63215 | 6223 | 70117 | 5022 | 73581 | 4099 | 78013 | 2721 | 95605 | 2243 | 61963 |
| 4L-8S | | MI | 32370 | 8427 | 52709 | 6202 | 57321 | 5018 | 58972 | 4111 | 59859 | 2701 | 72551 | 1849 | 52346 |
| 20-#14 | 2.33 | MA | 37896 | 8427 | 61803 | 6222 | 68296 | 5019 | 71351 | 4114 | 74830 | 2713 | 91707 | 2179 | 61222 |
| 5L-7S | | MI | 33050 | 8427 | 53891 | 6203 | 58906 | 5022 | 60857 | 4096 | 62566 | 2711 | 75807 | 1921 | 53669 |
| 20-#14 | 2.33 | MA | 37116 | 8427 | 60471 | 6221 | 66486 | 5037 | 69143 | 4110 | 71908 | 2725 | 87991 | 2095 | 60079 |
| 6E | | MI | 33740 | 8427 | 55180 | 6185 | 60476 | 5005 | 62782 | 4082 | 65152 | 2701 | 79249 | 2048 | 54388 |
| 20-#14 | 2.33 | MA | 36354 | 8427 | 59046 | 6240 | 64749 | 5034 | 67014 | 4125 | 69048 | 2736 | 84125 | 1969 | 59286 |
| 7L-5S | | MI | 34447 | 8427 | 56384 | 6187 | 62112 | 5009 | 64777 | 4088 | 67793 | 2690 | 82556 | 2132 | 55359 |
| 20-#14 | 2.33 | MA | 35604 | 8427 | 57739 | 6240 | 62996 | 5051 | 64930 | 4141 | 66052 | 2728 | 80481 | 1895 | 57752 |
| 8L-4S | | MI | 35188 | 8427 | 57660 | 6188 | 63758 | 4993 | 66792 | 4073 | 70668 | 2700 | 86040 | 2195 | 56056 |
| 20-#14 | 2.33 | MA | 34820 | 8427 | 56456 | 6239 | 61283 | 5049 | 62773 | 4136 | 63222 | 2740 | 76881 | 1814 | 56452 |
| 9L-3S | | MI | 36017 | 8427 | 59115 | 6170 | 65608 | 4996 | 69037 | 4079 | 73583 | 2690 | 89368 | 2323 | 56197 |
| 20-#14 | 2.33 | MA | 33992 | 8427 | 55055 | 6258 | 59553 | 5066 | 60701 | 4152 | 60413 | 2752 | 73389 | 1722 | 54769 |
| 10L-2S | | MI | 37192 | 8427 | 60926 | 6172 | 67916 | 4980 | 71844 | 4065 | 77385 | 2679 | 94453 | 2450 | 56262 |
| 20-#18 | 4.14 | MA | 42439 | 9669 | 73301 | 6973 | 82729 | 5593 | 88805 | 4454 | 98428 | 2620 | 123517 | 1698 | 102959 |
| 5L-7S | | MI | 36103 | 9669 | 62325 | 6958 | 69417 | 5575 | 73531 | 4431 | 79516 | 2608 | 99009 | 1244 | 87601 |
| 20-#18 | 4.14 | MA | 41120 | 9669 | 70957 | 6970 | 79545 | 5586 | 84922 | 4443 | 93287 | 2639 | 117085 | 1548 | 99997 |
| 6E | | MI | 37270 | 9669 | 64590 | 6927 | 72178 | 5548 | 76914 | 4409 | 84011 | 2590 | 104951 | 1469 | 90153 |
| 20-#18 | 4.14 | MA | 39833 | 9669 | 68449 | 7002 | 76488 | 5615 | 81175 | 4469 | 88255 | 2657 | 110391 | 1323 | 97017 |
| 7L-5S | | MI | 38466 | 9669 | 66707 | 6932 | 75052 | 5557 | 80419 | 4421 | 88603 | 2573 | 110655 | 1620 | 92872 |
| 20-#18 | 4.14 | MA | 38564 | 9669 | 66148 | 6999 | 73403 | 5608 | 77507 | 4494 | 82985 | 2640 | 104057 | 1194 | 93003 |
| 8L-4S | | MI | 39720 | 9669 | 68949 | 6936 | 77943 | 5530 | 83958 | 4398 | 93602 | 2590 | 116699 | 1727 | 95252 |
| 22-#11 | 1.78 | MA | 38826 | 8049 | 62086 | 5985 | 68783 | 4850 | 71997 | 3993 | 75744 | 2730 | 92178 | 2569 | 47952 |
| 2L-11S | | MI | 30369 | 8049 | 48418 | 5988 | 51938 | 4860 | 52401 | 4010 | 51015 | 2741 | 60981 | 1938 | 39845 |
| 22-#11 | 1.78 | MA | 37902 | 8049 | 60683 | 5985 | 66993 | 4848 | 69822 | 4004 | 72797 | 2739 | 88169 | 2480 | 47928 |
| 3L-10S | | MI | 30885 | 8049 | 49227 | 5989 | 53011 | 4862 | 53745 | 4013 | 52877 | 2748 | 63212 | 1992 | 40684 |
| 22-#11 | 1.78 | MA | 37254 | 8049 | 59559 | 5998 | 65564 | 4860 | 68087 | 4002 | 70545 | 2747 | 85537 | 2392 | 47870 |
| 4L-9S | | MI | 31414 | 8049 | 50047 | 5990 | 54102 | 4851 | 55051 | 4003 | 54648 | 2740 | 65398 | 2056 | 41255 |
| 22-#11 | 1.78 | MA | 36676 | 8049 | 58575 | 5998 | 64295 | 4859 | 66532 | 4013 | 68326 | 2742 | 82804 | 2347 | 47763 |
| 5L-8S | | MI | 31903 | 8049 | 50920 | 5977 | 55182 | 4853 | 56411 | 4006 | 56432 | 2732 | 67652 | 2112 | 41993 |
| 22-#11 | 1.78 | MA | 36124 | 8049 | 57647 | 5998 | 63033 | 4871 | 64994 | 4010 | 66289 | 2751 | 80193 | 2289 | 47233 |
| 6L-7S | | MI | 32383 | 8049 | 51744 | 5977 | 56288 | 4841 | 57725 | 3996 | 58320 | 2738 | 69938 | 2163 | 42329 |
| 22-#11 | 1.78 | MA | 35587 | 8049 | 56654 | 6011 | 61823 | 4870 | 63510 | 4021 | 64296 | 2760 | 77478 | 2201 | 46681 |
| 7L-6S | | MI | 32871 | 8049 | 52642 | 5964 | 57383 | 4843 | 59067 | 3985 | 60123 | 2730 | 72359 | 2250 | 42796 |
| 22-#11 | 1.78 | MA | 35056 | 8049 | 55743 | 6011 | 60601 | 4882 | 62057 | 4033 | 62208 | 2755 | 74923 | 2149 | 46278 |
| 8L-5S | | MI | 33370 | 8049 | 53482 | 5965 | 58523 | 4831 | 60458 | 3989 | 61965 | 2723 | 74686 | 2309 | 43275 |
| 22-#11 | 1.78 | MA | 34497 | 8049 | 54849 | 6011 | 59408 | 4881 | 60554 | 4030 | 60236 | 2764 | 72394 | 2093 | 45444 |
| 9L-4S | | MI | 33894 | 8049 | 54372 | 5966 | 59671 | 4834 | 61864 | 3978 | 63970 | 2729 | 77131 | 2353 | 43358 |
| 22-#11 | 1.78 | MA | 33914 | 8049 | 53873 | 6024 | 58202 | 4893 | 59111 | 4041 | 58278 | 2773 | 69940 | 2030 | 44777 |
| 10L-3S | | MI | 34480 | 8049 | 55387 | 5953 | 60962 | 4822 | 63431 | 3982 | 66005 | 2721 | 79475 | 2441 | 43398 |
| 22-#11 | 1.78 | MA | 33343 | 8049 | 52980 | 6024 | 57015 | 4892 | 57625 | 4039 | 56220 | 2768 | 67445 | 1975 | 43825 |
| 11L-2S | | MI | 35312 | 8049 | 56652 | 5954 | 62575 | 4824 | 65392 | 3971 | 68661 | 2713 | 83051 | 2530 | 43410 |
| 22-#14 | 2.56 | MA | 39642 | 8587 | 65225 | 6323 | 72680 | 5094 | 76697 | 4144 | 82233 | 2711 | 101315 | 2223 | 68019 |
| 4L-9S | | MI | 32542 | 8587 | 53269 | 6320 | 58080 | 5107 | 59828 | 4150 | 61102 | 2702 | 74433 | 1744 | 56441 |
| 22-#14 | 2.56 | MA | 38828 | 8587 | 63813 | 6322 | 70859 | 5092 | 74466 | 4159 | 79051 | 2703 | 97416 | 2159 | 67140 |
| 5L-8S | | MI | 33216 | 8587 | 54520 | 6302 | 59629 | 5090 | 61778 | 4156 | 63661 | 2691 | 77637 | 1825 | 57656 |
| 22-#14 | 2.56 | MA | 38053 | 8587 | 62482 | 6321 | 69049 | 5109 | 72259 | 4155 | 76128 | 2715 | 93700 | 2075 | 66038 |
| 6L-7S | | MI | 33892 | 8587 | 55702 | 6303 | 61214 | 5094 | 63663 | 4141 | 66368 | 2701 | 80893 | 1898 | 58940 |

## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

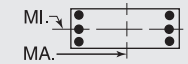
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 2.56 | MA | 37296 | 8587 | 61056 | 6340 | 67312 | 5106 | 70130 | 4170 | 73268 | 2726 | 89834 | 1948 | 65154 |
| 7L-6S | | MI | 34578 | 8587 | 56991 | 6285 | 62785 | 5078 | 65588 | 4127 | 68953 | 2691 | 84334 | 2024 | 59749 |
| 22-#14 | 2.56 | MA | 36550 | 8587 | 59749 | 6339 | 65559 | 5124 | 68045 | 4186 | 70273 | 2718 | 86190 | 1874 | 63662 |
| 8L-5S | | MI | 35281 | 8587 | 58195 | 6287 | 64421 | 5081 | 67583 | 4133 | 71595 | 2680 | 87641 | 2109 | 60682 |
| 22-#14 | 2.56 | MA | 35780 | 8587 | 58466 | 6339 | 63846 | 5121 | 65888 | 4181 | 67442 | 2730 | 82590 | 1793 | 62306 |
| 9L-4S | | MI | 36018 | 8587 | 59471 | 6288 | 66066 | 5065 | 69598 | 4118 | 74469 | 2690 | 91125 | 2171 | 61513 |
| 22-#14 | 2.56 | MA | 34948 | 8587 | 57065 | 6358 | 62115 | 5138 | 63817 | 4197 | 64634 | 2742 | 79098 | 1702 | 60659 |
| 10L-3S | | MI | 36841 | 8587 | 60926 | 6270 | 67916 | 5069 | 71844 | 4124 | 77385 | 2680 | 94453 | 2299 | 61675 |
| 22-#18 | 4.55 | MA | 42708 | 9952 | 74481 | 7147 | 84038 | 5715 | 90383 | 4523 | 100685 | 2621 | 126977 | 1506 | 110246 |
| 6L-7S | | MI | 37531 | 9952 | 65494 | 7135 | 73457 | 5704 | 78443 | 4511 | 86122 | 2588 | 107793 | 1195 | 96725 |
| 22-#18 | 4.55 | MA | 41432 | 9952 | 71973 | 7179 | 80980 | 5744 | 86637 | 4549 | 95654 | 2639 | 120282 | 1281 | 107358 |
| 7L-6S | | MI | 38688 | 9952 | 67759 | 7104 | 76218 | 5677 | 81825 | 4488 | 90616 | 2570 | 113735 | 1421 | 99339 |
| 22-#18 | 4.55 | MA | 40175 | 9952 | 69671 | 7176 | 77895 | 5737 | 82968 | 4574 | 90384 | 2622 | 113948 | 1152 | 103250 |
| 8L-5S | | MI | 39874 | 9952 | 69876 | 7109 | 79092 | 5685 | 85331 | 4501 | 95209 | 2552 | 119439 | 1571 | 102212 |
| 24-#11 | 1.94 | MA | 38557 | 8159 | 62086 | 6054 | 68783 | 4898 | 71997 | 4035 | 75744 | 2732 | 92178 | 2467 | 52185 |
| 3L-11S | | MI | 30973 | 8159 | 49683 | 6057 | 53551 | 4910 | 54362 | 4041 | 53671 | 2735 | 64557 | 1923 | 43549 |
| 24-#11 | 1.94 | MA | 37912 | 8159 | 60963 | 6067 | 67353 | 4911 | 70262 | 4033 | 73492 | 2740 | 89546 | 2379 | 52116 |
| 4L-10S | | MI | 31488 | 8159 | 50492 | 6058 | 54624 | 4912 | 55706 | 4044 | 55533 | 2741 | 66789 | 1977 | 44422 |
| 24-#11 | 1.94 | MA | 37336 | 8159 | 59979 | 6067 | 66084 | 4909 | 68708 | 4044 | 71273 | 2735 | 86813 | 2334 | 51995 |
| 5L-9S | | MI | 32014 | 8159 | 51313 | 6059 | 55715 | 4901 | 57012 | 4034 | 57304 | 2733 | 68974 | 2040 | 44980 |
| 24-#11 | 1.94 | MA | 36787 | 8159 | 59051 | 6067 | 64823 | 4922 | 67169 | 4041 | 69236 | 2744 | 84202 | 2275 | 51394 |
| 6L-8S | | MI | 32500 | 8159 | 52185 | 6046 | 56795 | 4903 | 58371 | 4037 | 59088 | 2725 | 71229 | 2097 | 45719 |
| 24-#11 | 1.94 | MA | 36252 | 8159 | 58057 | 6080 | 63612 | 4920 | 65685 | 4053 | 67243 | 2753 | 81487 | 2188 | 50858 |
| 7E | | MI | 32979 | 8159 | 53009 | 6047 | 57901 | 4891 | 59686 | 4027 | 60976 | 2731 | 73514 | 2148 | 46092 |
| 24-#11 | 1.94 | MA | 35725 | 8159 | 57147 | 6080 | 62391 | 4932 | 64233 | 4064 | 65155 | 2748 | 78932 | 2136 | 50444 |
| 8L-6S | | MI | 33464 | 8159 | 53907 | 6034 | 58996 | 4893 | 61028 | 4016 | 62779 | 2723 | 75935 | 2235 | 46543 |
| 24-#11 | 1.94 | MA | 35168 | 8159 | 56253 | 6080 | 61197 | 4931 | 62729 | 4061 | 63183 | 2757 | 76403 | 2080 | 49584 |
| 9L-5S | | MI | 33961 | 8159 | 54747 | 6034 | 60136 | 4882 | 62419 | 4020 | 64621 | 2716 | 78262 | 2294 | 47093 |
| 24-#11 | 1.94 | MA | 34587 | 8159 | 55277 | 6094 | 59991 | 4943 | 61286 | 4072 | 61225 | 2766 | 73949 | 2017 | 48932 |
| 10L-4S | | MI | 34483 | 8159 | 55637 | 6035 | 61284 | 4884 | 63825 | 4009 | 66627 | 2722 | 80708 | 2338 | 47187 |
| 24-#11 | 1.94 | MA | 34018 | 8159 | 54383 | 6093 | 58805 | 4942 | 59800 | 4070 | 59166 | 2761 | 71454 | 1962 | 47947 |
| 11L-3S | | MI | 35066 | 8159 | 56652 | 6022 | 62575 | 4872 | 65392 | 4013 | 68661 | 2714 | 83051 | 2426 | 47239 |
| 24-#11 | 1.94 | MA | 33460 | 8159 | 53422 | 6107 | 57607 | 4954 | 58360 | 4081 | 57212 | 2769 | 68711 | 1887 | 47088 |
| 12L-2S | | MI | 35895 | 8159 | 57917 | 6023 | 64188 | 4874 | 67353 | 4003 | 71318 | 2706 | 86627 | 2515 | 47261 |
| 24-#14 | 2.80 | MA | 39755 | 8747 | 65823 | 6422 | 73422 | 5164 | 77582 | 4204 | 83272 | 2693 | 103125 | 2138 | 73067 |
| 5L-9S | | MI | 33384 | 8747 | 55079 | 6420 | 60389 | 5179 | 62634 | 4195 | 64904 | 2692 | 79519 | 1720 | 61701 |
| 24-#14 | 2.80 | MA | 38984 | 8747 | 64492 | 6421 | 71612 | 5181 | 75374 | 4200 | 80349 | 2705 | 99409 | 2054 | 72002 |
| 6L-8S | | MI | 34057 | 8747 | 56330 | 6401 | 61938 | 5163 | 64584 | 4200 | 67462 | 2681 | 82722 | 1801 | 62973 |
| 24-#14 | 2.80 | MA | 38232 | 8747 | 63066 | 6440 | 69875 | 5179 | 73245 | 4215 | 77489 | 2717 | 95543 | 1928 | 71032 |
| 7E | | MI | 34729 | 8747 | 57513 | 6403 | 63523 | 5166 | 66469 | 4186 | 70170 | 2691 | 85978 | 1874 | 64220 |
| 24-#14 | 2.80 | MA | 37491 | 8747 | 61759 | 6439 | 68122 | 5196 | 71161 | 4231 | 74493 | 2709 | 91900 | 1854 | 69578 |
| 8L-6S | | MI | 35411 | 8747 | 58801 | 6385 | 65093 | 5150 | 68394 | 4172 | 72755 | 2681 | 89420 | 2001 | 65116 |
| 24-#14 | 2.80 | MA | 36722 | 8747 | 60476 | 6438 | 66409 | 5193 | 69004 | 4226 | 71663 | 2720 | 88299 | 1773 | 68167 |
| 9L-5S | | MI | 36109 | 8747 | 60006 | 6386 | 66729 | 5154 | 70389 | 4178 | 75397 | 2670 | 92726 | 2085 | 66015 |
| 24-#14 | 2.80 | MA | 35898 | 8747 | 59075 | 6457 | 64678 | 5211 | 66932 | 4242 | 68854 | 2732 | 84808 | 1681 | 66556 |
| 10L-4S | | MI | 36842 | 8747 | 61282 | 6388 | 68375 | 5137 | 72404 | 4163 | 78271 | 2680 | 96211 | 2147 | 66966 |
| 24-#18 | 4.97 | MA | 43019 | 10236 | 75496 | 7357 | 85473 | 5872 | 92098 | 4628 | 103052 | 2621 | 130174 | 1239 | 117547 |
| 7E | | MI | 38949 | 10236 | 68663 | 7312 | 77497 | 5832 | 83354 | 4591 | 92728 | 2567 | 116577 | 1147 | 105825 |
| 24-#18 | 4.97 | MA | 41773 | 10236 | 73195 | 7354 | 82388 | 5866 | 88429 | 4654 | 97782 | 2604 | 123840 | 1110 | 113513 |
| 8L-6S | | MI | 40096 | 10236 | 70928 | 7282 | 80258 | 5805 | 86737 | 4568 | 97222 | 2550 | 122519 | 1372 | 108543 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

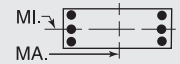



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.19 | MA | 39544 | 7980 | 62090 | 5946 | 67620 | 4840 | 69457 | 4023 | 70326 | 2855 | 83436 | 2693 | 35017 |
| 2L-3S | | MI | 32333 | 7980 | 51188 | 5888 | 54857 | 4823 | 55418 | 4008 | 54135 | 2835 | 62832 | 2410 | 30387 |
| 6-#18 | 1.19 | MA | 37077 | 7980 | 58389 | 5944 | 62901 | 4870 | 63721 | 4049 | 62555 | 2874 | 72990 | 2465 | 35060 |
| 3L-2S | | MI | 34439 | 7980 | 54357 | 5892 | 58897 | 4796 | 60329 | 3985 | 60741 | 2818 | 71616 | 2638 | 30298 |
| 8-#18 | 1.59 | MA | 41272 | 8263 | 65790 | 6124 | 72338 | 4969 | 75193 | 4103 | 78097 | 2837 | 93882 | 2653 | 46329 |
| 2L-4S | | MI | 32331 | 8263 | 51804 | 6096 | 55650 | 4943 | 56389 | 4075 | 55673 | 2833 | 65882 | 2134 | 39760 |
| 8-#18 | 1.59 | MA | 38828 | 8263 | 62090 | 6121 | 67620 | 4998 | 69457 | 4129 | 70326 | 2857 | 83436 | 2426 | 46278 |
| 3E | | MI | 33813 | 8263 | 54357 | 6065 | 58897 | 4951 | 60329 | 4088 | 60741 | 2815 | 71616 | 2362 | 40019 |
| 8-#18 | 1.59 | MA | 37105 | 8263 | 59119 | 6155 | 63841 | 4993 | 64871 | 4120 | 64373 | 2876 | 76594 | 2198 | 45871 |
| 4L-2S | | MI | 35901 | 8263 | 57526 | 6070 | 62937 | 4924 | 65241 | 4065 | 67346 | 2797 | 80400 | 2589 | 40009 |
| 10-#14 | 1.12 | MA | 39329 | 7927 | 61357 | 5947 | 66912 | 4844 | 68684 | 4032 | 69316 | 2876 | 82436 | 2734 | 33129 |
| 2L-5S | | MI | 31444 | 7927 | 49193 | 5913 | 52519 | 4833 | 52649 | 4020 | 50495 | 2861 | 59025 | 2367 | 28668 |
| 10-#14 | 1.12 | MA | 37918 | 7927 | 59247 | 5947 | 64222 | 4842 | 65414 | 4048 | 64886 | 2889 | 76415 | 2606 | 33165 |
| 3L-4S | | MI | 32210 | 7927 | 50468 | 5915 | 54164 | 4816 | 54664 | 4006 | 53370 | 2871 | 62510 | 2429 | 28755 |
| 10-#14 | 1.12 | MA | 36925 | 7927 | 57558 | 5966 | 62073 | 4860 | 62805 | 4044 | 61499 | 2901 | 72462 | 2478 | 33133 |
| 4L-3S | | MI | 33065 | 7927 | 51924 | 5896 | 56015 | 4820 | 56909 | 4012 | 56285 | 2860 | 65837 | 2557 | 28742 |
| 10-#14 | 1.12 | MA | 36037 | 7927 | 56078 | 5966 | 60165 | 4858 | 60468 | 4060 | 58163 | 2894 | 68357 | 2413 | 32971 |
| 5L-2S | | MI | 34273 | 7927 | 53734 | 5898 | 58323 | 4804 | 59716 | 3998 | 60087 | 2850 | 70923 | 2685 | 28691 |
| 10-#18 | 1.98 | MA | 42980 | 8547 | 69491 | 6301 | 77056 | 5097 | 80928 | 4183 | 85868 | 2819 | 104328 | 2614 | 57605 |
| 2L-5S | | MI | 32491 | 8547 | 52731 | 6268 | 56800 | 5098 | 57762 | 4178 | 57280 | 2795 | 68622 | 1978 | 46744 |
| 10-#18 | 1.98 | MA | 40558 | 8547 | 65790 | 6299 | 72338 | 5127 | 75193 | 4209 | 78097 | 2839 | 93882 | 2386 | 57469 |
| 3L-4S | | MI | 33809 | 8547 | 54973 | 6273 | 59690 | 5071 | 61301 | 4155 | 62279 | 2812 | 74666 | 2086 | 49265 |
| 10-#18 | 1.98 | MA | 38852 | 8547 | 62820 | 6332 | 68560 | 5121 | 70607 | 4200 | 72144 | 2858 | 87040 | 2159 | 56966 |
| 4L-3S | | MI | 35277 | 8547 | 57526 | 6242 | 62937 | 5080 | 65241 | 4168 | 67346 | 2795 | 80400 | 2313 | 49616 |
| 10-#18 | 1.98 | MA | 37325 | 8547 | 60216 | 6330 | 65201 | 5151 | 66494 | 4226 | 66275 | 2843 | 79893 | 2047 | 53950 |
| 5L-2S | | MI | 37346 | 8547 | 60695 | 6247 | 66978 | 5053 | 70152 | 4145 | 73952 | 2777 | 89184 | 2541 | 49686 |
| 12-#14 | 1.34 | MA | 40327 | 8086 | 63467 | 6047 | 69602 | 4916 | 71954 | 4077 | 73746 | 2866 | 88458 | 2715 | 39577 |
| 2L-6S | | MI | 31580 | 8086 | 49799 | 6011 | 53192 | 4901 | 53460 | 4060 | 51656 | 2861 | 60804 | 2259 | 33213 |
| 12-#14 | 1.34 | MA | 38923 | 8086 | 61357 | 6047 | 66912 | 4914 | 68684 | 4093 | 69316 | 2879 | 82436 | 2587 | 39588 |
| 3L-5S | | MI | 32307 | 8086 | 51003 | 6013 | 54828 | 4905 | 55455 | 4065 | 54297 | 2851 | 64110 | 2344 | 34125 |
| 12-#14 | 1.34 | MA | 37937 | 8086 | 59668 | 6066 | 64763 | 4932 | 66075 | 4089 | 65929 | 2891 | 78484 | 2459 | 39519 |
| 4E | | MI | 33068 | 8086 | 52279 | 6014 | 56473 | 4889 | 57470 | 4051 | 57172 | 2861 | 67595 | 2406 | 34247 |
| 12-#14 | 1.34 | MA | 37055 | 8086 | 58188 | 6066 | 62855 | 4930 | 63738 | 4105 | 62593 | 2884 | 74378 | 2394 | 39320 |
| 5L-3S | | MI | 33918 | 8086 | 53734 | 5996 | 58323 | 4892 | 59716 | 4057 | 60087 | 2850 | 70923 | 2534 | 34271 |
| 12-#14 | 1.34 | MA | 36215 | 8086 | 56793 | 6065 | 60958 | 4948 | 61424 | 4101 | 59530 | 2897 | 70457 | 2310 | 38192 |
| 6L-2S | | MI | 35119 | 8086 | 55545 | 5998 | 60632 | 4876 | 62522 | 4042 | 63889 | 2840 | 76008 | 2662 | 34238 |
| 12-#18 | 2.38 | MA | 44670 | 8831 | 73192 | 6478 | 81775 | 5226 | 86664 | 4263 | 93639 | 2802 | 114774 | 2574 | 68847 |
| 2L-6S | | MI | 32721 | 8831 | 53783 | 6441 | 57966 | 5218 | 59168 | 4245 | 59293 | 2792 | 71702 | 1779 | 54175 |
| 12-#18 | 2.38 | MA | 42268 | 8831 | 69491 | 6476 | 77056 | 5256 | 80928 | 4289 | 85868 | 2821 | 104328 | 2347 | 68642 |
| 3L-5S | | MI | 33966 | 8831 | 55900 | 6446 | 60840 | 5226 | 62673 | 4258 | 63885 | 2774 | 77406 | 1930 | 55981 |
| 12-#18 | 2.38 | MA | 40580 | 8831 | 66520 | 6509 | 73278 | 5250 | 76343 | 4280 | 79914 | 2841 | 97486 | 2119 | 68057 |
| 4E | | MI | 35271 | 8831 | 58142 | 6450 | 63731 | 5200 | 66212 | 4235 | 68884 | 2792 | 83450 | 2037 | 58761 |
| 12-#18 | 2.38 | MA | 39068 | 8831 | 63917 | 6507 | 69920 | 5280 | 72230 | 4306 | 74046 | 2825 | 90339 | 2007 | 64779 |
| 5L-3S | | MI | 36725 | 8831 | 60695 | 6420 | 66978 | 5208 | 70152 | 4248 | 73952 | 2774 | 89184 | 2265 | 59191 |
| 12-#18 | 2.38 | MA | 37627 | 8831 | 61459 | 6505 | 66582 | 5274 | 68158 | 4297 | 68655 | 2844 | 83544 | 1857 | 62627 |
| 6L-2S | | MI | 38778 | 8831 | 63864 | 6424 | 71018 | 5182 | 75064 | 4225 | 80558 | 2757 | 97968 | 2492 | 59329 |
| 14-#11 | 1.08 | MA | 39237 | 7903 | 61024 | 5950 | 66602 | 4847 | 68351 | 4037 | 68885 | 2887 | 82025 | 2753 | 32301 |
| 2L-7S | | MI | 31218 | 7903 | 48541 | 5927 | 51785 | 4826 | 51787 | 4029 | 49409 | 2887 | 57533 | 2341 | 27450 |
| 14-#11 | 1.08 | MA | 38250 | 7903 | 59552 | 5950 | 64725 | 4846 | 66069 | 4049 | 65793 | 2896 | 77799 | 2664 | 32326 |
| 3L-6S | | MI | 31715 | 7903 | 49440 | 5914 | 52880 | 4828 | 53129 | 4019 | 51211 | 2879 | 59954 | 2428 | 27968 |
| 14-#11 | 1.08 | MA | 37558 | 7903 | 58374 | 5963 | 63227 | 4859 | 64251 | 4046 | 63432 | 2905 | 75022 | 2575 | 32327 |
| 4L-5S | | MI | 32225 | 7903 | 50279 | 5914 | 54021 | 4817 | 54520 | 4022 | 53054 | 2871 | 62281 | 2487 | 28031 |
| 14-#11 | 1.08 | MA | 36939 | 7903 | 57343 | 5963 | 61897 | 4858 | 62621 | 4058 | 61107 | 2901 | 72146 | 2530 | 32281 |
| 5L-4S | | MI | 32760 | 7903 | 51169 | 5915 | 55168 | 4819 | 55926 | 4012 | 55059 | 2877 | 64727 | 2530 | 28043 |
| 14-#11 | 1.08 | MA | 36350 | 7903 | 56371 | 5963 | 60575 | 4871 | 61009 | 4056 | 58972 | 2910 | 69393 | 2472 | 32167 |
| 6L-3S | | MI | 33356 | 7903 | 52184 | 5902 | 56459 | 4807 | 57493 | 4015 | 57093 | 2870 | 67070 | 2619 | 28020 |

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis



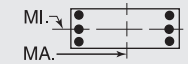

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.08 | MA | 35774 | 7903 | 55330 | 5977 | 59307 | 4869 | 59454 | 4067 | 56883 | 2919 | 66530 | 2385 | 31511 |
| 7L-2S | | MI | 34202 | 7903 | 53449 | 5903 | 58072 | 4809 | 59454 | 4005 | 59750 | 2862 | 70646 | 2708 | 27986 |
| 14-#14 | 1.56 | MA | 41318 | 8246 | 65577 | 6147 | 72292 | 4989 | 75224 | 4122 | 78176 | 2856 | 94480 | 2695 | 46015 |
| 2L-7S | | MI | 31737 | 8246 | 50321 | 6129 | 53930 | 4990 | 54341 | 4119 | 52872 | 2862 | 62447 | 2109 | 37849 |
| 14-#14 | 1.56 | MA | 39922 | 8246 | 63467 | 6146 | 69602 | 4987 | 71954 | 4138 | 73746 | 2869 | 88458 | 2567 | 45996 |
| 3L-6S | | MI | 32442 | 8246 | 51610 | 6111 | 55500 | 4974 | 56266 | 4105 | 55457 | 2851 | 65889 | 2235 | 38539 |
| 14-#14 | 1.56 | MA | 38942 | 8246 | 61777 | 6166 | 67453 | 5004 | 69345 | 4134 | 70359 | 2882 | 84506 | 2439 | 45897 |
| 4L-5S | | MI | 33164 | 8246 | 52814 | 6113 | 57136 | 4977 | 58261 | 4110 | 58099 | 2841 | 69196 | 2320 | 39575 |
| 14-#14 | 1.56 | MA | 38066 | 8246 | 60298 | 6165 | 65545 | 5002 | 67008 | 4150 | 67023 | 2874 | 80400 | 2375 | 45665 |
| 5L-4S | | MI | 33920 | 8246 | 54090 | 6114 | 58781 | 4961 | 60276 | 4096 | 60974 | 2851 | 72680 | 2382 | 39730 |
| 14-#14 | 1.56 | MA | 37230 | 8246 | 58903 | 6165 | 63648 | 5020 | 64694 | 4146 | 63960 | 2887 | 76479 | 2291 | 44412 |
| 6L-3S | | MI | 34765 | 8246 | 55545 | 6096 | 60632 | 4965 | 62522 | 4102 | 63889 | 2840 | 76008 | 2510 | 39784 |
| 14-#14 | 1.56 | MA | 36416 | 8246 | 57409 | 6184 | 61827 | 5018 | 62463 | 4162 | 60962 | 2899 | 72400 | 2165 | 43535 |
| 7L-2S | | MI | 35960 | 8246 | 57356 | 6098 | 62940 | 4948 | 65328 | 4087 | 67691 | 2830 | 81093 | 2638 | 39773 |
| 14-#18 | 2.78 | MA | 46343 | 9115 | 76893 | 6656 | 86493 | 5354 | 92400 | 4342 | 101410 | 2784 | 125220 | 2535 | 80072 |
| 2L-7S | | MI | 32989 | 9115 | 54687 | 6649 | 59245 | 5373 | 60697 | 4348 | 61404 | 2789 | 74544 | 1505 | 60348 |
| 14-#18 | 2.78 | MA | 43962 | 9115 | 73192 | 6653 | 81775 | 5384 | 86664 | 4369 | 93639 | 2804 | 114774 | 2307 | 79803 |
| 3L-6S | | MI | 34192 | 9115 | 56952 | 6618 | 62006 | 5346 | 64079 | 4325 | 65899 | 2772 | 80486 | 1731 | 63255 |
| 14-#18 | 2.78 | MA | 42289 | 9115 | 70221 | 6687 | 77997 | 5379 | 82079 | 4360 | 87685 | 2823 | 107931 | 2080 | 79145 |
| 4L-5S | | MI | 35425 | 9115 | 59069 | 6623 | 64880 | 5355 | 67585 | 4338 | 70491 | 2754 | 86190 | 1881 | 65246 |
| 14-#18 | 2.78 | MA | 40793 | 9115 | 67617 | 6684 | 74638 | 5408 | 77966 | 4386 | 81817 | 2807 | 100785 | 1968 | 75636 |
| 5L-4S | | MI | 36718 | 9115 | 61311 | 6628 | 67771 | 5328 | 71124 | 4315 | 75490 | 2772 | 92234 | 1989 | 68070 |
| 14-#18 | 2.78 | MA | 39366 | 9115 | 65160 | 6682 | 71300 | 5403 | 73894 | 4377 | 76426 | 2827 | 93990 | 1818 | 73306 |
| 6L-3S | | MI | 38159 | 9115 | 63864 | 6597 | 71018 | 5337 | 75064 | 4327 | 80558 | 2754 | 97968 | 2216 | 68752 |
| 14-#18 | 2.78 | MA | 37974 | 9115 | 62531 | 6715 | 68095 | 5432 | 69966 | 4403 | 71150 | 2846 | 86918 | 1593 | 69721 |
| 7L-2S | | MI | 40196 | 9115 | 67033 | 6602 | 75058 | 5310 | 79975 | 4305 | 87163 | 2736 | 106751 | 2444 | 68947 |
| 16-#11 | 1.24 | MA | 39938 | 8014 | 62497 | 6019 | 68480 | 4898 | 70634 | 4068 | 71977 | 2880 | 86251 | 2741 | 36801 |
| 2L-8S | | MI | 31338 | 8014 | 48982 | 5995 | 52293 | 4888 | 52433 | 4070 | 50177 | 2874 | 58824 | 2274 | 30837 |
| 16-#11 | 1.24 | MA | 38955 | 8014 | 61024 | 6019 | 66602 | 4897 | 68351 | 4080 | 68885 | 2889 | 82025 | 2652 | 36817 |
| 3L-7S | | MI | 31826 | 8014 | 49806 | 5996 | 53398 | 4876 | 53748 | 4060 | 52065 | 2880 | 61110 | 2325 | 31197 |
| 16-#11 | 1.24 | MA | 38266 | 8014 | 59846 | 6033 | 65104 | 4909 | 66533 | 4078 | 66524 | 2899 | 79248 | 2563 | 36799 |
| 4L-6S | | MI | 32321 | 8014 | 50705 | 5983 | 54493 | 4878 | 55090 | 4050 | 53868 | 2872 | 63531 | 2413 | 31731 |
| 16-#11 | 1.24 | MA | 37650 | 8014 | 58815 | 6033 | 63774 | 4908 | 64904 | 4089 | 64199 | 2894 | 76372 | 2518 | 36735 |
| 5E | | MI | 32829 | 8014 | 51544 | 5984 | 55634 | 4867 | 56481 | 4053 | 55710 | 2864 | 65857 | 2471 | 31865 |
| 16-#11 | 1.24 | MA | 37063 | 8014 | 57843 | 6033 | 62453 | 4921 | 63292 | 4087 | 62064 | 2903 | 73619 | 2460 | 36552 |
| 6L-4S | | MI | 33361 | 8014 | 52434 | 5984 | 56781 | 4869 | 57887 | 4043 | 57715 | 2871 | 68303 | 2515 | 31896 |
| 16-#11 | 1.24 | MA | 36491 | 8014 | 56803 | 6046 | 61184 | 4920 | 61737 | 4098 | 59976 | 2913 | 70756 | 2372 | 35878 |
| 7L-3S | | MI | 33955 | 8014 | 53449 | 5971 | 58072 | 4857 | 59454 | 4046 | 59750 | 2863 | 70646 | 2604 | 31887 |
| 16-#11 | 1.24 | MA | 35920 | 8014 | 55849 | 6046 | 59905 | 4932 | 60215 | 4110 | 57788 | 2908 | 68067 | 2320 | 35413 |
| 8L-2S | | MI | 34797 | 8014 | 54715 | 5972 | 59685 | 4859 | 61414 | 4036 | 62407 | 2855 | 74223 | 2693 | 31861 |
| 16-#14 | 1.79 | MA | 42302 | 8405 | 67687 | 6246 | 74982 | 5061 | 78494 | 4167 | 82606 | 2846 | 100501 | 2676 | 52440 |
| 2L-8S | | MI | 31907 | 8405 | 50949 | 6227 | 54653 | 5058 | 55263 | 4178 | 53967 | 2842 | 64277 | 2013 | 42053 |
| 16-#14 | 1.79 | MA | 40913 | 8405 | 65577 | 6246 | 72292 | 5059 | 75224 | 4183 | 78176 | 2859 | 94480 | 2548 | 52396 |
| 3L-7S | | MI | 32597 | 8405 | 52132 | 6229 | 56238 | 5062 | 57148 | 4164 | 56674 | 2852 | 67533 | 2085 | 43211 |
| 16-#14 | 1.79 | MA | 39939 | 8405 | 63887 | 6265 | 70143 | 5077 | 72615 | 4179 | 74790 | 2872 | 90527 | 2420 | 52269 |
| 4L-6S | | MI | 33297 | 8405 | 53420 | 6211 | 57809 | 5046 | 59073 | 4150 | 59259 | 2841 | 70974 | 2212 | 43876 |
| 16-#14 | 1.79 | MA | 39069 | 8405 | 62408 | 6265 | 68235 | 5074 | 70278 | 4195 | 71453 | 2864 | 86421 | 2356 | 52001 |
| 5E | | MI | 34015 | 8405 | 54625 | 6212 | 59444 | 5050 | 61068 | 4155 | 61901 | 2831 | 74281 | 2296 | 44957 |
| 16-#14 | 1.79 | MA | 38239 | 8405 | 61012 | 6265 | 66338 | 5092 | 67964 | 4191 | 68390 | 2877 | 82500 | 2272 | 50644 |
| 6L-4S | | MI | 34767 | 8405 | 55901 | 6214 | 61090 | 5033 | 63083 | 4141 | 64775 | 2841 | 77765 | 2359 | 45204 |
| 16-#14 | 1.79 | MA | 37430 | 8405 | 59519 | 6284 | 64517 | 5090 | 65733 | 4207 | 65393 | 2889 | 78422 | 2146 | 49795 |
| 7L-3S | | MI | 35606 | 8405 | 57356 | 6196 | 62940 | 5037 | 65328 | 4147 | 67691 | 2830 | 81093 | 2487 | 45284 |
| 16-#14 | 1.79 | MA | 36631 | 8405 | 58149 | 6284 | 62680 | 5108 | 63548 | 4223 | 62253 | 2882 | 74584 | 2071 | 48400 |
| 8L-2S | | MI | 36796 | 8405 | 59166 | 6197 | 65249 | 5021 | 68135 | 4132 | 71493 | 2820 | 86178 | 2615 | 45298 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

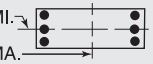


$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 3.17 | MA | 45639 | 9398 | 76893 | 6831 | 86493 | 5513 | 92400 | 4448 | 101410 | 2786 | 125220 | 2268 | 90955 |
| 3L-7S | | MI | 34457 | 9398 | 57856 | 6826 | 63285 | 5502 | 65608 | 4428 | 68010 | 2769 | 83328 | 1457 | 69565 |
| 16-#18 | 3.17 | MA | 43982 | 9398 | 73922 | 6864 | 82715 | 5507 | 87815 | 4439 | 95456 | 2805 | 118377 | 2040 | 89903 |
| 4L-6S | | MI | 35649 | 9398 | 60121 | 6796 | 66046 | 5475 | 68991 | 4405 | 72504 | 2751 | 89269 | 1682 | 72364 |
| 16-#18 | 3.17 | MA | 42500 | 9398 | 71318 | 6862 | 79357 | 5537 | 83702 | 4466 | 89588 | 2790 | 111231 | 1928 | 86517 |
| 5E | | MI | 36871 | 9398 | 62238 | 6800 | 68921 | 5484 | 72496 | 4418 | 77097 | 2733 | 94974 | 1833 | 74535 |
| 16-#18 | 3.17 | MA | 41088 | 9398 | 68861 | 6859 | 76018 | 5531 | 79630 | 4457 | 84197 | 2809 | 104435 | 1778 | 84013 |
| 6L-4S | | MI | 38152 | 9398 | 64480 | 6805 | 71811 | 5457 | 76035 | 4395 | 82096 | 2751 | 101018 | 1940 | 77217 |
| 16-#18 | 3.17 | MA | 39709 | 9398 | 66231 | 6892 | 72813 | 5561 | 75702 | 4483 | 78921 | 2829 | 97364 | 1554 | 80542 |
| 7L-3S | | MI | 39580 | 9398 | 67033 | 6774 | 75058 | 5465 | 79975 | 4407 | 87163 | 2733 | 106751 | 2168 | 78301 |
| 16-#18 | 3.17 | MA | 38350 | 9398 | 63819 | 6890 | 69579 | 5555 | 71856 | 4509 | 73395 | 2813 | 90685 | 1423 | 76720 |
| 8L-2S | | MI | 41602 | 9398 | 70202 | 6779 | 79098 | 5439 | 84887 | 4384 | 93769 | 2716 | 115535 | 2395 | 78551 |
| 18-#11 | 1.39 | MA | 40635 | 8124 | 63970 | 6088 | 70357 | 4948 | 72916 | 4099 | 75070 | 2873 | 90477 | 2729 | 41295 |
| 2L-9S | | MI | 31452 | 8124 | 49375 | 6077 | 52826 | 4936 | 53035 | 4098 | 51049 | 2875 | 60146 | 2203 | 34042 |
| 18-#11 | 1.39 | MA | 39656 | 8124 | 62497 | 6088 | 68480 | 4947 | 70634 | 4111 | 71977 | 2882 | 86251 | 2640 | 41298 |
| 3L-8S | | MI | 31946 | 8124 | 50247 | 6064 | 53906 | 4938 | 54394 | 4102 | 52833 | 2867 | 62400 | 2259 | 34600 |
| 18-#11 | 1.39 | MA | 38970 | 8124 | 61319 | 6102 | 66982 | 4959 | 68815 | 4109 | 69616 | 2892 | 83474 | 2551 | 41266 |
| 4L-7S | | MI | 32432 | 8124 | 51071 | 6065 | 55011 | 4926 | 55708 | 4091 | 54722 | 2873 | 64686 | 2310 | 34949 |
| 18-#11 | 1.39 | MA | 38357 | 8124 | 60288 | 6102 | 65652 | 4958 | 67186 | 4120 | 67291 | 2887 | 80598 | 2506 | 41186 |
| 5L-6S | | MI | 32924 | 8124 | 51970 | 6052 | 56106 | 4929 | 57051 | 4081 | 56524 | 2865 | 67107 | 2398 | 35461 |
| 18-#11 | 1.39 | MA | 37773 | 8124 | 59316 | 6102 | 64330 | 4971 | 65574 | 4118 | 65156 | 2896 | 77845 | 2448 | 40899 |
| 6L-5S | | MI | 33430 | 8124 | 52810 | 6053 | 57247 | 4917 | 58442 | 4084 | 58367 | 2858 | 69434 | 2456 | 35695 |
| 18-#11 | 1.39 | MA | 37204 | 8124 | 58275 | 6116 | 63062 | 4970 | 64019 | 4130 | 63068 | 2906 | 74982 | 2360 | 40250 |
| 7L-4S | | MI | 33959 | 8124 | 53699 | 6054 | 58394 | 4919 | 59847 | 4074 | 60372 | 2864 | 71879 | 2500 | 35740 |
| 18-#11 | 1.39 | MA | 36642 | 8124 | 57321 | 6116 | 61782 | 4982 | 62497 | 4141 | 60880 | 2901 | 72293 | 2308 | 39798 |
| 8L-3S | | MI | 34551 | 8124 | 54715 | 6041 | 59685 | 4907 | 61414 | 4077 | 62407 | 2856 | 74223 | 2589 | 35748 |
| 18-#11 | 1.39 | MA | 36042 | 8124 | 56385 | 6116 | 60532 | 4981 | 60923 | 4139 | 58814 | 2910 | 69625 | 2252 | 39106 |
| 9L-2S | | MI | 35390 | 8124 | 55980 | 6041 | 61298 | 4909 | 63375 | 4067 | 65063 | 2848 | 77799 | 2678 | 35729 |
| 18-#14 | 2.01 | MA | 43280 | 8565 | 69797 | 6346 | 77672 | 5133 | 81764 | 4211 | 87037 | 2837 | 106523 | 2657 | 58854 |
| 2L-9S | | MI | 32071 | 8565 | 51509 | 6345 | 55412 | 5147 | 56119 | 4217 | 55210 | 2842 | 66159 | 1908 | 46348 |
| 18-#14 | 2.01 | MA | 41898 | 8565 | 67687 | 6346 | 74982 | 5131 | 78494 | 4227 | 82606 | 2849 | 100501 | 2529 | 58789 |
| 3L-8S | | MI | 32765 | 8565 | 52760 | 6327 | 56961 | 5131 | 58069 | 4223 | 57768 | 2832 | 69362 | 1989 | 47343 |
| 18-#14 | 2.01 | MA | 40930 | 8565 | 65997 | 6365 | 72833 | 5149 | 75885 | 4224 | 79220 | 2862 | 96549 | 2401 | 58637 |
| 4L-7S | | MI | 33451 | 8565 | 53942 | 6329 | 58546 | 5134 | 59954 | 4209 | 60476 | 2842 | 72618 | 2062 | 48579 |
| 18-#14 | 2.01 | MA | 40065 | 8565 | 64518 | 6365 | 70924 | 5147 | 73548 | 4240 | 75884 | 2854 | 92443 | 2337 | 58189 |
| 5L-6S | | MI | 34147 | 8565 | 55231 | 6310 | 60117 | 5118 | 61879 | 4194 | 63061 | 2831 | 76060 | 2188 | 49222 |
| 18-#14 | 2.01 | MA | 39240 | 8565 | 63122 | 6364 | 69028 | 5165 | 71234 | 4236 | 72820 | 2867 | 88522 | 2253 | 56885 |
| 6L-5S | | MI | 34860 | 8565 | 56435 | 6312 | 61753 | 5122 | 63874 | 4200 | 65703 | 2821 | 79366 | 2273 | 50256 |
| 18-#14 | 2.01 | MA | 38436 | 8565 | 61629 | 6384 | 67207 | 5162 | 69003 | 4252 | 69823 | 2879 | 84444 | 2127 | 56062 |
| 7L-4S | | MI | 35608 | 8565 | 57711 | 6314 | 63398 | 5106 | 65889 | 4186 | 68577 | 2831 | 82851 | 2335 | 50672 |
| 18-#14 | 2.01 | MA | 37643 | 8565 | 60259 | 6383 | 65370 | 5180 | 66818 | 4268 | 66683 | 2872 | 80606 | 2052 | 54590 |
| 8L-3S | | MI | 36442 | 8565 | 59166 | 6295 | 65249 | 5109 | 68135 | 4191 | 71493 | 2820 | 86178 | 2463 | 50776 |
| 18-#14 | 2.01 | MA | 36803 | 8565 | 58915 | 6383 | 63576 | 5178 | 64558 | 4264 | 63717 | 2885 | 76807 | 1971 | 53352 |
| 9L-2S | | MI | 37626 | 8565 | 60977 | 6297 | 67557 | 5093 | 70941 | 4177 | 75295 | 2810 | 91264 | 2591 | 50814 |
| 18-#18 | 3.57 | MA | 45660 | 9682 | 77623 | 7041 | 87434 | 5636 | 93551 | 4519 | 103227 | 2788 | 128823 | 2001 | 100662 |
| 4L-7S | | MI | 35912 | 9682 | 61024 | 7004 | 67326 | 5630 | 70519 | 4508 | 74616 | 2748 | 92112 | 1408 | 78800 |
| 18-#18 | 3.57 | MA | 44192 | 9682 | 75019 | 7039 | 84075 | 5665 | 89438 | 4546 | 97359 | 2772 | 121677 | 1889 | 97419 |
| 5L-6S | | MI | 37093 | 9682 | 63290 | 6973 | 70087 | 5604 | 73902 | 4485 | 79110 | 2731 | 98053 | 1634 | 81499 |
| 18-#18 | 3.57 | MA | 42793 | 9682 | 72562 | 7037 | 80737 | 5660 | 85366 | 4537 | 91968 | 2791 | 114881 | 1739 | 94744 |
| 6L-5S | | MI | 38304 | 9682 | 65407 | 6978 | 72961 | 5612 | 77408 | 4497 | 83703 | 2713 | 103758 | 1784 | 83843 |
| 18-#18 | 3.57 | MA | 41427 | 9682 | 69932 | 7070 | 77532 | 5689 | 81438 | 4563 | 86692 | 2811 | 107810 | 1514 | 91381 |
| 7L-4S | | MI | 39574 | 9682 | 67649 | 6982 | 75851 | 5585 | 80947 | 4475 | 88701 | 2731 | 109801 | 1892 | 86398 |
| 18-#18 | 3.57 | MA | 40081 | 9682 | 67520 | 7068 | 74297 | 5684 | 77592 | 4589 | 81166 | 2795 | 101131 | 1384 | 87463 |
| 8L-3S | | MI | 40990 | 9682 | 70202 | 6952 | 79098 | 5594 | 84887 | 4487 | 93769 | 2713 | 115535 | 2119 | 87842 |
| 20-#11 | 1.55 | MA | 41329 | 8235 | 65442 | 6157 | 72235 | 4998 | 75199 | 4131 | 78162 | 2866 | 94703 | 2716 | 45786 |
| 2L-10S | | MI | 31527 | 8235 | 49820 | 6145 | 53348 | 4998 | 53689 | 4140 | 51935 | 2876 | 61537 | 2124 | 37164 |
| 20-#11 | 1.55 | MA | 40353 | 8235 | 63970 | 6157 | 70357 | 4997 | 72916 | 4142 | 75070 | 2876 | 90477 | 2628 | 45773 |
| 3L-9S | | MI | 32058 | 8235 | 50640 | 6146 | 54439 | 4986 | 54995 | 4129 | 53706 | 2868 | 63722 | 2188 | 37755 |

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

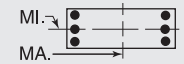
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.55 | MA | 39670 | 8235 | 62792 | 6171 | 68859 | 5009 | 71098 | 4140 | 72708 | 2885 | 87700 | 2539 | 45728 |
| 4L-8S | | MI | 32550 | 8235 | 51512 | 6133 | 55519 | 4988 | 56355 | 4133 | 55490 | 2860 | 65977 | 2244 | 38365 |
| 20-#11 | 1.55 | MA | 39060 | 8235 | 61761 | 6171 | 67529 | 5008 | 69469 | 4151 | 70383 | 2880 | 84824 | 2494 | 45634 |
| 5L-7S | | MI | 33034 | 8235 | 52337 | 6134 | 56624 | 4977 | 57669 | 4122 | 57378 | 2866 | 68262 | 2295 | 38706 |
| 20-#11 | 1.55 | MA | 38479 | 8235 | 60789 | 6171 | 66208 | 5021 | 67856 | 4149 | 68248 | 2889 | 82071 | 2435 | 45254 |
| 6E | | MI | 33524 | 8235 | 53235 | 6121 | 57719 | 4979 | 59011 | 4112 | 59181 | 2858 | 70683 | 2383 | 39197 |
| 20-#11 | 1.55 | MA | 37912 | 8235 | 59748 | 6185 | 64939 | 5020 | 66302 | 4161 | 66160 | 2899 | 79208 | 2348 | 44627 |
| 7L-5S | | MI | 34027 | 8235 | 54075 | 6122 | 58860 | 4967 | 60403 | 4115 | 61023 | 2851 | 73010 | 2441 | 39521 |
| 20-#11 | 1.55 | MA | 37354 | 8235 | 58794 | 6185 | 63660 | 5033 | 64780 | 4172 | 63972 | 2894 | 76519 | 2295 | 44185 |
| 8L-4S | | MI | 34555 | 8235 | 54964 | 6123 | 60007 | 4969 | 61808 | 4105 | 63028 | 2857 | 75456 | 2485 | 39579 |
| 20-#11 | 1.55 | MA | 36756 | 8235 | 57858 | 6185 | 62409 | 5031 | 63205 | 4170 | 61906 | 2903 | 73851 | 2240 | 43442 |
| 9L-3S | | MI | 35144 | 8235 | 55980 | 6110 | 61298 | 4957 | 63375 | 4108 | 65063 | 2849 | 77799 | 2574 | 39604 |
| 20-#11 | 1.55 | MA | 36141 | 8235 | 56835 | 6199 | 61146 | 5044 | 61693 | 4181 | 59855 | 2913 | 71263 | 2176 | 42704 |
| 10L-2S | | MI | 35980 | 8235 | 57245 | 6110 | 62911 | 4960 | 65336 | 4098 | 67720 | 2841 | 81375 | 2662 | 39593 |
| 20-#14 | 2.23 | MA | 42877 | 8724 | 69797 | 6446 | 77672 | 5204 | 81764 | 4272 | 87037 | 2839 | 106523 | 2510 | 65176 |
| 3L-9S | | MI | 32942 | 8724 | 53320 | 6445 | 57721 | 5219 | 58925 | 4262 | 59012 | 2832 | 71244 | 1884 | 51610 |
| 20-#14 | 2.23 | MA | 41914 | 8724 | 68107 | 6465 | 75523 | 5221 | 79155 | 4269 | 83650 | 2852 | 102570 | 2382 | 65000 |
| 4L-8S | | MI | 33618 | 8724 | 54571 | 6427 | 59270 | 5203 | 60875 | 4268 | 61570 | 2822 | 74447 | 1965 | 52643 |
| 20-#14 | 2.23 | MA | 41054 | 8724 | 66628 | 6465 | 73614 | 5219 | 76818 | 4285 | 80314 | 2844 | 98465 | 2318 | 64391 |
| 5L-7S | | MI | 34300 | 8724 | 55753 | 6428 | 60855 | 5207 | 62760 | 4254 | 64278 | 2832 | 77703 | 2038 | 53952 |
| 20-#14 | 2.23 | MA | 40235 | 8724 | 65232 | 6464 | 71718 | 5237 | 74504 | 4281 | 77250 | 2857 | 94544 | 2234 | 63135 |
| 6E | | MI | 34991 | 8724 | 57042 | 6410 | 62426 | 5191 | 64685 | 4239 | 66863 | 2821 | 81145 | 2165 | 54575 |
| 20-#14 | 2.23 | MA | 39436 | 8724 | 63739 | 6484 | 69897 | 5235 | 72273 | 4297 | 74253 | 2869 | 90465 | 2107 | 62333 |
| 7L-5S | | MI | 35700 | 8724 | 58246 | 6412 | 64061 | 5194 | 66680 | 4245 | 69505 | 2811 | 84451 | 2249 | 55566 |
| 20-#14 | 2.23 | MA | 38648 | 8724 | 62369 | 6483 | 68060 | 5252 | 70088 | 4313 | 71113 | 2862 | 86628 | 2032 | 60790 |
| 8L-4S | | MI | 36444 | 8724 | 59522 | 6413 | 65707 | 5178 | 68695 | 4231 | 72379 | 2821 | 87936 | 2311 | 56136 |
| 20-#14 | 2.23 | MA | 37813 | 8724 | 61025 | 6483 | 66265 | 5250 | 67828 | 4309 | 68147 | 2875 | 82829 | 1952 | 59562 |
| 9L-3S | | MI | 37274 | 8724 | 60977 | 6395 | 67557 | 5182 | 70941 | 4236 | 75295 | 2811 | 91264 | 2439 | 56262 |
| 20-#14 | 2.23 | MA | 36944 | 8724 | 59557 | 6502 | 64452 | 5268 | 65657 | 4325 | 65204 | 2887 | 79143 | 1860 | 57734 |
| 10L-2S | | MI | 38452 | 8724 | 62788 | 6397 | 69866 | 5165 | 73747 | 4222 | 79097 | 2800 | 96349 | 2567 | 56317 |
| 20-#18 | 3.97 | MA | 45869 | 9966 | 78720 | 7216 | 88794 | 5794 | 95174 | 4625 | 105130 | 2754 | 132122 | 1849 | 108337 |
| 5L-7S | | MI | 37354 | 9966 | 64193 | 7181 | 71366 | 5759 | 75431 | 4588 | 81221 | 2728 | 100895 | 1360 | 88052 |
| 20-#18 | 3.97 | MA | 44483 | 9966 | 76263 | 7214 | 85455 | 5788 | 91102 | 4616 | 99739 | 2774 | 125327 | 1699 | 105498 |
| 6E | | MI | 38525 | 9966 | 66459 | 7150 | 74127 | 5732 | 78814 | 4565 | 85716 | 2710 | 106837 | 1585 | 90657 |
| 20-#18 | 3.97 | MA | 43130 | 9966 | 73633 | 7247 | 82250 | 5818 | 87174 | 4643 | 94463 | 2793 | 118256 | 1475 | 102236 |
| 7L-5S | | MI | 39726 | 9966 | 68576 | 7155 | 77001 | 5741 | 82319 | 4577 | 90308 | 2693 | 112541 | 1736 | 93167 |
| 20-#18 | 3.97 | MA | 41797 | 9966 | 71221 | 7245 | 79016 | 5812 | 83328 | 4669 | 88937 | 2777 | 111577 | 1344 | 98223 |
| 8L-4S | | MI | 40984 | 9966 | 70818 | 7160 | 79892 | 5714 | 85858 | 4554 | 95307 | 2710 | 118585 | 1843 | 95606 |
| 22-#11 | 1.70 | MA | 42019 | 8346 | 66915 | 6226 | 74113 | 5048 | 77481 | 4162 | 81254 | 2859 | 98929 | 2704 | 50268 |
| 2L-11S | | MI | 31615 | 8346 | 50276 | 6214 | 53887 | 5046 | 54306 | 4167 | 52729 | 2863 | 62881 | 2055 | 40141 |
| 22-#11 | 1.70 | MA | 41047 | 8346 | 65442 | 6226 | 72235 | 5047 | 75199 | 4173 | 78162 | 2869 | 94703 | 2615 | 50245 |
| 3L-10S | | MI | 32133 | 8346 | 51085 | 6215 | 54961 | 5048 | 55650 | 4171 | 54592 | 2869 | 65113 | 2109 | 40897 |
| 22-#11 | 1.70 | MA | 40367 | 8346 | 64264 | 6240 | 70737 | 5060 | 73380 | 4171 | 75800 | 2878 | 91926 | 2527 | 50187 |
| 4L-9S | | MI | 32662 | 8346 | 51905 | 6215 | 56052 | 5036 | 56956 | 4160 | 56362 | 2861 | 67299 | 2173 | 41474 |
| 22-#11 | 1.70 | MA | 39760 | 8346 | 63233 | 6240 | 69407 | 5058 | 71751 | 4183 | 73475 | 2873 | 89050 | 2481 | 50079 |
| 5L-8S | | MI | 33151 | 8346 | 52778 | 6202 | 57132 | 5038 | 58316 | 4164 | 58146 | 2853 | 69553 | 2229 | 42133 |
| 22-#11 | 1.70 | MA | 39182 | 8346 | 62261 | 6240 | 68085 | 5071 | 70139 | 4180 | 71340 | 2883 | 86297 | 2423 | 49615 |
| 6L-7S | | MI | 33633 | 8346 | 53602 | 6203 | 58237 | 5027 | 59630 | 4153 | 60035 | 2859 | 71838 | 2280 | 42466 |
| 22-#11 | 1.70 | MA | 38618 | 8346 | 61221 | 6254 | 66817 | 5070 | 68584 | 4192 | 69252 | 2892 | 83434 | 2336 | 49009 |
| 7L-6S | | MI | 34121 | 8346 | 54500 | 6190 | 59332 | 5029 | 60972 | 4143 | 61837 | 2852 | 74260 | 2368 | 42940 |
| 22-#11 | 1.70 | MA | 38061 | 8346 | 60267 | 6254 | 65537 | 5083 | 67062 | 4203 | 67064 | 2887 | 80745 | 2283 | 48576 |
| 8L-5S | | MI | 34622 | 8346 | 55340 | 6191 | 60473 | 5017 | 62364 | 4146 | 63680 | 2844 | 76586 | 2426 | 43343 |
| 22-#11 | 1.70 | MA | 37467 | 8346 | 59330 | 6254 | 64287 | 5082 | 65487 | 4201 | 64998 | 2897 | 78077 | 2227 | 47784 |
| 9L-4S | | MI | 35147 | 8346 | 56230 | 6192 | 61620 | 5019 | 63769 | 4136 | 65685 | 2850 | 79032 | 2470 | 43415 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

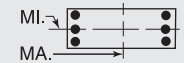



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.70 | MA | 36854 | 8346 | 58308 | 6268 | 63024 | 5094 | 63975 | 4213 | 62947 | 2906 | 75489 | 2164 | 47062 |
| 10L-3S | | MI | 35734 | 8346 | 57245 | 6179 | 62911 | 5008 | 65336 | 4140 | 67720 | 2842 | 81375 | 2559 | 43448 |
| 22-#11 | 1.70 | MA | 36255 | 8346 | 57372 | 6268 | 61781 | 5093 | 62419 | 4210 | 60790 | 2901 | 72863 | 2109 | 46147 |
| 11L-2S | | MI | 36567 | 8346 | 58510 | 6180 | 64524 | 5010 | 67297 | 4129 | 70376 | 2834 | 84951 | 2647 | 43453 |
| 22-#14 | 2.46 | MA | 42892 | 8884 | 70217 | 6565 | 78213 | 5294 | 82426 | 4313 | 88080 | 2842 | 108592 | 2363 | 71361 |
| 4L-9S | | MI | 33791 | 8884 | 55130 | 6545 | 60029 | 5292 | 61732 | 4307 | 62814 | 2822 | 76329 | 1861 | 56858 |
| 22-#14 | 2.46 | MA | 42038 | 8884 | 68738 | 6564 | 76304 | 5291 | 80088 | 4329 | 84744 | 2834 | 104486 | 2299 | 70604 |
| 5L-8S | | MI | 34465 | 8884 | 56381 | 6526 | 61578 | 5275 | 63682 | 4313 | 65372 | 2812 | 79532 | 1942 | 57950 |
| 22-#14 | 2.46 | MA | 41224 | 8884 | 67342 | 6564 | 74408 | 5309 | 77774 | 4326 | 81680 | 2847 | 100565 | 2215 | 69391 |
| 6L-7S | | MI | 35143 | 8884 | 57564 | 6528 | 63163 | 5279 | 65567 | 4298 | 68080 | 2822 | 82788 | 2015 | 59262 |
| 22-#14 | 2.46 | MA | 40430 | 8884 | 65849 | 6583 | 72587 | 5307 | 75543 | 4342 | 78683 | 2860 | 96487 | 2088 | 68610 |
| 7L-6S | | MI | 35831 | 8884 | 58852 | 6510 | 64734 | 5263 | 67491 | 4284 | 70665 | 2811 | 86230 | 2141 | 59936 |
| 22-#14 | 2.46 | MA | 39647 | 8884 | 64479 | 6583 | 70750 | 5325 | 73358 | 4358 | 75543 | 2852 | 92649 | 2013 | 66997 |
| 8L-5S | | MI | 36535 | 8884 | 60057 | 6512 | 66370 | 5266 | 69487 | 4290 | 73307 | 2801 | 89537 | 2225 | 60888 |
| 22-#14 | 2.46 | MA | 38817 | 8884 | 63135 | 6583 | 68955 | 5323 | 71098 | 4354 | 72578 | 2865 | 88850 | 1933 | 65712 |
| 9L-4S | | MI | 37275 | 8884 | 61333 | 6513 | 68015 | 5250 | 71502 | 4276 | 76181 | 2811 | 93021 | 2288 | 61595 |
| 22-#14 | 2.46 | MA | 37952 | 8884 | 61667 | 6602 | 67142 | 5340 | 68927 | 4370 | 69634 | 2877 | 85165 | 1841 | 63922 |
| 10L-3S | | MI | 38100 | 8884 | 62788 | 6495 | 69866 | 5254 | 73747 | 4281 | 79097 | 2801 | 96349 | 2416 | 61742 |
| 22-#18 | 4.37 | MA | 46159 | 10249 | 79964 | 7391 | 90174 | 5917 | 96838 | 4696 | 107509 | 2756 | 135773 | 1660 | 116272 |
| 6L-7S | | MI | 38785 | 10249 | 67362 | 7358 | 75406 | 5887 | 80342 | 4667 | 87827 | 2708 | 109679 | 1311 | 97319 |
| 22-#18 | 4.37 | MA | 44819 | 10249 | 77334 | 7424 | 86969 | 5947 | 92910 | 4722 | 102234 | 2775 | 128702 | 1435 | 113106 |
| 7L-6S | | MI | 39946 | 10249 | 69628 | 7328 | 78167 | 5861 | 83725 | 4645 | 92321 | 2690 | 115621 | 1537 | 99836 |
| 22-#18 | 4.37 | MA | 43497 | 10249 | 74922 | 7422 | 83734 | 5941 | 89064 | 4749 | 96708 | 2760 | 122023 | 1305 | 108998 |
| 8L-5S | | MI | 41136 | 10249 | 71745 | 7332 | 81041 | 5869 | 87230 | 4657 | 96914 | 2672 | 121325 | 1687 | 102505 |
| 24-#11 | 1.86 | MA | 41738 | 8456 | 66915 | 6295 | 74113 | 5097 | 77481 | 4204 | 81254 | 2862 | 98929 | 2603 | 54712 |
| 3L-11S | | MI | 32220 | 8456 | 51541 | 6283 | 55500 | 5096 | 56267 | 4198 | 55386 | 2856 | 66458 | 2040 | 43843 |
| 24-#11 | 1.86 | MA | 41061 | 8456 | 65737 | 6309 | 72614 | 5110 | 75662 | 4202 | 78893 | 2871 | 96152 | 2515 | 54643 |
| 4L-10S | | MI | 32736 | 8456 | 52350 | 6284 | 56574 | 5098 | 57611 | 4202 | 57248 | 2862 | 68689 | 2094 | 44635 |
| 24-#11 | 1.86 | MA | 40457 | 8456 | 64706 | 6309 | 71284 | 5109 | 74033 | 4214 | 76567 | 2866 | 93276 | 2469 | 54522 |
| 5L-9S | | MI | 33263 | 8456 | 53171 | 6285 | 57665 | 5086 | 58917 | 4192 | 59019 | 2854 | 70875 | 2158 | 45197 |
| 24-#11 | 1.86 | MA | 39881 | 8456 | 63734 | 6309 | 69963 | 5121 | 72421 | 4211 | 74433 | 2876 | 90523 | 2411 | 53981 |
| 6L-8S | | MI | 33750 | 8456 | 54043 | 6272 | 58745 | 5089 | 60277 | 4195 | 60803 | 2846 | 73129 | 2214 | 45903 |
| 24-#11 | 1.86 | MA | 39319 | 8456 | 62693 | 6323 | 68694 | 5120 | 70866 | 4223 | 72344 | 2885 | 87660 | 2324 | 53393 |
| 7E | | MI | 34229 | 8456 | 54867 | 6272 | 59850 | 5077 | 61591 | 4185 | 62691 | 2852 | 75415 | 2265 | 46229 |
| 24-#11 | 1.86 | MA | 38766 | 8456 | 61739 | 6323 | 67415 | 5133 | 69345 | 4234 | 70156 | 2880 | 84971 | 2271 | 52968 |
| 8L-6S | | MI | 34716 | 8456 | 55766 | 6259 | 60945 | 5079 | 62933 | 4174 | 64494 | 2845 | 77836 | 2353 | 46687 |
| 24-#11 | 1.86 | MA | 38173 | 8456 | 60803 | 6323 | 66164 | 5132 | 67770 | 4232 | 68090 | 2890 | 82303 | 2215 | 52130 |
| 9L-5S | | MI | 35214 | 8456 | 56605 | 6260 | 62086 | 5067 | 64325 | 4178 | 66336 | 2837 | 80162 | 2411 | 47163 |
| 24-#11 | 1.86 | MA | 37563 | 8456 | 59781 | 6337 | 64901 | 5144 | 66258 | 4244 | 66039 | 2899 | 79715 | 2152 | 51424 |
| 10L-4S | | MI | 35737 | 8456 | 57495 | 6261 | 63233 | 5069 | 65730 | 4167 | 68341 | 2843 | 82608 | 2455 | 47247 |
| 24-#11 | 1.86 | MA | 36967 | 8456 | 58844 | 6337 | 63658 | 5143 | 64701 | 4241 | 63882 | 2894 | 77089 | 2097 | 50475 |
| 11L-3S | | MI | 36321 | 8456 | 58510 | 6248 | 64524 | 5058 | 67297 | 4171 | 70376 | 2835 | 84951 | 2543 | 47291 |
| 24-#11 | 1.86 | MA | 36380 | 8456 | 57838 | 6351 | 62403 | 5156 | 63193 | 4253 | 61834 | 2904 | 74197 | 2022 | 49578 |
| 12L-2S | | MI | 37151 | 8456 | 59775 | 6249 | 66138 | 5060 | 69258 | 4160 | 73033 | 2827 | 88528 | 2632 | 47309 |
| 24-#14 | 2.68 | MA | 43015 | 9044 | 70847 | 6664 | 78994 | 5364 | 83358 | 4374 | 89174 | 2824 | 110508 | 2279 | 76826 |
| 5L-9S | | MI | 34634 | 9044 | 56941 | 6644 | 62338 | 5364 | 64538 | 4352 | 66615 | 2812 | 81414 | 1837 | 62115 |
| 24-#14 | 2.68 | MA | 42206 | 9044 | 69452 | 6664 | 77098 | 5381 | 81044 | 4370 | 86111 | 2837 | 106587 | 2195 | 75654 |
| 6L-8S | | MI | 35307 | 9044 | 58192 | 6626 | 63887 | 5348 | 66488 | 4358 | 69174 | 2802 | 84618 | 1918 | 63265 |
| 24-#14 | 2.68 | MA | 41417 | 9044 | 67958 | 6683 | 75277 | 5379 | 78813 | 4386 | 83113 | 2850 | 102508 | 2069 | 74801 |
| 7E | | MI | 35982 | 9044 | 59374 | 6628 | 65472 | 5351 | 68373 | 4343 | 71882 | 2812 | 87874 | 1991 | 64539 |
| 24-#14 | 2.68 | MA | 40639 | 9044 | 66589 | 6683 | 73440 | 5397 | 76628 | 4402 | 79974 | 2842 | 98671 | 1994 | 73211 |
| 8L-6S | | MI | 36665 | 9044 | 60663 | 6610 | 67043 | 5335 | 70298 | 4329 | 74467 | 2802 | 91315 | 2117 | 65302 |
| 24-#14 | 2.68 | MA | 39822 | 9044 | 65245 | 6682 | 71645 | 5395 | 74368 | 4399 | 77008 | 2855 | 94872 | 1913 | 71870 |
| 9L-5S | | MI | 37366 | 9044 | 61867 | 6611 | 68678 | 5339 | 72293 | 4335 | 77108 | 2791 | 94622 | 2202 | 66219 |
| 24-#14 | 2.68 | MA | 38954 | 9044 | 63777 | 6702 | 69832 | 5413 | 72197 | 4415 | 74064 | 2867 | 91187 | 1822 | 70117 |
| 10L-4S | | MI | 38101 | 9044 | 63143 | 6613 | 70324 | 5323 | 74308 | 4321 | 79983 | 2801 | 98106 | 2264 | 67052 |
| 24-#18 | 4.76 | MA | 46494 | 10533 | 81035 | 7602 | 91687 | 6075 | 98646 | 4802 | 110005 | 2758 | 139148 | 1396 | 123990 |
| 7E | | MI | 40205 | 10533 | 70531 | 7536 | 79446 | 6016 | 85254 | 4747 | 94433 | 2687 | 118463 | 1263 | 106514 |
| 24-#18 | 4.76 | MA | 45184 | 10533 | 78623 | 7600 | 88452 | 6069 | 94800 | 4829 | 104478 | 2742 | 132469 | 1265 | 119789 |
| 8L-6S | | MI | 41357 | 10533 | 72797 | 7505 | 82207 | 5989 | 88637 | 4724 | 98927 | 2670 | 124405 | 1488 | 109034 |

## RECTANGULAR TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.24 | MA | 34892 | 7697 | 55075 | 5699 | 59861 | 4636 | 61475 | 3850 | 62269 | 2719 | 73668 | 2547 | 31825 |
| 2L-3S | | MI | 32668 | 7697 | 51729 | 5695 | 55595 | 4664 | 56289 | 3874 | 55263 | 2736 | 64331 | 2320 | 31886 |
| 8-#18 | 1.65 | MA | 36439 | 7981 | 58422 | 5876 | 64127 | 4765 | 66662 | 3930 | 69276 | 2700 | 83006 | 2502 | 42063 |
| 2L-4S | | MI | 32676 | 7981 | 52383 | 5904 | 56437 | 4785 | 57320 | 3943 | 56894 | 2735 | 67565 | 2047 | 41682 |
| 10-#14 | 1.16 | MA | 34709 | 7644 | 54422 | 5701 | 59242 | 4642 | 60805 | 3860 | 61453 | 2744 | 72864 | 2591 | 30132 |
| 2L-5S | | MI | 31730 | 7644 | 49635 | 5717 | 53124 | 4652 | 53355 | 3885 | 51341 | 2758 | 60239 | 2272 | 30024 |
| 10-#14 | 1.16 | MA | 33435 | 7644 | 52512 | 5700 | 56807 | 4638 | 57844 | 3875 | 57442 | 2755 | 67467 | 2463 | 30173 |
| 3L-4S | | MI | 32536 | 7644 | 50979 | 5719 | 54857 | 4655 | 55477 | 3870 | 54369 | 2766 | 63931 | 2335 | 30158 |
| 10-#18 | 2.07 | MA | 37969 | 8264 | 61768 | 6053 | 68394 | 4893 | 71848 | 4010 | 76283 | 2681 | 92343 | 2457 | 52268 |
| 2L-5S | | MI | 32858 | 8264 | 53366 | 6077 | 57657 | 4942 | 58776 | 4046 | 58599 | 2699 | 70491 | 1892 | 48833 |
| 10-#18 | 2.07 | MA | 35786 | 8264 | 58422 | 6049 | 64127 | 4921 | 66662 | 4034 | 69276 | 2699 | 83006 | 2229 | 52154 |
| 3L-4S | | MI | 34242 | 8264 | 55729 | 6081 | 60703 | 4914 | 62506 | 4022 | 63901 | 2716 | 76903 | 2002 | 51708 |

## RECTANGULAR TIED COLUMNS 44" x 46"

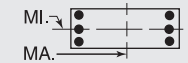
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.19 | MA | 37972 | 8008 | 59708 | 5951 | 64916 | 4844 | 66614 | 4027 | 67358 | 2857 | 79693 | 2687 | 33445 |
| 2L-3S | | MI | 34039 | 8008 | 53776 | 5930 | 57734 | 4857 | 58376 | 4038 | 57138 | 2862 | 66406 | 2441 | 31949 |
| 6-#18 | 1.19 | MA | 35626 | 8008 | 56184 | 5948 | 60424 | 4873 | 61152 | 4052 | 59960 | 2876 | 69801 | 2460 | 33506 |
| 3L-2S | | MI | 36265 | 8008 | 57122 | 5933 | 62000 | 4829 | 63562 | 4014 | 64144 | 2845 | 75744 | 2669 | 31872 |
| 8-#18 | 1.58 | MA | 39612 | 8292 | 63232 | 6129 | 69409 | 4973 | 72075 | 4106 | 74757 | 2840 | 89584 | 2645 | 44223 |
| 2L-4S | | MI | 34046 | 8292 | 54430 | 6139 | 58576 | 4978 | 59407 | 4107 | 58769 | 2861 | 69641 | 2169 | 41805 |
| 8-#18 | 1.58 | MA | 37286 | 8292 | 59708 | 6126 | 64916 | 5002 | 66614 | 4132 | 67358 | 2858 | 79693 | 2418 | 44195 |
| 3E | | MI | 35609 | 8292 | 57122 | 6107 | 62000 | 4986 | 63562 | 4118 | 64144 | 2844 | 75744 | 2396 | 42109 |
| 8-#18 | 1.58 | MA | 35643 | 8292 | 56876 | 6158 | 61315 | 4995 | 62243 | 4122 | 61684 | 2876 | 73220 | 2190 | 43842 |
| 4L-2S | | MI | 37816 | 8292 | 60469 | 6111 | 66266 | 4958 | 68749 | 4094 | 71151 | 2826 | 85081 | 2624 | 42116 |
| 10-#14 | 1.11 | MA | 37774 | 7955 | 59011 | 5954 | 64253 | 4850 | 65894 | 4037 | 66419 | 2880 | 78796 | 2730 | 31650 |
| 2L-5S | | MI | 33099 | 7955 | 51675 | 5954 | 55263 | 4847 | 55446 | 4050 | 53222 | 2885 | 62325 | 2395 | 30108 |
| 10-#14 | 1.11 | MA | 36430 | 7955 | 57001 | 5953 | 61691 | 4847 | 62778 | 4052 | 62198 | 2892 | 73087 | 2602 | 31692 |
| 3L-4S | | MI | 33906 | 7955 | 53018 | 5955 | 56996 | 4850 | 57568 | 4035 | 56251 | 2893 | 66016 | 2458 | 30217 |
| 10-#14 | 1.11 | MA | 35484 | 7955 | 55389 | 5972 | 59641 | 4864 | 60291 | 4048 | 58969 | 2904 | 69343 | 2474 | 31677 |
| 4L-3S | | MI | 34807 | 7955 | 54552 | 5936 | 58946 | 4833 | 59935 | 4040 | 59324 | 2882 | 69552 | 2586 | 30218 |
| 10-#14 | 1.11 | MA | 34636 | 7955 | 53978 | 5971 | 57820 | 4862 | 58061 | 4063 | 55786 | 2896 | 65444 | 2410 | 31543 |
| 5L-2S | | MI | 36083 | 7955 | 56462 | 5937 | 61382 | 4836 | 62896 | 4025 | 63335 | 2871 | 74949 | 2714 | 30171 |
| 10-#18 | 1.98 | MA | 41232 | 8575 | 66755 | 6306 | 73901 | 5101 | 77536 | 4186 | 82155 | 2822 | 99476 | 2603 | 54968 |
| 2L-5S | | MI | 34227 | 8575 | 55413 | 6312 | 59796 | 5135 | 60863 | 4211 | 60474 | 2825 | 72567 | 2014 | 49174 |
| 10-#18 | 1.98 | MA | 38928 | 8575 | 63232 | 6303 | 69409 | 5130 | 72075 | 4211 | 74757 | 2840 | 89584 | 2375 | 54854 |
| 3L-4S | | MI | 35614 | 8575 | 57776 | 6316 | 62843 | 5107 | 64594 | 4186 | 65775 | 2843 | 78978 | 2124 | 51840 |
| 10-#18 | 1.98 | MA | 37301 | 8575 | 60400 | 6335 | 65808 | 5124 | 67704 | 4201 | 69082 | 2858 | 83112 | 2148 | 54408 |
| 4L-3S | | MI | 37161 | 8575 | 60469 | 6284 | 66266 | 5114 | 68749 | 4198 | 71151 | 2825 | 85081 | 2351 | 52237 |
| 10-#18 | 1.98 | MA | 35843 | 8575 | 57916 | 6332 | 62605 | 5153 | 63783 | 4227 | 63488 | 2841 | 76333 | 2037 | 51577 |
| 5L-2S | | MI | 39349 | 8575 | 63815 | 6288 | 70533 | 5087 | 73935 | 4174 | 78158 | 2807 | 94418 | 2579 | 52330 |
| 12-#14 | 1.33 | MA | 38721 | 8114 | 61021 | 6054 | 66816 | 4922 | 69009 | 4081 | 70640 | 2870 | 84506 | 2710 | 37798 |
| 2L-6S | | MI | 33249 | 8114 | 52317 | 6052 | 55976 | 4936 | 56305 | 4090 | 54452 | 2886 | 64211 | 2289 | 34890 |
| 12-#14 | 1.33 | MA | 37385 | 8114 | 59011 | 6053 | 64253 | 4919 | 65894 | 4097 | 66419 | 2882 | 78796 | 2582 | 37819 |
| 3L-5S | | MI | 34014 | 8114 | 53585 | 6054 | 57699 | 4919 | 58407 | 4095 | 57234 | 2875 | 67722 | 2373 | 35862 |
| 12-#14 | 1.33 | MA | 36444 | 8114 | 57400 | 6072 | 62204 | 4937 | 63406 | 4092 | 63189 | 2894 | 75052 | 2454 | 37765 |
| 4E | | MI | 34816 | 8114 | 54929 | 6055 | 59432 | 4922 | 60529 | 4080 | 60262 | 2883 | 71414 | 2436 | 36008 |
| 12-#14 | 1.33 | MA | 35602 | 8114 | 55988 | 6071 | 60383 | 4934 | 61176 | 4108 | 60007 | 2886 | 71154 | 2390 | 37594 |
| 5L-3S | | MI | 35711 | 8114 | 56462 | 6036 | 61382 | 4905 | 62896 | 4085 | 63335 | 2872 | 74949 | 2564 | 36047 |
| 12-#14 | 1.33 | MA | 34800 | 8114 | 54656 | 6070 | 58573 | 4951 | 58969 | 4104 | 57084 | 2898 | 67438 | 2306 | 36550 |
| 6L-2S | | MI | 36980 | 8114 | 58372 | 6037 | 63817 | 4908 | 65857 | 4070 | 67346 | 2861 | 80347 | 2692 | 36018 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

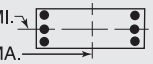



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 2.37 | MA | 42836 | 8859 | 70279 | 6483 | 78394 | 5230 | 82997 | 4266 | 89554 | 2804 | 109367 | 2561 | 65676 |
| 2L-6S | | MI | 34480 | 8859 | 56529 | 6486 | 61033 | 5256 | 62355 | 4279 | 62610 | 2824 | 75837 | 1819 | 57042 |
| 12-#18 | 2.37 | MA | 40551 | 8859 | 66755 | 6480 | 73901 | 5259 | 77536 | 4291 | 82155 | 2823 | 99476 | 2333 | 65495 |
| 3L-5S | | MI | 35791 | 8859 | 58760 | 6489 | 64062 | 5263 | 66049 | 4290 | 67481 | 2806 | 81904 | 1969 | 58940 |
| 12-#18 | 2.37 | MA | 38940 | 8859 | 63923 | 6513 | 70300 | 5252 | 73166 | 4281 | 76481 | 2841 | 93003 | 2106 | 64967 |
| 4E | | MI | 37165 | 8859 | 61122 | 6493 | 67109 | 5236 | 69780 | 4266 | 72782 | 2824 | 88315 | 2078 | 61868 |
| 12-#18 | 2.37 | MA | 37497 | 8859 | 61440 | 6510 | 67098 | 5281 | 69244 | 4306 | 70886 | 2823 | 86224 | 1995 | 61874 |
| 5L-3S | | MI | 38697 | 8859 | 63815 | 6462 | 70533 | 5243 | 73935 | 4278 | 78158 | 2806 | 94418 | 2306 | 62345 |
| 12-#18 | 2.37 | MA | 36121 | 8859 | 59096 | 6507 | 63914 | 5275 | 65361 | 4296 | 65745 | 2842 | 79793 | 1845 | 59861 |
| 6L-2S | | MI | 40867 | 8859 | 67161 | 6465 | 74799 | 5215 | 79121 | 4253 | 85164 | 2788 | 103756 | 2533 | 62503 |
| 14-#11 | 1.08 | MA | 37689 | 7931 | 58694 | 5957 | 63963 | 4854 | 65585 | 4042 | 66020 | 2891 | 78431 | 2750 | 30863 |
| 2L-7S | | MI | 32861 | 7931 | 50990 | 5967 | 54487 | 4860 | 54533 | 4058 | 52072 | 2910 | 60722 | 2368 | 28816 |
| 14-#11 | 1.08 | MA | 36749 | 7931 | 57290 | 5957 | 62174 | 4852 | 63410 | 4054 | 63073 | 2900 | 74421 | 2662 | 30892 |
| 3L-6S | | MI | 33384 | 7931 | 51936 | 5953 | 55640 | 4861 | 55946 | 4047 | 53970 | 2902 | 63290 | 2455 | 29372 |
| 14-#11 | 1.08 | MA | 36089 | 7931 | 56166 | 5970 | 60745 | 4865 | 61675 | 4051 | 60821 | 2909 | 71789 | 2573 | 30902 |
| 4L-5S | | MI | 33921 | 7931 | 52820 | 5954 | 56841 | 4849 | 57411 | 4050 | 55910 | 2894 | 65759 | 2514 | 29451 |
| 14-#11 | 1.08 | MA | 35498 | 7931 | 55182 | 5970 | 59475 | 4863 | 60121 | 4062 | 58602 | 2904 | 69056 | 2528 | 30867 |
| 5L-4S | | MI | 34484 | 7931 | 53757 | 5954 | 58050 | 4851 | 58892 | 4039 | 58022 | 2899 | 68348 | 2558 | 29474 |
| 14-#11 | 1.08 | MA | 34935 | 7931 | 54255 | 5970 | 58214 | 4875 | 58582 | 4060 | 56565 | 2912 | 66445 | 2470 | 30772 |
| 6L-3S | | MI | 35112 | 7931 | 54826 | 5941 | 59410 | 4839 | 60542 | 4042 | 60165 | 2891 | 70836 | 2647 | 29456 |
| 14-#11 | 1.08 | MA | 34385 | 7931 | 53261 | 5983 | 57004 | 4874 | 57098 | 4071 | 54572 | 2921 | 63730 | 2382 | 30170 |
| 7L-2S | | MI | 36005 | 7931 | 56161 | 5942 | 61111 | 4841 | 62610 | 4032 | 62967 | 2883 | 74629 | 2735 | 29425 |
| 14-#14 | 1.56 | MA | 39662 | 8274 | 63031 | 6153 | 69379 | 4994 | 72125 | 4126 | 74861 | 2860 | 90215 | 2689 | 43935 |
| 2L-7S | | MI | 33421 | 8274 | 52870 | 6171 | 56758 | 5005 | 57239 | 4150 | 55740 | 2887 | 65954 | 2141 | 39761 |
| 14-#14 | 1.56 | MA | 38333 | 8274 | 61021 | 6153 | 66816 | 4992 | 69009 | 4142 | 70640 | 2872 | 84506 | 2561 | 43927 |
| 3L-6S | | MI | 34162 | 8274 | 54227 | 6152 | 58411 | 5008 | 59266 | 4135 | 58463 | 2876 | 69608 | 2267 | 40513 |
| 14-#14 | 1.56 | MA | 37398 | 8274 | 59410 | 6172 | 64767 | 5009 | 66522 | 4137 | 67410 | 2884 | 80762 | 2433 | 43845 |
| 4L-5S | | MI | 34922 | 8274 | 55495 | 6153 | 60134 | 4991 | 61368 | 4140 | 61245 | 2865 | 73119 | 2351 | 41611 |
| 14-#14 | 1.56 | MA | 36562 | 8274 | 57998 | 6171 | 62946 | 5006 | 64292 | 4153 | 64228 | 2876 | 76863 | 2369 | 43641 |
| 5L-4S | | MI | 35719 | 8274 | 56839 | 6154 | 61867 | 4994 | 63490 | 4125 | 64274 | 2873 | 76811 | 2414 | 41789 |
| 14-#14 | 1.56 | MA | 35764 | 8274 | 56666 | 6170 | 61136 | 5024 | 62084 | 4148 | 61305 | 2888 | 73147 | 2285 | 42471 |
| 6L-3S | | MI | 36608 | 8274 | 58372 | 6136 | 63817 | 4978 | 65857 | 4130 | 67346 | 2862 | 80347 | 2542 | 41857 |
| 14-#14 | 1.56 | MA | 34986 | 8274 | 55241 | 6189 | 59399 | 5021 | 59955 | 4164 | 58445 | 2899 | 69281 | 2159 | 41657 |
| 7L-2S | | MI | 37871 | 8274 | 60283 | 6137 | 66253 | 4981 | 68817 | 4115 | 71358 | 2851 | 85744 | 2670 | 41854 |
| 14-#18 | 2.77 | MA | 44425 | 9143 | 73802 | 6661 | 82886 | 5359 | 88458 | 4346 | 96952 | 2787 | 119259 | 2518 | 76365 |
| 2L-7S | | MI | 34774 | 9143 | 57489 | 6694 | 62391 | 5412 | 63977 | 4383 | 64849 | 2823 | 78856 | 1549 | 63516 |
| 14-#18 | 2.77 | MA | 42158 | 9143 | 70279 | 6658 | 78394 | 5387 | 82997 | 4371 | 89554 | 2805 | 109367 | 2291 | 76123 |
| 3L-6S | | MI | 36041 | 9143 | 59876 | 6663 | 65300 | 5384 | 67541 | 4359 | 69616 | 2805 | 85174 | 1774 | 66653 |
| 14-#18 | 2.77 | MA | 40562 | 9143 | 67447 | 6690 | 74793 | 5381 | 78627 | 4361 | 83880 | 2823 | 102895 | 2063 | 75506 |
| 4L-5S | | MI | 37339 | 9143 | 62106 | 6667 | 68329 | 5392 | 71236 | 4370 | 74487 | 2787 | 91242 | 1924 | 68734 |
| 14-#18 | 2.77 | MA | 39134 | 9143 | 64964 | 6687 | 71590 | 5410 | 74705 | 4386 | 78285 | 2806 | 96116 | 1953 | 72199 |
| 5L-4S | | MI | 38699 | 9143 | 64469 | 6671 | 71375 | 5364 | 74966 | 4346 | 79789 | 2805 | 97653 | 2033 | 71801 |
| 14-#18 | 2.77 | MA | 37771 | 9143 | 62620 | 6684 | 68406 | 5403 | 70822 | 4376 | 73144 | 2824 | 89684 | 1803 | 70006 |
| 6L-3S | | MI | 40218 | 9143 | 67161 | 6639 | 74799 | 5372 | 79121 | 4357 | 85164 | 2787 | 103756 | 2261 | 72439 |
| 14-#18 | 2.77 | MA | 36441 | 9143 | 60112 | 6716 | 65349 | 5432 | 67075 | 4401 | 68112 | 2842 | 82990 | 1578 | 66642 |
| 7L-2S | | MI | 42370 | 9143 | 70508 | 6643 | 79065 | 5344 | 84307 | 4333 | 92171 | 2770 | 113093 | 2488 | 72657 |
| 16-#11 | 1.23 | MA | 38355 | 8042 | 60097 | 6026 | 65753 | 4904 | 67760 | 4074 | 68967 | 2884 | 82440 | 2737 | 35155 |
| 2L-8S | | MI | 32992 | 8042 | 51457 | 6035 | 55025 | 4922 | 55218 | 4100 | 52885 | 2898 | 62095 | 2302 | 32374 |
| 16-#11 | 1.23 | MA | 37418 | 8042 | 58694 | 6026 | 63963 | 4902 | 65585 | 4085 | 66020 | 2893 | 78431 | 2649 | 35175 |
| 3L-7S | | MI | 33505 | 8042 | 52325 | 6036 | 56189 | 4910 | 56601 | 4089 | 54874 | 2903 | 64515 | 2354 | 32769 |
| 16-#11 | 1.23 | MA | 36761 | 8042 | 57570 | 6040 | 62534 | 4915 | 63850 | 4082 | 63768 | 2902 | 75798 | 2560 | 35167 |
| 4L-6S | | MI | 34026 | 8042 | 53271 | 6022 | 57341 | 4912 | 58015 | 4078 | 56772 | 2895 | 67083 | 2441 | 33350 |
| 16-#11 | 1.23 | MA | 36173 | 8042 | 56586 | 6039 | 61265 | 4913 | 62296 | 4093 | 61549 | 2897 | 73066 | 2515 | 35115 |
| 5E | | MI | 34560 | 8042 | 54154 | 6023 | 58542 | 4900 | 59479 | 4081 | 58711 | 2887 | 69552 | 2500 | 33492 |
| 16-#11 | 1.23 | MA | 35613 | 8042 | 55658 | 6039 | 60003 | 4926 | 60757 | 4091 | 59512 | 2905 | 70455 | 2457 | 34958 |
| 6L-4S | | MI | 35120 | 8042 | 55091 | 6023 | 59751 | 4901 | 60960 | 4070 | 60823 | 2892 | 72141 | 2544 | 33532 |
| 16-#11 | 1.23 | MA | 35066 | 8042 | 54665 | 6053 | 58793 | 4924 | 59273 | 4102 | 57518 | 2914 | 67739 | 2369 | 34330 |
| 7L-3S | | MI | 35746 | 8042 | 56161 | 6010 | 61111 | 4889 | 62610 | 4073 | 62967 | 2884 | 74629 | 2633 | 33531 |

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

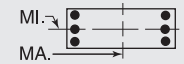



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.23 | MA | 34527 | 8042 | 53754 | 6052 | 57571 | 4937 | 57821 | 4113 | 55430 | 2909 | 65185 | 2317 | 33900 |
| 8L-2S | | MI | 36636 | 8042 | 57495 | 6011 | 62812 | 4891 | 64678 | 4063 | 65769 | 2876 | 78421 | 2721 | 33508 |
| 16-#14 | 1.78 | MA | 40597 | 8434 | 65042 | 6253 | 71942 | 5066 | 75240 | 4171 | 79081 | 2850 | 95924 | 2669 | 50062 |
| 2L-8S | | MI | 33606 | 8434 | 53536 | 6269 | 57524 | 5094 | 58215 | 4209 | 56900 | 2868 | 67902 | 2045 | 44197 |
| 16-#14 | 1.78 | MA | 39274 | 8434 | 63031 | 6252 | 69379 | 5064 | 72125 | 4187 | 74861 | 2862 | 90215 | 2541 | 50027 |
| 3L-7S | | MI | 34332 | 8434 | 54781 | 6271 | 59193 | 5077 | 60200 | 4194 | 59752 | 2877 | 71351 | 2119 | 45422 |
| 16-#14 | 1.78 | MA | 38345 | 8434 | 61420 | 6271 | 67330 | 5081 | 69637 | 4182 | 71631 | 2874 | 86471 | 2413 | 49918 |
| 4L-6S | | MI | 35069 | 8434 | 56138 | 6252 | 60847 | 5080 | 62227 | 4180 | 62474 | 2866 | 75005 | 2245 | 46147 |
| 16-#14 | 1.78 | MA | 37514 | 8434 | 60008 | 6271 | 65509 | 5079 | 67407 | 4198 | 68449 | 2866 | 82572 | 2349 | 49671 |
| 5E | | MI | 35824 | 8434 | 57406 | 6253 | 62570 | 5064 | 64328 | 4185 | 65256 | 2855 | 78516 | 2329 | 47322 |
| 16-#14 | 1.78 | MA | 36722 | 8434 | 58677 | 6270 | 63699 | 5096 | 65200 | 4193 | 65526 | 2878 | 78856 | 2265 | 48404 |
| 6L-4S | | MI | 36615 | 8434 | 58750 | 6254 | 64303 | 5067 | 66451 | 4170 | 68285 | 2863 | 82208 | 2392 | 47562 |
| 16-#14 | 1.78 | MA | 35949 | 8434 | 57251 | 6289 | 61962 | 5093 | 63070 | 4209 | 62666 | 2889 | 74990 | 2139 | 47617 |
| 7L-3S | | MI | 37500 | 8434 | 60283 | 6236 | 66253 | 5050 | 68817 | 4175 | 71358 | 2852 | 85744 | 2520 | 47656 |
| 16-#14 | 1.78 | MA | 35186 | 8434 | 55944 | 6288 | 60209 | 5111 | 60986 | 4224 | 59670 | 2881 | 71347 | 2064 | 46313 |
| 8L-2S | | MI | 38756 | 8434 | 62193 | 6237 | 68689 | 5053 | 71778 | 4160 | 75369 | 2841 | 91141 | 2648 | 47683 |
| 16-#18 | 3.16 | MA | 43751 | 9427 | 73802 | 6835 | 82886 | 5516 | 88458 | 4451 | 96952 | 2787 | 119259 | 2249 | 86741 |
| 3L-7S | | MI | 36331 | 9427 | 60835 | 6872 | 66657 | 5541 | 69163 | 4463 | 71855 | 2804 | 88193 | 1503 | 73266 |
| 16-#18 | 3.16 | MA | 42169 | 9427 | 70971 | 6867 | 79285 | 5509 | 84088 | 4441 | 91278 | 2805 | 112786 | 2021 | 85703 |
| 4L-6S | | MI | 37586 | 9427 | 63222 | 6840 | 69566 | 5513 | 72728 | 4439 | 76623 | 2786 | 94511 | 1728 | 76293 |
| 16-#18 | 3.16 | MA | 40754 | 9427 | 68487 | 6864 | 76082 | 5538 | 80166 | 4466 | 85684 | 2788 | 106007 | 1910 | 82548 |
| 5E | | MI | 38872 | 9427 | 65452 | 6844 | 72595 | 5520 | 76422 | 4450 | 81494 | 2769 | 100579 | 1879 | 78553 |
| 16-#18 | 3.16 | MA | 39405 | 9427 | 66143 | 6861 | 72899 | 5532 | 76283 | 4456 | 80542 | 2806 | 99576 | 1760 | 80178 |
| 6L-4S | | MI | 40220 | 9427 | 67815 | 6848 | 75641 | 5493 | 80152 | 4426 | 86795 | 2786 | 106990 | 1988 | 81473 |
| 16-#18 | 3.16 | MA | 38088 | 9427 | 63635 | 6894 | 69842 | 5560 | 72536 | 4481 | 75511 | 2824 | 92881 | 1535 | 76926 |
| 7L-3S | | MI | 41725 | 9427 | 70508 | 6816 | 79065 | 5500 | 84307 | 4437 | 92171 | 2769 | 113093 | 2215 | 82523 |
| 16-#18 | 3.16 | MA | 36789 | 9427 | 61334 | 6891 | 66756 | 5554 | 68868 | 4506 | 70241 | 2807 | 86547 | 1406 | 73315 |
| 8L-2S | | MI | 43861 | 9427 | 73854 | 6820 | 83332 | 5472 | 89494 | 4413 | 99177 | 2751 | 122431 | 2443 | 82796 |
| 18-#11 | 1.39 | MA | 39017 | 8153 | 61501 | 6095 | 67542 | 4954 | 69936 | 4105 | 71914 | 2877 | 86449 | 2724 | 39441 |
| 2L-9S | | MI | 33106 | 8153 | 51940 | 6104 | 55590 | 4970 | 55855 | 4128 | 53809 | 2899 | 63496 | 2232 | 35751 |
| 18-#11 | 1.39 | MA | 38084 | 8153 | 60097 | 6095 | 65753 | 4952 | 67760 | 4116 | 68967 | 2886 | 82440 | 2636 | 39452 |
| 3L-8S | | MI | 33635 | 8153 | 52792 | 6104 | 56726 | 4972 | 57286 | 4131 | 55687 | 2891 | 65887 | 2288 | 36344 |
| 18-#11 | 1.39 | MA | 37430 | 8153 | 58973 | 6109 | 64323 | 4965 | 66026 | 4113 | 66714 | 2895 | 79808 | 2547 | 39426 |
| 4L-7S | | MI | 34147 | 8153 | 53659 | 6105 | 57890 | 4960 | 58669 | 4120 | 57675 | 2897 | 68307 | 2340 | 36727 |
| 18-#11 | 1.39 | MA | 36845 | 8153 | 57989 | 6108 | 63054 | 4963 | 64471 | 4124 | 64496 | 2890 | 77075 | 2502 | 39359 |
| 5L-6S | | MI | 34665 | 8153 | 54605 | 6092 | 59043 | 4962 | 60083 | 4109 | 59573 | 2888 | 70876 | 2427 | 37285 |
| 18-#11 | 1.39 | MA | 36287 | 8153 | 57062 | 6108 | 61793 | 4976 | 62932 | 4122 | 62459 | 2899 | 74464 | 2444 | 39098 |
| 6L-5S | | MI | 35196 | 8153 | 55489 | 6092 | 60244 | 4950 | 61548 | 4112 | 61513 | 2880 | 73344 | 2486 | 37529 |
| 18-#11 | 1.39 | MA | 35743 | 8153 | 56068 | 6122 | 60582 | 4974 | 61449 | 4133 | 60465 | 2907 | 71748 | 2356 | 38495 |
| 7L-4S | | MI | 35754 | 8153 | 56425 | 6093 | 61452 | 4951 | 63028 | 4102 | 63625 | 2885 | 75934 | 2530 | 37584 |
| 18-#11 | 1.39 | MA | 35206 | 8153 | 55158 | 6122 | 59361 | 4987 | 59996 | 4144 | 58377 | 2902 | 69194 | 2304 | 38077 |
| 8L-3S | | MI | 36377 | 8153 | 57495 | 6079 | 62812 | 4939 | 64678 | 4105 | 65769 | 2877 | 78421 | 2619 | 37600 |
| 18-#11 | 1.39 | MA | 34641 | 8153 | 54264 | 6121 | 58167 | 4985 | 58493 | 4142 | 56405 | 2911 | 66664 | 2248 | 37439 |
| 9L-2S | | MI | 37263 | 8153 | 58829 | 6080 | 64513 | 4941 | 66747 | 4094 | 68570 | 2869 | 82214 | 2707 | 37585 |
| 18-#14 | 2.00 | MA | 41526 | 8593 | 67052 | 6353 | 74505 | 5139 | 78356 | 4216 | 83302 | 2840 | 101634 | 2648 | 56175 |
| 2L-9S | | MI | 33776 | 8593 | 54129 | 6388 | 58329 | 5163 | 59123 | 4249 | 58217 | 2869 | 69897 | 1942 | 48709 |
| 18-#14 | 2.00 | MA | 40210 | 8593 | 65042 | 6352 | 71942 | 5136 | 75240 | 4232 | 79081 | 2852 | 95924 | 2520 | 56120 |
| 3L-8S | | MI | 34515 | 8593 | 55447 | 6369 | 59960 | 5166 | 61176 | 4254 | 60911 | 2858 | 73299 | 2023 | 49786 |
| 18-#14 | 2.00 | MA | 39286 | 8593 | 63430 | 6371 | 69892 | 5153 | 72753 | 4227 | 75852 | 2864 | 92180 | 2392 | 55985 |
| 4L-7S | | MI | 35237 | 8593 | 56691 | 6370 | 61629 | 5150 | 63161 | 4239 | 63763 | 2867 | 76748 | 2097 | 51089 |
| 18-#14 | 2.00 | MA | 38460 | 8593 | 62018 | 6370 | 68071 | 5151 | 70523 | 4243 | 72669 | 2856 | 88282 | 2328 | 55562 |
| 5L-6S | | MI | 35969 | 8593 | 58048 | 6352 | 63283 | 5153 | 65188 | 4224 | 66486 | 2856 | 80402 | 2223 | 51791 |
| 18-#14 | 2.00 | MA | 37673 | 8593 | 60687 | 6370 | 66262 | 5168 | 68315 | 4238 | 69747 | 2868 | 84566 | 2244 | 54346 |
| 6L-5S | | MI | 36719 | 8593 | 59316 | 6353 | 65005 | 5136 | 67289 | 4229 | 69268 | 2845 | 83913 | 2307 | 52916 |
| 18-#14 | 2.00 | MA | 36904 | 8593 | 59261 | 6389 | 64525 | 5166 | 66186 | 4254 | 66887 | 2880 | 80699 | 2118 | 53584 |
| 7L-4S | | MI | 37506 | 8593 | 60660 | 6354 | 66739 | 5139 | 69412 | 4215 | 72296 | 2854 | 87605 | 2370 | 53330 |
| 18-#14 | 2.00 | MA | 36147 | 8593 | 57954 | 6388 | 62771 | 5183 | 64101 | 4269 | 63891 | 2872 | 77056 | 2044 | 52203 |
| 8L-3S | | MI | 38386 | 8593 | 62193 | 6335 | 68689 | 5122 | 71778 | 4220 | 75369 | 2842 | 91141 | 2498 | 53449 |
| 18-#14 | 2.00 | MA | 35357 | 8593 | 56671 | 6387 | 61059 | 5180 | 61944 | 4265 | 61061 | 2883 | 73456 | 1963 | 51045 |
| 9L-2S | | MI | 39635 | 8593 | 64104 | 6336 | 71124 | 5125 | 74739 | 4205 | 79380 | 2831 | 96538 | 2626 | 53495 |


## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

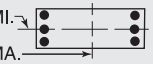

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 3.56 | MA | 43762 | 9710 | 74494 | 7045 | 83777 | 5638 | 89549 | 4521 | 98677 | 2788 | 122678 | 1979 | 95935 |
| 4L-7S | | MI | 37874 | 9710 | 64181 | 7049 | 70923 | 5669 | 74349 | 4543 | 78862 | 2785 | 97531 | 1458 | 83034 |
| 18-#18 | 3.56 | MA | 42359 | 9710 | 72011 | 7042 | 80575 | 5667 | 85627 | 4546 | 93082 | 2770 | 115899 | 1868 | 92917 |
| 5L-6S | | MI | 39117 | 9710 | 66568 | 7018 | 73832 | 5642 | 77914 | 4519 | 83629 | 2768 | 103849 | 1683 | 85958 |
| 18-#18 | 3.56 | MA | 41023 | 9710 | 69667 | 7039 | 77391 | 5660 | 81744 | 4536 | 87941 | 2789 | 109467 | 1718 | 90375 |
| 6L-5S | | MI | 40391 | 9710 | 68799 | 7021 | 76861 | 5649 | 81608 | 4530 | 88501 | 2750 | 109916 | 1834 | 88390 |
| 18-#18 | 3.56 | MA | 39718 | 9710 | 67159 | 7071 | 74334 | 5689 | 77998 | 4561 | 82910 | 2807 | 102773 | 1493 | 87229 |
| 7L-4S | | MI | 41727 | 9710 | 71161 | 7025 | 79908 | 5621 | 85339 | 4506 | 93802 | 2768 | 116328 | 1943 | 91178 |
| 18-#18 | 3.56 | MA | 38432 | 9710 | 64858 | 7068 | 71249 | 5683 | 74329 | 4586 | 77640 | 2789 | 96439 | 1364 | 83520 |
| 8L-3S | | MI | 43220 | 9710 | 73854 | 6994 | 83332 | 5629 | 89494 | 4517 | 99177 | 2750 | 122431 | 2170 | 92598 |
| 20-#11 | 1.54 | MA | 39676 | 8263 | 62904 | 6165 | 69331 | 5004 | 72111 | 4136 | 74861 | 2870 | 90458 | 2711 | 43722 |
| 2L-10S | | MI | 33189 | 8263 | 52345 | 6186 | 56142 | 5032 | 56548 | 4170 | 54747 | 2901 | 64968 | 2155 | 39030 |
| 20-#11 | 1.54 | MA | 38747 | 8263 | 61501 | 6164 | 67542 | 5003 | 69936 | 4147 | 71914 | 2879 | 86449 | 2623 | 43718 |
| 3L-9S | | MI | 33748 | 8263 | 53274 | 6173 | 57291 | 5020 | 57923 | 4159 | 56611 | 2892 | 67288 | 2218 | 39671 |
| 20-#11 | 1.54 | MA | 38095 | 8263 | 60377 | 6178 | 66113 | 5015 | 68201 | 4144 | 69661 | 2888 | 83817 | 2534 | 43681 |
| 4L-8S | | MI | 34275 | 8263 | 54126 | 6174 | 58428 | 5022 | 59354 | 4162 | 58489 | 2884 | 69680 | 2274 | 40317 |
| 20-#11 | 1.54 | MA | 37513 | 8263 | 59393 | 6178 | 64843 | 5014 | 66646 | 4156 | 67443 | 2883 | 81084 | 2489 | 43600 |
| 5L-7S | | MI | 34784 | 8263 | 54993 | 6174 | 59591 | 5010 | 60738 | 4151 | 60477 | 2890 | 72100 | 2326 | 40690 |
| 20-#11 | 1.54 | MA | 36958 | 8263 | 58465 | 6177 | 63582 | 5026 | 65108 | 4153 | 65405 | 2892 | 78473 | 2431 | 43247 |
| 6E | | MI | 35300 | 8263 | 55939 | 6161 | 60744 | 5012 | 62151 | 4141 | 62375 | 2881 | 74668 | 2413 | 41227 |
| 20-#11 | 1.54 | MA | 36416 | 8263 | 57472 | 6191 | 62372 | 5024 | 63624 | 4164 | 63412 | 2900 | 75758 | 2343 | 42665 |
| 7L-5S | | MI | 35829 | 8263 | 56823 | 6161 | 61945 | 5000 | 63616 | 4144 | 64315 | 2873 | 77137 | 2471 | 41562 |
| 20-#11 | 1.54 | MA | 35882 | 8263 | 56561 | 6191 | 61150 | 5037 | 62171 | 4175 | 61324 | 2895 | 73203 | 2291 | 42257 |
| 8L-4S | | MI | 36384 | 8263 | 57760 | 6162 | 63153 | 5002 | 65096 | 4133 | 66427 | 2879 | 79726 | 2516 | 41631 |
| 20-#11 | 1.54 | MA | 35320 | 8263 | 55667 | 6190 | 59956 | 5035 | 60668 | 4173 | 59352 | 2904 | 70674 | 2235 | 41567 |
| 9L-3S | | MI | 37005 | 8263 | 58829 | 6149 | 64513 | 4990 | 66747 | 4136 | 68570 | 2870 | 82214 | 2605 | 41660 |
| 20-#11 | 1.54 | MA | 34733 | 8263 | 54691 | 6204 | 58751 | 5048 | 59225 | 4184 | 57395 | 2913 | 68220 | 2172 | 40877 |
| 10L-2S | | MI | 37888 | 8263 | 60164 | 6149 | 66215 | 4991 | 68815 | 4125 | 71372 | 2862 | 86007 | 2693 | 41658 |
| 20-#14 | 2.22 | MA | 41140 | 8753 | 67052 | 6452 | 74505 | 5209 | 78356 | 4276 | 83302 | 2842 | 101634 | 2500 | 62206 |
| 3L-9S | | MI | 34695 | 8753 | 56040 | 6487 | 60764 | 5236 | 62084 | 4294 | 62228 | 2859 | 75294 | 1920 | 54300 |
| 20-#14 | 2.22 | MA | 40221 | 8753 | 65440 | 6471 | 72455 | 5226 | 75868 | 4272 | 80072 | 2854 | 97890 | 2372 | 62049 |
| 4L-8S | | MI | 35419 | 8753 | 57357 | 6469 | 62395 | 5239 | 64137 | 4299 | 64923 | 2848 | 78696 | 2001 | 55384 |
| 20-#14 | 2.22 | MA | 39400 | 8753 | 64029 | 6470 | 70634 | 5223 | 73638 | 4288 | 76890 | 2846 | 93991 | 2308 | 61466 |
| 5L-7S | | MI | 36136 | 8753 | 58602 | 6470 | 64064 | 5222 | 66122 | 4284 | 67774 | 2857 | 82146 | 2075 | 56761 |
| 20-#14 | 2.22 | MA | 38617 | 8753 | 62697 | 6469 | 68825 | 5240 | 71431 | 4283 | 73967 | 2858 | 90275 | 2224 | 60297 |
| 6E | | MI | 36864 | 8753 | 59959 | 6451 | 65718 | 5225 | 68149 | 4269 | 70497 | 2846 | 85800 | 2201 | 57443 |
| 20-#14 | 2.22 | MA | 37854 | 8753 | 61272 | 6488 | 67087 | 5238 | 69301 | 4299 | 71107 | 2870 | 86409 | 2098 | 59555 |
| 7L-5S | | MI | 37609 | 8753 | 61227 | 6452 | 67441 | 5208 | 70250 | 4274 | 73279 | 2835 | 89311 | 2285 | 58523 |
| 20-#14 | 2.22 | MA | 37101 | 8753 | 59964 | 6488 | 65334 | 5255 | 67217 | 4314 | 68112 | 2862 | 82765 | 2023 | 58101 |
| 8L-4S | | MI | 38392 | 8753 | 62570 | 6454 | 69174 | 5211 | 72373 | 4259 | 76308 | 2844 | 93002 | 2348 | 59094 |
| 20-#14 | 2.22 | MA | 36316 | 8753 | 58681 | 6487 | 63621 | 5253 | 65060 | 4310 | 65281 | 2873 | 79165 | 1942 | 56952 |
| 9L-3S | | MI | 39266 | 8753 | 64104 | 6435 | 71124 | 5195 | 74739 | 4264 | 79380 | 2832 | 96538 | 2476 | 59235 |
| 20-#14 | 2.22 | MA | 35487 | 8753 | 57280 | 6506 | 61891 | 5270 | 62988 | 4325 | 62473 | 2885 | 75673 | 1851 | 55234 |
| 10L-2S | | MI | 40510 | 8753 | 66014 | 6436 | 73560 | 5198 | 77700 | 4250 | 83391 | 2821 | 101935 | 2604 | 59300 |
| 20-#18 | 3.95 | MA | 43952 | 9994 | 75535 | 7219 | 85067 | 5795 | 91088 | 4626 | 100481 | 2753 | 125790 | 1826 | 103303 |
| 5L-7S | | MI | 39403 | 9994 | 67528 | 7226 | 75189 | 5798 | 79536 | 4623 | 85868 | 2767 | 106868 | 1413 | 92819 |
| 20-#18 | 3.95 | MA | 42627 | 9994 | 73191 | 7216 | 81883 | 5789 | 87205 | 4616 | 95340 | 2771 | 119359 | 1676 | 100596 |
| 6E | | MI | 40635 | 9994 | 69915 | 7195 | 78098 | 5770 | 83100 | 4598 | 90636 | 2749 | 113186 | 1638 | 95646 |
| 20-#18 | 3.95 | MA | 41334 | 9994 | 70682 | 7248 | 78826 | 5818 | 83459 | 4641 | 90308 | 2789 | 112664 | 1451 | 97549 |
| 7L-5S | | MI | 41898 | 9994 | 72145 | 7199 | 81127 | 5778 | 86794 | 4610 | 95507 | 2731 | 119254 | 1788 | 98245 |
| 20-#18 | 3.95 | MA | 40060 | 9994 | 68381 | 7245 | 75741 | 5811 | 79790 | 4666 | 85038 | 2772 | 106330 | 1322 | 93742 |
| 8L-4S | | MI | 43223 | 9994 | 74507 | 7202 | 84174 | 5750 | 90525 | 4586 | 100808 | 2749 | 125665 | 1897 | 100911 |
| 22-#11 | 1.70 | MA | 40333 | 8374 | 64308 | 6234 | 71121 | 5054 | 74286 | 4167 | 77808 | 2863 | 94468 | 2698 | 48000 |
| 2L-11S | | MI | 33286 | 8374 | 52828 | 6255 | 56713 | 5081 | 57201 | 4198 | 55588 | 2888 | 66398 | 2086 | 42170 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

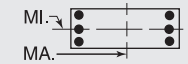



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.70 | MA | 39407 | 8374 | 62904 | 6233 | 69331 | 5053 | 72111 | 4178 | 74861 | 2872 | 90458 | 2609 | 47980 |
| 3L-10S | | MI | 33831 | 8374 | 53679 | 6255 | 57843 | 5083 | 58616 | 4201 | 57548 | 2894 | 68761 | 2141 | 42972 |
| 22-#11 | 1.70 | MA | 38758 | 8374 | 61780 | 6247 | 67902 | 5065 | 70376 | 4175 | 72608 | 2881 | 87826 | 2521 | 47932 |
| 4L-9S | | MI | 34388 | 8374 | 54609 | 6242 | 58992 | 5071 | 59991 | 4190 | 59412 | 2886 | 71081 | 2204 | 43597 |
| 22-#11 | 1.70 | MA | 38178 | 8374 | 60796 | 6247 | 66633 | 5064 | 68821 | 4187 | 70390 | 2876 | 85093 | 2476 | 47837 |
| 5L-8S | | MI | 34912 | 8374 | 55460 | 6243 | 60129 | 5072 | 61422 | 4193 | 61291 | 2877 | 73473 | 2260 | 44292 |
| 22-#11 | 1.70 | MA | 37625 | 8374 | 59869 | 6247 | 65372 | 5076 | 67283 | 4184 | 68352 | 2885 | 82483 | 2418 | 47401 |
| 6L-7S | | MI | 35419 | 8374 | 56328 | 6243 | 61292 | 5060 | 62806 | 4182 | 63279 | 2883 | 75893 | 2312 | 44657 |
| 22-#11 | 1.70 | MA | 37086 | 8374 | 58875 | 6260 | 64161 | 5075 | 65799 | 4195 | 66359 | 2894 | 79767 | 2330 | 46839 |
| 7L-6S | | MI | 35933 | 8374 | 57274 | 6230 | 62445 | 5062 | 64219 | 4172 | 65177 | 2874 | 78461 | 2399 | 45175 |
| 22-#11 | 1.70 | MA | 36555 | 8374 | 57965 | 6260 | 62939 | 5087 | 64346 | 4206 | 64271 | 2889 | 77212 | 2278 | 46440 |
| 8L-5S | | MI | 36459 | 8374 | 58157 | 6230 | 63646 | 5050 | 65684 | 4175 | 67116 | 2866 | 80930 | 2457 | 45592 |
| 22-#11 | 1.70 | MA | 35995 | 8374 | 57071 | 6260 | 61746 | 5086 | 62843 | 4204 | 62299 | 2897 | 74683 | 2222 | 45701 |
| 9L-4S | | MI | 37012 | 8374 | 59094 | 6231 | 64854 | 5052 | 67164 | 4164 | 69228 | 2872 | 83519 | 2502 | 45674 |
| 22-#11 | 1.70 | MA | 35410 | 8374 | 56095 | 6273 | 60540 | 5098 | 61400 | 4215 | 60342 | 2906 | 72229 | 2159 | 45027 |
| 10L-3S | | MI | 37630 | 8374 | 60164 | 6218 | 66215 | 5040 | 68815 | 4167 | 71372 | 2863 | 86007 | 2591 | 45715 |
| 22-#11 | 1.70 | MA | 34838 | 8374 | 55201 | 6273 | 59353 | 5097 | 59914 | 4212 | 58283 | 2901 | 69734 | 2104 | 44174 |
| 11L-2S | | MI | 38509 | 8374 | 61498 | 6218 | 67916 | 5041 | 70883 | 4156 | 74174 | 2855 | 89799 | 2679 | 45727 |
| 22-#14 | 2.45 | MA | 41150 | 8912 | 67450 | 6571 | 75018 | 5298 | 78984 | 4317 | 84293 | 2844 | 103599 | 2351 | 68109 |
| 4L-9S | | MI | 35594 | 8912 | 57950 | 6587 | 63200 | 5308 | 65044 | 4339 | 66239 | 2849 | 80691 | 1898 | 59848 |
| 22-#14 | 2.45 | MA | 40334 | 8912 | 66039 | 6570 | 73197 | 5296 | 76754 | 4332 | 81111 | 2836 | 99700 | 2288 | 67381 |
| 5L-8S | | MI | 36317 | 8912 | 59267 | 6569 | 64831 | 5311 | 67098 | 4344 | 68934 | 2838 | 84093 | 1979 | 60991 |
| 22-#14 | 2.45 | MA | 39556 | 8912 | 64707 | 6569 | 71387 | 5313 | 74546 | 4328 | 78188 | 2848 | 95984 | 2203 | 66254 |
| 6L-7S | | MI | 37030 | 8912 | 60512 | 6570 | 66500 | 5294 | 69083 | 4329 | 71786 | 2847 | 87543 | 2053 | 62411 |
| 22-#14 | 2.45 | MA | 38798 | 8912 | 63282 | 6588 | 69650 | 5310 | 72417 | 4344 | 75328 | 2860 | 92118 | 2077 | 65531 |
| 7L-6S | | MI | 37753 | 8912 | 61869 | 6551 | 68154 | 5297 | 71110 | 4314 | 74508 | 2836 | 91197 | 2179 | 63101 |
| 22-#14 | 2.45 | MA | 38049 | 8912 | 61975 | 6587 | 67897 | 5328 | 70332 | 4359 | 72332 | 2852 | 88474 | 2003 | 64008 |
| 8L-5S | | MI | 38494 | 8912 | 63137 | 6552 | 69877 | 5281 | 73211 | 4319 | 77290 | 2825 | 94708 | 2263 | 64141 |
| 22-#14 | 2.45 | MA | 37279 | 8912 | 60691 | 6587 | 66184 | 5325 | 68175 | 4355 | 69502 | 2863 | 84874 | 1922 | 62801 |
| 9L-4S | | MI | 39272 | 8912 | 64481 | 6553 | 71610 | 5284 | 75334 | 4304 | 80319 | 2834 | 98399 | 2326 | 64854 |
| 22-#14 | 2.45 | MA | 36444 | 8912 | 59290 | 6606 | 64453 | 5342 | 66104 | 4370 | 66693 | 2875 | 81382 | 1830 | 61120 |
| 10L-3S | | MI | 40142 | 8912 | 66014 | 6535 | 73560 | 5267 | 77700 | 4309 | 83391 | 2823 | 101935 | 2454 | 65016 |
| 22-#18 | 4.35 | MA | 44218 | 10278 | 76714 | 7393 | 86376 | 5917 | 92666 | 4695 | 102738 | 2753 | 129250 | 1634 | 110836 |
| 6L-7S | | MI | 40920 | 10278 | 70874 | 7404 | 79456 | 5927 | 84722 | 4702 | 92875 | 2748 | 116206 | 1368 | 102619 |
| 22-#18 | 4.35 | MA | 42937 | 10278 | 74206 | 7426 | 83319 | 5946 | 88920 | 4721 | 97707 | 2771 | 122556 | 1409 | 107883 |
| 7L-6S | | MI | 42141 | 10278 | 73261 | 7372 | 82365 | 5899 | 88287 | 4678 | 97643 | 2730 | 122524 | 1593 | 105355 |
| 22-#18 | 4.35 | MA | 41674 | 10278 | 71905 | 7423 | 80233 | 5940 | 85251 | 4746 | 92437 | 2754 | 116222 | 1280 | 103981 |
| 8L-5S | | MI | 43393 | 10278 | 75491 | 7376 | 85394 | 5906 | 91981 | 4690 | 102514 | 2713 | 128591 | 1743 | 108114 |
| 24-#11 | 1.85 | MA | 40063 | 8485 | 64308 | 6303 | 71121 | 5103 | 74286 | 4209 | 77808 | 2865 | 94468 | 2596 | 52240 |
| 3L-11S | | MI | 33926 | 8485 | 54162 | 6324 | 58414 | 5131 | 59269 | 4229 | 58390 | 2881 | 70191 | 2072 | 46080 |
| 24-#11 | 1.85 | MA | 39417 | 8485 | 63184 | 6316 | 69691 | 5115 | 72551 | 4207 | 75555 | 2874 | 91836 | 2508 | 52180 |
| 4L-10S | | MI | 34469 | 8485 | 55013 | 6325 | 59545 | 5133 | 60684 | 4232 | 60350 | 2887 | 72554 | 2126 | 46917 |
| 24-#11 | 1.85 | MA | 38839 | 8485 | 62200 | 6316 | 68422 | 5114 | 70997 | 4218 | 73337 | 2869 | 89103 | 2463 | 52073 |
| 5L-9S | | MI | 35024 | 8485 | 55943 | 6311 | 60693 | 5121 | 62059 | 4221 | 62214 | 2879 | 74874 | 2190 | 47527 |
| 24-#11 | 1.85 | MA | 38289 | 8485 | 61272 | 6316 | 67161 | 5126 | 69458 | 4215 | 71299 | 2878 | 86492 | 2405 | 51560 |
| 6L-8S | | MI | 35546 | 8485 | 56795 | 6312 | 61830 | 5122 | 63490 | 4224 | 64092 | 2870 | 77266 | 2246 | 48269 |
| 24-#11 | 1.85 | MA | 37753 | 8485 | 60279 | 6329 | 65950 | 5125 | 67974 | 4226 | 69306 | 2887 | 83776 | 2317 | 51016 |
| 7E | | MI | 36050 | 8485 | 57662 | 6312 | 62993 | 5110 | 64874 | 4214 | 66080 | 2876 | 79685 | 2298 | 48627 |
| 24-#11 | 1.85 | MA | 37224 | 8485 | 59368 | 6329 | 64729 | 5137 | 66522 | 4238 | 67218 | 2882 | 81222 | 2265 | 50625 |
| 8L-6S | | MI | 36562 | 8485 | 58608 | 6299 | 64146 | 5112 | 66287 | 4203 | 67978 | 2868 | 82254 | 2385 | 49129 |
| 24-#11 | 1.85 | MA | 36667 | 8485 | 58474 | 6329 | 63535 | 5136 | 65018 | 4235 | 65246 | 2890 | 78692 | 2209 | 49839 |
| 9L-5S | | MI | 37086 | 8485 | 59492 | 6300 | 65347 | 5100 | 67752 | 4206 | 69918 | 2859 | 84723 | 2443 | 49620 |
| 24-#11 | 1.85 | MA | 36084 | 8485 | 57498 | 6342 | 62329 | 5148 | 63575 | 4246 | 63289 | 2899 | 76238 | 2146 | 49180 |
| 10L-4S | | MI | 37636 | 8485 | 60428 | 6300 | 66556 | 5102 | 69232 | 4195 | 72030 | 2865 | 87312 | 2488 | 49714 |
| 24-#11 | 1.85 | MA | 35514 | 8485 | 56604 | 6342 | 61143 | 5147 | 62089 | 4243 | 61230 | 2894 | 73744 | 2091 | 48292 |
| 11L-3S | | MI | 38252 | 8485 | 61498 | 6287 | 67916 | 5090 | 70883 | 4198 | 74174 | 2856 | 89799 | 2577 | 49766 |
| 24-#11 | 1.85 | MA | 34954 | 8485 | 55643 | 6356 | 59945 | 5159 | 60649 | 4255 | 59275 | 2903 | 71000 | 2016 | 47451 |
| 12L-2S | | MI | 39128 | 8485 | 62832 | 6287 | 69617 | 5092 | 72951 | 4187 | 76975 | 2848 | 93592 | 2665 | 49788 |
| 24-#14 | 2.67 | MA | 41263 | 9072 | 68049 | 6670 | 75760 | 5368 | 79869 | 4377 | 85332 | 2826 | 105410 | 2267 | 73305 |
| 5L-9S | | MI | 36488 | 9072 | 59860 | 6687 | 65636 | 5380 | 68005 | 4384 | 70251 | 2839 | 86089 | 1876 | 65404 |

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#14 | 2.67 | MA | 40490 | 9072 | 66717 | 6669 | 73950 | 5385 | 77662 | 4373 | 82409 | 2838 | 101693 | 2183 | 72217 |
| 6L-8S | | MI | 37209 | 9072 | 61178 | 6668 | 67267 | 5383 | 70059 | 4389 | 72945 | 2828 | 89490 | 1957 | 66605 |
| 24-#14 | 2.67 | MA | 39735 | 9072 | 65292 | 6688 | 72213 | 5383 | 75532 | 4388 | 79549 | 2850 | 97827 | 2057 | 71408 |
| 7E | | MI | 37918 | 9072 | 62422 | 6669 | 68936 | 5367 | 72043 | 4374 | 75797 | 2837 | 92940 | 2031 | 67986 |
| 24-#14 | 2.67 | MA | 38992 | 9072 | 63985 | 6687 | 70460 | 5400 | 73448 | 4404 | 76553 | 2842 | 94184 | 1982 | 69921 |
| 8L-6S | | MI | 38637 | 9072 | 63780 | 6651 | 70590 | 5370 | 74071 | 4359 | 78520 | 2826 | 96594 | 2157 | 68766 |
| 24-#14 | 2.67 | MA | 38222 | 9072 | 62702 | 6686 | 68747 | 5397 | 71291 | 4400 | 73723 | 2854 | 90584 | 1901 | 68657 |
| 9L-5S | | MI | 39374 | 9072 | 65047 | 6652 | 72312 | 5353 | 76172 | 4364 | 81302 | 2815 | 100105 | 2241 | 69769 |
| 24-#14 | 2.67 | MA | 37395 | 9072 | 61301 | 6705 | 67016 | 5415 | 69219 | 4415 | 70914 | 2865 | 87092 | 1810 | 67012 |
| 10L-4S | | MI | 40147 | 9072 | 66391 | 6653 | 74046 | 5356 | 78294 | 4349 | 84330 | 2824 | 103797 | 2304 | 70611 |
| 24-#18 | 4.74 | MA | 44527 | 10561 | 77730 | 7603 | 87811 | 6075 | 94381 | 4801 | 105105 | 2754 | 132447 | 1367 | 118231 |
| 7E | | MI | 42425 | 10561 | 74220 | 7581 | 83722 | 6055 | 89908 | 4782 | 99882 | 2729 | 125543 | 1322 | 112432 |
| 24-#18 | 4.74 | MA | 43275 | 10561 | 75428 | 7600 | 84726 | 6068 | 90712 | 4826 | 99835 | 2736 | 126113 | 1237 | 114234 |
| 8L-6S | | MI | 43637 | 10561 | 76607 | 7550 | 86631 | 6027 | 93473 | 4758 | 104649 | 2712 | 131861 | 1548 | 115083 |

## RECTANGULAR TIED COLUMNS 44" x 48"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.14 | MA | 41178 | 8319 | 64517 | 6204 | 70165 | 5052 | 71945 | 4203 | 72565 | 2993 | 85917 | 2827 | 35065 |
| 2L-3S | | MI | 35409 | 8319 | 55823 | 6165 | 59873 | 5051 | 60463 | 4202 | 59013 | 2988 | 68481 | 2563 | 32007 |
| 6-#18 | 1.14 | MA | 38708 | 8319 | 60817 | 6202 | 65447 | 5082 | 66209 | 4230 | 64794 | 3013 | 75471 | 2599 | 35126 |
| 3L-2S | | MI | 37638 | 8319 | 59170 | 6168 | 64139 | 5023 | 65650 | 4178 | 66019 | 2971 | 77819 | 2791 | 31918 |
| 8-#18 | 1.52 | MA | 42910 | 8603 | 68218 | 6382 | 74884 | 5181 | 77681 | 4283 | 80336 | 2976 | 96363 | 2787 | 46383 |
| 2L-4S | | MI | 35416 | 8603 | 56477 | 6373 | 60715 | 5172 | 61494 | 4271 | 60644 | 2987 | 71716 | 2291 | 41920 |
| 8-#18 | 1.52 | MA | 40462 | 8603 | 64517 | 6379 | 70165 | 5211 | 71945 | 4309 | 72565 | 2995 | 85917 | 2560 | 46355 |
| 3E | | MI | 36982 | 8603 | 59170 | 6342 | 64139 | 5179 | 65650 | 4282 | 66019 | 2970 | 77819 | 2518 | 42179 |
| 8-#18 | 1.52 | MA | 38735 | 8603 | 61547 | 6412 | 66387 | 5205 | 67359 | 4300 | 66611 | 3015 | 79074 | 2332 | 46002 |
| 4L-2S | | MI | 39191 | 8603 | 62516 | 6346 | 68406 | 5151 | 70836 | 4258 | 73026 | 2952 | 87156 | 2746 | 42169 |
| 10-#14 | 1.07 | MA | 40963 | 8266 | 63777 | 6207 | 69458 | 5058 | 71176 | 4213 | 71562 | 3016 | 84928 | 2868 | 33169 |
| 2L-5S | | MI | 34469 | 8266 | 53714 | 6190 | 57402 | 5041 | 57537 | 4215 | 55104 | 3012 | 64410 | 2518 | 30187 |
| 10-#14 | 1.07 | MA | 39550 | 8266 | 61667 | 6206 | 66768 | 5055 | 67906 | 4229 | 67132 | 3028 | 78907 | 2740 | 33211 |
| 3L-4S | | MI | 35277 | 8266 | 55058 | 6191 | 59135 | 5044 | 59659 | 4200 | 58133 | 3020 | 68102 | 2581 | 30273 |
| 10-#14 | 1.07 | MA | 38556 | 8266 | 59977 | 6226 | 64619 | 5073 | 65297 | 4225 | 63745 | 3041 | 74954 | 2612 | 33195 |
| 4L-3S | | MI | 36178 | 8266 | 56591 | 6173 | 61085 | 5027 | 62026 | 4205 | 61205 | 3009 | 71638 | 2709 | 30261 |
| 10-#14 | 1.07 | MA | 37667 | 8266 | 58498 | 6225 | 62710 | 5071 | 62960 | 4241 | 60409 | 3033 | 70848 | 2548 | 33062 |
| 5L-2S | | MI | 37456 | 8266 | 58502 | 6174 | 63521 | 5031 | 64987 | 4190 | 65217 | 2998 | 77035 | 2837 | 30210 |
| 10-#18 | 1.89 | MA | 44622 | 8887 | 71919 | 6559 | 79602 | 5309 | 83416 | 4363 | 88107 | 2958 | 106809 | 2748 | 57668 |
| 2L-5S | | MI | 35596 | 8887 | 57461 | 6547 | 61935 | 5328 | 62950 | 4375 | 62349 | 2951 | 74642 | 2136 | 49507 |
| 10-#18 | 1.89 | MA | 42195 | 8887 | 68218 | 6557 | 74884 | 5339 | 77681 | 4389 | 80336 | 2977 | 96363 | 2520 | 57554 |
| 3L-4S | | MI | 36986 | 8887 | 59823 | 6551 | 64982 | 5300 | 66681 | 4351 | 67650 | 2969 | 81053 | 2245 | 51965 |
| 10-#18 | 1.89 | MA | 40485 | 8887 | 65247 | 6590 | 71106 | 5333 | 73095 | 4380 | 74382 | 2997 | 89520 | 2293 | 57108 |
| 4L-3S | | MI | 38536 | 8887 | 62516 | 6519 | 68406 | 5308 | 70836 | 4362 | 73026 | 2951 | 87156 | 2473 | 52316 |
| 10-#18 | 1.89 | MA | 38954 | 8887 | 62644 | 6588 | 67747 | 5363 | 68982 | 4406 | 68514 | 2981 | 82374 | 2181 | 54340 |
| 5L-2S | | MI | 40728 | 8887 | 65862 | 6523 | 72672 | 5280 | 76022 | 4338 | 80032 | 2933 | 96494 | 2701 | 52386 |
| 12-#14 | 1.28 | MA | 41963 | 8426 | 65887 | 6306 | 72148 | 5130 | 74446 | 4258 | 75992 | 3006 | 90950 | 2849 | 39621 |
| 2L-6S | | MI | 34618 | 8426 | 54357 | 6289 | 58115 | 5130 | 58396 | 4255 | 56333 | 3013 | 66296 | 2412 | 35092 |
| 12-#14 | 1.28 | MA | 40557 | 8426 | 63777 | 6306 | 69458 | 5128 | 71176 | 4274 | 71562 | 3018 | 84928 | 2721 | 39641 |
| 3L-5S | | MI | 35384 | 8426 | 55625 | 6290 | 59838 | 5114 | 60498 | 4260 | 59115 | 3002 | 69807 | 2496 | 35947 |
| 12-#14 | 1.28 | MA | 39570 | 8426 | 62087 | 6325 | 67309 | 5145 | 68567 | 4270 | 68175 | 3031 | 80976 | 2593 | 39588 |
| 4E | | MI | 36187 | 8426 | 56968 | 6291 | 61571 | 5117 | 62620 | 4245 | 62144 | 3010 | 73499 | 2559 | 36070 |
| 12-#14 | 1.28 | MA | 38686 | 8426 | 60607 | 6325 | 65400 | 5143 | 66230 | 4286 | 64839 | 3023 | 76870 | 2529 | 39417 |
| 5L-3S | | MI | 37083 | 8426 | 58502 | 6272 | 63521 | 5100 | 64987 | 4250 | 65217 | 2999 | 77035 | 2687 | 36094 |
| 12-#14 | 1.28 | MA | 37844 | 8426 | 59212 | 6325 | 63504 | 5161 | 63916 | 4282 | 61776 | 3036 | 72949 | 2445 | 38428 |
| 6L-2S | | MI | 38354 | 8426 | 60412 | 6274 | 65957 | 5103 | 67948 | 4235 | 69228 | 2988 | 82432 | 2815 | 36060 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

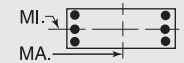
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 2.27 | MA | 46316 | 9170 | 75620 | 6736 | 84321 | 5438 | 89152 | 4443 | 95878 | 2940 | 117255 | 2708 | 68916 |
| 2L-6S | | MI | 35848 | 9170 | 58576 | 6720 | 63172 | 5449 | 64442 | 4443 | 64485 | 2950 | 77912 | 1941 | 57517 |
| 12-#18 | 2.27 | MA | 43909 | 9170 | 71919 | 6734 | 79602 | 5468 | 83416 | 4469 | 88107 | 2960 | 106809 | 2481 | 68735 |
| 3L-5S | | MI | 37162 | 9170 | 60807 | 6724 | 66201 | 5457 | 68136 | 4455 | 69356 | 2932 | 83979 | 2091 | 59267 |
| 12-#18 | 2.27 | MA | 42216 | 9170 | 68948 | 6767 | 75824 | 5462 | 78831 | 4460 | 82153 | 2979 | 99966 | 2253 | 68207 |
| 4E | | MI | 38539 | 9170 | 63169 | 6728 | 69248 | 5429 | 71867 | 4430 | 74657 | 2950 | 90391 | 2200 | 62001 |
| 12-#18 | 2.27 | MA | 40700 | 9170 | 66344 | 6765 | 72466 | 5492 | 74718 | 4486 | 76285 | 2963 | 92820 | 2141 | 65162 |
| 5L-3S | | MI | 40075 | 9170 | 65862 | 6696 | 72672 | 5436 | 76022 | 4442 | 80032 | 2932 | 96494 | 2428 | 62431 |
| 12-#18 | 2.27 | MA | 39255 | 9170 | 63887 | 6763 | 69127 | 5486 | 70646 | 4477 | 70894 | 2983 | 86024 | 1991 | 63128 |
| 6L-2S | | MI | 42249 | 9170 | 69208 | 6700 | 76938 | 5408 | 81208 | 4418 | 87039 | 2915 | 105831 | 2655 | 62569 |
| 14-#11 | 1.03 | MA | 40871 | 8243 | 63439 | 6210 | 69148 | 5062 | 70845 | 4219 | 71135 | 3027 | 84522 | 2888 | 32337 |
| 2L-7S | | MI | 34230 | 8243 | 53026 | 6204 | 56627 | 5055 | 56626 | 4224 | 53957 | 3038 | 62812 | 2491 | 28959 |
| 14-#11 | 1.03 | MA | 39883 | 8243 | 61967 | 6210 | 67271 | 5060 | 68563 | 4231 | 68043 | 3036 | 80296 | 2799 | 32366 |
| 3L-6S | | MI | 34754 | 8243 | 53972 | 6191 | 57779 | 5057 | 58039 | 4213 | 55855 | 3029 | 65381 | 2579 | 29442 |
| 14-#11 | 1.03 | MA | 39190 | 8243 | 60789 | 6224 | 65772 | 5073 | 66745 | 4228 | 65681 | 3045 | 77520 | 2711 | 32376 |
| 4L-5S | | MI | 35291 | 8243 | 54856 | 6191 | 58980 | 5045 | 59504 | 4216 | 57795 | 3021 | 67849 | 2637 | 29505 |
| 14-#11 | 1.03 | MA | 38570 | 8243 | 59758 | 6224 | 64442 | 5072 | 65115 | 4240 | 63356 | 3041 | 74643 | 2665 | 32342 |
| 5L-4S | | MI | 35855 | 8243 | 55792 | 6192 | 60189 | 5046 | 60984 | 4205 | 59907 | 3027 | 70439 | 2681 | 29517 |
| 14-#11 | 1.03 | MA | 37980 | 8243 | 58786 | 6224 | 63121 | 5085 | 63503 | 4238 | 61221 | 3050 | 71890 | 2607 | 32246 |
| 6L-3S | | MI | 36484 | 8243 | 56862 | 6178 | 61549 | 5034 | 62635 | 4208 | 62050 | 3018 | 72926 | 2770 | 29494 |
| 14-#11 | 1.03 | MA | 37404 | 8243 | 57745 | 6238 | 61853 | 5084 | 61949 | 4249 | 59133 | 3059 | 69027 | 2520 | 31678 |
| 7L-2S | | MI | 37378 | 8243 | 58196 | 6179 | 63250 | 5036 | 64703 | 4197 | 64852 | 3010 | 76719 | 2859 | 29460 |
| 14-#14 | 1.49 | MA | 42956 | 8585 | 67997 | 6406 | 74838 | 5202 | 77716 | 4303 | 80422 | 2996 | 96971 | 2830 | 46061 |
| 2L-7S | | MI | 34789 | 8585 | 54910 | 6407 | 58897 | 5200 | 59330 | 4315 | 57622 | 3014 | 68039 | 2263 | 39956 |
| 14-#14 | 1.49 | MA | 41557 | 8585 | 65887 | 6406 | 72148 | 5200 | 74446 | 4319 | 75992 | 3008 | 90950 | 2702 | 46054 |
| 3L-6S | | MI | 35532 | 8585 | 56267 | 6389 | 60551 | 5203 | 61357 | 4300 | 60345 | 3003 | 71693 | 2390 | 40713 |
| 14-#14 | 1.49 | MA | 40576 | 8585 | 64197 | 6425 | 69999 | 5218 | 71837 | 4315 | 72605 | 3021 | 86997 | 2574 | 45971 |
| 4L-5S | | MI | 36293 | 8585 | 57535 | 6390 | 62273 | 5186 | 63458 | 4305 | 63127 | 2992 | 75205 | 2474 | 41701 |
| 14-#14 | 1.49 | MA | 39698 | 8585 | 62717 | 6425 | 68090 | 5216 | 69500 | 4331 | 69269 | 3014 | 82892 | 2510 | 45767 |
| 5L-4S | | MI | 37091 | 8585 | 58879 | 6391 | 64007 | 5189 | 65581 | 4290 | 66155 | 3000 | 78896 | 2537 | 41856 |
| 14-#14 | 1.49 | MA | 38861 | 8585 | 61322 | 6424 | 66194 | 5233 | 67186 | 4327 | 66206 | 3026 | 78971 | 2426 | 44645 |
| 6L-3S | | MI | 37982 | 8585 | 60412 | 6372 | 65957 | 5172 | 67948 | 4295 | 69228 | 2989 | 82432 | 2665 | 41911 |
| 14-#14 | 1.49 | MA | 38044 | 8585 | 59828 | 6444 | 64373 | 5231 | 64955 | 4343 | 63208 | 3039 | 74892 | 2299 | 43762 |
| 7L-2S | | MI | 39247 | 8585 | 62322 | 6373 | 68392 | 5175 | 70908 | 4280 | 73239 | 2978 | 87829 | 2793 | 41899 |
| 14-#18 | 2.65 | MA | 47994 | 9454 | 79321 | 6914 | 89039 | 5567 | 94888 | 4523 | 103648 | 2922 | 127701 | 2669 | 80145 |
| 2L-7S | | MI | 36140 | 9454 | 59536 | 6929 | 64530 | 5605 | 66064 | 4547 | 66724 | 2949 | 80931 | 1670 | 64013 |
| 14-#18 | 2.65 | MA | 45606 | 9454 | 75620 | 6911 | 84321 | 5596 | 89152 | 4549 | 95878 | 2942 | 117255 | 2441 | 79903 |
| 3L-6S | | MI | 37411 | 9454 | 61923 | 6898 | 67439 | 5578 | 69629 | 4523 | 71491 | 2931 | 87249 | 1896 | 67216 |
| 14-#18 | 2.65 | MA | 43929 | 9454 | 72649 | 6944 | 80543 | 5591 | 84567 | 4540 | 89924 | 2961 | 110412 | 2214 | 79302 |
| 4L-5S | | MI | 38712 | 9454 | 64153 | 6902 | 70468 | 5585 | 73323 | 4534 | 76362 | 2914 | 93317 | 2046 | 69056 |
| 14-#18 | 2.65 | MA | 42428 | 9454 | 70045 | 6942 | 77184 | 5620 | 80454 | 4566 | 84056 | 2946 | 103265 | 2102 | 76013 |
| 5L-4S | | MI | 40077 | 9454 | 66516 | 6905 | 73514 | 5557 | 77053 | 4510 | 81664 | 2931 | 99728 | 2155 | 72031 |
| 14-#18 | 2.65 | MA | 40997 | 9454 | 67588 | 6940 | 73846 | 5615 | 76382 | 4557 | 78665 | 2965 | 96470 | 1952 | 73972 |
| 6L-3S | | MI | 41599 | 9454 | 69208 | 6874 | 76938 | 5565 | 81208 | 4521 | 87039 | 2914 | 105831 | 2383 | 72532 |
| 14-#18 | 2.65 | MA | 39600 | 9454 | 64958 | 6973 | 70641 | 5644 | 72454 | 4583 | 73389 | 2985 | 89399 | 1727 | 70306 |
| 7L-2S | | MI | 43756 | 9454 | 72555 | 6878 | 81204 | 5537 | 86395 | 4497 | 94046 | 2896 | 115169 | 2610 | 72727 |
| 16-#11 | 1.18 | MA | 41573 | 8353 | 64912 | 6279 | 71026 | 5112 | 73128 | 4250 | 74227 | 3020 | 88748 | 2876 | 36840 |
| 2L-8S | | MI | 34361 | 8353 | 53493 | 6273 | 57164 | 5117 | 57311 | 4266 | 54770 | 3025 | 64185 | 2425 | 32517 |
| 16-#11 | 1.18 | MA | 40589 | 8353 | 63439 | 6279 | 69148 | 5111 | 70845 | 4262 | 71135 | 3029 | 84522 | 2787 | 36859 |
| 3L-7S | | MI | 34875 | 8353 | 54360 | 6273 | 58328 | 5105 | 58694 | 4255 | 56759 | 3031 | 66605 | 2477 | 32912 |
| 16-#11 | 1.18 | MA | 39899 | 8353 | 62261 | 6293 | 67650 | 5123 | 69027 | 4259 | 68774 | 3038 | 81746 | 2698 | 36851 |
| 4L-6S | | MI | 35397 | 8353 | 55306 | 6260 | 59481 | 5107 | 60107 | 4244 | 58657 | 3023 | 69173 | 2564 | 33469 |
| 16-#11 | 1.18 | MA | 39282 | 8353 | 61230 | 6293 | 66320 | 5122 | 67398 | 4271 | 66448 | 3034 | 78869 | 2653 | 36800 |
| 5E | | MI | 35931 | 8353 | 56190 | 6260 | 60682 | 5095 | 61572 | 4247 | 60596 | 3014 | 71642 | 2623 | 33550 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.18 | MA | 38694 | 8353 | 60258 | 6293 | 64998 | 5135 | 65786 | 4269 | 64314 | 3043 | 76116 | 2595 | 36687 |
| 6L-4S | | MI | 36492 | 8353 | 57127 | 6261 | 61890 | 5096 | 63052 | 4236 | 62708 | 3020 | 74231 | 2667 | 33581 |
| 16-#11 | 1.18 | MA | 38121 | 8353 | 59218 | 6307 | 63730 | 5134 | 64231 | 4280 | 62225 | 3052 | 73253 | 2508 | 36044 |
| 7L-3S | | MI | 37119 | 8353 | 58196 | 6247 | 63250 | 5084 | 64703 | 4239 | 64852 | 3011 | 76719 | 2756 | 33571 |
| 16-#11 | 1.18 | MA | 37548 | 8353 | 58264 | 6307 | 62450 | 5146 | 62709 | 4292 | 60037 | 3048 | 70564 | 2455 | 35579 |
| 8L-2S | | MI | 38009 | 8353 | 59531 | 6248 | 64952 | 5086 | 66771 | 4228 | 67654 | 3003 | 80512 | 2845 | 33545 |
| 16-#14 | 1.70 | MA | 43942 | 8745 | 70106 | 6506 | 77528 | 5274 | 80986 | 4348 | 84852 | 2986 | 102993 | 2811 | 52492 |
| 2L-8S | | MI | 34974 | 8745 | 55576 | 6506 | 59663 | 5289 | 60306 | 4375 | 58782 | 2995 | 69987 | 2168 | 44517 |
| 16-#14 | 1.70 | MA | 42551 | 8745 | 67997 | 6505 | 74838 | 5272 | 77716 | 4364 | 80422 | 2998 | 96971 | 2683 | 52457 |
| 3L-7S | | MI | 35702 | 8745 | 56820 | 6507 | 61332 | 5272 | 62291 | 4360 | 61633 | 3004 | 73437 | 2241 | 45617 |
| 16-#14 | 1.70 | MA | 41575 | 8745 | 66307 | 6525 | 72689 | 5290 | 75107 | 4360 | 77036 | 3011 | 93019 | 2555 | 52348 |
| 4L-6S | | MI | 36440 | 8745 | 58177 | 6488 | 62986 | 5275 | 64318 | 4345 | 64356 | 2993 | 77091 | 2368 | 46345 |
| 16-#14 | 1.70 | MA | 40702 | 8745 | 64827 | 6525 | 70780 | 5288 | 72770 | 4376 | 73699 | 3004 | 88913 | 2491 | 52114 |
| 5E | | MI | 37196 | 8745 | 59445 | 6489 | 64709 | 5258 | 66419 | 4350 | 67138 | 2982 | 80602 | 2452 | 47451 |
| 16-#14 | 1.70 | MA | 39871 | 8745 | 63432 | 6524 | 68884 | 5306 | 70456 | 4372 | 70636 | 3016 | 84992 | 2407 | 50874 |
| 6L-4S | | MI | 37989 | 8745 | 60789 | 6491 | 66442 | 5261 | 68542 | 4335 | 70167 | 2990 | 84293 | 2515 | 47634 |
| 16-#14 | 1.70 | MA | 39060 | 8745 | 61938 | 6544 | 67063 | 5304 | 68225 | 4388 | 67639 | 3029 | 80914 | 2280 | 50021 |
| 7L-3S | | MI | 38875 | 8745 | 62322 | 6472 | 68392 | 5244 | 70908 | 4340 | 73239 | 2979 | 87829 | 2643 | 47714 |
| 16-#14 | 1.70 | MA | 38260 | 8745 | 60569 | 6543 | 65226 | 5321 | 66040 | 4404 | 64499 | 3021 | 77076 | 2205 | 48776 |
| 8L-2S | | MI | 40134 | 8745 | 64233 | 6473 | 70828 | 5248 | 73869 | 4325 | 77251 | 2968 | 93226 | 2771 | 47728 |
| 16-#18 | 3.03 | MA | 47288 | 9738 | 79321 | 7089 | 89039 | 5725 | 94888 | 4629 | 103648 | 2924 | 127701 | 2402 | 91061 |
| 3L-7S | | MI | 37700 | 9738 | 62882 | 7107 | 68796 | 5734 | 71250 | 4627 | 73730 | 2930 | 90269 | 1625 | 73756 |
| 16-#18 | 3.03 | MA | 45626 | 9738 | 76350 | 7122 | 85261 | 5719 | 90303 | 4620 | 97695 | 2944 | 120858 | 2174 | 90363 |
| 4L-6S | | MI | 38958 | 9738 | 65269 | 7075 | 71705 | 5706 | 74815 | 4603 | 78498 | 2913 | 96587 | 1850 | 76847 |
| 16-#18 | 3.03 | MA | 44139 | 9738 | 73746 | 7119 | 81903 | 5749 | 86190 | 4646 | 91827 | 2928 | 113711 | 2062 | 86888 |
| 5E | | MI | 40248 | 9738 | 67499 | 7079 | 74734 | 5714 | 78509 | 4614 | 83369 | 2895 | 102654 | 2001 | 78870 |
| 16-#18 | 3.03 | MA | 42721 | 9738 | 71289 | 7117 | 78564 | 5743 | 82118 | 4637 | 86436 | 2947 | 106916 | 1912 | 84669 |
| 6L-4S | | MI | 41600 | 9738 | 69862 | 7083 | 77781 | 5686 | 82239 | 4590 | 88670 | 2913 | 109066 | 2110 | 81863 |
| 16-#18 | 3.03 | MA | 41338 | 9738 | 68659 | 7150 | 75359 | 5773 | 78190 | 4663 | 81160 | 2967 | 99845 | 1688 | 81119 |
| 7L-3S | | MI | 43110 | 9738 | 72555 | 7051 | 81204 | 5693 | 86395 | 4601 | 94046 | 2895 | 115169 | 2337 | 82621 |
| 16-#18 | 3.03 | MA | 39974 | 9738 | 66247 | 7148 | 72125 | 5767 | 74344 | 4689 | 75634 | 2951 | 93166 | 1557 | 77526 |
| 8L-2S | | MI | 45251 | 9738 | 75901 | 7055 | 85471 | 5666 | 91581 | 4577 | 101052 | 2877 | 124506 | 2565 | 82871 |
| 18-#11 | 1.33 | MA | 42272 | 8464 | 66385 | 6348 | 72903 | 5162 | 75410 | 4281 | 77319 | 3013 | 92974 | 2864 | 41336 |
| 2L-9S | | MI | 34475 | 8464 | 53976 | 6341 | 57729 | 5165 | 57947 | 4294 | 55694 | 3027 | 65586 | 2355 | 35985 |
| 18-#11 | 1.33 | MA | 41291 | 8464 | 64912 | 6348 | 71026 | 5161 | 73128 | 4293 | 74227 | 3022 | 88748 | 2775 | 41348 |
| 3L-8S | | MI | 35005 | 8464 | 54827 | 6342 | 58866 | 5167 | 59379 | 4297 | 57572 | 3018 | 67978 | 2411 | 36487 |
| 18-#11 | 1.33 | MA | 40604 | 8464 | 63734 | 6362 | 69527 | 5173 | 71309 | 4291 | 71866 | 3031 | 85972 | 2686 | 41321 |
| 4L-7S | | MI | 35517 | 8464 | 55695 | 6342 | 60029 | 5155 | 60762 | 4286 | 59560 | 3024 | 70398 | 2463 | 36870 |
| 18-#11 | 1.33 | MA | 39990 | 8464 | 62703 | 6362 | 68197 | 5172 | 69680 | 4302 | 69540 | 3027 | 83095 | 2641 | 41255 |
| 5L-6S | | MI | 36036 | 8464 | 56641 | 6329 | 61182 | 5157 | 62175 | 4275 | 61458 | 3016 | 72966 | 2550 | 37439 |
| 18-#11 | 1.33 | MA | 39405 | 8464 | 61731 | 6362 | 66876 | 5185 | 68068 | 4300 | 67406 | 3036 | 80342 | 2583 | 41077 |
| 6L-5S | | MI | 36568 | 8464 | 57524 | 6329 | 62383 | 5145 | 63640 | 4278 | 63398 | 3007 | 75435 | 2609 | 37591 |
| 18-#11 | 1.33 | MA | 38834 | 8464 | 60690 | 6376 | 65608 | 5184 | 66513 | 4311 | 65317 | 3045 | 77479 | 2495 | 40415 |
| 7L-4S | | MI | 37127 | 8464 | 58461 | 6330 | 63591 | 5147 | 65120 | 4267 | 65510 | 3013 | 78024 | 2653 | 37636 |
| 18-#11 | 1.33 | MA | 38266 | 8464 | 59736 | 6376 | 64328 | 5196 | 64991 | 4323 | 63129 | 3041 | 74790 | 2443 | 39963 |
| 8L-3S | | MI | 37751 | 8464 | 59531 | 6317 | 64952 | 5135 | 66771 | 4270 | 67654 | 3005 | 80512 | 2742 | 37643 |
| 18-#11 | 1.33 | MA | 37671 | 8464 | 58800 | 6376 | 63077 | 5195 | 63417 | 4321 | 61063 | 3050 | 72123 | 2387 | 39380 |
| 9L-2S | | MI | 38638 | 8464 | 60865 | 6317 | 66653 | 5136 | 68839 | 4260 | 70455 | 2996 | 84304 | 2831 | 37625 |
| 18-#14 | 1.92 | MA | 44922 | 8904 | 72216 | 6606 | 80218 | 5347 | 84256 | 4393 | 89283 | 2976 | 109015 | 2792 | 58909 |
| 2L-9S | | MI | 35144 | 8904 | 56169 | 6624 | 60468 | 5358 | 61214 | 4415 | 60099 | 2996 | 71982 | 2065 | 49014 |
| 18-#14 | 1.92 | MA | 43538 | 8904 | 70106 | 6605 | 77528 | 5345 | 80986 | 4409 | 84852 | 2988 | 102993 | 2664 | 58853 |
| 3L-8S | | MI | 35884 | 8904 | 57486 | 6606 | 62099 | 5361 | 63267 | 4420 | 62793 | 2985 | 75384 | 2146 | 50103 |
| 18-#14 | 1.92 | MA | 42567 | 8904 | 68417 | 6625 | 75379 | 5362 | 78377 | 4405 | 81466 | 3001 | 99041 | 2536 | 58719 |
| 4L-7S | | MI | 36608 | 8904 | 58731 | 6607 | 63768 | 5344 | 65252 | 4405 | 65645 | 2994 | 78834 | 2219 | 51284 |
| 18-#14 | 1.92 | MA | 41700 | 8904 | 66937 | 6624 | 73470 | 5360 | 76040 | 4421 | 78130 | 2994 | 94935 | 2471 | 58449 |
| 5L-6S | | MI | 37341 | 8904 | 60088 | 6588 | 65422 | 5347 | 67279 | 4390 | 68367 | 2983 | 82488 | 2346 | 51988 |
| 18-#14 | 1.92 | MA | 40874 | 8904 | 65542 | 6624 | 71574 | 5378 | 73726 | 4417 | 75066 | 3006 | 91014 | 2387 | 57114 |
| 6L-5S | | MI | 38093 | 8904 | 61356 | 6589 | 67145 | 5330 | 69380 | 4395 | 71149 | 2972 | 85999 | 2430 | 53138 |
| 18-#14 | 1.92 | MA | 40068 | 8904 | 64048 | 6643 | 69753 | 5376 | 71495 | 4433 | 72069 | 3019 | 86935 | 2261 | 56287 |
| 7L-4S | | MI | 38882 | 8904 | 62700 | 6590 | 68878 | 5334 | 71503 | 4380 | 74178 | 2981 | 89690 | 2493 | 53406 |

## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

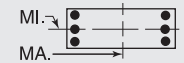
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 1.92 | MA | 39273 | 8904 | 62679 | 6643 | 67916 | 5394 | 69310 | 4449 | 68929 | 3011 | 83098 | 2186 | 54962 |
| 8L-3S | | MI | 39763 | 8904 | 64233 | 6572 | 70828 | 5317 | 73869 | 4385 | 77251 | 2969 | 93226 | 2621 | 53510 |
| 18-#14 | 1.92 | MA | 38431 | 8904 | 61334 | 6642 | 66121 | 5391 | 67050 | 4445 | 65963 | 3024 | 79299 | 2105 | 53709 |
| 9L-2S | | MI | 41015 | 8904 | 66143 | 6573 | 73264 | 5320 | 76830 | 4370 | 81262 | 2958 | 98623 | 2749 | 53547 |
| 18-#18 | 3.41 | MA | 47308 | 10021 | 80051 | 7299 | 89980 | 5848 | 96039 | 4699 | 105466 | 2926 | 131304 | 2135 | 101114 |
| 4L-7S | | MI | 39245 | 10021 | 66229 | 7284 | 73062 | 5863 | 76436 | 4707 | 80737 | 2911 | 99606 | 1580 | 83518 |
| 18-#18 | 3.41 | MA | 45834 | 10021 | 77447 | 7297 | 86621 | 5877 | 91926 | 4726 | 99598 | 2910 | 124157 | 2023 | 97785 |
| 5L-6S | | MI | 40492 | 10021 | 68615 | 7252 | 75971 | 5835 | 80001 | 4683 | 85504 | 2894 | 105924 | 1805 | 86504 |
| 18-#18 | 3.41 | MA | 44430 | 10021 | 74990 | 7295 | 83283 | 5872 | 87854 | 4717 | 94206 | 2930 | 117362 | 1873 | 95390 |
| 6L-5S | | MI | 41770 | 10021 | 70846 | 7256 | 79000 | 5842 | 83695 | 4694 | 90376 | 2876 | 111992 | 1955 | 88705 |
| 18-#18 | 3.41 | MA | 43059 | 10021 | 72360 | 7328 | 80078 | 5902 | 83926 | 4743 | 88931 | 2949 | 110291 | 1648 | 91950 |
| 7L-4S | | MI | 43111 | 10021 | 73208 | 7260 | 82047 | 5814 | 87426 | 4670 | 95677 | 2894 | 118403 | 2065 | 91561 |
| 18-#18 | 3.41 | MA | 41708 | 10021 | 69948 | 7325 | 76843 | 5896 | 80080 | 4769 | 83405 | 2933 | 103612 | 1518 | 88259 |
| 8L-3S | | MI | 44608 | 10021 | 75901 | 7228 | 85471 | 5822 | 91581 | 4681 | 101052 | 2876 | 124506 | 2292 | 92702 |
| 20-#11 | 1.48 | MA | 42967 | 8575 | 67857 | 6417 | 74781 | 5212 | 77693 | 4312 | 80411 | 3006 | 97200 | 2852 | 45828 |
| 2L-10S | | MI | 34558 | 8575 | 54380 | 6424 | 58282 | 5228 | 58641 | 4336 | 56632 | 3028 | 67059 | 2278 | 39255 |
| 20-#11 | 1.48 | MA | 41990 | 8575 | 66385 | 6417 | 72903 | 5211 | 75410 | 4324 | 77319 | 3015 | 92974 | 2763 | 45824 |
| 3L-9S | | MI | 35118 | 8575 | 55310 | 6410 | 59430 | 5216 | 60015 | 4325 | 58496 | 3020 | 69379 | 2341 | 39903 |
| 20-#11 | 1.48 | MA | 41306 | 8575 | 65207 | 6431 | 71405 | 5224 | 73592 | 4322 | 74958 | 3025 | 90198 | 2674 | 45787 |
| 4L-8S | | MI | 35645 | 8575 | 56162 | 6411 | 60567 | 5217 | 61447 | 4328 | 60374 | 3012 | 71771 | 2397 | 40460 |
| 20-#11 | 1.48 | MA | 40694 | 8575 | 64176 | 6431 | 70075 | 5222 | 71963 | 4333 | 72633 | 3020 | 87321 | 2629 | 45706 |
| 5L-7S | | MI | 36155 | 8575 | 57029 | 6411 | 61730 | 5205 | 62830 | 4317 | 62362 | 3017 | 74190 | 2449 | 40833 |
| 20-#11 | 1.48 | MA | 40112 | 8575 | 63204 | 6431 | 68753 | 5235 | 70350 | 4331 | 70498 | 3029 | 84568 | 2571 | 45430 |
| 6E | | MI | 36672 | 8575 | 57975 | 6398 | 62883 | 5207 | 64243 | 4306 | 64260 | 3009 | 76759 | 2536 | 41380 |
| 20-#11 | 1.48 | MA | 39544 | 8575 | 62163 | 6445 | 67485 | 5234 | 68796 | 4343 | 68409 | 3039 | 81705 | 2483 | 44792 |
| 7L-5S | | MI | 37202 | 8575 | 58859 | 6399 | 64084 | 5195 | 65708 | 4309 | 66200 | 3000 | 79228 | 2595 | 41627 |
| 20-#11 | 1.48 | MA | 38984 | 8575 | 61209 | 6445 | 66205 | 5247 | 67274 | 4354 | 66222 | 3034 | 79016 | 2431 | 44351 |
| 8L-4S | | MI | 37758 | 8575 | 59795 | 6399 | 65292 | 5197 | 67188 | 4299 | 68312 | 3006 | 81817 | 2639 | 41685 |
| 20-#11 | 1.48 | MA | 38386 | 8575 | 60273 | 6445 | 64955 | 5245 | 65699 | 4352 | 64155 | 3043 | 76348 | 2375 | 43714 |
| 9L-3S | | MI | 38380 | 8575 | 60865 | 6386 | 66653 | 5185 | 68839 | 4302 | 70455 | 2998 | 84304 | 2728 | 41710 |
| 20-#11 | 1.48 | MA | 37769 | 8575 | 59250 | 6459 | 63692 | 5258 | 64187 | 4363 | 62105 | 3052 | 73760 | 2311 | 42966 |
| 10L-2S | | MI | 39264 | 8575 | 62199 | 6386 | 68354 | 5186 | 70907 | 4291 | 73257 | 2989 | 88097 | 2817 | 41699 |
| 20-#14 | 2.13 | MA | 44519 | 9064 | 72216 | 6705 | 80218 | 5417 | 84256 | 4454 | 89283 | 2978 | 109015 | 2645 | 65244 |
| 3L-9S | | MI | 36053 | 9064 | 58079 | 6724 | 62904 | 5430 | 64174 | 4459 | 64110 | 2986 | 77380 | 2043 | 54639 |
| 20-#14 | 2.13 | MA | 43554 | 9064 | 70527 | 6724 | 78069 | 5435 | 81648 | 4450 | 85896 | 2991 | 105062 | 2517 | 65086 |
| 4L-8S | | MI | 36789 | 9064 | 59396 | 6705 | 64535 | 5433 | 66228 | 4464 | 66804 | 2975 | 80781 | 2124 | 55698 |
| 20-#14 | 2.13 | MA | 42692 | 9064 | 69047 | 6724 | 76160 | 5433 | 79310 | 4466 | 82560 | 2984 | 100957 | 2452 | 64647 |
| 5L-7S | | MI | 37508 | 9064 | 60641 | 6706 | 66204 | 5417 | 68213 | 4450 | 69656 | 2984 | 84231 | 2197 | 56955 |
| 20-#14 | 2.13 | MA | 41870 | 9064 | 67652 | 6724 | 74264 | 5450 | 76996 | 4462 | 79496 | 2996 | 97036 | 2368 | 63361 |
| 6E | | MI | 38237 | 9064 | 61998 | 6688 | 67858 | 5420 | 70240 | 4435 | 72379 | 2973 | 87885 | 2324 | 57639 |
| 20-#14 | 2.13 | MA | 41069 | 9064 | 66158 | 6743 | 72443 | 5448 | 74765 | 4478 | 76499 | 3009 | 92957 | 2242 | 62559 |
| 7L-5S | | MI | 38985 | 9064 | 63266 | 6689 | 69580 | 5403 | 72341 | 4440 | 75161 | 2962 | 91396 | 2408 | 58743 |
| 20-#14 | 2.13 | MA | 40279 | 9064 | 64789 | 6743 | 70606 | 5466 | 72580 | 4494 | 73359 | 3002 | 89119 | 2167 | 61158 |
| 8L-4S | | MI | 39769 | 9064 | 64610 | 6690 | 71314 | 5406 | 74464 | 4425 | 78189 | 2971 | 95088 | 2471 | 59173 |
| 20-#14 | 2.13 | MA | 39443 | 9064 | 63444 | 6742 | 68811 | 5464 | 70320 | 4490 | 70393 | 3014 | 85320 | 2086 | 59936 |
| 9L-3S | | MI | 40645 | 9064 | 66143 | 6671 | 73264 | 5389 | 76830 | 4430 | 81262 | 2959 | 98623 | 2599 | 59299 |
| 20-#14 | 2.13 | MA | 38572 | 9064 | 61976 | 6762 | 66998 | 5482 | 68149 | 4506 | 67450 | 3027 | 81635 | 1995 | 58225 |
| 10L-2S | | MI | 41892 | 9064 | 68054 | 6673 | 75699 | 5392 | 79791 | 4415 | 85273 | 2948 | 104021 | 2727 | 59355 |
| 20-#18 | 3.79 | MA | 47515 | 10305 | 81148 | 7474 | 91339 | 6006 | 97662 | 4806 | 107368 | 2893 | 134603 | 1983 | 108699 |
| 5L-7S | | MI | 40777 | 10305 | 69575 | 7461 | 77329 | 5991 | 81623 | 4787 | 87743 | 2893 | 108944 | 1535 | 93297 |
| 20-#18 | 3.79 | MA | 46123 | 10305 | 78691 | 7472 | 88001 | 6000 | 93590 | 4796 | 101977 | 2912 | 127808 | 1833 | 106135 |
| 6E | | MI | 42013 | 10305 | 71962 | 7430 | 80238 | 5963 | 85187 | 4763 | 92511 | 2875 | 115262 | 1760 | 96185 |
| 20-#18 | 3.79 | MA | 44765 | 10305 | 76061 | 7505 | 84796 | 6030 | 89662 | 4823 | 96701 | 2932 | 120737 | 1609 | 102798 |
| 7L-5S | | MI | 43280 | 10305 | 74192 | 7434 | 83267 | 5971 | 88881 | 4774 | 97382 | 2857 | 121329 | 1910 | 98556 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

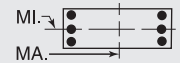



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#18 | 3.79 | MA | 43426 | 10305 | 73649 | 7503 | 81561 | 6024 | 85816 | 4849 | 91175 | 2916 | 114058 | 1478 | 99009 |
| 8L-4S | | MI | 44610 | 10305 | 76555 | 7437 | 86313 | 5943 | 92612 | 4750 | 102683 | 2875 | 127740 | 2019 | 101289 |
| 22-#11 | 1.63 | MA | 43659 | 8685 | 69330 | 6487 | 76658 | 5262 | 79975 | 4344 | 83503 | 2999 | 101426 | 2839 | 50317 |
| 2L-11S | | MI | 34654 | 8685 | 54863 | 6492 | 58853 | 5276 | 59294 | 4364 | 57473 | 3016 | 68489 | 2209 | 42483 |
| 22-#11 | 1.63 | MA | 42685 | 8685 | 67857 | 6487 | 74781 | 5261 | 77693 | 4355 | 80411 | 3008 | 97200 | 2751 | 50297 |
| 3L-10S | | MI | 35200 | 8685 | 55715 | 6493 | 59983 | 5278 | 60709 | 4367 | 59433 | 3021 | 70852 | 2264 | 43195 |
| 22-#11 | 1.63 | MA | 42004 | 8685 | 66679 | 6500 | 73282 | 5274 | 75874 | 4353 | 78050 | 3018 | 94424 | 2662 | 50248 |
| 4L-9S | | MI | 35758 | 8685 | 56644 | 6479 | 61131 | 5266 | 62084 | 4356 | 61297 | 3013 | 73171 | 2327 | 43827 |
| 22-#11 | 1.63 | MA | 41395 | 8685 | 65648 | 6500 | 71952 | 5273 | 74245 | 4364 | 75725 | 3013 | 91547 | 2617 | 50154 |
| 5L-8S | | MI | 36283 | 8685 | 57496 | 6480 | 62268 | 5267 | 63515 | 4359 | 63176 | 3005 | 75563 | 2383 | 44436 |
| 22-#11 | 1.63 | MA | 40816 | 8685 | 64676 | 6500 | 70631 | 5285 | 72633 | 4362 | 73590 | 3022 | 88794 | 2558 | 49790 |
| 6L-7S | | MI | 36790 | 8685 | 58363 | 6480 | 63431 | 5255 | 64898 | 4348 | 65164 | 3010 | 77983 | 2435 | 44800 |
| 22-#11 | 1.63 | MA | 40250 | 8685 | 63636 | 6514 | 69363 | 5284 | 71078 | 4374 | 71502 | 3032 | 85931 | 2471 | 49173 |
| 7L-6S | | MI | 37305 | 8685 | 59309 | 6467 | 64584 | 5257 | 66311 | 4337 | 67062 | 3002 | 80552 | 2522 | 45327 |
| 22-#11 | 1.63 | MA | 39693 | 8685 | 62682 | 6514 | 68083 | 5297 | 69556 | 4385 | 69314 | 3027 | 83242 | 2418 | 48742 |
| 8L-5S | | MI | 37833 | 8685 | 60193 | 6468 | 65785 | 5245 | 67776 | 4340 | 69001 | 2994 | 83020 | 2581 | 45660 |
| 22-#11 | 1.63 | MA | 39097 | 8685 | 61745 | 6514 | 66832 | 5296 | 67981 | 4383 | 67247 | 3036 | 80574 | 2363 | 48053 |
| 9L-4S | | MI | 38387 | 8685 | 61130 | 6468 | 66994 | 5247 | 69256 | 4330 | 71113 | 2999 | 85610 | 2625 | 45731 |
| 22-#11 | 1.63 | MA | 38483 | 8685 | 60723 | 6528 | 65569 | 5308 | 66469 | 4394 | 65197 | 3046 | 77986 | 2299 | 47323 |
| 10L-3S | | MI | 39006 | 8685 | 62199 | 6455 | 68354 | 5235 | 70907 | 4333 | 73257 | 2991 | 88097 | 2714 | 45765 |
| 22-#11 | 1.63 | MA | 37883 | 8685 | 59787 | 6528 | 64326 | 5307 | 64913 | 4392 | 63040 | 3041 | 75360 | 2244 | 46514 |
| 11L-2S | | MI | 39887 | 8685 | 63534 | 6455 | 70055 | 5237 | 72975 | 4322 | 76059 | 2982 | 91890 | 2802 | 45769 |
| 22-#14 | 2.34 | MA | 44534 | 9224 | 72637 | 6824 | 80759 | 5507 | 84918 | 4495 | 90326 | 2981 | 111084 | 2498 | 71450 |
| 4L-9S | | MI | 36965 | 9223 | 59990 | 6824 | 65339 | 5503 | 67135 | 4504 | 68121 | 2976 | 82777 | 2021 | 60270 |
| 22-#14 | 2.34 | MA | 43677 | 9223 | 71157 | 6824 | 78850 | 5505 | 82580 | 4511 | 86990 | 2974 | 106978 | 2433 | 70857 |
| 5L-8S | | MI | 37688 | 9223 | 61307 | 6805 | 66970 | 5506 | 69189 | 4509 | 70816 | 2965 | 86178 | 2102 | 61302 |
| 22-#14 | 2.34 | MA | 42861 | 9223 | 69762 | 6823 | 76954 | 5523 | 80266 | 4507 | 83926 | 2986 | 103057 | 2349 | 69617 |
| 6L-7S | | MI | 38403 | 9224 | 62552 | 6806 | 68639 | 5489 | 71174 | 4494 | 73667 | 2974 | 89628 | 2175 | 62632 |
| 22-#14 | 2.34 | MA | 42064 | 9224 | 68268 | 6843 | 75133 | 5520 | 78035 | 4523 | 80929 | 2999 | 98979 | 2223 | 68835 |
| 7L-6S | | MI | 39128 | 9224 | 63909 | 6788 | 70293 | 5492 | 73201 | 4480 | 76390 | 2963 | 93282 | 2302 | 63296 |
| 22-#14 | 2.34 | MA | 41279 | 9224 | 66899 | 6842 | 73296 | 5538 | 75850 | 4539 | 77789 | 2992 | 95141 | 2148 | 67361 |
| 8L-5S | | MI | 39871 | 9223 | 65177 | 6789 | 72016 | 5475 | 75302 | 4485 | 79172 | 2952 | 96793 | 2386 | 64359 |
| 22-#14 | 2.34 | MA | 40448 | 9224 | 65554 | 6842 | 71501 | 5536 | 73590 | 4535 | 74823 | 3004 | 91342 | 2067 | 66169 |
| 9L-4S | | MI | 40651 | 9223 | 66520 | 6790 | 73749 | 5478 | 77425 | 4470 | 82201 | 2961 | 100485 | 2449 | 64937 |
| 22-#14 | 2.34 | MA | 39581 | 9223 | 64086 | 6861 | 69688 | 5554 | 71419 | 4551 | 71880 | 3017 | 87657 | 1976 | 64408 |
| 10L-3S | | MI | 41523 | 9224 | 68054 | 6771 | 75699 | 5461 | 79791 | 4475 | 85273 | 2950 | 104021 | 2577 | 65083 |
| 22-#18 | 4.17 | MA | 47803 | 10589 | 82392 | 7649 | 92720 | 6129 | 99326 | 4876 | 109748 | 2894 | 138254 | 1794 | 116901 |
| 6L-7S | | MI | 42296 | 10589 | 72921 | 7639 | 81595 | 6120 | 86809 | 4866 | 94750 | 2874 | 118281 | 1490 | 103092 |
| 22-#18 | 4.17 | MA | 46457 | 10589 | 79762 | 7682 | 89514 | 6159 | 95398 | 4903 | 104472 | 2914 | 131183 | 1569 | 113662 |
| 7L-6S | | MI | 43522 | 10589 | 75308 | 7607 | 84504 | 6092 | 90374 | 4842 | 99518 | 2856 | 124599 | 1715 | 105887 |
| 22-#18 | 4.17 | MA | 45130 | 10589 | 77350 | 7680 | 86280 | 6153 | 91552 | 4929 | 98946 | 2898 | 124504 | 1439 | 109775 |
| 8L-5S | | MI | 44779 | 10589 | 77538 | 7611 | 87533 | 6099 | 94068 | 4854 | 104389 | 2839 | 130667 | 1865 | 108423 |
| 24-#11 | 1.77 | MA | 43378 | 8796 | 69330 | 6556 | 76658 | 5311 | 79975 | 4386 | 83503 | 3001 | 101426 | 2738 | 54767 |
| 3L-11S | | MI | 35295 | 8796 | 56198 | 6561 | 60554 | 5326 | 61362 | 4395 | 60275 | 3009 | 72281 | 2195 | 46390 |
| 24-#11 | 1.77 | MA | 42699 | 8796 | 68152 | 6569 | 75160 | 5324 | 78157 | 4384 | 81142 | 3011 | 98650 | 2650 | 54707 |
| 4L-10S | | MI | 35839 | 8796 | 57049 | 6562 | 61684 | 5328 | 62777 | 4398 | 62235 | 3014 | 74644 | 2250 | 47139 |
| 24-#11 | 1.77 | MA | 42093 | 8796 | 67121 | 6569 | 73830 | 5323 | 76527 | 4396 | 78817 | 3006 | 95773 | 2604 | 54600 |
| 5L-9S | | MI | 36395 | 8796 | 57979 | 6549 | 62832 | 5316 | 64152 | 4387 | 64099 | 3006 | 76964 | 2313 | 47756 |
| 24-#11 | 1.77 | MA | 41516 | 8796 | 66149 | 6569 | 72508 | 5335 | 74915 | 4393 | 76682 | 3015 | 93020 | 2546 | 54155 |
| 6L-8S | | MI | 36918 | 8796 | 58830 | 6549 | 63969 | 5318 | 65583 | 4390 | 65977 | 2998 | 79356 | 2369 | 48414 |
| 24-#11 | 1.77 | MA | 40953 | 8796 | 65108 | 6583 | 71240 | 5334 | 73360 | 4405 | 74594 | 3025 | 90157 | 2459 | 53557 |
| 7E | | MI | 37423 | 8796 | 59698 | 6550 | 65133 | 5306 | 66966 | 4379 | 67965 | 3003 | 81776 | 2421 | 48770 |
| 24-#11 | 1.77 | MA | 40398 | 8796 | 64154 | 6583 | 69960 | 5347 | 71839 | 4416 | 72406 | 3020 | 87468 | 2406 | 53135 |
| 8L-6S | | MI | 37935 | 8796 | 60644 | 6536 | 66285 | 5307 | 68379 | 4369 | 69863 | 2995 | 84344 | 2508 | 49279 |
| 24-#11 | 1.77 | MA | 39805 | 8796 | 63218 | 6583 | 68710 | 5346 | 70264 | 4414 | 70340 | 3029 | 84800 | 2350 | 52397 |
| 9L-5S | | MI | 38461 | 8796 | 61527 | 6537 | 67486 | 5295 | 69844 | 4372 | 71803 | 2987 | 86813 | 2567 | 49691 |
| 24-#11 | 1.77 | MA | 39194 | 8796 | 62196 | 6597 | 67447 | 5358 | 68752 | 4426 | 68289 | 3039 | 82212 | 2287 | 51683 |
| 10L-4S | | MI | 39012 | 8796 | 62464 | 6537 | 68695 | 5297 | 71324 | 4361 | 73915 | 2992 | 89402 | 2611 | 49774 |

## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis



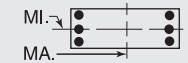

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 1.77 | MA | 38596 | 8796 | 61259 | 6597 | 66204 | 5357 | 67195 | 4423 | 66132 | 3034 | 79586 | 2232 | 50839 |
| 11L-3S | | MI | 39629 | 8796 | 63534 | 6524 | 70055 | 5285 | 72975 | 4364 | 76059 | 2984 | 91890 | 2700 | 49818 |
| 24-#11 | 1.77 | MA | 38008 | 8796 | 60253 | 6611 | 64949 | 5370 | 65687 | 4435 | 64084 | 3043 | 76694 | 2157 | 49929 |
| 12L-2S | | MI | 40507 | 8796 | 64868 | 6525 | 71756 | 5287 | 75043 | 4353 | 78860 | 2976 | 95682 | 2788 | 49836 |
| 24-#14 | 2.56 | MA | 44657 | 9383 | 73267 | 6923 | 81540 | 5577 | 85850 | 4556 | 91420 | 2964 | 113000 | 2414 | 77077 |
| 5L-9S | | MI | 37860 | 9383 | 61900 | 6923 | 67775 | 5575 | 70096 | 4549 | 72132 | 2966 | 88174 | 1999 | 65845 |
| 24-#14 | 2.56 | MA | 43845 | 9383 | 71871 | 6923 | 79644 | 5595 | 83536 | 4552 | 88357 | 2976 | 109079 | 2330 | 75878 |
| 6L-8S | | MI | 38582 | 9383 | 63217 | 6905 | 69406 | 5578 | 72150 | 4554 | 74827 | 2955 | 91576 | 2080 | 66913 |
| 24-#14 | 2.56 | MA | 43054 | 9383 | 70378 | 6943 | 77823 | 5593 | 81305 | 4568 | 85359 | 2989 | 105000 | 2204 | 75115 |
| 7E | | MI | 39293 | 9383 | 64462 | 6906 | 71075 | 5561 | 74134 | 4539 | 77679 | 2964 | 95025 | 2153 | 68312 |
| 24-#14 | 2.56 | MA | 42273 | 9383 | 69008 | 6942 | 75986 | 5611 | 79120 | 4584 | 82220 | 2982 | 101163 | 2129 | 73572 |
| 8L-6S | | MI | 40014 | 9383 | 65819 | 6887 | 72729 | 5564 | 76162 | 4524 | 80401 | 2953 | 98679 | 2280 | 68960 |
| 24-#14 | 2.56 | MA | 41455 | 9383 | 67664 | 6942 | 74191 | 5608 | 76860 | 4580 | 79254 | 2994 | 97364 | 2048 | 72390 |
| 9L-5S | | MI | 40753 | 9383 | 67087 | 6888 | 74452 | 5547 | 78263 | 4529 | 83183 | 2942 | 102190 | 2364 | 69985 |
| 24-#14 | 2.56 | MA | 40584 | 9383 | 66196 | 6961 | 72378 | 5626 | 74689 | 4596 | 76310 | 3007 | 93679 | 1957 | 70598 |
| 10L-4S | | MI | 41528 | 9383 | 68431 | 6890 | 76185 | 5551 | 80385 | 4515 | 86212 | 2951 | 105882 | 2427 | 70697 |
| 24-#18 | 4.55 | MA | 48136 | 10873 | 83463 | 7860 | 94233 | 6287 | 101134 | 4982 | 112243 | 2896 | 141628 | 1530 | 124538 |
| 7E | | MI | 43805 | 10873 | 76267 | 7816 | 85861 | 6248 | 91995 | 4946 | 101757 | 2855 | 127618 | 1444 | 112900 |
| 24-#18 | 4.55 | MA | 46820 | 10873 | 81051 | 7857 | 90998 | 6282 | 97288 | 5009 | 106717 | 2880 | 134950 | 1399 | 120557 |
| 8L-6S | | MI | 45021 | 10873 | 78654 | 7784 | 88770 | 6220 | 95560 | 4922 | 106524 | 2838 | 133936 | 1669 | 115608 |
| **RECTANGULAR TIED COLUMNS 46" x 46"** | | | | | | | | | | | | | | | |
| 6-#18 | 1.13 | MA | 39473 | 8333 | 61941 | 6198 | 67255 | 5047 | 68897 | 4199 | 69411 | 2990 | 81966 | 2815 | 33492 |
| 2L-3S | | MI | 37124 | 8333 | 58418 | 6195 | 62762 | 5076 | 63436 | 4224 | 62012 | 3008 | 72075 | 2588 | 33569 |
| 8-#18 | 1.51 | MA | 41116 | 8617 | 65465 | 6375 | 71747 | 5176 | 74358 | 4279 | 76810 | 2972 | 91858 | 2773 | 44276 |
| 2L-4S | | MI | 37141 | 8617 | 59110 | 6404 | 63654 | 5198 | 64527 | 4294 | 63737 | 3008 | 75494 | 2318 | 43965 |
| 10-#14 | 1.06 | MA | 39275 | 8280 | 61237 | 6202 | 66592 | 5053 | 68181 | 4210 | 68479 | 3013 | 81080 | 2859 | 31690 |
| 2L-5S | | MI | 36133 | 8280 | 56203 | 6219 | 60158 | 5066 | 60348 | 4236 | 57846 | 3029 | 67728 | 2539 | 31627 |
| 10-#14 | 1.06 | MA | 37929 | 8280 | 59226 | 6201 | 64029 | 5051 | 65065 | 4225 | 64258 | 3025 | 75371 | 2731 | 31736 |
| 3L-4S | | MI | 36981 | 8280 | 57615 | 6220 | 61979 | 5068 | 62578 | 4221 | 61029 | 3037 | 71627 | 2603 | 31736 |
| 10-#18 | 1.89 | MA | 42740 | 8901 | 68989 | 6552 | 76239 | 5304 | 79819 | 4358 | 84208 | 2954 | 101749 | 2731 | 55030 |
| 2L-5S | | MI | 37340 | 8901 | 60150 | 6579 | 64943 | 5355 | 66066 | 4399 | 65541 | 2973 | 78606 | 2165 | 51937 |
| 10-#18 | 1.89 | MA | 40431 | 8901 | 65465 | 6549 | 71747 | 5333 | 74358 | 4384 | 76810 | 2972 | 91858 | 2503 | 54937 |
| 3L-4S | | MI | 38801 | 8901 | 62633 | 6582 | 68146 | 5326 | 69988 | 4373 | 71135 | 2991 | 85385 | 2276 | 54540 |
| **RECTANGULAR TIED COLUMNS 46" x 48"** | | | | | | | | | | | | | | | |
| 6-#18 | 1.09 | MA | 42812 | 8659 | 66945 | 6462 | 72711 | 5264 | 74433 | 4383 | 74804 | 3132 | 88398 | 2961 | 35112 |
| 2L-3S | | MI | 38622 | 8659 | 60651 | 6441 | 65100 | 5278 | 65719 | 4396 | 64065 | 3140 | 74348 | 2716 | 33627 |
| 6-#18 | 1.09 | MA | 40339 | 8659 | 63244 | 6460 | 67993 | 5294 | 68697 | 4410 | 67033 | 3151 | 77952 | 2733 | 35189 |
| 3L-2S | | MI | 40974 | 8659 | 64175 | 6444 | 69593 | 5250 | 71180 | 4371 | 71464 | 3122 | 84240 | 2943 | 33538 |
| 8-#18 | 1.45 | MA | 44547 | 8942 | 70646 | 6639 | 77430 | 5393 | 80169 | 4463 | 82575 | 3114 | 98844 | 2921 | 46436 |
| 2L-4S | | MI | 38638 | 8942 | 61343 | 6651 | 65992 | 5400 | 66810 | 4466 | 65790 | 3141 | 77767 | 2446 | 44080 |
| 8-#18 | 1.45 | MA | 42095 | 8942 | 66945 | 6637 | 72711 | 5423 | 74433 | 4490 | 74804 | 3133 | 88398 | 2694 | 46429 |
| 3E | | MI | 40287 | 8942 | 64175 | 6618 | 69593 | 5407 | 71180 | 4476 | 71464 | 3122 | 84240 | 2673 | 44339 |
| 8-#18 | 1.45 | MA | 40366 | 8942 | 63974 | 6670 | 68933 | 5417 | 69847 | 4480 | 68850 | 3153 | 81555 | 2466 | 46125 |
| 4L-2S | | MI | 42619 | 8942 | 67699 | 6621 | 74085 | 5378 | 76641 | 4451 | 78862 | 3104 | 94131 | 2901 | 44329 |
| 10-#14 | 1.02 | MA | 42597 | 8605 | 66196 | 6466 | 72004 | 5271 | 73668 | 4394 | 73808 | 3155 | 87420 | 3003 | 33209 |
| 2L-5S | | MI | 37629 | 8605 | 58429 | 6467 | 62497 | 5270 | 62635 | 4410 | 59906 | 3162 | 70013 | 2668 | 31706 |
| 10-#14 | 1.02 | MA | 41182 | 8605 | 64086 | 6466 | 69314 | 5269 | 70398 | 4410 | 69378 | 3168 | 81398 | 2875 | 33255 |
| 3L-4S | | MI | 38479 | 8605 | 59840 | 6468 | 64317 | 5272 | 64865 | 4394 | 63088 | 3170 | 73911 | 2732 | 31792 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

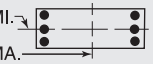



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.02 | MA | 40187 | 8605 | 62397 | 6485 | 67165 | 5287 | 67789 | 4407 | 65991 | 3180 | 77446 | 2747 | 33255 |
| 4L-3S | | MI | 39428 | 8605 | 61452 | 6449 | 66367 | 5255 | 67353 | 4399 | 66318 | 3158 | 77655 | 2860 | 31779 |
| 10-#14 | 1.02 | MA | 39297 | 8605 | 60917 | 6485 | 65256 | 5284 | 65452 | 4423 | 62655 | 3173 | 73340 | 2682 | 33146 |
| 5L-2S | | MI | 40775 | 8605 | 63462 | 6450 | 68930 | 5257 | 70468 | 4383 | 70539 | 3146 | 83365 | 2988 | 31729 |
| 10-#18 | 1.81 | MA | 46262 | 9226 | 74347 | 6817 | 82148 | 5522 | 85905 | 4543 | 90345 | 3096 | 109290 | 2882 | 57730 |
| 2L-5S | | MI | 38836 | 9226 | 62383 | 6825 | 67282 | 5558 | 68349 | 4571 | 67594 | 3106 | 80880 | 2293 | 52288 |
| 10-#18 | 1.81 | MA | 43831 | 9226 | 70646 | 6814 | 77430 | 5551 | 80169 | 4569 | 82575 | 3116 | 98844 | 2654 | 57637 |
| 3L-4S | | MI | 40300 | 9226 | 64867 | 6828 | 70484 | 5529 | 72271 | 4546 | 73188 | 3123 | 87659 | 2404 | 54665 |
| 10-#18 | 1.81 | MA | 42118 | 9226 | 67675 | 6848 | 73652 | 5546 | 75583 | 4560 | 76621 | 3135 | 92001 | 2427 | 57240 |
| 4L-3S | | MI | 41933 | 9226 | 67699 | 6796 | 74085 | 5536 | 76641 | 4556 | 78862 | 3105 | 94131 | 2631 | 55016 |
| 10-#18 | 1.81 | MA | 40584 | 9226 | 65071 | 6845 | 70293 | 5575 | 71470 | 4587 | 70753 | 3119 | 84854 | 2315 | 54719 |
| 5L-2S | | MI | 44247 | 9226 | 71222 | 6799 | 78577 | 5507 | 82102 | 4530 | 86261 | 3087 | 104023 | 2859 | 55086 |
| 12-#14 | 1.22 | MA | 43599 | 8765 | 68306 | 6566 | 74694 | 5343 | 76938 | 4439 | 78238 | 3145 | 93442 | 2984 | 39663 |
| 2L-6S | | MI | 37792 | 8765 | 59107 | 6566 | 63250 | 5359 | 63543 | 4450 | 61204 | 3164 | 72006 | 2563 | 36980 |
| 12-#14 | 1.22 | MA | 42191 | 8765 | 66196 | 6565 | 72004 | 5341 | 73668 | 4455 | 73808 | 3158 | 87420 | 2856 | 39692 |
| 3L-5S | | MI | 38598 | 8765 | 60439 | 6567 | 65059 | 5342 | 65750 | 4455 | 64127 | 3152 | 75722 | 2647 | 37770 |
| 12-#14 | 1.22 | MA | 41202 | 8765 | 64506 | 6585 | 69855 | 5359 | 71059 | 4452 | 70421 | 3170 | 83468 | 2728 | 39653 |
| 4E | | MI | 39442 | 8765 | 61851 | 6568 | 66880 | 5345 | 67981 | 4439 | 67309 | 3160 | 79620 | 2711 | 37892 |
| 12-#14 | 1.22 | MA | 40317 | 8765 | 63027 | 6584 | 67946 | 5357 | 68722 | 4468 | 67085 | 3163 | 79362 | 2663 | 39507 |
| 5L-3S | | MI | 40385 | 8765 | 63462 | 6549 | 68930 | 5327 | 70468 | 4443 | 70539 | 3148 | 83365 | 2839 | 37916 |
| 12-#14 | 1.22 | MA | 39473 | 8765 | 61631 | 6584 | 66050 | 5374 | 66408 | 4464 | 64021 | 3175 | 75441 | 2579 | 38656 |
| 6L-2S | | MI | 41726 | 8765 | 65472 | 6549 | 71493 | 5330 | 73584 | 4428 | 74759 | 3136 | 89074 | 2967 | 37883 |
| 12-#18 | 2.17 | MA | 47961 | 9510 | 78048 | 6994 | 86867 | 5650 | 91640 | 4623 | 98116 | 3079 | 119735 | 2842 | 68983 |
| 2L-6S | | MI | 39111 | 9510 | 63563 | 6999 | 68590 | 5680 | 69927 | 4641 | 69851 | 3106 | 84340 | 2101 | 60664 |
| 12-#18 | 2.17 | MA | 45549 | 9510 | 74347 | 6992 | 82148 | 5680 | 85905 | 4649 | 90345 | 3098 | 109290 | 2615 | 68825 |
| 3L-5S | | MI | 40494 | 9510 | 65907 | 7002 | 71774 | 5686 | 73810 | 4651 | 74992 | 3088 | 90771 | 2251 | 62573 |
| 12-#18 | 2.17 | MA | 43852 | 9510 | 71376 | 7025 | 78370 | 5674 | 81319 | 4640 | 84392 | 3118 | 102447 | 2387 | 68348 |
| 4E | | MI | 41944 | 9510 | 68390 | 7005 | 74976 | 5658 | 77732 | 4625 | 80587 | 3105 | 97550 | 2361 | 65241 |
| 12-#18 | 2.17 | MA | 42332 | 9510 | 68772 | 7023 | 75012 | 5704 | 77206 | 4666 | 78524 | 3102 | 95300 | 2275 | 65534 |
| 5L-3S | | MI | 43563 | 9510 | 71222 | 6973 | 78577 | 5664 | 82102 | 4636 | 86261 | 3087 | 104023 | 2589 | 65671 |
| 12-#18 | 2.17 | MA | 40883 | 9510 | 66315 | 7020 | 71673 | 5698 | 73134 | 4657 | 73132 | 3121 | 88505 | 2125 | 63482 |
| 6L-2S | | MI | 45858 | 9510 | 74746 | 6976 | 83070 | 5635 | 87563 | 4610 | 93660 | 3069 | 113914 | 2816 | 65809 |
| 14-#14 | 1.43 | MA | 44593 | 8925 | 70416 | 6666 | 77384 | 5416 | 80208 | 4484 | 82668 | 3135 | 99463 | 2965 | 46107 |
| 2L-7S | | MI | 37978 | 8925 | 59692 | 6685 | 64075 | 5429 | 64529 | 4510 | 62565 | 3166 | 73849 | 2417 | 42070 |
| 14-#14 | 1.43 | MA | 43192 | 8925 | 68306 | 6665 | 74694 | 5413 | 76938 | 4500 | 78238 | 3148 | 93442 | 2837 | 46109 |
| 3L-6S | | MI | 38759 | 8925 | 61117 | 6666 | 65813 | 5432 | 66658 | 4495 | 65425 | 3154 | 77715 | 2543 | 42897 |
| 14-#14 | 1.43 | MA | 42209 | 8925 | 66616 | 6685 | 72545 | 5431 | 74329 | 4496 | 74851 | 3160 | 89489 | 2709 | 46041 |
| 4L-5S | | MI | 39559 | 8925 | 62449 | 6667 | 67622 | 5414 | 68866 | 4499 | 68348 | 3142 | 81431 | 2627 | 43827 |
| 14-#14 | 1.43 | MA | 41330 | 8925 | 65137 | 6684 | 70636 | 5429 | 71992 | 4512 | 71515 | 3153 | 85383 | 2644 | 45863 |
| 5L-4S | | MI | 40399 | 8925 | 63861 | 6668 | 69443 | 5417 | 71096 | 4484 | 71530 | 3150 | 85330 | 2691 | 43982 |
| 14-#14 | 1.43 | MA | 40491 | 8925 | 63741 | 6684 | 68740 | 5447 | 69678 | 4509 | 68452 | 3165 | 81462 | 2560 | 44871 |
| 6L-3S | | MI | 41337 | 8925 | 65472 | 6648 | 71493 | 5400 | 73584 | 4488 | 74759 | 3138 | 89074 | 2819 | 44037 |
| 14-#14 | 1.43 | MA | 39673 | 8925 | 62248 | 6703 | 66919 | 5445 | 67447 | 4525 | 65454 | 3178 | 77384 | 2434 | 43980 |
| 7L-2S | | MI | 42670 | 8925 | 67482 | 6649 | 74055 | 5402 | 76699 | 4473 | 78980 | 3126 | 94783 | 2947 | 44025 |
| 14-#18 | 2.54 | MA | 49643 | 9793 | 81749 | 7171 | 91585 | 5779 | 97376 | 4703 | 105887 | 3061 | 130181 | 2803 | 80217 |
| 2L-7S | | MI | 39429 | 9793 | 64579 | 7209 | 70026 | 5837 | 71642 | 4746 | 72218 | 3107 | 87537 | 1834 | 67709 |
| 14-#18 | 2.54 | MA | 47250 | 9793 | 78048 | 7169 | 86867 | 5808 | 91640 | 4729 | 98116 | 3080 | 119735 | 2575 | 79999 |
| 3L-6S | | MI | 40766 | 9793 | 67087 | 7177 | 73083 | 5808 | 75388 | 4720 | 77250 | 3088 | 94232 | 2058 | 71061 |
| 14-#18 | 2.54 | MA | 45568 | 9793 | 75077 | 7202 | 83089 | 5803 | 87055 | 4720 | 92163 | 3100 | 112893 | 2347 | 79451 |
| 4L-5S | | MI | 42136 | 9793 | 69431 | 7180 | 76266 | 5815 | 79271 | 4731 | 82391 | 3070 | 100663 | 2208 | 72887 |
| 14-#18 | 2.54 | MA | 44063 | 9793 | 72473 | 7200 | 79730 | 5832 | 82942 | 4746 | 86295 | 3084 | 105746 | 2235 | 76379 |
| 5L-4S | | MI | 43573 | 9793 | 71914 | 7183 | 79469 | 5786 | 83193 | 4705 | 87985 | 3088 | 107442 | 2319 | 75811 |
| 14-#18 | 2.54 | MA | 42627 | 9793 | 70016 | 7198 | 76392 | 5827 | 78870 | 4737 | 80903 | 3104 | 98951 | 2086 | 74412 |
| 6L-3S | | MI | 45177 | 9793 | 74746 | 7150 | 83070 | 5793 | 87563 | 4715 | 93660 | 3069 | 113914 | 2547 | 76312 |
| 14-#18 | 2.54 | MA | 41227 | 9793 | 67386 | 7231 | 73187 | 5857 | 74942 | 4764 | 75628 | 3123 | 91880 | 1861 | 70877 |
| 7L-2S | | MI | 47455 | 9793 | 78269 | 7153 | 87562 | 5764 | 93024 | 4690 | 101058 | 3051 | 123806 | 2774 | 76507 |
| 16-#11 | 1.13 | MA | 43208 | 8693 | 67327 | 6539 | 73571 | 5326 | 75622 | 4432 | 76476 | 3160 | 91246 | 3011 | 36878 |
| 2L-8S | | MI | 37513 | 8693 | 58197 | 6550 | 62247 | 5346 | 62399 | 4461 | 59557 | 3176 | 69763 | 2576 | 34201 |

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis



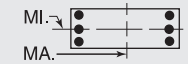

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.13 | MA | 42222 | 8693 | 65854 | 6539 | 71694 | 5325 | 73340 | 4444 | 73384 | 3169 | 87020 | 2922 | 36901 |
| 3L-7S | | MI | 38060 | 8693 | 59107 | 6550 | 63469 | 5334 | 63851 | 4450 | 61645 | 3181 | 72318 | 2628 | 34633 |
| 16-#11 | 1.13 | MA | 41531 | 8693 | 64676 | 6553 | 70196 | 5337 | 71521 | 4441 | 71023 | 3178 | 84243 | 2833 | 36902 |
| 4L-6S | | MI | 38608 | 8693 | 60101 | 6537 | 64680 | 5335 | 65335 | 4438 | 63638 | 3173 | 75033 | 2715 | 35154 |
| 16-#11 | 1.13 | MA | 40913 | 8693 | 63645 | 6553 | 68866 | 5336 | 69892 | 4453 | 68698 | 3174 | 81366 | 2788 | 36862 |
| 5E | | MI | 39170 | 8693 | 61029 | 6537 | 65941 | 5323 | 66874 | 4441 | 65675 | 3164 | 77644 | 2773 | 35235 |
| 16-#11 | 1.13 | MA | 40325 | 8693 | 62673 | 6553 | 67544 | 5349 | 68280 | 4451 | 66563 | 3183 | 78613 | 2730 | 36765 |
| 6L-4S | | MI | 39760 | 8693 | 62013 | 6537 | 67210 | 5324 | 68428 | 4430 | 67894 | 3169 | 80377 | 2818 | 35265 |
| 16-#11 | 1.13 | MA | 39751 | 8693 | 61633 | 6567 | 66276 | 5348 | 66725 | 4462 | 64475 | 3192 | 75750 | 2643 | 36204 |
| 7L-3S | | MI | 40419 | 8693 | 63136 | 6524 | 68639 | 5312 | 70163 | 4432 | 70146 | 3160 | 83009 | 2907 | 35256 |
| 16-#11 | 1.13 | MA | 39177 | 8693 | 60679 | 6567 | 64996 | 5360 | 65203 | 4474 | 62287 | 3188 | 73061 | 2590 | 35738 |
| 8L-2S | | MI | 41358 | 8693 | 64540 | 6524 | 70429 | 5313 | 72338 | 4421 | 73093 | 3151 | 87018 | 2996 | 35230 |
| 16-#14 | 1.63 | MA | 45582 | 9084 | 72526 | 6765 | 80074 | 5488 | 83478 | 4529 | 87098 | 3125 | 105485 | 2946 | 52543 |
| 2L-8S | | MI | 38177 | 9084 | 60395 | 6784 | 64885 | 5519 | 65560 | 4571 | 63790 | 3148 | 75915 | 2322 | 46999 |
| 16-#14 | 1.63 | MA | 44188 | 9084 | 70416 | 6765 | 77384 | 5486 | 80208 | 4545 | 82668 | 3138 | 99463 | 2818 | 52516 |
| 3L-7S | | MI | 38942 | 9084 | 61702 | 6785 | 66638 | 5501 | 67645 | 4555 | 66785 | 3156 | 79558 | 2396 | 48029 |
| 16-#14 | 1.63 | MA | 43210 | 9084 | 68726 | 6784 | 75235 | 5504 | 77600 | 4541 | 79281 | 3150 | 95511 | 2690 | 52422 |
| 4L-6S | | MI | 39719 | 9084 | 63127 | 6766 | 68375 | 5504 | 69774 | 4540 | 69645 | 3144 | 83424 | 2522 | 48825 |
| 16-#14 | 1.63 | MA | 42335 | 9084 | 67247 | 6784 | 73326 | 5501 | 75262 | 4557 | 75945 | 3143 | 91405 | 2625 | 52215 |
| 5E | | MI | 40514 | 9084 | 64459 | 6767 | 70185 | 5487 | 71981 | 4544 | 72568 | 3132 | 87140 | 2606 | 49881 |
| 16-#14 | 1.63 | MA | 41502 | 9084 | 65851 | 6784 | 71430 | 5519 | 72948 | 4553 | 72882 | 3155 | 87484 | 2541 | 51098 |
| 6L-4S | | MI | 41349 | 9084 | 65871 | 6767 | 72006 | 5489 | 74212 | 4529 | 75751 | 3140 | 91039 | 2670 | 50064 |
| 16-#14 | 1.63 | MA | 40689 | 9084 | 64358 | 6803 | 69609 | 5517 | 70717 | 4569 | 69885 | 3168 | 83406 | 2415 | 50239 |
| 7L-3S | | MI | 42281 | 9084 | 67482 | 6748 | 74055 | 5472 | 76699 | 4533 | 78980 | 3128 | 94783 | 2798 | 50144 |
| 16-#14 | 1.63 | MA | 39888 | 9084 | 62988 | 6803 | 67772 | 5535 | 68532 | 4585 | 66745 | 3161 | 79568 | 2340 | 49142 |
| 8L-2S | | MI | 43609 | 9084 | 69493 | 6749 | 76618 | 5474 | 79814 | 4518 | 83201 | 3116 | 100492 | 2926 | 50158 |
| 16-#18 | 2.90 | MA | 51311 | 10077 | 85450 | 7349 | 96304 | 5907 | 103112 | 4783 | 113658 | 3043 | 140627 | 2763 | 91436 |
| 2L-8S | | MI | 39773 | 10077 | 65801 | 7384 | 71433 | 5959 | 73434 | 4851 | 74347 | 3072 | 91094 | 1662 | 74783 |
| 16-#18 | 2.90 | MA | 48936 | 10077 | 81749 | 7346 | 91585 | 5937 | 97376 | 4809 | 105887 | 3063 | 130181 | 2535 | 91163 |
| 3L-7S | | MI | 41080 | 10077 | 68102 | 7386 | 74518 | 5966 | 77103 | 4826 | 79617 | 3089 | 97428 | 1791 | 77979 |
| 16-#18 | 2.90 | MA | 47268 | 10077 | 78778 | 7380 | 87807 | 5931 | 92791 | 4800 | 99934 | 3082 | 123339 | 2308 | 90550 |
| 4L-6S | | MI | 42405 | 10077 | 70610 | 7354 | 77575 | 5937 | 80849 | 4800 | 84648 | 3071 | 104123 | 2016 | 81372 |
| 16-#18 | 2.90 | MA | 45777 | 10077 | 76174 | 7377 | 84449 | 5961 | 88678 | 4826 | 94065 | 3066 | 116192 | 2196 | 87250 |
| 5E | | MI | 43762 | 10077 | 72954 | 7357 | 80759 | 5944 | 84732 | 4810 | 89789 | 3053 | 110554 | 2166 | 83226 |
| 16-#18 | 2.90 | MA | 44355 | 10077 | 73717 | 7375 | 81110 | 5955 | 84606 | 4817 | 88674 | 3086 | 109397 | 2046 | 85310 |
| 6L-4S | | MI | 45186 | 10077 | 75438 | 7360 | 83961 | 5915 | 88654 | 4785 | 95384 | 3070 | 117333 | 2277 | 86376 |
| 16-#18 | 2.90 | MA | 42967 | 10077 | 71087 | 7408 | 77905 | 5985 | 80678 | 4843 | 83398 | 3105 | 102326 | 1821 | 81682 |
| 7L-3S | | MI | 46777 | 10077 | 78269 | 7328 | 87562 | 5921 | 93024 | 4795 | 101058 | 3052 | 123806 | 2504 | 86941 |
| 16-#18 | 2.90 | MA | 41599 | 10077 | 68675 | 7406 | 74671 | 5979 | 76832 | 4870 | 77872 | 3090 | 95647 | 1691 | 78315 |
| 8L-2S | | MI | 49038 | 10077 | 81793 | 7331 | 92055 | 5892 | 98485 | 4770 | 108457 | 3034 | 133697 | 2732 | 87191 |
| 18-#11 | 1.27 | MA | 43908 | 8803 | 68800 | 6608 | 75449 | 5376 | 77904 | 4463 | 79569 | 3153 | 95472 | 2999 | 41376 |
| 2L-9S | | MI | 37634 | 8803 | 58706 | 6619 | 62843 | 5395 | 63071 | 4489 | 60532 | 3178 | 71243 | 2507 | 37939 |
| 18-#11 | 1.27 | MA | 42926 | 8803 | 67327 | 6608 | 73571 | 5375 | 75622 | 4475 | 76476 | 3162 | 91246 | 2910 | 41391 |
| 3L-8S | | MI | 38200 | 8803 | 59600 | 6619 | 64037 | 5396 | 64574 | 4492 | 62504 | 3170 | 73773 | 2563 | 38379 |
| 18-#11 | 1.27 | MA | 42237 | 8803 | 66149 | 6622 | 72073 | 5388 | 73803 | 4472 | 74115 | 3171 | 88469 | 2821 | 41375 |
| 4L-7S | | MI | 38738 | 8803 | 60511 | 6619 | 65258 | 5384 | 66027 | 4481 | 64592 | 3175 | 76327 | 2615 | 38797 |
| 18-#11 | 1.27 | MA | 41622 | 8803 | 65118 | 6622 | 70743 | 5386 | 72174 | 4484 | 71790 | 3167 | 85592 | 2776 | 41320 |
| 5L-6S | | MI | 39284 | 8803 | 61504 | 6606 | 66469 | 5385 | 67510 | 4469 | 66585 | 3166 | 79043 | 2702 | 39389 |
| 18-#11 | 1.27 | MA | 41036 | 8803 | 64146 | 6622 | 69422 | 5399 | 70562 | 4482 | 69655 | 3176 | 82839 | 2718 | 41207 |
| 6L-5S | | MI | 39843 | 8803 | 62432 | 6606 | 67730 | 5373 | 69049 | 4472 | 68622 | 3157 | 81654 | 2760 | 39486 |
| 18-#11 | 1.27 | MA | 40465 | 8803 | 63105 | 6636 | 68153 | 5398 | 69007 | 4493 | 67567 | 3185 | 79976 | 2631 | 40575 |
| 7L-4S | | MI | 40430 | 8803 | 63416 | 6606 | 68999 | 5374 | 70604 | 4461 | 70841 | 3162 | 84386 | 2805 | 39531 |
| 18-#11 | 1.27 | MA | 39896 | 8803 | 62152 | 6636 | 66873 | 5411 | 67485 | 4505 | 65379 | 3181 | 77287 | 2578 | 40122 |
| 8L-3S | | MI | 41087 | 8803 | 64540 | 6593 | 70429 | 5362 | 72338 | 4464 | 73093 | 3153 | 87018 | 2894 | 39538 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

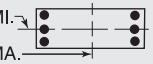



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.27 | MA | 39300 | 8803 | 61215 | 6636 | 65623 | 5409 | 65911 | 4503 | 63313 | 3190 | 74620 | 2522 | 39646 |
| 9L-2S | | MI | 42023 | 8803 | 65943 | 6593 | 72218 | 5363 | 74514 | 4452 | 76040 | 3144 | 91028 | 2983 | 39520 |
| 18-#14 | 1.83 | MA | 46564 | 9244 | 74636 | 6865 | 82764 | 5560 | 86748 | 4574 | 91528 | 3115 | 111507 | 2927 | 58962 |
| 2L-9S | | MI | 38348 | 9244 | 61122 | 6883 | 65735 | 5588 | 66519 | 4611 | 65180 | 3150 | 78024 | 2220 | 51694 |
| 18-#14 | 1.83 | MA | 45177 | 9244 | 72526 | 6865 | 80074 | 5558 | 83478 | 4590 | 87098 | 3128 | 105485 | 2799 | 58916 |
| 3L-8S | | MI | 39140 | 9244 | 62405 | 6884 | 67448 | 5591 | 68675 | 4616 | 68010 | 3138 | 81624 | 2301 | 52881 |
| 18-#14 | 1.83 | MA | 44204 | 9244 | 70836 | 6884 | 77925 | 5576 | 80870 | 4586 | 83712 | 3140 | 101532 | 2671 | 58798 |
| 4L-7S | | MI | 39901 | 9244 | 63712 | 6885 | 69201 | 5574 | 70760 | 4600 | 71006 | 3146 | 85268 | 2376 | 53995 |
| 18-#14 | 1.83 | MA | 43335 | 9244 | 69357 | 6884 | 76016 | 5574 | 78532 | 4602 | 80376 | 3133 | 97427 | 2606 | 58564 |
| 5L-6S | | MI | 40672 | 9244 | 65138 | 6865 | 70938 | 5576 | 72889 | 4585 | 73866 | 3134 | 89134 | 2502 | 54764 |
| 18-#14 | 1.83 | MA | 42507 | 9244 | 67961 | 6883 | 74120 | 5591 | 76218 | 4598 | 77312 | 3146 | 93506 | 2522 | 57335 |
| 6L-5S | | MI | 41463 | 9244 | 66469 | 6866 | 72748 | 5559 | 75097 | 4589 | 76789 | 3122 | 92850 | 2586 | 55930 |
| 18-#14 | 1.83 | MA | 41699 | 9244 | 66468 | 6903 | 72299 | 5589 | 73987 | 4614 | 74315 | 3158 | 89427 | 2396 | 56504 |
| 7L-4S | | MI | 42293 | 9244 | 67881 | 6867 | 74569 | 5561 | 77327 | 4574 | 79971 | 3130 | 96748 | 2650 | 56140 |
| 18-#14 | 1.83 | MA | 40902 | 9244 | 65098 | 6902 | 70462 | 5607 | 71802 | 4630 | 71175 | 3151 | 85590 | 2321 | 55324 |
| 8L-3S | | MI | 43221 | 9244 | 69493 | 6848 | 76618 | 5544 | 79814 | 4578 | 83201 | 3118 | 100492 | 2778 | 56243 |
| 18-#14 | 1.83 | MA | 40060 | 9244 | 63754 | 6902 | 68667 | 5605 | 69542 | 4627 | 68209 | 3163 | 81791 | 2240 | 54054 |
| 9L-2S | | MI | 44541 | 9244 | 71503 | 6849 | 79181 | 5547 | 82930 | 4563 | 87422 | 3106 | 106202 | 2906 | 56281 |
| 18-#18 | 3.26 | MA | 50608 | 10361 | 85450 | 7524 | 96304 | 6066 | 103112 | 4889 | 113658 | 3045 | 140627 | 2496 | 102318 |
| 3L-8S | | MI | 41420 | 10361 | 69325 | 7561 | 75925 | 6088 | 78895 | 4931 | 81745 | 3054 | 100986 | 1620 | 84970 |
| 18-#18 | 3.26 | MA | 48954 | 10361 | 82479 | 7557 | 92525 | 6060 | 98527 | 4880 | 107705 | 3065 | 133785 | 2268 | 101556 |
| 4L-7S | | MI | 42715 | 10361 | 71626 | 7564 | 79010 | 6094 | 82564 | 4905 | 87015 | 3071 | 107320 | 1749 | 88268 |
| 18-#18 | 3.26 | MA | 47476 | 10361 | 79875 | 7555 | 89167 | 6090 | 94414 | 4906 | 101836 | 3049 | 126638 | 2156 | 98142 |
| 5L-6S | | MI | 44029 | 10361 | 74134 | 7531 | 82067 | 6066 | 86310 | 4880 | 92047 | 3053 | 114015 | 1974 | 91552 |
| 18-#18 | 3.26 | MA | 46066 | 10361 | 77418 | 7552 | 85829 | 6084 | 90342 | 4897 | 96445 | 3068 | 119843 | 2007 | 96023 |
| 6L-5S | | MI | 45374 | 10361 | 76478 | 7534 | 85251 | 6072 | 90193 | 4890 | 97188 | 3035 | 120446 | 2124 | 93587 |
| 18-#18 | 3.26 | MA | 44691 | 10361 | 74788 | 7585 | 82624 | 6114 | 86414 | 4923 | 91169 | 3088 | 112772 | 1782 | 92506 |
| 7L-4S | | MI | 46786 | 10361 | 78961 | 7537 | 88454 | 6043 | 94115 | 4865 | 102782 | 3052 | 127225 | 2235 | 96759 |
| 18-#18 | 3.26 | MA | 43335 | 10361 | 72376 | 7583 | 79389 | 6108 | 82568 | 4949 | 85643 | 3072 | 106093 | 1651 | 89037 |
| 8L-3S | | MI | 48364 | 10361 | 81793 | 7505 | 92055 | 6050 | 98485 | 4875 | 108457 | 3034 | 133697 | 2462 | 97562 |
| 20-#11 | 1.41 | MA | 44605 | 8914 | 70272 | 6678 | 77326 | 5426 | 80187 | 4494 | 82661 | 3146 | 99697 | 2987 | 45870 |
| 2L-10S | | MI | 37724 | 8914 | 59134 | 6702 | 63427 | 5457 | 63803 | 4532 | 61521 | 3180 | 72798 | 2430 | 41355 |
| 20-#11 | 1.41 | MA | 43626 | 8914 | 68800 | 6678 | 75449 | 5425 | 77904 | 4506 | 79569 | 3155 | 95472 | 2898 | 45872 |
| 3L-9S | | MI | 38313 | 8914 | 60110 | 6688 | 64633 | 5445 | 65246 | 4520 | 63479 | 3171 | 75252 | 2493 | 42063 |
| 20-#11 | 1.41 | MA | 42940 | 8914 | 67622 | 6691 | 73951 | 5438 | 76086 | 4504 | 77207 | 3164 | 92695 | 2809 | 45843 |
| 4L-8S | | MI | 38877 | 8914 | 61004 | 6688 | 65826 | 5446 | 66749 | 4523 | 65451 | 3163 | 77782 | 2549 | 42560 |
| 20-#11 | 1.41 | MA | 42328 | 8914 | 66591 | 6691 | 72621 | 5437 | 74457 | 4515 | 74882 | 3160 | 89818 | 2764 | 45774 |
| 5L-7S | | MI | 39413 | 8914 | 61914 | 6688 | 67048 | 5434 | 68202 | 4512 | 67539 | 3168 | 80336 | 2602 | 42966 |
| 20-#11 | 1.41 | MA | 41744 | 8914 | 65619 | 6691 | 71299 | 5449 | 72844 | 4513 | 72747 | 3169 | 87065 | 2706 | 45602 |
| 6E | | MI | 39956 | 8914 | 62908 | 6675 | 68258 | 5435 | 69686 | 4501 | 69532 | 3159 | 83052 | 2689 | 43570 |
| 20-#11 | 1.41 | MA | 41175 | 8914 | 64578 | 6705 | 70031 | 5448 | 71290 | 4524 | 70659 | 3178 | 84202 | 2618 | 44951 |
| 7L-5S | | MI | 40513 | 8914 | 63836 | 6675 | 69520 | 5423 | 71224 | 4503 | 71569 | 3150 | 85663 | 2747 | 43733 |
| 20-#11 | 1.41 | MA | 40614 | 8914 | 63624 | 6705 | 68751 | 5461 | 69768 | 4536 | 68471 | 3174 | 81513 | 2566 | 44511 |
| 8L-4S | | MI | 41098 | 8914 | 64820 | 6675 | 70789 | 5424 | 72779 | 4492 | 73788 | 3155 | 88396 | 2792 | 43791 |
| 20-#11 | 1.41 | MA | 40015 | 8914 | 62688 | 6705 | 67501 | 5460 | 68193 | 4534 | 66405 | 3183 | 78846 | 2510 | 43978 |
| 9L-3S | | MI | 41752 | 8914 | 65943 | 6662 | 72218 | 5412 | 74514 | 4495 | 76040 | 3146 | 91028 | 2881 | 43816 |
| 20-#11 | 1.41 | MA | 39398 | 8914 | 61665 | 6719 | 66237 | 5472 | 66681 | 4545 | 64354 | 3192 | 76258 | 2447 | 43220 |
| 10L-2S | | MI | 42684 | 8914 | 67347 | 6662 | 74007 | 5413 | 76689 | 4483 | 78987 | 3137 | 95037 | 2970 | 43805 |
| 20-#14 | 2.04 | MA | 47541 | 9403 | 76746 | 6965 | 85454 | 5633 | 90018 | 4619 | 95959 | 3105 | 117528 | 2908 | 65375 |
| 2L-10S | | MI | 38477 | 9403 | 61731 | 7002 | 66567 | 5678 | 67563 | 4672 | 66592 | 3152 | 80241 | 2108 | 56128 |
| 20-#14 | 2.04 | MA | 46160 | 9403 | 74636 | 6964 | 82764 | 5630 | 86748 | 4635 | 91528 | 3118 | 111507 | 2780 | 65310 |
| 3L-9S | | MI | 39310 | 9403 | 63132 | 6983 | 68298 | 5661 | 69634 | 4656 | 69401 | 3140 | 83733 | 2200 | 57617 |
| 20-#14 | 2.04 | MA | 45193 | 9403 | 72946 | 6984 | 80615 | 5648 | 84140 | 4631 | 88142 | 3130 | 107554 | 2652 | 65169 |
| 4L-8S | | MI | 40096 | 9403 | 64415 | 6984 | 70011 | 5663 | 71791 | 4661 | 72231 | 3128 | 87333 | 2281 | 58772 |
| 20-#14 | 2.04 | MA | 44328 | 9403 | 71467 | 6983 | 78706 | 5646 | 81802 | 4647 | 84806 | 3123 | 103448 | 2587 | 64898 |
| 5L-7S | | MI | 40853 | 9403 | 65722 | 6984 | 71764 | 5646 | 73876 | 4645 | 75227 | 3136 | 90977 | 2355 | 59966 |
| 20-#14 | 2.04 | MA | 43505 | 9403 | 70071 | 6983 | 76810 | 5664 | 79488 | 4643 | 81742 | 3136 | 99527 | 2503 | 63581 |
| 6E | | MI | 41620 | 9403 | 67148 | 6965 | 73501 | 5648 | 76005 | 4630 | 78087 | 3124 | 94843 | 2481 | 60712 |
| 20-#14 | 2.04 | MA | 42702 | 9403 | 68577 | 7003 | 74989 | 5662 | 77257 | 4659 | 78745 | 3148 | 95449 | 2377 | 62775 |
| 7L-5S | | MI | 42406 | 9403 | 68480 | 6966 | 75311 | 5631 | 78212 | 4634 | 81010 | 3112 | 98559 | 2566 | 61935 |

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

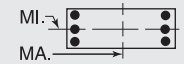



$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.04 | MA | 41910 | 9403 | 67208 | 7002 | 73152 | 5679 | 75072 | 4675 | 75605 | 3141 | 91611 | 2302 | 61516 |
| 8L-4S | | MI | 43232 | 9403 | 69891 | 6967 | 77132 | 5634 | 80442 | 4619 | 84192 | 3120 | 102458 | 2629 | 62211 |
| 20-#14 | 2.04 | MA | 41073 | 9403 | 65864 | 7002 | 71357 | 5677 | 72812 | 4671 | 72639 | 3153 | 87812 | 2221 | 60278 |
| 9L-3S | | MI | 44154 | 9403 | 71503 | 6948 | 79181 | 5617 | 82930 | 4623 | 87422 | 3108 | 106202 | 2757 | 62337 |
| 20-#14 | 2.04 | MA | 40200 | 9403 | 64396 | 7021 | 69544 | 5695 | 70641 | 4687 | 69696 | 3166 | 84127 | 2130 | 58703 |
| 10L-2S | | MI | 45469 | 9403 | 73513 | 6948 | 81744 | 5619 | 86045 | 4608 | 91642 | 3096 | 111911 | 2885 | 62392 |
| 20-#18 | 3.62 | MA | 50626 | 10645 | 86180 | 7734 | 97244 | 6188 | 104263 | 4959 | 115475 | 3047 | 144231 | 2229 | 112330 |
| 4L-8S | | MI | 43053 | 10645 | 72848 | 7738 | 80417 | 6216 | 84357 | 5010 | 89144 | 3036 | 110877 | 1578 | 95175 |
| 20-#18 | 3.62 | MA | 49160 | 10645 | 83576 | 7732 | 93885 | 6218 | 100150 | 4986 | 109607 | 3031 | 137084 | 2117 | 109052 |
| 5L-7S | | MI | 44337 | 10645 | 75149 | 7741 | 83503 | 6223 | 88025 | 4985 | 94414 | 3054 | 117211 | 1707 | 98574 |
| 20-#18 | 3.62 | MA | 47763 | 10645 | 81119 | 7730 | 90547 | 6213 | 96078 | 4977 | 104216 | 3051 | 130289 | 1967 | 106759 |
| 6E | | MI | 45639 | 10645 | 77658 | 7709 | 86560 | 6194 | 91771 | 4960 | 99445 | 3035 | 123906 | 1932 | 101756 |
| 20-#18 | 3.62 | MA | 46401 | 10645 | 78489 | 7763 | 87342 | 6242 | 92150 | 5003 | 98940 | 3070 | 123217 | 1742 | 103347 |
| 7L-5S | | MI | 46973 | 10645 | 80002 | 7712 | 89743 | 6201 | 95654 | 4970 | 104586 | 3017 | 130337 | 2082 | 103966 |
| 20-#18 | 3.62 | MA | 45057 | 10645 | 76077 | 7761 | 84107 | 6237 | 88304 | 5029 | 93414 | 3054 | 116539 | 1612 | 99778 |
| 8L-4S | | MI | 48374 | 10645 | 82485 | 7715 | 92946 | 6172 | 99576 | 4945 | 110181 | 3035 | 137116 | 2192 | 107006 |
| 22-#11 | 1.55 | MA | 45298 | 9025 | 71745 | 6747 | 79204 | 5476 | 82469 | 4525 | 85753 | 3139 | 103923 | 2974 | 50360 |
| 2L-11S | | MI | 37829 | 9025 | 59643 | 6770 | 64029 | 5506 | 64492 | 4560 | 62409 | 3168 | 74313 | 2362 | 44842 |
| 22-#11 | 1.55 | MA | 44323 | 9025 | 70272 | 6747 | 77326 | 5475 | 80187 | 4537 | 82661 | 3148 | 99697 | 2886 | 50348 |
| 3L-10S | | MI | 38403 | 9025 | 60537 | 6771 | 65216 | 5507 | 65978 | 4563 | 64468 | 3173 | 76808 | 2417 | 45502 |
| 22-#11 | 1.55 | MA | 43640 | 9025 | 69094 | 6761 | 75828 | 5488 | 78368 | 4535 | 80300 | 3157 | 96921 | 2797 | 50308 |
| 4L-9S | | MI | 38990 | 9025 | 61513 | 6757 | 66422 | 5495 | 67421 | 4551 | 66425 | 3165 | 79262 | 2480 | 46192 |
| 22-#11 | 1.55 | MA | 43030 | 9025 | 68063 | 6761 | 74498 | 5487 | 76739 | 4546 | 77974 | 3153 | 94044 | 2752 | 50225 |
| 5L-8S | | MI | 39551 | 9025 | 62407 | 6757 | 67615 | 5496 | 68924 | 4554 | 68398 | 3156 | 81791 | 2536 | 46743 |
| 22-#11 | 1.55 | MA | 42449 | 9025 | 67091 | 6761 | 73177 | 5499 | 75127 | 4544 | 75839 | 3162 | 91291 | 2694 | 49960 |
| 6L-7S | | MI | 40084 | 9025 | 63318 | 6758 | 68837 | 5484 | 70377 | 4543 | 70486 | 3161 | 84346 | 2589 | 47139 |
| 22-#11 | 1.55 | MA | 41883 | 9025 | 66051 | 6774 | 71908 | 5498 | 73572 | 4556 | 73751 | 3171 | 88428 | 2606 | 49331 |
| 7L-6S | | MI | 40626 | 9025 | 64311 | 6744 | 70048 | 5485 | 71861 | 4532 | 72479 | 3152 | 87061 | 2676 | 47722 |
| 22-#11 | 1.55 | MA | 41324 | 9025 | 65097 | 6774 | 70629 | 5511 | 72050 | 4567 | 71563 | 3167 | 85739 | 2554 | 48902 |
| 8L-5S | | MI | 41180 | 9025 | 65239 | 6744 | 71309 | 5473 | 73399 | 4534 | 74516 | 3143 | 89672 | 2734 | 47977 |
| 22-#11 | 1.55 | MA | 40728 | 9025 | 64160 | 6774 | 69378 | 5510 | 70475 | 4565 | 69497 | 3176 | 83072 | 2498 | 48315 |
| 9L-4S | | MI | 41763 | 9025 | 66223 | 6745 | 72578 | 5474 | 74954 | 4523 | 76735 | 3148 | 92405 | 2779 | 48048 |
| 22-#11 | 1.55 | MA | 40113 | 9025 | 63138 | 6788 | 68115 | 5522 | 68963 | 4576 | 67446 | 3185 | 80484 | 2434 | 47575 |
| 10L-3S | | MI | 42414 | 9025 | 67347 | 6731 | 74007 | 5462 | 76689 | 4526 | 78987 | 3139 | 95037 | 2868 | 48081 |
| 22-#11 | 1.55 | MA | 39512 | 9025 | 62202 | 6788 | 66872 | 5521 | 67407 | 4574 | 65289 | 3181 | 77857 | 2379 | 46871 |
| 11L-2S | | MI | 43343 | 9025 | 68750 | 6731 | 75797 | 5464 | 78864 | 4515 | 81934 | 3131 | 99046 | 2957 | 48086 |
| 22-#14 | 2.24 | MA | 47137 | 9563 | 76746 | 7064 | 85454 | 5703 | 90018 | 4680 | 95959 | 3108 | 117528 | 2761 | 71699 |
| 3L-10S | | MI | 39436 | 9563 | 63741 | 7102 | 69130 | 5750 | 70678 | 4717 | 70813 | 3142 | 85951 | 2088 | 62006 |
| 22-#14 | 2.24 | MA | 46175 | 9563 | 75056 | 7084 | 83305 | 5720 | 87410 | 4676 | 92572 | 3120 | 113576 | 2633 | 71537 |
| 4L-9S | | MI | 40265 | 9563 | 65142 | 7082 | 70860 | 5733 | 72749 | 4701 | 73622 | 3130 | 89442 | 2179 | 63546 |
| 22-#14 | 2.24 | MA | 45316 | 9563 | 73576 | 7083 | 81396 | 5718 | 85072 | 4692 | 89236 | 3113 | 109470 | 2568 | 71105 |
| 5L-8S | | MI | 41047 | 9563 | 66426 | 7083 | 72573 | 5736 | 74906 | 4706 | 76452 | 3118 | 93043 | 2260 | 64672 |
| 22-#14 | 2.24 | MA | 44497 | 9563 | 72181 | 7083 | 79499 | 5736 | 82758 | 4688 | 86172 | 3126 | 105549 | 2484 | 69835 |
| 6L-7S | | MI | 41799 | 9563 | 67733 | 7084 | 74327 | 5718 | 76991 | 4690 | 79448 | 3126 | 96686 | 2335 | 65942 |
| 22-#14 | 2.24 | MA | 43699 | 9563 | 70687 | 7102 | 77679 | 5734 | 80527 | 4704 | 83175 | 3138 | 101471 | 2358 | 69051 |
| 7L-6S | | MI | 42562 | 9563 | 69158 | 7065 | 76064 | 5721 | 79120 | 4675 | 82308 | 3114 | 100552 | 2461 | 66667 |
| 22-#14 | 2.24 | MA | 42911 | 9563 | 69318 | 7102 | 75842 | 5752 | 78342 | 4720 | 80035 | 3131 | 97633 | 2283 | 67715 |
| 8L-5S | | MI | 43344 | 9563 | 70490 | 7066 | 77873 | 5704 | 81328 | 4679 | 85231 | 3102 | 104268 | 2545 | 67845 |
| 22-#14 | 2.24 | MA | 42079 | 9563 | 67974 | 7101 | 74047 | 5750 | 76082 | 4716 | 77069 | 3143 | 93834 | 2202 | 66508 |
| 9L-4S | | MI | 44165 | 9563 | 71901 | 7067 | 79694 | 5706 | 83558 | 4664 | 88413 | 3110 | 108167 | 2609 | 68278 |
| 22-#14 | 2.24 | MA | 41210 | 9563 | 66506 | 7121 | 72234 | 5767 | 73911 | 4732 | 74126 | 3156 | 90149 | 2111 | 64882 |
| 10L-3S | | MI | 45083 | 9563 | 73513 | 7047 | 81744 | 5689 | 86045 | 4668 | 91642 | 3098 | 111911 | 2737 | 68424 |
| 22-#18 | 3.99 | MA | 50832 | 10928 | 87277 | 7909 | 98604 | 6347 | 105886 | 5066 | 117378 | 3013 | 147530 | 2077 | 119978 |
| 5L-8S | | MI | 44673 | 10928 | 76372 | 7915 | 84910 | 6345 | 89818 | 5090 | 96542 | 3019 | 120769 | 1536 | 105397 |
| 22-#18 | 3.99 | MA | 49447 | 10928 | 84820 | 7907 | 95266 | 6341 | 101814 | 5056 | 111987 | 3033 | 140735 | 1928 | 117516 |
| 6L-7S | | MI | 45946 | 10928 | 78673 | 7918 | 87995 | 6352 | 93486 | 5065 | 101812 | 3036 | 127103 | 1665 | 108896 |
| 22-#18 | 3.99 | MA | 48096 | 10928 | 82190 | 7940 | 92060 | 6371 | 97886 | 5083 | 106711 | 3052 | 133663 | 1703 | 114203 |
| 7L-6S | | MI | 47237 | 10928 | 81181 | 7886 | 91052 | 6323 | 97233 | 5040 | 106844 | 3018 | 133797 | 1889 | 111982 |
| 22-#18 | 3.99 | MA | 46763 | 10928 | 79778 | 7938 | 88826 | 6365 | 94040 | 5109 | 101185 | 3037 | 126985 | 1572 | 110536 |
| 8L-5S | | MI | 48560 | 10928 | 83525 | 7889 | 94236 | 6329 | 101116 | 5050 | 111985 | 3000 | 140229 | 2040 | 114361 |

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 1.70 | MA | 45988 | 9135 | 73218 | 6816 | 81081 | 5526 | 84751 | 4557 | 88845 | 3132 | 108149 | 2962 | 54843 |
| 2L-12S | | MI | 37945 | 9135 | 60086 | 6853 | 64621 | 5568 | 65227 | 4602 | 63402 | 3170 | 75579 | 2275 | 48091 |
| 24-#11 | 1.70 | MA | 45016 | 9135 | 71745 | 6816 | 79204 | 5525 | 82469 | 4568 | 85753 | 3141 | 103923 | 2874 | 54820 |
| 3L-11S | | MI | 38507 | 9135 | 61047 | 6840 | 65819 | 5556 | 66667 | 4591 | 65356 | 3161 | 78322 | 2349 | 48955 |
| 24-#11 | 1.70 | MA | 44336 | 9135 | 70567 | 6830 | 77706 | 5538 | 80651 | 4566 | 83392 | 3151 | 101147 | 2785 | 54769 |
| 4L-10S | | MI | 39078 | 9135 | 61941 | 6840 | 67005 | 5557 | 68153 | 4594 | 67415 | 3166 | 80817 | 2404 | 49653 |
| 24-#11 | 1.70 | MA | 43729 | 9135 | 69536 | 6830 | 76376 | 5537 | 79021 | 4577 | 81066 | 3146 | 98270 | 2740 | 54674 |
| 5L-9S | | MI | 39663 | 9135 | 62917 | 6826 | 68211 | 5545 | 69597 | 4583 | 69372 | 3158 | 83271 | 2467 | 50326 |
| 24-#11 | 1.70 | MA | 43151 | 9135 | 68564 | 6830 | 75054 | 5549 | 77409 | 4575 | 78932 | 3155 | 95517 | 2681 | 54325 |
| 6L-8S | | MI | 40222 | 9135 | 63811 | 6827 | 69405 | 5546 | 71100 | 4585 | 71345 | 3149 | 85800 | 2523 | 50929 |
| 24-#11 | 1.70 | MA | 42586 | 9135 | 67523 | 6844 | 73786 | 5548 | 75855 | 4587 | 76843 | 3164 | 92654 | 2594 | 53716 |
| 7E | | MI | 40753 | 9135 | 64721 | 6827 | 70626 | 5534 | 72552 | 4574 | 73433 | 3154 | 88355 | 2576 | 51316 |
| 24-#11 | 1.70 | MA | 42030 | 9135 | 66569 | 6844 | 72506 | 5561 | 74333 | 4598 | 74655 | 3160 | 89965 | 2541 | 53295 |
| 8L-6S | | MI | 41292 | 9135 | 65715 | 6813 | 71837 | 5536 | 74036 | 4563 | 75426 | 3145 | 91071 | 2663 | 51880 |
| 24-#11 | 1.70 | MA | 41437 | 9135 | 65633 | 6844 | 71256 | 5560 | 72758 | 4596 | 72589 | 3169 | 87298 | 2486 | 52657 |
| 9L-5S | | MI | 41844 | 9135 | 66643 | 6813 | 73098 | 5523 | 75575 | 4565 | 77463 | 3136 | 93681 | 2721 | 52218 |
| 24-#11 | 1.70 | MA | 40824 | 9135 | 64611 | 6857 | 69992 | 5573 | 71246 | 4607 | 70538 | 3178 | 84710 | 2422 | 51934 |
| 10L-4S | | MI | 42424 | 9135 | 67626 | 6814 | 74368 | 5525 | 77129 | 4554 | 79682 | 3141 | 96414 | 2766 | 52301 |
| 24-#11 | 1.70 | MA | 40225 | 9135 | 63674 | 6857 | 68749 | 5571 | 69689 | 4605 | 68381 | 3174 | 82083 | 2367 | 51193 |
| 11L-3S | | MI | 43073 | 9135 | 68750 | 6800 | 75797 | 5512 | 78864 | 4557 | 81934 | 3132 | 99046 | 2855 | 52345 |
| 24-#11 | 1.70 | MA | 39636 | 9135 | 62668 | 6871 | 67495 | 5584 | 68181 | 4617 | 66334 | 3183 | 79192 | 2292 | 50269 |
| 12L-2S | | MI | 43999 | 9135 | 70154 | 6800 | 77586 | 5514 | 81039 | 4546 | 84881 | 3124 | 103056 | 2943 | 52364 |
| 24-#14 | 2.45 | MA | 47153 | 9723 | 77166 | 7183 | 85995 | 5793 | 90680 | 4721 | 97002 | 3110 | 119597 | 2613 | 77901 |
| 4L-10S | | MI | 40390 | 9723 | 65752 | 7201 | 71693 | 5823 | 73793 | 4762 | 75034 | 3132 | 91660 | 2068 | 67890 |
| 24-#14 | 2.45 | MA | 46298 | 9723 | 75686 | 7183 | 84086 | 5791 | 88342 | 4737 | 93666 | 3103 | 115492 | 2549 | 77322 |
| 5L-9S | | MI | 41222 | 9723 | 67152 | 7182 | 73423 | 5805 | 75865 | 4746 | 77843 | 3120 | 95152 | 2159 | 69482 |
| 24-#14 | 2.45 | MA | 45484 | 9723 | 74291 | 7183 | 82189 | 5808 | 86028 | 4733 | 90603 | 3116 | 111571 | 2465 | 76096 |
| 6L-8S | | MI | 41993 | 9723 | 68436 | 7183 | 75136 | 5808 | 78022 | 4750 | 80673 | 3108 | 98752 | 2240 | 70580 |
| 24-#14 | 2.45 | MA | 44690 | 9723 | 72797 | 7202 | 80369 | 5806 | 83797 | 4749 | 87605 | 3128 | 107492 | 2339 | 75331 |
| 7E | | MI | 42741 | 9723 | 69743 | 7184 | 76889 | 5791 | 80106 | 4735 | 83668 | 3116 | 102396 | 2314 | 71922 |
| 24-#14 | 2.45 | MA | 43907 | 9723 | 71428 | 7202 | 78532 | 5824 | 81612 | 4765 | 84465 | 3121 | 103654 | 2264 | 73923 |
| 8L-6S | | MI | 43499 | 9723 | 71168 | 7165 | 78627 | 5793 | 82236 | 4720 | 86528 | 3104 | 106262 | 2441 | 72629 |
| 24-#14 | 2.45 | MA | 43079 | 9723 | 70083 | 7201 | 76737 | 5822 | 79352 | 4761 | 81500 | 3134 | 99856 | 2183 | 72744 |
| 9L-5S | | MI | 44277 | 9723 | 72500 | 7165 | 80436 | 5776 | 84443 | 4724 | 89451 | 3092 | 109978 | 2525 | 73766 |
| 24-#14 | 2.45 | MA | 42215 | 9723 | 68616 | 7221 | 74924 | 5840 | 77182 | 4777 | 78556 | 3146 | 96170 | 2092 | 71068 |
| 10L-4S | | MI | 45093 | 9723 | 73911 | 7166 | 82257 | 5778 | 86673 | 4708 | 92634 | 3100 | 113876 | 2588 | 74342 |
| 24-#18 | 4.35 | MA | 51119 | 11212 | 88521 | 8084 | 99984 | 6470 | 107550 | 5136 | 119758 | 3015 | 151181 | 1888 | 128293 |
| 6L-8S | | MI | 46280 | 11212 | 79895 | 8093 | 89402 | 6474 | 95279 | 5170 | 103941 | 3001 | 130660 | 1493 | 115634 |
| 24-#18 | 4.35 | MA | 49778 | 11212 | 85891 | 8117 | 96779 | 6499 | 103622 | 5163 | 114482 | 3035 | 144109 | 1663 | 125074 |
| 7E | | MI | 47543 | 11212 | 82197 | 8096 | 92487 | 6480 | 98947 | 5145 | 109211 | 3018 | 136994 | 1622 | 119233 |
| 24-#18 | 4.35 | MA | 48457 | 11212 | 83479 | 8115 | 93544 | 6494 | 99776 | 5189 | 108956 | 3019 | 137431 | 1533 | 121309 |
| 8L-6S | | MI | 48824 | 11212 | 84705 | 8063 | 95544 | 6451 | 102694 | 5120 | 114242 | 3000 | 143689 | 1847 | 122227 |

## RECTANGULAR TIED COLUMNS 48" x 48"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.04 | MA | 44446 | 8998 | 69373 | 6720 | 75257 | 5477 | 76921 | 4564 | 77042 | 3270 | 90878 | 3094 | 35158 |
| 2L-3S | | MI | 41970 | 8998 | 65672 | 6718 | 70539 | 5506 | 71185 | 4590 | 69272 | 3290 | 80433 | 2867 | 35247 |
| 8-#18 | 1.39 | MA | 46183 | 9282 | 73074 | 6897 | 79976 | 5605 | 82657 | 4643 | 84813 | 3252 | 101324 | 3055 | 46489 |
| 2L-4S | | MI | 41996 | 9282 | 66402 | 6928 | 71479 | 5629 | 72336 | 4661 | 71089 | 3291 | 84036 | 2600 | 46240 |
| 10-#18 | 1.74 | MA | 47902 | 9566 | 76775 | 7075 | 84694 | 5734 | 88393 | 4723 | 92584 | 3235 | 111770 | 3015 | 57786 |
| 2L-5S | | MI | 42213 | 9566 | 67499 | 7103 | 72839 | 5787 | 73958 | 4767 | 72992 | 3258 | 87335 | 2448 | 55090 |
| 10-#18 | 1.74 | MA | 45467 | 9566 | 73074 | 7072 | 79976 | 5763 | 82657 | 4750 | 84813 | 3254 | 101324 | 2788 | 57716 |
| 3L-4S | | MI | 43751 | 9566 | 70103 | 7105 | 76198 | 5758 | 78071 | 4740 | 78860 | 3274 | 94482 | 2560 | 57365 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 24"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.63 | MA | 6948 | 2870 | 11203 | 2038 | 11892 | 1651 | 12021 | 1359 | 11923 | 934 | 13819 | 844 | 6459 |
| 2L-3S | | MI | 6527 | 2870 | 10576 | 2030 | 11102 | 1660 | 11077 | 1368 | 10670 | 942 | 12200 | 757 | 6509 |
| 6-#14 | 2.34 | MA | 7283 | 3013 | 12015 | 2115 | 12850 | 1700 | 13154 | 1380 | 13424 | 899 | 15719 | 778 | 9036 |
| 2L-3S | | MI | 6691 | 3013 | 11125 | 2103 | 11739 | 1712 | 11825 | 1393 | 11661 | 911 | 13453 | 654 | 9083 |
| 6-#18 | 4.17 | MA | 8076 | 3376 | 13914 | 2309 | 15133 | 1822 | 15862 | 1431 | 17015 | 804 | 20208 | 596 | 15265 |
| 2L-3S | | MI | 7075 | 3376 | 12404 | 2287 | 13256 | 1844 | 13617 | 1453 | 14035 | 826 | 16416 | 375 | 14920 |
| 8-#11 | 2.17 | MA | 7221 | 2977 | 11829 | 2105 | 12682 | 1698 | 12965 | 1385 | 13176 | 916 | 15437 | 807 | 8455 |
| 2L-4S | | MI | 6499 | 2977 | 10682 | 2107 | 11242 | 1698 | 11251 | 1385 | 10966 | 934 | 12766 | 641 | 8493 |
| 8-#14 | 3.13 | MA | 7664 | 3168 | 12905 | 2212 | 13961 | 1766 | 14482 | 1416 | 15187 | 872 | 17986 | 722 | 11848 |
| 2L-4S | | MI | 6649 | 3168 | 11273 | 2213 | 11935 | 1766 | 12070 | 1416 | 12078 | 897 | 14242 | 486 | 11209 |
| 8-#18 | 5.56 | MA | 8711 | 3652 | 15424 | 2480 | 17011 | 1937 | 18107 | 1489 | 19996 | 750 | 24000 | 484 | 20041 |
| 2L-4S | | MI | 6999 | 3652 | 12653 | 2480 | 13586 | 1937 | 14028 | 1489 | 14741 | 794 | 17725 | 72 | 17318 |
| 10-#11 | 2.71 | MA | 7493 | 3085 | 12456 | 2173 | 13472 | 1745 | 13909 | 1410 | 14429 | 899 | 17056 | 771 | 10436 |
| 2L-5S | | MI | 6503 | 3085 | 10854 | 2167 | 11457 | 1753 | 11509 | 1419 | 11257 | 908 | 13269 | 566 | 9873 |
| 10-#11 | 2.71 | MA | 7078 | 3085 | 11829 | 2165 | 12682 | 1753 | 12965 | 1419 | 13176 | 908 | 15437 | 684 | 10458 |
| 3L-4S | | MI | 6776 | 3085 | 11308 | 2174 | 12032 | 1745 | 12195 | 1410 | 12219 | 916 | 14384 | 605 | 10338 |
| 10-#14 | 3.91 | MA | 8042 | 3324 | 13795 | 2310 | 15073 | 1833 | 15811 | 1451 | 16950 | 845 | 20252 | 666 | 14646 |
| 2L-5S | | MI | 6652 | 3324 | 11515 | 2298 | 12237 | 1845 | 12433 | 1464 | 12599 | 883 | 14946 | 373 | 13186 |
| 10-#14 | 3.91 | MA | 7460 | 3324 | 12905 | 2297 | 13961 | 1845 | 14482 | 1464 | 15187 | 858 | 17986 | 541 | 14604 |
| 3L-4S | | MI | 7035 | 3324 | 12163 | 2310 | 13046 | 1833 | 13398 | 1451 | 13841 | 870 | 16508 | 429 | 13773 |
| 10-#18 | 6.94 | MA | 8363 | 3929 | 15424 | 2628 | 17011 | 2073 | 18107 | 1570 | 19996 | 718 | 24000 | 150 | 23318 |
| 3L-4S | | MI | 7647 | 3929 | 14163 | 2650 | 15463 | 2051 | 16274 | 1547 | 17721 | 740 | 21517 | -41 | 21357 |

## RECTANGULAR TIED COLUMNS 24" x 26"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#11 | 1.00 | MA | 7801 | 2974 | 12289 | 2143 | 12959 | 1748 | 12937 | 1457 | 12445 | 1047 | 14252 | 977 | 4861 |
| 2E | | MI | 7181 | 2974 | 11353 | 2123 | 11896 | 1730 | 11842 | 1441 | 11351 | 1033 | 12947 | 959 | 4470 |
| 4-#14 | 1.44 | MA | 8056 | 3069 | 12901 | 2190 | 13681 | 1779 | 13786 | 1470 | 13569 | 1024 | 15686 | 935 | 6803 |
| 2E | | MI | 7407 | 3069 | 11903 | 2170 | 12532 | 1758 | 12589 | 1451 | 12339 | 1007 | 14196 | 913 | 6234 |
| 4-#18 | 2.56 | MA | 8664 | 3311 | 14387 | 2317 | 15415 | 1857 | 15833 | 1502 | 16278 | 962 | 19108 | 820 | 11512 |
| 2E | | MI | 7943 | 3311 | 13186 | 2289 | 14047 | 1832 | 14377 | 1478 | 14708 | 939 | 17152 | 787 | 10490 |
| 6-#11 | 1.50 | MA | 8111 | 3082 | 12983 | 2210 | 13846 | 1796 | 13997 | 1484 | 13851 | 1032 | 16081 | 944 | 7091 |
| 2L-3S | | MI | 7037 | 3082 | 11353 | 2183 | 11896 | 1785 | 11842 | 1475 | 11351 | 1024 | 12947 | 837 | 6548 |
| 6-#11 | 1.50 | MA | 7645 | 3082 | 12289 | 2203 | 12959 | 1805 | 12937 | 1492 | 12445 | 1040 | 14252 | 857 | 7141 |
| 3L-2S | | MI | 7458 | 3082 | 11979 | 2191 | 12686 | 1777 | 12787 | 1466 | 12603 | 1016 | 14565 | 923 | 6495 |
| 6-#14 | 2.16 | MA | 8490 | 3225 | 13889 | 2287 | 14932 | 1847 | 15282 | 1507 | 15552 | 1000 | 18255 | 884 | 9947 |
| 2L-3S | | MI | 7200 | 3225 | 11903 | 2255 | 12532 | 1837 | 12589 | 1499 | 12339 | 993 | 14196 | 733 | 9139 |
| 6-#14 | 2.16 | MA | 7832 | 3225 | 12901 | 2277 | 13681 | 1859 | 13786 | 1520 | 13569 | 1012 | 15686 | 760 | 9994 |
| 3L-2S | | MI | 7794 | 3225 | 12794 | 2267 | 13643 | 1825 | 13918 | 1487 | 14102 | 980 | 16463 | 857 | 9082 |
| 6-#18 | 3.85 | MA | 9389 | 3588 | 16094 | 2490 | 17540 | 1975 | 18373 | 1564 | 19649 | 913 | 23435 | 719 | 16885 |
| 2L-3S | | MI | 7585 | 3588 | 13186 | 2437 | 14047 | 1968 | 14377 | 1558 | 14708 | 907 | 17152 | 453 | 15244 |
| 6-#18 | 3.85 | MA | 8275 | 3588 | 14387 | 2468 | 15415 | 1997 | 15833 | 1587 | 16278 | 935 | 19108 | 497 | 16745 |
| 3L-2S | | MI | 8588 | 3588 | 14696 | 2459 | 15925 | 1946 | 16622 | 1536 | 17688 | 884 | 20944 | 674 | 15334 |
| 8-#11 | 2.00 | MA | 8419 | 3190 | 13677 | 2278 | 14733 | 1844 | 15057 | 1511 | 15257 | 1016 | 17910 | 911 | 9297 |
| 2L-4S | | MI | 7009 | 3190 | 11458 | 2260 | 12036 | 1824 | 12016 | 1492 | 11647 | 1016 | 13513 | 721 | 8556 |
| 8-#11 | 2.00 | MA | 7955 | 3190 | 12983 | 2271 | 13846 | 1853 | 13997 | 1519 | 13851 | 1025 | 16081 | 825 | 9333 |
| 3E | | MI | 7314 | 3190 | 11979 | 2250 | 12686 | 1832 | 12787 | 1500 | 12603 | 1007 | 14565 | 800 | 8537 |
| 8-#11 | 2.00 | MA | 7619 | 3190 | 12408 | 2281 | 13117 | 1844 | 13133 | 1511 | 12778 | 1033 | 14894 | 743 | 9335 |
| 4L-2S | | MI | 7732 | 3190 | 12606 | 2258 | 13476 | 1824 | 13731 | 1492 | 13856 | 999 | 16184 | 887 | 8496 |
| 8-#14 | 2.88 | MA | 8919 | 3381 | 14876 | 2385 | 16184 | 1915 | 16777 | 1545 | 17536 | 976 | 20825 | 833 | 13063 |
| 2L-4S | | MI | 7158 | 3381 | 12051 | 2365 | 12728 | 1891 | 12834 | 1522 | 12756 | 979 | 14985 | 564 | 11419 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 26"

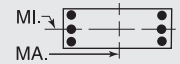
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.88 | MA | 8267 | 3381 | 13889 | 2374 | 14932 | 1928 | 15282 | 1557 | 15552 | 988 | 18255 | 709 | 13069 |
| 3E | | MI | 7588 | 3381 | 12794 | 2352 | 13643 | 1904 | 13918 | 1535 | 14102 | 966 | 16463 | 677 | 11924 |
| 8-#14 | 2.88 | MA | 7794 | 3381 | 13069 | 2388 | 13903 | 1915 | 14063 | 1545 | 14037 | 1001 | 16586 | 593 | 12508 |
| 4L-2S | | MI | 8176 | 3381 | 13684 | 2364 | 14754 | 1891 | 15246 | 1522 | 15865 | 954 | 18729 | 801 | 11901 |
| 8-#18 | 5.13 | MA | 10105 | 3865 | 17801 | 2663 | 19664 | 2093 | 20913 | 1627 | 23020 | 865 | 27762 | 617 | 22201 |
| 2L-4S | | MI | 7506 | 3865 | 13435 | 2630 | 14377 | 2060 | 14789 | 1594 | 15413 | 875 | 18461 | 149 | 17600 |
| 8-#18 | 5.13 | MA | 9004 | 3865 | 16094 | 2641 | 17540 | 2115 | 18373 | 1649 | 19649 | 887 | 23435 | 396 | 21568 |
| 3E | | MI | 8233 | 3865 | 14696 | 2608 | 15925 | 2082 | 16622 | 1616 | 17688 | 853 | 20944 | 340 | 19454 |
| 8-#18 | 5.13 | MA | 8204 | 3865 | 14670 | 2663 | 15790 | 2093 | 16300 | 1627 | 17076 | 909 | 20612 | 198 | 19371 |
| 4L-2S | | MI | 9226 | 3865 | 16206 | 2630 | 17802 | 2060 | 18868 | 1594 | 20669 | 830 | 24736 | 562 | 20125 |
| 10-#11 | 2.50 | MA | 8723 | 3298 | 14372 | 2345 | 15620 | 1892 | 16117 | 1538 | 16664 | 1001 | 19739 | 878 | 11489 |
| 2L-5S | | MI | 7011 | 3298 | 11631 | 2320 | 12251 | 1879 | 12274 | 1526 | 11937 | 990 | 14016 | 645 | 10020 |
| 10-#11 | 2.50 | MA | 8262 | 3298 | 13677 | 2338 | 14733 | 1901 | 15057 | 1546 | 15257 | 1009 | 17910 | 792 | 11511 |
| 3L-4S | | MI | 7285 | 3298 | 12085 | 2327 | 12826 | 1871 | 12961 | 1517 | 12900 | 998 | 15131 | 684 | 10500 |
| 10-#11 | 2.50 | MA | 7929 | 3298 | 13102 | 2349 | 14004 | 1892 | 14193 | 1538 | 14184 | 1018 | 16724 | 710 | 11482 |
| 4L-3S | | MI | 7588 | 3298 | 12606 | 2318 | 13476 | 1879 | 13731 | 1526 | 13856 | 990 | 16184 | 764 | 10510 |
| 10-#11 | 2.50 | MA | 7629 | 3298 | 12602 | 2342 | 13358 | 1901 | 13422 | 1546 | 13104 | 1009 | 15463 | 672 | 10939 |
| 5L-2S | | MI | 8004 | 3298 | 13233 | 2326 | 14266 | 1871 | 14675 | 1517 | 15109 | 981 | 17803 | 850 | 10481 |
| 10-#14 | 3.61 | MA | 9343 | 3536 | 15864 | 2482 | 17435 | 1984 | 18272 | 1582 | 19520 | 952 | 23395 | 783 | 16164 |
| 2L-5S | | MI | 7160 | 3536 | 12294 | 2450 | 13030 | 1970 | 13197 | 1570 | 13277 | 964 | 15690 | 452 | 13448 |
| 10-#14 | 3.61 | MA | 8696 | 3536 | 14876 | 2471 | 16184 | 1996 | 16777 | 1595 | 17536 | 964 | 20825 | 658 | 16123 |
| 3L-4S | | MI | 7545 | 3536 | 12942 | 2462 | 13839 | 1958 | 14162 | 1558 | 14519 | 952 | 17252 | 508 | 13980 |
| 10-#14 | 3.61 | MA | 8228 | 3536 | 14056 | 2486 | 15154 | 1984 | 15558 | 1582 | 16021 | 977 | 19155 | 543 | 15355 |
| 4L-3S | | MI | 7971 | 3536 | 13684 | 2449 | 14754 | 1970 | 15246 | 1570 | 15865 | 939 | 18729 | 620 | 14683 |
| 10-#14 | 3.61 | MA | 7806 | 3536 | 13341 | 2475 | 14244 | 1996 | 14471 | 1595 | 14497 | 964 | 17384 | 487 | 14721 |
| 5L-2S | | MI | 8555 | 3536 | 14574 | 2461 | 15866 | 1958 | 16575 | 1558 | 17628 | 927 | 20996 | 745 | 14700 |
| 10-#18 | 6.41 | MA | 9725 | 4141 | 17801 | 2814 | 19664 | 2233 | 20913 | 1711 | 23020 | 838 | 27762 | 294 | 26297 |
| 3L-4S | | MI | 8156 | 4141 | 14945 | 2800 | 16255 | 2174 | 17034 | 1652 | 18394 | 821 | 22253 | 37 | 22035 |
| 10-#18 | 6.41 | MA | 8934 | 4141 | 16377 | 2836 | 17915 | 2210 | 18841 | 1689 | 20447 | 860 | 24939 | 96 | 24321 |
| 4L-3S | | MI | 8875 | 4141 | 16206 | 2778 | 17802 | 2196 | 18868 | 1674 | 20669 | 799 | 24736 | 228 | 23683 |
| 12-#11 | 3.00 | MA | 9026 | 3405 | 15066 | 2412 | 16507 | 1941 | 17177 | 1565 | 18070 | 985 | 21569 | 845 | 13671 |
| 2L-6S | | MI | 7027 | 3405 | 11797 | 2397 | 12464 | 1918 | 12566 | 1560 | 12321 | 981 | 14599 | 551 | 11518 |
| 12-#11 | 3.00 | MA | 8568 | 3405 | 14372 | 2406 | 15620 | 1949 | 16117 | 1573 | 16664 | 994 | 19739 | 759 | 13674 |
| 3L-5S | | MI | 7287 | 3405 | 12257 | 2387 | 13041 | 1926 | 13219 | 1551 | 13190 | 973 | 15634 | 609 | 11874 |
| 12-#11 | 3.00 | MA | 8237 | 3405 | 13797 | 2416 | 14891 | 1941 | 15253 | 1565 | 15590 | 1002 | 18553 | 677 | 13523 |
| 4E | | MI | 7560 | 3405 | 12712 | 2395 | 13616 | 1918 | 13905 | 1543 | 14152 | 981 | 16750 | 648 | 12321 |
| 12-#11 | 3.00 | MA | 7938 | 3405 | 13296 | 2410 | 14245 | 1949 | 14482 | 1573 | 14510 | 994 | 17292 | 639 | 12995 |
| 5L-3S | | MI | 7861 | 3405 | 13233 | 2385 | 14266 | 1926 | 14675 | 1551 | 15109 | 973 | 17803 | 727 | 12473 |
| 12-#11 | 3.00 | MA | 7654 | 3405 | 12825 | 2403 | 13598 | 1941 | 13749 | 1582 | 13535 | 1002 | 16120 | 581 | 12596 |
| 6L-2S | | MI | 8275 | 3405 | 13860 | 2393 | 15056 | 1918 | 15619 | 1543 | 16362 | 964 | 19421 | 814 | 12457 |
| 12-#14 | 4.33 | MA | 9122 | 3692 | 15864 | 2569 | 17435 | 2064 | 18272 | 1632 | 19520 | 940 | 23395 | 608 | 19165 |
| 3L-5S | | MI | 7546 | 3692 | 13184 | 2548 | 14142 | 2037 | 14525 | 1605 | 15040 | 937 | 17956 | 395 | 15995 |
| 12-#14 | 4.33 | MA | 8658 | 3692 | 15044 | 2583 | 16405 | 2052 | 17053 | 1620 | 18005 | 953 | 21725 | 492 | 18226 |
| 4E | | MI | 7928 | 3692 | 13832 | 2560 | 14951 | 2024 | 15491 | 1593 | 16282 | 925 | 19518 | 452 | 16563 |
| 12-#14 | 4.33 | MA | 8239 | 3692 | 14329 | 2572 | 15495 | 2064 | 15966 | 1632 | 16481 | 940 | 19954 | 436 | 17608 |
| 5L-3S | | MI | 8351 | 3692 | 14574 | 2547 | 15866 | 2037 | 16575 | 1605 | 17628 | 913 | 20996 | 564 | 17429 |
| 12-#18 | 7.69 | MA | 9656 | 4418 | 18084 | 3009 | 20040 | 2328 | 21381 | 1751 | 23818 | 812 | 29267 | -6 | 29234 |
| 4E | | MI | 8869 | 4418 | 16454 | 2970 | 18132 | 2288 | 19279 | 1710 | 21374 | 767 | 26045 | -76 | 25700 |
| 14-#11 | 3.50 | MA | 8870 | 3513 | 15066 | 2473 | 16507 | 1997 | 17177 | 1600 | 18070 | 978 | 21569 | 726 | 15827 |
| 3L-6S | | MI | 7303 | 3513 | 12424 | 2464 | 13254 | 1965 | 13510 | 1585 | 13574 | 964 | 16218 | 515 | 13313 |
| 14-#11 | 3.50 | MA | 8542 | 3513 | 14491 | 2484 | 15778 | 1989 | 16313 | 1591 | 16996 | 987 | 20382 | 644 | 15547 |
| 4L-5S | | MI | 7561 | 3513 | 12884 | 2455 | 13831 | 1973 | 14163 | 1577 | 14443 | 955 | 17253 | 573 | 13737 |
| 14-#11 | 3.50 | MA | 8245 | 3513 | 13990 | 2477 | 15132 | 1997 | 15542 | 1600 | 15916 | 978 | 19121 | 606 | 15059 |
| 5L-4S | | MI | 7832 | 3513 | 13339 | 2462 | 14406 | 1965 | 14849 | 1568 | 15405 | 964 | 18368 | 611 | 14146 |
| 14-#11 | 3.50 | MA | 7962 | 3513 | 13519 | 2470 | 14485 | 1989 | 14809 | 1609 | 14941 | 987 | 17949 | 548 | 14592 |
| 6L-3S | | MI | 8132 | 3513 | 13860 | 2453 | 15056 | 1973 | 15619 | 1577 | 16362 | 955 | 19421 | 691 | 14419 |
| 14-#14 | 5.05 | MA | 9084 | 3847 | 16031 | 2680 | 17657 | 2120 | 18548 | 1658 | 19988 | 929 | 24295 | 441 | 21116 |
| 4L-5S | | MI | 7929 | 3847 | 14074 | 2645 | 15253 | 2103 | 15854 | 1641 | 16803 | 911 | 20223 | 339 | 18494 |

## RECTANGULAR TIED COLUMNS 24" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 5.05 | MA | 8668 | 3847 | 15316 | 2670 | 16746 | 2133 | 17461 | 1670 | 18465 | 916 | 22523 | 385 | 20395 |
| 5L-4S | | MI | 8309 | 3847 | 14722 | 2657 | 16062 | 2091 | 16820 | 1628 | 18045 | 898 | 21785 | 396 | 19164 |
| 16-#11 | 4.00 | MA | 8844 | 3621 | 15185 | 2551 | 16665 | 2037 | 17373 | 1618 | 18402 | 971 | 22212 | 611 | 17582 |
| 4L-6S | | MI | 7577 | 3621 | 13051 | 2532 | 14044 | 2012 | 14454 | 1611 | 14826 | 947 | 17837 | 478 | 15120 |
| 16-#11 | 4.00 | MA | 8550 | 3621 | 14684 | 2544 | 16019 | 2046 | 16602 | 1627 | 17322 | 963 | 20951 | 573 | 17129 |
| 5E | | MI | 7834 | 3621 | 13511 | 2522 | 14621 | 2020 | 15107 | 1602 | 15695 | 938 | 18871 | 536 | 15605 |
| 16-#11 | 4.00 | MA | 8269 | 3621 | 14213 | 2538 | 15372 | 2037 | 15869 | 1636 | 16347 | 971 | 19779 | 515 | 16599 |
| 6L-4S | | MI | 8103 | 3621 | 13965 | 2530 | 15196 | 2012 | 15794 | 1594 | 16658 | 947 | 19987 | 575 | 15982 |
| 16-#14 | 5.77 | MA | 9094 | 4003 | 16304 | 2767 | 17997 | 2201 | 18957 | 1708 | 20448 | 892 | 25093 | 335 | 23201 |
| 5E | | MI | 8310 | 4003 | 14964 | 2742 | 16365 | 2170 | 17182 | 1676 | 18566 | 884 | 22489 | 283 | 21012 |
| 18-#11 | 4.50 | MA | 8852 | 3729 | 15378 | 2612 | 16906 | 2094 | 17663 | 1654 | 18728 | 947 | 22780 | 540 | 19205 |
| 5L-6S | | MI | 7849 | 3729 | 13678 | 2599 | 14834 | 2059 | 15398 | 1637 | 16079 | 929 | 19455 | 442 | 16935 |
| 18-#11 | 4.50 | MA | 8573 | 3729 | 14907 | 2605 | 16259 | 2085 | 16929 | 1663 | 17753 | 956 | 21608 | 482 | 18616 |
| 6L-5S | | MI | 8105 | 3729 | 14138 | 2590 | 15411 | 2067 | 16051 | 1628 | 16948 | 921 | 20490 | 500 | 17478 |
| 20-#11 | 5.00 | MA | 8875 | 3837 | 15602 | 2673 | 17146 | 2133 | 17989 | 1689 | 19159 | 940 | 23437 | 449 | 20641 |
| 6E | | MI | 8119 | 3837 | 14304 | 2667 | 15624 | 2105 | 16343 | 1662 | 17332 | 912 | 21074 | 405 | 18758 |

## RECTANGULAR TIED COLUMNS 24" x 28"

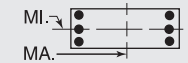
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.34 | MA | 9301 | 3281 | 14798 | 2362 | 15756 | 1923 | 15880 | 1594 | 15598 | 1121 | 18057 | 1034 | 7411 |
| 2E | | MI | 7917 | 3281 | 12682 | 2322 | 13325 | 1883 | 13353 | 1557 | 13017 | 1089 | 14939 | 992 | 6271 |
| 4-#18 | 2.38 | MA | 9982 | 3524 | 16443 | 2489 | 17708 | 2005 | 18183 | 1630 | 18645 | 1063 | 21940 | 928 | 12592 |
| 2E | | MI | 8454 | 3524 | 13968 | 2439 | 14839 | 1955 | 15138 | 1583 | 15380 | 1019 | 17888 | 865 | 10546 |
| 6-#11 | 1.39 | MA | 9361 | 3294 | 14884 | 2382 | 15909 | 1939 | 16105 | 1608 | 15901 | 1129 | 18481 | 1042 | 7723 |
| 2L-3S | | MI | 7546 | 3294 | 12130 | 2336 | 12689 | 1911 | 12608 | 1582 | 12031 | 1107 | 13694 | 916 | 6585 |
| 6-#11 | 1.39 | MA | 8847 | 3294 | 14123 | 2377 | 14933 | 1948 | 14929 | 1616 | 14342 | 1137 | 16440 | 956 | 7773 |
| 3L-2S | | MI | 7968 | 3294 | 12756 | 2344 | 13479 | 1903 | 13552 | 1573 | 13284 | 1098 | 15312 | 1002 | 6530 |
| 6-#14 | 2.01 | MA | 9783 | 3437 | 15883 | 2460 | 17147 | 1993 | 17542 | 1633 | 17803 | 1099 | 20931 | 987 | 10859 |
| 2L-3S | | MI | 7710 | 3437 | 12682 | 2407 | 13325 | 1962 | 13353 | 1605 | 13017 | 1074 | 14939 | 812 | 9191 |
| 6-#14 | 2.01 | MA | 9059 | 3437 | 14798 | 2450 | 15756 | 2006 | 15880 | 1645 | 15598 | 1112 | 18057 | 863 | 10906 |
| 3L-2S | | MI | 8304 | 3437 | 13572 | 2419 | 14436 | 1950 | 14682 | 1593 | 14780 | 1062 | 17206 | 936 | 9127 |
| 6-#18 | 3.57 | MA | 10791 | 3800 | 18323 | 2662 | 20081 | 2126 | 21019 | 1696 | 22408 | 1020 | 26805 | 836 | 18505 |
| 2L-3S | | MI | 8094 | 3800 | 13968 | 2587 | 14839 | 2091 | 15138 | 1663 | 15380 | 987 | 17888 | 531 | 15353 |
| 6-#18 | 3.57 | MA | 9561 | 3800 | 16443 | 2643 | 17708 | 2148 | 18183 | 1718 | 18645 | 1042 | 21940 | 614 | 18365 |
| 3L-2S | | MI | 9101 | 3800 | 15478 | 2609 | 16717 | 2069 | 17383 | 1641 | 18361 | 965 | 21680 | 752 | 15400 |
| 8-#11 | 1.86 | MA | 9702 | 3402 | 15646 | 2450 | 16885 | 1987 | 17281 | 1636 | 17461 | 1115 | 20522 | 1012 | 10139 |
| 2L-4S | | MI | 7518 | 3402 | 12235 | 2413 | 12829 | 1950 | 12782 | 1598 | 12327 | 1098 | 14259 | 800 | 8612 |
| 8-#11 | 1.86 | MA | 9192 | 3402 | 14884 | 2444 | 15909 | 1997 | 16105 | 1644 | 15901 | 1123 | 18481 | 926 | 10176 |
| 3E | | MI | 7823 | 3402 | 12756 | 2403 | 13479 | 1958 | 13552 | 1607 | 13284 | 1089 | 15312 | 880 | 8581 |
| 8-#11 | 1.86 | MA | 8825 | 3402 | 14256 | 2455 | 15108 | 1989 | 15147 | 1636 | 14710 | 1132 | 17160 | 842 | 10178 |
| 4L-2S | | MI | 8243 | 3402 | 13383 | 2411 | 14269 | 1950 | 14496 | 1598 | 14537 | 1081 | 16931 | 966 | 8536 |
| 8-#14 | 2.68 | MA | 10260 | 3593 | 16968 | 2557 | 18537 | 2063 | 19205 | 1672 | 20008 | 1078 | 23804 | 941 | 14278 |
| 2L-4S | | MI | 7667 | 3593 | 12830 | 2517 | 13521 | 2016 | 13598 | 1628 | 13434 | 1060 | 15728 | 643 | 11622 |
| 8-#14 | 2.68 | MA | 9542 | 3593 | 15883 | 2548 | 17147 | 2075 | 17542 | 1685 | 17803 | 1090 | 20931 | 817 | 14284 |
| 3E | | MI | 8098 | 3593 | 13572 | 2504 | 14436 | 2029 | 14682 | 1641 | 14780 | 1048 | 17206 | 755 | 11989 |
| 8-#14 | 2.68 | MA | 9025 | 3593 | 14985 | 2563 | 16004 | 2063 | 16188 | 1672 | 16119 | 1102 | 19068 | 698 | 13832 |
| 4L-2S | | MI | 8688 | 3593 | 14463 | 2516 | 15547 | 2016 | 16010 | 1628 | 16543 | 1035 | 19472 | 880 | 11951 |
| 8-#18 | 4.76 | MA | 11589 | 4077 | 20202 | 2835 | 22454 | 2247 | 23855 | 1762 | 26171 | 976 | 31671 | 743 | 24361 |
| 2L-4S | | MI | 8014 | 4077 | 14217 | 2780 | 15169 | 2183 | 15549 | 1699 | 16086 | 955 | 19197 | 227 | 17873 |
| 8-#18 | 4.76 | MA | 10374 | 4077 | 18323 | 2816 | 20081 | 2269 | 21019 | 1784 | 22408 | 998 | 26805 | 522 | 24102 |
| 3E | | MI | 8744 | 4077 | 15478 | 2757 | 16717 | 2205 | 17383 | 1721 | 18361 | 933 | 21680 | 418 | 19817 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis

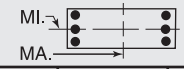



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 4.76 | MA | 9496 | 4077 | 16761 | 2841 | 18129 | 2247 | 18706 | 1762 | 19535 | 1020 | 23641 | 318 | 21457 |
| 4L-2S | | MI | 9740 | 4077 | 16988 | 2780 | 18594 | 2183 | 19628 | 1699 | 21341 | 911 | 25472 | 639 | 20206 |
| 10-#11 | 2.32 | MA | 10040 | 3510 | 16408 | 2517 | 17862 | 2036 | 18457 | 1664 | 19021 | 1101 | 22562 | 982 | 12542 |
| 2L-5S | | MI | 7520 | 3510 | 12407 | 2473 | 13044 | 2005 | 13040 | 1633 | 12617 | 1072 | 14762 | 725 | 10160 |
| 10-#11 | 2.32 | MA | 9533 | 3510 | 15646 | 2511 | 16885 | 2045 | 17281 | 1672 | 17461 | 1109 | 20522 | 896 | 12564 |
| 3L-4S | | MI | 7795 | 3510 | 12862 | 2480 | 13619 | 1996 | 13726 | 1624 | 13580 | 1081 | 15878 | 764 | 10566 |
| 10-#11 | 2.32 | MA | 9169 | 3510 | 15017 | 2523 | 16085 | 2037 | 16323 | 1664 | 16270 | 1118 | 19201 | 812 | 12535 |
| 4L-3S | | MI | 8099 | 3510 | 13383 | 2471 | 14269 | 2005 | 14496 | 1633 | 14537 | 1072 | 16931 | 843 | 10559 |
| 10-#11 | 2.32 | MA | 8841 | 3510 | 14470 | 2517 | 15376 | 2046 | 15468 | 1672 | 15073 | 1109 | 17794 | 774 | 12018 |
| 5L-2S | | MI | 8516 | 3510 | 14010 | 2478 | 15059 | 1996 | 15441 | 1624 | 15789 | 1063 | 18550 | 930 | 10525 |
| 10-#14 | 3.35 | MA | 10732 | 3748 | 18052 | 2654 | 19928 | 2133 | 20867 | 1712 | 22213 | 1056 | 26678 | 895 | 17683 |
| 2L-5S | | MI | 7668 | 3748 | 13072 | 2602 | 13823 | 2095 | 13961 | 1676 | 13955 | 1046 | 16433 | 530 | 13626 |
| 10-#14 | 3.35 | MA | 10020 | 3748 | 16968 | 2645 | 18537 | 2145 | 19205 | 1724 | 20008 | 1068 | 23804 | 771 | 17642 |
| 3L-4S | | MI | 8054 | 3748 | 13720 | 2614 | 14632 | 2083 | 14926 | 1664 | 15197 | 1033 | 17995 | 587 | 14179 |
| 10-#14 | 3.35 | MA | 9507 | 3748 | 16070 | 2661 | 17394 | 2133 | 17850 | 1712 | 18324 | 1081 | 21942 | 652 | 16964 |
| 4L-3S | | MI | 8482 | 3748 | 14463 | 2601 | 15547 | 2095 | 16010 | 1676 | 16543 | 1021 | 19472 | 699 | 14757 |
| 10-#14 | 3.35 | MA | 9046 | 3748 | 15289 | 2651 | 16382 | 2145 | 16642 | 1724 | 16631 | 1068 | 19961 | 597 | 16195 |
| 5L-2S | | MI | 9068 | 3748 | 15353 | 2613 | 16659 | 2083 | 17339 | 1664 | 18306 | 1009 | 21739 | 824 | 14756 |
| 10-#18 | 5.95 | MA | 11176 | 4353 | 20202 | 2989 | 22454 | 2390 | 23855 | 1850 | 26171 | 954 | 31671 | 429 | 29343 |
| 3L-4S | | MI | 8664 | 4353 | 15727 | 2950 | 17047 | 2297 | 17795 | 1757 | 19067 | 901 | 22989 | 115 | 22304 |
| 10-#18 | 5.95 | MA | 10309 | 4353 | 18640 | 3014 | 20501 | 2367 | 21542 | 1827 | 23298 | 976 | 28507 | 225 | 26918 |
| 4L-3S | | MI | 9387 | 4353 | 16988 | 2928 | 18594 | 2319 | 19628 | 1779 | 21341 | 879 | 25472 | 305 | 24038 |
| 12-#11 | 2.79 | MA | 10376 | 3618 | 17169 | 2585 | 18838 | 2084 | 19633 | 1692 | 20580 | 1087 | 24603 | 953 | 14935 |
| 2L-6S | | MI | 7535 | 3618 | 12574 | 2550 | 13257 | 2043 | 13331 | 1667 | 13001 | 1063 | 15346 | 631 | 11744 |
| 12-#11 | 2.79 | MA | 9872 | 3618 | 16408 | 2579 | 17862 | 2093 | 18457 | 1701 | 19021 | 1095 | 22562 | 866 | 14937 |
| 3L-5S | | MI | 7796 | 3618 | 13034 | 2540 | 13834 | 2052 | 13984 | 1658 | 13870 | 1055 | 16381 | 688 | 12014 |
| 12-#11 | 2.79 | MA | 9510 | 3618 | 15779 | 2590 | 17061 | 2086 | 17499 | 1692 | 17829 | 1104 | 21242 | 782 | 14883 |
| 4E | | MI | 8070 | 3618 | 13489 | 2548 | 14409 | 2043 | 14671 | 1650 | 14833 | 1063 | 17497 | 727 | 12484 |
| 12-#11 | 2.79 | MA | 9184 | 3618 | 15232 | 2584 | 16353 | 2095 | 16645 | 1701 | 16633 | 1095 | 19835 | 745 | 14274 |
| 5L-3S | | MI | 8372 | 3618 | 14010 | 2538 | 15059 | 2052 | 15441 | 1658 | 15789 | 1055 | 18550 | 807 | 12526 |
| 12-#11 | 2.79 | MA | 8874 | 3618 | 14718 | 2578 | 15642 | 2087 | 15831 | 1709 | 15551 | 1104 | 18525 | 687 | 13935 |
| 6L-2S | | MI | 8787 | 3618 | 14637 | 2546 | 15849 | 2043 | 16385 | 1650 | 17042 | 1046 | 20168 | 893 | 12504 |
| 12-#14 | 4.02 | MA | 10493 | 3904 | 18052 | 2742 | 19928 | 2215 | 20867 | 1764 | 22213 | 1047 | 26678 | 725 | 20988 |
| 3L-5S | | MI | 8055 | 3904 | 13962 | 2699 | 14935 | 2162 | 15289 | 1712 | 15718 | 1019 | 18700 | 474 | 16259 |
| 12-#14 | 4.02 | MA | 9984 | 3904 | 17155 | 2758 | 18785 | 2203 | 19513 | 1751 | 20529 | 1059 | 24816 | 606 | 20120 |
| 4E | | MI | 8439 | 3904 | 14611 | 2711 | 15744 | 2149 | 16255 | 1699 | 16960 | 1007 | 20261 | 531 | 16760 |
| 12-#14 | 4.02 | MA | 9527 | 3904 | 16374 | 2749 | 17773 | 2215 | 18304 | 1764 | 18836 | 1047 | 22835 | 551 | 19413 |
| 5L-3S | | MI | 8863 | 3904 | 15353 | 2699 | 16659 | 2162 | 17339 | 1712 | 18306 | 994 | 21739 | 643 | 17510 |
| 12-#14 | 4.02 | MA | 9091 | 3904 | 15639 | 2739 | 16758 | 2203 | 17154 | 1776 | 17307 | 1059 | 20992 | 468 | 18276 |
| 6L-2S | | MI | 9445 | 3904 | 16243 | 2711 | 17770 | 2149 | 18668 | 1699 | 20069 | 982 | 24006 | 768 | 17549 |
| 12-#18 | 7.14 | MA | 11112 | 4630 | 20520 | 3187 | 22874 | 2488 | 24379 | 1893 | 27061 | 932 | 33372 | 133 | 32416 |
| 4E | | MI | 9308 | 4630 | 17236 | 3120 | 18924 | 2411 | 20040 | 1815 | 22047 | 847 | 26781 | 2 | 26768 |
| 14-#11 | 3.25 | MA | 10208 | 3725 | 17169 | 2646 | 18838 | 2142 | 19633 | 1729 | 20580 | 1081 | 24603 | 836 | 17301 |
| 3L-6S | | MI | 7812 | 3725 | 13201 | 2617 | 14047 | 2090 | 14276 | 1692 | 14254 | 1046 | 16965 | 594 | 13536 |
| 14-#11 | 3.25 | MA | 9848 | 3725 | 16541 | 2658 | 18037 | 2134 | 18675 | 1720 | 19389 | 1090 | 23283 | 753 | 17137 |
| 4L-5S | | MI | 8071 | 3725 | 13661 | 2608 | 14624 | 2099 | 14929 | 1684 | 15123 | 1037 | 18000 | 652 | 13876 |
| 14-#11 | 3.25 | MA | 9525 | 3725 | 15994 | 2652 | 17329 | 2143 | 17821 | 1729 | 18192 | 1081 | 21876 | 715 | 16540 |
| 5L-4S | | MI | 8343 | 3725 | 14116 | 2615 | 15199 | 2090 | 15615 | 1675 | 16086 | 1046 | 19115 | 691 | 14308 |
| 14-#11 | 3.25 | MA | 9216 | 3725 | 15479 | 2646 | 16619 | 2135 | 17007 | 1737 | 17110 | 1090 | 20566 | 657 | 16130 |
| 6L-3S | | MI | 8643 | 3725 | 14637 | 2606 | 15849 | 2099 | 16385 | 1684 | 17042 | 1037 | 20168 | 770 | 14482 |
| 14-#11 | 3.25 | MA | 8915 | 3725 | 14917 | 2657 | 15940 | 2145 | 16149 | 1729 | 16053 | 1099 | 19331 | 593 | 15495 |
| 7L-2S | | MI | 9056 | 3725 | 15263 | 2613 | 16639 | 2090 | 17329 | 1675 | 18295 | 1029 | 21787 | 857 | 14476 |
| 14-#14 | 4.69 | MA | 10457 | 4060 | 18240 | 2855 | 20175 | 2273 | 21175 | 1790 | 22734 | 1037 | 27690 | 560 | 23296 |
| 4L-5S | | MI | 8439 | 4060 | 14853 | 2797 | 16046 | 2228 | 16618 | 1747 | 17481 | 992 | 20966 | 418 | 18806 |
| 14-#14 | 4.69 | MA | 10004 | 4060 | 17458 | 2846 | 19163 | 2285 | 19967 | 1803 | 21041 | 1025 | 25709 | 505 | 22642 |
| 5L-4S | | MI | 8820 | 4060 | 15501 | 2809 | 16855 | 2216 | 17584 | 1735 | 18723 | 980 | 22528 | 475 | 19359 |
| 14-#14 | 4.69 | MA | 9571 | 4060 | 16723 | 2837 | 18149 | 2273 | 18817 | 1815 | 19511 | 1037 | 23866 | 422 | 21418 |
| 6L-3S | | MI | 9242 | 4060 | 16243 | 2796 | 17770 | 2228 | 18668 | 1747 | 20069 | 967 | 24006 | 587 | 20254 |

## RECTANGULAR TIED COLUMNS 24" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 3.71 | MA | 10184 | 3833 | 17302 | 2725 | 19014 | 2182 | 19851 | 1748 | 20949 | 1076 | 25323 | 723 | 19370 |
| 4L-6S | | MI | 8086 | 3833 | 13828 | 2685 | 14837 | 2137 | 15220 | 1718 | 15507 | 1029 | 18584 | 558 | 15340 |
| 16-#11 | 3.71 | MA | 9863 | 3833 | 16755 | 2719 | 18305 | 2192 | 18997 | 1757 | 19752 | 1067 | 23917 | 685 | 18813 |
| 5E | | MI | 8344 | 3833 | 14288 | 2675 | 15414 | 2146 | 15873 | 1709 | 16376 | 1020 | 19618 | 615 | 15745 |
| 16-#11 | 3.71 | MA | 9556 | 3833 | 16241 | 2713 | 17595 | 2184 | 18183 | 1765 | 18670 | 1076 | 22607 | 627 | 18336 |
| 6L-4S | | MI | 8614 | 3833 | 14742 | 2683 | 15989 | 2137 | 16559 | 1701 | 17338 | 1029 | 20734 | 654 | 16143 |
| 16-#11 | 3.71 | MA | 9257 | 3833 | 15678 | 2725 | 16916 | 2193 | 17325 | 1757 | 17613 | 1085 | 21372 | 563 | 17733 |
| 7L-3S | | MI | 8913 | 3833 | 15263 | 2673 | 16639 | 2146 | 17329 | 1709 | 18295 | 1020 | 21787 | 734 | 16428 |
| 16-#14 | 5.36 | MA | 10477 | 4215 | 18543 | 2943 | 20554 | 2355 | 21629 | 1842 | 23246 | 1003 | 28583 | 459 | 25755 |
| 5E | | MI | 8820 | 4215 | 15743 | 2894 | 17158 | 2295 | 17946 | 1783 | 19244 | 966 | 23233 | 362 | 21320 |
| 16-#14 | 5.36 | MA | 10048 | 4215 | 17808 | 2934 | 19539 | 2342 | 20479 | 1855 | 21716 | 1016 | 26740 | 376 | 24575 |
| 6L-4S | | MI | 9199 | 4215 | 16391 | 2906 | 17966 | 2283 | 18912 | 1770 | 20486 | 953 | 24795 | 419 | 21972 |
| 18-#11 | 4.18 | MA | 10198 | 3941 | 17517 | 2787 | 19282 | 2240 | 20173 | 1785 | 21312 | 1053 | 25957 | 655 | 21092 |
| 5L-6S | | MI | 8358 | 3941 | 14454 | 2752 | 15627 | 2184 | 16164 | 1743 | 16760 | 1011 | 20202 | 521 | 17154 |
| 18-#11 | 4.18 | MA | 9894 | 3941 | 17003 | 2781 | 18571 | 2232 | 19359 | 1793 | 20230 | 1062 | 24647 | 598 | 20552 |
| 6L-5S | | MI | 8615 | 3941 | 14914 | 2742 | 16204 | 2193 | 16817 | 1735 | 17629 | 1003 | 21237 | 579 | 17619 |
| 18-#11 | 4.18 | MA | 9597 | 3941 | 16440 | 2792 | 17893 | 2242 | 18501 | 1785 | 19172 | 1071 | 23412 | 533 | 19979 |
| 7L-4S | | MI | 8884 | 3941 | 15369 | 2750 | 16779 | 2184 | 17503 | 1726 | 18591 | 1011 | 22352 | 618 | 17987 |
| 18-#14 | 6.03 | MA | 10520 | 4371 | 18893 | 3031 | 20930 | 2412 | 22142 | 1894 | 23921 | 994 | 29614 | 330 | 27744 |
| 6L-5S | | MI | 9199 | 4371 | 16633 | 2991 | 18269 | 2362 | 19275 | 1818 | 21007 | 939 | 25499 | 306 | 23851 |
| 20-#11 | 4.64 | MA | 10229 | 4049 | 17764 | 2848 | 19548 | 2281 | 20535 | 1821 | 21789 | 1048 | 26688 | 568 | 22776 |
| 6E | | MI | 8630 | 4049 | 15081 | 2819 | 16417 | 2231 | 17108 | 1769 | 18012 | 994 | 21821 | 485 | 18975 |
| 20-#11 | 4.64 | MA | 9934 | 4049 | 17202 | 2860 | 18869 | 2290 | 19678 | 1813 | 20732 | 1057 | 25453 | 503 | 22230 |
| 7L-5S | | MI | 8885 | 4049 | 15541 | 2810 | 16994 | 2240 | 17761 | 1760 | 18881 | 985 | 22856 | 543 | 19496 |
| 22-#11 | 5.11 | MA | 10269 | 4157 | 17963 | 2927 | 19845 | 2338 | 20854 | 1841 | 22292 | 1042 | 27494 | 473 | 24448 |
| 7L-6S | | MI | 8899 | 4157 | 15708 | 2887 | 17207 | 2278 | 18053 | 1794 | 19265 | 977 | 23439 | 448 | 20804 |

## RECTANGULAR TIED COLUMNS 24" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.25 | MA | 10632 | 3494 | 16816 | 2535 | 17933 | 2065 | 18106 | 1717 | 17749 | 1217 | 20565 | 1131 | 8018 |
| 2E | | MI | 8427 | 3494 | 13461 | 2474 | 14118 | 2008 | 14117 | 1663 | 13694 | 1170 | 15682 | 1071 | 6307 |
| 4-#18 | 2.22 | MA | 11387 | 3736 | 18619 | 2662 | 20135 | 2152 | 20666 | 1756 | 21135 | 1164 | 24912 | 1033 | 13672 |
| 2E | | MI | 8965 | 3736 | 14750 | 2589 | 15631 | 2078 | 15898 | 1688 | 16053 | 1100 | 18624 | 942 | 10600 |
| 6-#11 | 1.30 | MA | 10696 | 3506 | 16906 | 2555 | 18095 | 2081 | 18346 | 1731 | 18073 | 1225 | 21018 | 1139 | 8354 |
| 2L-3S | | MI | 8055 | 3506 | 12906 | 2489 | 13483 | 2037 | 13374 | 1688 | 12711 | 1189 | 14441 | 996 | 6620 |
| 6-#11 | 1.30 | MA | 10135 | 3506 | 16077 | 2550 | 17032 | 2091 | 17053 | 1740 | 16359 | 1234 | 18765 | 1053 | 8404 |
| 3L-2S | | MI | 8478 | 3506 | 13533 | 2497 | 14273 | 2028 | 14318 | 1680 | 13964 | 1180 | 16059 | 1082 | 6564 |
| 6-#14 | 1.88 | MA | 11163 | 3649 | 17998 | 2632 | 19448 | 2135 | 19936 | 1758 | 20176 | 1198 | 23744 | 1089 | 11770 |
| 2L-3S | | MI | 8220 | 3649 | 13461 | 2559 | 14118 | 2087 | 14117 | 1711 | 13694 | 1156 | 15682 | 890 | 9240 |
| 6-#14 | 1.88 | MA | 10372 | 3649 | 16816 | 2624 | 17933 | 2149 | 18106 | 1770 | 17749 | 1210 | 20565 | 964 | 11817 |
| 3L-2S | | MI | 8815 | 3649 | 14351 | 2571 | 15229 | 2075 | 15446 | 1699 | 15457 | 1144 | 17949 | 1015 | 9171 |
| 6-#18 | 3.33 | MA | 12281 | 4012 | 20672 | 2835 | 22756 | 2275 | 23799 | 1825 | 25291 | 1124 | 30318 | 949 | 20125 |
| 2L-3S | | MI | 8604 | 4012 | 14750 | 2737 | 15631 | 2214 | 15898 | 1768 | 16053 | 1068 | 18624 | 608 | 15453 |
| 6-#18 | 3.33 | MA | 10934 | 4012 | 18619 | 2818 | 20135 | 2298 | 20666 | 1847 | 21135 | 1146 | 24912 | 727 | 19985 |
| 3L-2S | | MI | 9613 | 4012 | 16260 | 2759 | 17508 | 2192 | 18143 | 1746 | 19034 | 1045 | 22416 | 830 | 15465 |
| 8-#11 | 1.73 | MA | 11071 | 3614 | 17735 | 2622 | 19158 | 2129 | 19638 | 1760 | 19786 | 1212 | 23271 | 1112 | 10982 |
| 2L-4S | | MI | 8027 | 3614 | 13012 | 2566 | 13623 | 2075 | 13548 | 1705 | 13008 | 1180 | 15006 | 880 | 8662 |
| 8-#11 | 1.73 | MA | 10514 | 3614 | 16906 | 2617 | 18095 | 2139 | 18346 | 1769 | 18073 | 1221 | 21018 | 1026 | 11018 |
| 3E | | MI | 8333 | 3614 | 13533 | 2556 | 14273 | 2084 | 14318 | 1714 | 13964 | 1171 | 16059 | 959 | 8622 |
| 8-#11 | 1.73 | MA | 10116 | 3614 | 16224 | 2629 | 17226 | 2132 | 17293 | 1760 | 16764 | 1230 | 19563 | 940 | 11020 |
| 4L-2S | | MI | 8753 | 3614 | 14160 | 2564 | 15063 | 2075 | 15262 | 1705 | 15217 | 1163 | 17678 | 1045 | 8574 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 30"

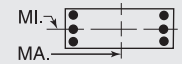
Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.50 | MA | 11688 | 3805 | 19180 | 2729 | 20963 | 2205 | 21766 | 1799 | 22602 | 1178 | 26923 | 1047 | 15493 |
| 2L-4S | | MI | 8176 | 3805 | 13609 | 2669 | 14314 | 2141 | 14362 | 1734 | 14111 | 1142 | 16472 | 722 | 11818 |
| 8-#14 | 2.50 | MA | 10904 | 3805 | 17998 | 2721 | 19448 | 2219 | 19936 | 1811 | 20176 | 1190 | 23744 | 922 | 15499 |
| 3E | | MI | 8608 | 3805 | 14351 | 2656 | 15229 | 2154 | 15446 | 1747 | 15457 | 1129 | 17949 | 834 | 12046 |
| 8-#14 | 2.50 | MA | 10342 | 3805 | 17023 | 2738 | 18206 | 2207 | 18445 | 1799 | 18322 | 1203 | 21688 | 801 | 15180 |
| 4L-2S | | MI | 9199 | 3805 | 15241 | 2668 | 16340 | 2141 | 16774 | 1734 | 17221 | 1117 | 20216 | 959 | 12000 |
| 8-#18 | 4.44 | MA | 13161 | 4289 | 22724 | 3008 | 25378 | 2399 | 26932 | 1894 | 29447 | 1084 | 35723 | 864 | 26521 |
| 2L-4S | | MI | 8521 | 4289 | 14999 | 2929 | 15961 | 2306 | 16310 | 1804 | 16759 | 1036 | 19933 | 305 | 18136 |
| 8-#18 | 4.44 | MA | 11831 | 4289 | 20672 | 2990 | 22756 | 2421 | 23799 | 1916 | 25291 | 1106 | 30318 | 643 | 26262 |
| 3E | | MI | 9255 | 4289 | 16260 | 2907 | 17508 | 2329 | 18143 | 1826 | 19034 | 1014 | 22416 | 496 | 20159 |
| 8-#18 | 4.44 | MA | 10876 | 4289 | 18972 | 3017 | 20601 | 2399 | 21245 | 1894 | 22117 | 1128 | 26811 | 433 | 23574 |
| 4L-2S | | MI | 10254 | 4289 | 17770 | 2929 | 19386 | 2306 | 20389 | 1804 | 22014 | 991 | 26208 | 717 | 20285 |
| 10-#11 | 2.17 | MA | 11443 | 3722 | 18564 | 2690 | 20221 | 2178 | 20930 | 1789 | 21500 | 1200 | 25524 | 1085 | 13595 |
| 2L-5S | | MI | 8029 | 3722 | 13184 | 2626 | 13838 | 2131 | 13806 | 1740 | 13298 | 1154 | 15509 | 804 | 10294 |
| 10-#11 | 2.17 | MA | 10890 | 3722 | 17735 | 2685 | 19158 | 2188 | 19638 | 1798 | 19786 | 1208 | 23271 | 998 | 13617 |
| 3L-4S | | MI | 8304 | 3722 | 13639 | 2633 | 14413 | 2122 | 14492 | 1731 | 14260 | 1163 | 16625 | 843 | 10627 |
| 10-#11 | 2.17 | MA | 10494 | 3722 | 17053 | 2697 | 18288 | 2181 | 18586 | 1789 | 18477 | 1217 | 21816 | 913 | 13588 |
| 4L-3S | | MI | 8609 | 3722 | 14160 | 2624 | 15063 | 2131 | 15262 | 1740 | 15217 | 1154 | 17678 | 923 | 10606 |
| 10-#11 | 2.17 | MA | 10139 | 3722 | 16460 | 2691 | 17520 | 2191 | 17646 | 1798 | 17163 | 1208 | 20263 | 875 | 13108 |
| 5L-2S | | MI | 9027 | 3722 | 14787 | 2631 | 15853 | 2122 | 16206 | 1731 | 16470 | 1146 | 19296 | 1009 | 10568 |
| 10-#14 | 3.13 | MA | 12208 | 3960 | 20362 | 2827 | 22479 | 2275 | 23595 | 1840 | 25029 | 1158 | 30102 | 1004 | 19202 |
| 2L-5S | | MI | 8176 | 3960 | 13851 | 2754 | 14616 | 2220 | 14725 | 1782 | 14633 | 1127 | 17176 | 609 | 13796 |
| 10-#14 | 3.13 | MA | 11430 | 3960 | 19180 | 2818 | 20963 | 2288 | 21766 | 1852 | 22602 | 1171 | 26923 | 880 | 19161 |
| 3L-4S | | MI | 8564 | 3960 | 14499 | 2766 | 15425 | 2208 | 15690 | 1770 | 15875 | 1115 | 18738 | 666 | 14372 |
| 10-#14 | 3.13 | MA | 10872 | 3960 | 18205 | 2835 | 19721 | 2277 | 20275 | 1840 | 20749 | 1183 | 24867 | 758 | 18596 |
| 4L-3S | | MI | 8993 | 3960 | 15241 | 2753 | 16340 | 2220 | 16774 | 1782 | 17221 | 1103 | 20216 | 778 | 14827 |
| 10-#14 | 3.13 | MA | 10372 | 3960 | 17357 | 2827 | 18623 | 2291 | 18945 | 1852 | 18887 | 1171 | 22675 | 704 | 17684 |
| 5L-2S | | MI | 9580 | 3960 | 16131 | 2765 | 17452 | 2208 | 18103 | 1770 | 18984 | 1090 | 22482 | 903 | 14810 |
| 10-#18 | 5.56 | MA | 12716 | 4566 | 22724 | 3163 | 25378 | 2544 | 26932 | 1985 | 29447 | 1066 | 35723 | 558 | 32454 |
| 3L-4S | | MI | 9173 | 4566 | 16509 | 3100 | 17838 | 2421 | 18555 | 1862 | 19740 | 982 | 23725 | 192 | 22564 |
| 10-#18 | 5.56 | MA | 11772 | 4566 | 21024 | 3190 | 23222 | 2522 | 24379 | 1963 | 26273 | 1088 | 32217 | 349 | 29548 |
| 4L-3S | | MI | 9899 | 4566 | 17770 | 3078 | 19386 | 2443 | 20389 | 1884 | 22014 | 960 | 26208 | 383 | 24382 |
| 10-#18 | 5.56 | MA | 10926 | 4566 | 19543 | 3173 | 21314 | 2544 | 22101 | 1985 | 23082 | 1066 | 28491 | 250 | 27123 |
| 5L-2S | | MI | 10889 | 4566 | 19280 | 3100 | 21263 | 2421 | 22634 | 1862 | 24995 | 937 | 30000 | 605 | 25052 |
| 12-#11 | 2.60 | MA | 11812 | 3830 | 19393 | 2757 | 21284 | 2226 | 22223 | 1818 | 23214 | 1187 | 27776 | 1057 | 16198 |
| 2L-6S | | MI | 8044 | 3830 | 13351 | 2703 | 14051 | 2169 | 14097 | 1774 | 13682 | 1145 | 16093 | 710 | 11921 |
| 12-#11 | 2.60 | MA | 11262 | 3830 | 18564 | 2752 | 20221 | 2236 | 20930 | 1827 | 21500 | 1196 | 25524 | 971 | 16201 |
| 3L-5S | | MI | 8306 | 3830 | 13811 | 2693 | 14628 | 2178 | 14750 | 1765 | 14551 | 1137 | 17128 | 768 | 12148 |
| 12-#11 | 2.60 | MA | 10869 | 3830 | 17882 | 2764 | 19351 | 2229 | 19878 | 1818 | 20191 | 1204 | 24069 | 886 | 16147 |
| 4E | | MI | 8580 | 3830 | 14266 | 2701 | 15203 | 2169 | 15436 | 1756 | 15513 | 1145 | 18244 | 807 | 12575 |
| 12-#11 | 2.60 | MA | 10516 | 3830 | 17289 | 2759 | 18583 | 2239 | 18939 | 1827 | 18877 | 1196 | 22515 | 848 | 15565 |
| 5L-3S | | MI | 8883 | 3830 | 14787 | 2691 | 15853 | 2178 | 16206 | 1765 | 16470 | 1137 | 19296 | 886 | 12578 |
| 12-#11 | 2.60 | MA | 10179 | 3830 | 16732 | 2754 | 17813 | 2232 | 18045 | 1836 | 17688 | 1204 | 21067 | 791 | 15189 |
| 6L-2S | | MI | 9298 | 3830 | 15414 | 2699 | 16643 | 2169 | 17151 | 1756 | 17723 | 1128 | 20915 | 972 | 12551 |
| 12-#14 | 3.75 | MA | 11951 | 4116 | 20362 | 2916 | 22479 | 2358 | 23595 | 1893 | 25029 | 1151 | 30102 | 838 | 22810 |
| 3L-5S | | MI | 8564 | 4116 | 14741 | 2851 | 15728 | 2287 | 16053 | 1818 | 16396 | 1101 | 19443 | 553 | 16429 |
| 12-#14 | 3.75 | MA | 11398 | 4116 | 19387 | 2932 | 21237 | 2347 | 22105 | 1881 | 23175 | 1163 | 28046 | 716 | 22039 |
| 4E | | MI | 8949 | 4116 | 15389 | 2863 | 16537 | 2274 | 17019 | 1805 | 17638 | 1088 | 21005 | 610 | 16951 |
| 12-#14 | 3.75 | MA | 10901 | 4116 | 18539 | 2924 | 20138 | 2361 | 20775 | 1893 | 21314 | 1151 | 25855 | 662 | 21194 |
| 5L-3S | | MI | 9375 | 4116 | 16131 | 2851 | 17452 | 2287 | 18103 | 1818 | 18984 | 1076 | 22482 | 722 | 17587 |
| 12-#14 | 3.75 | MA | 10429 | 4116 | 17742 | 2916 | 19037 | 2350 | 19509 | 1906 | 19630 | 1163 | 23813 | 579 | 20073 |
| 6L-2S | | MI | 9958 | 4116 | 17022 | 2863 | 18563 | 2274 | 19432 | 1805 | 20747 | 1063 | 24749 | 847 | 17606 |
| 12-#18 | 6.67 | MA | 12657 | 4842 | 23077 | 3363 | 25844 | 2645 | 27512 | 2032 | 30428 | 1048 | 37623 | 264 | 35561 |
| 4E | | MI | 9818 | 4842 | 18019 | 3270 | 19716 | 2535 | 20800 | 1920 | 22720 | 928 | 27517 | 80 | 27025 |
| 12-#18 | 6.67 | MA | 11821 | 4842 | 21596 | 3346 | 23936 | 2668 | 25234 | 2054 | 27238 | 1026 | 33897 | 166 | 32956 |
| 5L-3S | | MI | 10538 | 4842 | 19280 | 3248 | 21263 | 2557 | 22634 | 1942 | 24995 | 905 | 30000 | 271 | 28657 |
| 14-#11 | 3.03 | MA | 11632 | 3938 | 19393 | 2819 | 21284 | 2285 | 22223 | 1856 | 23214 | 1183 | 27776 | 944 | 18776 |
| 3L-6S | | MI | 8320 | 3938 | 13978 | 2770 | 14841 | 2216 | 15041 | 1799 | 14934 | 1128 | 17712 | 673 | 13752 |

## RECTANGULAR TIED COLUMNS 24" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

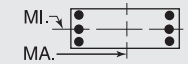
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 3.03 | MA | 11241 | 3938 | 18711 | 2831 | 20414 | 2277 | 21170 | 1847 | 21904 | 1192 | 26322 | 858 | 18701 |
| 4L-5S | | MI | 8581 | 3938 | 14438 | 2761 | 15418 | 2225 | 15694 | 1791 | 15803 | 1120 | 18747 | 731 | 14010 |
| 14-#11 | 3.03 | MA | 10890 | 3938 | 18118 | 2826 | 19646 | 2288 | 20231 | 1856 | 20590 | 1183 | 24768 | 821 | 18033 |
| 5L-4S | | MI | 8853 | 3938 | 14892 | 2768 | 15993 | 2216 | 16381 | 1782 | 16766 | 1128 | 19862 | 770 | 14464 |
| 14-#11 | 3.03 | MA | 10556 | 3938 | 17561 | 2821 | 18876 | 2281 | 19337 | 1865 | 19401 | 1192 | 23320 | 764 | 17679 |
| 6L-3S | | MI | 9155 | 3938 | 15414 | 2759 | 16643 | 2225 | 17151 | 1791 | 17723 | 1120 | 20915 | 850 | 14541 |
| 14-#11 | 3.03 | MA | 10230 | 3938 | 16951 | 2833 | 18140 | 2291 | 18395 | 1856 | 18240 | 1200 | 21961 | 698 | 16946 |
| 7L-2S | | MI | 9568 | 3938 | 16040 | 2766 | 17433 | 2216 | 18095 | 1782 | 18975 | 1111 | 22534 | 936 | 14525 |
| 14-#14 | 4.38 | MA | 11919 | 4272 | 20569 | 3030 | 22752 | 2417 | 23935 | 1922 | 25602 | 1144 | 31226 | 674 | 25502 |
| 4L-5S | | MI | 8948 | 4272 | 15631 | 2949 | 16839 | 2353 | 17382 | 1853 | 18159 | 1074 | 21709 | 497 | 19073 |
| 14-#14 | 4.38 | MA | 11426 | 4272 | 19721 | 3021 | 21654 | 2431 | 22605 | 1934 | 23740 | 1131 | 29034 | 620 | 24717 |
| 5L-4S | | MI | 9331 | 4272 | 16280 | 2961 | 17648 | 2341 | 18348 | 1841 | 19401 | 1061 | 23271 | 554 | 19548 |
| 14-#14 | 4.38 | MA | 10957 | 4272 | 18924 | 3013 | 20552 | 2420 | 21339 | 1946 | 22057 | 1144 | 26992 | 537 | 23505 |
| 6L-3S | | MI | 9754 | 4272 | 17022 | 2948 | 18563 | 2353 | 19432 | 1853 | 20747 | 1049 | 24749 | 666 | 20337 |
| 14-#18 | 7.78 | MA | 12706 | 5119 | 23648 | 3519 | 26558 | 2791 | 28367 | 2123 | 31393 | 986 | 39302 | 81 | 38827 |
| 5L-4S | | MI | 10535 | 5119 | 19528 | 3440 | 21593 | 2649 | 23046 | 1978 | 25701 | 874 | 31309 | -33 | 31138 |
| 16-#11 | 3.47 | MA | 11611 | 4046 | 19540 | 2899 | 21477 | 2326 | 22463 | 1876 | 23618 | 1179 | 28574 | 831 | 21180 |
| 4L-6S | | MI | 8595 | 4046 | 14604 | 2838 | 15631 | 2263 | 15985 | 1825 | 16187 | 1111 | 19330 | 637 | 15554 |
| 16-#11 | 3.47 | MA | 11262 | 4046 | 18947 | 2894 | 20709 | 2336 | 21524 | 1885 | 22304 | 1170 | 27021 | 793 | 20509 |
| 5E | | MI | 8854 | 4046 | 15065 | 2828 | 16208 | 2272 | 16638 | 1816 | 17056 | 1102 | 20365 | 695 | 15879 |
| 16-#11 | 3.47 | MA | 10930 | 4046 | 18390 | 2888 | 19939 | 2329 | 20630 | 1894 | 21115 | 1179 | 25573 | 736 | 20099 |
| 6L-4S | | MI | 9125 | 4046 | 15519 | 2836 | 16783 | 2263 | 17325 | 1808 | 18019 | 1111 | 21481 | 734 | 16298 |
| 16-#11 | 3.47 | MA | 10606 | 4046 | 17780 | 2901 | 19203 | 2339 | 19687 | 1885 | 19953 | 1187 | 24214 | 671 | 19386 |
| 7L-3S | | MI | 9425 | 4046 | 16040 | 2826 | 17433 | 2272 | 18095 | 1816 | 18975 | 1102 | 22534 | 813 | 16492 |
| 16-#14 | 5.00 | MA | 11946 | 4427 | 20903 | 3119 | 23169 | 2501 | 24435 | 1975 | 26167 | 1112 | 32213 | 578 | 28249 |
| 5E | | MI | 9330 | 4427 | 16522 | 3046 | 17950 | 2420 | 18710 | 1889 | 19922 | 1047 | 23976 | 441 | 21619 |
| 16-#14 | 5.00 | MA | 11481 | 4427 | 20106 | 3110 | 22068 | 2489 | 23169 | 1987 | 24483 | 1124 | 30172 | 495 | 26951 |
| 6L-4S | | MI | 9710 | 4427 | 17170 | 3058 | 18759 | 2408 | 19676 | 1876 | 21164 | 1035 | 25538 | 498 | 22160 |
| 18-#11 | 3.90 | MA | 11631 | 4153 | 19776 | 2961 | 21772 | 2384 | 22816 | 1914 | 24017 | 1157 | 29274 | 766 | 22991 |
| 5L-6S | | MI | 8868 | 4153 | 15231 | 2905 | 16421 | 2310 | 16930 | 1850 | 17440 | 1093 | 20949 | 601 | 17365 |
| 18-#11 | 3.90 | MA | 11301 | 4153 | 19219 | 2956 | 21001 | 2377 | 21922 | 1923 | 22828 | 1166 | 27826 | 709 | 22515 |
| 6L-5S | | MI | 9126 | 4153 | 15691 | 2895 | 16998 | 2319 | 17583 | 1842 | 18309 | 1085 | 21984 | 658 | 17753 |
| 18-#11 | 3.90 | MA | 10979 | 4153 | 18609 | 2968 | 20266 | 2388 | 20980 | 1914 | 21667 | 1175 | 26466 | 643 | 21834 |
| 7L-4S | | MI | 9396 | 4153 | 16146 | 2903 | 17573 | 2310 | 18269 | 1833 | 19272 | 1093 | 23099 | 697 | 18141 |
| 18-#14 | 5.63 | MA | 12001 | 4583 | 21288 | 3208 | 23583 | 2559 | 24999 | 2028 | 26910 | 1104 | 33351 | 453 | 30410 |
| 6L-5S | | MI | 9710 | 4583 | 17412 | 3143 | 19062 | 2487 | 20039 | 1924 | 21685 | 1020 | 26243 | 385 | 24145 |
| 20-#11 | 4.33 | MA | 11669 | 4261 | 20048 | 3023 | 22064 | 2426 | 23214 | 1952 | 24542 | 1153 | 30079 | 682 | 24939 |
| 6E | | MI | 9140 | 4261 | 15858 | 2972 | 17211 | 2357 | 17874 | 1876 | 18693 | 1076 | 22568 | 564 | 19185 |
| 20-#11 | 4.33 | MA | 11349 | 4261 | 19438 | 3035 | 21329 | 2436 | 22272 | 1943 | 23380 | 1162 | 28719 | 616 | 24288 |
| 7L-5S | | MI | 9396 | 4261 | 16318 | 2963 | 17788 | 2366 | 18527 | 1867 | 19562 | 1068 | 23602 | 622 | 19631 |
| 22-#11 | 4.77 | MA | 11718 | 4369 | 20267 | 3103 | 22391 | 2484 | 23565 | 1972 | 25094 | 1149 | 30972 | 588 | 26748 |
| 7L-6S | | MI | 9410 | 4369 | 16485 | 3040 | 18001 | 2404 | 18818 | 1901 | 19946 | 1059 | 24186 | 528 | 21012 |

## RECTANGULAR TIED COLUMNS 24" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.17 | MA | 12048 | 3706 | 18954 | 2707 | 20242 | 2207 | 20464 | 1840 | 20022 | 1313 | 23210 | 1227 | 8626 |
| 2E | | MI | 8937 | 3706 | 14239 | 2625 | 14911 | 2133 | 14881 | 1770 | 14372 | 1252 | 16426 | 1150 | 6342 |
| 4-#18 | 2.08 | MA | 12878 | 3948 | 20916 | 2834 | 22658 | 2296 | 23282 | 1882 | 23747 | 1263 | 28023 | 1136 | 14752 |
| 2E | | MI | 9475 | 3948 | 15532 | 2739 | 16422 | 2202 | 16659 | 1792 | 16726 | 1180 | 19360 | 1020 | 10653 |
| 6-#11 | 1.22 | MA | 12116 | 3718 | 19049 | 2727 | 20413 | 2223 | 20698 | 1853 | 20366 | 1321 | 23692 | 1236 | 8986 |
| 2L-3S | | MI | 8565 | 3718 | 13683 | 2642 | 14276 | 2163 | 14139 | 1795 | 13392 | 1271 | 15187 | 1075 | 6653 |
| 6-#11 | 1.22 | MA | 11509 | 3718 | 18152 | 2723 | 19264 | 2233 | 19296 | 1862 | 18498 | 1330 | 21226 | 1149 | 9036 |
| 3L-2S | | MI | 8988 | 3718 | 14310 | 2650 | 15066 | 2154 | 15084 | 1787 | 14645 | 1262 | 16806 | 1161 | 6597 |
| 6-#14 | 1.76 | MA | 12629 | 3861 | 20234 | 2805 | 21882 | 2277 | 22461 | 1882 | 22670 | 1295 | 26695 | 1188 | 12681 |
| 2L-3S | | MI | 8729 | 3861 | 14239 | 2711 | 14911 | 2212 | 14881 | 1818 | 14372 | 1238 | 16426 | 969 | 9287 |

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

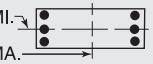
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.76 | MA | 11770 | 3861 | 18954 | 2797 | 20242 | 2292 | 20464 | 1895 | 20022 | 1308 | 23210 | 1064 | 12728 |
| 3L-2S | | MI | 9325 | 3861 | 15130 | 2723 | 16022 | 2200 | 16210 | 1805 | 16135 | 1225 | 18692 | 1094 | 9213 |
| 6-#18 | 3.13 | MA | 13857 | 4224 | 23142 | 3007 | 25511 | 2420 | 26712 | 1953 | 28297 | 1227 | 33970 | 1058 | 21745 |
| 2L-3S | | MI | 9113 | 4224 | 15532 | 2887 | 16422 | 2338 | 16659 | 1872 | 16726 | 1148 | 19360 | 686 | 15547 |
| 6-#18 | 3.13 | MA | 12393 | 4224 | 20916 | 2992 | 22658 | 2443 | 23282 | 1976 | 23747 | 1249 | 28023 | 837 | 21605 |
| 3L-2S | | MI | 10125 | 4224 | 17042 | 2909 | 18300 | 2316 | 18904 | 1850 | 19706 | 1126 | 23152 | 908 | 15528 |
| 8-#11 | 1.63 | MA | 12526 | 3826 | 19945 | 2795 | 21562 | 2271 | 22100 | 1882 | 22233 | 1310 | 26157 | 1210 | 11824 |
| 2L-4S | | MI | 8536 | 3826 | 13789 | 2719 | 14416 | 2201 | 14313 | 1812 | 13688 | 1262 | 15753 | 959 | 8709 |
| 8-#11 | 1.63 | MA | 11922 | 3826 | 19049 | 2790 | 20413 | 2282 | 20698 | 1891 | 20366 | 1318 | 23692 | 1124 | 11860 |
| 3E | | MI | 8843 | 3826 | 14310 | 2709 | 15066 | 2210 | 15084 | 1821 | 14645 | 1254 | 16806 | 1038 | 8662 |
| 8-#11 | 1.63 | MA | 11492 | 3826 | 18313 | 2803 | 19475 | 2275 | 19558 | 1883 | 18938 | 1327 | 22100 | 1038 | 11863 |
| 4L-2S | | MI | 9264 | 3826 | 14937 | 2717 | 15856 | 2201 | 16028 | 1812 | 15897 | 1245 | 18425 | 1125 | 8612 |
| 8-#14 | 2.34 | MA | 13203 | 4017 | 21513 | 2902 | 23521 | 2347 | 24459 | 1925 | 25319 | 1277 | 30180 | 1150 | 16708 |
| 2L-4S | | MI | 8685 | 4017 | 14388 | 2821 | 15107 | 2266 | 15126 | 1841 | 14789 | 1223 | 17215 | 801 | 12008 |
| 8-#14 | 2.34 | MA | 12351 | 4017 | 20234 | 2894 | 21882 | 2361 | 22461 | 1937 | 22670 | 1290 | 26695 | 1025 | 16714 |
| 3E | | MI | 9118 | 4017 | 15130 | 2808 | 16022 | 2279 | 16210 | 1853 | 16135 | 1211 | 18692 | 913 | 12101 |
| 8-#14 | 2.34 | MA | 11744 | 4017 | 19181 | 2912 | 20540 | 2351 | 20835 | 1925 | 20647 | 1302 | 24445 | 901 | 16550 |
| 4L-2S | | MI | 9710 | 4017 | 16020 | 2820 | 17133 | 2266 | 17538 | 1841 | 17898 | 1198 | 20959 | 1038 | 12048 |
| 8-#18 | 4.17 | MA | 14821 | 4501 | 25367 | 3180 | 28364 | 2544 | 30143 | 2025 | 32846 | 1190 | 39918 | 980 | 28681 |
| 2L-4S | | MI | 9029 | 4501 | 15781 | 3079 | 16753 | 2430 | 17070 | 1908 | 17432 | 1116 | 20669 | 383 | 18392 |
| 8-#18 | 4.17 | MA | 13375 | 4501 | 23142 | 3165 | 25511 | 2567 | 26712 | 2047 | 28297 | 1212 | 33970 | 759 | 28422 |
| 3E | | MI | 9765 | 4501 | 17042 | 3057 | 18300 | 2452 | 18904 | 1931 | 19706 | 1094 | 23152 | 574 | 20267 |
| 8-#18 | 4.17 | MA | 12341 | 4501 | 21304 | 3193 | 23169 | 2547 | 23918 | 2025 | 24821 | 1234 | 30120 | 545 | 25721 |
| 4L-2S | | MI | 10767 | 4501 | 18552 | 3079 | 20178 | 2430 | 21149 | 1908 | 22687 | 1072 | 26944 | 795 | 20354 |
| 10-#11 | 2.03 | MA | 12932 | 3934 | 20842 | 2862 | 22712 | 2319 | 23502 | 1911 | 24101 | 1298 | 28623 | 1185 | 14648 |
| 2L-5S | | MI | 8537 | 3934 | 13961 | 2779 | 14631 | 2257 | 14571 | 1846 | 13978 | 1236 | 16256 | 884 | 10423 |
| 10-#11 | 2.03 | MA | 12332 | 3934 | 19945 | 2857 | 21562 | 2330 | 22100 | 1921 | 22233 | 1307 | 26157 | 1099 | 14670 |
| 3L-4S | | MI | 8814 | 3934 | 14416 | 2786 | 15206 | 2248 | 15258 | 1838 | 14941 | 1245 | 17372 | 923 | 10680 |
| 10-#11 | 2.03 | MA | 11905 | 3934 | 19209 | 2870 | 20624 | 2324 | 20960 | 1912 | 20806 | 1315 | 24565 | 1013 | 14641 |
| 4L-3S | | MI | 9119 | 3934 | 14937 | 2777 | 15856 | 2257 | 16028 | 1846 | 15897 | 1236 | 18425 | 1002 | 10651 |
| 10-#11 | 2.03 | MA | 11522 | 3934 | 18570 | 2866 | 19796 | 2335 | 19943 | 1922 | 19374 | 1307 | 22868 | 975 | 14210 |
| 5L-2S | | MI | 9538 | 3934 | 15564 | 2784 | 16646 | 2248 | 16972 | 1838 | 17150 | 1228 | 20043 | 1088 | 10610 |
| 10-#14 | 2.93 | MA | 13771 | 4173 | 22792 | 2999 | 25161 | 2416 | 26457 | 1967 | 27968 | 1259 | 33666 | 1111 | 20721 |
| 2L-5S | | MI | 8684 | 4173 | 14630 | 2906 | 15409 | 2345 | 15489 | 1888 | 15311 | 1209 | 17920 | 688 | 13959 |
| 10-#14 | 2.93 | MA | 12926 | 4173 | 21513 | 2992 | 23521 | 2431 | 24459 | 1979 | 25319 | 1272 | 30180 | 986 | 20679 |
| 3L-4S | | MI | 9073 | 4173 | 15278 | 2918 | 16218 | 2333 | 16454 | 1876 | 16552 | 1197 | 19481 | 745 | 14559 |
| 10-#14 | 2.93 | MA | 12324 | 4173 | 20460 | 3009 | 22180 | 2421 | 22833 | 1967 | 23295 | 1284 | 27930 | 863 | 20252 |
| 4L-3S | | MI | 9504 | 4173 | 16020 | 2905 | 17133 | 2345 | 17538 | 1888 | 17898 | 1184 | 20959 | 857 | 14893 |
| 10-#14 | 2.93 | MA | 11783 | 4173 | 19546 | 3002 | 20996 | 2436 | 21381 | 1979 | 21264 | 1272 | 25527 | 809 | 19186 |
| 5L-2S | | MI | 10092 | 4173 | 16910 | 2917 | 18245 | 2333 | 18867 | 1876 | 19662 | 1172 | 23226 | 982 | 14863 |
| 10-#18 | 5.21 | MA | 14343 | 4778 | 25367 | 3338 | 28364 | 2691 | 30143 | 2119 | 32846 | 1176 | 39918 | 681 | 35223 |
| 3L-4S | | MI | 9681 | 4778 | 17291 | 3250 | 18630 | 2544 | 19316 | 1966 | 20412 | 1062 | 24461 | 270 | 22815 |
| 10-#18 | 5.21 | MA | 13322 | 4778 | 23529 | 3366 | 26022 | 2671 | 27348 | 2097 | 29371 | 1198 | 36068 | 467 | 32209 |
| 4L-3S | | MI | 10411 | 4778 | 18552 | 3227 | 20178 | 2566 | 21149 | 1989 | 22687 | 1040 | 26944 | 461 | 24719 |
| 10-#18 | 5.21 | MA | 12407 | 4778 | 21930 | 3351 | 23951 | 2694 | 24855 | 2119 | 25880 | 1176 | 31968 | 370 | 29777 |
| 5L-2S | | MI | 11404 | 4778 | 20062 | 3250 | 22055 | 2544 | 23394 | 1966 | 25668 | 1018 | 30736 | 682 | 25136 |
| 12-#11 | 2.44 | MA | 13335 | 4042 | 21738 | 2930 | 23861 | 2368 | 24904 | 1941 | 25969 | 1286 | 31088 | 1160 | 17462 |
| 2L-6S | | MI | 8552 | 4042 | 14128 | 2856 | 14844 | 2295 | 14863 | 1881 | 14362 | 1228 | 16840 | 789 | 12043 |
| 12-#11 | 2.44 | MA | 12739 | 4042 | 20842 | 2925 | 22712 | 2379 | 23502 | 1950 | 24101 | 1295 | 28623 | 1074 | 17464 |
| 3L-5S | | MI | 8815 | 4042 | 14588 | 2846 | 15421 | 2304 | 15516 | 1872 | 15231 | 1219 | 17875 | 847 | 12277 |
| 12-#11 | 2.44 | MA | 12314 | 4042 | 20106 | 2938 | 21774 | 2372 | 22362 | 1942 | 22674 | 1304 | 27031 | 987 | 17411 |
| 4E | | MI | 9089 | 4042 | 15042 | 2854 | 15996 | 2295 | 16202 | 1863 | 16194 | 1228 | 18990 | 886 | 12638 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

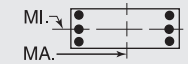
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.44 | MA | 11934 | 4042 | 19467 | 2933 | 20946 | 2383 | 21345 | 1951 | 21242 | 1295 | 25333 | 950 | 16869 |
| 5L-3S | | MI | 9393 | 4042 | 15564 | 2844 | 16646 | 2304 | 16972 | 1872 | 17150 | 1219 | 20043 | 966 | 12627 |
| 12-#11 | 2.44 | MA | 11571 | 4042 | 18867 | 2928 | 20116 | 2377 | 20377 | 1960 | 19946 | 1304 | 23746 | 893 | 16431 |
| 6L-2S | | MI | 9810 | 4042 | 16190 | 2852 | 17436 | 2295 | 17916 | 1863 | 18403 | 1210 | 21662 | 1052 | 12596 |
| 12-#14 | 3.52 | MA | 13495 | 4328 | 22792 | 3089 | 25161 | 2501 | 26457 | 2021 | 27968 | 1254 | 33666 | 947 | 24633 |
| 3L-5S | | MI | 9072 | 4328 | 15520 | 3003 | 16521 | 2412 | 16817 | 1924 | 17074 | 1182 | 20186 | 632 | 16592 |
| 12-#14 | 3.52 | MA | 12898 | 4328 | 21740 | 3107 | 23820 | 2491 | 24830 | 2009 | 25944 | 1266 | 31416 | 824 | 23981 |
| 4E | | MI | 9459 | 4328 | 16168 | 3015 | 17330 | 2399 | 17783 | 1912 | 18316 | 1170 | 21748 | 689 | 17136 |
| 12-#14 | 3.52 | MA | 12362 | 4328 | 20825 | 3099 | 22636 | 2506 | 23378 | 2021 | 23913 | 1254 | 29013 | 770 | 22990 |
| 5L-3S | | MI | 9886 | 4328 | 16910 | 3002 | 18245 | 2412 | 18867 | 1924 | 19662 | 1157 | 23226 | 801 | 17660 |
| 12-#14 | 3.52 | MA | 11852 | 4328 | 19966 | 3092 | 21448 | 2496 | 21996 | 2034 | 22075 | 1266 | 26772 | 688 | 21900 |
| 6L-2S | | MI | 10471 | 4328 | 17800 | 3014 | 19356 | 2399 | 20196 | 1912 | 21425 | 1145 | 25492 | 925 | 17663 |
| 12-#18 | 6.25 | MA | 14291 | 5054 | 25755 | 3539 | 28875 | 2795 | 30779 | 2168 | 33920 | 1161 | 42016 | 389 | 38737 |
| 4E | | MI | 10328 | 5054 | 18801 | 3420 | 20508 | 2658 | 21561 | 2025 | 23393 | 1008 | 28253 | 158 | 27275 |
| 12-#18 | 6.25 | MA | 13387 | 5054 | 24155 | 3524 | 26804 | 2818 | 28285 | 2190 | 30429 | 1139 | 37916 | 292 | 36122 |
| 5L-3S | | MI | 11051 | 5054 | 20062 | 3398 | 22055 | 2680 | 23394 | 2047 | 25668 | 986 | 30736 | 348 | 28987 |
| 14-#11 | 2.84 | MA | 13142 | 4150 | 21738 | 2992 | 23861 | 2427 | 24904 | 1979 | 25969 | 1283 | 31088 | 1049 | 20250 |
| 3L-6S | | MI | 8829 | 4150 | 14755 | 2923 | 15634 | 2342 | 15807 | 1906 | 15615 | 1210 | 18459 | 753 | 13924 |
| 14-#11 | 2.84 | MA | 12720 | 4150 | 21002 | 3005 | 22923 | 2421 | 23764 | 1971 | 24542 | 1292 | 29496 | 962 | 20175 |
| 4L-5S | | MI | 9090 | 4150 | 15215 | 2914 | 16211 | 2351 | 16460 | 1897 | 16484 | 1202 | 19494 | 811 | 14139 |
| 14-#11 | 2.84 | MA | 12342 | 4150 | 20363 | 3000 | 22095 | 2432 | 22747 | 1980 | 23110 | 1283 | 27799 | 925 | 19538 |
| 5L-4S | | MI | 9364 | 4150 | 15669 | 2921 | 16786 | 2342 | 17146 | 1889 | 17446 | 1210 | 20609 | 850 | 14583 |
| 14-#11 | 2.84 | MA | 11982 | 4150 | 19763 | 2996 | 21265 | 2425 | 21779 | 1990 | 21814 | 1292 | 26212 | 868 | 19126 |
| 6L-3S | | MI | 9666 | 4150 | 16190 | 2912 | 17436 | 2351 | 17916 | 1897 | 18403 | 1202 | 21662 | 929 | 14594 |
| 14-#11 | 2.84 | MA | 11630 | 4150 | 19106 | 3008 | 20473 | 2436 | 20759 | 1981 | 20548 | 1301 | 24514 | 777 | 18415 |
| 7L-2S | | MI | 10081 | 4150 | 16817 | 2919 | 18226 | 2342 | 18861 | 1889 | 19656 | 1193 | 23281 | 1015 | 14573 |
| 14-#14 | 4.10 | MA | 13467 | 4484 | 23019 | 3204 | 25460 | 2561 | 26828 | 2051 | 28592 | 1248 | 34901 | 785 | 27732 |
| 4L-5S | | MI | 9458 | 4484 | 16410 | 3101 | 17632 | 2478 | 18146 | 1959 | 18837 | 1155 | 22453 | 576 | 19236 |
| 14-#14 | 4.10 | MA | 12935 | 4484 | 22105 | 3196 | 24276 | 2576 | 25376 | 2064 | 26561 | 1236 | 32498 | 731 | 26806 |
| 5L-4S | | MI | 9842 | 4484 | 17058 | 3113 | 18441 | 2466 | 19112 | 1947 | 20079 | 1143 | 24015 | 633 | 19732 |
| 14-#14 | 4.10 | MA | 12429 | 4484 | 21246 | 3189 | 23088 | 2566 | 23994 | 2076 | 24724 | 1248 | 30257 | 649 | 25621 |
| 6L-3S | | MI | 10267 | 4484 | 17800 | 3100 | 19356 | 2478 | 20196 | 1959 | 21425 | 1131 | 25492 | 745 | 20416 |
| 14-#14 | 4.10 | MA | 11937 | 4484 | 20305 | 3207 | 21954 | 2581 | 22538 | 2064 | 22928 | 1261 | 28155 | 554 | 24499 |
| 7L-2S | | MI | 10848 | 4484 | 18691 | 3112 | 20467 | 2466 | 21524 | 1947 | 23188 | 1118 | 27759 | 869 | 20453 |
| 14-#18 | 7.29 | MA | 14355 | 5331 | 26381 | 3697 | 29657 | 2943 | 31716 | 2262 | 34979 | 1103 | 43864 | 214 | 42506 |
| 5L-4S | | MI | 10969 | 5331 | 20310 | 3590 | 22385 | 2772 | 23806 | 2083 | 26373 | 954 | 32045 | 45 | 31761 |
| 16-#11 | 3.25 | MA | 13124 | 4258 | 21899 | 3072 | 24072 | 2469 | 25166 | 2001 | 26409 | 1280 | 31961 | 937 | 22935 |
| 4L-6S | | MI | 9104 | 4258 | 15381 | 2991 | 16424 | 2389 | 16751 | 1932 | 16868 | 1193 | 20077 | 716 | 15761 |
| 16-#11 | 3.25 | MA | 12748 | 4258 | 21260 | 3068 | 23244 | 2480 | 24149 | 2010 | 24978 | 1272 | 30264 | 899 | 22217 |
| 5E | | MI | 9364 | 4258 | 15841 | 2981 | 17001 | 2398 | 17404 | 1923 | 17737 | 1184 | 21112 | 774 | 16009 |
| 16-#11 | 3.25 | MA | 12389 | 4258 | 20659 | 3063 | 22414 | 2474 | 23181 | 2019 | 23682 | 1280 | 28677 | 843 | 21826 |
| 6L-4S | | MI | 9636 | 4258 | 16296 | 2989 | 17576 | 2389 | 18091 | 1914 | 18699 | 1193 | 22228 | 813 | 16448 |
| 16-#11 | 3.25 | MA | 12040 | 4258 | 20003 | 3076 | 21622 | 2485 | 22161 | 2011 | 22415 | 1289 | 26979 | 752 | 21058 |
| 7L-3S | | MI | 9937 | 4258 | 16817 | 2979 | 18226 | 2398 | 18861 | 1923 | 19656 | 1184 | 23281 | 893 | 16553 |
| 16-#11 | 3.25 | MA | 11697 | 4258 | 19411 | 3071 | 20818 | 2478 | 21210 | 2020 | 21166 | 1298 | 25393 | 707 | 20390 |
| 8L-2S | | MI | 10350 | 4258 | 17444 | 2987 | 19016 | 2389 | 19805 | 1914 | 20909 | 1176 | 24899 | 979 | 16544 |
| 16-#14 | 4.69 | MA | 13503 | 4639 | 23384 | 3294 | 25916 | 2646 | 27374 | 2106 | 29210 | 1218 | 35983 | 692 | 30632 |
| 5E | | MI | 9840 | 4639 | 17300 | 3198 | 18743 | 2545 | 19474 | 1995 | 20600 | 1129 | 24719 | 520 | 21888 |
| 16-#14 | 4.69 | MA | 13001 | 4639 | 22525 | 3286 | 24728 | 2636 | 25992 | 2118 | 27372 | 1230 | 33742 | 610 | 29358 |
| 6L-4S | | MI | 10222 | 4639 | 17948 | 3210 | 19552 | 2533 | 20440 | 1982 | 21842 | 1116 | 26281 | 577 | 22342 |
| 16-#14 | 4.69 | MA | 12513 | 4639 | 21585 | 3304 | 23594 | 2651 | 24536 | 2106 | 25577 | 1243 | 31640 | 515 | 28173 |
| 7L-3S | | MI | 10644 | 4639 | 18691 | 3197 | 20467 | 2545 | 21524 | 1995 | 23188 | 1104 | 27759 | 689 | 23162 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

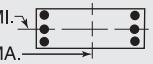
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 3.66 | MA | 13150 | 4366 | 22156 | 3135 | 24393 | 2528 | 25551 | 2039 | 26845 | 1260 | 32729 | 874 | 24902 |
| 5L-6S | | MI | 9378 | 4366 | 16008 | 3058 | 17214 | 2436 | 17695 | 1957 | 18120 | 1176 | 21696 | 680 | 17570 |
| 18-#11 | 3.66 | MA | 12794 | 4366 | 21556 | 3131 | 23564 | 2522 | 24583 | 2048 | 25549 | 1269 | 31143 | 817 | 24504 |
| 6L-5S | | MI | 9636 | 4366 | 16468 | 3048 | 17791 | 2445 | 18348 | 1949 | 18989 | 1167 | 22731 | 738 | 17883 |
| 18-#11 | 3.66 | MA | 12447 | 4366 | 20899 | 3143 | 22771 | 2533 | 23563 | 2040 | 24283 | 1277 | 29444 | 727 | 23708 |
| 7L-4S | | MI | 9907 | 4366 | 16923 | 3056 | 18366 | 2436 | 19035 | 1940 | 19952 | 1176 | 23846 | 777 | 18291 |
| 18-#11 | 3.66 | MA | 12106 | 4366 | 20308 | 3139 | 21967 | 2527 | 22612 | 2049 | 23034 | 1286 | 27859 | 682 | 22998 |
| 8L-3S | | MI | 10207 | 4366 | 17444 | 3046 | 19016 | 2445 | 19805 | 1949 | 20909 | 1167 | 24899 | 856 | 18501 |
| 18-#14 | 5.27 | MA | 13569 | 4795 | 23804 | 3384 | 26368 | 2706 | 27989 | 2160 | 30021 | 1212 | 37227 | 571 | 33108 |
| 6L-5S | | MI | 10220 | 4795 | 18191 | 3295 | 19855 | 2612 | 20803 | 2030 | 22363 | 1102 | 26986 | 464 | 24433 |
| 18-#14 | 5.27 | MA | 13084 | 4795 | 22864 | 3401 | 25234 | 2720 | 26533 | 2148 | 28225 | 1225 | 35125 | 476 | 31862 |
| 7L-4S | | MI | 10600 | 4795 | 18839 | 3307 | 20664 | 2599 | 21769 | 2018 | 23605 | 1090 | 28548 | 520 | 24964 |
| 20-#11 | 4.06 | MA | 13197 | 4473 | 22452 | 3198 | 24713 | 2571 | 25985 | 2078 | 27417 | 1257 | 33608 | 792 | 27129 |
| 6E | | MI | 9650 | 4473 | 16635 | 3125 | 18004 | 2483 | 18640 | 1983 | 19373 | 1158 | 23315 | 643 | 19388 |
| 20-#11 | 4.06 | MA | 12852 | 4473 | 21796 | 3211 | 23920 | 2581 | 24965 | 2070 | 26151 | 1266 | 31910 | 702 | 26366 |
| 7L-5S | | MI | 9907 | 4473 | 17095 | 3116 | 18581 | 2492 | 19293 | 1974 | 20242 | 1150 | 24349 | 701 | 19761 |
| 20-#11 | 4.06 | MA | 12512 | 4473 | 21204 | 3206 | 23116 | 2575 | 24014 | 2079 | 24901 | 1274 | 30324 | 657 | 25614 |
| 8L-4S | | MI | 10177 | 4473 | 17550 | 3123 | 19156 | 2483 | 19979 | 1965 | 21205 | 1158 | 25465 | 740 | 20141 |
| 20-#14 | 5.86 | MA | 13651 | 4951 | 24143 | 3499 | 26874 | 2790 | 28531 | 2190 | 30874 | 1207 | 38611 | 437 | 35563 |
| 7L-5S | | MI | 10599 | 4951 | 19081 | 3392 | 20966 | 2678 | 22132 | 2066 | 24126 | 1075 | 29252 | 408 | 26971 |
| 22-#11 | 4.47 | MA | 13253 | 4581 | 22692 | 3278 | 25070 | 2630 | 26367 | 2099 | 28018 | 1254 | 34375 | 677 | 29029 |
| 7L-6S | | MI | 9921 | 4581 | 17262 | 3193 | 18794 | 2530 | 19584 | 2008 | 20626 | 1141 | 24933 | 607 | 21214 |
| 22-#11 | 4.47 | MA | 12916 | 4581 | 22101 | 3274 | 24266 | 2623 | 25416 | 2108 | 26769 | 1263 | 32789 | 632 | 28236 |
| 8L-5S | | MI | 10177 | 4581 | 17722 | 3183 | 19371 | 2539 | 20237 | 2000 | 21495 | 1132 | 25968 | 665 | 21643 |
| 24-#11 | 4.88 | MA | 13317 | 4689 | 22997 | 3341 | 25415 | 2672 | 26818 | 2138 | 28637 | 1251 | 35255 | 607 | 30865 |
| 8L-6S | | MI | 10190 | 4689 | 17888 | 3260 | 19584 | 2577 | 20528 | 2034 | 21879 | 1124 | 26552 | 571 | 23045 |

## RECTANGULAR TIED COLUMNS 24" x 34"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.10 | MA | 13549 | 3918 | 21214 | 2880 | 22682 | 2349 | 22928 | 1961 | 22415 | 1409 | 25992 | 1323 | 9233 |
| 2E | | MI | 9446 | 3918 | 15018 | 2777 | 15703 | 2258 | 15645 | 1876 | 15050 | 1334 | 17169 | 1229 | 6376 |
| 4-#18 | 1.96 | MA | 14456 | 4160 | 23334 | 3007 | 25294 | 2437 | 26030 | 2007 | 26481 | 1362 | 31271 | 1237 | 15832 |
| 2E | | MI | 9986 | 4160 | 16314 | 2889 | 17214 | 2325 | 17419 | 1897 | 17399 | 1261 | 20096 | 1098 | 10704 |
| 6-#11 | 1.15 | MA | 13622 | 3930 | 21312 | 2900 | 22863 | 2364 | 23169 | 1973 | 22779 | 1417 | 26502 | 1331 | 9618 |
| 2L-3S | | MI | 9074 | 3930 | 14460 | 2795 | 15070 | 2289 | 14905 | 1902 | 14072 | 1353 | 15934 | 1154 | 6685 |
| 6-#11 | 1.15 | MA | 12967 | 3930 | 20348 | 2896 | 21627 | 2376 | 21661 | 1983 | 20757 | 1425 | 23824 | 1244 | 9668 |
| 3L-2S | | MI | 9497 | 3930 | 15087 | 2802 | 15860 | 2280 | 15849 | 1894 | 15325 | 1344 | 17553 | 1241 | 6629 |
| 6-#14 | 1.65 | MA | 14180 | 4074 | 22590 | 2977 | 24447 | 2419 | 25081 | 2004 | 25286 | 1392 | 29783 | 1287 | 13592 |
| 2L-3S | | MI | 9238 | 4074 | 15018 | 2863 | 15703 | 2337 | 15645 | 1924 | 15050 | 1319 | 17169 | 1048 | 9331 |
| 6-#14 | 1.65 | MA | 13254 | 4074 | 21214 | 2970 | 22682 | 2434 | 22928 | 2017 | 22415 | 1405 | 25992 | 1162 | 13639 |
| 3L-2S | | MI | 9835 | 4074 | 15908 | 2875 | 16815 | 2325 | 16974 | 1911 | 16813 | 1307 | 19436 | 1173 | 9253 |
| 6-#18 | 2.94 | MA | 15520 | 4437 | 25732 | 3180 | 28369 | 2561 | 29759 | 2081 | 31425 | 1328 | 37763 | 1165 | 23365 |
| 2L-3S | | MI | 9623 | 4437 | 16314 | 3037 | 17214 | 2461 | 17419 | 1977 | 17399 | 1229 | 20096 | 764 | 15634 |
| 6-#18 | 2.94 | MA | 13939 | 4437 | 23334 | 3166 | 25294 | 2587 | 26030 | 2103 | 26481 | 1350 | 31271 | 944 | 23225 |
| 3L-2S | | MI | 10636 | 4437 | 17824 | 3059 | 19092 | 2439 | 19664 | 1955 | 20379 | 1207 | 23888 | 985 | 15589 |
| 8-#11 | 1.53 | MA | 14066 | 4038 | 22276 | 2967 | 24099 | 2413 | 24676 | 2002 | 24801 | 1406 | 29180 | 1308 | 12667 |
| 2L-4S | | MI | 9045 | 4038 | 14566 | 2872 | 15210 | 2327 | 15079 | 1919 | 14368 | 1344 | 16500 | 1039 | 8752 |
| 8-#11 | 1.53 | MA | 13416 | 4038 | 21312 | 2963 | 22863 | 2424 | 23169 | 2012 | 22779 | 1415 | 26502 | 1221 | 12703 |
| 3E | | MI | 9352 | 4038 | 15087 | 2862 | 15860 | 2336 | 15849 | 1928 | 15325 | 1336 | 17553 | 1118 | 8700 |
| 8-#11 | 1.53 | MA | 12954 | 4038 | 20522 | 2976 | 21857 | 2419 | 21946 | 2005 | 21234 | 1423 | 24769 | 1135 | 12705 |
| 4L-2S | | MI | 9774 | 4038 | 15714 | 2870 | 16650 | 2327 | 16793 | 1919 | 16578 | 1327 | 19172 | 1204 | 8648 |
| 8-#14 | 2.21 | MA | 14803 | 4229 | 23967 | 3074 | 26212 | 2488 | 27233 | 2046 | 28157 | 1376 | 33575 | 1251 | 17923 |
| 2L-4S | | MI | 9194 | 4229 | 15166 | 2973 | 15900 | 2391 | 15890 | 1947 | 15467 | 1305 | 17958 | 880 | 12167 |
| 8-#14 | 2.21 | MA | 13884 | 4229 | 22590 | 3068 | 24447 | 2504 | 25081 | 2059 | 25286 | 1388 | 29783 | 1126 | 17929 |
| 3E | | MI | 9628 | 4229 | 15908 | 2960 | 16815 | 2404 | 16974 | 1959 | 16813 | 1292 | 19436 | 992 | 12153 |

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

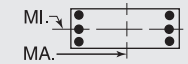



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.21 | MA | 13232 | 4229 | 21460 | 3086 | 23007 | 2495 | 23331 | 2048 | 23092 | 1401 | 27334 | 1002 | 17797 |
| 4L-2S | | MI | 10221 | 4229 | 16799 | 2972 | 17926 | 2391 | 18302 | 1947 | 18576 | 1280 | 21702 | 1117 | 12095 |
| 8-#18 | 3.92 | MA | 16568 | 4713 | 28131 | 3352 | 31443 | 2686 | 33487 | 2155 | 36369 | 1295 | 44254 | 1093 | 30841 |
| 2L-4S | | MI | 9537 | 4713 | 16563 | 3229 | 17544 | 2553 | 17831 | 2013 | 18105 | 1197 | 21406 | 461 | 18640 |
| 8-#18 | 3.92 | MA | 15006 | 4713 | 25732 | 3339 | 28369 | 2711 | 29759 | 2177 | 31425 | 1317 | 37763 | 872 | 30582 |
| 3E | | MI | 10276 | 4713 | 17824 | 3207 | 19092 | 2575 | 19664 | 2035 | 20379 | 1175 | 23888 | 651 | 20369 |
| 8-#18 | 3.92 | MA | 13894 | 4713 | 23756 | 3369 | 25851 | 2692 | 26722 | 2155 | 27648 | 1339 | 33568 | 654 | 27898 |
| 4L-2S | | MI | 11280 | 4713 | 19334 | 3229 | 20969 | 2553 | 21910 | 2013 | 23360 | 1152 | 27680 | 873 | 20423 |
| 10-#11 | 1.91 | MA | 14507 | 4146 | 23240 | 3034 | 25335 | 2461 | 26184 | 2032 | 26823 | 1395 | 31859 | 1284 | 15701 |
| 2L-5S | | MI | 9046 | 4146 | 14738 | 2932 | 15425 | 2383 | 15337 | 1953 | 14659 | 1318 | 17003 | 963 | 10548 |
| 10-#11 | 1.91 | MA | 13860 | 4146 | 22276 | 3030 | 24099 | 2473 | 24676 | 2042 | 24801 | 1404 | 29180 | 1198 | 15723 |
| 3L-4S | | MI | 9323 | 4146 | 15193 | 2939 | 16000 | 2374 | 16023 | 1945 | 15621 | 1327 | 18119 | 1002 | 10730 |
| 10-#11 | 1.91 | MA | 13401 | 4146 | 21486 | 3044 | 23092 | 2467 | 23453 | 2034 | 23256 | 1413 | 27447 | 1112 | 15694 |
| 4L-3S | | MI | 9629 | 4146 | 15714 | 2930 | 16650 | 2383 | 16793 | 1953 | 16578 | 1318 | 19172 | 1081 | 10694 |
| 10-#11 | 1.91 | MA | 12990 | 4146 | 20801 | 3039 | 22204 | 2478 | 22362 | 2044 | 21707 | 1404 | 25609 | 1073 | 15323 |
| 5L-2S | | MI | 10048 | 4146 | 16340 | 2937 | 17440 | 2374 | 17738 | 1945 | 17831 | 1310 | 20790 | 1168 | 10650 |
| 10-#14 | 2.76 | MA | 15420 | 4385 | 25343 | 3171 | 27976 | 2558 | 29386 | 2088 | 31028 | 1359 | 37367 | 1215 | 22239 |
| 2L-5S | | MI | 9193 | 4385 | 15408 | 3058 | 16202 | 2470 | 16253 | 1995 | 15989 | 1291 | 18663 | 767 | 14116 |
| 10-#14 | 2.76 | MA | 14508 | 4385 | 23967 | 3165 | 26212 | 2574 | 27233 | 2102 | 28157 | 1372 | 33575 | 1090 | 22198 |
| 3L-4S | | MI | 9583 | 4385 | 16056 | 3070 | 17011 | 2458 | 17218 | 1982 | 17230 | 1278 | 20225 | 824 | 14741 |
| 10-#14 | 2.76 | MA | 13861 | 4385 | 22836 | 3183 | 24772 | 2565 | 25484 | 2090 | 25963 | 1384 | 31126 | 966 | 21930 |
| 4L-3S | | MI | 10014 | 4385 | 16799 | 3057 | 17926 | 2470 | 18302 | 1995 | 18576 | 1266 | 21702 | 936 | 14952 |
| 10-#14 | 2.76 | MA | 13281 | 4385 | 21856 | 3177 | 23501 | 2581 | 23923 | 2104 | 23763 | 1372 | 28517 | 911 | 20702 |
| 5L-2S | | MI | 10604 | 4385 | 17689 | 3069 | 19038 | 2458 | 19631 | 1982 | 20339 | 1253 | 23969 | 1060 | 14914 |
| 10-#18 | 4.90 | MA | 16058 | 4990 | 28131 | 3511 | 31443 | 2835 | 33487 | 2250 | 36369 | 1283 | 44254 | 800 | 37923 |
| 3L-4S | | MI | 10190 | 4990 | 18073 | 3399 | 19422 | 2667 | 20076 | 2071 | 21085 | 1143 | 25197 | 348 | 23060 |
| 10-#18 | 4.90 | MA | 14960 | 4990 | 26155 | 3542 | 28926 | 2816 | 30451 | 2228 | 32592 | 1305 | 40060 | 582 | 34900 |
| 4L-3S | | MI | 10922 | 4990 | 19334 | 3377 | 20969 | 2689 | 21910 | 2093 | 23360 | 1121 | 27680 | 539 | 25047 |
| 10-#18 | 4.90 | MA | 13976 | 4990 | 24437 | 3528 | 26701 | 2842 | 27741 | 2250 | 28799 | 1283 | 35584 | 486 | 32484 |
| 5L-2S | | MI | 11918 | 4990 | 20844 | 3399 | 22847 | 2667 | 24155 | 2071 | 26340 | 1098 | 31472 | 760 | 25218 |
| 12-#11 | 2.29 | MA | 14944 | 4254 | 24204 | 3102 | 26570 | 2510 | 27691 | 2061 | 28845 | 1385 | 34537 | 1261 | 18726 |
| 2L-6S | | MI | 9061 | 4254 | 14905 | 3009 | 15638 | 2421 | 15628 | 1987 | 15042 | 1310 | 17587 | 869 | 12161 |
| 12-#11 | 2.29 | MA | 14301 | 4254 | 23240 | 3098 | 25335 | 2521 | 26184 | 2071 | 26823 | 1393 | 31859 | 1175 | 18728 |
| 3L-5S | | MI | 9324 | 4254 | 15365 | 2999 | 16215 | 2430 | 16281 | 1979 | 15911 | 1301 | 18622 | 927 | 12401 |
| 12-#11 | 2.29 | MA | 13845 | 4254 | 22450 | 3111 | 24328 | 2515 | 24961 | 2064 | 25278 | 1402 | 30126 | 1088 | 18674 |
| 4E | | MI | 9599 | 4254 | 15819 | 3007 | 16790 | 2421 | 16968 | 1970 | 16874 | 1310 | 19737 | 966 | 12696 |
| 12-#11 | 2.29 | MA | 13437 | 4254 | 21765 | 3107 | 23440 | 2527 | 23870 | 2074 | 23729 | 1393 | 28288 | 1050 | 18183 |
| 5L-3S | | MI | 9904 | 4254 | 16340 | 2997 | 17440 | 2430 | 17738 | 1979 | 17831 | 1301 | 20790 | 1045 | 12674 |
| 12-#11 | 2.29 | MA | 13047 | 4254 | 21122 | 3103 | 22551 | 2521 | 22783 | 2066 | 22326 | 1402 | 26562 | 993 | 17681 |
| 6L-2S | | MI | 10321 | 4254 | 16967 | 3005 | 18230 | 2421 | 18682 | 1970 | 19083 | 1292 | 22409 | 1131 | 12639 |
| 12-#14 | 3.31 | MA | 15126 | 4540 | 25343 | 3262 | 27976 | 2644 | 29386 | 2144 | 31028 | 1355 | 37367 | 1055 | 26455 |
| 3L-5S | | MI | 9581 | 4540 | 16299 | 3155 | 17314 | 2537 | 17581 | 2030 | 17752 | 1264 | 20929 | 711 | 16750 |
| 12-#14 | 3.31 | MA | 14484 | 4540 | 24213 | 3281 | 26536 | 2635 | 27636 | 2133 | 28834 | 1368 | 34918 | 930 | 25946 |
| 4E | | MI | 9969 | 4540 | 16947 | 3167 | 18123 | 2524 | 18547 | 2018 | 18993 | 1251 | 22491 | 768 | 17315 |
| 12-#14 | 3.31 | MA | 13909 | 4540 | 23232 | 3274 | 25265 | 2651 | 26075 | 2146 | 26634 | 1355 | 32309 | 876 | 24798 |
| 5L-3S | | MI | 10398 | 4540 | 17689 | 3154 | 19038 | 2537 | 19631 | 2030 | 20339 | 1239 | 23969 | 880 | 17729 |
| 12-#14 | 3.31 | MA | 13361 | 4540 | 22311 | 3267 | 23992 | 2642 | 24590 | 2159 | 24642 | 1368 | 29868 | 794 | 23755 |
| 6L-2S | | MI | 10984 | 4540 | 18579 | 3166 | 20149 | 2524 | 20960 | 2018 | 22102 | 1227 | 26235 | 1004 | 17718 |
| 12-#18 | 5.88 | MA | 16012 | 5267 | 28553 | 3715 | 32000 | 2941 | 34180 | 2302 | 37536 | 1272 | 46551 | 510 | 41945 |
| 4E | | MI | 10838 | 5267 | 19583 | 3570 | 21299 | 2781 | 22321 | 2129 | 24066 | 1089 | 28989 | 236 | 27517 |
| 12-#18 | 5.88 | MA | 15040 | 5267 | 26836 | 3701 | 29776 | 2966 | 31470 | 2324 | 33744 | 1250 | 42076 | 414 | 39344 |
| 5L-3S | | MI | 11564 | 5267 | 20844 | 3548 | 22847 | 2804 | 24155 | 2151 | 26340 | 1067 | 31472 | 426 | 29308 |
| 14-#11 | 2.68 | MA | 14738 | 4362 | 24204 | 3165 | 26570 | 2570 | 27691 | 2101 | 28845 | 1383 | 34537 | 1152 | 21724 |
| 3L-6S | | MI | 9338 | 4362 | 15531 | 3076 | 16428 | 2468 | 16573 | 2013 | 16295 | 1292 | 19206 | 832 | 14043 |
| 14-#11 | 2.68 | MA | 14286 | 4362 | 23414 | 3178 | 25564 | 2564 | 26468 | 2093 | 27300 | 1391 | 32804 | 1065 | 21649 |
| 4L-5S | | MI | 9600 | 4362 | 15991 | 3066 | 17005 | 2477 | 17226 | 2004 | 17164 | 1284 | 20240 | 890 | 14264 |
| 14-#11 | 2.68 | MA | 13880 | 4362 | 22729 | 3174 | 24676 | 2575 | 25377 | 2103 | 25751 | 1383 | 30966 | 1027 | 21055 |
| 5L-4S | | MI | 9874 | 4362 | 16446 | 3074 | 17580 | 2468 | 17912 | 1996 | 18127 | 1292 | 21356 | 929 | 14648 |

## RECTANGULAR TIED COLUMNS 24" x 34"

Short columns – no sidesway
Bending on major or minor axis

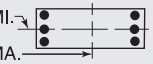



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.68 | MA | 13493 | 4362 | 22086 | 3170 | 23786 | 2570 | 24291 | 2096 | 24348 | 1391 | 29240 | 970 | 20581 |
| 6L-3S | | MI | 10177 | 4362 | 16967 | 3065 | 18230 | 2477 | 18682 | 2004 | 19083 | 1284 | 22409 | 1009 | 14646 |
| 14-#11 | 2.68 | MA | 13116 | 4362 | 21382 | 3183 | 22937 | 2581 | 23247 | 2106 | 22977 | 1400 | 27395 | 880 | 19902 |
| 7L-2S | | MI | 10592 | 4362 | 17594 | 3072 | 19020 | 2468 | 19626 | 1996 | 20336 | 1275 | 24027 | 1095 | 14620 |
| 14-#14 | 3.86 | MA | 15101 | 4696 | 25589 | 3378 | 28301 | 2705 | 29789 | 2175 | 31705 | 1351 | 38710 | 894 | 29986 |
| 4L-5S | | MI | 9967 | 4696 | 17189 | 3253 | 18425 | 2603 | 18910 | 2066 | 19515 | 1237 | 23196 | 655 | 19394 |
| 14-#14 | 3.86 | MA | 14531 | 4696 | 24609 | 3371 | 27030 | 2721 | 28228 | 2188 | 29505 | 1339 | 36100 | 840 | 28909 |
| 5L-4S | | MI | 10353 | 4696 | 17837 | 3265 | 19234 | 2591 | 19876 | 2053 | 20756 | 1225 | 24758 | 712 | 19909 |
| 14-#14 | 3.86 | MA | 13987 | 4696 | 23688 | 3365 | 25757 | 2712 | 26743 | 2202 | 27513 | 1351 | 33659 | 758 | 27767 |
| 6L-3S | | MI | 10779 | 4696 | 18579 | 3252 | 20149 | 2603 | 20960 | 2066 | 22102 | 1212 | 26235 | 824 | 20491 |
| 14-#14 | 3.86 | MA | 13459 | 4696 | 22680 | 3383 | 24540 | 2727 | 25178 | 2190 | 25566 | 1364 | 31047 | 627 | 26626 |
| 7L-2S | | MI | 11361 | 4696 | 19469 | 3264 | 21260 | 2591 | 22288 | 2053 | 23866 | 1200 | 28502 | 948 | 20516 |
| 14-#18 | 6.86 | MA | 16091 | 5543 | 29234 | 3874 | 32850 | 3090 | 35198 | 2398 | 38688 | 1216 | 48567 | 342 | 46242 |
| 5L-4S | | MI | 11480 | 5543 | 21092 | 3740 | 23177 | 2896 | 24567 | 2187 | 27046 | 1035 | 32781 | 123 | 32001 |
| 16-#11 | 3.06 | MA | 14723 | 4470 | 24378 | 3246 | 26799 | 2612 | 27976 | 2123 | 29322 | 1381 | 35482 | 1042 | 24620 |
| 4L-6S | | MI | 9613 | 4470 | 16158 | 3143 | 17218 | 2515 | 17517 | 2039 | 17548 | 1275 | 20824 | 796 | 15929 |
| 16-#11 | 3.06 | MA | 14319 | 4470 | 23693 | 3242 | 25912 | 2624 | 26885 | 2133 | 27773 | 1372 | 33644 | 1003 | 23936 |
| 5E | | MI | 9874 | 4470 | 16618 | 3134 | 17795 | 2523 | 18170 | 2030 | 18417 | 1266 | 21859 | 854 | 16133 |
| 16-#11 | 3.06 | MA | 13935 | 4470 | 23050 | 3238 | 25022 | 2618 | 25798 | 2125 | 26370 | 1381 | 31919 | 947 | 23486 |
| 6L-4S | | MI | 10147 | 4470 | 17073 | 3142 | 18370 | 2515 | 18856 | 2021 | 19380 | 1275 | 22975 | 893 | 16591 |
| 16-#11 | 3.06 | MA | 13561 | 4470 | 22346 | 3251 | 24173 | 2630 | 24754 | 2135 | 24999 | 1389 | 30073 | 856 | 22748 |
| 7L-3S | | MI | 10448 | 4470 | 17594 | 3132 | 19020 | 2523 | 19626 | 2030 | 20336 | 1266 | 24027 | 972 | 16610 |
| 16-#11 | 3.06 | MA | 13192 | 4470 | 21712 | 3247 | 23311 | 2624 | 23735 | 2145 | 23540 | 1381 | 28356 | 811 | 22118 |
| 8L-2S | | MI | 10862 | 4470 | 18221 | 3140 | 19810 | 2515 | 20570 | 2021 | 21589 | 1258 | 25646 | 1058 | 16593 |
| 16-#14 | 4.41 | MA | 15147 | 4852 | 25985 | 3469 | 28795 | 2790 | 30381 | 2231 | 32376 | 1322 | 39892 | 804 | 33030 |
| 5E | | MI | 10350 | 4852 | 18079 | 3350 | 19536 | 2670 | 20238 | 2101 | 21278 | 1210 | 25463 | 599 | 22046 |
| 16-#14 | 4.41 | MA | 14608 | 4852 | 25064 | 3462 | 27521 | 2781 | 28895 | 2244 | 30384 | 1335 | 37451 | 722 | 31795 |
| 6L-4S | | MI | 10733 | 4852 | 18727 | 3362 | 20345 | 2658 | 21204 | 2089 | 22520 | 1198 | 27024 | 655 | 22519 |
| 16-#14 | 4.41 | MA | 14084 | 4852 | 24056 | 3480 | 26305 | 2797 | 27330 | 2233 | 28437 | 1347 | 34839 | 592 | 30642 |
| 7L-3S | | MI | 11157 | 4852 | 19469 | 3349 | 21260 | 2670 | 22288 | 2101 | 23866 | 1185 | 28502 | 768 | 23243 |
| 18-#11 | 3.44 | MA | 14756 | 4578 | 24657 | 3309 | 27147 | 2672 | 28392 | 2162 | 29795 | 1361 | 36323 | 980 | 26825 |
| 5L-6S | | MI | 9887 | 4578 | 16785 | 3211 | 18008 | 2562 | 18461 | 2064 | 18801 | 1258 | 22443 | 759 | 17769 |
| 18-#11 | 3.44 | MA | 14374 | 4578 | 24014 | 3305 | 26258 | 2666 | 27306 | 2155 | 28392 | 1370 | 34597 | 924 | 26395 |
| 6L-5S | | MI | 10147 | 4578 | 17245 | 3201 | 18585 | 2570 | 19114 | 2055 | 19670 | 1249 | 23478 | 817 | 18008 |
| 18-#11 | 3.44 | MA | 14002 | 4578 | 23310 | 3318 | 25408 | 2678 | 26262 | 2164 | 27021 | 1379 | 32752 | 833 | 25601 |
| 7L-4S | | MI | 10419 | 4578 | 17700 | 3209 | 19160 | 2562 | 19800 | 2047 | 20632 | 1258 | 24593 | 856 | 18436 |
| 18-#11 | 3.44 | MA | 13636 | 4578 | 22676 | 3314 | 24547 | 2672 | 25242 | 2174 | 25562 | 1370 | 31034 | 787 | 24928 |
| 8L-3S | | MI | 10719 | 4578 | 18221 | 3199 | 19810 | 2570 | 20570 | 2055 | 21589 | 1249 | 25646 | 936 | 18563 |
| 18-#14 | 4.96 | MA | 15224 | 5007 | 26441 | 3559 | 29286 | 2851 | 31048 | 2287 | 33255 | 1318 | 41243 | 686 | 35836 |
| 6L-5S | | MI | 10731 | 5007 | 18969 | 3447 | 20648 | 2737 | 21567 | 2136 | 23041 | 1184 | 27729 | 543 | 24705 |
| 18-#14 | 4.96 | MA | 14703 | 5007 | 25433 | 3578 | 28070 | 2867 | 29483 | 2275 | 31308 | 1331 | 38631 | 556 | 34622 |
| 7L-4S | | MI | 11112 | 5007 | 19617 | 3459 | 21457 | 2724 | 22533 | 2124 | 24283 | 1171 | 29291 | 599 | 25140 |
| 20-#11 | 3.82 | MA | 14810 | 4686 | 24978 | 3373 | 27493 | 2715 | 28813 | 2184 | 30414 | 1359 | 37275 | 900 | 29308 |
| 6E | | MI | 10160 | 4686 | 17412 | 3278 | 18798 | 2609 | 19405 | 2090 | 20054 | 1240 | 24061 | 723 | 19586 |
| 20-#11 | 3.82 | MA | 14440 | 4686 | 24274 | 3386 | 26644 | 2726 | 27769 | 2194 | 29043 | 1368 | 35430 | 810 | 28461 |
| 7L-5S | | MI | 10418 | 4686 | 17872 | 3269 | 19375 | 2617 | 20058 | 2081 | 20923 | 1232 | 25096 | 781 | 19887 |
| 20-#11 | 3.82 | MA | 14076 | 4686 | 23640 | 3382 | 25783 | 2721 | 26750 | 2204 | 27584 | 1359 | 33712 | 764 | 27746 |
| 8L-4S | | MI | 10689 | 4686 | 18326 | 3276 | 19950 | 2609 | 20745 | 2072 | 21885 | 1240 | 26212 | 820 | 20285 |
| 20-#14 | 5.51 | MA | 15318 | 5163 | 26809 | 3675 | 29834 | 2937 | 31636 | 2317 | 34179 | 1314 | 42423 | 520 | 38613 |
| 7L-5S | | MI | 11110 | 5163 | 19859 | 3544 | 21759 | 2803 | 22896 | 2172 | 24804 | 1157 | 29996 | 486 | 27248 |
| 22-#11 | 4.21 | MA | 14876 | 4794 | 25238 | 3453 | 27880 | 2775 | 29277 | 2223 | 31065 | 1357 | 38108 | 787 | 31328 |
| 7L-6S | | MI | 10431 | 4794 | 18038 | 3346 | 19588 | 2656 | 20350 | 2115 | 21306 | 1223 | 25680 | 686 | 21410 |
| 22-#11 | 4.21 | MA | 14514 | 4794 | 24604 | 3449 | 27018 | 2769 | 28257 | 2233 | 29606 | 1349 | 36391 | 741 | 30571 |
| 8L-5S | | MI | 10689 | 4794 | 18499 | 3336 | 20165 | 2664 | 21003 | 2107 | 22175 | 1215 | 26715 | 744 | 21770 |
| 24-#11 | 4.59 | MA | 14949 | 4901 | 25568 | 3517 | 28254 | 2817 | 29765 | 2263 | 31628 | 1338 | 39069 | 718 | 33402 |
| 8L-6S | | MI | 10701 | 4901 | 18665 | 3413 | 20378 | 2703 | 21294 | 2141 | 22559 | 1206 | 27299 | 650 | 23240 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

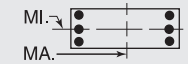
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.04 | MA | 15136 | 4130 | 23593 | 3052 | 25255 | 2491 | 25517 | 2082 | 24930 | 1504 | 28910 | 1417 | 9841 |
| 2E | | MI | 9956 | 4130 | 15797 | 2929 | 16496 | 2383 | 16409 | 1982 | 15728 | 1415 | 17912 | 1308 | 6409 |
| 4-#18 | 1.85 | MA | 16119 | 4372 | 25872 | 3179 | 28062 | 2579 | 28899 | 2131 | 29336 | 1460 | 34658 | 1337 | 16912 |
| 2E | | MI | 10496 | 4372 | 17097 | 3039 | 18006 | 2448 | 18180 | 2002 | 18072 | 1341 | 20833 | 1176 | 10753 |
| 6-#11 | 1.08 | MA | 15213 | 4143 | 23696 | 3072 | 25445 | 2506 | 25771 | 2094 | 25314 | 1512 | 29449 | 1425 | 10250 |
| 2L-3S | | MI | 9583 | 4143 | 15237 | 2948 | 15863 | 2414 | 15671 | 2009 | 14753 | 1435 | 16681 | 1234 | 6715 |
| 6-#11 | 1.08 | MA | 14511 | 4143 | 22665 | 3068 | 24123 | 2518 | 24158 | 2104 | 23138 | 1520 | 26557 | 1339 | 10300 |
| 3L-2S | | MI | 10007 | 4143 | 15864 | 2955 | 16653 | 2406 | 16615 | 2000 | 16005 | 1427 | 18300 | 1320 | 6660 |
| 6-#14 | 1.56 | MA | 15816 | 4286 | 25067 | 3149 | 27144 | 2560 | 27822 | 2124 | 28023 | 1489 | 33009 | 1384 | 14504 |
| 2L-3S | | MI | 9748 | 4286 | 15797 | 3015 | 16496 | 2462 | 16409 | 2030 | 15728 | 1401 | 17912 | 1127 | 9374 |
| 6-#14 | 1.56 | MA | 14823 | 4286 | 23593 | 3143 | 25255 | 2577 | 25517 | 2138 | 24930 | 1501 | 28910 | 1259 | 14551 |
| 3L-2S | | MI | 10346 | 4286 | 16687 | 3027 | 17608 | 2450 | 17738 | 2017 | 17491 | 1388 | 20179 | 1252 | 9293 |
| 6-#18 | 2.78 | MA | 17270 | 4649 | 28444 | 3352 | 31358 | 2703 | 32920 | 2206 | 34675 | 1429 | 41694 | 1270 | 24985 |
| 2L-3S | | MI | 10132 | 4649 | 17097 | 3187 | 18006 | 2584 | 18180 | 2082 | 18072 | 1309 | 20833 | 842 | 15716 |
| 6-#18 | 2.78 | MA | 15570 | 4649 | 25872 | 3339 | 28062 | 2730 | 28899 | 2229 | 29336 | 1451 | 34658 | 1049 | 24845 |
| 3L-2S | | MI | 11148 | 4649 | 18606 | 3209 | 19883 | 2562 | 20425 | 2060 | 21052 | 1287 | 24624 | 1063 | 15648 |
| 8-#11 | 1.44 | MA | 15692 | 4250 | 24727 | 3139 | 26767 | 2555 | 27384 | 2123 | 27491 | 1502 | 32340 | 1404 | 13509 |
| 2L-4S | | MI | 9554 | 4250 | 15343 | 3025 | 16003 | 2453 | 15845 | 2026 | 15049 | 1426 | 17247 | 1118 | 8793 |
| 8-#11 | 1.44 | MA | 14994 | 4250 | 23696 | 3136 | 25445 | 2567 | 25771 | 2133 | 25314 | 1511 | 29449 | 1317 | 13545 |
| 3E | | MI | 9862 | 4250 | 15864 | 3015 | 16653 | 2461 | 16615 | 2035 | 16005 | 1418 | 18300 | 1197 | 8736 |
| 8-#11 | 1.44 | MA | 14501 | 4250 | 22852 | 3149 | 24370 | 2561 | 24465 | 2127 | 23651 | 1519 | 27575 | 1231 | 13547 |
| 4L-2S | | MI | 10284 | 4250 | 16491 | 3023 | 17443 | 2453 | 17559 | 2026 | 17258 | 1409 | 19919 | 1284 | 8684 |
| 8-#14 | 2.08 | MA | 16489 | 4441 | 26541 | 3247 | 29034 | 2630 | 30127 | 2166 | 31117 | 1474 | 37108 | 1351 | 19138 |
| 2L-4S | | MI | 9703 | 4441 | 15945 | 3125 | 16693 | 2516 | 16654 | 2053 | 16145 | 1387 | 18701 | 959 | 12236 |
| 8-#14 | 2.08 | MA | 15503 | 4441 | 25067 | 3241 | 27144 | 2647 | 27822 | 2181 | 28023 | 1486 | 33009 | 1226 | 19144 |
| 3E | | MI | 10138 | 4441 | 16687 | 3112 | 17608 | 2529 | 17738 | 2065 | 17491 | 1374 | 20179 | 1071 | 12203 |
| 8-#14 | 2.08 | MA | 14805 | 4441 | 23859 | 3260 | 25605 | 2639 | 25952 | 2170 | 25659 | 1499 | 30356 | 1102 | 19012 |
| 4L-2S | | MI | 10732 | 4441 | 17577 | 3124 | 18719 | 2516 | 19066 | 2053 | 19254 | 1362 | 22446 | 1195 | 12140 |
| 8-#18 | 3.70 | MA | 18403 | 4925 | 31015 | 3525 | 34654 | 2827 | 36942 | 2281 | 40014 | 1398 | 48729 | 1204 | 33001 |
| 2L-4S | | MI | 10045 | 4925 | 17345 | 3379 | 18336 | 2676 | 18592 | 2118 | 18777 | 1277 | 22142 | 539 | 18881 |
| 8-#18 | 3.70 | MA | 16724 | 4925 | 28444 | 3512 | 31358 | 2855 | 32920 | 2304 | 34675 | 1420 | 41694 | 982 | 32742 |
| 3E | | MI | 10786 | 4925 | 18606 | 3357 | 19883 | 2699 | 20425 | 2140 | 21052 | 1255 | 24624 | 729 | 20465 |
| 8-#18 | 3.70 | MA | 15532 | 4925 | 26330 | 3544 | 28665 | 2838 | 29648 | 2282 | 30596 | 1442 | 37154 | 761 | 30103 |
| 4L-2S | | MI | 11793 | 4925 | 20116 | 3379 | 21761 | 2676 | 22670 | 2118 | 24033 | 1233 | 28416 | 951 | 20490 |
| 10-#11 | 1.81 | MA | 16167 | 4358 | 25759 | 3207 | 28089 | 2603 | 28997 | 2152 | 29667 | 1492 | 35232 | 1382 | 16754 |
| 2L-5S | | MI | 9555 | 4358 | 15515 | 3085 | 16218 | 2508 | 16103 | 2060 | 15339 | 1401 | 17750 | 1043 | 10704 |
| 10-#11 | 1.81 | MA | 15474 | 4358 | 24727 | 3203 | 26767 | 2615 | 27384 | 2163 | 27491 | 1501 | 32340 | 1296 | 16776 |
| 3L-4S | | MI | 9833 | 4358 | 15969 | 3092 | 16793 | 2500 | 16789 | 2052 | 16302 | 1409 | 18866 | 1081 | 10777 |
| 10-#11 | 1.81 | MA | 14983 | 4358 | 23884 | 3217 | 25692 | 2610 | 26078 | 2156 | 25827 | 1509 | 30466 | 1210 | 16747 |
| 4L-3S | | MI | 10139 | 4358 | 16491 | 3083 | 17443 | 2508 | 17559 | 2060 | 17258 | 1401 | 19919 | 1161 | 10735 |
| 10-#11 | 1.81 | MA | 14544 | 4358 | 23153 | 3213 | 24745 | 2622 | 24914 | 2167 | 24160 | 1501 | 28487 | 1170 | 16448 |
| 5L-2S | | MI | 10559 | 4358 | 17117 | 3090 | 18233 | 2500 | 18503 | 2052 | 18511 | 1392 | 21537 | 1247 | 10689 |
| 10-#14 | 2.60 | MA | 17155 | 4597 | 28015 | 3344 | 30923 | 2700 | 32432 | 2209 | 34211 | 1458 | 41207 | 1317 | 23758 |
| 2L-5S | | MI | 9701 | 4597 | 16187 | 3210 | 16995 | 2595 | 17017 | 2101 | 16666 | 1372 | 19406 | 846 | 14267 |
| 10-#14 | 2.60 | MA | 16176 | 4597 | 26541 | 3338 | 29034 | 2717 | 30127 | 2223 | 31117 | 1471 | 37108 | 1193 | 23717 |
| 3L-4S | | MI | 10092 | 4597 | 16835 | 3222 | 17804 | 2583 | 17982 | 2088 | 17908 | 1360 | 20968 | 903 | 14917 |
| 10-#14 | 2.60 | MA | 15484 | 4597 | 25333 | 3357 | 27495 | 2709 | 28257 | 2213 | 28753 | 1483 | 34455 | 1068 | 23536 |
| 4L-3S | | MI | 10525 | 4597 | 17577 | 3209 | 18719 | 2595 | 19066 | 2101 | 19254 | 1347 | 22446 | 1015 | 15008 |
| 10-#14 | 2.60 | MA | 14864 | 4597 | 24286 | 3351 | 26138 | 2725 | 26590 | 2227 | 26382 | 1471 | 31643 | 1013 | 22231 |
| 5L-2S | | MI | 11115 | 4597 | 18467 | 3221 | 19831 | 2583 | 20395 | 2088 | 21017 | 1335 | 24712 | 1139 | 14964 |
| 10-#18 | 4.63 | MA | 17861 | 5202 | 31015 | 3685 | 34654 | 2979 | 36942 | 2379 | 40014 | 1389 | 48729 | 915 | 40623 |
| 3L-4S | | MI | 10699 | 5202 | 18855 | 3549 | 20214 | 2791 | 20837 | 2176 | 21758 | 1223 | 25933 | 426 | 23298 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis

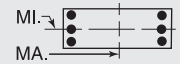



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 4.63 | MA | 16684 | 5202 | 28901 | 3717 | 31961 | 2962 | 33669 | 2358 | 35935 | 1411 | 44190 | 694 | 37621 |
| 4L-3S | | MI | 11434 | 5202 | 20116 | 3527 | 21761 | 2813 | 22670 | 2198 | 24033 | 1201 | 28416 | 617 | 25182 |
| 10-#18 | 4.63 | MA | 15631 | 5202 | 27066 | 3705 | 29583 | 2989 | 30748 | 2380 | 31841 | 1389 | 39339 | 599 | 35242 |
| 5L-2S | | MI | 12432 | 5202 | 21626 | 3549 | 23638 | 2791 | 24915 | 2176 | 27013 | 1179 | 32208 | 838 | 25297 |
| 12-#11 | 2.17 | MA | 16639 | 4466 | 26790 | 3274 | 29412 | 2651 | 30610 | 2182 | 31844 | 1482 | 38123 | 1361 | 19989 |
| 2L-6S | | MI | 9569 | 4466 | 15681 | 3162 | 16431 | 2547 | 16394 | 2094 | 15723 | 1392 | 18334 | 948 | 12273 |
| 12-#11 | 2.17 | MA | 15949 | 4466 | 25759 | 3271 | 28089 | 2663 | 28997 | 2192 | 29667 | 1491 | 35232 | 1274 | 19992 |
| 3L-5S | | MI | 9833 | 4466 | 16142 | 3152 | 17008 | 2555 | 17047 | 2086 | 16592 | 1383 | 19369 | 1006 | 12521 |
| 12-#11 | 2.17 | MA | 15462 | 4466 | 24915 | 3284 | 27014 | 2658 | 27691 | 2186 | 28004 | 1500 | 33358 | 1188 | 19938 |
| 4E | | MI | 10109 | 4466 | 16596 | 3160 | 17583 | 2547 | 17733 | 2077 | 17554 | 1392 | 20484 | 1045 | 12748 |
| 12-#11 | 2.17 | MA | 15025 | 4466 | 24184 | 3281 | 26067 | 2670 | 26527 | 2196 | 26336 | 1491 | 31379 | 1149 | 19509 |
| 5L-3S | | MI | 10414 | 4466 | 17117 | 3150 | 18233 | 2555 | 18503 | 2086 | 18511 | 1383 | 21537 | 1124 | 12720 |
| 12-#11 | 2.17 | MA | 14610 | 4466 | 23498 | 3277 | 25118 | 2665 | 25367 | 2189 | 24826 | 1500 | 29514 | 1092 | 18938 |
| 6L-2S | | MI | 10832 | 4466 | 17744 | 3158 | 19023 | 2547 | 19448 | 2077 | 19764 | 1375 | 23156 | 1211 | 12682 |
| 12-#14 | 3.13 | MA | 16843 | 4753 | 28015 | 3435 | 30923 | 2787 | 32432 | 2266 | 34211 | 1456 | 41207 | 1160 | 28278 |
| 3L-5S | | MI | 10090 | 4753 | 17077 | 3307 | 18107 | 2662 | 18345 | 2136 | 18430 | 1345 | 21673 | 790 | 16901 |
| 12-#14 | 3.13 | MA | 16156 | 4753 | 26807 | 3454 | 29384 | 2778 | 30562 | 2255 | 31846 | 1468 | 38554 | 1035 | 27934 |
| 4E | | MI | 10479 | 4753 | 17725 | 3319 | 18916 | 2649 | 19311 | 2124 | 19671 | 1333 | 23235 | 847 | 17490 |
| 12-#14 | 3.13 | MA | 15541 | 4753 | 25760 | 3448 | 28027 | 2795 | 28895 | 2269 | 29476 | 1456 | 35742 | 979 | 26621 |
| 5L-3S | | MI | 10909 | 4753 | 18467 | 3306 | 19831 | 2662 | 20395 | 2136 | 21017 | 1321 | 24712 | 959 | 17796 |
| 12-#14 | 3.13 | MA | 14956 | 4753 | 24777 | 3443 | 26667 | 2787 | 27234 | 2259 | 27329 | 1468 | 33100 | 898 | 25638 |
| 6L-2S | | MI | 11496 | 4753 | 19358 | 3318 | 20942 | 2649 | 21724 | 2124 | 22780 | 1308 | 26979 | 1083 | 17772 |
| 12-#18 | 5.56 | MA | 17821 | 5479 | 31472 | 3890 | 35258 | 3086 | 37691 | 2433 | 41274 | 1380 | 51226 | 627 | 45182 |
| 4E | | MI | 11348 | 5479 | 20365 | 3720 | 22091 | 2905 | 23082 | 2234 | 24739 | 1169 | 29725 | 313 | 27752 |
| 12-#18 | 5.56 | MA | 16780 | 5479 | 29637 | 3878 | 32879 | 3113 | 34770 | 2455 | 37180 | 1358 | 46375 | 532 | 42618 |
| 5L-3S | | MI | 12076 | 5479 | 21626 | 3697 | 23638 | 2927 | 24915 | 2256 | 27013 | 1147 | 32208 | 504 | 29623 |
| 12-#18 | 5.56 | MA | 15791 | 5479 | 27913 | 3865 | 30496 | 3096 | 31989 | 2478 | 33476 | 1380 | 41849 | 386 | 39778 |
| 6L-2S | | MI | 13067 | 5479 | 23136 | 3720 | 25516 | 2905 | 27161 | 2234 | 29994 | 1125 | 36000 | 726 | 30062 |
| 14-#11 | 2.53 | MA | 16421 | 4574 | 26790 | 3338 | 29412 | 2712 | 30610 | 2222 | 31844 | 1481 | 38123 | 1253 | 23198 |
| 3L-6S | | MI | 9847 | 4574 | 16308 | 3229 | 17221 | 2594 | 17338 | 2120 | 16976 | 1375 | 19952 | 912 | 14157 |
| 14-#11 | 2.53 | MA | 15936 | 4574 | 25946 | 3352 | 28336 | 2707 | 29304 | 2215 | 30180 | 1490 | 36249 | 1166 | 23123 |
| 4L-5S | | MI | 10109 | 4574 | 16768 | 3219 | 17798 | 2602 | 17991 | 2111 | 17845 | 1366 | 20987 | 970 | 14384 |
| 14-#11 | 2.53 | MA | 15503 | 4574 | 25215 | 3348 | 27389 | 2719 | 28139 | 2226 | 28513 | 1481 | 34270 | 1127 | 22583 |
| 5L-4S | | MI | 10384 | 4574 | 17223 | 3227 | 18373 | 2594 | 18678 | 2103 | 18807 | 1375 | 22103 | 1009 | 14710 |
| 14-#11 | 2.53 | MA | 15090 | 4574 | 24530 | 3344 | 26440 | 2714 | 26980 | 2219 | 27003 | 1490 | 32405 | 1071 | 22043 |
| 6L-3S | | MI | 10688 | 4574 | 17744 | 3217 | 19023 | 2602 | 19448 | 2111 | 19764 | 1366 | 23156 | 1088 | 14695 |
| 14-#11 | 2.53 | MA | 14687 | 4574 | 23778 | 3358 | 25534 | 2726 | 25866 | 2229 | 25527 | 1498 | 30413 | 980 | 21407 |
| 7L-2S | | MI | 11104 | 4574 | 18371 | 3225 | 19813 | 2594 | 20392 | 2103 | 21017 | 1357 | 24774 | 1174 | 14665 |
| 14-#14 | 3.65 | MA | 16822 | 4908 | 28281 | 3552 | 31273 | 2848 | 32867 | 2298 | 34940 | 1453 | 42653 | 1002 | 32261 |
| 4L-5S | | MI | 10476 | 4908 | 17967 | 3404 | 19218 | 2728 | 19674 | 2172 | 20193 | 1319 | 23939 | 734 | 19546 |
| 14-#14 | 3.65 | MA | 16212 | 4908 | 27234 | 3546 | 29916 | 2865 | 31200 | 2312 | 32570 | 1440 | 39841 | 946 | 31025 |
| 5L-4S | | MI | 10863 | 4908 | 18616 | 3416 | 20027 | 2716 | 20640 | 2159 | 21434 | 1306 | 25501 | 790 | 20082 |
| 14-#14 | 3.65 | MA | 15632 | 4908 | 26251 | 3540 | 28557 | 2857 | 29539 | 2301 | 30423 | 1453 | 37199 | 865 | 29941 |
| 6L-3S | | MI | 11290 | 4908 | 19358 | 3404 | 20942 | 2728 | 21724 | 2172 | 22780 | 1294 | 26979 | 903 | 20563 |
| 14-#14 | 3.65 | MA | 15067 | 4908 | 25175 | 3559 | 27259 | 2873 | 27943 | 2316 | 28325 | 1465 | 34375 | 734 | 28649 |
| 7L-2S | | MI | 11875 | 4908 | 20248 | 3416 | 22053 | 2716 | 23052 | 2159 | 24543 | 1281 | 29245 | 1027 | 20569 |
| 14-#18 | 6.48 | MA | 17916 | 5755 | 32208 | 4050 | 36176 | 3237 | 38791 | 2531 | 42520 | 1327 | 53411 | 465 | 50031 |
| 5L-4S | | MI | 11991 | 5755 | 21875 | 3890 | 23969 | 3019 | 25327 | 2292 | 27719 | 1115 | 33517 | 201 | 32235 |
| 14-#18 | 6.48 | MA | 16938 | 5755 | 30484 | 4038 | 33792 | 3220 | 36011 | 2553 | 38815 | 1349 | 48885 | 319 | 47182 |
| 6L-3S | | MI | 12714 | 5755 | 23136 | 3868 | 25516 | 3041 | 27161 | 2314 | 29994 | 1093 | 36000 | 392 | 33930 |
| 16-#11 | 2.89 | MA | 16408 | 4682 | 26978 | 3419 | 29659 | 2755 | 30917 | 2244 | 32357 | 1480 | 39141 | 1145 | 26305 |
| 4L-6S | | MI | 10122 | 4682 | 16935 | 3296 | 18011 | 2641 | 18282 | 2145 | 18228 | 1357 | 21571 | 875 | 16044 |
| 16-#11 | 2.89 | MA | 15977 | 4682 | 26247 | 3416 | 28711 | 2767 | 29752 | 2255 | 30690 | 1471 | 37162 | 1106 | 25667 |
| 5E | | MI | 10384 | 4682 | 17395 | 3287 | 18588 | 2649 | 18935 | 2137 | 19097 | 1349 | 22606 | 933 | 16254 |
| 16-#11 | 2.89 | MA | 15566 | 4682 | 25561 | 3412 | 27762 | 2762 | 28593 | 2248 | 29179 | 1480 | 35297 | 1049 | 25153 |
| 6L-4S | | MI | 10658 | 4682 | 17850 | 3294 | 19163 | 2641 | 19622 | 2128 | 20060 | 1357 | 23721 | 972 | 16657 |
| 16-#11 | 2.89 | MA | 15167 | 4682 | 24810 | 3426 | 26856 | 2774 | 27479 | 2259 | 27703 | 1489 | 33304 | 959 | 24455 |
| 7L-3S | | MI | 10960 | 4682 | 18371 | 3285 | 19813 | 2649 | 20392 | 2137 | 21017 | 1349 | 24774 | 1051 | 16663 |

## RECTANGULAR TIED COLUMNS 24" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

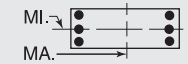
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.89 | MA | 14773 | 4682 | 24134 | 3422 | 25937 | 2769 | 26391 | 2269 | 26134 | 1480 | 31455 | 912 | 23755 |
| 8L-2S | | MI | 11374 | 4682 | 18998 | 3293 | 20603 | 2641 | 21336 | 2128 | 22269 | 1340 | 26393 | 1138 | 16641 |
| 16-#14 | 4.17 | MA | 16877 | 5064 | 28708 | 3643 | 31806 | 2935 | 33505 | 2354 | 35663 | 1425 | 43940 | 913 | 35441 |
| 5E | | MI | 10860 | 5064 | 18858 | 3502 | 20329 | 2795 | 21002 | 2207 | 21956 | 1292 | 26206 | 678 | 22199 |
| 16-#14 | 4.17 | MA | 16301 | 5064 | 27725 | 3637 | 30446 | 2927 | 31843 | 2344 | 33517 | 1438 | 41298 | 831 | 34260 |
| 6L-4S | | MI | 11245 | 5064 | 19506 | 3514 | 21138 | 2783 | 21968 | 2195 | 23197 | 1279 | 27768 | 734 | 22691 |
| 16-#14 | 4.17 | MA | 15741 | 5064 | 26649 | 3656 | 29148 | 2943 | 30248 | 2358 | 31419 | 1450 | 38474 | 701 | 33022 |
| 7L-3S | | MI | 11670 | 5064 | 20248 | 3501 | 22053 | 2795 | 23052 | 2207 | 24543 | 1267 | 29245 | 846 | 23320 |
| 16-#14 | 4.17 | MA | 15189 | 5064 | 25681 | 3650 | 27831 | 2935 | 28690 | 2372 | 29188 | 1438 | 35846 | 635 | 31388 |
| 8L-2S | | MI | 12251 | 5064 | 21138 | 3513 | 23165 | 2783 | 24381 | 2195 | 26307 | 1255 | 31512 | 971 | 23356 |
| 16-#18 | 7.41 | MA | 18073 | 6032 | 33056 | 4211 | 37088 | 3344 | 40032 | 2629 | 44154 | 1318 | 55920 | 252 | 54525 |
| 6L-4S | | MI | 12716 | 6032 | 23384 | 4060 | 25846 | 3133 | 27572 | 2350 | 30700 | 1061 | 37309 | 88 | 36739 |
| 18-#11 | 3.25 | MA | 16447 | 4790 | 27278 | 3483 | 30033 | 2816 | 31365 | 2284 | 32866 | 1462 | 40053 | 1084 | 28759 |
| 5L-6S | | MI | 10397 | 4790 | 17562 | 3364 | 18801 | 2688 | 19227 | 2171 | 19481 | 1340 | 23190 | 839 | 17934 |
| 18-#11 | 3.25 | MA | 16040 | 4790 | 26592 | 3479 | 29084 | 2810 | 30206 | 2278 | 31356 | 1470 | 38188 | 1028 | 28269 |
| 6L-5S | | MI | 10657 | 4790 | 18022 | 3354 | 19378 | 2696 | 19880 | 2162 | 20350 | 1331 | 24225 | 897 | 18129 |
| 18-#11 | 3.25 | MA | 15642 | 4790 | 25841 | 3493 | 28178 | 2823 | 29092 | 2288 | 29880 | 1479 | 36196 | 937 | 27511 |
| 7L-4S | | MI | 10930 | 4790 | 18477 | 3362 | 19953 | 2688 | 20566 | 2154 | 21313 | 1340 | 25340 | 936 | 18577 |
| 18-#11 | 3.25 | MA | 15251 | 4790 | 25166 | 3489 | 27259 | 2817 | 28004 | 2299 | 28310 | 1470 | 34346 | 891 | 26837 |
| 8L-3S | | MI | 11231 | 4790 | 18998 | 3352 | 20603 | 2696 | 21336 | 2162 | 22269 | 1331 | 26393 | 1015 | 18625 |
| 18-#11 | 3.25 | MA | 14864 | 4790 | 24439 | 3503 | 26364 | 2829 | 26867 | 2292 | 26848 | 1479 | 32538 | 836 | 25867 |
| 9L-2S | | MI | 11644 | 4790 | 19624 | 3360 | 21393 | 2688 | 22280 | 2154 | 23522 | 1323 | 28012 | 1101 | 18611 |
| 18-#14 | 4.69 | MA | 16965 | 5219 | 29199 | 3734 | 32335 | 2996 | 34148 | 2386 | 36610 | 1422 | 45397 | 798 | 38593 |
| 6L-5S | | MI | 11242 | 5219 | 19748 | 3599 | 21441 | 2862 | 22331 | 2243 | 23719 | 1265 | 28472 | 621 | 24858 |
| 18-#14 | 4.69 | MA | 16409 | 5219 | 28122 | 3754 | 31037 | 3013 | 32553 | 2401 | 34513 | 1435 | 42573 | 668 | 37404 |
| 7L-4S | | MI | 11624 | 5219 | 20396 | 3611 | 22250 | 2849 | 23297 | 2230 | 24961 | 1253 | 30034 | 678 | 25311 |
| 18-#14 | 4.69 | MA | 15862 | 5219 | 27154 | 3748 | 29720 | 3005 | 30995 | 2415 | 32281 | 1422 | 39945 | 602 | 35714 |
| 8L-3S | | MI | 12047 | 5219 | 21138 | 3598 | 23165 | 2862 | 24381 | 2243 | 26307 | 1240 | 31512 | 790 | 26069 |
| 20-#11 | 3.61 | MA | 16510 | 4898 | 27624 | 3547 | 30406 | 2859 | 31818 | 2307 | 33532 | 1460 | 41080 | 1006 | 31388 |
| 6E | | MI | 10670 | 4898 | 18189 | 3431 | 19591 | 2735 | 20171 | 2196 | 20734 | 1323 | 24808 | 802 | 19778 |
| 20-#11 | 3.61 | MA | 16115 | 4898 | 26872 | 3560 | 29500 | 2871 | 30705 | 2318 | 32056 | 1469 | 39087 | 916 | 30575 |
| 7L-5S | | MI | 10929 | 4898 | 18649 | 3422 | 20168 | 2743 | 20824 | 2188 | 21603 | 1314 | 25843 | 860 | 20009 |
| 20-#11 | 3.61 | MA | 15726 | 4898 | 26197 | 3557 | 28581 | 2866 | 29617 | 2328 | 30487 | 1460 | 37238 | 869 | 29906 |
| 8L-4S | | MI | 11200 | 4898 | 19103 | 3429 | 20743 | 2735 | 21510 | 2179 | 22566 | 1323 | 26959 | 899 | 20426 |
| 20-#11 | 3.61 | MA | 15341 | 4898 | 25470 | 3570 | 27687 | 2878 | 28480 | 2321 | 29024 | 1469 | 35430 | 815 | 28916 |
| 9L-3S | | MI | 11500 | 4898 | 19624 | 3420 | 21393 | 2743 | 22280 | 2188 | 23522 | 1314 | 28012 | 979 | 20573 |
| 20-#14 | 5.21 | MA | 17072 | 5375 | 29596 | 3851 | 32927 | 3083 | 34858 | 2443 | 37606 | 1420 | 46672 | 634 | 41707 |
| 7L-5S | | MI | 11621 | 5375 | 20638 | 3696 | 22552 | 2928 | 23660 | 2278 | 25482 | 1238 | 30739 | 565 | 27518 |
| 20-#14 | 5.21 | MA | 16529 | 5375 | 28628 | 3845 | 31610 | 3075 | 33300 | 2457 | 35375 | 1407 | 44044 | 568 | 40049 |
| 8L-4S | | MI | 12002 | 5375 | 21286 | 3708 | 23361 | 2916 | 24626 | 2266 | 26724 | 1226 | 32301 | 622 | 27941 |
| 22-#11 | 3.97 | MA | 16584 | 5006 | 27904 | 3628 | 30822 | 2919 | 32318 | 2347 | 34233 | 1459 | 41979 | 894 | 33645 |
| 7L-6S | | MI | 10942 | 5006 | 18815 | 3499 | 20381 | 2782 | 21115 | 2222 | 21987 | 1305 | 26427 | 766 | 21600 |
| 22-#11 | 3.97 | MA | 16198 | 5006 | 27228 | 3624 | 29903 | 2914 | 31230 | 2358 | 32664 | 1451 | 40129 | 848 | 32933 |
| 8L-5S | | MI | 11200 | 5006 | 19275 | 3489 | 20958 | 2790 | 21768 | 2213 | 22856 | 1297 | 27462 | 824 | 21892 |
| 22-#11 | 3.97 | MA | 15815 | 5006 | 26501 | 3638 | 29009 | 2926 | 30093 | 2351 | 31201 | 1459 | 38321 | 793 | 31971 |
| 9L-4S | | MI | 11470 | 5006 | 19730 | 3497 | 21533 | 2782 | 22455 | 2205 | 23818 | 1305 | 28577 | 863 | 22282 |
| 22-#14 | 5.73 | MA | 17191 | 5531 | 30102 | 3942 | 33499 | 3145 | 35605 | 2500 | 38469 | 1392 | 48143 | 535 | 44395 |
| 8L-5S | | MI | 11999 | 5531 | 21528 | 3794 | 23664 | 2995 | 24988 | 2314 | 27245 | 1212 | 33006 | 509 | 30063 |
| 24-#11 | 4.33 | MA | 16666 | 5114 | 28260 | 3692 | 31225 | 2963 | 32843 | 2387 | 34840 | 1441 | 43021 | 826 | 35967 |
| 8L-6S | | MI | 11212 | 5114 | 19442 | 3566 | 21171 | 2829 | 22060 | 2248 | 23240 | 1288 | 28046 | 729 | 23429 |
| 24-#11 | 4.33 | MA | 16286 | 5114 | 27533 | 3705 | 30331 | 2975 | 31706 | 2380 | 33377 | 1449 | 41213 | 772 | 35032 |
| 9L-5S | | MI | 11470 | 5114 | 19902 | 3557 | 21748 | 2837 | 22712 | 2239 | 24109 | 1279 | 29080 | 787 | 23777 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis

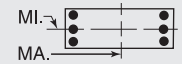



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.75 | MA | 17868 | 4584 | 28531 | 3351 | 30962 | 2721 | 31855 | 2251 | 32313 | 1557 | 38181 | 1436 | 17992 |
| 2E | | MI | 11006 | 4584 | 17879 | 3189 | 18798 | 2572 | 18940 | 2107 | 18744 | 1422 | 21569 | 1254 | 10802 |
| 6-#11 | 1.03 | MA | 16889 | 4355 | 26201 | 3244 | 28159 | 2648 | 28505 | 2214 | 27970 | 1607 | 32532 | 1519 | 10882 |
| 2L-3S | | MI | 10093 | 4355 | 16014 | 3101 | 16657 | 2540 | 16436 | 2116 | 15433 | 1517 | 17428 | 1313 | 6745 |
| 6-#11 | 1.03 | MA | 16140 | 4355 | 25102 | 3241 | 26750 | 2661 | 26787 | 2225 | 25639 | 1615 | 29427 | 1433 | 10932 |
| 3L-2S | | MI | 10517 | 4355 | 16641 | 3108 | 17447 | 2532 | 17381 | 2107 | 16686 | 1509 | 19047 | 1400 | 6690 |
| 6-#14 | 1.48 | MA | 17539 | 4498 | 27665 | 3322 | 29974 | 2702 | 30695 | 2245 | 30882 | 1585 | 36371 | 1480 | 15415 |
| 2L-3S | | MI | 10257 | 4498 | 16575 | 3167 | 17289 | 2587 | 17173 | 2136 | 16406 | 1482 | 18656 | 1206 | 9415 |
| 6-#14 | 1.48 | MA | 16477 | 4498 | 26094 | 3316 | 27960 | 2720 | 28238 | 2260 | 27565 | 1597 | 31964 | 1356 | 15462 |
| 3L-2S | | MI | 10856 | 4498 | 17466 | 3179 | 18401 | 2575 | 18502 | 2124 | 18169 | 1470 | 20922 | 1331 | 9332 |
| 6-#18 | 2.63 | MA | 19106 | 4861 | 31276 | 3524 | 34480 | 2845 | 36147 | 2326 | 38048 | 1528 | 45763 | 1374 | 26605 |
| 2L-3S | | MI | 10642 | 4861 | 17879 | 3337 | 18798 | 2708 | 18940 | 2187 | 18744 | 1390 | 21569 | 920 | 15793 |
| 6-#18 | 2.63 | MA | 17287 | 4861 | 28531 | 3513 | 30962 | 2874 | 31855 | 2351 | 32313 | 1550 | 38181 | 1152 | 26465 |
| 3L-2S | | MI | 11659 | 4861 | 19388 | 3359 | 20675 | 2686 | 21185 | 2165 | 21725 | 1368 | 25360 | 1141 | 15706 |
| 8-#11 | 1.37 | MA | 17403 | 4463 | 27299 | 3312 | 29568 | 2696 | 30224 | 2243 | 30301 | 1598 | 35637 | 1499 | 14351 |
| 2L-4S | | MI | 10063 | 4463 | 16120 | 3178 | 16797 | 2579 | 16610 | 2133 | 15729 | 1509 | 17994 | 1197 | 8832 |
| 8-#11 | 1.37 | MA | 16658 | 4463 | 26201 | 3309 | 28159 | 2709 | 28505 | 2255 | 27970 | 1606 | 32532 | 1413 | 14388 |
| 3E | | MI | 10372 | 4463 | 16641 | 3168 | 17447 | 2587 | 17381 | 2142 | 16686 | 1500 | 19047 | 1277 | 8772 |
| 8-#11 | 1.37 | MA | 16133 | 4463 | 25303 | 3323 | 27015 | 2704 | 27115 | 2248 | 26188 | 1615 | 30516 | 1327 | 14390 |
| 4L-2S | | MI | 10794 | 4463 | 17267 | 3176 | 18237 | 2579 | 18325 | 2133 | 17939 | 1491 | 20665 | 1363 | 8718 |
| 8-#14 | 1.97 | MA | 18261 | 4653 | 29236 | 3419 | 31988 | 2772 | 33152 | 2287 | 34198 | 1571 | 40777 | 1449 | 20353 |
| 2L-4S | | MI | 10212 | 4653 | 16724 | 3277 | 17486 | 2641 | 17418 | 2159 | 16823 | 1468 | 19445 | 1038 | 12298 |
| 8-#14 | 1.97 | MA | 17207 | 4653 | 27665 | 3414 | 29974 | 2789 | 30695 | 2302 | 30882 | 1583 | 36371 | 1325 | 20359 |
| 3E | | MI | 10648 | 4653 | 17466 | 3264 | 18401 | 2654 | 18502 | 2172 | 18169 | 1456 | 20922 | 1150 | 12252 |
| 8-#14 | 1.97 | MA | 16463 | 4653 | 26380 | 3433 | 28336 | 2782 | 28705 | 2293 | 28347 | 1596 | 33514 | 1200 | 20227 |
| 4L-2S | | MI | 11243 | 4653 | 18356 | 3276 | 19512 | 2641 | 19830 | 2159 | 19932 | 1443 | 23189 | 1274 | 12184 |
| 8-#18 | 3.51 | MA | 20325 | 5138 | 34020 | 3697 | 37998 | 2969 | 40439 | 2402 | 43782 | 1499 | 53344 | 1311 | 35161 |
| 2L-4S | | MI | 10554 | 5138 | 18127 | 3529 | 19128 | 2800 | 19352 | 2223 | 19450 | 1358 | 22878 | 616 | 19115 |
| 8-#18 | 3.51 | MA | 18527 | 5138 | 31276 | 3686 | 34480 | 2998 | 36147 | 2426 | 38048 | 1521 | 45763 | 1090 | 34902 |
| 3E | | MI | 11296 | 5138 | 19388 | 3507 | 20675 | 2822 | 21185 | 2245 | 21725 | 1336 | 25360 | 807 | 20557 |
| 8-#18 | 3.51 | MA | 17256 | 5138 | 29024 | 3719 | 31611 | 2982 | 32661 | 2406 | 33665 | 1544 | 40863 | 868 | 32335 |
| 4L-2S | | MI | 12305 | 5138 | 20898 | 3529 | 22553 | 2800 | 23431 | 2223 | 24705 | 1313 | 29152 | 1029 | 20556 |
| 10-#11 | 1.71 | MA | 17913 | 4570 | 28398 | 3379 | 30976 | 2745 | 31942 | 2273 | 32632 | 1589 | 38742 | 1479 | 17807 |
| 2L-5S | | MI | 10064 | 4570 | 16292 | 3237 | 17012 | 2634 | 16868 | 2167 | 16019 | 1483 | 18497 | 1122 | 10820 |
| 10-#11 | 1.71 | MA | 17172 | 4570 | 27299 | 3376 | 29568 | 2757 | 30224 | 2284 | 30301 | 1597 | 35637 | 1393 | 17829 |
| 3L-4S | | MI | 10342 | 4570 | 16746 | 3245 | 17587 | 2626 | 17555 | 2158 | 16982 | 1491 | 19612 | 1161 | 10822 |
| 10-#11 | 1.71 | MA | 16650 | 4570 | 26402 | 3390 | 28424 | 2753 | 28834 | 2278 | 28519 | 1606 | 33621 | 1307 | 17800 |
| 4L-3S | | MI | 10649 | 4570 | 17267 | 3236 | 18237 | 2634 | 18325 | 2167 | 17939 | 1483 | 20665 | 1240 | 10775 |
| 10-#11 | 1.71 | MA | 16183 | 4570 | 25625 | 3387 | 27417 | 2765 | 27596 | 2289 | 26734 | 1597 | 31501 | 1266 | 17582 |
| 5L-2S | | MI | 11069 | 4570 | 17894 | 3243 | 19027 | 2626 | 19269 | 2158 | 19191 | 1474 | 22284 | 1327 | 10727 |
| 10-#14 | 2.47 | MA | 18976 | 4809 | 30807 | 3516 | 34002 | 2842 | 35609 | 2329 | 37515 | 1557 | 45184 | 1418 | 25277 |
| 2L-5S | | MI | 10210 | 4809 | 16966 | 3362 | 17788 | 2720 | 17781 | 2207 | 17344 | 1454 | 20149 | 925 | 14414 |
| 10-#14 | 2.47 | MA | 17930 | 4809 | 29236 | 3511 | 31988 | 2859 | 33152 | 2345 | 34198 | 1569 | 40777 | 1294 | 25236 |
| 3L-4S | | MI | 10602 | 4809 | 17614 | 3374 | 18597 | 2708 | 18746 | 2195 | 18586 | 1441 | 21711 | 982 | 15070 |
| 10-#14 | 2.47 | MA | 17192 | 4809 | 27951 | 3531 | 30350 | 2852 | 31162 | 2335 | 31663 | 1582 | 37921 | 1169 | 25055 |
| 4L-3S | | MI | 11035 | 4809 | 18356 | 3361 | 19512 | 2720 | 19830 | 2207 | 19932 | 1429 | 23189 | 1094 | 15062 |
| 10-#14 | 2.47 | MA | 16532 | 4809 | 26837 | 3525 | 28907 | 2869 | 29389 | 2350 | 29123 | 1569 | 34905 | 1112 | 23773 |
| 5L-2S | | MI | 11627 | 4809 | 19246 | 3373 | 20624 | 2708 | 21159 | 2195 | 21695 | 1416 | 25455 | 1218 | 15013 |
| 10-#18 | 4.39 | MA | 19750 | 5414 | 34020 | 3859 | 37998 | 3122 | 40439 | 2502 | 43782 | 1493 | 53344 | 1028 | 43323 |
| 3L-4S | | MI | 11208 | 5414 | 19637 | 3699 | 21005 | 2914 | 21597 | 2281 | 22431 | 1304 | 26669 | 504 | 23530 |
| 10-#18 | 4.39 | MA | 18494 | 5414 | 31768 | 3892 | 35129 | 3106 | 36952 | 2482 | 39400 | 1515 | 48444 | 806 | 40370 |
| 4L-3S | | MI | 11945 | 5414 | 20898 | 3677 | 22553 | 2936 | 23431 | 2303 | 24705 | 1282 | 29152 | 695 | 25285 |
| 10-#18 | 4.39 | MA | 17372 | 5414 | 29815 | 3881 | 32597 | 3135 | 33843 | 2506 | 35005 | 1493 | 43232 | 709 | 38050 |
| 5L-2S | | MI | 12946 | 5414 | 22408 | 3699 | 24430 | 2914 | 25676 | 2281 | 27686 | 1259 | 32944 | 916 | 25375 |
| 12-#11 | 2.05 | MA | 18419 | 4678 | 29497 | 3447 | 32385 | 2793 | 33661 | 2302 | 34963 | 1579 | 41847 | 1459 | 21253 |
| 2L-6S | | MI | 10078 | 4678 | 16458 | 3315 | 17225 | 2673 | 17160 | 2201 | 16403 | 1474 | 19081 | 1028 | 12381 |

## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

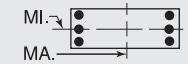
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 2.05 | MA | 17682 | 4678 | 28398 | 3443 | 30976 | 2806 | 31942 | 2313 | 32632 | 1588 | 38742 | 1373 | 21255 |
| 3L-5S | | MI | 10342 | 4678 | 16918 | 3305 | 17802 | 2681 | 17813 | 2193 | 17272 | 1465 | 20116 | 1085 | 12638 |
| 12-#11 | 2.05 | MA | 17163 | 4678 | 27501 | 3457 | 29833 | 2801 | 30552 | 2307 | 30850 | 1597 | 36726 | 1287 | 21201 |
| 4E | | MI | 10619 | 4678 | 17373 | 3313 | 18377 | 2673 | 18499 | 2184 | 18235 | 1474 | 21231 | 1124 | 12798 |
| 12-#11 | 2.05 | MA | 16699 | 4678 | 26724 | 3454 | 28825 | 2814 | 29315 | 2318 | 29065 | 1588 | 34606 | 1246 | 20846 |
| 5L-3S | | MI | 10924 | 4678 | 17894 | 3303 | 19027 | 2681 | 19269 | 2193 | 19191 | 1465 | 22284 | 1204 | 12764 |
| 12-#11 | 2.05 | MA | 16257 | 4678 | 25995 | 3451 | 27816 | 2809 | 28082 | 2312 | 27447 | 1597 | 32602 | 1190 | 20202 |
| 6L-2S | | MI | 11343 | 4678 | 18521 | 3311 | 19817 | 2673 | 20213 | 2184 | 20444 | 1457 | 23903 | 1290 | 12723 |
| 12-#14 | 2.96 | MA | 18646 | 4965 | 30807 | 3608 | 34002 | 2929 | 35609 | 2387 | 37515 | 1555 | 45184 | 1263 | 30100 |
| 3L-5S | | MI | 10599 | 4965 | 17856 | 3459 | 18900 | 2787 | 19109 | 2242 | 19107 | 1427 | 22416 | 869 | 17048 |
| 12-#14 | 2.96 | MA | 17914 | 4965 | 29522 | 3628 | 32364 | 2922 | 33619 | 2377 | 34980 | 1568 | 42327 | 1138 | 29877 |
| 4E | | MI | 10989 | 4965 | 18504 | 3471 | 19709 | 2774 | 20075 | 2230 | 20349 | 1415 | 23978 | 925 | 17659 |
| 12-#14 | 2.96 | MA | 17260 | 4965 | 28408 | 3623 | 30921 | 2939 | 31846 | 2393 | 32440 | 1555 | 39312 | 1081 | 28456 |
| 5L-3S | | MI | 11420 | 4965 | 19246 | 3458 | 20624 | 2787 | 21159 | 2242 | 21695 | 1402 | 25455 | 1038 | 17860 |
| 12-#14 | 2.96 | MA | 16637 | 4965 | 27364 | 3618 | 29475 | 2932 | 30080 | 2383 | 30138 | 1568 | 36470 | 1000 | 27548 |
| 6L-2S | | MI | 12008 | 4965 | 20136 | 3470 | 21735 | 2774 | 22488 | 2230 | 23458 | 1390 | 27722 | 1162 | 17825 |
| 12-#18 | 5.26 | MA | 19716 | 5691 | 34512 | 4065 | 38647 | 3231 | 41244 | 2557 | 45134 | 1486 | 56026 | 744 | 48449 |
| 4E | | MI | 11858 | 5691 | 21147 | 3869 | 22883 | 3028 | 23842 | 2339 | 25411 | 1250 | 30461 | 391 | 27982 |
| 12-#18 | 5.26 | MA | 18607 | 5691 | 32559 | 4054 | 36115 | 3259 | 38134 | 2581 | 40740 | 1464 | 50813 | 646 | 45943 |
| 5L-3S | | MI | 12588 | 5691 | 22408 | 3847 | 24430 | 3050 | 25676 | 2361 | 27686 | 1228 | 32944 | 582 | 29931 |
| 12-#18 | 5.26 | MA | 17553 | 5691 | 30725 | 4042 | 33579 | 3244 | 35035 | 2561 | 36760 | 1486 | 45931 | 501 | 42746 |
| 6L-2S | | MI | 13582 | 5691 | 23918 | 3869 | 26308 | 3028 | 27921 | 2339 | 30666 | 1205 | 36736 | 803 | 30146 |
| 14-#11 | 2.39 | MA | 18189 | 4786 | 29497 | 3511 | 32385 | 2854 | 33661 | 2343 | 34963 | 1579 | 41847 | 1353 | 24672 |
| 3L-6S | | MI | 10355 | 4786 | 17085 | 3382 | 18015 | 2720 | 18104 | 2227 | 17656 | 1457 | 20699 | 991 | 14266 |
| 14-#11 | 2.39 | MA | 17673 | 4786 | 28599 | 3525 | 31241 | 2850 | 32271 | 2337 | 33181 | 1588 | 39831 | 1266 | 24598 |
| 4L-5S | | MI | 10619 | 4786 | 17545 | 3372 | 18592 | 2728 | 18757 | 2218 | 18525 | 1448 | 21734 | 1049 | 14500 |
| 14-#11 | 2.39 | MA | 17211 | 4786 | 27823 | 3522 | 30234 | 2862 | 31033 | 2348 | 31396 | 1579 | 37711 | 1226 | 24122 |
| 5L-4S | | MI | 10894 | 4786 | 18000 | 3380 | 19167 | 2720 | 19443 | 2210 | 19488 | 1457 | 22850 | 1088 | 14764 |
| 14-#11 | 2.39 | MA | 16772 | 4786 | 27094 | 3518 | 29225 | 2857 | 29800 | 2342 | 29779 | 1588 | 35707 | 1170 | 23512 |
| 6L-3S | | MI | 11198 | 4786 | 18521 | 3370 | 19817 | 2728 | 20213 | 2218 | 20444 | 1448 | 23903 | 1167 | 14743 |
| 14-#11 | 2.39 | MA | 16344 | 4786 | 26296 | 3533 | 28262 | 2870 | 28617 | 2353 | 28198 | 1596 | 33567 | 1080 | 22928 |
| 7L-2S | | MI | 11615 | 4786 | 19148 | 3378 | 20607 | 2720 | 21158 | 2210 | 21697 | 1439 | 25521 | 1254 | 14709 |
| 14-#14 | 3.45 | MA | 18629 | 5120 | 31093 | 3725 | 34378 | 2992 | 36076 | 2420 | 38296 | 1554 | 46734 | 1107 | 34559 |
| 4L-5S | | MI | 10986 | 5120 | 18746 | 3556 | 20011 | 2853 | 20438 | 2278 | 20871 | 1400 | 24683 | 813 | 19693 |
| 14-#14 | 3.45 | MA | 17980 | 5120 | 29979 | 3720 | 32935 | 3009 | 34303 | 2435 | 35756 | 1541 | 43718 | 1051 | 33154 |
| 5L-4S | | MI | 11374 | 5120 | 19394 | 3568 | 20820 | 2841 | 21404 | 2265 | 22112 | 1388 | 26244 | 869 | 20251 |
| 14-#14 | 3.45 | MA | 17362 | 5120 | 28935 | 3715 | 31489 | 3002 | 32537 | 2425 | 33455 | 1554 | 40876 | 969 | 32143 |
| 6L-3S | | MI | 11802 | 5120 | 20136 | 3556 | 21735 | 2853 | 22488 | 2278 | 23458 | 1375 | 27722 | 981 | 20632 |
| 14-#14 | 3.45 | MA | 16760 | 5120 | 27791 | 3734 | 30109 | 3019 | 30840 | 2441 | 31206 | 1566 | 37840 | 839 | 30692 |
| 7L-2S | | MI | 12387 | 5120 | 21027 | 3568 | 22846 | 2841 | 23816 | 2265 | 25221 | 1363 | 29989 | 1106 | 20625 |
| 14-#18 | 6.14 | MA | 19828 | 5968 | 35303 | 4226 | 39633 | 3383 | 42426 | 2657 | 46474 | 1435 | 58394 | 584 | 53874 |
| 5L-4S | | MI | 12502 | 5968 | 22657 | 4040 | 24760 | 3142 | 26088 | 2397 | 28392 | 1196 | 34253 | 279 | 32463 |
| 14-#18 | 6.14 | MA | 18786 | 5968 | 33469 | 4215 | 37096 | 3368 | 39327 | 2637 | 42495 | 1457 | 53512 | 439 | 50824 |
| 6L-3S | | MI | 13227 | 5968 | 23918 | 4018 | 26308 | 3164 | 27921 | 2419 | 30666 | 1173 | 36736 | 469 | 34233 |
| 16-#11 | 2.74 | MA | 18178 | 4894 | 29698 | 3592 | 32650 | 2898 | 33989 | 2366 | 35513 | 1579 | 42936 | 1246 | 27989 |
| 4L-6S | | MI | 10632 | 4894 | 17712 | 3449 | 18805 | 2767 | 19048 | 2252 | 18909 | 1439 | 22318 | 955 | 16155 |
| 16-#11 | 2.74 | MA | 17720 | 4894 | 28921 | 3589 | 31642 | 2911 | 32751 | 2377 | 33727 | 1570 | 40816 | 1206 | 27409 |
| 5E | | MI | 10894 | 4894 | 18172 | 3440 | 19382 | 2775 | 19701 | 2244 | 19778 | 1431 | 23353 | 1013 | 16371 |
| 16-#11 | 2.74 | MA | 17283 | 4894 | 28193 | 3586 | 30634 | 2906 | 31519 | 2371 | 32110 | 1579 | 38812 | 1150 | 26828 |
| 6L-4S | | MI | 11168 | 4894 | 18627 | 3447 | 19957 | 2767 | 20388 | 2235 | 20740 | 1439 | 24468 | 1052 | 16719 |
| 16-#11 | 2.74 | MA | 16858 | 4894 | 27394 | 3600 | 29671 | 2918 | 30335 | 2382 | 30529 | 1587 | 36672 | 1060 | 26179 |
| 7L-3S | | MI | 11471 | 4894 | 19148 | 3438 | 20607 | 2775 | 21158 | 2244 | 21697 | 1431 | 25521 | 1131 | 16713 |
| 16-#11 | 2.74 | MA | 16439 | 4894 | 26677 | 3597 | 28694 | 2914 | 29179 | 2393 | 28848 | 1579 | 34690 | 1013 | 25395 |
| 8L-2S | | MI | 11886 | 4894 | 19774 | 3446 | 21397 | 2767 | 22102 | 2235 | 22950 | 1422 | 27140 | 1217 | 16688 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 38"

Short columns – no sidesway
Bending on major or minor axis



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.95 | MA | 18694 | 5276 | 31550 | 3817 | 34949 | 3079 | 36760 | 2477 | 39073 | 1527 | 48125 | 1020 | 37865 |
| 5E | | MI | 11370 | 5276 | 19636 | 3654 | 21122 | 2920 | 21766 | 2313 | 22634 | 1373 | 26949 | 756 | 22347 |
| 16-#14 | 3.95 | MA | 18081 | 5276 | 30506 | 3812 | 33503 | 3071 | 34993 | 2468 | 36771 | 1539 | 45283 | 938 | 36753 |
| 6L-4S | | MI | 11756 | 5276 | 20285 | 3666 | 21931 | 2908 | 22732 | 2301 | 23875 | 1361 | 28511 | 813 | 22858 |
| 16-#14 | 3.95 | MA | 17484 | 5276 | 29362 | 3832 | 32123 | 3089 | 33297 | 2483 | 34522 | 1552 | 42246 | 808 | 35359 |
| 7L-3S | | MI | 12182 | 5276 | 21027 | 3653 | 22846 | 2920 | 23816 | 2313 | 25221 | 1349 | 29989 | 925 | 23394 |
| 16-#14 | 3.95 | MA | 16896 | 5276 | 28333 | 3827 | 30723 | 3082 | 31641 | 2498 | 32131 | 1539 | 39428 | 741 | 33726 |
| 8L-2S | | MI | 12765 | 5276 | 21917 | 3665 | 23958 | 2908 | 25145 | 2301 | 26984 | 1336 | 32255 | 1050 | 23420 |
| 16-#18 | 7.02 | MA | 20004 | 6244 | 36213 | 4388 | 40614 | 3492 | 43619 | 2712 | 48230 | 1429 | 61094 | 376 | 58873 |
| 6L-4S | | MI | 13142 | 6244 | 24166 | 4210 | 26638 | 3256 | 28333 | 2455 | 31372 | 1142 | 38045 | 166 | 36966 |
| 18-#11 | 3.08 | MA | 18225 | 5002 | 30020 | 3657 | 33051 | 2959 | 34470 | 2407 | 36059 | 1561 | 43921 | 1186 | 30704 |
| 5L-6S | | MI | 10906 | 5002 | 18339 | 3517 | 19595 | 2814 | 19992 | 2278 | 20162 | 1422 | 23937 | 918 | 18046 |
| 18-#11 | 3.08 | MA | 17791 | 5002 | 29291 | 3653 | 32042 | 2954 | 33237 | 2400 | 34441 | 1570 | 41917 | 1130 | 30149 |
| 6L-5S | | MI | 11168 | 5002 | 18799 | 3507 | 20172 | 2822 | 20645 | 2269 | 21031 | 1413 | 24971 | 976 | 18247 |
| 18-#11 | 3.08 | MA | 17368 | 5002 | 28493 | 3667 | 31079 | 2967 | 32053 | 2412 | 32860 | 1578 | 39777 | 1040 | 29439 |
| 7L-4S | | MI | 11441 | 5002 | 19253 | 3515 | 20747 | 2814 | 21332 | 2261 | 21993 | 1422 | 26087 | 1015 | 18665 |
| 18-#11 | 3.08 | MA | 16952 | 5002 | 27776 | 3664 | 30103 | 2962 | 30898 | 2423 | 31180 | 1570 | 37795 | 992 | 28682 |
| 8L-3S | | MI | 11742 | 5002 | 19774 | 3505 | 21397 | 2822 | 22102 | 2269 | 22950 | 1413 | 27140 | 1094 | 18678 |
| 18-#11 | 3.08 | MA | 16540 | 5002 | 27003 | 3678 | 29153 | 2975 | 29690 | 2417 | 29613 | 1578 | 35852 | 938 | 27729 |
| 9L-2S | | MI | 12156 | 5002 | 20401 | 3513 | 22187 | 2814 | 23046 | 2261 | 24203 | 1405 | 28758 | 1181 | 18661 |
| 18-#14 | 4.44 | MA | 18793 | 5432 | 32077 | 3909 | 35517 | 3141 | 37450 | 2510 | 40088 | 1525 | 49690 | 907 | 41378 |
| 6L-5S | | MI | 11752 | 5432 | 20527 | 3751 | 22234 | 2987 | 23095 | 2349 | 24397 | 1347 | 29216 | 700 | 25007 |
| 18-#14 | 4.44 | MA | 18201 | 5432 | 30933 | 3929 | 34137 | 3159 | 35754 | 2525 | 37839 | 1538 | 46653 | 777 | 40037 |
| 7L-4S | | MI | 12136 | 5432 | 21175 | 3763 | 23043 | 2974 | 24061 | 2336 | 25638 | 1334 | 30778 | 757 | 25478 |
| 18-#14 | 4.44 | MA | 17618 | 5432 | 29904 | 3924 | 32737 | 3151 | 34098 | 2541 | 35447 | 1525 | 43835 | 710 | 38346 |
| 8L-3S | | MI | 12560 | 5432 | 21917 | 3750 | 23958 | 2987 | 25145 | 2349 | 26984 | 1322 | 32255 | 869 | 26148 |
| 20-#11 | 3.42 | MA | 18295 | 5110 | 30390 | 3721 | 33451 | 3003 | 34955 | 2430 | 36772 | 1561 | 45022 | 1110 | 33475 |
| 6E | | MI | 11180 | 5110 | 18965 | 3584 | 20385 | 2860 | 20937 | 2303 | 21414 | 1405 | 25555 | 882 | 19939 |
| 20-#11 | 3.42 | MA | 17875 | 5110 | 29592 | 3735 | 32488 | 3015 | 33772 | 2441 | 35191 | 1569 | 42882 | 1020 | 32705 |
| 7L-5S | | MI | 11440 | 5110 | 19426 | 3575 | 20962 | 2869 | 21590 | 2295 | 22283 | 1396 | 26590 | 940 | 20127 |
| 20-#11 | 3.42 | MA | 17461 | 5110 | 28875 | 3732 | 31511 | 3011 | 32616 | 2452 | 33511 | 1561 | 40900 | 972 | 31974 |
| 8L-4S | | MI | 11712 | 5110 | 19880 | 3582 | 21537 | 2860 | 22276 | 2286 | 23246 | 1405 | 27706 | 979 | 20563 |
| 20-#11 | 3.42 | MA | 17052 | 5110 | 28102 | 3746 | 30561 | 3023 | 31408 | 2446 | 31944 | 1569 | 38957 | 918 | 30982 |
| 9L-3S | | MI | 12012 | 5110 | 20401 | 3573 | 22187 | 2869 | 23046 | 2295 | 24203 | 1396 | 28758 | 1058 | 20634 |
| 20-#11 | 3.42 | MA | 16596 | 5110 | 27387 | 3742 | 29597 | 3018 | 30258 | 2457 | 30390 | 1578 | 37076 | 857 | 30042 |
| 10L-2S | | MI | 12424 | 5110 | 21028 | 3580 | 22977 | 2860 | 23990 | 2286 | 25455 | 1387 | 30377 | 1144 | 20629 |
| 20-#14 | 4.93 | MA | 18913 | 5587 | 32504 | 4026 | 36151 | 3229 | 38211 | 2568 | 41155 | 1524 | 51059 | 746 | 44723 |
| 7L-5S | | MI | 12133 | 5587 | 21417 | 3848 | 23345 | 3053 | 24424 | 2384 | 26160 | 1320 | 31482 | 644 | 27672 |
| 20-#14 | 4.93 | MA | 18334 | 5587 | 31475 | 4021 | 34751 | 3221 | 36555 | 2583 | 38764 | 1511 | 48241 | 679 | 42976 |
| 8L-4S | | MI | 12514 | 5587 | 22065 | 3860 | 24154 | 3041 | 25390 | 2372 | 27401 | 1308 | 33044 | 701 | 28108 |
| 22-#11 | 3.76 | MA | 18379 | 5218 | 30691 | 3802 | 33897 | 3064 | 35490 | 2470 | 37522 | 1560 | 45987 | 1000 | 35979 |
| 7L-6S | | MI | 11452 | 5218 | 19592 | 3652 | 21175 | 2907 | 21881 | 2329 | 22667 | 1387 | 27174 | 845 | 21786 |
| 22-#11 | 3.76 | MA | 17967 | 5218 | 29973 | 3799 | 32920 | 3059 | 34335 | 2481 | 35842 | 1552 | 44005 | 952 | 35271 |
| 8L-5S | | MI | 11711 | 5218 | 20052 | 3642 | 21752 | 2916 | 22534 | 2320 | 23536 | 1379 | 28209 | 903 | 22010 |
| 22-#11 | 3.76 | MA | 17560 | 5218 | 29201 | 3813 | 31970 | 3072 | 33126 | 2475 | 34275 | 1560 | 42062 | 898 | 34242 |
| 9L-4S | | MI | 11982 | 5218 | 20507 | 3650 | 22327 | 2907 | 23220 | 2312 | 24499 | 1387 | 29324 | 942 | 22418 |
| 22-#11 | 3.76 | MA | 17119 | 5218 | 28485 | 3810 | 31006 | 3067 | 31977 | 2486 | 32722 | 1569 | 40181 | 837 | 33271 |
| 10L-3S | | MI | 12281 | 5218 | 21028 | 3640 | 22977 | 2916 | 23990 | 2320 | 25455 | 1379 | 30377 | 1021 | 22583 |
| 22-#14 | 5.43 | MA | 19045 | 5743 | 33046 | 4118 | 36765 | 3291 | 39012 | 2626 | 42080 | 1497 | 52648 | 648 | 47615 |
| 8L-5S | | MI | 12511 | 5743 | 22307 | 3945 | 24457 | 3120 | 25752 | 2420 | 27923 | 1293 | 33749 | 588 | 30325 |
| 24-#11 | 4.11 | MA | 18470 | 5326 | 31072 | 3866 | 34329 | 3107 | 36053 | 2511 | 38173 | 1542 | 47110 | 932 | 38560 |
| 8L-6S | | MI | 11723 | 5326 | 20219 | 3719 | 21965 | 2954 | 22825 | 2354 | 23920 | 1370 | 28792 | 809 | 23614 |
| 24-#11 | 4.11 | MA | 18066 | 5326 | 30300 | 3880 | 33378 | 3120 | 34845 | 2505 | 36606 | 1551 | 45167 | 878 | 37507 |
| 9L-5S | | MI | 11981 | 5326 | 20679 | 3710 | 22542 | 2963 | 23478 | 2346 | 24789 | 1361 | 29827 | 867 | 23897 |
| 24-#11 | 4.11 | MA | 17624 | 5326 | 29584 | 3877 | 32415 | 3115 | 33695 | 2516 | 35053 | 1560 | 43286 | 817 | 36434 |
| 10L-4S | | MI | 12251 | 5326 | 21134 | 3717 | 23117 | 2954 | 24165 | 2337 | 25752 | 1370 | 30943 | 906 | 24279 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

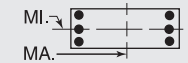
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.67 | MA | 19702 | 4796 | 31311 | 3524 | 33994 | 2863 | 34943 | 2372 | 35411 | 1653 | 41842 | 1534 | 19072 |
| 2E | | MI | 11516 | 4796 | 18661 | 3339 | 19589 | 2695 | 19701 | 2211 | 19417 | 1502 | 22305 | 1332 | 10849 |
| 6-#14 | 1.41 | MA | 19346 | 4710 | 30383 | 3494 | 32935 | 2844 | 33700 | 2365 | 33861 | 1681 | 39869 | 1576 | 16326 |
| 2L-3S | | MI | 10767 | 4710 | 17354 | 3318 | 18082 | 2712 | 17937 | 2242 | 17084 | 1564 | 19399 | 1285 | 9454 |
| 6-#14 | 1.41 | MA | 18216 | 4710 | 28715 | 3489 | 30796 | 2862 | 31091 | 2381 | 30322 | 1693 | 35154 | 1451 | 16373 |
| 3L-2S | | MI | 11366 | 4710 | 18244 | 3330 | 19194 | 2700 | 19266 | 2230 | 18847 | 1552 | 21666 | 1409 | 9370 |
| 6-#18 | 2.50 | MA | 21028 | 5073 | 34228 | 3697 | 37733 | 2987 | 39505 | 2447 | 41542 | 1627 | 49970 | 1475 | 28225 |
| 2L-3S | | MI | 11151 | 5073 | 18661 | 3487 | 19589 | 2831 | 19701 | 2291 | 19417 | 1470 | 22305 | 998 | 15862 |
| 6-#18 | 2.50 | MA | 19090 | 5073 | 31311 | 3687 | 33994 | 3017 | 34943 | 2473 | 35411 | 1649 | 41842 | 1254 | 28085 |
| 3L-2S | | MI | 12170 | 5073 | 20170 | 3509 | 21467 | 2809 | 21946 | 2269 | 22398 | 1448 | 26096 | 1219 | 15763 |
| 8-#11 | 1.30 | MA | 19200 | 4675 | 29992 | 3484 | 32500 | 2838 | 33195 | 2364 | 33215 | 1692 | 39069 | 1594 | 15194 |
| 2L-4S | | MI | 10573 | 4675 | 16896 | 3331 | 17590 | 2705 | 17376 | 2240 | 16410 | 1591 | 18741 | 1277 | 8868 |
| 8-#11 | 1.30 | MA | 18407 | 4675 | 28826 | 3481 | 31005 | 2851 | 31371 | 2376 | 30733 | 1701 | 35751 | 1508 | 15230 |
| 3E | | MI | 10881 | 4675 | 17417 | 3321 | 18241 | 2713 | 18146 | 2248 | 17366 | 1582 | 19794 | 1356 | 8806 |
| 8-#11 | 1.30 | MA | 17850 | 4675 | 27875 | 3496 | 29793 | 2847 | 29898 | 2370 | 28837 | 1710 | 33593 | 1422 | 15232 |
| 4L-2S | | MI | 11304 | 4675 | 18044 | 3329 | 19030 | 2705 | 19090 | 2240 | 18619 | 1574 | 21412 | 1442 | 8752 |
| 8-#14 | 1.88 | MA | 20119 | 4866 | 32051 | 3591 | 35074 | 2914 | 36309 | 2407 | 37401 | 1668 | 44583 | 1547 | 21568 |
| 2L-4S | | MI | 10721 | 4866 | 17502 | 3429 | 18279 | 2766 | 18182 | 2265 | 17501 | 1550 | 20188 | 1117 | 12354 |
| 8-#14 | 1.88 | MA | 18997 | 4866 | 30383 | 3587 | 32935 | 2932 | 33700 | 2423 | 33861 | 1680 | 39869 | 1423 | 21574 |
| 3E | | MI | 11157 | 4866 | 18244 | 3416 | 19194 | 2779 | 19266 | 2278 | 18847 | 1537 | 21666 | 1229 | 12298 |
| 8-#14 | 1.88 | MA | 18207 | 4866 | 29021 | 3607 | 31198 | 2925 | 31590 | 2415 | 31156 | 1692 | 36808 | 1298 | 21442 |
| 4L-2S | | MI | 11753 | 4866 | 19135 | 3428 | 20305 | 2766 | 20594 | 2265 | 20610 | 1525 | 23932 | 1353 | 12227 |
| 8-#18 | 3.33 | MA | 22333 | 5350 | 37145 | 3870 | 41473 | 3111 | 44067 | 2522 | 47672 | 1600 | 58097 | 1417 | 37321 |
| 2L-4S | | MI | 11062 | 5350 | 18909 | 3679 | 19919 | 2923 | 20113 | 2327 | 20123 | 1438 | 23614 | 694 | 19344 |
| 8-#18 | 3.33 | MA | 20417 | 5350 | 34228 | 3859 | 37733 | 3141 | 39505 | 2548 | 41542 | 1622 | 49970 | 1196 | 37062 |
| 3E | | MI | 11807 | 5350 | 20170 | 3657 | 21467 | 2945 | 21946 | 2350 | 22398 | 1416 | 26096 | 885 | 20644 |
| 8-#18 | 3.33 | MA | 19066 | 5350 | 31839 | 3894 | 34689 | 3127 | 35805 | 2530 | 36856 | 1644 | 44708 | 974 | 34594 |
| 4L-2S | | MI | 12817 | 5350 | 21680 | 3679 | 23344 | 2923 | 24191 | 2327 | 25378 | 1394 | 29888 | 1106 | 20620 |
| 10-#11 | 1.63 | MA | 19744 | 4783 | 31158 | 3552 | 33995 | 2887 | 35019 | 2393 | 35696 | 1683 | 42388 | 1575 | 18860 |
| 2L-5S | | MI | 10573 | 4783 | 17069 | 3390 | 17805 | 2760 | 17634 | 2274 | 16700 | 1565 | 19244 | 1201 | 10902 |
| 10-#11 | 1.63 | MA | 18956 | 4783 | 29992 | 3549 | 32500 | 2900 | 33195 | 2405 | 33215 | 1692 | 39069 | 1489 | 18882 |
| 3L-4S | | MI | 10851 | 4783 | 17523 | 3398 | 18380 | 2751 | 18320 | 2265 | 17662 | 1573 | 20359 | 1240 | 10865 |
| 10-#11 | 1.63 | MA | 18402 | 4783 | 29041 | 3563 | 31288 | 2895 | 31721 | 2399 | 31319 | 1701 | 36912 | 1403 | 18853 |
| 4L-3S | | MI | 11159 | 4783 | 18044 | 3389 | 19030 | 2760 | 19090 | 2274 | 18619 | 1565 | 21412 | 1320 | 10814 |
| 10-#11 | 1.63 | MA | 17907 | 4783 | 28218 | 3560 | 30221 | 2908 | 30410 | 2411 | 29420 | 1693 | 34651 | 1362 | 18728 |
| 5L-2S | | MI | 11579 | 4783 | 18671 | 3396 | 19820 | 2751 | 20035 | 2265 | 19872 | 1556 | 23031 | 1406 | 10765 |
| 10-#14 | 2.34 | MA | 20883 | 5021 | 33720 | 3689 | 37212 | 2984 | 38918 | 2450 | 40940 | 1655 | 49298 | 1518 | 26796 |
| 2L-5S | | MI | 10718 | 5021 | 17744 | 3514 | 18581 | 2845 | 18545 | 2313 | 18022 | 1535 | 20893 | 1004 | 14556 |
| 10-#14 | 2.34 | MA | 19770 | 5021 | 32051 | 3684 | 35074 | 3002 | 36309 | 2466 | 37401 | 1667 | 44583 | 1394 | 26754 |
| 3L-4S | | MI | 11111 | 5021 | 18393 | 3526 | 19390 | 2833 | 19510 | 2301 | 19264 | 1523 | 22455 | 1061 | 15139 |
| 10-#14 | 2.34 | MA | 18986 | 5021 | 30689 | 3704 | 33337 | 2995 | 34199 | 2457 | 34695 | 1679 | 41523 | 1269 | 26573 |
| 4L-3S | | MI | 11545 | 5021 | 19135 | 3513 | 20305 | 2845 | 20594 | 2313 | 20610 | 1511 | 23932 | 1173 | 15115 |
| 10-#14 | 2.34 | MA | 18286 | 5021 | 29509 | 3700 | 31808 | 3013 | 32320 | 2473 | 31985 | 1667 | 38304 | 1211 | 25327 |
| 5L-2S | | MI | 12138 | 5021 | 20025 | 3525 | 21417 | 2833 | 21923 | 2301 | 22373 | 1498 | 26199 | 1297 | 15060 |
| 10-#18 | 4.17 | MA | 21726 | 5626 | 37145 | 4032 | 41473 | 3265 | 44067 | 2624 | 47672 | 1596 | 58097 | 1137 | 46023 |
| 3L-4S | | MI | 11718 | 5626 | 20419 | 3849 | 21797 | 3037 | 22358 | 2386 | 23104 | 1384 | 27405 | 582 | 23756 |
| 10-#18 | 4.17 | MA | 20391 | 5626 | 34756 | 4066 | 38428 | 3251 | 40367 | 2605 | 42987 | 1618 | 52835 | 916 | 43146 |
| 4L-3S | | MI | 12456 | 5626 | 21680 | 3827 | 23344 | 3059 | 24191 | 2408 | 25378 | 1362 | 29888 | 772 | 25383 |
| 10-#18 | 4.17 | MA | 19199 | 5626 | 32684 | 4056 | 35744 | 3281 | 37069 | 2631 | 38290 | 1596 | 47262 | 816 | 40907 |
| 5L-2S | | MI | 13459 | 5626 | 23190 | 3849 | 25222 | 3037 | 26436 | 2386 | 28359 | 1340 | 33680 | 994 | 25442 |
| 12-#11 | 1.95 | MA | 20285 | 4891 | 32324 | 3619 | 35490 | 2935 | 36842 | 2423 | 38178 | 1675 | 45707 | 1557 | 22516 |
| 2L-6S | | MI | 10586 | 4891 | 17235 | 3467 | 18018 | 2798 | 17925 | 2308 | 17084 | 1556 | 19828 | 1107 | 12486 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis

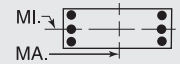



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.95 | MA | 19501 | 4891 | 31158 | 3616 | 33995 | 2948 | 35019 | 2434 | 35696 | 1683 | 42388 | 1470 | 22519 |
| 3L-5S | | MI | 10851 | 4891 | 17695 | 3458 | 18595 | 2807 | 18578 | 2299 | 17953 | 1548 | 20862 | 1165 | 12799 |
| 12-#11 | 1.95 | MA | 18951 | 4891 | 30207 | 3631 | 32783 | 2944 | 33545 | 2429 | 33800 | 1692 | 40230 | 1384 | 22465 |
| 4E | | MI | 11128 | 4891 | 18150 | 3466 | 19170 | 2798 | 19265 | 2291 | 18915 | 1556 | 21978 | 1204 | 12845 |
| 12-#11 | 1.95 | MA | 18458 | 4891 | 29384 | 3628 | 31716 | 2957 | 32234 | 2440 | 31902 | 1684 | 37970 | 1343 | 22193 |
| 5L-3S | | MI | 11434 | 4891 | 18671 | 3456 | 19820 | 2807 | 20035 | 2299 | 19872 | 1548 | 23031 | 1283 | 12807 |
| 12-#11 | 1.95 | MA | 17990 | 4891 | 28613 | 3625 | 30647 | 2953 | 30928 | 2435 | 30181 | 1693 | 35826 | 1287 | 21473 |
| 6L-2S | | MI | 11854 | 4891 | 19298 | 3464 | 20610 | 2798 | 20979 | 2291 | 21125 | 1539 | 24650 | 1370 | 12764 |
| 12-#14 | 2.81 | MA | 20535 | 5177 | 33720 | 3781 | 37212 | 3072 | 38918 | 2508 | 40940 | 1654 | 49298 | 1365 | 31923 |
| 3L-5S | | MI | 11108 | 5177 | 18635 | 3611 | 19693 | 2912 | 19873 | 2349 | 19785 | 1509 | 23159 | 948 | 17190 |
| 12-#14 | 2.81 | MA | 19758 | 5177 | 32357 | 3801 | 35476 | 3065 | 36808 | 2499 | 38235 | 1666 | 46237 | 1240 | 31700 |
| 4E | | MI | 11499 | 5177 | 19283 | 3623 | 20502 | 2899 | 20839 | 2336 | 21027 | 1496 | 24721 | 1004 | 17825 |
| 12-#14 | 2.81 | MA | 19063 | 5177 | 31178 | 3797 | 33946 | 3083 | 34929 | 2515 | 35524 | 1654 | 43018 | 1182 | 30303 |
| 5L-3S | | MI | 11931 | 5177 | 20025 | 3610 | 21417 | 2912 | 21923 | 2349 | 22373 | 1484 | 26199 | 1116 | 17914 |
| 12-#14 | 2.81 | MA | 18402 | 5177 | 30071 | 3792 | 32415 | 3076 | 33057 | 2507 | 33068 | 1666 | 39976 | 1101 | 29424 |
| 6L-2S | | MI | 12520 | 5177 | 20915 | 3622 | 22528 | 2899 | 23252 | 2336 | 24136 | 1471 | 28465 | 1241 | 17876 |
| 12-#18 | 5.00 | MA | 21699 | 5903 | 37673 | 4239 | 42168 | 3375 | 44929 | 2681 | 49117 | 1591 | 60963 | 858 | 51743 |
| 4E | | MI | 12367 | 5903 | 21929 | 4019 | 23674 | 3151 | 24603 | 2444 | 26084 | 1330 | 31197 | 469 | 28206 |
| 12-#18 | 5.00 | MA | 20521 | 5903 | 35602 | 4229 | 39483 | 3405 | 41631 | 2706 | 44421 | 1569 | 55390 | 758 | 49318 |
| 5L-3S | | MI | 13100 | 5903 | 23190 | 3997 | 25222 | 3174 | 26436 | 2466 | 28359 | 1308 | 33680 | 660 | 30097 |
| 12-#18 | 5.00 | MA | 19401 | 5903 | 33658 | 4219 | 36793 | 3391 | 38345 | 2688 | 40166 | 1591 | 50151 | 613 | 45748 |
| 6L-2S | | MI | 14096 | 5903 | 24700 | 4019 | 27099 | 3151 | 28682 | 2444 | 31339 | 1286 | 37472 | 881 | 30229 |
| 14-#11 | 2.27 | MA | 20042 | 4998 | 32324 | 3684 | 35490 | 2996 | 36842 | 2464 | 38178 | 1675 | 45707 | 1452 | 26147 |
| 3L-6S | | MI | 10864 | 4998 | 17862 | 3535 | 18808 | 2845 | 18870 | 2334 | 18336 | 1539 | 21446 | 1071 | 14372 |
| 14-#11 | 2.27 | MA | 19495 | 4998 | 31373 | 3698 | 34278 | 2992 | 35369 | 2458 | 36282 | 1684 | 43549 | 1365 | 26072 |
| 4L-5S | | MI | 11128 | 4998 | 18322 | 3525 | 19385 | 2854 | 19523 | 2325 | 19205 | 1530 | 22481 | 1128 | 14614 |
| 14-#11 | 2.27 | MA | 19005 | 4998 | 30550 | 3695 | 33211 | 3005 | 34058 | 2470 | 34383 | 1675 | 41288 | 1325 | 25672 |
| 5L-4S | | MI | 11404 | 4998 | 18777 | 3533 | 19960 | 2845 | 20209 | 2316 | 20168 | 1539 | 23597 | 1167 | 14816 |
| 14-#11 | 2.27 | MA | 18540 | 4998 | 29779 | 3692 | 32142 | 3001 | 32752 | 2464 | 32662 | 1684 | 39145 | 1268 | 24988 |
| 6L-3S | | MI | 11709 | 4998 | 19298 | 3523 | 20610 | 2854 | 20979 | 2325 | 21125 | 1530 | 24650 | 1247 | 14789 |
| 14-#11 | 2.27 | MA | 18086 | 4998 | 28934 | 3707 | 31123 | 3014 | 31499 | 2476 | 30981 | 1693 | 36857 | 1178 | 24465 |
| 7L-2S | | MI | 12126 | 4998 | 19925 | 3531 | 21400 | 2845 | 21923 | 2316 | 22377 | 1522 | 26268 | 1333 | 14753 |
| 14-#14 | 3.28 | MA | 20522 | 5332 | 34025 | 3899 | 37614 | 3135 | 39417 | 2542 | 41774 | 1653 | 50952 | 1211 | 36822 |
| 4L-5S | | MI | 11495 | 5332 | 19525 | 3708 | 20804 | 2978 | 21202 | 2384 | 21548 | 1482 | 25426 | 891 | 19836 |
| 14-#14 | 3.28 | MA | 19833 | 5332 | 32846 | 3894 | 36085 | 3153 | 37538 | 2558 | 39064 | 1641 | 47733 | 1153 | 35296 |
| 5L-4S | | MI | 11884 | 5332 | 20173 | 3720 | 21613 | 2966 | 22168 | 2372 | 22790 | 1469 | 26988 | 948 | 20415 |
| 14-#14 | 3.28 | MA | 19178 | 5332 | 31740 | 3889 | 34553 | 3146 | 35666 | 2549 | 36608 | 1653 | 44690 | 1072 | 34371 |
| 6L-3S | | MI | 12313 | 5332 | 20915 | 3707 | 22528 | 2978 | 23252 | 2384 | 24136 | 1457 | 28465 | 1060 | 20699 |
| 14-#14 | 3.28 | MA | 18539 | 5332 | 30528 | 3910 | 33092 | 3164 | 33869 | 2565 | 34207 | 1666 | 41440 | 942 | 32754 |
| 7L-2S | | MI | 12900 | 5332 | 21805 | 3719 | 23639 | 2966 | 24580 | 2372 | 25899 | 1445 | 30732 | 1185 | 20680 |
| 14-#18 | 5.83 | MA | 21827 | 6180 | 38519 | 4402 | 43223 | 3529 | 46193 | 2782 | 50551 | 1542 | 63517 | 700 | 57766 |
| 5L-4S | | MI | 13013 | 6180 | 23439 | 4190 | 25552 | 3266 | 26848 | 2502 | 29065 | 1276 | 34989 | 356 | 32686 |
| 14-#18 | 5.83 | MA | 20720 | 6180 | 36575 | 4392 | 40533 | 3515 | 42907 | 2763 | 46297 | 1564 | 58279 | 555 | 54350 |
| 6L-3S | | MI | 13740 | 6180 | 24700 | 4167 | 27099 | 3288 | 28682 | 2524 | 31339 | 1254 | 37472 | 547 | 34529 |
| 16-#11 | 2.60 | MA | 20035 | 5106 | 32539 | 3765 | 35773 | 3041 | 37193 | 2488 | 38763 | 1675 | 46868 | 1347 | 29674 |
| 4L-6S | | MI | 11141 | 5106 | 18489 | 3602 | 19598 | 2892 | 19814 | 2359 | 19589 | 1522 | 23065 | 1034 | 16261 |
| 16-#11 | 2.60 | MA | 19549 | 5106 | 31717 | 3763 | 34706 | 3054 | 35882 | 2499 | 36865 | 1667 | 44607 | 1306 | 29162 |
| 5E | | MI | 11404 | 5106 | 18949 | 3593 | 20175 | 2901 | 20467 | 2351 | 20458 | 1513 | 24100 | 1092 | 16484 |
| 16-#11 | 2.60 | MA | 19086 | 5106 | 30945 | 3760 | 33637 | 3049 | 34576 | 2494 | 35144 | 1676 | 42464 | 1250 | 28510 |
| 6L-4S | | MI | 11678 | 5106 | 19403 | 3600 | 20750 | 2892 | 21153 | 2342 | 21421 | 1522 | 25215 | 1131 | 16779 |
| 16-#11 | 2.60 | MA | 18635 | 5106 | 30100 | 3774 | 32618 | 3062 | 33323 | 2505 | 33462 | 1684 | 40176 | 1160 | 27920 |
| 7L-3S | | MI | 11982 | 5106 | 19925 | 3591 | 21400 | 2901 | 21923 | 2351 | 22377 | 1513 | 26268 | 1210 | 16763 |
| 16-#11 | 2.60 | MA | 18191 | 5106 | 29340 | 3771 | 31584 | 3058 | 32099 | 2517 | 31675 | 1676 | 38062 | 1112 | 27048 |
| 8L-2S | | MI | 12398 | 5106 | 20551 | 3598 | 22190 | 2892 | 22868 | 2342 | 23630 | 1504 | 27887 | 1297 | 16734 |
| 16-#14 | 3.75 | MA | 20596 | 5488 | 34514 | 3991 | 38224 | 3223 | 40147 | 2600 | 42603 | 1628 | 52447 | 1124 | 40301 |
| 5E | | MI | 11880 | 5488 | 20415 | 3806 | 21915 | 3045 | 22530 | 2420 | 23311 | 1455 | 27692 | 835 | 22490 |
| 16-#14 | 3.75 | MA | 19946 | 5488 | 33408 | 3987 | 36692 | 3216 | 38275 | 2591 | 40147 | 1640 | 49405 | 1043 | 39274 |
| 6L-4S | | MI | 12267 | 5488 | 21063 | 3818 | 22724 | 3033 | 23496 | 2407 | 24553 | 1443 | 29254 | 892 | 23021 |

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

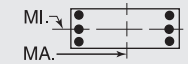
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.75 | MA | 19313 | 5488 | 32196 | 4007 | 35230 | 3234 | 36478 | 2607 | 37747 | 1653 | 46155 | 913 | 37717 |
| 7L-3S | | MI | 12694 | 5488 | 21805 | 3805 | 23639 | 3045 | 24580 | 2420 | 25899 | 1430 | 30732 | 1004 | 23466 |
| 16-#14 | 3.75 | MA | 18689 | 5488 | 31107 | 4002 | 33747 | 3227 | 34724 | 2623 | 35195 | 1640 | 43146 | 845 | 36095 |
| 8L-2S | | MI | 13278 | 5488 | 22696 | 3817 | 24751 | 3033 | 25909 | 2407 | 27662 | 1418 | 32998 | 1129 | 23475 |
| 16-#18 | 6.67 | MA | 22024 | 6456 | 39492 | 4565 | 44273 | 3639 | 47469 | 2839 | 52427 | 1538 | 66406 | 497 | 62976 |
| 6L-4S | | MI | 13654 | 6456 | 24949 | 4360 | 27430 | 3380 | 29093 | 2560 | 32045 | 1222 | 38781 | 244 | 37188 |
| 18-#11 | 2.92 | MA | 20088 | 5214 | 32883 | 3830 | 36201 | 3102 | 37706 | 2529 | 39346 | 1658 | 47926 | 1287 | 32661 |
| 5L-6S | | MI | 11416 | 5214 | 19116 | 3670 | 20388 | 2939 | 20758 | 2385 | 20842 | 1504 | 24683 | 998 | 18154 |
| 18-#11 | 2.92 | MA | 19628 | 5214 | 32111 | 3827 | 35133 | 3098 | 36400 | 2523 | 37625 | 1667 | 45782 | 1231 | 32037 |
| 6L-5S | | MI | 11678 | 5214 | 19576 | 3660 | 20965 | 2948 | 21411 | 2376 | 21711 | 1496 | 25718 | 1056 | 18360 |
| 18-#11 | 2.92 | MA | 19180 | 5214 | 31266 | 3842 | 34113 | 3111 | 35147 | 2535 | 35944 | 1676 | 43494 | 1141 | 31383 |
| 7L-4S | | MI | 11951 | 5214 | 20030 | 3668 | 21540 | 2939 | 22097 | 2367 | 22674 | 1504 | 26834 | 1094 | 18729 |
| 18-#11 | 2.92 | MA | 18739 | 5214 | 30507 | 3839 | 33079 | 3107 | 33923 | 2546 | 34157 | 1667 | 41381 | 1093 | 30540 |
| 8L-3S | | MI | 12254 | 5214 | 20551 | 3658 | 22190 | 2948 | 22868 | 2376 | 23630 | 1496 | 27887 | 1174 | 18731 |
| 18-#11 | 2.92 | MA | 18301 | 5214 | 29689 | 3853 | 32073 | 3120 | 32643 | 2541 | 32490 | 1676 | 39302 | 1039 | 29612 |
| 9L-2S | | MI | 12668 | 5214 | 21178 | 3666 | 22980 | 2939 | 23812 | 2367 | 24883 | 1487 | 29505 | 1260 | 18709 |
| 18-#14 | 4.22 | MA | 20708 | 5644 | 35076 | 4084 | 38831 | 3286 | 40884 | 2634 | 43686 | 1627 | 54119 | 1014 | 44191 |
| 6L-5S | | MI | 12263 | 5644 | 21305 | 3903 | 23027 | 3112 | 23859 | 2455 | 25075 | 1428 | 29959 | 779 | 25151 |
| 18-#14 | 4.22 | MA | 20079 | 5644 | 33864 | 4104 | 37369 | 3304 | 39087 | 2650 | 41286 | 1640 | 50870 | 884 | 42689 |
| 7L-4S | | MI | 12648 | 5644 | 21953 | 3915 | 23836 | 3099 | 24825 | 2443 | 26316 | 1416 | 31521 | 836 | 25640 |
| 18-#14 | 4.22 | MA | 19461 | 5644 | 32775 | 4100 | 35886 | 3297 | 37333 | 2666 | 38735 | 1627 | 47861 | 816 | 41009 |
| 8L-3S | | MI | 13073 | 5644 | 22696 | 3902 | 24751 | 3112 | 25909 | 2455 | 27662 | 1403 | 32998 | 948 | 26224 |
| 18-#14 | 4.22 | MA | 18849 | 5644 | 31602 | 4120 | 34443 | 3315 | 35498 | 2657 | 36356 | 1640 | 44911 | 738 | 39194 |
| 9L-2S | | MI | 13654 | 5644 | 23586 | 3914 | 25862 | 3099 | 27237 | 2443 | 29425 | 1391 | 35265 | 1073 | 26260 |
| 20-#11 | 3.25 | MA | 20167 | 5322 | 33278 | 3895 | 36628 | 3146 | 38224 | 2552 | 40107 | 1658 | 49101 | 1212 | 35569 |
| 6E | | MI | 11690 | 5322 | 19742 | 3737 | 21178 | 2986 | 21702 | 2410 | 22095 | 1487 | 26302 | 961 | 20049 |
| 20-#11 | 3.25 | MA | 19721 | 5322 | 32432 | 3909 | 35608 | 3159 | 36970 | 2564 | 38425 | 1667 | 46813 | 1122 | 34853 |
| 7L-5S | | MI | 11951 | 5322 | 20202 | 3728 | 21755 | 2995 | 22355 | 2402 | 22964 | 1478 | 27337 | 1019 | 20241 |
| 20-#11 | 3.25 | MA | 19283 | 5322 | 31673 | 3906 | 34574 | 3155 | 35747 | 2576 | 36638 | 1659 | 44699 | 1074 | 34037 |
| 8L-4S | | MI | 12223 | 5322 | 20657 | 3735 | 22330 | 2986 | 23042 | 2393 | 23926 | 1487 | 28452 | 1058 | 20674 |
| 20-#11 | 3.25 | MA | 18845 | 5322 | 30855 | 3921 | 33568 | 3168 | 34467 | 2570 | 34972 | 1668 | 42621 | 1020 | 33070 |
| 9L-3S | | MI | 12524 | 5322 | 21178 | 3726 | 22980 | 2995 | 23812 | 2402 | 24883 | 1478 | 29505 | 1137 | 20693 |
| 20-#11 | 3.25 | MA | 18354 | 5322 | 30098 | 3918 | 32547 | 3164 | 33250 | 2582 | 33319 | 1677 | 40608 | 959 | 32154 |
| 10L-2S | | MI | 12937 | 5322 | 21805 | 3733 | 23770 | 2986 | 24756 | 2393 | 26136 | 1470 | 31124 | 1224 | 20679 |
| 20-#14 | 4.69 | MA | 20840 | 5799 | 35532 | 4201 | 39508 | 3374 | 41696 | 2692 | 44826 | 1627 | 55584 | 855 | 47671 |
| 7L-5S | | MI | 12644 | 5799 | 22196 | 4000 | 24138 | 3178 | 25188 | 2490 | 26838 | 1402 | 32226 | 723 | 27817 |
| 20-#14 | 4.69 | MA | 20226 | 5799 | 34443 | 4197 | 38025 | 3367 | 39942 | 2708 | 42274 | 1614 | 52575 | 787 | 45934 |
| 8L-4S | | MI | 13027 | 5799 | 22844 | 4012 | 24947 | 3166 | 26154 | 2478 | 28079 | 1389 | 33788 | 780 | 28270 |
| 20-#14 | 4.69 | MA | 19615 | 5799 | 33270 | 4217 | 36582 | 3385 | 38107 | 2699 | 39895 | 1627 | 49625 | 709 | 44081 |
| 9L-3S | | MI | 13450 | 5799 | 23586 | 3999 | 25862 | 3178 | 27237 | 2490 | 29425 | 1377 | 35265 | 892 | 28975 |
| 22-#11 | 3.57 | MA | 20259 | 5430 | 33599 | 3976 | 37103 | 3208 | 38794 | 2593 | 40907 | 1659 | 50132 | 1103 | 38331 |
| 7L-6S | | MI | 11962 | 5430 | 20369 | 3805 | 21968 | 3033 | 22647 | 2436 | 23348 | 1470 | 27921 | 925 | 21944 |
| 22-#11 | 3.57 | MA | 19823 | 5430 | 32839 | 3974 | 36069 | 3203 | 37571 | 2605 | 39120 | 1650 | 48018 | 1055 | 37540 |
| 8L-5S | | MI | 12222 | 5430 | 20829 | 3795 | 22545 | 3042 | 23300 | 2427 | 24217 | 1461 | 28956 | 983 | 22126 |
| 22-#11 | 3.57 | MA | 19386 | 5430 | 32021 | 3988 | 35063 | 3216 | 36291 | 2599 | 37453 | 1659 | 45940 | 1001 | 36534 |
| 9L-4S | | MI | 12494 | 5430 | 21284 | 3803 | 23120 | 3033 | 23986 | 2419 | 25179 | 1470 | 30071 | 1022 | 22551 |
| 22-#11 | 3.57 | MA | 18900 | 5430 | 31264 | 3985 | 34042 | 3212 | 35074 | 2611 | 35801 | 1668 | 43927 | 940 | 35588 |
| 10L-3S | | MI | 12794 | 5430 | 21805 | 3793 | 23770 | 3042 | 24756 | 2427 | 26136 | 1461 | 31124 | 1101 | 22645 |
| 22-#14 | 5.16 | MA | 20985 | 5955 | 36111 | 4294 | 40163 | 3437 | 42551 | 2751 | 45814 | 1601 | 57290 | 758 | 50867 |
| 8L-5S | | MI | 13023 | 5955 | 23086 | 4097 | 25250 | 3245 | 26516 | 2526 | 28601 | 1375 | 34492 | 667 | 30487 |
| 22-#14 | 5.16 | MA | 20375 | 5955 | 34939 | 4314 | 38721 | 3455 | 40716 | 2742 | 43435 | 1614 | 54340 | 680 | 48976 |
| 9L-4S | | MI | 13404 | 5955 | 23734 | 4109 | 26059 | 3232 | 27482 | 2513 | 29842 | 1362 | 36054 | 724 | 30908 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

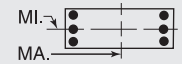
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 3.90 | MA | 20360 | 5538 | 34005 | 4041 | 37564 | 3252 | 39395 | 2634 | 41601 | 1642 | 51337 | 1037 | 41047 |
| 8L-6S | | MI | 12234 | 5538 | 20996 | 3872 | 22758 | 3080 | 23591 | 2461 | 24600 | 1452 | 29539 | 888 | 23794 |
| 24-#11 | 3.90 | MA | 19924 | 5538 | 33187 | 4055 | 36558 | 3265 | 38115 | 2629 | 39935 | 1650 | 49259 | 983 | 40003 |
| 9L-5S | | MI | 12493 | 5538 | 21456 | 3862 | 23335 | 3089 | 24244 | 2453 | 25469 | 1444 | 30574 | 946 | 24013 |
| 24-#11 | 3.90 | MA | 19454 | 5538 | 32430 | 4053 | 35537 | 3261 | 36898 | 2640 | 38282 | 1659 | 47246 | 922 | 39028 |
| 10L-4S | | MI | 12763 | 5538 | 21911 | 3870 | 23910 | 3080 | 24930 | 2444 | 26432 | 1452 | 31690 | 985 | 24412 |
| 24-#14 | 5.63 | MA | 21130 | 6111 | 36607 | 4412 | 40859 | 3525 | 43325 | 2784 | 46974 | 1601 | 59054 | 651 | 53880 |
| 9L-5S | | MI | 13400 | 6111 | 23976 | 4195 | 26361 | 3311 | 27845 | 2561 | 30364 | 1348 | 36759 | 611 | 33134 |

## RECTANGULAR TIED COLUMNS 24" x 42"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.59 | MA | 21622 | 5009 | 34211 | 3696 | 37158 | 3005 | 38162 | 2492 | 38631 | 1750 | 45639 | 1630 | 20152 |
| 2E | | MI | 12026 | 5009 | 19443 | 3488 | 20381 | 2818 | 20461 | 2316 | 20090 | 1583 | 23041 | 1409 | 10896 |
| 6-#14 | 1.34 | MA | 21239 | 4922 | 33222 | 3666 | 36028 | 2986 | 36836 | 2485 | 36944 | 1775 | 43504 | 1671 | 17237 |
| 2L-3S | | MI | 11276 | 4922 | 18133 | 3470 | 18875 | 2837 | 18701 | 2348 | 17762 | 1646 | 20142 | 1364 | 9491 |
| 6-#14 | 1.34 | MA | 20041 | 4922 | 31457 | 3662 | 33765 | 3005 | 34075 | 2502 | 33187 | 1788 | 38481 | 1546 | 17284 |
| 3L-2S | | MI | 11875 | 4922 | 19023 | 3482 | 19987 | 2825 | 20030 | 2336 | 19525 | 1633 | 22409 | 1488 | 9407 |
| 6-#18 | 2.38 | MA | 23036 | 5285 | 37301 | 3869 | 41119 | 3129 | 42994 | 2567 | 45157 | 1725 | 54314 | 1576 | 29845 |
| 2L-3S | | MI | 11660 | 5285 | 19443 | 3637 | 20381 | 2954 | 20461 | 2396 | 20090 | 1551 | 23041 | 1075 | 15929 |
| 6-#18 | 2.38 | MA | 20978 | 5285 | 34211 | 3860 | 37158 | 3160 | 38162 | 2595 | 38631 | 1747 | 45639 | 1354 | 29705 |
| 3L-2S | | MI | 12681 | 5285 | 20953 | 3659 | 22259 | 2932 | 22706 | 2374 | 23071 | 1529 | 26832 | 1297 | 15819 |
| 8-#11 | 1.24 | MA | 21081 | 4887 | 32805 | 3657 | 35564 | 2980 | 36297 | 2484 | 36221 | 1784 | 42638 | 1689 | 16036 |
| 2L-4S | | MI | 11082 | 4887 | 17673 | 3484 | 18384 | 2830 | 18142 | 2347 | 17090 | 1673 | 19488 | 1356 | 8903 |
| 8-#11 | 1.24 | MA | 20241 | 4887 | 31572 | 3654 | 33983 | 2976 | 34368 | 2496 | 33596 | 1794 | 39106 | 1602 | 16072 |
| 3E | | MI | 11391 | 4887 | 18194 | 3474 | 19034 | 2839 | 18912 | 2355 | 18047 | 1664 | 20541 | 1436 | 8839 |
| 8-#11 | 1.24 | MA | 19652 | 4887 | 30567 | 3669 | 32702 | 2990 | 32811 | 2491 | 31593 | 1803 | 36806 | 1516 | 16075 |
| 4L-2S | | MI | 11814 | 4887 | 18821 | 3482 | 19824 | 2830 | 19856 | 2347 | 19299 | 1656 | 22159 | 1522 | 8785 |
| 8-#14 | 1.79 | MA | 22062 | 5078 | 34988 | 3764 | 38291 | 3056 | 39597 | 2528 | 40701 | 1763 | 48526 | 1644 | 22783 |
| 2L-4S | | MI | 11230 | 5078 | 18281 | 3581 | 19072 | 2891 | 18946 | 2371 | 18179 | 1631 | 20931 | 1196 | 12408 |
| 8-#14 | 1.79 | MA | 20872 | 5078 | 33222 | 3760 | 36028 | 3074 | 36836 | 2545 | 36944 | 1775 | 43504 | 1519 | 22789 |
| 3E | | MI | 11667 | 5078 | 19023 | 3568 | 19987 | 2904 | 20030 | 2384 | 19525 | 1619 | 22409 | 1308 | 12343 |
| 8-#14 | 1.79 | MA | 20036 | 5078 | 31782 | 3780 | 34193 | 3068 | 34606 | 2536 | 34073 | 1788 | 40238 | 1395 | 22657 |
| 4L-2S | | MI | 12263 | 5078 | 19913 | 3580 | 21098 | 2891 | 21358 | 2371 | 21288 | 1606 | 24675 | 1432 | 12270 |
| 8-#18 | 3.17 | MA | 24428 | 5562 | 40391 | 4042 | 45080 | 3253 | 47827 | 2643 | 51684 | 1700 | 62988 | 1521 | 39481 |
| 2L-4S | | MI | 11571 | 5562 | 19691 | 3829 | 20711 | 3046 | 20873 | 2432 | 20796 | 1519 | 24350 | 772 | 19568 |
| 8-#18 | 3.17 | MA | 22394 | 5562 | 37301 | 4033 | 41119 | 3284 | 42994 | 2670 | 45157 | 1722 | 54314 | 1300 | 39222 |
| 3E | | MI | 12317 | 5562 | 20953 | 3807 | 22259 | 3069 | 22706 | 2454 | 23071 | 1497 | 26832 | 963 | 20727 |
| 8-#18 | 3.17 | MA | 20962 | 5562 | 34774 | 4068 | 37898 | 3271 | 39081 | 2653 | 40169 | 1744 | 48689 | 1078 | 36879 |
| 4L-2S | | MI | 13329 | 5562 | 22462 | 3829 | 24136 | 3046 | 24952 | 2432 | 26051 | 1475 | 30624 | 1184 | 20683 |
| 10-#11 | 1.55 | MA | 21661 | 4995 | 34039 | 3724 | 37146 | 3028 | 38226 | 2514 | 38846 | 1776 | 46171 | 1671 | 19913 |
| 2L-5S | | MI | 11082 | 4995 | 17845 | 3543 | 18599 | 2886 | 18400 | 2381 | 17380 | 1647 | 19991 | 1281 | 10950 |
| 10-#11 | 1.55 | MA | 20826 | 4995 | 32805 | 3721 | 35564 | 3025 | 36297 | 2526 | 36221 | 1785 | 42638 | 1585 | 19935 |
| 3L-4S | | MI | 11361 | 4995 | 18300 | 3551 | 19174 | 2877 | 19086 | 2372 | 18343 | 1656 | 21106 | 1320 | 10905 |
| 10-#11 | 1.55 | MA | 20240 | 4995 | 31800 | 3736 | 34284 | 3038 | 34741 | 2521 | 34218 | 1795 | 40339 | 1498 | 19906 |
| 4L-3S | | MI | 11668 | 4995 | 18821 | 3541 | 19824 | 2886 | 19856 | 2381 | 19299 | 1647 | 22159 | 1399 | 10852 |
| 10-#11 | 1.55 | MA | 19716 | 4995 | 30932 | 3734 | 33157 | 3034 | 33356 | 2533 | 32213 | 1787 | 37937 | 1457 | 19788 |
| 5L-2S | | MI | 12090 | 4995 | 19448 | 3549 | 20614 | 2877 | 20800 | 2372 | 20552 | 1638 | 23778 | 1485 | 10801 |
| 10-#14 | 2.23 | MA | 22876 | 5233 | 36753 | 3861 | 40555 | 3125 | 42358 | 2570 | 44457 | 1750 | 53549 | 1617 | 28314 |
| 2L-5S | | MI | 11227 | 5233 | 18523 | 3666 | 19374 | 2970 | 19309 | 2419 | 18700 | 1617 | 21636 | 1083 | 14695 |
| 10-#14 | 2.23 | MA | 21695 | 5233 | 34988 | 3857 | 38291 | 3144 | 39597 | 2587 | 40701 | 1763 | 48526 | 1492 | 28273 |
| 3L-4S | | MI | 11621 | 5233 | 19171 | 3678 | 20183 | 2958 | 20274 | 2407 | 19942 | 1605 | 23198 | 1139 | 15203 |
| 10-#14 | 2.23 | MA | 20866 | 5233 | 33548 | 3878 | 36456 | 3138 | 37367 | 2579 | 37830 | 1776 | 45261 | 1368 | 28092 |
| 4L-3S | | MI | 12055 | 5233 | 19913 | 3665 | 21098 | 2970 | 21358 | 2419 | 21288 | 1592 | 24675 | 1251 | 15166 |
| 10-#14 | 2.23 | MA | 20125 | 5233 | 32302 | 3873 | 34841 | 3157 | 35382 | 2596 | 34956 | 1764 | 41839 | 1309 | 26893 |
| 5L-2S | | MI | 12649 | 5233 | 20804 | 3677 | 22210 | 2958 | 22687 | 2407 | 23051 | 1580 | 26942 | 1376 | 15107 |
| 10-#18 | 3.97 | MA | 23789 | 5839 | 40391 | 4206 | 45080 | 3408 | 47827 | 2745 | 51684 | 1697 | 62988 | 1245 | 48723 |
| 3L-4S | | MI | 12227 | 5839 | 21201 | 3999 | 22589 | 3161 | 23118 | 2490 | 23776 | 1465 | 28142 | 659 | 23976 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

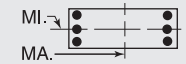
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.97 | MA | 22374 | 5839 | 37864 | 4241 | 41860 | 3395 | 43913 | 2728 | 46695 | 1719 | 57364 | 1024 | 45948 |
| 4L-3S | | MI | 12967 | 5839 | 22462 | 3977 | 24136 | 3183 | 24952 | 2512 | 26051 | 1443 | 30624 | 850 | 25477 |
| 10-#18 | 3.97 | MA | 21112 | 5839 | 35675 | 4232 | 39022 | 3426 | 40427 | 2756 | 41696 | 1697 | 51429 | 922 | 43483 |
| 5L-2S | | MI | 13972 | 5839 | 23972 | 3999 | 26014 | 3161 | 27197 | 2490 | 29032 | 1420 | 34416 | 1072 | 25511 |
| 12-#11 | 1.86 | MA | 22237 | 5103 | 35273 | 3791 | 38727 | 3077 | 40156 | 2543 | 41471 | 1767 | 49703 | 1653 | 23780 |
| 2L-6S | | MI | 11095 | 5103 | 18012 | 3620 | 18812 | 2924 | 18691 | 2415 | 17764 | 1638 | 20575 | 1186 | 12587 |
| 12-#11 | 1.86 | MA | 21406 | 5103 | 34039 | 3789 | 37146 | 3073 | 38226 | 2555 | 38846 | 1777 | 46171 | 1567 | 23782 |
| 3L-5S | | MI | 11361 | 5103 | 18472 | 3611 | 19389 | 2933 | 19344 | 2406 | 18633 | 1630 | 21609 | 1244 | 12908 |
| 12-#11 | 1.86 | MA | 20823 | 5103 | 33034 | 3804 | 35865 | 3086 | 36670 | 2550 | 36843 | 1786 | 43871 | 1481 | 23729 |
| 4E | | MI | 11638 | 5103 | 18927 | 3618 | 19964 | 2924 | 20030 | 2398 | 19596 | 1638 | 22725 | 1283 | 12891 |
| 12-#11 | 1.86 | MA | 20303 | 5103 | 32165 | 3801 | 34738 | 3083 | 35285 | 2562 | 34838 | 1778 | 41469 | 1439 | 23551 |
| 5L-3S | | MI | 11945 | 5103 | 19448 | 3609 | 20614 | 2933 | 20800 | 2406 | 20552 | 1630 | 23778 | 1363 | 12849 |
| 12-#11 | 1.86 | MA | 19808 | 5103 | 31351 | 3799 | 33610 | 3096 | 33907 | 2557 | 33021 | 1788 | 39186 | 1383 | 22751 |
| 6L-2S | | MI | 12364 | 5103 | 20075 | 3617 | 21404 | 2924 | 21745 | 2398 | 21805 | 1621 | 25396 | 1449 | 12804 |
| 12-#14 | 2.68 | MA | 22510 | 5389 | 36753 | 3954 | 40555 | 3214 | 42358 | 2629 | 44457 | 1750 | 53549 | 1465 | 33745 |
| 3L-5S | | MI | 11617 | 5389 | 19413 | 3763 | 20486 | 3037 | 20637 | 2455 | 20463 | 1590 | 23903 | 1026 | 17329 |
| 12-#14 | 2.68 | MA | 21687 | 5389 | 35313 | 3975 | 38720 | 3208 | 40128 | 2621 | 41587 | 1763 | 50284 | 1341 | 33522 |
| 4E | | MI | 12009 | 5389 | 20061 | 3775 | 21295 | 3024 | 21603 | 2442 | 21705 | 1578 | 25464 | 1083 | 17973 |
| 12-#14 | 2.68 | MA | 20953 | 5389 | 34067 | 3971 | 37104 | 3227 | 38143 | 2638 | 38712 | 1751 | 46862 | 1282 | 32164 |
| 5L-3S | | MI | 12441 | 5389 | 20804 | 3762 | 22210 | 3037 | 22687 | 2455 | 23051 | 1565 | 26942 | 1195 | 17970 |
| 12-#14 | 2.68 | MA | 20254 | 5389 | 32899 | 3967 | 35486 | 3221 | 36166 | 2630 | 36107 | 1764 | 43618 | 1201 | 31195 |
| 6L-2S | | MI | 13032 | 5389 | 21694 | 3774 | 23321 | 3024 | 24016 | 2442 | 24814 | 1553 | 29209 | 1320 | 17927 |
| 12-#18 | 4.76 | MA | 23768 | 6115 | 40954 | 4414 | 45821 | 3519 | 48746 | 2804 | 53222 | 1695 | 66038 | 969 | 55064 |
| 4E | | MI | 12877 | 6115 | 22711 | 4169 | 24466 | 3275 | 25363 | 2548 | 26757 | 1411 | 31933 | 547 | 28425 |
| 12-#18 | 4.76 | MA | 22521 | 6115 | 38765 | 4405 | 42983 | 3551 | 45259 | 2831 | 48223 | 1673 | 60104 | 868 | 52740 |
| 5L-3S | | MI | 13612 | 6115 | 23972 | 4147 | 26014 | 3297 | 27197 | 2570 | 29032 | 1389 | 34416 | 738 | 30200 |
| 12-#18 | 4.76 | MA | 21335 | 6115 | 36711 | 4396 | 40140 | 3537 | 41785 | 2814 | 43694 | 1695 | 54509 | 723 | 48784 |
| 6L-2S | | MI | 14610 | 6115 | 25482 | 4169 | 27891 | 3275 | 29442 | 2548 | 32012 | 1366 | 38208 | 959 | 30309 |
| 14-#11 | 2.17 | MA | 21981 | 5211 | 35273 | 3856 | 38727 | 3121 | 40156 | 2585 | 41471 | 1768 | 49703 | 1550 | 27621 |
| 3L-6S | | MI | 11373 | 5211 | 18639 | 3688 | 19602 | 2971 | 19635 | 2441 | 19017 | 1621 | 22193 | 1150 | 14474 |
| 14-#11 | 2.17 | MA | 21402 | 5211 | 34268 | 3871 | 37447 | 3135 | 38599 | 2580 | 39468 | 1777 | 47404 | 1463 | 27546 |
| 4L-5S | | MI | 11638 | 5211 | 19099 | 3678 | 20179 | 2980 | 20288 | 2432 | 19886 | 1612 | 23228 | 1208 | 14783 |
| 14-#11 | 2.17 | MA | 20885 | 5211 | 33399 | 3869 | 36320 | 3131 | 37215 | 2592 | 37463 | 1770 | 45002 | 1422 | 27232 |
| 5L-4S | | MI | 11914 | 5211 | 19554 | 3686 | 20754 | 2971 | 20975 | 2423 | 20848 | 1621 | 24343 | 1247 | 14866 |
| 14-#11 | 2.17 | MA | 20393 | 5211 | 32585 | 3866 | 35192 | 3144 | 35836 | 2586 | 35646 | 1779 | 42719 | 1366 | 26471 |
| 6L-3S | | MI | 12219 | 5211 | 20075 | 3676 | 21404 | 2980 | 21745 | 2432 | 21805 | 1612 | 25396 | 1326 | 14834 |
| 14-#11 | 2.17 | MA | 19913 | 5211 | 31692 | 3881 | 34116 | 3141 | 34513 | 2599 | 33871 | 1789 | 40283 | 1276 | 25982 |
| 7L-2S | | MI | 12637 | 5211 | 20701 | 3684 | 22194 | 2971 | 22689 | 2423 | 23058 | 1604 | 27015 | 1413 | 14795 |
| 14-#14 | 3.13 | MA | 22501 | 5545 | 37079 | 4072 | 40983 | 3278 | 42889 | 2664 | 45344 | 1751 | 55306 | 1314 | 38948 |
| 4L-5S | | MI | 12005 | 5545 | 20303 | 3860 | 21597 | 3103 | 21966 | 2490 | 22226 | 1563 | 26169 | 970 | 19975 |
| 14-#14 | 3.13 | MA | 21772 | 5545 | 35833 | 4068 | 39367 | 3296 | 40904 | 2680 | 42469 | 1739 | 51884 | 1255 | 37450 |
| 5L-4S | | MI | 12394 | 5545 | 20952 | 3872 | 22406 | 3091 | 22932 | 2478 | 23468 | 1551 | 27731 | 1027 | 20575 |
| 14-#14 | 3.13 | MA | 21079 | 5545 | 34665 | 4064 | 37750 | 3290 | 38927 | 2672 | 39864 | 1751 | 48640 | 1174 | 36525 |
| 6L-3S | | MI | 12825 | 5545 | 21694 | 3859 | 23321 | 3103 | 24016 | 2490 | 24814 | 1539 | 29209 | 1139 | 20764 |
| 14-#14 | 3.13 | MA | 20404 | 5545 | 33385 | 4085 | 36206 | 3309 | 37029 | 2689 | 37318 | 1764 | 45178 | 1044 | 34836 |
| 7L-2S | | MI | 13412 | 5545 | 22584 | 3871 | 24432 | 3091 | 25344 | 2478 | 26577 | 1526 | 31475 | 1264 | 20734 |
| 14-#18 | 5.56 | MA | 23912 | 6392 | 41855 | 4578 | 46944 | 3675 | 50092 | 2907 | 54750 | 1648 | 68778 | 813 | 61708 |
| 5L-4S | | MI | 13523 | 6392 | 24221 | 4339 | 26344 | 3389 | 27609 | 2606 | 29737 | 1357 | 35725 | 434 | 32903 |
| 14-#18 | 5.56 | MA | 22740 | 6392 | 39801 | 4568 | 44102 | 3662 | 46618 | 2890 | 50221 | 1670 | 63183 | 668 | 57910 |
| 6L-3S | | MI | 14253 | 6392 | 25482 | 4317 | 27891 | 3411 | 29442 | 2629 | 32012 | 1335 | 38208 | 625 | 34820 |
| 14-#18 | 5.56 | MA | 21600 | 6392 | 37552 | 4604 | 41388 | 3693 | 43282 | 2917 | 45795 | 1692 | 57205 | 437 | 53981 |
| 7L-2S | | MI | 15244 | 6392 | 26992 | 4339 | 29769 | 3389 | 31687 | 2606 | 34993 | 1312 | 41999 | 846 | 35072 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis

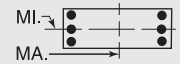


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.48 | MA | 21977 | 5318 | 35501 | 3938 | 39028 | 3183 | 40528 | 2609 | 42093 | 1769 | 50936 | 1446 | 31359 |
| 4L-6S | | MI | 11650 | 5318 | 19266 | 3755 | 20392 | 3018 | 20579 | 2466 | 20270 | 1604 | 23812 | 1113 | 16365 |
| 16-#11 | 2.48 | MA | 21463 | 5318 | 34633 | 3936 | 37901 | 3179 | 39144 | 2621 | 40088 | 1761 | 48534 | 1404 | 30925 |
| 5E | | MI | 11913 | 5318 | 19726 | 3746 | 20969 | 3027 | 21232 | 2457 | 21139 | 1595 | 24847 | 1171 | 16594 |
| 16-#11 | 2.48 | MA | 20974 | 5318 | 33818 | 3933 | 36773 | 3193 | 37765 | 2616 | 38271 | 1771 | 46251 | 1348 | 30199 |
| 6L-4S | | MI | 12189 | 5318 | 20180 | 3753 | 21544 | 3018 | 21919 | 2449 | 22101 | 1604 | 25962 | 1210 | 16832 |
| 16-#11 | 2.48 | MA | 20497 | 5318 | 32926 | 3948 | 35697 | 3189 | 36442 | 2628 | 36496 | 1780 | 43816 | 1258 | 29677 |
| 7L-3S | | MI | 12493 | 5318 | 20701 | 3744 | 22194 | 3027 | 22689 | 2457 | 23058 | 1595 | 27015 | 1290 | 16811 |
| 16-#11 | 2.48 | MA | 20028 | 5318 | 32125 | 3946 | 34605 | 3202 | 35150 | 2640 | 34609 | 1772 | 41570 | 1210 | 28713 |
| 8L-2S | | MI | 12909 | 5318 | 21328 | 3751 | 22984 | 3018 | 23633 | 2449 | 24311 | 1586 | 28634 | 1376 | 16779 |
| 16-#14 | 3.57 | MA | 22585 | 5700 | 37599 | 4165 | 41631 | 3366 | 43665 | 2723 | 46226 | 1726 | 56907 | 1228 | 42751 |
| 5E | | MI | 12390 | 5700 | 21194 | 3958 | 22708 | 3170 | 23294 | 2526 | 23989 | 1537 | 28436 | 914 | 22629 |
| 16-#14 | 3.57 | MA | 21897 | 5700 | 36430 | 4161 | 40013 | 3360 | 41688 | 2715 | 43620 | 1739 | 53663 | 1147 | 41820 |
| 6L-4S | | MI | 12778 | 5700 | 21842 | 3970 | 23517 | 3158 | 24260 | 2513 | 25231 | 1524 | 29998 | 971 | 23181 |
| 16-#14 | 3.57 | MA | 21227 | 5700 | 35151 | 4182 | 38470 | 3379 | 39790 | 2731 | 41074 | 1752 | 50201 | 1017 | 40093 |
| 7L-3S | | MI | 13206 | 5700 | 22584 | 3957 | 24432 | 3170 | 25344 | 2526 | 26577 | 1512 | 31475 | 1083 | 23535 |
| 16-#14 | 3.57 | MA | 20568 | 5700 | 34001 | 4178 | 36904 | 3373 | 37938 | 2748 | 38369 | 1740 | 47001 | 948 | 38494 |
| 8L-2S | | MI | 13791 | 5700 | 23474 | 3969 | 25544 | 3158 | 26673 | 2513 | 28340 | 1499 | 33742 | 1208 | 23532 |
| 16-#18 | 6.35 | MA | 24130 | 6668 | 42891 | 4741 | 48063 | 3786 | 51450 | 2965 | 56747 | 1645 | 71858 | 614 | 67061 |
| 6L-4S | | MI | 14165 | 6668 | 25731 | 4510 | 28221 | 3503 | 29854 | 2665 | 32718 | 1303 | 39517 | 322 | 37404 |
| 16-#18 | 6.35 | MA | 23002 | 6668 | 40642 | 4776 | 45349 | 3817 | 48115 | 2992 | 52321 | 1667 | 65880 | 382 | 63025 |
| 7L-3S | | MI | 14890 | 6668 | 26992 | 4488 | 29769 | 3525 | 31687 | 2687 | 34993 | 1280 | 41999 | 512 | 39156 |
| 18-#11 | 2.79 | MA | 22037 | 5426 | 35866 | 4003 | 39483 | 3228 | 41073 | 2650 | 42713 | 1752 | 52067 | 1387 | 34627 |
| 5L-6S | | MI | 11926 | 5426 | 19892 | 3823 | 21182 | 3065 | 21524 | 2492 | 21522 | 1586 | 25430 | 1077 | 18259 |
| 18-#11 | 2.79 | MA | 21551 | 5426 | 35052 | 4001 | 38355 | 3241 | 39695 | 2645 | 40896 | 1762 | 49784 | 1331 | 33932 |
| 6L-5S | | MI | 12188 | 5426 | 20352 | 3813 | 21759 | 3074 | 22177 | 2483 | 22391 | 1578 | 26465 | 1135 | 18471 |
| 18-#11 | 2.79 | MA | 21077 | 5426 | 34160 | 4016 | 37279 | 3237 | 38371 | 2657 | 39121 | 1771 | 47348 | 1241 | 33343 |
| 7L-4S | | MI | 12462 | 5426 | 20807 | 3821 | 22334 | 3065 | 22863 | 2474 | 23354 | 1586 | 27581 | 1174 | 18793 |
| 18-#11 | 2.79 | MA | 20611 | 5426 | 33358 | 4013 | 36187 | 3251 | 37080 | 2669 | 37234 | 1764 | 45102 | 1192 | 32411 |
| 8L-3S | | MI | 12765 | 5426 | 21328 | 3811 | 22984 | 3074 | 23633 | 2483 | 24311 | 1578 | 28634 | 1253 | 18781 |
| 18-#11 | 2.79 | MA | 20140 | 5426 | 32495 | 4028 | 35125 | 3247 | 35729 | 2664 | 35474 | 1773 | 42889 | 1138 | 31516 |
| 9L-2S | | MI | 13180 | 5426 | 21955 | 3819 | 23774 | 3065 | 24577 | 2474 | 25563 | 1569 | 30252 | 1340 | 18757 |
| 18-#14 | 4.02 | MA | 22708 | 5856 | 38196 | 4258 | 42276 | 3430 | 44449 | 2757 | 47377 | 1727 | 58686 | 1120 | 47030 |
| 6L-5S | | MI | 12773 | 5856 | 22084 | 4055 | 23820 | 3237 | 24623 | 2561 | 25752 | 1510 | 30702 | 858 | 25291 |
| 18-#14 | 4.02 | MA | 22044 | 5856 | 36916 | 4279 | 40733 | 3449 | 42552 | 2774 | 44831 | 1739 | 55223 | 990 | 45362 |
| 7L-4S | | MI | 13159 | 5856 | 22732 | 4067 | 24629 | 3224 | 25589 | 2549 | 26994 | 1497 | 32264 | 915 | 25799 |
| 18-#14 | 4.02 | MA | 21389 | 5856 | 35766 | 4275 | 39167 | 3443 | 40699 | 2791 | 42126 | 1727 | 52024 | 921 | 43703 |
| 8L-3S | | MI | 13585 | 5856 | 23474 | 4054 | 25544 | 3237 | 26673 | 2561 | 28340 | 1485 | 33742 | 1027 | 26298 |
| 18-#14 | 4.02 | MA | 20730 | 5856 | 34528 | 4296 | 37644 | 3461 | 38762 | 2783 | 39603 | 1740 | 48879 | 843 | 42050 |
| 9L-2S | | MI | 14168 | 5856 | 24364 | 4066 | 26655 | 3224 | 28001 | 2549 | 30103 | 1473 | 36008 | 1151 | 26324 |
| 18-#18 | 7.14 | MA | 24389 | 6945 | 43732 | 4949 | 49311 | 3941 | 52947 | 3068 | 58848 | 1642 | 74554 | 328 | 72092 |
| 7L-4S | | MI | 14803 | 6945 | 27240 | 4680 | 30099 | 3617 | 32099 | 2723 | 35698 | 1249 | 43309 | 209 | 41923 |
| 20-#11 | 3.10 | MA | 22124 | 5534 | 36286 | 4068 | 39936 | 3290 | 41624 | 2675 | 43521 | 1753 | 53317 | 1313 | 37670 |
| 6E | | MI | 12200 | 5534 | 20519 | 3890 | 21972 | 3112 | 22468 | 2517 | 22775 | 1569 | 27049 | 1041 | 20154 |
| 20-#11 | 3.10 | MA | 21653 | 5534 | 35393 | 4083 | 38860 | 3286 | 40301 | 2687 | 41745 | 1763 | 50881 | 1223 | 37018 |
| 7L-5S | | MI | 12461 | 5534 | 20979 | 3881 | 22549 | 3121 | 23121 | 2509 | 23644 | 1560 | 28084 | 1098 | 20353 |
| 20-#11 | 3.10 | MA | 21190 | 5534 | 34592 | 4080 | 37768 | 3299 | 39009 | 2699 | 39859 | 1755 | 48635 | 1175 | 36113 |
| 8L-4S | | MI | 12734 | 5534 | 21434 | 3888 | 23124 | 3112 | 23807 | 2500 | 24607 | 1569 | 29199 | 1137 | 20738 |
| 20-#11 | 3.10 | MA | 20719 | 5534 | 33729 | 4095 | 36706 | 3295 | 37658 | 2694 | 38099 | 1765 | 46421 | 1121 | 35178 |
| 9L-3S | | MI | 13036 | 5534 | 21955 | 3879 | 23774 | 3121 | 24577 | 2509 | 25563 | 1560 | 30252 | 1217 | 20747 |
| 20-#11 | 3.10 | MA | 20198 | 5534 | 32929 | 4093 | 35629 | 3309 | 36373 | 2706 | 36355 | 1774 | 44277 | 1060 | 34179 |
| 10L-2S | | MI | 13450 | 5534 | 22582 | 3886 | 24564 | 3112 | 25522 | 2500 | 26816 | 1552 | 31871 | 1303 | 20729 |
| 20-#14 | 4.46 | MA | 22853 | 6011 | 38682 | 4376 | 42996 | 3519 | 45313 | 2816 | 48588 | 1727 | 60246 | 963 | 50639 |
| 7L-5S | | MI | 13155 | 6011 | 22974 | 4152 | 24931 | 3303 | 25952 | 2597 | 27516 | 1483 | 32969 | 802 | 27958 |
| 20-#14 | 4.46 | MA | 22204 | 6011 | 37532 | 4372 | 41430 | 3512 | 43460 | 2833 | 45882 | 1715 | 57047 | 893 | 48922 |
| 8L-4S | | MI | 13539 | 6011 | 23622 | 4164 | 25740 | 3291 | 26918 | 2584 | 28757 | 1471 | 34531 | 859 | 28428 |
| 20-#14 | 4.46 | MA | 21546 | 6011 | 36293 | 4393 | 39907 | 3531 | 41523 | 2825 | 43359 | 1728 | 53901 | 816 | 47073 |
| 9L-3S | | MI | 13963 | 6011 | 24364 | 4151 | 26655 | 3303 | 28001 | 2597 | 30103 | 1458 | 36008 | 971 | 29053 |

## RECTANGULAR TIED COLUMNS 24" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.40 | MA | 22226 | 5642 | 36627 | 4150 | 40442 | 3334 | 42230 | 2716 | 44370 | 1754 | 54413 | 1206 | 40699 |
| 7L-6S | | MI | 12473 | 5642 | 21146 | 3958 | 22762 | 3159 | 23412 | 2543 | 24028 | 1552 | 28668 | 1004 | 22052 |
| 22-#11 | 3.40 | MA | 21765 | 5642 | 35825 | 4148 | 39350 | 3348 | 40938 | 2728 | 42484 | 1746 | 52168 | 1157 | 39821 |
| 8L-5S | | MI | 12733 | 5642 | 21606 | 3948 | 23339 | 3168 | 24065 | 2534 | 24897 | 1543 | 29702 | 1062 | 22238 |
| 22-#11 | 3.40 | MA | 21295 | 5642 | 34962 | 4163 | 38288 | 3344 | 39588 | 2723 | 40724 | 1756 | 49954 | 1103 | 38846 |
| 9L-4S | | MI | 13005 | 5642 | 22061 | 3956 | 23914 | 3159 | 24752 | 2525 | 25860 | 1552 | 30818 | 1101 | 22681 |
| 22-#11 | 3.40 | MA | 20778 | 5642 | 34163 | 4160 | 37211 | 3357 | 38303 | 2735 | 38980 | 1765 | 47809 | 1042 | 37871 |
| 10L-3S | | MI | 13306 | 5642 | 22582 | 3946 | 24564 | 3168 | 25522 | 2534 | 26816 | 1543 | 31871 | 1180 | 22708 |
| 22-#11 | 3.40 | MA | 20280 | 5642 | 33377 | 4158 | 36155 | 3353 | 36969 | 2730 | 37120 | 1758 | 45620 | 991 | 36567 |
| 11L-2S | | MI | 13718 | 5642 | 23209 | 3954 | 25354 | 3159 | 26466 | 2525 | 28069 | 1534 | 33489 | 1267 | 22697 |
| 22-#14 | 4.91 | MA | 23012 | 6167 | 39297 | 4469 | 43694 | 3582 | 46221 | 2875 | 49639 | 1702 | 62070 | 866 | 54151 |
| 8L-5S | | MI | 13534 | 6167 | 23864 | 4249 | 26043 | 3370 | 27280 | 2632 | 29279 | 1456 | 35235 | 746 | 30629 |
| 22-#14 | 4.91 | MA | 22355 | 6167 | 38059 | 4490 | 42171 | 3601 | 44284 | 2867 | 47116 | 1715 | 58924 | 789 | 52264 |
| 9L-4S | | MI | 13917 | 6167 | 24513 | 4261 | 26852 | 3357 | 28246 | 2620 | 30520 | 1444 | 36797 | 803 | 31066 |
| 24-#11 | 3.71 | MA | 22336 | 5750 | 37059 | 4215 | 40931 | 3396 | 42868 | 2758 | 45109 | 1738 | 55700 | 1140 | 43534 |
| 8L-6S | | MI | 12745 | 5750 | 21773 | 4025 | 23552 | 3206 | 24357 | 2568 | 25281 | 1534 | 30286 | 968 | 23950 |
| 24-#11 | 3.71 | MA | 21867 | 5750 | 36196 | 4230 | 39869 | 3392 | 41517 | 2753 | 43349 | 1747 | 53487 | 1086 | 42520 |
| 9L-5S | | MI | 13004 | 5750 | 22233 | 4015 | 24129 | 3215 | 25010 | 2560 | 26150 | 1526 | 31321 | 1026 | 24125 |
| 24-#11 | 3.71 | MA | 21355 | 5750 | 35397 | 4228 | 38792 | 3406 | 40232 | 2765 | 41605 | 1757 | 51342 | 1025 | 41567 |
| 10L-4S | | MI | 13275 | 5750 | 22687 | 4023 | 24704 | 3206 | 25696 | 2551 | 27112 | 1534 | 32437 | 1065 | 24542 |
| 24-#11 | 3.71 | MA | 20860 | 5750 | 34611 | 4225 | 37736 | 3402 | 38899 | 2759 | 39745 | 1749 | 49152 | 973 | 40238 |
| 11L-3S | | MI | 13575 | 5750 | 23209 | 4013 | 25354 | 3215 | 26466 | 2560 | 28069 | 1526 | 33489 | 1144 | 24655 |
| 24-#14 | 5.36 | MA | 23158 | 6323 | 39825 | 4587 | 44434 | 3671 | 47045 | 2910 | 50873 | 1703 | 63947 | 761 | 57463 |
| 9L-5S | | MI | 13912 | 6323 | 24755 | 4347 | 27154 | 3436 | 28609 | 2668 | 31042 | 1430 | 37502 | 690 | 33303 |

## RECTANGULAR TIED COLUMNS 24" x 44"

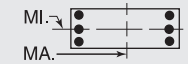
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.52 | MA | 23628 | 5221 | 37232 | 3869 | 40454 | 3146 | 41512 | 2612 | 41971 | 1846 | 49573 | 1726 | 21232 |
| 2E | | MI | 12536 | 5221 | 20225 | 3638 | 21173 | 2942 | 21222 | 2421 | 20763 | 1663 | 23777 | 1487 | 10941 |
| 6-#14 | 1.28 | MA | 23217 | 5134 | 36182 | 3839 | 39253 | 3128 | 40104 | 2606 | 40116 | 1868 | 47274 | 1765 | 18149 |
| 2L-3S | | MI | 11785 | 5134 | 18912 | 3622 | 19668 | 2962 | 19465 | 2455 | 18440 | 1727 | 20886 | 1443 | 9528 |
| 6-#14 | 1.28 | MA | 21950 | 5134 | 34319 | 3835 | 36865 | 3122 | 37190 | 2623 | 36152 | 1881 | 41943 | 1641 | 18196 |
| 3L-2S | | MI | 12385 | 5134 | 19802 | 3634 | 20780 | 2950 | 20794 | 2442 | 20203 | 1715 | 23152 | 1567 | 9443 |
| 6-#18 | 2.27 | MA | 25130 | 5497 | 40495 | 4041 | 44636 | 3271 | 46615 | 2688 | 48894 | 1822 | 58795 | 1675 | 31465 |
| 2L-3S | | MI | 12170 | 5497 | 20225 | 3786 | 21173 | 3078 | 21222 | 2501 | 20763 | 1631 | 23777 | 1153 | 15993 |
| 6-#18 | 2.27 | MA | 22951 | 5497 | 37232 | 4033 | 40454 | 3303 | 41512 | 2716 | 41971 | 1845 | 49573 | 1454 | 31325 |
| 3L-2S | | MI | 13192 | 5497 | 21735 | 3809 | 23050 | 3056 | 23467 | 2479 | 23743 | 1609 | 27568 | 1375 | 15873 |
| 8-#11 | 1.18 | MA | 23048 | 5099 | 35739 | 3829 | 38760 | 3122 | 39531 | 2605 | 39349 | 1877 | 46343 | 1782 | 16879 |
| 2L-4S | | MI | 11591 | 5099 | 18450 | 3637 | 19178 | 2956 | 18908 | 2454 | 17770 | 1755 | 20235 | 1436 | 8937 |
| 8-#11 | 1.18 | MA | 22161 | 5099 | 34438 | 3827 | 37093 | 3118 | 37496 | 2617 | 36580 | 1887 | 42596 | 1696 | 16915 |
| 3E | | MI | 11900 | 5099 | 18971 | 3627 | 19828 | 2965 | 19678 | 2462 | 18727 | 1746 | 21287 | 1515 | 8871 |
| 8-#11 | 1.18 | MA | 21539 | 5099 | 33380 | 3842 | 35743 | 3132 | 35856 | 2613 | 34470 | 1897 | 40155 | 1610 | 16917 |
| 4L-2S | | MI | 12323 | 5099 | 19598 | 3635 | 20618 | 2956 | 20622 | 2454 | 19980 | 1738 | 22906 | 1601 | 8817 |
| 8-#14 | 1.70 | MA | 24090 | 5290 | 38045 | 3936 | 41641 | 3197 | 43017 | 2648 | 44080 | 1855 | 52606 | 1740 | 23998 |
| 2L-4S | | MI | 11739 | 5290 | 19060 | 3732 | 19865 | 3016 | 19710 | 2478 | 18857 | 1713 | 21675 | 1274 | 12459 |
| 8-#14 | 1.70 | MA | 22832 | 5290 | 36182 | 3932 | 39253 | 3192 | 40104 | 2666 | 40116 | 1869 | 47274 | 1616 | 24004 |
| 3E | | MI | 12177 | 5290 | 19802 | 3720 | 20780 | 3029 | 20794 | 2490 | 20203 | 1700 | 23152 | 1387 | 12387 |
| 8-#14 | 1.70 | MA | 21950 | 5290 | 34664 | 3954 | 37319 | 3211 | 37753 | 2658 | 37091 | 1882 | 43804 | 1491 | 23872 |
| 4L-2S | | MI | 12774 | 5290 | 20692 | 3732 | 21891 | 3016 | 22122 | 2478 | 21966 | 1688 | 25419 | 1511 | 12311 |
| 8-#18 | 3.03 | MA | 26609 | 5774 | 43758 | 4214 | 48819 | 3395 | 51718 | 2763 | 55817 | 1799 | 68017 | 1624 | 41641 |
| 2L-4S | | MI | 12079 | 5774 | 20473 | 3979 | 21503 | 3170 | 21634 | 2537 | 21469 | 1599 | 25086 | 850 | 19787 |
| 8-#18 | 3.03 | MA | 24455 | 5774 | 40495 | 4206 | 44636 | 3427 | 46615 | 2792 | 48894 | 1821 | 58795 | 1402 | 41382 |
| 3E | | MI | 12827 | 5774 | 21735 | 3957 | 23050 | 3192 | 23467 | 2559 | 23743 | 1577 | 27568 | 1041 | 20807 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis

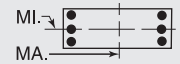



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.03 | MA | 22943 | 5774 | 37830 | 4242 | 41240 | 3415 | 42488 | 2776 | 43602 | 1843 | 52807 | 1181 | 39189 |
| 4L-2S | | MI | 13841 | 5774 | 23244 | 3979 | 24928 | 3170 | 25712 | 2537 | 26724 | 1555 | 31360 | 1262 | 20745 |
| 10-#11 | 1.48 | MA | 23663 | 5207 | 37040 | 3896 | 40428 | 3170 | 41566 | 2634 | 42117 | 1868 | 50090 | 1766 | 20966 |
| 2L-5S | | MI | 11591 | 5207 | 18622 | 3696 | 19393 | 3012 | 19165 | 2488 | 18061 | 1729 | 20738 | 1360 | 10995 |
| 10-#11 | 1.48 | MA | 22780 | 5207 | 35739 | 3894 | 38760 | 3167 | 39531 | 2647 | 39349 | 1878 | 46343 | 1680 | 20988 |
| 3L-4S | | MI | 11870 | 5207 | 19077 | 3704 | 19968 | 3003 | 19852 | 2479 | 19023 | 1738 | 21853 | 1399 | 10945 |
| 10-#11 | 1.48 | MA | 22162 | 5207 | 34681 | 3909 | 37411 | 3181 | 37891 | 2642 | 37238 | 1888 | 43901 | 1593 | 20959 |
| 4L-3S | | MI | 12178 | 5207 | 19598 | 3694 | 20618 | 3012 | 20622 | 2488 | 19980 | 1729 | 22906 | 1479 | 10889 |
| 10-#11 | 1.48 | MA | 21611 | 5207 | 33766 | 3907 | 36225 | 3177 | 36433 | 2655 | 35126 | 1881 | 41358 | 1551 | 20841 |
| 5L-2S | | MI | 12600 | 5207 | 20225 | 3702 | 21408 | 3003 | 21566 | 2479 | 21233 | 1721 | 24525 | 1565 | 10837 |
| 10-#14 | 2.13 | MA | 24954 | 5446 | 39907 | 4033 | 44029 | 3267 | 45930 | 2691 | 48043 | 1843 | 57937 | 1715 | 29833 |
| 2L-5S | | MI | 11736 | 5446 | 19302 | 3818 | 20167 | 3095 | 20073 | 2526 | 19378 | 1699 | 22379 | 1162 | 14829 |
| 10-#14 | 2.13 | MA | 23706 | 5446 | 38045 | 4030 | 41641 | 3262 | 43017 | 2708 | 44080 | 1856 | 52606 | 1590 | 29792 |
| 3L-4S | | MI | 12130 | 5446 | 19950 | 3830 | 20976 | 3083 | 21038 | 2513 | 20620 | 1686 | 23941 | 1218 | 15261 |
| 10-#14 | 2.13 | MA | 22831 | 5446 | 36527 | 4051 | 39707 | 3281 | 40666 | 2701 | 41055 | 1870 | 49136 | 1466 | 29611 |
| 4L-3S | | MI | 12566 | 5446 | 20692 | 3817 | 21891 | 3095 | 22122 | 2526 | 21966 | 1674 | 25419 | 1330 | 15215 |
| 10-#14 | 2.13 | MA | 22050 | 5446 | 35215 | 4047 | 38006 | 3275 | 38575 | 2718 | 38026 | 1859 | 45510 | 1406 | 28471 |
| 5L-2S | | MI | 13160 | 5446 | 21582 | 3829 | 23003 | 3083 | 23451 | 2513 | 23729 | 1661 | 27685 | 1455 | 15153 |
| 10-#18 | 3.79 | MA | 25938 | 6051 | 43758 | 4379 | 48819 | 3551 | 51718 | 2867 | 55817 | 1798 | 68017 | 1351 | 51423 |
| 3L-4S | | MI | 12736 | 6051 | 21983 | 4149 | 23380 | 3284 | 23879 | 2595 | 24449 | 1545 | 28878 | 737 | 24192 |
| 10-#18 | 3.79 | MA | 24444 | 6051 | 41093 | 4415 | 45423 | 3539 | 47591 | 2852 | 50525 | 1820 | 62029 | 1130 | 48777 |
| 4L-3S | | MI | 13478 | 6051 | 23244 | 4127 | 24928 | 3306 | 25712 | 2617 | 26724 | 1523 | 31360 | 928 | 25567 |
| 10-#18 | 3.79 | MA | 23110 | 6051 | 38786 | 4407 | 42432 | 3571 | 43916 | 2880 | 45224 | 1798 | 55734 | 1027 | 46061 |
| 5L-2S | | MI | 14485 | 6051 | 24754 | 4149 | 26805 | 3284 | 27957 | 2595 | 29704 | 1501 | 35152 | 1149 | 25579 |
| 12-#11 | 1.77 | MA | 24274 | 5315 | 38341 | 3964 | 42096 | 3219 | 43601 | 2664 | 44886 | 1860 | 53836 | 1750 | 25044 |
| 2L-6S | | MI | 11604 | 5315 | 18789 | 3773 | 19605 | 3050 | 19457 | 2522 | 18444 | 1720 | 21321 | 1266 | 12707 |
| 12-#11 | 1.77 | MA | 23395 | 5315 | 37040 | 3962 | 40428 | 3215 | 41566 | 2676 | 42117 | 1870 | 50090 | 1663 | 25046 |
| 3L-5S | | MI | 11870 | 5315 | 19249 | 3764 | 20183 | 3059 | 20110 | 2513 | 19313 | 1712 | 22356 | 1324 | 12969 |
| 12-#11 | 1.77 | MA | 22781 | 5315 | 35982 | 3977 | 39079 | 3229 | 39926 | 2671 | 40007 | 1880 | 47648 | 1577 | 24992 |
| 4E | | MI | 12148 | 5315 | 19704 | 3771 | 20757 | 3050 | 20796 | 2505 | 20276 | 1720 | 23472 | 1363 | 12935 |
| 12-#11 | 1.77 | MA | 22232 | 5315 | 35067 | 3974 | 37893 | 3225 | 38468 | 2684 | 37895 | 1873 | 45105 | 1535 | 24849 |
| 5L-3S | | MI | 12455 | 5315 | 20225 | 3762 | 21408 | 3059 | 21566 | 2513 | 21233 | 1712 | 24525 | 1442 | 12889 |
| 12-#11 | 1.77 | MA | 21711 | 5315 | 34210 | 3972 | 36705 | 3239 | 37016 | 2679 | 35982 | 1883 | 42682 | 1479 | 24035 |
| 6L-2S | | MI | 12875 | 5315 | 20852 | 3770 | 22198 | 3050 | 22510 | 2505 | 22485 | 1703 | 26143 | 1528 | 12842 |
| 12-#14 | 2.56 | MA | 24571 | 5601 | 39907 | 4127 | 44029 | 3332 | 45930 | 2751 | 48043 | 1844 | 57937 | 1565 | 35568 |
| 3L-5S | | MI | 12126 | 5601 | 20192 | 3915 | 21279 | 3162 | 21401 | 2561 | 21141 | 1672 | 24646 | 1105 | 17463 |
| 12-#14 | 2.56 | MA | 23702 | 5601 | 38390 | 4148 | 42095 | 3351 | 43580 | 2743 | 45018 | 1857 | 54467 | 1440 | 35345 |
| 4E | | MI | 12519 | 5601 | 20840 | 3927 | 22088 | 3149 | 22367 | 2549 | 22383 | 1659 | 26208 | 1162 | 18042 |
| 12-#14 | 2.56 | MA | 22928 | 5601 | 37078 | 4144 | 40394 | 3345 | 41489 | 2760 | 41990 | 1846 | 50841 | 1381 | 34036 |
| 5L-3S | | MI | 12952 | 5601 | 21582 | 3914 | 23003 | 3162 | 23451 | 2561 | 23729 | 1647 | 27685 | 1274 | 18024 |
| 12-#14 | 2.56 | MA | 22191 | 5601 | 35848 | 4141 | 38690 | 3365 | 39407 | 2753 | 39246 | 1860 | 47396 | 1300 | 32974 |
| 6L-2S | | MI | 13543 | 5601 | 22472 | 3926 | 24114 | 3149 | 24780 | 2549 | 25492 | 1635 | 29952 | 1399 | 17976 |
| 12-#18 | 4.55 | MA | 25924 | 6327 | 44356 | 4588 | 49606 | 3663 | 52694 | 2927 | 57449 | 1797 | 71251 | 1078 | 58412 |
| 4E | | MI | 13387 | 6327 | 23493 | 4319 | 25258 | 3398 | 26124 | 2653 | 27430 | 1491 | 32669 | 625 | 28639 |
| 12-#18 | 4.55 | MA | 24607 | 6327 | 42049 | 4580 | 46615 | 3696 | 49019 | 2955 | 52147 | 1775 | 64956 | 975 | 55849 |
| 5L-3S | | MI | 14124 | 6327 | 24754 | 4297 | 26805 | 3420 | 27957 | 2675 | 29704 | 1469 | 35152 | 815 | 30300 |
| 12-#18 | 4.55 | MA | 23355 | 6327 | 39886 | 4571 | 43620 | 3684 | 45358 | 2940 | 47343 | 1797 | 59003 | 831 | 51854 |
| 6L-2S | | MI | 15124 | 6327 | 26264 | 4319 | 28683 | 3398 | 30203 | 2653 | 32685 | 1447 | 38944 | 1037 | 30388 |
| 14-#11 | 2.07 | MA | 24006 | 5423 | 38341 | 4029 | 42096 | 3264 | 43601 | 2706 | 44886 | 1861 | 53836 | 1647 | 29095 |
| 3L-6S | | MI | 11882 | 5423 | 19416 | 3841 | 20395 | 3097 | 20401 | 2547 | 19697 | 1703 | 22940 | 1229 | 14572 |
| 14-#11 | 2.07 | MA | 23395 | 5423 | 37283 | 4044 | 40747 | 3277 | 41961 | 2701 | 42775 | 1871 | 51395 | 1560 | 29020 |
| 4L-5S | | MI | 12147 | 5423 | 19876 | 3831 | 20972 | 3106 | 21054 | 2539 | 20566 | 1694 | 23975 | 1287 | 14888 |
| 14-#11 | 2.07 | MA | 22850 | 5423 | 36368 | 4042 | 39561 | 3274 | 40503 | 2713 | 40663 | 1864 | 48851 | 1518 | 28802 |
| 5L-4S | | MI | 12424 | 5423 | 20330 | 3839 | 21547 | 3097 | 21740 | 2530 | 21529 | 1703 | 25090 | 1326 | 14914 |
| 14-#11 | 2.07 | MA | 22331 | 5423 | 35511 | 4040 | 38373 | 3288 | 39051 | 2709 | 38750 | 1874 | 46429 | 1463 | 27961 |
| 6L-3S | | MI | 12730 | 5423 | 20852 | 3829 | 22198 | 3106 | 22510 | 2539 | 22485 | 1694 | 26143 | 1406 | 14878 |
| 14-#11 | 2.07 | MA | 21826 | 5423 | 34572 | 4055 | 37240 | 3284 | 37658 | 2721 | 36881 | 1884 | 43845 | 1373 | 27429 |
| 7L-2S | | MI | 13148 | 5423 | 21478 | 3837 | 22988 | 3097 | 23455 | 2530 | 23738 | 1686 | 27762 | 1492 | 14837 |

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

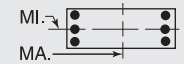
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.98 | MA | 24566 | 5757 | 40253 | 4245 | 44483 | 3421 | 46493 | 2785 | 48982 | 1845 | 59798 | 1415 | 41074 |
| 4L-5S | | MI | 12514 | 5757 | 21082 | 4012 | 22390 | 3228 | 22730 | 2596 | 22904 | 1645 | 26912 | 1049 | 20109 |
| 14-#14 | 2.98 | MA | 23797 | 5757 | 38941 | 4242 | 42782 | 3415 | 44402 | 2803 | 45954 | 1834 | 56172 | 1355 | 39617 |
| 5L-4S | | MI | 12905 | 5757 | 21730 | 4024 | 23199 | 3216 | 23696 | 2584 | 24146 | 1633 | 28474 | 1106 | 20732 |
| 14-#14 | 2.98 | MA | 23066 | 5757 | 37711 | 4238 | 41078 | 3434 | 42320 | 2795 | 43210 | 1847 | 52727 | 1274 | 38602 |
| 6L-3S | | MI | 13336 | 5757 | 22472 | 4011 | 24114 | 3228 | 24780 | 2596 | 25492 | 1620 | 29952 | 1218 | 20820 |
| 14-#14 | 2.98 | MA | 22354 | 5757 | 36363 | 4259 | 39453 | 3429 | 40321 | 2813 | 40528 | 1861 | 49051 | 1144 | 36936 |
| 7L-2S | | MI | 13924 | 5757 | 23363 | 4023 | 25225 | 3216 | 26108 | 2584 | 27255 | 1608 | 32218 | 1343 | 20787 |
| 14-#18 | 5.30 | MA | 26085 | 6604 | 45312 | 4753 | 50798 | 3820 | 54122 | 3031 | 59070 | 1752 | 74177 | 924 | 65658 |
| 5L-4S | | MI | 14034 | 6604 | 25003 | 4489 | 27135 | 3512 | 28369 | 2711 | 30410 | 1437 | 36461 | 512 | 33116 |
| 14-#18 | 5.30 | MA | 24847 | 6604 | 43148 | 4744 | 47802 | 3808 | 50461 | 3015 | 54266 | 1774 | 68225 | 780 | 61504 |
| 6L-3S | | MI | 14766 | 6604 | 26264 | 4467 | 28683 | 3534 | 30203 | 2733 | 32685 | 1415 | 38944 | 703 | 35013 |
| 14-#18 | 5.30 | MA | 23643 | 6604 | 40778 | 4780 | 44943 | 3840 | 46946 | 3044 | 49571 | 1796 | 61869 | 549 | 57525 |
| 7L-2S | | MI | 15759 | 6604 | 27774 | 4489 | 30560 | 3512 | 32448 | 2711 | 35665 | 1393 | 42736 | 924 | 35157 |
| 16-#11 | 2.36 | MA | 24005 | 5531 | 38584 | 4111 | 42415 | 3326 | 43995 | 2730 | 45544 | 1863 | 55141 | 1544 | 33044 |
| 4L-6S | | MI | 12159 | 5531 | 20042 | 3908 | 21185 | 3144 | 21345 | 2573 | 20950 | 1686 | 24559 | 1193 | 16465 |
| 16-#11 | 2.36 | MA | 23463 | 5531 | 37669 | 4109 | 41229 | 3322 | 42538 | 2743 | 43432 | 1855 | 52598 | 1502 | 32698 |
| 5E | | MI | 12423 | 5531 | 20503 | 3899 | 21762 | 3153 | 21998 | 2564 | 21819 | 1677 | 25593 | 1251 | 16702 |
| 16-#11 | 2.36 | MA | 22947 | 5531 | 36812 | 4107 | 40041 | 3336 | 41086 | 2738 | 41519 | 1865 | 50175 | 1446 | 31894 |
| 6L-4S | | MI | 12699 | 5531 | 20957 | 3906 | 22337 | 3144 | 22685 | 2556 | 22782 | 1686 | 26709 | 1290 | 16884 |
| 16-#11 | 2.36 | MA | 22445 | 5531 | 35873 | 4122 | 38908 | 3333 | 39693 | 2751 | 39650 | 1875 | 47592 | 1356 | 31379 |
| 7L-3S | | MI | 13003 | 5531 | 21478 | 3897 | 22988 | 3153 | 23455 | 2564 | 23738 | 1677 | 27762 | 1369 | 16858 |
| 16-#11 | 2.36 | MA | 21951 | 5531 | 35029 | 4120 | 37759 | 3346 | 38333 | 2763 | 37663 | 1868 | 45213 | 1307 | 30391 |
| 8L-2S | | MI | 13421 | 5531 | 22105 | 3904 | 23778 | 3144 | 24399 | 2556 | 24991 | 1669 | 29381 | 1455 | 16823 |
| 16-#14 | 3.41 | MA | 24659 | 5912 | 40804 | 4339 | 45170 | 3485 | 47315 | 2845 | 49917 | 1821 | 61504 | 1330 | 45213 |
| 5E | | MI | 12900 | 5912 | 21972 | 4109 | 23501 | 3295 | 24058 | 2632 | 24667 | 1618 | 29179 | 993 | 22765 |
| 16-#14 | 3.41 | MA | 23934 | 5912 | 39574 | 4335 | 43466 | 3504 | 45233 | 2838 | 47173 | 1835 | 58058 | 1249 | 44238 |
| 6L-4S | | MI | 13289 | 5912 | 22621 | 4121 | 24310 | 3282 | 25024 | 2619 | 25909 | 1606 | 30741 | 1050 | 23336 |
| 16-#14 | 3.41 | MA | 23228 | 5912 | 38226 | 4356 | 41841 | 3499 | 43234 | 2855 | 44492 | 1849 | 54383 | 1119 | 42489 |
| 7L-3S | | MI | 13718 | 5912 | 23363 | 4109 | 25225 | 3295 | 26108 | 2632 | 27255 | 1593 | 32218 | 1162 | 23602 |
| 16-#14 | 3.41 | MA | 22532 | 5912 | 37015 | 4353 | 40192 | 3518 | 41284 | 2873 | 41643 | 1837 | 50993 | 1049 | 40923 |
| 8L-2S | | MI | 14304 | 5912 | 24253 | 4121 | 26337 | 3282 | 27437 | 2619 | 29018 | 1581 | 34485 | 1287 | 23588 |
| 16-#18 | 6.06 | MA | 26323 | 6881 | 46411 | 4917 | 51985 | 3932 | 55564 | 3091 | 61189 | 1751 | 77447 | 728 | 71180 |
| 6L-4S | | MI | 14677 | 6881 | 26513 | 4660 | 29013 | 3626 | 30614 | 2769 | 33391 | 1383 | 40253 | 400 | 37616 |
| 16-#18 | 6.06 | MA | 25132 | 6881 | 44041 | 4953 | 49126 | 3964 | 52049 | 3119 | 56494 | 1773 | 71091 | 497 | 67094 |
| 7L-3S | | MI | 15404 | 6881 | 27774 | 4637 | 30560 | 3648 | 32448 | 2791 | 35665 | 1361 | 42736 | 590 | 39438 |
| 18-#11 | 2.66 | MA | 24072 | 5639 | 38970 | 4177 | 42897 | 3371 | 44572 | 2772 | 46200 | 1847 | 56345 | 1486 | 36604 |
| 5L-6S | | MI | 12435 | 5639 | 20669 | 3976 | 21975 | 3191 | 22289 | 2598 | 22203 | 1668 | 26177 | 1156 | 18360 |
| 18-#11 | 2.66 | MA | 23559 | 5639 | 38113 | 4174 | 41709 | 3384 | 43121 | 2767 | 44287 | 1857 | 53922 | 1430 | 35833 |
| 6L-5S | | MI | 12698 | 5639 | 21129 | 3966 | 22552 | 3200 | 22942 | 2590 | 23072 | 1660 | 27212 | 1214 | 18579 |
| 18-#11 | 2.66 | MA | 23060 | 5639 | 37174 | 4189 | 40576 | 3381 | 41728 | 2780 | 42418 | 1867 | 51338 | 1340 | 35319 |
| 7L-4S | | MI | 12973 | 5639 | 21584 | 3974 | 23127 | 3191 | 23629 | 2581 | 24034 | 1668 | 28328 | 1253 | 18848 |
| 18-#11 | 2.66 | MA | 22568 | 5639 | 36330 | 4187 | 39427 | 3395 | 40368 | 2792 | 40431 | 1860 | 48960 | 1291 | 34293 |
| 8L-3S | | MI | 13276 | 5639 | 22105 | 3964 | 23778 | 3200 | 24399 | 2590 | 24991 | 1660 | 29381 | 1333 | 18831 |
| 18-#11 | 2.66 | MA | 22051 | 5639 | 35505 | 4185 | 38309 | 3391 | 38946 | 2788 | 38579 | 1870 | 46611 | 1237 | 33439 |
| 9L-2S | | MI | 13692 | 5639 | 22732 | 3972 | 24567 | 3191 | 25343 | 2581 | 26244 | 1651 | 30999 | 1419 | 18803 |
| 18-#14 | 3.84 | MA | 24795 | 6068 | 41436 | 4432 | 45854 | 3574 | 48146 | 2880 | 51137 | 1823 | 63390 | 1223 | 49881 |
| 6L-5S | | MI | 13284 | 6068 | 22863 | 4207 | 24613 | 3362 | 25387 | 2667 | 26430 | 1592 | 31446 | 937 | 25427 |
| 18-#14 | 3.84 | MA | 24094 | 6068 | 40089 | 4454 | 44229 | 3568 | 46148 | 2898 | 48456 | 1836 | 59714 | 1094 | 48053 |
| 7L-4S | | MI | 13671 | 6068 | 23511 | 4219 | 25422 | 3349 | 26353 | 2655 | 27672 | 1579 | 33007 | 994 | 25954 |
| 18-#14 | 3.84 | MA | 23404 | 6068 | 38878 | 4450 | 42580 | 3588 | 44197 | 2915 | 45606 | 1825 | 56324 | 1024 | 46427 |
| 8L-3S | | MI | 14098 | 6068 | 24253 | 4206 | 26337 | 3362 | 27437 | 2667 | 29018 | 1567 | 34485 | 1106 | 26369 |
| 18-#14 | 3.84 | MA | 22697 | 6068 | 37575 | 4471 | 40976 | 3582 | 42157 | 2907 | 42949 | 1838 | 52983 | 946 | 44625 |
| 9L-2S | | MI | 14681 | 6068 | 25143 | 4218 | 27448 | 3349 | 28765 | 2655 | 30781 | 1554 | 36752 | 1230 | 26387 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

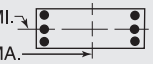
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 6.82 | MA | 26605 | 7157 | 47304 | 5126 | 53309 | 4088 | 57152 | 3194 | 63417 | 1750 | 80313 | 446 | 76686 |
| 7L-4S | | MI | 15316 | 7157 | 28022 | 4830 | 30890 | 3740 | 32860 | 2827 | 36371 | 1329 | 44045 | 287 | 42135 |
| 20-#11 | 2.95 | MA | 24167 | 5746 | 39414 | 4242 | 43377 | 3433 | 45155 | 2797 | 47056 | 1848 | 57669 | 1413 | 39778 |
| 6E | | MI | 12710 | 5746 | 21296 | 4043 | 22765 | 3238 | 23234 | 2624 | 23456 | 1651 | 27796 | 1120 | 20257 |
| 20-#11 | 2.95 | MA | 23671 | 5746 | 38475 | 4257 | 42244 | 3429 | 43762 | 2809 | 45186 | 1858 | 55085 | 1323 | 39198 |
| 7L-5S | | MI | 12972 | 5746 | 21756 | 4034 | 23342 | 3247 | 23887 | 2615 | 24325 | 1643 | 28831 | 1178 | 20461 |
| 20-#11 | 2.95 | MA | 23182 | 5746 | 37632 | 4255 | 41095 | 3443 | 42403 | 2822 | 43200 | 1851 | 52707 | 1274 | 38202 |
| 8L-4S | | MI | 13245 | 5746 | 22211 | 4041 | 23917 | 3238 | 24573 | 2607 | 25287 | 1651 | 29946 | 1217 | 20801 |
| 20-#11 | 2.95 | MA | 22678 | 5746 | 36806 | 4252 | 39977 | 3440 | 40981 | 2817 | 41348 | 1861 | 50358 | 1220 | 37306 |
| 9L-3S | | MI | 13548 | 5746 | 22732 | 4032 | 24567 | 3247 | 25343 | 2615 | 26244 | 1643 | 30999 | 1296 | 20799 |
| 20-#11 | 2.95 | MA | 22127 | 5746 | 35882 | 4267 | 38843 | 3453 | 39628 | 2830 | 39512 | 1871 | 48081 | 1159 | 36212 |
| 10L-2S | | MI | 13962 | 5746 | 23359 | 4039 | 25357 | 3238 | 26287 | 2607 | 27497 | 1634 | 32618 | 1383 | 20777 |
| 20-#14 | 4.26 | MA | 24953 | 6224 | 41952 | 4551 | 46617 | 3638 | 49061 | 2940 | 52419 | 1824 | 65045 | 1068 | 53627 |
| 7L-5S | | MI | 13666 | 6224 | 23753 | 4304 | 25724 | 3428 | 26716 | 2703 | 28193 | 1565 | 33712 | 881 | 28095 |
| 20-#14 | 4.26 | MA | 24268 | 6224 | 40741 | 4547 | 44968 | 3658 | 47110 | 2957 | 49570 | 1812 | 61655 | 998 | 51941 |
| 8L-4S | | MI | 14051 | 6224 | 24401 | 4316 | 26533 | 3416 | 27681 | 2690 | 29435 | 1552 | 35274 | 938 | 28583 |
| 20-#14 | 4.26 | MA | 23562 | 6224 | 39437 | 4568 | 43364 | 3652 | 45070 | 2950 | 46913 | 1826 | 58315 | 920 | 50185 |
| 9L-3S | | MI | 14476 | 6224 | 25143 | 4303 | 27448 | 3428 | 28765 | 2703 | 30781 | 1540 | 36752 | 1050 | 29128 |
| 22-#11 | 3.25 | MA | 24278 | 5854 | 39776 | 4324 | 43912 | 3478 | 45797 | 2839 | 47955 | 1850 | 58832 | 1307 | 43083 |
| 7L-6S | | MI | 12983 | 5854 | 21923 | 4111 | 23555 | 3285 | 24178 | 2650 | 24708 | 1634 | 29414 | 1084 | 22156 |
| 22-#11 | 3.25 | MA | 23792 | 5854 | 38933 | 4322 | 42763 | 3492 | 44437 | 2851 | 45968 | 1842 | 56453 | 1258 | 42115 |
| 8L-5S | | MI | 13244 | 5854 | 22383 | 4101 | 24132 | 3294 | 24831 | 2641 | 25577 | 1625 | 30449 | 1141 | 22347 |
| 22-#11 | 3.25 | MA | 23289 | 5854 | 38107 | 4320 | 41645 | 3488 | 43016 | 2847 | 44116 | 1852 | 54104 | 1204 | 41179 |
| 9L-4S | | MI | 13517 | 5854 | 22838 | 4109 | 24707 | 3285 | 25517 | 2632 | 26540 | 1634 | 31565 | 1180 | 22747 |
| 22-#11 | 3.25 | MA | 22742 | 5854 | 37183 | 4335 | 40511 | 3502 | 41663 | 2859 | 42280 | 1862 | 51828 | 1143 | 40110 |
| 10L-3S | | MI | 13818 | 5854 | 23359 | 4099 | 25357 | 3294 | 26287 | 2641 | 27497 | 1625 | 32618 | 1260 | 22762 |
| 22-#11 | 3.25 | MA | 22217 | 5854 | 36356 | 4333 | 39400 | 3498 | 40259 | 2854 | 40322 | 1855 | 49509 | 1091 | 38813 |
| 11L-2S | | MI | 14231 | 5854 | 23985 | 4107 | 26147 | 3285 | 27232 | 2632 | 28749 | 1617 | 34236 | 1346 | 22747 |
| 22-#14 | 4.69 | MA | 25125 | 6379 | 42604 | 4644 | 47356 | 3727 | 50023 | 3000 | 53534 | 1800 | 66986 | 973 | 57465 |
| 8L-5S | | MI | 14046 | 6379 | 24643 | 4401 | 26836 | 3495 | 28044 | 2738 | 29956 | 1538 | 35979 | 825 | 30767 |
| 22-#14 | 4.69 | MA | 24420 | 6379 | 41300 | 4666 | 45752 | 3722 | 47984 | 2992 | 50877 | 1814 | 63646 | 895 | 55592 |
| 9L-4S | | MI | 14429 | 6379 | 25291 | 4413 | 27645 | 3482 | 29010 | 2726 | 31198 | 1526 | 37541 | 881 | 31221 |
| 24-#11 | 3.55 | MA | 24398 | 5962 | 40234 | 4389 | 44431 | 3540 | 46472 | 2881 | 48737 | 1834 | 60200 | 1241 | 46034 |
| 8L-6S | | MI | 13255 | 5962 | 22550 | 4178 | 24345 | 3332 | 25122 | 2675 | 25961 | 1617 | 31033 | 1047 | 24056 |
| 24-#11 | 3.55 | MA | 23895 | 5962 | 39408 | 4387 | 43313 | 3537 | 45050 | 2876 | 46885 | 1844 | 57851 | 1188 | 45058 |
| 9L-5S | | MI | 13515 | 5962 | 23010 | 4168 | 24922 | 3341 | 25775 | 2666 | 26830 | 1608 | 32068 | 1105 | 24235 |
| 24-#11 | 3.55 | MA | 23354 | 5962 | 38484 | 4402 | 42179 | 3550 | 43698 | 2888 | 45048 | 1854 | 55575 | 1127 | 44012 |
| 10L-4S | | MI | 13787 | 5962 | 23464 | 4176 | 25497 | 3332 | 26462 | 2658 | 27793 | 1617 | 33183 | 1144 | 24669 |
| 24-#11 | 3.55 | MA | 22831 | 5962 | 37657 | 4400 | 41068 | 3547 | 42294 | 2884 | 43090 | 1847 | 53256 | 1074 | 42690 |
| 11L-3S | | MI | 14087 | 5962 | 23985 | 4166 | 26147 | 3341 | 27232 | 2666 | 28749 | 1608 | 34236 | 1223 | 24716 |
| 24-#14 | 5.11 | MA | 25273 | 6535 | 43163 | 4763 | 48140 | 3792 | 50897 | 3035 | 54840 | 1801 | 68977 | 870 | 61087 |
| 9L-5S | | MI | 14424 | 6535 | 25533 | 4498 | 27947 | 3561 | 29373 | 2774 | 31720 | 1511 | 38245 | 769 | 33442 |

## RECTANGULAR TIED COLUMNS 24" x 46"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.45 | MA | 25718 | 5433 | 40374 | 4041 | 43881 | 3288 | 44994 | 2733 | 45414 | 1940 | 53643 | 1822 | 22312 |
| 2E | | MI | 13046 | 5433 | 21007 | 3788 | 21964 | 3065 | 21982 | 2526 | 21436 | 1744 | 24513 | 1565 | 10985 |
| 6-#14 | 1.22 | MA | 25281 | 5347 | 39262 | 4011 | 42610 | 3269 | 43503 | 2726 | 43409 | 1960 | 51181 | 1860 | 19060 |
| 2L-3S | | MI | 12295 | 5347 | 19690 | 3774 | 20461 | 3087 | 20229 | 2561 | 19117 | 1809 | 21629 | 1522 | 9563 |
| 6-#14 | 1.22 | MA | 23945 | 5347 | 37302 | 4008 | 40098 | 3264 | 40437 | 2744 | 39238 | 1975 | 45541 | 1735 | 19107 |
| 3L-2S | | MI | 12895 | 5347 | 20580 | 3786 | 21573 | 3075 | 21558 | 2548 | 20881 | 1796 | 23895 | 1646 | 9479 |
| 6-#18 | 2.17 | MA | 27310 | 5710 | 43810 | 4214 | 48286 | 3412 | 50368 | 2808 | 52725 | 1918 | 63413 | 1774 | 33085 |
| 2L-3S | | MI | 12679 | 5710 | 21007 | 3936 | 21964 | 3201 | 21982 | 2606 | 21436 | 1712 | 24513 | 1231 | 16054 |
| 6-#18 | 2.17 | MA | 25010 | 5710 | 40374 | 4206 | 43881 | 3446 | 44994 | 2838 | 45414 | 1941 | 53643 | 1552 | 32945 |
| 3L-2S | | MI | 13702 | 5710 | 22517 | 3959 | 23842 | 3179 | 24228 | 2584 | 24416 | 1690 | 28305 | 1452 | 15927 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

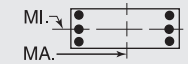
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.13 | MA | 25101 | 5311 | 38794 | 4001 | 42089 | 3264 | 42896 | 2725 | 42596 | 1970 | 50184 | 1876 | 17721 |
| 2L-4S | | MI | 12100 | 5311 | 19227 | 3790 | 19971 | 3082 | 19673 | 2560 | 18451 | 1837 | 20981 | 1515 | 8969 |
| 8-#11 | 1.13 | MA | 24165 | 5311 | 37425 | 3999 | 40334 | 3260 | 40756 | 2738 | 39685 | 1980 | 46223 | 1789 | 17757 |
| 3E | | MI | 12410 | 5311 | 19748 | 3780 | 20621 | 3091 | 20443 | 2569 | 19407 | 1829 | 22034 | 1594 | 8903 |
| 8-#11 | 1.13 | MA | 23511 | 5311 | 36313 | 4015 | 38917 | 3275 | 39033 | 2734 | 37467 | 1991 | 43639 | 1703 | 17759 |
| 4L-2S | | MI | 12833 | 5311 | 20375 | 3788 | 21411 | 3082 | 21387 | 2560 | 20660 | 1820 | 23653 | 1681 | 8849 |
| 8-#14 | 1.63 | MA | 26204 | 5502 | 41222 | 4108 | 45123 | 3339 | 46568 | 2769 | 47579 | 1948 | 56821 | 1836 | 25213 |
| 2L-4S | | MI | 12248 | 5502 | 19838 | 3884 | 20658 | 3141 | 20474 | 2584 | 19535 | 1794 | 22418 | 1353 | 12507 |
| 8-#14 | 1.63 | MA | 24878 | 5502 | 39262 | 4105 | 42610 | 3334 | 43503 | 2787 | 43409 | 1962 | 51181 | 1711 | 25219 |
| 3E | | MI | 12686 | 5502 | 20580 | 3872 | 21573 | 3154 | 21558 | 2596 | 20881 | 1782 | 23895 | 1465 | 12429 |
| 8-#14 | 1.63 | MA | 23950 | 5502 | 37667 | 4127 | 40578 | 3354 | 41032 | 2780 | 40229 | 1976 | 47506 | 1587 | 25087 |
| 4L-2S | | MI | 13284 | 5502 | 21471 | 3884 | 22684 | 3141 | 22886 | 2584 | 22644 | 1770 | 26162 | 1590 | 12351 |
| 8-#18 | 2.90 | MA | 28876 | 5986 | 47246 | 4387 | 52690 | 3537 | 55741 | 2884 | 60036 | 1896 | 73183 | 1725 | 43801 |
| 2L-4S | | MI | 12588 | 5986 | 21255 | 4129 | 22295 | 3293 | 22394 | 2642 | 22142 | 1680 | 25822 | 928 | 20000 |
| 8-#18 | 2.90 | MA | 26603 | 5986 | 43810 | 4379 | 48286 | 3570 | 50368 | 2913 | 52725 | 1919 | 63413 | 1504 | 43542 |
| 3E | | MI | 13337 | 5986 | 22517 | 4107 | 23842 | 3315 | 24228 | 2664 | 24416 | 1658 | 28305 | 1119 | 20881 |
| 8-#18 | 2.90 | MA | 25010 | 5986 | 41007 | 4416 | 44714 | 3559 | 46027 | 2899 | 47138 | 1941 | 57062 | 1282 | 41523 |
| 4L-2S | | MI | 14352 | 5986 | 24026 | 4129 | 25720 | 3293 | 26473 | 2642 | 27397 | 1636 | 32096 | 1340 | 20805 |
| 10-#11 | 1.41 | MA | 25751 | 5419 | 40162 | 4069 | 43843 | 3312 | 45037 | 2755 | 45508 | 1961 | 54144 | 1860 | 22019 |
| 2L-5S | | MI | 12100 | 5419 | 19399 | 3849 | 20186 | 3138 | 19931 | 2595 | 18741 | 1811 | 21485 | 1440 | 11038 |
| 10-#11 | 1.41 | MA | 24820 | 5419 | 38794 | 4067 | 42089 | 3309 | 42896 | 2768 | 42596 | 1971 | 50184 | 1774 | 22041 |
| 3L-4S | | MI | 12379 | 5419 | 19854 | 3857 | 20761 | 3129 | 20617 | 2586 | 19704 | 1820 | 22600 | 1479 | 10982 |
| 10-#11 | 1.41 | MA | 24170 | 5419 | 37682 | 4082 | 40671 | 3323 | 41173 | 2763 | 40379 | 1982 | 47600 | 1688 | 22012 |
| 4L-3S | | MI | 12688 | 5419 | 20375 | 3847 | 21411 | 3138 | 21387 | 2595 | 20660 | 1811 | 23653 | 1558 | 10924 |
| 10-#11 | 1.41 | MA | 23590 | 5419 | 36721 | 4080 | 39425 | 3320 | 39642 | 2776 | 38160 | 1975 | 44915 | 1645 | 21894 |
| 5L-2S | | MI | 13110 | 5419 | 21002 | 3855 | 22201 | 3129 | 22332 | 2586 | 21913 | 1803 | 25272 | 1644 | 10872 |
| 10-#14 | 2.04 | MA | 27119 | 5658 | 43182 | 4206 | 47636 | 3409 | 49633 | 2811 | 51750 | 1935 | 62461 | 1812 | 31352 |
| 2L-5S | | MI | 12245 | 5658 | 20080 | 3970 | 20960 | 3220 | 20837 | 2632 | 20056 | 1780 | 23123 | 1240 | 14960 |
| 10-#14 | 2.04 | MA | 25802 | 5658 | 41222 | 4202 | 45123 | 3404 | 46568 | 2829 | 47579 | 1950 | 56821 | 1687 | 31311 |
| 3L-4S | | MI | 12640 | 5658 | 20729 | 3982 | 21769 | 3208 | 21802 | 2619 | 21298 | 1768 | 24684 | 1297 | 15316 |
| 10-#14 | 2.04 | MA | 24881 | 5658 | 39627 | 4224 | 43090 | 3424 | 44097 | 2822 | 44400 | 1964 | 53146 | 1563 | 31130 |
| 4L-3S | | MI | 13076 | 5658 | 21471 | 3969 | 22684 | 3220 | 22886 | 2632 | 22644 | 1755 | 26162 | 1409 | 15263 |
| 10-#14 | 2.04 | MA | 24059 | 5658 | 38249 | 4221 | 41303 | 3419 | 41901 | 2840 | 41218 | 1953 | 49317 | 1502 | 30061 |
| 5L-2S | | MI | 13670 | 5658 | 22361 | 3981 | 23796 | 3208 | 24215 | 2619 | 24407 | 1743 | 28429 | 1534 | 15197 |
| 10-#18 | 3.62 | MA | 28173 | 6263 | 47246 | 4552 | 52690 | 3694 | 55741 | 2989 | 60036 | 1896 | 73183 | 1455 | 54123 |
| 3L-4S | | MI | 13245 | 6263 | 22765 | 4299 | 24172 | 3407 | 24639 | 2700 | 25122 | 1626 | 29614 | 815 | 24403 |
| 10-#18 | 3.62 | MA | 26599 | 6263 | 44443 | 4589 | 49119 | 3683 | 51400 | 2974 | 54449 | 1919 | 66832 | 1234 | 51630 |
| 4L-3S | | MI | 13989 | 6263 | 24026 | 4277 | 25720 | 3429 | 26473 | 2722 | 27397 | 1604 | 32096 | 1006 | 25654 |
| 10-#18 | 3.62 | MA | 25195 | 6263 | 42018 | 4582 | 45975 | 3716 | 47537 | 3004 | 48854 | 1897 | 60175 | 1130 | 48655 |
| 5L-2S | | MI | 14997 | 6263 | 25536 | 4299 | 27597 | 3407 | 28718 | 2700 | 30377 | 1581 | 35888 | 1227 | 25645 |
| 12-#11 | 1.70 | MA | 26396 | 5527 | 41531 | 4136 | 45597 | 3360 | 47177 | 2784 | 48420 | 1952 | 58105 | 1845 | 26307 |
| 2L-6S | | MI | 12113 | 5527 | 19566 | 3926 | 20399 | 3176 | 20222 | 2629 | 19125 | 1803 | 22068 | 1345 | 12801 |
| 12-#11 | 1.70 | MA | 25470 | 5527 | 40162 | 4134 | 43843 | 3357 | 45037 | 2797 | 45508 | 1963 | 54144 | 1759 | 26310 |
| 3L-5S | | MI | 12379 | 5527 | 20026 | 3917 | 20976 | 3185 | 20875 | 2620 | 19994 | 1794 | 23103 | 1403 | 13017 |
| 12-#11 | 1.70 | MA | 24824 | 5527 | 39050 | 4149 | 42425 | 3371 | 43314 | 2793 | 43291 | 1973 | 51561 | 1672 | 26256 |
| 4E | | MI | 12657 | 5527 | 20481 | 3924 | 21551 | 3176 | 21562 | 2612 | 20956 | 1803 | 24219 | 1442 | 12977 |
| 12-#11 | 1.70 | MA | 24247 | 5527 | 38090 | 4148 | 41179 | 3368 | 41782 | 2806 | 41072 | 1967 | 48876 | 1630 | 26112 |
| 5L-3S | | MI | 12964 | 5527 | 21002 | 3915 | 22201 | 3185 | 22332 | 2620 | 21913 | 1794 | 25272 | 1521 | 12928 |
| 12-#11 | 1.70 | MA | 23699 | 5527 | 37190 | 4146 | 39932 | 3382 | 40258 | 2801 | 39063 | 1977 | 46314 | 1574 | 25327 |
| 6L-2S | | MI | 13385 | 5527 | 21628 | 3922 | 22991 | 3176 | 23276 | 2612 | 23166 | 1785 | 26890 | 1608 | 12881 |
| 12-#14 | 2.45 | MA | 26717 | 5813 | 43182 | 4300 | 47636 | 3474 | 49633 | 2872 | 51750 | 1937 | 62461 | 1663 | 37390 |
| 3L-5S | | MI | 12635 | 5813 | 20971 | 4067 | 22072 | 3287 | 22165 | 2667 | 21819 | 1753 | 25389 | 1184 | 17594 |
| 12-#14 | 2.45 | MA | 25803 | 5813 | 41587 | 4321 | 45603 | 3494 | 47163 | 2865 | 48571 | 1952 | 58786 | 1539 | 37167 |
| 4E | | MI | 13028 | 5813 | 21619 | 4079 | 22881 | 3274 | 23131 | 2655 | 23061 | 1741 | 26951 | 1241 | 18107 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis

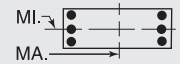



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 2.45 | MA | 24988 | 5813 | 40209 | 4318 | 43816 | 3489 | 44966 | 2883 | 45388 | 1941 | 54957 | 1478 | 35919 |
| 5L-3S | | MI | 13462 | 5813 | 22361 | 4066 | 23796 | 3287 | 24215 | 2667 | 24407 | 1729 | 28429 | 1353 | 18077 |
| 12-#14 | 2.45 | MA | 24213 | 5813 | 38918 | 4315 | 42026 | 3508 | 42779 | 2876 | 42505 | 1955 | 51310 | 1398 | 34761 |
| 6L-2S | | MI | 14054 | 5813 | 23251 | 4078 | 24907 | 3274 | 25544 | 2655 | 26170 | 1716 | 30695 | 1478 | 18025 |
| 12-#18 | 4.35 | MA | 28166 | 6540 | 47879 | 4762 | 53523 | 3807 | 56773 | 3050 | 61760 | 1897 | 76602 | 1186 | 61786 |
| 4E | | MI | 13897 | 6540 | 24275 | 4469 | 26050 | 3521 | 26885 | 2758 | 28103 | 1572 | 33405 | 703 | 28848 |
| 12-#18 | 4.35 | MA | 26779 | 6540 | 45454 | 4754 | 50379 | 3840 | 52910 | 3079 | 56165 | 1875 | 69944 | 1081 | 58970 |
| 5L-3S | | MI | 14636 | 6540 | 25536 | 4447 | 27597 | 3544 | 28718 | 2780 | 30377 | 1550 | 35888 | 893 | 30395 |
| 12-#18 | 4.35 | MA | 25461 | 6540 | 43181 | 4747 | 47231 | 3829 | 49062 | 3065 | 51094 | 1898 | 63635 | 937 | 54955 |
| 6L-2S | | MI | 15638 | 6540 | 27046 | 4469 | 29475 | 3521 | 30963 | 2758 | 33358 | 1527 | 39680 | 1115 | 30465 |
| 14-#11 | 1.98 | MA | 26116 | 5635 | 41531 | 4202 | 45597 | 3406 | 47177 | 2826 | 48420 | 1954 | 58105 | 1743 | 30569 |
| 3L-6S | | MI | 12391 | 5635 | 20193 | 3994 | 21189 | 3223 | 21167 | 2654 | 20378 | 1785 | 23687 | 1309 | 14668 |
| 14-#11 | 1.98 | MA | 25473 | 5635 | 40419 | 4217 | 44180 | 3420 | 45454 | 2822 | 46203 | 1965 | 55522 | 1657 | 30494 |
| 4L-5S | | MI | 12657 | 5635 | 20653 | 3984 | 21766 | 3232 | 21820 | 2646 | 21247 | 1777 | 24722 | 1367 | 14986 |
| 14-#11 | 1.98 | MA | 24900 | 5635 | 39458 | 4215 | 42934 | 3417 | 43922 | 2835 | 43984 | 1958 | 52837 | 1614 | 30327 |
| 5L-4S | | MI | 12934 | 5635 | 21107 | 3992 | 22341 | 3223 | 22506 | 2637 | 22209 | 1785 | 25837 | 1406 | 14960 |
| 14-#11 | 1.98 | MA | 24355 | 5635 | 38558 | 4213 | 41687 | 3431 | 42398 | 2831 | 41975 | 1969 | 50275 | 1559 | 29458 |
| 6L-3S | | MI | 13240 | 5635 | 21628 | 3982 | 22991 | 3232 | 23276 | 2646 | 23166 | 1777 | 26890 | 1485 | 14920 |
| 14-#11 | 1.98 | MA | 23824 | 5635 | 37572 | 4228 | 40497 | 3428 | 40935 | 2843 | 40012 | 1979 | 47543 | 1469 | 28881 |
| 7L-2S | | MI | 13659 | 5635 | 22255 | 3990 | 23781 | 3223 | 24220 | 2637 | 24419 | 1768 | 28509 | 1571 | 14878 |
| 14-#14 | 2.85 | MA | 26716 | 5969 | 43548 | 4419 | 48116 | 3563 | 50228 | 2907 | 52741 | 1939 | 64426 | 1515 | 43201 |
| 4L-5S | | MI | 13024 | 5969 | 21861 | 4164 | 23183 | 3353 | 23494 | 2703 | 23582 | 1727 | 27656 | 1128 | 20241 |
| 14-#14 | 2.85 | MA | 25908 | 5969 | 42169 | 4415 | 46328 | 3558 | 48031 | 2925 | 49559 | 1929 | 60597 | 1454 | 41796 |
| 5L-4S | | MI | 13415 | 5969 | 22509 | 4176 | 23992 | 3341 | 24460 | 2690 | 24824 | 1714 | 29218 | 1185 | 20876 |
| 14-#14 | 2.85 | MA | 25139 | 5969 | 40878 | 4412 | 44539 | 3578 | 45844 | 2918 | 46676 | 1943 | 56950 | 1374 | 40687 |
| 6L-3S | | MI | 13847 | 5969 | 23251 | 4163 | 24907 | 3353 | 25544 | 2703 | 26170 | 1702 | 30695 | 1297 | 20877 |
| 14-#14 | 2.85 | MA | 24390 | 5969 | 39462 | 4434 | 42831 | 3573 | 43745 | 2936 | 43860 | 1957 | 53061 | 1244 | 39054 |
| 7L-2S | | MI | 14436 | 5969 | 24141 | 4175 | 26018 | 3341 | 26872 | 2690 | 27933 | 1689 | 32962 | 1422 | 20839 |
| 14-#18 | 5.07 | MA | 28344 | 6816 | 48890 | 4927 | 54784 | 3964 | 58283 | 3155 | 63476 | 1853 | 79714 | 1033 | 69308 |
| 5L-4S | | MI | 14545 | 6816 | 25785 | 4639 | 27927 | 3636 | 29130 | 2816 | 31083 | 1518 | 37197 | 590 | 33324 |
| 14-#18 | 5.07 | MA | 27041 | 6816 | 46616 | 4920 | 51635 | 3954 | 54435 | 3140 | 58405 | 1876 | 73405 | 889 | 65131 |
| 6L-3S | | MI | 15279 | 6816 | 27046 | 4617 | 29475 | 3658 | 30963 | 2838 | 33358 | 1496 | 39680 | 781 | 35116 |
| 14-#18 | 5.07 | MA | 25773 | 6816 | 44126 | 4957 | 48631 | 3987 | 50742 | 3170 | 53450 | 1898 | 66670 | 658 | 61116 |
| 7L-2S | | MI | 16274 | 6816 | 28556 | 4639 | 31352 | 3636 | 33208 | 2816 | 36338 | 1473 | 43472 | 1002 | 35240 |
| 16-#11 | 2.26 | MA | 26118 | 5743 | 41787 | 4284 | 45934 | 3468 | 47594 | 2851 | 49115 | 1956 | 59482 | 1641 | 34729 |
| 4L-6S | | MI | 12669 | 5743 | 20819 | 4061 | 21979 | 3270 | 22111 | 2680 | 21630 | 1768 | 25306 | 1272 | 16562 |
| 16-#11 | 2.26 | MA | 25548 | 5743 | 40827 | 4282 | 44688 | 3465 | 46063 | 2864 | 46896 | 1949 | 56798 | 1599 | 34482 |
| 5E | | MI | 12933 | 5743 | 21279 | 4052 | 22556 | 3278 | 22764 | 2671 | 22499 | 1759 | 26340 | 1330 | 16874 |
| 16-#11 | 2.26 | MA | 25006 | 5743 | 39927 | 4280 | 43441 | 3479 | 44538 | 2860 | 44887 | 1960 | 54236 | 1543 | 33596 |
| 6L-4S | | MI | 13209 | 5743 | 21734 | 4059 | 23131 | 3270 | 23450 | 2663 | 23462 | 1768 | 27456 | 1369 | 16934 |
| 16-#11 | 2.26 | MA | 24478 | 5743 | 38941 | 4296 | 42251 | 3476 | 43075 | 2873 | 42924 | 1970 | 51504 | 1453 | 33038 |
| 7L-3S | | MI | 13514 | 5743 | 22255 | 4050 | 23781 | 3278 | 24220 | 2671 | 24419 | 1759 | 28509 | 1449 | 16903 |
| 16-#11 | 2.26 | MA | 23958 | 5743 | 38055 | 4294 | 41045 | 3490 | 41648 | 2886 | 40838 | 1964 | 48993 | 1403 | 32080 |
| 8L-2S | | MI | 13932 | 5743 | 22882 | 4057 | 24571 | 3270 | 25165 | 2663 | 25671 | 1751 | 30127 | 1535 | 16867 |
| 16-#14 | 3.26 | MA | 26820 | 6125 | 44129 | 4512 | 48841 | 3628 | 51097 | 2967 | 53730 | 1916 | 66237 | 1430 | 47686 |
| 5E | | MI | 13410 | 6125 | 22751 | 4261 | 24294 | 3420 | 24822 | 2738 | 25345 | 1700 | 29922 | 1072 | 22897 |
| 16-#14 | 3.26 | MA | 26057 | 6125 | 42838 | 4509 | 47051 | 3648 | 48909 | 2961 | 50847 | 1931 | 62590 | 1350 | 46622 |
| 6L-4S | | MI | 13799 | 6125 | 23399 | 4273 | 25103 | 3407 | 25788 | 2726 | 26587 | 1687 | 31484 | 1129 | 23489 |
| 16-#14 | 3.26 | MA | 25313 | 6125 | 41422 | 4531 | 45344 | 3643 | 46810 | 2979 | 48030 | 1945 | 58701 | 1220 | 44903 |
| 7L-3S | | MI | 14229 | 6125 | 24141 | 4261 | 26018 | 3420 | 26872 | 2738 | 27933 | 1675 | 32962 | 1241 | 23667 |
| 16-#14 | 3.26 | MA | 24582 | 6125 | 40151 | 4528 | 43613 | 3663 | 44761 | 2996 | 45037 | 1934 | 55120 | 1149 | 43379 |
| 8L-2S | | MI | 14816 | 6125 | 25032 | 4273 | 27130 | 3407 | 28201 | 2726 | 29696 | 1663 | 35228 | 1365 | 23642 |
| 16-#18 | 5.80 | MA | 28602 | 7093 | 50052 | 5093 | 56040 | 4078 | 59809 | 3216 | 65716 | 1854 | 83175 | 841 | 75332 |
| 6L-4S | | MI | 15188 | 7093 | 27295 | 4809 | 29805 | 3750 | 31375 | 2874 | 34064 | 1464 | 40989 | 477 | 37824 |
| 16-#18 | 5.80 | MA | 27348 | 7093 | 47561 | 5130 | 53035 | 4111 | 56115 | 3245 | 60760 | 1876 | 76439 | 610 | 71211 |
| 7L-3S | | MI | 15917 | 7093 | 28556 | 4787 | 31352 | 3772 | 33208 | 2896 | 36338 | 1441 | 43472 | 668 | 39714 |
| 16-#18 | 5.80 | MA | 26115 | 7093 | 45323 | 5122 | 49988 | 4100 | 52509 | 3275 | 55495 | 1855 | 70216 | 487 | 66573 |
| 8L-2S | | MI | 16907 | 7093 | 30066 | 4809 | 33230 | 3750 | 35454 | 2874 | 39319 | 1419 | 47263 | 890 | 39996 |

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

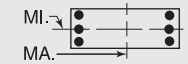
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.54 | MA | 26192 | 5851 | 42195 | 4350 | 46443 | 3514 | 48203 | 2894 | 49808 | 1941 | 60759 | 1583 | 38591 |
| 5L-6S | | MI | 12945 | 5851 | 21446 | 4129 | 22769 | 3317 | 23055 | 2705 | 22883 | 1751 | 26924 | 1236 | 18458 |
| 18-#11 | 2.54 | MA | 25653 | 5851 | 41295 | 4348 | 45195 | 3528 | 46678 | 2889 | 47799 | 1951 | 58196 | 1528 | 37741 |
| 6L-5S | | MI | 13208 | 5851 | 21906 | 4119 | 23346 | 3325 | 23708 | 2697 | 23752 | 1742 | 27959 | 1294 | 18684 |
| 18-#11 | 2.54 | MA | 25128 | 5851 | 40309 | 4363 | 44006 | 3524 | 45215 | 2902 | 45836 | 1962 | 55465 | 1438 | 37200 |
| 7L-4S | | MI | 13483 | 5851 | 22361 | 4127 | 23921 | 3317 | 24394 | 2688 | 24715 | 1751 | 29074 | 1333 | 18901 |
| 18-#11 | 2.54 | MA | 24611 | 5851 | 39423 | 4361 | 42799 | 3539 | 43788 | 2915 | 43750 | 1955 | 52954 | 1388 | 36188 |
| 8L-3S | | MI | 13787 | 5851 | 22882 | 4117 | 24571 | 3325 | 25165 | 2697 | 25671 | 1742 | 30127 | 1412 | 18879 |
| 18-#11 | 2.54 | MA | 24058 | 5851 | 38557 | 4359 | 41626 | 3535 | 42295 | 2911 | 41805 | 1966 | 50469 | 1334 | 35378 |
| 9L-2S | | MI | 14203 | 5851 | 23509 | 4125 | 25361 | 3317 | 26109 | 2688 | 26924 | 1733 | 31746 | 1498 | 18849 |
| 18-#14 | 3.67 | MA | 26967 | 6280 | 44798 | 4606 | 49564 | 3718 | 51975 | 3003 | 55017 | 1918 | 68230 | 1326 | 52563 |
| 6L-5S | | MI | 13794 | 6280 | 23641 | 4359 | 25406 | 3486 | 26151 | 2774 | 27108 | 1673 | 32189 | 1016 | 25560 |
| 18-#14 | 3.67 | MA | 26229 | 6280 | 43382 | 4628 | 47857 | 3713 | 49875 | 3021 | 52201 | 1932 | 64341 | 1196 | 50763 |
| 7L-4S | | MI | 14182 | 6280 | 24290 | 4371 | 26215 | 3474 | 27117 | 2761 | 28350 | 1661 | 33751 | 1073 | 26106 |
| 18-#14 | 3.67 | MA | 25503 | 6280 | 42111 | 4625 | 46125 | 3733 | 47827 | 3039 | 49207 | 1922 | 60760 | 1125 | 49179 |
| 8L-3S | | MI | 14610 | 6280 | 25032 | 4358 | 27130 | 3486 | 28201 | 2774 | 29696 | 1648 | 35228 | 1185 | 26438 |
| 18-#14 | 3.67 | MA | 24749 | 6280 | 40867 | 4622 | 44441 | 3727 | 45684 | 3032 | 46417 | 1936 | 57224 | 1048 | 47214 |
| 9L-2S | | MI | 15194 | 6280 | 25922 | 4370 | 28241 | 3474 | 29529 | 2761 | 31459 | 1636 | 37495 | 1309 | 26438 |
| 18-#18 | 6.52 | MA | 28907 | 7369 | 50997 | 5303 | 57440 | 4235 | 61488 | 3321 | 68071 | 1854 | 86209 | 561 | 81329 |
| 7L-4S | | MI | 15828 | 7369 | 28805 | 4980 | 31682 | 3864 | 33620 | 2932 | 37044 | 1410 | 44781 | 365 | 42342 |
| 18-#18 | 6.52 | MA | 27686 | 7369 | 48759 | 5295 | 54392 | 4224 | 57882 | 3350 | 62805 | 1832 | 79985 | 438 | 76632 |
| 8L-3S | | MI | 16553 | 7369 | 30066 | 4958 | 33230 | 3886 | 35454 | 2954 | 39319 | 1387 | 47263 | 556 | 44079 |
| 20-#11 | 2.83 | MA | 26295 | 5959 | 42664 | 4415 | 46950 | 3576 | 48819 | 2919 | 50711 | 1943 | 62157 | 1512 | 41892 |
| 6E | | MI | 13219 | 5959 | 22073 | 4196 | 23559 | 3364 | 23999 | 2731 | 24136 | 1733 | 28543 | 1199 | 20356 |
| 20-#11 | 2.83 | MA | 25773 | 5959 | 41678 | 4431 | 45760 | 3573 | 47356 | 2932 | 48748 | 1953 | 59425 | 1422 | 41365 |
| 7L-5S | | MI | 13482 | 5959 | 22533 | 4186 | 24136 | 3372 | 24652 | 2722 | 25005 | 1725 | 29578 | 1257 | 20567 |
| 20-#11 | 2.83 | MA | 25260 | 5959 | 40792 | 4429 | 44554 | 3587 | 45928 | 2945 | 46662 | 1946 | 56915 | 1373 | 40302 |
| 8L-4S | | MI | 13756 | 5959 | 22988 | 4194 | 24711 | 3364 | 25339 | 2714 | 25968 | 1733 | 30693 | 1296 | 20862 |
| 20-#11 | 2.83 | MA | 24710 | 5959 | 39926 | 4427 | 43380 | 3584 | 44435 | 2940 | 44717 | 1957 | 54430 | 1319 | 39454 |
| 9L-3S | | MI | 14059 | 5959 | 23509 | 4185 | 25361 | 3372 | 26109 | 2722 | 26924 | 1725 | 31746 | 1376 | 20849 |
| 20-#11 | 2.83 | MA | 24141 | 5959 | 38955 | 4442 | 42190 | 3598 | 43015 | 2953 | 42789 | 1968 | 52022 | 1258 | 38261 |
| 10L-2S | | MI | 14474 | 5959 | 24135 | 4192 | 26151 | 3364 | 27053 | 2714 | 28177 | 1716 | 33365 | 1462 | 20825 |
| 20-#14 | 4.08 | MA | 27138 | 6436 | 45343 | 4725 | 50370 | 3783 | 52941 | 3063 | 56371 | 1920 | 69981 | 1172 | 56633 |
| 7L-5S | | MI | 14177 | 6436 | 24532 | 4456 | 26517 | 3553 | 27480 | 2809 | 28871 | 1646 | 34455 | 960 | 28229 |
| 20-#14 | 4.08 | MA | 26417 | 6436 | 44071 | 4722 | 48638 | 3802 | 50892 | 3081 | 53378 | 1910 | 66400 | 1101 | 54989 |
| 8L-4S | | MI | 14563 | 6436 | 25180 | 4468 | 27326 | 3541 | 28445 | 2797 | 30113 | 1634 | 36017 | 1017 | 28735 |
| 20-#14 | 4.08 | MA | 25664 | 6436 | 42827 | 4719 | 46954 | 3797 | 48749 | 3074 | 50587 | 1924 | 62864 | 1024 | 53071 |
| 9L-3S | | MI | 14989 | 6436 | 25922 | 4455 | 28241 | 3553 | 29529 | 2809 | 31459 | 1621 | 37495 | 1129 | 29201 |
| 20-#14 | 4.08 | MA | 24852 | 6436 | 41435 | 4740 | 45245 | 3817 | 46711 | 3092 | 47820 | 1938 | 59438 | 936 | 50748 |
| 10L-2S | | MI | 15570 | 6436 | 26812 | 4467 | 29352 | 3541 | 30858 | 2797 | 33222 | 1609 | 39761 | 1253 | 29228 |
| 20-#18 | 7.25 | MA | 29242 | 7646 | 52195 | 5468 | 58797 | 4348 | 63256 | 3426 | 70116 | 1810 | 89755 | 390 | 86709 |
| 8L-4S | | MI | 16465 | 7646 | 30314 | 5150 | 33560 | 3978 | 35865 | 2990 | 40025 | 1356 | 48572 | 252 | 46874 |
| 22-#11 | 3.11 | MA | 26415 | 6066 | 43046 | 4498 | 47515 | 3621 | 49496 | 2961 | 51660 | 1945 | 63386 | 1407 | 45484 |
| 7L-6S | | MI | 13493 | 6066 | 22700 | 4263 | 24349 | 3411 | 24944 | 2756 | 25389 | 1716 | 30161 | 1163 | 22257 |
| 22-#11 | 3.11 | MA | 25904 | 6066 | 42161 | 4496 | 46308 | 3635 | 48068 | 2974 | 49574 | 1938 | 60876 | 1357 | 44421 |
| 8L-5S | | MI | 13755 | 6066 | 23160 | 4254 | 24926 | 3419 | 25597 | 2748 | 26258 | 1707 | 31196 | 1221 | 22453 |
| 22-#11 | 3.11 | MA | 25368 | 6066 | 41294 | 4494 | 45134 | 3632 | 46575 | 2970 | 47629 | 1948 | 58391 | 1304 | 43532 |
| 9L-4S | | MI | 14028 | 6066 | 23614 | 4262 | 25501 | 3411 | 26283 | 2739 | 27220 | 1716 | 32312 | 1260 | 22811 |
| 22-#11 | 3.11 | MA | 24792 | 6066 | 40324 | 4509 | 43944 | 3646 | 45155 | 2983 | 45701 | 1959 | 55983 | 1243 | 42365 |
| 10L-3S | | MI | 14330 | 6066 | 24135 | 4252 | 26151 | 3419 | 27053 | 2748 | 28177 | 1707 | 33365 | 1339 | 22815 |
| 22-#11 | 3.11 | MA | 24239 | 6066 | 39456 | 4507 | 42777 | 3643 | 43681 | 2978 | 43644 | 1952 | 53535 | 1190 | 41083 |
| 11L-2S | | MI | 14743 | 6066 | 24762 | 4260 | 26941 | 3411 | 27997 | 2739 | 29430 | 1699 | 34983 | 1426 | 22797 |
| 22-#14 | 4.48 | MA | 27324 | 6591 | 46031 | 4819 | 51151 | 3872 | 53957 | 3124 | 57549 | 1897 | 72040 | 1078 | 60808 |
| 8L-5S | | MI | 14557 | 6591 | 25422 | 4553 | 27629 | 3620 | 28808 | 2844 | 30634 | 1620 | 36722 | 904 | 30902 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 24" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

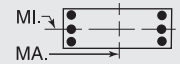
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 4.48 | MA | 26572 | 6591 | 44787 | 4816 | 49466 | 3867 | 51815 | 3117 | 54758 | 1911 | 68504 | 1000 | 58935 |
| 9L-4S | | MI | 14941 | 6591 | 26070 | 4565 | 28438 | 3607 | 29774 | 2832 | 31876 | 1607 | 38284 | 960 | 31372 |
| 22-#14 | 4.48 | MA | 25796 | 6591 | 43395 | 4838 | 47758 | 3887 | 49777 | 3135 | 51991 | 1926 | 65078 | 912 | 56576 |
| 10L-3S | | MI | 15366 | 6591 | 26812 | 4552 | 29352 | 3620 | 30858 | 2844 | 33222 | 1595 | 39761 | 1072 | 31957 |
| 24-#11 | 3.39 | MA | 26545 | 6174 | 43529 | 4563 | 48062 | 3684 | 50208 | 3003 | 52486 | 1929 | 64836 | 1342 | 48546 |
| 8L-6S | | MI | 13766 | 6174 | 23326 | 4331 | 25139 | 3458 | 25888 | 2782 | 26642 | 1699 | 31780 | 1126 | 24158 |
| 24-#11 | 3.39 | MA | 26009 | 6174 | 42663 | 4562 | 46889 | 3681 | 48715 | 2999 | 50541 | 1940 | 62352 | 1288 | 47616 |
| 9L-5S | | MI | 14026 | 6174 | 23786 | 4321 | 25716 | 3466 | 26541 | 2773 | 27511 | 1690 | 32815 | 1184 | 24342 |
| 24-#11 | 3.39 | MA | 25438 | 6174 | 41692 | 4577 | 45698 | 3695 | 47295 | 3012 | 48613 | 1950 | 59944 | 1227 | 46473 |
| 10L-4S | | MI | 14299 | 6174 | 24241 | 4329 | 26291 | 3458 | 27227 | 2765 | 28473 | 1699 | 33930 | 1223 | 24756 |
| 24-#11 | 3.39 | MA | 24888 | 6174 | 40824 | 4575 | 44531 | 3692 | 45821 | 3008 | 46556 | 1944 | 57495 | 1175 | 45165 |
| 11L-3S | | MI | 14600 | 6174 | 24762 | 4319 | 26941 | 3466 | 27997 | 2773 | 29430 | 1690 | 34983 | 1303 | 24777 |
| 24-#11 | 3.39 | MA | 24348 | 6174 | 39871 | 4590 | 43349 | 3706 | 44404 | 3021 | 44629 | 1954 | 54737 | 1098 | 43927 |
| 12L-2S | | MI | 15012 | 6174 | 25389 | 4327 | 27731 | 3458 | 28942 | 2765 | 30683 | 1681 | 36602 | 1389 | 24765 |
| 24-#14 | 4.89 | MA | 27473 | 6747 | 46747 | 4913 | 51979 | 3937 | 54880 | 3159 | 58929 | 1899 | 74144 | 976 | 64730 |
| 9L-5S | | MI | 14936 | 6747 | 26312 | 4650 | 28740 | 3686 | 30137 | 2880 | 32397 | 1593 | 38989 | 847 | 33578 |
| 24-#14 | 4.89 | MA | 26702 | 6747 | 45355 | 4935 | 50271 | 3957 | 52842 | 3177 | 56162 | 1913 | 70718 | 888 | 62410 |
| 10L-4S | | MI | 15319 | 6747 | 26960 | 4662 | 29549 | 3674 | 31103 | 2867 | 33639 | 1580 | 40551 | 904 | 34016 |

## RECTANGULAR TIED COLUMNS 24" x 48"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.39 | MA | 27894 | 5645 | 43636 | 4213 | 47441 | 3430 | 48608 | 2853 | 48938 | 2033 | 57849 | 1917 | 23392 |
| 2E | | MI | 13556 | 5645 | 21789 | 3938 | 22756 | 3188 | 22743 | 2630 | 22108 | 1824 | 25249 | 1643 | 11029 |
| 6-#14 | 1.17 | MA | 27429 | 5559 | 42463 | 4184 | 46100 | 3411 | 47033 | 2847 | 46822 | 2053 | 55224 | 1953 | 19971 |
| 2L-3S | | MI | 12804 | 5559 | 20469 | 3926 | 21254 | 3212 | 20993 | 2667 | 19795 | 1890 | 22372 | 1600 | 9598 |
| 6-#14 | 1.17 | MA | 26025 | 5559 | 40406 | 4181 | 43462 | 3407 | 43816 | 2865 | 42444 | 2068 | 49275 | 1829 | 20018 |
| 3L-2S | | MI | 13405 | 5559 | 21359 | 3938 | 22366 | 3200 | 22322 | 2654 | 21558 | 1878 | 24639 | 1725 | 9513 |
| 6-#18 | 2.08 | MA | 29575 | 5922 | 47245 | 4386 | 52067 | 3554 | 54252 | 2929 | 56617 | 2011 | 68168 | 1871 | 34705 |
| 2L-3S | | MI | 13189 | 5922 | 21789 | 4086 | 22756 | 3324 | 22743 | 2710 | 22108 | 1792 | 25249 | 1309 | 16114 |
| 6-#18 | 2.08 | MA | 27155 | 5922 | 43636 | 4380 | 47441 | 3588 | 48608 | 2960 | 48938 | 2035 | 57849 | 1650 | 34565 |
| 3L-2S | | MI | 14213 | 5922 | 23299 | 4108 | 24634 | 3302 | 24988 | 2688 | 25089 | 1770 | 29041 | 1530 | 15979 |
| 8-#11 | 1.08 | MA | 27238 | 5523 | 41969 | 4174 | 45549 | 3405 | 46393 | 2846 | 45965 | 2062 | 54160 | 1969 | 18563 |
| 2L-4S | | MI | 12609 | 5523 | 20004 | 3942 | 20765 | 3208 | 20439 | 2667 | 19131 | 1919 | 21728 | 1594 | 8999 |
| 8-#11 | 1.08 | MA | 26255 | 5523 | 40533 | 4172 | 43708 | 3403 | 44148 | 2859 | 42909 | 2073 | 49985 | 1883 | 18600 |
| 3E | | MI | 12919 | 5523 | 20525 | 3933 | 21415 | 3216 | 21209 | 2676 | 20088 | 1911 | 22781 | 1674 | 8933 |
| 8-#11 | 1.08 | MA | 25568 | 5523 | 39368 | 4187 | 42222 | 3417 | 42341 | 2855 | 40585 | 2084 | 47259 | 1796 | 18602 |
| 4L-2S | | MI | 13343 | 5523 | 21152 | 3941 | 22205 | 3208 | 22153 | 2667 | 21341 | 1902 | 24400 | 1760 | 8880 |
| 8-#14 | 1.56 | MA | 28403 | 5714 | 44521 | 4281 | 48737 | 3481 | 50251 | 2889 | 51200 | 2040 | 61173 | 1931 | 26428 |
| 2L-4S | | MI | 12757 | 5714 | 20617 | 4036 | 21451 | 3266 | 21238 | 2690 | 20212 | 1876 | 23161 | 1432 | 12553 |
| 8-#14 | 1.56 | MA | 27009 | 5714 | 42463 | 4278 | 46100 | 3476 | 47033 | 2908 | 46822 | 2055 | 55224 | 1806 | 26434 |
| 3E | | MI | 13196 | 5714 | 21359 | 4023 | 22366 | 3279 | 22322 | 2702 | 21558 | 1864 | 24639 | 1544 | 12470 |
| 8-#14 | 1.56 | MA | 26034 | 5714 | 40791 | 4300 | 43968 | 3497 | 44443 | 2901 | 43488 | 2070 | 51344 | 1682 | 26302 |
| 4L-2S | | MI | 13794 | 5714 | 22249 | 4035 | 23477 | 3266 | 23650 | 2690 | 23322 | 1851 | 26905 | 1669 | 12391 |
| 8-#18 | 2.78 | MA | 31230 | 6198 | 50854 | 4559 | 56693 | 3678 | 59895 | 3004 | 64296 | 1989 | 78486 | 1826 | 45961 |
| 2L-4S | | MI | 13097 | 6198 | 22037 | 4279 | 23086 | 3416 | 23155 | 2746 | 22814 | 1760 | 26558 | 1006 | 20210 |
| 8-#18 | 2.78 | MA | 28836 | 6198 | 47245 | 4552 | 52067 | 3712 | 54252 | 3035 | 56617 | 2013 | 68168 | 1604 | 45702 |
| 3E | | MI | 13847 | 6198 | 23299 | 4257 | 24634 | 3439 | 24988 | 2769 | 25089 | 1738 | 29041 | 1196 | 20950 |
| 8-#18 | 2.78 | MA | 27162 | 6198 | 44305 | 4590 | 48320 | 3702 | 49697 | 3021 | 50756 | 2036 | 61453 | 1383 | 43881 |
| 4L-2S | | MI | 14864 | 6198 | 24809 | 4279 | 26511 | 3416 | 27233 | 2746 | 28069 | 1716 | 32832 | 1418 | 20864 |
| 10-#11 | 1.35 | MA | 27923 | 5631 | 43405 | 4241 | 47390 | 3454 | 48639 | 2875 | 49020 | 2053 | 58335 | 1954 | 23072 |
| 2L-5S | | MI | 12609 | 5631 | 20176 | 4002 | 20980 | 3263 | 20697 | 2701 | 19421 | 1893 | 22231 | 1519 | 11078 |
| 10-#11 | 1.35 | MA | 26945 | 5631 | 41969 | 4239 | 45549 | 3451 | 46393 | 2888 | 45965 | 2064 | 54160 | 1868 | 23094 |
| 3L-4S | | MI | 12889 | 5631 | 20631 | 4010 | 21555 | 3255 | 21383 | 2693 | 20384 | 1902 | 23347 | 1558 | 11019 |
| 10-#11 | 1.35 | MA | 26263 | 5631 | 40803 | 4255 | 44063 | 3465 | 44587 | 2884 | 43640 | 2075 | 51434 | 1782 | 23065 |
| 4L-3S | | MI | 13197 | 5631 | 21152 | 4000 | 22205 | 3263 | 22153 | 2701 | 21341 | 1893 | 24400 | 1637 | 10959 |
| 10-#11 | 1.35 | MA | 25654 | 5631 | 39797 | 4253 | 42757 | 3463 | 42982 | 2898 | 41315 | 2069 | 48608 | 1739 | 22947 |
| 5L-2S | | MI | 13620 | 5631 | 21778 | 4008 | 22995 | 3255 | 23097 | 2693 | 22593 | 1885 | 26018 | 1724 | 10907 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



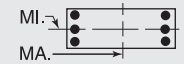

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.95 | MA | 29368 | 5870 | 46578 | 4378 | 51374 | 3551 | 53468 | 2932 | 55577 | 2028 | 67121 | 1908 | 32871 |
| 2L-5S | | MI | 12753 | 5870 | 20859 | 4122 | 21753 | 3345 | 21601 | 2738 | 20734 | 1862 | 23866 | 1319 | 15088 |
| 10-#14 | 1.95 | MA | 27983 | 5870 | 44521 | 4375 | 48737 | 3546 | 50251 | 2950 | 51200 | 2043 | 61173 | 1784 | 32829 |
| 3L-4S | | MI | 13149 | 5870 | 21507 | 4134 | 22562 | 3333 | 22566 | 2725 | 21976 | 1849 | 25428 | 1376 | 15369 |
| 10-#14 | 1.95 | MA | 27016 | 5870 | 42848 | 4397 | 46605 | 3567 | 47660 | 2944 | 47866 | 2058 | 57293 | 1659 | 32648 |
| 4L-3S | | MI | 13585 | 5870 | 22249 | 4121 | 23477 | 3345 | 23650 | 2738 | 23322 | 1837 | 26905 | 1488 | 15310 |
| 10-#14 | 1.95 | MA | 26154 | 5870 | 41404 | 4394 | 44732 | 3562 | 45357 | 2962 | 44529 | 2048 | 53260 | 1598 | 31661 |
| 5L-2S | | MI | 14181 | 5870 | 23140 | 4133 | 24589 | 3333 | 24979 | 2725 | 25085 | 1824 | 29172 | 1613 | 15241 |
| 10-#18 | 3.47 | MA | 30494 | 6475 | 50854 | 4725 | 56693 | 3837 | 59895 | 3110 | 64296 | 1990 | 78486 | 1559 | 56823 |
| 3L-4S | | MI | 13754 | 6475 | 23547 | 4449 | 24964 | 3531 | 25400 | 2805 | 25795 | 1706 | 30350 | 893 | 24610 |
| 10-#18 | 3.47 | MA | 28839 | 6475 | 47914 | 4763 | 52946 | 3827 | 55341 | 3097 | 58434 | 2014 | 71771 | 1337 | 54509 |
| 4L-3S | | MI | 14500 | 6475 | 24809 | 4427 | 26511 | 3553 | 27233 | 2827 | 28069 | 1684 | 32832 | 1084 | 25738 |
| 10-#18 | 3.47 | MA | 27365 | 6475 | 45371 | 4756 | 49649 | 3861 | 51289 | 3128 | 52566 | 1994 | 64752 | 1231 | 51263 |
| 5L-2S | | MI | 15510 | 6475 | 26318 | 4449 | 28389 | 3531 | 29478 | 2805 | 31050 | 1662 | 36624 | 1305 | 25711 |
| 12-#11 | 1.63 | MA | 28604 | 5739 | 44841 | 4309 | 49230 | 3502 | 50885 | 2905 | 52076 | 2045 | 62510 | 1940 | 27571 |
| 2L-6S | | MI | 12622 | 5739 | 20343 | 4079 | 21193 | 3302 | 20988 | 2736 | 19805 | 1885 | 22815 | 1425 | 12893 |
| 12-#11 | 1.63 | MA | 27630 | 5739 | 43405 | 4307 | 47390 | 3499 | 48639 | 2918 | 49020 | 2056 | 58335 | 1853 | 27573 |
| 3L-5S | | MI | 12888 | 5739 | 20803 | 4070 | 21770 | 3310 | 21641 | 2727 | 20674 | 1876 | 23850 | 1483 | 13063 |
| 12-#11 | 1.63 | MA | 26952 | 5739 | 42239 | 4322 | 45904 | 3514 | 46833 | 2914 | 46696 | 2067 | 55609 | 1767 | 27519 |
| 4E | | MI | 13167 | 5739 | 21257 | 4077 | 22345 | 3302 | 22327 | 2718 | 21637 | 1885 | 24966 | 1522 | 13018 |
| 12-#11 | 1.63 | MA | 26347 | 5739 | 41233 | 4321 | 44598 | 3511 | 45228 | 2927 | 44370 | 2061 | 52784 | 1724 | 27376 |
| 5L-3S | | MI | 13474 | 5739 | 21778 | 4068 | 22995 | 3310 | 23097 | 2727 | 22593 | 1876 | 26018 | 1601 | 12967 |
| 12-#11 | 1.63 | MA | 25772 | 5739 | 40290 | 4319 | 43291 | 3525 | 43630 | 2923 | 42265 | 2072 | 50081 | 1669 | 26624 |
| 6L-2S | | MI | 13895 | 5739 | 22405 | 4075 | 23785 | 3302 | 24042 | 2718 | 23846 | 1867 | 27637 | 1687 | 12918 |
| 12-#14 | 2.34 | MA | 28948 | 6025 | 46578 | 4472 | 51374 | 3616 | 53468 | 2993 | 55577 | 2030 | 67121 | 1761 | 39213 |
| 3L-5S | | MI | 13144 | 6026 | 21749 | 4219 | 22865 | 3412 | 22929 | 2773 | 22497 | 1835 | 26132 | 1263 | 17722 |
| 12-#14 | 2.34 | MA | 27989 | 6025 | 44906 | 4494 | 49243 | 3636 | 50877 | 2986 | 52243 | 2046 | 63242 | 1636 | 38990 |
| 4E | | MI | 13538 | 6025 | 22397 | 4231 | 23674 | 3399 | 23895 | 2761 | 23739 | 1823 | 27694 | 1320 | 18166 |
| 12-#14 | 2.34 | MA | 27133 | 6025 | 43461 | 4491 | 47369 | 3632 | 48575 | 3005 | 48907 | 2036 | 59209 | 1575 | 37815 |
| 5L-3S | | MI | 13973 | 6025 | 23140 | 4218 | 24589 | 3412 | 24979 | 2773 | 25085 | 1810 | 29172 | 1432 | 18128 |
| 12-#14 | 2.34 | MA | 26320 | 6026 | 42108 | 4489 | 45494 | 3652 | 46282 | 2998 | 45886 | 2051 | 55361 | 1495 | 36556 |
| 6L-2S | | MI | 14565 | 6025 | 24030 | 4230 | 25700 | 3399 | 26308 | 2761 | 26848 | 1798 | 31438 | 1557 | 18072 |
| 12-#18 | 4.17 | MA | 30495 | 6752 | 51522 | 4936 | 57572 | 3951 | 60984 | 3172 | 66113 | 1992 | 82089 | 1292 | 65184 |
| 4E | | MI | 14407 | 6752 | 25057 | 4619 | 26841 | 3645 | 27645 | 2863 | 28775 | 1652 | 34141 | 780 | 29054 |
| 12-#18 | 4.17 | MA | 29037 | 6752 | 48980 | 4929 | 54275 | 3985 | 56933 | 3203 | 60245 | 1972 | 75070 | 1186 | 62106 |
| 5L-3S | | MI | 15147 | 6752 | 26318 | 4597 | 28389 | 3667 | 29478 | 2885 | 31050 | 1630 | 36624 | 971 | 30488 |
| 12-#18 | 4.17 | MA | 27652 | 6752 | 46597 | 4922 | 50974 | 3975 | 52898 | 3189 | 54927 | 1996 | 68403 | 1042 | 58087 |
| 6L-2S | | MI | 16151 | 6752 | 27828 | 4619 | 30266 | 3645 | 31724 | 2863 | 34030 | 1608 | 40416 | 1193 | 30530 |
| 14-#11 | 1.90 | MA | 28311 | 5847 | 44841 | 4374 | 49230 | 3548 | 50885 | 2947 | 52076 | 2047 | 62510 | 1839 | 32043 |
| 3L-6S | | MI | 12900 | 5847 | 20969 | 4147 | 21983 | 3349 | 21932 | 2761 | 21058 | 1867 | 24434 | 1388 | 14792 |
| 14-#11 | 1.90 | MA | 27636 | 5847 | 43675 | 4390 | 47744 | 3562 | 49078 | 2943 | 49751 | 2058 | 59785 | 1753 | 31969 |
| 4L-5S | | MI | 13166 | 5847 | 21430 | 4137 | 22560 | 3357 | 22585 | 2753 | 21927 | 1859 | 25469 | 1446 | 15037 |
| 14-#11 | 1.90 | MA | 27035 | 5847 | 42669 | 4388 | 46439 | 3559 | 47474 | 2956 | 47426 | 2052 | 56959 | 1710 | 31802 |
| 5L-4S | | MI | 13444 | 5847 | 21884 | 4145 | 23135 | 3349 | 23272 | 2744 | 22890 | 1867 | 26584 | 1485 | 15005 |
| 14-#11 | 1.90 | MA | 26463 | 5847 | 41726 | 4386 | 45132 | 3574 | 45876 | 2952 | 45320 | 2063 | 54256 | 1654 | 30960 |
| 6L-3S | | MI | 13750 | 5847 | 22405 | 4135 | 23785 | 3357 | 24042 | 2753 | 23846 | 1859 | 27637 | 1564 | 14962 |
| 14-#11 | 1.90 | MA | 25906 | 5847 | 40693 | 4402 | 43886 | 3571 | 44343 | 2966 | 43264 | 2074 | 51377 | 1564 | 30337 |
| 7L-2S | | MI | 14170 | 5847 | 23032 | 4143 | 24575 | 3349 | 24986 | 2744 | 25099 | 1850 | 29256 | 1651 | 14918 |
| 14-#14 | 2.73 | MA | 28952 | 6181 | 46963 | 4592 | 51880 | 3706 | 54095 | 3029 | 56621 | 2033 | 69191 | 1614 | 45327 |
| 4L-5S | | MI | 13533 | 6181 | 22640 | 4316 | 23976 | 3478 | 24258 | 2809 | 24260 | 1808 | 28399 | 1207 | 20369 |
| 14-#14 | 2.73 | MA | 28104 | 6181 | 45518 | 4589 | 50007 | 3702 | 51792 | 3047 | 53285 | 2023 | 65158 | 1553 | 43986 |
| 5L-4S | | MI | 13925 | 6181 | 23288 | 4328 | 24785 | 3466 | 25224 | 2796 | 25502 | 1796 | 29961 | 1264 | 20944 |
| 14-#14 | 2.73 | MA | 27297 | 6181 | 44165 | 4586 | 48131 | 3722 | 49500 | 3041 | 50263 | 2038 | 61309 | 1472 | 42780 |
| 6L-3S | | MI | 14358 | 6181 | 24030 | 4315 | 25700 | 3478 | 26308 | 2809 | 26848 | 1783 | 31438 | 1376 | 20932 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis

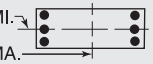


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.73 | MA | 26511 | 6181 | 42682 | 4608 | 46342 | 3717 | 47300 | 3059 | 47311 | 2053 | 57207 | 1343 | 41190 |
| 7L-2S | | MI | 14948 | 6181 | 24920 | 4327 | 26811 | 3466 | 27636 | 2796 | 28611 | 1771 | 33705 | 1500 | 20890 |
| 14-#18 | 4.86 | MA | 30689 | 7028 | 52589 | 5102 | 58901 | 4109 | 62577 | 3278 | 67923 | 1950 | 85389 | 1140 | 72973 |
| 5L-4S | | MI | 15055 | 7028 | 26567 | 4789 | 28719 | 3759 | 29890 | 2921 | 31756 | 1598 | 37933 | 668 | 33528 |
| 14-#18 | 4.86 | MA | 29320 | 7028 | 50205 | 5095 | 55600 | 4099 | 58542 | 3265 | 62606 | 1974 | 78721 | 996 | 68789 |
| 6L-3S | | MI | 15791 | 7028 | 27828 | 4767 | 30266 | 3781 | 31724 | 2943 | 34030 | 1576 | 40416 | 859 | 35216 |
| 14-#18 | 4.86 | MA | 27988 | 7028 | 47594 | 5133 | 52450 | 4133 | 54669 | 3296 | 57410 | 1998 | 71607 | 766 | 64753 |
| 7L-2S | | MI | 16788 | 7028 | 29338 | 4789 | 32144 | 3759 | 33969 | 2921 | 37011 | 1554 | 44208 | 1080 | 35321 |
| 16-#11 | 2.17 | MA | 28316 | 5955 | 45111 | 4457 | 49585 | 3611 | 51324 | 2973 | 52807 | 2050 | 63960 | 1738 | 36413 |
| 4L-6S | | MI | 13178 | 5955 | 21596 | 4214 | 22773 | 3396 | 22877 | 2787 | 22311 | 1850 | 26052 | 1352 | 16656 |
| 16-#11 | 2.17 | MA | 27718 | 5955 | 44105 | 4456 | 48280 | 3608 | 49719 | 2986 | 50481 | 2043 | 61134 | 1695 | 36226 |
| 5E | | MI | 13443 | 5955 | 22056 | 4205 | 23350 | 3404 | 23529 | 2778 | 23180 | 1841 | 27087 | 1410 | 16974 |
| 16-#11 | 2.17 | MA | 27150 | 5955 | 43162 | 4454 | 46973 | 3622 | 48122 | 2982 | 48376 | 2054 | 58432 | 1639 | 35305 |
| 6L-4S | | MI | 13719 | 5955 | 22511 | 4212 | 23925 | 3396 | 24216 | 2769 | 24142 | 1850 | 28203 | 1449 | 16982 |
| 16-#11 | 2.17 | MA | 26596 | 5955 | 42129 | 4469 | 45727 | 3619 | 46589 | 2995 | 46319 | 2065 | 55552 | 1550 | 34702 |
| 7L-3S | | MI | 14025 | 5955 | 23032 | 4203 | 24575 | 3404 | 24986 | 2778 | 25099 | 1841 | 29256 | 1528 | 16948 |
| 16-#11 | 2.17 | MA | 26051 | 5955 | 41201 | 4468 | 44463 | 3634 | 45093 | 3008 | 44133 | 2059 | 52909 | 1499 | 33781 |
| 8L-2S | | MI | 14443 | 5955 | 23659 | 4210 | 25365 | 3396 | 25930 | 2769 | 26352 | 1833 | 30874 | 1614 | 16909 |
| 16-#14 | 3.13 | MA | 29066 | 6337 | 47576 | 4686 | 52644 | 3771 | 55010 | 3090 | 57662 | 2011 | 71106 | 1530 | 50172 |
| 5E | | MI | 13920 | 6337 | 23530 | 4413 | 25087 | 3545 | 25586 | 2844 | 26023 | 1781 | 30666 | 1151 | 23026 |
| 16-#14 | 3.13 | MA | 28265 | 6337 | 46222 | 4683 | 50768 | 3792 | 52717 | 3083 | 54641 | 2026 | 67258 | 1450 | 49013 |
| 6L-4S | | MI | 14310 | 6337 | 24178 | 4425 | 25896 | 3532 | 26552 | 2832 | 27265 | 1769 | 32227 | 1208 | 23638 |
| 16-#14 | 3.13 | MA | 27485 | 6337 | 44739 | 4705 | 48980 | 3787 | 50517 | 3102 | 51689 | 2041 | 63155 | 1320 | 47335 |
| 7L-3S | | MI | 14741 | 6337 | 24920 | 4412 | 26811 | 3545 | 27636 | 2844 | 28611 | 1757 | 33705 | 1320 | 23731 |
| 16-#14 | 3.13 | MA | 26717 | 6337 | 43407 | 4702 | 47165 | 3807 | 48370 | 3120 | 48552 | 2031 | 59384 | 1249 | 45824 |
| 8L-2S | | MI | 15328 | 6337 | 25810 | 4424 | 27923 | 3532 | 28965 | 2832 | 30374 | 1744 | 35972 | 1444 | 23696 |
| 16-#18 | 5.56 | MA | 30968 | 7305 | 53814 | 5268 | 60226 | 4223 | 64185 | 3340 | 70285 | 1952 | 89039 | 951 | 79516 |
| 6L-4S | | MI | 15700 | 7305 | 28077 | 4959 | 30596 | 3873 | 32135 | 2979 | 34736 | 1544 | 41725 | 555 | 38027 |
| 16-#18 | 5.56 | MA | 29651 | 7305 | 51203 | 5306 | 57076 | 4257 | 60312 | 3371 | 65089 | 1976 | 81925 | 720 | 75376 |
| 7L-3S | | MI | 16431 | 7305 | 29338 | 4937 | 32144 | 3895 | 33969 | 3001 | 37011 | 1522 | 44208 | 746 | 39929 |
| 16-#18 | 5.56 | MA | 28355 | 7305 | 48856 | 5299 | 53881 | 4247 | 56532 | 3402 | 59567 | 1955 | 75362 | 595 | 70660 |
| 8L-2S | | MI | 17422 | 7305 | 30848 | 4959 | 34021 | 3873 | 36214 | 2979 | 39992 | 1500 | 47999 | 967 | 40083 |
| 18-#11 | 2.44 | MA | 28397 | 6063 | 45541 | 4523 | 50120 | 3656 | 51965 | 3015 | 53537 | 2035 | 65309 | 1681 | 40588 |
| 5L-6S | | MI | 13454 | 6063 | 22223 | 4282 | 23562 | 3443 | 23821 | 2812 | 23564 | 1833 | 27671 | 1315 | 18553 |
| 18-#11 | 2.44 | MA | 27832 | 6063 | 44598 | 4521 | 48814 | 3671 | 50367 | 3011 | 51431 | 2046 | 62607 | 1625 | 39656 |
| 6L-5S | | MI | 13718 | 6063 | 22683 | 4272 | 24140 | 3451 | 24474 | 2804 | 24433 | 1824 | 28706 | 1373 | 18863 |
| 18-#11 | 2.44 | MA | 27281 | 6063 | 43565 | 4537 | 47567 | 3668 | 48835 | 3024 | 49375 | 2057 | 59727 | 1535 | 39071 |
| 7L-4S | | MI | 13994 | 6063 | 23138 | 4280 | 24715 | 3443 | 25160 | 2795 | 25395 | 1833 | 29821 | 1412 | 18952 |
| 18-#11 | 2.44 | MA | 26739 | 6063 | 42637 | 4535 | 46303 | 3682 | 47339 | 3038 | 47189 | 2050 | 57084 | 1485 | 38094 |
| 8L-3S | | MI | 14298 | 6063 | 23659 | 4270 | 25365 | 3451 | 25930 | 2804 | 26352 | 1824 | 30874 | 1492 | 18926 |
| 18-#11 | 2.44 | MA | 26150 | 6063 | 41730 | 4533 | 45074 | 3679 | 45775 | 3034 | 45151 | 2061 | 54464 | 1431 | 37218 |
| 9L-2S | | MI | 14715 | 6063 | 24286 | 4278 | 26155 | 3443 | 26874 | 2795 | 27605 | 1816 | 32493 | 1578 | 18893 |
| 18-#14 | 3.52 | MA | 29225 | 6492 | 48280 | 4780 | 53406 | 3861 | 55935 | 3126 | 59018 | 2013 | 73207 | 1427 | 55253 |
| 6L-5S | | MI | 14304 | 6492 | 24420 | 4511 | 26199 | 3611 | 26915 | 2880 | 27786 | 1755 | 32932 | 1095 | 25690 |
| 18-#14 | 3.52 | MA | 28451 | 6492 | 46797 | 4802 | 51617 | 3857 | 53735 | 3144 | 56067 | 2029 | 69104 | 1298 | 53491 |
| 7L-4S | | MI | 14693 | 6492 | 25068 | 4523 | 27008 | 3599 | 27881 | 2867 | 29028 | 1742 | 34494 | 1152 | 26255 |
| 18-#14 | 3.52 | MA | 27689 | 6492 | 45465 | 4799 | 49802 | 3877 | 51588 | 3163 | 52929 | 2019 | 65333 | 1226 | 51959 |
| 8L-3S | | MI | 15122 | 6492 | 25810 | 4510 | 27923 | 3611 | 28965 | 2880 | 30374 | 1730 | 35972 | 1264 | 26505 |
| 18-#14 | 3.52 | MA | 26887 | 6492 | 44162 | 4796 | 48038 | 3872 | 49342 | 3156 | 50005 | 2034 | 61601 | 1149 | 49826 |
| 9L-2S | | MI | 15707 | 6492 | 26701 | 4522 | 29034 | 3599 | 30293 | 2867 | 32137 | 1717 | 38238 | 1388 | 26494 |
| 18-#18 | 6.25 | MA | 31296 | 7582 | 54811 | 5479 | 61703 | 4381 | 65956 | 3446 | 72767 | 1954 | 92243 | 674 | 86020 |
| 7L-4S | | MI | 16340 | 7582 | 29587 | 5130 | 32474 | 3987 | 34381 | 3037 | 37717 | 1490 | 45517 | 443 | 42545 |
| 18-#18 | 6.25 | MA | 30013 | 7582 | 52465 | 5472 | 58508 | 4371 | 62176 | 3477 | 67246 | 1933 | 85680 | 550 | 81247 |
| 8L-3S | | MI | 17067 | 7582 | 30848 | 5107 | 34021 | 4009 | 36214 | 3059 | 39992 | 1468 | 47999 | 633 | 44347 |
| 20-#11 | 2.71 | MA | 28509 | 6171 | 46034 | 4589 | 50654 | 3719 | 52613 | 3041 | 54487 | 2037 | 66782 | 1610 | 44013 |
| 6E | | MI | 13729 | 6171 | 22850 | 4349 | 24352 | 3490 | 24765 | 2838 | 24816 | 1815 | 29290 | 1279 | 20453 |
| 20-#11 | 2.71 | MA | 27962 | 6171 | 45001 | 4604 | 49408 | 3716 | 51081 | 3054 | 52430 | 2048 | 63902 | 1521 | 43444 |
| 7L-5S | | MI | 13992 | 6171 | 23310 | 4339 | 24930 | 3498 | 25418 | 2829 | 25685 | 1807 | 30324 | 1337 | 20670 |

## RECTANGULAR TIED COLUMNS 24" x 48"

Short columns – no sidesway
Bending on major or minor axis



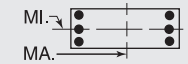

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.71 | MA | 27423 | 6171 | 44073 | 4602 | 48144 | 3731 | 49585 | 3067 | 50244 | 2042 | 61259 | 1470 | 42414 |
| 8L-4S | | MI | 14267 | 6171 | 23764 | 4347 | 25505 | 3490 | 26104 | 2821 | 26648 | 1815 | 31440 | 1376 | 20916 |
| 20-#11 | 2.71 | MA | 26838 | 6171 | 43166 | 4601 | 46915 | 3728 | 48021 | 3063 | 48207 | 2053 | 58639 | 1417 | 41560 |
| 9L-3S | | MI | 14570 | 6171 | 24286 | 4337 | 26155 | 3498 | 26874 | 2829 | 27605 | 1807 | 32493 | 1455 | 20899 |
| 20-#11 | 2.71 | MA | 26240 | 6171 | 42149 | 4616 | 45668 | 3742 | 46533 | 3076 | 46186 | 2064 | 56099 | 1356 | 40326 |
| 10L-2S | | MI | 14986 | 6171 | 24912 | 4345 | 26945 | 3490 | 27819 | 2821 | 28857 | 1798 | 34112 | 1541 | 20872 |
| 20-#14 | 3.91 | MA | 29409 | 6648 | 48854 | 4900 | 54254 | 3927 | 56952 | 3186 | 60444 | 2016 | 75053 | 1275 | 59657 |
| 7L-5S | | MI | 14687 | 6648 | 25310 | 4608 | 27310 | 3678 | 28244 | 2915 | 29549 | 1728 | 35199 | 1039 | 28359 |
| 20-#14 | 3.91 | MA | 28652 | 6648 | 47522 | 4897 | 52440 | 3947 | 54805 | 3205 | 57307 | 2006 | 71281 | 1203 | 58065 |
| 8L-4S | | MI | 15074 | 6648 | 25958 | 4620 | 28119 | 3666 | 29209 | 2903 | 30791 | 1716 | 36761 | 1095 | 28883 |
| 20-#14 | 3.91 | MA | 27852 | 6648 | 46219 | 4894 | 50675 | 3942 | 52560 | 3199 | 54382 | 2021 | 67550 | 1126 | 55979 |
| 9L-3S | | MI | 15501 | 6648 | 26701 | 4607 | 29034 | 3678 | 30293 | 2915 | 32137 | 1703 | 38238 | 1207 | 29272 |
| 20-#14 | 3.91 | MA | 26997 | 6648 | 44760 | 4916 | 48885 | 3962 | 50424 | 3217 | 51483 | 2036 | 63934 | 1038 | 53649 |
| 10L-2S | | MI | 16084 | 6648 | 27591 | 4619 | 30145 | 3666 | 31622 | 2903 | 33900 | 1691 | 40505 | 1332 | 29291 |
| 20-#18 | 6.94 | MA | 31655 | 7858 | 56074 | 5645 | 63134 | 4495 | 67820 | 3553 | 74924 | 1911 | 95999 | 504 | 91853 |
| 8L-4S | | MI | 16978 | 7858 | 31096 | 5300 | 34351 | 4101 | 36626 | 3095 | 40697 | 1436 | 49308 | 330 | 47077 |
| 22-#11 | 2.98 | MA | 28638 | 6279 | 46437 | 4672 | 51249 | 3765 | 53326 | 3083 | 55486 | 2039 | 68077 | 1506 | 47819 |
| 7L-6S | | MI | 14003 | 6279 | 23476 | 4416 | 25142 | 3537 | 25709 | 2863 | 26069 | 1798 | 30908 | 1242 | 22355 |
| 22-#11 | 2.98 | MA | 28102 | 6279 | 45509 | 4670 | 49985 | 3779 | 51831 | 3097 | 53300 | 2033 | 65434 | 1456 | 46739 |
| 8L-5S | | MI | 14265 | 6279 | 23937 | 4407 | 25719 | 3545 | 26362 | 2855 | 26938 | 1790 | 31943 | 1300 | 22557 |
| 22-#11 | 2.98 | MA | 27521 | 6279 | 44602 | 4668 | 48756 | 3776 | 50266 | 3093 | 51262 | 2044 | 62814 | 1402 | 45904 |
| 9L-4S | | MI | 14539 | 6279 | 24391 | 4414 | 26294 | 3537 | 27049 | 2846 | 27901 | 1798 | 33059 | 1339 | 22872 |
| 22-#11 | 2.98 | MA | 26926 | 6279 | 43585 | 4684 | 47509 | 3790 | 48779 | 3106 | 49242 | 2055 | 60274 | 1341 | 44636 |
| 10L-3S | | MI | 14841 | 6279 | 24912 | 4405 | 26945 | 3545 | 27819 | 2855 | 28857 | 1790 | 34112 | 1419 | 22867 |
| 22-#11 | 2.98 | MA | 26346 | 6279 | 42676 | 4682 | 46286 | 3788 | 47234 | 3102 | 47087 | 2049 | 57696 | 1288 | 43375 |
| 11L-2S | | MI | 15256 | 6279 | 25539 | 4413 | 27735 | 3537 | 28763 | 2846 | 30110 | 1781 | 35730 | 1505 | 22846 |
| 22-#14 | 4.30 | MA | 29609 | 6804 | 49579 | 4994 | 55077 | 4017 | 58023 | 3247 | 61684 | 1994 | 77230 | 1181 | 64180 |
| 8L-5S | | MI | 15068 | 6804 | 26200 | 4705 | 28422 | 3745 | 29572 | 2951 | 31312 | 1701 | 37465 | 983 | 31033 |
| 22-#14 | 4.30 | MA | 28809 | 6804 | 48276 | 4991 | 53312 | 4012 | 55777 | 3241 | 58760 | 2009 | 73499 | 1104 | 62141 |
| 9L-4S | | MI | 15454 | 6804 | 26849 | 4717 | 29230 | 3732 | 30538 | 2938 | 32554 | 1689 | 39027 | 1039 | 31520 |
| 22-#14 | 4.30 | MA | 27965 | 6804 | 46817 | 5013 | 51522 | 4032 | 53642 | 3260 | 55860 | 2024 | 69882 | 1016 | 59774 |
| 10L-3S | | MI | 15879 | 6804 | 27591 | 4704 | 30145 | 3745 | 31622 | 2951 | 33900 | 1676 | 40505 | 1151 | 32032 |
| 24-#11 | 3.25 | MA | 28778 | 6387 | 46945 | 4737 | 51826 | 3827 | 54076 | 3126 | 56355 | 2025 | 69609 | 1441 | 51070 |
| 8L-6S | | MI | 14276 | 6387 | 24103 | 4484 | 25932 | 3584 | 26654 | 2889 | 27322 | 1781 | 32527 | 1206 | 24257 |
| 24-#11 | 3.25 | MA | 28200 | 6387 | 46038 | 4736 | 50596 | 3825 | 52512 | 3122 | 54317 | 2036 | 66989 | 1388 | 50193 |
| 9L-5S | | MI | 14537 | 6387 | 24563 | 4474 | 26509 | 3592 | 27307 | 2880 | 28191 | 1772 | 33562 | 1264 | 24447 |
| 24-#11 | 3.25 | MA | 27608 | 6387 | 45021 | 4751 | 49349 | 3839 | 51024 | 3135 | 52297 | 2046 | 64449 | 1327 | 48950 |
| 10L-4S | | MI | 14810 | 6387 | 25018 | 4482 | 27084 | 3584 | 27993 | 2872 | 29154 | 1781 | 34677 | 1303 | 24820 |
| 24-#11 | 3.25 | MA | 27030 | 6387 | 44112 | 4749 | 48127 | 3836 | 49480 | 3131 | 50143 | 2040 | 61871 | 1274 | 47663 |
| 11L-3S | | MI | 15112 | 6387 | 25539 | 4472 | 27735 | 3592 | 28763 | 2880 | 30110 | 1772 | 35730 | 1382 | 24830 |
| 24-#11 | 3.25 | MA | 26464 | 6387 | 43114 | 4765 | 46889 | 3850 | 47995 | 3144 | 48124 | 2051 | 58964 | 1197 | 46378 |
| 12L-2S | | MI | 15525 | 6387 | 26166 | 4480 | 28525 | 3584 | 29707 | 2872 | 31363 | 1764 | 37349 | 1468 | 24815 |
| 24-#14 | 4.69 | MA | 29760 | 6959 | 50334 | 5088 | 55950 | 4082 | 58995 | 3283 | 63138 | 1996 | 79448 | 1081 | 68309 |
| 9L-5S | | MI | 15448 | 6959 | 27091 | 4802 | 29533 | 3811 | 30901 | 2986 | 33075 | 1674 | 39732 | 926 | 33710 |
| 24-#14 | 4.69 | MA | 28949 | 6959 | 48874 | 5110 | 54160 | 4102 | 56859 | 3302 | 60238 | 2011 | 75831 | 993 | 65906 |
| 10L-4S | | MI | 15832 | 6959 | 27739 | 4814 | 30342 | 3799 | 31867 | 2974 | 34317 | 1662 | 41294 | 983 | 34165 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 26"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

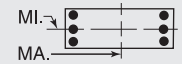
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.38 | MA | 8710 | 3312 | 13892 | 2377 | 14778 | 1934 | 14898 | 1601 | 14654 | 1122 | 16964 | 1031 | 7127 |
| 2L-3S | | MI | 8242 | 3312 | 13197 | 2371 | 13891 | 1942 | 13838 | 1609 | 13248 | 1130 | 15134 | 944 | 7180 |
| 6-#14 | 2.00 | MA | 9090 | 3455 | 14799 | 2454 | 15864 | 1984 | 16181 | 1623 | 16352 | 1089 | 19134 | 971 | 9994 |
| 2L-3S | | MI | 8430 | 3455 | 13812 | 2443 | 14613 | 1996 | 14686 | 1636 | 14369 | 1101 | 16565 | 846 | 10050 |
| 6-#18 | 3.55 | MA | 9991 | 3818 | 17009 | 2654 | 18470 | 2110 | 19269 | 1679 | 20444 | 1001 | 24306 | 804 | 16954 |
| 2L-3S | | MI | 8873 | 3818 | 15302 | 2632 | 16345 | 2132 | 16729 | 1701 | 17073 | 1023 | 19979 | 583 | 16864 |
| 8-#11 | 1.85 | MA | 9018 | 3419 | 14586 | 2445 | 15665 | 1982 | 15958 | 1628 | 16060 | 1106 | 18793 | 998 | 9338 |
| 2L-4S | | MI | 8217 | 3419 | 13317 | 2449 | 14049 | 1982 | 14034 | 1628 | 13580 | 1123 | 15777 | 830 | 9399 |
| 8-#14 | 2.66 | MA | 9520 | 3610 | 15787 | 2551 | 17115 | 2052 | 17677 | 1661 | 18336 | 1065 | 21704 | 920 | 13116 |
| 2L-4S | | MI | 8391 | 3610 | 13979 | 2555 | 14835 | 2052 | 14962 | 1661 | 14838 | 1090 | 17464 | 680 | 12742 |
| 8-#18 | 4.73 | MA | 10710 | 4094 | 18715 | 2827 | 20595 | 2228 | 21809 | 1742 | 23815 | 953 | 28633 | 702 | 22285 |
| 2L-4S | | MI | 8800 | 4094 | 15585 | 2828 | 16721 | 2228 | 17196 | 1742 | 17871 | 997 | 21483 | 283 | 19684 |
| 10-#11 | 2.31 | MA | 9324 | 3527 | 15280 | 2512 | 16552 | 2030 | 17018 | 1655 | 17466 | 1090 | 20622 | 965 | 11534 |
| 2L-5S | | MI | 8226 | 3527 | 13510 | 2509 | 14290 | 2039 | 14324 | 1663 | 13907 | 1099 | 16345 | 758 | 11099 |
| 10-#11 | 2.31 | MA | 8862 | 3527 | 14586 | 2506 | 15665 | 2039 | 15958 | 1663 | 16060 | 1099 | 18793 | 878 | 11563 |
| 3L-4S | | MI | 8527 | 3527 | 14011 | 2516 | 14936 | 2030 | 15094 | 1655 | 14986 | 1108 | 17606 | 797 | 11553 |
| 10-#14 | 3.33 | MA | 9946 | 3766 | 16774 | 2648 | 18366 | 2120 | 19172 | 1699 | 20320 | 1041 | 24273 | 869 | 16219 |
| 2L-5S | | MI | 8402 | 3766 | 14252 | 2641 | 15175 | 2133 | 15371 | 1711 | 15297 | 1053 | 18263 | 573 | 14923 |
| 10-#14 | 3.33 | MA | 9297 | 3766 | 15787 | 2638 | 17115 | 2133 | 17677 | 1711 | 18336 | 1053 | 21704 | 745 | 16202 |
| 3L-4S | | MI | 8826 | 3766 | 14967 | 2652 | 16086 | 2120 | 16457 | 1699 | 16821 | 1066 | 20034 | 629 | 15585 |
| 10-#18 | 5.92 | MA | 10327 | 4371 | 18715 | 2978 | 20595 | 2368 | 21809 | 1826 | 23815 | 926 | 28633 | 379 | 26711 |
| 3L-4S | | MI | 9531 | 4371 | 17291 | 3001 | 18845 | 2346 | 19737 | 1804 | 21242 | 949 | 25811 | 181 | 24628 |

## RECTANGULAR TIED COLUMNS 26" x 28"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.24 | MA | 9995 | 3529 | 15851 | 2543 | 16837 | 2072 | 16926 | 1720 | 16531 | 1218 | 19082 | 1127 | 7449 |
| 2E | | MI | 9253 | 3529 | 14722 | 2523 | 15545 | 2052 | 15586 | 1702 | 15169 | 1202 | 17443 | 1108 | 6879 |
| 4-#18 | 2.20 | MA | 10678 | 3771 | 17500 | 2668 | 18788 | 2152 | 19225 | 1755 | 19572 | 1159 | 22957 | 1021 | 12650 |
| 2E | | MI | 9863 | 3771 | 16216 | 2646 | 17276 | 2128 | 17625 | 1732 | 17868 | 1138 | 20850 | 991 | 11626 |
| 6-#11 | 1.29 | MA | 10055 | 3541 | 15934 | 2564 | 16991 | 2088 | 17153 | 1735 | 16837 | 1226 | 19511 | 1137 | 7759 |
| 2L-3S | | MI | 8840 | 3541 | 14106 | 2538 | 14823 | 2080 | 14740 | 1726 | 14051 | 1220 | 16017 | 1031 | 7217 |
| 6-#11 | 1.29 | MA | 9541 | 3541 | 15173 | 2558 | 16014 | 2098 | 15977 | 1743 | 15277 | 1235 | 17470 | 1050 | 7812 |
| 3L-2S | | MI | 9309 | 3541 | 14800 | 2545 | 15710 | 2072 | 15800 | 1718 | 15457 | 1211 | 17846 | 1118 | 7162 |
| 6-#14 | 1.85 | MA | 10479 | 3685 | 16935 | 2640 | 18228 | 2142 | 18589 | 1759 | 18735 | 1196 | 21956 | 1081 | 10905 |
| 2L-3S | | MI | 9028 | 3685 | 14722 | 2609 | 15545 | 2133 | 15586 | 1752 | 15169 | 1191 | 17443 | 932 | 10102 |
| 6-#14 | 1.85 | MA | 9753 | 3685 | 15851 | 2631 | 16837 | 2154 | 16926 | 1772 | 16531 | 1209 | 19082 | 957 | 10961 |
| 3L-2S | | MI | 9689 | 3685 | 15710 | 2620 | 16796 | 2121 | 17081 | 1740 | 17152 | 1178 | 20013 | 1057 | 10038 |
| 6-#18 | 3.30 | MA | 11489 | 4048 | 19380 | 2841 | 21161 | 2273 | 22062 | 1820 | 23335 | 1116 | 27823 | 928 | 18574 |
| 2L-3S | | MI | 9471 | 4048 | 16216 | 2797 | 17276 | 2267 | 17625 | 1816 | 17868 | 1112 | 20850 | 668 | 16973 |
| 6-#18 | 3.30 | MA | 10255 | 4048 | 17500 | 2822 | 18788 | 2295 | 19225 | 1843 | 19572 | 1138 | 22957 | 707 | 18484 |
| 3L-2S | | MI | 10593 | 4048 | 17923 | 2819 | 19401 | 2245 | 20165 | 1794 | 21239 | 1090 | 25177 | 889 | 17020 |
| 8-#11 | 1.71 | MA | 10397 | 3649 | 16696 | 2632 | 17967 | 2137 | 18329 | 1763 | 18396 | 1212 | 21551 | 1107 | 10181 |
| 2L-4S | | MI | 8815 | 3649 | 14225 | 2616 | 14981 | 2120 | 14936 | 1745 | 14383 | 1213 | 16660 | 917 | 9455 |
| 8-#11 | 1.71 | MA | 9886 | 3649 | 15934 | 2626 | 16991 | 2146 | 17153 | 1771 | 16837 | 1221 | 19511 | 1020 | 10222 |
| 3E | | MI | 9152 | 3649 | 14800 | 2605 | 15710 | 2128 | 15800 | 1753 | 15457 | 1204 | 17846 | 998 | 9423 |
| 8-#11 | 1.71 | MA | 9518 | 3649 | 15306 | 2637 | 16190 | 2138 | 16195 | 1763 | 15645 | 1230 | 18190 | 937 | 10241 |
| 4L-2S | | MI | 9617 | 3649 | 15494 | 2612 | 16597 | 2120 | 16860 | 1745 | 16863 | 1196 | 19676 | 1085 | 9378 |
| 8-#14 | 2.47 | MA | 10957 | 3840 | 18020 | 2738 | 19618 | 2212 | 20251 | 1799 | 20940 | 1175 | 24830 | 1035 | 14331 |
| 2L-4S | | MI | 8989 | 3840 | 14890 | 2721 | 15767 | 2189 | 15862 | 1777 | 15638 | 1179 | 18343 | 766 | 12967 |
| 8-#14 | 2.47 | MA | 10237 | 3840 | 16935 | 2728 | 18228 | 2224 | 18589 | 1811 | 18735 | 1187 | 21956 | 911 | 14354 |
| 3E | | MI | 9464 | 3840 | 15710 | 2707 | 16796 | 2201 | 17081 | 1790 | 17152 | 1167 | 20013 | 882 | 13204 |
| 8-#14 | 2.47 | MA | 9718 | 3840 | 16038 | 2744 | 17085 | 2212 | 17234 | 1799 | 17051 | 1199 | 20094 | 792 | 14091 |
| 4L-2S | | MI | 10120 | 3840 | 16697 | 2717 | 18047 | 2189 | 18576 | 1777 | 19136 | 1154 | 22583 | 1006 | 13166 |
| 8-#18 | 4.40 | MA | 12290 | 4324 | 21259 | 3014 | 23534 | 2394 | 24898 | 1886 | 27098 | 1072 | 32688 | 836 | 24445 |
| 2L-4S | | MI | 9396 | 4324 | 16499 | 2992 | 17651 | 2363 | 18093 | 1856 | 18665 | 1085 | 22354 | 368 | 19986 |
| 8-#18 | 4.40 | MA | 11070 | 4324 | 19380 | 2995 | 21161 | 2416 | 22062 | 1908 | 23335 | 1094 | 27823 | 615 | 24238 |
| 3E | | MI | 10204 | 4324 | 17923 | 2970 | 19401 | 2385 | 20165 | 1879 | 21239 | 1063 | 25177 | 566 | 22203 |

## RECTANGULAR TIED COLUMNS 26" x 28"

Short columns – no sidesway
Bending on major or minor axis



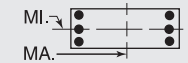

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 4.40 | MA | 10188 | 4324 | 17818 | 3019 | 19209 | 2394 | 19749 | 1886 | 20462 | 1116 | 24659 | 410 | 21802 |
| 4L-2S | | MI | 11314 | 4324 | 19630 | 2991 | 21525 | 2363 | 22705 | 1856 | 24610 | 1041 | 29504 | 788 | 22366 |
| 10-#11 | 2.14 | MA | 10736 | 3757 | 17458 | 2699 | 18943 | 2185 | 19505 | 1791 | 19956 | 1198 | 23592 | 1077 | 12587 |
| 2L-5S | | MI | 8823 | 3757 | 14418 | 2677 | 15223 | 2176 | 15225 | 1780 | 14710 | 1189 | 17228 | 845 | 11252 |
| 10-#11 | 2.14 | MA | 10228 | 3757 | 16696 | 2693 | 17967 | 2195 | 18329 | 1799 | 18396 | 1207 | 21551 | 990 | 12616 |
| 3L-4S | | MI | 9125 | 3757 | 14919 | 2683 | 15868 | 2168 | 15996 | 1771 | 15789 | 1198 | 18489 | 884 | 11619 |
| 10-#11 | 2.14 | MA | 9863 | 3757 | 16067 | 2704 | 17166 | 2187 | 17371 | 1791 | 17205 | 1216 | 20231 | 907 | 12606 |
| 4L-3S | | MI | 9460 | 3757 | 15494 | 2673 | 16597 | 2176 | 16860 | 1780 | 16863 | 1189 | 19676 | 965 | 11612 |
| 10-#11 | 2.14 | MA | 9534 | 3757 | 15520 | 2699 | 16458 | 2196 | 16517 | 1799 | 16008 | 1207 | 18824 | 869 | 12191 |
| 5L-2S | | MI | 9924 | 3757 | 16188 | 2680 | 17484 | 2168 | 17920 | 1771 | 18269 | 1180 | 21505 | 1052 | 11578 |
| 10-#14 | 3.09 | MA | 11430 | 3996 | 19105 | 2835 | 21009 | 2281 | 21913 | 1838 | 23145 | 1153 | 27704 | 989 | 17738 |
| 2L-5S | | MI | 8999 | 3996 | 15162 | 2808 | 16107 | 2270 | 16270 | 1827 | 16098 | 1143 | 19142 | 659 | 15116 |
| 10-#14 | 3.09 | MA | 10716 | 3996 | 18020 | 2826 | 19618 | 2294 | 20251 | 1850 | 20940 | 1165 | 24830 | 865 | 17721 |
| 3L-4S | | MI | 9424 | 3996 | 15877 | 2818 | 17018 | 2257 | 17357 | 1815 | 17621 | 1155 | 20913 | 715 | 15806 |
| 10-#14 | 3.09 | MA | 10201 | 3996 | 17123 | 2841 | 18475 | 2281 | 18896 | 1838 | 19256 | 1178 | 22968 | 746 | 17217 |
| 4L-3S | | MI | 9896 | 3996 | 16697 | 2804 | 18047 | 2270 | 18576 | 1827 | 19136 | 1143 | 22583 | 831 | 16276 |
| 10-#14 | 3.09 | MA | 9738 | 3996 | 16341 | 2832 | 17463 | 2294 | 17688 | 1850 | 17564 | 1165 | 20986 | 691 | 16414 |
| 5L-2S | | MI | 10547 | 3996 | 17685 | 2814 | 19298 | 2257 | 20071 | 1815 | 21120 | 1130 | 25152 | 956 | 16275 |
| 10-#18 | 5.49 | MA | 11874 | 4601 | 21259 | 3167 | 23534 | 2536 | 24898 | 1974 | 27098 | 1050 | 32688 | 522 | 29809 |
| 3L-4S | | MI | 10129 | 4601 | 18206 | 3165 | 19776 | 2481 | 20633 | 1919 | 22036 | 1037 | 26682 | 266 | 24925 |
| 10-#18 | 5.49 | MA | 11003 | 4601 | 19697 | 3192 | 21582 | 2514 | 22585 | 1952 | 24224 | 1072 | 29524 | 318 | 27257 |
| 4L-3S | | MI | 10928 | 4601 | 19630 | 3143 | 21525 | 2503 | 22705 | 1941 | 24610 | 1015 | 29504 | 465 | 27113 |
| 12-#11 | 2.57 | MA | 11073 | 3865 | 18219 | 2766 | 19920 | 2234 | 20681 | 1819 | 21516 | 1184 | 25633 | 1047 | 14984 |
| 2L-6S | | MI | 8847 | 3865 | 14641 | 2737 | 15462 | 2216 | 15552 | 1816 | 15140 | 1182 | 17885 | 755 | 13029 |
| 12-#11 | 2.57 | MA | 10568 | 3865 | 17458 | 2761 | 18943 | 2243 | 19505 | 1828 | 19956 | 1193 | 23592 | 960 | 15000 |
| 3L-5S | | MI | 9134 | 3865 | 15113 | 2744 | 16110 | 2225 | 16285 | 1807 | 16116 | 1173 | 19058 | 812 | 13305 |
| 12-#11 | 2.57 | MA | 10204 | 3865 | 16829 | 2772 | 18143 | 2235 | 18547 | 1819 | 18765 | 1202 | 22272 | 877 | 14962 |
| 4E | | MI | 9434 | 3865 | 15613 | 2751 | 16755 | 2216 | 17056 | 1798 | 17195 | 1182 | 20318 | 851 | 13771 |
| 12-#11 | 2.57 | MA | 9877 | 3865 | 16282 | 2766 | 17434 | 2244 | 17693 | 1828 | 17568 | 1193 | 20865 | 839 | 14446 |
| 5L-3S | | MI | 9767 | 3865 | 16188 | 2740 | 17484 | 2225 | 17920 | 1807 | 18269 | 1173 | 21505 | 932 | 13790 |
| 12-#11 | 2.57 | MA | 9566 | 3865 | 15768 | 2760 | 16724 | 2236 | 16879 | 1836 | 16486 | 1202 | 19555 | 782 | 14120 |
| 6L-2S | | MI | 10228 | 3865 | 16883 | 2747 | 18371 | 2216 | 18980 | 1798 | 19675 | 1165 | 23334 | 1019 | 13768 |
| 12-#14 | 3.71 | MA | 11190 | 4151 | 19105 | 2923 | 21009 | 2364 | 21913 | 1890 | 23145 | 1144 | 27704 | 818 | 21074 |
| 3L-5S | | MI | 9433 | 4151 | 16150 | 2905 | 17358 | 2338 | 17765 | 1865 | 18081 | 1119 | 21712 | 609 | 18041 |
| 12-#14 | 3.71 | MA | 10680 | 4151 | 18207 | 2938 | 19866 | 2351 | 20559 | 1877 | 21461 | 1156 | 25842 | 700 | 20369 |
| 4E | | MI | 9856 | 4151 | 16865 | 2916 | 18269 | 2326 | 18852 | 1852 | 19605 | 1131 | 23483 | 665 | 18671 |
| 12-#14 | 3.71 | MA | 10220 | 4151 | 17426 | 2929 | 18854 | 2364 | 19350 | 1890 | 19769 | 1144 | 23860 | 645 | 19631 |
| 5L-3S | | MI | 10325 | 4151 | 17685 | 2901 | 19298 | 2338 | 20071 | 1865 | 21120 | 1119 | 25152 | 780 | 19333 |
| 12-#14 | 3.71 | MA | 9782 | 4151 | 16691 | 2920 | 17839 | 2351 | 18201 | 1902 | 18239 | 1156 | 22018 | 562 | 18623 |
| 6L-2S | | MI | 10971 | 4151 | 18672 | 2912 | 20549 | 2326 | 21567 | 1852 | 23103 | 1106 | 27722 | 905 | 19372 |
| 12-#18 | 6.59 | MA | 11808 | 4878 | 21577 | 3365 | 23955 | 2635 | 25421 | 2018 | 27987 | 1028 | 34390 | 226 | 32749 |
| 4E | | MI | 10854 | 4878 | 19913 | 3338 | 21901 | 2599 | 23173 | 1981 | 25407 | 988 | 31009 | 165 | 29901 |
| 14-#11 | 3.00 | MA | 10905 | 3973 | 18219 | 2828 | 19920 | 2291 | 20681 | 1856 | 21516 | 1179 | 25633 | 931 | 17368 |
| 3L-6S | | MI | 9156 | 3973 | 15336 | 2805 | 16349 | 2264 | 16612 | 1843 | 16546 | 1167 | 19715 | 722 | 15099 |
| 14-#11 | 3.00 | MA | 10544 | 3973 | 17590 | 2839 | 19119 | 2283 | 19723 | 1847 | 20324 | 1188 | 24312 | 847 | 17312 |
| 4L-5S | | MI | 9442 | 3973 | 15807 | 2812 | 16997 | 2273 | 17345 | 1834 | 17522 | 1158 | 20887 | 779 | 15368 |
| 14-#11 | 3.00 | MA | 10219 | 3973 | 17044 | 2833 | 18411 | 2293 | 18869 | 1856 | 19127 | 1179 | 22906 | 809 | 16711 |
| 5L-4S | | MI | 9740 | 3973 | 16308 | 2818 | 17642 | 2264 | 18116 | 1825 | 18601 | 1167 | 22148 | 818 | 15911 |
| 14-#11 | 3.00 | MA | 9909 | 3973 | 16529 | 2828 | 17700 | 2285 | 18055 | 1864 | 18045 | 1188 | 21596 | 752 | 16405 |
| 6L-3S | | MI | 10072 | 3973 | 16883 | 2808 | 18371 | 2273 | 18980 | 1834 | 19675 | 1158 | 23334 | 900 | 15956 |
| 14-#11 | 3.00 | MA | 9607 | 3973 | 15967 | 2839 | 17021 | 2294 | 17197 | 1856 | 16988 | 1196 | 20361 | 687 | 15750 |
| 7L-2S | | MI | 10530 | 3973 | 17577 | 2814 | 19258 | 2264 | 20040 | 1825 | 21081 | 1149 | 25164 | 986 | 15950 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

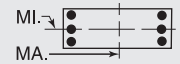
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 4.33 | MA | 11154 | 4307 | 19292 | 3036 | 21257 | 2421 | 22221 | 1917 | 23666 | 1134 | 28715 | 654 | 23542 |
| 4L-5S | | MI | 9865 | 4307 | 17137 | 3002 | 18609 | 2406 | 19261 | 1902 | 20065 | 1095 | 24281 | 558 | 20976 |
| 14-#14 | 4.33 | MA | 10698 | 4307 | 18511 | 3026 | 20245 | 2434 | 21013 | 1929 | 21973 | 1122 | 26734 | 599 | 22859 |
| 5L-4S | | MI | 10284 | 4307 | 17852 | 3013 | 19520 | 2394 | 20348 | 1890 | 21589 | 1107 | 26052 | 614 | 21555 |
| 14-#14 | 4.33 | MA | 10263 | 4307 | 17776 | 3017 | 19230 | 2421 | 19863 | 1942 | 20444 | 1134 | 24892 | 516 | 21760 |
| 6L-3S | | MI | 10749 | 4307 | 18672 | 2998 | 20549 | 2406 | 21567 | 1902 | 23103 | 1095 | 27722 | 730 | 22380 |
| 16-#11 | 3.43 | MA | 10881 | 4081 | 18352 | 2907 | 20095 | 2332 | 20900 | 1875 | 21884 | 1174 | 26353 | 817 | 19572 |
| 4L-6S | | MI | 9464 | 4081 | 16030 | 2872 | 17236 | 2312 | 17672 | 1869 | 17952 | 1151 | 21544 | 689 | 17100 |
| 16-#11 | 3.43 | MA | 10558 | 4081 | 17805 | 2901 | 19387 | 2341 | 20045 | 1884 | 20687 | 1165 | 24946 | 779 | 18983 |
| 5E | | MI | 9748 | 4081 | 16501 | 2879 | 17884 | 2321 | 18405 | 1861 | 18928 | 1142 | 22716 | 747 | 17439 |
| 16-#11 | 3.43 | MA | 10249 | 4081 | 17291 | 2895 | 18677 | 2333 | 19231 | 1892 | 19605 | 1174 | 23636 | 722 | 18618 |
| 6L-4S | | MI | 10045 | 4081 | 17002 | 2886 | 18529 | 2312 | 19176 | 1852 | 20007 | 1151 | 23977 | 785 | 17943 |
| 16-#11 | 3.43 | MA | 9949 | 4081 | 16728 | 2906 | 17998 | 2343 | 18373 | 1884 | 18548 | 1182 | 22402 | 657 | 17986 |
| 7L-3S | | MI | 10374 | 4081 | 17577 | 2875 | 19258 | 2321 | 20040 | 1861 | 21081 | 1142 | 25164 | 867 | 18113 |
| 16-#14 | 4.95 | MA | 11172 | 4463 | 19595 | 3124 | 21635 | 2503 | 22675 | 1969 | 24178 | 1100 | 29608 | 552 | 26096 |
| 5E | | MI | 10293 | 4463 | 18125 | 3100 | 19860 | 2475 | 20756 | 1940 | 22048 | 1071 | 26851 | 507 | 23905 |
| 16-#14 | 4.95 | MA | 10740 | 4463 | 18861 | 3114 | 20620 | 2491 | 21525 | 1981 | 22649 | 1113 | 27766 | 470 | 24912 |
| 6L-4S | | MI | 10709 | 4463 | 18840 | 3110 | 20771 | 2462 | 21843 | 1928 | 23572 | 1083 | 28622 | 563 | 24455 |
| 18-#11 | 3.86 | MA | 10894 | 4189 | 18567 | 2968 | 20363 | 2390 | 21221 | 1912 | 22247 | 1151 | 26987 | 749 | 21262 |
| 5L-6S | | MI | 9770 | 4189 | 16724 | 2940 | 18123 | 2360 | 18732 | 1896 | 19358 | 1135 | 23373 | 656 | 19111 |
| 18-#11 | 3.86 | MA | 10588 | 4189 | 18053 | 2962 | 19653 | 2382 | 20407 | 1920 | 21165 | 1159 | 25677 | 692 | 20830 |
| 6L-5S | | MI | 10052 | 4189 | 17195 | 2946 | 18771 | 2369 | 19465 | 1888 | 20334 | 1127 | 24545 | 714 | 19515 |
| 18-#11 | 3.86 | MA | 10289 | 4189 | 17490 | 2974 | 18974 | 2391 | 19550 | 1912 | 20108 | 1168 | 24442 | 628 | 20229 |
| 7L-4S | | MI | 10348 | 4189 | 17696 | 2953 | 19416 | 2360 | 20236 | 1879 | 21413 | 1135 | 25806 | 752 | 19985 |
| 18-#14 | 5.56 | MA | 11214 | 4618 | 19945 | 3212 | 22011 | 2561 | 23188 | 2020 | 24854 | 1091 | 30640 | 423 | 28077 |
| 6L-5S | | MI | 10718 | 4618 | 19112 | 3197 | 21111 | 2543 | 22251 | 1978 | 24032 | 1047 | 29421 | 457 | 26718 |
| 20-#11 | 4.29 | MA | 10924 | 4297 | 18814 | 3030 | 20629 | 2430 | 21583 | 1948 | 22724 | 1145 | 27718 | 662 | 23052 |
| 6E | | MI | 10074 | 4297 | 17418 | 3007 | 19010 | 2408 | 19792 | 1923 | 20764 | 1120 | 25203 | 623 | 21131 |
| 20-#11 | 4.29 | MA | 10627 | 4297 | 18252 | 3041 | 19951 | 2439 | 20726 | 1940 | 21667 | 1154 | 26483 | 598 | 22479 |
| 7L-5S | | MI | 10354 | 4297 | 17889 | 3014 | 19658 | 2417 | 20525 | 1915 | 21740 | 1111 | 26375 | 681 | 21595 |
| 22-#11 | 4.71 | MA | 10963 | 4405 | 19013 | 3109 | 20927 | 2488 | 21902 | 1968 | 23227 | 1140 | 28524 | 568 | 24734 |
| 7L-6S | | MI | 10376 | 4405 | 18112 | 3075 | 19897 | 2457 | 20852 | 1950 | 22170 | 1104 | 27032 | 590 | 23158 |

## RECTANGULAR TIED COLUMNS 26" x 30"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.15 | MA | 11429 | 3759 | 18020 | 2730 | 19175 | 2226 | 19310 | 1853 | 18824 | 1322 | 21749 | 1232 | 8057 |
| 2E | | MI | 9852 | 3759 | 15633 | 2689 | 16476 | 2189 | 16485 | 1818 | 15969 | 1292 | 18322 | 1194 | 6915 |
| 4-#18 | 2.05 | MA | 12186 | 4001 | 19829 | 2855 | 21375 | 2311 | 21866 | 1891 | 22204 | 1268 | 26087 | 1134 | 13730 |
| 2E | | MI | 10462 | 4001 | 17131 | 2810 | 18206 | 2263 | 18521 | 1847 | 18663 | 1226 | 21721 | 1076 | 11680 |
| 6-#11 | 1.20 | MA | 11493 | 3771 | 18108 | 2751 | 19337 | 2242 | 19551 | 1868 | 19151 | 1331 | 22206 | 1241 | 8391 |
| 2L-3S | | MI | 9438 | 3771 | 15014 | 2705 | 15755 | 2218 | 15641 | 1843 | 14854 | 1310 | 16900 | 1118 | 7251 |
| 6-#11 | 1.20 | MA | 10931 | 3771 | 17279 | 2746 | 18275 | 2252 | 18259 | 1877 | 17437 | 1339 | 19953 | 1155 | 8443 |
| 3L-2S | | MI | 9907 | 3771 | 15708 | 2712 | 16642 | 2209 | 16701 | 1835 | 16260 | 1301 | 18729 | 1204 | 7196 |
| 6-#14 | 1.73 | MA | 11961 | 3914 | 19202 | 2827 | 20690 | 2295 | 21140 | 1894 | 21251 | 1302 | 24928 | 1190 | 11816 |
| 2L-3S | | MI | 9626 | 3914 | 15633 | 2776 | 16476 | 2270 | 16485 | 1868 | 15969 | 1280 | 18322 | 1019 | 10152 |
| 6-#14 | 1.73 | MA | 11168 | 3914 | 18020 | 2819 | 19175 | 2309 | 19310 | 1907 | 18824 | 1315 | 21749 | 1065 | 11873 |
| 3L-2S | | MI | 10288 | 3914 | 16620 | 2786 | 17727 | 2257 | 17981 | 1856 | 17953 | 1268 | 20892 | 1143 | 10082 |
| 6-#18 | 3.08 | MA | 13082 | 4278 | 21881 | 3028 | 23997 | 2434 | 24999 | 1960 | 26359 | 1228 | 31493 | 1049 | 20194 |
| 2L-3S | | MI | 10069 | 4278 | 17131 | 2961 | 18206 | 2403 | 18521 | 1931 | 18663 | 1200 | 21721 | 753 | 17073 |
| 6-#18 | 3.08 | MA | 11731 | 4278 | 19829 | 3011 | 21375 | 2456 | 21866 | 1982 | 22204 | 1250 | 26087 | 827 | 20104 |
| 3L-2S | | MI | 11194 | 4278 | 18838 | 2983 | 20331 | 2380 | 21061 | 1909 | 22034 | 1178 | 26048 | 975 | 17085 |
| 8-#11 | 1.60 | MA | 11869 | 3879 | 18937 | 2818 | 20400 | 2290 | 20844 | 1897 | 20864 | 1318 | 24459 | 1214 | 11023 |
| 2L-4S | | MI | 9412 | 3879 | 15133 | 2783 | 15913 | 2257 | 15837 | 1861 | 15186 | 1303 | 17543 | 1003 | 9505 |
| 8-#11 | 1.60 | MA | 11311 | 3879 | 18108 | 2813 | 19337 | 2301 | 19551 | 1906 | 19151 | 1326 | 22206 | 1128 | 11064 |
| 3E | | MI | 9750 | 3879 | 15708 | 2773 | 16642 | 2266 | 16701 | 1870 | 16260 | 1294 | 18729 | 1085 | 9464 |

## RECTANGULAR TIED COLUMNS 26" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

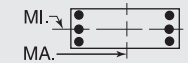
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.60 | MA | 10912 | 3879 | 17425 | 2825 | 18468 | 2293 | 18499 | 1897 | 17841 | 1335 | 20751 | 1042 | 11083 |
| 4L-2S | | MI | 10216 | 3879 | 16403 | 2779 | 17530 | 2257 | 17761 | 1861 | 17666 | 1286 | 20558 | 1171 | 9417 |
| 8-#14 | 2.31 | MA | 12488 | 4070 | 20384 | 2924 | 22205 | 2365 | 22969 | 1935 | 23677 | 1283 | 28107 | 1148 | 15546 |
| 2L-4S | | MI | 9586 | 4070 | 15800 | 2887 | 16698 | 2326 | 16761 | 1893 | 16438 | 1268 | 19222 | 852 | 13185 |
| 8-#14 | 2.31 | MA | 11701 | 4070 | 19202 | 2916 | 20690 | 2379 | 21140 | 1948 | 21251 | 1295 | 24928 | 1023 | 15569 |
| 3E | | MI | 10063 | 4070 | 16620 | 2873 | 17727 | 2338 | 17981 | 1906 | 17953 | 1256 | 20892 | 968 | 13261 |
| 8-#14 | 2.31 | MA | 11137 | 4070 | 18227 | 2933 | 19448 | 2368 | 19649 | 1935 | 19397 | 1308 | 22872 | 902 | 15464 |
| 4L-2S | | MI | 10720 | 4070 | 17608 | 2884 | 18978 | 2326 | 19476 | 1893 | 19936 | 1244 | 23462 | 1093 | 13215 |
| 8-#18 | 4.10 | MA | 13965 | 4554 | 23934 | 3201 | 26619 | 2558 | 28132 | 2029 | 30515 | 1188 | 36898 | 964 | 26605 |
| 2L-4S | | MI | 9993 | 4554 | 17414 | 3156 | 18582 | 2498 | 18989 | 1971 | 19460 | 1173 | 23226 | 453 | 20279 |
| 8-#18 | 4.10 | MA | 12630 | 4554 | 21881 | 3183 | 23997 | 2580 | 24999 | 2051 | 26359 | 1210 | 31493 | 743 | 26398 |
| 3E | | MI | 10803 | 4554 | 18838 | 3134 | 20331 | 2520 | 21061 | 1993 | 22034 | 1151 | 26048 | 651 | 22319 |
| 8-#18 | 4.10 | MA | 11670 | 4554 | 20181 | 3210 | 21841 | 2558 | 22445 | 2029 | 23186 | 1232 | 27986 | 533 | 23953 |
| 4L-2S | | MI | 11917 | 4554 | 20544 | 3156 | 22456 | 2498 | 23601 | 1971 | 25404 | 1129 | 30375 | 873 | 22445 |
| 10-#11 | 2.00 | MA | 12242 | 3987 | 19766 | 2886 | 21463 | 2339 | 22136 | 1926 | 22578 | 1305 | 26712 | 1186 | 13640 |
| 2L-5S | | MI | 9420 | 3987 | 15327 | 2844 | 16155 | 2314 | 16127 | 1897 | 15512 | 1279 | 18111 | 932 | 11398 |
| 10-#11 | 2.00 | MA | 11687 | 3987 | 18937 | 2881 | 20400 | 2349 | 20844 | 1935 | 20864 | 1314 | 24459 | 1100 | 13669 |
| 3L-4S | | MI | 9724 | 3987 | 15828 | 2851 | 16800 | 2305 | 16897 | 1888 | 16592 | 1287 | 19372 | 971 | 11680 |
| 10-#11 | 2.00 | MA | 11291 | 3987 | 18254 | 2893 | 19531 | 2342 | 19791 | 1926 | 19555 | 1322 | 23004 | 1015 | 13659 |
| 4L-3S | | MI | 10059 | 3987 | 16403 | 2840 | 17530 | 2314 | 17761 | 1897 | 17666 | 1279 | 20558 | 1052 | 11659 |
| 10-#11 | 2.00 | MA | 10934 | 3987 | 17661 | 2887 | 18762 | 2352 | 18852 | 1935 | 18241 | 1314 | 21451 | 977 | 13296 |
| 5L-2S | | MI | 10523 | 3987 | 17097 | 2847 | 18417 | 2305 | 18821 | 1888 | 19072 | 1270 | 22388 | 1139 | 11621 |
| 10-#14 | 2.88 | MA | 13009 | 4226 | 21566 | 3022 | 23720 | 2435 | 24799 | 1976 | 26104 | 1263 | 31286 | 1106 | 19257 |
| 2L-5S | | MI | 9595 | 4226 | 16073 | 2974 | 17039 | 2406 | 17170 | 1943 | 16898 | 1232 | 20021 | 746 | 15301 |
| 10-#14 | 2.88 | MA | 12229 | 4226 | 20384 | 3013 | 22205 | 2449 | 22969 | 1989 | 23677 | 1275 | 28107 | 981 | 19239 |
| 3L-4S | | MI | 10023 | 4226 | 16788 | 2985 | 17949 | 2394 | 18257 | 1931 | 18421 | 1244 | 21792 | 802 | 16020 |
| 10-#14 | 2.88 | MA | 11669 | 4226 | 19409 | 3030 | 20963 | 2438 | 21479 | 1976 | 21823 | 1288 | 26051 | 860 | 18874 |
| 4L-3S | | MI | 10496 | 4226 | 17608 | 2970 | 18978 | 2406 | 19476 | 1943 | 19936 | 1232 | 23462 | 917 | 16345 |
| 10-#14 | 2.88 | MA | 11166 | 4226 | 18561 | 3022 | 19865 | 2451 | 20149 | 1989 | 19962 | 1275 | 23859 | 805 | 17920 |
| 5L-2S | | MI | 11148 | 4226 | 18595 | 2981 | 20229 | 2394 | 20971 | 1931 | 21920 | 1220 | 26031 | 1042 | 16329 |
| 10-#18 | 5.13 | MA | 13518 | 4831 | 23934 | 3356 | 26619 | 2703 | 28132 | 2120 | 30515 | 1170 | 36898 | 658 | 32672 |
| 3L-4S | | MI | 10727 | 4831 | 19120 | 3329 | 20706 | 2616 | 21529 | 2034 | 22831 | 1125 | 27553 | 352 | 25213 |
| 10-#18 | 5.13 | MA | 12569 | 4831 | 22234 | 3383 | 24463 | 2681 | 25578 | 2098 | 27341 | 1192 | 33392 | 449 | 29919 |
| 4L-3S | | MI | 11529 | 4831 | 20544 | 3307 | 22456 | 2638 | 23601 | 2056 | 25404 | 1103 | 30375 | 550 | 27504 |
| 10-#18 | 5.13 | MA | 11717 | 4831 | 20753 | 3366 | 22555 | 2703 | 23301 | 2120 | 24150 | 1170 | 29666 | 350 | 27715 |
| 5L-2S | | MI | 12632 | 4831 | 22251 | 3329 | 24581 | 2616 | 26142 | 2034 | 28775 | 1081 | 34703 | 771 | 27752 |
| 12-#11 | 2.40 | MA | 12612 | 4095 | 20595 | 2953 | 22526 | 2387 | 23428 | 1955 | 24291 | 1292 | 28965 | 1159 | 16248 |
| 2L-6S | | MI | 9443 | 4095 | 15550 | 2905 | 16394 | 2354 | 16453 | 1933 | 15943 | 1272 | 18768 | 842 | 13167 |
| 12-#11 | 2.40 | MA | 12061 | 4095 | 19766 | 2948 | 21463 | 2397 | 22136 | 1964 | 22578 | 1301 | 26712 | 1073 | 16263 |
| 3L-5S | | MI | 9731 | 4095 | 16021 | 2911 | 17042 | 2362 | 17187 | 1924 | 16918 | 1263 | 19940 | 899 | 13451 |
| 12-#11 | 2.40 | MA | 11667 | 4095 | 19083 | 2960 | 20593 | 2390 | 21084 | 1955 | 21269 | 1310 | 25257 | 987 | 16226 |
| 4E | | MI | 10033 | 4095 | 16522 | 2918 | 17687 | 2354 | 17957 | 1915 | 17998 | 1272 | 21201 | 938 | 13839 |
| 12-#11 | 2.40 | MA | 11312 | 4095 | 18491 | 2955 | 19825 | 2400 | 20145 | 1964 | 19954 | 1301 | 23704 | 950 | 15751 |
| 5L-3S | | MI | 10367 | 4095 | 17097 | 2908 | 18417 | 2362 | 18821 | 1924 | 19072 | 1263 | 22388 | 1019 | 13841 |
| 12-#11 | 2.40 | MA | 10974 | 4095 | 17933 | 2950 | 19055 | 2393 | 19251 | 1973 | 18766 | 1310 | 22256 | 893 | 15364 |
| 6L-2S | | MI | 10828 | 4095 | 17791 | 2914 | 19304 | 2354 | 19881 | 1915 | 20478 | 1255 | 24217 | 1106 | 13814 |
| 12-#14 | 3.46 | MA | 12751 | 4381 | 21566 | 3111 | 23720 | 2519 | 24799 | 2029 | 26104 | 1256 | 31286 | 939 | 22897 |
| 3L-5S | | MI | 10031 | 4381 | 17060 | 3071 | 18290 | 2475 | 18665 | 1981 | 18881 | 1208 | 22590 | 695 | 18225 |
| 12-#14 | 3.46 | MA | 12196 | 4381 | 20591 | 3127 | 22478 | 2508 | 23309 | 2017 | 24250 | 1268 | 29230 | 818 | 22311 |
| 4E | | MI | 10455 | 4381 | 17775 | 3082 | 19200 | 2462 | 19752 | 1969 | 20405 | 1220 | 24361 | 751 | 18882 |
| 12-#14 | 3.46 | MA | 11697 | 4381 | 19743 | 3119 | 21380 | 2521 | 21979 | 2029 | 22388 | 1256 | 27038 | 763 | 21429 |
| 5L-3S | | MI | 10925 | 4381 | 18595 | 3068 | 20229 | 2475 | 20971 | 1981 | 21920 | 1208 | 26031 | 867 | 19410 |
| 12-#14 | 3.46 | MA | 11222 | 4381 | 18946 | 3111 | 20279 | 2510 | 20713 | 2042 | 20705 | 1268 | 24997 | 681 | 20455 |
| 6L-2S | | MI | 11573 | 4381 | 19583 | 3078 | 21480 | 2462 | 22466 | 1969 | 23904 | 1196 | 28601 | 991 | 19429 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 30"

Short columns – no sidesway
Bending on major or minor axis

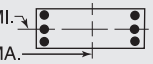



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 6.15 | MA | 13457 | 5107 | 24286 | 3556 | 27085 | 2804 | 28712 | 2167 | 31497 | 1152 | 38798 | 364 | 35925 |
| 4E | | MI | 11453 | 5107 | 20827 | 3502 | 22831 | 2734 | 24069 | 2096 | 26202 | 1076 | 31880 | 250 | 30184 |
| 12-#18 | 6.15 | MA | 12614 | 5107 | 22805 | 3539 | 25177 | 2826 | 26434 | 2189 | 28306 | 1130 | 35072 | 266 | 33536 |
| 5L-3S | | MI | 12248 | 5107 | 22251 | 3480 | 24581 | 2756 | 26142 | 2118 | 28775 | 1054 | 34703 | 448 | 32268 |
| 14-#11 | 2.80 | MA | 12432 | 4203 | 20595 | 3015 | 22526 | 2446 | 23428 | 1993 | 24291 | 1288 | 28965 | 1045 | 18842 |
| 3L-6S | | MI | 9754 | 4203 | 16244 | 2972 | 17281 | 2402 | 17514 | 1959 | 17349 | 1256 | 20597 | 809 | 15250 |
| 14-#11 | 2.80 | MA | 12040 | 4203 | 19913 | 3027 | 21656 | 2439 | 22376 | 1984 | 22982 | 1297 | 27510 | 960 | 18786 |
| 4L-5S | | MI | 10040 | 4203 | 16715 | 2979 | 17929 | 2410 | 18247 | 1951 | 18324 | 1248 | 21770 | 866 | 15514 |
| 14-#11 | 2.80 | MA | 11687 | 4203 | 19320 | 3022 | 20888 | 2449 | 21437 | 1993 | 21668 | 1288 | 25957 | 923 | 18217 |
| 5L-4S | | MI | 10340 | 4203 | 17216 | 2986 | 18574 | 2402 | 19017 | 1942 | 19404 | 1256 | 23030 | 905 | 15989 |
| 14-#11 | 2.80 | MA | 11351 | 4203 | 18762 | 3017 | 20118 | 2442 | 20543 | 2002 | 20479 | 1297 | 24508 | 866 | 17854 |
| 6L-3S | | MI | 10672 | 4203 | 17791 | 2975 | 19304 | 2410 | 19881 | 1951 | 20478 | 1248 | 24217 | 986 | 16016 |
| 14-#11 | 2.80 | MA | 11024 | 4203 | 18153 | 3029 | 19382 | 2452 | 19601 | 1993 | 19317 | 1305 | 23149 | 800 | 17224 |
| 7L-2S | | MI | 11131 | 4203 | 18485 | 2982 | 20191 | 2402 | 20941 | 1942 | 21884 | 1239 | 26046 | 1073 | 15999 |
| 14-#14 | 4.04 | MA | 12718 | 4537 | 21773 | 3225 | 23994 | 2577 | 25139 | 2058 | 26676 | 1248 | 32409 | 775 | 25771 |
| 4L-5S | | MI | 10463 | 4537 | 18048 | 3169 | 19541 | 2543 | 20160 | 2019 | 20865 | 1184 | 25160 | 644 | 21160 |
| 14-#14 | 4.04 | MA | 12223 | 4537 | 20925 | 3216 | 22895 | 2591 | 23809 | 2070 | 24815 | 1236 | 30218 | 721 | 24950 |
| 5L-4S | | MI | 10884 | 4537 | 18763 | 3179 | 20451 | 2531 | 21247 | 2006 | 22389 | 1196 | 26931 | 700 | 21764 |
| 14-#14 | 4.04 | MA | 11752 | 4537 | 20128 | 3208 | 21794 | 2580 | 22543 | 2083 | 23131 | 1248 | 28176 | 638 | 23881 |
| 6L-3S | | MI | 11351 | 4537 | 19583 | 3165 | 21480 | 2543 | 22466 | 2019 | 23904 | 1184 | 28601 | 816 | 22463 |
| 14-#18 | 7.18 | MA | 13502 | 5384 | 24858 | 3712 | 27799 | 2950 | 29567 | 2258 | 32462 | 1090 | 40477 | 181 | 39397 |
| 5L-4S | | MI | 12173 | 5384 | 22534 | 3675 | 24956 | 2851 | 26609 | 2158 | 29573 | 1028 | 36207 | 149 | 35185 |
| 16-#11 | 3.20 | MA | 12410 | 4311 | 20742 | 3095 | 22719 | 2487 | 23669 | 2013 | 24696 | 1284 | 29763 | 933 | 21341 |
| 4L-6S | | MI | 10062 | 4311 | 16938 | 3040 | 18168 | 2450 | 18574 | 1986 | 18755 | 1241 | 22427 | 776 | 17337 |
| 16-#11 | 3.20 | MA | 12060 | 4311 | 20149 | 3090 | 21951 | 2497 | 22729 | 2022 | 23382 | 1275 | 28209 | 895 | 20692 |
| 5E | | MI | 10347 | 4311 | 17409 | 3046 | 18816 | 2458 | 19307 | 1978 | 19731 | 1232 | 23599 | 833 | 17584 |
| 16-#11 | 3.20 | MA | 11726 | 4311 | 19592 | 3085 | 21181 | 2490 | 21835 | 2031 | 22193 | 1284 | 26761 | 838 | 20349 |
| 6L-4S | | MI | 10645 | 4311 | 17910 | 3053 | 19461 | 2450 | 20077 | 1969 | 20810 | 1241 | 24860 | 872 | 18114 |
| 16-#11 | 3.20 | MA | 11400 | 4311 | 18982 | 3097 | 20445 | 2500 | 20893 | 2022 | 21031 | 1293 | 25402 | 772 | 19661 |
| 7L-3S | | MI | 10975 | 4311 | 18485 | 3042 | 20191 | 2458 | 20941 | 1978 | 21884 | 1232 | 26046 | 954 | 18176 |
| 16-#14 | 4.62 | MA | 12745 | 4692 | 22107 | 3314 | 24411 | 2661 | 25639 | 2111 | 27241 | 1216 | 33397 | 679 | 28481 |
| 5E | | MI | 10892 | 4692 | 19035 | 3266 | 20792 | 2612 | 21656 | 2056 | 22849 | 1160 | 27730 | 594 | 24104 |
| 16-#14 | 4.62 | MA | 12277 | 4692 | 21310 | 3305 | 23310 | 2650 | 24373 | 2124 | 25558 | 1229 | 31355 | 596 | 27322 |
| 6L-4S | | MI | 11310 | 4692 | 19750 | 3276 | 21702 | 2599 | 22743 | 2044 | 24372 | 1172 | 29501 | 650 | 24661 |
| 18-#11 | 3.60 | MA | 12430 | 4419 | 20978 | 3157 | 23014 | 2546 | 24022 | 2051 | 25095 | 1263 | 30462 | 868 | 23173 |
| 5L-6S | | MI | 10368 | 4419 | 17632 | 3107 | 19055 | 2498 | 19634 | 2013 | 20161 | 1225 | 24256 | 743 | 19346 |
| 18-#11 | 3.60 | MA | 12098 | 4419 | 20421 | 3152 | 22244 | 2539 | 23128 | 2060 | 23906 | 1271 | 29014 | 811 | 22821 |
| 6L-5S | | MI | 10651 | 4419 | 18104 | 3114 | 19703 | 2507 | 20367 | 2005 | 21137 | 1217 | 25428 | 801 | 19660 |
| 18-#11 | 3.60 | MA | 11774 | 4419 | 19811 | 3164 | 21508 | 2549 | 22186 | 2051 | 22745 | 1280 | 27655 | 745 | 22107 |
| 7L-4S | | MI | 10948 | 4419 | 18604 | 3120 | 20348 | 2498 | 21137 | 1996 | 22216 | 1225 | 26689 | 839 | 20154 |
| 18-#14 | 5.19 | MA | 12798 | 4848 | 22492 | 3403 | 24825 | 2720 | 26203 | 2164 | 27984 | 1209 | 34535 | 554 | 30776 |
| 6L-5S | | MI | 11318 | 4848 | 20023 | 3363 | 22043 | 2680 | 23151 | 2094 | 24832 | 1136 | 30299 | 543 | 27049 |
| 20-#11 | 4.00 | MA | 12468 | 4526 | 21250 | 3219 | 23306 | 2587 | 24420 | 2089 | 25620 | 1259 | 31267 | 783 | 25242 |
| 6E | | MI | 10673 | 4526 | 18327 | 3175 | 19942 | 2546 | 20694 | 2040 | 21567 | 1210 | 26085 | 710 | 21364 |
| 20-#11 | 4.00 | MA | 12146 | 4526 | 20640 | 3231 | 22571 | 2597 | 23478 | 2080 | 24458 | 1267 | 29908 | 718 | 24559 |
| 7L-5S | | MI | 10955 | 4526 | 18798 | 3181 | 20590 | 2555 | 21427 | 2032 | 22543 | 1201 | 27258 | 768 | 21740 |
| 22-#11 | 4.40 | MA | 12515 | 4634 | 21469 | 3299 | 23634 | 2646 | 24770 | 2109 | 26172 | 1255 | 32160 | 690 | 27016 |
| 7L-6S | | MI | 10976 | 4634 | 19021 | 3242 | 20829 | 2594 | 21754 | 2067 | 22973 | 1194 | 27915 | 677 | 23389 |

## RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis



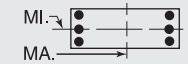

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.08 | MA | 12954 | 3989 | 20321 | 2917 | 21655 | 2379 | 21836 | 1987 | 21249 | 1426 | 24563 | 1336 | 8664 |
| 2E | | MI | 10450 | 3989 | 16543 | 2855 | 17408 | 2326 | 17385 | 1935 | 16769 | 1381 | 19201 | 1280 | 6950 |
| 4-#18 | 1.92 | MA | 13787 | 4231 | 22288 | 3042 | 24071 | 2466 | 24650 | 2027 | 24968 | 1375 | 29366 | 1244 | 14810 |
| 2E | | MI | 11062 | 4231 | 18045 | 2974 | 19137 | 2398 | 19417 | 1961 | 19457 | 1315 | 22592 | 1161 | 11733 |
| 6-#11 | 1.13 | MA | 13023 | 4001 | 20412 | 2938 | 21827 | 2396 | 22072 | 2000 | 21596 | 1434 | 25050 | 1345 | 9022 |
| 2L-3S | | MI | 10036 | 4001 | 15923 | 2873 | 16688 | 2355 | 16542 | 1960 | 15657 | 1400 | 17782 | 1205 | 7285 |
| 6-#11 | 1.13 | MA | 12414 | 4001 | 19516 | 2933 | 20678 | 2406 | 20670 | 2009 | 19728 | 1443 | 22584 | 1258 | 9075 |
| 3L-2S | | MI | 10505 | 4001 | 16617 | 2879 | 17575 | 2347 | 17602 | 1951 | 17063 | 1391 | 19612 | 1291 | 7229 |
| 6-#14 | 1.62 | MA | 13536 | 4144 | 21600 | 3014 | 23295 | 2449 | 23834 | 2029 | 23897 | 1408 | 28048 | 1297 | 12727 |
| 2L-3S | | MI | 10224 | 4144 | 16543 | 2942 | 17408 | 2407 | 17385 | 1985 | 16769 | 1369 | 19201 | 1105 | 10198 |
| 6-#14 | 1.62 | MA | 12676 | 4144 | 20321 | 3007 | 21655 | 2464 | 21836 | 2041 | 21249 | 1420 | 24563 | 1173 | 12784 |
| 3L-2S | | MI | 10887 | 4144 | 17531 | 2953 | 18659 | 2394 | 18880 | 1972 | 18753 | 1357 | 21771 | 1230 | 10124 |
| 6-#18 | 2.88 | MA | 14769 | 4507 | 24514 | 3215 | 26924 | 2590 | 28081 | 2098 | 29517 | 1338 | 35314 | 1166 | 21814 |
| 2L-3S | | MI | 10668 | 4507 | 18045 | 3125 | 19137 | 2538 | 19417 | 2046 | 19457 | 1288 | 22592 | 838 | 17167 |
| 6-#18 | 2.88 | MA | 13300 | 4507 | 22288 | 3199 | 24071 | 2614 | 24650 | 2120 | 24968 | 1360 | 29366 | 945 | 21724 |
| 3L-2S | | MI | 11795 | 4507 | 19752 | 3147 | 21262 | 2516 | 21957 | 2024 | 22828 | 1266 | 26919 | 1060 | 17148 |
| 8-#11 | 1.50 | MA | 13433 | 4109 | 21309 | 3005 | 22976 | 2444 | 23474 | 2029 | 23464 | 1423 | 27515 | 1320 | 11865 |
| 2L-4S | | MI | 10010 | 4109 | 16042 | 2951 | 16845 | 2395 | 16738 | 1978 | 15989 | 1393 | 18425 | 1090 | 9551 |
| 8-#11 | 1.50 | MA | 12829 | 4109 | 20412 | 3000 | 21827 | 2455 | 22072 | 2038 | 21596 | 1431 | 25050 | 1233 | 11906 |
| 3E | | MI | 10348 | 4109 | 16617 | 2940 | 17575 | 2404 | 17602 | 1987 | 17063 | 1384 | 19612 | 1172 | 9504 |
| 8-#11 | 1.50 | MA | 12398 | 4109 | 19676 | 3013 | 20889 | 2449 | 20932 | 2030 | 20169 | 1440 | 23458 | 1147 | 11926 |
| 4L-2S | | MI | 10815 | 4109 | 17311 | 2947 | 18462 | 2395 | 18662 | 1978 | 18469 | 1376 | 21441 | 1258 | 9454 |
| 8-#14 | 2.16 | MA | 14112 | 4300 | 22879 | 3111 | 24935 | 2519 | 25831 | 2071 | 26546 | 1390 | 31534 | 1258 | 16761 |
| 2L-4S | | MI | 10184 | 4300 | 16711 | 3054 | 17630 | 2463 | 17661 | 2010 | 17238 | 1358 | 20101 | 939 | 13309 |
| 8-#14 | 2.16 | MA | 13259 | 4300 | 21600 | 3104 | 23295 | 2534 | 23834 | 2083 | 23897 | 1402 | 28048 | 1134 | 16784 |
| 3E | | MI | 10662 | 4300 | 17531 | 3039 | 18659 | 2475 | 18880 | 2022 | 18753 | 1345 | 21771 | 1054 | 13316 |
| 8-#14 | 2.16 | MA | 12649 | 4300 | 20547 | 3121 | 21954 | 2524 | 22207 | 2071 | 21874 | 1415 | 25798 | 1010 | 16690 |
| 4L-2S | | MI | 11320 | 4300 | 18518 | 3050 | 19910 | 2463 | 20375 | 2010 | 20736 | 1333 | 24340 | 1179 | 13263 |
| 8-#18 | 3.85 | MA | 15736 | 4784 | 26739 | 3387 | 29776 | 2714 | 31511 | 2170 | 34067 | 1302 | 41262 | 1088 | 28765 |
| 2L-4S | | MI | 10589 | 4784 | 18328 | 3321 | 19512 | 2633 | 19885 | 2086 | 20255 | 1262 | 24097 | 539 | 20562 |
| 8-#18 | 3.85 | MA | 14285 | 4784 | 24514 | 3372 | 26924 | 2738 | 28081 | 2192 | 29517 | 1324 | 35314 | 867 | 28558 |
| 3E | | MI | 11403 | 4784 | 19752 | 3298 | 21262 | 2655 | 21957 | 2108 | 22828 | 1240 | 26919 | 737 | 22427 |
| 8-#18 | 3.85 | MA | 13246 | 4784 | 22676 | 3401 | 24582 | 2717 | 25286 | 2170 | 26042 | 1346 | 31464 | 653 | 26135 |
| 4L-2S | | MI | 12519 | 4784 | 21459 | 3320 | 23386 | 2633 | 24497 | 2086 | 26199 | 1217 | 31246 | 958 | 22514 |
| 10-#11 | 1.87 | MA | 13841 | 4217 | 22205 | 3073 | 24125 | 2492 | 24876 | 2058 | 25331 | 1411 | 29981 | 1294 | 14693 |
| 2L-5S | | MI | 10018 | 4217 | 16235 | 3011 | 17087 | 2452 | 17028 | 2014 | 16315 | 1369 | 18994 | 1019 | 11539 |
| 10-#11 | 1.87 | MA | 13240 | 4217 | 21309 | 3068 | 22976 | 2503 | 23474 | 2068 | 23464 | 1420 | 27515 | 1208 | 14722 |
| 3L-4S | | MI | 10322 | 4217 | 16736 | 3018 | 17732 | 2443 | 17799 | 2005 | 17395 | 1377 | 20255 | 1057 | 11733 |
| 10-#11 | 1.87 | MA | 12811 | 4217 | 20572 | 3081 | 22038 | 2497 | 22334 | 2059 | 22036 | 1428 | 25923 | 1122 | 14712 |
| 4L-3S | | MI | 10658 | 4217 | 17311 | 3008 | 18462 | 2452 | 18662 | 2014 | 18469 | 1369 | 21441 | 1139 | 11704 |
| 10-#11 | 1.87 | MA | 12427 | 4217 | 19933 | 3076 | 21210 | 2508 | 21317 | 2069 | 20605 | 1420 | 24226 | 1084 | 14412 |
| 5L-2S | | MI | 11123 | 4217 | 18005 | 3014 | 19349 | 2443 | 19722 | 2005 | 19875 | 1360 | 23270 | 1225 | 11663 |
| 10-#14 | 2.70 | MA | 14682 | 4455 | 24159 | 3208 | 26575 | 2589 | 27829 | 2113 | 29195 | 1372 | 35019 | 1220 | 20775 |
| 2L-5S | | MI | 10192 | 4455 | 16983 | 3140 | 17970 | 2543 | 18069 | 2060 | 17698 | 1321 | 20900 | 832 | 15478 |
| 10-#14 | 2.70 | MA | 13835 | 4455 | 22879 | 3201 | 24935 | 2604 | 25831 | 2126 | 26546 | 1384 | 31534 | 1095 | 20758 |
| 3L-4S | | MI | 10621 | 4455 | 17698 | 3151 | 18881 | 2531 | 19156 | 2047 | 19222 | 1334 | 22671 | 888 | 16227 |
| 10-#14 | 2.70 | MA | 13230 | 4455 | 21827 | 3219 | 23594 | 2594 | 24205 | 2113 | 24522 | 1397 | 29284 | 971 | 20555 |
| 4L-3S | | MI | 11095 | 4455 | 18518 | 3137 | 19910 | 2543 | 20375 | 2060 | 20736 | 1321 | 24340 | 1004 | 16411 |
| 10-#14 | 2.70 | MA | 12688 | 4455 | 20912 | 3211 | 22409 | 2608 | 22753 | 2126 | 22491 | 1384 | 26881 | 917 | 19440 |
| 5L-2S | | MI | 11749 | 4455 | 19506 | 3147 | 21161 | 2531 | 21871 | 2047 | 22720 | 1309 | 26910 | 1128 | 16381 |
| 10-#18 | 4.81 | MA | 15256 | 5061 | 26739 | 3545 | 29776 | 2862 | 31511 | 2264 | 34067 | 1287 | 41262 | 789 | 35372 |
| 3L-4S | | MI | 11324 | 5061 | 20035 | 3493 | 21637 | 2751 | 22425 | 2148 | 23626 | 1213 | 28424 | 437 | 25491 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis

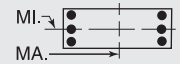



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 4.81 | MA | 14229 | 5061 | 24901 | 3574 | 27435 | 2841 | 28717 | 2241 | 30591 | 1309 | 37412 | 575 | 32614 |
| 4L-3S | | MI | 12130 | 5061 | 21459 | 3471 | 23386 | 2773 | 24497 | 2170 | 26199 | 1191 | 31246 | 635 | 27660 |
| 10-#18 | 4.81 | MA | 13309 | 5061 | 23302 | 3558 | 25364 | 2865 | 26223 | 2264 | 27100 | 1287 | 33312 | 478 | 30431 |
| 5L-2S | | MI | 13236 | 5061 | 23166 | 3493 | 25511 | 2751 | 27038 | 2148 | 29570 | 1169 | 35574 | 857 | 27836 |
| 12-#11 | 2.25 | MA | 14245 | 4325 | 23102 | 3140 | 25275 | 2541 | 26278 | 2088 | 27199 | 1399 | 32446 | 1269 | 17511 |
| 2L-6S | | MI | 10040 | 4325 | 16458 | 3072 | 17326 | 2491 | 17355 | 2049 | 16746 | 1362 | 19651 | 929 | 13298 |
| 12-#11 | 2.25 | MA | 13647 | 4325 | 22205 | 3135 | 24125 | 2552 | 24876 | 2097 | 25331 | 1408 | 29981 | 1183 | 17527 |
| 3L-5S | | MI | 10329 | 4325 | 16929 | 3079 | 17974 | 2500 | 18088 | 2041 | 17721 | 1353 | 20823 | 986 | 13591 |
| 12-#11 | 2.25 | MA | 13222 | 4325 | 21469 | 3148 | 23187 | 2545 | 23736 | 2089 | 23904 | 1417 | 28389 | 1097 | 17490 |
| 4E | | MI | 10631 | 4325 | 17430 | 3085 | 18619 | 2491 | 18859 | 2032 | 18801 | 1362 | 22084 | 1024 | 13901 |
| 12-#11 | 2.25 | MA | 12839 | 4325 | 20830 | 3143 | 22359 | 2556 | 22719 | 2098 | 22472 | 1408 | 26691 | 1059 | 17069 |
| 5L-3S | | MI | 10966 | 4325 | 18005 | 3075 | 19349 | 2500 | 19722 | 2041 | 19875 | 1353 | 23270 | 1106 | 13890 |
| 12-#11 | 2.25 | MA | 12475 | 4325 | 20230 | 3139 | 21530 | 2550 | 21751 | 2107 | 21176 | 1417 | 25104 | 1002 | 16617 |
| 6L-2S | | MI | 11428 | 4325 | 18699 | 3082 | 20236 | 2491 | 20782 | 2032 | 21281 | 1345 | 25100 | 1193 | 13859 |
| 12-#14 | 3.25 | MA | 14406 | 4611 | 24159 | 3298 | 26575 | 2673 | 27829 | 2168 | 29195 | 1366 | 35019 | 1056 | 24719 |
| 3L-5S | | MI | 10628 | 4611 | 17971 | 3238 | 19221 | 2612 | 19565 | 2097 | 19681 | 1297 | 23469 | 781 | 18402 |
| 12-#14 | 3.25 | MA | 13806 | 4611 | 23106 | 3316 | 25234 | 2663 | 26203 | 2155 | 27171 | 1379 | 32769 | 933 | 24278 |
| 4E | | MI | 11054 | 4611 | 18686 | 3248 | 20132 | 2599 | 20652 | 2085 | 21205 | 1310 | 25240 | 837 | 19086 |
| 12-#14 | 3.25 | MA | 13268 | 4611 | 22192 | 3309 | 24049 | 2678 | 24751 | 2168 | 25140 | 1366 | 30366 | 879 | 23241 |
| 5L-3S | | MI | 11525 | 4611 | 19506 | 3234 | 21161 | 2612 | 21871 | 2097 | 22720 | 1297 | 26910 | 953 | 19482 |
| 12-#14 | 3.25 | MA | 12755 | 4611 | 21333 | 3301 | 22862 | 2668 | 23369 | 2180 | 23302 | 1379 | 28125 | 796 | 22317 |
| 6L-2S | | MI | 12175 | 4611 | 20493 | 3244 | 22412 | 2599 | 23366 | 2085 | 24704 | 1285 | 29480 | 1078 | 19485 |
| 12-#18 | 5.77 | MA | 15201 | 5337 | 27127 | 3747 | 30288 | 2966 | 32147 | 2313 | 35141 | 1273 | 43360 | 497 | 39134 |
| 4E | | MI | 12052 | 5337 | 21742 | 3666 | 23761 | 2869 | 24965 | 2211 | 26997 | 1165 | 32751 | 335 | 30459 |
| 12-#18 | 5.77 | MA | 14291 | 5337 | 25528 | 3731 | 28217 | 2989 | 29654 | 2335 | 31650 | 1251 | 39260 | 400 | 36764 |
| 5L-3S | | MI | 12851 | 5337 | 23166 | 3644 | 25511 | 2891 | 27038 | 2233 | 29570 | 1143 | 35574 | 533 | 32641 |
| 14-#11 | 2.63 | MA | 14052 | 4433 | 23102 | 3203 | 25275 | 2600 | 26278 | 2126 | 27199 | 1396 | 32446 | 1158 | 20316 |
| 3L-6S | | MI | 10351 | 4433 | 17152 | 3140 | 18213 | 2539 | 18415 | 2076 | 18152 | 1346 | 21480 | 896 | 15383 |
| 14-#11 | 2.63 | MA | 13629 | 4433 | 22365 | 3215 | 24337 | 2594 | 25138 | 2118 | 25772 | 1405 | 30854 | 1071 | 20260 |
| 4L-5S | | MI | 10638 | 4433 | 17624 | 3146 | 18861 | 2548 | 19148 | 2068 | 19127 | 1338 | 22652 | 953 | 15653 |
| 14-#11 | 2.63 | MA | 13249 | 4433 | 21726 | 3211 | 23509 | 2605 | 24121 | 2127 | 24340 | 1396 | 29157 | 1034 | 19736 |
| 5L-4S | | MI | 10939 | 4433 | 18124 | 3153 | 19506 | 2539 | 19919 | 2059 | 20207 | 1346 | 23913 | 992 | 16057 |
| 14-#11 | 2.63 | MA | 12887 | 4433 | 21126 | 3206 | 22679 | 2598 | 23153 | 2137 | 23044 | 1405 | 27570 | 977 | 19312 |
| 6L-3S | | MI | 11272 | 4433 | 18699 | 3142 | 20236 | 2548 | 20782 | 2068 | 21281 | 1338 | 25100 | 1073 | 16069 |
| 14-#11 | 2.63 | MA | 12534 | 4433 | 20469 | 3219 | 21886 | 2609 | 22134 | 2128 | 21778 | 1414 | 25872 | 887 | 18717 |
| 7L-2S | | MI | 11732 | 4433 | 19394 | 3149 | 21123 | 2539 | 21842 | 2059 | 22687 | 1329 | 26929 | 1160 | 16047 |
| 14-#14 | 3.79 | MA | 14377 | 4767 | 24385 | 3413 | 26874 | 2733 | 28200 | 2198 | 29819 | 1361 | 36254 | 894 | 28025 |
| 4L-5S | | MI | 11061 | 4767 | 18958 | 3335 | 20472 | 2680 | 21060 | 2135 | 21665 | 1273 | 26039 | 731 | 21337 |
| 14-#14 | 3.79 | MA | 13843 | 4767 | 23471 | 3406 | 25689 | 2748 | 26749 | 2210 | 27789 | 1348 | 33851 | 840 | 27055 |
| 5L-4S | | MI | 11484 | 4767 | 19673 | 3345 | 21383 | 2668 | 22147 | 2122 | 23189 | 1286 | 27810 | 787 | 21966 |
| 14-#14 | 3.79 | MA | 13334 | 4767 | 22612 | 3399 | 24502 | 2738 | 25367 | 2222 | 25951 | 1361 | 31610 | 758 | 26032 |
| 6L-3S | | MI | 11952 | 4767 | 20493 | 3331 | 22412 | 2680 | 23366 | 2135 | 24704 | 1273 | 29480 | 902 | 22542 |
| 14-#14 | 3.79 | MA | 12839 | 4767 | 21672 | 3416 | 23368 | 2753 | 23910 | 2210 | 24155 | 1373 | 29508 | 662 | 24997 |
| 7L-2S | | MI | 12599 | 4767 | 21481 | 3342 | 23663 | 2668 | 24861 | 2122 | 26687 | 1261 | 32049 | 1027 | 22579 |
| 14-#18 | 6.73 | MA | 15261 | 5614 | 27753 | 3904 | 31070 | 3113 | 33084 | 2407 | 36199 | 1214 | 45208 | 322 | 43136 |
| 5L-4S | | MI | 12774 | 5614 | 23448 | 3839 | 25886 | 2987 | 27505 | 2273 | 30368 | 1116 | 37078 | 234 | 35457 |
| 16-#11 | 3.00 | MA | 14033 | 4541 | 23262 | 3283 | 25486 | 2642 | 26540 | 2148 | 27639 | 1393 | 33319 | 1046 | 23026 |
| 4L-6S | | MI | 10660 | 4541 | 17847 | 3207 | 19100 | 2587 | 19475 | 2103 | 19558 | 1331 | 23309 | 863 | 17471 |
| 16-#11 | 3.00 | MA | 13656 | 4541 | 22623 | 3278 | 24658 | 2653 | 25523 | 2157 | 26208 | 1385 | 31622 | 1009 | 22413 |
| 5E | | MI | 10945 | 4541 | 18318 | 3214 | 19748 | 2596 | 20208 | 2095 | 20533 | 1322 | 24482 | 920 | 17724 |
| 16-#11 | 3.00 | MA | 13296 | 4541 | 22023 | 3274 | 23828 | 2647 | 24555 | 2166 | 24912 | 1393 | 30035 | 952 | 22012 |
| 6L-4S | | MI | 11244 | 4541 | 18819 | 3220 | 20393 | 2587 | 20979 | 2086 | 21613 | 1331 | 25743 | 959 | 18207 |
| 16-#11 | 3.00 | MA | 12945 | 4541 | 21366 | 3286 | 23036 | 2658 | 23536 | 2158 | 23646 | 1402 | 28337 | 861 | 21356 |
| 7L-3S | | MI | 11576 | 4541 | 19394 | 3210 | 21123 | 2596 | 21842 | 2095 | 22687 | 1322 | 26929 | 1040 | 18238 |
| 16-#11 | 3.00 | MA | 12600 | 4541 | 20775 | 3282 | 22232 | 2651 | 22585 | 2167 | 22396 | 1411 | 26751 | 817 | 20795 |
| 8L-2S | | MI | 12034 | 4541 | 20088 | 3217 | 22010 | 2587 | 22902 | 2086 | 24093 | 1313 | 28758 | 1127 | 18228 |
| 16-#14 | 4.33 | MA | 14412 | 4922 | 24750 | 3503 | 27329 | 2818 | 28746 | 2252 | 30437 | 1330 | 37337 | 801 | 30880 |
| 5E | | MI | 11491 | 4922 | 19946 | 3432 | 21723 | 2748 | 22555 | 2172 | 23649 | 1249 | 28609 | 680 | 24280 |

## RECTANGULAR TIED COLUMNS 26" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 4.33 | MA | 13907 | 4922 | 23891 | 3496 | 26142 | 2808 | 27364 | 2265 | 28599 | 1343 | 35095 | 719 | 29763 |
| 6L-4S | | MI | 11911 | 4922 | 20661 | 3443 | 22634 | 2736 | 23642 | 2160 | 25173 | 1262 | 30380 | 736 | 24861 |
| 16-#14 | 4.33 | MA | 13416 | 4922 | 22951 | 3513 | 25008 | 2823 | 25908 | 2252 | 26804 | 1355 | 32993 | 624 | 28729 |
| 7L-3S | | MI | 12377 | 4922 | 21481 | 3428 | 23663 | 2748 | 24861 | 2172 | 26687 | 1249 | 32049 | 852 | 25592 |
| 18-#11 | 3.37 | MA | 14059 | 4648 | 23519 | 3346 | 25807 | 2702 | 26925 | 2186 | 28075 | 1373 | 34087 | 984 | 25097 |
| 5L-6S | | MI | 10966 | 4648 | 18541 | 3274 | 19987 | 2636 | 20535 | 2130 | 20964 | 1315 | 25139 | 830 | 19562 |
| 18-#11 | 3.37 | MA | 13702 | 4648 | 22919 | 3341 | 24977 | 2695 | 25957 | 2195 | 26780 | 1382 | 32500 | 927 | 24716 |
| 6L-5S | | MI | 11251 | 4648 | 19012 | 3281 | 20635 | 2644 | 21268 | 2122 | 21939 | 1307 | 26311 | 887 | 19800 |
| 18-#11 | 3.37 | MA | 13353 | 4648 | 22262 | 3354 | 24185 | 2706 | 24938 | 2187 | 25513 | 1390 | 30802 | 836 | 24003 |
| 7L-4S | | MI | 11548 | 4648 | 19513 | 3288 | 21280 | 2636 | 22039 | 2113 | 23019 | 1315 | 27572 | 926 | 20319 |
| 18-#11 | 3.37 | MA | 13010 | 4648 | 21671 | 3349 | 23381 | 2700 | 23987 | 2196 | 24264 | 1399 | 29217 | 792 | 23409 |
| 8L-3S | | MI | 11878 | 4648 | 20088 | 3277 | 22010 | 2644 | 22902 | 2122 | 24093 | 1307 | 28758 | 1007 | 20396 |
| 18-#14 | 4.87 | MA | 14477 | 5078 | 25170 | 3593 | 27782 | 2878 | 29362 | 2307 | 31248 | 1325 | 38581 | 680 | 33508 |
| 6L-5S | | MI | 11918 | 5078 | 20933 | 3529 | 22975 | 2817 | 24051 | 2210 | 25632 | 1225 | 31178 | 629 | 27231 |
| 18-#14 | 4.87 | MA | 13988 | 5078 | 24230 | 3611 | 26648 | 2893 | 27906 | 2294 | 29453 | 1337 | 36479 | 585 | 32411 |
| 7L-4S | | MI | 12335 | 5078 | 21648 | 3540 | 23885 | 2804 | 25137 | 2198 | 27156 | 1238 | 32949 | 685 | 27770 |
| 20-#11 | 3.75 | MA | 14105 | 4756 | 23816 | 3409 | 26127 | 2744 | 27359 | 2225 | 28647 | 1370 | 34966 | 902 | 27423 |
| 6E | | MI | 11272 | 4756 | 19235 | 3342 | 20874 | 2684 | 21595 | 2157 | 22370 | 1300 | 26968 | 797 | 21589 |
| 20-#11 | 3.75 | MA | 13758 | 4756 | 23159 | 3421 | 25334 | 2754 | 26340 | 2217 | 27381 | 1379 | 33268 | 811 | 26658 |
| 7L-5S | | MI | 11555 | 4756 | 19706 | 3349 | 21522 | 2692 | 22328 | 2148 | 23345 | 1291 | 28140 | 854 | 21881 |
| 20-#11 | 3.75 | MA | 13417 | 4756 | 22568 | 3417 | 24530 | 2748 | 25389 | 2226 | 26132 | 1387 | 31682 | 766 | 26020 |
| 8L-4S | | MI | 11851 | 4756 | 20207 | 3355 | 22167 | 2684 | 23099 | 2140 | 24425 | 1300 | 29401 | 893 | 22367 |
| 20-#14 | 5.41 | MA | 14557 | 5234 | 25510 | 3708 | 28288 | 2963 | 29903 | 2336 | 32101 | 1319 | 39964 | 546 | 36105 |
| 7L-5S | | MI | 12342 | 5234 | 21921 | 3627 | 24226 | 2885 | 25546 | 2248 | 27616 | 1201 | 33748 | 579 | 30187 |
| 22-#11 | 4.13 | MA | 14161 | 4864 | 24055 | 3489 | 26483 | 2803 | 27742 | 2246 | 29249 | 1367 | 35733 | 786 | 29319 |
| 7L-6S | | MI | 11575 | 4864 | 19929 | 3409 | 21761 | 2732 | 22655 | 2184 | 23776 | 1284 | 28797 | 764 | 23612 |
| 22-#11 | 4.13 | MA | 13822 | 4864 | 23464 | 3484 | 25679 | 2797 | 26791 | 2255 | 27999 | 1376 | 34147 | 741 | 28638 |
| 8L-5S | | MI | 11857 | 4864 | 20400 | 3416 | 22409 | 2741 | 23388 | 2175 | 24751 | 1276 | 29970 | 822 | 23965 |
| 24-#11 | 4.50 | MA | 14224 | 4972 | 24361 | 3551 | 26829 | 2845 | 28193 | 2285 | 29867 | 1364 | 36613 | 716 | 31264 |
| 8L-6S | | MI | 11878 | 4972 | 20623 | 3477 | 22648 | 2780 | 23715 | 2211 | 25182 | 1269 | 30627 | 731 | 25643 |

## RECTANGULAR TIED COLUMNS 26" x 34"

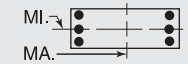
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#14 | 1.02 | MA | 14572 | 4218 | 22752 | 3103 | 24278 | 2533 | 24480 | 2118 | 23805 | 1529 | 27526 | 1439 | 9272 |
| 2E | | MI | 11048 | 4219 | 17454 | 3022 | 18339 | 2463 | 18285 | 2051 | 17569 | 1470 | 20080 | 1367 | 6984 |
| 4-#18 | 1.81 | MA | 15481 | 4461 | 24879 | 3228 | 26889 | 2620 | 27578 | 2162 | 27863 | 1481 | 32795 | 1353 | 15890 |
| 2E | | MI | 11661 | 4461 | 18960 | 3138 | 20067 | 2533 | 20313 | 2076 | 20252 | 1403 | 23463 | 1247 | 11784 |
| 6-#11 | 1.06 | MA | 14645 | 4231 | 22847 | 3124 | 24460 | 2549 | 24723 | 2130 | 24172 | 1537 | 28041 | 1448 | 9654 |
| 2L-3S | | MI | 10634 | 4231 | 16831 | 3040 | 17620 | 2493 | 17444 | 2077 | 16459 | 1490 | 18665 | 1292 | 7316 |
| 6-#11 | 1.06 | MA | 13990 | 4231 | 21883 | 3120 | 23224 | 2561 | 23215 | 2140 | 22150 | 1546 | 25363 | 1361 | 9707 |
| 3L-2S | | MI | 11104 | 4231 | 17525 | 3047 | 18507 | 2484 | 18504 | 2068 | 17865 | 1481 | 20495 | 1378 | 7261 |
| 6-#14 | 1.53 | MA | 15204 | 4374 | 24128 | 3201 | 26043 | 2603 | 26632 | 2160 | 26676 | 1513 | 31317 | 1403 | 13639 |
| 2L-3S | | MI | 10822 | 4374 | 17454 | 3108 | 18339 | 2543 | 18285 | 2101 | 17569 | 1459 | 20080 | 1191 | 10243 |
| 6-#14 | 1.53 | MA | 14277 | 4374 | 22752 | 3194 | 24278 | 2618 | 24480 | 2173 | 23805 | 1525 | 27526 | 1278 | 13695 |
| 3L-2S | | MI | 11486 | 4374 | 18441 | 3119 | 19591 | 2531 | 19780 | 2088 | 19553 | 1446 | 22650 | 1316 | 10165 |
| 6-#18 | 2.71 | MA | 16549 | 4737 | 27277 | 3401 | 29964 | 2744 | 31306 | 2236 | 32808 | 1447 | 39287 | 1281 | 23434 |
| 2L-3S | | MI | 11266 | 4737 | 18960 | 3290 | 20067 | 2673 | 20313 | 2161 | 20252 | 1376 | 23463 | 924 | 17254 |
| 6-#18 | 2.71 | MA | 14963 | 4737 | 24879 | 3387 | 26889 | 2769 | 27578 | 2258 | 27863 | 1469 | 32795 | 1059 | 23344 |
| 3L-2S | | MI | 12395 | 4737 | 20666 | 3311 | 22192 | 2651 | 22853 | 2138 | 23623 | 1354 | 27790 | 1145 | 17209 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis

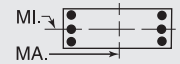



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.41 | MA | 15091 | 4339 | 23811 | 3192 | 25695 | 2598 | 26230 | 2160 | 26194 | 1527 | 30719 | 1424 | 12708 |
| 2L-4S | | MI | 10607 | 4339 | 16950 | 3118 | 17777 | 2533 | 17640 | 2095 | 16791 | 1483 | 19308 | 1177 | 9595 |
| 8-#11 | 1.41 | MA | 14439 | 4339 | 22847 | 3188 | 24460 | 2609 | 24723 | 2169 | 24172 | 1535 | 28041 | 1338 | 12749 |
| 3E | | MI | 10946 | 4339 | 17525 | 3107 | 18507 | 2541 | 18504 | 2104 | 17865 | 1474 | 20495 | 1259 | 9542 |
| 8-#11 | 1.41 | MA | 13976 | 4339 | 22057 | 3201 | 23453 | 2603 | 23499 | 2162 | 22627 | 1544 | 26308 | 1252 | 12768 |
| 4L-2S | | MI | 11414 | 4339 | 18219 | 3114 | 19394 | 2533 | 19564 | 2095 | 19271 | 1465 | 22324 | 1345 | 9491 |
| 8-#14 | 2.04 | MA | 15829 | 4530 | 25505 | 3298 | 27808 | 2672 | 28785 | 2202 | 29547 | 1496 | 35109 | 1367 | 17976 |
| 2L-4S | | MI | 10781 | 4530 | 17621 | 3220 | 18561 | 2599 | 18561 | 2126 | 18038 | 1447 | 20980 | 1025 | 13382 |
| 8-#14 | 2.04 | MA | 14909 | 4530 | 24128 | 3291 | 26043 | 2688 | 26632 | 2216 | 26676 | 1508 | 31317 | 1242 | 17999 |
| 3E | | MI | 11260 | 4530 | 18441 | 3206 | 19591 | 2612 | 19780 | 2138 | 19553 | 1435 | 22650 | 1141 | 13368 |
| 8-#14 | 2.04 | MA | 14254 | 4530 | 22998 | 3310 | 24603 | 2679 | 24883 | 2204 | 24482 | 1521 | 28868 | 1118 | 17905 |
| 4L-2S | | MI | 11920 | 4530 | 19429 | 3216 | 20842 | 2599 | 21275 | 2126 | 21536 | 1422 | 25219 | 1265 | 13310 |
| 8-#18 | 3.62 | MA | 17601 | 5014 | 29676 | 3574 | 33039 | 2868 | 35035 | 2309 | 37752 | 1414 | 45778 | 1209 | 30925 |
| 2L-4S | | MI | 11186 | 5014 | 19243 | 3485 | 20442 | 2768 | 20781 | 2201 | 21050 | 1350 | 24968 | 624 | 20837 |
| 8-#18 | 3.62 | MA | 16033 | 5014 | 27277 | 3560 | 29964 | 2893 | 31306 | 2332 | 32808 | 1436 | 39287 | 987 | 30718 |
| 3E | | MI | 12002 | 5014 | 20666 | 3462 | 22192 | 2791 | 22853 | 2223 | 23623 | 1328 | 27790 | 822 | 22529 |
| 8-#18 | 3.62 | MA | 14915 | 5014 | 25301 | 3591 | 27447 | 2875 | 28270 | 2309 | 29030 | 1458 | 35092 | 769 | 28348 |
| 4L-2S | | MI | 13121 | 5014 | 22373 | 3484 | 24317 | 2768 | 25393 | 2201 | 26994 | 1306 | 32118 | 1043 | 22583 |
| 10-#11 | 1.76 | MA | 15532 | 4447 | 24775 | 3259 | 26931 | 2646 | 27738 | 2189 | 28216 | 1516 | 33398 | 1401 | 15746 |
| 2L-5S | | MI | 10615 | 4447 | 17144 | 3179 | 18019 | 2589 | 17929 | 2131 | 17118 | 1459 | 19876 | 1106 | 11675 |
| 10-#11 | 1.76 | MA | 14884 | 4447 | 23811 | 3255 | 25695 | 2658 | 26230 | 2199 | 26194 | 1525 | 30719 | 1315 | 15775 |
| 3L-4S | | MI | 10919 | 4447 | 17644 | 3185 | 18664 | 2581 | 18700 | 2122 | 18198 | 1467 | 21137 | 1144 | 11783 |
| 10-#11 | 1.76 | MA | 14424 | 4447 | 23021 | 3268 | 24689 | 2652 | 25007 | 2191 | 24649 | 1533 | 28986 | 1228 | 15765 |
| 4L-3S | | MI | 11257 | 4447 | 18219 | 3175 | 19394 | 2589 | 19564 | 2131 | 19271 | 1459 | 22324 | 1226 | 11747 |
| 10-#11 | 1.76 | MA | 14012 | 4447 | 22336 | 3264 | 23801 | 2663 | 23916 | 2201 | 23100 | 1525 | 27148 | 1190 | 15541 |
| 5L-2S | | MI | 11722 | 4447 | 18913 | 3182 | 20281 | 2581 | 20624 | 2122 | 20677 | 1450 | 24153 | 1312 | 11703 |
| 10-#14 | 2.55 | MA | 16448 | 4685 | 26881 | 3395 | 29572 | 2742 | 30938 | 2245 | 32418 | 1480 | 38901 | 1331 | 22294 |
| 2L-5S | | MI | 10789 | 4685 | 17894 | 3307 | 18902 | 2680 | 18969 | 2176 | 18498 | 1411 | 21779 | 918 | 15649 |
| 10-#14 | 2.55 | MA | 15534 | 4685 | 25505 | 3389 | 27808 | 2758 | 28785 | 2258 | 29547 | 1492 | 35109 | 1207 | 22277 |
| 3L-4S | | MI | 11219 | 4685 | 18609 | 3317 | 19812 | 2668 | 20056 | 2163 | 20022 | 1423 | 23550 | 974 | 16428 |
| 10-#14 | 2.55 | MA | 14885 | 4685 | 24375 | 3407 | 26368 | 2749 | 27036 | 2247 | 27353 | 1504 | 32660 | 1082 | 22136 |
| 4L-3S | | MI | 11695 | 4685 | 19429 | 3303 | 20842 | 2680 | 21275 | 2176 | 21536 | 1411 | 25219 | 1090 | 16470 |
| 10-#14 | 2.55 | MA | 14302 | 4685 | 23394 | 3401 | 25097 | 2765 | 25475 | 2260 | 25152 | 1492 | 30051 | 1028 | 20974 |
| 5L-2S | | MI | 12350 | 4685 | 20416 | 3313 | 22093 | 2668 | 22770 | 2163 | 23520 | 1398 | 27789 | 1215 | 16433 |
| 10-#18 | 4.52 | MA | 17089 | 5290 | 29676 | 3733 | 33039 | 3018 | 35035 | 2405 | 37752 | 1402 | 45778 | 915 | 38072 |
| 3L-4S | | MI | 11922 | 5290 | 20949 | 3658 | 22567 | 2886 | 23321 | 2263 | 24421 | 1301 | 29295 | 522 | 25761 |
| 10-#18 | 4.52 | MA | 15984 | 5290 | 27699 | 3764 | 30521 | 2999 | 31999 | 2383 | 33974 | 1424 | 41584 | 697 | 35340 |
| 4L-3S | | MI | 12731 | 5290 | 22373 | 3635 | 24317 | 2908 | 25393 | 2285 | 26994 | 1279 | 32118 | 720 | 27774 |
| 10-#18 | 4.52 | MA | 14995 | 5290 | 25982 | 3750 | 28296 | 3024 | 29289 | 2405 | 30182 | 1402 | 37108 | 601 | 33203 |
| 5L-2S | | MI | 13840 | 5290 | 24080 | 3657 | 26441 | 2886 | 27934 | 2263 | 30365 | 1257 | 36445 | 942 | 27918 |
| 12-#11 | 2.12 | MA | 15971 | 4555 | 25739 | 3327 | 28167 | 2695 | 29245 | 2218 | 30238 | 1505 | 36076 | 1378 | 18775 |
| 2L-6S | | MI | 10637 | 4555 | 17367 | 3239 | 18258 | 2629 | 18256 | 2166 | 17549 | 1452 | 20534 | 1015 | 13424 |
| 12-#11 | 2.12 | MA | 15326 | 4555 | 24775 | 3323 | 26931 | 2706 | 27738 | 2228 | 28216 | 1514 | 33398 | 1291 | 18791 |
| 3L-5S | | MI | 10927 | 4555 | 17838 | 3246 | 18906 | 2637 | 18989 | 2158 | 18524 | 1443 | 21706 | 1073 | 13726 |
| 12-#11 | 2.12 | MA | 14869 | 4555 | 23985 | 3336 | 25924 | 2700 | 26514 | 2221 | 26671 | 1523 | 31665 | 1205 | 18753 |
| 4E | | MI | 11229 | 4555 | 18339 | 3253 | 19551 | 2629 | 19760 | 2149 | 19604 | 1452 | 22967 | 1111 | 13959 |
| 12-#11 | 2.12 | MA | 14459 | 4555 | 23300 | 3332 | 25036 | 2712 | 25424 | 2231 | 25122 | 1514 | 29827 | 1167 | 18398 |
| 5L-3S | | MI | 11565 | 4555 | 18913 | 3242 | 20281 | 2637 | 20624 | 2158 | 20677 | 1443 | 24153 | 1193 | 13938 |
| 12-#11 | 2.12 | MA | 14069 | 4555 | 22657 | 3328 | 24147 | 2706 | 24337 | 2223 | 23718 | 1523 | 28101 | 1110 | 17878 |
| 6L-2S | | MI | 12028 | 4555 | 19608 | 3249 | 21168 | 2629 | 21684 | 2149 | 22083 | 1434 | 25983 | 1279 | 13903 |
| 12-#14 | 3.05 | MA | 16154 | 4841 | 26881 | 3486 | 29572 | 2828 | 30938 | 2301 | 32418 | 1475 | 38901 | 1171 | 26542 |
| 3L-5S | | MI | 11226 | 4841 | 18881 | 3404 | 20153 | 2748 | 20464 | 2213 | 20482 | 1387 | 24348 | 868 | 18572 |
| 12-#14 | 3.05 | MA | 15509 | 4841 | 25751 | 3504 | 28132 | 2819 | 29188 | 2289 | 30224 | 1488 | 36452 | 1046 | 26269 |
| 4E | | MI | 11653 | 4841 | 19596 | 3414 | 21064 | 2736 | 21551 | 2201 | 22005 | 1399 | 26119 | 924 | 19284 |
| 12-#14 | 3.05 | MA | 14932 | 4841 | 24771 | 3498 | 26862 | 2835 | 27627 | 2302 | 28023 | 1475 | 33843 | 992 | 25067 |
| 5L-3S | | MI | 12126 | 4841 | 20416 | 3400 | 22093 | 2748 | 22770 | 2213 | 23520 | 1387 | 27789 | 1039 | 19552 |
| 12-#14 | 3.05 | MA | 14381 | 4841 | 23850 | 3491 | 25588 | 2826 | 26142 | 2316 | 26031 | 1488 | 31402 | 910 | 24210 |
| 6L-2S | | MI | 12777 | 4841 | 21404 | 3411 | 23344 | 2736 | 24266 | 2201 | 25504 | 1374 | 30359 | 1164 | 19541 |

## RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

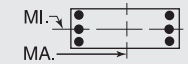
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 5.43 | MA | 17040 | 5567 | 30098 | 3937 | 33596 | 3123 | 35727 | 2457 | 38918 | 1391 | 48075 | 625 | 42376 |
| 4E | | MI | 12651 | 5567 | 22656 | 3831 | 24692 | 3004 | 25861 | 2325 | 27791 | 1253 | 33622 | 421 | 30726 |
| 12-#18 | 5.43 | MA | 16061 | 5567 | 28381 | 3923 | 31371 | 3148 | 33017 | 2479 | 35126 | 1369 | 43600 | 529 | 40049 |
| 5L-3S | | MI | 13453 | 5567 | 24080 | 3808 | 26441 | 3026 | 27934 | 2348 | 30365 | 1231 | 36445 | 619 | 33000 |
| 14-#11 | 2.47 | MA | 15765 | 4663 | 25739 | 3390 | 28167 | 2754 | 29245 | 2258 | 30238 | 1503 | 36076 | 1268 | 21790 |
| 3L-6S | | MI | 10948 | 4663 | 18061 | 3307 | 19145 | 2677 | 19316 | 2193 | 18955 | 1436 | 22363 | 983 | 15509 |
| 14-#11 | 2.47 | MA | 15311 | 4663 | 24949 | 3403 | 27160 | 2749 | 28022 | 2250 | 28693 | 1512 | 34343 | 1182 | 21734 |
| 4L-5S | | MI | 11236 | 4663 | 18532 | 3314 | 19793 | 2686 | 20049 | 2185 | 19930 | 1427 | 23535 | 1040 | 15788 |
| 14-#11 | 2.47 | MA | 14903 | 4663 | 24264 | 3399 | 26272 | 2760 | 26931 | 2260 | 27144 | 1503 | 32505 | 1143 | 21267 |
| 5L-4S | | MI | 11538 | 4663 | 19033 | 3320 | 20438 | 2677 | 20820 | 2176 | 21010 | 1436 | 24796 | 1078 | 16122 |
| 14-#11 | 2.47 | MA | 14515 | 4663 | 23621 | 3395 | 25383 | 2755 | 25844 | 2253 | 25740 | 1512 | 30779 | 1087 | 20777 |
| 6L-3S | | MI | 11871 | 4663 | 19608 | 3310 | 21168 | 2686 | 21684 | 2185 | 22083 | 1427 | 25983 | 1160 | 16120 |
| 14-#11 | 2.47 | MA | 14137 | 4663 | 22917 | 3408 | 24533 | 2766 | 24801 | 2263 | 24369 | 1521 | 28934 | 996 | 20228 |
| 7L-2S | | MI | 12333 | 4663 | 20302 | 3316 | 22055 | 2677 | 22744 | 2176 | 23489 | 1419 | 27812 | 1247 | 16094 |
| 14-#14 | 3.56 | MA | 16128 | 4997 | 27128 | 3602 | 29897 | 2889 | 31341 | 2331 | 33095 | 1471 | 40244 | 1010 | 30303 |
| 4L-5S | | MI | 11659 | 4997 | 19869 | 3501 | 21404 | 2817 | 21960 | 2251 | 22465 | 1363 | 26918 | 817 | 21507 |
| 14-#14 | 3.56 | MA | 15555 | 4997 | 26147 | 3595 | 28626 | 2905 | 29780 | 2345 | 30894 | 1459 | 37634 | 956 | 29175 |
| 5L-4S | | MI | 12084 | 4997 | 20584 | 3512 | 22315 | 2804 | 23047 | 2239 | 23989 | 1375 | 28689 | 873 | 22162 |
| 14-#14 | 3.56 | MA | 15009 | 4997 | 25226 | 3589 | 27353 | 2896 | 28295 | 2358 | 28902 | 1471 | 35193 | 874 | 28215 |
| 6L-3S | | MI | 12553 | 4997 | 21404 | 3497 | 23344 | 2817 | 24266 | 2251 | 25504 | 1363 | 30359 | 989 | 22617 |
| 14-#14 | 3.56 | MA | 14477 | 4997 | 24218 | 3607 | 26136 | 2911 | 26730 | 2347 | 26956 | 1484 | 32581 | 744 | 27029 |
| 7L-2S | | MI | 13201 | 4997 | 22391 | 3508 | 24595 | 2804 | 25761 | 2239 | 27487 | 1350 | 32928 | 1113 | 22643 |
| 14-#18 | 6.33 | MA | 17116 | 5844 | 30779 | 4096 | 34446 | 3273 | 36746 | 2553 | 40070 | 1335 | 50091 | 457 | 46935 |
| 5L-4S | | MI | 13374 | 5844 | 24363 | 4003 | 26817 | 3122 | 28401 | 2388 | 31162 | 1204 | 37949 | 319 | 35721 |
| 16-#11 | 2.82 | MA | 15749 | 4770 | 25913 | 3471 | 28396 | 2797 | 29529 | 2280 | 30715 | 1501 | 37021 | 1159 | 24711 |
| 4L-6S | | MI | 11257 | 4770 | 18755 | 3374 | 20032 | 2725 | 20376 | 2220 | 20361 | 1421 | 24192 | 950 | 17599 |
| 16-#11 | 2.82 | MA | 15344 | 4770 | 25228 | 3467 | 27508 | 2809 | 28439 | 2290 | 29166 | 1493 | 35183 | 1120 | 24146 |
| 5E | | MI | 11544 | 4770 | 19226 | 3381 | 20680 | 2734 | 21109 | 2212 | 21336 | 1412 | 25364 | 1007 | 17858 |
| 16-#11 | 2.82 | MA | 14958 | 4770 | 24585 | 3462 | 26618 | 2803 | 27352 | 2282 | 27763 | 1501 | 33458 | 1063 | 23682 |
| 6L-4S | | MI | 11844 | 4770 | 19727 | 3388 | 21325 | 2725 | 21880 | 2203 | 22416 | 1421 | 26625 | 1046 | 18276 |
| 16-#11 | 2.82 | MA | 14582 | 4770 | 23881 | 3476 | 25769 | 2814 | 26308 | 2292 | 26391 | 1510 | 31612 | 973 | 23070 |
| 7L-3S | | MI | 12176 | 4770 | 20302 | 3377 | 22055 | 2734 | 22744 | 2212 | 23489 | 1412 | 27812 | 1127 | 18295 |
| 16-#11 | 2.82 | MA | 14212 | 4770 | 23247 | 3472 | 24908 | 2809 | 25289 | 2302 | 24933 | 1501 | 29895 | 927 | 22429 |
| 8L-2S | | MI | 12635 | 4770 | 20996 | 3384 | 22942 | 2725 | 23804 | 2203 | 24896 | 1403 | 29641 | 1214 | 18278 |
| 16-#14 | 4.07 | MA | 16173 | 5152 | 27524 | 3692 | 30391 | 2974 | 31933 | 2387 | 33765 | 1442 | 41426 | 920 | 33294 |
| 5E | | MI | 12090 | 5152 | 20856 | 3598 | 22655 | 2885 | 23455 | 2289 | 24449 | 1339 | 29487 | 766 | 24451 |
| 16-#14 | 4.07 | MA | 15632 | 5152 | 26603 | 3686 | 29117 | 2965 | 30447 | 2401 | 31773 | 1455 | 38985 | 838 | 32236 |
| 6L-4S | | MI | 12511 | 5152 | 21571 | 3609 | 23566 | 2873 | 24542 | 2276 | 25973 | 1351 | 31259 | 822 | 25056 |
| 16-#14 | 4.07 | MA | 15104 | 5152 | 25595 | 3704 | 27901 | 2981 | 28882 | 2389 | 29827 | 1467 | 36373 | 708 | 31102 |
| 7L-3S | | MI | 12979 | 5152 | 22391 | 3595 | 24595 | 2885 | 25761 | 2289 | 27487 | 1339 | 32928 | 938 | 25673 |
| 18-#11 | 3.18 | MA | 15782 | 4878 | 26192 | 3534 | 28744 | 2857 | 29946 | 2319 | 31188 | 1482 | 37861 | 1097 | 27034 |
| 5L-6S | | MI | 11565 | 4878 | 19449 | 3442 | 20919 | 2773 | 21436 | 2247 | 21767 | 1405 | 26022 | 917 | 19691 |
| 18-#11 | 3.18 | MA | 15398 | 4878 | 25549 | 3530 | 27854 | 2851 | 28859 | 2312 | 29785 | 1491 | 36136 | 1040 | 26592 |
| 6L-5S | | MI | 11850 | 4878 | 19920 | 3448 | 21567 | 2782 | 22169 | 2238 | 22742 | 1396 | 27194 | 974 | 19935 |
| 18-#11 | 3.18 | MA | 15024 | 4878 | 24845 | 3543 | 27005 | 2863 | 27816 | 2321 | 28414 | 1499 | 34291 | 950 | 25919 |
| 7L-4S | | MI | 12149 | 4878 | 20421 | 3455 | 22212 | 2773 | 22940 | 2230 | 23822 | 1405 | 28455 | 1013 | 20425 |
| 18-#11 | 3.18 | MA | 14656 | 4878 | 24211 | 3539 | 26143 | 2857 | 26796 | 2331 | 26955 | 1491 | 32573 | 904 | 25304 |
| 8L-3S | | MI | 12479 | 4878 | 20996 | 3445 | 22942 | 2782 | 23804 | 2238 | 24896 | 1396 | 29641 | 1094 | 20459 |
| 18-#14 | 4.58 | MA | 16249 | 5308 | 27979 | 3783 | 30882 | 3035 | 32600 | 2443 | 34644 | 1438 | 42777 | 802 | 36271 |
| 6L-5S | | MI | 12517 | 5308 | 21844 | 3696 | 23906 | 2954 | 24950 | 2326 | 26432 | 1315 | 32057 | 716 | 27402 |
| 18-#14 | 4.58 | MA | 15725 | 5308 | 26971 | 3801 | 29666 | 3051 | 31035 | 2431 | 32698 | 1451 | 40165 | 672 | 35186 |
| 7L-4S | | MI | 12937 | 5308 | 22559 | 3706 | 24817 | 2941 | 26037 | 2314 | 27956 | 1327 | 33828 | 772 | 27963 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

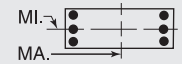
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 3.53 | MA | 15836 | 4986 | 26513 | 3597 | 29090 | 2900 | 30367 | 2341 | 31807 | 1480 | 38814 | 1017 | 29505 |
| 6E | | MI | 11870 | 4986 | 20143 | 3509 | 21806 | 2821 | 22496 | 2274 | 23173 | 1390 | 27851 | 884 | 21786 |
| 20-#11 | 3.53 | MA | 15464 | 4986 | 25809 | 3610 | 28240 | 2911 | 29323 | 2351 | 30436 | 1489 | 36969 | 927 | 28776 |
| 7L-5S | | MI | 12154 | 4986 | 20615 | 3516 | 22454 | 2830 | 23230 | 2265 | 24148 | 1381 | 29023 | 941 | 22016 |
| 20-#11 | 3.53 | MA | 15098 | 4986 | 25175 | 3606 | 27379 | 2906 | 28304 | 2361 | 28977 | 1480 | 35251 | 881 | 28183 |
| 8L-4S | | MI | 12452 | 4986 | 21115 | 3523 | 23099 | 2821 | 24000 | 2257 | 25228 | 1390 | 30284 | 980 | 22525 |
| 20-#14 | 5.09 | MA | 16342 | 5463 | 28348 | 3899 | 31430 | 3121 | 33188 | 2474 | 35569 | 1434 | 43957 | 636 | 39208 |
| 7L-5S | | MI | 12943 | 5463 | 22831 | 3793 | 25157 | 3022 | 26445 | 2364 | 28416 | 1291 | 34627 | 665 | 30359 |
| 22-#11 | 3.88 | MA | 15901 | 5094 | 26773 | 3678 | 29476 | 2960 | 30831 | 2380 | 32458 | 1478 | 39647 | 903 | 31640 |
| 7L-6S | | MI | 12175 | 5094 | 20838 | 3577 | 22693 | 2870 | 23556 | 2301 | 24579 | 1374 | 29680 | 851 | 23829 |
| 22-#11 | 3.88 | MA | 15537 | 5094 | 26139 | 3674 | 28615 | 2954 | 29811 | 2390 | 30999 | 1469 | 37930 | 858 | 31009 |
| 8L-5S | | MI | 12457 | 5094 | 21309 | 3583 | 23341 | 2878 | 24290 | 2292 | 25554 | 1365 | 30852 | 908 | 24101 |
| 24-#11 | 4.24 | MA | 15973 | 5202 | 27103 | 3741 | 29850 | 3002 | 31319 | 2420 | 33021 | 1459 | 40608 | 834 | 33836 |
| 8L-6S | | MI | 12478 | 5202 | 21532 | 3644 | 23580 | 2918 | 24616 | 2328 | 25985 | 1358 | 31510 | 818 | 25858 |

## RECTANGULAR TIED COLUMNS 26" x 36"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.71 | MA | 17268 | 4690 | 27600 | 3415 | 29851 | 2773 | 30637 | 2296 | 30891 | 1586 | 36373 | 1460 | 16970 |
| 2E | | MI | 12259 | 4690 | 19874 | 3303 | 20998 | 2668 | 21209 | 2191 | 21047 | 1491 | 24334 | 1332 | 11833 |
| 6-#11 | 1.00 | MA | 16360 | 4461 | 25413 | 3311 | 27235 | 2703 | 27516 | 2261 | 26880 | 1640 | 31180 | 1550 | 10286 |
| 2L-3S | | MI | 11232 | 4461 | 17739 | 3207 | 18552 | 2631 | 18345 | 2194 | 17262 | 1579 | 19548 | 1379 | 7347 |
| 6-#11 | 1.00 | MA | 15657 | 4461 | 24381 | 3308 | 25913 | 2715 | 25903 | 2271 | 24703 | 1649 | 28289 | 1463 | 10339 |
| 3L-2S | | MI | 11702 | 4461 | 18433 | 3214 | 19439 | 2622 | 19405 | 2185 | 18668 | 1571 | 21377 | 1465 | 7292 |
| 6-#14 | 1.44 | MA | 16965 | 4604 | 26788 | 3387 | 28934 | 2756 | 29565 | 2290 | 29585 | 1617 | 34735 | 1508 | 14550 |
| 2L-3S | | MI | 11420 | 4604 | 18364 | 3275 | 19271 | 2680 | 19184 | 2217 | 18369 | 1548 | 20959 | 1278 | 10285 |
| 6-#14 | 1.44 | MA | 15969 | 4604 | 25314 | 3382 | 27045 | 2773 | 27260 | 2305 | 26492 | 1629 | 30636 | 1383 | 14606 |
| 3L-2S | | MI | 12084 | 4604 | 19352 | 3285 | 20522 | 2668 | 20680 | 2205 | 20353 | 1536 | 23529 | 1402 | 10205 |
| 6-#18 | 2.56 | MA | 18423 | 4967 | 30171 | 3588 | 33147 | 2898 | 34658 | 2371 | 36230 | 1555 | 43409 | 1393 | 25054 |
| 2L-3S | | MI | 11864 | 4967 | 19874 | 3454 | 20998 | 2808 | 21209 | 2275 | 21047 | 1465 | 24334 | 1009 | 17336 |
| 6-#18 | 2.56 | MA | 16718 | 4967 | 27600 | 3576 | 29851 | 2925 | 30637 | 2393 | 30891 | 1577 | 36373 | 1172 | 24964 |
| 3L-2S | | MI | 12995 | 4967 | 21581 | 3476 | 23122 | 2786 | 23749 | 2253 | 24418 | 1442 | 28661 | 1230 | 17268 |
| 8-#11 | 1.33 | MA | 16840 | 4569 | 26444 | 3379 | 28557 | 2751 | 29129 | 2290 | 29056 | 1630 | 34072 | 1528 | 13550 |
| 2L-4S | | MI | 11205 | 4569 | 17859 | 3285 | 18709 | 2670 | 18541 | 2212 | 17594 | 1573 | 20191 | 1264 | 9636 |
| 8-#11 | 1.33 | MA | 16141 | 4569 | 25413 | 3375 | 27235 | 2763 | 27516 | 2301 | 26880 | 1639 | 31180 | 1442 | 13591 |
| 3E | | MI | 11544 | 4569 | 18433 | 3275 | 19439 | 2679 | 19405 | 2221 | 18668 | 1564 | 21377 | 1346 | 9579 |
| 8-#11 | 1.33 | MA | 15647 | 4569 | 24569 | 3389 | 26160 | 2758 | 26209 | 2294 | 25216 | 1648 | 29306 | 1355 | 13611 |
| 4L-2S | | MI | 12012 | 4569 | 19128 | 3281 | 20326 | 2670 | 20465 | 2212 | 20074 | 1555 | 23207 | 1432 | 9526 |
| 8-#14 | 1.92 | MA | 17640 | 4760 | 28261 | 3485 | 30823 | 2826 | 31869 | 2333 | 32679 | 1602 | 38834 | 1474 | 19191 |
| 2L-4S | | MI | 11379 | 4760 | 18532 | 3386 | 19493 | 2736 | 19460 | 2242 | 18838 | 1536 | 21859 | 1111 | 13451 |
| 8-#14 | 1.92 | MA | 16651 | 4760 | 26788 | 3479 | 28934 | 2843 | 29565 | 2347 | 29585 | 1614 | 34735 | 1350 | 19214 |
| 3E | | MI | 11859 | 4760 | 19352 | 3372 | 20522 | 2749 | 20680 | 2255 | 20353 | 1524 | 23529 | 1227 | 13418 |
| 8-#14 | 1.92 | MA | 15951 | 4760 | 25580 | 3498 | 27395 | 2835 | 27695 | 2337 | 27221 | 1626 | 32082 | 1225 | 19120 |
| 4L-2S | | MI | 12519 | 4760 | 20339 | 3382 | 21773 | 2736 | 22175 | 2242 | 22337 | 1512 | 26098 | 1352 | 13355 |
| 8-#18 | 3.42 | MA | 19561 | 5244 | 32742 | 3761 | 36444 | 3022 | 38680 | 2446 | 41569 | 1524 | 50445 | 1326 | 33085 |
| 2L-4S | | MI | 11783 | 5244 | 20157 | 3649 | 21373 | 2904 | 21677 | 2316 | 21844 | 1438 | 25839 | 709 | 21104 |
| 8-#18 | 3.42 | MA | 17875 | 5244 | 30171 | 3748 | 33147 | 3049 | 34658 | 2469 | 36230 | 1546 | 43409 | 1105 | 32878 |
| 3E | | MI | 12601 | 5244 | 21581 | 3627 | 23122 | 2926 | 23749 | 2338 | 24418 | 1416 | 28661 | 907 | 22625 |
| 8-#18 | 3.42 | MA | 16678 | 5244 | 28057 | 3780 | 30454 | 3032 | 31386 | 2447 | 32151 | 1569 | 38870 | 884 | 30590 |
| 4L-2S | | MI | 13723 | 5244 | 23288 | 3649 | 25247 | 2904 | 26290 | 2316 | 27789 | 1394 | 32989 | 1129 | 22650 |
| 10-#11 | 1.67 | MA | 17317 | 4677 | 27476 | 3446 | 29879 | 2800 | 30742 | 2319 | 31233 | 1621 | 36963 | 1506 | 16799 |
| 2L-5S | | MI | 11212 | 4677 | 18052 | 3346 | 18951 | 2727 | 18831 | 2248 | 17921 | 1548 | 20759 | 1193 | 11807 |
| 10-#11 | 1.67 | MA | 16622 | 4677 | 26444 | 3442 | 28557 | 2812 | 29129 | 2330 | 29056 | 1629 | 34072 | 1420 | 16828 |
| 3L-4S | | MI | 11517 | 4677 | 18553 | 3353 | 19596 | 2718 | 19601 | 2239 | 19000 | 1557 | 22020 | 1231 | 11830 |
| 10-#11 | 1.67 | MA | 16130 | 4677 | 25600 | 3456 | 27482 | 2807 | 27822 | 2323 | 27392 | 1638 | 32197 | 1334 | 16818 |
| 4L-3S | | MI | 11855 | 4677 | 19128 | 3342 | 20326 | 2727 | 20465 | 2248 | 20074 | 1548 | 23207 | 1313 | 11788 |

## RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

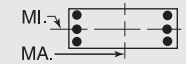
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.67 | MA | 15690 | 4677 | 24869 | 3452 | 26534 | 2819 | 26658 | 2334 | 25725 | 1629 | 30218 | 1294 | 16681 |
| 5L-2S | | MI | 12321 | 4677 | 19822 | 3349 | 21213 | 2718 | 21525 | 2239 | 21480 | 1540 | 25036 | 1399 | 11742 |
| 10-#14 | 2.40 | MA | 18308 | 4915 | 29735 | 3582 | 32713 | 2896 | 34174 | 2375 | 35773 | 1586 | 42933 | 1441 | 23813 |
| 2L-5S | | MI | 11386 | 4915 | 18805 | 3473 | 19834 | 2817 | 19869 | 2292 | 19298 | 1500 | 22657 | 1005 | 15814 |
| 10-#14 | 2.40 | MA | 17326 | 4915 | 28261 | 3576 | 30823 | 2913 | 31869 | 2390 | 32679 | 1599 | 38834 | 1317 | 23796 |
| 3L-4S | | MI | 11817 | 4915 | 19519 | 3483 | 20744 | 2805 | 20956 | 2280 | 20822 | 1512 | 24428 | 1061 | 16516 |
| 10-#14 | 2.40 | MA | 16632 | 4915 | 27054 | 3595 | 29284 | 2904 | 29999 | 2379 | 30315 | 1611 | 36181 | 1192 | 23655 |
| 4L-3S | | MI | 12294 | 4915 | 20339 | 3469 | 21773 | 2817 | 22175 | 2292 | 22337 | 1500 | 26098 | 1176 | 16527 |
| 10-#14 | 2.40 | MA | 16009 | 4915 | 26007 | 3589 | 27927 | 2921 | 28332 | 2393 | 27944 | 1599 | 33369 | 1136 | 22522 |
| 5L-2S | | MI | 12950 | 4915 | 21327 | 3480 | 23024 | 2805 | 23670 | 2280 | 24320 | 1488 | 28668 | 1301 | 16483 |
| 10-#18 | 4.27 | MA | 19016 | 5520 | 32742 | 3921 | 36444 | 3173 | 38680 | 2544 | 41569 | 1515 | 50445 | 1038 | 40772 |
| 3L-4S | | MI | 12520 | 5520 | 21864 | 3822 | 23498 | 3021 | 24217 | 2378 | 25215 | 1390 | 30166 | 608 | 26024 |
| 10-#18 | 4.27 | MA | 17833 | 5520 | 30628 | 3953 | 33750 | 3156 | 35407 | 2523 | 37490 | 1538 | 45906 | 817 | 38096 |
| 4L-3S | | MI | 13331 | 5520 | 23288 | 3800 | 25247 | 3043 | 26290 | 2400 | 27789 | 1368 | 32989 | 806 | 27882 |
| 10-#18 | 4.27 | MA | 16774 | 5520 | 28793 | 3941 | 31372 | 3183 | 32486 | 2545 | 33396 | 1515 | 41055 | 721 | 36028 |
| 5L-2S | | MI | 14443 | 5520 | 24995 | 3821 | 27372 | 3021 | 28830 | 2378 | 31160 | 1345 | 37316 | 1027 | 27997 |
| 12-#11 | 2.00 | MA | 17790 | 4784 | 28507 | 3513 | 31201 | 2848 | 32355 | 2349 | 33409 | 1611 | 39855 | 1485 | 20038 |
| 2L-6S | | MI | 11234 | 4784 | 18275 | 3407 | 19190 | 2767 | 19158 | 2283 | 18351 | 1541 | 21416 | 1102 | 13545 |
| 12-#11 | 2.00 | MA | 17098 | 4784 | 27476 | 3510 | 29879 | 2860 | 30742 | 2359 | 31233 | 1619 | 36963 | 1399 | 20054 |
| 3L-5S | | MI | 11524 | 4784 | 18746 | 3413 | 19838 | 2775 | 19891 | 2275 | 19327 | 1533 | 22588 | 1160 | 13857 |
| 12-#11 | 2.00 | MA | 16610 | 4784 | 26632 | 3523 | 28804 | 2855 | 29435 | 2353 | 29569 | 1628 | 35089 | 1312 | 20017 |
| 4E | | MI | 11828 | 4784 | 19247 | 3420 | 20483 | 2767 | 20661 | 2266 | 20406 | 1541 | 23849 | 1198 | 14012 |
| 12-#11 | 2.00 | MA | 16172 | 4784 | 25901 | 3520 | 27857 | 2867 | 28271 | 2363 | 27902 | 1619 | 33110 | 1273 | 19739 |
| 5L-3S | | MI | 12164 | 4784 | 19822 | 3410 | 21213 | 2775 | 21525 | 2275 | 21480 | 1533 | 25036 | 1280 | 13984 |
| 12-#11 | 2.00 | MA | 15755 | 4784 | 25215 | 3516 | 26907 | 2862 | 27111 | 2357 | 26391 | 1628 | 31245 | 1216 | 19146 |
| 6L-2S | | MI | 12628 | 4784 | 20516 | 3416 | 22100 | 2767 | 22585 | 2266 | 22886 | 1524 | 26865 | 1366 | 13945 |
| 12-#14 | 2.88 | MA | 17995 | 5071 | 29735 | 3673 | 32713 | 2982 | 34174 | 2432 | 35773 | 1584 | 42933 | 1283 | 28364 |
| 3L-5S | | MI | 11823 | 5071 | 19792 | 3570 | 21085 | 2885 | 21364 | 2330 | 21282 | 1476 | 25227 | 954 | 18736 |
| 12-#14 | 2.88 | MA | 17306 | 5071 | 28527 | 3692 | 31174 | 2974 | 32304 | 2422 | 33408 | 1596 | 40280 | 1159 | 28183 |
| 4E | | MI | 12251 | 5071 | 20507 | 3581 | 21995 | 2873 | 22451 | 2317 | 22805 | 1488 | 26998 | 1010 | 19477 |
| 12-#14 | 2.88 | MA | 16688 | 5071 | 27480 | 3687 | 29817 | 2991 | 30637 | 2436 | 31038 | 1584 | 37468 | 1103 | 26908 |
| 5L-3S | | MI | 12725 | 5071 | 21327 | 3566 | 23024 | 2885 | 23670 | 2330 | 24320 | 1476 | 28668 | 1126 | 19618 |
| 12-#14 | 2.88 | MA | 16100 | 5071 | 26498 | 3681 | 28457 | 2983 | 28976 | 2425 | 28891 | 1596 | 34826 | 1021 | 26131 |
| 6L-2S | | MI | 13378 | 5071 | 22314 | 3577 | 24275 | 2873 | 25165 | 2317 | 26304 | 1464 | 31237 | 1250 | 19595 |
| 12-#18 | 5.13 | MA | 18973 | 5797 | 33200 | 4126 | 37047 | 3280 | 39429 | 2598 | 42829 | 1507 | 52941 | 750 | 45648 |
| 4E | | MI | 13250 | 5797 | 23571 | 3995 | 25622 | 3139 | 26757 | 2440 | 28586 | 1341 | 34493 | 506 | 30986 |
| 12-#18 | 5.13 | MA | 17926 | 5797 | 31364 | 4114 | 34669 | 3307 | 36508 | 2620 | 38735 | 1485 | 48090 | 654 | 43389 |
| 5L-3S | | MI | 14055 | 5797 | 24995 | 3973 | 27372 | 3161 | 28830 | 2462 | 31160 | 1319 | 37316 | 704 | 33117 |
| 12-#18 | 5.13 | MA | 16931 | 5797 | 29640 | 4101 | 32285 | 3290 | 33727 | 2643 | 35031 | 1507 | 43564 | 508 | 40430 |
| 6L-2S | | MI | 15158 | 5797 | 26701 | 3994 | 29497 | 3139 | 31370 | 2440 | 34531 | 1297 | 41643 | 925 | 33302 |
| 14-#11 | 2.33 | MA | 17572 | 4892 | 28507 | 3577 | 31201 | 2909 | 32355 | 2389 | 33409 | 1610 | 39855 | 1377 | 23264 |
| 3L-6S | | MI | 11546 | 4892 | 18969 | 3474 | 20077 | 2815 | 20218 | 2310 | 19757 | 1526 | 23246 | 1069 | 15631 |
| 14-#11 | 2.33 | MA | 17086 | 4892 | 27663 | 3591 | 30126 | 2903 | 31048 | 2382 | 31746 | 1618 | 37980 | 1291 | 23209 |
| 4L-5S | | MI | 11834 | 4892 | 19440 | 3481 | 20725 | 2823 | 20951 | 2302 | 20733 | 1517 | 24418 | 1127 | 15919 |
| 14-#11 | 2.33 | MA | 16650 | 4892 | 26932 | 3587 | 29179 | 2916 | 29884 | 2393 | 30078 | 1610 | 36001 | 1251 | 22810 |
| 5L-4S | | MI | 12136 | 4892 | 19941 | 3488 | 21370 | 2815 | 21721 | 2293 | 21812 | 1526 | 25679 | 1165 | 16184 |
| 14-#11 | 2.33 | MA | 16236 | 4892 | 26246 | 3584 | 28230 | 2910 | 28724 | 2386 | 28568 | 1618 | 34137 | 1195 | 22250 |
| 6L-3S | | MI | 12471 | 4892 | 20516 | 3477 | 22100 | 2823 | 22585 | 2302 | 22886 | 1517 | 26865 | 1247 | 16169 |
| 14-#11 | 2.33 | MA | 15832 | 4892 | 25495 | 3597 | 27323 | 2922 | 27610 | 2396 | 27092 | 1627 | 32144 | 1105 | 21758 |
| 7L-2S | | MI | 12933 | 4892 | 21210 | 3484 | 22987 | 2815 | 23645 | 2293 | 24292 | 1509 | 28695 | 1333 | 16139 |
| 14-#14 | 3.37 | MA | 17974 | 5226 | 30001 | 3790 | 33063 | 3044 | 34609 | 2464 | 36502 | 1581 | 44379 | 1126 | 32605 |
| 4L-5S | | MI | 12257 | 5226 | 20779 | 3667 | 22336 | 2954 | 22859 | 2367 | 23265 | 1452 | 27797 | 903 | 21671 |
| 14-#14 | 3.37 | MA | 17361 | 5226 | 28954 | 3784 | 31706 | 3061 | 32942 | 2478 | 34132 | 1568 | 41567 | 1070 | 31309 |
| 5L-4S | | MI | 12683 | 5226 | 21494 | 3678 | 23246 | 2941 | 23946 | 2355 | 24789 | 1464 | 29568 | 959 | 22352 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis

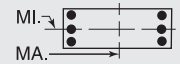



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 3.37 | MA | 16778 | 5226 | 27972 | 3778 | 30346 | 3053 | 31281 | 2468 | 31985 | 1581 | 38925 | 988 | 30426 |
| 6L-3S | | MI | 13154 | 5226 | 22314 | 3664 | 24275 | 2954 | 25165 | 2367 | 26304 | 1452 | 31237 | 1075 | 22689 |
| 14-#14 | 3.37 | MA | 16209 | 5226 | 26895 | 3797 | 29048 | 3069 | 29685 | 2482 | 29887 | 1593 | 36101 | 858 | 29081 |
| 7L-2S | | MI | 13803 | 5226 | 23302 | 3674 | 25526 | 2941 | 26661 | 2355 | 28288 | 1440 | 33807 | 1200 | 22695 |
| 14-#18 | 5.98 | MA | 19065 | 6074 | 33936 | 4287 | 37965 | 3431 | 40529 | 2696 | 44074 | 1454 | 55126 | 587 | 50789 |
| 5L-4S | | MI | 13975 | 6074 | 25277 | 4168 | 27747 | 3257 | 29297 | 2503 | 31957 | 1293 | 38821 | 404 | 35979 |
| 14-#18 | 5.98 | MA | 18081 | 6074 | 32212 | 4274 | 35581 | 3414 | 37749 | 2718 | 40370 | 1476 | 50600 | 442 | 47975 |
| 6L-3S | | MI | 14773 | 6074 | 26701 | 4145 | 29497 | 3279 | 31370 | 2525 | 34531 | 1270 | 41643 | 602 | 38157 |
| 16-#11 | 2.67 | MA | 17558 | 5000 | 28694 | 3658 | 31448 | 2952 | 32661 | 2412 | 33922 | 1608 | 40872 | 1269 | 26395 |
| 4L-6S | | MI | 11855 | 5000 | 19663 | 3542 | 20964 | 2863 | 21278 | 2337 | 21163 | 1510 | 25075 | 1037 | 17721 |
| 16-#11 | 2.67 | MA | 17126 | 5000 | 27964 | 3655 | 30501 | 2964 | 31497 | 2422 | 32255 | 1600 | 38893 | 1230 | 25891 |
| 5E | | MI | 12142 | 5000 | 20135 | 3548 | 21612 | 2871 | 22011 | 2328 | 22139 | 1502 | 26247 | 1094 | 17989 |
| 16-#11 | 2.67 | MA | 16714 | 5000 | 27278 | 3651 | 29552 | 2959 | 30337 | 2415 | 30745 | 1608 | 37028 | 1173 | 25360 |
| 6L-4S | | MI | 12443 | 5000 | 20635 | 3555 | 22258 | 2863 | 22781 | 2320 | 23218 | 1510 | 27508 | 1132 | 18342 |
| 16-#11 | 2.67 | MA | 16312 | 5000 | 26527 | 3665 | 28646 | 2971 | 29223 | 2426 | 29269 | 1617 | 35035 | 1083 | 24801 |
| 7L-3S | | MI | 12776 | 5000 | 21210 | 3544 | 22987 | 2871 | 23645 | 2328 | 24292 | 1502 | 28695 | 1214 | 18347 |
| 16-#11 | 2.67 | MA | 15917 | 5000 | 25851 | 3661 | 27727 | 2966 | 28136 | 2436 | 27699 | 1608 | 33186 | 1036 | 24077 |
| 8L-2S | | MI | 13236 | 5000 | 21904 | 3551 | 23874 | 2863 | 24705 | 2320 | 25698 | 1493 | 30524 | 1300 | 18326 |
| 16-#14 | 3.85 | MA | 18028 | 5382 | 30428 | 3881 | 33595 | 3131 | 35247 | 2521 | 37225 | 1553 | 45666 | 1037 | 35722 |
| 5E | | MI | 12689 | 5382 | 21767 | 3765 | 23587 | 3022 | 24355 | 2405 | 25249 | 1428 | 30366 | 853 | 24615 |
| 16-#14 | 3.85 | MA | 17449 | 5382 | 29445 | 3875 | 32236 | 3123 | 33586 | 2510 | 35078 | 1566 | 43024 | 955 | 34738 |
| 6L-4S | | MI | 13112 | 5382 | 22482 | 3775 | 24497 | 3010 | 25441 | 2392 | 26773 | 1440 | 32137 | 909 | 25245 |
| 16-#14 | 3.85 | MA | 16885 | 5382 | 28369 | 3894 | 30938 | 3139 | 31990 | 2525 | 32981 | 1578 | 40200 | 825 | 33449 |
| 7L-3S | | MI | 13580 | 5382 | 23302 | 3761 | 25526 | 3022 | 26661 | 2405 | 28288 | 1428 | 33807 | 1024 | 25750 |
| 16-#14 | 3.85 | MA | 16330 | 5382 | 27401 | 3889 | 29621 | 3131 | 30432 | 2539 | 30750 | 1566 | 37572 | 759 | 31974 |
| 8L-2S | | MI | 14226 | 5382 | 24289 | 3771 | 26777 | 3010 | 28156 | 2392 | 30271 | 1415 | 36377 | 1149 | 25786 |
| 16-#18 | 6.84 | MA | 19218 | 6350 | 34783 | 4447 | 38878 | 3538 | 41770 | 2794 | 45709 | 1445 | 57636 | 375 | 55516 |
| 6L-4S | | MI | 14694 | 6350 | 26984 | 4341 | 29872 | 3375 | 31837 | 2565 | 35328 | 1244 | 43148 | 303 | 40995 |
| 18-#11 | 3.00 | MA | 17598 | 5108 | 28995 | 3722 | 31823 | 3012 | 33110 | 2451 | 34431 | 1590 | 41784 | 1208 | 28982 |
| 5L-6S | | MI | 12163 | 5108 | 20358 | 3609 | 21851 | 2911 | 22338 | 2364 | 22570 | 1495 | 26904 | 1004 | 19815 |
| 18-#11 | 3.00 | MA | 17188 | 5108 | 28309 | 3718 | 30874 | 3007 | 31950 | 2445 | 32921 | 1599 | 39920 | 1152 | 28476 |
| 6L-5S | | MI | 12449 | 5108 | 20829 | 3616 | 22499 | 2920 | 23071 | 2355 | 23545 | 1486 | 28076 | 1061 | 20065 |
| 18-#11 | 3.00 | MA | 16789 | 5108 | 27558 | 3732 | 29968 | 3019 | 30836 | 2455 | 31445 | 1607 | 37927 | 1061 | 27854 |
| 7L-4S | | MI | 12748 | 5108 | 21330 | 3622 | 23145 | 2911 | 23841 | 2347 | 24624 | 1495 | 29337 | 1100 | 20494 |
| 18-#11 | 3.00 | MA | 16396 | 5108 | 26882 | 3728 | 29049 | 3014 | 29749 | 2466 | 29876 | 1599 | 36078 | 1015 | 27156 |
| 8L-3S | | MI | 13080 | 5108 | 21904 | 3612 | 23874 | 2920 | 24705 | 2355 | 25698 | 1486 | 30524 | 1181 | 20520 |
| 18-#11 | 3.00 | MA | 16007 | 5108 | 26155 | 3742 | 28154 | 3026 | 28612 | 2459 | 28413 | 1607 | 34270 | 961 | 26307 |
| 9L-2S | | MI | 13538 | 5108 | 22599 | 3619 | 24761 | 2911 | 25765 | 2347 | 27104 | 1478 | 32353 | 1268 | 20507 |
| 18-#14 | 4.33 | MA | 18115 | 5538 | 30919 | 3973 | 34125 | 3192 | 35891 | 2553 | 38172 | 1550 | 47123 | 922 | 39065 |
| 6L-5S | | MI | 13117 | 5538 | 22754 | 3862 | 24838 | 3090 | 25850 | 2442 | 27233 | 1404 | 32936 | 802 | 27567 |
| 18-#14 | 4.33 | MA | 17555 | 5538 | 29843 | 3992 | 32827 | 3209 | 34295 | 2567 | 36074 | 1563 | 44299 | 791 | 37827 |
| 7L-4S | | MI | 13538 | 5538 | 23469 | 3873 | 25748 | 3078 | 26937 | 2430 | 28756 | 1416 | 34707 | 858 | 28151 |
| 18-#14 | 4.33 | MA | 17004 | 5538 | 28875 | 3986 | 31510 | 3201 | 32737 | 2581 | 33843 | 1550 | 41671 | 725 | 36293 |
| 8L-3S | | MI | 14004 | 5538 | 24289 | 3858 | 26777 | 3090 | 28156 | 2442 | 30271 | 1404 | 36377 | 974 | 28803 |
| 20-#11 | 3.33 | MA | 17660 | 5216 | 29340 | 3786 | 32196 | 3056 | 33563 | 2474 | 35098 | 1589 | 42811 | 1130 | 31595 |
| 6E | | MI | 12469 | 5216 | 21052 | 3676 | 22738 | 2959 | 23398 | 2391 | 23976 | 1479 | 28734 | 971 | 21911 |
| 20-#11 | 3.33 | MA | 17263 | 5216 | 28589 | 3800 | 31290 | 3068 | 32449 | 2485 | 33622 | 1597 | 40819 | 1040 | 30914 |
| 7L-5S | | MI | 12754 | 5216 | 21523 | 3683 | 23386 | 2968 | 24131 | 2382 | 24951 | 1471 | 29906 | 1028 | 22147 |
| 20-#11 | 3.33 | MA | 16872 | 5216 | 27914 | 3796 | 30371 | 3063 | 31362 | 2495 | 32052 | 1589 | 38969 | 993 | 30240 |
| 8L-4S | | MI | 13052 | 5216 | 22024 | 3690 | 24032 | 2959 | 24901 | 2374 | 26030 | 1479 | 31167 | 1067 | 22642 |
| 20-#11 | 3.33 | MA | 16485 | 5216 | 27187 | 3810 | 29477 | 3075 | 30225 | 2489 | 30590 | 1597 | 37161 | 939 | 29352 |
| 9L-3S | | MI | 13382 | 5216 | 22599 | 3679 | 24761 | 2968 | 25765 | 2382 | 27104 | 1471 | 32353 | 1148 | 22679 |
| 20-#14 | 4.81 | MA | 18220 | 5693 | 31317 | 4089 | 34716 | 3279 | 36600 | 2609 | 39168 | 1548 | 48398 | 758 | 42214 |
| 7L-5S | | MI | 13543 | 5693 | 23742 | 3959 | 26089 | 3159 | 27345 | 2480 | 29216 | 1380 | 35506 | 751 | 30524 |
| 20-#14 | 4.81 | MA | 17673 | 5693 | 30349 | 4083 | 33399 | 3271 | 35042 | 2624 | 36937 | 1535 | 45770 | 692 | 40622 |
| 8L-4S | | MI | 13962 | 5693 | 24457 | 3970 | 26999 | 3146 | 28432 | 2468 | 30740 | 1392 | 37277 | 807 | 31069 |

## RECTANGULAR TIED COLUMNS 26" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.67 | MA | 17733 | 5324 | 29621 | 3867 | 32612 | 3116 | 34062 | 2514 | 35798 | 1588 | 43710 | 1018 | 33980 |
| 7L-6S | | MI | 12774 | 5324 | 21746 | 3744 | 23625 | 3007 | 24458 | 2418 | 25382 | 1464 | 30563 | 938 | 24010 |
| 22-#11 | 3.67 | MA | 17345 | 5324 | 28945 | 3863 | 31693 | 3111 | 32975 | 2525 | 34229 | 1579 | 41861 | 972 | 33330 |
| 8L-5S | | MI | 13058 | 5324 | 22217 | 3751 | 24273 | 3016 | 25191 | 2409 | 26357 | 1455 | 31735 | 995 | 24232 |
| 22-#11 | 3.67 | MA | 16960 | 5324 | 28218 | 3877 | 30799 | 3123 | 31838 | 2518 | 32766 | 1588 | 40053 | 918 | 32404 |
| 9L-4S | | MI | 13355 | 5324 | 22718 | 3757 | 24919 | 3007 | 25961 | 2401 | 27436 | 1464 | 32996 | 1034 | 24733 |
| 22-#14 | 5.29 | MA | 18337 | 5849 | 31822 | 4180 | 35289 | 3341 | 37347 | 2666 | 40031 | 1520 | 49869 | 659 | 44961 |
| 8L-5S | | MI | 13967 | 5849 | 24729 | 4057 | 27340 | 3227 | 28840 | 2518 | 31200 | 1356 | 38075 | 701 | 33486 |
| 24-#11 | 4.00 | MA | 17815 | 5432 | 29977 | 3931 | 33015 | 3159 | 34588 | 2554 | 36405 | 1569 | 44752 | 950 | 36424 |
| 8L-6S | | MI | 13078 | 5432 | 22440 | 3811 | 24512 | 3055 | 25518 | 2445 | 26788 | 1448 | 32392 | 905 | 26068 |
| 24-#11 | 4.00 | MA | 17432 | 5432 | 29249 | 3944 | 32121 | 3171 | 33451 | 2547 | 34943 | 1578 | 42944 | 896 | 35460 |
| 9L-5S | | MI | 13360 | 5432 | 22911 | 3818 | 25160 | 3064 | 26251 | 2436 | 27763 | 1440 | 33564 | 962 | 26321 |

## RECTANGULAR TIED COLUMNS 26" x 38"

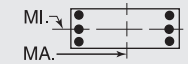
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.62 | MA | 19148 | 4920 | 30452 | 3602 | 32956 | 2927 | 33795 | 2426 | 34050 | 1691 | 40100 | 1566 | 18050 |
| 2E | | MI | 12858 | 4920 | 20789 | 3467 | 21928 | 2803 | 22105 | 2306 | 21841 | 1579 | 25205 | 1417 | 11882 |
| 6-#14 | 1.37 | MA | 18818 | 4834 | 29577 | 3574 | 31968 | 2910 | 32639 | 2421 | 32626 | 1721 | 38300 | 1611 | 15461 |
| 2L-3S | | MI | 12018 | 4834 | 19275 | 3441 | 20203 | 2817 | 20084 | 2333 | 19169 | 1637 | 21838 | 1364 | 10326 |
| 6-#14 | 1.37 | MA | 17754 | 4834 | 28006 | 3569 | 29954 | 2927 | 30182 | 2436 | 29310 | 1733 | 33893 | 1487 | 15518 |
| 3L-2S | | MI | 12683 | 4834 | 20262 | 3451 | 21454 | 2805 | 21579 | 2321 | 21153 | 1625 | 24407 | 1489 | 10243 |
| 6-#18 | 2.43 | MA | 20390 | 5197 | 33196 | 3775 | 36474 | 3051 | 38086 | 2502 | 39785 | 1663 | 47681 | 1504 | 26674 |
| 2L-3S | | MI | 12462 | 5197 | 20789 | 3618 | 21928 | 2943 | 22105 | 2390 | 21841 | 1553 | 25205 | 1094 | 17413 |
| 6-#18 | 2.43 | MA | 18566 | 5197 | 30452 | 3764 | 32956 | 3080 | 33795 | 2526 | 34050 | 1685 | 40100 | 1282 | 26584 |
| 3L-2S | | MI | 13595 | 5197 | 22495 | 3640 | 24053 | 2921 | 24645 | 2368 | 25212 | 1531 | 29532 | 1316 | 17326 |
| 8-#11 | 1.26 | MA | 18683 | 4799 | 29208 | 3565 | 31562 | 2905 | 32170 | 2421 | 32049 | 1734 | 37572 | 1631 | 14393 |
| 2L-4S | | MI | 11803 | 4799 | 18767 | 3453 | 19642 | 2808 | 19443 | 2329 | 18397 | 1662 | 21073 | 1351 | 9674 |
| 8-#11 | 1.26 | MA | 17936 | 4799 | 28109 | 3562 | 30153 | 2918 | 30451 | 2432 | 29718 | 1742 | 34467 | 1545 | 14434 |
| 3E | | MI | 12142 | 4799 | 19342 | 3442 | 20371 | 2817 | 20307 | 2338 | 19471 | 1654 | 22260 | 1433 | 9614 |
| 8-#11 | 1.26 | MA | 17410 | 4799 | 27212 | 3576 | 29010 | 2913 | 29061 | 2426 | 27936 | 1751 | 32451 | 1458 | 14453 |
| 4L-2S | | MI | 12611 | 4799 | 20036 | 3449 | 21258 | 2808 | 21367 | 2329 | 20877 | 1645 | 24089 | 1519 | 9561 |
| 8-#14 | 1.82 | MA | 19543 | 4989 | 31148 | 3671 | 33982 | 2980 | 35096 | 2463 | 35943 | 1706 | 42706 | 1580 | 20406 |
| 2L-4S | | MI | 11976 | 4989 | 19442 | 3553 | 20425 | 2873 | 20360 | 2358 | 19638 | 1626 | 22738 | 1198 | 13513 |
| 8-#14 | 1.82 | MA | 18487 | 4989 | 29577 | 3666 | 31968 | 2997 | 32639 | 2479 | 32626 | 1719 | 38300 | 1456 | 20429 |
| 3E | | MI | 12457 | 4989 | 20262 | 3538 | 21454 | 2885 | 21579 | 2371 | 21153 | 1613 | 24407 | 1313 | 13467 |
| 8-#14 | 1.82 | MA | 17740 | 4989 | 28292 | 3686 | 30330 | 2990 | 30649 | 2469 | 30091 | 1731 | 35443 | 1331 | 20335 |
| 4L-2S | | MI | 13118 | 4989 | 21250 | 3549 | 22705 | 2873 | 23074 | 2358 | 23137 | 1601 | 26977 | 1438 | 13399 |
| 8-#18 | 3.24 | MA | 21614 | 5474 | 35940 | 3948 | 39992 | 3175 | 42378 | 2577 | 45519 | 1634 | 55262 | 1441 | 35245 |
| 2L-4S | | MI | 12380 | 5474 | 21072 | 3813 | 22303 | 3039 | 22573 | 2430 | 22639 | 1526 | 26710 | 795 | 21364 |
| 8-#18 | 3.24 | MA | 19810 | 5474 | 33196 | 3936 | 36474 | 3204 | 38086 | 2601 | 39785 | 1656 | 47681 | 1220 | 35038 |
| 3E | | MI | 13200 | 5474 | 22495 | 3791 | 24053 | 3061 | 24645 | 2452 | 25212 | 1504 | 29532 | 993 | 22717 |
| 8-#18 | 3.24 | MA | 18533 | 5474 | 30944 | 3969 | 33605 | 3188 | 34600 | 2581 | 35402 | 1678 | 42781 | 999 | 32860 |
| 4L-2S | | MI | 14324 | 5474 | 24202 | 3813 | 26178 | 3039 | 27186 | 2430 | 28583 | 1482 | 33860 | 1214 | 22716 |
| 10-#11 | 1.58 | MA | 19194 | 4906 | 30307 | 3633 | 32971 | 2953 | 33888 | 2450 | 34380 | 1725 | 40677 | 1611 | 17852 |
| 2L-5S | | MI | 11810 | 4906 | 18960 | 3513 | 19883 | 2865 | 19732 | 2365 | 18724 | 1638 | 21642 | 1280 | 11903 |
| 10-#11 | 1.58 | MA | 18452 | 4906 | 29208 | 3630 | 31562 | 2966 | 32170 | 2461 | 32049 | 1733 | 37572 | 1525 | 17881 |
| 3L-4S | | MI | 12115 | 4906 | 19461 | 3520 | 20529 | 2856 | 20503 | 2356 | 19803 | 1647 | 22903 | 1318 | 11875 |
| 10-#11 | 1.58 | MA | 17928 | 4906 | 28311 | 3644 | 30418 | 2961 | 30780 | 2455 | 30267 | 1742 | 35556 | 1438 | 17871 |
| 4L-3S | | MI | 12453 | 4906 | 20036 | 3509 | 21258 | 2865 | 21367 | 2365 | 20877 | 1638 | 24089 | 1400 | 11828 |
| 10-#11 | 1.58 | MA | 17459 | 4906 | 27534 | 3640 | 29411 | 2974 | 29542 | 2466 | 28482 | 1733 | 33436 | 1398 | 17786 |
| 5L-2S | | MI | 12920 | 4906 | 20730 | 3516 | 22145 | 2856 | 22427 | 2356 | 22283 | 1630 | 25919 | 1486 | 11780 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis

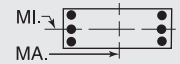



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.28 | MA | 20260 | 5145 | 32719 | 3769 | 35996 | 3050 | 37553 | 2506 | 39259 | 1692 | 47113 | 1550 | 25332 |
| 2L-5S | | MI | 11983 | 5145 | 19715 | 3639 | 20765 | 2954 | 20768 | 2408 | 20098 | 1589 | 23536 | 1091 | 15974 |
| 10-#14 | 2.28 | MA | 19212 | 5145 | 31148 | 3763 | 33982 | 3067 | 35096 | 2521 | 35943 | 1705 | 42706 | 1425 | 25314 |
| 3L-4S | | MI | 12415 | 5145 | 20430 | 3650 | 21676 | 2941 | 21855 | 2396 | 21622 | 1602 | 25307 | 1147 | 16589 |
| 10-#14 | 2.28 | MA | 18471 | 5145 | 29863 | 3783 | 32344 | 3060 | 33106 | 2511 | 33408 | 1717 | 39850 | 1300 | 25174 |
| 4L-3S | | MI | 12893 | 5145 | 21250 | 3635 | 22705 | 2954 | 23074 | 2408 | 23137 | 1589 | 26977 | 1263 | 16581 |
| 10-#14 | 2.28 | MA | 17809 | 5145 | 28750 | 3778 | 30901 | 3077 | 31333 | 2527 | 30868 | 1705 | 36834 | 1244 | 24083 |
| 5L-2S | | MI | 13550 | 5145 | 22237 | 3646 | 23956 | 2941 | 24570 | 2396 | 25120 | 1577 | 29547 | 1387 | 16531 |
| 10-#18 | 4.05 | MA | 21037 | 5750 | 35940 | 4109 | 39992 | 3328 | 42378 | 2677 | 45519 | 1627 | 55262 | 1158 | 43472 |
| 3L-4S | | MI | 13118 | 5750 | 22778 | 3986 | 24428 | 3157 | 25113 | 2493 | 26010 | 1478 | 31037 | 693 | 26281 |
| 10-#18 | 4.05 | MA | 19775 | 5750 | 33688 | 4142 | 37123 | 3313 | 38892 | 2657 | 41137 | 1649 | 50362 | 936 | 40882 |
| 4L-3S | | MI | 13932 | 5750 | 24202 | 3964 | 26178 | 3179 | 27186 | 2515 | 28583 | 1456 | 33860 | 891 | 27985 |
| 10-#18 | 4.05 | MA | 18646 | 5750 | 31735 | 4131 | 34591 | 3341 | 35782 | 2681 | 36742 | 1627 | 45150 | 839 | 38828 |
| 5L-2S | | MI | 15046 | 5750 | 25909 | 3986 | 28302 | 3157 | 29726 | 2493 | 31954 | 1434 | 38187 | 1112 | 28075 |
| 12-#11 | 1.89 | MA | 19701 | 5014 | 31406 | 3700 | 34379 | 3002 | 35606 | 2479 | 36711 | 1716 | 43782 | 1591 | 21302 |
| 2L-6S | | MI | 11831 | 5014 | 19183 | 3574 | 20122 | 2904 | 20059 | 2400 | 19154 | 1631 | 22299 | 1189 | 13661 |
| 12-#11 | 1.89 | MA | 18963 | 5014 | 30307 | 3697 | 32971 | 3014 | 33888 | 2490 | 34380 | 1724 | 40677 | 1505 | 21318 |
| 3L-5S | | MI | 12122 | 5014 | 19654 | 3581 | 20770 | 2913 | 20792 | 2392 | 20130 | 1623 | 23471 | 1247 | 13984 |
| 12-#11 | 1.89 | MA | 18442 | 5014 | 29409 | 3711 | 31827 | 3010 | 32498 | 2484 | 32598 | 1733 | 38661 | 1418 | 21280 |
| 4E | | MI | 12426 | 5014 | 20155 | 3587 | 21416 | 2904 | 21563 | 2383 | 21209 | 1631 | 24732 | 1285 | 14061 |
| 12-#11 | 1.89 | MA | 17977 | 5014 | 28632 | 3708 | 30820 | 3022 | 31260 | 2495 | 30813 | 1724 | 36541 | 1378 | 21091 |
| 5L-3S | | MI | 12763 | 5014 | 20730 | 3577 | 22145 | 2913 | 22427 | 2392 | 22283 | 1623 | 25919 | 1367 | 14028 |
| 12-#11 | 1.89 | MA | 17533 | 5014 | 27904 | 3705 | 29811 | 3018 | 30028 | 2489 | 29195 | 1733 | 34537 | 1322 | 20422 |
| 6L-2S | | MI | 13227 | 5014 | 21424 | 3584 | 23032 | 2904 | 23487 | 2383 | 23689 | 1614 | 27748 | 1453 | 13987 |
| 12-#14 | 2.73 | MA | 19930 | 5301 | 32719 | 3861 | 35996 | 3137 | 37553 | 2563 | 39259 | 1691 | 47113 | 1394 | 30187 |
| 3L-5S | | MI | 12421 | 5301 | 20703 | 3737 | 22016 | 3022 | 22264 | 2446 | 22082 | 1565 | 26106 | 1040 | 18896 |
| 12-#14 | 2.73 | MA | 19195 | 5301 | 31434 | 3880 | 34358 | 3129 | 35563 | 2554 | 36724 | 1703 | 44256 | 1270 | 30005 |
| 4E | | MI | 12850 | 5301 | 21417 | 3747 | 22927 | 3010 | 23351 | 2433 | 23606 | 1578 | 27877 | 1096 | 19648 |
| 12-#14 | 2.73 | MA | 18537 | 5301 | 30321 | 3875 | 32915 | 3147 | 33790 | 2569 | 34184 | 1691 | 41241 | 1213 | 28762 |
| 5L-3S | | MI | 13325 | 5301 | 22237 | 3733 | 23956 | 3022 | 24570 | 2446 | 25120 | 1565 | 29547 | 1212 | 19682 |
| 12-#14 | 2.73 | MA | 17912 | 5301 | 29277 | 3870 | 31469 | 3140 | 32023 | 2559 | 31883 | 1703 | 38399 | 1131 | 27954 |
| 6L-2S | | MI | 13979 | 5301 | 23225 | 3743 | 25207 | 3010 | 26065 | 2433 | 27104 | 1553 | 32116 | 1337 | 19647 |
| 12-#18 | 4.86 | MA | 21001 | 6027 | 36432 | 4315 | 40640 | 3437 | 43183 | 2732 | 46871 | 1621 | 57944 | 874 | 48950 |
| 4E | | MI | 13849 | 6027 | 24485 | 4159 | 26553 | 3274 | 27653 | 2555 | 29381 | 1429 | 35364 | 591 | 31239 |
| 12-#18 | 4.86 | MA | 19885 | 6027 | 34479 | 4304 | 38109 | 3465 | 40074 | 2756 | 42477 | 1599 | 52731 | 776 | 46782 |
| 5L-3S | | MI | 14657 | 6027 | 25909 | 4137 | 28302 | 3296 | 29726 | 2577 | 31954 | 1407 | 38187 | 789 | 33230 |
| 12-#18 | 4.86 | MA | 18824 | 6027 | 32645 | 4293 | 35572 | 3450 | 36975 | 2736 | 38497 | 1621 | 47849 | 631 | 43450 |
| 6L-2S | | MI | 15763 | 6027 | 27616 | 4159 | 30427 | 3274 | 32266 | 2555 | 35325 | 1385 | 42514 | 1011 | 33386 |
| 14-#11 | 2.21 | MA | 19471 | 5122 | 31406 | 3764 | 34379 | 3063 | 35606 | 2520 | 36711 | 1715 | 43782 | 1484 | 24739 |
| 3L-6S | | MI | 12143 | 5122 | 19878 | 3641 | 21010 | 2952 | 21119 | 2427 | 20560 | 1616 | 24128 | 1156 | 15748 |
| 14-#11 | 2.21 | MA | 18953 | 5122 | 30508 | 3778 | 33236 | 3058 | 34216 | 2514 | 34929 | 1724 | 41766 | 1398 | 24683 |
| 4L-5S | | MI | 12432 | 5122 | 20349 | 3648 | 21657 | 2961 | 21852 | 2418 | 21536 | 1607 | 25301 | 1214 | 16045 |
| 14-#11 | 2.21 | MA | 18490 | 5122 | 29731 | 3775 | 32228 | 3071 | 32979 | 2525 | 33144 | 1715 | 39646 | 1358 | 24364 |
| 5L-4S | | MI | 12735 | 5122 | 20849 | 3655 | 22303 | 2952 | 22623 | 2410 | 22615 | 1616 | 26561 | 1252 | 16238 |
| 14-#11 | 2.21 | MA | 18049 | 5122 | 29003 | 3772 | 31219 | 3066 | 31746 | 2519 | 31527 | 1724 | 37642 | 1302 | 23731 |
| 6L-3S | | MI | 13070 | 5122 | 21424 | 3644 | 23032 | 2961 | 23487 | 2418 | 23689 | 1607 | 27748 | 1334 | 16217 |
| 14-#11 | 2.21 | MA | 17620 | 5122 | 28204 | 3786 | 30257 | 3079 | 30562 | 2530 | 29946 | 1732 | 35502 | 1212 | 23304 |
| 7L-2S | | MI | 13533 | 5122 | 22119 | 3651 | 23919 | 2952 | 24547 | 2410 | 25095 | 1599 | 29577 | 1420 | 16184 |
| 14-#14 | 3.19 | MA | 19912 | 5456 | 33005 | 3978 | 36372 | 3199 | 38020 | 2596 | 40041 | 1689 | 48663 | 1239 | 34832 |
| 4L-5S | | MI | 12856 | 5456 | 21690 | 3834 | 23267 | 3090 | 23759 | 2483 | 24065 | 1541 | 28676 | 990 | 21830 |
| 14-#14 | 3.19 | MA | 19260 | 5456 | 31892 | 3972 | 34929 | 3217 | 36247 | 2611 | 37500 | 1677 | 45648 | 1182 | 33456 |
| 5L-4S | | MI | 13282 | 5456 | 22405 | 3844 | 24178 | 3078 | 24846 | 2471 | 25589 | 1554 | 30447 | 1046 | 22538 |
| 14-#14 | 3.19 | MA | 18639 | 5456 | 30848 | 3967 | 33483 | 3209 | 34480 | 2602 | 35199 | 1689 | 42806 | 1100 | 32666 |
| 6L-3S | | MI | 13755 | 5456 | 23225 | 3830 | 25207 | 3090 | 26065 | 2483 | 27104 | 1541 | 32116 | 1161 | 22759 |
| 14-#14 | 3.19 | MA | 18034 | 5456 | 29704 | 3987 | 32103 | 3227 | 32784 | 2617 | 32950 | 1702 | 39769 | 970 | 31155 |
| 7L-2S | | MI | 14405 | 5456 | 24212 | 3840 | 26458 | 3078 | 27560 | 2471 | 29088 | 1529 | 34686 | 1286 | 22751 |
| 14-#18 | 5.67 | MA | 21109 | 6303 | 37223 | 4477 | 41627 | 3589 | 44365 | 2832 | 48211 | 1570 | 60313 | 714 | 54699 |
| 5L-4S | | MI | 14575 | 6303 | 26192 | 4332 | 28678 | 3392 | 30193 | 2617 | 32752 | 1381 | 39692 | 490 | 36229 |

## RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

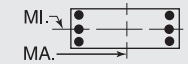
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 5.67 | MA | 20060 | 6303 | 35389 | 4466 | 39090 | 3574 | 41266 | 2812 | 44232 | 1592 | 55431 | 569 | 51517 |
| 6L-3S | | MI | 15376 | 6303 | 27616 | 4310 | 30427 | 3414 | 32266 | 2639 | 35325 | 1359 | 42514 | 688 | 38459 |
| 16-#11 | 2.53 | MA | 19460 | 5230 | 31607 | 3846 | 34644 | 3107 | 35935 | 2543 | 37261 | 1715 | 44871 | 1378 | 28080 |
| 4L-6S | | MI | 12453 | 5230 | 20572 | 3709 | 21897 | 3000 | 22179 | 2454 | 21966 | 1600 | 25958 | 1123 | 17839 |
| 16-#11 | 2.53 | MA | 19000 | 5230 | 30830 | 3843 | 33637 | 3119 | 34697 | 2554 | 35475 | 1706 | 42751 | 1338 | 27648 |
| 5E | | MI | 12741 | 5230 | 21043 | 3716 | 22544 | 3009 | 22912 | 2445 | 22942 | 1592 | 27130 | 1181 | 18115 |
| 16-#11 | 2.53 | MA | 18562 | 5230 | 30101 | 3839 | 32628 | 3114 | 33464 | 2548 | 33858 | 1715 | 40747 | 1282 | 27046 |
| 6L-4S | | MI | 13042 | 5230 | 21544 | 3722 | 23190 | 3000 | 23683 | 2437 | 24021 | 1600 | 28391 | 1219 | 18404 |
| 16-#11 | 2.53 | MA | 18135 | 5230 | 29303 | 3853 | 31665 | 3127 | 32281 | 2559 | 32277 | 1723 | 38607 | 1191 | 26551 |
| 7L-3S | | MI | 13376 | 5230 | 22119 | 3712 | 23919 | 3009 | 24547 | 2445 | 25095 | 1592 | 29577 | 1301 | 18398 |
| 16-#11 | 2.53 | MA | 17714 | 5230 | 28586 | 3850 | 30689 | 3122 | 31125 | 2570 | 30597 | 1715 | 36625 | 1144 | 25738 |
| 8L-2S | | MI | 13837 | 5230 | 22813 | 3718 | 24806 | 3000 | 25607 | 2437 | 26501 | 1583 | 31407 | 1387 | 18373 |
| 16-#14 | 3.64 | MA | 19976 | 5612 | 33463 | 4070 | 36943 | 3287 | 38704 | 2654 | 40817 | 1663 | 50054 | 1151 | 38164 |
| 5E | | MI | 13287 | 5612 | 22677 | 3931 | 24518 | 3159 | 25254 | 2521 | 26049 | 1517 | 31245 | 939 | 24775 |
| 16-#14 | 3.64 | MA | 19360 | 5612 | 32419 | 4065 | 35497 | 3279 | 36937 | 2644 | 38515 | 1675 | 47212 | 1069 | 37270 |
| 6L-4S | | MI | 13712 | 5612 | 23392 | 3942 | 25429 | 3146 | 26341 | 2509 | 27573 | 1530 | 33016 | 995 | 25429 |
| 16-#14 | 3.64 | MA | 18759 | 5612 | 31275 | 4084 | 34117 | 3297 | 35241 | 2659 | 36267 | 1688 | 44175 | 939 | 35817 |
| 7L-3S | | MI | 14182 | 5612 | 24212 | 3927 | 26458 | 3159 | 27560 | 2521 | 29088 | 1517 | 34686 | 1111 | 25824 |
| 16-#14 | 3.64 | MA | 18169 | 5612 | 30246 | 4079 | 32718 | 3289 | 33585 | 2675 | 33875 | 1675 | 41357 | 872 | 34360 |
| 8L-2S | | MI | 14829 | 5612 | 25200 | 3938 | 27709 | 3146 | 29055 | 2509 | 31071 | 1505 | 37256 | 1235 | 25850 |
| 16-#18 | 6.48 | MA | 21282 | 6580 | 38134 | 4639 | 42608 | 3698 | 45558 | 2887 | 49967 | 1563 | 63012 | 506 | 59608 |
| 6L-4S | | MI | 15295 | 6580 | 27899 | 4505 | 30802 | 3510 | 32733 | 2680 | 36123 | 1332 | 44019 | 388 | 41244 |
| 18-#11 | 2.84 | MA | 19507 | 5338 | 31929 | 3910 | 35046 | 3167 | 36416 | 2584 | 37807 | 1697 | 45856 | 1318 | 30941 |
| 5L-6S | | MI | 12761 | 5338 | 21266 | 3776 | 22784 | 3049 | 23239 | 2481 | 23372 | 1585 | 27787 | 1090 | 19934 |
| 18-#11 | 2.84 | MA | 19071 | 5338 | 31200 | 3907 | 34037 | 3163 | 35183 | 2578 | 36189 | 1706 | 43852 | 1262 | 30367 |
| 6L-5S | | MI | 13048 | 5338 | 21737 | 3783 | 23431 | 3057 | 23972 | 2472 | 24348 | 1576 | 28959 | 1148 | 20192 |
| 18-#11 | 2.84 | MA | 18646 | 5338 | 30402 | 3921 | 33074 | 3175 | 33999 | 2589 | 34608 | 1714 | 41712 | 1171 | 29806 |
| 7L-4S | | MI | 13348 | 5338 | 22238 | 3790 | 24077 | 3049 | 24743 | 2464 | 25427 | 1585 | 30220 | 1186 | 20561 |
| 18-#11 | 2.84 | MA | 18228 | 5338 | 29684 | 3918 | 32097 | 3171 | 32844 | 2600 | 32928 | 1706 | 39730 | 1124 | 29022 |
| 8L-3S | | MI | 13681 | 5338 | 22813 | 3779 | 24806 | 3057 | 25607 | 2472 | 26501 | 1576 | 31407 | 1268 | 20574 |
| 18-#11 | 2.84 | MA | 17814 | 5338 | 28912 | 3932 | 31147 | 3183 | 31635 | 2594 | 31361 | 1714 | 37787 | 1070 | 28203 |
| 9L-2S | | MI | 14140 | 5338 | 23507 | 3786 | 25693 | 3049 | 26667 | 2464 | 27907 | 1568 | 33236 | 1354 | 20556 |
| 18-#14 | 4.10 | MA | 20075 | 5767 | 33990 | 4162 | 37511 | 3349 | 39394 | 2687 | 41832 | 1661 | 51619 | 1038 | 41887 |
| 6L-5S | | MI | 13717 | 5767 | 23665 | 4028 | 25769 | 3227 | 26749 | 2559 | 28033 | 1493 | 33815 | 888 | 27727 |
| 18-#14 | 4.10 | MA | 19479 | 5767 | 32846 | 4181 | 36131 | 3366 | 37698 | 2702 | 39583 | 1673 | 48582 | 908 | 40489 |
| 7L-4S | | MI | 14139 | 5767 | 24380 | 4039 | 26680 | 3215 | 27836 | 2546 | 29556 | 1506 | 35586 | 944 | 28334 |
| 18-#14 | 4.10 | MA | 18892 | 5767 | 31817 | 4176 | 34732 | 3359 | 36042 | 2717 | 37192 | 1661 | 45764 | 841 | 38972 |
| 8L-3S | | MI | 14606 | 5767 | 25200 | 4024 | 27709 | 3227 | 29055 | 2559 | 31071 | 1493 | 37256 | 1060 | 28882 |
| 20-#11 | 3.16 | MA | 19577 | 5446 | 32299 | 3974 | 35445 | 3211 | 36901 | 2607 | 38520 | 1697 | 46957 | 1242 | 33692 |
| 6E | | MI | 13068 | 5446 | 21960 | 3844 | 23671 | 3097 | 24299 | 2508 | 24778 | 1569 | 29616 | 1058 | 22032 |
| 20-#11 | 3.16 | MA | 19154 | 5446 | 31501 | 3988 | 34482 | 3224 | 35718 | 2618 | 36939 | 1705 | 44817 | 1151 | 33069 |
| 7L-5S | | MI | 13354 | 5446 | 22431 | 3850 | 24318 | 3105 | 25032 | 2499 | 25754 | 1561 | 30788 | 1115 | 22273 |
| 20-#11 | 3.16 | MA | 18738 | 5446 | 30783 | 3985 | 33506 | 3219 | 34562 | 2629 | 35259 | 1697 | 42835 | 1104 | 32311 |
| 8L-4S | | MI | 13652 | 5446 | 22932 | 3857 | 24964 | 3097 | 25803 | 2491 | 26833 | 1569 | 32049 | 1153 | 22713 |
| 20-#11 | 3.16 | MA | 18327 | 5446 | 30011 | 3999 | 32556 | 3232 | 33354 | 2623 | 33692 | 1705 | 40892 | 1050 | 31451 |
| 9L-3S | | MI | 13983 | 5446 | 23507 | 3847 | 25693 | 3105 | 26667 | 2499 | 27907 | 1561 | 33236 | 1235 | 22740 |
| 20-#11 | 3.16 | MA | 17870 | 5446 | 29295 | 3996 | 31592 | 3227 | 32204 | 2634 | 32138 | 1714 | 39011 | 989 | 30605 |
| 10L-2S | | MI | 14441 | 5446 | 24201 | 3853 | 26580 | 3097 | 27727 | 2491 | 29313 | 1552 | 35065 | 1322 | 22735 |
| 20-#14 | 4.55 | MA | 20193 | 5923 | 34417 | 4279 | 38145 | 3436 | 40155 | 2744 | 42899 | 1659 | 52989 | 877 | 45171 |
| 7L-5S | | MI | 14144 | 5923 | 24652 | 4126 | 27020 | 3296 | 28245 | 2596 | 30016 | 1469 | 36384 | 838 | 30685 |
| 20-#14 | 4.55 | MA | 19610 | 5923 | 33388 | 4274 | 36745 | 3429 | 38499 | 2760 | 40508 | 1647 | 50170 | 810 | 43595 |
| 8L-4S | | MI | 14563 | 5923 | 25367 | 4136 | 27931 | 3283 | 29332 | 2584 | 31540 | 1482 | 38156 | 894 | 31251 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

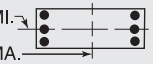
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.47 | MA | 19659 | 5554 | 32600 | 4056 | 35891 | 3272 | 37436 | 2647 | 39270 | 1696 | 47922 | 1131 | 36339 |
| 7L-6S | | MI | 13373 | 5554 | 22654 | 3911 | 24558 | 3145 | 25359 | 2535 | 26184 | 1554 | 31446 | 1025 | 24131 |
| 22-#11 | 3.47 | MA | 19246 | 5554 | 31882 | 4053 | 34914 | 3268 | 36280 | 2659 | 37590 | 1688 | 45940 | 1084 | 35605 |
| 8L-5S | | MI | 13658 | 5554 | 23126 | 3918 | 25205 | 3153 | 26092 | 2526 | 27160 | 1545 | 32618 | 1082 | 24359 |
| 22-#11 | 3.47 | MA | 18837 | 5554 | 31110 | 4067 | 33964 | 3280 | 35072 | 2652 | 36023 | 1696 | 43997 | 1030 | 34706 |
| 9L-4S | | MI | 13955 | 5554 | 23626 | 3925 | 25851 | 3145 | 26863 | 2518 | 28239 | 1554 | 33879 | 1121 | 24860 |
| 22-#11 | 3.47 | MA | 18382 | 5554 | 30394 | 4063 | 33000 | 3275 | 33923 | 2664 | 34470 | 1705 | 42116 | 969 | 33867 |
| 10L-3S | | MI | 14285 | 5554 | 24201 | 3914 | 26580 | 3153 | 27727 | 2526 | 29313 | 1545 | 35065 | 1202 | 24899 |
| 22-#14 | 5.01 | MA | 20323 | 6079 | 34959 | 4371 | 38759 | 3499 | 40956 | 2802 | 43825 | 1633 | 54577 | 779 | 48227 |
| 8L-5S | | MI | 14568 | 6079 | 25640 | 4223 | 28271 | 3364 | 29740 | 2634 | 32000 | 1445 | 38954 | 787 | 33648 |
| 24-#11 | 3.79 | MA | 19750 | 5662 | 32981 | 4120 | 36323 | 3316 | 37999 | 2688 | 39921 | 1679 | 49045 | 1064 | 38904 |
| 8L-6S | | MI | 13677 | 5662 | 23349 | 3979 | 25445 | 3193 | 26419 | 2562 | 27590 | 1538 | 33275 | 992 | 26232 |
| 24-#11 | 3.79 | MA | 19343 | 5662 | 32208 | 4134 | 35373 | 3329 | 36791 | 2682 | 38354 | 1687 | 47102 | 1010 | 37967 |
| 9L-5S | | MI | 13961 | 5662 | 23820 | 3985 | 26092 | 3202 | 27152 | 2553 | 28566 | 1530 | 34447 | 1049 | 26449 |
| 24-#11 | 3.79 | MA | 18901 | 5662 | 31493 | 4131 | 34409 | 3324 | 35641 | 2693 | 36801 | 1696 | 45221 | 949 | 37097 |
| 10L-4S | | MI | 14257 | 5662 | 24320 | 3992 | 26738 | 3193 | 27923 | 2544 | 29645 | 1538 | 35708 | 1088 | 26942 |

## RECTANGULAR TIED COLUMNS 26" x 40"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.54 | MA | 21121 | 5150 | 33434 | 3789 | 36203 | 3081 | 37094 | 2557 | 37340 | 1796 | 43974 | 1671 | 19130 |
| 2E | | MI | 13457 | 5150 | 21703 | 3631 | 22859 | 2938 | 23001 | 2421 | 22636 | 1667 | 26076 | 1503 | 11929 |
| 6-#14 | 1.30 | MA | 20764 | 5064 | 32498 | 3761 | 35145 | 3064 | 35856 | 2551 | 35798 | 1824 | 42013 | 1715 | 16373 |
| 2L-3S | | MI | 12616 | 5064 | 20185 | 3607 | 21134 | 2954 | 20984 | 2449 | 19969 | 1727 | 22717 | 1450 | 10365 |
| 6-#14 | 1.30 | MA | 19632 | 5064 | 30830 | 3756 | 33006 | 3082 | 33247 | 2567 | 32259 | 1836 | 37298 | 1590 | 16429 |
| 3L-2S | | MI | 13281 | 5064 | 21173 | 3618 | 22385 | 2941 | 22479 | 2437 | 21953 | 1714 | 25286 | 1575 | 10281 |
| 6-#18 | 2.31 | MA | 22451 | 5427 | 36351 | 3961 | 39943 | 3205 | 41656 | 2632 | 43471 | 1769 | 52102 | 1613 | 28294 |
| 2L-3S | | MI | 13060 | 5427 | 21703 | 3782 | 22859 | 3078 | 23001 | 2505 | 22636 | 1641 | 26076 | 1180 | 17482 |
| 6-#18 | 2.31 | MA | 20507 | 5427 | 33434 | 3951 | 36203 | 3235 | 37094 | 2658 | 37340 | 1791 | 43974 | 1391 | 28204 |
| 3L-2S | | MI | 14195 | 5427 | 23410 | 3804 | 24983 | 3056 | 25541 | 2483 | 26007 | 1619 | 30404 | 1401 | 17383 |
| 8-#11 | 1.20 | MA | 20617 | 5028 | 32103 | 3752 | 34710 | 3059 | 35353 | 2551 | 35155 | 1836 | 41219 | 1733 | 15235 |
| 2L-4S | | MI | 12400 | 5028 | 19675 | 3620 | 20574 | 2946 | 20344 | 2446 | 19200 | 1752 | 21956 | 1438 | 9711 |
| 8-#11 | 1.20 | MA | 19823 | 5028 | 30936 | 3749 | 33215 | 3072 | 33529 | 2563 | 32674 | 1845 | 37900 | 1647 | 15276 |
| 3E | | MI | 12740 | 5028 | 20250 | 3609 | 21303 | 2954 | 21208 | 2455 | 20274 | 1744 | 23143 | 1520 | 9648 |
| 8-#11 | 1.20 | MA | 19265 | 5028 | 29985 | 3764 | 32003 | 3067 | 32056 | 2557 | 30778 | 1853 | 35743 | 1561 | 15295 |
| 4L-2S | | MI | 13209 | 5028 | 20944 | 3616 | 22190 | 2946 | 22268 | 2446 | 21680 | 1735 | 24972 | 1606 | 9595 |
| 8-#14 | 1.73 | MA | 21539 | 5219 | 34166 | 3858 | 37283 | 3133 | 38465 | 2594 | 39338 | 1811 | 46727 | 1686 | 21621 |
| 2L-4S | | MI | 12574 | 5219 | 20353 | 3719 | 21356 | 3010 | 21260 | 2475 | 20438 | 1715 | 23617 | 1284 | 13569 |
| 8-#14 | 1.73 | MA | 20414 | 5219 | 32498 | 3854 | 35145 | 3151 | 35856 | 2610 | 35798 | 1823 | 42013 | 1561 | 21644 |
| 3E | | MI | 13055 | 5219 | 21173 | 3705 | 22385 | 3022 | 22479 | 2487 | 21953 | 1703 | 25286 | 1400 | 13513 |
| 8-#14 | 1.73 | MA | 19622 | 5219 | 31135 | 3874 | 33408 | 3145 | 33746 | 2601 | 33093 | 1836 | 38952 | 1437 | 21550 |
| 4L-2S | | MI | 13717 | 5219 | 22160 | 3715 | 23636 | 3010 | 23974 | 2475 | 23937 | 1690 | 27856 | 1524 | 13442 |
| 8-#18 | 3.08 | MA | 23761 | 5703 | 39268 | 4134 | 43683 | 3329 | 46218 | 2707 | 49601 | 1742 | 60229 | 1555 | 37405 |
| 2L-4S | | MI | 12977 | 5703 | 21986 | 3978 | 23234 | 3174 | 23469 | 2545 | 23434 | 1615 | 27581 | 880 | 21618 |
| 8-#18 | 3.08 | MA | 21839 | 5703 | 36351 | 4124 | 39943 | 3359 | 41656 | 2733 | 43471 | 1764 | 52102 | 1333 | 37198 |
| 3E | | MI | 13799 | 5703 | 23410 | 3955 | 24983 | 3196 | 25541 | 2567 | 26007 | 1592 | 30404 | 1078 | 22804 |
| 8-#18 | 3.08 | MA | 20481 | 5703 | 33962 | 4158 | 36898 | 3345 | 37956 | 2715 | 38786 | 1787 | 46840 | 1112 | 35159 |
| 4L-2S | | MI | 14925 | 5703 | 25117 | 3977 | 27108 | 3174 | 28082 | 2545 | 29378 | 1570 | 34731 | 1299 | 22780 |
| 10-#11 | 1.50 | MA | 21163 | 5136 | 33269 | 3819 | 36205 | 3107 | 37177 | 2580 | 37637 | 1827 | 44538 | 1715 | 18905 |
| 2L-5S | | MI | 12407 | 5136 | 19869 | 3681 | 20815 | 3002 | 20634 | 2482 | 19526 | 1728 | 22525 | 1367 | 11955 |
| 10-#11 | 1.50 | MA | 20374 | 5136 | 32103 | 3817 | 34710 | 3120 | 35353 | 2592 | 35155 | 1836 | 41219 | 1628 | 18934 |
| 3L-4S | | MI | 12713 | 5136 | 20369 | 3687 | 21461 | 2994 | 21404 | 2473 | 20606 | 1737 | 23786 | 1405 | 11918 |
| 10-#11 | 1.50 | MA | 19818 | 5136 | 31151 | 3831 | 33498 | 3116 | 33880 | 2586 | 33259 | 1845 | 39061 | 1542 | 18924 |
| 4L-3S | | MI | 13052 | 5136 | 20944 | 3677 | 22190 | 3002 | 22268 | 2482 | 21680 | 1728 | 24972 | 1487 | 11867 |
| 10-#11 | 1.50 | MA | 19321 | 5136 | 30329 | 3828 | 32431 | 3129 | 32569 | 2598 | 31361 | 1836 | 36800 | 1501 | 18839 |
| 5L-2S | | MI | 13519 | 5136 | 21639 | 3683 | 23077 | 2994 | 23328 | 2473 | 23086 | 1719 | 26801 | 1573 | 11818 |
| 10-#14 | 2.16 | MA | 22306 | 5375 | 35835 | 3955 | 39422 | 3203 | 41074 | 2636 | 42877 | 1798 | 51442 | 1657 | 26850 |
| 2L-5S | | MI | 12580 | 5375 | 20626 | 3806 | 21697 | 3091 | 21668 | 2525 | 20898 | 1679 | 24415 | 1177 | 16129 |

## RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

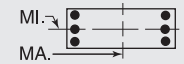
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.16 | MA | 21189 | 5375 | 34166 | 3951 | 37283 | 3221 | 38465 | 2652 | 39338 | 1810 | 46727 | 1532 | 26833 |
| 3L-4S | | MI | 13013 | 5375 | 21340 | 3816 | 22607 | 3078 | 22755 | 2512 | 22422 | 1691 | 26186 | 1233 | 16657 |
| 10-#14 | 2.16 | MA | 20403 | 5375 | 32804 | 3971 | 35547 | 3215 | 36355 | 2643 | 36632 | 1823 | 43666 | 1408 | 26692 |
| 4L-3S | | MI | 13491 | 5375 | 22160 | 3802 | 23636 | 3091 | 23974 | 2525 | 23937 | 1679 | 27856 | 1349 | 16634 |
| 10-#14 | 2.16 | MA | 19700 | 5375 | 31624 | 3966 | 34018 | 3233 | 34476 | 2659 | 33922 | 1810 | 40448 | 1350 | 25657 |
| 5L-2S | | MI | 14150 | 5375 | 23148 | 3812 | 24887 | 3078 | 25469 | 2512 | 25920 | 1666 | 30426 | 1474 | 16579 |
| 10-#18 | 3.85 | MA | 23152 | 5980 | 39268 | 4297 | 43683 | 3483 | 46218 | 2809 | 49601 | 1738 | 60229 | 1275 | 46172 |
| 3L-4S | | MI | 13716 | 5980 | 23693 | 4151 | 25359 | 3292 | 26009 | 2607 | 26805 | 1566 | 31908 | 778 | 26531 |
| 10-#18 | 3.85 | MA | 21810 | 5980 | 36879 | 4331 | 40638 | 3469 | 42518 | 2790 | 44916 | 1760 | 54967 | 1053 | 43696 |
| 4L-3S | | MI | 14532 | 5980 | 25117 | 4128 | 27108 | 3314 | 28082 | 2630 | 29378 | 1544 | 34731 | 976 | 28083 |
| 10-#18 | 3.85 | MA | 20611 | 5980 | 34808 | 4321 | 37953 | 3499 | 39220 | 2816 | 40219 | 1738 | 49394 | 954 | 41401 |
| 5L-2S | | MI | 15649 | 5980 | 26823 | 4150 | 29233 | 3292 | 30622 | 2607 | 32749 | 1522 | 39058 | 1198 | 28142 |
| 12-#11 | 1.80 | MA | 21706 | 5244 | 34435 | 3887 | 37700 | 3155 | 39001 | 2610 | 40118 | 1818 | 47856 | 1696 | 22566 |
| 2L-6S | | MI | 12429 | 5244 | 20092 | 3741 | 21055 | 3042 | 20960 | 2517 | 19957 | 1721 | 23182 | 1276 | 13773 |
| 12-#11 | 1.80 | MA | 20920 | 5244 | 33269 | 3884 | 36205 | 3168 | 37177 | 2622 | 37637 | 1827 | 44538 | 1610 | 22581 |
| 3L-5S | | MI | 12720 | 5244 | 20563 | 3748 | 21702 | 3050 | 21694 | 2509 | 20932 | 1713 | 24354 | 1334 | 14128 |
| 12-#11 | 1.80 | MA | 20368 | 5244 | 32318 | 3898 | 34993 | 3164 | 35704 | 2616 | 35741 | 1836 | 42380 | 1523 | 22544 |
| 4E | | MI | 13024 | 5244 | 21064 | 3755 | 22348 | 3042 | 22464 | 2500 | 22012 | 1721 | 25615 | 1372 | 14109 |
| 12-#11 | 1.80 | MA | 19874 | 5244 | 31495 | 3896 | 33926 | 3177 | 34392 | 2628 | 33842 | 1828 | 40119 | 1482 | 22433 |
| 5L-3S | | MI | 13361 | 5244 | 21639 | 3744 | 23077 | 3050 | 23328 | 2509 | 23086 | 1713 | 26801 | 1454 | 14071 |
| 12-#11 | 1.80 | MA | 19404 | 5244 | 30723 | 3893 | 32857 | 3173 | 33087 | 2622 | 32121 | 1837 | 37976 | 1426 | 21705 |
| 6L-2S | | MI | 13827 | 5244 | 22333 | 3751 | 23964 | 3042 | 24388 | 2500 | 24492 | 1704 | 28631 | 1540 | 14028 |
| 12-#14 | 2.60 | MA | 21957 | 5530 | 35835 | 4048 | 39422 | 3291 | 41074 | 2695 | 42877 | 1797 | 51442 | 1503 | 32009 |
| 3L-5S | | MI | 13019 | 5530 | 21613 | 3903 | 22948 | 3159 | 23163 | 2562 | 22882 | 1655 | 26985 | 1127 | 19050 |
| 12-#14 | 2.60 | MA | 21177 | 5530 | 34472 | 4068 | 37686 | 3284 | 38964 | 2686 | 40172 | 1810 | 48381 | 1379 | 31828 |
| 4E | | MI | 13449 | 5530 | 22328 | 3913 | 23858 | 3147 | 24250 | 2550 | 24406 | 1667 | 28756 | 1183 | 19723 |
| 12-#14 | 2.60 | MA | 20480 | 5530 | 33292 | 4064 | 36156 | 3303 | 37085 | 2702 | 37461 | 1797 | 45162 | 1321 | 30629 |
| 5L-3S | | MI | 13925 | 5530 | 23148 | 3899 | 24887 | 3159 | 25469 | 2562 | 25920 | 1655 | 30426 | 1298 | 19737 |
| 12-#14 | 2.60 | MA | 19816 | 5530 | 32186 | 4059 | 34625 | 3296 | 35213 | 2693 | 35005 | 1810 | 42119 | 1240 | 29732 |
| 6L-2S | | MI | 14580 | 5530 | 24135 | 3910 | 26139 | 3147 | 26965 | 2550 | 27904 | 1642 | 32995 | 1423 | 19699 |
| 12-#18 | 4.62 | MA | 23122 | 6257 | 39796 | 4504 | 44377 | 3593 | 47081 | 2866 | 51047 | 1733 | 63095 | 995 | 52282 |
| 4E | | MI | 14448 | 6257 | 25400 | 4323 | 27483 | 3409 | 28549 | 2670 | 30176 | 1518 | 36235 | 677 | 31486 |
| 12-#18 | 4.62 | MA | 21937 | 6257 | 37725 | 4494 | 41693 | 3623 | 43783 | 2892 | 46350 | 1711 | 57522 | 896 | 50127 |
| 5L-3S | | MI | 15258 | 6257 | 26823 | 4301 | 29233 | 3432 | 30622 | 2692 | 32749 | 1495 | 39058 | 875 | 33337 |
| 12-#18 | 4.62 | MA | 20810 | 6257 | 35781 | 4484 | 39003 | 3609 | 40496 | 2873 | 42096 | 1733 | 52284 | 751 | 46506 |
| 6L-2S | | MI | 16367 | 6257 | 28530 | 4323 | 31358 | 3409 | 33162 | 2670 | 36120 | 1473 | 43385 | 1096 | 33469 |
| 14-#11 | 2.10 | MA | 21463 | 5352 | 34435 | 3951 | 37700 | 3217 | 39001 | 2651 | 40118 | 1819 | 47856 | 1591 | 26213 |
| 3L-6S | | MI | 12740 | 5352 | 20786 | 3809 | 21942 | 3090 | 22020 | 2544 | 21363 | 1706 | 25011 | 1243 | 15861 |
| 14-#11 | 2.10 | MA | 20913 | 5352 | 33484 | 3966 | 36488 | 3213 | 37527 | 2645 | 38222 | 1828 | 45699 | 1504 | 26157 |
| 4L-5S | | MI | 13030 | 5352 | 21257 | 3815 | 22589 | 3099 | 22754 | 2535 | 22338 | 1697 | 26183 | 1301 | 16168 |
| 14-#11 | 2.10 | MA | 20422 | 5352 | 32661 | 3963 | 35421 | 3226 | 36216 | 2657 | 36324 | 1819 | 43438 | 1464 | 25929 |
| 5L-4S | | MI | 13334 | 5352 | 21758 | 3822 | 23235 | 3090 | 23524 | 2527 | 23418 | 1706 | 27444 | 1339 | 16290 |
| 14-#11 | 2.10 | MA | 19955 | 5352 | 31890 | 3960 | 34352 | 3221 | 34911 | 2651 | 34603 | 1828 | 41294 | 1407 | 25218 |
| 6L-3S | | MI | 13669 | 5352 | 22333 | 3812 | 23964 | 3099 | 24388 | 2535 | 24492 | 1697 | 28631 | 1421 | 16263 |
| 14-#11 | 2.10 | MA | 19500 | 5352 | 31044 | 3975 | 33333 | 3234 | 33657 | 2663 | 32921 | 1837 | 39006 | 1317 | 24772 |
| 7L-2S | | MI | 14133 | 5352 | 23027 | 3818 | 24851 | 3090 | 25448 | 2527 | 25898 | 1688 | 30460 | 1507 | 16227 |
| 14-#14 | 3.03 | MA | 21944 | 5686 | 36140 | 4166 | 39824 | 3354 | 41573 | 2728 | 43711 | 1797 | 53095 | 1350 | 36958 |
| 4L-5S | | MI | 13454 | 5686 | 22601 | 4000 | 24199 | 3227 | 24659 | 2600 | 24865 | 1631 | 29554 | 1076 | 21985 |
| 14-#14 | 3.03 | MA | 21252 | 5686 | 34961 | 4161 | 38295 | 3372 | 39694 | 2744 | 41001 | 1784 | 49877 | 1292 | 35617 |
| 5L-4S | | MI | 13881 | 5686 | 23315 | 4011 | 25109 | 3215 | 25746 | 2587 | 26389 | 1643 | 31325 | 1132 | 22719 |
| 14-#14 | 3.03 | MA | 20593 | 5686 | 33854 | 4156 | 36763 | 3366 | 37822 | 2735 | 38544 | 1797 | 46834 | 1211 | 34762 |
| 6L-3S | | MI | 14355 | 5686 | 24135 | 3996 | 26139 | 3227 | 26965 | 2600 | 27904 | 1631 | 32995 | 1248 | 22825 |
| 14-#14 | 3.03 | MA | 19951 | 5686 | 32642 | 4176 | 35301 | 3384 | 36025 | 2752 | 36144 | 1809 | 43584 | 1081 | 33249 |
| 7L-2S | | MI | 15007 | 5686 | 25123 | 4007 | 27390 | 3215 | 28460 | 2587 | 29888 | 1618 | 35565 | 1372 | 22807 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis

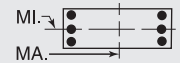



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 5.38 | MA | 23247 | 6533 | 40642 | 4667 | 45432 | 3747 | 48345 | 2967 | 52480 | 1685 | 65649 | 837 | 58661 |
| 5L-4S | | MI | 15175 | 6533 | 27106 | 4496 | 29608 | 3527 | 31089 | 2732 | 33547 | 1469 | 40563 | 575 | 36474 |
| 14-#18 | 5.38 | MA | 22132 | 6533 | 38698 | 4657 | 42743 | 3733 | 45058 | 2949 | 48226 | 1707 | 60411 | 692 | 55095 |
| 6L-3S | | MI | 15978 | 6533 | 28530 | 4474 | 31358 | 3549 | 33162 | 2754 | 36120 | 1447 | 43385 | 773 | 38575 |
| 16-#11 | 2.40 | MA | 21455 | 5460 | 34650 | 4033 | 37983 | 3261 | 39351 | 2675 | 40704 | 1819 | 49017 | 1486 | 29765 |
| 4L-6S | | MI | 13051 | 5460 | 21480 | 3876 | 22829 | 3138 | 23081 | 2571 | 22769 | 1690 | 26840 | 1210 | 17953 |
| 16-#11 | 2.40 | MA | 20967 | 5460 | 33827 | 4030 | 36916 | 3274 | 38040 | 2686 | 38805 | 1811 | 46757 | 1445 | 29416 |
| 5E | | MI | 13339 | 5460 | 21951 | 3883 | 23476 | 3147 | 23814 | 2562 | 23744 | 1682 | 28013 | 1268 | 18238 |
| 16-#11 | 2.40 | MA | 20502 | 5460 | 33056 | 4028 | 35847 | 3270 | 36734 | 2681 | 37084 | 1819 | 44613 | 1389 | 28739 |
| 6L-4S | | MI | 13641 | 5460 | 22452 | 3890 | 24122 | 3138 | 24584 | 2554 | 24824 | 1690 | 29274 | 1306 | 18464 |
| 16-#11 | 2.40 | MA | 20050 | 5460 | 32211 | 4042 | 34828 | 3283 | 35481 | 2692 | 35403 | 1828 | 42325 | 1299 | 28307 |
| 7L-3S | | MI | 13976 | 5460 | 23027 | 3879 | 24851 | 3147 | 25448 | 2562 | 25898 | 1682 | 30460 | 1388 | 18448 |
| 16-#11 | 2.40 | MA | 19604 | 5460 | 31451 | 4039 | 33794 | 3279 | 34257 | 2704 | 33616 | 1820 | 40211 | 1251 | 27412 |
| 8L-2S | | MI | 14438 | 5460 | 23721 | 3886 | 25738 | 3138 | 26508 | 2554 | 27304 | 1673 | 32289 | 1474 | 18419 |
| 16-#14 | 3.46 | MA | 22017 | 5842 | 36629 | 4258 | 40434 | 3442 | 42303 | 2787 | 44540 | 1771 | 54591 | 1263 | 40619 |
| 5E | | MI | 13886 | 5842 | 23588 | 4097 | 25450 | 3296 | 26154 | 2637 | 26849 | 1607 | 32124 | 1025 | 24929 |
| 16-#14 | 3.46 | MA | 21363 | 5842 | 35523 | 4254 | 38902 | 3436 | 40431 | 2778 | 42084 | 1784 | 51548 | 1182 | 39801 |
| 6L-4S | | MI | 14312 | 5842 | 24303 | 4108 | 26360 | 3283 | 27241 | 2625 | 28373 | 1619 | 33895 | 1081 | 25608 |
| 16-#14 | 3.46 | MA | 20727 | 5842 | 34311 | 4274 | 37440 | 3454 | 38634 | 2794 | 39683 | 1796 | 48299 | 1052 | 38205 |
| 7L-3S | | MI | 14783 | 5842 | 25123 | 4094 | 27390 | 3296 | 28460 | 2637 | 29888 | 1607 | 35565 | 1197 | 25896 |
| 16-#14 | 3.46 | MA | 20100 | 5842 | 33221 | 4269 | 35957 | 3447 | 36880 | 2810 | 37132 | 1784 | 45290 | 984 | 36777 |
| 8L-2S | | MI | 15431 | 5842 | 26110 | 4104 | 28641 | 3283 | 29955 | 2625 | 31871 | 1594 | 38134 | 1322 | 25905 |
| 16-#18 | 6.15 | MA | 23440 | 6810 | 41615 | 4830 | 46482 | 3857 | 49620 | 3024 | 54357 | 1680 | 68539 | 634 | 63710 |
| 6L-4S | | MI | 15896 | 6810 | 28813 | 4669 | 31733 | 3645 | 33629 | 2794 | 36918 | 1421 | 44890 | 473 | 41487 |
| 18-#11 | 2.70 | MA | 21508 | 5568 | 34993 | 4098 | 38411 | 3322 | 39864 | 2716 | 41287 | 1802 | 50075 | 1426 | 32912 |
| 5L-6S | | MI | 13359 | 5568 | 22174 | 3944 | 23716 | 3186 | 24141 | 2598 | 24175 | 1675 | 28670 | 1177 | 20049 |
| 18-#11 | 2.70 | MA | 21046 | 5568 | 34222 | 4095 | 37343 | 3318 | 38558 | 2710 | 39566 | 1811 | 47932 | 1370 | 32265 |
| 6L-5S | | MI | 13647 | 5568 | 22645 | 3950 | 24363 | 3195 | 24874 | 2589 | 25150 | 1666 | 29842 | 1235 | 20314 |
| 18-#11 | 2.70 | MA | 20596 | 5568 | 33377 | 4109 | 36323 | 3331 | 37305 | 2722 | 37884 | 1820 | 45644 | 1280 | 31775 |
| 7L-4S | | MI | 13948 | 5568 | 23146 | 3957 | 25009 | 3186 | 25644 | 2581 | 26230 | 1675 | 31103 | 1273 | 20624 |
| 18-#11 | 2.70 | MA | 20153 | 5568 | 32617 | 4107 | 35289 | 3327 | 36081 | 2733 | 36097 | 1811 | 43530 | 1232 | 30901 |
| 8L-3S | | MI | 14281 | 5568 | 23721 | 3947 | 25738 | 3195 | 26508 | 2589 | 27304 | 1666 | 32289 | 1355 | 20626 |
| 18-#11 | 2.70 | MA | 19714 | 5568 | 31799 | 4121 | 34283 | 3340 | 34802 | 2728 | 34431 | 1820 | 41452 | 1178 | 30120 |
| 9L-2S | | MI | 14741 | 5568 | 24415 | 3953 | 26625 | 3186 | 27568 | 2581 | 28710 | 1657 | 34119 | 1441 | 20605 |
| 18-#14 | 3.89 | MA | 22127 | 5997 | 37191 | 4351 | 41041 | 3505 | 43040 | 2820 | 45623 | 1771 | 56263 | 1153 | 44739 |
| 6L-5S | | MI | 14316 | 5997 | 24575 | 4195 | 26701 | 3364 | 27649 | 2675 | 28833 | 1583 | 34694 | 975 | 27882 |
| 18-#14 | 3.89 | MA | 21495 | 5997 | 35979 | 4371 | 39579 | 3523 | 41243 | 2836 | 43223 | 1783 | 53013 | 1023 | 43172 |
| 7L-4S | | MI | 14739 | 5997 | 25290 | 4205 | 27612 | 3352 | 28736 | 2662 | 30357 | 1595 | 36465 | 1031 | 28513 |
| 18-#14 | 3.89 | MA | 20873 | 5997 | 34890 | 4366 | 38096 | 3517 | 39489 | 2852 | 40672 | 1771 | 50005 | 955 | 41683 |
| 8L-3S | | MI | 15208 | 5997 | 26110 | 4191 | 28641 | 3364 | 29955 | 2675 | 31871 | 1583 | 38134 | 1146 | 28958 |
| 18-#14 | 3.89 | MA | 20258 | 5997 | 33717 | 4387 | 36653 | 3535 | 37654 | 2844 | 38293 | 1783 | 47054 | 877 | 40139 |
| 9L-2S | | MI | 15854 | 5997 | 27098 | 4201 | 29892 | 3352 | 31450 | 2662 | 33855 | 1570 | 40704 | 1271 | 28993 |
| 20-#11 | 3.00 | MA | 21586 | 5676 | 35388 | 4162 | 38838 | 3367 | 40382 | 2740 | 42047 | 1802 | 51251 | 1351 | 35797 |
| 6E | | MI | 13667 | 5676 | 22869 | 4011 | 24603 | 3234 | 25201 | 2625 | 25581 | 1659 | 30499 | 1144 | 22148 |
| 20-#11 | 3.00 | MA | 21139 | 5676 | 34543 | 4177 | 37818 | 3380 | 39129 | 2751 | 40366 | 1811 | 48963 | 1261 | 35242 |
| 7L-5S | | MI | 13953 | 5676 | 23340 | 4018 | 25250 | 3243 | 25934 | 2616 | 26556 | 1650 | 31671 | 1202 | 22397 |
| 20-#11 | 3.00 | MA | 20698 | 5676 | 33783 | 4174 | 36784 | 3375 | 37905 | 2763 | 38579 | 1803 | 46849 | 1213 | 34395 |
| 8L-4S | | MI | 14253 | 5676 | 23840 | 4024 | 25896 | 3234 | 26704 | 2608 | 27636 | 1659 | 32932 | 1240 | 22780 |
| 20-#11 | 3.00 | MA | 20260 | 5676 | 32966 | 4188 | 35778 | 3388 | 36626 | 2757 | 36912 | 1812 | 44771 | 1159 | 33572 |
| 9L-3S | | MI | 14584 | 5676 | 24415 | 4014 | 26625 | 3243 | 27568 | 2616 | 28710 | 1650 | 34119 | 1322 | 22799 |
| 20-#11 | 3.00 | MA | 19766 | 5676 | 32208 | 4186 | 34757 | 3384 | 35408 | 2769 | 35260 | 1820 | 42758 | 1098 | 32633 |
| 10L-2S | | MI | 15043 | 5676 | 25110 | 4021 | 27512 | 3234 | 28628 | 2608 | 30116 | 1642 | 35948 | 1408 | 22785 |
| 20-#14 | 4.33 | MA | 22258 | 6153 | 37647 | 4468 | 41717 | 3593 | 43852 | 2879 | 46762 | 1770 | 57728 | 994 | 48149 |
| 7L-5S | | MI | 14744 | 6153 | 25563 | 4292 | 27952 | 3432 | 29144 | 2712 | 30816 | 1559 | 37263 | 924 | 30840 |
| 20-#14 | 4.33 | MA | 21641 | 6153 | 36558 | 4464 | 40235 | 3587 | 42098 | 2895 | 44211 | 1758 | 54719 | 926 | 46600 |
| 8L-4S | | MI | 15165 | 6153 | 26278 | 4302 | 28863 | 3420 | 30231 | 2700 | 32340 | 1571 | 39034 | 980 | 31428 |
| 20-#14 | 4.33 | MA | 21029 | 6153 | 35385 | 4484 | 38792 | 3605 | 40263 | 2886 | 41832 | 1770 | 51769 | 848 | 45072 |
| 9L-3S | | MI | 15631 | 6153 | 27098 | 4288 | 29892 | 3432 | 31450 | 2712 | 33855 | 1559 | 40704 | 1096 | 32013 |

## RECTANGULAR TIED COLUMNS 26" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.30 | MA | 21678 | 5784 | 35709 | 4244 | 39313 | 3428 | 40953 | 2781 | 42847 | 1802 | 52281 | 1243 | 38715 |
| 7L-6S | | MI | 13972 | 5784 | 23563 | 4079 | 25490 | 3282 | 26261 | 2652 | 26987 | 1644 | 32328 | 1112 | 24249 |
| 22-#11 | 3.30 | MA | 21240 | 5784 | 34950 | 4241 | 38279 | 3424 | 39729 | 2792 | 41060 | 1794 | 50168 | 1195 | 37895 |
| 8L-5S | | MI | 14258 | 5784 | 24034 | 4085 | 26137 | 3291 | 26994 | 2643 | 27963 | 1635 | 33501 | 1169 | 24483 |
| 22-#11 | 3.30 | MA | 20802 | 5784 | 34132 | 4256 | 37273 | 3437 | 38449 | 2787 | 39394 | 1803 | 48089 | 1141 | 37031 |
| 9L-4S | | MI | 14556 | 5784 | 24535 | 4092 | 26783 | 3282 | 27764 | 2634 | 29042 | 1644 | 34761 | 1207 | 24931 |
| 22-#11 | 3.30 | MA | 20313 | 5784 | 33374 | 4253 | 36252 | 3433 | 37232 | 2798 | 37741 | 1812 | 46076 | 1079 | 36116 |
| 10L-3S | | MI | 14887 | 5784 | 25110 | 4081 | 27512 | 3291 | 28628 | 2643 | 30116 | 1635 | 35948 | 1289 | 24961 |
| 22-#14 | 4.76 | MA | 22402 | 6309 | 38226 | 4561 | 42373 | 3656 | 44707 | 2937 | 47751 | 1745 | 59434 | 897 | 51526 |
| 8L-5S | | MI | 15169 | 6309 | 26550 | 4389 | 29203 | 3501 | 30640 | 2750 | 32800 | 1535 | 39833 | 873 | 33804 |
| 22-#14 | 4.76 | MA | 21791 | 6309 | 37053 | 4581 | 40931 | 3675 | 42872 | 2928 | 45372 | 1757 | 56483 | 819 | 49818 |
| 9L-4S | | MI | 15588 | 6309 | 27265 | 4400 | 30114 | 3488 | 31727 | 2738 | 34324 | 1547 | 41604 | 929 | 34354 |
| 24-#11 | 3.60 | MA | 21779 | 5891 | 36116 | 4309 | 39774 | 3472 | 41553 | 2822 | 43542 | 1785 | 53486 | 1176 | 41399 |
| 8L-6S | | MI | 14277 | 5891 | 24257 | 4146 | 26377 | 3331 | 27321 | 2679 | 28393 | 1628 | 34158 | 1079 | 26351 |
| 24-#11 | 3.60 | MA | 21341 | 5891 | 35298 | 4323 | 38768 | 3485 | 40273 | 2816 | 41875 | 1794 | 51408 | 1122 | 40496 |
| 9L-5S | | MI | 14561 | 5891 | 24728 | 4153 | 27024 | 3339 | 28054 | 2670 | 29369 | 1619 | 35330 | 1136 | 26573 |
| 24-#11 | 3.60 | MA | 20857 | 5891 | 34541 | 4320 | 37747 | 3481 | 39056 | 2828 | 40223 | 1803 | 49395 | 1061 | 39603 |
| 10L-4S | | MI | 14858 | 5891 | 25229 | 4159 | 27670 | 3331 | 28824 | 2661 | 30448 | 1628 | 36591 | 1175 | 27078 |
| 24-#14 | 5.19 | MA | 22548 | 6464 | 38722 | 4678 | 43069 | 3744 | 45482 | 2971 | 48911 | 1744 | 61198 | 790 | 54714 |
| 9L-5S | | MI | 15592 | 6464 | 27538 | 4486 | 30454 | 3569 | 32135 | 2788 | 34784 | 1511 | 42403 | 823 | 36771 |

## RECTANGULAR TIED COLUMNS 26" x 42"

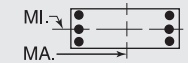
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.47 | MA | 23186 | 5380 | 36547 | 3975 | 39594 | 3234 | 40537 | 2687 | 40762 | 1900 | 47997 | 1775 | 20210 |
| 2E | | MI | 14055 | 5380 | 22618 | 3796 | 23789 | 3074 | 23897 | 2535 | 23431 | 1756 | 26947 | 1588 | 11976 |
| 6-#14 | 1.24 | MA | 22802 | 5293 | 35549 | 3948 | 38465 | 3217 | 39215 | 2682 | 39083 | 1926 | 45873 | 1817 | 17284 |
| 2L-3S | | MI | 13214 | 5293 | 21096 | 3774 | 22066 | 3091 | 21883 | 2566 | 20770 | 1816 | 23595 | 1537 | 10403 |
| 6-#14 | 1.24 | MA | 21601 | 5293 | 33784 | 3943 | 36201 | 3236 | 36454 | 2699 | 35327 | 1939 | 40850 | 1692 | 17340 |
| 3L-2S | | MI | 13880 | 5293 | 22083 | 3784 | 23317 | 3078 | 23378 | 2553 | 22753 | 1803 | 26165 | 1661 | 10318 |
| 6-#18 | 2.20 | MA | 24604 | 5657 | 39637 | 4148 | 43555 | 3358 | 45369 | 2762 | 47289 | 1875 | 56671 | 1721 | 29914 |
| 2L-3S | | MI | 13658 | 5657 | 22618 | 3947 | 23789 | 3213 | 23897 | 2620 | 23431 | 1729 | 26947 | 1265 | 17549 |
| 6-#18 | 2.20 | MA | 22540 | 5657 | 36547 | 4139 | 39594 | 3390 | 40537 | 2790 | 40762 | 1897 | 47997 | 1499 | 29824 |
| 3L-2S | | MI | 14795 | 5657 | 24324 | 3968 | 25914 | 3191 | 26437 | 2598 | 26802 | 1707 | 31275 | 1486 | 17439 |
| 8-#11 | 1.14 | MA | 22644 | 5258 | 35128 | 3939 | 38001 | 3212 | 38679 | 2682 | 38365 | 1936 | 45014 | 1835 | 16077 |
| 2L-4S | | MI | 12998 | 5258 | 20584 | 3787 | 21506 | 3083 | 21245 | 2563 | 20003 | 1842 | 22839 | 1525 | 9746 |
| 8-#11 | 1.14 | MA | 21803 | 5258 | 33894 | 3936 | 36419 | 3208 | 36749 | 2694 | 35740 | 1945 | 41481 | 1749 | 16118 |
| 3E | | MI | 13338 | 5258 | 21159 | 3777 | 22235 | 3092 | 22109 | 2572 | 21076 | 1833 | 24025 | 1606 | 9681 |
| 8-#11 | 1.14 | MA | 21212 | 5258 | 32889 | 3951 | 35139 | 3222 | 35193 | 2689 | 33737 | 1955 | 39182 | 1662 | 16138 |
| 4L-2S | | MI | 13808 | 5258 | 21853 | 3783 | 23122 | 3083 | 23169 | 2563 | 22483 | 1825 | 25855 | 1693 | 9628 |
| 8-#14 | 1.65 | MA | 23627 | 5449 | 37315 | 4045 | 40728 | 3287 | 41977 | 2724 | 42840 | 1914 | 50896 | 1790 | 22836 |
| 2L-4S | | MI | 13172 | 5449 | 21263 | 3885 | 22288 | 3147 | 22159 | 2591 | 21238 | 1804 | 24495 | 1370 | 13623 |
| 8-#14 | 1.65 | MA | 22435 | 5449 | 35549 | 4041 | 38465 | 3306 | 39215 | 2741 | 39083 | 1926 | 45873 | 1665 | 22859 |
| 3E | | MI | 13653 | 5449 | 22083 | 3871 | 23317 | 3159 | 23378 | 2603 | 22753 | 1792 | 26165 | 1486 | 13558 |
| 8-#14 | 1.65 | MA | 21596 | 5449 | 34109 | 4061 | 36629 | 3300 | 36985 | 2733 | 36213 | 1939 | 42608 | 1541 | 22765 |
| 4L-2S | | MI | 14316 | 5449 | 23071 | 3881 | 24568 | 3147 | 24874 | 2591 | 24737 | 1779 | 28735 | 1611 | 13485 |
| 8-#18 | 2.93 | MA | 26002 | 5933 | 42727 | 4321 | 47516 | 3483 | 50202 | 2838 | 53815 | 1850 | 65346 | 1666 | 39565 |
| 2L-4S | | MI | 13574 | 5933 | 22900 | 4142 | 24164 | 3309 | 24365 | 2660 | 24228 | 1703 | 28452 | 965 | 21866 |
| 8-#18 | 2.93 | MA | 23960 | 5933 | 39637 | 4312 | 43555 | 3514 | 45369 | 2865 | 47289 | 1872 | 56671 | 1445 | 39358 |
| 3E | | MI | 14398 | 5933 | 24324 | 4120 | 25914 | 3331 | 26437 | 2682 | 26802 | 1681 | 31275 | 1163 | 22887 |
| 8-#18 | 2.93 | MA | 22522 | 5933 | 37110 | 4347 | 40335 | 3501 | 41455 | 2848 | 42300 | 1894 | 51047 | 1223 | 37484 |
| 4L-2S | | MI | 15526 | 5933 | 26031 | 4141 | 28039 | 3309 | 28978 | 2660 | 30173 | 1659 | 35602 | 1385 | 22843 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis

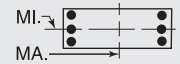



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.43 | MA | 23225 | 5366 | 36362 | 4006 | 39582 | 3261 | 40608 | 2711 | 40990 | 1927 | 48546 | 1818 | 19958 |
| 2L-5S | | MI | 13005 | 5366 | 20777 | 3848 | 21747 | 3140 | 21535 | 2599 | 20329 | 1818 | 23407 | 1453 | 12003 |
| 10-#11 | 1.43 | MA | 22388 | 5366 | 35128 | 4004 | 38001 | 3257 | 38679 | 2723 | 38365 | 1937 | 45014 | 1731 | 19987 |
| 3L-4S | | MI | 13311 | 5366 | 21278 | 3855 | 22393 | 3131 | 22305 | 2590 | 21409 | 1827 | 24668 | 1492 | 11958 |
| 10-#11 | 1.43 | MA | 21801 | 5366 | 34123 | 4018 | 36720 | 3270 | 37122 | 2718 | 36362 | 1946 | 42714 | 1645 | 19977 |
| 4L-3S | | MI | 13650 | 5366 | 21853 | 3844 | 23122 | 3140 | 23169 | 2599 | 22483 | 1818 | 25855 | 1573 | 11905 |
| 10-#11 | 1.43 | MA | 21276 | 5366 | 33254 | 4016 | 35593 | 3266 | 35738 | 2730 | 34356 | 1939 | 40312 | 1603 | 19892 |
| 5L-2S | | MI | 14118 | 5366 | 22547 | 3851 | 24009 | 3131 | 24229 | 2590 | 23889 | 1809 | 27684 | 1660 | 11854 |
| 10-#14 | 2.06 | MA | 24444 | 5605 | 39080 | 4142 | 42991 | 3357 | 44738 | 2767 | 46597 | 1901 | 55919 | 1763 | 28369 |
| 2L-5S | | MI | 13178 | 5605 | 21536 | 3972 | 22628 | 3227 | 22568 | 2641 | 21698 | 1768 | 25294 | 1264 | 16280 |
| 10-#14 | 2.06 | MA | 23260 | 5605 | 37315 | 4138 | 40728 | 3376 | 41977 | 2784 | 42840 | 1914 | 50896 | 1638 | 28352 |
| 3L-4S | | MI | 13611 | 5605 | 22251 | 3982 | 23539 | 3215 | 23655 | 2628 | 23222 | 1780 | 27065 | 1320 | 16722 |
| 10-#14 | 2.06 | MA | 22428 | 5605 | 35875 | 4159 | 38893 | 3369 | 39746 | 2775 | 39970 | 1927 | 47631 | 1514 | 28211 |
| 4L-3S | | MI | 14090 | 5605 | 23071 | 3968 | 24568 | 3227 | 24874 | 2641 | 24737 | 1768 | 28735 | 1435 | 16685 |
| 10-#14 | 2.06 | MA | 21685 | 5605 | 34629 | 4155 | 37277 | 3388 | 37761 | 2792 | 37095 | 1915 | 44208 | 1455 | 27244 |
| 5L-2S | | MI | 14750 | 5605 | 24058 | 3979 | 25819 | 3215 | 26369 | 2628 | 26721 | 1755 | 31304 | 1560 | 16626 |
| 10-#18 | 3.66 | MA | 25361 | 6210 | 42727 | 4485 | 47516 | 3638 | 50202 | 2941 | 53815 | 1847 | 65346 | 1390 | 48872 |
| 3L-4S | | MI | 14314 | 6210 | 24607 | 4315 | 26289 | 3427 | 26905 | 2722 | 27599 | 1654 | 32779 | 864 | 26775 |
| 10-#18 | 3.66 | MA | 23939 | 6210 | 40200 | 4520 | 44296 | 3625 | 46288 | 2924 | 48827 | 1869 | 59721 | 1169 | 46538 |
| 4L-3S | | MI | 15132 | 6210 | 26031 | 4292 | 28039 | 3449 | 28978 | 2744 | 30173 | 1632 | 35602 | 1062 | 28177 |
| 10-#18 | 3.66 | MA | 22670 | 6210 | 38011 | 4511 | 41458 | 3656 | 42801 | 2951 | 43828 | 1847 | 53787 | 1067 | 43991 |
| 5L-2S | | MI | 16251 | 6210 | 27738 | 4314 | 30163 | 3427 | 31518 | 2722 | 33544 | 1610 | 39929 | 1283 | 28211 |
| 12-#11 | 1.71 | MA | 23803 | 5474 | 37595 | 4074 | 41164 | 3309 | 42537 | 2740 | 43615 | 1919 | 52079 | 1800 | 23829 |
| 2L-6S | | MI | 13026 | 5474 | 21000 | 3909 | 21987 | 3179 | 21862 | 2634 | 20760 | 1811 | 24065 | 1363 | 13881 |
| 12-#11 | 1.71 | MA | 22970 | 5474 | 36362 | 4071 | 39582 | 3305 | 40608 | 2752 | 40990 | 1928 | 48546 | 1714 | 23845 |
| 3L-5S | | MI | 13317 | 5474 | 21471 | 3915 | 22634 | 3188 | 22595 | 2625 | 21735 | 1802 | 25237 | 1421 | 14182 |
| 12-#11 | 1.71 | MA | 22385 | 5474 | 35357 | 4086 | 38302 | 3319 | 39052 | 2747 | 38987 | 1938 | 46247 | 1627 | 23808 |
| 4E | | MI | 13622 | 5474 | 21972 | 3922 | 23280 | 3179 | 23365 | 2617 | 22815 | 1811 | 26498 | 1459 | 14155 |
| 12-#11 | 1.71 | MA | 21863 | 5474 | 34488 | 4083 | 37175 | 3315 | 37667 | 2759 | 36981 | 1930 | 43845 | 1586 | 23697 |
| 5L-3S | | MI | 13960 | 5474 | 22547 | 3912 | 24009 | 3188 | 24229 | 2625 | 23889 | 1802 | 27684 | 1541 | 14112 |
| 12-#11 | 1.71 | MA | 21367 | 5474 | 33674 | 4081 | 36047 | 3328 | 36288 | 2754 | 35164 | 1939 | 41562 | 1530 | 22995 |
| 6L-2S | | MI | 14426 | 5474 | 23241 | 3918 | 24896 | 3179 | 25289 | 2617 | 25295 | 1794 | 29513 | 1627 | 14067 |
| 12-#14 | 2.47 | MA | 24077 | 5760 | 39080 | 4235 | 42991 | 3445 | 44738 | 2826 | 46597 | 1902 | 55919 | 1611 | 33832 |
| 3L-5S | | MI | 13616 | 5760 | 22524 | 4069 | 23879 | 3296 | 24063 | 2678 | 23682 | 1744 | 27864 | 1213 | 19200 |
| 12-#14 | 2.47 | MA | 23252 | 5760 | 37640 | 4256 | 41156 | 3439 | 42507 | 2818 | 43726 | 1914 | 52653 | 1487 | 33650 |
| 4E | | MI | 14047 | 5760 | 23238 | 4080 | 24790 | 3283 | 25150 | 2666 | 25206 | 1756 | 29635 | 1269 | 19795 |
| 12-#14 | 2.47 | MA | 22514 | 5760 | 36395 | 4252 | 39541 | 3458 | 40522 | 2835 | 40852 | 1902 | 49231 | 1428 | 32509 |
| 5L-3S | | MI | 14524 | 5760 | 24058 | 4065 | 25819 | 3296 | 26369 | 2678 | 26721 | 1744 | 31304 | 1385 | 19793 |
| 12-#14 | 2.47 | MA | 21812 | 5760 | 35226 | 4248 | 37923 | 3452 | 38545 | 2826 | 38246 | 1915 | 45987 | 1347 | 31518 |
| 6L-2S | | MI | 15180 | 5760 | 25046 | 4076 | 27070 | 3283 | 27864 | 2666 | 28704 | 1731 | 33874 | 1509 | 19749 |
| 12-#18 | 4.40 | MA | 25338 | 6486 | 43290 | 4693 | 48257 | 3749 | 51120 | 2999 | 55354 | 1845 | 68396 | 1114 | 55642 |
| 4E | | MI | 15047 | 6486 | 26314 | 4488 | 28414 | 3545 | 29445 | 2785 | 30970 | 1606 | 37107 | 762 | 31727 |
| 12-#18 | 4.40 | MA | 24083 | 6486 | 41101 | 4684 | 45419 | 3780 | 47634 | 3026 | 50355 | 1822 | 62461 | 1013 | 53243 |
| 5L-3S | | MI | 15859 | 6486 | 27738 | 4465 | 30163 | 3567 | 31518 | 2807 | 33544 | 1584 | 39929 | 960 | 33440 |
| 12-#18 | 4.40 | MA | 22889 | 6486 | 39047 | 4675 | 42577 | 3767 | 44160 | 3009 | 45825 | 1845 | 56866 | 868 | 49597 |
| 6L-2S | | MI | 16970 | 6486 | 29445 | 4487 | 32288 | 3545 | 34058 | 2785 | 36915 | 1562 | 44256 | 1181 | 33549 |
| 14-#11 | 2.00 | MA | 23547 | 5582 | 37595 | 4139 | 41164 | 3354 | 42537 | 2782 | 43615 | 1920 | 52079 | 1696 | 27687 |
| 3L-6S | | MI | 13338 | 5582 | 21694 | 3976 | 22874 | 3228 | 22922 | 2661 | 22166 | 1796 | 25894 | 1330 | 15970 |
| 14-#11 | 2.00 | MA | 22966 | 5582 | 36590 | 4153 | 39883 | 3367 | 40981 | 2777 | 41612 | 1929 | 49779 | 1610 | 27631 |
| 4L-5S | | MI | 13628 | 5582 | 22165 | 3983 | 23521 | 3236 | 23655 | 2652 | 23141 | 1787 | 27066 | 1388 | 16288 |
| 14-#11 | 2.00 | MA | 22447 | 5582 | 35722 | 4151 | 38756 | 3363 | 39596 | 2789 | 39606 | 1921 | 47377 | 1568 | 27498 |
| 5L-4S | | MI | 13932 | 5582 | 22666 | 3990 | 24167 | 3228 | 24426 | 2644 | 24221 | 1796 | 28327 | 1426 | 16340 |
| 14-#11 | 2.00 | MA | 21953 | 5582 | 34907 | 4148 | 37628 | 3377 | 38218 | 2784 | 37789 | 1931 | 45094 | 1512 | 26713 |
| 6L-3S | | MI | 14268 | 5582 | 23241 | 3979 | 24896 | 3236 | 25289 | 2652 | 25295 | 1787 | 29513 | 1508 | 16308 |
| 14-#11 | 2.00 | MA | 21472 | 5582 | 34015 | 4163 | 36552 | 3373 | 36894 | 2796 | 36014 | 1940 | 42659 | 1422 | 26223 |
| 7L-2S | | MI | 14732 | 5582 | 23935 | 3986 | 25783 | 3228 | 26349 | 2644 | 26701 | 1778 | 31343 | 1594 | 16270 |
| 14-#14 | 2.88 | MA | 24068 | 5916 | 39406 | 4353 | 43419 | 3509 | 45268 | 2860 | 47483 | 1902 | 57676 | 1460 | 39084 |
| 4L-5S | | MI | 14052 | 5916 | 23511 | 4166 | 25130 | 3364 | 25558 | 2716 | 25666 | 1720 | 30433 | 1162 | 22135 |

## RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis



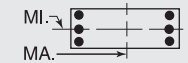

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.88 | MA | 23336 | 5916 | 38160 | 4349 | 41804 | 3528 | 43284 | 2877 | 44609 | 1890 | 54254 | 1401 | 37791 |
| 5L-4S | | MI | 14481 | 5916 | 24226 | 4177 | 26041 | 3352 | 26645 | 2703 | 27189 | 1732 | 32204 | 1218 | 22856 |
| 14-#14 | 2.88 | MA | 22640 | 5916 | 36992 | 4345 | 40186 | 3522 | 41307 | 2869 | 42003 | 1902 | 51010 | 1320 | 36846 |
| 6L-3S | | MI | 14955 | 5916 | 25046 | 4163 | 27070 | 3364 | 27864 | 2716 | 28704 | 1720 | 33874 | 1334 | 22890 |
| 14-#14 | 2.88 | MA | 21961 | 5916 | 35712 | 4366 | 38643 | 3540 | 39409 | 2886 | 39457 | 1915 | 47547 | 1190 | 35363 |
| 7L-2S | | MI | 15608 | 5916 | 26033 | 4173 | 28321 | 3352 | 29360 | 2703 | 30688 | 1707 | 36444 | 1459 | 22860 |
| 14-#18 | 5.13 | MA | 25479 | 6763 | 44191 | 4857 | 49381 | 3904 | 52466 | 3102 | 56881 | 1798 | 71136 | 958 | 62518 |
| 5L-4S | | MI | 15775 | 6763 | 28021 | 4661 | 30538 | 3662 | 31985 | 2847 | 34341 | 1557 | 41434 | 660 | 36713 |
| 14-#18 | 5.13 | MA | 24299 | 6763 | 42137 | 4848 | 46538 | 3891 | 48993 | 3085 | 52352 | 1820 | 65541 | 813 | 58709 |
| 6L-3S | | MI | 16581 | 6763 | 29445 | 4638 | 32288 | 3684 | 34058 | 2869 | 36915 | 1535 | 44256 | 858 | 38686 |
| 14-#18 | 5.13 | MA | 23151 | 6763 | 39888 | 4883 | 43824 | 3923 | 45657 | 3112 | 47926 | 1842 | 59563 | 582 | 55067 |
| 7L-2S | | MI | 17684 | 6763 | 31152 | 4660 | 34413 | 3662 | 36598 | 2847 | 40286 | 1513 | 48584 | 1080 | 38852 |
| 16-#11 | 2.29 | MA | 23543 | 5690 | 37824 | 4221 | 41465 | 3415 | 42910 | 2806 | 44237 | 1920 | 53312 | 1592 | 31450 |
| 4L-6S | | MI | 13648 | 5690 | 22389 | 4044 | 23761 | 3276 | 23982 | 2688 | 23572 | 1780 | 27723 | 1297 | 18063 |
| 16-#11 | 2.29 | MA | 23027 | 5690 | 36955 | 4218 | 40338 | 3412 | 41526 | 2818 | 42231 | 1913 | 50910 | 1551 | 31195 |
| 5E | | MI | 13938 | 5690 | 22860 | 4050 | 24408 | 3284 | 24715 | 2679 | 24547 | 1771 | 28895 | 1355 | 18357 |
| 16-#11 | 2.29 | MA | 22535 | 5690 | 36141 | 4216 | 39210 | 3425 | 40147 | 2813 | 40414 | 1922 | 48627 | 1495 | 30439 |
| 6L-4S | | MI | 14240 | 5690 | 23360 | 4057 | 25054 | 3276 | 25486 | 2671 | 25627 | 1780 | 30156 | 1393 | 18517 |
| 16-#11 | 2.29 | MA | 22057 | 5690 | 35249 | 4230 | 38134 | 3421 | 38824 | 2825 | 38639 | 1932 | 46191 | 1405 | 29966 |
| 7L-3S | | MI | 14575 | 5690 | 23935 | 4046 | 25783 | 3284 | 26349 | 2679 | 26701 | 1771 | 31343 | 1475 | 18496 |
| 16-#11 | 2.29 | MA | 21586 | 5690 | 34447 | 4228 | 37042 | 3435 | 37532 | 2837 | 36752 | 1924 | 43945 | 1356 | 29099 |
| 8L-2S | | MI | 15038 | 5690 | 24630 | 4053 | 26670 | 3276 | 27409 | 2671 | 28107 | 1763 | 33172 | 1561 | 18464 |
| 16-#14 | 3.30 | MA | 24151 | 6072 | 39926 | 4446 | 44067 | 3598 | 46045 | 2919 | 48365 | 1877 | 59277 | 1374 | 43087 |
| 5E | | MI | 14485 | 6072 | 24499 | 4264 | 26382 | 3432 | 27054 | 2753 | 27649 | 1696 | 33003 | 1112 | 25079 |
| 16-#14 | 3.30 | MA | 23460 | 6072 | 38758 | 4442 | 42450 | 3592 | 44068 | 2911 | 45760 | 1890 | 56033 | 1293 | 42182 |
| 6L-4S | | MI | 14911 | 6072 | 25213 | 4274 | 27292 | 3420 | 28140 | 2741 | 29173 | 1708 | 34774 | 1168 | 25784 |
| 16-#14 | 3.30 | MA | 22786 | 6072 | 37478 | 4463 | 40906 | 3610 | 42170 | 2928 | 43214 | 1903 | 52570 | 1163 | 40614 |
| 7L-3S | | MI | 15383 | 6072 | 26033 | 4260 | 28321 | 3432 | 29360 | 2753 | 30688 | 1696 | 36444 | 1283 | 25965 |
| 16-#14 | 3.30 | MA | 22124 | 6072 | 36328 | 4459 | 39340 | 3604 | 40317 | 2945 | 40508 | 1891 | 49371 | 1094 | 39226 |
| 8L-2S | | MI | 16033 | 6072 | 27021 | 4270 | 29572 | 3420 | 30855 | 2741 | 32671 | 1683 | 39013 | 1408 | 25962 |
| 16-#18 | 5.86 | MA | 25692 | 7040 | 45227 | 5021 | 50499 | 4015 | 53825 | 3160 | 58879 | 1795 | 74215 | 759 | 67847 |
| 6L-4S | | MI | 16497 | 7040 | 29728 | 4833 | 32663 | 3780 | 34525 | 2909 | 37712 | 1509 | 45761 | 559 | 41725 |
| 16-#18 | 5.86 | MA | 24556 | 7040 | 42978 | 5056 | 47786 | 4047 | 50490 | 3187 | 54453 | 1817 | 68237 | 527 | 64097 |
| 7L-3S | | MI | 17298 | 7040 | 31152 | 4811 | 34413 | 3802 | 36598 | 2931 | 40286 | 1487 | 48584 | 757 | 43918 |
| 18-#11 | 2.57 | MA | 23602 | 5798 | 38189 | 4286 | 41919 | 3460 | 43455 | 2848 | 44856 | 1904 | 54443 | 1533 | 34894 |
| 5L-6S | | MI | 13958 | 5798 | 23083 | 4111 | 24648 | 3324 | 25042 | 2715 | 24978 | 1764 | 29553 | 1264 | 20160 |
| 18-#11 | 2.57 | MA | 23114 | 5798 | 37375 | 4283 | 40791 | 3473 | 42076 | 2842 | 43039 | 1914 | 52160 | 1477 | 34171 |
| 6L-5S | | MI | 14246 | 5798 | 23554 | 4118 | 25295 | 3332 | 25775 | 2706 | 25953 | 1756 | 30725 | 1322 | 20434 |
| 18-#11 | 2.57 | MA | 22638 | 5798 | 36482 | 4298 | 39715 | 3470 | 40753 | 2855 | 41264 | 1923 | 49724 | 1387 | 33712 |
| 7L-4S | | MI | 14547 | 5798 | 24055 | 4124 | 25941 | 3324 | 26546 | 2698 | 27033 | 1764 | 31986 | 1360 | 20689 |
| 18-#11 | 2.57 | MA | 22170 | 5798 | 35681 | 4295 | 38623 | 3483 | 39461 | 2867 | 39377 | 1915 | 47478 | 1339 | 32793 |
| 8L-3S | | MI | 14881 | 5798 | 24630 | 4114 | 26670 | 3332 | 27409 | 2706 | 28107 | 1756 | 33172 | 1442 | 20677 |
| 18-#11 | 2.57 | MA | 21687 | 5798 | 34817 | 4310 | 37562 | 3479 | 38111 | 2862 | 37618 | 1925 | 45264 | 1285 | 32058 |
| 9L-2S | | MI | 15341 | 5798 | 25324 | 4121 | 27557 | 3324 | 28469 | 2698 | 29513 | 1747 | 35001 | 1528 | 20652 |
| 18-#14 | 3.71 | MA | 24273 | 6227 | 40523 | 4540 | 44713 | 3661 | 46829 | 2954 | 49517 | 1878 | 61056 | 1266 | 47525 |
| 6L-5S | | MI | 14915 | 6227 | 25486 | 4361 | 27633 | 3501 | 28549 | 2791 | 29633 | 1672 | 35573 | 1061 | 28032 |
| 18-#14 | 3.71 | MA | 23605 | 6227 | 39243 | 4560 | 43169 | 3680 | 44931 | 2970 | 46971 | 1890 | 57593 | 1136 | 45876 |
| 7L-4S | | MI | 15340 | 6227 | 26201 | 4371 | 28543 | 3488 | 29636 | 2779 | 31157 | 1684 | 37344 | 1117 | 28687 |
| 18-#14 | 3.71 | MA | 22947 | 6227 | 38093 | 4556 | 41604 | 3674 | 43078 | 2987 | 44265 | 1878 | 54394 | 1067 | 44426 |
| 8L-3S | | MI | 15810 | 6227 | 27021 | 4357 | 29572 | 3501 | 30855 | 2791 | 32671 | 1672 | 39013 | 1233 | 29031 |
| 18-#14 | 3.71 | MA | 22287 | 6227 | 36855 | 4577 | 40080 | 3693 | 41141 | 2979 | 41742 | 1891 | 51248 | 989 | 42722 |
| 9L-2S | | MI | 16456 | 6227 | 28008 | 4368 | 30823 | 3488 | 32350 | 2779 | 34655 | 1659 | 41583 | 1357 | 29058 |
| 18-#18 | 6.59 | MA | 25947 | 7316 | 46068 | 5229 | 51747 | 4171 | 55322 | 3263 | 60980 | 1792 | 76912 | 473 | 73150 |
| 7L-4S | | MI | 17216 | 7316 | 31434 | 5006 | 34788 | 3898 | 37066 | 2972 | 41083 | 1460 | 50088 | 457 | 46756 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

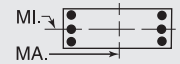
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.86 | MA | 23689 | 5906 | 38608 | 4351 | 42373 | 3522 | 44006 | 2872 | 45664 | 1905 | 55692 | 1460 | 37909 |
| 6E | | MI | 14265 | 5906 | 23777 | 4178 | 25535 | 3372 | 26102 | 2742 | 26384 | 1749 | 31382 | 1231 | 22260 |
| 20-#11 | 2.86 | MA | 23216 | 5906 | 37716 | 4365 | 41297 | 3518 | 42682 | 2884 | 43889 | 1914 | 53257 | 1370 | 37432 |
| 7L-5S | | MI | 14552 | 5906 | 24248 | 4185 | 26182 | 3381 | 26835 | 2733 | 27359 | 1740 | 32554 | 1289 | 22516 |
| 20-#11 | 2.86 | MA | 22750 | 5906 | 36914 | 4363 | 40205 | 3531 | 41391 | 2896 | 42002 | 1907 | 51011 | 1321 | 36492 |
| 8L-4S | | MI | 14852 | 5906 | 24749 | 4192 | 26828 | 3372 | 27606 | 2724 | 28439 | 1749 | 33815 | 1327 | 22844 |
| 20-#11 | 2.86 | MA | 22279 | 5906 | 36051 | 4377 | 39143 | 3528 | 40040 | 2891 | 40243 | 1916 | 48797 | 1267 | 35715 |
| 9L-3S | | MI | 15185 | 5906 | 25324 | 4181 | 27557 | 3381 | 28469 | 2733 | 29513 | 1740 | 35001 | 1409 | 22853 |
| 20-#11 | 2.86 | MA | 21755 | 5906 | 35252 | 4375 | 38066 | 3541 | 38755 | 2903 | 38499 | 1926 | 46652 | 1206 | 34680 |
| 10L-2S | | MI | 15644 | 5906 | 26018 | 4188 | 28444 | 3372 | 29530 | 2724 | 30919 | 1732 | 36831 | 1495 | 22835 |
| 20-#14 | 4.12 | MA | 24417 | 6383 | 41009 | 4657 | 45433 | 3750 | 47692 | 3013 | 50727 | 1878 | 62616 | 1109 | 51148 |
| 7L-5S | | MI | 15344 | 6383 | 26473 | 4458 | 28884 | 3569 | 30044 | 2829 | 31617 | 1648 | 38142 | 1010 | 30991 |
| 20-#14 | 4.12 | MA | 23764 | 6383 | 39859 | 4653 | 43867 | 3744 | 45840 | 3030 | 48022 | 1866 | 59416 | 1040 | 49637 |
| 8L-4S | | MI | 15766 | 6383 | 27188 | 4469 | 29794 | 3557 | 31131 | 2816 | 33140 | 1660 | 39913 | 1066 | 31602 |
| 20-#14 | 4.12 | MA | 23105 | 6383 | 38621 | 4674 | 42344 | 3763 | 43902 | 3021 | 45499 | 1879 | 56271 | 962 | 47978 |
| 9L-3S | | MI | 16234 | 6383 | 28008 | 4454 | 30823 | 3569 | 32350 | 2829 | 34655 | 1648 | 41583 | 1182 | 32090 |
| 22-#11 | 3.14 | MA | 23790 | 6013 | 38950 | 4433 | 42878 | 3566 | 44612 | 2913 | 46514 | 1906 | 56789 | 1352 | 41109 |
| 7L-6S | | MI | 14571 | 6013 | 24471 | 4246 | 26422 | 3420 | 27162 | 2769 | 27790 | 1733 | 33211 | 1198 | 24362 |
| 22-#11 | 3.14 | MA | 23327 | 6013 | 38148 | 4430 | 41786 | 3580 | 43320 | 2925 | 44627 | 1898 | 54543 | 1304 | 40197 |
| 8L-5S | | MI | 14857 | 6013 | 24942 | 4253 | 27069 | 3429 | 27895 | 2760 | 28765 | 1725 | 34383 | 1256 | 24603 |
| 22-#11 | 3.14 | MA | 22856 | 6013 | 37285 | 4445 | 40724 | 3576 | 41969 | 2920 | 42868 | 1907 | 52330 | 1250 | 39378 |
| 9L-4S | | MI | 15156 | 6013 | 25443 | 4259 | 27715 | 3420 | 28666 | 2751 | 29845 | 1733 | 35644 | 1294 | 24999 |
| 22-#11 | 3.14 | MA | 22337 | 6013 | 36486 | 4442 | 39647 | 3589 | 40684 | 2932 | 41123 | 1917 | 50185 | 1189 | 38367 |
| 10L-3S | | MI | 15488 | 6013 | 26018 | 4249 | 28444 | 3429 | 29530 | 2760 | 30919 | 1725 | 36831 | 1376 | 25024 |
| 22-#11 | 3.14 | MA | 21836 | 6013 | 35700 | 4440 | 38591 | 3586 | 39351 | 2927 | 39263 | 1909 | 47995 | 1137 | 37205 |
| 11L-2S | | MI | 15945 | 6013 | 26712 | 4255 | 29331 | 3420 | 30590 | 2751 | 32325 | 1716 | 38660 | 1462 | 25013 |
| 22-#14 | 4.53 | MA | 24575 | 6538 | 41624 | 4751 | 46130 | 3814 | 48601 | 3072 | 51779 | 1853 | 64439 | 1012 | 54858 |
| 8L-5S | | MI | 15770 | 6538 | 27461 | 4555 | 30135 | 3638 | 31539 | 2866 | 33600 | 1624 | 40712 | 960 | 33956 |
| 22-#14 | 4.53 | MA | 23916 | 6538 | 40386 | 4771 | 44607 | 3832 | 46664 | 3064 | 49255 | 1866 | 61294 | 935 | 53242 |
| 9L-4S | | MI | 16190 | 6538 | 28176 | 4566 | 31045 | 3625 | 32626 | 2854 | 35124 | 1636 | 42483 | 1016 | 34527 |
| 24-#11 | 3.43 | MA | 23900 | 6121 | 39382 | 4498 | 43368 | 3628 | 45249 | 2955 | 47252 | 1889 | 58076 | 1286 | 43907 |
| 8L-6S | | MI | 14876 | 6121 | 25165 | 4313 | 27309 | 3468 | 28222 | 2796 | 29196 | 1718 | 35040 | 1165 | 26466 |
| 24-#11 | 3.43 | MA | 23430 | 6121 | 38518 | 4512 | 42306 | 3624 | 43899 | 2950 | 45493 | 1899 | 55862 | 1232 | 43047 |
| 9L-5S | | MI | 15161 | 6121 | 25636 | 4320 | 27956 | 3477 | 28955 | 2787 | 30171 | 1709 | 36213 | 1223 | 26693 |
| 24-#11 | 3.43 | MA | 22915 | 6121 | 37719 | 4510 | 41229 | 3638 | 42614 | 2962 | 43748 | 1908 | 53718 | 1171 | 42060 |
| 10L-4S | | MI | 15459 | 6121 | 26137 | 4327 | 28602 | 3468 | 29726 | 2778 | 31251 | 1718 | 37474 | 1261 | 27149 |
| 24-#11 | 3.43 | MA | 22417 | 6121 | 36933 | 4507 | 40173 | 3634 | 41280 | 2957 | 41888 | 1901 | 51528 | 1120 | 40871 |
| 11L-3S | | MI | 15789 | 6121 | 26712 | 4316 | 29331 | 3477 | 30590 | 2787 | 32325 | 1709 | 38660 | 1343 | 27182 |
| 24-#14 | 4.95 | MA | 24722 | 6694 | 42152 | 4869 | 46870 | 3902 | 49425 | 3106 | 53012 | 1854 | 66317 | 908 | 58503 |
| 9L-5S | | MI | 16194 | 6694 | 28448 | 4653 | 31386 | 3706 | 33035 | 2904 | 35584 | 1600 | 43282 | 909 | 36924 |

## RECTANGULAR TIED COLUMNS 26" x 44"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.40 | MA | 25344 | 5610 | 39791 | 4162 | 43128 | 3388 | 44121 | 2818 | 44315 | 2003 | 52167 | 1879 | 21290 |
| 2E | | MI | 14654 | 5610 | 23532 | 3960 | 24719 | 3209 | 24793 | 2650 | 24225 | 1844 | 27819 | 1673 | 12021 |
| 6-#14 | 1.18 | MA | 24932 | 5523 | 38731 | 4134 | 41927 | 3371 | 42717 | 2812 | 42468 | 2026 | 49881 | 1919 | 18195 |
| 2L-3S | | MI | 13811 | 5523 | 22006 | 3940 | 22998 | 3227 | 22783 | 2682 | 21570 | 1905 | 24474 | 1623 | 10439 |
| 6-#14 | 1.18 | MA | 23663 | 5523 | 36869 | 4131 | 39539 | 3365 | 39804 | 2830 | 38504 | 2040 | 44550 | 1794 | 18251 |
| 3L-2S | | MI | 14478 | 5523 | 22994 | 3950 | 24249 | 3215 | 24278 | 2669 | 23553 | 1893 | 27044 | 1748 | 10354 |
| 6-#18 | 2.10 | MA | 26851 | 5886 | 43054 | 4335 | 47310 | 3512 | 49224 | 2893 | 51238 | 1980 | 61389 | 1828 | 31534 |
| 2L-3S | | MI | 14256 | 5886 | 23532 | 4111 | 24719 | 3349 | 24793 | 2735 | 24225 | 1817 | 27819 | 1350 | 17613 |
| 6-#18 | 2.10 | MA | 24666 | 5886 | 39791 | 4327 | 43128 | 3544 | 44121 | 2922 | 44315 | 2002 | 52167 | 1606 | 31444 |
| 3L-2S | | MI | 15394 | 5886 | 25239 | 4133 | 26844 | 3326 | 27334 | 2712 | 27596 | 1795 | 32146 | 1572 | 17493 |
| 8-#11 | 1.09 | MA | 24763 | 5488 | 38284 | 4126 | 41435 | 3366 | 42147 | 2812 | 41705 | 2036 | 48956 | 1936 | 16920 |
| 2L-4S | | MI | 13596 | 5488 | 21492 | 3955 | 22438 | 3221 | 22147 | 2680 | 20805 | 1932 | 23722 | 1612 | 9779 |
| 8-#11 | 1.09 | MA | 23874 | 5488 | 36983 | 4123 | 39767 | 3362 | 40112 | 2825 | 38936 | 2046 | 45209 | 1850 | 16961 |
| 3E | | MI | 13936 | 5488 | 22067 | 3944 | 23167 | 3229 | 23011 | 2689 | 21879 | 1923 | 24908 | 1693 | 9714 |

## RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

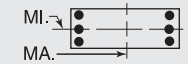
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.09 | MA | 23251 | 5488 | 35924 | 4138 | 38417 | 3376 | 38472 | 2820 | 36826 | 2056 | 42768 | 1764 | 16980 |
| 4L-2S | | MI | 14406 | 5488 | 22761 | 3951 | 24054 | 3221 | 24071 | 2680 | 23285 | 1915 | 26738 | 1780 | 9660 |
| 8-#14 | 1.57 | MA | 25808 | 5679 | 40594 | 4232 | 44315 | 3441 | 45631 | 2855 | 46432 | 2014 | 55212 | 1894 | 24051 |
| 2L-4S | | MI | 13769 | 5679 | 22174 | 4051 | 23219 | 3283 | 23059 | 2707 | 22039 | 1894 | 25374 | 1457 | 13674 |
| 8-#14 | 1.57 | MA | 24547 | 5679 | 38731 | 4228 | 41927 | 3435 | 42717 | 2872 | 42468 | 2027 | 49881 | 1769 | 24074 |
| 3E | | MI | 14252 | 5679 | 22994 | 4037 | 24249 | 3296 | 24278 | 2719 | 23553 | 1881 | 27044 | 1572 | 13602 |
| 8-#14 | 1.57 | MA | 23663 | 5679 | 37214 | 4249 | 39993 | 3454 | 40367 | 2865 | 39443 | 2041 | 46411 | 1644 | 23980 |
| 4L-2S | | MI | 14915 | 5679 | 23981 | 4048 | 25500 | 3283 | 25773 | 2707 | 25537 | 1869 | 29614 | 1697 | 13526 |
| 8-#18 | 2.80 | MA | 28336 | 6163 | 46317 | 4508 | 51493 | 3636 | 54327 | 2968 | 58161 | 1957 | 70611 | 1776 | 41725 |
| 2L-4S | | MI | 14171 | 6163 | 23815 | 4306 | 25095 | 3444 | 25261 | 2775 | 25023 | 1791 | 29323 | 1051 | 22108 |
| 8-#18 | 2.80 | MA | 26175 | 6163 | 43054 | 4500 | 47310 | 3668 | 49224 | 2997 | 51238 | 1979 | 61389 | 1555 | 41518 |
| 3E | | MI | 14997 | 6163 | 25239 | 4284 | 26844 | 3466 | 27334 | 2797 | 27596 | 1769 | 32146 | 1249 | 22967 |
| 8-#18 | 2.80 | MA | 24656 | 6163 | 40389 | 4536 | 43914 | 3657 | 45097 | 2981 | 45946 | 2001 | 55401 | 1333 | 39835 |
| 4L-2S | | MI | 16127 | 6163 | 26946 | 4306 | 28969 | 3444 | 29874 | 2775 | 30967 | 1747 | 36473 | 1470 | 22905 |
| 10-#11 | 1.36 | MA | 25380 | 5596 | 39585 | 4193 | 43102 | 3414 | 44182 | 2841 | 44473 | 2028 | 52703 | 1920 | 21011 |
| 2L-5S | | MI | 13602 | 5596 | 21685 | 4015 | 22679 | 3278 | 22436 | 2715 | 21132 | 1908 | 24290 | 1540 | 12048 |
| 10-#11 | 1.36 | MA | 24495 | 5596 | 38284 | 4191 | 41435 | 3411 | 42147 | 2854 | 41705 | 2038 | 48956 | 1834 | 21040 |
| 3L-4S | | MI | 13909 | 5596 | 22186 | 4022 | 23325 | 3269 | 23207 | 2707 | 22211 | 1916 | 25551 | 1579 | 11998 |
| 10-#11 | 1.36 | MA | 23875 | 5596 | 37225 | 4206 | 40085 | 3425 | 40507 | 2849 | 39595 | 2048 | 46514 | 1747 | 21030 |
| 4L-3S | | MI | 14248 | 5596 | 22761 | 4011 | 24054 | 3278 | 24071 | 2715 | 23285 | 1908 | 26738 | 1660 | 11942 |
| 10-#11 | 1.36 | MA | 23322 | 5596 | 36311 | 4204 | 38899 | 3421 | 39049 | 2862 | 37483 | 2040 | 43971 | 1705 | 20945 |
| 5L-2S | | MI | 14716 | 5596 | 23455 | 4018 | 24941 | 3269 | 25131 | 2707 | 24691 | 1899 | 28567 | 1747 | 11890 |
| 10-#14 | 1.97 | MA | 26675 | 5835 | 42457 | 4329 | 46703 | 3510 | 48544 | 2897 | 50396 | 2001 | 60543 | 1868 | 29888 |
| 2L-5S | | MI | 13775 | 5835 | 22447 | 4138 | 23560 | 3364 | 23467 | 2757 | 22498 | 1857 | 26173 | 1350 | 16426 |
| 10-#14 | 1.97 | MA | 25423 | 5835 | 40594 | 4325 | 44315 | 3505 | 45631 | 2915 | 46432 | 2015 | 55212 | 1744 | 29871 |
| 3L-4S | | MI | 14209 | 5835 | 23161 | 4149 | 24471 | 3352 | 24554 | 2744 | 24022 | 1870 | 27944 | 1406 | 16779 |
| 10-#14 | 1.97 | MA | 24545 | 5835 | 39077 | 4346 | 42381 | 3524 | 43280 | 2907 | 43407 | 2029 | 51742 | 1619 | 29730 |
| 4L-3S | | MI | 14689 | 5835 | 23981 | 4134 | 25500 | 3364 | 25773 | 2757 | 25537 | 1857 | 29614 | 1522 | 16734 |
| 10-#14 | 1.97 | MA | 23761 | 5835 | 37765 | 4343 | 40680 | 3519 | 41189 | 2925 | 40378 | 2017 | 48117 | 1559 | 28843 |
| 5L-2S | | MI | 15349 | 5835 | 24969 | 4145 | 26751 | 3352 | 27269 | 2744 | 27521 | 1845 | 32183 | 1646 | 16671 |
| 10-#18 | 3.50 | MA | 27662 | 6440 | 46317 | 4673 | 51493 | 3793 | 54327 | 3072 | 58161 | 1956 | 70611 | 1503 | 51572 |
| 3L-4S | | MI | 14912 | 6440 | 25522 | 4479 | 27219 | 3562 | 27801 | 2837 | 28394 | 1743 | 33650 | 949 | 27013 |
| 10-#18 | 3.50 | MA | 26161 | 6440 | 43652 | 4709 | 48097 | 3781 | 50200 | 3057 | 52869 | 1978 | 64623 | 1282 | 49407 |
| 4L-3S | | MI | 15731 | 6440 | 26946 | 4457 | 28969 | 3584 | 29874 | 2859 | 30967 | 1720 | 36473 | 1147 | 28267 |
| 10-#18 | 3.50 | MA | 24821 | 6440 | 41345 | 4700 | 45106 | 3813 | 46525 | 3085 | 47568 | 1956 | 58328 | 1179 | 46597 |
| 5L-2S | | MI | 16853 | 6440 | 28652 | 4479 | 31094 | 3562 | 32414 | 2837 | 34338 | 1698 | 40800 | 1368 | 28279 |
| 12-#11 | 1.64 | MA | 25992 | 5704 | 40886 | 4260 | 44770 | 3463 | 46217 | 2871 | 47242 | 2019 | 56449 | 1904 | 25093 |
| 2L-6S | | MI | 13623 | 5704 | 21909 | 4076 | 22919 | 3317 | 22763 | 2751 | 21563 | 1901 | 24947 | 1450 | 13987 |
| 12-#11 | 1.64 | MA | 25111 | 5704 | 39585 | 4258 | 43102 | 3459 | 44182 | 2883 | 44473 | 2029 | 52703 | 1817 | 25109 |
| 3L-5S | | MI | 13915 | 5704 | 22380 | 4083 | 23566 | 3326 | 23496 | 2742 | 22538 | 1892 | 26119 | 1507 | 14233 |
| 12-#11 | 1.64 | MA | 24495 | 5704 | 38526 | 4273 | 41753 | 3473 | 42542 | 2879 | 42363 | 2039 | 50261 | 1731 | 25071 |
| 4E | | MI | 14221 | 5704 | 22880 | 4089 | 24212 | 3317 | 24267 | 2734 | 23617 | 1901 | 27380 | 1546 | 14199 |
| 12-#11 | 1.64 | MA | 23945 | 5704 | 37612 | 4271 | 40567 | 3469 | 41084 | 2891 | 40251 | 2032 | 47718 | 1689 | 24960 |
| 5L-3S | | MI | 14559 | 5704 | 23455 | 4079 | 24941 | 3326 | 25131 | 2742 | 24691 | 1892 | 28567 | 1627 | 14153 |
| 12-#11 | 1.64 | MA | 23422 | 5704 | 36755 | 4269 | 39379 | 3483 | 39632 | 2886 | 38338 | 2042 | 45295 | 1633 | 24292 |
| 6L-2S | | MI | 15025 | 5704 | 24150 | 4086 | 25828 | 3317 | 26191 | 2734 | 26097 | 1884 | 30396 | 1714 | 14106 |
| 12-#14 | 2.36 | MA | 26290 | 5990 | 42457 | 4422 | 46703 | 3575 | 48544 | 2957 | 50396 | 2003 | 60543 | 1718 | 35654 |
| 3L-5S | | MI | 14214 | 5990 | 23434 | 4235 | 24811 | 3433 | 24963 | 2795 | 24482 | 1833 | 28742 | 1300 | 19346 |
| 12-#14 | 2.36 | MA | 25419 | 5990 | 40939 | 4444 | 44769 | 3594 | 46193 | 2950 | 47371 | 2016 | 57074 | 1594 | 35473 |
| 4E | | MI | 14645 | 5990 | 24149 | 4246 | 25722 | 3420 | 26050 | 2782 | 26006 | 1846 | 30514 | 1355 | 19864 |
| 12-#14 | 2.36 | MA | 24641 | 5990 | 39627 | 4440 | 43068 | 3588 | 44102 | 2967 | 44342 | 2005 | 53448 | 1534 | 34401 |
| 5L-3S | | MI | 15123 | 5990 | 24969 | 4232 | 26751 | 3433 | 27269 | 2795 | 27521 | 1833 | 32183 | 1471 | 19847 |
| 12-#14 | 2.36 | MA | 23901 | 5990 | 38398 | 4436 | 41364 | 3608 | 42020 | 2959 | 41598 | 2019 | 50003 | 1453 | 33312 |
| 6L-2S | | MI | 15780 | 5990 | 25956 | 4242 | 28002 | 3420 | 28764 | 2782 | 29504 | 1821 | 34753 | 1596 | 19799 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis

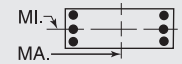


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 4.20 | MA | 27647 | 6716 | 46915 | 4881 | 52280 | 3905 | 55303 | 3132 | 59792 | 1955 | 73845 | 1231 | 59029 |
| 4E | | MI | 15646 | 6716 | 27229 | 4652 | 29344 | 3680 | 30341 | 2899 | 31765 | 1694 | 37978 | 847 | 31963 |
| 12-#18 | 4.20 | MA | 26321 | 6716 | 44608 | 4873 | 49289 | 3937 | 51628 | 3161 | 54491 | 1933 | 67550 | 1128 | 56376 |
| 5L-3S | | MI | 16460 | 6716 | 28652 | 4630 | 31094 | 3702 | 32414 | 2922 | 34338 | 1672 | 40800 | 1045 | 33540 |
| 12-#18 | 4.20 | MA | 25062 | 6716 | 42444 | 4865 | 46293 | 3925 | 47967 | 3145 | 49687 | 1955 | 61598 | 983 | 52722 |
| 6L-2S | | MI | 17573 | 6716 | 30359 | 4651 | 33218 | 3680 | 34954 | 2899 | 37709 | 1650 | 45127 | 1267 | 33628 |
| 14-#11 | 1.91 | MA | 25724 | 5812 | 40886 | 4326 | 44770 | 3508 | 46217 | 2913 | 47242 | 2020 | 56449 | 1801 | 29161 |
| 3L-6S | | MI | 13935 | 5812 | 22603 | 4143 | 23806 | 3365 | 23823 | 2778 | 22969 | 1885 | 26777 | 1417 | 16076 |
| 14-#11 | 1.91 | MA | 25111 | 5812 | 39828 | 4341 | 43421 | 3521 | 44577 | 2908 | 45132 | 2030 | 54008 | 1714 | 29105 |
| 4L-5S | | MI | 14226 | 5812 | 23074 | 4150 | 24453 | 3374 | 24556 | 2769 | 23944 | 1877 | 27949 | 1474 | 16408 |
| 14-#11 | 1.91 | MA | 24564 | 5812 | 38913 | 4338 | 42235 | 3518 | 43119 | 2921 | 43020 | 2023 | 51465 | 1672 | 28972 |
| 5L-4S | | MI | 14531 | 5812 | 23575 | 4157 | 25099 | 3365 | 25327 | 2761 | 25023 | 1885 | 29210 | 1513 | 16388 |
| 14-#11 | 1.91 | MA | 24044 | 5812 | 38056 | 4336 | 41047 | 3532 | 41667 | 2916 | 41106 | 2033 | 49042 | 1617 | 28215 |
| 6L-3S | | MI | 14867 | 5812 | 24150 | 4146 | 25828 | 3374 | 26191 | 2769 | 26097 | 1877 | 30396 | 1595 | 16352 |
| 14-#11 | 1.91 | MA | 23537 | 5812 | 37117 | 4351 | 39914 | 3528 | 40274 | 2928 | 39237 | 2043 | 46458 | 1527 | 27680 |
| 7L-2S | | MI | 15332 | 5812 | 24844 | 4153 | 26715 | 3365 | 27251 | 2761 | 27503 | 1868 | 32226 | 1681 | 16311 |
| 14-#14 | 2.75 | MA | 26285 | 6146 | 42802 | 4541 | 47157 | 3664 | 49107 | 2992 | 51334 | 2004 | 62405 | 1568 | 41210 |
| 4L-5S | | MI | 14650 | 6146 | 24422 | 4333 | 26062 | 3501 | 26458 | 2832 | 26466 | 1809 | 31312 | 1249 | 22280 |
| 14-#14 | 2.75 | MA | 25513 | 6146 | 41490 | 4537 | 45456 | 3658 | 47016 | 3009 | 48306 | 1993 | 58779 | 1509 | 39977 |
| 5L-4S | | MI | 15079 | 6146 | 25136 | 4343 | 26973 | 3489 | 27545 | 2820 | 27990 | 1822 | 33083 | 1305 | 22930 |
| 14-#14 | 2.75 | MA | 24779 | 6146 | 40260 | 4534 | 43752 | 3678 | 44933 | 3002 | 45562 | 2006 | 55334 | 1428 | 38938 |
| 6L-3S | | MI | 15555 | 6146 | 25956 | 4329 | 28002 | 3501 | 28764 | 2832 | 29504 | 1809 | 34753 | 1420 | 22946 |
| 14-#14 | 2.75 | MA | 24064 | 6146 | 38913 | 4555 | 42127 | 3672 | 42935 | 3019 | 42880 | 2020 | 51658 | 1298 | 37497 |
| 7L-2S | | MI | 16209 | 6146 | 26944 | 4339 | 29253 | 3489 | 30259 | 2820 | 31488 | 1797 | 37323 | 1545 | 22913 |
| 14-#18 | 4.90 | MA | 27804 | 6993 | 47871 | 5046 | 53472 | 4061 | 56730 | 3236 | 61414 | 1910 | 76772 | 1076 | 66179 |
| 5L-4S | | MI | 16375 | 6993 | 28935 | 4825 | 31469 | 3797 | 32881 | 2962 | 35136 | 1645 | 42305 | 746 | 36947 |
| 14-#18 | 4.90 | MA | 26559 | 6993 | 45707 | 5038 | 50476 | 4049 | 53070 | 3220 | 56610 | 1932 | 70819 | 932 | 62359 |
| 6L-3S | | MI | 17183 | 6993 | 30359 | 4802 | 33218 | 3820 | 34954 | 2984 | 37709 | 1623 | 45127 | 944 | 38793 |
| 14-#18 | 4.90 | MA | 25346 | 6993 | 43337 | 5074 | 47617 | 4082 | 49555 | 3249 | 51915 | 1954 | 64463 | 701 | 58693 |
| 7L-2S | | MI | 18289 | 6993 | 32066 | 4824 | 35343 | 3797 | 37494 | 2962 | 41080 | 1601 | 49455 | 1165 | 38937 |
| 16-#11 | 2.18 | MA | 25723 | 5920 | 41129 | 4408 | 45089 | 3570 | 46611 | 2937 | 47900 | 2022 | 57754 | 1698 | 33135 |
| 4L-6S | | MI | 14246 | 5920 | 23297 | 4211 | 24693 | 3413 | 24883 | 2805 | 24375 | 1870 | 28606 | 1384 | 18170 |
| 16-#11 | 2.18 | MA | 25179 | 5920 | 40214 | 4406 | 43903 | 3566 | 45154 | 2950 | 45788 | 2015 | 55211 | 1656 | 32981 |
| 5E | | MI | 14536 | 5920 | 23768 | 4218 | 25340 | 3422 | 25616 | 2796 | 25350 | 1861 | 29778 | 1442 | 18474 |
| 16-#11 | 2.18 | MA | 24661 | 5920 | 39357 | 4404 | 42715 | 3580 | 43702 | 2945 | 43875 | 2025 | 52788 | 1600 | 32146 |
| 6L-4S | | MI | 14839 | 5920 | 24269 | 4224 | 25986 | 3413 | 26387 | 2788 | 26430 | 1870 | 31039 | 1480 | 18569 |
| 16-#11 | 2.18 | MA | 24157 | 5920 | 38418 | 4419 | 41582 | 3577 | 42309 | 2958 | 42006 | 2035 | 50205 | 1510 | 31629 |
| 7L-3S | | MI | 15175 | 5920 | 24844 | 4214 | 26715 | 3422 | 27251 | 2796 | 27503 | 1861 | 32226 | 1562 | 18542 |
| 16-#11 | 2.18 | MA | 23661 | 5920 | 37574 | 4416 | 40433 | 3590 | 40949 | 2970 | 40019 | 2027 | 47826 | 1461 | 30799 |
| 8L-2S | | MI | 15638 | 5920 | 25538 | 4220 | 27602 | 3413 | 28311 | 2788 | 28909 | 1853 | 34055 | 1648 | 18508 |
| 16-#14 | 3.15 | MA | 26378 | 6301 | 43353 | 4634 | 47844 | 3728 | 49929 | 3052 | 52269 | 1980 | 64110 | 1483 | 45568 |
| 5E | | MI | 15083 | 6301 | 25409 | 4430 | 27313 | 3569 | 27953 | 2870 | 28449 | 1785 | 33882 | 1198 | 25225 |
| 16-#14 | 3.15 | MA | 25649 | 6301 | 42123 | 4631 | 46140 | 3747 | 47847 | 3044 | 49525 | 1994 | 60665 | 1402 | 44572 |
| 6L-4S | | MI | 15511 | 6301 | 26124 | 4440 | 28224 | 3557 | 29040 | 2857 | 29973 | 1798 | 35653 | 1254 | 25955 |
| 16-#14 | 3.15 | MA | 24939 | 6301 | 40776 | 4652 | 44515 | 3742 | 45848 | 3062 | 46844 | 2007 | 56989 | 1273 | 43042 |
| 7L-3S | | MI | 15984 | 6301 | 26944 | 4426 | 29253 | 3569 | 30259 | 2870 | 31488 | 1785 | 37323 | 1370 | 26032 |
| 16-#14 | 3.15 | MA | 24240 | 6301 | 39565 | 4648 | 42866 | 3761 | 43897 | 3079 | 43995 | 1996 | 53599 | 1202 | 41705 |
| 8L-2S | | MI | 16635 | 6301 | 27931 | 4437 | 30504 | 3557 | 31754 | 2857 | 33472 | 1773 | 39892 | 1494 | 26018 |
| 16-#18 | 5.59 | MA | 28039 | 7270 | 48970 | 5211 | 54659 | 4173 | 58173 | 3296 | 63533 | 1909 | 80041 | 881 | 72021 |
| 6L-4S | | MI | 17098 | 7270 | 30642 | 4998 | 33594 | 3915 | 35422 | 3024 | 38507 | 1597 | 46632 | 644 | 41957 |
| 16-#18 | 5.59 | MA | 26839 | 7270 | 46600 | 5247 | 51800 | 4206 | 54658 | 3324 | 58838 | 1931 | 73685 | 650 | 68247 |
| 7L-3S | | MI | 17901 | 7270 | 32066 | 4975 | 35343 | 3937 | 37494 | 3046 | 41080 | 1575 | 49455 | 842 | 44032 |
| 18-#11 | 2.45 | MA | 25789 | 6027 | 41515 | 4473 | 45571 | 3615 | 47188 | 2979 | 48557 | 2006 | 58958 | 1640 | 36887 |
| 5L-6S | | MI | 14556 | 6027 | 23991 | 4278 | 25580 | 3462 | 25943 | 2832 | 25781 | 1854 | 30435 | 1351 | 20268 |
| 18-#11 | 2.45 | MA | 25275 | 6027 | 40658 | 4471 | 44383 | 3629 | 45737 | 2975 | 46643 | 2016 | 56535 | 1584 | 36084 |
| 6L-5S | | MI | 14844 | 6027 | 24462 | 4285 | 26227 | 3470 | 26676 | 2823 | 26756 | 1846 | 31607 | 1409 | 20550 |
| 18-#11 | 2.45 | MA | 24773 | 6027 | 39719 | 4486 | 43250 | 3625 | 44344 | 2987 | 44774 | 2026 | 53951 | 1494 | 35583 |
| 7L-4S | | MI | 15146 | 6027 | 24963 | 4292 | 26873 | 3462 | 27447 | 2814 | 27836 | 1854 | 32868 | 1447 | 20743 |

## RECTANGULAR TIED COLUMNS 26" x 44"

Short columns – no sidesway
Bending on major or minor axis

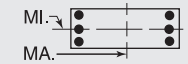



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.45 | MA | 24280 | 6027 | 38875 | 4484 | 42101 | 3639 | 42984 | 3000 | 42788 | 2019 | 51573 | 1445 | 34697 |
| 8L-3S | | MI | 15481 | 6027 | 25538 | 4281 | 27602 | 3470 | 28311 | 2823 | 28909 | 1846 | 34055 | 1529 | 20726 |
| 18-#11 | 2.45 | MA | 23761 | 6027 | 38050 | 4482 | 40983 | 3635 | 41562 | 2995 | 40936 | 2029 | 49224 | 1391 | 33935 |
| 9L-2S | | MI | 15942 | 6027 | 26232 | 4288 | 28489 | 3462 | 29371 | 2814 | 30315 | 1837 | 35884 | 1615 | 20699 |
| 18-#14 | 3.54 | MA | 26512 | 6457 | 43986 | 4728 | 48528 | 3817 | 50760 | 3087 | 53489 | 1981 | 65996 | 1377 | 50214 |
| 6L-5S | | MI | 15515 | 6457 | 26397 | 4527 | 28564 | 3638 | 29448 | 2907 | 30433 | 1761 | 36451 | 1147 | 28179 |
| 18-#14 | 3.54 | MA | 25807 | 6457 | 42638 | 4749 | 46903 | 3812 | 48761 | 3104 | 50808 | 1995 | 62321 | 1247 | 48600 |
| 7L-4S | | MI | 15940 | 6457 | 27111 | 4538 | 29475 | 3625 | 30535 | 2895 | 31957 | 1774 | 38222 | 1203 | 28857 |
| 18-#14 | 3.54 | MA | 25114 | 6457 | 41428 | 4746 | 45254 | 3831 | 46811 | 3122 | 47958 | 1984 | 58930 | 1177 | 47200 |
| 8L-3S | | MI | 16411 | 6457 | 27931 | 4523 | 30504 | 3638 | 31754 | 2907 | 33472 | 1761 | 39892 | 1319 | 29103 |
| 18-#14 | 3.54 | MA | 24406 | 6457 | 40124 | 4767 | 43650 | 3825 | 44771 | 3114 | 45301 | 1997 | 55590 | 1099 | 45330 |
| 9L-2S | | MI | 17059 | 6457 | 28919 | 4534 | 31755 | 3625 | 33250 | 2895 | 35455 | 1749 | 42462 | 1444 | 29121 |
| 18-#18 | 6.29 | MA | 28316 | 7546 | 49863 | 5420 | 55983 | 4330 | 59761 | 3400 | 65761 | 1908 | 82907 | 598 | 77824 |
| 7L-4S | | MI | 17818 | 7546 | 32349 | 5171 | 35718 | 4033 | 37962 | 3086 | 41878 | 1548 | 50959 | 542 | 46988 |
| 20-#11 | 2.73 | MA | 25884 | 6135 | 41959 | 4538 | 46051 | 3677 | 47771 | 3004 | 49412 | 2007 | 60282 | 1567 | 40027 |
| 6E | | MI | 14864 | 6135 | 24685 | 4346 | 26467 | 3510 | 27003 | 2859 | 27187 | 1839 | 32265 | 1318 | 22369 |
| 20-#11 | 2.73 | MA | 25386 | 6135 | 41020 | 4553 | 44918 | 3673 | 46378 | 3017 | 47543 | 2017 | 57698 | 1477 | 39541 |
| 7L-5S | | MI | 15151 | 6135 | 25156 | 4352 | 27114 | 3518 | 27736 | 2850 | 28162 | 1830 | 33437 | 1376 | 22633 |
| 20-#11 | 2.73 | MA | 24895 | 6135 | 40176 | 4551 | 43769 | 3687 | 45019 | 3029 | 45556 | 2010 | 55320 | 1428 | 38602 |
| 8L-4S | | MI | 15452 | 6135 | 25657 | 4359 | 27760 | 3510 | 28507 | 2841 | 29242 | 1839 | 34698 | 1414 | 22907 |
| 20-#11 | 2.73 | MA | 24379 | 6135 | 39351 | 4549 | 42651 | 3684 | 43597 | 3024 | 43704 | 2020 | 52971 | 1374 | 37860 |
| 9L-3S | | MI | 15785 | 6135 | 26232 | 4349 | 28489 | 3518 | 29371 | 2850 | 30315 | 1830 | 35884 | 1496 | 22905 |
| 20-#11 | 2.73 | MA | 23836 | 6135 | 38427 | 4564 | 41518 | 3697 | 42244 | 3037 | 41868 | 2030 | 50694 | 1313 | 36743 |
| 10L-2S | | MI | 16245 | 6135 | 26926 | 4355 | 29376 | 3510 | 30431 | 2841 | 31721 | 1822 | 37713 | 1582 | 22883 |
| 20-#14 | 3.93 | MA | 26669 | 6613 | 44501 | 4846 | 49291 | 3881 | 51675 | 3147 | 54771 | 1982 | 67652 | 1222 | 54167 |
| 7L-5S | | MI | 15944 | 6613 | 27384 | 4624 | 29815 | 3706 | 30944 | 2945 | 32417 | 1737 | 39021 | 1097 | 31138 |
| 20-#14 | 3.93 | MA | 25980 | 6613 | 43291 | 4843 | 47642 | 3901 | 49724 | 3164 | 51922 | 1971 | 64262 | 1152 | 52706 |
| 8L-4S | | MI | 16367 | 6613 | 28099 | 4635 | 30726 | 3694 | 32031 | 2932 | 33940 | 1750 | 40792 | 1153 | 31771 |
| 20-#14 | 3.93 | MA | 25273 | 6613 | 41987 | 4864 | 46038 | 3895 | 47684 | 3156 | 49265 | 1985 | 60921 | 1074 | 50882 |
| 9L-3S | | MI | 16836 | 6613 | 28919 | 4621 | 31755 | 3706 | 33250 | 2945 | 35455 | 1737 | 42462 | 1268 | 32166 |
| 22-#11 | 3.00 | MA | 25994 | 6243 | 42321 | 4621 | 46586 | 3722 | 48413 | 3046 | 50311 | 2009 | 61445 | 1461 | 43501 |
| 7L-6S | | MI | 15170 | 6243 | 25380 | 4413 | 27354 | 3558 | 28063 | 2886 | 28593 | 1823 | 34094 | 1285 | 24472 |
| 22-#11 | 3.00 | MA | 25506 | 6243 | 41477 | 4619 | 45437 | 3736 | 47053 | 3059 | 48325 | 2002 | 59066 | 1412 | 42512 |
| 8L-5S | | MI | 15457 | 6243 | 25851 | 4420 | 28001 | 3566 | 28797 | 2877 | 29568 | 1815 | 35266 | 1343 | 24720 |
| 22-#11 | 3.00 | MA | 25002 | 6243 | 40652 | 4616 | 44319 | 3732 | 45632 | 3054 | 46473 | 2012 | 56717 | 1358 | 41746 |
| 9L-4S | | MI | 15757 | 6243 | 26351 | 4427 | 28647 | 3558 | 29567 | 2868 | 30648 | 1823 | 36527 | 1381 | 25064 |
| 22-#11 | 3.00 | MA | 24453 | 6243 | 39728 | 4631 | 43185 | 3746 | 44279 | 3066 | 44636 | 2022 | 54441 | 1297 | 40636 |
| 10L-3S | | MI | 16088 | 6243 | 26926 | 4416 | 29376 | 3566 | 30431 | 2877 | 31721 | 1815 | 37713 | 1463 | 25079 |
| 22-#11 | 3.00 | MA | 23925 | 6243 | 38901 | 4629 | 42074 | 3742 | 42875 | 3062 | 42678 | 2014 | 52122 | 1245 | 39494 |
| 11L-2S | | MI | 16547 | 6243 | 27621 | 4423 | 30263 | 3558 | 31491 | 2868 | 33128 | 1806 | 39543 | 1549 | 25064 |
| 22-#14 | 4.33 | MA | 26840 | 6768 | 45153 | 4940 | 50030 | 3971 | 52637 | 3206 | 55886 | 1959 | 69593 | 1126 | 58221 |
| 8L-5S | | MI | 16370 | 6768 | 28371 | 4722 | 31066 | 3774 | 32439 | 2982 | 34400 | 1713 | 41591 | 1046 | 34103 |
| 22-#14 | 4.33 | MA | 26135 | 6768 | 43850 | 4961 | 48426 | 3965 | 50597 | 3199 | 53229 | 1972 | 66253 | 1049 | 56442 |
| 9L-4S | | MI | 16792 | 6768 | 29086 | 4732 | 31977 | 3762 | 33526 | 2970 | 35924 | 1726 | 43362 | 1102 | 34696 |
| 24-#11 | 3.27 | MA | 26114 | 6351 | 42778 | 4686 | 47105 | 3784 | 49088 | 3088 | 51093 | 1993 | 62813 | 1395 | 46427 |
| 8L-6S | | MI | 15476 | 6351 | 26074 | 4481 | 28241 | 3606 | 29123 | 2912 | 29999 | 1808 | 35923 | 1252 | 26577 |
| 24-#11 | 3.27 | MA | 25611 | 6351 | 41953 | 4684 | 45987 | 3781 | 47666 | 3083 | 49241 | 2003 | 60464 | 1342 | 45619 |
| 9L-5S | | MI | 15761 | 6351 | 26545 | 4487 | 28888 | 3615 | 29857 | 2904 | 30974 | 1799 | 37095 | 1310 | 26811 |
| 24-#11 | 3.27 | MA | 25066 | 6351 | 41029 | 4699 | 44853 | 3794 | 46314 | 3096 | 47405 | 2013 | 58188 | 1281 | 44534 |
| 10L-4S | | MI | 16060 | 6351 | 27046 | 4494 | 29534 | 3606 | 30627 | 2895 | 32054 | 1808 | 38356 | 1348 | 27217 |
| 24-#11 | 3.27 | MA | 24541 | 6351 | 40202 | 4697 | 43742 | 3791 | 44910 | 3091 | 45446 | 2006 | 55869 | 1228 | 43365 |
| 11L-3S | | MI | 16391 | 6351 | 27621 | 4483 | 30263 | 3615 | 31491 | 2904 | 33128 | 1799 | 39543 | 1430 | 27243 |
| 24-#14 | 4.72 | MA | 26990 | 6924 | 45712 | 5058 | 50815 | 4035 | 53511 | 3241 | 57192 | 1960 | 71584 | 1023 | 62010 |
| 9L-5S | | MI | 16795 | 6924 | 29359 | 4819 | 32317 | 3843 | 33934 | 3020 | 36384 | 1689 | 44160 | 995 | 37072 |

## RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

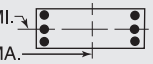
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.34 | MA | 27594 | 5840 | 43166 | 4349 | 46804 | 3542 | 47848 | 2948 | 47980 | 2106 | 56485 | 1982 | 22370 |
| 2E | | MI | 15252 | 5840 | 24447 | 4124 | 25650 | 3344 | 25689 | 2765 | 25020 | 1932 | 28690 | 1759 | 12065 |
| 6-#14 | 1.13 | MA | 27155 | 5753 | 42044 | 4321 | 45533 | 3524 | 46362 | 2943 | 45984 | 2127 | 54036 | 2020 | 19106 |
| 2L-3S | | MI | 14409 | 5753 | 22917 | 4106 | 23929 | 3364 | 23683 | 2798 | 22370 | 1995 | 25353 | 1709 | 10475 |
| 6-#14 | 1.13 | MA | 25817 | 5753 | 40084 | 4318 | 43020 | 3519 | 43296 | 2961 | 41813 | 2141 | 48396 | 1896 | 19163 |
| 3L-2S | | MI | 15076 | 5753 | 23904 | 4117 | 25180 | 3352 | 25178 | 2786 | 24353 | 1982 | 27923 | 1834 | 10390 |
| 6-#18 | 2.01 | MA | 29190 | 6116 | 46602 | 4522 | 51209 | 3666 | 53222 | 3023 | 55291 | 2083 | 66255 | 1933 | 33154 |
| 2L-3S | | MI | 14854 | 6116 | 24447 | 4275 | 25650 | 3484 | 25689 | 2849 | 25020 | 1906 | 28690 | 1435 | 17674 |
| 6-#18 | 2.01 | MA | 26884 | 6116 | 43166 | 4514 | 46804 | 3699 | 47848 | 3053 | 47980 | 2106 | 56485 | 1712 | 33064 |
| 3L-2S | | MI | 15993 | 6116 | 26153 | 4297 | 27775 | 3462 | 28230 | 2827 | 28391 | 1884 | 33017 | 1657 | 17547 |
| 8-#11 | 1.04 | MA | 26974 | 5718 | 41571 | 4312 | 45011 | 3519 | 45758 | 2943 | 45176 | 2137 | 53045 | 2037 | 17762 |
| 2L-4S | | MI | 14193 | 5718 | 22400 | 4122 | 23370 | 3358 | 23048 | 2797 | 21608 | 2022 | 24604 | 1698 | 9811 |
| 8-#11 | 1.04 | MA | 26038 | 5718 | 40202 | 4310 | 43257 | 3516 | 43617 | 2955 | 42264 | 2147 | 49084 | 1951 | 17803 |
| 3E | | MI | 14534 | 5718 | 22975 | 4111 | 24099 | 3367 | 23912 | 2805 | 22682 | 2013 | 25791 | 1780 | 9745 |
| 8-#11 | 1.04 | MA | 25382 | 5718 | 39090 | 4326 | 41839 | 3530 | 41894 | 2951 | 40046 | 2158 | 46501 | 1865 | 17823 |
| 4L-2S | | MI | 15004 | 5718 | 23670 | 4118 | 24986 | 3358 | 24972 | 2797 | 24088 | 2005 | 27620 | 1867 | 9691 |
| 8-#14 | 1.51 | MA | 28081 | 5909 | 44004 | 4418 | 48046 | 3594 | 49427 | 2985 | 50154 | 2114 | 59676 | 1997 | 25266 |
| 2L-4S | | MI | 14367 | 5909 | 23084 | 4218 | 24151 | 3420 | 23959 | 2823 | 22839 | 1983 | 26253 | 1543 | 13722 |
| 8-#14 | 1.51 | MA | 26752 | 5909 | 42044 | 4415 | 45533 | 3589 | 46362 | 3003 | 45984 | 2129 | 54036 | 1872 | 25289 |
| 3E | | MI | 14850 | 5909 | 23904 | 4203 | 25180 | 3433 | 25178 | 2836 | 24353 | 1971 | 27923 | 1659 | 13644 |
| 8-#14 | 1.51 | MA | 25821 | 5909 | 40449 | 4437 | 43500 | 3609 | 43891 | 2996 | 42804 | 2143 | 50361 | 1747 | 25195 |
| 4L-2S | | MI | 15514 | 5909 | 24892 | 4214 | 26431 | 3420 | 26673 | 2823 | 26337 | 1958 | 30492 | 1783 | 13566 |
| 8-#18 | 2.68 | MA | 30763 | 6393 | 50038 | 4695 | 55613 | 3790 | 58595 | 3099 | 62602 | 2061 | 76025 | 1885 | 43885 |
| 2L-4S | | MI | 14768 | 6393 | 24729 | 4470 | 26025 | 3579 | 26157 | 2890 | 25818 | 1879 | 30194 | 1136 | 22345 |
| 8-#18 | 2.68 | MA | 28482 | 6393 | 46602 | 4687 | 51209 | 3823 | 53222 | 3129 | 55291 | 2084 | 66255 | 1664 | 43678 |
| 3E | | MI | 15596 | 6393 | 26153 | 4448 | 27775 | 3601 | 28230 | 2912 | 28391 | 1857 | 33017 | 1334 | 23041 |
| 8-#18 | 2.68 | MA | 26882 | 6393 | 43799 | 4724 | 47637 | 3812 | 48881 | 3114 | 49704 | 2106 | 59904 | 1442 | 42212 |
| 4L-2S | | MI | 16727 | 6393 | 27860 | 4470 | 29899 | 3579 | 30770 | 2890 | 31762 | 1835 | 37344 | 1555 | 22965 |
| 10-#11 | 1.30 | MA | 27626 | 5826 | 42939 | 4380 | 46766 | 3568 | 47898 | 2972 | 48087 | 2128 | 57006 | 2022 | 22064 |
| 2L-5S | | MI | 14200 | 5826 | 22594 | 4183 | 23611 | 3415 | 23338 | 2832 | 21935 | 1998 | 25173 | 1627 | 12091 |
| 10-#11 | 1.30 | MA | 26694 | 5826 | 41571 | 4378 | 45011 | 3565 | 45758 | 2985 | 45176 | 2138 | 53045 | 1935 | 22093 |
| 3L-4S | | MI | 14507 | 5826 | 23095 | 4189 | 24257 | 3407 | 24108 | 2824 | 23014 | 2006 | 26434 | 1666 | 12035 |
| 10-#11 | 1.30 | MA | 26042 | 5826 | 40458 | 4393 | 43594 | 3579 | 44035 | 2981 | 42958 | 2149 | 50462 | 1849 | 22083 |
| 4L-3S | | MI | 14846 | 5826 | 23670 | 4179 | 24986 | 3415 | 24972 | 2832 | 24088 | 1998 | 27620 | 1747 | 11977 |
| 10-#11 | 1.30 | MA | 25461 | 5826 | 39498 | 4391 | 42348 | 3576 | 42503 | 2993 | 40739 | 2142 | 47777 | 1807 | 21998 |
| 5L-2S | | MI | 15315 | 5826 | 24364 | 4185 | 25873 | 3407 | 26032 | 2824 | 25494 | 1989 | 29450 | 1834 | 11925 |
| 10-#14 | 1.88 | MA | 28999 | 6064 | 45964 | 4516 | 50559 | 3664 | 52492 | 3028 | 54325 | 2102 | 65316 | 1973 | 31407 |
| 2L-5S | | MI | 14372 | 6064 | 23357 | 4304 | 24492 | 3501 | 24367 | 2873 | 23299 | 1946 | 27052 | 1437 | 16569 |
| 10-#14 | 1.88 | MA | 27678 | 6064 | 44004 | 4512 | 48046 | 3659 | 49427 | 3046 | 50154 | 2116 | 59676 | 1848 | 31389 |
| 3L-4S | | MI | 14807 | 6064 | 24072 | 4315 | 25402 | 3489 | 25454 | 2861 | 24822 | 1959 | 28823 | 1492 | 16835 |
| 10-#14 | 1.88 | MA | 26754 | 6064 | 42409 | 4534 | 46013 | 3679 | 46956 | 3039 | 46975 | 2130 | 56001 | 1724 | 31249 |
| 4L-3S | | MI | 15287 | 6064 | 24892 | 4301 | 26431 | 3501 | 26673 | 2873 | 26337 | 1946 | 30492 | 1608 | 16782 |
| 10-#14 | 1.88 | MA | 25930 | 6064 | 41031 | 4531 | 44226 | 3674 | 44760 | 3057 | 43792 | 2120 | 52172 | 1663 | 30454 |
| 5L-2S | | MI | 15948 | 6064 | 25879 | 4311 | 27682 | 3489 | 28168 | 2861 | 28321 | 1934 | 33062 | 1733 | 16716 |
| 10-#18 | 3.34 | MA | 30057 | 6670 | 50038 | 4860 | 55613 | 3947 | 58595 | 3204 | 62602 | 2062 | 76025 | 1615 | 54272 |
| 3L-4S | | MI | 15510 | 6670 | 26436 | 4643 | 28150 | 3697 | 28697 | 2952 | 29189 | 1831 | 34521 | 1034 | 27247 |
| 10-#18 | 3.34 | MA | 28475 | 6670 | 47235 | 4897 | 52041 | 3936 | 54254 | 3189 | 57015 | 2084 | 69674 | 1394 | 52302 |
| 4L-3S | | MI | 16331 | 6670 | 27860 | 4621 | 29899 | 3719 | 30770 | 2974 | 31762 | 1809 | 37344 | 1232 | 28354 |
| 10-#18 | 3.34 | MA | 27064 | 6670 | 44810 | 4889 | 48897 | 3970 | 50391 | 3219 | 51421 | 2063 | 63017 | 1289 | 49219 |
| 5L-2S | | MI | 17454 | 6670 | 29567 | 4643 | 32024 | 3697 | 33310 | 2952 | 35133 | 1787 | 41671 | 1454 | 28345 |
| 12-#11 | 1.57 | MA | 28274 | 5934 | 44308 | 4447 | 48520 | 3616 | 50038 | 3001 | 50999 | 2119 | 60967 | 2006 | 26356 |
| 2L-6S | | MI | 14220 | 5934 | 22817 | 4243 | 23851 | 3455 | 23665 | 2868 | 22365 | 1991 | 25830 | 1537 | 14114 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

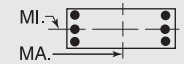
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.57 | MA | 27346 | 5934 | 42939 | 4445 | 46766 | 3613 | 47898 | 3014 | 48087 | 2130 | 57006 | 1920 | 26372 |
| 3L-5S | | MI | 14513 | 5934 | 23288 | 4250 | 24498 | 3463 | 24398 | 2859 | 23341 | 1982 | 27002 | 1594 | 14281 |
| 12-#11 | 1.57 | MA | 26697 | 5934 | 41827 | 4460 | 45348 | 3627 | 46175 | 3010 | 45870 | 2140 | 54422 | 1834 | 26335 |
| 4E | | MI | 14819 | 5934 | 23789 | 4257 | 25144 | 3455 | 25168 | 2851 | 24420 | 1991 | 28263 | 1633 | 14241 |
| 12-#11 | 1.57 | MA | 26119 | 5934 | 40866 | 4458 | 44102 | 3624 | 44644 | 3023 | 43651 | 2134 | 51738 | 1791 | 26224 |
| 5L-3S | | MI | 15157 | 5934 | 24364 | 4246 | 25873 | 3463 | 26032 | 2859 | 25494 | 1982 | 29450 | 1714 | 14192 |
| 12-#11 | 1.57 | MA | 25569 | 5934 | 39966 | 4457 | 42855 | 3638 | 43119 | 3018 | 41642 | 2144 | 49176 | 1735 | 25596 |
| 6L-2S | | MI | 15624 | 5934 | 25058 | 4253 | 26760 | 3455 | 27092 | 2851 | 26900 | 1974 | 31279 | 1801 | 14144 |
| 12-#14 | 2.26 | MA | 28596 | 6220 | 45964 | 4610 | 50559 | 3729 | 52492 | 3088 | 54325 | 2104 | 65316 | 1824 | 37477 |
| 3L-5S | | MI | 14811 | 6220 | 24345 | 4402 | 25743 | 3569 | 25862 | 2911 | 25282 | 1922 | 29621 | 1386 | 19488 |
| 12-#14 | 2.26 | MA | 27679 | 6220 | 44369 | 4631 | 48526 | 3749 | 50022 | 3081 | 51145 | 2118 | 61641 | 1700 | 37295 |
| 4E | | MI | 15244 | 6220 | 25059 | 4412 | 26653 | 3557 | 26949 | 2898 | 26806 | 1935 | 31392 | 1442 | 19930 |
| 12-#14 | 2.26 | MA | 26861 | 6220 | 42991 | 4628 | 46738 | 3744 | 47825 | 3099 | 47963 | 2108 | 57812 | 1639 | 36305 |
| 5L-3S | | MI | 15722 | 6220 | 25879 | 4398 | 27682 | 3569 | 28168 | 2911 | 28321 | 1922 | 33062 | 1557 | 19899 |
| 12-#14 | 2.26 | MA | 26083 | 6220 | 41699 | 4625 | 44949 | 3763 | 45637 | 3092 | 45080 | 2122 | 54165 | 1559 | 35115 |
| 6L-2S | | MI | 16380 | 6220 | 26867 | 4408 | 28933 | 3557 | 29664 | 2898 | 30304 | 1910 | 35632 | 1682 | 19847 |
| 12-#18 | 4.01 | MA | 30049 | 6946 | 50671 | 5070 | 56446 | 4060 | 59627 | 3265 | 64326 | 2062 | 79444 | 1346 | 62443 |
| 4E | | MI | 16245 | 6946 | 28143 | 4816 | 30275 | 3815 | 31237 | 3014 | 32560 | 1782 | 38849 | 933 | 32194 |
| 12-#18 | 4.01 | MA | 28653 | 6946 | 48246 | 5062 | 53302 | 4094 | 55764 | 3295 | 58731 | 2041 | 72786 | 1241 | 59525 |
| 5L-3S | | MI | 17061 | 6946 | 29567 | 4794 | 32024 | 3837 | 33310 | 3036 | 35133 | 1760 | 41671 | 1131 | 33635 |
| 12-#18 | 4.01 | MA | 27327 | 6946 | 45973 | 5055 | 50153 | 4083 | 51916 | 3280 | 53660 | 2063 | 66477 | 1097 | 55881 |
| 6L-2S | | MI | 18176 | 6946 | 31274 | 4816 | 34149 | 3815 | 35850 | 3014 | 38504 | 1738 | 45999 | 1352 | 33705 |
| 14-#11 | 1.83 | MA | 27993 | 6042 | 44308 | 4513 | 48520 | 3662 | 50038 | 3044 | 50999 | 2121 | 60967 | 1905 | 30635 |
| 3L-6S | | MI | 14533 | 6042 | 23511 | 4311 | 24738 | 3503 | 24725 | 2895 | 23771 | 1975 | 27659 | 1504 | 16178 |
| 14-#11 | 1.83 | MA | 27348 | 6042 | 43195 | 4528 | 47102 | 3676 | 48315 | 3039 | 48782 | 2132 | 58383 | 1818 | 30580 |
| 4L-5S | | MI | 14824 | 6042 | 23982 | 4317 | 25385 | 3512 | 25458 | 2886 | 24747 | 1967 | 28831 | 1561 | 16461 |
| 14-#11 | 1.83 | MA | 26773 | 6042 | 42235 | 4526 | 45856 | 3673 | 46784 | 3052 | 46563 | 2125 | 55699 | 1776 | 30446 |
| 5L-4S | | MI | 15129 | 6042 | 24483 | 4324 | 26031 | 3503 | 26228 | 2878 | 25826 | 1975 | 30092 | 1600 | 16434 |
| 14-#11 | 1.83 | MA | 26226 | 6042 | 41335 | 4524 | 44609 | 3687 | 45259 | 3048 | 44554 | 2136 | 53136 | 1720 | 29724 |
| 6L-3S | | MI | 15466 | 6042 | 25058 | 4314 | 26760 | 3512 | 27092 | 2886 | 26900 | 1967 | 31279 | 1681 | 16395 |
| 14-#11 | 1.83 | MA | 25693 | 6042 | 40349 | 4539 | 43420 | 3683 | 43796 | 3061 | 42591 | 2146 | 50405 | 1630 | 29141 |
| 7L-2S | | MI | 15931 | 6042 | 25752 | 4320 | 27647 | 3503 | 28152 | 2878 | 28306 | 1958 | 33108 | 1768 | 16352 |
| 14-#14 | 2.63 | MA | 28595 | 6376 | 46329 | 4728 | 51038 | 3818 | 53087 | 3124 | 55316 | 2106 | 67281 | 1676 | 43337 |
| 4L-5S | | MI | 15248 | 6376 | 25332 | 4499 | 26994 | 3638 | 27358 | 2948 | 27266 | 1898 | 32191 | 1335 | 22423 |
| 14-#14 | 2.63 | MA | 27783 | 6376 | 44951 | 4725 | 49251 | 3813 | 50890 | 3142 | 52134 | 2095 | 63452 | 1615 | 42176 |
| 5L-4S | | MI | 15678 | 6376 | 26047 | 4510 | 27904 | 3625 | 28444 | 2936 | 28790 | 1911 | 33962 | 1391 | 23002 |
| 14-#14 | 2.63 | MA | 27011 | 6376 | 43660 | 4722 | 47461 | 3833 | 48703 | 3135 | 49251 | 2109 | 59805 | 1535 | 41038 |
| 6L-3S | | MI | 16154 | 6376 | 26867 | 4495 | 28933 | 3638 | 29664 | 2948 | 30304 | 1898 | 35632 | 1507 | 23003 |
| 14-#14 | 2.63 | MA | 26258 | 6376 | 42244 | 4743 | 45754 | 3828 | 46604 | 3153 | 46434 | 2124 | 55916 | 1405 | 39649 |
| 7L-2S | | MI | 16809 | 6376 | 27854 | 4506 | 30184 | 3625 | 31159 | 2936 | 32288 | 1886 | 38201 | 1631 | 22965 |
| 14-#18 | 4.68 | MA | 30223 | 7223 | 51682 | 5235 | 57706 | 4218 | 61137 | 3370 | 66042 | 2019 | 82556 | 1193 | 69856 |
| 5L-4S | | MI | 16974 | 7223 | 29850 | 4989 | 32399 | 3933 | 33777 | 3077 | 35931 | 1734 | 43176 | 831 | 37176 |
| 14-#18 | 4.68 | MA | 28912 | 7223 | 49408 | 5228 | 54558 | 4207 | 57289 | 3355 | 60971 | 2041 | 76247 | 1049 | 66042 |
| 6L-3S | | MI | 17785 | 7223 | 31274 | 4967 | 34149 | 3955 | 35850 | 3099 | 38504 | 1712 | 45999 | 1029 | 38896 |
| 14-#18 | 4.68 | MA | 27635 | 7223 | 46918 | 5265 | 51553 | 4240 | 53596 | 3385 | 56016 | 2064 | 69511 | 818 | 62367 |
| 7L-2S | | MI | 18893 | 7223 | 32980 | 4989 | 36274 | 3933 | 38390 | 3077 | 41875 | 1689 | 50326 | 1250 | 39020 |
| 16-#11 | 2.09 | MA | 27995 | 6149 | 44564 | 4595 | 48857 | 3724 | 50455 | 3069 | 51694 | 2123 | 62344 | 1803 | 34819 |
| 4L-6S | | MI | 14844 | 6149 | 24205 | 4378 | 25625 | 3551 | 25785 | 2922 | 25177 | 1960 | 29489 | 1471 | 18273 |
| 16-#11 | 2.09 | MA | 27423 | 6149 | 43603 | 4593 | 47611 | 3721 | 48924 | 3082 | 49475 | 2116 | 59660 | 1760 | 34666 |
| 5E | | MI | 15134 | 6149 | 24676 | 4385 | 26272 | 3560 | 26518 | 2913 | 26153 | 1951 | 30661 | 1528 | 18632 |
| 16-#11 | 2.09 | MA | 26879 | 6149 | 42704 | 4591 | 46364 | 3735 | 47399 | 3077 | 47466 | 2127 | 57097 | 1705 | 33861 |
| 6L-4S | | MI | 15438 | 6149 | 25177 | 4392 | 26918 | 3551 | 27288 | 2904 | 27232 | 1960 | 31922 | 1567 | 18618 |
| 16-#11 | 2.09 | MA | 26349 | 6149 | 41717 | 4607 | 45174 | 3732 | 45936 | 3090 | 45503 | 2137 | 54365 | 1615 | 33298 |
| 7L-3S | | MI | 15774 | 6149 | 25752 | 4381 | 27647 | 3560 | 28152 | 2913 | 28306 | 1951 | 33108 | 1649 | 18588 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis

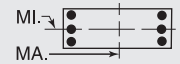



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.09 | MA | 25827 | 6149 | 40832 | 4605 | 43967 | 3746 | 44509 | 3103 | 43417 | 2131 | 51855 | 1565 | 32511 |
| 8L-2S | | MI | 16237 | 6149 | 26446 | 4388 | 28534 | 3551 | 29212 | 2904 | 29712 | 1942 | 34938 | 1735 | 18551 |
| 16-#14 | 3.01 | MA | 28698 | 6531 | 46911 | 4822 | 51764 | 3883 | 53956 | 3184 | 56304 | 2083 | 69092 | 1591 | 48061 |
| 5E | | MI | 15682 | 6531 | 26320 | 4596 | 28245 | 3706 | 28853 | 2986 | 29249 | 1874 | 34761 | 1285 | 25368 |
| 16-#14 | 3.01 | MA | 27931 | 6531 | 45620 | 4819 | 49974 | 3903 | 51768 | 3177 | 53421 | 2097 | 65445 | 1511 | 46970 |
| 6L-4S | | MI | 16110 | 6531 | 27034 | 4607 | 29155 | 3694 | 29940 | 2973 | 30773 | 1887 | 36532 | 1340 | 26064 |
| 16-#14 | 3.01 | MA | 27184 | 6531 | 44204 | 4841 | 48267 | 3898 | 49669 | 3195 | 50605 | 2111 | 61556 | 1381 | 45490 |
| 7L-3S | | MI | 16584 | 6531 | 27854 | 4592 | 30184 | 3706 | 31159 | 2986 | 32288 | 1874 | 38201 | 1456 | 26097 |
| 16-#14 | 3.01 | MA | 26449 | 6531 | 42933 | 4837 | 46535 | 3918 | 47620 | 3213 | 47612 | 2101 | 57975 | 1310 | 44056 |
| 8L-2S | | MI | 17236 | 6531 | 28842 | 4603 | 31435 | 3694 | 32654 | 2973 | 34272 | 1862 | 40771 | 1581 | 26072 |
| 16-#18 | 5.35 | MA | 30478 | 7499 | 52844 | 5401 | 58962 | 4331 | 62663 | 3431 | 68282 | 2019 | 86017 | 1000 | 76229 |
| 6L-4S | | MI | 17699 | 7499 | 31557 | 5162 | 34524 | 4050 | 36318 | 3139 | 39302 | 1685 | 47503 | 729 | 42184 |
| 16-#18 | 5.35 | MA | 29215 | 7499 | 50353 | 5438 | 55958 | 4364 | 58969 | 3460 | 63327 | 2042 | 79281 | 769 | 72447 |
| 7L-3S | | MI | 18504 | 7499 | 32980 | 5140 | 36274 | 4072 | 38390 | 3161 | 41875 | 1663 | 50326 | 927 | 44142 |
| 16-#18 | 5.35 | MA | 27972 | 7499 | 48115 | 5430 | 52910 | 4353 | 55363 | 3490 | 58061 | 2020 | 73057 | 646 | 68113 |
| 8L-2S | | MI | 19606 | 7499 | 34687 | 5162 | 38398 | 4050 | 40930 | 3139 | 45246 | 1641 | 54653 | 1149 | 44316 |
| 18-#11 | 2.35 | MA | 28069 | 6257 | 44972 | 4661 | 49365 | 3769 | 51064 | 3111 | 52387 | 2108 | 63620 | 1745 | 38883 |
| 5L-6S | | MI | 15154 | 6257 | 24899 | 4446 | 26512 | 3599 | 26845 | 2949 | 26583 | 1944 | 31318 | 1438 | 20372 |
| 18-#11 | 2.35 | MA | 27528 | 6257 | 44072 | 4659 | 48118 | 3783 | 49540 | 3107 | 50378 | 2118 | 61058 | 1689 | 38004 |
| 6L-5S | | MI | 15443 | 6257 | 25371 | 4452 | 27159 | 3608 | 27578 | 2940 | 27559 | 1936 | 32490 | 1496 | 20664 |
| 18-#11 | 2.35 | MA | 27001 | 6257 | 43086 | 4674 | 46928 | 3780 | 48077 | 3120 | 48415 | 2129 | 58326 | 1599 | 37459 |
| 7L-4S | | MI | 15745 | 6257 | 25871 | 4459 | 27805 | 3599 | 28348 | 2931 | 28638 | 1944 | 33751 | 1534 | 20796 |
| 18-#11 | 2.35 | MA | 26482 | 6257 | 42200 | 4672 | 45722 | 3794 | 46649 | 3132 | 46329 | 2122 | 55816 | 1550 | 36614 |
| 8L-3S | | MI | 16080 | 6257 | 26446 | 4448 | 28534 | 3608 | 29212 | 2940 | 29712 | 1936 | 34938 | 1616 | 20774 |
| 18-#11 | 2.35 | MA | 25927 | 6257 | 41334 | 4670 | 44548 | 3791 | 45156 | 3128 | 44384 | 2133 | 53331 | 1496 | 35786 |
| 9L-2S | | MI | 16542 | 6257 | 27141 | 4455 | 29421 | 3599 | 30272 | 2931 | 31118 | 1927 | 36767 | 1702 | 20744 |
| 18-#14 | 3.39 | MA | 28844 | 6687 | 47580 | 4916 | 52487 | 3973 | 54834 | 3220 | 57592 | 2085 | 71085 | 1487 | 52910 |
| 6L-5S | | MI | 16114 | 6687 | 27307 | 4693 | 29496 | 3774 | 30348 | 3023 | 31233 | 1850 | 37330 | 1234 | 28321 |
| 18-#14 | 3.39 | MA | 28103 | 6687 | 46164 | 4938 | 50780 | 3968 | 52734 | 3238 | 54776 | 2099 | 67196 | 1357 | 51343 |
| 7L-4S | | MI | 16540 | 6687 | 28022 | 4704 | 30406 | 3762 | 31435 | 3011 | 32757 | 1863 | 39101 | 1290 | 29024 |
| 18-#14 | 3.39 | MA | 27373 | 6687 | 44893 | 4935 | 49048 | 3988 | 50685 | 3256 | 51782 | 2088 | 63615 | 1286 | 49952 |
| 8L-3S | | MI | 17012 | 6687 | 28842 | 4690 | 31435 | 3774 | 32654 | 3023 | 34272 | 1850 | 40771 | 1405 | 29172 |
| 18-#14 | 3.39 | MA | 26618 | 6687 | 43649 | 4931 | 47364 | 3982 | 48543 | 3249 | 48991 | 2103 | 60079 | 1209 | 47962 |
| 9L-2S | | MI | 17661 | 6687 | 29829 | 4700 | 32687 | 3762 | 34149 | 3011 | 36255 | 1838 | 43341 | 1530 | 29171 |
| 18-#18 | 6.02 | MA | 30779 | 7776 | 53789 | 5610 | 60363 | 4488 | 64342 | 3536 | 70637 | 2019 | 89051 | 721 | 82549 |
| 7L-4S | | MI | 18419 | 7776 | 33263 | 5335 | 36649 | 4168 | 38858 | 3201 | 42673 | 1637 | 51830 | 628 | 47214 |
| 18-#18 | 6.02 | MA | 29549 | 7776 | 51551 | 5603 | 57315 | 4477 | 60736 | 3566 | 65371 | 1998 | 82827 | 598 | 78156 |
| 8L-3S | | MI | 19219 | 7776 | 34687 | 5313 | 38398 | 4190 | 40930 | 3223 | 45246 | 1615 | 54653 | 826 | 49376 |
| 20-#11 | 2.61 | MA | 28172 | 6365 | 45441 | 4726 | 49872 | 3832 | 51680 | 3136 | 53290 | 2110 | 65019 | 1674 | 42153 |
| 6E | | MI | 15462 | 6365 | 25594 | 4513 | 27399 | 3647 | 27905 | 2976 | 27989 | 1929 | 33147 | 1405 | 22474 |
| 20-#11 | 2.61 | MA | 27648 | 6365 | 44454 | 4742 | 48683 | 3829 | 50217 | 3149 | 51327 | 2120 | 62287 | 1584 | 41624 |
| 7L-5S | | MI | 15750 | 6365 | 26065 | 4520 | 28046 | 3656 | 28638 | 2967 | 28965 | 1920 | 34319 | 1463 | 22747 |
| 20-#11 | 2.61 | MA | 27132 | 6365 | 43569 | 4740 | 47476 | 3843 | 48789 | 3162 | 49241 | 2113 | 59776 | 1534 | 40724 |
| 8L-4S | | MI | 16052 | 6365 | 26566 | 4526 | 28692 | 3647 | 29408 | 2958 | 30044 | 1929 | 35580 | 1501 | 22968 |
| 20-#11 | 2.61 | MA | 26581 | 6365 | 42702 | 4738 | 46303 | 3840 | 47296 | 3158 | 47296 | 2124 | 57292 | 1480 | 39917 |
| 9L-3S | | MI | 16385 | 6365 | 27141 | 4516 | 29421 | 3656 | 30272 | 2967 | 31118 | 1920 | 36767 | 1583 | 22955 |
| 20-#11 | 2.61 | MA | 26009 | 6365 | 41732 | 4753 | 45112 | 3854 | 45876 | 3170 | 45368 | 2135 | 54884 | 1420 | 38823 |
| 10L-2S | | MI | 16846 | 6365 | 27835 | 4523 | 30308 | 3647 | 31332 | 2958 | 32524 | 1911 | 38596 | 1669 | 22931 |
| 20-#14 | 3.76 | MA | 29014 | 6842 | 48124 | 5035 | 53292 | 4038 | 55800 | 3280 | 58946 | 2087 | 72836 | 1333 | 57206 |
| 7L-5S | | MI | 16543 | 6842 | 28295 | 4791 | 30747 | 3843 | 31843 | 3061 | 33217 | 1826 | 39900 | 1183 | 31282 |
| 20-#14 | 3.76 | MA | 28289 | 6842 | 46853 | 5032 | 51561 | 4057 | 53751 | 3298 | 55953 | 2076 | 69255 | 1262 | 55804 |
| 8L-4S | | MI | 16968 | 6842 | 29009 | 4801 | 31657 | 3830 | 32930 | 3049 | 34741 | 1839 | 41671 | 1239 | 31937 |
| 20-#14 | 3.76 | MA | 27535 | 6842 | 45609 | 5029 | 49876 | 4052 | 51608 | 3291 | 53162 | 2090 | 65719 | 1185 | 53811 |
| 9L-3S | | MI | 17437 | 6842 | 29829 | 4787 | 32687 | 3843 | 34149 | 3061 | 36255 | 1826 | 43341 | 1355 | 32238 |
| 20-#14 | 3.76 | MA | 26718 | 6842 | 44217 | 5050 | 48168 | 4072 | 49570 | 3309 | 50395 | 2105 | 62293 | 1097 | 51698 |
| 10L-2S | | MI | 18084 | 6842 | 30817 | 4797 | 33938 | 3830 | 35645 | 3049 | 38239 | 1814 | 45910 | 1479 | 32265 |
| 20-#18 | 6.69 | MA | 31109 | 8053 | 54987 | 5776 | 61719 | 4602 | 66110 | 3641 | 72682 | 1976 | 92597 | 550 | 88218 |
| 8L-4S | | MI | 19136 | 8053 | 34970 | 5508 | 38774 | 4286 | 41398 | 3263 | 46044 | 1588 | 56158 | 526 | 52260 |

## RECTANGULAR TIED COLUMNS 26" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.87 | MA | 28292 | 6473 | 45823 | 4809 | 50437 | 3877 | 52357 | 3178 | 54239 | 2112 | 66248 | 1568 | 45792 |
| 7L-6S | | MI | 15769 | 6473 | 26288 | 4580 | 28286 | 3695 | 28965 | 3002 | 29395 | 1913 | 34977 | 1372 | 24579 |
| 22-#11 | 2.87 | MA | 27778 | 6473 | 44937 | 4807 | 49230 | 3891 | 50930 | 3191 | 52153 | 2105 | 63737 | 1519 | 44840 |
| 8L-5S | | MI | 16056 | 6473 | 26759 | 4587 | 28933 | 3704 | 29698 | 2994 | 30371 | 1905 | 36149 | 1430 | 24834 |
| 22-#11 | 2.87 | MA | 27231 | 6473 | 44071 | 4805 | 48057 | 3888 | 49436 | 3187 | 50208 | 2115 | 61253 | 1465 | 44053 |
| 9L-4S | | MI | 16357 | 6473 | 27260 | 4594 | 29579 | 3695 | 30468 | 2985 | 31450 | 1913 | 37410 | 1468 | 25127 |
| 22-#11 | 2.87 | MA | 26662 | 6473 | 43100 | 4820 | 46867 | 3902 | 48016 | 3200 | 48280 | 2126 | 58845 | 1404 | 42922 |
| 10L-3S | | MI | 16689 | 6473 | 27835 | 4583 | 30308 | 3704 | 31332 | 2994 | 32524 | 1905 | 38596 | 1550 | 25131 |
| 22-#11 | 2.87 | MA | 26106 | 6473 | 42232 | 4818 | 45699 | 3899 | 46542 | 3196 | 46223 | 2119 | 56396 | 1351 | 41889 |
| 11L-2S | | MI | 17148 | 6473 | 28529 | 4590 | 31195 | 3695 | 32392 | 2985 | 33930 | 1896 | 40426 | 1636 | 25114 |
| 22-#14 | 4.14 | MA | 29199 | 6998 | 48813 | 5129 | 54073 | 4127 | 56816 | 3340 | 60123 | 2064 | 74895 | 1238 | 61615 |
| 8L-5S | | MI | 16971 | 6998 | 29282 | 4888 | 31998 | 3911 | 33339 | 3099 | 35200 | 1802 | 42470 | 1133 | 34247 |
| 22-#14 | 4.14 | MA | 28446 | 6998 | 47569 | 5126 | 52389 | 4122 | 54674 | 3333 | 57333 | 2078 | 71359 | 1161 | 59668 |
| 9L-4S | | MI | 17393 | 6998 | 29997 | 4899 | 32908 | 3899 | 34426 | 3086 | 36724 | 1815 | 44241 | 1188 | 34861 |
| 22-#14 | 4.14 | MA | 27638 | 6998 | 46177 | 5148 | 50681 | 4142 | 52636 | 3351 | 54566 | 2092 | 67933 | 1073 | 57517 |
| 10L-3S | | MI | 17861 | 6998 | 30817 | 4884 | 33938 | 3911 | 35645 | 3099 | 38239 | 1802 | 45910 | 1304 | 35299 |
| 24-#11 | 3.13 | MA | 28421 | 6581 | 46306 | 4874 | 50985 | 3940 | 53070 | 3221 | 55065 | 2096 | 67698 | 1503 | 48961 |
| 8L-6S | | MI | 16075 | 6581 | 26982 | 4648 | 29173 | 3744 | 30025 | 3029 | 30802 | 1898 | 36806 | 1339 | 26684 |
| 24-#11 | 3.13 | MA | 27884 | 6581 | 45439 | 4872 | 49811 | 3936 | 51577 | 3216 | 53120 | 2107 | 65214 | 1450 | 48192 |
| 9L-5S | | MI | 16361 | 6581 | 27453 | 4655 | 29821 | 3752 | 30758 | 3021 | 31777 | 1889 | 37978 | 1397 | 26926 |
| 24-#11 | 3.13 | MA | 27310 | 6581 | 44469 | 4888 | 48621 | 3951 | 50157 | 3229 | 51192 | 2117 | 62805 | 1389 | 47026 |
| 10L-4S | | MI | 16660 | 6581 | 27954 | 4661 | 30466 | 3744 | 31528 | 3012 | 32856 | 1898 | 39239 | 1435 | 27283 |
| 24-#11 | 3.13 | MA | 26757 | 6581 | 43601 | 4886 | 47454 | 3947 | 48683 | 3225 | 49135 | 2111 | 60357 | 1336 | 45883 |
| 11L-3S | | MI | 16992 | 6581 | 28529 | 4651 | 31195 | 3752 | 32392 | 3021 | 33930 | 1889 | 40426 | 1517 | 27304 |
| 24-#11 | 3.13 | MA | 26215 | 6581 | 42648 | 4901 | 46272 | 3962 | 47265 | 3238 | 47208 | 2121 | 57599 | 1259 | 44656 |
| 12L-2S | | MI | 17450 | 6581 | 29223 | 4657 | 32082 | 3744 | 33452 | 3012 | 35336 | 1880 | 42255 | 1603 | 27292 |
| 24-#14 | 4.52 | MA | 29350 | 7154 | 49529 | 5223 | 54902 | 4192 | 57739 | 3376 | 61503 | 2065 | 76999 | 1137 | 65532 |
| 9L-5S | | MI | 17396 | 7154 | 30270 | 4985 | 33249 | 3980 | 34834 | 3136 | 37184 | 1778 | 45039 | 1082 | 37217 |
| 24-#14 | 4.52 | MA | 28574 | 7154 | 48137 | 5245 | 53193 | 4212 | 55701 | 3394 | 58736 | 2080 | 73573 | 1049 | 63343 |
| 10L-4S | | MI | 17817 | 7154 | 30984 | 4996 | 34160 | 3967 | 35921 | 3124 | 38708 | 1791 | 46810 | 1138 | 37793 |

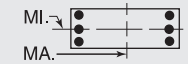
## RECTANGULAR TIED COLUMNS 26" x 48"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.28 | MA | 29936 | 6069 | 46671 | 4536 | 50624 | 3695 | 51718 | 3079 | 51737 | 2206 | 60950 | 2084 | 23450 |
| 2E | | MI | 15851 | 6069 | 25361 | 4288 | 26580 | 3479 | 26585 | 2880 | 25815 | 2020 | 29561 | 1844 | 12109 |
| 6-#14 | 1.08 | MA | 29470 | 5983 | 45487 | 4508 | 49282 | 3678 | 50148 | 3073 | 49629 | 2227 | 58339 | 2122 | 20018 |
| 2L-3S | | MI | 15007 | 5983 | 23827 | 4272 | 24861 | 3501 | 24582 | 2914 | 23170 | 2084 | 26232 | 1796 | 10509 |
| 6-#14 | 1.08 | MA | 28063 | 5983 | 43430 | 4505 | 46644 | 3673 | 46931 | 3092 | 45252 | 2242 | 52390 | 1997 | 20074 |
| 3L-2S | | MI | 15675 | 5983 | 24815 | 4283 | 26112 | 3489 | 26077 | 2902 | 25154 | 2071 | 28802 | 1920 | 10425 |
| 6-#18 | 1.92 | MA | 31622 | 6346 | 50280 | 4708 | 55250 | 3819 | 57362 | 3154 | 59415 | 2184 | 71269 | 2039 | 34774 |
| 2L-3S | | MI | 15452 | 6346 | 25361 | 4439 | 26580 | 3619 | 26585 | 2964 | 25815 | 1994 | 29561 | 1521 | 17734 |
| 6-#18 | 1.92 | MA | 29195 | 6346 | 46671 | 4702 | 50624 | 3853 | 51718 | 3185 | 51737 | 2208 | 60950 | 1817 | 34684 |
| 3L-2S | | MI | 16592 | 6346 | 27068 | 4461 | 28705 | 3597 | 29126 | 2942 | 29186 | 1972 | 33888 | 1742 | 17599 |
| 8-#11 | 1.00 | MA | 29278 | 5948 | 44988 | 4499 | 48731 | 3673 | 49511 | 3073 | 48777 | 2237 | 57282 | 2138 | 18605 |
| 2L-4S | | MI | 14791 | 5948 | 23309 | 4289 | 24302 | 3496 | 23950 | 2914 | 22411 | 2112 | 25487 | 1785 | 9842 |
| 8-#11 | 1.00 | MA | 28293 | 5948 | 43552 | 4497 | 46890 | 3670 | 47265 | 3086 | 45721 | 2248 | 53107 | 2051 | 18646 |
| 3E | | MI | 15132 | 5948 | 23884 | 4279 | 25031 | 3505 | 24814 | 2922 | 23485 | 2103 | 26674 | 1867 | 9775 |
| 8-#11 | 1.00 | MA | 27606 | 5948 | 42386 | 4513 | 45404 | 3685 | 45459 | 3082 | 43397 | 2259 | 50381 | 1965 | 18665 |
| 4L-2S | | MI | 15602 | 5948 | 24578 | 4285 | 25918 | 3496 | 25874 | 2914 | 24891 | 2094 | 28503 | 1953 | 9722 |
| 8-#14 | 1.44 | MA | 30447 | 6139 | 47545 | 4605 | 51919 | 3748 | 53366 | 3116 | 54007 | 2214 | 64287 | 2099 | 26481 |
| 2L-4S | | MI | 14964 | 6139 | 23995 | 4384 | 25083 | 3557 | 24858 | 2939 | 23639 | 2072 | 27132 | 1629 | 13768 |
| 8-#14 | 1.44 | MA | 29049 | 6139 | 45487 | 4602 | 49282 | 3743 | 50148 | 3134 | 49629 | 2230 | 58339 | 1974 | 26504 |
| 3E | | MI | 15448 | 6139 | 24815 | 4370 | 26112 | 3569 | 26077 | 2952 | 25154 | 2060 | 28802 | 1745 | 13685 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

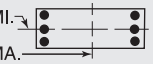



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.44 | MA | 28072 | 6139 | 43815 | 4624 | 47150 | 3763 | 47558 | 3128 | 46295 | 2245 | 54459 | 1850 | 26410 |
| 4L-2S | | MI | 16112 | 6139 | 25802 | 4380 | 27363 | 3557 | 27573 | 2939 | 27137 | 2047 | 31371 | 1870 | 13606 |
| 8-#18 | 2.56 | MA | 33283 | 6623 | 53889 | 4881 | 59876 | 3943 | 63005 | 3229 | 67094 | 2162 | 81587 | 1993 | 46045 |
| 2L-4S | | MI | 15365 | 6623 | 25644 | 4635 | 26956 | 3715 | 27053 | 3004 | 26612 | 1967 | 31065 | 1221 | 22577 |
| 8-#18 | 2.56 | MA | 30882 | 6623 | 50280 | 4875 | 55250 | 3978 | 57362 | 3260 | 59415 | 2186 | 71269 | 1772 | 45838 |
| 3E | | MI | 16194 | 6623 | 27068 | 4612 | 28705 | 3737 | 29126 | 3026 | 29186 | 1945 | 33888 | 1419 | 23110 |
| 8-#18 | 2.56 | MA | 29201 | 6623 | 47340 | 4912 | 51502 | 3968 | 52807 | 3247 | 53554 | 2210 | 64554 | 1550 | 44613 |
| 4L-2S | | MI | 17327 | 6623 | 28775 | 4634 | 30830 | 3715 | 31666 | 3004 | 32557 | 1923 | 38215 | 1641 | 23024 |
| 10-#11 | 1.25 | MA | 29965 | 6056 | 46424 | 4566 | 50572 | 3722 | 51756 | 3102 | 51832 | 2228 | 61457 | 2123 | 23117 |
| 2L-5S | | MI | 14797 | 6056 | 23502 | 4350 | 24543 | 3553 | 24239 | 2949 | 22737 | 2088 | 26056 | 1714 | 12131 |
| 10-#11 | 1.25 | MA | 28985 | 6056 | 44988 | 4565 | 48731 | 3719 | 49511 | 3116 | 48777 | 2239 | 57282 | 2037 | 23146 |
| 3L-4S | | MI | 15104 | 6056 | 24003 | 4357 | 25189 | 3544 | 25010 | 2941 | 23817 | 2096 | 27316 | 1752 | 12072 |
| 10-#11 | 1.25 | MA | 28301 | 6056 | 43822 | 4580 | 47245 | 3733 | 47704 | 3112 | 46452 | 2250 | 54556 | 1951 | 23136 |
| 4L-3S | | MI | 15444 | 6056 | 24578 | 4346 | 25918 | 3553 | 25874 | 2949 | 24891 | 2088 | 28503 | 1834 | 12012 |
| 10-#11 | 1.25 | MA | 27691 | 6056 | 42816 | 4579 | 45939 | 3730 | 46100 | 3125 | 44127 | 2244 | 51730 | 1908 | 23051 |
| 5L-2S | | MI | 15913 | 6056 | 25272 | 4353 | 26805 | 3544 | 26934 | 2941 | 26297 | 2079 | 30332 | 1920 | 11960 |
| 10-#14 | 1.80 | MA | 31415 | 6294 | 49602 | 4702 | 54557 | 3818 | 56583 | 3158 | 58385 | 2202 | 70236 | 2076 | 32925 |
| 2L-5S | | MI | 14969 | 6294 | 24268 | 4471 | 25423 | 3638 | 25267 | 2989 | 24099 | 2036 | 27931 | 1523 | 16709 |
| 10-#14 | 1.80 | MA | 30026 | 6294 | 47545 | 4699 | 51919 | 3813 | 53366 | 3177 | 54007 | 2217 | 64287 | 1952 | 32908 |
| 3L-4S | | MI | 15405 | 6294 | 24982 | 4481 | 26334 | 3625 | 26354 | 2977 | 25622 | 2048 | 29702 | 1579 | 16888 |
| 10-#14 | 1.80 | MA | 29056 | 6294 | 45873 | 4721 | 49788 | 3833 | 50775 | 3170 | 50673 | 2232 | 60408 | 1827 | 32767 |
| 4L-3S | | MI | 15886 | 6294 | 25802 | 4467 | 27363 | 3638 | 27573 | 2989 | 27137 | 2036 | 31371 | 1694 | 16828 |
| 10-#14 | 1.80 | MA | 28191 | 6294 | 44428 | 4719 | 47914 | 3829 | 48472 | 3189 | 47337 | 2222 | 56375 | 1766 | 32076 |
| 5L-2S | | MI | 16547 | 6294 | 26790 | 4477 | 28614 | 3625 | 29068 | 2977 | 29121 | 2023 | 33941 | 1819 | 16760 |
| 10-#18 | 3.21 | MA | 32545 | 6899 | 53889 | 5048 | 59876 | 4102 | 63005 | 3336 | 67094 | 2163 | 81587 | 1726 | 56972 |
| 3L-4S | | MI | 16108 | 6899 | 27351 | 4808 | 29080 | 3832 | 29593 | 3067 | 29983 | 1919 | 35393 | 1119 | 27475 |
| 10-#18 | 3.21 | MA | 30883 | 6899 | 50949 | 5085 | 56129 | 4092 | 58451 | 3322 | 61233 | 2187 | 74872 | 1504 | 55223 |
| 4L-3S | | MI | 16931 | 6899 | 28775 | 4785 | 30830 | 3854 | 31666 | 3089 | 32557 | 1897 | 38215 | 1317 | 28438 |
| 10-#18 | 3.21 | MA | 29401 | 6899 | 48406 | 5078 | 52832 | 4126 | 54399 | 3353 | 55365 | 2167 | 67853 | 1399 | 51856 |
| 5L-2S | | MI | 18056 | 6899 | 30481 | 4807 | 32955 | 3832 | 34206 | 3067 | 35928 | 1875 | 42542 | 1539 | 28411 |
| 12-#11 | 1.50 | MA | 30648 | 6163 | 47860 | 4634 | 52413 | 3770 | 54002 | 3132 | 54888 | 2220 | 65632 | 2109 | 27620 |
| 2L-6S | | MI | 14818 | 6163 | 23725 | 4411 | 24783 | 3592 | 24566 | 2985 | 23168 | 2081 | 26713 | 1624 | 14213 |
| 12-#11 | 1.50 | MA | 29672 | 6163 | 46424 | 4632 | 50572 | 3767 | 51756 | 3145 | 51832 | 2231 | 61457 | 2022 | 27636 |
| 3L-5S | | MI | 15110 | 6163 | 24196 | 4417 | 25431 | 3601 | 25299 | 2976 | 24143 | 2072 | 27885 | 1681 | 14327 |
| 12-#11 | 1.50 | MA | 28992 | 6163 | 45258 | 4648 | 49086 | 3781 | 49950 | 3141 | 49508 | 2242 | 58731 | 1936 | 27598 |
| 4E | | MI | 15417 | 6163 | 24697 | 4424 | 26076 | 3592 | 26070 | 2968 | 25223 | 2081 | 29146 | 1719 | 14282 |
| 12-#11 | 1.50 | MA | 28386 | 6163 | 44252 | 4646 | 47780 | 3779 | 48345 | 3154 | 47182 | 2235 | 55905 | 1893 | 27487 |
| 5L-3S | | MI | 15755 | 6163 | 25272 | 4413 | 26805 | 3601 | 26934 | 2976 | 26297 | 2072 | 30332 | 1801 | 14230 |
| 12-#11 | 1.50 | MA | 27809 | 6163 | 43309 | 4644 | 46473 | 3793 | 46748 | 3150 | 45077 | 2246 | 53203 | 1837 | 26907 |
| 6L-2S | | MI | 16223 | 6163 | 25966 | 4420 | 27692 | 3592 | 27994 | 2968 | 27703 | 2063 | 32162 | 1888 | 14181 |
| 12-#14 | 2.16 | MA | 30994 | 6450 | 49602 | 4797 | 54557 | 3883 | 56583 | 3219 | 58385 | 2205 | 70236 | 1929 | 39299 |
| 3L-5S | | MI | 15409 | 6450 | 25255 | 4568 | 26674 | 3706 | 26762 | 3027 | 26082 | 2012 | 30500 | 1472 | 19627 |
| 12-#14 | 2.16 | MA | 30031 | 6450 | 47930 | 4819 | 52425 | 3903 | 53993 | 3213 | 55051 | 2220 | 66357 | 1805 | 39118 |
| 4E | | MI | 15842 | 6450 | 25970 | 4579 | 27585 | 3694 | 27849 | 3014 | 27606 | 2024 | 32271 | 1528 | 19989 |
| 12-#14 | 2.16 | MA | 29173 | 6450 | 46485 | 4816 | 50552 | 3899 | 51690 | 3231 | 51714 | 2210 | 62324 | 1744 | 38222 |
| 5L-3S | | MI | 16321 | 6450 | 26790 | 4564 | 28614 | 3706 | 29068 | 3027 | 29121 | 2012 | 33941 | 1644 | 19951 |
| 12-#14 | 2.16 | MA | 28356 | 6450 | 45132 | 4813 | 48676 | 3919 | 49397 | 3225 | 48693 | 2225 | 58475 | 1663 | 36925 |
| 6L-2S | | MI | 16980 | 6450 | 27777 | 4575 | 29865 | 3694 | 30563 | 3014 | 31105 | 1999 | 36511 | 1768 | 19895 |
| 12-#18 | 3.85 | MA | 32544 | 7176 | 54557 | 5258 | 60755 | 4216 | 64094 | 3397 | 68911 | 2165 | 85190 | 1459 | 65883 |
| 4E | | MI | 16843 | 7176 | 29057 | 4981 | 31205 | 3950 | 32133 | 3129 | 33354 | 1870 | 39720 | 1018 | 32420 |
| 12-#18 | 3.85 | MA | 31078 | 7176 | 52015 | 5251 | 57458 | 4250 | 60043 | 3428 | 63043 | 2145 | 78171 | 1353 | 62690 |
| 5L-3S | | MI | 17661 | 7176 | 30481 | 4958 | 32955 | 3972 | 34206 | 3151 | 35928 | 1848 | 42542 | 1216 | 33728 |
| 12-#18 | 3.85 | MA | 29685 | 7176 | 49631 | 5245 | 54156 | 4240 | 56008 | 3415 | 57726 | 2169 | 71504 | 1209 | 59073 |
| 6L-2S | | MI | 18779 | 7176 | 32188 | 4980 | 35079 | 3950 | 36746 | 3129 | 39299 | 1826 | 46870 | 1437 | 33770 |
| 14-#11 | 1.75 | MA | 30355 | 6271 | 47860 | 4700 | 52413 | 3816 | 54002 | 3175 | 54888 | 2222 | 65632 | 2008 | 32110 |
| 3L-6S | | MI | 15130 | 6271 | 24419 | 4478 | 25670 | 3641 | 25626 | 3012 | 24574 | 2065 | 28542 | 1591 | 16314 |
| 14-#11 | 1.75 | MA | 29678 | 6271 | 46694 | 4715 | 50927 | 3830 | 52196 | 3171 | 52563 | 2233 | 62906 | 1922 | 32054 |
| 4L-5S | | MI | 15422 | 6271 | 24891 | 4485 | 26318 | 3649 | 26359 | 3003 | 25549 | 2056 | 29714 | 1648 | 16511 |

## RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

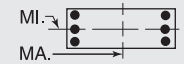



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.75 | MA | 29075 | 6271 | 45688 | 4713 | 49621 | 3827 | 50591 | 3184 | 50238 | 2227 | 60080 | 1879 | 31920 |
| 5L-4S | | MI | 15727 | 6271 | 25391 | 4491 | 26963 | 3641 | 27130 | 2994 | 26629 | 2065 | 30975 | 1687 | 16479 |
| 14-#11 | 1.75 | MA | 28501 | 6271 | 44745 | 4712 | 48314 | 3841 | 48994 | 3180 | 48132 | 2238 | 57378 | 1823 | 31240 |
| 6L-3S | | MI | 16065 | 6271 | 25966 | 4481 | 27692 | 3649 | 27994 | 3003 | 27703 | 2056 | 32162 | 1768 | 16436 |
| 14-#11 | 1.75 | MA | 27942 | 6271 | 43712 | 4727 | 47068 | 3839 | 47461 | 3193 | 46076 | 2249 | 54498 | 1733 | 30607 |
| 7L-2S | | MI | 16531 | 6271 | 26661 | 4488 | 28579 | 3641 | 29054 | 2994 | 29109 | 2048 | 33991 | 1855 | 16392 |
| 14-#14 | 2.52 | MA | 30998 | 6605 | 49987 | 4916 | 55062 | 3973 | 57210 | 3255 | 59428 | 2207 | 72305 | 1782 | 45463 |
| 4L-5S | | MI | 15846 | 6605 | 26243 | 4665 | 27925 | 3775 | 28257 | 3065 | 28066 | 1988 | 33070 | 1422 | 22561 |
| 14-#14 | 2.52 | MA | 30146 | 6605 | 48543 | 4913 | 53189 | 3968 | 54907 | 3274 | 56092 | 2197 | 68272 | 1721 | 44387 |
| 5L-4S | | MI | 16277 | 6605 | 26957 | 4676 | 28836 | 3762 | 29344 | 3052 | 29590 | 2000 | 34841 | 1477 | 23071 |
| 14-#14 | 2.52 | MA | 29335 | 6605 | 47189 | 4910 | 51313 | 3989 | 52615 | 3267 | 53071 | 2212 | 64424 | 1641 | 43146 |
| 6L-3S | | MI | 16754 | 6605 | 27777 | 4661 | 29865 | 3775 | 30563 | 3065 | 31105 | 1988 | 36511 | 1593 | 23058 |
| 14-#14 | 2.52 | MA | 28546 | 6605 | 45706 | 4932 | 49524 | 3984 | 50415 | 3286 | 50119 | 2228 | 60321 | 1511 | 41820 |
| 7L-2S | | MI | 17410 | 6605 | 28765 | 4672 | 31116 | 3762 | 32058 | 3052 | 33088 | 1975 | 39080 | 1718 | 23016 |
| 14-#18 | 4.49 | MA | 32736 | 7453 | 55623 | 5424 | 62084 | 4374 | 65687 | 3504 | 70722 | 2123 | 88490 | 1307 | 73549 |
| 5L-4S | | MI | 17574 | 7453 | 30764 | 5153 | 33330 | 4068 | 34673 | 3191 | 36725 | 1822 | 44047 | 916 | 37400 |
| 14-#18 | 4.49 | MA | 31358 | 7453 | 53240 | 5418 | 58782 | 4364 | 61652 | 3490 | 65404 | 2147 | 81822 | 1164 | 69759 |
| 6L-3S | | MI | 18386 | 7453 | 32188 | 5131 | 35079 | 4090 | 36746 | 3213 | 39299 | 1800 | 46870 | 1114 | 38996 |
| 14-#18 | 4.49 | MA | 30017 | 7453 | 50629 | 5455 | 55633 | 4398 | 57779 | 3521 | 60209 | 2171 | 74708 | 933 | 66090 |
| 7L-2S | | MI | 19497 | 7453 | 33895 | 5153 | 37204 | 4068 | 39286 | 3191 | 42670 | 1778 | 51197 | 1336 | 39101 |
| 16-#11 | 2.00 | MA | 30360 | 6379 | 48130 | 4783 | 52767 | 3878 | 54442 | 3200 | 55618 | 2224 | 67081 | 1907 | 36504 |
| 4L-6S | | MI | 15442 | 6379 | 25114 | 4545 | 26557 | 3689 | 26686 | 3039 | 25980 | 2050 | 30371 | 1558 | 18374 |
| 16-#11 | 2.00 | MA | 29760 | 6379 | 47124 | 4781 | 51462 | 3875 | 52837 | 3213 | 53293 | 2218 | 64256 | 1864 | 36350 |
| 5E | | MI | 15733 | 6379 | 25585 | 4552 | 27205 | 3697 | 27419 | 3030 | 26956 | 2041 | 31544 | 1615 | 18687 |
| 16-#11 | 2.00 | MA | 29189 | 6379 | 46181 | 4779 | 50155 | 3890 | 51239 | 3209 | 51188 | 2229 | 61553 | 1808 | 35582 |
| 6L-4S | | MI | 16037 | 6379 | 26086 | 4559 | 27850 | 3689 | 28190 | 3021 | 28035 | 2050 | 32804 | 1654 | 18666 |
| 16-#11 | 2.00 | MA | 28634 | 6379 | 45148 | 4795 | 48909 | 3887 | 49707 | 3222 | 49131 | 2240 | 58673 | 1719 | 34971 |
| 7L-3S | | MI | 16373 | 6379 | 26661 | 4548 | 28579 | 3697 | 29054 | 3030 | 29109 | 2041 | 33991 | 1735 | 18633 |
| 16-#11 | 2.00 | MA | 28086 | 6379 | 44220 | 4793 | 47645 | 3901 | 48211 | 3236 | 46945 | 2234 | 56030 | 1668 | 34235 |
| 8L-2S | | MI | 16837 | 6379 | 27355 | 4555 | 29466 | 3689 | 30114 | 3021 | 30515 | 2032 | 35820 | 1822 | 18594 |
| 16-#14 | 2.88 | MA | 31111 | 6761 | 50600 | 5010 | 55826 | 4038 | 58125 | 3316 | 60470 | 2185 | 74221 | 1699 | 50567 |
| 5E | | MI | 16281 | 6761 | 27230 | 4763 | 29176 | 3843 | 29752 | 3102 | 30050 | 1964 | 35640 | 1371 | 25507 |
| 16-#14 | 2.88 | MA | 30306 | 6761 | 49247 | 5007 | 53951 | 4058 | 55832 | 3310 | 57448 | 2200 | 70373 | 1618 | 49376 |
| 6L-4S | | MI | 16710 | 6761 | 27945 | 4773 | 30087 | 3831 | 30839 | 3090 | 31573 | 1976 | 37411 | 1427 | 26137 |
| 16-#14 | 2.88 | MA | 29522 | 6761 | 47764 | 5029 | 52162 | 4054 | 53632 | 3328 | 54496 | 2215 | 66270 | 1489 | 47956 |
| 7L-3S | | MI | 17184 | 6761 | 28765 | 4759 | 31116 | 3843 | 32058 | 3102 | 33088 | 1964 | 39080 | 1542 | 26161 |
| 16-#14 | 2.88 | MA | 28751 | 6761 | 46432 | 5026 | 50347 | 4074 | 51485 | 3347 | 51359 | 2205 | 62498 | 1417 | 46401 |
| 8L-2S | | MI | 17838 | 6761 | 29752 | 4769 | 32367 | 3831 | 33554 | 3090 | 35072 | 1951 | 41650 | 1667 | 26126 |
| 16-#18 | 5.13 | MA | 33012 | 7729 | 56849 | 5590 | 63409 | 4488 | 67295 | 3566 | 73083 | 2125 | 92140 | 1118 | 80471 |
| 6L-4S | | MI | 18300 | 7729 | 32471 | 5326 | 35455 | 4185 | 37214 | 3254 | 40096 | 1773 | 48374 | 815 | 42407 |
| 16-#18 | 5.13 | MA | 31684 | 7729 | 54238 | 5628 | 60259 | 4522 | 63423 | 3596 | 67887 | 2149 | 85026 | 887 | 76695 |
| 7L-3S | | MI | 19107 | 7729 | 33895 | 5304 | 37204 | 4208 | 39286 | 3276 | 42670 | 1751 | 51197 | 1013 | 44249 |
| 16-#18 | 5.13 | MA | 30379 | 7729 | 51891 | 5621 | 57064 | 4512 | 59642 | 3627 | 62366 | 2128 | 78463 | 763 | 72281 |
| 8L-2S | | MI | 20211 | 7729 | 35602 | 5326 | 39329 | 4185 | 41826 | 3254 | 46041 | 1729 | 55524 | 1234 | 44403 |
| 18-#11 | 2.25 | MA | 30441 | 6487 | 48560 | 4848 | 53303 | 3924 | 55083 | 3243 | 56349 | 2209 | 68431 | 1850 | 40778 |
| 5L-6S | | MI | 15752 | 6487 | 25808 | 4613 | 27444 | 3737 | 27746 | 3066 | 27386 | 2034 | 32201 | 1525 | 20474 |
| 18-#11 | 2.25 | MA | 29873 | 6487 | 47617 | 4847 | 51996 | 3938 | 53485 | 3239 | 54243 | 2220 | 65728 | 1794 | 39931 |
| 6L-5S | | MI | 16042 | 6487 | 26279 | 4620 | 28092 | 3745 | 28479 | 3057 | 28362 | 2025 | 33373 | 1582 | 20775 |
| 18-#11 | 2.25 | MA | 29320 | 6487 | 46584 | 4862 | 50750 | 3935 | 51952 | 3252 | 52187 | 2231 | 62848 | 1704 | 39340 |
| 7L-4S | | MI | 16344 | 6487 | 26780 | 4626 | 28737 | 3737 | 29250 | 3048 | 29441 | 2034 | 34634 | 1621 | 20847 |
| 18-#11 | 2.25 | MA | 28776 | 6487 | 45656 | 4860 | 49485 | 3950 | 50457 | 3265 | 50001 | 2225 | 60205 | 1654 | 38544 |
| 8L-3S | | MI | 16680 | 6487 | 27355 | 4616 | 29466 | 3745 | 30114 | 3057 | 30515 | 2025 | 35820 | 1702 | 20822 |
| 18-#11 | 2.25 | MA | 28186 | 6487 | 44749 | 4859 | 48256 | 3947 | 48892 | 3261 | 47963 | 2236 | 57585 | 1600 | 37646 |
| 9L-2S | | MI | 17142 | 6487 | 28049 | 4622 | 30353 | 3737 | 31174 | 3048 | 31921 | 2017 | 37650 | 1789 | 20789 |
| 18-#14 | 3.25 | MA | 31269 | 6917 | 51304 | 5105 | 56588 | 4128 | 59050 | 3352 | 61826 | 2188 | 76322 | 1596 | 55615 |
| 6L-5S | | MI | 16713 | 6917 | 28218 | 4860 | 30427 | 3911 | 31248 | 3140 | 32033 | 1940 | 38209 | 1320 | 28461 |
| 18-#14 | 3.25 | MA | 30491 | 6917 | 49821 | 5127 | 54799 | 4124 | 56850 | 3371 | 58874 | 2203 | 72219 | 1466 | 54105 |
| 7L-4S | | MI | 17140 | 6917 | 28932 | 4870 | 31338 | 3899 | 32335 | 3127 | 33557 | 1952 | 39980 | 1376 | 29187 |

## RECTANGULAR TIED COLUMNS 26" x 48"

Short columns – no sidesway
Bending on major or minor axis

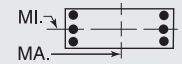



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 3.25 | MA | 29725 | 6917 | 48489 | 5124 | 52985 | 4144 | 54703 | 3389 | 55737 | 2193 | 68447 | 1394 | 52594 |
| 8L-3S | | MI | 17613 | 6917 | 29752 | 4856 | 32367 | 3911 | 33554 | 3140 | 35072 | 1940 | 41650 | 1492 | 29239 |
| 18-#14 | 3.25 | MA | 28922 | 6917 | 47186 | 5121 | 51220 | 4139 | 52458 | 3383 | 52812 | 2208 | 64716 | 1317 | 50618 |
| 9L-2S | | MI | 18263 | 6917 | 30740 | 4867 | 33618 | 3899 | 35049 | 3127 | 37055 | 1927 | 44220 | 1616 | 29228 |
| 18-#18 | 5.77 | MA | 33335 | 8006 | 57846 | 5801 | 64885 | 4646 | 69066 | 3672 | 75566 | 2127 | 95344 | 842 | 87323 |
| 7L-4S | | MI | 19021 | 8006 | 34178 | 5499 | 37579 | 4303 | 39754 | 3316 | 43467 | 1725 | 52702 | 713 | 47436 |
| 18-#18 | 5.77 | MA | 32042 | 8006 | 55500 | 5794 | 61690 | 4636 | 65286 | 3702 | 70044 | 2106 | 88782 | 717 | 82880 |
| 8L-3S | | MI | 19823 | 8006 | 35602 | 5477 | 39329 | 4325 | 41826 | 3338 | 46041 | 1703 | 55524 | 911 | 49489 |
| 20-#11 | 2.50 | MA | 30553 | 6595 | 49053 | 4914 | 53837 | 3987 | 55731 | 3268 | 57299 | 2212 | 69903 | 1779 | 44286 |
| 6E | | MI | 16060 | 6595 | 26502 | 4680 | 28331 | 3785 | 28806 | 3092 | 28792 | 2019 | 34030 | 1492 | 22577 |
| 20-#11 | 2.50 | MA | 30003 | 6595 | 48020 | 4929 | 52590 | 3984 | 54198 | 3281 | 55242 | 2223 | 67024 | 1689 | 43712 |
| 7L-5S | | MI | 16349 | 6595 | 26973 | 4687 | 28979 | 3794 | 29539 | 3084 | 29768 | 2010 | 35202 | 1549 | 22858 |
| 20-#11 | 2.50 | MA | 29461 | 6595 | 47092 | 4928 | 51326 | 3998 | 52702 | 3294 | 53056 | 2216 | 64381 | 1639 | 42859 |
| 8L-4S | | MI | 16651 | 6595 | 27474 | 4694 | 29624 | 3785 | 30310 | 3075 | 30847 | 2019 | 36463 | 1588 | 23022 |
| 20-#11 | 2.50 | MA | 28875 | 6595 | 46184 | 4926 | 50097 | 3995 | 51138 | 3291 | 51018 | 2227 | 61760 | 1586 | 41984 |
| 9L-3S | | MI | 16985 | 6595 | 28049 | 4683 | 30353 | 3794 | 31174 | 3084 | 31921 | 2010 | 37650 | 1670 | 23005 |
| 20-#11 | 2.50 | MA | 28275 | 6595 | 45168 | 4942 | 48850 | 4010 | 49650 | 3304 | 48998 | 2238 | 59220 | 1525 | 40920 |
| 10L-2S | | MI | 17446 | 6595 | 28743 | 4690 | 31240 | 3785 | 32234 | 3075 | 33327 | 2001 | 39479 | 1756 | 22978 |
| 20-#14 | 3.61 | MA | 31452 | 7072 | 51878 | 5224 | 57437 | 4193 | 60067 | 3413 | 63252 | 2190 | 78168 | 1443 | 60264 |
| 7L-5S | | MI | 17143 | 7072 | 29205 | 4957 | 31678 | 3980 | 32743 | 3177 | 34017 | 1916 | 40779 | 1270 | 31422 |
| 20-#14 | 3.61 | MA | 30691 | 7072 | 50546 | 5221 | 55622 | 4214 | 57920 | 3432 | 60114 | 2180 | 74396 | 1372 | 58795 |
| 8L-4S | | MI | 17568 | 7072 | 29920 | 4968 | 32589 | 3967 | 33830 | 3165 | 35541 | 1928 | 42550 | 1325 | 32100 |
| 20-#14 | 3.61 | MA | 29889 | 7072 | 49243 | 5218 | 53857 | 4209 | 55675 | 3425 | 57190 | 2195 | 70665 | 1295 | 56764 |
| 9L-3S | | MI | 18039 | 7072 | 30740 | 4953 | 33618 | 3980 | 35049 | 3177 | 37055 | 1916 | 44220 | 1441 | 32309 |
| 20-#14 | 3.61 | MA | 29029 | 7072 | 47784 | 5240 | 52067 | 4229 | 53539 | 3444 | 54290 | 2211 | 67048 | 1207 | 54660 |
| 10L-2S | | MI | 18687 | 7072 | 31727 | 4964 | 34869 | 3967 | 36544 | 3165 | 39039 | 1903 | 46789 | 1566 | 32329 |
| 20-#18 | 6.41 | MA | 33689 | 8283 | 59109 | 5967 | 66316 | 4761 | 70930 | 3778 | 77723 | 2084 | 99100 | 672 | 93470 |
| 8L-4S | | MI | 19739 | 8283 | 35885 | 5672 | 39704 | 4421 | 42294 | 3378 | 46838 | 1676 | 57029 | 611 | 52482 |
| 22-#11 | 2.75 | MA | 30681 | 6703 | 49456 | 4997 | 54431 | 4032 | 56444 | 3311 | 58297 | 2214 | 71199 | 1675 | 48088 |
| 7L-6S | | MI | 16368 | 6703 | 27196 | 4748 | 29218 | 3833 | 29866 | 3119 | 30198 | 2003 | 35859 | 1459 | 24682 |
| 22-#11 | 2.75 | MA | 30143 | 6703 | 48528 | 4995 | 53167 | 4047 | 54948 | 3324 | 56111 | 2208 | 68556 | 1625 | 47180 |
| 8L-5S | | MI | 16656 | 6703 | 27667 | 4754 | 29866 | 3842 | 30599 | 3111 | 31174 | 1994 | 37032 | 1517 | 24946 |
| 22-#11 | 2.75 | MA | 29560 | 6703 | 47620 | 4993 | 51938 | 4044 | 53384 | 3320 | 54074 | 2219 | 65935 | 1571 | 46326 |
| 9L-4S | | MI | 16957 | 6703 | 28168 | 4761 | 30511 | 3833 | 31370 | 3102 | 32253 | 2003 | 38292 | 1555 | 25188 |
| 22-#11 | 2.75 | MA | 28963 | 6703 | 46604 | 5009 | 50691 | 4058 | 51896 | 3333 | 52054 | 2230 | 63395 | 1510 | 45224 |
| 10L-3S | | MI | 17290 | 6703 | 28743 | 4751 | 31240 | 3842 | 32234 | 3111 | 33327 | 1994 | 39479 | 1637 | 25183 |
| 22-#11 | 2.75 | MA | 28380 | 6703 | 45695 | 5007 | 49468 | 4055 | 50352 | 3329 | 49899 | 2224 | 60818 | 1457 | 44206 |
| 11L-2S | | MI | 17749 | 6703 | 29437 | 4757 | 32127 | 3833 | 33294 | 3102 | 34733 | 1986 | 41308 | 1723 | 25162 |
| 22-#14 | 3.97 | MA | 31651 | 7228 | 52604 | 5318 | 58259 | 4284 | 61138 | 3474 | 64492 | 2168 | 80345 | 1349 | 65002 |
| 8L-5S | | MI | 17571 | 7228 | 30193 | 5054 | 32930 | 4048 | 34238 | 3215 | 36001 | 1892 | 43348 | 1219 | 34388 |
| 22-#14 | 3.97 | MA | 30850 | 7228 | 51301 | 5315 | 56495 | 4279 | 58892 | 3468 | 61567 | 2183 | 76614 | 1272 | 62918 |
| 9L-4S | | MI | 17995 | 7228 | 30907 | 5065 | 33840 | 4036 | 35325 | 3202 | 37524 | 1904 | 45120 | 1275 | 35023 |
| 22-#14 | 3.97 | MA | 29999 | 7228 | 49841 | 5337 | 54705 | 4299 | 56757 | 3486 | 58668 | 2198 | 72997 | 1184 | 60776 |
| 10L-3S | | MI | 18463 | 7228 | 31727 | 5050 | 34869 | 4048 | 36544 | 3215 | 39039 | 1892 | 46789 | 1390 | 35373 |
| 24-#11 | 3.00 | MA | 30820 | 6811 | 49964 | 5063 | 55008 | 4095 | 57194 | 3353 | 59167 | 2199 | 72731 | 1610 | 51506 |
| 8L-6S | | MI | 16674 | 6811 | 27890 | 4815 | 30105 | 3881 | 30926 | 3146 | 31604 | 1987 | 37689 | 1426 | 26789 |
| 24-#11 | 3.00 | MA | 30241 | 6811 | 49056 | 5061 | 53779 | 4092 | 55629 | 3349 | 57129 | 2210 | 70111 | 1557 | 50673 |
| 9L-5S | | MI | 16961 | 6811 | 28362 | 4822 | 30753 | 3890 | 31659 | 3138 | 32580 | 1979 | 38861 | 1484 | 27038 |
| 24-#11 | 3.00 | MA | 29646 | 6811 | 48040 | 5076 | 52532 | 4107 | 54142 | 3363 | 55109 | 2221 | 67570 | 1496 | 49534 |
| 10L-4S | | MI | 17261 | 6811 | 28862 | 4829 | 31398 | 3881 | 32430 | 3129 | 33659 | 1987 | 40122 | 1522 | 27347 |
| 24-#11 | 3.00 | MA | 29066 | 6811 | 47131 | 5075 | 51309 | 4104 | 52598 | 3359 | 52955 | 2215 | 64993 | 1443 | 48424 |
| 11L-3S | | MI | 17593 | 6811 | 29437 | 4818 | 32127 | 3890 | 33294 | 3138 | 34733 | 1979 | 41308 | 1604 | 27358 |
| 24-#11 | 3.00 | MA | 28497 | 6811 | 46133 | 5090 | 50071 | 4118 | 51112 | 3372 | 50936 | 2226 | 62085 | 1366 | 47094 |
| 12L-2S | | MI | 18051 | 6811 | 30132 | 4825 | 33015 | 3881 | 34354 | 3129 | 36139 | 1970 | 43138 | 1690 | 27343 |
| 24-#14 | 4.33 | MA | 31804 | 7383 | 53358 | 5413 | 59132 | 4349 | 62110 | 3510 | 65945 | 2171 | 82562 | 1249 | 69079 |
| 9L-5S | | MI | 17997 | 7383 | 31180 | 5152 | 34181 | 4116 | 35733 | 3252 | 37984 | 1868 | 45918 | 1168 | 37358 |
| 24-#14 | 4.33 | MA | 30963 | 7383 | 51899 | 5435 | 57342 | 4369 | 59974 | 3529 | 63045 | 2186 | 78946 | 1162 | 66899 |
| 10L-4S | | MI | 18419 | 7383 | 31895 | 5162 | 35091 | 4104 | 36820 | 3240 | 39508 | 1880 | 47689 | 1224 | 37955 |

## RECTANGULAR TIED COLUMNS 28" x 28"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.19 | MA | 10749 | 3789 | 16984 | 2746 | 18072 | 2238 | 18201 | 1862 | 17772 | 1324 | 20541 | 1231 | 7794 |
| 2L-3S | | MI | 10234 | 3789 | 16223 | 2740 | 17096 | 2247 | 17025 | 1870 | 16212 | 1333 | 18500 | 1145 | 7848 |
| 6-#14 | 1.72 | MA | 11174 | 3932 | 17988 | 2821 | 19309 | 2290 | 19635 | 1886 | 19668 | 1293 | 22982 | 1175 | 10950 |
| 2L-3S | | MI | 10447 | 3932 | 16903 | 2812 | 17918 | 2303 | 17973 | 1898 | 17463 | 1306 | 20108 | 1051 | 11014 |
| 6-#18 | 3.06 | MA | 12187 | 4295 | 20437 | 3020 | 22241 | 2420 | 23104 | 1945 | 24262 | 1211 | 28840 | 1021 | 18640 |
| 2L-3S | | MI | 10949 | 4295 | 18557 | 3000 | 19868 | 2442 | 20268 | 1967 | 20499 | 1234 | 23975 | 800 | 18593 |
| 8-#11 | 1.59 | MA | 11092 | 3897 | 17746 | 2813 | 19049 | 2286 | 19377 | 1890 | 19332 | 1310 | 22581 | 1201 | 10221 |
| 2L-4S | | MI | 10211 | 3897 | 16356 | 2819 | 17271 | 2288 | 17243 | 1890 | 16580 | 1327 | 19220 | 1031 | 10297 |
| 8-#14 | 2.30 | MA | 11653 | 4088 | 19073 | 2918 | 20700 | 2360 | 21297 | 1925 | 21873 | 1272 | 25856 | 1129 | 14381 |
| 2L-4S | | MI | 10411 | 4088 | 17090 | 2925 | 18166 | 2360 | 18280 | 1925 | 17984 | 1296 | 21119 | 886 | 14339 |
| 8-#18 | 4.08 | MA | 12990 | 4572 | 22316 | 3193 | 24614 | 2541 | 25940 | 2011 | 28024 | 1168 | 33706 | 929 | 24526 |
| 2L-4S | | MI | 10880 | 4572 | 18874 | 3198 | 20289 | 2541 | 20791 | 2011 | 21388 | 1212 | 25676 | 503 | 22135 |
| 10-#11 | 1.99 | MA | 11432 | 4005 | 18508 | 2881 | 20025 | 2335 | 20553 | 1918 | 20891 | 1296 | 24622 | 1171 | 12631 |
| 2L-5S | | MI | 10226 | 4005 | 16570 | 2880 | 17539 | 2345 | 17565 | 1926 | 16943 | 1305 | 19854 | 963 | 12357 |
| 10-#11 | 1.99 | MA | 10923 | 4005 | 17746 | 2875 | 19049 | 2344 | 19377 | 1926 | 19332 | 1305 | 22581 | 1085 | 12665 |
| 3L-4S | | MI | 10556 | 4005 | 17117 | 2886 | 18248 | 2336 | 18419 | 1918 | 18140 | 1313 | 21261 | 1001 | 12672 |
| 10-#14 | 2.87 | MA | 12128 | 4243 | 20157 | 3016 | 22090 | 2430 | 22960 | 1964 | 24078 | 1250 | 28730 | 1083 | 17793 |
| 2L-5S | | MI | 10430 | 4243 | 17394 | 3013 | 18545 | 2443 | 18734 | 1977 | 18496 | 1262 | 22012 | 784 | 16623 |
| 10-#14 | 2.87 | MA | 11411 | 4243 | 19073 | 3006 | 20700 | 2443 | 21297 | 1977 | 21873 | 1262 | 25856 | 958 | 17794 |
| 3L-4S | | MI | 10895 | 4243 | 18175 | 3022 | 19557 | 2430 | 19943 | 1964 | 20189 | 1275 | 23993 | 840 | 17461 |
| 10-#18 | 5.10 | MA | 12572 | 4848 | 22316 | 3346 | 24614 | 2683 | 25940 | 2099 | 28024 | 1146 | 33706 | 615 | 30111 |
| 3L-4S | | MI | 11696 | 4848 | 20754 | 3371 | 22662 | 2661 | 23628 | 2077 | 25151 | 1168 | 30542 | 411 | 27583 |

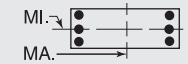
## RECTANGULAR TIED COLUMNS 28" x 30"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.07 | MA | 12225 | 4024 | 19225 | 2925 | 20417 | 2386 | 20514 | 1990 | 19899 | 1427 | 22933 | 1333 | 8094 |
| 2E | | MI | 11383 | 4024 | 17955 | 2904 | 19000 | 2369 | 19019 | 1972 | 18395 | 1412 | 21134 | 1315 | 7522 |
| 4-#18 | 1.90 | MA | 12984 | 4266 | 21038 | 3048 | 22616 | 2470 | 23066 | 2026 | 23272 | 1371 | 27262 | 1234 | 13786 |
| 2E | | MI | 12068 | 4266 | 19614 | 3025 | 20949 | 2446 | 21310 | 2004 | 21425 | 1351 | 24992 | 1206 | 12760 |
| 6-#11 | 1.11 | MA | 12289 | 4036 | 19309 | 2947 | 20580 | 2403 | 20757 | 2005 | 20228 | 1436 | 23394 | 1343 | 8426 |
| 2L-3S | | MI | 10928 | 4036 | 17273 | 2922 | 18178 | 2397 | 18073 | 1997 | 17147 | 1430 | 19530 | 1239 | 7883 |
| 6-#11 | 1.11 | MA | 11727 | 4036 | 18480 | 2942 | 19517 | 2413 | 19465 | 2014 | 18515 | 1444 | 21142 | 1257 | 8480 |
| 3L-2S | | MI | 11443 | 4036 | 18034 | 2928 | 19154 | 2387 | 19249 | 1989 | 18707 | 1421 | 21570 | 1325 | 7828 |
| 6-#14 | 1.61 | MA | 12759 | 4180 | 20407 | 3022 | 21932 | 2456 | 22343 | 2031 | 22325 | 1407 | 26112 | 1291 | 11861 |
| 2L-3S | | MI | 11140 | 4180 | 17955 | 2992 | 19000 | 2451 | 19019 | 2024 | 18395 | 1403 | 21134 | 1144 | 11063 |
| 6-#14 | 1.61 | MA | 11965 | 4180 | 19225 | 3014 | 20417 | 2470 | 20514 | 2043 | 19899 | 1420 | 22933 | 1167 | 11925 |
| 3L-2S | | MI | 11869 | 4180 | 19040 | 3002 | 20390 | 2439 | 20681 | 2012 | 20600 | 1390 | 24008 | 1269 | 10993 |
| 6-#18 | 2.86 | MA | 13883 | 4543 | 23091 | 3221 | 25238 | 2593 | 26199 | 2095 | 27428 | 1331 | 32668 | 1149 | 20260 |
| 2L-3S | | MI | 11643 | 4543 | 19614 | 3179 | 20949 | 2589 | 21310 | 2092 | 21425 | 1329 | 24992 | 893 | 18693 |
| 6-#18 | 2.86 | MA | 12528 | 4543 | 21038 | 3204 | 22616 | 2615 | 23066 | 2117 | 23272 | 1353 | 27262 | 928 | 20213 |
| 3L-2S | | MI | 12884 | 4543 | 21494 | 3198 | 23322 | 2567 | 24147 | 2070 | 25188 | 1307 | 29858 | 1114 | 18705 |
| 8-#11 | 1.49 | MA | 12666 | 4144 | 20139 | 3014 | 21642 | 2452 | 22049 | 2034 | 21942 | 1423 | 25647 | 1316 | 11063 |
| 2L-4S | | MI | 10904 | 4144 | 17406 | 3000 | 18353 | 2437 | 18291 | 2017 | 17516 | 1425 | 20250 | 1125 | 10347 |
| 8-#11 | 1.49 | MA | 12108 | 4144 | 19309 | 3009 | 20580 | 2462 | 20757 | 2043 | 20228 | 1432 | 23394 | 1229 | 11108 |
| 3E | | MI | 11274 | 4144 | 18034 | 2989 | 19154 | 2445 | 19249 | 2025 | 18707 | 1416 | 21570 | 1209 | 10307 |
| 8-#11 | 1.49 | MA | 11708 | 4144 | 18627 | 3021 | 19710 | 2455 | 19705 | 2034 | 18919 | 1440 | 21940 | 1144 | 11139 |
| 4L-2S | | MI | 11786 | 4144 | 18796 | 2995 | 20130 | 2436 | 20425 | 2017 | 20267 | 1407 | 23611 | 1295 | 10259 |
| 8-#14 | 2.14 | MA | 13287 | 4335 | 21589 | 3119 | 23447 | 2526 | 24173 | 2072 | 24752 | 1387 | 29291 | 1249 | 15596 |
| 2L-4S | | MI | 11104 | 4335 | 18143 | 3105 | 19247 | 2509 | 19327 | 2051 | 18916 | 1393 | 22145 | 979 | 14444 |
| 8-#14 | 2.14 | MA | 12499 | 4335 | 20407 | 3111 | 21932 | 2539 | 22343 | 2084 | 22325 | 1400 | 26112 | 1125 | 15634 |
| 3E | | MI | 11626 | 4335 | 19040 | 3090 | 20390 | 2521 | 20681 | 2064 | 20600 | 1381 | 24008 | 1098 | 14476 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis

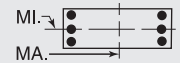



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.14 | MA | 11933 | 4335 | 19432 | 3128 | 20690 | 2528 | 20853 | 2072 | 20472 | 1412 | 24056 | 1003 | 15571 |
| 4L-2S | | MI | 12349 | 4335 | 20125 | 3099 | 21781 | 2509 | 22344 | 2051 | 22805 | 1369 | 26882 | 1223 | 14430 |
| 8-#18 | 3.81 | MA | 14769 | 4819 | 25144 | 3394 | 27860 | 2716 | 29332 | 2164 | 31584 | 1291 | 38073 | 1064 | 26686 |
| 2L-4S | | MI | 11572 | 4819 | 19931 | 3377 | 21369 | 2688 | 21834 | 2136 | 22315 | 1308 | 26694 | 596 | 22458 |
| 8-#18 | 3.81 | MA | 13429 | 4819 | 23091 | 3376 | 25238 | 2738 | 26199 | 2186 | 27428 | 1313 | 32668 | 843 | 26523 |
| 3E | | MI | 12461 | 4819 | 21494 | 3352 | 23322 | 2710 | 24147 | 2158 | 25188 | 1286 | 29858 | 800 | 24479 |
| 8-#18 | 3.81 | MA | 12465 | 4819 | 21391 | 3403 | 23082 | 2716 | 23645 | 2164 | 24254 | 1336 | 29161 | 634 | 24318 |
| 4L-2S | | MI | 13689 | 4819 | 23373 | 3371 | 25694 | 2688 | 26983 | 2136 | 28951 | 1264 | 34723 | 1021 | 24605 |
| 10-#11 | 1.86 | MA | 13040 | 4252 | 20968 | 3082 | 22705 | 2500 | 23342 | 2063 | 23655 | 1410 | 27900 | 1288 | 13684 |
| 2L-5S | | MI | 10919 | 4252 | 17620 | 3062 | 18621 | 2495 | 18613 | 2053 | 17879 | 1402 | 20884 | 1057 | 12516 |
| 10-#11 | 1.86 | MA | 12485 | 4252 | 20139 | 3077 | 21642 | 2510 | 22049 | 2072 | 21942 | 1419 | 25647 | 1202 | 13718 |
| 3L-4S | | MI | 11250 | 4252 | 18167 | 3068 | 19330 | 2486 | 19467 | 2045 | 19075 | 1411 | 22291 | 1095 | 12733 |
| 10-#11 | 1.86 | MA | 12087 | 4252 | 19456 | 3089 | 20773 | 2503 | 20997 | 2063 | 20633 | 1428 | 24192 | 1117 | 13725 |
| 4L-3S | | MI | 11617 | 4252 | 18796 | 3056 | 20130 | 2493 | 20425 | 2053 | 20267 | 1402 | 23611 | 1179 | 12712 |
| 10-#11 | 1.86 | MA | 11729 | 4252 | 18863 | 3083 | 20005 | 2513 | 20058 | 2072 | 19319 | 1419 | 22639 | 1079 | 13475 |
| 5L-2S | | MI | 12127 | 4252 | 19558 | 3062 | 21107 | 2484 | 21602 | 2045 | 21826 | 1393 | 25652 | 1265 | 12674 |
| 10-#14 | 2.68 | MA | 13810 | 4491 | 22771 | 3217 | 24962 | 2595 | 26003 | 2112 | 27178 | 1368 | 32470 | 1207 | 19312 |
| 2L-5S | | MI | 11122 | 4491 | 18446 | 3193 | 19626 | 2591 | 19781 | 2103 | 19428 | 1359 | 23038 | 878 | 16823 |
| 10-#14 | 2.68 | MA | 13027 | 4491 | 21589 | 3208 | 23447 | 2609 | 24173 | 2125 | 24752 | 1380 | 29291 | 1082 | 19313 |
| 3L-4S | | MI | 11589 | 4491 | 19227 | 3203 | 20638 | 2579 | 20989 | 2091 | 21121 | 1372 | 25019 | 933 | 17696 |
| 10-#14 | 2.68 | MA | 12466 | 4491 | 20614 | 3225 | 22205 | 2598 | 22683 | 2112 | 22898 | 1393 | 27235 | 961 | 19141 |
| 4L-3S | | MI | 12107 | 4491 | 20125 | 3187 | 21781 | 2591 | 22344 | 2103 | 22805 | 1359 | 26882 | 1052 | 17864 |
| 10-#14 | 2.68 | MA | 11961 | 4491 | 19766 | 3217 | 21107 | 2612 | 21353 | 2125 | 21036 | 1380 | 25043 | 907 | 18145 |
| 5L-2S | | MI | 12825 | 4491 | 21210 | 3196 | 23171 | 2579 | 24006 | 2091 | 25010 | 1347 | 29756 | 1177 | 17848 |
| 10-#18 | 4.76 | MA | 14319 | 5096 | 25144 | 3549 | 27860 | 2862 | 29332 | 2255 | 31584 | 1274 | 38073 | 758 | 32811 |
| 3L-4S | | MI | 12390 | 5096 | 21811 | 3550 | 23742 | 2808 | 24670 | 2202 | 26078 | 1264 | 31559 | 503 | 27900 |
| 10-#18 | 4.76 | MA | 13366 | 5096 | 23443 | 3576 | 25704 | 2840 | 26778 | 2233 | 28410 | 1296 | 34567 | 549 | 30277 |
| 4L-3S | | MI | 13270 | 5096 | 23373 | 3525 | 25694 | 2830 | 26983 | 2224 | 28951 | 1242 | 34723 | 708 | 30239 |
| 10-#18 | 4.76 | MA | 12509 | 5096 | 21962 | 3559 | 23796 | 2862 | 24501 | 2255 | 25219 | 1274 | 30841 | 451 | 28289 |
| 5L-2S | | MI | 14486 | 5096 | 25253 | 3544 | 28067 | 2808 | 29819 | 2202 | 32714 | 1220 | 39588 | 929 | 30452 |
| 12-#11 | 2.23 | MA | 13412 | 4360 | 21797 | 3149 | 23768 | 2549 | 24634 | 2092 | 25369 | 1398 | 30153 | 1261 | 16295 |
| 2L-6S | | MI | 10950 | 4360 | 17868 | 3124 | 18887 | 2535 | 18975 | 2090 | 18356 | 1397 | 21615 | 970 | 14423 |
| 12-#11 | 2.23 | MA | 12859 | 4360 | 20968 | 3144 | 22705 | 2559 | 23342 | 2101 | 23655 | 1406 | 27900 | 1175 | 16317 |
| 3L-5S | | MI | 11264 | 4360 | 18382 | 3129 | 19598 | 2543 | 19789 | 2081 | 19438 | 1388 | 22925 | 1028 | 14768 |
| 12-#11 | 2.23 | MA | 12464 | 4360 | 20285 | 3156 | 21836 | 2552 | 22290 | 2092 | 22346 | 1415 | 26445 | 1089 | 16299 |
| 4E | | MI | 11593 | 4360 | 18929 | 3135 | 20306 | 2534 | 20644 | 2073 | 20635 | 1397 | 24331 | 1065 | 15102 |
| 12-#11 | 2.23 | MA | 12108 | 4360 | 19692 | 3151 | 21067 | 2562 | 21350 | 2101 | 21032 | 1406 | 24892 | 1052 | 15929 |
| 5L-3S | | MI | 11958 | 4360 | 19558 | 3124 | 21107 | 2542 | 21602 | 2081 | 21826 | 1388 | 25652 | 1149 | 15105 |
| 12-#11 | 2.23 | MA | 11769 | 4360 | 19135 | 3146 | 20297 | 2555 | 20456 | 2110 | 19843 | 1415 | 23444 | 995 | 15530 |
| 6L-2S | | MI | 12466 | 4360 | 20319 | 3130 | 22083 | 2533 | 22778 | 2073 | 23386 | 1379 | 27693 | 1236 | 15078 |
| 12-#14 | 3.21 | MA | 14329 | 4646 | 23953 | 3314 | 26478 | 2665 | 27833 | 2153 | 29605 | 1348 | 35649 | 1165 | 23017 |
| 2L-6S | | MI | 11164 | 4646 | 18796 | 3281 | 20002 | 2649 | 20293 | 2155 | 20104 | 1350 | 24069 | 749 | 19281 |
| 12-#14 | 3.21 | MA | 13551 | 4646 | 22771 | 3306 | 24962 | 2679 | 26003 | 2166 | 27178 | 1360 | 32470 | 1040 | 22978 |
| 3L-5S | | MI | 11606 | 4646 | 19531 | 3291 | 21017 | 2661 | 21443 | 2142 | 21633 | 1338 | 25912 | 832 | 20037 |
| 12-#14 | 3.21 | MA | 12994 | 4646 | 21796 | 3322 | 23720 | 2668 | 24513 | 2153 | 25325 | 1373 | 30414 | 919 | 22574 |
| 4E | | MI | 12069 | 4646 | 20312 | 3300 | 22028 | 2649 | 22651 | 2130 | 23326 | 1350 | 27893 | 887 | 20841 |
| 12-#14 | 3.21 | MA | 12493 | 4646 | 20948 | 3314 | 22622 | 2682 | 23183 | 2166 | 23463 | 1360 | 28222 | 864 | 21652 |
| 5L-3S | | MI | 12584 | 4646 | 21210 | 3284 | 23171 | 2661 | 24006 | 2142 | 25010 | 1338 | 29756 | 1006 | 21232 |
| 12-#14 | 3.21 | MA | 12016 | 4646 | 20151 | 3306 | 21521 | 2671 | 21917 | 2178 | 21780 | 1373 | 26181 | 782 | 20823 |
| 6L-2S | | MI | 13298 | 4646 | 22294 | 3294 | 24562 | 2648 | 25668 | 2130 | 27215 | 1325 | 32630 | 1131 | 21251 |
| 12-#18 | 5.71 | MA | 14256 | 5373 | 25496 | 3749 | 28326 | 2963 | 29912 | 2302 | 32566 | 1256 | 39973 | 464 | 36277 |
| 4E | | MI | 13199 | 5373 | 23691 | 3722 | 26115 | 2929 | 27506 | 2268 | 29841 | 1220 | 36425 | 411 | 33382 |
| 12-#18 | 5.71 | MA | 13408 | 5373 | 24015 | 3732 | 26418 | 2985 | 27634 | 2324 | 29375 | 1234 | 36247 | 366 | 34100 |
| 5L-3S | | MI | 14070 | 5373 | 25253 | 3698 | 28067 | 2951 | 29819 | 2290 | 32714 | 1198 | 39588 | 615 | 35957 |
| 14-#11 | 2.60 | MA | 13781 | 4468 | 22626 | 3217 | 24831 | 2597 | 25927 | 2121 | 27083 | 1385 | 32406 | 1234 | 18898 |
| 2L-7S | | MI | 10990 | 4468 | 18067 | 3202 | 19185 | 2593 | 19294 | 2110 | 18859 | 1391 | 22420 | 876 | 16230 |
| 14-#11 | 2.60 | MA | 13231 | 4468 | 21797 | 3211 | 23768 | 2607 | 24634 | 2130 | 25369 | 1393 | 30153 | 1147 | 18904 |
| 3L-6S | | MI | 11294 | 4468 | 18629 | 3191 | 19864 | 2584 | 20151 | 2118 | 19916 | 1383 | 23655 | 940 | 16709 |

## RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

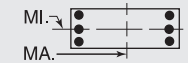
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.60 | MA | 12838 | 4468 | 21114 | 3224 | 22899 | 2600 | 23582 | 2121 | 24060 | 1402 | 28698 | 1062 | 18865 |
| 4L-5S | | MI | 11607 | 4468 | 19144 | 3197 | 20574 | 2592 | 20965 | 2110 | 20998 | 1374 | 24965 | 998 | 17031 |
| 14-#11 | 2.60 | MA | 12484 | 4468 | 20521 | 3218 | 22130 | 2610 | 22643 | 2130 | 22746 | 1393 | 27145 | 1024 | 18393 |
| 5L-4S | | MI | 11934 | 4468 | 19690 | 3203 | 21282 | 2582 | 21820 | 2101 | 22195 | 1383 | 26372 | 1036 | 17463 |
| 14-#11 | 2.60 | MA | 12147 | 4468 | 19964 | 3213 | 21360 | 2603 | 21749 | 2139 | 21557 | 1402 | 25697 | 967 | 18020 |
| 6L-3S | | MI | 12297 | 4468 | 20319 | 3191 | 22083 | 2590 | 22778 | 2110 | 23386 | 1374 | 27693 | 1119 | 17490 |
| 14-#11 | 2.60 | MA | 11818 | 4468 | 19354 | 3225 | 20625 | 2613 | 20806 | 2130 | 20395 | 1411 | 24337 | 901 | 17491 |
| 7L-2S | | MI | 12802 | 4468 | 21081 | 3197 | 23060 | 2581 | 23954 | 2101 | 24946 | 1365 | 29734 | 1206 | 17473 |
| 14-#14 | 3.75 | MA | 14071 | 4802 | 23953 | 3403 | 26478 | 2749 | 27833 | 2207 | 29605 | 1341 | 35649 | 998 | 26633 |
| 3L-6S | | MI | 11647 | 4802 | 19881 | 3379 | 21392 | 2719 | 21956 | 2194 | 22309 | 1328 | 26943 | 703 | 22409 |
| 14-#14 | 3.75 | MA | 13518 | 4802 | 22978 | 3420 | 25236 | 2738 | 26343 | 2194 | 27751 | 1353 | 33593 | 877 | 26030 |
| 4L-5S | | MI | 12086 | 4802 | 20616 | 3388 | 22407 | 2731 | 23105 | 2182 | 23838 | 1316 | 28786 | 786 | 23264 |
| 14-#14 | 3.75 | MA | 13021 | 4802 | 22130 | 3411 | 24137 | 2752 | 25013 | 2207 | 25889 | 1341 | 31402 | 822 | 25172 |
| 5L-4S | | MI | 12546 | 4802 | 21397 | 3397 | 23419 | 2718 | 24314 | 2169 | 25531 | 1328 | 30767 | 841 | 24008 |
| 14-#14 | 3.75 | MA | 12547 | 4802 | 21333 | 3403 | 23036 | 2740 | 23747 | 2219 | 24206 | 1353 | 29360 | 740 | 24243 |
| 6L-3S | | MI | 13057 | 4802 | 22294 | 3381 | 24562 | 2731 | 25668 | 2182 | 27215 | 1316 | 32630 | 960 | 24589 |
| 14-#18 | 6.67 | MA | 14298 | 5649 | 26068 | 3905 | 29039 | 3108 | 30767 | 2393 | 33531 | 1194 | 41652 | 281 | 39951 |
| 5L-4S | | MI | 14000 | 5649 | 25570 | 3895 | 28488 | 3050 | 30342 | 2334 | 33603 | 1176 | 41290 | 319 | 38896 |
| 16-#11 | 2.97 | MA | 13600 | 4576 | 22626 | 3279 | 24831 | 2656 | 25927 | 2159 | 27083 | 1381 | 32406 | 1120 | 21482 |
| 3L-7S | | MI | 11334 | 4576 | 18828 | 3270 | 20161 | 2641 | 20470 | 2138 | 20418 | 1377 | 24461 | 846 | 18462 |
| 16-#11 | 2.97 | MA | 13209 | 4576 | 21943 | 3291 | 23961 | 2648 | 24874 | 2150 | 25773 | 1389 | 30951 | 1034 | 21425 |
| 4L-6S | | MI | 11636 | 4576 | 19391 | 3258 | 20840 | 2632 | 21327 | 2146 | 21476 | 1369 | 25696 | 910 | 19001 |
| 16-#11 | 2.97 | MA | 12858 | 4576 | 21350 | 3286 | 23193 | 2659 | 23935 | 2159 | 24459 | 1381 | 29398 | 997 | 20867 |
| 5E | | MI | 11947 | 4576 | 19905 | 3264 | 21550 | 2640 | 22141 | 2138 | 22558 | 1360 | 27006 | 968 | 19303 |
| 16-#11 | 2.97 | MA | 12522 | 4576 | 20793 | 3281 | 22423 | 2652 | 23041 | 2168 | 23270 | 1389 | 27950 | 940 | 20515 |
| 6L-4S | | MI | 12272 | 4576 | 20452 | 3270 | 22259 | 2631 | 22996 | 2129 | 23754 | 1369 | 28413 | 1006 | 19818 |
| 16-#11 | 2.97 | MA | 12195 | 4576 | 20183 | 3293 | 21687 | 2662 | 22099 | 2159 | 22109 | 1398 | 26590 | 874 | 19925 |
| 7L-3S | | MI | 12634 | 4576 | 21081 | 3259 | 23060 | 2639 | 23954 | 2138 | 24946 | 1360 | 29734 | 1089 | 19861 |
| 16-#14 | 4.29 | MA | 14037 | 4958 | 24160 | 3517 | 26751 | 2808 | 28172 | 2235 | 30178 | 1333 | 36772 | 834 | 29504 |
| 4L-6S | | MI | 12127 | 4958 | 20965 | 3476 | 22783 | 2788 | 23618 | 2233 | 24513 | 1307 | 29817 | 657 | 25552 |
| 16-#14 | 4.29 | MA | 13544 | 4958 | 23312 | 3509 | 25653 | 2821 | 26842 | 2247 | 28316 | 1321 | 34581 | 780 | 28702 |
| 5E | | MI | 12562 | 4958 | 21700 | 3485 | 23798 | 2801 | 24768 | 2221 | 26043 | 1294 | 31660 | 740 | 26500 |
| 16-#14 | 4.29 | MA | 13073 | 4958 | 22515 | 3500 | 24551 | 2810 | 25577 | 2260 | 26633 | 1333 | 32539 | 698 | 27679 |
| 6L-4S | | MI | 13020 | 4958 | 22482 | 3494 | 24810 | 2788 | 25976 | 2209 | 27736 | 1307 | 33641 | 795 | 27192 |
| 18-#11 | 3.34 | MA | 13578 | 4684 | 22772 | 3358 | 25024 | 2697 | 26167 | 2180 | 27487 | 1377 | 33204 | 1007 | 23981 |
| 4L-7S | | MI | 11675 | 4684 | 19590 | 3337 | 21138 | 2690 | 21646 | 2166 | 21978 | 1363 | 26502 | 816 | 20701 |
| 18-#11 | 3.34 | MA | 13229 | 4684 | 22179 | 3353 | 24256 | 2707 | 25227 | 2188 | 26173 | 1368 | 31651 | 970 | 23348 |
| 5L-6S | | MI | 11976 | 4684 | 20153 | 3326 | 21816 | 2681 | 22503 | 2174 | 23035 | 1355 | 27737 | 881 | 21296 |
| 18-#11 | 3.34 | MA | 12895 | 4684 | 21622 | 3348 | 23486 | 2700 | 24333 | 2197 | 24984 | 1377 | 30202 | 913 | 23015 |
| 6L-5S | | MI | 12285 | 4684 | 20667 | 3332 | 22527 | 2689 | 23317 | 2166 | 24117 | 1346 | 29047 | 938 | 21581 |
| 18-#11 | 3.34 | MA | 12570 | 4684 | 21012 | 3360 | 22750 | 2710 | 23391 | 2188 | 23822 | 1385 | 28843 | 847 | 22368 |
| 7L-4S | | MI | 12609 | 4684 | 21214 | 3338 | 23235 | 2679 | 24172 | 2157 | 25314 | 1355 | 30454 | 976 | 22169 |
| 18-#14 | 4.82 | MA | 14063 | 5113 | 24494 | 3606 | 27168 | 2891 | 28672 | 2288 | 30743 | 1301 | 37760 | 738 | 32240 |
| 5L-6S | | MI | 12602 | 5113 | 22050 | 3573 | 24173 | 2858 | 25280 | 2273 | 26718 | 1285 | 32691 | 611 | 28710 |
| 18-#14 | 4.82 | MA | 13596 | 5113 | 23697 | 3598 | 26067 | 2880 | 27407 | 2301 | 29059 | 1314 | 35718 | 655 | 31129 |
| 6L-5S | | MI | 13036 | 5113 | 22785 | 3582 | 25188 | 2871 | 26430 | 2260 | 28248 | 1273 | 34534 | 694 | 29744 |
| 20-#11 | 3.71 | MA | 13598 | 4792 | 23008 | 3421 | 25319 | 2755 | 26520 | 2217 | 27886 | 1355 | 33903 | 942 | 25834 |
| 5L-7S | | MI | 12015 | 4792 | 20352 | 3405 | 22114 | 2738 | 22822 | 2194 | 23538 | 1349 | 28543 | 786 | 22947 |
| 20-#11 | 3.71 | MA | 13266 | 4792 | 22451 | 3415 | 24549 | 2748 | 25626 | 2226 | 26697 | 1364 | 32455 | 885 | 25517 |
| 6E | | MI | 12314 | 4792 | 20914 | 3393 | 22793 | 2729 | 23680 | 2202 | 24595 | 1341 | 29778 | 851 | 23574 |
| 20-#11 | 3.71 | MA | 12943 | 4792 | 21841 | 3427 | 23813 | 2759 | 24684 | 2217 | 25536 | 1373 | 31096 | 819 | 24818 |
| 7L-5S | | MI | 12622 | 4792 | 21428 | 3399 | 23503 | 2737 | 24493 | 2194 | 25677 | 1332 | 31088 | 908 | 23864 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

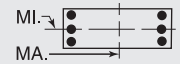
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 5.36 | MA | 14114 | 5269 | 24879 | 3695 | 27582 | 2950 | 29236 | 2342 | 31486 | 1294 | 38898 | 613 | 34592 |
| 6E | | MI | 13075 | 5269 | 23135 | 3670 | 25564 | 2928 | 26943 | 2312 | 28923 | 1263 | 35565 | 565 | 31879 |
| 22-#11 | 4.09 | MA | 13634 | 4900 | 23280 | 3483 | 25612 | 2797 | 26918 | 2255 | 28411 | 1351 | 34708 | 858 | 27959 |
| 6L-7S | | MI | 12352 | 4900 | 21113 | 3472 | 23090 | 2787 | 23998 | 2222 | 25097 | 1335 | 30584 | 756 | 25199 |
| 22-#11 | 4.09 | MA | 13313 | 4900 | 22670 | 3495 | 24876 | 2807 | 25976 | 2246 | 27249 | 1360 | 33349 | 792 | 27274 |
| 7L-6S | | MI | 12650 | 4900 | 21676 | 3461 | 23769 | 2777 | 24856 | 2230 | 26154 | 1327 | 31819 | 821 | 25798 |
| 24-#11 | 4.46 | MA | 13681 | 5007 | 23500 | 3562 | 25939 | 2855 | 27268 | 2275 | 28963 | 1347 | 35602 | 765 | 29735 |
| 7E | | MI | 12688 | 5007 | 21875 | 3539 | 24067 | 2835 | 25174 | 2250 | 26657 | 1321 | 32624 | 726 | 27457 |

## RECTANGULAR TIED COLUMNS 28" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#14 | 1.00 | MA | 13861 | 4272 | 21687 | 3126 | 23068 | 2551 | 23209 | 2133 | 22476 | 1538 | 25916 | 1445 | 8701 |
| 2E | | MI | 12077 | 4272 | 19008 | 3085 | 20081 | 2518 | 20065 | 2099 | 19328 | 1509 | 22159 | 1409 | 7557 |
| 4-#18 | 1.79 | MA | 14695 | 4514 | 23661 | 3249 | 25483 | 2637 | 26018 | 2172 | 26188 | 1486 | 30710 | 1352 | 14866 |
| 2E | | MI | 12763 | 4514 | 20671 | 3204 | 22029 | 2593 | 22353 | 2129 | 22352 | 1447 | 26010 | 1299 | 12813 |
| 6-#11 | 1.04 | MA | 13929 | 4284 | 21775 | 3148 | 23241 | 2569 | 23446 | 2147 | 22826 | 1547 | 26408 | 1454 | 9057 |
| 2L-3S | | MI | 11621 | 4284 | 18323 | 3103 | 19259 | 2546 | 19121 | 2124 | 18083 | 1528 | 20559 | 1333 | 7916 |
| 6-#11 | 1.04 | MA | 13320 | 4284 | 20879 | 3143 | 22091 | 2580 | 22044 | 2156 | 20958 | 1556 | 23942 | 1368 | 9112 |
| 3L-2S | | MI | 12137 | 4284 | 19084 | 3109 | 20236 | 2537 | 20297 | 2116 | 19642 | 1519 | 22600 | 1420 | 7861 |
| 6-#14 | 1.51 | MA | 14444 | 4427 | 22966 | 3223 | 24708 | 2621 | 25206 | 2175 | 25124 | 1520 | 29402 | 1406 | 12772 |
| 2L-3S | | MI | 11834 | 4427 | 19008 | 3173 | 20081 | 2600 | 20065 | 2150 | 19328 | 1500 | 22159 | 1238 | 11110 |
| 6-#14 | 1.51 | MA | 13582 | 4427 | 21687 | 3216 | 23068 | 2636 | 23209 | 2188 | 22476 | 1533 | 25916 | 1281 | 12836 |
| 3L-2S | | MI | 12563 | 4427 | 20093 | 3182 | 21472 | 2588 | 21727 | 2138 | 21533 | 1487 | 25033 | 1363 | 11035 |
| 6-#18 | 2.68 | MA | 15679 | 4790 | 25886 | 3422 | 28336 | 2761 | 29449 | 2243 | 30738 | 1449 | 36658 | 1274 | 21880 |
| 2L-3S | | MI | 12337 | 4790 | 20671 | 3358 | 22029 | 2736 | 22353 | 2217 | 22352 | 1425 | 26010 | 985 | 18787 |
| 6-#18 | 2.68 | MA | 14207 | 4790 | 23661 | 3406 | 25483 | 2784 | 26018 | 2265 | 26188 | 1472 | 30710 | 1052 | 21833 |
| 3L-2S | | MI | 13581 | 4790 | 22551 | 3377 | 24402 | 2714 | 25189 | 2195 | 26115 | 1403 | 30875 | 1207 | 18768 |
| 8-#11 | 1.39 | MA | 14341 | 4392 | 22672 | 3215 | 24390 | 2617 | 24848 | 2176 | 24694 | 1536 | 28873 | 1429 | 11905 |
| 2L-4S | | MI | 11598 | 4392 | 18455 | 3182 | 19435 | 2587 | 19339 | 2144 | 18451 | 1522 | 21280 | 1220 | 10394 |
| 8-#11 | 1.39 | MA | 13735 | 4392 | 21775 | 3211 | 23241 | 2628 | 23446 | 2185 | 22826 | 1544 | 26408 | 1343 | 11950 |
| 3E | | MI | 11967 | 4392 | 19084 | 3171 | 20236 | 2594 | 20297 | 2152 | 19642 | 1514 | 22600 | 1303 | 10346 |
| 8-#11 | 1.39 | MA | 13303 | 4392 | 21039 | 3224 | 22303 | 2622 | 22307 | 2177 | 21399 | 1553 | 24816 | 1256 | 11982 |
| 4L-2S | | MI | 12481 | 4392 | 19846 | 3177 | 21212 | 2585 | 21474 | 2144 | 21202 | 1505 | 24641 | 1390 | 10297 |
| 8-#14 | 2.01 | MA | 15021 | 4583 | 24246 | 3321 | 26348 | 2691 | 27204 | 2217 | 27773 | 1502 | 32887 | 1367 | 16811 |
| 2L-4S | | MI | 11797 | 4583 | 19195 | 3286 | 20328 | 2658 | 20373 | 2177 | 19849 | 1490 | 23171 | 1073 | 14524 |
| 8-#14 | 2.01 | MA | 14166 | 4583 | 22966 | 3313 | 24708 | 2706 | 25206 | 2230 | 25124 | 1515 | 29402 | 1242 | 16849 |
| 3E | | MI | 12320 | 4583 | 20093 | 3270 | 21472 | 2670 | 21727 | 2190 | 21533 | 1478 | 25033 | 1192 | 14531 |
| 8-#14 | 2.01 | MA | 13555 | 4583 | 21914 | 3331 | 23367 | 2696 | 23580 | 2217 | 23101 | 1527 | 27152 | 1119 | 16786 |
| 4L-2S | | MI | 13045 | 4583 | 21177 | 3280 | 22862 | 2657 | 23390 | 2177 | 23737 | 1466 | 27907 | 1317 | 14478 |
| 8-#18 | 3.57 | MA | 16650 | 5067 | 28112 | 3595 | 31189 | 2885 | 32880 | 2315 | 35287 | 1413 | 42606 | 1196 | 28846 |
| 2L-4S | | MI | 12265 | 5067 | 20988 | 3555 | 22449 | 2835 | 22876 | 2261 | 23242 | 1404 | 27711 | 689 | 22770 |
| 8-#18 | 3.57 | MA | 15194 | 5067 | 25886 | 3579 | 28336 | 2909 | 29449 | 2337 | 30738 | 1435 | 36658 | 974 | 28683 |
| 3E | | MI | 13157 | 5067 | 22551 | 3530 | 24402 | 2857 | 25189 | 2283 | 26115 | 1382 | 30875 | 893 | 24587 |
| 8-#18 | 3.57 | MA | 14151 | 5067 | 24048 | 3608 | 25995 | 2888 | 26654 | 2315 | 27263 | 1457 | 32808 | 761 | 26534 |
| 4L-2S | | MI | 14388 | 5067 | 24430 | 3550 | 26775 | 2835 | 28025 | 2261 | 29878 | 1359 | 35740 | 1114 | 24674 |
| 10-#11 | 1.74 | MA | 14749 | 4500 | 23568 | 3283 | 25539 | 2666 | 26251 | 2206 | 26561 | 1524 | 31338 | 1404 | 14737 |
| 2L-5S | | MI | 11612 | 4500 | 18670 | 3244 | 19703 | 2644 | 19661 | 2180 | 18814 | 1500 | 21914 | 1152 | 12669 |
| 10-#11 | 1.74 | MA | 14147 | 4500 | 22672 | 3278 | 24390 | 2676 | 24848 | 2215 | 24694 | 1533 | 28873 | 1317 | 14771 |
| 3L-4S | | MI | 11944 | 4500 | 19217 | 3250 | 20411 | 2635 | 20516 | 2172 | 20011 | 1508 | 23320 | 1190 | 12786 |
| 10-#11 | 1.74 | MA | 13717 | 4500 | 21936 | 3291 | 23452 | 2670 | 23709 | 2207 | 23267 | 1541 | 27281 | 1231 | 14778 |
| 4L-3S | | MI | 12311 | 4500 | 19846 | 3238 | 21212 | 2643 | 21474 | 2180 | 21202 | 1500 | 24641 | 1273 | 12757 |
| 10-#11 | 1.74 | MA | 13332 | 4500 | 21297 | 3286 | 22624 | 2681 | 22692 | 2216 | 21835 | 1533 | 25584 | 1193 | 14606 |
| 5L-2S | | MI | 12822 | 4500 | 20608 | 3244 | 22188 | 2634 | 22650 | 2172 | 22762 | 1491 | 26682 | 1360 | 12716 |
| 10-#14 | 2.51 | MA | 15593 | 4738 | 25525 | 3418 | 27988 | 2761 | 29201 | 2259 | 30422 | 1484 | 36372 | 1328 | 20831 |
| 2L-5S | | MI | 11815 | 4738 | 19498 | 3374 | 20707 | 2740 | 20827 | 2229 | 20361 | 1456 | 24064 | 972 | 17015 |

## RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

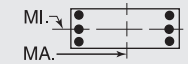
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.51 | MA | 14743 | 4738 | 24246 | 3411 | 26348 | 2776 | 27204 | 2272 | 27773 | 1497 | 32887 | 1204 | 20832 |
| 3L-4S | | MI | 12283 | 4738 | 20280 | 3383 | 21719 | 2727 | 22035 | 2217 | 22053 | 1469 | 26045 | 1027 | 17874 |
| 10-#14 | 2.51 | MA | 14137 | 4738 | 23193 | 3428 | 25007 | 2766 | 25577 | 2259 | 25749 | 1509 | 30637 | 1080 | 20725 |
| 4L-3S | | MI | 12802 | 4738 | 21177 | 3368 | 22862 | 2740 | 23390 | 2229 | 23737 | 1456 | 27907 | 1146 | 17930 |
| 10-#14 | 2.51 | MA | 13593 | 4738 | 22279 | 3421 | 23823 | 2781 | 24126 | 2272 | 23718 | 1497 | 28234 | 1026 | 19682 |
| 5L-2S | | MI | 13522 | 4738 | 22262 | 3377 | 24253 | 2727 | 25052 | 2217 | 25942 | 1444 | 30781 | 1271 | 17900 |
| 10-#18 | 4.46 | MA | 16168 | 5344 | 28112 | 3752 | 31189 | 3033 | 32880 | 2408 | 35287 | 1399 | 42606 | 897 | 35511 |
| 3L-4S | | MI | 13084 | 5344 | 22868 | 3728 | 24822 | 2955 | 25713 | 2327 | 27004 | 1360 | 32576 | 596 | 28206 |
| 10-#18 | 4.46 | MA | 15137 | 5344 | 26273 | 3781 | 28848 | 3012 | 30085 | 2386 | 31812 | 1421 | 38756 | 683 | 33004 |
| 4L-3S | | MI | 13967 | 5344 | 24430 | 3703 | 26775 | 2977 | 28025 | 2349 | 29878 | 1338 | 35740 | 800 | 30360 |
| 10-#18 | 4.46 | MA | 14211 | 5344 | 24674 | 3766 | 26777 | 3035 | 27591 | 2408 | 28321 | 1399 | 34656 | 585 | 31066 |
| 5L-2S | | MI | 15187 | 5344 | 26310 | 3723 | 29147 | 2955 | 30861 | 2327 | 33640 | 1316 | 40606 | 1022 | 30536 |
| 12-#11 | 2.09 | MA | 15155 | 4608 | 24465 | 3350 | 26689 | 2714 | 27653 | 2235 | 28429 | 1512 | 33804 | 1379 | 17559 |
| 2L-6S | | MI | 11643 | 4608 | 18918 | 3305 | 19969 | 2685 | 20023 | 2217 | 19291 | 1494 | 22644 | 1065 | 14563 |
| 12-#11 | 2.09 | MA | 14555 | 4608 | 23568 | 3346 | 25539 | 2725 | 26251 | 2244 | 26561 | 1521 | 31338 | 1292 | 17581 |
| 3L-5S | | MI | 11957 | 4608 | 19432 | 3311 | 20679 | 2693 | 20837 | 2208 | 20373 | 1486 | 23954 | 1122 | 14920 |
| 12-#11 | 2.09 | MA | 14128 | 4608 | 22832 | 3358 | 24601 | 2719 | 25111 | 2236 | 25134 | 1530 | 29747 | 1206 | 17562 |
| 4E | | MI | 12287 | 4608 | 19979 | 3317 | 21388 | 2683 | 21692 | 2200 | 21570 | 1494 | 25361 | 1160 | 15165 |
| 12-#11 | 2.09 | MA | 13745 | 4608 | 22193 | 3354 | 23773 | 2729 | 24094 | 2245 | 23703 | 1521 | 28049 | 1168 | 17260 |
| 5L-3S | | MI | 12653 | 4608 | 20608 | 3306 | 22188 | 2691 | 22650 | 2208 | 22762 | 1486 | 26682 | 1243 | 15154 |
| 12-#11 | 2.09 | MA | 13380 | 4608 | 21593 | 3349 | 22943 | 2723 | 23126 | 2254 | 22407 | 1530 | 26462 | 1111 | 16793 |
| 6L-2S | | MI | 13162 | 4608 | 21369 | 3311 | 23165 | 2682 | 23826 | 2200 | 24321 | 1477 | 28723 | 1330 | 15123 |
| 12-#14 | 3.01 | MA | 16160 | 4894 | 26804 | 3515 | 29628 | 2831 | 31199 | 2302 | 33070 | 1466 | 39857 | 1289 | 24839 |
| 2L-6S | | MI | 11856 | 4894 | 19848 | 3462 | 21083 | 2797 | 21339 | 2281 | 21036 | 1447 | 25095 | 843 | 19594 |
| 12-#14 | 3.01 | MA | 15316 | 4894 | 25525 | 3508 | 27988 | 2846 | 29201 | 2314 | 30422 | 1479 | 36372 | 1165 | 24800 |
| 3L-5S | | MI | 12299 | 4894 | 20583 | 3471 | 22098 | 2810 | 22489 | 2269 | 22566 | 1435 | 26938 | 926 | 20228 |
| 12-#14 | 3.01 | MA | 14714 | 4894 | 24472 | 3525 | 26647 | 2836 | 27575 | 2302 | 28398 | 1491 | 34122 | 1041 | 24565 |
| 4E | | MI | 12764 | 4894 | 21365 | 3480 | 23110 | 2797 | 23698 | 2256 | 24258 | 1447 | 28919 | 981 | 21066 |
| 12-#14 | 3.01 | MA | 14174 | 4894 | 23558 | 3518 | 25463 | 2851 | 26123 | 2314 | 26367 | 1479 | 31719 | 987 | 23481 |
| 5L-3S | | MI | 13280 | 4894 | 22262 | 3465 | 24253 | 2810 | 25052 | 2269 | 25942 | 1435 | 30781 | 1100 | 21305 |
| 12-#14 | 3.01 | MA | 13659 | 4894 | 22699 | 3511 | 24275 | 2841 | 24741 | 2327 | 24529 | 1491 | 29478 | 905 | 22720 |
| 6L-2S | | MI | 13996 | 4894 | 23347 | 3474 | 25643 | 2797 | 26715 | 2256 | 28147 | 1422 | 33655 | 1224 | 21308 |
| 12-#18 | 5.36 | MA | 16111 | 5620 | 28499 | 3954 | 31701 | 3136 | 33515 | 2458 | 36362 | 1384 | 44704 | 605 | 39517 |
| 4E | | MI | 13894 | 5620 | 24748 | 3901 | 27195 | 3076 | 28549 | 2393 | 30767 | 1316 | 37442 | 504 | 33684 |
| 12-#18 | 5.36 | MA | 15195 | 5620 | 26900 | 3939 | 29629 | 3160 | 31022 | 2480 | 32870 | 1362 | 40604 | 507 | 37387 |
| 5L-3S | | MI | 14769 | 5620 | 26310 | 3876 | 29147 | 3098 | 30861 | 2415 | 33640 | 1294 | 40606 | 708 | 36115 |
| 14-#11 | 2.44 | MA | 15558 | 4716 | 25361 | 3418 | 27838 | 2762 | 29055 | 2264 | 30297 | 1501 | 36269 | 1353 | 20372 |
| 2L-7S | | MI | 11682 | 4716 | 19117 | 3384 | 20266 | 2743 | 20342 | 2236 | 19794 | 1489 | 23450 | 970 | 16457 |
| 14-#11 | 2.44 | MA | 14961 | 4716 | 24465 | 3413 | 26689 | 2773 | 27653 | 2273 | 28429 | 1509 | 33804 | 1267 | 20379 |
| 3L-6S | | MI | 11987 | 4716 | 19679 | 3373 | 20945 | 2733 | 21199 | 2245 | 20851 | 1480 | 24685 | 1035 | 16850 |
| 14-#11 | 2.44 | MA | 14537 | 4716 | 23729 | 3426 | 25750 | 2767 | 26513 | 2265 | 27002 | 1518 | 32212 | 1181 | 20339 |
| 4L-5S | | MI | 12300 | 4716 | 20193 | 3379 | 21656 | 2741 | 22013 | 2236 | 21933 | 1472 | 25995 | 1092 | 17182 |
| 14-#11 | 2.44 | MA | 14155 | 4716 | 23090 | 3421 | 24922 | 2778 | 25496 | 2274 | 25570 | 1509 | 30514 | 1143 | 19926 |
| 5L-4S | | MI | 12629 | 4716 | 20740 | 3384 | 22364 | 2732 | 22868 | 2228 | 23130 | 1480 | 27402 | 1130 | 17532 |
| 14-#11 | 2.44 | MA | 13792 | 4716 | 22490 | 3417 | 24093 | 2771 | 24528 | 2284 | 24274 | 1518 | 28928 | 1086 | 19488 |
| 6L-3S | | MI | 12993 | 4716 | 21369 | 3373 | 23165 | 2740 | 23826 | 2236 | 24321 | 1472 | 28723 | 1214 | 17543 |
| 14-#11 | 2.44 | MA | 13438 | 4716 | 21833 | 3429 | 23300 | 2782 | 23508 | 2275 | 23008 | 1527 | 27230 | 996 | 19006 |
| 7L-2S | | MI | 13499 | 4716 | 22131 | 3379 | 24141 | 2730 | 25002 | 2228 | 25881 | 1463 | 30763 | 1300 | 17521 |
| 14-#14 | 3.52 | MA | 15884 | 5050 | 26804 | 3605 | 29628 | 2915 | 31199 | 2356 | 33070 | 1461 | 39857 | 1126 | 28759 |
| 3L-6S | | MI | 12340 | 5050 | 20933 | 3559 | 22474 | 2867 | 23002 | 2320 | 23241 | 1425 | 27969 | 797 | 22718 |
| 14-#14 | 3.52 | MA | 15286 | 5050 | 25751 | 3623 | 28287 | 2905 | 29573 | 2344 | 31047 | 1473 | 37607 | 1002 | 28307 |
| 4L-5S | | MI | 12780 | 5050 | 21668 | 3568 | 23488 | 2880 | 24152 | 2308 | 24771 | 1413 | 29812 | 880 | 23454 |
| 14-#14 | 3.52 | MA | 14750 | 5050 | 24837 | 3615 | 27103 | 2920 | 28121 | 2356 | 29016 | 1461 | 35205 | 949 | 27293 |
| 5L-4S | | MI | 13242 | 5050 | 22449 | 3578 | 24500 | 2867 | 25360 | 2295 | 26463 | 1425 | 31793 | 935 | 24230 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis

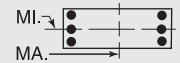



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 3.52 | MA | 14239 | 5050 | 23978 | 3608 | 25915 | 2910 | 26739 | 2369 | 27178 | 1473 | 32963 | 866 | 26429 |
| 6L-3S | | MI | 13755 | 5050 | 23347 | 3562 | 25643 | 2879 | 26715 | 2308 | 28147 | 1413 | 33655 | 1054 | 24668 |
| 14-#14 | 3.52 | MA | 13741 | 5050 | 23038 | 3626 | 24781 | 2925 | 25283 | 2356 | 25382 | 1486 | 30861 | 771 | 25355 |
| 7L-2S | | MI | 14466 | 5050 | 24432 | 3571 | 27034 | 2867 | 28377 | 2295 | 30352 | 1401 | 36529 | 1178 | 24705 |
| 14-#18 | 6.25 | MA | 16168 | 5897 | 29125 | 4111 | 32482 | 3284 | 34453 | 2551 | 37420 | 1325 | 46552 | 430 | 43748 |
| 5L-4S | | MI | 14698 | 5897 | 26627 | 4074 | 29568 | 3197 | 31385 | 2458 | 34530 | 1272 | 42307 | 411 | 39194 |
| 16-#11 | 2.79 | MA | 15364 | 4823 | 25361 | 3481 | 27838 | 2822 | 29055 | 2303 | 30297 | 1498 | 36269 | 1242 | 23167 |
| 3L-7S | | MI | 12026 | 4823 | 19878 | 3451 | 21243 | 2791 | 21518 | 2265 | 21354 | 1475 | 25491 | 940 | 18686 |
| 16-#11 | 2.79 | MA | 14942 | 4823 | 24625 | 3493 | 26900 | 2815 | 27915 | 2295 | 28870 | 1506 | 34677 | 1156 | 23110 |
| 4L-6S | | MI | 12330 | 4823 | 20441 | 3440 | 21922 | 2782 | 22375 | 2273 | 22411 | 1466 | 26726 | 1005 | 19143 |
| 16-#11 | 2.79 | MA | 14563 | 4823 | 23986 | 3489 | 26072 | 2826 | 26898 | 2304 | 27438 | 1498 | 32980 | 1118 | 22601 |
| 5E | | MI | 12641 | 4823 | 20955 | 3446 | 22632 | 2790 | 23189 | 2265 | 23493 | 1458 | 28036 | 1062 | 19453 |
| 16-#11 | 2.79 | MA | 14202 | 4823 | 23386 | 3484 | 25242 | 2820 | 25930 | 2313 | 26142 | 1506 | 31393 | 1061 | 22188 |
| 6L-4S | | MI | 12968 | 4823 | 21502 | 3452 | 23340 | 2780 | 24044 | 2256 | 24689 | 1466 | 29443 | 1100 | 19892 |
| 16-#11 | 2.79 | MA | 13850 | 4823 | 22729 | 3497 | 24449 | 2831 | 24910 | 2305 | 24876 | 1515 | 29695 | 971 | 21642 |
| 7L-3S | | MI | 13330 | 4823 | 22131 | 3440 | 24141 | 2788 | 25002 | 2265 | 25881 | 1458 | 30763 | 1184 | 19922 |
| 16-#11 | 2.79 | MA | 13503 | 4823 | 22138 | 3492 | 23645 | 2824 | 23959 | 2314 | 23626 | 1524 | 28109 | 926 | 21064 |
| 8L-2S | | MI | 13834 | 4823 | 22892 | 3446 | 25118 | 2779 | 26178 | 2256 | 27441 | 1449 | 32804 | 1270 | 19913 |
| 16-#14 | 4.02 | MA | 15854 | 5205 | 27031 | 3720 | 29927 | 2975 | 31570 | 2386 | 33695 | 1455 | 41093 | 964 | 32068 |
| 4L-6S | | MI | 12820 | 5205 | 22018 | 3656 | 23864 | 2937 | 24664 | 2360 | 25446 | 1404 | 30843 | 751 | 25858 |
| 16-#14 | 4.02 | MA | 15321 | 5205 | 26116 | 3713 | 28743 | 2990 | 30119 | 2398 | 31664 | 1443 | 38690 | 910 | 31117 |
| 5E | | MI | 13258 | 5205 | 22753 | 3666 | 24879 | 2949 | 25814 | 2347 | 26975 | 1391 | 32686 | 834 | 26690 |
| 16-#14 | 4.02 | MA | 14814 | 5205 | 25258 | 3705 | 27555 | 2980 | 28737 | 2411 | 29826 | 1455 | 36449 | 828 | 30154 |
| 6L-4S | | MI | 13716 | 5205 | 23534 | 3675 | 25891 | 2937 | 27022 | 2335 | 28668 | 1404 | 34667 | 889 | 27411 |
| 16-#14 | 4.02 | MA | 14319 | 5205 | 24317 | 3723 | 26421 | 2995 | 27280 | 2398 | 28031 | 1468 | 34347 | 732 | 29131 |
| 7L-3S | | MI | 14226 | 5205 | 24432 | 3659 | 27034 | 2949 | 28377 | 2347 | 30352 | 1391 | 36529 | 1008 | 28022 |
| 18-#11 | 3.13 | MA | 15345 | 4931 | 25522 | 3561 | 28049 | 2864 | 29317 | 2324 | 30737 | 1495 | 37143 | 1130 | 25877 |
| 4L-7S | | MI | 12368 | 4931 | 20640 | 3519 | 22219 | 2839 | 22694 | 2293 | 22913 | 1461 | 27532 | 911 | 20924 |
| 18-#11 | 3.13 | MA | 14968 | 4931 | 24883 | 3556 | 27221 | 2875 | 28300 | 2333 | 29306 | 1486 | 35445 | 1093 | 25284 |
| 5L-6S | | MI | 12670 | 4931 | 21203 | 3507 | 22898 | 2830 | 23552 | 2301 | 23970 | 1452 | 28767 | 975 | 21439 |
| 18-#11 | 3.13 | MA | 14609 | 4931 | 24283 | 3551 | 26391 | 2868 | 27332 | 2342 | 28010 | 1495 | 33858 | 1036 | 24892 |
| 6L-5S | | MI | 12980 | 4931 | 21717 | 3513 | 23608 | 2838 | 24365 | 2293 | 25052 | 1444 | 30077 | 1032 | 21731 |
| 18-#11 | 3.13 | MA | 14259 | 4931 | 23626 | 3564 | 25599 | 2879 | 26312 | 2334 | 26743 | 1503 | 32160 | 945 | 24286 |
| 7L-4S | | MI | 13305 | 4931 | 22264 | 3519 | 24317 | 2829 | 25220 | 2284 | 26249 | 1452 | 31484 | 1070 | 22247 |
| 18-#11 | 3.13 | MA | 13914 | 4931 | 23034 | 3560 | 24795 | 2873 | 25361 | 2343 | 25494 | 1512 | 30575 | 901 | 23732 |
| 8L-3S | | MI | 13666 | 4931 | 22892 | 3508 | 25118 | 2837 | 26178 | 2293 | 27441 | 1444 | 32804 | 1154 | 22292 |
| 18-#14 | 4.52 | MA | 15888 | 5361 | 27396 | 3810 | 30383 | 3060 | 32116 | 2441 | 34313 | 1425 | 42175 | 871 | 34949 |
| 5L-6S | | MI | 13297 | 5361 | 23102 | 3754 | 25255 | 3007 | 26327 | 2399 | 27651 | 1382 | 33717 | 705 | 29012 |
| 18-#14 | 4.52 | MA | 15384 | 5361 | 26537 | 3802 | 29195 | 3050 | 30734 | 2453 | 32475 | 1437 | 39934 | 789 | 33894 |
| 6L-5S | | MI | 13732 | 5361 | 23837 | 3763 | 26270 | 3019 | 27476 | 2387 | 29180 | 1370 | 35559 | 788 | 29935 |
| 18-#14 | 4.52 | MA | 14893 | 5361 | 25597 | 3820 | 28061 | 3065 | 29278 | 2441 | 30680 | 1450 | 37832 | 693 | 32917 |
| 7L-4S | | MI | 14188 | 5361 | 24619 | 3772 | 27281 | 3007 | 28685 | 2374 | 30873 | 1382 | 37541 | 843 | 30607 |
| 20-#11 | 3.48 | MA | 15371 | 5039 | 25779 | 3624 | 28370 | 2923 | 29702 | 2363 | 31173 | 1474 | 37911 | 1068 | 27974 |
| 5L-7S | | MI | 12708 | 5039 | 21402 | 3586 | 23196 | 2888 | 23870 | 2321 | 24473 | 1447 | 29573 | 881 | 23168 |
| 20-#11 | 3.48 | MA | 15013 | 5039 | 25179 | 3619 | 27540 | 2917 | 28734 | 2372 | 29877 | 1483 | 36324 | 1011 | 27600 |
| 6E | | MI | 13009 | 5039 | 21964 | 3575 | 23874 | 2878 | 24728 | 2329 | 25530 | 1438 | 30808 | 945 | 23738 |
| 20-#11 | 3.48 | MA | 14665 | 5039 | 24522 | 3632 | 26748 | 2928 | 27714 | 2364 | 28611 | 1492 | 34626 | 920 | 26938 |
| 7L-5S | | MI | 13318 | 5039 | 22478 | 3581 | 24585 | 2886 | 25541 | 2321 | 26612 | 1430 | 32118 | 1002 | 24014 |
| 20-#11 | 3.48 | MA | 14322 | 5039 | 23931 | 3627 | 25944 | 2921 | 26763 | 2373 | 27362 | 1500 | 33040 | 876 | 26406 |
| 8L-4S | | MI | 13641 | 5039 | 23025 | 3587 | 25293 | 2877 | 26396 | 2312 | 27809 | 1438 | 33524 | 1040 | 24597 |
| 20-#14 | 5.02 | MA | 15951 | 5516 | 27816 | 3900 | 30835 | 3120 | 32732 | 2495 | 35124 | 1419 | 43419 | 750 | 37646 |
| 6E | | MI | 13770 | 5516 | 24187 | 3851 | 26645 | 3077 | 27989 | 2438 | 29856 | 1360 | 36591 | 659 | 32178 |
| 20-#14 | 5.02 | MA | 15463 | 5516 | 26876 | 3917 | 29701 | 3135 | 31276 | 2483 | 33328 | 1431 | 41317 | 655 | 36630 |
| 7L-5S | | MI | 14203 | 5516 | 24922 | 3860 | 27660 | 3089 | 29139 | 2426 | 31385 | 1348 | 38433 | 742 | 33185 |
| 22-#11 | 3.83 | MA | 15415 | 5147 | 26076 | 3686 | 28690 | 2965 | 30136 | 2401 | 31745 | 1471 | 38789 | 986 | 30311 |
| 6L-7S | | MI | 13046 | 5147 | 22163 | 3654 | 24172 | 2936 | 25046 | 2349 | 26033 | 1433 | 31614 | 851 | 25419 |

## RECTANGULAR TIED COLUMNS 28" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.83 | MA | 15069 | 5147 | 25419 | 3699 | 27897 | 2976 | 29116 | 2393 | 30479 | 1480 | 37091 | 895 | 29597 |
| 7L-6S | | MI | 13346 | 5147 | 22726 | 3642 | 24851 | 2927 | 25904 | 2357 | 27090 | 1424 | 32848 | 915 | 26039 |
| 22-#11 | 3.83 | MA | 14728 | 5147 | 24827 | 3694 | 27093 | 2970 | 28165 | 2402 | 29230 | 1489 | 35505 | 851 | 29026 |
| 8L-5S | | MI | 13653 | 5147 | 23240 | 3648 | 25561 | 2935 | 26717 | 2349 | 28172 | 1416 | 34158 | 972 | 26302 |
| 22-#14 | 5.52 | MA | 16029 | 5672 | 28155 | 4015 | 31341 | 3205 | 33273 | 2525 | 35977 | 1413 | 44802 | 616 | 40331 |
| 7L-6S | | MI | 14241 | 5672 | 25272 | 3948 | 28036 | 3146 | 29651 | 2478 | 32060 | 1339 | 39465 | 613 | 35355 |
| 24-#11 | 4.18 | MA | 15471 | 5255 | 26315 | 3766 | 29046 | 3024 | 30518 | 2423 | 32347 | 1468 | 39556 | 870 | 32261 |
| 7E | | MI | 13383 | 5255 | 22925 | 3721 | 25148 | 2985 | 26222 | 2377 | 27592 | 1419 | 33654 | 821 | 27675 |
| 24-#11 | 4.18 | MA | 15131 | 5255 | 25724 | 3762 | 28242 | 3018 | 29567 | 2432 | 31097 | 1477 | 37971 | 825 | 31648 |
| 8L-6S | | MI | 13681 | 5255 | 23487 | 3710 | 25827 | 2975 | 27080 | 2385 | 28649 | 1410 | 34889 | 885 | 28274 |

## RECTANGULAR TIED COLUMNS 28" x 34"

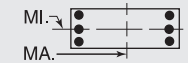
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.68 | MA | 16506 | 4761 | 26424 | 3450 | 28485 | 2802 | 29126 | 2317 | 29246 | 1600 | 34319 | 1468 | 15946 |
| 2E | | MI | 13458 | 4761 | 21728 | 3383 | 23109 | 2740 | 23395 | 2254 | 23279 | 1543 | 27027 | 1392 | 12864 |
| 6-#14 | 1.42 | MA | 16229 | 4675 | 25667 | 3424 | 27639 | 2787 | 28184 | 2316 | 28065 | 1633 | 32851 | 1519 | 13683 |
| 2L-3S | | MI | 12527 | 4675 | 20060 | 3354 | 21162 | 2749 | 21111 | 2277 | 20260 | 1597 | 23185 | 1332 | 11154 |
| 6-#14 | 1.42 | MA | 15299 | 4675 | 24290 | 3418 | 25874 | 2803 | 26032 | 2330 | 25194 | 1645 | 29060 | 1395 | 13747 |
| 3L-2S | | MI | 13258 | 4675 | 21145 | 3363 | 22553 | 2736 | 22774 | 2264 | 22465 | 1584 | 26059 | 1456 | 11076 |
| 6-#18 | 2.52 | MA | 17577 | 5038 | 28822 | 3623 | 31559 | 2926 | 32854 | 2391 | 34190 | 1566 | 40811 | 1396 | 23500 |
| 2L-3S | | MI | 13031 | 5038 | 21728 | 3536 | 23109 | 2883 | 23395 | 2342 | 23279 | 1521 | 27027 | 1078 | 18874 |
| 6-#18 | 2.52 | MA | 15986 | 5038 | 26424 | 3609 | 28485 | 2952 | 29126 | 2413 | 29246 | 1588 | 34319 | 1174 | 23453 |
| 3L-2S | | MI | 14277 | 5038 | 23607 | 3556 | 25482 | 2861 | 26232 | 2320 | 27041 | 1499 | 31892 | 1299 | 18829 |
| 8-#11 | 1.31 | MA | 16115 | 4639 | 25346 | 3417 | 27292 | 2783 | 27784 | 2317 | 27587 | 1647 | 32258 | 1541 | 12748 |
| 2L-4S | | MI | 12291 | 4639 | 19505 | 3364 | 20516 | 2736 | 20388 | 2271 | 19386 | 1620 | 22310 | 1314 | 10437 |
| 8-#11 | 1.31 | MA | 15462 | 4639 | 24382 | 3413 | 26056 | 2794 | 26277 | 2327 | 25565 | 1656 | 29580 | 1455 | 12793 |
| 3E | | MI | 12661 | 4639 | 20134 | 3352 | 21317 | 2744 | 21346 | 2279 | 20578 | 1611 | 23630 | 1398 | 10385 |
| 8-#11 | 1.31 | MA | 14998 | 4639 | 23592 | 3426 | 25049 | 2788 | 25053 | 2319 | 24020 | 1665 | 27847 | 1368 | 12824 |
| 4L-2S | | MI | 13175 | 4639 | 20896 | 3358 | 22294 | 2735 | 22522 | 2271 | 22137 | 1603 | 25671 | 1484 | 10333 |
| 8-#14 | 1.89 | MA | 16855 | 4830 | 27043 | 3522 | 29404 | 2857 | 30337 | 2359 | 30936 | 1616 | 36643 | 1483 | 18026 |
| 2L-4S | | MI | 12490 | 4830 | 20247 | 3467 | 21410 | 2806 | 21419 | 2304 | 20781 | 1587 | 24196 | 1167 | 14597 |
| 8-#14 | 1.89 | MA | 15933 | 4830 | 25667 | 3515 | 27639 | 2872 | 28184 | 2372 | 28065 | 1629 | 32851 | 1359 | 18064 |
| 3E | | MI | 13014 | 4830 | 21145 | 3451 | 22553 | 2819 | 22774 | 2316 | 22465 | 1575 | 26059 | 1286 | 14583 |
| 8-#14 | 1.89 | MA | 15276 | 4830 | 24537 | 3534 | 26199 | 2863 | 26435 | 2361 | 25871 | 1641 | 30402 | 1234 | 18001 |
| 4L-2S | | MI | 13740 | 4830 | 22230 | 3460 | 23943 | 2806 | 24436 | 2304 | 24670 | 1563 | 28933 | 1410 | 14525 |
| 8-#18 | 3.36 | MA | 18633 | 5314 | 31220 | 3796 | 34634 | 3050 | 36583 | 2464 | 39134 | 1533 | 47302 | 1324 | 31006 |
| 2L-4S | | MI | 12957 | 5314 | 22045 | 3734 | 23530 | 2981 | 23919 | 2386 | 24168 | 1500 | 28728 | 781 | 23073 |
| 8-#18 | 3.36 | MA | 17059 | 5314 | 28822 | 3782 | 31559 | 3076 | 32854 | 2487 | 34190 | 1555 | 40811 | 1102 | 30843 |
| 3E | | MI | 13852 | 5314 | 23607 | 3709 | 25482 | 3004 | 26232 | 2408 | 27041 | 1477 | 31892 | 986 | 24689 |
| 8-#18 | 3.36 | MA | 15937 | 5314 | 26846 | 3812 | 29042 | 3057 | 29818 | 2464 | 30413 | 1577 | 36616 | 885 | 28781 |
| 4L-2S | | MI | 15087 | 5314 | 25487 | 3728 | 27855 | 2981 | 29068 | 2386 | 30804 | 1455 | 36758 | 1207 | 24743 |
| 10-#11 | 1.64 | MA | 16558 | 4747 | 26310 | 3484 | 28527 | 2831 | 29292 | 2346 | 29609 | 1637 | 34937 | 1518 | 15790 |
| 2L-5S | | MI | 12305 | 4747 | 19720 | 3425 | 20784 | 2794 | 20709 | 2307 | 19749 | 1597 | 22943 | 1246 | 12818 |
| 10-#11 | 1.64 | MA | 15908 | 4747 | 25346 | 3480 | 27292 | 2843 | 27784 | 2356 | 27587 | 1645 | 32258 | 1431 | 15824 |
| 3L-4S | | MI | 12637 | 4747 | 20267 | 3431 | 21493 | 2784 | 21564 | 2299 | 20946 | 1606 | 24350 | 1284 | 12836 |
| 10-#11 | 1.64 | MA | 15447 | 4747 | 24556 | 3493 | 26285 | 2837 | 26561 | 2349 | 26042 | 1654 | 30525 | 1345 | 15831 |
| 4L-3S | | MI | 13006 | 4747 | 20896 | 3420 | 22294 | 2792 | 22522 | 2307 | 22137 | 1597 | 25671 | 1368 | 12800 |
| 10-#11 | 1.64 | MA | 15034 | 4747 | 23871 | 3489 | 25397 | 2848 | 25470 | 2358 | 24492 | 1645 | 28687 | 1306 | 15749 |
| 5L-2S | | MI | 13517 | 4747 | 21657 | 3426 | 23270 | 2783 | 23698 | 2299 | 23697 | 1589 | 27712 | 1454 | 12756 |
| 10-#14 | 2.36 | MA | 17476 | 4986 | 28420 | 3619 | 31168 | 2926 | 32490 | 2401 | 33807 | 1600 | 40435 | 1447 | 22350 |
| 2L-5S | | MI | 12507 | 4986 | 20551 | 3555 | 21788 | 2888 | 21873 | 2355 | 21293 | 1553 | 25089 | 1066 | 17201 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis

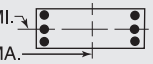



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 2.36 | MA | 16560 | 4986 | 27043 | 3612 | 29404 | 2942 | 30337 | 2414 | 30936 | 1612 | 36643 | 1323 | 22351 |
| 3L-4S | | MI | 12976 | 4986 | 21332 | 3564 | 22800 | 2876 | 23081 | 2343 | 22986 | 1566 | 27070 | 1121 | 17958 |
| 10-#14 | 2.36 | MA | 15908 | 4986 | 25913 | 3631 | 27964 | 2933 | 28587 | 2403 | 28742 | 1625 | 34194 | 1198 | 22243 |
| 4L-3S | | MI | 13497 | 4986 | 22230 | 3548 | 23943 | 2888 | 24436 | 2355 | 24670 | 1553 | 28933 | 1240 | 17989 |
| 10-#14 | 2.36 | MA | 15324 | 4986 | 24932 | 3624 | 26693 | 2949 | 27026 | 2416 | 26542 | 1612 | 31585 | 1144 | 21234 |
| 5L-2S | | MI | 14218 | 4986 | 23314 | 3558 | 25334 | 2876 | 26098 | 2343 | 26875 | 1541 | 31807 | 1364 | 17951 |
| 10-#18 | 4.20 | MA | 18119 | 5591 | 31220 | 3955 | 34634 | 3200 | 36583 | 2560 | 39134 | 1521 | 47302 | 1030 | 38211 |
| 3L-4S | | MI | 13778 | 5591 | 23925 | 3907 | 25902 | 3102 | 26755 | 2452 | 27931 | 1456 | 33594 | 689 | 28503 |
| 10-#18 | 4.20 | MA | 17009 | 5591 | 29244 | 3985 | 32117 | 3181 | 33546 | 2538 | 35357 | 1543 | 43108 | 812 | 35764 |
| 4L-3S | | MI | 14664 | 5591 | 25487 | 3882 | 27855 | 3124 | 29068 | 2474 | 30804 | 1434 | 36758 | 893 | 30474 |
| 10-#18 | 4.20 | MA | 16014 | 5591 | 27527 | 3972 | 29892 | 3207 | 30837 | 2560 | 31565 | 1521 | 38632 | 716 | 33900 |
| 5L-2S | | MI | 15888 | 5591 | 27367 | 3901 | 30228 | 3102 | 31904 | 2452 | 34567 | 1412 | 41623 | 1115 | 30618 |
| 12-#11 | 1.97 | MA | 16998 | 4855 | 27274 | 3551 | 29763 | 2879 | 30799 | 2375 | 31631 | 1626 | 37615 | 1495 | 18822 |
| 2L-6S | | MI | 12335 | 4855 | 19968 | 3487 | 21051 | 2834 | 21071 | 2344 | 20227 | 1592 | 23674 | 1159 | 14698 |
| 12-#11 | 1.97 | MA | 16351 | 4855 | 26310 | 3547 | 28527 | 2891 | 29292 | 2385 | 29609 | 1635 | 34937 | 1408 | 18844 |
| 3L-5S | | MI | 12651 | 4855 | 20482 | 3493 | 21761 | 2842 | 21885 | 2335 | 21309 | 1583 | 24984 | 1216 | 15067 |
| 12-#11 | 1.97 | MA | 15893 | 4855 | 25520 | 3561 | 27521 | 2885 | 28068 | 2378 | 28064 | 1643 | 33204 | 1322 | 18826 |
| 4E | | MI | 12981 | 4855 | 21029 | 3499 | 22469 | 2833 | 22740 | 2327 | 22505 | 1592 | 26391 | 1254 | 15223 |
| 12-#11 | 1.97 | MA | 15482 | 4855 | 24835 | 3556 | 26633 | 2897 | 26978 | 2388 | 26514 | 1635 | 31366 | 1283 | 18603 |
| 5L-3S | | MI | 13348 | 4855 | 21657 | 3487 | 23270 | 2841 | 23698 | 2335 | 23697 | 1583 | 27712 | 1338 | 15201 |
| 12-#11 | 1.97 | MA | 15090 | 4855 | 24192 | 3552 | 25743 | 2891 | 25891 | 2380 | 25111 | 1643 | 29640 | 1227 | 18064 |
| 6L-2S | | MI | 13857 | 4855 | 22419 | 3493 | 24247 | 2831 | 24874 | 2327 | 25256 | 1575 | 29752 | 1424 | 15166 |
| 12-#14 | 2.84 | MA | 18092 | 5142 | 29796 | 3716 | 32933 | 2996 | 34643 | 2444 | 36678 | 1583 | 44227 | 1412 | 26662 |
| 2L-6S | | MI | 12548 | 5142 | 20901 | 3643 | 22164 | 2946 | 22386 | 2407 | 21969 | 1544 | 26121 | 937 | 19898 |
| 12-#14 | 2.84 | MA | 17181 | 5142 | 28420 | 3710 | 31168 | 3012 | 32490 | 2457 | 33807 | 1596 | 40435 | 1287 | 26623 |
| 3L-5S | | MI | 12993 | 5141 | 21636 | 3652 | 23179 | 2958 | 23536 | 2395 | 23498 | 1532 | 27963 | 1020 | 20412 |
| 12-#14 | 2.84 | MA | 16534 | 5142 | 27290 | 3728 | 29728 | 3003 | 30740 | 2445 | 31613 | 1608 | 37986 | 1162 | 26476 |
| 4E | | MI | 13459 | 5142 | 22417 | 3661 | 24191 | 2946 | 24744 | 2382 | 25191 | 1544 | 29944 | 1075 | 21284 |
| 12-#14 | 2.84 | MA | 15954 | 5141 | 26309 | 3722 | 28458 | 3019 | 29179 | 2459 | 29413 | 1596 | 35377 | 1108 | 25324 |
| 5L-3S | | MI | 13976 | 5142 | 23314 | 3646 | 25334 | 2958 | 26098 | 2395 | 26875 | 1532 | 31807 | 1194 | 21374 |
| 12-#14 | 2.84 | MA | 15402 | 5142 | 25388 | 3715 | 27184 | 3010 | 27694 | 2472 | 27421 | 1608 | 32935 | 1026 | 24648 |
| 6L-2S | | MI | 14693 | 5141 | 24399 | 3655 | 26725 | 2946 | 27761 | 2382 | 29080 | 1519 | 34681 | 1318 | 21363 |
| 12-#18 | 5.04 | MA | 18067 | 5868 | 31643 | 4158 | 35191 | 3305 | 37275 | 2612 | 40301 | 1510 | 49599 | 740 | 42791 |
| 4E | | MI | 14590 | 5868 | 25805 | 4080 | 28275 | 3223 | 29591 | 2517 | 31694 | 1412 | 38459 | 597 | 33977 |
| 12-#18 | 5.04 | MA | 17083 | 5868 | 29925 | 4144 | 32966 | 3331 | 34565 | 2634 | 36509 | 1488 | 45124 | 644 | 40734 |
| 5L-3S | | MI | 15468 | 5868 | 27367 | 4055 | 30228 | 3245 | 31904 | 2540 | 34567 | 1390 | 41623 | 801 | 36240 |
| 14-#11 | 2.29 | MA | 17435 | 4963 | 28238 | 3619 | 30999 | 2928 | 32307 | 2405 | 33653 | 1615 | 40293 | 1471 | 21847 |
| 2L-7S | | MI | 12374 | 4963 | 20167 | 3566 | 21348 | 2892 | 21390 | 2363 | 20729 | 1586 | 24480 | 1065 | 16677 |
| 14-#11 | 2.29 | MA | 16792 | 4963 | 27274 | 3615 | 29763 | 2939 | 30799 | 2415 | 31631 | 1624 | 37615 | 1385 | 21853 |
| 3L-6S | | MI | 12680 | 4963 | 20729 | 3554 | 22027 | 2883 | 22247 | 2372 | 21786 | 1578 | 25715 | 1129 | 16986 |
| 14-#11 | 2.29 | MA | 16336 | 4963 | 26484 | 3628 | 28756 | 2934 | 29576 | 2407 | 30086 | 1633 | 35882 | 1299 | 21813 |
| 4L-5S | | MI | 12994 | 4963 | 21243 | 3560 | 22737 | 2891 | 23061 | 2363 | 22868 | 1569 | 27025 | 1186 | 17328 |
| 14-#11 | 2.29 | MA | 15927 | 4963 | 25799 | 3624 | 27869 | 2945 | 28485 | 2417 | 28536 | 1624 | 34044 | 1260 | 21470 |
| 5L-4S | | MI | 13323 | 4963 | 21790 | 3566 | 23446 | 2881 | 23916 | 2355 | 24065 | 1578 | 28432 | 1224 | 17596 |
| 14-#11 | 2.29 | MA | 15537 | 4963 | 25156 | 3620 | 26979 | 2939 | 27398 | 2410 | 27133 | 1633 | 32318 | 1203 | 20963 |
| 6L-3S | | MI | 13688 | 4963 | 22419 | 3555 | 24247 | 2889 | 24874 | 2363 | 25256 | 1569 | 29752 | 1308 | 17594 |
| 14-#11 | 2.29 | MA | 15158 | 4963 | 24452 | 3633 | 26130 | 2951 | 26354 | 2420 | 25762 | 1641 | 30473 | 1113 | 20541 |
| 7L-2S | | MI | 14195 | 4963 | 23181 | 3561 | 25223 | 2880 | 26050 | 2355 | 26816 | 1561 | 31793 | 1394 | 17568 |
| 14-#14 | 3.31 | MA | 17797 | 5297 | 29796 | 3807 | 32933 | 3082 | 34643 | 2499 | 36678 | 1579 | 44227 | 1251 | 30885 |
| 3L-6S | | MI | 13032 | 5297 | 21985 | 3740 | 23555 | 3016 | 24048 | 2447 | 24173 | 1522 | 28995 | 891 | 23018 |
| 14-#14 | 3.31 | MA | 17155 | 5297 | 28666 | 3825 | 31493 | 3073 | 32893 | 2488 | 34484 | 1592 | 41778 | 1127 | 30609 |
| 4L-5S | | MI | 13474 | 5297 | 22720 | 3749 | 24570 | 3028 | 25198 | 2434 | 25703 | 1510 | 30837 | 974 | 23638 |
| 14-#14 | 3.31 | MA | 16579 | 5297 | 27686 | 3819 | 30222 | 3089 | 31332 | 2501 | 32284 | 1579 | 39168 | 1072 | 29429 |
| 5L-4S | | MI | 13937 | 5297 | 23502 | 3758 | 25581 | 3016 | 26406 | 2422 | 27395 | 1522 | 32818 | 1029 | 24445 |
| 14-#14 | 3.31 | MA | 16031 | 5297 | 26765 | 3812 | 28949 | 3080 | 29846 | 2514 | 30292 | 1592 | 36727 | 990 | 28646 |
| 6L-3S | | MI | 14452 | 5297 | 24399 | 3743 | 26725 | 3028 | 27761 | 2434 | 29080 | 1510 | 34681 | 1148 | 24743 |
| 14-#14 | 3.31 | MA | 15497 | 5297 | 25757 | 3831 | 27733 | 3096 | 28281 | 2503 | 28345 | 1604 | 34115 | 860 | 27414 |
| 7L-2S | | MI | 15165 | 5297 | 25484 | 3752 | 28115 | 3016 | 29423 | 2422 | 31284 | 1498 | 37555 | 1272 | 24769 |

## RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

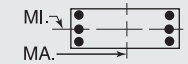
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 5.88 | MA | 18141 | 6144 | 32324 | 4317 | 36041 | 3455 | 38294 | 2708 | 41453 | 1454 | 51615 | 572 | 47607 |
| 5L-4S | | MI | 15395 | 6144 | 27684 | 4253 | 30648 | 3344 | 32428 | 2583 | 35457 | 1368 | 43325 | 504 | 39483 |
| 16-#11 | 2.62 | MA | 17229 | 5071 | 28238 | 3682 | 30999 | 2988 | 32307 | 2444 | 33653 | 1613 | 40293 | 1362 | 24852 |
| 3L-7S | | MI | 12719 | 5071 | 20928 | 3633 | 22325 | 2940 | 22566 | 2391 | 22289 | 1572 | 26521 | 1035 | 18904 |
| 16-#11 | 2.62 | MA | 16775 | 5071 | 27448 | 3695 | 29992 | 2982 | 31083 | 2437 | 32108 | 1622 | 38560 | 1275 | 24795 |
| 4L-6S | | MI | 13023 | 5071 | 21491 | 3622 | 23003 | 2931 | 23424 | 2400 | 23346 | 1564 | 27756 | 1099 | 19279 |
| 16-#11 | 2.62 | MA | 16369 | 5071 | 26763 | 3691 | 29104 | 2994 | 29993 | 2447 | 30558 | 1613 | 36722 | 1237 | 24348 |
| 5E | | MI | 13336 | 5071 | 22005 | 3628 | 23714 | 2939 | 24237 | 2391 | 24428 | 1555 | 29066 | 1156 | 19599 |
| 16-#11 | 2.62 | MA | 15981 | 5071 | 26120 | 3687 | 28215 | 2988 | 28906 | 2439 | 29155 | 1622 | 34996 | 1180 | 23868 |
| 6L-4S | | MI | 13663 | 5071 | 22552 | 3633 | 24422 | 2930 | 25092 | 2383 | 25625 | 1564 | 30473 | 1194 | 19961 |
| 16-#11 | 2.62 | MA | 15604 | 5071 | 25416 | 3700 | 27365 | 2999 | 27862 | 2449 | 27784 | 1631 | 33151 | 1090 | 23378 |
| 7L-3S | | MI | 14026 | 5071 | 23181 | 3622 | 25223 | 2938 | 26050 | 2391 | 26816 | 1555 | 31793 | 1278 | 19980 |
| 16-#11 | 2.62 | MA | 15232 | 5071 | 24782 | 3696 | 26504 | 2994 | 26843 | 2459 | 26326 | 1622 | 31434 | 1044 | 22716 |
| 8L-2S | | MI | 14531 | 5071 | 23942 | 3628 | 26199 | 2928 | 27226 | 2383 | 28376 | 1547 | 33834 | 1364 | 19963 |
| 16-#14 | 3.78 | MA | 17771 | 5453 | 30043 | 3923 | 33258 | 3143 | 35046 | 2530 | 37355 | 1575 | 45570 | 1091 | 34658 |
| 4L-6S | | MI | 13513 | 5453 | 23070 | 3837 | 24945 | 3086 | 25711 | 2486 | 26378 | 1501 | 31869 | 845 | 26154 |
| 16-#14 | 3.78 | MA | 17199 | 5453 | 29062 | 3916 | 31987 | 3159 | 33485 | 2544 | 35155 | 1563 | 42960 | 1036 | 33546 |
| 5E | | MI | 13952 | 5453 | 23805 | 3846 | 25960 | 3098 | 26860 | 2474 | 27908 | 1488 | 33711 | 928 | 26874 |
| 16-#14 | 3.78 | MA | 16655 | 5453 | 28141 | 3910 | 30713 | 3150 | 31999 | 2557 | 33163 | 1575 | 40519 | 954 | 32661 |
| 6L-4S | | MI | 14413 | 5453 | 24586 | 3856 | 26972 | 3086 | 28069 | 2461 | 29600 | 1501 | 35692 | 983 | 27624 |
| 16-#14 | 3.78 | MA | 16124 | 5453 | 27133 | 3928 | 29497 | 3165 | 30434 | 2545 | 31216 | 1587 | 37907 | 824 | 31483 |
| 7L-3S | | MI | 14924 | 5453 | 25484 | 3840 | 28115 | 3098 | 29423 | 2474 | 31284 | 1488 | 37555 | 1102 | 28103 |
| 18-#11 | 2.95 | MA | 17212 | 5179 | 28412 | 3763 | 31228 | 3030 | 32591 | 2466 | 34130 | 1611 | 41239 | 1252 | 27772 |
| 4L-7S | | MI | 13061 | 5179 | 21690 | 3701 | 23301 | 2989 | 23742 | 2420 | 23848 | 1558 | 28562 | 1005 | 21139 |
| 18-#11 | 2.95 | MA | 16808 | 5179 | 27727 | 3759 | 30340 | 3042 | 31500 | 2476 | 32580 | 1603 | 39400 | 1214 | 27233 |
| 5L-6S | | MI | 13364 | 5179 | 22253 | 3689 | 23980 | 2980 | 24600 | 2428 | 24906 | 1550 | 29797 | 1069 | 21576 |
| 18-#11 | 2.95 | MA | 16422 | 5179 | 27084 | 3755 | 29450 | 3036 | 30413 | 2469 | 31177 | 1611 | 37675 | 1157 | 26778 |
| 6L-5S | | MI | 13675 | 5179 | 22767 | 3695 | 24690 | 2987 | 25413 | 2420 | 25988 | 1541 | 31107 | 1126 | 21876 |
| 18-#11 | 2.95 | MA | 16047 | 5179 | 26380 | 3768 | 28601 | 3048 | 29369 | 2479 | 29806 | 1620 | 35829 | 1067 | 26225 |
| 7L-4S | | MI | 14001 | 5179 | 23314 | 3701 | 25398 | 2978 | 26268 | 2411 | 27184 | 1550 | 32514 | 1164 | 22320 |
| 18-#11 | 2.95 | MA | 15677 | 5179 | 25746 | 3764 | 27740 | 3042 | 28350 | 2488 | 28348 | 1611 | 34112 | 1021 | 25589 |
| 8L-3S | | MI | 14363 | 5179 | 23942 | 3690 | 26199 | 2986 | 27226 | 2420 | 28376 | 1541 | 33834 | 1248 | 22354 |
| 18-#14 | 4.25 | MA | 17815 | 5608 | 30439 | 4013 | 33752 | 3228 | 35637 | 2586 | 38026 | 1546 | 46752 | 1000 | 37673 |
| 5L-6S | | MI | 13991 | 5608 | 24155 | 3934 | 26336 | 3155 | 27373 | 2525 | 28583 | 1479 | 34743 | 799 | 29305 |
| 18-#14 | 4.25 | MA | 17274 | 5608 | 29518 | 4007 | 32478 | 3219 | 34152 | 2599 | 36034 | 1558 | 44311 | 919 | 36691 |
| 6L-5S | | MI | 14428 | 5608 | 24890 | 3944 | 27351 | 3168 | 28523 | 2513 | 30113 | 1467 | 36585 | 882 | 30118 |
| 18-#14 | 4.25 | MA | 16747 | 5608 | 28510 | 4025 | 31262 | 3235 | 32587 | 2588 | 34087 | 1571 | 41699 | 788 | 35563 |
| 7L-4S | | MI | 14885 | 5608 | 25671 | 3953 | 28363 | 3155 | 29731 | 2500 | 31805 | 1479 | 38566 | 937 | 30818 |
| 20-#11 | 3.28 | MA | 17244 | 5287 | 28691 | 3826 | 31576 | 3090 | 33008 | 2505 | 34602 | 1592 | 42079 | 1190 | 30126 |
| 5L-7S | | MI | 13402 | 5287 | 22452 | 3768 | 24277 | 3037 | 24918 | 2448 | 25408 | 1544 | 30603 | 975 | 23382 |
| 20-#11 | 3.28 | MA | 16861 | 5287 | 28048 | 3822 | 30686 | 3085 | 31921 | 2498 | 33199 | 1601 | 40353 | 1134 | 29691 |
| 6E | | MI | 13704 | 5287 | 23014 | 3757 | 24956 | 3028 | 25776 | 2456 | 26465 | 1536 | 31837 | 1039 | 23875 |
| 20-#11 | 3.28 | MA | 16488 | 5287 | 27344 | 3835 | 29837 | 3096 | 30877 | 2508 | 31828 | 1609 | 38508 | 1043 | 29079 |
| 7L-5S | | MI | 14013 | 5287 | 23528 | 3762 | 25666 | 3036 | 26589 | 2448 | 27547 | 1527 | 33147 | 1097 | 24160 |
| 20-#11 | 3.28 | MA | 16120 | 5287 | 26710 | 3831 | 28975 | 3090 | 29858 | 2518 | 30370 | 1601 | 36790 | 998 | 28466 |
| 8L-4S | | MI | 14338 | 5287 | 24075 | 3768 | 26375 | 3027 | 27444 | 2439 | 28744 | 1536 | 34554 | 1134 | 24675 |
| 20-#14 | 4.73 | MA | 17888 | 5764 | 30894 | 4104 | 34243 | 3289 | 36305 | 2642 | 38904 | 1542 | 48103 | 883 | 40733 |
| 6E | | MI | 14465 | 5764 | 25240 | 4032 | 27727 | 3225 | 29035 | 2565 | 30788 | 1457 | 37617 | 753 | 32468 |
| 20-#14 | 4.73 | MA | 17365 | 5764 | 29886 | 4122 | 33026 | 3305 | 34740 | 2630 | 36958 | 1554 | 45491 | 752 | 39652 |
| 7L-5S | | MI | 14900 | 5764 | 25975 | 4041 | 28741 | 3238 | 30185 | 2552 | 32317 | 1445 | 39459 | 836 | 33368 |
| 22-#11 | 3.61 | MA | 17297 | 5395 | 29012 | 3890 | 31922 | 3133 | 33428 | 2528 | 35221 | 1590 | 43031 | 1110 | 32608 |
| 6L-7S | | MI | 13741 | 5395 | 23213 | 3835 | 25254 | 3086 | 26094 | 2476 | 26968 | 1530 | 32643 | 945 | 25632 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

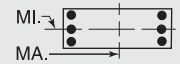
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.61 | MA | 16925 | 5395 | 28308 | 3903 | 31073 | 3145 | 32384 | 2537 | 33850 | 1599 | 41186 | 1020 | 31940 |
| 7L-6S | | MI | 14041 | 5395 | 23776 | 3824 | 25932 | 3076 | 26952 | 2484 | 28025 | 1522 | 33878 | 1009 | 26178 |
| 22-#11 | 3.61 | MA | 16560 | 5395 | 27674 | 3899 | 30211 | 3139 | 31365 | 2547 | 32392 | 1590 | 39468 | 974 | 31349 |
| 8L-5S | | MI | 14349 | 5395 | 24290 | 3830 | 26643 | 3084 | 27765 | 2476 | 29107 | 1513 | 35188 | 1067 | 26447 |
| 22-#14 | 5.20 | MA | 17979 | 5920 | 31263 | 4220 | 34791 | 3375 | 36892 | 2673 | 39829 | 1538 | 49283 | 716 | 43749 |
| 7L-6S | | MI | 14937 | 5920 | 26324 | 4129 | 29117 | 3295 | 30698 | 2604 | 32993 | 1436 | 40491 | 707 | 35642 |
| 24-#11 | 3.93 | MA | 17361 | 5503 | 29272 | 3970 | 32308 | 3193 | 33892 | 2567 | 35872 | 1588 | 43864 | 997 | 34807 |
| 7E | | MI | 14078 | 5503 | 23975 | 3903 | 26230 | 3134 | 27270 | 2504 | 28527 | 1516 | 34684 | 915 | 27887 |
| 24-#11 | 3.93 | MA | 16997 | 5503 | 28638 | 3966 | 31447 | 3187 | 32873 | 2577 | 34414 | 1579 | 42147 | 951 | 34236 |
| 8L-6S | | MI | 14377 | 5503 | 24537 | 3891 | 26909 | 3125 | 28128 | 2512 | 29585 | 1508 | 35919 | 979 | 28482 |

## RECTANGULAR TIED COLUMNS 28" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.59 | MA | 18417 | 5009 | 29327 | 3651 | 31640 | 2968 | 32375 | 2461 | 32446 | 1713 | 38089 | 1582 | 17026 |
| 2E | | MI | 14152 | 5009 | 22785 | 3561 | 24189 | 2887 | 24438 | 2379 | 24205 | 1639 | 28044 | 1485 | 12913 |
| 6-#14 | 1.34 | MA | 18113 | 4922 | 28508 | 3626 | 30724 | 2952 | 31307 | 2457 | 31147 | 1745 | 36461 | 1631 | 14595 |
| 2L-3S | | MI | 13221 | 4922 | 21113 | 3534 | 22243 | 2897 | 22158 | 2403 | 21192 | 1694 | 24211 | 1426 | 11196 |
| 6-#14 | 1.34 | MA | 17116 | 4922 | 27034 | 3620 | 28834 | 2969 | 29002 | 2471 | 28054 | 1757 | 32362 | 1507 | 14659 |
| 3L-2S | | MI | 13952 | 4922 | 22197 | 3544 | 23634 | 2885 | 23820 | 2391 | 23397 | 1681 | 27085 | 1550 | 11116 |
| 6-#18 | 2.38 | MA | 19575 | 5285 | 31899 | 3824 | 34936 | 3092 | 36397 | 2536 | 37785 | 1682 | 45125 | 1516 | 25120 |
| 2L-3S | | MI | 13725 | 5285 | 22785 | 3715 | 24189 | 3030 | 24438 | 2467 | 24205 | 1617 | 28044 | 1171 | 18956 |
| 6-#18 | 2.38 | MA | 17866 | 5285 | 29327 | 3812 | 31640 | 3119 | 32375 | 2558 | 32446 | 1704 | 38089 | 1294 | 25073 |
| 3L-2S | | MI | 14973 | 5285 | 24664 | 3734 | 26562 | 3008 | 27274 | 2445 | 27968 | 1595 | 32910 | 1392 | 18888 |
| 8-#11 | 1.24 | MA | 17988 | 4887 | 28161 | 3618 | 30347 | 2948 | 30873 | 2457 | 30621 | 1759 | 35803 | 1652 | 13590 |
| 2L-4S | | MI | 12984 | 4887 | 20555 | 3545 | 21598 | 2886 | 21436 | 2398 | 20321 | 1717 | 23339 | 1408 | 10478 |
| 8-#11 | 1.24 | MA | 17288 | 4887 | 27130 | 3614 | 29025 | 2960 | 29260 | 2468 | 28445 | 1767 | 32911 | 1566 | 13635 |
| 3E | | MI | 13355 | 4887 | 21184 | 3534 | 22399 | 2893 | 22394 | 2406 | 21513 | 1709 | 24660 | 1492 | 10421 |
| 8-#11 | 1.24 | MA | 16793 | 4887 | 26286 | 3628 | 27950 | 2955 | 27953 | 2461 | 26781 | 1776 | 31037 | 1479 | 13667 |
| 4L-2S | | MI | 13869 | 4887 | 21946 | 3540 | 23375 | 2884 | 23570 | 2398 | 23072 | 1700 | 26701 | 1578 | 10369 |
| 8-#14 | 1.79 | MA | 18790 | 5078 | 29982 | 3723 | 32613 | 3022 | 33612 | 2499 | 34241 | 1729 | 40560 | 1598 | 19241 |
| 2L-4S | | MI | 13183 | 5078 | 21300 | 3647 | 22491 | 2955 | 22465 | 2430 | 21713 | 1685 | 25222 | 1261 | 14666 |
| 8-#14 | 1.79 | MA | 17799 | 5078 | 28508 | 3717 | 30724 | 3039 | 31307 | 2514 | 31147 | 1742 | 36461 | 1473 | 19279 |
| 3E | | MI | 13708 | 5078 | 22197 | 3632 | 23634 | 2967 | 23820 | 2442 | 23397 | 1672 | 27085 | 1380 | 14633 |
| 8-#14 | 1.79 | MA | 17097 | 5078 | 27300 | 3736 | 29185 | 3031 | 29437 | 2503 | 28783 | 1754 | 33808 | 1349 | 19216 |
| 4L-2S | | MI | 14435 | 5078 | 23282 | 3641 | 25025 | 2955 | 25482 | 2430 | 25602 | 1660 | 29959 | 1504 | 14570 |
| 8-#18 | 3.17 | MA | 20717 | 5562 | 34470 | 3997 | 38233 | 3216 | 40418 | 2611 | 43124 | 1651 | 52160 | 1449 | 33166 |
| 2L-4S | | MI | 13650 | 5562 | 23102 | 3913 | 24610 | 3128 | 24961 | 2511 | 25095 | 1596 | 29746 | 874 | 23367 |
| 8-#18 | 3.17 | MA | 19026 | 5562 | 31899 | 3985 | 34936 | 3243 | 36397 | 2634 | 37785 | 1673 | 45125 | 1227 | 33003 |
| 3E | | MI | 14547 | 5562 | 24664 | 3888 | 26562 | 3151 | 27274 | 2533 | 27968 | 1573 | 32910 | 1078 | 24785 |
| 8-#18 | 3.17 | MA | 17824 | 5562 | 29785 | 4016 | 32243 | 3226 | 33124 | 2612 | 33705 | 1695 | 40585 | 1006 | 31059 |
| 4L-2S | | MI | 15784 | 5562 | 26544 | 3907 | 28935 | 3128 | 30110 | 2511 | 31731 | 1551 | 37775 | 1300 | 24810 |
| 10-#11 | 1.55 | MA | 18466 | 4995 | 29192 | 3685 | 31669 | 2996 | 32486 | 2487 | 32798 | 1749 | 38694 | 1631 | 16843 |
| 2L-5S | | MI | 12998 | 4995 | 20770 | 3607 | 21866 | 2943 | 21757 | 2434 | 20684 | 1695 | 23973 | 1341 | 12900 |
| 10-#11 | 1.55 | MA | 17770 | 4995 | 28161 | 3682 | 30347 | 3009 | 30873 | 2497 | 30621 | 1758 | 35803 | 1544 | 16877 |
| 3L-4S | | MI | 13331 | 4995 | 21317 | 3613 | 22575 | 2934 | 22612 | 2426 | 21881 | 1703 | 25380 | 1378 | 12883 |
| 10-#11 | 1.55 | MA | 17277 | 4995 | 27317 | 3695 | 29272 | 3003 | 29566 | 2490 | 28958 | 1766 | 33928 | 1458 | 16884 |
| 4L-3S | | MI | 13700 | 4995 | 21946 | 3602 | 23375 | 2942 | 23570 | 2434 | 23072 | 1695 | 26701 | 1462 | 12841 |
| 10-#11 | 1.55 | MA | 16835 | 4995 | 26586 | 3692 | 28324 | 3015 | 28402 | 2501 | 27291 | 1758 | 31950 | 1419 | 16825 |
| 5L-2S | | MI | 14212 | 4995 | 22707 | 3607 | 24352 | 2933 | 24746 | 2426 | 24632 | 1686 | 28742 | 1548 | 12795 |
| 10-#14 | 2.23 | MA | 19460 | 5233 | 31456 | 3820 | 34502 | 3092 | 35917 | 2542 | 37334 | 1714 | 44659 | 1565 | 23868 |
| 2L-5S | | MI | 13200 | 5233 | 21603 | 3735 | 22870 | 3037 | 22919 | 2482 | 22226 | 1650 | 26115 | 1160 | 17380 |
| 10-#14 | 2.23 | MA | 18476 | 5233 | 29982 | 3814 | 32613 | 3109 | 33612 | 2556 | 34241 | 1727 | 40560 | 1440 | 23869 |
| 3L-4S | | MI | 13670 | 5233 | 22385 | 3745 | 23882 | 3025 | 24128 | 2469 | 23918 | 1663 | 28096 | 1215 | 18035 |
| 10-#14 | 2.23 | MA | 17779 | 5233 | 28774 | 3833 | 31074 | 3100 | 31742 | 2546 | 31877 | 1739 | 37907 | 1316 | 23762 |
| 4L-3S | | MI | 14192 | 5233 | 23282 | 3729 | 25025 | 3037 | 25482 | 2482 | 25602 | 1650 | 29959 | 1334 | 18046 |
| 10-#14 | 2.23 | MA | 17155 | 5233 | 27727 | 3827 | 29717 | 3117 | 30075 | 2560 | 29506 | 1727 | 35095 | 1260 | 22800 |
| 5L-2S | | MI | 14914 | 5233 | 24367 | 3738 | 26415 | 3025 | 27145 | 2469 | 27807 | 1638 | 32833 | 1458 | 18001 |

## RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

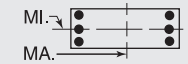
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.97 | MA | 20170 | 5839 | 34470 | 4157 | 38233 | 3367 | 40418 | 2709 | 43124 | 1642 | 52160 | 1160 | 40911 |
| 3L-4S | | MI | 14471 | 5839 | 24982 | 4086 | 26983 | 3249 | 27798 | 2576 | 28858 | 1552 | 34611 | 782 | 28793 |
| 10-#18 | 3.97 | MA | 18982 | 5839 | 32356 | 4189 | 35539 | 3350 | 37145 | 2688 | 39044 | 1664 | 47621 | 939 | 38555 |
| 4L-3S | | MI | 15361 | 5839 | 26544 | 4061 | 28935 | 3271 | 30110 | 2598 | 31731 | 1530 | 37775 | 986 | 30582 |
| 10-#18 | 3.97 | MA | 17917 | 5839 | 30521 | 4177 | 33161 | 3377 | 34224 | 2710 | 34951 | 1642 | 42770 | 844 | 36678 |
| 5L-2S | | MI | 16587 | 5839 | 28424 | 4080 | 31308 | 3249 | 32947 | 2576 | 35494 | 1507 | 42641 | 1207 | 30697 |
| 12-#11 | 1.86 | MA | 18940 | 5103 | 30224 | 3753 | 32991 | 3045 | 34099 | 2516 | 34974 | 1739 | 41586 | 1609 | 20086 |
| 2L-6S | | MI | 13028 | 5103 | 21018 | 3669 | 22132 | 2984 | 22119 | 2471 | 21162 | 1689 | 24704 | 1253 | 14827 |
| 12-#11 | 1.86 | MA | 18247 | 5103 | 29192 | 3749 | 31669 | 3057 | 32486 | 2527 | 32798 | 1748 | 38694 | 1523 | 20108 |
| 3L-5S | | MI | 13344 | 5103 | 21532 | 3674 | 22843 | 2992 | 22933 | 2462 | 22244 | 1681 | 26014 | 1311 | 15209 |
| 12-#11 | 1.86 | MA | 17757 | 5103 | 28349 | 3763 | 30594 | 3052 | 31179 | 2520 | 31134 | 1756 | 36820 | 1436 | 20089 |
| 4E | | MI | 13675 | 5103 | 22079 | 3680 | 23551 | 2982 | 23788 | 2454 | 23441 | 1689 | 27421 | 1348 | 15275 |
| 12-#11 | 1.86 | MA | 17318 | 5103 | 27618 | 3759 | 29646 | 3064 | 30015 | 2530 | 29467 | 1748 | 34841 | 1397 | 19959 |
| 5L-3S | | MI | 14042 | 5103 | 22707 | 3669 | 24352 | 2990 | 24746 | 2462 | 24632 | 1681 | 28742 | 1432 | 15247 |
| 12-#11 | 1.86 | MA | 16900 | 5103 | 26932 | 3755 | 28697 | 3059 | 28855 | 2524 | 27957 | 1756 | 32976 | 1341 | 19344 |
| 6L-2S | | MI | 14553 | 5103 | 23469 | 3675 | 25328 | 2981 | 25922 | 2454 | 26192 | 1672 | 30782 | 1519 | 15209 |
| 12-#14 | 2.68 | MA | 20124 | 5389 | 32929 | 3917 | 36392 | 3162 | 38221 | 2584 | 40428 | 1699 | 48758 | 1531 | 28484 |
| 2L-6S | | MI | 13240 | 5389 | 21953 | 3823 | 23245 | 3095 | 23432 | 2533 | 22901 | 1641 | 27147 | 1031 | 20153 |
| 12-#14 | 2.68 | MA | 19147 | 5389 | 31456 | 3911 | 34502 | 3178 | 35917 | 2598 | 37334 | 1711 | 44659 | 1407 | 28445 |
| 3L-5S | | MI | 13686 | 5389 | 22688 | 3833 | 24260 | 3107 | 24582 | 2521 | 24430 | 1629 | 28989 | 1114 | 20590 |
| 12-#14 | 2.68 | MA | 18455 | 5389 | 30248 | 3931 | 32963 | 3170 | 34047 | 2588 | 34970 | 1724 | 42006 | 1282 | 28299 |
| 4E | | MI | 14153 | 5389 | 23469 | 3842 | 25272 | 3094 | 25790 | 2509 | 26123 | 1641 | 30970 | 1169 | 21390 |
| 12-#14 | 2.68 | MA | 17835 | 5389 | 29201 | 3925 | 31606 | 3187 | 32380 | 2602 | 32600 | 1711 | 39194 | 1227 | 27182 |
| 5L-3S | | MI | 14672 | 5389 | 24367 | 3826 | 26415 | 3107 | 27145 | 2521 | 27807 | 1629 | 32833 | 1288 | 21441 |
| 12-#14 | 2.68 | MA | 17245 | 5389 | 28218 | 3919 | 30247 | 3179 | 30718 | 2592 | 30453 | 1724 | 36552 | 1145 | 26449 |
| 6L-2S | | MI | 15390 | 5389 | 25452 | 3836 | 27806 | 3094 | 28807 | 2509 | 30012 | 1616 | 35707 | 1412 | 21417 |
| 12-#18 | 4.76 | MA | 20125 | 6115 | 34927 | 4362 | 38836 | 3474 | 41167 | 2763 | 44383 | 1633 | 54657 | 872 | 46097 |
| 4E | | MI | 15285 | 6115 | 26862 | 4258 | 29355 | 3370 | 30634 | 2642 | 32621 | 1508 | 39477 | 689 | 34262 |
| 12-#18 | 4.76 | MA | 19072 | 6115 | 33092 | 4350 | 36458 | 3501 | 38246 | 2785 | 40290 | 1611 | 49806 | 777 | 44137 |
| 5L-3S | | MI | 16166 | 6115 | 28424 | 4234 | 31308 | 3392 | 32947 | 2664 | 35494 | 1486 | 42641 | 893 | 36357 |
| 12-#18 | 4.76 | MA | 18071 | 6115 | 31368 | 4337 | 34074 | 3484 | 35465 | 2808 | 36586 | 1633 | 45280 | 631 | 41060 |
| 6L-2S | | MI | 17383 | 6115 | 30304 | 4253 | 33681 | 3370 | 35783 | 2642 | 39257 | 1464 | 47506 | 1115 | 36542 |
| 14-#11 | 2.17 | MA | 19412 | 5211 | 31255 | 3820 | 34314 | 3093 | 35712 | 2545 | 37151 | 1729 | 44477 | 1588 | 23321 |
| 2L-7S | | MI | 13066 | 5211 | 21217 | 3747 | 22430 | 3041 | 22438 | 2490 | 21664 | 1684 | 25510 | 1159 | 16890 |
| 14-#11 | 2.17 | MA | 18722 | 5211 | 30224 | 3816 | 32991 | 3105 | 34099 | 2556 | 34974 | 1738 | 41586 | 1501 | 23327 |
| 3L-6S | | MI | 13373 | 5211 | 21779 | 3736 | 23109 | 3032 | 23296 | 2499 | 22722 | 1675 | 26745 | 1223 | 17115 |
| 14-#11 | 2.17 | MA | 18234 | 5211 | 29380 | 3830 | 31916 | 3100 | 32792 | 2549 | 33311 | 1747 | 39712 | 1415 | 23287 |
| 4L-5S | | MI | 13688 | 5211 | 22293 | 3742 | 23819 | 3040 | 24109 | 2490 | 23804 | 1667 | 28055 | 1281 | 17469 |
| 14-#11 | 2.17 | MA | 17798 | 5211 | 28649 | 3826 | 30969 | 3112 | 31628 | 2560 | 31644 | 1738 | 37733 | 1375 | 23027 |
| 5L-4S | | MI | 14018 | 5211 | 22840 | 3748 | 24527 | 3031 | 24964 | 2482 | 25000 | 1675 | 29462 | 1319 | 17659 |
| 14-#11 | 2.17 | MA | 17382 | 5211 | 27963 | 3823 | 30019 | 3107 | 30468 | 2553 | 30133 | 1747 | 35868 | 1319 | 22447 |
| 6L-3S | | MI | 14383 | 5211 | 23469 | 3736 | 25328 | 3039 | 25922 | 2490 | 26192 | 1667 | 30782 | 1402 | 17643 |
| 14-#11 | 2.17 | MA | 16977 | 5211 | 27212 | 3836 | 29113 | 3119 | 29355 | 2564 | 28657 | 1755 | 33875 | 1229 | 22082 |
| 7L-2S | | MI | 14891 | 5211 | 24231 | 3742 | 26305 | 3029 | 27098 | 2482 | 27751 | 1658 | 32823 | 1489 | 17613 |
| 14-#14 | 3.13 | MA | 19812 | 5545 | 32929 | 4009 | 36392 | 3248 | 38221 | 2641 | 40428 | 1696 | 48758 | 1374 | 33011 |
| 3L-6S | | MI | 13725 | 5545 | 23038 | 3921 | 24636 | 3164 | 25094 | 2573 | 25106 | 1619 | 30020 | 985 | 23309 |
| 14-#14 | 3.13 | MA | 19125 | 5545 | 31722 | 4028 | 34853 | 3240 | 36351 | 2630 | 38064 | 1709 | 46105 | 1249 | 32829 |
| 4L-5S | | MI | 14168 | 5545 | 23773 | 3930 | 25651 | 3177 | 26244 | 2560 | 26635 | 1607 | 31863 | 1068 | 23815 |
| 14-#14 | 3.13 | MA | 18509 | 5545 | 30675 | 4022 | 33496 | 3257 | 34684 | 2645 | 35693 | 1696 | 43293 | 1193 | 31580 |
| 5L-4S | | MI | 14633 | 5545 | 24554 | 3939 | 26663 | 3164 | 27453 | 2548 | 28328 | 1619 | 33844 | 1123 | 24654 |
| 14-#14 | 3.13 | MA | 17923 | 5545 | 29692 | 4016 | 32136 | 3249 | 33023 | 2634 | 33547 | 1709 | 40651 | 1112 | 30884 |
| 6L-3S | | MI | 15148 | 5545 | 25452 | 3923 | 27806 | 3177 | 28807 | 2560 | 30012 | 1607 | 35707 | 1241 | 24815 |
| 14-#14 | 3.13 | MA | 17353 | 5545 | 28616 | 4035 | 30838 | 3265 | 31428 | 2649 | 31449 | 1721 | 37827 | 981 | 29496 |
| 7L-2S | | MI | 15863 | 5545 | 26536 | 3933 | 29196 | 3164 | 30469 | 2548 | 32217 | 1595 | 38581 | 1366 | 24822 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis

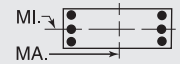


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 5.56 | MA | 20215 | 6392 | 35663 | 4523 | 39754 | 3626 | 42267 | 2861 | 45629 | 1580 | 56842 | 710 | 51525 |
| 5L-4S | | MI | 16091 | 6392 | 28741 | 4431 | 31728 | 3491 | 33470 | 2708 | 36383 | 1464 | 44342 | 597 | 39765 |
| 14-#18 | 5.56 | MA | 19224 | 6392 | 33939 | 4510 | 37370 | 3609 | 39487 | 2883 | 41925 | 1602 | 52316 | 564 | 48594 |
| 6L-3S | | MI | 16966 | 6392 | 30304 | 4406 | 33681 | 3513 | 35783 | 2730 | 39257 | 1442 | 47506 | 801 | 42118 |
| 16-#11 | 2.48 | MA | 19193 | 5318 | 31255 | 3884 | 34314 | 3154 | 35712 | 2585 | 37151 | 1728 | 44477 | 1480 | 26537 |
| 3L-7S | | MI | 13411 | 5318 | 21978 | 3815 | 23406 | 3090 | 23614 | 2518 | 23224 | 1670 | 27551 | 1129 | 19114 |
| 16-#11 | 2.48 | MA | 18708 | 5318 | 30411 | 3897 | 33238 | 3149 | 34405 | 2579 | 35487 | 1737 | 42603 | 1393 | 26479 |
| 4L-6S | | MI | 13717 | 5318 | 22541 | 3803 | 24085 | 3081 | 24472 | 2527 | 24281 | 1661 | 28786 | 1193 | 19409 |
| 16-#11 | 2.48 | MA | 18274 | 5318 | 29680 | 3894 | 32291 | 3161 | 33241 | 2589 | 33820 | 1728 | 40624 | 1354 | 26106 |
| 5E | | MI | 14030 | 5318 | 23055 | 3809 | 24795 | 3089 | 25285 | 2518 | 25363 | 1653 | 30096 | 1251 | 19739 |
| 16-#11 | 2.48 | MA | 17861 | 5318 | 28995 | 3890 | 31342 | 3156 | 32081 | 2582 | 32310 | 1737 | 38759 | 1297 | 25556 |
| 6L-4S | | MI | 14358 | 5318 | 23602 | 3815 | 25504 | 3079 | 26140 | 2510 | 26560 | 1661 | 31503 | 1289 | 20026 |
| 16-#11 | 2.48 | MA | 17458 | 5318 | 28243 | 3904 | 30436 | 3168 | 30968 | 2593 | 30834 | 1745 | 36767 | 1207 | 25134 |
| 7L-3S | | MI | 14722 | 5318 | 24231 | 3804 | 26305 | 3087 | 27098 | 2518 | 27751 | 1653 | 32823 | 1372 | 20032 |
| 16-#11 | 2.48 | MA | 17061 | 5318 | 27568 | 3900 | 29516 | 3162 | 29880 | 2604 | 29265 | 1737 | 34917 | 1161 | 24383 |
| 8L-2S | | MI | 15228 | 5318 | 24992 | 3810 | 27281 | 3078 | 28274 | 2510 | 29311 | 1644 | 34864 | 1459 | 20011 |
| 16-#14 | 3.57 | MA | 19789 | 5700 | 33195 | 4125 | 36742 | 3310 | 38656 | 2673 | 41157 | 1693 | 50204 | 1216 | 37273 |
| 4L-6S | | MI | 14206 | 5700 | 24123 | 4018 | 26027 | 3234 | 26757 | 2612 | 27311 | 1598 | 32894 | 939 | 26442 |
| 16-#14 | 3.57 | MA | 19178 | 5700 | 32148 | 4119 | 35385 | 3327 | 36989 | 2687 | 38787 | 1681 | 47392 | 1160 | 35991 |
| 5E | | MI | 14647 | 5700 | 24857 | 4027 | 27041 | 3247 | 27907 | 2600 | 28840 | 1585 | 34737 | 1021 | 27051 |
| 16-#14 | 3.57 | MA | 18596 | 5700 | 31166 | 4113 | 34025 | 3318 | 35328 | 2677 | 36640 | 1693 | 44750 | 1079 | 35199 |
| 6L-4S | | MI | 15109 | 5700 | 25639 | 4036 | 28053 | 3234 | 29115 | 2587 | 30533 | 1598 | 36718 | 1077 | 27831 |
| 16-#14 | 3.57 | MA | 18030 | 5700 | 30090 | 4132 | 32727 | 3335 | 33733 | 2691 | 34543 | 1706 | 41926 | 948 | 33858 |
| 7L-3S | | MI | 15622 | 5700 | 26536 | 4021 | 29196 | 3247 | 30469 | 2600 | 32217 | 1585 | 38581 | 1195 | 28180 |
| 16-#14 | 3.57 | MA | 17472 | 5700 | 29122 | 4127 | 31411 | 3327 | 32175 | 2705 | 32312 | 1693 | 39298 | 882 | 32540 |
| 8L-2S | | MI | 16333 | 5700 | 27621 | 4030 | 30587 | 3234 | 32132 | 2587 | 34422 | 1573 | 41455 | 1320 | 28216 |
| 16-#18 | 6.35 | MA | 20364 | 6668 | 36511 | 4683 | 40667 | 3733 | 43508 | 2959 | 47264 | 1571 | 59351 | 497 | 56154 |
| 6L-4S | | MI | 16891 | 6668 | 30621 | 4604 | 34101 | 3612 | 36306 | 2774 | 40146 | 1420 | 49208 | 504 | 45295 |
| 18-#11 | 2.79 | MA | 19180 | 5426 | 31443 | 3965 | 34560 | 3197 | 36018 | 2608 | 37664 | 1727 | 45495 | 1372 | 29667 |
| 4L-7S | | MI | 13754 | 5426 | 22740 | 3882 | 24383 | 3138 | 24790 | 2547 | 24784 | 1656 | 29592 | 1099 | 21348 |
| 18-#11 | 2.79 | MA | 18748 | 5426 | 30712 | 3961 | 33613 | 3209 | 34854 | 2619 | 35997 | 1718 | 43516 | 1332 | 29195 |
| 5L-6S | | MI | 14058 | 5426 | 23303 | 3871 | 25061 | 3129 | 25648 | 2555 | 25841 | 1647 | 30827 | 1164 | 21707 |
| 18-#11 | 2.79 | MA | 18336 | 5426 | 30026 | 3958 | 32664 | 3204 | 33694 | 2612 | 34486 | 1727 | 41651 | 1276 | 28671 |
| 6L-5S | | MI | 14370 | 5426 | 23817 | 3877 | 25772 | 3137 | 26461 | 2547 | 26923 | 1639 | 32137 | 1221 | 22017 |
| 18-#11 | 2.79 | MA | 17935 | 5426 | 29275 | 3971 | 31758 | 3216 | 32581 | 2622 | 33010 | 1736 | 39658 | 1186 | 28182 |
| 7L-4S | | MI | 14697 | 5426 | 24364 | 3883 | 26480 | 3128 | 27316 | 2538 | 28120 | 1647 | 33543 | 1259 | 22390 |
| 18-#11 | 2.79 | MA | 17541 | 5426 | 28599 | 3968 | 30839 | 3211 | 31493 | 2633 | 31441 | 1727 | 37809 | 1139 | 27460 |
| 8L-3S | | MI | 15059 | 5426 | 24992 | 3871 | 27281 | 3136 | 28274 | 2547 | 29311 | 1639 | 34864 | 1342 | 22415 |
| 18-#11 | 2.79 | MA | 17150 | 5426 | 27872 | 3981 | 29944 | 3223 | 30356 | 2626 | 29978 | 1736 | 36001 | 1085 | 26731 |
| 9L-2S | | MI | 15563 | 5426 | 25754 | 3877 | 28257 | 3126 | 29450 | 2538 | 30871 | 1630 | 36905 | 1429 | 22402 |
| 18-#14 | 4.02 | MA | 19842 | 5856 | 33622 | 4217 | 37274 | 3396 | 39294 | 2730 | 41881 | 1666 | 51491 | 1127 | 40412 |
| 5L-6S | | MI | 14685 | 5856 | 25207 | 4115 | 27417 | 3304 | 28419 | 2652 | 29515 | 1576 | 35768 | 893 | 29589 |
| 18-#14 | 4.02 | MA | 19264 | 5856 | 32640 | 4211 | 35915 | 3388 | 37633 | 2719 | 39734 | 1678 | 48849 | 1045 | 39519 |
| 6L-5S | | MI | 15123 | 5856 | 25942 | 4124 | 28432 | 3316 | 29569 | 2639 | 31045 | 1564 | 37611 | 975 | 30295 |
| 18-#14 | 4.02 | MA | 18702 | 5856 | 31563 | 4230 | 34617 | 3405 | 36037 | 2733 | 37636 | 1691 | 46025 | 915 | 38231 |
| 7L-4S | | MI | 15583 | 5856 | 26724 | 4134 | 29444 | 3304 | 30777 | 2627 | 32738 | 1576 | 39592 | 1030 | 31024 |
| 18-#14 | 4.02 | MA | 18148 | 5856 | 30595 | 4224 | 33300 | 3397 | 34480 | 2748 | 35405 | 1678 | 43397 | 849 | 36852 |
| 8L-3S | | MI | 16092 | 5856 | 27621 | 4118 | 30587 | 3316 | 32132 | 2639 | 34422 | 1564 | 41455 | 1149 | 31537 |
| 20-#11 | 3.10 | MA | 19218 | 5534 | 31743 | 4029 | 34935 | 3258 | 36467 | 2648 | 38173 | 1709 | 46407 | 1311 | 32290 |
| 5L-7S | | MI | 14095 | 5534 | 23501 | 3950 | 25359 | 3187 | 25966 | 2575 | 26343 | 1642 | 31632 | 1069 | 23590 |
| 20-#11 | 3.10 | MA | 18809 | 5534 | 31057 | 4025 | 33986 | 3252 | 35307 | 2641 | 36663 | 1717 | 44542 | 1254 | 31791 |
| 6E | | MI | 14398 | 5534 | 24064 | 3938 | 26038 | 3177 | 26824 | 2583 | 27400 | 1633 | 32867 | 1134 | 24008 |
| 20-#11 | 3.10 | MA | 18410 | 5534 | 30306 | 4039 | 33080 | 3264 | 34193 | 2652 | 35187 | 1726 | 42550 | 1164 | 31239 |
| 7L-5S | | MI | 14709 | 5534 | 24578 | 3944 | 26748 | 3185 | 27637 | 2575 | 28482 | 1625 | 34177 | 1191 | 24300 |
| 20-#11 | 3.10 | MA | 18018 | 5534 | 29631 | 4035 | 32161 | 3259 | 33106 | 2662 | 33618 | 1717 | 40700 | 1118 | 30542 |
| 8L-4S | | MI | 15034 | 5534 | 25125 | 3950 | 27456 | 3176 | 28492 | 2566 | 29679 | 1633 | 35584 | 1229 | 24748 |
| 20-#11 | 3.10 | MA | 17629 | 5534 | 28904 | 4049 | 31266 | 3271 | 31969 | 2656 | 32155 | 1726 | 38892 | 1063 | 29771 |
| 9L-3S | | MI | 15395 | 5534 | 25754 | 3939 | 28257 | 3184 | 29450 | 2575 | 30871 | 1625 | 36905 | 1312 | 24785 |

## RECTANGULAR TIED COLUMNS 28" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 4.46 | MA | 19927 | 6011 | 34113 | 4308 | 37804 | 3458 | 39938 | 2761 | 42828 | 1663 | 52948 | 1012 | 43853 |
| 6E | | MI | 15161 | 6011 | 26292 | 4212 | 28808 | 3374 | 30082 | 2691 | 31720 | 1554 | 38642 | 846 | 32750 |
| 20-#14 | 4.46 | MA | 19368 | 6011 | 33037 | 4327 | 36506 | 3475 | 38342 | 2776 | 40730 | 1675 | 50124 | 882 | 42614 |
| 7L-5S | | MI | 15596 | 6011 | 27027 | 4222 | 29823 | 3386 | 31231 | 2678 | 33250 | 1542 | 40485 | 929 | 33545 |
| 20-#14 | 4.46 | MA | 18818 | 6011 | 32069 | 4321 | 35189 | 3467 | 36784 | 2790 | 38499 | 1663 | 47496 | 816 | 41175 |
| 8L-4S | | MI | 16053 | 6011 | 27808 | 4231 | 30835 | 3374 | 32440 | 2666 | 34942 | 1554 | 42466 | 984 | 34229 |
| 22-#11 | 3.40 | MA | 19279 | 5642 | 32089 | 4092 | 35308 | 3301 | 36920 | 2671 | 38839 | 1707 | 47434 | 1233 | 34914 |
| 6L-7S | | MI | 14435 | 5642 | 24263 | 4017 | 26335 | 3235 | 27142 | 2603 | 27903 | 1628 | 33673 | 1039 | 25838 |
| 22-#11 | 3.40 | MA | 18882 | 5642 | 31337 | 4106 | 34402 | 3313 | 35806 | 2681 | 37364 | 1716 | 45441 | 1143 | 34302 |
| 7L-6S | | MI | 14736 | 5642 | 24826 | 4006 | 27014 | 3226 | 28000 | 2611 | 28960 | 1619 | 34908 | 1104 | 26311 |
| 22-#11 | 3.40 | MA | 18492 | 5642 | 30662 | 4102 | 33483 | 3308 | 34719 | 2692 | 35794 | 1707 | 43592 | 1096 | 33629 |
| 8L-5S | | MI | 15046 | 5642 | 25340 | 4012 | 27724 | 3234 | 28813 | 2603 | 30042 | 1611 | 36218 | 1161 | 26588 |
| 22-#11 | 3.40 | MA | 18105 | 5642 | 29935 | 4116 | 32589 | 3320 | 33582 | 2685 | 34331 | 1716 | 41784 | 1042 | 32819 |
| 9L-4S | | MI | 15369 | 5642 | 25887 | 4017 | 28433 | 3224 | 29668 | 2594 | 31239 | 1619 | 37625 | 1199 | 27103 |
| 22-#14 | 4.91 | MA | 20031 | 6167 | 34511 | 4424 | 38395 | 3545 | 40647 | 2818 | 43824 | 1660 | 54223 | 848 | 47006 |
| 7L-6S | | MI | 15633 | 6167 | 27377 | 4310 | 30198 | 3444 | 31744 | 2730 | 33925 | 1533 | 41516 | 800 | 35922 |
| 22-#14 | 4.91 | MA | 19484 | 6167 | 33543 | 4418 | 37078 | 3536 | 39089 | 2833 | 41592 | 1648 | 51595 | 782 | 45508 |
| 8L-5S | | MI | 16067 | 6167 | 28112 | 4319 | 31213 | 3456 | 32894 | 2718 | 35455 | 1520 | 43359 | 883 | 36802 |
| 24-#11 | 3.71 | MA | 19352 | 5750 | 32369 | 4174 | 35724 | 3361 | 37419 | 2711 | 39540 | 1706 | 48333 | 1121 | 37372 |
| 7E | | MI | 14773 | 5750 | 25025 | 4084 | 27312 | 3284 | 28318 | 2631 | 29463 | 1614 | 35714 | 1009 | 28092 |
| 24-#11 | 3.71 | MA | 18963 | 5750 | 31693 | 4170 | 34805 | 3356 | 36332 | 2721 | 37971 | 1698 | 46483 | 1074 | 36721 |
| 8L-6S | | MI | 15073 | 5750 | 25587 | 4073 | 27990 | 3274 | 29176 | 2639 | 30520 | 1605 | 36949 | 1074 | 28616 |
| 24-#11 | 3.71 | MA | 18579 | 5750 | 30966 | 4184 | 33911 | 3368 | 35195 | 2714 | 36508 | 1706 | 44675 | 1020 | 35872 |
| 9L-5S | | MI | 15381 | 5750 | 26102 | 4079 | 28701 | 3282 | 29989 | 2631 | 31602 | 1597 | 38259 | 1131 | 28880 |
| 24-#14 | 5.36 | MA | 20146 | 6323 | 35017 | 4516 | 38968 | 3606 | 41394 | 2875 | 44686 | 1633 | 55694 | 749 | 49850 |
| 8L-6S | | MI | 16104 | 6323 | 28462 | 4407 | 31589 | 3514 | 33406 | 2770 | 36130 | 1511 | 44390 | 754 | 39103 |

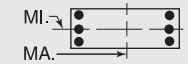
## RECTANGULAR TIED COLUMNS 28" x 38"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.50 | MA | 20428 | 5256 | 32372 | 3852 | 34950 | 3133 | 35734 | 2601 | 35787 | 1826 | 42018 | 1696 | 18106 |
| 2E | | MI | 14847 | 5256 | 23842 | 3740 | 25269 | 3034 | 25481 | 2504 | 25132 | 1735 | 29062 | 1577 | 12962 |
| 6-#14 | 1.27 | MA | 20098 | 5170 | 31490 | 3827 | 33962 | 3118 | 34583 | 2597 | 34371 | 1856 | 40229 | 1743 | 15506 |
| 2L-3S | | MI | 13914 | 5170 | 22165 | 3715 | 23325 | 3046 | 23204 | 2529 | 22125 | 1791 | 25237 | 1520 | 11237 |
| 6-#14 | 1.27 | MA | 19032 | 5170 | 29919 | 3821 | 31948 | 3135 | 32126 | 2613 | 31054 | 1869 | 35822 | 1618 | 15570 |
| 3L-2S | | MI | 14646 | 5170 | 23250 | 3724 | 24715 | 3034 | 24866 | 2517 | 24330 | 1778 | 28111 | 1644 | 11155 |
| 6-#18 | 2.26 | MA | 21674 | 5533 | 35116 | 4025 | 38467 | 3257 | 40026 | 2677 | 41522 | 1797 | 49599 | 1634 | 26740 |
| 2L-3S | | MI | 14418 | 5533 | 23842 | 3893 | 25269 | 3177 | 25481 | 2592 | 25132 | 1713 | 29062 | 1264 | 19033 |
| 6-#18 | 2.26 | MA | 19845 | 5533 | 32372 | 4014 | 34950 | 3286 | 35734 | 2701 | 35787 | 1819 | 42018 | 1412 | 26693 |
| 3L-2S | | MI | 15669 | 5533 | 25721 | 3913 | 27642 | 3155 | 28317 | 2569 | 28895 | 1691 | 33927 | 1485 | 18946 |
| 8-#11 | 1.17 | MA | 19962 | 5134 | 31117 | 3819 | 33557 | 3113 | 34115 | 2598 | 33797 | 1870 | 39506 | 1763 | 14433 |
| 2L-4S | | MI | 13677 | 5134 | 21605 | 3727 | 22680 | 3035 | 22484 | 2524 | 21257 | 1815 | 24369 | 1503 | 10517 |
| 8-#11 | 1.17 | MA | 19214 | 5134 | 30018 | 3816 | 32148 | 3126 | 32397 | 2609 | 31466 | 1878 | 36401 | 1676 | 14477 |
| 3E | | MI | 14048 | 5134 | 22234 | 3716 | 23481 | 3043 | 23442 | 2533 | 22448 | 1806 | 25690 | 1586 | 10457 |
| 8-#11 | 1.17 | MA | 18686 | 5134 | 29120 | 3830 | 31004 | 3121 | 31007 | 2603 | 29684 | 1887 | 34385 | 1590 | 14509 |
| 4L-2S | | MI | 14563 | 5134 | 22996 | 3722 | 24457 | 3034 | 24618 | 2524 | 24008 | 1798 | 27731 | 1673 | 10403 |
| 8-#14 | 1.69 | MA | 20824 | 5325 | 33061 | 3924 | 35976 | 3187 | 37040 | 2640 | 37687 | 1842 | 44636 | 1712 | 20456 |
| 2L-4S | | MI | 13876 | 5325 | 22352 | 3828 | 23572 | 3103 | 23512 | 2556 | 22646 | 1782 | 26248 | 1355 | 14728 |
| 8-#14 | 1.69 | MA | 19766 | 5325 | 31490 | 3919 | 33962 | 3205 | 34583 | 2655 | 34371 | 1855 | 40229 | 1587 | 20494 |
| 3E | | MI | 14402 | 5325 | 23250 | 3812 | 24715 | 3116 | 24866 | 2569 | 24330 | 1769 | 28111 | 1473 | 14682 |
| 8-#14 | 1.69 | MA | 19017 | 5325 | 30205 | 3938 | 32325 | 3198 | 32593 | 2645 | 31836 | 1867 | 37372 | 1463 | 20431 |
| 4L-2S | | MI | 15130 | 5325 | 24334 | 3822 | 26106 | 3103 | 26529 | 2556 | 26535 | 1757 | 30985 | 1598 | 14614 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis

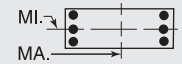



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.01 | MA | 22902 | 5809 | 37860 | 4198 | 41985 | 3381 | 44317 | 2752 | 47256 | 1768 | 57181 | 1571 | 35326 |
| 2L-4S | | MI | 14342 | 5809 | 24159 | 4091 | 25690 | 3275 | 26004 | 2635 | 26022 | 1691 | 30763 | 967 | 23654 |
| 8-#18 | 3.01 | MA | 21092 | 5809 | 35116 | 4187 | 38467 | 3410 | 40026 | 2776 | 41522 | 1790 | 49599 | 1350 | 35163 |
| 3E | | MI | 15242 | 5809 | 25721 | 4066 | 27642 | 3298 | 28317 | 2657 | 28895 | 1669 | 33927 | 1171 | 24877 |
| 8-#18 | 3.01 | MA | 19810 | 5809 | 32864 | 4220 | 35598 | 3394 | 36539 | 2756 | 37139 | 1813 | 44699 | 1129 | 33367 |
| 4L-2S | | MI | 16482 | 5809 | 27601 | 4086 | 30015 | 3275 | 31153 | 2635 | 32658 | 1647 | 38793 | 1393 | 24876 |
| 10-#11 | 1.47 | MA | 20474 | 5242 | 32215 | 3886 | 34965 | 3162 | 35834 | 2627 | 36128 | 1861 | 42611 | 1743 | 17896 |
| 2L-5S | | MI | 13691 | 5242 | 21820 | 3789 | 22948 | 3093 | 22805 | 2561 | 21619 | 1792 | 25003 | 1435 | 12956 |
| 10-#11 | 1.47 | MA | 19730 | 5242 | 31117 | 3883 | 33557 | 3174 | 34115 | 2638 | 33797 | 1869 | 39506 | 1656 | 17930 |
| 3L-4S | | MI | 14024 | 5242 | 22367 | 3795 | 23656 | 3083 | 23660 | 2553 | 22816 | 1801 | 26410 | 1473 | 12928 |
| 10-#11 | 1.47 | MA | 19206 | 5242 | 30219 | 3897 | 32413 | 3170 | 32725 | 2632 | 32015 | 1878 | 37490 | 1570 | 17937 |
| 4L-3S | | MI | 14394 | 5242 | 22996 | 3783 | 24457 | 3091 | 24618 | 2561 | 24008 | 1792 | 27731 | 1556 | 12881 |
| 10-#11 | 1.47 | MA | 18736 | 5242 | 29442 | 3894 | 31406 | 3182 | 31488 | 2643 | 30230 | 1869 | 35370 | 1530 | 17878 |
| 5L-2S | | MI | 14907 | 5242 | 23757 | 3789 | 25433 | 3082 | 25794 | 2553 | 25567 | 1784 | 29771 | 1643 | 12833 |
| 10-#14 | 2.11 | MA | 21544 | 5481 | 34632 | 4021 | 37990 | 3257 | 39497 | 2682 | 41003 | 1828 | 49042 | 1681 | 25387 |
| 2L-5S | | MI | 13892 | 5481 | 22656 | 3916 | 23951 | 3186 | 23966 | 2608 | 23158 | 1747 | 27141 | 1254 | 17553 |
| 10-#14 | 2.11 | MA | 20492 | 5481 | 33061 | 4016 | 35976 | 3275 | 37040 | 2697 | 37687 | 1840 | 44636 | 1556 | 25388 |
| 3L-4S | | MI | 14364 | 5481 | 23437 | 3925 | 24963 | 3173 | 25174 | 2595 | 24850 | 1760 | 29122 | 1309 | 18108 |
| 10-#14 | 2.11 | MA | 19750 | 5481 | 31776 | 4036 | 34339 | 3267 | 35050 | 2688 | 35152 | 1853 | 41779 | 1432 | 25281 |
| 4L-3S | | MI | 14886 | 5481 | 24334 | 3910 | 26106 | 3186 | 26529 | 2608 | 26535 | 1747 | 30985 | 1427 | 18100 |
| 10-#14 | 2.11 | MA | 19085 | 5481 | 30663 | 4030 | 32895 | 3285 | 33277 | 2703 | 32612 | 1840 | 38764 | 1375 | 24380 |
| 5L-2S | | MI | 15610 | 5481 | 25419 | 3919 | 27496 | 3173 | 28191 | 2595 | 28739 | 1735 | 33858 | 1552 | 18050 |
| 10-#18 | 3.76 | MA | 22323 | 6086 | 37860 | 4360 | 41985 | 3534 | 44317 | 2852 | 47256 | 1762 | 57181 | 1288 | 43611 |
| 3L-4S | | MI | 15165 | 6086 | 26039 | 4264 | 28063 | 3396 | 28840 | 2701 | 29784 | 1648 | 35629 | 875 | 29074 |
| 10-#18 | 3.76 | MA | 21055 | 6086 | 35608 | 4393 | 39116 | 3519 | 40831 | 2832 | 42874 | 1784 | 52281 | 1066 | 41376 |
| 4L-3S | | MI | 16057 | 6086 | 27601 | 4239 | 30015 | 3418 | 31153 | 2723 | 32658 | 1625 | 38793 | 1079 | 30685 |
| 10-#18 | 3.76 | MA | 19921 | 6086 | 33655 | 4382 | 36585 | 3547 | 37721 | 2856 | 38479 | 1762 | 47068 | 969 | 39259 |
| 5L-2S | | MI | 17287 | 6086 | 29481 | 4259 | 32388 | 3396 | 33989 | 2701 | 36420 | 1603 | 43658 | 1300 | 30775 |
| 12-#11 | 1.76 | MA | 20983 | 5350 | 33314 | 3954 | 36374 | 3210 | 37552 | 2657 | 38459 | 1852 | 45716 | 1722 | 21350 |
| 2L-6S | | MI | 13720 | 5350 | 22068 | 3850 | 23214 | 3133 | 23168 | 2598 | 22097 | 1787 | 25734 | 1348 | 14951 |
| 12-#11 | 1.76 | MA | 20243 | 5350 | 32215 | 3950 | 34965 | 3223 | 35834 | 2668 | 36128 | 1860 | 42611 | 1636 | 21372 |
| 3L-5S | | MI | 14037 | 5350 | 22582 | 3856 | 23924 | 3141 | 23981 | 2589 | 23179 | 1778 | 27044 | 1405 | 15331 |
| 12-#11 | 1.76 | MA | 19721 | 5350 | 31318 | 3964 | 33821 | 3218 | 34444 | 2662 | 34346 | 1869 | 40595 | 1550 | 21353 |
| 4E | | MI | 14369 | 5350 | 23129 | 3862 | 24633 | 3132 | 24836 | 2581 | 24376 | 1787 | 28451 | 1443 | 15325 |
| 12-#11 | 1.76 | MA | 19254 | 5350 | 30541 | 3961 | 32814 | 3231 | 33206 | 2673 | 32561 | 1860 | 38475 | 1510 | 21269 |
| 5L-3S | | MI | 14737 | 5350 | 23757 | 3851 | 25433 | 3140 | 25794 | 2589 | 25567 | 1778 | 29771 | 1526 | 15291 |
| 12-#11 | 1.76 | MA | 18809 | 5350 | 29812 | 3958 | 31805 | 3226 | 31973 | 2666 | 30943 | 1869 | 36471 | 1453 | 20631 |
| 6L-2S | | MI | 15248 | 5350 | 24519 | 3857 | 26410 | 3130 | 26970 | 2581 | 27127 | 1770 | 31812 | 1613 | 15251 |
| 12-#14 | 2.54 | MA | 22257 | 5637 | 36203 | 4118 | 40004 | 3327 | 41954 | 2725 | 44320 | 1814 | 53449 | 1650 | 30307 |
| 2L-6S | | MI | 13932 | 5637 | 23005 | 4004 | 24327 | 3243 | 24478 | 2660 | 23833 | 1738 | 28172 | 1125 | 20318 |
| 12-#14 | 2.54 | MA | 21212 | 5637 | 34632 | 4113 | 37990 | 3345 | 39497 | 2740 | 41003 | 1826 | 49042 | 1525 | 30268 |
| 3L-5S | | MI | 14379 | 5637 | 23740 | 4013 | 25341 | 3256 | 25628 | 2647 | 25363 | 1726 | 30015 | 1207 | 20762 |
| 12-#14 | 2.54 | MA | 20475 | 5637 | 33347 | 4133 | 36353 | 3337 | 37507 | 2730 | 38469 | 1839 | 46186 | 1401 | 30121 |
| 4E | | MI | 14847 | 5637 | 24522 | 4022 | 26353 | 3243 | 26836 | 2635 | 27055 | 1738 | 31996 | 1263 | 21470 |
| 12-#14 | 2.54 | MA | 19815 | 5637 | 32234 | 4128 | 34909 | 3355 | 35734 | 2745 | 35928 | 1826 | 43170 | 1344 | 29054 |
| 5L-3S | | MI | 15367 | 5637 | 25419 | 4007 | 27496 | 3255 | 28191 | 2647 | 28739 | 1726 | 33858 | 1381 | 21505 |
| 12-#14 | 2.54 | MA | 19187 | 5637 | 31189 | 4123 | 33464 | 3347 | 33967 | 2736 | 33627 | 1839 | 40328 | 1262 | 28231 |
| 6L-2S | | MI | 16087 | 5637 | 26504 | 4016 | 28887 | 3243 | 29853 | 2635 | 30944 | 1713 | 36732 | 1506 | 21470 |
| 12-#18 | 4.51 | MA | 22285 | 6363 | 38353 | 4566 | 42634 | 3643 | 45123 | 2907 | 48608 | 1755 | 59862 | 1004 | 49434 |
| 4E | | MI | 15980 | 6363 | 27919 | 4437 | 30436 | 3517 | 31676 | 2767 | 33547 | 1604 | 40494 | 782 | 34540 |
| 12-#18 | 4.51 | MA | 21162 | 6363 | 36399 | 4555 | 40103 | 3671 | 42013 | 2931 | 44214 | 1733 | 54650 | 906 | 47453 |
| 5L-3S | | MI | 16864 | 6363 | 29481 | 4412 | 32388 | 3539 | 33989 | 2789 | 36420 | 1582 | 43658 | 986 | 36470 |
| 12-#18 | 4.51 | MA | 20095 | 6363 | 34565 | 4543 | 37566 | 3656 | 38914 | 2911 | 40234 | 1755 | 49768 | 761 | 44130 |
| 6L-2S | | MI | 18084 | 6363 | 31360 | 4432 | 34761 | 3517 | 36825 | 2767 | 40183 | 1559 | 48524 | 1208 | 36626 |
| 14-#11 | 2.05 | MA | 21489 | 5458 | 34413 | 4021 | 37782 | 3259 | 39271 | 2686 | 40790 | 1843 | 48821 | 1702 | 24795 |
| 2L-7S | | MI | 13759 | 5458 | 22267 | 3929 | 23511 | 3191 | 23486 | 2617 | 22600 | 1782 | 26540 | 1253 | 17032 |
| 14-#11 | 2.05 | MA | 20752 | 5458 | 33314 | 4018 | 36374 | 3271 | 37552 | 2697 | 38459 | 1851 | 45716 | 1616 | 24801 |
| 3L-6S | | MI | 14066 | 5458 | 22829 | 3918 | 24190 | 3182 | 24344 | 2626 | 23657 | 1773 | 27775 | 1318 | 17240 |

## RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

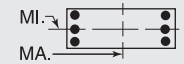
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.05 | MA | 20233 | 5458 | 32417 | 4032 | 35230 | 3267 | 36162 | 2691 | 36677 | 1860 | 43700 | 1530 | 24761 |
| 4L-5S | | MI | 14382 | 5458 | 23343 | 3924 | 24901 | 3190 | 25157 | 2617 | 24739 | 1764 | 29085 | 1375 | 17606 |
| 14-#11 | 2.05 | MA | 19769 | 5458 | 31640 | 4029 | 34223 | 3279 | 34925 | 2702 | 34892 | 1851 | 41581 | 1490 | 24596 |
| 5L-4S | | MI | 14712 | 5458 | 23890 | 3929 | 25609 | 3180 | 26012 | 2609 | 25935 | 1773 | 30492 | 1413 | 17713 |
| 14-#11 | 2.05 | MA | 19326 | 5458 | 30911 | 4025 | 33214 | 3275 | 33692 | 2696 | 33275 | 1860 | 39576 | 1433 | 23938 |
| 6L-3S | | MI | 15078 | 5458 | 24519 | 3918 | 26410 | 3188 | 26970 | 2617 | 27127 | 1764 | 31812 | 1497 | 17691 |
| 14-#11 | 2.05 | MA | 18895 | 5458 | 30113 | 4040 | 32251 | 3287 | 32508 | 2707 | 31694 | 1869 | 37436 | 1343 | 23532 |
| 7L-2S | | MI | 15587 | 5458 | 25281 | 3924 | 27386 | 3179 | 28146 | 2609 | 28687 | 1756 | 33853 | 1583 | 17658 |
| 14-#14 | 2.96 | MA | 21927 | 5792 | 36203 | 4210 | 40004 | 3414 | 41954 | 2782 | 44320 | 1812 | 53449 | 1494 | 35138 |
| 3L-6S | | MI | 14417 | 5792 | 24090 | 4101 | 25717 | 3313 | 26141 | 2699 | 26038 | 1716 | 31046 | 1078 | 23572 |
| 14-#14 | 2.96 | MA | 21194 | 5792 | 34918 | 4230 | 38366 | 3407 | 39963 | 2773 | 41785 | 1825 | 50592 | 1370 | 34956 |
| 4L-5S | | MI | 14862 | 5792 | 24825 | 4110 | 26732 | 3325 | 27290 | 2687 | 27568 | 1704 | 32889 | 1161 | 23987 |
| 14-#14 | 2.96 | MA | 20539 | 5792 | 33805 | 4225 | 36923 | 3424 | 38190 | 2788 | 39245 | 1812 | 47577 | 1313 | 33745 |
| 5L-4S | | MI | 15328 | 5792 | 25606 | 4120 | 27744 | 3313 | 28499 | 2674 | 29260 | 1716 | 34870 | 1216 | 24821 |
| 14-#14 | 2.96 | MA | 19916 | 5792 | 32760 | 4220 | 35478 | 3417 | 36424 | 2778 | 36943 | 1825 | 44735 | 1231 | 32963 |
| 6L-3S | | MI | 15845 | 5792 | 26504 | 4104 | 28887 | 3325 | 29853 | 2687 | 30944 | 1704 | 36732 | 1335 | 24885 |
| 14-#14 | 2.96 | MA | 19308 | 5792 | 31616 | 4239 | 34098 | 3435 | 34728 | 2793 | 34694 | 1837 | 41698 | 1101 | 31599 |
| 7L-2S | | MI | 16561 | 5792 | 27589 | 4113 | 30278 | 3313 | 31516 | 2674 | 33149 | 1692 | 39606 | 1460 | 24878 |
| 14-#18 | 5.26 | MA | 22390 | 6639 | 39144 | 4727 | 43621 | 3796 | 46305 | 3007 | 49948 | 1704 | 62231 | 844 | 55499 |
| 5L-4S | | MI | 16788 | 6639 | 29798 | 4610 | 32809 | 3638 | 34513 | 2833 | 37310 | 1560 | 45360 | 690 | 40040 |
| 14-#18 | 5.26 | MA | 21334 | 6639 | 37310 | 4716 | 41084 | 3780 | 43206 | 2987 | 45969 | 1727 | 57349 | 699 | 52185 |
| 6L-3S | | MI | 17665 | 6639 | 31360 | 4585 | 34761 | 3660 | 36825 | 2855 | 40183 | 1538 | 48524 | 894 | 42239 |
| 16-#11 | 2.35 | MA | 21258 | 5566 | 34413 | 4085 | 37782 | 3320 | 39271 | 2726 | 40790 | 1842 | 48821 | 1596 | 28221 |
| 3L-7S | | MI | 14104 | 5566 | 23028 | 3996 | 24488 | 3239 | 24662 | 2645 | 24159 | 1768 | 28581 | 1224 | 19319 |
| 16-#11 | 2.35 | MA | 20742 | 5566 | 33516 | 4099 | 36639 | 3315 | 37881 | 2720 | 39009 | 1851 | 46805 | 1510 | 28164 |
| 4L-6S | | MI | 14410 | 5566 | 23591 | 3985 | 25167 | 3230 | 25520 | 2654 | 25216 | 1759 | 29816 | 1288 | 19534 |
| 16-#11 | 2.35 | MA | 20280 | 5566 | 32739 | 4096 | 35631 | 3328 | 36643 | 2731 | 37224 | 1842 | 44686 | 1470 | 27877 |
| 5E | | MI | 14724 | 5566 | 24105 | 3991 | 25877 | 3238 | 26333 | 2645 | 26298 | 1750 | 31126 | 1345 | 19876 |
| 16-#11 | 2.35 | MA | 19840 | 5566 | 32010 | 4093 | 34623 | 3323 | 35410 | 2725 | 35606 | 1851 | 42681 | 1413 | 27252 |
| 6L-4S | | MI | 15053 | 5566 | 24652 | 3997 | 26585 | 3229 | 27188 | 2637 | 27495 | 1759 | 32532 | 1383 | 20089 |
| 16-#11 | 2.35 | MA | 19411 | 5566 | 31212 | 4107 | 33660 | 3336 | 34227 | 2736 | 34025 | 1860 | 40541 | 1323 | 26862 |
| 7L-3S | | MI | 15418 | 5566 | 25281 | 3986 | 27386 | 3237 | 28146 | 2645 | 28687 | 1750 | 33853 | 1467 | 20083 |
| 16-#11 | 2.35 | MA | 18989 | 5566 | 30494 | 4104 | 32683 | 3331 | 33071 | 2748 | 32345 | 1851 | 38560 | 1276 | 26064 |
| 8L-2S | | MI | 15925 | 5566 | 26042 | 3991 | 28363 | 3227 | 29322 | 2637 | 30246 | 1742 | 35894 | 1553 | 20058 |
| 16-#14 | 3.38 | MA | 21908 | 5948 | 36489 | 4327 | 40380 | 3477 | 42420 | 2815 | 45102 | 1811 | 54999 | 1339 | 39786 |
| 4L-6S | | MI | 14900 | 5948 | 25175 | 4198 | 27108 | 3383 | 27803 | 2738 | 28243 | 1695 | 33920 | 1032 | 26722 |
| 16-#14 | 3.38 | MA | 21258 | 5948 | 35376 | 4322 | 38937 | 3494 | 40647 | 2830 | 42561 | 1798 | 51983 | 1282 | 38449 |
| 5E | | MI | 15342 | 5948 | 25910 | 4208 | 28123 | 3395 | 28953 | 2726 | 29773 | 1682 | 35763 | 1115 | 27222 |
| 16-#14 | 3.38 | MA | 20638 | 5948 | 34331 | 4317 | 37492 | 3487 | 38881 | 2821 | 40260 | 1811 | 49141 | 1200 | 37703 |
| 6L-4S | | MI | 15805 | 5948 | 26691 | 4217 | 29135 | 3383 | 30161 | 2714 | 31465 | 1695 | 37744 | 1170 | 28033 |
| 16-#14 | 3.38 | MA | 20035 | 5948 | 33187 | 4337 | 36112 | 3504 | 37185 | 2836 | 38011 | 1823 | 46105 | 1070 | 36255 |
| 7L-3S | | MI | 16319 | 5948 | 27589 | 4201 | 30278 | 3395 | 31516 | 2726 | 33149 | 1682 | 39606 | 1289 | 28254 |
| 16-#14 | 3.38 | MA | 19442 | 5948 | 32158 | 4332 | 34712 | 3497 | 35528 | 2851 | 35620 | 1811 | 43286 | 1003 | 34971 |
| 8L-2S | | MI | 17032 | 5948 | 28673 | 4211 | 31668 | 3383 | 33178 | 2714 | 35354 | 1670 | 42480 | 1414 | 28280 |
| 16-#18 | 6.02 | MA | 22560 | 6916 | 40054 | 4889 | 44602 | 3904 | 47497 | 3062 | 51704 | 1698 | 64930 | 636 | 60266 |
| 6L-4S | | MI | 17589 | 6916 | 31678 | 4783 | 35181 | 3758 | 37349 | 2899 | 41073 | 1516 | 50225 | 597 | 45567 |
| 18-#11 | 2.64 | MA | 21247 | 5674 | 34614 | 4167 | 38047 | 3363 | 39599 | 2750 | 41340 | 1842 | 49910 | 1490 | 31563 |
| 4L-7S | | MI | 14447 | 5674 | 23790 | 4064 | 25464 | 3288 | 25838 | 2673 | 25719 | 1754 | 30622 | 1194 | 21551 |
| 18-#11 | 2.64 | MA | 20788 | 5674 | 33837 | 4164 | 37040 | 3376 | 38362 | 2761 | 39555 | 1833 | 47791 | 1449 | 31168 |
| 5L-6S | | MI | 14752 | 5674 | 24352 | 4053 | 26143 | 3278 | 26696 | 2682 | 26776 | 1745 | 31856 | 1258 | 21833 |
| 18-#11 | 2.64 | MA | 20350 | 5674 | 33109 | 4160 | 36031 | 3371 | 37129 | 2755 | 37937 | 1842 | 45787 | 1393 | 30573 |
| 6L-5S | | MI | 15065 | 5674 | 24867 | 4058 | 26853 | 3286 | 27509 | 2673 | 27858 | 1736 | 33166 | 1315 | 22153 |
| 18-#11 | 2.64 | MA | 19924 | 5674 | 32311 | 4174 | 35068 | 3384 | 35945 | 2766 | 36356 | 1850 | 43646 | 1303 | 30158 |
| 7L-4S | | MI | 15392 | 5674 | 25414 | 4064 | 27562 | 3277 | 28364 | 2665 | 29055 | 1745 | 34573 | 1353 | 22456 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 38"

Short columns – no sidesway
Bending on major or minor axis

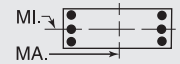



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.64 | MA | 19504 | 5674 | 31593 | 4171 | 34092 | 3379 | 34790 | 2777 | 34676 | 1842 | 41665 | 1256 | 29345 |
| 8L-3S | | MI | 15756 | 5674 | 26042 | 4053 | 28363 | 3285 | 29322 | 2673 | 30246 | 1736 | 35894 | 1437 | 22469 |
| 18-#11 | 2.64 | MA | 19088 | 5674 | 30821 | 4185 | 33141 | 3392 | 33581 | 2771 | 33109 | 1850 | 39722 | 1202 | 28658 |
| 9L-2S | | MI | 16261 | 5674 | 26804 | 4059 | 29339 | 3276 | 30498 | 2665 | 31806 | 1728 | 37935 | 1523 | 22452 |
| 18-#14 | 3.81 | MA | 21970 | 6103 | 36947 | 4419 | 40951 | 3564 | 43104 | 2873 | 45878 | 1784 | 56390 | 1251 | 43165 |
| 5L-6S | | MI | 15379 | 6103 | 26260 | 4296 | 28498 | 3453 | 29465 | 2778 | 30448 | 1673 | 36794 | 986 | 29867 |
| 18-#14 | 3.81 | MA | 21355 | 6103 | 35902 | 4414 | 39506 | 3557 | 41338 | 2863 | 43576 | 1797 | 53548 | 1169 | 42378 |
| 6L-5S | | MI | 15819 | 6103 | 26995 | 4305 | 29513 | 3465 | 30615 | 2765 | 31977 | 1661 | 38637 | 1069 | 30466 |
| 18-#14 | 3.81 | MA | 20756 | 6103 | 34758 | 4434 | 38126 | 3574 | 39642 | 2878 | 41327 | 1809 | 50511 | 1039 | 40923 |
| 7L-4S | | MI | 16280 | 6103 | 27776 | 4314 | 30525 | 3453 | 31824 | 2753 | 33670 | 1673 | 40618 | 1124 | 31224 |
| 18-#14 | 3.81 | MA | 20167 | 6103 | 33729 | 4429 | 36726 | 3567 | 37985 | 2894 | 38936 | 1797 | 47693 | 972 | 39576 |
| 8L-3S | | MI | 16791 | 6103 | 28673 | 4299 | 31668 | 3465 | 33178 | 2765 | 35354 | 1661 | 42480 | 1243 | 31616 |
| 20-#11 | 2.93 | MA | 21293 | 5782 | 34936 | 4231 | 38449 | 3424 | 40080 | 2790 | 41886 | 1824 | 50896 | 1429 | 34467 |
| 5L-7S | | MI | 14789 | 5782 | 24551 | 4131 | 26441 | 3336 | 27014 | 2702 | 27279 | 1740 | 32662 | 1164 | 23791 |
| 20-#11 | 2.93 | MA | 20857 | 5782 | 34208 | 4228 | 37440 | 3420 | 38847 | 2784 | 40268 | 1833 | 48892 | 1373 | 33898 |
| 6E | | MI | 15093 | 5782 | 25114 | 4120 | 27119 | 3327 | 27872 | 2710 | 28336 | 1731 | 33897 | 1228 | 24135 |
| 20-#11 | 2.93 | MA | 20433 | 5782 | 33409 | 4242 | 36477 | 3432 | 37663 | 2795 | 38687 | 1841 | 46751 | 1283 | 33418 |
| 7L-5S | | MI | 15404 | 5782 | 25628 | 4126 | 27830 | 3335 | 28685 | 2702 | 29418 | 1722 | 35207 | 1285 | 24436 |
| 20-#11 | 2.93 | MA | 20016 | 5782 | 32692 | 4239 | 35500 | 3428 | 36508 | 2806 | 37007 | 1833 | 44770 | 1236 | 32632 |
| 8L-4S | | MI | 15730 | 5782 | 26175 | 4132 | 28538 | 3325 | 29540 | 2693 | 30614 | 1731 | 36614 | 1323 | 24819 |
| 20-#11 | 2.93 | MA | 19602 | 5782 | 31919 | 4253 | 34550 | 3440 | 35300 | 2800 | 35440 | 1841 | 42827 | 1182 | 31902 |
| 9L-3S | | MI | 16092 | 5782 | 26804 | 4120 | 29339 | 3333 | 30498 | 2702 | 31806 | 1722 | 37935 | 1407 | 24846 |
| 20-#11 | 2.93 | MA | 19144 | 5782 | 31204 | 4249 | 33586 | 3436 | 34150 | 2811 | 33886 | 1850 | 40945 | 1120 | 31028 |
| 10L-2S | | MI | 16595 | 5782 | 27566 | 4126 | 30315 | 3324 | 31674 | 2693 | 33365 | 1714 | 39975 | 1493 | 24841 |
| 20-#14 | 4.23 | MA | 22067 | 6259 | 37473 | 4512 | 41520 | 3627 | 43795 | 2905 | 46893 | 1783 | 57955 | 1139 | 47003 |
| 6E | | MI | 15855 | 6259 | 27344 | 4393 | 29889 | 3523 | 31128 | 2817 | 32653 | 1651 | 39668 | 940 | 33025 |
| 20-#14 | 4.23 | MA | 21472 | 6259 | 36329 | 4531 | 40140 | 3644 | 42098 | 2921 | 44644 | 1795 | 54918 | 1008 | 45600 |
| 7L-5S | | MI | 16293 | 6259 | 28079 | 4402 | 30904 | 3535 | 32278 | 2805 | 34182 | 1639 | 41511 | 1023 | 33717 |
| 20-#14 | 4.23 | MA | 20887 | 6259 | 35301 | 4526 | 38740 | 3637 | 40442 | 2936 | 42253 | 1783 | 52100 | 941 | 44192 |
| 8L-4S | | MI | 16751 | 6259 | 28861 | 4412 | 31916 | 3522 | 33486 | 2792 | 35875 | 1651 | 43492 | 1078 | 34427 |
| 22-#11 | 3.23 | MA | 21362 | 5890 | 35306 | 4295 | 38848 | 3468 | 40565 | 2814 | 42599 | 1824 | 51997 | 1353 | 37227 |
| 6L-7S | | MI | 15129 | 5890 | 25313 | 4199 | 27417 | 3385 | 28190 | 2730 | 28838 | 1725 | 34703 | 1134 | 26038 |
| 22-#11 | 3.23 | MA | 20940 | 5890 | 34508 | 4309 | 37885 | 3481 | 39382 | 2825 | 41018 | 1832 | 49856 | 1263 | 36684 |
| 7L-6S | | MI | 15431 | 5890 | 25876 | 4187 | 28096 | 3375 | 29048 | 2738 | 29895 | 1717 | 35938 | 1198 | 26439 |
| 22-#11 | 3.23 | MA | 20524 | 5890 | 33791 | 4306 | 36909 | 3476 | 38226 | 2836 | 39338 | 1824 | 47875 | 1216 | 35924 |
| 8L-5S | | MI | 15742 | 5890 | 26390 | 4193 | 28806 | 3383 | 29861 | 2730 | 30977 | 1708 | 37248 | 1255 | 26724 |
| 22-#11 | 3.23 | MA | 20113 | 5890 | 33018 | 4320 | 35959 | 3489 | 37018 | 2830 | 37771 | 1832 | 45932 | 1162 | 35152 |
| 9L-4S | | MI | 16066 | 5890 | 26937 | 4199 | 29514 | 3374 | 30716 | 2721 | 32174 | 1717 | 38655 | 1293 | 27177 |
| 22-#11 | 3.23 | MA | 19657 | 5890 | 32303 | 4317 | 34995 | 3484 | 35868 | 2841 | 36218 | 1841 | 44050 | 1100 | 34301 |
| 10L-3S | | MI | 16427 | 5890 | 27566 | 4188 | 30315 | 3382 | 31674 | 2730 | 33365 | 1708 | 39975 | 1377 | 27216 |
| 22-#14 | 4.65 | MA | 22183 | 6415 | 37900 | 4628 | 42154 | 3714 | 44555 | 2963 | 47960 | 1781 | 59324 | 977 | 50286 |
| 7L-6S | | MI | 16329 | 6415 | 28429 | 4490 | 31280 | 3592 | 32790 | 2857 | 34858 | 1630 | 42542 | 894 | 36194 |
| 22-#14 | 4.65 | MA | 21601 | 6415 | 36872 | 4623 | 40754 | 3706 | 42899 | 2978 | 45569 | 1768 | 56506 | 910 | 48818 |
| 8L-5S | | MI | 16764 | 6415 | 29164 | 4499 | 32294 | 3605 | 33940 | 2844 | 36387 | 1617 | 44385 | 977 | 36974 |
| 24-#11 | 3.52 | MA | 21443 | 5998 | 35607 | 4377 | 39294 | 3529 | 41100 | 2854 | 43349 | 1823 | 52961 | 1243 | 39957 |
| 7E | | MI | 15467 | 5998 | 26075 | 4266 | 28393 | 3433 | 29366 | 2758 | 30398 | 1711 | 36744 | 1104 | 28291 |
| 24-#11 | 3.52 | MA | 21030 | 5998 | 34889 | 4373 | 38317 | 3525 | 39945 | 2865 | 41669 | 1815 | 50980 | 1196 | 39221 |
| 8L-6S | | MI | 15769 | 5998 | 26637 | 4255 | 29072 | 3424 | 30224 | 2766 | 31455 | 1703 | 37979 | 1168 | 28746 |
| 24-#11 | 3.52 | MA | 20621 | 5998 | 34117 | 4387 | 37367 | 3537 | 38737 | 2859 | 40102 | 1823 | 49037 | 1141 | 38409 |
| 9L-5S | | MI | 16078 | 5998 | 27152 | 4261 | 29782 | 3432 | 31038 | 2758 | 32537 | 1694 | 39289 | 1225 | 29017 |
| 24-#11 | 3.52 | MA | 20168 | 5998 | 33402 | 4384 | 36403 | 3532 | 37587 | 2870 | 38549 | 1832 | 47155 | 1080 | 37580 |
| 10L-4S | | MI | 16401 | 5998 | 27698 | 4267 | 30491 | 3422 | 31892 | 2749 | 33734 | 1703 | 40696 | 1263 | 29531 |
| 24-#14 | 5.08 | MA | 22311 | 6570 | 38443 | 4721 | 42768 | 3776 | 45356 | 3021 | 48886 | 1754 | 60913 | 879 | 53453 |
| 8L-6S | | MI | 16801 | 6570 | 29514 | 4587 | 32670 | 3662 | 34453 | 2896 | 37062 | 1608 | 45416 | 848 | 39373 |

## RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

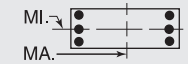
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.43 | MA | 22539 | 5504 | 35557 | 4053 | 38413 | 3299 | 39246 | 2742 | 39270 | 1938 | 46106 | 1809 | 19186 |
| 2E | | MI | 15541 | 5504 | 24899 | 3919 | 26350 | 3181 | 26523 | 2628 | 26059 | 1831 | 30079 | 1670 | 13009 |
| 6-#14 | 1.21 | MA | 22181 | 5417 | 34613 | 4028 | 37355 | 3283 | 38012 | 2738 | 37735 | 1967 | 44157 | 1853 | 16417 |
| 2L-3S | | MI | 14607 | 5417 | 23217 | 3896 | 24406 | 3195 | 24250 | 2655 | 23057 | 1888 | 26262 | 1613 | 11276 |
| 6-#14 | 1.21 | MA | 21047 | 5417 | 32945 | 4023 | 35216 | 3301 | 35403 | 2754 | 34196 | 1980 | 39442 | 1729 | 16481 |
| 3L-2S | | MI | 15340 | 5417 | 24302 | 3905 | 25796 | 3182 | 25913 | 2643 | 25262 | 1875 | 29136 | 1738 | 11192 |
| 6-#18 | 2.14 | MA | 23873 | 5780 | 38474 | 4226 | 42153 | 3423 | 43808 | 2817 | 45400 | 1911 | 54234 | 1750 | 28360 |
| 2L-3S | | MI | 15112 | 5780 | 24899 | 4072 | 26350 | 3324 | 26523 | 2716 | 26059 | 1809 | 30079 | 1356 | 19102 |
| 6-#18 | 2.14 | MA | 21924 | 5780 | 35557 | 4216 | 38413 | 3453 | 39246 | 2843 | 39270 | 1933 | 46106 | 1529 | 28313 |
| 3L-2S | | MI | 16364 | 5780 | 26778 | 4091 | 28722 | 3302 | 29359 | 2694 | 29821 | 1787 | 34945 | 1578 | 19003 |
| 8-#11 | 1.11 | MA | 22034 | 5382 | 34213 | 4020 | 36920 | 3279 | 37511 | 2738 | 37096 | 1980 | 43369 | 1872 | 15275 |
| 2L-4S | | MI | 14370 | 5382 | 22655 | 3909 | 23761 | 3184 | 23532 | 2651 | 22192 | 1913 | 25399 | 1597 | 10553 |
| 8-#11 | 1.11 | MA | 21239 | 5382 | 33047 | 4017 | 35425 | 3292 | 35687 | 2750 | 34615 | 1988 | 40050 | 1786 | 15320 |
| 3E | | MI | 14742 | 5382 | 23284 | 3897 | 24562 | 3192 | 24490 | 2660 | 23383 | 1904 | 26720 | 1681 | 10491 |
| 8-#11 | 1.11 | MA | 20679 | 5382 | 32096 | 4031 | 34213 | 3288 | 34214 | 2744 | 32719 | 1997 | 37892 | 1700 | 15351 |
| 4L-2S | | MI | 15257 | 5382 | 24046 | 3903 | 25539 | 3183 | 25666 | 2651 | 24943 | 1895 | 28761 | 1767 | 10437 |
| 8-#14 | 1.61 | MA | 22958 | 5573 | 36281 | 4125 | 39493 | 3353 | 40621 | 2780 | 41274 | 1954 | 48871 | 1824 | 21671 |
| 2L-4S | | MI | 14569 | 5573 | 23405 | 4009 | 24653 | 3252 | 24558 | 2682 | 23578 | 1879 | 27274 | 1448 | 14784 |
| 8-#14 | 1.61 | MA | 21831 | 5573 | 34613 | 4120 | 37355 | 3371 | 38012 | 2796 | 37735 | 1967 | 44157 | 1700 | 21709 |
| 3E | | MI | 15096 | 5573 | 24302 | 3993 | 25796 | 3264 | 25913 | 2695 | 25262 | 1866 | 29136 | 1567 | 14728 |
| 8-#14 | 1.61 | MA | 21037 | 5573 | 33250 | 4141 | 35618 | 3364 | 35902 | 2788 | 35029 | 1979 | 41096 | 1575 | 21646 |
| 4L-2S | | MI | 15825 | 5573 | 25387 | 4002 | 27187 | 3252 | 27575 | 2682 | 27467 | 1854 | 32010 | 1692 | 14657 |
| 8-#18 | 2.86 | MA | 25188 | 6057 | 41391 | 4399 | 45892 | 3547 | 48370 | 2892 | 51531 | 1885 | 62362 | 1692 | 37486 |
| 2L-4S | | MI | 15035 | 6057 | 25216 | 4270 | 26770 | 3422 | 27047 | 2760 | 26948 | 1787 | 31781 | 1060 | 23934 |
| 8-#18 | 2.86 | MA | 23259 | 6057 | 38474 | 4389 | 42153 | 3577 | 43808 | 2918 | 45400 | 1907 | 54234 | 1471 | 37323 |
| 3E | | MI | 15937 | 6057 | 26778 | 4245 | 28722 | 3444 | 29359 | 2782 | 29821 | 1765 | 34945 | 1264 | 24964 |
| 8-#18 | 2.86 | MA | 21896 | 6057 | 36085 | 4423 | 39108 | 3563 | 40108 | 2900 | 40715 | 1929 | 48972 | 1249 | 35703 |
| 4L-2S | | MI | 17179 | 6057 | 28658 | 4264 | 31095 | 3422 | 32195 | 2760 | 33584 | 1743 | 39810 | 1485 | 24940 |
| 10-#11 | 1.39 | MA | 22582 | 5490 | 35379 | 4087 | 38415 | 3327 | 39335 | 2768 | 39578 | 1971 | 46687 | 1854 | 18949 |
| 2L-5S | | MI | 14384 | 5490 | 22870 | 3970 | 24029 | 3242 | 23853 | 2688 | 22555 | 1890 | 26033 | 1529 | 13008 |
| 10-#11 | 1.39 | MA | 21791 | 5490 | 34213 | 4085 | 36920 | 3340 | 37511 | 2779 | 37096 | 1980 | 43369 | 1767 | 18983 |
| 3L-4S | | MI | 14717 | 5490 | 23417 | 3976 | 24738 | 3233 | 24708 | 2680 | 23751 | 1899 | 27440 | 1567 | 12971 |
| 10-#11 | 1.39 | MA | 21234 | 5490 | 33262 | 4099 | 35708 | 3336 | 36038 | 2774 | 35200 | 1989 | 41211 | 1681 | 18990 |
| 4L-3S | | MI | 15087 | 5490 | 24046 | 3965 | 25539 | 3241 | 25666 | 2688 | 24943 | 1890 | 28761 | 1651 | 12920 |
| 10-#11 | 1.39 | MA | 20736 | 5490 | 32439 | 4096 | 34641 | 3349 | 34727 | 2785 | 33302 | 1980 | 38950 | 1640 | 18931 |
| 5L-2S | | MI | 15601 | 5490 | 24807 | 3971 | 26515 | 3231 | 26842 | 2680 | 26502 | 1881 | 30801 | 1737 | 12871 |
| 10-#14 | 2.01 | MA | 23727 | 5728 | 37949 | 4222 | 41632 | 3423 | 43230 | 2823 | 44814 | 1941 | 53586 | 1795 | 26906 |
| 2L-5S | | MI | 14585 | 5728 | 23708 | 4097 | 25032 | 3334 | 25012 | 2734 | 24090 | 1844 | 28167 | 1347 | 17721 |
| 10-#14 | 2.01 | MA | 22608 | 5728 | 36281 | 4218 | 39493 | 3441 | 40621 | 2839 | 41274 | 1954 | 48871 | 1671 | 26907 |
| 3L-4S | | MI | 15057 | 5728 | 24489 | 4106 | 26044 | 3322 | 26220 | 2722 | 25783 | 1857 | 30148 | 1402 | 18176 |
| 10-#14 | 2.01 | MA | 21820 | 5728 | 34919 | 4238 | 37757 | 3434 | 38511 | 2830 | 38569 | 1966 | 45810 | 1546 | 26800 |
| 4L-3S | | MI | 15581 | 5728 | 25387 | 4090 | 27187 | 3334 | 27575 | 2734 | 27467 | 1844 | 32010 | 1521 | 18152 |
| 10-#14 | 2.01 | MA | 21115 | 5728 | 33739 | 4233 | 36228 | 3452 | 36632 | 2846 | 35859 | 1954 | 42591 | 1488 | 25973 |
| 5L-2S | | MI | 16306 | 5728 | 26472 | 4100 | 28578 | 3322 | 29237 | 2722 | 29672 | 1832 | 34884 | 1646 | 18098 |
| 10-#18 | 3.57 | MA | 24577 | 6334 | 41391 | 4562 | 45892 | 3701 | 48370 | 2994 | 51531 | 1880 | 62362 | 1412 | 46311 |
| 3L-4S | | MI | 15859 | 6334 | 27096 | 4443 | 29143 | 3543 | 29883 | 2826 | 30711 | 1744 | 36646 | 967 | 29349 |
| 10-#18 | 3.57 | MA | 23229 | 6334 | 39002 | 4596 | 42847 | 3687 | 44670 | 2975 | 46845 | 1902 | 57100 | 1191 | 44228 |
| 4L-3S | | MI | 16753 | 6334 | 28658 | 4418 | 31095 | 3565 | 32195 | 2848 | 33584 | 1721 | 39810 | 1171 | 30783 |
| 10-#18 | 3.57 | MA | 22024 | 6334 | 36931 | 4586 | 40163 | 3717 | 41372 | 3001 | 42148 | 1880 | 51526 | 1091 | 41858 |
| 5L-2S | | MI | 17985 | 6334 | 30538 | 4437 | 33468 | 3543 | 35032 | 2826 | 37347 | 1699 | 44676 | 1393 | 30842 |
| 12-#11 | 1.67 | MA | 23126 | 5598 | 36546 | 4155 | 39910 | 3376 | 41159 | 2797 | 42059 | 1962 | 50006 | 1835 | 22613 |
| 2L-6S | | MI | 14413 | 5598 | 23118 | 4032 | 24296 | 3283 | 24216 | 2725 | 23032 | 1885 | 26764 | 1442 | 15071 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis

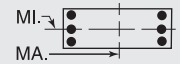


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.67 | MA | 22338 | 5598 | 35379 | 4152 | 38415 | 3389 | 39335 | 2809 | 39578 | 1971 | 46687 | 1749 | 22635 |
| 3L-5S | | MI | 14730 | 5598 | 23632 | 4038 | 25006 | 3291 | 25029 | 2716 | 24114 | 1876 | 28074 | 1499 | 15392 |
| 12-#11 | 1.67 | MA | 21784 | 5598 | 34428 | 4166 | 37203 | 3385 | 37862 | 2803 | 37682 | 1980 | 44530 | 1662 | 22617 |
| 4E | | MI | 15063 | 5598 | 24179 | 4044 | 25714 | 3281 | 25884 | 2708 | 25311 | 1885 | 29481 | 1537 | 15373 |
| 12-#11 | 1.67 | MA | 21289 | 5598 | 33605 | 4163 | 36136 | 3398 | 36551 | 2815 | 35783 | 1972 | 42269 | 1621 | 22533 |
| 5L-3S | | MI | 15431 | 5598 | 24807 | 4032 | 26515 | 3289 | 26842 | 2716 | 26502 | 1876 | 30801 | 1621 | 15334 |
| 12-#11 | 1.67 | MA | 20818 | 5598 | 32834 | 4161 | 35067 | 3393 | 35245 | 2809 | 34062 | 1981 | 40125 | 1565 | 21925 |
| 6L-2S | | MI | 15943 | 5598 | 25569 | 4038 | 27492 | 3280 | 28018 | 2708 | 28062 | 1867 | 32842 | 1707 | 15291 |
| 12-#14 | 2.41 | MA | 24490 | 5884 | 39618 | 4320 | 43771 | 3493 | 45839 | 2865 | 48353 | 1928 | 58300 | 1766 | 32129 |
| 2L-6S | | MI | 14624 | 5884 | 24058 | 4185 | 25408 | 3392 | 25525 | 2786 | 24766 | 1835 | 29198 | 1218 | 20476 |
| 12-#14 | 2.41 | MA | 23378 | 5884 | 37949 | 4315 | 41632 | 3511 | 43230 | 2881 | 44814 | 1941 | 53586 | 1642 | 32090 |
| 3L-5S | | MI | 15072 | 5884 | 24793 | 4194 | 26423 | 3404 | 26674 | 2774 | 26295 | 1823 | 31041 | 1301 | 20929 |
| 12-#14 | 2.41 | MA | 22595 | 5884 | 36587 | 4335 | 39896 | 3504 | 41120 | 2872 | 42108 | 1953 | 50525 | 1517 | 31944 |
| 4E | | MI | 15542 | 5884 | 25574 | 4203 | 27435 | 3392 | 27883 | 2761 | 27988 | 1835 | 33022 | 1356 | 21546 |
| 12-#14 | 2.41 | MA | 21895 | 5884 | 35407 | 4330 | 38366 | 3522 | 39241 | 2888 | 39398 | 1941 | 47306 | 1459 | 30940 |
| 5L-3S | | MI | 16062 | 5884 | 26472 | 4188 | 28578 | 3404 | 29237 | 2774 | 29672 | 1823 | 34884 | 1475 | 21559 |
| 12-#14 | 2.41 | MA | 21229 | 5884 | 34301 | 4326 | 36835 | 3515 | 37369 | 2880 | 36942 | 1953 | 44263 | 1378 | 30023 |
| 6L-2S | | MI | 16784 | 5884 | 27556 | 4197 | 29968 | 3392 | 30900 | 2761 | 31877 | 1810 | 37758 | 1600 | 21521 |
| 12-#18 | 4.29 | MA | 24545 | 6610 | 41919 | 4769 | 46587 | 3811 | 49232 | 3051 | 52976 | 1875 | 65227 | 1133 | 52802 |
| 4E | | MI | 16675 | 6610 | 28976 | 4616 | 31516 | 3664 | 32719 | 2892 | 34474 | 1700 | 41512 | 875 | 34811 |
| 12-#18 | 4.29 | MA | 23353 | 6610 | 39848 | 4759 | 43902 | 3841 | 45934 | 3077 | 48279 | 1853 | 59654 | 1033 | 50577 |
| 5L-3S | | MI | 17562 | 6610 | 30538 | 4591 | 33468 | 3686 | 35032 | 2914 | 37347 | 1678 | 44676 | 1079 | 36577 |
| 12-#18 | 4.29 | MA | 22220 | 6610 | 37904 | 4749 | 41213 | 3827 | 42648 | 3058 | 44025 | 1875 | 54416 | 888 | 47237 |
| 6L-2S | | MI | 18785 | 6610 | 32417 | 4610 | 35841 | 3664 | 37868 | 2892 | 41110 | 1655 | 49541 | 1300 | 36709 |
| 14-#11 | 1.95 | MA | 23666 | 5706 | 37712 | 4222 | 41405 | 3424 | 42983 | 2826 | 44541 | 1954 | 53325 | 1816 | 26269 |
| 2L-7S | | MI | 14451 | 5706 | 23316 | 4111 | 24593 | 3340 | 24534 | 2744 | 23535 | 1879 | 27570 | 1348 | 17151 |
| 14-#11 | 1.95 | MA | 22882 | 5706 | 36546 | 4219 | 39910 | 3437 | 41159 | 2838 | 42059 | 1963 | 50006 | 1730 | 26275 |
| 3L-6S | | MI | 14759 | 5706 | 23879 | 4099 | 25272 | 3331 | 25392 | 2753 | 24592 | 1871 | 28805 | 1412 | 17360 |
| 14-#11 | 1.95 | MA | 22331 | 5706 | 35594 | 4234 | 38698 | 3433 | 39686 | 2832 | 40163 | 1971 | 47848 | 1644 | 26236 |
| 4L-5S | | MI | 15075 | 5706 | 24393 | 4105 | 25982 | 3339 | 26205 | 2744 | 25674 | 1862 | 30115 | 1469 | 17739 |
| 14-#11 | 1.95 | MA | 21839 | 5706 | 34772 | 4231 | 37631 | 3446 | 38375 | 2844 | 38265 | 1963 | 45587 | 1603 | 26130 |
| 5L-4S | | MI | 15406 | 5706 | 24940 | 4111 | 26691 | 3330 | 27060 | 2736 | 26871 | 1871 | 31522 | 1507 | 17764 |
| 14-#11 | 1.95 | MA | 21370 | 5706 | 34000 | 4228 | 36562 | 3442 | 37069 | 2839 | 36544 | 1972 | 43444 | 1547 | 25437 |
| 6L-3S | | MI | 15773 | 5706 | 25569 | 4100 | 27492 | 3338 | 28018 | 2744 | 28062 | 1862 | 32842 | 1591 | 17737 |
| 14-#11 | 1.95 | MA | 20913 | 5706 | 33155 | 4242 | 35543 | 3455 | 35815 | 2850 | 34862 | 1981 | 41156 | 1457 | 24988 |
| 7L-2S | | MI | 16283 | 5706 | 26331 | 4106 | 28468 | 3328 | 29194 | 2736 | 29622 | 1853 | 34883 | 1677 | 17701 |
| 14-#14 | 2.81 | MA | 24142 | 6040 | 39618 | 4412 | 43771 | 3581 | 45839 | 2924 | 48353 | 1928 | 58300 | 1613 | 37264 |
| 3L-6S | | MI | 15110 | 6040 | 25143 | 4282 | 26798 | 3462 | 27187 | 2825 | 26971 | 1813 | 32072 | 1172 | 23731 |
| 14-#14 | 2.81 | MA | 23364 | 6040 | 38255 | 4432 | 42034 | 3574 | 43729 | 2915 | 45648 | 1940 | 55239 | 1488 | 37082 |
| 4L-5S | | MI | 15556 | 6040 | 25877 | 4291 | 27813 | 3474 | 28337 | 2813 | 28500 | 1801 | 33914 | 1255 | 24153 |
| 14-#14 | 2.81 | MA | 22669 | 6040 | 37076 | 4428 | 40505 | 3592 | 41850 | 2931 | 42938 | 1928 | 52021 | 1430 | 35924 |
| 5L-4S | | MI | 16023 | 6040 | 26659 | 4300 | 28825 | 3462 | 29545 | 2800 | 30193 | 1813 | 35896 | 1310 | 24904 |
| 14-#14 | 2.81 | MA | 22008 | 6040 | 35969 | 4423 | 38973 | 3585 | 39978 | 2922 | 40481 | 1940 | 48978 | 1349 | 35052 |
| 6L-3S | | MI | 16541 | 6040 | 27556 | 4285 | 29968 | 3474 | 30900 | 2813 | 31877 | 1801 | 37758 | 1429 | 24952 |
| 14-#14 | 2.81 | MA | 21364 | 6040 | 34757 | 4443 | 37511 | 3603 | 38181 | 2938 | 38081 | 1952 | 45728 | 1219 | 33724 |
| 7L-2S | | MI | 17258 | 6040 | 28641 | 4294 | 31359 | 3461 | 32562 | 2800 | 34081 | 1789 | 40632 | 1554 | 24933 |
| 14-#18 | 5.00 | MA | 24667 | 6887 | 42765 | 4932 | 47642 | 3965 | 50496 | 3152 | 54409 | 1827 | 67782 | 975 | 59320 |
| 5L-4S | | MI | 17484 | 6887 | 30855 | 4789 | 33889 | 3785 | 35555 | 2958 | 38237 | 1656 | 46377 | 782 | 40308 |
| 14-#18 | 5.00 | MA | 23546 | 6887 | 40821 | 4922 | 44952 | 3951 | 47210 | 3134 | 50155 | 1849 | 62543 | 830 | 55814 |
| 6L-3S | | MI | 18364 | 6887 | 32417 | 4764 | 35841 | 3807 | 37868 | 2980 | 41110 | 1634 | 49541 | 987 | 42355 |
| 16-#11 | 2.23 | MA | 23423 | 5814 | 37712 | 4287 | 41405 | 3486 | 42983 | 2867 | 44541 | 1954 | 53325 | 1711 | 29906 |
| 3L-7S | | MI | 14797 | 5814 | 24078 | 4178 | 25569 | 3389 | 25710 | 2772 | 25094 | 1865 | 29611 | 1318 | 19458 |
| 16-#11 | 2.23 | MA | 22875 | 5814 | 36761 | 4301 | 40193 | 3481 | 41510 | 2862 | 42645 | 1963 | 51167 | 1625 | 29849 |
| 4L-6S | | MI | 15104 | 5814 | 24641 | 4167 | 26248 | 3380 | 26568 | 2781 | 26152 | 1856 | 30846 | 1382 | 19656 |
| 16-#11 | 2.23 | MA | 22385 | 5814 | 35938 | 4298 | 39126 | 3494 | 40198 | 2874 | 40746 | 1954 | 48906 | 1584 | 29660 |
| 5E | | MI | 15418 | 5814 | 25155 | 4173 | 26959 | 3387 | 27381 | 2772 | 27234 | 1848 | 32155 | 1439 | 20008 |
| 16-#11 | 2.23 | MA | 21919 | 5814 | 35166 | 4295 | 38057 | 3490 | 38893 | 2868 | 39025 | 1963 | 46763 | 1528 | 28956 |
| 6L-4S | | MI | 15748 | 5814 | 25702 | 4179 | 27667 | 3378 | 28236 | 2764 | 28430 | 1856 | 33562 | 1477 | 20149 |

## RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

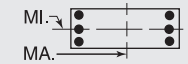
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.23 | MA | 21464 | 5814 | 34321 | 4310 | 37038 | 3503 | 37639 | 2880 | 37344 | 1972 | 44475 | 1438 | 28524 |
| 7L-3S | | MI | 16113 | 5814 | 26331 | 4167 | 28468 | 3386 | 29194 | 2772 | 29622 | 1848 | 34883 | 1561 | 20132 |
| 16-#11 | 2.23 | MA | 21017 | 5814 | 33562 | 4307 | 36004 | 3499 | 36416 | 2891 | 35557 | 1964 | 42361 | 1390 | 27759 |
| 8L-2S | | MI | 16621 | 5814 | 27092 | 4173 | 29444 | 3377 | 30370 | 2764 | 31181 | 1839 | 36924 | 1647 | 20104 |
| 16-#14 | 3.21 | MA | 24127 | 6195 | 39923 | 4530 | 44173 | 3644 | 46338 | 2957 | 49187 | 1927 | 59954 | 1460 | 42216 |
| 4L-6S | | MI | 15593 | 6195 | 26227 | 4379 | 28189 | 3532 | 28849 | 2865 | 29175 | 1792 | 34946 | 1126 | 26993 |
| 16-#14 | 3.21 | MA | 23437 | 6195 | 38744 | 4525 | 42644 | 3662 | 44459 | 2973 | 46477 | 1915 | 56735 | 1402 | 40922 |
| 5E | | MI | 16036 | 6195 | 26962 | 4388 | 29204 | 3544 | 29999 | 2852 | 30705 | 1779 | 36788 | 1209 | 27388 |
| 16-#14 | 3.21 | MA | 22780 | 6195 | 37638 | 4520 | 41112 | 3655 | 42587 | 2964 | 44021 | 1927 | 53692 | 1320 | 40089 |
| 6L-4S | | MI | 16501 | 6195 | 27744 | 4398 | 30216 | 3531 | 31207 | 2840 | 32397 | 1792 | 38769 | 1264 | 28230 |
| 16-#14 | 3.21 | MA | 22141 | 6195 | 36426 | 4541 | 39650 | 3673 | 40790 | 2980 | 41620 | 1939 | 50443 | 1190 | 38674 |
| 7L-3S | | MI | 17016 | 6195 | 28641 | 4382 | 31359 | 3544 | 32562 | 2852 | 34081 | 1779 | 40632 | 1383 | 28326 |
| 16-#14 | 3.21 | MA | 21511 | 6195 | 35336 | 4536 | 38167 | 3666 | 39036 | 2996 | 39069 | 1927 | 47434 | 1122 | 37435 |
| 8L-2S | | MI | 17730 | 6195 | 29726 | 4391 | 32749 | 3531 | 34224 | 2840 | 36286 | 1767 | 43506 | 1508 | 28335 |
| 16-#18 | 5.71 | MA | 24857 | 7164 | 43738 | 5095 | 48692 | 4075 | 51772 | 3209 | 56286 | 1822 | 70671 | 772 | 64418 |
| 6L-4S | | MI | 18287 | 7164 | 32735 | 4961 | 36262 | 3905 | 38391 | 3024 | 41999 | 1612 | 51242 | 690 | 45832 |
| 18-#11 | 2.51 | MA | 23415 | 5921 | 37927 | 4369 | 41688 | 3530 | 43333 | 2891 | 45126 | 1954 | 54486 | 1606 | 33458 |
| 4L-7S | | MI | 15140 | 5921 | 24840 | 4246 | 26546 | 3437 | 26886 | 2800 | 26654 | 1851 | 31651 | 1288 | 21748 |
| 18-#11 | 2.51 | MA | 22927 | 5921 | 37104 | 4366 | 40621 | 3543 | 42022 | 2903 | 43228 | 1946 | 52225 | 1565 | 33153 |
| 5L-6S | | MI | 15446 | 5921 | 25402 | 4234 | 27225 | 3428 | 27744 | 2809 | 27711 | 1842 | 32886 | 1352 | 21955 |
| 18-#11 | 2.51 | MA | 22464 | 5921 | 36333 | 4363 | 39552 | 3539 | 40717 | 2897 | 41507 | 1955 | 50081 | 1509 | 32482 |
| 6L-5S | | MI | 15760 | 5921 | 25917 | 4240 | 27935 | 3436 | 28557 | 2800 | 28793 | 1834 | 34196 | 1409 | 22285 |
| 18-#11 | 2.51 | MA | 22012 | 5921 | 35487 | 4377 | 38533 | 3552 | 39463 | 2909 | 39825 | 1964 | 47793 | 1419 | 32063 |
| 7L-4S | | MI | 16088 | 5921 | 26463 | 4246 | 28643 | 3427 | 29412 | 2792 | 29990 | 1842 | 35603 | 1447 | 22520 |
| 18-#11 | 2.51 | MA | 21567 | 5921 | 34728 | 4374 | 37499 | 3547 | 38239 | 2921 | 38038 | 1955 | 45680 | 1371 | 31244 |
| 8L-3S | | MI | 16452 | 5921 | 27092 | 4235 | 29444 | 3434 | 30370 | 2800 | 31181 | 1834 | 36924 | 1531 | 22521 |
| 18-#11 | 2.51 | MA | 21126 | 5921 | 33910 | 4389 | 36493 | 3560 | 36960 | 2915 | 36372 | 1964 | 43601 | 1317 | 30597 |
| 9L-2S | | MI | 16958 | 5921 | 27854 | 4241 | 30421 | 3425 | 31546 | 2792 | 32741 | 1825 | 38964 | 1617 | 22500 |
| 18-#14 | 3.62 | MA | 24199 | 6351 | 40412 | 4622 | 44782 | 3732 | 47068 | 3016 | 50017 | 1901 | 61450 | 1373 | 45932 |
| 5L-6S | | MI | 16073 | 6351 | 27312 | 4476 | 29580 | 3601 | 30512 | 2904 | 31380 | 1770 | 37820 | 1080 | 30138 |
| 18-#14 | 3.62 | MA | 23547 | 6351 | 39306 | 4618 | 43251 | 3725 | 45196 | 3007 | 47560 | 1914 | 58407 | 1292 | 45133 |
| 6L-5S | | MI | 16514 | 6351 | 28047 | 4486 | 30595 | 3614 | 31661 | 2892 | 32910 | 1758 | 39662 | 1163 | 30632 |
| 18-#14 | 3.62 | MA | 22911 | 6351 | 38094 | 4638 | 41789 | 3743 | 43399 | 3023 | 45160 | 1926 | 55157 | 1161 | 43635 |
| 7L-4S | | MI | 16976 | 6351 | 28828 | 4495 | 31606 | 3601 | 32870 | 2879 | 34602 | 1770 | 41643 | 1218 | 31419 |
| 18-#14 | 3.62 | MA | 22286 | 6351 | 37005 | 4633 | 40306 | 3736 | 41645 | 3039 | 42609 | 1914 | 52148 | 1093 | 42333 |
| 8L-3S | | MI | 17489 | 6351 | 29726 | 4479 | 32749 | 3614 | 34224 | 2892 | 36286 | 1758 | 43506 | 1337 | 31692 |
| 18-#14 | 3.62 | MA | 21667 | 6351 | 35832 | 4653 | 38863 | 3754 | 39810 | 3030 | 40230 | 1926 | 49198 | 1015 | 40734 |
| 9L-2S | | MI | 18199 | 6351 | 30811 | 4489 | 34140 | 3601 | 35887 | 2879 | 38491 | 1745 | 46380 | 1461 | 31727 |
| 20-#11 | 2.79 | MA | 23467 | 6029 | 38270 | 4433 | 42116 | 3591 | 43846 | 2932 | 45709 | 1937 | 55544 | 1547 | 36655 |
| 5L-7S | | MI | 15483 | 6029 | 25601 | 4313 | 27522 | 3486 | 28062 | 2829 | 28214 | 1837 | 33692 | 1258 | 23987 |
| 20-#11 | 2.79 | MA | 23005 | 6029 | 37499 | 4430 | 41048 | 3587 | 42540 | 2927 | 43988 | 1946 | 53400 | 1490 | 36012 |
| 6E | | MI | 15787 | 6029 | 26164 | 4302 | 28201 | 3476 | 28920 | 2837 | 29271 | 1828 | 34927 | 1322 | 24258 |
| 20-#11 | 2.79 | MA | 22556 | 6029 | 36654 | 4445 | 40028 | 3600 | 41287 | 2938 | 42307 | 1955 | 51112 | 1400 | 35606 |
| 7L-5S | | MI | 16099 | 6029 | 26678 | 4308 | 28911 | 3484 | 29733 | 2829 | 30353 | 1820 | 36237 | 1380 | 24568 |
| 20-#11 | 2.79 | MA | 22113 | 6029 | 35894 | 4442 | 38994 | 3596 | 40063 | 2950 | 40520 | 1947 | 48998 | 1352 | 34736 |
| 8L-4S | | MI | 16426 | 6029 | 27225 | 4313 | 29620 | 3475 | 30588 | 2820 | 31550 | 1828 | 37644 | 1417 | 24886 |
| 20-#11 | 2.79 | MA | 21675 | 6029 | 35076 | 4456 | 37988 | 3609 | 38784 | 2944 | 38853 | 1955 | 46920 | 1298 | 34055 |
| 9L-3S | | MI | 16789 | 6029 | 27854 | 4302 | 30421 | 3483 | 31546 | 2829 | 32741 | 1820 | 38964 | 1501 | 24905 |
| 20-#11 | 2.79 | MA | 21178 | 6029 | 34319 | 4453 | 36967 | 3605 | 37567 | 2956 | 37201 | 1964 | 44907 | 1237 | 33084 |
| 10L-2S | | MI | 17293 | 6029 | 28616 | 4308 | 31397 | 3474 | 32722 | 2820 | 34301 | 1811 | 41005 | 1588 | 24891 |
| 20-#14 | 4.02 | MA | 24307 | 6506 | 40974 | 4715 | 45389 | 3795 | 47805 | 3049 | 51100 | 1901 | 63121 | 1263 | 50183 |
| 6E | | MI | 16550 | 6507 | 28397 | 4574 | 30970 | 3671 | 32174 | 2943 | 33585 | 1748 | 40694 | 1034 | 33293 |
| 20-#14 | 4.02 | MA | 23676 | 6506 | 39762 | 4735 | 43927 | 3813 | 46008 | 3065 | 48699 | 1913 | 59872 | 1133 | 48607 |
| 7L-5S | | MI | 16989 | 6507 | 29132 | 4583 | 31985 | 3684 | 33324 | 2931 | 35115 | 1736 | 42536 | 1117 | 33883 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

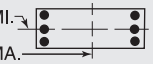
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 4.02 | MA | 23055 | 6507 | 38673 | 4730 | 42445 | 3806 | 44254 | 3081 | 46148 | 1901 | 56863 | 1064 | 47242 |
| 8L-4S | | MI | 17449 | 6507 | 29913 | 4592 | 32997 | 3671 | 34532 | 2919 | 36807 | 1748 | 44517 | 1172 | 34621 |
| 20-#14 | 4.02 | MA | 22441 | 6506 | 37500 | 4751 | 41002 | 3824 | 42419 | 3072 | 43769 | 1913 | 53913 | 986 | 45688 |
| 9L-3S | | MI | 17959 | 6506 | 30811 | 4577 | 34140 | 3683 | 35887 | 2931 | 38491 | 1736 | 46380 | 1291 | 35050 |
| 22-#11 | 3.06 | MA | 23544 | 6137 | 38665 | 4498 | 42543 | 3635 | 44364 | 2956 | 46470 | 1937 | 56719 | 1472 | 39547 |
| 6L-7S | | MI | 15823 | 6137 | 26363 | 4380 | 28499 | 3534 | 29238 | 2857 | 29773 | 1823 | 35733 | 1228 | 26232 |
| 22-#11 | 3.06 | MA | 23097 | 6137 | 37820 | 4512 | 41523 | 3648 | 43111 | 2968 | 44788 | 1946 | 54431 | 1382 | 39084 |
| 7L-6S | | MI | 16126 | 6137 | 26926 | 4369 | 29177 | 3525 | 30096 | 2865 | 30831 | 1814 | 36968 | 1292 | 26563 |
| 22-#11 | 3.06 | MA | 22656 | 6137 | 37060 | 4509 | 40489 | 3644 | 41887 | 2979 | 43001 | 1938 | 52317 | 1334 | 38232 |
| 8L-5S | | MI | 16437 | 6137 | 27440 | 4375 | 29888 | 3533 | 30910 | 2857 | 31913 | 1806 | 38278 | 1350 | 26857 |
| 22-#11 | 3.06 | MA | 22218 | 6137 | 36242 | 4524 | 39483 | 3657 | 40608 | 2974 | 41335 | 1947 | 50239 | 1280 | 37509 |
| 9L-4S | | MI | 16763 | 6137 | 27987 | 4381 | 30596 | 3523 | 31764 | 2848 | 33109 | 1814 | 39685 | 1388 | 27247 |
| 22-#11 | 3.06 | MA | 21727 | 6137 | 35485 | 4521 | 38462 | 3653 | 39390 | 2985 | 39682 | 1956 | 48226 | 1218 | 36562 |
| 10L-3S | | MI | 17124 | 6137 | 28616 | 4369 | 31397 | 3531 | 32722 | 2857 | 34301 | 1806 | 41005 | 1471 | 27278 |
| 22-#14 | 4.42 | MA | 24436 | 6662 | 41430 | 4832 | 46066 | 3883 | 48617 | 3108 | 52239 | 1900 | 64586 | 1104 | 53588 |
| 7L-6S | | MI | 17025 | 6662 | 29482 | 4671 | 32361 | 3741 | 33836 | 2983 | 35790 | 1727 | 43568 | 988 | 36459 |
| 22-#14 | 4.42 | MA | 23819 | 6662 | 40341 | 4828 | 44583 | 3876 | 46863 | 3124 | 49688 | 1888 | 61577 | 1035 | 52162 |
| 8L-5S | | MI | 17462 | 6662 | 30216 | 4680 | 33376 | 3753 | 34986 | 2970 | 37319 | 1714 | 45410 | 1071 | 37141 |
| 22-#14 | 4.42 | MA | 23207 | 6662 | 39168 | 4848 | 43141 | 3894 | 45029 | 3115 | 47309 | 1900 | 58627 | 957 | 50650 |
| 9L-4S | | MI | 17919 | 6662 | 30998 | 4689 | 34388 | 3741 | 36195 | 2958 | 39012 | 1727 | 47391 | 1126 | 37834 |
| 24-#11 | 3.34 | MA | 23635 | 6245 | 38986 | 4580 | 43018 | 3697 | 44935 | 2997 | 47270 | 1938 | 57750 | 1363 | 42560 |
| 7E | | MI | 16162 | 6245 | 27125 | 4448 | 29475 | 3583 | 30414 | 2885 | 31333 | 1809 | 37774 | 1198 | 28484 |
| 24-#11 | 3.34 | MA | 23197 | 6245 | 38226 | 4577 | 41984 | 3693 | 43711 | 3009 | 45483 | 1929 | 55636 | 1315 | 41734 |
| 8L-6S | | MI | 16464 | 6245 | 27687 | 4436 | 30154 | 3573 | 31272 | 2893 | 32390 | 1800 | 39009 | 1262 | 28871 |
| 24-#11 | 3.34 | MA | 22759 | 6245 | 37409 | 4591 | 40978 | 3706 | 42432 | 3003 | 43816 | 1938 | 53558 | 1261 | 40970 |
| 9L-5S | | MI | 16774 | 6245 | 28201 | 4442 | 30864 | 3581 | 32086 | 2885 | 33472 | 1792 | 40319 | 1320 | 29149 |
| 24-#11 | 3.34 | MA | 22272 | 6245 | 36651 | 4588 | 39957 | 3701 | 41214 | 3015 | 42164 | 1947 | 51545 | 1200 | 40046 |
| 10L-4S | | MI | 17098 | 6245 | 28748 | 4448 | 31572 | 3572 | 32940 | 2876 | 34669 | 1800 | 41726 | 1358 | 29605 |
| 24-#14 | 4.82 | MA | 24578 | 6818 | 42009 | 4925 | 46722 | 3946 | 49472 | 3166 | 53227 | 1875 | 66292 | 1006 | 57091 |
| 8L-6S | | MI | 17497 | 6818 | 30566 | 4768 | 33751 | 3811 | 35499 | 3022 | 37995 | 1705 | 46442 | 942 | 39637 |
| 24-#14 | 4.82 | MA | 23966 | 6818 | 40837 | 4945 | 45279 | 3964 | 47638 | 3157 | 50848 | 1887 | 63342 | 928 | 55619 |
| 9L-5S | | MI | 17932 | 6818 | 31301 | 4777 | 34766 | 3823 | 36649 | 3010 | 39524 | 1693 | 48284 | 1025 | 40402 |

## RECTANGULAR TIED COLUMNS 28" x 42"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.36 | MA | 24749 | 5751 | 38883 | 4255 | 42030 | 3464 | 42911 | 2882 | 42893 | 2050 | 50354 | 1920 | 20266 |
| 2E | | MI | 16235 | 5751 | 25956 | 4097 | 27430 | 3328 | 27566 | 2753 | 26985 | 1927 | 31097 | 1763 | 13056 |
| 6-#14 | 1.15 | MA | 24364 | 5665 | 37876 | 4229 | 40901 | 3449 | 41595 | 2878 | 41223 | 2077 | 48243 | 1963 | 17328 |
| 2L-3S | | MI | 15301 | 5665 | 24270 | 4076 | 25487 | 3343 | 25296 | 2782 | 23990 | 1985 | 27288 | 1707 | 11314 |
| 6-#14 | 1.15 | MA | 23162 | 5665 | 36111 | 4225 | 38638 | 3467 | 38834 | 2895 | 37466 | 2090 | 43220 | 1839 | 17392 |
| 3L-2S | | MI | 16034 | 5665 | 25355 | 4086 | 26878 | 3331 | 26959 | 2769 | 26194 | 1972 | 30162 | 1832 | 11229 |
| 6-#18 | 2.04 | MA | 26172 | 6028 | 41973 | 4427 | 45991 | 3588 | 47744 | 2958 | 49420 | 2025 | 59029 | 1866 | 29980 |
| 2L-3S | | MI | 15806 | 6028 | 25956 | 4251 | 27430 | 3471 | 27566 | 2841 | 26985 | 1905 | 31097 | 1449 | 19169 |
| 6-#18 | 2.04 | MA | 24102 | 6028 | 38883 | 4418 | 42030 | 3619 | 42911 | 2985 | 42893 | 2047 | 50354 | 1644 | 29933 |
| 3L-2S | | MI | 17060 | 6028 | 27835 | 4270 | 29803 | 3449 | 30402 | 2819 | 30748 | 1883 | 35962 | 1670 | 19059 |
| 8-#11 | 1.06 | MA | 24206 | 5629 | 37450 | 4221 | 40437 | 3444 | 41060 | 2879 | 40508 | 2088 | 47389 | 1982 | 16117 |
| 2L-4S | | MI | 15063 | 5629 | 23705 | 4091 | 24843 | 3334 | 24580 | 2778 | 23127 | 2010 | 26429 | 1691 | 10588 |
| 8-#11 | 1.06 | MA | 23363 | 5629 | 36217 | 4219 | 38856 | 3441 | 39131 | 2891 | 37883 | 2097 | 43857 | 1895 | 16162 |
| 3E | | MI | 15435 | 5629 | 24334 | 4079 | 25644 | 3342 | 25538 | 2787 | 24318 | 2002 | 27750 | 1775 | 10524 |
| 8-#11 | 1.06 | MA | 22772 | 5629 | 35212 | 4233 | 37575 | 3454 | 37575 | 2886 | 35880 | 2106 | 41557 | 1809 | 16194 |
| 4L-2S | | MI | 15951 | 5629 | 25096 | 4085 | 26620 | 3333 | 26714 | 2778 | 25878 | 1993 | 29790 | 1861 | 10470 |
| 8-#14 | 1.53 | MA | 25191 | 5820 | 39642 | 4326 | 43164 | 3518 | 44356 | 2921 | 44980 | 2065 | 53266 | 1936 | 22886 |
| 2L-4S | | MI | 15263 | 5820 | 24457 | 4189 | 25735 | 3401 | 25604 | 2809 | 24510 | 1976 | 28299 | 1542 | 14838 |
| 8-#14 | 1.53 | MA | 23997 | 5820 | 37876 | 4322 | 40901 | 3537 | 41595 | 2938 | 41223 | 2077 | 48243 | 1811 | 22924 |
| 3E | | MI | 15790 | 5820 | 25355 | 4174 | 26878 | 3413 | 26959 | 2821 | 26194 | 1963 | 30162 | 1661 | 14773 |
| 8-#14 | 1.53 | MA | 23156 | 5820 | 36436 | 4343 | 39066 | 3531 | 39364 | 2929 | 38352 | 2090 | 44977 | 1687 | 22861 |
| 4L-2S | | MI | 16519 | 5820 | 26439 | 4183 | 28268 | 3401 | 28621 | 2809 | 28399 | 1951 | 33036 | 1786 | 14700 |

## RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

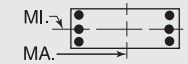
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 2.72 | MA | 27574 | 6304 | 45063 | 4600 | 49953 | 3712 | 52576 | 3033 | 55947 | 2000 | 67703 | 1811 | 39646 |
| 2L-4S | | MI | 15728 | 6304 | 26273 | 4449 | 27850 | 3569 | 28089 | 2885 | 27875 | 1883 | 32798 | 1152 | 24207 |
| 8-#18 | 2.72 | MA | 25526 | 6304 | 41973 | 4591 | 45991 | 3743 | 47744 | 3060 | 49420 | 2022 | 59029 | 1590 | 39483 |
| 3E | | MI | 16631 | 6304 | 27835 | 4424 | 29803 | 3591 | 30402 | 2907 | 30748 | 1861 | 35962 | 1357 | 25047 |
| 8-#18 | 2.72 | MA | 24083 | 6304 | 39446 | 4626 | 42771 | 3730 | 43830 | 3043 | 44432 | 2044 | 53404 | 1368 | 38067 |
| 4L-2S | | MI | 17875 | 6304 | 29715 | 4443 | 32176 | 3569 | 33238 | 2885 | 34511 | 1839 | 40827 | 1578 | 25003 |
| 10-#11 | 1.33 | MA | 24789 | 5737 | 38684 | 4288 | 42019 | 3493 | 42990 | 2908 | 43133 | 2079 | 50922 | 1964 | 20002 |
| 2L-5S | | MI | 15077 | 5737 | 23920 | 4152 | 25111 | 3392 | 24901 | 2815 | 23490 | 1987 | 27063 | 1624 | 13056 |
| 10-#11 | 1.33 | MA | 23950 | 5737 | 37450 | 4286 | 40437 | 3489 | 41060 | 2920 | 40508 | 2088 | 47389 | 1878 | 20036 |
| 3L-4S | | MI | 15411 | 5737 | 24467 | 4158 | 25819 | 3382 | 25756 | 2806 | 24687 | 1996 | 28470 | 1661 | 13011 |
| 10-#11 | 1.33 | MA | 23361 | 5737 | 36446 | 4301 | 39157 | 3502 | 39504 | 2915 | 38505 | 2098 | 45090 | 1791 | 20043 |
| 4L-3S | | MI | 15781 | 5737 | 25096 | 4147 | 26620 | 3390 | 26714 | 2815 | 25878 | 1987 | 29790 | 1745 | 12958 |
| 10-#11 | 1.33 | MA | 22835 | 5737 | 35577 | 4298 | 38030 | 3499 | 38119 | 2927 | 36500 | 2090 | 42688 | 1750 | 19984 |
| 5L-2S | | MI | 16295 | 5737 | 25857 | 4152 | 27597 | 3381 | 27890 | 2806 | 27438 | 1979 | 31831 | 1831 | 12907 |
| 10-#14 | 1.91 | MA | 26011 | 5976 | 41407 | 4423 | 45428 | 3588 | 47117 | 2963 | 48736 | 2052 | 58288 | 1909 | 28425 |
| 2L-5S | | MI | 15278 | 5976 | 24760 | 4277 | 26113 | 3483 | 26058 | 2860 | 25023 | 1941 | 29192 | 1441 | 17885 |
| 10-#14 | 1.91 | MA | 24824 | 5976 | 39642 | 4419 | 43164 | 3607 | 44356 | 2980 | 44980 | 2065 | 53266 | 1784 | 28426 |
| 3L-4S | | MI | 15751 | 5976 | 25542 | 4287 | 27125 | 3471 | 27267 | 2848 | 26715 | 1954 | 31173 | 1496 | 18241 |
| 10-#14 | 1.91 | MA | 23990 | 5976 | 38202 | 4440 | 41329 | 3601 | 42126 | 2972 | 42109 | 2078 | 50000 | 1660 | 28318 |
| 4L-3S | | MI | 16275 | 5976 | 26439 | 4271 | 28268 | 3483 | 28621 | 2860 | 28399 | 1941 | 33036 | 1615 | 18203 |
| 10-#14 | 1.91 | MA | 23244 | 5976 | 36956 | 4436 | 39714 | 3620 | 40141 | 2989 | 39235 | 2066 | 46578 | 1601 | 27579 |
| 5L-2S | | MI | 17001 | 5976 | 27524 | 4280 | 29659 | 3470 | 30284 | 2848 | 30604 | 1929 | 35910 | 1740 | 18144 |
| 10-#18 | 3.40 | MA | 26931 | 6581 | 45063 | 4764 | 49953 | 3868 | 52576 | 3136 | 55947 | 1997 | 67703 | 1535 | 49011 |
| 3L-4S | | MI | 16553 | 6581 | 28153 | 4621 | 30223 | 3690 | 30925 | 2951 | 31638 | 1839 | 37664 | 1060 | 29618 |
| 10-#18 | 3.40 | MA | 25503 | 6581 | 42536 | 4799 | 46732 | 3855 | 48663 | 3119 | 50958 | 2019 | 62079 | 1314 | 47107 |
| 4L-3S | | MI | 17449 | 6581 | 29715 | 4597 | 32176 | 3712 | 33238 | 2973 | 34511 | 1817 | 40827 | 1264 | 30877 |
| 10-#18 | 3.40 | MA | 24228 | 6581 | 40347 | 4790 | 43894 | 3886 | 45176 | 3146 | 45959 | 1997 | 56144 | 1212 | 44474 |
| 5L-2S | | MI | 18684 | 6581 | 31595 | 4616 | 34548 | 3690 | 36074 | 2951 | 38274 | 1795 | 45693 | 1486 | 30911 |
| 12-#11 | 1.59 | MA | 25368 | 5845 | 39918 | 4356 | 43600 | 3541 | 44919 | 2938 | 45758 | 2070 | 54455 | 1947 | 23877 |
| 2L-6S | | MI | 15106 | 5845 | 24167 | 4214 | 25377 | 3432 | 25264 | 2852 | 23968 | 1982 | 27794 | 1536 | 15187 |
| 12-#11 | 1.59 | MA | 24533 | 5845 | 38684 | 4353 | 42019 | 3537 | 42990 | 2950 | 43133 | 2080 | 50922 | 1860 | 23899 |
| 3L-5S | | MI | 15424 | 5845 | 24682 | 4219 | 26088 | 3440 | 26077 | 2843 | 25050 | 1973 | 29104 | 1594 | 15446 |
| 12-#11 | 1.59 | MA | 23947 | 5845 | 37679 | 4368 | 40738 | 3551 | 41433 | 2945 | 41130 | 2089 | 48623 | 1774 | 23880 |
| 4E | | MI | 15756 | 5845 | 25229 | 4225 | 26796 | 3431 | 26932 | 2835 | 26246 | 1982 | 30511 | 1631 | 15418 |
| 12-#11 | 1.59 | MA | 23424 | 5845 | 36811 | 4366 | 39611 | 3547 | 40049 | 2957 | 39125 | 2081 | 46221 | 1732 | 23796 |
| 5L-3S | | MI | 16125 | 5845 | 25857 | 4214 | 27597 | 3439 | 27890 | 2843 | 27438 | 1973 | 31831 | 1715 | 15376 |
| 12-#11 | 1.59 | MA | 22926 | 5845 | 35996 | 4363 | 38483 | 3560 | 38670 | 2952 | 37308 | 2091 | 43938 | 1676 | 23227 |
| 6L-2S | | MI | 16638 | 5845 | 26619 | 4220 | 28573 | 3429 | 29066 | 2835 | 28997 | 1965 | 33872 | 1802 | 15331 |
| 12-#14 | 2.30 | MA | 26824 | 6132 | 43173 | 4521 | 47691 | 3658 | 49878 | 3006 | 52493 | 2040 | 63311 | 1882 | 33952 |
| 2L-6S | | MI | 15316 | 6132 | 25110 | 4365 | 26489 | 3540 | 26571 | 2912 | 25698 | 1932 | 30224 | 1312 | 20629 |
| 12-#14 | 2.30 | MA | 25644 | 6132 | 41407 | 4516 | 45428 | 3677 | 47117 | 3022 | 48736 | 2053 | 58288 | 1757 | 33913 |
| 3L-5S | | MI | 15765 | 6132 | 25845 | 4375 | 27504 | 3553 | 27721 | 2900 | 27228 | 1920 | 32066 | 1395 | 21092 |
| 12-#14 | 2.30 | MA | 24815 | 6132 | 39967 | 4537 | 43593 | 3671 | 44887 | 3014 | 45866 | 2065 | 55023 | 1633 | 33766 |
| 4E | | MI | 16236 | 6132 | 26627 | 4384 | 28516 | 3540 | 28929 | 2887 | 28920 | 1932 | 34047 | 1450 | 21618 |
| 12-#14 | 2.30 | MA | 24075 | 6132 | 38722 | 4533 | 41977 | 3689 | 42902 | 3031 | 42991 | 2053 | 51601 | 1574 | 32839 |
| 5L-3S | | MI | 16758 | 6132 | 27524 | 4368 | 29659 | 3553 | 30284 | 2900 | 30604 | 1920 | 35910 | 1569 | 21615 |
| 12-#14 | 2.30 | MA | 23371 | 6132 | 37554 | 4529 | 40359 | 3683 | 40925 | 3023 | 40386 | 2066 | 48357 | 1493 | 31823 |
| 6L-2S | | MI | 17480 | 6132 | 28609 | 4378 | 31050 | 3540 | 31946 | 2887 | 32809 | 1907 | 38784 | 1693 | 21572 |
| 12-#18 | 4.08 | MA | 26906 | 6858 | 45626 | 4972 | 50693 | 3979 | 53495 | 3194 | 57485 | 1995 | 70753 | 1259 | 56198 |
| 4E | | MI | 17370 | 6858 | 30033 | 4794 | 32596 | 3811 | 33761 | 3017 | 35400 | 1796 | 42529 | 968 | 35075 |
| 12-#18 | 4.08 | MA | 25644 | 6858 | 43437 | 4963 | 47856 | 4010 | 50009 | 3221 | 52486 | 1972 | 64819 | 1158 | 53719 |
| 5L-3S | | MI | 18259 | 6858 | 31595 | 4769 | 34548 | 3833 | 36074 | 3039 | 38274 | 1773 | 45693 | 1172 | 36680 |
| 12-#18 | 4.08 | MA | 24445 | 6858 | 41383 | 4954 | 45013 | 3997 | 46535 | 3204 | 47957 | 1995 | 59224 | 1013 | 50381 |
| 6L-2S | | MI | 19485 | 6858 | 33474 | 4789 | 36921 | 3811 | 38910 | 3017 | 42037 | 1751 | 50558 | 1393 | 36789 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis

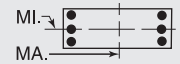



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.86 | MA | 25943 | 5953 | 41151 | 4423 | 45182 | 3590 | 46848 | 2967 | 48383 | 2062 | 57987 | 1929 | 27743 |
| 2L-7S | | MI | 15143 | 5953 | 24366 | 4292 | 25675 | 3490 | 25582 | 2871 | 24470 | 1977 | 28600 | 1442 | 17265 |
| 14-#11 | 1.86 | MA | 25112 | 5953 | 39918 | 4421 | 43600 | 3586 | 44919 | 2979 | 45758 | 2071 | 54455 | 1843 | 27750 |
| 3L-6S | | MI | 15452 | 5953 | 24929 | 4281 | 26354 | 3481 | 26440 | 2880 | 25527 | 1968 | 29835 | 1506 | 17477 |
| 14-#11 | 1.86 | MA | 24529 | 5953 | 38913 | 4436 | 42320 | 3599 | 43362 | 2974 | 43755 | 2081 | 52155 | 1756 | 27710 |
| 4L-5S | | MI | 15769 | 5953 | 25443 | 4287 | 27064 | 3488 | 27253 | 2871 | 26609 | 1959 | 31145 | 1564 | 17823 |
| 14-#11 | 1.86 | MA | 24009 | 5953 | 38044 | 4433 | 41193 | 3595 | 41978 | 2986 | 41750 | 2073 | 49753 | 1715 | 27604 |
| 5L-4S | | MI | 16100 | 5953 | 25990 | 4293 | 27772 | 3479 | 28108 | 2863 | 27806 | 1968 | 32551 | 1602 | 17814 |
| 14-#11 | 1.86 | MA | 23513 | 5953 | 37230 | 4430 | 40065 | 3609 | 40599 | 2981 | 39933 | 2082 | 47470 | 1659 | 26943 |
| 6L-3S | | MI | 16468 | 5953 | 26619 | 4281 | 28573 | 3487 | 29066 | 2871 | 28997 | 1959 | 33872 | 1685 | 17782 |
| 14-#11 | 1.86 | MA | 23031 | 5953 | 36338 | 4445 | 38989 | 3605 | 39276 | 2993 | 38157 | 2092 | 45034 | 1569 | 26448 |
| 7L-2S | | MI | 16978 | 5953 | 27381 | 4287 | 29550 | 3478 | 30242 | 2863 | 30557 | 1951 | 35913 | 1772 | 17744 |
| 14-#14 | 2.68 | MA | 26457 | 6287 | 43173 | 4614 | 47691 | 3747 | 49878 | 3065 | 52493 | 2040 | 63311 | 1730 | 39390 |
| 3L-6S | | MI | 15803 | 6287 | 26195 | 4463 | 27880 | 3610 | 28233 | 2952 | 27903 | 1911 | 33098 | 1266 | 23885 |
| 14-#14 | 2.68 | MA | 25634 | 6287 | 41733 | 4634 | 45856 | 3740 | 47648 | 3057 | 49623 | 2053 | 60046 | 1606 | 39208 |
| 4L-5S | | MI | 16250 | 6287 | 26930 | 4472 | 28895 | 3623 | 29383 | 2939 | 29432 | 1898 | 34940 | 1349 | 24315 |
| 14-#14 | 2.68 | MA | 24899 | 6287 | 40487 | 4630 | 44241 | 3759 | 45663 | 3073 | 46748 | 2041 | 56624 | 1547 | 38116 |
| 5L-4S | | MI | 16718 | 6287 | 27711 | 4481 | 29906 | 3610 | 30591 | 2927 | 31125 | 1911 | 36921 | 1404 | 24982 |
| 14-#14 | 2.68 | MA | 24200 | 6287 | 39319 | 4626 | 42623 | 3753 | 43686 | 3065 | 44143 | 2054 | 53380 | 1466 | 37149 |
| 6L-3S | | MI | 17237 | 6287 | 28609 | 4465 | 31050 | 3623 | 31946 | 2939 | 32809 | 1898 | 38784 | 1523 | 25016 |
| 14-#14 | 2.68 | MA | 23519 | 6287 | 38039 | 4647 | 41079 | 3772 | 41788 | 3082 | 41597 | 2066 | 49917 | 1336 | 35869 |
| 7L-2S | | MI | 17955 | 6287 | 29694 | 4475 | 32440 | 3610 | 33608 | 2927 | 35014 | 1886 | 41658 | 1647 | 24987 |
| 14-#18 | 4.76 | MA | 27045 | 7134 | 46527 | 5136 | 51817 | 4134 | 54841 | 3297 | 59013 | 1948 | 73493 | 1103 | 62988 |
| 5L-4S | | MI | 18180 | 7134 | 31912 | 4967 | 34969 | 3932 | 36598 | 3083 | 39163 | 1752 | 47394 | 875 | 40569 |
| 14-#18 | 4.76 | MA | 25858 | 7134 | 44473 | 5127 | 48974 | 4121 | 51367 | 3280 | 54484 | 1970 | 67898 | 958 | 59481 |
| 6L-3S | | MI | 19063 | 7134 | 33474 | 4942 | 36921 | 3954 | 38910 | 3105 | 42037 | 1730 | 50558 | 1079 | 42466 |
| 14-#18 | 4.76 | MA | 24702 | 7134 | 42224 | 5162 | 46261 | 4152 | 48032 | 3307 | 50058 | 1992 | 61920 | 727 | 56121 |
| 7L-2S | | MI | 20280 | 7134 | 35354 | 4962 | 39294 | 3932 | 41747 | 3083 | 45799 | 1707 | 55424 | 1301 | 42632 |
| 16-#11 | 2.12 | MA | 25687 | 6061 | 41151 | 4488 | 45182 | 3634 | 46848 | 3009 | 48383 | 2063 | 57987 | 1825 | 31591 |
| 3L-7S | | MI | 15489 | 6061 | 25128 | 4360 | 26651 | 3538 | 26758 | 2899 | 26030 | 1963 | 30640 | 1412 | 19573 |
| 16-#11 | 2.12 | MA | 25107 | 6061 | 40147 | 4503 | 43901 | 3648 | 45292 | 3003 | 46380 | 2072 | 55688 | 1739 | 31534 |
| 4L-6S | | MI | 15797 | 6061 | 25691 | 4348 | 27330 | 3529 | 27616 | 2908 | 27087 | 1954 | 31875 | 1476 | 19773 |
| 16-#11 | 2.12 | MA | 24590 | 6061 | 39278 | 4500 | 42774 | 3644 | 43907 | 3015 | 44375 | 2064 | 53286 | 1697 | 31408 |
| 5E | | MI | 16112 | 6061 | 26205 | 4354 | 28040 | 3537 | 28429 | 2899 | 28169 | 1945 | 33185 | 1534 | 20137 |
| 16-#11 | 2.12 | MA | 24097 | 6061 | 38463 | 4498 | 41646 | 3657 | 42529 | 3010 | 42558 | 2074 | 51003 | 1641 | 30667 |
| 6L-4S | | MI | 16442 | 6061 | 26752 | 4360 | 28749 | 3528 | 29284 | 2891 | 29366 | 1954 | 34592 | 1572 | 20202 |
| 16-#11 | 2.12 | MA | 23617 | 6061 | 37571 | 4513 | 40570 | 3653 | 41205 | 3022 | 40782 | 2083 | 48567 | 1551 | 30191 |
| 7L-3S | | MI | 16808 | 6061 | 27381 | 4349 | 29550 | 3536 | 30242 | 2899 | 30557 | 1945 | 35913 | 1655 | 20180 |
| 16-#11 | 2.12 | MA | 23144 | 6061 | 36770 | 4510 | 39478 | 3667 | 39914 | 3035 | 38896 | 2075 | 46321 | 1503 | 29467 |
| 8L-2S | | MI | 17317 | 6061 | 28142 | 4355 | 30526 | 3526 | 31418 | 2891 | 32117 | 1937 | 37954 | 1742 | 20149 |
| 16-#14 | 3.06 | MA | 26447 | 6443 | 43499 | 4732 | 48119 | 3810 | 50409 | 3099 | 53379 | 2040 | 65068 | 1579 | 44646 |
| 4L-6S | | MI | 16286 | 6443 | 27280 | 4560 | 29270 | 3680 | 29896 | 2991 | 30108 | 1889 | 35972 | 1220 | 27147 |
| 16-#14 | 3.06 | MA | 25717 | 6443 | 42253 | 4728 | 46504 | 3829 | 48424 | 3116 | 50505 | 2028 | 61646 | 1520 | 43408 |
| 5E | | MI | 16731 | 6443 | 28015 | 4569 | 30285 | 3693 | 31045 | 2978 | 31637 | 1876 | 37814 | 1303 | 27550 |
| 16-#14 | 3.06 | MA | 25022 | 6443 | 41085 | 4723 | 44886 | 3823 | 46447 | 3108 | 47899 | 2041 | 58402 | 1439 | 42484 |
| 6L-4S | | MI | 17197 | 6443 | 28796 | 4578 | 31297 | 3680 | 32254 | 2966 | 33330 | 1889 | 39795 | 1358 | 28336 |
| 16-#14 | 3.06 | MA | 24346 | 6443 | 39805 | 4744 | 43343 | 3842 | 44549 | 3125 | 45353 | 2054 | 54940 | 1309 | 41113 |
| 7L-3S | | MI | 17713 | 6443 | 29694 | 4563 | 32440 | 3692 | 33608 | 2978 | 35014 | 1876 | 41658 | 1477 | 28395 |
| 16-#14 | 3.06 | MA | 23680 | 6443 | 38655 | 4740 | 41777 | 3836 | 42697 | 3141 | 42648 | 2042 | 51740 | 1240 | 39880 |
| 8L-2S | | MI | 18428 | 6443 | 30778 | 4572 | 33831 | 3680 | 35271 | 2966 | 37219 | 1864 | 44532 | 1601 | 28392 |
| 16-#18 | 5.44 | MA | 27255 | 7411 | 47563 | 5300 | 52935 | 4245 | 56200 | 3355 | 61010 | 1945 | 76573 | 904 | 68607 |
| 6L-4S | | MI | 18985 | 7411 | 33792 | 5140 | 37342 | 4052 | 39434 | 3149 | 42926 | 1708 | 52260 | 783 | 46091 |
| 16-#18 | 5.44 | MA | 26111 | 7411 | 45314 | 5335 | 50222 | 4276 | 52864 | 3382 | 56584 | 1967 | 70595 | 672 | 65137 |
| 7L-3S | | MI | 19861 | 7411 | 35354 | 5115 | 39294 | 4075 | 41747 | 3171 | 45799 | 1686 | 55424 | 987 | 48238 |
| 18-#11 | 2.39 | MA | 25682 | 6169 | 41380 | 4570 | 45483 | 3696 | 47221 | 3033 | 49005 | 2063 | 59220 | 1721 | 35354 |
| 4L-7S | | MI | 15834 | 6169 | 25890 | 4427 | 27628 | 3587 | 27934 | 2927 | 27589 | 1949 | 32681 | 1382 | 21884 |
| 18-#11 | 2.39 | MA | 25167 | 6169 | 40511 | 4568 | 44356 | 3692 | 45837 | 3045 | 47000 | 2056 | 56818 | 1680 | 35150 |
| 5L-6S | | MI | 16140 | 6169 | 26452 | 4416 | 28306 | 3577 | 28792 | 2936 | 28646 | 1940 | 33916 | 1447 | 22073 |

## RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

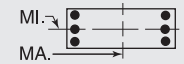
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.39 | MA | 24677 | 6169 | 39697 | 4565 | 43228 | 3706 | 44458 | 3040 | 45183 | 2065 | 54535 | 1624 | 34398 |
| 6L-5S | | MI | 16454 | 6169 | 26967 | 4422 | 29017 | 3585 | 29605 | 2927 | 29728 | 1931 | 35226 | 1504 | 22414 |
| 18-#11 | 2.39 | MA | 24199 | 6169 | 38805 | 4580 | 42152 | 3702 | 43135 | 3052 | 43407 | 2075 | 52100 | 1534 | 33938 |
| 7L-4S | | MI | 16783 | 6169 | 27513 | 4428 | 29725 | 3576 | 30460 | 2919 | 30925 | 1940 | 36633 | 1542 | 22584 |
| 18-#11 | 2.39 | MA | 23729 | 6169 | 38003 | 4578 | 41060 | 3715 | 41843 | 3064 | 41521 | 2067 | 49854 | 1485 | 33157 |
| 8L-3S | | MI | 17148 | 6169 | 28142 | 4416 | 30526 | 3584 | 31418 | 2927 | 32117 | 1931 | 37954 | 1625 | 22572 |
| 18-#11 | 2.39 | MA | 23245 | 6169 | 37140 | 4592 | 39998 | 3711 | 40492 | 3059 | 39761 | 2076 | 47640 | 1431 | 32445 |
| 9L-2S | | MI | 17654 | 6169 | 28904 | 4422 | 31502 | 3575 | 32594 | 2919 | 33676 | 1923 | 39994 | 1712 | 22547 |
| 18-#14 | 3.44 | MA | 26528 | 6598 | 44018 | 4825 | 48767 | 3899 | 51185 | 3158 | 54262 | 2016 | 66669 | 1493 | 48713 |
| 5L-6S | | MI | 16767 | 6598 | 28364 | 4657 | 30661 | 3750 | 31558 | 3030 | 32313 | 1867 | 38846 | 1174 | 30402 |
| 18-#14 | 3.44 | MA | 25838 | 6598 | 42850 | 4821 | 47149 | 3893 | 49208 | 3150 | 51656 | 2029 | 63425 | 1412 | 47826 |
| 6L-5S | | MI | 17209 | 6598 | 29099 | 4666 | 31676 | 3762 | 32708 | 3018 | 33842 | 1855 | 40688 | 1257 | 30794 |
| 18-#14 | 3.44 | MA | 25166 | 6598 | 41570 | 4841 | 45606 | 3911 | 47310 | 3167 | 49110 | 2041 | 59963 | 1282 | 46369 |
| 7L-4S | | MI | 17673 | 6598 | 29881 | 4676 | 32688 | 3750 | 33916 | 3005 | 35535 | 1867 | 42669 | 1312 | 31609 |
| 18-#14 | 3.44 | MA | 24505 | 6598 | 40420 | 4837 | 44040 | 3905 | 45458 | 3184 | 46405 | 2029 | 56763 | 1213 | 45123 |
| 8L-3S | | MI | 18186 | 6598 | 30778 | 4660 | 33831 | 3762 | 35271 | 3018 | 37219 | 1855 | 44532 | 1431 | 31765 |
| 18-#14 | 3.44 | MA | 23844 | 6598 | 39182 | 4858 | 42517 | 3924 | 43521 | 3176 | 43881 | 2042 | 53618 | 1135 | 43358 |
| 9L-2S | | MI | 18899 | 6598 | 31863 | 4669 | 35221 | 3750 | 36933 | 3005 | 39424 | 1842 | 47406 | 1555 | 31792 |
| 18-#18 | 6.12 | MA | 27507 | 7688 | 48404 | 5508 | 54183 | 4400 | 57697 | 3458 | 63111 | 1942 | 79269 | 618 | 74176 |
| 7L-4S | | MI | 19784 | 7688 | 35672 | 5313 | 39715 | 4173 | 42270 | 3214 | 46689 | 1664 | 57125 | 690 | 51636 |
| 20-#11 | 2.65 | MA | 25741 | 6277 | 41745 | 4635 | 45937 | 3741 | 47766 | 3074 | 49625 | 2047 | 60351 | 1662 | 38855 |
| 5L-7S | | MI | 16176 | 6277 | 26651 | 4495 | 28604 | 3635 | 29110 | 2955 | 29149 | 1935 | 34722 | 1352 | 24177 |
| 20-#11 | 2.65 | MA | 25253 | 6277 | 40931 | 4633 | 44809 | 3754 | 46387 | 3069 | 47808 | 2056 | 58068 | 1606 | 38135 |
| 6E | | MI | 16481 | 6277 | 27214 | 4483 | 29283 | 3626 | 29968 | 2964 | 30206 | 1926 | 35957 | 1417 | 24377 |
| 20-#11 | 2.65 | MA | 24778 | 6277 | 40039 | 4647 | 43733 | 3750 | 45064 | 3081 | 46032 | 2066 | 55632 | 1516 | 37688 |
| 7L-5S | | MI | 16794 | 6277 | 27728 | 4489 | 29993 | 3634 | 30782 | 2955 | 31288 | 1917 | 37267 | 1474 | 24697 |
| 20-#11 | 2.65 | MA | 24310 | 6277 | 39237 | 4645 | 42641 | 3764 | 43772 | 3093 | 44146 | 2058 | 53386 | 1468 | 36853 |
| 8L-4S | | MI | 17122 | 6277 | 28275 | 4495 | 30701 | 3624 | 31636 | 2947 | 32485 | 1926 | 38674 | 1512 | 24950 |
| 20-#11 | 2.65 | MA | 23829 | 6277 | 38374 | 4660 | 41580 | 3760 | 42422 | 3088 | 42386 | 2068 | 51173 | 1414 | 36161 |
| 9L-3S | | MI | 17485 | 6277 | 28904 | 4484 | 31502 | 3632 | 32594 | 2955 | 33676 | 1917 | 39994 | 1595 | 24959 |
| 20-#11 | 2.65 | MA | 23312 | 6277 | 37575 | 4657 | 40502 | 3773 | 41137 | 3100 | 40642 | 2077 | 49028 | 1353 | 35158 |
| 10L-2S | | MI | 17990 | 6277 | 29665 | 4490 | 32479 | 3623 | 33770 | 2947 | 35236 | 1909 | 42035 | 1682 | 24941 |
| 20-#14 | 3.83 | MA | 26648 | 6754 | 44616 | 4918 | 49413 | 3963 | 51969 | 3193 | 55413 | 2016 | 68448 | 1385 | 53174 |
| 6E | | MI | 17245 | 6754 | 29449 | 4754 | 32051 | 3820 | 33220 | 3070 | 34517 | 1845 | 41719 | 1128 | 33554 |
| 20-#14 | 3.83 | MA | 25981 | 6754 | 43336 | 4939 | 47869 | 3981 | 50072 | 3209 | 52867 | 2029 | 64985 | 1255 | 51636 |
| 7L-5S | | MI | 17685 | 6754 | 30184 | 4764 | 33066 | 3832 | 34370 | 3057 | 36047 | 1833 | 43562 | 1211 | 34045 |
| 20-#14 | 3.83 | MA | 25324 | 6754 | 42186 | 4935 | 46303 | 3975 | 48219 | 3226 | 50161 | 2017 | 61786 | 1186 | 50327 |
| 8L-4S | | MI | 18146 | 6754 | 30965 | 4773 | 34078 | 3820 | 35578 | 3045 | 37739 | 1845 | 45543 | 1266 | 34810 |
| 20-#14 | 3.83 | MA | 24664 | 6754 | 40948 | 4955 | 44780 | 3994 | 46282 | 3218 | 47638 | 2030 | 58641 | 1108 | 48607 |
| 9L-3S | | MI | 18657 | 6754 | 31863 | 4757 | 35221 | 3832 | 36933 | 3057 | 39424 | 1833 | 47406 | 1385 | 35128 |
| 22-#11 | 2.92 | MA | 25827 | 6385 | 42164 | 4700 | 46391 | 3802 | 48317 | 3099 | 50433 | 2048 | 61601 | 1589 | 41876 |
| 6L-7S | | MI | 16517 | 6385 | 27413 | 4562 | 29580 | 3684 | 30286 | 2984 | 30709 | 1921 | 36763 | 1322 | 26422 |
| 22-#11 | 2.92 | MA | 25354 | 6385 | 41272 | 4715 | 45315 | 3799 | 46993 | 3111 | 48657 | 2057 | 59165 | 1499 | 41441 |
| 7L-6S | | MI | 16821 | 6385 | 27976 | 4551 | 30259 | 3674 | 31144 | 2992 | 31766 | 1912 | 37998 | 1387 | 26683 |
| 22-#11 | 2.92 | MA | 24888 | 6385 | 40471 | 4712 | 44223 | 3812 | 45702 | 3123 | 46771 | 2050 | 56919 | 1450 | 40555 |
| 8L-5S | | MI | 17133 | 6385 | 28490 | 4557 | 30969 | 3682 | 31958 | 2984 | 32848 | 1903 | 39308 | 1444 | 26986 |
| 22-#11 | 2.92 | MA | 24417 | 6385 | 39607 | 4727 | 43161 | 3808 | 44351 | 3118 | 45011 | 2059 | 54705 | 1396 | 39881 |
| 9L-4S | | MI | 17459 | 6385 | 29037 | 4563 | 31678 | 3673 | 32812 | 2975 | 34044 | 1912 | 40715 | 1482 | 27315 |
| 22-#11 | 2.92 | MA | 23896 | 6385 | 38808 | 4725 | 42084 | 3822 | 43066 | 3130 | 43267 | 2069 | 52561 | 1335 | 38842 |
| 10L-3S | | MI | 17821 | 6385 | 29665 | 4551 | 32479 | 3681 | 33770 | 2984 | 35236 | 1903 | 42035 | 1566 | 27341 |
| 22-#11 | 2.92 | MA | 23393 | 6385 | 38022 | 4722 | 41028 | 3818 | 41732 | 3125 | 41407 | 2061 | 50371 | 1284 | 37891 |
| 11L-2S | | MI | 18324 | 6385 | 30427 | 4557 | 33455 | 3671 | 34946 | 2975 | 36796 | 1895 | 44076 | 1652 | 27330 |
| 22-#14 | 4.21 | MA | 26790 | 6910 | 45102 | 5036 | 50133 | 4051 | 52833 | 3252 | 56624 | 2017 | 70008 | 1228 | 56912 |
| 7L-6S | | MI | 17720 | 6910 | 30534 | 4852 | 33442 | 3890 | 34883 | 3109 | 36722 | 1824 | 44593 | 1082 | 36719 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

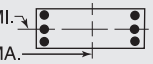
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 4.21 | MA | 26137 | 6910 | 43952 | 5032 | 48567 | 4045 | 50980 | 3268 | 53918 | 2004 | 66809 | 1158 | 55540 |
| 8L-5S | | MI | 18159 | 6910 | 31269 | 4861 | 34457 | 3902 | 36032 | 3097 | 38252 | 1811 | 46436 | 1165 | 37303 |
| 22-#14 | 4.21 | MA | 25478 | 6910 | 42713 | 5053 | 47044 | 4064 | 49043 | 3260 | 51395 | 2017 | 63663 | 1081 | 53864 |
| 9L-4S | | MI | 18617 | 6910 | 32050 | 4870 | 35469 | 3890 | 37241 | 3084 | 39944 | 1824 | 48417 | 1220 | 38022 |
| 24-#11 | 3.18 | MA | 25926 | 6493 | 42506 | 4782 | 46896 | 3847 | 48923 | 3140 | 51282 | 2049 | 62697 | 1481 | 45182 |
| 7E | | MI | 16857 | 6493 | 28175 | 4630 | 30557 | 3732 | 31462 | 3012 | 32268 | 1907 | 38804 | 1292 | 28672 |
| 24-#11 | 3.18 | MA | 25463 | 6493 | 41704 | 4780 | 45804 | 3860 | 47631 | 3152 | 49396 | 2041 | 60451 | 1433 | 44262 |
| 8L-6S | | MI | 17160 | 6493 | 28737 | 4618 | 31235 | 3723 | 32320 | 3020 | 33325 | 1898 | 40039 | 1357 | 28992 |
| 24-#11 | 3.18 | MA | 24993 | 6493 | 40841 | 4795 | 44742 | 3857 | 46280 | 3147 | 47636 | 2050 | 58238 | 1379 | 43553 |
| 9L-5S | | MI | 17470 | 6493 | 29251 | 4624 | 31946 | 3731 | 33134 | 3012 | 34407 | 1889 | 41349 | 1414 | 29278 |
| 24-#11 | 3.18 | MA | 24475 | 6493 | 40042 | 4792 | 43665 | 3870 | 44995 | 3159 | 45892 | 2060 | 56093 | 1318 | 42531 |
| 10L-4S | | MI | 17795 | 6493 | 29798 | 4630 | 32654 | 3721 | 33988 | 3003 | 35604 | 1898 | 42755 | 1452 | 29676 |
| 24-#11 | 3.18 | MA | 23975 | 6493 | 39256 | 4789 | 42609 | 3866 | 43662 | 3154 | 44032 | 2052 | 53903 | 1266 | 41550 |
| 11L-3S | | MI | 18156 | 6493 | 30427 | 4619 | 33455 | 3729 | 34946 | 3012 | 36796 | 1889 | 44076 | 1536 | 29709 |
| 24-#14 | 4.59 | MA | 26945 | 7065 | 45717 | 5129 | 50830 | 4115 | 53741 | 3311 | 57675 | 1992 | 71831 | 1131 | 60763 |
| 8L-6S | | MI | 18194 | 7065 | 31619 | 4949 | 34833 | 3959 | 36545 | 3148 | 38927 | 1802 | 47467 | 1036 | 39894 |
| 24-#14 | 4.59 | MA | 26286 | 7065 | 44479 | 5150 | 49307 | 4134 | 51804 | 3303 | 55152 | 2005 | 68686 | 1054 | 59130 |
| 9L-5S | | MI | 18630 | 7065 | 32354 | 4958 | 35848 | 3972 | 37695 | 3136 | 40457 | 1790 | 49310 | 1119 | 40565 |

## RECTANGULAR TIED COLUMNS 28" x 44"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.30 | MA | 27059 | 5999 | 42350 | 4456 | 45802 | 3629 | 46730 | 3023 | 46659 | 2161 | 54761 | 2031 | 21346 |
| 2E | | MI | 16929 | 5999 | 27013 | 4276 | 28510 | 3475 | 28608 | 2878 | 27912 | 2023 | 32114 | 1856 | 13101 |
| 6-#14 | 1.10 | MA | 26647 | 5912 | 41281 | 4430 | 44601 | 3614 | 45331 | 3019 | 44820 | 2185 | 52488 | 2072 | 18240 |
| 2L-3S | | MI | 15994 | 5912 | 25322 | 4257 | 26568 | 3492 | 26343 | 2908 | 24922 | 2082 | 28314 | 1801 | 11350 |
| 6-#14 | 1.10 | MA | 25376 | 5912 | 39418 | 4426 | 42213 | 3608 | 42418 | 3036 | 40857 | 2199 | 47156 | 1948 | 18304 |
| 3L-2S | | MI | 16728 | 5912 | 26407 | 4266 | 27959 | 3479 | 28005 | 2896 | 27127 | 2069 | 31188 | 1926 | 11266 |
| 6-#18 | 1.95 | MA | 28571 | 6275 | 45613 | 4629 | 49984 | 3754 | 51833 | 3098 | 53582 | 2138 | 63983 | 1980 | 31600 |
| 2L-3S | | MI | 16499 | 6275 | 27013 | 4429 | 28510 | 3618 | 28608 | 2966 | 27912 | 2001 | 32114 | 1542 | 19233 |
| 6-#18 | 1.95 | MA | 26380 | 6275 | 42350 | 4620 | 45802 | 3786 | 46730 | 3127 | 46659 | 2160 | 54761 | 1759 | 31553 |
| 3L-2S | | MI | 17755 | 6275 | 28892 | 4449 | 30883 | 3596 | 31444 | 2944 | 31675 | 1979 | 36979 | 1763 | 19113 |
| 8-#11 | 1.01 | MA | 26477 | 5877 | 40828 | 4422 | 44109 | 3610 | 44763 | 3019 | 44061 | 2196 | 51569 | 2090 | 16960 |
| 2L-4S | | MI | 15756 | 5877 | 24755 | 4272 | 25925 | 3483 | 25628 | 2905 | 24062 | 2108 | 27459 | 1786 | 10621 |
| 8-#11 | 1.01 | MA | 25587 | 5877 | 39527 | 4420 | 42441 | 3606 | 42728 | 3032 | 41293 | 2206 | 47822 | 2004 | 17005 |
| 3E | | MI | 16129 | 5877 | 25384 | 4261 | 26726 | 3491 | 26586 | 2914 | 25254 | 2099 | 28779 | 1869 | 10556 |
| 8-#11 | 1.01 | MA | 24963 | 5877 | 38469 | 4435 | 41092 | 3620 | 41088 | 3027 | 39182 | 2216 | 45381 | 1918 | 17036 |
| 4L-2S | | MI | 16645 | 5877 | 26146 | 4267 | 27702 | 3482 | 27762 | 2905 | 26813 | 2090 | 30820 | 1956 | 10502 |
| 8-#14 | 1.46 | MA | 27525 | 6068 | 43144 | 4527 | 46989 | 3684 | 48244 | 3061 | 48784 | 2173 | 57819 | 2047 | 24101 |
| 2L-4S | | MI | 15956 | 6068 | 25509 | 4370 | 26816 | 3549 | 26650 | 2935 | 25443 | 2073 | 29325 | 1636 | 14889 |
| 8-#14 | 1.46 | MA | 26261 | 6068 | 41281 | 4524 | 44601 | 3678 | 45331 | 3079 | 44820 | 2186 | 52488 | 1923 | 24139 |
| 3E | | MI | 16484 | 6068 | 26407 | 4354 | 27959 | 3562 | 28005 | 2947 | 27127 | 2060 | 31188 | 1755 | 14817 |
| 8-#14 | 1.46 | MA | 25375 | 6068 | 39763 | 4545 | 42667 | 3698 | 42980 | 3071 | 41795 | 2200 | 49018 | 1798 | 24076 |
| 4L-2S | | MI | 17214 | 6068 | 27492 | 4364 | 29350 | 3549 | 29667 | 2935 | 29332 | 2048 | 34062 | 1879 | 14741 |
| 8-#18 | 2.60 | MA | 30061 | 6552 | 48876 | 4801 | 54167 | 3878 | 56936 | 3174 | 60505 | 2115 | 73205 | 1929 | 41806 |
| 2L-4S | | MI | 16421 | 6552 | 27330 | 4627 | 28931 | 3716 | 29132 | 3010 | 28801 | 1979 | 33815 | 1245 | 24474 |
| 8-#18 | 2.60 | MA | 27893 | 6552 | 45613 | 4793 | 49984 | 3910 | 51833 | 3202 | 53582 | 2137 | 63983 | 1707 | 41643 |
| 3E | | MI | 17326 | 6552 | 28892 | 4602 | 30883 | 3738 | 31444 | 3032 | 31675 | 1957 | 36979 | 1449 | 25127 |
| 8-#18 | 2.60 | MA | 26369 | 6552 | 42948 | 4829 | 46588 | 3898 | 47706 | 3186 | 48290 | 2159 | 57996 | 1486 | 40458 |
| 4L-2S | | MI | 18572 | 6552 | 30772 | 4622 | 33256 | 3716 | 34281 | 3010 | 35438 | 1935 | 41845 | 1671 | 25065 |
| 10-#11 | 1.27 | MA | 27095 | 5985 | 42130 | 4490 | 45777 | 3658 | 46798 | 3049 | 46830 | 2187 | 55316 | 2074 | 21055 |
| 2L-5S | | MI | 15770 | 5985 | 24970 | 4334 | 26193 | 3541 | 25949 | 2942 | 24425 | 2085 | 28093 | 1718 | 13101 |
| 10-#11 | 1.27 | MA | 26209 | 5985 | 40828 | 4487 | 44109 | 3655 | 44763 | 3061 | 44061 | 2197 | 51569 | 1988 | 21089 |
| 3L-4S | | MI | 16104 | 5985 | 25517 | 4340 | 26901 | 3532 | 26804 | 2933 | 25622 | 2094 | 29500 | 1756 | 13051 |
| 10-#11 | 1.27 | MA | 25588 | 5985 | 39770 | 4502 | 42759 | 3669 | 43123 | 3057 | 41951 | 2207 | 49127 | 1901 | 21096 |
| 4L-3S | | MI | 16475 | 5985 | 26146 | 4328 | 27702 | 3540 | 27762 | 2942 | 26813 | 2085 | 30820 | 1839 | 12995 |
| 10-#11 | 1.27 | MA | 25034 | 5985 | 38855 | 4500 | 41573 | 3665 | 41665 | 3069 | 39839 | 2200 | 46584 | 1859 | 21037 |
| 5L-2S | | MI | 16990 | 5985 | 26907 | 4334 | 28678 | 3530 | 28938 | 2933 | 28373 | 2076 | 32861 | 1926 | 12943 |

## RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

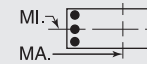
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.83 | MA | 28394 | 6223 | 45006 | 4624 | 49378 | 3754 | 51158 | 3104 | 52748 | 2160 | 63150 | 2022 | 29943 |
| 2L-5S | | MI | 15971 | 6223 | 25813 | 4458 | 27195 | 3632 | 27105 | 2987 | 25955 | 2038 | 30218 | 1535 | 18044 |
| 10-#14 | 1.83 | MA | 27139 | 6223 | 43144 | 4621 | 46989 | 3748 | 48244 | 3121 | 48784 | 2174 | 57819 | 1897 | 29944 |
| 3L-4S | | MI | 16444 | 6223 | 26594 | 4467 | 28206 | 3619 | 28313 | 2974 | 27648 | 2051 | 32199 | 1590 | 18298 |
| 10-#14 | 1.83 | MA | 26259 | 6223 | 41626 | 4642 | 45055 | 3767 | 45894 | 3114 | 45759 | 2187 | 54349 | 1773 | 29837 |
| 4L-3S | | MI | 16970 | 6223 | 27492 | 4452 | 29350 | 3632 | 29667 | 2987 | 29332 | 2038 | 34062 | 1709 | 18253 |
| 10-#14 | 1.83 | MA | 25473 | 6223 | 40314 | 4638 | 43354 | 3762 | 43803 | 3131 | 42730 | 2176 | 50723 | 1713 | 29198 |
| 5L-2S | | MI | 17696 | 6223 | 28576 | 4461 | 30740 | 3619 | 31330 | 2974 | 31537 | 2026 | 36936 | 1833 | 18190 |
| 10-#18 | 3.25 | MA | 29385 | 6829 | 48876 | 4966 | 54167 | 4034 | 56936 | 3277 | 60505 | 2114 | 73205 | 1656 | 51711 |
| 3L-4S | | MI | 17246 | 6829 | 29210 | 4800 | 31303 | 3837 | 31968 | 3076 | 32564 | 1935 | 38681 | 1153 | 29880 |
| 10-#18 | 3.25 | MA | 27877 | 6829 | 46211 | 5002 | 50771 | 4022 | 52809 | 3262 | 55213 | 2136 | 67218 | 1435 | 50015 |
| 4L-3S | | MI | 18145 | 6829 | 30772 | 4775 | 33256 | 3859 | 34281 | 3098 | 35438 | 1913 | 41845 | 1357 | 30967 |
| 10-#18 | 3.25 | MA | 26531 | 6829 | 43904 | 4994 | 47780 | 4054 | 49134 | 3290 | 49912 | 2114 | 60922 | 1331 | 47107 |
| 5L-2S | | MI | 19382 | 6829 | 32652 | 4795 | 35629 | 3837 | 37117 | 3076 | 39200 | 1891 | 46710 | 1578 | 30979 |
| 12-#11 | 1.52 | MA | 27709 | 6093 | 43431 | 4557 | 47444 | 3707 | 48832 | 3078 | 49598 | 2178 | 59062 | 2058 | 25140 |
| 2L-6S | | MI | 15799 | 6093 | 25217 | 4395 | 26459 | 3582 | 26312 | 2979 | 24903 | 2080 | 28824 | 1631 | 15300 |
| 12-#11 | 1.52 | MA | 26827 | 6093 | 42130 | 4555 | 45777 | 3703 | 46798 | 3091 | 46830 | 2188 | 55316 | 1971 | 25162 |
| 3L-5S | | MI | 16117 | 6093 | 25732 | 4401 | 27169 | 3590 | 27125 | 2970 | 25985 | 2071 | 30134 | 1688 | 15496 |
| 12-#11 | 1.52 | MA | 26209 | 6093 | 41071 | 4570 | 44427 | 3717 | 45158 | 3086 | 44719 | 2198 | 52874 | 1885 | 25144 |
| 4E | | MI | 16450 | 6093 | 26278 | 4407 | 27878 | 3580 | 27980 | 2962 | 27181 | 2080 | 31540 | 1726 | 15462 |
| 12-#11 | 1.52 | MA | 25658 | 6093 | 40156 | 4568 | 43241 | 3713 | 43700 | 3098 | 42607 | 2191 | 50331 | 1843 | 25060 |
| 5L-3S | | MI | 16820 | 6093 | 26907 | 4396 | 28678 | 3588 | 28938 | 2970 | 28373 | 2071 | 32861 | 1810 | 15416 |
| 12-#11 | 1.52 | MA | 25133 | 6093 | 39299 | 4565 | 42053 | 3727 | 42248 | 3094 | 40694 | 2201 | 47908 | 1787 | 24536 |
| 6L-2S | | MI | 17332 | 6093 | 27669 | 4402 | 29655 | 3579 | 30114 | 2962 | 29933 | 2062 | 34902 | 1896 | 15370 |
| 12-#14 | 2.19 | MA | 29257 | 6379 | 46869 | 4722 | 51766 | 3823 | 54071 | 3146 | 56711 | 2148 | 68481 | 1996 | 35774 |
| 2L-6S | | MI | 16008 | 6379 | 26163 | 4546 | 27570 | 3689 | 27617 | 3038 | 26630 | 2029 | 31249 | 1406 | 20776 |
| 12-#14 | 2.19 | MA | 28009 | 6379 | 45006 | 4718 | 49378 | 3818 | 51158 | 3164 | 52748 | 2161 | 63150 | 1872 | 35735 |
| 3L-5S | | MI | 16459 | 6379 | 26898 | 4555 | 28585 | 3701 | 28767 | 3026 | 28160 | 2017 | 33092 | 1489 | 21250 |
| 12-#14 | 2.19 | MA | 27135 | 6379 | 43489 | 4739 | 47444 | 3837 | 48807 | 3156 | 49723 | 2175 | 59680 | 1747 | 35589 |
| 4E | | MI | 16930 | 6379 | 27679 | 4564 | 29597 | 3689 | 29975 | 3014 | 29852 | 2029 | 35073 | 1544 | 21687 |
| 12-#14 | 2.19 | MA | 26355 | 6379 | 42177 | 4736 | 45742 | 3832 | 46716 | 3174 | 46694 | 2164 | 56055 | 1687 | 34750 |
| 5L-3S | | MI | 17452 | 6379 | 28576 | 4549 | 30740 | 3701 | 31330 | 3026 | 31537 | 2017 | 36936 | 1663 | 21669 |
| 12-#14 | 2.19 | MA | 25612 | 6379 | 40947 | 4732 | 44038 | 3851 | 44634 | 3166 | 43950 | 2177 | 52609 | 1607 | 33632 |
| 6L-2S | | MI | 18176 | 6379 | 29661 | 4558 | 32131 | 3689 | 32992 | 3014 | 33741 | 2004 | 39810 | 1787 | 21621 |
| 12-#18 | 3.90 | MA | 29368 | 7105 | 49474 | 5175 | 54954 | 4146 | 57911 | 3337 | 62136 | 2112 | 76439 | 1383 | 59623 |
| 4E | | MI | 18065 | 7105 | 31090 | 4973 | 33676 | 3958 | 34804 | 3142 | 36327 | 1892 | 43546 | 1060 | 35334 |
| 12-#18 | 3.90 | MA | 28036 | 7105 | 47167 | 5167 | 51963 | 4179 | 54237 | 3366 | 56835 | 2090 | 70144 | 1280 | 56878 |
| 5L-3S | | MI | 18956 | 7105 | 32652 | 4948 | 35629 | 3980 | 37117 | 3164 | 39200 | 1869 | 46710 | 1264 | 36780 |
| 12-#18 | 3.90 | MA | 26770 | 7105 | 45003 | 5159 | 48967 | 4167 | 50576 | 3350 | 52030 | 2112 | 64192 | 1136 | 53561 |
| 6L-2S | | MI | 20185 | 7105 | 34531 | 4967 | 38001 | 3958 | 39953 | 3142 | 42963 | 1847 | 51576 | 1486 | 36868 |
| 14-#11 | 1.77 | MA | 28319 | 6201 | 44732 | 4624 | 49112 | 3755 | 50867 | 3108 | 52367 | 2170 | 62809 | 2041 | 29218 |
| 2L-7S | | MI | 15836 | 6201 | 25416 | 4474 | 26756 | 3639 | 26630 | 2998 | 25405 | 2074 | 29630 | 1536 | 17375 |
| 14-#11 | 1.77 | MA | 27441 | 6201 | 43431 | 4622 | 47444 | 3752 | 48832 | 3120 | 49598 | 2180 | 59062 | 1955 | 29224 |
| 3L-6S | | MI | 16145 | 6201 | 25979 | 4463 | 27435 | 3630 | 27488 | 3007 | 26462 | 2066 | 30864 | 1601 | 17590 |
| 14-#11 | 1.77 | MA | 26826 | 6201 | 42372 | 4637 | 46095 | 3765 | 47193 | 3115 | 47488 | 2190 | 56621 | 1868 | 29184 |
| 4L-5S | | MI | 16462 | 6201 | 26493 | 4469 | 28146 | 3638 | 28301 | 2998 | 27544 | 2057 | 32174 | 1658 | 17882 |
| 14-#11 | 1.77 | MA | 26278 | 6201 | 41457 | 4635 | 44909 | 3762 | 45735 | 3128 | 45376 | 2183 | 54078 | 1826 | 29078 |
| 5L-4S | | MI | 16794 | 6201 | 27040 | 4474 | 28854 | 3629 | 29156 | 2990 | 28741 | 2066 | 33581 | 1696 | 17862 |
| 14-#11 | 1.77 | MA | 25756 | 6201 | 40600 | 4633 | 43721 | 3776 | 44283 | 3123 | 43463 | 2193 | 51655 | 1771 | 28457 |
| 6L-3S | | MI | 17162 | 6201 | 27669 | 4463 | 29655 | 3637 | 30114 | 2998 | 29933 | 2057 | 34902 | 1780 | 17826 |
| 14-#11 | 1.77 | MA | 25247 | 6201 | 39661 | 4648 | 42588 | 3772 | 42890 | 3136 | 41594 | 2203 | 49071 | 1681 | 27914 |
| 7L-2S | | MI | 17673 | 6201 | 28431 | 4469 | 30631 | 3627 | 31290 | 2990 | 31492 | 2048 | 36943 | 1866 | 17785 |
| 14-#14 | 2.56 | MA | 28872 | 6535 | 46869 | 4815 | 51766 | 3888 | 54071 | 3206 | 56711 | 2149 | 68481 | 1846 | 41516 |
| 3L-6S | | MI | 16496 | 6535 | 27247 | 4643 | 28961 | 3759 | 29279 | 3078 | 28835 | 2008 | 34123 | 1360 | 24033 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

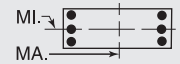



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.56 | MA | 28004 | 6535 | 45352 | 4836 | 49832 | 3907 | 51720 | 3199 | 53686 | 2163 | 65011 | 1722 | 41334 |
| 4L-5S | | MI | 16943 | 6535 | 27982 | 4652 | 29976 | 3771 | 30429 | 3065 | 30365 | 1995 | 35966 | 1443 | 24472 |
| 14-#14 | 2.56 | MA | 27229 | 6535 | 44040 | 4833 | 48130 | 3901 | 49629 | 3216 | 50658 | 2151 | 61386 | 1662 | 40321 |
| 5L-4S | | MI | 17412 | 6535 | 28764 | 4662 | 30988 | 3759 | 31638 | 3053 | 32057 | 2008 | 37947 | 1498 | 25057 |
| 14-#14 | 2.56 | MA | 26492 | 6535 | 42810 | 4829 | 46426 | 3921 | 47547 | 3208 | 47914 | 2165 | 57941 | 1581 | 39255 |
| 6L-3S | | MI | 17932 | 6535 | 29661 | 4646 | 32131 | 3771 | 32992 | 3065 | 33741 | 1995 | 39810 | 1617 | 25073 |
| 14-#14 | 2.56 | MA | 25773 | 6535 | 41462 | 4850 | 44801 | 3915 | 45549 | 3226 | 45232 | 2178 | 54265 | 1451 | 38034 |
| 7L-2S | | MI | 18652 | 6535 | 30746 | 4655 | 33521 | 3759 | 34655 | 3053 | 35946 | 1983 | 42684 | 1741 | 25039 |
| 14-#18 | 4.55 | MA | 29523 | 7382 | 50430 | 5340 | 56146 | 4303 | 59339 | 3441 | 63758 | 2067 | 79366 | 1229 | 66674 |
| 5L-4S | | MI | 18876 | 7382 | 32969 | 5146 | 36049 | 4079 | 37640 | 3207 | 40090 | 1848 | 48412 | 968 | 40825 |
| 14-#18 | 4.55 | MA | 28270 | 7382 | 48266 | 5331 | 53150 | 4291 | 55679 | 3425 | 58953 | 2089 | 73414 | 1085 | 63183 |
| 6L-3S | | MI | 19762 | 7382 | 34531 | 5121 | 38001 | 4101 | 39953 | 3230 | 42963 | 1826 | 51576 | 1172 | 42573 |
| 14-#18 | 4.55 | MA | 27050 | 7382 | 45896 | 5367 | 50291 | 4323 | 52164 | 3454 | 54258 | 2111 | 67057 | 853 | 59825 |
| 7L-2S | | MI | 20982 | 7382 | 36411 | 5140 | 40374 | 4079 | 42789 | 3207 | 46726 | 1803 | 56441 | 1393 | 42717 |
| 16-#11 | 2.03 | MA | 28051 | 6309 | 44732 | 4690 | 49112 | 3800 | 50867 | 3149 | 52367 | 2171 | 62809 | 1938 | 33276 |
| 3L-7S | | MI | 16182 | 6309 | 26178 | 4541 | 27733 | 3688 | 27806 | 3026 | 26965 | 2060 | 31670 | 1507 | 19685 |
| 16-#11 | 2.03 | MA | 27440 | 6309 | 43673 | 4705 | 47763 | 3814 | 49227 | 3145 | 50256 | 2181 | 60367 | 1852 | 33219 |
| 4L-6S | | MI | 16490 | 6309 | 26741 | 4530 | 28412 | 3678 | 28664 | 3035 | 28022 | 2052 | 32905 | 1571 | 19886 |
| 16-#11 | 2.03 | MA | 26894 | 6309 | 42759 | 4702 | 46577 | 3810 | 47770 | 3157 | 48144 | 2174 | 57824 | 1810 | 33093 |
| 5E | | MI | 16806 | 6309 | 27255 | 4536 | 29122 | 3686 | 29477 | 3026 | 29104 | 2043 | 34215 | 1628 | 20255 |
| 16-#11 | 2.03 | MA | 26375 | 6309 | 41901 | 4700 | 45389 | 3824 | 46318 | 3153 | 46231 | 2184 | 55401 | 1754 | 32386 |
| 6L-4S | | MI | 17137 | 6309 | 27802 | 4542 | 29830 | 3677 | 30332 | 3018 | 30301 | 2052 | 35622 | 1666 | 20253 |
| 16-#11 | 2.03 | MA | 25869 | 6309 | 40962 | 4715 | 44256 | 3821 | 44925 | 3165 | 44362 | 2194 | 52818 | 1664 | 31863 |
| 7L-3S | | MI | 17504 | 6309 | 28431 | 4531 | 30631 | 3685 | 31290 | 3026 | 31492 | 2043 | 36943 | 1750 | 20227 |
| 16-#11 | 2.03 | MA | 25371 | 6309 | 40119 | 4713 | 43107 | 3834 | 43565 | 3178 | 42375 | 2187 | 50440 | 1615 | 31188 |
| 8L-2S | | MI | 18013 | 6309 | 29192 | 4536 | 31608 | 3676 | 32466 | 3018 | 33052 | 2034 | 38983 | 1836 | 20193 |
| 16-#14 | 2.92 | MA | 28866 | 6690 | 47215 | 4934 | 52220 | 3977 | 54633 | 3241 | 57650 | 2150 | 70343 | 1696 | 47076 |
| 4L-6S | | MI | 16980 | 6690 | 28332 | 4740 | 30352 | 3829 | 30942 | 3117 | 31040 | 1986 | 36997 | 1314 | 27297 |
| 16-#14 | 2.92 | MA | 28096 | 6690 | 45902 | 4930 | 50518 | 3971 | 52543 | 3258 | 54622 | 2139 | 66717 | 1637 | 45908 |
| 5E | | MI | 17425 | 6690 | 29067 | 4750 | 31366 | 3841 | 32092 | 3105 | 32570 | 1973 | 38840 | 1397 | 27707 |
| 16-#14 | 2.92 | MA | 27364 | 6690 | 44673 | 4926 | 48814 | 3991 | 50460 | 3251 | 51877 | 2152 | 63272 | 1556 | 44887 |
| 6L-4S | | MI | 17892 | 6690 | 29848 | 4759 | 32378 | 3829 | 33300 | 3092 | 34262 | 1986 | 40821 | 1452 | 28417 |
| 16-#14 | 2.92 | MA | 26651 | 6690 | 43325 | 4948 | 47189 | 3985 | 48462 | 3268 | 49196 | 2166 | 59596 | 1426 | 43573 |
| 7L-3S | | MI | 18409 | 6690 | 30746 | 4743 | 33521 | 3841 | 34655 | 3105 | 35946 | 1973 | 42684 | 1571 | 28462 |
| 16-#14 | 2.92 | MA | 25949 | 6690 | 42114 | 4944 | 45540 | 4004 | 46511 | 3286 | 46347 | 2155 | 56206 | 1356 | 42221 |
| 8L-2S | | MI | 19126 | 6690 | 31831 | 4753 | 34912 | 3829 | 36317 | 3092 | 38151 | 1961 | 45558 | 1695 | 28448 |
| 16-#18 | 5.19 | MA | 29754 | 7659 | 51529 | 5504 | 57333 | 4415 | 60781 | 3501 | 65877 | 2066 | 82635 | 1033 | 72833 |
| 6L-4S | | MI | 19682 | 7659 | 34849 | 5319 | 38422 | 4199 | 40476 | 3273 | 43853 | 1804 | 53277 | 875 | 46345 |
| 16-#18 | 5.19 | MA | 28547 | 7659 | 49159 | 5540 | 54474 | 4447 | 57267 | 3529 | 61181 | 2088 | 76279 | 802 | 69364 |
| 7L-3S | | MI | 20561 | 7659 | 36411 | 5294 | 40374 | 4221 | 42789 | 3295 | 46726 | 1782 | 56441 | 1080 | 48352 |
| 18-#11 | 2.28 | MA | 28049 | 6416 | 44974 | 4772 | 49431 | 3862 | 51262 | 3174 | 53025 | 2172 | 64114 | 1836 | 37249 |
| 4L-7S | | MI | 16527 | 6416 | 26940 | 4609 | 28709 | 3736 | 28982 | 3054 | 28525 | 2046 | 33711 | 1477 | 21996 |
| 18-#11 | 2.28 | MA | 27506 | 6416 | 44060 | 4770 | 48245 | 3859 | 49804 | 3187 | 50913 | 2165 | 61571 | 1794 | 37105 |
| 5L-6S | | MI | 16834 | 6416 | 27502 | 4598 | 29388 | 3727 | 29840 | 3063 | 29582 | 2038 | 34946 | 1541 | 22187 |
| 18-#11 | 2.28 | MA | 26990 | 6416 | 43202 | 4768 | 47057 | 3873 | 48353 | 3182 | 49000 | 2175 | 59148 | 1738 | 36322 |
| 6L-5S | | MI | 17148 | 6416 | 28016 | 4603 | 30098 | 3735 | 30653 | 3054 | 30664 | 2029 | 36256 | 1598 | 22539 |
| 18-#11 | 2.28 | MA | 26486 | 6416 | 42263 | 4783 | 45924 | 3869 | 46960 | 3194 | 47130 | 2185 | 56564 | 1648 | 35817 |
| 7L-4S | | MI | 17478 | 6416 | 28563 | 4609 | 30807 | 3725 | 31508 | 3046 | 31860 | 2038 | 37663 | 1636 | 22639 |
| 18-#11 | 2.28 | MA | 25991 | 6416 | 41420 | 4780 | 44775 | 3883 | 45600 | 3207 | 45144 | 2178 | 54186 | 1599 | 35083 |
| 8L-3S | | MI | 17843 | 6416 | 29192 | 4598 | 31608 | 3733 | 32466 | 3054 | 33052 | 2029 | 38983 | 1720 | 22622 |
| 18-#11 | 2.28 | MA | 25471 | 6416 | 40594 | 4778 | 43657 | 3879 | 44178 | 3202 | 43292 | 2188 | 51837 | 1545 | 34303 |
| 9L-2S | | MI | 18351 | 6416 | 29954 | 4604 | 32584 | 3724 | 33642 | 3046 | 34611 | 2020 | 41024 | 1806 | 22594 |
| 18-#14 | 3.29 | MA | 28957 | 6846 | 47765 | 5027 | 52906 | 4041 | 55456 | 3301 | 58585 | 2126 | 72048 | 1611 | 51507 |
| 5L-6S | | MI | 17461 | 6846 | 29417 | 4838 | 31742 | 3899 | 32604 | 3157 | 33245 | 1964 | 39871 | 1268 | 30566 |
| 18-#14 | 3.29 | MA | 28230 | 6846 | 46535 | 5024 | 51202 | 4060 | 53374 | 3293 | 55841 | 2140 | 68603 | 1530 | 50527 |
| 6L-5S | | MI | 17904 | 6846 | 30152 | 4847 | 32757 | 3911 | 33754 | 3144 | 34774 | 1952 | 41714 | 1351 | 30951 |
| 18-#14 | 3.29 | MA | 27521 | 6846 | 45188 | 5045 | 49577 | 4055 | 51375 | 3311 | 53160 | 2154 | 64927 | 1401 | 49124 |
| 7L-4S | | MI | 18369 | 6846 | 30933 | 4856 | 33769 | 3899 | 34962 | 3132 | 36467 | 1964 | 43695 | 1406 | 31769 |

## RECTANGULAR TIED COLUMNS 28" x 44"

Short columns – no sidesway
Bending on major or minor axis

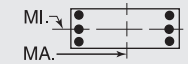



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 3.29 | MA | 26824 | 6846 | 43977 | 5041 | 47928 | 4074 | 49424 | 3328 | 50310 | 2142 | 61537 | 1331 | 47814 |
| 8L-3S | | MI | 18884 | 6846 | 31831 | 4841 | 34912 | 3911 | 36317 | 3144 | 38151 | 1952 | 45558 | 1525 | 31836 |
| 18-#14 | 3.29 | MA | 26115 | 6846 | 42673 | 5062 | 46325 | 4069 | 47384 | 3321 | 47653 | 2156 | 58197 | 1253 | 46007 |
| 9L-2S | | MI | 19597 | 6846 | 32915 | 4850 | 36303 | 3898 | 37979 | 3132 | 40356 | 1939 | 48431 | 1649 | 31855 |
| 18-#18 | 5.84 | MA | 30028 | 7935 | 52422 | 5713 | 58657 | 4571 | 62370 | 3605 | 68105 | 2065 | 85501 | 751 | 78927 |
| 7L-4S | | MI | 20483 | 7935 | 36729 | 5492 | 40795 | 4320 | 43313 | 3339 | 47616 | 1760 | 58143 | 783 | 51888 |
| 20-#11 | 2.53 | MA | 28115 | 6524 | 45361 | 4837 | 49913 | 3907 | 51839 | 3216 | 53681 | 2157 | 65317 | 1777 | 41066 |
| 5L-7S | | MI | 16870 | 6524 | 27701 | 4676 | 29686 | 3785 | 30158 | 3082 | 30084 | 2032 | 35752 | 1447 | 24310 |
| 20-#11 | 2.53 | MA | 27601 | 6524 | 44504 | 4835 | 48725 | 3921 | 50387 | 3211 | 51768 | 2167 | 62895 | 1721 | 40264 |
| 6E | | MI | 17176 | 6524 | 28264 | 4665 | 30364 | 3775 | 31016 | 3091 | 31141 | 2024 | 36987 | 1511 | 24492 |
| 20-#11 | 2.53 | MA | 27100 | 6524 | 43564 | 4850 | 47592 | 3917 | 48994 | 3224 | 49899 | 2177 | 60311 | 1631 | 39775 |
| 7L-5S | | MI | 17489 | 6524 | 28778 | 4671 | 31075 | 3783 | 31830 | 3082 | 32223 | 2015 | 38297 | 1568 | 24823 |
| 20-#11 | 2.53 | MA | 26607 | 6524 | 42721 | 4848 | 46443 | 3931 | 47635 | 3236 | 47912 | 2169 | 57933 | 1582 | 38983 |
| 8L-4S | | MI | 17817 | 6524 | 29325 | 4677 | 31783 | 3774 | 32684 | 3074 | 33420 | 2024 | 39704 | 1606 | 25013 |
| 20-#11 | 2.53 | MA | 26091 | 6524 | 41895 | 4846 | 45325 | 3928 | 46213 | 3232 | 46060 | 2180 | 55584 | 1528 | 38225 |
| 9L-3S | | MI | 18181 | 6524 | 29954 | 4665 | 32584 | 3782 | 33642 | 3082 | 34611 | 2015 | 41024 | 1690 | 25011 |
| 20-#11 | 2.53 | MA | 25546 | 6524 | 40971 | 4861 | 44192 | 3942 | 44860 | 3244 | 44224 | 2190 | 53307 | 1467 | 37251 |
| 10L-2S | | MI | 18687 | 6524 | 30715 | 4671 | 33560 | 3772 | 34818 | 3074 | 36171 | 2006 | 43065 | 1776 | 24989 |
| 20-#14 | 3.65 | MA | 29089 | 7002 | 48398 | 5121 | 53590 | 4130 | 56287 | 3336 | 59805 | 2128 | 73934 | 1505 | 56174 |
| 6E | | MI | 17940 | 7002 | 30502 | 4935 | 33133 | 3968 | 34267 | 3196 | 35450 | 1942 | 42745 | 1222 | 33810 |
| 20-#14 | 3.65 | MA | 28385 | 7002 | 47051 | 5142 | 51965 | 4125 | 54288 | 3353 | 57124 | 2141 | 70258 | 1375 | 54685 |
| 7L-5S | | MI | 18381 | 7002 | 31237 | 4944 | 34148 | 3981 | 35416 | 3183 | 36979 | 1930 | 44588 | 1305 | 34203 |
| 20-#14 | 3.65 | MA | 27693 | 7002 | 45840 | 5138 | 50316 | 4144 | 52338 | 3370 | 54274 | 2130 | 66868 | 1305 | 53415 |
| 8L-4S | | MI | 18843 | 7002 | 32018 | 4953 | 35159 | 3968 | 36625 | 3171 | 38672 | 1942 | 46569 | 1360 | 34995 |
| 20-#14 | 3.65 | MA | 26985 | 7002 | 44536 | 5160 | 48713 | 4138 | 50298 | 3363 | 51617 | 2143 | 63528 | 1227 | 51552 |
| 9L-3S | | MI | 19356 | 7002 | 32915 | 4938 | 36303 | 3981 | 37979 | 3183 | 40356 | 1930 | 48431 | 1478 | 35203 |
| 22-#11 | 2.79 | MA | 28209 | 6632 | 45805 | 4902 | 50393 | 3969 | 52422 | 3241 | 54537 | 2158 | 66641 | 1705 | 44211 |
| 6L-7S | | MI | 17211 | 6632 | 28463 | 4744 | 30662 | 3833 | 31334 | 3111 | 31644 | 2018 | 37793 | 1417 | 26606 |
| 22-#11 | 2.79 | MA | 27711 | 6632 | 44865 | 4917 | 49260 | 3966 | 51029 | 3253 | 52667 | 2168 | 64058 | 1615 | 43735 |
| 7L-6S | | MI | 17516 | 6632 | 29026 | 4732 | 31341 | 3824 | 32192 | 3119 | 32701 | 2010 | 39028 | 1481 | 26799 |
| 22-#11 | 2.79 | MA | 27220 | 6632 | 44022 | 4915 | 48111 | 3980 | 49669 | 3266 | 50681 | 2161 | 61679 | 1566 | 42890 |
| 8L-5S | | MI | 17828 | 6632 | 29540 | 4738 | 32051 | 3832 | 33006 | 3111 | 33783 | 2001 | 40338 | 1538 | 27111 |
| 22-#11 | 2.79 | MA | 26707 | 6632 | 43196 | 4913 | 46993 | 3976 | 48248 | 3261 | 48829 | 2171 | 59330 | 1512 | 42152 |
| 9L-4S | | MI | 18155 | 6632 | 30087 | 4744 | 32759 | 3822 | 33860 | 3102 | 34980 | 2010 | 41744 | 1576 | 27381 |
| 22-#11 | 2.79 | MA | 26164 | 6632 | 42272 | 4928 | 45860 | 3990 | 46895 | 3274 | 46992 | 2181 | 57054 | 1451 | 41140 |
| 10L-3S | | MI | 18518 | 6632 | 30715 | 4733 | 33560 | 3830 | 34818 | 3111 | 36171 | 2001 | 43065 | 1660 | 27395 |
| 22-#11 | 2.79 | MA | 25634 | 6632 | 41445 | 4926 | 44748 | 3986 | 45491 | 3269 | 45034 | 2174 | 54735 | 1399 | 40224 |
| 11L-2S | | MI | 19022 | 6632 | 31477 | 4739 | 34537 | 3821 | 35995 | 3102 | 37731 | 1992 | 45106 | 1746 | 27381 |
| 22-#14 | 4.02 | MA | 29244 | 7157 | 48913 | 5239 | 54353 | 4194 | 57202 | 3395 | 61087 | 2129 | 75590 | 1350 | 60257 |
| 7L-6S | | MI | 18416 | 7157 | 31586 | 5032 | 34523 | 4038 | 35929 | 3235 | 37655 | 1921 | 45619 | 1176 | 36973 |
| 22-#14 | 4.02 | MA | 28555 | 7157 | 47703 | 5236 | 52704 | 4214 | 55251 | 3413 | 58238 | 2117 | 72200 | 1280 | 58951 |
| 8L-5S | | MI | 18855 | 7157 | 32321 | 5041 | 35538 | 4051 | 37079 | 3223 | 39184 | 1908 | 47462 | 1258 | 37460 |
| 22-#14 | 4.02 | MA | 27849 | 7157 | 46399 | 5257 | 51101 | 4208 | 53211 | 3405 | 55581 | 2131 | 68859 | 1202 | 57105 |
| 9L-4S | | MI | 19315 | 7157 | 33103 | 5051 | 36550 | 4038 | 38287 | 3210 | 40877 | 1921 | 49443 | 1314 | 38206 |
| 24-#11 | 3.04 | MA | 28318 | 6740 | 46166 | 4985 | 50928 | 4014 | 53064 | 3283 | 55436 | 2159 | 67804 | 1598 | 47699 |
| 7E | | MI | 17551 | 6740 | 29225 | 4811 | 31638 | 3881 | 32510 | 3139 | 33203 | 2004 | 39834 | 1387 | 28856 |
| 24-#11 | 3.04 | MA | 27830 | 6740 | 45323 | 4983 | 49779 | 4028 | 51704 | 3295 | 53449 | 2152 | 65426 | 1549 | 46802 |
| 8L-6S | | MI | 17855 | 6740 | 29787 | 4800 | 32317 | 3872 | 33368 | 3147 | 34261 | 1996 | 41068 | 1451 | 29109 |
| 24-#11 | 3.04 | MA | 27326 | 6740 | 44497 | 4980 | 48661 | 4025 | 50282 | 3290 | 51597 | 2162 | 63077 | 1496 | 46083 |
| 9L-5S | | MI | 18166 | 6740 | 30301 | 4806 | 33027 | 3880 | 34182 | 3139 | 35343 | 1987 | 42378 | 1508 | 29404 |
| 24-#11 | 3.04 | MA | 26779 | 6740 | 43573 | 4995 | 47527 | 4038 | 48930 | 3303 | 49761 | 2172 | 60801 | 1435 | 45034 |
| 10L-4S | | MI | 18492 | 6740 | 30848 | 4812 | 33736 | 3871 | 35037 | 3130 | 36539 | 1996 | 43785 | 1546 | 29745 |
| 24-#11 | 3.04 | MA | 26251 | 6740 | 42746 | 4993 | 46416 | 4035 | 47526 | 3298 | 47803 | 2165 | 58482 | 1382 | 44087 |
| 11L-3S | | MI | 18853 | 6740 | 31477 | 4800 | 34537 | 3879 | 35995 | 3139 | 37731 | 1987 | 45106 | 1630 | 29770 |
| 24-#14 | 4.38 | MA | 29412 | 7313 | 49566 | 5333 | 55092 | 4284 | 58164 | 3455 | 62201 | 2105 | 77531 | 1254 | 64469 |
| 8L-6S | | MI | 18890 | 7313 | 32671 | 5129 | 35914 | 4108 | 37591 | 3275 | 39860 | 1899 | 48493 | 1130 | 40146 |
| 24-#14 | 4.38 | MA | 28706 | 7313 | 48262 | 5354 | 53489 | 4278 | 56124 | 3448 | 59544 | 2119 | 74190 | 1177 | 62666 |
| 9L-5S | | MI | 19327 | 7313 | 33406 | 5139 | 36929 | 4120 | 38741 | 3262 | 41389 | 1887 | 50336 | 1212 | 40723 |

## RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

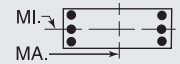
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.24 | MA | 29469 | 6246 | 45958 | 4657 | 49727 | 3795 | 50702 | 3163 | 50546 | 2271 | 59327 | 2142 | 22426 |
| 2E | | MI | 17623 | 6246 | 28070 | 4455 | 29590 | 3622 | 29651 | 3003 | 28839 | 2119 | 33131 | 1948 | 13145 |
| 6-#14 | 1.05 | MA | 29029 | 6160 | 44826 | 4631 | 48456 | 3779 | 49221 | 3160 | 48558 | 2293 | 56891 | 2181 | 19151 |
| 2L-3S | | MI | 16687 | 6160 | 26375 | 4438 | 27650 | 3641 | 27389 | 3034 | 25854 | 2179 | 29340 | 1895 | 11386 |
| 6-#14 | 1.05 | MA | 27689 | 6160 | 42866 | 4628 | 45943 | 3774 | 46155 | 3177 | 44388 | 2307 | 51251 | 2057 | 19215 |
| 3L-2S | | MI | 17422 | 6160 | 27459 | 4447 | 29040 | 3628 | 29051 | 3022 | 28059 | 2166 | 32213 | 2019 | 11301 |
| 6-#18 | 1.86 | MA | 31069 | 6523 | 49394 | 4830 | 54131 | 3919 | 56076 | 3239 | 57857 | 2249 | 69097 | 2093 | 33220 |
| 2L-3S | | MI | 17193 | 6523 | 28070 | 4608 | 29590 | 3765 | 29651 | 3091 | 28839 | 2097 | 33131 | 1635 | 19294 |
| 6-#18 | 1.86 | MA | 28758 | 6523 | 45958 | 4822 | 49727 | 3952 | 50702 | 3268 | 50546 | 2271 | 59327 | 1872 | 33173 |
| 3L-2S | | MI | 18450 | 6523 | 29949 | 4627 | 31963 | 3743 | 32487 | 3069 | 32601 | 2075 | 37997 | 1856 | 19167 |
| 8-#14 | 1.40 | MA | 29957 | 6315 | 46786 | 4728 | 50969 | 3849 | 52286 | 3202 | 52729 | 2281 | 62531 | 2157 | 25316 |
| 2L-4S | | MI | 16649 | 6315 | 26562 | 4551 | 27897 | 3698 | 27697 | 3061 | 26375 | 2170 | 30351 | 1730 | 14937 |
| 8-#14 | 1.40 | MA | 28625 | 6315 | 44826 | 4725 | 48456 | 3844 | 49221 | 3220 | 48558 | 2295 | 56891 | 2033 | 25354 |
| 3E | | MI | 17177 | 6315 | 27459 | 4535 | 29040 | 3710 | 29051 | 3074 | 28059 | 2157 | 32213 | 1849 | 14859 |
| 8-#14 | 1.40 | MA | 27693 | 6315 | 43231 | 4747 | 46423 | 3864 | 46750 | 3213 | 45379 | 2309 | 53217 | 1908 | 25291 |
| 4L-2S | | MI | 17908 | 6315 | 28544 | 4544 | 30431 | 3698 | 30714 | 3061 | 30264 | 2145 | 35087 | 1973 | 14781 |
| 8-#18 | 2.48 | MA | 32648 | 6800 | 52829 | 5003 | 58536 | 4043 | 61449 | 3314 | 65168 | 2227 | 78867 | 2045 | 43966 |
| 2L-4S | | MI | 17114 | 6800 | 28387 | 4806 | 30011 | 3863 | 30174 | 3135 | 29728 | 2075 | 34833 | 1338 | 24735 |
| 8-#18 | 2.48 | MA | 30360 | 6800 | 49394 | 4995 | 54131 | 4076 | 56076 | 3344 | 57857 | 2249 | 69097 | 1824 | 43803 |
| 3E | | MI | 18020 | 6800 | 29949 | 4781 | 31963 | 3885 | 32487 | 3157 | 32601 | 2053 | 37997 | 1542 | 25201 |
| 8-#18 | 2.48 | MA | 28754 | 6800 | 46591 | 5032 | 50560 | 4065 | 51735 | 3329 | 52270 | 2272 | 62746 | 1602 | 42875 |
| 4L-2S | | MI | 19268 | 6800 | 31829 | 4800 | 34336 | 3863 | 35323 | 3135 | 36364 | 2031 | 42862 | 1764 | 25125 |
| 10-#11 | 1.21 | MA | 29501 | 6232 | 45716 | 4691 | 49688 | 3824 | 50759 | 3189 | 50667 | 2295 | 59868 | 2183 | 22108 |
| 2L-5S | | MI | 16463 | 6232 | 26020 | 4515 | 27274 | 3691 | 26997 | 3069 | 25360 | 2183 | 29123 | 1812 | 13144 |
| 10-#11 | 1.21 | MA | 28567 | 6232 | 44347 | 4689 | 47934 | 3821 | 48619 | 3202 | 47755 | 2305 | 55907 | 2097 | 22142 |
| 3L-4S | | MI | 16797 | 6232 | 26567 | 4521 | 27983 | 3681 | 27852 | 3060 | 26557 | 2191 | 30530 | 1850 | 13088 |
| 10-#11 | 1.21 | MA | 27914 | 6232 | 43235 | 4704 | 46516 | 3835 | 46896 | 3198 | 45537 | 2316 | 53323 | 2011 | 22149 |
| 4L-3S | | MI | 17169 | 6232 | 27196 | 4510 | 28784 | 3689 | 28810 | 3069 | 27748 | 2183 | 31850 | 1934 | 13030 |
| 10-#11 | 1.21 | MA | 27332 | 6232 | 42275 | 4702 | 45270 | 3832 | 45365 | 3211 | 43319 | 2309 | 50639 | 1968 | 22090 |
| 5L-2S | | MI | 17684 | 6232 | 27957 | 4516 | 29760 | 3680 | 29986 | 3060 | 29308 | 2174 | 33891 | 2020 | 12978 |
| 10-#14 | 1.75 | MA | 30877 | 6471 | 48746 | 4826 | 53481 | 3919 | 55351 | 3244 | 56900 | 2268 | 68171 | 2134 | 31462 |
| 2L-5S | | MI | 16663 | 6471 | 26865 | 4639 | 28276 | 3780 | 28151 | 3113 | 26887 | 2136 | 31244 | 1629 | 18199 |
| 10-#14 | 1.75 | MA | 29554 | 6471 | 46786 | 4822 | 50969 | 3914 | 52286 | 3262 | 52729 | 2283 | 62531 | 2009 | 31463 |
| 3L-4S | | MI | 17138 | 6471 | 27647 | 4648 | 29288 | 3768 | 29359 | 3100 | 28580 | 2148 | 33225 | 1684 | 18354 |
| 10-#14 | 1.75 | MA | 28628 | 6471 | 45191 | 4844 | 48936 | 3934 | 49815 | 3255 | 49549 | 2297 | 58856 | 1885 | 31356 |
| 4L-3S | | MI | 17664 | 6471 | 28544 | 4632 | 30431 | 3780 | 30714 | 3113 | 30264 | 2136 | 35087 | 1803 | 18300 |
| 10-#14 | 1.75 | MA | 27801 | 6471 | 43813 | 4841 | 47148 | 3929 | 47618 | 3273 | 46367 | 2286 | 55027 | 1824 | 30830 |
| 5L-2S | | MI | 18391 | 6471 | 29629 | 4642 | 31821 | 3768 | 32376 | 3100 | 32469 | 2123 | 37961 | 1927 | 18235 |
| 10-#18 | 3.11 | MA | 31940 | 7076 | 52829 | 5168 | 58536 | 4201 | 61449 | 3419 | 65168 | 2227 | 78867 | 1775 | 54411 |
| 3L-4S | | MI | 17940 | 7076 | 30267 | 4979 | 32384 | 3984 | 33010 | 3201 | 33491 | 2031 | 39698 | 1246 | 30137 |
| 10-#18 | 3.11 | MA | 30352 | 7076 | 50027 | 5205 | 54964 | 4190 | 57108 | 3405 | 59581 | 2250 | 72516 | 1554 | 52950 |
| 4L-3S | | MI | 18840 | 7076 | 31829 | 4954 | 34336 | 4006 | 35323 | 3223 | 36364 | 2009 | 42862 | 1450 | 31054 |
| 10-#18 | 3.11 | MA | 28934 | 7076 | 47602 | 5197 | 51820 | 4223 | 53245 | 3434 | 53987 | 2228 | 65858 | 1449 | 49756 |
| 5L-2S | | MI | 20079 | 7076 | 33709 | 4973 | 36709 | 3984 | 38159 | 3201 | 40127 | 1987 | 47728 | 1671 | 31045 |
| 12-#11 | 1.45 | MA | 30150 | 6340 | 47084 | 4758 | 51443 | 3872 | 52899 | 3219 | 53578 | 2286 | 63829 | 2168 | 26404 |
| 2L-6S | | MI | 16491 | 6340 | 26267 | 4577 | 27541 | 3731 | 27360 | 3106 | 25838 | 2177 | 29854 | 1725 | 15439 |
| 12-#11 | 1.45 | MA | 29221 | 6340 | 45716 | 4756 | 49688 | 3869 | 50759 | 3232 | 50667 | 2297 | 59868 | 2082 | 26426 |
| 3L-5S | | MI | 16810 | 6340 | 26782 | 4583 | 28251 | 3739 | 28173 | 3097 | 26920 | 2169 | 31163 | 1782 | 15545 |
| 12-#11 | 1.45 | MA | 28571 | 6340 | 44604 | 4771 | 48271 | 3883 | 49036 | 3227 | 48449 | 2307 | 57284 | 1995 | 26407 |
| 4E | | MI | 17144 | 6340 | 27328 | 4589 | 28959 | 3730 | 29028 | 3088 | 28117 | 2177 | 32570 | 1820 | 15504 |
| 12-#11 | 1.45 | MA | 27991 | 6340 | 43643 | 4769 | 47025 | 3880 | 47505 | 3240 | 46230 | 2301 | 54600 | 1953 | 26323 |
| 5L-3S | | MI | 17514 | 6340 | 27957 | 4577 | 29760 | 3738 | 29986 | 3097 | 29308 | 2169 | 33891 | 1904 | 15456 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

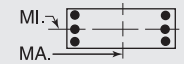
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.45 | MA | 27440 | 6340 | 42743 | 4768 | 45777 | 3894 | 45980 | 3236 | 44221 | 2311 | 52037 | 1897 | 25853 |
| 6L-2S | | MI | 18027 | 6340 | 28719 | 4583 | 30736 | 3728 | 31162 | 3088 | 30868 | 2160 | 35932 | 1990 | 15408 |
| 12-#14 | 2.10 | MA | 31790 | 6627 | 50706 | 4923 | 55994 | 3989 | 58417 | 3287 | 61070 | 2256 | 73811 | 2110 | 37597 |
| 2L-6S | | MI | 16701 | 6627 | 27215 | 4727 | 28652 | 3838 | 28663 | 3165 | 27563 | 2126 | 32275 | 1500 | 20919 |
| 12-#14 | 2.10 | MA | 30474 | 6627 | 48746 | 4920 | 53481 | 3984 | 55351 | 3305 | 56900 | 2270 | 68171 | 1985 | 37558 |
| 3L-5S | | MI | 17152 | 6627 | 27950 | 4736 | 29666 | 3850 | 29813 | 3152 | 29092 | 2114 | 34118 | 1583 | 21404 |
| 12-#14 | 2.10 | MA | 29554 | 6627 | 47151 | 4941 | 51448 | 4004 | 52881 | 3298 | 53720 | 2284 | 64496 | 1861 | 37411 |
| 4E | | MI | 17624 | 6627 | 28731 | 4745 | 30678 | 3838 | 31021 | 3140 | 30785 | 2126 | 36099 | 1638 | 21752 |
| 12-#14 | 2.10 | MA | 28733 | 6627 | 45773 | 4938 | 49661 | 3999 | 50684 | 3316 | 50538 | 2274 | 60667 | 1800 | 36675 |
| 5L-3S | | MI | 18147 | 6627 | 29629 | 4730 | 31821 | 3850 | 32376 | 3152 | 32469 | 2114 | 37961 | 1757 | 21722 |
| 12-#14 | 2.10 | MA | 27953 | 6627 | 44481 | 4935 | 47871 | 4018 | 48496 | 3309 | 47655 | 2288 | 57021 | 1720 | 35449 |
| 6L-2S | | MI | 18871 | 6627 | 30714 | 4739 | 33212 | 3838 | 34038 | 3140 | 34674 | 2101 | 40835 | 1881 | 21670 |
| 12-#18 | 3.73 | MA | 31930 | 7353 | 53463 | 5378 | 59369 | 4314 | 62481 | 3480 | 66892 | 2228 | 82286 | 1505 | 63077 |
| 4E | | MI | 18759 | 7353 | 32147 | 5152 | 34756 | 4105 | 35847 | 3266 | 37254 | 1987 | 44564 | 1153 | 35587 |
| 12-#18 | 3.73 | MA | 30528 | 7353 | 51038 | 5370 | 56225 | 4347 | 58618 | 3510 | 61297 | 2206 | 75628 | 1401 | 60054 |
| 5L-3S | | MI | 19653 | 7353 | 33709 | 5127 | 36709 | 4127 | 38159 | 3289 | 40127 | 1965 | 47728 | 1357 | 36875 |
| 12-#18 | 3.73 | MA | 29194 | 7353 | 48764 | 5363 | 53076 | 4336 | 54770 | 3495 | 56226 | 2229 | 69319 | 1257 | 56775 |
| 6L-2S | | MI | 20884 | 7353 | 35588 | 5146 | 39082 | 4105 | 40995 | 3266 | 43890 | 1943 | 52593 | 1579 | 36945 |
| 14-#11 | 1.70 | MA | 30795 | 6448 | 48453 | 4826 | 53197 | 3921 | 55040 | 3248 | 56490 | 2278 | 67789 | 2152 | 30692 |
| 2L-7S | | MI | 16528 | 6448 | 26466 | 4656 | 27838 | 3789 | 27678 | 3125 | 26340 | 2172 | 30659 | 1631 | 17481 |
| 14-#11 | 1.70 | MA | 29870 | 6448 | 47084 | 4824 | 51443 | 3917 | 52899 | 3261 | 53578 | 2288 | 63829 | 2066 | 30698 |
| 3L-6S | | MI | 16838 | 6448 | 27029 | 4644 | 28517 | 3780 | 28536 | 3134 | 27398 | 2163 | 31894 | 1695 | 17700 |
| 14-#11 | 1.70 | MA | 29223 | 6448 | 45972 | 4839 | 50025 | 3931 | 51176 | 3257 | 51361 | 2299 | 61245 | 1980 | 30658 |
| 4L-5S | | MI | 17156 | 6448 | 27543 | 4650 | 29227 | 3787 | 29349 | 3125 | 28480 | 2155 | 33204 | 1752 | 17935 |
| 14-#11 | 1.70 | MA | 28646 | 6448 | 45012 | 4837 | 48779 | 3928 | 49645 | 3270 | 49142 | 2292 | 58561 | 1937 | 30552 |
| 5L-4S | | MI | 17488 | 6448 | 28090 | 4656 | 29936 | 3778 | 30204 | 3117 | 29676 | 2163 | 34611 | 1790 | 17908 |
| 14-#11 | 1.70 | MA | 28098 | 6448 | 44112 | 4835 | 47532 | 3942 | 48120 | 3265 | 47133 | 2303 | 55998 | 1881 | 29978 |
| 6L-3S | | MI | 17857 | 6448 | 28719 | 4645 | 30736 | 3786 | 31162 | 3125 | 30868 | 2155 | 35932 | 1874 | 17869 |
| 14-#11 | 1.70 | MA | 27563 | 6448 | 43125 | 4850 | 46342 | 3939 | 46658 | 3278 | 45170 | 2313 | 53266 | 1792 | 29384 |
| 7L-2S | | MI | 18368 | 6448 | 29480 | 4651 | 31713 | 3777 | 32338 | 3117 | 32427 | 2146 | 37972 | 1960 | 17826 |
| 14-#14 | 2.45 | MA | 31387 | 6782 | 50706 | 5017 | 55994 | 4054 | 58417 | 3347 | 61070 | 2258 | 73811 | 1961 | 43643 |
| 3L-6S | | MI | 17188 | 6782 | 28300 | 4824 | 30042 | 3908 | 30326 | 3204 | 29768 | 2105 | 35149 | 1454 | 24177 |
| 14-#14 | 2.45 | MA | 30473 | 6782 | 49111 | 5038 | 53961 | 4073 | 55946 | 3340 | 57891 | 2272 | 70136 | 1837 | 43461 |
| 4L-5S | | MI | 17637 | 6782 | 29035 | 4833 | 31057 | 3920 | 31476 | 3192 | 31297 | 2092 | 36992 | 1537 | 24626 |
| 14-#14 | 2.45 | MA | 29658 | 6782 | 47733 | 5035 | 52174 | 4068 | 53749 | 3358 | 54708 | 2262 | 66307 | 1776 | 42539 |
| 5L-4S | | MI | 18107 | 6782 | 29816 | 4842 | 32069 | 3907 | 32684 | 3179 | 32990 | 2105 | 38973 | 1592 | 25128 |
| 14-#14 | 2.45 | MA | 28883 | 6782 | 46441 | 5032 | 50384 | 4088 | 51562 | 3351 | 51826 | 2276 | 62660 | 1696 | 41369 |
| 6L-3S | | MI | 18628 | 6782 | 30714 | 4827 | 33212 | 3920 | 34038 | 3192 | 34674 | 2092 | 40835 | 1710 | 25129 |
| 14-#14 | 2.45 | MA | 28127 | 6782 | 45026 | 5053 | 48677 | 4083 | 49463 | 3369 | 49009 | 2290 | 58771 | 1566 | 40219 |
| 7L-2S | | MI | 19349 | 6782 | 31798 | 4836 | 34603 | 3907 | 35701 | 3179 | 36879 | 2080 | 43709 | 1835 | 25091 |
| 14-#18 | 4.35 | MA | 32102 | 7629 | 54474 | 5543 | 60629 | 4471 | 63991 | 3585 | 68608 | 2184 | 85398 | 1353 | 70377 |
| 5L-4S | | MI | 19572 | 7629 | 34026 | 5325 | 37129 | 4226 | 38683 | 3332 | 41017 | 1944 | 49429 | 1061 | 41075 |
| 14-#18 | 4.35 | MA | 30783 | 7629 | 52200 | 5536 | 57481 | 4460 | 60143 | 3571 | 63537 | 2206 | 79089 | 1209 | 66921 |
| 6L-3S | | MI | 20460 | 7629 | 35588 | 5300 | 39082 | 4248 | 40995 | 3354 | 43890 | 1921 | 52593 | 1265 | 42676 |
| 14-#18 | 4.35 | MA | 29499 | 7629 | 49709 | 5573 | 54476 | 4493 | 56450 | 3600 | 58582 | 2229 | 72353 | 978 | 63580 |
| 7L-2S | | MI | 21682 | 7629 | 37468 | 5319 | 41455 | 4226 | 43832 | 3332 | 47653 | 1899 | 57459 | 1486 | 42800 |
| 16-#11 | 1.94 | MA | 30515 | 6556 | 48453 | 4891 | 53197 | 3966 | 55040 | 3290 | 56490 | 2280 | 67789 | 2051 | 34961 |
| 3L-7S | | MI | 16875 | 6556 | 27228 | 4723 | 28814 | 3837 | 28854 | 3153 | 27900 | 2158 | 32700 | 1601 | 19792 |
| 16-#11 | 1.94 | MA | 29871 | 6556 | 47341 | 4906 | 51779 | 3980 | 53317 | 3286 | 54273 | 2290 | 65206 | 1964 | 34903 |
| 4L-6S | | MI | 17184 | 6556 | 27791 | 4712 | 29493 | 3828 | 29712 | 3162 | 28957 | 2149 | 33935 | 1665 | 19997 |
| 16-#11 | 1.94 | MA | 29298 | 6556 | 46380 | 4904 | 50533 | 3977 | 51785 | 3299 | 52054 | 2283 | 62521 | 1922 | 34778 |
| 5E | | MI | 17500 | 6556 | 28305 | 4718 | 30204 | 3836 | 30525 | 3153 | 30039 | 2141 | 35245 | 1722 | 20317 |
| 16-#11 | 1.94 | MA | 28752 | 6556 | 45480 | 4902 | 49286 | 3991 | 50261 | 3295 | 50045 | 2294 | 59959 | 1866 | 34112 |
| 6L-4S | | MI | 17831 | 6556 | 28852 | 4724 | 30912 | 3827 | 31380 | 3145 | 31236 | 2149 | 36652 | 1760 | 20303 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.94 | MA | 28220 | 6556 | 44494 | 4918 | 48097 | 3988 | 48798 | 3307 | 48082 | 2304 | 57227 | 1776 | 33541 |
| 7L-3S | | MI | 18198 | 6556 | 29480 | 4712 | 31713 | 3834 | 32338 | 3153 | 32427 | 2141 | 37972 | 1844 | 20273 |
| 16-#11 | 1.94 | MA | 27697 | 6556 | 43608 | 4916 | 46890 | 4002 | 47370 | 3320 | 45996 | 2298 | 54717 | 1726 | 32922 |
| 8L-2S | | MI | 18708 | 6556 | 30242 | 4718 | 32689 | 3825 | 33514 | 3145 | 33987 | 2132 | 40013 | 1930 | 20236 |
| 16-#14 | 2.80 | MA | 31385 | 6938 | 51071 | 5136 | 56474 | 4143 | 59011 | 3383 | 62061 | 2260 | 75776 | 1813 | 49506 |
| 4L-6S | | MI | 17673 | 6938 | 29385 | 4921 | 31433 | 3977 | 31988 | 3243 | 31972 | 2083 | 38023 | 1408 | 27442 |
| 16-#14 | 2.80 | MA | 30576 | 6938 | 49693 | 5132 | 54686 | 4138 | 56814 | 3401 | 58879 | 2249 | 71947 | 1752 | 48420 |
| 5E | | MI | 18120 | 6938 | 30119 | 4930 | 32448 | 3990 | 33138 | 3231 | 33502 | 2070 | 39866 | 1491 | 27860 |
| 16-#14 | 2.80 | MA | 29805 | 6938 | 48401 | 5129 | 52897 | 4158 | 54627 | 3394 | 55996 | 2263 | 68300 | 1672 | 47299 |
| 6L-4S | | MI | 18587 | 6938 | 30901 | 4940 | 33459 | 3977 | 34346 | 3219 | 35195 | 2083 | 41847 | 1546 | 28494 |
| 16-#14 | 2.80 | MA | 29055 | 6938 | 46986 | 5151 | 51190 | 4153 | 52528 | 3412 | 53180 | 2278 | 64411 | 1542 | 46053 |
| 7L-3S | | MI | 19106 | 6938 | 31798 | 4924 | 34603 | 3990 | 35701 | 3231 | 36879 | 2070 | 43709 | 1664 | 28527 |
| 16-#14 | 2.80 | MA | 28317 | 6938 | 45715 | 5147 | 49458 | 4173 | 50479 | 3430 | 50186 | 2267 | 60830 | 1471 | 44578 |
| 8L-2S | | MI | 19823 | 6938 | 32883 | 4933 | 35993 | 3977 | 37363 | 3219 | 39083 | 2058 | 46583 | 1789 | 28502 |
| 16-#18 | 4.97 | MA | 32354 | 7906 | 55636 | 5709 | 61885 | 4584 | 65517 | 3646 | 70848 | 2184 | 88858 | 1160 | 77095 |
| 6L-4S | | MI | 20379 | 7906 | 35906 | 5497 | 39502 | 4346 | 41519 | 3398 | 44779 | 1900 | 54295 | 968 | 46593 |
| 16-#18 | 4.97 | MA | 31083 | 7906 | 53145 | 5746 | 58881 | 4618 | 61823 | 3676 | 65893 | 2207 | 82123 | 929 | 73644 |
| 7L-3S | | MI | 21261 | 7906 | 37468 | 5473 | 41455 | 4368 | 43832 | 3420 | 47653 | 1878 | 57459 | 1172 | 48462 |
| 16-#18 | 4.97 | MA | 29832 | 7906 | 50907 | 5738 | 55833 | 4607 | 58217 | 3705 | 60627 | 2185 | 75899 | 806 | 69448 |
| 8L-2S | | MI | 22476 | 7906 | 39348 | 5492 | 43827 | 4346 | 46668 | 3398 | 51416 | 1855 | 62324 | 1394 | 48636 |
| 18-#11 | 2.18 | MA | 30516 | 6664 | 48709 | 4974 | 53534 | 4028 | 55457 | 3315 | 57185 | 2281 | 69167 | 1949 | 39144 |
| 4L-7S | | MI | 17220 | 6664 | 27990 | 4791 | 29791 | 3886 | 30030 | 3181 | 29460 | 2144 | 34741 | 1571 | 22105 |
| 18-#11 | 2.18 | MA | 29945 | 6664 | 47749 | 4972 | 52288 | 4025 | 53925 | 3328 | 54966 | 2275 | 66482 | 1906 | 39001 |
| 5L-6S | | MI | 17527 | 6664 | 28552 | 4779 | 30470 | 3876 | 30888 | 3190 | 30517 | 2135 | 35976 | 1635 | 22298 |
| 18-#11 | 2.18 | MA | 29402 | 6664 | 46849 | 4970 | 51041 | 4039 | 52401 | 3324 | 52957 | 2285 | 63920 | 1851 | 38253 |
| 6L-5S | | MI | 17843 | 6664 | 29066 | 4785 | 31180 | 3884 | 31702 | 3181 | 31599 | 2127 | 37286 | 1693 | 22662 |
| 18-#11 | 2.18 | MA | 28873 | 6664 | 45862 | 4985 | 49851 | 4036 | 50938 | 3337 | 50994 | 2296 | 61188 | 1761 | 37702 |
| 7L-4S | | MI | 18173 | 6664 | 29613 | 4791 | 31888 | 3875 | 32556 | 3173 | 32796 | 2135 | 38693 | 1730 | 22691 |
| 18-#11 | 2.18 | MA | 28352 | 6664 | 44977 | 4983 | 48644 | 4050 | 49510 | 3350 | 48908 | 2289 | 58677 | 1711 | 37021 |
| 8L-3S | | MI | 18538 | 6664 | 30242 | 4780 | 32689 | 3883 | 33514 | 3181 | 33987 | 2127 | 40013 | 1814 | 22670 |
| 18-#11 | 2.18 | MA | 27797 | 6664 | 44110 | 4981 | 47471 | 4047 | 48017 | 3345 | 46963 | 2300 | 56193 | 1657 | 36172 |
| 9L-2S | | MI | 19047 | 6664 | 31004 | 4786 | 33666 | 3874 | 34690 | 3173 | 35547 | 2118 | 42054 | 1900 | 22639 |
| 18-#14 | 3.14 | MA | 31486 | 7093 | 51653 | 5230 | 57199 | 4208 | 59880 | 3443 | 63050 | 2237 | 77587 | 1728 | 54314 |
| 5L-6S | | MI | 18155 | 7093 | 30469 | 5018 | 32823 | 4047 | 33650 | 3283 | 34177 | 2061 | 40897 | 1362 | 30712 |
| 18-#14 | 3.14 | MA | 30721 | 7093 | 50361 | 5226 | 55409 | 4228 | 57692 | 3436 | 60167 | 2251 | 73940 | 1648 | 53237 |
| 6L-5S | | MI | 18599 | 7093 | 31204 | 5028 | 33838 | 4060 | 34800 | 3270 | 35707 | 2049 | 42740 | 1444 | 31104 |
| 18-#14 | 3.14 | MA | 29976 | 7093 | 48946 | 5248 | 53702 | 4223 | 55593 | 3454 | 57350 | 2265 | 70051 | 1518 | 51899 |
| 7L-4S | | MI | 19065 | 7093 | 31986 | 5037 | 34850 | 4047 | 36009 | 3258 | 37399 | 2061 | 44721 | 1500 | 31850 |
| 18-#14 | 3.14 | MA | 29243 | 7093 | 47675 | 5245 | 51971 | 4243 | 53544 | 3472 | 54357 | 2255 | 66470 | 1447 | 50468 |
| 8L-3S | | MI | 19581 | 7093 | 32883 | 5021 | 35993 | 4060 | 37363 | 3270 | 39083 | 2049 | 46583 | 1618 | 31906 |
| 18-#14 | 3.14 | MA | 28486 | 7093 | 46431 | 5241 | 50286 | 4237 | 51402 | 3465 | 51566 | 2269 | 62934 | 1370 | 48681 |
| 9L-2S | | MI | 20296 | 7093 | 33968 | 5031 | 37384 | 4047 | 39026 | 3258 | 41288 | 2036 | 49457 | 1743 | 31905 |
| 18-#18 | 5.59 | MA | 32651 | 8183 | 56581 | 5918 | 63285 | 4742 | 67196 | 3751 | 73203 | 2185 | 91893 | 881 | 83731 |
| 7L-4S | | MI | 21181 | 8183 | 37786 | 5670 | 41875 | 4467 | 44355 | 3464 | 48542 | 1856 | 59160 | 876 | 52135 |
| 18-#18 | 5.59 | MA | 31412 | 8183 | 54343 | 5911 | 60238 | 4731 | 63590 | 3781 | 67938 | 2163 | 85669 | 758 | 79638 |
| 8L-3S | | MI | 22057 | 8183 | 39348 | 5645 | 43827 | 4489 | 46668 | 3486 | 51416 | 1834 | 62324 | 1080 | 54236 |
| 20-#11 | 2.42 | MA | 30589 | 6772 | 49117 | 5039 | 54042 | 4074 | 56066 | 3358 | 57878 | 2266 | 70443 | 1891 | 43221 |
| 5L-7S | | MI | 17563 | 6772 | 28751 | 4858 | 30767 | 3934 | 31206 | 3209 | 31019 | 2130 | 36782 | 1541 | 24420 |
| 20-#11 | 2.42 | MA | 30048 | 6772 | 48217 | 5037 | 52795 | 4088 | 54541 | 3353 | 55869 | 2277 | 67881 | 1835 | 42401 |
| 6E | | MI | 17870 | 6772 | 29314 | 4847 | 31446 | 3925 | 32064 | 3218 | 32077 | 2121 | 38017 | 1605 | 24604 |
| 20-#11 | 2.42 | MA | 29522 | 6772 | 47231 | 5053 | 51605 | 4085 | 53078 | 3366 | 53906 | 2287 | 65149 | 1745 | 41867 |
| 7L-5S | | MI | 18184 | 6772 | 29828 | 4853 | 32156 | 3933 | 32878 | 3209 | 33159 | 2113 | 39327 | 1663 | 24945 |
| 20-#11 | 2.42 | MA | 29004 | 6772 | 46345 | 5051 | 50399 | 4099 | 51651 | 3379 | 51820 | 2280 | 62638 | 1696 | 41127 |
| 8L-4S | | MI | 18513 | 6772 | 30375 | 4858 | 32865 | 3923 | 33732 | 3201 | 34355 | 2121 | 40734 | 1700 | 25074 |
| 20-#11 | 2.42 | MA | 28452 | 6772 | 45479 | 5049 | 49225 | 4095 | 50157 | 3375 | 49875 | 2291 | 60154 | 1642 | 40300 |
| 9L-3S | | MI | 18877 | 6772 | 31004 | 4847 | 33666 | 3931 | 34690 | 3209 | 35547 | 2113 | 42054 | 1784 | 25061 |
| 20-#11 | 2.42 | MA | 27878 | 6772 | 44509 | 5064 | 48035 | 4110 | 48737 | 3388 | 47947 | 2302 | 57745 | 1581 | 39361 |
| 10L-2S | | MI | 19384 | 6772 | 31765 | 4853 | 34642 | 3922 | 35867 | 3201 | 37106 | 2104 | 44095 | 1871 | 25037 |

## RECTANGULAR TIED COLUMNS 28" x 46"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

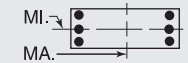
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 3.49 | MA | 31630 | 7249 | 52322 | 5324 | 57922 | 4298 | 60758 | 3479 | 64337 | 2239 | 79580 | 1624 | 59183 |
| 6E | | MI | 18634 | 7249 | 31554 | 5116 | 34214 | 4117 | 35313 | 3322 | 36382 | 2039 | 43771 | 1315 | 33985 |
| 20-#14 | 3.49 | MA | 30890 | 7249 | 50906 | 5345 | 56215 | 4293 | 58659 | 3497 | 61521 | 2253 | 75691 | 1494 | 57755 |
| 7L-5S | | MI | 19077 | 7249 | 32289 | 5125 | 35229 | 4129 | 36463 | 3310 | 37912 | 2027 | 45613 | 1398 | 34356 |
| 20-#14 | 3.49 | MA | 30161 | 7249 | 49635 | 5342 | 54483 | 4312 | 56610 | 3515 | 58528 | 2242 | 72110 | 1423 | 56366 |
| 8L-4S | | MI | 19540 | 7249 | 33070 | 5134 | 36241 | 4117 | 37671 | 3297 | 39604 | 2039 | 47595 | 1453 | 35176 |
| 20-#14 | 3.49 | MA | 29406 | 7249 | 48391 | 5339 | 52799 | 4307 | 54467 | 3508 | 55737 | 2257 | 68574 | 1346 | 54522 |
| 9L-3S | | MI | 20054 | 7249 | 33968 | 5119 | 37384 | 4129 | 39026 | 3310 | 41288 | 2027 | 49457 | 1572 | 35276 |
| 20-#14 | 3.49 | MA | 28585 | 7249 | 46998 | 5360 | 51091 | 4327 | 52429 | 3526 | 52970 | 2271 | 65148 | 1258 | 52615 |
| 10L-2S | | MI | 20765 | 7249 | 35053 | 5128 | 38774 | 4117 | 40688 | 3297 | 43493 | 2015 | 52331 | 1697 | 35303 |
| 20-#18 | 6.21 | MA | 32977 | 8459 | 57778 | 6084 | 64642 | 4855 | 68964 | 3856 | 75248 | 2141 | 95439 | 710 | 89685 |
| 8L-4S | | MI | 21978 | 8459 | 39665 | 5843 | 44248 | 4588 | 47191 | 3530 | 52305 | 1812 | 64026 | 783 | 57696 |
| 22-#11 | 2.66 | MA | 30691 | 6880 | 49586 | 5105 | 54549 | 4136 | 56681 | 3383 | 58781 | 2268 | 71841 | 1820 | 46554 |
| 6L-7S | | MI | 17905 | 6880 | 29513 | 4925 | 31744 | 3982 | 32382 | 3237 | 32579 | 2116 | 38823 | 1511 | 26736 |
| 22-#11 | 2.66 | MA | 30167 | 6880 | 48599 | 5120 | 53360 | 4133 | 55218 | 3396 | 56818 | 2279 | 69110 | 1730 | 46035 |
| 7L-6S | | MI | 18210 | 6880 | 30076 | 4914 | 32422 | 3973 | 33240 | 3246 | 33636 | 2107 | 40057 | 1575 | 26912 |
| 22-#11 | 2.66 | MA | 29652 | 6880 | 47714 | 5118 | 52153 | 4147 | 53791 | 3409 | 54732 | 2272 | 66599 | 1680 | 45239 |
| 8L-5S | | MI | 18523 | 6880 | 30590 | 4920 | 33133 | 3981 | 34054 | 3237 | 34718 | 2099 | 41367 | 1633 | 27234 |
| 22-#11 | 2.66 | MA | 29103 | 6880 | 46847 | 5116 | 50980 | 4144 | 52298 | 3404 | 52787 | 2282 | 64114 | 1626 | 44433 |
| 9L-4S | | MI | 18851 | 6880 | 31137 | 4926 | 33841 | 3972 | 34909 | 3229 | 35915 | 2107 | 42774 | 1671 | 27444 |
| 22-#11 | 2.66 | MA | 28532 | 6880 | 45877 | 5131 | 49789 | 4158 | 50878 | 3417 | 50859 | 2293 | 61706 | 1566 | 43455 |
| 10L-3S | | MI | 19214 | 6880 | 31765 | 4915 | 34642 | 3980 | 35867 | 3237 | 37106 | 2099 | 44095 | 1754 | 27448 |
| 22-#11 | 2.66 | MA | 27975 | 6880 | 45009 | 5129 | 48622 | 4155 | 49404 | 3413 | 48802 | 2286 | 59258 | 1513 | 42490 |
| 11L-2S | | MI | 19719 | 6880 | 32527 | 4920 | 35618 | 3970 | 37043 | 3229 | 38666 | 2090 | 46136 | 1841 | 27430 |
| 22-#14 | 3.84 | MA | 31798 | 7405 | 52866 | 5442 | 58728 | 4362 | 61724 | 3539 | 65692 | 2241 | 81331 | 1470 | 63622 |
| 7L-6S | | MI | 19111 | 7405 | 32639 | 5213 | 35605 | 4187 | 36975 | 3361 | 38587 | 2018 | 46645 | 1269 | 37221 |
| 22-#14 | 3.84 | MA | 31074 | 7405 | 51595 | 5439 | 56996 | 4382 | 59675 | 3557 | 62698 | 2230 | 77750 | 1399 | 62271 |
| 8L-5S | | MI | 19552 | 7405 | 33374 | 5222 | 36619 | 4199 | 38125 | 3349 | 40117 | 2005 | 48487 | 1352 | 37614 |
| 22-#14 | 3.84 | MA | 30320 | 7405 | 50351 | 5436 | 55312 | 4377 | 57532 | 3550 | 59907 | 2244 | 74214 | 1322 | 60372 |
| 9L-4S | | MI | 20013 | 7405 | 34155 | 5231 | 37631 | 4187 | 39333 | 3337 | 41809 | 2018 | 50468 | 1407 | 38386 |
| 22-#14 | 3.84 | MA | 29507 | 7405 | 48958 | 5458 | 53603 | 4397 | 55494 | 3568 | 57140 | 2259 | 70788 | 1234 | 58425 |
| 10L-3S | | MI | 20524 | 7405 | 35053 | 5216 | 38774 | 4199 | 40688 | 3349 | 43493 | 2005 | 52331 | 1526 | 38640 |
| 24-#11 | 2.91 | MA | 30809 | 6988 | 49968 | 5187 | 55114 | 4181 | 57359 | 3425 | 59730 | 2270 | 73070 | 1714 | 50206 |
| 7E | | MI | 18245 | 6988 | 30275 | 4993 | 32720 | 4031 | 33559 | 3266 | 34139 | 2102 | 40863 | 1481 | 29035 |
| 24-#11 | 2.91 | MA | 30296 | 6988 | 49082 | 5185 | 53907 | 4195 | 55931 | 3438 | 57644 | 2263 | 70560 | 1665 | 49356 |
| 8L-6S | | MI | 18550 | 6988 | 30837 | 4982 | 33399 | 4022 | 34416 | 3274 | 35196 | 2093 | 42098 | 1545 | 29223 |
| 24-#11 | 2.91 | MA | 29750 | 6988 | 48216 | 5183 | 52734 | 4192 | 54438 | 3434 | 55699 | 2274 | 68075 | 1611 | 48571 |
| 9L-5S | | MI | 18862 | 6988 | 31351 | 4987 | 34109 | 4030 | 35230 | 3266 | 36278 | 2085 | 43408 | 1603 | 29527 |
| 24-#11 | 2.91 | MA | 29182 | 6988 | 47246 | 5199 | 51544 | 4206 | 53018 | 3447 | 53771 | 2284 | 65667 | 1550 | 47554 |
| 10L-4S | | MI | 19188 | 6988 | 31898 | 4993 | 34817 | 4020 | 36085 | 3257 | 37475 | 2093 | 44815 | 1641 | 29811 |
| 24-#11 | 2.91 | MA | 28627 | 6988 | 46377 | 5197 | 50376 | 4203 | 51544 | 3442 | 51714 | 2278 | 63219 | 1497 | 46609 |
| 11L-3S | | MI | 19550 | 6988 | 32527 | 4982 | 35618 | 4028 | 37043 | 3266 | 38666 | 2085 | 46136 | 1724 | 29831 |
| 24-#11 | 2.91 | MA | 28082 | 6988 | 45425 | 5212 | 49194 | 4217 | 50126 | 3455 | 49787 | 2288 | 60460 | 1421 | 45304 |
| 12L-2S | | MI | 20054 | 6988 | 33289 | 4988 | 36595 | 4019 | 38219 | 3257 | 40226 | 2076 | 48176 | 1811 | 29819 |
| 24-#14 | 4.19 | MA | 31980 | 7560 | 53555 | 5536 | 59509 | 4452 | 62740 | 3599 | 66869 | 2218 | 83390 | 1376 | 68183 |
| 8L-6S | | MI | 19586 | 7560 | 33724 | 5310 | 36995 | 4257 | 38638 | 3401 | 40792 | 1996 | 49519 | 1223 | 40392 |
| 24-#14 | 4.19 | MA | 31227 | 7560 | 52311 | 5533 | 57824 | 4447 | 60598 | 3592 | 64078 | 2232 | 79854 | 1298 | 66229 |
| 9L-5S | | MI | 20024 | 7560 | 34458 | 5319 | 38010 | 4269 | 39787 | 3388 | 42321 | 1984 | 51361 | 1306 | 40878 |
| 24-#14 | 4.19 | MA | 30423 | 7560 | 50919 | 5555 | 56116 | 4467 | 58560 | 3610 | 61311 | 2246 | 76428 | 1210 | 64244 |
| 10L-4S | | MI | 20483 | 7560 | 35240 | 5329 | 39022 | 4257 | 40996 | 3376 | 44014 | 1996 | 53342 | 1361 | 41606 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis

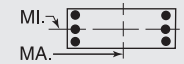



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.19 | MA | 31977 | 6494 | 49706 | 4858 | 53806 | 3960 | 54828 | 3304 | 54535 | 2379 | 64051 | 2252 | 23506 |
| 2E | | MI | 18317 | 6494 | 29127 | 4633 | 30670 | 3769 | 30693 | 3128 | 29765 | 2215 | 34149 | 2041 | 13189 |
| 6-#14 | 1.00 | MA | 31510 | 6407 | 48512 | 4832 | 52464 | 3945 | 53264 | 3300 | 52437 | 2401 | 61453 | 2290 | 20062 |
| 2L-3S | | MI | 17381 | 6407 | 27427 | 4618 | 28731 | 3789 | 28435 | 3160 | 26787 | 2276 | 30365 | 1989 | 11420 |
| 6-#14 | 1.00 | MA | 30101 | 6407 | 46454 | 4829 | 49827 | 3940 | 50046 | 3319 | 48059 | 2416 | 55504 | 2165 | 20126 |
| 3L-2S | | MI | 18115 | 6407 | 28512 | 4628 | 30121 | 3777 | 30098 | 3148 | 28992 | 2263 | 33239 | 2113 | 11336 |
| 6-#18 | 1.79 | MA | 33668 | 6770 | 53315 | 5031 | 58432 | 4084 | 60472 | 3379 | 62214 | 2357 | 74370 | 2206 | 34840 |
| 2L-3S | | MI | 17886 | 6770 | 29127 | 4787 | 30670 | 3912 | 30693 | 3216 | 29765 | 2193 | 34149 | 1727 | 19354 |
| 6-#18 | 1.79 | MA | 31235 | 6770 | 49706 | 5024 | 53806 | 4119 | 54828 | 3410 | 54535 | 2381 | 64051 | 1985 | 34793 |
| 3L-2S | | MI | 19145 | 6770 | 31006 | 4806 | 33043 | 3889 | 33529 | 3194 | 33528 | 2171 | 39014 | 1949 | 19219 |
| 8-#14 | 1.34 | MA | 32489 | 6563 | 50569 | 4929 | 55101 | 4015 | 56481 | 3342 | 56815 | 2389 | 67402 | 2267 | 26531 |
| 2L-4S | | MI | 17342 | 6563 | 27614 | 4731 | 28978 | 3847 | 28743 | 3187 | 27308 | 2267 | 31377 | 1824 | 14983 |
| 8-#14 | 1.34 | MA | 31089 | 6563 | 48512 | 4927 | 52464 | 4010 | 53264 | 3361 | 52437 | 2404 | 61453 | 2143 | 26569 |
| 3E | | MI | 17871 | 6563 | 28512 | 4716 | 30121 | 3859 | 30098 | 3200 | 28992 | 2254 | 33239 | 1943 | 14900 |
| 8-#14 | 1.34 | MA | 30110 | 6563 | 46840 | 4948 | 50333 | 4030 | 50673 | 3355 | 49103 | 2419 | 57574 | 2018 | 26506 |
| 4L-2S | | MI | 18602 | 6563 | 29596 | 4725 | 31512 | 3847 | 31760 | 3187 | 31196 | 2242 | 36113 | 2067 | 14821 |
| 8-#18 | 2.38 | MA | 35335 | 7047 | 56924 | 5204 | 63058 | 4209 | 66115 | 3455 | 69892 | 2335 | 84688 | 2160 | 46126 |
| 2L-4S | | MI | 17806 | 7047 | 29444 | 4984 | 31091 | 4010 | 31217 | 3260 | 30655 | 2171 | 35850 | 1431 | 24991 |
| 8-#18 | 2.38 | MA | 32926 | 7047 | 53315 | 5197 | 58432 | 4243 | 60472 | 3485 | 62214 | 2359 | 74370 | 1939 | 45963 |
| 3E | | MI | 18715 | 7047 | 31006 | 4960 | 33043 | 4032 | 33529 | 3282 | 33528 | 2149 | 39014 | 1635 | 25270 |
| 8-#18 | 2.38 | MA | 31239 | 7047 | 50375 | 5235 | 54685 | 4233 | 55917 | 3472 | 56353 | 2383 | 67655 | 1717 | 45292 |
| 4L-2S | | MI | 19964 | 7047 | 32886 | 4979 | 35416 | 4010 | 36366 | 3260 | 37291 | 2127 | 43880 | 1856 | 25184 |
| 10-#11 | 1.16 | MA | 32006 | 6480 | 49443 | 4892 | 53754 | 3989 | 54874 | 3330 | 54644 | 2403 | 64578 | 2292 | 23161 |
| 2L-5S | | MI | 17156 | 6480 | 27070 | 4697 | 28356 | 3840 | 28045 | 3196 | 26296 | 2280 | 30153 | 1907 | 13184 |
| 10-#11 | 1.16 | MA | 31025 | 6480 | 48007 | 4890 | 51913 | 3986 | 52628 | 3343 | 51589 | 2414 | 60403 | 2206 | 23195 |
| 3L-4S | | MI | 17491 | 6480 | 27617 | 4703 | 29064 | 3831 | 28900 | 3187 | 27492 | 2289 | 31559 | 1944 | 13125 |
| 10-#11 | 1.16 | MA | 30340 | 6480 | 46841 | 4906 | 50427 | 4001 | 50822 | 3339 | 49264 | 2425 | 57677 | 2120 | 23202 |
| 4L-3S | | MI | 17862 | 6480 | 28246 | 4692 | 29865 | 3839 | 29858 | 3196 | 28684 | 2280 | 32880 | 2028 | 13065 |
| 10-#11 | 1.16 | MA | 29729 | 6480 | 45835 | 4904 | 49121 | 3998 | 49217 | 3352 | 46939 | 2419 | 54852 | 2077 | 23143 |
| 5L-2S | | MI | 18378 | 6480 | 29007 | 4698 | 30842 | 3829 | 31034 | 3187 | 30243 | 2272 | 34921 | 2114 | 13013 |
| 10-#14 | 1.67 | MA | 33460 | 6719 | 52626 | 5027 | 57739 | 4085 | 59698 | 3385 | 61192 | 2376 | 73351 | 2245 | 32981 |
| 2L-5S | | MI | 17356 | 6719 | 27918 | 4819 | 29357 | 3929 | 29197 | 3239 | 27820 | 2233 | 32269 | 1723 | 18350 |
| 10-#14 | 1.67 | MA | 32068 | 6719 | 50569 | 5024 | 55101 | 4080 | 56481 | 3403 | 56815 | 2391 | 67402 | 2120 | 32982 |
| 3L-4S | | MI | 17831 | 6719 | 28699 | 4829 | 30369 | 3916 | 30405 | 3227 | 29512 | 2245 | 34251 | 1778 | 18407 |
| 10-#14 | 1.67 | MA | 31096 | 6719 | 48897 | 5046 | 52970 | 4100 | 53890 | 3397 | 53480 | 2406 | 63522 | 1996 | 32875 |
| 4L-3S | | MI | 18358 | 6719 | 29596 | 4813 | 31512 | 3929 | 31760 | 3239 | 31196 | 2233 | 36113 | 1896 | 18347 |
| 10-#14 | 1.67 | MA | 30228 | 6719 | 47452 | 5043 | 51096 | 4096 | 51588 | 3416 | 50144 | 2396 | 59490 | 1935 | 32474 |
| 5L-2S | | MI | 19086 | 6719 | 30681 | 4822 | 32903 | 3916 | 33422 | 3227 | 33401 | 2220 | 38987 | 2021 | 18279 |
| 10-#18 | 2.98 | MA | 34595 | 7324 | 56924 | 5370 | 63058 | 4367 | 66115 | 3561 | 69892 | 2337 | 84688 | 1893 | 57111 |
| 3L-4S | | MI | 18634 | 7324 | 31324 | 5157 | 33464 | 4131 | 34053 | 3325 | 34418 | 2127 | 40716 | 1338 | 30388 |
| 10-#18 | 2.98 | MA | 32926 | 7324 | 53983 | 5407 | 59311 | 4357 | 61561 | 3547 | 64031 | 2361 | 77973 | 1672 | 55912 |
| 4L-3S | | MI | 19536 | 7324 | 32886 | 5132 | 35416 | 4153 | 36366 | 3347 | 37291 | 2105 | 43880 | 1542 | 31138 |
| 10-#18 | 2.98 | MA | 31437 | 7324 | 51441 | 5401 | 56014 | 4391 | 57509 | 3578 | 58163 | 2340 | 70954 | 1566 | 52422 |
| 5L-2S | | MI | 20776 | 7324 | 34766 | 5152 | 37789 | 4131 | 39202 | 3325 | 41054 | 2083 | 48745 | 1764 | 31111 |
| 12-#11 | 1.39 | MA | 32691 | 6588 | 50879 | 4959 | 55595 | 4038 | 57120 | 3359 | 57699 | 2394 | 68754 | 2278 | 27668 |
| 2L-6S | | MI | 17184 | 6588 | 27317 | 4759 | 28622 | 3881 | 28408 | 3233 | 26773 | 2275 | 30883 | 1819 | 15545 |
| 12-#11 | 1.39 | MA | 31713 | 6588 | 49443 | 4958 | 53754 | 4035 | 54874 | 3372 | 54644 | 2405 | 64578 | 2191 | 27690 |
| 3L-5S | | MI | 17503 | 6588 | 27832 | 4765 | 29332 | 3888 | 29221 | 3224 | 27855 | 2266 | 32193 | 1877 | 15591 |
| 12-#11 | 1.39 | MA | 31032 | 6588 | 48277 | 4973 | 52268 | 4049 | 53068 | 3368 | 52320 | 2416 | 61853 | 2105 | 27671 |
| 4E | | MI | 17837 | 6588 | 28378 | 4770 | 30041 | 3879 | 30076 | 3215 | 29052 | 2275 | 33600 | 1914 | 15545 |
| 12-#11 | 1.39 | MA | 30424 | 6588 | 47271 | 4971 | 50962 | 4046 | 51463 | 3382 | 49994 | 2410 | 59027 | 2062 | 27587 |
| 5L-3S | | MI | 18208 | 6588 | 29007 | 4759 | 30842 | 3887 | 31034 | 3224 | 30243 | 2266 | 34921 | 1998 | 15494 |
| 12-#11 | 1.39 | MA | 29845 | 6588 | 46328 | 4970 | 49655 | 4061 | 49866 | 3378 | 47889 | 2421 | 56325 | 2006 | 27176 |
| 6L-2S | | MI | 18721 | 6588 | 29769 | 4765 | 31818 | 3878 | 32210 | 3215 | 31803 | 2258 | 36962 | 2085 | 15445 |
| 12-#14 | 2.01 | MA | 34423 | 6874 | 54684 | 5124 | 60376 | 4154 | 62916 | 3427 | 65570 | 2364 | 79300 | 2222 | 39419 |
| 2L-6S | | MI | 17393 | 6874 | 28267 | 4907 | 29733 | 3986 | 29710 | 3291 | 28495 | 2223 | 33301 | 1594 | 21057 |

## RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

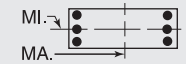
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 2.01 | MA | 33039 | 6874 | 52626 | 5121 | 57739 | 4150 | 59698 | 3446 | 61192 | 2379 | 73351 | 2098 | 39380 |
| 3L-5S | | MI | 17845 | 6874 | 29002 | 4917 | 30748 | 3999 | 30859 | 3279 | 30025 | 2211 | 35143 | 1676 | 21554 |
| 12-#14 | 2.01 | MA | 32073 | 6874 | 50954 | 5143 | 55607 | 4170 | 57108 | 3439 | 57858 | 2394 | 69471 | 1973 | 39234 |
| 4E | | MI | 18318 | 6874 | 29784 | 4926 | 31760 | 3986 | 32068 | 3266 | 31717 | 2223 | 37124 | 1732 | 21811 |
| 12-#14 | 2.01 | MA | 31212 | 6874 | 49510 | 5140 | 53734 | 4165 | 54805 | 3458 | 54522 | 2384 | 65438 | 1912 | 38612 |
| 5L-3S | | MI | 18842 | 6874 | 30681 | 4910 | 32903 | 3999 | 33422 | 3279 | 33401 | 2211 | 38987 | 1850 | 21773 |
| 12-#14 | 2.01 | MA | 30392 | 6874 | 48156 | 5137 | 51858 | 4186 | 52512 | 3452 | 51500 | 2399 | 61590 | 1832 | 37275 |
| 6L-2S | | MI | 19567 | 6874 | 31766 | 4919 | 34293 | 3986 | 35085 | 3266 | 35606 | 2198 | 41861 | 1975 | 21717 |
| 12-#18 | 3.57 | MA | 34592 | 7600 | 57592 | 5580 | 63937 | 4481 | 67205 | 3623 | 71710 | 2338 | 88292 | 1626 | 66557 |
| 4E | | MI | 19454 | 7600 | 33204 | 5330 | 35837 | 4252 | 36889 | 3391 | 38180 | 2083 | 45581 | 1246 | 35835 |
| 12-#18 | 3.57 | MA | 33119 | 7600 | 55050 | 5574 | 60640 | 4515 | 63153 | 3653 | 65842 | 2318 | 81272 | 1520 | 63246 |
| 5L-3S | | MI | 20350 | 7600 | 34766 | 5305 | 37789 | 4274 | 39202 | 3413 | 41054 | 2061 | 48745 | 1450 | 36968 |
| 12-#18 | 3.57 | MA | 31719 | 7600 | 52666 | 5567 | 57339 | 4505 | 59118 | 3640 | 60524 | 2342 | 74605 | 1377 | 60023 |
| 6L-2S | | MI | 21582 | 7600 | 36645 | 5325 | 40162 | 4252 | 42038 | 3391 | 44816 | 2039 | 53611 | 1671 | 37010 |
| 14-#11 | 1.63 | MA | 33371 | 6696 | 52315 | 5027 | 57436 | 4086 | 59365 | 3389 | 60755 | 2386 | 72929 | 2263 | 32166 |
| 2L-7S | | MI | 17221 | 6696 | 27516 | 4837 | 28920 | 3938 | 28726 | 3252 | 27276 | 2269 | 31689 | 1725 | 17583 |
| 14-#11 | 1.63 | MA | 32398 | 6696 | 50879 | 5025 | 55595 | 4083 | 57120 | 3402 | 57699 | 2397 | 68754 | 2177 | 32172 |
| 3L-6S | | MI | 17531 | 6696 | 28079 | 4826 | 29599 | 3929 | 29584 | 3261 | 28333 | 2261 | 32924 | 1789 | 17807 |
| 14-#11 | 1.63 | MA | 31719 | 6696 | 49713 | 5040 | 54109 | 4098 | 55313 | 3398 | 55375 | 2408 | 66028 | 2090 | 32132 |
| 4L-5S | | MI | 17849 | 6696 | 28593 | 4832 | 30309 | 3937 | 30397 | 3252 | 29415 | 2252 | 34234 | 1847 | 17985 |
| 14-#11 | 1.63 | MA | 31114 | 6696 | 48707 | 5039 | 52803 | 4095 | 53709 | 3411 | 53050 | 2401 | 63202 | 2048 | 32027 |
| 5L-4S | | MI | 18182 | 6696 | 29140 | 4838 | 31017 | 3928 | 31252 | 3244 | 30612 | 2261 | 35641 | 1885 | 17953 |
| 14-#11 | 1.63 | MA | 30539 | 6696 | 47764 | 5037 | 51496 | 4109 | 52111 | 3407 | 50944 | 2412 | 60500 | 1992 | 31506 |
| 6L-3S | | MI | 18551 | 6696 | 29769 | 4826 | 31818 | 3935 | 32210 | 3252 | 31803 | 2252 | 36962 | 1968 | 17910 |
| 14-#11 | 1.63 | MA | 29979 | 6696 | 46731 | 5053 | 50250 | 4106 | 50579 | 3420 | 48888 | 2423 | 57620 | 1902 | 30860 |
| 7L-2S | | MI | 19063 | 6696 | 30530 | 4832 | 32795 | 3926 | 33386 | 3244 | 33363 | 2244 | 39002 | 2055 | 17866 |
| 14-#14 | 2.34 | MA | 34002 | 7030 | 54684 | 5218 | 60376 | 4220 | 62916 | 3488 | 65570 | 2366 | 79300 | 2075 | 45769 |
| 3L-6S | | MI | 17881 | 7030 | 29352 | 5004 | 31123 | 4056 | 31372 | 3330 | 30700 | 2202 | 36175 | 1548 | 24316 |
| 14-#14 | 2.34 | MA | 33042 | 7030 | 53011 | 5240 | 58245 | 4240 | 60325 | 3482 | 62236 | 2381 | 75420 | 1951 | 45587 |
| 4L-5S | | MI | 18331 | 7030 | 30087 | 5014 | 32138 | 4069 | 32522 | 3318 | 32230 | 2189 | 38017 | 1630 | 24775 |
| 14-#14 | 2.34 | MA | 32187 | 7030 | 51567 | 5237 | 56371 | 4235 | 58022 | 3500 | 58899 | 2372 | 71387 | 1890 | 44770 |
| 5L-4S | | MI | 18802 | 7030 | 30868 | 5023 | 33150 | 4056 | 33730 | 3305 | 33922 | 2202 | 39998 | 1685 | 25197 |
| 14-#14 | 2.34 | MA | 31373 | 7030 | 50214 | 5234 | 54496 | 4255 | 55730 | 3494 | 55878 | 2387 | 67539 | 1809 | 43492 |
| 6L-3S | | MI | 19323 | 7030 | 31766 | 5007 | 34293 | 4068 | 35085 | 3318 | 35606 | 2189 | 41861 | 1804 | 25185 |
| 14-#14 | 2.34 | MA | 30581 | 7030 | 48731 | 5256 | 52707 | 4251 | 53530 | 3512 | 52926 | 2402 | 63436 | 1679 | 42423 |
| 7L-2S | | MI | 20045 | 7030 | 32851 | 5017 | 35684 | 4056 | 36747 | 3305 | 37811 | 2177 | 44735 | 1929 | 25142 |
| 14-#18 | 4.17 | MA | 34782 | 7877 | 58658 | 5747 | 65266 | 4639 | 68797 | 3729 | 73520 | 2296 | 91591 | 1475 | 74097 |
| 5L-4S | | MI | 20268 | 7877 | 35083 | 5503 | 38210 | 4373 | 39725 | 3457 | 41943 | 2039 | 50447 | 1153 | 41321 |
| 14-#18 | 4.17 | MA | 33396 | 7877 | 56275 | 5740 | 61965 | 4629 | 64762 | 3715 | 68203 | 2320 | 84923 | 1331 | 70694 |
| 6L-3S | | MI | 21158 | 7877 | 36645 | 5478 | 40162 | 4395 | 42038 | 3479 | 44816 | 2017 | 53611 | 1358 | 42776 |
| 14-#18 | 4.17 | MA | 32047 | 7877 | 53664 | 5777 | 58815 | 4663 | 60889 | 3746 | 63007 | 2344 | 77809 | 1100 | 67385 |
| 7L-2S | | MI | 22383 | 7877 | 38525 | 5498 | 42535 | 4373 | 44874 | 3457 | 48579 | 1995 | 58476 | 1579 | 42881 |
| 16-#11 | 1.86 | MA | 33078 | 6804 | 52315 | 5092 | 57436 | 4132 | 59365 | 3431 | 60755 | 2388 | 72929 | 2162 | 36645 |
| 3L-7S | | MI | 17568 | 6804 | 28278 | 4905 | 29896 | 3987 | 29902 | 3280 | 28835 | 2255 | 33730 | 1695 | 19895 |
| 16-#11 | 1.86 | MA | 32403 | 6804 | 51149 | 5108 | 55949 | 4146 | 57559 | 3427 | 58430 | 2399 | 70203 | 2076 | 36588 |
| 4L-6S | | MI | 17877 | 6804 | 28841 | 4893 | 30575 | 3977 | 30760 | 3289 | 29892 | 2247 | 34965 | 1759 | 20104 |
| 16-#11 | 1.86 | MA | 31801 | 6804 | 50142 | 5106 | 54644 | 4143 | 55954 | 3441 | 56105 | 2393 | 67377 | 2033 | 36463 |
| 5E | | MI | 18194 | 6804 | 29355 | 4899 | 31285 | 3985 | 31574 | 3280 | 30974 | 2238 | 36275 | 1817 | 20372 |
| 16-#11 | 1.86 | MA | 31229 | 6804 | 49200 | 5104 | 53337 | 4157 | 54357 | 3437 | 54000 | 2404 | 64675 | 1977 | 35845 |
| 6L-4S | | MI | 18526 | 6804 | 29902 | 4905 | 31994 | 3976 | 32428 | 3272 | 32171 | 2247 | 37682 | 1855 | 20351 |
| 16-#11 | 1.86 | MA | 30671 | 6804 | 48166 | 5120 | 52091 | 4155 | 52824 | 3450 | 51943 | 2415 | 61795 | 1887 | 35223 |
| 7L-3S | | MI | 18893 | 6804 | 30530 | 4894 | 32795 | 3984 | 33386 | 3280 | 33363 | 2238 | 39002 | 1938 | 20317 |
| 16-#11 | 1.86 | MA | 30122 | 6804 | 47239 | 5118 | 50827 | 4169 | 51329 | 3463 | 49757 | 2408 | 59152 | 1837 | 34669 |
| 8L-2S | | MI | 19404 | 6804 | 31292 | 4900 | 33771 | 3975 | 34562 | 3272 | 34922 | 2230 | 41043 | 2025 | 20279 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis

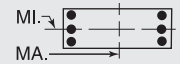



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.68 | MA | 34005 | 7185 | 55069 | 5338 | 60882 | 4310 | 63543 | 3524 | 66613 | 2369 | 81369 | 1928 | 51936 |
| 4L-6S | | MI | 18366 | 7185 | 30437 | 5102 | 32514 | 4126 | 33034 | 3370 | 32905 | 2180 | 39049 | 1501 | 27582 |
| 16-#14 | 2.68 | MA | 33155 | 7185 | 53624 | 5335 | 59009 | 4305 | 61240 | 3543 | 63277 | 2359 | 77336 | 1867 | 50945 |
| 5E | | MI | 18814 | 7185 | 31172 | 5111 | 33529 | 4138 | 34184 | 3357 | 34434 | 2167 | 40891 | 1584 | 28009 |
| 16-#14 | 2.68 | MA | 32347 | 7185 | 52271 | 5332 | 57133 | 4325 | 58947 | 3536 | 60256 | 2374 | 73488 | 1787 | 49720 |
| 6L-4S | | MI | 19282 | 7185 | 31953 | 5120 | 34541 | 4126 | 35392 | 3345 | 36127 | 2180 | 42872 | 1639 | 28567 |
| 16-#14 | 2.68 | MA | 31560 | 7185 | 50788 | 5354 | 55344 | 4321 | 56747 | 3555 | 57304 | 2389 | 69385 | 1657 | 48552 |
| 7L-3S | | MI | 19802 | 7185 | 32851 | 5105 | 35684 | 4138 | 36747 | 3357 | 37811 | 2167 | 44735 | 1758 | 28591 |
| 16-#14 | 2.68 | MA | 30785 | 7185 | 49456 | 5351 | 53530 | 4341 | 54601 | 3573 | 54167 | 2379 | 65613 | 1585 | 46949 |
| 8L-2S | | MI | 20520 | 7185 | 33935 | 5114 | 37074 | 4126 | 38409 | 3345 | 40016 | 2155 | 47609 | 1883 | 28556 |
| 16-#18 | 4.76 | MA | 35055 | 8154 | 59884 | 5913 | 66591 | 4753 | 70405 | 3791 | 75881 | 2298 | 95242 | 1285 | 81392 |
| 6L-4S | | MI | 21076 | 8154 | 36963 | 5676 | 40582 | 4493 | 42561 | 3523 | 45706 | 1996 | 55312 | 1061 | 46837 |
| 16-#18 | 4.76 | MA | 33719 | 8154 | 57272 | 5950 | 63441 | 4787 | 66533 | 3821 | 70686 | 2322 | 88127 | 1055 | 77974 |
| 7L-3S | | MI | 21960 | 8154 | 38525 | 5651 | 42535 | 4515 | 44874 | 3545 | 48579 | 1974 | 58476 | 1265 | 48569 |
| 16-#18 | 4.76 | MA | 32405 | 8154 | 54926 | 5944 | 60246 | 4777 | 62752 | 3852 | 65164 | 2302 | 81564 | 930 | 73633 |
| 8L-2S | | MI | 23178 | 8154 | 40405 | 5671 | 44908 | 4493 | 47710 | 3523 | 52342 | 1951 | 63342 | 1486 | 48723 |
| 18-#11 | 2.09 | MA | 33082 | 6911 | 52585 | 5175 | 57790 | 4194 | 59805 | 3457 | 61486 | 2390 | 74378 | 2061 | 41040 |
| 4L-7S | | MI | 17913 | 6911 | 29040 | 4972 | 30873 | 4035 | 31078 | 3308 | 30395 | 2241 | 35771 | 1665 | 22210 |
| 18-#11 | 2.09 | MA | 32483 | 6911 | 51578 | 5174 | 56485 | 4192 | 58200 | 3470 | 59161 | 2384 | 71552 | 2018 | 40896 |
| 5L-6S | | MI | 18221 | 6911 | 29602 | 4961 | 31551 | 4026 | 31936 | 3317 | 31452 | 2233 | 37006 | 1730 | 22406 |
| 18-#11 | 2.09 | MA | 31914 | 6911 | 50636 | 5172 | 55178 | 4206 | 56603 | 3466 | 57055 | 2395 | 68850 | 1963 | 40192 |
| 6L-5S | | MI | 18537 | 6911 | 30116 | 4967 | 32262 | 4034 | 32750 | 3308 | 32534 | 2224 | 38316 | 1787 | 22747 |
| 18-#11 | 2.09 | MA | 31359 | 6911 | 49602 | 5187 | 53932 | 4203 | 55070 | 3479 | 54999 | 2406 | 65970 | 1873 | 39591 |
| 7L-4S | | MI | 18867 | 6911 | 30663 | 4973 | 32970 | 4024 | 33604 | 3300 | 33731 | 2233 | 39723 | 1825 | 22742 |
| 18-#11 | 2.09 | MA | 30813 | 6911 | 48675 | 5186 | 52668 | 4217 | 53574 | 3492 | 52813 | 2400 | 63327 | 1823 | 38972 |
| 8L-3S | | MI | 19234 | 6911 | 31292 | 4961 | 33771 | 4032 | 34562 | 3308 | 34922 | 2224 | 41043 | 1908 | 22717 |
| 18-#11 | 2.09 | MA | 30222 | 6911 | 47767 | 5184 | 51438 | 4215 | 52010 | 3488 | 50775 | 2411 | 60707 | 1769 | 38050 |
| 9L-2S | | MI | 19743 | 6911 | 32054 | 4967 | 34747 | 4023 | 35739 | 3300 | 36482 | 2216 | 43084 | 1995 | 22684 |
| 18-#14 | 3.01 | MA | 34115 | 7341 | 55682 | 5432 | 61646 | 4375 | 64457 | 3585 | 67655 | 2347 | 83285 | 1845 | 57134 |
| 5L-6S | | MI | 18849 | 7341 | 31522 | 5199 | 33905 | 4196 | 34697 | 3409 | 35110 | 2158 | 41923 | 1455 | 30853 |
| 18-#14 | 3.01 | MA | 33312 | 7341 | 54328 | 5429 | 59770 | 4395 | 62165 | 3579 | 64633 | 2362 | 79437 | 1764 | 55956 |
| 6L-5S | | MI | 19294 | 7341 | 32257 | 5208 | 34919 | 4208 | 35847 | 3397 | 36639 | 2146 | 43765 | 1538 | 31254 |
| 18-#14 | 3.01 | MA | 32531 | 7341 | 52845 | 5451 | 57981 | 4390 | 59965 | 3597 | 61681 | 2377 | 75334 | 1634 | 54693 |
| 7L-4S | | MI | 19761 | 7341 | 33038 | 5218 | 35931 | 4196 | 37055 | 3384 | 38332 | 2158 | 45746 | 1593 | 31929 |
| 18-#14 | 3.01 | MA | 31761 | 7341 | 51513 | 5448 | 56167 | 4411 | 57818 | 3616 | 58544 | 2367 | 71562 | 1563 | 53137 |
| 8L-3S | | MI | 20278 | 7341 | 33935 | 5202 | 37074 | 4208 | 38409 | 3397 | 40016 | 2146 | 47609 | 1712 | 31973 |
| 18-#14 | 3.01 | MA | 30935 | 7341 | 50210 | 5445 | 54402 | 4406 | 55573 | 3609 | 55620 | 2382 | 67831 | 1485 | 51380 |
| 9L-2S | | MI | 20994 | 7341 | 35020 | 5211 | 38465 | 4196 | 40072 | 3384 | 42221 | 2133 | 50483 | 1837 | 31962 |
| 18-#18 | 5.36 | MA | 35374 | 8430 | 60881 | 6123 | 68067 | 4912 | 72176 | 3897 | 78364 | 2300 | 98446 | 1009 | 88586 |
| 7L-4S | | MI | 21879 | 8430 | 38843 | 5849 | 42955 | 4614 | 45398 | 3589 | 49469 | 1952 | 60178 | 968 | 52377 |
| 18-#18 | 5.36 | MA | 34073 | 8430 | 58535 | 6117 | 64872 | 4902 | 68396 | 3928 | 72843 | 2279 | 91883 | 885 | 84153 |
| 8L-3S | | MI | 22758 | 8430 | 40405 | 5824 | 44908 | 4636 | 47710 | 3611 | 52342 | 1930 | 63342 | 1173 | 54349 |
| 20-#11 | 2.32 | MA | 33162 | 7019 | 53014 | 5241 | 58326 | 4240 | 60446 | 3499 | 62216 | 2376 | 75727 | 2004 | 45327 |
| 5L-7S | | MI | 18257 | 7019 | 29801 | 5040 | 31849 | 4084 | 32254 | 3336 | 31955 | 2227 | 37812 | 1635 | 24527 |
| 20-#11 | 2.32 | MA | 32595 | 7019 | 52072 | 5239 | 57019 | 4254 | 58848 | 3495 | 60111 | 2386 | 73025 | 1948 | 44545 |
| 6E | | MI | 18564 | 7019 | 30364 | 5028 | 32528 | 4074 | 33112 | 3345 | 33012 | 2219 | 39047 | 1700 | 24712 |
| 20-#11 | 2.32 | MA | 32043 | 7019 | 51038 | 5255 | 55772 | 4251 | 57316 | 3509 | 58054 | 2397 | 70145 | 1858 | 43963 |
| 7L-5S | | MI | 18878 | 7019 | 30878 | 5034 | 33238 | 4082 | 33926 | 3336 | 34094 | 2210 | 40357 | 1757 | 25064 |
| 20-#11 | 2.32 | MA | 31500 | 7019 | 50111 | 5253 | 54508 | 4266 | 55820 | 3522 | 55868 | 2391 | 67502 | 1808 | 43283 |
| 8L-4S | | MI | 19208 | 7019 | 31425 | 5040 | 33946 | 4073 | 34781 | 3328 | 35290 | 2219 | 41763 | 1795 | 25128 |
| 20-#11 | 2.32 | MA | 30912 | 7019 | 49203 | 5251 | 53279 | 4263 | 54256 | 3518 | 53830 | 2402 | 64882 | 1755 | 42385 |
| 9L-3S | | MI | 19573 | 7019 | 32054 | 5029 | 34747 | 4081 | 35739 | 3336 | 36482 | 2210 | 43084 | 1878 | 25111 |
| 20-#11 | 2.32 | MA | 30310 | 7019 | 48187 | 5267 | 52032 | 4277 | 52768 | 3531 | 51810 | 2413 | 62342 | 1694 | 41488 |
| 10L-2S | | MI | 20080 | 7019 | 32815 | 5035 | 35724 | 4071 | 36915 | 3328 | 38042 | 2201 | 45125 | 1965 | 25084 |
| 20-#14 | 3.35 | MA | 34272 | 7497 | 56386 | 5526 | 62408 | 4465 | 65382 | 3621 | 69011 | 2349 | 85385 | 1742 | 62199 |
| 6E | | MI | 19329 | 7497 | 32606 | 5296 | 35295 | 4266 | 36359 | 3448 | 37315 | 2137 | 44797 | 1409 | 34128 |
| 20-#14 | 3.35 | MA | 33495 | 7497 | 54903 | 5548 | 60619 | 4460 | 63182 | 3640 | 66059 | 2364 | 81283 | 1612 | 60845 |
| 7L-5S | | MI | 19772 | 7497 | 33341 | 5306 | 36310 | 4278 | 37509 | 3436 | 38844 | 2124 | 46639 | 1492 | 34506 |

## RECTANGULAR TIED COLUMNS 28" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

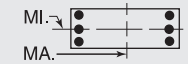
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 3.35 | MA | 32730 | 7497 | 53571 | 5545 | 58804 | 4481 | 61035 | 3658 | 62922 | 2355 | 77511 | 1540 | 59332 |
| 8L-4S | | MI | 20237 | 7497 | 34123 | 5315 | 37322 | 4266 | 38717 | 3424 | 40537 | 2137 | 48620 | 1547 | 35283 |
| 20-#14 | 3.35 | MA | 31927 | 7497 | 52268 | 5542 | 57040 | 4476 | 58790 | 3652 | 59997 | 2370 | 73780 | 1463 | 57517 |
| 9L-3S | | MI | 20751 | 7497 | 35020 | 5299 | 38465 | 4278 | 40072 | 3436 | 42221 | 2124 | 50483 | 1666 | 35347 |
| 20-#14 | 3.35 | MA | 31062 | 7497 | 50808 | 5564 | 55249 | 4496 | 56655 | 3670 | 57098 | 2385 | 70163 | 1375 | 55634 |
| 10L-2S | | MI | 21464 | 7497 | 36105 | 5309 | 39856 | 4266 | 41734 | 3424 | 44426 | 2112 | 53357 | 1791 | 35366 |
| 20-#18 | 5.95 | MA | 35725 | 8707 | 62144 | 6289 | 69499 | 5026 | 74040 | 4003 | 80521 | 2257 | 102201 | 839 | 94904 |
| 8L-4S | | MI | 22678 | 8707 | 40722 | 6022 | 45328 | 4735 | 48234 | 3655 | 53232 | 1908 | 65043 | 876 | 57936 |
| 22-#11 | 2.55 | MA | 33273 | 7127 | 53508 | 5307 | 58860 | 4303 | 61094 | 3525 | 63166 | 2378 | 77200 | 1934 | 48904 |
| 6L-7S | | MI | 18599 | 7127 | 30563 | 5107 | 32825 | 4132 | 33431 | 3364 | 33514 | 2213 | 39852 | 1605 | 26844 |
| 22-#11 | 2.55 | MA | 32724 | 7127 | 52474 | 5322 | 57613 | 4300 | 59561 | 3538 | 61109 | 2389 | 74320 | 1844 | 48339 |
| 7L-6S | | MI | 18905 | 7127 | 31126 | 5096 | 33504 | 4123 | 34288 | 3373 | 34571 | 2205 | 41087 | 1670 | 27022 |
| 22-#11 | 2.55 | MA | 32183 | 7127 | 51547 | 5321 | 56349 | 4314 | 58066 | 3551 | 58923 | 2383 | 71677 | 1794 | 47600 |
| 8L-5S | | MI | 19218 | 7127 | 31640 | 5102 | 34214 | 4131 | 35102 | 3364 | 35653 | 2196 | 42397 | 1727 | 27353 |
| 22-#11 | 2.55 | MA | 31598 | 7127 | 50639 | 5319 | 55120 | 4311 | 56501 | 3547 | 56886 | 2394 | 69057 | 1740 | 46725 |
| 9L-4S | | MI | 19547 | 7127 | 32187 | 5108 | 34923 | 4121 | 35957 | 3356 | 36850 | 2205 | 43804 | 1765 | 27505 |
| 22-#11 | 2.55 | MA | 30999 | 7127 | 49623 | 5334 | 53873 | 4326 | 55014 | 3560 | 54866 | 2405 | 66517 | 1679 | 45787 |
| 10L-3S | | MI | 19911 | 7127 | 32815 | 5096 | 35724 | 4129 | 36915 | 3364 | 38042 | 2196 | 45125 | 1849 | 27500 |
| 22-#11 | 2.55 | MA | 30414 | 7127 | 48714 | 5333 | 52650 | 4323 | 53469 | 3557 | 52711 | 2398 | 63939 | 1626 | 44742 |
| 11L-2S | | MI | 20416 | 7127 | 33577 | 5102 | 36700 | 4120 | 38091 | 3356 | 39601 | 2187 | 47166 | 1935 | 27479 |
| 22-#14 | 3.68 | MA | 34452 | 7652 | 56960 | 5645 | 63256 | 4530 | 66400 | 3682 | 70437 | 2352 | 87231 | 1589 | 67007 |
| 7L-6S | | MI | 19806 | 7652 | 33691 | 5394 | 36686 | 4336 | 38022 | 3488 | 39519 | 2115 | 47671 | 1363 | 37407 |
| 22-#14 | 3.68 | MA | 33692 | 7652 | 55628 | 5643 | 61442 | 4550 | 64253 | 3701 | 67299 | 2342 | 83460 | 1518 | 65535 |
| 8L-5S | | MI | 20248 | 7652 | 34426 | 5403 | 37701 | 4348 | 39171 | 3475 | 41049 | 2102 | 49513 | 1446 | 37764 |
| 22-#14 | 3.68 | MA | 32890 | 7652 | 54325 | 5640 | 59677 | 4546 | 62008 | 3694 | 64375 | 2357 | 79728 | 1440 | 63664 |
| 9L-4S | | MI | 20710 | 7652 | 35207 | 5412 | 38713 | 4335 | 40380 | 3463 | 42741 | 2115 | 51494 | 1501 | 38562 |
| 22-#14 | 3.68 | MA | 32035 | 7652 | 52866 | 5662 | 57887 | 4566 | 59872 | 3713 | 61475 | 2372 | 76112 | 1353 | 61742 |
| 10L-3S | | MI | 21223 | 7652 | 36105 | 5396 | 39856 | 4348 | 41734 | 3475 | 44426 | 2102 | 53357 | 1620 | 38714 |
| 24-#11 | 2.79 | MA | 33400 | 7235 | 53910 | 5390 | 59454 | 4348 | 61807 | 3567 | 64165 | 2380 | 78496 | 1829 | 52718 |
| 7E | | MI | 18940 | 7235 | 31324 | 5175 | 33802 | 4180 | 34607 | 3392 | 35074 | 2199 | 41893 | 1575 | 29163 |
| 24-#11 | 2.79 | MA | 32862 | 7235 | 52983 | 5388 | 58190 | 4363 | 60311 | 3581 | 61979 | 2374 | 75852 | 1779 | 51923 |
| 8L-6S | | MI | 19245 | 7235 | 31887 | 5163 | 34480 | 4171 | 35464 | 3401 | 36131 | 2191 | 43128 | 1640 | 29333 |
| 24-#11 | 2.79 | MA | 32281 | 7235 | 52075 | 5386 | 56961 | 4360 | 58747 | 3577 | 59941 | 2385 | 73232 | 1726 | 51069 |
| 9L-5S | | MI | 19557 | 7235 | 32401 | 5169 | 35191 | 4179 | 36278 | 3392 | 37213 | 2182 | 44438 | 1697 | 29647 |
| 24-#11 | 2.79 | MA | 31684 | 7235 | 51059 | 5402 | 55714 | 4374 | 57259 | 3590 | 57921 | 2396 | 70692 | 1665 | 50092 |
| 10L-4S | | MI | 19884 | 7235 | 32948 | 5175 | 35899 | 4170 | 37133 | 3384 | 38410 | 2191 | 45845 | 1735 | 29874 |
| 24-#11 | 2.79 | MA | 31102 | 7235 | 50150 | 5400 | 54491 | 4371 | 55715 | 3586 | 55766 | 2390 | 68114 | 1612 | 49067 |
| 11L-3S | | MI | 20247 | 7235 | 33577 | 5164 | 36700 | 4178 | 38091 | 3392 | 39601 | 2182 | 47166 | 1819 | 29885 |
| 24-#11 | 2.79 | MA | 30530 | 7235 | 49152 | 5416 | 53253 | 4386 | 54230 | 3599 | 53747 | 2401 | 65207 | 1535 | 47780 |
| 12L-2S | | MI | 20751 | 7235 | 34339 | 5170 | 37676 | 4168 | 39267 | 3384 | 41161 | 2173 | 49206 | 1905 | 29870 |
| 24-#14 | 4.02 | MA | 34648 | 7808 | 57685 | 5740 | 64079 | 4620 | 67470 | 3743 | 71677 | 2330 | 89409 | 1495 | 71744 |
| 8L-6S | | MI | 20282 | 7808 | 34776 | 5491 | 38076 | 4405 | 39684 | 3527 | 41724 | 2093 | 50545 | 1317 | 40633 |
| 24-#14 | 4.02 | MA | 33847 | 7808 | 56382 | 5737 | 62314 | 4616 | 65225 | 3737 | 68752 | 2345 | 85677 | 1418 | 69818 |
| 9L-5S | | MI | 20721 | 7808 | 35511 | 5500 | 39091 | 4418 | 40834 | 3515 | 43254 | 2081 | 52387 | 1400 | 41028 |
| 24-#14 | 4.02 | MA | 33001 | 7808 | 54923 | 5759 | 60524 | 4636 | 63089 | 3755 | 65853 | 2360 | 82061 | 1330 | 67856 |
| 10L-4S | | MI | 21182 | 7808 | 36292 | 5509 | 40103 | 4405 | 42042 | 3502 | 44946 | 2093 | 54368 | 1455 | 41782 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 30"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

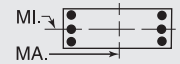
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.04 | MA | 13086 | 4302 | 20511 | 3143 | 21822 | 2565 | 21963 | 2142 | 21306 | 1541 | 24583 | 1445 | 8460 |
| 2L-3S | | MI | 12523 | 4302 | 19682 | 3138 | 20759 | 2575 | 20670 | 2151 | 19592 | 1550 | 22330 | 1358 | 8515 |
| 6-#14 | 1.50 | MA | 13556 | 4445 | 21611 | 3217 | 23174 | 2616 | 23547 | 2167 | 23400 | 1512 | 27296 | 1392 | 11904 |
| 2L-3S | | MI | 12761 | 4445 | 20429 | 3209 | 21658 | 2630 | 21717 | 2179 | 20973 | 1524 | 24116 | 1268 | 11974 |
| 6-#18 | 2.67 | MA | 14683 | 4808 | 24300 | 3414 | 26479 | 2752 | 27399 | 2230 | 28497 | 1435 | 33843 | 1249 | 20325 |
| 2L-3S | | MI | 13325 | 4808 | 22248 | 3397 | 23857 | 2774 | 24266 | 2252 | 24341 | 1457 | 28437 | 1028 | 20313 |
| 8-#11 | 1.39 | MA | 13464 | 4410 | 21340 | 3210 | 22885 | 2613 | 23255 | 2171 | 23020 | 1528 | 26836 | 1417 | 11102 |
| 2L-4S | | MI | 12503 | 4410 | 19829 | 3217 | 20952 | 2616 | 20911 | 2171 | 19997 | 1546 | 23128 | 1246 | 11190 |
| 8-#14 | 2.00 | MA | 14086 | 4600 | 22793 | 3314 | 24689 | 2686 | 25377 | 2208 | 25826 | 1492 | 30475 | 1350 | 15645 |
| 2L-4S | | MI | 12729 | 4600 | 20636 | 3323 | 21932 | 2689 | 22057 | 2208 | 21546 | 1517 | 25239 | 1104 | 15659 |
| 8-#18 | 3.56 | MA | 15572 | 5085 | 26353 | 3587 | 29101 | 2875 | 30532 | 2299 | 32652 | 1395 | 39249 | 1165 | 26765 |
| 2L-4S | | MI | 13260 | 5085 | 22600 | 3596 | 24323 | 2875 | 24845 | 2299 | 25323 | 1439 | 30336 | 734 | 24672 |
| 10-#11 | 1.73 | MA | 13839 | 4517 | 22169 | 3278 | 23947 | 2661 | 24548 | 2200 | 24733 | 1516 | 29088 | 1390 | 13727 |
| 2L-5S | | MI | 12525 | 4517 | 20065 | 3280 | 21247 | 2675 | 21264 | 2209 | 20396 | 1524 | 23827 | 1181 | 13648 |
| 10-#11 | 1.73 | MA | 13282 | 4517 | 21340 | 3273 | 22885 | 2672 | 23255 | 2209 | 23020 | 1524 | 26836 | 1304 | 13765 |
| 3L-4S | | MI | 12883 | 4517 | 20658 | 3285 | 22015 | 2664 | 22203 | 2200 | 21710 | 1533 | 25381 | 1218 | 13786 |
| 10-#14 | 2.50 | MA | 14610 | 4756 | 23975 | 3412 | 26204 | 2756 | 27207 | 2249 | 28253 | 1472 | 33654 | 1308 | 19366 |
| 2L-5S | | MI | 12756 | 4756 | 20970 | 3412 | 22349 | 2772 | 22557 | 2261 | 22111 | 1485 | 26227 | 1008 | 18361 |
| 10-#14 | 2.50 | MA | 13826 | 4756 | 22793 | 3404 | 24689 | 2770 | 25377 | 2261 | 25826 | 1485 | 30475 | 1184 | 19383 |
| 3L-4S | | MI | 13263 | 4756 | 21818 | 3420 | 23447 | 2759 | 23887 | 2249 | 23973 | 1497 | 28419 | 1062 | 19303 |
| 10-#18 | 4.44 | MA | 16451 | 5361 | 28406 | 3760 | 31722 | 2998 | 33665 | 2368 | 36808 | 1355 | 44654 | 1080 | 33152 |
| 2L-5S | | MI | 13302 | 5361 | 23172 | 3752 | 25037 | 3021 | 25701 | 2390 | 26288 | 1377 | 32016 | 551 | 28847 |
| 10-#18 | 4.44 | MA | 15120 | 5361 | 26353 | 3742 | 29101 | 3021 | 30532 | 2390 | 32652 | 1377 | 39249 | 859 | 32939 |
| 3L-4S | | MI | 14163 | 5361 | 24653 | 3769 | 26945 | 2998 | 27978 | 2368 | 29479 | 1399 | 35742 | 649 | 30623 |

## RECTANGULAR TIED COLUMNS 30" x 32"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.67 | MA | 15603 | 4796 | 25033 | 3456 | 26896 | 2807 | 27387 | 2317 | 27409 | 1597 | 32054 | 1459 | 14920 |
| 2E | | MI | 14579 | 4796 | 23457 | 3434 | 25098 | 2787 | 25466 | 2296 | 25410 | 1579 | 29612 | 1434 | 13893 |
| 6-#14 | 1.41 | MA | 15351 | 4710 | 24333 | 3433 | 26122 | 2794 | 26579 | 2321 | 26351 | 1633 | 30755 | 1515 | 12816 |
| 2L-3S | | MI | 13557 | 4710 | 21633 | 3404 | 22900 | 2790 | 22921 | 2316 | 22048 | 1629 | 25300 | 1369 | 12021 |
| 6-#14 | 1.41 | MA | 14488 | 4710 | 23053 | 3425 | 24482 | 2808 | 24581 | 2334 | 23703 | 1645 | 27270 | 1390 | 12885 |
| 3L-2S | | MI | 14354 | 4710 | 22815 | 3412 | 24415 | 2777 | 24751 | 2303 | 24475 | 1617 | 28479 | 1494 | 11946 |
| 6-#18 | 2.50 | MA | 16590 | 5073 | 27258 | 3629 | 29749 | 2931 | 30817 | 2388 | 31958 | 1561 | 38002 | 1381 | 21945 |
| 2L-3S | | MI | 14121 | 5073 | 23457 | 3590 | 25098 | 2933 | 25466 | 2387 | 25410 | 1561 | 29612 | 1128 | 20407 |
| 6-#18 | 2.50 | MA | 15114 | 5073 | 25033 | 3614 | 26896 | 2955 | 27387 | 2410 | 27409 | 1583 | 32054 | 1160 | 21933 |
| 3L-2S | | MI | 15482 | 5073 | 25510 | 3607 | 27720 | 2911 | 28599 | 2365 | 29565 | 1539 | 35018 | 1350 | 20388 |
| 8-#11 | 1.30 | MA | 15248 | 4675 | 24035 | 3426 | 25804 | 2790 | 26223 | 2323 | 25924 | 1649 | 30231 | 1538 | 11944 |
| 2L-4S | | MI | 13299 | 4675 | 21030 | 3413 | 22195 | 2777 | 22116 | 2308 | 21074 | 1651 | 24316 | 1347 | 11236 |
| 8-#11 | 1.30 | MA | 14641 | 4675 | 23139 | 3421 | 24655 | 2801 | 24821 | 2332 | 24056 | 1657 | 27766 | 1452 | 11992 |
| 3E | | MI | 13700 | 4675 | 21713 | 3401 | 23064 | 2784 | 23169 | 2317 | 22384 | 1642 | 25771 | 1433 | 11189 |
| 8-#11 | 1.30 | MA | 14209 | 4675 | 22402 | 3434 | 23716 | 2795 | 23681 | 2324 | 22629 | 1666 | 26174 | 1365 | 12032 |
| 4L-2S | | MI | 14261 | 4675 | 22542 | 3406 | 24127 | 2774 | 24461 | 2308 | 24097 | 1634 | 28024 | 1519 | 11139 |
| 8-#14 | 1.88 | MA | 15930 | 4866 | 25612 | 3530 | 27762 | 2863 | 28576 | 2364 | 29000 | 1615 | 34240 | 1476 | 16860 |
| 2L-4S | | MI | 13524 | 4866 | 21840 | 3518 | 23173 | 2849 | 23261 | 2344 | 22621 | 1622 | 26423 | 1206 | 15739 |
| 8-#14 | 1.88 | MA | 15073 | 4866 | 24333 | 3523 | 26122 | 2878 | 26579 | 2376 | 26351 | 1627 | 30755 | 1351 | 16906 |
| 3E | | MI | 14093 | 4866 | 22815 | 3501 | 24415 | 2860 | 24751 | 2357 | 24475 | 1609 | 28479 | 1327 | 15746 |
| 8-#14 | 1.88 | MA | 14460 | 4866 | 23280 | 3540 | 24781 | 2868 | 24952 | 2364 | 24328 | 1640 | 28505 | 1228 | 16874 |
| 4L-2S | | MI | 14884 | 4866 | 23997 | 3510 | 25931 | 2847 | 26581 | 2344 | 26901 | 1597 | 31659 | 1452 | 15693 |
| 8-#18 | 3.33 | MA | 17563 | 5350 | 29484 | 3802 | 32602 | 3056 | 34248 | 2460 | 36508 | 1524 | 43950 | 1303 | 28925 |
| 2L-4S | | MI | 14056 | 5350 | 23810 | 3789 | 25564 | 3034 | 26045 | 2434 | 26391 | 1543 | 31511 | 834 | 25014 |
| 8-#18 | 3.33 | MA | 16103 | 5350 | 27258 | 3787 | 29749 | 3079 | 30817 | 2482 | 31958 | 1546 | 38002 | 1082 | 28799 |
| 3E | | MI | 15026 | 5350 | 25510 | 3762 | 27720 | 3056 | 28599 | 2456 | 29565 | 1521 | 35018 | 1043 | 26747 |
| 8-#18 | 3.33 | MA | 15056 | 5350 | 25420 | 3816 | 27407 | 3058 | 28023 | 2460 | 28483 | 1569 | 34152 | 868 | 26920 |
| 4L-2S | | MI | 16374 | 5350 | 27563 | 3780 | 30342 | 3034 | 31732 | 2434 | 33721 | 1499 | 40424 | 1265 | 26834 |

## RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

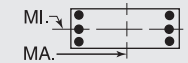
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.63 | MA | 15657 | 4783 | 24932 | 3493 | 26953 | 2839 | 27625 | 2353 | 27792 | 1637 | 32696 | 1513 | 14780 |
| 2L-5S | | MI | 13320 | 4783 | 21266 | 3476 | 22489 | 2836 | 22469 | 2346 | 21474 | 1630 | 25016 | 1283 | 13814 |
| 10-#11 | 1.63 | MA | 15054 | 4783 | 24035 | 3489 | 25804 | 2850 | 26223 | 2362 | 25924 | 1646 | 30231 | 1427 | 14818 |
| 3L-4S | | MI | 13679 | 4783 | 21859 | 3481 | 23257 | 2826 | 23409 | 2337 | 22788 | 1638 | 26569 | 1320 | 13839 |
| 10-#11 | 1.63 | MA | 14623 | 4783 | 23299 | 3501 | 24866 | 2843 | 25083 | 2354 | 24497 | 1654 | 28639 | 1340 | 14839 |
| 4L-3S | | MI | 14079 | 4783 | 22542 | 3469 | 24127 | 2833 | 24461 | 2346 | 24097 | 1630 | 28024 | 1406 | 13810 |
| 10-#11 | 1.63 | MA | 14237 | 4783 | 22660 | 3497 | 24038 | 2854 | 24066 | 2363 | 23065 | 1646 | 26942 | 1303 | 14792 |
| 5L-2S | | MI | 14637 | 4783 | 23371 | 3474 | 25190 | 2823 | 25753 | 2337 | 25811 | 1621 | 30277 | 1492 | 13769 |
| 10-#14 | 2.34 | MA | 16503 | 5021 | 26891 | 3627 | 29402 | 2933 | 30574 | 2406 | 31649 | 1597 | 37725 | 1437 | 20885 |
| 2L-5S | | MI | 13551 | 5021 | 22174 | 3607 | 23590 | 2933 | 23761 | 2397 | 23186 | 1590 | 27411 | 1109 | 18569 |
| 10-#14 | 2.34 | MA | 15652 | 5021 | 25612 | 3620 | 27762 | 2948 | 28576 | 2418 | 29000 | 1609 | 34240 | 1312 | 20902 |
| 3L-4S | | MI | 14059 | 5021 | 23022 | 3615 | 24689 | 2919 | 25091 | 2385 | 25047 | 1602 | 29603 | 1163 | 19393 |
| 10-#14 | 2.34 | MA | 15044 | 5021 | 24559 | 3637 | 26421 | 2938 | 26950 | 2406 | 26976 | 1622 | 31990 | 1189 | 20822 |
| 4L-3S | | MI | 14623 | 5021 | 23997 | 3599 | 25931 | 2930 | 26581 | 2397 | 26901 | 1590 | 31659 | 1285 | 19449 |
| 10-#14 | 2.34 | MA | 14497 | 5021 | 23645 | 3630 | 25236 | 2953 | 25498 | 2418 | 24945 | 1609 | 29587 | 1135 | 19915 |
| 5L-2S | | MI | 15410 | 5021 | 25179 | 3607 | 27446 | 2916 | 28411 | 2385 | 29328 | 1577 | 34838 | 1409 | 19419 |
| 10-#18 | 4.17 | MA | 18526 | 5626 | 31709 | 3975 | 35455 | 3180 | 37679 | 2531 | 41058 | 1488 | 49898 | 1226 | 35852 |
| 2L-5S | | MI | 14095 | 5626 | 24381 | 3945 | 26278 | 3179 | 26901 | 2525 | 27356 | 1481 | 33191 | 651 | 29391 |
| 10-#18 | 4.17 | MA | 17079 | 5626 | 29484 | 3960 | 32602 | 3203 | 34248 | 2553 | 36508 | 1510 | 43950 | 1004 | 35639 |
| 3L-4S | | MI | 14959 | 5626 | 25862 | 3962 | 28186 | 3157 | 29178 | 2502 | 30547 | 1503 | 36917 | 749 | 30958 |
| 10-#18 | 4.17 | MA | 16044 | 5626 | 27645 | 3988 | 30260 | 3183 | 31453 | 2531 | 33033 | 1532 | 40100 | 790 | 33381 |
| 4L-3S | | MI | 15921 | 5626 | 27563 | 3935 | 30342 | 3179 | 31732 | 2525 | 33721 | 1481 | 40424 | 959 | 33060 |
| 10-#18 | 4.17 | MA | 15114 | 5626 | 26046 | 3973 | 28189 | 3206 | 28960 | 2553 | 29541 | 1510 | 36000 | 693 | 31682 |
| 5L-2S | | MI | 17256 | 5626 | 29615 | 3953 | 32963 | 3157 | 34865 | 2502 | 37877 | 1459 | 45829 | 1180 | 33236 |
| 12-#11 | 1.95 | MA | 16064 | 4891 | 25828 | 3561 | 28102 | 2887 | 29027 | 2382 | 29659 | 1625 | 35162 | 1488 | 17605 |
| 2L-6S | | MI | 13359 | 4891 | 21538 | 3538 | 22782 | 2877 | 22868 | 2384 | 21999 | 1625 | 25820 | 1198 | 15837 |
| 12-#11 | 1.95 | MA | 15463 | 4891 | 24932 | 3556 | 26953 | 2898 | 27625 | 2391 | 27792 | 1634 | 32696 | 1401 | 17632 |
| 3L-5S | | MI | 13700 | 4891 | 22095 | 3543 | 23552 | 2884 | 23762 | 2375 | 23187 | 1617 | 27269 | 1255 | 16263 |
| 12-#11 | 1.95 | MA | 15035 | 4891 | 24195 | 3569 | 26015 | 2892 | 26485 | 2383 | 26364 | 1643 | 31105 | 1315 | 17629 |
| 4E | | MI | 14057 | 4891 | 22688 | 3548 | 24320 | 2874 | 24701 | 2366 | 24502 | 1625 | 28822 | 1293 | 16428 |
| 12-#11 | 1.95 | MA | 14651 | 4891 | 23556 | 3564 | 25187 | 2902 | 25468 | 2392 | 24933 | 1634 | 29407 | 1278 | 17443 |
| 5L-3S | | MI | 14455 | 4891 | 23371 | 3536 | 25190 | 2881 | 25753 | 2375 | 25811 | 1617 | 30277 | 1378 | 16418 |
| 12-#11 | 1.95 | MA | 14284 | 4891 | 22956 | 3560 | 24357 | 2896 | 24500 | 2401 | 23637 | 1643 | 27820 | 1221 | 16960 |
| 6L-2S | | MI | 15010 | 4891 | 24200 | 3541 | 26253 | 2871 | 27046 | 2366 | 27524 | 1608 | 32530 | 1464 | 16386 |
| 12-#14 | 2.81 | MA | 17072 | 5177 | 28170 | 3724 | 31042 | 3003 | 32571 | 2448 | 34297 | 1579 | 41211 | 1398 | 24896 |
| 2L-6S | | MI | 13604 | 5177 | 22559 | 3696 | 24005 | 2992 | 24325 | 2451 | 23929 | 1582 | 28549 | 984 | 21523 |
| 12-#14 | 2.81 | MA | 16226 | 5177 | 26891 | 3717 | 29402 | 3018 | 30574 | 2460 | 31649 | 1591 | 37725 | 1274 | 24877 |
| 3L-5S | | MI | 14085 | 5177 | 23356 | 3704 | 25106 | 3003 | 25590 | 2438 | 25612 | 1570 | 30590 | 1067 | 22072 |
| 12-#14 | 2.81 | MA | 15622 | 5177 | 25839 | 3735 | 28061 | 3008 | 28947 | 2448 | 29625 | 1604 | 35476 | 1150 | 24760 |
| 4E | | MI | 14589 | 5177 | 24204 | 3712 | 26204 | 2989 | 26920 | 2426 | 27474 | 1582 | 32782 | 1121 | 23036 |
| 12-#14 | 2.81 | MA | 15080 | 5177 | 24924 | 3727 | 26876 | 3023 | 27496 | 2460 | 27594 | 1591 | 33073 | 1096 | 23711 |
| 5L-3S | | MI | 15150 | 5177 | 25179 | 3696 | 27446 | 3000 | 28411 | 2438 | 29328 | 1570 | 34838 | 1243 | 23127 |
| 12-#14 | 2.81 | MA | 14563 | 5177 | 24065 | 3720 | 25689 | 3013 | 26114 | 2473 | 25756 | 1604 | 30832 | 1014 | 23109 |
| 6L-2S | | MI | 15932 | 5177 | 26361 | 3704 | 28961 | 2986 | 30241 | 2426 | 31754 | 1558 | 38017 | 1367 | 23130 |
| 12-#18 | 5.00 | MA | 18045 | 5903 | 31709 | 4133 | 35455 | 3327 | 37679 | 2625 | 41058 | 1473 | 49898 | 926 | 42464 |
| 3L-5S | | MI | 14998 | 5903 | 26434 | 4118 | 28900 | 3303 | 30034 | 2594 | 31512 | 1441 | 38597 | 566 | 35182 |
| 12-#18 | 5.00 | MA | 17020 | 5903 | 29871 | 4161 | 33113 | 3307 | 34884 | 2603 | 37582 | 1495 | 46048 | 712 | 39888 |
| 4E | | MI | 15854 | 5903 | 27915 | 4135 | 30808 | 3281 | 32311 | 2571 | 34703 | 1463 | 42323 | 665 | 36947 |
| 12-#18 | 5.00 | MA | 16100 | 5903 | 28272 | 4146 | 31042 | 3330 | 32390 | 2625 | 34091 | 1473 | 41948 | 615 | 37993 |
| 5L-3S | | MI | 16806 | 5903 | 29615 | 4108 | 32963 | 3303 | 34865 | 2594 | 37877 | 1441 | 45829 | 874 | 39355 |
| 14-#11 | 2.27 | MA | 16468 | 4998 | 26725 | 3628 | 29252 | 2935 | 30429 | 2411 | 31527 | 1614 | 37627 | 1463 | 20422 |
| 2L-7S | | MI | 13407 | 4998 | 21757 | 3617 | 23109 | 2936 | 23218 | 2404 | 22551 | 1621 | 26714 | 1105 | 17995 |
| 14-#11 | 2.27 | MA | 15870 | 4998 | 25828 | 3624 | 28102 | 2946 | 29027 | 2420 | 29659 | 1622 | 35162 | 1376 | 20438 |
| 3L-6S | | MI | 13738 | 4998 | 22367 | 3605 | 23845 | 2926 | 24160 | 2413 | 23712 | 1613 | 28073 | 1171 | 18328 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis

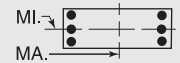



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.27 | MA | 15444 | 4998 | 25092 | 3636 | 27164 | 2940 | 27887 | 2412 | 28232 | 1631 | 33570 | 1290 | 20412 |
| 4L-5S | | MI | 14077 | 4998 | 22924 | 3610 | 24615 | 2933 | 25054 | 2404 | 24901 | 1604 | 29521 | 1228 | 18726 |
| 14-#11 | 2.27 | MA | 15062 | 4998 | 24453 | 3632 | 26336 | 2951 | 26870 | 2422 | 26800 | 1622 | 31872 | 1252 | 20107 |
| 5L-4S | | MI | 14433 | 4998 | 23517 | 3616 | 25383 | 2923 | 25993 | 2395 | 26215 | 1613 | 31075 | 1265 | 19006 |
| 14-#11 | 2.27 | MA | 14697 | 4998 | 23853 | 3627 | 25506 | 2945 | 25902 | 2431 | 25505 | 1631 | 30286 | 1196 | 19654 |
| 6L-3S | | MI | 14828 | 4998 | 24200 | 3604 | 26253 | 2930 | 27046 | 2404 | 27524 | 1604 | 32530 | 1351 | 19017 |
| 14-#11 | 2.27 | MA | 14342 | 4998 | 23196 | 3640 | 24714 | 2955 | 24882 | 2423 | 24238 | 1640 | 28587 | 1105 | 19284 |
| 7L-2S | | MI | 15381 | 4998 | 25029 | 3609 | 27315 | 2920 | 28338 | 2395 | 29238 | 1595 | 34782 | 1437 | 18995 |
| 14-#14 | 3.28 | MA | 16795 | 5332 | 28170 | 3814 | 31042 | 3088 | 32571 | 2503 | 34297 | 1573 | 41211 | 1235 | 28842 |
| 3L-6S | | MI | 14137 | 5332 | 23741 | 3793 | 25520 | 3061 | 26155 | 2492 | 26355 | 1563 | 31728 | 942 | 24933 |
| 14-#14 | 3.28 | MA | 16195 | 5332 | 27118 | 3832 | 29701 | 3078 | 30945 | 2490 | 32274 | 1586 | 38961 | 1111 | 28580 |
| 4L-5S | | MI | 14614 | 5332 | 24538 | 3801 | 26621 | 3072 | 27420 | 2479 | 28039 | 1550 | 33769 | 1025 | 25589 |
| 14-#14 | 3.28 | MA | 15657 | 5332 | 26204 | 3825 | 28516 | 3093 | 29493 | 2503 | 30243 | 1573 | 36558 | 1057 | 27521 |
| 5L-4S | | MI | 15115 | 5332 | 25386 | 3810 | 27719 | 3059 | 28750 | 2467 | 29900 | 1563 | 35961 | 1079 | 26523 |
| 14-#14 | 3.28 | MA | 15144 | 5332 | 25345 | 3817 | 27329 | 3083 | 28111 | 2515 | 28405 | 1586 | 34317 | 975 | 26812 |
| 6L-3S | | MI | 15672 | 5332 | 26361 | 3793 | 28961 | 3070 | 30241 | 2479 | 31754 | 1550 | 38017 | 1201 | 26794 |
| 14-#14 | 3.28 | MA | 14644 | 5332 | 24404 | 3835 | 26195 | 3098 | 26655 | 2503 | 26609 | 1598 | 32215 | 880 | 25698 |
| 7L-2S | | MI | 16450 | 5332 | 27543 | 3801 | 30477 | 3056 | 32071 | 2467 | 34181 | 1538 | 41196 | 1325 | 26832 |
| 14-#18 | 5.83 | MA | 17987 | 6180 | 32096 | 4334 | 35966 | 3431 | 38314 | 2674 | 42132 | 1459 | 51996 | 635 | 46430 |
| 4L-5S | | MI | 15891 | 6180 | 28487 | 4291 | 31521 | 3426 | 33167 | 2662 | 35668 | 1401 | 44002 | 482 | 41014 |
| 14-#18 | 5.83 | MA | 17075 | 6180 | 30497 | 4319 | 33895 | 3454 | 35821 | 2696 | 38641 | 1437 | 47895 | 537 | 44344 |
| 5L-4S | | MI | 16739 | 6180 | 29967 | 4308 | 33429 | 3404 | 35445 | 2640 | 38859 | 1423 | 47729 | 580 | 42970 |
| 16-#11 | 2.60 | MA | 16274 | 5106 | 26725 | 3691 | 29252 | 2995 | 30429 | 2450 | 31527 | 1611 | 37627 | 1351 | 23231 |
| 3L-7S | | MI | 13786 | 5106 | 22586 | 3685 | 24172 | 2984 | 24510 | 2433 | 24264 | 1609 | 28967 | 1078 | 20424 |
| 16-#11 | 2.60 | MA | 15851 | 5106 | 25988 | 3704 | 28313 | 2988 | 29289 | 2442 | 30100 | 1619 | 36035 | 1265 | 23188 |
| 4L-6S | | MI | 14115 | 5106 | 23196 | 3673 | 24908 | 2974 | 25452 | 2442 | 25426 | 1600 | 30326 | 1144 | 20824 |
| 16-#11 | 2.60 | MA | 15470 | 5106 | 25349 | 3699 | 27485 | 2999 | 28272 | 2451 | 28668 | 1611 | 34338 | 1227 | 22782 |
| 5E | | MI | 14452 | 5106 | 23753 | 3678 | 25678 | 2981 | 26346 | 2433 | 26615 | 1591 | 31774 | 1201 | 21197 |
| 16-#11 | 2.60 | MA | 15108 | 5106 | 24749 | 3694 | 26656 | 2993 | 27304 | 2460 | 27372 | 1619 | 32751 | 1170 | 22355 |
| 6L-4S | | MI | 14806 | 5106 | 24346 | 3683 | 26446 | 2971 | 27286 | 2424 | 27929 | 1600 | 33328 | 1238 | 21577 |
| 16-#11 | 2.60 | MA | 14754 | 5106 | 24092 | 3707 | 25863 | 3004 | 26284 | 2452 | 26106 | 1628 | 31053 | 1080 | 21917 |
| 7L-3S | | MI | 15200 | 5106 | 25029 | 3671 | 27315 | 2978 | 28338 | 2433 | 29238 | 1591 | 34782 | 1323 | 21607 |
| 16-#11 | 2.60 | MA | 14407 | 5106 | 23501 | 3703 | 25059 | 2998 | 25333 | 2461 | 24857 | 1637 | 29467 | 1035 | 21320 |
| 8L-2S | | MI | 15750 | 5106 | 25858 | 3676 | 28378 | 2968 | 29630 | 2424 | 30951 | 1583 | 37035 | 1410 | 21598 |
| 16-#14 | 3.75 | MA | 16764 | 5488 | 28397 | 3929 | 31341 | 3148 | 32943 | 2532 | 34922 | 1568 | 42446 | 1072 | 32337 |
| 4L-6S | | MI | 14665 | 5488 | 24923 | 3891 | 27035 | 3131 | 27984 | 2532 | 28782 | 1543 | 34907 | 900 | 28360 |
| 16-#14 | 3.75 | MA | 16229 | 5488 | 27483 | 3922 | 30156 | 3162 | 31491 | 2545 | 32891 | 1555 | 40043 | 1019 | 31343 |
| 5E | | MI | 15140 | 5488 | 25720 | 3899 | 28136 | 3142 | 29250 | 2520 | 30465 | 1530 | 36948 | 983 | 29118 |
| 16-#14 | 3.75 | MA | 15720 | 5488 | 26624 | 3915 | 28969 | 3152 | 30109 | 2557 | 31054 | 1568 | 37802 | 936 | 30532 |
| 6L-4S | | MI | 15638 | 5488 | 26568 | 3907 | 29235 | 3129 | 30580 | 2508 | 32327 | 1543 | 39140 | 1037 | 29990 |
| 16-#14 | 3.75 | MA | 15223 | 5488 | 25684 | 3932 | 27835 | 3167 | 28653 | 2545 | 29258 | 1580 | 35700 | 841 | 29470 |
| 7L-3S | | MI | 16191 | 5488 | 27543 | 3890 | 30477 | 3140 | 32071 | 2520 | 34181 | 1530 | 41196 | 1158 | 30452 |
| 16-#18 | 6.67 | MA | 18042 | 6456 | 32723 | 4492 | 36748 | 3579 | 39252 | 2768 | 43190 | 1400 | 53843 | 459 | 50730 |
| 5E | | MI | 16777 | 6456 | 30539 | 4464 | 34143 | 3549 | 36300 | 2731 | 39824 | 1361 | 49408 | 397 | 46882 |
| 18-#11 | 2.92 | MA | 16255 | 5214 | 26885 | 3771 | 29463 | 3037 | 30691 | 2471 | 31968 | 1608 | 38501 | 1240 | 25959 |
| 4L-7S | | MI | 14162 | 5214 | 23416 | 3752 | 25235 | 3033 | 25803 | 2462 | 25978 | 1596 | 31219 | 1050 | 22862 |
| 18-#11 | 2.92 | MA | 15876 | 5214 | 26246 | 3766 | 28635 | 3048 | 29674 | 2480 | 30536 | 1599 | 36803 | 1202 | 25464 |
| 5L-6S | | MI | 14489 | 5214 | 24025 | 3740 | 25970 | 3023 | 26745 | 2471 | 27139 | 1587 | 32579 | 1116 | 23325 |
| 18-#11 | 2.92 | MA | 15516 | 5214 | 25646 | 3762 | 27805 | 3041 | 28706 | 2489 | 29240 | 1608 | 35216 | 1145 | 25060 |
| 6L-5S | | MI | 14825 | 5214 | 24582 | 3745 | 26740 | 3030 | 27639 | 2462 | 28328 | 1579 | 34027 | 1173 | 23677 |
| 18-#11 | 2.92 | MA | 15164 | 5214 | 24989 | 3775 | 27012 | 3052 | 27686 | 2481 | 27974 | 1616 | 33518 | 1055 | 24559 |
| 7L-4S | | MI | 15177 | 5214 | 25175 | 3750 | 27509 | 3019 | 28578 | 2454 | 29642 | 1587 | 35580 | 1211 | 24142 |
| 18-#11 | 2.92 | MA | 14818 | 5214 | 24398 | 3770 | 26208 | 3046 | 26735 | 2490 | 26724 | 1625 | 31932 | 1010 | 23986 |
| 8L-3S | | MI | 15569 | 5214 | 25858 | 3738 | 28378 | 3027 | 29630 | 2462 | 30951 | 1579 | 37035 | 1296 | 24187 |
| 18-#14 | 4.22 | MA | 16798 | 5644 | 28762 | 4019 | 31796 | 3232 | 33489 | 2587 | 35540 | 1537 | 43528 | 980 | 35175 |
| 5L-6S | | MI | 15190 | 5644 | 26105 | 3988 | 28550 | 3201 | 29814 | 2573 | 31208 | 1523 | 38086 | 858 | 31802 |
| 18-#14 | 4.22 | MA | 16292 | 5644 | 27903 | 4012 | 30609 | 3222 | 32107 | 2599 | 33702 | 1550 | 41287 | 898 | 34267 |
| 6L-5S | | MI | 15662 | 5644 | 26902 | 3996 | 29652 | 3212 | 31080 | 2561 | 32892 | 1511 | 40128 | 940 | 32655 |

## RECTANGULAR TIED COLUMNS 30" x 32"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 4.22 | MA | 15798 | 5644 | 26963 | 4029 | 29474 | 3237 | 30650 | 2587 | 31907 | 1562 | 39185 | 802 | 33253 |
| 7L-4S | | MI | 16156 | 5644 | 27750 | 4004 | 30750 | 3198 | 32410 | 2548 | 34754 | 1523 | 42319 | 995 | 33474 |
| 20-#11 | 3.25 | MA | 16280 | 5322 | 27142 | 3834 | 29784 | 3096 | 31076 | 2510 | 32404 | 1587 | 39269 | 1177 | 28153 |
| 5L-7S | | MI | 14536 | 5322 | 24245 | 3820 | 26297 | 3081 | 27095 | 2491 | 27691 | 1583 | 33472 | 1023 | 25307 |
| 20-#11 | 3.25 | MA | 15921 | 5322 | 26542 | 3829 | 28954 | 3090 | 30108 | 2519 | 31108 | 1596 | 37682 | 1120 | 27768 |
| 6E | | MI | 14862 | 5322 | 24854 | 3808 | 27033 | 3071 | 28037 | 2500 | 28853 | 1574 | 34832 | 1089 | 25829 |
| 20-#11 | 3.25 | MA | 15571 | 5322 | 25885 | 3842 | 28162 | 3101 | 29088 | 2511 | 29841 | 1605 | 35984 | 1030 | 27208 |
| 7L-5S | | MI | 15196 | 5322 | 25412 | 3813 | 27803 | 3078 | 28931 | 2491 | 30042 | 1566 | 36280 | 1146 | 26163 |
| 20-#11 | 3.25 | MA | 15227 | 5322 | 25294 | 3837 | 27358 | 3094 | 28137 | 2520 | 28592 | 1613 | 34398 | 985 | 26659 |
| 8L-4S | | MI | 15546 | 5322 | 26004 | 3818 | 28571 | 3068 | 29870 | 2483 | 31356 | 1574 | 37833 | 1183 | 26703 |
| 20-#14 | 4.69 | MA | 16860 | 5799 | 29182 | 4109 | 32249 | 3292 | 34104 | 2642 | 36351 | 1532 | 44772 | 859 | 38015 |
| 6E | | MI | 15711 | 5799 | 27287 | 4085 | 30066 | 3271 | 31644 | 2614 | 33635 | 1503 | 41265 | 816 | 35257 |
| 20-#14 | 4.69 | MA | 16370 | 5799 | 28242 | 4127 | 31114 | 3307 | 32648 | 2629 | 34555 | 1544 | 42670 | 763 | 37045 |
| 7L-5S | | MI | 16180 | 5799 | 28084 | 4093 | 31167 | 3282 | 32910 | 2602 | 35318 | 1491 | 43307 | 898 | 36200 |
| 22-#11 | 3.57 | MA | 16324 | 5430 | 27439 | 3897 | 30103 | 3138 | 31510 | 2548 | 32975 | 1584 | 40147 | 1095 | 30480 |
| 6L-7S | | MI | 14908 | 5430 | 25074 | 3887 | 27360 | 3130 | 28387 | 2520 | 29405 | 1570 | 35725 | 996 | 27760 |
| 22-#11 | 3.57 | MA | 15976 | 5430 | 26782 | 3909 | 29311 | 3149 | 30490 | 2540 | 31709 | 1593 | 38449 | 1004 | 29864 |
| 7L-6S | | MI | 15232 | 5430 | 25683 | 3875 | 28096 | 3119 | 29329 | 2529 | 30566 | 1562 | 37085 | 1061 | 28335 |
| 22-#11 | 3.57 | MA | 15634 | 5430 | 26191 | 3905 | 28507 | 3143 | 29539 | 2549 | 30460 | 1602 | 36863 | 960 | 29336 |
| 8L-5S | | MI | 15565 | 5430 | 26241 | 3880 | 28866 | 3126 | 30224 | 2520 | 31755 | 1553 | 38533 | 1118 | 28653 |
| 22-#14 | 5.16 | MA | 16937 | 5955 | 29521 | 4224 | 32754 | 3377 | 34646 | 2671 | 37204 | 1526 | 46156 | 725 | 40835 |
| 7L-6S | | MI | 16230 | 5955 | 28469 | 4182 | 31581 | 3341 | 33474 | 2655 | 36062 | 1484 | 44445 | 774 | 38723 |
| 24-#11 | 3.90 | MA | 16379 | 5538 | 27678 | 3977 | 30460 | 3198 | 31892 | 2570 | 33577 | 1581 | 40914 | 979 | 32526 |
| 7E | | MI | 15278 | 5538 | 25903 | 3954 | 28423 | 3178 | 29680 | 2549 | 31118 | 1558 | 37978 | 968 | 30218 |
| 24-#11 | 3.90 | MA | 16038 | 5538 | 27087 | 3972 | 29656 | 3191 | 30941 | 2579 | 32327 | 1590 | 39329 | 935 | 32017 |
| 8L-6S | | MI | 15600 | 5538 | 26513 | 3942 | 29159 | 3168 | 30622 | 2558 | 32280 | 1549 | 39338 | 1034 | 30844 |

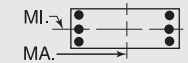
## RECTANGULAR TIED COLUMNS 30" x 34"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.57 | MA | 17531 | 5062 | 27968 | 3672 | 30080 | 2985 | 30673 | 2472 | 30629 | 1719 | 35843 | 1583 | 16000 |
| 2E | | MI | 15377 | 5062 | 24667 | 3627 | 26339 | 2946 | 26666 | 2431 | 26478 | 1682 | 30787 | 1534 | 13944 |
| 6-#14 | 1.32 | MA | 17253 | 4975 | 27205 | 3648 | 29235 | 2971 | 29736 | 2473 | 29455 | 1753 | 34385 | 1635 | 13727 |
| 2L-3S | | MI | 14353 | 4975 | 22838 | 3599 | 24142 | 2951 | 24125 | 2452 | 23123 | 1734 | 26484 | 1470 | 12065 |
| 6-#14 | 1.32 | MA | 16322 | 4975 | 25829 | 3642 | 27471 | 2987 | 27583 | 2486 | 26584 | 1765 | 30594 | 1511 | 13797 |
| 3L-2S | | MI | 15151 | 4975 | 24020 | 3607 | 25657 | 2937 | 25955 | 2439 | 25549 | 1721 | 29663 | 1595 | 11987 |
| 6-#18 | 2.35 | MA | 18604 | 5338 | 30367 | 3845 | 33155 | 3109 | 34402 | 2546 | 35573 | 1685 | 42335 | 1511 | 23565 |
| 2L-3S | | MI | 14918 | 5338 | 24667 | 3783 | 26339 | 3091 | 26666 | 2522 | 26478 | 1664 | 30787 | 1228 | 20494 |
| 6-#18 | 2.35 | MA | 17010 | 5338 | 27968 | 3831 | 30080 | 3134 | 30673 | 2568 | 30629 | 1708 | 35843 | 1289 | 23553 |
| 3L-2S | | MI | 16282 | 5338 | 26719 | 3800 | 28961 | 3069 | 29799 | 2500 | 30634 | 1642 | 36193 | 1450 | 20449 |
| 8-#11 | 1.22 | MA | 17139 | 4940 | 26881 | 3641 | 28888 | 2968 | 29338 | 2474 | 28980 | 1768 | 33797 | 1658 | 12786 |
| 2L-4S | | MI | 14095 | 4940 | 22232 | 3609 | 23437 | 2939 | 23322 | 2445 | 22152 | 1756 | 25504 | 1449 | 11280 |
| 8-#11 | 1.22 | MA | 16485 | 4940 | 25917 | 3637 | 27652 | 2979 | 27830 | 2484 | 26958 | 1777 | 31119 | 1571 | 12834 |
| 3E | | MI | 14497 | 4940 | 22914 | 3597 | 24306 | 2946 | 24374 | 2454 | 23461 | 1748 | 26959 | 1535 | 11227 |
| 8-#11 | 1.22 | MA | 16020 | 4940 | 25127 | 3650 | 26646 | 2973 | 26607 | 2476 | 25412 | 1785 | 29386 | 1485 | 12874 |
| 4L-2S | | MI | 15058 | 4940 | 23743 | 3603 | 25369 | 2936 | 25667 | 2445 | 25175 | 1739 | 29212 | 1621 | 11176 |
| 8-#14 | 1.76 | MA | 17881 | 5131 | 28582 | 3745 | 31000 | 3041 | 31889 | 2515 | 32326 | 1736 | 38177 | 1599 | 18075 |
| 2L-4S | | MI | 14320 | 5131 | 23045 | 3713 | 24415 | 3010 | 24465 | 2480 | 23696 | 1727 | 27607 | 1307 | 15812 |
| 8-#14 | 1.76 | MA | 16956 | 5131 | 27205 | 3739 | 29235 | 3056 | 29736 | 2528 | 29455 | 1749 | 34385 | 1475 | 18121 |
| 3E | | MI | 14889 | 5131 | 24020 | 3696 | 25657 | 3021 | 25955 | 2493 | 25549 | 1714 | 29663 | 1428 | 15798 |
| 8-#14 | 1.76 | MA | 16298 | 5131 | 26075 | 3757 | 27795 | 3047 | 27986 | 2517 | 27261 | 1761 | 31936 | 1350 | 18089 |
| 4L-2S | | MI | 15682 | 5131 | 25202 | 3705 | 27173 | 3007 | 27785 | 2480 | 27976 | 1702 | 32843 | 1553 | 15740 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis

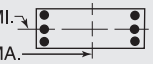



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 3.14 | MA | 19664 | 5615 | 32765 | 4018 | 36229 | 3233 | 38131 | 2619 | 40517 | 1652 | 48826 | 1439 | 31085 |
| 2L-4S | | MI | 14851 | 5615 | 25019 | 3982 | 26805 | 3193 | 27245 | 2568 | 27460 | 1647 | 32686 | 934 | 25346 |
| 8-#18 | 3.14 | MA | 18085 | 5615 | 30367 | 4004 | 33155 | 3258 | 34402 | 2641 | 35573 | 1674 | 42335 | 1217 | 30959 |
| 3E | | MI | 15825 | 5615 | 26719 | 3955 | 28961 | 3215 | 29799 | 2591 | 30634 | 1624 | 36193 | 1144 | 26849 |
| 8-#18 | 3.14 | MA | 16959 | 5615 | 28391 | 4034 | 30637 | 3240 | 31366 | 2619 | 31796 | 1696 | 38140 | 1000 | 29201 |
| 4L-2S | | MI | 17175 | 5615 | 28772 | 3973 | 31583 | 3193 | 32932 | 2568 | 34790 | 1602 | 41599 | 1365 | 26903 |
| 10-#11 | 1.53 | MA | 17583 | 5048 | 27845 | 3709 | 30124 | 3016 | 30845 | 2503 | 31002 | 1757 | 36476 | 1634 | 15833 |
| 2L-5S | | MI | 14116 | 5048 | 22468 | 3672 | 23731 | 2997 | 23675 | 2483 | 22552 | 1735 | 26204 | 1384 | 13890 |
| 10-#11 | 1.53 | MA | 16932 | 5048 | 26881 | 3705 | 28888 | 3027 | 29338 | 2513 | 28980 | 1766 | 33797 | 1548 | 15871 |
| 3L-4S | | MI | 14476 | 5048 | 23061 | 3677 | 24500 | 2987 | 24614 | 2474 | 23866 | 1743 | 27757 | 1422 | 13889 |
| 10-#11 | 1.53 | MA | 16470 | 5048 | 26091 | 3718 | 27881 | 3022 | 28115 | 2506 | 27434 | 1775 | 32064 | 1462 | 15892 |
| 4L-3S | | MI | 14876 | 5048 | 23743 | 3665 | 25369 | 2994 | 25667 | 2483 | 25175 | 1735 | 29212 | 1507 | 13853 |
| 10-#11 | 1.53 | MA | 16056 | 5048 | 25406 | 3714 | 26993 | 3033 | 27024 | 2516 | 25885 | 1766 | 30226 | 1423 | 15854 |
| 5L-2S | | MI | 15434 | 5048 | 24572 | 3670 | 26432 | 2984 | 26959 | 2474 | 26888 | 1726 | 31465 | 1594 | 13809 |
| 10-#14 | 2.21 | MA | 18504 | 5286 | 29958 | 3843 | 32764 | 3110 | 34042 | 2557 | 35197 | 1720 | 41969 | 1564 | 22404 |
| 2L-5S | | MI | 14347 | 5286 | 23379 | 3802 | 24832 | 3093 | 24964 | 2534 | 24261 | 1694 | 28595 | 1210 | 18769 |
| 10-#14 | 2.21 | MA | 17585 | 5286 | 28582 | 3836 | 31000 | 3126 | 31889 | 2571 | 32326 | 1732 | 38177 | 1439 | 22420 |
| 3L-4S | | MI | 14856 | 5286 | 24227 | 3810 | 25931 | 3079 | 26294 | 2521 | 26122 | 1707 | 30786 | 1265 | 19476 |
| 10-#14 | 2.21 | MA | 16931 | 5286 | 27452 | 3855 | 29560 | 3117 | 30139 | 2559 | 30132 | 1745 | 35728 | 1314 | 22341 |
| 4L-3S | | MI | 15421 | 5286 | 25202 | 3794 | 27173 | 3091 | 27785 | 2534 | 27976 | 1694 | 32843 | 1386 | 19508 |
| 10-#14 | 2.21 | MA | 16345 | 5286 | 26471 | 3848 | 28289 | 3133 | 28578 | 2573 | 27931 | 1732 | 33119 | 1260 | 21484 |
| 5L-2S | | MI | 16209 | 5286 | 26384 | 3802 | 28688 | 3077 | 29615 | 2521 | 30402 | 1682 | 36022 | 1511 | 19470 |
| 10-#18 | 3.92 | MA | 20710 | 5892 | 35163 | 4191 | 39304 | 3357 | 41859 | 2693 | 45461 | 1618 | 55317 | 1367 | 38552 |
| 2L-5S | | MI | 14889 | 5892 | 25591 | 4138 | 27519 | 3338 | 28101 | 2659 | 28425 | 1584 | 34366 | 751 | 29921 |
| 10-#18 | 3.92 | MA | 19147 | 5892 | 32765 | 4177 | 36229 | 3382 | 38131 | 2715 | 40517 | 1640 | 48826 | 1145 | 38339 |
| 3L-4S | | MI | 15756 | 5892 | 27072 | 4155 | 29427 | 3316 | 30378 | 2637 | 31616 | 1607 | 38092 | 850 | 31284 |
| 10-#18 | 3.92 | MA | 18033 | 5892 | 30789 | 4207 | 33712 | 3364 | 35094 | 2693 | 36740 | 1662 | 44632 | 928 | 36173 |
| 4L-3S | | MI | 16721 | 5892 | 28772 | 4128 | 31583 | 3338 | 32932 | 2659 | 34790 | 1584 | 41599 | 1059 | 33174 |
| 10-#18 | 3.92 | MA | 17034 | 5892 | 29072 | 4193 | 31487 | 3389 | 32384 | 2715 | 32948 | 1640 | 40156 | 831 | 34479 |
| 5L-2S | | MI | 18060 | 5892 | 30825 | 4146 | 34204 | 3316 | 36065 | 2637 | 38946 | 1562 | 47004 | 1280 | 33318 |
| 12-#11 | 1.84 | MA | 18024 | 5156 | 28809 | 3776 | 31359 | 3064 | 32353 | 2533 | 33024 | 1747 | 39154 | 1611 | 18869 |
| 2L-6S | | MI | 14154 | 5156 | 22740 | 3734 | 24024 | 3039 | 24073 | 2521 | 23076 | 1731 | 27009 | 1300 | 15980 |
| 12-#11 | 1.84 | MA | 17376 | 5156 | 27845 | 3772 | 30124 | 3076 | 30845 | 2542 | 31002 | 1755 | 36476 | 1525 | 18896 |
| 3L-5S | | MI | 14496 | 5156 | 23297 | 3739 | 24794 | 3046 | 24967 | 2512 | 24265 | 1722 | 28457 | 1357 | 16422 |
| 12-#11 | 1.84 | MA | 16917 | 5156 | 27055 | 3785 | 29117 | 3070 | 29622 | 2535 | 29456 | 1764 | 34743 | 1439 | 18893 |
| 4E | | MI | 14854 | 5156 | 23890 | 3744 | 25562 | 3035 | 25907 | 2503 | 25579 | 1731 | 30010 | 1395 | 16487 |
| 12-#11 | 1.84 | MA | 16504 | 5156 | 26370 | 3781 | 28229 | 3082 | 28532 | 2545 | 27907 | 1755 | 32904 | 1400 | 18801 |
| 5L-3S | | MI | 15252 | 5156 | 24572 | 3732 | 26432 | 3043 | 26959 | 2512 | 26888 | 1722 | 31465 | 1480 | 16465 |
| 12-#11 | 1.84 | MA | 16112 | 5156 | 25727 | 3777 | 27340 | 3076 | 27445 | 2538 | 26504 | 1764 | 31179 | 1343 | 18242 |
| 6L-2S | | MI | 15808 | 5156 | 25401 | 3737 | 27495 | 3032 | 28251 | 2503 | 28602 | 1713 | 33718 | 1566 | 16430 |
| 12-#14 | 2.65 | MA | 19121 | 5442 | 31335 | 3940 | 34529 | 3180 | 36194 | 2600 | 38068 | 1703 | 45761 | 1528 | 26719 |
| 2L-6S | | MI | 14399 | 5442 | 23764 | 3891 | 25246 | 3152 | 25529 | 2587 | 25004 | 1687 | 29732 | 1086 | 21760 |
| 12-#14 | 2.65 | MA | 18208 | 5442 | 29958 | 3933 | 32764 | 3196 | 34042 | 2613 | 35197 | 1716 | 41969 | 1403 | 26700 |
| 3L-5S | | MI | 14881 | 5442 | 24561 | 3899 | 26348 | 3163 | 26794 | 2575 | 26687 | 1675 | 31774 | 1168 | 22270 |
| 12-#14 | 2.65 | MA | 17559 | 5442 | 28828 | 3952 | 31324 | 3187 | 32292 | 2602 | 33003 | 1728 | 39520 | 1279 | 26583 |
| 4E | | MI | 15387 | 5442 | 25409 | 3907 | 27446 | 3149 | 28124 | 2562 | 28549 | 1687 | 33966 | 1223 | 23127 |
| 12-#14 | 2.65 | MA | 16977 | 5442 | 27847 | 3945 | 30054 | 3203 | 30731 | 2615 | 30802 | 1716 | 36911 | 1224 | 25570 |
| 5L-3S | | MI | 15949 | 5442 | 26384 | 3891 | 28688 | 3160 | 29615 | 2575 | 30402 | 1675 | 36022 | 1344 | 23197 |
| 12-#14 | 2.65 | MA | 16423 | 5442 | 26927 | 3939 | 28780 | 3194 | 29246 | 2628 | 28810 | 1728 | 34469 | 1142 | 24911 |
| 6L-2S | | MI | 16732 | 5442 | 27566 | 3899 | 30203 | 3147 | 31444 | 2562 | 32829 | 1662 | 39201 | 1469 | 23186 |
| 12-#18 | 4.71 | MA | 20198 | 6168 | 35163 | 4350 | 39304 | 3507 | 41859 | 2789 | 45461 | 1607 | 55317 | 1073 | 45704 |
| 3L-5S | | MI | 15793 | 6168 | 27643 | 4311 | 30141 | 3461 | 31234 | 2728 | 32581 | 1545 | 39772 | 667 | 35703 |
| 12-#18 | 4.71 | MA | 19094 | 6168 | 33187 | 4380 | 36787 | 3488 | 38823 | 2767 | 41684 | 1629 | 51123 | 856 | 43193 |
| 4E | | MI | 16652 | 6168 | 29124 | 4328 | 32049 | 3439 | 33511 | 2706 | 35772 | 1567 | 43498 | 765 | 37267 |
| 12-#18 | 4.71 | MA | 18105 | 6168 | 31470 | 4366 | 34562 | 3513 | 36113 | 2789 | 37892 | 1607 | 46648 | 759 | 41399 |
| 5L-3S | | MI | 17608 | 6168 | 30825 | 4301 | 34204 | 3461 | 36065 | 2728 | 38946 | 1545 | 47004 | 974 | 39480 |
| 14-#11 | 2.14 | MA | 18462 | 5264 | 29773 | 3844 | 32595 | 3113 | 33860 | 2562 | 35046 | 1736 | 41832 | 1588 | 21896 |
| 2L-7S | | MI | 14202 | 5264 | 22959 | 3813 | 24351 | 3097 | 24424 | 2541 | 23628 | 1727 | 27902 | 1207 | 18226 |

## RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

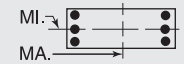
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 2.14 | MA | 17817 | 5264 | 28809 | 3840 | 31359 | 3124 | 32353 | 2572 | 33024 | 1745 | 39154 | 1502 | 21912 |
| 3L-6S | | MI | 14534 | 5264 | 23569 | 3801 | 25087 | 3087 | 25366 | 2550 | 24790 | 1718 | 29261 | 1273 | 18471 |
| 14-#11 | 2.14 | MA | 17360 | 5264 | 28019 | 3853 | 30353 | 3119 | 31130 | 2564 | 31478 | 1753 | 37421 | 1415 | 21886 |
| 4L-5S | | MI | 14874 | 5264 | 24126 | 3806 | 25857 | 3094 | 26260 | 2541 | 25979 | 1709 | 30710 | 1330 | 18883 |
| 14-#11 | 2.14 | MA | 16950 | 5264 | 27334 | 3849 | 29465 | 3130 | 30039 | 2574 | 29929 | 1745 | 35583 | 1377 | 21665 |
| 5L-4S | | MI | 15230 | 5264 | 24719 | 3812 | 26625 | 3084 | 27199 | 2532 | 27293 | 1718 | 32263 | 1367 | 19070 |
| 14-#11 | 2.14 | MA | 16559 | 5264 | 26691 | 3845 | 28575 | 3124 | 28952 | 2567 | 28526 | 1753 | 33857 | 1320 | 21140 |
| 6L-3S | | MI | 15626 | 5264 | 25401 | 3800 | 27495 | 3091 | 28251 | 2541 | 28602 | 1709 | 33718 | 1453 | 19068 |
| 14-#11 | 2.14 | MA | 16178 | 5264 | 25987 | 3858 | 27726 | 3136 | 27908 | 2577 | 27155 | 1762 | 32012 | 1230 | 20816 |
| 7L-2S | | MI | 16180 | 5264 | 26231 | 3805 | 28558 | 3081 | 29544 | 2532 | 30316 | 1701 | 35971 | 1539 | 19042 |
| 14-#14 | 3.09 | MA | 18826 | 5598 | 31335 | 4031 | 34529 | 3266 | 36194 | 2656 | 38068 | 1699 | 45761 | 1367 | 30968 |
| 3L-6S | | MI | 14932 | 5598 | 24946 | 3988 | 26762 | 3222 | 27358 | 2628 | 27430 | 1667 | 32912 | 1044 | 25263 |
| 14-#14 | 3.09 | MA | 18181 | 5598 | 30205 | 4049 | 33089 | 3257 | 34445 | 2644 | 35874 | 1712 | 43312 | 1243 | 30817 |
| 4L-5S | | MI | 15411 | 5598 | 25743 | 3997 | 27863 | 3233 | 28624 | 2615 | 29114 | 1655 | 34953 | 1126 | 25786 |
| 14-#14 | 3.09 | MA | 17603 | 5598 | 29224 | 4043 | 31818 | 3273 | 32884 | 2657 | 33673 | 1699 | 40702 | 1188 | 29673 |
| 5L-4S | | MI | 15914 | 5598 | 26591 | 4005 | 28961 | 3219 | 29954 | 2603 | 30975 | 1667 | 37145 | 1180 | 26758 |
| 14-#14 | 3.09 | MA | 17053 | 5598 | 28303 | 4036 | 30545 | 3264 | 31398 | 2671 | 31681 | 1712 | 38261 | 1106 | 29049 |
| 6L-3S | | MI | 16472 | 5598 | 27566 | 3988 | 30203 | 3230 | 31444 | 2615 | 32829 | 1655 | 39201 | 1302 | 26870 |
| 14-#14 | 3.09 | MA | 16516 | 5598 | 27295 | 4054 | 29329 | 3280 | 29833 | 2659 | 29734 | 1724 | 35649 | 976 | 27785 |
| 7L-2S | | MI | 17252 | 5598 | 28748 | 3996 | 31718 | 3216 | 33274 | 2603 | 35255 | 1643 | 42380 | 1426 | 26895 |
| 14-#18 | 5.49 | MA | 20145 | 6445 | 35586 | 4553 | 39861 | 3612 | 42551 | 2841 | 46628 | 1595 | 57614 | 784 | 50250 |
| 4L-5S | | MI | 16688 | 6445 | 29696 | 4484 | 32762 | 3585 | 34367 | 2797 | 36736 | 1505 | 45177 | 582 | 41526 |
| 14-#18 | 5.49 | MA | 19165 | 6445 | 33868 | 4539 | 37637 | 3637 | 39842 | 2863 | 42836 | 1573 | 53139 | 687 | 48261 |
| 5L-4S | | MI | 17540 | 6445 | 31177 | 4501 | 34670 | 3563 | 36645 | 2775 | 39927 | 1527 | 48904 | 680 | 43286 |
| 16-#11 | 2.45 | MA | 18256 | 5372 | 29773 | 3907 | 32595 | 3173 | 33860 | 2601 | 35046 | 1734 | 41832 | 1478 | 24916 |
| 3L-7S | | MI | 14581 | 5372 | 23788 | 3881 | 25414 | 3146 | 25716 | 2570 | 25342 | 1714 | 30155 | 1179 | 20661 |
| 16-#11 | 2.45 | MA | 17801 | 5372 | 28983 | 3920 | 31588 | 3167 | 32637 | 2594 | 33501 | 1743 | 40099 | 1392 | 24873 |
| 4L-6S | | MI | 14911 | 5372 | 24398 | 3869 | 26150 | 3135 | 26658 | 2579 | 26503 | 1705 | 31514 | 1245 | 20968 |
| 16-#11 | 2.45 | MA | 17393 | 5372 | 28298 | 3916 | 30701 | 3179 | 31547 | 2604 | 31951 | 1734 | 38261 | 1353 | 24541 |
| 5E | | MI | 15249 | 5372 | 24955 | 3874 | 26920 | 3142 | 27552 | 2570 | 27692 | 1697 | 32963 | 1302 | 21354 |
| 16-#11 | 2.45 | MA | 17004 | 5372 | 27655 | 3912 | 29811 | 3173 | 30460 | 2596 | 30548 | 1743 | 36535 | 1297 | 24044 |
| 6L-4S | | MI | 15604 | 5372 | 25548 | 3879 | 27688 | 3132 | 28491 | 2561 | 29006 | 1705 | 34516 | 1340 | 21646 |
| 16-#11 | 2.45 | MA | 16625 | 5372 | 26951 | 3925 | 28962 | 3184 | 29416 | 2606 | 29177 | 1751 | 34690 | 1207 | 23676 |
| 7L-3S | | MI | 15999 | 5372 | 26231 | 3867 | 28558 | 3139 | 29544 | 2570 | 30316 | 1697 | 35971 | 1425 | 21664 |
| 16-#11 | 2.45 | MA | 16252 | 5372 | 26317 | 3921 | 28100 | 3179 | 28397 | 2616 | 27719 | 1743 | 32973 | 1161 | 22991 |
| 8L-2S | | MI | 16550 | 5372 | 27060 | 3872 | 29620 | 3129 | 30836 | 2561 | 32029 | 1688 | 38224 | 1512 | 21647 |
| 16-#14 | 3.53 | MA | 18799 | 5753 | 31581 | 4146 | 34854 | 3327 | 36597 | 2687 | 38745 | 1695 | 47104 | 1207 | 34950 |
| 4L-6S | | MI | 15461 | 5753 | 26128 | 4086 | 28277 | 3292 | 29188 | 2669 | 29857 | 1648 | 36091 | 1001 | 28685 |
| 16-#14 | 3.53 | MA | 18225 | 5753 | 30600 | 4140 | 33583 | 3343 | 35037 | 2700 | 36544 | 1683 | 44494 | 1152 | 33788 |
| 5E | | MI | 15938 | 5753 | 26925 | 4094 | 29378 | 3303 | 30454 | 2656 | 31540 | 1635 | 38132 | 1084 | 29314 |
| 16-#14 | 3.53 | MA | 17678 | 5753 | 29680 | 4133 | 32309 | 3334 | 33551 | 2713 | 34552 | 1695 | 42053 | 1071 | 33072 |
| 6L-4S | | MI | 16437 | 5753 | 27773 | 4102 | 30476 | 3289 | 31784 | 2644 | 33402 | 1648 | 40324 | 1138 | 30223 |
| 16-#14 | 3.53 | MA | 17145 | 5753 | 28671 | 4152 | 31093 | 3349 | 31986 | 2702 | 32605 | 1708 | 39441 | 940 | 31849 |
| 7L-3S | | MI | 16993 | 5753 | 28748 | 4085 | 31718 | 3300 | 33274 | 2656 | 35255 | 1635 | 42380 | 1260 | 30533 |
| 16-#18 | 6.27 | MA | 20215 | 6722 | 36267 | 4712 | 40711 | 3762 | 43570 | 2937 | 47780 | 1540 | 59630 | 615 | 55159 |
| 5E | | MI | 17575 | 6722 | 31749 | 4657 | 35384 | 3708 | 37500 | 2866 | 40892 | 1465 | 50583 | 497 | 47386 |
| 18-#11 | 2.75 | MA | 18239 | 5479 | 29947 | 3988 | 32824 | 3215 | 34145 | 2623 | 35523 | 1732 | 42778 | 1369 | 27855 |
| 4L-7S | | MI | 14958 | 5479 | 24617 | 3948 | 26477 | 3194 | 27008 | 2599 | 27055 | 1701 | 32408 | 1152 | 23096 |
| 18-#11 | 2.75 | MA | 17833 | 5479 | 29262 | 3984 | 31936 | 3227 | 33054 | 2633 | 33973 | 1723 | 40939 | 1330 | 27425 |
| 5L-6S | | MI | 15286 | 5479 | 25227 | 3936 | 27213 | 3184 | 27950 | 2608 | 28217 | 1692 | 33767 | 1218 | 23469 |
| 18-#11 | 2.75 | MA | 17446 | 5479 | 28619 | 3979 | 31047 | 3221 | 31967 | 2626 | 32570 | 1732 | 39214 | 1274 | 26954 |
| 6L-5S | | MI | 15623 | 5479 | 25784 | 3941 | 27983 | 3191 | 28845 | 2599 | 29406 | 1684 | 35215 | 1275 | 23833 |
| 18-#11 | 2.75 | MA | 17070 | 5479 | 27915 | 3993 | 30197 | 3233 | 30923 | 2636 | 31199 | 1741 | 37368 | 1183 | 26519 |
| 7L-4S | | MI | 15976 | 5479 | 26377 | 3947 | 28751 | 3181 | 29784 | 2591 | 30720 | 1692 | 36769 | 1312 | 24215 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

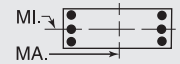
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.75 | MA | 16698 | 5479 | 27281 | 3989 | 29336 | 3227 | 29904 | 2646 | 29741 | 1732 | 35651 | 1138 | 25861 |
| 8L-3S | | MI | 16369 | 5479 | 27060 | 3934 | 29620 | 3188 | 30836 | 2599 | 32029 | 1684 | 38224 | 1398 | 24249 |
| 18-#14 | 3.97 | MA | 18842 | 5909 | 31977 | 4237 | 35348 | 3412 | 37189 | 2742 | 39415 | 1666 | 48286 | 1117 | 37914 |
| 5L-6S | | MI | 15987 | 5909 | 27310 | 4183 | 29792 | 3362 | 31018 | 2710 | 32283 | 1628 | 39270 | 959 | 32123 |
| 18-#14 | 3.97 | MA | 18299 | 5909 | 31056 | 4231 | 34074 | 3403 | 35704 | 2756 | 37423 | 1679 | 45845 | 1035 | 37097 |
| 6L-5S | | MI | 16461 | 5909 | 28107 | 4191 | 30893 | 3373 | 32284 | 2697 | 33967 | 1616 | 41312 | 1042 | 32851 |
| 18-#14 | 3.97 | MA | 17769 | 5909 | 30048 | 4249 | 32858 | 3419 | 34139 | 2744 | 35476 | 1691 | 43233 | 904 | 35925 |
| 7L-4S | | MI | 16957 | 5909 | 28955 | 4199 | 31992 | 3359 | 33614 | 2685 | 35828 | 1628 | 43503 | 1096 | 33704 |
| 20-#11 | 3.06 | MA | 18271 | 5587 | 30226 | 4051 | 33172 | 3275 | 34562 | 2663 | 35995 | 1713 | 43618 | 1307 | 30317 |
| 5L-7S | | MI | 15332 | 5587 | 25446 | 4016 | 27540 | 3242 | 28301 | 2628 | 28769 | 1688 | 34661 | 1125 | 25540 |
| 20-#11 | 3.06 | MA | 17886 | 5587 | 29583 | 4047 | 32282 | 3270 | 33475 | 2655 | 34592 | 1721 | 41892 | 1250 | 29868 |
| 6E | | MI | 15659 | 5587 | 26056 | 4004 | 28275 | 3232 | 29243 | 2637 | 29930 | 1680 | 36020 | 1191 | 25974 |
| 20-#11 | 3.06 | MA | 17511 | 5587 | 28879 | 4060 | 31433 | 3281 | 32431 | 2665 | 33221 | 1730 | 40047 | 1160 | 29370 |
| 7L-5S | | MI | 15994 | 5587 | 26613 | 4009 | 29045 | 3239 | 30137 | 2628 | 31119 | 1671 | 37468 | 1248 | 26318 |
| 20-#11 | 3.06 | MA | 17142 | 5587 | 28245 | 4056 | 30572 | 3275 | 31412 | 2675 | 31763 | 1721 | 38329 | 1114 | 28737 |
| 8L-4S | | MI | 16346 | 5587 | 27206 | 4014 | 29814 | 3229 | 31076 | 2620 | 32433 | 1680 | 39022 | 1285 | 26781 |
| 20-#14 | 4.41 | MA | 18915 | 6064 | 32433 | 4328 | 35839 | 3473 | 37857 | 2798 | 40294 | 1662 | 49637 | 999 | 41135 |
| 6E | | MI | 16510 | 6065 | 28492 | 4280 | 31308 | 3431 | 32848 | 2750 | 34710 | 1608 | 42449 | 917 | 35575 |
| 20-#14 | 4.41 | MA | 18389 | 6064 | 31424 | 4346 | 34622 | 3489 | 36292 | 2787 | 38347 | 1675 | 47025 | 868 | 40010 |
| 7L-5S | | MI | 16981 | 6064 | 29289 | 4288 | 32409 | 3442 | 34114 | 2738 | 36393 | 1596 | 44491 | 1000 | 36395 |
| 22-#11 | 3.36 | MA | 18323 | 5695 | 30547 | 4114 | 33518 | 3318 | 34982 | 2685 | 36614 | 1711 | 44570 | 1227 | 32786 |
| 6L-7S | | MI | 15705 | 5695 | 26275 | 4083 | 28603 | 3291 | 29593 | 2657 | 30482 | 1676 | 36913 | 1097 | 27990 |
| 22-#11 | 3.36 | MA | 17950 | 5695 | 29843 | 4127 | 32669 | 3330 | 33938 | 2694 | 35243 | 1719 | 42725 | 1137 | 32228 |
| 7L-6S | | MI | 16030 | 5695 | 26885 | 4071 | 29338 | 3281 | 30535 | 2666 | 31644 | 1667 | 38273 | 1163 | 28482 |
| 22-#11 | 3.36 | MA | 17583 | 5695 | 29209 | 4123 | 31807 | 3324 | 32919 | 2704 | 33785 | 1711 | 41007 | 1091 | 31618 |
| 8L-5S | | MI | 16364 | 5695 | 27442 | 4076 | 30108 | 3288 | 31429 | 2657 | 32833 | 1658 | 39721 | 1220 | 28809 |
| 22-#14 | 4.85 | MA | 19005 | 6220 | 32801 | 4443 | 36387 | 3559 | 38444 | 2829 | 41218 | 1658 | 50817 | 833 | 44104 |
| 7L-6S | | MI | 17029 | 6220 | 29674 | 4377 | 32823 | 3501 | 34678 | 2791 | 37136 | 1589 | 45628 | 875 | 39038 |
| 24-#11 | 3.67 | MA | 18387 | 5803 | 30807 | 4195 | 33905 | 3378 | 35446 | 2724 | 37265 | 1709 | 45403 | 1114 | 35093 |
| 7E | | MI | 16075 | 5803 | 27104 | 4150 | 29665 | 3339 | 30885 | 2686 | 32196 | 1663 | 39166 | 1070 | 30447 |
| 24-#11 | 3.67 | MA | 18021 | 5803 | 30173 | 4191 | 33043 | 3372 | 34427 | 2734 | 35807 | 1700 | 43686 | 1068 | 34504 |
| 8L-6S | | MI | 16400 | 5803 | 27714 | 4138 | 30401 | 3329 | 31828 | 2695 | 33358 | 1654 | 40526 | 1136 | 30992 |

## RECTANGULAR TIED COLUMNS 30" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.48 | MA | 19566 | 5327 | 31055 | 3887 | 33429 | 3162 | 34113 | 2626 | 34001 | 1840 | 39804 | 1705 | 17080 |
| 2E | | MI | 16174 | 5327 | 25876 | 3820 | 27580 | 3105 | 27866 | 2565 | 27547 | 1786 | 31962 | 1635 | 13993 |
| 6-#14 | 1.25 | MA | 19261 | 5240 | 30229 | 3864 | 32513 | 3148 | 33049 | 2623 | 32709 | 1873 | 38187 | 1755 | 14638 |
| 2L-3S | | MI | 15149 | 5240 | 24042 | 3794 | 25384 | 3111 | 25329 | 2588 | 24197 | 1839 | 27668 | 1572 | 12108 |
| 6-#14 | 1.25 | MA | 18262 | 5240 | 28755 | 3858 | 30624 | 3165 | 30744 | 2638 | 29615 | 1885 | 34088 | 1630 | 14708 |
| 3L-2S | | MI | 15948 | 5240 | 25224 | 3802 | 26899 | 3098 | 27159 | 2576 | 26624 | 1826 | 30847 | 1696 | 12027 |
| 6-#18 | 2.22 | MA | 20727 | 5604 | 33626 | 4060 | 36726 | 3286 | 38135 | 2701 | 39340 | 1809 | 46840 | 1638 | 25185 |
| 2L-3S | | MI | 15714 | 5604 | 25876 | 3976 | 27580 | 3250 | 27866 | 2657 | 27547 | 1768 | 31962 | 1329 | 20576 |
| 6-#18 | 2.22 | MA | 19013 | 5604 | 31055 | 4048 | 33429 | 3313 | 34113 | 2723 | 34001 | 1831 | 39804 | 1417 | 25173 |
| 3L-2S | | MI | 17081 | 5604 | 27929 | 3993 | 30202 | 3228 | 30999 | 2634 | 31703 | 1746 | 37368 | 1550 | 20508 |
| 8-#11 | 1.16 | MA | 19136 | 5205 | 29878 | 3857 | 32137 | 3145 | 32617 | 2624 | 32187 | 1887 | 37534 | 1776 | 13629 |
| 2L-4S | | MI | 14890 | 5205 | 23433 | 3805 | 24679 | 3100 | 24528 | 2582 | 23230 | 1861 | 26693 | 1551 | 11320 |
| 8-#11 | 1.16 | MA | 18435 | 5205 | 28846 | 3853 | 30815 | 3157 | 31004 | 2635 | 30010 | 1896 | 34642 | 1690 | 13676 |
| 3E | | MI | 15293 | 5205 | 24116 | 3793 | 25548 | 3107 | 25580 | 2591 | 24539 | 1853 | 28148 | 1636 | 11264 |
| 8-#11 | 1.16 | MA | 17939 | 5205 | 28003 | 3867 | 29740 | 3152 | 29698 | 2628 | 28347 | 1904 | 32768 | 1604 | 13717 |
| 4L-2S | | MI | 15855 | 5205 | 24945 | 3799 | 26611 | 3097 | 26872 | 2582 | 26253 | 1844 | 30400 | 1723 | 11211 |
| 8-#14 | 1.67 | MA | 19939 | 5396 | 31702 | 3961 | 34403 | 3218 | 35354 | 2666 | 35803 | 1857 | 42286 | 1722 | 19290 |
| 2L-4S | | MI | 15116 | 5396 | 24249 | 3908 | 25657 | 3170 | 25668 | 2617 | 24770 | 1831 | 28791 | 1408 | 15881 |
| 8-#14 | 1.67 | MA | 18947 | 5396 | 30229 | 3955 | 32513 | 3235 | 33049 | 2680 | 32709 | 1870 | 38187 | 1597 | 19336 |
| 3E | | MI | 15686 | 5396 | 25224 | 3891 | 26899 | 3181 | 27159 | 2629 | 26624 | 1819 | 30847 | 1530 | 15848 |

## RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

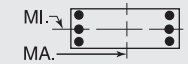
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.67 | MA | 18243 | 5396 | 29021 | 3974 | 30975 | 3226 | 31179 | 2669 | 30345 | 1882 | 35534 | 1473 | 19304 |
| 4L-2S | | MI | 16480 | 5396 | 26406 | 3900 | 28414 | 3167 | 28989 | 2617 | 29051 | 1806 | 34026 | 1654 | 15785 |
| 8-#18 | 2.96 | MA | 21872 | 5880 | 36197 | 4233 | 40022 | 3410 | 42156 | 2776 | 44679 | 1778 | 53876 | 1571 | 33245 |
| 2L-4S | | MI | 15646 | 5880 | 26229 | 4175 | 28046 | 3351 | 28445 | 2703 | 28529 | 1750 | 33861 | 1035 | 25669 |
| 8-#18 | 2.96 | MA | 20176 | 5880 | 33626 | 4221 | 36726 | 3437 | 38135 | 2799 | 39340 | 1800 | 46840 | 1350 | 33119 |
| 3E | | MI | 16623 | 5880 | 27929 | 4148 | 30202 | 3374 | 30999 | 2725 | 31703 | 1728 | 37368 | 1244 | 26945 |
| 8-#18 | 2.96 | MA | 18970 | 5880 | 31512 | 4252 | 34032 | 3420 | 34862 | 2777 | 35260 | 1822 | 42301 | 1129 | 31513 |
| 4L-2S | | MI | 17976 | 5880 | 29982 | 4166 | 32823 | 3351 | 34132 | 2703 | 35858 | 1706 | 42774 | 1465 | 26970 |
| 10-#11 | 1.44 | MA | 19615 | 5313 | 30909 | 3924 | 33459 | 3193 | 34230 | 2654 | 34363 | 1877 | 40426 | 1755 | 16886 |
| 2L-5S | | MI | 14911 | 5313 | 23669 | 3868 | 24974 | 3158 | 24881 | 2620 | 23629 | 1840 | 27392 | 1486 | 13953 |
| 10-#11 | 1.44 | MA | 18917 | 5313 | 29878 | 3921 | 32137 | 3205 | 32617 | 2664 | 32187 | 1886 | 37534 | 1668 | 16924 |
| 3L-4S | | MI | 15272 | 5313 | 24262 | 3873 | 25742 | 3148 | 25820 | 2611 | 24943 | 1849 | 28945 | 1524 | 13936 |
| 10-#11 | 1.44 | MA | 18423 | 5313 | 29034 | 3934 | 31062 | 3200 | 31311 | 2658 | 30523 | 1895 | 35660 | 1582 | 16945 |
| 4L-3S | | MI | 15672 | 5313 | 24945 | 3861 | 26611 | 3155 | 26872 | 2620 | 26253 | 1840 | 30400 | 1609 | 13894 |
| 10-#11 | 1.44 | MA | 17981 | 5313 | 28303 | 3931 | 30114 | 3212 | 30147 | 2668 | 28856 | 1886 | 33681 | 1543 | 16907 |
| 5L-2S | | MI | 16232 | 5313 | 25774 | 3866 | 27674 | 3145 | 28165 | 2611 | 27966 | 1831 | 32653 | 1695 | 13848 |
| 10-#14 | 2.08 | MA | 20611 | 5552 | 33176 | 4058 | 36292 | 3288 | 37659 | 2708 | 38896 | 1842 | 46385 | 1688 | 23923 |
| 2L-5S | | MI | 15142 | 5552 | 24583 | 3997 | 26074 | 3254 | 26168 | 2670 | 25335 | 1799 | 29779 | 1312 | 18962 |
| 10-#14 | 2.08 | MA | 19625 | 5552 | 31702 | 4052 | 34403 | 3304 | 35354 | 2722 | 35803 | 1855 | 42286 | 1564 | 23939 |
| 3L-4S | | MI | 15652 | 5552 | 25431 | 4005 | 27172 | 3240 | 27498 | 2658 | 27197 | 1812 | 31970 | 1366 | 19554 |
| 10-#14 | 2.08 | MA | 18926 | 5552 | 30495 | 4071 | 32864 | 3296 | 33484 | 2712 | 33438 | 1867 | 39633 | 1439 | 23860 |
| 4L-3S | | MI | 16219 | 5552 | 26406 | 3989 | 28414 | 3251 | 28989 | 2670 | 29051 | 1799 | 34026 | 1487 | 19564 |
| 10-#14 | 2.08 | MA | 18300 | 5552 | 29448 | 4066 | 31507 | 3313 | 31817 | 2726 | 31068 | 1855 | 36821 | 1384 | 23067 |
| 5L-2S | | MI | 17008 | 5552 | 27588 | 3997 | 29930 | 3237 | 30818 | 2658 | 31477 | 1787 | 37206 | 1612 | 19520 |
| 10-#18 | 3.70 | MA | 23004 | 6157 | 38769 | 4406 | 43318 | 3534 | 46177 | 2852 | 50018 | 1747 | 60912 | 1504 | 41252 |
| 2L-5S | | MI | 15683 | 6157 | 26800 | 4331 | 28760 | 3497 | 29301 | 2794 | 29494 | 1688 | 35541 | 851 | 30246 |
| 10-#18 | 3.70 | MA | 21324 | 6157 | 36197 | 4394 | 40022 | 3561 | 42156 | 2874 | 44679 | 1769 | 53876 | 1283 | 41039 |
| 3L-4S | | MI | 16553 | 6157 | 28281 | 4348 | 30668 | 3475 | 31578 | 2772 | 32684 | 1710 | 39267 | 950 | 31601 |
| 10-#18 | 3.70 | MA | 20130 | 6157 | 34083 | 4425 | 37329 | 3544 | 38883 | 2853 | 40599 | 1791 | 49337 | 1062 | 38998 |
| 4L-3S | | MI | 17521 | 6157 | 29982 | 4321 | 32823 | 3497 | 34132 | 2794 | 35858 | 1688 | 42774 | 1159 | 33282 |
| 10-#18 | 3.70 | MA | 19061 | 6157 | 32248 | 4413 | 34951 | 3572 | 35963 | 2875 | 36506 | 1769 | 44486 | 966 | 37066 |
| 5L-2S | | MI | 18863 | 6157 | 32034 | 4339 | 35445 | 3475 | 37265 | 2772 | 40014 | 1666 | 48179 | 1381 | 33397 |
| 12-#11 | 1.73 | MA | 20090 | 5421 | 31941 | 3992 | 34781 | 3242 | 35843 | 2683 | 36540 | 1868 | 43317 | 1733 | 20132 |
| 2L-6S | | MI | 14949 | 5421 | 23941 | 3930 | 25266 | 3200 | 25279 | 2658 | 24154 | 1836 | 28197 | 1402 | 16118 |
| 12-#11 | 1.73 | MA | 19396 | 5421 | 30909 | 3988 | 33459 | 3254 | 34230 | 2694 | 34363 | 1876 | 40426 | 1647 | 20159 |
| 3L-5S | | MI | 15292 | 5421 | 24498 | 3935 | 26036 | 3207 | 26173 | 2649 | 25343 | 1827 | 29645 | 1459 | 16530 |
| 12-#11 | 1.73 | MA | 18905 | 5421 | 30065 | 4002 | 32384 | 3249 | 32924 | 2687 | 32700 | 1885 | 38551 | 1561 | 20157 |
| 4E | | MI | 15651 | 5421 | 25091 | 3940 | 26805 | 3197 | 27112 | 2640 | 26657 | 1836 | 31198 | 1496 | 16539 |
| 12-#11 | 1.73 | MA | 18465 | 5421 | 29334 | 3998 | 31436 | 3261 | 31760 | 2697 | 31033 | 1876 | 36572 | 1521 | 20095 |
| 5L-3S | | MI | 16050 | 5421 | 25774 | 3928 | 27674 | 3204 | 28165 | 2649 | 27966 | 1827 | 32653 | 1582 | 16511 |
| 12-#11 | 1.73 | MA | 18045 | 5421 | 28649 | 3994 | 30487 | 3255 | 30600 | 2691 | 29522 | 1885 | 34707 | 1465 | 19531 |
| 6L-2S | | MI | 16606 | 5421 | 26603 | 3933 | 28737 | 3194 | 29457 | 2640 | 29680 | 1819 | 34906 | 1668 | 16473 |
| 12-#14 | 2.50 | MA | 21278 | 5707 | 34650 | 4155 | 38181 | 3358 | 39964 | 2750 | 41990 | 1827 | 50484 | 1655 | 28541 |
| 2L-6S | | MI | 15193 | 5707 | 24968 | 4086 | 26488 | 3312 | 26732 | 2723 | 26078 | 1792 | 30916 | 1187 | 21942 |
| 12-#14 | 2.50 | MA | 20298 | 5707 | 33176 | 4150 | 36292 | 3374 | 37659 | 2765 | 38896 | 1839 | 46385 | 1531 | 28522 |
| 3L-5S | | MI | 15677 | 5707 | 25765 | 4094 | 27589 | 3324 | 27998 | 2711 | 27762 | 1779 | 32958 | 1269 | 22462 |
| 12-#14 | 2.50 | MA | 19604 | 5707 | 31968 | 4169 | 34753 | 3366 | 35789 | 2754 | 36532 | 1852 | 43732 | 1406 | 28405 |
| 4E | | MI | 16184 | 5707 | 26613 | 4103 | 28688 | 3310 | 29328 | 2698 | 29623 | 1792 | 35150 | 1324 | 23212 |
| 12-#14 | 2.50 | MA | 18982 | 5707 | 30921 | 4163 | 33396 | 3383 | 34122 | 2769 | 34162 | 1839 | 40920 | 1350 | 27445 |
| 5L-3S | | MI | 16747 | 5707 | 27588 | 4086 | 29930 | 3321 | 30818 | 2711 | 31477 | 1779 | 37206 | 1445 | 23263 |
| 12-#14 | 2.50 | MA | 18389 | 5707 | 29939 | 4157 | 32037 | 3375 | 32461 | 2758 | 32015 | 1852 | 38278 | 1269 | 26697 |
| 6L-2S | | MI | 17532 | 5707 | 28770 | 4094 | 31445 | 3307 | 32648 | 2698 | 33904 | 1767 | 40385 | 1570 | 23240 |
| 12-#18 | 4.44 | MA | 22459 | 6433 | 38769 | 4566 | 43318 | 3686 | 46177 | 2950 | 50018 | 1738 | 60912 | 1216 | 48944 |
| 3L-5S | | MI | 16588 | 6433 | 28853 | 4504 | 31381 | 3620 | 32434 | 2863 | 33649 | 1648 | 40947 | 767 | 36211 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis

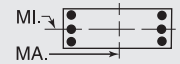



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 4.44 | MA | 21277 | 6433 | 36655 | 4598 | 40625 | 3669 | 42905 | 2928 | 45938 | 1760 | 56372 | 995 | 46531 |
| 4E | | MI | 17451 | 6433 | 30334 | 4521 | 33289 | 3598 | 34711 | 2841 | 36840 | 1670 | 44673 | 865 | 37579 |
| 12-#18 | 4.44 | MA | 20219 | 6433 | 34819 | 4586 | 38247 | 3696 | 39984 | 2950 | 41845 | 1738 | 51521 | 899 | 44730 |
| 5L-3S | | MI | 18410 | 6433 | 32034 | 4494 | 35445 | 3620 | 37265 | 2863 | 40014 | 1648 | 48179 | 1075 | 39597 |
| 12-#18 | 4.44 | MA | 19212 | 6433 | 33095 | 4573 | 35863 | 3679 | 37204 | 2973 | 38141 | 1760 | 46995 | 754 | 41669 |
| 6L-2S | | MI | 19741 | 6433 | 34087 | 4511 | 38067 | 3598 | 40398 | 2841 | 44170 | 1626 | 53585 | 1296 | 39782 |
| 14-#11 | 2.02 | MA | 20563 | 5529 | 32972 | 4059 | 36103 | 3290 | 37456 | 2713 | 38716 | 1858 | 46209 | 1712 | 23370 |
| 2L-7S | | MI | 14997 | 5529 | 24161 | 4009 | 25593 | 3258 | 25629 | 2678 | 24706 | 1832 | 29090 | 1309 | 18364 |
| 14-#11 | 2.02 | MA | 19872 | 5529 | 31941 | 4056 | 34781 | 3302 | 35843 | 2723 | 36540 | 1866 | 43317 | 1625 | 23387 |
| 3L-6S | | MI | 15329 | 5529 | 24770 | 3997 | 26329 | 3248 | 26571 | 2687 | 25868 | 1823 | 30450 | 1375 | 18609 |
| 14-#11 | 2.02 | MA | 19383 | 5529 | 31097 | 4069 | 33706 | 3297 | 34537 | 2716 | 34876 | 1875 | 41443 | 1539 | 23360 |
| 4L-5S | | MI | 15670 | 5529 | 25328 | 4003 | 27099 | 3255 | 27466 | 2678 | 27056 | 1815 | 31898 | 1432 | 19035 |
| 14-#11 | 2.02 | MA | 18945 | 5529 | 30366 | 4066 | 32759 | 3309 | 33373 | 2727 | 33209 | 1866 | 39464 | 1500 | 23236 |
| 5L-4S | | MI | 16027 | 5529 | 25920 | 4008 | 27867 | 3245 | 28405 | 2669 | 28371 | 1823 | 33451 | 1469 | 19133 |
| 14-#11 | 2.02 | MA | 18528 | 5529 | 29680 | 4062 | 31809 | 3304 | 32213 | 2720 | 31699 | 1875 | 37599 | 1443 | 22633 |
| 6L-3S | | MI | 16424 | 5529 | 26603 | 3996 | 28737 | 3252 | 29457 | 2678 | 29680 | 1815 | 34906 | 1554 | 19117 |
| 14-#11 | 2.02 | MA | 18121 | 5529 | 28929 | 4076 | 30903 | 3316 | 31099 | 2731 | 30223 | 1884 | 35606 | 1353 | 22269 |
| 7L-2S | | MI | 16979 | 5529 | 27432 | 4001 | 29800 | 3242 | 30749 | 2669 | 31393 | 1806 | 37159 | 1641 | 19088 |
| 14-#14 | 2.92 | MA | 20965 | 5863 | 34650 | 4247 | 38181 | 3444 | 39964 | 2807 | 41990 | 1824 | 50484 | 1497 | 33094 |
| 3L-6S | | MI | 15727 | 5863 | 26150 | 4183 | 28004 | 3382 | 28562 | 2764 | 28505 | 1772 | 34095 | 1145 | 25490 |
| 14-#14 | 2.92 | MA | 20275 | 5863 | 33442 | 4266 | 36642 | 3436 | 38094 | 2797 | 39626 | 1837 | 47831 | 1373 | 32943 |
| 4L-5S | | MI | 16208 | 5863 | 26947 | 4192 | 29105 | 3393 | 29828 | 2752 | 30188 | 1760 | 36137 | 1227 | 25977 |
| 14-#14 | 2.92 | MA | 19657 | 5863 | 32395 | 4260 | 35285 | 3453 | 36427 | 2811 | 37255 | 1824 | 45019 | 1317 | 31840 |
| 5L-4S | | MI | 16712 | 5863 | 27795 | 4200 | 30203 | 3380 | 31158 | 2739 | 32050 | 1772 | 38329 | 1282 | 26861 |
| 14-#14 | 2.92 | MA | 19069 | 5863 | 31413 | 4254 | 33926 | 3444 | 34766 | 2801 | 35109 | 1837 | 42377 | 1235 | 31132 |
| 6L-3S | | MI | 17272 | 5863 | 28770 | 4183 | 31445 | 3391 | 32648 | 2752 | 33904 | 1760 | 40385 | 1403 | 26942 |
| 14-#14 | 2.92 | MA | 18496 | 5863 | 30336 | 4273 | 32628 | 3461 | 33170 | 2815 | 33011 | 1849 | 39553 | 1105 | 29894 |
| 7L-2S | | MI | 18053 | 5863 | 29952 | 4191 | 32960 | 3377 | 34478 | 2739 | 36330 | 1747 | 43564 | 1528 | 26948 |
| 14-#18 | 5.19 | MA | 22412 | 6710 | 39226 | 4771 | 43921 | 3793 | 46926 | 3003 | 51277 | 1729 | 63408 | 928 | 54104 |
| 4L-5S | | MI | 17484 | 6710 | 30906 | 4677 | 34003 | 3744 | 35567 | 2932 | 37805 | 1608 | 46352 | 682 | 42026 |
| 14-#18 | 5.19 | MA | 21364 | 6710 | 37391 | 4759 | 41543 | 3820 | 44005 | 3026 | 47184 | 1707 | 58557 | 833 | 52239 |
| 5L-4S | | MI | 18340 | 6710 | 32387 | 4694 | 35911 | 3721 | 37844 | 2910 | 40996 | 1630 | 50079 | 781 | 43593 |
| 14-#18 | 5.19 | MA | 20367 | 6710 | 35667 | 4746 | 39160 | 3803 | 41225 | 3048 | 43480 | 1729 | 54031 | 687 | 49193 |
| 6L-3S | | MI | 19291 | 6710 | 34087 | 4667 | 38067 | 3744 | 40398 | 2932 | 44170 | 1608 | 53585 | 990 | 45898 |
| 16-#11 | 2.31 | MA | 20344 | 5637 | 32972 | 4123 | 36103 | 3351 | 37456 | 2752 | 38716 | 1857 | 46209 | 1604 | 26600 |
| 3L-7S | | MI | 15376 | 5637 | 24990 | 4077 | 26656 | 3307 | 26922 | 2707 | 26419 | 1819 | 31343 | 1281 | 20872 |
| 16-#11 | 2.31 | MA | 19858 | 5637 | 32128 | 4137 | 35028 | 3345 | 36150 | 2746 | 37053 | 1865 | 44334 | 1517 | 26558 |
| 4L-6S | | MI | 15707 | 5637 | 25599 | 4065 | 27392 | 3297 | 27864 | 2716 | 27581 | 1811 | 32703 | 1347 | 21106 |
| 16-#11 | 2.31 | MA | 19423 | 5637 | 31397 | 4133 | 34081 | 3357 | 34986 | 2756 | 35386 | 1857 | 42355 | 1478 | 26313 |
| 5E | | MI | 16046 | 5637 | 26157 | 4070 | 28162 | 3304 | 28758 | 2707 | 28770 | 1802 | 34151 | 1404 | 21505 |
| 16-#11 | 2.31 | MA | 19008 | 5637 | 30711 | 4129 | 33131 | 3352 | 33826 | 2750 | 33875 | 1865 | 40491 | 1422 | 25743 |
| 6L-4S | | MI | 16402 | 5637 | 26750 | 4075 | 28930 | 3294 | 29697 | 2698 | 30084 | 1811 | 35704 | 1442 | 21711 |
| 16-#11 | 2.31 | MA | 18603 | 5637 | 29960 | 4143 | 32225 | 3364 | 32712 | 2760 | 32399 | 1874 | 38498 | 1331 | 25392 |
| 7L-3S | | MI | 16797 | 5637 | 27432 | 4063 | 29800 | 3301 | 30749 | 2707 | 31393 | 1802 | 37159 | 1527 | 21717 |
| 16-#11 | 2.31 | MA | 18205 | 5637 | 29285 | 4139 | 31306 | 3359 | 31624 | 2771 | 30830 | 1865 | 36648 | 1285 | 24677 |
| 8L-2S | | MI | 17350 | 5637 | 28261 | 4068 | 30863 | 3291 | 32042 | 2698 | 33107 | 1793 | 39412 | 1613 | 21696 |
| 16-#14 | 3.33 | MA | 20942 | 6018 | 34916 | 4363 | 38532 | 3506 | 40399 | 2839 | 42719 | 1821 | 51930 | 1340 | 37476 |
| 4L-6S | | MI | 16258 | 6018 | 27332 | 4281 | 29519 | 3452 | 30392 | 2805 | 30931 | 1752 | 37275 | 1103 | 29002 |
| 16-#14 | 3.33 | MA | 20328 | 6018 | 33869 | 4357 | 37175 | 3522 | 38732 | 2853 | 40349 | 1809 | 49118 | 1284 | 36249 |
| 5E | | MI | 16736 | 6018 | 28129 | 4289 | 30620 | 3463 | 31658 | 2793 | 32615 | 1740 | 39316 | 1185 | 29504 |
| 16-#14 | 3.33 | MA | 19744 | 6018 | 32886 | 4352 | 35815 | 3514 | 37070 | 2843 | 38202 | 1821 | 46476 | 1202 | 35574 |
| 6L-4S | | MI | 17237 | 6018 | 28977 | 4297 | 31718 | 3449 | 32988 | 2780 | 34476 | 1752 | 41508 | 1240 | 30449 |
| 16-#14 | 3.33 | MA | 19175 | 6018 | 31810 | 4371 | 34517 | 3531 | 35475 | 2857 | 36105 | 1834 | 43652 | 1072 | 34252 |
| 7L-3S | | MI | 17793 | 6018 | 29952 | 4280 | 32960 | 3461 | 34478 | 2793 | 36330 | 1740 | 43564 | 1361 | 30610 |
| 16-#14 | 3.33 | MA | 18615 | 6018 | 30842 | 4365 | 33200 | 3523 | 33917 | 2872 | 33873 | 1821 | 41024 | 1006 | 33087 |
| 8L-2S | | MI | 18570 | 6018 | 31134 | 4289 | 34476 | 3447 | 36308 | 2780 | 38757 | 1728 | 46743 | 1485 | 30646 |
| 16-#18 | 5.93 | MA | 22498 | 6987 | 39962 | 4932 | 44839 | 3944 | 48026 | 3101 | 52523 | 1676 | 65593 | 766 | 59650 |
| 5E | | MI | 18374 | 6987 | 32958 | 4850 | 36625 | 3867 | 38700 | 3001 | 41961 | 1568 | 51758 | 598 | 47879 |

## RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

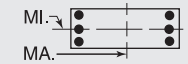
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 5.93 | MA | 21511 | 6987 | 38238 | 4919 | 42456 | 3927 | 45246 | 3124 | 48819 | 1698 | 61067 | 620 | 56744 |
| 6L-4S | | MI | 19222 | 6987 | 34439 | 4867 | 38533 | 3845 | 40978 | 2979 | 45152 | 1590 | 55484 | 696 | 49636 |
| 18-#11 | 2.60 | MA | 20331 | 5745 | 33159 | 4204 | 36350 | 3394 | 37763 | 2775 | 39229 | 1855 | 47226 | 1496 | 29750 |
| 4L-7S | | MI | 15753 | 5745 | 25819 | 4144 | 27719 | 3355 | 28214 | 2736 | 28133 | 1806 | 33596 | 1254 | 23324 |
| 18-#11 | 2.60 | MA | 19897 | 5745 | 32429 | 4200 | 35403 | 3406 | 36598 | 2786 | 37562 | 1847 | 45247 | 1456 | 29399 |
| 5L-6S | | MI | 16083 | 5745 | 26429 | 4132 | 28455 | 3345 | 29156 | 2745 | 29295 | 1798 | 34955 | 1320 | 23608 |
| 18-#11 | 2.60 | MA | 19484 | 5745 | 31743 | 4197 | 34454 | 3401 | 35439 | 2779 | 36052 | 1855 | 43382 | 1400 | 28857 |
| 6L-5S | | MI | 16421 | 5745 | 26986 | 4137 | 29225 | 3352 | 30050 | 2736 | 30484 | 1789 | 36404 | 1377 | 23984 |
| 18-#11 | 2.60 | MA | 19082 | 5745 | 30992 | 4210 | 33548 | 3413 | 34325 | 2789 | 34576 | 1864 | 41389 | 1310 | 28499 |
| 7L-4S | | MI | 16775 | 5745 | 27579 | 4143 | 29993 | 3342 | 30989 | 2727 | 31798 | 1798 | 37957 | 1414 | 24285 |
| 18-#11 | 2.60 | MA | 18686 | 5745 | 30316 | 4207 | 32628 | 3408 | 33237 | 2800 | 33007 | 1855 | 39540 | 1263 | 27750 |
| 8L-3S | | MI | 17168 | 5745 | 28261 | 4131 | 30863 | 3349 | 32042 | 2736 | 33107 | 1789 | 39412 | 1500 | 24311 |
| 18-#11 | 2.60 | MA | 18294 | 5745 | 29589 | 4220 | 31734 | 3420 | 32101 | 2793 | 31544 | 1864 | 37732 | 1209 | 27138 |
| 9L-2S | | MI | 17718 | 5745 | 29090 | 4136 | 31925 | 3339 | 33334 | 2727 | 34820 | 1781 | 41665 | 1586 | 24298 |
| 18-#14 | 3.75 | MA | 20994 | 6174 | 35343 | 4455 | 39064 | 3592 | 41036 | 2896 | 43443 | 1794 | 53217 | 1251 | 40668 |
| 5L-6S | | MI | 16784 | 6174 | 28514 | 4378 | 31034 | 3522 | 32222 | 2846 | 33358 | 1733 | 40454 | 1060 | 32436 |
| 18-#14 | 3.75 | MA | 20413 | 6174 | 34360 | 4449 | 37704 | 3584 | 39375 | 2885 | 41296 | 1806 | 50575 | 1169 | 39959 |
| 6L-5S | | MI | 17260 | 6174 | 29311 | 4386 | 32135 | 3533 | 33488 | 2833 | 35041 | 1720 | 42495 | 1143 | 33040 |
| 18-#14 | 3.75 | MA | 19848 | 6174 | 33284 | 4468 | 36406 | 3601 | 37780 | 2900 | 39198 | 1819 | 47751 | 1039 | 38621 |
| 7L-4S | | MI | 17758 | 6174 | 30159 | 4394 | 33233 | 3519 | 34818 | 2821 | 36903 | 1733 | 44687 | 1197 | 33927 |
| 18-#14 | 3.75 | MA | 19292 | 6174 | 32316 | 4462 | 35090 | 3593 | 36222 | 2914 | 36967 | 1806 | 45123 | 973 | 37393 |
| 8L-3S | | MI | 18312 | 6174 | 31134 | 4378 | 34476 | 3530 | 36308 | 2833 | 38757 | 1720 | 46743 | 1319 | 34271 |
| 18-#18 | 6.67 | MA | 22644 | 7263 | 40809 | 5092 | 45752 | 4051 | 49267 | 3199 | 54158 | 1667 | 68103 | 553 | 64319 |
| 6L-5S | | MI | 19256 | 7263 | 35011 | 5023 | 39247 | 3990 | 41833 | 3070 | 46117 | 1528 | 57164 | 513 | 53763 |
| 20-#11 | 2.89 | MA | 20369 | 5852 | 33460 | 4268 | 36725 | 3454 | 38211 | 2815 | 39739 | 1837 | 48138 | 1435 | 32494 |
| 5L-7S | | MI | 16128 | 5852 | 26648 | 4212 | 28782 | 3404 | 29506 | 2765 | 29847 | 1794 | 35849 | 1227 | 25765 |
| 20-#11 | 2.89 | MA | 19958 | 5852 | 32774 | 4264 | 35776 | 3449 | 37052 | 2808 | 38228 | 1846 | 46274 | 1379 | 31977 |
| 6E | | MI | 16457 | 5852 | 27258 | 4200 | 29518 | 3394 | 30449 | 2774 | 31008 | 1785 | 37208 | 1292 | 26114 |
| 20-#11 | 2.89 | MA | 19558 | 5852 | 32023 | 4278 | 34870 | 3461 | 35938 | 2819 | 36752 | 1854 | 44281 | 1288 | 31552 |
| 7L-5S | | MI | 16793 | 5852 | 27815 | 4205 | 30288 | 3401 | 31343 | 2765 | 32197 | 1776 | 38657 | 1349 | 26469 |
| 20-#11 | 2.89 | MA | 19164 | 5852 | 31347 | 4274 | 33951 | 3456 | 34850 | 2829 | 35183 | 1846 | 42431 | 1242 | 30830 |
| 8L-4S | | MI | 17145 | 5852 | 28408 | 4210 | 31056 | 3390 | 32282 | 2757 | 33511 | 1785 | 40210 | 1387 | 26854 |
| 20-#11 | 2.89 | MA | 18773 | 5852 | 30620 | 4288 | 33056 | 3468 | 33713 | 2823 | 33720 | 1854 | 40623 | 1187 | 30175 |
| 9L-3S | | MI | 17537 | 5852 | 29090 | 4198 | 31925 | 3397 | 33334 | 2765 | 34820 | 1776 | 41665 | 1472 | 26891 |
| 20-#14 | 4.17 | MA | 21078 | 6330 | 35834 | 4546 | 39594 | 3654 | 41680 | 2928 | 44389 | 1791 | 54674 | 1136 | 44287 |
| 6E | | MI | 17308 | 6330 | 29696 | 4475 | 32549 | 3592 | 34052 | 2887 | 35784 | 1713 | 43633 | 1018 | 35884 |
| 20-#14 | 4.17 | MA | 20516 | 6330 | 34758 | 4565 | 38296 | 3671 | 40085 | 2942 | 42292 | 1803 | 51850 | 1005 | 43000 |
| 7L-5S | | MI | 17780 | 6330 | 30493 | 4483 | 33651 | 3603 | 35318 | 2874 | 37468 | 1701 | 45675 | 1101 | 36585 |
| 20-#14 | 4.17 | MA | 19964 | 6330 | 33790 | 4559 | 36979 | 3663 | 38527 | 2956 | 40061 | 1791 | 49222 | 939 | 41710 |
| 8L-4S | | MI | 18276 | 6330 | 31341 | 4492 | 34749 | 3589 | 36648 | 2862 | 39329 | 1713 | 47866 | 1155 | 37420 |
| 22-#11 | 3.18 | MA | 20430 | 5960 | 33805 | 4332 | 37098 | 3498 | 38665 | 2838 | 40405 | 1836 | 49165 | 1357 | 35100 |
| 6L-7S | | MI | 16502 | 5960 | 27477 | 4279 | 29845 | 3452 | 30799 | 2794 | 31560 | 1781 | 38102 | 1199 | 28214 |
| 22-#11 | 3.18 | MA | 20031 | 5960 | 33054 | 4345 | 36192 | 3510 | 37551 | 2848 | 38929 | 1845 | 47172 | 1267 | 34612 |
| 7L-6S | | MI | 16828 | 5960 | 28087 | 4267 | 30580 | 3442 | 31741 | 2803 | 32722 | 1772 | 39461 | 1265 | 28622 |
| 22-#11 | 3.18 | MA | 19639 | 5960 | 32379 | 4342 | 35273 | 3504 | 36463 | 2859 | 37360 | 1836 | 45323 | 1220 | 33916 |
| 8L-5S | | MI | 17163 | 5960 | 28644 | 4272 | 31351 | 3449 | 32635 | 2794 | 33911 | 1764 | 40909 | 1322 | 28959 |
| 22-#11 | 3.18 | MA | 19251 | 5960 | 31652 | 4355 | 34378 | 3517 | 35326 | 2852 | 35897 | 1845 | 43515 | 1166 | 33219 |
| 9L-4S | | MI | 17514 | 5960 | 29237 | 4277 | 32119 | 3439 | 33574 | 2786 | 35225 | 1772 | 42463 | 1359 | 29420 |
| 22-#14 | 4.58 | MA | 21180 | 6485 | 36231 | 4662 | 40185 | 3741 | 42389 | 2985 | 45385 | 1788 | 55949 | 972 | 47388 |
| 7L-6S | | MI | 17828 | 6485 | 30878 | 4572 | 34065 | 3662 | 35882 | 2928 | 38211 | 1693 | 46812 | 976 | 39344 |
| 22-#14 | 4.58 | MA | 20631 | 6485 | 35263 | 4657 | 38868 | 3732 | 40832 | 2999 | 43154 | 1776 | 53321 | 906 | 46037 |
| 8L-5S | | MI | 18298 | 6485 | 31675 | 4581 | 35166 | 3673 | 37147 | 2915 | 39894 | 1681 | 48854 | 1059 | 40135 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

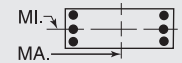
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 3.47 | MA | 20502 | 6068 | 34086 | 4413 | 37514 | 3558 | 39164 | 2878 | 41105 | 1835 | 50064 | 1245 | 37680 |
| 7E | | MI | 16873 | 6068 | 28306 | 4347 | 30908 | 3501 | 32091 | 2823 | 33274 | 1768 | 40355 | 1172 | 30669 |
| 24-#11 | 3.47 | MA | 20112 | 6068 | 33410 | 4409 | 36595 | 3553 | 38076 | 2888 | 39536 | 1826 | 48214 | 1199 | 37006 |
| 8L-6S | | MI | 17198 | 6068 | 28916 | 4334 | 31643 | 3490 | 33033 | 2832 | 34435 | 1760 | 41714 | 1238 | 31133 |
| 24-#11 | 3.47 | MA | 19725 | 6068 | 32683 | 4423 | 35701 | 3565 | 36939 | 2882 | 38073 | 1835 | 46407 | 1144 | 36268 |
| 9L-5S | | MI | 17532 | 6068 | 29473 | 4340 | 32413 | 3497 | 33927 | 2823 | 35624 | 1751 | 43162 | 1295 | 31454 |
| 24-#14 | 5.00 | MA | 21294 | 6641 | 36737 | 4754 | 40757 | 3802 | 43136 | 3041 | 46248 | 1760 | 57420 | 873 | 50374 |
| 8L-6S | | MI | 18346 | 6641 | 32060 | 4670 | 35580 | 3731 | 37712 | 2969 | 40637 | 1674 | 49992 | 934 | 42814 |

## RECTANGULAR TIED COLUMNS 30" x 38"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.40 | MA | 21708 | 5592 | 34292 | 4103 | 36943 | 3339 | 37673 | 2776 | 37524 | 1960 | 43936 | 1826 | 18160 |
| 2E | | MI | 16971 | 5592 | 27086 | 4013 | 28821 | 3264 | 29066 | 2700 | 28615 | 1889 | 33137 | 1735 | 14042 |
| 6-#14 | 1.18 | MA | 21377 | 5506 | 33403 | 4079 | 35956 | 3325 | 36526 | 2774 | 36115 | 1992 | 42158 | 1874 | 15549 |
| 2L-3S | | MI | 15945 | 5506 | 25246 | 3989 | 26626 | 3272 | 26533 | 2724 | 25272 | 1943 | 28852 | 1673 | 12148 |
| 6-#14 | 1.18 | MA | 20309 | 5506 | 31832 | 4074 | 33942 | 3343 | 34070 | 2789 | 32798 | 2004 | 37752 | 1749 | 15619 |
| 3L-2S | | MI | 16744 | 5506 | 26428 | 3997 | 28141 | 3258 | 28363 | 2712 | 27699 | 1931 | 32031 | 1798 | 12066 |
| 6-#18 | 2.11 | MA | 22957 | 5869 | 37036 | 4276 | 40461 | 3463 | 41965 | 2852 | 43259 | 1932 | 51517 | 1764 | 26805 |
| 2L-3S | | MI | 16511 | 5869 | 27086 | 4169 | 28821 | 3409 | 29066 | 2791 | 28615 | 1872 | 33137 | 1429 | 20653 |
| 6-#18 | 2.11 | MA | 21123 | 5869 | 34292 | 4264 | 36943 | 3492 | 37673 | 2876 | 37524 | 1954 | 43936 | 1542 | 26793 |
| 3L-2S | | MI | 17879 | 5869 | 29139 | 4186 | 31443 | 3387 | 32199 | 2769 | 32771 | 1850 | 38543 | 1650 | 20566 |
| 8-#11 | 1.09 | MA | 21240 | 5470 | 33025 | 4072 | 35551 | 3322 | 36061 | 2775 | 35545 | 2006 | 41441 | 1894 | 14471 |
| 2L-4S | | MI | 15686 | 5470 | 24635 | 4001 | 25921 | 3261 | 25733 | 2719 | 24308 | 1967 | 27881 | 1653 | 11359 |
| 8-#11 | 1.09 | MA | 20492 | 5470 | 31927 | 4069 | 34142 | 3335 | 34343 | 2786 | 33214 | 2015 | 38336 | 1808 | 14519 |
| 3E | | MI | 16089 | 5470 | 25317 | 3989 | 26791 | 3268 | 26786 | 2728 | 25617 | 1958 | 29336 | 1738 | 11299 |
| 8-#11 | 1.09 | MA | 19963 | 5470 | 31029 | 4083 | 32999 | 3330 | 32953 | 2780 | 31432 | 2023 | 36320 | 1722 | 14559 |
| 4L-2S | | MI | 16651 | 5470 | 26147 | 3995 | 27854 | 3258 | 28078 | 2719 | 27330 | 1949 | 31589 | 1825 | 11246 |
| 8-#14 | 1.58 | MA | 22105 | 5661 | 34974 | 4176 | 37970 | 3395 | 38983 | 2816 | 39431 | 1978 | 46565 | 1843 | 20505 |
| 2L-4S | | MI | 15912 | 5661 | 25453 | 4103 | 26899 | 3331 | 26872 | 2753 | 25845 | 1936 | 29975 | 1509 | 15943 |
| 8-#14 | 1.58 | MA | 21044 | 5661 | 33403 | 4171 | 35956 | 3413 | 36526 | 2831 | 36115 | 1990 | 42158 | 1718 | 20551 |
| 3E | | MI | 16483 | 5661 | 26428 | 4086 | 28141 | 3342 | 28363 | 2765 | 27699 | 1924 | 32031 | 1631 | 15897 |
| 8-#14 | 1.58 | MA | 20294 | 5661 | 32118 | 4191 | 34319 | 3405 | 34536 | 2822 | 33580 | 2003 | 39302 | 1594 | 20519 |
| 4L-2S | | MI | 17278 | 5661 | 27610 | 4095 | 29656 | 3328 | 30192 | 2753 | 30125 | 1911 | 35210 | 1755 | 15829 |
| 8-#18 | 2.81 | MA | 24189 | 6145 | 39781 | 4449 | 43979 | 3587 | 46257 | 2927 | 48993 | 1903 | 59099 | 1701 | 35405 |
| 2L-4S | | MI | 16442 | 6145 | 27438 | 4368 | 29287 | 3510 | 29645 | 2838 | 29597 | 1854 | 35036 | 1135 | 25984 |
| 8-#18 | 2.81 | MA | 22374 | 6145 | 37036 | 4437 | 40461 | 3616 | 41965 | 2951 | 43259 | 1925 | 51517 | 1480 | 35279 |
| 3E | | MI | 17420 | 6145 | 29139 | 4341 | 31443 | 3532 | 32199 | 2860 | 32771 | 1832 | 38543 | 1344 | 27037 |
| 8-#18 | 2.81 | MA | 21087 | 6145 | 34785 | 4470 | 37592 | 3601 | 38479 | 2931 | 38876 | 1947 | 46618 | 1259 | 33856 |
| 4L-2S | | MI | 18777 | 6145 | 31191 | 4359 | 34064 | 3510 | 35332 | 2838 | 36927 | 1810 | 43949 | 1566 | 27036 |
| 10-#11 | 1.37 | MA | 21754 | 5578 | 34124 | 4140 | 36960 | 3370 | 37780 | 2804 | 37876 | 1997 | 44546 | 1874 | 17939 |
| 2L-5S | | MI | 15707 | 5578 | 24871 | 4064 | 26216 | 3320 | 26086 | 2757 | 24707 | 1945 | 28581 | 1588 | 14009 |
| 10-#11 | 1.37 | MA | 21009 | 5578 | 33025 | 4137 | 35551 | 3383 | 36061 | 2815 | 35545 | 2006 | 41441 | 1788 | 17977 |
| 3L-4S | | MI | 16068 | 5578 | 25464 | 4069 | 26984 | 3310 | 27026 | 2748 | 26021 | 1954 | 30134 | 1625 | 13981 |
| 10-#11 | 1.37 | MA | 20483 | 5578 | 32128 | 4151 | 34407 | 3378 | 34671 | 2809 | 33763 | 2014 | 39425 | 1701 | 17998 |
| 4L-3S | | MI | 16469 | 5578 | 26147 | 4057 | 27854 | 3317 | 28078 | 2757 | 27330 | 1945 | 31589 | 1711 | 13934 |
| 10-#11 | 1.37 | MA | 20013 | 5578 | 31351 | 4147 | 33400 | 3391 | 33434 | 2820 | 31978 | 2006 | 37305 | 1661 | 17960 |
| 5L-2S | | MI | 17029 | 5578 | 26976 | 4062 | 28916 | 3307 | 29370 | 2748 | 29044 | 1937 | 33842 | 1797 | 13886 |
| 10-#14 | 1.97 | MA | 22826 | 5817 | 36545 | 4274 | 39984 | 3465 | 41440 | 2859 | 42748 | 1964 | 50972 | 1812 | 25441 |
| 2L-5S | | MI | 15937 | 5817 | 25787 | 4192 | 27316 | 3414 | 27372 | 2806 | 26410 | 1904 | 30962 | 1413 | 19150 |
| 10-#14 | 1.97 | MA | 21773 | 5817 | 34974 | 4268 | 37970 | 3482 | 38983 | 2874 | 39431 | 1976 | 46565 | 1687 | 25458 |
| 3L-4S | | MI | 16448 | 5817 | 26635 | 4200 | 28414 | 3400 | 28702 | 2794 | 28271 | 1916 | 33154 | 1467 | 19626 |
| 10-#14 | 1.97 | MA | 21028 | 5817 | 33689 | 4288 | 36333 | 3475 | 36993 | 2864 | 36897 | 1988 | 43708 | 1563 | 25378 |
| 4L-3S | | MI | 17016 | 5817 | 27610 | 4184 | 29656 | 3411 | 30192 | 2806 | 30125 | 1904 | 35210 | 1589 | 19619 |
| 10-#14 | 1.97 | MA | 20361 | 5817 | 32575 | 4283 | 34890 | 3493 | 35220 | 2879 | 34356 | 1976 | 40693 | 1506 | 24665 |
| 5L-2S | | MI | 17807 | 5817 | 28792 | 4192 | 31172 | 3398 | 32022 | 2794 | 32552 | 1891 | 38389 | 1713 | 19569 |
| 10-#18 | 3.51 | MA | 25406 | 6422 | 42525 | 4621 | 47497 | 3712 | 50548 | 3002 | 54728 | 1874 | 66680 | 1639 | 43952 |
| 2L-5S | | MI | 16476 | 6422 | 28010 | 4524 | 30001 | 3656 | 30501 | 2929 | 30562 | 1792 | 36716 | 952 | 30518 |

## RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis



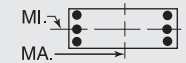

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 3.51 | MA | 23608 | 6422 | 39781 | 4610 | 43979 | 3740 | 46257 | 3027 | 48993 | 1896 | 59099 | 1418 | 43739 |
| 3L-4S | | MI | 17350 | 6422 | 29491 | 4541 | 31909 | 3634 | 32778 | 2907 | 33753 | 1814 | 40442 | 1050 | 31909 |
| 10-#18 | 3.51 | MA | 22335 | 6422 | 37529 | 4643 | 41110 | 3725 | 42770 | 3007 | 44611 | 1918 | 54199 | 1196 | 41854 |
| 4L-3S | | MI | 18320 | 6422 | 31191 | 4514 | 34064 | 3656 | 35332 | 2929 | 36927 | 1792 | 43949 | 1259 | 33385 |
| 10-#18 | 3.51 | MA | 21196 | 6422 | 35575 | 4632 | 38579 | 3753 | 39661 | 3031 | 40216 | 1896 | 48986 | 1099 | 39670 |
| 5L-2S | | MI | 19665 | 6422 | 33244 | 4532 | 36686 | 3634 | 38465 | 2907 | 41083 | 1770 | 49354 | 1481 | 33475 |
| 12-#11 | 1.64 | MA | 22264 | 5686 | 35223 | 4207 | 38368 | 3419 | 39498 | 2834 | 40207 | 1988 | 47651 | 1854 | 21396 |
| 2L-6S | | MI | 15745 | 5686 | 25143 | 4126 | 26509 | 3361 | 26485 | 2795 | 25232 | 1941 | 29385 | 1504 | 16251 |
| 12-#11 | 1.64 | MA | 21523 | 5686 | 34124 | 4204 | 36960 | 3431 | 37780 | 2845 | 37876 | 1997 | 44546 | 1768 | 21423 |
| 3L-5S | | MI | 16088 | 5686 | 25700 | 4131 | 27279 | 3368 | 27379 | 2786 | 26421 | 1933 | 30833 | 1561 | 16595 |
| 12-#11 | 1.64 | MA | 21000 | 5686 | 33227 | 4218 | 35816 | 3427 | 36390 | 2839 | 36094 | 2005 | 42530 | 1681 | 21420 |
| 4E | | MI | 16447 | 5686 | 26293 | 4136 | 28047 | 3358 | 28318 | 2777 | 27735 | 1941 | 32387 | 1598 | 16589 |
| 12-#11 | 1.64 | MA | 20531 | 5686 | 32450 | 4215 | 34809 | 3439 | 35152 | 2850 | 34309 | 1997 | 40410 | 1641 | 21359 |
| 5L-3S | | MI | 16847 | 5686 | 26976 | 4124 | 28916 | 3365 | 29370 | 2786 | 29044 | 1933 | 33842 | 1684 | 16555 |
| 12-#11 | 1.64 | MA | 20085 | 5686 | 31721 | 4212 | 33800 | 3435 | 33919 | 2844 | 32691 | 2005 | 38406 | 1585 | 20829 |
| 6L-2S | | MI | 17404 | 5686 | 27805 | 4129 | 29979 | 3355 | 30663 | 2777 | 30757 | 1924 | 36094 | 1770 | 16514 |
| 12-#14 | 2.37 | MA | 23542 | 5972 | 38116 | 4371 | 41998 | 3535 | 43897 | 2901 | 46064 | 1950 | 55378 | 1781 | 30364 |
| 2L-6S | | MI | 15988 | 5972 | 26172 | 4281 | 27730 | 3473 | 27936 | 2860 | 27153 | 1897 | 32100 | 1288 | 22117 |
| 12-#14 | 2.37 | MA | 22495 | 5972 | 36545 | 4366 | 39984 | 3552 | 41440 | 2916 | 42748 | 1962 | 50972 | 1656 | 30345 |
| 3L-5S | | MI | 16473 | 5972 | 26969 | 4289 | 28831 | 3484 | 29202 | 2847 | 28836 | 1884 | 34142 | 1371 | 22648 |
| 12-#14 | 2.37 | MA | 21755 | 5972 | 35260 | 4385 | 38347 | 3545 | 39450 | 2907 | 40213 | 1974 | 48115 | 1532 | 30228 |
| 4E | | MI | 16981 | 5972 | 27817 | 4298 | 29930 | 3470 | 30532 | 2835 | 30698 | 1897 | 36333 | 1425 | 23293 |
| 12-#14 | 2.37 | MA | 21093 | 5972 | 34146 | 4380 | 36904 | 3562 | 37677 | 2922 | 37673 | 1962 | 45099 | 1475 | 29335 |
| 5L-3S | | MI | 17546 | 5972 | 28792 | 4281 | 31172 | 3481 | 32022 | 2847 | 32552 | 1884 | 38389 | 1547 | 23327 |
| 12-#14 | 2.37 | MA | 20463 | 5972 | 33102 | 4375 | 35458 | 3555 | 35911 | 2912 | 35371 | 1974 | 42257 | 1393 | 28493 |
| 6L-2S | | MI | 18332 | 5972 | 29974 | 4289 | 32687 | 3468 | 33852 | 2835 | 34978 | 1872 | 41569 | 1671 | 23292 |
| 12-#18 | 4.21 | MA | 24828 | 6699 | 42525 | 4783 | 47497 | 3864 | 50548 | 3102 | 54728 | 1868 | 66680 | 1355 | 52184 |
| 3L-5S | | MI | 17383 | 6699 | 30062 | 4697 | 32622 | 3779 | 33634 | 2998 | 34718 | 1752 | 42122 | 867 | 36605 |
| 12-#18 | 4.21 | MA | 23568 | 6699 | 40273 | 4816 | 44628 | 3849 | 47062 | 3082 | 50345 | 1890 | 61780 | 1134 | 49902 |
| 4E | | MI | 18249 | 6699 | 31543 | 4714 | 34530 | 3757 | 35911 | 2976 | 37909 | 1774 | 45848 | 965 | 37882 |
| 12-#18 | 4.21 | MA | 22440 | 6699 | 38320 | 4805 | 42097 | 3877 | 43952 | 3106 | 45951 | 1868 | 56568 | 1036 | 47860 |
| 5L-3S | | MI | 19211 | 6699 | 33244 | 4687 | 36686 | 3779 | 38465 | 2998 | 41083 | 1752 | 49354 | 1175 | 39710 |
| 12-#18 | 4.21 | MA | 21368 | 6699 | 36486 | 4794 | 39560 | 3862 | 40853 | 3086 | 41971 | 1890 | 51686 | 891 | 44787 |
| 6L-2S | | MI | 20546 | 6699 | 35296 | 4704 | 39308 | 3757 | 41598 | 2976 | 45239 | 1730 | 54760 | 1396 | 39866 |
| 14-#11 | 1.92 | MA | 22771 | 5794 | 36322 | 4275 | 39777 | 3467 | 41216 | 2863 | 42539 | 1979 | 50756 | 1834 | 24844 |
| 2L-7S | | MI | 15792 | 5794 | 25362 | 4205 | 26836 | 3420 | 26835 | 2815 | 25784 | 1937 | 30279 | 1410 | 18494 |
| 14-#11 | 1.92 | MA | 22033 | 5794 | 35223 | 4271 | 38368 | 3480 | 39498 | 2874 | 40207 | 1987 | 47651 | 1748 | 24861 |
| 3L-6S | | MI | 16125 | 5794 | 25972 | 4193 | 27571 | 3410 | 27777 | 2824 | 26945 | 1929 | 31638 | 1476 | 18742 |
| 14-#11 | 1.92 | MA | 21513 | 5794 | 34325 | 4285 | 37224 | 3475 | 38108 | 2868 | 38425 | 1996 | 45635 | 1661 | 24834 |
| 4L-5S | | MI | 16467 | 5794 | 26529 | 4199 | 28341 | 3417 | 28671 | 2815 | 28134 | 1920 | 33086 | 1533 | 19170 |
| 14-#11 | 1.92 | MA | 21047 | 5794 | 33549 | 4282 | 36217 | 3488 | 36871 | 2879 | 36640 | 1987 | 43515 | 1621 | 24752 |
| 5L-4S | | MI | 16824 | 5794 | 27122 | 4204 | 29110 | 3406 | 29610 | 2806 | 29448 | 1929 | 34639 | 1571 | 19187 |
| 14-#11 | 1.92 | MA | 20603 | 5794 | 32820 | 4279 | 35208 | 3483 | 35638 | 2873 | 35023 | 1996 | 41511 | 1565 | 24135 |
| 6L-3S | | MI | 17222 | 5794 | 27805 | 4192 | 29979 | 3414 | 30663 | 2815 | 30757 | 1920 | 36094 | 1656 | 19165 |
| 14-#11 | 1.92 | MA | 20171 | 5794 | 32022 | 4293 | 34246 | 3496 | 34454 | 2884 | 33442 | 2005 | 39371 | 1475 | 23727 |
| 7L-2S | | MI | 17778 | 5794 | 28634 | 4197 | 31042 | 3403 | 31955 | 2806 | 32471 | 1911 | 38347 | 1743 | 19132 |
| 14-#14 | 2.76 | MA | 23211 | 6128 | 38116 | 4463 | 41998 | 3622 | 43897 | 2959 | 46064 | 1948 | 55378 | 1625 | 35220 |
| 3L-6S | | MI | 16523 | 6128 | 27354 | 4378 | 29245 | 3543 | 29766 | 2900 | 29579 | 1877 | 35279 | 1246 | 25666 |
| 14-#14 | 2.76 | MA | 22476 | 6128 | 36831 | 4483 | 40361 | 3615 | 41907 | 2949 | 43529 | 1960 | 52521 | 1501 | 35070 |
| 4L-5S | | MI | 17005 | 6128 | 28151 | 4387 | 30347 | 3554 | 31032 | 2888 | 31263 | 1864 | 37321 | 1329 | 26161 |
| 14-#14 | 2.76 | MA | 21819 | 6128 | 35717 | 4477 | 38918 | 3632 | 40134 | 2964 | 40989 | 1948 | 49506 | 1444 | 34022 |
| 5L-4S | | MI | 17510 | 6128 | 28999 | 4395 | 31445 | 3540 | 32362 | 2876 | 33125 | 1877 | 39513 | 1383 | 26948 |
| 14-#14 | 2.76 | MA | 21193 | 6128 | 34673 | 4472 | 37472 | 3625 | 38368 | 2955 | 38688 | 1960 | 46664 | 1362 | 33224 |
| 6L-3S | | MI | 18072 | 6128 | 29974 | 4378 | 32687 | 3551 | 33852 | 2888 | 34978 | 1864 | 41569 | 1504 | 27011 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis

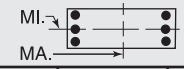


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.76 | MA | 20583 | 6128 | 33529 | 4492 | 36092 | 3642 | 36671 | 2970 | 36439 | 1973 | 43627 | 1232 | 32026 |
| 7L-2S | | MI | 18854 | 6128 | 31156 | 4386 | 34202 | 3537 | 35682 | 2876 | 37405 | 1852 | 44748 | 1629 | 27004 |
| 14-#18 | 4.91 | MA | 24788 | 6975 | 43017 | 4989 | 48146 | 3973 | 51354 | 3157 | 56080 | 1861 | 69362 | 1072 | 57990 |
| 4L-5S | | MI | 18281 | 6975 | 32115 | 4870 | 35244 | 3902 | 36767 | 3067 | 38874 | 1712 | 47527 | 782 | 42515 |
| 14-#18 | 4.91 | MA | 23671 | 6975 | 41064 | 4978 | 45615 | 4002 | 48244 | 3182 | 51685 | 1839 | 64149 | 974 | 56071 |
| 5L-4S | | MI | 19140 | 6975 | 33596 | 4887 | 37152 | 3880 | 39044 | 3045 | 42065 | 1734 | 51254 | 881 | 43892 |
| 14-#18 | 4.91 | MA | 22609 | 6975 | 39230 | 4967 | 43078 | 3986 | 45145 | 3162 | 47706 | 1861 | 59267 | 829 | 52832 |
| 6L-3S | | MI | 20094 | 6975 | 35296 | 4860 | 39308 | 3902 | 41598 | 3067 | 45239 | 1712 | 54760 | 1090 | 46019 |
| 16-#11 | 2.19 | MA | 22540 | 5902 | 36322 | 4339 | 39777 | 3528 | 41216 | 2904 | 42539 | 1978 | 50756 | 1728 | 28285 |
| 3L-7S | | MI | 16171 | 5902 | 26191 | 4273 | 27898 | 3468 | 28127 | 2844 | 27497 | 1924 | 32531 | 1383 | 21005 |
| 16-#11 | 2.19 | MA | 22022 | 5902 | 35424 | 4353 | 38633 | 3524 | 39827 | 2897 | 40757 | 1987 | 48740 | 1641 | 28242 |
| 4L-6S | | MI | 16503 | 5902 | 26801 | 4261 | 28634 | 3458 | 29070 | 2853 | 28659 | 1916 | 33891 | 1449 | 21240 |
| 16-#11 | 2.19 | MA | 21559 | 5902 | 34647 | 4350 | 37626 | 3536 | 38589 | 2909 | 38972 | 1978 | 46620 | 1601 | 28097 |
| 5E | | MI | 16843 | 5902 | 27358 | 4266 | 29404 | 3465 | 29964 | 2844 | 29848 | 1907 | 35339 | 1506 | 21652 |
| 16-#11 | 2.19 | MA | 21118 | 5902 | 33919 | 4346 | 36617 | 3532 | 37356 | 2902 | 37354 | 1987 | 44616 | 1545 | 27449 |
| 6L-4S | | MI | 17200 | 5902 | 27951 | 4271 | 30172 | 3455 | 30903 | 2835 | 31162 | 1916 | 36892 | 1543 | 21773 |
| 16-#11 | 2.19 | MA | 20688 | 5902 | 33121 | 4360 | 35654 | 3544 | 36172 | 2914 | 35773 | 1996 | 42476 | 1455 | 27057 |
| 7L-3S | | MI | 17596 | 5902 | 28634 | 4259 | 31042 | 3462 | 31955 | 2844 | 32471 | 1907 | 38347 | 1629 | 21768 |
| 16-#11 | 2.19 | MA | 20264 | 5902 | 32403 | 4357 | 34677 | 3539 | 35017 | 2925 | 34093 | 1987 | 40494 | 1407 | 26377 |
| 8L-2S | | MI | 18149 | 5902 | 29463 | 4264 | 32105 | 3452 | 33247 | 2835 | 34185 | 1899 | 40600 | 1715 | 21743 |
| 16-#14 | 3.16 | MA | 23192 | 6284 | 38402 | 4580 | 42375 | 3685 | 44364 | 2991 | 46846 | 1946 | 56928 | 1470 | 39906 |
| 4L-6S | | MI | 17054 | 6284 | 28536 | 4476 | 30761 | 3613 | 31596 | 2941 | 32006 | 1857 | 38459 | 1204 | 29221 |
| 16-#14 | 3.16 | MA | 22539 | 6284 | 37288 | 4575 | 40932 | 3702 | 42591 | 3007 | 44306 | 1934 | 53913 | 1413 | 38724 |
| 5E | | MI | 17533 | 6284 | 29333 | 4484 | 31862 | 3624 | 32862 | 2929 | 33689 | 1845 | 40500 | 1286 | 29688 |
| 16-#14 | 3.16 | MA | 21917 | 6284 | 36244 | 4570 | 39486 | 3695 | 40825 | 2997 | 42004 | 1946 | 51071 | 1332 | 37963 |
| 6L-4S | | MI | 18036 | 6284 | 30181 | 4492 | 32960 | 3610 | 34192 | 2916 | 35551 | 1857 | 42692 | 1341 | 30594 |
| 16-#14 | 3.16 | MA | 21311 | 6284 | 35100 | 4589 | 38106 | 3712 | 39128 | 3012 | 39755 | 1959 | 48034 | 1201 | 36677 |
| 7L-3S | | MI | 18594 | 6284 | 31156 | 4475 | 34202 | 3621 | 35682 | 2929 | 37405 | 1845 | 44748 | 1462 | 30684 |
| 16-#14 | 3.16 | MA | 20715 | 6284 | 34071 | 4584 | 36706 | 3705 | 37472 | 3028 | 37364 | 1946 | 45216 | 1134 | 35561 |
| 8L-2S | | MI | 19372 | 6284 | 32338 | 4484 | 35717 | 3607 | 37512 | 2916 | 39831 | 1832 | 47927 | 1587 | 30710 |
| 16-#18 | 5.61 | MA | 24890 | 7252 | 43808 | 5151 | 49133 | 4126 | 52536 | 3257 | 57420 | 1810 | 71730 | 912 | 64202 |
| 5E | | MI | 19172 | 7252 | 34168 | 5043 | 37866 | 4026 | 39900 | 3136 | 43029 | 1672 | 52933 | 698 | 48360 |
| 16-#18 | 5.61 | MA | 23838 | 7252 | 41974 | 5140 | 46596 | 4110 | 49437 | 3237 | 53441 | 1832 | 66848 | 766 | 60903 |
| 6L-4S | | MI | 20024 | 7252 | 35649 | 5060 | 39774 | 4004 | 42178 | 3114 | 46220 | 1694 | 56659 | 796 | 49932 |
| 18-#11 | 2.46 | MA | 22529 | 6010 | 36523 | 4420 | 40042 | 3572 | 41545 | 2927 | 43088 | 1978 | 51845 | 1621 | 31646 |
| 4L-7S | | MI | 16549 | 6010 | 27020 | 4340 | 28961 | 3517 | 29420 | 2873 | 29211 | 1912 | 34784 | 1356 | 23517 |
| 18-#11 | 2.46 | MA | 22068 | 6010 | 35746 | 4417 | 39034 | 3585 | 40307 | 2938 | 41303 | 1969 | 49725 | 1581 | 31386 |
| 5L-6S | | MI | 16879 | 6010 | 27630 | 4328 | 29697 | 3506 | 30362 | 2882 | 30372 | 1903 | 36144 | 1422 | 23742 |
| 18-#11 | 2.46 | MA | 21629 | 6010 | 35017 | 4414 | 38026 | 3580 | 39075 | 2932 | 39685 | 1978 | 47721 | 1525 | 30768 |
| 6L-5S | | MI | 17218 | 6010 | 28187 | 4333 | 30467 | 3513 | 31256 | 2873 | 31561 | 1894 | 37592 | 1479 | 24130 |
| 18-#11 | 2.46 | MA | 21201 | 6010 | 34219 | 4428 | 37063 | 3593 | 37891 | 2943 | 38104 | 1987 | 45581 | 1435 | 30390 |
| 7L-4S | | MI | 17573 | 6010 | 28780 | 4339 | 31235 | 3503 | 32195 | 2864 | 32875 | 1903 | 39145 | 1516 | 24352 |
| 18-#11 | 2.46 | MA | 20780 | 6010 | 33502 | 4425 | 36086 | 3588 | 36735 | 2954 | 36424 | 1978 | 43599 | 1387 | 29655 |
| 8L-3S | | MI | 17967 | 6010 | 29463 | 4327 | 32105 | 3510 | 33247 | 2873 | 34185 | 1894 | 40600 | 1601 | 24365 |
| 18-#11 | 2.46 | MA | 20363 | 6010 | 32729 | 4439 | 35136 | 3600 | 35527 | 2948 | 34857 | 1987 | 41656 | 1333 | 29059 |
| 9L-2S | | MI | 18519 | 6010 | 30292 | 4332 | 33168 | 3500 | 34540 | 2864 | 35898 | 1886 | 42853 | 1688 | 24347 |
| 18-#14 | 3.55 | MA | 23253 | 6439 | 38859 | 4672 | 42946 | 3772 | 45048 | 3049 | 47622 | 1920 | 58319 | 1382 | 43437 |
| 5L-6S | | MI | 17581 | 6439 | 29718 | 4573 | 32276 | 3682 | 33426 | 2982 | 34433 | 1837 | 41638 | 1162 | 32741 |
| 18-#14 | 3.55 | MA | 22636 | 6439 | 37815 | 4667 | 41500 | 3764 | 43282 | 3040 | 45321 | 1932 | 55477 | 1301 | 42709 |
| 6L-5S | | MI | 18058 | 6439 | 30515 | 4581 | 33377 | 3694 | 34692 | 2970 | 36116 | 1825 | 43679 | 1244 | 33224 |
| 18-#14 | 3.55 | MA | 22034 | 6439 | 36671 | 4686 | 40120 | 3782 | 41585 | 3055 | 43072 | 1945 | 52440 | 1170 | 41339 |
| 7L-4S | | MI | 18558 | 6439 | 31363 | 4589 | 34475 | 3680 | 36022 | 2957 | 37978 | 1837 | 45871 | 1299 | 34145 |
| 18-#14 | 3.55 | MA | 21442 | 6439 | 35642 | 4681 | 38720 | 3775 | 39929 | 3070 | 40681 | 1932 | 49622 | 1103 | 40159 |
| 8L-3S | | MI | 19113 | 6439 | 32338 | 4573 | 35717 | 3691 | 37512 | 2970 | 39831 | 1825 | 47927 | 1420 | 34349 |
| 18-#18 | 6.32 | MA | 25056 | 7529 | 44718 | 5312 | 50114 | 4234 | 53728 | 3313 | 59175 | 1804 | 74430 | 704 | 68999 |
| 6L-5S | | MI | 20056 | 7529 | 36220 | 5216 | 40487 | 4149 | 43033 | 3205 | 47185 | 1632 | 58339 | 613 | 54238 |
| 20-#11 | 2.74 | MA | 22574 | 6118 | 36845 | 4485 | 40443 | 3633 | 42026 | 2967 | 43634 | 1960 | 52830 | 1561 | 34683 |
| 5L-7S | | MI | 16925 | 6118 | 27849 | 4408 | 30024 | 3565 | 30712 | 2902 | 30924 | 1899 | 37037 | 1328 | 25984 |

## RECTANGULAR TIED COLUMNS 30" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.74 | MA | 22138 | 6118 | 36116 | 4481 | 39434 | 3628 | 40793 | 2961 | 42016 | 1969 | 50826 | 1505 | 34093 |
| 6E | | MI | 17254 | 6118 | 28459 | 4396 | 30760 | 3555 | 31654 | 2911 | 32086 | 1890 | 38397 | 1394 | 26248 |
| 20-#11 | 2.74 | MA | 21712 | 6118 | 35318 | 4495 | 38471 | 3641 | 39609 | 2972 | 40435 | 1978 | 48686 | 1415 | 33727 |
| 7L-5S | | MI | 17591 | 6118 | 29016 | 4401 | 31530 | 3562 | 32548 | 2902 | 33275 | 1882 | 39845 | 1451 | 26615 |
| 20-#11 | 2.74 | MA | 21293 | 6118 | 34601 | 4492 | 37495 | 3636 | 38454 | 2983 | 38755 | 1969 | 46704 | 1367 | 32939 |
| 8L-4S | | MI | 17944 | 6118 | 29609 | 4406 | 32298 | 3552 | 33488 | 2894 | 34589 | 1890 | 41398 | 1489 | 26925 |
| 20-#11 | 2.74 | MA | 20878 | 6118 | 33828 | 4506 | 36544 | 3649 | 37246 | 2977 | 37188 | 1978 | 44761 | 1313 | 32336 |
| 9L-3S | | MI | 18337 | 6118 | 30292 | 4394 | 33168 | 3559 | 34540 | 2902 | 35898 | 1882 | 42853 | 1574 | 26952 |
| 20-#11 | 2.74 | MA | 20419 | 6118 | 33113 | 4503 | 35581 | 3644 | 36096 | 2988 | 35634 | 1986 | 42880 | 1252 | 31433 |
| 10L-2S | | MI | 18886 | 6118 | 31121 | 4399 | 34230 | 3549 | 35832 | 2894 | 37612 | 1873 | 45106 | 1660 | 26947 |
| 20-#14 | 3.95 | MA | 23349 | 6595 | 39386 | 4764 | 43514 | 3834 | 45739 | 3082 | 48637 | 1918 | 59884 | 1270 | 47461 |
| 6E | | MI | 18106 | 6595 | 30900 | 4670 | 33791 | 3752 | 35256 | 3023 | 36859 | 1818 | 44817 | 1120 | 36185 |
| 20-#14 | 3.95 | MA | 22752 | 6595 | 38242 | 4784 | 42134 | 3852 | 44042 | 3097 | 46388 | 1931 | 56847 | 1139 | 46012 |
| 7L-5S | | MI | 18580 | 6595 | 31697 | 4678 | 34892 | 3763 | 36521 | 3011 | 38543 | 1805 | 46858 | 1202 | 36768 |
| 20-#14 | 3.95 | MA | 22163 | 6595 | 37213 | 4779 | 40734 | 3844 | 42386 | 3112 | 43997 | 1918 | 54029 | 1072 | 44769 |
| 8L-4S | | MI | 19077 | 6595 | 32545 | 4687 | 35991 | 3750 | 37851 | 2998 | 40404 | 1818 | 49050 | 1256 | 37636 |
| 22-#11 | 3.01 | MA | 22643 | 6226 | 37215 | 4549 | 40843 | 3677 | 42511 | 2991 | 44347 | 1960 | 53931 | 1485 | 37422 |
| 6L-7S | | MI | 17299 | 6226 | 28678 | 4475 | 31087 | 3613 | 32005 | 2931 | 32638 | 1886 | 39290 | 1301 | 28431 |
| 22-#11 | 3.01 | MA | 22220 | 6226 | 36417 | 4563 | 39880 | 3689 | 41328 | 3002 | 42766 | 1969 | 51791 | 1395 | 37016 |
| 7L-6S | | MI | 17626 | 6226 | 29288 | 4463 | 31823 | 3603 | 32947 | 2940 | 33799 | 1878 | 40649 | 1367 | 28758 |
| 22-#11 | 3.01 | MA | 21802 | 6226 | 35699 | 4560 | 38903 | 3685 | 40172 | 3013 | 41086 | 1960 | 49809 | 1347 | 36229 |
| 8L-5S | | MI | 17962 | 6226 | 29845 | 4468 | 32593 | 3610 | 33841 | 2931 | 34988 | 1869 | 42098 | 1424 | 29105 |
| 22-#11 | 3.01 | MA | 21389 | 6226 | 34927 | 4574 | 37953 | 3697 | 38964 | 3007 | 39519 | 1969 | 47866 | 1293 | 35582 |
| 9L-4S | | MI | 18314 | 6226 | 30438 | 4473 | 33361 | 3600 | 34780 | 2923 | 36302 | 1878 | 43651 | 1461 | 29493 |
| 22-#11 | 3.01 | MA | 20933 | 6226 | 34211 | 4570 | 36989 | 3693 | 37814 | 3018 | 37966 | 1977 | 45985 | 1232 | 34703 |
| 10L-3S | | MI | 18705 | 6226 | 31121 | 4461 | 34230 | 3607 | 35832 | 2931 | 37612 | 1869 | 45106 | 1547 | 29533 |
| 22-#14 | 4.34 | MA | 23464 | 6751 | 39813 | 4881 | 44148 | 3922 | 46499 | 3140 | 49705 | 1917 | 61254 | 1108 | 50694 |
| 7L-6S | | MI | 18627 | 6751 | 32082 | 4767 | 35307 | 3822 | 37086 | 3064 | 39286 | 1798 | 47996 | 1077 | 39642 |
| 22-#14 | 4.34 | MA | 22880 | 6751 | 38784 | 4876 | 42748 | 3914 | 44843 | 3155 | 47314 | 1904 | 58435 | 1041 | 49389 |
| 8L-5S | | MI | 19099 | 6751 | 32879 | 4776 | 36408 | 3833 | 38351 | 3051 | 40969 | 1786 | 50038 | 1160 | 40318 |
| 24-#11 | 3.28 | MA | 22725 | 6333 | 37516 | 4630 | 41289 | 3738 | 43046 | 3031 | 45097 | 1960 | 54896 | 1375 | 40286 |
| 7E | | MI | 17671 | 6333 | 29507 | 4543 | 32150 | 3662 | 33297 | 2960 | 34351 | 1873 | 41543 | 1274 | 30885 |
| 24-#11 | 3.28 | MA | 22309 | 6333 | 36798 | 4627 | 40312 | 3733 | 41891 | 3042 | 43417 | 1951 | 52914 | 1327 | 39524 |
| 8L-6S | | MI | 17997 | 6333 | 30117 | 4531 | 32885 | 3652 | 34239 | 2969 | 35513 | 1865 | 42902 | 1339 | 31269 |
| 24-#11 | 3.28 | MA | 21898 | 6333 | 36026 | 4641 | 39362 | 3746 | 40682 | 3036 | 41850 | 1960 | 50971 | 1273 | 38835 |
| 9L-5S | | MI | 18332 | 6333 | 30674 | 4536 | 33656 | 3659 | 35133 | 2960 | 36702 | 1856 | 44351 | 1396 | 31600 |
| 24-#11 | 3.28 | MA | 21444 | 6333 | 35310 | 4638 | 38398 | 3741 | 39533 | 3047 | 40297 | 1968 | 49090 | 1212 | 37978 |
| 10L-4S | | MI | 18682 | 6333 | 31267 | 4541 | 34424 | 3649 | 36072 | 2952 | 38016 | 1865 | 45904 | 1434 | 32059 |
| 24-#14 | 4.74 | MA | 23591 | 6906 | 40355 | 4973 | 44762 | 3984 | 47300 | 3197 | 50630 | 1890 | 62842 | 1010 | 54019 |
| 8L-6S | | MI | 19146 | 6906 | 33264 | 4865 | 36822 | 3892 | 38915 | 3105 | 41712 | 1778 | 51175 | 1035 | 43110 |

## RECTANGULAR TIED COLUMNS 30" x 40"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.33 | MA | 23957 | 5857 | 37680 | 4318 | 40623 | 3516 | 41397 | 2927 | 41199 | 2080 | 48239 | 1946 | 19240 |
| 2E | | MI | 17768 | 5857 | 28295 | 4206 | 30062 | 3422 | 30266 | 2835 | 29684 | 1993 | 34312 | 1835 | 14089 |
| 6-#14 | 1.13 | MA | 23598 | 5771 | 36728 | 4295 | 39565 | 3503 | 40168 | 2924 | 39672 | 2111 | 46300 | 1992 | 16461 |
| 2L-3S | | MI | 16741 | 5771 | 26451 | 4184 | 27868 | 3432 | 27737 | 2861 | 26347 | 2048 | 30036 | 1774 | 12187 |
| 6-#14 | 1.13 | MA | 22463 | 5771 | 35059 | 4290 | 37426 | 3521 | 37559 | 2940 | 36132 | 2123 | 41586 | 1867 | 16530 |
| 3L-2S | | MI | 17541 | 5771 | 27633 | 4192 | 29383 | 3419 | 29566 | 2848 | 28773 | 2036 | 33215 | 1899 | 12104 |
| 6-#18 | 2.00 | MA | 25294 | 6134 | 40597 | 4491 | 44362 | 3641 | 45960 | 3002 | 47329 | 2053 | 56366 | 1888 | 28425 |
| 2L-3S | | MI | 17307 | 6134 | 28295 | 4362 | 30062 | 3568 | 30266 | 2926 | 29684 | 1975 | 34312 | 1529 | 20722 |
| 6-#18 | 2.00 | MA | 23340 | 6134 | 37680 | 4481 | 40623 | 3671 | 41397 | 3028 | 41199 | 2076 | 48239 | 1666 | 28413 |
| 3L-2S | | MI | 18678 | 6134 | 30348 | 4379 | 32684 | 3546 | 33399 | 2904 | 33840 | 1953 | 39718 | 1750 | 20623 |
| 8-#11 | 1.04 | MA | 23451 | 5736 | 36324 | 4288 | 39130 | 3499 | 39669 | 2925 | 39037 | 2123 | 45518 | 2011 | 15314 |
| 2L-4S | | MI | 16482 | 5736 | 25836 | 4198 | 27163 | 3422 | 26939 | 2856 | 25385 | 2072 | 29069 | 1755 | 11396 |
| 8-#11 | 1.04 | MA | 22655 | 5736 | 35158 | 4285 | 37635 | 3512 | 37846 | 2937 | 36555 | 2132 | 42199 | 1925 | 15361 |
| 3E | | MI | 16885 | 5736 | 26519 | 4185 | 28033 | 3430 | 27991 | 2865 | 26694 | 2063 | 30524 | 1840 | 11333 |

## RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

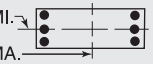
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 1.04 | MA | 22094 | 5736 | 34206 | 4299 | 36423 | 3508 | 36372 | 2931 | 34659 | 2141 | 40042 | 1839 | 15402 |
| 4L-2S | | MI | 17448 | 5736 | 27348 | 4191 | 29096 | 3419 | 29284 | 2856 | 28408 | 2055 | 32777 | 1926 | 11279 |
| 8-#14 | 1.50 | MA | 24377 | 5926 | 38396 | 4392 | 41703 | 3572 | 42777 | 2967 | 43211 | 2098 | 51015 | 1963 | 21720 |
| 2L-4S | | MI | 16707 | 5926 | 26658 | 4298 | 28141 | 3491 | 28076 | 2889 | 26920 | 2041 | 31159 | 1611 | 15999 |
| 8-#14 | 1.50 | MA | 23248 | 5926 | 36728 | 4387 | 39565 | 3591 | 40168 | 2983 | 39672 | 2110 | 46300 | 1838 | 21766 |
| 3E | | MI | 17279 | 5926 | 27633 | 4281 | 29383 | 3502 | 29566 | 2902 | 28773 | 2028 | 33215 | 1732 | 15943 |
| 8-#14 | 1.50 | MA | 22452 | 5926 | 35365 | 4407 | 37828 | 3584 | 38058 | 2974 | 36966 | 2122 | 43239 | 1714 | 21734 |
| 4L-2S | | MI | 18075 | 5926 | 28815 | 4290 | 30898 | 3488 | 31396 | 2889 | 31200 | 2016 | 36394 | 1857 | 15872 |
| 8-#18 | 2.67 | MA | 26613 | 6411 | 43514 | 4664 | 48102 | 3765 | 50522 | 3078 | 53460 | 2027 | 64494 | 1830 | 37565 |
| 2L-4S | | MI | 17237 | 6411 | 28648 | 4561 | 30528 | 3669 | 30845 | 2973 | 30666 | 1957 | 36211 | 1235 | 26291 |
| 8-#18 | 2.67 | MA | 24679 | 6411 | 40597 | 4654 | 44362 | 3795 | 45960 | 3103 | 47329 | 2049 | 56366 | 1608 | 37439 |
| 3E | | MI | 18218 | 6411 | 30348 | 4534 | 32684 | 3691 | 33399 | 2995 | 33840 | 1935 | 39718 | 1444 | 27124 |
| 8-#18 | 2.67 | MA | 23312 | 6411 | 38208 | 4688 | 41317 | 3780 | 42260 | 3085 | 42644 | 2071 | 51104 | 1387 | 36228 |
| 4L-2S | | MI | 19577 | 6411 | 32401 | 4552 | 35305 | 3669 | 36532 | 2973 | 37996 | 1913 | 45124 | 1666 | 27100 |
| 10-#11 | 1.30 | MA | 24000 | 5843 | 37490 | 4355 | 40625 | 3548 | 41493 | 2955 | 41518 | 2115 | 48837 | 1993 | 18992 |
| 2L-5S | | MI | 16502 | 5843 | 26073 | 4260 | 27458 | 3481 | 27292 | 2894 | 25785 | 2051 | 29769 | 1690 | 14061 |
| 10-#11 | 1.30 | MA | 23207 | 5843 | 36324 | 4352 | 39130 | 3561 | 39669 | 2966 | 39037 | 2124 | 45518 | 1906 | 19030 |
| 3L-4S | | MI | 16864 | 5843 | 26666 | 4265 | 28226 | 3471 | 28231 | 2885 | 27099 | 2059 | 31322 | 1727 | 14024 |
| 10-#11 | 1.30 | MA | 22649 | 5843 | 35373 | 4367 | 37918 | 3557 | 38196 | 2961 | 37141 | 2133 | 43360 | 1820 | 19051 |
| 4L-3S | | MI | 17266 | 5843 | 27348 | 4253 | 29096 | 3478 | 29284 | 2894 | 28408 | 2051 | 32777 | 1813 | 13973 |
| 10-#11 | 1.30 | MA | 22151 | 5843 | 34550 | 4364 | 36851 | 3570 | 36885 | 2972 | 35242 | 2124 | 41100 | 1779 | 19013 |
| 5L-2S | | MI | 17826 | 5843 | 28177 | 4258 | 30159 | 3468 | 30576 | 2885 | 30122 | 2042 | 35030 | 1899 | 13924 |
| 10-#14 | 1.88 | MA | 25148 | 6082 | 40064 | 4489 | 43842 | 3642 | 45386 | 3009 | 46751 | 2084 | 55729 | 1934 | 26960 |
| 2L-5S | | MI | 16732 | 6082 | 26992 | 4387 | 28558 | 3575 | 28576 | 2943 | 27485 | 2009 | 32146 | 1514 | 19332 |
| 10-#14 | 1.88 | MA | 24027 | 6082 | 38396 | 4484 | 41703 | 3660 | 42777 | 3025 | 43211 | 2097 | 51015 | 1809 | 26977 |
| 3L-4S | | MI | 17245 | 6082 | 27840 | 4395 | 29656 | 3561 | 29906 | 2930 | 29346 | 2021 | 34338 | 1569 | 19695 |
| 10-#14 | 1.88 | MA | 23236 | 6082 | 37033 | 4505 | 39967 | 3654 | 40667 | 3016 | 40506 | 2109 | 47954 | 1685 | 26897 |
| 4L-3S | | MI | 17813 | 6082 | 28815 | 4379 | 30898 | 3572 | 31396 | 2943 | 31200 | 2009 | 36394 | 1690 | 19671 |
| 10-#14 | 1.88 | MA | 22529 | 6082 | 35854 | 4500 | 38437 | 3672 | 38788 | 3032 | 37796 | 2097 | 44735 | 1627 | 26276 |
| 5L-2S | | MI | 18605 | 6082 | 29997 | 4387 | 32413 | 3558 | 33226 | 2930 | 33626 | 1996 | 39573 | 1815 | 19617 |
| 10-#18 | 3.33 | MA | 27916 | 6687 | 46432 | 4837 | 51841 | 3889 | 55084 | 3153 | 59590 | 2000 | 72621 | 1771 | 46652 |
| 2L-5S | | MI | 17271 | 6687 | 29219 | 4717 | 31242 | 3814 | 31701 | 3064 | 31631 | 1895 | 37891 | 1052 | 30781 |
| 10-#18 | 3.33 | MA | 26000 | 6687 | 43514 | 4827 | 48102 | 3919 | 50522 | 3179 | 53460 | 2022 | 64494 | 1550 | 46439 |
| 3L-4S | | MI | 18146 | 6687 | 30700 | 4734 | 33150 | 3792 | 33978 | 3042 | 34822 | 1918 | 41617 | 1150 | 32210 |
| 10-#18 | 3.33 | MA | 24647 | 6687 | 41125 | 4861 | 45057 | 3905 | 46822 | 3160 | 48774 | 2044 | 59232 | 1328 | 44741 |
| 4L-3S | | MI | 19119 | 6687 | 32401 | 4707 | 35305 | 3814 | 36532 | 3064 | 37996 | 1895 | 45124 | 1360 | 33483 |
| 10-#18 | 3.33 | MA | 23437 | 6687 | 39054 | 4851 | 42372 | 3935 | 43524 | 3186 | 44078 | 2022 | 53659 | 1229 | 42294 |
| 5L-2S | | MI | 20468 | 6687 | 34453 | 4725 | 37927 | 3792 | 39665 | 3042 | 42151 | 1873 | 50529 | 1581 | 33542 |
| 12-#11 | 1.56 | MA | 24545 | 5951 | 38656 | 4423 | 42120 | 3596 | 43317 | 2984 | 44000 | 2106 | 52155 | 1974 | 22659 |
| 2L-6S | | MI | 16540 | 5951 | 26345 | 4322 | 27751 | 3522 | 27691 | 2932 | 26309 | 2047 | 30573 | 1605 | 16380 |
| 12-#11 | 1.56 | MA | 23756 | 5951 | 37490 | 4420 | 40625 | 3609 | 41493 | 2996 | 41518 | 2115 | 48837 | 1888 | 22686 |
| 3L-5S | | MI | 16884 | 5951 | 26902 | 4327 | 28521 | 3529 | 28585 | 2923 | 27498 | 2038 | 32022 | 1662 | 16655 |
| 12-#11 | 1.56 | MA | 23201 | 5951 | 36539 | 4434 | 39413 | 3605 | 40020 | 2990 | 39622 | 2124 | 46679 | 1801 | 22684 |
| 4E | | MI | 17244 | 5951 | 27495 | 4332 | 29289 | 3519 | 29524 | 2914 | 28812 | 2047 | 33575 | 1700 | 16636 |
| 12-#11 | 1.56 | MA | 22705 | 5951 | 35716 | 4431 | 38346 | 3618 | 38709 | 3002 | 37724 | 2116 | 44418 | 1761 | 22622 |
| 5L-3S | | MI | 17644 | 5951 | 28177 | 4320 | 30159 | 3526 | 30576 | 2923 | 30122 | 2038 | 35030 | 1785 | 16598 |
| 12-#11 | 1.56 | MA | 22232 | 5951 | 34944 | 4428 | 37277 | 3614 | 37403 | 2996 | 36003 | 2124 | 42275 | 1704 | 22135 |
| 6L-2S | | MI | 18202 | 5951 | 29006 | 4326 | 31221 | 3516 | 31868 | 2914 | 31835 | 2029 | 37283 | 1872 | 16555 |
| 12-#14 | 2.25 | MA | 25913 | 6238 | 41733 | 4586 | 45981 | 3712 | 47995 | 3052 | 50290 | 2071 | 60444 | 1905 | 32186 |
| 2L-6S | | MI | 16783 | 6238 | 27377 | 4476 | 28972 | 3633 | 29140 | 2996 | 28228 | 2001 | 33284 | 1389 | 22285 |
| 12-#14 | 2.25 | MA | 24799 | 6238 | 40064 | 4582 | 43842 | 3730 | 45386 | 3068 | 46751 | 2084 | 55729 | 1780 | 32167 |
| 3L-5S | | MI | 17269 | 6238 | 28174 | 4484 | 30073 | 3644 | 30406 | 2983 | 29911 | 1989 | 35326 | 1472 | 22828 |
| 12-#14 | 2.25 | MA | 24013 | 6238 | 38702 | 4602 | 42105 | 3724 | 43276 | 3059 | 44045 | 2096 | 52668 | 1656 | 32050 |
| 4E | | MI | 17778 | 6238 | 29022 | 4493 | 31171 | 3631 | 31736 | 2971 | 31773 | 2001 | 37517 | 1526 | 23368 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis



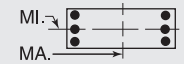

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 2.25 | MA | 23311 | 6238 | 37522 | 4597 | 40576 | 3742 | 41397 | 3075 | 41335 | 2084 | 49450 | 1598 | 31238 |
| 5L-3S | | MI | 18344 | 6238 | 29997 | 4476 | 32413 | 3642 | 33226 | 2983 | 33626 | 1989 | 39573 | 1648 | 23382 |
| 12-#14 | 2.25 | MA | 22643 | 6238 | 36416 | 4593 | 39044 | 3735 | 39525 | 3066 | 38879 | 2096 | 46407 | 1517 | 30298 |
| 6L-2S | | MI | 19131 | 6238 | 31179 | 4484 | 33929 | 3628 | 35056 | 2971 | 36053 | 1976 | 42753 | 1772 | 23344 |
| 12-#18 | 4.00 | MA | 27307 | 6964 | 46432 | 5000 | 51841 | 4043 | 55084 | 3254 | 59590 | 1996 | 72621 | 1492 | 55424 |
| 3L-5S | | MI | 18178 | 6964 | 31272 | 4890 | 33863 | 3938 | 34834 | 3133 | 35787 | 1855 | 43297 | 967 | 36867 |
| 12-#18 | 4.00 | MA | 25967 | 6964 | 44042 | 5034 | 48796 | 4029 | 51384 | 3236 | 54905 | 2018 | 67359 | 1270 | 53304 |
| 4E | | MI | 19047 | 6964 | 32753 | 4907 | 35771 | 3916 | 37111 | 3111 | 38977 | 1878 | 47023 | 1066 | 38178 |
| 12-#18 | 4.00 | MA | 24769 | 6964 | 41971 | 5024 | 46112 | 4059 | 48086 | 3262 | 50208 | 1996 | 61786 | 1171 | 51008 |
| 5L-3S | | MI | 20012 | 6964 | 34453 | 4880 | 37927 | 3938 | 39665 | 3133 | 42151 | 1855 | 50529 | 1275 | 39817 |
| 12-#18 | 4.00 | MA | 23630 | 6964 | 40027 | 5014 | 43422 | 4044 | 44799 | 3243 | 45954 | 2018 | 56548 | 1026 | 47944 |
| 6L-2S | | MI | 21350 | 6964 | 36506 | 4897 | 40549 | 3916 | 42798 | 3111 | 46307 | 1833 | 55935 | 1496 | 39949 |
| 14-#11 | 1.82 | MA | 25087 | 6059 | 39822 | 4490 | 43615 | 3645 | 45141 | 3014 | 46481 | 2098 | 55474 | 1955 | 26319 |
| 2L-7S | | MI | 16587 | 6059 | 26564 | 4401 | 28078 | 3581 | 28041 | 2952 | 26861 | 2042 | 31467 | 1512 | 18620 |
| 14-#11 | 1.82 | MA | 24301 | 6059 | 38656 | 4487 | 42120 | 3658 | 43317 | 3025 | 44000 | 2106 | 52155 | 1869 | 26335 |
| 3L-6S | | MI | 16921 | 6059 | 27174 | 4389 | 28814 | 3571 | 28983 | 2961 | 28023 | 2034 | 32826 | 1578 | 18871 |
| 14-#11 | 1.82 | MA | 23749 | 6059 | 37705 | 4502 | 40908 | 3653 | 41844 | 3020 | 42104 | 2115 | 49998 | 1783 | 26309 |
| 4L-5S | | MI | 17263 | 6059 | 27731 | 4395 | 29584 | 3578 | 29877 | 2952 | 29212 | 2025 | 34275 | 1635 | 19235 |
| 14-#11 | 1.82 | MA | 23255 | 6059 | 36882 | 4499 | 39841 | 3666 | 40533 | 3031 | 40205 | 2107 | 47737 | 1742 | 26226 |
| 5L-4S | | MI | 17621 | 6059 | 28324 | 4400 | 30352 | 3568 | 30816 | 2943 | 30526 | 2034 | 35828 | 1673 | 19239 |
| 14-#11 | 1.82 | MA | 22785 | 6059 | 36111 | 4496 | 38772 | 3662 | 39227 | 3026 | 38484 | 2116 | 45593 | 1686 | 25645 |
| 6L-3S | | MI | 18020 | 6059 | 29006 | 4388 | 31221 | 3575 | 31868 | 2952 | 31835 | 2025 | 37283 | 1758 | 19212 |
| 14-#11 | 1.82 | MA | 22327 | 6059 | 35265 | 4510 | 37753 | 3675 | 37974 | 3037 | 36803 | 2125 | 43306 | 1596 | 25191 |
| 7L-2S | | MI | 18576 | 6059 | 29835 | 4393 | 32284 | 3565 | 33161 | 2943 | 33549 | 2017 | 39536 | 1844 | 19176 |
| 14-#14 | 2.63 | MA | 25564 | 6393 | 41733 | 4679 | 45981 | 3800 | 47995 | 3110 | 50290 | 2071 | 60444 | 1752 | 37347 |
| 3L-6S | | MI | 17318 | 6393 | 28559 | 4573 | 30487 | 3703 | 30970 | 3037 | 30654 | 1982 | 36463 | 1347 | 25834 |
| 14-#14 | 2.63 | MA | 24784 | 6393 | 40370 | 4699 | 44244 | 3793 | 45885 | 3101 | 47585 | 2083 | 57383 | 1627 | 37196 |
| 4L-5S | | MI | 17801 | 6393 | 29356 | 4582 | 31588 | 3714 | 32236 | 3024 | 32338 | 1969 | 38505 | 1430 | 26341 |
| 14-#14 | 2.63 | MA | 24087 | 6393 | 39190 | 4695 | 42715 | 3811 | 44006 | 3117 | 44875 | 2071 | 54164 | 1569 | 36218 |
| 5L-4S | | MI | 18308 | 6393 | 30204 | 4590 | 32687 | 3701 | 33566 | 3012 | 34199 | 1982 | 40696 | 1484 | 27030 |
| 14-#14 | 2.63 | MA | 23423 | 6393 | 38084 | 4690 | 41183 | 3805 | 42134 | 3108 | 42418 | 2083 | 51121 | 1488 | 35325 |
| 6L-3S | | MI | 18871 | 6393 | 31179 | 4573 | 33929 | 3712 | 35056 | 3024 | 36053 | 1969 | 42753 | 1606 | 27078 |
| 14-#14 | 2.63 | MA | 22776 | 6393 | 36872 | 4710 | 39721 | 3823 | 40337 | 3124 | 40018 | 2096 | 47872 | 1358 | 34180 |
| 7L-2S | | MI | 19654 | 6393 | 32361 | 4581 | 35444 | 3698 | 36886 | 3012 | 38480 | 1957 | 45932 | 1730 | 27059 |
| 14-#18 | 4.67 | MA | 27273 | 7240 | 46959 | 5207 | 52536 | 4153 | 55946 | 3311 | 61035 | 1991 | 75487 | 1212 | 61909 |
| 4L-5S | | MI | 19078 | 7240 | 33325 | 5063 | 36485 | 4061 | 37967 | 3202 | 39942 | 1816 | 48702 | 883 | 42973 |
| 14-#18 | 4.67 | MA | 26087 | 7240 | 44888 | 5197 | 49851 | 4183 | 52648 | 3337 | 56339 | 1969 | 69914 | 1112 | 59745 |
| 5L-4S | | MI | 19940 | 7240 | 34806 | 5080 | 38393 | 4039 | 40244 | 3180 | 43133 | 1838 | 52429 | 981 | 44184 |
| 14-#18 | 4.67 | MA | 24959 | 7240 | 42944 | 5187 | 47162 | 4169 | 49361 | 3319 | 52085 | 1991 | 64676 | 967 | 56510 |
| 6L-3S | | MI | 20897 | 7240 | 36506 | 5053 | 40549 | 4061 | 42798 | 3202 | 46307 | 1816 | 55935 | 1190 | 46135 |
| 16-#11 | 2.08 | MA | 24843 | 6167 | 39822 | 4555 | 43615 | 3706 | 45141 | 3055 | 46481 | 2098 | 55474 | 1850 | 29970 |
| 3L-7S | | MI | 16967 | 6167 | 27393 | 4469 | 29141 | 3629 | 29333 | 2981 | 28575 | 2030 | 33720 | 1485 | 21131 |
| 16-#11 | 2.08 | MA | 24294 | 6167 | 38871 | 4569 | 42403 | 3702 | 43668 | 3049 | 44585 | 2107 | 53317 | 1764 | 29927 |
| 4L-6S | | MI | 17299 | 6167 | 28003 | 4457 | 29876 | 3619 | 30275 | 2990 | 29736 | 2021 | 35079 | 1551 | 21368 |
| 16-#11 | 2.08 | MA | 23802 | 6167 | 38048 | 4566 | 41336 | 3715 | 42357 | 3061 | 42687 | 2098 | 51056 | 1723 | 29826 |
| 5E | | MI | 17640 | 6167 | 28560 | 4462 | 30646 | 3626 | 31169 | 2981 | 30925 | 2012 | 36527 | 1608 | 21795 |
| 16-#11 | 2.08 | MA | 23335 | 6167 | 37277 | 4563 | 40267 | 3711 | 41051 | 3055 | 40966 | 2107 | 48912 | 1667 | 29163 |
| 6L-4S | | MI | 17997 | 6167 | 29153 | 4467 | 31415 | 3616 | 32109 | 2972 | 32239 | 2021 | 38081 | 1645 | 21833 |
| 16-#11 | 2.08 | MA | 22879 | 6167 | 36432 | 4578 | 39248 | 3724 | 39797 | 3067 | 39284 | 2116 | 46624 | 1577 | 28727 |
| 7L-3S | | MI | 18394 | 6167 | 29835 | 4455 | 32284 | 3623 | 33161 | 2981 | 33549 | 2012 | 39536 | 1731 | 21817 |
| 16-#11 | 2.08 | MA | 22430 | 6167 | 35672 | 4575 | 38214 | 3719 | 38574 | 3078 | 37497 | 2108 | 44511 | 1529 | 28091 |
| 8L-2S | | MI | 18948 | 6167 | 30664 | 4460 | 33347 | 3613 | 34453 | 2972 | 35262 | 2004 | 41788 | 1817 | 21789 |
| 16-#14 | 3.00 | MA | 25549 | 6549 | 42038 | 4796 | 46383 | 3863 | 48494 | 3144 | 51124 | 2070 | 62098 | 1598 | 42336 |
| 4L-6S | | MI | 17850 | 6549 | 29741 | 4671 | 32003 | 3773 | 32800 | 3078 | 33081 | 1962 | 39642 | 1305 | 29391 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis

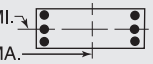


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 3.00 | MA | 24857 | 6549 | 40859 | 4792 | 44853 | 3881 | 46615 | 3160 | 48414 | 2058 | 58879 | 1540 | 41213 |
| 5E | | MI | 18331 | 6549 | 30538 | 4679 | 33104 | 3784 | 34066 | 3065 | 34764 | 1949 | 41684 | 1388 | 29866 |
| 16-#14 | 3.00 | MA | 24197 | 6549 | 39752 | 4787 | 43322 | 3875 | 44743 | 3151 | 45958 | 2070 | 55836 | 1459 | 40362 |
| 6L-4S | | MI | 18834 | 6549 | 31386 | 4687 | 34202 | 3770 | 35396 | 3053 | 36626 | 1962 | 43876 | 1442 | 30682 |
| 16-#14 | 3.00 | MA | 23555 | 6549 | 38540 | 4807 | 41860 | 3893 | 42946 | 3167 | 43557 | 2083 | 52586 | 1329 | 39124 |
| 7L-3S | | MI | 19394 | 6549 | 32361 | 4670 | 35444 | 3781 | 36886 | 3065 | 38480 | 1949 | 45932 | 1563 | 30756 |
| 16-#14 | 3.00 | MA | 22922 | 6549 | 37451 | 4803 | 40377 | 3886 | 41192 | 3183 | 41006 | 2070 | 49578 | 1261 | 37977 |
| 8L-2S | | MI | 20174 | 6549 | 33543 | 4679 | 36959 | 3768 | 38716 | 3053 | 40906 | 1937 | 49111 | 1688 | 30765 |
| 16-#18 | 5.33 | MA | 27391 | 7517 | 47805 | 5370 | 53591 | 4307 | 57210 | 3412 | 62469 | 1942 | 78041 | 1054 | 68502 |
| 5E | | MI | 19970 | 7517 | 35377 | 5236 | 39107 | 4184 | 41100 | 3271 | 44098 | 1776 | 54108 | 798 | 48832 |
| 16-#18 | 5.33 | MA | 26274 | 7517 | 45861 | 5359 | 50901 | 4293 | 53923 | 3394 | 58215 | 1964 | 72803 | 909 | 65103 |
| 6L-4S | | MI | 20826 | 7517 | 36858 | 5253 | 41015 | 4162 | 43377 | 3249 | 47289 | 1798 | 57834 | 896 | 50221 |
| 18-#11 | 2.34 | MA | 24835 | 6275 | 40037 | 4636 | 43898 | 3750 | 45492 | 3078 | 47067 | 2098 | 56635 | 1745 | 33541 |
| 4L-7S | | MI | 17345 | 6275 | 28222 | 4536 | 30204 | 3678 | 30626 | 3010 | 30288 | 2017 | 35973 | 1458 | 23645 |
| 18-#11 | 2.34 | MA | 24346 | 6275 | 39215 | 4634 | 42831 | 3763 | 44181 | 3090 | 45168 | 2090 | 54374 | 1704 | 33385 |
| 5L-6S | | MI | 17676 | 6275 | 28832 | 4524 | 30939 | 3668 | 31568 | 3019 | 31450 | 2008 | 37332 | 1523 | 23871 |
| 18-#11 | 2.34 | MA | 23881 | 6275 | 38443 | 4631 | 41762 | 3759 | 42875 | 3085 | 43447 | 2099 | 52231 | 1648 | 32688 |
| 6L-5S | | MI | 18015 | 6275 | 29389 | 4529 | 31709 | 3675 | 32462 | 3010 | 32639 | 2000 | 38780 | 1580 | 24272 |
| 18-#11 | 2.34 | MA | 23427 | 6275 | 37598 | 4645 | 40743 | 3772 | 41621 | 3096 | 41766 | 2107 | 49943 | 1558 | 32267 |
| 7L-4S | | MI | 18371 | 6275 | 29982 | 4535 | 32478 | 3665 | 33401 | 3001 | 33953 | 2008 | 40333 | 1618 | 24415 |
| 18-#11 | 2.34 | MA | 22981 | 6275 | 36838 | 4642 | 39709 | 3768 | 40398 | 3108 | 39979 | 2099 | 47829 | 1510 | 31573 |
| 8L-3S | | MI | 18766 | 6275 | 30664 | 4523 | 33347 | 3672 | 34453 | 3010 | 35262 | 2000 | 41788 | 1703 | 24417 |
| 18-#11 | 2.34 | MA | 22527 | 6275 | 36020 | 4657 | 38703 | 3781 | 39118 | 3102 | 38312 | 2108 | 45751 | 1456 | 30912 |
| 9L-2S | | MI | 19318 | 6275 | 31493 | 4528 | 34410 | 3661 | 35746 | 3001 | 36976 | 1991 | 44041 | 1790 | 24396 |
| 18-#14 | 3.38 | MA | 25621 | 6704 | 42527 | 4889 | 46992 | 3951 | 49224 | 3202 | 51953 | 2045 | 63593 | 1511 | 46221 |
| 5L-6S | | MI | 18378 | 6704 | 30923 | 4768 | 33518 | 3843 | 34630 | 3118 | 35507 | 1942 | 42822 | 1263 | 32952 |
| 18-#14 | 3.38 | MA | 24965 | 6704 | 41421 | 4884 | 45460 | 3944 | 47352 | 3193 | 49497 | 2057 | 60551 | 1430 | 45405 |
| 6L-5S | | MI | 18857 | 6704 | 31720 | 4776 | 34619 | 3854 | 35895 | 3106 | 37191 | 1930 | 44863 | 1345 | 33402 |
| 18-#14 | 3.38 | MA | 24327 | 6704 | 40209 | 4905 | 43999 | 3963 | 45555 | 3209 | 47097 | 2070 | 57301 | 1300 | 44081 |
| 7L-4S | | MI | 19358 | 6704 | 32568 | 4784 | 35717 | 3840 | 37225 | 3094 | 39052 | 1942 | 47055 | 1400 | 34328 |
| 18-#14 | 3.38 | MA | 23699 | 6704 | 39119 | 4900 | 42516 | 3956 | 43801 | 3225 | 44546 | 2057 | 54292 | 1232 | 42961 |
| 8L-3S | | MI | 19914 | 6704 | 33543 | 4768 | 36959 | 3851 | 38716 | 3106 | 40906 | 1930 | 49111 | 1521 | 34425 |
| 18-#14 | 3.38 | MA | 23077 | 6704 | 37947 | 4920 | 41073 | 3974 | 41967 | 3216 | 42167 | 2070 | 51342 | 1154 | 41307 |
| 9L-2S | | MI | 20691 | 6704 | 34725 | 4776 | 38475 | 3838 | 40546 | 3094 | 43333 | 1917 | 52290 | 1646 | 34461 |
| 18-#18 | 6.00 | MA | 27577 | 7794 | 48778 | 5532 | 54641 | 4417 | 58485 | 3469 | 64345 | 1938 | 80931 | 851 | 73720 |
| 6L-5S | | MI | 20856 | 7794 | 37430 | 5409 | 41728 | 4308 | 44233 | 3340 | 48254 | 1736 | 59514 | 713 | 54703 |
| 20-#11 | 2.60 | MA | 24887 | 6383 | 40381 | 4701 | 44326 | 3812 | 46004 | 3120 | 47650 | 2081 | 57693 | 1686 | 36885 |
| 5L-7S | | MI | 17721 | 6383 | 29051 | 4604 | 31266 | 3726 | 31918 | 3039 | 32002 | 2004 | 38225 | 1430 | 26161 |
| 20-#11 | 2.60 | MA | 24424 | 6383 | 39609 | 4698 | 43258 | 3807 | 44699 | 3114 | 45929 | 2090 | 55550 | 1630 | 36218 |
| 6E | | MI | 18051 | 6383 | 29661 | 4592 | 32002 | 3716 | 32860 | 3048 | 33164 | 1996 | 39585 | 1496 | 26378 |
| 20-#11 | 2.60 | MA | 23973 | 6383 | 38764 | 4713 | 42238 | 3820 | 43445 | 3126 | 44247 | 2099 | 53262 | 1539 | 35811 |
| 7L-5S | | MI | 18389 | 6383 | 30218 | 4597 | 32772 | 3723 | 33754 | 3039 | 34352 | 1987 | 41033 | 1553 | 26757 |
| 20-#11 | 2.60 | MA | 23528 | 6383 | 38005 | 4710 | 41204 | 3816 | 42222 | 3137 | 42460 | 2090 | 51148 | 1491 | 35062 |
| 8L-4S | | MI | 18743 | 6383 | 30811 | 4602 | 33540 | 3713 | 34693 | 3031 | 35667 | 1996 | 42586 | 1590 | 26992 |
| 20-#11 | 2.60 | MA | 23088 | 6383 | 37187 | 4724 | 40198 | 3829 | 40942 | 3132 | 40794 | 2099 | 49070 | 1437 | 34421 |
| 9L-3S | | MI | 19137 | 6383 | 31493 | 4590 | 34410 | 3720 | 35746 | 3039 | 36976 | 1987 | 44041 | 1676 | 27011 |
| 20-#11 | 2.60 | MA | 22591 | 6383 | 36429 | 4721 | 39177 | 3825 | 39725 | 3143 | 39141 | 2108 | 47057 | 1376 | 33516 |
| 10L-2S | | MI | 19687 | 6383 | 32322 | 4595 | 35473 | 3710 | 37038 | 3031 | 38689 | 1978 | 46294 | 1762 | 26997 |
| 20-#14 | 3.75 | MA | 25728 | 6860 | 43089 | 4982 | 47599 | 4014 | 49961 | 3236 | 53037 | 2044 | 65265 | 1401 | 50455 |
| 6E | | MI | 18904 | 6860 | 32105 | 4865 | 35033 | 3913 | 36459 | 3159 | 37934 | 1922 | 46001 | 1221 | 36479 |
| 20-#14 | 3.75 | MA | 25094 | 6860 | 41877 | 5002 | 46137 | 4032 | 48164 | 3252 | 50636 | 2057 | 62015 | 1271 | 49048 |
| 7L-5S | | MI | 19379 | 6860 | 32902 | 4873 | 36134 | 3924 | 37725 | 3147 | 39617 | 1910 | 48042 | 1303 | 36946 |
| 20-#14 | 3.75 | MA | 24470 | 6860 | 40788 | 4997 | 44654 | 4026 | 46410 | 3268 | 48085 | 2044 | 59007 | 1203 | 47864 |
| 8L-4S | | MI | 19878 | 6860 | 33750 | 4882 | 37232 | 3910 | 39055 | 3134 | 41479 | 1922 | 50234 | 1358 | 37846 |
| 20-#14 | 3.75 | MA | 23852 | 6860 | 39615 | 5018 | 43212 | 4044 | 44576 | 3259 | 45706 | 2057 | 56056 | 1125 | 46255 |
| 9L-3S | | MI | 20432 | 6860 | 34725 | 4865 | 38475 | 3921 | 40546 | 3147 | 43333 | 1910 | 52290 | 1479 | 38088 |
| 22-#11 | 2.86 | MA | 24964 | 6491 | 40776 | 4766 | 44753 | 3856 | 46523 | 3143 | 48410 | 2081 | 58868 | 1611 | 39752 |
| 6L-7S | | MI | 18096 | 6491 | 29880 | 4671 | 32329 | 3775 | 33210 | 3068 | 33715 | 1992 | 40478 | 1403 | 28643 |

## RECTANGULAR TIED COLUMNS 30" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.86 | MA | 24515 | 6491 | 39930 | 4780 | 43733 | 3869 | 45269 | 3155 | 46729 | 2090 | 56580 | 1521 | 39357 |
| 7L-6S | | MI | 18424 | 6491 | 30490 | 4659 | 33065 | 3764 | 34152 | 3077 | 34877 | 1983 | 41838 | 1469 | 28888 |
| 22-#11 | 2.86 | MA | 24073 | 6491 | 39171 | 4777 | 42699 | 3865 | 44045 | 3167 | 44942 | 2082 | 54467 | 1473 | 38556 |
| 8L-5S | | MI | 18761 | 6491 | 31047 | 4664 | 33835 | 3772 | 35046 | 3068 | 36066 | 1974 | 43286 | 1526 | 29247 |
| 22-#11 | 2.86 | MA | 23634 | 6491 | 38353 | 4792 | 41693 | 3878 | 42766 | 3161 | 43275 | 2091 | 52388 | 1419 | 37933 |
| 9L-4S | | MI | 19114 | 6491 | 31640 | 4670 | 34603 | 3761 | 35986 | 3060 | 37380 | 1983 | 44839 | 1563 | 29564 |
| 22-#11 | 2.86 | MA | 23140 | 6491 | 37596 | 4789 | 40672 | 3873 | 41549 | 3173 | 41623 | 2100 | 50376 | 1358 | 36991 |
| 10L-3S | | MI | 19506 | 6491 | 32322 | 4657 | 35473 | 3768 | 37038 | 3068 | 38689 | 1974 | 46294 | 1648 | 29595 |
| 22-#14 | 4.13 | MA | 25856 | 7016 | 43545 | 5099 | 48276 | 4102 | 50773 | 3294 | 54176 | 2044 | 66730 | 1242 | 54024 |
| 7L-6S | | MI | 19426 | 7016 | 33287 | 4962 | 36548 | 3983 | 38289 | 3200 | 40360 | 1903 | 49180 | 1179 | 39933 |
| 22-#14 | 4.13 | MA | 25236 | 7016 | 42456 | 5095 | 46793 | 4095 | 49019 | 3310 | 51625 | 2031 | 63721 | 1174 | 52777 |
| 8L-5S | | MI | 19900 | 7016 | 34084 | 4971 | 37650 | 3994 | 39555 | 3188 | 42044 | 1890 | 51222 | 1261 | 40496 |
| 22-#14 | 4.13 | MA | 24622 | 7016 | 41283 | 5115 | 45350 | 4114 | 47185 | 3301 | 49246 | 2044 | 60771 | 1096 | 51212 |
| 9L-4S | | MI | 20396 | 7016 | 34932 | 4979 | 38748 | 3980 | 40885 | 3175 | 43905 | 1903 | 53413 | 1316 | 41347 |
| 24-#11 | 3.12 | MA | 25054 | 6599 | 41097 | 4847 | 45228 | 3917 | 47093 | 3184 | 49210 | 2082 | 59899 | 1502 | 42906 |
| 7E | | MI | 18468 | 6599 | 30709 | 4739 | 33392 | 3823 | 34503 | 3097 | 35429 | 1979 | 42731 | 1375 | 31095 |
| 24-#11 | 3.12 | MA | 24614 | 6599 | 40337 | 4845 | 44194 | 3913 | 45869 | 3196 | 47423 | 2073 | 57785 | 1454 | 42055 |
| 8L-6S | | MI | 18796 | 6599 | 31319 | 4727 | 34128 | 3813 | 35445 | 3106 | 36591 | 1970 | 44091 | 1441 | 31401 |
| 24-#11 | 3.12 | MA | 24176 | 6599 | 39519 | 4859 | 43188 | 3926 | 44590 | 3190 | 45757 | 2082 | 55707 | 1400 | 41426 |
| 9L-5S | | MI | 19131 | 6599 | 31876 | 4732 | 34898 | 3820 | 36339 | 3097 | 37780 | 1962 | 45539 | 1498 | 31742 |
| 24-#11 | 3.12 | MA | 23687 | 6599 | 38762 | 4856 | 42167 | 3922 | 43373 | 3202 | 44104 | 2091 | 53694 | 1339 | 40471 |
| 10L-4S | | MI | 19482 | 6599 | 32469 | 4737 | 35666 | 3810 | 37278 | 3089 | 39094 | 1970 | 47092 | 1536 | 32132 |
| 24-#14 | 4.50 | MA | 25997 | 7171 | 44124 | 5192 | 48932 | 4165 | 51628 | 3353 | 55164 | 2018 | 68436 | 1145 | 57700 |
| 8L-6S | | MI | 19946 | 7171 | 34469 | 5060 | 38064 | 4052 | 40119 | 3241 | 42787 | 1883 | 52359 | 1137 | 43398 |
| 24-#14 | 4.50 | MA | 25384 | 7171 | 42951 | 5212 | 47489 | 4183 | 49794 | 3344 | 52785 | 2031 | 65486 | 1067 | 56176 |
| 9L-5S | | MI | 20417 | 7171 | 35266 | 5068 | 39165 | 4063 | 41385 | 3229 | 44470 | 1871 | 54401 | 1219 | 44053 |

## RECTANGULAR TIED COLUMNS 30" x 42"

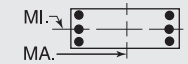
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.27 | MA | 26312 | 6122 | 41219 | 4534 | 44467 | 3694 | 45286 | 3077 | 45025 | 2199 | 52712 | 2065 | 20320 |
| 2E | | MI | 18565 | 6122 | 29505 | 4399 | 31303 | 3581 | 31466 | 2970 | 30753 | 2097 | 35487 | 1935 | 14136 |
| 6-#14 | 1.07 | MA | 25926 | 6036 | 40204 | 4510 | 43338 | 3680 | 43974 | 3075 | 43362 | 2228 | 50612 | 2109 | 17372 |
| 2L-3S | | MI | 17537 | 6036 | 27655 | 4379 | 29109 | 3593 | 28940 | 2997 | 27422 | 2153 | 31220 | 1876 | 12225 |
| 6-#14 | 1.07 | MA | 24722 | 6036 | 38438 | 4506 | 41074 | 3699 | 41213 | 3092 | 39606 | 2241 | 45590 | 1985 | 17442 |
| 3L-2S | | MI | 18338 | 6036 | 28837 | 4387 | 30625 | 3579 | 30770 | 2985 | 29848 | 2140 | 34399 | 2000 | 12141 |
| 6-#18 | 1.90 | MA | 27738 | 6399 | 44309 | 4707 | 48428 | 3818 | 50119 | 3153 | 51552 | 2175 | 61386 | 2011 | 30045 |
| 2L-3S | | MI | 18104 | 6399 | 29505 | 4555 | 31303 | 3727 | 31466 | 3061 | 30753 | 2079 | 35487 | 1629 | 20789 |
| 6-#18 | 1.90 | MA | 25664 | 6399 | 41219 | 4698 | 44467 | 3849 | 45286 | 3180 | 45025 | 2197 | 52712 | 1789 | 30033 |
| 3L-2S | | MI | 19476 | 6399 | 31558 | 4572 | 33925 | 3704 | 34599 | 3039 | 34909 | 2057 | 40893 | 1851 | 20679 |
| 8-#14 | 1.43 | MA | 26755 | 6192 | 41969 | 4607 | 45601 | 3750 | 46735 | 3117 | 47119 | 2216 | 55635 | 2082 | 22935 |
| 2L-4S | | MI | 17503 | 6192 | 27862 | 4493 | 29383 | 3651 | 29280 | 3026 | 27994 | 2145 | 32343 | 1712 | 16053 |
| 8-#14 | 1.43 | MA | 25559 | 6192 | 40204 | 4603 | 43338 | 3768 | 43974 | 3134 | 43362 | 2228 | 50612 | 1957 | 22981 |
| 3E | | MI | 18076 | 6192 | 28837 | 4476 | 30625 | 3663 | 30770 | 3038 | 29848 | 2133 | 34399 | 1833 | 15988 |
| 8-#14 | 1.43 | MA | 24717 | 6192 | 38764 | 4624 | 41502 | 3762 | 41744 | 3126 | 40492 | 2241 | 47347 | 1833 | 22949 |
| 4L-2S | | MI | 18872 | 6192 | 30019 | 4485 | 32140 | 3649 | 32600 | 3026 | 32275 | 2121 | 37578 | 1958 | 15915 |
| 8-#18 | 2.54 | MA | 29145 | 6676 | 47399 | 4880 | 52389 | 3942 | 54951 | 3228 | 58078 | 2150 | 70061 | 1956 | 39725 |
| 2L-4S | | MI | 18032 | 6676 | 29857 | 4754 | 31769 | 3828 | 32045 | 3108 | 31735 | 2061 | 37386 | 1335 | 26590 |
| 8-#18 | 2.54 | MA | 27091 | 6676 | 44309 | 4870 | 48428 | 3973 | 50119 | 3255 | 51552 | 2172 | 61386 | 1735 | 39599 |
| 3E | | MI | 19015 | 6676 | 31558 | 4727 | 33925 | 3850 | 34599 | 3130 | 34909 | 2039 | 40893 | 1545 | 27207 |
| 8-#18 | 2.54 | MA | 25643 | 6676 | 41782 | 4906 | 45207 | 3960 | 46205 | 3238 | 46563 | 2194 | 55762 | 1513 | 38630 |
| 4L-2S | | MI | 20377 | 6676 | 33610 | 4745 | 36546 | 3828 | 37732 | 3108 | 39064 | 2017 | 46299 | 1766 | 27163 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis

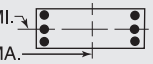



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.24 | MA | 26352 | 6109 | 41007 | 4571 | 44455 | 3725 | 45371 | 3105 | 45277 | 2230 | 53298 | 2111 | 20045 |
| 2L-5S | | MI | 17298 | 6109 | 27274 | 4456 | 28700 | 3642 | 28498 | 3031 | 26862 | 2156 | 30957 | 1792 | 14109 |
| 10-#11 | 1.24 | MA | 25512 | 6109 | 39773 | 4568 | 42874 | 3721 | 43442 | 3118 | 42652 | 2240 | 49765 | 2024 | 20083 |
| 3L-4S | | MI | 17660 | 6109 | 27867 | 4461 | 29468 | 3632 | 29437 | 3022 | 28176 | 2165 | 32510 | 1829 | 14064 |
| 10-#11 | 1.24 | MA | 24922 | 6109 | 38768 | 4583 | 41593 | 3735 | 41885 | 3112 | 40649 | 2249 | 47466 | 1938 | 20104 |
| 4L-3S | | MI | 18062 | 6109 | 28550 | 4449 | 30338 | 3639 | 30489 | 3031 | 29486 | 2156 | 33965 | 1914 | 14011 |
| 10-#11 | 1.24 | MA | 24395 | 6109 | 37899 | 4580 | 40467 | 3731 | 40501 | 3124 | 38643 | 2242 | 45064 | 1897 | 20066 |
| 5L-2S | | MI | 18623 | 6109 | 29379 | 4454 | 31401 | 3629 | 31782 | 3022 | 31199 | 2147 | 36218 | 2001 | 13960 |
| 10-#14 | 1.79 | MA | 27577 | 6347 | 43735 | 4705 | 47864 | 3820 | 49497 | 3160 | 50876 | 2203 | 60658 | 2055 | 28479 |
| 2L-5S | | MI | 17528 | 6347 | 28196 | 4582 | 29800 | 3735 | 29780 | 3079 | 28559 | 2113 | 33330 | 1615 | 19509 |
| 10-#14 | 1.79 | MA | 26387 | 6347 | 41969 | 4700 | 45601 | 3838 | 46735 | 3177 | 47119 | 2216 | 55635 | 1930 | 28495 |
| 3L-4S | | MI | 18041 | 6347 | 29044 | 4590 | 30898 | 3721 | 31110 | 3066 | 30421 | 2126 | 35522 | 1670 | 19760 |
| 10-#14 | 1.79 | MA | 25551 | 6347 | 40529 | 4721 | 43766 | 3832 | 44505 | 3168 | 44249 | 2229 | 52370 | 1806 | 28416 |
| 4L-3S | | MI | 18611 | 6347 | 30019 | 4574 | 32140 | 3732 | 32600 | 3079 | 32275 | 2113 | 37578 | 1791 | 19722 |
| 10-#14 | 1.79 | MA | 24804 | 6347 | 39283 | 4717 | 42150 | 3851 | 42520 | 3185 | 41374 | 2217 | 48948 | 1747 | 27902 |
| 5L-2S | | MI | 19403 | 6347 | 31201 | 4582 | 33655 | 3719 | 34430 | 3066 | 34701 | 2101 | 40757 | 1916 | 19663 |
| 10-#18 | 3.17 | MA | 30535 | 6952 | 50489 | 5052 | 56350 | 4066 | 59783 | 3303 | 64605 | 2125 | 78735 | 1901 | 49352 |
| 2L-5S | | MI | 18065 | 6952 | 30429 | 4910 | 32483 | 3973 | 32901 | 3199 | 32699 | 1999 | 39066 | 1152 | 31036 |
| 10-#18 | 3.17 | MA | 28500 | 6952 | 47399 | 5043 | 52389 | 4097 | 54951 | 3331 | 58078 | 2147 | 70061 | 1680 | 49139 |
| 3L-4S | | MI | 18943 | 6952 | 31910 | 4927 | 34391 | 3951 | 35178 | 3177 | 35890 | 2021 | 42792 | 1251 | 32504 |
| 10-#18 | 3.17 | MA | 27067 | 6952 | 44872 | 5078 | 49169 | 4084 | 51037 | 3314 | 53090 | 2169 | 64436 | 1459 | 47657 |
| 4L-3S | | MI | 19918 | 6952 | 33610 | 4900 | 36546 | 3973 | 37732 | 3199 | 39064 | 1999 | 46299 | 1460 | 33577 |
| 10-#18 | 3.17 | MA | 25786 | 6952 | 42683 | 5069 | 46331 | 4115 | 47551 | 3341 | 48091 | 2147 | 58502 | 1357 | 44935 |
| 5L-2S | | MI | 21269 | 6952 | 35663 | 4918 | 39168 | 3951 | 40865 | 3177 | 43220 | 1977 | 51704 | 1681 | 33611 |
| 12-#11 | 1.49 | MA | 26932 | 6217 | 42240 | 4638 | 46037 | 3773 | 47301 | 3135 | 47902 | 2222 | 56830 | 2093 | 23923 |
| 2L-6S | | MI | 17335 | 6217 | 27546 | 4518 | 28993 | 3684 | 28896 | 3069 | 27387 | 2152 | 31762 | 1707 | 16504 |
| 12-#11 | 1.49 | MA | 26096 | 6217 | 41007 | 4636 | 44455 | 3770 | 45371 | 3147 | 45277 | 2231 | 53298 | 2007 | 23950 |
| 3L-5S | | MI | 17679 | 6217 | 28103 | 4523 | 29763 | 3691 | 29790 | 3060 | 28576 | 2143 | 33210 | 1764 | 16709 |
| 12-#11 | 1.49 | MA | 25509 | 6217 | 40002 | 4650 | 43175 | 3783 | 43815 | 3142 | 43274 | 2241 | 50998 | 1920 | 23947 |
| 4E | | MI | 18040 | 6217 | 28696 | 4528 | 30531 | 3681 | 30730 | 3051 | 29890 | 2152 | 34763 | 1802 | 16682 |
| 12-#11 | 1.49 | MA | 24984 | 6217 | 39133 | 4648 | 42048 | 3779 | 42430 | 3154 | 41268 | 2233 | 48596 | 1879 | 23886 |
| 5L-3S | | MI | 18441 | 6217 | 29379 | 4516 | 31401 | 3688 | 31782 | 3060 | 31199 | 2143 | 36218 | 1887 | 16639 |
| 12-#11 | 1.49 | MA | 24485 | 6217 | 38319 | 4645 | 40920 | 3793 | 41052 | 3149 | 39451 | 2243 | 46313 | 1823 | 23448 |
| 6L-2S | | MI | 18999 | 6217 | 30208 | 4522 | 32464 | 3678 | 33074 | 3051 | 32913 | 2135 | 38471 | 1973 | 16594 |
| 12-#14 | 2.14 | MA | 28392 | 6503 | 45500 | 4802 | 50128 | 3889 | 52258 | 3202 | 54633 | 2191 | 65681 | 2028 | 34009 |
| 2L-6S | | MI | 17578 | 6503 | 28581 | 4671 | 30214 | 3794 | 30344 | 3132 | 29302 | 2106 | 34468 | 1491 | 22448 |
| 12-#14 | 2.14 | MA | 27209 | 6503 | 43735 | 4798 | 47864 | 3908 | 49497 | 3219 | 50876 | 2204 | 60658 | 1903 | 33990 |
| 3L-5S | | MI | 18065 | 6503 | 29378 | 4679 | 31315 | 3805 | 31610 | 3120 | 30986 | 2094 | 36509 | 1573 | 23003 |
| 12-#14 | 2.14 | MA | 26379 | 6503 | 42295 | 4818 | 46029 | 3902 | 47266 | 3211 | 48005 | 2216 | 57393 | 1779 | 33873 |
| 4E | | MI | 18575 | 6503 | 30226 | 4688 | 32413 | 3791 | 32940 | 3107 | 32847 | 2106 | 38701 | 1628 | 23440 |
| 12-#14 | 2.14 | MA | 25636 | 6503 | 41049 | 4814 | 44414 | 3921 | 45281 | 3228 | 45131 | 2204 | 53970 | 1720 | 33155 |
| 5L-3S | | MI | 19142 | 6503 | 31201 | 4671 | 33655 | 3802 | 34430 | 3120 | 34701 | 2094 | 40757 | 1749 | 23438 |
| 12-#14 | 2.14 | MA | 24930 | 6503 | 39881 | 4810 | 42796 | 3915 | 43304 | 3219 | 42525 | 2217 | 50727 | 1639 | 32112 |
| 6L-2S | | MI | 19930 | 6503 | 32383 | 4679 | 35171 | 3788 | 36260 | 3107 | 37128 | 2081 | 43936 | 1874 | 23394 |
| 12-#18 | 3.81 | MA | 29893 | 7229 | 50489 | 5216 | 56350 | 4221 | 59783 | 3406 | 64605 | 2122 | 78735 | 1625 | 58664 |
| 3L-5S | | MI | 18974 | 7229 | 32482 | 5083 | 35104 | 4097 | 36034 | 3268 | 36855 | 1959 | 44472 | 1067 | 37120 |
| 12-#18 | 3.81 | MA | 28474 | 7229 | 47962 | 5251 | 53130 | 4208 | 55870 | 3389 | 59616 | 2144 | 73111 | 1404 | 56736 |
| 4E | | MI | 19845 | 7229 | 33962 | 5100 | 37012 | 4074 | 38311 | 3246 | 40046 | 1981 | 48198 | 1166 | 38467 |
| 12-#18 | 3.81 | MA | 27206 | 7229 | 45773 | 5242 | 50292 | 4240 | 52383 | 3416 | 54617 | 2122 | 67176 | 1303 | 54174 |
| 5L-3S | | MI | 20812 | 7229 | 35663 | 5073 | 39168 | 4097 | 40865 | 3268 | 43220 | 1959 | 51704 | 1375 | 39920 |
| 12-#18 | 3.81 | MA | 26001 | 7229 | 43719 | 5233 | 47449 | 4227 | 48910 | 3399 | 50088 | 2144 | 61581 | 1158 | 51139 |
| 6L-2S | | MI | 22154 | 7229 | 37715 | 5090 | 41790 | 4074 | 43998 | 3246 | 47376 | 1937 | 57110 | 1597 | 40029 |
| 14-#11 | 1.73 | MA | 27509 | 6324 | 43474 | 4706 | 47618 | 3822 | 49230 | 3164 | 50527 | 2213 | 60363 | 2076 | 27793 |
| 2L-7S | | MI | 17382 | 6324 | 27765 | 4597 | 29320 | 3742 | 29246 | 3089 | 27939 | 2148 | 32655 | 1614 | 18740 |
| 14-#11 | 1.73 | MA | 26676 | 6324 | 42240 | 4703 | 46037 | 3818 | 47301 | 3176 | 47902 | 2223 | 56830 | 1989 | 27809 |
| 3L-6S | | MI | 17716 | 6324 | 28375 | 4585 | 30056 | 3732 | 30189 | 3098 | 29101 | 2139 | 34015 | 1680 | 18995 |
| 14-#11 | 1.73 | MA | 26092 | 6324 | 41235 | 4718 | 44756 | 3831 | 45744 | 3171 | 45899 | 2232 | 54531 | 1903 | 27783 |
| 4L-5S | | MI | 18059 | 6324 | 28932 | 4591 | 30826 | 3739 | 31083 | 3089 | 30289 | 2130 | 35463 | 1737 | 19298 |

## RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

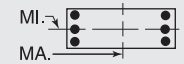
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.73 | MA | 25570 | 6324 | 40367 | 4715 | 43629 | 3828 | 44360 | 3183 | 43893 | 2224 | 52129 | 1861 | 27700 |
| 5L-4S | | MI | 18418 | 6324 | 29525 | 4596 | 31594 | 3729 | 32022 | 3080 | 31604 | 2139 | 37016 | 1774 | 19288 |
| 14-#11 | 1.73 | MA | 25073 | 6324 | 39552 | 4713 | 42501 | 3841 | 42981 | 3178 | 42076 | 2234 | 49846 | 1805 | 27162 |
| 6L-3S | | MI | 18817 | 6324 | 30208 | 4584 | 32464 | 3736 | 33074 | 3089 | 32913 | 2130 | 38471 | 1860 | 19257 |
| 14-#11 | 1.73 | MA | 24589 | 6324 | 38660 | 4727 | 41425 | 3837 | 41658 | 3190 | 40301 | 2243 | 47410 | 1715 | 26660 |
| 7L-2S | | MI | 19374 | 6324 | 31037 | 4589 | 33526 | 3726 | 34367 | 3080 | 34626 | 2122 | 40724 | 1946 | 19218 |
| 14-#14 | 2.50 | MA | 28025 | 6658 | 45500 | 4895 | 50128 | 3978 | 52258 | 3261 | 54633 | 2191 | 65681 | 1876 | 39473 |
| 3L-6S | | MI | 18114 | 6658 | 29763 | 4768 | 31729 | 3864 | 32174 | 3173 | 31729 | 2086 | 37647 | 1449 | 25997 |
| 14-#14 | 2.50 | MA | 27199 | 6658 | 44060 | 4916 | 48292 | 3972 | 50027 | 3253 | 51762 | 2204 | 62415 | 1752 | 39322 |
| 4L-5S | | MI | 18598 | 6658 | 30560 | 4777 | 32830 | 3875 | 33440 | 3161 | 33412 | 2074 | 39689 | 1531 | 26515 |
| 14-#14 | 2.50 | MA | 26462 | 6658 | 42814 | 4912 | 46677 | 3991 | 48042 | 3270 | 48888 | 2192 | 58993 | 1693 | 38428 |
| 5L-4S | | MI | 19106 | 6658 | 31408 | 4785 | 33929 | 3861 | 34770 | 3148 | 35274 | 2086 | 41880 | 1586 | 27108 |
| 14-#14 | 2.50 | MA | 25760 | 6658 | 41646 | 4907 | 45059 | 3984 | 46065 | 3262 | 46282 | 2205 | 55749 | 1612 | 37436 |
| 6L-3S | | MI | 19669 | 6658 | 32383 | 4768 | 35171 | 3872 | 36260 | 3161 | 37128 | 2074 | 43936 | 1707 | 27142 |
| 14-#14 | 2.50 | MA | 25077 | 6658 | 40367 | 4928 | 43516 | 4003 | 44167 | 3279 | 43736 | 2217 | 52287 | 1482 | 36355 |
| 7L-2S | | MI | 20454 | 6658 | 33565 | 4776 | 36686 | 3858 | 38090 | 3148 | 39554 | 2061 | 47116 | 1831 | 27113 |
| 14-#18 | 4.44 | MA | 29866 | 7506 | 51052 | 5424 | 57091 | 4333 | 60702 | 3465 | 66143 | 2120 | 81785 | 1349 | 65858 |
| 4L-5S | | MI | 19875 | 7506 | 34534 | 5256 | 37726 | 4220 | 39167 | 3337 | 41011 | 1919 | 49877 | 983 | 43226 |
| 14-#18 | 4.44 | MA | 28610 | 7506 | 48863 | 5415 | 54253 | 4364 | 57216 | 3492 | 61144 | 2098 | 75851 | 1248 | 63438 |
| 5L-4S | | MI | 20739 | 7506 | 36015 | 5273 | 39634 | 4198 | 41444 | 3315 | 44202 | 1941 | 53604 | 1081 | 44470 |
| 14-#18 | 4.44 | MA | 27417 | 7506 | 46809 | 5406 | 51410 | 4351 | 53742 | 3475 | 56615 | 2120 | 70256 | 1103 | 60226 |
| 6L-3S | | MI | 21699 | 7506 | 37715 | 5246 | 41790 | 4220 | 43998 | 3337 | 47376 | 1919 | 57110 | 1291 | 46246 |
| 14-#18 | 4.44 | MA | 26255 | 7506 | 44560 | 5441 | 48697 | 4382 | 50407 | 3502 | 52189 | 2142 | 64278 | 872 | 57144 |
| 7L-2S | | MI | 23031 | 7506 | 39768 | 5263 | 44411 | 4198 | 47131 | 3315 | 51532 | 1897 | 62516 | 1512 | 46412 |
| 16-#11 | 1.98 | MA | 27253 | 6432 | 43474 | 4770 | 47618 | 3866 | 49230 | 3206 | 50527 | 2214 | 60363 | 1972 | 31655 |
| 3L-7S | | MI | 17762 | 6432 | 28594 | 4665 | 30383 | 3791 | 30539 | 3118 | 29653 | 2135 | 34908 | 1587 | 21253 |
| 16-#11 | 1.98 | MA | 26671 | 6432 | 42469 | 4785 | 46338 | 3880 | 47673 | 3201 | 48524 | 2224 | 58063 | 1885 | 31612 |
| 4L-6S | | MI | 18095 | 6432 | 29204 | 4653 | 31119 | 3781 | 31481 | 3127 | 30814 | 2126 | 36267 | 1653 | 21493 |
| 16-#11 | 1.98 | MA | 26152 | 6432 | 41600 | 4783 | 45211 | 3876 | 46289 | 3213 | 46518 | 2216 | 55661 | 1844 | 31510 |
| 5E | | MI | 18437 | 6432 | 29761 | 4658 | 31889 | 3788 | 32375 | 3118 | 32003 | 2118 | 37716 | 1710 | 21876 |
| 16-#11 | 1.98 | MA | 25658 | 6432 | 40786 | 4780 | 44083 | 3889 | 44910 | 3208 | 44701 | 2225 | 53378 | 1788 | 30885 |
| 6L-4S | | MI | 18794 | 6432 | 30354 | 4663 | 32657 | 3777 | 33314 | 3109 | 33317 | 2126 | 39269 | 1747 | 21887 |
| 16-#11 | 1.98 | MA | 25177 | 6432 | 39894 | 4795 | 43007 | 3886 | 43587 | 3220 | 42926 | 2235 | 50943 | 1698 | 30402 |
| 7L-3S | | MI | 19192 | 6432 | 31037 | 4651 | 33526 | 3785 | 34367 | 3118 | 34626 | 2118 | 40724 | 1832 | 21865 |
| 16-#11 | 1.98 | MA | 24702 | 6432 | 39092 | 4792 | 41915 | 3899 | 42295 | 3232 | 41039 | 2227 | 48697 | 1649 | 29820 |
| 8L-2S | | MI | 19747 | 6432 | 31866 | 4656 | 34589 | 3774 | 35659 | 3109 | 36340 | 2109 | 42977 | 1919 | 21834 |
| 16-#14 | 2.86 | MA | 28014 | 6814 | 45826 | 5013 | 50556 | 4042 | 52788 | 3296 | 55519 | 2191 | 67438 | 1725 | 44766 |
| 4L-6S | | MI | 18646 | 6814 | 30945 | 4866 | 33244 | 3933 | 34004 | 3214 | 34155 | 2067 | 40826 | 1406 | 29554 |
| 16-#14 | 2.86 | MA | 27282 | 6814 | 44580 | 5009 | 48940 | 4060 | 50803 | 3312 | 52644 | 2179 | 64016 | 1666 | 43717 |
| 5E | | MI | 19128 | 6814 | 31742 | 4874 | 34346 | 3945 | 35269 | 3201 | 35839 | 2054 | 42868 | 1489 | 30039 |
| 16-#14 | 2.86 | MA | 26584 | 6814 | 43412 | 5005 | 47323 | 4054 | 48826 | 3304 | 50039 | 2192 | 60772 | 1585 | 42769 |
| 6L-4S | | MI | 19633 | 6814 | 32590 | 4882 | 35444 | 3931 | 36599 | 3189 | 37700 | 2067 | 45060 | 1543 | 30766 |
| 16-#14 | 2.86 | MA | 25905 | 6814 | 42132 | 5025 | 45779 | 4073 | 46929 | 3321 | 47493 | 2205 | 57309 | 1455 | 41593 |
| 7L-3S | | MI | 20194 | 6814 | 33565 | 4865 | 36686 | 3942 | 38090 | 3201 | 39554 | 2054 | 47116 | 1665 | 30825 |
| 16-#14 | 2.86 | MA | 25237 | 6814 | 40982 | 5021 | 44213 | 4067 | 45076 | 3338 | 44787 | 2193 | 54110 | 1386 | 40327 |
| 8L-2S | | MI | 20975 | 6814 | 34747 | 4874 | 38201 | 3928 | 39920 | 3189 | 41981 | 2042 | 50295 | 1789 | 30822 |
| 16-#18 | 5.08 | MA | 30001 | 7782 | 51953 | 5588 | 58214 | 4488 | 62048 | 3567 | 67671 | 2073 | 84525 | 1193 | 72722 |
| 5E | | MI | 20768 | 7782 | 36587 | 5429 | 40348 | 4343 | 42300 | 3406 | 45167 | 1879 | 55283 | 898 | 49294 |
| 16-#18 | 5.08 | MA | 28818 | 7782 | 49899 | 5579 | 55372 | 4475 | 58575 | 3550 | 63142 | 2095 | 78930 | 1049 | 69341 |
| 6L-4S | | MI | 21627 | 7782 | 38068 | 5446 | 42256 | 4321 | 44577 | 3384 | 48358 | 1901 | 59009 | 997 | 50503 |
| 16-#18 | 5.08 | MA | 27668 | 7782 | 47650 | 5614 | 52658 | 4506 | 55239 | 3578 | 58716 | 2117 | 72952 | 817 | 66146 |
| 7L-3S | | MI | 22580 | 7782 | 39768 | 5419 | 44411 | 4343 | 47131 | 3406 | 51532 | 1879 | 62516 | 1206 | 52558 |
| 18-#11 | 2.23 | MA | 27248 | 6540 | 43703 | 4853 | 47919 | 3928 | 49603 | 3230 | 51149 | 2215 | 61596 | 1868 | 35436 |
| 4L-7S | | MI | 18141 | 6540 | 29423 | 4732 | 31446 | 3839 | 31831 | 3147 | 31366 | 2122 | 37161 | 1559 | 23768 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis

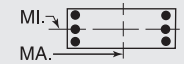


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.23 | MA | 26731 | 6540 | 42834 | 4850 | 46792 | 3924 | 48218 | 3242 | 49143 | 2207 | 59194 | 1826 | 35317 |
| 5L-6S | | MI | 18473 | 6540 | 30033 | 4720 | 32181 | 3829 | 32773 | 3156 | 32528 | 2114 | 38520 | 1625 | 23996 |
| 18-#11 | 2.23 | MA | 26239 | 6540 | 42020 | 4848 | 45664 | 3938 | 46840 | 3237 | 47326 | 2217 | 56911 | 1770 | 34615 |
| 6L-5S | | MI | 18813 | 6540 | 30590 | 4726 | 32952 | 3836 | 33667 | 3147 | 33717 | 2105 | 39969 | 1682 | 24410 |
| 18-#11 | 2.23 | MA | 25760 | 6540 | 41127 | 4862 | 44588 | 3934 | 45516 | 3249 | 45551 | 2226 | 54475 | 1680 | 34150 |
| 7L-4S | | MI | 19169 | 6540 | 31183 | 4731 | 33720 | 3826 | 34607 | 3138 | 35031 | 2114 | 41522 | 1720 | 24479 |
| 18-#11 | 2.23 | MA | 25288 | 6540 | 40326 | 4860 | 43496 | 3947 | 44225 | 3261 | 43664 | 2218 | 52229 | 1632 | 33506 |
| 8L-3S | | MI | 19565 | 6540 | 31866 | 4719 | 34589 | 3833 | 35659 | 3147 | 36340 | 2105 | 42977 | 1805 | 24468 |
| 18-#11 | 2.23 | MA | 24803 | 6540 | 39463 | 4874 | 42435 | 3944 | 42874 | 3256 | 41905 | 2228 | 50016 | 1578 | 32777 |
| 9L-2S | | MI | 20118 | 6540 | 32695 | 4724 | 35652 | 3823 | 36951 | 3138 | 38053 | 2096 | 45230 | 1891 | 24443 |
| 18-#14 | 3.21 | MA | 28095 | 6970 | 46345 | 5106 | 51204 | 4130 | 53565 | 3355 | 56401 | 2167 | 69039 | 1639 | 49018 |
| 5L-6S | | MI | 19175 | 6970 | 32127 | 4963 | 34760 | 4003 | 35833 | 3255 | 36582 | 2047 | 44005 | 1364 | 33117 |
| 18-#14 | 3.21 | MA | 27402 | 6970 | 45177 | 5102 | 49586 | 4124 | 51588 | 3347 | 53796 | 2180 | 65795 | 1558 | 48111 |
| 6L-5S | | MI | 19655 | 6970 | 32924 | 4971 | 35861 | 4014 | 37099 | 3242 | 38265 | 2034 | 46047 | 1447 | 33575 |
| 18-#14 | 3.21 | MA | 26728 | 6970 | 43898 | 5123 | 48042 | 4143 | 49690 | 3363 | 51250 | 2192 | 62332 | 1428 | 46844 |
| 7L-4S | | MI | 20157 | 6970 | 33772 | 4979 | 36959 | 4001 | 38429 | 3230 | 40127 | 2047 | 48239 | 1501 | 34417 |
| 18-#14 | 3.21 | MA | 26063 | 6970 | 42748 | 5119 | 46477 | 4137 | 47837 | 3380 | 48544 | 2180 | 59133 | 1359 | 45619 |
| 8L-3S | | MI | 20715 | 6970 | 34747 | 4963 | 38201 | 4012 | 39920 | 3242 | 41981 | 2034 | 50295 | 1623 | 34499 |
| 18-#14 | 3.21 | MA | 25402 | 6970 | 41509 | 5139 | 44953 | 4155 | 45900 | 3372 | 46021 | 2193 | 55988 | 1281 | 43969 |
| 9L-2S | | MI | 21493 | 6970 | 35929 | 4971 | 39716 | 3998 | 41749 | 3230 | 44407 | 2022 | 53474 | 1747 | 34525 |
| 18-#18 | 5.71 | MA | 30206 | 8059 | 52989 | 5752 | 59333 | 4599 | 63407 | 3626 | 69668 | 2070 | 87605 | 994 | 78480 |
| 6L-5S | | MI | 21656 | 8059 | 38639 | 5602 | 42969 | 4467 | 45433 | 3475 | 49322 | 1839 | 60689 | 814 | 55159 |
| 18-#18 | 5.71 | MA | 29066 | 8059 | 50740 | 5787 | 56619 | 4630 | 60072 | 3653 | 65242 | 2092 | 81627 | 763 | 75173 |
| 7L-4S | | MI | 22508 | 8059 | 40120 | 5619 | 44877 | 4445 | 47711 | 3453 | 52513 | 1861 | 64415 | 912 | 56562 |
| 20-#11 | 2.48 | MA | 27307 | 6648 | 44068 | 4918 | 48374 | 3973 | 50148 | 3271 | 51768 | 2199 | 62727 | 1809 | 39098 |
| 5L-7S | | MI | 18518 | 6648 | 30253 | 4800 | 32509 | 3888 | 33124 | 3176 | 33080 | 2110 | 39414 | 1532 | 26286 |
| 20-#11 | 2.48 | MA | 26817 | 6648 | 43253 | 4915 | 47246 | 3986 | 48769 | 3266 | 49951 | 2208 | 60444 | 1753 | 38350 |
| 6E | | MI | 18848 | 6648 | 30862 | 4788 | 33244 | 3877 | 34066 | 3185 | 34241 | 2101 | 40773 | 1598 | 26504 |
| 20-#11 | 2.48 | MA | 26340 | 6648 | 42361 | 4930 | 46170 | 3982 | 47446 | 3278 | 48176 | 2218 | 58008 | 1663 | 37900 |
| 7L-5S | | MI | 19187 | 6648 | 31419 | 4793 | 34014 | 3884 | 34960 | 3176 | 35430 | 2092 | 42221 | 1655 | 26895 |
| 20-#11 | 2.48 | MA | 25871 | 6648 | 41559 | 4927 | 45078 | 3996 | 46154 | 3291 | 46289 | 2210 | 55762 | 1614 | 37198 |
| 8L-4S | | MI | 19542 | 6648 | 32012 | 4798 | 34783 | 3874 | 35899 | 3168 | 36744 | 2101 | 43775 | 1692 | 27056 |
| 20-#11 | 2.48 | MA | 25389 | 6648 | 40696 | 4942 | 44016 | 3992 | 44803 | 3285 | 44530 | 2219 | 53548 | 1560 | 36491 |
| 9L-3S | | MI | 19936 | 6648 | 32695 | 4786 | 35652 | 3881 | 36951 | 3176 | 38053 | 2092 | 45230 | 1778 | 27065 |
| 20-#11 | 2.48 | MA | 24870 | 6648 | 39897 | 4939 | 42939 | 4005 | 43518 | 3298 | 42785 | 2229 | 51404 | 1499 | 35618 |
| 10L-2S | | MI | 20487 | 6648 | 33524 | 4791 | 36715 | 3871 | 38244 | 3168 | 39767 | 2084 | 47482 | 1864 | 27047 |
| 20-#14 | 3.57 | MA | 28215 | 7125 | 46943 | 5199 | 51849 | 4194 | 54349 | 3389 | 57552 | 2167 | 70818 | 1531 | 53458 |
| 6E | | MI | 19702 | 7125 | 33309 | 5060 | 36275 | 4073 | 37663 | 3296 | 39008 | 2027 | 47185 | 1322 | 36684 |
| 20-#14 | 3.57 | MA | 27544 | 7125 | 45663 | 5220 | 50306 | 4213 | 52451 | 3406 | 55006 | 2180 | 67355 | 1401 | 52105 |
| 7L-5S | | MI | 20179 | 7125 | 34106 | 5068 | 37376 | 4084 | 38929 | 3283 | 40692 | 2015 | 49226 | 1405 | 37119 |
| 20-#14 | 3.57 | MA | 26884 | 7125 | 44513 | 5216 | 48740 | 4207 | 50598 | 3423 | 52301 | 2168 | 64156 | 1332 | 50919 |
| 8L-4S | | MI | 20678 | 7125 | 34954 | 5077 | 38474 | 4070 | 40259 | 3271 | 42554 | 2027 | 51418 | 1459 | 38052 |
| 20-#14 | 3.57 | MA | 26223 | 7125 | 43275 | 5237 | 47217 | 4225 | 48661 | 3414 | 49778 | 2181 | 61010 | 1254 | 49212 |
| 9L-3S | | MI | 21234 | 7125 | 35929 | 5060 | 39716 | 4082 | 41749 | 3283 | 44407 | 2015 | 53474 | 1580 | 38165 |
| 20-#18 | 6.35 | MA | 30453 | 8336 | 53830 | 5960 | 60581 | 4754 | 64904 | 3728 | 71769 | 2067 | 90301 | 708 | 84222 |
| 7L-5S | | MI | 22537 | 8336 | 40692 | 5775 | 45591 | 4590 | 48566 | 3544 | 53478 | 1799 | 66095 | 729 | 61053 |
| 22-#11 | 2.72 | MA | 27392 | 6756 | 44487 | 4982 | 48827 | 4035 | 50698 | 3296 | 52576 | 2199 | 63976 | 1735 | 42090 |
| 6L-7S | | MI | 18893 | 6756 | 31082 | 4867 | 33571 | 3936 | 34416 | 3205 | 34793 | 2097 | 41667 | 1505 | 28805 |
| 22-#11 | 2.72 | MA | 26917 | 6756 | 43595 | 4997 | 47751 | 4031 | 49375 | 3308 | 50801 | 2209 | 61540 | 1645 | 41654 |
| 7L-6S | | MI | 19222 | 6756 | 31691 | 4855 | 34307 | 3926 | 35358 | 3214 | 35955 | 2088 | 43026 | 1570 | 29015 |
| 22-#11 | 2.72 | MA | 26450 | 6756 | 42793 | 4995 | 46659 | 4044 | 48083 | 3320 | 48914 | 2201 | 59294 | 1597 | 40897 |
| 8L-5S | | MI | 19559 | 6756 | 32249 | 4860 | 35077 | 3933 | 36252 | 3205 | 37144 | 2080 | 44474 | 1627 | 29385 |
| 22-#11 | 2.72 | MA | 25979 | 6756 | 41930 | 5009 | 45598 | 4040 | 46733 | 3315 | 47155 | 2211 | 57081 | 1543 | 40210 |
| 9L-4S | | MI | 19913 | 6756 | 32842 | 4866 | 35845 | 3923 | 37191 | 3197 | 38458 | 2088 | 46027 | 1665 | 29632 |
| 22-#11 | 2.72 | MA | 25454 | 6756 | 41131 | 5007 | 44520 | 4054 | 45448 | 3327 | 45410 | 2220 | 54936 | 1482 | 39297 |
| 10L-3S | | MI | 20306 | 6756 | 33524 | 4854 | 36715 | 3930 | 38244 | 3205 | 39767 | 2080 | 47482 | 1750 | 29658 |
| 22-#11 | 2.72 | MA | 24950 | 6756 | 40345 | 5004 | 43464 | 4050 | 44114 | 3322 | 43550 | 2212 | 52746 | 1430 | 38466 |
| 11L-2S | | MI | 20855 | 6756 | 34353 | 4859 | 37778 | 3920 | 39536 | 3197 | 41481 | 2071 | 49735 | 1837 | 29647 |

## RECTANGULAR TIED COLUMNS 30" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 3.93 | MA | 28355 | 7281 | 47429 | 5317 | 52569 | 4283 | 55212 | 3448 | 58763 | 2168 | 72378 | 1374 | 57376 |
| 7L-6S | | MI | 20225 | 7281 | 34491 | 5157 | 37790 | 4143 | 39493 | 3336 | 41435 | 2007 | 50364 | 1280 | 40217 |
| 22-#14 | 3.93 | MA | 27699 | 7281 | 46279 | 5313 | 51003 | 4276 | 53359 | 3465 | 56058 | 2155 | 69178 | 1304 | 56200 |
| 8L-5S | | MI | 20700 | 7281 | 35288 | 5166 | 38891 | 4154 | 40759 | 3324 | 43118 | 1995 | 52405 | 1362 | 40669 |
| 22-#14 | 3.93 | MA | 27039 | 7281 | 45040 | 5334 | 49480 | 4295 | 51422 | 3457 | 53534 | 2168 | 66033 | 1227 | 54464 |
| 9L-4S | | MI | 21197 | 7281 | 36136 | 5174 | 39990 | 4140 | 42089 | 3312 | 44980 | 2007 | 54597 | 1417 | 41551 |
| 24-#11 | 2.97 | MA | 27491 | 6864 | 44828 | 5065 | 49333 | 4079 | 51304 | 3337 | 53426 | 2200 | 65073 | 1628 | 45410 |
| 7E | | MI | 19266 | 6864 | 31911 | 4935 | 34634 | 3984 | 35708 | 3234 | 36507 | 2084 | 43919 | 1477 | 31299 |
| 24-#11 | 2.97 | MA | 27026 | 6864 | 44027 | 5062 | 48241 | 4093 | 50013 | 3349 | 51539 | 2193 | 62827 | 1579 | 44602 |
| 8L-6S | | MI | 19594 | 6864 | 32521 | 4923 | 35370 | 3974 | 36650 | 3243 | 37668 | 2075 | 45279 | 1543 | 31528 |
| 24-#11 | 2.97 | MA | 26555 | 6864 | 43164 | 5077 | 47179 | 4089 | 48662 | 3344 | 49780 | 2202 | 60613 | 1525 | 43932 |
| 9L-5S | | MI | 19930 | 6864 | 33078 | 4928 | 36140 | 3981 | 37544 | 3234 | 38857 | 2067 | 46727 | 1600 | 31880 |
| 24-#11 | 2.97 | MA | 26035 | 6864 | 42364 | 5074 | 46102 | 4102 | 47377 | 3356 | 48035 | 2211 | 58469 | 1464 | 42982 |
| 10L-4S | | MI | 20282 | 6864 | 33671 | 4933 | 36908 | 3971 | 38484 | 3226 | 40171 | 2075 | 48280 | 1637 | 32203 |
| 24-#11 | 2.97 | MA | 25533 | 6864 | 41578 | 5072 | 45046 | 4098 | 46043 | 3351 | 46175 | 2204 | 56279 | 1413 | 42134 |
| 11L-3S | | MI | 20674 | 6864 | 34353 | 4921 | 37778 | 3978 | 39536 | 3234 | 41481 | 2067 | 49735 | 1723 | 32236 |
| 24-#14 | 4.29 | MA | 28509 | 7437 | 48044 | 5410 | 53267 | 4346 | 56121 | 3507 | 59814 | 2143 | 74201 | 1277 | 61417 |
| 8L-6S | | MI | 20746 | 7437 | 35673 | 5255 | 39305 | 4213 | 41323 | 3377 | 43862 | 1988 | 53543 | 1238 | 43680 |
| 24-#14 | 4.29 | MA | 27850 | 7437 | 46806 | 5431 | 51743 | 4365 | 54183 | 3499 | 57291 | 2156 | 71056 | 1200 | 59724 |
| 9L-5S | | MI | 21218 | 7437 | 36470 | 5263 | 40407 | 4224 | 42589 | 3365 | 45545 | 1975 | 55585 | 1320 | 44226 |

## RECTANGULAR TIED COLUMNS 30" x 44"

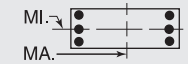
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.21 | MA | 28774 | 6388 | 44909 | 4749 | 48476 | 3871 | 49339 | 3228 | 49002 | 2319 | 57355 | 2184 | 21400 |
| 2E | | MI | 19362 | 6388 | 30714 | 4592 | 32544 | 3740 | 32666 | 3105 | 31821 | 2200 | 36662 | 2035 | 14181 |
| 6-#14 | 1.02 | MA | 28361 | 6301 | 43830 | 4726 | 47276 | 3857 | 47945 | 3226 | 47172 | 2344 | 55094 | 2226 | 18283 |
| 2L-3S | | MI | 18333 | 6301 | 28859 | 4574 | 30351 | 3753 | 30144 | 3133 | 28496 | 2258 | 32403 | 1977 | 12262 |
| 6-#14 | 1.02 | MA | 27088 | 6301 | 41967 | 4722 | 44888 | 3852 | 45031 | 3243 | 43209 | 2357 | 49763 | 2101 | 18353 |
| 3L-2S | | MI | 19134 | 6301 | 30041 | 4582 | 31867 | 3739 | 31974 | 3121 | 30923 | 2245 | 35583 | 2101 | 12177 |
| 6-#18 | 1.82 | MA | 30289 | 6664 | 48172 | 4922 | 52658 | 3995 | 54442 | 3303 | 55925 | 2295 | 66577 | 2132 | 31665 |
| 2L-3S | | MI | 18900 | 6664 | 30714 | 4748 | 32544 | 3885 | 32666 | 3196 | 31821 | 2183 | 36662 | 1729 | 20853 |
| 6-#18 | 1.82 | MA | 28094 | 6664 | 44909 | 4914 | 48476 | 4027 | 49339 | 3332 | 49002 | 2317 | 57355 | 1911 | 31653 |
| 3L-2S | | MI | 20274 | 6664 | 32767 | 4765 | 35166 | 3863 | 35799 | 3174 | 35977 | 2160 | 42068 | 1951 | 20733 |
| 8-#14 | 1.36 | MA | 29241 | 6457 | 45693 | 4823 | 49664 | 3927 | 50858 | 3268 | 51136 | 2331 | 60426 | 2201 | 24150 |
| 2L-4S | | MI | 18299 | 6457 | 29066 | 4688 | 30625 | 3812 | 30484 | 3162 | 29069 | 2250 | 33527 | 1813 | 16104 |
| 8-#14 | 1.36 | MA | 27975 | 6457 | 43830 | 4819 | 47276 | 3921 | 47945 | 3285 | 47172 | 2345 | 55094 | 2076 | 24196 |
| 3E | | MI | 18872 | 6457 | 30041 | 4671 | 31867 | 3823 | 31974 | 3174 | 30923 | 2238 | 35583 | 1935 | 16032 |
| 8-#14 | 1.36 | MA | 27087 | 6457 | 42313 | 4840 | 45342 | 3941 | 45594 | 3278 | 44147 | 2359 | 51624 | 1951 | 24164 |
| 4L-2S | | MI | 19670 | 6457 | 31223 | 4680 | 33382 | 3809 | 33804 | 3162 | 33349 | 2225 | 38762 | 2059 | 15956 |
| 8-#18 | 2.42 | MA | 31784 | 6941 | 51435 | 5095 | 56841 | 4119 | 59545 | 3379 | 62849 | 2272 | 75799 | 2081 | 41885 |
| 2L-4S | | MI | 18828 | 6941 | 31067 | 4947 | 33010 | 3987 | 33245 | 3243 | 32803 | 2165 | 38561 | 1435 | 26883 |
| 8-#18 | 2.42 | MA | 29610 | 6941 | 48172 | 5087 | 52658 | 4152 | 54442 | 3407 | 55925 | 2294 | 66577 | 1860 | 41759 |
| 3E | | MI | 19813 | 6941 | 32767 | 4920 | 35166 | 4009 | 35799 | 3265 | 35977 | 2143 | 42068 | 1645 | 27287 |
| 8-#18 | 2.42 | MA | 28081 | 6941 | 45507 | 5123 | 49262 | 4140 | 50315 | 3392 | 50633 | 2316 | 60590 | 1638 | 41060 |
| 4L-2S | | MI | 21176 | 6941 | 34820 | 4938 | 37787 | 3987 | 38932 | 3243 | 40133 | 2121 | 47474 | 1866 | 27225 |
| 10-#11 | 1.18 | MA | 28810 | 6374 | 44674 | 4786 | 48451 | 3902 | 49414 | 3256 | 49186 | 2346 | 57929 | 2228 | 21098 |
| 2L-5S | | MI | 18093 | 6374 | 28476 | 4652 | 29942 | 3804 | 29704 | 3168 | 27940 | 2261 | 32145 | 1893 | 14154 |
| 10-#11 | 1.18 | MA | 27923 | 6374 | 43373 | 4784 | 46783 | 3899 | 47379 | 3269 | 46417 | 2356 | 54182 | 2142 | 21136 |
| 3L-4S | | MI | 18456 | 6374 | 29069 | 4657 | 30711 | 3793 | 30643 | 3159 | 29254 | 2270 | 33699 | 1931 | 14104 |
| 10-#11 | 1.18 | MA | 27301 | 6374 | 42315 | 4799 | 45434 | 3913 | 45739 | 3264 | 44307 | 2366 | 51740 | 2055 | 21157 |
| 4L-3S | | MI | 18858 | 6374 | 29751 | 4645 | 31580 | 3801 | 31695 | 3168 | 30563 | 2261 | 35154 | 2016 | 14048 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis

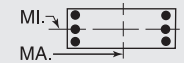



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.18 | MA | 26745 | 6374 | 41400 | 4797 | 44247 | 3909 | 44281 | 3276 | 42195 | 2359 | 49197 | 2013 | 21119 |
| 5L-2S | | MI | 19420 | 6374 | 30580 | 4650 | 32643 | 3790 | 32988 | 3159 | 32277 | 2253 | 37406 | 2103 | 13996 |
| 10-#14 | 1.70 | MA | 30113 | 6612 | 47556 | 4920 | 52052 | 3997 | 53771 | 3310 | 55100 | 2319 | 65757 | 2175 | 29998 |
| 2L-5S | | MI | 18323 | 6612 | 29400 | 4777 | 31042 | 3896 | 30984 | 3215 | 29634 | 2218 | 34514 | 1717 | 19681 |
| 10-#14 | 1.70 | MA | 28855 | 6612 | 45693 | 4916 | 49664 | 3991 | 50858 | 3328 | 51136 | 2333 | 60426 | 2051 | 30014 |
| 3L-4S | | MI | 18837 | 6612 | 30248 | 4785 | 32140 | 3882 | 32314 | 3203 | 31496 | 2231 | 36706 | 1771 | 19817 |
| 10-#14 | 1.70 | MA | 27973 | 6612 | 44176 | 4938 | 47730 | 4011 | 48507 | 3320 | 48111 | 2346 | 56956 | 1926 | 29935 |
| 4L-3S | | MI | 19407 | 6612 | 31223 | 4769 | 33382 | 3893 | 33804 | 3215 | 33349 | 2218 | 38762 | 1892 | 19771 |
| 10-#14 | 1.70 | MA | 27185 | 6612 | 42864 | 4934 | 46028 | 4005 | 46416 | 3338 | 45083 | 2335 | 53330 | 1866 | 29540 |
| 5L-2S | | MI | 20201 | 6612 | 32405 | 4777 | 34897 | 3879 | 35634 | 3203 | 35776 | 2206 | 41941 | 2017 | 19709 |
| 10-#18 | 3.03 | MA | 33261 | 7218 | 54698 | 5268 | 61024 | 4243 | 64648 | 3454 | 69772 | 2249 | 85021 | 2030 | 52052 |
| 2L-5S | | MI | 18859 | 7218 | 31638 | 5103 | 33723 | 4132 | 34101 | 3334 | 33768 | 2103 | 40241 | 1252 | 31283 |
| 10-#18 | 3.03 | MA | 31107 | 7218 | 51435 | 5260 | 56841 | 4276 | 59545 | 3483 | 62849 | 2271 | 75799 | 1808 | 51839 |
| 3L-4S | | MI | 19740 | 7218 | 33119 | 5120 | 35632 | 4110 | 36378 | 3312 | 36959 | 2125 | 43967 | 1351 | 32791 |
| 10-#18 | 3.03 | MA | 29594 | 7218 | 48770 | 5296 | 53445 | 4264 | 55417 | 3467 | 57557 | 2293 | 69812 | 1587 | 50603 |
| 4L-3S | | MI | 20717 | 7218 | 34820 | 5093 | 37787 | 4132 | 38932 | 3334 | 40133 | 2103 | 47474 | 1560 | 33667 |
| 10-#18 | 3.03 | MA | 28242 | 7218 | 46463 | 5287 | 50454 | 4296 | 51743 | 3495 | 52255 | 2271 | 63516 | 1484 | 47594 |
| 5L-2S | | MI | 22070 | 7218 | 36872 | 5111 | 40409 | 4110 | 42065 | 3312 | 44289 | 2081 | 52879 | 1782 | 33679 |
| 12-#11 | 1.42 | MA | 29426 | 6482 | 45975 | 4854 | 50118 | 3951 | 51448 | 3285 | 51954 | 2338 | 61675 | 2212 | 25187 |
| 2L-6S | | MI | 18131 | 6482 | 28748 | 4714 | 30235 | 3845 | 30102 | 3206 | 28465 | 2257 | 32950 | 1809 | 16625 |
| 12-#11 | 1.42 | MA | 28542 | 6482 | 44674 | 4851 | 48451 | 3947 | 49414 | 3298 | 49186 | 2348 | 57929 | 2125 | 25214 |
| 3L-5S | | MI | 18475 | 6482 | 29305 | 4719 | 31005 | 3852 | 30996 | 3197 | 29654 | 2248 | 34398 | 1866 | 16760 |
| 12-#11 | 1.42 | MA | 27923 | 6482 | 43616 | 4866 | 47101 | 3961 | 47774 | 3293 | 47076 | 2358 | 55487 | 2039 | 25211 |
| 4E | | MI | 18836 | 6482 | 29898 | 4724 | 31774 | 3842 | 31935 | 3188 | 30968 | 2257 | 35951 | 1903 | 16726 |
| 12-#11 | 1.42 | MA | 27370 | 6482 | 42701 | 4864 | 45915 | 3958 | 46316 | 3306 | 44964 | 2350 | 52944 | 1997 | 25150 |
| 5L-3S | | MI | 19237 | 6482 | 30580 | 4712 | 32643 | 3849 | 32988 | 3197 | 32277 | 2248 | 37406 | 1989 | 16680 |
| 12-#11 | 1.42 | MA | 26845 | 6482 | 41844 | 4862 | 44727 | 3971 | 44864 | 3301 | 43050 | 2360 | 50521 | 1941 | 24769 |
| 6L-2S | | MI | 19797 | 6482 | 31409 | 4718 | 33706 | 3839 | 34280 | 3188 | 33990 | 2240 | 39659 | 2075 | 16633 |
| 12-#14 | 2.05 | MA | 30978 | 6768 | 49419 | 5017 | 54440 | 4067 | 56684 | 3353 | 59063 | 2307 | 71088 | 2150 | 35831 |
| 2L-6S | | MI | 18373 | 6768 | 29785 | 4866 | 31456 | 3954 | 31548 | 3268 | 30377 | 2211 | 35652 | 1592 | 22604 |
| 12-#14 | 2.05 | MA | 29727 | 6768 | 47556 | 5014 | 52052 | 4061 | 53771 | 3370 | 55100 | 2320 | 65757 | 2025 | 35812 |
| 3L-5S | | MI | 18861 | 6768 | 30582 | 4874 | 32557 | 3965 | 32814 | 3256 | 32060 | 2198 | 37693 | 1674 | 23174 |
| 12-#14 | 2.05 | MA | 28851 | 6768 | 46038 | 5035 | 50118 | 4080 | 51421 | 3363 | 52075 | 2334 | 62287 | 1901 | 35695 |
| 4E | | MI | 19372 | 6768 | 31430 | 4883 | 33655 | 3952 | 34143 | 3244 | 33922 | 2211 | 39885 | 1729 | 23509 |
| 12-#14 | 2.05 | MA | 28068 | 6768 | 44726 | 5031 | 48416 | 4075 | 49330 | 3380 | 49046 | 2322 | 58661 | 1841 | 35086 |
| 5L-3S | | MI | 19939 | 6768 | 32405 | 4866 | 34897 | 3963 | 35634 | 3256 | 35776 | 2198 | 41941 | 1850 | 23492 |
| 12-#14 | 2.05 | MA | 27323 | 6768 | 43496 | 5027 | 46712 | 4094 | 47247 | 3373 | 46302 | 2336 | 55216 | 1760 | 33935 |
| 6L-2S | | MI | 20729 | 6768 | 33587 | 4874 | 36412 | 3949 | 37464 | 3244 | 38202 | 2186 | 45120 | 1975 | 23444 |
| 12-#18 | 3.64 | MA | 32587 | 7494 | 54698 | 5433 | 61024 | 4400 | 64648 | 3558 | 69772 | 2248 | 85021 | 1757 | 61904 |
| 3L-5S | | MI | 19769 | 7494 | 33691 | 5276 | 36345 | 4255 | 37234 | 3403 | 37924 | 2063 | 45647 | 1168 | 37367 |
| 12-#18 | 3.64 | MA | 31088 | 7494 | 52033 | 5469 | 57628 | 4388 | 60520 | 3542 | 64480 | 2270 | 79034 | 1536 | 60198 |
| 4E | | MI | 20643 | 7494 | 35172 | 5293 | 38253 | 4233 | 39511 | 3381 | 41115 | 2085 | 49373 | 1266 | 38750 |
| 12-#18 | 3.64 | MA | 29750 | 7494 | 49726 | 5460 | 54637 | 4420 | 56845 | 3571 | 59178 | 2248 | 72738 | 1433 | 57358 |
| 5L-3S | | MI | 21613 | 7494 | 36872 | 5266 | 40409 | 4255 | 42065 | 3403 | 44289 | 2063 | 52879 | 1475 | 40020 |
| 12-#18 | 3.64 | MA | 28478 | 7494 | 47562 | 5452 | 51641 | 4408 | 53185 | 3555 | 54374 | 2270 | 66786 | 1288 | 54371 |
| 6L-2S | | MI | 22957 | 7494 | 38925 | 5284 | 43031 | 4233 | 45198 | 3381 | 48444 | 2041 | 58285 | 1697 | 40108 |
| 14-#11 | 1.65 | MA | 30038 | 6590 | 47276 | 4921 | 51786 | 3999 | 53483 | 3315 | 54723 | 2329 | 65422 | 2195 | 29267 |
| 2L-7S | | MI | 18177 | 6590 | 28967 | 4794 | 30562 | 3904 | 30452 | 3226 | 29017 | 2253 | 33843 | 1716 | 18856 |
| 14-#11 | 1.65 | MA | 29157 | 6590 | 45975 | 4919 | 50118 | 3996 | 51448 | 3327 | 51954 | 2339 | 61675 | 2109 | 29283 |
| 3L-6S | | MI | 18512 | 6590 | 29577 | 4781 | 31298 | 3893 | 31394 | 3235 | 30178 | 2244 | 35203 | 1782 | 19116 |
| 14-#11 | 1.65 | MA | 28541 | 6590 | 44917 | 4934 | 48769 | 4009 | 49809 | 3323 | 49844 | 2349 | 59234 | 2022 | 29257 |
| 4L-5S | | MI | 18855 | 6590 | 30134 | 4787 | 32068 | 3900 | 32288 | 3226 | 31367 | 2236 | 36651 | 1839 | 19356 |
| 14-#11 | 1.65 | MA | 27991 | 6590 | 44002 | 4932 | 47583 | 4006 | 48351 | 3335 | 47732 | 2342 | 56691 | 1980 | 29174 |
| 5L-4S | | MI | 19215 | 6590 | 30727 | 4792 | 32836 | 3890 | 33228 | 3217 | 32681 | 2244 | 38204 | 1876 | 19336 |
| 14-#11 | 1.65 | MA | 27468 | 6590 | 43145 | 4929 | 46395 | 4020 | 46899 | 3330 | 45819 | 2352 | 54268 | 1925 | 28687 |
| 6L-3S | | MI | 19614 | 6590 | 31409 | 4780 | 33706 | 3897 | 34280 | 3226 | 33990 | 2236 | 39659 | 1962 | 19300 |
| 14-#11 | 1.65 | MA | 26958 | 6590 | 42206 | 4944 | 45262 | 4016 | 45506 | 3343 | 43950 | 2362 | 51684 | 1835 | 28134 |
| 7L-2S | | MI | 20172 | 6590 | 32238 | 4785 | 34769 | 3887 | 35572 | 3217 | 35704 | 2227 | 41912 | 2048 | 19260 |

## RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

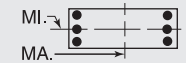
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.39 | MA | 30593 | 6924 | 49419 | 5111 | 54440 | 4131 | 56684 | 3413 | 59063 | 2308 | 71088 | 2000 | 41599 |
| 3L-6S | | MI | 18909 | 6924 | 30967 | 4963 | 32971 | 4024 | 33378 | 3309 | 32804 | 2191 | 38831 | 1550 | 26155 |
| 14-#14 | 2.39 | MA | 29722 | 6924 | 47901 | 5132 | 52506 | 4150 | 54334 | 3405 | 56038 | 2321 | 67618 | 1875 | 41448 |
| 4L-5S | | MI | 19395 | 6924 | 31764 | 4972 | 34072 | 4035 | 34643 | 3297 | 34487 | 2179 | 40872 | 1632 | 26684 |
| 14-#14 | 2.39 | MA | 28944 | 6924 | 46589 | 5128 | 50804 | 4145 | 52243 | 3422 | 53010 | 2310 | 63993 | 1816 | 40652 |
| 5L-4S | | MI | 19903 | 6924 | 32612 | 4980 | 35170 | 4021 | 35973 | 3284 | 36349 | 2191 | 43064 | 1687 | 27183 |
| 14-#14 | 2.39 | MA | 28204 | 6924 | 45359 | 5125 | 49101 | 4164 | 50161 | 3415 | 50266 | 2324 | 60547 | 1735 | 39555 |
| 6L-3S | | MI | 20468 | 6924 | 33587 | 4963 | 36412 | 4033 | 37464 | 3297 | 38202 | 2179 | 45120 | 1808 | 27199 |
| 14-#14 | 2.39 | MA | 27483 | 6924 | 44012 | 5146 | 47475 | 4158 | 48162 | 3432 | 47585 | 2337 | 56871 | 1605 | 38552 |
| 7L-2S | | MI | 21254 | 6924 | 34769 | 4971 | 37928 | 4019 | 39294 | 3284 | 40629 | 2166 | 48299 | 1933 | 27166 |
| 14-#18 | 4.24 | MA | 32567 | 7771 | 55296 | 5641 | 61811 | 4512 | 65623 | 3618 | 71403 | 2247 | 88255 | 1484 | 69837 |
| 4L-5S | | MI | 20671 | 7771 | 35744 | 5449 | 38967 | 4379 | 40367 | 3472 | 42080 | 2023 | 51053 | 1083 | 43472 |
| 14-#18 | 4.24 | MA | 31242 | 7771 | 52989 | 5633 | 58820 | 4544 | 61948 | 3646 | 66102 | 2225 | 81960 | 1381 | 67148 |
| 5L-4S | | MI | 21539 | 7771 | 37225 | 5466 | 40875 | 4357 | 42644 | 3450 | 45270 | 2045 | 54779 | 1181 | 44749 |
| 14-#18 | 4.24 | MA | 29982 | 7771 | 50825 | 5625 | 55824 | 4532 | 58288 | 3631 | 61297 | 2247 | 76008 | 1237 | 63981 |
| 6L-3S | | MI | 22501 | 7771 | 38925 | 5439 | 43031 | 4379 | 45198 | 3472 | 48444 | 2023 | 58285 | 1391 | 46353 |
| 14-#18 | 4.24 | MA | 28756 | 7771 | 48455 | 5661 | 52965 | 4565 | 54773 | 3659 | 56602 | 2269 | 69651 | 1006 | 60924 |
| 7L-2S | | MI | 23836 | 7771 | 40977 | 5456 | 45652 | 4357 | 48331 | 3450 | 52600 | 2001 | 63691 | 1612 | 46497 |
| 16-#11 | 1.89 | MA | 29769 | 6698 | 47276 | 4986 | 51786 | 4044 | 53483 | 3357 | 54723 | 2330 | 65422 | 2092 | 33340 |
| 3L-7S | | MI | 18558 | 6698 | 29796 | 4861 | 31625 | 3952 | 31745 | 3255 | 30730 | 2240 | 36096 | 1688 | 21370 |
| 16-#11 | 1.89 | MA | 29156 | 6698 | 46218 | 5001 | 50437 | 4058 | 51843 | 3352 | 52613 | 2340 | 62980 | 2006 | 33297 |
| 4L-6S | | MI | 18891 | 6698 | 30406 | 4849 | 32361 | 3942 | 32687 | 3264 | 31892 | 2232 | 37456 | 1754 | 21614 |
| 16-#11 | 1.89 | MA | 28609 | 6698 | 45303 | 4999 | 49251 | 4054 | 50386 | 3365 | 50501 | 2333 | 60437 | 1964 | 33195 |
| 5E | | MI | 19233 | 6698 | 30963 | 4854 | 33131 | 3949 | 33581 | 3255 | 33081 | 2223 | 38904 | 1811 | 21939 |
| 16-#11 | 1.89 | MA | 28088 | 6698 | 44446 | 4997 | 48063 | 4068 | 48934 | 3360 | 48587 | 2343 | 58015 | 1908 | 32615 |
| 6L-4S | | MI | 19592 | 6698 | 31556 | 4859 | 33899 | 3939 | 34520 | 3246 | 34395 | 2232 | 40457 | 1849 | 21938 |
| 16-#11 | 1.89 | MA | 27581 | 6698 | 43507 | 5012 | 46930 | 4065 | 47541 | 3372 | 46718 | 2353 | 55431 | 1818 | 32083 |
| 7L-3S | | MI | 19990 | 6698 | 32238 | 4847 | 34769 | 3946 | 35572 | 3255 | 35704 | 2223 | 41912 | 1934 | 21912 |
| 16-#11 | 1.89 | MA | 27081 | 6698 | 42663 | 5010 | 45781 | 4078 | 46181 | 3385 | 44732 | 2346 | 53053 | 1769 | 31561 |
| 8L-2S | | MI | 20545 | 6698 | 33068 | 4852 | 35832 | 3936 | 36865 | 3246 | 37418 | 2214 | 44165 | 2021 | 21878 |
| 16-#14 | 2.73 | MA | 30586 | 7079 | 49764 | 5229 | 54894 | 4220 | 57247 | 3448 | 60002 | 2309 | 72949 | 1850 | 47196 |
| 4L-6S | | MI | 19442 | 7079 | 32149 | 5061 | 34486 | 4094 | 35207 | 3350 | 35230 | 2171 | 42010 | 1508 | 29713 |
| 16-#14 | 2.73 | MA | 29813 | 7079 | 48452 | 5226 | 53192 | 4214 | 55156 | 3465 | 56974 | 2298 | 69324 | 1790 | 46234 |
| 5E | | MI | 19925 | 7079 | 32946 | 5069 | 35587 | 4105 | 36473 | 3338 | 36914 | 2159 | 44052 | 1590 | 30208 |
| 16-#14 | 2.73 | MA | 29078 | 7079 | 47222 | 5222 | 51489 | 4234 | 53074 | 3457 | 54230 | 2311 | 65879 | 1709 | 45186 |
| 6L-4S | | MI | 20431 | 7079 | 33794 | 5077 | 36686 | 4091 | 37803 | 3325 | 38775 | 2171 | 46243 | 1645 | 30847 |
| 16-#14 | 2.73 | MA | 28362 | 7079 | 45875 | 5243 | 49863 | 4228 | 51075 | 3475 | 51548 | 2325 | 62203 | 1580 | 44084 |
| 7L-3S | | MI | 20993 | 7079 | 34769 | 5060 | 37928 | 4102 | 39294 | 3338 | 40629 | 2159 | 48299 | 1766 | 30892 |
| 16-#14 | 2.73 | MA | 27658 | 7079 | 44664 | 5239 | 48214 | 4247 | 49125 | 3492 | 48699 | 2313 | 58813 | 1509 | 42693 |
| 8L-2S | | MI | 21776 | 7079 | 35951 | 5069 | 39443 | 4089 | 41123 | 3325 | 43055 | 2146 | 51479 | 1891 | 30878 |
| 16-#18 | 4.85 | MA | 32718 | 8048 | 56252 | 5806 | 63003 | 4668 | 67051 | 3722 | 73025 | 2202 | 91182 | 1330 | 76959 |
| 5E | | MI | 21566 | 8048 | 37796 | 5622 | 41589 | 4502 | 43500 | 3541 | 46235 | 1983 | 56458 | 998 | 49595 |
| 16-#18 | 4.85 | MA | 31470 | 8048 | 54088 | 5798 | 60007 | 4656 | 63390 | 3706 | 68220 | 2224 | 85230 | 1186 | 73618 |
| 6L-4S | | MI | 22427 | 8048 | 39277 | 5639 | 43497 | 4480 | 45777 | 3518 | 49426 | 2005 | 60184 | 1097 | 50779 |
| 16-#18 | 4.85 | MA | 30256 | 8048 | 51718 | 5834 | 57148 | 4689 | 59876 | 3734 | 63525 | 2246 | 78873 | 954 | 70449 |
| 7L-3S | | MI | 23384 | 8048 | 40977 | 5612 | 45652 | 4502 | 48331 | 3541 | 52600 | 1983 | 63691 | 1306 | 52672 |
| 18-#11 | 2.13 | MA | 29767 | 6805 | 47519 | 5069 | 52105 | 4106 | 53878 | 3381 | 55381 | 2332 | 66727 | 1990 | 37332 |
| 4L-7S | | MI | 18937 | 6805 | 30625 | 4928 | 32688 | 4000 | 33037 | 3284 | 32444 | 2228 | 38349 | 1661 | 23887 |
| 18-#11 | 2.13 | MA | 29223 | 6805 | 46604 | 5066 | 50919 | 4103 | 52420 | 3394 | 53269 | 2325 | 64184 | 1948 | 37213 |
| 5L-6S | | MI | 19269 | 6805 | 31235 | 4916 | 33424 | 3990 | 33979 | 3293 | 33605 | 2219 | 39709 | 1727 | 24118 |
| 18-#11 | 2.13 | MA | 28704 | 6805 | 45747 | 5064 | 49731 | 4117 | 50969 | 3389 | 51356 | 2335 | 61761 | 1892 | 36549 |
| 6L-5S | | MI | 19610 | 6805 | 31792 | 4922 | 34194 | 3997 | 34873 | 3284 | 34794 | 2210 | 41157 | 1784 | 24516 |
| 18-#11 | 2.13 | MA | 28200 | 6805 | 44808 | 5079 | 48598 | 4113 | 49576 | 3402 | 49487 | 2345 | 59177 | 1802 | 36037 |
| 7L-4S | | MI | 19967 | 6805 | 32385 | 4927 | 34962 | 3987 | 35812 | 3275 | 36108 | 2219 | 42710 | 1821 | 24534 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis

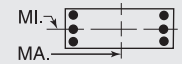


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.13 | MA | 27702 | 6805 | 43964 | 5077 | 47449 | 4127 | 48216 | 3414 | 47500 | 2337 | 56799 | 1753 | 35452 |
| 8L-3S | | MI | 20363 | 6805 | 33068 | 4915 | 35832 | 3994 | 36865 | 3284 | 37418 | 2210 | 44165 | 1907 | 24517 |
| 18-#11 | 2.13 | MA | 27182 | 6805 | 43139 | 5075 | 46331 | 4123 | 46794 | 3410 | 45648 | 2347 | 54450 | 1699 | 34653 |
| 9L-2S | | MI | 20917 | 6805 | 33897 | 4920 | 36894 | 3984 | 38157 | 3275 | 39131 | 2202 | 46418 | 1993 | 24489 |
| 18-#14 | 3.07 | MA | 30677 | 7235 | 50315 | 5323 | 55580 | 4284 | 58069 | 3507 | 60937 | 2285 | 74655 | 1765 | 51829 |
| 5L-6S | | MI | 19972 | 7235 | 33331 | 5158 | 36002 | 4164 | 37037 | 3391 | 37657 | 2152 | 45189 | 1466 | 33276 |
| 18-#14 | 3.07 | MA | 29946 | 7235 | 49085 | 5319 | 53877 | 4304 | 55987 | 3500 | 58193 | 2299 | 71210 | 1684 | 50825 |
| 6L-5S | | MI | 20453 | 7235 | 34128 | 5166 | 37103 | 4175 | 38303 | 3379 | 39340 | 2139 | 47231 | 1548 | 33743 |
| 18-#14 | 3.07 | MA | 29235 | 7235 | 47737 | 5340 | 52251 | 4298 | 53989 | 3517 | 55512 | 2312 | 67534 | 1554 | 49628 |
| 7L-4S | | MI | 20956 | 7235 | 34976 | 5174 | 38201 | 4161 | 39633 | 3366 | 41202 | 2152 | 49423 | 1602 | 34502 |
| 18-#14 | 3.07 | MA | 28535 | 7235 | 46527 | 5337 | 50602 | 4317 | 52038 | 3535 | 52662 | 2301 | 64144 | 1484 | 48282 |
| 8L-3S | | MI | 21516 | 7235 | 35951 | 5158 | 39443 | 4172 | 41123 | 3379 | 43055 | 2139 | 51479 | 1724 | 34570 |
| 18-#14 | 3.07 | MA | 27825 | 7235 | 45223 | 5358 | 48999 | 4312 | 49998 | 3527 | 50005 | 2315 | 60803 | 1406 | 46658 |
| 9L-2S | | MI | 22295 | 7235 | 37133 | 5166 | 40958 | 4158 | 42953 | 3366 | 45482 | 2127 | 54658 | 1848 | 34588 |
| 18-#18 | 5.45 | MA | 32945 | 8324 | 57351 | 5971 | 64190 | 4781 | 68493 | 3781 | 75144 | 2201 | 94451 | 1134 | 83280 |
| 6L-5S | | MI | 22455 | 8324 | 39849 | 5795 | 44210 | 4625 | 46633 | 3609 | 50391 | 1943 | 61864 | 914 | 55605 |
| 18-#18 | 5.45 | MA | 31741 | 8324 | 54981 | 6007 | 61331 | 4813 | 64979 | 3810 | 70448 | 2223 | 88095 | 903 | 79999 |
| 7L-4S | | MI | 23310 | 8324 | 41330 | 5812 | 46118 | 4603 | 48910 | 3587 | 53582 | 1965 | 65590 | 1012 | 56835 |
| 20-#11 | 2.36 | MA | 29833 | 6913 | 47905 | 5134 | 52587 | 4151 | 54455 | 3423 | 56037 | 2316 | 67931 | 1931 | 41228 |
| 5L-7S | | MI | 19314 | 6913 | 31454 | 4996 | 33751 | 4049 | 34329 | 3313 | 34157 | 2215 | 40602 | 1634 | 26406 |
| 20-#11 | 2.36 | MA | 29317 | 6913 | 47048 | 5132 | 51399 | 4165 | 53003 | 3419 | 54124 | 2326 | 65508 | 1875 | 40490 |
| 6E | | MI | 19645 | 6913 | 32064 | 4984 | 34486 | 4039 | 35271 | 3322 | 35319 | 2206 | 41961 | 1700 | 26626 |
| 20-#11 | 2.36 | MA | 28815 | 6913 | 46109 | 5147 | 50266 | 4161 | 51610 | 3431 | 52255 | 2336 | 62924 | 1785 | 39995 |
| 7L-5S | | MI | 19984 | 6913 | 32621 | 4989 | 35257 | 4046 | 36165 | 3313 | 36508 | 2198 | 43410 | 1757 | 27029 |
| 20-#11 | 2.36 | MA | 28320 | 6913 | 45265 | 5144 | 49117 | 4175 | 50251 | 3444 | 50269 | 2329 | 60546 | 1736 | 39349 |
| 8L-4S | | MI | 20340 | 6913 | 33214 | 4994 | 36025 | 4036 | 37105 | 3305 | 37822 | 2206 | 44963 | 1794 | 27119 |
| 20-#11 | 2.36 | MA | 27803 | 6913 | 44440 | 5142 | 47999 | 4172 | 48829 | 3439 | 48417 | 2339 | 58197 | 1682 | 38572 |
| 9L-3S | | MI | 20735 | 6913 | 33897 | 4982 | 36894 | 4043 | 38157 | 3313 | 39131 | 2198 | 46418 | 1879 | 27117 |
| 20-#11 | 2.36 | MA | 27256 | 6913 | 43516 | 5157 | 46866 | 4186 | 47476 | 3451 | 46580 | 2349 | 55920 | 1621 | 37738 |
| 10L-2S | | MI | 21287 | 6913 | 34726 | 4987 | 37957 | 4032 | 39449 | 3305 | 40845 | 2189 | 48671 | 1966 | 27095 |
| 20-#14 | 3.41 | MA | 30808 | 7391 | 50948 | 5416 | 56265 | 4373 | 58900 | 3542 | 62157 | 2286 | 76541 | 1659 | 56471 |
| 6E | | MI | 20499 | 7391 | 34513 | 5255 | 37517 | 4234 | 38867 | 3432 | 40083 | 2132 | 48369 | 1423 | 36845 |
| 20-#14 | 3.41 | MA | 30101 | 7390 | 49600 | 5438 | 54639 | 4368 | 56902 | 3560 | 59476 | 2300 | 72865 | 1529 | 55184 |
| 7L-5S | | MI | 20977 | 7391 | 35310 | 5263 | 38618 | 4245 | 40133 | 3419 | 41767 | 2119 | 50410 | 1506 | 37287 |
| 20-#14 | 3.41 | MA | 29405 | 7390 | 48389 | 5434 | 52990 | 4387 | 54951 | 3577 | 56626 | 2289 | 69475 | 1459 | 53879 |
| 8L-4S | | MI | 21479 | 7391 | 36158 | 5272 | 39716 | 4231 | 41463 | 3407 | 43628 | 2132 | 52602 | 1560 | 38152 |
| 20-#14 | 3.41 | MA | 28697 | 7391 | 47086 | 5455 | 51387 | 4382 | 52911 | 3570 | 53969 | 2302 | 66135 | 1381 | 52196 |
| 9L-3S | | MI | 22035 | 7391 | 37133 | 5255 | 40958 | 4242 | 42953 | 3419 | 45482 | 2119 | 54658 | 1682 | 38241 |
| 20-#18 | 6.06 | MA | 33213 | 8601 | 58244 | 6180 | 65514 | 4937 | 70081 | 3885 | 77372 | 2200 | 97317 | 852 | 89570 |
| 7L-5S | | MI | 23338 | 8601 | 41901 | 5968 | 46832 | 4749 | 49766 | 3678 | 54547 | 1903 | 67270 | 829 | 61494 |
| 22-#11 | 2.60 | MA | 29927 | 7021 | 48349 | 5199 | 53067 | 4213 | 55038 | 3448 | 56893 | 2317 | 69254 | 1859 | 44436 |
| 6L-7S | | MI | 19689 | 7021 | 32283 | 5063 | 34814 | 4097 | 35622 | 3342 | 35871 | 2202 | 42855 | 1606 | 28926 |
| 22-#11 | 2.60 | MA | 29427 | 7021 | 47410 | 5214 | 51934 | 4210 | 53645 | 3461 | 55024 | 2327 | 66671 | 1769 | 43956 |
| 7L-6S | | MI | 20019 | 7021 | 32893 | 5051 | 35549 | 4087 | 36564 | 3351 | 37032 | 2193 | 44214 | 1672 | 29137 |
| 22-#11 | 2.60 | MA | 28934 | 7021 | 46566 | 5212 | 50785 | 4224 | 52285 | 3473 | 53037 | 2320 | 64292 | 1720 | 43253 |
| 8L-5S | | MI | 20357 | 7021 | 33450 | 5056 | 36319 | 4094 | 37458 | 3342 | 38221 | 2185 | 45663 | 1729 | 29519 |
| 22-#11 | 2.60 | MA | 28420 | 7021 | 45741 | 5210 | 49667 | 4220 | 50864 | 3468 | 51185 | 2330 | 61943 | 1666 | 42497 |
| 9L-4S | | MI | 20712 | 7021 | 34043 | 5062 | 37088 | 4084 | 38397 | 3334 | 39535 | 2193 | 47216 | 1767 | 29697 |
| 22-#11 | 2.60 | MA | 27875 | 7021 | 44817 | 5225 | 48534 | 4234 | 49511 | 3481 | 49349 | 2340 | 59667 | 1605 | 41623 |
| 10L-3S | | MI | 21105 | 7021 | 34726 | 5050 | 37957 | 4091 | 39449 | 3342 | 40845 | 2185 | 48671 | 1852 | 29712 |
| 22-#11 | 2.60 | MA | 27343 | 7021 | 43990 | 5222 | 47422 | 4230 | 48107 | 3476 | 47390 | 2333 | 57348 | 1553 | 40713 |
| 11L-2S | | MI | 21656 | 7021 | 35555 | 5055 | 39020 | 4081 | 40742 | 3334 | 42558 | 2176 | 50923 | 1938 | 29697 |
| 22-#14 | 3.75 | MA | 30962 | 7546 | 51463 | 5535 | 57027 | 4438 | 59815 | 3602 | 63439 | 2287 | 78196 | 1503 | 60750 |
| 7L-6S | | MI | 21023 | 7546 | 35695 | 5352 | 39032 | 4303 | 40697 | 3473 | 42510 | 2112 | 51548 | 1381 | 40417 |
| 22-#14 | 3.75 | MA | 30270 | 7546 | 50252 | 5531 | 55378 | 4457 | 57864 | 3619 | 60590 | 2276 | 74806 | 1433 | 59483 |
| 8L-5S | | MI | 21499 | 7546 | 36492 | 5361 | 40133 | 4315 | 41963 | 3460 | 44193 | 2100 | 53589 | 1464 | 40838 |
| 22-#14 | 3.75 | MA | 29563 | 7546 | 48949 | 5552 | 53775 | 4451 | 55825 | 3612 | 57933 | 2290 | 71466 | 1356 | 57744 |
| 9L-4S | | MI | 21998 | 7546 | 37340 | 5369 | 41231 | 4301 | 43293 | 3448 | 46055 | 2112 | 55781 | 1518 | 41751 |

## RECTANGULAR TIED COLUMNS 30" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.84 | MA | 30035 | 7129 | 48711 | 5282 | 53602 | 4258 | 55680 | 3490 | 57792 | 2319 | 70417 | 1752 | 47920 |
| 7E | | MI | 20063 | 7129 | 33112 | 5131 | 35876 | 4146 | 36914 | 3371 | 37584 | 2189 | 45108 | 1579 | 31448 |
| 24-#11 | 2.84 | MA | 29545 | 7129 | 47867 | 5279 | 52453 | 4272 | 54320 | 3502 | 55806 | 2312 | 68039 | 1703 | 47162 |
| 8L-6S | | MI | 20392 | 7129 | 33722 | 5119 | 36612 | 4135 | 37856 | 3380 | 38746 | 2181 | 46467 | 1645 | 31652 |
| 24-#11 | 2.84 | MA | 29034 | 7129 | 47042 | 5277 | 51335 | 4269 | 52898 | 3498 | 53953 | 2322 | 65690 | 1650 | 46426 |
| 9L-5S | | MI | 20729 | 7129 | 34279 | 5124 | 37382 | 4143 | 38750 | 3371 | 39935 | 2172 | 47915 | 1702 | 32014 |
| 24-#11 | 2.84 | MA | 28491 | 7129 | 46118 | 5292 | 50202 | 4282 | 51546 | 3510 | 52117 | 2332 | 63414 | 1589 | 45513 |
| 10L-4S | | MI | 21082 | 7129 | 34872 | 5129 | 38150 | 4132 | 39689 | 3363 | 41249 | 2181 | 49469 | 1739 | 32272 |
| 24-#11 | 2.84 | MA | 27962 | 7129 | 45291 | 5290 | 49090 | 4279 | 50142 | 3506 | 50159 | 2324 | 61095 | 1536 | 44622 |
| 11L-3S | | MI | 21474 | 7129 | 35555 | 5117 | 39020 | 4139 | 40742 | 3371 | 42558 | 2172 | 50923 | 1825 | 32297 |
| 24-#14 | 4.09 | MA | 31130 | 7702 | 52115 | 5628 | 57766 | 4527 | 60778 | 3662 | 64554 | 2264 | 80138 | 1408 | 65093 |
| 8L-6S | | MI | 21545 | 7702 | 36877 | 5450 | 40547 | 4373 | 42527 | 3514 | 44936 | 2092 | 54727 | 1339 | 43955 |
| 24-#14 | 4.09 | MA | 30423 | 7702 | 50811 | 5650 | 56163 | 4521 | 58738 | 3654 | 61897 | 2277 | 76797 | 1330 | 63299 |
| 9L-5S | | MI | 22019 | 7702 | 37674 | 5458 | 41648 | 4384 | 43793 | 3501 | 46620 | 2080 | 56769 | 1422 | 44394 |

## RECTANGULAR TIED COLUMNS 30" x 46"

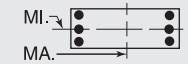
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.16 | MA | 31343 | 6653 | 48750 | 4965 | 52649 | 4048 | 53556 | 3378 | 53112 | 2436 | 62169 | 2302 | 22480 |
| 2E | | MI | 20158 | 6653 | 31924 | 4785 | 33785 | 3899 | 33866 | 3240 | 32890 | 2304 | 37837 | 2136 | 14225 |
| 6-#18 | 1.74 | MA | 32948 | 6930 | 52186 | 5138 | 57054 | 4172 | 58930 | 3454 | 60423 | 2414 | 71939 | 2253 | 33285 |
| 2L-3S | | MI | 19696 | 6930 | 31924 | 4941 | 33785 | 4044 | 33866 | 3331 | 32890 | 2286 | 37837 | 1830 | 20914 |
| 6-#18 | 1.74 | MA | 30631 | 6930 | 48750 | 5130 | 52649 | 4206 | 53556 | 3484 | 53112 | 2437 | 62169 | 2032 | 33273 |
| 3L-2S | | MI | 21071 | 6930 | 33977 | 4958 | 36406 | 4022 | 36999 | 3309 | 37046 | 2264 | 43243 | 2051 | 20787 |
| 8-#14 | 1.30 | MA | 31833 | 6722 | 49568 | 5038 | 53891 | 4104 | 55145 | 3419 | 55304 | 2447 | 65386 | 2318 | 25365 |
| 2L-4S | | MI | 19094 | 6722 | 30271 | 4883 | 31866 | 3972 | 31688 | 3298 | 30144 | 2355 | 34710 | 1915 | 16152 |
| 8-#14 | 1.30 | MA | 30499 | 6722 | 47608 | 5035 | 51378 | 4099 | 52079 | 3436 | 51133 | 2461 | 59746 | 2194 | 25411 |
| 3E | | MI | 19668 | 6722 | 31246 | 4866 | 33108 | 3983 | 33178 | 3311 | 31997 | 2343 | 36766 | 2036 | 16074 |
| 8-#14 | 1.30 | MA | 29564 | 6722 | 46013 | 5057 | 49346 | 4119 | 49609 | 3430 | 47953 | 2476 | 56072 | 2069 | 25379 |
| 4L-2S | | MI | 20467 | 6722 | 32428 | 4875 | 34624 | 3970 | 35008 | 3298 | 34424 | 2330 | 39946 | 2160 | 15996 |
| 8-#18 | 2.32 | MA | 34531 | 7206 | 55621 | 5310 | 61458 | 4297 | 64303 | 3529 | 67734 | 2392 | 81709 | 2205 | 44045 |
| 2L-4S | | MI | 19623 | 7206 | 32276 | 5140 | 34251 | 4145 | 34445 | 3378 | 33872 | 2268 | 39736 | 1536 | 27169 |
| 8-#18 | 2.32 | MA | 32237 | 7206 | 52186 | 5303 | 57054 | 4330 | 58930 | 3559 | 60423 | 2415 | 71939 | 1983 | 43919 |
| 3E | | MI | 20610 | 7206 | 33977 | 5113 | 36406 | 4167 | 36999 | 3400 | 37046 | 2246 | 43243 | 1745 | 27361 |
| 8-#18 | 2.32 | MA | 30626 | 7206 | 49383 | 5340 | 53482 | 4319 | 54589 | 3544 | 54836 | 2437 | 65588 | 1762 | 43351 |
| 4L-2S | | MI | 21975 | 7206 | 36029 | 5131 | 39028 | 4145 | 40132 | 3378 | 41202 | 2224 | 48649 | 1966 | 27285 |
| 10-#11 | 1.13 | MA | 31376 | 6639 | 48492 | 5002 | 52611 | 4080 | 53620 | 3407 | 53246 | 2462 | 62729 | 2345 | 22151 |
| 2L-5S | | MI | 18889 | 6639 | 29677 | 4848 | 31185 | 3965 | 30909 | 3305 | 29018 | 2367 | 33334 | 1995 | 14197 |
| 10-#11 | 1.13 | MA | 30440 | 6639 | 47124 | 5000 | 50856 | 4076 | 51480 | 3419 | 50334 | 2472 | 58769 | 2258 | 22189 |
| 3L-4S | | MI | 19252 | 6639 | 30270 | 4853 | 31953 | 3955 | 31849 | 3296 | 30332 | 2375 | 34887 | 2033 | 14141 |
| 10-#11 | 1.13 | MA | 29786 | 6639 | 46012 | 5015 | 49439 | 4090 | 49757 | 3415 | 48116 | 2483 | 56185 | 2172 | 22210 |
| 4L-3S | | MI | 19655 | 6639 | 30953 | 4841 | 32822 | 3962 | 32901 | 3305 | 31641 | 2367 | 36342 | 2118 | 14083 |
| 10-#11 | 1.13 | MA | 29202 | 6639 | 45051 | 5013 | 48193 | 4087 | 48226 | 3428 | 45898 | 2476 | 53501 | 2130 | 22172 |
| 5L-2S | | MI | 20217 | 6639 | 31782 | 4846 | 33885 | 3952 | 34193 | 3296 | 33355 | 2358 | 38595 | 2204 | 14031 |
| 10-#14 | 1.63 | MA | 32755 | 6878 | 51528 | 5136 | 56404 | 4174 | 58210 | 3461 | 59474 | 2435 | 71026 | 2295 | 31516 |
| 2L-5S | | MI | 19119 | 6878 | 30605 | 4972 | 32283 | 4056 | 32188 | 3351 | 30709 | 2323 | 35698 | 1818 | 19849 |
| 10-#14 | 1.63 | MA | 31429 | 6878 | 49568 | 5132 | 53891 | 4169 | 55145 | 3479 | 55304 | 2449 | 65386 | 2170 | 31533 |
| 3L-4S | | MI | 19633 | 6878 | 31453 | 4980 | 33382 | 4042 | 33517 | 3339 | 32570 | 2335 | 37890 | 1872 | 19872 |
| 10-#14 | 1.63 | MA | 30500 | 6878 | 47973 | 5154 | 51858 | 4189 | 52674 | 3472 | 52124 | 2463 | 61712 | 2045 | 31453 |
| 4L-3S | | MI | 20204 | 6878 | 32428 | 4964 | 34624 | 4053 | 35008 | 3351 | 34424 | 2323 | 39946 | 1994 | 19819 |
| 10-#14 | 1.63 | MA | 29672 | 6878 | 46595 | 5151 | 50071 | 4184 | 50477 | 3490 | 48942 | 2453 | 57882 | 1985 | 31191 |
| 5L-2S | | MI | 20999 | 6878 | 33610 | 4972 | 36139 | 4040 | 36838 | 3339 | 36851 | 2310 | 43125 | 2118 | 19754 |
| 10-#18 | 2.90 | MA | 36096 | 7483 | 59057 | 5483 | 65863 | 4421 | 69676 | 3605 | 75044 | 2370 | 91478 | 2157 | 54752 |
| 2L-5S | | MI | 19654 | 7483 | 32848 | 5296 | 34964 | 4291 | 35301 | 3469 | 34837 | 2206 | 41416 | 1353 | 31524 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 2.90 | MA | 33822 | 7483 | 55621 | 5476 | 61458 | 4454 | 64303 | 3634 | 67734 | 2393 | 81709 | 1935 | 54539 |
| 3L-4S | | MI | 20536 | 7483 | 34329 | 5313 | 36872 | 4269 | 37578 | 3447 | 38028 | 2228 | 45142 | 1451 | 33071 |
| 10-#18 | 2.90 | MA | 32227 | 7483 | 52819 | 5513 | 57887 | 4443 | 59962 | 3620 | 62147 | 2415 | 75358 | 1714 | 53576 |
| 4L-3S | | MI | 21515 | 7483 | 36029 | 5286 | 39028 | 4291 | 40132 | 3469 | 41202 | 2206 | 48649 | 1660 | 33754 |
| 10-#18 | 2.90 | MA | 30805 | 7483 | 50394 | 5505 | 54743 | 4476 | 56099 | 3649 | 56553 | 2393 | 68700 | 1609 | 50270 |
| 5L-2S | | MI | 22871 | 7483 | 38082 | 5304 | 41650 | 4269 | 43265 | 3447 | 45357 | 2184 | 54054 | 1882 | 33745 |
| 12-#11 | 1.36 | MA | 32026 | 6747 | 49861 | 5069 | 54365 | 4128 | 55761 | 3436 | 56158 | 2453 | 66690 | 2329 | 26450 |
| 2L-6S | | MI | 18926 | 6747 | 29949 | 4910 | 31477 | 4006 | 31308 | 3343 | 29542 | 2362 | 34138 | 1911 | 16742 |
| 12-#11 | 1.36 | MA | 31095 | 6747 | 48492 | 5067 | 52611 | 4125 | 53620 | 3449 | 53246 | 2464 | 62729 | 2243 | 26477 |
| 3L-5S | | MI | 19271 | 6747 | 30506 | 4915 | 32248 | 4013 | 32202 | 3334 | 30731 | 2354 | 35587 | 1968 | 16808 |
| 12-#11 | 1.36 | MA | 30444 | 6747 | 47380 | 5082 | 51193 | 4139 | 51897 | 3445 | 51028 | 2474 | 60146 | 2157 | 26475 |
| 4E | | MI | 19633 | 6747 | 31099 | 4921 | 33016 | 4003 | 33141 | 3325 | 32045 | 2362 | 37140 | 2005 | 16768 |
| 12-#11 | 1.36 | MA | 29863 | 6747 | 46420 | 5080 | 49947 | 4136 | 50366 | 3457 | 48810 | 2468 | 57461 | 2114 | 26413 |
| 5L-3S | | MI | 20034 | 6747 | 31782 | 4908 | 33885 | 4010 | 34193 | 3334 | 33355 | 2354 | 38595 | 2091 | 16719 |
| 12-#11 | 1.36 | MA | 29310 | 6747 | 45520 | 5078 | 48700 | 4150 | 48842 | 3453 | 46800 | 2478 | 54899 | 2058 | 26098 |
| 6L-2S | | MI | 20594 | 6747 | 32611 | 4914 | 34948 | 4000 | 35486 | 3325 | 35068 | 2345 | 40847 | 2177 | 16671 |
| 12-#14 | 1.96 | MA | 33671 | 7033 | 53488 | 5233 | 58917 | 4244 | 61276 | 3503 | 63645 | 2422 | 76666 | 2271 | 37654 |
| 2L-6S | | MI | 19168 | 7033 | 30990 | 5061 | 32698 | 4115 | 32752 | 3405 | 31452 | 2316 | 36836 | 1693 | 22756 |
| 12-#14 | 1.96 | MA | 32352 | 7033 | 51528 | 5230 | 56404 | 4239 | 58210 | 3521 | 59474 | 2437 | 71026 | 2146 | 37635 |
| 3L-5S | | MI | 19656 | 7033 | 31787 | 5069 | 33799 | 4126 | 34017 | 3392 | 33135 | 2303 | 38877 | 1776 | 23340 |
| 12-#14 | 1.96 | MA | 31429 | 7033 | 49933 | 5251 | 54371 | 4259 | 55739 | 3514 | 56295 | 2451 | 67352 | 2022 | 37518 |
| 4E | | MI | 20168 | 7033 | 32635 | 5078 | 34897 | 4112 | 35347 | 3380 | 34997 | 2316 | 41069 | 1830 | 23575 |
| 12-#14 | 1.96 | MA | 30606 | 7033 | 48555 | 5248 | 52584 | 4254 | 53543 | 3532 | 53112 | 2440 | 63522 | 1961 | 37030 |
| 5L-3S | | MI | 20737 | 7033 | 33610 | 5061 | 36139 | 4123 | 36838 | 3392 | 36851 | 2303 | 43125 | 1952 | 23544 |
| 12-#14 | 1.96 | MA | 29823 | 7033 | 47263 | 5245 | 50794 | 4273 | 51355 | 3526 | 50230 | 2455 | 59876 | 1880 | 35766 |
| 6L-2S | | MI | 21528 | 7033 | 34792 | 5069 | 37654 | 4109 | 38668 | 3380 | 39277 | 2291 | 46304 | 2076 | 23492 |
| 12-#18 | 3.48 | MA | 35389 | 7759 | 59057 | 5649 | 65863 | 4578 | 69676 | 3710 | 75044 | 2370 | 91478 | 1887 | 65144 |
| 3L-5S | | MI | 20565 | 7759 | 34901 | 5469 | 37586 | 4414 | 38434 | 3538 | 38992 | 2166 | 46822 | 1268 | 37606 |
| 12-#18 | 3.48 | MA | 33810 | 7759 | 56255 | 5686 | 62291 | 4567 | 65335 | 3695 | 69458 | 2393 | 85128 | 1665 | 63689 |
| 4E | | MI | 21441 | 7759 | 36382 | 5486 | 39494 | 4392 | 40711 | 3516 | 42183 | 2189 | 50548 | 1366 | 39026 |
| 12-#18 | 3.48 | MA | 32401 | 7759 | 53830 | 5678 | 59147 | 4600 | 61472 | 3725 | 63863 | 2371 | 78470 | 1561 | 60560 |
| 5L-3S | | MI | 22412 | 7759 | 38082 | 5459 | 41650 | 4414 | 43265 | 3538 | 45357 | 2166 | 54054 | 1576 | 40115 |
| 12-#18 | 3.48 | MA | 31062 | 7759 | 51556 | 5671 | 55999 | 4589 | 57624 | 3710 | 58793 | 2394 | 72161 | 1417 | 57639 |
| 6L-2S | | MI | 23759 | 7759 | 40134 | 5477 | 44272 | 4392 | 46398 | 3516 | 49513 | 2144 | 59460 | 1797 | 40185 |
| 14-#11 | 1.58 | MA | 32673 | 6855 | 51229 | 5137 | 56120 | 4176 | 57901 | 3465 | 59069 | 2445 | 70651 | 2314 | 30741 |
| 2L-7S | | MI | 18972 | 6855 | 30169 | 4990 | 31805 | 4065 | 31658 | 3363 | 30094 | 2358 | 35032 | 1818 | 18967 |
| 14-#11 | 1.58 | MA | 31745 | 6855 | 49861 | 5135 | 54365 | 4173 | 55761 | 3478 | 56158 | 2455 | 66690 | 2228 | 30758 |
| 3L-6S | | MI | 19308 | 6855 | 30778 | 4978 | 32540 | 4055 | 32600 | 3372 | 31256 | 2350 | 36391 | 1883 | 19233 |
| 14-#11 | 1.58 | MA | 31097 | 6855 | 48749 | 5150 | 52948 | 4187 | 54038 | 3474 | 53940 | 2466 | 64107 | 2141 | 30731 |
| 4L-5S | | MI | 19651 | 6855 | 31335 | 4983 | 33310 | 4062 | 33494 | 3363 | 32445 | 2341 | 37839 | 1940 | 19409 |
| 14-#11 | 1.58 | MA | 30519 | 6855 | 47788 | 5148 | 51702 | 4184 | 52506 | 3487 | 51721 | 2459 | 61422 | 2099 | 30649 |
| 5L-4S | | MI | 20012 | 6855 | 31928 | 4988 | 34079 | 4052 | 34433 | 3354 | 33759 | 2350 | 39393 | 1978 | 19382 |
| 14-#11 | 1.58 | MA | 29969 | 6855 | 46888 | 5146 | 50454 | 4198 | 50982 | 3482 | 49712 | 2470 | 58860 | 2043 | 30220 |
| 6L-3S | | MI | 20412 | 6855 | 32611 | 4976 | 34948 | 4059 | 35486 | 3363 | 35068 | 2341 | 40847 | 2063 | 19343 |
| 14-#11 | 1.58 | MA | 29434 | 6855 | 45902 | 5161 | 49265 | 4195 | 49519 | 3495 | 47749 | 2480 | 56128 | 1953 | 29614 |
| 7L-2S | | MI | 20970 | 6855 | 33440 | 4981 | 36011 | 4049 | 36778 | 3354 | 36782 | 2332 | 43100 | 2150 | 19300 |
| 14-#14 | 2.28 | MA | 33267 | 7189 | 53488 | 5327 | 58917 | 4309 | 61276 | 3564 | 63645 | 2424 | 76666 | 2122 | 43725 |
| 3L-6S | | MI | 19705 | 7189 | 32172 | 5158 | 34213 | 4185 | 34581 | 3446 | 33878 | 2296 | 40015 | 1651 | 26307 |
| 14-#14 | 2.28 | MA | 32350 | 7189 | 51893 | 5348 | 56884 | 4328 | 58805 | 3557 | 60465 | 2439 | 72991 | 1998 | 43575 |
| 4L-5S | | MI | 20191 | 7189 | 32969 | 5167 | 35314 | 4196 | 35847 | 3433 | 35562 | 2283 | 42056 | 1734 | 26849 |
| 14-#14 | 2.28 | MA | 31533 | 7189 | 50515 | 5345 | 55096 | 4323 | 56608 | 3575 | 57283 | 2428 | 69162 | 1937 | 42889 |
| 5L-4S | | MI | 20700 | 7189 | 33817 | 5175 | 36412 | 4182 | 37177 | 3421 | 37423 | 2296 | 44248 | 1788 | 27255 |
| 14-#14 | 2.28 | MA | 30755 | 7189 | 49223 | 5342 | 53307 | 4343 | 54421 | 3568 | 54400 | 2442 | 65516 | 1857 | 41684 |
| 6L-3S | | MI | 21266 | 7189 | 34792 | 5158 | 37654 | 4193 | 38668 | 3433 | 39277 | 2283 | 46304 | 1909 | 27256 |
| 14-#14 | 2.28 | MA | 29997 | 7189 | 47808 | 5363 | 51600 | 4338 | 52321 | 3586 | 51584 | 2457 | 61626 | 1727 | 40768 |
| 7L-2S | | MI | 22054 | 7189 | 35974 | 5166 | 39170 | 4179 | 40497 | 3421 | 41704 | 2271 | 49483 | 2034 | 27218 |
| 14-#18 | 4.06 | MA | 35376 | 8036 | 59690 | 5859 | 66696 | 4691 | 70709 | 3771 | 76769 | 2371 | 94897 | 1617 | 73846 |
| 4L-5S | | MI | 21468 | 8036 | 36953 | 5642 | 40208 | 4538 | 41567 | 3607 | 43148 | 2126 | 52228 | 1183 | 43711 |

## RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

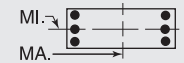
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 4.06 | MA | 33981 | 8036 | 57266 | 5851 | 63552 | 4724 | 66845 | 3800 | 71174 | 2349 | 88240 | 1512 | 70876 |
| 5L-4S | | MI | 22338 | 8036 | 38434 | 5659 | 42116 | 4515 | 43844 | 3584 | 46339 | 2149 | 55954 | 1282 | 45022 |
| 14-#18 | 4.06 | MA | 32654 | 8036 | 54992 | 5844 | 60403 | 4714 | 62997 | 3786 | 66103 | 2372 | 81931 | 1369 | 67771 |
| 6L-3S | | MI | 23303 | 8036 | 40134 | 5632 | 44272 | 4538 | 46398 | 3607 | 49513 | 2126 | 59460 | 1491 | 46456 |
| 14-#18 | 4.06 | MA | 31363 | 8036 | 52501 | 5881 | 57399 | 4747 | 59304 | 3815 | 61148 | 2394 | 75195 | 1138 | 64700 |
| 7L-2S | | MI | 24641 | 8036 | 42187 | 5649 | 46893 | 4515 | 49531 | 3584 | 53669 | 2104 | 64866 | 1712 | 46580 |
| 16-#11 | 1.81 | MA | 32392 | 6963 | 51229 | 5202 | 56120 | 4222 | 57901 | 3508 | 59069 | 2447 | 70651 | 2212 | 35024 |
| 3L-7S | | MI | 19353 | 6963 | 30998 | 5057 | 32867 | 4113 | 32950 | 3392 | 31808 | 2346 | 37285 | 1790 | 21483 |
| 16-#11 | 1.81 | MA | 31747 | 6963 | 50117 | 5217 | 54702 | 4236 | 56178 | 3503 | 56852 | 2457 | 68067 | 2126 | 34982 |
| 4L-6S | | MI | 19687 | 6963 | 31607 | 5045 | 33603 | 4103 | 33892 | 3401 | 32970 | 2337 | 38644 | 1856 | 21731 |
| 16-#11 | 1.81 | MA | 31172 | 6963 | 49157 | 5215 | 53456 | 4233 | 54647 | 3516 | 54633 | 2450 | 65383 | 2083 | 34880 |
| 5E | | MI | 20030 | 6963 | 32165 | 5050 | 34373 | 4110 | 34786 | 3392 | 34158 | 2328 | 40092 | 1913 | 22002 |
| 16-#11 | 1.81 | MA | 30625 | 6963 | 48257 | 5213 | 52209 | 4247 | 53122 | 3512 | 52624 | 2461 | 62821 | 2027 | 34352 |
| 6L-4S | | MI | 20389 | 6963 | 32758 | 5055 | 35141 | 4100 | 35726 | 3383 | 35473 | 2337 | 41645 | 1951 | 21988 |
| 16-#11 | 1.81 | MA | 30091 | 6963 | 47271 | 5229 | 51019 | 4244 | 51659 | 3525 | 50661 | 2471 | 60089 | 1938 | 33770 |
| 7L-3S | | MI | 20787 | 6963 | 33440 | 5043 | 36011 | 4107 | 36778 | 3392 | 36782 | 2328 | 43100 | 2036 | 21958 |
| 16-#11 | 1.81 | MA | 29566 | 6963 | 46385 | 5227 | 49813 | 4258 | 50231 | 3538 | 48575 | 2465 | 57578 | 1888 | 33316 |
| 8L-2S | | MI | 21344 | 6963 | 34269 | 5049 | 37074 | 4097 | 38070 | 3383 | 38495 | 2320 | 45353 | 2122 | 21921 |
| 16-#14 | 2.61 | MA | 33265 | 7344 | 53853 | 5446 | 59397 | 4398 | 61870 | 3599 | 64636 | 2426 | 78631 | 1974 | 49626 |
| 4L-6S | | MI | 20238 | 7344 | 33354 | 5256 | 35728 | 4254 | 36411 | 3486 | 36305 | 2276 | 43194 | 1609 | 29866 |
| 16-#14 | 2.61 | MA | 32452 | 7344 | 52475 | 5442 | 57609 | 4393 | 59673 | 3617 | 61454 | 2416 | 74802 | 1913 | 48765 |
| 5E | | MI | 20722 | 7344 | 34151 | 5264 | 36829 | 4265 | 37677 | 3474 | 37988 | 2264 | 45236 | 1691 | 30373 |
| 16-#14 | 2.61 | MA | 31679 | 7344 | 51183 | 5439 | 55819 | 4413 | 57486 | 3610 | 58571 | 2430 | 71155 | 1833 | 47611 |
| 6L-4S | | MI | 21229 | 7344 | 34999 | 5272 | 37927 | 4252 | 39007 | 3462 | 39850 | 2276 | 47427 | 1746 | 30924 |
| 16-#14 | 2.61 | MA | 30926 | 7344 | 49768 | 5461 | 54112 | 4408 | 55387 | 3628 | 55754 | 2444 | 67266 | 1703 | 46594 |
| 7L-3S | | MI | 21792 | 7344 | 35974 | 5256 | 39170 | 4263 | 40497 | 3474 | 41704 | 2264 | 49483 | 1867 | 30957 |
| 16-#14 | 2.61 | MA | 30185 | 7344 | 48497 | 5457 | 52381 | 4428 | 53338 | 3646 | 52761 | 2434 | 63685 | 1632 | 45075 |
| 8L-2S | | MI | 22576 | 7344 | 37156 | 5264 | 40685 | 4249 | 42327 | 3462 | 44130 | 2251 | 52663 | 1992 | 30932 |
| 16-#18 | 4.64 | MA | 35544 | 8313 | 60701 | 6024 | 67956 | 4849 | 72219 | 3876 | 78485 | 2327 | 98010 | 1464 | 81214 |
| 5E | | MI | 22364 | 8313 | 39006 | 5815 | 42829 | 4661 | 44700 | 3675 | 47304 | 2087 | 57633 | 1099 | 49834 |
| 16-#18 | 4.64 | MA | 34230 | 8313 | 58428 | 6017 | 64808 | 4838 | 68371 | 3861 | 73414 | 2350 | 91700 | 1320 | 77932 |
| 6L-4S | | MI | 23228 | 8313 | 40487 | 5832 | 44738 | 4639 | 46977 | 3653 | 50495 | 2109 | 61360 | 1197 | 51049 |
| 16-#18 | 4.64 | MA | 32951 | 8313 | 55937 | 6053 | 61803 | 4871 | 64677 | 3891 | 68459 | 2372 | 84965 | 1089 | 74806 |
| 7L-3S | | MI | 24187 | 8313 | 42187 | 5805 | 46893 | 4661 | 49531 | 3675 | 53669 | 2087 | 64866 | 1406 | 52782 |
| 16-#18 | 4.64 | MA | 31693 | 8313 | 53699 | 6046 | 58756 | 4860 | 61071 | 3921 | 63193 | 2351 | 78741 | 966 | 70680 |
| 8L-2S | | MI | 25516 | 8313 | 44239 | 5822 | 49515 | 4639 | 52664 | 3653 | 57825 | 2064 | 70272 | 1628 | 52956 |
| 18-#11 | 2.03 | MA | 32393 | 7071 | 51486 | 5285 | 56456 | 4284 | 58318 | 3533 | 59764 | 2448 | 72028 | 2110 | 39227 |
| 4L-7S | | MI | 19732 | 7071 | 31827 | 5124 | 33930 | 4162 | 34243 | 3421 | 33521 | 2333 | 39537 | 1763 | 24001 |
| 18-#11 | 2.03 | MA | 31821 | 7071 | 50525 | 5283 | 55210 | 4281 | 56787 | 3546 | 57545 | 2442 | 69344 | 2068 | 39108 |
| 5L-6S | | MI | 20065 | 7071 | 32437 | 5112 | 34666 | 4152 | 35185 | 3430 | 34683 | 2324 | 40897 | 1829 | 24236 |
| 18-#11 | 2.03 | MA | 31276 | 7071 | 49625 | 5281 | 53963 | 4295 | 55262 | 3541 | 55536 | 2452 | 66781 | 2012 | 38491 |
| 6L-5S | | MI | 20407 | 7071 | 32994 | 5118 | 35436 | 4159 | 36079 | 3421 | 35872 | 2316 | 42345 | 1886 | 24581 |
| 18-#11 | 2.03 | MA | 30745 | 7071 | 48639 | 5296 | 52774 | 4292 | 53799 | 3554 | 53573 | 2463 | 64050 | 1922 | 37930 |
| 7L-4S | | MI | 20764 | 7071 | 33587 | 5123 | 36204 | 4148 | 37018 | 3412 | 37186 | 2324 | 43898 | 1923 | 24587 |
| 18-#11 | 2.03 | MA | 30223 | 7071 | 47753 | 5294 | 51567 | 4306 | 52372 | 3567 | 51487 | 2456 | 61539 | 1872 | 37411 |
| 8L-3S | | MI | 21161 | 7071 | 34269 | 5111 | 37074 | 4156 | 38070 | 3421 | 38495 | 2316 | 45353 | 2009 | 24565 |
| 18-#11 | 2.03 | MA | 29667 | 7071 | 46887 | 5292 | 50393 | 4303 | 50879 | 3563 | 49542 | 2467 | 59054 | 1819 | 36538 |
| 9L-2S | | MI | 21716 | 7071 | 35098 | 5116 | 38137 | 4145 | 39363 | 3412 | 40209 | 2307 | 47606 | 2095 | 24535 |
| 18-#14 | 2.93 | MA | 33366 | 7500 | 54435 | 5540 | 60122 | 4463 | 62739 | 3660 | 65624 | 2403 | 80442 | 1889 | 54654 |
| 5L-6S | | MI | 20769 | 7500 | 34536 | 5353 | 37243 | 4324 | 38241 | 3527 | 38731 | 2256 | 46373 | 1567 | 33431 |
| 18-#14 | 2.93 | MA | 32597 | 7500 | 53143 | 5536 | 58332 | 4483 | 60551 | 3653 | 62742 | 2417 | 76795 | 1809 | 53548 |
| 6L-5S | | MI | 21251 | 7500 | 35333 | 5361 | 38345 | 4335 | 39507 | 3515 | 40415 | 2244 | 48415 | 1649 | 33907 |
| 18-#14 | 2.93 | MA | 31849 | 7500 | 51728 | 5558 | 56625 | 4478 | 58452 | 3671 | 59925 | 2432 | 72906 | 1679 | 52434 |
| 7L-4S | | MI | 21755 | 7500 | 36181 | 5369 | 39443 | 4322 | 40837 | 3502 | 42276 | 2256 | 50606 | 1704 | 34584 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis

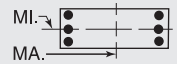


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.93 | MA | 31113 | 7500 | 50457 | 5555 | 54893 | 4498 | 56403 | 3689 | 56932 | 2421 | 69325 | 1608 | 50961 |
| 8L-3S | | MI | 22316 | 7500 | 37156 | 5353 | 40685 | 4333 | 42327 | 3515 | 44130 | 2244 | 52663 | 1825 | 34639 |
| 18-#14 | 2.93 | MA | 30337 | 7500 | 49213 | 5551 | 53209 | 4492 | 54261 | 3682 | 54141 | 2436 | 65790 | 1531 | 49373 |
| 9L-2S | | MI | 23096 | 7500 | 38338 | 5361 | 42200 | 4319 | 44157 | 3502 | 46557 | 2232 | 55842 | 1950 | 34639 |
| 18-#18 | 5.22 | MA | 35791 | 8589 | 61864 | 6190 | 69212 | 4962 | 73744 | 3937 | 80725 | 2328 | 101470 | 1272 | 88117 |
| 6L-5S | | MI | 23255 | 8589 | 41058 | 5988 | 45451 | 4784 | 47833 | 3744 | 51460 | 2047 | 63039 | 1014 | 55970 |
| 18-#18 | 5.22 | MA | 34524 | 8589 | 59373 | 6226 | 66208 | 4995 | 70050 | 3966 | 75769 | 2350 | 94735 | 1041 | 84879 |
| 7L-4S | | MI | 24112 | 8589 | 42539 | 6005 | 47359 | 4762 | 50110 | 3722 | 54651 | 2069 | 66765 | 1112 | 57103 |
| 18-#18 | 5.22 | MA | 33277 | 8589 | 57134 | 6219 | 63160 | 4984 | 66444 | 3996 | 70504 | 2329 | 88511 | 918 | 80865 |
| 8L-3S | | MI | 25065 | 8589 | 44239 | 5978 | 49515 | 4784 | 52664 | 3744 | 57825 | 2047 | 70272 | 1322 | 59096 |
| 20-#11 | 2.26 | MA | 32466 | 7178 | 51894 | 5350 | 56965 | 4329 | 58927 | 3575 | 60457 | 2433 | 73305 | 2052 | 43334 |
| 5L-7S | | MI | 20110 | 7178 | 32656 | 5192 | 34993 | 4210 | 35535 | 3450 | 35235 | 2320 | 41790 | 1736 | 26521 |
| 20-#11 | 2.26 | MA | 31924 | 7178 | 50994 | 5348 | 55718 | 4344 | 57402 | 3571 | 58448 | 2444 | 70742 | 1997 | 42637 |
| 6E | | MI | 20442 | 7178 | 33266 | 5180 | 35729 | 4200 | 36477 | 3459 | 36397 | 2311 | 43150 | 1801 | 26744 |
| 20-#11 | 2.26 | MA | 31396 | 7178 | 50008 | 5363 | 54528 | 4340 | 55940 | 3584 | 56485 | 2454 | 68011 | 1907 | 42095 |
| 7L-5S | | MI | 20782 | 7178 | 33823 | 5185 | 36499 | 4207 | 37371 | 3450 | 37586 | 2303 | 44598 | 1858 | 27156 |
| 20-#11 | 2.26 | MA | 30876 | 7178 | 49122 | 5362 | 53321 | 4354 | 54512 | 3597 | 54399 | 2447 | 65500 | 1857 | 41513 |
| 8L-4S | | MI | 21138 | 7178 | 34416 | 5190 | 37267 | 4197 | 38310 | 3442 | 38900 | 2311 | 46151 | 1896 | 27180 |
| 20-#11 | 2.26 | MA | 30323 | 7178 | 48256 | 5360 | 52148 | 4351 | 53019 | 3592 | 52454 | 2458 | 63015 | 1803 | 40664 |
| 9L-3S | | MI | 21534 | 7178 | 35098 | 5178 | 38137 | 4204 | 39363 | 3450 | 40209 | 2303 | 47606 | 1981 | 27167 |
| 20-#11 | 2.26 | MA | 29748 | 7178 | 47285 | 5375 | 50957 | 4365 | 51599 | 3605 | 50526 | 2469 | 60607 | 1742 | 39877 |
| 10L-2S | | MI | 22087 | 7178 | 35927 | 5183 | 39199 | 4194 | 40655 | 3442 | 41922 | 2294 | 49859 | 2068 | 27143 |
| 20-#14 | 3.26 | MA | 33509 | 7656 | 55103 | 5634 | 60845 | 4553 | 63617 | 3695 | 66912 | 2405 | 82435 | 1785 | 59492 |
| 6E | | MI | 21297 | 7656 | 35718 | 5450 | 38759 | 4394 | 40071 | 3568 | 41158 | 2237 | 49552 | 1525 | 37000 |
| 20-#14 | 3.26 | MA | 32766 | 7656 | 53688 | 5655 | 59138 | 4548 | 61517 | 3713 | 64096 | 2419 | 78546 | 1655 | 58284 |
| 7L-5S | | MI | 21776 | 7656 | 36515 | 5458 | 39860 | 4405 | 41337 | 3556 | 42841 | 2224 | 51594 | 1607 | 37451 |
| 20-#14 | 3.26 | MA | 32034 | 7656 | 52417 | 5652 | 57406 | 4567 | 59469 | 3731 | 61102 | 2409 | 74965 | 1584 | 56854 |
| 8L-4S | | MI | 22278 | 7656 | 37363 | 5467 | 40958 | 4391 | 42667 | 3543 | 44703 | 2237 | 53786 | 1662 | 38238 |
| 20-#14 | 3.26 | MA | 31278 | 7656 | 51173 | 5649 | 55722 | 4562 | 57326 | 3724 | 58312 | 2423 | 71429 | 1507 | 55207 |
| 9L-3S | | MI | 22836 | 7656 | 38338 | 5450 | 42200 | 4402 | 44157 | 3556 | 46557 | 2224 | 55842 | 1783 | 38313 |
| 20-#14 | 3.26 | MA | 30452 | 7656 | 49780 | 5670 | 54013 | 4582 | 55288 | 3742 | 55544 | 2438 | 68003 | 1419 | 53628 |
| 10L-2S | | MI | 23614 | 7656 | 39520 | 5458 | 43715 | 4389 | 45987 | 3543 | 48983 | 2212 | 59021 | 1907 | 38340 |
| 20-#18 | 5.80 | MA | 36082 | 8866 | 62809 | 6399 | 70612 | 5119 | 75423 | 4042 | 83080 | 2328 | 104505 | 992 | 94975 |
| 7L-5S | | MI | 24139 | 8866 | 43111 | 6161 | 48073 | 4908 | 50966 | 3813 | 55616 | 2007 | 68445 | 929 | 61927 |
| 20-#18 | 5.80 | MA | 34847 | 8866 | 60570 | 6392 | 67565 | 5108 | 71818 | 4071 | 77814 | 2306 | 98281 | 870 | 90888 |
| 8L-4S | | MI | 24991 | 8866 | 44592 | 6178 | 49981 | 4885 | 53244 | 3791 | 58806 | 2029 | 72171 | 1028 | 63178 |
| 22-#11 | 2.49 | MA | 32568 | 7286 | 52362 | 5416 | 57472 | 4392 | 59543 | 3600 | 61360 | 2435 | 74703 | 1981 | 46789 |
| 6L-7S | | MI | 20486 | 7286 | 33485 | 5259 | 36056 | 4259 | 36827 | 3479 | 36949 | 2307 | 44043 | 1708 | 29043 |
| 22-#11 | 2.49 | MA | 32043 | 7286 | 51376 | 5431 | 56282 | 4389 | 58080 | 3613 | 59397 | 2446 | 71971 | 1891 | 46263 |
| 7L-6S | | MI | 20817 | 7286 | 34095 | 5247 | 36792 | 4248 | 37769 | 3488 | 38110 | 2299 | 45403 | 1774 | 29257 |
| 22-#11 | 2.49 | MA | 31525 | 7286 | 50490 | 5429 | 55076 | 4403 | 56652 | 3626 | 57311 | 2439 | 69461 | 1842 | 45621 |
| 8L-5S | | MI | 21155 | 7286 | 34652 | 5252 | 37562 | 4255 | 38664 | 3479 | 39299 | 2290 | 46851 | 1831 | 29650 |
| 22-#11 | 2.49 | MA | 30975 | 7286 | 49624 | 5427 | 53902 | 4400 | 55159 | 3622 | 55366 | 2449 | 66976 | 1788 | 44795 |
| 9L-4S | | MI | 21510 | 7286 | 35245 | 5258 | 38330 | 4245 | 39603 | 3471 | 40613 | 2299 | 48404 | 1868 | 29760 |
| 22-#11 | 2.49 | MA | 30402 | 7286 | 48654 | 5442 | 52712 | 4414 | 53739 | 3634 | 53438 | 2460 | 64568 | 1727 | 43966 |
| 10L-3S | | MI | 21905 | 7286 | 35927 | 5246 | 39199 | 4252 | 40655 | 3479 | 41922 | 2290 | 49859 | 1954 | 29765 |
| 22-#11 | 2.49 | MA | 29843 | 7286 | 47786 | 5440 | 51545 | 4411 | 52265 | 3630 | 51381 | 2453 | 62120 | 1674 | 42976 |
| 11L-2S | | MI | 22456 | 7286 | 36756 | 5251 | 40262 | 4242 | 41947 | 3471 | 43636 | 2282 | 52112 | 2040 | 29747 |
| 22-#14 | 3.59 | MA | 33676 | 7811 | 55648 | 5752 | 61650 | 4617 | 64583 | 3756 | 68266 | 2407 | 84186 | 1631 | 64145 |
| 7L-6S | | MI | 21822 | 7811 | 36900 | 5547 | 40274 | 4464 | 41901 | 3609 | 43584 | 2217 | 52732 | 1482 | 40573 |
| 22-#14 | 3.59 | MA | 32948 | 7811 | 54377 | 5749 | 59919 | 4637 | 62534 | 3774 | 65273 | 2396 | 80605 | 1560 | 62755 |
| 8L-5S | | MI | 22299 | 7811 | 37697 | 5556 | 41375 | 4475 | 43167 | 3597 | 45268 | 2205 | 54773 | 1565 | 41002 |
| 22-#14 | 3.59 | MA | 32193 | 7811 | 53133 | 5746 | 58234 | 4632 | 60391 | 3767 | 62482 | 2411 | 77069 | 1483 | 61050 |
| 9L-4S | | MI | 22799 | 7811 | 38545 | 5564 | 42473 | 4461 | 44497 | 3584 | 47129 | 2217 | 56965 | 1619 | 41886 |
| 22-#14 | 3.59 | MA | 31376 | 7811 | 51740 | 5767 | 56526 | 4652 | 58353 | 3785 | 59715 | 2425 | 73643 | 1395 | 59303 |
| 10L-3S | | MI | 23354 | 7811 | 39520 | 5547 | 43715 | 4472 | 45987 | 3597 | 48983 | 2205 | 59021 | 1741 | 41981 |
| 22-#18 | 6.38 | MA | 36402 | 9143 | 64006 | 6565 | 71969 | 5232 | 77191 | 4147 | 85125 | 2284 | 108051 | 821 | 101114 |
| 8L-5S | | MI | 25018 | 9143 | 45163 | 6333 | 50695 | 5031 | 54099 | 3882 | 59771 | 1967 | 73851 | 845 | 67837 |

## RECTANGULAR TIED COLUMNS 30" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.71 | MA | 32686 | 7394 | 52745 | 5498 | 58037 | 4437 | 60220 | 3642 | 62309 | 2437 | 75932 | 1876 | 50435 |
| 7E | | MI | 20860 | 7394 | 34314 | 5327 | 37119 | 4307 | 38120 | 3508 | 38662 | 2295 | 46296 | 1681 | 31567 |
| 24-#11 | 2.71 | MA | 32171 | 7394 | 51859 | 5496 | 56830 | 4451 | 58792 | 3655 | 60223 | 2430 | 73422 | 1826 | 49736 |
| 8L-6S | | MI | 21190 | 7394 | 34924 | 5315 | 37854 | 4297 | 39062 | 3517 | 39824 | 2286 | 47655 | 1747 | 31772 |
| 24-#11 | 2.71 | MA | 31624 | 7394 | 50993 | 5494 | 55657 | 4448 | 57299 | 3651 | 58278 | 2441 | 70937 | 1773 | 48930 |
| 9L-5S | | MI | 21528 | 7394 | 35481 | 5320 | 38624 | 4304 | 39956 | 3508 | 41013 | 2277 | 49104 | 1804 | 32145 |
| 24-#11 | 2.71 | MA | 31053 | 7394 | 50022 | 5510 | 54466 | 4462 | 55879 | 3664 | 56350 | 2451 | 68529 | 1712 | 48061 |
| 10L-4S | | MI | 21881 | 7394 | 36074 | 5325 | 39393 | 4294 | 40895 | 3500 | 42327 | 2286 | 50657 | 1841 | 32338 |
| 24-#11 | 2.71 | MA | 30496 | 7394 | 49154 | 5508 | 53299 | 4459 | 54405 | 3660 | 54293 | 2445 | 66080 | 1659 | 47091 |
| 11L-3S | | MI | 22274 | 7394 | 36756 | 5313 | 40262 | 4301 | 41947 | 3508 | 43636 | 2277 | 52112 | 1927 | 32358 |
| 24-#11 | 2.71 | MA | 29950 | 7394 | 48201 | 5523 | 52117 | 4473 | 52987 | 3672 | 52366 | 2455 | 63322 | 1582 | 45927 |
| 12L-2S | | MI | 22824 | 7394 | 37585 | 5318 | 41325 | 4291 | 43240 | 3500 | 45349 | 2269 | 54365 | 2013 | 32346 |
| 24-#14 | 3.91 | MA | 33857 | 7967 | 56337 | 5846 | 62431 | 4707 | 65599 | 3816 | 69444 | 2384 | 86245 | 1536 | 68663 |
| 8L-6S | | MI | 22344 | 7967 | 38082 | 5645 | 41789 | 4534 | 43731 | 3650 | 46011 | 2197 | 55911 | 1440 | 44150 |
| 24-#14 | 3.91 | MA | 33103 | 7967 | 55093 | 5843 | 60747 | 4702 | 63457 | 3809 | 66653 | 2398 | 82709 | 1459 | 66901 |
| 9L-5S | | MI | 22819 | 7967 | 38879 | 5653 | 42890 | 4545 | 44997 | 3638 | 47694 | 2185 | 57952 | 1523 | 44558 |
| 24-#14 | 3.91 | MA | 32295 | 7967 | 53700 | 5865 | 59039 | 4722 | 61419 | 3827 | 63886 | 2413 | 79283 | 1371 | 65114 |
| 10L-4S | | MI | 23317 | 7967 | 39727 | 5661 | 43989 | 4531 | 46326 | 3625 | 49556 | 2197 | 60144 | 1577 | 45454 |

## RECTANGULAR TIED COLUMNS 30" x 48"

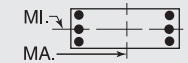
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.11 | MA | 34018 | 6918 | 52741 | 5180 | 56988 | 4225 | 57938 | 3529 | 57334 | 2552 | 67153 | 2419 | 23560 |
| 2E | | MI | 20955 | 6918 | 33133 | 4978 | 35026 | 4057 | 35066 | 3375 | 33959 | 2408 | 39012 | 2236 | 14269 |
| 6-#18 | 1.67 | MA | 35712 | 7195 | 56350 | 5353 | 61615 | 4350 | 63582 | 3604 | 65012 | 2530 | 77471 | 2373 | 34905 |
| 2L-3S | | MI | 20492 | 7195 | 33133 | 5134 | 35026 | 4203 | 35066 | 3466 | 33959 | 2390 | 39012 | 1930 | 20974 |
| 6-#18 | 1.67 | MA | 33275 | 7195 | 52741 | 5346 | 56988 | 4384 | 57938 | 3635 | 57334 | 2554 | 67153 | 2152 | 34893 |
| 3L-2S | | MI | 21869 | 7195 | 35186 | 5151 | 37647 | 4181 | 38199 | 3444 | 38114 | 2368 | 44418 | 2151 | 20839 |
| 8-#14 | 1.25 | MA | 34531 | 6987 | 53593 | 5254 | 58284 | 4282 | 59596 | 3569 | 59622 | 2563 | 70517 | 2436 | 26580 |
| 2L-4S | | MI | 19890 | 6987 | 31475 | 5078 | 33108 | 4133 | 32891 | 3434 | 31218 | 2460 | 35894 | 2016 | 16198 |
| 8-#14 | 1.25 | MA | 33128 | 6987 | 51536 | 5251 | 55646 | 4277 | 56379 | 3588 | 55244 | 2578 | 64568 | 2311 | 26626 |
| 3E | | MI | 20465 | 6987 | 32450 | 5062 | 34350 | 4144 | 34382 | 3447 | 33072 | 2447 | 37950 | 2137 | 16115 |
| 8-#14 | 1.25 | MA | 32147 | 6987 | 49864 | 5273 | 53515 | 4297 | 53788 | 3581 | 51910 | 2593 | 60688 | 2187 | 26594 |
| 4L-2S | | MI | 21264 | 6987 | 33632 | 5070 | 35866 | 4130 | 36212 | 3434 | 35499 | 2435 | 41130 | 2262 | 16036 |
| 8-#18 | 2.22 | MA | 37385 | 7471 | 59959 | 5526 | 66241 | 4474 | 69225 | 3680 | 72691 | 2508 | 87789 | 2328 | 46205 |
| 2L-4S | | MI | 20419 | 7471 | 33486 | 5333 | 35492 | 4304 | 35645 | 3513 | 34940 | 2372 | 40911 | 1636 | 27360 |
| 8-#18 | 2.22 | MA | 34970 | 7471 | 56350 | 5519 | 61615 | 4508 | 63582 | 3711 | 65012 | 2532 | 77471 | 2106 | 46079 |
| 3E | | MI | 21407 | 7471 | 35186 | 5306 | 37647 | 4326 | 38199 | 3535 | 38114 | 2350 | 44418 | 1845 | 27430 |
| 8-#18 | 2.22 | MA | 33278 | 7471 | 53410 | 5557 | 57867 | 4498 | 59027 | 3697 | 59151 | 2556 | 70756 | 1885 | 45511 |
| 4L-2S | | MI | 22774 | 7471 | 37239 | 5324 | 40269 | 4304 | 41332 | 3513 | 42270 | 2328 | 49824 | 2067 | 27344 |
| 10-#11 | 1.08 | MA | 34047 | 6904 | 52462 | 5217 | 56936 | 4257 | 57992 | 3557 | 57456 | 2578 | 67700 | 2461 | 23204 |
| 2L-5S | | MI | 19684 | 6904 | 30879 | 5044 | 32427 | 4126 | 32115 | 3442 | 30095 | 2472 | 34522 | 2097 | 14237 |
| 10-#11 | 1.08 | MA | 33064 | 6904 | 51026 | 5215 | 55095 | 4254 | 55746 | 3570 | 54401 | 2589 | 63525 | 2375 | 23242 |
| 3L-4S | | MI | 20048 | 6904 | 31472 | 5049 | 33195 | 4116 | 33054 | 3433 | 31410 | 2480 | 36075 | 2134 | 14178 |
| 10-#11 | 1.08 | MA | 32378 | 6904 | 49860 | 5231 | 53609 | 4268 | 53940 | 3566 | 52076 | 2600 | 60799 | 2288 | 23263 |
| 4L-3S | | MI | 20451 | 6904 | 32154 | 5037 | 34065 | 4123 | 34107 | 3442 | 32719 | 2472 | 37530 | 2220 | 14118 |
| 10-#11 | 1.08 | MA | 31766 | 6904 | 48853 | 5229 | 52304 | 4265 | 52335 | 3580 | 49751 | 2593 | 57973 | 2246 | 23225 |
| 5L-2S | | MI | 21013 | 6904 | 32984 | 5042 | 35127 | 4113 | 35399 | 3433 | 34432 | 2463 | 39783 | 2306 | 14066 |
| 10-#14 | 1.56 | MA | 35504 | 7143 | 55651 | 5351 | 60921 | 4351 | 62814 | 3612 | 64000 | 2550 | 76466 | 2413 | 33035 |
| 2L-5S | | MI | 19914 | 7143 | 31809 | 5167 | 33525 | 4216 | 33391 | 3488 | 31783 | 2428 | 36882 | 1919 | 19940 |
| 10-#14 | 1.56 | MA | 34110 | 7143 | 53593 | 5348 | 58284 | 4347 | 59596 | 3630 | 59622 | 2565 | 70517 | 2289 | 33052 |
| 3L-4S | | MI | 20429 | 7143 | 32657 | 5175 | 34624 | 4203 | 34721 | 3475 | 33645 | 2440 | 39073 | 1974 | 19926 |
| 10-#14 | 1.56 | MA | 33135 | 7143 | 51921 | 5370 | 56152 | 4367 | 57005 | 3624 | 56288 | 2580 | 66637 | 2164 | 32972 |
| 4L-3S | | MI | 21001 | 7143 | 33632 | 5159 | 35866 | 4214 | 36212 | 3488 | 35499 | 2428 | 41130 | 2095 | 19866 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis

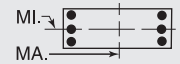



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.56 | MA | 32265 | 7143 | 50477 | 5367 | 54279 | 4362 | 54703 | 3642 | 52952 | 2571 | 62604 | 2103 | 32729 |
| 5L-2S | | MI | 21796 | 7143 | 34814 | 5167 | 37381 | 4200 | 38042 | 3475 | 37925 | 2415 | 44309 | 2220 | 19797 |
| 10-#18 | 2.78 | MA | 39037 | 7748 | 63567 | 5699 | 70867 | 4598 | 74869 | 3755 | 80370 | 2486 | 98107 | 2282 | 57452 |
| 2L-5S | | MI | 20449 | 7748 | 34057 | 5489 | 36205 | 4450 | 36501 | 3604 | 35905 | 2310 | 42591 | 1453 | 31759 |
| 10-#18 | 2.78 | MA | 36643 | 7748 | 59959 | 5692 | 66241 | 4632 | 69225 | 3786 | 72691 | 2510 | 87789 | 2061 | 57239 |
| 3L-4S | | MI | 21333 | 7748 | 35538 | 5506 | 38113 | 4428 | 38778 | 3581 | 39096 | 2332 | 46317 | 1551 | 33347 |
| 10-#18 | 2.78 | MA | 34968 | 7748 | 57018 | 5730 | 62493 | 4622 | 64671 | 3772 | 66830 | 2534 | 81074 | 1839 | 56568 |
| 4L-3S | | MI | 22313 | 7748 | 37239 | 5479 | 40269 | 4450 | 41332 | 3604 | 42270 | 2310 | 49824 | 1761 | 33838 |
| 10-#18 | 2.78 | MA | 33474 | 7748 | 54476 | 5723 | 59196 | 4656 | 60619 | 3803 | 60961 | 2513 | 74055 | 1733 | 52963 |
| 5L-2S | | MI | 23671 | 7748 | 39291 | 5497 | 42891 | 4428 | 44465 | 3581 | 46426 | 2288 | 55229 | 1982 | 33811 |
| 12-#11 | 1.30 | MA | 34733 | 7012 | 53898 | 5285 | 58777 | 4305 | 60237 | 3587 | 60511 | 2569 | 71875 | 2447 | 27714 |
| 2L-6S | | MI | 19721 | 7012 | 31151 | 5106 | 32720 | 4168 | 32513 | 3480 | 30620 | 2468 | 35327 | 2013 | 16879 |
| 12-#11 | 1.30 | MA | 33754 | 7012 | 52462 | 5283 | 56936 | 4302 | 57992 | 3600 | 57456 | 2580 | 67700 | 2360 | 27741 |
| 3L-5S | | MI | 20067 | 7012 | 31708 | 5111 | 33490 | 4175 | 33407 | 3471 | 31809 | 2459 | 36775 | 2070 | 16854 |
| 12-#11 | 1.30 | MA | 33071 | 7012 | 51296 | 5298 | 55450 | 4317 | 56185 | 3596 | 55131 | 2591 | 64974 | 2274 | 27738 |
| 4E | | MI | 20429 | 7012 | 32301 | 5117 | 34258 | 4164 | 34347 | 3462 | 33123 | 2468 | 38328 | 2107 | 16809 |
| 12-#11 | 1.30 | MA | 32462 | 7012 | 50289 | 5297 | 54144 | 4314 | 54581 | 3609 | 52806 | 2585 | 62148 | 2231 | 27677 |
| 5L-3S | | MI | 20831 | 7012 | 32984 | 5105 | 35127 | 4172 | 35399 | 3471 | 34432 | 2459 | 39783 | 2192 | 16758 |
| 12-#11 | 1.30 | MA | 31882 | 7012 | 49347 | 5295 | 52838 | 4328 | 52983 | 3605 | 50701 | 2596 | 59446 | 2175 | 27433 |
| 6L-2S | | MI | 21391 | 7012 | 33813 | 5110 | 36190 | 4161 | 36691 | 3462 | 36146 | 2450 | 42036 | 2279 | 16709 |
| 12-#14 | 1.88 | MA | 36470 | 7298 | 57708 | 5448 | 63559 | 4421 | 66031 | 3654 | 68377 | 2538 | 82414 | 2391 | 39476 |
| 2L-6S | | MI | 19963 | 7298 | 32194 | 5256 | 33939 | 4275 | 33955 | 3541 | 32526 | 2420 | 38019 | 1795 | 22904 |
| 12-#14 | 1.88 | MA | 35083 | 7298 | 55651 | 5445 | 60921 | 4417 | 62814 | 3672 | 64000 | 2553 | 76466 | 2266 | 39457 |
| 3L-5S | | MI | 20452 | 7298 | 32991 | 5264 | 35041 | 4286 | 35221 | 3529 | 34210 | 2408 | 40061 | 1877 | 23502 |
| 12-#14 | 1.88 | MA | 34114 | 7298 | 53978 | 5467 | 58790 | 4437 | 60223 | 3666 | 60665 | 2568 | 72586 | 2142 | 39340 |
| 4E | | MI | 20965 | 7298 | 33839 | 5273 | 36139 | 4272 | 36551 | 3516 | 36071 | 2420 | 42253 | 1931 | 23634 |
| 12-#14 | 1.88 | MA | 33250 | 7298 | 52534 | 5464 | 56916 | 4432 | 57920 | 3685 | 57329 | 2558 | 68553 | 2081 | 38987 |
| 5L-3S | | MI | 21534 | 7298 | 34814 | 5256 | 37381 | 4284 | 38042 | 3529 | 37925 | 2408 | 44309 | 2053 | 23596 |
| 12-#14 | 1.88 | MA | 32429 | 7298 | 51181 | 5462 | 55041 | 4452 | 55628 | 3678 | 54308 | 2573 | 64705 | 2000 | 37606 |
| 6L-2S | | MI | 22326 | 7298 | 35996 | 5264 | 38896 | 4270 | 39871 | 3516 | 40352 | 2395 | 47488 | 2177 | 23540 |
| 12-#18 | 3.33 | MA | 38298 | 8025 | 63567 | 5865 | 70867 | 4756 | 74869 | 3861 | 80370 | 2488 | 98107 | 2015 | 68384 |
| 3L-5S | | MI | 21360 | 8025 | 36110 | 5662 | 38827 | 4573 | 39634 | 3672 | 40061 | 2270 | 47997 | 1368 | 37840 |
| 12-#18 | 3.33 | MA | 36639 | 8025 | 60627 | 5903 | 67120 | 4746 | 70315 | 3848 | 74508 | 2511 | 91393 | 1794 | 67208 |
| 4E | | MI | 22238 | 8025 | 37591 | 5679 | 40735 | 4551 | 41911 | 3650 | 43252 | 2292 | 51723 | 1467 | 39297 |
| 12-#18 | 3.33 | MA | 35160 | 8025 | 58085 | 5896 | 63822 | 4780 | 66263 | 3879 | 68640 | 2491 | 84374 | 1688 | 63779 |
| 5L-3S | | MI | 23212 | 8025 | 39291 | 5652 | 42891 | 4573 | 44465 | 3672 | 46426 | 2270 | 55229 | 1676 | 40208 |
| 12-#18 | 3.33 | MA | 33753 | 8025 | 55701 | 5889 | 60521 | 4770 | 62228 | 3865 | 63323 | 2515 | 77706 | 1544 | 60941 |
| 6L-2S | | MI | 24561 | 8025 | 41344 | 5670 | 45512 | 4551 | 47598 | 3650 | 50582 | 2248 | 60635 | 1897 | 40250 |
| 14-#11 | 1.52 | MA | 35415 | 7120 | 55333 | 5352 | 60618 | 4354 | 62483 | 3616 | 63567 | 2560 | 76050 | 2432 | 32215 |
| 2L-7S | | MI | 19767 | 7120 | 31370 | 5186 | 33047 | 4226 | 32864 | 3500 | 31172 | 2464 | 36220 | 1919 | 19075 |
| 14-#11 | 1.52 | MA | 34440 | 7120 | 53898 | 5350 | 58777 | 4351 | 60237 | 3629 | 60511 | 2571 | 71875 | 2346 | 32232 |
| 3L-6S | | MI | 20103 | 7120 | 31980 | 5174 | 33782 | 4216 | 33806 | 3509 | 32334 | 2455 | 37579 | 1985 | 19347 |
| 14-#11 | 1.52 | MA | 33760 | 7120 | 52732 | 5366 | 57291 | 4365 | 58431 | 3625 | 58187 | 2582 | 69149 | 2259 | 32205 |
| 4L-5S | | MI | 20448 | 7120 | 32537 | 5179 | 34553 | 4223 | 34700 | 3500 | 33523 | 2446 | 39028 | 2042 | 19459 |
| 14-#11 | 1.52 | MA | 33154 | 7120 | 51725 | 5364 | 55985 | 4362 | 56826 | 3638 | 55862 | 2576 | 66324 | 2216 | 32123 |
| 5L-4S | | MI | 20808 | 7120 | 33130 | 5184 | 35321 | 4213 | 35639 | 3491 | 34837 | 2455 | 40581 | 2080 | 19427 |
| 14-#11 | 1.52 | MA | 32577 | 7120 | 50783 | 5362 | 54678 | 4377 | 55229 | 3634 | 53756 | 2587 | 63621 | 2161 | 31760 |
| 6L-3S | | MI | 21209 | 7120 | 33813 | 5172 | 36190 | 4220 | 36691 | 3500 | 36146 | 2446 | 42036 | 2165 | 19385 |
| 14-#11 | 1.52 | MA | 32015 | 7120 | 49749 | 5378 | 53432 | 4374 | 53696 | 3648 | 51700 | 2598 | 60741 | 2071 | 31099 |
| 7L-2S | | MI | 21767 | 7120 | 34642 | 5177 | 37253 | 4210 | 37984 | 3491 | 37859 | 2438 | 44289 | 2251 | 19340 |
| 14-#14 | 2.19 | MA | 36049 | 7454 | 57708 | 5543 | 63559 | 4486 | 66031 | 3715 | 68377 | 2541 | 82414 | 2244 | 45852 |
| 3L-6S | | MI | 20500 | 7454 | 33376 | 5353 | 35455 | 4345 | 35785 | 3582 | 34953 | 2401 | 41199 | 1752 | 26455 |
| 14-#14 | 2.19 | MA | 35086 | 7454 | 56036 | 5565 | 61427 | 4507 | 63440 | 3708 | 65043 | 2556 | 78535 | 2119 | 45701 |
| 4L-5S | | MI | 20987 | 7454 | 34173 | 5362 | 36556 | 4356 | 37051 | 3569 | 36636 | 2388 | 43240 | 1835 | 27011 |
| 14-#14 | 2.19 | MA | 34228 | 7454 | 54591 | 5562 | 59553 | 4502 | 61138 | 3727 | 61707 | 2546 | 74502 | 2058 | 45139 |
| 5L-4S | | MI | 21498 | 7454 | 35021 | 5370 | 37654 | 4342 | 38381 | 3557 | 38498 | 2401 | 45432 | 1889 | 27323 |
| 14-#14 | 2.19 | MA | 33412 | 7454 | 53238 | 5559 | 57678 | 4522 | 58845 | 3721 | 58685 | 2561 | 70654 | 1977 | 43821 |
| 6L-3S | | MI | 22064 | 7454 | 35996 | 5353 | 38896 | 4353 | 39871 | 3569 | 40352 | 2388 | 47488 | 2011 | 27311 |

## RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

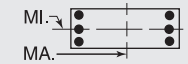
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.19 | MA | 32617 | 7454 | 51755 | 5581 | 55889 | 4518 | 56645 | 3739 | 55734 | 2576 | 66551 | 1848 | 42960 |
| 7L-2S | | MI | 22853 | 7454 | 37178 | 5362 | 40411 | 4340 | 41701 | 3557 | 42778 | 2376 | 50667 | 2135 | 27268 |
| 14-#18 | 3.89 | MA | 38292 | 8301 | 64236 | 6076 | 71746 | 4870 | 75958 | 3923 | 82187 | 2489 | 101711 | 1748 | 77883 |
| 4L-5S | | MI | 22265 | 8301 | 38163 | 5835 | 41449 | 4696 | 42767 | 3741 | 44217 | 2230 | 53403 | 1283 | 43944 |
| 14-#18 | 3.89 | MA | 36827 | 8301 | 61693 | 6069 | 68449 | 4904 | 71907 | 3954 | 76319 | 2469 | 94692 | 1642 | 74622 |
| 5L-4S | | MI | 23136 | 8301 | 39644 | 5852 | 43357 | 4674 | 45044 | 3719 | 47408 | 2252 | 57129 | 1382 | 45289 |
| 14-#18 | 3.89 | MA | 35434 | 8301 | 59310 | 6062 | 65147 | 4894 | 67872 | 3941 | 71001 | 2493 | 88024 | 1498 | 71598 |
| 6L-3S | | MI | 24104 | 8301 | 41344 | 5825 | 45512 | 4696 | 47598 | 3741 | 50582 | 2230 | 60635 | 1591 | 46556 |
| 14-#18 | 3.89 | MA | 34078 | 8301 | 56699 | 6100 | 61997 | 4928 | 63999 | 3971 | 65805 | 2517 | 80910 | 1268 | 68255 |
| 7L-2S | | MI | 25444 | 8301 | 43396 | 5842 | 48134 | 4674 | 50731 | 3719 | 54737 | 2208 | 66041 | 1813 | 46661 |
| 16-#11 | 1.73 | MA | 35122 | 7228 | 55333 | 5418 | 60618 | 4399 | 62483 | 3659 | 63567 | 2563 | 76050 | 2331 | 36709 |
| 3L-7S | | MI | 20149 | 7228 | 32199 | 5253 | 34110 | 4275 | 34156 | 3529 | 32886 | 2451 | 38473 | 1892 | 21592 |
| 16-#11 | 1.73 | MA | 34445 | 7228 | 54168 | 5433 | 59132 | 4414 | 60677 | 3655 | 61242 | 2574 | 73325 | 2245 | 36666 |
| 4L-6S | | MI | 20483 | 7228 | 32809 | 5241 | 34845 | 4264 | 35098 | 3538 | 34047 | 2442 | 39832 | 1958 | 21846 |
| 16-#11 | 1.73 | MA | 33841 | 7228 | 53161 | 5431 | 57826 | 4411 | 59072 | 3668 | 58917 | 2567 | 70499 | 2202 | 36565 |
| 5E | | MI | 20826 | 7228 | 33366 | 5246 | 35615 | 4271 | 35992 | 3529 | 35236 | 2434 | 41281 | 2015 | 22056 |
| 16-#11 | 1.73 | MA | 33268 | 7228 | 52219 | 5430 | 56519 | 4425 | 57474 | 3664 | 56812 | 2578 | 67796 | 2146 | 36096 |
| 6L-4S | | MI | 21186 | 7228 | 33959 | 5251 | 36384 | 4261 | 36931 | 3520 | 36550 | 2442 | 42834 | 2052 | 22036 |
| 16-#11 | 1.73 | MA | 32708 | 7228 | 51185 | 5445 | 55273 | 4422 | 55942 | 3677 | 54755 | 2589 | 64917 | 2056 | 35461 |
| 7L-3S | | MI | 21585 | 7228 | 34642 | 5239 | 37253 | 4268 | 37984 | 3529 | 37859 | 2434 | 44289 | 2138 | 22002 |
| 16-#11 | 1.73 | MA | 32158 | 7228 | 50258 | 5444 | 54009 | 4437 | 54446 | 3690 | 52569 | 2583 | 62274 | 2006 | 34996 |
| 8L-2S | | MI | 22142 | 7228 | 35471 | 5245 | 38316 | 4258 | 39276 | 3520 | 39573 | 2425 | 46541 | 2224 | 21963 |
| 16-#14 | 2.50 | MA | 36051 | 7610 | 58093 | 5662 | 64064 | 4576 | 66658 | 3751 | 69421 | 2543 | 84484 | 2097 | 52056 |
| 4L-6S | | MI | 21034 | 7610 | 34558 | 5451 | 36970 | 4415 | 37615 | 3623 | 37379 | 2381 | 44378 | 1710 | 30015 |
| 16-#14 | 2.50 | MA | 35198 | 7610 | 56649 | 5659 | 62191 | 4572 | 64355 | 3769 | 66084 | 2533 | 80451 | 2035 | 51308 |
| 5E | | MI | 21519 | 7610 | 35355 | 5459 | 38071 | 4426 | 38881 | 3610 | 39063 | 2368 | 46419 | 1793 | 30533 |
| 16-#14 | 2.50 | MA | 34387 | 7610 | 55295 | 5656 | 60315 | 4592 | 62062 | 3763 | 63063 | 2548 | 76603 | 1955 | 50046 |
| 6L-4S | | MI | 22027 | 7610 | 36203 | 5467 | 39169 | 4412 | 40211 | 3598 | 40925 | 2381 | 48611 | 1847 | 30997 |
| 16-#14 | 2.50 | MA | 33597 | 7610 | 53812 | 5678 | 58526 | 4587 | 59863 | 3782 | 60111 | 2563 | 72500 | 1825 | 49125 |
| 7L-3S | | MI | 22591 | 7610 | 37178 | 5451 | 40411 | 4423 | 41701 | 3610 | 42778 | 2368 | 50667 | 1969 | 31021 |
| 16-#14 | 2.50 | MA | 32819 | 7610 | 52480 | 5675 | 56712 | 4608 | 57716 | 3800 | 56974 | 2554 | 68728 | 1754 | 47473 |
| 8L-2S | | MI | 23376 | 7610 | 38360 | 5459 | 41927 | 4409 | 43531 | 3598 | 45205 | 2356 | 53846 | 2093 | 30986 |
| 16-#18 | 4.44 | MA | 38477 | 8578 | 65302 | 6242 | 73075 | 5029 | 77550 | 4029 | 83997 | 2447 | 105010 | 1596 | 85487 |
| 5E | | MI | 23162 | 8578 | 40215 | 6008 | 44070 | 4820 | 45900 | 3810 | 48373 | 2190 | 58808 | 1199 | 50066 |
| 16-#18 | 4.44 | MA | 37098 | 8578 | 62919 | 6235 | 69773 | 5019 | 73515 | 4016 | 78680 | 2471 | 98343 | 1453 | 82282 |
| 6L-4S | | MI | 24028 | 8578 | 41696 | 6025 | 45978 | 4798 | 48177 | 3788 | 51563 | 2212 | 62535 | 1297 | 51314 |
| 16-#18 | 4.44 | MA | 35754 | 8578 | 60307 | 6273 | 66624 | 5053 | 69643 | 4047 | 73484 | 2495 | 91228 | 1222 | 79053 |
| 7L-3S | | MI | 24989 | 8578 | 43396 | 5998 | 48134 | 4820 | 50731 | 3810 | 54737 | 2190 | 66041 | 1507 | 52889 |
| 16-#18 | 4.44 | MA | 34433 | 8578 | 57961 | 6266 | 63429 | 5043 | 65862 | 4077 | 67962 | 2475 | 84665 | 1098 | 74725 |
| 8L-2S | | MI | 26322 | 8578 | 45449 | 6015 | 50756 | 4798 | 53864 | 3788 | 58893 | 2168 | 71447 | 1728 | 53043 |
| 18-#11 | 1.95 | MA | 35126 | 7336 | 55604 | 5501 | 60972 | 4462 | 62922 | 3684 | 64298 | 2565 | 77500 | 2230 | 41123 |
| 4L-7S | | MI | 20528 | 7336 | 33028 | 5320 | 35172 | 4323 | 35448 | 3558 | 34599 | 2438 | 40726 | 1865 | 24111 |
| 18-#11 | 1.95 | MA | 34526 | 7336 | 54597 | 5499 | 59667 | 4459 | 61318 | 3697 | 61972 | 2559 | 74674 | 2187 | 41003 |
| 5L-6S | | MI | 20862 | 7336 | 33638 | 5308 | 35908 | 4313 | 36390 | 3567 | 35761 | 2429 | 42085 | 1931 | 24350 |
| 18-#11 | 1.95 | MA | 33954 | 7336 | 53654 | 5497 | 58360 | 4474 | 59720 | 3693 | 59867 | 2570 | 71972 | 2132 | 40441 |
| 6L-5S | | MI | 21204 | 7336 | 34195 | 5314 | 36678 | 4320 | 37285 | 3558 | 36950 | 2421 | 43533 | 1988 | 24643 |
| 18-#11 | 1.95 | MA | 33398 | 7336 | 52621 | 5513 | 57114 | 4471 | 58187 | 3707 | 57810 | 2581 | 69092 | 2042 | 39828 |
| 7L-4S | | MI | 21562 | 7336 | 34788 | 5319 | 37446 | 4310 | 38224 | 3549 | 38264 | 2429 | 45087 | 2025 | 24638 |
| 18-#11 | 1.95 | MA | 32850 | 7336 | 51694 | 5511 | 55850 | 4485 | 56692 | 3720 | 55624 | 2575 | 66449 | 1992 | 39374 |
| 8L-3S | | MI | 21959 | 7336 | 35471 | 5307 | 38316 | 4317 | 39276 | 3558 | 39573 | 2421 | 46541 | 2110 | 24612 |
| 18-#11 | 1.95 | MA | 32258 | 7336 | 50786 | 5509 | 54620 | 4482 | 55128 | 3716 | 53587 | 2586 | 63828 | 1938 | 38435 |
| 9L-2S | | MI | 22515 | 7336 | 36300 | 5312 | 39379 | 4307 | 40568 | 3549 | 41287 | 2412 | 48794 | 2197 | 24580 |
| 18-#14 | 2.81 | MA | 36161 | 7765 | 58706 | 5756 | 64828 | 4642 | 67572 | 3812 | 70462 | 2521 | 86400 | 2013 | 57493 |
| 5L-6S | | MI | 21566 | 7765 | 35740 | 5548 | 38485 | 4485 | 39445 | 3664 | 39806 | 2361 | 47557 | 1668 | 33580 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis

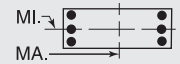


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.81 | MA | 35355 | 7765 | 57353 | 5753 | 62953 | 4662 | 65280 | 3805 | 67441 | 2536 | 82551 | 1932 | 56280 |
| 6L-5S | | MI | 22048 | 7765 | 36537 | 5556 | 39586 | 4496 | 40711 | 3651 | 41489 | 2349 | 49599 | 1751 | 34068 |
| 18-#14 | 2.81 | MA | 34570 | 7765 | 55869 | 5775 | 61164 | 4657 | 63080 | 3824 | 64489 | 2551 | 78449 | 1803 | 55259 |
| 7L-4S | | MI | 22554 | 7765 | 37385 | 5564 | 40685 | 4482 | 42041 | 3639 | 43351 | 2361 | 51790 | 1805 | 34663 |
| 18-#14 | 2.81 | MA | 33797 | 7765 | 54538 | 5772 | 59349 | 4677 | 60933 | 3842 | 61352 | 2541 | 74677 | 1731 | 53655 |
| 8L-3S | | MI | 23115 | 7765 | 38360 | 5548 | 41927 | 4493 | 43531 | 3651 | 45205 | 2349 | 53846 | 1926 | 34707 |
| 18-#14 | 2.81 | MA | 32970 | 7765 | 53235 | 5769 | 57584 | 4673 | 58688 | 3836 | 58427 | 2556 | 70946 | 1654 | 52113 |
| 9L-2S | | MI | 23897 | 7765 | 39542 | 5556 | 43442 | 4479 | 45361 | 3639 | 47631 | 2336 | 57026 | 2051 | 34695 |
| 18-#18 | 5.00 | MA | 38745 | 8855 | 66527 | 6408 | 74400 | 5143 | 79159 | 4091 | 86359 | 2449 | 108661 | 1407 | 92992 |
| 6L-5S | | MI | 24054 | 8855 | 42268 | 6181 | 46692 | 4943 | 49033 | 3879 | 52528 | 2150 | 64214 | 1114 | 56203 |
| 18-#18 | 5.00 | MA | 37414 | 8855 | 63916 | 6445 | 71250 | 5177 | 75286 | 4122 | 81163 | 2473 | 101547 | 1176 | 89813 |
| 7L-4S | | MI | 24914 | 8855 | 43749 | 6198 | 48600 | 4921 | 51310 | 3857 | 55719 | 2172 | 67940 | 1213 | 57365 |
| 18-#18 | 5.00 | MA | 36105 | 8855 | 61570 | 6439 | 68055 | 5167 | 71506 | 4153 | 75641 | 2453 | 94984 | 1052 | 85437 |
| 8L-3S | | MI | 25869 | 8855 | 45449 | 6171 | 50756 | 4943 | 53864 | 3879 | 58893 | 2150 | 71447 | 1422 | 59209 |
| 20-#11 | 2.17 | MA | 35206 | 7444 | 56033 | 5566 | 61508 | 4508 | 63563 | 3727 | 65028 | 2550 | 78849 | 2173 | 45440 |
| 5L-7S | | MI | 20906 | 7444 | 33857 | 5388 | 36235 | 4371 | 36741 | 3587 | 36313 | 2425 | 42979 | 1837 | 26633 |
| 20-#11 | 2.17 | MA | 34637 | 7444 | 55090 | 5565 | 60201 | 4522 | 61966 | 3723 | 62923 | 2561 | 76147 | 2117 | 44792 |
| 6E | | MI | 21239 | 7444 | 34467 | 5376 | 36971 | 4361 | 37683 | 3596 | 37474 | 2417 | 44338 | 1903 | 26860 |
| 20-#11 | 2.17 | MA | 34083 | 7444 | 54057 | 5580 | 58955 | 4519 | 60433 | 3736 | 60866 | 2572 | 73267 | 2027 | 44200 |
| 7L-5S | | MI | 21579 | 7444 | 35024 | 5381 | 37741 | 4368 | 38577 | 3587 | 38663 | 2408 | 45786 | 1960 | 27221 |
| 20-#11 | 2.17 | MA | 33538 | 7444 | 53130 | 5578 | 57691 | 4533 | 58937 | 3749 | 58680 | 2566 | 70624 | 1977 | 43690 |
| 8L-4S | | MI | 21936 | 7444 | 35617 | 5386 | 38509 | 4358 | 39516 | 3579 | 39977 | 2417 | 47339 | 1998 | 27234 |
| 20-#11 | 2.17 | MA | 32949 | 7444 | 52222 | 5577 | 56461 | 4531 | 57373 | 3745 | 56642 | 2577 | 68004 | 1924 | 42767 |
| 9L-3S | | MI | 22333 | 7444 | 36300 | 5374 | 39379 | 4365 | 40568 | 3587 | 41287 | 2408 | 48794 | 2083 | 27217 |
| 20-#11 | 2.17 | MA | 32346 | 7444 | 51206 | 5592 | 55214 | 4545 | 55886 | 3758 | 54622 | 2588 | 65463 | 1863 | 42033 |
| 10L-2S | | MI | 22886 | 7444 | 37129 | 5379 | 40442 | 4355 | 41861 | 3579 | 43000 | 2400 | 51047 | 2169 | 27190 |
| 20-#14 | 3.13 | MA | 36317 | 7921 | 59410 | 5851 | 65590 | 4732 | 68497 | 3848 | 71818 | 2524 | 88500 | 1910 | 62522 |
| 6E | | MI | 22094 | 7921 | 36922 | 5645 | 40001 | 4554 | 41275 | 3704 | 42233 | 2341 | 50736 | 1626 | 37151 |
| 20-#14 | 3.13 | MA | 35537 | 7921 | 57927 | 5873 | 63801 | 4727 | 66297 | 3866 | 68867 | 2539 | 84397 | 1780 | 61405 |
| 7L-5S | | MI | 22575 | 7921 | 37719 | 5653 | 41102 | 4566 | 42541 | 3692 | 43916 | 2329 | 52778 | 1708 | 37611 |
| 20-#14 | 3.13 | MA | 34769 | 7921 | 56595 | 5870 | 61987 | 4747 | 64150 | 3885 | 65729 | 2529 | 80626 | 1709 | 59846 |
| 8L-4S | | MI | 23078 | 7921 | 38567 | 5662 | 42200 | 4552 | 43871 | 3680 | 45778 | 2341 | 54970 | 1763 | 38321 |
| 20-#14 | 3.13 | MA | 33947 | 7921 | 55292 | 5867 | 60222 | 4743 | 61905 | 3879 | 62805 | 2544 | 76894 | 1631 | 58243 |
| 9L-3S | | MI | 23637 | 7921 | 39542 | 5645 | 43442 | 4563 | 45361 | 3692 | 47631 | 2329 | 57026 | 1884 | 38384 |
| 20-#14 | 3.13 | MA | 33095 | 7921 | 53833 | 5889 | 58432 | 4763 | 59770 | 3897 | 59905 | 2559 | 73278 | 1543 | 56531 |
| 10L-2S | | MI | 24416 | 7921 | 40724 | 5653 | 44957 | 4549 | 47191 | 3680 | 50058 | 2317 | 60205 | 2009 | 38404 |
| 20-#18 | 5.56 | MA | 39059 | 9131 | 67525 | 6618 | 75876 | 5301 | 80930 | 4197 | 88841 | 2451 | 111865 | 1131 | 100433 |
| 7L-5S | | MI | 24940 | 9131 | 44320 | 6354 | 49314 | 5066 | 52166 | 3948 | 56684 | 2110 | 69620 | 1030 | 62350 |
| 20-#18 | 5.56 | MA | 37761 | 9131 | 65179 | 6612 | 72681 | 5291 | 77150 | 4228 | 83320 | 2430 | 105302 | 1006 | 96167 |
| 8L-4S | | MI | 25795 | 9131 | 45801 | 6371 | 51222 | 5044 | 54443 | 3926 | 59875 | 2132 | 73346 | 1128 | 63438 |
| 22-#11 | 2.38 | MA | 35317 | 7552 | 56526 | 5632 | 62042 | 4570 | 64211 | 3752 | 65978 | 2553 | 80322 | 2103 | 49150 |
| 6L-7S | | MI | 21283 | 7552 | 34686 | 5455 | 37298 | 4420 | 38033 | 3616 | 38026 | 2413 | 45231 | 1810 | 29156 |
| 22-#11 | 2.38 | MA | 34765 | 7552 | 55493 | 5648 | 60795 | 4568 | 62679 | 3765 | 63921 | 2564 | 77442 | 2013 | 48576 |
| 7L-6S | | MI | 21614 | 7552 | 35296 | 5443 | 38034 | 4410 | 38975 | 3625 | 39188 | 2404 | 46591 | 1876 | 29372 |
| 22-#11 | 2.38 | MA | 34223 | 7552 | 54565 | 5646 | 59531 | 4582 | 61183 | 3779 | 61735 | 2557 | 74799 | 1963 | 48003 |
| 8L-5S | | MI | 21953 | 7552 | 35853 | 5449 | 38804 | 4417 | 39869 | 3616 | 40377 | 2395 | 48039 | 1933 | 29778 |
| 22-#11 | 2.38 | MA | 33637 | 7552 | 53658 | 5644 | 58302 | 4579 | 59619 | 3775 | 59698 | 2568 | 72179 | 1909 | 47104 |
| 9L-4S | | MI | 22309 | 7552 | 36446 | 5454 | 39572 | 4407 | 40809 | 3608 | 41691 | 2404 | 49592 | 1970 | 29821 |
| 22-#11 | 2.38 | MA | 33036 | 7552 | 52642 | 5660 | 57055 | 4593 | 58131 | 3788 | 57678 | 2579 | 69639 | 1848 | 46328 |
| 10L-3S | | MI | 22704 | 7552 | 37129 | 5442 | 40442 | 4414 | 41861 | 3616 | 43000 | 2395 | 51047 | 2056 | 29816 |
| 22-#11 | 2.38 | MA | 32449 | 7552 | 51732 | 5658 | 55832 | 4591 | 56587 | 3784 | 55523 | 2573 | 67061 | 1795 | 45253 |
| 11L-2S | | MI | 23256 | 7552 | 37958 | 5447 | 41504 | 4403 | 43153 | 3608 | 44714 | 2387 | 53300 | 2142 | 29795 |
| 22-#14 | 3.44 | MA | 36497 | 8077 | 59984 | 5970 | 66439 | 4797 | 69515 | 3909 | 73244 | 2526 | 90346 | 1758 | 67561 |
| 7L-6S | | MI | 22620 | 8077 | 38104 | 5743 | 41516 | 4624 | 43105 | 3745 | 44659 | 2322 | 53915 | 1584 | 40725 |
| 22-#14 | 3.44 | MA | 35733 | 8077 | 58652 | 5967 | 64624 | 4817 | 67368 | 3927 | 70107 | 2516 | 86574 | 1686 | 66044 |
| 8L-5S | | MI | 23098 | 8077 | 38901 | 5751 | 42617 | 4635 | 44371 | 3733 | 46343 | 2309 | 55957 | 1666 | 41162 |
| 22-#14 | 3.44 | MA | 34931 | 8077 | 57349 | 5964 | 62859 | 4813 | 65123 | 3921 | 67182 | 2531 | 82843 | 1609 | 64382 |
| 9L-4S | | MI | 23599 | 8077 | 39749 | 5759 | 43715 | 4622 | 45700 | 3720 | 48204 | 2322 | 58149 | 1721 | 41973 |

## RECTANGULAR TIED COLUMNS 30" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 3.44 | MA | 34070 | 8077 | 55890 | 5986 | 61069 | 4833 | 62987 | 3939 | 64283 | 2546 | 79227 | 1521 | 62707 |
| 10L-3S | | MI | 24156 | 8077 | 40724 | 5742 | 44957 | 4633 | 47191 | 3733 | 50058 | 2309 | 60205 | 1842 | 42055 |
| 22-#18 | 6.11 | MA | 39403 | 9408 | 68787 | 6785 | 77307 | 5415 | 82793 | 4304 | 90998 | 2408 | 115620 | 961 | 106913 |
| 8L-5S | | MI | 25820 | 9408 | 46373 | 6527 | 51935 | 5190 | 55299 | 4017 | 60840 | 2070 | 75026 | 945 | 68258 |
| 24-#11 | 2.60 | MA | 35444 | 7659 | 56929 | 5715 | 62636 | 4616 | 64924 | 3795 | 66977 | 2555 | 81617 | 1998 | 52955 |
| 7E | | MI | 21657 | 7659 | 35515 | 5523 | 38361 | 4468 | 39325 | 3645 | 39740 | 2400 | 47484 | 1783 | 31681 |
| 24-#11 | 2.60 | MA | 34904 | 7659 | 56001 | 5713 | 61372 | 4630 | 63429 | 3808 | 64791 | 2549 | 78974 | 1948 | 52323 |
| 8L-6S | | MI | 21988 | 7659 | 36125 | 5511 | 39097 | 4458 | 40268 | 3654 | 40901 | 2391 | 48844 | 1848 | 31888 |
| 24-#11 | 2.60 | MA | 34321 | 7659 | 55094 | 5712 | 60143 | 4627 | 61865 | 3804 | 62753 | 2560 | 76354 | 1894 | 51445 |
| 9L-5S | | MI | 22326 | 7659 | 36682 | 5516 | 39867 | 4465 | 41162 | 3645 | 42090 | 2383 | 50292 | 1905 | 32273 |
| 24-#11 | 2.60 | MA | 33722 | 7659 | 54077 | 5727 | 58896 | 4642 | 60377 | 3817 | 60733 | 2571 | 73814 | 1834 | 50628 |
| 10L-4S | | MI | 22680 | 7659 | 37275 | 5521 | 40635 | 4455 | 42101 | 3637 | 43404 | 2391 | 51845 | 1943 | 32402 |
| 24-#11 | 2.60 | MA | 33138 | 7659 | 53168 | 5725 | 57673 | 4639 | 58833 | 3813 | 58578 | 2564 | 71236 | 1781 | 49575 |
| 11L-3S | | MI | 23074 | 7659 | 37958 | 5509 | 41504 | 4462 | 43153 | 3645 | 44714 | 2383 | 53300 | 2028 | 32412 |
| 24-#11 | 2.60 | MA | 32564 | 7659 | 52170 | 5741 | 56435 | 4653 | 57348 | 3826 | 56559 | 2575 | 68329 | 1704 | 48439 |
| 12L-2S | | MI | 23624 | 7659 | 38787 | 5514 | 42567 | 4452 | 44446 | 3637 | 46427 | 2374 | 55553 | 2115 | 32397 |
| 24-#14 | 3.75 | MA | 36692 | 8232 | 60710 | 6064 | 67261 | 4887 | 70585 | 3970 | 74484 | 2504 | 92523 | 1664 | 72249 |
| 8L-6S | | MI | 23143 | 8232 | 39286 | 5840 | 43031 | 4694 | 44935 | 3786 | 47086 | 2302 | 57095 | 1542 | 44303 |
| 24-#14 | 3.75 | MA | 35890 | 8232 | 59406 | 6061 | 65497 | 4882 | 68340 | 3963 | 71560 | 2519 | 88792 | 1586 | 70530 |
| 9L-5S | | MI | 23619 | 8232 | 40083 | 5848 | 44132 | 4705 | 46200 | 3774 | 48769 | 2290 | 59136 | 1624 | 44719 |
| 24-#14 | 3.75 | MA | 35039 | 8232 | 57947 | 6083 | 63707 | 4903 | 66205 | 3982 | 68660 | 2534 | 85176 | 1498 | 68890 |
| 10L-4S | | MI | 24118 | 8232 | 40931 | 5856 | 45230 | 4691 | 47530 | 3761 | 50631 | 2302 | 61328 | 1678 | 45621 |

## RECTANGULAR TIED COLUMNS 32" x 32"

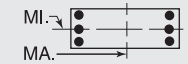
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#14 | 1.32 | MA | 16258 | 4993 | 25699 | 3642 | 27535 | 2966 | 27951 | 2468 | 27579 | 1745 | 32108 | 1623 | 12858 |
| 2L-3S | | MI | 15394 | 4993 | 24420 | 3635 | 25895 | 2981 | 25953 | 2480 | 24930 | 1758 | 28623 | 1499 | 12932 |
| 6-#18 | 2.34 | MA | 17499 | 5356 | 28630 | 3837 | 31161 | 3102 | 32186 | 2533 | 33179 | 1672 | 39346 | 1489 | 22008 |
| 2L-3S | | MI | 16020 | 5356 | 26405 | 3821 | 28309 | 3126 | 28755 | 2555 | 28630 | 1694 | 33398 | 1268 | 22027 |
| 8-#11 | 1.22 | MA | 16155 | 4958 | 25398 | 3636 | 27218 | 2963 | 27597 | 2470 | 27154 | 1762 | 31589 | 1647 | 11982 |
| 2L-4S | | MI | 15114 | 4958 | 23766 | 3644 | 25130 | 2968 | 25055 | 2471 | 23859 | 1779 | 27532 | 1475 | 12079 |
| 8-#14 | 1.76 | MA | 16838 | 5149 | 26978 | 3739 | 29175 | 3036 | 29949 | 2510 | 30227 | 1727 | 35593 | 1584 | 16908 |
| 2L-4S | | MI | 15366 | 5149 | 24646 | 3750 | 26194 | 3041 | 26325 | 2510 | 25555 | 1752 | 29858 | 1336 | 16954 |
| 8-#18 | 3.13 | MA | 18476 | 5633 | 30856 | 4010 | 34014 | 3226 | 35616 | 2605 | 37729 | 1636 | 45294 | 1411 | 28994 |
| 2L-4S | | MI | 15961 | 5633 | 26792 | 4023 | 28820 | 3229 | 29391 | 2605 | 29704 | 1680 | 35496 | 976 | 27293 |
| 10-#11 | 1.52 | MA | 16565 | 5066 | 26295 | 3704 | 28367 | 3012 | 28999 | 2500 | 29022 | 1750 | 34054 | 1622 | 14822 |
| 2L-5S | | MI | 15142 | 5066 | 24023 | 3707 | 25451 | 3027 | 25440 | 2510 | 24295 | 1759 | 28300 | 1412 | 14876 |
| 10-#11 | 1.52 | MA | 15960 | 5066 | 25398 | 3699 | 27218 | 3023 | 27597 | 2509 | 27154 | 1759 | 31589 | 1536 | 14863 |
| 3L-4S | | MI | 15529 | 5066 | 24662 | 3712 | 26279 | 3016 | 26457 | 2501 | 25727 | 1767 | 29997 | 1450 | 14892 |
| 10-#14 | 2.20 | MA | 17413 | 5304 | 28258 | 3837 | 30815 | 3105 | 31946 | 2552 | 32876 | 1709 | 39079 | 1546 | 20938 |
| 2L-5S | | MI | 15402 | 5304 | 25011 | 3840 | 26650 | 3125 | 26870 | 2565 | 26172 | 1722 | 30941 | 1244 | 20138 |
| 10-#14 | 2.20 | MA | 16559 | 5304 | 26978 | 3829 | 29175 | 3120 | 29949 | 2565 | 30227 | 1722 | 35593 | 1421 | 20968 |
| 3L-4S | | MI | 15950 | 5304 | 25926 | 3847 | 27834 | 3110 | 28322 | 2552 | 28203 | 1734 | 33344 | 1297 | 20912 |
| 10-#18 | 3.91 | MA | 19441 | 5909 | 33081 | 4182 | 36867 | 3350 | 39047 | 2676 | 42278 | 1599 | 51242 | 1333 | 35936 |
| 2L-5S | | MI | 16017 | 5909 | 27418 | 4180 | 29602 | 3377 | 30328 | 2698 | 30762 | 1621 | 37344 | 801 | 32239 |
| 10-#18 | 3.91 | MA | 17990 | 5909 | 30856 | 4167 | 34014 | 3374 | 35616 | 2698 | 37729 | 1621 | 45294 | 1112 | 35760 |
| 3L-4S | | MI | 16951 | 5909 | 29018 | 4196 | 31673 | 3353 | 32822 | 2676 | 34253 | 1643 | 41444 | 898 | 33747 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis

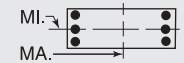



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.47 | MA | 18555 | 5362 | 29513 | 3894 | 31675 | 3167 | 32221 | 2627 | 32012 | 1838 | 37368 | 1698 | 16053 |
| 2E | | MI | 17417 | 5362 | 27777 | 3871 | 29721 | 3149 | 30124 | 2606 | 29850 | 1820 | 34742 | 1675 | 15024 |
| 6-#14 | 1.24 | MA | 18277 | 5276 | 28744 | 3872 | 30831 | 3155 | 31288 | 2629 | 30844 | 1873 | 35919 | 1751 | 13769 |
| 2L-3S | | MI | 16300 | 5276 | 25786 | 3844 | 27309 | 3153 | 27326 | 2626 | 26157 | 1870 | 29976 | 1607 | 12976 |
| 6-#14 | 1.24 | MA | 17345 | 5276 | 27367 | 3865 | 29067 | 3171 | 29135 | 2642 | 27973 | 1886 | 32128 | 1627 | 13843 |
| 3L-2S | | MI | 17165 | 5276 | 27065 | 3851 | 28949 | 3138 | 29323 | 2614 | 28806 | 1858 | 33462 | 1732 | 12898 |
| 6-#18 | 2.21 | MA | 19631 | 5639 | 31911 | 4066 | 34750 | 3291 | 35950 | 2701 | 36956 | 1805 | 43859 | 1626 | 23628 |
| 2L-3S | | MI | 16927 | 5639 | 27777 | 4029 | 29721 | 3296 | 30124 | 2700 | 29850 | 1806 | 34742 | 1375 | 22114 |
| 6-#18 | 2.21 | MA | 18033 | 5639 | 29513 | 4053 | 31675 | 3317 | 32221 | 2723 | 32012 | 1827 | 37368 | 1405 | 23647 |
| 3L-2S | | MI | 18409 | 5639 | 30002 | 4044 | 32574 | 3273 | 33554 | 2678 | 34400 | 1784 | 40690 | 1597 | 22069 |
| 8-#11 | 1.15 | MA | 18162 | 5241 | 28416 | 3866 | 30484 | 3152 | 30892 | 2631 | 30372 | 1889 | 35336 | 1774 | 12824 |
| 2L-4S | | MI | 16019 | 5241 | 25129 | 3855 | 26544 | 3141 | 26429 | 2618 | 25089 | 1892 | 28890 | 1584 | 12122 |
| 8-#11 | 1.15 | MA | 17508 | 5241 | 27452 | 3862 | 29249 | 3164 | 29384 | 2641 | 28350 | 1897 | 32658 | 1688 | 12874 |
| 3E | | MI | 16453 | 5241 | 25865 | 3842 | 27482 | 3147 | 27569 | 2626 | 26517 | 1883 | 30482 | 1670 | 12069 |
| 8-#11 | 1.15 | MA | 17043 | 5241 | 26662 | 3875 | 28242 | 3158 | 28161 | 2633 | 26805 | 1906 | 30925 | 1602 | 12921 |
| 4L-2S | | MI | 17061 | 5241 | 26762 | 3847 | 28631 | 3136 | 28971 | 2617 | 28384 | 1875 | 32947 | 1757 | 12018 |
| 8-#14 | 1.65 | MA | 18906 | 5431 | 30120 | 3969 | 32596 | 3225 | 33441 | 2671 | 33715 | 1857 | 39711 | 1716 | 18123 |
| 2L-4S | | MI | 16271 | 5431 | 26013 | 3959 | 27608 | 3213 | 27697 | 2656 | 26782 | 1865 | 31212 | 1445 | 17027 |
| 8-#14 | 1.65 | MA | 17980 | 5431 | 28744 | 3963 | 30831 | 3241 | 31288 | 2685 | 30844 | 1869 | 35919 | 1591 | 18176 |
| 3E | | MI | 16886 | 5431 | 27065 | 3941 | 28949 | 3223 | 29323 | 2669 | 28806 | 1852 | 33462 | 1569 | 17013 |
| 8-#14 | 1.65 | MA | 17321 | 5431 | 27613 | 3981 | 29391 | 3232 | 29538 | 2673 | 28650 | 1881 | 33470 | 1467 | 18169 |
| 4L-2S | | MI | 17746 | 5431 | 28345 | 3949 | 30589 | 3208 | 31321 | 2656 | 31454 | 1840 | 36947 | 1693 | 16955 |
| 8-#18 | 2.94 | MA | 20693 | 5916 | 34310 | 4239 | 37825 | 3415 | 39678 | 2774 | 41900 | 1771 | 50350 | 1554 | 31154 |
| 2L-4S | | MI | 16866 | 5916 | 28164 | 4230 | 30233 | 3400 | 30760 | 2750 | 30924 | 1791 | 36840 | 1084 | 27656 |
| 8-#18 | 2.94 | MA | 19111 | 5916 | 31911 | 4226 | 34750 | 3441 | 35950 | 2796 | 36956 | 1793 | 43859 | 1333 | 31067 |
| 3E | | MI | 17919 | 5916 | 30002 | 4201 | 32574 | 3420 | 33554 | 2772 | 34400 | 1769 | 40690 | 1297 | 29009 |
| 8-#18 | 2.94 | MA | 17981 | 5916 | 29935 | 4256 | 32233 | 3422 | 32913 | 2774 | 33178 | 1815 | 39664 | 1115 | 29607 |
| 4L-2S | | MI | 19388 | 5916 | 32228 | 4217 | 35427 | 3397 | 36985 | 2750 | 38949 | 1747 | 46638 | 1519 | 29063 |
| 10-#11 | 1.43 | MA | 18607 | 5348 | 29380 | 3934 | 31720 | 3201 | 32399 | 2660 | 32395 | 1878 | 38015 | 1751 | 15875 |
| 2L-5S | | MI | 16047 | 5348 | 25386 | 3918 | 26865 | 3200 | 26814 | 2657 | 25526 | 1872 | 29658 | 1521 | 14943 |
| 10-#11 | 1.43 | MA | 17956 | 5348 | 28416 | 3930 | 30484 | 3212 | 30892 | 2670 | 30372 | 1887 | 35336 | 1665 | 15916 |
| 3L-4S | | MI | 16435 | 5348 | 26025 | 3922 | 27693 | 3189 | 27832 | 2648 | 26957 | 1880 | 31355 | 1559 | 14942 |
| 10-#11 | 1.43 | MA | 17493 | 5348 | 27626 | 3943 | 29478 | 3207 | 29669 | 2663 | 28827 | 1895 | 33603 | 1578 | 15945 |
| 4L-3S | | MI | 16867 | 5348 | 26762 | 3910 | 28631 | 3196 | 28971 | 2656 | 28384 | 1872 | 32947 | 1645 | 14906 |
| 10-#11 | 1.43 | MA | 17078 | 5348 | 26941 | 3939 | 28590 | 3218 | 28578 | 2673 | 27278 | 1887 | 31765 | 1540 | 15929 |
| 5L-2S | | MI | 17472 | 5348 | 27658 | 3914 | 29781 | 3185 | 30373 | 2647 | 30252 | 1863 | 35412 | 1731 | 14862 |
| 10-#14 | 2.07 | MA | 19530 | 5587 | 31497 | 4066 | 34361 | 3295 | 35594 | 2714 | 36586 | 1840 | 43503 | 1680 | 22456 |
| 2L-5S | | MI | 16307 | 5587 | 26378 | 4049 | 28063 | 3298 | 28243 | 2711 | 27399 | 1834 | 32294 | 1352 | 20354 |
| 10-#14 | 2.07 | MA | 18610 | 5587 | 30120 | 4060 | 32596 | 3310 | 33441 | 2727 | 33715 | 1852 | 39711 | 1555 | 22486 |
| 3L-4S | | MI | 16856 | 5587 | 27292 | 4056 | 29248 | 3283 | 29695 | 2698 | 29430 | 1846 | 34697 | 1406 | 20995 |
| 10-#14 | 2.07 | MA | 17955 | 5587 | 28990 | 4078 | 31156 | 3301 | 31691 | 2716 | 31521 | 1865 | 37262 | 1431 | 22431 |
| 4L-3S | | MI | 17467 | 5587 | 28345 | 4039 | 30589 | 3293 | 31321 | 2711 | 31454 | 1834 | 36947 | 1530 | 21027 |
| 10-#14 | 2.07 | MA | 17367 | 5587 | 28009 | 4072 | 29885 | 3317 | 30130 | 2729 | 29321 | 1852 | 34653 | 1376 | 21724 |
| 5L-2S | | MI | 18322 | 5587 | 29624 | 4046 | 32229 | 3278 | 33319 | 2698 | 34103 | 1822 | 40432 | 1654 | 20989 |
| 10-#18 | 3.68 | MA | 21744 | 6192 | 36708 | 4412 | 40899 | 3539 | 43407 | 2848 | 46844 | 1737 | 56842 | 1482 | 38636 |
| 2L-5S | | MI | 16920 | 6192 | 28790 | 4388 | 31014 | 3547 | 31697 | 2843 | 31983 | 1733 | 38687 | 908 | 32553 |
| 10-#18 | 3.68 | MA | 20176 | 6192 | 34310 | 4398 | 37825 | 3565 | 39678 | 2870 | 41900 | 1759 | 50350 | 1261 | 38460 |
| 3L-4S | | MI | 17857 | 6192 | 30390 | 4403 | 33086 | 3524 | 34190 | 2821 | 35474 | 1755 | 42788 | 1006 | 34102 |
| 10-#18 | 3.68 | MA | 19057 | 6192 | 32334 | 4429 | 35307 | 3546 | 36642 | 2848 | 38122 | 1782 | 46156 | 1043 | 36570 |
| 4L-3S | | MI | 18901 | 6192 | 32228 | 4374 | 35427 | 3544 | 36985 | 2843 | 38949 | 1733 | 46638 | 1220 | 35874 |
| 10-#18 | 3.68 | MA | 18054 | 6192 | 30616 | 4415 | 33083 | 3572 | 33932 | 2870 | 34330 | 1759 | 41680 | 946 | 34828 |
| 5L-2S | | MI | 20356 | 6192 | 34453 | 4390 | 38280 | 3521 | 40415 | 2821 | 43499 | 1711 | 52586 | 1441 | 36018 |
| 12-#11 | 1.72 | MA | 19049 | 5456 | 30344 | 4001 | 32956 | 3249 | 33907 | 2690 | 34417 | 1868 | 40693 | 1728 | 18914 |
| 2L-6S | | MI | 16094 | 5456 | 25683 | 3980 | 27185 | 3242 | 27249 | 2695 | 26097 | 1869 | 30536 | 1439 | 17272 |
| 12-#11 | 1.72 | MA | 18400 | 5456 | 29380 | 3997 | 31720 | 3261 | 32399 | 2699 | 32395 | 1876 | 38015 | 1642 | 18945 |
| 3L-5S | | MI | 16462 | 5456 | 26283 | 3985 | 28014 | 3249 | 28217 | 2686 | 27393 | 1860 | 32123 | 1496 | 17725 |

## RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

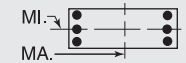
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.72 | MA | 17940 | 5456 | 28590 | 4010 | 30713 | 3255 | 31176 | 2692 | 30849 | 1885 | 36282 | 1555 | 18956 |
| 4E | | MI | 16848 | 5456 | 26922 | 3990 | 28843 | 3238 | 29234 | 2677 | 28825 | 1869 | 33820 | 1534 | 17750 |
| 12-#11 | 1.72 | MA | 17527 | 5456 | 27905 | 4006 | 29825 | 3267 | 30085 | 2702 | 29300 | 1876 | 34443 | 1517 | 18913 |
| 5L-3S | | MI | 17278 | 5456 | 27658 | 3977 | 29781 | 3244 | 30373 | 2685 | 30252 | 1860 | 35412 | 1620 | 17729 |
| 12-#11 | 1.72 | MA | 17133 | 5456 | 27262 | 4002 | 28936 | 3261 | 28999 | 2695 | 27897 | 1885 | 32718 | 1460 | 18411 |
| 6L-2S | | MI | 17881 | 5456 | 28555 | 3982 | 30930 | 3233 | 31775 | 2676 | 32120 | 1851 | 37878 | 1706 | 17694 |
| 12-#14 | 2.48 | MA | 20149 | 5743 | 32873 | 4164 | 36125 | 3364 | 37746 | 2756 | 39457 | 1824 | 47295 | 1644 | 26775 |
| 2L-6S | | MI | 16371 | 5743 | 26798 | 4139 | 28516 | 3357 | 28858 | 2765 | 28210 | 1828 | 33538 | 1231 | 23549 |
| 12-#14 | 2.48 | MA | 19234 | 5743 | 31497 | 4157 | 34361 | 3380 | 35594 | 2770 | 36586 | 1836 | 43503 | 1519 | 26772 |
| 3L-5S | | MI | 16891 | 5743 | 27657 | 4146 | 29703 | 3367 | 30240 | 2753 | 30048 | 1816 | 35779 | 1314 | 24145 |
| 12-#14 | 2.48 | MA | 18583 | 5743 | 30366 | 4176 | 32921 | 3371 | 33844 | 2758 | 34392 | 1848 | 41054 | 1395 | 26681 |
| 4E | | MI | 17436 | 5743 | 28571 | 4154 | 30888 | 3352 | 31692 | 2741 | 32079 | 1828 | 38182 | 1367 | 24949 |
| 12-#14 | 2.48 | MA | 18000 | 5743 | 29386 | 4169 | 31650 | 3387 | 32283 | 2771 | 32192 | 1836 | 38444 | 1340 | 25807 |
| 5L-3S | | MI | 18044 | 5743 | 29624 | 4136 | 32229 | 3362 | 33319 | 2753 | 34103 | 1816 | 40432 | 1491 | 25019 |
| 12-#14 | 2.48 | MA | 17443 | 5743 | 28465 | 4163 | 30376 | 3378 | 30797 | 2785 | 30199 | 1848 | 36003 | 1259 | 25135 |
| 6L-2S | | MI | 18894 | 5743 | 30903 | 4143 | 33869 | 3348 | 35316 | 2741 | 36751 | 1804 | 43917 | 1616 | 25008 |
| 12-#18 | 4.41 | MA | 21229 | 6469 | 36708 | 4571 | 40899 | 3689 | 43407 | 2944 | 46844 | 1726 | 56842 | 1188 | 45835 |
| 3L-5S | | MI | 17910 | 6469 | 31016 | 4561 | 33867 | 3671 | 35127 | 2915 | 36532 | 1696 | 44635 | 830 | 39157 |
| 12-#18 | 4.41 | MA | 20121 | 6469 | 34732 | 4602 | 38382 | 3670 | 40371 | 2922 | 43067 | 1748 | 52647 | 971 | 43582 |
| 4E | | MI | 18838 | 6469 | 32615 | 4576 | 35939 | 3648 | 37621 | 2893 | 40024 | 1718 | 48736 | 928 | 40595 |
| 12-#18 | 4.41 | MA | 19127 | 6469 | 33015 | 4588 | 36157 | 3696 | 37661 | 2944 | 39274 | 1726 | 48172 | 874 | 41965 |
| 5L-3S | | MI | 19872 | 6469 | 34453 | 4547 | 38280 | 3669 | 40415 | 2915 | 43499 | 1696 | 52586 | 1142 | 42720 |
| 14-#11 | 2.01 | MA | 19488 | 5564 | 31308 | 4068 | 34191 | 3298 | 35414 | 2719 | 36439 | 1857 | 43371 | 1705 | 21944 |
| 2L-7S | | MI | 16151 | 5564 | 25922 | 4061 | 27541 | 3302 | 27631 | 2717 | 26699 | 1866 | 31303 | 1324 | 19682 |
| 14-#11 | 2.01 | MA | 18843 | 5564 | 30344 | 4064 | 32956 | 3309 | 33907 | 2729 | 34417 | 1865 | 40693 | 1618 | 21965 |
| 3L-6S | | MI | 16508 | 5564 | 26579 | 4048 | 28334 | 3291 | 28651 | 2725 | 27965 | 1857 | 33002 | 1414 | 19966 |
| 14-#11 | 2.01 | MA | 18384 | 5564 | 29554 | 4078 | 31949 | 3303 | 32684 | 2722 | 32871 | 1874 | 38960 | 1532 | 21954 |
| 4L-5S | | MI | 16875 | 5564 | 27179 | 4052 | 29164 | 3297 | 29619 | 2716 | 29261 | 1848 | 34588 | 1471 | 20452 |
| 14-#11 | 2.01 | MA | 17973 | 5564 | 28869 | 4073 | 31061 | 3315 | 31593 | 2731 | 31322 | 1865 | 37122 | 1493 | 21853 |
| 5L-4S | | MI | 17259 | 5564 | 27818 | 4057 | 29992 | 3286 | 30636 | 2706 | 30693 | 1857 | 36286 | 1508 | 20544 |
| 14-#11 | 2.01 | MA | 17582 | 5564 | 28226 | 4069 | 30172 | 3309 | 30506 | 2724 | 29919 | 1874 | 35396 | 1437 | 21309 |
| 6L-3S | | MI | 17686 | 5564 | 28555 | 4044 | 30930 | 3293 | 31775 | 2715 | 32120 | 1848 | 37878 | 1595 | 20542 |
| 14-#11 | 2.01 | MA | 17200 | 5564 | 27522 | 4083 | 29322 | 3321 | 29462 | 2734 | 28548 | 1883 | 33551 | 1346 | 20984 |
| 7L-2S | | MI | 18287 | 5564 | 29451 | 4049 | 32079 | 3282 | 33178 | 2705 | 33987 | 1840 | 40343 | 1681 | 20516 |
| 14-#14 | 2.90 | MA | 20764 | 5898 | 34250 | 4261 | 37890 | 3434 | 39899 | 2799 | 42328 | 1807 | 51087 | 1608 | 31084 |
| 2L-7S | | MI | 16450 | 5898 | 27137 | 4254 | 29022 | 3442 | 29400 | 2795 | 29064 | 1823 | 34921 | 1097 | 26349 |
| 14-#14 | 2.90 | MA | 19854 | 5898 | 32873 | 4254 | 36125 | 3450 | 37746 | 2812 | 39457 | 1819 | 47295 | 1484 | 31047 |
| 3L-6S | | MI | 16954 | 5898 | 28077 | 4236 | 30156 | 3427 | 30856 | 2808 | 30859 | 1810 | 37023 | 1193 | 27391 |
| 14-#14 | 2.90 | MA | 19207 | 5898 | 31743 | 4273 | 34685 | 3441 | 35997 | 2801 | 37263 | 1832 | 44846 | 1359 | 30923 |
| 4L-5S | | MI | 17470 | 5898 | 28936 | 4243 | 31343 | 3437 | 32238 | 2795 | 32697 | 1798 | 39264 | 1275 | 27952 |
| 14-#14 | 2.90 | MA | 18627 | 5898 | 30762 | 4266 | 33414 | 3457 | 34436 | 2814 | 35063 | 1819 | 42236 | 1305 | 29908 |
| 5L-4S | | MI | 18012 | 5898 | 29850 | 4251 | 32528 | 3422 | 33690 | 2783 | 34728 | 1810 | 41667 | 1329 | 28895 |
| 14-#14 | 2.90 | MA | 18075 | 5898 | 29841 | 4260 | 32141 | 3448 | 32950 | 2827 | 33070 | 1832 | 39795 | 1223 | 29273 |
| 6L-3S | | MI | 18616 | 5898 | 30903 | 4233 | 33869 | 3432 | 35316 | 2795 | 36751 | 1798 | 43917 | 1452 | 28996 |
| 14-#14 | 2.90 | MA | 17536 | 5898 | 28833 | 4278 | 30925 | 3464 | 31385 | 2816 | 31124 | 1844 | 37183 | 1092 | 28142 |
| 7L-2S | | MI | 19461 | 5898 | 32182 | 4241 | 35509 | 3417 | 37314 | 2783 | 39400 | 1786 | 47403 | 1577 | 29021 |
| 14-#18 | 5.15 | MA | 21174 | 6745 | 37131 | 4775 | 41457 | 3794 | 44099 | 2996 | 48011 | 1714 | 59138 | 899 | 50633 |
| 4L-5S | | MI | 18889 | 6745 | 33241 | 4734 | 36720 | 3796 | 38558 | 2986 | 41082 | 1660 | 50583 | 753 | 45489 |
| 14-#18 | 5.15 | MA | 20190 | 6745 | 35413 | 4761 | 39232 | 3820 | 41389 | 3018 | 44218 | 1692 | 54663 | 802 | 48898 |
| 5L-4S | | MI | 19809 | 6745 | 34841 | 4749 | 38792 | 3772 | 41051 | 2964 | 44573 | 1682 | 54683 | 850 | 47126 |
| 16-#11 | 2.29 | MA | 19925 | 5672 | 32272 | 4136 | 35427 | 3346 | 36922 | 2748 | 38461 | 1846 | 46049 | 1681 | 24968 |
| 2L-8S | | MI | 16214 | 5672 | 26228 | 4123 | 27887 | 3344 | 28082 | 2755 | 27317 | 1863 | 32183 | 1254 | 21802 |
| 16-#11 | 2.29 | MA | 19282 | 5672 | 31308 | 4132 | 34191 | 3358 | 35414 | 2758 | 36439 | 1855 | 43371 | 1595 | 24977 |
| 3L-7S | | MI | 16564 | 5672 | 26819 | 4128 | 28691 | 3350 | 29033 | 2746 | 28566 | 1854 | 33769 | 1298 | 22395 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis

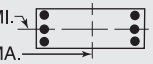



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 2.29 | MA | 18826 | 5672 | 30518 | 4145 | 33185 | 3352 | 34191 | 2751 | 34893 | 1863 | 41638 | 1509 | 24946 |
| 4L-6S | | MI | 16920 | 5672 | 27476 | 4115 | 29483 | 3339 | 30053 | 2754 | 29833 | 1845 | 35467 | 1389 | 22667 |
| 16-#11 | 2.29 | MA | 18417 | 5672 | 29833 | 4141 | 32297 | 3363 | 33100 | 2761 | 33344 | 1855 | 39800 | 1470 | 24727 |
| 5E | | MI | 17285 | 5672 | 28076 | 4120 | 30313 | 3346 | 31021 | 2745 | 31129 | 1837 | 37054 | 1446 | 23124 |
| 16-#11 | 2.29 | MA | 18027 | 5672 | 29190 | 4137 | 31407 | 3358 | 32014 | 2753 | 31941 | 1863 | 38074 | 1414 | 24213 |
| 6L-4S | | MI | 17667 | 5672 | 28715 | 4124 | 31141 | 3335 | 32038 | 2736 | 32560 | 1845 | 38751 | 1483 | 23330 |
| 16-#11 | 2.29 | MA | 17647 | 5672 | 28486 | 4150 | 30558 | 3369 | 30970 | 2763 | 30570 | 1872 | 36229 | 1323 | 23902 |
| 7L-3S | | MI | 18093 | 5672 | 29451 | 4112 | 32079 | 3341 | 33178 | 2744 | 33987 | 1837 | 40343 | 1570 | 23349 |
| 16-#11 | 2.29 | MA | 17273 | 5672 | 27852 | 4146 | 29697 | 3364 | 29950 | 2773 | 29111 | 1863 | 34511 | 1278 | 23254 |
| 8L-2S | | MI | 18690 | 5672 | 30348 | 4116 | 33228 | 3330 | 34580 | 2735 | 35855 | 1828 | 42809 | 1656 | 23332 |
| 16-#14 | 3.31 | MA | 20469 | 6054 | 34250 | 4352 | 37890 | 3520 | 39899 | 2854 | 42328 | 1803 | 51087 | 1448 | 35312 |
| 3L-7S | | MI | 17032 | 6054 | 28416 | 4351 | 30661 | 3512 | 31398 | 2837 | 31712 | 1805 | 38407 | 1058 | 30114 |
| 16-#14 | 3.31 | MA | 19826 | 6054 | 33119 | 4370 | 36450 | 3511 | 38149 | 2843 | 40134 | 1815 | 48638 | 1323 | 35158 |
| 4L-6S | | MI | 17532 | 6054 | 29357 | 4333 | 31796 | 3497 | 32854 | 2850 | 33508 | 1792 | 40509 | 1154 | 31241 |
| 16-#14 | 3.31 | MA | 19250 | 6054 | 32139 | 4364 | 35179 | 3527 | 36588 | 2856 | 37934 | 1803 | 46028 | 1269 | 34021 |
| 5E | | MI | 18046 | 6054 | 30215 | 4341 | 32983 | 3507 | 34236 | 2837 | 35345 | 1780 | 42750 | 1236 | 31772 |
| 16-#14 | 3.31 | MA | 18701 | 6054 | 31218 | 4357 | 33906 | 3518 | 35103 | 2870 | 35941 | 1815 | 43587 | 1187 | 33419 |
| 6L-4S | | MI | 18584 | 6054 | 31130 | 4348 | 34168 | 3492 | 35687 | 2825 | 37376 | 1792 | 45153 | 1290 | 32833 |
| 16-#14 | 3.31 | MA | 18166 | 6054 | 30210 | 4375 | 32689 | 3534 | 33538 | 2858 | 33995 | 1828 | 40975 | 1056 | 32202 |
| 7L-3S | | MI | 19184 | 6054 | 32182 | 4330 | 35509 | 3502 | 37314 | 2837 | 39400 | 1780 | 47403 | 1414 | 32963 |
| 16-#18 | 5.88 | MA | 21242 | 7022 | 37812 | 4934 | 42307 | 3944 | 45118 | 3092 | 49162 | 1659 | 61154 | 730 | 55786 |
| 5E | | MI | 19860 | 7022 | 35467 | 4906 | 39573 | 3920 | 41988 | 3058 | 45631 | 1623 | 56531 | 675 | 51857 |
| 18-#11 | 2.58 | MA | 19719 | 5780 | 32272 | 4199 | 35427 | 3406 | 36922 | 2788 | 38461 | 1844 | 46049 | 1572 | 27978 |
| 3L-8S | | MI | 16627 | 5780 | 27124 | 4191 | 29036 | 3392 | 29484 | 2785 | 29185 | 1851 | 34648 | 1229 | 24465 |
| 18-#11 | 2.58 | MA | 19265 | 5780 | 31482 | 4212 | 34420 | 3400 | 35698 | 2780 | 36915 | 1853 | 44316 | 1486 | 27933 |
| 4L-7S | | MI | 16975 | 5780 | 27715 | 4195 | 29840 | 3398 | 30435 | 2775 | 30434 | 1842 | 36234 | 1273 | 25076 |
| 18-#11 | 2.58 | MA | 18858 | 5780 | 30797 | 4208 | 33533 | 3412 | 34608 | 2790 | 35366 | 1844 | 42478 | 1447 | 27610 |
| 5L-6S | | MI | 17329 | 5780 | 28372 | 4183 | 30632 | 3388 | 31455 | 2784 | 31700 | 1834 | 37932 | 1364 | 25372 |
| 18-#11 | 2.58 | MA | 18470 | 5780 | 30154 | 4204 | 32643 | 3406 | 33521 | 2783 | 33963 | 1853 | 40753 | 1390 | 27123 |
| 6L-5S | | MI | 17692 | 5780 | 28972 | 4187 | 31462 | 3394 | 32423 | 2774 | 32996 | 1825 | 39519 | 1421 | 25804 |
| 18-#11 | 2.58 | MA | 18092 | 5780 | 29450 | 4217 | 31794 | 3418 | 32477 | 2793 | 32592 | 1861 | 38907 | 1300 | 26803 |
| 7L-4S | | MI | 18073 | 5780 | 29611 | 4192 | 32290 | 3383 | 33440 | 2765 | 34428 | 1834 | 41217 | 1458 | 26111 |
| 18-#11 | 2.58 | MA | 17720 | 5780 | 28816 | 4213 | 30932 | 3412 | 31458 | 2803 | 31133 | 1853 | 37190 | 1254 | 26122 |
| 8L-3S | | MI | 18497 | 5780 | 30348 | 4179 | 33228 | 3389 | 34580 | 2773 | 35855 | 1825 | 42809 | 1544 | 26145 |
| 18-#14 | 3.72 | MA | 20441 | 6209 | 34496 | 4467 | 38214 | 3581 | 40302 | 2885 | 43005 | 1799 | 52430 | 1287 | 39290 |
| 4L-7S | | MI | 17609 | 6209 | 29696 | 4448 | 32301 | 3582 | 33395 | 2880 | 34361 | 1787 | 41892 | 1020 | 33890 |
| 18-#14 | 3.72 | MA | 19869 | 6209 | 33515 | 4461 | 36944 | 3597 | 38741 | 2899 | 40804 | 1786 | 49820 | 1233 | 38145 |
| 5L-6S | | MI | 18106 | 6209 | 30636 | 4431 | 33436 | 3567 | 34851 | 2892 | 36156 | 1774 | 43994 | 1115 | 34980 |
| 18-#14 | 3.72 | MA | 19323 | 6209 | 32595 | 4454 | 35670 | 3588 | 37256 | 2912 | 38812 | 1799 | 47379 | 1151 | 37490 |
| 6L-5S | | MI | 18617 | 6209 | 31495 | 4438 | 34623 | 3577 | 36233 | 2880 | 37994 | 1762 | 46235 | 1197 | 35601 |
| 18-#14 | 3.72 | MA | 18792 | 6209 | 31586 | 4473 | 34454 | 3603 | 35691 | 2901 | 36866 | 1811 | 44767 | 1020 | 36274 |
| 7L-4S | | MI | 19152 | 6209 | 32409 | 4445 | 35808 | 3562 | 37685 | 2867 | 40025 | 1774 | 48638 | 1251 | 36618 |
| 20-#11 | 2.87 | MA | 19702 | 5888 | 32446 | 4280 | 35656 | 3449 | 37206 | 2810 | 38937 | 1842 | 46995 | 1462 | 30915 |
| 4L-8S | | MI | 17037 | 5888 | 28021 | 4258 | 30185 | 3441 | 30886 | 2814 | 31052 | 1839 | 37114 | 1203 | 27134 |
| 20-#11 | 2.87 | MA | 19297 | 5888 | 31761 | 4276 | 34768 | 3460 | 36115 | 2820 | 37388 | 1834 | 45157 | 1424 | 30501 |
| 5L-7S | | MI | 17384 | 5888 | 28612 | 4263 | 30989 | 3447 | 31837 | 2805 | 32302 | 1831 | 38700 | 1248 | 27720 |
| 20-#11 | 2.87 | MA | 18911 | 5888 | 31118 | 4272 | 33879 | 3455 | 35029 | 2812 | 35985 | 1842 | 43431 | 1367 | 30037 |
| 6E | | MI | 17736 | 5888 | 29269 | 4250 | 31782 | 3436 | 32857 | 2813 | 33568 | 1822 | 40398 | 1339 | 28082 |
| 20-#11 | 2.87 | MA | 18534 | 5888 | 30414 | 4285 | 33029 | 3466 | 33985 | 2822 | 34614 | 1851 | 41586 | 1277 | 29651 |
| 7L-5S | | MI | 18098 | 5888 | 29869 | 4255 | 32612 | 3442 | 33825 | 2804 | 34864 | 1813 | 41985 | 1395 | 28491 |
| 20-#11 | 2.87 | MA | 18164 | 5888 | 29780 | 4281 | 32168 | 3460 | 32965 | 2832 | 33156 | 1842 | 39868 | 1231 | 28996 |
| 8L-4S | | MI | 18476 | 5888 | 30508 | 4259 | 33440 | 3431 | 34842 | 2795 | 36296 | 1822 | 43682 | 1433 | 28887 |
| 20-#14 | 4.14 | MA | 20483 | 6365 | 34892 | 4558 | 38708 | 3666 | 40894 | 2941 | 43675 | 1770 | 53612 | 1197 | 42278 |
| 5L-7S | | MI | 18182 | 6365 | 30975 | 4545 | 33941 | 3652 | 35393 | 2922 | 37009 | 1769 | 45377 | 981 | 37677 |
| 20-#14 | 4.14 | MA | 19941 | 6365 | 33971 | 4552 | 37435 | 3657 | 39408 | 2954 | 41683 | 1782 | 51171 | 1115 | 41523 |
| 6E | | MI | 18677 | 6365 | 31915 | 4528 | 35076 | 3637 | 36849 | 2934 | 38805 | 1756 | 47479 | 1076 | 38719 |
| 20-#14 | 4.14 | MA | 19413 | 6365 | 32963 | 4570 | 36219 | 3673 | 37843 | 2943 | 39737 | 1795 | 48559 | 985 | 40356 |
| 7L-5S | | MI | 19185 | 6365 | 32774 | 4535 | 36263 | 3647 | 38231 | 2922 | 40642 | 1744 | 49720 | 1158 | 39440 |

## RECTANGULAR TIED COLUMNS 32" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 3.15 | MA | 19733 | 5996 | 32725 | 4343 | 36004 | 3509 | 37623 | 2849 | 39410 | 1823 | 47835 | 1400 | 33397 |
| 5L-8S | | MI | 17445 | 5996 | 28917 | 4326 | 31335 | 3489 | 32288 | 2843 | 32920 | 1828 | 39579 | 1178 | 29809 |
| 22-#11 | 3.15 | MA | 19349 | 5996 | 32082 | 4339 | 35115 | 3503 | 36536 | 2842 | 38007 | 1832 | 46109 | 1344 | 32955 |
| 6L-7S | | MI | 17791 | 5996 | 29508 | 4330 | 32138 | 3495 | 33239 | 2834 | 34169 | 1819 | 41165 | 1223 | 30372 |
| 22-#11 | 3.15 | MA | 18974 | 5996 | 31378 | 4352 | 34265 | 3514 | 35492 | 2852 | 36636 | 1840 | 44264 | 1253 | 32507 |
| 7L-6S | | MI | 18141 | 5996 | 30165 | 4318 | 32931 | 3484 | 34259 | 2842 | 35436 | 1810 | 42863 | 1313 | 30795 |
| 22-#11 | 3.15 | MA | 18606 | 5996 | 30744 | 4348 | 33404 | 3509 | 34473 | 2861 | 35178 | 1832 | 42546 | 1208 | 31876 |
| 8L-5S | | MI | 18501 | 5996 | 30765 | 4322 | 33761 | 3491 | 35227 | 2833 | 36732 | 1802 | 44450 | 1370 | 31185 |
| 22-#14 | 4.55 | MA | 20555 | 6521 | 35348 | 4649 | 39199 | 3727 | 41561 | 2997 | 44554 | 1766 | 54963 | 1079 | 45568 |
| 6L-7S | | MI | 18753 | 6521 | 32254 | 4643 | 35581 | 3721 | 37391 | 2964 | 39658 | 1751 | 48862 | 942 | 41472 |
| 22-#14 | 4.55 | MA | 20030 | 6521 | 34339 | 4667 | 37983 | 3743 | 39996 | 2985 | 42608 | 1778 | 52351 | 949 | 44447 |
| 7L-6S | | MI | 19244 | 6521 | 33194 | 4625 | 36716 | 3707 | 38847 | 2976 | 41453 | 1738 | 50964 | 1037 | 42471 |
| 24-#11 | 3.44 | MA | 19785 | 6104 | 33046 | 4407 | 36350 | 3551 | 38044 | 2871 | 40029 | 1821 | 48788 | 1321 | 35876 |
| 6L-8S | | MI | 17852 | 6104 | 29814 | 4393 | 32484 | 3537 | 33690 | 2873 | 34788 | 1816 | 42045 | 1153 | 32488 |
| 24-#11 | 3.44 | MA | 19412 | 6104 | 32342 | 4420 | 35501 | 3563 | 37000 | 2881 | 38658 | 1829 | 46942 | 1230 | 35369 |
| 7E | | MI | 18195 | 6104 | 30405 | 4398 | 33288 | 3544 | 34641 | 2864 | 36037 | 1807 | 43630 | 1198 | 33030 |
| 24-#11 | 3.44 | MA | 19045 | 6104 | 31708 | 4416 | 34639 | 3557 | 35980 | 2891 | 37200 | 1821 | 45225 | 1185 | 34760 |
| 8L-6S | | MI | 18544 | 6104 | 31062 | 4385 | 34080 | 3533 | 35661 | 2872 | 37303 | 1799 | 45329 | 1288 | 33511 |
| 24-#14 | 4.96 | MA | 20643 | 6676 | 35716 | 4764 | 39748 | 3813 | 42149 | 3028 | 45479 | 1762 | 56143 | 913 | 48546 |
| 7E | | MI | 19319 | 6676 | 33533 | 4740 | 37221 | 3791 | 39388 | 3006 | 42307 | 1733 | 52348 | 903 | 45275 |

## RECTANGULAR TIED COLUMNS 32" x 36"

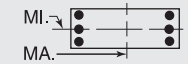
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.39 | MA | 20714 | 5645 | 32782 | 4123 | 35218 | 3356 | 35851 | 2791 | 35556 | 1967 | 41520 | 1828 | 17133 |
| 2E | | MI | 18324 | 5645 | 29149 | 4078 | 31134 | 3319 | 31492 | 2751 | 31071 | 1931 | 36086 | 1782 | 15073 |
| 6-#14 | 1.17 | MA | 20409 | 5559 | 31949 | 4102 | 34303 | 3344 | 34791 | 2790 | 34271 | 2000 | 39913 | 1879 | 14680 |
| 2L-3S | | MI | 17205 | 5559 | 27152 | 4054 | 28722 | 3325 | 28698 | 2773 | 27384 | 1983 | 31330 | 1716 | 13019 |
| 6-#14 | 1.17 | MA | 19409 | 5559 | 30475 | 4096 | 32414 | 3361 | 32487 | 2804 | 31177 | 2013 | 35814 | 1754 | 14755 |
| 3L-2S | | MI | 18072 | 5559 | 28432 | 4061 | 30362 | 3310 | 30696 | 2760 | 30033 | 1970 | 34815 | 1841 | 12938 |
| 6-#18 | 2.08 | MA | 21878 | 5922 | 35354 | 4296 | 38515 | 3480 | 39873 | 2866 | 40895 | 1936 | 48556 | 1761 | 25248 |
| 2L-3S | | MI | 17833 | 5922 | 29149 | 4236 | 31134 | 3467 | 31492 | 2845 | 31071 | 1917 | 36086 | 1483 | 22196 |
| 6-#18 | 2.08 | MA | 20161 | 5922 | 32782 | 4284 | 35218 | 3507 | 35851 | 2888 | 35556 | 1958 | 41520 | 1539 | 25267 |
| 3L-2S | | MI | 19317 | 5922 | 31375 | 4251 | 33987 | 3443 | 34923 | 2823 | 35620 | 1895 | 42034 | 1704 | 22128 |
| 8-#11 | 1.08 | MA | 20284 | 5523 | 31595 | 4096 | 33927 | 3342 | 34362 | 2791 | 33752 | 2016 | 39265 | 1901 | 13666 |
| 2L-4S | | MI | 16925 | 5523 | 26492 | 4065 | 27958 | 3314 | 27804 | 2765 | 26320 | 2005 | 30248 | 1693 | 12163 |
| 8-#11 | 1.08 | MA | 19582 | 5523 | 30563 | 4092 | 32605 | 3354 | 32749 | 2802 | 31576 | 2024 | 36374 | 1814 | 13716 |
| 3E | | MI | 17359 | 5523 | 27229 | 4053 | 28896 | 3320 | 28944 | 2773 | 27747 | 1996 | 31840 | 1780 | 12106 |
| 8-#11 | 1.08 | MA | 19085 | 5523 | 29720 | 4106 | 31529 | 3348 | 31442 | 2795 | 29912 | 2033 | 34499 | 1728 | 13763 |
| 4L-2S | | MI | 17968 | 5523 | 28125 | 4057 | 30045 | 3310 | 30346 | 2764 | 29615 | 1988 | 34305 | 1866 | 12053 |
| 8-#14 | 1.56 | MA | 21089 | 5714 | 33423 | 4199 | 36192 | 3414 | 37096 | 2832 | 37365 | 1985 | 44012 | 1845 | 19338 |
| 2L-4S | | MI | 17176 | 5714 | 27379 | 4168 | 29021 | 3385 | 29069 | 2803 | 28009 | 1977 | 32565 | 1554 | 17096 |
| 8-#14 | 1.56 | MA | 20094 | 5714 | 31949 | 4193 | 34303 | 3431 | 34791 | 2846 | 34271 | 1998 | 39913 | 1721 | 19391 |
| 3E | | MI | 17792 | 5714 | 28432 | 4151 | 30362 | 3395 | 30696 | 2815 | 30033 | 1965 | 34815 | 1677 | 17063 |
| 8-#14 | 1.56 | MA | 19389 | 5714 | 30741 | 4212 | 32764 | 3422 | 32922 | 2836 | 31907 | 2010 | 37260 | 1596 | 19384 |
| 4L-2S | | MI | 18654 | 5714 | 29711 | 4158 | 32002 | 3380 | 32693 | 2803 | 32681 | 1952 | 38300 | 1802 | 17000 |
| 8-#18 | 2.78 | MA | 23026 | 6198 | 37925 | 4469 | 41811 | 3604 | 43894 | 2941 | 46234 | 1905 | 55591 | 1694 | 33314 |
| 2L-4S | | MI | 17771 | 6198 | 29536 | 4438 | 31645 | 3570 | 32128 | 2894 | 32145 | 1903 | 38184 | 1191 | 28009 |
| 8-#18 | 2.78 | MA | 21326 | 6198 | 35354 | 4457 | 38515 | 3632 | 39873 | 2964 | 40895 | 1927 | 48556 | 1472 | 33227 |
| 3E | | MI | 18827 | 6198 | 31375 | 4409 | 33987 | 3591 | 34923 | 2917 | 35620 | 1881 | 42034 | 1405 | 29105 |
| 8-#18 | 2.78 | MA | 20116 | 6198 | 33240 | 4489 | 35821 | 3614 | 36600 | 2942 | 36815 | 1949 | 44016 | 1251 | 31952 |
| 4L-2S | | MI | 20299 | 6198 | 33600 | 4424 | 36840 | 3567 | 38353 | 2894 | 40170 | 1858 | 47982 | 1627 | 29130 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.35 | MA | 20763 | 5631 | 32626 | 4163 | 35249 | 3390 | 35975 | 2821 | 35929 | 2006 | 42157 | 1879 | 16928 |
| 2L-5S | | MI | 16952 | 5631 | 26750 | 4128 | 28279 | 3373 | 28189 | 2804 | 26756 | 1985 | 31016 | 1630 | 15006 |
| 10-#11 | 1.35 | MA | 20065 | 5631 | 31595 | 4160 | 33927 | 3402 | 34362 | 2831 | 33752 | 2014 | 39265 | 1793 | 16969 |
| 3L-4S | | MI | 17341 | 5631 | 27389 | 4133 | 29107 | 3363 | 29206 | 2795 | 28187 | 1993 | 32713 | 1668 | 14989 |
| 10-#11 | 1.35 | MA | 19570 | 5631 | 30751 | 4173 | 32852 | 3397 | 33055 | 2825 | 32089 | 2023 | 37391 | 1706 | 16998 |
| 4L-3S | | MI | 17773 | 5631 | 28125 | 4120 | 30045 | 3369 | 30346 | 2803 | 29615 | 1985 | 34305 | 1754 | 14947 |
| 10-#11 | 1.35 | MA | 19127 | 5631 | 30020 | 4170 | 31904 | 3409 | 31891 | 2835 | 30421 | 2014 | 35412 | 1667 | 16982 |
| 5L-2S | | MI | 18379 | 5631 | 29022 | 4125 | 31194 | 3358 | 31748 | 2794 | 31482 | 1976 | 36770 | 1841 | 14901 |
| 10-#14 | 1.95 | MA | 21762 | 5870 | 34897 | 4296 | 38082 | 3484 | 39401 | 2874 | 40458 | 1970 | 48111 | 1812 | 23975 |
| 2L-5S | | MI | 17212 | 5870 | 27744 | 4258 | 29477 | 3470 | 29615 | 2857 | 28627 | 1947 | 33647 | 1461 | 20562 |
| 10-#14 | 1.95 | MA | 20774 | 5870 | 33423 | 4290 | 36192 | 3500 | 37096 | 2889 | 37365 | 1982 | 44012 | 1687 | 24005 |
| 3L-4S | | MI | 17762 | 5870 | 28658 | 4266 | 30661 | 3455 | 31067 | 2845 | 30658 | 1959 | 36050 | 1515 | 21073 |
| 10-#14 | 1.95 | MA | 20073 | 5870 | 32215 | 4310 | 34654 | 3492 | 35226 | 2878 | 35000 | 1995 | 41359 | 1563 | 23949 |
| 4L-3S | | MI | 18374 | 5870 | 29711 | 4248 | 32002 | 3465 | 32693 | 2857 | 32681 | 1947 | 38300 | 1639 | 21083 |
| 10-#14 | 1.95 | MA | 19446 | 5870 | 31168 | 4304 | 33297 | 3509 | 33559 | 2893 | 32630 | 1982 | 38546 | 1507 | 23324 |
| 5L-2S | | MI | 19231 | 5870 | 30990 | 4255 | 33642 | 3450 | 34691 | 2845 | 35330 | 1934 | 41785 | 1763 | 21039 |
| 10-#18 | 3.47 | MA | 24162 | 6475 | 40496 | 4642 | 45107 | 3729 | 47915 | 3017 | 51573 | 1874 | 62627 | 1627 | 41336 |
| 2L-5S | | MI | 17824 | 6475 | 30163 | 4595 | 32427 | 3718 | 33065 | 2988 | 33203 | 1844 | 40031 | 1016 | 32854 |
| 10-#18 | 3.47 | MA | 22476 | 6475 | 37925 | 4630 | 41811 | 3756 | 43894 | 3039 | 46234 | 1896 | 55591 | 1406 | 41160 |
| 3L-4S | | MI | 18764 | 6475 | 31762 | 4611 | 34498 | 3694 | 35558 | 2966 | 36695 | 1866 | 44132 | 1113 | 34447 |
| 10-#18 | 3.47 | MA | 21278 | 6475 | 35811 | 4661 | 39118 | 3739 | 40621 | 3018 | 42154 | 1918 | 51052 | 1184 | 39427 |
| 4L-3S | | MI | 19811 | 6475 | 33600 | 4582 | 36840 | 3715 | 38353 | 2988 | 40170 | 1844 | 47982 | 1327 | 35982 |
| 10-#18 | 3.47 | MA | 20205 | 6475 | 33976 | 4649 | 36740 | 3766 | 37701 | 3040 | 38061 | 1896 | 46201 | 1089 | 37437 |
| 5L-2S | | MI | 21270 | 6475 | 35825 | 4597 | 39693 | 3692 | 41784 | 2966 | 44720 | 1822 | 53930 | 1549 | 36097 |
| 12-#11 | 1.63 | MA | 21240 | 5739 | 33657 | 4231 | 36571 | 3438 | 37588 | 2850 | 38105 | 1996 | 45048 | 1857 | 20177 |
| 2L-6S | | MI | 16999 | 5739 | 27046 | 4191 | 28598 | 3415 | 28623 | 2842 | 27327 | 1982 | 31894 | 1548 | 17419 |
| 12-#11 | 1.63 | MA | 20544 | 5739 | 32626 | 4227 | 35249 | 3450 | 35975 | 2861 | 35929 | 2005 | 42157 | 1771 | 20208 |
| 3L-5S | | MI | 17368 | 5739 | 27646 | 4195 | 29428 | 3422 | 29591 | 2833 | 28623 | 1973 | 33481 | 1605 | 17794 |
| 12-#11 | 1.63 | MA | 20052 | 5739 | 31782 | 4241 | 34174 | 3445 | 34668 | 2854 | 34265 | 2013 | 40282 | 1685 | 20219 |
| 4E | | MI | 17755 | 5739 | 28285 | 4200 | 30256 | 3411 | 30608 | 2824 | 30055 | 1982 | 35178 | 1643 | 17802 |
| 12-#11 | 1.63 | MA | 19611 | 5739 | 31051 | 4237 | 33226 | 3457 | 33504 | 2865 | 32598 | 2005 | 38303 | 1645 | 20177 |
| 5L-3S | | MI | 18185 | 5739 | 29022 | 4187 | 31194 | 3417 | 31748 | 2832 | 31482 | 1973 | 36770 | 1729 | 17774 |
| 12-#11 | 1.63 | MA | 19191 | 5739 | 30365 | 4234 | 32277 | 3452 | 32344 | 2858 | 31088 | 2013 | 36439 | 1589 | 19711 |
| 6L-2S | | MI | 18789 | 5739 | 29918 | 4192 | 32344 | 3406 | 33150 | 2823 | 33350 | 1964 | 39236 | 1816 | 17736 |
| 12-#14 | 2.34 | MA | 22430 | 6026 | 36370 | 4394 | 39971 | 3553 | 41706 | 2917 | 43552 | 1955 | 52210 | 1779 | 28598 |
| 2L-6S | | MI | 17275 | 6026 | 28164 | 4348 | 29929 | 3530 | 30231 | 2912 | 29437 | 1941 | 34891 | 1340 | 23742 |
| 12-#14 | 2.34 | MA | 21448 | 6026 | 34897 | 4388 | 38082 | 3570 | 39401 | 2931 | 40458 | 1967 | 48111 | 1654 | 28595 |
| 3L-5S | | MI | 17797 | 6025 | 29023 | 4356 | 31117 | 3540 | 31613 | 2899 | 31275 | 1928 | 37132 | 1422 | 24351 |
| 12-#14 | 2.34 | MA | 20752 | 6025 | 33689 | 4407 | 36543 | 3562 | 37531 | 2921 | 38094 | 1980 | 45458 | 1530 | 28503 |
| 4E | | MI | 18344 | 6026 | 29938 | 4363 | 32301 | 3525 | 33065 | 2887 | 33306 | 1941 | 39535 | 1476 | 25035 |
| 12-#14 | 2.34 | MA | 20128 | 6025 | 32642 | 4401 | 35186 | 3579 | 35864 | 2935 | 35724 | 1967 | 42646 | 1474 | 27699 |
| 5L-3S | | MI | 18952 | 6025 | 30990 | 4345 | 33642 | 3535 | 34691 | 2899 | 35330 | 1928 | 41785 | 1600 | 25086 |
| 12-#14 | 2.34 | MA | 19534 | 6026 | 31659 | 4395 | 33826 | 3571 | 34203 | 2925 | 33577 | 1980 | 40004 | 1392 | 26933 |
| 6L-2S | | MI | 19804 | 6025 | 32269 | 4353 | 35282 | 3520 | 36689 | 2887 | 37978 | 1916 | 45271 | 1724 | 25062 |
| 12-#18 | 4.17 | MA | 23615 | 6752 | 40496 | 4803 | 45107 | 3880 | 47915 | 3115 | 51573 | 1865 | 62627 | 1339 | 49075 |
| 3L-5S | | MI | 18815 | 6752 | 32388 | 4768 | 35280 | 3842 | 36496 | 3060 | 37753 | 1807 | 45979 | 938 | 39464 |
| 12-#18 | 4.17 | MA | 22428 | 6752 | 38382 | 4834 | 42414 | 3863 | 44643 | 3093 | 47493 | 1887 | 58088 | 1118 | 46952 |
| 4E | | MI | 19747 | 6752 | 33987 | 4783 | 37351 | 3819 | 38989 | 3038 | 41244 | 1830 | 50079 | 1035 | 40934 |
| 12-#18 | 4.17 | MA | 21365 | 6752 | 36547 | 4822 | 40036 | 3890 | 41722 | 3115 | 43400 | 1865 | 53237 | 1022 | 45097 |
| 5L-3S | | MI | 20784 | 6752 | 35825 | 4755 | 39693 | 3839 | 41784 | 3060 | 44720 | 1807 | 53930 | 1249 | 42837 |
| 12-#18 | 4.17 | MA | 20354 | 6752 | 34823 | 4809 | 37652 | 3873 | 38942 | 3138 | 39695 | 1887 | 48711 | 876 | 42259 |
| 6L-2S | | MI | 22231 | 6752 | 38051 | 4770 | 42546 | 3816 | 45214 | 3038 | 49269 | 1785 | 59877 | 1471 | 43022 |
| 14-#11 | 1.90 | MA | 21714 | 5847 | 34689 | 4298 | 37893 | 3487 | 39201 | 2880 | 40282 | 1986 | 47940 | 1836 | 23418 |
| 2L-7S | | MI | 17055 | 5847 | 27286 | 4271 | 28955 | 3475 | 29005 | 2864 | 27929 | 1979 | 32661 | 1433 | 19826 |
| 14-#11 | 1.90 | MA | 21021 | 5847 | 33657 | 4295 | 36571 | 3499 | 37588 | 2890 | 38105 | 1995 | 45048 | 1750 | 23440 |
| 3L-6S | | MI | 17414 | 5847 | 27943 | 4258 | 29748 | 3464 | 30025 | 2872 | 29195 | 1970 | 34360 | 1523 | 20113 |
| 14-#11 | 1.90 | MA | 20531 | 5847 | 32814 | 4308 | 35496 | 3494 | 36281 | 2883 | 36442 | 2004 | 43174 | 1663 | 23428 |
| 4L-5S | | MI | 17781 | 5847 | 28543 | 4263 | 30578 | 3470 | 30993 | 2863 | 30491 | 1961 | 35946 | 1580 | 20574 |

## RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

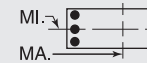
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.90 | MA | 20092 | 5847 | 32083 | 4305 | 34548 | 3506 | 35117 | 2894 | 34775 | 1995 | 41195 | 1624 | 23366 |
| 5L-4S | | MI | 18166 | 5847 | 29182 | 4267 | 31406 | 3459 | 32010 | 2853 | 31923 | 1970 | 37644 | 1618 | 20607 |
| 14-#11 | 1.90 | MA | 19674 | 5847 | 31397 | 4301 | 33599 | 3501 | 33957 | 2887 | 33264 | 2004 | 39330 | 1567 | 22812 |
| 6L-3S | | MI | 18594 | 5847 | 29918 | 4255 | 32344 | 3466 | 33150 | 2862 | 33350 | 1961 | 39236 | 1704 | 20592 |
| 14-#11 | 1.90 | MA | 19266 | 5847 | 30646 | 4315 | 32693 | 3513 | 32843 | 2898 | 31788 | 2012 | 37338 | 1477 | 22444 |
| 7L-2S | | MI | 19195 | 5847 | 30815 | 4259 | 33493 | 3455 | 34552 | 2852 | 35218 | 1953 | 41701 | 1790 | 20562 |
| 14-#14 | 2.73 | MA | 23093 | 6181 | 37844 | 4491 | 41860 | 3623 | 44011 | 2959 | 46645 | 1940 | 56309 | 1746 | 33210 |
| 2L-7S | | MI | 17354 | 6181 | 28503 | 4463 | 30435 | 3614 | 30772 | 2942 | 30291 | 1935 | 36275 | 1206 | 26659 |
| 14-#14 | 2.73 | MA | 22117 | 6181 | 36370 | 4485 | 39971 | 3640 | 41706 | 2974 | 43552 | 1952 | 52210 | 1621 | 33173 |
| 3L-6S | | MI | 17859 | 6181 | 29444 | 4446 | 31569 | 3599 | 32228 | 2954 | 32086 | 1923 | 38377 | 1301 | 27585 |
| 14-#14 | 2.73 | MA | 21425 | 6181 | 35163 | 4504 | 38432 | 3632 | 39836 | 2963 | 41188 | 1964 | 49557 | 1496 | 33049 |
| 4L-5S | | MI | 18377 | 6181 | 30303 | 4453 | 32757 | 3609 | 33610 | 2942 | 33924 | 1910 | 40618 | 1383 | 28156 |
| 14-#14 | 2.73 | MA | 20805 | 6181 | 34116 | 4498 | 37075 | 3649 | 38169 | 2977 | 38817 | 1952 | 46745 | 1441 | 32091 |
| 5L-4S | | MI | 18921 | 6181 | 31217 | 4460 | 33941 | 3595 | 35062 | 2929 | 35955 | 1923 | 43021 | 1437 | 28987 |
| 14-#14 | 2.73 | MA | 20215 | 6181 | 33133 | 4492 | 35716 | 3640 | 36508 | 2967 | 36671 | 1964 | 44103 | 1359 | 31367 |
| 6L-3S | | MI | 19525 | 6181 | 32269 | 4443 | 35282 | 3605 | 36689 | 2942 | 37978 | 1910 | 45271 | 1561 | 29068 |
| 14-#14 | 2.73 | MA | 19640 | 6181 | 32057 | 4511 | 34417 | 3657 | 34912 | 2981 | 34573 | 1977 | 41279 | 1229 | 30278 |
| 7L-2S | | MI | 20373 | 6181 | 33549 | 4450 | 36922 | 3590 | 38686 | 2929 | 40627 | 1898 | 48756 | 1686 | 29074 |
| 14-#18 | 4.86 | MA | 23566 | 7028 | 40953 | 5007 | 45710 | 3987 | 48664 | 3168 | 52832 | 1856 | 65124 | 1051 | 54517 |
| 4L-5S | | MI | 19796 | 7028 | 34614 | 4941 | 38133 | 3966 | 39926 | 3131 | 42303 | 1771 | 51927 | 860 | 46040 |
| 14-#18 | 4.86 | MA | 22513 | 7028 | 39118 | 4995 | 43332 | 4014 | 45743 | 3191 | 48739 | 1834 | 60273 | 955 | 52780 |
| 5L-4S | | MI | 20720 | 7028 | 36213 | 4956 | 40204 | 3943 | 42420 | 3109 | 45794 | 1793 | 56027 | 958 | 47460 |
| 14-#18 | 4.86 | MA | 21511 | 7028 | 37394 | 4982 | 40949 | 3997 | 42963 | 3213 | 45034 | 1856 | 55747 | 809 | 49774 |
| 6L-3S | | MI | 21749 | 7028 | 38051 | 4928 | 42546 | 3963 | 45214 | 3131 | 49269 | 1771 | 59877 | 1171 | 49678 |
| 16-#11 | 2.17 | MA | 22185 | 5955 | 35720 | 4366 | 39215 | 3535 | 40814 | 2909 | 42458 | 1976 | 50831 | 1814 | 26652 |
| 2L-8S | | MI | 17118 | 5955 | 27591 | 4334 | 29301 | 3517 | 29456 | 2902 | 28547 | 1976 | 33541 | 1363 | 22030 |
| 16-#11 | 2.17 | MA | 21495 | 5955 | 34689 | 4362 | 37893 | 3547 | 39201 | 2920 | 40282 | 1985 | 47940 | 1728 | 26662 |
| 3L-7S | | MI | 17469 | 5955 | 28182 | 4338 | 30104 | 3523 | 30407 | 2893 | 29797 | 1967 | 35127 | 1408 | 22540 |
| 16-#11 | 2.17 | MA | 21007 | 5955 | 33845 | 4376 | 36818 | 3542 | 37894 | 2913 | 38618 | 1994 | 46065 | 1642 | 26631 |
| 4L-6S | | MI | 17826 | 5955 | 28839 | 4326 | 30897 | 3512 | 31427 | 2901 | 31063 | 1958 | 36825 | 1498 | 22813 |
| 16-#11 | 2.17 | MA | 20571 | 5955 | 33114 | 4372 | 35871 | 3554 | 36730 | 2923 | 36951 | 1985 | 44086 | 1602 | 26512 |
| 5E | | MI | 18191 | 5955 | 29439 | 4330 | 31727 | 3519 | 32395 | 2892 | 32359 | 1950 | 38412 | 1555 | 23286 |
| 16-#11 | 2.17 | MA | 20154 | 5955 | 32428 | 4368 | 34921 | 3549 | 35570 | 2917 | 35441 | 1994 | 42222 | 1546 | 25921 |
| 6L-4S | | MI | 18575 | 5955 | 30078 | 4335 | 32555 | 3508 | 33412 | 2883 | 33790 | 1958 | 40109 | 1593 | 23396 |
| 16-#11 | 2.17 | MA | 19749 | 5955 | 31677 | 4382 | 34015 | 3561 | 34456 | 2927 | 33965 | 2002 | 40229 | 1456 | 25568 |
| 7L-3S | | MI | 19001 | 5955 | 30815 | 4322 | 33493 | 3514 | 34552 | 2891 | 35218 | 1950 | 41701 | 1679 | 23402 |
| 16-#11 | 2.17 | MA | 19349 | 5955 | 31002 | 4378 | 33096 | 3556 | 33369 | 2938 | 32395 | 1994 | 38380 | 1409 | 24958 |
| 8L-2S | | MI | 19600 | 5955 | 31711 | 4327 | 34642 | 3503 | 35954 | 2882 | 37085 | 1941 | 44167 | 1765 | 23380 |
| 16-#14 | 3.13 | MA | 22781 | 6337 | 37844 | 4582 | 41860 | 3710 | 44011 | 3016 | 46645 | 1937 | 56309 | 1588 | 37742 |
| 3L-7S | | MI | 17936 | 6337 | 29783 | 4560 | 32075 | 3684 | 32770 | 2984 | 32939 | 1917 | 39760 | 1167 | 30420 |
| 16-#14 | 3.13 | MA | 22093 | 6337 | 36636 | 4601 | 40321 | 3702 | 42141 | 3006 | 44281 | 1949 | 53656 | 1463 | 37588 |
| 4L-6S | | MI | 18438 | 6337 | 30723 | 4543 | 33209 | 3669 | 34226 | 2996 | 34735 | 1905 | 41862 | 1263 | 31435 |
| 16-#14 | 3.13 | MA | 21478 | 6337 | 35589 | 4595 | 38964 | 3718 | 40474 | 3020 | 41911 | 1937 | 50844 | 1407 | 36497 |
| 5E | | MI | 18953 | 6337 | 31582 | 4550 | 34397 | 3679 | 35608 | 2984 | 36572 | 1892 | 44103 | 1345 | 31975 |
| 16-#14 | 3.13 | MA | 20891 | 6337 | 34607 | 4590 | 37605 | 3710 | 38813 | 3009 | 39764 | 1949 | 48202 | 1326 | 35810 |
| 6L-4S | | MI | 19494 | 6337 | 32496 | 4557 | 35581 | 3664 | 37060 | 2971 | 38603 | 1905 | 46506 | 1399 | 32931 |
| 16-#14 | 3.13 | MA | 20320 | 6337 | 33531 | 4609 | 36307 | 3727 | 37217 | 3024 | 37666 | 1962 | 45378 | 1196 | 34631 |
| 7L-3S | | MI | 20095 | 6337 | 33549 | 4540 | 36922 | 3674 | 38686 | 2984 | 40627 | 1892 | 48756 | 1522 | 33040 |
| 16-#14 | 3.13 | MA | 19757 | 6337 | 32563 | 4603 | 34990 | 3719 | 35659 | 3038 | 35435 | 1949 | 42750 | 1130 | 33617 |
| 8L-2S | | MI | 20938 | 6337 | 34828 | 4547 | 38562 | 3660 | 40684 | 2971 | 43276 | 1880 | 52241 | 1647 | 33076 |
| 16-#18 | 5.56 | MA | 23650 | 7305 | 41689 | 5168 | 46628 | 4138 | 49764 | 3266 | 54078 | 1803 | 67309 | 888 | 60335 |
| 5E | | MI | 20769 | 7305 | 36839 | 5114 | 40986 | 4090 | 43357 | 3203 | 46852 | 1734 | 57875 | 782 | 52400 |
| 16-#18 | 5.56 | MA | 22657 | 7305 | 39966 | 5155 | 44245 | 4121 | 46984 | 3289 | 50373 | 1825 | 62782 | 742 | 57317 |
| 6L-4S | | MI | 21685 | 7305 | 38438 | 5129 | 43057 | 4067 | 45850 | 3181 | 50343 | 1756 | 61975 | 880 | 54017 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis

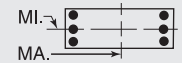


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.44 | MA | 21966 | 6063 | 35720 | 4430 | 39215 | 3596 | 40814 | 2949 | 42458 | 1975 | 50831 | 1706 | 29873 |
| 3L-8S | | MI | 17532 | 6063 | 28487 | 4401 | 30450 | 3565 | 30858 | 2932 | 30415 | 1964 | 36006 | 1338 | 24691 |
| 18-#11 | 2.44 | MA | 21481 | 6063 | 34876 | 4443 | 38140 | 3591 | 39507 | 2942 | 40795 | 1984 | 48957 | 1620 | 29828 |
| 4L-7S | | MI | 17881 | 6063 | 29079 | 4406 | 31254 | 3572 | 31809 | 2922 | 31664 | 1955 | 37592 | 1382 | 25257 |
| 18-#11 | 2.44 | MA | 21046 | 6063 | 34145 | 4440 | 37193 | 3603 | 38343 | 2953 | 39128 | 1975 | 46978 | 1581 | 29597 |
| 5L-6S | | MI | 18236 | 6063 | 29736 | 4393 | 32046 | 3561 | 32829 | 2931 | 32931 | 1947 | 39290 | 1473 | 25519 |
| 18-#11 | 2.44 | MA | 20632 | 6063 | 33460 | 4436 | 36244 | 3597 | 37183 | 2946 | 37617 | 1984 | 45113 | 1524 | 29035 |
| 6L-5S | | MI | 18600 | 6063 | 30336 | 4398 | 32876 | 3567 | 33797 | 2921 | 34227 | 1938 | 40877 | 1530 | 25965 |
| 18-#11 | 2.44 | MA | 20228 | 6063 | 32708 | 4450 | 35337 | 3610 | 36069 | 2957 | 36141 | 1993 | 43121 | 1434 | 28696 |
| 7L-4S | | MI | 18981 | 6063 | 30975 | 4402 | 33704 | 3556 | 34814 | 2912 | 35658 | 1947 | 42575 | 1567 | 26181 |
| 18-#11 | 2.44 | MA | 19831 | 6063 | 32033 | 4446 | 34418 | 3604 | 34982 | 2967 | 34572 | 1984 | 41271 | 1387 | 28029 |
| 8L-3S | | MI | 19406 | 6063 | 31711 | 4390 | 34642 | 3563 | 35954 | 2920 | 37085 | 1938 | 44167 | 1654 | 26206 |
| 18-#11 | 2.44 | MA | 19437 | 6063 | 31306 | 4460 | 33524 | 3616 | 33845 | 2960 | 33109 | 1993 | 39463 | 1333 | 27486 |
| 9L-2S | | MI | 20003 | 6063 | 32608 | 4394 | 35791 | 3552 | 37356 | 2911 | 38953 | 1929 | 46632 | 1740 | 26193 |
| 18-#14 | 3.52 | MA | 22757 | 6492 | 38110 | 4699 | 42211 | 3772 | 44446 | 3048 | 47375 | 1934 | 57755 | 1430 | 42123 |
| 4L-7S | | MI | 18514 | 6492 | 31062 | 4658 | 33715 | 3754 | 34768 | 3026 | 35588 | 1899 | 43245 | 1128 | 34194 |
| 18-#14 | 3.52 | MA | 22145 | 6492 | 37063 | 4693 | 40854 | 3788 | 42779 | 3062 | 45004 | 1922 | 54943 | 1374 | 40914 |
| 5L-6S | | MI | 19014 | 6492 | 32002 | 4640 | 34849 | 3739 | 36224 | 3038 | 37383 | 1887 | 45347 | 1224 | 35291 |
| 18-#14 | 3.52 | MA | 21562 | 6492 | 36081 | 4687 | 39494 | 3780 | 41118 | 3052 | 42858 | 1934 | 52301 | 1293 | 40258 |
| 6L-5S | | MI | 19526 | 6492 | 32861 | 4647 | 36037 | 3749 | 37606 | 3026 | 39221 | 1874 | 47588 | 1306 | 35804 |
| 18-#14 | 3.52 | MA | 20994 | 6492 | 35004 | 4706 | 38196 | 3797 | 39522 | 3066 | 40760 | 1946 | 49477 | 1162 | 38996 |
| 7L-4S | | MI | 20063 | 6492 | 33775 | 4655 | 37221 | 3734 | 39058 | 3013 | 41252 | 1887 | 49991 | 1360 | 36861 |
| 18-#14 | 3.52 | MA | 20435 | 6492 | 34036 | 4700 | 36879 | 3789 | 37964 | 3080 | 38529 | 1934 | 46849 | 1096 | 37916 |
| 8L-3S | | MI | 20661 | 6492 | 34828 | 4637 | 38562 | 3744 | 40684 | 3026 | 43276 | 1874 | 52241 | 1483 | 37004 |
| 18-#18 | 6.25 | MA | 23793 | 7582 | 42537 | 5328 | 47541 | 4245 | 51005 | 3364 | 55713 | 1794 | 69818 | 676 | 64883 |
| 6L-5S | | MI | 21734 | 7582 | 39065 | 5287 | 43839 | 4215 | 46787 | 3274 | 51402 | 1698 | 63823 | 704 | 58793 |
| 20-#11 | 2.71 | MA | 21952 | 6171 | 35908 | 4511 | 39462 | 3639 | 41120 | 2972 | 42971 | 1974 | 51849 | 1599 | 33021 |
| 4L-8S | | MI | 17942 | 6171 | 29384 | 4469 | 31599 | 3614 | 32260 | 2961 | 32283 | 1952 | 38472 | 1313 | 27359 |
| 20-#11 | 2.71 | MA | 21519 | 6171 | 35177 | 4507 | 38515 | 3651 | 39956 | 2982 | 41304 | 1965 | 49870 | 1559 | 32690 |
| 5L-7S | | MI | 18290 | 6171 | 29975 | 4473 | 32403 | 3620 | 33211 | 2952 | 33532 | 1944 | 40058 | 1357 | 27964 |
| 20-#11 | 2.71 | MA | 21107 | 6171 | 34491 | 4503 | 37566 | 3646 | 38796 | 2975 | 39794 | 1974 | 48005 | 1503 | 32154 |
| 6E | | MI | 18644 | 6171 | 30632 | 4461 | 33196 | 3609 | 34231 | 2960 | 34798 | 1935 | 41756 | 1448 | 28229 |
| 20-#11 | 2.71 | MA | 20705 | 6171 | 33740 | 4517 | 36660 | 3658 | 37682 | 2986 | 38318 | 1983 | 46012 | 1412 | 31826 |
| 7L-5S | | MI | 19006 | 6171 | 31232 | 4465 | 34025 | 3615 | 35199 | 2951 | 36094 | 1926 | 43343 | 1505 | 28652 |
| 20-#11 | 2.71 | MA | 20310 | 6171 | 33064 | 4513 | 35740 | 3653 | 36595 | 2997 | 36749 | 1974 | 44163 | 1366 | 31107 |
| 8L-4S | | MI | 19386 | 6171 | 31871 | 4470 | 34853 | 3605 | 36216 | 2942 | 37526 | 1935 | 45040 | 1542 | 28960 |
| 20-#11 | 2.71 | MA | 19918 | 6171 | 32337 | 4527 | 34846 | 3665 | 35458 | 2990 | 35286 | 1983 | 42355 | 1312 | 30565 |
| 9L-3S | | MI | 19809 | 6171 | 32608 | 4457 | 35791 | 3611 | 37356 | 2950 | 38953 | 1926 | 46632 | 1629 | 28997 |
| 20-#14 | 3.91 | MA | 22808 | 6648 | 38537 | 4790 | 42743 | 3858 | 45084 | 3105 | 48098 | 1906 | 59042 | 1341 | 45341 |
| 5L-7S | | MI | 19089 | 6648 | 32341 | 4755 | 35355 | 3824 | 36765 | 3068 | 38236 | 1881 | 46730 | 1090 | 37978 |
| 20-#14 | 3.91 | MA | 22229 | 6648 | 37554 | 4784 | 41383 | 3850 | 43422 | 3094 | 45951 | 1919 | 56400 | 1259 | 44708 |
| 6E | | MI | 19585 | 6648 | 33281 | 4737 | 36489 | 3809 | 38221 | 3081 | 40032 | 1869 | 48832 | 1185 | 39057 |
| 20-#14 | 3.91 | MA | 21664 | 6648 | 36478 | 4803 | 40085 | 3867 | 41827 | 3109 | 43854 | 1931 | 53576 | 1129 | 43371 |
| 7L-5S | | MI | 20095 | 6648 | 34140 | 4745 | 37676 | 3819 | 39603 | 3068 | 41870 | 1856 | 51073 | 1267 | 39641 |
| 20-#14 | 3.91 | MA | 21109 | 6648 | 35510 | 4797 | 38769 | 3858 | 40269 | 3123 | 41623 | 1919 | 50948 | 1063 | 42228 |
| 8L-4S | | MI | 20629 | 6648 | 35055 | 4752 | 38861 | 3804 | 41055 | 3056 | 43901 | 1869 | 53476 | 1321 | 40641 |
| 22-#11 | 2.98 | MA | 21990 | 6279 | 36208 | 4574 | 39837 | 3699 | 41569 | 3012 | 43481 | 1956 | 52761 | 1538 | 35790 |
| 5L-8S | | MI | 18351 | 6279 | 30280 | 4536 | 32748 | 3662 | 33662 | 2990 | 34150 | 1941 | 40937 | 1288 | 30033 |
| 22-#11 | 2.98 | MA | 21579 | 6279 | 35522 | 4571 | 38888 | 3694 | 40409 | 3005 | 41970 | 1964 | 50896 | 1481 | 35278 |
| 6L-7S | | MI | 18698 | 6279 | 30872 | 4541 | 33552 | 3668 | 34613 | 2981 | 35400 | 1932 | 42523 | 1332 | 30614 |
| 22-#11 | 2.98 | MA | 21180 | 6279 | 34771 | 4584 | 37982 | 3706 | 39295 | 3015 | 40494 | 1973 | 48904 | 1391 | 34912 |
| 7L-6S | | MI | 19050 | 6279 | 31529 | 4528 | 34345 | 3658 | 35633 | 2989 | 36666 | 1923 | 44221 | 1423 | 30943 |
| 22-#11 | 2.98 | MA | 20786 | 6279 | 34096 | 4581 | 37063 | 3701 | 38208 | 3026 | 38925 | 1964 | 47054 | 1344 | 34191 |
| 8L-5S | | MI | 19410 | 6279 | 32129 | 4533 | 35175 | 3664 | 36601 | 2980 | 37962 | 1915 | 45808 | 1479 | 31345 |
| 22-#11 | 2.98 | MA | 20396 | 6279 | 33369 | 4594 | 36168 | 3713 | 37071 | 3019 | 37462 | 1973 | 45246 | 1290 | 33605 |
| 9L-4S | | MI | 19788 | 6279 | 32768 | 4537 | 36003 | 3653 | 37618 | 2971 | 39394 | 1923 | 47505 | 1517 | 31736 |
| 22-#14 | 4.30 | MA | 22891 | 6804 | 39028 | 4881 | 43273 | 3920 | 45727 | 3137 | 49045 | 1904 | 60499 | 1226 | 49044 |
| 6L-7S | | MI | 19660 | 6804 | 33620 | 4852 | 36995 | 3894 | 38763 | 3110 | 40885 | 1863 | 50216 | 1051 | 41771 |

## RECTANGULAR TIED COLUMNS 32" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 22-#14 | 4.30 | MA | 22330 | 6804 | 37952 | 4901 | 41975 | 3936 | 44132 | 3151 | 46947 | 1916 | 57675 | 1096 | 47756 |
| 7L-6S | | MI | 20154 | 6804 | 34561 | 4835 | 38129 | 3879 | 40219 | 3123 | 42680 | 1851 | 52318 | 1146 | 42805 |
| 22-#14 | 4.30 | MA | 21778 | 6804 | 36984 | 4895 | 40658 | 3928 | 42574 | 3165 | 44716 | 1904 | 55047 | 1030 | 46550 |
| 8L-5S | | MI | 20660 | 6804 | 35420 | 4842 | 39316 | 3889 | 41601 | 3110 | 44518 | 1838 | 54559 | 1228 | 43486 |
| 24-#11 | 3.25 | MA | 22049 | 6387 | 36554 | 4638 | 40210 | 3743 | 42022 | 3034 | 44147 | 1955 | 53788 | 1460 | 38405 |
| 6L-8S | | MI | 18758 | 6387 | 31177 | 4603 | 33898 | 3711 | 35064 | 3020 | 36018 | 1929 | 43403 | 1262 | 32711 |
| 24-#11 | 3.25 | MA | 21651 | 6387 | 35802 | 4652 | 39304 | 3755 | 40908 | 3045 | 42671 | 1963 | 51795 | 1369 | 37976 |
| 7E | | MI | 19103 | 6387 | 31768 | 4608 | 34702 | 3717 | 36015 | 3011 | 37267 | 1920 | 44988 | 1307 | 33271 |
| 24-#11 | 3.25 | MA | 21260 | 6387 | 35127 | 4648 | 38385 | 3750 | 39821 | 3055 | 41102 | 1955 | 49946 | 1323 | 37279 |
| 8L-6S | | MI | 19453 | 6387 | 32425 | 4595 | 35494 | 3706 | 37035 | 3019 | 38534 | 1912 | 46686 | 1398 | 33659 |
| 24-#11 | 3.25 | MA | 20872 | 6387 | 34400 | 4662 | 37490 | 3762 | 38684 | 3049 | 39639 | 1963 | 48138 | 1269 | 36651 |
| 9L-5S | | MI | 19813 | 6387 | 33025 | 4600 | 36324 | 3712 | 38003 | 3010 | 39830 | 1903 | 48273 | 1454 | 34043 |
| 24-#14 | 4.69 | MA | 22992 | 6959 | 39426 | 4998 | 43864 | 4006 | 46437 | 3193 | 50041 | 1901 | 61774 | 1063 | 52148 |
| 7E | | MI | 20228 | 6959 | 34900 | 4949 | 38635 | 3964 | 40761 | 3152 | 43534 | 1845 | 53701 | 1012 | 45572 |
| 24-#14 | 4.69 | MA | 22443 | 6959 | 38458 | 4992 | 42547 | 3998 | 44879 | 3208 | 47810 | 1888 | 59146 | 997 | 50882 |
| 8L-6S | | MI | 20719 | 6959 | 35840 | 4932 | 39769 | 3949 | 42217 | 3165 | 45329 | 1833 | 55803 | 1107 | 46564 |

## RECTANGULAR TIED COLUMNS 32" x 38"

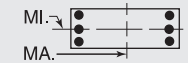
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 4-#18 | 1.32 | MA | 22987 | 5928 | 36212 | 4353 | 38937 | 3545 | 39613 | 2951 | 39261 | 2095 | 45854 | 1956 | 18213 |
| 2E | | MI | 19231 | 5928 | 30521 | 4286 | 32547 | 3490 | 32860 | 2896 | 32292 | 2043 | 37430 | 1890 | 15122 |
| 6-#14 | 1.11 | MA | 22655 | 5842 | 35315 | 4332 | 37951 | 3533 | 38470 | 2950 | 37859 | 2127 | 44088 | 2005 | 15591 |
| 2L-3S | | MI | 18111 | 5842 | 28519 | 4263 | 30136 | 3497 | 30070 | 2919 | 28611 | 2095 | 32683 | 1825 | 13060 |
| 6-#14 | 1.11 | MA | 21587 | 5842 | 33744 | 4326 | 35937 | 3551 | 36013 | 2965 | 34543 | 2140 | 39681 | 1880 | 15666 |
| 3L-2S | | MI | 18978 | 5842 | 29798 | 4270 | 31776 | 3483 | 32068 | 2907 | 31260 | 2083 | 36168 | 1949 | 12977 |
| 6-#18 | 1.97 | MA | 24239 | 6205 | 38957 | 4526 | 42455 | 3669 | 43904 | 3027 | 44996 | 2066 | 53436 | 1894 | 26868 |
| 2L-3S | | MI | 18739 | 6205 | 30521 | 4443 | 32547 | 3637 | 32860 | 2990 | 32292 | 2028 | 37430 | 1591 | 22273 |
| 6-#18 | 1.97 | MA | 22402 | 6205 | 36212 | 4515 | 38937 | 3698 | 39613 | 3051 | 39261 | 2088 | 45854 | 1672 | 26887 |
| 3L-2S | | MI | 20226 | 6205 | 32747 | 4459 | 35399 | 3614 | 36291 | 2968 | 36841 | 2006 | 43378 | 1812 | 22186 |
| 8-#11 | 1.03 | MA | 22519 | 5806 | 34934 | 4326 | 37545 | 3531 | 38007 | 2952 | 37293 | 2142 | 43376 | 2026 | 14509 |
| 2L-4S | | MI | 17830 | 5806 | 27856 | 4276 | 29372 | 3487 | 29178 | 2912 | 27550 | 2118 | 31606 | 1802 | 12201 |
| 8-#11 | 1.03 | MA | 21769 | 5806 | 33835 | 4323 | 36137 | 3543 | 36289 | 2963 | 34962 | 2151 | 40271 | 1940 | 14558 |
| 3E | | MI | 18265 | 5806 | 28592 | 4263 | 30310 | 3494 | 30318 | 2920 | 28977 | 2109 | 33198 | 1889 | 12141 |
| 8-#11 | 1.03 | MA | 21240 | 5806 | 32938 | 4337 | 34993 | 3539 | 34899 | 2957 | 33180 | 2159 | 38255 | 1853 | 14606 |
| 4L-2S | | MI | 18874 | 5806 | 29488 | 4268 | 31459 | 3483 | 31720 | 2911 | 30845 | 2100 | 35663 | 1975 | 12088 |
| 8-#14 | 1.48 | MA | 23385 | 5997 | 36886 | 4429 | 39965 | 3603 | 40927 | 2993 | 41176 | 2113 | 48494 | 1974 | 20553 |
| 2L-4S | | MI | 18082 | 5997 | 28745 | 4378 | 30435 | 3557 | 30442 | 2949 | 29236 | 2089 | 33918 | 1662 | 17158 |
| 8-#14 | 1.48 | MA | 22323 | 5997 | 35315 | 4424 | 37951 | 3620 | 38470 | 3008 | 37859 | 2126 | 44088 | 1849 | 20606 |
| 3E | | MI | 18699 | 5997 | 29798 | 4360 | 31776 | 3567 | 32068 | 2961 | 31260 | 2077 | 36168 | 1786 | 17112 |
| 8-#14 | 1.48 | MA | 21571 | 5997 | 34030 | 4443 | 36313 | 3613 | 36480 | 2998 | 35324 | 2138 | 41231 | 1725 | 20599 |
| 4L-2S | | MI | 19561 | 5997 | 31077 | 4368 | 33416 | 3552 | 34066 | 2949 | 33908 | 2065 | 39653 | 1911 | 17044 |
| 8-#18 | 2.63 | MA | 25474 | 6481 | 41701 | 4699 | 45973 | 3793 | 48196 | 3102 | 50730 | 2037 | 61017 | 1831 | 35474 |
| 2L-4S | | MI | 18677 | 6481 | 30908 | 4645 | 33058 | 3741 | 33496 | 3039 | 33366 | 2014 | 39528 | 1299 | 28352 |
| 8-#18 | 2.63 | MA | 23655 | 6481 | 38957 | 4688 | 42455 | 3822 | 43904 | 3126 | 44996 | 2059 | 53436 | 1610 | 35387 |
| 3E | | MI | 19735 | 6481 | 32747 | 4616 | 35399 | 3762 | 36291 | 3061 | 36841 | 1992 | 43378 | 1513 | 29197 |
| 8-#18 | 2.63 | MA | 22364 | 6481 | 36705 | 4721 | 39586 | 3807 | 40418 | 3106 | 40613 | 2082 | 48536 | 1389 | 34330 |
| 4L-2S | | MI | 21209 | 6481 | 34972 | 4632 | 38252 | 3738 | 39721 | 3039 | 41391 | 1970 | 49326 | 1734 | 29196 |
| 10-#11 | 1.28 | MA | 23033 | 5914 | 36033 | 4393 | 38954 | 3579 | 39725 | 2981 | 39624 | 2133 | 46481 | 2006 | 17981 |
| 2L-5S | | MI | 17858 | 5914 | 28113 | 4338 | 29693 | 3546 | 29563 | 2951 | 27986 | 2097 | 32374 | 1740 | 15062 |
| 10-#11 | 1.28 | MA | 22287 | 5914 | 34934 | 4390 | 37545 | 3592 | 38007 | 2993 | 37293 | 2142 | 43376 | 1919 | 18022 |
| 3L-4S | | MI | 18247 | 5914 | 28752 | 4343 | 30521 | 3536 | 30580 | 2942 | 29418 | 2106 | 34071 | 1777 | 15034 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis

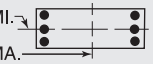



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 10-#11 | 1.28 | MA | 21761 | 5914 | 34037 | 4404 | 36402 | 3587 | 36617 | 2986 | 35511 | 2150 | 41360 | 1833 | 18051 |
| 4L-3S | | MI | 18680 | 5914 | 29488 | 4330 | 31459 | 3542 | 31720 | 2950 | 30845 | 2097 | 35663 | 1864 | 14987 |
| 10-#11 | 1.28 | MA | 21289 | 5914 | 33260 | 4401 | 35394 | 3599 | 35380 | 2998 | 33726 | 2142 | 39240 | 1793 | 18035 |
| 5L-2S | | MI | 19286 | 5914 | 30385 | 4335 | 32608 | 3531 | 33122 | 2941 | 32712 | 2089 | 38128 | 1950 | 14939 |
| 10-#14 | 1.85 | MA | 24108 | 6153 | 38457 | 4526 | 41979 | 3673 | 43384 | 3035 | 44492 | 2099 | 52901 | 1943 | 25494 |
| 2L-5S | | MI | 18117 | 6153 | 29110 | 4468 | 30890 | 3642 | 30987 | 3004 | 29854 | 2059 | 35000 | 1570 | 20764 |
| 10-#14 | 1.85 | MA | 23052 | 6153 | 36886 | 4521 | 39965 | 3690 | 40927 | 3050 | 41176 | 2112 | 48494 | 1818 | 25524 |
| 3L-4S | | MI | 18668 | 6153 | 30025 | 4475 | 32075 | 3627 | 32439 | 2991 | 31885 | 2071 | 37403 | 1624 | 21145 |
| 10-#14 | 1.85 | MA | 22306 | 6153 | 35601 | 4541 | 38327 | 3683 | 38937 | 3041 | 38641 | 2124 | 45637 | 1694 | 25468 |
| 4L-3S | | MI | 19282 | 6153 | 31077 | 4457 | 33416 | 3637 | 34066 | 3004 | 33908 | 2059 | 39653 | 1747 | 21137 |
| 10-#14 | 1.85 | MA | 21638 | 6153 | 34488 | 4535 | 36884 | 3700 | 37164 | 3056 | 36101 | 2112 | 42622 | 1637 | 24939 |
| 5L-2S | | MI | 20139 | 6153 | 32356 | 4465 | 35056 | 3622 | 36063 | 2991 | 36557 | 2047 | 43139 | 1872 | 21088 |
| 10-#18 | 3.29 | MA | 26696 | 6758 | 44445 | 4872 | 49491 | 3918 | 52488 | 3177 | 56465 | 2009 | 68598 | 1769 | 44036 |
| 2L-5S | | MI | 18728 | 6758 | 31535 | 4802 | 33840 | 3889 | 34433 | 3133 | 34424 | 1955 | 41375 | 1124 | 33146 |
| 10-#18 | 3.29 | MA | 24892 | 6758 | 41701 | 4861 | 45973 | 3946 | 48196 | 3202 | 50730 | 2031 | 61017 | 1548 | 43860 |
| 3L-4S | | MI | 19671 | 6758 | 33134 | 4818 | 35911 | 3865 | 36927 | 3111 | 37915 | 1977 | 45475 | 1221 | 34783 |
| 10-#18 | 3.29 | MA | 23615 | 6758 | 39449 | 4894 | 43104 | 3931 | 44710 | 3182 | 46348 | 2053 | 56117 | 1326 | 42317 |
| 4L-3S | | MI | 20720 | 6758 | 34972 | 4789 | 38252 | 3886 | 39721 | 3133 | 41391 | 1955 | 49326 | 1435 | 36085 |
| 10-#18 | 3.29 | MA | 22471 | 6758 | 37496 | 4883 | 40573 | 3959 | 41600 | 3206 | 41953 | 2031 | 50905 | 1229 | 40065 |
| 5L-2S | | MI | 22183 | 6758 | 37198 | 4805 | 41105 | 3862 | 43152 | 3111 | 45940 | 1933 | 55273 | 1656 | 36175 |
| 12-#11 | 1.54 | MA | 23545 | 6022 | 37132 | 4461 | 40363 | 3627 | 41444 | 3011 | 41955 | 2124 | 49586 | 1986 | 21441 |
| 2L-6S | | MI | 17904 | 6022 | 28409 | 4401 | 30012 | 3589 | 29997 | 2989 | 28558 | 2094 | 33252 | 1658 | 17561 |
| 12-#11 | 1.54 | MA | 22802 | 6022 | 36033 | 4457 | 38954 | 3640 | 39725 | 3022 | 39624 | 2133 | 46481 | 1899 | 21472 |
| 3L-5S | | MI | 18273 | 6022 | 29010 | 4406 | 30842 | 3595 | 30965 | 2980 | 29854 | 2086 | 34839 | 1715 | 17858 |
| 12-#11 | 1.54 | MA | 22278 | 6022 | 35135 | 4472 | 37810 | 3635 | 38336 | 3016 | 37842 | 2141 | 44465 | 1813 | 21483 |
| 4E | | MI | 18661 | 6022 | 29649 | 4410 | 31670 | 3584 | 31982 | 2971 | 31285 | 2094 | 36536 | 1752 | 17852 |
| 12-#11 | 1.54 | MA | 21809 | 6022 | 34358 | 4468 | 36803 | 3648 | 37098 | 3027 | 36057 | 2133 | 42345 | 1773 | 21440 |
| 5L-3S | | MI | 19092 | 6022 | 30385 | 4398 | 32608 | 3590 | 33122 | 2979 | 32712 | 2086 | 38128 | 1838 | 17819 |
| 12-#11 | 1.54 | MA | 21362 | 6022 | 33630 | 4465 | 35794 | 3643 | 35865 | 3021 | 34440 | 2141 | 40341 | 1717 | 21019 |
| 6L-2S | | MI | 19696 | 6022 | 31281 | 4402 | 33757 | 3579 | 34524 | 2970 | 34580 | 2077 | 40594 | 1925 | 17778 |
| 12-#14 | 2.22 | MA | 24826 | 6308 | 40028 | 4623 | 43993 | 3743 | 45841 | 3077 | 47809 | 2085 | 57307 | 1912 | 30420 |
| 2L-6S | | MI | 18180 | 6308 | 29531 | 4558 | 31343 | 3702 | 31603 | 3058 | 30665 | 2053 | 36245 | 1449 | 23928 |
| 12-#14 | 2.22 | MA | 23776 | 6308 | 38457 | 4618 | 41979 | 3760 | 43384 | 3093 | 44492 | 2098 | 52901 | 1787 | 30417 |
| 3L-5S | | MI | 18702 | 6308 | 30390 | 4565 | 32530 | 3712 | 32985 | 3046 | 32502 | 2041 | 38486 | 1531 | 24551 |
| 12-#14 | 2.22 | MA | 23035 | 6308 | 37172 | 4638 | 40341 | 3753 | 41394 | 3083 | 41957 | 2110 | 50044 | 1663 | 30326 |
| 4E | | MI | 19250 | 6308 | 31304 | 4572 | 33715 | 3697 | 34437 | 3033 | 34533 | 2053 | 40889 | 1585 | 25115 |
| 12-#14 | 2.22 | MA | 22371 | 6308 | 36059 | 4633 | 38898 | 3770 | 39621 | 3098 | 39417 | 2098 | 47029 | 1606 | 29605 |
| 5L-3S | | MI | 19860 | 6308 | 32356 | 4555 | 35056 | 3707 | 36063 | 3046 | 36557 | 2041 | 43139 | 1709 | 25150 |
| 12-#14 | 2.22 | MA | 21738 | 6308 | 35014 | 4628 | 37452 | 3763 | 37854 | 3089 | 37116 | 2110 | 44187 | 1525 | 28742 |
| 6L-2S | | MI | 20713 | 6308 | 33636 | 4562 | 36696 | 3692 | 38061 | 3033 | 39205 | 2029 | 46624 | 1833 | 25115 |
| 12-#18 | 3.95 | MA | 26116 | 7035 | 44445 | 5034 | 49491 | 4070 | 52488 | 3277 | 56465 | 2002 | 68598 | 1485 | 52315 |
| 3L-5S | | MI | 19720 | 7035 | 33760 | 4975 | 36693 | 4013 | 37864 | 3205 | 38974 | 1919 | 47323 | 1046 | 39753 |
| 12-#18 | 3.95 | MA | 24851 | 7035 | 42193 | 5067 | 46622 | 4055 | 49001 | 3257 | 52082 | 2024 | 63698 | 1264 | 50355 |
| 4E | | MI | 20655 | 7035 | 35359 | 4991 | 38764 | 3989 | 40357 | 3182 | 42465 | 1941 | 51423 | 1143 | 41265 |
| 12-#18 | 3.95 | MA | 23718 | 7035 | 40240 | 5055 | 44091 | 4083 | 45892 | 3281 | 47688 | 2002 | 58486 | 1166 | 48249 |
| 5L-3S | | MI | 21696 | 7035 | 37198 | 4962 | 41105 | 4010 | 43152 | 3205 | 45940 | 1919 | 55273 | 1357 | 42950 |
| 12-#18 | 3.95 | MA | 22640 | 7035 | 38406 | 5044 | 41554 | 4068 | 42793 | 3261 | 43708 | 2024 | 53604 | 1021 | 45424 |
| 6L-2S | | MI | 23147 | 7035 | 39423 | 4977 | 43958 | 3986 | 46583 | 3182 | 50490 | 1897 | 61221 | 1578 | 43106 |
| 14-#11 | 1.80 | MA | 24053 | 6130 | 38230 | 4528 | 41771 | 3676 | 43162 | 3040 | 44287 | 2115 | 52691 | 1966 | 24892 |
| 2L-7S | | MI | 17960 | 6130 | 28649 | 4481 | 30369 | 3648 | 30379 | 3011 | 29159 | 2091 | 34019 | 1542 | 19963 |
| 14-#11 | 1.80 | MA | 23313 | 6130 | 37132 | 4525 | 40363 | 3688 | 41444 | 3051 | 41955 | 2124 | 49586 | 1879 | 24914 |
| 3L-6S | | MI | 18319 | 6130 | 29306 | 4469 | 31162 | 3637 | 31399 | 3019 | 30425 | 2083 | 35717 | 1633 | 20254 |
| 14-#11 | 1.80 | MA | 22792 | 6130 | 36234 | 4539 | 39219 | 3684 | 40054 | 3045 | 40173 | 2132 | 47570 | 1793 | 24903 |
| 4L-5S | | MI | 18687 | 6130 | 29906 | 4473 | 31991 | 3643 | 32367 | 3010 | 31721 | 2074 | 37304 | 1689 | 20644 |
| 14-#11 | 1.80 | MA | 22325 | 6130 | 35457 | 4536 | 38212 | 3696 | 38816 | 3056 | 38388 | 2124 | 45450 | 1753 | 24840 |
| 5L-4S | | MI | 19073 | 6130 | 30545 | 4478 | 32819 | 3632 | 33384 | 3001 | 33153 | 2083 | 39002 | 1727 | 20661 |
| 14-#11 | 1.80 | MA | 21880 | 6130 | 34729 | 4533 | 37203 | 3692 | 37584 | 3050 | 36771 | 2132 | 43446 | 1697 | 24324 |
| 6L-3S | | MI | 19502 | 6130 | 31281 | 4465 | 33757 | 3639 | 34524 | 3009 | 34580 | 2074 | 40594 | 1813 | 20639 |

## RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

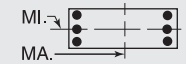
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.80 | MA | 21447 | 6130 | 33930 | 4547 | 36240 | 3704 | 36400 | 3061 | 35190 | 2141 | 41306 | 1606 | 23911 |
| 7L-2S | | MI | 20104 | 6130 | 32178 | 4470 | 34907 | 3628 | 35926 | 2999 | 36448 | 2066 | 43059 | 1900 | 20606 |
| 14-#14 | 2.59 | MA | 25538 | 6464 | 41599 | 4721 | 46007 | 3812 | 48298 | 3120 | 51125 | 2071 | 61714 | 1881 | 35337 |
| 2L-7S | | MI | 18257 | 6464 | 29870 | 4673 | 31848 | 3787 | 32145 | 3088 | 31518 | 2048 | 37628 | 1315 | 26959 |
| 14-#14 | 2.59 | MA | 24494 | 6464 | 40028 | 4715 | 43993 | 3830 | 45841 | 3135 | 47809 | 2084 | 57307 | 1756 | 35299 |
| 3L-6S | | MI | 18764 | 6464 | 30810 | 4655 | 32983 | 3772 | 33601 | 3100 | 33313 | 2035 | 39730 | 1410 | 27771 |
| 14-#14 | 2.59 | MA | 23757 | 6464 | 38743 | 4735 | 42355 | 3822 | 43851 | 3126 | 45274 | 2096 | 54451 | 1632 | 35175 |
| 4L-5S | | MI | 19284 | 6464 | 31669 | 4662 | 34170 | 3782 | 34983 | 3088 | 35151 | 2023 | 41971 | 1492 | 28354 |
| 14-#14 | 2.59 | MA | 23098 | 6464 | 37630 | 4730 | 40912 | 3840 | 42078 | 3141 | 42734 | 2084 | 51435 | 1575 | 34289 |
| 5L-4S | | MI | 19829 | 6464 | 32583 | 4670 | 35355 | 3767 | 36435 | 3075 | 37182 | 2035 | 44374 | 1546 | 29074 |
| 14-#14 | 2.59 | MA | 22470 | 6464 | 36585 | 4725 | 39466 | 3833 | 40311 | 3131 | 40432 | 2096 | 48593 | 1494 | 33472 |
| 6L-3S | | MI | 20435 | 6464 | 33636 | 4652 | 36696 | 3777 | 38061 | 3088 | 39205 | 2023 | 46624 | 1670 | 29137 |
| 14-#14 | 2.59 | MA | 21858 | 6464 | 35441 | 4744 | 38086 | 3850 | 38615 | 3146 | 38183 | 2108 | 45556 | 1363 | 32438 |
| 7L-2S | | MI | 21284 | 6464 | 34915 | 4659 | 38336 | 3762 | 40059 | 3075 | 41854 | 2011 | 50109 | 1794 | 29130 |
| 14-#18 | 4.61 | MA | 26074 | 7311 | 44937 | 5240 | 50140 | 4179 | 53293 | 3332 | 57817 | 1996 | 71280 | 1202 | 58435 |
| 4L-5S | | MI | 20703 | 7311 | 35986 | 5148 | 39546 | 4137 | 41295 | 3276 | 43523 | 1882 | 53271 | 968 | 46383 |
| 14-#18 | 4.61 | MA | 24952 | 7311 | 42984 | 5228 | 47609 | 4208 | 50183 | 3357 | 53422 | 1973 | 66067 | 1104 | 56457 |
| 5L-4S | | MI | 21631 | 7311 | 37585 | 5164 | 41617 | 4113 | 43788 | 3254 | 47014 | 1904 | 57371 | 1065 | 47786 |
| 14-#18 | 4.61 | MA | 23885 | 7311 | 41150 | 5217 | 45072 | 4192 | 47084 | 3337 | 49443 | 1996 | 61185 | 959 | 53459 |
| 6L-3S | | MI | 22663 | 7311 | 39423 | 5135 | 43958 | 4134 | 46583 | 3276 | 50490 | 1882 | 61221 | 1279 | 49799 |
| 16-#11 | 2.05 | MA | 24559 | 6238 | 39329 | 4596 | 43180 | 3724 | 44881 | 3070 | 46618 | 2106 | 55796 | 1946 | 28337 |
| 2L-8S | | MI | 18023 | 6238 | 28954 | 4544 | 30714 | 3690 | 30830 | 3049 | 29778 | 2088 | 34899 | 1472 | 22251 |
| 16-#11 | 2.05 | MA | 23822 | 6238 | 38230 | 4592 | 41771 | 3737 | 43162 | 3081 | 44287 | 2115 | 52691 | 1859 | 28346 |
| 3L-7S | | MI | 18374 | 6238 | 29545 | 4549 | 31518 | 3696 | 31782 | 3040 | 31027 | 2080 | 36485 | 1517 | 22679 |
| 16-#11 | 2.05 | MA | 23303 | 6238 | 37333 | 4606 | 40627 | 3732 | 41772 | 3075 | 42505 | 2123 | 50675 | 1773 | 28316 |
| 4L-6S | | MI | 18732 | 6238 | 30202 | 4536 | 32311 | 3685 | 32801 | 3048 | 32293 | 2071 | 38183 | 1607 | 22955 |
| 16-#11 | 2.05 | MA | 22838 | 6238 | 36556 | 4603 | 39620 | 3745 | 40535 | 3086 | 40720 | 2115 | 48555 | 1733 | 28234 |
| 5E | | MI | 19098 | 6238 | 30803 | 4541 | 33141 | 3692 | 33769 | 3039 | 33589 | 2063 | 39770 | 1664 | 23423 |
| 16-#11 | 2.05 | MA | 22396 | 6238 | 35827 | 4600 | 38611 | 3740 | 39302 | 3080 | 39102 | 2123 | 46551 | 1677 | 27637 |
| 6L-4S | | MI | 19482 | 6238 | 31441 | 4545 | 33969 | 3681 | 34786 | 3030 | 35021 | 2071 | 41467 | 1702 | 23458 |
| 16-#11 | 2.05 | MA | 21964 | 6238 | 35029 | 4614 | 37649 | 3753 | 38118 | 3091 | 37521 | 2132 | 44411 | 1586 | 27241 |
| 7L-3S | | MI | 19910 | 6238 | 32178 | 4533 | 34907 | 3687 | 35926 | 3038 | 36448 | 2063 | 43059 | 1788 | 23453 |
| 16-#11 | 2.05 | MA | 21540 | 6238 | 34312 | 4611 | 36672 | 3748 | 36963 | 3102 | 35841 | 2123 | 42429 | 1539 | 26677 |
| 8L-2S | | MI | 20509 | 6238 | 33074 | 4537 | 36056 | 3676 | 37328 | 3029 | 38316 | 2054 | 45524 | 1874 | 23427 |
| 16-#14 | 2.96 | MA | 25207 | 6620 | 41599 | 4813 | 46007 | 3900 | 48298 | 3178 | 51125 | 2069 | 61714 | 1725 | 40172 |
| 3L-7S | | MI | 18841 | 6620 | 31149 | 4770 | 33488 | 3856 | 34142 | 3130 | 34166 | 2030 | 41113 | 1276 | 30717 |
| 16-#14 | 2.96 | MA | 24475 | 6620 | 40314 | 4832 | 44369 | 3892 | 46308 | 3168 | 48590 | 2082 | 58857 | 1601 | 40018 |
| 4L-6S | | MI | 19344 | 6620 | 32089 | 4752 | 34623 | 3842 | 35598 | 3142 | 35962 | 2017 | 43215 | 1371 | 31621 |
| 16-#14 | 2.96 | MA | 23819 | 6620 | 39201 | 4827 | 42926 | 3910 | 44535 | 3183 | 46050 | 2069 | 55842 | 1544 | 38988 |
| 5E | | MI | 19861 | 6620 | 32948 | 4760 | 35810 | 3852 | 36980 | 3130 | 37799 | 2005 | 45456 | 1453 | 32172 |
| 16-#14 | 2.96 | MA | 23195 | 6620 | 38157 | 4822 | 41480 | 3902 | 42768 | 3174 | 43749 | 2082 | 53000 | 1463 | 38210 |
| 6L-4S | | MI | 20403 | 6620 | 33862 | 4767 | 36995 | 3837 | 38432 | 3118 | 39830 | 2017 | 47859 | 1507 | 33024 |
| 16-#14 | 2.96 | MA | 22587 | 6620 | 37012 | 4842 | 40100 | 3920 | 41072 | 3189 | 41500 | 2094 | 49963 | 1332 | 37084 |
| 7L-3S | | MI | 21006 | 6620 | 34915 | 4749 | 38336 | 3847 | 40059 | 3130 | 41854 | 2005 | 50109 | 1631 | 33114 |
| 16-#14 | 2.96 | MA | 21989 | 6620 | 35984 | 4837 | 38700 | 3912 | 39416 | 3204 | 39109 | 2082 | 47145 | 1265 | 36026 |
| 8L-2S | | MI | 21850 | 6620 | 36194 | 4757 | 39976 | 3832 | 42056 | 3118 | 44503 | 1992 | 53594 | 1755 | 33140 |
| 16-#18 | 5.26 | MA | 26174 | 7588 | 45728 | 5401 | 51126 | 4332 | 54475 | 3432 | 59157 | 1945 | 73649 | 1042 | 64684 |
| 5E | | MI | 21678 | 7588 | 38211 | 5321 | 42399 | 4261 | 44725 | 3348 | 48073 | 1846 | 59219 | 890 | 52932 |
| 16-#18 | 5.26 | MA | 25116 | 7588 | 43894 | 5390 | 48590 | 4316 | 51376 | 3412 | 55178 | 1967 | 68767 | 896 | 61521 |
| 6L-4S | | MI | 22598 | 7588 | 39810 | 5337 | 44470 | 4237 | 47219 | 3325 | 51564 | 1868 | 63319 | 987 | 54338 |
| 18-#11 | 2.31 | MA | 24328 | 6346 | 39329 | 4660 | 43180 | 3785 | 44881 | 3110 | 46618 | 2106 | 55796 | 1839 | 31769 |
| 3L-8S | | MI | 18436 | 6346 | 29851 | 4612 | 31864 | 3738 | 32232 | 3079 | 31645 | 2077 | 37364 | 1447 | 24910 |
| 18-#11 | 2.31 | MA | 23811 | 6346 | 38432 | 4674 | 42036 | 3781 | 43491 | 3104 | 44836 | 2114 | 53780 | 1753 | 31724 |
| 4L-7S | | MI | 18787 | 6346 | 30442 | 4616 | 32668 | 3745 | 33184 | 3069 | 32895 | 2068 | 38950 | 1492 | 25397 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis

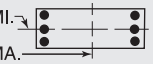


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.31 | MA | 23348 | 6346 | 37655 | 4671 | 41029 | 3793 | 42253 | 3115 | 43051 | 2106 | 51660 | 1713 | 31596 |
| 5L-6S | | MI | 19142 | 6346 | 31099 | 4604 | 33460 | 3734 | 34203 | 3078 | 34161 | 2060 | 40648 | 1582 | 25661 |
| 18-#11 | 2.31 | MA | 22908 | 6346 | 36926 | 4667 | 40020 | 3789 | 41020 | 3109 | 41433 | 2114 | 49656 | 1656 | 30956 |
| 6L-5S | | MI | 19507 | 6346 | 31699 | 4608 | 34290 | 3740 | 35171 | 3068 | 35457 | 2051 | 42235 | 1639 | 26122 |
| 18-#11 | 2.31 | MA | 22479 | 6346 | 36128 | 4681 | 39057 | 3801 | 39837 | 3120 | 39852 | 2123 | 47516 | 1566 | 30575 |
| 7L-4S | | MI | 19889 | 6346 | 32338 | 4613 | 35118 | 3729 | 36188 | 3059 | 36888 | 2060 | 43933 | 1677 | 26247 |
| 18-#11 | 2.31 | MA | 22056 | 6346 | 35410 | 4678 | 38081 | 3796 | 38681 | 3131 | 38172 | 2114 | 45534 | 1519 | 29952 |
| 8L-3S | | MI | 20315 | 6346 | 33074 | 4600 | 36056 | 3736 | 37328 | 3067 | 38316 | 2051 | 45524 | 1763 | 26260 |
| 18-#11 | 2.31 | MA | 21638 | 6346 | 34638 | 4692 | 37130 | 3809 | 37473 | 3125 | 36605 | 2123 | 43591 | 1465 | 29344 |
| 9L-2S | | MI | 20913 | 6346 | 33971 | 4605 | 37205 | 3725 | 38730 | 3058 | 40183 | 2042 | 47990 | 1849 | 26243 |
| 18-#14 | 3.33 | MA | 25187 | 6775 | 41885 | 4930 | 46383 | 3962 | 48765 | 3210 | 51907 | 2068 | 63264 | 1570 | 44857 |
| 4L-7S | | MI | 19420 | 6775 | 32428 | 4867 | 35128 | 3926 | 36140 | 3172 | 36815 | 2012 | 44598 | 1237 | 34488 |
| 18-#14 | 3.33 | MA | 24536 | 6775 | 40772 | 4924 | 44940 | 3980 | 46992 | 3226 | 49366 | 2055 | 60248 | 1513 | 43699 |
| 5L-6S | | MI | 19921 | 6775 | 33368 | 4849 | 36263 | 3911 | 37596 | 3185 | 38610 | 1999 | 46700 | 1332 | 35478 |
| 18-#14 | 3.33 | MA | 23916 | 6775 | 39728 | 4919 | 43494 | 3972 | 45225 | 3216 | 47065 | 2068 | 57406 | 1432 | 42956 |
| 6L-5S | | MI | 20434 | 6775 | 34227 | 4857 | 37450 | 3921 | 38978 | 3172 | 40448 | 1987 | 48941 | 1415 | 36000 |
| 18-#14 | 3.33 | MA | 23312 | 6775 | 38584 | 4939 | 42114 | 3990 | 43529 | 3231 | 44816 | 2080 | 54370 | 1301 | 41741 |
| 7L-4S | | MI | 20973 | 6775 | 35142 | 4864 | 38635 | 3907 | 40430 | 3160 | 42479 | 1999 | 51344 | 1469 | 36968 |
| 18-#14 | 3.33 | MA | 22717 | 6775 | 37555 | 4934 | 40714 | 3982 | 41873 | 3246 | 42425 | 2068 | 51551 | 1234 | 40722 |
| 8L-3S | | MI | 21573 | 6775 | 36194 | 4847 | 39976 | 3916 | 42056 | 3172 | 44503 | 1987 | 53594 | 1592 | 37083 |
| 18-#18 | 5.92 | MA | 26337 | 7864 | 46638 | 5563 | 52108 | 4440 | 55668 | 3488 | 60912 | 1938 | 76348 | 834 | 69608 |
| 6L-5S | | MI | 22645 | 7864 | 40437 | 5494 | 45252 | 4385 | 48156 | 3419 | 52622 | 1809 | 65167 | 812 | 59317 |
| 20-#11 | 2.57 | MA | 24316 | 6454 | 39531 | 4741 | 43445 | 3829 | 45209 | 3133 | 47167 | 2105 | 56885 | 1733 | 35127 |
| 4L-8S | | MI | 18848 | 6454 | 30747 | 4679 | 33013 | 3787 | 33634 | 3108 | 33513 | 2065 | 39830 | 1422 | 27577 |
| 20-#11 | 2.57 | MA | 23856 | 6454 | 38754 | 4738 | 42437 | 3842 | 43972 | 3145 | 45382 | 2096 | 54765 | 1693 | 34892 |
| 5L-7S | | MI | 19197 | 6454 | 31338 | 4684 | 33817 | 3793 | 34586 | 3099 | 34762 | 2057 | 41416 | 1467 | 28118 |
| 20-#11 | 2.57 | MA | 23418 | 6454 | 38025 | 4735 | 41429 | 3837 | 42739 | 3138 | 43764 | 2105 | 52761 | 1636 | 34280 |
| 6E | | MI | 19551 | 6454 | 31995 | 4671 | 34609 | 3782 | 35605 | 3107 | 36028 | 2048 | 43114 | 1557 | 28372 |
| 20-#11 | 2.57 | MA | 22990 | 6454 | 37227 | 4749 | 40466 | 3849 | 41555 | 3150 | 42183 | 2114 | 50621 | 1546 | 33912 |
| 7L-5S | | MI | 19914 | 6454 | 32596 | 4676 | 35439 | 3789 | 36573 | 3098 | 37324 | 2039 | 44700 | 1614 | 28808 |
| 20-#11 | 2.57 | MA | 22570 | 6454 | 36509 | 4746 | 39489 | 3845 | 40400 | 3161 | 40503 | 2105 | 48639 | 1499 | 33234 |
| 8L-4S | | MI | 20295 | 6454 | 33234 | 4680 | 36267 | 3778 | 37590 | 3089 | 38756 | 2048 | 46398 | 1651 | 29031 |
| 20-#11 | 2.57 | MA | 22153 | 6454 | 35737 | 4760 | 38539 | 3857 | 39191 | 3155 | 38936 | 2114 | 46696 | 1445 | 32645 |
| 9L-3S | | MI | 20719 | 6454 | 33971 | 4668 | 37205 | 3784 | 38730 | 3097 | 40183 | 2039 | 47990 | 1738 | 29058 |
| 20-#11 | 2.57 | MA | 21694 | 6454 | 35021 | 4756 | 37575 | 3853 | 38042 | 3166 | 37383 | 2122 | 44815 | 1384 | 31822 |
| 10L-2S | | MI | 21314 | 6454 | 34867 | 4672 | 38355 | 3773 | 40132 | 3088 | 42051 | 2031 | 50455 | 1824 | 29053 |
| 20-#14 | 3.70 | MA | 25248 | 6931 | 42343 | 5022 | 46954 | 4049 | 49449 | 3268 | 52683 | 2041 | 64655 | 1482 | 48420 |
| 5L-7S | | MI | 19995 | 6931 | 33707 | 4964 | 36768 | 3996 | 38138 | 3214 | 39463 | 1994 | 48084 | 1198 | 38269 |
| 20-#14 | 3.70 | MA | 24631 | 6931 | 41299 | 5017 | 45508 | 4042 | 47682 | 3258 | 50382 | 2054 | 61813 | 1401 | 47708 |
| 6E | | MI | 20493 | 6931 | 34648 | 4947 | 37903 | 3981 | 39594 | 3227 | 41259 | 1981 | 50186 | 1294 | 39340 |
| 20-#14 | 3.70 | MA | 24031 | 6931 | 40155 | 5036 | 44128 | 4059 | 45986 | 3274 | 48133 | 2066 | 58776 | 1271 | 46410 |
| 7L-5S | | MI | 21005 | 6931 | 35507 | 4954 | 39090 | 3991 | 40976 | 3214 | 43097 | 1969 | 52427 | 1376 | 39837 |
| 20-#14 | 3.70 | MA | 23440 | 6931 | 39126 | 5031 | 42728 | 4052 | 44330 | 3289 | 45741 | 2054 | 55958 | 1203 | 45329 |
| 8L-4S | | MI | 21541 | 6931 | 36421 | 4961 | 40274 | 3976 | 42428 | 3202 | 45128 | 1981 | 54830 | 1430 | 40875 |
| 22-#11 | 2.82 | MA | 24361 | 6562 | 39852 | 4805 | 43846 | 3890 | 45690 | 3174 | 47713 | 2087 | 57870 | 1673 | 38194 |
| 5L-8S | | MI | 19257 | 6562 | 31644 | 4746 | 34162 | 3835 | 35036 | 3137 | 35381 | 2054 | 42295 | 1397 | 30249 |
| 22-#11 | 2.82 | MA | 23924 | 6562 | 39124 | 4802 | 42837 | 3885 | 44457 | 3168 | 46095 | 2096 | 55866 | 1616 | 37609 |
| 6L-7S | | MI | 19605 | 6562 | 32235 | 4751 | 34966 | 3842 | 35988 | 3128 | 36630 | 2045 | 43881 | 1441 | 30841 |
| 22-#11 | 2.82 | MA | 23499 | 6562 | 38326 | 4816 | 41874 | 3898 | 43274 | 3179 | 44514 | 2105 | 53726 | 1526 | 37252 |
| 7L-6S | | MI | 19957 | 6562 | 32892 | 4738 | 35759 | 3831 | 37007 | 3136 | 37896 | 2036 | 45579 | 1532 | 31086 |
| 22-#11 | 2.82 | MA | 23080 | 6562 | 37608 | 4813 | 40898 | 3893 | 42118 | 3190 | 42834 | 2096 | 51744 | 1479 | 36521 |
| 8L-5S | | MI | 20319 | 6562 | 33492 | 4743 | 36588 | 3837 | 37975 | 3127 | 39192 | 2028 | 47166 | 1589 | 31501 |
| 22-#11 | 2.82 | MA | 22666 | 6562 | 36836 | 4827 | 39948 | 3906 | 40910 | 3184 | 41267 | 2105 | 49801 | 1425 | 35950 |
| 9L-4S | | MI | 20698 | 6562 | 34131 | 4748 | 37416 | 3826 | 38992 | 3118 | 40624 | 2036 | 48863 | 1626 | 31810 |
| 22-#11 | 2.82 | MA | 22209 | 6562 | 36120 | 4824 | 38984 | 3901 | 39760 | 3195 | 39714 | 2113 | 47920 | 1363 | 35089 |
| 10L-3S | | MI | 21121 | 6562 | 34867 | 4735 | 38355 | 3832 | 40132 | 3126 | 42051 | 2028 | 50455 | 1713 | 31849 |
| 22-#14 | 4.07 | MA | 25342 | 7086 | 42870 | 5114 | 47522 | 4112 | 50139 | 3301 | 53698 | 2040 | 66220 | 1370 | 52465 |
| 6L-7S | | MI | 20568 | 7086 | 34987 | 5062 | 38408 | 4066 | 40135 | 3257 | 42112 | 1976 | 51569 | 1160 | 42060 |

## RECTANGULAR TIED COLUMNS 32" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 4.07 | MA | 24745 | 7086 | 41726 | 5133 | 46142 | 4129 | 48443 | 3316 | 51449 | 2052 | 63183 | 1240 | 51088 |
| 7L-6S | | MI | 21063 | 7086 | 35927 | 5044 | 39543 | 4051 | 41591 | 3269 | 43908 | 1963 | 53671 | 1255 | 43131 |
| 22-#14 | 4.07 | MA | 24158 | 7086 | 40697 | 5128 | 44742 | 4122 | 46787 | 3331 | 49058 | 2040 | 60365 | 1172 | 49943 |
| 8L-5S | | MI | 21571 | 7086 | 36786 | 5051 | 40730 | 4061 | 42973 | 3257 | 45745 | 1951 | 55912 | 1337 | 43681 |
| 24-#11 | 3.08 | MA | 24429 | 6669 | 40223 | 4870 | 44246 | 3934 | 46176 | 3197 | 48426 | 2087 | 58971 | 1596 | 40942 |
| 6L-8S | | MI | 19665 | 6669 | 32540 | 4814 | 35311 | 3884 | 36439 | 3167 | 37248 | 2042 | 44761 | 1372 | 32926 |
| 24-#11 | 3.08 | MA | 24005 | 6669 | 39424 | 4884 | 43283 | 3946 | 44992 | 3208 | 46845 | 2096 | 56831 | 1506 | 40594 |
| 7E | | MI | 20011 | 6669 | 33131 | 4818 | 36115 | 3890 | 37390 | 3158 | 38498 | 2033 | 46346 | 1416 | 33504 |
| 24-#11 | 3.08 | MA | 23589 | 6669 | 38707 | 4880 | 42306 | 3942 | 43836 | 3219 | 45165 | 2087 | 54849 | 1459 | 39814 |
| 8L-6S | | MI | 20362 | 6669 | 33788 | 4806 | 36908 | 3879 | 38409 | 3166 | 39764 | 2025 | 48044 | 1507 | 33803 |
| 24-#11 | 3.08 | MA | 23176 | 6669 | 37934 | 4895 | 41356 | 3954 | 42628 | 3213 | 43598 | 2096 | 52906 | 1405 | 39246 |
| 9L-5S | | MI | 20722 | 6669 | 34388 | 4810 | 37738 | 3885 | 39377 | 3157 | 41060 | 2016 | 49631 | 1564 | 34199 |
| 24-#11 | 3.08 | MA | 22721 | 6669 | 37219 | 4891 | 40392 | 3950 | 41479 | 3224 | 42045 | 2104 | 51025 | 1343 | 38362 |
| 10L-4S | | MI | 21100 | 6669 | 35027 | 4815 | 38566 | 3875 | 40394 | 3148 | 42491 | 2025 | 51329 | 1601 | 34586 |
| 24-#14 | 4.44 | MA | 25456 | 7242 | 43297 | 5231 | 48156 | 4199 | 50900 | 3358 | 54765 | 2038 | 67589 | 1209 | 55775 |
| 7E | | MI | 21137 | 7242 | 36266 | 5159 | 40048 | 4136 | 42133 | 3299 | 44761 | 1958 | 55054 | 1121 | 45859 |
| 24-#14 | 4.44 | MA | 24871 | 7242 | 42268 | 5226 | 46756 | 4192 | 49244 | 3374 | 52374 | 2026 | 64771 | 1141 | 54567 |
| 8L-6S | | MI | 21630 | 7242 | 37206 | 5141 | 41182 | 4121 | 43589 | 3311 | 46556 | 1945 | 57156 | 1216 | 46887 |

## RECTANGULAR TIED COLUMNS 32" x 40"

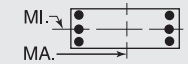
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.25 | MA | 25374 | 6211 | 39803 | 4583 | 42832 | 3734 | 43549 | 3112 | 43128 | 2222 | 50371 | 2084 | 19293 |
| 2E | | MI | 20138 | 6211 | 31893 | 4493 | 33959 | 3660 | 34229 | 3041 | 33512 | 2154 | 38774 | 1998 | 15169 |
| 6-#14 | 1.05 | MA | 25015 | 6124 | 38843 | 4561 | 41774 | 3722 | 42324 | 3111 | 41609 | 2254 | 48444 | 2130 | 16503 |
| 2L-3S | | MI | 19017 | 6124 | 29885 | 4472 | 31549 | 3670 | 31443 | 3065 | 29838 | 2207 | 34036 | 1934 | 13099 |
| 6-#14 | 1.05 | MA | 23878 | 6124 | 37174 | 4557 | 39636 | 3740 | 39715 | 3127 | 38069 | 2266 | 43730 | 2006 | 16577 |
| 3L-2S | | MI | 19885 | 6124 | 31164 | 4480 | 33189 | 3655 | 33440 | 3053 | 32487 | 2195 | 37521 | 2058 | 13015 |
| 6-#18 | 1.88 | MA | 26714 | 6488 | 42720 | 4756 | 46572 | 3858 | 48111 | 3187 | 49259 | 2196 | 58498 | 2025 | 28488 |
| 2L-3S | | MI | 19645 | 6488 | 31893 | 4651 | 33959 | 3808 | 34229 | 3135 | 33512 | 2140 | 38774 | 1698 | 22342 |
| 6-#18 | 1.88 | MA | 24757 | 6488 | 39803 | 4746 | 42832 | 3888 | 43549 | 3213 | 43128 | 2218 | 50371 | 1804 | 28507 |
| 3L-2S | | MI | 21134 | 6488 | 34119 | 4666 | 36812 | 3784 | 37659 | 3113 | 38062 | 2118 | 44722 | 1920 | 22243 |
| 8-#14 | 1.41 | MA | 25795 | 6280 | 40511 | 4659 | 43913 | 3792 | 44933 | 3153 | 45148 | 2241 | 53159 | 2101 | 21768 |
| 2L-4S | | MI | 18987 | 6280 | 30112 | 4587 | 31848 | 3730 | 31814 | 3095 | 30463 | 2202 | 35271 | 1771 | 17214 |
| 8-#14 | 1.41 | MA | 24665 | 6280 | 38843 | 4654 | 41774 | 3810 | 42324 | 3169 | 41609 | 2253 | 48444 | 1977 | 21821 |
| 3E | | MI | 19605 | 6280 | 31164 | 4570 | 33189 | 3740 | 33440 | 3108 | 32487 | 2189 | 37521 | 1895 | 17158 |
| 8-#14 | 1.41 | MA | 23867 | 6280 | 37480 | 4674 | 40038 | 3803 | 40214 | 3160 | 38903 | 2266 | 45383 | 1852 | 21814 |
| 4L-2S | | MI | 20468 | 6280 | 32444 | 4577 | 34829 | 3725 | 35438 | 3095 | 35135 | 2177 | 41007 | 2019 | 17087 |
| 8-#18 | 2.50 | MA | 28037 | 6764 | 45638 | 4929 | 50311 | 3983 | 52673 | 3263 | 55389 | 2169 | 66626 | 1967 | 37634 |
| 2L-4S | | MI | 19582 | 6764 | 32281 | 4852 | 34471 | 3911 | 34865 | 3184 | 34586 | 2125 | 40871 | 1407 | 28686 |
| 8-#18 | 2.50 | MA | 26098 | 6764 | 42720 | 4919 | 46572 | 4013 | 48111 | 3288 | 49259 | 2191 | 58498 | 1746 | 37547 |
| 3E | | MI | 20643 | 6764 | 34119 | 4824 | 36812 | 3932 | 37659 | 3206 | 38062 | 2103 | 44722 | 1620 | 29284 |
| 8-#18 | 2.50 | MA | 24727 | 6764 | 40331 | 4953 | 43527 | 3998 | 44411 | 3270 | 44573 | 2213 | 53237 | 1524 | 36738 |
| 4L-2S | | MI | 22120 | 6764 | 36344 | 4839 | 39665 | 3909 | 41090 | 3184 | 42611 | 2081 | 50669 | 1842 | 29260 |
| 10-#11 | 1.22 | MA | 25417 | 6197 | 39601 | 4623 | 42835 | 3768 | 43652 | 3142 | 43459 | 2259 | 50986 | 2132 | 19034 |
| 2L-5S | | MI | 18763 | 6197 | 29476 | 4549 | 31107 | 3720 | 30937 | 3098 | 29216 | 2210 | 33732 | 1849 | 15114 |
| 10-#11 | 1.22 | MA | 24623 | 6197 | 38434 | 4620 | 41340 | 3781 | 41828 | 3154 | 40978 | 2267 | 47668 | 2045 | 19075 |
| 3L-4S | | MI | 19152 | 6197 | 30115 | 4553 | 31935 | 3709 | 31954 | 3089 | 30648 | 2219 | 35429 | 1887 | 15077 |
| 10-#11 | 1.22 | MA | 24065 | 6197 | 37483 | 4635 | 40128 | 3777 | 40354 | 3148 | 39082 | 2276 | 45510 | 1959 | 19104 |
| 4L-3S | | MI | 19586 | 6197 | 30852 | 4541 | 32873 | 3715 | 33094 | 3097 | 32075 | 2210 | 37021 | 1973 | 15026 |
| 10-#11 | 1.22 | MA | 23565 | 6197 | 36660 | 4632 | 39061 | 3790 | 39043 | 3160 | 37183 | 2268 | 43249 | 1918 | 19088 |
| 5L-2S | | MI | 20193 | 6197 | 31748 | 4545 | 34022 | 3704 | 34496 | 3088 | 33943 | 2202 | 39486 | 2059 | 14977 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.76 | MA | 26568 | 6436 | 42179 | 4756 | 46052 | 3862 | 47542 | 3196 | 48688 | 2228 | 57873 | 2072 | 27013 |
| 2L-5S | | MI | 19022 | 6436 | 30477 | 4677 | 32304 | 3814 | 32360 | 3150 | 31081 | 2171 | 36354 | 1678 | 20961 |
| 10-#14 | 1.76 | MA | 25445 | 6436 | 40511 | 4751 | 43913 | 3880 | 44933 | 3212 | 45148 | 2240 | 53159 | 1948 | 27043 |
| 3L-4S | | MI | 19574 | 6436 | 31391 | 4684 | 33488 | 3799 | 33812 | 3137 | 33112 | 2184 | 38757 | 1732 | 21214 |
| 10-#14 | 1.76 | MA | 24652 | 6436 | 39148 | 4772 | 42177 | 3873 | 42823 | 3203 | 42443 | 2253 | 50098 | 1823 | 26987 |
| 4L-3S | | MI | 20189 | 6436 | 32444 | 4667 | 34829 | 3809 | 35438 | 3150 | 35135 | 2171 | 41007 | 1856 | 21190 |
| 10-#14 | 1.76 | MA | 23944 | 6436 | 37969 | 4767 | 40647 | 3891 | 40944 | 3219 | 39732 | 2240 | 46879 | 1765 | 26569 |
| 5L-2S | | MI | 21048 | 6436 | 33723 | 4674 | 36469 | 3795 | 37436 | 3137 | 37784 | 2159 | 44492 | 1981 | 21135 |
| 10-#18 | 3.13 | MA | 29345 | 7041 | 48555 | 5102 | 54051 | 4107 | 57235 | 3338 | 61519 | 2142 | 74754 | 1909 | 46736 |
| 2L-5S | | MI | 19632 | 7041 | 32907 | 5010 | 35252 | 4059 | 35802 | 3278 | 35645 | 2067 | 42719 | 1231 | 33428 |
| 10-#18 | 3.13 | MA | 27423 | 7041 | 45638 | 5092 | 50311 | 4137 | 52673 | 3364 | 55389 | 2164 | 66626 | 1687 | 46560 |
| 3L-4S | | MI | 20578 | 7041 | 34506 | 5025 | 37324 | 4036 | 38295 | 3256 | 39136 | 2089 | 46819 | 1329 | 35111 |
| 10-#18 | 3.13 | MA | 26065 | 7041 | 43248 | 5126 | 47266 | 4122 | 48973 | 3345 | 50704 | 2187 | 61364 | 1466 | 45238 |
| 4L-3S | | MI | 21630 | 7041 | 36344 | 4996 | 39665 | 4056 | 41090 | 3278 | 42611 | 2067 | 50669 | 1543 | 36183 |
| 10-#18 | 3.13 | MA | 24851 | 7041 | 41177 | 5116 | 44582 | 4152 | 45675 | 3371 | 46007 | 2164 | 55791 | 1366 | 42712 |
| 5L-2S | | MI | 23095 | 7041 | 38570 | 5012 | 42518 | 4033 | 44520 | 3256 | 47161 | 2045 | 56617 | 1764 | 36242 |
| 12-#11 | 1.46 | MA | 25963 | 6305 | 40767 | 4691 | 44330 | 3817 | 45475 | 3171 | 45941 | 2250 | 54305 | 2113 | 22704 |
| 2L-6S | | MI | 18809 | 6305 | 29773 | 4612 | 31426 | 3762 | 31372 | 3136 | 29788 | 2207 | 34610 | 1767 | 17698 |
| 12-#11 | 1.46 | MA | 25173 | 6305 | 39601 | 4688 | 42835 | 3830 | 43652 | 3183 | 43459 | 2259 | 50986 | 2027 | 22736 |
| 3L-5S | | MI | 19179 | 6305 | 30373 | 4616 | 32256 | 3768 | 32339 | 3127 | 31084 | 2199 | 36197 | 1824 | 17919 |
| 12-#11 | 1.46 | MA | 24617 | 6305 | 38649 | 4702 | 41623 | 3825 | 42178 | 3177 | 41563 | 2268 | 48829 | 1940 | 22746 |
| 4E | | MI | 19567 | 6305 | 31012 | 4621 | 33084 | 3757 | 33356 | 3118 | 32515 | 2207 | 37894 | 1861 | 17900 |
| 12-#11 | 1.46 | MA | 24120 | 6305 | 37827 | 4699 | 40556 | 3838 | 40867 | 3189 | 39664 | 2259 | 46568 | 1900 | 22704 |
| 5L-3S | | MI | 19999 | 6305 | 31748 | 4608 | 34022 | 3763 | 34496 | 3126 | 33943 | 2199 | 39486 | 1948 | 17861 |
| 12-#11 | 1.46 | MA | 23646 | 6305 | 37055 | 4696 | 39487 | 3834 | 39561 | 3183 | 37944 | 2268 | 44424 | 1843 | 22336 |
| 6L-2S | | MI | 20604 | 6305 | 32645 | 4613 | 35171 | 3753 | 35898 | 3117 | 35810 | 2190 | 41952 | 2034 | 17818 |
| 12-#14 | 2.11 | MA | 27336 | 6591 | 43847 | 4853 | 48190 | 3932 | 50151 | 3238 | 52227 | 2215 | 62588 | 2044 | 32243 |
| 2L-6S | | MI | 19084 | 6591 | 30897 | 4767 | 32756 | 3874 | 32975 | 3204 | 31892 | 2166 | 37598 | 1558 | 24106 |
| 12-#14 | 2.11 | MA | 26218 | 6591 | 42179 | 4849 | 46052 | 3950 | 47542 | 3254 | 48688 | 2227 | 57873 | 1919 | 32240 |
| 3L-5S | | MI | 19608 | 6591 | 31756 | 4774 | 33944 | 3884 | 34357 | 3192 | 33729 | 2153 | 39839 | 1640 | 24745 |
| 12-#14 | 2.11 | MA | 25431 | 6591 | 40817 | 4869 | 44315 | 3943 | 45432 | 3245 | 45982 | 2240 | 54812 | 1794 | 32148 |
| 4E | | MI | 20157 | 6591 | 32670 | 4782 | 35128 | 3869 | 35809 | 3180 | 35760 | 2166 | 42242 | 1694 | 25191 |
| 12-#14 | 2.11 | MA | 24727 | 6591 | 39637 | 4864 | 42786 | 3961 | 43553 | 3261 | 43272 | 2227 | 51594 | 1736 | 31525 |
| 5L-3S | | MI | 20768 | 6591 | 33723 | 4764 | 36469 | 3879 | 37436 | 3192 | 37784 | 2153 | 44492 | 1817 | 25204 |
| 12-#14 | 2.11 | MA | 24057 | 6591 | 38531 | 4860 | 41254 | 3954 | 41681 | 3253 | 40816 | 2240 | 48551 | 1655 | 30559 |
| 6L-2S | | MI | 21623 | 6591 | 35002 | 4771 | 38109 | 3864 | 39433 | 3180 | 40432 | 2141 | 47977 | 1942 | 25166 |
| 12-#18 | 3.75 | MA | 28733 | 7317 | 48555 | 5265 | 54051 | 4261 | 57235 | 3439 | 61519 | 2138 | 74754 | 1629 | 55555 |
| 3L-5S | | MI | 20626 | 7317 | 35132 | 5183 | 38105 | 4183 | 39232 | 3349 | 40194 | 2030 | 48667 | 1153 | 40033 |
| 12-#18 | 3.75 | MA | 27388 | 7317 | 46165 | 5299 | 51006 | 4247 | 53535 | 3421 | 56834 | 2160 | 69492 | 1408 | 53791 |
| 4E | | MI | 21564 | 7317 | 36731 | 5198 | 40177 | 4160 | 41726 | 3327 | 43686 | 2052 | 52767 | 1251 | 41587 |
| 12-#18 | 3.75 | MA | 26186 | 7317 | 44094 | 5289 | 48321 | 4277 | 50237 | 3447 | 52137 | 2138 | 63918 | 1308 | 51420 |
| 5L-3S | | MI | 22607 | 7317 | 38570 | 5169 | 42518 | 4180 | 44520 | 3349 | 47161 | 2030 | 56617 | 1465 | 43057 |
| 12-#18 | 3.75 | MA | 25042 | 7317 | 42150 | 5279 | 45632 | 4262 | 46951 | 3428 | 47883 | 2160 | 58680 | 1163 | 48630 |
| 6L-2S | | MI | 24061 | 7317 | 40795 | 5185 | 45371 | 4157 | 47951 | 3327 | 51710 | 2008 | 62565 | 1686 | 43189 |
| 14-#11 | 1.71 | MA | 26507 | 6413 | 41933 | 4758 | 45825 | 3865 | 47299 | 3201 | 48422 | 2241 | 57624 | 2094 | 26366 |
| 2L-7S | | MI | 18865 | 6413 | 30012 | 4692 | 31783 | 3821 | 31754 | 3158 | 30389 | 2204 | 35377 | 1651 | 20095 |
| 14-#11 | 1.71 | MA | 25720 | 6413 | 40767 | 4755 | 44330 | 3878 | 45475 | 3212 | 45941 | 2250 | 54305 | 2008 | 26388 |
| 3L-6S | | MI | 19224 | 6413 | 30669 | 4679 | 32575 | 3810 | 32774 | 3166 | 31656 | 2196 | 37075 | 1742 | 20391 |
| 14-#11 | 1.71 | MA | 25166 | 6413 | 39816 | 4769 | 43118 | 3874 | 44002 | 3207 | 44045 | 2259 | 52147 | 1922 | 26377 |
| 4L-5S | | MI | 19593 | 6413 | 31269 | 4684 | 33405 | 3816 | 33741 | 3157 | 32952 | 2187 | 38662 | 1799 | 20710 |
| 14-#11 | 1.71 | MA | 24671 | 6413 | 38993 | 4767 | 42051 | 3887 | 42691 | 3218 | 42146 | 2251 | 49886 | 1881 | 26314 |
| 5L-4S | | MI | 19979 | 6413 | 31908 | 4688 | 34233 | 3806 | 34759 | 3148 | 34383 | 2196 | 40360 | 1836 | 20713 |
| 14-#11 | 1.71 | MA | 24200 | 6413 | 38221 | 4764 | 40982 | 3883 | 41385 | 3213 | 40425 | 2260 | 47743 | 1825 | 25844 |
| 6L-3S | | MI | 20409 | 6413 | 32645 | 4676 | 35171 | 3812 | 35898 | 3156 | 35810 | 2187 | 41952 | 1923 | 20686 |
| 14-#11 | 1.71 | MA | 23741 | 6413 | 37376 | 4778 | 39963 | 3896 | 40132 | 3225 | 38744 | 2269 | 45455 | 1735 | 25382 |
| 7L-2S | | MI | 21012 | 6413 | 33541 | 4680 | 36321 | 3801 | 37300 | 3147 | 37678 | 2179 | 44417 | 2009 | 20650 |
| 14-#14 | 2.46 | MA | 28097 | 6747 | 45516 | 4950 | 50329 | 4001 | 52760 | 3281 | 55767 | 2202 | 67302 | 2015 | 37463 |
| 2L-7S | | MI | 19161 | 6747 | 31236 | 4882 | 33262 | 3959 | 33517 | 3234 | 32745 | 2160 | 38981 | 1423 | 27251 |

## RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

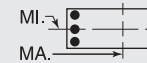
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.46 | MA | 26986 | 6747 | 43847 | 4946 | 48190 | 4020 | 50151 | 3297 | 52227 | 2214 | 62588 | 1890 | 37426 |
| 3L-6S | | MI | 19669 | 6747 | 32176 | 4864 | 34396 | 3944 | 34973 | 3247 | 34540 | 2148 | 41083 | 1519 | 27950 |
| 14-#14 | 2.46 | MA | 26204 | 6747 | 42485 | 4966 | 46454 | 4013 | 48041 | 3288 | 49522 | 2227 | 59527 | 1766 | 37301 |
| 4L-5S | | MI | 20190 | 6747 | 33035 | 4872 | 35584 | 3954 | 36355 | 3234 | 36378 | 2135 | 43324 | 1601 | 28547 |
| 14-#14 | 2.46 | MA | 25504 | 6747 | 41305 | 4961 | 44925 | 4031 | 46162 | 3304 | 46811 | 2214 | 56308 | 1708 | 36502 |
| 5L-4S | | MI | 20736 | 6747 | 33949 | 4879 | 36768 | 3939 | 37807 | 3222 | 38409 | 2148 | 45727 | 1655 | 29156 |
| 14-#14 | 2.46 | MA | 24838 | 6747 | 40199 | 4957 | 43393 | 4024 | 44290 | 3295 | 44355 | 2227 | 53265 | 1626 | 35586 |
| 6L-3S | | MI | 21344 | 6747 | 35002 | 4861 | 38109 | 3949 | 39433 | 3234 | 40432 | 2135 | 47977 | 1778 | 29204 |
| 14-#14 | 2.46 | MA | 24189 | 6747 | 38987 | 4977 | 41931 | 4042 | 42493 | 3311 | 41955 | 2239 | 50016 | 1496 | 34620 |
| 7L-2S | | MI | 22194 | 6747 | 36281 | 4869 | 39749 | 3934 | 41431 | 3222 | 43081 | 2123 | 51462 | 1903 | 29185 |
| 14-#18 | 4.38 | MA | 28698 | 7594 | 49082 | 5472 | 54746 | 4371 | 58097 | 3496 | 62965 | 2133 | 77619 | 1349 | 62386 |
| 4L-5S | | MI | 21610 | 7594 | 37358 | 5356 | 40958 | 4307 | 42663 | 3421 | 44744 | 1994 | 54615 | 1076 | 46662 |
| 14-#18 | 4.38 | MA | 27506 | 7594 | 47011 | 5461 | 52061 | 4401 | 54799 | 3522 | 58268 | 2111 | 72046 | 1250 | 60153 |
| 5L-4S | | MI | 22541 | 7594 | 38957 | 5371 | 43030 | 4284 | 45156 | 3399 | 48235 | 2016 | 58715 | 1173 | 48103 |
| 14-#18 | 4.38 | MA | 26373 | 7594 | 45067 | 5451 | 49371 | 4387 | 51513 | 3504 | 54014 | 2133 | 66808 | 1105 | 57184 |
| 6L-3S | | MI | 23576 | 7594 | 40795 | 5342 | 45371 | 4305 | 47951 | 3421 | 51710 | 1994 | 62565 | 1387 | 49915 |
| 16-#11 | 1.95 | MA | 27047 | 6521 | 43099 | 4825 | 47320 | 3913 | 49123 | 3230 | 50904 | 2233 | 60942 | 2076 | 30022 |
| 2L-8S | | MI | 18927 | 6521 | 30317 | 4755 | 32128 | 3863 | 32205 | 3196 | 31008 | 2201 | 36257 | 1582 | 22464 |
| 16-#11 | 1.95 | MA | 26263 | 6521 | 41933 | 4823 | 45825 | 3926 | 47299 | 3242 | 48422 | 2242 | 57624 | 1989 | 30031 |
| 3L-7S | | MI | 19280 | 6521 | 30909 | 4759 | 32932 | 3869 | 33156 | 3187 | 32257 | 2193 | 37843 | 1626 | 22812 |
| 16-#11 | 1.95 | MA | 25712 | 6521 | 40982 | 4837 | 44613 | 3922 | 45826 | 3236 | 46526 | 2251 | 55466 | 1903 | 30001 |
| 4L-6S | | MI | 19638 | 6521 | 31566 | 4747 | 33725 | 3859 | 34176 | 3195 | 33523 | 2184 | 39541 | 1717 | 23092 |
| 16-#11 | 1.95 | MA | 25219 | 6521 | 40159 | 4834 | 43546 | 3935 | 44515 | 3248 | 44627 | 2242 | 53205 | 1862 | 29919 |
| 5E | | MI | 20005 | 6521 | 32166 | 4751 | 34554 | 3865 | 35144 | 3186 | 34819 | 2176 | 41128 | 1773 | 23494 |
| 16-#11 | 1.95 | MA | 24750 | 6521 | 39388 | 4831 | 42477 | 3931 | 43209 | 3242 | 42907 | 2251 | 51062 | 1806 | 29361 |
| 6L-4S | | MI | 20389 | 6521 | 32805 | 4756 | 35382 | 3854 | 36161 | 3177 | 36251 | 2184 | 42825 | 1811 | 23518 |
| 16-#11 | 1.95 | MA | 24293 | 6521 | 38542 | 4846 | 41458 | 3944 | 41956 | 3254 | 41225 | 2260 | 48774 | 1716 | 28919 |
| 7L-3S | | MI | 20818 | 6521 | 33541 | 4743 | 36321 | 3860 | 37300 | 3185 | 37678 | 2176 | 44417 | 1897 | 23502 |
| 16-#11 | 1.95 | MA | 23843 | 6521 | 37783 | 4843 | 40424 | 3940 | 40732 | 3266 | 39438 | 2252 | 46660 | 1668 | 28411 |
| 8L-2S | | MI | 21418 | 6521 | 34438 | 4748 | 37470 | 3849 | 38702 | 3176 | 39546 | 2167 | 46882 | 1984 | 23473 |
| 16-#14 | 2.81 | MA | 27748 | 6902 | 45516 | 5043 | 50329 | 4089 | 52760 | 3339 | 55767 | 2201 | 67302 | 1861 | 42602 |
| 3L-7S | | MI | 19745 | 6902 | 32515 | 4979 | 34902 | 4029 | 35515 | 3276 | 35393 | 2142 | 42466 | 1385 | 31006 |
| 16-#14 | 2.81 | MA | 26971 | 6902 | 44153 | 5063 | 48593 | 4083 | 50650 | 3330 | 53061 | 2214 | 64241 | 1737 | 42448 |
| 4L-6S | | MI | 20250 | 6902 | 33456 | 4962 | 36036 | 4014 | 36971 | 3289 | 37189 | 2130 | 44568 | 1480 | 31801 |
| 16-#14 | 2.81 | MA | 26276 | 6902 | 42974 | 5059 | 47063 | 4101 | 48771 | 3346 | 50351 | 2201 | 61023 | 1679 | 41493 |
| 5E | | MI | 20768 | 6902 | 34314 | 4969 | 37224 | 4024 | 38353 | 3276 | 39026 | 2117 | 46809 | 1562 | 32363 |
| 16-#14 | 2.81 | MA | 25614 | 6902 | 41867 | 5054 | 45532 | 4094 | 46899 | 3337 | 47895 | 2214 | 57980 | 1598 | 40621 |
| 6L-4S | | MI | 21311 | 6902 | 35229 | 4976 | 38408 | 4009 | 39805 | 3264 | 41057 | 2130 | 49212 | 1616 | 33112 |
| 16-#14 | 2.81 | MA | 24969 | 6902 | 40655 | 5074 | 44070 | 4112 | 45102 | 3353 | 45494 | 2226 | 54730 | 1467 | 39559 |
| 7L-3S | | MI | 21916 | 6902 | 36281 | 4959 | 39749 | 4019 | 41431 | 3276 | 43081 | 2117 | 51462 | 1740 | 33186 |
| 16-#14 | 2.81 | MA | 24334 | 6902 | 39566 | 5070 | 42587 | 4106 | 43348 | 3369 | 42943 | 2214 | 51721 | 1399 | 38382 |
| 8L-2S | | MI | 22762 | 6902 | 37561 | 4966 | 41389 | 4004 | 43429 | 3264 | 45730 | 2105 | 54948 | 1864 | 33195 |
| 16-#18 | 5.00 | MA | 28814 | 7871 | 49928 | 5634 | 55801 | 4525 | 59361 | 3597 | 64398 | 2085 | 80174 | 1192 | 68907 |
| 5E | | MI | 22587 | 7871 | 39583 | 5529 | 43811 | 4432 | 46093 | 3492 | 49293 | 1957 | 60563 | 998 | 53307 |
| 16-#18 | 5.00 | MA | 27691 | 7871 | 47984 | 5624 | 53111 | 4511 | 56075 | 3579 | 60144 | 2107 | 74935 | 1047 | 65767 |
| 6L-4S | | MI | 23510 | 7871 | 41182 | 5544 | 45883 | 4408 | 48587 | 3470 | 52785 | 1979 | 64663 | 1095 | 54652 |
| 18-#11 | 2.19 | MA | 26803 | 6629 | 43099 | 4890 | 47320 | 3975 | 49123 | 3271 | 50904 | 2233 | 60942 | 1971 | 33664 |
| 3L-8S | | MI | 19341 | 6629 | 31214 | 4822 | 33277 | 3911 | 33607 | 3226 | 32875 | 2190 | 38722 | 1556 | 25122 |
| 18-#11 | 2.19 | MA | 26255 | 6629 | 42148 | 4904 | 46108 | 3971 | 47650 | 3266 | 49008 | 2242 | 58785 | 1884 | 33619 |
| 4L-7S | | MI | 19692 | 6629 | 31805 | 4827 | 34081 | 3918 | 34558 | 3217 | 34125 | 2181 | 40308 | 1601 | 25531 |
| 18-#11 | 2.19 | MA | 25765 | 6629 | 41325 | 4902 | 45041 | 3984 | 46339 | 3277 | 47109 | 2234 | 56524 | 1843 | 33521 |
| 5L-6S | | MI | 20049 | 6629 | 32462 | 4814 | 34874 | 3907 | 35578 | 3225 | 35391 | 2173 | 42006 | 1691 | 25798 |
| 18-#11 | 2.19 | MA | 25298 | 6629 | 40554 | 4899 | 43972 | 3979 | 45033 | 3272 | 45388 | 2242 | 54380 | 1787 | 32885 |
| 6L-5S | | MI | 20414 | 6629 | 33062 | 4819 | 35704 | 3913 | 36546 | 3215 | 36687 | 2164 | 43593 | 1748 | 26272 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis

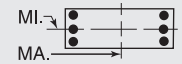



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.19 | MA | 24843 | 6629 | 39709 | 4913 | 42953 | 3992 | 43780 | 3283 | 43707 | 2251 | 52093 | 1697 | 32460 |
| 7L-4S | | MI | 20797 | 6629 | 33701 | 4823 | 36532 | 3902 | 37563 | 3206 | 38119 | 2173 | 45291 | 1786 | 26311 |
| 18-#11 | 2.19 | MA | 24395 | 6629 | 38949 | 4910 | 41919 | 3988 | 42556 | 3295 | 41920 | 2243 | 49979 | 1649 | 31889 |
| 8L-3S | | MI | 21224 | 6629 | 34438 | 4811 | 37470 | 3909 | 38702 | 3214 | 39546 | 2164 | 46882 | 1872 | 26312 |
| 18-#11 | 2.19 | MA | 23939 | 6629 | 38131 | 4925 | 40913 | 4001 | 41277 | 3289 | 40253 | 2252 | 47901 | 1595 | 31213 |
| 9L-2S | | MI | 21823 | 6629 | 35334 | 4815 | 38619 | 3898 | 40105 | 3205 | 41413 | 2155 | 49348 | 1959 | 26291 |
| 18-#14 | 3.16 | MA | 27733 | 7058 | 45821 | 5161 | 50731 | 4153 | 53259 | 3373 | 56601 | 2201 | 68956 | 1708 | 47590 |
| 4L-7S | | MI | 20325 | 7058 | 33795 | 5076 | 36542 | 4099 | 37512 | 3319 | 38042 | 2124 | 45952 | 1346 | 34774 |
| 18-#14 | 3.16 | MA | 27042 | 7058 | 44642 | 5156 | 49202 | 4171 | 51380 | 3389 | 53890 | 2188 | 65737 | 1650 | 46498 |
| 5L-6S | | MI | 20827 | 7058 | 34735 | 5059 | 37676 | 4084 | 38968 | 3331 | 39837 | 2112 | 48054 | 1441 | 35658 |
| 18-#14 | 3.16 | MA | 26384 | 7058 | 43536 | 5151 | 47670 | 4164 | 49508 | 3380 | 51434 | 2201 | 62694 | 1569 | 45664 |
| 6L-5S | | MI | 21343 | 7058 | 35594 | 5066 | 38863 | 4094 | 40350 | 3319 | 41675 | 2099 | 50295 | 1523 | 36190 |
| 18-#14 | 3.16 | MA | 25743 | 7058 | 42324 | 5172 | 46209 | 4182 | 47711 | 3396 | 49034 | 2213 | 59445 | 1439 | 44510 |
| 7L-4S | | MI | 21883 | 7058 | 36508 | 5073 | 40048 | 4079 | 41802 | 3306 | 43706 | 2112 | 52698 | 1577 | 37062 |
| 18-#14 | 3.16 | MA | 25112 | 7058 | 41234 | 5167 | 44726 | 4175 | 45957 | 3412 | 46482 | 2201 | 56436 | 1370 | 43374 |
| 8L-3S | | MI | 22485 | 7058 | 37561 | 5056 | 41389 | 4089 | 43429 | 3319 | 45730 | 2099 | 54948 | 1701 | 37159 |
| 18-#14 | 3.16 | MA | 24488 | 7058 | 40061 | 5187 | 43283 | 4193 | 44123 | 3403 | 44103 | 2213 | 53486 | 1292 | 41861 |
| 9L-2S | | MI | 23327 | 7058 | 38840 | 5063 | 43029 | 4074 | 45426 | 3306 | 48378 | 2087 | 58433 | 1825 | 37195 |
| 18-#18 | 5.63 | MA | 28997 | 8147 | 50901 | 5797 | 56850 | 4635 | 60637 | 3655 | 66275 | 2080 | 83063 | 988 | 74374 |
| 6L-5S | | MI | 23556 | 8147 | 41809 | 5701 | 46664 | 4556 | 49524 | 3564 | 53843 | 1921 | 66511 | 920 | 59830 |
| 20-#11 | 2.44 | MA | 26795 | 6736 | 43314 | 4972 | 47603 | 4019 | 49474 | 3295 | 51489 | 2233 | 62104 | 1866 | 37233 |
| 4L-8S | | MI | 19753 | 6736 | 32110 | 4889 | 34427 | 3960 | 35009 | 3255 | 34743 | 2178 | 41188 | 1531 | 27787 |
| 20-#11 | 2.44 | MA | 26307 | 6736 | 42491 | 4969 | 46536 | 4032 | 48163 | 3307 | 49590 | 2225 | 59843 | 1825 | 37106 |
| 5L-7S | | MI | 20103 | 6736 | 32702 | 4894 | 35231 | 3966 | 35960 | 3246 | 35992 | 2170 | 42773 | 1576 | 28254 |
| 20-#11 | 2.44 | MA | 25842 | 6736 | 41720 | 4966 | 45467 | 4028 | 46857 | 3301 | 47870 | 2234 | 57699 | 1769 | 36414 |
| 6E | | MI | 20458 | 6736 | 33359 | 4881 | 36023 | 3955 | 36980 | 3254 | 37259 | 2161 | 44472 | 1666 | 28509 |
| 20-#11 | 2.44 | MA | 25389 | 6736 | 40875 | 4980 | 44448 | 4041 | 45603 | 3313 | 46188 | 2243 | 55411 | 1679 | 36004 |
| 7L-5S | | MI | 20822 | 6736 | 33959 | 4886 | 36853 | 3962 | 37948 | 3245 | 38555 | 2152 | 46058 | 1723 | 28960 |
| 20-#11 | 2.44 | MA | 24944 | 6736 | 40115 | 4978 | 43414 | 4037 | 44380 | 3324 | 44401 | 2234 | 53298 | 1631 | 35375 |
| 8L-4S | | MI | 21204 | 6736 | 34598 | 4891 | 37681 | 3951 | 38965 | 3236 | 39986 | 2161 | 47756 | 1761 | 29098 |
| 20-#11 | 2.44 | MA | 24502 | 6736 | 39297 | 4992 | 42408 | 4050 | 43100 | 3319 | 42735 | 2243 | 51219 | 1577 | 34720 |
| 9L-3S | | MI | 21628 | 6736 | 35334 | 4878 | 38619 | 3957 | 40105 | 3244 | 41413 | 2152 | 49348 | 1847 | 29117 |
| 20-#11 | 2.44 | MA | 24004 | 6736 | 38540 | 4989 | 41387 | 4045 | 41883 | 3330 | 41082 | 2252 | 49206 | 1515 | 33931 |
| 10L-2S | | MI | 22225 | 6736 | 36231 | 4883 | 39768 | 3946 | 41507 | 3235 | 43281 | 2144 | 51813 | 1933 | 29103 |
| 20-#14 | 3.52 | MA | 27802 | 7214 | 46310 | 5253 | 51341 | 4241 | 53989 | 3431 | 57430 | 2175 | 70452 | 1621 | 51514 |
| 5L-7S | | MI | 20902 | 7214 | 35074 | 5174 | 38182 | 4168 | 39510 | 3361 | 40690 | 2106 | 49437 | 1307 | 38553 |
| 20-#14 | 3.52 | MA | 27149 | 7214 | 45204 | 5249 | 49809 | 4234 | 52117 | 3422 | 54974 | 2188 | 67409 | 1540 | 50714 |
| 6E | | MI | 21401 | 7214 | 36014 | 5156 | 39316 | 4154 | 40966 | 3373 | 42486 | 2094 | 51539 | 1402 | 39521 |
| 20-#14 | 3.52 | MA | 26512 | 7214 | 43992 | 5269 | 48347 | 4252 | 50320 | 3438 | 52573 | 2200 | 64159 | 1410 | 49472 |
| 7L-5S | | MI | 21914 | 7214 | 36873 | 5163 | 40503 | 4163 | 42348 | 3361 | 44324 | 2081 | 53780 | 1485 | 40027 |
| 20-#14 | 3.52 | MA | 25885 | 7214 | 42903 | 5264 | 46864 | 4245 | 48566 | 3454 | 50022 | 2188 | 61150 | 1341 | 48374 |
| 8L-4S | | MI | 22452 | 7214 | 37787 | 5171 | 41688 | 4149 | 43800 | 3348 | 46355 | 2094 | 56183 | 1538 | 41006 |
| 20-#14 | 3.52 | MA | 25264 | 7214 | 41730 | 5284 | 45422 | 4263 | 46732 | 3445 | 47643 | 2200 | 58200 | 1263 | 46803 |
| 9L-3S | | MI | 23050 | 7214 | 38840 | 5153 | 43029 | 4159 | 45426 | 3361 | 48378 | 2081 | 58433 | 1662 | 41125 |
| 22-#11 | 2.68 | MA | 26846 | 6844 | 43658 | 5036 | 48031 | 4080 | 49987 | 3336 | 52072 | 2216 | 63161 | 1806 | 40612 |
| 5L-8S | | MI | 20163 | 6844 | 33007 | 4957 | 35576 | 4008 | 36411 | 3284 | 36611 | 2167 | 43653 | 1506 | 30458 |
| 22-#11 | 2.68 | MA | 26383 | 6844 | 42886 | 5034 | 46963 | 4076 | 48681 | 3331 | 50351 | 2225 | 61018 | 1750 | 39948 |
| 6L-7S | | MI | 20511 | 6844 | 33598 | 4961 | 36380 | 4015 | 37362 | 3275 | 37860 | 2158 | 45239 | 1551 | 30978 |
| 22-#11 | 2.68 | MA | 25933 | 6844 | 42041 | 5048 | 45943 | 4089 | 47427 | 3342 | 48670 | 2234 | 58730 | 1660 | 39551 |
| 7L-6S | | MI | 20865 | 6844 | 34255 | 4949 | 37172 | 4004 | 38382 | 3283 | 39126 | 2149 | 46937 | 1641 | 31224 |
| 22-#11 | 2.68 | MA | 25489 | 6844 | 41281 | 5045 | 44909 | 4085 | 46204 | 3354 | 46883 | 2226 | 56616 | 1612 | 38866 |
| 8L-5S | | MI | 21228 | 6844 | 34855 | 4953 | 38002 | 4010 | 39350 | 3274 | 40422 | 2141 | 48524 | 1698 | 31652 |
| 22-#11 | 2.68 | MA | 25050 | 6844 | 40464 | 5059 | 43903 | 4098 | 44924 | 3348 | 45216 | 2235 | 54538 | 1558 | 38231 |
| 9L-4S | | MI | 21608 | 6844 | 35494 | 4958 | 38830 | 3999 | 40367 | 3265 | 41854 | 2149 | 50221 | 1736 | 31881 |
| 22-#11 | 2.68 | MA | 24554 | 6844 | 39706 | 5057 | 42882 | 4094 | 43707 | 3360 | 43564 | 2243 | 52525 | 1497 | 37403 |
| 10L-3S | | MI | 22031 | 6844 | 36231 | 4945 | 39768 | 4006 | 41507 | 3273 | 43281 | 2141 | 51813 | 1822 | 31911 |
| 22-#14 | 3.87 | MA | 27909 | 7369 | 46872 | 5346 | 51948 | 4304 | 54727 | 3465 | 58513 | 2174 | 72123 | 1511 | 55769 |
| 6L-7S | | MI | 21475 | 7369 | 36353 | 5271 | 39822 | 4238 | 41508 | 3403 | 43339 | 2088 | 52922 | 1268 | 42341 |

## RECTANGULAR TIED COLUMNS 32" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 3.87 | MA | 27276 | 7369 | 45660 | 5366 | 50486 | 4322 | 52929 | 3481 | 56113 | 2187 | 68874 | 1381 | 54445 |
| 7L-6S | | MI | 21972 | 7369 | 37293 | 5253 | 40956 | 4223 | 42964 | 3415 | 45135 | 2076 | 55024 | 1364 | 43388 |
| 22-#14 | 3.87 | MA | 26652 | 7369 | 44571 | 5361 | 49003 | 4315 | 51175 | 3497 | 53561 | 2174 | 65865 | 1312 | 53373 |
| 8L-5S | | MI | 22482 | 7369 | 38152 | 5261 | 42143 | 4233 | 44346 | 3403 | 46972 | 2063 | 57265 | 1446 | 43871 |
| 22-#14 | 3.87 | MA | 26036 | 7369 | 43398 | 5382 | 47560 | 4333 | 49341 | 3488 | 51182 | 2187 | 62915 | 1234 | 51754 |
| 9L-4S | | MI | 23017 | 7369 | 39066 | 5268 | 43328 | 4218 | 45798 | 3391 | 49003 | 2076 | 59668 | 1500 | 44892 |
| 24-#11 | 2.92 | MA | 26922 | 6952 | 44052 | 5101 | 48458 | 4125 | 50505 | 3360 | 52833 | 2217 | 64337 | 1731 | 43487 |
| 6L-8S | | MI | 20571 | 6952 | 33903 | 5024 | 36725 | 4057 | 37813 | 3314 | 38479 | 2155 | 46118 | 1481 | 33135 |
| 24-#11 | 2.92 | MA | 26474 | 6952 | 43207 | 5115 | 47438 | 4138 | 49251 | 3372 | 51151 | 2225 | 62049 | 1641 | 43100 |
| 7E | | MI | 20918 | 6952 | 34495 | 5029 | 37529 | 4063 | 38764 | 3305 | 39728 | 2146 | 47704 | 1526 | 33703 |
| 24-#11 | 2.92 | MA | 26032 | 6952 | 42448 | 5112 | 46404 | 4133 | 48028 | 3383 | 49364 | 2217 | 59935 | 1593 | 42364 |
| 8L-6S | | MI | 21271 | 6952 | 35152 | 5016 | 38322 | 4052 | 39784 | 3313 | 40994 | 2138 | 49402 | 1616 | 33941 |
| 24-#11 | 2.92 | MA | 25593 | 6952 | 41630 | 5127 | 45398 | 4146 | 46748 | 3378 | 47698 | 2226 | 57857 | 1539 | 41746 |
| 9L-5S | | MI | 21632 | 6952 | 35752 | 5021 | 39151 | 4059 | 40752 | 3304 | 42290 | 2129 | 50989 | 1673 | 34350 |
| 24-#11 | 2.92 | MA | 25101 | 6952 | 40872 | 5124 | 44377 | 4142 | 45531 | 3389 | 46045 | 2235 | 55844 | 1478 | 40879 |
| 10L-4S | | MI | 22010 | 6952 | 36391 | 5025 | 39979 | 4048 | 41769 | 3295 | 43722 | 2138 | 52687 | 1710 | 34660 |
| 24-#14 | 4.22 | MA | 28035 | 7525 | 47328 | 5463 | 52625 | 4392 | 55538 | 3523 | 59652 | 2174 | 73588 | 1352 | 59426 |
| 7E | | MI | 22045 | 7525 | 37632 | 5368 | 41462 | 4308 | 43505 | 3445 | 45988 | 2070 | 56407 | 1229 | 46138 |
| 24-#14 | 4.22 | MA | 27415 | 7525 | 46239 | 5459 | 51142 | 4385 | 53784 | 3539 | 57101 | 2161 | 70580 | 1284 | 58290 |
| 8L-6S | | MI | 22540 | 7525 | 38573 | 5351 | 42596 | 4293 | 44961 | 3458 | 47783 | 2058 | 58509 | 1325 | 47201 |
| 24-#14 | 4.22 | MA | 26802 | 7525 | 45066 | 5479 | 49699 | 4403 | 51950 | 3530 | 54722 | 2174 | 67629 | 1206 | 56713 |
| 9L-5S | | MI | 23047 | 7525 | 39431 | 5358 | 43783 | 4303 | 46343 | 3445 | 49621 | 2045 | 60750 | 1407 | 47721 |

## RECTANGULAR TIED COLUMNS 32" x 42"

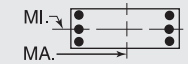
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.19 | MA | 27874 | 6494 | 43555 | 4813 | 46903 | 3923 | 47661 | 3272 | 47156 | 2349 | 55069 | 2210 | 20373 |
| 2E | | MI | 21044 | 6494 | 33265 | 4701 | 35372 | 3831 | 35597 | 3186 | 34733 | 2266 | 40118 | 2105 | 15216 |
| 6-#14 | 1.00 | MA | 27488 | 6407 | 42531 | 4791 | 45774 | 3911 | 46354 | 3271 | 45502 | 2379 | 52982 | 2255 | 17414 |
| 2L-3S | | MI | 19922 | 6407 | 31251 | 4682 | 32963 | 3842 | 32815 | 3212 | 31065 | 2320 | 35389 | 2042 | 13136 |
| 6-#14 | 1.00 | MA | 26282 | 6407 | 40765 | 4787 | 43511 | 3930 | 43593 | 3288 | 41745 | 2392 | 47959 | 2131 | 17488 |
| 3L-2S | | MI | 20791 | 6407 | 32531 | 4689 | 34603 | 3827 | 34813 | 3199 | 33714 | 2307 | 38875 | 2167 | 13052 |
| 6-#18 | 1.79 | MA | 29304 | 6770 | 46645 | 4986 | 50864 | 4048 | 52493 | 3348 | 53683 | 2325 | 63744 | 2156 | 30108 |
| 2L-3S | | MI | 20551 | 6770 | 33265 | 4858 | 35372 | 3979 | 35597 | 3280 | 34733 | 2251 | 40118 | 1806 | 22409 |
| 6-#18 | 1.79 | MA | 27226 | 6770 | 43555 | 4977 | 46903 | 4079 | 47661 | 3375 | 47156 | 2347 | 55069 | 1934 | 30127 |
| 3L-2S | | MI | 22042 | 6770 | 35491 | 4873 | 38225 | 3955 | 39028 | 3258 | 39282 | 2229 | 46065 | 2027 | 22299 |
| 8-#14 | 1.34 | MA | 28319 | 6563 | 44296 | 4889 | 48037 | 3981 | 49115 | 3314 | 49259 | 2367 | 58005 | 2228 | 22983 |
| 2L-4S | | MI | 19893 | 6563 | 31478 | 4797 | 33262 | 3902 | 33186 | 3242 | 31690 | 2314 | 36625 | 1880 | 17268 |
| 8-#14 | 1.34 | MA | 27120 | 6563 | 42531 | 4884 | 45774 | 4000 | 46354 | 3331 | 45502 | 2379 | 52982 | 2103 | 23036 |
| 3E | | MI | 20511 | 6563 | 32531 | 4779 | 34603 | 3912 | 34813 | 3254 | 33714 | 2302 | 38875 | 2004 | 17203 |
| 8-#14 | 1.34 | MA | 26276 | 6563 | 41091 | 4905 | 43939 | 3994 | 44123 | 3323 | 42631 | 2392 | 49717 | 1979 | 23029 |
| 4L-2S | | MI | 21375 | 6563 | 33810 | 4786 | 36243 | 3897 | 36810 | 3242 | 36362 | 2289 | 42360 | 2128 | 17130 |
| 8-#18 | 2.38 | MA | 30715 | 7047 | 49735 | 5159 | 54825 | 4172 | 57326 | 3423 | 60210 | 2300 | 72418 | 2101 | 39794 |
| 2L-4S | | MI | 20487 | 7047 | 33653 | 5060 | 35883 | 4082 | 36233 | 3329 | 35807 | 2237 | 42215 | 1514 | 29013 |
| 8-#18 | 2.38 | MA | 28656 | 7047 | 46645 | 5150 | 50864 | 4203 | 52493 | 3450 | 53683 | 2322 | 63744 | 1880 | 39707 |
| 3E | | MI | 21550 | 7047 | 35491 | 5031 | 38225 | 4103 | 39028 | 3351 | 39282 | 2215 | 46065 | 1728 | 29367 |
| 8-#18 | 2.38 | MA | 27203 | 7047 | 44118 | 5185 | 47644 | 4190 | 48580 | 3433 | 48695 | 2344 | 58119 | 1658 | 39175 |
| 4L-2S | | MI | 23029 | 7047 | 37716 | 5046 | 41078 | 4079 | 42458 | 3329 | 43832 | 2193 | 52013 | 1950 | 29323 |
| 10-#11 | 1.16 | MA | 27914 | 6480 | 43329 | 4853 | 46892 | 3957 | 47753 | 3303 | 47420 | 2382 | 55673 | 2257 | 20087 |
| 2L-5S | | MI | 19668 | 6480 | 30840 | 4759 | 32520 | 3893 | 32312 | 3245 | 30446 | 2323 | 35089 | 1958 | 15162 |
| 10-#11 | 1.16 | MA | 27073 | 6480 | 42096 | 4850 | 45310 | 3953 | 45824 | 3315 | 44795 | 2392 | 52141 | 2171 | 20128 |
| 3L-4S | | MI | 20058 | 6480 | 31479 | 4764 | 33348 | 3882 | 33329 | 3236 | 31878 | 2332 | 36787 | 1996 | 15117 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis

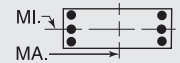



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.16 | MA | 26482 | 6480 | 41091 | 4865 | 44030 | 3967 | 44267 | 3310 | 42792 | 2401 | 49841 | 2084 | 20157 |
| 4L-3S | | MI | 20492 | 6480 | 32215 | 4751 | 34286 | 3888 | 34469 | 3244 | 33305 | 2323 | 38379 | 2082 | 15064 |
| 10-#11 | 1.16 | MA | 25954 | 6480 | 40222 | 4863 | 42903 | 3963 | 42883 | 3322 | 40787 | 2393 | 47439 | 2043 | 20141 |
| 5L-2S | | MI | 21100 | 6480 | 33111 | 4756 | 35436 | 3877 | 35871 | 3235 | 35173 | 2315 | 40844 | 2168 | 15013 |
| 10-#14 | 1.67 | MA | 29142 | 6719 | 46062 | 4986 | 50301 | 4051 | 51876 | 3356 | 53015 | 2354 | 63027 | 2201 | 28531 |
| 2L-5S | | MI | 19927 | 6719 | 31843 | 4887 | 33717 | 3987 | 33732 | 3296 | 32308 | 2284 | 37707 | 1787 | 21151 |
| 10-#14 | 1.67 | MA | 27951 | 6719 | 44296 | 4982 | 48037 | 4070 | 49115 | 3373 | 49259 | 2367 | 58005 | 2076 | 28561 |
| 3L-4S | | MI | 20480 | 6719 | 32757 | 4894 | 34902 | 3972 | 35184 | 3284 | 34339 | 2296 | 40110 | 1841 | 21278 |
| 10-#14 | 1.67 | MA | 27112 | 6719 | 42856 | 5002 | 46202 | 4064 | 46884 | 3365 | 46388 | 2380 | 54739 | 1952 | 28506 |
| 4L-3S | | MI | 21095 | 6719 | 33810 | 4876 | 36243 | 3982 | 36810 | 3296 | 36362 | 2284 | 42360 | 1965 | 21241 |
| 10-#14 | 1.67 | MA | 26363 | 6719 | 41610 | 4998 | 44587 | 4082 | 44899 | 3382 | 43513 | 2368 | 51317 | 1893 | 28212 |
| 5L-2S | | MI | 21955 | 6719 | 35089 | 4884 | 37883 | 3967 | 38808 | 3284 | 39011 | 2271 | 45845 | 2089 | 21182 |
| 10-#18 | 2.98 | MA | 32109 | 7324 | 52825 | 5332 | 58786 | 4296 | 62158 | 3499 | 66736 | 2275 | 81093 | 2046 | 49436 |
| 2L-5S | | MI | 20536 | 7324 | 34279 | 5217 | 36665 | 4230 | 37170 | 3423 | 36865 | 2178 | 44063 | 1339 | 33702 |
| 10-#18 | 2.98 | MA | 30068 | 7324 | 49735 | 5323 | 54825 | 4327 | 57326 | 3526 | 60210 | 2297 | 72418 | 1825 | 49260 |
| 3L-4S | | MI | 21484 | 7324 | 35878 | 5233 | 38736 | 4206 | 39664 | 3401 | 40357 | 2200 | 48163 | 1436 | 35431 |
| 10-#18 | 2.98 | MA | 28630 | 7324 | 47208 | 5358 | 51605 | 4314 | 53412 | 3509 | 55221 | 2319 | 66794 | 1604 | 48190 |
| 4L-3S | | MI | 22538 | 7324 | 37716 | 5204 | 41078 | 4227 | 42458 | 3423 | 43832 | 2178 | 52013 | 1650 | 36277 |
| 10-#18 | 2.98 | MA | 27345 | 7324 | 45019 | 5348 | 48767 | 4345 | 49926 | 3536 | 50222 | 2297 | 60859 | 1502 | 45378 |
| 5L-2S | | MI | 24007 | 7324 | 39942 | 5219 | 43931 | 4203 | 45889 | 3401 | 48382 | 2156 | 57961 | 1872 | 36311 |
| 12-#11 | 1.39 | MA | 28496 | 6588 | 44563 | 4920 | 48473 | 4006 | 49682 | 3332 | 50045 | 2373 | 59206 | 2240 | 23968 |
| 2L-6S | | MI | 19714 | 6588 | 31136 | 4822 | 32840 | 3935 | 32746 | 3283 | 31018 | 2320 | 35968 | 1876 | 17831 |
| 12-#11 | 1.39 | MA | 27658 | 6588 | 43329 | 4918 | 46892 | 4002 | 47753 | 3344 | 47420 | 2383 | 55673 | 2153 | 23999 |
| 3L-5S | | MI | 20084 | 6588 | 31736 | 4827 | 33670 | 3941 | 33714 | 3274 | 32314 | 2312 | 37555 | 1933 | 17973 |
| 12-#11 | 1.39 | MA | 27070 | 6588 | 42324 | 4933 | 45611 | 4015 | 46196 | 3339 | 45417 | 2392 | 53374 | 2067 | 24010 |
| 4E | | MI | 20473 | 6588 | 32375 | 4831 | 34498 | 3930 | 34731 | 3265 | 33746 | 2320 | 39252 | 1971 | 17945 |
| 12-#11 | 1.39 | MA | 26545 | 6588 | 41456 | 4930 | 44485 | 4011 | 44812 | 3351 | 43412 | 2385 | 50972 | 2026 | 23968 |
| 5L-3S | | MI | 20905 | 6588 | 33111 | 4819 | 35436 | 3937 | 35871 | 3273 | 35173 | 2312 | 40844 | 2057 | 17903 |
| 12-#11 | 1.39 | MA | 26044 | 6588 | 40641 | 4928 | 43356 | 4025 | 43433 | 3346 | 41595 | 2394 | 48689 | 1970 | 23660 |
| 6L-2S | | MI | 21511 | 6588 | 34008 | 4823 | 36585 | 3926 | 37273 | 3264 | 37041 | 2303 | 43310 | 2143 | 17858 |
| 12-#14 | 2.01 | MA | 29960 | 6874 | 47827 | 5083 | 52564 | 4121 | 54637 | 3399 | 56772 | 2342 | 68050 | 2174 | 34065 |
| 2L-6S | | MI | 19989 | 6874 | 32263 | 4976 | 34170 | 4046 | 34348 | 3351 | 33119 | 2278 | 38951 | 1666 | 24279 |
| 12-#14 | 2.01 | MA | 28774 | 6874 | 46062 | 5079 | 50301 | 4139 | 51876 | 3415 | 53015 | 2355 | 63027 | 2049 | 34062 |
| 3L-5S | | MI | 20514 | 6874 | 33122 | 4984 | 35357 | 4056 | 35730 | 3338 | 34956 | 2266 | 41192 | 1748 | 24933 |
| 12-#14 | 2.01 | MA | 27941 | 6874 | 44622 | 5100 | 48466 | 4133 | 49645 | 3407 | 50145 | 2367 | 59762 | 1925 | 33971 |
| 4E | | MI | 21064 | 6874 | 34036 | 4991 | 36542 | 4042 | 37182 | 3326 | 36987 | 2278 | 43595 | 1802 | 25263 |
| 12-#14 | 2.01 | MA | 27197 | 6874 | 43376 | 5096 | 46850 | 4152 | 47661 | 3424 | 47270 | 2355 | 56340 | 1866 | 33461 |
| 5L-3S | | MI | 21676 | 6874 | 35089 | 4974 | 37883 | 4052 | 38808 | 3338 | 39011 | 2266 | 45845 | 1926 | 25260 |
| 12-#14 | 2.01 | MA | 26489 | 6874 | 42208 | 5091 | 45232 | 4146 | 45684 | 3416 | 44665 | 2368 | 53096 | 1785 | 32387 |
| 6L-2S | | MI | 22532 | 6874 | 36368 | 4981 | 39523 | 4037 | 40806 | 3326 | 41660 | 2253 | 49330 | 2051 | 25217 |
| 12-#18 | 3.57 | MA | 31465 | 7600 | 52825 | 5495 | 58786 | 4451 | 62158 | 3601 | 66736 | 2272 | 81093 | 1770 | 58795 |
| 3L-5S | | MI | 21531 | 7600 | 36504 | 5390 | 39518 | 4354 | 40601 | 3494 | 41415 | 2142 | 50011 | 1261 | 40305 |
| 12-#18 | 3.57 | MA | 30041 | 7600 | 50298 | 5531 | 55566 | 4438 | 58245 | 3584 | 61748 | 2294 | 75468 | 1549 | 57258 |
| 4E | | MI | 22472 | 7600 | 38104 | 5406 | 41589 | 4330 | 43094 | 3472 | 44906 | 2164 | 54111 | 1358 | 41901 |
| 12-#18 | 3.57 | MA | 28768 | 7600 | 48109 | 5521 | 52728 | 4469 | 54758 | 3612 | 56749 | 2272 | 69534 | 1448 | 54611 |
| 5L-3S | | MI | 23518 | 7600 | 39942 | 5377 | 43931 | 4351 | 45889 | 3494 | 48382 | 2142 | 57961 | 1572 | 43160 |
| 12-#18 | 3.57 | MA | 27557 | 7600 | 46055 | 5512 | 49886 | 4456 | 51284 | 3595 | 52220 | 2294 | 63939 | 1303 | 51874 |
| 6L-2S | | MI | 24975 | 7600 | 42167 | 5392 | 46784 | 4328 | 49319 | 3472 | 52931 | 2119 | 63909 | 1794 | 43269 |
| 14-#11 | 1.63 | MA | 29074 | 6696 | 45796 | 4988 | 50055 | 4054 | 51612 | 3361 | 52670 | 2365 | 62739 | 2222 | 27841 |
| 2L-7S | | MI | 19769 | 6696 | 31376 | 4902 | 33197 | 3994 | 33128 | 3305 | 31620 | 2317 | 36735 | 1761 | 20222 |
| 14-#11 | 1.63 | MA | 28240 | 6696 | 44563 | 4985 | 48473 | 4050 | 49682 | 3374 | 50045 | 2374 | 59206 | 2136 | 27862 |
| 3L-6S | | MI | 20130 | 6696 | 32033 | 4890 | 33989 | 3983 | 34148 | 3313 | 32886 | 2309 | 38433 | 1851 | 20523 |
| 14-#11 | 1.63 | MA | 27654 | 6696 | 43558 | 5000 | 47193 | 4064 | 48126 | 3368 | 48042 | 2384 | 56906 | 2049 | 27851 |
| 4L-5S | | MI | 20499 | 6696 | 32633 | 4894 | 34819 | 3990 | 35116 | 3304 | 34182 | 2300 | 40020 | 1908 | 20772 |
| 14-#11 | 1.63 | MA | 27131 | 6696 | 42689 | 4997 | 46066 | 4060 | 46741 | 3381 | 46037 | 2376 | 54504 | 2008 | 27788 |
| 5L-4S | | MI | 20886 | 6696 | 33272 | 4899 | 35647 | 3979 | 36133 | 3295 | 35613 | 2309 | 41718 | 1945 | 20762 |
| 14-#11 | 1.63 | MA | 26633 | 6696 | 41875 | 4995 | 44938 | 4073 | 45363 | 3375 | 44220 | 2385 | 52221 | 1952 | 27372 |
| 6L-3S | | MI | 21316 | 6696 | 34008 | 4886 | 36585 | 3985 | 37273 | 3303 | 37041 | 2300 | 43310 | 2032 | 20731 |

## RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

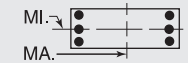
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.63 | MA | 26148 | 6696 | 40983 | 5010 | 43862 | 4069 | 44039 | 3387 | 42444 | 2395 | 49786 | 1862 | 26860 |
| 7L-2S | | MI | 21920 | 6696 | 34904 | 4891 | 37734 | 3974 | 38675 | 3294 | 38908 | 2292 | 45775 | 2118 | 20692 |
| 14-#14 | 2.34 | MA | 30771 | 7030 | 49593 | 5180 | 54827 | 4191 | 57398 | 3441 | 60529 | 2329 | 73073 | 2147 | 39589 |
| 2L-7S | | MI | 20065 | 7030 | 32602 | 5091 | 34675 | 4131 | 34889 | 3381 | 33972 | 2273 | 40334 | 1532 | 27535 |
| 14-#14 | 2.34 | MA | 29592 | 7030 | 47827 | 5176 | 52564 | 4209 | 54637 | 3458 | 56772 | 2342 | 68050 | 2022 | 39552 |
| 3L-6S | | MI | 20574 | 7030 | 33543 | 5074 | 35810 | 4116 | 36346 | 3393 | 35767 | 2260 | 42436 | 1628 | 28122 |
| 14-#14 | 2.34 | MA | 28764 | 7030 | 46387 | 5197 | 50729 | 4203 | 52407 | 3450 | 53902 | 2355 | 64785 | 1898 | 39428 |
| 4L-5S | | MI | 21096 | 7030 | 34401 | 5081 | 36997 | 4126 | 37728 | 3381 | 37605 | 2248 | 44678 | 1710 | 28733 |
| 14-#14 | 2.34 | MA | 28025 | 7030 | 45141 | 5193 | 49114 | 4222 | 50422 | 3466 | 51027 | 2343 | 61363 | 1839 | 38729 |
| 5L-4S | | MI | 21644 | 7030 | 35316 | 5088 | 38182 | 4111 | 39179 | 3368 | 39636 | 2260 | 47080 | 1764 | 29235 |
| 14-#14 | 2.34 | MA | 27320 | 7030 | 43973 | 5189 | 47496 | 4216 | 48445 | 3458 | 48422 | 2356 | 58119 | 1758 | 37709 |
| 6L-3S | | MI | 22253 | 7030 | 36368 | 5071 | 39523 | 4121 | 40806 | 3381 | 41660 | 2248 | 49330 | 1887 | 29269 |
| 14-#14 | 2.34 | MA | 26635 | 7030 | 42694 | 5209 | 45952 | 4235 | 46547 | 3475 | 45876 | 2368 | 54656 | 1628 | 36825 |
| 7L-2S | | MI | 23104 | 7030 | 37648 | 5078 | 41163 | 4106 | 42803 | 3368 | 44308 | 2235 | 52816 | 2012 | 29239 |
| 14-#18 | 4.17 | MA | 31437 | 7877 | 53388 | 5703 | 59527 | 4562 | 63077 | 3660 | 68275 | 2270 | 84143 | 1494 | 66370 |
| 4L-5S | | MI | 22517 | 7877 | 38730 | 5563 | 42371 | 4478 | 44031 | 3566 | 45965 | 2105 | 55959 | 1183 | 46932 |
| 14-#18 | 4.17 | MA | 30176 | 7877 | 51199 | 5694 | 56689 | 4593 | 59590 | 3687 | 63276 | 2248 | 78208 | 1393 | 63869 |
| 5L-4S | | MI | 23451 | 7877 | 40329 | 5578 | 44442 | 4455 | 46525 | 3544 | 49456 | 2127 | 60059 | 1281 | 48413 |
| 14-#18 | 4.17 | MA | 28976 | 7877 | 49145 | 5685 | 53847 | 4580 | 56117 | 3670 | 58746 | 2270 | 72613 | 1248 | 60949 |
| 6L-3S | | MI | 24489 | 7877 | 42167 | 5550 | 46784 | 4475 | 49319 | 3566 | 52931 | 2105 | 63909 | 1494 | 50026 |
| 14-#18 | 4.17 | MA | 27809 | 7877 | 46896 | 5720 | 51133 | 4612 | 52781 | 3697 | 54320 | 2292 | 66635 | 1017 | 58140 |
| 7L-2S | | MI | 25936 | 7877 | 44393 | 5565 | 49637 | 4452 | 52750 | 3544 | 57481 | 2083 | 69857 | 1716 | 50192 |
| 16-#11 | 1.86 | MA | 29649 | 6804 | 47030 | 5055 | 51636 | 4102 | 53541 | 3391 | 55295 | 2356 | 66271 | 2205 | 31707 |
| 2L-8S | | MI | 19831 | 6804 | 31681 | 4965 | 33542 | 4036 | 33579 | 3343 | 32238 | 2314 | 37615 | 1691 | 22672 |
| 16-#11 | 1.86 | MA | 28818 | 6804 | 45796 | 5053 | 50055 | 4099 | 51612 | 3403 | 52670 | 2366 | 62739 | 2118 | 31716 |
| 3L-7S | | MI | 20185 | 6804 | 32272 | 4970 | 34346 | 4042 | 34530 | 3334 | 33487 | 2306 | 39201 | 1735 | 22939 |
| 16-#11 | 1.86 | MA | 28235 | 6804 | 44792 | 5067 | 48774 | 4112 | 50055 | 3398 | 50667 | 2375 | 60439 | 2032 | 31685 |
| 4L-6S | | MI | 20543 | 6804 | 32929 | 4957 | 35138 | 4032 | 35550 | 3342 | 34754 | 2297 | 40899 | 1826 | 23224 |
| 16-#11 | 1.86 | MA | 27715 | 6804 | 43923 | 5065 | 47647 | 4108 | 48671 | 3410 | 48662 | 2367 | 58037 | 1991 | 31604 |
| 5E | | MI | 20911 | 6804 | 33529 | 4962 | 35968 | 4038 | 36518 | 3333 | 36049 | 2289 | 42486 | 1883 | 23561 |
| 16-#11 | 1.86 | MA | 27219 | 6804 | 43109 | 5062 | 46519 | 4122 | 47292 | 3405 | 46845 | 2377 | 55754 | 1935 | 31093 |
| 6L-4S | | MI | 21296 | 6804 | 34168 | 4966 | 36796 | 4027 | 37535 | 3324 | 37481 | 2297 | 44183 | 1920 | 23572 |
| 16-#11 | 1.86 | MA | 26736 | 6804 | 42216 | 5077 | 45443 | 4118 | 45969 | 3417 | 45069 | 2386 | 53318 | 1845 | 30602 |
| 7L-3S | | MI | 21725 | 6804 | 34904 | 4953 | 37734 | 4033 | 38675 | 3332 | 38908 | 2289 | 45775 | 2007 | 23550 |
| 16-#11 | 1.86 | MA | 26261 | 6804 | 41415 | 5075 | 44352 | 4131 | 44677 | 3429 | 43183 | 2379 | 51072 | 1796 | 30158 |
| 8L-2S | | MI | 22327 | 6804 | 35801 | 4958 | 38884 | 4023 | 40077 | 3323 | 40776 | 2280 | 48240 | 2093 | 23518 |
| 16-#14 | 2.68 | MA | 30404 | 7185 | 49593 | 5273 | 54827 | 4279 | 57398 | 3500 | 60529 | 2330 | 73073 | 1995 | 45032 |
| 3L-7S | | MI | 20650 | 7185 | 33882 | 5189 | 36315 | 4201 | 36887 | 3423 | 36620 | 2255 | 43820 | 1493 | 31287 |
| 16-#14 | 2.68 | MA | 29581 | 7185 | 48153 | 5294 | 52992 | 4273 | 55168 | 3492 | 57658 | 2342 | 69808 | 1871 | 44878 |
| 4L-6S | | MI | 21156 | 7185 | 34822 | 5171 | 37450 | 4186 | 38343 | 3435 | 38416 | 2242 | 45922 | 1589 | 31974 |
| 16-#14 | 2.68 | MA | 28846 | 7185 | 46907 | 5290 | 51377 | 4292 | 53183 | 3509 | 54784 | 2330 | 66386 | 1812 | 44014 |
| 5E | | MI | 21675 | 7185 | 35681 | 5178 | 38637 | 4196 | 39725 | 3423 | 40253 | 2230 | 48163 | 1671 | 32549 |
| 16-#14 | 2.68 | MA | 28146 | 7185 | 45739 | 5286 | 49759 | 4286 | 51206 | 3501 | 52178 | 2343 | 63142 | 1731 | 43041 |
| 6L-4S | | MI | 22220 | 7185 | 36595 | 5186 | 39822 | 4181 | 41177 | 3410 | 42284 | 2242 | 50566 | 1725 | 33196 |
| 16-#14 | 2.68 | MA | 27465 | 7185 | 44459 | 5307 | 48216 | 4304 | 49308 | 3518 | 49632 | 2356 | 59679 | 1601 | 42057 |
| 7L-3S | | MI | 22826 | 7185 | 37648 | 5168 | 41163 | 4191 | 42803 | 3423 | 44308 | 2230 | 52816 | 1848 | 33255 |
| 16-#14 | 2.68 | MA | 26794 | 7185 | 43309 | 5303 | 46650 | 4298 | 47455 | 3534 | 46927 | 2344 | 56480 | 1532 | 40756 |
| 8L-2S | | MI | 23674 | 7185 | 38927 | 5175 | 42803 | 4176 | 44801 | 3410 | 46957 | 2217 | 56301 | 1973 | 33252 |
| 16-#18 | 4.76 | MA | 31570 | 8154 | 54289 | 5867 | 60651 | 4718 | 64423 | 3762 | 69802 | 2223 | 86883 | 1338 | 73148 |
| 5E | | MI | 23495 | 8154 | 40955 | 5736 | 45224 | 4602 | 47462 | 3637 | 50514 | 2068 | 61907 | 1105 | 53577 |
| 16-#18 | 4.76 | MA | 30381 | 8154 | 52235 | 5858 | 57808 | 4705 | 60949 | 3745 | 65273 | 2245 | 81288 | 1194 | 70053 |
| 6L-4S | | MI | 24422 | 8154 | 42555 | 5751 | 47295 | 4579 | 49955 | 3615 | 54005 | 2091 | 66007 | 1203 | 54958 |
| 16-#18 | 4.76 | MA | 29224 | 8154 | 49985 | 5893 | 55094 | 4736 | 57614 | 3773 | 60847 | 2267 | 75310 | 962 | 67129 |
| 7L-3S | | MI | 25453 | 8154 | 44393 | 5723 | 49637 | 4599 | 52750 | 3637 | 57481 | 2068 | 69857 | 1417 | 56878 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis

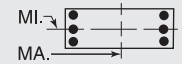


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.09 | MA | 29393 | 6911 | 47030 | 5120 | 51636 | 4147 | 53541 | 3432 | 55295 | 2357 | 66271 | 2101 | 35560 |
| 3L-8S | | MI | 20246 | 6911 | 32577 | 5032 | 34691 | 4085 | 34981 | 3373 | 34106 | 2303 | 40080 | 1666 | 25328 |
| 18-#11 | 2.09 | MA | 28813 | 6911 | 46025 | 5135 | 50356 | 4160 | 51984 | 3427 | 53292 | 2367 | 63972 | 2014 | 35514 |
| 4L-7S | | MI | 20598 | 6911 | 33169 | 5037 | 35495 | 4091 | 35932 | 3364 | 35355 | 2294 | 41666 | 1710 | 25660 |
| 18-#11 | 2.09 | MA | 28295 | 6911 | 45157 | 5132 | 49229 | 4157 | 50600 | 3439 | 51287 | 2359 | 61570 | 1973 | 35416 |
| 5L-6S | | MI | 20955 | 6911 | 33826 | 5024 | 36288 | 4080 | 36952 | 3372 | 36621 | 2286 | 43364 | 1801 | 25930 |
| 18-#11 | 2.09 | MA | 27801 | 6911 | 44342 | 5130 | 48101 | 4170 | 49221 | 3434 | 49470 | 2368 | 59287 | 1917 | 34822 |
| 6L-5S | | MI | 21321 | 6911 | 34426 | 5029 | 37117 | 4086 | 37920 | 3363 | 37917 | 2277 | 44951 | 1858 | 26343 |
| 18-#11 | 2.09 | MA | 27321 | 6911 | 43450 | 5145 | 47025 | 4166 | 47898 | 3446 | 47694 | 2378 | 56851 | 1827 | 34350 |
| 7L-4S | | MI | 21705 | 6911 | 35065 | 5034 | 37945 | 4075 | 38937 | 3353 | 39349 | 2286 | 46649 | 1895 | 26375 |
| 18-#11 | 2.09 | MA | 26848 | 6911 | 42648 | 5142 | 45933 | 4180 | 46606 | 3458 | 45808 | 2370 | 54605 | 1778 | 33841 |
| 8L-3S | | MI | 22133 | 6911 | 35801 | 5021 | 38884 | 4082 | 40077 | 3362 | 40776 | 2277 | 48240 | 1981 | 26363 |
| 18-#11 | 2.09 | MA | 26362 | 6911 | 41785 | 5157 | 44871 | 4176 | 45256 | 3453 | 44048 | 2379 | 52391 | 1725 | 33094 |
| 9L-2S | | MI | 22732 | 6911 | 36697 | 5026 | 40033 | 4071 | 41479 | 3352 | 42644 | 2268 | 50706 | 2068 | 26338 |
| 18-#14 | 3.01 | MA | 30392 | 7341 | 49918 | 5391 | 55256 | 4343 | 57929 | 3535 | 61415 | 2330 | 74830 | 1844 | 50324 |
| 4L-7S | | MI | 21231 | 7341 | 35161 | 5286 | 37955 | 4271 | 38885 | 3465 | 39269 | 2237 | 47305 | 1455 | 35052 |
| 18-#14 | 3.01 | MA | 29662 | 7341 | 48673 | 5387 | 53640 | 4362 | 55944 | 3551 | 58541 | 2318 | 71408 | 1785 | 49312 |
| 5L-6S | | MI | 21734 | 7341 | 36101 | 5268 | 39090 | 4256 | 40341 | 3477 | 41064 | 2224 | 49407 | 1550 | 35832 |
| 18-#14 | 3.01 | MA | 28966 | 7341 | 47504 | 5383 | 52022 | 4355 | 53967 | 3543 | 55935 | 2331 | 68164 | 1704 | 48381 |
| 6L-5S | | MI | 22251 | 7341 | 36960 | 5276 | 40277 | 4266 | 41723 | 3465 | 42902 | 2212 | 51648 | 1632 | 36375 |
| 18-#14 | 3.01 | MA | 28289 | 7341 | 46225 | 5404 | 50479 | 4374 | 52069 | 3560 | 53389 | 2343 | 64702 | 1574 | 47301 |
| 7L-4S | | MI | 22793 | 7341 | 37874 | 5283 | 41461 | 4251 | 43175 | 3452 | 44933 | 2224 | 54051 | 1686 | 37151 |
| 18-#14 | 3.01 | MA | 27622 | 7341 | 45075 | 5400 | 48913 | 4368 | 50217 | 3577 | 50684 | 2331 | 61502 | 1505 | 46044 |
| 8L-3S | | MI | 23395 | 7341 | 38927 | 5265 | 42803 | 4261 | 44801 | 3465 | 46957 | 2212 | 56301 | 1810 | 37233 |
| 18-#14 | 3.01 | MA | 26960 | 7341 | 43836 | 5420 | 47390 | 4387 | 48279 | 3569 | 48160 | 2344 | 58357 | 1427 | 44560 |
| 9L-2S | | MI | 24240 | 7341 | 40206 | 5273 | 44442 | 4246 | 46799 | 3452 | 49605 | 2199 | 59786 | 1934 | 37259 |
| 18-#18 | 5.36 | MA | 31773 | 8430 | 55325 | 6031 | 61769 | 4829 | 65782 | 3821 | 71800 | 2220 | 89962 | 1139 | 79182 |
| 6L-5S | | MI | 24466 | 8430 | 43181 | 5909 | 48077 | 4726 | 50892 | 3709 | 55064 | 2032 | 67855 | 1027 | 60237 |
| 18-#18 | 5.36 | MA | 30626 | 8430 | 53075 | 6066 | 59056 | 4860 | 62446 | 3848 | 67374 | 2242 | 83984 | 908 | 76143 |
| 7L-4S | | MI | 25386 | 8430 | 44780 | 5924 | 50148 | 4703 | 53386 | 3687 | 58555 | 2054 | 71955 | 1125 | 61530 |
| 20-#11 | 2.32 | MA | 29387 | 7019 | 47259 | 5202 | 51937 | 4209 | 53914 | 3457 | 55917 | 2358 | 67504 | 1997 | 39339 |
| 4L-8S | | MI | 20658 | 7019 | 33474 | 5100 | 35840 | 4133 | 36383 | 3402 | 35973 | 2291 | 42546 | 1640 | 27992 |
| 20-#11 | 2.32 | MA | 28871 | 7019 | 46390 | 5200 | 50810 | 4205 | 52529 | 3469 | 53912 | 2350 | 65102 | 1956 | 39225 |
| 5L-7S | | MI | 21009 | 7019 | 34065 | 5104 | 36644 | 4139 | 37334 | 3393 | 37223 | 2283 | 44131 | 1685 | 28384 |
| 20-#11 | 2.32 | MA | 28381 | 7019 | 45576 | 5197 | 49682 | 4218 | 51150 | 3464 | 52095 | 2360 | 62819 | 1900 | 38556 |
| 6E | | MI | 21365 | 7019 | 34722 | 5092 | 37437 | 4128 | 38354 | 3401 | 38489 | 2274 | 45830 | 1776 | 28642 |
| 20-#11 | 2.32 | MA | 27902 | 7019 | 44684 | 5212 | 48606 | 4215 | 49827 | 3476 | 50319 | 2369 | 60383 | 1810 | 38101 |
| 7L-5S | | MI | 21730 | 7019 | 35322 | 5096 | 38267 | 4135 | 39322 | 3392 | 39785 | 2265 | 47416 | 1832 | 29108 |
| 20-#11 | 2.32 | MA | 27431 | 7019 | 43882 | 5209 | 47514 | 4228 | 48536 | 3488 | 48433 | 2361 | 58137 | 1761 | 37530 |
| 8L-4S | | MI | 22112 | 7019 | 35961 | 5101 | 39095 | 4124 | 40339 | 3383 | 41216 | 2274 | 49114 | 1870 | 29162 |
| 20-#11 | 2.32 | MA | 26948 | 7019 | 43019 | 5224 | 46453 | 4224 | 47185 | 3483 | 46673 | 2371 | 55924 | 1707 | 36806 |
| 9L-3S | | MI | 22538 | 7019 | 36697 | 5088 | 40033 | 4130 | 41479 | 3391 | 42644 | 2265 | 50706 | 1956 | 29171 |
| 20-#11 | 2.32 | MA | 26428 | 7019 | 42220 | 5222 | 45375 | 4238 | 45900 | 3495 | 44929 | 2380 | 53779 | 1646 | 36060 |
| 10L-2S | | MI | 23135 | 7019 | 37594 | 5093 | 41182 | 4119 | 42881 | 3382 | 44511 | 2257 | 53171 | 2043 | 29153 |
| 20-#14 | 3.35 | MA | 30472 | 7497 | 50438 | 5485 | 55904 | 4431 | 58705 | 3594 | 62297 | 2306 | 76431 | 1758 | 54622 |
| 5L-7S | | MI | 21808 | 7497 | 36440 | 5383 | 39595 | 4341 | 40882 | 3507 | 41917 | 2219 | 50790 | 1416 | 38829 |
| 20-#14 | 3.35 | MA | 29781 | 7497 | 49270 | 5480 | 54286 | 4425 | 56728 | 3586 | 59692 | 2318 | 73187 | 1677 | 53729 |
| 6E | | MI | 22309 | 7497 | 37380 | 5366 | 40730 | 4326 | 42338 | 3520 | 43713 | 2206 | 52892 | 1511 | 39695 |
| 20-#14 | 3.35 | MA | 29107 | 7497 | 47990 | 5501 | 52742 | 4444 | 54830 | 3602 | 57146 | 2331 | 69724 | 1547 | 52558 |
| 7L-5S | | MI | 22823 | 7497 | 38239 | 5373 | 41917 | 4336 | 43720 | 3507 | 45551 | 2194 | 55133 | 1593 | 40211 |
| 20-#14 | 3.35 | MA | 28444 | 7497 | 46840 | 5497 | 51176 | 4438 | 52978 | 3619 | 54440 | 2319 | 66525 | 1478 | 51340 |
| 8L-4S | | MI | 23362 | 7497 | 39154 | 5380 | 43101 | 4321 | 45172 | 3495 | 47582 | 2206 | 57536 | 1647 | 41099 |
| 20-#14 | 3.35 | MA | 27783 | 7497 | 45602 | 5518 | 49653 | 4457 | 51041 | 3611 | 51917 | 2332 | 63380 | 1400 | 49797 |
| 9L-3S | | MI | 23962 | 7497 | 40206 | 5363 | 44442 | 4331 | 46799 | 3507 | 49605 | 2194 | 59786 | 1771 | 41203 |
| 20-#18 | 5.95 | MA | 32016 | 8707 | 56165 | 6239 | 63017 | 4984 | 67279 | 3923 | 73901 | 2217 | 92659 | 853 | 85181 |
| 7L-5S | | MI | 25430 | 8707 | 45406 | 6082 | 50930 | 4850 | 54323 | 3780 | 59613 | 1995 | 73802 | 950 | 66734 |
| 22-#11 | 2.55 | MA | 29445 | 7127 | 47624 | 5267 | 52392 | 4253 | 54459 | 3498 | 56537 | 2342 | 68635 | 1938 | 43032 |
| 5L-8S | | MI | 21069 | 7127 | 34370 | 5167 | 36990 | 4181 | 37785 | 3431 | 37841 | 2280 | 45011 | 1615 | 30662 |

## RECTANGULAR TIED COLUMNS 32" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.55 | MA | 28957 | 7127 | 46810 | 5265 | 51264 | 4267 | 53080 | 3493 | 54720 | 2351 | 66352 | 1882 | 42296 |
| 6L-7S | | MI | 21418 | 7127 | 34962 | 5172 | 37794 | 4188 | 38736 | 3422 | 39090 | 2271 | 46597 | 1660 | 31109 |
| 22-#11 | 2.55 | MA | 28481 | 7127 | 45917 | 5279 | 50188 | 4263 | 51757 | 3505 | 52944 | 2360 | 63916 | 1792 | 41855 |
| 7L-6S | | MI | 21773 | 7127 | 35619 | 5159 | 38586 | 4177 | 39756 | 3430 | 40357 | 2262 | 48295 | 1750 | 31357 |
| 22-#11 | 2.55 | MA | 28012 | 7127 | 45116 | 5277 | 49096 | 4276 | 50465 | 3517 | 51058 | 2353 | 61670 | 1743 | 41226 |
| 8L-5S | | MI | 22136 | 7127 | 36219 | 5164 | 39416 | 4183 | 40724 | 3421 | 41653 | 2254 | 49882 | 1807 | 31800 |
| 22-#11 | 2.55 | MA | 27532 | 7127 | 44252 | 5292 | 48034 | 4273 | 49114 | 3512 | 49298 | 2362 | 59457 | 1689 | 40523 |
| 9L-4S | | MI | 22517 | 7127 | 36858 | 5168 | 40244 | 4172 | 41741 | 3412 | 43084 | 2262 | 51579 | 1845 | 31949 |
| 22-#11 | 2.55 | MA | 27013 | 7127 | 43453 | 5289 | 46957 | 4286 | 47829 | 3524 | 47554 | 2372 | 57312 | 1628 | 39736 |
| 10L-3S | | MI | 22941 | 7127 | 37594 | 5156 | 41182 | 4179 | 42881 | 3420 | 44511 | 2254 | 53171 | 1931 | 31974 |
| 22-#11 | 2.55 | MA | 26508 | 7127 | 42667 | 5287 | 45901 | 4282 | 46496 | 3519 | 45694 | 2364 | 55122 | 1577 | 38884 |
| 11L-2S | | MI | 23537 | 7127 | 38490 | 5160 | 42331 | 4168 | 44283 | 3411 | 46379 | 2245 | 55637 | 2018 | 31963 |
| 22-#14 | 3.68 | MA | 30590 | 7652 | 51036 | 5578 | 56549 | 4495 | 59489 | 3628 | 63449 | 2306 | 78210 | 1650 | 59082 |
| 6L-7S | | MI | 22382 | 7652 | 37719 | 5480 | 41235 | 4410 | 42880 | 3549 | 44566 | 2201 | 54275 | 1377 | 42615 |
| 22-#14 | 3.68 | MA | 29920 | 7652 | 49756 | 5598 | 55006 | 4514 | 57591 | 3645 | 60903 | 2319 | 74747 | 1520 | 57824 |
| 7L-6S | | MI | 22881 | 7652 | 38660 | 5463 | 42369 | 4396 | 44336 | 3562 | 46362 | 2188 | 56377 | 1472 | 43563 |
| 22-#14 | 3.68 | MA | 29261 | 7652 | 48606 | 5594 | 53440 | 4508 | 55739 | 3662 | 58197 | 2306 | 71548 | 1450 | 56643 |
| 8L-5S | | MI | 23392 | 7652 | 39519 | 5470 | 43557 | 4406 | 45718 | 3549 | 48199 | 2176 | 58618 | 1555 | 44055 |
| 22-#14 | 3.68 | MA | 28601 | 7652 | 47367 | 5615 | 51917 | 4526 | 53802 | 3653 | 55674 | 2319 | 68403 | 1373 | 55043 |
| 9L-4S | | MI | 23929 | 7652 | 40433 | 5477 | 44741 | 4391 | 47170 | 3537 | 50230 | 2188 | 61021 | 1608 | 45043 |
| 24-#11 | 2.79 | MA | 29530 | 7235 | 48043 | 5332 | 52845 | 4315 | 55009 | 3522 | 57345 | 2342 | 69884 | 1864 | 46040 |
| 6L-8S | | MI | 21478 | 7235 | 35267 | 5235 | 38139 | 4230 | 39187 | 3461 | 39709 | 2268 | 47476 | 1590 | 33337 |
| 24-#11 | 2.79 | MA | 29056 | 7235 | 47151 | 5347 | 51769 | 4311 | 53686 | 3534 | 55569 | 2352 | 67449 | 1774 | 45612 |
| 7E | | MI | 21826 | 7235 | 35858 | 5239 | 38943 | 4236 | 40138 | 3452 | 40958 | 2259 | 49062 | 1635 | 33836 |
| 24-#11 | 2.79 | MA | 28589 | 7235 | 46349 | 5344 | 50677 | 4325 | 52394 | 3547 | 53683 | 2344 | 65203 | 1726 | 44928 |
| 8L-6S | | MI | 22179 | 7235 | 36515 | 5227 | 39735 | 4225 | 41158 | 3460 | 42224 | 2251 | 50760 | 1725 | 34075 |
| 24-#11 | 2.79 | MA | 28118 | 7235 | 45486 | 5359 | 49616 | 4321 | 51044 | 3541 | 51923 | 2354 | 62989 | 1672 | 44244 |
| 9L-5S | | MI | 22541 | 7235 | 37115 | 5231 | 40565 | 4232 | 42126 | 3451 | 43520 | 2242 | 52347 | 1782 | 34497 |
| 24-#11 | 2.79 | MA | 27595 | 7235 | 44687 | 5356 | 48538 | 4334 | 49759 | 3554 | 50179 | 2363 | 60845 | 1611 | 43417 |
| 10L-4S | | MI | 22920 | 7235 | 37754 | 5236 | 41393 | 4221 | 43143 | 3442 | 44952 | 2251 | 54045 | 1820 | 34731 |
| 24-#11 | 2.79 | MA | 27092 | 7235 | 43901 | 5354 | 47482 | 4331 | 48425 | 3548 | 48319 | 2355 | 58655 | 1559 | 42584 |
| 11L-3S | | MI | 23343 | 7235 | 38490 | 5223 | 42331 | 4227 | 44283 | 3450 | 46379 | 2242 | 55637 | 1906 | 34764 |
| 24-#14 | 4.02 | MA | 30729 | 7808 | 51521 | 5696 | 57269 | 4584 | 60353 | 3687 | 64659 | 2306 | 79770 | 1493 | 63099 |
| 7E | | MI | 22953 | 7808 | 38999 | 5578 | 42875 | 4480 | 44878 | 3591 | 47215 | 2183 | 57761 | 1338 | 46410 |
| 24-#14 | 4.02 | MA | 30074 | 7808 | 50371 | 5692 | 55703 | 4578 | 58500 | 3704 | 61954 | 2294 | 76571 | 1423 | 61954 |
| 8L-6S | | MI | 23450 | 7808 | 39939 | 5560 | 44009 | 4465 | 46334 | 3604 | 49010 | 2170 | 59863 | 1434 | 47434 |
| 24-#14 | 4.02 | MA | 29413 | 7808 | 49133 | 5712 | 54180 | 4596 | 56563 | 3696 | 59431 | 2307 | 73425 | 1346 | 60297 |
| 9L-5S | | MI | 23959 | 7808 | 40798 | 5567 | 45197 | 4475 | 47716 | 3591 | 50848 | 2158 | 62104 | 1516 | 47905 |

## RECTANGULAR TIED COLUMNS 32" x 44"

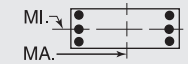
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.14 | MA | 30489 | 6777 | 47468 | 5043 | 51150 | 4112 | 51948 | 3433 | 51346 | 2476 | 59949 | 2336 | 21453 |
| 2E | | MI | 21951 | 6777 | 34637 | 4908 | 36784 | 4002 | 36965 | 3331 | 35954 | 2377 | 41461 | 2213 | 15261 |
| 6-#18 | 1.70 | MA | 32007 | 7053 | 50731 | 5216 | 55332 | 4237 | 57051 | 3508 | 58269 | 2453 | 69171 | 2285 | 31728 |
| 2L-3S | | MI | 21457 | 7053 | 34637 | 5065 | 36784 | 4149 | 36965 | 3425 | 35954 | 2363 | 41461 | 1914 | 22473 |
| 6-#18 | 1.70 | MA | 29808 | 7053 | 47468 | 5207 | 51150 | 4269 | 51948 | 3537 | 51346 | 2475 | 59949 | 2063 | 31747 |
| 3L-2S | | MI | 22950 | 7053 | 36863 | 5081 | 39637 | 4126 | 40396 | 3403 | 40503 | 2340 | 47409 | 2135 | 22353 |
| 8-#14 | 1.28 | MA | 30956 | 6846 | 48242 | 5118 | 52338 | 4170 | 53472 | 3475 | 53488 | 2490 | 63032 | 2354 | 24198 |
| 2L-4S | | MI | 20798 | 6846 | 32844 | 5006 | 34675 | 4074 | 34559 | 3388 | 32917 | 2427 | 37978 | 1989 | 17319 |
| 8-#14 | 1.28 | MA | 29689 | 6846 | 46380 | 5115 | 49950 | 4165 | 50558 | 3492 | 49524 | 2504 | 57701 | 2229 | 24251 |
| 3E | | MI | 21417 | 6846 | 33897 | 4988 | 36016 | 4084 | 36185 | 3400 | 34941 | 2414 | 40228 | 2112 | 17247 |
| 8-#14 | 1.28 | MA | 28799 | 6846 | 44862 | 5136 | 48016 | 4184 | 48208 | 3484 | 46499 | 2517 | 54231 | 2105 | 24244 |
| 4L-2S | | MI | 22282 | 6846 | 35176 | 4996 | 37656 | 4069 | 38183 | 3388 | 37589 | 2402 | 43713 | 2237 | 17171 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis

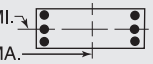



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 2.27 | MA | 33507 | 7330 | 53994 | 5389 | 59515 | 4361 | 62154 | 3584 | 65192 | 2430 | 78393 | 2233 | 41954 |
| 2L-4S | | MI | 21392 | 7330 | 35025 | 5267 | 37296 | 4253 | 37601 | 3474 | 37028 | 2348 | 43559 | 1622 | 29302 |
| 8-#18 | 2.27 | MA | 31327 | 7330 | 50731 | 5380 | 55332 | 4393 | 57051 | 3612 | 58269 | 2452 | 69171 | 2012 | 41867 |
| 3E | | MI | 22457 | 7330 | 36863 | 5238 | 39637 | 4273 | 40396 | 3496 | 40503 | 2326 | 47409 | 1836 | 29447 |
| 8-#18 | 2.27 | MA | 29794 | 7330 | 48066 | 5416 | 51936 | 4381 | 52924 | 3597 | 52977 | 2474 | 63184 | 1791 | 41387 |
| 4L-2S | | MI | 23939 | 7330 | 39088 | 5254 | 42490 | 4250 | 43827 | 3474 | 45053 | 2304 | 53357 | 2057 | 29385 |
| 10-#11 | 1.11 | MA | 30525 | 6763 | 47219 | 5083 | 51125 | 4146 | 52030 | 3463 | 51542 | 2505 | 60542 | 2382 | 21140 |
| 2L-5S | | MI | 20573 | 6763 | 32203 | 4970 | 33934 | 4066 | 33686 | 3392 | 31677 | 2436 | 36447 | 2067 | 15207 |
| 10-#11 | 1.11 | MA | 29636 | 6763 | 45918 | 5081 | 49457 | 4143 | 49995 | 3476 | 48774 | 2516 | 56795 | 2296 | 21181 |
| 3L-4S | | MI | 20964 | 6763 | 32842 | 4974 | 34762 | 4055 | 34703 | 3383 | 33108 | 2445 | 38145 | 2105 | 15157 |
| 10-#11 | 1.11 | MA | 29013 | 6763 | 44859 | 5096 | 48108 | 4157 | 48355 | 3471 | 46663 | 2526 | 54353 | 2209 | 21210 |
| 4L-3S | | MI | 21398 | 6763 | 33578 | 4962 | 35700 | 4061 | 35843 | 3391 | 34535 | 2436 | 39737 | 2191 | 15101 |
| 10-#11 | 1.11 | MA | 28457 | 6763 | 43944 | 5093 | 46921 | 4153 | 46897 | 3484 | 44551 | 2518 | 51810 | 2167 | 21194 |
| 5L-2S | | MI | 22007 | 6763 | 34475 | 4966 | 36850 | 4050 | 37245 | 3382 | 36403 | 2428 | 42202 | 2278 | 15049 |
| 10-#14 | 1.60 | MA | 31830 | 7001 | 50105 | 5216 | 54726 | 4240 | 56385 | 3517 | 57452 | 2478 | 68364 | 2329 | 30050 |
| 2L-5S | | MI | 20832 | 7001 | 33209 | 5096 | 35131 | 4159 | 35105 | 3442 | 33535 | 2396 | 39060 | 1896 | 21312 |
| 10-#14 | 1.60 | MA | 30570 | 7001 | 48242 | 5212 | 52338 | 4234 | 53472 | 3534 | 53488 | 2491 | 63032 | 2204 | 30080 |
| 3L-4S | | MI | 21386 | 7001 | 34124 | 5103 | 36315 | 4144 | 36556 | 3430 | 35566 | 2409 | 41463 | 1950 | 21336 |
| 10-#14 | 1.60 | MA | 29686 | 7001 | 46725 | 5233 | 50404 | 4254 | 51121 | 3527 | 50463 | 2505 | 59562 | 2080 | 30024 |
| 4L-3S | | MI | 22002 | 7001 | 35176 | 5086 | 37656 | 4154 | 38183 | 3442 | 37589 | 2396 | 43713 | 2073 | 21290 |
| 10-#14 | 1.60 | MA | 28896 | 7001 | 45413 | 5229 | 48702 | 4248 | 49030 | 3544 | 47435 | 2494 | 55937 | 2020 | 29828 |
| 5L-2S | | MI | 22863 | 7001 | 36455 | 5093 | 39296 | 4139 | 40180 | 3430 | 40238 | 2384 | 47198 | 2198 | 21228 |
| 10-#18 | 2.84 | MA | 34988 | 7607 | 57257 | 5561 | 63698 | 4485 | 67257 | 3659 | 72116 | 2407 | 87615 | 2182 | 52136 |
| 2L-5S | | MI | 21440 | 7607 | 35651 | 5425 | 38078 | 4400 | 38539 | 3568 | 38086 | 2289 | 45407 | 1447 | 33967 |
| 10-#18 | 2.84 | MA | 32828 | 7607 | 53994 | 5553 | 59515 | 4517 | 62154 | 3688 | 65192 | 2429 | 78393 | 1961 | 51960 |
| 3L-4S | | MI | 22391 | 7607 | 37250 | 5440 | 40149 | 4377 | 41032 | 3546 | 41577 | 2312 | 49507 | 1544 | 35744 |
| 10-#18 | 2.84 | MA | 31309 | 7607 | 51329 | 5589 | 56119 | 4505 | 58026 | 3672 | 59900 | 2451 | 72406 | 1739 | 51172 |
| 4L-3S | | MI | 23447 | 7607 | 39088 | 5411 | 42490 | 4397 | 43827 | 3568 | 45053 | 2289 | 53357 | 1758 | 36367 |
| 10-#18 | 2.84 | MA | 29953 | 7607 | 49022 | 5581 | 53128 | 4537 | 54351 | 3701 | 54599 | 2429 | 66110 | 1636 | 48062 |
| 5L-2S | | MI | 24918 | 7607 | 41314 | 5427 | 45343 | 4374 | 47257 | 3546 | 49602 | 2267 | 59305 | 1979 | 36379 |
| 12-#11 | 1.33 | MA | 31142 | 6871 | 48520 | 5150 | 52793 | 4195 | 54064 | 3493 | 54311 | 2497 | 64288 | 2366 | 25232 |
| 2L-6S | | MI | 20619 | 6871 | 32499 | 5032 | 34254 | 4108 | 34120 | 3430 | 32248 | 2433 | 37326 | 1985 | 17960 |
| 12-#11 | 1.33 | MA | 30257 | 6871 | 47219 | 5148 | 51125 | 4191 | 52030 | 3505 | 51542 | 2507 | 60542 | 2279 | 25263 |
| 3L-5S | | MI | 20990 | 6871 | 33099 | 5037 | 35083 | 4114 | 35088 | 3421 | 33544 | 2425 | 38913 | 2042 | 18024 |
| 12-#11 | 1.33 | MA | 29637 | 6871 | 46160 | 5163 | 49776 | 4205 | 50390 | 3500 | 49432 | 2517 | 58100 | 2193 | 25274 |
| 4E | | MI | 21379 | 6871 | 33738 | 5042 | 35911 | 4103 | 36105 | 3412 | 34976 | 2433 | 40610 | 2080 | 17989 |
| 12-#11 | 1.33 | MA | 29083 | 6871 | 45246 | 5161 | 48589 | 4202 | 48932 | 3513 | 47320 | 2510 | 55557 | 2151 | 25231 |
| 5L-3S | | MI | 21812 | 6871 | 34475 | 5029 | 36850 | 4110 | 37245 | 3420 | 36403 | 2425 | 42202 | 2166 | 17943 |
| 12-#11 | 1.33 | MA | 28556 | 6871 | 44388 | 5159 | 47402 | 4215 | 47480 | 3508 | 45407 | 2520 | 53134 | 2095 | 24992 |
| 6L-2S | | MI | 22418 | 6871 | 35371 | 5034 | 37999 | 4099 | 38647 | 3411 | 38271 | 2416 | 44668 | 2253 | 17897 |
| 12-#14 | 1.92 | MA | 32698 | 7157 | 51968 | 5313 | 57114 | 4310 | 59298 | 3559 | 61415 | 2465 | 73695 | 2303 | 35888 |
| 2L-6S | | MI | 20894 | 7157 | 33630 | 5186 | 35583 | 4219 | 35720 | 3497 | 34346 | 2391 | 40305 | 1775 | 24445 |
| 12-#14 | 1.92 | MA | 31445 | 7157 | 50105 | 5309 | 54726 | 4304 | 56385 | 3577 | 57452 | 2479 | 68364 | 2179 | 35885 |
| 3L-5S | | MI | 21419 | 7157 | 34489 | 5193 | 36771 | 4229 | 37102 | 3485 | 36183 | 2378 | 42546 | 1857 | 25117 |
| 12-#14 | 1.92 | MA | 30566 | 7157 | 48588 | 5330 | 52792 | 4324 | 54034 | 3569 | 54427 | 2492 | 64894 | 2054 | 35793 |
| 4E | | MI | 21971 | 7157 | 35403 | 5200 | 37955 | 4214 | 38554 | 3472 | 38214 | 2391 | 44948 | 1911 | 25332 |
| 12-#14 | 1.92 | MA | 29781 | 7157 | 47276 | 5327 | 51090 | 4318 | 51943 | 3587 | 51398 | 2481 | 61268 | 1994 | 35409 |
| 5L-3S | | MI | 22583 | 7157 | 36455 | 5183 | 39296 | 4224 | 40180 | 3485 | 40238 | 2378 | 47198 | 2035 | 25314 |
| 12-#14 | 1.92 | MA | 29034 | 7157 | 46046 | 5323 | 49387 | 4337 | 49861 | 3579 | 48654 | 2495 | 57823 | 1914 | 34223 |
| 6L-2S | | MI | 23440 | 7157 | 37735 | 5190 | 40936 | 4209 | 42178 | 3472 | 42887 | 2366 | 50684 | 2159 | 25266 |
| 12-#18 | 3.41 | MA | 34312 | 7883 | 57257 | 5726 | 63698 | 4641 | 67257 | 3763 | 72116 | 2406 | 87615 | 1909 | 62035 |
| 3L-5S | | MI | 22437 | 7883 | 37877 | 5597 | 40931 | 4524 | 41969 | 3639 | 42636 | 2253 | 51355 | 1369 | 40569 |
| 12-#18 | 3.41 | MA | 32808 | 7883 | 54592 | 5762 | 60302 | 4629 | 63129 | 3747 | 66823 | 2428 | 81628 | 1688 | 60755 |
| 4E | | MI | 23380 | 7883 | 39476 | 5613 | 43002 | 4501 | 44463 | 3617 | 46127 | 2275 | 55455 | 1466 | 42209 |
| 12-#18 | 3.41 | MA | 31464 | 7883 | 52285 | 5754 | 57311 | 4662 | 59454 | 3776 | 61522 | 2406 | 75332 | 1585 | 57819 |
| 5L-3S | | MI | 24428 | 7883 | 41314 | 5584 | 45343 | 4522 | 47257 | 3639 | 49602 | 2253 | 59305 | 1680 | 43260 |
| 12-#18 | 3.41 | MA | 30187 | 7883 | 50121 | 5746 | 54315 | 4650 | 55794 | 3760 | 56718 | 2428 | 69380 | 1441 | 55156 |
| 6L-2S | | MI | 25889 | 7883 | 43539 | 5600 | 48196 | 4498 | 50688 | 3617 | 54152 | 2231 | 65253 | 1901 | 43348 |

## RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

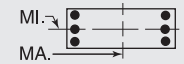
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.55 | MA | 31755 | 6979 | 49821 | 5218 | 54460 | 4243 | 56099 | 3522 | 57079 | 2488 | 68035 | 2349 | 29315 |
| 2L-7S | | MI | 20674 | 6979 | 32739 | 5113 | 34610 | 4167 | 34502 | 3452 | 32850 | 2430 | 38093 | 1870 | 20344 |
| 14-#11 | 1.55 | MA | 30873 | 6979 | 48520 | 5215 | 52793 | 4240 | 54064 | 3535 | 54311 | 2498 | 64288 | 2263 | 29336 |
| 3L-6S | | MI | 21035 | 6979 | 33396 | 5100 | 35403 | 4156 | 35522 | 3460 | 34116 | 2422 | 39791 | 1960 | 20652 |
| 14-#11 | 1.55 | MA | 30256 | 6979 | 47461 | 5230 | 51443 | 4253 | 52425 | 3530 | 52200 | 2508 | 61847 | 2176 | 29325 |
| 4L-5S | | MI | 21405 | 6979 | 33996 | 5105 | 36233 | 4163 | 36490 | 3451 | 35412 | 2413 | 41378 | 2017 | 20830 |
| 14-#11 | 1.55 | MA | 29705 | 6979 | 46547 | 5228 | 50257 | 4250 | 50967 | 3542 | 50088 | 2501 | 59304 | 2134 | 29262 |
| 5L-4S | | MI | 21792 | 6979 | 34635 | 5109 | 37061 | 4152 | 37507 | 3442 | 36844 | 2422 | 43076 | 2055 | 20810 |
| 14-#11 | 1.55 | MA | 29180 | 6979 | 45689 | 5226 | 49069 | 4264 | 49515 | 3538 | 48175 | 2511 | 56881 | 2079 | 28908 |
| 6L-3S | | MI | 22223 | 6979 | 35371 | 5096 | 37999 | 4158 | 38647 | 3450 | 38271 | 2413 | 44668 | 2141 | 20775 |
| 14-#11 | 1.55 | MA | 28669 | 6979 | 44750 | 5241 | 47937 | 4260 | 48122 | 3550 | 46306 | 2521 | 54297 | 1989 | 28343 |
| 7L-2S | | MI | 22828 | 6979 | 36268 | 5101 | 39148 | 4147 | 40049 | 3441 | 40138 | 2405 | 47133 | 2227 | 20734 |
| 14-#14 | 2.24 | MA | 33559 | 7313 | 53831 | 5410 | 59502 | 4380 | 62211 | 3602 | 65379 | 2453 | 79026 | 2278 | 41715 |
| 2L-7S | | MI | 20970 | 7313 | 33969 | 5301 | 36089 | 4303 | 36262 | 3527 | 35199 | 2385 | 41688 | 1641 | 27812 |
| 14-#14 | 2.24 | MA | 32312 | 7313 | 51968 | 5406 | 57114 | 4374 | 59298 | 3619 | 61415 | 2466 | 73695 | 2153 | 41678 |
| 3L-6S | | MI | 21480 | 7313 | 34909 | 5283 | 37223 | 4289 | 37718 | 3539 | 36994 | 2373 | 43790 | 1736 | 28289 |
| 14-#14 | 2.24 | MA | 31439 | 7313 | 50451 | 5428 | 55180 | 4393 | 56948 | 3612 | 58390 | 2480 | 70225 | 2029 | 41554 |
| 4L-5S | | MI | 22003 | 7313 | 35768 | 5290 | 38410 | 4299 | 39100 | 3527 | 38832 | 2360 | 46031 | 1818 | 28915 |
| 14-#14 | 2.24 | MA | 30659 | 7313 | 49139 | 5424 | 53478 | 4388 | 54857 | 3629 | 55362 | 2469 | 66599 | 1969 | 40970 |
| 5L-4S | | MI | 22551 | 7313 | 36682 | 5298 | 39595 | 4284 | 40552 | 3514 | 40863 | 2373 | 48434 | 1872 | 29309 |
| 14-#14 | 2.24 | MA | 29917 | 7313 | 47909 | 5420 | 51775 | 4407 | 52774 | 3622 | 52618 | 2482 | 63154 | 1888 | 39842 |
| 6L-3S | | MI | 23161 | 7313 | 37735 | 5280 | 40936 | 4294 | 42178 | 3527 | 42887 | 2360 | 50684 | 1996 | 29325 |
| 14-#14 | 2.24 | MA | 29194 | 7313 | 46561 | 5441 | 50149 | 4401 | 50776 | 3639 | 49937 | 2496 | 59478 | 1758 | 39051 |
| 7L-2S | | MI | 24014 | 7313 | 39014 | 5287 | 42576 | 4279 | 44176 | 3514 | 45535 | 2348 | 54169 | 2120 | 29292 |
| 14-#18 | 3.98 | MA | 34291 | 8160 | 57855 | 5935 | 64485 | 4754 | 68232 | 3823 | 73747 | 2405 | 90850 | 1637 | 70384 |
| 4L-5S | | MI | 23424 | 8160 | 40102 | 5770 | 43784 | 4649 | 45400 | 3711 | 47185 | 2216 | 57303 | 1291 | 47194 |
| 14-#18 | 3.98 | MA | 32960 | 8160 | 55548 | 5927 | 61494 | 4786 | 64557 | 3851 | 68445 | 2383 | 84554 | 1534 | 67603 |
| 5L-4S | | MI | 24360 | 8160 | 41701 | 5786 | 45855 | 4625 | 47893 | 3689 | 50676 | 2238 | 61403 | 1388 | 48716 |
| 14-#18 | 3.98 | MA | 31694 | 8160 | 53384 | 5919 | 58498 | 4774 | 60896 | 3836 | 63641 | 2405 | 78602 | 1389 | 64753 |
| 6L-3S | | MI | 25401 | 8160 | 43539 | 5757 | 48196 | 4646 | 50688 | 3711 | 54152 | 2216 | 65253 | 1602 | 50133 |
| 14-#18 | 3.98 | MA | 30462 | 8160 | 51014 | 5955 | 55639 | 4806 | 57382 | 3864 | 58946 | 2427 | 72245 | 1158 | 61866 |
| 7L-2S | | MI | 26852 | 8160 | 45765 | 5772 | 51049 | 4622 | 54118 | 3689 | 58701 | 2194 | 71201 | 1823 | 50277 |
| 16-#11 | 1.77 | MA | 32365 | 7086 | 51122 | 5285 | 56128 | 4292 | 58134 | 3551 | 59847 | 2480 | 71782 | 2333 | 33392 |
| 2L-8S | | MI | 20736 | 7086 | 33044 | 5175 | 34956 | 4209 | 34953 | 3490 | 33468 | 2427 | 38973 | 1800 | 22867 |
| 16-#11 | 1.77 | MA | 31487 | 7086 | 49821 | 5283 | 54460 | 4288 | 56099 | 3564 | 57079 | 2490 | 68035 | 2246 | 33401 |
| 3L-7S | | MI | 21090 | 7086 | 33635 | 5180 | 35760 | 4216 | 35904 | 3481 | 34717 | 2419 | 40559 | 1845 | 23062 |
| 16-#11 | 1.77 | MA | 30872 | 7086 | 48762 | 5298 | 53111 | 4302 | 54459 | 3559 | 54969 | 2500 | 65593 | 2160 | 33370 |
| 4L-6S | | MI | 21449 | 7086 | 34292 | 5167 | 36552 | 4205 | 36924 | 3489 | 35984 | 2410 | 42257 | 1935 | 23352 |
| 16-#11 | 1.77 | MA | 30323 | 7086 | 47848 | 5296 | 51925 | 4298 | 53002 | 3572 | 52857 | 2492 | 63050 | 2118 | 33289 |
| 5E | | MI | 21817 | 7086 | 34892 | 5172 | 37382 | 4211 | 37892 | 3480 | 37280 | 2402 | 43844 | 1992 | 23624 |
| 16-#11 | 1.77 | MA | 29801 | 7086 | 46991 | 5293 | 50737 | 4312 | 51550 | 3567 | 50944 | 2502 | 60628 | 2062 | 32833 |
| 6L-4S | | MI | 22203 | 7086 | 35531 | 5177 | 38210 | 4200 | 38909 | 3471 | 38711 | 2410 | 45541 | 2030 | 23623 |
| 16-#11 | 1.77 | MA | 29293 | 7086 | 46051 | 5308 | 49604 | 4309 | 50157 | 3580 | 49074 | 2513 | 58044 | 1972 | 32292 |
| 7L-3S | | MI | 22633 | 7086 | 36268 | 5164 | 39148 | 4207 | 40049 | 3479 | 40138 | 2402 | 47133 | 2116 | 23597 |
| 16-#11 | 1.77 | MA | 28792 | 7086 | 45208 | 5306 | 48455 | 4322 | 48797 | 3592 | 47088 | 2505 | 55666 | 1923 | 31896 |
| 8L-2S | | MI | 23235 | 7086 | 37164 | 5168 | 40297 | 4196 | 41451 | 3470 | 42006 | 2393 | 49598 | 2202 | 23563 |
| 16-#14 | 2.56 | MA | 33174 | 7468 | 53831 | 5504 | 59502 | 4444 | 62211 | 3662 | 65379 | 2454 | 79026 | 2128 | 47462 |
| 3L-7S | | MI | 21555 | 7468 | 35248 | 5398 | 37729 | 4373 | 38259 | 3569 | 37847 | 2367 | 45173 | 1602 | 31561 |
| 16-#14 | 2.56 | MA | 32305 | 7468 | 52313 | 5525 | 57568 | 4463 | 59861 | 3654 | 62354 | 2468 | 75556 | 2003 | 47308 |
| 4L-6S | | MI | 22062 | 7468 | 36188 | 5380 | 38863 | 4358 | 39716 | 3581 | 39643 | 2355 | 47275 | 1697 | 32141 |
| 16-#14 | 2.56 | MA | 31530 | 7468 | 51001 | 5521 | 55866 | 4458 | 57770 | 3671 | 59326 | 2456 | 71931 | 1944 | 46548 |
| 5E | | MI | 22583 | 7468 | 37047 | 5388 | 40050 | 4368 | 41098 | 3569 | 41481 | 2342 | 49516 | 1780 | 32729 |
| 16-#14 | 2.56 | MA | 30793 | 7468 | 49772 | 5518 | 54163 | 4477 | 55688 | 3664 | 56582 | 2470 | 68485 | 1863 | 45471 |
| 6L-4S | | MI | 23128 | 7468 | 37961 | 5395 | 41235 | 4353 | 42549 | 3557 | 43511 | 2355 | 51919 | 1833 | 33277 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis

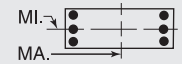


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.56 | MA | 30074 | 7468 | 48424 | 5539 | 52537 | 4471 | 53689 | 3681 | 53900 | 2483 | 64809 | 1733 | 44576 |
| 7L-3S | | MI | 23735 | 7468 | 39014 | 5377 | 42576 | 4363 | 44176 | 3569 | 45535 | 2342 | 54169 | 1957 | 33322 |
| 16-#14 | 2.56 | MA | 29367 | 7468 | 47213 | 5535 | 50888 | 4491 | 51738 | 3699 | 51051 | 2472 | 61419 | 1663 | 43146 |
| 8L-2S | | MI | 24584 | 7468 | 40293 | 5385 | 44216 | 4349 | 46173 | 3557 | 48184 | 2330 | 57654 | 2082 | 33308 |
| 16-#18 | 4.55 | MA | 34440 | 8436 | 58811 | 6100 | 65677 | 4910 | 69660 | 3927 | 75369 | 2359 | 93776 | 1482 | 77409 |
| 5E | | MI | 24404 | 8436 | 42328 | 5943 | 46637 | 4773 | 48830 | 3782 | 51735 | 2180 | 63251 | 1213 | 53839 |
| 16-#18 | 4.55 | MA | 33186 | 8436 | 56647 | 6091 | 62681 | 4898 | 65999 | 3911 | 70564 | 2382 | 87824 | 1338 | 74379 |
| 6L-4S | | MI | 25333 | 8436 | 43927 | 5959 | 48708 | 4749 | 51324 | 3760 | 55226 | 2202 | 67351 | 1310 | 55258 |
| 16-#18 | 4.55 | MA | 31965 | 8436 | 54277 | 6127 | 59822 | 4930 | 62485 | 3940 | 65869 | 2404 | 81467 | 1107 | 71505 |
| 7L-3S | | MI | 26367 | 8436 | 45765 | 5930 | 51049 | 4770 | 54118 | 3782 | 58701 | 2180 | 71201 | 1524 | 56992 |
| 18-#11 | 1.99 | MA | 32096 | 7194 | 51122 | 5350 | 56128 | 4336 | 58134 | 3593 | 59847 | 2481 | 71782 | 2230 | 37455 |
| 3L-8S | | MI | 21151 | 7194 | 33941 | 5243 | 36105 | 4258 | 36355 | 3520 | 35336 | 2416 | 41438 | 1775 | 25529 |
| 18-#11 | 1.99 | MA | 31484 | 7194 | 50063 | 5365 | 54779 | 4350 | 56494 | 3589 | 57737 | 2491 | 69340 | 2144 | 37410 |
| 4L-7S | | MI | 21503 | 7194 | 34532 | 5247 | 36909 | 4264 | 37306 | 3511 | 36585 | 2407 | 43024 | 1819 | 25784 |
| 18-#11 | 1.99 | MA | 30938 | 7194 | 49149 | 5363 | 53593 | 4347 | 55036 | 3601 | 55625 | 2484 | 66797 | 2102 | 37311 |
| 5L-6S | | MI | 21861 | 7194 | 35189 | 5235 | 37701 | 4253 | 38326 | 3519 | 37851 | 2399 | 44722 | 1910 | 26059 |
| 18-#11 | 1.99 | MA | 30419 | 7194 | 48292 | 5361 | 52405 | 4361 | 53585 | 3596 | 53712 | 2494 | 64374 | 2046 | 36766 |
| 6L-5S | | MI | 22228 | 7194 | 35789 | 5239 | 38531 | 4259 | 39294 | 3510 | 39147 | 2390 | 46309 | 1967 | 26411 |
| 18-#11 | 1.99 | MA | 29912 | 7194 | 47352 | 5376 | 51272 | 4357 | 52192 | 3609 | 51843 | 2504 | 61790 | 1956 | 36245 |
| 7L-4S | | MI | 22613 | 7194 | 36428 | 5244 | 39359 | 4249 | 40311 | 3500 | 40579 | 2399 | 48006 | 2004 | 26429 |
| 18-#11 | 1.99 | MA | 29414 | 7194 | 46509 | 5374 | 50123 | 4371 | 50832 | 3622 | 49856 | 2497 | 59412 | 1907 | 35806 |
| 8L-3S | | MI | 23041 | 7194 | 37164 | 5231 | 40297 | 4255 | 41451 | 3509 | 42006 | 2390 | 49598 | 2091 | 26412 |
| 18-#11 | 1.99 | MA | 28893 | 7194 | 45683 | 5371 | 49006 | 4367 | 49410 | 3617 | 48004 | 2507 | 57063 | 1853 | 34986 |
| 9L-2S | | MI | 23641 | 7194 | 38061 | 5236 | 41447 | 4244 | 42853 | 3499 | 43874 | 2381 | 52064 | 2177 | 26385 |
| 18-#14 | 2.88 | MA | 33166 | 7624 | 54176 | 5622 | 59956 | 4533 | 62774 | 3696 | 66318 | 2455 | 80887 | 1978 | 53058 |
| 4L-7S | | MI | 22136 | 7624 | 36527 | 5495 | 39369 | 4443 | 40257 | 3611 | 40496 | 2349 | 48658 | 1563 | 35323 |
| 18-#14 | 2.88 | MA | 32396 | 7624 | 52864 | 5618 | 58254 | 4527 | 60683 | 3714 | 63289 | 2444 | 77262 | 1918 | 52140 |
| 5L-6S | | MI | 22641 | 7624 | 37467 | 5478 | 40503 | 4428 | 41713 | 3624 | 42291 | 2337 | 50760 | 1659 | 36000 |
| 18-#14 | 2.88 | MA | 31663 | 7624 | 51634 | 5615 | 56551 | 4547 | 58601 | 3706 | 60545 | 2457 | 73817 | 1837 | 51108 |
| 6L-5S | | MI | 23159 | 7624 | 38326 | 5485 | 41690 | 4438 | 43095 | 3611 | 44129 | 2324 | 53001 | 1741 | 36555 |
| 18-#14 | 2.88 | MA | 30948 | 7624 | 50287 | 5636 | 54925 | 4541 | 56602 | 3724 | 57864 | 2471 | 70141 | 1708 | 50115 |
| 7L-4S | | MI | 23702 | 7624 | 39241 | 5492 | 42875 | 4423 | 44547 | 3599 | 46160 | 2337 | 55404 | 1795 | 37236 |
| 18-#14 | 2.88 | MA | 30245 | 7624 | 49076 | 5632 | 53277 | 4560 | 54652 | 3741 | 55015 | 2460 | 66751 | 1637 | 48730 |
| 8L-3S | | MI | 24306 | 7624 | 40293 | 5475 | 44216 | 4433 | 46173 | 3611 | 48184 | 2324 | 57654 | 1918 | 37304 |
| 18-#14 | 2.88 | MA | 29535 | 7624 | 47772 | 5653 | 51673 | 4555 | 52612 | 3734 | 52358 | 2473 | 63410 | 1560 | 47287 |
| 9L-2S | | MI | 25152 | 7624 | 41573 | 5482 | 45856 | 4418 | 48171 | 3599 | 50832 | 2312 | 61139 | 2043 | 37322 |
| 18-#18 | 5.11 | MA | 34664 | 8713 | 59910 | 6264 | 66864 | 5022 | 71102 | 3986 | 77487 | 2358 | 97046 | 1287 | 84031 |
| 6L-5S | | MI | 25376 | 8713 | 44553 | 6116 | 49490 | 4897 | 52261 | 3854 | 56284 | 2143 | 69198 | 1135 | 60498 |
| 18-#18 | 5.11 | MA | 33454 | 8713 | 57540 | 6300 | 64005 | 5054 | 67587 | 4015 | 72792 | 2380 | 90689 | 1056 | 81041 |
| 7L-4S | | MI | 26299 | 8713 | 46152 | 6132 | 51561 | 4873 | 54754 | 3832 | 59776 | 2165 | 73299 | 1232 | 61826 |
| 20-#11 | 2.22 | MA | 32094 | 7302 | 51365 | 5433 | 56447 | 4399 | 58529 | 3618 | 60506 | 2482 | 73087 | 2127 | 41445 |
| 4L-8S | | MI | 21564 | 7302 | 34837 | 5310 | 37254 | 4306 | 37757 | 3549 | 37204 | 2404 | 43904 | 1750 | 28191 |
| 20-#11 | 2.22 | MA | 31550 | 7302 | 50450 | 5430 | 55261 | 4395 | 57071 | 3631 | 58394 | 2475 | 70544 | 2085 | 41331 |
| 5L-7S | | MI | 21915 | 7302 | 35428 | 5315 | 38058 | 4312 | 38709 | 3540 | 38453 | 2396 | 45489 | 1794 | 28509 |
| 20-#11 | 2.22 | MA | 31033 | 7302 | 49593 | 5428 | 54073 | 4409 | 55619 | 3626 | 56481 | 2485 | 68121 | 2029 | 40706 |
| 6E | | MI | 22272 | 7302 | 36085 | 5302 | 38851 | 4302 | 39728 | 3548 | 39719 | 2387 | 47188 | 1885 | 28771 |
| 20-#11 | 2.22 | MA | 30529 | 7302 | 48653 | 5443 | 52940 | 4405 | 54226 | 3638 | 54611 | 2495 | 65537 | 1939 | 40203 |
| 7L-5S | | MI | 22637 | 7302 | 36685 | 5307 | 39680 | 4308 | 40696 | 3539 | 41015 | 2378 | 48774 | 1942 | 29193 |
| 20-#11 | 2.22 | MA | 30033 | 7302 | 47810 | 5441 | 51791 | 4419 | 52867 | 3651 | 52625 | 2488 | 63159 | 1890 | 39700 |
| 8L-4S | | MI | 23020 | 7302 | 37324 | 5311 | 40508 | 4297 | 41713 | 3530 | 42447 | 2387 | 50472 | 1979 | 29225 |
| 20-#11 | 2.22 | MA | 29514 | 7302 | 46984 | 5439 | 50673 | 4416 | 51445 | 3646 | 50773 | 2498 | 60810 | 1836 | 38904 |
| 9L-3S | | MI | 23447 | 7302 | 38061 | 5299 | 41447 | 4303 | 42853 | 3538 | 43874 | 2378 | 52064 | 2066 | 29223 |
| 20-#11 | 2.22 | MA | 28966 | 7302 | 46060 | 5454 | 49540 | 4430 | 50092 | 3659 | 48936 | 2508 | 58533 | 1775 | 38207 |
| 10L-2S | | MI | 24045 | 7302 | 38957 | 5303 | 42596 | 4292 | 44255 | 3529 | 45742 | 2370 | 54529 | 2152 | 29201 |
| 20-#14 | 3.20 | MA | 33256 | 7779 | 54727 | 5716 | 60642 | 4597 | 63596 | 3756 | 67253 | 2431 | 82593 | 1893 | 57744 |
| 5L-7S | | MI | 22714 | 7779 | 37806 | 5592 | 41009 | 4513 | 42255 | 3653 | 43145 | 2331 | 52143 | 1524 | 39098 |
| 20-#14 | 3.20 | MA | 32527 | 7779 | 53497 | 5712 | 58939 | 4617 | 61514 | 3749 | 64509 | 2445 | 79148 | 1812 | 56753 |
| 6E | | MI | 23217 | 7779 | 38747 | 5575 | 42143 | 4498 | 43711 | 3666 | 44940 | 2319 | 54245 | 1620 | 39864 |

## RECTANGULAR TIED COLUMNS 32" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

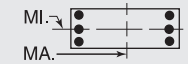
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 3.20 | MA | 31817 | 7779 | 52150 | 5733 | 57313 | 4611 | 59516 | 3766 | 61828 | 2459 | 75472 | 1682 | 55665 |
| 7L-5S | | MI | 23732 | 7779 | 39606 | 5582 | 43330 | 4508 | 45093 | 3653 | 46778 | 2306 | 56487 | 1702 | 40391 |
| 20-#14 | 3.20 | MA | 31118 | 7779 | 50939 | 5730 | 55665 | 4630 | 57565 | 3784 | 58978 | 2447 | 72082 | 1612 | 54323 |
| 8L-4S | | MI | 24273 | 7779 | 40520 | 5590 | 44515 | 4493 | 46545 | 3641 | 48809 | 2319 | 58889 | 1756 | 41189 |
| 20-#14 | 3.20 | MA | 30409 | 7779 | 49635 | 5751 | 54061 | 4625 | 55525 | 3776 | 56321 | 2461 | 68741 | 1534 | 52819 |
| 9L-3S | | MI | 24874 | 7779 | 41573 | 5572 | 45856 | 4503 | 48171 | 3653 | 50832 | 2306 | 61139 | 1880 | 41278 |
| 20-#18 | 5.68 | MA | 34930 | 8990 | 60802 | 6473 | 68188 | 5179 | 72690 | 4090 | 79715 | 2357 | 99911 | 1004 | 90601 |
| 7L-5S | | MI | 26342 | 8990 | 46778 | 6289 | 52343 | 5021 | 55691 | 3925 | 60834 | 2107 | 75146 | 1057 | 67170 |
| 22-#11 | 2.44 | MA | 32159 | 7410 | 51751 | 5498 | 56929 | 4444 | 59106 | 3660 | 61162 | 2467 | 74290 | 2069 | 45348 |
| 5L-8S | | MI | 21975 | 7410 | 35734 | 5378 | 38403 | 4354 | 39159 | 3579 | 39071 | 2393 | 46369 | 1725 | 30860 |
| 22-#11 | 2.44 | MA | 31644 | 7410 | 50894 | 5496 | 55741 | 4457 | 57654 | 3655 | 59249 | 2477 | 71868 | 2013 | 44651 |
| 6L-7S | | MI | 22325 | 7410 | 36325 | 5382 | 39207 | 4361 | 40111 | 3569 | 40321 | 2384 | 47955 | 1769 | 31236 |
| 22-#11 | 2.44 | MA | 31142 | 7410 | 49955 | 5511 | 54608 | 4454 | 56261 | 3668 | 57380 | 2487 | 69284 | 1923 | 44165 |
| 7L-6S | | MI | 22680 | 7410 | 36982 | 5370 | 40000 | 4350 | 41130 | 3578 | 41587 | 2375 | 49653 | 1860 | 31486 |
| 22-#11 | 2.44 | MA | 30648 | 7410 | 49111 | 5508 | 53459 | 4468 | 54901 | 3680 | 55393 | 2479 | 66906 | 1874 | 43601 |
| 8L-5S | | MI | 23044 | 7410 | 37582 | 5374 | 40830 | 4356 | 42098 | 3568 | 42883 | 2367 | 51240 | 1916 | 31943 |
| 22-#11 | 2.44 | MA | 30133 | 7410 | 48286 | 5506 | 52341 | 4464 | 53480 | 3676 | 53541 | 2489 | 64556 | 1820 | 42826 |
| 9L-4S | | MI | 23426 | 7410 | 38221 | 5379 | 41658 | 4345 | 43115 | 3559 | 44314 | 2375 | 52937 | 1954 | 32014 |
| 22-#11 | 2.44 | MA | 29586 | 7410 | 47361 | 5521 | 51208 | 4478 | 52127 | 3688 | 51705 | 2500 | 62280 | 1759 | 42088 |
| 10L-3S | | MI | 23851 | 7410 | 38957 | 5366 | 42596 | 4352 | 44255 | 3567 | 45742 | 2367 | 54529 | 2040 | 32028 |
| 22-#11 | 2.44 | MA | 29053 | 7410 | 46534 | 5519 | 50096 | 4474 | 50723 | 3683 | 49747 | 2492 | 59961 | 1707 | 41155 |
| 11L-2S | | MI | 24448 | 7410 | 39854 | 5371 | 43745 | 4341 | 45657 | 3558 | 47609 | 2358 | 56995 | 2127 | 32014 |
| 22-#14 | 3.52 | MA | 33386 | 7935 | 55360 | 5809 | 61327 | 4686 | 64427 | 3791 | 68473 | 2433 | 84479 | 1787 | 62404 |
| 6L-7S | | MI | 23289 | 7935 | 39086 | 5690 | 42649 | 4583 | 44252 | 3696 | 45793 | 2313 | 55629 | 1486 | 42882 |
| 22-#14 | 3.52 | MA | 32680 | 7935 | 54012 | 5830 | 59701 | 4681 | 62429 | 3809 | 65791 | 2446 | 80803 | 1657 | 61226 |
| 7L-6S | | MI | 23789 | 7935 | 40026 | 5672 | 43783 | 4568 | 45708 | 3708 | 47589 | 2301 | 57731 | 1581 | 43733 |
| 22-#14 | 3.52 | MA | 31985 | 7935 | 52802 | 5827 | 58053 | 4700 | 60478 | 3826 | 62942 | 2435 | 77413 | 1587 | 59923 |
| 8L-5S | | MI | 24302 | 7935 | 40885 | 5679 | 44970 | 4578 | 47090 | 3696 | 49426 | 2288 | 59972 | 1663 | 44234 |
| 22-#14 | 3.52 | MA | 31277 | 7935 | 51498 | 5848 | 56449 | 4695 | 58438 | 3819 | 60285 | 2449 | 74073 | 1509 | 58360 |
| 9L-4S | | MI | 24840 | 7935 | 41799 | 5687 | 46155 | 4563 | 48542 | 3683 | 51457 | 2301 | 62375 | 1717 | 45137 |
| 24-#11 | 2.66 | MA | 32252 | 7518 | 52195 | 5563 | 57409 | 4506 | 59689 | 3685 | 62017 | 2468 | 75614 | 1996 | 48601 |
| 6L-8S | | MI | 22384 | 7518 | 36630 | 5445 | 39553 | 4403 | 40561 | 3608 | 40939 | 2381 | 48834 | 1699 | 33534 |
| 24-#11 | 2.66 | MA | 31752 | 7518 | 51256 | 5578 | 56276 | 4502 | 58296 | 3697 | 60148 | 2478 | 73030 | 1906 | 48129 |
| 7E | | MI | 22733 | 7518 | 37221 | 5450 | 40357 | 4409 | 41513 | 3599 | 42188 | 2372 | 50420 | 1744 | 33964 |
| 24-#11 | 2.66 | MA | 31260 | 7518 | 50412 | 5576 | 55127 | 4516 | 56936 | 3710 | 58162 | 2471 | 70652 | 1857 | 47507 |
| 8L-6S | | MI | 23087 | 7518 | 37878 | 5437 | 41149 | 4398 | 42532 | 3607 | 43454 | 2364 | 52118 | 1835 | 34205 |
| 24-#11 | 2.66 | MA | 30748 | 7518 | 49587 | 5574 | 54009 | 4513 | 55514 | 3705 | 56310 | 2481 | 68303 | 1804 | 46753 |
| 9L-5S | | MI | 23450 | 7518 | 38478 | 5442 | 41979 | 4405 | 43500 | 3598 | 44750 | 2355 | 53705 | 1891 | 34640 |
| 24-#11 | 2.66 | MA | 30203 | 7518 | 48662 | 5589 | 52876 | 4526 | 54162 | 3718 | 54473 | 2491 | 66027 | 1743 | 45974 |
| 10L-4S | | MI | 23830 | 7518 | 39117 | 5446 | 42807 | 4394 | 44517 | 3589 | 46182 | 2364 | 55403 | 1929 | 34799 |
| 24-#11 | 2.66 | MA | 29672 | 7518 | 47835 | 5586 | 51764 | 4523 | 52758 | 3713 | 52515 | 2484 | 63708 | 1690 | 45061 |
| 11L-3S | | MI | 24254 | 7518 | 39854 | 5434 | 43745 | 4400 | 45657 | 3597 | 47609 | 2355 | 56995 | 2015 | 34825 |
| 24-#14 | 3.84 | MA | 33537 | 8091 | 55875 | 5928 | 62089 | 4751 | 65342 | 3851 | 69755 | 2434 | 86134 | 1631 | 66796 |
| 7E | | MI | 23861 | 8091 | 40365 | 5787 | 44289 | 4653 | 46250 | 3738 | 48442 | 2295 | 59114 | 1447 | 46675 |
| 24-#14 | 3.84 | MA | 32846 | 8091 | 54665 | 5924 | 60441 | 4770 | 63391 | 3868 | 66906 | 2423 | 82744 | 1561 | 65530 |
| 8L-6S | | MI | 24359 | 8091 | 41305 | 5769 | 45423 | 4638 | 47706 | 3750 | 50237 | 2283 | 61216 | 1542 | 47605 |
| 24-#14 | 3.84 | MA | 32139 | 8091 | 53361 | 5945 | 58837 | 4764 | 61352 | 3861 | 64249 | 2436 | 79404 | 1484 | 63910 |
| 9L-5S | | MI | 24870 | 8091 | 42164 | 5777 | 46610 | 4648 | 49088 | 3738 | 52075 | 2270 | 63457 | 1624 | 48084 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis

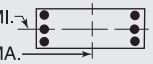



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.09 | MA | 33217 | 7060 | 51542 | 5273 | 55572 | 4302 | 56410 | 3594 | 55678 | 2602 | 65011 | 2461 | 22533 |
| 2E | | MI | 22857 | 7060 | 36010 | 5115 | 38197 | 4172 | 38334 | 3476 | 37174 | 2488 | 42805 | 2321 | 15305 |
| 6-#18 | 1.63 | MA | 34825 | 7336 | 54977 | 5445 | 59977 | 4426 | 61784 | 3669 | 62989 | 2580 | 74781 | 2413 | 33348 |
| 2L-3S | | MI | 22363 | 7336 | 36010 | 5273 | 38197 | 4320 | 38334 | 3570 | 37174 | 2474 | 42805 | 2021 | 22534 |
| 6-#18 | 1.63 | MA | 32504 | 7336 | 51542 | 5438 | 55572 | 4459 | 56410 | 3699 | 55678 | 2602 | 65011 | 2192 | 33367 |
| 3L-2S | | MI | 23858 | 7336 | 38235 | 5288 | 41050 | 4296 | 41764 | 3547 | 41724 | 2452 | 48753 | 2243 | 22407 |
| 8-#14 | 1.22 | MA | 33707 | 7129 | 52350 | 5348 | 56814 | 4359 | 58004 | 3635 | 57878 | 2614 | 68241 | 2479 | 25413 |
| 2L-4S | | MI | 21703 | 7129 | 34211 | 5215 | 36089 | 4246 | 35931 | 3534 | 34144 | 2539 | 39331 | 2097 | 17367 |
| 8-#14 | 1.22 | MA | 32372 | 7129 | 50390 | 5345 | 54301 | 4354 | 54938 | 3653 | 53708 | 2628 | 62601 | 2355 | 25466 |
| 3E | | MI | 22323 | 7129 | 35263 | 5198 | 37430 | 4256 | 37558 | 3547 | 36168 | 2527 | 41581 | 2221 | 17289 |
| 8-#14 | 1.22 | MA | 31435 | 7129 | 48795 | 5367 | 52268 | 4374 | 52468 | 3646 | 50528 | 2642 | 58927 | 2230 | 25459 |
| 4L-2S | | MI | 23189 | 7129 | 36543 | 5205 | 39070 | 4242 | 39555 | 3534 | 38816 | 2514 | 45066 | 2346 | 17211 |
| 8-#18 | 2.17 | MA | 36413 | 7613 | 58413 | 5618 | 64381 | 4550 | 67157 | 3744 | 70300 | 2557 | 84551 | 2365 | 44114 |
| 2L-4S | | MI | 22298 | 7613 | 36397 | 5474 | 38709 | 4423 | 38970 | 3619 | 38248 | 2459 | 44903 | 1730 | 29414 |
| 8-#18 | 2.17 | MA | 34113 | 7613 | 54977 | 5611 | 59977 | 4583 | 61784 | 3774 | 62989 | 2580 | 74781 | 2143 | 44027 |
| 3E | | MI | 23364 | 7613 | 38235 | 5446 | 41050 | 4444 | 41764 | 3641 | 41724 | 2437 | 48753 | 1943 | 29521 |
| 8-#18 | 2.17 | MA | 32498 | 7613 | 52175 | 5648 | 56405 | 4572 | 57443 | 3760 | 57403 | 2603 | 68430 | 1922 | 43547 |
| 4L-2S | | MI | 24848 | 7613 | 40461 | 5461 | 43903 | 4420 | 45195 | 3619 | 46273 | 2415 | 54701 | 2165 | 29445 |
| 10-#11 | 1.06 | MA | 33250 | 7046 | 51269 | 5313 | 55533 | 4335 | 56482 | 3624 | 55825 | 2629 | 65591 | 2506 | 22193 |
| 2L-5S | | MI | 21478 | 7046 | 33566 | 5180 | 35348 | 4239 | 35060 | 3539 | 32907 | 2549 | 37805 | 2177 | 15250 |
| 10-#11 | 1.06 | MA | 32313 | 7046 | 49901 | 5311 | 53779 | 4332 | 54342 | 3637 | 52913 | 2639 | 61630 | 2420 | 22234 |
| 3L-4S | | MI | 21869 | 7046 | 34205 | 5185 | 36176 | 4228 | 36077 | 3530 | 34338 | 2558 | 39503 | 2214 | 15194 |
| 10-#11 | 1.06 | MA | 31658 | 7046 | 48788 | 5326 | 52361 | 4346 | 52618 | 3632 | 50695 | 2650 | 59047 | 2334 | 22263 |
| 4L-3S | | MI | 22304 | 7046 | 34941 | 5172 | 37114 | 4234 | 37217 | 3538 | 35766 | 2549 | 41095 | 2301 | 15136 |
| 10-#11 | 1.06 | MA | 31073 | 7046 | 47828 | 5324 | 51116 | 4343 | 51087 | 3645 | 48477 | 2643 | 56362 | 2291 | 22247 |
| 5L-2S | | MI | 22913 | 7046 | 35838 | 5177 | 38263 | 4223 | 38619 | 3529 | 37633 | 2541 | 43560 | 2387 | 15084 |
| 10-#14 | 1.53 | MA | 34632 | 7284 | 54310 | 5445 | 59327 | 4429 | 61069 | 3678 | 62049 | 2601 | 73881 | 2455 | 31569 |
| 2L-5S | | MI | 21737 | 7284 | 34576 | 5305 | 36544 | 4331 | 36477 | 3589 | 34762 | 2509 | 40414 | 2005 | 21387 |
| 10-#14 | 1.53 | MA | 33304 | 7284 | 52350 | 5442 | 56814 | 4424 | 58004 | 3695 | 57878 | 2615 | 68241 | 2331 | 31599 |
| 3L-4S | | MI | 22292 | 7284 | 35490 | 5313 | 37729 | 4316 | 37929 | 3576 | 36793 | 2521 | 42817 | 2059 | 21391 |
| 10-#14 | 1.53 | MA | 32373 | 7284 | 50755 | 5464 | 54781 | 4444 | 55533 | 3689 | 54699 | 2630 | 64567 | 2206 | 31543 |
| 4L-3S | | MI | 22909 | 7284 | 36543 | 5295 | 39070 | 4326 | 39555 | 3589 | 38816 | 2509 | 45066 | 2182 | 21338 |
| 10-#14 | 1.53 | MA | 31543 | 7284 | 49377 | 5461 | 52994 | 4439 | 53336 | 3707 | 51517 | 2619 | 60737 | 2146 | 31346 |
| 5L-2S | | MI | 23771 | 7284 | 37822 | 5302 | 40710 | 4311 | 41553 | 3576 | 41465 | 2496 | 48552 | 2307 | 21272 |
| 10-#18 | 2.72 | MA | 37982 | 7889 | 61849 | 5791 | 68786 | 4674 | 72530 | 3820 | 77610 | 2535 | 94320 | 2316 | 54836 |
| 2L-5S | | MI | 22345 | 7889 | 37023 | 5632 | 39490 | 4571 | 39907 | 3713 | 39307 | 2401 | 46751 | 1554 | 34226 |
| 10-#18 | 2.72 | MA | 35702 | 7889 | 58413 | 5784 | 64381 | 4707 | 67157 | 3849 | 70300 | 2558 | 84551 | 2095 | 54660 |
| 3L-4S | | MI | 23297 | 7889 | 38622 | 5647 | 41562 | 4547 | 42400 | 3691 | 42798 | 2423 | 50851 | 1652 | 36050 |
| 10-#18 | 2.72 | MA | 34103 | 7889 | 55611 | 5821 | 60809 | 4696 | 62816 | 3835 | 64713 | 2580 | 78200 | 1874 | 54078 |
| 4L-3S | | MI | 24356 | 7889 | 40461 | 5619 | 43903 | 4568 | 45195 | 3713 | 46273 | 2401 | 54701 | 1866 | 36454 |
| 10-#18 | 2.72 | MA | 32675 | 7889 | 53186 | 5813 | 57665 | 4730 | 58953 | 3865 | 59119 | 2559 | 71542 | 1769 | 50764 |
| 5L-2S | | MI | 25829 | 7889 | 42686 | 5634 | 46756 | 4545 | 48626 | 3691 | 50823 | 2379 | 60649 | 2087 | 36445 |
| 12-#11 | 1.27 | MA | 33902 | 7154 | 52638 | 5380 | 57288 | 4384 | 58622 | 3653 | 58737 | 2620 | 69552 | 2491 | 26495 |
| 2L-6S | | MI | 21524 | 7154 | 33863 | 5243 | 35667 | 4281 | 35494 | 3578 | 33479 | 2546 | 38684 | 2095 | 18085 |
| 12-#11 | 1.27 | MA | 32969 | 7154 | 51269 | 5378 | 55533 | 4381 | 56482 | 3666 | 55825 | 2631 | 65591 | 2404 | 26526 |
| 3L-5S | | MI | 21895 | 7154 | 34463 | 5247 | 36497 | 4287 | 36462 | 3568 | 34774 | 2538 | 40271 | 2152 | 18072 |
| 12-#11 | 1.27 | MA | 32316 | 7154 | 50157 | 5393 | 54116 | 4395 | 54759 | 3662 | 53607 | 2641 | 63007 | 2318 | 26537 |
| 4E | | MI | 22285 | 7154 | 35102 | 5252 | 37325 | 4276 | 37479 | 3559 | 36206 | 2546 | 41968 | 2189 | 18032 |
| 12-#11 | 1.27 | MA | 31734 | 7154 | 49196 | 5391 | 52870 | 4392 | 53227 | 3675 | 51389 | 2635 | 60323 | 2276 | 26495 |
| 5L-3S | | MI | 22718 | 7154 | 35838 | 5239 | 38263 | 4283 | 38619 | 3567 | 37633 | 2538 | 43560 | 2275 | 17983 |
| 12-#11 | 1.27 | MA | 31181 | 7154 | 48296 | 5389 | 51623 | 4406 | 51703 | 3670 | 49379 | 2645 | 57761 | 2220 | 26332 |
| 6L-2S | | MI | 23325 | 7154 | 36734 | 5244 | 39413 | 4272 | 40021 | 3558 | 39501 | 2529 | 46026 | 2362 | 17935 |
| 12-#14 | 1.83 | MA | 35550 | 7440 | 56270 | 5543 | 61839 | 4499 | 64134 | 3720 | 66220 | 2589 | 79521 | 2432 | 37710 |
| 2L-6S | | MI | 21798 | 7440 | 34996 | 5395 | 36997 | 4391 | 37093 | 3643 | 35573 | 2503 | 41658 | 1884 | 24607 |
| 12-#14 | 1.83 | MA | 34228 | 7440 | 54310 | 5539 | 59327 | 4494 | 61069 | 3738 | 62049 | 2603 | 73881 | 2307 | 37707 |
| 3L-5S | | MI | 22325 | 7440 | 35855 | 5403 | 38184 | 4401 | 38475 | 3631 | 37410 | 2491 | 43899 | 1966 | 25295 |

## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

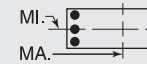
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 1.83 | MA | 33304 | 7440 | 52715 | 5561 | 57294 | 4514 | 58598 | 3731 | 58869 | 2617 | 70207 | 2182 | 37616 |
| 4E | | MI | 22877 | 7440 | 36769 | 5410 | 39369 | 4386 | 39926 | 3619 | 39441 | 2503 | 46302 | 2020 | 25397 |
| 12-#14 | 1.83 | MA | 32478 | 7440 | 51337 | 5558 | 55506 | 4509 | 56402 | 3749 | 55687 | 2607 | 66377 | 2122 | 37372 |
| 5L-3S | | MI | 23491 | 7440 | 37822 | 5392 | 40710 | 4396 | 41553 | 3631 | 41465 | 2491 | 48552 | 2143 | 25367 |
| 12-#14 | 1.83 | MA | 31693 | 7440 | 50045 | 5555 | 53717 | 4528 | 54214 | 3742 | 52804 | 2621 | 62731 | 2041 | 36069 |
| 6L-2S | | MI | 24349 | 7440 | 39101 | 5400 | 42350 | 4381 | 43550 | 3619 | 44114 | 2478 | 52037 | 2268 | 25315 |
| 12-#18 | 3.26 | MA | 37274 | 8166 | 61849 | 5957 | 68786 | 4831 | 72530 | 3925 | 77610 | 2536 | 94320 | 2047 | 65275 |
| 3L-5S | | MI | 23342 | 8166 | 39249 | 5805 | 42343 | 4695 | 43337 | 3784 | 43856 | 2364 | 52699 | 1477 | 40825 |
| 12-#18 | 3.26 | MA | 35689 | 8166 | 59046 | 5994 | 65214 | 4820 | 68189 | 3910 | 72024 | 2558 | 87970 | 1825 | 64282 |
| 4E | | MI | 24287 | 8166 | 40848 | 5820 | 44415 | 4672 | 45831 | 3762 | 47348 | 2386 | 56799 | 1574 | 42510 |
| 12-#18 | 3.26 | MA | 34275 | 8166 | 56622 | 5986 | 62070 | 4854 | 64326 | 3940 | 66429 | 2537 | 81312 | 1721 | 61046 |
| 5L-3S | | MI | 25338 | 8166 | 42686 | 5791 | 46756 | 4692 | 48626 | 3784 | 50823 | 2364 | 60649 | 1788 | 43355 |
| 12-#18 | 3.26 | MA | 32930 | 8166 | 54348 | 5979 | 58921 | 4843 | 60478 | 3926 | 61359 | 2559 | 75003 | 1577 | 58476 |
| 6L-2S | | MI | 26802 | 8166 | 44912 | 5807 | 49609 | 4669 | 52056 | 3762 | 55372 | 2342 | 66597 | 2009 | 43425 |
| 14-#11 | 1.48 | MA | 34550 | 7261 | 54006 | 5447 | 59042 | 4432 | 60762 | 3683 | 61649 | 2612 | 73513 | 2475 | 30789 |
| 2L-7S | | MI | 21579 | 7261 | 34102 | 5323 | 36024 | 4340 | 35877 | 3599 | 34080 | 2543 | 39451 | 1979 | 20462 |
| 14-#11 | 1.48 | MA | 33621 | 7261 | 52638 | 5446 | 57288 | 4429 | 58622 | 3696 | 58737 | 2622 | 69552 | 2389 | 30811 |
| 3L-6S | | MI | 21940 | 7261 | 34759 | 5310 | 36817 | 4329 | 36896 | 3607 | 35346 | 2535 | 41149 | 2070 | 20777 |
| 14-#11 | 1.48 | MA | 32971 | 7261 | 51525 | 5461 | 55870 | 4443 | 56899 | 3691 | 56519 | 2633 | 66968 | 2303 | 30799 |
| 4L-5S | | MI | 22311 | 7261 | 35359 | 5315 | 37646 | 4336 | 37864 | 3598 | 36642 | 2526 | 42736 | 2126 | 20883 |
| 14-#11 | 1.48 | MA | 32392 | 7261 | 50565 | 5459 | 54624 | 4440 | 55368 | 3704 | 54301 | 2626 | 64284 | 2260 | 30737 |
| 5L-4S | | MI | 22699 | 7261 | 35998 | 5320 | 38474 | 4325 | 38881 | 3589 | 38074 | 2535 | 44434 | 2164 | 20857 |
| 14-#11 | 1.48 | MA | 31841 | 7261 | 49665 | 5457 | 53377 | 4454 | 53843 | 3700 | 52291 | 2637 | 61721 | 2204 | 30452 |
| 6L-3S | | MI | 23130 | 7261 | 36734 | 5307 | 39413 | 4331 | 40021 | 3597 | 39501 | 2526 | 46026 | 2250 | 20817 |
| 14-#11 | 1.48 | MA | 31304 | 7261 | 48679 | 5472 | 52187 | 4451 | 52380 | 3713 | 50328 | 2647 | 58990 | 2115 | 29831 |
| 7L-2S | | MI | 23735 | 7261 | 37631 | 5311 | 40562 | 4320 | 41423 | 3588 | 41369 | 2518 | 48491 | 2337 | 20775 |
| 14-#14 | 2.14 | MA | 36461 | 7596 | 58230 | 5640 | 64352 | 4569 | 67200 | 3762 | 70390 | 2576 | 85161 | 2408 | 43842 |
| 2L-7S | | MI | 21874 | 7596 | 35335 | 5510 | 37502 | 4476 | 37634 | 3673 | 36426 | 2498 | 43041 | 1750 | 28067 |
| 14-#14 | 2.14 | MA | 35146 | 7596 | 56270 | 5637 | 61839 | 4564 | 64134 | 3780 | 66220 | 2591 | 79521 | 2283 | 43804 |
| 3L-6S | | MI | 22385 | 7596 | 36275 | 5493 | 38637 | 4461 | 39090 | 3686 | 38221 | 2485 | 45143 | 1845 | 28450 |
| 14-#14 | 2.14 | MA | 34227 | 7596 | 54675 | 5658 | 59807 | 4583 | 61664 | 3773 | 63040 | 2605 | 75847 | 2159 | 43680 |
| 4L-5S | | MI | 22909 | 7596 | 37134 | 5500 | 39824 | 4471 | 40472 | 3673 | 40059 | 2473 | 47384 | 1927 | 29093 |
| 14-#14 | 2.14 | MA | 33407 | 7596 | 53297 | 5655 | 58019 | 4578 | 59467 | 3791 | 59858 | 2594 | 72017 | 2098 | 43225 |
| 5L-4S | | MI | 23458 | 7596 | 38048 | 5507 | 41009 | 4456 | 41924 | 3661 | 42090 | 2485 | 49787 | 1981 | 29381 |
| 14-#14 | 2.14 | MA | 32626 | 7596 | 52005 | 5652 | 56229 | 4598 | 57280 | 3785 | 56975 | 2609 | 68371 | 2017 | 41983 |
| 6L-3S | | MI | 24069 | 7596 | 39101 | 5490 | 42350 | 4466 | 43550 | 3673 | 44114 | 2473 | 52037 | 2105 | 29382 |
| 14-#14 | 2.14 | MA | 31866 | 7596 | 50590 | 5673 | 54522 | 4593 | 55180 | 3802 | 54159 | 2623 | 64481 | 1888 | 41186 |
| 7L-2S | | MI | 24924 | 7596 | 40380 | 5497 | 43990 | 4451 | 45548 | 3661 | 46762 | 2460 | 55522 | 2229 | 29344 |
| 14-#18 | 3.80 | MA | 37259 | 8443 | 62482 | 6166 | 69618 | 4945 | 73563 | 3986 | 79335 | 2536 | 97739 | 1777 | 74428 |
| 4L-5S | | MI | 24331 | 8443 | 41474 | 5978 | 45196 | 4819 | 46768 | 3856 | 48406 | 2328 | 58647 | 1399 | 47450 |
| 14-#18 | 3.80 | MA | 35858 | 8443 | 60057 | 6159 | 66475 | 4978 | 69699 | 4015 | 73740 | 2515 | 91082 | 1672 | 71355 |
| 5L-4S | | MI | 25269 | 8443 | 43073 | 5993 | 47268 | 4796 | 49261 | 3834 | 51897 | 2350 | 62747 | 1496 | 49013 |
| 14-#18 | 3.80 | MA | 34526 | 8443 | 57784 | 6152 | 63326 | 4967 | 65851 | 4001 | 68669 | 2537 | 84773 | 1528 | 68595 |
| 6L-3S | | MI | 26313 | 8443 | 44912 | 5964 | 49609 | 4816 | 52056 | 3856 | 55372 | 2328 | 66597 | 1710 | 50236 |
| 14-#18 | 3.80 | MA | 33229 | 8443 | 55293 | 6188 | 60322 | 5000 | 62158 | 4031 | 63714 | 2560 | 78037 | 1297 | 65436 |
| 7L-2S | | MI | 27767 | 8443 | 47137 | 5980 | 52462 | 4793 | 55487 | 3834 | 59922 | 2306 | 72545 | 1931 | 50360 |
| 16-#11 | 1.70 | MA | 35195 | 7369 | 55375 | 5515 | 60797 | 4481 | 62902 | 3712 | 64560 | 2603 | 77474 | 2460 | 35076 |
| 2L-8S | | MI | 21640 | 7369 | 34407 | 5386 | 36369 | 4382 | 36328 | 3637 | 34698 | 2540 | 40331 | 1909 | 22987 |
| 16-#11 | 1.70 | MA | 34269 | 7369 | 54006 | 5513 | 59042 | 4477 | 60762 | 3725 | 61649 | 2614 | 73513 | 2374 | 35086 |
| 3L-7S | | MI | 21995 | 7369 | 34999 | 5390 | 37173 | 4389 | 37279 | 3628 | 35948 | 2532 | 41917 | 1954 | 23181 |
| 16-#11 | 1.70 | MA | 33622 | 7369 | 52894 | 5528 | 57625 | 4492 | 59039 | 3721 | 59431 | 2624 | 70929 | 2287 | 35055 |
| 4L-6S | | MI | 22355 | 7369 | 35656 | 5378 | 37966 | 4378 | 38299 | 3636 | 37214 | 2523 | 43615 | 2044 | 23477 |
| 16-#11 | 1.70 | MA | 33046 | 7369 | 51933 | 5526 | 56379 | 4488 | 57508 | 3734 | 57212 | 2617 | 68245 | 2245 | 34974 |
| 5E | | MI | 22724 | 7369 | 36256 | 5382 | 38796 | 4384 | 39266 | 3627 | 38510 | 2515 | 45202 | 2101 | 23687 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis

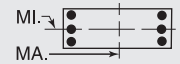



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.70 | MA | 32497 | 7369 | 51033 | 5524 | 55131 | 4503 | 55983 | 3729 | 55203 | 2628 | 65682 | 2189 | 34581 |
| 6L-4S | | MI | 23110 | 7369 | 36895 | 5387 | 39624 | 4373 | 40283 | 3618 | 39942 | 2523 | 46899 | 2139 | 23673 |
| 16-#11 | 1.70 | MA | 31962 | 7369 | 50047 | 5540 | 53942 | 4499 | 54520 | 3742 | 53240 | 2638 | 62951 | 2099 | 33986 |
| 7L-3S | | MI | 23540 | 7369 | 37631 | 5374 | 40562 | 4380 | 41423 | 3626 | 41369 | 2515 | 48491 | 2225 | 23642 |
| 16-#11 | 1.70 | MA | 31436 | 7369 | 49162 | 5538 | 52735 | 4513 | 53093 | 3755 | 51154 | 2632 | 60440 | 2049 | 33559 |
| 8L-2S | | MI | 24143 | 7369 | 38527 | 5379 | 41711 | 4369 | 42825 | 3617 | 43236 | 2506 | 50956 | 2311 | 23606 |
| 16-#14 | 2.45 | MA | 36058 | 7751 | 58230 | 5734 | 64352 | 4634 | 67200 | 3823 | 70390 | 2578 | 85161 | 2259 | 49892 |
| 3L-7S | | MI | 22459 | 7751 | 36614 | 5607 | 39142 | 4546 | 39632 | 3715 | 39074 | 2480 | 46526 | 1711 | 31828 |
| 16-#14 | 2.45 | MA | 35144 | 7751 | 56635 | 5756 | 62319 | 4653 | 64729 | 3816 | 67211 | 2593 | 81486 | 2135 | 49738 |
| 4L-6S | | MI | 22968 | 7751 | 37554 | 5590 | 40277 | 4531 | 41088 | 3728 | 40870 | 2467 | 48628 | 1806 | 32303 |
| 16-#14 | 2.45 | MA | 34329 | 7751 | 55257 | 5752 | 60532 | 4648 | 62532 | 3834 | 64028 | 2582 | 77657 | 2074 | 49096 |
| 5E | | MI | 23490 | 7751 | 38413 | 5597 | 41464 | 4541 | 42470 | 3715 | 42708 | 2455 | 50869 | 1888 | 32906 |
| 16-#14 | 2.45 | MA | 33553 | 7751 | 53965 | 5749 | 58742 | 4668 | 60345 | 3827 | 61146 | 2596 | 74011 | 1994 | 47909 |
| 6L-4S | | MI | 24036 | 7751 | 39328 | 5604 | 42648 | 4526 | 43922 | 3703 | 44739 | 2467 | 53272 | 1942 | 33354 |
| 16-#14 | 2.45 | MA | 32797 | 7751 | 52550 | 5771 | 57035 | 4663 | 58246 | 3845 | 58329 | 2611 | 70121 | 1864 | 47117 |
| 7L-3S | | MI | 24644 | 7751 | 40380 | 5587 | 43990 | 4536 | 45548 | 3715 | 46762 | 2455 | 55522 | 2066 | 33387 |
| 16-#14 | 2.45 | MA | 32054 | 7751 | 51278 | 5767 | 55303 | 4683 | 56197 | 3863 | 55336 | 2600 | 66540 | 1793 | 45552 |
| 8L-2S | | MI | 25495 | 7751 | 41660 | 5594 | 45629 | 4521 | 47546 | 3703 | 49411 | 2442 | 59007 | 2190 | 33362 |
| 16-#18 | 4.35 | MA | 37426 | 8719 | 63493 | 6332 | 70879 | 5102 | 75073 | 4091 | 81051 | 2493 | 100852 | 1624 | 81688 |
| 5E | | MI | 25312 | 8719 | 43700 | 6151 | 48049 | 4943 | 50199 | 3927 | 52955 | 2291 | 64594 | 1321 | 54093 |
| 16-#18 | 4.35 | MA | 36106 | 8719 | 61220 | 6325 | 67730 | 5091 | 71225 | 4076 | 75980 | 2515 | 94542 | 1480 | 78744 |
| 6L-4S | | MI | 26244 | 8719 | 45299 | 6166 | 50121 | 4920 | 52692 | 3905 | 56447 | 2313 | 68695 | 1418 | 55551 |
| 16-#18 | 4.35 | MA | 34820 | 8719 | 58729 | 6361 | 64726 | 5124 | 67531 | 4106 | 71025 | 2538 | 87807 | 1249 | 75696 |
| 7L-3S | | MI | 27281 | 8719 | 47137 | 6137 | 52462 | 4941 | 55487 | 3927 | 59922 | 2291 | 72545 | 1632 | 57102 |
| 16-#18 | 4.35 | MA | 33556 | 8719 | 56491 | 6354 | 61679 | 5113 | 63925 | 4136 | 65759 | 2516 | 81583 | 1126 | 71676 |
| 8L-2S | | MI | 28725 | 8719 | 49363 | 6153 | 55315 | 4917 | 58917 | 3905 | 64471 | 2269 | 78493 | 1853 | 57276 |
| 18-#11 | 1.91 | MA | 34914 | 7477 | 55375 | 5580 | 60797 | 4526 | 62902 | 3754 | 64560 | 2605 | 77474 | 2358 | 39350 |
| 3L-8S | | MI | 22056 | 7477 | 35304 | 5453 | 37519 | 4431 | 37730 | 3667 | 36566 | 2529 | 42796 | 1884 | 25717 |
| 18-#11 | 1.91 | MA | 34270 | 7477 | 54262 | 5596 | 59379 | 4540 | 61179 | 3750 | 62343 | 2615 | 74890 | 2272 | 39305 |
| 4L-7S | | MI | 22409 | 7477 | 35895 | 5458 | 38323 | 4437 | 38681 | 3658 | 37815 | 2520 | 44382 | 1929 | 25904 |
| 18-#11 | 1.91 | MA | 33696 | 7477 | 53302 | 5594 | 58133 | 4537 | 59648 | 3763 | 60124 | 2609 | 72206 | 2229 | 39207 |
| 5L-6S | | MI | 22767 | 7477 | 36552 | 5445 | 39115 | 4426 | 39701 | 3666 | 39082 | 2512 | 46080 | 2019 | 26184 |
| 18-#11 | 1.91 | MA | 33150 | 7477 | 52402 | 5592 | 56886 | 4551 | 58123 | 3759 | 58115 | 2619 | 69643 | 2174 | 38719 |
| 6L-5S | | MI | 23135 | 7477 | 37152 | 5450 | 39945 | 4433 | 40668 | 3657 | 40378 | 2503 | 47667 | 2076 | 26476 |
| 18-#11 | 1.91 | MA | 32618 | 7477 | 51416 | 5607 | 55696 | 4548 | 56661 | 3772 | 56152 | 2630 | 66911 | 2084 | 38147 |
| 7L-4S | | MI | 23520 | 7477 | 37791 | 5454 | 40773 | 4422 | 41686 | 3647 | 41809 | 2512 | 49364 | 2114 | 26482 |
| 18-#11 | 1.91 | MA | 32094 | 7477 | 50530 | 5605 | 54490 | 4562 | 55233 | 3784 | 54066 | 2623 | 64401 | 2034 | 37729 |
| 8L-3S | | MI | 23949 | 7477 | 38527 | 5442 | 41711 | 4428 | 42825 | 3656 | 43236 | 2503 | 50956 | 2200 | 26461 |
| 18-#11 | 1.91 | MA | 31537 | 7477 | 49664 | 5603 | 53316 | 4559 | 53740 | 3780 | 52121 | 2634 | 61916 | 1980 | 36889 |
| 9L-2S | | MI | 24550 | 7477 | 39424 | 5446 | 42860 | 4417 | 44227 | 3646 | 45104 | 2494 | 53422 | 2286 | 26430 |
| 18-#14 | 2.75 | MA | 36055 | 7907 | 58595 | 5853 | 64832 | 4723 | 67794 | 3858 | 71381 | 2580 | 87126 | 2111 | 55792 |
| 4L-7S | | MI | 23042 | 7907 | 37894 | 5705 | 40782 | 4615 | 41629 | 3758 | 41723 | 2462 | 50011 | 1672 | 35588 |
| 18-#14 | 2.75 | MA | 35244 | 7907 | 57217 | 5850 | 63044 | 4718 | 65598 | 3876 | 68199 | 2570 | 83297 | 2050 | 54982 |
| 5L-6S | | MI | 23548 | 7907 | 38834 | 5687 | 41917 | 4600 | 43086 | 3770 | 43518 | 2449 | 52114 | 1767 | 36163 |
| 18-#14 | 2.75 | MA | 34473 | 7907 | 55925 | 5846 | 61255 | 4738 | 63410 | 3869 | 65316 | 2584 | 79651 | 1970 | 53844 |
| 6L-5S | | MI | 24067 | 7907 | 39693 | 5694 | 43104 | 4610 | 44468 | 3758 | 45356 | 2437 | 54355 | 1850 | 36731 |
| 18-#14 | 2.75 | MA | 33722 | 7907 | 54510 | 5868 | 59548 | 4733 | 61311 | 3887 | 62500 | 2598 | 75761 | 1840 | 52950 |
| 7L-4S | | MI | 24611 | 7907 | 40607 | 5702 | 44288 | 4596 | 45919 | 3745 | 47387 | 2449 | 56757 | 1903 | 37318 |
| 18-#14 | 2.75 | MA | 32983 | 7907 | 53239 | 5865 | 57816 | 4753 | 59262 | 3905 | 59506 | 2588 | 72180 | 1769 | 51433 |
| 8L-3S | | MI | 25216 | 7907 | 41660 | 5684 | 45629 | 4606 | 47546 | 3758 | 49411 | 2437 | 59007 | 2027 | 37373 |
| 18-#14 | 2.75 | MA | 32205 | 7907 | 51995 | 5861 | 56132 | 4747 | 57120 | 3898 | 56716 | 2602 | 68645 | 1692 | 50041 |
| 9L-2S | | MI | 26063 | 7907 | 42939 | 5691 | 47269 | 4591 | 49543 | 3745 | 52059 | 2424 | 62493 | 2152 | 37373 |
| 18-#18 | 4.89 | MA | 37671 | 8996 | 64656 | 6497 | 72135 | 5215 | 76598 | 4152 | 83291 | 2493 | 104312 | 1432 | 88918 |
| 6L-5S | | MI | 26286 | 8996 | 45925 | 6324 | 50902 | 5068 | 53629 | 3999 | 57505 | 2255 | 70542 | 1243 | 60752 |
| 18-#18 | 4.89 | MA | 36397 | 8996 | 62165 | 6534 | 69131 | 5248 | 72904 | 4181 | 78335 | 2516 | 97577 | 1201 | 85976 |
| 7L-4S | | MI | 27212 | 8996 | 47524 | 6339 | 52974 | 5044 | 56123 | 3977 | 60996 | 2277 | 74643 | 1340 | 62117 |
| 18-#18 | 4.89 | MA | 35143 | 8996 | 59926 | 6527 | 66083 | 5237 | 69298 | 4211 | 73070 | 2494 | 91353 | 1078 | 81849 |
| 8L-3S | | MI | 28242 | 8996 | 49363 | 6310 | 55315 | 5065 | 58917 | 3999 | 64471 | 2255 | 78493 | 1554 | 63956 |

## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

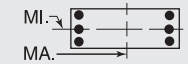
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.12 | MA | 34914 | 7585 | 55631 | 5663 | 61133 | 4588 | 63320 | 3779 | 65255 | 2607 | 78851 | 2256 | 43551 |
| 4L-8S | | MI | 22469 | 7585 | 36200 | 5521 | 38668 | 4479 | 39132 | 3696 | 38434 | 2517 | 45262 | 1859 | 28384 |
| 20-#11 | 2.12 | MA | 34343 | 7585 | 54670 | 5661 | 59887 | 4585 | 61788 | 3792 | 63036 | 2600 | 76166 | 2214 | 43437 |
| 5L-7S | | MI | 22821 | 7585 | 36792 | 5525 | 39472 | 4486 | 40083 | 3687 | 39683 | 2509 | 46847 | 1904 | 28630 |
| 20-#11 | 2.12 | MA | 33799 | 7585 | 53771 | 5659 | 58640 | 4599 | 60264 | 3788 | 61027 | 2611 | 73604 | 2158 | 42864 |
| 6E | | MI | 23178 | 7585 | 37449 | 5513 | 40264 | 4475 | 41103 | 3695 | 40949 | 2500 | 48546 | 1994 | 28896 |
| 20-#11 | 2.12 | MA | 33269 | 7585 | 52784 | 5674 | 57451 | 4596 | 58801 | 3801 | 59064 | 2621 | 70872 | 2068 | 42311 |
| 7L-5S | | MI | 23544 | 7585 | 38049 | 5517 | 41094 | 4481 | 42071 | 3686 | 42245 | 2491 | 50132 | 2051 | 29262 |
| 20-#11 | 2.12 | MA | 32748 | 7585 | 51899 | 5672 | 56244 | 4610 | 57373 | 3814 | 56978 | 2614 | 68362 | 2018 | 41884 |
| 8L-4S | | MI | 23928 | 7585 | 38688 | 5522 | 41922 | 4470 | 43088 | 3677 | 43677 | 2500 | 51830 | 2088 | 29286 |
| 20-#11 | 2.12 | MA | 32194 | 7585 | 51032 | 5671 | 55070 | 4607 | 55880 | 3809 | 55033 | 2625 | 65877 | 1965 | 41012 |
| 9L-3S | | MI | 24355 | 7585 | 39424 | 5509 | 42860 | 4476 | 44227 | 3685 | 45104 | 2491 | 53422 | 2175 | 29273 |
| 20-#11 | 2.12 | MA | 31617 | 7585 | 50062 | 5686 | 53880 | 4621 | 54460 | 3822 | 53105 | 2636 | 63469 | 1904 | 40346 |
| 10L-2S | | MI | 24955 | 7585 | 40320 | 5514 | 44010 | 4466 | 45630 | 3676 | 46972 | 2483 | 55887 | 2261 | 29249 |
| 20-#14 | 3.06 | MA | 36154 | 8062 | 59177 | 5947 | 65557 | 4788 | 68663 | 3919 | 72370 | 2557 | 88937 | 2026 | 60881 |
| 5L-7S | | MI | 23620 | 8062 | 39173 | 5802 | 42422 | 4685 | 43627 | 3800 | 44372 | 2444 | 53497 | 1633 | 39360 |
| 20-#14 | 3.06 | MA | 35387 | 8062 | 57885 | 5944 | 63767 | 4808 | 66476 | 3912 | 69487 | 2572 | 85290 | 1946 | 59786 |
| 6E | | MI | 24124 | 8062 | 40113 | 5784 | 43556 | 4670 | 45083 | 3812 | 46167 | 2431 | 55599 | 1729 | 40028 |
| 20-#14 | 3.06 | MA | 34641 | 8062 | 56470 | 5965 | 62060 | 4803 | 64376 | 3930 | 66670 | 2586 | 81401 | 1816 | 58794 |
| 7L-5S | | MI | 24641 | 8062 | 40972 | 5792 | 44744 | 4680 | 46465 | 3800 | 48005 | 2419 | 57840 | 1811 | 40566 |
| 20-#14 | 3.06 | MA | 33906 | 8062 | 55199 | 5962 | 60329 | 4822 | 62328 | 3948 | 63677 | 2575 | 77820 | 1745 | 57322 |
| 8L-4S | | MI | 25183 | 8062 | 41886 | 5799 | 45928 | 4665 | 47917 | 3787 | 50036 | 2431 | 60243 | 1865 | 41275 |
| 20-#14 | 3.06 | MA | 33149 | 8062 | 53955 | 5959 | 58644 | 4817 | 60185 | 3941 | 60886 | 2590 | 74285 | 1668 | 55868 |
| 9L-3S | | MI | 25785 | 8062 | 42939 | 5781 | 47269 | 4675 | 49543 | 3800 | 52059 | 2419 | 62493 | 1988 | 41351 |
| 20-#14 | 3.06 | MA | 32320 | 8062 | 52562 | 5980 | 56936 | 4837 | 58147 | 3959 | 58119 | 2604 | 70858 | 1580 | 54247 |
| 10L-2S | | MI | 26629 | 8062 | 44218 | 5789 | 48909 | 4661 | 51541 | 3787 | 54708 | 2406 | 65978 | 2113 | 41378 |
| 20-#18 | 5.43 | MA | 37959 | 9273 | 65601 | 6707 | 73535 | 5373 | 78277 | 4257 | 85646 | 2493 | 107347 | 1152 | 96078 |
| 7L-5S | | MI | 27254 | 9273 | 48151 | 6496 | 53755 | 5192 | 57060 | 4070 | 62054 | 2218 | 76490 | 1165 | 67424 |
| 20-#18 | 5.43 | MA | 36716 | 9273 | 63362 | 6700 | 70488 | 5362 | 74672 | 4286 | 80380 | 2472 | 101123 | 1029 | 92040 |
| 8L-4S | | MI | 28174 | 9273 | 49750 | 6512 | 55827 | 5168 | 59553 | 4048 | 65546 | 2240 | 80590 | 1262 | 68706 |
| 22-#11 | 2.33 | MA | 34986 | 7693 | 56039 | 5729 | 61642 | 4634 | 63929 | 3822 | 65948 | 2592 | 80127 | 2198 | 47665 |
| 5L-8S | | MI | 22880 | 7693 | 37097 | 5588 | 39817 | 4528 | 40534 | 3726 | 40301 | 2506 | 47727 | 1834 | 31052 |
| 22-#11 | 2.33 | MA | 34445 | 7693 | 55139 | 5727 | 60394 | 4648 | 62404 | 3817 | 63939 | 2602 | 77565 | 2143 | 47015 |
| 6L-7S | | MI | 23231 | 7693 | 37688 | 5593 | 40621 | 4534 | 41485 | 3716 | 41551 | 2497 | 49313 | 1878 | 31358 |
| 22-#11 | 2.33 | MA | 33918 | 7693 | 54153 | 5742 | 59205 | 4645 | 60941 | 3830 | 61976 | 2613 | 74833 | 2053 | 46480 |
| 7L-6S | | MI | 23587 | 7693 | 38345 | 5580 | 41414 | 4523 | 42505 | 3725 | 42817 | 2488 | 51011 | 1969 | 31612 |
| 22-#11 | 2.33 | MA | 33398 | 7693 | 53267 | 5740 | 57998 | 4659 | 59513 | 3843 | 59890 | 2606 | 72322 | 2003 | 45989 |
| 8L-5S | | MI | 23952 | 7693 | 38945 | 5585 | 42244 | 4529 | 43473 | 3715 | 44113 | 2480 | 52598 | 2026 | 32042 |
| 22-#11 | 2.33 | MA | 32847 | 7693 | 52401 | 5738 | 56825 | 4656 | 58020 | 3839 | 57945 | 2616 | 69838 | 1949 | 45140 |
| 9L-4S | | MI | 24335 | 7693 | 39584 | 5589 | 43072 | 4519 | 44490 | 3706 | 45545 | 2488 | 54295 | 2063 | 32077 |
| 22-#11 | 2.33 | MA | 32273 | 7693 | 51430 | 5753 | 55634 | 4670 | 56600 | 3852 | 56017 | 2627 | 67430 | 1889 | 44459 |
| 10L-3S | | MI | 24760 | 7693 | 40320 | 5577 | 44010 | 4525 | 45630 | 3714 | 46972 | 2480 | 55887 | 2150 | 32081 |
| 22-#11 | 2.33 | MA | 31712 | 7693 | 50562 | 5751 | 54467 | 4666 | 55126 | 3847 | 53960 | 2620 | 64981 | 1836 | 43441 |
| 11L-2S | | MI | 25358 | 7693 | 41217 | 5581 | 45159 | 4514 | 47032 | 3705 | 48839 | 2471 | 58353 | 2236 | 32063 |
| 22-#14 | 3.36 | MA | 36296 | 8218 | 59845 | 6041 | 66280 | 4877 | 69541 | 3954 | 73658 | 2559 | 90930 | 1922 | 65735 |
| 6L-7S | | MI | 24196 | 8218 | 40452 | 5899 | 44062 | 4755 | 45625 | 3842 | 47020 | 2426 | 56982 | 1594 | 43143 |
| 22-#14 | 3.36 | MA | 35553 | 8218 | 58430 | 6062 | 64573 | 4872 | 67442 | 3972 | 70841 | 2573 | 87041 | 1792 | 64649 |
| 7L-6S | | MI | 24698 | 8218 | 41392 | 5882 | 45196 | 4740 | 47081 | 3854 | 48816 | 2413 | 59084 | 1690 | 43897 |
| 22-#14 | 3.36 | MA | 34823 | 8218 | 57159 | 6059 | 62841 | 4892 | 65393 | 3990 | 67848 | 2563 | 83460 | 1721 | 63219 |
| 8L-5S | | MI | 25212 | 8218 | 42251 | 5889 | 46384 | 4750 | 48463 | 3842 | 50653 | 2401 | 61325 | 1772 | 44409 |
| 22-#14 | 3.36 | MA | 34067 | 8218 | 55915 | 6056 | 61157 | 4887 | 63250 | 3983 | 65057 | 2577 | 79924 | 1644 | 61705 |
| 9L-4S | | MI | 25751 | 8218 | 43165 | 5896 | 47568 | 4735 | 49915 | 3829 | 52684 | 2413 | 63728 | 1826 | 45227 |
| 22-#14 | 3.36 | MA | 33246 | 8218 | 54522 | 6077 | 59449 | 4907 | 61212 | 4001 | 62290 | 2592 | 76498 | 1556 | 60121 |
| 10L-3S | | MI | 26351 | 8218 | 44218 | 5879 | 48909 | 4745 | 51541 | 3842 | 54708 | 2401 | 65978 | 1950 | 45322 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 32" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

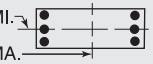
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#18 | 5.98 | MA | 38276 | 9549 | 66798 | 6873 | 74892 | 5486 | 80045 | 4362 | 87691 | 2450 | 110893 | 981 | 102248 |
| 8L-5S | | MI | 28215 | 9549 | 50376 | 6669 | 56608 | 5316 | 60490 | 4142 | 66604 | 2182 | 82438 | 1087 | 74106 |
| 24-#11 | 2.54 | MA | 35088 | 7801 | 56508 | 5794 | 62149 | 4696 | 64544 | 3847 | 66851 | 2593 | 81526 | 2127 | 51170 |
| 6L-8S | | MI | 23290 | 7801 | 37993 | 5656 | 40966 | 4576 | 41936 | 3755 | 42169 | 2494 | 50192 | 1809 | 33725 |
| 24-#11 | 2.54 | MA | 34563 | 7801 | 55521 | 5809 | 60959 | 4693 | 63081 | 3860 | 64888 | 2604 | 78794 | 2037 | 50651 |
| 7E | | MI | 23640 | 7801 | 38585 | 5660 | 41770 | 4582 | 42887 | 3746 | 43418 | 2485 | 51778 | 1853 | 34087 |
| 24-#11 | 2.54 | MA | 34046 | 7801 | 54636 | 5807 | 59753 | 4707 | 61654 | 3873 | 62802 | 2597 | 76283 | 1988 | 50100 |
| 8L-6S | | MI | 23995 | 7801 | 39242 | 5647 | 42563 | 4571 | 43907 | 3754 | 44685 | 2477 | 53476 | 1944 | 34332 |
| 24-#11 | 2.54 | MA | 33497 | 7801 | 53769 | 5805 | 58579 | 4704 | 60161 | 3868 | 60857 | 2608 | 73799 | 1934 | 49273 |
| 9L-5S | | MI | 24358 | 7801 | 39842 | 5652 | 43393 | 4578 | 44875 | 3745 | 45981 | 2468 | 55063 | 2001 | 34780 |
| 24-#11 | 2.54 | MA | 32925 | 7801 | 52799 | 5821 | 57389 | 4718 | 58740 | 3881 | 58929 | 2618 | 71390 | 1873 | 48550 |
| 10L-4S | | MI | 24739 | 7801 | 40481 | 5657 | 44221 | 4567 | 45892 | 3736 | 47412 | 2477 | 56761 | 2038 | 34865 |
| 24-#11 | 2.54 | MA | 32366 | 7801 | 51931 | 5819 | 56222 | 4715 | 57266 | 3877 | 56872 | 2612 | 68942 | 1820 | 47553 |
| 11L-3S | | MI | 25164 | 7801 | 41217 | 5644 | 45159 | 4573 | 47032 | 3744 | 48839 | 2468 | 58353 | 2124 | 34885 |
| 24-#11 | 2.54 | MA | 31818 | 7801 | 50978 | 5834 | 55040 | 4729 | 55849 | 3890 | 54945 | 2622 | 66184 | 1744 | 46595 |
| 12L-2S | | MI | 25759 | 7801 | 42113 | 5649 | 46308 | 4562 | 48434 | 3735 | 50707 | 2460 | 60818 | 2211 | 34874 |
| 24-#14 | 3.67 | MA | 36461 | 8374 | 60390 | 6160 | 67086 | 4942 | 70507 | 4015 | 75012 | 2561 | 92681 | 1768 | 70514 |
| 7E | | MI | 24769 | 8374 | 41731 | 5996 | 45702 | 4825 | 47622 | 3884 | 49669 | 2408 | 60467 | 1556 | 46934 |
| 24-#14 | 3.67 | MA | 35734 | 8374 | 59119 | 6156 | 65354 | 4962 | 68458 | 4033 | 72018 | 2550 | 89100 | 1697 | 69123 |
| 8L-6S | | MI | 25269 | 8374 | 42672 | 5979 | 46836 | 4810 | 49078 | 3897 | 51464 | 2395 | 62569 | 1651 | 47770 |
| 24-#14 | 3.67 | MA | 34979 | 8374 | 57875 | 6153 | 63670 | 4957 | 66316 | 4026 | 69228 | 2565 | 85564 | 1620 | 67550 |
| 9L-5S | | MI | 25781 | 8374 | 43530 | 5986 | 48024 | 4820 | 50460 | 3884 | 53302 | 2383 | 64810 | 1733 | 48259 |
| 24-#14 | 3.67 | MA | 34166 | 8374 | 56482 | 6175 | 61961 | 4977 | 64278 | 4044 | 66460 | 2579 | 82138 | 1532 | 66001 |
| 10L-4S | | MI | 26317 | 8374 | 44445 | 5993 | 49208 | 4805 | 51912 | 3872 | 55333 | 2395 | 67213 | 1787 | 49175 |

## RECTANGULAR TIED COLUMNS 32" x 48"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.04 | MA | 36058 | 7342 | 55776 | 5502 | 60171 | 4491 | 61048 | 3754 | 60132 | 2725 | 70254 | 2586 | 23613 |
| 2E | | MI | 23763 | 7342 | 37382 | 5323 | 39610 | 4343 | 39702 | 3621 | 38395 | 2600 | 44149 | 2428 | 15349 |
| 6-#18 | 1.56 | MA | 37756 | 7619 | 59385 | 5675 | 64797 | 4615 | 66692 | 3830 | 67811 | 2703 | 80572 | 2541 | 34968 |
| 2L-3S | | MI | 23269 | 7619 | 37382 | 5480 | 39610 | 4490 | 39702 | 3714 | 38395 | 2585 | 44149 | 2129 | 22594 |
| 6-#18 | 1.56 | MA | 35314 | 7619 | 55776 | 5669 | 60171 | 4649 | 61048 | 3860 | 60132 | 2727 | 70254 | 2319 | 34987 |
| 3L-2S | | MI | 24765 | 7619 | 39607 | 5496 | 42463 | 4467 | 43133 | 3692 | 42944 | 2563 | 50097 | 2350 | 22459 |
| 8-#14 | 1.17 | MA | 36572 | 7412 | 56618 | 5578 | 61466 | 4548 | 62711 | 3796 | 62429 | 2737 | 73632 | 2604 | 26628 |
| 2L-4S | | MI | 22609 | 7412 | 35577 | 5425 | 37502 | 4419 | 37304 | 3681 | 35371 | 2652 | 40685 | 2206 | 17413 |
| 8-#14 | 1.17 | MA | 35168 | 7412 | 54560 | 5575 | 58829 | 4544 | 59494 | 3814 | 58052 | 2752 | 67683 | 2480 | 26681 |
| 3E | | MI | 23229 | 7412 | 36630 | 5407 | 38843 | 4429 | 38930 | 3693 | 37395 | 2639 | 42935 | 2330 | 17330 |
| 8-#14 | 1.17 | MA | 34185 | 7412 | 52888 | 5597 | 56697 | 4564 | 56903 | 3808 | 54718 | 2767 | 63803 | 2355 | 26674 |
| 4L-2S | | MI | 24096 | 7412 | 37909 | 5415 | 40483 | 4414 | 40928 | 3681 | 40043 | 2627 | 46420 | 2454 | 17251 |
| 8-#18 | 2.08 | MA | 39433 | 7896 | 62994 | 5848 | 69423 | 4739 | 72335 | 3905 | 75489 | 2681 | 90890 | 2495 | 46274 |
| 2L-4S | | MI | 23203 | 7896 | 37769 | 5682 | 40121 | 4594 | 40338 | 3764 | 39469 | 2571 | 46247 | 1837 | 29520 |
| 8-#18 | 2.08 | MA | 37013 | 7896 | 59385 | 5842 | 64797 | 4773 | 66692 | 3936 | 67811 | 2705 | 80572 | 2274 | 46187 |
| 3E | | MI | 24271 | 7896 | 39607 | 5653 | 42463 | 4615 | 43133 | 3786 | 42944 | 2549 | 50097 | 2051 | 29590 |
| 8-#18 | 2.08 | MA | 35316 | 7896 | 56445 | 5879 | 61050 | 4763 | 62137 | 3922 | 61949 | 2729 | 73857 | 2052 | 45707 |
| 4L-2S | | MI | 25757 | 7896 | 41833 | 5668 | 45316 | 4591 | 46563 | 3764 | 47494 | 2527 | 56045 | 2273 | 29504 |
| 10-#11 | 1.02 | MA | 36087 | 7329 | 55480 | 5542 | 60118 | 4524 | 61109 | 3784 | 60268 | 2752 | 70822 | 2630 | 23246 |
| 2L-5S | | MI | 22383 | 7329 | 34929 | 5390 | 36762 | 4412 | 36435 | 3686 | 34137 | 2662 | 39163 | 2286 | 15290 |
| 10-#11 | 1.02 | MA | 35103 | 7329 | 54044 | 5541 | 58277 | 4522 | 58863 | 3798 | 57212 | 2763 | 66647 | 2544 | 23287 |
| 3L-4S | | MI | 22775 | 7329 | 35568 | 5395 | 37590 | 4401 | 37452 | 3677 | 35569 | 2671 | 40861 | 2324 | 15231 |
| 10-#11 | 1.02 | MA | 34416 | 7329 | 52879 | 5556 | 56791 | 4536 | 57057 | 3794 | 54888 | 2774 | 63921 | 2457 | 23316 |
| 4L-3S | | MI | 23210 | 7329 | 36305 | 5382 | 38528 | 4407 | 38592 | 3685 | 36996 | 2662 | 42453 | 2410 | 15171 |
| 10-#11 | 1.02 | MA | 33803 | 7329 | 51872 | 5555 | 55486 | 4533 | 55452 | 3807 | 52563 | 2768 | 61095 | 2414 | 23300 |
| 5L-2S | | MI | 23819 | 7329 | 37201 | 5387 | 39677 | 4397 | 39994 | 3676 | 38864 | 2654 | 44918 | 2496 | 15119 |
| 10-#14 | 1.46 | MA | 37548 | 7567 | 58675 | 5675 | 64103 | 4618 | 65929 | 3838 | 66807 | 2725 | 79580 | 2582 | 33088 |
| 2L-5S | | MI | 22642 | 7567 | 35942 | 5515 | 37958 | 4503 | 37849 | 3735 | 35989 | 2621 | 41767 | 2113 | 21458 |
| 10-#14 | 1.46 | MA | 36150 | 7567 | 56618 | 5672 | 61466 | 4614 | 62711 | 3857 | 62429 | 2740 | 73632 | 2457 | 33118 |
| 3L-4S | | MI | 23198 | 7567 | 36856 | 5522 | 39142 | 4489 | 39301 | 3723 | 38020 | 2634 | 44170 | 2167 | 21444 |

## RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

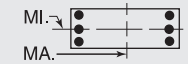
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.46 | MA | 35174 | 7567 | 54945 | 5694 | 59335 | 4634 | 60120 | 3850 | 59095 | 2755 | 69752 | 2333 | 33062 |
| 4L-3S | | MI | 23815 | 7567 | 37909 | 5504 | 40483 | 4498 | 40928 | 3735 | 40043 | 2621 | 46420 | 2291 | 21385 |
| 10-#14 | 1.46 | MA | 34303 | 7567 | 53501 | 5691 | 57461 | 4629 | 57818 | 3869 | 55759 | 2745 | 65719 | 2271 | 32865 |
| 5L-2S | | MI | 24678 | 7567 | 39188 | 5512 | 42123 | 4484 | 42925 | 3723 | 42692 | 2609 | 49905 | 2415 | 21316 |
| 10-#18 | 2.60 | MA | 41091 | 8172 | 66602 | 6021 | 74049 | 4863 | 77979 | 3980 | 83168 | 2659 | 101208 | 2449 | 57536 |
| 2L-5S | | MI | 23249 | 8172 | 38395 | 5839 | 40903 | 4742 | 41275 | 3858 | 40527 | 2512 | 48095 | 1662 | 34478 |
| 10-#18 | 2.60 | MA | 38691 | 8172 | 62994 | 6014 | 69423 | 4897 | 72335 | 4011 | 75489 | 2683 | 90890 | 2228 | 57360 |
| 3L-4S | | MI | 24203 | 8172 | 39994 | 5855 | 42974 | 4718 | 43769 | 3835 | 44019 | 2534 | 52195 | 1759 | 36349 |
| 10-#18 | 2.60 | MA | 37010 | 8172 | 60053 | 6052 | 65676 | 4887 | 67781 | 3998 | 69628 | 2707 | 84176 | 2007 | 56778 |
| 4L-3S | | MI | 25264 | 8172 | 41833 | 5826 | 45316 | 4739 | 46563 | 3858 | 47494 | 2512 | 56045 | 1973 | 36538 |
| 10-#18 | 2.60 | MA | 35511 | 8172 | 57511 | 6045 | 62379 | 4921 | 63729 | 4028 | 63760 | 2686 | 77156 | 1901 | 53483 |
| 5L-2S | | MI | 26739 | 8172 | 44058 | 5841 | 48169 | 4715 | 49994 | 3835 | 52044 | 2490 | 61993 | 2195 | 36511 |
| 12-#11 | 1.22 | MA | 36775 | 7436 | 56916 | 5610 | 61959 | 4573 | 63355 | 3814 | 63323 | 2744 | 74997 | 2616 | 27759 |
| 2L-6S | | MI | 22429 | 7436 | 35226 | 5453 | 37081 | 4454 | 36869 | 3725 | 34709 | 2659 | 40042 | 2204 | 18142 |
| 12-#11 | 1.22 | MA | 35794 | 7436 | 55480 | 5608 | 60118 | 4570 | 61109 | 3827 | 60268 | 2755 | 70822 | 2529 | 27790 |
| 3L-5S | | MI | 22801 | 7436 | 35826 | 5458 | 37911 | 4460 | 37837 | 3715 | 36005 | 2651 | 41629 | 2261 | 18118 |
| 12-#11 | 1.22 | MA | 35110 | 7436 | 54315 | 5624 | 58632 | 4584 | 59303 | 3823 | 57943 | 2766 | 68096 | 2443 | 27801 |
| 4E | | MI | 23191 | 7436 | 36465 | 5463 | 38739 | 4450 | 38854 | 3706 | 37436 | 2659 | 43326 | 2298 | 18072 |
| 12-#11 | 1.22 | MA | 34499 | 7436 | 53308 | 5622 | 57327 | 4582 | 57698 | 3836 | 55618 | 2759 | 65270 | 2400 | 27758 |
| 5L-3S | | MI | 23624 | 7436 | 37201 | 5450 | 39677 | 4456 | 39994 | 3714 | 38864 | 2651 | 44918 | 2385 | 18021 |
| 12-#11 | 1.22 | MA | 33919 | 7436 | 52365 | 5620 | 56020 | 4596 | 56101 | 3832 | 53513 | 2770 | 62568 | 2344 | 27642 |
| 6L-2S | | MI | 24232 | 7436 | 38098 | 5454 | 40826 | 4445 | 41396 | 3705 | 40731 | 2642 | 47384 | 2471 | 17972 |
| 12-#14 | 1.76 | MA | 38516 | 7723 | 60732 | 5773 | 66741 | 4688 | 69146 | 3881 | 71185 | 2712 | 85529 | 2559 | 39533 |
| 2L-6S | | MI | 22703 | 7723 | 36362 | 5605 | 38410 | 4563 | 38465 | 3790 | 36800 | 2616 | 43011 | 1992 | 24764 |
| 12-#14 | 1.76 | MA | 37126 | 7723 | 58675 | 5770 | 64103 | 4683 | 65929 | 3899 | 66807 | 2727 | 79580 | 2435 | 39530 |
| 3L-5S | | MI | 23231 | 7723 | 37221 | 5612 | 39597 | 4573 | 39847 | 3777 | 38637 | 2603 | 45252 | 2075 | 25431 |
| 12-#14 | 1.76 | MA | 36155 | 7723 | 57003 | 5792 | 61972 | 4704 | 63338 | 3893 | 63473 | 2742 | 75701 | 2310 | 39438 |
| 4E | | MI | 23783 | 7723 | 38135 | 5619 | 40782 | 4558 | 41299 | 3765 | 40668 | 2616 | 47655 | 2128 | 25456 |
| 12-#14 | 1.76 | MA | 35289 | 7723 | 55558 | 5789 | 60098 | 4699 | 61035 | 3911 | 60137 | 2732 | 71668 | 2249 | 39201 |
| 5L-3S | | MI | 24398 | 7723 | 39188 | 5602 | 42123 | 4568 | 42925 | 3777 | 42692 | 2603 | 49905 | 2252 | 25418 |
| 12-#14 | 1.76 | MA | 34465 | 7723 | 54205 | 5786 | 58223 | 4719 | 58743 | 3905 | 57115 | 2747 | 67820 | 2168 | 37923 |
| 6L-2S | | MI | 25257 | 7723 | 40467 | 5609 | 43763 | 4553 | 44923 | 3765 | 45341 | 2591 | 53390 | 2377 | 25362 |
| 12-#18 | 3.13 | MA | 40350 | 8449 | 66602 | 6187 | 74049 | 5021 | 77979 | 4087 | 83168 | 2661 | 101208 | 2182 | 68515 |
| 3L-5S | | MI | 24247 | 8449 | 40621 | 6012 | 43756 | 4866 | 44706 | 3929 | 45077 | 2476 | 54043 | 1584 | 41075 |
| 12-#18 | 3.13 | MA | 38685 | 8449 | 63662 | 6225 | 70302 | 5011 | 73425 | 4073 | 77307 | 2685 | 94494 | 1961 | 67838 |
| 4E | | MI | 25195 | 8449 | 42220 | 6028 | 45827 | 4842 | 47199 | 3907 | 48568 | 2498 | 58143 | 1681 | 42804 |
| 12-#18 | 3.13 | MA | 37200 | 8449 | 61120 | 6218 | 67005 | 5045 | 69373 | 4104 | 71438 | 2664 | 87475 | 1855 | 64290 |
| 5L-3S | | MI | 26248 | 8449 | 44058 | 5999 | 48169 | 4863 | 49994 | 3929 | 52044 | 2476 | 61993 | 1895 | 43448 |
| 12-#18 | 3.13 | MA | 35788 | 8449 | 58736 | 6212 | 63704 | 5035 | 65338 | 4090 | 66121 | 2688 | 80807 | 1711 | 61831 |
| 6L-2S | | MI | 27714 | 8449 | 46284 | 6014 | 51022 | 4839 | 53425 | 3907 | 56593 | 2454 | 67941 | 2117 | 43490 |
| 14-#11 | 1.42 | MA | 37458 | 7544 | 58352 | 5677 | 63800 | 4621 | 65600 | 3843 | 66379 | 2735 | 79172 | 2601 | 32263 |
| 2L-7S | | MI | 22484 | 7544 | 35465 | 5533 | 37438 | 4513 | 37251 | 3746 | 35310 | 2656 | 40809 | 2088 | 20576 |
| 14-#11 | 1.42 | MA | 36482 | 7544 | 56916 | 5676 | 61959 | 4618 | 63355 | 3857 | 63323 | 2746 | 74997 | 2515 | 32285 |
| 3L-6S | | MI | 22846 | 7544 | 36122 | 5521 | 38230 | 4503 | 38271 | 3754 | 36576 | 2648 | 42507 | 2179 | 20898 |
| 14-#11 | 1.42 | MA | 35800 | 7544 | 55751 | 5691 | 60473 | 4633 | 61548 | 3853 | 60999 | 2757 | 72271 | 2428 | 32274 |
| 4L-5S | | MI | 23216 | 7544 | 36722 | 5525 | 39060 | 4509 | 39239 | 3745 | 37872 | 2639 | 44094 | 2236 | 20934 |
| 14-#11 | 1.42 | MA | 35192 | 7544 | 54744 | 5689 | 59167 | 4630 | 59944 | 3866 | 58674 | 2751 | 69445 | 2385 | 32211 |
| 5L-4S | | MI | 23605 | 7544 | 37361 | 5530 | 39888 | 4498 | 40256 | 3736 | 39304 | 2648 | 45792 | 2273 | 20901 |
| 14-#11 | 1.42 | MA | 34615 | 7544 | 53801 | 5688 | 57861 | 4644 | 58346 | 3862 | 56568 | 2762 | 66743 | 2330 | 32003 |
| 6L-3S | | MI | 24037 | 7544 | 38098 | 5517 | 40826 | 4504 | 41396 | 3744 | 40731 | 2639 | 47384 | 2360 | 20859 |
| 14-#11 | 1.42 | MA | 34052 | 7544 | 52768 | 5703 | 56614 | 4642 | 56814 | 3875 | 54512 | 2773 | 63863 | 2240 | 31325 |
| 7L-2S | | MI | 24643 | 7544 | 38994 | 5522 | 41976 | 4493 | 42798 | 3735 | 42599 | 2631 | 49849 | 2446 | 20815 |
| 14-#14 | 2.05 | MA | 39477 | 7878 | 62790 | 5870 | 69378 | 4758 | 72363 | 3923 | 75562 | 2700 | 91478 | 2537 | 45968 |
| 2L-7S | | MI | 22778 | 7878 | 36701 | 5719 | 38916 | 4648 | 39007 | 3820 | 37653 | 2610 | 44394 | 1858 | 28223 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

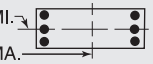


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.05 | MA | 38094 | 7878 | 60732 | 5867 | 66741 | 4753 | 69146 | 3941 | 71185 | 2715 | 85529 | 2412 | 45931 |
| 3L-6S | | MI | 23290 | 7878 | 37642 | 5702 | 40050 | 4633 | 40463 | 3832 | 39448 | 2598 | 46496 | 1954 | 28607 |
| 14-#14 | 2.05 | MA | 37129 | 7878 | 59060 | 5889 | 64609 | 4773 | 66555 | 3935 | 67850 | 2730 | 81650 | 2288 | 45806 |
| 4L-5S | | MI | 23815 | 7878 | 38500 | 5709 | 41237 | 4643 | 41845 | 3820 | 41286 | 2585 | 48737 | 2036 | 29266 |
| 14-#14 | 2.05 | MA | 36268 | 7878 | 57616 | 5886 | 62736 | 4769 | 64253 | 3954 | 64514 | 2720 | 77617 | 2226 | 45494 |
| 5L-4S | | MI | 24365 | 7878 | 39415 | 5717 | 42422 | 4628 | 43296 | 3807 | 43317 | 2598 | 51140 | 2090 | 29449 |
| 14-#14 | 2.05 | MA | 35450 | 7878 | 56262 | 5883 | 60860 | 4789 | 61960 | 3947 | 61493 | 2735 | 73769 | 2146 | 44134 |
| 6L-3S | | MI | 24977 | 7878 | 40467 | 5699 | 43763 | 4638 | 44923 | 3820 | 45341 | 2585 | 53390 | 2213 | 29437 |
| 14-#14 | 2.05 | MA | 34652 | 7878 | 54779 | 5905 | 59071 | 4784 | 59760 | 3966 | 58541 | 2750 | 69666 | 2016 | 43274 |
| 7L-2S | | MI | 25833 | 7878 | 41747 | 5706 | 45403 | 4623 | 46921 | 3807 | 47989 | 2573 | 56875 | 2338 | 29395 |
| 14-#18 | 3.65 | MA | 40343 | 8726 | 67271 | 6398 | 74928 | 5135 | 79068 | 4148 | 84985 | 2662 | 104812 | 1915 | 78501 |
| 4L-5S | | MI | 25238 | 8726 | 42846 | 6185 | 46609 | 4990 | 48136 | 4001 | 49626 | 2439 | 59990 | 1506 | 47698 |
| 14-#18 | 3.65 | MA | 38871 | 8726 | 64728 | 6391 | 71631 | 5170 | 75017 | 4179 | 79117 | 2642 | 97793 | 1809 | 75125 |
| 5L-4S | | MI | 26179 | 8726 | 44445 | 6201 | 48680 | 4966 | 50630 | 3978 | 53118 | 2461 | 64091 | 1604 | 49303 |
| 14-#18 | 3.65 | MA | 37472 | 8726 | 62345 | 6384 | 68330 | 5160 | 70982 | 4166 | 73800 | 2666 | 91125 | 1666 | 72474 |
| 6L-3S | | MI | 27224 | 8726 | 46284 | 6172 | 51022 | 4987 | 53425 | 4001 | 56593 | 2439 | 67941 | 1817 | 50336 |
| 14-#18 | 3.65 | MA | 36110 | 8726 | 59734 | 6422 | 65180 | 5194 | 67109 | 4196 | 68604 | 2690 | 84011 | 1435 | 69032 |
| 7L-2S | | MI | 28681 | 8726 | 48509 | 6187 | 53875 | 4963 | 56855 | 3978 | 61143 | 2417 | 73889 | 2039 | 50441 |
| 16-#11 | 1.63 | MA | 38138 | 7652 | 59788 | 5745 | 65641 | 4670 | 67846 | 3873 | 69434 | 2726 | 83347 | 2586 | 36761 |
| 2L-8S | | MI | 22545 | 7652 | 35771 | 5596 | 37783 | 4555 | 37702 | 3784 | 35929 | 2653 | 41689 | 2019 | 23103 |
| 16-#11 | 1.63 | MA | 37165 | 7652 | 58352 | 5743 | 63800 | 4667 | 65600 | 3886 | 66379 | 2737 | 79172 | 2500 | 36770 |
| 3L-7S | | MI | 22900 | 7652 | 36362 | 5601 | 38587 | 4562 | 38653 | 3775 | 37178 | 2645 | 43275 | 2063 | 23296 |
| 16-#11 | 1.63 | MA | 36486 | 7652 | 57186 | 5759 | 62314 | 4681 | 63794 | 3882 | 64054 | 2748 | 76446 | 2414 | 36740 |
| 4L-6S | | MI | 23260 | 7652 | 37019 | 5588 | 39380 | 4551 | 39673 | 3783 | 38444 | 2636 | 44973 | 2154 | 23598 |
| 16-#11 | 1.63 | MA | 35882 | 7652 | 56180 | 5757 | 61008 | 4678 | 62189 | 3895 | 61729 | 2742 | 73620 | 2371 | 36658 |
| 5E | | MI | 23630 | 7652 | 37619 | 5593 | 40210 | 4557 | 40641 | 3774 | 39740 | 2628 | 46560 | 2210 | 23741 |
| 16-#11 | 1.63 | MA | 35306 | 7652 | 55237 | 5755 | 59701 | 4693 | 60592 | 3891 | 59624 | 2753 | 70918 | 2315 | 36337 |
| 6L-4S | | MI | 24017 | 7652 | 38258 | 5597 | 41038 | 4546 | 41658 | 3765 | 41172 | 2636 | 48257 | 2248 | 23721 |
| 16-#11 | 1.63 | MA | 34746 | 7652 | 54204 | 5771 | 58455 | 4690 | 59059 | 3904 | 57567 | 2764 | 68038 | 2225 | 35686 |
| 7L-3S | | MI | 24448 | 7652 | 38994 | 5585 | 41976 | 4553 | 42798 | 3773 | 42599 | 2628 | 49849 | 2334 | 23687 |
| 16-#11 | 1.63 | MA | 34185 | 7652 | 53276 | 5769 | 57191 | 4704 | 57564 | 3918 | 55381 | 2758 | 65395 | 2175 | 35226 |
| 8L-2S | | MI | 25051 | 7652 | 39891 | 5589 | 43125 | 4542 | 44200 | 3764 | 44467 | 2619 | 52314 | 2421 | 23648 |
| 16-#14 | 2.34 | MA | 39056 | 8034 | 62790 | 5964 | 69378 | 4823 | 72363 | 3984 | 75562 | 2702 | 91478 | 2390 | 52322 |
| 3L-7S | | MI | 23364 | 8034 | 37981 | 5817 | 40556 | 4718 | 41004 | 3862 | 40301 | 2592 | 47880 | 1820 | 32090 |
| 16-#14 | 2.34 | MA | 38096 | 8034 | 61117 | 5986 | 67247 | 4843 | 69773 | 3978 | 72228 | 2717 | 87598 | 2265 | 52168 |
| 4L-6S | | MI | 23874 | 8034 | 38921 | 5799 | 41690 | 4703 | 42460 | 3874 | 42097 | 2580 | 49982 | 1915 | 32460 |
| 16-#14 | 2.34 | MA | 37241 | 8034 | 59673 | 5983 | 65373 | 4839 | 67470 | 3996 | 68892 | 2708 | 83566 | 2204 | 51658 |
| 5E | | MI | 24396 | 8034 | 39780 | 5806 | 42877 | 4713 | 43842 | 3862 | 43935 | 2567 | 52223 | 1997 | 33078 |
| 16-#14 | 2.34 | MA | 36427 | 8034 | 58320 | 5980 | 63498 | 4859 | 65177 | 3990 | 65871 | 2723 | 79717 | 2123 | 50357 |
| 6L-4S | | MI | 24944 | 8034 | 40694 | 5814 | 44062 | 4698 | 45294 | 3849 | 45966 | 2580 | 54626 | 2051 | 33427 |
| 16-#14 | 2.34 | MA | 35634 | 8034 | 56836 | 6002 | 61709 | 4854 | 62978 | 4008 | 62919 | 2738 | 75615 | 1994 | 49523 |
| 7L-3S | | MI | 25553 | 8034 | 41747 | 5796 | 45403 | 4708 | 46921 | 3862 | 47989 | 2567 | 56875 | 2175 | 33451 |
| 16-#14 | 2.34 | MA | 34854 | 8034 | 55505 | 5999 | 59894 | 4874 | 60831 | 4027 | 59782 | 2728 | 71843 | 1922 | 47975 |
| 8L-2S | | MI | 26405 | 8034 | 43026 | 5804 | 47043 | 4693 | 48918 | 3849 | 50638 | 2555 | 60361 | 2299 | 33416 |
| 16-#18 | 4.17 | MA | 40527 | 9002 | 68337 | 6564 | 76257 | 5294 | 80660 | 4255 | 86796 | 2620 | 108111 | 1764 | 85984 |
| 5E | | MI | 26220 | 9002 | 45072 | 6358 | 49462 | 5114 | 51567 | 4072 | 54176 | 2403 | 65938 | 1428 | 54341 |
| 16-#18 | 4.17 | MA | 39140 | 9002 | 65954 | 6557 | 72956 | 5284 | 76626 | 4241 | 81478 | 2644 | 101444 | 1620 | 83146 |
| 6L-4S | | MI | 27155 | 9002 | 46671 | 6373 | 51533 | 5090 | 54060 | 4050 | 57667 | 2425 | 70039 | 1526 | 55838 |
| 16-#18 | 4.17 | MA | 37790 | 9002 | 63342 | 6595 | 69806 | 5318 | 72753 | 4272 | 76283 | 2668 | 94329 | 1389 | 79821 |
| 7L-3S | | MI | 28194 | 9002 | 48509 | 6345 | 53875 | 5111 | 56855 | 4072 | 61143 | 2403 | 73889 | 1740 | 57209 |
| 16-#18 | 4.17 | MA | 36462 | 9002 | 60996 | 6588 | 66611 | 5308 | 68973 | 4303 | 70761 | 2648 | 87767 | 1265 | 75784 |
| 8L-2S | | MI | 29642 | 9002 | 50735 | 6360 | 56728 | 5088 | 60286 | 4050 | 65692 | 2380 | 79837 | 1961 | 57363 |
| 18-#11 | 1.83 | MA | 37845 | 7760 | 59788 | 5810 | 65641 | 4715 | 67846 | 3915 | 69434 | 2729 | 83347 | 2486 | 41246 |
| 3L-8S | | MI | 22961 | 7760 | 36667 | 5664 | 38932 | 4604 | 39104 | 3814 | 37796 | 2642 | 44154 | 1993 | 25834 |
| 18-#11 | 1.83 | MA | 37169 | 7760 | 58622 | 5826 | 64155 | 4730 | 66040 | 3911 | 67110 | 2740 | 80621 | 2399 | 41201 |
| 4L-7S | | MI | 23314 | 7760 | 37258 | 5668 | 39736 | 4610 | 40055 | 3805 | 39046 | 2633 | 45740 | 2038 | 26020 |
| 18-#11 | 1.83 | MA | 36567 | 7760 | 57616 | 5824 | 62849 | 4727 | 64435 | 3925 | 64784 | 2734 | 77796 | 2356 | 41102 |
| 5L-6S | | MI | 23674 | 7760 | 37915 | 5656 | 40529 | 4599 | 41075 | 3813 | 40312 | 2625 | 47438 | 2129 | 26305 |

## RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

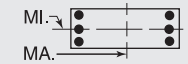
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.83 | MA | 35994 | 7760 | 56673 | 5823 | 61542 | 4741 | 62838 | 3921 | 62679 | 2745 | 75093 | 2301 | 40680 |
| 6L-5S | | MI | 24042 | 7760 | 38515 | 5660 | 41359 | 4606 | 42043 | 3804 | 41608 | 2616 | 49025 | 2185 | 26538 |
| 18-#11 | 1.83 | MA | 35436 | 7760 | 55640 | 5838 | 60296 | 4738 | 61305 | 3934 | 60622 | 2756 | 72213 | 2211 | 40053 |
| 7L-4S | | MI | 24427 | 7760 | 39154 | 5665 | 42187 | 4595 | 43060 | 3795 | 43039 | 2625 | 50722 | 2223 | 26533 |
| 18-#11 | 1.83 | MA | 34887 | 7760 | 54712 | 5836 | 59032 | 4753 | 59809 | 3947 | 58436 | 2749 | 69570 | 2161 | 39605 |
| 8L-3S | | MI | 24857 | 7760 | 39891 | 5652 | 43125 | 4601 | 44200 | 3803 | 44467 | 2616 | 52314 | 2309 | 26508 |
| 18-#11 | 1.83 | MA | 34294 | 7760 | 53805 | 5835 | 57802 | 4750 | 58245 | 3943 | 56399 | 2760 | 66950 | 2107 | 38802 |
| 9L-2S | | MI | 25458 | 7760 | 40787 | 5657 | 44274 | 4590 | 45602 | 3793 | 46334 | 2607 | 54780 | 2396 | 26475 |
| 18-#14 | 2.64 | MA | 39057 | 8190 | 63175 | 6083 | 69884 | 4913 | 72990 | 4020 | 76606 | 2705 | 93547 | 2242 | 58525 |
| 4L-7S | | MI | 23947 | 8190 | 39260 | 5914 | 42196 | 4788 | 43002 | 3904 | 42950 | 2574 | 51365 | 1781 | 35847 |
| 18-#14 | 2.64 | MA | 38207 | 8190 | 61730 | 6081 | 68010 | 4908 | 70688 | 4038 | 73270 | 2695 | 89514 | 2181 | 57838 |
| 5L-6S | | MI | 24454 | 8190 | 40200 | 5896 | 43330 | 4773 | 44458 | 3916 | 44746 | 2562 | 53467 | 1876 | 36320 |
| 18-#14 | 2.64 | MA | 37398 | 8190 | 60377 | 6078 | 66135 | 4929 | 68395 | 4032 | 70248 | 2710 | 85666 | 2101 | 56589 |
| 6L-5S | | MI | 24974 | 8190 | 41059 | 5904 | 44517 | 4783 | 45840 | 3904 | 46583 | 2549 | 55708 | 1958 | 36902 |
| 18-#14 | 2.64 | MA | 36610 | 8190 | 58894 | 6100 | 64346 | 4924 | 66195 | 4051 | 67296 | 2725 | 81563 | 1971 | 55778 |
| 7L-4S | | MI | 25520 | 8190 | 41973 | 5911 | 45702 | 4768 | 47292 | 3891 | 48614 | 2562 | 58111 | 2012 | 37397 |
| 18-#14 | 2.64 | MA | 35834 | 8190 | 57562 | 6097 | 62532 | 4944 | 64048 | 4069 | 64159 | 2715 | 77792 | 1900 | 54152 |
| 8L-3S | | MI | 26126 | 8190 | 43026 | 5893 | 47043 | 4778 | 48918 | 3904 | 50638 | 2549 | 60361 | 2136 | 37440 |
| 18-#14 | 2.64 | MA | 35005 | 8190 | 56259 | 6094 | 60767 | 4940 | 61803 | 4063 | 61235 | 2730 | 74060 | 1822 | 52821 |
| 9L-2S | | MI | 26974 | 8190 | 44305 | 5901 | 48683 | 4763 | 50916 | 3891 | 53286 | 2537 | 63846 | 2260 | 37429 |
| 18-#18 | 4.69 | MA | 40792 | 9279 | 69562 | 6730 | 77582 | 5408 | 82269 | 4317 | 89157 | 2622 | 111762 | 1574 | 93843 |
| 6L-5S | | MI | 27196 | 9279 | 47297 | 6531 | 52315 | 5238 | 54998 | 4144 | 58726 | 2366 | 71886 | 1350 | 61000 |
| 18-#18 | 4.69 | MA | 39454 | 9279 | 66951 | 6768 | 74432 | 5442 | 78396 | 4347 | 83961 | 2646 | 104648 | 1344 | 90627 |
| 7L-4S | | MI | 28124 | 9279 | 48896 | 6546 | 54386 | 5215 | 57491 | 4122 | 62217 | 2388 | 75986 | 1448 | 62401 |
| 18-#18 | 4.69 | MA | 38137 | 9279 | 64605 | 6761 | 71237 | 5432 | 74616 | 4378 | 78439 | 2626 | 98085 | 1219 | 86483 |
| 8L-3S | | MI | 29157 | 9279 | 50735 | 6518 | 56728 | 5235 | 60286 | 4144 | 65692 | 2366 | 79837 | 1662 | 64069 |
| 20-#11 | 2.03 | MA | 37849 | 7868 | 60058 | 5893 | 65995 | 4778 | 68286 | 3941 | 70165 | 2731 | 84796 | 2385 | 45657 |
| 4L-8S | | MI | 23374 | 7868 | 37564 | 5731 | 40082 | 4652 | 40506 | 3843 | 39664 | 2630 | 46620 | 1968 | 28566 |
| 20-#11 | 2.03 | MA | 37249 | 7868 | 59052 | 5892 | 64690 | 4775 | 66681 | 3954 | 67840 | 2725 | 81971 | 2342 | 45543 |
| 5L-7S | | MI | 23727 | 7868 | 38155 | 5736 | 40886 | 4659 | 41457 | 3834 | 40913 | 2622 | 48205 | 2013 | 28747 |
| 20-#11 | 2.03 | MA | 36679 | 7868 | 58109 | 5890 | 63383 | 4790 | 65083 | 3950 | 65734 | 2736 | 79268 | 2286 | 45029 |
| 6E | | MI | 24085 | 7868 | 38812 | 5723 | 41678 | 4648 | 42477 | 3842 | 42180 | 2613 | 49904 | 2103 | 29018 |
| 20-#11 | 2.03 | MA | 36123 | 7868 | 57076 | 5905 | 62137 | 4787 | 63551 | 3963 | 63678 | 2747 | 76388 | 2196 | 44425 |
| 7L-5S | | MI | 24452 | 7868 | 39412 | 5728 | 42508 | 4654 | 43445 | 3833 | 43475 | 2604 | 51490 | 2160 | 29327 |
| 20-#11 | 2.03 | MA | 35576 | 7868 | 56148 | 5904 | 60873 | 4801 | 62055 | 3977 | 61492 | 2741 | 73745 | 2146 | 43986 |
| 8L-4S | | MI | 24836 | 7868 | 40051 | 5732 | 43336 | 4643 | 44462 | 3824 | 44907 | 2613 | 53188 | 2198 | 29340 |
| 20-#11 | 2.03 | MA | 34987 | 7868 | 55241 | 5902 | 59643 | 4798 | 60491 | 3973 | 59454 | 2752 | 71125 | 2092 | 43131 |
| 9L-3S | | MI | 25264 | 7868 | 40787 | 5720 | 44274 | 4650 | 45602 | 3832 | 46334 | 2604 | 54780 | 2284 | 29323 |
| 20-#11 | 2.03 | MA | 34382 | 7868 | 54224 | 5918 | 58396 | 4813 | 59003 | 3986 | 57434 | 2763 | 68585 | 2032 | 42412 |
| 10L-2S | | MI | 25864 | 7868 | 41684 | 5724 | 45423 | 4639 | 47004 | 3823 | 48202 | 2596 | 57245 | 2370 | 29296 |
| 20-#14 | 2.93 | MA | 39166 | 8345 | 63788 | 6178 | 70648 | 4978 | 73905 | 4081 | 77647 | 2683 | 95463 | 2159 | 64031 |
| 5L-7S | | MI | 24527 | 8345 | 40539 | 6011 | 43836 | 4857 | 44999 | 3946 | 45599 | 2556 | 54850 | 1742 | 39617 |
| 20-#14 | 2.93 | MA | 38362 | 8345 | 62434 | 6175 | 68772 | 4999 | 71612 | 4074 | 74626 | 2698 | 91615 | 2078 | 62829 |
| 6E | | MI | 25032 | 8345 | 41479 | 5994 | 44970 | 4843 | 46456 | 3958 | 47394 | 2544 | 56952 | 1837 | 40186 |
| 20-#14 | 2.93 | MA | 37578 | 8345 | 60951 | 6197 | 66983 | 4994 | 69412 | 4093 | 71674 | 2713 | 87512 | 1949 | 61945 |
| 7L-5S | | MI | 25549 | 8345 | 42338 | 6001 | 46157 | 4853 | 47838 | 3946 | 49232 | 2531 | 59193 | 1919 | 40737 |
| 20-#14 | 2.93 | MA | 36807 | 8345 | 59619 | 6194 | 65169 | 5014 | 67266 | 4111 | 68537 | 2703 | 83740 | 1877 | 60338 |
| 8L-4S | | MI | 26092 | 8345 | 43253 | 6008 | 47342 | 4838 | 49289 | 3934 | 51263 | 2544 | 61596 | 1973 | 41358 |
| 20-#14 | 2.93 | MA | 35984 | 8345 | 58316 | 6191 | 63404 | 5010 | 65020 | 4105 | 65612 | 2718 | 80009 | 1800 | 58944 |
| 9L-3S | | MI | 26696 | 8345 | 44305 | 5991 | 48683 | 4848 | 50916 | 3946 | 53286 | 2531 | 63846 | 2097 | 41422 |
| 20-#14 | 2.93 | MA | 35130 | 8345 | 56857 | 6213 | 61614 | 5030 | 62885 | 4124 | 62713 | 2733 | 76393 | 1712 | 57184 |
| 10L-2S | | MI | 27541 | 8345 | 45584 | 5998 | 50323 | 4833 | 52913 | 3934 | 55935 | 2519 | 67331 | 2222 | 41441 |
| 20-#18 | 5.21 | MA | 41104 | 9556 | 70560 | 6941 | 79058 | 5566 | 84040 | 4423 | 91640 | 2624 | 114966 | 1298 | 101451 |
| 7L-5S | | MI | 28165 | 9556 | 49523 | 6704 | 55168 | 5362 | 58428 | 4215 | 63275 | 2329 | 77834 | 1273 | 67672 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 32" x 48"

Short columns – no sidesway
Bending on major or minor axis

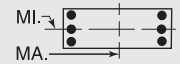


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#18 | 5.21 | MA | 39798 | 9556 | 68213 | 6934 | 75863 | 5556 | 80260 | 4453 | 86118 | 2604 | 108403 | 1174 | 97201 |
| 8L-4S | | MI | 29088 | 9556 | 51122 | 6719 | 57239 | 5339 | 60922 | 4193 | 66766 | 2352 | 81934 | 1370 | 68987 |
| 22-#11 | 2.23 | MA | 37928 | 7976 | 60488 | 5959 | 66531 | 4824 | 68926 | 3983 | 70895 | 2716 | 86146 | 2327 | 49982 |
| 5L-8S | | MI | 23786 | 7976 | 38460 | 5799 | 41231 | 4701 | 41908 | 3873 | 41532 | 2619 | 49085 | 1943 | 31240 |
| 22-#11 | 2.23 | MA | 37360 | 7976 | 59545 | 5957 | 65224 | 4838 | 67329 | 3979 | 68790 | 2727 | 83443 | 2271 | 49385 |
| 6L-7S | | MI | 24138 | 7976 | 39051 | 5803 | 42035 | 4707 | 42859 | 3863 | 42781 | 2610 | 50671 | 1988 | 31476 |
| 22-#11 | 2.23 | MA | 36807 | 7976 | 58512 | 5973 | 63978 | 4835 | 65796 | 3993 | 66733 | 2738 | 80564 | 2182 | 48800 |
| 7L-6S | | MI | 24494 | 7976 | 39708 | 5790 | 42827 | 4696 | 43879 | 3872 | 44047 | 2601 | 52369 | 2078 | 31734 |
| 22-#11 | 2.23 | MA | 36262 | 7976 | 57584 | 5971 | 62713 | 4850 | 64301 | 4006 | 64547 | 2732 | 77921 | 2131 | 48369 |
| 8L-5S | | MI | 24860 | 7976 | 40308 | 5795 | 43657 | 4703 | 44847 | 3862 | 45343 | 2593 | 53956 | 2135 | 32112 |
| 22-#11 | 2.23 | MA | 35675 | 7976 | 56677 | 5969 | 61484 | 4847 | 62736 | 4002 | 62510 | 2743 | 75300 | 2078 | 47465 |
| 9L-4S | | MI | 25243 | 7976 | 40947 | 5800 | 44485 | 4692 | 45864 | 3853 | 46775 | 2601 | 55653 | 2173 | 32138 |
| 22-#11 | 2.23 | MA | 35073 | 7976 | 55660 | 5985 | 60237 | 4861 | 61249 | 4015 | 60490 | 2754 | 72760 | 2017 | 46762 |
| 10L-3S | | MI | 25669 | 7976 | 41684 | 5787 | 45423 | 4698 | 47004 | 3861 | 48202 | 2593 | 57245 | 2259 | 32133 |
| 22-#11 | 2.23 | MA | 34484 | 7976 | 54751 | 5983 | 59015 | 4858 | 59705 | 4011 | 58335 | 2748 | 70183 | 1964 | 45743 |
| 11L-2S | | MI | 26268 | 7976 | 42580 | 5792 | 46573 | 4687 | 48406 | 3852 | 50070 | 2584 | 59711 | 2345 | 32112 |
| 22-#14 | 3.22 | MA | 39320 | 8501 | 64491 | 6272 | 71410 | 5068 | 74830 | 4117 | 79003 | 2685 | 97564 | 2056 | 69076 |
| 6L-7S | | MI | 25103 | 8501 | 41818 | 6109 | 45476 | 4927 | 46997 | 3988 | 48247 | 2538 | 58335 | 1703 | 43397 |
| 22-#14 | 3.22 | MA | 38541 | 8501 | 63008 | 6294 | 69621 | 5064 | 72630 | 4135 | 76052 | 2700 | 93461 | 1926 | 68095 |
| 7L-6S | | MI | 25606 | 8501 | 42759 | 6091 | 46610 | 4912 | 48453 | 4001 | 50043 | 2526 | 60437 | 1799 | 44057 |
| 22-#14 | 3.22 | MA | 37774 | 8501 | 61677 | 6291 | 67806 | 5084 | 70483 | 4154 | 72914 | 2691 | 89689 | 1855 | 66532 |
| 8L-5S | | MI | 26122 | 8501 | 43617 | 6098 | 47797 | 4922 | 49835 | 3988 | 51880 | 2513 | 62678 | 1881 | 44580 |
| 22-#14 | 3.22 | MA | 36971 | 8501 | 60373 | 6288 | 66041 | 5079 | 68238 | 4148 | 69990 | 2706 | 85958 | 1777 | 65076 |
| 9L-4S | | MI | 26662 | 8501 | 44532 | 6106 | 48982 | 4908 | 51287 | 3976 | 53911 | 2526 | 65081 | 1935 | 45315 |
| 22-#14 | 3.22 | MA | 36106 | 8501 | 58914 | 6310 | 64251 | 5100 | 66102 | 4166 | 67090 | 2721 | 82342 | 1689 | 63355 |
| 10L-3S | | MI | 27263 | 8501 | 45584 | 6088 | 50323 | 4917 | 52913 | 3988 | 55935 | 2513 | 67331 | 2058 | 45397 |
| 22-#18 | 5.73 | MA | 41445 | 9832 | 71822 | 7107 | 80490 | 5680 | 85903 | 4529 | 93797 | 2581 | 118721 | 1128 | 107936 |
| 8L-5S | | MI | 29128 | 9832 | 51748 | 6877 | 58021 | 5486 | 61859 | 4287 | 67825 | 2293 | 83782 | 1195 | 74354 |
| 24-#11 | 2.44 | MA | 38038 | 8084 | 60981 | 6025 | 67065 | 4886 | 69575 | 4009 | 71845 | 2719 | 87619 | 2257 | 53747 |
| 6L-8S | | MI | 24197 | 8084 | 39357 | 5866 | 42380 | 4749 | 43310 | 3902 | 43399 | 2607 | 51550 | 1918 | 33912 |
| 24-#11 | 2.44 | MA | 37487 | 8084 | 59948 | 6040 | 65818 | 4884 | 68042 | 4022 | 69789 | 2730 | 84739 | 2167 | 53179 |
| 7E | | MI | 24547 | 8084 | 39948 | 5871 | 43184 | 4755 | 44261 | 3893 | 44649 | 2598 | 53136 | 1963 | 34207 |
| 24-#11 | 2.44 | MA | 36945 | 8084 | 59020 | 6039 | 64554 | 4898 | 66546 | 4035 | 67603 | 2723 | 82096 | 2117 | 52707 |
| 8L-6S | | MI | 24902 | 8084 | 40605 | 5858 | 43977 | 4745 | 45281 | 3901 | 45915 | 2590 | 54834 | 2053 | 34454 |
| 24-#11 | 2.44 | MA | 36361 | 8084 | 58113 | 6037 | 63325 | 4895 | 64982 | 4031 | 65565 | 2734 | 79475 | 2063 | 51804 |
| 9L-5S | | MI | 25267 | 8084 | 41205 | 5862 | 44807 | 4751 | 46249 | 3892 | 47211 | 2581 | 56421 | 2110 | 34892 |
| 24-#11 | 2.44 | MA | 35760 | 8084 | 57096 | 6052 | 62078 | 4910 | 63494 | 4045 | 63545 | 2745 | 76935 | 2003 | 51116 |
| 10L-4S | | MI | 25648 | 8084 | 41844 | 5867 | 45635 | 4740 | 47266 | 3883 | 48642 | 2590 | 58119 | 2147 | 34929 |
| 24-#11 | 2.44 | MA | 35174 | 8084 | 56187 | 6051 | 60855 | 4907 | 61950 | 4041 | 61390 | 2739 | 74358 | 1949 | 50061 |
| 11L-3S | | MI | 26073 | 8084 | 42580 | 5854 | 46573 | 4746 | 48406 | 3891 | 50070 | 2581 | 59711 | 2234 | 34939 |
| 24-#11 | 2.44 | MA | 34599 | 8084 | 55189 | 6066 | 59617 | 4921 | 60465 | 4054 | 59371 | 2750 | 71450 | 1873 | 49144 |
| 12L-2S | | MI | 26670 | 8084 | 43477 | 5859 | 47722 | 4736 | 49808 | 3882 | 51937 | 2573 | 62176 | 2320 | 34924 |
| 24-#14 | 3.52 | MA | 39498 | 8656 | 65066 | 6391 | 72258 | 5134 | 75847 | 4178 | 80429 | 2688 | 99410 | 1904 | 74255 |
| 7E | | MI | 25677 | 8656 | 43098 | 6206 | 47116 | 4997 | 48995 | 4030 | 50896 | 2520 | 61820 | 1664 | 47187 |
| 24-#14 | 3.52 | MA | 38736 | 8656 | 63734 | 6388 | 70444 | 5154 | 73700 | 4196 | 77292 | 2678 | 95638 | 1832 | 72733 |
| 8L-6S | | MI | 26178 | 8656 | 44038 | 6188 | 48250 | 4982 | 50451 | 4043 | 52691 | 2508 | 63923 | 1760 | 47931 |
| 24-#14 | 3.52 | MA | 37933 | 8656 | 62431 | 6386 | 68679 | 5149 | 71455 | 4190 | 74367 | 2693 | 91907 | 1755 | 71217 |
| 9L-5S | | MI | 26691 | 8656 | 44897 | 6196 | 49437 | 4992 | 51833 | 4030 | 54529 | 2495 | 66164 | 1842 | 48430 |
| 24-#14 | 3.52 | MA | 37077 | 8656 | 60972 | 6407 | 66889 | 5169 | 69320 | 4208 | 71468 | 2708 | 88290 | 1667 | 69532 |
| 10L-4S | | MI | 27229 | 8656 | 45811 | 6203 | 50622 | 4977 | 53285 | 4018 | 56560 | 2508 | 68567 | 1896 | 49266 |

## RECTANGULAR TIED COLUMNS 34" x 34"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.17 | MA | 19300 | 5576 | 30282 | 4096 | 32427 | 3339 | 32840 | 2785 | 32233 | 1993 | 37453 | 1868 | 13810 |
| 2L-3S | | MI | 18367 | 5576 | 28905 | 4089 | 30663 | 3355 | 30687 | 2799 | 29362 | 2006 | 33662 | 1743 | 13888 |
| 6-#18 | 2.08 | MA | 20658 | 5939 | 33456 | 4288 | 36345 | 3474 | 37497 | 2855 | 38338 | 1924 | 45383 | 1741 | 23689 |
| 2L-3S | | MI | 19057 | 5939 | 31058 | 4274 | 33271 | 3499 | 33769 | 2878 | 33394 | 1946 | 38892 | 1520 | 23734 |
| 8-#11 | 1.08 | MA | 19186 | 5541 | 29951 | 4091 | 32081 | 3337 | 32446 | 2788 | 31765 | 2010 | 36875 | 1891 | 12860 |
| 2L-4S | | MI | 18065 | 5541 | 28197 | 4100 | 29838 | 3343 | 29715 | 2790 | 28198 | 2027 | 32464 | 1718 | 12964 |
| 8-#14 | 1.56 | MA | 19931 | 5732 | 31658 | 4193 | 34192 | 3409 | 34993 | 2828 | 35104 | 1977 | 41245 | 1832 | 18170 |
| 2L-4S | | MI | 18343 | 5732 | 29152 | 4205 | 30987 | 3416 | 31090 | 2830 | 30040 | 2002 | 35004 | 1583 | 18242 |
| 8-#18 | 2.77 | MA | 21723 | 6216 | 35855 | 4461 | 39420 | 3598 | 41226 | 2929 | 43282 | 1890 | 51874 | 1669 | 31223 |
| 2L-4S | | MI | 19003 | 6216 | 31480 | 4478 | 33828 | 3604 | 34461 | 2929 | 34561 | 1934 | 41188 | 1230 | 30001 |
| 10-#11 | 1.35 | MA | 19631 | 5649 | 30915 | 4158 | 33316 | 3386 | 33953 | 2817 | 33787 | 1999 | 39553 | 1868 | 15915 |
| 2L-5S | | MI | 18099 | 5649 | 28476 | 4163 | 30186 | 3403 | 30132 | 2830 | 28671 | 2007 | 33304 | 1657 | 15996 |
| 10-#11 | 1.35 | MA | 18979 | 5649 | 29951 | 4154 | 32081 | 3397 | 32446 | 2827 | 31765 | 2007 | 36875 | 1782 | 15959 |
| 3L-4S | | MI | 18515 | 5649 | 29161 | 4167 | 31074 | 3392 | 31222 | 2820 | 30220 | 2016 | 35142 | 1695 | 15995 |
| 10-#14 | 1.95 | MA | 20556 | 5888 | 33035 | 4290 | 35957 | 3479 | 37145 | 2870 | 37975 | 1960 | 45037 | 1796 | 22508 |
| 2L-5S | | MI | 18389 | 5888 | 29548 | 4296 | 31481 | 3501 | 31682 | 2885 | 30710 | 1973 | 36187 | 1492 | 21955 |
| 10-#14 | 1.95 | MA | 19634 | 5888 | 31658 | 4284 | 34192 | 3494 | 34993 | 2884 | 35104 | 1973 | 41245 | 1671 | 22545 |
| 3L-4S | | MI | 18978 | 5888 | 30528 | 4302 | 32752 | 3485 | 33243 | 2872 | 32911 | 1985 | 38796 | 1547 | 22514 |
| 10-#18 | 3.46 | MA | 22776 | 6493 | 38253 | 4634 | 42495 | 3722 | 44955 | 3003 | 48226 | 1856 | 58366 | 1597 | 38718 |
| 2L-5S | | MI | 19074 | 6493 | 32161 | 4637 | 34678 | 3754 | 35480 | 3025 | 35713 | 1879 | 43205 | 1062 | 35163 |
| 10-#18 | 3.46 | MA | 21203 | 6493 | 35855 | 4620 | 39420 | 3747 | 41226 | 3025 | 43282 | 1879 | 51874 | 1376 | 38574 |
| 3L-4S | | MI | 20081 | 6493 | 33879 | 4651 | 36903 | 3729 | 38190 | 3003 | 39505 | 1901 | 47680 | 1158 | 36956 |

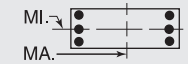
## RECTANGULAR TIED COLUMNS 34" x 36"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.31 | MA | 21862 | 5963 | 34510 | 4359 | 37008 | 3550 | 37589 | 2956 | 37110 | 2094 | 43235 | 1950 | 17184 |
| 2E | | MI | 20603 | 5963 | 32603 | 4337 | 34866 | 3532 | 35317 | 2937 | 34777 | 2076 | 40416 | 1928 | 16153 |
| 6-#14 | 1.10 | MA | 21557 | 5877 | 33669 | 4340 | 36093 | 3540 | 36534 | 2956 | 35833 | 2128 | 41639 | 2002 | 14721 |
| 2L-3S | | MI | 19390 | 5877 | 30444 | 4313 | 32259 | 3539 | 32239 | 2955 | 30752 | 2126 | 35196 | 1859 | 13930 |
| 6-#14 | 1.10 | MA | 20555 | 5877 | 32196 | 4334 | 34203 | 3557 | 34229 | 2970 | 32739 | 2141 | 37540 | 1878 | 14799 |
| 3L-2S | | MI | 20324 | 5877 | 31820 | 4319 | 34023 | 3523 | 34392 | 2942 | 33623 | 2113 | 38987 | 1984 | 13850 |
| 6-#18 | 1.96 | MA | 23028 | 6240 | 37081 | 4532 | 40304 | 3674 | 41611 | 3031 | 42449 | 2063 | 50271 | 1883 | 25309 |
| 2L-3S | | MI | 20080 | 6240 | 32603 | 4496 | 34866 | 3681 | 35317 | 3033 | 34777 | 2065 | 40416 | 1635 | 23816 |
| 6-#18 | 1.96 | MA | 21308 | 6240 | 34510 | 4520 | 37008 | 3702 | 37589 | 3053 | 37110 | 2085 | 43235 | 1662 | 25354 |
| 3L-2S | | MI | 21683 | 6240 | 35001 | 4510 | 37941 | 3656 | 39045 | 3010 | 39721 | 2043 | 46907 | 1856 | 23748 |
| 8-#11 | 1.02 | MA | 21431 | 5842 | 33311 | 4335 | 35717 | 3538 | 36106 | 2959 | 35318 | 2144 | 40996 | 2025 | 13703 |
| 2L-4S | | MI | 19087 | 5842 | 29732 | 4325 | 31435 | 3528 | 31269 | 2947 | 29591 | 2147 | 34003 | 1835 | 13005 |
| 8-#11 | 1.02 | MA | 20728 | 5842 | 32280 | 4332 | 34395 | 3550 | 34493 | 2969 | 33141 | 2153 | 38105 | 1938 | 13754 |
| 3E | | MI | 19553 | 5842 | 30522 | 4312 | 32441 | 3534 | 32492 | 2955 | 31136 | 2139 | 35736 | 1921 | 12948 |
| 8-#11 | 1.02 | MA | 20230 | 5842 | 31436 | 4345 | 33319 | 3545 | 33187 | 2962 | 31477 | 2161 | 36231 | 1852 | 13807 |
| 4L-2S | | MI | 20209 | 5842 | 31486 | 4316 | 33677 | 3522 | 34000 | 2945 | 33158 | 2130 | 38414 | 2008 | 12896 |
| 8-#14 | 1.47 | MA | 22237 | 6033 | 35143 | 4437 | 37982 | 3610 | 38839 | 2998 | 38926 | 2113 | 45738 | 1969 | 19385 |
| 2L-4S | | MI | 19365 | 6033 | 30690 | 4429 | 32583 | 3600 | 32642 | 2986 | 31429 | 2122 | 36538 | 1699 | 18311 |
| 8-#14 | 1.47 | MA | 21242 | 6033 | 33669 | 4431 | 36093 | 3626 | 36534 | 3013 | 35833 | 2126 | 41639 | 1844 | 19443 |
| 3E | | MI | 20027 | 6033 | 31820 | 4410 | 34023 | 3609 | 34392 | 2998 | 33623 | 2109 | 38987 | 1823 | 18278 |
| 8-#14 | 1.47 | MA | 20535 | 6033 | 32462 | 4450 | 34554 | 3618 | 34664 | 3002 | 33469 | 2138 | 38986 | 1720 | 19457 |
| 4L-2S | | MI | 20956 | 6033 | 33197 | 4417 | 35788 | 3593 | 36545 | 2984 | 36494 | 2097 | 42779 | 1948 | 18215 |
| 8-#18 | 2.61 | MA | 24180 | 6517 | 39652 | 4705 | 43600 | 3799 | 45632 | 3106 | 47789 | 2032 | 57307 | 1816 | 33383 |
| 2L-4S | | MI | 20025 | 6517 | 33025 | 4699 | 35424 | 3787 | 36009 | 3084 | 35944 | 2053 | 42713 | 1345 | 30384 |
| 8-#18 | 2.61 | MA | 22475 | 6517 | 37081 | 4693 | 40304 | 3826 | 41611 | 3129 | 42449 | 2054 | 50271 | 1595 | 33329 |
| 3E | | MI | 21161 | 6517 | 35001 | 4669 | 37941 | 3806 | 39045 | 3106 | 39721 | 2031 | 46907 | 1563 | 31265 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis

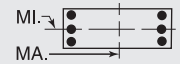



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 2.61 | MA | 21262 | 6517 | 34967 | 4725 | 37611 | 3809 | 38338 | 3107 | 38370 | 2076 | 45732 | 1374 | 32379 |
| 4L-2S | | MI | 22751 | 6517 | 37399 | 4683 | 41016 | 3780 | 42774 | 3084 | 44665 | 2009 | 53398 | 1784 | 31290 |
| 10-#11 | 1.27 | MA | 21911 | 5950 | 34343 | 4403 | 37039 | 3587 | 37719 | 2988 | 37494 | 2134 | 43888 | 2003 | 16968 |
| 2L-5S | | MI | 19121 | 5950 | 30011 | 4388 | 31782 | 3588 | 31686 | 2987 | 30063 | 2128 | 34843 | 1773 | 16059 |
| 10-#11 | 1.27 | MA | 21212 | 5950 | 33311 | 4399 | 35717 | 3599 | 36106 | 2998 | 35318 | 2143 | 40996 | 1917 | 17012 |
| 3L-4S | | MI | 19538 | 5950 | 30696 | 4392 | 32670 | 3576 | 32776 | 2977 | 31613 | 2137 | 36681 | 1812 | 16042 |
| 10-#11 | 1.27 | MA | 20716 | 5950 | 32468 | 4413 | 34642 | 3594 | 34800 | 2992 | 33654 | 2152 | 39122 | 1830 | 17048 |
| 4L-3S | | MI | 20002 | 5950 | 31486 | 4379 | 33677 | 3582 | 34000 | 2984 | 33158 | 2128 | 38414 | 1898 | 16000 |
| 10-#11 | 1.27 | MA | 20272 | 5950 | 31737 | 4409 | 33694 | 3606 | 33635 | 3002 | 31987 | 2143 | 37143 | 1791 | 17049 |
| 5L-2S | | MI | 20655 | 5950 | 32450 | 4383 | 34913 | 3571 | 35507 | 2974 | 35180 | 2120 | 41092 | 1985 | 15954 |
| 10-#14 | 1.84 | MA | 22912 | 6188 | 36617 | 4534 | 39871 | 3680 | 41143 | 3041 | 42020 | 2098 | 49837 | 1936 | 24026 |
| 2L-5S | | MI | 19410 | 6188 | 31086 | 4519 | 33077 | 3685 | 33234 | 3042 | 32099 | 2093 | 37721 | 1609 | 22179 |
| 10-#14 | 1.84 | MA | 21922 | 6188 | 35143 | 4529 | 37982 | 3696 | 38839 | 3055 | 38926 | 2110 | 45738 | 1811 | 24064 |
| 3L-4S | | MI | 20001 | 6188 | 32067 | 4526 | 34348 | 3670 | 34795 | 3028 | 34300 | 2105 | 40330 | 1663 | 22591 |
| 10-#14 | 1.84 | MA | 21220 | 6188 | 33936 | 4548 | 36443 | 3688 | 36969 | 3045 | 36562 | 2123 | 43085 | 1687 | 24033 |
| 4L-3S | | MI | 20658 | 6188 | 33197 | 4507 | 35788 | 3679 | 36545 | 3040 | 36494 | 2093 | 42779 | 1788 | 22602 |
| 10-#14 | 1.84 | MA | 20591 | 6188 | 32889 | 4542 | 35086 | 3705 | 35302 | 3059 | 34192 | 2110 | 40272 | 1631 | 23572 |
| 5L-2S | | MI | 21582 | 6188 | 34573 | 4514 | 37553 | 3663 | 38697 | 3027 | 39365 | 2080 | 46571 | 1912 | 22558 |
| 10-#18 | 3.27 | MA | 25318 | 6793 | 42224 | 4878 | 46896 | 3923 | 49653 | 3182 | 53128 | 2001 | 64343 | 1750 | 41418 |
| 2L-5S | | MI | 20095 | 6793 | 33706 | 4858 | 36273 | 3936 | 37028 | 3180 | 37096 | 1998 | 44729 | 1177 | 35485 |
| 10-#18 | 3.27 | MA | 23628 | 6793 | 39652 | 4866 | 43600 | 3950 | 45632 | 3204 | 47789 | 2023 | 57307 | 1528 | 41274 |
| 3L-4S | | MI | 21105 | 6793 | 35423 | 4872 | 38498 | 3911 | 39737 | 3158 | 40888 | 2020 | 49204 | 1273 | 37330 |
| 10-#18 | 3.27 | MA | 22427 | 6793 | 37538 | 4898 | 40907 | 3933 | 42360 | 3183 | 43709 | 2045 | 52768 | 1307 | 39844 |
| 4L-3S | | MI | 22231 | 6793 | 37399 | 4842 | 41016 | 3930 | 42774 | 3180 | 44665 | 1998 | 53398 | 1491 | 38682 |
| 10-#18 | 3.27 | MA | 21349 | 6793 | 35703 | 4885 | 38529 | 3960 | 39439 | 3205 | 39616 | 2023 | 47917 | 1212 | 37793 |
| 5L-2S | | MI | 23807 | 6793 | 39798 | 4856 | 44090 | 3904 | 46502 | 3158 | 49609 | 1976 | 59890 | 1712 | 38797 |
| 12-#11 | 1.53 | MA | 22389 | 6057 | 35374 | 4470 | 38361 | 3635 | 39332 | 3017 | 39671 | 2124 | 46779 | 1982 | 20221 |
| 2L-6S | | MI | 19176 | 6057 | 30332 | 4451 | 32129 | 3631 | 32106 | 3009 | 30682 | 2126 | 35796 | 1693 | 18730 |
| 12-#11 | 1.53 | MA | 21692 | 6057 | 34343 | 4466 | 37039 | 3647 | 37719 | 3028 | 37494 | 2133 | 43888 | 1895 | 20256 |
| 3L-5S | | MI | 19572 | 6057 | 30975 | 4456 | 33018 | 3636 | 33193 | 3016 | 32085 | 2118 | 37521 | 1750 | 19057 |
| 12-#11 | 1.53 | MA | 21199 | 6057 | 33499 | 4480 | 35964 | 3642 | 36412 | 3021 | 35831 | 2142 | 42014 | 1809 | 20277 |
| 4E | | MI | 19986 | 6057 | 31660 | 4460 | 33906 | 3625 | 34284 | 3006 | 33635 | 2126 | 39359 | 1789 | 19066 |
| 12-#11 | 1.53 | MA | 20757 | 6057 | 32768 | 4476 | 35016 | 3654 | 35248 | 3032 | 34163 | 2133 | 40035 | 1769 | 20252 |
| 5L-3S | | MI | 20449 | 6057 | 32450 | 4446 | 34913 | 3631 | 35507 | 3014 | 35180 | 2118 | 41092 | 1875 | 19038 |
| 12-#11 | 1.53 | MA | 20336 | 6057 | 32082 | 4473 | 34067 | 3649 | 34089 | 3025 | 32653 | 2142 | 38170 | 1713 | 19883 |
| 6L-2S | | MI | 21099 | 6057 | 33414 | 4451 | 36148 | 3619 | 37014 | 3004 | 37202 | 2109 | 43771 | 1961 | 19000 |
| 12-#14 | 2.21 | MA | 23582 | 6344 | 38091 | 4632 | 41761 | 3749 | 43448 | 3083 | 45114 | 2083 | 53936 | 1902 | 28653 |
| 2L-6S | | MI | 19486 | 6344 | 31542 | 4610 | 33568 | 3746 | 33901 | 3098 | 32978 | 2089 | 39071 | 1491 | 25553 |
| 12-#14 | 2.21 | MA | 22598 | 6344 | 36617 | 4626 | 39871 | 3766 | 41143 | 3098 | 42020 | 2095 | 49837 | 1778 | 28664 |
| 3L-5S | | MI | 20045 | 6344 | 32463 | 4617 | 34842 | 3755 | 35387 | 3084 | 34970 | 2076 | 41512 | 1573 | 26257 |
| 12-#14 | 2.21 | MA | 21900 | 6344 | 35409 | 4645 | 38333 | 3758 | 39274 | 3087 | 39656 | 2108 | 47184 | 1653 | 28594 |
| 4E | | MI | 20632 | 6344 | 33443 | 4623 | 36113 | 3739 | 36948 | 3071 | 37171 | 2089 | 44122 | 1627 | 26857 |
| 12-#14 | 2.21 | MA | 21275 | 6344 | 34362 | 4639 | 36976 | 3775 | 37607 | 3101 | 37285 | 2095 | 44371 | 1598 | 27943 |
| 5L-3S | | MI | 21285 | 6344 | 34573 | 4605 | 37553 | 3748 | 38697 | 3082 | 39365 | 2076 | 46571 | 1752 | 26908 |
| 12-#14 | 2.21 | MA | 20679 | 6344 | 33380 | 4633 | 35616 | 3766 | 35945 | 3091 | 35139 | 2108 | 41730 | 1516 | 27159 |
| 6L-2S | | MI | 22204 | 6344 | 35950 | 4611 | 39317 | 3733 | 40850 | 3069 | 42236 | 2064 | 50363 | 1876 | 26885 |
| 12-#18 | 3.92 | MA | 24770 | 7070 | 42224 | 5039 | 46896 | 4074 | 49653 | 3280 | 53128 | 1992 | 64343 | 1461 | 49200 |
| 3L-5S | | MI | 21172 | 7070 | 36104 | 5031 | 39348 | 4061 | 40756 | 3254 | 42040 | 1964 | 51220 | 1105 | 42616 |
| 12-#18 | 3.92 | MA | 23579 | 7070 | 40110 | 5070 | 44203 | 4057 | 46381 | 3258 | 49048 | 2014 | 59803 | 1240 | 47361 |
| 4E | | MI | 22173 | 7070 | 37822 | 5045 | 41573 | 4035 | 43466 | 3232 | 45832 | 1986 | 55695 | 1201 | 44328 |
| 12-#18 | 3.92 | MA | 22512 | 7070 | 38274 | 5058 | 41825 | 4084 | 43460 | 3280 | 44955 | 1992 | 54952 | 1145 | 45450 |
| 5L-3S | | MI | 23289 | 7070 | 39798 | 5015 | 44090 | 4054 | 46502 | 3254 | 49609 | 1964 | 59890 | 1419 | 46077 |
| 12-#18 | 3.92 | MA | 21496 | 7070 | 36550 | 5046 | 39441 | 4067 | 40680 | 3303 | 41250 | 2014 | 50426 | 999 | 42833 |
| 6L-2S | | MI | 24852 | 7070 | 42196 | 5029 | 47165 | 4028 | 50231 | 3232 | 54553 | 1942 | 66381 | 1640 | 46262 |
| 14-#11 | 1.78 | MA | 22864 | 6165 | 36406 | 4537 | 39683 | 3684 | 40945 | 3047 | 41847 | 2115 | 49671 | 1960 | 23465 |
| 2L-7S | | MI | 19242 | 6165 | 30592 | 4532 | 32515 | 3691 | 32570 | 3048 | 31333 | 2124 | 36629 | 1580 | 21294 |
| 14-#11 | 1.78 | MA | 22170 | 6165 | 35374 | 4534 | 38361 | 3696 | 39332 | 3057 | 39671 | 2123 | 46779 | 1874 | 23491 |
| 3L-6S | | MI | 19626 | 6165 | 31296 | 4519 | 33364 | 3679 | 33614 | 3038 | 32704 | 2116 | 38474 | 1670 | 21626 |

## RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis



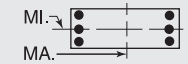

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.78 | MA | 21679 | 6165 | 34530 | 4547 | 37286 | 3690 | 38025 | 3051 | 38007 | 2132 | 44905 | 1787 | 23493 |
| 4L-5S | | MI | 20019 | 6165 | 31939 | 4523 | 34254 | 3685 | 34701 | 3046 | 34107 | 2107 | 40200 | 1727 | 22048 |
| 14-#11 | 1.78 | MA | 21239 | 6165 | 33799 | 4544 | 36338 | 3703 | 36861 | 3061 | 36340 | 2123 | 42926 | 1748 | 23447 |
| 5L-4S | | MI | 20432 | 6165 | 32624 | 4527 | 35142 | 3673 | 35791 | 3036 | 35657 | 2116 | 42038 | 1765 | 22081 |
| 14-#11 | 1.78 | MA | 20820 | 6165 | 33114 | 4540 | 35389 | 3697 | 35701 | 3054 | 34830 | 2132 | 41061 | 1692 | 22983 |
| 6L-3S | | MI | 20892 | 6165 | 33414 | 4514 | 36148 | 3679 | 37014 | 3043 | 37202 | 2107 | 43771 | 1852 | 22066 |
| 14-#11 | 1.78 | MA | 20411 | 6165 | 32363 | 4554 | 34483 | 3709 | 34588 | 3065 | 33354 | 2141 | 39069 | 1601 | 22611 |
| 7L-2S | | MI | 21540 | 6165 | 34378 | 4518 | 37384 | 3668 | 38522 | 3033 | 39224 | 2098 | 46449 | 1938 | 22036 |
| 14-#14 | 2.57 | MA | 24247 | 6499 | 39565 | 4729 | 43650 | 3819 | 45753 | 3126 | 48207 | 2067 | 58035 | 1869 | 33274 |
| 2L-7S | | MI | 19577 | 6499 | 31910 | 4726 | 34117 | 3832 | 34489 | 3128 | 33903 | 2085 | 40251 | 1325 | 28821 |
| 14-#14 | 2.57 | MA | 23268 | 6499 | 38091 | 4723 | 41761 | 3836 | 43448 | 3140 | 45114 | 2080 | 53936 | 1745 | 33248 |
| 3L-6S | | MI | 20119 | 6499 | 32918 | 4707 | 35333 | 3816 | 36054 | 3140 | 35849 | 2072 | 42863 | 1455 | 29691 |
| 14-#14 | 2.57 | MA | 22575 | 6499 | 36883 | 4742 | 40222 | 3828 | 41578 | 3130 | 42749 | 2092 | 51283 | 1620 | 33147 |
| 4L-5S | | MI | 20675 | 6499 | 33839 | 4714 | 36607 | 3825 | 37539 | 3127 | 37841 | 2060 | 45304 | 1537 | 30353 |
| 14-#14 | 2.57 | MA | 21953 | 6499 | 35836 | 4736 | 38865 | 3844 | 39911 | 3144 | 40379 | 2080 | 48471 | 1564 | 32332 |
| 5L-4S | | MI | 21258 | 6499 | 34820 | 4720 | 37877 | 3809 | 39100 | 3113 | 40042 | 2072 | 47914 | 1591 | 31113 |
| 14-#14 | 2.57 | MA | 21361 | 6499 | 34853 | 4731 | 37505 | 3836 | 38250 | 3133 | 38232 | 2092 | 45829 | 1483 | 31592 |
| 6L-3S | | MI | 21908 | 6499 | 35950 | 4702 | 39317 | 3818 | 40850 | 3125 | 42236 | 2060 | 50363 | 1716 | 31194 |
| 14-#14 | 2.57 | MA | 20784 | 6499 | 33777 | 4750 | 36207 | 3853 | 36655 | 3148 | 36135 | 2105 | 43005 | 1352 | 30650 |
| 7L-2S | | MI | 22822 | 6499 | 37326 | 4708 | 41082 | 3802 | 43003 | 3111 | 45107 | 2047 | 54155 | 1840 | 31200 |
| 14-#18 | 4.58 | MA | 24720 | 7347 | 42681 | 5243 | 47499 | 4181 | 50402 | 3333 | 54387 | 1983 | 66839 | 1173 | 54919 |
| 4L-5S | | MI | 22239 | 7347 | 38503 | 5204 | 42423 | 4185 | 44485 | 3328 | 46984 | 1930 | 57711 | 1033 | 49770 |
| 14-#18 | 4.58 | MA | 23662 | 7347 | 40846 | 5231 | 45121 | 4208 | 47481 | 3356 | 50294 | 1961 | 61988 | 1078 | 53130 |
| 5L-4S | | MI | 23231 | 7347 | 40220 | 5218 | 44647 | 4159 | 47195 | 3306 | 50776 | 1953 | 62187 | 1129 | 51366 |
| 14-#18 | 4.58 | MA | 22656 | 7347 | 39122 | 5218 | 42738 | 4191 | 44701 | 3378 | 46589 | 1983 | 57462 | 932 | 50338 |
| 6L-3S | | MI | 24338 | 7347 | 42196 | 5188 | 47165 | 4178 | 50231 | 3328 | 54553 | 1930 | 66381 | 1347 | 53458 |
| 16-#11 | 2.04 | MA | 23336 | 6273 | 37437 | 4605 | 41005 | 3732 | 42558 | 3076 | 44024 | 2105 | 52563 | 1938 | 26702 |
| 2L-8S | | MI | 19315 | 6273 | 30923 | 4595 | 32889 | 3733 | 33058 | 3087 | 31897 | 2105 | 37589 | 1511 | 23752 |
| 16-#11 | 2.04 | MA | 22645 | 6273 | 36406 | 4601 | 39683 | 3744 | 40945 | 3087 | 41847 | 2114 | 49671 | 1852 | 26719 |
| 3L-7S | | MI | 19691 | 6273 | 31556 | 4600 | 33751 | 3739 | 34077 | 3077 | 33355 | 2113 | 39307 | 1557 | 24214 |
| 16-#11 | 2.04 | MA | 22156 | 6273 | 35562 | 4615 | 38608 | 3739 | 39638 | 3080 | 40184 | 2122 | 47797 | 1766 | 26700 |
| 4L-6S | | MI | 20073 | 6273 | 32260 | 4586 | 34600 | 3728 | 35121 | 3068 | 34726 | 2105 | 41152 | 1647 | 24530 |
| 16-#11 | 2.04 | MA | 21718 | 6273 | 34831 | 4611 | 37660 | 3751 | 38474 | 3090 | 38516 | 2114 | 45818 | 1726 | 26636 |
| 5E | | MI | 20465 | 6273 | 32903 | 4590 | 35490 | 3733 | 36208 | 3075 | 36129 | 2096 | 42878 | 1704 | 25032 |
| 16-#11 | 2.04 | MA | 21301 | 6273 | 34145 | 4608 | 36711 | 3746 | 37314 | 3084 | 37006 | 2122 | 43953 | 1670 | 26091 |
| 6L-4S | | MI | 20876 | 6273 | 33588 | 4595 | 36377 | 3722 | 37299 | 3065 | 37679 | 2105 | 44716 | 1742 | 25081 |
| 16-#11 | 2.04 | MA | 20894 | 6273 | 33394 | 4621 | 35805 | 3758 | 36201 | 3094 | 35530 | 2131 | 41960 | 1580 | 25736 |
| 7L-3S | | MI | 21334 | 6273 | 34378 | 4581 | 37384 | 3727 | 38522 | 3072 | 39224 | 2096 | 46449 | 1829 | 25087 |
| 16-#11 | 2.04 | MA | 20494 | 6273 | 32718 | 4618 | 34886 | 3753 | 35113 | 3105 | 33961 | 2122 | 40111 | 1533 | 25229 |
| 8L-2S | | MI | 21979 | 6273 | 35342 | 4585 | 38620 | 3716 | 40029 | 3063 | 41246 | 2088 | 49127 | 1915 | 25065 |
| 16-#14 | 2.94 | MA | 23934 | 6655 | 39565 | 4820 | 43650 | 3906 | 45753 | 3182 | 48207 | 2065 | 58035 | 1711 | 37823 |
| 3L-7S | | MI | 20209 | 6655 | 33287 | 4823 | 35881 | 3902 | 36642 | 3171 | 36774 | 2068 | 44043 | 1289 | 32874 |
| 16-#14 | 2.94 | MA | 23244 | 6655 | 38357 | 4839 | 42111 | 3898 | 43883 | 3172 | 45843 | 2077 | 55382 | 1587 | 37693 |
| 4L-6S | | MI | 20747 | 6655 | 34295 | 4805 | 37098 | 3886 | 38207 | 3182 | 38720 | 2056 | 46655 | 1419 | 33837 |
| 16-#14 | 2.94 | MA | 22627 | 6655 | 37310 | 4834 | 40754 | 3914 | 42216 | 3186 | 43473 | 2065 | 52570 | 1531 | 36736 |
| 5E | | MI | 21300 | 6655 | 35216 | 4811 | 38371 | 3895 | 39692 | 3169 | 40712 | 2043 | 49096 | 1501 | 34463 |
| 16-#14 | 2.94 | MA | 22038 | 6655 | 36327 | 4828 | 39395 | 3906 | 40555 | 3176 | 41326 | 2077 | 49928 | 1449 | 36034 |
| 6L-4S | | MI | 21880 | 6655 | 36196 | 4818 | 39642 | 3879 | 41253 | 3156 | 42913 | 2056 | 51706 | 1556 | 35361 |
| 16-#14 | 2.94 | MA | 21465 | 6655 | 35251 | 4847 | 38096 | 3923 | 38960 | 3190 | 39228 | 2090 | 47104 | 1319 | 34998 |
| 7L-3S | | MI | 22526 | 6655 | 37326 | 4799 | 41082 | 3888 | 43003 | 3167 | 45107 | 2043 | 54155 | 1680 | 35470 |
| 16-#14 | 2.94 | MA | 20900 | 6655 | 34283 | 4841 | 36780 | 3915 | 37402 | 3204 | 36997 | 2077 | 44476 | 1253 | 34032 |
| 8L-2S | | MI | 23436 | 6655 | 38703 | 4806 | 42847 | 3872 | 45155 | 3154 | 47978 | 2031 | 57947 | 1805 | 35506 |
| 16-#18 | 5.23 | MA | 24802 | 7623 | 43417 | 5404 | 48418 | 4332 | 51502 | 3431 | 55633 | 1930 | 69024 | 1011 | 60829 |
| 5E | | MI | 23296 | 7623 | 40901 | 5377 | 45497 | 4309 | 48213 | 3402 | 51928 | 1897 | 64203 | 961 | 56942 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis

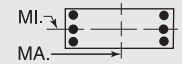


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 5.23 | MA | 23804 | 7623 | 41693 | 5391 | 46034 | 4315 | 48722 | 3454 | 51928 | 1952 | 64498 | 865 | 57873 |
| 6L-4S | | MI | 24280 | 7623 | 42618 | 5391 | 47722 | 4283 | 50923 | 3379 | 55720 | 1919 | 68678 | 1057 | 58437 |
| 18-#11 | 2.29 | MA | 23117 | 6381 | 37437 | 4669 | 41005 | 3792 | 42558 | 3116 | 44024 | 2104 | 52563 | 1831 | 29936 |
| 3L-8S | | MI | 19762 | 6381 | 31886 | 4663 | 34125 | 3782 | 34566 | 3117 | 33919 | 2094 | 40268 | 1488 | 26616 |
| 18-#11 | 2.29 | MA | 22631 | 6381 | 36593 | 4682 | 39930 | 3787 | 41251 | 3109 | 42360 | 2112 | 50688 | 1744 | 29902 |
| 4L-7S | | MI | 20137 | 6381 | 32520 | 4667 | 34986 | 3787 | 35585 | 3107 | 35377 | 2103 | 41985 | 1533 | 27138 |
| 18-#11 | 2.29 | MA | 22195 | 6381 | 35862 | 4679 | 38983 | 3799 | 40087 | 3120 | 40693 | 2104 | 48709 | 1705 | 29787 |
| 5L-6S | | MI | 20517 | 6381 | 33224 | 4654 | 35836 | 3776 | 36629 | 3097 | 36748 | 2094 | 43831 | 1624 | 27440 |
| 18-#11 | 2.29 | MA | 21780 | 6381 | 35176 | 4675 | 38033 | 3794 | 38927 | 3113 | 39183 | 2112 | 46844 | 1648 | 29206 |
| 6L-5S | | MI | 20907 | 6381 | 33867 | 4658 | 36725 | 3782 | 37716 | 3104 | 38152 | 2086 | 45556 | 1680 | 27962 |
| 18-#11 | 2.29 | MA | 21375 | 6381 | 34425 | 4689 | 37127 | 3806 | 37814 | 3124 | 37707 | 2121 | 44852 | 1558 | 28864 |
| 7L-4S | | MI | 21317 | 6381 | 34552 | 4662 | 37613 | 3770 | 38806 | 3094 | 39701 | 2094 | 47394 | 1719 | 28076 |
| 18-#11 | 2.29 | MA | 20976 | 6381 | 33750 | 4685 | 36208 | 3801 | 36726 | 3134 | 36137 | 2112 | 43002 | 1512 | 28298 |
| 8L-3S | | MI | 21773 | 6381 | 35342 | 4649 | 38620 | 3776 | 40029 | 3102 | 41246 | 2086 | 49127 | 1805 | 28102 |
| 18-#11 | 2.29 | MA | 20582 | 6381 | 33023 | 4699 | 35314 | 3813 | 35589 | 3128 | 34675 | 2121 | 41194 | 1457 | 27744 |
| 9L-2S | | MI | 22416 | 6381 | 36306 | 4653 | 39855 | 3764 | 41537 | 3092 | 43268 | 2077 | 51806 | 1892 | 28088 |
| 18-#14 | 3.31 | MA | 23910 | 6811 | 39831 | 4937 | 44000 | 3967 | 46188 | 3214 | 48937 | 2062 | 59481 | 1554 | 42233 |
| 4L-7S | | MI | 20836 | 6811 | 34663 | 4920 | 37646 | 3972 | 38794 | 3213 | 39645 | 2052 | 47835 | 1253 | 36939 |
| 18-#14 | 3.31 | MA | 23296 | 6811 | 38784 | 4931 | 42643 | 3984 | 44521 | 3229 | 46566 | 2049 | 56669 | 1498 | 41152 |
| 5L-6S | | MI | 21372 | 6811 | 35671 | 4902 | 38862 | 3956 | 40359 | 3225 | 41591 | 2039 | 50447 | 1383 | 37990 |
| 18-#14 | 3.31 | MA | 22711 | 6811 | 37801 | 4925 | 41284 | 3976 | 42860 | 3218 | 44420 | 2062 | 54027 | 1416 | 40483 |
| 6L-5S | | MI | 21921 | 6811 | 36592 | 4908 | 40136 | 3965 | 41845 | 3211 | 43583 | 2027 | 52888 | 1465 | 38585 |
| 18-#14 | 3.31 | MA | 22141 | 6811 | 36725 | 4944 | 39986 | 3993 | 41264 | 3233 | 42322 | 2074 | 51203 | 1286 | 39359 |
| 7L-4S | | MI | 22498 | 6811 | 37573 | 4915 | 41407 | 3949 | 43406 | 3198 | 45784 | 2039 | 55498 | 1520 | 39604 |
| 18-#14 | 3.31 | MA | 21580 | 6811 | 35757 | 4938 | 38669 | 3985 | 39706 | 3247 | 40091 | 2062 | 48575 | 1220 | 38425 |
| 8L-3S | | MI | 23141 | 6811 | 38703 | 4896 | 42847 | 3958 | 45155 | 3210 | 47978 | 2027 | 57947 | 1644 | 39738 |
| 18-#18 | 5.88 | MA | 24943 | 7900 | 44264 | 5564 | 49330 | 4440 | 52743 | 3529 | 57267 | 1921 | 71534 | 798 | 65431 |
| 6L-5S | | MI | 24344 | 7900 | 43300 | 5550 | 48572 | 4433 | 51942 | 3475 | 56872 | 1863 | 70694 | 889 | 63896 |
| 20-#11 | 2.55 | MA | 23103 | 6489 | 37624 | 4750 | 41252 | 3836 | 42864 | 3139 | 44537 | 2103 | 53580 | 1723 | 33099 |
| 4L-8S | | MI | 20208 | 6489 | 32850 | 4730 | 35361 | 3830 | 36073 | 3146 | 35941 | 2084 | 42946 | 1465 | 29487 |
| 20-#11 | 2.55 | MA | 22669 | 6489 | 36894 | 4746 | 40305 | 3848 | 41700 | 3149 | 42869 | 2094 | 51601 | 1683 | 32879 |
| 5L-7S | | MI | 20581 | 6489 | 33484 | 4734 | 36222 | 3836 | 37092 | 3136 | 37399 | 2092 | 44664 | 1510 | 30064 |
| 20-#11 | 2.55 | MA | 22256 | 6489 | 36208 | 4742 | 39356 | 3843 | 40540 | 3143 | 41359 | 2103 | 49736 | 1627 | 32325 |
| 6E | | MI | 20960 | 6489 | 34188 | 4721 | 37071 | 3824 | 38136 | 3126 | 38770 | 2084 | 46509 | 1601 | 30355 |
| 20-#11 | 2.55 | MA | 21853 | 6489 | 35457 | 4756 | 38449 | 3855 | 39427 | 3153 | 39883 | 2111 | 47743 | 1537 | 31996 |
| 7L-5S | | MI | 21348 | 6489 | 34831 | 4725 | 37961 | 3830 | 39223 | 3134 | 40174 | 2075 | 48234 | 1657 | 30850 |
| 20-#11 | 2.55 | MA | 21456 | 6489 | 34781 | 4752 | 37530 | 3850 | 38339 | 3164 | 38314 | 2103 | 45894 | 1490 | 31374 |
| 8L-4S | | MI | 21755 | 6489 | 35516 | 4729 | 38849 | 3819 | 40314 | 3124 | 41723 | 2084 | 50073 | 1696 | 31066 |
| 20-#11 | 2.55 | MA | 21063 | 6489 | 34054 | 4766 | 36636 | 3862 | 37202 | 3157 | 36851 | 2111 | 44086 | 1436 | 30838 |
| 9L-3S | | MI | 22210 | 6489 | 36306 | 4716 | 39855 | 3824 | 41537 | 3131 | 43268 | 2075 | 51806 | 1782 | 31103 |
| 20-#14 | 3.68 | MA | 23960 | 6966 | 40257 | 5028 | 44533 | 4054 | 46826 | 3271 | 49660 | 2034 | 60768 | 1465 | 45578 |
| 5L-7S | | MI | 21460 | 6966 | 36040 | 5017 | 39411 | 4041 | 40947 | 3256 | 42516 | 2035 | 51627 | 1217 | 41015 |
| 20-#14 | 3.68 | MA | 23379 | 6966 | 39275 | 5022 | 43173 | 4046 | 45165 | 3261 | 47513 | 2047 | 58126 | 1383 | 44938 |
| 6E | | MI | 21992 | 6966 | 37048 | 4999 | 40627 | 4026 | 42512 | 3267 | 44462 | 2023 | 54239 | 1348 | 42147 |
| 20-#14 | 3.68 | MA | 22812 | 6966 | 38199 | 5041 | 41875 | 4063 | 43569 | 3275 | 45416 | 2059 | 55302 | 1253 | 43730 |
| 7L-5S | | MI | 22539 | 6966 | 37969 | 5006 | 41900 | 4035 | 43998 | 3254 | 46454 | 2010 | 56680 | 1429 | 42715 |
| 20-#14 | 3.68 | MA | 22254 | 6966 | 37231 | 5036 | 40558 | 4054 | 42011 | 3289 | 43184 | 2047 | 52674 | 1187 | 42731 |
| 8L-4S | | MI | 23112 | 6966 | 38949 | 5012 | 43171 | 4019 | 45559 | 3240 | 48655 | 2023 | 59289 | 1484 | 43841 |
| 22-#11 | 2.80 | MA | 23141 | 6597 | 37925 | 4814 | 41627 | 3896 | 43313 | 3179 | 45046 | 2084 | 54492 | 1662 | 35978 |
| 5L-8S | | MI | 20651 | 6597 | 33814 | 4798 | 36596 | 3879 | 37581 | 3176 | 37963 | 2073 | 45624 | 1441 | 32363 |
| 22-#11 | 2.80 | MA | 22729 | 6597 | 37239 | 4810 | 40678 | 3891 | 42153 | 3172 | 43536 | 2093 | 52628 | 1605 | 35448 |
| 6L-7S | | MI | 21023 | 6597 | 34448 | 4802 | 37458 | 3884 | 38600 | 3166 | 39421 | 2082 | 47342 | 1487 | 32992 |
| 22-#11 | 2.80 | MA | 22328 | 6597 | 36488 | 4824 | 39772 | 3903 | 41040 | 3183 | 42060 | 2101 | 50635 | 1515 | 35130 |
| 7L-6S | | MI | 21400 | 6597 | 35152 | 4789 | 38307 | 3873 | 39644 | 3156 | 40792 | 2073 | 49187 | 1577 | 33273 |
| 22-#11 | 2.80 | MA | 21933 | 6597 | 35812 | 4820 | 38853 | 3898 | 39952 | 3193 | 40490 | 2093 | 48785 | 1469 | 34455 |
| 8L-5S | | MI | 21786 | 6597 | 35795 | 4793 | 39197 | 3879 | 40731 | 3163 | 42196 | 2064 | 50913 | 1634 | 33746 |
| 22-#11 | 2.80 | MA | 21542 | 6597 | 35085 | 4834 | 37958 | 3910 | 38815 | 3186 | 39028 | 2101 | 46977 | 1414 | 33937 |
| 9L-4S | | MI | 22192 | 6597 | 36480 | 4797 | 40085 | 3867 | 41821 | 3153 | 43745 | 2073 | 52751 | 1672 | 34053 |

## RECTANGULAR TIED COLUMNS 34" x 36"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 4.04 | MA | 24043 | 7122 | 40749 | 5120 | 45062 | 4116 | 47470 | 3303 | 50607 | 2031 | 62225 | 1350 | 49397 |
| 6L-7S | | MI | 22080 | 7122 | 37416 | 5115 | 41175 | 4111 | 43100 | 3298 | 45387 | 2018 | 55419 | 1181 | 45100 |
| 22-#14 | 4.04 | MA | 23479 | 7122 | 39672 | 5139 | 43764 | 4132 | 45874 | 3317 | 48509 | 2044 | 59401 | 1219 | 48111 |
| 7L-6S | | MI | 22609 | 7122 | 38424 | 5096 | 42392 | 4095 | 44665 | 3310 | 47333 | 2006 | 58031 | 1312 | 46305 |
| 22-#14 | 4.04 | MA | 22925 | 7122 | 38704 | 5133 | 42448 | 4124 | 44316 | 3332 | 46278 | 2031 | 56773 | 1153 | 47048 |
| 8L-5S | | MI | 23153 | 7122 | 39345 | 5103 | 43665 | 4104 | 46150 | 3296 | 49325 | 1994 | 60472 | 1394 | 46854 |
| 24-#11 | 3.06 | MA | 23200 | 6705 | 38270 | 4877 | 42000 | 3939 | 43766 | 3201 | 45712 | 2083 | 55519 | 1584 | 38575 |
| 6L-8S | | MI | 21092 | 6705 | 34778 | 4865 | 37832 | 3927 | 39088 | 3205 | 39985 | 2062 | 48303 | 1418 | 35245 |
| 24-#11 | 3.06 | MA | 22801 | 6705 | 37519 | 4891 | 41094 | 3952 | 42652 | 3212 | 44236 | 2092 | 53526 | 1493 | 38263 |
| 7E | | MI | 21462 | 6705 | 35412 | 4869 | 38694 | 3933 | 40107 | 3195 | 41443 | 2071 | 50020 | 1464 | 35895 |
| 24-#11 | 3.06 | MA | 22407 | 6705 | 36844 | 4887 | 40175 | 3946 | 41565 | 3222 | 42667 | 2083 | 51677 | 1447 | 37542 |
| 8L-6S | | MI | 21837 | 6705 | 36116 | 4856 | 39543 | 3921 | 41151 | 3185 | 42815 | 2062 | 51865 | 1554 | 36195 |
| 24-#11 | 3.06 | MA | 22018 | 6705 | 36117 | 4901 | 39280 | 3958 | 40428 | 3216 | 41204 | 2092 | 49869 | 1393 | 37022 |
| 9L-5S | | MI | 22223 | 6705 | 36759 | 4860 | 40432 | 3927 | 42238 | 3193 | 44218 | 2054 | 53591 | 1611 | 36647 |
| 24-#14 | 4.41 | MA | 24143 | 7277 | 41146 | 5236 | 45654 | 4202 | 48179 | 3360 | 51603 | 2029 | 63500 | 1186 | 52501 |
| 7E | | MI | 22696 | 7277 | 38793 | 5212 | 42940 | 4181 | 45253 | 3340 | 48258 | 2002 | 59211 | 1145 | 49194 |
| 24-#14 | 4.41 | MA | 23591 | 7277 | 40178 | 5230 | 44337 | 4194 | 46621 | 3374 | 49372 | 2016 | 60872 | 1120 | 51375 |
| 8L-6S | | MI | 23222 | 7277 | 39801 | 5194 | 44156 | 4165 | 46818 | 3352 | 50204 | 1990 | 61823 | 1276 | 50353 |

## RECTANGULAR TIED COLUMNS 34" x 38"

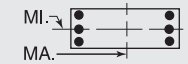
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.24 | MA | 24266 | 6264 | 38133 | 4604 | 40931 | 3751 | 41552 | 3126 | 40998 | 2229 | 47773 | 2086 | 18264 |
| 2E | | MI | 21626 | 6264 | 34147 | 4559 | 36462 | 3714 | 36864 | 3092 | 36160 | 2195 | 41940 | 2043 | 16202 |
| 6-#14 | 1.04 | MA | 23934 | 6177 | 37228 | 4584 | 39945 | 3741 | 40414 | 3127 | 39604 | 2263 | 46017 | 2136 | 15632 |
| 2L-3S | | MI | 20412 | 6177 | 31982 | 4537 | 33855 | 3723 | 33791 | 3111 | 32141 | 2246 | 36729 | 1975 | 13971 |
| 6-#14 | 1.04 | MA | 22864 | 6177 | 35657 | 4579 | 37931 | 3758 | 37957 | 3142 | 36287 | 2275 | 41610 | 2011 | 15710 |
| 3L-2S | | MI | 21347 | 6177 | 33359 | 4543 | 35619 | 3707 | 35944 | 3098 | 35012 | 2234 | 40521 | 2100 | 13888 |
| 6-#18 | 1.86 | MA | 25520 | 6541 | 40877 | 4777 | 44449 | 3875 | 45844 | 3202 | 46733 | 2201 | 55354 | 2024 | 26929 |
| 2L-3S | | MI | 21103 | 6541 | 34147 | 4718 | 36462 | 3864 | 36864 | 3187 | 36160 | 2184 | 41940 | 1750 | 23893 |
| 6-#18 | 1.86 | MA | 23680 | 6541 | 38133 | 4765 | 40931 | 3904 | 41552 | 3226 | 40998 | 2223 | 47773 | 1802 | 26974 |
| 3L-2S | | MI | 22709 | 6541 | 36546 | 4732 | 39536 | 3838 | 40593 | 3165 | 41104 | 2162 | 48431 | 1971 | 23806 |
| 8-#14 | 1.39 | MA | 24665 | 6333 | 38799 | 4681 | 41959 | 3811 | 42871 | 3169 | 42920 | 2249 | 50423 | 2105 | 20600 |
| 2L-4S | | MI | 20387 | 6333 | 32228 | 4652 | 34180 | 3784 | 34194 | 3142 | 32818 | 2242 | 38072 | 1815 | 18373 |
| 8-#14 | 1.39 | MA | 23601 | 6333 | 37228 | 4676 | 39945 | 3828 | 40414 | 3184 | 39604 | 2261 | 46017 | 1980 | 20658 |
| 3E | | MI | 21050 | 6333 | 33359 | 4634 | 35619 | 3793 | 35944 | 3154 | 35012 | 2229 | 40521 | 1940 | 18327 |
| 8-#14 | 1.39 | MA | 22848 | 6333 | 35943 | 4696 | 38307 | 3821 | 38424 | 3175 | 37069 | 2274 | 43160 | 1856 | 20672 |
| 4L-2S | | MI | 21980 | 6333 | 34735 | 4640 | 37384 | 3777 | 38096 | 3141 | 37883 | 2217 | 44313 | 2064 | 18259 |
| 8-#18 | 2.48 | MA | 26759 | 6817 | 43621 | 4949 | 47967 | 4000 | 50135 | 3277 | 52467 | 2172 | 62935 | 1962 | 35543 |
| 2L-4S | | MI | 21047 | 6817 | 34570 | 4921 | 37019 | 3969 | 37557 | 3239 | 37327 | 2172 | 44237 | 1460 | 30756 |
| 8-#18 | 2.48 | MA | 24935 | 6817 | 40877 | 4938 | 44449 | 4028 | 45844 | 3301 | 46733 | 2194 | 55354 | 1740 | 35489 |
| 3E | | MI | 22186 | 6817 | 36546 | 4891 | 39536 | 3988 | 40593 | 3261 | 41104 | 2150 | 48431 | 1678 | 31357 |
| 8-#18 | 2.48 | MA | 23641 | 6817 | 38625 | 4971 | 41580 | 4013 | 42357 | 3281 | 42350 | 2216 | 50454 | 1519 | 34789 |
| 4L-2S | | MI | 23779 | 6817 | 38944 | 4905 | 42611 | 3963 | 44321 | 3239 | 46048 | 2128 | 54922 | 1899 | 31356 |
| 10-#11 | 1.21 | MA | 24312 | 6250 | 37942 | 4647 | 40948 | 3788 | 41671 | 3159 | 41372 | 2269 | 48415 | 2137 | 18021 |
| 2L-5S | | MI | 20143 | 6250 | 31546 | 4613 | 33379 | 3773 | 33240 | 3144 | 31456 | 2249 | 36382 | 1890 | 16115 |
| 10-#11 | 1.21 | MA | 23565 | 6250 | 36843 | 4644 | 39540 | 3800 | 39953 | 3170 | 39041 | 2278 | 45310 | 2051 | 18065 |
| 3L-4S | | MI | 20560 | 6250 | 32231 | 4617 | 34267 | 3761 | 34330 | 3134 | 33006 | 2258 | 38220 | 1929 | 16087 |
| 10-#11 | 1.21 | MA | 23038 | 6250 | 35945 | 4658 | 38396 | 3795 | 38563 | 3164 | 37259 | 2286 | 43295 | 1965 | 18101 |
| 4L-3S | | MI | 21025 | 6250 | 33021 | 4604 | 35273 | 3767 | 35553 | 3141 | 34551 | 2249 | 39953 | 2015 | 16040 |
| 10-#11 | 1.21 | MA | 22566 | 6250 | 35168 | 4654 | 37389 | 3808 | 37325 | 3175 | 35474 | 2278 | 41175 | 1925 | 18102 |
| 5L-2S | | MI | 21679 | 6250 | 33985 | 4608 | 36509 | 3756 | 37061 | 3131 | 36573 | 2240 | 42631 | 2101 | 15992 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.74 | MA | 25389 | 6489 | 40370 | 4779 | 43973 | 3880 | 45328 | 3212 | 46237 | 2235 | 54830 | 2074 | 25545 |
| 2L-5S | | MI | 20432 | 6489 | 32624 | 4743 | 34673 | 3869 | 34786 | 3198 | 33489 | 2213 | 39255 | 1725 | 22396 |
| 10-#14 | 1.74 | MA | 24332 | 6489 | 38799 | 4773 | 41959 | 3898 | 42871 | 3227 | 42920 | 2247 | 50423 | 1949 | 25583 |
| 3L-4S | | MI | 21024 | 6489 | 33605 | 4750 | 35944 | 3854 | 36347 | 3185 | 35689 | 2225 | 41864 | 1779 | 22664 |
| 10-#14 | 1.74 | MA | 23584 | 6489 | 37514 | 4793 | 40321 | 3891 | 40881 | 3217 | 40385 | 2260 | 47567 | 1825 | 25551 |
| 4L-3S | | MI | 21682 | 6489 | 34735 | 4731 | 37384 | 3863 | 38096 | 3196 | 37883 | 2213 | 44313 | 1904 | 22656 |
| 10-#14 | 1.74 | MA | 22914 | 6489 | 36401 | 4788 | 38878 | 3908 | 39108 | 3232 | 37845 | 2247 | 44551 | 1768 | 25204 |
| 5L-2S | | MI | 22608 | 6489 | 36112 | 4738 | 39149 | 3847 | 40249 | 3183 | 40754 | 2201 | 48105 | 2028 | 22606 |
| 10-#18 | 3.10 | MA | 27984 | 7094 | 46365 | 5122 | 51485 | 4124 | 54427 | 3352 | 58202 | 2143 | 70517 | 1899 | 44118 |
| 2L-5S | | MI | 21115 | 7094 | 35251 | 5080 | 37869 | 4119 | 38575 | 3335 | 38479 | 2117 | 46253 | 1292 | 35797 |
| 10-#18 | 3.10 | MA | 26176 | 7094 | 43621 | 5111 | 47967 | 4152 | 50135 | 3377 | 52467 | 2165 | 62935 | 1678 | 43974 |
| 3L-4S | | MI | 22129 | 7094 | 36968 | 5094 | 40094 | 4093 | 41285 | 3313 | 42271 | 2139 | 50728 | 1388 | 37695 |
| 10-#18 | 3.10 | MA | 24894 | 7094 | 41369 | 5144 | 45098 | 4137 | 46649 | 3357 | 48085 | 2187 | 58035 | 1456 | 42766 |
| 4L-3S | | MI | 23257 | 7094 | 38944 | 5064 | 42611 | 4112 | 44321 | 3335 | 46048 | 2117 | 54922 | 1606 | 38785 |
| 10-#18 | 3.10 | MA | 23746 | 7094 | 39416 | 5133 | 42567 | 4165 | 43539 | 3381 | 43690 | 2165 | 52823 | 1359 | 40444 |
| 5L-2S | | MI | 24837 | 7094 | 41343 | 5077 | 45686 | 4087 | 48050 | 3313 | 50992 | 2095 | 61414 | 1827 | 38875 |
| 12-#11 | 1.45 | MA | 24825 | 6358 | 39040 | 4714 | 42357 | 3836 | 43390 | 3188 | 43703 | 2260 | 51520 | 2117 | 21484 |
| 2L-6S | | MI | 20198 | 6358 | 31867 | 4676 | 33725 | 3816 | 33660 | 3166 | 32075 | 2247 | 37335 | 1810 | 18881 |
| 12-#11 | 1.45 | MA | 24081 | 6358 | 37942 | 4711 | 40948 | 3849 | 41671 | 3199 | 41372 | 2269 | 48415 | 2031 | 21519 |
| 3L-5S | | MI | 20594 | 6358 | 32510 | 4680 | 34615 | 3821 | 34747 | 3173 | 33478 | 2238 | 39060 | 1867 | 19122 |
| 12-#11 | 1.45 | MA | 23556 | 6358 | 37044 | 4725 | 39805 | 3844 | 40281 | 3193 | 39590 | 2277 | 46400 | 1945 | 21541 |
| 4E | | MI | 21009 | 6358 | 33195 | 4684 | 35502 | 3810 | 35838 | 3163 | 35028 | 2247 | 40898 | 1905 | 19116 |
| 12-#11 | 1.45 | MA | 23086 | 6358 | 36267 | 4722 | 38797 | 3856 | 39044 | 3204 | 37805 | 2269 | 44280 | 1905 | 21515 |
| 5L-3S | | MI | 21472 | 6358 | 33985 | 4671 | 36509 | 3816 | 37061 | 3171 | 36573 | 2238 | 42631 | 1992 | 19082 |
| 12-#11 | 1.45 | MA | 22638 | 6358 | 35538 | 4719 | 37789 | 3852 | 37811 | 3198 | 36188 | 2277 | 42276 | 1848 | 21202 |
| 6L-2S | | MI | 22124 | 6358 | 34949 | 4675 | 37745 | 3804 | 38568 | 3161 | 38595 | 2230 | 45310 | 2078 | 19041 |
| 12-#14 | 2.09 | MA | 26109 | 6644 | 41941 | 4876 | 45987 | 3950 | 47785 | 3254 | 49553 | 2221 | 59237 | 2043 | 30476 |
| 2L-6S | | MI | 20507 | 6644 | 33080 | 4834 | 35165 | 3930 | 35453 | 3254 | 34368 | 2209 | 40605 | 1607 | 25750 |
| 12-#14 | 2.09 | MA | 25057 | 6644 | 40370 | 4871 | 43973 | 3968 | 45328 | 3269 | 46237 | 2233 | 54830 | 1918 | 30487 |
| 3L-5S | | MI | 21067 | 6644 | 34001 | 4840 | 36438 | 3939 | 36938 | 3241 | 36360 | 2196 | 43046 | 1689 | 26471 |
| 12-#14 | 2.09 | MA | 24314 | 6644 | 39085 | 4890 | 42335 | 3960 | 43338 | 3260 | 43702 | 2246 | 51973 | 1794 | 30417 |
| 4E | | MI | 21655 | 6644 | 34982 | 4847 | 37709 | 3923 | 38499 | 3227 | 38560 | 2209 | 45656 | 1743 | 26938 |
| 12-#14 | 2.09 | MA | 23648 | 6644 | 37972 | 4885 | 40892 | 3978 | 41565 | 3275 | 41161 | 2233 | 48958 | 1737 | 29865 |
| 5L-3S | | MI | 22311 | 6644 | 36112 | 4828 | 39149 | 3932 | 40249 | 3239 | 40754 | 2196 | 48105 | 1868 | 26972 |
| 12-#14 | 2.09 | MA | 23014 | 6644 | 36927 | 4880 | 39447 | 3970 | 39798 | 3265 | 38860 | 2246 | 46116 | 1656 | 28979 |
| 6L-2S | | MI | 23231 | 6644 | 37488 | 4835 | 40913 | 3917 | 42402 | 3225 | 43625 | 2184 | 51897 | 1992 | 26937 |
| 12-#18 | 3.72 | MA | 27403 | 7370 | 46365 | 5284 | 51485 | 4276 | 54427 | 3452 | 58202 | 2137 | 70517 | 1615 | 52440 |
| 3L-5S | | MI | 22194 | 7370 | 37649 | 5253 | 40943 | 4243 | 42304 | 3409 | 43423 | 2083 | 52744 | 1220 | 42925 |
| 12-#18 | 3.72 | MA | 26133 | 7370 | 44113 | 5317 | 48616 | 4261 | 50941 | 3432 | 53819 | 2159 | 65617 | 1394 | 50795 |
| 4E | | MI | 23199 | 7370 | 39366 | 5267 | 43168 | 4218 | 45014 | 3387 | 47215 | 2105 | 57219 | 1316 | 44686 |
| 12-#18 | 3.72 | MA | 24996 | 7370 | 42160 | 5306 | 46084 | 4290 | 47831 | 3456 | 49425 | 2137 | 60404 | 1297 | 48624 |
| 5L-3S | | MI | 24318 | 7370 | 41343 | 5237 | 45686 | 4236 | 48050 | 3409 | 50992 | 2083 | 61414 | 1534 | 46190 |
| 12-#18 | 3.72 | MA | 23914 | 7370 | 40326 | 5295 | 43548 | 4274 | 44732 | 3436 | 45445 | 2159 | 55522 | 1151 | 46043 |
| 6L-2S | | MI | 25886 | 7370 | 43741 | 5250 | 48760 | 4211 | 51779 | 3387 | 55936 | 2061 | 67905 | 1755 | 46346 |
| 14-#11 | 1.69 | MA | 25334 | 6466 | 40139 | 4782 | 43766 | 3884 | 45108 | 3217 | 46035 | 2251 | 54625 | 2097 | 24939 |
| 2L-7S | | MI | 20263 | 6466 | 32127 | 4757 | 34111 | 3876 | 34124 | 3205 | 32726 | 2245 | 38168 | 1697 | 21439 |
| 14-#11 | 1.69 | MA | 24593 | 6466 | 39040 | 4778 | 42357 | 3897 | 43390 | 3228 | 43703 | 2260 | 51520 | 2011 | 24965 |
| 3L-6S | | MI | 20648 | 6466 | 32831 | 4744 | 34961 | 3864 | 35168 | 3195 | 34097 | 2236 | 40013 | 1787 | 21776 |
| 14-#11 | 1.69 | MA | 24071 | 6466 | 38143 | 4792 | 41213 | 3892 | 42000 | 3222 | 41921 | 2268 | 49505 | 1925 | 24967 |
| 4L-5S | | MI | 21042 | 6466 | 33474 | 4748 | 35850 | 3870 | 36254 | 3203 | 35500 | 2228 | 41739 | 1844 | 22118 |
| 14-#11 | 1.69 | MA | 23603 | 6466 | 37366 | 4789 | 40206 | 3905 | 40762 | 3233 | 40136 | 2260 | 47385 | 1884 | 24921 |
| 5L-4S | | MI | 21456 | 6466 | 34159 | 4752 | 36738 | 3858 | 37345 | 3193 | 37050 | 2236 | 43577 | 1882 | 22135 |
| 14-#11 | 1.69 | MA | 23157 | 6466 | 36637 | 4786 | 39197 | 3900 | 39529 | 3227 | 38519 | 2268 | 45381 | 1828 | 24505 |
| 6L-3S | | MI | 21917 | 6466 | 34949 | 4739 | 37745 | 3864 | 38568 | 3200 | 38595 | 2228 | 45310 | 1968 | 22114 |
| 14-#11 | 1.69 | MA | 22723 | 6466 | 35839 | 4800 | 38234 | 3913 | 38346 | 3238 | 36938 | 2277 | 43240 | 1738 | 24085 |
| 7L-2S | | MI | 22566 | 6466 | 35913 | 4743 | 38980 | 3852 | 40076 | 3190 | 40617 | 2219 | 47988 | 2055 | 22081 |
| 14-#14 | 2.44 | MA | 26823 | 6800 | 43512 | 4973 | 48001 | 4020 | 50242 | 3296 | 52870 | 2207 | 63643 | 2012 | 35400 |
| 2L-7S | | MI | 20598 | 6800 | 33448 | 4949 | 35713 | 4016 | 36041 | 3285 | 35292 | 2205 | 41785 | 1441 | 29146 |

## RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

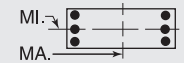
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.44 | MA | 25777 | 6800 | 41941 | 4968 | 45987 | 4038 | 47785 | 3312 | 49553 | 2219 | 59237 | 1887 | 35375 |
| 3L-6S | | MI | 21141 | 6800 | 34457 | 4931 | 36929 | 4000 | 37606 | 3296 | 37239 | 2192 | 44397 | 1571 | 29887 |
| 14-#14 | 2.44 | MA | 25038 | 6800 | 40656 | 4988 | 44349 | 4030 | 45795 | 3302 | 47018 | 2232 | 56380 | 1763 | 35273 |
| 4L-5S | | MI | 21698 | 6800 | 35377 | 4938 | 38203 | 4009 | 39091 | 3283 | 39231 | 2180 | 46838 | 1653 | 30565 |
| 14-#14 | 2.44 | MA | 24377 | 6800 | 39543 | 4982 | 42906 | 4048 | 44022 | 3317 | 44478 | 2219 | 53364 | 1706 | 34546 |
| 5L-4S | | MI | 22283 | 6800 | 36358 | 4944 | 39473 | 3993 | 40652 | 3270 | 41431 | 2192 | 49448 | 1708 | 31200 |
| 14-#14 | 2.44 | MA | 23747 | 6800 | 38498 | 4977 | 41461 | 4040 | 42255 | 3308 | 42177 | 2232 | 50522 | 1625 | 33708 |
| 6L-3S | | MI | 22934 | 6800 | 37488 | 4926 | 40913 | 4002 | 42402 | 3281 | 43625 | 2180 | 51897 | 1832 | 31264 |
| 14-#14 | 2.44 | MA | 23133 | 6800 | 37354 | 4997 | 40081 | 4058 | 40559 | 3323 | 39928 | 2244 | 47486 | 1495 | 32836 |
| 7L-2S | | MI | 23850 | 6800 | 38865 | 4932 | 42678 | 3986 | 44555 | 3268 | 46496 | 2167 | 55689 | 1957 | 31256 |
| 14-#18 | 4.33 | MA | 27359 | 7647 | 46858 | 5490 | 52134 | 4385 | 55232 | 3508 | 59554 | 2130 | 73198 | 1332 | 58868 |
| 4L-5S | | MI | 23263 | 7647 | 40048 | 5426 | 44018 | 4367 | 46032 | 3483 | 48367 | 2050 | 59235 | 1148 | 50077 |
| 14-#18 | 4.33 | MA | 26233 | 7647 | 44904 | 5479 | 49602 | 4414 | 52123 | 3532 | 55159 | 2108 | 67986 | 1234 | 56828 |
| 5L-4S | | MI | 24259 | 7647 | 41765 | 5440 | 46243 | 4342 | 48742 | 3461 | 52159 | 2072 | 63711 | 1244 | 51719 |
| 14-#18 | 4.33 | MA | 25160 | 7647 | 43070 | 5468 | 47066 | 4398 | 49024 | 3512 | 51180 | 2130 | 63104 | 1089 | 54068 |
| 6L-3S | | MI | 25369 | 7647 | 43741 | 5409 | 48760 | 4360 | 51779 | 3483 | 55936 | 2050 | 67905 | 1462 | 53579 |
| 16-#11 | 1.93 | MA | 25841 | 6574 | 41238 | 4849 | 45174 | 3933 | 46827 | 3247 | 48366 | 2242 | 57731 | 2077 | 28387 |
| 2L-8S | | MI | 20336 | 6574 | 32458 | 4820 | 34486 | 3918 | 34612 | 3244 | 33290 | 2226 | 39128 | 1628 | 23989 |
| 16-#11 | 1.93 | MA | 25103 | 6574 | 40139 | 4846 | 43766 | 3945 | 45108 | 3258 | 46035 | 2251 | 54625 | 1991 | 28404 |
| 3L-7S | | MI | 20713 | 6574 | 33091 | 4824 | 35347 | 3924 | 35631 | 3235 | 34748 | 2234 | 40846 | 1673 | 24360 |
| 16-#11 | 1.93 | MA | 24583 | 6574 | 39242 | 4860 | 42622 | 3941 | 43718 | 3252 | 44253 | 2259 | 52610 | 1905 | 28385 |
| 4L-6S | | MI | 21095 | 6574 | 33795 | 4811 | 36196 | 3912 | 36675 | 3225 | 36119 | 2226 | 42691 | 1764 | 24680 |
| 16-#11 | 1.93 | MA | 24117 | 6574 | 38465 | 4857 | 41615 | 3953 | 42481 | 3263 | 42468 | 2251 | 50490 | 1864 | 28321 |
| 5E | | MI | 21488 | 6574 | 34438 | 4815 | 37086 | 3918 | 37762 | 3232 | 37522 | 2217 | 44417 | 1820 | 25107 |
| 16-#11 | 1.93 | MA | 23673 | 6574 | 37736 | 4853 | 40606 | 3949 | 41248 | 3257 | 40850 | 2259 | 48486 | 1808 | 27817 |
| 6L-4S | | MI | 21900 | 6574 | 35123 | 4819 | 37974 | 3907 | 38853 | 3222 | 39072 | 2226 | 46255 | 1859 | 25143 |
| 16-#11 | 1.93 | MA | 23241 | 6574 | 36938 | 4867 | 39643 | 3961 | 40064 | 3268 | 39269 | 2268 | 46345 | 1718 | 27415 |
| 7L-3S | | MI | 22359 | 6574 | 35913 | 4806 | 38980 | 3912 | 40076 | 3230 | 40617 | 2217 | 47988 | 1945 | 25137 |
| 16-#11 | 1.93 | MA | 22815 | 6574 | 36220 | 4864 | 38666 | 3957 | 38909 | 3279 | 37589 | 2259 | 44364 | 1671 | 26966 |
| 8L-2S | | MI | 23005 | 6574 | 36877 | 4810 | 40216 | 3901 | 41583 | 3220 | 42639 | 2208 | 50666 | 2032 | 25112 |
| 16-#14 | 2.79 | MA | 26492 | 6956 | 43512 | 5065 | 48001 | 4107 | 50242 | 3354 | 52870 | 2205 | 63643 | 1857 | 40253 |
| 3L-7S | | MI | 21230 | 6956 | 34825 | 5047 | 37478 | 4086 | 38194 | 3327 | 38163 | 2188 | 45577 | 1405 | 33194 |
| 16-#14 | 2.79 | MA | 25757 | 6956 | 42227 | 5085 | 46363 | 4100 | 48252 | 3344 | 50335 | 2217 | 60787 | 1732 | 40123 |
| 4L-6S | | MI | 21770 | 6956 | 35833 | 5028 | 38694 | 4070 | 39759 | 3339 | 40110 | 2176 | 48189 | 1535 | 34033 |
| 16-#14 | 2.79 | MA | 25100 | 6956 | 41114 | 5080 | 44920 | 4117 | 46479 | 3360 | 47794 | 2205 | 57771 | 1675 | 39242 |
| 5E | | MI | 22325 | 6956 | 36754 | 5035 | 39967 | 4079 | 41244 | 3325 | 42102 | 2163 | 50630 | 1617 | 34673 |
| 16-#14 | 2.79 | MA | 24474 | 6956 | 40069 | 5075 | 43475 | 4110 | 44712 | 3350 | 45493 | 2217 | 54929 | 1594 | 38447 |
| 6L-4S | | MI | 22906 | 6956 | 37735 | 5041 | 41238 | 4063 | 42805 | 3312 | 44302 | 2176 | 53240 | 1672 | 35454 |
| 16-#14 | 2.79 | MA | 23864 | 6956 | 38925 | 5094 | 42095 | 4128 | 43016 | 3365 | 43244 | 2230 | 51892 | 1464 | 37477 |
| 7L-3S | | MI | 23554 | 6956 | 38865 | 5023 | 42678 | 4072 | 44555 | 3324 | 46496 | 2163 | 55689 | 1796 | 35544 |
| 16-#14 | 2.79 | MA | 23263 | 6956 | 37896 | 5089 | 40695 | 4120 | 41360 | 3380 | 40853 | 2217 | 49074 | 1396 | 36392 |
| 8L-2S | | MI | 24465 | 6956 | 40241 | 5029 | 44443 | 4056 | 46707 | 3310 | 49367 | 2151 | 59481 | 1921 | 35570 |
| 16-#18 | 4.95 | MA | 27458 | 7924 | 47648 | 5652 | 53120 | 4538 | 56414 | 3607 | 60894 | 2079 | 75567 | 1172 | 65052 |
| 5E | | MI | 24322 | 7924 | 42446 | 5599 | 47093 | 4491 | 49761 | 3556 | 53311 | 2016 | 65727 | 1076 | 57247 |
| 16-#18 | 4.95 | MA | 26395 | 7924 | 45815 | 5641 | 50584 | 4522 | 53315 | 3587 | 56915 | 2101 | 70685 | 1026 | 62121 |
| 6L-4S | | MI | 25311 | 7924 | 44163 | 5613 | 49317 | 4466 | 52471 | 3534 | 57103 | 2038 | 70202 | 1172 | 58785 |
| 18-#11 | 2.17 | MA | 25610 | 6682 | 41238 | 4913 | 45174 | 3994 | 46827 | 3287 | 48366 | 2242 | 57731 | 1971 | 31831 |
| 3L-8S | | MI | 20784 | 6682 | 33421 | 4888 | 35721 | 3967 | 36119 | 3274 | 35312 | 2215 | 41807 | 1604 | 26851 |
| 18-#11 | 2.17 | MA | 25092 | 6682 | 40340 | 4927 | 44031 | 3989 | 45437 | 3281 | 46584 | 2250 | 55715 | 1885 | 31797 |
| 4L-7S | | MI | 21159 | 6682 | 34055 | 4892 | 36583 | 3972 | 37139 | 3264 | 36770 | 2224 | 43524 | 1650 | 27284 |
| 18-#11 | 2.17 | MA | 24628 | 6682 | 39564 | 4924 | 43023 | 4002 | 44199 | 3292 | 44799 | 2242 | 53595 | 1844 | 31717 |
| 5L-6S | | MI | 21541 | 6682 | 34759 | 4879 | 37432 | 3961 | 38183 | 3254 | 38141 | 2215 | 45369 | 1740 | 27590 |
| 18-#11 | 2.17 | MA | 24187 | 6682 | 38835 | 4921 | 42014 | 3997 | 42966 | 3286 | 43181 | 2250 | 51591 | 1788 | 31135 |
| 6L-5S | | MI | 21932 | 6682 | 35402 | 4883 | 38322 | 3967 | 39269 | 3261 | 39544 | 2206 | 47095 | 1797 | 28092 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis

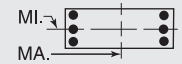


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 2.17 | MA | 23756 | 6682 | 38037 | 4935 | 41052 | 4010 | 41783 | 3297 | 41600 | 2259 | 49450 | 1698 | 30750 |
| 7L-4S | | MI | 22342 | 6682 | 36087 | 4887 | 39209 | 3955 | 40360 | 3252 | 41094 | 2215 | 48933 | 1836 | 28142 |
| 18-#11 | 2.17 | MA | 23332 | 6682 | 37319 | 4932 | 40075 | 4005 | 40627 | 3308 | 39920 | 2250 | 47469 | 1651 | 30238 |
| 8L-3S | | MI | 22799 | 6682 | 36877 | 4874 | 40216 | 3961 | 41583 | 3259 | 42639 | 2206 | 50666 | 1922 | 28155 |
| 18-#11 | 2.17 | MA | 22913 | 6682 | 36547 | 4946 | 39125 | 4018 | 39419 | 3302 | 38353 | 2259 | 45526 | 1596 | 29616 |
| 9L-2S | | MI | 23443 | 6682 | 37841 | 4878 | 41452 | 3949 | 43091 | 3249 | 44661 | 2198 | 53345 | 2008 | 28138 |
| 18-#14 | 3.13 | MA | 26472 | 7111 | 43798 | 5182 | 48377 | 4170 | 50709 | 3387 | 53651 | 2203 | 65193 | 1701 | 44967 |
| 4L-7S | | MI | 21859 | 7111 | 36201 | 5144 | 39242 | 4156 | 40346 | 3370 | 41034 | 2172 | 49369 | 1369 | 37256 |
| 18-#14 | 3.13 | MA | 25818 | 7111 | 42685 | 5177 | 46934 | 4187 | 48935 | 3402 | 51111 | 2191 | 62178 | 1644 | 43951 |
| 5L-6S | | MI | 22396 | 7111 | 37210 | 5126 | 40458 | 4140 | 41911 | 3381 | 42981 | 2159 | 51981 | 1500 | 38186 |
| 18-#14 | 3.13 | MA | 25196 | 7111 | 41640 | 5172 | 45489 | 4180 | 47169 | 3392 | 48809 | 2203 | 59336 | 1563 | 43192 |
| 6L-5S | | MI | 22947 | 7111 | 38130 | 5132 | 41732 | 4149 | 43397 | 3368 | 44973 | 2147 | 54422 | 1581 | 38794 |
| 18-#14 | 3.13 | MA | 24589 | 7111 | 40496 | 5191 | 44109 | 4197 | 45473 | 3408 | 46560 | 2216 | 56299 | 1433 | 42130 |
| 7L-4S | | MI | 23525 | 7111 | 39111 | 5139 | 43003 | 4133 | 44958 | 3354 | 47173 | 2159 | 57032 | 1636 | 39702 |
| 18-#14 | 3.13 | MA | 23992 | 7111 | 39467 | 5186 | 42709 | 4190 | 43816 | 3423 | 44169 | 2203 | 53481 | 1365 | 41085 |
| 8L-3S | | MI | 24170 | 7111 | 40241 | 5120 | 44443 | 4142 | 46707 | 3366 | 49367 | 2147 | 59481 | 1760 | 39817 |
| 18-#18 | 5.57 | MA | 27618 | 8200 | 48559 | 5813 | 54102 | 4646 | 57607 | 3663 | 62649 | 2073 | 78266 | 964 | 70199 |
| 6L-5S | | MI | 25373 | 8200 | 44844 | 5772 | 50167 | 4615 | 53490 | 3630 | 58255 | 1982 | 72218 | 1004 | 64433 |
| 20-#11 | 2.41 | MA | 25598 | 6790 | 41439 | 4995 | 45439 | 4038 | 47155 | 3311 | 48915 | 2241 | 58820 | 1864 | 35205 |
| 4L-8S | | MI | 21230 | 6790 | 34385 | 4955 | 36957 | 4015 | 37627 | 3303 | 37334 | 2204 | 44485 | 1581 | 29720 |
| 20-#11 | 2.41 | MA | 25137 | 6790 | 40662 | 4992 | 44432 | 4050 | 45917 | 3322 | 47130 | 2233 | 56700 | 1824 | 35093 |
| 5L-7S | | MI | 21604 | 6790 | 35019 | 4959 | 37819 | 4021 | 38646 | 3293 | 38792 | 2213 | 46202 | 1627 | 30211 |
| 20-#11 | 2.41 | MA | 24697 | 6790 | 39934 | 4988 | 43423 | 4045 | 44685 | 3316 | 45512 | 2241 | 54696 | 1768 | 34459 |
| 6E | | MI | 21984 | 6790 | 35723 | 4946 | 38668 | 4009 | 39690 | 3283 | 40163 | 2204 | 48048 | 1717 | 30505 |
| 20-#11 | 2.41 | MA | 24269 | 6790 | 39135 | 5002 | 42460 | 4058 | 43501 | 3327 | 43931 | 2250 | 52555 | 1678 | 34088 |
| 7L-5S | | MI | 22373 | 6790 | 36366 | 4950 | 39557 | 4015 | 40777 | 3291 | 41566 | 2196 | 49773 | 1774 | 31017 |
| 20-#11 | 2.41 | MA | 23847 | 6790 | 38418 | 4999 | 41484 | 4053 | 42345 | 3338 | 42251 | 2241 | 50574 | 1631 | 33517 |
| 8L-4S | | MI | 22781 | 6790 | 37051 | 4954 | 40445 | 4004 | 41868 | 3281 | 43116 | 2204 | 51612 | 1812 | 31137 |
| 20-#11 | 2.41 | MA | 23429 | 6790 | 37645 | 5013 | 40533 | 4066 | 41137 | 3332 | 40684 | 2250 | 48631 | 1576 | 32916 |
| 9L-3S | | MI | 23237 | 6790 | 37841 | 4941 | 41452 | 4009 | 43091 | 3288 | 44661 | 2196 | 53345 | 1899 | 31164 |
| 20-#11 | 2.41 | MA | 22969 | 6790 | 36930 | 5010 | 39570 | 4061 | 39988 | 3343 | 39131 | 2258 | 46749 | 1515 | 32198 |
| 10L-2S | | MI | 23879 | 6790 | 38805 | 4945 | 42688 | 3998 | 44598 | 3278 | 46683 | 2187 | 56023 | 1985 | 31159 |
| 20-#14 | 3.48 | MA | 26532 | 7267 | 44256 | 5274 | 48948 | 4257 | 51392 | 3444 | 54427 | 2177 | 66584 | 1613 | 48671 |
| 5L-7S | | MI | 22483 | 7267 | 37578 | 5241 | 41007 | 4226 | 42499 | 3412 | 43905 | 2155 | 53161 | 1333 | 41329 |
| 20-#14 | 3.48 | MA | 25913 | 7267 | 43211 | 5269 | 47503 | 4250 | 49626 | 3435 | 52126 | 2189 | 63742 | 1532 | 47944 |
| 6E | | MI | 23018 | 7267 | 38586 | 5223 | 42223 | 4210 | 44064 | 3424 | 45852 | 2143 | 55773 | 1464 | 42345 |
| 20-#14 | 3.48 | MA | 25310 | 7267 | 42067 | 5289 | 46123 | 4267 | 47930 | 3450 | 49877 | 2202 | 60706 | 1402 | 46795 |
| 7L-5S | | MI | 23566 | 7267 | 39507 | 5229 | 43497 | 4219 | 45549 | 3410 | 47844 | 2130 | 58214 | 1546 | 42924 |
| 20-#14 | 3.48 | MA | 24716 | 7267 | 41038 | 5284 | 44723 | 4260 | 46273 | 3465 | 47486 | 2189 | 57887 | 1334 | 45786 |
| 8L-4S | | MI | 24141 | 7267 | 40488 | 5236 | 44767 | 4203 | 47110 | 3397 | 50044 | 2143 | 60823 | 1600 | 43945 |
| 22-#11 | 2.66 | MA | 25643 | 6897 | 41761 | 5059 | 45840 | 4099 | 47636 | 3351 | 49461 | 2224 | 59805 | 1804 | 38394 |
| 5L-8S | | MI | 21674 | 6897 | 35349 | 5023 | 38193 | 4064 | 39134 | 3333 | 39356 | 2194 | 47163 | 1558 | 32595 |
| 22-#11 | 2.66 | MA | 25205 | 6897 | 41032 | 5056 | 44832 | 4094 | 46403 | 3345 | 47843 | 2232 | 57801 | 1748 | 37788 |
| 6L-7S | | MI | 22046 | 6897 | 35983 | 5027 | 39054 | 4069 | 40154 | 3323 | 40814 | 2202 | 48881 | 1604 | 33140 |
| 22-#11 | 2.66 | MA | 24779 | 6897 | 40234 | 5070 | 43869 | 4106 | 45219 | 3356 | 46262 | 2241 | 55661 | 1658 | 37429 |
| 7L-6S | | MI | 22424 | 6897 | 36687 | 5013 | 39904 | 4058 | 41198 | 3313 | 42185 | 2194 | 50726 | 1694 | 33423 |
| 22-#11 | 2.66 | MA | 24358 | 6897 | 39517 | 5067 | 42892 | 4102 | 44064 | 3367 | 44582 | 2232 | 53679 | 1611 | 36803 |
| 8L-5S | | MI | 22812 | 6897 | 37330 | 5018 | 40793 | 4063 | 42284 | 3320 | 43588 | 2185 | 52452 | 1751 | 33912 |
| 22-#11 | 2.66 | MA | 23943 | 6897 | 38744 | 5081 | 41942 | 4114 | 42856 | 3361 | 43015 | 2241 | 51736 | 1556 | 36220 |
| 9L-4S | | MI | 23219 | 6897 | 38015 | 5022 | 41681 | 4052 | 43375 | 3310 | 45138 | 2194 | 54290 | 1789 | 34127 |
| 22-#11 | 2.66 | MA | 23485 | 6897 | 38029 | 5077 | 40978 | 4110 | 41706 | 3372 | 41462 | 2249 | 49854 | 1495 | 35462 |
| 10L-3S | | MI | 23672 | 6897 | 38805 | 5008 | 42688 | 4058 | 44598 | 3318 | 46683 | 2185 | 56023 | 1876 | 34166 |
| 22-#14 | 3.83 | MA | 26626 | 7422 | 44782 | 5366 | 49517 | 4320 | 52083 | 3477 | 55442 | 2175 | 68149 | 1501 | 52701 |
| 6L-7S | | MI | 23104 | 7422 | 38954 | 5338 | 42771 | 4295 | 44652 | 3454 | 46776 | 2139 | 56953 | 1297 | 45412 |
| 22-#14 | 3.83 | MA | 26026 | 7422 | 43638 | 5386 | 48137 | 4337 | 50387 | 3492 | 53193 | 2188 | 65112 | 1371 | 51469 |
| 7L-6S | | MI | 23636 | 7422 | 39963 | 5320 | 43988 | 4279 | 46217 | 3466 | 48723 | 2126 | 59565 | 1428 | 46508 |
| 22-#14 | 3.83 | MA | 25436 | 7422 | 42609 | 5381 | 46737 | 4330 | 48730 | 3508 | 50802 | 2175 | 62294 | 1303 | 50481 |
| 8L-5S | | MI | 24181 | 7422 | 40883 | 5327 | 45261 | 4289 | 47702 | 3453 | 50715 | 2114 | 62006 | 1510 | 47062 |

## RECTANGULAR TIED COLUMNS 34" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.90 | MA | 25711 | 7005 | 42131 | 5123 | 46240 | 4142 | 48121 | 3374 | 50174 | 2223 | 60906 | 1728 | 41121 |
| 6L-8S | | MI | 22116 | 7005 | 36313 | 5090 | 39428 | 4112 | 40642 | 3362 | 41378 | 2183 | 49841 | 1535 | 35475 |
| 24-#11 | 2.90 | MA | 25286 | 7005 | 41333 | 5137 | 45277 | 4155 | 46938 | 3385 | 48594 | 2232 | 58766 | 1638 | 40772 |
| 7E | | MI | 22487 | 7005 | 36947 | 5094 | 40290 | 4118 | 41661 | 3352 | 42836 | 2192 | 51559 | 1580 | 36072 |
| 24-#11 | 2.90 | MA | 24868 | 7005 | 40615 | 5134 | 44301 | 4150 | 45782 | 3397 | 46913 | 2223 | 56784 | 1590 | 40094 |
| 8L-6S | | MI | 22863 | 7005 | 37651 | 5081 | 41139 | 4106 | 42705 | 3342 | 44207 | 2183 | 53404 | 1671 | 36346 |
| 24-#11 | 2.90 | MA | 24453 | 7005 | 39843 | 5148 | 43351 | 4163 | 44574 | 3390 | 45346 | 2232 | 54841 | 1536 | 39528 |
| 9L-5S | | MI | 23249 | 7005 | 38294 | 5085 | 42029 | 4112 | 43792 | 3350 | 45610 | 2174 | 55130 | 1727 | 36812 |
| 24-#11 | 2.90 | MA | 23998 | 7005 | 39128 | 5145 | 42387 | 4158 | 43424 | 3402 | 43793 | 2240 | 52959 | 1475 | 38731 |
| 10L-4S | | MI | 23655 | 7005 | 38979 | 5089 | 42917 | 4100 | 44883 | 3340 | 47160 | 2183 | 56968 | 1766 | 37113 |
| 24-#14 | 4.18 | MA | 26738 | 7578 | 45209 | 5483 | 50151 | 4407 | 52844 | 3535 | 56510 | 2174 | 69519 | 1340 | 56153 |
| 7E | | MI | 23722 | 7578 | 40331 | 5436 | 44536 | 4365 | 46805 | 3497 | 49647 | 2122 | 60745 | 1262 | 49503 |
| 24-#14 | 4.18 | MA | 26151 | 7578 | 44181 | 5478 | 48751 | 4399 | 51187 | 3550 | 54119 | 2161 | 66701 | 1273 | 55099 |
| 8L-6S | | MI | 24250 | 7578 | 41339 | 5417 | 45752 | 4349 | 48370 | 3508 | 51594 | 2110 | 63357 | 1392 | 50674 |

## RECTANGULAR TIED COLUMNS 34" x 40"

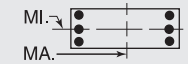
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.18 | MA | 26791 | 6564 | 41926 | 4848 | 45042 | 3952 | 45701 | 3297 | 45057 | 2365 | 52503 | 2221 | 19344 |
| 2E | | MI | 22650 | 6564 | 35692 | 4780 | 38057 | 3897 | 38412 | 3247 | 37543 | 2314 | 43464 | 2159 | 16249 |
| 6-#18 | 1.76 | MA | 28134 | 6841 | 44844 | 5021 | 48781 | 4076 | 50263 | 3372 | 51188 | 2338 | 60631 | 2163 | 28549 |
| 2L-3S | | MI | 22126 | 6841 | 35692 | 4940 | 38057 | 4046 | 38412 | 3342 | 37543 | 2303 | 43464 | 1865 | 23962 |
| 6-#18 | 1.76 | MA | 26173 | 6841 | 41926 | 5011 | 45042 | 4106 | 45701 | 3398 | 45057 | 2360 | 52503 | 1941 | 28594 |
| 3L-2S | | MI | 23734 | 6841 | 38091 | 4953 | 41132 | 4021 | 42141 | 3320 | 42487 | 2281 | 49955 | 2087 | 23863 |
| 8-#14 | 1.32 | MA | 27213 | 6634 | 42626 | 4926 | 46123 | 4012 | 47089 | 3340 | 47085 | 2384 | 55302 | 2240 | 21815 |
| 2L-4S | | MI | 21409 | 6634 | 33767 | 4876 | 35776 | 3968 | 35746 | 3299 | 34208 | 2362 | 39606 | 1931 | 18429 |
| 8-#14 | 1.32 | MA | 26081 | 6634 | 40957 | 4921 | 43984 | 4030 | 44480 | 3356 | 43546 | 2397 | 50588 | 2115 | 21873 |
| 3E | | MI | 22073 | 6634 | 34897 | 4858 | 37216 | 3977 | 37495 | 3310 | 36402 | 2350 | 42055 | 2056 | 18373 |
| 8-#14 | 1.32 | MA | 25282 | 6634 | 39595 | 4941 | 42248 | 4023 | 42370 | 3347 | 40840 | 2409 | 47527 | 1991 | 21887 |
| 4L-2S | | MI | 23004 | 6634 | 36274 | 4864 | 38980 | 3961 | 39648 | 3297 | 39273 | 2337 | 45847 | 2180 | 18302 |
| 8-#18 | 2.35 | MA | 29460 | 7118 | 47761 | 5194 | 52521 | 4200 | 54825 | 3448 | 57318 | 2311 | 68758 | 2105 | 37703 |
| 2L-4S | | MI | 22069 | 7118 | 36114 | 5143 | 38614 | 4152 | 39104 | 3394 | 38709 | 2291 | 45761 | 1575 | 31120 |
| 8-#18 | 2.35 | MA | 27517 | 7118 | 44844 | 5184 | 48781 | 4230 | 50263 | 3473 | 51188 | 2333 | 60631 | 1883 | 37649 |
| 3E | | MI | 23211 | 7118 | 38091 | 5112 | 41132 | 4170 | 42141 | 3416 | 42487 | 2269 | 49955 | 1793 | 31444 |
| 8-#18 | 2.35 | MA | 26142 | 7118 | 42454 | 5218 | 45736 | 4216 | 46563 | 3455 | 46502 | 2355 | 55369 | 1662 | 37232 |
| 4L-2S | | MI | 24806 | 7118 | 40489 | 5126 | 44206 | 4145 | 45869 | 3394 | 47431 | 2247 | 56446 | 2014 | 31420 |
| 10-#11 | 1.15 | MA | 26834 | 6551 | 41711 | 4891 | 45045 | 3988 | 45810 | 3329 | 45400 | 2402 | 53136 | 2271 | 19074 |
| 2L-5S | | MI | 21165 | 6551 | 33081 | 4838 | 34975 | 3958 | 34793 | 3301 | 32849 | 2370 | 37921 | 2007 | 16167 |
| 10-#11 | 1.15 | MA | 26040 | 6551 | 40545 | 4888 | 43550 | 4002 | 43986 | 3341 | 42918 | 2411 | 49817 | 2185 | 19118 |
| 3L-4S | | MI | 21583 | 6551 | 33766 | 4842 | 35863 | 3946 | 35884 | 3291 | 34398 | 2378 | 39759 | 2045 | 16130 |
| 10-#11 | 1.15 | MA | 25480 | 6551 | 39594 | 4903 | 42338 | 3997 | 42513 | 3335 | 41022 | 2420 | 47659 | 2098 | 19154 |
| 4L-3S | | MI | 22048 | 6551 | 34556 | 4829 | 36870 | 3952 | 37107 | 3298 | 35944 | 2370 | 41492 | 2132 | 16079 |
| 10-#11 | 1.15 | MA | 24980 | 6551 | 38771 | 4900 | 41271 | 4010 | 41202 | 3347 | 39124 | 2412 | 45399 | 2057 | 19155 |
| 5L-2S | | MI | 22703 | 6551 | 35520 | 4833 | 38105 | 3941 | 38615 | 3288 | 37966 | 2361 | 44170 | 2218 | 16030 |
| 10-#14 | 1.65 | MA | 27988 | 6789 | 44294 | 5023 | 48262 | 4081 | 49698 | 3382 | 50625 | 2371 | 60017 | 2211 | 27064 |
| 2L-5S | | MI | 21454 | 6789 | 34163 | 4967 | 36269 | 4054 | 36338 | 3354 | 34878 | 2333 | 40789 | 1841 | 22607 |
| 10-#14 | 1.65 | MA | 26862 | 6789 | 42626 | 5018 | 46123 | 4099 | 47089 | 3398 | 47085 | 2384 | 55302 | 2086 | 27102 |
| 3L-4S | | MI | 22046 | 6789 | 35143 | 4973 | 37540 | 4038 | 37899 | 3341 | 37079 | 2346 | 43398 | 1895 | 22732 |
| 10-#14 | 1.65 | MA | 26068 | 6789 | 41263 | 5038 | 44387 | 4093 | 44979 | 3389 | 44380 | 2396 | 52241 | 1962 | 27070 |
| 4L-3S | | MI | 22706 | 6789 | 36274 | 4955 | 38980 | 4047 | 39648 | 3353 | 39273 | 2333 | 45847 | 2020 | 22709 |
| 10-#14 | 1.65 | MA | 25358 | 6789 | 40084 | 5034 | 42857 | 4111 | 43100 | 3405 | 41669 | 2384 | 49023 | 1904 | 26851 |
| 5L-2S | | MI | 23633 | 6789 | 37650 | 4961 | 40745 | 4031 | 41801 | 3339 | 42144 | 2321 | 49639 | 2144 | 22654 |
| 10-#18 | 2.94 | MA | 30772 | 7394 | 50678 | 5367 | 56260 | 4325 | 59387 | 3523 | 63449 | 2285 | 76886 | 2046 | 46818 |
| 2L-5S | | MI | 22136 | 7394 | 36796 | 5302 | 39464 | 4301 | 40123 | 3490 | 39861 | 2236 | 47777 | 1407 | 36098 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis

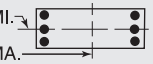



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 2.94 | MA | 28845 | 7394 | 47761 | 5357 | 52521 | 4355 | 54825 | 3549 | 57318 | 2307 | 68758 | 1825 | 46674 |
| 3L-4S | | MI | 23152 | 7394 | 38513 | 5316 | 41689 | 4276 | 42833 | 3468 | 43653 | 2258 | 52252 | 1503 | 38051 |
| 10-#18 | 2.94 | MA | 27483 | 7394 | 45371 | 5391 | 49476 | 4340 | 51125 | 3531 | 52633 | 2329 | 63496 | 1604 | 45721 |
| 4L-3S | | MI | 24284 | 7394 | 40489 | 5285 | 44206 | 4295 | 45869 | 3490 | 47431 | 2236 | 56446 | 1721 | 38883 |
| 10-#18 | 2.94 | MA | 26264 | 7394 | 43300 | 5381 | 46791 | 4370 | 47827 | 3556 | 47936 | 2307 | 57923 | 1504 | 43115 |
| 5L-2S | | MI | 25867 | 7394 | 42887 | 5299 | 47281 | 4269 | 49598 | 3468 | 52375 | 2214 | 62938 | 1942 | 38942 |
| 12-#11 | 1.38 | MA | 27382 | 6659 | 42877 | 4958 | 46540 | 4037 | 47634 | 3359 | 47881 | 2394 | 56455 | 2252 | 22748 |
| 2L-6S | | MI | 21220 | 6659 | 33402 | 4901 | 35321 | 4001 | 35214 | 3323 | 33468 | 2368 | 38873 | 1927 | 19026 |
| 12-#11 | 1.38 | MA | 26590 | 6659 | 41711 | 4956 | 45045 | 4050 | 45810 | 3370 | 45400 | 2403 | 53136 | 2166 | 22783 |
| 3L-5S | | MI | 21616 | 6659 | 34045 | 4905 | 36211 | 4006 | 36301 | 3330 | 34871 | 2359 | 40599 | 1984 | 19183 |
| 12-#11 | 1.38 | MA | 26033 | 6659 | 40760 | 4970 | 43833 | 4046 | 44337 | 3365 | 43504 | 2412 | 50978 | 2080 | 22805 |
| 4E | | MI | 22032 | 6659 | 34730 | 4909 | 37099 | 3995 | 37391 | 3320 | 36420 | 2368 | 42437 | 2022 | 19163 |
| 12-#11 | 1.38 | MA | 25535 | 6659 | 39937 | 4967 | 42766 | 4059 | 43026 | 3376 | 41605 | 2403 | 48717 | 2039 | 22779 |
| 5L-3S | | MI | 22496 | 6659 | 35520 | 4896 | 38105 | 4000 | 38615 | 3328 | 37966 | 2359 | 44170 | 2108 | 19125 |
| 12-#11 | 1.38 | MA | 25061 | 6659 | 39166 | 4964 | 41697 | 4054 | 41720 | 3371 | 39884 | 2412 | 46574 | 1983 | 22529 |
| 6L-2S | | MI | 23148 | 6659 | 36484 | 4900 | 39341 | 3989 | 40122 | 3318 | 39988 | 2350 | 46849 | 2195 | 19082 |
| 12-#14 | 1.99 | MA | 28757 | 6945 | 45962 | 5120 | 50400 | 4151 | 52307 | 3425 | 54164 | 2358 | 64731 | 2182 | 32298 |
| 2L-6S | | MI | 21528 | 6945 | 34618 | 5058 | 36761 | 4114 | 37005 | 3410 | 35757 | 2329 | 42139 | 1723 | 25939 |
| 12-#14 | 1.99 | MA | 27637 | 6945 | 44294 | 5115 | 48262 | 4169 | 49698 | 3441 | 50625 | 2371 | 60017 | 2058 | 32309 |
| 3L-5S | | MI | 22090 | 6945 | 35539 | 5064 | 38034 | 4123 | 38490 | 3397 | 37749 | 2317 | 44580 | 1805 | 26679 |
| 12-#14 | 1.99 | MA | 26848 | 6945 | 42931 | 5136 | 46525 | 4163 | 47588 | 3432 | 47919 | 2383 | 56956 | 1933 | 32239 |
| 4E | | MI | 22679 | 6945 | 36520 | 5071 | 39305 | 4108 | 40051 | 3384 | 39950 | 2329 | 47190 | 1860 | 27013 |
| 12-#14 | 1.99 | MA | 26143 | 6945 | 41752 | 5131 | 44996 | 4181 | 45709 | 3448 | 45209 | 2371 | 53737 | 1875 | 31803 |
| 5L-3S | | MI | 23335 | 6945 | 37650 | 5052 | 40745 | 4117 | 41801 | 3395 | 42144 | 2317 | 49639 | 1984 | 27027 |
| 12-#14 | 1.99 | MA | 25471 | 6945 | 40646 | 5126 | 43464 | 4174 | 43837 | 3439 | 42753 | 2383 | 50694 | 1794 | 30810 |
| 6L-2S | | MI | 24257 | 6945 | 39027 | 5059 | 42509 | 4101 | 43954 | 3382 | 45015 | 2304 | 53431 | 2109 | 26989 |
| 12-#18 | 3.53 | MA | 30159 | 7671 | 50678 | 5529 | 56260 | 4479 | 59387 | 3624 | 63449 | 2280 | 76886 | 1767 | 55680 |
| 3L-5S | | MI | 23217 | 7671 | 39194 | 5475 | 42539 | 4425 | 43852 | 3564 | 44805 | 2202 | 54268 | 1335 | 43224 |
| 12-#18 | 3.53 | MA | 28809 | 7671 | 48288 | 5564 | 53216 | 4464 | 55687 | 3606 | 58763 | 2302 | 71624 | 1545 | 54263 |
| 4E | | MI | 24224 | 7671 | 40911 | 5489 | 44764 | 4400 | 46562 | 3542 | 48597 | 2224 | 58743 | 1431 | 45035 |
| 12-#18 | 3.53 | MA | 27602 | 7671 | 46217 | 5553 | 50531 | 4494 | 52389 | 3632 | 54066 | 2280 | 66051 | 1446 | 51817 |
| 5L-3S | | MI | 25347 | 7671 | 42887 | 5458 | 47281 | 4419 | 49598 | 3564 | 52375 | 2202 | 62938 | 1649 | 46297 |
| 12-#18 | 3.53 | MA | 26453 | 7671 | 44273 | 5543 | 47841 | 4480 | 49102 | 3613 | 49812 | 2302 | 60812 | 1301 | 49295 |
| 6L-2S | | MI | 26918 | 7671 | 45286 | 5472 | 50356 | 4393 | 53326 | 3542 | 57319 | 2180 | 69429 | 1870 | 46429 |
| 14-#11 | 1.61 | MA | 27926 | 6766 | 44044 | 5026 | 48035 | 4085 | 49458 | 3388 | 50363 | 2385 | 59773 | 2234 | 26413 |
| 2L-7S | | MI | 21285 | 6766 | 33662 | 4982 | 35708 | 4060 | 35678 | 3362 | 34119 | 2366 | 39706 | 1813 | 21578 |
| 14-#11 | 1.61 | MA | 27138 | 6766 | 42877 | 5023 | 46540 | 4098 | 47634 | 3400 | 47881 | 2394 | 56455 | 2147 | 26439 |
| 3L-6S | | MI | 21670 | 6766 | 34366 | 4968 | 36557 | 4049 | 36722 | 3352 | 35490 | 2357 | 41552 | 1904 | 21921 |
| 14-#11 | 1.61 | MA | 26583 | 6766 | 41926 | 5037 | 45328 | 4094 | 46160 | 3394 | 45985 | 2403 | 54297 | 2061 | 26441 |
| 4L-5S | | MI | 22065 | 6766 | 35009 | 4973 | 37447 | 4055 | 37808 | 3360 | 36893 | 2348 | 43277 | 1960 | 22184 |
| 14-#11 | 1.61 | MA | 26087 | 6766 | 41103 | 5035 | 44261 | 4107 | 44849 | 3406 | 44087 | 2395 | 52036 | 2020 | 26395 |
| 5L-4S | | MI | 22479 | 6766 | 35694 | 4977 | 38334 | 4043 | 38899 | 3350 | 38442 | 2357 | 45116 | 1999 | 22187 |
| 14-#11 | 1.61 | MA | 25615 | 6766 | 40332 | 5032 | 43192 | 4103 | 43544 | 3400 | 42366 | 2403 | 49893 | 1964 | 26035 |
| 6L-3S | | MI | 22941 | 6766 | 36484 | 4963 | 39341 | 4049 | 40122 | 3357 | 39988 | 2348 | 46849 | 2085 | 22160 |
| 14-#11 | 1.61 | MA | 25155 | 6766 | 39487 | 5046 | 42173 | 4116 | 42290 | 3412 | 40684 | 2412 | 47605 | 1874 | 25565 |
| 7L-2S | | MI | 23591 | 6766 | 37448 | 4968 | 40577 | 4037 | 41630 | 3347 | 42010 | 2340 | 49527 | 2172 | 22124 |
| 14-#14 | 2.32 | MA | 29521 | 7100 | 47631 | 5217 | 52539 | 4221 | 54917 | 3467 | 57704 | 2345 | 69446 | 2153 | 37526 |
| 2L-7S | | MI | 21618 | 7100 | 34987 | 5173 | 37309 | 4200 | 37593 | 3441 | 36682 | 2325 | 43319 | 1557 | 29461 |
| 14-#14 | 2.32 | MA | 28407 | 7100 | 45962 | 5213 | 50400 | 4239 | 52307 | 3483 | 54164 | 2357 | 64731 | 2029 | 37501 |
| 3L-6S | | MI | 22163 | 7100 | 35995 | 5155 | 38525 | 4184 | 39158 | 3453 | 38628 | 2313 | 45931 | 1687 | 30076 |
| 14-#14 | 2.32 | MA | 27623 | 7100 | 44600 | 5233 | 48664 | 4232 | 50197 | 3474 | 51459 | 2370 | 61671 | 1904 | 37400 |
| 4L-5S | | MI | 22722 | 7100 | 36916 | 5161 | 39799 | 4193 | 40643 | 3439 | 40620 | 2300 | 48372 | 1769 | 30771 |
| 14-#14 | 2.32 | MA | 26921 | 7100 | 43420 | 5228 | 47135 | 4251 | 48318 | 3490 | 48748 | 2357 | 58452 | 1846 | 36775 |
| 5L-4S | | MI | 23308 | 7100 | 37896 | 5168 | 41070 | 4177 | 42204 | 3426 | 42821 | 2313 | 50982 | 1824 | 31282 |
| 14-#14 | 2.32 | MA | 26253 | 7100 | 42314 | 5224 | 45603 | 4244 | 46446 | 3481 | 46292 | 2370 | 55409 | 1765 | 35834 |
| 6L-3S | | MI | 23960 | 7100 | 39027 | 5149 | 42509 | 4186 | 43954 | 3437 | 45015 | 2300 | 53431 | 1948 | 31330 |
| 14-#14 | 2.32 | MA | 25602 | 7100 | 41102 | 5244 | 44141 | 4262 | 44649 | 3497 | 43892 | 2382 | 52159 | 1635 | 35046 |
| 7L-2S | | MI | 24878 | 7100 | 40403 | 5156 | 44274 | 4171 | 46106 | 3424 | 47886 | 2288 | 57223 | 2073 | 31312 |

## RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis



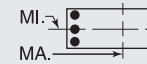

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 4.12 | MA | 30122 | 7948 | 51205 | 5736 | 56955 | 4589 | 60249 | 3681 | 64894 | 2276 | 79752 | 1487 | 62850 |
| 4L-5S | | MI | 24287 | 7948 | 41592 | 5648 | 45613 | 4550 | 47580 | 3638 | 49749 | 2169 | 60759 | 1263 | 50374 |
| 14-#18 | 4.12 | MA | 28925 | 7948 | 49134 | 5726 | 54271 | 4619 | 56951 | 3707 | 60197 | 2253 | 74178 | 1387 | 60546 |
| 5L-4S | | MI | 25287 | 7948 | 43310 | 5662 | 47838 | 4524 | 50290 | 3616 | 53541 | 2191 | 65235 | 1359 | 52062 |
| 14-#18 | 4.12 | MA | 27787 | 7948 | 47190 | 5716 | 51581 | 4604 | 53664 | 3689 | 55943 | 2276 | 68940 | 1242 | 57839 |
| 6L-3S | | MI | 26400 | 7948 | 45286 | 5631 | 50356 | 4543 | 53326 | 3638 | 57319 | 2169 | 69429 | 1577 | 53695 |
| 16-#11 | 1.84 | MA | 28467 | 6874 | 45210 | 5093 | 49530 | 4134 | 51281 | 3417 | 52844 | 2377 | 63092 | 2215 | 30071 |
| 2L-8S | | MI | 21357 | 6874 | 33993 | 5045 | 36082 | 4103 | 36166 | 3401 | 34683 | 2346 | 40667 | 1744 | 24218 |
| 16-#11 | 1.84 | MA | 27682 | 6874 | 44044 | 5090 | 48035 | 4147 | 49458 | 3429 | 50363 | 2385 | 59773 | 2128 | 30088 |
| 3L-7S | | MI | 21735 | 6874 | 34626 | 5049 | 36943 | 4109 | 37185 | 3392 | 36141 | 2355 | 42385 | 1790 | 24499 |
| 16-#11 | 1.84 | MA | 27130 | 6874 | 43092 | 5105 | 46823 | 4143 | 47984 | 3423 | 48467 | 2394 | 57616 | 2042 | 30070 |
| 4L-6S | | MI | 22118 | 6874 | 35330 | 5036 | 37793 | 4097 | 38229 | 3382 | 37512 | 2346 | 44230 | 1880 | 24825 |
| 16-#11 | 1.84 | MA | 26636 | 6874 | 42270 | 5102 | 45756 | 4156 | 46673 | 3435 | 46568 | 2386 | 55355 | 2001 | 30006 |
| 5E | | MI | 22512 | 6874 | 35973 | 5040 | 38682 | 4103 | 39316 | 3389 | 38915 | 2338 | 45956 | 1937 | 25178 |
| 16-#11 | 1.84 | MA | 26166 | 6874 | 41498 | 5099 | 44687 | 4151 | 45367 | 3429 | 44847 | 2395 | 53211 | 1945 | 29551 |
| 6L-4S | | MI | 22924 | 6874 | 36658 | 5044 | 39570 | 4092 | 40406 | 3379 | 40464 | 2346 | 47794 | 1976 | 25203 |
| 16-#11 | 1.84 | MA | 25708 | 6874 | 40653 | 5113 | 43668 | 4164 | 44114 | 3441 | 43166 | 2404 | 50923 | 1855 | 29101 |
| 7L-3S | | MI | 23384 | 6874 | 37448 | 5031 | 40577 | 4097 | 41630 | 3387 | 42010 | 2338 | 49527 | 2062 | 25187 |
| 16-#11 | 1.84 | MA | 25257 | 6874 | 39893 | 5111 | 42634 | 4160 | 42890 | 3453 | 41379 | 2395 | 48810 | 1807 | 28718 |
| 8L-2S | | MI | 24031 | 6874 | 38412 | 5035 | 41812 | 4086 | 43137 | 3377 | 44032 | 2329 | 52205 | 2148 | 25158 |
| 16-#14 | 2.65 | MA | 29171 | 7256 | 47631 | 5310 | 52539 | 4309 | 54917 | 3525 | 57704 | 2344 | 69446 | 2000 | 42683 |
| 3L-7S | | MI | 22252 | 7256 | 36363 | 5270 | 39074 | 4270 | 39745 | 3484 | 39553 | 2308 | 47111 | 1521 | 33506 |
| 16-#14 | 2.65 | MA | 28392 | 7256 | 46268 | 5330 | 50803 | 4302 | 52806 | 3517 | 54998 | 2357 | 66385 | 1875 | 42553 |
| 4L-6S | | MI | 22793 | 7256 | 37371 | 5252 | 40290 | 4254 | 41310 | 3495 | 41499 | 2296 | 49723 | 1652 | 34223 |
| 16-#14 | 2.65 | MA | 27694 | 7256 | 45088 | 5326 | 49273 | 4320 | 50927 | 3533 | 52288 | 2344 | 63166 | 1817 | 41764 |
| 5E | | MI | 23349 | 7256 | 38292 | 5259 | 41563 | 4263 | 42796 | 3482 | 43491 | 2284 | 52164 | 1733 | 34878 |
| 16-#14 | 2.65 | MA | 27030 | 7256 | 43982 | 5321 | 47742 | 4314 | 49055 | 3524 | 49831 | 2357 | 60124 | 1736 | 40869 |
| 6L-4S | | MI | 23932 | 7256 | 39273 | 5265 | 42834 | 4247 | 44357 | 3468 | 45692 | 2296 | 54774 | 1788 | 35542 |
| 16-#14 | 2.65 | MA | 26383 | 7256 | 42770 | 5341 | 46280 | 4332 | 47258 | 3540 | 47431 | 2369 | 56874 | 1606 | 39979 |
| 7L-3S | | MI | 24581 | 7256 | 40403 | 5247 | 44274 | 4256 | 46106 | 3480 | 47886 | 2284 | 57223 | 1912 | 35616 |
| 16-#14 | 2.65 | MA | 25747 | 7256 | 41681 | 5337 | 44797 | 4325 | 45504 | 3556 | 44880 | 2357 | 53865 | 1538 | 38771 |
| 8L-2S | | MI | 25494 | 7256 | 41780 | 5253 | 46039 | 4240 | 48259 | 3467 | 50757 | 2271 | 61015 | 2037 | 35625 |
| 16-#18 | 4.71 | MA | 30237 | 8224 | 52051 | 5899 | 58010 | 4743 | 61513 | 3783 | 66327 | 2227 | 82306 | 1329 | 69296 |
| 5E | | MI | 25349 | 8224 | 43991 | 5821 | 48688 | 4674 | 51309 | 3711 | 54693 | 2135 | 67251 | 1191 | 57543 |
| 16-#18 | 4.71 | MA | 29108 | 8224 | 50107 | 5889 | 55320 | 4729 | 58226 | 3764 | 62073 | 2249 | 77068 | 1184 | 66412 |
| 6L-4S | | MI | 26340 | 8224 | 45708 | 5834 | 50913 | 4648 | 54019 | 3689 | 58485 | 2157 | 71726 | 1287 | 59124 |
| 18-#11 | 2.06 | MA | 28224 | 6982 | 45210 | 5158 | 49530 | 4195 | 51281 | 3458 | 52844 | 2377 | 63092 | 2110 | 33727 |
| 3L-8S | | MI | 21806 | 6982 | 34956 | 5112 | 37318 | 4152 | 37673 | 3431 | 36705 | 2336 | 43346 | 1721 | 27078 |
| 18-#11 | 2.06 | MA | 27674 | 6982 | 44259 | 5172 | 48318 | 4191 | 49808 | 3453 | 50948 | 2386 | 60934 | 2023 | 33692 |
| 4L-7S | | MI | 22182 | 6982 | 35590 | 5117 | 38179 | 4157 | 38693 | 3421 | 38163 | 2344 | 45063 | 1767 | 27424 |
| 18-#11 | 2.06 | MA | 27183 | 6982 | 43436 | 5169 | 47251 | 4204 | 48497 | 3464 | 49050 | 2377 | 58673 | 1983 | 33612 |
| 5L-6S | | MI | 22564 | 6982 | 36294 | 5103 | 39028 | 4146 | 39737 | 3411 | 39534 | 2336 | 46908 | 1857 | 27734 |
| 18-#11 | 2.06 | MA | 26715 | 6982 | 42664 | 5167 | 46182 | 4200 | 47191 | 3459 | 47329 | 2386 | 56530 | 1926 | 33074 |
| 6L-5S | | MI | 22956 | 6982 | 36937 | 5107 | 39918 | 4152 | 40823 | 3418 | 40937 | 2327 | 48634 | 1914 | 28167 |
| 18-#11 | 2.06 | MA | 26258 | 6982 | 41819 | 5181 | 45163 | 4213 | 45938 | 3471 | 45647 | 2395 | 54242 | 1836 | 32642 |
| 7L-4S | | MI | 23367 | 6982 | 37622 | 5111 | 40806 | 4140 | 41914 | 3409 | 42486 | 2336 | 50472 | 1952 | 28206 |
| 18-#11 | 2.06 | MA | 25809 | 6982 | 41060 | 5178 | 44129 | 4209 | 44714 | 3482 | 43860 | 2387 | 52128 | 1788 | 32194 |
| 8L-3S | | MI | 23825 | 6982 | 38412 | 5098 | 41812 | 4146 | 43137 | 3416 | 44032 | 2327 | 52205 | 2039 | 28208 |
| 18-#11 | 2.06 | MA | 25352 | 6982 | 40242 | 5192 | 43123 | 4222 | 43435 | 3477 | 42194 | 2396 | 50050 | 1734 | 31501 |
| 9L-2S | | MI | 24470 | 6982 | 39376 | 5102 | 43048 | 4134 | 44645 | 3406 | 46054 | 2318 | 54884 | 2125 | 28186 |
| 18-#14 | 2.98 | MA | 29155 | 7412 | 47936 | 5427 | 52941 | 4372 | 55415 | 3559 | 58538 | 2344 | 71100 | 1846 | 47701 |
| 4L-7S | | MI | 22881 | 7412 | 37740 | 5368 | 40838 | 4340 | 41898 | 3526 | 42424 | 2292 | 50903 | 1485 | 37564 |
| 18-#14 | 2.98 | MA | 28462 | 7412 | 46757 | 5423 | 51412 | 4390 | 53536 | 3575 | 55827 | 2331 | 67881 | 1788 | 46766 |
| 5L-6S | | MI | 23420 | 7412 | 38748 | 5349 | 42055 | 4324 | 43463 | 3537 | 44370 | 2279 | 53515 | 1616 | 38376 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis

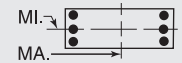


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.98 | MA | 27802 | 7412 | 45650 | 5418 | 49880 | 4383 | 51664 | 3566 | 53371 | 2344 | 64838 | 1707 | 45911 |
| 6L-5S | | MI | 23973 | 7412 | 39669 | 5356 | 43328 | 4333 | 44949 | 3524 | 46362 | 2267 | 55956 | 1698 | 38997 |
| 18-#14 | 2.98 | MA | 27159 | 7412 | 44438 | 5438 | 48418 | 4402 | 49867 | 3582 | 50971 | 2356 | 61588 | 1577 | 44925 |
| 7L-4S | | MI | 24552 | 7412 | 40649 | 5362 | 44599 | 4317 | 46510 | 3511 | 48563 | 2279 | 58566 | 1752 | 39796 |
| 18-#14 | 2.98 | MA | 26526 | 7412 | 43349 | 5434 | 46936 | 4395 | 48113 | 3598 | 48419 | 2344 | 58580 | 1509 | 43759 |
| 8L-3S | | MI | 25199 | 7412 | 41780 | 5344 | 46039 | 4326 | 48259 | 3522 | 50757 | 2267 | 61015 | 1877 | 39893 |
| 18-#14 | 2.98 | MA | 25899 | 7412 | 42176 | 5454 | 45493 | 4413 | 46279 | 3589 | 46040 | 2356 | 55629 | 1431 | 42396 |
| 9L-2S | | MI | 26107 | 7412 | 43156 | 5351 | 47803 | 4310 | 50412 | 3509 | 53628 | 2255 | 64807 | 2001 | 39928 |
| 18-#18 | 5.29 | MA | 30417 | 8501 | 53024 | 6062 | 59060 | 4853 | 62789 | 3840 | 68204 | 2222 | 85195 | 1126 | 75010 |
| 6L-5S | | MI | 26402 | 8501 | 46389 | 5994 | 51763 | 4798 | 55037 | 3785 | 59637 | 2101 | 73742 | 1119 | 64727 |
| 20-#11 | 2.29 | MA | 28215 | 7090 | 45425 | 5240 | 49813 | 4239 | 51632 | 3482 | 53430 | 2377 | 64253 | 2005 | 37311 |
| 4L-8S | | MI | 22252 | 7090 | 35920 | 5180 | 38553 | 4200 | 39181 | 3460 | 38727 | 2325 | 46024 | 1698 | 29945 |
| 20-#11 | 2.29 | MA | 27726 | 7090 | 44602 | 5237 | 48746 | 4252 | 50321 | 3494 | 51531 | 2369 | 61992 | 1964 | 37215 |
| 5L-7S | | MI | 22627 | 7090 | 36554 | 5184 | 39415 | 4206 | 40200 | 3450 | 40185 | 2334 | 47741 | 1744 | 30353 |
| 20-#11 | 2.29 | MA | 27260 | 7090 | 43831 | 5234 | 47677 | 4248 | 49015 | 3488 | 49810 | 2378 | 59849 | 1908 | 36603 |
| 6E | | MI | 23008 | 7090 | 37258 | 5171 | 40264 | 4194 | 41244 | 3441 | 41556 | 2325 | 49587 | 1834 | 30649 |
| 20-#11 | 2.29 | MA | 26806 | 7090 | 42985 | 5248 | 46658 | 4261 | 47762 | 3500 | 48129 | 2387 | 57561 | 1818 | 36187 |
| 7L-5S | | MI | 23398 | 7090 | 37901 | 5175 | 41154 | 4200 | 42331 | 3448 | 42959 | 2316 | 51312 | 1891 | 31151 |
| 20-#11 | 2.29 | MA | 26359 | 7090 | 42226 | 5246 | 45624 | 4257 | 46538 | 3512 | 46342 | 2378 | 55447 | 1770 | 35676 |
| 8L-4S | | MI | 23807 | 7090 | 38586 | 5179 | 42041 | 4188 | 43421 | 3438 | 44508 | 2325 | 53151 | 1929 | 31204 |
| 20-#11 | 2.29 | MA | 25906 | 7090 | 41408 | 5260 | 44618 | 4270 | 45259 | 3506 | 44675 | 2387 | 53369 | 1716 | 35006 |
| 9L-3S | | MI | 24263 | 7090 | 39376 | 5166 | 43048 | 4194 | 44645 | 3445 | 46054 | 2316 | 54884 | 2015 | 31223 |
| 20-#11 | 2.29 | MA | 25417 | 7090 | 40651 | 5257 | 43597 | 4266 | 44041 | 3518 | 43023 | 2396 | 51356 | 1654 | 34332 |
| 10L-2S | | MI | 24906 | 7090 | 40340 | 5170 | 44284 | 4183 | 46152 | 3436 | 48076 | 2308 | 57562 | 2102 | 31209 |
| 20-#14 | 3.31 | MA | 29225 | 7567 | 48425 | 5520 | 53551 | 4460 | 56145 | 3617 | 59367 | 2318 | 72595 | 1759 | 51779 |
| 5L-7S | | MI | 23507 | 7567 | 39116 | 5465 | 42603 | 4410 | 44051 | 3568 | 45295 | 2275 | 54695 | 1449 | 41634 |
| 20-#14 | 3.31 | MA | 28569 | 7567 | 47319 | 5515 | 52019 | 4453 | 54274 | 3609 | 56910 | 2331 | 69553 | 1678 | 50961 |
| 6E | | MI | 24043 | 7567 | 40125 | 5447 | 43819 | 4394 | 45616 | 3580 | 47241 | 2263 | 57307 | 1580 | 42535 |
| 20-#14 | 3.31 | MA | 27929 | 7567 | 46107 | 5536 | 50557 | 4471 | 52476 | 3625 | 54510 | 2343 | 66303 | 1548 | 49883 |
| 7L-5S | | MI | 24593 | 7567 | 41045 | 5453 | 45093 | 4403 | 47101 | 3567 | 49233 | 2250 | 59748 | 1662 | 43126 |
| 20-#14 | 3.31 | MA | 27300 | 7567 | 45017 | 5531 | 49074 | 4465 | 50722 | 3641 | 51959 | 2331 | 63294 | 1480 | 48756 |
| 8L-4S | | MI | 25169 | 7567 | 42026 | 5460 | 46363 | 4387 | 48662 | 3553 | 51434 | 2263 | 62357 | 1716 | 44043 |
| 20-#14 | 3.31 | MA | 26677 | 7567 | 43845 | 5551 | 47632 | 4483 | 48888 | 3632 | 49580 | 2343 | 60344 | 1402 | 47333 |
| 9L-3S | | MI | 25812 | 7567 | 43156 | 5441 | 47803 | 4396 | 50412 | 3565 | 53628 | 2250 | 64807 | 1841 | 44163 |
| 22-#11 | 2.52 | MA | 28266 | 7198 | 45768 | 5304 | 50241 | 4301 | 52145 | 3523 | 54013 | 2360 | 65311 | 1945 | 40816 |
| 5L-8S | | MI | 22697 | 7198 | 36884 | 5247 | 39789 | 4248 | 40688 | 3490 | 40749 | 2314 | 48702 | 1675 | 32819 |
| 22-#11 | 2.52 | MA | 27802 | 7198 | 44997 | 5301 | 49173 | 4297 | 50839 | 3518 | 52292 | 2369 | 63167 | 1889 | 40136 |
| 6L-7S | | MI | 23070 | 7198 | 37518 | 5251 | 40651 | 4254 | 41708 | 3480 | 42207 | 2323 | 50420 | 1720 | 33283 |
| 22-#11 | 2.52 | MA | 27350 | 7198 | 44152 | 5316 | 48153 | 4310 | 49586 | 3529 | 50610 | 2378 | 60880 | 1799 | 39735 |
| 7L-6S | | MI | 23449 | 7198 | 38222 | 5238 | 41500 | 4243 | 42752 | 3470 | 43578 | 2314 | 52265 | 1811 | 33569 |
| 22-#11 | 2.52 | MA | 26905 | 7198 | 43392 | 5313 | 47119 | 4305 | 48362 | 3541 | 48823 | 2370 | 58766 | 1751 | 39166 |
| 8L-5S | | MI | 23838 | 7198 | 38865 | 5242 | 42389 | 4248 | 43838 | 3477 | 44981 | 2306 | 53991 | 1867 | 34073 |
| 22-#11 | 2.52 | MA | 26464 | 7198 | 42574 | 5327 | 46113 | 4318 | 47083 | 3535 | 47157 | 2378 | 56688 | 1697 | 38515 |
| 9L-4S | | MI | 24246 | 7198 | 39550 | 5246 | 43277 | 4237 | 44929 | 3467 | 46530 | 2314 | 55829 | 1906 | 34197 |
| 22-#11 | 2.52 | MA | 25968 | 7198 | 41817 | 5324 | 45092 | 4314 | 45865 | 3547 | 45504 | 2387 | 54675 | 1636 | 37800 |
| 10L-3S | | MI | 24700 | 7198 | 40340 | 5233 | 44284 | 4243 | 46152 | 3475 | 48076 | 2306 | 57562 | 1992 | 34228 |
| 22-#14 | 3.64 | MA | 29331 | 7723 | 48987 | 5613 | 54158 | 4523 | 56883 | 3651 | 60450 | 2318 | 74267 | 1649 | 56015 |
| 6L-7S | | MI | 24129 | 7723 | 40493 | 5562 | 44368 | 4479 | 46204 | 3611 | 48166 | 2259 | 58487 | 1414 | 45715 |
| 22-#14 | 3.64 | MA | 28695 | 7723 | 47775 | 5633 | 52696 | 4541 | 55085 | 3667 | 58050 | 2330 | 71017 | 1519 | 54851 |
| 7L-6S | | MI | 24662 | 7723 | 41501 | 5544 | 45584 | 4464 | 47769 | 3622 | 50112 | 2246 | 61099 | 1544 | 46699 |
| 22-#14 | 3.64 | MA | 28069 | 7723 | 46686 | 5628 | 51213 | 4535 | 53331 | 3683 | 55498 | 2318 | 68009 | 1451 | 53761 |
| 8L-5S | | MI | 25209 | 7723 | 42422 | 5550 | 46857 | 4473 | 49254 | 3609 | 52104 | 2234 | 63540 | 1626 | 47263 |
| 22-#14 | 3.64 | MA | 27450 | 7723 | 45513 | 5649 | 49770 | 4553 | 51497 | 3674 | 53119 | 2330 | 65059 | 1373 | 52279 |
| 9L-4S | | MI | 25783 | 7723 | 43402 | 5557 | 48128 | 4457 | 50815 | 3596 | 54305 | 2246 | 66149 | 1680 | 48286 |
| 24-#11 | 2.75 | MA | 28342 | 7306 | 46163 | 5369 | 50668 | 4345 | 52663 | 3547 | 54773 | 2360 | 66486 | 1870 | 43675 |
| 6L-8S | | MI | 23139 | 7306 | 37848 | 5315 | 41025 | 4297 | 42196 | 3519 | 42771 | 2304 | 51380 | 1651 | 35698 |
| 24-#11 | 2.75 | MA | 27892 | 7306 | 45318 | 5383 | 49648 | 4358 | 51409 | 3559 | 53092 | 2369 | 64198 | 1780 | 43285 |
| 7E | | MI | 23511 | 7306 | 38482 | 5319 | 41886 | 4303 | 43215 | 3509 | 44229 | 2312 | 53098 | 1697 | 36216 |

## RECTANGULAR TIED COLUMNS 34" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.75 | MA | 27449 | 7306 | 44558 | 5380 | 48614 | 4354 | 50186 | 3570 | 51305 | 2361 | 62085 | 1732 | 42661 |
| 8L-6S | | MI | 23889 | 7306 | 39186 | 5306 | 42736 | 4291 | 44259 | 3499 | 45600 | 2304 | 54943 | 1787 | 36491 |
| 24-#11 | 2.75 | MA | 27010 | 7306 | 43740 | 5395 | 47608 | 4367 | 48906 | 3565 | 49638 | 2370 | 60006 | 1678 | 42029 |
| 9L-5S | | MI | 24276 | 7306 | 39829 | 5310 | 43625 | 4297 | 45346 | 3507 | 47003 | 2295 | 56669 | 1844 | 36973 |
| 24-#11 | 2.75 | MA | 26516 | 7306 | 42983 | 5392 | 46587 | 4363 | 47689 | 3576 | 47986 | 2379 | 57993 | 1617 | 41274 |
| 10L-4S | | MI | 24682 | 7306 | 40514 | 5314 | 44513 | 4285 | 46436 | 3497 | 48553 | 2304 | 58507 | 1883 | 37187 |
| 24-#14 | 3.97 | MA | 29456 | 7879 | 49443 | 5730 | 54834 | 4611 | 57695 | 3709 | 61589 | 2317 | 75732 | 1490 | 59828 |
| 7E | | MI | 24747 | 7879 | 41869 | 5659 | 46132 | 4549 | 48356 | 3653 | 51037 | 2242 | 62279 | 1378 | 49804 |
| 24-#14 | 3.97 | MA | 28833 | 7879 | 48354 | 5726 | 53352 | 4604 | 55940 | 3726 | 59038 | 2305 | 72723 | 1422 | 58771 |
| 8L-6S | | MI | 25278 | 7879 | 42878 | 5641 | 47348 | 4533 | 49921 | 3665 | 52983 | 2230 | 64891 | 1508 | 50866 |
| 24-#14 | 3.97 | MA | 28217 | 7879 | 47181 | 5746 | 51909 | 4623 | 54106 | 3717 | 56659 | 2317 | 69773 | 1344 | 57233 |
| 9L-5S | | MI | 25822 | 7879 | 43798 | 5648 | 48622 | 4542 | 51407 | 3651 | 54975 | 2217 | 67332 | 1590 | 51408 |

## RECTANGULAR TIED COLUMNS 34" x 42"

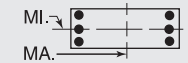
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.12 | MA | 29436 | 6865 | 45891 | 5092 | 49339 | 4153 | 50036 | 3467 | 49288 | 2499 | 57427 | 2355 | 20424 |
| 2E | | MI | 23673 | 6865 | 37237 | 5002 | 39652 | 4079 | 39960 | 3401 | 38925 | 2434 | 44988 | 2274 | 16296 |
| 6-#18 | 1.68 | MA | 30869 | 7142 | 48981 | 5265 | 53300 | 4277 | 54868 | 3543 | 55814 | 2475 | 66101 | 2301 | 30169 |
| 2L-3S | | MI | 23149 | 7142 | 37237 | 5161 | 39652 | 4229 | 39960 | 3497 | 38925 | 2422 | 44988 | 1980 | 24029 |
| 6-#18 | 1.68 | MA | 28787 | 7142 | 45891 | 5256 | 49339 | 4308 | 50036 | 3570 | 49288 | 2497 | 57427 | 2079 | 30214 |
| 3L-2S | | MI | 24759 | 7142 | 39635 | 5175 | 42727 | 4203 | 43688 | 3475 | 43869 | 2400 | 51479 | 2202 | 23919 |
| 8-#14 | 1.26 | MA | 29882 | 6934 | 46623 | 5170 | 50474 | 4212 | 51494 | 3510 | 51398 | 2518 | 60374 | 2374 | 23030 |
| 2L-4S | | MI | 22431 | 6934 | 35305 | 5100 | 37372 | 4152 | 37298 | 3455 | 35597 | 2482 | 41140 | 2047 | 18483 |
| 8-#14 | 1.26 | MA | 28681 | 6934 | 44858 | 5166 | 48211 | 4231 | 48733 | 3527 | 47641 | 2530 | 55352 | 2250 | 23088 |
| 3E | | MI | 23096 | 6934 | 36435 | 5081 | 38812 | 4161 | 39047 | 3467 | 37791 | 2470 | 43589 | 2172 | 18418 |
| 8-#14 | 1.26 | MA | 27836 | 6934 | 43418 | 5186 | 46375 | 4225 | 46503 | 3519 | 44771 | 2543 | 52086 | 2125 | 23102 |
| 4L-2S | | MI | 24028 | 6934 | 37812 | 5088 | 40576 | 4145 | 41200 | 3453 | 40662 | 2457 | 47381 | 2296 | 18345 |
| 8-#18 | 2.24 | MA | 32283 | 7418 | 52071 | 5438 | 57262 | 4401 | 59700 | 3618 | 62341 | 2450 | 74776 | 2246 | 39863 |
| 2L-4S | | MI | 23092 | 7418 | 37659 | 5365 | 40210 | 4334 | 40652 | 3549 | 40092 | 2411 | 47285 | 1690 | 31343 |
| 8-#18 | 2.24 | MA | 30220 | 7418 | 48981 | 5429 | 53300 | 4433 | 54868 | 3646 | 55814 | 2472 | 66101 | 2025 | 39809 |
| 3E | | MI | 24235 | 7418 | 39635 | 5334 | 42727 | 4353 | 43688 | 3571 | 43869 | 2388 | 51479 | 1908 | 31527 |
| 8-#18 | 2.24 | MA | 28764 | 7418 | 46454 | 5464 | 50080 | 4420 | 50954 | 3629 | 50826 | 2494 | 60477 | 1803 | 39406 |
| 4L-2S | | MI | 25833 | 7418 | 42034 | 5348 | 45802 | 4327 | 47417 | 3549 | 48813 | 2366 | 57970 | 2130 | 31483 |
| 10-#11 | 1.09 | MA | 29477 | 6851 | 45652 | 5135 | 49328 | 4189 | 50135 | 3500 | 49564 | 2534 | 58049 | 2404 | 20127 |
| 2L-5S | | MI | 22187 | 6851 | 34616 | 5062 | 36571 | 4143 | 36347 | 3458 | 34242 | 2490 | 39460 | 2123 | 16215 |
| 10-#11 | 1.09 | MA | 28634 | 6851 | 44418 | 5133 | 47747 | 4186 | 48205 | 3512 | 46939 | 2543 | 54516 | 2317 | 20171 |
| 3L-4S | | MI | 22605 | 6851 | 35301 | 5067 | 37459 | 4131 | 37438 | 3448 | 35791 | 2499 | 41298 | 2162 | 16170 |
| 10-#11 | 1.09 | MA | 28043 | 6851 | 43413 | 5147 | 46466 | 4199 | 46649 | 3507 | 44936 | 2553 | 52217 | 2231 | 20207 |
| 4L-3S | | MI | 23071 | 6851 | 36091 | 5053 | 38466 | 4137 | 38661 | 3455 | 37336 | 2490 | 43031 | 2248 | 16117 |
| 10-#11 | 1.09 | MA | 27514 | 6851 | 42545 | 5145 | 45340 | 4195 | 45264 | 3519 | 42930 | 2545 | 49815 | 2190 | 20208 |
| 5L-2S | | MI | 23726 | 6851 | 37055 | 5057 | 39702 | 4125 | 40169 | 3446 | 39358 | 2482 | 45709 | 2335 | 16066 |
| 10-#14 | 1.58 | MA | 30707 | 7090 | 48389 | 5267 | 52737 | 4282 | 54255 | 3553 | 55155 | 2505 | 65397 | 2347 | 28583 |
| 2L-5S | | MI | 22476 | 7090 | 35701 | 5191 | 37866 | 4238 | 37889 | 3511 | 36268 | 2453 | 42323 | 1957 | 22750 |
| 10-#14 | 1.58 | MA | 29513 | 7090 | 46623 | 5263 | 50474 | 4301 | 51494 | 3570 | 51398 | 2518 | 60374 | 2222 | 28620 |
| 3L-4S | | MI | 23069 | 7090 | 36682 | 5197 | 39136 | 4222 | 39450 | 3497 | 38468 | 2466 | 44932 | 2012 | 22797 |
| 10-#14 | 1.58 | MA | 28673 | 7090 | 45183 | 5284 | 48639 | 4295 | 49264 | 3561 | 48528 | 2531 | 57109 | 2098 | 28589 |
| 4L-3S | | MI | 23730 | 7090 | 37812 | 5179 | 40576 | 4231 | 41200 | 3509 | 40662 | 2453 | 47381 | 2136 | 22760 |
| 10-#14 | 1.58 | MA | 27923 | 7090 | 43938 | 5279 | 47023 | 4314 | 47279 | 3578 | 45653 | 2519 | 53687 | 2039 | 28431 |
| 5L-2S | | MI | 24658 | 7090 | 39188 | 5185 | 42341 | 4215 | 43353 | 3496 | 43533 | 2441 | 51173 | 2261 | 22701 |
| 10-#18 | 2.80 | MA | 33682 | 7695 | 55161 | 5611 | 61223 | 4526 | 64533 | 3694 | 68868 | 2425 | 83450 | 2191 | 49518 |
| 2L-5S | | MI | 23157 | 7695 | 38340 | 5524 | 41060 | 4484 | 41671 | 3645 | 41244 | 2355 | 49301 | 1522 | 36391 |
| 10-#18 | 2.80 | MA | 31636 | 7695 | 52071 | 5602 | 57262 | 4557 | 59700 | 3721 | 62341 | 2447 | 74776 | 1970 | 49374 |
| 3L-4S | | MI | 24176 | 7695 | 40058 | 5537 | 43284 | 4458 | 44381 | 3623 | 45036 | 2377 | 53776 | 1618 | 38398 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

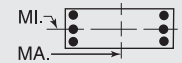



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 2.80 | MA | 30193 | 7695 | 49544 | 5637 | 54041 | 4544 | 55787 | 3704 | 57353 | 2469 | 69151 | 1749 | 48707 |
| 4L-3S | | MI | 25310 | 7695 | 42034 | 5507 | 45802 | 4477 | 47417 | 3645 | 48813 | 2355 | 57970 | 1836 | 38977 |
| 10-#18 | 2.80 | MA | 28904 | 7695 | 47355 | 5628 | 51203 | 4575 | 52300 | 3731 | 52354 | 2447 | 63217 | 1647 | 45804 |
| 5L-2S | | MI | 26896 | 7695 | 44432 | 5521 | 48876 | 4452 | 51146 | 3623 | 53757 | 2333 | 64462 | 2058 | 39011 |
| 12-#11 | 1.31 | MA | 30059 | 6959 | 46885 | 5203 | 50910 | 4238 | 52064 | 3529 | 52189 | 2525 | 61582 | 2386 | 24012 |
| 2L-6S | | MI | 22241 | 6959 | 34937 | 5126 | 36918 | 4185 | 36768 | 3480 | 34861 | 2488 | 40412 | 2044 | 19168 |
| 12-#11 | 1.31 | MA | 29220 | 6959 | 45652 | 5200 | 49328 | 4234 | 50135 | 3541 | 49564 | 2534 | 58049 | 2300 | 24047 |
| 3L-5S | | MI | 22639 | 6959 | 35580 | 5130 | 37807 | 4191 | 37855 | 3487 | 36264 | 2480 | 42138 | 2100 | 19236 |
| 12-#11 | 1.31 | MA | 28631 | 6959 | 44647 | 5215 | 48048 | 4247 | 48578 | 3536 | 47561 | 2544 | 55749 | 2214 | 24068 |
| 4E | | MI | 23055 | 6959 | 36265 | 5134 | 38695 | 4180 | 38945 | 3477 | 37813 | 2488 | 43976 | 2139 | 19209 |
| 12-#11 | 1.31 | MA | 28105 | 6959 | 43778 | 5212 | 46921 | 4244 | 47194 | 3548 | 45555 | 2536 | 53347 | 2172 | 24043 |
| 5L-3S | | MI | 23519 | 6959 | 37055 | 5121 | 39702 | 4185 | 40169 | 3485 | 39358 | 2480 | 45709 | 2225 | 19167 |
| 12-#11 | 1.31 | MA | 27604 | 6959 | 42964 | 5210 | 45793 | 4257 | 45815 | 3543 | 43738 | 2546 | 51064 | 2116 | 23864 |
| 6L-2S | | MI | 24172 | 6959 | 38019 | 5125 | 40937 | 4174 | 41676 | 3475 | 41380 | 2471 | 48388 | 2311 | 19122 |
| 12-#14 | 1.89 | MA | 31526 | 7245 | 50154 | 5364 | 55001 | 4352 | 57016 | 3595 | 58911 | 2493 | 70420 | 2320 | 34121 |
| 2L-6S | | MI | 22550 | 7245 | 36157 | 5281 | 38357 | 4298 | 38557 | 3567 | 37147 | 2449 | 43673 | 1839 | 26122 |
| 12-#14 | 1.89 | MA | 30339 | 7245 | 48389 | 5360 | 52737 | 4371 | 54255 | 3612 | 55155 | 2506 | 65397 | 2195 | 34132 |
| 3L-5S | | MI | 23112 | 7245 | 37078 | 5288 | 39630 | 4308 | 40042 | 3553 | 39139 | 2437 | 46114 | 1921 | 26881 |
| 12-#14 | 1.89 | MA | 29504 | 7245 | 46949 | 5381 | 50902 | 4365 | 52025 | 3604 | 52284 | 2518 | 62132 | 2071 | 34062 |
| 4E | | MI | 23703 | 7245 | 38058 | 5294 | 40901 | 4292 | 41603 | 3540 | 41339 | 2449 | 48724 | 1976 | 27085 |
| 12-#14 | 1.89 | MA | 28758 | 7245 | 45703 | 5377 | 49287 | 4383 | 50040 | 3621 | 49410 | 2506 | 58710 | 2012 | 33755 |
| 5L-3S | | MI | 24360 | 7245 | 39188 | 5276 | 42341 | 4301 | 43353 | 3551 | 43533 | 2437 | 51173 | 2100 | 27083 |
| 12-#14 | 1.89 | MA | 28047 | 7245 | 44535 | 5373 | 47669 | 4377 | 48063 | 3612 | 46804 | 2519 | 55466 | 1931 | 32650 |
| 6L-2S | | MI | 25283 | 7245 | 40565 | 5282 | 44106 | 4285 | 45506 | 3538 | 46404 | 2424 | 54965 | 2225 | 27039 |
| 12-#18 | 3.36 | MA | 33036 | 7972 | 55161 | 5775 | 61223 | 4681 | 64533 | 3796 | 68868 | 2422 | 83450 | 1915 | 58920 |
| 3L-5S | | MI | 24239 | 7972 | 40739 | 5697 | 44134 | 4608 | 45399 | 3719 | 46188 | 2321 | 55792 | 1450 | 43514 |
| 12-#18 | 3.36 | MA | 31607 | 7972 | 52634 | 5810 | 58002 | 4668 | 60619 | 3779 | 63879 | 2444 | 77826 | 1694 | 57764 |
| 4E | | MI | 25250 | 7972 | 42456 | 5710 | 46359 | 4582 | 48109 | 3697 | 49980 | 2343 | 60267 | 1546 | 45376 |
| 12-#18 | 3.36 | MA | 30329 | 7972 | 50445 | 5801 | 55164 | 4699 | 57133 | 3807 | 58880 | 2422 | 71891 | 1593 | 55031 |
| 5L-3S | | MI | 26375 | 7972 | 44432 | 5680 | 48876 | 4601 | 51146 | 3719 | 53757 | 2321 | 64462 | 1764 | 46400 |
| 12-#18 | 3.36 | MA | 29114 | 7972 | 48391 | 5791 | 52322 | 4686 | 53659 | 3790 | 54351 | 2444 | 66296 | 1448 | 52587 |
| 6L-2S | | MI | 27950 | 7972 | 46831 | 5694 | 51951 | 4576 | 54874 | 3697 | 58701 | 2299 | 70953 | 1986 | 46509 |
| 14-#11 | 1.53 | MA | 30639 | 7067 | 48119 | 5270 | 52491 | 4286 | 53993 | 3559 | 54814 | 2516 | 65114 | 2369 | 27887 |
| 2L-7S | | MI | 22306 | 7067 | 35197 | 5206 | 37304 | 4245 | 37232 | 3519 | 35512 | 2486 | 41245 | 1930 | 21711 |
| 14-#11 | 1.53 | MA | 29803 | 7067 | 46885 | 5268 | 50910 | 4282 | 52064 | 3571 | 52189 | 2526 | 61582 | 2282 | 27913 |
| 3L-6S | | MI | 22692 | 7067 | 35901 | 5193 | 38153 | 4234 | 38275 | 3509 | 36883 | 2478 | 43091 | 2020 | 22062 |
| 14-#11 | 1.53 | MA | 29216 | 7067 | 45881 | 5282 | 49629 | 4296 | 50507 | 3566 | 50186 | 2535 | 59282 | 2196 | 27915 |
| 4L-5S | | MI | 23088 | 7067 | 36544 | 5197 | 39043 | 4240 | 39362 | 3517 | 38286 | 2469 | 44816 | 2077 | 22246 |
| 14-#11 | 1.53 | MA | 28692 | 7067 | 45012 | 5280 | 48503 | 4292 | 49123 | 3578 | 48180 | 2528 | 56880 | 2155 | 27869 |
| 5L-4S | | MI | 23503 | 7067 | 37229 | 5201 | 39931 | 4228 | 40453 | 3507 | 39835 | 2478 | 46655 | 2116 | 22237 |
| 14-#11 | 1.53 | MA | 28193 | 7067 | 44197 | 5277 | 47374 | 4305 | 47744 | 3573 | 46363 | 2537 | 54597 | 2099 | 27574 |
| 6L-3S | | MI | 23965 | 7067 | 38019 | 5188 | 40937 | 4234 | 41676 | 3514 | 41380 | 2469 | 48388 | 2202 | 22205 |
| 14-#11 | 1.53 | MA | 27707 | 7067 | 43305 | 5292 | 46298 | 4302 | 46421 | 3585 | 44588 | 2547 | 52161 | 2009 | 27050 |
| 7L-2S | | MI | 24616 | 7067 | 38983 | 5192 | 42173 | 4222 | 43184 | 3504 | 43402 | 2460 | 51066 | 2288 | 22166 |
| 14-#14 | 2.21 | MA | 32340 | 7401 | 51920 | 5462 | 57264 | 4422 | 59778 | 3638 | 62668 | 2480 | 75443 | 2293 | 39653 |
| 2L-7S | | MI | 22639 | 7401 | 36525 | 5397 | 38905 | 4384 | 39145 | 3597 | 38071 | 2445 | 44853 | 1673 | 29768 |
| 14-#14 | 2.21 | MA | 31158 | 7401 | 50154 | 5457 | 55001 | 4441 | 57016 | 3654 | 58911 | 2493 | 70420 | 2168 | 39627 |
| 3L-6S | | MI | 23185 | 7401 | 37533 | 5379 | 40121 | 4368 | 40710 | 3609 | 40018 | 2433 | 47465 | 1804 | 30259 |
| 14-#14 | 2.21 | MA | 30328 | 7401 | 48714 | 5478 | 53165 | 4435 | 54786 | 3646 | 56041 | 2506 | 67155 | 2044 | 39526 |
| 4L-5S | | MI | 23745 | 7401 | 38454 | 5385 | 41395 | 4377 | 42195 | 3596 | 42010 | 2420 | 49906 | 1885 | 30971 |
| 14-#14 | 2.21 | MA | 29587 | 7401 | 47469 | 5474 | 51550 | 4453 | 52801 | 3663 | 53166 | 2494 | 63732 | 1985 | 39019 |
| 5L-4S | | MI | 24332 | 7401 | 39435 | 5392 | 42666 | 4361 | 43756 | 3582 | 44210 | 2433 | 52516 | 1940 | 31361 |
| 14-#14 | 2.21 | MA | 28881 | 7401 | 46300 | 5470 | 49932 | 4447 | 50824 | 3655 | 50561 | 2507 | 60488 | 1904 | 37970 |
| 6L-3S | | MI | 24986 | 7401 | 40565 | 5373 | 44106 | 4371 | 45506 | 3594 | 46404 | 2420 | 54965 | 2064 | 31395 |
| 14-#14 | 2.21 | MA | 28193 | 7401 | 45021 | 5491 | 48389 | 4466 | 48926 | 3672 | 48015 | 2519 | 57026 | 1774 | 37278 |
| 7L-2S | | MI | 25905 | 7401 | 41941 | 5380 | 45870 | 4355 | 47658 | 3580 | 49275 | 2408 | 58757 | 2189 | 31365 |
| 14-#18 | 3.92 | MA | 33007 | 8248 | 55724 | 5983 | 61963 | 4792 | 65452 | 3855 | 70406 | 2420 | 86500 | 1639 | 66866 |
| 4L-5S | | MI | 25311 | 8248 | 43137 | 5869 | 47209 | 4732 | 49128 | 3793 | 51132 | 2288 | 62283 | 1378 | 50661 |

## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

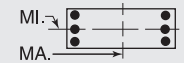
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.92 | MA | 31740 | 8248 | 53535 | 5973 | 59126 | 4823 | 61965 | 3882 | 65407 | 2397 | 80566 | 1538 | 64284 |
| 5L-4S | | MI | 26314 | 8248 | 44854 | 5883 | 49434 | 4707 | 51838 | 3770 | 54924 | 2310 | 66759 | 1474 | 52398 |
| 14-#18 | 3.92 | MA | 30536 | 8248 | 51481 | 5964 | 56283 | 4810 | 58492 | 3865 | 60878 | 2420 | 74971 | 1393 | 61651 |
| 6L-3S | | MI | 27431 | 8248 | 46831 | 5853 | 51951 | 4725 | 54874 | 3793 | 58701 | 2288 | 70953 | 1692 | 53806 |
| 14-#18 | 3.92 | MA | 29363 | 8248 | 49231 | 5999 | 53569 | 4841 | 55156 | 3892 | 56452 | 2442 | 68993 | 1162 | 58957 |
| 7L-2S | | MI | 28995 | 8248 | 49229 | 5867 | 55026 | 4700 | 58603 | 3770 | 63645 | 2266 | 77444 | 1913 | 53972 |
| 16-#11 | 1.75 | MA | 31215 | 7175 | 49353 | 5337 | 54073 | 4335 | 55923 | 3588 | 57439 | 2508 | 68647 | 2351 | 31756 |
| 2L-8S | | MI | 22378 | 7175 | 35528 | 5270 | 37678 | 4288 | 37720 | 3559 | 36075 | 2467 | 42206 | 1861 | 24407 |
| 16-#11 | 1.75 | MA | 30382 | 7175 | 48119 | 5335 | 52491 | 4331 | 53993 | 3600 | 54814 | 2517 | 65114 | 2265 | 31773 |
| 3L-7S | | MI | 22756 | 7175 | 36161 | 5274 | 38540 | 4294 | 38739 | 3549 | 37534 | 2476 | 43924 | 1907 | 24633 |
| 16-#11 | 1.75 | MA | 29798 | 7175 | 47114 | 5350 | 51211 | 4344 | 52437 | 3595 | 52811 | 2527 | 62815 | 2179 | 31754 |
| 4L-6S | | MI | 23141 | 7175 | 36865 | 5261 | 39389 | 4282 | 39783 | 3539 | 38905 | 2467 | 45769 | 1997 | 24965 |
| 16-#11 | 1.75 | MA | 29277 | 7175 | 46245 | 5347 | 50084 | 4340 | 51052 | 3607 | 50805 | 2519 | 60413 | 2137 | 31691 |
| 5E | | MI | 23535 | 7175 | 37508 | 5265 | 40279 | 4288 | 40870 | 3546 | 40308 | 2458 | 47495 | 2054 | 25245 |
| 16-#11 | 1.75 | MA | 28780 | 7175 | 45431 | 5345 | 48956 | 4354 | 49674 | 3602 | 48988 | 2528 | 58130 | 2081 | 31293 |
| 6L-4S | | MI | 23948 | 7175 | 38193 | 5269 | 41166 | 4277 | 41960 | 3536 | 41857 | 2467 | 49333 | 2092 | 25256 |
| 16-#11 | 1.75 | MA | 28296 | 7175 | 44539 | 5359 | 47880 | 4350 | 48350 | 3614 | 47213 | 2538 | 55694 | 1991 | 30793 |
| 7L-3S | | MI | 24409 | 7175 | 38983 | 5256 | 42173 | 4282 | 43184 | 3544 | 43402 | 2458 | 51066 | 2179 | 25235 |
| 16-#11 | 1.75 | MA | 27819 | 7175 | 43737 | 5357 | 46788 | 4363 | 47059 | 3626 | 45326 | 2530 | 53448 | 1942 | 30433 |
| 8L-2S | | MI | 25057 | 7175 | 39947 | 5260 | 43409 | 4271 | 44691 | 3534 | 45424 | 2450 | 53744 | 2265 | 25203 |
| 16-#14 | 2.52 | MA | 31973 | 7557 | 51920 | 5555 | 57264 | 4511 | 59778 | 3697 | 62668 | 2481 | 75443 | 2141 | 45113 |
| 3L-7S | | MI | 23273 | 7557 | 37902 | 5494 | 40670 | 4454 | 41297 | 3640 | 40942 | 2429 | 48645 | 1637 | 33809 |
| 16-#14 | 2.52 | MA | 31147 | 7557 | 50480 | 5575 | 55429 | 4504 | 57547 | 3689 | 59798 | 2493 | 72177 | 2017 | 44983 |
| 4L-6S | | MI | 23816 | 7557 | 38910 | 5476 | 41886 | 4438 | 42862 | 3651 | 42889 | 2416 | 51257 | 1768 | 34405 |
| 16-#14 | 2.52 | MA | 30410 | 7557 | 49234 | 5571 | 53813 | 4523 | 55562 | 3705 | 56923 | 2481 | 68755 | 1958 | 44300 |
| 5E | | MI | 24373 | 7557 | 39831 | 5482 | 43159 | 4447 | 44348 | 3638 | 44881 | 2404 | 53698 | 1850 | 35076 |
| 16-#14 | 2.52 | MA | 29708 | 7557 | 48066 | 5567 | 52196 | 4517 | 53585 | 3697 | 54318 | 2494 | 65511 | 1877 | 43301 |
| 6L-4S | | MI | 24957 | 7557 | 40811 | 5489 | 44430 | 4431 | 45909 | 3625 | 47081 | 2416 | 56308 | 1904 | 35626 |
| 16-#14 | 2.52 | MA | 29024 | 7557 | 46786 | 5588 | 50652 | 4536 | 51687 | 3714 | 51772 | 2507 | 62049 | 1747 | 42505 |
| 7L-3S | | MI | 25608 | 7557 | 41941 | 5471 | 45870 | 4440 | 47658 | 3636 | 49275 | 2404 | 58757 | 2029 | 35685 |
| 16-#14 | 2.52 | MA | 28351 | 7557 | 45636 | 5584 | 49086 | 4530 | 49835 | 3731 | 49066 | 2495 | 58849 | 1678 | 41167 |
| 8L-2S | | MI | 26523 | 7557 | 43318 | 5477 | 47635 | 4424 | 49811 | 3623 | 52146 | 2391 | 62549 | 2153 | 35682 |
| 16-#18 | 4.48 | MA | 33138 | 8525 | 56625 | 6146 | 63087 | 4947 | 66798 | 3957 | 71934 | 2373 | 89240 | 1483 | 73559 |
| 5E | | MI | 26375 | 8525 | 45535 | 6042 | 50283 | 4856 | 52857 | 3866 | 56076 | 2254 | 68775 | 1306 | 57829 |
| 16-#18 | 4.48 | MA | 31944 | 8525 | 54571 | 6137 | 60244 | 4934 | 63324 | 3940 | 67405 | 2395 | 83645 | 1339 | 70745 |
| 6L-4S | | MI | 27370 | 8525 | 47253 | 6056 | 52508 | 4831 | 55566 | 3844 | 59868 | 2276 | 73250 | 1402 | 59455 |
| 16-#18 | 4.48 | MA | 30781 | 8525 | 52321 | 6172 | 57531 | 4965 | 59989 | 3968 | 62979 | 2417 | 77667 | 1107 | 68087 |
| 7L-3S | | MI | 28478 | 8525 | 49229 | 6026 | 55026 | 4849 | 58603 | 3866 | 63645 | 2254 | 77444 | 1620 | 61198 |
| 18-#11 | 1.97 | MA | 30959 | 7283 | 49353 | 5402 | 54073 | 4379 | 55923 | 3630 | 57439 | 2509 | 68647 | 2247 | 35622 |
| 3L-8S | | MI | 22827 | 7283 | 36492 | 5337 | 38914 | 4337 | 39227 | 3588 | 38097 | 2456 | 44884 | 1838 | 27299 |
| 18-#11 | 1.97 | MA | 30377 | 7283 | 48348 | 5417 | 52792 | 4393 | 54366 | 3624 | 55436 | 2518 | 66347 | 2161 | 35588 |
| 4L-7S | | MI | 23204 | 7283 | 37125 | 5341 | 39775 | 4342 | 40247 | 3578 | 39556 | 2465 | 46602 | 1884 | 27559 |
| 18-#11 | 1.97 | MA | 29858 | 7283 | 47479 | 5415 | 51665 | 4389 | 52982 | 3637 | 53430 | 2510 | 63945 | 2120 | 35508 |
| 5L-6S | | MI | 23587 | 7283 | 37829 | 5328 | 40625 | 4331 | 41290 | 3568 | 40927 | 2456 | 48447 | 1974 | 27875 |
| 18-#11 | 1.97 | MA | 29363 | 7283 | 46665 | 5412 | 50537 | 4402 | 51603 | 3631 | 51613 | 2520 | 61662 | 2064 | 35020 |
| 6L-5S | | MI | 23980 | 7283 | 38472 | 5332 | 41514 | 4336 | 42377 | 3576 | 42330 | 2448 | 50173 | 2030 | 28239 |
| 18-#11 | 1.97 | MA | 28881 | 7283 | 45773 | 5427 | 49461 | 4398 | 50280 | 3643 | 49838 | 2529 | 59226 | 1974 | 34540 |
| 7L-4S | | MI | 24391 | 7283 | 39157 | 5336 | 42402 | 4325 | 43468 | 3566 | 43879 | 2456 | 52011 | 2069 | 28270 |
| 18-#11 | 1.97 | MA | 28407 | 7283 | 44971 | 5424 | 48370 | 4412 | 48988 | 3656 | 47951 | 2522 | 56981 | 1925 | 34164 |
| 8L-3S | | MI | 24850 | 7283 | 39947 | 5323 | 43409 | 4331 | 44691 | 3573 | 45424 | 2448 | 53744 | 2155 | 28258 |
| 18-#11 | 1.97 | MA | 27921 | 7283 | 44108 | 5439 | 47308 | 4408 | 47637 | 3650 | 46192 | 2531 | 54767 | 1871 | 33398 |
| 9L-2S | | MI | 25496 | 7283 | 40911 | 5327 | 44644 | 4319 | 46199 | 3563 | 47447 | 2439 | 56422 | 2242 | 28234 |
| 18-#14 | 2.84 | MA | 31961 | 7712 | 52245 | 5673 | 57692 | 4574 | 60308 | 3731 | 63555 | 2481 | 77200 | 1990 | 50435 |
| 4L-7S | | MI | 23904 | 7712 | 39278 | 5591 | 42434 | 4524 | 43450 | 3682 | 43813 | 2412 | 52437 | 1601 | 37865 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis

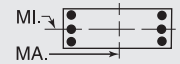


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.84 | MA | 31227 | 7712 | 51000 | 5669 | 56077 | 4593 | 58323 | 3748 | 60680 | 2469 | 73778 | 1931 | 49596 |
| 5L-6S | | MI | 24444 | 7712 | 40286 | 5573 | 43651 | 4508 | 45015 | 3694 | 45760 | 2400 | 55049 | 1732 | 38559 |
| 18-#14 | 2.84 | MA | 30530 | 7712 | 49832 | 5664 | 54459 | 4587 | 56346 | 3740 | 58075 | 2482 | 70534 | 1850 | 48640 |
| 6L-5S | | MI | 24998 | 7712 | 41207 | 5580 | 44924 | 4517 | 46500 | 3680 | 47752 | 2387 | 57490 | 1814 | 39194 |
| 18-#14 | 2.84 | MA | 29850 | 7712 | 48552 | 5685 | 52915 | 4606 | 54449 | 3756 | 55529 | 2494 | 67071 | 1720 | 47744 |
| 7L-4S | | MI | 25579 | 7712 | 42188 | 5586 | 46195 | 4501 | 48061 | 3667 | 49952 | 2400 | 60100 | 1868 | 39885 |
| 18-#14 | 2.84 | MA | 29181 | 7712 | 47402 | 5681 | 51350 | 4599 | 52596 | 3773 | 52823 | 2482 | 63872 | 1651 | 46451 |
| 8L-3S | | MI | 26227 | 7712 | 43318 | 5568 | 47635 | 4510 | 49811 | 3679 | 52146 | 2387 | 62549 | 1993 | 39966 |
| 18-#14 | 2.84 | MA | 28518 | 7712 | 46164 | 5702 | 49826 | 4618 | 50659 | 3765 | 50300 | 2495 | 60727 | 1573 | 45131 |
| 9L-2S | | MI | 27137 | 7712 | 44695 | 5574 | 49399 | 4494 | 51964 | 3665 | 55017 | 2375 | 66341 | 2117 | 39993 |
| 18-#18 | 5.04 | MA | 33339 | 8802 | 57661 | 6310 | 64205 | 5058 | 68157 | 4016 | 73931 | 2370 | 92320 | 1284 | 79864 |
| 6L-5S | | MI | 27430 | 8802 | 47934 | 6215 | 53358 | 4980 | 56585 | 3940 | 61020 | 2221 | 75266 | 1234 | 65013 |
| 18-#18 | 5.04 | MA | 32187 | 8802 | 55411 | 6345 | 61492 | 5090 | 64821 | 4043 | 69505 | 2392 | 86342 | 1053 | 77089 |
| 7L-4S | | MI | 28418 | 8802 | 49651 | 6229 | 55583 | 4955 | 59295 | 3918 | 64812 | 2243 | 79741 | 1330 | 66541 |
| 20-#11 | 2.18 | MA | 30953 | 7391 | 49582 | 5485 | 54374 | 4441 | 56295 | 3654 | 58061 | 2509 | 69880 | 2144 | 39417 |
| 4L-8S | | MI | 23274 | 7391 | 37455 | 5405 | 40150 | 4385 | 40735 | 3617 | 40119 | 2446 | 47563 | 1815 | 30165 |
| 20-#11 | 2.18 | MA | 30436 | 7391 | 48713 | 5482 | 53247 | 4437 | 54911 | 3666 | 56055 | 2502 | 67478 | 2102 | 39321 |
| 5L-7S | | MI | 23650 | 7391 | 38089 | 5409 | 41011 | 4391 | 41754 | 3607 | 41578 | 2454 | 49280 | 1860 | 30488 |
| 20-#11 | 2.18 | MA | 29944 | 7391 | 47898 | 5479 | 52119 | 4451 | 53532 | 3661 | 54238 | 2511 | 65195 | 2046 | 38754 |
| 6E | | MI | 24031 | 7391 | 38793 | 5396 | 41860 | 4379 | 42798 | 3598 | 42949 | 2446 | 51126 | 1951 | 30790 |
| 20-#11 | 2.18 | MA | 29464 | 7391 | 47006 | 5494 | 51043 | 4447 | 52209 | 3673 | 52463 | 2521 | 62759 | 1956 | 38291 |
| 7L-5S | | MI | 24422 | 7391 | 39436 | 5400 | 42750 | 4385 | 43885 | 3605 | 44352 | 2437 | 52851 | 2007 | 31227 |
| 20-#11 | 2.18 | MA | 28991 | 7391 | 46205 | 5492 | 49951 | 4460 | 50917 | 3685 | 50576 | 2513 | 60513 | 1907 | 37850 |
| 8L-4S | | MI | 24832 | 7391 | 40121 | 5404 | 43638 | 4373 | 44975 | 3595 | 45901 | 2446 | 54689 | 2046 | 31268 |
| 20-#11 | 2.18 | MA | 28508 | 7391 | 45341 | 5506 | 48889 | 4456 | 49567 | 3680 | 48817 | 2522 | 58300 | 1854 | 37108 |
| 9L-3S | | MI | 25290 | 7391 | 40911 | 5391 | 44644 | 4379 | 46199 | 3602 | 47447 | 2437 | 56422 | 2132 | 31277 |
| 20-#11 | 2.18 | MA | 27986 | 7391 | 44542 | 5504 | 47812 | 4470 | 48282 | 3692 | 47072 | 2532 | 56155 | 1792 | 36486 |
| 10L-2S | | MI | 25934 | 7391 | 41875 | 5395 | 45880 | 4368 | 47706 | 3593 | 49469 | 2428 | 59101 | 2219 | 31259 |
| 20-#14 | 3.15 | MA | 32040 | 7868 | 52765 | 5766 | 58340 | 4663 | 61085 | 3790 | 64437 | 2457 | 78801 | 1904 | 54903 |
| 5L-7S | | MI | 24530 | 7868 | 40655 | 5689 | 44199 | 4594 | 45603 | 3725 | 46684 | 2396 | 56229 | 1566 | 41932 |
| 20-#14 | 3.15 | MA | 31346 | 7868 | 51597 | 5762 | 56722 | 4657 | 59107 | 3782 | 61831 | 2469 | 75557 | 1823 | 53987 |
| 6E | | MI | 25068 | 7868 | 41663 | 5670 | 45415 | 4578 | 47168 | 3736 | 48631 | 2383 | 58841 | 1696 | 42718 |
| 20-#14 | 3.15 | MA | 30670 | 7868 | 50317 | 5782 | 55179 | 4675 | 57210 | 3799 | 59285 | 2482 | 72094 | 1693 | 52995 |
| 7L-5S | | MI | 25619 | 7868 | 42584 | 5677 | 46689 | 4587 | 48653 | 3723 | 50623 | 2371 | 61282 | 1778 | 43322 |
| 20-#14 | 3.15 | MA | 30005 | 7868 | 49167 | 5778 | 53613 | 4669 | 55357 | 3816 | 56580 | 2470 | 68895 | 1624 | 51744 |
| 8L-4S | | MI | 26197 | 7868 | 43564 | 5683 | 47960 | 4571 | 50214 | 3710 | 52823 | 2383 | 63891 | 1832 | 44137 |
| 20-#14 | 3.15 | MA | 29343 | 7868 | 47929 | 5799 | 52090 | 4688 | 53420 | 3808 | 54057 | 2483 | 65750 | 1546 | 50363 |
| 9L-3S | | MI | 26842 | 7868 | 44695 | 5665 | 49399 | 4580 | 51964 | 3721 | 55017 | 2371 | 66341 | 1957 | 44240 |
| 20-#18 | 5.60 | MA | 33580 | 9078 | 58501 | 6518 | 65453 | 5214 | 69653 | 4119 | 76032 | 2367 | 95016 | 998 | 86115 |
| 7L-5S | | MI | 28477 | 9078 | 50332 | 6388 | 56433 | 5104 | 60314 | 4014 | 65964 | 2187 | 81757 | 1162 | 72210 |
| 22-#11 | 2.40 | MA | 31011 | 7499 | 49946 | 5549 | 54828 | 4486 | 56840 | 3695 | 58680 | 2493 | 71010 | 2085 | 43132 |
| 5L-8S | | MI | 23719 | 7499 | 38419 | 5472 | 41385 | 4433 | 42242 | 3647 | 42141 | 2435 | 50241 | 1791 | 33037 |
| 22-#11 | 2.40 | MA | 30521 | 7499 | 49132 | 5547 | 53700 | 4499 | 55461 | 3690 | 56863 | 2503 | 68727 | 2029 | 42493 |
| 6L-7S | | MI | 24094 | 7499 | 39053 | 5476 | 42247 | 4439 | 43262 | 3637 | 43600 | 2444 | 51959 | 1837 | 33420 |
| 22-#11 | 2.40 | MA | 30043 | 7499 | 48240 | 5562 | 52624 | 4495 | 54138 | 3702 | 55088 | 2512 | 66292 | 1939 | 42046 |
| 7L-6S | | MI | 24474 | 7499 | 39757 | 5463 | 43096 | 4428 | 44305 | 3627 | 44971 | 2435 | 53804 | 1927 | 33709 |
| 22-#11 | 2.40 | MA | 29573 | 7499 | 47438 | 5559 | 51532 | 4509 | 52847 | 3714 | 53201 | 2504 | 64046 | 1890 | 41544 |
| 8L-5S | | MI | 24863 | 7499 | 40400 | 5467 | 43986 | 4433 | 45392 | 3634 | 46374 | 2426 | 55530 | 1984 | 34211 |
| 22-#11 | 2.40 | MA | 29092 | 7499 | 46575 | 5574 | 50471 | 4505 | 51496 | 3709 | 51442 | 2514 | 61832 | 1836 | 40822 |
| 9L-4S | | MI | 25272 | 7499 | 41085 | 5471 | 44874 | 4422 | 46483 | 3625 | 47923 | 2435 | 57368 | 2023 | 34265 |
| 22-#11 | 2.40 | MA | 28572 | 7499 | 45776 | 5571 | 49393 | 4518 | 50211 | 3721 | 49697 | 2523 | 59688 | 1775 | 40159 |
| 10L-3S | | MI | 25727 | 7499 | 41875 | 5458 | 45880 | 4427 | 47706 | 3632 | 49469 | 2426 | 59101 | 2109 | 34291 |
| 22-#11 | 2.40 | MA | 28065 | 7499 | 44990 | 5569 | 48337 | 4514 | 48877 | 3716 | 47837 | 2516 | 57498 | 1723 | 39286 |
| 11L-2S | | MI | 26369 | 7499 | 42839 | 5462 | 47116 | 4416 | 49214 | 3622 | 51491 | 2418 | 61779 | 2195 | 34280 |
| 22-#14 | 3.47 | MA | 32157 | 8023 | 53363 | 5859 | 58986 | 4726 | 61869 | 3825 | 65588 | 2457 | 80580 | 1796 | 59339 |
| 6L-7S | | MI | 25153 | 8023 | 42031 | 5786 | 45964 | 4664 | 47755 | 3767 | 49555 | 2379 | 60021 | 1530 | 46009 |
| 22-#14 | 3.47 | MA | 31485 | 8023 | 52083 | 5880 | 57442 | 4745 | 59971 | 3841 | 63042 | 2470 | 77117 | 1666 | 58257 |
| 7L-6S | | MI | 25688 | 8023 | 43039 | 5768 | 47180 | 4648 | 49320 | 3779 | 51502 | 2367 | 62633 | 1660 | 46883 |

## RECTANGULAR TIED COLUMNS 34" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

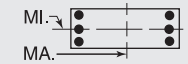
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 3.47 | MA | 30824 | 8023 | 50933 | 5875 | 55876 | 4739 | 58118 | 3858 | 60337 | 2458 | 73918 | 1597 | 57045 |
| 8L-5S | | MI | 26237 | 8023 | 43960 | 5774 | 48453 | 4657 | 50806 | 3765 | 53494 | 2354 | 65074 | 1742 | 47459 |
| 22-#14 | 3.47 | MA | 30162 | 8023 | 49695 | 5896 | 54353 | 4758 | 56181 | 3850 | 57813 | 2470 | 70772 | 1519 | 55603 |
| 9L-4S | | MI | 26812 | 8023 | 44941 | 5781 | 49724 | 4641 | 52367 | 3752 | 55694 | 2367 | 67683 | 1797 | 48384 |
| 24-#11 | 2.62 | MA | 31096 | 7606 | 50366 | 5614 | 55282 | 4547 | 57391 | 3720 | 59488 | 2494 | 72260 | 2011 | 46237 |
| 6L-8S | | MI | 24163 | 7606 | 39383 | 5539 | 42621 | 4482 | 43750 | 3676 | 44163 | 2424 | 52919 | 1768 | 35915 |
| 24-#11 | 2.62 | MA | 30620 | 7606 | 49474 | 5629 | 54206 | 4544 | 56067 | 3732 | 57713 | 2503 | 69824 | 1921 | 45803 |
| 7E | | MI | 24535 | 7606 | 40017 | 5544 | 43483 | 4488 | 44769 | 3666 | 45622 | 2433 | 54637 | 1814 | 36354 |
| 24-#11 | 2.62 | MA | 30152 | 7606 | 48672 | 5627 | 53114 | 4557 | 54776 | 3744 | 55826 | 2496 | 67578 | 1872 | 45243 |
| 8L-6S | | MI | 24914 | 7606 | 40721 | 5530 | 44332 | 4476 | 45813 | 3656 | 46993 | 2424 | 56482 | 1904 | 36632 |
| 24-#11 | 2.62 | MA | 29673 | 7606 | 47809 | 5641 | 52052 | 4553 | 53425 | 3739 | 54067 | 2505 | 65365 | 1819 | 44542 |
| 9L-5S | | MI | 25302 | 7606 | 41364 | 5534 | 45221 | 4482 | 46900 | 3664 | 48396 | 2416 | 58208 | 1961 | 37130 |
| 24-#11 | 2.62 | MA | 29155 | 7606 | 47009 | 5639 | 50975 | 4567 | 52140 | 3751 | 52322 | 2515 | 63220 | 1757 | 43836 |
| 10L-4S | | MI | 25709 | 7606 | 42049 | 5539 | 46109 | 4470 | 47990 | 3654 | 49945 | 2424 | 60046 | 1999 | 37258 |
| 24-#11 | 2.62 | MA | 28650 | 7606 | 46224 | 5636 | 49919 | 4563 | 50807 | 3746 | 50462 | 2507 | 61030 | 1706 | 42983 |
| 11L-3S | | MI | 26163 | 7606 | 42839 | 5525 | 47116 | 4476 | 49214 | 3661 | 51491 | 2416 | 61779 | 2086 | 37291 |
| 24-#14 | 3.78 | MA | 32295 | 8179 | 53848 | 5977 | 59705 | 4815 | 62732 | 3884 | 66799 | 2457 | 82140 | 1639 | 63528 |
| 7E | | MI | 25773 | 8179 | 43408 | 5883 | 47728 | 4733 | 49908 | 3810 | 52426 | 2362 | 63813 | 1494 | 50096 |
| 24-#14 | 3.78 | MA | 31637 | 8179 | 52698 | 5973 | 58140 | 4809 | 60879 | 3900 | 64093 | 2445 | 78940 | 1569 | 62352 |
| 8L-6S | | MI | 26305 | 8179 | 44416 | 5865 | 48944 | 4717 | 51473 | 3821 | 54373 | 2350 | 66425 | 1624 | 51051 |
| 24-#14 | 3.78 | MA | 30977 | 8179 | 51460 | 5993 | 56616 | 4828 | 58942 | 3892 | 61570 | 2458 | 75795 | 1492 | 60852 |
| 9L-5S | | MI | 26851 | 8179 | 45337 | 5871 | 50218 | 4727 | 52959 | 3808 | 56365 | 2338 | 68866 | 1706 | 51603 |

## RECTANGULAR TIED COLUMNS 34" x 44"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.07 | MA | 32203 | 7166 | 50027 | 5336 | 53823 | 4354 | 54557 | 3638 | 53690 | 2634 | 62543 | 2489 | 21504 |
| 2E | | MI | 24697 | 7166 | 38782 | 5224 | 41248 | 4262 | 41507 | 3556 | 40308 | 2553 | 46512 | 2389 | 16341 |
| 6-#18 | 1.60 | MA | 33725 | 7442 | 53290 | 5509 | 58006 | 4478 | 59660 | 3714 | 60613 | 2611 | 71765 | 2437 | 31789 |
| 2L-3S | | MI | 24171 | 7442 | 38782 | 5383 | 41248 | 4411 | 41507 | 3652 | 40308 | 2541 | 46512 | 2095 | 24093 |
| 6-#18 | 1.60 | MA | 31522 | 7442 | 50027 | 5501 | 53823 | 4510 | 54557 | 3742 | 53690 | 2633 | 62543 | 2216 | 31834 |
| 3L-2S | | MI | 25784 | 7442 | 41180 | 5397 | 44322 | 4386 | 45236 | 3630 | 45252 | 2519 | 53003 | 2317 | 23973 |
| 8-#14 | 1.20 | MA | 32671 | 7235 | 50792 | 5414 | 55012 | 4413 | 56085 | 3681 | 55840 | 2649 | 65639 | 2507 | 24245 |
| 2L-4S | | MI | 23453 | 7235 | 36844 | 5324 | 38968 | 4336 | 38850 | 3611 | 36987 | 2602 | 42674 | 2164 | 18534 |
| 8-#14 | 1.20 | MA | 31402 | 7235 | 48929 | 5410 | 52624 | 4408 | 53172 | 3698 | 51876 | 2662 | 60308 | 2383 | 24303 |
| 3E | | MI | 24119 | 7235 | 37974 | 5305 | 40408 | 4345 | 40599 | 3623 | 39181 | 2590 | 45123 | 2288 | 18462 |
| 8-#14 | 1.20 | MA | 30511 | 7235 | 47412 | 5431 | 50690 | 4427 | 50821 | 3691 | 48851 | 2676 | 56838 | 2258 | 24317 |
| 4L-2S | | MI | 25051 | 7235 | 39350 | 5312 | 42172 | 4329 | 42752 | 3610 | 42052 | 2578 | 48915 | 2413 | 18386 |
| 8-#18 | 2.14 | MA | 35228 | 7719 | 56553 | 5682 | 62189 | 4602 | 64763 | 3789 | 67536 | 2588 | 80987 | 2386 | 42023 |
| 2L-4S | | MI | 24114 | 7719 | 39204 | 5586 | 41805 | 4517 | 42200 | 3704 | 41475 | 2530 | 48809 | 1806 | 31462 |
| 8-#18 | 2.14 | MA | 33044 | 7719 | 53290 | 5674 | 58006 | 4635 | 59660 | 3817 | 60613 | 2610 | 71765 | 2165 | 41969 |
| 3E | | MI | 25259 | 7719 | 41180 | 5556 | 44322 | 4535 | 45236 | 3726 | 45252 | 2508 | 53003 | 2023 | 31607 |
| 8-#18 | 2.14 | MA | 31506 | 7719 | 50625 | 5710 | 54610 | 4623 | 55532 | 3802 | 55321 | 2632 | 65778 | 1943 | 41566 |
| 4L-2S | | MI | 26859 | 7719 | 43579 | 5570 | 47397 | 4510 | 48965 | 3704 | 50196 | 2485 | 59495 | 2245 | 31545 |
| 10-#11 | 1.04 | MA | 32240 | 7152 | 49763 | 5379 | 53799 | 4390 | 54646 | 3671 | 53898 | 2665 | 63155 | 2536 | 21180 |
| 2L-5S | | MI | 23209 | 7152 | 36151 | 5287 | 38168 | 4328 | 37901 | 3615 | 35634 | 2611 | 40999 | 2240 | 16260 |
| 10-#11 | 1.04 | MA | 31350 | 7152 | 48462 | 5377 | 52131 | 4387 | 52611 | 3683 | 51130 | 2675 | 59408 | 2450 | 21224 |
| 3L-4S | | MI | 23628 | 7152 | 36836 | 5291 | 39056 | 4316 | 38992 | 3605 | 37184 | 2620 | 42837 | 2279 | 16210 |
| 10-#11 | 1.04 | MA | 30726 | 7152 | 47404 | 5392 | 50782 | 4401 | 50971 | 3678 | 49020 | 2685 | 56966 | 2363 | 21260 |
| 4L-3S | | MI | 24094 | 7152 | 37626 | 5278 | 40062 | 4322 | 40215 | 3613 | 38729 | 2611 | 44570 | 2365 | 16154 |
| 10-#11 | 1.04 | MA | 30169 | 7152 | 46489 | 5390 | 49595 | 4397 | 49513 | 3691 | 46908 | 2678 | 54423 | 2321 | 21261 |
| 5L-2S | | MI | 24750 | 7152 | 38590 | 5282 | 41298 | 4310 | 41722 | 3603 | 40751 | 2602 | 47248 | 2451 | 16102 |
| 10-#14 | 1.50 | MA | 33547 | 7390 | 52655 | 5511 | 57400 | 4483 | 58999 | 3723 | 59804 | 2636 | 70970 | 2482 | 30101 |
| 2L-5S | | MI | 23498 | 7390 | 37239 | 5414 | 39462 | 4422 | 39441 | 3667 | 37657 | 2573 | 43857 | 2073 | 22831 |
| 10-#14 | 1.50 | MA | 32285 | 7390 | 50792 | 5508 | 55012 | 4478 | 56085 | 3741 | 55840 | 2650 | 65639 | 2358 | 30139 |
| 3L-4S | | MI | 24092 | 7390 | 38220 | 5421 | 40732 | 4406 | 41002 | 3654 | 39858 | 2586 | 46466 | 2128 | 22854 |
| 10-#14 | 1.50 | MA | 31399 | 7390 | 49274 | 5529 | 53078 | 4497 | 53735 | 3733 | 52815 | 2664 | 62169 | 2233 | 30108 |
| 4L-3S | | MI | 24754 | 7390 | 39350 | 5402 | 42172 | 4415 | 42752 | 3665 | 42052 | 2573 | 48915 | 2252 | 22809 |

## RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

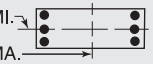
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.50 | MA | 30608 | 7390 | 47962 | 5525 | 51376 | 4491 | 51644 | 3751 | 49787 | 2652 | 58544 | 2173 | 29950 |
| 5L-2S | | MI | 25682 | 7390 | 40727 | 5409 | 43937 | 4399 | 44905 | 3652 | 44923 | 2561 | 52707 | 2377 | 22746 |
| 10-#18 | 2.67 | MA | 36714 | 7996 | 59816 | 5855 | 66372 | 4726 | 69865 | 3864 | 74459 | 2564 | 90209 | 2335 | 52218 |
| 2L-5S | | MI | 24178 | 7996 | 39885 | 5745 | 42655 | 4666 | 43218 | 3800 | 42627 | 2474 | 50825 | 1637 | 36675 |
| 10-#18 | 2.67 | MA | 34548 | 7996 | 56553 | 5847 | 62189 | 4759 | 64763 | 3893 | 67536 | 2586 | 80987 | 2113 | 52074 |
| 3L-4S | | MI | 25199 | 7996 | 41602 | 5759 | 44880 | 4641 | 45928 | 3778 | 46419 | 2496 | 55300 | 1734 | 38738 |
| 10-#18 | 2.67 | MA | 33025 | 7996 | 53888 | 5883 | 58793 | 4747 | 60635 | 3877 | 62244 | 2609 | 75000 | 1892 | 51570 |
| 4L-3S | | MI | 26336 | 7996 | 43579 | 5729 | 47397 | 4659 | 48965 | 3800 | 50196 | 2474 | 59495 | 1951 | 39067 |
| 10-#18 | 2.67 | MA | 31664 | 7996 | 51581 | 5875 | 55802 | 4779 | 56960 | 3906 | 56943 | 2586 | 68704 | 1789 | 48513 |
| 5L-2S | | MI | 27925 | 7996 | 45977 | 5743 | 50472 | 4634 | 52693 | 3778 | 55140 | 2452 | 65986 | 2173 | 39079 |
| 12-#11 | 1.25 | MA | 32857 | 7260 | 51064 | 5447 | 55467 | 4439 | 56680 | 3700 | 56667 | 2656 | 66901 | 2520 | 25275 |
| 2L-6S | | MI | 23263 | 7260 | 36472 | 5351 | 38514 | 4370 | 38322 | 3637 | 36253 | 2609 | 41951 | 2160 | 19287 |
| 12-#11 | 1.25 | MA | 31971 | 7260 | 49763 | 5445 | 53799 | 4435 | 54646 | 3712 | 53898 | 2666 | 63155 | 2433 | 25310 |
| 3L-5S | | MI | 23661 | 7260 | 37115 | 5355 | 39404 | 4376 | 39409 | 3644 | 37657 | 2600 | 43677 | 2217 | 19287 |
| 12-#11 | 1.25 | MA | 31350 | 7260 | 48705 | 5460 | 52450 | 4449 | 53006 | 3708 | 51788 | 2676 | 60713 | 2347 | 25332 |
| 4E | | MI | 24078 | 7260 | 37800 | 5359 | 40291 | 4365 | 40499 | 3635 | 39206 | 2609 | 45515 | 2256 | 19253 |
| 12-#11 | 1.25 | MA | 30795 | 7260 | 47790 | 5457 | 51263 | 4446 | 51548 | 3720 | 49676 | 2669 | 58170 | 2305 | 25306 |
| 5L-3S | | MI | 24542 | 7260 | 38590 | 5346 | 41298 | 4370 | 41722 | 3642 | 40751 | 2600 | 47248 | 2342 | 19207 |
| 12-#11 | 1.25 | MA | 30267 | 7260 | 46933 | 5455 | 50076 | 4459 | 50096 | 3716 | 47763 | 2679 | 55747 | 2249 | 25207 |
| 6L-2S | | MI | 25196 | 7260 | 39554 | 5350 | 42534 | 4359 | 43230 | 3632 | 42773 | 2592 | 49926 | 2428 | 19160 |
| 12-#14 | 1.80 | MA | 34417 | 7546 | 54518 | 5608 | 59788 | 4553 | 61912 | 3766 | 63768 | 2624 | 76302 | 2457 | 35943 |
| 2L-6S | | MI | 23571 | 7546 | 37695 | 5505 | 39953 | 4483 | 40109 | 3723 | 38536 | 2569 | 45207 | 1956 | 26298 |
| 12-#14 | 1.80 | MA | 33161 | 7546 | 52655 | 5605 | 57400 | 4547 | 58999 | 3783 | 59804 | 2638 | 70970 | 2332 | 35954 |
| 3L-5S | | MI | 24135 | 7546 | 38616 | 5512 | 41226 | 4492 | 41594 | 3710 | 40528 | 2557 | 47648 | 2037 | 27078 |
| 12-#14 | 1.80 | MA | 32280 | 7546 | 51137 | 5626 | 55466 | 4567 | 56648 | 3776 | 56779 | 2651 | 67500 | 2208 | 35884 |
| 4E | | MI | 24726 | 7546 | 39597 | 5518 | 42497 | 4476 | 43155 | 3696 | 42729 | 2569 | 50258 | 2092 | 27154 |
| 12-#14 | 1.80 | MA | 31494 | 7546 | 49825 | 5622 | 53764 | 4561 | 54557 | 3793 | 53750 | 2640 | 63875 | 2148 | 35687 |
| 5L-3S | | MI | 25384 | 7546 | 40727 | 5500 | 43937 | 4485 | 44905 | 3708 | 44923 | 2557 | 52707 | 2216 | 27137 |
| 12-#14 | 1.80 | MA | 30745 | 7546 | 48595 | 5619 | 52061 | 4580 | 52475 | 3786 | 51006 | 2654 | 60430 | 2067 | 34500 |
| 6L-2S | | MI | 26309 | 7546 | 42103 | 5506 | 45702 | 4469 | 47057 | 3694 | 47794 | 2545 | 56499 | 2341 | 27089 |
| 12-#18 | 3.21 | MA | 36036 | 8272 | 59816 | 6020 | 66372 | 4883 | 69865 | 3968 | 74459 | 2563 | 90209 | 2062 | 62160 |
| 3L-5S | | MI | 25262 | 8272 | 42283 | 5918 | 45730 | 4790 | 46947 | 3874 | 47571 | 2440 | 57316 | 1565 | 43795 |
| 12-#18 | 3.21 | MA | 34527 | 8272 | 57151 | 6056 | 62976 | 4871 | 65738 | 3953 | 69167 | 2585 | 84222 | 1840 | 61295 |
| 4E | | MI | 26275 | 8272 | 44001 | 5932 | 47954 | 4765 | 49657 | 3852 | 51363 | 2462 | 61791 | 1661 | 45710 |
| 12-#18 | 3.21 | MA | 33178 | 8272 | 54844 | 6047 | 59985 | 4903 | 62063 | 3981 | 63866 | 2563 | 77926 | 1737 | 58263 |
| 5L-3S | | MI | 27403 | 8272 | 45977 | 5902 | 50472 | 4784 | 52693 | 3874 | 55140 | 2440 | 65986 | 1879 | 46500 |
| 12-#18 | 3.21 | MA | 31896 | 8272 | 52680 | 6039 | 56989 | 4891 | 58402 | 3965 | 59061 | 2585 | 71974 | 1593 | 55918 |
| 6L-2S | | MI | 28980 | 8272 | 48375 | 5916 | 53546 | 4758 | 56422 | 3852 | 60084 | 2418 | 72477 | 2101 | 46588 |
| 14-#11 | 1.46 | MA | 33472 | 7368 | 52365 | 5514 | 57135 | 4487 | 58715 | 3729 | 59435 | 2648 | 70648 | 2503 | 29362 |
| 2L-7S | | MI | 23328 | 7368 | 36732 | 5431 | 38900 | 4430 | 38785 | 3676 | 36904 | 2607 | 42784 | 2047 | 21839 |
| 14-#11 | 1.46 | MA | 32589 | 7368 | 51064 | 5512 | 55467 | 4484 | 56680 | 3742 | 56667 | 2658 | 66901 | 2417 | 29388 |
| 3L-6S | | MI | 23714 | 7368 | 37436 | 5418 | 39750 | 4419 | 39829 | 3666 | 38275 | 2598 | 44630 | 2137 | 22199 |
| 14-#11 | 1.46 | MA | 31970 | 7368 | 50006 | 5527 | 54117 | 4497 | 55041 | 3737 | 54557 | 2668 | 64460 | 2330 | 29390 |
| 4L-5S | | MI | 24111 | 7368 | 38079 | 5422 | 40639 | 4425 | 40916 | 3674 | 39679 | 2590 | 46355 | 2194 | 22304 |
| 14-#11 | 1.46 | MA | 31418 | 7368 | 49091 | 5525 | 52931 | 4494 | 53583 | 3750 | 52445 | 2660 | 61917 | 2288 | 29344 |
| 5L-4S | | MI | 24526 | 7368 | 38764 | 5426 | 41527 | 4413 | 42007 | 3664 | 41228 | 2598 | 48193 | 2232 | 22285 |
| 14-#11 | 1.46 | MA | 30892 | 7368 | 48234 | 5523 | 51744 | 4508 | 52131 | 3745 | 50531 | 2670 | 59494 | 2233 | 29120 |
| 6L-3S | | MI | 24989 | 7368 | 39554 | 5413 | 42534 | 4419 | 43230 | 3671 | 42773 | 2590 | 49926 | 2319 | 22249 |
| 14-#11 | 1.46 | MA | 30380 | 7368 | 47295 | 5538 | 50611 | 4504 | 50738 | 3757 | 48662 | 2680 | 56910 | 2143 | 28541 |
| 7L-2S | | MI | 25640 | 7368 | 40518 | 5417 | 43769 | 4407 | 44737 | 3661 | 44795 | 2581 | 52605 | 2405 | 22208 |
| 14-#14 | 2.11 | MA | 35280 | 7702 | 56380 | 5706 | 62176 | 4623 | 64825 | 3808 | 67731 | 2612 | 81633 | 2431 | 41779 |
| 2L-7S | | MI | 23660 | 7702 | 38064 | 5621 | 40501 | 4568 | 40696 | 3754 | 39461 | 2565 | 46387 | 1789 | 29995 |
| 14-#14 | 2.11 | MA | 34031 | 7702 | 54518 | 5702 | 59788 | 4617 | 61912 | 3826 | 63768 | 2625 | 76302 | 2307 | 41753 |
| 3L-6S | | MI | 24207 | 7702 | 39072 | 5602 | 41717 | 4552 | 42261 | 3765 | 41407 | 2553 | 48999 | 1920 | 30435 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

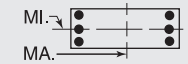
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.11 | MA | 33155 | 7702 | 53000 | 5723 | 57854 | 4637 | 59561 | 3818 | 60743 | 2639 | 72832 | 2182 | 41652 |
| 4L-5S | | MI | 24768 | 7702 | 39993 | 5609 | 42991 | 4561 | 43747 | 3752 | 43399 | 2540 | 51440 | 2002 | 31166 |
| 14-#14 | 2.11 | MA | 32373 | 7702 | 51688 | 5720 | 56152 | 4631 | 57470 | 3836 | 57714 | 2627 | 69206 | 2122 | 41278 |
| 5L-4S | | MI | 25356 | 7702 | 40973 | 5615 | 44262 | 4546 | 45308 | 3739 | 45600 | 2553 | 54050 | 2056 | 31435 |
| 14-#14 | 2.11 | MA | 31629 | 7702 | 50458 | 5716 | 54449 | 4650 | 55388 | 3828 | 54970 | 2641 | 65761 | 2042 | 40116 |
| 6L-3S | | MI | 26011 | 7702 | 42103 | 5597 | 45702 | 4555 | 47057 | 3750 | 47794 | 2540 | 56499 | 2181 | 31451 |
| 14-#14 | 2.11 | MA | 30904 | 7702 | 49111 | 5737 | 52823 | 4645 | 53390 | 3846 | 52289 | 2655 | 62085 | 1912 | 39379 |
| 7L-2S | | MI | 26932 | 7702 | 43480 | 5604 | 47466 | 4539 | 49210 | 3737 | 50665 | 2528 | 60291 | 2305 | 31418 |
| 14-#18 | 3.74 | MA | 36013 | 8549 | 60413 | 6229 | 67159 | 4995 | 70841 | 4028 | 76090 | 2562 | 93444 | 1789 | 70914 |
| 4L-5S | | MI | 26335 | 8549 | 44682 | 6091 | 48804 | 4914 | 50676 | 3948 | 52515 | 2407 | 63807 | 1493 | 50941 |
| 14-#18 | 3.74 | MA | 34677 | 8549 | 58107 | 6220 | 64168 | 5027 | 67166 | 4057 | 70789 | 2540 | 87148 | 1686 | 68041 |
| 5L-4S | | MI | 27341 | 8549 | 46399 | 6105 | 51029 | 4889 | 53386 | 3925 | 56307 | 2429 | 68283 | 1589 | 52726 |
| 14-#18 | 3.74 | MA | 33406 | 8549 | 55943 | 6212 | 61172 | 5015 | 63505 | 4041 | 65985 | 2562 | 81196 | 1542 | 65504 |
| 6L-3S | | MI | 28460 | 8549 | 48375 | 6075 | 53546 | 4908 | 56422 | 3948 | 60084 | 2407 | 72477 | 1807 | 53913 |
| 14-#18 | 3.74 | MA | 32168 | 8549 | 53573 | 6248 | 58313 | 5048 | 59991 | 4069 | 61289 | 2584 | 74839 | 1311 | 62537 |
| 7L-2S | | MI | 30028 | 8549 | 50774 | 6088 | 56621 | 4882 | 60151 | 3925 | 65028 | 2385 | 78969 | 2029 | 54057 |
| 16-#11 | 1.67 | MA | 34083 | 7475 | 53667 | 5582 | 58802 | 4536 | 60750 | 3759 | 62204 | 2639 | 74395 | 2487 | 33441 |
| 2L-8S | | MI | 23399 | 7475 | 37063 | 5495 | 39275 | 4473 | 39274 | 3716 | 37468 | 2588 | 43745 | 1978 | 24538 |
| 16-#11 | 1.67 | MA | 33203 | 7475 | 52365 | 5579 | 57135 | 4532 | 58715 | 3771 | 59435 | 2649 | 70648 | 2400 | 33458 |
| 3L-7S | | MI | 23778 | 7475 | 37696 | 5499 | 40136 | 4479 | 40293 | 3706 | 38926 | 2596 | 45463 | 2023 | 24762 |
| 16-#11 | 1.67 | MA | 32587 | 7475 | 51307 | 5594 | 55785 | 4546 | 57075 | 3767 | 57325 | 2659 | 68206 | 2314 | 33439 |
| 4L-6S | | MI | 24163 | 7475 | 38400 | 5485 | 40985 | 4467 | 41337 | 3696 | 40297 | 2588 | 47308 | 2114 | 25101 |
| 16-#11 | 1.67 | MA | 32038 | 7475 | 50392 | 5592 | 54599 | 4542 | 55618 | 3779 | 55213 | 2652 | 65663 | 2272 | 33375 |
| 5E | | MI | 24558 | 7475 | 39043 | 5490 | 41875 | 4473 | 42424 | 3703 | 41701 | 2579 | 49034 | 2170 | 25309 |
| 16-#11 | 1.67 | MA | 31514 | 7475 | 49535 | 5590 | 53411 | 4556 | 54166 | 3774 | 53300 | 2662 | 63241 | 2216 | 33044 |
| 6L-4S | | MI | 24972 | 7475 | 39728 | 5494 | 42763 | 4461 | 43514 | 3693 | 43250 | 2588 | 50872 | 2209 | 25308 |
| 16-#11 | 1.67 | MA | 31004 | 7475 | 48596 | 5605 | 52279 | 4553 | 52773 | 3787 | 51431 | 2672 | 60657 | 2126 | 32490 |
| 7L-3S | | MI | 25433 | 7475 | 40518 | 5480 | 43769 | 4467 | 44737 | 3701 | 44795 | 2579 | 52605 | 2295 | 25282 |
| 16-#11 | 1.67 | MA | 30502 | 7475 | 47752 | 5603 | 51129 | 4566 | 51413 | 3799 | 49444 | 2665 | 58279 | 2077 | 32099 |
| 8L-2S | | MI | 26082 | 7475 | 41482 | 5485 | 45005 | 4456 | 46245 | 3691 | 46817 | 2570 | 55283 | 2382 | 25247 |
| 16-#14 | 2.41 | MA | 34895 | 7857 | 56380 | 5799 | 62176 | 4687 | 64825 | 3868 | 67731 | 2613 | 81633 | 2281 | 47543 |
| 3L-7S | | MI | 24295 | 7857 | 39440 | 5718 | 42266 | 4638 | 42849 | 3796 | 42332 | 2549 | 50179 | 1753 | 34105 |
| 16-#14 | 2.41 | MA | 34024 | 7857 | 54863 | 5820 | 60242 | 4706 | 62474 | 3861 | 64706 | 2626 | 78163 | 2157 | 47413 |
| 4L-6S | | MI | 24839 | 7857 | 40448 | 5700 | 43482 | 4622 | 44414 | 3808 | 44278 | 2536 | 52791 | 1884 | 34582 |
| 16-#14 | 2.41 | MA | 33247 | 7857 | 53551 | 5817 | 58540 | 4701 | 60384 | 3878 | 61678 | 2615 | 74537 | 2097 | 46852 |
| 5E | | MI | 25397 | 7857 | 41369 | 5706 | 44756 | 4631 | 45900 | 3794 | 46270 | 2524 | 55232 | 1966 | 35270 |
| 16-#14 | 2.41 | MA | 32507 | 7857 | 52321 | 5813 | 56837 | 4720 | 58301 | 3871 | 58934 | 2629 | 71092 | 2016 | 45743 |
| 6L-4S | | MI | 25983 | 7857 | 42350 | 5713 | 46026 | 4615 | 47461 | 3781 | 48471 | 2536 | 57842 | 2020 | 35707 |
| 16-#14 | 2.41 | MA | 31786 | 7857 | 50973 | 5834 | 55211 | 4715 | 56303 | 3888 | 56252 | 2642 | 67416 | 1886 | 45030 |
| 7L-3S | | MI | 26635 | 7857 | 43480 | 5694 | 47466 | 4624 | 49210 | 3793 | 50665 | 2524 | 60291 | 2145 | 35752 |
| 16-#14 | 2.41 | MA | 31076 | 7857 | 49763 | 5831 | 53563 | 4734 | 54352 | 3905 | 53403 | 2631 | 64026 | 1816 | 43581 |
| 8L-2S | | MI | 27551 | 7857 | 44856 | 5701 | 49231 | 4609 | 51363 | 3779 | 53536 | 2511 | 64083 | 2269 | 35738 |
| 16-#18 | 4.28 | MA | 36161 | 8825 | 61369 | 6393 | 68351 | 5151 | 72269 | 4132 | 77712 | 2517 | 96370 | 1635 | 77842 |
| 5E | | MI | 27400 | 8825 | 47080 | 6264 | 51879 | 5039 | 54404 | 4021 | 57459 | 2373 | 70299 | 1421 | 58108 |
| 16-#18 | 4.28 | MA | 34901 | 8825 | 59206 | 6385 | 65355 | 5139 | 68608 | 4116 | 72908 | 2539 | 90418 | 1490 | 75119 |
| 6L-4S | | MI | 28399 | 8825 | 48798 | 6278 | 54104 | 5013 | 57114 | 3999 | 61251 | 2395 | 74774 | 1517 | 59779 |
| 16-#18 | 4.28 | MA | 33675 | 8825 | 56836 | 6421 | 62496 | 5172 | 65093 | 4145 | 68213 | 2561 | 84061 | 1259 | 72262 |
| 7L-3S | | MI | 29510 | 8825 | 50774 | 6248 | 56621 | 5032 | 60151 | 4021 | 65028 | 2373 | 78969 | 1735 | 61312 |
| 18-#11 | 1.88 | MA | 33815 | 7583 | 53667 | 5647 | 58802 | 4581 | 60750 | 3801 | 62204 | 2640 | 74395 | 2384 | 37517 |
| 3L-8S | | MI | 23849 | 7583 | 38027 | 5562 | 40510 | 4521 | 40781 | 3745 | 39490 | 2577 | 46423 | 1955 | 27472 |
| 18-#11 | 1.88 | MA | 33201 | 7583 | 52608 | 5662 | 57453 | 4594 | 59110 | 3796 | 60093 | 2650 | 71953 | 2298 | 37483 |
| 4L-7S | | MI | 24227 | 7583 | 38660 | 5566 | 41372 | 4527 | 41800 | 3735 | 40948 | 2586 | 48141 | 2000 | 27689 |
| 18-#11 | 1.88 | MA | 32654 | 7583 | 51693 | 5660 | 56267 | 4591 | 57652 | 3808 | 57981 | 2643 | 69410 | 2256 | 37403 |
| 5L-6S | | MI | 24610 | 7583 | 39364 | 5553 | 42221 | 4516 | 42844 | 3725 | 42320 | 2577 | 49986 | 2091 | 28011 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis

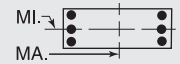



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.88 | MA | 32133 | 7583 | 50836 | 5657 | 55079 | 4605 | 56201 | 3804 | 56068 | 2653 | 66987 | 2200 | 36975 |
| 6L-5S | | MI | 25003 | 7583 | 40007 | 5557 | 43111 | 4521 | 43931 | 3733 | 43723 | 2568 | 51712 | 2147 | 28307 |
| 18-#11 | 1.88 | MA | 31625 | 7583 | 49897 | 5672 | 53946 | 4601 | 54808 | 3816 | 54199 | 2663 | 64404 | 2110 | 36443 |
| 7L-4S | | MI | 25416 | 7583 | 40692 | 5561 | 43998 | 4510 | 45022 | 3723 | 45272 | 2577 | 53550 | 2186 | 28325 |
| 18-#11 | 1.88 | MA | 31125 | 7583 | 49053 | 5670 | 52797 | 4615 | 53448 | 3829 | 52213 | 2656 | 62025 | 2061 | 36062 |
| 8L-3S | | MI | 25875 | 7583 | 41482 | 5548 | 45005 | 4516 | 46245 | 3730 | 46817 | 2568 | 55283 | 2272 | 28308 |
| 18-#11 | 1.88 | MA | 30603 | 7583 | 48228 | 5668 | 51680 | 4611 | 52026 | 3824 | 50361 | 2666 | 59676 | 2007 | 35306 |
| 9L-2S | | MI | 26522 | 7583 | 42446 | 5552 | 46241 | 4504 | 47752 | 3720 | 48839 | 2560 | 57961 | 2358 | 28280 |
| 18-#14 | 2.71 | MA | 34887 | 8013 | 56726 | 5918 | 62630 | 4776 | 65388 | 3903 | 68670 | 2614 | 83494 | 2131 | 53168 |
| 4L-7S | | MI | 24926 | 8013 | 40817 | 5815 | 44030 | 4708 | 45002 | 3839 | 45203 | 2532 | 53971 | 1718 | 38157 |
| 18-#14 | 2.71 | MA | 34114 | 8013 | 55414 | 5914 | 60928 | 4771 | 63297 | 3920 | 65642 | 2603 | 79868 | 2072 | 52440 |
| 5L-6S | | MI | 25467 | 8013 | 41825 | 5797 | 45247 | 4692 | 46567 | 3850 | 47149 | 2520 | 56583 | 1848 | 38736 |
| 18-#14 | 2.71 | MA | 33378 | 8013 | 54184 | 5910 | 59225 | 4790 | 61215 | 3913 | 62897 | 2616 | 76423 | 1991 | 51379 |
| 6L-5S | | MI | 26023 | 8013 | 42746 | 5803 | 46520 | 4701 | 48052 | 3837 | 49141 | 2507 | 59024 | 1930 | 39386 |
| 18-#14 | 2.71 | MA | 32662 | 8013 | 52836 | 5932 | 57599 | 4784 | 59216 | 3930 | 60216 | 2630 | 72747 | 1861 | 50585 |
| 7L-4S | | MI | 26605 | 8013 | 43726 | 5810 | 47791 | 4685 | 49613 | 3824 | 51342 | 2520 | 61634 | 1984 | 39970 |
| 18-#14 | 2.71 | MA | 31956 | 8013 | 51626 | 5928 | 55951 | 4804 | 57265 | 3948 | 57367 | 2619 | 69357 | 1791 | 49161 |
| 8L-3S | | MI | 27254 | 8013 | 44856 | 5792 | 49231 | 4694 | 51363 | 3835 | 53536 | 2507 | 64083 | 2109 | 40038 |
| 18-#14 | 2.71 | MA | 31229 | 8013 | 50322 | 5949 | 54347 | 4798 | 55225 | 3940 | 54710 | 2632 | 66017 | 1713 | 47895 |
| 9L-2S | | MI | 28167 | 8013 | 46233 | 5798 | 50996 | 4678 | 53516 | 3822 | 56407 | 2495 | 67875 | 2233 | 40056 |
| 18-#18 | 4.81 | MA | 36383 | 9102 | 62469 | 6558 | 69538 | 5264 | 73711 | 4192 | 79831 | 2516 | 99640 | 1439 | 84759 |
| 6L-5S | | MI | 28457 | 9102 | 49479 | 6437 | 54953 | 5163 | 58133 | 4095 | 62403 | 2340 | 76790 | 1349 | 65291 |
| 18-#18 | 4.81 | MA | 35167 | 9102 | 60099 | 6594 | 66679 | 5296 | 70196 | 4220 | 75136 | 2538 | 93283 | 1208 | 82006 |
| 7L-4S | | MI | 29449 | 9102 | 51196 | 6451 | 57178 | 5137 | 60843 | 4073 | 66195 | 2362 | 81265 | 1445 | 66861 |
| 20-#11 | 2.09 | MA | 33812 | 7691 | 53909 | 5729 | 59121 | 4643 | 61145 | 3825 | 62862 | 2642 | 75700 | 2281 | 41523 |
| 4L-8S | | MI | 24296 | 7691 | 38990 | 5629 | 41746 | 4570 | 42289 | 3774 | 41512 | 2566 | 49102 | 1931 | 30378 |
| 20-#11 | 2.09 | MA | 33267 | 7691 | 52994 | 5727 | 57935 | 4639 | 59687 | 3838 | 60750 | 2635 | 73157 | 2239 | 41427 |
| 5L-7S | | MI | 24673 | 7691 | 39624 | 5633 | 42608 | 4576 | 43308 | 3765 | 42970 | 2575 | 50819 | 1977 | 30619 |
| 20-#11 | 2.09 | MA | 32748 | 7691 | 52137 | 5725 | 56747 | 4653 | 58235 | 3833 | 58837 | 2645 | 70734 | 2183 | 40914 |
| 6E | | MI | 25055 | 7691 | 40328 | 5620 | 43457 | 4564 | 44352 | 3755 | 44342 | 2566 | 52665 | 2067 | 30926 |
| 20-#11 | 2.09 | MA | 32243 | 7691 | 51198 | 5740 | 55614 | 4649 | 56842 | 3846 | 56968 | 2655 | 68150 | 2093 | 40401 |
| 7L-5S | | MI | 25447 | 7691 | 40971 | 5624 | 44346 | 4570 | 45439 | 3762 | 45745 | 2558 | 54390 | 2124 | 31299 |
| 20-#11 | 2.09 | MA | 31745 | 7691 | 50354 | 5738 | 54465 | 4663 | 55483 | 3858 | 54981 | 2647 | 65772 | 2044 | 40028 |
| 8L-4S | | MI | 25858 | 7691 | 41656 | 5628 | 45234 | 4558 | 46529 | 3752 | 47294 | 2566 | 56228 | 2163 | 31331 |
| 20-#11 | 2.09 | MA | 31226 | 7691 | 49529 | 5735 | 53348 | 4660 | 54061 | 3853 | 53129 | 2657 | 63423 | 1990 | 39221 |
| 9L-3S | | MI | 26316 | 7691 | 42446 | 5615 | 46241 | 4564 | 47752 | 3760 | 48839 | 2558 | 57961 | 2249 | 31329 |
| 20-#11 | 2.09 | MA | 30676 | 7691 | 48605 | 5750 | 52214 | 4674 | 52708 | 3866 | 51293 | 2667 | 61146 | 1929 | 38600 |
| 10L-2S | | MI | 26961 | 7691 | 43410 | 5619 | 47477 | 4552 | 49260 | 3750 | 50861 | 2549 | 60640 | 2335 | 31307 |
| 20-#14 | 3.01 | MA | 34976 | 8168 | 57276 | 6011 | 63316 | 4840 | 66210 | 3963 | 69605 | 2590 | 85200 | 2046 | 58041 |
| 5L-7S | | MI | 25553 | 8168 | 42193 | 5912 | 45795 | 4778 | 47155 | 3881 | 48074 | 2516 | 57763 | 1682 | 42222 |
| 20-#14 | 3.01 | MA | 34245 | 8168 | 56047 | 6008 | 61613 | 4860 | 64128 | 3955 | 66861 | 2604 | 81754 | 1965 | 57023 |
| 6E | | MI | 26092 | 8168 | 43201 | 5894 | 47011 | 4762 | 48720 | 3893 | 50020 | 2503 | 60375 | 1812 | 42896 |
| 20-#14 | 3.01 | MA | 33532 | 8168 | 54699 | 6029 | 59987 | 4854 | 62129 | 3973 | 64180 | 2617 | 78079 | 1836 | 56130 |
| 7L-5S | | MI | 26645 | 8168 | 44122 | 5901 | 48285 | 4771 | 50205 | 3879 | 52012 | 2491 | 62816 | 1894 | 43514 |
| 20-#14 | 3.01 | MA | 32831 | 8168 | 53488 | 6025 | 58339 | 4873 | 60179 | 3990 | 61330 | 2606 | 74689 | 1766 | 54749 |
| 8L-4S | | MI | 27225 | 8168 | 45103 | 5907 | 49556 | 4755 | 51766 | 3866 | 54213 | 2503 | 65425 | 1949 | 44227 |
| 20-#14 | 3.01 | MA | 32121 | 8168 | 52185 | 6046 | 56735 | 4868 | 58139 | 3983 | 58673 | 2620 | 71348 | 1688 | 53421 |
| 9L-3S | | MI | 27871 | 8168 | 46233 | 5889 | 50996 | 4764 | 53516 | 3877 | 56407 | 2491 | 67875 | 2073 | 44316 |
| 20-#18 | 5.35 | MA | 36647 | 9379 | 63361 | 6767 | 70862 | 5420 | 75299 | 4296 | 82059 | 2515 | 102505 | 1157 | 91605 |
| 7L-5S | | MI | 29507 | 9379 | 51877 | 6610 | 58028 | 5287 | 61862 | 4169 | 67347 | 2306 | 83281 | 1277 | 72487 |
| 22-#11 | 2.29 | MA | 33877 | 7799 | 54296 | 5795 | 59603 | 4688 | 61722 | 3867 | 63518 | 2626 | 76903 | 2223 | 45449 |
| 5L-8S | | MI | 24742 | 7799 | 39954 | 5697 | 42982 | 4618 | 43796 | 3804 | 43534 | 2556 | 51780 | 1908 | 33249 |
| 22-#11 | 2.29 | MA | 33361 | 7799 | 53438 | 5792 | 58415 | 4701 | 60270 | 3863 | 61605 | 2636 | 74481 | 2167 | 44858 |
| 6L-7S | | MI | 25117 | 7799 | 40588 | 5701 | 43843 | 4624 | 44815 | 3794 | 44993 | 2564 | 53498 | 1954 | 33552 |
| 22-#11 | 2.29 | MA | 32857 | 7799 | 52499 | 5807 | 57282 | 4698 | 58877 | 3875 | 59736 | 2646 | 71897 | 2077 | 44363 |
| 7L-6S | | MI | 25498 | 7799 | 41292 | 5688 | 44693 | 4612 | 45859 | 3784 | 46364 | 2556 | 55343 | 2044 | 33846 |
| 22-#11 | 2.29 | MA | 32362 | 7799 | 51656 | 5805 | 56133 | 4712 | 57517 | 3888 | 57750 | 2639 | 69519 | 2028 | 43936 |
| 8L-5S | | MI | 25888 | 7799 | 41935 | 5692 | 45582 | 4618 | 46946 | 3791 | 47767 | 2547 | 57069 | 2101 | 34287 |

## RECTANGULAR TIED COLUMNS 34" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.29 | MA | 31845 | 7799 | 50830 | 5803 | 55015 | 4708 | 56096 | 3883 | 55897 | 2649 | 67169 | 1974 | 43141 |
| 9L-4S | | MI | 26298 | 7799 | 42620 | 5696 | 46470 | 4607 | 48037 | 3782 | 49316 | 2556 | 58907 | 2139 | 34330 |
| 22-#11 | 2.29 | MA | 31297 | 7799 | 49906 | 5818 | 53882 | 4722 | 54743 | 3895 | 54061 | 2659 | 64893 | 1913 | 42535 |
| 10L-3S | | MI | 26754 | 7799 | 43410 | 5683 | 47477 | 4612 | 49260 | 3789 | 50861 | 2547 | 60640 | 2226 | 34345 |
| 22-#11 | 2.29 | MA | 30763 | 7799 | 49079 | 5816 | 52770 | 4718 | 53339 | 3891 | 52103 | 2652 | 62574 | 1861 | 41579 |
| 11L-2S | | MI | 27397 | 7799 | 44374 | 5687 | 48712 | 4601 | 50767 | 3779 | 52883 | 2539 | 63318 | 2312 | 34330 |
| 22-#14 | 3.31 | MA | 35106 | 8324 | 57909 | 6105 | 64001 | 4930 | 67041 | 3998 | 70825 | 2591 | 87086 | 1940 | 62673 |
| 6L-7S | | MI | 26177 | 8324 | 43570 | 6010 | 47560 | 4848 | 49307 | 3924 | 50944 | 2499 | 61555 | 1646 | 46297 |
| 22-#14 | 3.31 | MA | 34397 | 8324 | 56562 | 6126 | 62375 | 4924 | 65043 | 4015 | 68144 | 2605 | 83410 | 1810 | 61686 |
| 7L-6S | | MI | 26714 | 8324 | 44578 | 5991 | 48776 | 4832 | 50872 | 3935 | 52891 | 2487 | 64167 | 1776 | 47061 |
| 22-#14 | 3.31 | MA | 33699 | 8324 | 55351 | 6122 | 60727 | 4943 | 63092 | 4033 | 65294 | 2594 | 80020 | 1740 | 60346 |
| 8L-5S | | MI | 27264 | 8324 | 45499 | 5998 | 50049 | 4841 | 52358 | 3922 | 54883 | 2474 | 66608 | 1858 | 47650 |
| 22-#14 | 3.31 | MA | 32990 | 8324 | 54047 | 6144 | 59123 | 4938 | 61052 | 4025 | 62637 | 2607 | 76679 | 1662 | 58957 |
| 9L-4S | | MI | 27841 | 8324 | 46479 | 6004 | 51320 | 4825 | 53919 | 3908 | 57084 | 2487 | 69217 | 1913 | 48478 |
| 24-#11 | 2.50 | MA | 33970 | 7907 | 54739 | 5860 | 60083 | 4750 | 62305 | 3892 | 64374 | 2627 | 78227 | 2150 | 48807 |
| 6L-8S | | MI | 25186 | 7907 | 40918 | 5764 | 44217 | 4667 | 45304 | 3833 | 45556 | 2545 | 54458 | 1885 | 36125 |
| 24-#11 | 2.50 | MA | 33469 | 7907 | 53800 | 5875 | 58950 | 4746 | 60912 | 3904 | 62505 | 2637 | 75643 | 2061 | 48328 |
| 7E | | MI | 25560 | 7907 | 41552 | 5768 | 45079 | 4672 | 46323 | 3823 | 47015 | 2554 | 56176 | 1931 | 36487 |
| 24-#11 | 2.50 | MA | 32975 | 7907 | 52957 | 5872 | 57801 | 4760 | 59552 | 3917 | 60518 | 2630 | 73265 | 2011 | 47840 |
| 8L-6S | | MI | 25939 | 7907 | 42256 | 5755 | 45928 | 4661 | 47367 | 3813 | 48386 | 2545 | 58021 | 2021 | 36769 |
| 24-#11 | 2.50 | MA | 32461 | 7907 | 52131 | 5870 | 56683 | 4757 | 58130 | 3912 | 58666 | 2640 | 70916 | 1958 | 47066 |
| 9L-5S | | MI | 26328 | 7907 | 42899 | 5759 | 46818 | 4667 | 48454 | 3821 | 49789 | 2537 | 59747 | 2077 | 37271 |
| 24-#11 | 2.50 | MA | 31916 | 7907 | 51207 | 5885 | 55550 | 4770 | 56778 | 3925 | 56830 | 2650 | 68640 | 1897 | 46419 |
| 10L-4S | | MI | 26736 | 7907 | 43584 | 5763 | 47706 | 4655 | 49544 | 3811 | 51338 | 2545 | 61585 | 2116 | 37326 |
| 24-#11 | 2.50 | MA | 31383 | 7907 | 50380 | 5883 | 54438 | 4767 | 55374 | 3920 | 54871 | 2643 | 66321 | 1844 | 45482 |
| 11L-3S | | MI | 27191 | 7907 | 44374 | 5750 | 48712 | 4661 | 50767 | 3818 | 52883 | 2537 | 63318 | 2202 | 37352 |
| 24-#14 | 3.61 | MA | 35257 | 8480 | 58425 | 6223 | 64763 | 4994 | 67956 | 4058 | 72107 | 2593 | 88741 | 1785 | 67252 |
| 7E | | MI | 26798 | 8480 | 44946 | 6107 | 49324 | 4917 | 51460 | 3966 | 53815 | 2483 | 65347 | 1610 | 50382 |
| 24-#14 | 3.61 | MA | 34563 | 8480 | 57214 | 6220 | 63115 | 5013 | 66005 | 4075 | 69258 | 2581 | 85351 | 1715 | 65950 |
| 8L-6S | | MI | 27332 | 8480 | 45954 | 6089 | 50541 | 4902 | 53025 | 3977 | 55762 | 2470 | 67959 | 1741 | 51230 |
| 24-#14 | 3.61 | MA | 33855 | 8480 | 55910 | 6241 | 61511 | 5008 | 63965 | 4067 | 66601 | 2595 | 82011 | 1637 | 64501 |
| 9L-5S | | MI | 27880 | 8480 | 46875 | 6095 | 51814 | 4911 | 54511 | 3964 | 57754 | 2458 | 70400 | 1822 | 51794 |

## RECTANGULAR TIED COLUMNS 34" x 46"

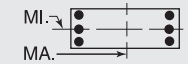
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.02 | MA | 35090 | 7466 | 54334 | 5581 | 58495 | 4555 | 59264 | 3809 | 58244 | 2767 | 67853 | 2621 | 22584 |
| 2E | | MI | 25720 | 7466 | 40327 | 5446 | 42843 | 4444 | 43055 | 3711 | 41691 | 2672 | 48036 | 2504 | 16385 |
| 6-#18 | 1.53 | MA | 36702 | 7743 | 57769 | 5753 | 62899 | 4679 | 64638 | 3884 | 65555 | 2745 | 77623 | 2573 | 33409 |
| 2L-3S | | MI | 25194 | 7743 | 40327 | 5605 | 42843 | 4594 | 43055 | 3807 | 41691 | 2660 | 48036 | 2211 | 24154 |
| 6-#18 | 1.53 | MA | 34377 | 7743 | 54334 | 5746 | 58495 | 4712 | 59264 | 3914 | 58244 | 2768 | 67853 | 2352 | 33454 |
| 3L-2S | | MI | 26808 | 7743 | 42725 | 5619 | 45918 | 4568 | 46784 | 3785 | 46635 | 2638 | 54527 | 2432 | 24027 |
| 8-#14 | 1.15 | MA | 35582 | 7535 | 55131 | 5658 | 59737 | 4614 | 60863 | 3852 | 60453 | 2780 | 71096 | 2640 | 25460 |
| 2L-4S | | MI | 24475 | 7535 | 38382 | 5547 | 40564 | 4520 | 40401 | 3768 | 38376 | 2723 | 44208 | 2280 | 18582 |
| 8-#14 | 1.15 | MA | 34244 | 7535 | 53171 | 5655 | 57224 | 4609 | 57797 | 3870 | 56282 | 2794 | 65457 | 2516 | 25518 |
| 3E | | MI | 25141 | 7535 | 39512 | 5529 | 42004 | 4529 | 42151 | 3779 | 40570 | 2710 | 46657 | 2404 | 18504 |
| 8-#14 | 1.15 | MA | 33307 | 7535 | 51577 | 5676 | 55191 | 4629 | 55327 | 3863 | 53103 | 2809 | 61782 | 2391 | 25532 |
| 4L-2S | | MI | 26075 | 7535 | 40889 | 5536 | 43768 | 4513 | 44304 | 3766 | 43441 | 2698 | 50449 | 2529 | 18426 |
| 8-#18 | 2.05 | MA | 38293 | 8019 | 61205 | 5926 | 67304 | 4803 | 70011 | 3960 | 72866 | 2723 | 87392 | 2525 | 44183 |
| 2L-4S | | MI | 25136 | 8019 | 40749 | 5808 | 43401 | 4699 | 43748 | 3859 | 42858 | 2649 | 50333 | 1921 | 31574 |
| 8-#18 | 2.05 | MA | 35989 | 8019 | 57769 | 5919 | 62899 | 4836 | 64638 | 3989 | 65555 | 2745 | 77623 | 2303 | 44129 |
| 3E | | MI | 26283 | 8019 | 42725 | 5778 | 45918 | 4718 | 46784 | 3881 | 46635 | 2627 | 54527 | 2138 | 31681 |
| 8-#18 | 2.05 | MA | 34370 | 8019 | 54967 | 5956 | 59328 | 4825 | 60297 | 3975 | 59969 | 2768 | 71272 | 2082 | 43726 |
| 4L-2S | | MI | 27885 | 8019 | 45123 | 5791 | 48992 | 4692 | 50512 | 3859 | 51579 | 2604 | 61019 | 2360 | 31605 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis

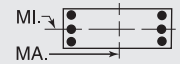



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.44 | MA | 36509 | 7691 | 57091 | 5755 | 62249 | 4684 | 63928 | 3894 | 64624 | 2768 | 76736 | 2616 | 31620 |
| 2L-5S | | MI | 24519 | 7691 | 38778 | 5638 | 41058 | 4606 | 40993 | 3824 | 39047 | 2694 | 45390 | 2189 | 22906 |
| 10-#14 | 1.44 | MA | 35178 | 7691 | 55131 | 5752 | 59737 | 4679 | 60863 | 3912 | 60453 | 2782 | 71096 | 2492 | 31658 |
| 3L-4S | | MI | 25115 | 7691 | 39759 | 5645 | 42329 | 4590 | 42554 | 3810 | 41247 | 2706 | 48000 | 2244 | 22910 |
| 10-#14 | 1.44 | MA | 34246 | 7691 | 53537 | 5774 | 57704 | 4699 | 58392 | 3905 | 57274 | 2796 | 67422 | 2367 | 31626 |
| 4L-3S | | MI | 25777 | 7691 | 40889 | 5626 | 43768 | 4599 | 44304 | 3822 | 43441 | 2694 | 50449 | 2368 | 22857 |
| 10-#14 | 1.44 | MA | 33413 | 7691 | 52158 | 5770 | 55916 | 4694 | 56195 | 3923 | 54091 | 2786 | 63593 | 2307 | 31469 |
| 5L-2S | | MI | 26707 | 7691 | 42265 | 5633 | 45533 | 4583 | 46457 | 3808 | 46312 | 2681 | 54241 | 2493 | 22791 |
| 10-#18 | 2.56 | MA | 39868 | 8296 | 64641 | 6099 | 71708 | 4927 | 75384 | 4035 | 80177 | 2701 | 97162 | 2476 | 54918 |
| 2L-5S | | MI | 25200 | 8296 | 41430 | 5967 | 44250 | 4849 | 44766 | 3955 | 44009 | 2593 | 52349 | 1752 | 36952 |
| 10-#18 | 2.56 | MA | 37582 | 8296 | 61205 | 6092 | 67304 | 4961 | 70011 | 4065 | 72866 | 2723 | 87392 | 2255 | 54774 |
| 3L-4S | | MI | 26223 | 8296 | 43147 | 5981 | 46475 | 4823 | 47476 | 3933 | 47802 | 2615 | 56824 | 1849 | 38957 |
| 10-#18 | 2.56 | MA | 35978 | 8296 | 58402 | 6129 | 63732 | 4950 | 65670 | 4050 | 67279 | 2746 | 81042 | 2033 | 54270 |
| 4L-3S | | MI | 27361 | 8296 | 45123 | 5951 | 48992 | 4842 | 50512 | 3955 | 51579 | 2593 | 61019 | 2066 | 39154 |
| 10-#18 | 2.56 | MA | 34545 | 8296 | 55978 | 6121 | 60588 | 4983 | 61807 | 4080 | 61685 | 2724 | 74384 | 1929 | 51239 |
| 5L-2S | | MI | 28953 | 8296 | 47522 | 5964 | 52067 | 4816 | 54241 | 3933 | 56523 | 2571 | 67510 | 2288 | 39145 |
| 12-#11 | 1.20 | MA | 35776 | 7560 | 55414 | 5691 | 60210 | 4640 | 61483 | 3871 | 61316 | 2787 | 72414 | 2652 | 26539 |
| 2L-6S | | MI | 24285 | 7560 | 38007 | 5575 | 40110 | 4555 | 39876 | 3794 | 37646 | 2730 | 43490 | 2277 | 19349 |
| 12-#11 | 1.20 | MA | 34842 | 7560 | 54046 | 5689 | 58456 | 4636 | 59343 | 3883 | 58404 | 2798 | 68453 | 2566 | 26574 |
| 3L-5S | | MI | 24683 | 7560 | 38650 | 5579 | 41000 | 4561 | 40962 | 3801 | 39049 | 2721 | 45216 | 2334 | 19335 |
| 12-#11 | 1.20 | MA | 34189 | 7560 | 52934 | 5704 | 57038 | 4651 | 57620 | 3879 | 56186 | 2808 | 65869 | 2480 | 26595 |
| 4E | | MI | 25101 | 7560 | 39335 | 5584 | 41888 | 4550 | 42053 | 3792 | 40599 | 2730 | 47054 | 2372 | 19295 |
| 12-#11 | 1.20 | MA | 33606 | 7560 | 51973 | 5702 | 55792 | 4647 | 56089 | 3892 | 53968 | 2802 | 63185 | 2437 | 26570 |
| 5L-3S | | MI | 25566 | 7560 | 40125 | 5570 | 42894 | 4555 | 43276 | 3799 | 42144 | 2721 | 48787 | 2459 | 19246 |
| 12-#11 | 1.20 | MA | 33051 | 7560 | 51073 | 5700 | 54545 | 4662 | 54564 | 3888 | 51958 | 2812 | 60622 | 2381 | 26479 |
| 6L-2S | | MI | 26220 | 7560 | 41089 | 5574 | 44130 | 4544 | 44784 | 3789 | 44166 | 2713 | 51465 | 2545 | 19199 |
| 12-#14 | 1.73 | MA | 37428 | 7847 | 59052 | 5853 | 64762 | 4754 | 66993 | 3937 | 68794 | 2755 | 82376 | 2592 | 37766 |
| 2L-6S | | MI | 24592 | 7847 | 39234 | 5729 | 41549 | 4667 | 41660 | 3879 | 39926 | 2690 | 46741 | 2072 | 26470 |
| 12-#14 | 1.73 | MA | 36104 | 7847 | 57091 | 5849 | 62249 | 4749 | 63928 | 3955 | 64624 | 2769 | 76736 | 2468 | 37777 |
| 3L-5S | | MI | 25157 | 7847 | 40154 | 5735 | 42822 | 4676 | 43146 | 3866 | 41918 | 2677 | 49182 | 2154 | 27175 |
| 12-#14 | 1.73 | MA | 35178 | 7847 | 55497 | 5871 | 60217 | 4769 | 61457 | 3948 | 61444 | 2784 | 73062 | 2343 | 37707 |
| 4E | | MI | 25749 | 7847 | 41135 | 5742 | 44093 | 4660 | 44707 | 3853 | 44118 | 2690 | 51792 | 2208 | 27220 |
| 12-#14 | 1.73 | MA | 34350 | 7847 | 54118 | 5868 | 58429 | 4764 | 59260 | 3966 | 58262 | 2773 | 69232 | 2283 | 37510 |
| 5L-3S | | MI | 26409 | 7847 | 42265 | 5724 | 45533 | 4669 | 46457 | 3864 | 46312 | 2677 | 54241 | 2333 | 27189 |
| 12-#14 | 1.73 | MA | 33563 | 7847 | 52827 | 5864 | 56639 | 4783 | 57073 | 3959 | 55379 | 2788 | 65586 | 2202 | 36358 |
| 6L-2S | | MI | 27334 | 7847 | 43642 | 5730 | 47298 | 4653 | 48609 | 3851 | 49183 | 2665 | 58033 | 2457 | 27137 |
| 12-#18 | 3.07 | MA | 39158 | 8573 | 64641 | 6265 | 71708 | 5085 | 75384 | 4140 | 80177 | 2701 | 97162 | 2207 | 65400 |
| 3L-5S | | MI | 26284 | 8573 | 43828 | 6140 | 47325 | 4973 | 48495 | 4029 | 48954 | 2559 | 58840 | 1680 | 44069 |
| 12-#18 | 3.07 | MA | 37568 | 8573 | 61838 | 6302 | 68137 | 5074 | 71043 | 4126 | 74590 | 2724 | 90811 | 1985 | 64808 |
| 4E | | MI | 27300 | 8573 | 45546 | 6154 | 49550 | 4947 | 51205 | 4007 | 52746 | 2582 | 63315 | 1777 | 46036 |
| 12-#18 | 3.07 | MA | 36149 | 8573 | 59414 | 6294 | 64993 | 5107 | 67180 | 4155 | 68995 | 2702 | 84154 | 1881 | 61514 |
| 5L-3S | | MI | 28430 | 8573 | 47522 | 6123 | 52067 | 4966 | 54241 | 4029 | 56523 | 2559 | 67510 | 1994 | 46595 |
| 12-#18 | 3.07 | MA | 34799 | 8573 | 57140 | 6287 | 61844 | 5096 | 63332 | 4141 | 63925 | 2725 | 77845 | 1737 | 59288 |
| 6L-2S | | MI | 30011 | 8573 | 49920 | 6137 | 55142 | 4941 | 57970 | 4007 | 61467 | 2537 | 74001 | 2216 | 46665 |
| 14-#11 | 1.40 | MA | 36426 | 7668 | 56783 | 5758 | 61965 | 4688 | 63623 | 3900 | 64228 | 2779 | 76374 | 2637 | 30836 |
| 2L-7S | | MI | 24349 | 7668 | 38267 | 5656 | 40497 | 4615 | 40339 | 3833 | 38297 | 2728 | 44323 | 2163 | 21963 |
| 14-#11 | 1.40 | MA | 35495 | 7668 | 55414 | 5756 | 60210 | 4685 | 61483 | 3913 | 61316 | 2789 | 72414 | 2550 | 30862 |
| 3L-6S | | MI | 24736 | 7668 | 38971 | 5643 | 41346 | 4604 | 41383 | 3824 | 39668 | 2719 | 46169 | 2254 | 22331 |
| 14-#11 | 1.40 | MA | 34845 | 7668 | 54302 | 5772 | 58793 | 4699 | 59760 | 3909 | 59098 | 2800 | 69830 | 2464 | 30864 |
| 4L-5S | | MI | 25133 | 7668 | 39614 | 5647 | 42236 | 4609 | 42470 | 3831 | 41071 | 2710 | 47894 | 2310 | 22357 |
| 14-#11 | 1.40 | MA | 34264 | 7668 | 53342 | 5770 | 57547 | 4696 | 58229 | 3921 | 56880 | 2793 | 67146 | 2422 | 30818 |
| 5L-4S | | MI | 25549 | 7668 | 40299 | 5651 | 43123 | 4598 | 43561 | 3821 | 42621 | 2719 | 49732 | 2349 | 22331 |
| 14-#11 | 1.40 | MA | 33712 | 7668 | 52442 | 5768 | 56300 | 4710 | 56704 | 3917 | 54870 | 2804 | 64583 | 2366 | 30675 |
| 6L-3S | | MI | 26013 | 7668 | 41089 | 5638 | 44130 | 4604 | 44784 | 3828 | 44166 | 2710 | 51465 | 2435 | 22291 |
| 14-#11 | 1.40 | MA | 33174 | 7668 | 51455 | 5783 | 55110 | 4707 | 55241 | 3930 | 52907 | 2814 | 61851 | 2276 | 30038 |
| 7L-2S | | MI | 26665 | 7668 | 42053 | 5642 | 45366 | 4592 | 46291 | 3819 | 46188 | 2702 | 54144 | 2522 | 22249 |
| 14-#14 | 2.01 | MA | 38342 | 8002 | 61012 | 5950 | 67275 | 4824 | 70059 | 3979 | 72965 | 2743 | 88016 | 2569 | 43905 |
| 2L-7S | | MI | 24681 | 8002 | 39602 | 5844 | 42097 | 4752 | 42248 | 3910 | 40850 | 2685 | 47921 | 1905 | 30165 |

## RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

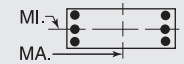
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.01 | MA | 37025 | 8002 | 59052 | 5947 | 64762 | 4819 | 66993 | 3997 | 68794 | 2757 | 82376 | 2444 | 43880 |
| 3L-6S | | MI | 25229 | 8002 | 40610 | 5826 | 43313 | 4736 | 43813 | 3922 | 42797 | 2673 | 50533 | 2036 | 30606 |
| 14-#14 | 2.01 | MA | 36103 | 8002 | 57457 | 5968 | 62729 | 4838 | 64523 | 3990 | 65615 | 2771 | 78702 | 2320 | 43778 |
| 4L-5S | | MI | 25791 | 8002 | 41531 | 5833 | 44587 | 4746 | 45299 | 3908 | 44789 | 2661 | 52974 | 2118 | 31356 |
| 14-#14 | 2.01 | MA | 35281 | 8002 | 56078 | 5965 | 60942 | 4833 | 62326 | 4008 | 62433 | 2761 | 74872 | 2259 | 43547 |
| 5L-4S | | MI | 26380 | 8002 | 42512 | 5839 | 45858 | 4730 | 46860 | 3895 | 46989 | 2673 | 55584 | 2172 | 31507 |
| 14-#14 | 2.01 | MA | 34498 | 8002 | 54787 | 5962 | 59152 | 4853 | 60138 | 4001 | 59550 | 2775 | 71226 | 2178 | 42270 |
| 6L-3S | | MI | 27037 | 8002 | 43642 | 5821 | 47298 | 4739 | 48609 | 3907 | 49183 | 2661 | 58033 | 2297 | 31508 |
| 14-#14 | 2.01 | MA | 33736 | 8002 | 53372 | 5983 | 57445 | 4848 | 58039 | 4019 | 56733 | 2790 | 67337 | 2049 | 41471 |
| 7L-2S | | MI | 27958 | 8002 | 45018 | 5827 | 49062 | 4723 | 50762 | 3893 | 52054 | 2648 | 61825 | 2421 | 31470 |
| 14-#18 | 3.58 | MA | 39142 | 8849 | 65274 | 6474 | 72541 | 5198 | 76417 | 4201 | 81901 | 2702 | 100581 | 1937 | 74992 |
| 4L-5S | | MI | 27359 | 8849 | 46227 | 6313 | 50400 | 5097 | 52223 | 4102 | 53898 | 2526 | 65332 | 1608 | 51213 |
| 14-#18 | 3.58 | MA | 37735 | 8849 | 62849 | 6467 | 69397 | 5231 | 72553 | 4231 | 76306 | 2680 | 93924 | 1832 | 71816 |
| 5L-4S | | MI | 28367 | 8849 | 47944 | 6327 | 52624 | 5071 | 54933 | 4080 | 57690 | 2548 | 69807 | 1705 | 53047 |
| 14-#18 | 3.58 | MA | 36398 | 8849 | 60576 | 6460 | 66249 | 5220 | 68705 | 4216 | 71235 | 2703 | 87614 | 1688 | 69395 |
| 6L-3S | | MI | 29490 | 8849 | 49920 | 6296 | 55142 | 5090 | 57970 | 4102 | 61467 | 2526 | 74001 | 1922 | 54016 |
| 14-#18 | 3.58 | MA | 35095 | 8849 | 58085 | 6496 | 63244 | 5253 | 65012 | 4246 | 66280 | 2725 | 80879 | 1457 | 66146 |
| 7L-2S | | MI | 31060 | 8849 | 52318 | 6310 | 58216 | 5065 | 61698 | 4080 | 66411 | 2504 | 80493 | 2144 | 54140 |
| 16-#11 | 1.60 | MA | 37072 | 7776 | 58151 | 5826 | 63719 | 4736 | 65764 | 3929 | 67140 | 2770 | 80335 | 2621 | 35126 |
| 2L-8S | | MI | 24420 | 7776 | 38598 | 5719 | 40871 | 4658 | 40827 | 3873 | 38861 | 2708 | 45284 | 2095 | 24663 |
| 16-#11 | 1.60 | MA | 36145 | 7776 | 56783 | 5824 | 61965 | 4733 | 63623 | 3942 | 64228 | 2781 | 76374 | 2535 | 35143 |
| 3L-7S | | MI | 24800 | 7776 | 39231 | 5723 | 41732 | 4664 | 41847 | 3863 | 40319 | 2717 | 47002 | 2140 | 24887 |
| 16-#11 | 1.60 | MA | 35497 | 7776 | 55671 | 5839 | 60547 | 4747 | 61900 | 3938 | 62010 | 2791 | 73791 | 2449 | 35124 |
| 4L-6S | | MI | 25186 | 7776 | 39935 | 5710 | 42582 | 4652 | 42891 | 3853 | 41690 | 2708 | 48847 | 2231 | 25233 |
| 16-#11 | 1.60 | MA | 34919 | 7776 | 54710 | 5837 | 59301 | 4744 | 60369 | 3951 | 59792 | 2784 | 71106 | 2406 | 35060 |
| 5E | | MI | 25581 | 7776 | 40578 | 5714 | 43471 | 4658 | 43977 | 3860 | 43093 | 2700 | 50573 | 2287 | 25372 |
| 16-#11 | 1.60 | MA | 34369 | 7776 | 53810 | 5835 | 58054 | 4758 | 58845 | 3947 | 57782 | 2795 | 68544 | 2350 | 34802 |
| 6L-4S | | MI | 25996 | 7776 | 41263 | 5718 | 44359 | 4646 | 45068 | 3850 | 44643 | 2708 | 52411 | 2326 | 25358 |
| 16-#11 | 1.60 | MA | 33834 | 7776 | 52824 | 5851 | 56864 | 4755 | 57382 | 3959 | 55819 | 2805 | 65812 | 2261 | 34193 |
| 7L-3S | | MI | 26457 | 7776 | 42053 | 5705 | 45366 | 4652 | 46291 | 3858 | 46188 | 2700 | 54144 | 2412 | 25327 |
| 16-#11 | 1.60 | MA | 33306 | 7776 | 51938 | 5849 | 55658 | 4769 | 55954 | 3972 | 53733 | 2799 | 63302 | 2211 | 33769 |
| 8L-2S | | MI | 27107 | 7776 | 43017 | 5709 | 46601 | 4641 | 47799 | 3848 | 48210 | 2691 | 56822 | 2498 | 25291 |
| 16-#14 | 2.30 | MA | 37939 | 8158 | 61012 | 6044 | 67275 | 4888 | 70059 | 4039 | 72965 | 2745 | 88016 | 2420 | 49973 |
| 3L-7S | | MI | 25317 | 8158 | 40978 | 5942 | 43862 | 4822 | 44401 | 3953 | 43721 | 2669 | 51713 | 1870 | 34331 |
| 16-#14 | 2.30 | MA | 37022 | 8158 | 59417 | 6066 | 65242 | 4908 | 67588 | 4032 | 69786 | 2759 | 84342 | 2296 | 49843 |
| 4L-6S | | MI | 25862 | 8158 | 41987 | 5923 | 45078 | 4806 | 45966 | 3964 | 45668 | 2656 | 54325 | 2000 | 34753 |
| 16-#14 | 2.30 | MA | 36204 | 8158 | 58039 | 6062 | 63454 | 4903 | 65391 | 4050 | 66603 | 2748 | 80512 | 2235 | 49417 |
| 5E | | MI | 26421 | 8158 | 42907 | 5930 | 46352 | 4815 | 47451 | 3951 | 47660 | 2644 | 56766 | 2082 | 35458 |
| 16-#14 | 2.30 | MA | 35426 | 8158 | 56747 | 6059 | 61665 | 4923 | 63204 | 4044 | 63720 | 2763 | 76866 | 2155 | 48194 |
| 6L-4S | | MI | 27008 | 8158 | 43888 | 5936 | 47622 | 4799 | 49012 | 3937 | 49860 | 2656 | 59376 | 2136 | 35784 |
| 16-#14 | 2.30 | MA | 34669 | 8158 | 55332 | 6081 | 59958 | 4918 | 61105 | 4061 | 60904 | 2777 | 72976 | 2025 | 47421 |
| 7L-3S | | MI | 27661 | 8158 | 45018 | 5918 | 49062 | 4809 | 50762 | 3949 | 52054 | 2644 | 61825 | 2261 | 35817 |
| 16-#14 | 2.30 | MA | 33922 | 8158 | 54060 | 6077 | 58226 | 4938 | 59056 | 4079 | 57911 | 2767 | 69396 | 1954 | 46011 |
| 8L-2S | | MI | 28578 | 8158 | 46395 | 5925 | 50827 | 4793 | 52915 | 3936 | 54925 | 2632 | 65617 | 2386 | 35792 |
| 16-#18 | 4.09 | MA | 39307 | 9126 | 66285 | 6640 | 73802 | 5355 | 77927 | 4306 | 83617 | 2658 | 103694 | 1784 | 82143 |
| 5E | | MI | 28426 | 9126 | 48625 | 6486 | 53474 | 5221 | 55952 | 4176 | 58842 | 2492 | 71823 | 1536 | 58379 |
| 16-#18 | 4.09 | MA | 37981 | 9126 | 64012 | 6632 | 70653 | 5344 | 74079 | 4292 | 78546 | 2680 | 97384 | 1640 | 79532 |
| 6L-4S | | MI | 29427 | 9126 | 50342 | 6500 | 55699 | 5196 | 58662 | 4154 | 62634 | 2514 | 76298 | 1633 | 60096 |
| 16-#18 | 4.09 | MA | 36690 | 9126 | 61521 | 6669 | 67649 | 5378 | 70385 | 4321 | 73591 | 2703 | 90649 | 1409 | 76397 |
| 7L-3S | | MI | 30542 | 9126 | 52318 | 6469 | 58216 | 5214 | 61698 | 4176 | 66411 | 2492 | 80493 | 1850 | 61422 |
| 16-#18 | 4.09 | MA | 35419 | 9126 | 59282 | 6662 | 64601 | 5367 | 66779 | 4351 | 68325 | 2681 | 84425 | 1286 | 72643 |
| 8L-2S | | MI | 32103 | 9126 | 54717 | 6483 | 61291 | 5189 | 65427 | 4154 | 71355 | 2470 | 86984 | 2072 | 61596 |
| 18-#11 | 1.80 | MA | 36791 | 7884 | 58151 | 5891 | 63719 | 4782 | 65764 | 3972 | 67140 | 2772 | 80335 | 2520 | 39413 |
| 3L-8S | | MI | 24870 | 7884 | 39562 | 5787 | 42107 | 4706 | 42335 | 3902 | 40883 | 2698 | 47962 | 2071 | 27599 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis

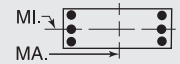


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.80 | MA | 36146 | 7884 | 57039 | 5907 | 62302 | 4796 | 64041 | 3967 | 64922 | 2782 | 77752 | 2433 | 39379 |
| 4L-7S | | MI | 25249 | 7884 | 40195 | 5791 | 42968 | 4712 | 43354 | 3892 | 42341 | 2706 | 49680 | 2117 | 27815 |
| 18-#11 | 1.80 | MA | 35571 | 7884 | 56079 | 5905 | 61056 | 4793 | 62509 | 3980 | 62703 | 2776 | 75067 | 2391 | 39298 |
| 5L-6S | | MI | 25633 | 7884 | 40899 | 5778 | 43817 | 4701 | 44398 | 3882 | 43712 | 2698 | 51525 | 2207 | 28143 |
| 18-#11 | 1.80 | MA | 35023 | 7884 | 55179 | 5903 | 59808 | 4807 | 60985 | 3976 | 60694 | 2786 | 72505 | 2335 | 38938 |
| 6L-5S | | MI | 26027 | 7884 | 41542 | 5782 | 44707 | 4706 | 45485 | 3890 | 45115 | 2689 | 53251 | 2264 | 28371 |
| 18-#11 | 1.80 | MA | 34490 | 7884 | 54192 | 5918 | 58619 | 4804 | 59522 | 3989 | 58731 | 2797 | 69773 | 2245 | 38353 |
| 7L-4S | | MI | 26440 | 7884 | 42227 | 5786 | 45595 | 4695 | 46576 | 3880 | 46665 | 2698 | 55089 | 2302 | 28378 |
| 18-#11 | 1.80 | MA | 33964 | 7884 | 53307 | 5916 | 57412 | 4818 | 58094 | 4002 | 56645 | 2790 | 67262 | 2195 | 37940 |
| 8L-3S | | MI | 26900 | 7884 | 43017 | 5773 | 46601 | 4700 | 47799 | 3887 | 48210 | 2689 | 56822 | 2389 | 28356 |
| 18-#11 | 1.80 | MA | 33407 | 7884 | 52440 | 5914 | 56239 | 4815 | 56601 | 3997 | 54700 | 2801 | 64778 | 2142 | 37225 |
| 9L-2S | | MI | 27548 | 7884 | 43981 | 5777 | 47837 | 4689 | 49306 | 3877 | 50232 | 2681 | 59500 | 2475 | 28326 |
| 18-#14 | 2.59 | MA | 37935 | 8313 | 61377 | 6163 | 67755 | 4978 | 70653 | 4075 | 73956 | 2747 | 89982 | 2272 | 55902 |
| 4L-7S | | MI | 25948 | 8313 | 42355 | 6039 | 45627 | 4892 | 46554 | 3995 | 46592 | 2652 | 55505 | 1834 | 38443 |
| 18-#14 | 2.59 | MA | 37122 | 8313 | 59999 | 6159 | 65967 | 4973 | 68457 | 4093 | 70774 | 2736 | 86152 | 2211 | 55299 |
| 5L-6S | | MI | 26491 | 8313 | 43363 | 6021 | 46843 | 4876 | 48119 | 4007 | 48538 | 2640 | 58117 | 1964 | 38907 |
| 18-#14 | 2.59 | MA | 36348 | 8313 | 58707 | 6156 | 64177 | 4993 | 66269 | 4086 | 67891 | 2750 | 82506 | 2131 | 54127 |
| 6L-5S | | MI | 27048 | 8313 | 44284 | 6027 | 48116 | 4885 | 49604 | 3993 | 50531 | 2628 | 60558 | 2046 | 39574 |
| 18-#14 | 2.59 | MA | 35595 | 8313 | 57292 | 6178 | 62470 | 4988 | 64170 | 4104 | 65075 | 2765 | 78616 | 2001 | 53377 |
| 7L-4S | | MI | 27631 | 8313 | 45265 | 6034 | 49387 | 4869 | 51165 | 3980 | 52731 | 2640 | 63167 | 2101 | 40052 |
| 18-#14 | 2.59 | MA | 34853 | 8313 | 56020 | 6175 | 60739 | 5008 | 62121 | 4122 | 62081 | 2754 | 75036 | 1930 | 51887 |
| 8L-3S | | MI | 28282 | 8313 | 46395 | 6015 | 50827 | 4878 | 52915 | 3991 | 54925 | 2628 | 65617 | 2225 | 40107 |
| 18-#14 | 2.59 | MA | 34074 | 8313 | 54776 | 6171 | 59054 | 5002 | 59978 | 4115 | 59290 | 2769 | 71500 | 1852 | 50687 |
| 9L-2S | | MI | 29196 | 8313 | 47771 | 6022 | 52592 | 4862 | 55068 | 3978 | 57796 | 2615 | 69409 | 2350 | 40106 |
| 18-#18 | 4.60 | MA | 39550 | 9403 | 67447 | 6805 | 75058 | 5468 | 79452 | 4367 | 85857 | 2658 | 107154 | 1592 | 89695 |
| 6L-5S | | MI | 29485 | 9403 | 51023 | 6659 | 56549 | 5345 | 59681 | 4250 | 63786 | 2459 | 78314 | 1464 | 65561 |
| 18-#18 | 4.60 | MA | 38270 | 9403 | 64957 | 6842 | 72053 | 5502 | 75758 | 4397 | 80901 | 2681 | 100419 | 1361 | 86668 |
| 7L-4S | | MI | 30479 | 9403 | 52741 | 6673 | 58774 | 5320 | 62391 | 4228 | 67578 | 2481 | 82789 | 1560 | 67174 |
| 18-#18 | 4.60 | MA | 37010 | 9403 | 62718 | 6835 | 69006 | 5491 | 72152 | 4426 | 75636 | 2659 | 94195 | 1238 | 82804 |
| 8L-3S | | MI | 31586 | 9403 | 54717 | 6642 | 61291 | 5338 | 65427 | 4250 | 71355 | 2459 | 86984 | 1778 | 68816 |
| 20-#11 | 1.99 | MA | 36792 | 7992 | 58408 | 5974 | 64056 | 4844 | 66181 | 3997 | 67834 | 2774 | 81713 | 2418 | 43629 |
| 4L-8S | | MI | 25319 | 7992 | 40525 | 5854 | 43342 | 4755 | 43842 | 3932 | 42905 | 2687 | 50641 | 2048 | 30536 |
| 20-#11 | 1.99 | MA | 36219 | 7992 | 57447 | 5972 | 62810 | 4841 | 64650 | 4010 | 65615 | 2767 | 79028 | 2375 | 43533 |
| 5L-7S | | MI | 25696 | 7992 | 41159 | 5858 | 44204 | 4761 | 44862 | 3922 | 44363 | 2696 | 52358 | 2094 | 30746 |
| 20-#11 | 1.99 | MA | 35674 | 7992 | 56547 | 5970 | 61563 | 4855 | 63125 | 4005 | 63606 | 2778 | 76466 | 2320 | 43081 |
| 6E | | MI | 26078 | 7992 | 41863 | 5845 | 45053 | 4749 | 45906 | 3912 | 45734 | 2687 | 54204 | 2184 | 31058 |
| 20-#11 | 1.99 | MA | 35142 | 7992 | 55561 | 5985 | 60373 | 4852 | 61662 | 4018 | 61643 | 2788 | 73734 | 2230 | 42517 |
| 7L-5S | | MI | 26471 | 7992 | 42506 | 5849 | 45943 | 4755 | 46992 | 3919 | 47137 | 2679 | 55929 | 2241 | 31368 |
| 20-#11 | 1.99 | MA | 34619 | 7992 | 54675 | 5983 | 59167 | 4866 | 60234 | 4031 | 59557 | 2781 | 71223 | 2180 | 42113 |
| 8L-4S | | MI | 26883 | 7992 | 43191 | 5853 | 46830 | 4743 | 48083 | 3909 | 48687 | 2687 | 57767 | 2279 | 31392 |
| 20-#11 | 1.99 | MA | 34065 | 7992 | 53809 | 5981 | 57993 | 4863 | 58741 | 4027 | 57612 | 2792 | 68739 | 2126 | 41345 |
| 9L-3S | | MI | 27341 | 7992 | 43981 | 5840 | 47837 | 4749 | 49306 | 3917 | 50232 | 2679 | 59500 | 2366 | 31379 |
| 20-#11 | 1.99 | MA | 33487 | 7992 | 52839 | 5997 | 56803 | 4877 | 57321 | 4040 | 55684 | 2803 | 66330 | 2065 | 40671 |
| 10L-2S | | MI | 27987 | 7992 | 44945 | 5844 | 49073 | 4737 | 50814 | 3907 | 52254 | 2670 | 62179 | 2452 | 31355 |
| 20-#14 | 2.88 | MA | 38034 | 8469 | 61959 | 6257 | 68480 | 5043 | 71522 | 4135 | 74944 | 2724 | 91792 | 2187 | 61194 |
| 5L-7S | | MI | 26577 | 8469 | 43731 | 6136 | 47391 | 4962 | 48706 | 4037 | 49463 | 2636 | 59297 | 1798 | 42505 |
| 20-#14 | 2.88 | MA | 37265 | 8469 | 60667 | 6253 | 66690 | 5063 | 69334 | 4128 | 72062 | 2738 | 88146 | 2107 | 60068 |
| 6E | | MI | 27117 | 8469 | 44740 | 6118 | 48607 | 4946 | 50271 | 4049 | 51409 | 2623 | 61909 | 1928 | 43068 |
| 20-#14 | 2.88 | MA | 36515 | 8469 | 59252 | 6275 | 64983 | 5058 | 67235 | 4146 | 69245 | 2752 | 84256 | 1977 | 59288 |
| 7L-5S | | MI | 27671 | 8469 | 45660 | 6124 | 49881 | 4955 | 51757 | 4036 | 53402 | 2611 | 64350 | 2010 | 43700 |
| 20-#14 | 2.88 | MA | 35778 | 8469 | 57980 | 6272 | 63251 | 5077 | 65186 | 4164 | 66252 | 2742 | 80675 | 1906 | 57772 |
| 8L-4S | | MI | 28252 | 8469 | 46641 | 6131 | 51152 | 4939 | 53318 | 4022 | 55602 | 2623 | 66959 | 2065 | 44313 |
| 20-#14 | 2.88 | MA | 35004 | 8469 | 56737 | 6269 | 61567 | 5072 | 63044 | 4157 | 63461 | 2756 | 77140 | 1829 | 56508 |
| 9L-3S | | MI | 28899 | 8469 | 47771 | 6113 | 52592 | 4948 | 55068 | 4034 | 57796 | 2611 | 69409 | 2189 | 44389 |
| 20-#14 | 2.88 | MA | 34188 | 8469 | 55344 | 6290 | 59859 | 5092 | 61006 | 4175 | 60694 | 2771 | 73713 | 1741 | 54844 |
| 10L-2S | | MI | 29809 | 8469 | 49148 | 6119 | 54356 | 4932 | 57220 | 4020 | 60667 | 2599 | 73201 | 2314 | 44415 |
| 20-#18 | 5.12 | MA | 39836 | 9679 | 68392 | 7015 | 76458 | 5626 | 81131 | 4472 | 88212 | 2659 | 110189 | 1312 | 96956 |
| 7L-5S | | MI | 30536 | 9679 | 53422 | 6832 | 59623 | 5469 | 63409 | 4324 | 68730 | 2425 | 84806 | 1392 | 72756 |
| 20-#18 | 5.12 | MA | 38586 | 9679 | 66154 | 7008 | 73410 | 5615 | 77526 | 4502 | 82946 | 2637 | 103965 | 1189 | 92984 |
| 8L-4S | | MI | 31524 | 9679 | 55139 | 6845 | 61848 | 5444 | 66119 | 4302 | 72522 | 2447 | 89281 | 1488 | 74278 |

## RECTANGULAR TIED COLUMNS 34" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

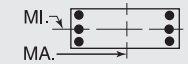
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.19 | MA | 36864 | 8100 | 58816 | 6040 | 64564 | 4890 | 66790 | 4039 | 68527 | 2759 | 82989 | 2360 | 47765 |
| 5L-8S | | MI | 25765 | 8100 | 41489 | 5922 | 44578 | 4803 | 45350 | 3961 | 44927 | 2676 | 53319 | 2025 | 33455 |
| 22-#11 | 2.19 | MA | 36321 | 8100 | 57916 | 6038 | 63317 | 4904 | 65265 | 4035 | 66518 | 2769 | 80426 | 2304 | 47231 |
| 6L-7S | | MI | 26141 | 8100 | 42123 | 5926 | 45440 | 4809 | 46369 | 3951 | 46385 | 2685 | 55037 | 2070 | 33680 |
| 22-#11 | 2.19 | MA | 35792 | 8100 | 56929 | 6053 | 62128 | 4900 | 63802 | 4048 | 64555 | 2780 | 77695 | 2214 | 46686 |
| 7L-6S | | MI | 26522 | 8100 | 42827 | 5913 | 46289 | 4797 | 47413 | 3941 | 47756 | 2676 | 56882 | 2161 | 33978 |
| 22-#11 | 2.19 | MA | 35271 | 8100 | 56044 | 6051 | 60921 | 4915 | 62375 | 4061 | 62469 | 2773 | 75184 | 2164 | 46290 |
| 8L-5S | | MI | 26913 | 8100 | 43470 | 5917 | 47178 | 4803 | 48500 | 3949 | 49159 | 2668 | 58607 | 2217 | 34359 |
| 22-#11 | 2.19 | MA | 34719 | 8100 | 55177 | 6049 | 59747 | 4911 | 60882 | 4056 | 60524 | 2783 | 72699 | 2111 | 45471 |
| 9L-4S | | MI | 27323 | 8100 | 44155 | 5921 | 48066 | 4792 | 49591 | 3939 | 50709 | 2676 | 60446 | 2256 | 34394 |
| 22-#11 | 2.19 | MA | 34143 | 8100 | 54207 | 6064 | 58557 | 4925 | 59461 | 4069 | 58596 | 2794 | 70291 | 2050 | 44813 |
| 10L-3S | | MI | 27780 | 8100 | 44945 | 5908 | 49073 | 4797 | 50814 | 3946 | 52254 | 2668 | 62179 | 2342 | 34398 |
| 22-#11 | 2.19 | MA | 33581 | 8100 | 53339 | 6062 | 57390 | 4922 | 57987 | 4065 | 56539 | 2787 | 67843 | 1997 | 43889 |
| 11L-2S | | MI | 28424 | 8100 | 45909 | 5912 | 50309 | 4786 | 52321 | 3936 | 54276 | 2659 | 64857 | 2429 | 34380 |
| 22-#14 | 3.16 | MA | 38175 | 8625 | 62627 | 6351 | 69203 | 5132 | 72400 | 4171 | 76232 | 2726 | 93785 | 2083 | 66016 |
| 6L-7S | | MI | 27201 | 8625 | 45108 | 6233 | 49156 | 5032 | 50859 | 4080 | 52334 | 2619 | 63089 | 1762 | 46577 |
| 22-#14 | 3.16 | MA | 37430 | 8625 | 61212 | 6372 | 67496 | 5127 | 70301 | 4189 | 73416 | 2740 | 89896 | 1953 | 65138 |
| 7L-6S | | MI | 27739 | 8625 | 46116 | 6215 | 50372 | 5016 | 52424 | 4091 | 54280 | 2607 | 65701 | 1893 | 47234 |
| 22-#14 | 3.16 | MA | 36697 | 8625 | 59940 | 6369 | 65764 | 5147 | 68252 | 4207 | 70422 | 2729 | 86315 | 1882 | 63665 |
| 8L-5S | | MI | 28291 | 8625 | 47037 | 6222 | 51646 | 5025 | 53910 | 4078 | 56273 | 2594 | 68142 | 1974 | 47836 |
| 22-#14 | 3.16 | MA | 35940 | 8625 | 58697 | 6366 | 64080 | 5142 | 66109 | 4200 | 67632 | 2744 | 82780 | 1805 | 62339 |
| 9L-4S | | MI | 28869 | 8625 | 48018 | 6228 | 52916 | 5009 | 55471 | 4065 | 58473 | 2607 | 70751 | 2029 | 48569 |
| 22-#14 | 3.16 | MA | 35115 | 8625 | 57304 | 6387 | 62371 | 5162 | 64071 | 4218 | 64865 | 2758 | 79353 | 1717 | 60712 |
| 10L-3S | | MI | 29514 | 8625 | 49148 | 6210 | 54356 | 5018 | 57220 | 4076 | 60667 | 2594 | 73201 | 2153 | 48664 |
| 22-#18 | 5.63 | MA | 40150 | 9956 | 69590 | 7181 | 77815 | 5739 | 82899 | 4577 | 90257 | 2615 | 113735 | 1141 | 103182 |
| 8L-5S | | MI | 31581 | 9956 | 55820 | 7005 | 62698 | 5593 | 67138 | 4398 | 73674 | 2392 | 91297 | 1320 | 79964 |
| 24-#11 | 2.39 | MA | 36965 | 8208 | 59284 | 6105 | 65071 | 4952 | 67405 | 4064 | 69430 | 2760 | 84387 | 2289 | 51386 |
| 6L-8S | | MI | 26209 | 8208 | 42453 | 5989 | 45814 | 4852 | 46857 | 3990 | 46949 | 2666 | 55997 | 2002 | 36330 |
| 24-#11 | 2.39 | MA | 36439 | 8208 | 58298 | 6120 | 63882 | 4949 | 65943 | 4077 | 67467 | 2771 | 81656 | 2199 | 50857 |
| 7E | | MI | 26584 | 8208 | 43087 | 5993 | 46675 | 4857 | 47877 | 3980 | 48407 | 2674 | 57715 | 2047 | 36615 |
| 24-#11 | 2.39 | MA | 35920 | 8208 | 57412 | 6118 | 62675 | 4963 | 64515 | 4090 | 65381 | 2764 | 79145 | 2149 | 50451 |
| 8L-6S | | MI | 26964 | 8208 | 43791 | 5980 | 47525 | 4846 | 48921 | 3971 | 49778 | 2666 | 59560 | 2138 | 36902 |
| 24-#11 | 2.39 | MA | 35371 | 8208 | 56546 | 6116 | 61502 | 4960 | 63022 | 4086 | 63436 | 2775 | 76660 | 2095 | 49602 |
| 9L-5S | | MI | 27353 | 8208 | 44434 | 5984 | 48414 | 4852 | 50007 | 3978 | 51181 | 2657 | 61286 | 2194 | 37347 |
| 24-#11 | 2.39 | MA | 34797 | 8208 | 55576 | 6132 | 60311 | 4974 | 61602 | 4098 | 61508 | 2785 | 74252 | 2035 | 48959 |
| 10L-4S | | MI | 27762 | 8208 | 45119 | 5988 | 49302 | 4840 | 51098 | 3968 | 52731 | 2666 | 63124 | 2233 | 37392 |
| 24-#11 | 2.39 | MA | 34236 | 8208 | 54707 | 6130 | 59144 | 4971 | 60128 | 4094 | 59451 | 2779 | 71804 | 1982 | 47998 |
| 11L-3S | | MI | 28218 | 8208 | 45909 | 5975 | 50309 | 4846 | 52321 | 3975 | 54276 | 2657 | 64857 | 2319 | 37413 |
| 24-#11 | 2.39 | MA | 33687 | 8208 | 53755 | 6145 | 57962 | 4985 | 58710 | 4107 | 57524 | 2789 | 69045 | 1905 | 47171 |
| 12L-2S | | MI | 28860 | 8208 | 46873 | 5979 | 51544 | 4834 | 53829 | 3966 | 56298 | 2649 | 67535 | 2405 | 37401 |
| 24-#14 | 3.45 | MA | 38340 | 8780 | 63172 | 6470 | 70008 | 5197 | 73366 | 4231 | 77586 | 2727 | 95536 | 1929 | 70998 |
| 7E | | MI | 27823 | 8780 | 46484 | 6331 | 50920 | 5102 | 53012 | 4122 | 55205 | 2603 | 66881 | 1726 | 50660 |
| 24-#14 | 3.45 | MA | 37610 | 8780 | 61901 | 6466 | 68277 | 5217 | 71317 | 4249 | 74593 | 2717 | 91955 | 1858 | 69566 |
| 8L-6S | | MI | 28359 | 8780 | 47493 | 6312 | 52137 | 5086 | 54577 | 4134 | 57151 | 2590 | 69493 | 1857 | 51403 |
| 24-#14 | 3.45 | MA | 36854 | 8780 | 60657 | 6463 | 66593 | 5212 | 69175 | 4242 | 71802 | 2731 | 88419 | 1781 | 68178 |
| 9L-5S | | MI | 28908 | 8780 | 48413 | 6319 | 53410 | 5095 | 56062 | 4120 | 59144 | 2578 | 71934 | 1939 | 51979 |
| 24-#14 | 3.45 | MA | 36037 | 8780 | 59264 | 6485 | 64884 | 5232 | 67136 | 4260 | 69035 | 2746 | 84993 | 1693 | 66587 |
| 10L-4S | | MI | 29483 | 8780 | 49394 | 6325 | 54681 | 5079 | 57623 | 4107 | 61344 | 2590 | 74543 | 1993 | 52820 |

## RECTANGULAR TIED COLUMNS 34" x 48"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.47 | MA | 39799 | 8043 | 62420 | 5998 | 67979 | 4880 | 69802 | 4055 | 70609 | 2876 | 83673 | 2708 | 35029 |
| 2L-3S | | MI | 26217 | 8043 | 41871 | 5827 | 44439 | 4776 | 44603 | 3962 | 43073 | 2779 | 49560 | 2326 | 24214 |
| 6-#18 | 1.47 | MA | 37353 | 8043 | 58811 | 5991 | 63353 | 4914 | 64158 | 4086 | 62930 | 2900 | 73355 | 2487 | 35074 |
| 3L-2S | | MI | 27832 | 8043 | 44270 | 5840 | 47513 | 4751 | 48332 | 3940 | 48018 | 2757 | 56051 | 2547 | 24079 |
| 8-#14 | 1.10 | MA | 38613 | 7836 | 59642 | 5902 | 64648 | 4815 | 65826 | 4022 | 65237 | 2911 | 76746 | 2773 | 26675 |
| 2L-4S | | MI | 25498 | 7836 | 39920 | 5771 | 42160 | 4704 | 41953 | 3924 | 39766 | 2843 | 45742 | 2396 | 18628 |
| 8-#14 | 1.10 | MA | 37206 | 7836 | 57585 | 5899 | 62011 | 4811 | 62609 | 4041 | 60859 | 2926 | 70798 | 2648 | 26733 |
| 3E | | MI | 26164 | 7836 | 41051 | 5753 | 43600 | 4713 | 43703 | 3936 | 41960 | 2830 | 48191 | 2521 | 18545 |

## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

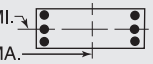
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.10 | MA | 36222 | 7836 | 55912 | 5921 | 59879 | 4831 | 60018 | 4034 | 57525 | 2941 | 66918 | 2524 | 26747 |
| 4L-2S | | MI | 27098 | 7836 | 42427 | 5759 | 45365 | 4697 | 45856 | 3922 | 44831 | 2818 | 51983 | 2645 | 18466 |
| 8-#18 | 1.96 | MA | 41480 | 8320 | 66028 | 6171 | 72605 | 5004 | 75446 | 4130 | 78288 | 2854 | 93991 | 2662 | 46343 |
| 2L-4S | | MI | 26158 | 8320 | 42294 | 6030 | 44996 | 4881 | 45295 | 4014 | 44240 | 2768 | 51857 | 2036 | 31680 |
| 8-#18 | 1.96 | MA | 39055 | 8320 | 62420 | 6164 | 67979 | 5038 | 69802 | 4161 | 70609 | 2878 | 83673 | 2441 | 46289 |
| 3E | | MI | 27307 | 8320 | 44270 | 5999 | 47513 | 4900 | 48332 | 4036 | 48018 | 2746 | 56051 | 2254 | 31750 |
| 8-#18 | 1.96 | MA | 37354 | 8320 | 59480 | 6201 | 64232 | 5028 | 65247 | 4148 | 64748 | 2902 | 76958 | 2220 | 45886 |
| 4L-2S | | MI | 28911 | 8320 | 46668 | 6013 | 50588 | 4875 | 52060 | 4014 | 52962 | 2724 | 62543 | 2475 | 31664 |
| 10-#14 | 1.38 | MA | 39590 | 7991 | 61699 | 6000 | 67286 | 4885 | 69044 | 4065 | 69614 | 2899 | 82695 | 2750 | 33139 |
| 2L-5S | | MI | 25541 | 7991 | 40316 | 5862 | 42654 | 4790 | 42545 | 3980 | 40436 | 2814 | 46924 | 2306 | 22977 |
| 10-#14 | 1.38 | MA | 38191 | 7991 | 59642 | 5997 | 64648 | 4880 | 65826 | 4083 | 65237 | 2914 | 76746 | 2626 | 33177 |
| 3L-4S | | MI | 26137 | 7991 | 41297 | 5868 | 43925 | 4774 | 44106 | 3967 | 42637 | 2826 | 49534 | 2360 | 22963 |
| 10-#14 | 1.38 | MA | 37213 | 7991 | 57970 | 6019 | 62517 | 4901 | 63235 | 4077 | 61903 | 2929 | 72867 | 2501 | 33145 |
| 4L-3S | | MI | 26800 | 7991 | 42427 | 5850 | 45365 | 4783 | 45856 | 3978 | 44831 | 2814 | 51983 | 2485 | 22903 |
| 10-#14 | 1.38 | MA | 36340 | 7991 | 56525 | 6016 | 60643 | 4896 | 60933 | 4095 | 58567 | 2919 | 68834 | 2440 | 32987 |
| 5L-2S | | MI | 27731 | 7991 | 43804 | 5857 | 47129 | 4767 | 48008 | 3965 | 47702 | 2801 | 55775 | 2609 | 22835 |
| 10-#18 | 2.45 | MA | 43143 | 8597 | 69637 | 6343 | 77232 | 5128 | 81089 | 4206 | 85966 | 2832 | 104309 | 2617 | 57618 |
| 2L-5S | | MI | 26221 | 8597 | 42975 | 6189 | 45846 | 5031 | 46314 | 4110 | 45392 | 2712 | 53873 | 1867 | 37222 |
| 10-#18 | 2.45 | MA | 40737 | 8597 | 66028 | 6337 | 72605 | 5162 | 75446 | 4236 | 78288 | 2856 | 93991 | 2395 | 57474 |
| 3L-4S | | MI | 27246 | 8597 | 44692 | 6203 | 48071 | 5006 | 49024 | 4088 | 49184 | 2734 | 58348 | 1964 | 39075 |
| 10-#18 | 2.45 | MA | 39051 | 8597 | 63088 | 6374 | 68858 | 5152 | 70891 | 4223 | 72426 | 2880 | 87277 | 2174 | 56970 |
| 4L-3S | | MI | 28386 | 8597 | 46668 | 6172 | 50588 | 5024 | 52060 | 4110 | 52962 | 2712 | 62543 | 2182 | 39238 |
| 10-#18 | 2.45 | MA | 37548 | 8597 | 60546 | 6368 | 65561 | 5186 | 66839 | 4254 | 66558 | 2859 | 80257 | 2068 | 53984 |
| 5L-2S | | MI | 29980 | 8597 | 49066 | 6186 | 53662 | 4999 | 55789 | 4088 | 57906 | 2690 | 69034 | 2403 | 39211 |
| 12-#11 | 1.15 | MA | 38816 | 7861 | 59935 | 5935 | 65141 | 4841 | 66472 | 4041 | 66135 | 2918 | 78118 | 2784 | 27802 |
| 2L-6S | | MI | 25307 | 7861 | 39542 | 5800 | 41707 | 4740 | 41429 | 3951 | 39039 | 2850 | 45029 | 2394 | 19406 |
| 12-#11 | 1.15 | MA | 37834 | 7861 | 58499 | 5933 | 63300 | 4838 | 64227 | 4054 | 63080 | 2929 | 73943 | 2698 | 27837 |
| 3L-5S | | MI | 25705 | 7861 | 40185 | 5804 | 42596 | 4746 | 42516 | 3959 | 40442 | 2842 | 46755 | 2450 | 19381 |
| 12-#11 | 1.15 | MA | 37149 | 7861 | 57333 | 5949 | 61814 | 4852 | 62420 | 4050 | 60755 | 2940 | 71218 | 2612 | 27859 |
| 4E | | MI | 26123 | 7861 | 40870 | 5808 | 43484 | 4734 | 43607 | 3949 | 41991 | 2850 | 48593 | 2489 | 19336 |
| 12-#11 | 1.15 | MA | 36537 | 7861 | 56327 | 5947 | 60509 | 4849 | 60816 | 4064 | 58430 | 2934 | 68392 | 2569 | 27833 |
| 5L-3S | | MI | 26589 | 7861 | 41660 | 5795 | 44491 | 4740 | 44830 | 3956 | 43537 | 2842 | 50326 | 2575 | 19285 |
| 12-#11 | 1.15 | MA | 35956 | 7861 | 55384 | 5946 | 59202 | 4864 | 59218 | 4060 | 56325 | 2945 | 65689 | 2513 | 27743 |
| 6L-2S | | MI | 27243 | 7861 | 42624 | 5799 | 45726 | 4729 | 46338 | 3946 | 45559 | 2833 | 53004 | 2662 | 19236 |
| 12-#14 | 1.65 | MA | 40561 | 8147 | 63757 | 6097 | 69923 | 4955 | 72261 | 4107 | 73992 | 2886 | 88644 | 2728 | 39588 |
| 2L-6S | | MI | 25614 | 8147 | 40772 | 5953 | 43145 | 4851 | 43212 | 4036 | 41315 | 2810 | 48275 | 2188 | 26636 |
| 12-#14 | 1.65 | MA | 39168 | 8147 | 61699 | 6094 | 67286 | 4950 | 69044 | 4126 | 69614 | 2901 | 82695 | 2603 | 39599 |
| 3L-5S | | MI | 26180 | 8147 | 41693 | 5959 | 44418 | 4860 | 44698 | 4022 | 43307 | 2797 | 50716 | 2270 | 27253 |
| 12-#14 | 1.65 | MA | 38195 | 8147 | 60027 | 6116 | 65154 | 4970 | 66453 | 4119 | 66280 | 2916 | 78816 | 2478 | 39529 |
| 4E | | MI | 26773 | 8147 | 42673 | 5966 | 45689 | 4844 | 46259 | 4009 | 45508 | 2810 | 53326 | 2324 | 27279 |
| 12-#14 | 1.65 | MA | 37328 | 8147 | 58583 | 6113 | 63281 | 4966 | 64150 | 4138 | 62944 | 2907 | 74783 | 2417 | 39332 |
| 5L-3S | | MI | 27433 | 8147 | 43804 | 5947 | 47129 | 4853 | 48008 | 4021 | 47702 | 2797 | 55775 | 2449 | 27241 |
| 12-#14 | 1.65 | MA | 36502 | 8147 | 57229 | 6110 | 61405 | 4986 | 61858 | 4131 | 59923 | 2922 | 70934 | 2337 | 38227 |
| 6L-2S | | MI | 28359 | 8147 | 45180 | 5954 | 48894 | 4837 | 50161 | 4007 | 50573 | 2785 | 59567 | 2573 | 27185 |
| 12-#18 | 2.94 | MA | 42401 | 8873 | 69637 | 6510 | 77232 | 5287 | 81089 | 4312 | 85966 | 2834 | 104309 | 2350 | 68640 |
| 3L-5S | | MI | 27307 | 8873 | 45373 | 6362 | 48920 | 5155 | 50043 | 4184 | 50336 | 2679 | 60364 | 1795 | 44336 |
| 12-#18 | 2.94 | MA | 40730 | 8873 | 66697 | 6547 | 73484 | 5276 | 76535 | 4298 | 80105 | 2858 | 97595 | 2128 | 68048 |
| 4E | | MI | 28324 | 8873 | 47090 | 6376 | 51145 | 5130 | 52752 | 4162 | 54128 | 2701 | 64840 | 1892 | 46355 |
| 12-#18 | 2.94 | MA | 39240 | 8873 | 64154 | 6541 | 70187 | 5311 | 72483 | 4329 | 74237 | 2837 | 90576 | 2022 | 64782 |
| 5L-3S | | MI | 29457 | 8873 | 49066 | 6345 | 53662 | 5148 | 55789 | 4184 | 57906 | 2679 | 69034 | 2110 | 46688 |
| 12-#18 | 2.94 | MA | 37823 | 8873 | 61771 | 6534 | 66886 | 5301 | 68448 | 4316 | 68919 | 2861 | 83908 | 1879 | 62695 |
| 6L-2S | | MI | 31040 | 8873 | 51465 | 6359 | 56737 | 5123 | 59517 | 4162 | 62850 | 2656 | 75525 | 2331 | 46730 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis

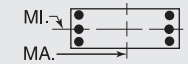



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.34 | MA | 39501 | 7969 | 61371 | 6003 | 66982 | 4889 | 68718 | 4071 | 69191 | 2910 | 82294 | 2770 | 32310 |
| 2L-7S | | MI | 25371 | 7969 | 39802 | 5881 | 42093 | 4800 | 41893 | 3990 | 39690 | 2848 | 45862 | 2280 | 22083 |
| 14-#11 | 1.34 | MA | 38523 | 7969 | 59935 | 6001 | 65141 | 4886 | 66472 | 4084 | 66135 | 2921 | 78118 | 2684 | 32336 |
| 3L-6S | | MI | 25758 | 7969 | 40506 | 5868 | 42942 | 4789 | 42937 | 3981 | 41061 | 2840 | 47708 | 2371 | 22412 |
| 14-#11 | 1.34 | MA | 37840 | 7969 | 58769 | 6016 | 63655 | 4900 | 64666 | 4080 | 63811 | 2932 | 75393 | 2597 | 32338 |
| 4L-5S | | MI | 26156 | 7969 | 41149 | 5872 | 43832 | 4794 | 44024 | 3988 | 42464 | 2831 | 49433 | 2427 | 22408 |
| 14-#11 | 1.34 | MA | 37231 | 7969 | 57763 | 6015 | 62349 | 4898 | 63061 | 4093 | 61485 | 2926 | 72567 | 2554 | 32292 |
| 5L-4S | | MI | 26572 | 7969 | 41834 | 5876 | 44720 | 4783 | 45114 | 3978 | 44013 | 2840 | 51271 | 2466 | 22376 |
| 14-#11 | 1.34 | MA | 36652 | 7969 | 56820 | 6013 | 61043 | 4912 | 61464 | 4089 | 59380 | 2936 | 69865 | 2499 | 32180 |
| 6L-3S | | MI | 27036 | 7969 | 42624 | 5863 | 45726 | 4789 | 46338 | 3985 | 45559 | 2831 | 53004 | 2552 | 22333 |
| 14-#11 | 1.34 | MA | 36088 | 7969 | 55787 | 6029 | 59796 | 4909 | 59931 | 4102 | 57323 | 2947 | 66985 | 2409 | 31541 |
| 7L-2S | | MI | 27689 | 7969 | 43588 | 5867 | 46962 | 4777 | 47845 | 3976 | 47581 | 2823 | 55683 | 2638 | 22289 |
| 14-#14 | 1.93 | MA | 41525 | 8303 | 65814 | 6194 | 72560 | 5025 | 75479 | 4150 | 78370 | 2874 | 94593 | 2705 | 46031 |
| 2L-7S | | MI | 25702 | 8303 | 41140 | 6068 | 43693 | 4936 | 43800 | 4067 | 42239 | 2806 | 49455 | 2022 | 30329 |
| 14-#14 | 1.93 | MA | 40139 | 8303 | 63757 | 6191 | 69923 | 5020 | 72261 | 4168 | 73992 | 2889 | 88644 | 2580 | 46006 |
| 3L-6S | | MI | 26251 | 8303 | 42148 | 6050 | 44910 | 4921 | 45365 | 4078 | 44186 | 2793 | 52067 | 2152 | 30773 |
| 14-#14 | 1.93 | MA | 39171 | 8303 | 62084 | 6213 | 67792 | 5040 | 69670 | 4162 | 70658 | 2904 | 84764 | 2456 | 45905 |
| 4L-5S | | MI | 26814 | 8303 | 43069 | 6056 | 46183 | 4930 | 46851 | 4065 | 46178 | 2781 | 54508 | 2234 | 31517 |
| 14-#14 | 1.93 | MA | 38309 | 8303 | 60640 | 6210 | 65918 | 5036 | 67368 | 4180 | 67322 | 2894 | 80731 | 2395 | 45673 |
| 5L-4S | | MI | 27404 | 8303 | 44050 | 6063 | 47454 | 4914 | 48411 | 4051 | 48379 | 2793 | 57118 | 2288 | 31576 |
| 14-#14 | 1.93 | MA | 37488 | 8303 | 59287 | 6207 | 64042 | 5056 | 65075 | 4174 | 64300 | 2909 | 76883 | 2314 | 44435 |
| 6L-3S | | MI | 28061 | 8303 | 45180 | 6045 | 48894 | 4923 | 50161 | 4063 | 50573 | 2781 | 59567 | 2413 | 31563 |
| 14-#14 | 1.93 | MA | 36688 | 8303 | 57803 | 6229 | 62254 | 5051 | 62875 | 4192 | 61349 | 2924 | 72781 | 2185 | 43569 |
| 7L-2S | | MI | 28984 | 8303 | 46557 | 6051 | 50658 | 4907 | 52314 | 4050 | 53443 | 2768 | 63359 | 2538 | 31521 |
| 14-#18 | 3.43 | MA | 42393 | 9150 | 70306 | 6720 | 78110 | 5401 | 82178 | 4374 | 87784 | 2836 | 107913 | 2083 | 79101 |
| 4L-5S | | MI | 28383 | 9150 | 47771 | 6535 | 51995 | 5279 | 53771 | 4257 | 55280 | 2645 | 66856 | 1723 | 51479 |
| 14-#18 | 3.43 | MA | 40915 | 9150 | 67763 | 6713 | 74813 | 5435 | 78127 | 4404 | 81916 | 2815 | 100894 | 1977 | 75611 |
| 5L-4S | | MI | 29394 | 9150 | 49489 | 6548 | 54220 | 5254 | 56481 | 4235 | 59072 | 2667 | 71331 | 1820 | 53362 |
| 14-#18 | 3.43 | MA | 39511 | 9150 | 65380 | 6707 | 71512 | 5425 | 74092 | 4391 | 76598 | 2839 | 94227 | 1833 | 73325 |
| 6L-3S | | MI | 30519 | 9150 | 51465 | 6518 | 56737 | 5273 | 59517 | 4257 | 62850 | 2645 | 75525 | 2037 | 54116 |
| 14-#18 | 3.43 | MA | 38143 | 9150 | 62769 | 6744 | 68362 | 5459 | 70219 | 4422 | 71402 | 2863 | 87112 | 1602 | 69783 |
| 7L-2S | | MI | 32092 | 9150 | 53863 | 6532 | 59812 | 5247 | 63246 | 4235 | 67794 | 2623 | 82017 | 2259 | 54221 |
| 16-#11 | 1.53 | MA | 40183 | 8077 | 62807 | 6070 | 68823 | 4937 | 70964 | 4100 | 72246 | 2901 | 86469 | 2755 | 36811 |
| 2L-8S | | MI | 25442 | 8077 | 40133 | 5944 | 42467 | 4843 | 42381 | 4030 | 40254 | 2829 | 46823 | 2211 | 24784 |
| 16-#11 | 1.53 | MA | 39208 | 8077 | 61371 | 6068 | 66982 | 4935 | 68718 | 4113 | 69191 | 2912 | 82294 | 2669 | 36828 |
| 3L-7S | | MI | 25822 | 8077 | 40766 | 5948 | 43329 | 4849 | 43401 | 4020 | 41712 | 2838 | 48541 | 2257 | 25008 |
| 16-#11 | 1.53 | MA | 38528 | 8077 | 60205 | 6084 | 65496 | 4949 | 66912 | 4109 | 66866 | 2923 | 79568 | 2583 | 36809 |
| 4L-6S | | MI | 26208 | 8077 | 41470 | 5935 | 44178 | 4837 | 44444 | 4010 | 43083 | 2829 | 50386 | 2347 | 25362 |
| 16-#11 | 1.53 | MA | 37921 | 8077 | 59199 | 6082 | 64190 | 4946 | 65307 | 4123 | 64541 | 2917 | 76742 | 2540 | 36745 |
| 5E | | MI | 26604 | 8077 | 42113 | 5939 | 45068 | 4843 | 45531 | 4017 | 44486 | 2821 | 52112 | 2404 | 25426 |
| 16-#11 | 1.53 | MA | 37345 | 8077 | 58256 | 6080 | 62883 | 4960 | 63710 | 4119 | 62435 | 2928 | 74040 | 2484 | 36569 |
| 6L-4S | | MI | 27019 | 8077 | 42798 | 5943 | 45955 | 4831 | 46622 | 4008 | 46035 | 2829 | 53950 | 2442 | 25406 |
| 16-#11 | 1.53 | MA | 36783 | 8077 | 57223 | 6096 | 61637 | 4958 | 62177 | 4132 | 60379 | 2939 | 71160 | 2394 | 35901 |
| 7L-3S | | MI | 27481 | 8077 | 43588 | 5930 | 46962 | 4837 | 47845 | 4015 | 47581 | 2821 | 55683 | 2529 | 25372 |
| 16-#11 | 1.53 | MA | 36221 | 8077 | 56295 | 6094 | 60373 | 4972 | 60681 | 4145 | 58193 | 2933 | 68517 | 2344 | 35443 |
| 8L-2S | | MI | 28132 | 8077 | 44552 | 5934 | 48198 | 4825 | 49353 | 4005 | 49603 | 2812 | 58361 | 2615 | 25333 |
| 16-#14 | 2.21 | MA | 41103 | 8458 | 65814 | 6289 | 72560 | 5090 | 75479 | 4211 | 78370 | 2876 | 94593 | 2558 | 52403 |
| 3L-7S | | MI | 26338 | 8458 | 42517 | 6165 | 45458 | 5006 | 45953 | 4109 | 45110 | 2789 | 53247 | 1986 | 34496 |
| 16-#14 | 2.21 | MA | 40141 | 8458 | 64142 | 6310 | 70429 | 5110 | 72888 | 4204 | 75036 | 2892 | 90713 | 2433 | 52273 |
| 4L-6S | | MI | 26885 | 8458 | 43525 | 6147 | 46674 | 4990 | 47518 | 4121 | 47057 | 2777 | 55859 | 2116 | 34919 |
| 16-#14 | 2.21 | MA | 39283 | 8458 | 62697 | 6308 | 68555 | 5105 | 70585 | 4223 | 71699 | 2882 | 86680 | 2372 | 51997 |
| 5E | | MI | 27445 | 8458 | 44446 | 6154 | 47948 | 4999 | 49003 | 4107 | 49049 | 2764 | 58300 | 2198 | 35642 |
| 16-#14 | 2.21 | MA | 38467 | 8458 | 61344 | 6305 | 66680 | 5126 | 68293 | 4216 | 68678 | 2897 | 82832 | 2292 | 50654 |
| 6L-4S | | MI | 28032 | 8458 | 45426 | 6160 | 49219 | 4984 | 50564 | 4094 | 51250 | 2777 | 60910 | 2253 | 35857 |
| 16-#14 | 2.21 | MA | 37672 | 8458 | 59861 | 6327 | 64891 | 5121 | 66093 | 4235 | 65726 | 2912 | 78729 | 2162 | 49818 |
| 7L-3S | | MI | 28687 | 8458 | 46557 | 6142 | 50658 | 4993 | 52314 | 4105 | 53443 | 2764 | 63359 | 2377 | 35881 |
| 16-#14 | 2.21 | MA | 36889 | 8458 | 58529 | 6324 | 63076 | 5141 | 63946 | 4253 | 62589 | 2902 | 74958 | 2091 | 48458 |
| 8L-2S | | MI | 29606 | 8458 | 47933 | 6148 | 52423 | 4977 | 54467 | 4092 | 56314 | 2752 | 67151 | 2502 | 35846 |
| 16-#18 | 3.92 | MA | 42575 | 9427 | 71372 | 6886 | 79440 | 5559 | 83770 | 4480 | 89594 | 2793 | 111212 | 1931 | 86463 |
| 5E | | MI | 29451 | 9427 | 50170 | 6708 | 55070 | 5403 | 57500 | 4331 | 60224 | 2611 | 73347 | 1651 | 58643 |

## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

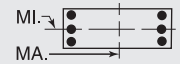
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 3.92 | MA | 41182 | 9427 | 68989 | 6880 | 76138 | 5549 | 79736 | 4466 | 84277 | 2817 | 104545 | 1787 | 83984 |
| 6L-4S | | MI | 30455 | 9427 | 51887 | 6721 | 57294 | 5378 | 60210 | 4309 | 64016 | 2633 | 77822 | 1748 | 60406 |
| 16-#18 | 3.92 | MA | 39826 | 9427 | 66377 | 6917 | 72988 | 5583 | 75863 | 4497 | 79081 | 2841 | 97431 | 1557 | 80561 |
| 7L-3S | | MI | 31573 | 9427 | 53863 | 6691 | 59812 | 5397 | 63246 | 4331 | 67794 | 2611 | 82017 | 1965 | 61529 |
| 16-#18 | 3.92 | MA | 38492 | 9427 | 64031 | 6910 | 69793 | 5573 | 72083 | 4528 | 73559 | 2821 | 90868 | 1432 | 76812 |
| 8L-2S | | MI | 33137 | 9427 | 56262 | 6705 | 62886 | 5371 | 66975 | 4309 | 72738 | 2589 | 88508 | 2187 | 61683 |
| 18-#11 | 1.72 | MA | 39889 | 8184 | 62807 | 6136 | 68823 | 4983 | 70964 | 4143 | 72246 | 2904 | 86469 | 2654 | 41308 |
| 3L-8S | | MI | 25892 | 8184 | 41097 | 6012 | 43703 | 4891 | 43889 | 4059 | 42276 | 2819 | 49501 | 2188 | 27721 |
| 18-#11 | 1.72 | MA | 39212 | 8184 | 61641 | 6151 | 67337 | 4997 | 69157 | 4139 | 69922 | 2915 | 83743 | 2568 | 41274 |
| 4L-7S | | MI | 26271 | 8184 | 41730 | 6016 | 44564 | 4897 | 44908 | 4049 | 43734 | 2827 | 51219 | 2234 | 27936 |
| 18-#11 | 1.72 | MA | 38608 | 8184 | 60635 | 6150 | 66031 | 4994 | 67553 | 4152 | 67596 | 2908 | 80917 | 2525 | 41194 |
| 5L-6S | | MI | 26656 | 8184 | 42434 | 6002 | 45414 | 4886 | 45952 | 4039 | 45105 | 2819 | 53064 | 2324 | 28272 |
| 18-#11 | 1.72 | MA | 38034 | 8184 | 59692 | 6148 | 64724 | 5009 | 65955 | 4148 | 65491 | 2919 | 78215 | 2469 | 40909 |
| 6L-5S | | MI | 27051 | 8184 | 43077 | 6007 | 46303 | 4891 | 47039 | 4047 | 46508 | 2810 | 54790 | 2381 | 28433 |
| 18-#11 | 1.72 | MA | 37475 | 8184 | 58659 | 6163 | 63478 | 5006 | 64423 | 4161 | 63434 | 2930 | 75335 | 2380 | 40267 |
| 7L-4S | | MI | 27464 | 8184 | 43762 | 6011 | 47191 | 4880 | 48129 | 4037 | 48058 | 2819 | 56628 | 2419 | 28429 |
| 18-#11 | 1.72 | MA | 36924 | 8184 | 57731 | 6162 | 62214 | 5020 | 62927 | 4174 | 61248 | 2924 | 72692 | 2329 | 39821 |
| 8L-3S | | MI | 27925 | 8184 | 44552 | 5997 | 48198 | 4885 | 49353 | 4044 | 49603 | 2810 | 58361 | 2506 | 28403 |
| 18-#11 | 1.72 | MA | 36330 | 8184 | 56824 | 6160 | 60985 | 5018 | 61363 | 4170 | 59211 | 2935 | 70072 | 2276 | 39155 |
| 9L-2S | | MI | 28574 | 8184 | 45516 | 6002 | 49433 | 4874 | 50860 | 4034 | 51625 | 2801 | 61039 | 2592 | 28370 |
| 18-#14 | 2.48 | MA | 41104 | 8614 | 66199 | 6408 | 73066 | 5180 | 76105 | 4247 | 79413 | 2879 | 96662 | 2411 | 58636 |
| 4L-7S | | MI | 26971 | 8614 | 43893 | 6263 | 47223 | 5076 | 48106 | 4151 | 47981 | 2773 | 57039 | 1950 | 38667 |
| 18-#14 | 2.48 | MA | 40251 | 8614 | 64754 | 6405 | 71193 | 5175 | 73803 | 4265 | 76077 | 2869 | 92629 | 2350 | 58172 |
| 5L-6S | | MI | 27515 | 8614 | 44902 | 6244 | 48439 | 5060 | 49671 | 4163 | 49928 | 2760 | 59651 | 2080 | 39074 |
| 18-#14 | 2.48 | MA | 39439 | 8614 | 63401 | 6402 | 69317 | 5196 | 71510 | 4259 | 73056 | 2884 | 88781 | 2269 | 56884 |
| 6L-5S | | MI | 28072 | 8614 | 45822 | 6251 | 49712 | 5069 | 51156 | 4150 | 51920 | 2748 | 62092 | 2162 | 39757 |
| 18-#14 | 2.48 | MA | 38649 | 8614 | 61918 | 6424 | 67528 | 5191 | 69310 | 4277 | 70104 | 2899 | 84678 | 2140 | 56074 |
| 7L-4S | | MI | 28657 | 8614 | 46803 | 6257 | 50983 | 5053 | 52717 | 4136 | 54121 | 2760 | 64701 | 2217 | 40130 |
| 18-#14 | 2.48 | MA | 37871 | 8614 | 60586 | 6421 | 65714 | 5211 | 67163 | 4296 | 66967 | 2890 | 80906 | 2068 | 54630 |
| 8L-3S | | MI | 29309 | 8614 | 47933 | 6239 | 52423 | 5062 | 54467 | 4148 | 56314 | 2748 | 67151 | 2341 | 40174 |
| 18-#14 | 2.48 | MA | 37041 | 8614 | 59283 | 6418 | 63949 | 5206 | 64918 | 4289 | 64042 | 2905 | 77175 | 1991 | 53409 |
| 9L-2S | | MI | 30224 | 8614 | 49310 | 6246 | 54188 | 5047 | 56619 | 4134 | 59185 | 2735 | 70943 | 2466 | 40163 |
| 18-#18 | 4.41 | MA | 42839 | 9703 | 72597 | 7053 | 80764 | 5673 | 85379 | 4542 | 91955 | 2795 | 114863 | 1742 | 94669 |
| 6L-5S | | MI | 30512 | 9703 | 52568 | 6880 | 58144 | 5528 | 61228 | 4405 | 65168 | 2578 | 79838 | 1579 | 65824 |
| 18-#18 | 4.41 | MA | 41494 | 9703 | 69986 | 7090 | 77615 | 5707 | 81506 | 4573 | 86760 | 2819 | 107749 | 1511 | 91359 |
| 7L-4S | | MI | 31509 | 9703 | 54285 | 6894 | 60369 | 5502 | 63938 | 4383 | 68960 | 2600 | 84314 | 1676 | 67481 |
| 18-#18 | 4.41 | MA | 40171 | 9703 | 67640 | 7083 | 74420 | 5697 | 77726 | 4603 | 81238 | 2799 | 101186 | 1387 | 87500 |
| 8L-3S | | MI | 32619 | 9703 | 56262 | 6864 | 62886 | 5521 | 66975 | 4405 | 72738 | 2578 | 88508 | 1893 | 68929 |
| 20-#11 | 1.91 | MA | 39893 | 8292 | 63077 | 6219 | 69177 | 5046 | 71403 | 4168 | 72977 | 2906 | 87918 | 2554 | 45735 |
| 4L-8S | | MI | 26341 | 8292 | 42061 | 6079 | 44939 | 4940 | 45396 | 4089 | 44298 | 2808 | 52180 | 2165 | 30660 |
| 20-#11 | 1.91 | MA | 39292 | 8292 | 62071 | 6217 | 67872 | 5043 | 69798 | 4181 | 70652 | 2900 | 85092 | 2511 | 45639 |
| 5L-7S | | MI | 26718 | 8292 | 42694 | 6083 | 45800 | 4945 | 46416 | 4079 | 45756 | 2816 | 53897 | 2210 | 30868 |
| 20-#11 | 1.91 | MA | 38720 | 8292 | 61128 | 6215 | 66565 | 5057 | 68201 | 4177 | 68546 | 2911 | 82390 | 2455 | 45257 |
| 6E | | MI | 27102 | 8292 | 43398 | 6070 | 46650 | 4934 | 47459 | 4069 | 47127 | 2808 | 55742 | 2301 | 31187 |
| 20-#11 | 1.91 | MA | 38163 | 8292 | 60095 | 6231 | 65319 | 5054 | 66668 | 4191 | 66490 | 2922 | 79510 | 2365 | 44638 |
| 7L-5S | | MI | 27495 | 8292 | 44041 | 6074 | 47539 | 4940 | 48546 | 4076 | 48530 | 2799 | 57468 | 2357 | 31433 |
| 20-#11 | 1.91 | MA | 37614 | 8292 | 59167 | 6229 | 64055 | 5069 | 65173 | 4204 | 64304 | 2915 | 76867 | 2315 | 44203 |
| 8L-4S | | MI | 27907 | 8292 | 44726 | 6078 | 48427 | 4928 | 49637 | 4066 | 50080 | 2808 | 59306 | 2396 | 31446 |
| 20-#11 | 1.91 | MA | 37024 | 8292 | 58260 | 6227 | 62825 | 5066 | 63608 | 4200 | 62266 | 2926 | 74247 | 2261 | 43481 |
| 9L-3S | | MI | 28367 | 8292 | 45516 | 6065 | 49433 | 4934 | 50860 | 4074 | 51625 | 2799 | 61039 | 2482 | 31429 |
| 20-#11 | 1.91 | MA | 36417 | 8292 | 57243 | 6243 | 61578 | 5080 | 62121 | 4213 | 60246 | 2937 | 71707 | 2201 | 42751 |
| 10L-2S | | MI | 29013 | 8292 | 46480 | 6069 | 50669 | 4922 | 52368 | 4064 | 53647 | 2791 | 63718 | 2569 | 31402 |
| 20-#14 | 2.76 | MA | 41213 | 8770 | 66812 | 6502 | 73830 | 5245 | 77020 | 4307 | 80455 | 2857 | 98578 | 2327 | 64361 |
| 5L-7S | | MI | 27600 | 8770 | 45270 | 6360 | 48987 | 5146 | 50258 | 4194 | 50852 | 2756 | 60831 | 1914 | 42781 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

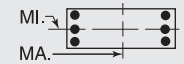
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.76 | MA | 40406 | 8770 | 65458 | 6499 | 71955 | 5265 | 74727 | 4301 | 77433 | 2872 | 94730 | 2247 | 63123 |
| 6E | | MI | 28141 | 8770 | 46278 | 6342 | 50203 | 5130 | 51823 | 4205 | 52799 | 2744 | 63443 | 2045 | 43235 |
| 20-#14 | 2.76 | MA | 39620 | 8770 | 63975 | 6521 | 70166 | 5261 | 72528 | 4320 | 74481 | 2887 | 90627 | 2117 | 62334 |
| 7L-5S | | MI | 28696 | 8770 | 47199 | 6348 | 51477 | 5139 | 53309 | 4192 | 54791 | 2731 | 65884 | 2126 | 43883 |
| 20-#14 | 2.76 | MA | 38846 | 8770 | 62643 | 6518 | 68351 | 5281 | 70381 | 4338 | 71344 | 2877 | 86855 | 2045 | 60811 |
| 8L-4S | | MI | 29279 | 8770 | 48179 | 6355 | 52748 | 5123 | 54870 | 4179 | 56992 | 2744 | 68493 | 2181 | 44396 |
| 20-#14 | 2.76 | MA | 38021 | 8770 | 61340 | 6515 | 66586 | 5276 | 68135 | 4332 | 68420 | 2892 | 83124 | 1968 | 59621 |
| 9L-3S | | MI | 29927 | 8770 | 49310 | 6336 | 54188 | 5132 | 56619 | 4190 | 59185 | 2731 | 70943 | 2305 | 44459 |
| 20-#14 | 2.76 | MA | 37164 | 8770 | 59881 | 6537 | 64796 | 5297 | 66000 | 4350 | 65520 | 2907 | 79507 | 1880 | 57814 |
| 10L-2S | | MI | 30839 | 8770 | 50686 | 6343 | 55952 | 5116 | 58772 | 4177 | 62056 | 2719 | 74735 | 2430 | 44479 |
| 20-#18 | 4.90 | MA | 43148 | 9980 | 73595 | 7263 | 82241 | 5831 | 87150 | 4648 | 94438 | 2797 | 118067 | 1465 | 102174 |
| 7L-5S | | MI | 31565 | 9980 | 54967 | 7053 | 61219 | 5652 | 64957 | 4479 | 70112 | 2544 | 86330 | 1507 | 73019 |
| 20-#18 | 4.90 | MA | 41835 | 9980 | 71248 | 7256 | 79046 | 5821 | 83370 | 4679 | 88916 | 2777 | 111504 | 1341 | 98206 |
| 8L-4S | | MI | 32556 | 9980 | 56684 | 7067 | 63444 | 5626 | 67667 | 4457 | 73904 | 2566 | 90805 | 1604 | 74581 |
| 22-#11 | 2.10 | MA | 39972 | 8400 | 63507 | 6284 | 69713 | 5091 | 72044 | 4211 | 73707 | 2891 | 89267 | 2496 | 50082 |
| 5L-8S | | MI | 26787 | 8400 | 43024 | 6146 | 46174 | 4988 | 46904 | 4118 | 46320 | 2797 | 54858 | 2142 | 33600 |
| 22-#11 | 2.10 | MA | 39402 | 8400 | 62564 | 6283 | 68406 | 5106 | 70447 | 4207 | 71602 | 2902 | 86565 | 2440 | 49612 |
| 6L-7S | | MI | 27164 | 8400 | 43658 | 6150 | 47036 | 4994 | 47923 | 4108 | 47778 | 2806 | 56575 | 2187 | 33803 |
| 22-#11 | 2.10 | MA | 38848 | 8400 | 61531 | 6298 | 67160 | 5103 | 68914 | 4220 | 69545 | 2913 | 83685 | 2351 | 49014 |
| 7L-6S | | MI | 27546 | 8400 | 44362 | 6137 | 47885 | 4982 | 48967 | 4098 | 49149 | 2797 | 58421 | 2278 | 34107 |
| 22-#11 | 2.10 | MA | 38301 | 8400 | 60603 | 6297 | 65896 | 5117 | 67418 | 4233 | 67359 | 2907 | 81042 | 2300 | 48587 |
| 8L-5S | | MI | 27938 | 8400 | 45005 | 6141 | 48775 | 4988 | 50054 | 4106 | 50552 | 2789 | 60146 | 2334 | 34428 |
| 22-#11 | 2.10 | MA | 37714 | 8400 | 59696 | 6295 | 64666 | 5114 | 65854 | 4229 | 65322 | 2918 | 78422 | 2247 | 47812 |
| 9L-4S | | MI | 28349 | 8400 | 45690 | 6145 | 49663 | 4977 | 51144 | 4096 | 52102 | 2797 | 61985 | 2373 | 34455 |
| 22-#11 | 2.10 | MA | 37109 | 8400 | 58679 | 6310 | 63419 | 5129 | 64366 | 4243 | 63302 | 2929 | 75882 | 2186 | 47100 |
| 10L-3S | | MI | 28806 | 8400 | 46480 | 6132 | 50669 | 4982 | 52368 | 4103 | 53647 | 2789 | 63718 | 2459 | 34450 |
| 22-#11 | 2.10 | MA | 36520 | 8400 | 57770 | 6309 | 62197 | 5126 | 62822 | 4239 | 61147 | 2922 | 73304 | 2133 | 46214 |
| 11L-2S | | MI | 29451 | 8400 | 47444 | 6136 | 51905 | 4971 | 53875 | 4093 | 55669 | 2780 | 66396 | 2545 | 34429 |
| 22-#14 | 3.03 | MA | 41367 | 8925 | 67516 | 6596 | 74592 | 5335 | 77945 | 4344 | 81811 | 2859 | 100679 | 2224 | 69369 |
| 6L-7S | | MI | 28225 | 8925 | 46646 | 6457 | 50752 | 5216 | 52411 | 4236 | 53723 | 2739 | 64623 | 1878 | 46852 |
| 22-#14 | 3.03 | MA | 40585 | 8925 | 66033 | 6618 | 72803 | 5331 | 75745 | 4362 | 78859 | 2874 | 96576 | 2095 | 68599 |
| 7L-6S | | MI | 28764 | 8925 | 47655 | 6439 | 51968 | 5200 | 53976 | 4248 | 55670 | 2727 | 67235 | 2009 | 47401 |
| 22-#14 | 3.03 | MA | 39815 | 8925 | 64701 | 6615 | 70989 | 5351 | 73598 | 4381 | 75722 | 2865 | 92804 | 2023 | 67001 |
| 8L-5S | | MI | 29317 | 8925 | 48575 | 6445 | 53242 | 5209 | 55462 | 4234 | 57662 | 2715 | 69676 | 2091 | 48018 |
| 22-#14 | 3.03 | MA | 38996 | 8925 | 63398 | 6613 | 69224 | 5346 | 71353 | 4374 | 72797 | 2880 | 89073 | 1946 | 65748 |
| 9L-4S | | MI | 29897 | 8925 | 49556 | 6452 | 54512 | 5193 | 57022 | 4221 | 59863 | 2727 | 72285 | 2145 | 48656 |
| 22-#14 | 3.03 | MA | 38142 | 8925 | 61939 | 6635 | 67434 | 5366 | 69217 | 4393 | 69898 | 2895 | 85456 | 1858 | 63979 |
| 10L-3S | | MI | 30543 | 8925 | 50686 | 6434 | 55952 | 5202 | 58772 | 4233 | 62056 | 2715 | 74735 | 2270 | 48738 |
| 22-#18 | 5.39 | MA | 43486 | 10256 | 74857 | 7429 | 83672 | 5945 | 89014 | 4754 | 96595 | 2754 | 121822 | 1295 | 108930 |
| 8L-5S | | MI | 32612 | 10256 | 57365 | 7226 | 64293 | 5776 | 68686 | 4553 | 75056 | 2511 | 92821 | 1435 | 80226 |
| 24-#11 | 2.29 | MA | 40082 | 8508 | 64000 | 6350 | 70247 | 5154 | 72692 | 4236 | 74657 | 2893 | 90740 | 2426 | 53972 |
| 6L-8S | | MI | 27232 | 8508 | 43988 | 6214 | 47410 | 5037 | 48411 | 4147 | 48342 | 2787 | 57536 | 2118 | 36530 |
| 24-#11 | 2.29 | MA | 39529 | 8508 | 62967 | 6366 | 69000 | 5151 | 71160 | 4249 | 72601 | 2904 | 87860 | 2336 | 53392 |
| 7E | | MI | 27607 | 8508 | 44622 | 6218 | 48272 | 5042 | 49431 | 4138 | 49800 | 2795 | 59254 | 2164 | 36740 |
| 24-#11 | 2.29 | MA | 38985 | 8508 | 62039 | 6364 | 67736 | 5166 | 69664 | 4263 | 70415 | 2898 | 85217 | 2286 | 52974 |
| 8L-6S | | MI | 27988 | 8508 | 45326 | 6205 | 49121 | 5031 | 50474 | 4128 | 51171 | 2787 | 61099 | 2254 | 37032 |
| 24-#11 | 2.29 | MA | 38400 | 8508 | 61132 | 6362 | 66507 | 5163 | 68100 | 4259 | 68377 | 2909 | 82597 | 2232 | 52149 |
| 9L-5S | | MI | 28379 | 8508 | 45969 | 6209 | 50010 | 5036 | 51561 | 4135 | 52574 | 2778 | 62825 | 2311 | 37419 |
| 24-#11 | 2.29 | MA | 37798 | 8508 | 60115 | 6378 | 65260 | 5177 | 66612 | 4272 | 66357 | 2920 | 80057 | 2172 | 51452 |
| 10L-4S | | MI | 28788 | 8508 | 46654 | 6213 | 50898 | 5025 | 52652 | 4125 | 54124 | 2787 | 64663 | 2349 | 37456 |
| 24-#11 | 2.29 | MA | 37210 | 8508 | 59206 | 6376 | 64038 | 5174 | 65068 | 4268 | 64202 | 2914 | 77479 | 2118 | 50529 |
| 11L-3S | | MI | 29245 | 8508 | 47444 | 6200 | 51905 | 5031 | 53875 | 4132 | 55669 | 2778 | 66396 | 2436 | 37466 |
| 24-#11 | 2.29 | MA | 36634 | 8508 | 58208 | 6392 | 62799 | 5189 | 63583 | 4281 | 62183 | 2925 | 74572 | 2042 | 49643 |
| 12L-2S | | MI | 29888 | 8508 | 48408 | 6204 | 53141 | 5019 | 55383 | 4123 | 57691 | 2769 | 69074 | 2522 | 37451 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 34" x 48"

Short columns – no sidesway
Bending on major or minor axis

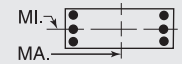



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#14 | 3.31 | MA | 41544 | 9081 | 68090 | 6716 | 75440 | 5400 | 78962 | 4404 | 83237 | 2862 | 102525 | 2072 | 74766 |
| 7E | | MI | 28848 | 9081 | 48023 | 6555 | 52517 | 5286 | 54564 | 4279 | 56594 | 2723 | 68415 | 1842 | 50932 |
| 24-#14 | 3.31 | MA | 40778 | 9081 | 66758 | 6713 | 73626 | 5421 | 76816 | 4423 | 80099 | 2852 | 98753 | 2000 | 73198 |
| 8L-6S | | MI | 29385 | 9081 | 49031 | 6536 | 53733 | 5270 | 56129 | 4290 | 58541 | 2711 | 71027 | 1973 | 51572 |
| 24-#14 | 3.31 | MA | 39975 | 9081 | 65455 | 6710 | 71861 | 5416 | 74570 | 4417 | 77175 | 2867 | 95022 | 1923 | 71883 |
| 9L-5S | | MI | 29935 | 9081 | 49952 | 6543 | 55006 | 5279 | 57614 | 4277 | 60533 | 2698 | 73468 | 2055 | 52161 |
| 24-#14 | 3.31 | MA | 39115 | 9081 | 63996 | 6732 | 70071 | 5436 | 72435 | 4435 | 74275 | 2882 | 91405 | 1835 | 70151 |
| 10L-4S | | MI | 30512 | 9081 | 50932 | 6549 | 56277 | 5263 | 59175 | 4263 | 62734 | 2711 | 76077 | 2109 | 52911 |
| **RECTANGULAR TIED COLUMNS 36" x 36"** | | | | | | | | | | | | | | | |
| 6-#14 | 1.04 | MA | 22704 | 6195 | 35390 | 4578 | 37882 | 3736 | 38276 | 3122 | 37395 | 2256 | 43365 | 2126 | 14761 |
| 2L-3S | | MI | 21701 | 6195 | 33916 | 4572 | 35993 | 3752 | 35971 | 3137 | 34301 | 2269 | 39266 | 2001 | 14841 |
| 6-#18 | 1.85 | MA | 24178 | 6558 | 38809 | 4768 | 42093 | 3869 | 43349 | 3196 | 44004 | 2189 | 51987 | 2006 | 25368 |
| 2L-3S | | MI | 22455 | 6558 | 36237 | 4756 | 38797 | 3896 | 39327 | 3218 | 38665 | 2211 | 44951 | 1785 | 25436 |
| 8-#14 | 1.39 | MA | 23386 | 6351 | 36864 | 4675 | 39772 | 3806 | 40581 | 3165 | 40488 | 2241 | 47464 | 2093 | 19430 |
| 2L-4S | | MI | 21681 | 6351 | 34182 | 4689 | 36344 | 3814 | 36406 | 3169 | 35030 | 2266 | 40712 | 1843 | 19526 |
| 8-#18 | 2.47 | MA | 25332 | 6835 | 41380 | 4941 | 45389 | 3993 | 47370 | 3271 | 49343 | 2158 | 59022 | 1939 | 33450 |
| 2L-4S | | MI | 22408 | 6835 | 36695 | 4961 | 39400 | 4003 | 40076 | 3272 | 39925 | 2203 | 47447 | 1496 | 32793 |
| 10-#11 | 1.20 | MA | 23059 | 6268 | 36060 | 4642 | 38829 | 3783 | 39463 | 3155 | 39059 | 2263 | 45619 | 2127 | 17007 |
| 2L-5S | | MI | 21418 | 6268 | 33454 | 4648 | 35484 | 3802 | 35380 | 3169 | 33552 | 2271 | 38874 | 1915 | 17112 |
| 10-#11 | 1.20 | MA | 22359 | 6268 | 35028 | 4638 | 37507 | 3795 | 37851 | 3166 | 36883 | 2271 | 42728 | 2041 | 17053 |
| 3L-4S | | MI | 21863 | 6268 | 34185 | 4652 | 36431 | 3790 | 36544 | 3159 | 35219 | 2280 | 40853 | 1955 | 17095 |
| 10-#14 | 1.74 | MA | 24062 | 6506 | 38338 | 4773 | 41661 | 3875 | 42886 | 3207 | 43582 | 2226 | 51563 | 2059 | 24076 |
| 2L-5S | | MI | 21737 | 6506 | 34609 | 4780 | 36876 | 3901 | 37044 | 3225 | 35754 | 2238 | 41998 | 1754 | 23812 |
| 10-#14 | 1.74 | MA | 23071 | 6506 | 36864 | 4767 | 39772 | 3892 | 40581 | 3222 | 40488 | 2238 | 47464 | 1935 | 24121 |
| 3L-4S | | MI | 22367 | 6506 | 35656 | 4786 | 38233 | 3884 | 38711 | 3211 | 38124 | 2251 | 44811 | 1810 | 24110 |
| 10-#18 | 3.09 | MA | 26474 | 7112 | 43951 | 5114 | 48685 | 4117 | 51391 | 3347 | 54682 | 2127 | 66058 | 1872 | 41497 |
| 2L-5S | | MI | 22494 | 7112 | 37431 | 5121 | 40318 | 4154 | 41177 | 3370 | 41170 | 2149 | 49632 | 1334 | 38137 |
| 10-#18 | 3.09 | MA | 24780 | 7112 | 41380 | 5102 | 45389 | 4144 | 47370 | 3369 | 49343 | 2149 | 59022 | 1651 | 41382 |
| 3L-4S | | MI | 23575 | 7112 | 39266 | 5134 | 42696 | 4127 | 44098 | 3348 | 45264 | 2172 | 54483 | 1430 | 40249 |
| **RECTANGULAR TIED COLUMNS 36" x 38"** | | | | | | | | | | | | | | | |
| 4-#18 | 1.17 | MA | 25545 | 6600 | 40053 | 4854 | 42925 | 3957 | 43491 | 3301 | 42735 | 2364 | 49691 | 2216 | 18313 |
| 2E | | MI | 24157 | 6600 | 37965 | 4832 | 40586 | 3939 | 41066 | 3286 | 40220 | 2347 | 46666 | 2195 | 17282 |
| 6-#18 | 1.75 | MA | 26801 | 6876 | 42797 | 5027 | 46443 | 4081 | 47783 | 3377 | 48470 | 2335 | 57272 | 2154 | 26988 |
| 2L-3S | | MI | 23602 | 6876 | 37965 | 4992 | 40586 | 4090 | 41066 | 3383 | 40220 | 2338 | 46666 | 1907 | 25513 |
| 6-#18 | 1.75 | MA | 24958 | 6876 | 40053 | 5016 | 42925 | 4110 | 43491 | 3401 | 42735 | 2357 | 49691 | 1932 | 27056 |
| 3L-2S | | MI | 25328 | 6876 | 40536 | 5005 | 43882 | 4063 | 45087 | 3361 | 45559 | 2316 | 53702 | 2129 | 25426 |
| 8-#14 | 1.32 | MA | 25944 | 6669 | 40712 | 4934 | 43953 | 4018 | 44815 | 3346 | 44664 | 2384 | 52353 | 2236 | 20645 |
| 2L-4S | | MI | 22827 | 6669 | 35903 | 4927 | 38133 | 4010 | 38148 | 3335 | 36592 | 2394 | 42438 | 1967 | 19588 |
| 8-#14 | 1.32 | MA | 24879 | 6669 | 39141 | 4929 | 41939 | 4036 | 42358 | 3361 | 41348 | 2397 | 47946 | 2111 | 20708 |
| 3E | | MI | 23536 | 6669 | 37110 | 4908 | 39672 | 4018 | 40018 | 3346 | 38957 | 2381 | 45091 | 2092 | 19542 |
| 8-#14 | 1.32 | MA | 24125 | 6669 | 37855 | 4948 | 40302 | 4028 | 40367 | 3351 | 38813 | 2409 | 45089 | 1987 | 20741 |
| 4L-2S | | MI | 24534 | 6669 | 38584 | 4913 | 41561 | 4002 | 42323 | 3331 | 42050 | 2369 | 49190 | 2216 | 19474 |
| 8-#18 | 2.34 | MA | 28043 | 7153 | 45541 | 5200 | 49961 | 4206 | 52075 | 3452 | 54204 | 2306 | 64853 | 2092 | 35610 |
| 2L-4S | | MI | 23554 | 7153 | 38422 | 5197 | 41189 | 4197 | 41814 | 3437 | 41480 | 2329 | 49163 | 1619 | 33197 |
| 8-#18 | 2.34 | MA | 26215 | 7153 | 42797 | 5189 | 46443 | 4234 | 47783 | 3476 | 48470 | 2329 | 57272 | 1870 | 35585 |
| 3E | | MI | 24773 | 7153 | 40536 | 5165 | 43882 | 4214 | 45087 | 3459 | 45559 | 2307 | 53702 | 1840 | 33517 |
| 8-#18 | 2.34 | MA | 24918 | 7153 | 40545 | 5222 | 43574 | 4219 | 44297 | 3456 | 44087 | 2351 | 52372 | 1649 | 35236 |
| 4L-2S | | MI | 26484 | 7153 | 43107 | 5177 | 47178 | 4187 | 49108 | 3436 | 50898 | 2285 | 60738 | 2062 | 33516 |
| 10-#11 | 1.14 | MA | 25591 | 6586 | 39850 | 4900 | 42943 | 3996 | 43617 | 3336 | 43120 | 2405 | 50350 | 2269 | 18060 |
| 2L-5S | | MI | 22564 | 6586 | 35170 | 4887 | 37274 | 3999 | 37124 | 3336 | 35118 | 2400 | 40605 | 2039 | 17168 |
| 10-#11 | 1.14 | MA | 24843 | 6586 | 38751 | 4897 | 41534 | 4009 | 41899 | 3347 | 40789 | 2414 | 47245 | 2183 | 18106 |
| 3L-4S | | MI | 23009 | 6586 | 35901 | 4891 | 38221 | 3987 | 38288 | 3326 | 36785 | 2408 | 42584 | 2079 | 17140 |

## RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

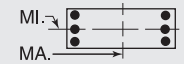
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#11 | 1.14 | MA | 24315 | 6586 | 37854 | 4911 | 40391 | 4004 | 40509 | 3341 | 39007 | 2423 | 45229 | 2096 | 18148 |
| 4L-3S | | MI | 23506 | 6586 | 36745 | 4877 | 39297 | 3992 | 39595 | 3333 | 38448 | 2400 | 44459 | 2165 | 17093 |
| 10-#11 | 1.14 | MA | 23842 | 6586 | 37077 | 4908 | 39383 | 4017 | 39271 | 3352 | 37222 | 2414 | 43109 | 2056 | 18165 |
| 5L-2S | | MI | 24207 | 6586 | 37776 | 4881 | 40619 | 3980 | 41208 | 3322 | 40625 | 2391 | 47350 | 2251 | 17045 |
| 10-#14 | 1.64 | MA | 26670 | 6825 | 42283 | 5031 | 45967 | 4088 | 47272 | 3388 | 47981 | 2370 | 56759 | 2205 | 25595 |
| 2L-5S | | MI | 22882 | 6825 | 36330 | 5018 | 38666 | 4097 | 38786 | 3392 | 37316 | 2366 | 43724 | 1878 | 24044 |
| 10-#14 | 1.64 | MA | 25611 | 6825 | 40712 | 5026 | 43953 | 4106 | 44815 | 3403 | 44664 | 2383 | 52353 | 2081 | 25639 |
| 3L-4S | | MI | 23514 | 6825 | 37377 | 5024 | 40023 | 4080 | 40453 | 3378 | 39686 | 2379 | 46537 | 1934 | 24183 |
| 10-#14 | 1.64 | MA | 24862 | 6825 | 39426 | 5046 | 42316 | 4098 | 42824 | 3394 | 42130 | 2395 | 49496 | 1956 | 25629 |
| 4L-3S | | MI | 24219 | 6825 | 38584 | 5005 | 41561 | 4088 | 42323 | 3388 | 42050 | 2366 | 49190 | 2058 | 24175 |
| 10-#14 | 1.64 | MA | 24191 | 6825 | 38313 | 5040 | 40873 | 4116 | 41051 | 3409 | 39589 | 2383 | 46480 | 1899 | 25460 |
| 5L-2S | | MI | 25212 | 6825 | 40058 | 5011 | 43451 | 4071 | 44628 | 3374 | 45144 | 2354 | 53289 | 2183 | 24125 |
| 10-#18 | 2.92 | MA | 29271 | 7430 | 48285 | 5373 | 53479 | 4330 | 56366 | 3527 | 59939 | 2278 | 72435 | 2029 | 44197 |
| 2L-5S | | MI | 23639 | 7430 | 39158 | 5357 | 42107 | 4348 | 42915 | 3535 | 42725 | 2276 | 51348 | 1457 | 38469 |
| 10-#18 | 2.92 | MA | 27459 | 7430 | 45541 | 5362 | 49961 | 4358 | 52075 | 3552 | 54204 | 2300 | 64853 | 1808 | 44082 |
| 3L-4S | | MI | 24723 | 7430 | 40993 | 5370 | 44485 | 4321 | 45836 | 3513 | 46819 | 2298 | 56199 | 1552 | 40644 |
| 10-#18 | 2.92 | MA | 26173 | 7430 | 43289 | 5395 | 47092 | 4343 | 48588 | 3532 | 49822 | 2322 | 59954 | 1586 | 43203 |
| 4L-3S | | MI | 25931 | 7430 | 43107 | 5338 | 47178 | 4338 | 49108 | 3534 | 50898 | 2276 | 60738 | 1773 | 41485 |
| 10-#18 | 2.92 | MA | 25022 | 7430 | 41336 | 5383 | 44560 | 4371 | 45479 | 3556 | 45427 | 2300 | 54741 | 1489 | 40810 |
| 5L-2S | | MI | 27629 | 7430 | 45679 | 5350 | 50475 | 4311 | 53129 | 3512 | 56237 | 2254 | 67774 | 1995 | 41575 |
| 12-#11 | 1.37 | MA | 26105 | 6694 | 40949 | 4968 | 44351 | 4045 | 45336 | 3365 | 45451 | 2396 | 53455 | 2249 | 21527 |
| 2L-6S | | MI | 22627 | 6694 | 35516 | 4951 | 37647 | 4042 | 37577 | 3359 | 35784 | 2399 | 41632 | 1961 | 20209 |
| 12-#11 | 1.37 | MA | 25360 | 6694 | 39850 | 4964 | 42943 | 4057 | 43617 | 3376 | 43120 | 2405 | 50350 | 2163 | 21565 |
| 3L-5S | | MI | 23050 | 6694 | 36202 | 4955 | 38596 | 4048 | 38737 | 3366 | 37294 | 2390 | 43497 | 2018 | 20385 |
| 12-#11 | 1.37 | MA | 24834 | 6694 | 38953 | 4979 | 41799 | 4052 | 42227 | 3370 | 41338 | 2414 | 48334 | 2076 | 21593 |
| 4E | | MI | 23493 | 6694 | 36933 | 4958 | 39543 | 4035 | 39901 | 3355 | 38961 | 2399 | 45476 | 2057 | 20379 |
| 12-#11 | 1.37 | MA | 24363 | 6694 | 38176 | 4975 | 40792 | 4065 | 40990 | 3381 | 39553 | 2405 | 46214 | 2036 | 21585 |
| 5L-3S | | MI | 23988 | 6694 | 37776 | 4945 | 40619 | 4041 | 41208 | 3362 | 40625 | 2390 | 47350 | 2144 | 20346 |
| 12-#11 | 1.37 | MA | 23914 | 6694 | 37447 | 4972 | 39783 | 4060 | 39757 | 3375 | 37936 | 2414 | 44210 | 1980 | 21378 |
| 6L-2S | | MI | 24686 | 6694 | 38808 | 4948 | 41941 | 4029 | 42821 | 3352 | 42801 | 2381 | 50242 | 2230 | 20305 |
| 12-#14 | 1.97 | MA | 27391 | 6980 | 43854 | 5128 | 47981 | 4158 | 49728 | 3430 | 51297 | 2356 | 61166 | 2174 | 30530 |
| 2L-6S | | MI | 22969 | 6980 | 36821 | 5110 | 39195 | 4158 | 39430 | 3424 | 38263 | 2363 | 45182 | 1763 | 27583 |
| 12-#14 | 1.97 | MA | 26338 | 6980 | 42283 | 5123 | 45967 | 4175 | 47272 | 3446 | 47981 | 2369 | 56759 | 2050 | 30553 |
| 3L-5S | | MI | 23568 | 6980 | 37803 | 5115 | 40555 | 4166 | 41091 | 3434 | 40409 | 2351 | 47823 | 1845 | 28408 |
| 12-#14 | 1.97 | MA | 25593 | 6980 | 40998 | 5143 | 44330 | 4168 | 45281 | 3436 | 45446 | 2381 | 53903 | 1925 | 30502 |
| 4E | | MI | 24196 | 6980 | 38850 | 5121 | 41912 | 4150 | 42758 | 3420 | 42780 | 2363 | 50636 | 1901 | 28760 |
| 12-#14 | 1.97 | MA | 24926 | 6980 | 39884 | 5138 | 42887 | 4186 | 43508 | 3451 | 42906 | 2369 | 50887 | 1868 | 30118 |
| 5L-3S | | MI | 24897 | 6980 | 40058 | 5102 | 43451 | 4158 | 44628 | 3430 | 45144 | 2351 | 53289 | 2025 | 28795 |
| 12-#14 | 1.97 | MA | 24290 | 6980 | 38840 | 5132 | 41441 | 4178 | 41742 | 3442 | 40604 | 2381 | 48045 | 1787 | 29207 |
| 6L-2S | | MI | 25884 | 6980 | 41532 | 5108 | 45340 | 4141 | 46933 | 3416 | 48237 | 2338 | 57388 | 2150 | 28760 |
| 12-#18 | 3.51 | MA | 30487 | 7706 | 51030 | 5546 | 56997 | 4454 | 60658 | 3603 | 65673 | 2249 | 80016 | 1967 | 52742 |
| 2L-6S | | MI | 23782 | 7706 | 40005 | 5518 | 43020 | 4456 | 44156 | 3633 | 44360 | 2267 | 53857 | 1244 | 43934 |
| 12-#18 | 3.51 | MA | 28689 | 7706 | 48285 | 5535 | 53479 | 4483 | 56366 | 3627 | 59939 | 2271 | 72435 | 1745 | 52557 |
| 3L-5S | | MI | 24805 | 7706 | 41729 | 5530 | 45403 | 4473 | 46936 | 3610 | 48064 | 2245 | 58383 | 1390 | 46119 |
| 12-#18 | 3.51 | MA | 27415 | 7706 | 46034 | 5568 | 50610 | 4467 | 52880 | 3607 | 55556 | 2293 | 67535 | 1524 | 51223 |
| 4E | | MI | 25879 | 7706 | 43565 | 5543 | 47781 | 4445 | 49857 | 3588 | 52158 | 2267 | 63234 | 1485 | 48145 |
| 12-#18 | 3.51 | MA | 26274 | 7706 | 44080 | 5556 | 48078 | 4496 | 49770 | 3631 | 51162 | 2271 | 62322 | 1427 | 48985 |
| 5L-3S | | MI | 27078 | 7706 | 45679 | 5511 | 50475 | 4463 | 53129 | 3610 | 56237 | 2245 | 67774 | 1706 | 49430 |
| 12-#18 | 3.51 | MA | 25188 | 7706 | 42246 | 5545 | 45542 | 4480 | 46671 | 3611 | 47182 | 2293 | 57440 | 1281 | 46645 |
| 6L-2S | | MI | 28763 | 7706 | 48250 | 5523 | 53771 | 4435 | 57151 | 3587 | 61576 | 2223 | 74810 | 1928 | 49586 |
| 14-#11 | 1.60 | MA | 26615 | 6802 | 42048 | 5035 | 45760 | 4093 | 47054 | 3395 | 47783 | 2387 | 56560 | 2229 | 24984 |
| 2L-7S | | MI | 22702 | 6802 | 35796 | 5032 | 38063 | 4103 | 38076 | 3399 | 36484 | 2397 | 42531 | 1850 | 22921 |
| 14-#11 | 1.60 | MA | 25873 | 6802 | 40949 | 5032 | 44351 | 4106 | 45336 | 3406 | 45451 | 2396 | 53455 | 2143 | 25014 |
| 3L-6S | | MI | 23112 | 6802 | 36547 | 5018 | 38969 | 4091 | 39190 | 3389 | 37960 | 2389 | 44524 | 1940 | 23308 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis

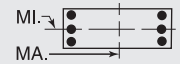


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.60 | MA | 25349 | 6802 | 40052 | 5046 | 43208 | 4101 | 43946 | 3400 | 43670 | 2405 | 51439 | 2056 | 25030 |
| 4L-5S | | MI | 23533 | 6802 | 37233 | 5022 | 39918 | 4096 | 40350 | 3395 | 39471 | 2380 | 46389 | 1996 | 23592 |
| 14-#11 | 1.60 | MA | 24881 | 6802 | 39275 | 5043 | 42201 | 4113 | 42708 | 3411 | 41884 | 2396 | 49319 | 2016 | 24996 |
| 5L-4S | | MI | 23974 | 6802 | 37964 | 5026 | 40866 | 4084 | 41514 | 3385 | 41138 | 2389 | 48367 | 2036 | 23609 |
| 14-#11 | 1.60 | MA | 24434 | 6802 | 38546 | 5040 | 41192 | 4109 | 41475 | 3404 | 40267 | 2405 | 47315 | 1960 | 24680 |
| 6L-3S | | MI | 24467 | 6802 | 38808 | 5012 | 41941 | 4089 | 42821 | 3391 | 42801 | 2380 | 50242 | 2122 | 23588 |
| 14-#11 | 1.60 | MA | 23999 | 6802 | 37748 | 5054 | 40229 | 4121 | 40292 | 3416 | 38686 | 2413 | 45175 | 1870 | 24251 |
| 7L-2S | | MI | 25163 | 6802 | 39839 | 5016 | 43263 | 4077 | 44434 | 3381 | 44978 | 2372 | 53133 | 2208 | 23555 |
| 14-#14 | 2.30 | MA | 28108 | 7136 | 45425 | 5226 | 49995 | 4228 | 52185 | 3473 | 54614 | 2342 | 65572 | 2143 | 35453 |
| 2L-7S | | MI | 23073 | 7136 | 37218 | 5226 | 39787 | 4245 | 40139 | 3481 | 39259 | 2360 | 46457 | 1600 | 31358 |
| 14-#14 | 2.30 | MA | 27059 | 7136 | 43854 | 5220 | 47981 | 4245 | 49728 | 3488 | 51297 | 2355 | 61166 | 2019 | 35447 |
| 3L-6S | | MI | 23653 | 7136 | 38294 | 5207 | 41085 | 4228 | 41735 | 3466 | 41356 | 2348 | 49281 | 1730 | 32015 |
| 14-#14 | 2.30 | MA | 26318 | 7136 | 42569 | 5240 | 46344 | 4238 | 47738 | 3478 | 48763 | 2367 | 58309 | 1894 | 35366 |
| 4L-5S | | MI | 24248 | 7136 | 39277 | 5213 | 42444 | 4236 | 43396 | 3477 | 43503 | 2336 | 51922 | 1812 | 32792 |
| 14-#14 | 2.30 | MA | 25655 | 7136 | 41455 | 5235 | 44901 | 4255 | 45965 | 3494 | 46222 | 2355 | 55294 | 1837 | 34795 |
| 5L-4S | | MI | 24873 | 7136 | 40324 | 5218 | 43801 | 4220 | 45063 | 3462 | 45873 | 2348 | 54735 | 1867 | 33326 |
| 14-#14 | 2.30 | MA | 25024 | 7136 | 40411 | 5230 | 43455 | 4248 | 44199 | 3484 | 43921 | 2367 | 52452 | 1756 | 33935 |
| 6L-3S | | MI | 25570 | 7136 | 41532 | 5199 | 45340 | 4228 | 46933 | 3473 | 48237 | 2336 | 57388 | 1992 | 33390 |
| 14-#14 | 2.30 | MA | 24408 | 7136 | 39267 | 5249 | 42075 | 4265 | 42502 | 3499 | 41672 | 2380 | 49415 | 1626 | 33222 |
| 7L-2S | | MI | 26553 | 7136 | 43006 | 5205 | 47229 | 4211 | 49238 | 3458 | 51331 | 2323 | 61487 | 2116 | 33383 |
| 14-#18 | 4.09 | MA | 29908 | 7983 | 51030 | 5707 | 56997 | 4607 | 60658 | 3702 | 65673 | 2242 | 80016 | 1683 | 61018 |
| 3L-6S | | MI | 24945 | 7983 | 42577 | 5691 | 46316 | 4580 | 48177 | 3708 | 49699 | 2236 | 60893 | 1177 | 51422 |
| 14-#18 | 4.09 | MA | 28644 | 7983 | 48778 | 5740 | 54128 | 4591 | 57172 | 3683 | 61291 | 2265 | 75116 | 1462 | 59288 |
| 4L-5S | | MI | 25960 | 7983 | 44301 | 5703 | 48700 | 4597 | 50957 | 3686 | 53403 | 2214 | 65419 | 1323 | 53793 |
| 14-#18 | 4.09 | MA | 27513 | 7983 | 46825 | 5729 | 51596 | 4620 | 54062 | 3707 | 56896 | 2242 | 69904 | 1364 | 57186 |
| 5L-4S | | MI | 27025 | 7983 | 46136 | 5716 | 51078 | 4570 | 53878 | 3663 | 57497 | 2236 | 70270 | 1418 | 55690 |
| 14-#18 | 4.09 | MA | 26436 | 7983 | 44991 | 5718 | 49060 | 4604 | 50963 | 3687 | 52917 | 2265 | 65022 | 1219 | 54660 |
| 6L-3S | | MI | 28214 | 7983 | 48250 | 5684 | 53771 | 4587 | 57151 | 3685 | 61576 | 2214 | 74810 | 1640 | 57359 |
| 16-#11 | 1.82 | MA | 27123 | 6910 | 43147 | 5103 | 47169 | 4141 | 48772 | 3424 | 50114 | 2378 | 59665 | 2209 | 28435 |
| 2L-8S | | MI | 22784 | 6910 | 36152 | 5096 | 38466 | 4146 | 38602 | 3439 | 37092 | 2379 | 43573 | 1781 | 25744 |
| 16-#11 | 1.82 | MA | 26384 | 6910 | 42048 | 5099 | 45760 | 4154 | 47054 | 3435 | 47783 | 2387 | 56560 | 2123 | 28456 |
| 3L-7S | | MI | 23186 | 6910 | 36828 | 5100 | 39385 | 4151 | 39689 | 3429 | 38661 | 2388 | 45423 | 1828 | 26047 |
| 16-#11 | 1.82 | MA | 25862 | 6910 | 41150 | 5113 | 44616 | 4149 | 45664 | 3429 | 46001 | 2395 | 54544 | 2036 | 28450 |
| 4L-6S | | MI | 23594 | 6910 | 37579 | 5086 | 40291 | 4139 | 40803 | 3418 | 40137 | 2379 | 47415 | 1918 | 26414 |
| 16-#11 | 1.82 | MA | 25396 | 6910 | 40373 | 5110 | 43609 | 4162 | 44426 | 3440 | 44216 | 2387 | 52424 | 1996 | 28402 |
| 5E | | MI | 24014 | 6910 | 38264 | 5090 | 41240 | 4144 | 41963 | 3425 | 41647 | 2370 | 49280 | 1975 | 26792 |
| 16-#11 | 1.82 | MA | 24951 | 6910 | 39645 | 5107 | 42600 | 4157 | 43194 | 3434 | 42598 | 2395 | 50420 | 1940 | 27990 |
| 6L-4S | | MI | 24453 | 6910 | 38995 | 5093 | 42188 | 4132 | 43127 | 3414 | 43314 | 2379 | 51259 | 2014 | 26828 |
| 16-#11 | 1.82 | MA | 24518 | 6910 | 38847 | 5121 | 41637 | 4170 | 42010 | 3445 | 41017 | 2404 | 48280 | 1850 | 27582 |
| 7L-3S | | MI | 24944 | 6910 | 39839 | 5080 | 43263 | 4137 | 44434 | 3421 | 44978 | 2370 | 53133 | 2100 | 26822 |
| 16-#11 | 1.82 | MA | 24091 | 6910 | 38129 | 5118 | 40661 | 4165 | 40854 | 3456 | 39337 | 2395 | 46299 | 1802 | 27245 |
| 8L-2S | | MI | 25637 | 6910 | 40871 | 5083 | 44585 | 4125 | 46047 | 3410 | 47154 | 2362 | 56025 | 2187 | 26797 |
| 16-#14 | 2.63 | MA | 28819 | 7291 | 46996 | 5323 | 52009 | 4298 | 54642 | 3515 | 57930 | 2328 | 69979 | 2112 | 40366 |
| 2L-8S | | MI | 23188 | 7291 | 37724 | 5317 | 40359 | 4306 | 40886 | 3537 | 40121 | 2333 | 47928 | 1500 | 34684 |
| 16-#14 | 2.63 | MA | 27776 | 7291 | 45425 | 5318 | 49995 | 4315 | 52185 | 3530 | 54614 | 2341 | 65572 | 1988 | 40330 |
| 3L-7S | | MI | 23756 | 7291 | 38692 | 5323 | 41676 | 4315 | 42444 | 3523 | 42352 | 2345 | 50556 | 1566 | 35698 |
| 16-#14 | 2.63 | MA | 27039 | 7291 | 44140 | 5337 | 48358 | 4308 | 50195 | 3521 | 52079 | 2353 | 62716 | 1863 | 40221 |
| 4L-6S | | MI | 24332 | 7291 | 39768 | 5304 | 42974 | 4298 | 44040 | 3509 | 44450 | 2333 | 53380 | 1697 | 36457 |
| 16-#14 | 2.63 | MA | 26380 | 7291 | 43026 | 5332 | 46915 | 4325 | 48422 | 3536 | 49539 | 2341 | 59700 | 1806 | 39489 |
| 5E | | MI | 24924 | 7291 | 40751 | 5310 | 44334 | 4306 | 45701 | 3519 | 46596 | 2320 | 56022 | 1778 | 37192 |
| 16-#14 | 2.63 | MA | 25752 | 7291 | 41982 | 5327 | 45469 | 4318 | 46656 | 3526 | 47237 | 2353 | 56858 | 1725 | 38673 |
| 6L-4S | | MI | 25545 | 7291 | 41798 | 5316 | 45691 | 4289 | 47368 | 3505 | 48967 | 2333 | 58834 | 1834 | 37884 |
| 16-#14 | 2.63 | MA | 25140 | 7291 | 40838 | 5347 | 44089 | 4335 | 44959 | 3542 | 44988 | 2366 | 53822 | 1595 | 37857 |
| 7L-3S | | MI | 26239 | 7291 | 43006 | 5297 | 47229 | 4298 | 49238 | 3515 | 51331 | 2320 | 61487 | 1959 | 37974 |
| 16-#14 | 2.63 | MA | 24537 | 7291 | 39809 | 5341 | 42689 | 4328 | 43303 | 3557 | 42597 | 2353 | 51003 | 1527 | 36745 |
| 8L-2S | | MI | 27217 | 7291 | 44479 | 5302 | 49119 | 4281 | 51543 | 3501 | 54425 | 2308 | 65586 | 2083 | 38000 |
| 16-#18 | 4.68 | MA | 29863 | 8260 | 51522 | 5913 | 57646 | 4715 | 61463 | 3758 | 67026 | 2236 | 82698 | 1399 | 67388 |
| 4L-6S | | MI | 26098 | 8260 | 45148 | 5864 | 49612 | 4704 | 52198 | 3784 | 55038 | 2205 | 67929 | 1110 | 58941 |
| 16-#18 | 4.68 | MA | 28741 | 8260 | 49569 | 5902 | 55114 | 4744 | 58354 | 3782 | 62631 | 2214 | 77485 | 1302 | 65407 |
| 5E | | MI | 27104 | 8260 | 46872 | 5876 | 51996 | 4721 | 54979 | 3761 | 58742 | 2183 | 72455 | 1256 | 61488 |

## RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

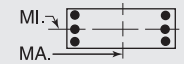
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 4.68 | MA | 27673 | 8260 | 47735 | 5891 | 52577 | 4728 | 55255 | 3762 | 58652 | 2236 | 72603 | 1157 | 62704 |
| 6L-4S | | MI | 28161 | 8260 | 48707 | 5888 | 54374 | 4694 | 57899 | 3739 | 62836 | 2205 | 77306 | 1351 | 63269 |
| 18-#11 | 2.05 | MA | 27628 | 7018 | 44245 | 5170 | 48577 | 4190 | 50491 | 3453 | 52445 | 2369 | 62770 | 2189 | 31879 |
| 2L-9S | | MI | 22870 | 7018 | 36456 | 5177 | 38894 | 4207 | 39078 | 3462 | 37805 | 2378 | 44657 | 1706 | 28229 |
| 18-#11 | 2.05 | MA | 26892 | 7018 | 43147 | 5167 | 47169 | 4202 | 48772 | 3464 | 50114 | 2378 | 59665 | 2103 | 31892 |
| 3L-8S | | MI | 23267 | 7018 | 37183 | 5163 | 39788 | 4195 | 40215 | 3468 | 39268 | 2369 | 46465 | 1760 | 28808 |
| 18-#11 | 2.05 | MA | 26372 | 7018 | 42249 | 5181 | 46025 | 4198 | 47382 | 3458 | 48332 | 2386 | 57649 | 2016 | 31867 |
| 4L-7S | | MI | 23668 | 7018 | 37859 | 5167 | 40707 | 4200 | 41302 | 3458 | 40837 | 2378 | 48314 | 1806 | 29177 |
| 18-#11 | 2.05 | MA | 25908 | 7018 | 41472 | 5178 | 45018 | 4210 | 46145 | 3469 | 46547 | 2378 | 55529 | 1976 | 31802 |
| 5L-6S | | MI | 24074 | 7018 | 38610 | 5153 | 41613 | 4188 | 42416 | 3447 | 42313 | 2369 | 50307 | 1897 | 29528 |
| 18-#11 | 2.05 | MA | 25465 | 7018 | 40744 | 5174 | 44009 | 4206 | 44912 | 3463 | 44929 | 2386 | 53525 | 1920 | 31308 |
| 6L-5S | | MI | 24492 | 7018 | 39296 | 5157 | 42562 | 4193 | 43576 | 3454 | 43824 | 2361 | 52172 | 1953 | 29987 |
| 18-#11 | 2.05 | MA | 25034 | 7018 | 39945 | 5188 | 43046 | 4218 | 43728 | 3474 | 43348 | 2395 | 51385 | 1830 | 30917 |
| 7L-4S | | MI | 24930 | 7018 | 40027 | 5161 | 43510 | 4181 | 44740 | 3444 | 45491 | 2369 | 54151 | 1993 | 30038 |
| 18-#11 | 2.05 | MA | 24609 | 7018 | 39228 | 5185 | 42069 | 4214 | 42573 | 3486 | 41668 | 2386 | 49404 | 1782 | 30515 |
| 8L-3S | | MI | 25418 | 7018 | 40871 | 5147 | 44585 | 4186 | 46047 | 3450 | 47154 | 2361 | 56025 | 2079 | 30051 |
| 18-#11 | 2.05 | MA | 24178 | 7018 | 38455 | 5199 | 41119 | 4226 | 41365 | 3479 | 40101 | 2395 | 47461 | 1728 | 29878 |
| 9L-2S | | MI | 26109 | 7018 | 41902 | 5151 | 45907 | 4174 | 47660 | 3440 | 49331 | 2352 | 58916 | 2165 | 30033 |
| 18-#14 | 2.96 | MA | 28488 | 7447 | 46996 | 5415 | 52009 | 4385 | 54642 | 3573 | 57930 | 2327 | 69979 | 1957 | 45206 |
| 3L-8S | | MI | 23869 | 7447 | 39198 | 5415 | 42248 | 4376 | 43191 | 3580 | 43215 | 2318 | 52027 | 1467 | 39076 |
| 18-#14 | 2.96 | MA | 27755 | 7447 | 45711 | 5435 | 50372 | 4378 | 52652 | 3563 | 55395 | 2339 | 67122 | 1832 | 45071 |
| 4L-7S | | MI | 24434 | 7447 | 40166 | 5420 | 43565 | 4384 | 44749 | 3565 | 45446 | 2330 | 54655 | 1533 | 40051 |
| 18-#14 | 2.96 | MA | 27100 | 7447 | 44597 | 5429 | 48929 | 4395 | 50879 | 3578 | 52855 | 2327 | 64107 | 1775 | 44196 |
| 5L-6S | | MI | 25007 | 7447 | 41242 | 5401 | 44863 | 4368 | 46344 | 3551 | 47543 | 2318 | 57479 | 1664 | 40906 |
| 18-#14 | 2.96 | MA | 26475 | 7447 | 43553 | 5424 | 47483 | 4388 | 49113 | 3569 | 50554 | 2339 | 61265 | 1694 | 43418 |
| 6L-5S | | MI | 25596 | 7447 | 42225 | 5407 | 46223 | 4376 | 48006 | 3562 | 49690 | 2305 | 60121 | 1745 | 41605 |
| 18-#14 | 2.96 | MA | 25867 | 7447 | 42409 | 5444 | 46103 | 4405 | 47416 | 3584 | 48305 | 2351 | 58228 | 1564 | 42506 |
| 7L-4S | | MI | 26214 | 7447 | 43272 | 5413 | 47580 | 4359 | 49673 | 3547 | 52060 | 2318 | 62933 | 1801 | 42436 |
| 18-#14 | 2.96 | MA | 25268 | 7447 | 41380 | 5439 | 44703 | 4398 | 45760 | 3599 | 45914 | 2339 | 55410 | 1496 | 41435 |
| 8L-3S | | MI | 26903 | 7447 | 44479 | 5394 | 49119 | 4367 | 51543 | 3558 | 54425 | 2305 | 65586 | 1925 | 42551 |
| 18-#18 | 5.26 | MA | 29959 | 8536 | 52313 | 6075 | 58632 | 4868 | 62645 | 3858 | 68365 | 2185 | 85066 | 1240 | 73645 |
| 5L-6S | | MI | 27241 | 8536 | 47719 | 6036 | 52909 | 4828 | 56220 | 3859 | 60377 | 2174 | 74965 | 1043 | 66485 |
| 18-#18 | 5.26 | MA | 28900 | 8536 | 50479 | 6064 | 56095 | 4852 | 59546 | 3838 | 64386 | 2207 | 80185 | 1094 | 70775 |
| 6L-5S | | MI | 28240 | 8536 | 49443 | 6049 | 55292 | 4845 | 59000 | 3837 | 64082 | 2152 | 79491 | 1189 | 69199 |
| 20-#11 | 2.28 | MA | 27397 | 7125 | 44245 | 5234 | 48577 | 4251 | 50491 | 3494 | 52445 | 2369 | 62770 | 2082 | 35315 |
| 3L-9S | | MI | 23353 | 7125 | 37488 | 5244 | 40216 | 4255 | 40691 | 3491 | 39982 | 2368 | 47548 | 1684 | 31320 |
| 20-#11 | 2.28 | MA | 26880 | 7125 | 43348 | 5248 | 47434 | 4246 | 49101 | 3488 | 50663 | 2377 | 60754 | 1996 | 35278 |
| 4L-8S | | MI | 23748 | 7125 | 38215 | 5231 | 41110 | 4243 | 41828 | 3498 | 41445 | 2359 | 49356 | 1738 | 31880 |
| 20-#11 | 2.28 | MA | 26417 | 7125 | 42571 | 5245 | 46426 | 4259 | 47863 | 3499 | 48878 | 2369 | 58634 | 1956 | 35199 |
| 5L-7S | | MI | 24147 | 7125 | 38890 | 5234 | 42029 | 4248 | 42915 | 3487 | 43014 | 2368 | 51206 | 1785 | 32311 |
| 20-#11 | 2.28 | MA | 25977 | 7125 | 41842 | 5242 | 45417 | 4254 | 46630 | 3493 | 47260 | 2377 | 56630 | 1900 | 34632 |
| 6E | | MI | 24552 | 7125 | 39641 | 5221 | 42935 | 4236 | 44029 | 3477 | 44490 | 2359 | 53198 | 1875 | 32647 |
| 20-#11 | 2.28 | MA | 25547 | 7125 | 41044 | 5256 | 44455 | 4267 | 45447 | 3504 | 45679 | 2386 | 54490 | 1810 | 34256 |
| 7L-5S | | MI | 24968 | 7125 | 40327 | 5224 | 43885 | 4241 | 45189 | 3484 | 46000 | 2351 | 55063 | 1932 | 33178 |
| 20-#11 | 2.28 | MA | 25124 | 7125 | 40327 | 5253 | 43478 | 4262 | 44291 | 3515 | 43999 | 2377 | 52509 | 1762 | 33791 |
| 8L-4S | | MI | 25404 | 7125 | 41058 | 5228 | 44832 | 4229 | 46353 | 3473 | 47667 | 2359 | 57042 | 1971 | 33243 |
| 20-#11 | 2.28 | MA | 24705 | 7125 | 39554 | 5267 | 42528 | 4275 | 43083 | 3509 | 42432 | 2386 | 50566 | 1708 | 33176 |
| 9L-3S | | MI | 25890 | 7125 | 41902 | 5214 | 45907 | 4234 | 47660 | 3480 | 49331 | 2351 | 58916 | 2057 | 33270 |
| 20-#11 | 2.28 | MA | 24244 | 7125 | 38839 | 5263 | 41564 | 4270 | 41933 | 3520 | 40879 | 2395 | 48684 | 1647 | 32562 |
| 10L-2S | | MI | 26579 | 7125 | 42933 | 5218 | 47229 | 4222 | 49273 | 3469 | 51507 | 2342 | 61808 | 2144 | 33265 |
| 20-#14 | 3.29 | MA | 28467 | 7603 | 47282 | 5532 | 52386 | 4447 | 55109 | 3606 | 58712 | 2325 | 71529 | 1801 | 49916 |
| 4L-8S | | MI | 24546 | 7603 | 40672 | 5512 | 44138 | 4446 | 45496 | 3622 | 46308 | 2302 | 56126 | 1434 | 43477 |
| 20-#14 | 3.29 | MA | 27815 | 7603 | 46168 | 5527 | 50943 | 4465 | 53336 | 3621 | 56172 | 2313 | 68514 | 1744 | 48913 |
| 5L-7S | | MI | 25108 | 7603 | 41640 | 5518 | 45454 | 4454 | 47054 | 3608 | 48539 | 2315 | 58754 | 1500 | 44416 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 38"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

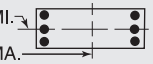
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 3.29 | MA | 27194 | 7603 | 45124 | 5522 | 49497 | 4457 | 51570 | 3611 | 53870 | 2325 | 65672 | 1663 | 48170 |
| 6E | | MI | 25678 | 7603 | 42716 | 5499 | 46753 | 4438 | 48649 | 3593 | 50637 | 2302 | 61578 | 1630 | 45361 |
| 20-#14 | 3.29 | MA | 26589 | 7603 | 43980 | 5541 | 48117 | 4475 | 49873 | 3626 | 51621 | 2337 | 62635 | 1533 | 47167 |
| 7L-5S | | MI | 26264 | 7603 | 43698 | 5504 | 48112 | 4446 | 50311 | 3604 | 52784 | 2290 | 64220 | 1712 | 46028 |
| 20-#14 | 3.29 | MA | 25993 | 7603 | 42951 | 5536 | 46717 | 4468 | 48217 | 3642 | 49230 | 2325 | 59817 | 1466 | 46134 |
| 8L-4S | | MI | 26878 | 7603 | 44745 | 5510 | 49469 | 4429 | 51978 | 3590 | 55154 | 2302 | 67032 | 1768 | 46982 |
| 20-#18 | 5.85 | MA | 30116 | 8813 | 53223 | 6237 | 59613 | 4977 | 63838 | 3913 | 70121 | 2178 | 87766 | 1032 | 78868 |
| 6E | | MI | 28376 | 8813 | 50291 | 6209 | 56205 | 4952 | 60241 | 3934 | 65716 | 2143 | 82001 | 976 | 74052 |
| 22-#11 | 2.51 | MA | 27385 | 7233 | 44447 | 5316 | 48842 | 4295 | 50819 | 3517 | 52994 | 2368 | 63859 | 1976 | 38686 |
| 4L-9S | | MI | 23833 | 7233 | 38519 | 5312 | 41538 | 4303 | 42304 | 3521 | 42158 | 2358 | 50440 | 1663 | 34417 |
| 22-#11 | 2.51 | MA | 26924 | 7233 | 43670 | 5312 | 47835 | 4307 | 49582 | 3528 | 51209 | 2360 | 61739 | 1936 | 38588 |
| 5L-8S | | MI | 24226 | 7233 | 39246 | 5298 | 42432 | 4291 | 43441 | 3527 | 43621 | 2350 | 52248 | 1717 | 34958 |
| 22-#11 | 2.51 | MA | 26485 | 7233 | 42941 | 5309 | 46826 | 4302 | 48349 | 3522 | 49591 | 2368 | 59735 | 1880 | 37961 |
| 6L-7S | | MI | 24624 | 7233 | 39922 | 5302 | 43351 | 4297 | 44528 | 3517 | 45190 | 2358 | 54097 | 1763 | 35447 |
| 22-#11 | 2.51 | MA | 26058 | 7233 | 42143 | 5323 | 45863 | 4315 | 47165 | 3533 | 48010 | 2377 | 57595 | 1789 | 37598 |
| 7L-6S | | MI | 25027 | 7233 | 40673 | 5288 | 44258 | 4284 | 45642 | 3506 | 46666 | 2350 | 56090 | 1854 | 35771 |
| 22-#11 | 2.51 | MA | 25636 | 7233 | 41425 | 5320 | 44887 | 4310 | 46010 | 3544 | 46330 | 2368 | 55614 | 1742 | 37075 |
| 8L-5S | | MI | 25441 | 7233 | 41359 | 5292 | 45207 | 4290 | 46802 | 3513 | 48177 | 2341 | 57955 | 1910 | 36337 |
| 22-#11 | 2.51 | MA | 25219 | 7233 | 40653 | 5334 | 43936 | 4323 | 44802 | 3538 | 44763 | 2377 | 53671 | 1688 | 36479 |
| 9L-4S | | MI | 25875 | 7233 | 42089 | 5295 | 46154 | 4278 | 47966 | 3502 | 49844 | 2350 | 59934 | 1949 | 36443 |
| 22-#11 | 2.51 | MA | 24761 | 7233 | 39937 | 5331 | 42973 | 4318 | 43652 | 3549 | 43210 | 2386 | 51789 | 1627 | 35822 |
| 10L-3S | | MI | 26360 | 7233 | 42933 | 5282 | 47229 | 4283 | 49273 | 3509 | 51507 | 2341 | 61808 | 2036 | 36482 |
| 22-#14 | 3.62 | MA | 28526 | 7758 | 47739 | 5624 | 52957 | 4535 | 55793 | 3663 | 59488 | 2298 | 72920 | 1713 | 53640 |
| 5L-8S | | MI | 25219 | 7758 | 42145 | 5609 | 46027 | 4516 | 47801 | 3665 | 49402 | 2287 | 60225 | 1401 | 47886 |
| 22-#14 | 3.62 | MA | 27908 | 7758 | 46695 | 5619 | 51511 | 4527 | 54027 | 3654 | 57187 | 2311 | 70078 | 1632 | 52927 |
| 6L-7S | | MI | 25777 | 7758 | 43113 | 5615 | 47344 | 4524 | 49359 | 3650 | 51633 | 2300 | 62853 | 1467 | 48791 |
| 22-#14 | 3.62 | MA | 27307 | 7758 | 45551 | 5638 | 50131 | 4545 | 52330 | 3669 | 54938 | 2323 | 67041 | 1502 | 51838 |
| 7L-6S | | MI | 26345 | 7758 | 44190 | 5596 | 48642 | 4507 | 50954 | 3636 | 53731 | 2287 | 65677 | 1597 | 49821 |
| 22-#14 | 3.62 | MA | 26714 | 7758 | 44522 | 5633 | 48731 | 4537 | 50674 | 3684 | 52547 | 2311 | 64223 | 1435 | 50839 |
| 8L-5S | | MI | 26927 | 7758 | 45172 | 5602 | 50001 | 4516 | 52615 | 3646 | 55877 | 2275 | 68319 | 1679 | 50460 |
| 24-#11 | 2.74 | MA | 27429 | 7341 | 44769 | 5380 | 49244 | 4356 | 51300 | 3558 | 53540 | 2351 | 64844 | 1916 | 41895 |
| 5L-9S | | MI | 24311 | 7341 | 39550 | 5379 | 42860 | 4352 | 43917 | 3550 | 44335 | 2348 | 53331 | 1641 | 37518 |
| 24-#11 | 2.74 | MA | 26992 | 7341 | 44040 | 5377 | 48235 | 4351 | 50067 | 3552 | 51922 | 2359 | 62840 | 1860 | 41293 |
| 6L-8S | | MI | 24703 | 7341 | 40277 | 5366 | 43754 | 4340 | 45054 | 3557 | 45798 | 2340 | 55139 | 1695 | 38042 |
| 24-#11 | 2.74 | MA | 26566 | 7341 | 43242 | 5391 | 47272 | 4363 | 48884 | 3563 | 50342 | 2368 | 60700 | 1769 | 40942 |
| 7E | | MI | 25098 | 7341 | 40953 | 5369 | 44674 | 4345 | 46141 | 3546 | 47367 | 2348 | 56989 | 1742 | 38585 |
| 24-#11 | 2.74 | MA | 26146 | 7341 | 42524 | 5387 | 46295 | 4359 | 47728 | 3574 | 48661 | 2359 | 58719 | 1722 | 40364 |
| 8L-6S | | MI | 25500 | 7341 | 41704 | 5356 | 45580 | 4333 | 47255 | 3536 | 48843 | 2340 | 58981 | 1832 | 38898 |
| 24-#11 | 2.74 | MA | 25731 | 7341 | 41752 | 5402 | 45345 | 4371 | 46520 | 3568 | 47094 | 2368 | 56776 | 1668 | 39786 |
| 9L-5S | | MI | 25913 | 7341 | 42390 | 5359 | 46529 | 4338 | 48415 | 3542 | 50353 | 2331 | 60846 | 1889 | 39440 |
| 24-#11 | 2.74 | MA | 25275 | 7341 | 41036 | 5398 | 44381 | 4367 | 45370 | 3579 | 45541 | 2377 | 54894 | 1607 | 39089 |
| 10L-4S | | MI | 26345 | 7341 | 43121 | 5363 | 47476 | 4326 | 49579 | 3532 | 52020 | 2340 | 62825 | 1928 | 39640 |
| 24-#14 | 3.95 | MA | 28619 | 7914 | 48266 | 5716 | 53525 | 4597 | 56484 | 3696 | 60503 | 2297 | 74485 | 1601 | 57689 |
| 6L-8S | | MI | 25888 | 7914 | 43619 | 5706 | 47916 | 4586 | 50106 | 3707 | 52495 | 2272 | 64324 | 1367 | 52301 |
| 24-#14 | 3.95 | MA | 28020 | 7914 | 47122 | 5736 | 52145 | 4615 | 54787 | 3711 | 58254 | 2309 | 71448 | 1471 | 56518 |
| 7E | | MI | 26444 | 7914 | 44587 | 5712 | 49233 | 4594 | 51664 | 3693 | 54727 | 2284 | 66952 | 1433 | 53175 |
| 24-#14 | 3.95 | MA | 27431 | 7914 | 46093 | 5731 | 50745 | 4607 | 53131 | 3727 | 55863 | 2297 | 68630 | 1404 | 55552 |
| 8L-6S | | MI | 27008 | 7914 | 45663 | 5693 | 50531 | 4577 | 53259 | 3678 | 56824 | 2272 | 69776 | 1564 | 54285 |

## RECTANGULAR TIED COLUMNS 36" x 40"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.11 | MA | 28207 | 6918 | 44050 | 5113 | 47251 | 4170 | 47852 | 3482 | 46986 | 2507 | 54635 | 2359 | 19393 |
| 2E | | MI | 25305 | 6918 | 39692 | 5068 | 42375 | 4133 | 42804 | 3451 | 41775 | 2474 | 48382 | 2318 | 17329 |
| 6-#18 | 1.67 | MA | 29553 | 7195 | 46967 | 5286 | 50991 | 4294 | 52414 | 3557 | 53117 | 2480 | 62763 | 2300 | 28608 |
| 2L-3S | | MI | 24749 | 7195 | 39692 | 5228 | 42375 | 4284 | 42804 | 3548 | 41775 | 2465 | 48382 | 2030 | 25582 |
| 6-#18 | 1.67 | MA | 27589 | 7195 | 44050 | 5276 | 47251 | 4324 | 47852 | 3583 | 46986 | 2502 | 54635 | 2079 | 28676 |
| 3L-2S | | MI | 26477 | 7195 | 42264 | 5241 | 45671 | 4257 | 46825 | 3526 | 47114 | 2443 | 55418 | 2251 | 25483 |

## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

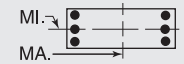
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 1.25 | MA | 28630 | 6987 | 44741 | 5192 | 48333 | 4231 | 49245 | 3526 | 49022 | 2527 | 57446 | 2378 | 21860 |
| 2L-4S | | MI | 23973 | 6987 | 37623 | 5165 | 39923 | 4206 | 39891 | 3501 | 38154 | 2522 | 44164 | 2091 | 19644 |
| 8-#14 | 1.25 | MA | 27497 | 6987 | 43072 | 5188 | 46194 | 4249 | 46636 | 3542 | 45483 | 2540 | 52732 | 2254 | 21923 |
| 3E | | MI | 24683 | 6987 | 38831 | 5146 | 41462 | 4214 | 41761 | 3512 | 40519 | 2509 | 46816 | 2215 | 19588 |
| 8-#14 | 1.25 | MA | 26697 | 6987 | 41710 | 5208 | 44458 | 4242 | 44526 | 3533 | 42777 | 2552 | 49671 | 2129 | 21956 |
| 4L-2S | | MI | 25682 | 6987 | 40305 | 5152 | 43351 | 4197 | 44066 | 3498 | 43612 | 2497 | 50916 | 2340 | 19517 |
| 8-#18 | 2.22 | MA | 30883 | 7471 | 49884 | 5459 | 54730 | 4418 | 56976 | 3633 | 59247 | 2453 | 70891 | 2242 | 37770 |
| 2L-4S | | MI | 24700 | 7471 | 40150 | 5433 | 42978 | 4391 | 43552 | 3602 | 43034 | 2456 | 50878 | 1742 | 33375 |
| 8-#18 | 2.22 | MA | 28935 | 7471 | 46967 | 5448 | 50991 | 4448 | 52414 | 3659 | 53117 | 2476 | 62763 | 2021 | 37745 |
| 3E | | MI | 25921 | 7471 | 42264 | 5401 | 45671 | 4408 | 46825 | 3624 | 47114 | 2434 | 55418 | 1963 | 33604 |
| 8-#18 | 2.22 | MA | 27557 | 7471 | 44577 | 5483 | 47946 | 4434 | 48714 | 3640 | 48432 | 2498 | 57501 | 1799 | 37408 |
| 4L-2S | | MI | 27636 | 7471 | 44835 | 5414 | 48967 | 4381 | 50846 | 3601 | 52453 | 2412 | 62453 | 2184 | 33580 |
| 10-#11 | 1.08 | MA | 28251 | 6904 | 43822 | 5159 | 47255 | 4209 | 47968 | 3516 | 47340 | 2546 | 55285 | 2410 | 19113 |
| 2L-5S | | MI | 23709 | 6904 | 36887 | 5126 | 39064 | 4196 | 38869 | 3504 | 36683 | 2528 | 42337 | 2164 | 17220 |
| 10-#11 | 1.08 | MA | 27456 | 6904 | 42656 | 5156 | 45760 | 4222 | 46144 | 3528 | 44859 | 2555 | 51967 | 2324 | 19159 |
| 3L-4S | | MI | 24155 | 6904 | 37618 | 5130 | 40011 | 4184 | 40033 | 3493 | 38350 | 2537 | 44316 | 2203 | 17183 |
| 10-#11 | 1.08 | MA | 26895 | 6904 | 41704 | 5170 | 44548 | 4218 | 44671 | 3522 | 42963 | 2564 | 49809 | 2237 | 19201 |
| 4L-3S | | MI | 24653 | 6904 | 38462 | 5116 | 41086 | 4189 | 41339 | 3500 | 40014 | 2528 | 46190 | 2289 | 17132 |
| 10-#11 | 1.08 | MA | 26394 | 6904 | 40882 | 5168 | 43481 | 4231 | 43360 | 3534 | 41064 | 2556 | 47548 | 2196 | 19218 |
| 5L-2S | | MI | 25355 | 6904 | 39493 | 5120 | 42409 | 4177 | 42952 | 3489 | 42190 | 2520 | 49082 | 2376 | 17083 |
| 10-#14 | 1.56 | MA | 29407 | 7143 | 46409 | 5290 | 50472 | 4301 | 51855 | 3569 | 52562 | 2514 | 62161 | 2350 | 27114 |
| 2L-5S | | MI | 24028 | 7143 | 38050 | 5256 | 40455 | 4293 | 40529 | 3558 | 38878 | 2494 | 45450 | 2002 | 24182 |
| 10-#14 | 1.56 | MA | 28279 | 7143 | 44741 | 5285 | 48333 | 4319 | 49245 | 3585 | 49022 | 2527 | 57446 | 2225 | 27158 |
| 3L-4S | | MI | 24661 | 7143 | 39097 | 5262 | 41812 | 4276 | 42196 | 3544 | 41248 | 2506 | 48263 | 2058 | 24251 |
| 10-#14 | 1.56 | MA | 27484 | 7143 | 43378 | 5305 | 46596 | 4312 | 47135 | 3576 | 46317 | 2539 | 54385 | 2100 | 27148 |
| 4L-3S | | MI | 25366 | 7143 | 40305 | 5243 | 43351 | 4284 | 44066 | 3554 | 43612 | 2494 | 50916 | 2182 | 24227 |
| 10-#14 | 1.56 | MA | 26773 | 7143 | 42198 | 5301 | 45067 | 4330 | 45256 | 3592 | 43606 | 2527 | 51167 | 2043 | 27024 |
| 5L-2S | | MI | 26361 | 7143 | 41778 | 5249 | 45240 | 4267 | 46370 | 3540 | 46706 | 2482 | 55015 | 2307 | 24173 |
| 10-#18 | 2.78 | MA | 32198 | 7748 | 52801 | 5631 | 58470 | 4542 | 61538 | 3708 | 65378 | 2427 | 79018 | 2184 | 46897 |
| 2L-5S | | MI | 24784 | 7748 | 40885 | 5593 | 43896 | 4543 | 44653 | 3700 | 44280 | 2403 | 53063 | 1579 | 38791 |
| 10-#18 | 2.78 | MA | 30266 | 7748 | 49884 | 5621 | 54730 | 4572 | 56976 | 3734 | 59247 | 2449 | 70891 | 1962 | 46782 |
| 3L-4S | | MI | 25870 | 7748 | 42721 | 5606 | 46274 | 4516 | 47574 | 3677 | 48373 | 2425 | 57914 | 1675 | 41028 |
| 10-#18 | 2.78 | MA | 28900 | 7748 | 47494 | 5655 | 51686 | 4558 | 53276 | 3716 | 54562 | 2471 | 65629 | 1741 | 46190 |
| 4L-3S | | MI | 27082 | 7748 | 44835 | 5574 | 48967 | 4533 | 50846 | 3699 | 52453 | 2403 | 62453 | 1896 | 41583 |
| 10-#18 | 2.78 | MA | 27678 | 7748 | 45423 | 5645 | 49001 | 4588 | 49978 | 3741 | 49865 | 2449 | 60055 | 1641 | 43503 |
| 5L-2S | | MI | 28783 | 7748 | 47406 | 5586 | 52264 | 4506 | 54867 | 3677 | 57792 | 2381 | 69489 | 2117 | 41642 |
| 12-#11 | 1.30 | MA | 28799 | 7012 | 44988 | 5226 | 48750 | 4257 | 49792 | 3546 | 49822 | 2538 | 58604 | 2391 | 22791 |
| 2L-6S | | MI | 23772 | 7012 | 37233 | 5190 | 39437 | 4239 | 39322 | 3526 | 37349 | 2527 | 43363 | 2086 | 20364 |
| 12-#11 | 1.30 | MA | 28007 | 7012 | 43822 | 5223 | 47255 | 4270 | 47968 | 3557 | 47340 | 2547 | 55285 | 2305 | 22829 |
| 3L-5S | | MI | 24196 | 7012 | 37919 | 5194 | 40386 | 4244 | 40482 | 3533 | 38860 | 2518 | 45228 | 2142 | 20446 |
| 12-#11 | 1.30 | MA | 27449 | 7012 | 42871 | 5238 | 46043 | 4266 | 46495 | 3552 | 45445 | 2555 | 53128 | 2219 | 22857 |
| 4E | | MI | 24640 | 7012 | 38650 | 5197 | 41333 | 4232 | 41646 | 3522 | 40527 | 2527 | 47207 | 2181 | 20427 |
| 12-#11 | 1.30 | MA | 26950 | 7012 | 42048 | 5235 | 44976 | 4279 | 45184 | 3563 | 43546 | 2547 | 50867 | 2178 | 22848 |
| 5L-3S | | MI | 25135 | 7012 | 39493 | 5184 | 42409 | 4237 | 42952 | 3529 | 42190 | 2518 | 49082 | 2268 | 20389 |
| 12-#11 | 1.30 | MA | 26475 | 7012 | 41276 | 5232 | 43907 | 4275 | 43878 | 3558 | 41825 | 2556 | 48723 | 2122 | 22715 |
| 6L-2S | | MI | 25835 | 7012 | 40525 | 5187 | 43731 | 4225 | 44565 | 3519 | 44367 | 2510 | 51973 | 2354 | 20346 |
| 12-#14 | 1.88 | MA | 30178 | 7298 | 48077 | 5387 | 52610 | 4371 | 54464 | 3611 | 56101 | 2501 | 66875 | 2321 | 32352 |
| 2L-6S | | MI | 24114 | 7298 | 38541 | 5348 | 40985 | 4354 | 41172 | 3590 | 39824 | 2491 | 46908 | 1887 | 27783 |
| 12-#14 | 1.88 | MA | 29056 | 7298 | 46409 | 5382 | 50472 | 4389 | 51855 | 3627 | 52562 | 2514 | 62161 | 2196 | 32376 |
| 3L-5S | | MI | 24714 | 7298 | 39524 | 5353 | 42345 | 4362 | 42833 | 3601 | 41971 | 2479 | 49549 | 1969 | 28631 |
| 12-#14 | 1.88 | MA | 28266 | 7298 | 45046 | 5403 | 48735 | 4382 | 49744 | 3618 | 49856 | 2526 | 59100 | 2072 | 32325 |
| 4E | | MI | 25343 | 7298 | 40571 | 5359 | 43702 | 4346 | 44500 | 3586 | 44341 | 2491 | 52362 | 2024 | 28836 |
| 12-#14 | 1.88 | MA | 27558 | 7298 | 43867 | 5398 | 47206 | 4400 | 47865 | 3634 | 47146 | 2514 | 55881 | 2014 | 32071 |
| 5L-3S | | MI | 26045 | 7298 | 41778 | 5340 | 45240 | 4354 | 46370 | 3597 | 46706 | 2479 | 55015 | 2149 | 28849 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis

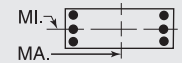



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 1.88 | MA | 26884 | 7298 | 42760 | 5393 | 45674 | 4394 | 45993 | 3625 | 44689 | 2526 | 52838 | 1932 | 31050 |
| 6L-2S | | MI | 27035 | 7298 | 43252 | 5346 | 47130 | 4337 | 48675 | 3582 | 49799 | 2466 | 59114 | 2273 | 28811 |
| 12-#18 | 3.33 | MA | 33500 | 8025 | 55718 | 5804 | 62209 | 4667 | 66100 | 3784 | 71508 | 2400 | 87146 | 2126 | 55982 |
| 2L-6S | | MI | 24925 | 8025 | 41733 | 5754 | 44809 | 4650 | 45894 | 3798 | 45915 | 2394 | 55573 | 1367 | 44463 |
| 12-#18 | 3.33 | MA | 31583 | 8025 | 52801 | 5794 | 58470 | 4697 | 61538 | 3809 | 65378 | 2422 | 79018 | 1904 | 55797 |
| 3L-5S | | MI | 25951 | 8025 | 43457 | 5766 | 47192 | 4667 | 48674 | 3775 | 49619 | 2372 | 60099 | 1512 | 46437 |
| 12-#18 | 3.33 | MA | 30229 | 8025 | 50411 | 5828 | 55425 | 4682 | 57838 | 3791 | 60693 | 2444 | 73756 | 1683 | 54723 |
| 4E | | MI | 27029 | 8025 | 45292 | 5779 | 49570 | 4640 | 51595 | 3753 | 53713 | 2394 | 64950 | 1608 | 48522 |
| 12-#18 | 3.33 | MA | 29018 | 8025 | 48340 | 5818 | 52740 | 4712 | 54540 | 3817 | 55996 | 2422 | 68183 | 1583 | 52200 |
| 5L-3S | | MI | 28231 | 8025 | 47406 | 5747 | 52264 | 4657 | 54867 | 3775 | 57792 | 2372 | 69489 | 1829 | 49537 |
| 12-#18 | 3.33 | MA | 27865 | 8025 | 46396 | 5808 | 50051 | 4698 | 51254 | 3798 | 51742 | 2444 | 62945 | 1438 | 49942 |
| 6L-2S | | MI | 29920 | 8025 | 49977 | 5759 | 55560 | 4630 | 58889 | 3752 | 63131 | 2350 | 76525 | 2050 | 49669 |
| 14-#11 | 1.52 | MA | 29345 | 7120 | 46154 | 5294 | 50245 | 4306 | 51616 | 3575 | 52304 | 2529 | 61923 | 2373 | 26459 |
| 2L-7S | | MI | 23847 | 7120 | 37513 | 5271 | 39853 | 4300 | 39821 | 3566 | 38050 | 2526 | 44262 | 1974 | 23067 |
| 14-#11 | 1.52 | MA | 28555 | 7120 | 44988 | 5291 | 48750 | 4319 | 49792 | 3587 | 49822 | 2538 | 58604 | 2286 | 26488 |
| 3L-6S | | MI | 24258 | 7120 | 38264 | 5258 | 40759 | 4288 | 40935 | 3556 | 39526 | 2517 | 46255 | 2064 | 23461 |
| 14-#11 | 1.52 | MA | 28000 | 7120 | 44037 | 5305 | 47538 | 4314 | 48319 | 3581 | 47926 | 2547 | 56446 | 2200 | 26504 |
| 4L-5S | | MI | 24680 | 7120 | 38950 | 5261 | 41708 | 4293 | 42094 | 3562 | 41036 | 2509 | 48120 | 2120 | 23658 |
| 14-#11 | 1.52 | MA | 27503 | 7120 | 43214 | 5302 | 46471 | 4327 | 47008 | 3593 | 46027 | 2538 | 54186 | 2159 | 26470 |
| 5L-4S | | MI | 25122 | 7120 | 39681 | 5265 | 42656 | 4281 | 43259 | 3552 | 42703 | 2517 | 50099 | 2160 | 23661 |
| 14-#11 | 1.52 | MA | 27030 | 7120 | 42442 | 5300 | 45402 | 4323 | 45702 | 3587 | 44307 | 2547 | 52042 | 2103 | 26220 |
| 6L-3S | | MI | 25615 | 7120 | 40525 | 5251 | 43731 | 4286 | 44565 | 3559 | 44367 | 2509 | 51973 | 2246 | 23634 |
| 14-#11 | 1.52 | MA | 26569 | 7120 | 41597 | 5314 | 44383 | 4336 | 44448 | 3599 | 42625 | 2556 | 49754 | 2013 | 25738 |
| 7L-2S | | MI | 26312 | 7120 | 41556 | 5255 | 45053 | 4274 | 46178 | 3548 | 46543 | 2500 | 54865 | 2333 | 23598 |
| 14-#14 | 2.19 | MA | 30944 | 7454 | 49745 | 5484 | 54749 | 4441 | 57073 | 3653 | 59641 | 2488 | 71590 | 2292 | 37579 |
| 2L-7S | | MI | 24218 | 7454 | 38939 | 5464 | 41576 | 4441 | 41882 | 3647 | 40820 | 2488 | 48183 | 1723 | 31697 |
| 14-#14 | 2.19 | MA | 29828 | 7454 | 48077 | 5480 | 52610 | 4459 | 54464 | 3670 | 56101 | 2501 | 66875 | 2167 | 37573 |
| 3L-6S | | MI | 24799 | 7454 | 40015 | 5445 | 42874 | 4424 | 43477 | 3633 | 42918 | 2476 | 51007 | 1854 | 32214 |
| 14-#14 | 2.19 | MA | 29041 | 7454 | 46715 | 5500 | 50874 | 4452 | 52353 | 3661 | 53396 | 2513 | 63814 | 2043 | 37492 |
| 4L-5S | | MI | 25396 | 7454 | 40998 | 5451 | 44234 | 4432 | 45138 | 3643 | 45065 | 2464 | 53648 | 1935 | 33012 |
| 14-#14 | 2.19 | MA | 28338 | 7454 | 45535 | 5495 | 49345 | 4470 | 50474 | 3677 | 50685 | 2501 | 60596 | 1985 | 37040 |
| 5L-4S | | MI | 26022 | 7454 | 42045 | 5457 | 45591 | 4415 | 46805 | 3629 | 47435 | 2476 | 56461 | 1991 | 33409 |
| 14-#14 | 2.19 | MA | 27668 | 7454 | 44429 | 5491 | 47813 | 4463 | 48602 | 3668 | 48229 | 2513 | 57553 | 1904 | 36073 |
| 6L-3S | | MI | 26720 | 7454 | 43252 | 5437 | 47130 | 4424 | 48675 | 3639 | 49799 | 2464 | 59114 | 2116 | 33457 |
| 14-#14 | 2.19 | MA | 27016 | 7454 | 43217 | 5511 | 46351 | 4482 | 46805 | 3684 | 45828 | 2526 | 54303 | 1774 | 35457 |
| 7L-2S | | MI | 27705 | 7454 | 44726 | 5443 | 49019 | 4407 | 50980 | 3625 | 52893 | 2451 | 63213 | 2240 | 33438 |
| 14-#18 | 3.89 | MA | 32888 | 8301 | 55718 | 5967 | 62209 | 4821 | 66100 | 3885 | 71508 | 2396 | 87146 | 1846 | 64798 |
| 3L-6S | | MI | 26090 | 8301 | 44304 | 5927 | 48105 | 4774 | 49915 | 3873 | 51254 | 2363 | 62609 | 1300 | 51944 |
| 14-#18 | 3.89 | MA | 31545 | 8301 | 53328 | 6001 | 59165 | 4807 | 62400 | 3866 | 66823 | 2418 | 81884 | 1624 | 63301 |
| 4L-5S | | MI | 27108 | 8301 | 46028 | 5939 | 50489 | 4791 | 52695 | 3851 | 54958 | 2341 | 67135 | 1446 | 54109 |
| 14-#18 | 3.89 | MA | 30344 | 8301 | 51257 | 5991 | 56480 | 4836 | 59102 | 3892 | 62126 | 2396 | 76310 | 1525 | 60925 |
| 5L-4S | | MI | 28177 | 8301 | 47863 | 5952 | 52867 | 4764 | 55616 | 3828 | 59052 | 2363 | 71986 | 1541 | 56061 |
| 14-#18 | 3.89 | MA | 29201 | 8301 | 49313 | 5981 | 53790 | 4822 | 55816 | 3874 | 57872 | 2418 | 71072 | 1380 | 58476 |
| 6L-3S | | MI | 29370 | 8301 | 49977 | 5920 | 55560 | 4781 | 58889 | 3850 | 63131 | 2341 | 76525 | 1762 | 57475 |
| 16-#11 | 1.73 | MA | 29888 | 7228 | 47320 | 5361 | 51740 | 4354 | 53440 | 3605 | 54785 | 2520 | 65242 | 2354 | 30120 |
| 2L-8S | | MI | 23928 | 7228 | 37869 | 5335 | 40256 | 4343 | 40346 | 3606 | 38657 | 2507 | 45304 | 1906 | 25935 |
| 16-#11 | 1.73 | MA | 29101 | 7228 | 46154 | 5358 | 50245 | 4367 | 51616 | 3616 | 52304 | 2529 | 61923 | 2268 | 30141 |
| 3L-7S | | MI | 24332 | 7228 | 38544 | 5339 | 41175 | 4348 | 41434 | 3596 | 40226 | 2516 | 47154 | 1952 | 26193 |
| 16-#11 | 1.73 | MA | 28548 | 7228 | 45203 | 5373 | 49033 | 4363 | 50143 | 3611 | 50408 | 2538 | 59765 | 2181 | 30135 |
| 4L-6S | | MI | 24741 | 7228 | 39295 | 5325 | 42081 | 4336 | 42548 | 3585 | 41702 | 2507 | 49146 | 2042 | 26567 |
| 16-#11 | 1.73 | MA | 28053 | 7228 | 44380 | 5370 | 47966 | 4376 | 48832 | 3622 | 48509 | 2530 | 57504 | 2140 | 30086 |
| 5E | | MI | 25161 | 7228 | 39981 | 5329 | 43030 | 4341 | 43707 | 3592 | 43213 | 2499 | 51011 | 2099 | 26863 |
| 16-#11 | 1.73 | MA | 27582 | 7228 | 43609 | 5367 | 46897 | 4372 | 47526 | 3617 | 46788 | 2539 | 55361 | 2084 | 29734 |
| 6L-4S | | MI | 25601 | 7228 | 40712 | 5332 | 43978 | 4329 | 44872 | 3581 | 44880 | 2507 | 52990 | 2138 | 26888 |
| 16-#11 | 1.73 | MA | 27123 | 7228 | 42763 | 5381 | 45878 | 4385 | 46272 | 3628 | 45106 | 2548 | 53073 | 1994 | 29275 |
| 7L-3S | | MI | 26093 | 7228 | 41556 | 5319 | 45053 | 4334 | 46178 | 3588 | 46543 | 2499 | 54865 | 2225 | 26872 |
| 16-#11 | 1.73 | MA | 26670 | 7228 | 42004 | 5379 | 44844 | 4380 | 45049 | 3640 | 43319 | 2539 | 50959 | 1946 | 28950 |
| 8L-2S | | MI | 26787 | 7228 | 42587 | 5322 | 46375 | 4322 | 47791 | 3577 | 48720 | 2490 | 57756 | 2311 | 26843 |

## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

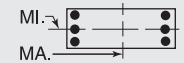
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 2.50 | MA | 31704 | 7610 | 51414 | 5581 | 56888 | 4510 | 59682 | 3696 | 63180 | 2475 | 76304 | 2263 | 42796 |
| 2L-8S | | MI | 24332 | 7610 | 39445 | 5555 | 42149 | 4502 | 42629 | 3704 | 41683 | 2461 | 49654 | 1624 | 34994 |
| 16-#14 | 2.50 | MA | 30594 | 7610 | 49745 | 5577 | 54749 | 4529 | 57073 | 3712 | 59641 | 2488 | 71590 | 2138 | 42760 |
| 3L-7S | | MI | 24901 | 7610 | 40413 | 5561 | 43466 | 4511 | 44186 | 3689 | 43914 | 2473 | 52282 | 1690 | 36033 |
| 16-#14 | 2.50 | MA | 29812 | 7610 | 48383 | 5597 | 53012 | 4522 | 54962 | 3703 | 56935 | 2500 | 68529 | 2014 | 42651 |
| 4L-6S | | MI | 25479 | 7610 | 41489 | 5542 | 44764 | 4494 | 45782 | 3675 | 46012 | 2461 | 55106 | 1820 | 36656 |
| 16-#14 | 2.50 | MA | 29112 | 7610 | 47203 | 5592 | 51483 | 4540 | 53083 | 3719 | 54225 | 2488 | 65310 | 1956 | 42026 |
| 5E | | MI | 26073 | 7610 | 42471 | 5548 | 46123 | 4502 | 47443 | 3685 | 48158 | 2448 | 57747 | 1902 | 37410 |
| 16-#14 | 2.50 | MA | 28447 | 7610 | 46097 | 5588 | 49952 | 4533 | 51212 | 3710 | 51768 | 2500 | 62267 | 1875 | 41107 |
| 6L-4S | | MI | 26695 | 7610 | 43518 | 5554 | 47480 | 4485 | 49110 | 3671 | 50529 | 2461 | 60560 | 1958 | 37972 |
| 16-#14 | 2.50 | MA | 27798 | 7610 | 44885 | 5608 | 48490 | 4551 | 49414 | 3726 | 49368 | 2513 | 59018 | 1745 | 40386 |
| 7L-3S | | MI | 27390 | 7610 | 44726 | 5535 | 49019 | 4493 | 50980 | 3682 | 52893 | 2448 | 63213 | 2082 | 38046 |
| 16-#14 | 2.50 | MA | 27159 | 7610 | 43796 | 5603 | 47007 | 4545 | 47660 | 3742 | 46817 | 2500 | 56009 | 1676 | 39146 |
| 8L-2S | | MI | 28370 | 7610 | 46200 | 5541 | 50908 | 4477 | 53285 | 3667 | 55987 | 2436 | 67312 | 2207 | 38055 |
| 16-#18 | 4.44 | MA | 32849 | 8578 | 56245 | 6174 | 62904 | 4931 | 66962 | 3942 | 72953 | 2391 | 90011 | 1566 | 71917 |
| 4L-6S | | MI | 27245 | 8578 | 46875 | 6100 | 51401 | 4898 | 53936 | 3949 | 56593 | 2332 | 69644 | 1233 | 59455 |
| 16-#18 | 4.44 | MA | 31658 | 8578 | 54174 | 6164 | 60220 | 4961 | 63664 | 3968 | 68257 | 2369 | 84438 | 1467 | 69671 |
| 5E | | MI | 28255 | 8578 | 48599 | 6112 | 53785 | 4915 | 56717 | 3926 | 60297 | 2310 | 74171 | 1379 | 61801 |
| 16-#18 | 4.44 | MA | 30525 | 8578 | 52230 | 6154 | 57530 | 4946 | 60378 | 3949 | 64003 | 2391 | 79200 | 1322 | 67040 |
| 6L-4S | | MI | 29316 | 8578 | 50435 | 6125 | 56163 | 4888 | 59637 | 3904 | 64391 | 2332 | 79022 | 1474 | 63635 |
| 18-#11 | 1.95 | MA | 30428 | 7336 | 48487 | 5429 | 53235 | 4403 | 55264 | 3634 | 57267 | 2512 | 68560 | 2335 | 33775 |
| 2L-9S | | MI | 24015 | 7336 | 38173 | 5416 | 40684 | 4403 | 40822 | 3629 | 39371 | 2506 | 46388 | 1830 | 28458 |
| 18-#11 | 1.95 | MA | 29644 | 7336 | 47320 | 5426 | 51740 | 4416 | 53440 | 3646 | 54785 | 2521 | 65242 | 2249 | 33788 |
| 3L-8S | | MI | 24412 | 7336 | 38900 | 5402 | 41578 | 4391 | 41959 | 3636 | 40833 | 2498 | 48196 | 1884 | 29051 |
| 18-#11 | 1.95 | MA | 29093 | 7336 | 46369 | 5440 | 50528 | 4411 | 51966 | 3640 | 52889 | 2530 | 63084 | 2162 | 33762 |
| 4L-7S | | MI | 24814 | 7336 | 39576 | 5406 | 42497 | 4396 | 43047 | 3625 | 42403 | 2506 | 50045 | 1931 | 29324 |
| 18-#11 | 1.95 | MA | 28600 | 7336 | 45546 | 5437 | 49461 | 4424 | 50655 | 3652 | 50990 | 2521 | 60823 | 2122 | 33698 |
| 5L-6S | | MI | 25222 | 7336 | 40327 | 5392 | 43403 | 4384 | 44161 | 3615 | 43879 | 2498 | 52038 | 2021 | 29681 |
| 18-#11 | 1.95 | MA | 28131 | 7336 | 44775 | 5434 | 48392 | 4420 | 49350 | 3646 | 49270 | 2530 | 58680 | 2066 | 33256 |
| 6L-5S | | MI | 25640 | 7336 | 41013 | 5396 | 44352 | 4390 | 45320 | 3621 | 45389 | 2489 | 53903 | 2077 | 30063 |
| 18-#11 | 1.95 | MA | 27674 | 7336 | 43930 | 5449 | 47373 | 4433 | 48096 | 3658 | 47588 | 2539 | 56392 | 1975 | 32816 |
| 7L-4S | | MI | 26078 | 7336 | 41744 | 5400 | 45300 | 4377 | 46484 | 3611 | 47056 | 2498 | 55882 | 2117 | 30101 |
| 18-#11 | 1.95 | MA | 27224 | 7336 | 43170 | 5446 | 46339 | 4429 | 46873 | 3669 | 45801 | 2531 | 54278 | 1927 | 32488 |
| 8L-3S | | MI | 26568 | 7336 | 42587 | 5386 | 46375 | 4383 | 47791 | 3617 | 48720 | 2489 | 57756 | 2203 | 30103 |
| 18-#11 | 1.95 | MA | 26765 | 7336 | 42352 | 5460 | 45333 | 4442 | 45593 | 3664 | 44134 | 2539 | 52200 | 1873 | 31778 |
| 9L-2S | | MI | 27260 | 7336 | 43619 | 5390 | 47697 | 4371 | 49404 | 3607 | 50896 | 2480 | 60648 | 2289 | 30082 |
| 18-#14 | 2.81 | MA | 31355 | 7765 | 51414 | 5674 | 56888 | 4598 | 59682 | 3754 | 63180 | 2475 | 76304 | 2109 | 47939 |
| 3L-8S | | MI | 25014 | 7765 | 40918 | 5653 | 44038 | 4572 | 44933 | 3746 | 44777 | 2445 | 53753 | 1591 | 39384 |
| 18-#14 | 2.81 | MA | 30577 | 7765 | 50051 | 5694 | 55151 | 4592 | 57571 | 3745 | 60474 | 2487 | 73243 | 1985 | 47805 |
| 4L-7S | | MI | 25580 | 7765 | 41886 | 5659 | 45355 | 4580 | 46491 | 3732 | 47008 | 2458 | 56381 | 1657 | 40382 |
| 18-#14 | 2.81 | MA | 29882 | 7765 | 48872 | 5690 | 53622 | 4610 | 55692 | 3762 | 57764 | 2475 | 70025 | 1927 | 47025 |
| 5L-6S | | MI | 26155 | 7765 | 42962 | 5639 | 46653 | 4564 | 48087 | 3717 | 49105 | 2445 | 59205 | 1787 | 41105 |
| 18-#14 | 2.81 | MA | 29220 | 7765 | 47765 | 5685 | 52090 | 4603 | 53821 | 3753 | 55308 | 2487 | 66982 | 1846 | 46148 |
| 6L-5S | | MI | 26746 | 7765 | 43945 | 5645 | 48013 | 4572 | 49748 | 3728 | 51252 | 2433 | 61847 | 1869 | 41821 |
| 18-#14 | 2.81 | MA | 28575 | 7765 | 46553 | 5705 | 50628 | 4621 | 52023 | 3769 | 52907 | 2500 | 63732 | 1716 | 45328 |
| 7L-4S | | MI | 27365 | 7765 | 44992 | 5651 | 49370 | 4555 | 51415 | 3714 | 53622 | 2445 | 64659 | 1925 | 42529 |
| 18-#14 | 2.81 | MA | 27939 | 7765 | 45464 | 5701 | 49146 | 4614 | 50269 | 3785 | 50356 | 2487 | 60724 | 1647 | 44131 |
| 8L-3S | | MI | 28056 | 7765 | 46200 | 5632 | 50908 | 4563 | 53285 | 3724 | 55987 | 2433 | 67312 | 2049 | 42627 |
| 18-#14 | 2.81 | MA | 27311 | 7765 | 44291 | 5721 | 47703 | 4633 | 48435 | 3776 | 47977 | 2500 | 57773 | 1569 | 42915 |
| 9L-2S | | MI | 29032 | 7765 | 47674 | 5638 | 52798 | 4547 | 55590 | 3710 | 59080 | 2421 | 71411 | 2174 | 42662 |
| 18-#18 | 5.00 | MA | 32962 | 8855 | 57091 | 6337 | 63959 | 5085 | 68226 | 4043 | 74387 | 2342 | 92566 | 1408 | 78435 |
| 5L-6S | | MI | 28390 | 8855 | 49447 | 6273 | 54698 | 5022 | 57958 | 4024 | 61932 | 2301 | 76680 | 1166 | 66993 |
| 18-#18 | 5.00 | MA | 31837 | 8855 | 55147 | 6327 | 61269 | 5071 | 64940 | 4025 | 70133 | 2364 | 87327 | 1263 | 75629 |
| 6L-5S | | MI | 29393 | 8855 | 51171 | 6285 | 57081 | 5039 | 60738 | 4002 | 65636 | 2279 | 81207 | 1312 | 69511 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis

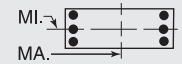


$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 2.17 | MA | 30184 | 7444 | 48487 | 5493 | 53235 | 4464 | 55264 | 3675 | 57267 | 2512 | 68560 | 2230 | 37421 |
| 3L-9S | | MI | 24498 | 7444 | 39205 | 5484 | 42006 | 4452 | 42435 | 3658 | 41547 | 2496 | 49279 | 1808 | 31549 |
| 20-#11 | 2.17 | MA | 29635 | 7444 | 47535 | 5508 | 52023 | 4460 | 53790 | 3669 | 55371 | 2521 | 66403 | 2144 | 37384 |
| 4L-8S | | MI | 24894 | 7444 | 39932 | 5470 | 42900 | 4440 | 43572 | 3665 | 43010 | 2488 | 51087 | 1863 | 32121 |
| 20-#11 | 2.17 | MA | 29144 | 7444 | 46713 | 5505 | 50956 | 4473 | 52479 | 3681 | 53472 | 2513 | 64142 | 2103 | 37305 |
| 5L-7S | | MI | 25294 | 7444 | 40607 | 5474 | 43819 | 4445 | 44660 | 3654 | 44579 | 2496 | 52937 | 1909 | 32458 |
| 20-#11 | 2.17 | MA | 28677 | 7444 | 45941 | 5502 | 49887 | 4469 | 51173 | 3675 | 51751 | 2521 | 61998 | 2047 | 36784 |
| 6E | | MI | 25700 | 7444 | 41358 | 5460 | 44725 | 4433 | 45773 | 3644 | 46055 | 2488 | 54930 | 1999 | 32800 |
| 20-#11 | 2.17 | MA | 28222 | 7444 | 45096 | 5516 | 48868 | 4482 | 49920 | 3687 | 50069 | 2530 | 59710 | 1957 | 36362 |
| 7L-5S | | MI | 26116 | 7444 | 42044 | 5464 | 45674 | 4438 | 46933 | 3651 | 47566 | 2479 | 56794 | 2056 | 33257 |
| 20-#11 | 2.17 | MA | 27774 | 7444 | 44336 | 5513 | 47834 | 4477 | 48696 | 3699 | 48282 | 2522 | 57597 | 1909 | 35968 |
| 8L-4S | | MI | 26553 | 7444 | 42775 | 5467 | 46622 | 4426 | 48097 | 3640 | 49233 | 2488 | 58773 | 2095 | 33310 |
| 20-#11 | 2.17 | MA | 27319 | 7444 | 43518 | 5528 | 46828 | 4490 | 47417 | 3693 | 46616 | 2531 | 55518 | 1855 | 35280 |
| 9L-3S | | MI | 27041 | 7444 | 43619 | 5454 | 47697 | 4431 | 49404 | 3647 | 50896 | 2479 | 60648 | 2182 | 33329 |
| 20-#11 | 2.17 | MA | 26831 | 7444 | 42761 | 5525 | 45807 | 4486 | 46200 | 3705 | 44964 | 2540 | 53505 | 1794 | 34720 |
| 10L-2S | | MI | 27731 | 7444 | 44650 | 5457 | 49019 | 4419 | 51017 | 3636 | 53073 | 2471 | 63539 | 2268 | 33315 |
| 20-#14 | 3.13 | MA | 31338 | 7921 | 51719 | 5792 | 57290 | 4661 | 60180 | 3788 | 64014 | 2474 | 77958 | 1956 | 52954 |
| 4L-8S | | MI | 25692 | 7921 | 42392 | 5750 | 45927 | 4642 | 47238 | 3789 | 47870 | 2430 | 57852 | 1558 | 43782 |
| 20-#14 | 3.13 | MA | 30647 | 7921 | 50540 | 5787 | 55761 | 4680 | 58301 | 3804 | 61304 | 2462 | 74739 | 1898 | 52036 |
| 5L-7S | | MI | 26255 | 7921 | 43360 | 5756 | 47244 | 4650 | 48796 | 3774 | 50101 | 2443 | 60480 | 1624 | 44744 |
| 20-#14 | 3.13 | MA | 29988 | 7921 | 49434 | 5782 | 54229 | 4673 | 56430 | 3795 | 58847 | 2474 | 71696 | 1817 | 51197 |
| 6E | | MI | 26827 | 7921 | 44436 | 5737 | 48542 | 4634 | 50392 | 3760 | 52199 | 2430 | 63304 | 1754 | 45560 |
| 20-#14 | 3.13 | MA | 29347 | 7921 | 48222 | 5803 | 52767 | 4691 | 54633 | 3811 | 56447 | 2487 | 68447 | 1687 | 50281 |
| 7L-5S | | MI | 27415 | 7921 | 45419 | 5743 | 49902 | 4642 | 52053 | 3770 | 54346 | 2418 | 65946 | 1836 | 46243 |
| 20-#14 | 3.13 | MA | 28715 | 7921 | 47132 | 5798 | 51284 | 4684 | 52878 | 3827 | 53896 | 2474 | 65438 | 1619 | 49124 |
| 8L-4S | | MI | 28031 | 7921 | 46466 | 5748 | 51259 | 4625 | 53720 | 3756 | 56716 | 2430 | 68758 | 1891 | 47081 |
| 20-#14 | 3.13 | MA | 28090 | 7921 | 45959 | 5818 | 49842 | 4702 | 51044 | 3818 | 51517 | 2487 | 62488 | 1540 | 47846 |
| 9L-3S | | MI | 28719 | 7921 | 47674 | 5729 | 52798 | 4633 | 55590 | 3766 | 59080 | 2418 | 71411 | 2016 | 47200 |
| 20-#18 | 5.56 | MA | 33139 | 9131 | 58064 | 6500 | 65009 | 5195 | 69502 | 4100 | 76263 | 2338 | 95455 | 1205 | 84243 |
| 6E | | MI | 29527 | 9131 | 52018 | 6445 | 57994 | 5146 | 61979 | 4099 | 67271 | 2270 | 83716 | 1099 | 74554 |
| 22-#11 | 2.38 | MA | 30175 | 7552 | 48702 | 5575 | 53518 | 4508 | 55614 | 3699 | 57852 | 2512 | 69721 | 2125 | 41003 |
| 4L-9S | | MI | 24979 | 7552 | 40236 | 5551 | 43328 | 4500 | 44048 | 3688 | 43724 | 2487 | 52171 | 1787 | 34644 |
| 22-#11 | 2.38 | MA | 29686 | 7552 | 47879 | 5572 | 52451 | 4521 | 54303 | 3710 | 55953 | 2504 | 67460 | 2084 | 40909 |
| 5L-8S | | MI | 25373 | 7552 | 40963 | 5537 | 44222 | 4488 | 45185 | 3694 | 45187 | 2478 | 53979 | 1841 | 35197 |
| 22-#11 | 2.38 | MA | 29221 | 7552 | 47107 | 5569 | 51382 | 4517 | 52997 | 3705 | 54233 | 2513 | 65317 | 2028 | 40318 |
| 6L-7S | | MI | 25771 | 7552 | 41638 | 5541 | 45141 | 4493 | 46273 | 3684 | 46756 | 2487 | 55828 | 1888 | 35595 |
| 22-#11 | 2.38 | MA | 28768 | 7552 | 46262 | 5584 | 50363 | 4530 | 51744 | 3717 | 52551 | 2522 | 63029 | 1938 | 39910 |
| 7L-6S | | MI | 26176 | 7552 | 42390 | 5527 | 46047 | 4481 | 47386 | 3673 | 48232 | 2478 | 57821 | 1978 | 35923 |
| 22-#11 | 2.38 | MA | 28321 | 7552 | 45503 | 5581 | 49329 | 4526 | 50520 | 3728 | 50764 | 2513 | 60915 | 1890 | 39455 |
| 8L-5S | | MI | 26591 | 7552 | 43075 | 5531 | 46997 | 4486 | 48546 | 3680 | 49742 | 2469 | 59686 | 2034 | 36448 |
| 22-#11 | 2.38 | MA | 27871 | 7552 | 44685 | 5595 | 48323 | 4539 | 49241 | 3723 | 49098 | 2522 | 58837 | 1836 | 38788 |
| 9L-4S | | MI | 27026 | 7552 | 43806 | 5535 | 47944 | 4474 | 49710 | 3670 | 51409 | 2478 | 61665 | 2074 | 36514 |
| 22-#11 | 2.38 | MA | 27382 | 7552 | 43927 | 5592 | 47302 | 4535 | 48024 | 3734 | 47445 | 2531 | 56824 | 1775 | 38185 |
| 10L-3S | | MI | 27512 | 7552 | 44650 | 5521 | 49019 | 4479 | 51017 | 3676 | 53073 | 2469 | 63539 | 2160 | 36544 |
| 22-#14 | 3.44 | MA | 31407 | 8077 | 52208 | 5884 | 57899 | 4749 | 60910 | 3846 | 64843 | 2449 | 79454 | 1869 | 57057 |
| 5L-8S | | MI | 26366 | 8077 | 43866 | 5847 | 47817 | 4712 | 49543 | 3831 | 50964 | 2415 | 61951 | 1524 | 48189 |
| 22-#14 | 3.44 | MA | 30752 | 8077 | 51102 | 5880 | 56368 | 4743 | 59039 | 3838 | 62387 | 2461 | 76411 | 1788 | 56252 |
| 6L-7S | | MI | 26926 | 8077 | 44834 | 5853 | 49133 | 4720 | 51101 | 3817 | 53195 | 2427 | 64579 | 1590 | 49116 |
| 22-#14 | 3.44 | MA | 30114 | 8077 | 49890 | 5900 | 54906 | 4761 | 57242 | 3854 | 59986 | 2474 | 73161 | 1658 | 55245 |
| 7L-6S | | MI | 27496 | 8077 | 45910 | 5834 | 50432 | 4703 | 52696 | 3802 | 55293 | 2415 | 67403 | 1721 | 50021 |
| 22-#14 | 3.44 | MA | 29485 | 8077 | 48801 | 5895 | 53423 | 4754 | 55487 | 3870 | 57435 | 2461 | 70153 | 1590 | 54126 |
| 8L-5S | | MI | 28080 | 8077 | 46893 | 5840 | 51791 | 4712 | 54358 | 3813 | 57439 | 2403 | 70045 | 1802 | 50674 |
| 22-#14 | 3.44 | MA | 28864 | 8077 | 47628 | 5915 | 51980 | 4772 | 53653 | 3861 | 55056 | 2474 | 67202 | 1512 | 52787 |
| 9L-4S | | MI | 28693 | 8077 | 47940 | 5846 | 53148 | 4695 | 56025 | 3798 | 59810 | 2415 | 72857 | 1858 | 51627 |
| 24-#11 | 2.60 | MA | 30225 | 7659 | 49045 | 5640 | 53946 | 4570 | 56127 | 3740 | 58435 | 2495 | 70779 | 2066 | 44511 |
| 5L-9S | | MI | 25457 | 7659 | 41267 | 5618 | 44650 | 4549 | 45661 | 3717 | 45900 | 2477 | 55062 | 1765 | 37744 |
| 24-#11 | 2.60 | MA | 29762 | 7659 | 48274 | 5637 | 52878 | 4565 | 54821 | 3734 | 56714 | 2504 | 68636 | 2009 | 43855 |
| 6L-8S | | MI | 25850 | 7659 | 41994 | 5605 | 45544 | 4537 | 46798 | 3724 | 47363 | 2468 | 56870 | 1819 | 38280 |

## RECTANGULAR TIED COLUMNS 36" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.60 | MA | 29311 | 7659 | 47428 | 5651 | 51858 | 4578 | 53568 | 3746 | 55032 | 2513 | 66348 | 1919 | 43461 |
| 7E | | MI | 26247 | 7659 | 42670 | 5608 | 46463 | 4542 | 47886 | 3713 | 48932 | 2477 | 58720 | 1866 | 38734 |
| 24-#11 | 2.60 | MA | 28866 | 7659 | 46669 | 5648 | 50824 | 4574 | 52344 | 3758 | 53246 | 2505 | 64234 | 1871 | 42947 |
| 8L-6S | | MI | 26650 | 7659 | 43421 | 5595 | 47370 | 4530 | 48999 | 3703 | 50408 | 2468 | 60713 | 1956 | 39051 |
| 24-#11 | 2.60 | MA | 28426 | 7659 | 45851 | 5663 | 49818 | 4587 | 51065 | 3752 | 51579 | 2514 | 62156 | 1817 | 42301 |
| 9L-5S | | MI | 27063 | 7659 | 44107 | 5598 | 48319 | 4535 | 50159 | 3709 | 51919 | 2460 | 62577 | 2013 | 39611 |
| 24-#11 | 2.60 | MA | 27931 | 7659 | 45094 | 5660 | 48797 | 4583 | 49847 | 3764 | 49927 | 2522 | 60143 | 1756 | 41655 |
| 10L-4S | | MI | 27497 | 7659 | 44838 | 5602 | 49266 | 4523 | 51323 | 3699 | 53586 | 2468 | 64556 | 2052 | 39714 |
| 24-#14 | 3.75 | MA | 31511 | 8232 | 52770 | 5977 | 58506 | 4813 | 61648 | 3880 | 65926 | 2448 | 81125 | 1759 | 61312 |
| 6L-8S | | MI | 27036 | 8232 | 45340 | 5944 | 49706 | 4782 | 51848 | 3873 | 54057 | 2400 | 66050 | 1491 | 52602 |
| 24-#14 | 3.75 | MA | 30876 | 8232 | 51558 | 5997 | 57044 | 4831 | 59851 | 3896 | 63526 | 2460 | 77876 | 1629 | 60219 |
| 7E | | MI | 27594 | 8232 | 46308 | 5950 | 51023 | 4790 | 53406 | 3859 | 56288 | 2412 | 68678 | 1557 | 53497 |
| 24-#14 | 3.75 | MA | 30252 | 8232 | 50469 | 5992 | 55561 | 4824 | 58096 | 3912 | 60975 | 2448 | 74867 | 1561 | 59134 |
| 8L-6S | | MI | 28160 | 8232 | 47384 | 5931 | 52321 | 4773 | 55001 | 3845 | 58386 | 2400 | 71502 | 1687 | 54486 |
| 24-#14 | 3.75 | MA | 29633 | 8232 | 49296 | 6013 | 54119 | 4842 | 56262 | 3903 | 58596 | 2460 | 71917 | 1483 | 57737 |
| 9L-5S | | MI | 28742 | 8232 | 48366 | 5937 | 53680 | 4781 | 56663 | 3855 | 60533 | 2387 | 74144 | 1769 | 55112 |

## RECTANGULAR TIED COLUMNS 36" x 42"

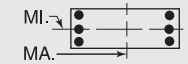
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4-#18 | 1.06 | MA | 30998 | 7236 | 48227 | 5371 | 51775 | 4383 | 52410 | 3663 | 51419 | 2649 | 59784 | 2500 | 20473 |
| 2E | | MI | 26452 | 7236 | 41420 | 5304 | 44164 | 4327 | 44542 | 3615 | 43330 | 2601 | 50097 | 2441 | 17376 |
| 6-#18 | 1.59 | MA | 32433 | 7513 | 51317 | 5544 | 55737 | 4507 | 57243 | 3738 | 57946 | 2624 | 68459 | 2446 | 30228 |
| 2L-3S | | MI | 25895 | 7513 | 41420 | 5464 | 44164 | 4479 | 44542 | 3713 | 43330 | 2592 | 50097 | 2152 | 25649 |
| 6-#18 | 1.59 | MA | 30348 | 7513 | 48227 | 5535 | 51775 | 4538 | 52410 | 3765 | 51419 | 2647 | 59784 | 2224 | 30296 |
| 3L-2S | | MI | 27626 | 7513 | 43991 | 5477 | 47460 | 4451 | 48563 | 3691 | 48669 | 2570 | 57133 | 2374 | 25539 |
| 8-#14 | 1.19 | MA | 31444 | 7305 | 48950 | 5451 | 52910 | 4444 | 53874 | 3707 | 53537 | 2669 | 62744 | 2520 | 23075 |
| 2L-4S | | MI | 25119 | 7305 | 39344 | 5403 | 41713 | 4402 | 41633 | 3668 | 39716 | 2649 | 45890 | 2214 | 19698 |
| 8-#14 | 1.19 | MA | 30242 | 7305 | 47185 | 5447 | 50647 | 4463 | 51112 | 3724 | 49781 | 2681 | 57721 | 2396 | 23138 |
| 3E | | MI | 25829 | 7305 | 40551 | 5384 | 43252 | 4410 | 43503 | 3678 | 42080 | 2637 | 48542 | 2339 | 19633 |
| 8-#14 | 1.19 | MA | 29396 | 7305 | 45745 | 5468 | 48812 | 4456 | 48882 | 3716 | 46910 | 2694 | 54456 | 2271 | 23171 |
| 4L-2S | | MI | 26830 | 7305 | 42025 | 5390 | 45141 | 4393 | 45808 | 3664 | 45174 | 2625 | 52641 | 2463 | 19560 |
| 8-#18 | 2.12 | MA | 33851 | 7790 | 54407 | 5717 | 59698 | 4631 | 62075 | 3813 | 64473 | 2600 | 77133 | 2391 | 39930 |
| 2L-4S | | MI | 25846 | 7790 | 41877 | 5669 | 44767 | 4586 | 45290 | 3767 | 44589 | 2583 | 52594 | 1864 | 33503 |
| 8-#18 | 2.12 | MA | 31783 | 7790 | 51317 | 5708 | 55737 | 4662 | 57243 | 3841 | 57946 | 2622 | 68459 | 2170 | 39905 |
| 3E | | MI | 27070 | 7790 | 43991 | 5637 | 47460 | 4603 | 48563 | 3789 | 48669 | 2561 | 57133 | 2085 | 33687 |
| 8-#18 | 2.12 | MA | 30324 | 7790 | 48790 | 5743 | 52516 | 4649 | 53329 | 3824 | 52957 | 2644 | 62834 | 1948 | 39568 |
| 4L-2S | | MI | 28787 | 7790 | 46562 | 5650 | 50757 | 4576 | 52584 | 3766 | 54008 | 2539 | 64169 | 2307 | 33643 |
| 10-#11 | 1.03 | MA | 31039 | 7222 | 47974 | 5417 | 51765 | 4422 | 52516 | 3697 | 51707 | 2685 | 60425 | 2550 | 20166 |
| 2L-5S | | MI | 24855 | 7222 | 38604 | 5366 | 40854 | 4393 | 40613 | 3671 | 38248 | 2657 | 44068 | 2288 | 17268 |
| 10-#11 | 1.03 | MA | 30195 | 7222 | 46741 | 5415 | 50183 | 4418 | 50587 | 3709 | 49082 | 2695 | 56892 | 2464 | 20212 |
| 3L-4S | | MI | 25301 | 7222 | 39335 | 5369 | 41801 | 4381 | 41777 | 3660 | 39916 | 2665 | 46047 | 2327 | 17223 |
| 10-#11 | 1.03 | MA | 29603 | 7222 | 45736 | 5430 | 48903 | 4431 | 49030 | 3704 | 47079 | 2704 | 54592 | 2378 | 20254 |
| 4L-3S | | MI | 25799 | 7222 | 40179 | 5356 | 42876 | 4386 | 43084 | 3667 | 41579 | 2657 | 47921 | 2413 | 17170 |
| 10-#11 | 1.03 | MA | 29073 | 7222 | 44867 | 5427 | 47776 | 4427 | 47646 | 3716 | 45074 | 2696 | 52190 | 2336 | 20271 |
| 5L-2S | | MI | 26502 | 7222 | 41210 | 5359 | 44198 | 4374 | 44697 | 3656 | 43756 | 2648 | 50813 | 2500 | 17119 |
| 10-#14 | 1.49 | MA | 32271 | 7461 | 50716 | 5548 | 55174 | 4514 | 56635 | 3749 | 57294 | 2656 | 67767 | 2493 | 28633 |
| 2L-5S | | MI | 25173 | 7461 | 39771 | 5494 | 42245 | 4488 | 42271 | 3725 | 40439 | 2622 | 47176 | 2125 | 24269 |
| 10-#14 | 1.49 | MA | 31076 | 7461 | 48950 | 5544 | 52910 | 4532 | 53874 | 3766 | 53537 | 2669 | 62744 | 2368 | 28677 |
| 3L-4S | | MI | 25807 | 7461 | 40817 | 5500 | 43602 | 4472 | 43938 | 3710 | 42810 | 2634 | 49989 | 2181 | 24316 |
| 10-#14 | 1.49 | MA | 30234 | 7461 | 47510 | 5565 | 51075 | 4526 | 51643 | 3758 | 50667 | 2682 | 59479 | 2244 | 28666 |
| 4L-3S | | MI | 26514 | 7461 | 42025 | 5481 | 45141 | 4480 | 45808 | 3721 | 45174 | 2622 | 52641 | 2306 | 24278 |
| 10-#14 | 1.49 | MA | 29482 | 7461 | 46265 | 5561 | 49460 | 4545 | 49658 | 3775 | 47792 | 2670 | 56057 | 2185 | 28542 |
| 5L-2S | | MI | 27509 | 7461 | 43499 | 5487 | 47030 | 4463 | 48113 | 3706 | 48268 | 2609 | 56741 | 2430 | 24219 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis

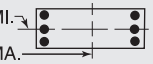



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 2.65 | MA | 35253 | 8066 | 57497 | 5890 | 63659 | 4755 | 66908 | 3889 | 70999 | 2575 | 85808 | 2336 | 49597 |
| 2L-5S | | MI | 25929 | 8066 | 42613 | 5830 | 45685 | 4737 | 46391 | 3865 | 45835 | 2530 | 54779 | 1702 | 39104 |
| 10-#18 | 2.65 | MA | 33202 | 8066 | 54407 | 5881 | 59698 | 4786 | 62075 | 3916 | 64473 | 2597 | 77133 | 2115 | 49482 |
| 3L-4S | | MI | 27018 | 8066 | 44448 | 5842 | 48063 | 4710 | 49312 | 3842 | 49928 | 2552 | 59630 | 1797 | 41401 |
| 10-#18 | 2.65 | MA | 31756 | 8066 | 51880 | 5916 | 56477 | 4773 | 58162 | 3899 | 59484 | 2619 | 71509 | 1893 | 49046 |
| 4L-3S | | MI | 28232 | 8066 | 46562 | 5810 | 50757 | 4727 | 52584 | 3864 | 54008 | 2530 | 64169 | 2019 | 41677 |
| 10-#18 | 2.65 | MA | 30463 | 8066 | 49691 | 5907 | 53640 | 4805 | 54675 | 3926 | 54485 | 2597 | 65574 | 1792 | 46216 |
| 5L-2S | | MI | 29937 | 8066 | 49134 | 5823 | 54053 | 4700 | 56605 | 3842 | 59347 | 2508 | 71205 | 2240 | 41711 |
| 12-#11 | 1.24 | MA | 31622 | 7330 | 49208 | 5485 | 53346 | 4470 | 54446 | 3726 | 54332 | 2677 | 63957 | 2533 | 24054 |
| 2L-6S | | MI | 24918 | 7330 | 38950 | 5429 | 41227 | 4436 | 41066 | 3693 | 38915 | 2655 | 45095 | 2210 | 20485 |
| 12-#11 | 1.24 | MA | 30782 | 7330 | 47974 | 5482 | 51765 | 4466 | 52516 | 3739 | 51707 | 2686 | 60425 | 2446 | 24092 |
| 3L-5S | | MI | 25342 | 7330 | 39635 | 5433 | 42176 | 4441 | 42226 | 3700 | 40425 | 2647 | 46959 | 2266 | 20500 |
| 12-#11 | 1.24 | MA | 30192 | 7330 | 46969 | 5497 | 50484 | 4480 | 50960 | 3733 | 49704 | 2696 | 58125 | 2360 | 24120 |
| 4E | | MI | 25786 | 7330 | 40366 | 5437 | 43123 | 4429 | 43390 | 3690 | 42092 | 2655 | 48938 | 2306 | 20473 |
| 12-#11 | 1.24 | MA | 29665 | 7330 | 46101 | 5495 | 49358 | 4476 | 49575 | 3746 | 47699 | 2688 | 55723 | 2319 | 24112 |
| 5L-3S | | MI | 26282 | 7330 | 41210 | 5423 | 44198 | 4434 | 44697 | 3696 | 43756 | 2647 | 50813 | 2392 | 20430 |
| 12-#11 | 1.24 | MA | 29163 | 7330 | 45286 | 5492 | 48229 | 4489 | 48197 | 3740 | 45882 | 2697 | 53440 | 2263 | 24044 |
| 6L-2S | | MI | 26983 | 7330 | 42241 | 5427 | 45521 | 4422 | 46310 | 3686 | 45932 | 2638 | 53704 | 2478 | 20385 |
| 12-#14 | 1.79 | MA | 33092 | 7617 | 52482 | 5645 | 57437 | 4583 | 59396 | 3792 | 61051 | 2644 | 72789 | 2466 | 34175 |
| 2L-6S | | MI | 25259 | 7617 | 40262 | 5586 | 42775 | 4550 | 42915 | 3757 | 41386 | 2619 | 48634 | 2011 | 27976 |
| 12-#14 | 1.79 | MA | 31903 | 7617 | 50716 | 5641 | 55174 | 4602 | 56635 | 3808 | 57294 | 2657 | 67767 | 2341 | 34198 |
| 3L-5S | | MI | 25860 | 7617 | 41244 | 5592 | 44134 | 4558 | 44576 | 3767 | 43533 | 2607 | 51275 | 2092 | 28825 |
| 12-#14 | 1.79 | MA | 31066 | 7617 | 49276 | 5662 | 53339 | 4596 | 54404 | 3800 | 54424 | 2669 | 64501 | 2217 | 34147 |
| 4E | | MI | 26491 | 7617 | 42291 | 5597 | 45491 | 4542 | 46243 | 3753 | 45903 | 2619 | 54088 | 2148 | 28908 |
| 12-#14 | 1.79 | MA | 30318 | 7617 | 48030 | 5658 | 51723 | 4615 | 52419 | 3817 | 51549 | 2657 | 61079 | 2158 | 33985 |
| 5L-3S | | MI | 27194 | 7617 | 43499 | 5578 | 47030 | 4550 | 48113 | 3763 | 48268 | 2607 | 56741 | 2272 | 28905 |
| 12-#14 | 1.79 | MA | 29606 | 7617 | 46862 | 5654 | 50105 | 4609 | 50442 | 3809 | 48944 | 2670 | 57835 | 2077 | 32902 |
| 6L-2S | | MI | 28185 | 7617 | 44973 | 5584 | 48919 | 4533 | 50418 | 3749 | 51361 | 2594 | 60840 | 2397 | 28862 |
| 12-#18 | 3.17 | MA | 36642 | 8343 | 60587 | 6063 | 67620 | 4879 | 71740 | 3964 | 77526 | 2550 | 94482 | 2282 | 59222 |
| 2L-6S | | MI | 26069 | 8343 | 43460 | 5990 | 46598 | 4844 | 47632 | 3963 | 47470 | 2521 | 57288 | 1489 | 44981 |
| 12-#18 | 3.17 | MA | 34607 | 8343 | 57497 | 6054 | 63659 | 4911 | 66908 | 3991 | 70999 | 2572 | 85808 | 2060 | 59037 |
| 3L-5S | | MI | 27098 | 8343 | 45184 | 6002 | 48981 | 4861 | 50412 | 3940 | 51174 | 2499 | 61814 | 1635 | 46746 |
| 12-#18 | 3.17 | MA | 33173 | 8343 | 54970 | 6089 | 60439 | 4897 | 62994 | 3974 | 66011 | 2594 | 80183 | 1839 | 58256 |
| 4E | | MI | 28179 | 8343 | 47020 | 6015 | 51360 | 4834 | 53333 | 3918 | 55267 | 2521 | 66665 | 1730 | 48891 |
| 12-#18 | 3.17 | MA | 31891 | 8343 | 52781 | 6080 | 57601 | 4929 | 59508 | 4002 | 61012 | 2572 | 74249 | 1737 | 55436 |
| 5L-3S | | MI | 29383 | 8343 | 49134 | 5983 | 54053 | 4851 | 56605 | 3940 | 59347 | 2499 | 71205 | 1952 | 49640 |
| 12-#18 | 3.17 | MA | 30671 | 8343 | 50727 | 6071 | 54758 | 4916 | 56034 | 3985 | 56483 | 2594 | 68654 | 1593 | 53281 |
| 6L-2S | | MI | 31076 | 8343 | 51705 | 5995 | 57349 | 4824 | 60627 | 3917 | 64686 | 2477 | 78241 | 2173 | 49749 |
| 14-#11 | 1.44 | MA | 32203 | 7438 | 50442 | 5552 | 54928 | 4518 | 56375 | 3756 | 56957 | 2668 | 67490 | 2515 | 27933 |
| 2L-7S | | MI | 24992 | 7438 | 39230 | 5510 | 41643 | 4496 | 41565 | 3733 | 39615 | 2654 | 45993 | 2098 | 23207 |
| 14-#11 | 1.44 | MA | 31366 | 7438 | 49208 | 5550 | 53346 | 4515 | 54446 | 3768 | 54332 | 2677 | 63957 | 2429 | 27963 |
| 3L-6S | | MI | 25404 | 7438 | 39981 | 5497 | 42549 | 4484 | 42679 | 3723 | 41091 | 2646 | 47986 | 2188 | 23611 |
| 14-#11 | 1.44 | MA | 30778 | 7438 | 48203 | 5564 | 52066 | 4528 | 52889 | 3763 | 52329 | 2687 | 61658 | 2343 | 27978 |
| 4L-5S | | MI | 25826 | 7438 | 40667 | 5500 | 43498 | 4489 | 43839 | 3730 | 42601 | 2637 | 49851 | 2245 | 23720 |
| 14-#11 | 1.44 | MA | 30253 | 7438 | 47334 | 5562 | 50939 | 4524 | 51505 | 3775 | 50324 | 2679 | 59256 | 2301 | 27945 |
| 5L-4S | | MI | 26269 | 7438 | 41398 | 5504 | 44445 | 4477 | 45003 | 3719 | 44269 | 2646 | 51830 | 2284 | 23711 |
| 14-#11 | 1.44 | MA | 29753 | 7438 | 46520 | 5559 | 49811 | 4538 | 50126 | 3770 | 48507 | 2689 | 56973 | 2245 | 27768 |
| 6L-3S | | MI | 26763 | 7438 | 42241 | 5490 | 45521 | 4483 | 46310 | 3726 | 45932 | 2637 | 53704 | 2370 | 23679 |
| 14-#11 | 1.44 | MA | 29266 | 7438 | 45628 | 5574 | 48735 | 4534 | 48803 | 3782 | 46731 | 2698 | 54537 | 2155 | 27232 |
| 7L-2S | | MI | 27461 | 7438 | 43273 | 5494 | 46843 | 4470 | 47922 | 3715 | 48109 | 2628 | 56596 | 2457 | 23641 |
| 14-#14 | 2.08 | MA | 33908 | 7772 | 54247 | 5743 | 59700 | 4653 | 62157 | 3834 | 64808 | 2631 | 77812 | 2439 | 39705 |
| 2L-7S | | MI | 25362 | 7772 | 40659 | 5702 | 43366 | 4637 | 43624 | 3813 | 42382 | 2616 | 49909 | 1847 | 31909 |
| 14-#14 | 2.08 | MA | 32724 | 7772 | 52482 | 5739 | 57437 | 4672 | 59396 | 3851 | 61051 | 2644 | 72789 | 2314 | 39699 |
| 3L-6S | | MI | 25945 | 7772 | 41735 | 5683 | 44664 | 4620 | 45219 | 3799 | 44480 | 2604 | 52733 | 1977 | 32407 |
| 14-#14 | 2.08 | MA | 31892 | 7772 | 51042 | 5759 | 55602 | 4666 | 57165 | 3843 | 58180 | 2657 | 69524 | 2190 | 39618 |
| 4L-5S | | MI | 26543 | 7772 | 42718 | 5689 | 46024 | 4628 | 46881 | 3809 | 46627 | 2591 | 55374 | 2059 | 33226 |
| 14-#14 | 2.08 | MA | 31149 | 7772 | 49796 | 5755 | 53987 | 4685 | 55180 | 3860 | 55306 | 2645 | 66102 | 2131 | 39300 |
| 5L-4S | | MI | 27170 | 7772 | 43765 | 5695 | 47381 | 4611 | 48548 | 3795 | 48997 | 2604 | 58187 | 2115 | 33487 |

## RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

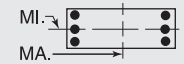
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.08 | MA | 30441 | 7772 | 48628 | 5751 | 52369 | 4679 | 53203 | 3851 | 52701 | 2658 | 62858 | 2050 | 38221 |
| 6L-3S | | MI | 27870 | 7772 | 44973 | 5676 | 48919 | 4620 | 50418 | 3806 | 51361 | 2591 | 60840 | 2239 | 33521 |
| 14-#14 | 2.08 | MA | 29751 | 7772 | 47348 | 5772 | 50825 | 4697 | 51306 | 3868 | 50155 | 2670 | 59395 | 1920 | 37545 |
| 7L-2S | | MI | 28856 | 7772 | 46446 | 5681 | 50809 | 4603 | 52722 | 3791 | 54455 | 2579 | 64939 | 2364 | 33492 |
| 14-#18 | 3.70 | MA | 35998 | 8620 | 60587 | 6227 | 67620 | 5035 | 71740 | 4067 | 77526 | 2547 | 94482 | 2006 | 68578 |
| 3L-6S | | MI | 27235 | 8620 | 46032 | 6163 | 49894 | 4968 | 51653 | 4038 | 52809 | 2490 | 64324 | 1422 | 52454 |
| 14-#18 | 3.70 | MA | 34576 | 8620 | 58060 | 6262 | 64400 | 5022 | 67826 | 4050 | 72537 | 2569 | 88858 | 1784 | 67349 |
| 4L-5S | | MI | 28257 | 8620 | 47756 | 6175 | 52278 | 4985 | 54433 | 4016 | 56513 | 2468 | 68850 | 1568 | 54415 |
| 14-#18 | 3.70 | MA | 33305 | 8620 | 55871 | 6253 | 61562 | 5053 | 64340 | 4077 | 67538 | 2547 | 82923 | 1683 | 64684 |
| 5L-4S | | MI | 29329 | 8620 | 49591 | 6188 | 54656 | 4958 | 57354 | 3993 | 60606 | 2490 | 73701 | 1664 | 56423 |
| 14-#18 | 3.70 | MA | 32095 | 8620 | 53817 | 6244 | 58719 | 5040 | 60866 | 4060 | 63009 | 2569 | 77328 | 1538 | 62334 |
| 6L-3S | | MI | 30525 | 8620 | 51705 | 6156 | 57349 | 4975 | 60627 | 4015 | 64686 | 2468 | 78241 | 1885 | 57586 |
| 14-#18 | 3.70 | MA | 30918 | 8620 | 51567 | 6279 | 56006 | 5071 | 57531 | 4087 | 58583 | 2592 | 71350 | 1307 | 59568 |
| 7L-2S | | MI | 32205 | 8620 | 54276 | 6168 | 60645 | 4948 | 64648 | 3992 | 70025 | 2446 | 85277 | 2106 | 57752 |
| 16-#11 | 1.65 | MA | 32780 | 7546 | 51675 | 5620 | 56509 | 4567 | 58304 | 3785 | 59582 | 2659 | 71022 | 2498 | 31804 |
| 2L-8S | | MI | 25073 | 7546 | 39586 | 5574 | 42046 | 4540 | 42091 | 3773 | 40222 | 2636 | 47036 | 2030 | 26077 |
| 16-#11 | 1.65 | MA | 31946 | 7546 | 50442 | 5617 | 54928 | 4563 | 56375 | 3797 | 56957 | 2669 | 67490 | 2411 | 31826 |
| 3L-7S | | MI | 25477 | 7546 | 40261 | 5578 | 42965 | 4545 | 43178 | 3763 | 41792 | 2644 | 48885 | 2076 | 26334 |
| 16-#11 | 1.65 | MA | 31361 | 7546 | 49437 | 5632 | 53647 | 4576 | 54818 | 3792 | 54954 | 2678 | 65190 | 2325 | 31820 |
| 4L-6S | | MI | 25887 | 7546 | 41012 | 5564 | 43871 | 4533 | 44292 | 3752 | 43268 | 2636 | 50878 | 2167 | 26716 |
| 16-#11 | 1.65 | MA | 30838 | 7546 | 48568 | 5629 | 52521 | 4573 | 53434 | 3804 | 52949 | 2671 | 62788 | 2284 | 31771 |
| 5E | | MI | 26308 | 7546 | 41698 | 5568 | 44820 | 4538 | 45452 | 3759 | 44778 | 2627 | 52742 | 2223 | 26930 |
| 16-#11 | 1.65 | MA | 30341 | 7546 | 47754 | 5627 | 51392 | 4586 | 52055 | 3799 | 51132 | 2680 | 60505 | 2228 | 31486 |
| 6L-4S | | MI | 26749 | 7546 | 42429 | 5571 | 45768 | 4526 | 46616 | 3748 | 46445 | 2636 | 54721 | 2262 | 26941 |
| 16-#11 | 1.65 | MA | 29856 | 7546 | 46861 | 5642 | 50316 | 4582 | 50732 | 3811 | 49356 | 2689 | 58070 | 2138 | 30974 |
| 7L-3S | | MI | 27241 | 7546 | 43273 | 5558 | 46843 | 4531 | 47922 | 3755 | 48109 | 2627 | 56596 | 2349 | 26920 |
| 16-#11 | 1.65 | MA | 29378 | 7546 | 46060 | 5639 | 49225 | 4596 | 49440 | 3823 | 47469 | 2682 | 55824 | 2089 | 30618 |
| 8L-2S | | MI | 27937 | 7546 | 44304 | 5561 | 48165 | 4519 | 49535 | 3745 | 50285 | 2619 | 59487 | 2435 | 26888 |
| 16-#14 | 2.38 | MA | 34718 | 7928 | 56013 | 5840 | 61964 | 4723 | 64918 | 3877 | 68564 | 2619 | 82835 | 2412 | 45226 |
| 2L-8S | | MI | 25476 | 7928 | 41165 | 5794 | 43938 | 4698 | 44371 | 3870 | 43245 | 2589 | 51380 | 1748 | 35294 |
| 16-#14 | 2.38 | MA | 33540 | 7928 | 54247 | 5836 | 59700 | 4742 | 62157 | 3893 | 64808 | 2632 | 77812 | 2287 | 45190 |
| 3L-7S | | MI | 26046 | 7928 | 42133 | 5799 | 45255 | 4706 | 45929 | 3856 | 45476 | 2601 | 54008 | 1814 | 36359 |
| 16-#14 | 2.38 | MA | 32713 | 7928 | 52807 | 5857 | 57865 | 4736 | 59927 | 3885 | 61937 | 2645 | 74547 | 2163 | 45081 |
| 4L-6S | | MI | 26626 | 7928 | 43209 | 5780 | 46553 | 4690 | 47524 | 3841 | 47574 | 2589 | 56832 | 1944 | 36848 |
| 16-#14 | 2.38 | MA | 31973 | 7928 | 51561 | 5852 | 56250 | 4754 | 57942 | 3902 | 59063 | 2632 | 71125 | 2104 | 44578 |
| 5E | | MI | 27221 | 7928 | 44192 | 5786 | 47913 | 4698 | 49185 | 3852 | 49720 | 2576 | 59473 | 2026 | 37622 |
| 16-#14 | 2.38 | MA | 31270 | 7928 | 50393 | 5848 | 54632 | 4748 | 55965 | 3894 | 56457 | 2645 | 67881 | 2023 | 43550 |
| 6L-4S | | MI | 27845 | 7928 | 45239 | 5792 | 49270 | 4681 | 50852 | 3838 | 52091 | 2589 | 62286 | 2081 | 38056 |
| 16-#14 | 2.38 | MA | 30584 | 7928 | 49113 | 5869 | 53089 | 4767 | 54067 | 3911 | 53911 | 2658 | 64418 | 1893 | 42898 |
| 7L-3S | | MI | 28541 | 7928 | 46446 | 5773 | 50809 | 4689 | 52722 | 3848 | 54455 | 2576 | 64939 | 2206 | 38115 |
| 16-#14 | 2.38 | MA | 29909 | 7928 | 47963 | 5865 | 51523 | 4761 | 52214 | 3927 | 51206 | 2646 | 61219 | 1824 | 41564 |
| 8L-2S | | MI | 29523 | 7928 | 47920 | 5779 | 52698 | 4673 | 55027 | 3834 | 57548 | 2564 | 69038 | 2330 | 38112 |
| 16-#18 | 4.23 | MA | 35966 | 8896 | 61150 | 6435 | 68361 | 5146 | 72659 | 4125 | 79064 | 2545 | 97532 | 1730 | 76481 |
| 4L-6S | | MI | 28392 | 8896 | 48603 | 6336 | 53190 | 5092 | 55674 | 4114 | 58148 | 2459 | 71360 | 1355 | 59957 |
| 16-#18 | 4.23 | MA | 34706 | 8896 | 58961 | 6426 | 65523 | 5177 | 69172 | 4153 | 74065 | 2523 | 91598 | 1628 | 73955 |
| 5E | | MI | 29406 | 8896 | 50327 | 6348 | 55574 | 5109 | 58455 | 4091 | 61852 | 2437 | 75886 | 1501 | 62105 |
| 16-#18 | 4.23 | MA | 33506 | 8896 | 56907 | 6416 | 62680 | 5164 | 65699 | 4136 | 69536 | 2545 | 86003 | 1484 | 71418 |
| 6L-4S | | MI | 30470 | 8896 | 52162 | 6361 | 57952 | 5082 | 61375 | 4069 | 65945 | 2459 | 80737 | 1597 | 63992 |
| 16-#18 | 4.23 | MA | 32339 | 8896 | 54657 | 6452 | 59967 | 5195 | 62363 | 4163 | 65110 | 2567 | 80025 | 1252 | 68760 |
| 7L-3S | | MI | 31657 | 8896 | 54276 | 6329 | 60645 | 5099 | 64648 | 4090 | 70025 | 2437 | 85277 | 1818 | 65518 |
| 18-#11 | 1.86 | MA | 33355 | 7654 | 52909 | 5687 | 58091 | 4615 | 60234 | 3815 | 62207 | 2651 | 74555 | 2480 | 35670 |
| 2L-9S | | MI | 25159 | 7654 | 39890 | 5655 | 42473 | 4600 | 42567 | 3796 | 40936 | 2635 | 48119 | 1954 | 28680 |
| 18-#11 | 1.86 | MA | 32524 | 7654 | 51675 | 5685 | 56509 | 4611 | 58304 | 3827 | 59582 | 2660 | 71022 | 2394 | 35683 |
| 3L-8S | | MI | 25558 | 7654 | 40617 | 5642 | 43368 | 4588 | 43704 | 3803 | 42399 | 2626 | 49927 | 2008 | 29217 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis

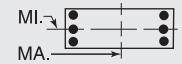


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.86 | MA | 31941 | 7654 | 50670 | 5699 | 55229 | 4625 | 56748 | 3822 | 57579 | 2670 | 68723 | 2308 | 35658 |
| 4L-7S | | MI | 25960 | 7654 | 41293 | 5645 | 44287 | 4593 | 44791 | 3792 | 43968 | 2635 | 51777 | 2055 | 29465 |
| 18-#11 | 1.86 | MA | 31420 | 7654 | 49802 | 5697 | 54102 | 4621 | 55363 | 3834 | 55574 | 2662 | 66321 | 2266 | 35593 |
| 5L-6S | | MI | 26369 | 7654 | 42044 | 5632 | 45193 | 4581 | 45905 | 3782 | 45444 | 2626 | 53769 | 2145 | 29829 |
| 18-#11 | 1.86 | MA | 30925 | 7654 | 48987 | 5694 | 52974 | 4634 | 53984 | 3829 | 53757 | 2671 | 64038 | 2210 | 35212 |
| 6L-5S | | MI | 26788 | 7654 | 42729 | 5635 | 46142 | 4586 | 47065 | 3788 | 46954 | 2617 | 55634 | 2202 | 30134 |
| 18-#11 | 1.86 | MA | 30442 | 7654 | 48095 | 5709 | 51898 | 4631 | 52661 | 3841 | 51981 | 2681 | 61602 | 2120 | 34722 |
| 7L-4S | | MI | 27227 | 7654 | 43460 | 5639 | 47090 | 4574 | 48229 | 3778 | 48622 | 2626 | 57613 | 2241 | 30166 |
| 18-#11 | 1.86 | MA | 29966 | 7654 | 47294 | 5706 | 50806 | 4644 | 51370 | 3853 | 50094 | 2673 | 59356 | 2071 | 34374 |
| 8L-3S | | MI | 27717 | 7654 | 44304 | 5625 | 48165 | 4579 | 49535 | 3785 | 50285 | 2617 | 59487 | 2327 | 30154 |
| 18-#11 | 1.86 | MA | 29479 | 7654 | 46430 | 5721 | 49744 | 4640 | 50019 | 3848 | 48335 | 2683 | 57143 | 2018 | 33689 |
| 9L-2S | | MI | 28411 | 7654 | 45336 | 5629 | 49487 | 4567 | 51148 | 3774 | 52462 | 2609 | 62379 | 2414 | 30129 |
| 18-#14 | 2.68 | MA | 34351 | 8084 | 56013 | 5933 | 61964 | 4812 | 64918 | 3936 | 68564 | 2619 | 82835 | 2260 | 50673 |
| 3L-8S | | MI | 26159 | 8084 | 42639 | 5891 | 45828 | 4768 | 46676 | 3912 | 46338 | 2573 | 55479 | 1714 | 39681 |
| 18-#14 | 2.68 | MA | 33528 | 8084 | 54573 | 5954 | 60129 | 4806 | 62688 | 3928 | 65694 | 2632 | 79570 | 2136 | 50539 |
| 4L-7S | | MI | 26726 | 8084 | 43607 | 5897 | 47145 | 4776 | 48234 | 3898 | 48570 | 2586 | 58107 | 1780 | 40705 |
| 18-#14 | 2.68 | MA | 32793 | 8084 | 53327 | 5950 | 58513 | 4824 | 60703 | 3944 | 62819 | 2620 | 76148 | 2077 | 49870 |
| 5L-6S | | MI | 27303 | 8084 | 44683 | 5878 | 48443 | 4760 | 49829 | 3884 | 50667 | 2573 | 60931 | 1911 | 41297 |
| 18-#14 | 2.68 | MA | 32093 | 8084 | 52159 | 5946 | 56896 | 4818 | 58726 | 3936 | 60214 | 2633 | 72904 | 1996 | 48889 |
| 6L-5S | | MI | 27895 | 8084 | 45666 | 5883 | 49802 | 4768 | 51490 | 3894 | 52814 | 2561 | 63572 | 1992 | 42031 |
| 18-#14 | 2.68 | MA | 31411 | 8084 | 50879 | 5966 | 55352 | 4837 | 56828 | 3953 | 57668 | 2645 | 69441 | 1866 | 48173 |
| 7L-4S | | MI | 28516 | 8084 | 46713 | 5889 | 51159 | 4751 | 53157 | 3880 | 55184 | 2573 | 66385 | 2048 | 42618 |
| 18-#14 | 2.68 | MA | 30739 | 8084 | 49729 | 5962 | 53786 | 4831 | 54975 | 3970 | 54962 | 2633 | 66242 | 1797 | 46844 |
| 8L-3S | | MI | 29209 | 8084 | 47920 | 5870 | 52698 | 4759 | 55027 | 3890 | 57548 | 2561 | 69038 | 2173 | 42700 |
| 18-#14 | 2.68 | MA | 30075 | 8084 | 48491 | 5983 | 52263 | 4850 | 53038 | 3962 | 52439 | 2646 | 63096 | 1719 | 45686 |
| 9L-2S | | MI | 30186 | 8084 | 49394 | 5876 | 54587 | 4742 | 57332 | 3876 | 60642 | 2549 | 73137 | 2297 | 42727 |
| 18-#18 | 4.76 | MA | 36095 | 9173 | 62051 | 6598 | 69484 | 5301 | 74005 | 4228 | 80592 | 2498 | 100272 | 1574 | 83245 |
| 5L-6S | | MI | 29539 | 9173 | 51174 | 6509 | 56487 | 5216 | 59696 | 4189 | 63487 | 2428 | 78396 | 1289 | 67489 |
| 18-#18 | 4.76 | MA | 34905 | 9173 | 59997 | 6589 | 66642 | 5288 | 70531 | 4211 | 76063 | 2520 | 94677 | 1429 | 80528 |
| 6L-5S | | MI | 30546 | 9173 | 52898 | 6521 | 58870 | 5234 | 62476 | 4167 | 67191 | 2406 | 82922 | 1434 | 69813 |
| 18-#18 | 4.76 | MA | 33747 | 9173 | 57747 | 6624 | 63928 | 5319 | 67196 | 4238 | 71637 | 2542 | 88699 | 1198 | 77970 |
| 7L-4S | | MI | 31602 | 9173 | 54733 | 6534 | 61248 | 5206 | 65397 | 4144 | 71285 | 2428 | 87773 | 1530 | 71592 |
| 20-#11 | 2.06 | MA | 33099 | 7762 | 52909 | 5752 | 58091 | 4660 | 60234 | 3856 | 62207 | 2652 | 74555 | 2376 | 39527 |
| 3L-9S | | MI | 25643 | 7762 | 40921 | 5723 | 43796 | 4649 | 44180 | 3825 | 43113 | 2625 | 51011 | 1932 | 31769 |
| 20-#11 | 2.06 | MA | 32518 | 7762 | 51904 | 5767 | 56810 | 4673 | 58677 | 3851 | 60204 | 2661 | 72256 | 2290 | 39490 |
| 4L-8S | | MI | 26040 | 7762 | 41648 | 5709 | 44690 | 4636 | 45317 | 3832 | 44575 | 2616 | 52819 | 1987 | 32355 |
| 20-#11 | 2.06 | MA | 32000 | 7762 | 51035 | 5764 | 55684 | 4669 | 57293 | 3863 | 58199 | 2653 | 69854 | 2249 | 39411 |
| 5L-7S | | MI | 26441 | 7762 | 42324 | 5713 | 45609 | 4642 | 46404 | 3822 | 46145 | 2625 | 54668 | 2033 | 32600 |
| 20-#11 | 2.06 | MA | 31506 | 7762 | 50221 | 5762 | 54555 | 4683 | 55914 | 3858 | 56382 | 2663 | 67571 | 2193 | 38945 |
| 6E | | MI | 26848 | 7762 | 43075 | 5699 | 46515 | 4630 | 47518 | 3811 | 47621 | 2616 | 56661 | 2124 | 32948 |
| 20-#11 | 2.06 | MA | 31025 | 7762 | 49329 | 5776 | 53479 | 4679 | 54590 | 3870 | 54606 | 2672 | 65135 | 2103 | 38473 |
| 7L-5S | | MI | 27265 | 7762 | 43761 | 5703 | 47464 | 4635 | 48678 | 3818 | 49131 | 2608 | 58526 | 2180 | 33333 |
| 20-#11 | 2.06 | MA | 30552 | 7762 | 48527 | 5774 | 52388 | 4692 | 53299 | 3882 | 52719 | 2664 | 62889 | 2054 | 38134 |
| 8L-4S | | MI | 27703 | 7762 | 44492 | 5706 | 48412 | 4623 | 49842 | 3807 | 50798 | 2616 | 60504 | 2219 | 33374 |
| 20-#11 | 2.06 | MA | 30067 | 7762 | 47664 | 5789 | 51326 | 4689 | 51948 | 3877 | 50960 | 2674 | 60675 | 2000 | 37397 |
| 9L-3S | | MI | 28191 | 7762 | 45336 | 5693 | 49487 | 4628 | 51148 | 3814 | 52462 | 2608 | 62379 | 2306 | 33383 |
| 20-#11 | 2.06 | MA | 29545 | 7762 | 46865 | 5786 | 50249 | 4702 | 50663 | 3889 | 49216 | 2683 | 58531 | 1939 | 36823 |
| 10L-2S | | MI | 28882 | 7762 | 46367 | 5696 | 50809 | 4616 | 52761 | 3803 | 54638 | 2599 | 65270 | 2392 | 33365 |
| 20-#14 | 2.98 | MA | 34338 | 8239 | 56338 | 6051 | 62392 | 4875 | 65449 | 3970 | 69451 | 2620 | 84592 | 2109 | 55991 |
| 4L-8S | | MI | 26837 | 8239 | 44113 | 5988 | 47717 | 4838 | 48981 | 3955 | 49432 | 2558 | 59578 | 1681 | 44078 |
| 20-#14 | 2.98 | MA | 33607 | 8239 | 55092 | 6047 | 60777 | 4894 | 63464 | 3987 | 66576 | 2608 | 81170 | 2050 | 55175 |
| 5L-7S | | MI | 27402 | 8239 | 45081 | 5994 | 49034 | 4846 | 50538 | 3941 | 51663 | 2571 | 62206 | 1747 | 45063 |
| 20-#14 | 2.98 | MA | 32911 | 8239 | 53924 | 6043 | 59159 | 4888 | 61487 | 3979 | 63971 | 2620 | 77926 | 1969 | 54235 |
| 6E | | MI | 27976 | 8239 | 46157 | 5975 | 50332 | 4829 | 52134 | 3926 | 53761 | 2558 | 65030 | 1878 | 45753 |
| 20-#14 | 2.98 | MA | 32233 | 8239 | 52645 | 6064 | 57615 | 4907 | 59589 | 3995 | 61425 | 2633 | 74464 | 1839 | 53419 |
| 7L-5S | | MI | 28565 | 8239 | 47139 | 5981 | 51692 | 4838 | 53795 | 3937 | 55907 | 2546 | 67672 | 1959 | 46452 |
| 20-#14 | 2.98 | MA | 31565 | 8239 | 51494 | 6059 | 56049 | 4901 | 57736 | 4012 | 58719 | 2621 | 71264 | 1770 | 52134 |
| 8L-4S | | MI | 29183 | 8239 | 48186 | 5986 | 53049 | 4821 | 55462 | 3922 | 58278 | 2558 | 70484 | 2015 | 47174 |
| 20-#14 | 2.98 | MA | 30902 | 8239 | 50256 | 6080 | 54526 | 4919 | 55799 | 4004 | 56196 | 2634 | 68119 | 1692 | 50911 |
| 9L-3S | | MI | 29872 | 8239 | 49394 | 5967 | 54587 | 4829 | 57332 | 3933 | 60642 | 2546 | 73137 | 2139 | 47278 |

## RECTANGULAR TIED COLUMNS 36" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

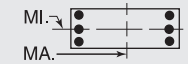
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#18 | 5.29 | MA | 36293 | 9449 | 63087 | 6762 | 70603 | 5412 | 75364 | 4286 | 82589 | 2495 | 103352 | 1374 | 89662 |
| 6E | | MI | 30678 | 9449 | 53745 | 6682 | 59783 | 5341 | 63717 | 4264 | 68826 | 2397 | 85432 | 1222 | 75044 |
| 20-#18 | 5.29 | MA | 35144 | 9449 | 60837 | 6797 | 67889 | 5443 | 72028 | 4314 | 78163 | 2517 | 97374 | 1143 | 87027 |
| 7L-5S | | MI | 31678 | 9449 | 55469 | 6694 | 62167 | 5358 | 66497 | 4242 | 72530 | 2375 | 89958 | 1367 | 77535 |
| 22-#11 | 2.27 | MA | 33093 | 7870 | 53138 | 5834 | 58392 | 4722 | 60606 | 3880 | 62829 | 2652 | 75788 | 2273 | 43319 |
| 4L-9S | | MI | 26124 | 7870 | 41953 | 5790 | 45118 | 4697 | 45793 | 3855 | 45289 | 2615 | 53902 | 1911 | 34864 |
| 22-#11 | 2.27 | MA | 32576 | 7870 | 52269 | 5832 | 57265 | 4718 | 59222 | 3893 | 60824 | 2645 | 73386 | 2231 | 43226 |
| 5L-8S | | MI | 26520 | 7870 | 42680 | 5776 | 46012 | 4685 | 46930 | 3862 | 46752 | 2606 | 55710 | 1965 | 35430 |
| 22-#11 | 2.27 | MA | 32085 | 7870 | 51455 | 5829 | 56137 | 4731 | 57843 | 3887 | 59007 | 2654 | 71103 | 2175 | 42683 |
| 6L-7S | | MI | 26919 | 7870 | 43355 | 5780 | 46931 | 4690 | 48017 | 3851 | 48321 | 2615 | 57560 | 2012 | 35738 |
| 22-#11 | 2.27 | MA | 31606 | 7870 | 50562 | 5844 | 55061 | 4727 | 56520 | 3900 | 57231 | 2664 | 68667 | 2085 | 42228 |
| 7L-6S | | MI | 27324 | 7870 | 44106 | 5766 | 47837 | 4678 | 49131 | 3840 | 49797 | 2606 | 59552 | 2102 | 36072 |
| 22-#11 | 2.27 | MA | 31134 | 7870 | 49761 | 5841 | 53969 | 4741 | 55228 | 3912 | 55344 | 2656 | 66421 | 2036 | 41850 |
| 8L-5S | | MI | 27740 | 7870 | 44792 | 5770 | 48786 | 4683 | 50291 | 3847 | 51308 | 2598 | 61417 | 2158 | 36528 |
| 22-#11 | 2.27 | MA | 30652 | 7870 | 48898 | 5856 | 52907 | 4737 | 53877 | 3906 | 53585 | 2665 | 64208 | 1983 | 41110 |
| 9L-4S | | MI | 28176 | 7870 | 45523 | 5774 | 49734 | 4671 | 51455 | 3837 | 52975 | 2606 | 63396 | 2198 | 36582 |
| 22-#11 | 2.27 | MA | 30132 | 7870 | 48098 | 5854 | 51830 | 4750 | 52593 | 3919 | 51841 | 2675 | 62063 | 1922 | 40550 |
| 10L-3S | | MI | 28663 | 7870 | 46367 | 5760 | 50809 | 4676 | 52761 | 3843 | 54638 | 2598 | 65270 | 2284 | 36607 |
| 22-#11 | 2.27 | MA | 29623 | 7870 | 47313 | 5851 | 50774 | 4747 | 51259 | 3913 | 49981 | 2667 | 59873 | 1870 | 39672 |
| 11L-2S | | MI | 29352 | 7870 | 47398 | 5764 | 52131 | 4664 | 54374 | 3833 | 56815 | 2589 | 68162 | 2371 | 36596 |
| 22-#14 | 3.27 | MA | 34416 | 8395 | 56858 | 6144 | 63040 | 4964 | 66225 | 4029 | 70333 | 2595 | 86193 | 2023 | 60490 |
| 5L-8S | | MI | 27512 | 8395 | 45586 | 6085 | 49606 | 4908 | 51285 | 3997 | 52526 | 2543 | 63677 | 1648 | 48483 |
| 22-#14 | 3.27 | MA | 33724 | 8395 | 55690 | 6140 | 61422 | 4958 | 64248 | 4021 | 67728 | 2608 | 82949 | 1942 | 59587 |
| 6L-7S | | MI | 28075 | 8395 | 46554 | 6091 | 50923 | 4916 | 52843 | 3983 | 54757 | 2555 | 66305 | 1714 | 49432 |
| 22-#14 | 3.27 | MA | 33049 | 8395 | 54410 | 6161 | 59879 | 4977 | 62350 | 4038 | 65182 | 2621 | 79486 | 1812 | 58677 |
| 7L-6S | | MI | 28646 | 8395 | 47630 | 6072 | 52221 | 4899 | 54439 | 3969 | 56854 | 2543 | 69129 | 1844 | 50214 |
| 22-#14 | 3.27 | MA | 32385 | 8395 | 53260 | 6157 | 58313 | 4970 | 60498 | 4055 | 62476 | 2609 | 76287 | 1743 | 57431 |
| 8L-5S | | MI | 29232 | 8395 | 48613 | 6078 | 53581 | 4907 | 56100 | 3979 | 59001 | 2530 | 71771 | 1926 | 50882 |
| 22-#14 | 3.27 | MA | 31723 | 8395 | 52022 | 6177 | 56790 | 4989 | 58560 | 4046 | 59953 | 2621 | 73142 | 1665 | 56146 |
| 9L-4S | | MI | 29847 | 8395 | 49660 | 6084 | 54938 | 4891 | 57767 | 3965 | 61371 | 2543 | 74583 | 1982 | 51725 |
| 22-#18 | 5.82 | MA | 36529 | 9726 | 63927 | 6970 | 71851 | 5568 | 76861 | 4389 | 84690 | 2492 | 106048 | 1088 | 96064 |
| 7L-6S | | MI | 31810 | 9726 | 56317 | 6854 | 63079 | 5465 | 67738 | 4340 | 74165 | 2366 | 92468 | 1155 | 82620 |
| 24-#11 | 2.48 | MA | 33150 | 7978 | 53503 | 5899 | 58846 | 4766 | 61151 | 3922 | 63449 | 2636 | 76919 | 2214 | 47039 |
| 5L-9S | | MI | 26604 | 7978 | 42984 | 5858 | 46440 | 4745 | 47406 | 3884 | 47466 | 2605 | 56794 | 1889 | 37963 |
| 24-#11 | 2.48 | MA | 32661 | 7978 | 52688 | 5897 | 57718 | 4780 | 59772 | 3917 | 61632 | 2646 | 74636 | 2158 | 46426 |
| 6L-8S | | MI | 26997 | 7978 | 43711 | 5844 | 47334 | 4733 | 48543 | 3891 | 48928 | 2597 | 58602 | 1944 | 38511 |
| 24-#11 | 2.48 | MA | 32184 | 7978 | 51796 | 5911 | 56642 | 4776 | 58449 | 3929 | 59856 | 2655 | 72200 | 2068 | 45986 |
| 7E | | MI | 27395 | 7978 | 44387 | 5848 | 48253 | 4738 | 49630 | 3880 | 50498 | 2605 | 60451 | 1990 | 38878 |
| 24-#11 | 2.48 | MA | 31714 | 7978 | 50994 | 5909 | 55550 | 4789 | 57157 | 3941 | 57969 | 2647 | 69954 | 2019 | 45547 |
| 8L-6S | | MI | 27799 | 7978 | 45138 | 5834 | 49159 | 4726 | 50744 | 3870 | 51974 | 2597 | 62444 | 2080 | 39199 |
| 24-#11 | 2.48 | MA | 31235 | 7978 | 50131 | 5923 | 54489 | 4785 | 55807 | 3936 | 56210 | 2657 | 67740 | 1965 | 44828 |
| 9L-5S | | MI | 28213 | 7978 | 45824 | 5838 | 50109 | 4732 | 51904 | 3877 | 53484 | 2588 | 64309 | 2137 | 39719 |
| 24-#11 | 2.48 | MA | 30716 | 7978 | 49332 | 5921 | 53412 | 4799 | 54522 | 3948 | 54466 | 2666 | 65596 | 1904 | 44242 |
| 10L-4S | | MI | 28648 | 7978 | 46555 | 5841 | 51056 | 4719 | 53068 | 3866 | 55151 | 2597 | 66288 | 2176 | 39785 |
| 24-#11 | 2.48 | MA | 30209 | 7978 | 48546 | 5918 | 52355 | 4795 | 53188 | 3943 | 52606 | 2658 | 63406 | 1852 | 43367 |
| 11L-3S | | MI | 29133 | 7978 | 47398 | 5828 | 52131 | 4725 | 54374 | 3873 | 56815 | 2588 | 68162 | 2263 | 39818 |
| 24-#14 | 3.57 | MA | 34533 | 8550 | 57455 | 6237 | 63686 | 5028 | 67009 | 4063 | 71484 | 2595 | 87972 | 1915 | 64944 |
| 6L-8S | | MI | 28184 | 8550 | 47060 | 6183 | 51496 | 4978 | 53590 | 4040 | 55619 | 2528 | 67776 | 1615 | 52895 |
| 24-#14 | 3.57 | MA | 33862 | 8550 | 56176 | 6258 | 62142 | 5046 | 65111 | 4080 | 68938 | 2608 | 84509 | 1785 | 63944 |
| 7E | | MI | 28743 | 8550 | 48028 | 6188 | 52812 | 4986 | 55148 | 4025 | 57850 | 2540 | 70404 | 1681 | 53811 |
| 24-#14 | 3.57 | MA | 33201 | 8550 | 55026 | 6254 | 60576 | 5040 | 63259 | 4097 | 66233 | 2596 | 81310 | 1715 | 62736 |
| 8L-6S | | MI | 29312 | 8550 | 49104 | 6169 | 54111 | 4969 | 56744 | 4011 | 59948 | 2528 | 73228 | 1811 | 54680 |
| 24-#14 | 3.57 | MA | 32540 | 8550 | 53787 | 6275 | 59053 | 5059 | 61322 | 4089 | 63710 | 2609 | 78165 | 1638 | 61390 |
| 9L-5S | | MI | 29895 | 8550 | 50087 | 6175 | 55470 | 4977 | 58405 | 4022 | 62095 | 2515 | 75870 | 1893 | 55319 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis

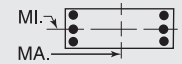



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.01 | MA | 33917 | 7555 | 52586 | 5630 | 56497 | 4595 | 57166 | 3843 | 56033 | 2791 | 65137 | 2641 | 21553 |
| 2E | | MI | 27599 | 7555 | 43147 | 5540 | 45953 | 4522 | 46280 | 3780 | 44885 | 2727 | 51813 | 2563 | 17421 |
| 6-#18 | 1.52 | MA | 35441 | 7831 | 55849 | 5803 | 60680 | 4720 | 62269 | 3919 | 62957 | 2768 | 74359 | 2590 | 31848 |
| 2L-3S | | MI | 27042 | 7831 | 43147 | 5700 | 45953 | 4673 | 46280 | 3878 | 44885 | 2719 | 51813 | 2275 | 25713 |
| 6-#18 | 1.52 | MA | 33235 | 7831 | 52586 | 5795 | 56497 | 4752 | 57166 | 3947 | 56033 | 2790 | 65137 | 2368 | 31916 |
| 3L-2S | | MI | 28774 | 7831 | 45719 | 5713 | 49249 | 4646 | 50301 | 3856 | 50224 | 2697 | 58849 | 2496 | 25593 |
| 8-#14 | 1.14 | MA | 34386 | 7624 | 53341 | 5710 | 57686 | 4657 | 58699 | 3888 | 58192 | 2808 | 68246 | 2661 | 24290 |
| 2L-4S | | MI | 26265 | 7624 | 41064 | 5641 | 43502 | 4598 | 43375 | 3834 | 41278 | 2777 | 47616 | 2338 | 19749 |
| 8-#14 | 1.14 | MA | 33116 | 7624 | 51479 | 5706 | 55298 | 4651 | 55786 | 3905 | 54229 | 2821 | 62915 | 2536 | 24353 |
| 3E | | MI | 26976 | 7624 | 42272 | 5622 | 45041 | 4606 | 45245 | 3845 | 43642 | 2765 | 50268 | 2463 | 19677 |
| 8-#14 | 1.14 | MA | 32223 | 7624 | 49961 | 5727 | 53364 | 4670 | 53435 | 3898 | 51204 | 2835 | 59445 | 2412 | 24386 |
| 4L-2S | | MI | 27977 | 7624 | 43746 | 5628 | 46931 | 4589 | 47550 | 3830 | 46736 | 2753 | 54367 | 2587 | 19601 |
| 8-#18 | 2.02 | MA | 36948 | 8108 | 59112 | 5976 | 64863 | 4844 | 67371 | 3994 | 69880 | 2745 | 83581 | 2538 | 42090 |
| 2L-4S | | MI | 26992 | 8108 | 43605 | 5905 | 46556 | 4780 | 47029 | 3932 | 46144 | 2710 | 54309 | 1987 | 33622 |
| 8-#18 | 2.02 | MA | 34760 | 8108 | 55849 | 5967 | 60680 | 4876 | 62269 | 4023 | 62957 | 2767 | 74359 | 2317 | 42065 |
| 3E | | MI | 28218 | 8108 | 45719 | 5873 | 49249 | 4797 | 50301 | 3954 | 50224 | 2688 | 58849 | 2208 | 33767 |
| 8-#18 | 2.02 | MA | 33219 | 8108 | 53184 | 6003 | 57284 | 4864 | 58141 | 4007 | 57665 | 2789 | 68372 | 2096 | 41728 |
| 4L-2S | | MI | 29937 | 8108 | 48290 | 5886 | 52546 | 4770 | 54322 | 3931 | 55563 | 2666 | 65884 | 2429 | 33705 |
| 10-#14 | 1.42 | MA | 35264 | 7779 | 55204 | 5807 | 60074 | 4726 | 61612 | 3930 | 62156 | 2795 | 73577 | 2636 | 30151 |
| 2L-5S | | MI | 26319 | 7779 | 41491 | 5732 | 44035 | 4684 | 44013 | 3891 | 42001 | 2750 | 48902 | 2249 | 24349 |
| 10-#14 | 1.42 | MA | 34000 | 7779 | 53341 | 5803 | 57686 | 4721 | 58699 | 3947 | 58192 | 2809 | 68246 | 2511 | 30196 |
| 3L-4S | | MI | 26954 | 7779 | 42538 | 5738 | 45392 | 4668 | 45680 | 3877 | 44372 | 2762 | 51715 | 2305 | 24373 |
| 10-#14 | 1.42 | MA | 33112 | 7779 | 51824 | 5824 | 55752 | 4740 | 56348 | 3940 | 55167 | 2822 | 64776 | 2386 | 30185 |
| 4L-3S | | MI | 27661 | 7779 | 43746 | 5719 | 46931 | 4676 | 47550 | 3887 | 46736 | 2750 | 54367 | 2429 | 24328 |
| 10-#14 | 1.42 | MA | 32319 | 7779 | 50512 | 5821 | 54050 | 4734 | 54257 | 3957 | 52139 | 2811 | 61150 | 2327 | 30061 |
| 5L-2S | | MI | 28658 | 7779 | 45219 | 5725 | 48820 | 4659 | 49855 | 3873 | 49830 | 2737 | 58467 | 2554 | 24265 |
| 10-#18 | 2.53 | MA | 38438 | 8384 | 62374 | 6149 | 69046 | 4968 | 72474 | 4069 | 76803 | 2722 | 92803 | 2487 | 52297 |
| 2L-5S | | MI | 27074 | 8384 | 44340 | 6066 | 47474 | 4931 | 48129 | 4030 | 47390 | 2657 | 56494 | 1824 | 39407 |
| 10-#18 | 2.53 | MA | 36267 | 8384 | 59112 | 6140 | 64863 | 5000 | 67371 | 4098 | 69880 | 2744 | 83581 | 2266 | 52182 |
| 3L-4S | | MI | 28165 | 8384 | 46176 | 6078 | 49852 | 4904 | 51050 | 4007 | 51483 | 2679 | 61345 | 1920 | 41533 |
| 10-#18 | 2.53 | MA | 34740 | 8384 | 56447 | 6176 | 61467 | 4988 | 63244 | 4082 | 64588 | 2766 | 77594 | 2044 | 51746 |
| 4L-3S | | MI | 29382 | 8384 | 48290 | 6046 | 52546 | 4921 | 54322 | 4029 | 55563 | 2657 | 65884 | 2141 | 41767 |
| 10-#18 | 2.53 | MA | 33375 | 8384 | 54140 | 6168 | 58476 | 5020 | 59569 | 4111 | 59286 | 2744 | 71298 | 1941 | 48948 |
| 5L-2S | | MI | 31089 | 8384 | 50861 | 6059 | 55842 | 4894 | 58343 | 4007 | 60902 | 2635 | 72920 | 2363 | 41779 |
| 12-#11 | 1.18 | MA | 34573 | 7649 | 53609 | 5743 | 58141 | 4683 | 59296 | 3907 | 59023 | 2815 | 69514 | 2674 | 25318 |
| 2L-6S | | MI | 26063 | 7649 | 40666 | 5668 | 43016 | 4633 | 42810 | 3861 | 40480 | 2784 | 46826 | 2334 | 20551 |
| 12-#11 | 1.18 | MA | 33685 | 7649 | 52308 | 5741 | 56473 | 4679 | 57262 | 3920 | 56255 | 2825 | 65768 | 2587 | 25356 |
| 3L-5S | | MI | 26488 | 7649 | 41352 | 5672 | 43966 | 4638 | 43970 | 3867 | 41990 | 2775 | 48691 | 2390 | 20551 |
| 12-#11 | 1.18 | MA | 33063 | 7649 | 51249 | 5756 | 55124 | 4693 | 55622 | 3915 | 54144 | 2835 | 63326 | 2501 | 25384 |
| 4E | | MI | 26933 | 7649 | 42083 | 5676 | 44913 | 4626 | 45134 | 3857 | 43657 | 2784 | 50670 | 2430 | 20517 |
| 12-#11 | 1.18 | MA | 32507 | 7649 | 50335 | 5754 | 53937 | 4690 | 54164 | 3927 | 52032 | 2828 | 60783 | 2459 | 25375 |
| 5L-3S | | MI | 27430 | 7649 | 42927 | 5662 | 45988 | 4631 | 46441 | 3863 | 45321 | 2775 | 52544 | 2516 | 20471 |
| 12-#11 | 1.18 | MA | 31979 | 7649 | 49478 | 5752 | 52750 | 4703 | 52712 | 3923 | 50119 | 2838 | 58360 | 2403 | 25308 |
| 6L-2S | | MI | 28130 | 7649 | 43958 | 5666 | 47310 | 4619 | 48054 | 3853 | 47498 | 2767 | 55435 | 2602 | 20424 |
| 12-#14 | 1.70 | MA | 36135 | 7935 | 57067 | 5904 | 62462 | 4796 | 64525 | 3972 | 66120 | 2783 | 78908 | 2610 | 35997 |
| 2L-6S | | MI | 26405 | 7935 | 41982 | 5824 | 44564 | 4746 | 44657 | 3923 | 42948 | 2747 | 50360 | 2134 | 28163 |
| 12-#14 | 1.70 | MA | 34877 | 7935 | 55204 | 5900 | 60074 | 4791 | 61612 | 3990 | 62156 | 2796 | 73577 | 2486 | 36021 |
| 3L-5S | | MI | 27007 | 7935 | 42965 | 5830 | 45924 | 4754 | 46318 | 3933 | 45095 | 2734 | 53001 | 2216 | 28914 |
| 12-#14 | 1.70 | MA | 33995 | 7935 | 53687 | 5922 | 58140 | 4810 | 59262 | 3982 | 59131 | 2810 | 70107 | 2361 | 35970 |
| 4E | | MI | 27638 | 7935 | 44012 | 5836 | 47281 | 4737 | 47985 | 3919 | 47465 | 2747 | 55814 | 2272 | 28977 |
| 12-#14 | 1.70 | MA | 33207 | 7935 | 52375 | 5918 | 56438 | 4804 | 57171 | 4000 | 56102 | 2799 | 66481 | 2301 | 35807 |
| 5L-3S | | MI | 28342 | 7935 | 45219 | 5816 | 48820 | 4746 | 49855 | 3930 | 49830 | 2734 | 58467 | 2396 | 28959 |
| 12-#14 | 1.70 | MA | 32456 | 7935 | 51145 | 5914 | 54735 | 4824 | 55088 | 3992 | 53358 | 2812 | 63036 | 2221 | 34765 |
| 6L-2S | | MI | 29334 | 7935 | 46693 | 5822 | 50709 | 4729 | 52160 | 3915 | 52923 | 2722 | 62566 | 2521 | 28911 |
| 12-#18 | 3.03 | MA | 39914 | 8661 | 65637 | 6321 | 73229 | 5092 | 77577 | 4145 | 83726 | 2699 | 102025 | 2436 | 62462 |
| 2L-6S | | MI | 27212 | 8661 | 45188 | 6226 | 48387 | 5038 | 49370 | 4128 | 49024 | 2648 | 59004 | 1612 | 45487 |

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

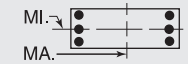
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 3.03 | MA | 37759 | 8661 | 62374 | 6313 | 69046 | 5124 | 72474 | 4173 | 76803 | 2721 | 92803 | 2214 | 62277 |
| 3L-5S | | MI | 28244 | 8661 | 46912 | 6239 | 50771 | 5055 | 52150 | 4105 | 52729 | 2626 | 63530 | 1758 | 47046 |
| 12-#18 | 3.03 | MA | 36245 | 8661 | 59709 | 6349 | 65650 | 5112 | 68347 | 4158 | 71511 | 2743 | 86816 | 1993 | 61756 |
| 4E | | MI | 29328 | 8661 | 48747 | 6251 | 53149 | 5028 | 55071 | 4083 | 56822 | 2648 | 68381 | 1853 | 49251 |
| 12-#18 | 3.03 | MA | 34892 | 8661 | 57403 | 6341 | 62659 | 5145 | 64672 | 4186 | 66210 | 2721 | 80520 | 1890 | 58691 |
| 5L-3S | | MI | 30535 | 8661 | 50861 | 6219 | 55842 | 5045 | 58343 | 4105 | 60902 | 2626 | 72920 | 2074 | 49740 |
| 12-#18 | 3.03 | MA | 33605 | 8661 | 55239 | 6333 | 59663 | 5133 | 61011 | 4171 | 61405 | 2743 | 74568 | 1746 | 56660 |
| 6L-2S | | MI | 32231 | 8661 | 53432 | 6232 | 59138 | 5018 | 62365 | 4082 | 66241 | 2604 | 79956 | 2296 | 49828 |
| 14-#11 | 1.38 | MA | 35188 | 7757 | 54910 | 5811 | 59809 | 4731 | 61331 | 3937 | 61791 | 2807 | 73261 | 2657 | 29407 |
| 2L-7S | | MI | 26138 | 7757 | 40947 | 5750 | 43432 | 4693 | 43310 | 3900 | 41180 | 2783 | 47725 | 2222 | 23342 |
| 14-#11 | 1.38 | MA | 34304 | 7757 | 53609 | 5809 | 58141 | 4728 | 59296 | 3949 | 59023 | 2817 | 69514 | 2571 | 29437 |
| 3L-6S | | MI | 26550 | 7757 | 41698 | 5736 | 44339 | 4681 | 44423 | 3890 | 42656 | 2774 | 49717 | 2312 | 23755 |
| 14-#11 | 1.38 | MA | 33684 | 7757 | 52550 | 5824 | 56792 | 4741 | 57657 | 3944 | 56913 | 2827 | 67073 | 2484 | 29452 |
| 4L-5S | | MI | 26973 | 7757 | 42384 | 5740 | 45288 | 4686 | 45583 | 3897 | 44167 | 2765 | 51582 | 2369 | 23779 |
| 14-#11 | 1.38 | MA | 33131 | 7757 | 51636 | 5821 | 55605 | 4738 | 56199 | 3957 | 54801 | 2820 | 64530 | 2442 | 29419 |
| 5L-4S | | MI | 27416 | 7757 | 43115 | 5743 | 46235 | 4674 | 46747 | 3886 | 45834 | 2774 | 53561 | 2408 | 23759 |
| 14-#11 | 1.38 | MA | 32605 | 7757 | 50779 | 5819 | 54418 | 4752 | 54747 | 3952 | 52888 | 2830 | 62107 | 2387 | 29325 |
| 6L-3S | | MI | 27911 | 7757 | 43958 | 5730 | 47310 | 4679 | 48054 | 3893 | 47498 | 2765 | 55435 | 2495 | 23723 |
| 14-#11 | 1.38 | MA | 32091 | 7757 | 49839 | 5834 | 53285 | 4748 | 53354 | 3965 | 51018 | 2840 | 59523 | 2297 | 28731 |
| 7L-2S | | MI | 28609 | 7757 | 44990 | 5733 | 48633 | 4667 | 49667 | 3882 | 49674 | 2757 | 58327 | 2581 | 23682 |
| 14-#14 | 1.99 | MA | 37001 | 8091 | 58930 | 6001 | 64850 | 4866 | 67439 | 4015 | 70083 | 2770 | 84239 | 2585 | 41832 |
| 2L-7S | | MI | 26507 | 8091 | 42380 | 5940 | 45156 | 4833 | 45366 | 3980 | 43944 | 2744 | 51635 | 1971 | 32094 |
| 14-#14 | 1.99 | MA | 35749 | 8091 | 57067 | 5998 | 62462 | 4860 | 64525 | 4032 | 66120 | 2784 | 78908 | 2460 | 41825 |
| 3L-6S | | MI | 27091 | 8091 | 43456 | 5921 | 46454 | 4816 | 46962 | 3965 | 46042 | 2732 | 54459 | 2101 | 32594 |
| 14-#14 | 1.99 | MA | 34871 | 8091 | 55550 | 6019 | 60528 | 4880 | 62175 | 4025 | 63095 | 2797 | 75438 | 2336 | 41744 |
| 4L-5S | | MI | 27690 | 8091 | 44439 | 5927 | 47813 | 4824 | 48623 | 3976 | 48189 | 2719 | 57100 | 2183 | 33434 |
| 14-#14 | 1.99 | MA | 34087 | 8091 | 54238 | 6015 | 58826 | 4874 | 60084 | 4042 | 60066 | 2786 | 71813 | 2276 | 41548 |
| 5L-4S | | MI | 28318 | 8091 | 45486 | 5933 | 49170 | 4807 | 50290 | 3962 | 50559 | 2732 | 59913 | 2238 | 33562 |
| 14-#14 | 1.99 | MA | 33341 | 8091 | 53008 | 6011 | 57123 | 4893 | 58002 | 4035 | 57322 | 2800 | 68368 | 2195 | 40379 |
| 6L-3S | | MI | 29019 | 8091 | 46693 | 5914 | 50709 | 4815 | 52160 | 3972 | 52923 | 2719 | 62566 | 2363 | 33578 |
| 14-#14 | 1.99 | MA | 32614 | 8091 | 51660 | 6033 | 55497 | 4888 | 56003 | 4052 | 54641 | 2813 | 64692 | 2065 | 39640 |
| 7L-2S | | MI | 30007 | 8091 | 48167 | 5920 | 52598 | 4799 | 54465 | 3958 | 56017 | 2707 | 66665 | 2487 | 33544 |
| 14-#18 | 3.54 | MA | 39237 | 8938 | 65637 | 6486 | 73229 | 5248 | 77577 | 4249 | 83726 | 2698 | 102025 | 2163 | 72358 |
| 3L-6S | | MI | 28381 | 8938 | 47759 | 6399 | 51683 | 5162 | 53391 | 4203 | 54363 | 2617 | 66040 | 1545 | 52952 |
| 14-#18 | 3.54 | MA | 37735 | 8938 | 62972 | 6522 | 69833 | 5237 | 73450 | 4233 | 78434 | 2720 | 96038 | 1942 | 71429 |
| 4L-5S | | MI | 29405 | 8938 | 49483 | 6411 | 54067 | 5179 | 56171 | 4181 | 58068 | 2595 | 70566 | 1691 | 54712 |
| 14-#18 | 3.54 | MA | 36394 | 8938 | 60665 | 6514 | 66842 | 5269 | 69775 | 4262 | 73133 | 2698 | 89742 | 1839 | 68463 |
| 5L-4S | | MI | 30480 | 8938 | 51318 | 6424 | 56445 | 5152 | 59092 | 4158 | 62161 | 2617 | 75417 | 1786 | 56777 |
| 14-#18 | 3.54 | MA | 35118 | 8938 | 58502 | 6506 | 63846 | 5257 | 66114 | 4246 | 68328 | 2720 | 83790 | 1694 | 66234 |
| 6L-3S | | MI | 31679 | 8938 | 53432 | 6392 | 59138 | 5169 | 62365 | 4180 | 66241 | 2595 | 79956 | 2007 | 57693 |
| 14-#18 | 3.54 | MA | 33876 | 8938 | 56132 | 6542 | 60987 | 5289 | 62600 | 4274 | 63633 | 2742 | 77433 | 1463 | 63186 |
| 7L-2S | | MI | 33363 | 8938 | 56004 | 6404 | 62434 | 5142 | 66386 | 4157 | 71580 | 2573 | 86992 | 2229 | 57837 |
| 16-#11 | 1.58 | MA | 35801 | 7864 | 56211 | 5878 | 61477 | 4780 | 63366 | 3966 | 64560 | 2798 | 77008 | 2641 | 33489 |
| 2L-8S | | MI | 26218 | 7864 | 41303 | 5813 | 43836 | 4736 | 43835 | 3940 | 41788 | 2764 | 48767 | 2154 | 26214 |
| 16-#11 | 1.58 | MA | 34919 | 7864 | 54910 | 5876 | 59809 | 4776 | 61331 | 3979 | 61791 | 2808 | 73261 | 2554 | 33511 |
| 3L-7S | | MI | 26623 | 7864 | 41978 | 5817 | 44755 | 4742 | 44923 | 3930 | 43357 | 2773 | 50616 | 2201 | 26469 |
| 16-#11 | 1.58 | MA | 34302 | 7864 | 53852 | 5891 | 58459 | 4790 | 59691 | 3974 | 59681 | 2818 | 70819 | 2468 | 33505 |
| 4L-6S | | MI | 27034 | 7864 | 42729 | 5803 | 45661 | 4729 | 46036 | 3919 | 44833 | 2764 | 52609 | 2291 | 26860 |
| 16-#11 | 1.58 | MA | 33751 | 7864 | 52937 | 5889 | 57273 | 4786 | 58234 | 3986 | 57569 | 2811 | 68276 | 2426 | 33456 |
| 5E | | MI | 27455 | 7864 | 43415 | 5807 | 46610 | 4735 | 47196 | 3926 | 46343 | 2756 | 54474 | 2347 | 26994 |
| 16-#11 | 1.58 | MA | 33227 | 7864 | 52080 | 5887 | 56086 | 4800 | 56782 | 3982 | 55656 | 2821 | 65854 | 2370 | 33246 |
| 6L-4S | | MI | 27897 | 7864 | 44146 | 5811 | 47557 | 4723 | 48360 | 3916 | 48010 | 2764 | 56453 | 2387 | 26993 |
| 16-#11 | 1.58 | MA | 32716 | 7864 | 51140 | 5902 | 54953 | 4797 | 55389 | 3994 | 53787 | 2831 | 63270 | 2280 | 32679 |
| 7L-3S | | MI | 28390 | 7864 | 44990 | 5797 | 48633 | 4728 | 49667 | 3922 | 49674 | 2756 | 58327 | 2473 | 26966 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis

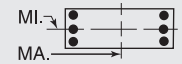


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.58 | MA | 32213 | 7864 | 50297 | 5899 | 53803 | 4810 | 54029 | 4007 | 51800 | 2824 | 60892 | 2231 | 32290 |
| 8L-2S | | MI | 29086 | 7864 | 46021 | 5801 | 49955 | 4716 | 51280 | 3912 | 51851 | 2747 | 61218 | 2559 | 26932 |
| 16-#14 | 2.27 | MA | 37861 | 8246 | 60793 | 6099 | 67238 | 4936 | 70352 | 4057 | 74047 | 2758 | 89571 | 2559 | 47656 |
| 2L-8S | | MI | 26620 | 8246 | 42885 | 6032 | 45728 | 4894 | 46113 | 4036 | 44807 | 2716 | 53106 | 1871 | 35585 |
| 16-#14 | 2.27 | MA | 36615 | 8246 | 58930 | 6095 | 64850 | 4930 | 67439 | 4075 | 70083 | 2771 | 84239 | 2435 | 47620 |
| 3L-7S | | MI | 27192 | 8246 | 43854 | 6037 | 47045 | 4902 | 47671 | 4022 | 47038 | 2729 | 55734 | 1937 | 36556 |
| 16-#14 | 2.27 | MA | 35742 | 8246 | 57412 | 6116 | 62916 | 4950 | 65088 | 4067 | 67058 | 2785 | 80770 | 2310 | 47511 |
| 4L-6S | | MI | 27773 | 8246 | 44930 | 6018 | 48343 | 4886 | 49267 | 4008 | 49135 | 2716 | 58558 | 2068 | 37034 |
| 16-#14 | 2.27 | MA | 34962 | 8246 | 56100 | 6112 | 61214 | 4944 | 62997 | 4085 | 64030 | 2774 | 77144 | 2251 | 47145 |
| 5E | | MI | 28369 | 8246 | 45912 | 6024 | 49703 | 4894 | 50928 | 4018 | 51282 | 2704 | 61199 | 2149 | 37828 |
| 16-#14 | 2.27 | MA | 34221 | 8246 | 54870 | 6109 | 59511 | 4963 | 60915 | 4077 | 61286 | 2787 | 73699 | 2170 | 46004 |
| 6L-4S | | MI | 28994 | 8246 | 46959 | 6030 | 51060 | 4877 | 52595 | 4004 | 53652 | 2716 | 64012 | 2205 | 38137 |
| 16-#14 | 2.27 | MA | 33498 | 8246 | 53523 | 6130 | 57885 | 4958 | 58916 | 4094 | 58605 | 2801 | 70023 | 2040 | 45291 |
| 7L-3S | | MI | 29692 | 8246 | 48167 | 6011 | 52598 | 4885 | 54465 | 4014 | 56017 | 2704 | 66665 | 2330 | 38182 |
| 16-#14 | 2.27 | MA | 32786 | 8246 | 52312 | 6126 | 56237 | 4977 | 56966 | 4112 | 55755 | 2790 | 66633 | 1970 | 44000 |
| 8L-2S | | MI | 30675 | 8246 | 49641 | 6017 | 54488 | 4869 | 56770 | 4000 | 59110 | 2692 | 70764 | 2454 | 38168 |
| 16-#18 | 4.04 | MA | 39212 | 9214 | 66235 | 6695 | 74016 | 5361 | 78553 | 4309 | 85357 | 2697 | 105260 | 1890 | 81077 |
| 4L-6S | | MI | 29539 | 9214 | 50330 | 6572 | 54980 | 5287 | 57412 | 4279 | 59702 | 2586 | 73075 | 1478 | 60449 |
| 16-#18 | 4.04 | MA | 37882 | 9214 | 63928 | 6687 | 71025 | 5393 | 74878 | 4337 | 80056 | 2675 | 98964 | 1787 | 78260 |
| 5E | | MI | 30556 | 9214 | 52054 | 6584 | 57363 | 5304 | 60193 | 4256 | 63407 | 2564 | 77602 | 1624 | 62401 |
| 16-#18 | 4.04 | MA | 36617 | 9214 | 61765 | 6679 | 68029 | 5381 | 71217 | 4321 | 75252 | 2697 | 93012 | 1643 | 75838 |
| 6L-4S | | MI | 31623 | 9214 | 53890 | 6597 | 59741 | 5276 | 63114 | 4234 | 67500 | 2586 | 82453 | 1719 | 64341 |
| 16-#18 | 4.04 | MA | 35385 | 9214 | 59395 | 6715 | 65170 | 5413 | 67702 | 4350 | 70556 | 2719 | 86655 | 1412 | 72902 |
| 7L-3S | | MI | 32814 | 9214 | 56004 | 6565 | 62434 | 5294 | 66386 | 4255 | 71580 | 2564 | 86992 | 1940 | 65632 |
| 18-#11 | 1.77 | MA | 36411 | 7972 | 57512 | 5946 | 63144 | 4828 | 65401 | 3995 | 67328 | 2790 | 80754 | 2624 | 37565 |
| 2L-9S | | MI | 26296 | 7972 | 41607 | 5894 | 44263 | 4797 | 44311 | 3963 | 42501 | 2763 | 49850 | 2078 | 28895 |
| 18-#11 | 1.77 | MA | 35532 | 7972 | 56211 | 5943 | 61477 | 4825 | 63366 | 4008 | 64560 | 2800 | 77008 | 2538 | 37579 |
| 3L-8S | | MI | 26703 | 7972 | 42334 | 5881 | 45158 | 4785 | 45448 | 3970 | 43964 | 2754 | 51658 | 2132 | 29354 |
| 18-#11 | 1.77 | MA | 34917 | 7972 | 55153 | 5958 | 60127 | 4838 | 61726 | 4003 | 62450 | 2810 | 74566 | 2452 | 37553 |
| 4L-7S | | MI | 27106 | 7972 | 43009 | 5884 | 46077 | 4790 | 46535 | 3959 | 45534 | 2763 | 53508 | 2179 | 29601 |
| 18-#11 | 1.77 | MA | 34369 | 7972 | 54238 | 5956 | 58941 | 4835 | 60268 | 4016 | 60338 | 2802 | 72023 | 2410 | 37488 |
| 5L-6S | | MI | 27516 | 7972 | 43760 | 5871 | 46983 | 4778 | 47649 | 3949 | 47009 | 2754 | 55500 | 2269 | 29973 |
| 18-#11 | 1.77 | MA | 33847 | 7972 | 53381 | 5954 | 57753 | 4849 | 58817 | 4011 | 58425 | 2812 | 69600 | 2354 | 37176 |
| 6L-5S | | MI | 27935 | 7972 | 44446 | 5874 | 47932 | 4783 | 48809 | 3955 | 48520 | 2746 | 57365 | 2326 | 30202 |
| 18-#11 | 1.77 | MA | 33338 | 7972 | 52442 | 5969 | 56621 | 4845 | 57424 | 4024 | 56555 | 2822 | 67017 | 2264 | 36633 |
| 7L-4S | | MI | 28375 | 7972 | 45177 | 5878 | 48880 | 4771 | 49973 | 3945 | 50187 | 2754 | 59344 | 2365 | 30220 |
| 18-#11 | 1.77 | MA | 32837 | 7972 | 51598 | 5967 | 55471 | 4859 | 56064 | 4036 | 54569 | 2815 | 64638 | 2215 | 36254 |
| 8L-3S | | MI | 28867 | 7972 | 46021 | 5864 | 49955 | 4776 | 51280 | 3952 | 51851 | 2746 | 61218 | 2451 | 30203 |
| 18-#11 | 1.77 | MA | 32314 | 7972 | 50773 | 5965 | 54354 | 4855 | 54642 | 4031 | 52717 | 2825 | 62289 | 2161 | 35613 |
| 9L-2S | | MI | 29561 | 7972 | 47052 | 5868 | 51277 | 4764 | 52893 | 3941 | 54027 | 2737 | 64110 | 2538 | 30176 |
| 18-#14 | 2.56 | MA | 37476 | 8402 | 60793 | 6192 | 67238 | 5000 | 70352 | 4117 | 74047 | 2759 | 89571 | 2409 | 53407 |
| 3L-8S | | MI | 27304 | 8402 | 44359 | 6129 | 47617 | 4964 | 48418 | 4079 | 47900 | 2701 | 57205 | 1838 | 39971 |
| 18-#14 | 2.56 | MA | 36607 | 8402 | 59275 | 6213 | 65304 | 5019 | 68001 | 4110 | 71022 | 2773 | 86101 | 2285 | 53272 |
| 4L-7S | | MI | 27873 | 8402 | 45327 | 6135 | 48934 | 4972 | 49976 | 4065 | 50131 | 2714 | 59833 | 1904 | 41020 |
| 18-#14 | 2.56 | MA | 35832 | 8402 | 57963 | 6210 | 63603 | 5014 | 65910 | 4127 | 67994 | 2761 | 82475 | 2225 | 52731 |
| 5L-6S | | MI | 28451 | 8402 | 46403 | 6116 | 50232 | 4955 | 51571 | 4050 | 52229 | 2701 | 62657 | 2034 | 41484 |
| 18-#14 | 2.56 | MA | 35094 | 8402 | 56733 | 6206 | 61899 | 5033 | 63828 | 4119 | 65249 | 2775 | 79030 | 2144 | 51639 |
| 6L-5S | | MI | 29044 | 8402 | 47386 | 6122 | 51592 | 4964 | 53233 | 4061 | 54376 | 2689 | 65298 | 2116 | 42236 |
| 18-#14 | 2.56 | MA | 34375 | 8402 | 55386 | 6227 | 60273 | 5028 | 61830 | 4137 | 62568 | 2789 | 75354 | 2015 | 50948 |
| 7L-4S | | MI | 29666 | 8402 | 48433 | 6127 | 52949 | 4947 | 54900 | 4046 | 56746 | 2701 | 68111 | 2172 | 42704 |
| 18-#14 | 2.56 | MA | 33667 | 8402 | 54175 | 6223 | 58625 | 5047 | 59879 | 4154 | 59719 | 2777 | 71964 | 1944 | 49576 |
| 8L-3S | | MI | 30360 | 8402 | 49641 | 6108 | 54488 | 4955 | 56770 | 4057 | 59110 | 2689 | 70764 | 2296 | 42771 |
| 18-#14 | 2.56 | MA | 32939 | 8402 | 52871 | 6245 | 57021 | 5041 | 57839 | 4147 | 57062 | 2791 | 68624 | 1867 | 48485 |
| 9L-2S | | MI | 31340 | 8402 | 51115 | 6114 | 56377 | 4938 | 59074 | 4043 | 62204 | 2676 | 74863 | 2421 | 42790 |
| 18-#18 | 4.55 | MA | 39357 | 9491 | 67191 | 6860 | 75208 | 5517 | 79981 | 4412 | 86979 | 2652 | 108186 | 1736 | 88076 |
| 5L-6S | | MI | 30688 | 9491 | 52902 | 6745 | 58276 | 5411 | 61434 | 4354 | 65042 | 2555 | 80111 | 1411 | 67973 |
| 18-#18 | 4.55 | MA | 38102 | 9491 | 65028 | 6852 | 72212 | 5505 | 76320 | 4397 | 82175 | 2674 | 102234 | 1592 | 85469 |
| 6L-5S | | MI | 31698 | 9491 | 54626 | 6757 | 60659 | 5428 | 64214 | 4332 | 68746 | 2533 | 84638 | 1557 | 70107 |
| 18-#18 | 4.55 | MA | 36880 | 9491 | 62657 | 6887 | 69353 | 5537 | 72805 | 4425 | 77480 | 2696 | 95877 | 1360 | 82639 |
| 7L-4S | | MI | 32758 | 9491 | 56461 | 6770 | 63038 | 5401 | 67135 | 4309 | 72839 | 2555 | 89489 | 1652 | 71937 |

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis

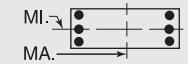



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.97 | MA | 36142 | 8080 | 57512 | 6011 | 63144 | 4873 | 65401 | 4037 | 67328 | 2791 | 80754 | 2522 | 41633 |
| 3L-9S | | MI | 26788 | 8080 | 42638 | 5962 | 45586 | 4845 | 45924 | 3992 | 44678 | 2753 | 52742 | 2057 | 31983 |
| 20-#11 | 1.97 | MA | 35530 | 8080 | 56454 | 6026 | 61795 | 4887 | 63761 | 4033 | 65218 | 2801 | 78313 | 2435 | 41596 |
| 4L-8S | | MI | 27186 | 8080 | 43365 | 5948 | 46480 | 4833 | 47061 | 3999 | 46141 | 2745 | 54550 | 2111 | 32497 |
| 20-#11 | 1.97 | MA | 34983 | 8080 | 55539 | 6024 | 60609 | 4883 | 62303 | 4045 | 63106 | 2794 | 75770 | 2393 | 41517 |
| 5L-7S | | MI | 27587 | 8080 | 44041 | 5952 | 47399 | 4838 | 48148 | 3989 | 47710 | 2753 | 56399 | 2157 | 32737 |
| 20-#11 | 1.97 | MA | 34463 | 8080 | 54682 | 6021 | 59421 | 4897 | 60851 | 4040 | 61193 | 2804 | 73347 | 2337 | 41114 |
| 6E | | MI | 27995 | 8080 | 44792 | 5938 | 48305 | 4826 | 49262 | 3978 | 49186 | 2745 | 58392 | 2248 | 33091 |
| 20-#11 | 1.97 | MA | 33956 | 8080 | 53743 | 6036 | 58288 | 4894 | 59458 | 4053 | 59324 | 2814 | 70763 | 2247 | 40591 |
| 7L-5S | | MI | 28413 | 8080 | 45478 | 5942 | 49254 | 4831 | 50422 | 3985 | 50696 | 2736 | 60257 | 2304 | 33405 |
| 20-#11 | 1.97 | MA | 33457 | 8080 | 52899 | 6034 | 57139 | 4907 | 58099 | 4065 | 57337 | 2807 | 68385 | 2198 | 40221 |
| 8L-4S | | MI | 28852 | 8080 | 46209 | 5945 | 50202 | 4819 | 51586 | 3974 | 52364 | 2745 | 62236 | 2344 | 33437 |
| 20-#11 | 1.97 | MA | 32938 | 8080 | 52074 | 6032 | 56022 | 4904 | 56677 | 4061 | 55485 | 2817 | 66036 | 2144 | 39526 |
| 9L-3S | | MI | 29341 | 8080 | 47052 | 5932 | 51277 | 4825 | 52893 | 3981 | 54027 | 2736 | 64110 | 2430 | 33435 |
| 20-#11 | 1.97 | MA | 32387 | 8080 | 51149 | 6047 | 54888 | 4918 | 55324 | 4073 | 53649 | 2827 | 63759 | 2083 | 38898 |
| 10L-2S | | MI | 30033 | 8080 | 48084 | 5935 | 52599 | 4812 | 54506 | 3970 | 56204 | 2727 | 67002 | 2516 | 33413 |
| 20-#14 | 2.84 | MA | 37467 | 8557 | 61138 | 6311 | 67692 | 5089 | 70915 | 4152 | 74986 | 2760 | 91432 | 2259 | 59029 |
| 4L-8S | | MI | 27983 | 8557 | 45833 | 6226 | 49507 | 5034 | 50723 | 4121 | 50994 | 2686 | 61304 | 1805 | 44365 |
| 20-#14 | 2.84 | MA | 36696 | 8557 | 59826 | 6307 | 65991 | 5084 | 68824 | 4169 | 71957 | 2749 | 87806 | 2200 | 58329 |
| 5L-7S | | MI | 28550 | 8557 | 46801 | 6232 | 50824 | 5042 | 52281 | 4107 | 53225 | 2698 | 63932 | 1871 | 45375 |
| 20-#14 | 2.84 | MA | 35962 | 8557 | 58596 | 6303 | 64287 | 5103 | 66741 | 4162 | 69213 | 2763 | 84361 | 2119 | 57282 |
| 6E | | MI | 29125 | 8557 | 47877 | 6213 | 52122 | 5025 | 53876 | 4093 | 55323 | 2686 | 66756 | 2001 | 45939 |
| 20-#14 | 2.84 | MA | 35247 | 8557 | 57248 | 6324 | 62661 | 5097 | 64743 | 4179 | 66532 | 2776 | 80685 | 1989 | 56581 |
| 7L-5S | | MI | 29715 | 8557 | 48860 | 6219 | 53481 | 5033 | 55537 | 4103 | 57469 | 2674 | 69397 | 2083 | 46655 |
| 20-#14 | 2.84 | MA | 34543 | 8557 | 56038 | 6321 | 61013 | 5117 | 62792 | 4197 | 63682 | 2765 | 77295 | 1919 | 55161 |
| 8L-4S | | MI | 30335 | 8557 | 49907 | 6225 | 54838 | 5017 | 57204 | 4089 | 59840 | 2686 | 72210 | 2139 | 47264 |
| 20-#14 | 2.84 | MA | 33833 | 8557 | 54734 | 6342 | 59409 | 5111 | 60752 | 4189 | 61025 | 2778 | 73955 | 1841 | 54006 |
| 9L-3S | | MI | 31026 | 8557 | 51115 | 6206 | 56377 | 5025 | 59074 | 4099 | 62204 | 2674 | 74863 | 2263 | 47353 |
| 20-#18 | 5.05 | MA | 39576 | 9768 | 68290 | 7024 | 76395 | 5629 | 81423 | 4472 | 89098 | 2651 | 111456 | 1540 | 95124 |
| 6E | | MI | 31829 | 9768 | 55473 | 6918 | 61572 | 5535 | 65455 | 4429 | 70381 | 2524 | 87147 | 1344 | 75523 |
| 20-#18 | 5.05 | MA | 38363 | 9768 | 65920 | 7060 | 73536 | 5662 | 77908 | 4501 | 84403 | 2673 | 105099 | 1309 | 92393 |
| 7L-5S | | MI | 32832 | 9768 | 57197 | 6930 | 63956 | 5552 | 68235 | 4407 | 74085 | 2502 | 91673 | 1490 | 77829 |
| 22-#11 | 2.17 | MA | 36139 | 8188 | 57755 | 6093 | 63463 | 4935 | 65796 | 4062 | 67987 | 2792 | 82059 | 2419 | 45636 |
| 4L-9S | | MI | 27270 | 8188 | 43670 | 6029 | 46908 | 4894 | 47537 | 4022 | 46855 | 2744 | 55633 | 2035 | 35077 |
| 22-#11 | 2.17 | MA | 35595 | 8188 | 56840 | 6091 | 62277 | 4932 | 64338 | 4075 | 65875 | 2785 | 79516 | 2377 | 45543 |
| 5L-8S | | MI | 27666 | 8188 | 44397 | 6016 | 47802 | 4882 | 48674 | 4029 | 48317 | 2735 | 57441 | 2089 | 35641 |
| 22-#11 | 2.17 | MA | 35077 | 8188 | 55983 | 6089 | 61089 | 4945 | 62886 | 4070 | 63961 | 2795 | 77094 | 2321 | 45057 |
| 6L-7S | | MI | 28066 | 8188 | 45072 | 6019 | 48721 | 4887 | 49761 | 4018 | 49887 | 2744 | 59291 | 2136 | 35876 |
| 22-#11 | 2.17 | MA | 34572 | 8188 | 55044 | 6104 | 59956 | 4942 | 61493 | 4082 | 62092 | 2805 | 74510 | 2231 | 44552 |
| 7L-6S | | MI | 28473 | 8188 | 45823 | 6006 | 49627 | 4875 | 50875 | 4008 | 51363 | 2735 | 61283 | 2226 | 36215 |
| 22-#11 | 2.17 | MA | 34075 | 8188 | 54200 | 6102 | 58807 | 4956 | 60133 | 4095 | 60106 | 2798 | 72132 | 2182 | 44191 |
| 8L-5S | | MI | 28889 | 8188 | 46509 | 6009 | 50576 | 4880 | 52035 | 4014 | 52873 | 2726 | 63148 | 2283 | 36603 |
| 22-#11 | 2.17 | MA | 33558 | 8188 | 53375 | 6099 | 57690 | 4952 | 58712 | 4090 | 58254 | 2808 | 69783 | 2128 | 43444 |
| 9L-4S | | MI | 29326 | 8188 | 47240 | 6013 | 51524 | 4868 | 53199 | 4004 | 54540 | 2735 | 65127 | 2322 | 36647 |
| 22-#11 | 2.17 | MA | 33009 | 8188 | 52451 | 6114 | 56556 | 4966 | 57359 | 4103 | 56417 | 2818 | 67506 | 2067 | 42832 |
| 10L-3S | | MI | 29814 | 8188 | 48084 | 5999 | 52599 | 4873 | 54506 | 4010 | 56204 | 2726 | 67002 | 2408 | 36662 |
| 22-#11 | 2.17 | MA | 32473 | 8188 | 51624 | 6112 | 55444 | 4963 | 55955 | 4098 | 54459 | 2811 | 65187 | 2015 | 41988 |
| 11L-2S | | MI | 30504 | 8188 | 49115 | 6003 | 53921 | 4861 | 56119 | 4000 | 58380 | 2718 | 69893 | 2495 | 36647 |
| 22-#14 | 3.13 | MA | 37555 | 8713 | 61689 | 6404 | 68379 | 5153 | 71737 | 4212 | 75921 | 2736 | 93138 | 2174 | 63938 |
| 5L-8S | | MI | 28659 | 8713 | 47307 | 6323 | 51396 | 5104 | 53028 | 4164 | 54088 | 2671 | 65403 | 1772 | 48768 |
| 22-#14 | 3.13 | MA | 36825 | 8713 | 60459 | 6400 | 66675 | 5173 | 69655 | 4204 | 73177 | 2750 | 89692 | 2094 | 62931 |
| 6L-7S | | MI | 29223 | 8713 | 48275 | 6329 | 52713 | 5112 | 54586 | 4149 | 56319 | 2683 | 68031 | 1838 | 49741 |
| 22-#14 | 3.13 | MA | 36114 | 8713 | 59111 | 6422 | 65049 | 5167 | 67656 | 4222 | 70496 | 2764 | 86017 | 1964 | 62132 |
| 7L-6S | | MI | 29796 | 8713 | 49351 | 6310 | 54011 | 5095 | 56181 | 4135 | 58416 | 2671 | 70855 | 1968 | 50401 |
| 22-#14 | 3.13 | MA | 35414 | 8713 | 57901 | 6418 | 63401 | 5186 | 65705 | 4239 | 67646 | 2752 | 82627 | 1894 | 60754 |
| 8L-5S | | MI | 30383 | 8713 | 50334 | 6316 | 55371 | 5103 | 57842 | 4146 | 60563 | 2658 | 73497 | 2050 | 51084 |
| 22-#14 | 3.13 | MA | 34704 | 8713 | 56597 | 6439 | 61797 | 5181 | 63666 | 4232 | 64989 | 2766 | 79286 | 1816 | 59535 |
| 9L-4S | | MI | 31000 | 8713 | 51381 | 6322 | 56728 | 5087 | 59509 | 4131 | 62933 | 2671 | 76309 | 2105 | 51820 |
| 22-#18 | 5.56 | MA | 39835 | 10044 | 69183 | 7233 | 77719 | 5786 | 83011 | 4576 | 91326 | 2649 | 114321 | 1258 | 102143 |
| 7L-6S | | MI | 32963 | 10044 | 58044 | 7091 | 64868 | 5659 | 69476 | 4505 | 75720 | 2493 | 94183 | 1277 | 83093 |

## RECTANGULAR TIED COLUMNS 36" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.36 | MA | 36203 | 8296 | 58141 | 6159 | 63945 | 4980 | 66373 | 4104 | 68643 | 2777 | 83263 | 2360 | 49566 |
| 5L-9S | | MI | 27750 | 8296 | 44701 | 6097 | 48230 | 4942 | 49150 | 4051 | 49031 | 2734 | 58525 | 2014 | 38175 |
| 24-#11 | 2.36 | MA | 35687 | 8296 | 57284 | 6156 | 62757 | 4994 | 64921 | 4099 | 66730 | 2787 | 80840 | 2304 | 49006 |
| 6L-8S | | MI | 28145 | 8296 | 45428 | 6083 | 49124 | 4930 | 50287 | 4058 | 50494 | 2725 | 60333 | 2068 | 38735 |
| 24-#11 | 2.36 | MA | 35185 | 8296 | 56345 | 6171 | 61624 | 4990 | 63528 | 4112 | 64861 | 2797 | 78256 | 2215 | 48517 |
| 7E | | MI | 28543 | 8296 | 46103 | 6087 | 50043 | 4935 | 51374 | 4047 | 52063 | 2734 | 62182 | 2114 | 39017 |
| 24-#11 | 2.36 | MA | 34690 | 8296 | 55501 | 6169 | 60475 | 5004 | 62168 | 4124 | 62874 | 2789 | 75878 | 2165 | 48161 |
| 8L-6S | | MI | 28948 | 8296 | 46855 | 6073 | 50949 | 4923 | 52488 | 4037 | 53539 | 2725 | 64175 | 2205 | 39343 |
| 24-#11 | 2.36 | MA | 34175 | 8296 | 54676 | 6167 | 59357 | 5001 | 60746 | 4120 | 61022 | 2799 | 73529 | 2112 | 47367 |
| 9L-5S | | MI | 29363 | 8296 | 47540 | 6077 | 51899 | 4928 | 53648 | 4044 | 55049 | 2716 | 66040 | 2261 | 39798 |
| 24-#11 | 2.36 | MA | 33628 | 8296 | 53752 | 6182 | 58224 | 5014 | 59394 | 4132 | 59186 | 2809 | 71253 | 2051 | 46769 |
| 10L-4S | | MI | 29799 | 8296 | 48271 | 6080 | 52846 | 4916 | 54812 | 4033 | 56717 | 2725 | 68019 | 2300 | 39853 |
| 24-#11 | 2.36 | MA | 33094 | 8296 | 52925 | 6180 | 57112 | 5011 | 57990 | 4127 | 57228 | 2802 | 68934 | 1998 | 45888 |
| 11L-3S | | MI | 30285 | 8296 | 49115 | 6067 | 53921 | 4921 | 56119 | 4040 | 58380 | 2716 | 69893 | 2387 | 39879 |
| 24-#14 | 3.41 | MA | 37683 | 8869 | 62322 | 6498 | 69063 | 5243 | 72568 | 4247 | 77141 | 2738 | 95024 | 2068 | 68587 |
| 6L-8S | | MI | 29332 | 8869 | 48781 | 6421 | 53285 | 5174 | 55333 | 4206 | 57181 | 2656 | 69502 | 1738 | 53178 |
| 24-#14 | 3.41 | MA | 36976 | 8869 | 60974 | 6519 | 67437 | 5237 | 70569 | 4264 | 74459 | 2751 | 91348 | 1938 | 67693 |
| 7E | | MI | 29893 | 8869 | 49749 | 6427 | 54602 | 5182 | 56890 | 4192 | 59412 | 2668 | 72130 | 1804 | 54117 |
| 24-#14 | 3.41 | MA | 36279 | 8869 | 59763 | 6515 | 65789 | 5256 | 68619 | 4282 | 71610 | 2740 | 87958 | 1868 | 66355 |
| 8L-6S | | MI | 30463 | 8869 | 50825 | 6407 | 55900 | 5165 | 58486 | 4177 | 61510 | 2656 | 74954 | 1935 | 54867 |
| 24-#14 | 3.41 | MA | 35570 | 8869 | 58460 | 6536 | 64185 | 5251 | 66579 | 4274 | 68953 | 2754 | 84617 | 1791 | 65074 |
| 9L-5S | | MI | 31048 | 8869 | 51807 | 6413 | 57260 | 5173 | 60147 | 4188 | 63657 | 2643 | 77596 | 2016 | 55521 |

## RECTANGULAR TIED COLUMNS 36" x 46"

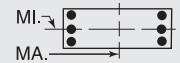
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.45 | MA | 38578 | 8149 | 60561 | 6061 | 65822 | 4932 | 67492 | 4099 | 68121 | 2910 | 80465 | 2733 | 33468 |
| 2L-3S | | MI | 28189 | 8149 | 44875 | 5937 | 47742 | 4867 | 48018 | 4043 | 46439 | 2845 | 53528 | 2398 | 25774 |
| 6-#18 | 1.45 | MA | 36250 | 8149 | 57125 | 6054 | 61418 | 4966 | 62118 | 4129 | 60810 | 2933 | 70695 | 2511 | 33536 |
| 3L-2S | | MI | 29923 | 8149 | 47446 | 5949 | 51038 | 4840 | 52039 | 4021 | 51778 | 2823 | 60564 | 2619 | 25647 |
| 8-#14 | 1.09 | MA | 37456 | 7942 | 57913 | 5968 | 62659 | 4869 | 63722 | 4068 | 63028 | 2946 | 73952 | 2801 | 25505 |
| 2L-4S | | MI | 27411 | 7942 | 42785 | 5879 | 45292 | 4794 | 45118 | 4001 | 42840 | 2905 | 49342 | 2462 | 19797 |
| 8-#14 | 1.09 | MA | 36117 | 7942 | 55953 | 5965 | 60147 | 4864 | 60656 | 4086 | 58857 | 2961 | 68312 | 2677 | 25568 |
| 3E | | MI | 28123 | 7942 | 43992 | 5860 | 46831 | 4802 | 46988 | 4011 | 45204 | 2893 | 51994 | 2586 | 19719 |
| 8-#14 | 1.09 | MA | 35178 | 7942 | 54358 | 5986 | 58114 | 4884 | 58185 | 4079 | 55678 | 2975 | 64637 | 2552 | 25601 |
| 4L-2S | | MI | 29125 | 7942 | 45466 | 5866 | 48720 | 4785 | 49292 | 3997 | 48298 | 2880 | 56093 | 2711 | 19641 |
| 8-#18 | 1.93 | MA | 40173 | 8426 | 63997 | 6234 | 70227 | 5057 | 72865 | 4175 | 75432 | 2888 | 90234 | 2685 | 44250 |
| 2L-4S | | MI | 28138 | 8426 | 45332 | 6141 | 48345 | 4974 | 48767 | 4097 | 47699 | 2837 | 56025 | 2109 | 33734 |
| 8-#18 | 1.93 | MA | 37864 | 8426 | 60561 | 6227 | 65822 | 5090 | 67492 | 4204 | 68121 | 2911 | 80465 | 2463 | 44225 |
| 3E | | MI | 29366 | 8426 | 47446 | 6109 | 51038 | 4991 | 52039 | 4119 | 51778 | 2814 | 60564 | 2331 | 33841 |
| 8-#18 | 1.93 | MA | 36242 | 8426 | 57759 | 6264 | 62250 | 5079 | 63151 | 4190 | 62535 | 2933 | 74114 | 2242 | 43888 |
| 4L-2S | | MI | 31088 | 8426 | 50017 | 6122 | 54335 | 4964 | 56060 | 4096 | 57118 | 2792 | 67600 | 2552 | 33765 |
| 10-#14 | 1.36 | MA | 38384 | 8098 | 59873 | 6065 | 65172 | 4939 | 66787 | 4111 | 67199 | 2934 | 79592 | 2777 | 31670 |
| 2L-5S | | MI | 27465 | 8098 | 43211 | 5971 | 45824 | 4880 | 45756 | 4057 | 43563 | 2878 | 50628 | 2373 | 24425 |
| 10-#14 | 1.36 | MA | 37052 | 8098 | 57913 | 6062 | 62659 | 4934 | 63722 | 4129 | 63028 | 2948 | 73952 | 2653 | 31714 |
| 3L-4S | | MI | 28100 | 8098 | 44258 | 5976 | 47181 | 4864 | 47423 | 4043 | 45934 | 2890 | 53441 | 2428 | 24429 |
| 10-#14 | 1.36 | MA | 36118 | 8098 | 56318 | 6084 | 60627 | 4954 | 61251 | 4122 | 59848 | 2963 | 70277 | 2528 | 31704 |
| 4L-3S | | MI | 28809 | 8098 | 45466 | 5957 | 48720 | 4872 | 49292 | 4054 | 48298 | 2878 | 56093 | 2553 | 24375 |
| 10-#14 | 1.36 | MA | 35284 | 8098 | 54940 | 6080 | 58839 | 4949 | 59054 | 4140 | 56666 | 2952 | 66448 | 2468 | 31580 |
| 5L-2S | | MI | 29806 | 8098 | 46940 | 5963 | 50610 | 4855 | 51597 | 4039 | 51391 | 2865 | 60192 | 2678 | 24310 |
| 10-#18 | 2.42 | MA | 41752 | 8703 | 67433 | 6407 | 74631 | 5181 | 78238 | 4250 | 82743 | 2866 | 100004 | 2636 | 54997 |
| 2L-5S | | MI | 28219 | 8703 | 46068 | 6302 | 49263 | 5125 | 49867 | 4195 | 48945 | 2783 | 58210 | 1947 | 39703 |
| 10-#18 | 2.42 | MA | 39460 | 8703 | 63997 | 6400 | 70227 | 5214 | 72865 | 4280 | 75432 | 2889 | 90234 | 2415 | 54882 |
| 3L-4S | | MI | 29313 | 8703 | 47903 | 6314 | 51642 | 5098 | 52788 | 4172 | 53038 | 2806 | 63061 | 2043 | 41657 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

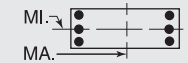
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 2.42 | MA | 37852 | 8703 | 61194 | 6437 | 66655 | 5203 | 68524 | 4265 | 69845 | 2911 | 83884 | 2193 | 54446 |
| 4L-3S | | MI | 30531 | 8703 | 50017 | 6282 | 54335 | 5115 | 56060 | 4194 | 57118 | 2783 | 67600 | 2264 | 41854 |
| 10-#18 | 2.42 | MA | 36416 | 8703 | 58770 | 6429 | 63511 | 5236 | 64661 | 4295 | 64251 | 2890 | 77226 | 2089 | 51699 |
| 5L-2S | | MI | 32242 | 8703 | 52589 | 6295 | 57631 | 5088 | 60082 | 4172 | 62457 | 2761 | 74636 | 2485 | 41845 |
| 12-#11 | 1.13 | MA | 37651 | 7967 | 58191 | 6002 | 63133 | 4895 | 64345 | 4088 | 63895 | 2954 | 75275 | 2814 | 26581 |
| 2L-6S | | MI | 27209 | 7967 | 42383 | 5908 | 44806 | 4829 | 44555 | 4028 | 42045 | 2912 | 48557 | 2458 | 20613 |
| 12-#11 | 1.13 | MA | 36715 | 7967 | 56822 | 6000 | 61379 | 4892 | 62204 | 4101 | 60983 | 2965 | 71314 | 2727 | 26620 |
| 3L-5S | | MI | 27634 | 7967 | 43069 | 5911 | 45755 | 4835 | 45715 | 4034 | 43556 | 2904 | 50422 | 2514 | 20599 |
| 12-#11 | 1.13 | MA | 36061 | 7967 | 55710 | 6015 | 59961 | 4906 | 60481 | 4096 | 58765 | 2975 | 68731 | 2641 | 26648 |
| 4E | | MI | 28080 | 7967 | 43800 | 5915 | 46703 | 4822 | 46879 | 4024 | 45223 | 2912 | 52401 | 2554 | 20559 |
| 12-#11 | 1.13 | MA | 35477 | 7967 | 54750 | 6013 | 58715 | 4903 | 58950 | 4109 | 56547 | 2969 | 66046 | 2599 | 26639 |
| 5L-3S | | MI | 28577 | 7967 | 44644 | 5901 | 47778 | 4828 | 48185 | 4031 | 46886 | 2904 | 54275 | 2640 | 20510 |
| 12-#11 | 1.13 | MA | 34922 | 7967 | 53850 | 6011 | 57468 | 4917 | 57425 | 4105 | 54537 | 2979 | 63484 | 2543 | 26571 |
| 6L-2S | | MI | 29278 | 7967 | 45675 | 5905 | 49100 | 4816 | 49798 | 4020 | 49063 | 2895 | 57167 | 2727 | 20462 |
| 12-#14 | 1.63 | MA | 39306 | 8253 | 61833 | 6163 | 67685 | 5009 | 69852 | 4153 | 71369 | 2922 | 85231 | 2753 | 37820 |
| 2L-6S | | MI | 27550 | 8253 | 43703 | 6062 | 46354 | 4942 | 46399 | 4089 | 44510 | 2875 | 52086 | 2258 | 28345 |
| 12-#14 | 1.63 | MA | 37980 | 8253 | 59873 | 6159 | 65172 | 5004 | 66787 | 4171 | 67199 | 2936 | 79592 | 2629 | 37843 |
| 3L-5S | | MI | 28153 | 8253 | 44685 | 6068 | 47714 | 4950 | 48060 | 4100 | 46657 | 2862 | 54727 | 2339 | 28997 |
| 12-#14 | 1.63 | MA | 37051 | 8253 | 58278 | 6181 | 63139 | 5024 | 64316 | 4164 | 64019 | 2950 | 75917 | 2504 | 37792 |
| 4E | | MI | 28785 | 8253 | 45732 | 6074 | 49071 | 4933 | 49727 | 4086 | 49027 | 2875 | 57540 | 2395 | 29042 |
| 12-#14 | 1.63 | MA | 36222 | 8253 | 56900 | 6178 | 61352 | 5019 | 62119 | 4182 | 60837 | 2940 | 72088 | 2444 | 37630 |
| 5L-3S | | MI | 29490 | 8253 | 46940 | 6055 | 50610 | 4942 | 51597 | 4096 | 51391 | 2862 | 60192 | 2520 | 29012 |
| 12-#14 | 1.63 | MA | 35434 | 8253 | 55609 | 6174 | 59562 | 5038 | 59932 | 4175 | 57954 | 2954 | 68441 | 2363 | 36637 |
| 6L-2S | | MI | 30484 | 8253 | 48414 | 6060 | 52499 | 4925 | 53902 | 4082 | 54485 | 2850 | 64292 | 2644 | 28960 |
| 12-#18 | 2.90 | MA | 43315 | 8979 | 70869 | 6580 | 79036 | 5305 | 83611 | 4326 | 90053 | 2844 | 109774 | 2588 | 65702 |
| 2L-6S | | MI | 28356 | 8979 | 46915 | 6462 | 50176 | 5233 | 51108 | 4293 | 50579 | 2775 | 60719 | 1734 | 45982 |
| 12-#18 | 2.90 | MA | 41041 | 8979 | 67433 | 6573 | 74631 | 5338 | 78238 | 4355 | 82743 | 2867 | 100004 | 2366 | 65517 |
| 3L-5S | | MI | 29391 | 8979 | 48639 | 6475 | 52560 | 5250 | 53888 | 4270 | 54284 | 2752 | 65245 | 1880 | 47338 |
| 12-#18 | 2.90 | MA | 39446 | 8979 | 64630 | 6609 | 71059 | 5327 | 73897 | 4341 | 77156 | 2889 | 93653 | 2145 | 64996 |
| 4E | | MI | 30477 | 8979 | 50475 | 6487 | 54938 | 5222 | 56809 | 4248 | 58377 | 2775 | 70096 | 1976 | 49562 |
| 12-#18 | 2.90 | MA | 38022 | 8979 | 62205 | 6602 | 67915 | 5360 | 70034 | 4370 | 71562 | 2867 | 86996 | 2040 | 61965 |
| 5L-3S | | MI | 31687 | 8979 | 52589 | 6455 | 57631 | 5240 | 60082 | 4270 | 62457 | 2752 | 74636 | 2197 | 49835 |
| 12-#18 | 2.90 | MA | 36668 | 8979 | 59932 | 6595 | 64767 | 5349 | 66186 | 4356 | 66491 | 2890 | 80687 | 1897 | 60078 |
| 6L-2S | | MI | 33386 | 8979 | 55160 | 6468 | 60927 | 5212 | 64103 | 4247 | 67796 | 2730 | 81672 | 2418 | 49905 |
| 14-#11 | 1.32 | MA | 38302 | 8075 | 59559 | 6069 | 64887 | 4944 | 66485 | 4117 | 66807 | 2946 | 79236 | 2798 | 30881 |
| 2L-7S | | MI | 27283 | 8075 | 42663 | 5989 | 45222 | 4890 | 45054 | 4068 | 42746 | 2911 | 49456 | 2346 | 23472 |
| 14-#11 | 1.32 | MA | 37370 | 8075 | 58191 | 6067 | 63133 | 4941 | 64345 | 4130 | 63895 | 2956 | 75275 | 2712 | 30911 |
| 3L-6S | | MI | 27696 | 8075 | 43415 | 5975 | 46128 | 4878 | 46168 | 4057 | 44222 | 2902 | 51449 | 2437 | 23823 |
| 14-#11 | 1.32 | MA | 36718 | 8075 | 57079 | 6083 | 61715 | 4955 | 62621 | 4126 | 61677 | 2967 | 72692 | 2626 | 30926 |
| 4L-5S | | MI | 28119 | 8075 | 44100 | 5979 | 47078 | 4883 | 47328 | 4064 | 45732 | 2894 | 53313 | 2493 | 23832 |
| 14-#11 | 1.32 | MA | 36137 | 8075 | 56118 | 6081 | 60469 | 4952 | 61090 | 4139 | 59459 | 2960 | 70007 | 2583 | 30893 |
| 5L-4S | | MI | 28563 | 8075 | 44831 | 5982 | 48025 | 4871 | 48492 | 4053 | 47399 | 2902 | 55292 | 2532 | 23805 |
| 14-#11 | 1.32 | MA | 35583 | 8075 | 55218 | 6079 | 59222 | 4966 | 59566 | 4134 | 57449 | 2971 | 67445 | 2527 | 30804 |
| 6L-3S | | MI | 29058 | 8075 | 45675 | 5969 | 49100 | 4876 | 49798 | 4060 | 49063 | 2894 | 57167 | 2619 | 23766 |
| 14-#11 | 1.32 | MA | 35044 | 8075 | 54232 | 6094 | 58033 | 4963 | 58103 | 4147 | 55487 | 2981 | 64713 | 2437 | 30236 |
| 7L-2S | | MI | 29758 | 8075 | 46706 | 5972 | 50423 | 4864 | 51411 | 4049 | 51239 | 2885 | 60058 | 2705 | 23723 |
| 14-#14 | 1.90 | MA | 40222 | 8409 | 63793 | 6260 | 70197 | 5079 | 72918 | 4196 | 75540 | 2909 | 90871 | 2730 | 43958 |
| 2L-7S | | MI | 27652 | 8409 | 44100 | 6178 | 46945 | 5028 | 47109 | 4146 | 45506 | 2872 | 53361 | 2094 | 32272 |
| 14-#14 | 1.90 | MA | 38902 | 8409 | 61833 | 6257 | 67685 | 5074 | 69852 | 4214 | 71369 | 2924 | 85231 | 2605 | 43952 |
| 3L-6S | | MI | 28237 | 8409 | 45176 | 6159 | 48243 | 5012 | 48704 | 4132 | 47604 | 2860 | 56185 | 2225 | 32775 |
| 14-#14 | 1.90 | MA | 37978 | 8409 | 60239 | 6278 | 65652 | 5093 | 67382 | 4207 | 68190 | 2938 | 81557 | 2480 | 43871 |
| 4L-5S | | MI | 28837 | 8409 | 46159 | 6165 | 49603 | 5020 | 50365 | 4142 | 49750 | 2847 | 58826 | 2306 | 33558 |
| 14-#14 | 1.90 | MA | 37154 | 8409 | 58860 | 6275 | 63864 | 5088 | 65185 | 4225 | 65007 | 2927 | 77728 | 2420 | 43674 |
| 5L-4S | | MI | 29466 | 8409 | 47206 | 6171 | 50960 | 5003 | 52032 | 4128 | 52121 | 2860 | 61639 | 2362 | 33633 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis

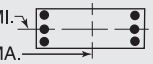



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 1.90 | MA | 36370 | 8409 | 57569 | 6272 | 62075 | 5108 | 62997 | 4218 | 62125 | 2942 | 74081 | 2339 | 42546 |
| 6L-3S | | MI | 30168 | 8409 | 48414 | 6152 | 52499 | 5011 | 53902 | 4138 | 54485 | 2847 | 64292 | 2486 | 33634 |
| 14-#14 | 1.90 | MA | 35605 | 8409 | 56153 | 6293 | 60368 | 5103 | 60898 | 4236 | 59308 | 2956 | 70192 | 2210 | 41742 |
| 7L-2S | | MI | 31157 | 8409 | 49887 | 6158 | 54388 | 4995 | 56207 | 4124 | 57579 | 2835 | 68391 | 2611 | 33596 |
| 14-#18 | 3.38 | MA | 42606 | 9256 | 70869 | 6746 | 79036 | 5462 | 83611 | 4431 | 90053 | 2844 | 109774 | 2318 | 76138 |
| 3L-6S | | MI | 29526 | 9256 | 49487 | 6635 | 53472 | 5357 | 55129 | 4368 | 55918 | 2744 | 67755 | 1667 | 53439 |
| 14-#18 | 3.38 | MA | 41024 | 9256 | 68066 | 6782 | 75464 | 5451 | 79270 | 4416 | 84467 | 2867 | 103423 | 2097 | 75540 |
| 4L-5S | | MI | 30553 | 9256 | 51211 | 6648 | 55856 | 5374 | 57909 | 4346 | 59623 | 2721 | 72281 | 1813 | 55002 |
| 14-#18 | 3.38 | MA | 39612 | 9256 | 65641 | 6775 | 72320 | 5484 | 75407 | 4446 | 78872 | 2845 | 96766 | 1992 | 72262 |
| 5L-4S | | MI | 31631 | 9256 | 53046 | 6660 | 58234 | 5347 | 60830 | 4323 | 63716 | 2744 | 77132 | 1909 | 57124 |
| 14-#18 | 3.38 | MA | 38269 | 9256 | 63368 | 6768 | 69171 | 5473 | 71559 | 4431 | 73801 | 2868 | 90456 | 1848 | 70173 |
| 6L-3S | | MI | 32833 | 9256 | 55160 | 6628 | 60927 | 5364 | 64103 | 4345 | 67796 | 2721 | 81672 | 2130 | 57796 |
| 14-#18 | 3.38 | MA | 36962 | 9256 | 60877 | 6804 | 66167 | 5507 | 67866 | 4461 | 68846 | 2891 | 83721 | 1617 | 66833 |
| 7L-2S | | MI | 34521 | 9256 | 57731 | 6641 | 64224 | 5337 | 68124 | 4322 | 73135 | 2699 | 88708 | 2351 | 57920 |
| 16-#11 | 1.51 | MA | 38949 | 8183 | 60928 | 6137 | 66642 | 4992 | 68625 | 4147 | 69719 | 2937 | 83197 | 2783 | 35174 |
| 2L-8S | | MI | 27364 | 8183 | 43019 | 6052 | 45625 | 4933 | 45579 | 4108 | 43353 | 2893 | 50498 | 2278 | 26344 |
| 16-#11 | 1.51 | MA | 38021 | 8183 | 59559 | 6135 | 64887 | 4989 | 66485 | 4160 | 66807 | 2948 | 79236 | 2696 | 35195 |
| 3L-7S | | MI | 27769 | 8183 | 43695 | 6056 | 46545 | 4938 | 46667 | 4097 | 44922 | 2901 | 52347 | 2325 | 26600 |
| 16-#11 | 1.51 | MA | 37371 | 8183 | 58447 | 6150 | 63470 | 5003 | 64762 | 4155 | 64589 | 2958 | 76653 | 2610 | 35190 |
| 4L-6S | | MI | 28180 | 8183 | 44446 | 6042 | 47451 | 4926 | 47781 | 4086 | 46398 | 2893 | 54340 | 2415 | 27000 |
| 16-#11 | 1.51 | MA | 36792 | 8183 | 57487 | 6148 | 62224 | 5000 | 63230 | 4168 | 62371 | 2951 | 73968 | 2568 | 35141 |
| 5E | | MI | 28602 | 8183 | 45132 | 6046 | 48400 | 4931 | 48941 | 4093 | 47909 | 2884 | 56205 | 2471 | 27056 |
| 16-#11 | 1.51 | MA | 36241 | 8183 | 56587 | 6146 | 60977 | 5014 | 61706 | 4164 | 60361 | 2962 | 71406 | 2512 | 35015 |
| 6L-4S | | MI | 29044 | 8183 | 45863 | 6050 | 49347 | 4919 | 50105 | 4083 | 49576 | 2893 | 58184 | 2511 | 27042 |
| 16-#11 | 1.51 | MA | 35705 | 8183 | 55601 | 6162 | 59787 | 5011 | 60243 | 4177 | 58398 | 2972 | 68674 | 2422 | 34390 |
| 7L-3S | | MI | 29538 | 8183 | 46706 | 6036 | 50423 | 4924 | 51411 | 4089 | 51239 | 2884 | 60058 | 2597 | 27012 |
| 16-#11 | 1.51 | MA | 35176 | 8183 | 54715 | 6160 | 58580 | 5025 | 58815 | 4190 | 56312 | 2966 | 66163 | 2372 | 33967 |
| 8L-2S | | MI | 30235 | 8183 | 47738 | 6040 | 51745 | 4912 | 53024 | 4079 | 53416 | 2875 | 62950 | 2684 | 26975 |
| 16-#14 | 2.17 | MA | 41132 | 8564 | 65753 | 6357 | 72710 | 5149 | 75983 | 4238 | 79710 | 2897 | 96511 | 2706 | 50086 |
| 2L-8S | | MI | 27764 | 8564 | 44606 | 6270 | 47518 | 5090 | 47855 | 4203 | 46369 | 2844 | 54832 | 1995 | 35869 |
| 16-#14 | 2.17 | MA | 39818 | 8564 | 63793 | 6354 | 70197 | 5143 | 72918 | 4256 | 75540 | 2911 | 90871 | 2581 | 50050 |
| 3L-7S | | MI | 28338 | 8564 | 45574 | 6276 | 48835 | 5098 | 49413 | 4189 | 48600 | 2857 | 57460 | 2061 | 36735 |
| 16-#14 | 2.17 | MA | 38899 | 8564 | 62199 | 6375 | 68165 | 5163 | 70447 | 4249 | 72360 | 2925 | 87197 | 2457 | 49941 |
| 4L-6S | | MI | 28920 | 8564 | 46650 | 6257 | 50133 | 5082 | 51009 | 4174 | 50697 | 2844 | 60284 | 2191 | 37215 |
| 16-#14 | 2.17 | MA | 38079 | 8564 | 60820 | 6372 | 66377 | 5158 | 68250 | 4267 | 69178 | 2915 | 83367 | 2396 | 49714 |
| 5E | | MI | 29517 | 8564 | 47633 | 6262 | 51492 | 5090 | 52670 | 4185 | 52844 | 2832 | 62925 | 2273 | 38029 |
| 16-#14 | 2.17 | MA | 37299 | 8564 | 59529 | 6369 | 64587 | 5178 | 66063 | 4260 | 66295 | 2929 | 79721 | 2315 | 48467 |
| 6L-4S | | MI | 30143 | 8564 | 48680 | 6268 | 52849 | 5073 | 54337 | 4170 | 55214 | 2844 | 65738 | 2329 | 38214 |
| 16-#14 | 2.17 | MA | 36540 | 8564 | 58113 | 6391 | 62880 | 5173 | 63963 | 4278 | 63479 | 2944 | 75832 | 2186 | 47692 |
| 7L-3S | | MI | 30842 | 8564 | 49887 | 6249 | 54388 | 5081 | 56207 | 4181 | 57579 | 2832 | 68391 | 2453 | 38247 |
| 16-#14 | 2.17 | MA | 35791 | 8564 | 56842 | 6387 | 61149 | 5193 | 61915 | 4296 | 60485 | 2933 | 72251 | 2115 | 46454 |
| 8L-2S | | MI | 31827 | 8564 | 51361 | 6255 | 56277 | 5064 | 58512 | 4167 | 60672 | 2819 | 72490 | 2578 | 38222 |
| 16-#18 | 3.86 | MA | 42588 | 9533 | 71502 | 6955 | 79868 | 5575 | 84644 | 4492 | 91778 | 2845 | 113193 | 2048 | 85706 |
| 4L-6S | | MI | 30686 | 9533 | 52058 | 6808 | 56769 | 5481 | 59150 | 4444 | 61257 | 2713 | 74791 | 1601 | 60930 |
| 16-#18 | 3.86 | MA | 41188 | 9533 | 69077 | 6948 | 76724 | 5609 | 80781 | 4521 | 86183 | 2823 | 106536 | 1944 | 82583 |
| 5E | | MI | 31706 | 9533 | 53782 | 6820 | 59152 | 5498 | 61931 | 4421 | 64962 | 2690 | 79317 | 1746 | 62689 |
| 16-#18 | 3.86 | MA | 39856 | 9533 | 66803 | 6940 | 73576 | 5598 | 76933 | 4507 | 81112 | 2846 | 100226 | 1800 | 80298 |
| 6L-4S | | MI | 32776 | 9533 | 55617 | 6833 | 61530 | 5471 | 64852 | 4399 | 69055 | 2713 | 84168 | 1842 | 64683 |
| 16-#18 | 3.86 | MA | 38559 | 9533 | 64313 | 6977 | 70571 | 5631 | 73239 | 4536 | 76157 | 2868 | 93491 | 1569 | 77076 |
| 7L-3S | | MI | 33970 | 9533 | 57731 | 6801 | 64224 | 5488 | 68124 | 4420 | 73135 | 2690 | 88708 | 2063 | 65742 |
| 16-#18 | 3.86 | MA | 37283 | 9533 | 62074 | 6970 | 67524 | 5620 | 69633 | 4566 | 70891 | 2847 | 87267 | 1446 | 73583 |
| 8L-2S | | MI | 35647 | 9533 | 60302 | 6813 | 67520 | 5461 | 72145 | 4398 | 78474 | 2668 | 95743 | 2284 | 65916 |
| 18-#11 | 1.70 | MA | 39594 | 8291 | 62296 | 6204 | 68396 | 5041 | 70765 | 4176 | 72631 | 2928 | 87158 | 2767 | 39461 |
| 2L-9S | | MI | 27441 | 8291 | 43324 | 6134 | 46053 | 4994 | 46056 | 4130 | 44067 | 2892 | 51581 | 2202 | 29103 |
| 18-#11 | 1.70 | MA | 38668 | 8291 | 60928 | 6202 | 66642 | 5038 | 68625 | 4189 | 69719 | 2939 | 83197 | 2681 | 39474 |
| 3L-8S | | MI | 27849 | 8291 | 44051 | 6120 | 46948 | 4982 | 47192 | 4137 | 45530 | 2883 | 53389 | 2257 | 29486 |
| 18-#11 | 1.70 | MA | 38022 | 8291 | 59816 | 6218 | 65224 | 5052 | 66902 | 4185 | 67501 | 2949 | 80613 | 2595 | 39448 |
| 4L-7S | | MI | 28253 | 8291 | 44726 | 6124 | 47867 | 4987 | 48280 | 4126 | 47099 | 2892 | 55239 | 2303 | 29733 |

## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

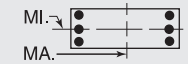
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.70 | MA | 37445 | 8291 | 58855 | 6216 | 63978 | 5049 | 65371 | 4198 | 65283 | 2943 | 77929 | 2552 | 39384 |
| 5L-6S | | MI | 28662 | 8291 | 45477 | 6110 | 48773 | 4975 | 49394 | 4116 | 48575 | 2883 | 57232 | 2393 | 30113 |
| 18-#11 | 1.70 | MA | 36896 | 8291 | 57955 | 6214 | 62731 | 5063 | 63846 | 4193 | 63273 | 2953 | 75366 | 2496 | 39149 |
| 6L-5S | | MI | 29083 | 8291 | 46163 | 6114 | 49722 | 4980 | 50553 | 4123 | 50085 | 2874 | 59096 | 2450 | 30267 |
| 18-#11 | 1.70 | MA | 36362 | 8291 | 56969 | 6229 | 61541 | 5059 | 62383 | 4206 | 61310 | 2964 | 72635 | 2407 | 38549 |
| 7L-4S | | MI | 29524 | 8291 | 46894 | 6117 | 50669 | 4968 | 51718 | 4112 | 51752 | 2883 | 61075 | 2489 | 30273 |
| 18-#11 | 1.70 | MA | 35835 | 8291 | 56083 | 6227 | 60335 | 5074 | 60955 | 4219 | 59224 | 2957 | 70124 | 2357 | 38138 |
| 8L-3S | | MI | 30016 | 8291 | 47738 | 6104 | 51745 | 4973 | 53024 | 4119 | 53416 | 2874 | 62950 | 2576 | 30251 |
| 18-#11 | 1.70 | MA | 35277 | 8291 | 55217 | 6225 | 59161 | 5070 | 59462 | 4215 | 57279 | 2968 | 67639 | 2303 | 37548 |
| 9L-2S | | MI | 30710 | 8291 | 48769 | 6107 | 53067 | 4961 | 54637 | 4108 | 55592 | 2866 | 65841 | 2662 | 30221 |
| 18-#14 | 2.45 | MA | 40729 | 8720 | 65753 | 6451 | 72710 | 5213 | 75983 | 4298 | 79710 | 2899 | 96511 | 2557 | 56141 |
| 3L-8S | | MI | 28449 | 8720 | 46080 | 6367 | 49407 | 5160 | 50160 | 4245 | 49462 | 2829 | 58931 | 1962 | 40252 |
| 18-#14 | 2.45 | MA | 39815 | 8720 | 64159 | 6473 | 70677 | 5233 | 73512 | 4291 | 76531 | 2913 | 92837 | 2433 | 56006 |
| 4L-7S | | MI | 29019 | 8720 | 47048 | 6373 | 50724 | 5168 | 51718 | 4231 | 51693 | 2842 | 61559 | 2028 | 41202 |
| 18-#14 | 2.45 | MA | 38999 | 8720 | 62780 | 6469 | 68890 | 5228 | 71315 | 4309 | 73349 | 2902 | 89007 | 2372 | 55606 |
| 5L-6S | | MI | 29599 | 8720 | 48124 | 6354 | 52022 | 5151 | 53314 | 4217 | 53791 | 2829 | 64383 | 2158 | 41664 |
| 18-#14 | 2.45 | MA | 38223 | 8720 | 61489 | 6466 | 67100 | 5248 | 69128 | 4303 | 70466 | 2917 | 85361 | 2292 | 54399 |
| 6L-5S | | MI | 30193 | 8720 | 49107 | 6360 | 53382 | 5160 | 54975 | 4227 | 55938 | 2817 | 67024 | 2240 | 42436 |
| 18-#14 | 2.45 | MA | 37468 | 8720 | 60073 | 6488 | 65393 | 5243 | 67029 | 4320 | 67649 | 2931 | 81471 | 2162 | 53648 |
| 7L-4S | | MI | 30816 | 8720 | 50154 | 6365 | 54739 | 5143 | 56642 | 4213 | 58308 | 2829 | 69837 | 2295 | 42785 |
| 18-#14 | 2.45 | MA | 36723 | 8720 | 58802 | 6484 | 63661 | 5262 | 64980 | 4338 | 64656 | 2921 | 77891 | 2091 | 52325 |
| 8L-3S | | MI | 31512 | 8720 | 51361 | 6346 | 56277 | 5151 | 58512 | 4223 | 60672 | 2817 | 72490 | 2420 | 42841 |
| 18-#14 | 2.45 | MA | 35944 | 8720 | 57558 | 6481 | 61977 | 5257 | 62837 | 4332 | 61865 | 2935 | 74355 | 2013 | 51179 |
| 9L-2S | | MI | 32493 | 8720 | 52835 | 6352 | 58167 | 5134 | 60817 | 4209 | 63766 | 2804 | 76589 | 2545 | 42840 |
| 18-#18 | 4.35 | MA | 42750 | 9809 | 72513 | 7121 | 81129 | 5733 | 86154 | 4597 | 93494 | 2801 | 116306 | 1895 | 92926 |
| 5L-6S | | MI | 31837 | 9809 | 54629 | 6981 | 60065 | 5605 | 63172 | 4519 | 66596 | 2682 | 81827 | 1534 | 68448 |
| 18-#18 | 4.35 | MA | 41429 | 9809 | 70239 | 7113 | 77980 | 5722 | 82306 | 4582 | 88423 | 2824 | 109996 | 1751 | 90451 |
| 6L-5S | | MI | 32850 | 9809 | 56353 | 6993 | 62449 | 5622 | 65952 | 4497 | 70301 | 2659 | 86353 | 1680 | 70394 |
| 18-#18 | 4.35 | MA | 40143 | 9809 | 67749 | 7150 | 74976 | 5755 | 78612 | 4612 | 83468 | 2846 | 103261 | 1520 | 87338 |
| 7L-4S | | MI | 33913 | 9809 | 58188 | 7006 | 64827 | 5595 | 68873 | 4474 | 74394 | 2682 | 91204 | 1775 | 72274 |
| 18-#18 | 4.35 | MA | 38877 | 9809 | 65510 | 7143 | 71928 | 5744 | 75006 | 4641 | 78202 | 2825 | 97037 | 1398 | 83734 |
| 8L-3S | | MI | 35099 | 9809 | 60302 | 6974 | 67520 | 5612 | 72145 | 4496 | 78474 | 2659 | 95743 | 1996 | 73676 |
| 20-#11 | 1.88 | MA | 39313 | 8398 | 62296 | 6270 | 68396 | 5086 | 70765 | 4218 | 72631 | 2930 | 87158 | 2666 | 43739 |
| 3L-9S | | MI | 27933 | 8398 | 44355 | 6201 | 47375 | 5042 | 47668 | 4160 | 46243 | 2882 | 54473 | 2181 | 32190 |
| 20-#11 | 1.88 | MA | 38669 | 8398 | 61184 | 6285 | 66978 | 5100 | 69042 | 4214 | 70413 | 2941 | 84574 | 2579 | 43702 |
| 4L-8S | | MI | 28332 | 8398 | 45082 | 6187 | 48270 | 5030 | 48805 | 4166 | 47706 | 2873 | 56281 | 2235 | 32631 |
| 20-#11 | 1.88 | MA | 38094 | 8398 | 60224 | 6283 | 65733 | 5097 | 67511 | 4227 | 68195 | 2934 | 81890 | 2537 | 43623 |
| 5L-7S | | MI | 28734 | 8398 | 45758 | 6191 | 49189 | 5035 | 49893 | 4156 | 49275 | 2882 | 58130 | 2282 | 32869 |
| 20-#11 | 1.88 | MA | 37548 | 8398 | 59324 | 6281 | 64485 | 5111 | 65986 | 4223 | 66185 | 2945 | 79327 | 2481 | 43291 |
| 6E | | MI | 29143 | 8398 | 46509 | 6177 | 50095 | 5023 | 51007 | 4145 | 50751 | 2873 | 60123 | 2372 | 33231 |
| 20-#11 | 1.88 | MA | 37015 | 8398 | 58338 | 6296 | 63296 | 5108 | 64523 | 4236 | 64222 | 2955 | 76596 | 2391 | 42714 |
| 7L-5S | | MI | 29561 | 8398 | 47194 | 6181 | 51044 | 5028 | 52166 | 4152 | 52262 | 2864 | 61988 | 2428 | 33474 |
| 20-#11 | 1.88 | MA | 36491 | 8398 | 57452 | 6294 | 62089 | 5122 | 63096 | 4248 | 62136 | 2948 | 74085 | 2341 | 42313 |
| 8L-4S | | MI | 30001 | 8398 | 47925 | 6185 | 51992 | 5016 | 53331 | 4141 | 53929 | 2873 | 63967 | 2468 | 33498 |
| 20-#11 | 1.88 | MA | 35936 | 8398 | 56585 | 6292 | 60916 | 5119 | 61603 | 4244 | 60191 | 2959 | 71600 | 2288 | 41666 |
| 9L-3S | | MI | 30491 | 8398 | 48769 | 6171 | 53067 | 5021 | 54637 | 4148 | 55592 | 2864 | 65841 | 2554 | 33485 |
| 20-#11 | 1.88 | MA | 35356 | 8398 | 55615 | 6308 | 59725 | 5133 | 60183 | 4257 | 58263 | 2970 | 69192 | 2227 | 40982 |
| 10L-2S | | MI | 31184 | 8398 | 49801 | 6175 | 54389 | 5009 | 56250 | 4138 | 57769 | 2856 | 68733 | 2640 | 33461 |
| 20-#14 | 2.72 | MA | 40724 | 8876 | 66119 | 6570 | 73190 | 5303 | 76578 | 4334 | 80702 | 2901 | 98477 | 2409 | 62066 |
| 4L-8S | | MI | 29129 | 8876 | 47553 | 6464 | 51296 | 5230 | 52465 | 4288 | 52556 | 2814 | 63030 | 1929 | 44644 |
| 20-#14 | 2.72 | MA | 39913 | 8876 | 64740 | 6567 | 71403 | 5298 | 74381 | 4352 | 77519 | 2890 | 94647 | 2348 | 61497 |
| 5L-7S | | MI | 29697 | 8876 | 48522 | 6470 | 52613 | 5238 | 54023 | 4273 | 54787 | 2826 | 65658 | 1995 | 45674 |
| 20-#14 | 2.72 | MA | 39142 | 8876 | 63449 | 6563 | 69613 | 5318 | 72193 | 4345 | 74636 | 2904 | 91001 | 2268 | 60339 |
| 6E | | MI | 30274 | 8876 | 49598 | 6451 | 53911 | 5221 | 55619 | 4259 | 56885 | 2814 | 68482 | 2125 | 46120 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis

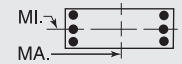



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.72 | MA | 38390 | 8876 | 62034 | 6585 | 67906 | 5313 | 70094 | 4363 | 71820 | 2919 | 87111 | 2138 | 59609 |
| 7L-5S | | MI | 30865 | 8876 | 50580 | 6457 | 55271 | 5229 | 57280 | 4270 | 59031 | 2801 | 71123 | 2206 | 46854 |
| 20-#14 | 2.72 | MA | 37650 | 8876 | 60762 | 6582 | 66174 | 5332 | 68045 | 4381 | 68827 | 2908 | 83531 | 2067 | 58206 |
| 8L-4S | | MI | 31486 | 8876 | 51627 | 6463 | 56628 | 5213 | 58947 | 4255 | 61402 | 2814 | 73936 | 2262 | 47350 |
| 20-#14 | 2.72 | MA | 36875 | 8876 | 59518 | 6578 | 64490 | 5327 | 65903 | 4374 | 66036 | 2923 | 79995 | 1990 | 57091 |
| 9L-3S | | MI | 32178 | 8876 | 52835 | 6444 | 58167 | 5221 | 60817 | 4266 | 63766 | 2801 | 76589 | 2387 | 47426 |
| 20-#14 | 2.72 | MA | 36056 | 8876 | 58126 | 6600 | 62781 | 5347 | 63865 | 4392 | 63269 | 2937 | 76568 | 1902 | 55420 |
| 10L-2S | | MI | 33156 | 8876 | 54309 | 6449 | 60056 | 5204 | 63122 | 4251 | 66859 | 2789 | 80688 | 2511 | 47453 |
| 20-#18 | 4.83 | MA | 42989 | 10086 | 73675 | 7286 | 82385 | 5846 | 87679 | 4657 | 95734 | 2802 | 119766 | 1703 | 100628 |
| 6E | | MI | 32980 | 10086 | 57200 | 7154 | 63361 | 5729 | 67193 | 4594 | 71935 | 2651 | 88863 | 1467 | 75992 |
| 20-#18 | 4.83 | MA | 41713 | 10086 | 71184 | 7323 | 79381 | 5879 | 83985 | 4687 | 90778 | 2824 | 113031 | 1472 | 97618 |
| 7L-5S | | MI | 33986 | 10086 | 58924 | 7166 | 65745 | 5746 | 69973 | 4572 | 75640 | 2628 | 93389 | 1613 | 78114 |
| 20-#18 | 4.83 | MA | 40457 | 10086 | 68946 | 7316 | 76333 | 5868 | 80380 | 4717 | 85512 | 2803 | 106807 | 1349 | 93903 |
| 8L-4S | | MI | 35043 | 10086 | 60760 | 7179 | 68123 | 5719 | 72894 | 4549 | 79733 | 2651 | 98240 | 1708 | 79892 |
| 22-#11 | 2.07 | MA | 39313 | 8506 | 62553 | 6352 | 68733 | 5148 | 71182 | 4243 | 73325 | 2932 | 88535 | 2564 | 47952 |
| 4L-9S | | MI | 28416 | 8506 | 45386 | 6268 | 48698 | 5090 | 49281 | 4189 | 48420 | 2872 | 57365 | 2159 | 35283 |
| 22-#11 | 2.07 | MA | 38741 | 8506 | 61592 | 6350 | 67487 | 5145 | 69651 | 4256 | 71106 | 2926 | 85851 | 2521 | 47859 |
| 5L-8S | | MI | 28813 | 8506 | 46113 | 6255 | 49592 | 5078 | 50418 | 4196 | 49883 | 2863 | 59172 | 2214 | 35776 |
| 22-#11 | 2.07 | MA | 38196 | 8506 | 60692 | 6349 | 66240 | 5159 | 68127 | 4252 | 69097 | 2936 | 83288 | 2466 | 47439 |
| 6L-7S | | MI | 29214 | 8506 | 46789 | 6258 | 50511 | 5084 | 51506 | 4185 | 51452 | 2872 | 61022 | 2260 | 36009 |
| 22-#11 | 2.07 | MA | 37666 | 8506 | 59706 | 6364 | 65050 | 5156 | 66664 | 4265 | 67134 | 2947 | 80556 | 2376 | 46882 |
| 7L-6S | | MI | 29621 | 8506 | 47540 | 6245 | 51417 | 5071 | 52620 | 4175 | 52928 | 2863 | 63015 | 2350 | 36355 |
| 22-#11 | 2.07 | MA | 37144 | 8506 | 58820 | 6362 | 63843 | 5170 | 65236 | 4278 | 65048 | 2940 | 78046 | 2326 | 46490 |
| 8L-5S | | MI | 30038 | 8506 | 48226 | 6248 | 52366 | 5077 | 53779 | 4181 | 54438 | 2855 | 64879 | 2407 | 36676 |
| 22-#11 | 2.07 | MA | 36591 | 8506 | 57954 | 6360 | 62670 | 5167 | 63743 | 4273 | 63103 | 2950 | 75561 | 2272 | 45789 |
| 9L-4S | | MI | 30476 | 8506 | 48957 | 6252 | 53314 | 5065 | 54943 | 4171 | 56105 | 2863 | 66858 | 2446 | 36710 |
| 22-#11 | 2.07 | MA | 36014 | 8506 | 56984 | 6375 | 61480 | 5181 | 62323 | 4286 | 61175 | 2961 | 73153 | 2211 | 45123 |
| 10L-3S | | MI | 30965 | 8506 | 49801 | 6238 | 54389 | 5070 | 56250 | 4178 | 57769 | 2855 | 68733 | 2533 | 36714 |
| 22-#11 | 2.07 | MA | 35450 | 8506 | 56116 | 6373 | 60312 | 5178 | 60849 | 4282 | 59118 | 2954 | 70705 | 2159 | 44320 |
| 11L-2S | | MI | 31655 | 8506 | 50832 | 6242 | 55711 | 5058 | 57863 | 4167 | 59946 | 2846 | 71624 | 2619 | 36697 |
| 22-#14 | 2.99 | MA | 40822 | 9031 | 66701 | 6664 | 73915 | 5368 | 77446 | 4394 | 81690 | 2878 | 100287 | 2324 | 67401 |
| 5L-8S | | MI | 29806 | 9031 | 49027 | 6562 | 53186 | 5300 | 54770 | 4330 | 55649 | 2799 | 67129 | 1895 | 49046 |
| 22-#14 | 2.99 | MA | 40054 | 9031 | 65409 | 6661 | 72126 | 5387 | 75259 | 4387 | 78807 | 2892 | 96641 | 2244 | 66286 |
| 6L-7S | | MI | 30371 | 9031 | 49995 | 6567 | 54503 | 5308 | 56328 | 4316 | 57881 | 2811 | 69757 | 1961 | 50042 |
| 22-#14 | 2.99 | MA | 39307 | 9031 | 63994 | 6682 | 70418 | 5382 | 73159 | 4405 | 75991 | 2906 | 92751 | 2114 | 65574 |
| 7L-6S | | MI | 30945 | 9031 | 51071 | 6548 | 55801 | 5291 | 57923 | 4301 | 59978 | 2799 | 72581 | 2092 | 50582 |
| 22-#14 | 2.99 | MA | 38570 | 9031 | 62722 | 6679 | 68687 | 5402 | 71111 | 4423 | 72997 | 2896 | 89170 | 2043 | 64095 |
| 8L-5S | | MI | 31534 | 9031 | 52054 | 6554 | 57160 | 5299 | 59585 | 4312 | 62125 | 2786 | 75223 | 2173 | 51282 |
| 22-#14 | 2.99 | MA | 37813 | 9031 | 61478 | 6676 | 67002 | 5397 | 68968 | 4416 | 70206 | 2910 | 85635 | 1966 | 62953 |
| 9L-4S | | MI | 32152 | 9031 | 53101 | 6560 | 58517 | 5283 | 61252 | 4298 | 64495 | 2799 | 78035 | 2229 | 51910 |
| 22-#14 | 2.99 | MA | 36985 | 9031 | 60086 | 6697 | 65294 | 5417 | 66930 | 4434 | 67439 | 2925 | 82208 | 1878 | 61283 |
| 10L-3S | | MI | 32842 | 9031 | 54309 | 6541 | 60056 | 5291 | 63122 | 4308 | 66859 | 2786 | 80688 | 2353 | 52005 |
| 22-#18 | 5.31 | MA | 43271 | 10363 | 74620 | 7496 | 83785 | 6003 | 89359 | 4763 | 98089 | 2802 | 122801 | 1424 | 107915 |
| 7L-6S | | MI | 34116 | 10363 | 59772 | 7327 | 66658 | 5853 | 71214 | 4670 | 77275 | 2620 | 95899 | 1400 | 83557 |
| 22-#18 | 5.31 | MA | 42025 | 10363 | 72382 | 7489 | 80737 | 5992 | 85753 | 4792 | 92823 | 2780 | 116577 | 1301 | 104091 |
| 8L-5S | | MI | 35115 | 10363 | 61496 | 7339 | 69041 | 5870 | 73994 | 4647 | 80979 | 2598 | 100425 | 1546 | 85847 |
| 24-#11 | 2.26 | MA | 39384 | 8614 | 62961 | 6418 | 69241 | 5194 | 71791 | 4286 | 74018 | 2917 | 89811 | 2506 | 52093 |
| 5L-9S | | MI | 28896 | 8614 | 46418 | 6336 | 50020 | 5139 | 50894 | 4218 | 50596 | 2862 | 60256 | 2138 | 38381 |
| 24-#11 | 2.26 | MA | 38842 | 8614 | 62061 | 6416 | 67994 | 5208 | 70267 | 4281 | 72009 | 2927 | 87249 | 2450 | 51593 |
| 6L-8S | | MI | 29292 | 8614 | 47145 | 6322 | 50914 | 5127 | 52031 | 4225 | 52059 | 2854 | 62064 | 2192 | 38923 |
| 24-#11 | 2.26 | MA | 38314 | 8614 | 61075 | 6431 | 66804 | 5205 | 68804 | 4294 | 70046 | 2938 | 84517 | 2360 | 51054 |
| 7E | | MI | 29691 | 8614 | 47820 | 6326 | 51833 | 5132 | 53119 | 4215 | 53628 | 2862 | 63914 | 2239 | 39151 |
| 24-#11 | 2.26 | MA | 37794 | 8614 | 60189 | 6429 | 65598 | 5219 | 67376 | 4307 | 67960 | 2931 | 82007 | 2311 | 50670 |
| 8L-6S | | MI | 30097 | 8614 | 48571 | 6312 | 52739 | 5120 | 54232 | 4204 | 55104 | 2854 | 65906 | 2329 | 39483 |
| 24-#11 | 2.26 | MA | 37243 | 8614 | 59323 | 6427 | 64424 | 5216 | 65883 | 4303 | 66015 | 2942 | 79522 | 2257 | 49918 |
| 9L-5S | | MI | 30513 | 8614 | 49257 | 6316 | 53688 | 5125 | 55392 | 4211 | 56615 | 2845 | 67771 | 2385 | 39874 |
| 24-#11 | 2.26 | MA | 36668 | 8614 | 58352 | 6443 | 63234 | 5230 | 64463 | 4316 | 64087 | 2952 | 77114 | 2196 | 49267 |
| 10L-4S | | MI | 30949 | 8614 | 49988 | 6319 | 54636 | 5113 | 56556 | 4200 | 58282 | 2854 | 69750 | 2425 | 39919 |

## RECTANGULAR TIED COLUMNS 36" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.26 | MA | 36106 | 8614 | 57484 | 6441 | 62067 | 5227 | 62989 | 4311 | 62030 | 2946 | 74666 | 2143 | 48426 |
| 11L-3S | | MI | 31436 | 8614 | 50832 | 6306 | 55711 | 5118 | 57863 | 4207 | 59946 | 2845 | 71624 | 2511 | 39940 |
| 24-#11 | 2.26 | MA | 35555 | 8614 | 56531 | 6456 | 60885 | 5241 | 61571 | 4324 | 60103 | 2956 | 71907 | 2066 | 47592 |
| 12L-2S | | MI | 32125 | 8614 | 51863 | 6309 | 57033 | 5106 | 59476 | 4196 | 62122 | 2836 | 74516 | 2597 | 39928 |
| 24-#14 | 3.26 | MA | 40962 | 9187 | 67369 | 6758 | 74638 | 5457 | 78324 | 4430 | 82978 | 2880 | 102280 | 2220 | 72239 |
| 6L-8S | | MI | 30479 | 9187 | 50501 | 6659 | 55075 | 5369 | 57075 | 4373 | 58743 | 2783 | 71228 | 1862 | 53454 |
| 24-#14 | 3.26 | MA | 40218 | 9187 | 65954 | 6780 | 72931 | 5452 | 76225 | 4448 | 80161 | 2894 | 98391 | 2090 | 71466 |
| 7E | | MI | 31042 | 9187 | 51469 | 6665 | 56392 | 5378 | 58633 | 4358 | 60974 | 2796 | 73856 | 1928 | 54416 |
| 24-#14 | 3.26 | MA | 39486 | 9187 | 64682 | 6776 | 71199 | 5472 | 74176 | 4466 | 77168 | 2883 | 94810 | 2019 | 69992 |
| 8L-6S | | MI | 31614 | 9187 | 52545 | 6646 | 57690 | 5361 | 60228 | 4344 | 63072 | 2783 | 76680 | 2058 | 55049 |
| 24-#14 | 3.26 | MA | 38729 | 9187 | 63438 | 6773 | 69515 | 5467 | 72033 | 4459 | 74377 | 2898 | 91275 | 1942 | 68787 |
| 9L-5S | | MI | 32200 | 9187 | 53528 | 6651 | 59050 | 5369 | 61889 | 4354 | 65218 | 2771 | 79322 | 2140 | 55718 |
| 24-#14 | 3.26 | MA | 37909 | 9187 | 62046 | 6795 | 67807 | 5487 | 69995 | 4477 | 71610 | 2912 | 87848 | 1854 | 67154 |
| 10L-4S | | MI | 32815 | 9187 | 54575 | 6657 | 60407 | 5352 | 63556 | 4340 | 67589 | 2783 | 82134 | 2196 | 56465 |
| 24-#18 | 5.80 | MA | 43581 | 10639 | 75817 | 7661 | 85142 | 6117 | 91126 | 4868 | 100134 | 2758 | 126347 | 1252 | 114295 |
| 8L-6S | | MI | 35244 | 10639 | 62343 | 7500 | 69954 | 5977 | 75235 | 4745 | 82614 | 2589 | 102934 | 1333 | 91143 |

## RECTANGULAR TIED COLUMNS 36" x 48"

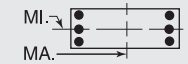
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.39 | MA | 41842 | 8468 | 65455 | 6320 | 71162 | 5145 | 72912 | 4280 | 73408 | 3049 | 86774 | 2875 | 35088 |
| 2L-3S | | MI | 29335 | 8468 | 46602 | 6173 | 49531 | 5061 | 49756 | 4208 | 47994 | 2972 | 55244 | 2520 | 25834 |
| 6-#18 | 1.39 | MA | 39392 | 8468 | 61846 | 6313 | 66536 | 5179 | 67268 | 4311 | 65729 | 3073 | 76456 | 2654 | 35156 |
| 3L-2S | | MI | 31071 | 8468 | 49173 | 6185 | 52828 | 5034 | 53777 | 4186 | 53333 | 2950 | 62280 | 2741 | 25699 |
| 8-#14 | 1.04 | MA | 40653 | 8260 | 62666 | 6227 | 67831 | 5082 | 68941 | 4249 | 68044 | 3085 | 79861 | 2941 | 26720 |
| 2L-4S | | MI | 28557 | 8260 | 44505 | 6117 | 47082 | 4990 | 46860 | 4167 | 44402 | 3033 | 51068 | 2585 | 19843 |
| 8-#14 | 1.04 | MA | 39245 | 8260 | 60609 | 6224 | 65193 | 5077 | 65724 | 4267 | 63667 | 3100 | 73912 | 2816 | 26783 |
| 3E | | MI | 29269 | 8260 | 45713 | 6098 | 48621 | 4998 | 48730 | 4178 | 46766 | 3021 | 53720 | 2710 | 19760 |
| 8-#14 | 1.04 | MA | 38260 | 8260 | 58937 | 6246 | 63062 | 5098 | 63133 | 4261 | 60333 | 3115 | 70033 | 2692 | 26816 |
| 4L-2S | | MI | 30272 | 8260 | 47187 | 6104 | 50510 | 4981 | 51035 | 4163 | 49860 | 3008 | 57819 | 2834 | 19681 |
| 8-#18 | 1.85 | MA | 43527 | 8744 | 69063 | 6493 | 75788 | 5269 | 78556 | 4355 | 81086 | 3027 | 97092 | 2830 | 46410 |
| 2L-4S | | MI | 29284 | 8744 | 47059 | 6377 | 50134 | 5168 | 50505 | 4262 | 49254 | 2963 | 57740 | 2232 | 33840 |
| 8-#18 | 1.85 | MA | 41097 | 8744 | 65455 | 6486 | 71162 | 5303 | 72912 | 4386 | 73408 | 3051 | 86774 | 2608 | 46385 |
| 3E | | MI | 30513 | 8744 | 49173 | 6346 | 52828 | 5185 | 53777 | 4284 | 53333 | 2941 | 62280 | 2453 | 33910 |
| 8-#18 | 1.85 | MA | 39392 | 8744 | 62514 | 6524 | 67414 | 5293 | 68357 | 4373 | 67546 | 3075 | 80059 | 2387 | 46048 |
| 4L-2S | | MI | 32238 | 8744 | 51745 | 6358 | 56124 | 5158 | 57798 | 4261 | 58672 | 2919 | 69315 | 2675 | 33824 |
| 10-#14 | 1.30 | MA | 41633 | 8416 | 64723 | 6324 | 70468 | 5152 | 72159 | 4291 | 72422 | 3073 | 85810 | 2918 | 33189 |
| 2L-5S | | MI | 28610 | 8416 | 44932 | 6209 | 47614 | 5076 | 47498 | 4224 | 45125 | 3005 | 52354 | 2496 | 24496 |
| 10-#14 | 1.30 | MA | 40231 | 8416 | 62666 | 6321 | 67831 | 5147 | 68941 | 4310 | 68044 | 3088 | 79861 | 2794 | 33233 |
| 3L-4S | | MI | 29247 | 8416 | 45979 | 6215 | 48971 | 5059 | 49165 | 4210 | 47495 | 3018 | 55167 | 2552 | 24482 |
| 10-#14 | 1.30 | MA | 39251 | 8416 | 60994 | 6343 | 65699 | 5167 | 66351 | 4304 | 64710 | 3103 | 75982 | 2669 | 33223 |
| 4L-3S | | MI | 29956 | 8416 | 47187 | 6195 | 50510 | 5068 | 51035 | 4220 | 49860 | 3005 | 57819 | 2677 | 24422 |
| 10-#14 | 1.30 | MA | 38377 | 8416 | 59550 | 6340 | 63826 | 5163 | 64048 | 4322 | 61374 | 3093 | 71949 | 2608 | 33099 |
| 5L-2S | | MI | 30954 | 8416 | 48660 | 6201 | 52399 | 5051 | 53340 | 4206 | 52953 | 2993 | 61918 | 2801 | 24354 |
| 10-#18 | 2.31 | MA | 45194 | 9021 | 72672 | 6666 | 80414 | 5393 | 84199 | 4431 | 88765 | 3005 | 107410 | 2784 | 57697 |
| 2L-5S | | MI | 29364 | 9021 | 47795 | 6538 | 51053 | 5320 | 51605 | 4360 | 50499 | 2910 | 59925 | 2070 | 39991 |
| 10-#18 | 2.31 | MA | 42782 | 9021 | 69063 | 6659 | 75788 | 5428 | 78556 | 4462 | 81086 | 3029 | 97092 | 2563 | 57582 |
| 3L-4S | | MI | 30460 | 9021 | 49631 | 6550 | 53431 | 5293 | 54526 | 4337 | 54593 | 2932 | 64776 | 2165 | 41775 |
| 10-#18 | 2.31 | MA | 41092 | 9021 | 66123 | 6697 | 72041 | 5417 | 74001 | 4448 | 75225 | 3053 | 90378 | 2341 | 57146 |
| 4L-3S | | MI | 31681 | 9021 | 51745 | 6518 | 56124 | 5310 | 57798 | 4359 | 58672 | 2910 | 69315 | 2386 | 41938 |
| 10-#18 | 2.31 | MA | 39584 | 9021 | 63581 | 6690 | 68744 | 5452 | 69950 | 4479 | 69357 | 3033 | 83359 | 2235 | 54468 |
| 5L-2S | | MI | 33393 | 9021 | 54316 | 6531 | 59420 | 5282 | 61820 | 4337 | 64011 | 2888 | 76351 | 2608 | 41911 |
| 12-#11 | 1.08 | MA | 40857 | 8285 | 62954 | 6261 | 68323 | 5108 | 69590 | 4269 | 68947 | 3093 | 81240 | 2953 | 27845 |
| 2L-6S | | MI | 28355 | 8285 | 44100 | 6147 | 46596 | 5026 | 46299 | 4195 | 43611 | 3041 | 50288 | 2582 | 20670 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

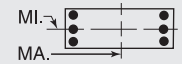



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.08 | MA | 39874 | 8285 | 61518 | 6259 | 66482 | 5105 | 67344 | 4282 | 65892 | 3104 | 77065 | 2867 | 27883 |
| 3L-5S | | MI | 28780 | 8285 | 44786 | 6150 | 47545 | 5031 | 47459 | 4201 | 45121 | 3032 | 52153 | 2639 | 20645 |
| 12-#11 | 1.08 | MA | 39187 | 8285 | 60352 | 6274 | 64996 | 5120 | 65538 | 4278 | 63567 | 3115 | 74339 | 2781 | 27911 |
| 4E | | MI | 29226 | 8285 | 45517 | 6154 | 48493 | 5019 | 48623 | 4191 | 46788 | 3041 | 54132 | 2678 | 20600 |
| 12-#11 | 1.08 | MA | 38575 | 8285 | 59346 | 6273 | 63691 | 5117 | 63933 | 4291 | 61242 | 3109 | 71513 | 2738 | 27903 |
| 5L-3S | | MI | 29723 | 8285 | 46361 | 6140 | 49568 | 5024 | 49930 | 4198 | 48452 | 3032 | 56006 | 2764 | 20548 |
| 12-#11 | 1.08 | MA | 37992 | 8285 | 58403 | 6271 | 62384 | 5131 | 62336 | 4287 | 59137 | 3120 | 68811 | 2682 | 27835 |
| 6L-2S | | MI | 30425 | 8285 | 47392 | 6144 | 50890 | 5012 | 51543 | 4187 | 50628 | 3023 | 58898 | 2851 | 20499 |
| 12-#14 | 1.56 | MA | 42605 | 8571 | 66781 | 6421 | 73105 | 5222 | 75376 | 4334 | 76799 | 3060 | 91759 | 2896 | 39642 |
| 2L-6S | | MI | 28695 | 8571 | 45423 | 6300 | 48144 | 5138 | 48141 | 4256 | 46072 | 3003 | 53812 | 2381 | 28522 |
| 12-#14 | 1.56 | MA | 41210 | 8571 | 64723 | 6418 | 70468 | 5217 | 72159 | 4352 | 72422 | 3076 | 85810 | 2771 | 39666 |
| 3L-5S | | MI | 29299 | 8571 | 46406 | 6306 | 49503 | 5146 | 49803 | 4266 | 48219 | 2990 | 56453 | 2463 | 29076 |
| 12-#14 | 1.56 | MA | 40236 | 8571 | 63051 | 6440 | 68336 | 5237 | 69568 | 4346 | 69088 | 3091 | 81930 | 2647 | 39615 |
| 4E | | MI | 29933 | 8571 | 47453 | 6312 | 50860 | 5129 | 51470 | 4252 | 50589 | 3003 | 59266 | 2519 | 29101 |
| 12-#14 | 1.56 | MA | 39366 | 8571 | 61607 | 6437 | 66463 | 5233 | 67265 | 4364 | 65752 | 3081 | 77897 | 2586 | 39452 |
| 5L-3S | | MI | 30638 | 8571 | 48660 | 6293 | 52399 | 5137 | 53340 | 4262 | 52953 | 2990 | 61918 | 2643 | 29063 |
| 12-#14 | 1.56 | MA | 38539 | 8571 | 60253 | 6434 | 64587 | 5253 | 64973 | 4358 | 62730 | 3096 | 74049 | 2505 | 38518 |
| 6L-2S | | MI | 31633 | 8571 | 50134 | 6299 | 54289 | 5121 | 55644 | 4248 | 56047 | 2978 | 66017 | 2768 | 29007 |
| 12-#18 | 2.78 | MA | 46845 | 9298 | 76281 | 6839 | 85040 | 5518 | 89843 | 4506 | 96443 | 2983 | 117729 | 2738 | 68942 |
| 2L-6S | | MI | 29500 | 9298 | 48643 | 6698 | 51965 | 5427 | 52846 | 4458 | 52134 | 2901 | 62435 | 1857 | 46440 |
| 12-#18 | 2.78 | MA | 44451 | 9298 | 72672 | 6832 | 80414 | 5552 | 84199 | 4537 | 88765 | 3007 | 107410 | 2517 | 68757 |
| 3L-5S | | MI | 30537 | 9298 | 50367 | 6711 | 54349 | 5444 | 55626 | 4435 | 55839 | 2879 | 66961 | 2003 | 47623 |
| 12-#18 | 2.78 | MA | 42775 | 9298 | 69732 | 6869 | 76667 | 5542 | 79645 | 4524 | 82904 | 3031 | 100696 | 2296 | 68236 |
| 4E | | MI | 31626 | 9298 | 52202 | 6723 | 56727 | 5417 | 58547 | 4413 | 59932 | 2901 | 71812 | 2098 | 49690 |
| 12-#18 | 2.78 | MA | 41280 | 9298 | 67189 | 6863 | 73370 | 5576 | 75593 | 4554 | 77035 | 3010 | 93677 | 2190 | 65258 |
| 5L-3S | | MI | 32838 | 9298 | 54316 | 6691 | 59420 | 5434 | 61820 | 4435 | 64011 | 2879 | 76351 | 2319 | 49928 |
| 12-#18 | 2.78 | MA | 39858 | 9298 | 64806 | 6856 | 70068 | 5566 | 71558 | 4541 | 71718 | 3034 | 87009 | 2046 | 63251 |
| 6L-2S | | MI | 34540 | 9298 | 56887 | 6704 | 62716 | 5407 | 65841 | 4412 | 69351 | 2857 | 83387 | 2541 | 49970 |
| 14-#11 | 1.26 | MA | 41543 | 8393 | 64390 | 6328 | 70164 | 5157 | 71836 | 4298 | 72003 | 3085 | 85415 | 2939 | 32355 |
| 2L-7S | | MI | 28428 | 8393 | 44380 | 6228 | 47012 | 5087 | 46798 | 4235 | 44311 | 3040 | 51187 | 2470 | 23599 |
| 14-#11 | 1.26 | MA | 40563 | 8393 | 62954 | 6326 | 68323 | 5154 | 69590 | 4311 | 68947 | 3096 | 81240 | 2852 | 32385 |
| 3L-6S | | MI | 28842 | 8393 | 45131 | 6214 | 47918 | 5075 | 47912 | 4224 | 45787 | 3031 | 53180 | 2561 | 23887 |
| 14-#11 | 1.26 | MA | 39879 | 8393 | 61788 | 6342 | 66837 | 5168 | 67784 | 4307 | 66623 | 3106 | 78514 | 2766 | 32401 |
| 4L-5S | | MI | 29265 | 8393 | 45817 | 6218 | 48868 | 5080 | 49072 | 4231 | 47298 | 3022 | 55045 | 2617 | 23882 |
| 14-#11 | 1.26 | MA | 39270 | 8393 | 60782 | 6340 | 65532 | 5165 | 66179 | 4320 | 64297 | 3100 | 75688 | 2723 | 32367 |
| 5L-4S | | MI | 29710 | 8393 | 46548 | 6221 | 49815 | 5068 | 50236 | 4220 | 48965 | 3031 | 57023 | 2657 | 23850 |
| 14-#11 | 1.26 | MA | 38690 | 8393 | 59839 | 6338 | 64225 | 5180 | 64581 | 4316 | 62192 | 3111 | 72986 | 2667 | 32278 |
| 6L-3S | | MI | 30206 | 8393 | 47392 | 6208 | 50890 | 5073 | 51543 | 4227 | 50628 | 3022 | 58898 | 2743 | 23807 |
| 14-#11 | 1.26 | MA | 38124 | 8393 | 58806 | 6354 | 62979 | 5177 | 63049 | 4330 | 60135 | 3122 | 70106 | 2578 | 31747 |
| 7L-2S | | MI | 30906 | 8393 | 48423 | 6211 | 52212 | 5061 | 53156 | 4217 | 52805 | 3014 | 61789 | 2829 | 23763 |
| 14-#14 | 1.82 | MA | 43571 | 8727 | 68838 | 6518 | 75743 | 5291 | 78594 | 4376 | 81177 | 3048 | 97708 | 2873 | 46084 |
| 2L-7S | | MI | 28797 | 8727 | 45821 | 6416 | 48735 | 5224 | 48851 | 4313 | 47068 | 3000 | 55087 | 2218 | 32443 |
| 14-#14 | 1.82 | MA | 42183 | 8727 | 66781 | 6516 | 73105 | 5287 | 75376 | 4395 | 76799 | 3063 | 91759 | 2749 | 46078 |
| 3L-6S | | MI | 29383 | 8727 | 46897 | 6397 | 50033 | 5208 | 50446 | 4298 | 49166 | 2987 | 57911 | 2348 | 32950 |
| 14-#14 | 1.82 | MA | 41213 | 8727 | 65109 | 6538 | 70974 | 5307 | 72785 | 4388 | 73465 | 3078 | 87879 | 2624 | 45997 |
| 4L-5S | | MI | 29984 | 8727 | 47880 | 6403 | 51393 | 5216 | 52108 | 4309 | 51312 | 2975 | 60552 | 2430 | 33644 |
| 14-#14 | 1.82 | MA | 40348 | 8727 | 63664 | 6535 | 69100 | 5302 | 70483 | 4407 | 70129 | 3068 | 83846 | 2563 | 45800 |
| 5L-4S | | MI | 30614 | 8727 | 48926 | 6409 | 52750 | 5199 | 53775 | 4294 | 53683 | 2987 | 63365 | 2486 | 33702 |
| 14-#14 | 1.82 | MA | 39526 | 8727 | 62311 | 6532 | 67225 | 5323 | 68190 | 4401 | 67108 | 3083 | 79998 | 2483 | 44723 |
| 6L-3S | | MI | 31317 | 8727 | 50134 | 6390 | 54289 | 5207 | 55644 | 4305 | 56047 | 2975 | 66017 | 2610 | 33690 |
| 14-#14 | 1.82 | MA | 38724 | 8727 | 60828 | 6554 | 65436 | 5318 | 65990 | 4419 | 64156 | 3098 | 75895 | 2353 | 43850 |
| 7L-2S | | MI | 32307 | 8727 | 51608 | 6396 | 56178 | 5191 | 57949 | 4291 | 59141 | 2963 | 70117 | 2735 | 33647 |
| 14-#18 | 3.24 | MA | 46104 | 9574 | 76281 | 7005 | 85040 | 5676 | 89843 | 4612 | 96443 | 2985 | 117729 | 2471 | 79918 |
| 3L-6S | | MI | 30671 | 9574 | 51214 | 6871 | 55262 | 5551 | 56867 | 4533 | 57473 | 2870 | 69471 | 1790 | 53917 |
| 14-#18 | 3.24 | MA | 44441 | 9574 | 73341 | 7042 | 81293 | 5666 | 85288 | 4599 | 90582 | 3009 | 111014 | 2250 | 79320 |
| 4L-5S | | MI | 31701 | 9574 | 52938 | 6884 | 57645 | 5568 | 59648 | 4511 | 61178 | 2848 | 73997 | 1936 | 55284 |
| 14-#18 | 3.24 | MA | 42959 | 9574 | 70798 | 7036 | 77996 | 5700 | 81237 | 4630 | 84714 | 2988 | 103995 | 2144 | 76079 |
| 5L-4S | | MI | 32782 | 9574 | 54773 | 6896 | 60023 | 5541 | 62568 | 4488 | 65271 | 2870 | 78848 | 2031 | 57463 |
| 14-#18 | 3.24 | MA | 41549 | 9574 | 68415 | 7029 | 74694 | 5690 | 77202 | 4616 | 79397 | 3012 | 97328 | 2000 | 74152 |
| 6L-3S | | MI | 33986 | 9574 | 56887 | 6864 | 62716 | 5558 | 65841 | 4510 | 69351 | 2848 | 83387 | 2253 | 57896 |

## RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

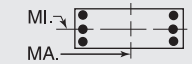
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.24 | MA | 40176 | 9574 | 65803 | 7067 | 71545 | 5724 | 73329 | 4647 | 74201 | 3036 | 90213 | 1770 | 70509 |
| 7L-2S | | MI | 35677 | 9574 | 59459 | 6877 | 66013 | 5531 | 69862 | 4487 | 74690 | 2826 | 90423 | 2474 | 58001 |
| 16-#11 | 1.44 | MA | 42226 | 8501 | 65826 | 6395 | 72005 | 5205 | 74081 | 4327 | 75058 | 3076 | 89590 | 2924 | 36859 |
| 2L-8S | | MI | 28509 | 8501 | 44736 | 6292 | 47415 | 5130 | 47324 | 4275 | 44918 | 3021 | 52229 | 2402 | 26470 |
| 16-#11 | 1.44 | MA | 41249 | 8501 | 64390 | 6394 | 70164 | 5202 | 71836 | 4341 | 72003 | 3087 | 85415 | 2838 | 36880 |
| 3L-7S | | MI | 28915 | 8501 | 45412 | 6295 | 48334 | 5135 | 48411 | 4264 | 46488 | 3030 | 54079 | 2449 | 26727 |
| 16-#11 | 1.44 | MA | 40568 | 8501 | 63224 | 6409 | 68678 | 5217 | 70029 | 4337 | 69678 | 3098 | 82689 | 2752 | 36874 |
| 4L-6S | | MI | 29326 | 8501 | 46163 | 6282 | 49240 | 5123 | 49525 | 4254 | 47964 | 3021 | 56071 | 2539 | 27095 |
| 16-#11 | 1.44 | MA | 39961 | 8501 | 62218 | 6407 | 67372 | 5214 | 68425 | 4350 | 67353 | 3092 | 79864 | 2709 | 36826 |
| 5E | | MI | 29749 | 8501 | 46849 | 6285 | 50190 | 5128 | 50685 | 4260 | 49474 | 3013 | 57936 | 2596 | 27111 |
| 16-#11 | 1.44 | MA | 39383 | 8501 | 61275 | 6406 | 66066 | 5228 | 66827 | 4346 | 65247 | 3103 | 77161 | 2653 | 36718 |
| 6L-4S | | MI | 30192 | 8501 | 47580 | 6289 | 51137 | 5116 | 51849 | 4250 | 51141 | 3021 | 59915 | 2635 | 27090 |
| 16-#11 | 1.44 | MA | 38820 | 8501 | 60242 | 6421 | 64819 | 5225 | 65294 | 4359 | 63191 | 3114 | 74281 | 2563 | 36106 |
| 7L-3S | | MI | 30686 | 8501 | 48423 | 6275 | 52212 | 5121 | 53156 | 4256 | 52805 | 3013 | 61789 | 2721 | 27057 |
| 16-#11 | 1.44 | MA | 38257 | 8501 | 59314 | 6420 | 63555 | 5240 | 63799 | 4372 | 61005 | 3107 | 71638 | 2513 | 35647 |
| 8L-2S | | MI | 31384 | 8501 | 49455 | 6279 | 53535 | 5109 | 54769 | 4246 | 54981 | 3004 | 64681 | 2808 | 27018 |
| 16-#14 | 2.08 | MA | 44532 | 8883 | 70895 | 6616 | 78380 | 5361 | 81811 | 4419 | 85555 | 3036 | 103656 | 2851 | 52516 |
| 2L-8S | | MI | 28909 | 8883 | 46326 | 6508 | 49307 | 5286 | 49598 | 4369 | 47930 | 2972 | 56558 | 2119 | 36145 |
| 16-#14 | 2.08 | MA | 43150 | 8883 | 68838 | 6613 | 75743 | 5357 | 78594 | 4437 | 81177 | 3051 | 97708 | 2726 | 52480 |
| 3L-7S | | MI | 29483 | 8883 | 47294 | 6514 | 50624 | 5294 | 51156 | 4355 | 50162 | 2985 | 59186 | 2185 | 36907 |
| 16-#14 | 2.08 | MA | 42185 | 8883 | 67166 | 6635 | 73611 | 5377 | 76003 | 4431 | 77843 | 3066 | 93828 | 2602 | 52371 |
| 4L-6S | | MI | 30066 | 8883 | 48371 | 6495 | 51922 | 5277 | 52751 | 4341 | 52259 | 2972 | 62010 | 2315 | 37390 |
| 16-#14 | 2.08 | MA | 41325 | 8883 | 65721 | 6632 | 71738 | 5372 | 73700 | 4449 | 74507 | 3056 | 89795 | 2541 | 52144 |
| 5E | | MI | 30665 | 8883 | 49353 | 6500 | 53282 | 5286 | 54412 | 4351 | 54406 | 2960 | 64651 | 2397 | 38203 |
| 16-#14 | 2.08 | MA | 40506 | 8883 | 64368 | 6629 | 69862 | 5392 | 71408 | 4443 | 71485 | 3071 | 85947 | 2460 | 50941 |
| 6L-4S | | MI | 31292 | 8883 | 50400 | 6506 | 54639 | 5269 | 56079 | 4337 | 56776 | 2972 | 67464 | 2452 | 38287 |
| 16-#14 | 2.08 | MA | 39709 | 8883 | 62885 | 6651 | 68073 | 5388 | 69208 | 4461 | 68534 | 3086 | 81844 | 2331 | 50098 |
| 7L-3S | | MI | 31992 | 8883 | 51608 | 6487 | 56178 | 5277 | 57949 | 4347 | 59141 | 2960 | 70117 | 2577 | 38311 |
| 16-#14 | 2.08 | MA | 38924 | 8883 | 61553 | 6648 | 66259 | 5408 | 67061 | 4480 | 65396 | 3076 | 78072 | 2259 | 48924 |
| 8L-2S | | MI | 32978 | 8883 | 53082 | 6493 | 58067 | 5260 | 60254 | 4333 | 62234 | 2947 | 74216 | 2701 | 38276 |
| 16-#18 | 3.70 | MA | 46093 | 9851 | 76949 | 7215 | 85919 | 5790 | 90932 | 4674 | 98261 | 2987 | 121332 | 2204 | 90367 |
| 4L-6S | | MI | 31833 | 9851 | 53785 | 7044 | 58558 | 5675 | 60889 | 4609 | 62812 | 2839 | 76506 | 1723 | 61401 |
| 16-#18 | 3.70 | MA | 44622 | 9851 | 74407 | 7209 | 82622 | 5824 | 86881 | 4705 | 92393 | 2966 | 114313 | 2098 | 86926 |
| 5E | | MI | 32856 | 9851 | 55509 | 7057 | 60941 | 5692 | 63669 | 4586 | 66517 | 2817 | 81033 | 1869 | 62969 |
| 16-#18 | 3.70 | MA | 43224 | 9851 | 72023 | 7202 | 79321 | 5814 | 82846 | 4692 | 87075 | 2990 | 107646 | 1955 | 84799 |
| 6L-4S | | MI | 33929 | 9851 | 57345 | 7069 | 63319 | 5665 | 66590 | 4564 | 70610 | 2839 | 85884 | 1964 | 65017 |
| 16-#18 | 3.70 | MA | 41862 | 9851 | 69412 | 7239 | 76171 | 5848 | 78973 | 4722 | 81879 | 3014 | 100532 | 1724 | 81278 |
| 7L-3S | | MI | 35125 | 9851 | 59459 | 7037 | 66013 | 5682 | 69862 | 4585 | 74690 | 2817 | 90423 | 2186 | 65849 |
| 16-#18 | 3.70 | MA | 40522 | 9851 | 67066 | 7233 | 72976 | 5838 | 75193 | 4753 | 76358 | 2994 | 93969 | 1600 | 77813 |
| 8L-2S | | MI | 36806 | 9851 | 62030 | 7050 | 69309 | 5655 | 73883 | 4563 | 80029 | 2795 | 97459 | 2407 | 66003 |
| 18-#11 | 1.63 | MA | 42906 | 8609 | 67262 | 6463 | 73846 | 5253 | 76327 | 4357 | 78113 | 3067 | 93765 | 2910 | 41356 |
| 2L-9S | | MI | 28585 | 8609 | 45040 | 6373 | 47843 | 5190 | 47800 | 4297 | 45632 | 3020 | 53313 | 2327 | 29306 |
| 18-#11 | 1.63 | MA | 41932 | 8609 | 65826 | 6461 | 72005 | 5251 | 74081 | 4370 | 75058 | 3078 | 89590 | 2823 | 41369 |
| 3L-8S | | MI | 28994 | 8609 | 45768 | 6359 | 48737 | 5178 | 48937 | 4304 | 47095 | 3011 | 55121 | 2381 | 29614 |
| 18-#11 | 1.63 | MA | 41254 | 8609 | 64660 | 6477 | 70519 | 5265 | 72275 | 4366 | 72734 | 3089 | 86865 | 2737 | 41344 |
| 4L-7S | | MI | 29399 | 8609 | 46443 | 6363 | 49657 | 5183 | 50024 | 4293 | 48664 | 3020 | 56970 | 2427 | 29860 |
| 18-#11 | 1.63 | MA | 40649 | 8609 | 63654 | 6475 | 69213 | 5262 | 70670 | 4379 | 70408 | 3083 | 84039 | 2694 | 41279 |
| 5L-6S | | MI | 29809 | 8609 | 47194 | 6349 | 50563 | 5171 | 51138 | 4283 | 50140 | 3011 | 58963 | 2518 | 30249 |
| 18-#11 | 1.63 | MA | 40073 | 8609 | 62711 | 6473 | 67906 | 5276 | 69073 | 4375 | 68303 | 3094 | 81336 | 2638 | 41130 |
| 6L-5S | | MI | 30230 | 8609 | 47880 | 6353 | 51512 | 5177 | 52298 | 4290 | 51651 | 3003 | 60828 | 2574 | 30329 |
| 18-#11 | 1.63 | MA | 39513 | 8609 | 61678 | 6489 | 66660 | 5274 | 67540 | 4389 | 66246 | 3105 | 78457 | 2549 | 40472 |
| 7L-4S | | MI | 30672 | 8609 | 48611 | 6356 | 52459 | 5164 | 53462 | 4279 | 53318 | 3011 | 62807 | 2613 | 30324 |
| 18-#11 | 1.63 | MA | 38954 | 8609 | 60750 | 6487 | 65396 | 5288 | 66044 | 4402 | 64060 | 3099 | 75814 | 2498 | 40026 |
| 8L-3S | | MI | 31164 | 8609 | 49455 | 6343 | 53535 | 5170 | 54769 | 4286 | 54981 | 3003 | 64681 | 2700 | 30299 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis

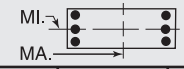


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.63 | MA | 38367 | 8609 | 59842 | 6485 | 64167 | 5285 | 64480 | 4398 | 62023 | 3110 | 73193 | 2445 | 39494 |
| 9L-2S | | MI | 31860 | 8609 | 50486 | 6346 | 54857 | 5158 | 56382 | 4275 | 57158 | 2994 | 67572 | 2786 | 30266 |
| 18-#14 | 2.34 | MA | 44110 | 9038 | 70895 | 6710 | 78380 | 5427 | 81811 | 4480 | 85555 | 3038 | 103656 | 2704 | 58874 |
| 3L-8S | | MI | 29594 | 9038 | 47800 | 6605 | 51197 | 5356 | 51903 | 4412 | 51024 | 2957 | 60657 | 2085 | 40526 |
| 18-#14 | 2.34 | MA | 43150 | 9038 | 69223 | 6732 | 76249 | 5447 | 79220 | 4473 | 82221 | 3053 | 99777 | 2579 | 58740 |
| 4L-7S | | MI | 30165 | 9038 | 48768 | 6611 | 52514 | 5364 | 53461 | 4397 | 53255 | 2969 | 63285 | 2151 | 41376 |
| 18-#14 | 2.34 | MA | 42295 | 9038 | 67779 | 6729 | 74375 | 5442 | 76918 | 4492 | 78884 | 3043 | 95744 | 2518 | 58484 |
| 5L-6S | | MI | 30746 | 9038 | 49844 | 6592 | 53812 | 5347 | 55056 | 4383 | 55353 | 2957 | 66109 | 2282 | 41840 |
| 18-#14 | 2.34 | MA | 41481 | 9038 | 66425 | 6726 | 72500 | 5462 | 74625 | 4485 | 75863 | 3058 | 91896 | 2438 | 57168 |
| 6L-5S | | MI | 31342 | 9038 | 50827 | 6598 | 55171 | 5355 | 56717 | 4394 | 57500 | 2945 | 68750 | 2363 | 42631 |
| 18-#14 | 2.34 | MA | 40688 | 9038 | 64942 | 6748 | 70711 | 5458 | 72425 | 4504 | 72911 | 3074 | 87793 | 2308 | 56354 |
| 7L-4S | | MI | 31966 | 9038 | 51874 | 6604 | 56528 | 5339 | 58384 | 4379 | 59870 | 2957 | 71563 | 2419 | 42864 |
| 18-#14 | 2.34 | MA | 39907 | 9038 | 63610 | 6745 | 68896 | 5478 | 70278 | 4522 | 69774 | 3064 | 84021 | 2236 | 55091 |
| 8L-3S | | MI | 32663 | 9038 | 53082 | 6585 | 58067 | 5347 | 60254 | 4390 | 62234 | 2945 | 74216 | 2544 | 42908 |
| 18-#14 | 2.34 | MA | 39076 | 9038 | 62307 | 6742 | 67131 | 5473 | 68033 | 4516 | 66849 | 3079 | 80290 | 2159 | 53849 |
| 9L-2S | | MI | 33645 | 9038 | 54555 | 6590 | 59956 | 5330 | 62559 | 4375 | 65328 | 2932 | 78315 | 2668 | 42897 |
| 18-#18 | 4.17 | MA | 46272 | 10128 | 78015 | 7381 | 87248 | 5948 | 92524 | 4780 | 100071 | 2944 | 124631 | 2053 | 97795 |
| 5L-6S | | MI | 32986 | 10128 | 56357 | 7217 | 61854 | 5799 | 64910 | 4684 | 68151 | 2808 | 83542 | 1656 | 68913 |
| 18-#18 | 4.17 | MA | 44884 | 10128 | 75632 | 7375 | 83947 | 5938 | 88489 | 4767 | 94754 | 2968 | 117964 | 1909 | 95473 |
| 6L-5S | | MI | 34002 | 10128 | 58081 | 7229 | 64238 | 5816 | 67690 | 4662 | 71856 | 2786 | 88069 | 1802 | 70673 |
| 18-#18 | 4.17 | MA | 43534 | 10128 | 73021 | 7412 | 80797 | 5972 | 84616 | 4798 | 89558 | 2992 | 110850 | 1678 | 92067 |
| 7L-4S | | MI | 35068 | 10128 | 59916 | 7242 | 66616 | 5789 | 70611 | 4639 | 75949 | 2808 | 92920 | 1898 | 72605 |
| 18-#18 | 4.17 | MA | 42205 | 10128 | 70675 | 7406 | 77602 | 5962 | 80836 | 4828 | 84036 | 2972 | 104287 | 1554 | 88488 |
| 8L-3S | | MI | 36256 | 10128 | 62030 | 7210 | 69309 | 5806 | 73883 | 4661 | 80029 | 2786 | 97459 | 2119 | 73789 |
| 20-#11 | 1.81 | MA | 42612 | 8717 | 67262 | 6529 | 73846 | 5299 | 76327 | 4399 | 78113 | 3070 | 93765 | 2809 | 45845 |
| 3L-9S | | MI | 29072 | 8717 | 46072 | 6440 | 49165 | 5239 | 49413 | 4327 | 47809 | 3010 | 56204 | 2305 | 32392 |
| 20-#11 | 1.81 | MA | 41936 | 8717 | 66096 | 6544 | 72360 | 5313 | 74521 | 4395 | 75789 | 3081 | 91040 | 2723 | 45808 |
| 4L-8S | | MI | 29478 | 8717 | 46799 | 6426 | 50060 | 5227 | 50550 | 4333 | 49272 | 3002 | 58012 | 2359 | 32759 |
| 20-#11 | 1.81 | MA | 41334 | 8717 | 65089 | 6542 | 71054 | 5311 | 72916 | 4409 | 73464 | 3074 | 88214 | 2680 | 45729 |
| 5L-7S | | MI | 29881 | 8717 | 47474 | 6430 | 50979 | 5232 | 51637 | 4323 | 50841 | 3010 | 59862 | 2406 | 32997 |
| 20-#11 | 1.81 | MA | 40760 | 8717 | 64147 | 6541 | 69747 | 5325 | 71318 | 4405 | 71358 | 3085 | 85512 | 2624 | 45477 |
| 6E | | MI | 30290 | 8717 | 48226 | 6416 | 51885 | 5220 | 52751 | 4312 | 52317 | 3002 | 61854 | 2496 | 33367 |
| 20-#11 | 1.81 | MA | 40202 | 8717 | 63114 | 6556 | 68501 | 5322 | 69786 | 4418 | 69302 | 3096 | 82632 | 2534 | 44843 |
| 7L-5S | | MI | 30709 | 8717 | 48911 | 6420 | 52834 | 5225 | 53911 | 4319 | 53827 | 2993 | 63719 | 2552 | 33539 |
| 20-#11 | 1.81 | MA | 39652 | 8717 | 62186 | 6554 | 67237 | 5336 | 68290 | 4431 | 67116 | 3090 | 79989 | 2484 | 44409 |
| 8L-4S | | MI | 31149 | 8717 | 49642 | 6424 | 53782 | 5213 | 55075 | 4309 | 55494 | 3002 | 65698 | 2592 | 33552 |
| 20-#11 | 1.81 | MA | 39061 | 8717 | 61278 | 6553 | 66008 | 5334 | 66726 | 4427 | 65078 | 3101 | 77368 | 2430 | 43817 |
| 9L-3S | | MI | 31640 | 8717 | 50486 | 6410 | 54857 | 5218 | 56382 | 4315 | 57158 | 2993 | 67572 | 2678 | 33535 |
| 20-#11 | 1.81 | MA | 38453 | 8717 | 60262 | 6568 | 64761 | 5348 | 65238 | 4440 | 63058 | 3112 | 74828 | 2370 | 43076 |
| 10L-2S | | MI | 32334 | 8717 | 51517 | 6414 | 56179 | 5206 | 57994 | 4305 | 59334 | 2984 | 70464 | 2765 | 33508 |
| 20-#14 | 2.60 | MA | 44110 | 9194 | 71281 | 6829 | 78886 | 5517 | 82438 | 4516 | 86598 | 3041 | 105726 | 2557 | 65104 |
| 4L-8S | | MI | 30275 | 9194 | 49274 | 6702 | 53086 | 5426 | 54207 | 4454 | 54118 | 2942 | 64756 | 2052 | 44916 |
| 20-#14 | 2.60 | MA | 43259 | 9194 | 69836 | 6826 | 77012 | 5512 | 80135 | 4534 | 83262 | 3031 | 101693 | 2496 | 64681 |
| 5L-7S | | MI | 30844 | 9194 | 50242 | 6708 | 54403 | 5434 | 55765 | 4440 | 56349 | 2954 | 67384 | 2118 | 45849 |
| 20-#14 | 2.60 | MA | 42449 | 9194 | 68483 | 6823 | 75137 | 5532 | 77843 | 4528 | 80241 | 3046 | 97844 | 2415 | 63405 |
| 6E | | MI | 31422 | 9194 | 51318 | 6689 | 55701 | 5417 | 57361 | 4425 | 58446 | 2942 | 70208 | 2248 | 46296 |
| 20-#14 | 2.60 | MA | 41661 | 9194 | 67000 | 6845 | 73348 | 5528 | 75643 | 4546 | 77289 | 3061 | 93742 | 2285 | 62614 |
| 7L-5S | | MI | 32015 | 9194 | 52301 | 6695 | 57061 | 5425 | 59022 | 4436 | 60593 | 2929 | 72849 | 2330 | 47048 |
| 20-#14 | 2.60 | MA | 40884 | 9194 | 65668 | 6843 | 71533 | 5548 | 73496 | 4565 | 74152 | 3051 | 89970 | 2214 | 61268 |
| 8L-4S | | MI | 32637 | 9194 | 53348 | 6701 | 58418 | 5409 | 60689 | 4422 | 62963 | 2942 | 75662 | 2386 | 47433 |
| 20-#14 | 2.60 | MA | 40058 | 9194 | 64365 | 6840 | 69769 | 5543 | 71250 | 4558 | 71227 | 3066 | 86239 | 2136 | 60059 |
| 9L-3S | | MI | 33331 | 9194 | 54555 | 6682 | 59956 | 5417 | 62559 | 4432 | 65328 | 2929 | 78315 | 2510 | 47497 |
| 20-#14 | 2.60 | MA | 39199 | 9194 | 62905 | 6862 | 67979 | 5563 | 69115 | 4577 | 68327 | 3081 | 82622 | 2049 | 58422 |
| 10L-2S | | MI | 34309 | 9194 | 56029 | 6688 | 61846 | 5400 | 64864 | 4418 | 68421 | 2917 | 82414 | 2635 | 47516 |
| 20-#18 | 4.63 | MA | 46532 | 10404 | 79241 | 7548 | 88573 | 6062 | 94133 | 4842 | 102432 | 2946 | 128282 | 1863 | 106172 |
| 6E | | MI | 34131 | 10404 | 58928 | 7390 | 65150 | 5923 | 68931 | 4759 | 73490 | 2777 | 90578 | 1589 | 76451 |
| 20-#18 | 4.63 | MA | 45191 | 10404 | 76629 | 7585 | 85423 | 6096 | 90260 | 4873 | 97237 | 2970 | 121168 | 1633 | 102874 |
| 7L-5S | | MI | 35140 | 10404 | 60652 | 7402 | 67534 | 5940 | 71711 | 4737 | 77195 | 2755 | 95104 | 1735 | 78392 |
| 20-#18 | 4.63 | MA | 43873 | 10404 | 74283 | 7579 | 82228 | 6086 | 86480 | 4904 | 91715 | 2950 | 114605 | 1508 | 99183 |
| 8L-4S | | MI | 36199 | 10404 | 62487 | 7415 | 69912 | 5913 | 74632 | 4714 | 81288 | 2777 | 99955 | 1831 | 80219 |

## RECTANGULAR TIED COLUMNS 36" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.99 | MA | 42615 | 8825 | 67532 | 6612 | 74200 | 5362 | 76766 | 4425 | 78844 | 3072 | 95215 | 2708 | 50269 |
| 4L-9S | | MI | 29562 | 8825 | 47103 | 6508 | 50487 | 5287 | 51026 | 4356 | 49985 | 3000 | 59096 | 2283 | 35484 |
| 22-#11 | 1.99 | MA | 42015 | 8825 | 66525 | 6610 | 72895 | 5359 | 75162 | 4438 | 76519 | 3066 | 92389 | 2665 | 50176 |
| 5L-8S | | MI | 29959 | 8825 | 47830 | 6494 | 51382 | 5275 | 52163 | 4363 | 51448 | 2992 | 60904 | 2338 | 35906 |
| 22-#11 | 1.99 | MA | 41444 | 8825 | 65583 | 6608 | 71588 | 5373 | 73564 | 4434 | 74414 | 3077 | 89687 | 2609 | 49830 |
| 6L-7S | | MI | 30361 | 8825 | 48506 | 6498 | 52301 | 5280 | 53250 | 4352 | 53017 | 3000 | 62753 | 2384 | 36138 |
| 22-#11 | 1.99 | MA | 40888 | 8825 | 64549 | 6624 | 70342 | 5370 | 72031 | 4447 | 72357 | 3088 | 86807 | 2520 | 49218 |
| 7L-6S | | MI | 30769 | 8825 | 49257 | 6484 | 53207 | 5268 | 54364 | 4342 | 54493 | 2992 | 64746 | 2474 | 36491 |
| 22-#11 | 1.99 | MA | 40341 | 8825 | 63622 | 6622 | 69078 | 5385 | 70536 | 4461 | 70171 | 3081 | 84164 | 2469 | 48794 |
| 8L-5S | | MI | 31187 | 8825 | 49943 | 6488 | 54156 | 5273 | 55524 | 4348 | 56004 | 2983 | 66611 | 2531 | 36745 |
| 22-#11 | 1.99 | MA | 39752 | 8825 | 62714 | 6620 | 67848 | 5382 | 68972 | 4457 | 68134 | 3092 | 81544 | 2416 | 48146 |
| 9L-4S | | MI | 31625 | 8825 | 50674 | 6491 | 55104 | 5261 | 56688 | 4338 | 57671 | 2992 | 68590 | 2570 | 36771 |
| 22-#11 | 1.99 | MA | 39146 | 8825 | 61698 | 6636 | 66601 | 5396 | 67484 | 4470 | 66113 | 3103 | 79003 | 2355 | 47423 |
| 10L-3S | | MI | 32115 | 8825 | 51517 | 6478 | 56179 | 5266 | 57994 | 4345 | 59334 | 2983 | 70464 | 2657 | 36766 |
| 22-#11 | 1.99 | MA | 38555 | 8825 | 60789 | 6634 | 65379 | 5394 | 65940 | 4466 | 63959 | 3097 | 76426 | 2302 | 46669 |
| 11L-2S | | MI | 32807 | 8825 | 52549 | 6481 | 57501 | 5254 | 59607 | 4334 | 61511 | 2975 | 73355 | 2743 | 36745 |
| 22-#14 | 2.86 | MA | 44218 | 9349 | 71893 | 6924 | 79650 | 5582 | 83353 | 4577 | 87640 | 3019 | 107642 | 2473 | 70879 |
| 5L-8S | | MI | 30953 | 9349 | 50748 | 6800 | 54975 | 5496 | 56512 | 4497 | 57211 | 2927 | 68855 | 2019 | 49316 |
| 22-#14 | 2.86 | MA | 43412 | 9349 | 70540 | 6921 | 77774 | 5602 | 81060 | 4570 | 84618 | 3034 | 103793 | 2393 | 69650 |
| 6L-7S | | MI | 31519 | 9349 | 51716 | 6806 | 56292 | 5504 | 58070 | 4482 | 59442 | 2939 | 71483 | 2085 | 50325 |
| 22-#14 | 2.86 | MA | 42628 | 9349 | 69057 | 6943 | 75985 | 5597 | 78860 | 4589 | 81666 | 3049 | 99691 | 2263 | 68879 |
| 7L-6S | | MI | 32095 | 9349 | 52792 | 6786 | 57590 | 5487 | 59666 | 4468 | 61540 | 2927 | 74307 | 2215 | 50758 |
| 22-#14 | 2.86 | MA | 41855 | 9349 | 67725 | 6940 | 74171 | 5618 | 76713 | 4607 | 78529 | 3039 | 95919 | 2191 | 67454 |
| 8L-5S | | MI | 32685 | 9349 | 53775 | 6792 | 58950 | 5495 | 61327 | 4478 | 63687 | 2914 | 76948 | 2297 | 51475 |
| 22-#14 | 2.86 | MA | 41034 | 9349 | 66422 | 6937 | 72406 | 5613 | 74468 | 4601 | 75605 | 3054 | 92188 | 2114 | 66275 |
| 9L-4S | | MI | 33304 | 9349 | 54822 | 6798 | 60307 | 5478 | 62994 | 4464 | 66057 | 2927 | 79761 | 2353 | 51997 |
| 22-#14 | 2.86 | MA | 40179 | 9349 | 64963 | 6959 | 70616 | 5633 | 72332 | 4619 | 72705 | 3069 | 88571 | 2026 | 64582 |
| 10L-3S | | MI | 33995 | 9349 | 56029 | 6779 | 61846 | 5487 | 64864 | 4474 | 68421 | 2914 | 82414 | 2477 | 52079 |
| 22-#18 | 5.09 | MA | 46836 | 10681 | 80238 | 7758 | 90049 | 6221 | 95904 | 4949 | 104915 | 2948 | 131486 | 1587 | 113697 |
| 7L-6S | | MI | 35268 | 10681 | 61499 | 7563 | 68447 | 6047 | 72952 | 4835 | 78829 | 2746 | 97614 | 1522 | 84012 |
| 22-#18 | 5.09 | MA | 45527 | 10681 | 77892 | 7751 | 86854 | 6210 | 92124 | 4979 | 99394 | 2928 | 124923 | 1463 | 109896 |
| 8L-5S | | MI | 36271 | 10681 | 63223 | 7575 | 70830 | 6065 | 75733 | 4812 | 82534 | 2724 | 102140 | 1668 | 86124 |
| 24-#11 | 2.17 | MA | 42694 | 8932 | 67961 | 6677 | 74736 | 5407 | 77407 | 4467 | 79575 | 3057 | 96564 | 2651 | 54620 |
| 5L-9S | | MI | 30042 | 8932 | 48135 | 6575 | 51810 | 5336 | 52639 | 4386 | 52162 | 2991 | 61987 | 2262 | 38581 |
| 24-#11 | 2.17 | MA | 42125 | 8932 | 67019 | 6675 | 73429 | 5422 | 75810 | 4464 | 77469 | 3068 | 93862 | 2595 | 54189 |
| 6L-8S | | MI | 30439 | 8932 | 48862 | 6561 | 52704 | 5324 | 53776 | 4392 | 53625 | 2982 | 63795 | 2316 | 39055 |
| 24-#11 | 2.17 | MA | 41571 | 8932 | 65985 | 6691 | 72183 | 5419 | 74277 | 4477 | 75413 | 3079 | 90982 | 2505 | 53596 |
| 7E | | MI | 30839 | 8932 | 49537 | 6565 | 53623 | 5329 | 54863 | 4382 | 55194 | 2991 | 65645 | 2363 | 39280 |
| 24-#11 | 2.17 | MA | 41026 | 8932 | 65058 | 6689 | 70919 | 5433 | 72781 | 4490 | 73226 | 3073 | 88339 | 2455 | 53181 |
| 8L-6S | | MI | 31245 | 8932 | 50288 | 6551 | 54529 | 5317 | 55977 | 4371 | 56670 | 2982 | 67637 | 2453 | 39619 |
| 24-#11 | 2.17 | MA | 40440 | 8932 | 64150 | 6688 | 69689 | 5430 | 71217 | 4486 | 71189 | 3084 | 85719 | 2401 | 52480 |
| 9L-5S | | MI | 31662 | 8932 | 50974 | 6555 | 55478 | 5322 | 57137 | 4378 | 58180 | 2973 | 69502 | 2509 | 39946 |
| 24-#11 | 2.17 | MA | 39836 | 8932 | 63134 | 6703 | 68442 | 5445 | 69730 | 4499 | 69169 | 3095 | 83179 | 2340 | 51773 |
| 10L-4S | | MI | 32099 | 8932 | 51705 | 6559 | 56426 | 5310 | 58301 | 4367 | 59847 | 2982 | 71481 | 2549 | 39983 |
| 24-#11 | 2.17 | MA | 39247 | 8932 | 62225 | 6701 | 67220 | 5442 | 68185 | 4495 | 67014 | 3089 | 80601 | 2287 | 50980 |
| 11L-3S | | MI | 32587 | 8932 | 52549 | 6545 | 57501 | 5315 | 59607 | 4374 | 61511 | 2973 | 73355 | 2635 | 39994 |
| 24-#11 | 2.17 | MA | 38668 | 8932 | 61227 | 6717 | 65981 | 5456 | 66700 | 4509 | 64995 | 3099 | 77693 | 2211 | 50077 |
| 12L-2S | | MI | 33277 | 8932 | 53580 | 6549 | 58823 | 5303 | 61220 | 4364 | 63687 | 2965 | 76247 | 2721 | 39979 |
| 24-#14 | 3.13 | MA | 44370 | 9505 | 72597 | 7018 | 80412 | 5672 | 84277 | 4613 | 88996 | 3021 | 109742 | 2370 | 75901 |
| 6L-8S | | MI | 31627 | 9505 | 52222 | 6897 | 56865 | 5565 | 58817 | 4539 | 60305 | 2911 | 72954 | 1986 | 53723 |
| 24-#14 | 3.13 | MA | 43589 | 9505 | 71114 | 7040 | 78623 | 5667 | 82078 | 4631 | 86044 | 3036 | 105639 | 2240 | 75149 |
| 7E | | MI | 32191 | 9505 | 53190 | 6903 | 58182 | 5574 | 60375 | 4525 | 62536 | 2924 | 75582 | 2052 | 54708 |
| 24-#14 | 3.13 | MA | 42821 | 9505 | 69782 | 7037 | 76808 | 5687 | 79931 | 4650 | 82907 | 3026 | 101868 | 2169 | 73647 |
| 8L-6S | | MI | 32764 | 9505 | 54266 | 6884 | 59480 | 5557 | 61971 | 4510 | 64634 | 2911 | 78406 | 2182 | 55225 |
| 24-#14 | 3.13 | MA | 42005 | 9505 | 68479 | 7034 | 75043 | 5683 | 77685 | 4643 | 79982 | 3041 | 98136 | 2091 | 72497 |
| 9L-5S | | MI | 33352 | 9505 | 55248 | 6890 | 60839 | 5565 | 63632 | 4521 | 66780 | 2899 | 81048 | 2264 | 55911 |
| 24-#14 | 3.13 | MA | 41153 | 9505 | 67020 | 7056 | 73253 | 5703 | 75550 | 4662 | 77083 | 3057 | 94520 | 2004 | 70749 |
| 10L-4S | | MI | 33969 | 9505 | 56295 | 6895 | 62196 | 5548 | 65299 | 4506 | 69151 | 2911 | 83860 | 2319 | 56556 |
| 24-#18 | 5.56 | MA | 47170 | 10957 | 81501 | 7924 | 91481 | 6335 | 97767 | 5055 | 107072 | 2905 | 135242 | 1417 | 120626 |
| 8L-6S | | MI | 36399 | 10957 | 64071 | 7736 | 71743 | 6172 | 76974 | 4910 | 84168 | 2715 | 104650 | 1456 | 91592 |

## RECTANGULAR TIED COLUMNS 38" x 38"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.66 | MA | 28082 | 7212 | 44717 | 5278 | 48437 | 4288 | 49722 | 3552 | 50207 | 2470 | 59190 | 2284 | 27046 |
| 2L-3S | | MI | 26236 | 7212 | 41973 | 5266 | 44919 | 4316 | 45431 | 3576 | 44472 | 2492 | 51609 | 2063 | 27133 |
| 8-#14 | 1.25 | MA | 27223 | 7005 | 42624 | 5186 | 45948 | 4226 | 46758 | 3522 | 46409 | 2520 | 54282 | 2367 | 20689 |
| 2L-4S | | MI | 25402 | 7005 | 39768 | 5201 | 42296 | 4236 | 42311 | 3528 | 40558 | 2545 | 47019 | 2118 | 20803 |
| 8-#18 | 2.22 | MA | 29326 | 7489 | 47462 | 5450 | 51955 | 4412 | 54014 | 3627 | 55941 | 2441 | 66772 | 2222 | 35676 |
| 2L-4S | | MI | 26195 | 7489 | 42466 | 5472 | 45568 | 4425 | 46236 | 3631 | 45824 | 2485 | 54290 | 1779 | 35397 |
| 10-#11 | 1.08 | MA | 26870 | 6922 | 41759 | 5154 | 44937 | 4205 | 45563 | 3513 | 44868 | 2542 | 52285 | 2401 | 18098 |
| 2L-5S | | MI | 25119 | 6922 | 38986 | 5161 | 41378 | 4225 | 41217 | 3529 | 38970 | 2550 | 45044 | 2188 | 18221 |
| 10-#11 | 1.08 | MA | 26121 | 6922 | 40660 | 5151 | 43529 | 4217 | 43845 | 3524 | 42537 | 2550 | 49180 | 2314 | 18146 |
| 3L-4S | | MI | 25592 | 6922 | 39763 | 5165 | 42385 | 4213 | 42455 | 3518 | 40755 | 2559 | 47164 | 2228 | 18193 |
| 10-#14 | 1.56 | MA | 27951 | 7161 | 44195 | 5284 | 47962 | 4296 | 49215 | 3564 | 49725 | 2506 | 58688 | 2336 | 25644 |
| 2L-5S | | MI | 25467 | 7161 | 40226 | 5293 | 42867 | 4323 | 42995 | 3585 | 41334 | 2518 | 48410 | 2030 | 25607 |
| 10-#14 | 1.56 | MA | 26890 | 7161 | 42624 | 5278 | 45948 | 4313 | 46758 | 3580 | 46409 | 2518 | 54282 | 2212 | 25694 |
| 3L-4S | | MI | 26140 | 7161 | 41339 | 5298 | 44310 | 4306 | 44768 | 3570 | 43874 | 2531 | 51425 | 2087 | 25701 |
| 10-#18 | 2.77 | MA | 30558 | 7766 | 50206 | 5623 | 55473 | 4536 | 58305 | 3702 | 61676 | 2412 | 74353 | 2159 | 44275 |
| 2L-5S | | MI | 26298 | 7766 | 43256 | 5634 | 46554 | 4578 | 47418 | 3731 | 47164 | 2434 | 56659 | 1619 | 41163 |
| 10-#18 | 2.77 | MA | 28741 | 7766 | 47462 | 5612 | 51955 | 4564 | 54014 | 3727 | 55941 | 2434 | 66772 | 1938 | 44185 |
| 3L-4S | | MI | 27452 | 7766 | 45210 | 5645 | 49086 | 4549 | 50528 | 3707 | 51559 | 2456 | 61872 | 1716 | 43628 |

## RECTANGULAR TIED COLUMNS 38" x 40"

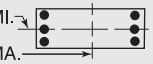
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.05 | MA | 29624 | 7272 | 46173 | 5378 | 49461 | 4388 | 50004 | 3667 | 48916 | 2649 | 56768 | 2496 | 19442 |
| 2E | | MI | 28101 | 7272 | 43893 | 5355 | 46913 | 4369 | 47370 | 3651 | 46209 | 2633 | 53527 | 2476 | 18409 |
| 6-#18 | 1.58 | MA | 30972 | 7548 | 49090 | 5550 | 53200 | 4512 | 54566 | 3742 | 55046 | 2622 | 64895 | 2438 | 28666 |
| 2L-3S | | MI | 27514 | 7548 | 43893 | 5517 | 46913 | 4522 | 47370 | 3751 | 46209 | 2626 | 53527 | 2193 | 27202 |
| 6-#18 | 1.58 | MA | 29005 | 7548 | 46173 | 5540 | 49461 | 4542 | 50004 | 3768 | 48916 | 2644 | 56768 | 2216 | 28753 |
| 3L-2S | | MI | 29362 | 7548 | 46638 | 5528 | 50431 | 4494 | 51662 | 3727 | 51944 | 2604 | 61109 | 2414 | 27103 |
| 8-#14 | 1.18 | MA | 30047 | 7341 | 46855 | 5459 | 50543 | 4451 | 51402 | 3713 | 50959 | 2671 | 59590 | 2517 | 21904 |
| 2L-4S | | MI | 26679 | 7341 | 41681 | 5453 | 44290 | 4444 | 44255 | 3704 | 42302 | 2681 | 48948 | 2249 | 20859 |
| 8-#14 | 1.18 | MA | 28913 | 7341 | 45187 | 5455 | 48404 | 4469 | 48792 | 3729 | 47419 | 2683 | 54875 | 2392 | 21972 |
| 3E | | MI | 27435 | 7341 | 42966 | 5434 | 45928 | 4451 | 46245 | 3714 | 44837 | 2668 | 51804 | 2374 | 20803 |
| 8-#14 | 1.18 | MA | 28112 | 7341 | 43825 | 5475 | 46668 | 4462 | 46682 | 3720 | 44714 | 2696 | 51814 | 2268 | 22018 |
| 4L-2S | | MI | 28502 | 7341 | 44537 | 5439 | 47942 | 4434 | 48702 | 3698 | 48153 | 2656 | 56211 | 2498 | 20732 |
| 8-#18 | 2.11 | MA | 32304 | 7825 | 52007 | 5723 | 56940 | 4636 | 59128 | 3818 | 61177 | 2596 | 73023 | 2380 | 37836 |
| 2L-4S | | MI | 27472 | 7825 | 44386 | 5723 | 47562 | 4631 | 48175 | 3806 | 47561 | 2620 | 56209 | 1909 | 35535 |
| 8-#18 | 2.11 | MA | 30353 | 7825 | 49090 | 5713 | 53200 | 4666 | 54566 | 3844 | 55046 | 2618 | 64895 | 2158 | 37837 |
| 3E | | MI | 28775 | 7825 | 46638 | 5690 | 50431 | 4646 | 51662 | 3826 | 51944 | 2598 | 61109 | 2130 | 35764 |
| 8-#18 | 2.11 | MA | 28972 | 7825 | 46700 | 5747 | 50156 | 4652 | 50866 | 3825 | 50361 | 2640 | 59633 | 1937 | 37557 |
| 4L-2S | | MI | 30609 | 7825 | 49382 | 5701 | 53948 | 4618 | 55953 | 3802 | 57678 | 2575 | 68690 | 2352 | 35740 |
| 10-#11 | 1.03 | MA | 29668 | 7258 | 45932 | 5427 | 49465 | 4429 | 50126 | 3704 | 49281 | 2690 | 57435 | 2549 | 19151 |
| 2L-5S | | MI | 26395 | 7258 | 40894 | 5415 | 43372 | 4434 | 43163 | 3706 | 40718 | 2686 | 46979 | 2319 | 18273 |
| 10-#11 | 1.03 | MA | 28871 | 7258 | 44766 | 5424 | 47970 | 4442 | 48303 | 3715 | 46800 | 2699 | 54116 | 2463 | 19199 |
| 3L-4S | | MI | 26869 | 7258 | 41671 | 5418 | 44379 | 4421 | 44401 | 3695 | 42503 | 2695 | 49099 | 2360 | 18236 |
| 10-#11 | 1.03 | MA | 28310 | 7258 | 43815 | 5438 | 46758 | 4438 | 46829 | 3710 | 44904 | 2708 | 51959 | 2376 | 19246 |
| 4L-3S | | MI | 27399 | 7258 | 42569 | 5404 | 45523 | 4426 | 45790 | 3701 | 44285 | 2686 | 51115 | 2446 | 18185 |
| 10-#11 | 1.03 | MA | 27809 | 7258 | 42992 | 5435 | 45691 | 4451 | 45518 | 3721 | 43005 | 2700 | 49698 | 2336 | 19274 |
| 5L-2S | | MI | 28148 | 7258 | 43668 | 5407 | 46932 | 4413 | 47509 | 3690 | 46616 | 2678 | 54220 | 2532 | 18136 |
| 10-#14 | 1.48 | MA | 30825 | 7496 | 48524 | 5557 | 52681 | 4520 | 54011 | 3755 | 54498 | 2658 | 64304 | 2488 | 27163 |
| 2L-5S | | MI | 26744 | 7496 | 42139 | 5545 | 44861 | 4531 | 44939 | 3762 | 43078 | 2654 | 50339 | 2161 | 25700 |
| 10-#14 | 1.48 | MA | 29696 | 7496 | 46855 | 5552 | 50543 | 4539 | 51402 | 3771 | 50959 | 2670 | 59590 | 2364 | 27212 |
| 3L-4S | | MI | 27417 | 7496 | 43252 | 5551 | 46304 | 4514 | 46712 | 3746 | 45618 | 2666 | 53354 | 2218 | 25770 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

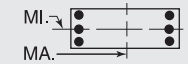
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 1.48 | MA | 28900 | 7496 | 45493 | 5572 | 48806 | 4532 | 49291 | 3762 | 48253 | 2683 | 56529 | 2239 | 27220 |
| 4L-3S | | MI | 28169 | 7496 | 44537 | 5531 | 47942 | 4521 | 48702 | 3756 | 48153 | 2654 | 56211 | 2343 | 25746 |
| 10-#14 | 1.48 | MA | 28187 | 7496 | 44313 | 5568 | 47277 | 4550 | 47412 | 3778 | 45543 | 2670 | 53310 | 2181 | 27125 |
| 5L-2S | | MI | 29231 | 7496 | 46108 | 5536 | 49956 | 4504 | 51159 | 3741 | 51470 | 2642 | 60618 | 2467 | 25692 |
| 10-#18 | 2.63 | MA | 33623 | 8102 | 54924 | 5896 | 60679 | 4760 | 63690 | 3893 | 67307 | 2569 | 81150 | 2321 | 46975 |
| 2L-5S | | MI | 27574 | 8102 | 45177 | 5884 | 48548 | 4784 | 49357 | 3906 | 48901 | 2569 | 58578 | 1749 | 41506 |
| 10-#18 | 2.63 | MA | 31687 | 8102 | 52007 | 5886 | 56940 | 4790 | 59128 | 3919 | 61177 | 2591 | 73023 | 2100 | 46885 |
| 3L-4S | | MI | 28731 | 8102 | 47130 | 5896 | 51079 | 4755 | 52467 | 3882 | 53296 | 2591 | 63790 | 1847 | 43960 |
| 10-#18 | 2.63 | MA | 30318 | 8102 | 49617 | 5920 | 53895 | 4776 | 55428 | 3901 | 56491 | 2613 | 67761 | 1879 | 46509 |
| 4L-3S | | MI | 30023 | 8102 | 49382 | 5863 | 53948 | 4771 | 55953 | 3902 | 57678 | 2569 | 68690 | 2068 | 44283 |
| 10-#18 | 2.63 | MA | 29092 | 8102 | 47546 | 5910 | 51210 | 4806 | 52130 | 3926 | 51794 | 2591 | 62188 | 1779 | 43878 |
| 5L-2S | | MI | 31843 | 8102 | 52126 | 5874 | 57466 | 4742 | 60245 | 3877 | 63413 | 2547 | 76271 | 2289 | 44342 |
| 12-#11 | 1.23 | MA | 30217 | 7366 | 47099 | 5494 | 50960 | 4478 | 51950 | 3733 | 51763 | 2682 | 60754 | 2530 | 22832 |
| 2L-6S | | MI | 26467 | 7366 | 41265 | 5479 | 43772 | 4477 | 43649 | 3729 | 41432 | 2686 | 48080 | 2243 | 21678 |
| 12-#11 | 1.23 | MA | 29424 | 7366 | 45932 | 5491 | 49465 | 4491 | 50126 | 3745 | 49281 | 2690 | 57435 | 2444 | 22873 |
| 3L-5S | | MI | 26917 | 7366 | 41993 | 5482 | 44781 | 4482 | 44881 | 3736 | 43049 | 2677 | 50084 | 2299 | 21710 |
| 12-#11 | 1.23 | MA | 28865 | 7366 | 44981 | 5506 | 48253 | 4486 | 48653 | 3739 | 47385 | 2699 | 55277 | 2358 | 22907 |
| 4E | | MI | 27389 | 7366 | 42770 | 5486 | 45788 | 4470 | 46119 | 3724 | 44834 | 2686 | 52204 | 2340 | 21691 |
| 12-#11 | 1.23 | MA | 28365 | 7366 | 44158 | 5503 | 47186 | 4499 | 47342 | 3751 | 45487 | 2691 | 53016 | 2317 | 22913 |
| 5L-3S | | MI | 27917 | 7366 | 43668 | 5472 | 46932 | 4474 | 47509 | 3731 | 46616 | 2677 | 54220 | 2426 | 21652 |
| 12-#11 | 1.23 | MA | 27889 | 7366 | 43387 | 5500 | 46117 | 4495 | 46036 | 3745 | 43766 | 2700 | 50873 | 2261 | 22864 |
| 6L-2S | | MI | 28663 | 7366 | 44766 | 5475 | 48340 | 4462 | 49227 | 3719 | 48947 | 2669 | 57325 | 2512 | 21609 |
| 12-#14 | 1.78 | MA | 31598 | 7652 | 50192 | 5654 | 54820 | 4590 | 56620 | 3798 | 58038 | 2645 | 69019 | 2459 | 32405 |
| 2L-6S | | MI | 26842 | 7652 | 42665 | 5637 | 45429 | 4594 | 45629 | 3794 | 44093 | 2652 | 51904 | 2049 | 29638 |
| 12-#14 | 1.78 | MA | 30475 | 7652 | 48524 | 5649 | 52681 | 4608 | 54011 | 3814 | 54498 | 2657 | 64304 | 2335 | 32440 |
| 3L-5S | | MI | 27480 | 7652 | 43710 | 5643 | 46875 | 4601 | 47396 | 3804 | 46395 | 2640 | 54746 | 2130 | 30552 |
| 12-#14 | 1.78 | MA | 29682 | 7652 | 47161 | 5669 | 50945 | 4602 | 51900 | 3805 | 51793 | 2670 | 61244 | 2210 | 32405 |
| 4E | | MI | 28150 | 7652 | 44823 | 5648 | 48318 | 4584 | 49169 | 3789 | 48935 | 2652 | 57761 | 2187 | 30658 |
| 12-#14 | 1.78 | MA | 28974 | 7652 | 45982 | 5665 | 49416 | 4620 | 50021 | 3821 | 49083 | 2657 | 58025 | 2152 | 32273 |
| 5L-3S | | MI | 28898 | 7652 | 46108 | 5628 | 49956 | 4591 | 51159 | 3798 | 51470 | 2640 | 60618 | 2312 | 30672 |
| 12-#14 | 1.78 | MA | 28298 | 7652 | 44875 | 5660 | 47884 | 4613 | 48149 | 3812 | 46626 | 2670 | 54982 | 2071 | 31281 |
| 6L-2S | | MI | 29955 | 7652 | 47679 | 5633 | 51970 | 4573 | 53616 | 3783 | 54786 | 2628 | 65024 | 2436 | 30634 |
| 12-#18 | 3.16 | MA | 34928 | 8378 | 57841 | 6069 | 64419 | 4885 | 68252 | 3969 | 73437 | 2542 | 89278 | 2263 | 56066 |
| 2L-6S | | MI | 27736 | 8378 | 46087 | 6046 | 49529 | 4892 | 50550 | 3962 | 50656 | 2562 | 61277 | 1541 | 47803 |
| 12-#18 | 3.16 | MA | 33007 | 8378 | 54924 | 6059 | 60679 | 4914 | 63690 | 3994 | 67307 | 2565 | 81150 | 2042 | 55910 |
| 3L-5S | | MI | 28829 | 8378 | 47921 | 6057 | 52066 | 4908 | 53649 | 3981 | 54636 | 2540 | 66159 | 1687 | 49672 |
| 12-#18 | 3.16 | MA | 31649 | 8378 | 52534 | 6093 | 57635 | 4900 | 59990 | 3976 | 62622 | 2587 | 75888 | 1820 | 55170 |
| 4E | | MI | 29977 | 8378 | 49874 | 6069 | 54597 | 4879 | 56759 | 3957 | 59030 | 2562 | 71371 | 1784 | 52046 |
| 12-#18 | 3.16 | MA | 30434 | 8378 | 50463 | 6083 | 54950 | 4930 | 56692 | 4002 | 57925 | 2565 | 70315 | 1721 | 52571 |
| 5L-3S | | MI | 31259 | 8378 | 52126 | 6035 | 57466 | 4895 | 60245 | 3977 | 63413 | 2540 | 76271 | 2006 | 52777 |
| 12-#18 | 3.16 | MA | 29277 | 8378 | 48519 | 6073 | 52260 | 4916 | 53405 | 3984 | 53671 | 2587 | 65077 | 1576 | 50572 |
| 6L-2S | | MI | 33066 | 8378 | 54870 | 6047 | 60984 | 4866 | 64536 | 3953 | 69147 | 2518 | 83853 | 2227 | 52909 |
| 14-#11 | 1.44 | MA | 30763 | 7474 | 48265 | 5562 | 52455 | 4526 | 53774 | 3762 | 54244 | 2673 | 64072 | 2512 | 26503 |
| 2L-7S | | MI | 26551 | 7474 | 41565 | 5561 | 44218 | 4538 | 44183 | 3770 | 42182 | 2685 | 49045 | 2133 | 24562 |
| 14-#11 | 1.44 | MA | 29973 | 7474 | 47099 | 5559 | 50960 | 4539 | 51950 | 3774 | 51763 | 2682 | 60754 | 2425 | 26536 |
| 3L-6S | | MI | 26988 | 7474 | 42363 | 5547 | 45181 | 4526 | 45367 | 3759 | 43763 | 2677 | 51185 | 2223 | 25011 |
| 14-#11 | 1.44 | MA | 29416 | 7474 | 46147 | 5573 | 49748 | 4535 | 50477 | 3768 | 49867 | 2691 | 58596 | 2339 | 26558 |
| 4L-5S | | MI | 27436 | 7474 | 43092 | 5550 | 46189 | 4531 | 46600 | 3765 | 45381 | 2668 | 53189 | 2279 | 25132 |
| 14-#11 | 1.44 | MA | 28919 | 7474 | 45325 | 5570 | 48681 | 4548 | 49166 | 3780 | 47968 | 2682 | 56335 | 2298 | 26541 |
| 5L-4S | | MI | 27906 | 7474 | 43869 | 5553 | 47197 | 4518 | 47837 | 3754 | 47166 | 2677 | 55309 | 2320 | 25135 |
| 14-#11 | 1.44 | MA | 28445 | 7474 | 44553 | 5567 | 47612 | 4544 | 47860 | 3774 | 46247 | 2691 | 54192 | 2242 | 26397 |
| 6L-3S | | MI | 28432 | 7474 | 44766 | 5539 | 48340 | 4523 | 49227 | 3760 | 48947 | 2668 | 57325 | 2406 | 25108 |
| 14-#11 | 1.44 | MA | 27983 | 7474 | 43708 | 5582 | 46593 | 4557 | 46607 | 3786 | 44566 | 2700 | 51904 | 2152 | 25905 |
| 7L-2S | | MI | 29176 | 7474 | 45865 | 5542 | 49749 | 4510 | 50946 | 3749 | 51279 | 2660 | 60430 | 2492 | 25072 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 2.07 | MA | 32365 | 7808 | 51860 | 5751 | 56959 | 4660 | 59229 | 3840 | 61577 | 2632 | 73734 | 2430 | 37635 |
| 2L-7S | | MI | 26959 | 7808 | 43092 | 5754 | 46063 | 4681 | 46390 | 3852 | 45161 | 2651 | 53273 | 1888 | 33808 |
| 14-#14 | 2.07 | MA | 31247 | 7808 | 50192 | 5746 | 54820 | 4678 | 56620 | 3856 | 58038 | 2644 | 69019 | 2306 | 37642 |
| 3L-6S | | MI | 27578 | 7808 | 44236 | 5735 | 47443 | 4663 | 48086 | 3837 | 47410 | 2638 | 56310 | 2018 | 34364 |
| 14-#14 | 2.07 | MA | 30459 | 7808 | 48829 | 5767 | 53084 | 4672 | 54509 | 3847 | 55332 | 2657 | 65958 | 2181 | 37579 |
| 4L-5S | | MI | 28212 | 7808 | 45281 | 5740 | 48889 | 4671 | 49853 | 3847 | 49711 | 2626 | 59152 | 2099 | 35271 |
| 14-#14 | 2.07 | MA | 29755 | 7808 | 47650 | 5762 | 51554 | 4690 | 52630 | 3863 | 52622 | 2644 | 62739 | 2123 | 37297 |
| 5L-4S | | MI | 28878 | 7808 | 46394 | 5745 | 50332 | 4653 | 51626 | 3831 | 52251 | 2638 | 62168 | 2156 | 35535 |
| 14-#14 | 2.07 | MA | 29083 | 7808 | 46544 | 5757 | 50023 | 4683 | 50759 | 3854 | 50166 | 2657 | 59697 | 2042 | 36303 |
| 6L-3S | | MI | 29622 | 7808 | 47679 | 5725 | 51970 | 4661 | 53616 | 3841 | 54786 | 2626 | 65024 | 2281 | 35583 |
| 14-#14 | 2.07 | MA | 28429 | 7808 | 45332 | 5778 | 48561 | 4701 | 48961 | 3870 | 47765 | 2669 | 56447 | 1912 | 35687 |
| 7L-2S | | MI | 30674 | 7808 | 49250 | 5731 | 53984 | 4643 | 56073 | 3826 | 58103 | 2613 | 69431 | 2405 | 35564 |
| 14-#18 | 3.68 | MA | 34315 | 8655 | 57841 | 6232 | 64419 | 5039 | 68252 | 4070 | 73437 | 2538 | 89278 | 1983 | 64919 |
| 3L-6S | | MI | 28989 | 8655 | 48831 | 6219 | 53047 | 5016 | 54842 | 4037 | 56391 | 2534 | 68858 | 1479 | 55800 |
| 14-#18 | 3.68 | MA | 32968 | 8655 | 55451 | 6266 | 61374 | 5024 | 64552 | 4051 | 68752 | 2560 | 84016 | 1762 | 63741 |
| 4L-5S | | MI | 30073 | 8655 | 50665 | 6230 | 55584 | 5032 | 57941 | 4057 | 60370 | 2511 | 73740 | 1624 | 57866 |
| 14-#18 | 3.68 | MA | 31763 | 8655 | 53380 | 6256 | 58690 | 5054 | 61254 | 4077 | 64055 | 2538 | 78443 | 1662 | 61291 |
| 5L-4S | | MI | 31212 | 8655 | 52618 | 6241 | 58115 | 5003 | 61050 | 4033 | 64765 | 2534 | 78953 | 1722 | 60096 |
| 14-#18 | 3.68 | MA | 30616 | 8655 | 51436 | 6246 | 56000 | 5040 | 57968 | 4059 | 59801 | 2560 | 73205 | 1517 | 59096 |
| 6L-3S | | MI | 32483 | 8655 | 54870 | 6208 | 60984 | 5019 | 64536 | 4053 | 69147 | 2511 | 83853 | 1943 | 61255 |
| 16-#11 | 1.64 | MA | 31307 | 7582 | 49431 | 5629 | 53950 | 4574 | 55598 | 3792 | 56726 | 2664 | 67391 | 2493 | 30167 |
| 2L-8S | | MI | 26642 | 7582 | 41946 | 5625 | 44650 | 4582 | 44746 | 3810 | 42833 | 2668 | 50168 | 2066 | 27605 |
| 16-#11 | 1.64 | MA | 30519 | 7582 | 48265 | 5626 | 52455 | 4588 | 53774 | 3803 | 54244 | 2673 | 64072 | 2407 | 30192 |
| 3L-7S | | MI | 27071 | 7582 | 42664 | 5628 | 45626 | 4587 | 45902 | 3799 | 44513 | 2676 | 52150 | 2113 | 27894 |
| 16-#11 | 1.64 | MA | 29965 | 7582 | 47314 | 5641 | 51243 | 4583 | 52301 | 3798 | 52348 | 2682 | 61915 | 2320 | 30197 |
| 4L-6S | | MI | 27506 | 7582 | 43462 | 5614 | 46589 | 4574 | 47085 | 3788 | 46094 | 2668 | 54290 | 2203 | 28320 |
| 16-#11 | 1.64 | MA | 29469 | 7582 | 46491 | 5638 | 50176 | 4596 | 50990 | 3809 | 50450 | 2674 | 59654 | 2279 | 30162 |
| 5E | | MI | 27952 | 7582 | 44191 | 5617 | 47598 | 4579 | 48318 | 3794 | 47712 | 2659 | 56294 | 2259 | 28548 |
| 16-#11 | 1.64 | MA | 28997 | 7582 | 45719 | 5635 | 49107 | 4592 | 49684 | 3804 | 48729 | 2683 | 57510 | 2223 | 29910 |
| 6L-4S | | MI | 28421 | 7582 | 44968 | 5620 | 48605 | 4566 | 49556 | 3783 | 49497 | 2668 | 58414 | 2299 | 28573 |
| 16-#11 | 1.64 | MA | 28537 | 7582 | 44874 | 5649 | 48088 | 4605 | 48431 | 3815 | 47047 | 2691 | 55222 | 2133 | 29441 |
| 7L-3S | | MI | 28944 | 7582 | 45865 | 5606 | 49749 | 4571 | 50946 | 3789 | 51279 | 2659 | 60430 | 2386 | 28556 |
| 16-#11 | 1.64 | MA | 28084 | 7582 | 44114 | 5646 | 47054 | 4601 | 47207 | 3827 | 45260 | 2683 | 53109 | 2085 | 29119 |
| 8L-2S | | MI | 29686 | 7582 | 46964 | 5610 | 51158 | 4559 | 52664 | 3778 | 53610 | 2651 | 63535 | 2472 | 28528 |
| 16-#14 | 2.37 | MA | 33128 | 7963 | 53529 | 5848 | 59097 | 4730 | 61838 | 3882 | 65117 | 2619 | 78448 | 2401 | 42860 |
| 2L-8S | | MI | 27087 | 7963 | 43634 | 5846 | 46678 | 4743 | 47191 | 3910 | 46086 | 2624 | 54862 | 1790 | 37416 |
| 16-#14 | 2.37 | MA | 32015 | 7963 | 51860 | 5844 | 56959 | 4748 | 59229 | 3898 | 61577 | 2631 | 73734 | 2277 | 42834 |
| 3L-7S | | MI | 27693 | 7963 | 44663 | 5852 | 48077 | 4751 | 48847 | 3895 | 48477 | 2637 | 57680 | 1857 | 38565 |
| 16-#14 | 2.37 | MA | 31231 | 7963 | 50498 | 5864 | 55222 | 4741 | 57118 | 3890 | 58872 | 2644 | 70673 | 2152 | 42744 |
| 4L-6S | | MI | 28308 | 7963 | 45807 | 5832 | 49457 | 4733 | 50543 | 3879 | 50726 | 2624 | 60717 | 1987 | 39100 |
| 16-#14 | 2.37 | MA | 30530 | 7963 | 49318 | 5859 | 53693 | 4759 | 55239 | 3906 | 56162 | 2631 | 67454 | 2094 | 42279 |
| 5E | | MI | 28939 | 7963 | 46852 | 5837 | 50903 | 4741 | 52310 | 3889 | 53028 | 2612 | 63559 | 2068 | 39959 |
| 16-#14 | 2.37 | MA | 29863 | 7963 | 48212 | 5855 | 52161 | 4753 | 53368 | 3897 | 53705 | 2644 | 64411 | 2013 | 41335 |
| 6L-4S | | MI | 29602 | 7963 | 47965 | 5842 | 52346 | 4723 | 54083 | 3874 | 55568 | 2624 | 66574 | 2125 | 40402 |
| 16-#14 | 2.37 | MA | 29212 | 7963 | 47000 | 5875 | 50700 | 4771 | 51570 | 3913 | 51305 | 2656 | 61161 | 1883 | 40742 |
| 7L-3S | | MI | 30342 | 7963 | 49250 | 5823 | 53984 | 4731 | 56073 | 3883 | 58103 | 2612 | 69431 | 2250 | 40476 |
| 16-#14 | 2.37 | MA | 28572 | 7963 | 45911 | 5870 | 49217 | 4764 | 49816 | 3929 | 48754 | 2644 | 58153 | 1815 | 39507 |
| 8L-2S | | MI | 31389 | 7963 | 50821 | 5828 | 55998 | 4713 | 58530 | 3868 | 61419 | 2599 | 73838 | 2374 | 40485 |
| 16-#18 | 4.21 | MA | 34275 | 8932 | 58368 | 6439 | 65114 | 5149 | 69114 | 4127 | 74883 | 2533 | 92144 | 1704 | 72350 |
| 4L-6S | | MI | 30230 | 8932 | 51575 | 6392 | 56565 | 5140 | 59133 | 4112 | 62126 | 2505 | 76440 | 1417 | 63828 |
| 16-#18 | 4.21 | MA | 33080 | 8932 | 56297 | 6429 | 62429 | 5179 | 65816 | 4153 | 70186 | 2511 | 86570 | 1604 | 70034 |
| 5E | | MI | 31306 | 8932 | 53409 | 6403 | 59102 | 5156 | 62232 | 4132 | 66105 | 2483 | 81322 | 1562 | 66082 |
| 16-#18 | 4.21 | MA | 31942 | 8932 | 54353 | 6419 | 59739 | 5164 | 62530 | 4134 | 65932 | 2533 | 81332 | 1459 | 67651 |
| 6L-4S | | MI | 32436 | 8932 | 55363 | 6414 | 61633 | 5127 | 65342 | 4108 | 70500 | 2505 | 86534 | 1660 | 68185 |
| 18-#11 | 1.85 | MA | 31848 | 7689 | 50597 | 5696 | 55445 | 4623 | 57422 | 3821 | 59207 | 2656 | 70710 | 2474 | 33824 |
| 2L-9S | | MI | 26728 | 7689 | 42273 | 5706 | 45108 | 4643 | 45256 | 3834 | 43597 | 2667 | 51330 | 1991 | 30373 |
| 18-#11 | 1.85 | MA | 31063 | 7689 | 49431 | 5694 | 53950 | 4636 | 55598 | 3833 | 56726 | 2665 | 67391 | 2388 | 33842 |
| 3L-8S | | MI | 27161 | 7689 | 43045 | 5692 | 46058 | 4631 | 46465 | 3840 | 45164 | 2659 | 53273 | 2045 | 30950 |

## RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

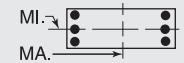
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.85 | MA | 30511 | 7689 | 48480 | 5708 | 52738 | 4632 | 54125 | 3827 | 54830 | 2673 | 65233 | 2302 | 33829 |
| 4L-7S | | MI | 27588 | 7689 | 43763 | 5695 | 47035 | 4635 | 47620 | 3829 | 46844 | 2667 | 55255 | 2093 | 31230 |
| 18-#11 | 1.85 | MA | 30017 | 7689 | 47657 | 5705 | 51671 | 4645 | 52814 | 3839 | 52931 | 2665 | 62973 | 2261 | 33778 |
| 5L-6S | | MI | 28021 | 7689 | 44561 | 5681 | 47998 | 4623 | 48804 | 3818 | 48425 | 2659 | 57395 | 2183 | 31636 |
| 18-#11 | 1.85 | MA | 29547 | 7689 | 46886 | 5702 | 50602 | 4640 | 51508 | 3833 | 51210 | 2674 | 60829 | 2205 | 33431 |
| 6L-5S | | MI | 28466 | 7689 | 45290 | 5685 | 49007 | 4627 | 50037 | 3824 | 50043 | 2650 | 59399 | 2239 | 31958 |
| 18-#11 | 1.85 | MA | 29089 | 7689 | 46040 | 5717 | 49583 | 4653 | 50254 | 3845 | 49529 | 2683 | 58541 | 2115 | 32983 |
| 7L-4S | | MI | 28933 | 7689 | 46066 | 5688 | 50014 | 4615 | 51274 | 3813 | 51828 | 2659 | 61519 | 2279 | 31997 |
| 18-#11 | 1.85 | MA | 28638 | 7689 | 45281 | 5714 | 48549 | 4649 | 49031 | 3857 | 47742 | 2674 | 56427 | 2066 | 32670 |
| 8L-3S | | MI | 29454 | 7689 | 46964 | 5674 | 51158 | 4620 | 52664 | 3819 | 53610 | 2650 | 63535 | 2366 | 31998 |
| 18-#11 | 1.85 | MA | 28178 | 7689 | 44463 | 5728 | 47543 | 4662 | 47751 | 3851 | 46075 | 2683 | 54349 | 2013 | 32044 |
| 9L-2S | | MI | 30193 | 7689 | 48063 | 5677 | 52566 | 4607 | 54382 | 3808 | 55941 | 2641 | 66640 | 2452 | 31977 |
| 18-#14 | 2.66 | MA | 32778 | 8119 | 53529 | 5941 | 59097 | 4818 | 61838 | 3941 | 65117 | 2618 | 78448 | 2248 | 48018 |
| 3L-8S | | MI | 27819 | 8119 | 45205 | 5944 | 48692 | 4813 | 49648 | 3952 | 49402 | 2610 | 59268 | 1759 | 42100 |
| 18-#14 | 2.66 | MA | 31999 | 8119 | 52166 | 5961 | 57361 | 4811 | 59727 | 3932 | 62411 | 2630 | 75387 | 2123 | 47903 |
| 4L-7S | | MI | 28422 | 8119 | 46234 | 5949 | 50091 | 4821 | 51304 | 3937 | 51794 | 2623 | 62087 | 1826 | 43227 |
| 18-#14 | 2.66 | MA | 31301 | 8119 | 50986 | 5957 | 55832 | 4829 | 57848 | 3948 | 59701 | 2618 | 72168 | 2065 | 47276 |
| 5L-6S | | MI | 29034 | 8119 | 47378 | 5929 | 51471 | 4803 | 53000 | 3922 | 54043 | 2610 | 65123 | 1956 | 43845 |
| 18-#14 | 2.66 | MA | 30637 | 8119 | 49880 | 5952 | 54300 | 4823 | 55977 | 3939 | 57245 | 2630 | 69126 | 1984 | 46376 |
| 6L-5S | | MI | 29662 | 8119 | 48423 | 5934 | 52917 | 4810 | 54767 | 3931 | 56344 | 2598 | 67965 | 2037 | 44662 |
| 18-#14 | 2.66 | MA | 29990 | 8119 | 48668 | 5972 | 52838 | 4841 | 54180 | 3955 | 54844 | 2643 | 65876 | 1854 | 45718 |
| 7L-4S | | MI | 30321 | 8119 | 49536 | 5940 | 54360 | 4793 | 56540 | 3916 | 58884 | 2610 | 70981 | 2094 | 45263 |
| 18-#14 | 2.66 | MA | 29353 | 8119 | 47579 | 5967 | 51355 | 4834 | 52425 | 3971 | 52293 | 2630 | 62867 | 1786 | 44489 |
| 8L-3S | | MI | 31057 | 8119 | 50821 | 5920 | 55998 | 4800 | 58530 | 3926 | 61419 | 2598 | 73838 | 2219 | 45360 |
| 18-#14 | 2.66 | MA | 28723 | 8119 | 46406 | 5988 | 49913 | 4852 | 50591 | 3962 | 49914 | 2643 | 59917 | 1708 | 43419 |
| 9L-2S | | MI | 32100 | 8119 | 52392 | 5925 | 58012 | 4783 | 60987 | 3910 | 64736 | 2585 | 78244 | 2343 | 45396 |
| 18-#18 | 4.74 | MA | 34386 | 9208 | 59214 | 6602 | 66169 | 5303 | 70378 | 4228 | 76316 | 2485 | 94698 | 1546 | 78795 |
| 5L-6S | | MI | 31461 | 9208 | 54319 | 6565 | 60083 | 5265 | 63425 | 4188 | 67860 | 2476 | 84021 | 1354 | 71883 |
| 18-#18 | 4.74 | MA | 33257 | 9208 | 57270 | 6592 | 63479 | 5288 | 67092 | 4210 | 72062 | 2507 | 89460 | 1401 | 76232 |
| 6L-5S | | MI | 32529 | 9208 | 56153 | 6576 | 62620 | 5280 | 66524 | 4208 | 71839 | 2454 | 88903 | 1500 | 74316 |
| 20-#11 | 2.05 | MA | 32387 | 7797 | 51763 | 5764 | 56940 | 4671 | 59246 | 3851 | 61689 | 2647 | 74029 | 2456 | 37477 |
| 2L-10S | | MI | 26795 | 7797 | 42656 | 5770 | 45553 | 4687 | 45825 | 3874 | 44375 | 2667 | 52554 | 1910 | 33187 |
| 20-#11 | 2.05 | MA | 31605 | 7797 | 50597 | 5761 | 55445 | 4684 | 57422 | 3862 | 59207 | 2656 | 70710 | 2369 | 37482 |
| 3L-9S | | MI | 27248 | 7797 | 43371 | 5774 | 46517 | 4692 | 46975 | 3863 | 45928 | 2658 | 54435 | 1971 | 33668 |
| 20-#11 | 2.05 | MA | 31054 | 7797 | 49646 | 5775 | 54233 | 4680 | 55949 | 3857 | 57311 | 2665 | 68552 | 2283 | 37455 |
| 4L-8S | | MI | 27678 | 7797 | 44144 | 5760 | 47467 | 4679 | 48183 | 3869 | 47495 | 2650 | 56378 | 2025 | 34297 |
| 20-#11 | 2.05 | MA | 30563 | 7797 | 48823 | 5773 | 53166 | 4693 | 54638 | 3868 | 55413 | 2656 | 66291 | 2242 | 37390 |
| 5L-7S | | MI | 28103 | 7797 | 44861 | 5763 | 48444 | 4684 | 49338 | 3858 | 49175 | 2658 | 58360 | 2073 | 34571 |
| 20-#11 | 2.05 | MA | 30095 | 7797 | 48052 | 5770 | 52097 | 4689 | 53332 | 3863 | 53692 | 2665 | 64148 | 2186 | 36959 |
| 6E | | MI | 28535 | 7797 | 45660 | 5749 | 49406 | 4671 | 50522 | 3847 | 50756 | 2650 | 60500 | 2163 | 34959 |
| 20-#11 | 2.05 | MA | 29638 | 7797 | 47207 | 5784 | 51078 | 4702 | 52078 | 3874 | 52010 | 2674 | 61860 | 2096 | 36529 |
| 7L-5S | | MI | 28977 | 7797 | 46388 | 5752 | 50415 | 4676 | 51755 | 3853 | 52374 | 2641 | 62504 | 2219 | 35363 |
| 20-#11 | 2.05 | MA | 29189 | 7797 | 46447 | 5781 | 50044 | 4698 | 50855 | 3886 | 50223 | 2666 | 59746 | 2048 | 36223 |
| 8L-4S | | MI | 29442 | 7797 | 47165 | 5755 | 51422 | 4663 | 52993 | 3842 | 54159 | 2650 | 64624 | 2259 | 35416 |
| 20-#11 | 2.05 | MA | 28733 | 7797 | 45629 | 5796 | 49038 | 4711 | 49575 | 3880 | 48557 | 2675 | 57668 | 1994 | 35545 |
| 9L-3S | | MI | 29962 | 7797 | 48063 | 5741 | 52566 | 4668 | 54382 | 3848 | 55941 | 2641 | 66640 | 2346 | 35435 |
| 20-#11 | 2.05 | MA | 28244 | 7797 | 44872 | 5793 | 48017 | 4706 | 48358 | 3892 | 46904 | 2684 | 55655 | 1933 | 35017 |
| 10L-2S | | MI | 30698 | 7797 | 49162 | 5744 | 53975 | 4655 | 56101 | 3837 | 58272 | 2632 | 69745 | 2432 | 35421 |
| 20-#14 | 2.96 | MA | 32761 | 8274 | 53834 | 6058 | 59500 | 4881 | 62336 | 3974 | 65951 | 2617 | 80102 | 2094 | 53057 |
| 4L-8S | | MI | 28547 | 8275 | 46776 | 6041 | 50706 | 4883 | 52105 | 3995 | 52719 | 2596 | 63675 | 1728 | 46793 |
| 20-#14 | 2.96 | MA | 32068 | 8274 | 52655 | 6054 | 57970 | 4899 | 60457 | 3990 | 63241 | 2605 | 76883 | 2037 | 52286 |
| 5L-7S | | MI | 29146 | 8275 | 47805 | 6046 | 52105 | 4890 | 53761 | 3979 | 55110 | 2609 | 66493 | 1795 | 47880 |
| 20-#14 | 2.96 | MA | 31407 | 8275 | 51548 | 6049 | 56439 | 4892 | 58586 | 3982 | 60784 | 2617 | 73840 | 1955 | 51425 |
| 6E | | MI | 29755 | 8275 | 48949 | 6026 | 53485 | 4873 | 55457 | 3964 | 57359 | 2596 | 69530 | 1925 | 48597 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 40"

Short columns – no sidesway
Bending on major or minor axis

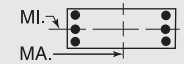


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.96 | MA | 30764 | 8275 | 50336 | 6069 | 54977 | 4911 | 56789 | 3998 | 58384 | 2630 | 70591 | 1825 | 50667 |
| 7L-5S | | MI | 30380 | 8275 | 49994 | 6032 | 54931 | 4880 | 57224 | 3974 | 59660 | 2584 | 72372 | 2006 | 49377 |
| 20-#14 | 2.96 | MA | 30130 | 8275 | 49247 | 6065 | 53494 | 4904 | 55034 | 4014 | 55833 | 2617 | 67582 | 1757 | 49480 |
| 8L-4S | | MI | 31036 | 8275 | 51107 | 6037 | 56374 | 4863 | 58997 | 3959 | 62201 | 2596 | 75387 | 2063 | 50118 |
| 20-#14 | 2.96 | MA | 29503 | 8275 | 48074 | 6085 | 52051 | 4922 | 53200 | 4005 | 53454 | 2630 | 64632 | 1679 | 48345 |
| 9L-3S | | MI | 31768 | 8275 | 52392 | 6017 | 58012 | 4870 | 60987 | 3968 | 64736 | 2584 | 78244 | 2188 | 50238 |
| 20-#18 | 5.26 | MA | 34562 | 9485 | 60188 | 6765 | 67219 | 5413 | 71654 | 4285 | 78193 | 2480 | 97587 | 1343 | 84838 |
| 6E | | MI | 32683 | 9485 | 57064 | 6738 | 63601 | 5389 | 67717 | 4263 | 73595 | 2447 | 91602 | 1292 | 79962 |
| 22-#11 | 2.26 | MA | 32143 | 7905 | 51763 | 5828 | 56940 | 4733 | 59246 | 3892 | 61689 | 2647 | 74029 | 2350 | 41116 |
| 3L-10S | | MI | 27313 | 7905 | 43755 | 5838 | 46961 | 4735 | 47544 | 3904 | 46706 | 2658 | 55659 | 1890 | 36500 |
| 22-#11 | 2.26 | MA | 31595 | 7905 | 50812 | 5843 | 55728 | 4729 | 57772 | 3886 | 59793 | 2656 | 71871 | 2264 | 41076 |
| 4L-9S | | MI | 27772 | 7905 | 44470 | 5841 | 47925 | 4740 | 48693 | 3893 | 48259 | 2649 | 57540 | 1951 | 36968 |
| 22-#11 | 2.26 | MA | 31106 | 7905 | 49989 | 5840 | 54661 | 4742 | 56461 | 3898 | 57894 | 2648 | 69610 | 2223 | 40998 |
| 5L-8S | | MI | 28192 | 7905 | 45243 | 5827 | 48875 | 4727 | 49901 | 3899 | 49826 | 2641 | 59483 | 2005 | 37593 |
| 22-#11 | 2.26 | MA | 30639 | 7905 | 49218 | 5837 | 53592 | 4737 | 55156 | 3892 | 56173 | 2657 | 67467 | 2167 | 40492 |
| 6L-7S | | MI | 28615 | 7905 | 45960 | 5830 | 49852 | 4732 | 51057 | 3888 | 51506 | 2649 | 61465 | 2053 | 37914 |
| 22-#11 | 2.26 | MA | 30185 | 7905 | 48373 | 5852 | 52573 | 4750 | 53902 | 3904 | 54492 | 2666 | 65179 | 2077 | 40078 |
| 7L-6S | | MI | 29045 | 7905 | 46758 | 5816 | 50815 | 4720 | 52241 | 3876 | 53087 | 2641 | 63605 | 2143 | 38288 |
| 22-#11 | 2.26 | MA | 29737 | 7905 | 47613 | 5849 | 51539 | 4746 | 52679 | 3915 | 52705 | 2657 | 63065 | 2029 | 39734 |
| 8L-5S | | MI | 29486 | 7905 | 47487 | 5819 | 51824 | 4724 | 53473 | 3883 | 54705 | 2632 | 65609 | 2199 | 38765 |
| 22-#11 | 2.26 | MA | 29285 | 7905 | 46795 | 5863 | 50533 | 4759 | 51399 | 3910 | 51038 | 2666 | 60987 | 1975 | 39051 |
| 9L-4S | | MI | 29949 | 7905 | 48264 | 5823 | 52831 | 4712 | 54711 | 3871 | 56490 | 2641 | 67729 | 2239 | 38830 |
| 22-#11 | 2.26 | MA | 28796 | 7905 | 46038 | 5860 | 49512 | 4755 | 50182 | 3921 | 49386 | 2675 | 58974 | 1914 | 38537 |
| 10L-3S | | MI | 30467 | 7905 | 49162 | 5809 | 53975 | 4716 | 56101 | 3878 | 58272 | 2632 | 69745 | 2326 | 38861 |
| 22-#14 | 3.26 | MA | 32830 | 8430 | 54323 | 6151 | 60109 | 4969 | 63067 | 4033 | 66780 | 2592 | 81598 | 2008 | 57305 |
| 5L-8S | | MI | 29270 | 8430 | 48347 | 6138 | 52720 | 4953 | 54562 | 4037 | 56035 | 2582 | 68082 | 1697 | 51495 |
| 22-#14 | 3.26 | MA | 32173 | 8430 | 53217 | 6146 | 58577 | 4962 | 61195 | 4024 | 64324 | 2604 | 78555 | 1926 | 56479 |
| 6L-7S | | MI | 29867 | 8430 | 49376 | 6143 | 54119 | 4960 | 56218 | 4022 | 58426 | 2594 | 70900 | 1764 | 52544 |
| 22-#14 | 3.26 | MA | 31532 | 8430 | 52005 | 6167 | 57116 | 4980 | 59398 | 4040 | 61923 | 2617 | 75305 | 1796 | 55628 |
| 7L-6S | | MI | 30473 | 8430 | 50520 | 6124 | 55499 | 4943 | 57914 | 4007 | 60675 | 2582 | 73937 | 1894 | 53354 |
| 22-#14 | 3.26 | MA | 30902 | 8430 | 50915 | 6162 | 55633 | 4974 | 57643 | 4056 | 59372 | 2604 | 72296 | 1728 | 54479 |
| 8L-5S | | MI | 31094 | 8430 | 51565 | 6129 | 56945 | 4950 | 59681 | 4016 | 62977 | 2570 | 76779 | 1976 | 54101 |
| 22-#14 | 3.26 | MA | 30278 | 8430 | 49743 | 6182 | 54190 | 4992 | 55809 | 4047 | 56993 | 2617 | 69346 | 1650 | 53282 |
| 9L-4S | | MI | 31747 | 8430 | 52678 | 6134 | 58388 | 4933 | 61454 | 4001 | 65517 | 2582 | 79794 | 2032 | 54968 |
| 24-#11 | 2.46 | MA | 32134 | 8013 | 51979 | 5910 | 57223 | 4777 | 59596 | 3915 | 62274 | 2648 | 75190 | 2245 | 44695 |
| 4L-10S | | MI | 27828 | 8013 | 44854 | 5905 | 48370 | 4784 | 49262 | 3933 | 49037 | 2649 | 58764 | 1870 | 39772 |
| 24-#11 | 2.46 | MA | 31646 | 8013 | 51156 | 5907 | 56156 | 4790 | 58285 | 3927 | 60376 | 2639 | 72929 | 2205 | 44603 |
| 5L-9S | | MI | 28286 | 8013 | 45569 | 5909 | 49334 | 4788 | 50412 | 3922 | 50591 | 2640 | 60645 | 1931 | 40273 |
| 24-#11 | 2.46 | MA | 31181 | 8013 | 50384 | 5905 | 55088 | 4786 | 56979 | 3921 | 58655 | 2648 | 70785 | 2148 | 44030 |
| 6L-8S | | MI | 28704 | 8013 | 46342 | 5895 | 50284 | 4776 | 51620 | 3928 | 52157 | 2632 | 62588 | 1985 | 40878 |
| 24-#11 | 2.46 | MA | 30729 | 8013 | 49539 | 5919 | 54068 | 4799 | 55726 | 3933 | 56973 | 2657 | 68497 | 2058 | 43630 |
| 7E | | MI | 29125 | 8013 | 47059 | 5898 | 51261 | 4781 | 52775 | 3917 | 53838 | 2640 | 64570 | 2033 | 41260 |
| 24-#11 | 2.46 | MA | 30283 | 8013 | 48779 | 5916 | 53034 | 4795 | 54502 | 3945 | 55186 | 2649 | 66384 | 2010 | 43225 |
| 8L-6S | | MI | 29554 | 8013 | 47857 | 5884 | 52224 | 4768 | 53959 | 3906 | 55419 | 2632 | 66710 | 2123 | 41620 |
| 24-#11 | 2.46 | MA | 29841 | 8013 | 47962 | 5930 | 52028 | 4808 | 53223 | 3939 | 53520 | 2657 | 64305 | 1956 | 42562 |
| 9L-5S | | MI | 29993 | 8013 | 48586 | 5887 | 53232 | 4773 | 55192 | 3912 | 57036 | 2623 | 68714 | 2179 | 42163 |
| 24-#11 | 2.46 | MA | 29346 | 8013 | 47204 | 5928 | 51007 | 4803 | 52006 | 3951 | 51867 | 2666 | 62292 | 1895 | 42024 |
| 10L-4S | | MI | 30455 | 8013 | 49363 | 5890 | 54240 | 4760 | 56429 | 3901 | 58821 | 2632 | 70834 | 2219 | 42241 |
| 24-#14 | 3.55 | MA | 32934 | 8586 | 54885 | 6244 | 60716 | 5032 | 63804 | 4066 | 67863 | 2591 | 83269 | 1898 | 61539 |
| 6L-8S | | MI | 29990 | 8586 | 49918 | 6235 | 54734 | 5023 | 57018 | 4079 | 59352 | 2568 | 72488 | 1666 | 56203 |
| 24-#14 | 3.55 | MA | 32297 | 8586 | 53673 | 6264 | 59254 | 5050 | 62007 | 4082 | 65463 | 2604 | 80020 | 1768 | 60598 |
| 7E | | MI | 30583 | 8586 | 50947 | 6241 | 56133 | 5030 | 58675 | 4064 | 61743 | 2580 | 75306 | 1733 | 57218 |
| 24-#14 | 3.55 | MA | 31670 | 8586 | 52584 | 6259 | 57771 | 5043 | 60252 | 4098 | 62912 | 2591 | 77011 | 1699 | 59485 |
| 8L-6S | | MI | 31186 | 8586 | 52091 | 6221 | 57513 | 5013 | 60371 | 4049 | 63992 | 2568 | 78343 | 1863 | 58117 |
| 24-#14 | 3.55 | MA | 31049 | 8586 | 51411 | 6280 | 56329 | 5062 | 58418 | 4090 | 60533 | 2604 | 74061 | 1621 | 58227 |
| 9L-5S | | MI | 31805 | 8586 | 53136 | 6226 | 58959 | 5020 | 62137 | 4059 | 66293 | 2556 | 81185 | 1945 | 58834 |

## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

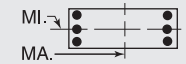
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 4-#18 | 1.00 | MA | 32560 | 7608 | 50563 | 5650 | 54212 | 4612 | 54785 | 3858 | 53551 | 2799 | 62142 | 2645 | 20522 |
| 2E | | MI | 29379 | 7608 | 45814 | 5606 | 48906 | 4575 | 49309 | 3826 | 47946 | 2767 | 55445 | 2606 | 18456 |
| 6-#18 | 1.50 | MA | 33997 | 7884 | 53653 | 5823 | 58173 | 4737 | 59618 | 3933 | 60077 | 2774 | 70816 | 2591 | 30286 |
| 2L-3S | | MI | 28791 | 7884 | 45814 | 5767 | 48906 | 4728 | 49309 | 3926 | 47946 | 2761 | 55445 | 2323 | 27269 |
| 6-#18 | 1.50 | MA | 31909 | 7884 | 50563 | 5814 | 54212 | 4768 | 54785 | 3960 | 53551 | 2797 | 62142 | 2369 | 30373 |
| 3L-2S | | MI | 30642 | 7884 | 48558 | 5778 | 52424 | 4700 | 53601 | 3902 | 53681 | 2739 | 63027 | 2544 | 27159 |
| 8-#14 | 1.13 | MA | 33007 | 7677 | 51278 | 5732 | 55347 | 4675 | 56253 | 3903 | 55677 | 2820 | 65114 | 2666 | 23119 |
| 2L-4S | | MI | 27956 | 7677 | 43593 | 5706 | 46285 | 4652 | 46199 | 3880 | 44046 | 2816 | 50877 | 2380 | 20913 |
| 8-#14 | 1.13 | MA | 31803 | 7677 | 49512 | 5728 | 53084 | 4694 | 53492 | 3920 | 51920 | 2833 | 60091 | 2542 | 23187 |
| 3E | | MI | 28712 | 7677 | 44879 | 5686 | 47922 | 4659 | 48189 | 3890 | 46581 | 2804 | 53734 | 2505 | 20848 |
| 8-#14 | 1.13 | MA | 30956 | 7677 | 48072 | 5749 | 51248 | 4688 | 51261 | 3912 | 49050 | 2845 | 56825 | 2417 | 23233 |
| 4L-2S | | MI | 29781 | 7677 | 46450 | 5691 | 49936 | 4642 | 50646 | 3875 | 49898 | 2791 | 58140 | 2629 | 20775 |
| 8-#18 | 2.01 | MA | 35418 | 8161 | 56743 | 5996 | 62134 | 4861 | 64450 | 4008 | 66604 | 2750 | 79491 | 2536 | 39996 |
| 2L-4S | | MI | 28749 | 8161 | 46306 | 5973 | 49555 | 4837 | 50115 | 3981 | 49298 | 2754 | 58127 | 2039 | 35663 |
| 8-#18 | 2.01 | MA | 33347 | 8161 | 53653 | 5987 | 58173 | 4892 | 59618 | 4036 | 60077 | 2772 | 70816 | 2314 | 39997 |
| 3E | | MI | 30054 | 8161 | 48558 | 5940 | 52424 | 4852 | 53601 | 4001 | 53681 | 2732 | 63027 | 2260 | 35847 |
| 8-#18 | 2.01 | MA | 31884 | 8161 | 51126 | 6022 | 54952 | 4879 | 55704 | 4019 | 55089 | 2794 | 65192 | 2093 | 39717 |
| 4L-2S | | MI | 31891 | 8161 | 51302 | 5951 | 55942 | 4824 | 57892 | 3977 | 59415 | 2710 | 70608 | 2482 | 35803 |
| 10-#14 | 1.41 | MA | 33835 | 7832 | 53043 | 5829 | 57610 | 4745 | 59014 | 3946 | 59434 | 2807 | 70136 | 2639 | 28681 |
| 2L-5S | | MI | 28020 | 7832 | 44051 | 5798 | 46855 | 4739 | 46883 | 3938 | 44822 | 2790 | 52268 | 2292 | 25787 |
| 10-#14 | 1.41 | MA | 32638 | 7832 | 51278 | 5825 | 55347 | 4764 | 56253 | 3963 | 55677 | 2820 | 65114 | 2514 | 28731 |
| 3L-4S | | MI | 28695 | 7832 | 45164 | 5803 | 48299 | 4721 | 48656 | 3923 | 47363 | 2802 | 55284 | 2349 | 25835 |
| 10-#14 | 1.41 | MA | 31795 | 7832 | 49838 | 5846 | 53512 | 4758 | 54023 | 3954 | 52806 | 2833 | 61848 | 2390 | 28739 |
| 4L-3S | | MI | 29447 | 7832 | 46450 | 5783 | 49936 | 4729 | 50646 | 3933 | 49898 | 2790 | 58140 | 2474 | 25797 |
| 10-#14 | 1.41 | MA | 31042 | 7832 | 48592 | 5842 | 51896 | 4776 | 52038 | 3971 | 49932 | 2821 | 58426 | 2331 | 28644 |
| 5L-2S | | MI | 30511 | 7832 | 48021 | 5789 | 51950 | 4711 | 53103 | 3917 | 53214 | 2777 | 62547 | 2598 | 25738 |
| 10-#18 | 2.51 | MA | 36824 | 8438 | 59833 | 6169 | 66095 | 4985 | 69282 | 4084 | 73131 | 2725 | 88165 | 2481 | 49675 |
| 2L-5S | | MI | 28849 | 8438 | 47097 | 6135 | 50542 | 4990 | 51297 | 4081 | 50638 | 2703 | 60496 | 1879 | 41839 |
| 10-#18 | 2.51 | MA | 34768 | 8438 | 56743 | 6160 | 62134 | 5016 | 64450 | 4111 | 66604 | 2747 | 79491 | 2260 | 49585 |
| 3L-4S | | MI | 30010 | 8438 | 49050 | 6146 | 53073 | 4961 | 54406 | 4057 | 55033 | 2725 | 65708 | 1977 | 44101 |
| 10-#18 | 2.51 | MA | 33319 | 8438 | 54216 | 6195 | 58914 | 5003 | 60536 | 4094 | 61616 | 2769 | 73866 | 2038 | 49209 |
| 4L-3S | | MI | 31304 | 8438 | 51302 | 6113 | 55942 | 4977 | 57892 | 4077 | 59415 | 2703 | 70608 | 2198 | 44377 |
| 10-#18 | 2.51 | MA | 32022 | 8438 | 52027 | 6186 | 56076 | 5034 | 57050 | 4121 | 56617 | 2747 | 67932 | 1937 | 46614 |
| 5L-2S | | MI | 33128 | 8438 | 54046 | 6124 | 59460 | 4948 | 62184 | 4052 | 65150 | 2681 | 78189 | 2419 | 44411 |
| 12-#11 | 1.17 | MA | 33185 | 7702 | 51531 | 5767 | 55783 | 4702 | 56827 | 3924 | 56476 | 2828 | 66333 | 2679 | 24096 |
| 2L-6S | | MI | 27743 | 7702 | 43173 | 5733 | 45766 | 4686 | 45594 | 3907 | 43180 | 2822 | 50015 | 2375 | 21749 |
| 12-#11 | 1.17 | MA | 32344 | 7702 | 50297 | 5765 | 54201 | 4698 | 54898 | 3936 | 53851 | 2838 | 62800 | 2593 | 24137 |
| 3L-5S | | MI | 28194 | 7702 | 43902 | 5736 | 46775 | 4691 | 46827 | 3913 | 44797 | 2813 | 52019 | 2431 | 21764 |
| 12-#11 | 1.17 | MA | 31753 | 7702 | 49292 | 5779 | 52921 | 4712 | 53341 | 3931 | 51847 | 2847 | 60501 | 2507 | 24170 |
| 4E | | MI | 28667 | 7702 | 44679 | 5739 | 47782 | 4678 | 48065 | 3902 | 46582 | 2822 | 54138 | 2471 | 21736 |
| 12-#11 | 1.17 | MA | 31225 | 7702 | 48423 | 5777 | 51794 | 4708 | 51957 | 3943 | 49842 | 2839 | 58099 | 2465 | 24176 |
| 5L-3S | | MI | 29195 | 7702 | 45576 | 5725 | 48926 | 4683 | 49455 | 3908 | 48364 | 2813 | 56154 | 2558 | 21694 |
| 12-#11 | 1.17 | MA | 30722 | 7702 | 47609 | 5774 | 50666 | 4721 | 50578 | 3938 | 48025 | 2849 | 55816 | 2409 | 24128 |
| 6L-2S | | MI | 29942 | 7702 | 46675 | 5728 | 50335 | 4670 | 51173 | 3897 | 50696 | 2805 | 59259 | 2644 | 21649 |
| 12-#14 | 1.69 | MA | 34658 | 7988 | 54809 | 5927 | 59874 | 4815 | 61775 | 3988 | 63190 | 2795 | 75159 | 2612 | 34227 |
| 2L-6S | | MI | 28119 | 7988 | 44578 | 5890 | 47424 | 4801 | 47573 | 3971 | 45838 | 2788 | 53833 | 2180 | 29842 |
| 12-#14 | 1.69 | MA | 33466 | 7988 | 53043 | 5923 | 57610 | 4834 | 59014 | 4005 | 59434 | 2808 | 70136 | 2487 | 34262 |
| 3L-5S | | MI | 28758 | 7988 | 45622 | 5895 | 48869 | 4809 | 49339 | 3981 | 48139 | 2776 | 56675 | 2261 | 30647 |
| 12-#14 | 1.69 | MA | 32628 | 7988 | 51603 | 5943 | 55775 | 4827 | 56784 | 3997 | 56563 | 2820 | 66871 | 2363 | 34228 |
| 4E | | MI | 29429 | 7988 | 46735 | 5900 | 50313 | 4791 | 51113 | 3965 | 50679 | 2788 | 59690 | 2318 | 30730 |
| 12-#14 | 1.69 | MA | 31879 | 7988 | 50357 | 5939 | 54160 | 4846 | 54799 | 4014 | 53689 | 2808 | 63449 | 2304 | 34095 |
| 5L-3S | | MI | 30177 | 7988 | 48021 | 5881 | 51950 | 4799 | 53103 | 3975 | 53214 | 2776 | 62547 | 2443 | 30728 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

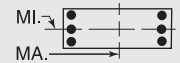


$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 1.69 | MA | 31166 | 7988 | 49189 | 5935 | 52542 | 4840 | 52822 | 4006 | 51083 | 2821 | 60205 | 2223 | 33146 |
| 6L-2S | | MI | 31236 | 7988 | 49592 | 5886 | 53964 | 4781 | 55560 | 3960 | 56531 | 2763 | 66954 | 2567 | 30684 |
| 12-#18 | 3.01 | MA | 38216 | 8714 | 62923 | 6342 | 70057 | 5109 | 74115 | 4159 | 79657 | 2700 | 96840 | 2427 | 59306 |
| 2L-6S | | MI | 29011 | 8714 | 48007 | 6297 | 51523 | 5098 | 52489 | 4137 | 52393 | 2697 | 63195 | 1671 | 48361 |
| 12-#18 | 3.01 | MA | 36176 | 8714 | 59833 | 6333 | 66095 | 5140 | 69282 | 4187 | 73131 | 2722 | 88165 | 2205 | 59150 |
| 3L-5S | | MI | 30107 | 8714 | 49841 | 6308 | 54060 | 5114 | 55588 | 4156 | 56373 | 2675 | 68077 | 1817 | 50001 |
| 12-#18 | 3.01 | MA | 34738 | 8714 | 57306 | 6368 | 62875 | 5127 | 65369 | 4170 | 68142 | 2744 | 82541 | 1984 | 58690 |
| 4E | | MI | 31258 | 8714 | 51794 | 6319 | 56591 | 5085 | 58698 | 4132 | 60767 | 2697 | 73290 | 1914 | 52443 |
| 12-#18 | 3.01 | MA | 33452 | 8714 | 55117 | 6359 | 60037 | 5158 | 61882 | 4197 | 63143 | 2722 | 76606 | 1882 | 55828 |
| 5L-3S | | MI | 32542 | 8714 | 54046 | 6286 | 59460 | 5101 | 62184 | 4152 | 65150 | 2675 | 78189 | 2136 | 52880 |
| 12-#18 | 3.01 | MA | 32228 | 8714 | 53063 | 6350 | 57194 | 5145 | 58409 | 4180 | 58614 | 2744 | 71011 | 1738 | 53956 |
| 6L-2S | | MI | 34353 | 8714 | 56790 | 6297 | 62978 | 5072 | 66476 | 4128 | 70884 | 2653 | 85771 | 2357 | 52989 |
| 14-#11 | 1.37 | MA | 33766 | 7810 | 52764 | 5835 | 57364 | 4751 | 58757 | 3953 | 59101 | 2820 | 69865 | 2662 | 27977 |
| 2L-7S | | MI | 27827 | 7810 | 43474 | 5814 | 46212 | 4747 | 46129 | 3947 | 43930 | 2822 | 50979 | 2265 | 24709 |
| 14-#11 | 1.37 | MA | 32928 | 7810 | 51531 | 5832 | 55783 | 4747 | 56827 | 3965 | 56476 | 2829 | 66333 | 2575 | 28010 |
| 3L-6S | | MI | 28265 | 7810 | 44272 | 5800 | 47175 | 4734 | 47313 | 3936 | 45511 | 2813 | 53120 | 2355 | 25158 |
| 14-#11 | 1.37 | MA | 32340 | 7810 | 50526 | 5847 | 54502 | 4760 | 55271 | 3960 | 54472 | 2838 | 64033 | 2489 | 28032 |
| 4L-5S | | MI | 28713 | 7810 | 45001 | 5803 | 48184 | 4739 | 48546 | 3942 | 47129 | 2804 | 55124 | 2411 | 25194 |
| 14-#11 | 1.37 | MA | 31814 | 7810 | 49657 | 5844 | 53376 | 4756 | 53886 | 3972 | 52467 | 2831 | 61631 | 2448 | 28015 |
| 5L-4S | | MI | 29184 | 7810 | 45778 | 5806 | 49191 | 4727 | 49783 | 3931 | 48914 | 2813 | 57243 | 2451 | 25185 |
| 14-#11 | 1.37 | MA | 31313 | 7810 | 48843 | 5842 | 52248 | 4770 | 52507 | 3967 | 50650 | 2840 | 59348 | 2392 | 27946 |
| 6L-3S | | MI | 29710 | 7810 | 46675 | 5792 | 50335 | 4731 | 51173 | 3937 | 50696 | 2804 | 59259 | 2537 | 25153 |
| 14-#11 | 1.37 | MA | 30825 | 7810 | 47950 | 5856 | 51171 | 4766 | 51184 | 3979 | 48875 | 2850 | 56913 | 2302 | 27406 |
| 7L-2S | | MI | 30455 | 7810 | 47774 | 5796 | 51743 | 4719 | 52892 | 3926 | 53027 | 2796 | 62364 | 2624 | 25115 |
| 14-#14 | 1.97 | MA | 35475 | 8144 | 56574 | 6024 | 62137 | 4885 | 64536 | 4031 | 66947 | 2782 | 80182 | 2585 | 39761 |
| 2L-7S | | MI | 28235 | 8144 | 45005 | 6007 | 48058 | 4889 | 48334 | 4029 | 46905 | 2786 | 55203 | 2019 | 34009 |
| 14-#14 | 1.97 | MA | 34289 | 8144 | 54809 | 6020 | 59874 | 4903 | 61775 | 4047 | 63190 | 2795 | 75159 | 2460 | 39769 |
| 3L-6S | | MI | 28854 | 8144 | 46149 | 5987 | 49438 | 4871 | 50030 | 4013 | 49154 | 2774 | 58239 | 2149 | 34567 |
| 14-#14 | 1.97 | MA | 33456 | 8144 | 53369 | 6041 | 58038 | 4897 | 59545 | 4039 | 60320 | 2808 | 71894 | 2336 | 39705 |
| 4L-5S | | MI | 29490 | 8144 | 47193 | 5992 | 50883 | 4879 | 51796 | 4023 | 51455 | 2761 | 61081 | 2230 | 35498 |
| 14-#14 | 1.97 | MA | 32710 | 8144 | 52123 | 6036 | 56423 | 4916 | 57560 | 4056 | 57445 | 2796 | 68472 | 2277 | 39539 |
| 5L-4S | | MI | 30158 | 8144 | 48306 | 5998 | 52327 | 4861 | 53569 | 4008 | 53996 | 2774 | 64097 | 2287 | 35613 |
| 14-#14 | 1.97 | MA | 32001 | 8144 | 50955 | 6032 | 54805 | 4910 | 55583 | 4048 | 54840 | 2809 | 65228 | 2196 | 38462 |
| 6L-3S | | MI | 30903 | 8144 | 49592 | 5978 | 53964 | 4868 | 55560 | 4017 | 56531 | 2761 | 66954 | 2412 | 35647 |
| 14-#14 | 1.97 | MA | 31310 | 8144 | 49675 | 6053 | 53262 | 4929 | 53685 | 4065 | 52294 | 2821 | 61765 | 2066 | 37784 |
| 7L-2S | | MI | 31957 | 8144 | 51163 | 5983 | 55978 | 4851 | 58017 | 4002 | 59847 | 2749 | 71360 | 2536 | 35618 |
| 14-#18 | 3.51 | MA | 37571 | 8991 | 62923 | 6506 | 70057 | 5264 | 74115 | 4262 | 79657 | 2697 | 96840 | 2151 | 68699 |
| 3L-6S | | MI | 30265 | 8991 | 50751 | 6469 | 55041 | 5222 | 56781 | 4212 | 58128 | 2668 | 70777 | 1609 | 56350 |
| 14-#18 | 3.51 | MA | 36144 | 8991 | 60396 | 6541 | 66836 | 5251 | 70201 | 4245 | 74669 | 2719 | 91215 | 1929 | 67819 |
| 4L-5S | | MI | 31353 | 8991 | 52585 | 6481 | 57578 | 5238 | 59880 | 4232 | 62107 | 2646 | 75658 | 1754 | 58191 |
| 14-#18 | 3.51 | MA | 34869 | 8991 | 58207 | 6532 | 63998 | 5283 | 66715 | 4272 | 69670 | 2697 | 85281 | 1828 | 65071 |
| 5L-4S | | MI | 32495 | 8991 | 54539 | 6492 | 60109 | 5209 | 62990 | 4208 | 66502 | 2668 | 80871 | 1852 | 60486 |
| 14-#18 | 3.51 | MA | 33655 | 8991 | 56153 | 6523 | 61156 | 5269 | 63241 | 4255 | 65141 | 2719 | 79686 | 1683 | 62999 |
| 6L-3S | | MI | 33770 | 8991 | 56790 | 6459 | 62978 | 5225 | 66476 | 4228 | 70884 | 2646 | 85771 | 2073 | 61366 |
| 14-#18 | 3.51 | MA | 32474 | 8991 | 53903 | 6558 | 58442 | 5301 | 59906 | 4283 | 60715 | 2742 | 73708 | 1452 | 60160 |
| 7L-2S | | MI | 35568 | 8991 | 59535 | 6470 | 66496 | 5196 | 70767 | 4203 | 76619 | 2624 | 93352 | 2295 | 61532 |
| 16-#11 | 1.56 | MA | 34345 | 7917 | 53998 | 5902 | 58946 | 4799 | 60686 | 3983 | 61726 | 2811 | 73398 | 2644 | 31851 |
| 2L-8S | | MI | 27918 | 7917 | 43855 | 5878 | 46644 | 4791 | 46692 | 3988 | 44581 | 2804 | 52103 | 2197 | 27753 |
| 16-#11 | 1.56 | MA | 33510 | 7917 | 52764 | 5899 | 57364 | 4795 | 58757 | 3995 | 59101 | 2820 | 69865 | 2558 | 31877 |
| 3L-7S | | MI | 28347 | 7917 | 44573 | 5881 | 47621 | 4795 | 47848 | 3976 | 46261 | 2813 | 54084 | 2245 | 28041 |
| 16-#11 | 1.56 | MA | 32924 | 7917 | 51759 | 5914 | 56084 | 4809 | 57200 | 3989 | 57097 | 2830 | 67566 | 2472 | 31882 |
| 4L-6S | | MI | 28783 | 7917 | 45371 | 5867 | 48584 | 4783 | 49031 | 3965 | 47842 | 2804 | 56225 | 2335 | 28477 |
| 16-#11 | 1.56 | MA | 32400 | 7917 | 50891 | 5912 | 54957 | 4805 | 55816 | 4002 | 55092 | 2822 | 65164 | 2430 | 31847 |
| 5E | | MI | 29230 | 7917 | 46099 | 5871 | 49592 | 4788 | 50264 | 3971 | 49460 | 2795 | 58229 | 2391 | 28615 |
| 16-#11 | 1.56 | MA | 31901 | 7917 | 50076 | 5909 | 53829 | 4818 | 54437 | 3996 | 53275 | 2832 | 62881 | 2374 | 31672 |
| 6L-4S | | MI | 29700 | 7917 | 46876 | 5874 | 50600 | 4775 | 51502 | 3960 | 51245 | 2804 | 60348 | 2431 | 28626 |
| 16-#11 | 1.56 | MA | 31415 | 7917 | 49184 | 5924 | 52753 | 4814 | 53114 | 4009 | 51500 | 2841 | 60445 | 2284 | 31148 |
| 7L-3S | | MI | 30224 | 7917 | 47774 | 5860 | 51743 | 4780 | 52892 | 3966 | 53027 | 2795 | 62364 | 2517 | 28604 |

## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

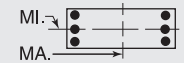
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.56 | MA | 30937 | 7917 | 48382 | 5921 | 51661 | 4828 | 51822 | 4021 | 49613 | 2833 | 58199 | 2236 | 30793 |
| 8L-2S | | MI | 30966 | 7917 | 48873 | 5863 | 53152 | 4767 | 54610 | 3955 | 55358 | 2787 | 65469 | 2604 | 28573 |
| 16-#14 | 2.26 | MA | 36288 | 8299 | 58340 | 6121 | 64400 | 4954 | 67298 | 4073 | 70704 | 2770 | 85205 | 2558 | 45290 |
| 2L-8S | | MI | 28362 | 8299 | 45547 | 6099 | 48672 | 4951 | 49134 | 4086 | 47830 | 2760 | 56791 | 1921 | 37736 |
| 16-#14 | 2.26 | MA | 35107 | 8299 | 56574 | 6117 | 62137 | 4973 | 64536 | 4090 | 66947 | 2783 | 80182 | 2433 | 45264 |
| 3L-7S | | MI | 28969 | 8299 | 46576 | 6104 | 50072 | 4958 | 50791 | 4071 | 50221 | 2772 | 59609 | 1988 | 38767 |
| 16-#14 | 2.26 | MA | 34278 | 8299 | 55134 | 6138 | 60302 | 4967 | 62306 | 4082 | 64077 | 2796 | 76916 | 2309 | 45174 |
| 4L-6S | | MI | 29586 | 8299 | 47720 | 6084 | 51452 | 4941 | 52487 | 4056 | 52470 | 2760 | 62646 | 2118 | 39303 |
| 16-#14 | 2.26 | MA | 33537 | 8299 | 53888 | 6134 | 58686 | 4986 | 60321 | 4098 | 61202 | 2783 | 73494 | 2250 | 44847 |
| 5E | | MI | 30218 | 8299 | 48764 | 6090 | 52897 | 4948 | 54253 | 4065 | 54772 | 2747 | 65488 | 2199 | 40185 |
| 16-#14 | 2.26 | MA | 32831 | 8299 | 52720 | 6130 | 57069 | 4980 | 58344 | 4090 | 58597 | 2796 | 70250 | 2169 | 43790 |
| 6L-4S | | MI | 30882 | 8299 | 49878 | 6095 | 54341 | 4931 | 56026 | 4050 | 57312 | 2760 | 68503 | 2256 | 40486 |
| 16-#14 | 2.26 | MA | 32143 | 8299 | 51441 | 6150 | 55525 | 4998 | 56446 | 4107 | 56051 | 2809 | 66788 | 2039 | 43137 |
| 7L-3S | | MI | 31624 | 8299 | 51163 | 6075 | 55978 | 4938 | 58017 | 4060 | 59847 | 2747 | 71360 | 2381 | 40545 |
| 16-#14 | 2.26 | MA | 31466 | 8299 | 50291 | 6146 | 53959 | 4992 | 54594 | 4124 | 53345 | 2797 | 63588 | 1970 | 41947 |
| 8L-2S | | MI | 32673 | 8299 | 52734 | 6080 | 57992 | 4921 | 60473 | 4045 | 63163 | 2735 | 75767 | 2505 | 40542 |
| 16-#18 | 4.01 | MA | 37538 | 9267 | 63486 | 6714 | 70797 | 5375 | 75034 | 4320 | 81196 | 2695 | 99890 | 1875 | 76943 |
| 4L-6S | | MI | 31509 | 9267 | 53496 | 6642 | 58559 | 5347 | 61073 | 4287 | 63863 | 2639 | 78358 | 1547 | 64370 |
| 16-#18 | 4.01 | MA | 36273 | 9267 | 61297 | 6705 | 67959 | 5407 | 71547 | 4348 | 76197 | 2673 | 93955 | 1773 | 74338 |
| 5E | | MI | 32588 | 9267 | 55329 | 6654 | 61096 | 5362 | 64172 | 4307 | 67842 | 2617 | 83240 | 1692 | 66405 |
| 16-#18 | 4.01 | MA | 35069 | 9267 | 59243 | 6696 | 65117 | 5394 | 68074 | 4331 | 71667 | 2695 | 88360 | 1629 | 72073 |
| 6L-4S | | MI | 33722 | 9267 | 57283 | 6665 | 63627 | 5333 | 67281 | 4283 | 72237 | 2639 | 88452 | 1790 | 68568 |
| 16-#18 | 4.01 | MA | 33897 | 9267 | 56993 | 6731 | 62403 | 5425 | 64738 | 4358 | 67241 | 2717 | 82382 | 1397 | 69345 |
| 7L-3S | | MI | 34987 | 9267 | 59535 | 6632 | 66496 | 5349 | 70767 | 4303 | 76619 | 2617 | 93352 | 2011 | 69838 |
| 18-#11 | 1.76 | MA | 34921 | 8025 | 55231 | 5969 | 60527 | 4847 | 62615 | 4012 | 64351 | 2802 | 76931 | 2627 | 35720 |
| 2L-9S | | MI | 28004 | 8025 | 44181 | 5960 | 47103 | 4852 | 47202 | 4011 | 45345 | 2803 | 53265 | 2123 | 30608 |
| 18-#11 | 1.76 | MA | 34089 | 8025 | 53998 | 5967 | 58946 | 4844 | 60686 | 4024 | 61726 | 2812 | 73398 | 2540 | 35737 |
| 3L-8S | | MI | 28438 | 8025 | 44954 | 5946 | 48053 | 4839 | 48410 | 4017 | 46912 | 2795 | 55208 | 2177 | 31099 |
| 18-#11 | 1.76 | MA | 33505 | 8025 | 52993 | 5982 | 57665 | 4857 | 59129 | 4019 | 59722 | 2821 | 71099 | 2454 | 35724 |
| 4L-7S | | MI | 28865 | 8025 | 45671 | 5949 | 49029 | 4844 | 49566 | 4006 | 48592 | 2803 | 57189 | 2224 | 31378 |
| 18-#11 | 1.76 | MA | 32983 | 8025 | 52124 | 5979 | 56539 | 4853 | 57745 | 4031 | 57717 | 2813 | 68697 | 2413 | 35673 |
| 5L-6S | | MI | 29299 | 8025 | 46470 | 5935 | 49992 | 4831 | 50750 | 3995 | 50173 | 2795 | 59330 | 2315 | 31793 |
| 18-#11 | 1.76 | MA | 32486 | 8025 | 51310 | 5977 | 55410 | 4867 | 56366 | 4026 | 55900 | 2823 | 66414 | 2357 | 35397 |
| 6L-5S | | MI | 29745 | 8025 | 47198 | 5938 | 51001 | 4836 | 51982 | 4001 | 51791 | 2786 | 61334 | 2371 | 32029 |
| 18-#11 | 1.76 | MA | 32002 | 8025 | 50418 | 5991 | 54334 | 4863 | 55043 | 4038 | 54125 | 2832 | 63978 | 2267 | 34895 |
| 7L-4S | | MI | 30212 | 8025 | 47975 | 5941 | 52008 | 4823 | 53220 | 3990 | 53576 | 2795 | 63454 | 2411 | 32061 |
| 18-#11 | 1.76 | MA | 31526 | 8025 | 49616 | 5989 | 53243 | 4876 | 53751 | 4050 | 52238 | 2825 | 61732 | 2218 | 34551 |
| 8L-3S | | MI | 30734 | 8025 | 48873 | 5927 | 53152 | 4828 | 54610 | 3996 | 55358 | 2786 | 65469 | 2497 | 32049 |
| 18-#11 | 1.76 | MA | 31038 | 8025 | 48753 | 6003 | 52181 | 4872 | 52401 | 4045 | 50479 | 2834 | 59518 | 2164 | 33970 |
| 9L-2S | | MI | 31475 | 8025 | 49971 | 5931 | 54561 | 4815 | 56328 | 3985 | 57689 | 2778 | 68574 | 2584 | 32024 |
| 18-#14 | 2.54 | MA | 35920 | 8455 | 58340 | 6214 | 64400 | 5043 | 67298 | 4132 | 70704 | 2770 | 85205 | 2406 | 50752 |
| 3L-8S | | MI | 29095 | 8455 | 47118 | 6196 | 50686 | 5021 | 51591 | 4129 | 51147 | 2746 | 61198 | 1890 | 42417 |
| 18-#14 | 2.54 | MA | 35095 | 8455 | 56900 | 6235 | 62565 | 5037 | 65067 | 4124 | 67833 | 2783 | 81939 | 2282 | 50637 |
| 4L-7S | | MI | 29699 | 8455 | 48147 | 6201 | 52086 | 5028 | 53248 | 4113 | 53538 | 2758 | 64016 | 1957 | 43530 |
| 18-#14 | 2.54 | MA | 34357 | 8455 | 55654 | 6231 | 60950 | 5056 | 63082 | 4141 | 64959 | 2771 | 78517 | 2223 | 50136 |
| 5L-6S | | MI | 30313 | 8455 | 49291 | 6182 | 53466 | 5011 | 54944 | 4098 | 55787 | 2746 | 67053 | 2087 | 44047 |
| 18-#14 | 2.54 | MA | 33656 | 8455 | 54486 | 6227 | 59332 | 5050 | 61105 | 4133 | 62354 | 2784 | 75273 | 2142 | 49128 |
| 6L-5S | | MI | 30942 | 8455 | 50335 | 6187 | 54911 | 5018 | 56710 | 4108 | 58088 | 2733 | 69895 | 2169 | 44886 |
| 18-#14 | 2.54 | MA | 32972 | 8455 | 53206 | 6248 | 57788 | 5068 | 59207 | 4149 | 59807 | 2797 | 71811 | 2012 | 48496 |
| 7L-4S | | MI | 31603 | 8455 | 51449 | 6192 | 56355 | 5001 | 58483 | 4093 | 60629 | 2746 | 72910 | 2225 | 45352 |
| 18-#14 | 2.54 | MA | 32298 | 8455 | 52056 | 6243 | 56223 | 5062 | 57355 | 4166 | 57102 | 2784 | 68611 | 1943 | 47224 |
| 8L-3S | | MI | 32341 | 8455 | 52734 | 6172 | 57992 | 5008 | 60473 | 4102 | 63163 | 2733 | 75767 | 2350 | 45434 |
| 18-#14 | 2.54 | MA | 31632 | 8455 | 50818 | 6264 | 54699 | 5081 | 55418 | 4158 | 54579 | 2797 | 65466 | 1865 | 46224 |
| 9L-2S | | MI | 33386 | 8455 | 54305 | 6178 | 60006 | 4991 | 62930 | 4087 | 66480 | 2721 | 80173 | 2475 | 45460 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis

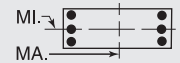



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 4.51 | MA | 37665 | 9544 | 64387 | 6878 | 71921 | 5531 | 76380 | 4423 | 82723 | 2648 | 102630 | 1719 | 83625 |
| 5L-6S | | MI | 32742 | 9544 | 56240 | 6815 | 62077 | 5471 | 65364 | 4363 | 69597 | 2611 | 85939 | 1484 | 72418 |
| 18-#18 | 4.51 | MA | 36471 | 9544 | 62333 | 6869 | 69078 | 5518 | 72906 | 4406 | 78194 | 2670 | 97035 | 1574 | 81174 |
| 6L-5S | | MI | 33814 | 9544 | 58074 | 6826 | 64614 | 5486 | 68463 | 4383 | 73576 | 2589 | 90821 | 1630 | 74637 |
| 18-#18 | 4.51 | MA | 35308 | 9544 | 60083 | 6904 | 66364 | 5549 | 69571 | 4433 | 73768 | 2692 | 91057 | 1343 | 78548 |
| 7L-4S | | MI | 34939 | 9544 | 60027 | 6838 | 67145 | 5458 | 71573 | 4358 | 77971 | 2611 | 96034 | 1727 | 76683 |
| 20-#11 | 1.95 | MA | 35494 | 8133 | 56465 | 6037 | 62109 | 4896 | 64545 | 4041 | 66976 | 2794 | 80463 | 2609 | 39583 |
| 2L-10S | | MI | 28071 | 8133 | 44565 | 6024 | 47547 | 4896 | 47771 | 4051 | 46123 | 2803 | 54488 | 2042 | 33415 |
| 20-#11 | 1.95 | MA | 34665 | 8133 | 55231 | 6034 | 60527 | 4892 | 62615 | 4053 | 64351 | 2803 | 76931 | 2523 | 39588 |
| 3L-9S | | MI | 28524 | 8133 | 45280 | 6027 | 48511 | 4900 | 48921 | 4040 | 47676 | 2794 | 56370 | 2103 | 33902 |
| 20-#11 | 1.95 | MA | 34083 | 8133 | 54227 | 6049 | 59247 | 4905 | 61059 | 4048 | 62347 | 2813 | 74631 | 2437 | 39561 |
| 4L-8S | | MI | 28955 | 8133 | 46053 | 6013 | 49461 | 4888 | 50129 | 4046 | 49243 | 2786 | 58313 | 2157 | 34448 |
| 20-#11 | 1.95 | MA | 33563 | 8133 | 53358 | 6046 | 58120 | 4902 | 59674 | 4060 | 60342 | 2805 | 72229 | 2395 | 39496 |
| 5L-7S | | MI | 29381 | 8133 | 46770 | 6016 | 50438 | 4892 | 51284 | 4035 | 50923 | 2794 | 60294 | 2204 | 34719 |
| 20-#11 | 1.95 | MA | 33069 | 8133 | 52544 | 6044 | 56992 | 4915 | 58295 | 4055 | 58525 | 2814 | 69946 | 2339 | 39129 |
| 6E | | MI | 29813 | 8133 | 47568 | 6002 | 51401 | 4880 | 52468 | 4024 | 52504 | 2786 | 62435 | 2295 | 35115 |
| 20-#11 | 1.95 | MA | 32587 | 8133 | 51651 | 6059 | 55916 | 4911 | 56972 | 4067 | 56750 | 2824 | 67510 | 2249 | 38647 |
| 7L-5S | | MI | 30257 | 8133 | 48297 | 6006 | 52410 | 4884 | 53701 | 4030 | 54122 | 2777 | 64439 | 2351 | 35439 |
| 20-#11 | 1.95 | MA | 32112 | 8133 | 50850 | 6056 | 54824 | 4925 | 55681 | 4079 | 54863 | 2816 | 65264 | 2200 | 38311 |
| 8L-4S | | MI | 30723 | 8133 | 49074 | 6009 | 53417 | 4872 | 54938 | 4019 | 55907 | 2786 | 66559 | 2391 | 35480 |
| 20-#11 | 1.95 | MA | 31627 | 8133 | 49986 | 6071 | 53762 | 4921 | 54330 | 4074 | 53104 | 2826 | 63051 | 2147 | 37676 |
| 9L-3S | | MI | 31243 | 8133 | 49971 | 5995 | 54561 | 4876 | 56328 | 4025 | 57689 | 2777 | 68574 | 2477 | 35489 |
| 20-#11 | 1.95 | MA | 31103 | 8133 | 49187 | 6068 | 52685 | 4934 | 53045 | 4086 | 51359 | 2835 | 60906 | 2086 | 37095 |
| 10L-2S | | MI | 31981 | 8133 | 51070 | 5998 | 55969 | 4864 | 58047 | 4014 | 60020 | 2769 | 71679 | 2564 | 35471 |
| 20-#14 | 2.82 | MA | 35907 | 8610 | 58665 | 6332 | 64828 | 5107 | 67828 | 4167 | 71590 | 2771 | 86962 | 2255 | 56095 |
| 4L-8S | | MI | 29824 | 8610 | 48689 | 6293 | 52700 | 5091 | 54048 | 4171 | 54463 | 2732 | 65604 | 1859 | 47108 |
| 20-#14 | 2.82 | MA | 35173 | 8610 | 57419 | 6328 | 63213 | 5126 | 65843 | 4183 | 68716 | 2759 | 83540 | 2196 | 55439 |
| 5L-7S | | MI | 30425 | 8610 | 49718 | 6299 | 54100 | 5098 | 55704 | 4156 | 56854 | 2744 | 68422 | 1926 | 48223 |
| 20-#14 | 2.82 | MA | 34475 | 8610 | 56251 | 6324 | 61595 | 5119 | 63866 | 4175 | 66110 | 2771 | 80296 | 2115 | 54473 |
| 6E | | MI | 31035 | 8610 | 50862 | 6279 | 55480 | 5081 | 57401 | 4141 | 59103 | 2732 | 71459 | 2056 | 48799 |
| 20-#14 | 2.82 | MA | 33795 | 8610 | 54972 | 6345 | 60052 | 5138 | 61968 | 4192 | 63564 | 2784 | 76833 | 1985 | 53831 |
| 7L-5S | | MI | 31662 | 8610 | 51906 | 6284 | 56925 | 5088 | 59167 | 4150 | 61405 | 2719 | 74301 | 2138 | 49599 |
| 20-#14 | 2.82 | MA | 33125 | 8610 | 53822 | 6341 | 58486 | 5132 | 60116 | 4209 | 60859 | 2772 | 73634 | 1916 | 52510 |
| 8L-4S | | MI | 32319 | 8610 | 53020 | 6289 | 58369 | 5071 | 60940 | 4135 | 63945 | 2732 | 77317 | 2194 | 50212 |
| 20-#14 | 2.82 | MA | 32462 | 8610 | 52583 | 6361 | 56963 | 5151 | 58179 | 4201 | 58336 | 2785 | 70489 | 1838 | 51444 |
| 9L-3S | | MI | 33054 | 8610 | 54305 | 6270 | 60006 | 5078 | 62930 | 4145 | 66480 | 2719 | 80173 | 2319 | 50315 |
| 20-#18 | 5.01 | MA | 37861 | 9821 | 65423 | 7041 | 73039 | 5642 | 77738 | 4481 | 84721 | 2645 | 105709 | 1519 | 90300 |
| 6E | | MI | 33966 | 9821 | 58984 | 6988 | 65595 | 5595 | 69656 | 4438 | 75332 | 2582 | 93521 | 1422 | 80490 |
| 20-#18 | 5.01 | MA | 36707 | 9821 | 63173 | 7077 | 70326 | 5673 | 74403 | 4509 | 80295 | 2667 | 99731 | 1288 | 87770 |
| 7L-5S | | MI | 35030 | 9821 | 60818 | 6999 | 68131 | 5610 | 72755 | 4458 | 79311 | 2560 | 98402 | 1567 | 82884 |
| 22-#11 | 2.15 | MA | 35238 | 8241 | 56465 | 6102 | 62109 | 4940 | 64545 | 4083 | 66976 | 2795 | 80463 | 2505 | 43432 |
| 3L-10S | | MI | 28589 | 8241 | 45664 | 6091 | 48956 | 4944 | 49489 | 4081 | 48454 | 2794 | 57593 | 2022 | 36728 |
| 22-#11 | 2.15 | MA | 34659 | 8241 | 55460 | 6116 | 60828 | 4954 | 62988 | 4078 | 64972 | 2804 | 78164 | 2419 | 43393 |
| 4L-9S | | MI | 29042 | 8241 | 46379 | 6095 | 49920 | 4949 | 50639 | 4070 | 50007 | 2785 | 59475 | 2083 | 37201 |
| 22-#11 | 2.15 | MA | 34141 | 8241 | 54592 | 6114 | 59702 | 4950 | 61604 | 4090 | 62967 | 2796 | 75762 | 2378 | 43314 |
| 5L-8S | | MI | 29469 | 8241 | 47151 | 6081 | 50870 | 4936 | 51847 | 4076 | 51574 | 2777 | 61418 | 2137 | 37798 |
| 22-#11 | 2.15 | MA | 33648 | 8241 | 53777 | 6111 | 58573 | 4963 | 60225 | 4085 | 61150 | 2806 | 73479 | 2322 | 42866 |
| 6L-7S | | MI | 29894 | 8241 | 47869 | 6084 | 51847 | 4941 | 53003 | 4065 | 53254 | 2785 | 63399 | 2184 | 38063 |
| 22-#11 | 2.15 | MA | 33168 | 8241 | 52885 | 6126 | 57497 | 4960 | 58901 | 4097 | 59375 | 2815 | 71043 | 2232 | 42403 |
| 7L-6S | | MI | 30325 | 8241 | 48667 | 6070 | 52809 | 4928 | 54186 | 4054 | 54835 | 2777 | 65540 | 2275 | 38444 |
| 22-#11 | 2.15 | MA | 32695 | 8241 | 52083 | 6124 | 56406 | 4973 | 57610 | 4109 | 57488 | 2807 | 68797 | 2183 | 42074 |
| 8L-5S | | MI | 30767 | 8241 | 49396 | 6073 | 53818 | 4933 | 55419 | 4060 | 56453 | 2768 | 67544 | 2331 | 38844 |
| 22-#11 | 2.15 | MA | 32213 | 8241 | 51220 | 6138 | 55344 | 4969 | 56259 | 4104 | 55729 | 2817 | 66583 | 2129 | 41387 |
| 9L-4S | | MI | 31231 | 8241 | 50173 | 6076 | 54825 | 4920 | 56657 | 4049 | 58238 | 2777 | 69664 | 2371 | 38898 |
| 22-#11 | 2.15 | MA | 31691 | 8241 | 50421 | 6136 | 54267 | 4983 | 54974 | 4116 | 53984 | 2826 | 64439 | 2068 | 40821 |
| 10L-3S | | MI | 31749 | 8241 | 51070 | 6062 | 55969 | 4925 | 58047 | 4055 | 60020 | 2768 | 71679 | 2457 | 38924 |
| 22-#11 | 2.15 | MA | 31181 | 8241 | 49635 | 6133 | 53210 | 4979 | 53641 | 4111 | 52124 | 2819 | 62249 | 2017 | 40046 |
| 11L-2S | | MI | 32485 | 8241 | 52169 | 6065 | 57378 | 4912 | 59765 | 4044 | 62351 | 2760 | 74784 | 2544 | 38913 |

## RECTANGULAR TIED COLUMNS 38" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 3.10 | MA | 35985 | 8766 | 59185 | 6425 | 65476 | 5195 | 68604 | 4226 | 72472 | 2746 | 88563 | 2169 | 60752 |
| 5L-8S | | MI | 30548 | 8766 | 50260 | 6391 | 54714 | 5161 | 56505 | 4213 | 57780 | 2718 | 70011 | 1828 | 51807 |
| 22-#14 | 3.10 | MA | 35290 | 8766 | 58017 | 6421 | 63859 | 5189 | 66627 | 4218 | 69867 | 2759 | 85319 | 2088 | 59825 |
| 6L-7S | | MI | 31147 | 8766 | 51289 | 6396 | 56114 | 5168 | 58161 | 4198 | 60171 | 2730 | 72829 | 1895 | 52883 |
| 22-#14 | 3.10 | MA | 34613 | 8766 | 56737 | 6442 | 62315 | 5208 | 64730 | 4234 | 67321 | 2772 | 81856 | 1958 | 59084 |
| 7L-6S | | MI | 31754 | 8766 | 52433 | 6376 | 57494 | 5150 | 59858 | 4183 | 62420 | 2718 | 75866 | 2025 | 53557 |
| 22-#14 | 3.10 | MA | 33947 | 8766 | 55587 | 6438 | 60749 | 5202 | 62877 | 4251 | 64615 | 2760 | 78657 | 1889 | 57804 |
| 8L-5S | | MI | 32377 | 8766 | 53477 | 6381 | 58939 | 5158 | 61624 | 4193 | 64721 | 2705 | 78708 | 2107 | 54322 |
| 22-#14 | 3.10 | MA | 33285 | 8766 | 54349 | 6459 | 59226 | 5221 | 60940 | 4243 | 62092 | 2772 | 75511 | 1811 | 56674 |
| 9L-4S | | MI | 33032 | 8766 | 54591 | 6387 | 60383 | 5140 | 63397 | 4177 | 67262 | 2718 | 81723 | 2164 | 55067 |
| 22-#18 | 5.51 | MA | 38096 | 10097 | 66263 | 7249 | 74287 | 5797 | 79235 | 4584 | 86822 | 2642 | 108406 | 1233 | 96946 |
| 7L-6S | | MI | 35182 | 10097 | 61728 | 7161 | 69113 | 5719 | 73948 | 4514 | 81066 | 2553 | 101102 | 1360 | 88585 |
| 24-#11 | 2.35 | MA | 35232 | 8349 | 56694 | 6184 | 62410 | 5002 | 64917 | 4107 | 67597 | 2795 | 81696 | 2402 | 47222 |
| 4L-10S | | MI | 29105 | 8349 | 46762 | 6159 | 50365 | 4992 | 51208 | 4110 | 50785 | 2785 | 60698 | 2002 | 40044 |
| 24-#11 | 2.35 | MA | 34716 | 8349 | 55825 | 6181 | 61283 | 4998 | 63533 | 4119 | 65592 | 2788 | 79294 | 2360 | 47131 |
| 5L-9S | | MI | 29563 | 8349 | 47478 | 6162 | 51328 | 4997 | 52357 | 4099 | 52339 | 2776 | 62580 | 2063 | 40504 |
| 24-#11 | 2.35 | MA | 34225 | 8349 | 55011 | 6179 | 60155 | 5012 | 62154 | 4114 | 63775 | 2797 | 77011 | 2304 | 46609 |
| 6L-8S | | MI | 29982 | 8349 | 48250 | 6148 | 52278 | 4984 | 53566 | 4105 | 53905 | 2768 | 64523 | 2117 | 41124 |
| 24-#11 | 2.35 | MA | 33747 | 8349 | 54119 | 6194 | 59079 | 5008 | 60831 | 4126 | 62000 | 2807 | 74576 | 2214 | 46161 |
| 7E | | MI | 30405 | 8349 | 48968 | 6151 | 53255 | 4989 | 54721 | 4094 | 55586 | 2776 | 66504 | 2164 | 41409 |
| 24-#11 | 2.35 | MA | 33276 | 8349 | 53317 | 6191 | 57987 | 5021 | 59539 | 4138 | 60113 | 2799 | 72330 | 2165 | 45839 |
| 8L-6S | | MI | 30834 | 8349 | 49766 | 6137 | 54218 | 4977 | 55905 | 4083 | 57167 | 2768 | 68645 | 2254 | 41776 |
| 24-#11 | 2.35 | MA | 32796 | 8349 | 52454 | 6206 | 56925 | 5018 | 58188 | 4133 | 58354 | 2808 | 70116 | 2112 | 45103 |
| 9L-5S | | MI | 31275 | 8349 | 50495 | 6140 | 55227 | 4981 | 57138 | 4089 | 58784 | 2759 | 70649 | 2311 | 42246 |
| 24-#11 | 2.35 | MA | 32276 | 8349 | 51655 | 6203 | 55848 | 5031 | 56904 | 4145 | 56609 | 2818 | 67971 | 2051 | 44551 |
| 10L-4S | | MI | 31737 | 8349 | 51272 | 6144 | 56234 | 4969 | 58375 | 4078 | 60569 | 2768 | 72769 | 2351 | 42312 |
| 24-#11 | 2.35 | MA | 31768 | 8349 | 50869 | 6201 | 54792 | 5027 | 55570 | 4140 | 54749 | 2810 | 65782 | 1999 | 43738 |
| 11L-3S | | MI | 32254 | 8349 | 52169 | 6130 | 57378 | 4973 | 59765 | 4084 | 62351 | 2759 | 74784 | 2437 | 42345 |
| 24-#14 | 3.38 | MA | 36101 | 8922 | 59782 | 6519 | 66122 | 5259 | 69389 | 4260 | 73624 | 2746 | 90341 | 2061 | 65182 |
| 6L-8S | | MI | 31269 | 8922 | 51831 | 6488 | 56728 | 5230 | 58962 | 4256 | 61096 | 2704 | 74417 | 1797 | 56513 |
| 24-#14 | 3.38 | MA | 35427 | 8922 | 58503 | 6539 | 64578 | 5278 | 67491 | 4277 | 71078 | 2759 | 86879 | 1931 | 64347 |
| 7E | | MI | 31865 | 8922 | 52860 | 6493 | 58128 | 5238 | 60618 | 4241 | 63487 | 2716 | 77236 | 1864 | 57554 |
| 24-#14 | 3.38 | MA | 34764 | 8922 | 57353 | 6535 | 63013 | 5272 | 65638 | 4293 | 68372 | 2747 | 83680 | 1861 | 63106 |
| 8L-6S | | MI | 32469 | 8922 | 54004 | 6473 | 59508 | 5220 | 62315 | 4225 | 65736 | 2704 | 80272 | 1994 | 58320 |
| 24-#14 | 3.38 | MA | 34103 | 8922 | 56114 | 6556 | 61489 | 5290 | 63701 | 4285 | 65849 | 2760 | 80534 | 1784 | 61913 |
| 9L-5S | | MI | 33090 | 8922 | 55048 | 6479 | 60953 | 5228 | 64081 | 4235 | 68038 | 2691 | 83114 | 2076 | 59053 |

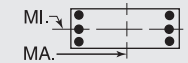
## RECTANGULAR TIED COLUMNS 38" x 44"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.44 | MA | 37158 | 8220 | 58408 | 6096 | 63354 | 4961 | 64877 | 4124 | 65300 | 2926 | 76954 | 2742 | 31906 |
| 2L-3S | | MI | 30069 | 8220 | 47734 | 6018 | 50900 | 4934 | 51249 | 4101 | 49683 | 2895 | 57364 | 2453 | 27333 |
| 6-#18 | 1.44 | MA | 34948 | 8220 | 55145 | 6088 | 59171 | 4993 | 59775 | 4152 | 58377 | 2948 | 67732 | 2521 | 31993 |
| 3L-2S | | MI | 31922 | 8220 | 50478 | 6029 | 54418 | 4906 | 55540 | 4077 | 55418 | 2873 | 64945 | 2674 | 27213 |
| 8-#14 | 1.08 | MA | 36101 | 8013 | 55891 | 6005 | 60360 | 4900 | 61313 | 4094 | 60544 | 2966 | 70853 | 2814 | 24334 |
| 2L-4S | | MI | 29233 | 8013 | 45506 | 5958 | 48279 | 4859 | 48142 | 4057 | 45791 | 2952 | 52806 | 2511 | 20964 |
| 8-#14 | 1.08 | MA | 34829 | 8013 | 54028 | 6001 | 57972 | 4894 | 58399 | 4112 | 56581 | 2980 | 65521 | 2690 | 24402 |
| 3E | | MI | 29990 | 8013 | 46791 | 5939 | 49917 | 4867 | 50132 | 4067 | 48326 | 2939 | 55663 | 2636 | 20892 |
| 8-#14 | 1.08 | MA | 33935 | 8013 | 52511 | 6023 | 56038 | 4913 | 56049 | 4104 | 53556 | 2994 | 62051 | 2565 | 24448 |
| 4L-2S | | MI | 31059 | 8013 | 48362 | 5944 | 51931 | 4849 | 52589 | 4051 | 51642 | 2927 | 60070 | 2760 | 20816 |
| 8-#18 | 1.91 | MA | 38667 | 8497 | 61670 | 6269 | 67537 | 5085 | 69980 | 4199 | 72224 | 2903 | 86175 | 2691 | 42156 |
| 2L-4S | | MI | 30026 | 8497 | 48226 | 6224 | 51549 | 5043 | 52054 | 4156 | 51035 | 2889 | 60045 | 2169 | 35782 |
| 8-#18 | 1.91 | MA | 36475 | 8497 | 58408 | 6261 | 63354 | 5118 | 64877 | 4228 | 65300 | 2925 | 76954 | 2469 | 42157 |
| 3E | | MI | 31333 | 8497 | 50478 | 6191 | 54418 | 5058 | 55540 | 4176 | 55418 | 2867 | 64945 | 2390 | 35927 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#18 | 1.91 | MA | 34931 | 8497 | 55743 | 6297 | 59958 | 5106 | 60750 | 4212 | 60008 | 2947 | 70966 | 2248 | 41877 |
| 4L-2S | | MI | 33173 | 8497 | 53222 | 6202 | 57936 | 5030 | 59832 | 4152 | 61152 | 2844 | 72526 | 2612 | 35865 |
| 10-#14 | 1.35 | MA | 36980 | 8168 | 57754 | 6102 | 62748 | 4970 | 64226 | 4137 | 64508 | 2954 | 76184 | 2789 | 30200 |
| 2L-5S | | MI | 29297 | 8168 | 45964 | 6050 | 48850 | 4947 | 48826 | 4115 | 46567 | 2925 | 54197 | 2423 | 25868 |
| 10-#14 | 1.35 | MA | 35714 | 8168 | 55891 | 6099 | 60360 | 4964 | 61313 | 4154 | 60544 | 2967 | 70853 | 2664 | 30250 |
| 3L-4S | | MI | 29972 | 8168 | 47077 | 6056 | 50293 | 4929 | 50599 | 4099 | 49107 | 2938 | 57213 | 2480 | 25892 |
| 10-#14 | 1.35 | MA | 34825 | 8168 | 54373 | 6120 | 58426 | 4983 | 58962 | 4146 | 57519 | 2981 | 67383 | 2540 | 30258 |
| 4L-3S | | MI | 30726 | 8168 | 48362 | 6036 | 51931 | 4937 | 52589 | 4109 | 51642 | 2925 | 60070 | 2605 | 25846 |
| 10-#14 | 1.35 | MA | 34031 | 8168 | 53061 | 6116 | 56725 | 4978 | 56871 | 4164 | 54491 | 2970 | 63757 | 2480 | 30163 |
| 5L-2S | | MI | 31790 | 8168 | 49933 | 6041 | 53945 | 4919 | 55046 | 4094 | 54958 | 2913 | 64476 | 2729 | 25784 |
| 10-#18 | 2.39 | MA | 40161 | 8773 | 64933 | 6442 | 71720 | 5209 | 75083 | 4275 | 79147 | 2880 | 95397 | 2639 | 52375 |
| 2L-5S | | MI | 30125 | 8773 | 49017 | 6385 | 52536 | 5196 | 53236 | 4256 | 52375 | 2838 | 62414 | 2009 | 42162 |
| 10-#18 | 2.39 | MA | 37986 | 8773 | 61670 | 6434 | 67537 | 5242 | 69980 | 4303 | 72224 | 2902 | 86175 | 2418 | 52285 |
| 3L-4S | | MI | 31288 | 8773 | 50970 | 6397 | 55067 | 5167 | 56346 | 4232 | 56770 | 2860 | 67626 | 2107 | 44233 |
| 10-#18 | 2.39 | MA | 36455 | 8773 | 59005 | 6470 | 64141 | 5230 | 65853 | 4287 | 66931 | 2924 | 80188 | 2197 | 51909 |
| 4L-3S | | MI | 32585 | 8773 | 53222 | 6364 | 57936 | 5183 | 59832 | 4252 | 61152 | 2838 | 72526 | 2328 | 44467 |
| 10-#18 | 2.39 | MA | 35086 | 8773 | 56699 | 6462 | 61150 | 5262 | 62178 | 4316 | 61630 | 2902 | 73892 | 2094 | 49368 |
| 5L-2S | | MI | 34412 | 8773 | 55966 | 6375 | 61454 | 5154 | 64123 | 4228 | 66887 | 2816 | 80108 | 2549 | 44479 |
| 12-#11 | 1.12 | MA | 36287 | 8038 | 56154 | 6040 | 60815 | 4927 | 61912 | 4114 | 61379 | 2975 | 72127 | 2828 | 25359 |
| 2L-6S | | MI | 29020 | 8038 | 45082 | 5986 | 47761 | 4895 | 47540 | 4084 | 44928 | 2958 | 51949 | 2506 | 21815 |
| 12-#11 | 1.12 | MA | 35399 | 8038 | 54852 | 6038 | 59147 | 4923 | 59878 | 4127 | 58611 | 2985 | 68381 | 2741 | 25400 |
| 3L-5S | | MI | 29471 | 8038 | 45811 | 5989 | 48770 | 4899 | 48773 | 4090 | 46545 | 2950 | 53953 | 2563 | 21814 |
| 12-#11 | 1.12 | MA | 34776 | 8038 | 53794 | 6053 | 57798 | 4937 | 58238 | 4122 | 56501 | 2995 | 65939 | 2655 | 25434 |
| 4E | | MI | 29944 | 8038 | 46587 | 5993 | 49777 | 4887 | 50011 | 4079 | 48330 | 2958 | 56073 | 2603 | 21780 |
| 12-#11 | 1.12 | MA | 34220 | 8038 | 52879 | 6051 | 56611 | 4934 | 56780 | 4135 | 54389 | 2988 | 63396 | 2613 | 25440 |
| 5L-3S | | MI | 30473 | 8038 | 47485 | 5979 | 50921 | 4891 | 51401 | 4085 | 50112 | 2950 | 58089 | 2689 | 21734 |
| 12-#11 | 1.12 | MA | 33690 | 8038 | 52022 | 6048 | 55424 | 4947 | 55328 | 4130 | 52475 | 2998 | 60973 | 2557 | 25391 |
| 6L-2S | | MI | 31221 | 8038 | 48584 | 5982 | 52329 | 4879 | 53119 | 4074 | 52444 | 2941 | 61194 | 2776 | 21688 |
| 12-#14 | 1.61 | MA | 37853 | 8324 | 59616 | 6200 | 65136 | 5039 | 67139 | 4179 | 68472 | 2941 | 81515 | 2764 | 36050 |
| 2L-6S | | MI | 29395 | 8324 | 46490 | 6142 | 49418 | 5009 | 49517 | 4147 | 47582 | 2924 | 55762 | 2311 | 30040 |
| 12-#14 | 1.61 | MA | 36593 | 8324 | 57754 | 6196 | 62748 | 5034 | 64226 | 4196 | 64508 | 2955 | 76184 | 2639 | 36085 |
| 3L-5S | | MI | 30035 | 8324 | 47535 | 6148 | 50864 | 5016 | 51283 | 4157 | 49883 | 2911 | 58604 | 2392 | 30736 |
| 12-#14 | 1.61 | MA | 35709 | 8324 | 56236 | 6217 | 60814 | 5053 | 61875 | 4189 | 61483 | 2969 | 72714 | 2515 | 36050 |
| 4E | | MI | 30707 | 8324 | 48648 | 6153 | 52307 | 4999 | 53056 | 4142 | 52424 | 2924 | 61619 | 2449 | 30799 |
| 12-#14 | 1.61 | MA | 34919 | 8324 | 54924 | 6213 | 59113 | 5047 | 59784 | 4206 | 58455 | 2957 | 69088 | 2455 | 35918 |
| 5L-3S | | MI | 31457 | 8324 | 49933 | 6133 | 53945 | 5006 | 55046 | 4151 | 54958 | 2911 | 64476 | 2574 | 30782 |
| 12-#14 | 1.61 | MA | 34167 | 8324 | 53694 | 6210 | 57409 | 5067 | 57702 | 4199 | 55710 | 2971 | 65643 | 2374 | 35020 |
| 6L-2S | | MI | 32517 | 8324 | 51504 | 6138 | 55959 | 4989 | 57503 | 4136 | 58275 | 2899 | 68883 | 2698 | 30734 |
| 12-#18 | 2.87 | MA | 41641 | 9050 | 68196 | 6615 | 75903 | 5334 | 80186 | 4350 | 86070 | 2857 | 104619 | 2588 | 62546 |
| 2L-6S | | MI | 30285 | 9050 | 49927 | 6547 | 53517 | 5304 | 54429 | 4312 | 54130 | 2831 | 65113 | 1801 | 48907 |
| 12-#18 | 2.87 | MA | 39481 | 9050 | 64933 | 6607 | 71720 | 5366 | 75083 | 4379 | 79147 | 2879 | 95397 | 2367 | 62390 |
| 3L-5S | | MI | 31384 | 9050 | 51761 | 6558 | 56054 | 5320 | 57528 | 4331 | 58110 | 2809 | 69995 | 1947 | 50320 |
| 12-#18 | 2.87 | MA | 37963 | 9050 | 62268 | 6643 | 68324 | 5354 | 70956 | 4363 | 73855 | 2901 | 89410 | 2145 | 61930 |
| 4E | | MI | 32538 | 9050 | 53715 | 6569 | 58585 | 5291 | 60637 | 4307 | 62504 | 2831 | 75208 | 2044 | 52667 |
| 12-#18 | 2.87 | MA | 36606 | 9050 | 59961 | 6635 | 65333 | 5386 | 67281 | 4391 | 68553 | 2879 | 83114 | 2042 | 59105 |
| 5L-3S | | MI | 33826 | 9050 | 55966 | 6536 | 61454 | 5307 | 64123 | 4327 | 66887 | 2809 | 80108 | 2266 | 52980 |
| 12-#18 | 2.87 | MA | 35315 | 9050 | 57798 | 6626 | 62337 | 5374 | 63620 | 4376 | 63749 | 2901 | 77162 | 1898 | 57382 |
| 6L-2S | | MI | 35640 | 9050 | 58711 | 6548 | 64972 | 5278 | 68415 | 4303 | 72621 | 2787 | 87689 | 2487 | 53068 |
| 14-#11 | 1.31 | MA | 36904 | 8145 | 57455 | 6107 | 62483 | 4975 | 63947 | 4144 | 64148 | 2966 | 75874 | 2811 | 29452 |
| 2L-7S | | MI | 29103 | 8145 | 45382 | 6068 | 48207 | 4956 | 48075 | 4124 | 45678 | 2958 | 52914 | 2396 | 24851 |
| 14-#11 | 1.31 | MA | 36018 | 8145 | 56154 | 6105 | 60815 | 4972 | 61912 | 4156 | 61379 | 2976 | 72127 | 2725 | 29485 |
| 3L-6S | | MI | 29541 | 8145 | 46181 | 6054 | 49169 | 4943 | 49259 | 4113 | 47259 | 2949 | 55054 | 2486 | 25230 |
| 14-#11 | 1.31 | MA | 35398 | 8145 | 55095 | 6120 | 59466 | 4985 | 60273 | 4152 | 59269 | 2986 | 69686 | 2638 | 29506 |
| 4L-5S | | MI | 29991 | 8145 | 46909 | 6057 | 50178 | 4948 | 50491 | 4119 | 48877 | 2940 | 57058 | 2543 | 25253 |
| 14-#11 | 1.31 | MA | 34844 | 8145 | 54180 | 6118 | 58279 | 4982 | 58815 | 4164 | 57157 | 2979 | 67143 | 2596 | 29489 |
| 5L-4S | | MI | 30462 | 8145 | 47686 | 6060 | 51186 | 4935 | 51729 | 4108 | 50662 | 2949 | 59178 | 2583 | 25233 |
| 14-#11 | 1.31 | MA | 34317 | 8145 | 53323 | 6116 | 57092 | 4996 | 57363 | 4159 | 55244 | 2989 | 64720 | 2541 | 29420 |
| 6L-3S | | MI | 30989 | 8145 | 48584 | 6046 | 52329 | 4940 | 53119 | 4114 | 52444 | 2940 | 61194 | 2669 | 25197 |

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

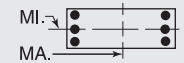
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.31 | MA | 33803 | 8145 | 52384 | 6131 | 55959 | 4992 | 55970 | 4172 | 53375 | 2999 | 62136 | 2451 | 28913 |
| 7L-2S | | MI | 31735 | 8145 | 49682 | 6049 | 53738 | 4927 | 54837 | 4103 | 54775 | 2932 | 64299 | 2755 | 25156 |
| 14-#14 | 1.88 | MA | 38721 | 8480 | 61479 | 6297 | 67524 | 5109 | 70052 | 4221 | 72435 | 2929 | 86846 | 2738 | 41888 |
| 2L-7S | | MI | 29510 | 8480 | 46917 | 6259 | 50052 | 5096 | 50277 | 4205 | 48649 | 2922 | 57132 | 2150 | 34202 |
| 14-#14 | 1.88 | MA | 37467 | 8480 | 59616 | 6293 | 65136 | 5104 | 67139 | 4239 | 68472 | 2943 | 81515 | 2614 | 41895 |
| 3L-6S | | MI | 30131 | 8480 | 48061 | 6240 | 51432 | 5079 | 51974 | 4190 | 50898 | 2910 | 60169 | 2280 | 34764 |
| 14-#14 | 1.88 | MA | 36587 | 8480 | 58099 | 6314 | 63202 | 5123 | 64788 | 4231 | 65447 | 2956 | 78045 | 2489 | 41831 |
| 4L-5S | | MI | 30768 | 8480 | 49106 | 6245 | 52878 | 5086 | 53740 | 4199 | 53200 | 2897 | 63011 | 2362 | 35594 |
| 14-#14 | 1.88 | MA | 35801 | 8480 | 56787 | 6311 | 61501 | 5117 | 62698 | 4249 | 62418 | 2945 | 74419 | 2429 | 41665 |
| 5L-4S | | MI | 31437 | 8480 | 50219 | 6250 | 54321 | 5069 | 55513 | 4184 | 55740 | 2910 | 66026 | 2418 | 35688 |
| 14-#14 | 1.88 | MA | 35054 | 8480 | 55557 | 6307 | 59797 | 5137 | 60615 | 4241 | 59674 | 2959 | 70974 | 2349 | 40632 |
| 6L-3S | | MI | 32183 | 8480 | 51504 | 6230 | 55959 | 5076 | 57503 | 4194 | 58275 | 2897 | 68883 | 2543 | 35704 |
| 14-#14 | 1.88 | MA | 34325 | 8480 | 54210 | 6328 | 58171 | 5131 | 58617 | 4259 | 56993 | 2972 | 67298 | 2219 | 39888 |
| 7L-2S | | MI | 33239 | 8480 | 53075 | 6236 | 57973 | 5059 | 59960 | 4179 | 61591 | 2885 | 73289 | 2668 | 35671 |
| 14-#18 | 3.35 | MA | 40963 | 9327 | 68196 | 6780 | 75903 | 5490 | 80186 | 4454 | 86070 | 2856 | 104619 | 2315 | 72479 |
| 3L-6S | | MI | 31542 | 9327 | 52672 | 6720 | 57035 | 5428 | 58720 | 4387 | 59865 | 2803 | 72695 | 1739 | 56887 |
| 14-#18 | 3.35 | MA | 39456 | 9327 | 65531 | 6816 | 72507 | 5478 | 76059 | 4438 | 80778 | 2878 | 98632 | 2094 | 71931 |
| 4L-5S | | MI | 32632 | 9327 | 54506 | 6731 | 59572 | 5444 | 61819 | 4407 | 63844 | 2780 | 77577 | 1884 | 58507 |
| 14-#18 | 3.35 | MA | 38111 | 9327 | 63224 | 6807 | 69516 | 5510 | 72384 | 4467 | 75477 | 2856 | 92336 | 1991 | 68872 |
| 5L-4S | | MI | 33778 | 9327 | 56459 | 6742 | 62103 | 5415 | 64929 | 4383 | 68239 | 2803 | 82789 | 1982 | 60867 |
| 14-#18 | 3.35 | MA | 36830 | 9327 | 61061 | 6799 | 66520 | 5498 | 68723 | 4451 | 70672 | 2878 | 86384 | 1847 | 66944 |
| 6L-3S | | MI | 35056 | 9327 | 58711 | 6709 | 64972 | 5431 | 68415 | 4403 | 72621 | 2780 | 87689 | 2203 | 61473 |
| 14-#18 | 3.35 | MA | 35584 | 9327 | 58691 | 6835 | 63661 | 5531 | 65208 | 4480 | 65977 | 2900 | 80028 | 1615 | 63814 |
| 7L-2S | | MI | 36858 | 9327 | 61455 | 6721 | 68490 | 5402 | 72707 | 4378 | 78356 | 2758 | 95270 | 2425 | 61617 |
| 16-#11 | 1.49 | MA | 37518 | 8253 | 58756 | 6175 | 64151 | 5024 | 65982 | 4173 | 66916 | 2957 | 79621 | 2795 | 33536 |
| 2L-8S | | MI | 29194 | 8253 | 45764 | 6132 | 48639 | 4999 | 48638 | 4165 | 46329 | 2940 | 54038 | 2329 | 27895 |
| 16-#11 | 1.49 | MA | 36635 | 8253 | 57455 | 6173 | 62483 | 5020 | 63947 | 4186 | 64148 | 2968 | 75874 | 2708 | 33561 |
| 3L-7S | | MI | 29624 | 8253 | 46481 | 6135 | 49615 | 5004 | 49793 | 4154 | 48009 | 2949 | 56019 | 2376 | 28183 |
| 16-#11 | 1.49 | MA | 36017 | 8253 | 56396 | 6188 | 61134 | 5034 | 62307 | 4181 | 62037 | 2978 | 73432 | 2622 | 33567 |
| 4L-6S | | MI | 30061 | 8253 | 47279 | 6121 | 50578 | 4991 | 50977 | 4142 | 49590 | 2940 | 58159 | 2466 | 28629 |
| 16-#11 | 1.49 | MA | 35465 | 8253 | 55481 | 6185 | 59947 | 5030 | 60850 | 4194 | 59925 | 2970 | 70889 | 2580 | 33531 |
| 5E | | MI | 30508 | 8253 | 48008 | 6124 | 51587 | 4996 | 52210 | 4149 | 51208 | 2931 | 60163 | 2523 | 28679 |
| 16-#11 | 1.49 | MA | 34940 | 8253 | 54624 | 6183 | 58760 | 5044 | 59398 | 4189 | 58012 | 2980 | 68467 | 2524 | 33442 |
| 6L-4S | | MI | 30978 | 8253 | 48785 | 6127 | 52594 | 4984 | 53447 | 4138 | 52993 | 2940 | 62283 | 2563 | 28677 |
| 16-#11 | 1.49 | MA | 34428 | 8253 | 53685 | 6198 | 57627 | 5041 | 58005 | 4201 | 56143 | 2990 | 65883 | 2434 | 32861 |
| 7L-3S | | MI | 31503 | 8253 | 49682 | 6113 | 53738 | 4988 | 54837 | 4144 | 54775 | 2931 | 64299 | 2649 | 28651 |
| 16-#11 | 1.49 | MA | 33924 | 8253 | 52841 | 6196 | 56478 | 5054 | 56645 | 4214 | 54157 | 2983 | 63505 | 2385 | 32472 |
| 8L-2S | | MI | 32247 | 8253 | 50781 | 6117 | 55146 | 4976 | 56556 | 4133 | 57106 | 2923 | 67404 | 2735 | 28617 |
| 16-#14 | 2.15 | MA | 39583 | 8635 | 63342 | 6394 | 69912 | 5179 | 72966 | 4264 | 76399 | 2917 | 92177 | 2713 | 47720 |
| 2L-8S | | MI | 29637 | 8635 | 47460 | 6351 | 50666 | 5159 | 51078 | 4263 | 49575 | 2895 | 58720 | 2052 | 38046 |
| 16-#14 | 2.15 | MA | 38334 | 8635 | 61479 | 6390 | 67524 | 5173 | 70052 | 4281 | 72435 | 2930 | 86846 | 2588 | 47694 |
| 3L-7S | | MI | 30246 | 8635 | 48488 | 6357 | 52066 | 5166 | 52734 | 4247 | 51966 | 2908 | 61538 | 2119 | 38961 |
| 16-#14 | 2.15 | MA | 37459 | 8635 | 59962 | 6412 | 65590 | 5193 | 67702 | 4274 | 69410 | 2944 | 83376 | 2464 | 47604 |
| 4L-6S | | MI | 30864 | 8635 | 49632 | 6337 | 53446 | 5149 | 54431 | 4232 | 54215 | 2895 | 64575 | 2249 | 39499 |
| 16-#14 | 2.15 | MA | 36678 | 8635 | 58650 | 6408 | 63889 | 5187 | 65611 | 4291 | 66382 | 2933 | 79751 | 2404 | 47408 |
| 5E | | MI | 31497 | 8635 | 50677 | 6342 | 54892 | 5156 | 56197 | 4242 | 56516 | 2883 | 67417 | 2331 | 40405 |
| 16-#14 | 2.15 | MA | 35934 | 8635 | 57420 | 6404 | 62185 | 5206 | 63529 | 4284 | 63638 | 2946 | 76305 | 2323 | 46256 |
| 6L-4S | | MI | 32163 | 8635 | 51790 | 6347 | 56335 | 5139 | 57970 | 4227 | 59057 | 2895 | 70433 | 2388 | 40567 |
| 16-#14 | 2.15 | MA | 35210 | 8635 | 56072 | 6425 | 60560 | 5201 | 61530 | 4301 | 60957 | 2960 | 72630 | 2193 | 45540 |
| 7L-3S | | MI | 32906 | 8635 | 53075 | 6328 | 57973 | 5146 | 59960 | 4236 | 61591 | 2883 | 73289 | 2512 | 40612 |
| 16-#14 | 2.15 | MA | 34496 | 8635 | 54862 | 6422 | 58911 | 5220 | 59579 | 4318 | 58107 | 2948 | 69240 | 2123 | 44406 |
| 8L-2S | | MI | 33957 | 8635 | 54646 | 6333 | 59987 | 5129 | 62417 | 4221 | 64908 | 2871 | 77696 | 2637 | 40598 |
| 16-#18 | 3.83 | MA | 40937 | 9603 | 68794 | 6989 | 76690 | 5602 | 81162 | 4514 | 87701 | 2854 | 107854 | 2043 | 81570 |
| 4L-6S | | MI | 32787 | 9603 | 55416 | 6893 | 60553 | 5553 | 63012 | 4462 | 65600 | 2774 | 80276 | 1677 | 64900 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis

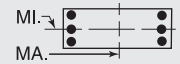



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 3.83 | MA | 39602 | 9603 | 66487 | 6980 | 73699 | 5634 | 77487 | 4542 | 82400 | 2832 | 101558 | 1940 | 78664 |
| 5E | | MI | 33870 | 9603 | 57250 | 6904 | 63089 | 5568 | 66111 | 4482 | 69579 | 2752 | 85158 | 1822 | 66718 |
| 16-#18 | 3.83 | MA | 38332 | 9603 | 64324 | 6972 | 70703 | 5623 | 73826 | 4527 | 77595 | 2854 | 95606 | 1795 | 76538 |
| 6L-4S | | MI | 35007 | 9603 | 59203 | 6915 | 65621 | 5539 | 69221 | 4458 | 73974 | 2774 | 90370 | 1920 | 68944 |
| 16-#18 | 3.83 | MA | 37095 | 9603 | 61953 | 7008 | 67844 | 5655 | 70311 | 4555 | 72900 | 2877 | 89249 | 1564 | 73523 |
| 7L-3S | | MI | 36276 | 9603 | 61455 | 6882 | 68490 | 5555 | 72707 | 4478 | 78356 | 2752 | 95270 | 2141 | 69952 |
| 18-#11 | 1.68 | MA | 38129 | 8361 | 60057 | 6242 | 65819 | 5072 | 68017 | 4203 | 69685 | 2949 | 83367 | 2778 | 37615 |
| 2L-9S | | MI | 29279 | 8361 | 46090 | 6213 | 49097 | 5060 | 49148 | 4188 | 47093 | 2940 | 55200 | 2255 | 30836 |
| 18-#11 | 1.68 | MA | 37249 | 8361 | 58756 | 6240 | 64151 | 5069 | 65982 | 4215 | 66916 | 2959 | 79621 | 2692 | 37632 |
| 3L-8S | | MI | 29714 | 8361 | 46863 | 6199 | 50047 | 5048 | 50356 | 4194 | 48660 | 2931 | 57143 | 2309 | 31242 |
| 18-#11 | 1.68 | MA | 36633 | 8361 | 57697 | 6255 | 62801 | 5082 | 64342 | 4210 | 64806 | 2969 | 77179 | 2606 | 37619 |
| 4L-7S | | MI | 30142 | 8361 | 47580 | 6202 | 51024 | 5052 | 51512 | 4183 | 50340 | 2940 | 59124 | 2356 | 31520 |
| 18-#11 | 1.68 | MA | 36084 | 8361 | 56783 | 6253 | 61615 | 5079 | 62884 | 4223 | 62694 | 2962 | 74636 | 2564 | 37569 |
| 5L-6S | | MI | 30577 | 8361 | 48378 | 6188 | 51987 | 5040 | 52695 | 4172 | 51921 | 2931 | 61264 | 2446 | 31945 |
| 18-#11 | 1.68 | MA | 35560 | 8361 | 55925 | 6251 | 60428 | 5093 | 61433 | 4218 | 60781 | 2972 | 72213 | 2508 | 37371 |
| 6L-5S | | MI | 31023 | 8361 | 49107 | 6192 | 52995 | 5045 | 53928 | 4178 | 53539 | 2922 | 63268 | 2503 | 32097 |
| 18-#11 | 1.68 | MA | 35050 | 8361 | 54986 | 6266 | 59295 | 5089 | 60039 | 4231 | 58912 | 2982 | 69630 | 2418 | 36814 |
| 7L-4S | | MI | 31492 | 8361 | 49884 | 6195 | 54003 | 5032 | 55166 | 4167 | 55324 | 2931 | 65388 | 2543 | 32116 |
| 18-#11 | 1.68 | MA | 34548 | 8361 | 54143 | 6263 | 58145 | 5103 | 58680 | 4243 | 56925 | 2975 | 67251 | 2369 | 36437 |
| 8L-3S | | MI | 32015 | 8361 | 50781 | 6181 | 55146 | 5037 | 56556 | 4173 | 57106 | 2922 | 67404 | 2629 | 32099 |
| 18-#11 | 1.68 | MA | 34025 | 8361 | 53317 | 6261 | 57028 | 5099 | 57258 | 4239 | 55073 | 2985 | 64902 | 2315 | 35909 |
| 9L-2S | | MI | 32756 | 8361 | 51880 | 6184 | 56555 | 5024 | 58274 | 4162 | 59437 | 2914 | 70509 | 2715 | 32071 |
| 18-#14 | 2.42 | MA | 39197 | 8791 | 63342 | 6488 | 69912 | 5243 | 72966 | 4324 | 76399 | 2918 | 92177 | 2563 | 53486 |
| 3L-8S | | MI | 30371 | 8791 | 49031 | 6449 | 52680 | 5229 | 53535 | 4305 | 52891 | 2881 | 63127 | 2021 | 42725 |
| 18-#14 | 2.42 | MA | 38326 | 8791 | 61825 | 6509 | 67978 | 5263 | 70615 | 4316 | 73374 | 2931 | 88708 | 2438 | 53371 |
| 4L-7S | | MI | 30977 | 8791 | 50059 | 6454 | 54080 | 5236 | 55191 | 4290 | 55282 | 2894 | 65945 | 2088 | 43725 |
| 18-#14 | 2.42 | MA | 37549 | 8791 | 60513 | 6505 | 66277 | 5257 | 68524 | 4334 | 70346 | 2920 | 85082 | 2379 | 53012 |
| 5L-6S | | MI | 31591 | 8791 | 51203 | 6434 | 55460 | 5219 | 56888 | 4275 | 57531 | 2881 | 68982 | 2218 | 44243 |
| 18-#14 | 2.42 | MA | 36809 | 8791 | 59283 | 6502 | 64573 | 5276 | 66442 | 4326 | 67602 | 2934 | 81637 | 2298 | 51889 |
| 6L-5S | | MI | 32222 | 8791 | 52248 | 6439 | 56906 | 5226 | 58654 | 4284 | 59833 | 2869 | 71824 | 2300 | 45104 |
| 18-#14 | 2.42 | MA | 36088 | 8791 | 57935 | 6523 | 62948 | 5271 | 64443 | 4343 | 64920 | 2947 | 77961 | 2168 | 51197 |
| 7L-4S | | MI | 32884 | 8791 | 53361 | 6445 | 58349 | 5208 | 60427 | 4269 | 62373 | 2881 | 74839 | 2357 | 45437 |
| 18-#14 | 2.42 | MA | 35379 | 8791 | 56724 | 6519 | 61299 | 5290 | 62493 | 4361 | 62071 | 2936 | 74571 | 2098 | 49977 |
| 8L-3S | | MI | 33624 | 8791 | 54646 | 6425 | 59987 | 5216 | 62417 | 4279 | 64908 | 2869 | 77696 | 2481 | 45505 |
| 18-#14 | 2.42 | MA | 34649 | 8791 | 55421 | 6540 | 59695 | 5284 | 60453 | 4353 | 59414 | 2950 | 71230 | 2020 | 48909 |
| 9L-2S | | MI | 34671 | 8791 | 56217 | 6430 | 62001 | 5198 | 64874 | 4263 | 68224 | 2857 | 82103 | 2606 | 45523 |
| 18-#18 | 4.31 | MA | 41081 | 9880 | 69750 | 7153 | 77882 | 5759 | 82590 | 4618 | 89323 | 2809 | 110780 | 1888 | 88476 |
| 5L-6S | | MI | 34022 | 9880 | 58160 | 7066 | 64071 | 5677 | 67304 | 4538 | 71334 | 2745 | 87857 | 1614 | 72941 |
| 18-#18 | 4.31 | MA | 39821 | 9880 | 67586 | 7145 | 74886 | 5747 | 78929 | 4602 | 84518 | 2831 | 104828 | 1744 | 86159 |
| 6L-5S | | MI | 35098 | 9880 | 59994 | 7077 | 66607 | 5692 | 70403 | 4558 | 75313 | 2723 | 92739 | 1760 | 74948 |
| 18-#18 | 4.31 | MA | 38594 | 9880 | 65216 | 7181 | 72027 | 5779 | 75414 | 4630 | 79823 | 2853 | 98471 | 1513 | 83252 |
| 7L-4S | | MI | 36227 | 9880 | 61947 | 7088 | 69139 | 5664 | 73512 | 4533 | 79708 | 2745 | 97952 | 1857 | 77053 |
| 20-#11 | 1.87 | MA | 38737 | 8469 | 61358 | 6310 | 67486 | 5120 | 70052 | 4232 | 72453 | 2940 | 87114 | 2762 | 41689 |
| 2L-10S | | MI | 29346 | 8469 | 46473 | 6277 | 49542 | 5104 | 49717 | 4229 | 47871 | 2939 | 56423 | 2173 | 33635 |
| 20-#11 | 1.87 | MA | 37860 | 8469 | 60057 | 6308 | 65819 | 5117 | 68017 | 4245 | 69685 | 2950 | 83367 | 2676 | 41694 |
| 3L-9S | | MI | 29800 | 8469 | 47189 | 6281 | 50506 | 5109 | 50866 | 4217 | 49424 | 2931 | 58305 | 2235 | 34128 |
| 20-#11 | 1.87 | MA | 37247 | 8469 | 58998 | 6323 | 64469 | 5131 | 66377 | 4240 | 67574 | 2960 | 80926 | 2589 | 41667 |
| 4L-8S | | MI | 30232 | 8469 | 47961 | 6267 | 51456 | 5096 | 52075 | 4224 | 50991 | 2922 | 60248 | 2289 | 34592 |
| 20-#11 | 1.87 | MA | 36699 | 8469 | 58084 | 6320 | 63283 | 5127 | 64919 | 4252 | 65462 | 2953 | 78383 | 2547 | 41602 |
| 5L-7S | | MI | 30659 | 8469 | 48679 | 6270 | 52432 | 5101 | 53230 | 4212 | 52671 | 2931 | 62229 | 2336 | 34862 |
| 20-#11 | 1.87 | MA | 36178 | 8469 | 57226 | 6318 | 62095 | 5141 | 63467 | 4248 | 63549 | 2963 | 75960 | 2491 | 41307 |
| 6E | | MI | 31092 | 8469 | 49477 | 6256 | 53395 | 5088 | 54414 | 4201 | 54252 | 2922 | 64369 | 2426 | 35267 |
| 20-#11 | 1.87 | MA | 35670 | 8469 | 56287 | 6333 | 60963 | 5138 | 62074 | 4260 | 61680 | 2973 | 73376 | 2401 | 40772 |
| 7L-5S | | MI | 31536 | 8469 | 50206 | 6259 | 54404 | 5093 | 55647 | 4207 | 55870 | 2913 | 66373 | 2482 | 35511 |
| 20-#11 | 1.87 | MA | 35170 | 8469 | 55444 | 6331 | 59813 | 5151 | 60715 | 4273 | 59694 | 2966 | 70998 | 2352 | 40405 |
| 8L-4S | | MI | 32003 | 8469 | 50983 | 6262 | 55411 | 5080 | 56884 | 4196 | 57655 | 2922 | 68493 | 2523 | 35543 |
| 20-#11 | 1.87 | MA | 34649 | 8469 | 54618 | 6329 | 58696 | 5148 | 59293 | 4268 | 57841 | 2976 | 68649 | 2298 | 39819 |
| 9L-3S | | MI | 32524 | 8469 | 51880 | 6248 | 56555 | 5085 | 58274 | 4202 | 59437 | 2913 | 70509 | 2609 | 35541 |

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

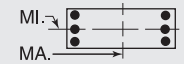
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.87 | MA | 34097 | 8469 | 53694 | 6344 | 57562 | 5162 | 57940 | 4280 | 56005 | 2986 | 66373 | 2237 | 39183 |
| 10L-2S | | MI | 33263 | 8469 | 52979 | 6251 | 57964 | 5072 | 59993 | 4191 | 61768 | 2905 | 73614 | 2695 | 35519 |
| 20-#14 | 2.69 | MA | 39188 | 8946 | 63687 | 6606 | 70366 | 5332 | 73528 | 4359 | 77338 | 2919 | 94039 | 2413 | 59132 |
| 4L-8S | | MI | 31101 | 8946 | 50602 | 6546 | 54694 | 5298 | 55992 | 4347 | 56208 | 2867 | 67533 | 1990 | 47413 |
| 20-#14 | 2.69 | MA | 38415 | 8946 | 62375 | 6602 | 68665 | 5327 | 71437 | 4376 | 74309 | 2908 | 90413 | 2353 | 58607 |
| 5L-7S | | MI | 31703 | 8946 | 51630 | 6551 | 56094 | 5306 | 57648 | 4332 | 58599 | 2880 | 70352 | 2057 | 48494 |
| 20-#14 | 2.69 | MA | 37679 | 8946 | 61145 | 6599 | 66961 | 5346 | 69355 | 4368 | 71565 | 2921 | 86968 | 2272 | 57531 |
| 6E | | MI | 32315 | 8946 | 52774 | 6531 | 57474 | 5288 | 59344 | 4317 | 60848 | 2867 | 73388 | 2187 | 48995 |
| 20-#14 | 2.69 | MA | 36962 | 8946 | 59798 | 6620 | 65336 | 5341 | 67357 | 4386 | 68884 | 2935 | 83292 | 2143 | 56859 |
| 7L-5S | | MI | 32943 | 8946 | 53819 | 6537 | 58920 | 5296 | 61111 | 4327 | 63149 | 2855 | 76230 | 2269 | 49815 |
| 20-#14 | 2.69 | MA | 36256 | 8946 | 58587 | 6616 | 63687 | 5360 | 65406 | 4403 | 66034 | 2924 | 79902 | 2073 | 55558 |
| 8L-4S | | MI | 33602 | 8946 | 54932 | 6542 | 60363 | 5278 | 62884 | 4311 | 65689 | 2867 | 79246 | 2326 | 50302 |
| 20-#14 | 2.69 | MA | 35531 | 8946 | 57284 | 6637 | 62083 | 5354 | 63366 | 4396 | 63378 | 2937 | 76562 | 1995 | 54520 |
| 9L-3S | | MI | 34338 | 8946 | 56217 | 6522 | 62001 | 5286 | 64874 | 4321 | 68224 | 2855 | 82103 | 2450 | 50391 |
| 20-#18 | 4.78 | MA | 41298 | 10157 | 70849 | 7318 | 79069 | 5871 | 84032 | 4677 | 91442 | 2808 | 114050 | 1693 | 95806 |
| 6E | | MI | 35249 | 10157 | 60904 | 7239 | 67589 | 5801 | 71595 | 4613 | 77069 | 2717 | 95439 | 1552 | 81007 |
| 20-#18 | 4.78 | MA | 40080 | 10157 | 68479 | 7354 | 76210 | 5903 | 80517 | 4706 | 86746 | 2830 | 107693 | 1461 | 92999 |
| 7L-5S | | MI | 36317 | 10157 | 62738 | 7250 | 70125 | 5816 | 74694 | 4633 | 81048 | 2694 | 100321 | 1697 | 83194 |
| 22-#11 | 2.05 | MA | 38468 | 8577 | 61358 | 6375 | 67486 | 5165 | 70052 | 4274 | 72453 | 2942 | 87114 | 2659 | 45749 |
| 3L-10S | | MI | 29865 | 8577 | 47572 | 6345 | 50950 | 5152 | 51435 | 4258 | 50202 | 2930 | 59528 | 2153 | 36947 |
| 22-#11 | 2.05 | MA | 37857 | 8577 | 60299 | 6390 | 66137 | 5179 | 68412 | 4269 | 70343 | 2952 | 84672 | 2573 | 45710 |
| 4L-9S | | MI | 30319 | 8577 | 48288 | 6348 | 51914 | 5157 | 52585 | 4247 | 51755 | 2922 | 61410 | 2215 | 37426 |
| 22-#11 | 2.05 | MA | 37311 | 8577 | 59385 | 6388 | 64951 | 5176 | 66954 | 4282 | 68231 | 2944 | 82129 | 2531 | 45631 |
| 5L-8S | | MI | 30747 | 8577 | 49060 | 6334 | 52864 | 5145 | 53793 | 4253 | 53322 | 2913 | 63353 | 2269 | 37943 |
| 22-#11 | 2.05 | MA | 36792 | 8577 | 58528 | 6385 | 63763 | 5189 | 65502 | 4277 | 66318 | 2954 | 79707 | 2475 | 45249 |
| 6L-7S | | MI | 31172 | 8577 | 49778 | 6337 | 53841 | 5149 | 54949 | 4242 | 55003 | 2922 | 65334 | 2316 | 38206 |
| 22-#11 | 2.05 | MA | 36287 | 8577 | 57588 | 6400 | 62630 | 5186 | 64109 | 4290 | 64449 | 2965 | 77123 | 2385 | 44734 |
| 7L-6S | | MI | 31604 | 8577 | 50576 | 6323 | 54804 | 5137 | 56132 | 4231 | 56583 | 2913 | 67474 | 2406 | 38595 |
| 22-#11 | 2.05 | MA | 35788 | 8577 | 56745 | 6398 | 61481 | 5200 | 62749 | 4302 | 62462 | 2957 | 74745 | 2336 | 44375 |
| 8L-5S | | MI | 32047 | 8577 | 51305 | 6326 | 55813 | 5141 | 57365 | 4237 | 58201 | 2904 | 69478 | 2462 | 38920 |
| 22-#11 | 2.05 | MA | 35270 | 8577 | 55919 | 6396 | 60364 | 5196 | 61327 | 4297 | 60610 | 2967 | 72396 | 2282 | 43736 |
| 9L-4S | | MI | 32512 | 8577 | 52081 | 6330 | 56820 | 5129 | 58603 | 4226 | 59986 | 2913 | 71598 | 2503 | 38964 |
| 22-#11 | 2.05 | MA | 34720 | 8577 | 54995 | 6411 | 59230 | 5210 | 59975 | 4310 | 58774 | 2977 | 70119 | 2221 | 43115 |
| 10L-3S | | MI | 33031 | 8577 | 52979 | 6316 | 57964 | 5133 | 59993 | 4232 | 61768 | 2904 | 73614 | 2589 | 38978 |
| 22-#11 | 2.05 | MA | 34183 | 8577 | 54168 | 6409 | 58118 | 5207 | 58571 | 4305 | 56815 | 2970 | 67800 | 2169 | 42383 |
| 11L-2S | | MI | 33768 | 8577 | 54078 | 6319 | 59372 | 5121 | 61711 | 4221 | 64099 | 2896 | 76719 | 2675 | 38964 |
| 22-#14 | 2.96 | MA | 39276 | 9102 | 64238 | 6700 | 71053 | 5397 | 74351 | 4418 | 78273 | 2895 | 95744 | 2328 | 64214 |
| 5L-8S | | MI | 31826 | 9102 | 52173 | 6643 | 56708 | 5368 | 58449 | 4390 | 59524 | 2853 | 71940 | 1959 | 52110 |
| 22-#14 | 2.96 | MA | 38544 | 9102 | 63008 | 6696 | 69349 | 5416 | 72268 | 4411 | 75529 | 2909 | 92299 | 2247 | 63180 |
| 6L-7S | | MI | 32426 | 9102 | 53201 | 6648 | 58108 | 5376 | 60105 | 4375 | 61915 | 2866 | 74758 | 2026 | 53214 |
| 22-#14 | 2.96 | MA | 37830 | 9102 | 61661 | 6717 | 67724 | 5410 | 70270 | 4428 | 72848 | 2922 | 88623 | 2117 | 62526 |
| 7L-6S | | MI | 33035 | 9102 | 54345 | 6629 | 59488 | 5358 | 61801 | 4359 | 64164 | 2853 | 77795 | 2156 | 53753 |
| 22-#14 | 2.96 | MA | 37128 | 9102 | 60450 | 6714 | 66075 | 5430 | 68319 | 4446 | 69998 | 2911 | 85233 | 2047 | 61148 |
| 8L-5S | | MI | 33660 | 9102 | 55390 | 6634 | 60934 | 5366 | 63568 | 4369 | 66466 | 2841 | 80637 | 2238 | 54537 |
| 22-#14 | 2.96 | MA | 36418 | 9102 | 59146 | 6735 | 64471 | 5424 | 66279 | 4438 | 67341 | 2925 | 81893 | 1969 | 60097 |
| 9L-4S | | MI | 34316 | 9102 | 56503 | 6639 | 62377 | 5348 | 65341 | 4354 | 69006 | 2853 | 83653 | 2295 | 55161 |
| 22-#18 | 5.26 | MA | 41555 | 10433 | 71742 | 7527 | 80393 | 6027 | 85620 | 4781 | 93670 | 2807 | 116915 | 1410 | 102763 |
| 7L-6S | | MI | 36467 | 10433 | 63648 | 7412 | 71107 | 5925 | 75887 | 4689 | 82803 | 2688 | 103020 | 1490 | 89095 |
| 24-#11 | 2.24 | MA | 38465 | 8685 | 61600 | 6457 | 67805 | 5228 | 70447 | 4299 | 73111 | 2943 | 88419 | 2556 | 49749 |
| 4L-10S | | MI | 30382 | 8685 | 48671 | 6412 | 52359 | 5201 | 53154 | 4287 | 52533 | 2921 | 62633 | 2133 | 40263 |
| 24-#11 | 2.24 | MA | 37921 | 8685 | 60686 | 6455 | 66619 | 5224 | 68989 | 4311 | 70999 | 2936 | 85876 | 2514 | 49658 |
| 5L-9S | | MI | 30841 | 8685 | 49386 | 6416 | 53323 | 5206 | 54303 | 4276 | 54087 | 2913 | 64515 | 2194 | 40728 |
| 24-#11 | 2.24 | MA | 37404 | 8685 | 59829 | 6453 | 65431 | 5238 | 67537 | 4306 | 69086 | 2946 | 83453 | 2458 | 49197 |
| 6L-8S | | MI | 31260 | 8685 | 50159 | 6402 | 54273 | 5193 | 55511 | 4282 | 55653 | 2904 | 66458 | 2249 | 41296 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

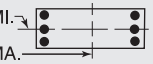
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.24 | MA | 36900 | 8685 | 58889 | 6468 | 64298 | 5234 | 66144 | 4319 | 67217 | 2956 | 80870 | 2369 | 48699 |
| 7E | | MI | 31684 | 8685 | 50876 | 6405 | 55250 | 5198 | 56667 | 4271 | 57334 | 2913 | 68439 | 2296 | 41554 |
| 24-#11 | 2.24 | MA | 36404 | 8685 | 58046 | 6466 | 63149 | 5248 | 64784 | 4332 | 65230 | 2949 | 78491 | 2319 | 48347 |
| 8L-6S | | MI | 32114 | 8685 | 51675 | 6391 | 56212 | 5185 | 57851 | 4260 | 58915 | 2904 | 70579 | 2386 | 41927 |
| 24-#11 | 2.24 | MA | 35888 | 8685 | 57220 | 6463 | 62032 | 5245 | 63362 | 4327 | 63378 | 2959 | 76142 | 2266 | 47657 |
| 9L-5S | | MI | 32556 | 8685 | 52403 | 6394 | 57221 | 5190 | 59083 | 4266 | 60532 | 2895 | 72583 | 2442 | 42325 |
| 24-#11 | 2.24 | MA | 35340 | 8685 | 56296 | 6478 | 60898 | 5258 | 62010 | 4339 | 61542 | 2969 | 73866 | 2205 | 47052 |
| 10L-4S | | MI | 33019 | 8685 | 53180 | 6397 | 58228 | 5177 | 60321 | 4255 | 62317 | 2904 | 74703 | 2483 | 42381 |
| 24-#11 | 2.24 | MA | 34805 | 8685 | 55469 | 6476 | 59786 | 5255 | 60606 | 4335 | 59584 | 2962 | 71547 | 2152 | 46280 |
| 11L-3S | | MI | 33537 | 8685 | 54078 | 6383 | 59372 | 5182 | 61711 | 4261 | 64099 | 2895 | 76719 | 2569 | 42406 |
| 24-#14 | 3.23 | MA | 39404 | 9258 | 64871 | 6793 | 71737 | 5486 | 75182 | 4453 | 79493 | 2896 | 97630 | 2222 | 68835 |
| 6L-8S | | MI | 32548 | 9258 | 53744 | 6740 | 58722 | 5438 | 60906 | 4432 | 62841 | 2839 | 76347 | 1928 | 56815 |
| 24-#14 | 3.23 | MA | 38694 | 9258 | 63524 | 6815 | 70112 | 5480 | 73183 | 4471 | 76811 | 2910 | 93955 | 2092 | 68122 |
| 7E | | MI | 33145 | 9258 | 54772 | 6746 | 60122 | 5445 | 62562 | 4417 | 65232 | 2852 | 79165 | 1995 | 57882 |
| 24-#14 | 3.23 | MA | 37995 | 9258 | 62313 | 6811 | 68463 | 5499 | 71232 | 4488 | 73962 | 2899 | 90564 | 2022 | 66746 |
| 8L-6S | | MI | 33752 | 9258 | 55916 | 6726 | 61502 | 5428 | 64258 | 4402 | 67481 | 2839 | 82202 | 2125 | 58516 |
| 24-#14 | 3.23 | MA | 37286 | 9258 | 61009 | 6832 | 66859 | 5494 | 69193 | 4481 | 71305 | 2912 | 87224 | 1944 | 65631 |
| 9L-5S | | MI | 34374 | 9258 | 56961 | 6731 | 62948 | 5435 | 66025 | 4411 | 69782 | 2827 | 85044 | 2207 | 59267 |

## RECTANGULAR TIED COLUMNS 38" x 46"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.37 | MA | 40453 | 8556 | 63353 | 6369 | 68745 | 5186 | 70346 | 4315 | 70687 | 3076 | 83306 | 2893 | 33526 |
| 2L-3S | | MI | 31346 | 8556 | 49654 | 6268 | 52894 | 5140 | 53188 | 4276 | 51420 | 3030 | 59282 | 2583 | 27394 |
| 6-#18 | 1.37 | MA | 38122 | 8556 | 59917 | 6362 | 64340 | 5219 | 64972 | 4344 | 63376 | 3098 | 73537 | 2671 | 33613 |
| 3L-2S | | MI | 33201 | 8556 | 52398 | 6279 | 56412 | 5112 | 57479 | 4252 | 57155 | 3008 | 66863 | 2804 | 27267 |
| 8-#14 | 1.03 | MA | 39330 | 8349 | 60695 | 6278 | 65582 | 5124 | 66580 | 4285 | 65603 | 3113 | 76807 | 2962 | 25549 |
| 2L-4S | | MI | 30509 | 8349 | 47419 | 6211 | 50273 | 5067 | 50086 | 4233 | 47535 | 3087 | 54735 | 2642 | 21012 |
| 8-#14 | 1.03 | MA | 37989 | 8349 | 58735 | 6275 | 63069 | 5119 | 63515 | 4303 | 61432 | 3127 | 71167 | 2838 | 25617 |
| 3E | | MI | 31267 | 8349 | 48704 | 6191 | 51911 | 5074 | 52076 | 4243 | 50070 | 3075 | 57592 | 2767 | 20934 |
| 8-#14 | 1.03 | MA | 37049 | 8349 | 57140 | 6296 | 61037 | 5139 | 61044 | 4296 | 58252 | 3142 | 67492 | 2713 | 25663 |
| 4L-2S | | MI | 32338 | 8349 | 50275 | 6196 | 53925 | 5057 | 54533 | 4228 | 53386 | 3062 | 61999 | 2891 | 20856 |
| 8-#18 | 1.83 | MA | 42052 | 8833 | 66789 | 6542 | 73149 | 5310 | 75719 | 4390 | 77998 | 3054 | 93076 | 2844 | 44316 |
| 2L-4S | | MI | 31303 | 8833 | 50147 | 6474 | 53543 | 5249 | 53993 | 4331 | 52772 | 3023 | 61963 | 2299 | 35894 |
| 8-#18 | 1.83 | MA | 39739 | 8833 | 63353 | 6535 | 68745 | 5343 | 70346 | 4420 | 70687 | 3076 | 83306 | 2623 | 44317 |
| 3E | | MI | 32612 | 8833 | 52398 | 6441 | 56412 | 5265 | 57479 | 4351 | 57155 | 3001 | 66863 | 2520 | 36001 |
| 8-#18 | 1.83 | MA | 38113 | 8833 | 60550 | 6572 | 65173 | 5332 | 66005 | 4405 | 65101 | 3099 | 76956 | 2402 | 44037 |
| 4L-2S | | MI | 34454 | 8833 | 55143 | 6452 | 59930 | 5236 | 61771 | 4327 | 62889 | 2979 | 74445 | 2742 | 35925 |
| 10-#14 | 1.29 | MA | 40260 | 8504 | 62655 | 6375 | 68095 | 5194 | 69646 | 4327 | 69773 | 3100 | 82447 | 2938 | 31719 |
| 2L-5S | | MI | 30573 | 8504 | 47876 | 6303 | 50844 | 5154 | 50770 | 4291 | 48311 | 3061 | 56127 | 2555 | 25944 |
| 10-#14 | 1.29 | MA | 38925 | 8504 | 60695 | 6372 | 65582 | 5189 | 66580 | 4345 | 65603 | 3115 | 76807 | 2814 | 31769 |
| 3L-4S | | MI | 31249 | 8504 | 48990 | 6308 | 52287 | 5137 | 52543 | 4276 | 50851 | 3073 | 59142 | 2611 | 25947 |
| 10-#14 | 1.29 | MA | 37990 | 8504 | 59100 | 6394 | 63549 | 5209 | 64110 | 4338 | 62423 | 3129 | 73132 | 2689 | 31776 |
| 4L-3S | | MI | 32004 | 8504 | 50275 | 6288 | 53925 | 5144 | 54533 | 4285 | 53386 | 3061 | 61999 | 2736 | 25894 |
| 10-#14 | 1.29 | MA | 37155 | 8504 | 57722 | 6390 | 61762 | 5204 | 61913 | 4356 | 59241 | 3119 | 69303 | 2629 | 31682 |
| 5L-2S | | MI | 33070 | 8504 | 51846 | 6294 | 55939 | 5127 | 56990 | 4270 | 56703 | 3048 | 66405 | 2861 | 25829 |
| 10-#18 | 2.29 | MA | 43634 | 9109 | 70225 | 6715 | 77554 | 5434 | 81092 | 4465 | 85309 | 3031 | 102846 | 2796 | 55075 |
| 2L-5S | | MI | 31402 | 9109 | 50937 | 6636 | 54530 | 5402 | 55175 | 4431 | 54112 | 2972 | 64332 | 2139 | 42477 |
| 10-#18 | 2.29 | MA | 41339 | 9109 | 66789 | 6708 | 73149 | 5467 | 75719 | 4495 | 77998 | 3054 | 93076 | 2575 | 54985 |
| 3L-4S | | MI | 32567 | 9109 | 52891 | 6647 | 57061 | 5373 | 58285 | 4407 | 58507 | 2994 | 69545 | 2237 | 44357 |
| 10-#18 | 2.29 | MA | 39726 | 9109 | 63986 | 6744 | 69578 | 5456 | 71378 | 4481 | 72411 | 3077 | 86726 | 2353 | 54609 |
| 4L-3S | | MI | 33866 | 9109 | 55143 | 6614 | 59930 | 5389 | 61771 | 4427 | 62889 | 2972 | 74445 | 2458 | 44554 |
| 10-#18 | 2.29 | MA | 38286 | 9109 | 61562 | 6737 | 66434 | 5489 | 67515 | 4510 | 66817 | 3055 | 80068 | 2249 | 52143 |
| 5L-2S | | MI | 35696 | 9109 | 57887 | 6625 | 63448 | 5360 | 66063 | 4403 | 68624 | 2950 | 82026 | 2679 | 44545 |
| 12-#11 | 1.07 | MA | 39525 | 8373 | 60968 | 6313 | 66056 | 5151 | 67206 | 4305 | 66474 | 3121 | 78137 | 2975 | 26623 |
| 2L-6S | | MI | 30296 | 8373 | 46991 | 6240 | 49755 | 5103 | 49486 | 4261 | 46676 | 3094 | 53884 | 2638 | 21876 |
| 12-#11 | 1.07 | MA | 38588 | 8373 | 59599 | 6311 | 64301 | 5148 | 65066 | 4318 | 63562 | 3132 | 74176 | 2889 | 26664 |
| 3L-5S | | MI | 30748 | 8373 | 47719 | 6243 | 50764 | 5108 | 50719 | 4267 | 48293 | 3086 | 55888 | 2694 | 21863 |

## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

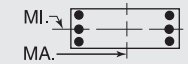
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.07 | MA | 37933 | 8373 | 58487 | 6326 | 62884 | 5162 | 63343 | 4314 | 61344 | 3142 | 71593 | 2802 | 26697 |
| 4E | | MI | 31222 | 8373 | 48496 | 6246 | 51771 | 5095 | 51956 | 4256 | 50079 | 3094 | 58008 | 2734 | 21822 |
| 12-#11 | 1.07 | MA | 37349 | 8373 | 57526 | 6324 | 61638 | 5159 | 61811 | 4327 | 59126 | 3136 | 68908 | 2760 | 26703 |
| 5L-3S | | MI | 31751 | 8373 | 49394 | 6232 | 52915 | 5100 | 53346 | 4262 | 51860 | 3086 | 60024 | 2821 | 21774 |
| 12-#11 | 1.07 | MA | 36792 | 8373 | 56626 | 6322 | 60390 | 5173 | 60287 | 4322 | 57117 | 3146 | 66346 | 2704 | 26655 |
| 6L-2S | | MI | 32500 | 8373 | 50492 | 6235 | 54324 | 5087 | 55065 | 4251 | 54192 | 3077 | 63129 | 2907 | 21726 |
| 12-#14 | 1.54 | MA | 41183 | 8660 | 64615 | 6473 | 70607 | 5264 | 72711 | 4370 | 73944 | 3088 | 88087 | 2914 | 37872 |
| 2L-6S | | MI | 30671 | 8660 | 48403 | 6395 | 51412 | 5217 | 51460 | 4324 | 49326 | 3059 | 57691 | 2442 | 30232 |
| 12-#14 | 1.54 | MA | 39855 | 8660 | 62655 | 6469 | 68095 | 5259 | 69646 | 4388 | 69773 | 3102 | 82447 | 2790 | 37907 |
| 3L-5S | | MI | 31312 | 8660 | 49447 | 6400 | 52858 | 5224 | 53227 | 4333 | 51628 | 3047 | 60533 | 2524 | 30820 |
| 12-#14 | 1.54 | MA | 38925 | 8660 | 61060 | 6491 | 66062 | 5279 | 67175 | 4381 | 66594 | 3117 | 78772 | 2665 | 37873 |
| 4E | | MI | 31985 | 8660 | 50561 | 6405 | 54301 | 5207 | 55000 | 4318 | 54168 | 3059 | 63549 | 2581 | 30865 |
| 12-#14 | 1.54 | MA | 38094 | 8660 | 59682 | 6488 | 64274 | 5274 | 64978 | 4399 | 63411 | 3106 | 74943 | 2605 | 37740 |
| 5L-3S | | MI | 32736 | 8660 | 51846 | 6386 | 55939 | 5214 | 56990 | 4328 | 56703 | 3047 | 66405 | 2705 | 30834 |
| 12-#14 | 1.54 | MA | 37304 | 8660 | 58390 | 6484 | 62485 | 5293 | 62791 | 4392 | 60529 | 3121 | 71296 | 2524 | 36905 |
| 6L-2S | | MI | 33797 | 8660 | 53417 | 6391 | 57953 | 5197 | 59447 | 4313 | 60019 | 3034 | 70812 | 2830 | 30782 |
| 12-#18 | 2.75 | MA | 45202 | 9386 | 73660 | 6888 | 81958 | 5558 | 86465 | 4541 | 92619 | 3009 | 112616 | 2748 | 65786 |
| 2L-6S | | MI | 31560 | 9386 | 51848 | 6798 | 55511 | 5510 | 56368 | 4487 | 55867 | 2966 | 67032 | 1931 | 49312 |
| 12-#18 | 2.75 | MA | 42922 | 9386 | 70225 | 6881 | 77554 | 5591 | 81092 | 4570 | 85309 | 3032 | 102846 | 2526 | 65630 |
| 3L-5S | | MI | 32662 | 9386 | 53682 | 6809 | 58047 | 5526 | 59467 | 4507 | 59847 | 2944 | 71914 | 2077 | 50631 |
| 12-#18 | 2.75 | MA | 41323 | 9386 | 67422 | 6917 | 73982 | 5580 | 76751 | 4556 | 79722 | 3054 | 96495 | 2305 | 65170 |
| 4E | | MI | 33819 | 9386 | 55635 | 6820 | 60579 | 5497 | 62577 | 4482 | 64241 | 2966 | 77126 | 2174 | 52802 |
| 12-#18 | 2.75 | MA | 39895 | 9386 | 64997 | 6910 | 70838 | 5614 | 72888 | 4586 | 74128 | 3033 | 89838 | 2200 | 62402 |
| 5L-3S | | MI | 35109 | 9386 | 57887 | 6787 | 63448 | 5513 | 66063 | 4502 | 68624 | 2944 | 82026 | 2396 | 53075 |
| 12-#18 | 2.75 | MA | 38537 | 9386 | 62724 | 6903 | 67690 | 5603 | 69040 | 4571 | 69057 | 3055 | 83528 | 2056 | 60531 |
| 6L-2S | | MI | 36926 | 9386 | 60631 | 6798 | 66966 | 5484 | 70354 | 4478 | 74358 | 2922 | 89607 | 2617 | 53145 |
| 14-#11 | 1.25 | MA | 40177 | 8481 | 62336 | 6380 | 67810 | 5200 | 69346 | 4335 | 69386 | 3113 | 82098 | 2960 | 30926 |
| 2L-7S | | MI | 30379 | 8481 | 47291 | 6321 | 50201 | 5164 | 50021 | 4301 | 47426 | 3094 | 54849 | 2528 | 24988 |
| 14-#11 | 1.25 | MA | 39244 | 8481 | 60968 | 6378 | 66056 | 5197 | 67206 | 4347 | 66474 | 3123 | 78137 | 2873 | 30959 |
| 3L-6S | | MI | 30818 | 8481 | 48089 | 6307 | 51164 | 5152 | 51204 | 4290 | 49007 | 3085 | 56989 | 2618 | 25297 |
| 14-#11 | 1.25 | MA | 38591 | 8481 | 59855 | 6394 | 64638 | 5211 | 65483 | 4343 | 64256 | 3134 | 75553 | 2787 | 30980 |
| 4L-5S | | MI | 31268 | 8481 | 48818 | 6310 | 52173 | 5156 | 52437 | 4296 | 50625 | 3077 | 58993 | 2674 | 25306 |
| 14-#11 | 1.25 | MA | 38009 | 8481 | 58895 | 6392 | 63392 | 5207 | 63951 | 4356 | 62038 | 3127 | 72869 | 2745 | 30963 |
| 5L-4S | | MI | 31740 | 8481 | 49595 | 6313 | 53180 | 5144 | 53675 | 4285 | 52410 | 3085 | 61113 | 2714 | 25279 |
| 14-#11 | 1.25 | MA | 37454 | 8481 | 57995 | 6390 | 62145 | 5222 | 62427 | 4352 | 60028 | 3138 | 70306 | 2689 | 30894 |
| 6L-3S | | MI | 32268 | 8481 | 50492 | 6299 | 54324 | 5148 | 55065 | 4291 | 54192 | 3077 | 63129 | 2801 | 25240 |
| 14-#11 | 1.25 | MA | 36914 | 8481 | 57009 | 6405 | 60955 | 5218 | 60964 | 4365 | 58066 | 3148 | 67575 | 2599 | 30426 |
| 7L-2S | | MI | 33014 | 8481 | 51591 | 6303 | 55732 | 5136 | 56783 | 4280 | 56523 | 3068 | 66234 | 2887 | 25197 |
| 14-#14 | 1.80 | MA | 42101 | 8815 | 66575 | 6570 | 73120 | 5334 | 75776 | 4412 | 78115 | 3076 | 93726 | 2890 | 44014 |
| 2L-7S | | MI | 30786 | 8815 | 48830 | 6512 | 52046 | 5304 | 52221 | 4381 | 50394 | 3058 | 59061 | 2281 | 34387 |
| 14-#14 | 1.80 | MA | 40779 | 8815 | 64615 | 6567 | 70607 | 5329 | 72711 | 4430 | 73944 | 3090 | 88087 | 2766 | 44021 |
| 3L-6S | | MI | 31408 | 8815 | 49974 | 6492 | 53426 | 5287 | 53917 | 4366 | 52643 | 3045 | 62098 | 2411 | 34955 |
| 14-#14 | 1.80 | MA | 39853 | 8815 | 63020 | 6588 | 68575 | 5348 | 70240 | 4423 | 70764 | 3104 | 84412 | 2641 | 43958 |
| 4L-5S | | MI | 32046 | 8815 | 51018 | 6497 | 54872 | 5294 | 55684 | 4376 | 54944 | 3033 | 64940 | 2493 | 35684 |
| 14-#14 | 1.80 | MA | 39027 | 8815 | 61642 | 6585 | 66787 | 5343 | 68044 | 4441 | 67582 | 3094 | 80583 | 2581 | 43792 |
| 5L-4S | | MI | 32716 | 8815 | 52132 | 6503 | 56315 | 5277 | 57457 | 4361 | 57484 | 3045 | 67955 | 2550 | 35760 |
| 14-#14 | 1.80 | MA | 38241 | 8815 | 60351 | 6582 | 64997 | 5363 | 65856 | 4434 | 64699 | 3108 | 76936 | 2500 | 42812 |
| 6L-3S | | MI | 33464 | 8815 | 53417 | 6483 | 57953 | 5284 | 59447 | 4370 | 60019 | 3033 | 70812 | 2674 | 35761 |
| 14-#14 | 1.80 | MA | 37475 | 8815 | 58935 | 6603 | 63290 | 5358 | 63757 | 4452 | 61883 | 3123 | 73047 | 2371 | 41999 |
| 7L-2S | | MI | 34520 | 8815 | 54988 | 6488 | 59967 | 5266 | 61904 | 4355 | 63336 | 3020 | 75219 | 2799 | 35723 |
| 14-#18 | 3.20 | MA | 44492 | 9663 | 73660 | 7053 | 81958 | 5716 | 86465 | 4646 | 92619 | 3010 | 112616 | 2478 | 76259 |
| 3L-6S | | MI | 32818 | 9663 | 54592 | 6970 | 59029 | 5634 | 60660 | 4562 | 61602 | 2937 | 74613 | 1869 | 57413 |
| 14-#18 | 3.20 | MA | 42905 | 9663 | 70858 | 7090 | 78387 | 5705 | 82124 | 4631 | 87033 | 3032 | 106265 | 2257 | 75724 |
| 4L-5S | | MI | 33912 | 9663 | 56426 | 6982 | 61565 | 5650 | 63759 | 4582 | 65581 | 2915 | 79495 | 2014 | 58815 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

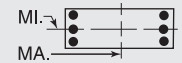



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#18 | 3.20 | MA | 41488 | 9663 | 68433 | 7083 | 75243 | 5738 | 78261 | 4661 | 81438 | 3011 | 99608 | 2152 | 72693 |
| 5L-4S | | MI | 35060 | 9663 | 58379 | 6993 | 64097 | 5621 | 66868 | 4558 | 69976 | 2937 | 84707 | 2112 | 61235 |
| 14-#18 | 3.20 | MA | 40141 | 9663 | 66160 | 7075 | 72094 | 5727 | 74413 | 4646 | 76367 | 3033 | 93298 | 2008 | 70904 |
| 6L-3S | | MI | 36341 | 9663 | 60631 | 6960 | 66966 | 5637 | 70354 | 4578 | 74358 | 2915 | 89607 | 2333 | 61576 |
| 14-#18 | 3.20 | MA | 38829 | 9663 | 63669 | 7112 | 69090 | 5760 | 70720 | 4676 | 71412 | 3056 | 86563 | 1777 | 67499 |
| 7L-2S | | MI | 38147 | 9663 | 63375 | 6971 | 70484 | 5608 | 74646 | 4553 | 80093 | 2893 | 97189 | 2555 | 61700 |
| 16-#11 | 1.43 | MA | 40826 | 8589 | 63705 | 6448 | 69564 | 5248 | 71486 | 4364 | 72298 | 3104 | 86059 | 2944 | 35221 |
| 2L-8S | | MI | 30470 | 8589 | 47672 | 6385 | 50633 | 5208 | 50584 | 4342 | 48077 | 3076 | 55972 | 2460 | 28031 |
| 16-#11 | 1.43 | MA | 39896 | 8589 | 62336 | 6446 | 67810 | 5245 | 69346 | 4377 | 69386 | 3115 | 82098 | 2858 | 35246 |
| 3L-7S | | MI | 30901 | 8589 | 48390 | 6389 | 51610 | 5213 | 51739 | 4331 | 49757 | 3085 | 57954 | 2508 | 28320 |
| 16-#11 | 1.43 | MA | 39245 | 8589 | 61224 | 6461 | 66392 | 5259 | 67623 | 4373 | 67168 | 3125 | 79514 | 2772 | 35252 |
| 4L-6S | | MI | 31338 | 8589 | 49188 | 6374 | 52572 | 5200 | 52923 | 4320 | 51338 | 3076 | 60094 | 2598 | 28711 |
| 16-#11 | 1.43 | MA | 38665 | 8589 | 60263 | 6459 | 65146 | 5256 | 66092 | 4385 | 64950 | 3118 | 76830 | 2729 | 35216 |
| 5E | | MI | 31786 | 8589 | 49917 | 6378 | 53581 | 5205 | 54156 | 4326 | 52956 | 3068 | 62098 | 2654 | 28741 |
| 16-#11 | 1.43 | MA | 38113 | 8589 | 59363 | 6457 | 63899 | 5270 | 64567 | 4381 | 62940 | 3129 | 74267 | 2673 | 35129 |
| 6L-4S | | MI | 32257 | 8589 | 50694 | 6381 | 54589 | 5192 | 55393 | 4315 | 54741 | 3076 | 64218 | 2694 | 28727 |
| 16-#11 | 1.43 | MA | 37576 | 8589 | 58377 | 6472 | 62710 | 5267 | 63104 | 4394 | 60978 | 3139 | 71536 | 2583 | 34579 |
| 7L-3S | | MI | 32782 | 8589 | 51591 | 6367 | 55732 | 5197 | 56783 | 4321 | 56523 | 3068 | 66234 | 2781 | 28697 |
| 16-#11 | 1.43 | MA | 37038 | 8589 | 57492 | 6471 | 61503 | 5281 | 61677 | 4407 | 58891 | 3133 | 69025 | 2534 | 34154 |
| 8L-2S | | MI | 33527 | 8589 | 52690 | 6370 | 57141 | 5184 | 58502 | 4310 | 58854 | 3059 | 69339 | 2867 | 28660 |
| 16-#14 | 2.06 | MA | 43014 | 8971 | 68535 | 6667 | 75633 | 5404 | 78842 | 4455 | 82285 | 3063 | 99366 | 2867 | 50150 |
| 2L-8S | | MI | 30912 | 8971 | 49372 | 6604 | 52661 | 5366 | 53022 | 4439 | 51319 | 3031 | 60649 | 2183 | 38348 |
| 16-#14 | 2.06 | MA | 41697 | 8971 | 66575 | 6664 | 73120 | 5398 | 75776 | 4473 | 78115 | 3078 | 93726 | 2742 | 50124 |
| 3L-7S | | MI | 31522 | 8971 | 50401 | 6609 | 54060 | 5374 | 54678 | 4424 | 53710 | 3043 | 63468 | 2250 | 39147 |
| 16-#14 | 2.06 | MA | 40776 | 8971 | 64980 | 6685 | 71087 | 5418 | 73306 | 4466 | 74935 | 3092 | 90052 | 2617 | 50034 |
| 4L-6S | | MI | 32141 | 8971 | 51545 | 6589 | 55440 | 5356 | 56374 | 4409 | 55959 | 3031 | 66504 | 2380 | 39689 |
| 16-#14 | 2.06 | MA | 39954 | 8971 | 63602 | 6682 | 69300 | 5413 | 71109 | 4484 | 71753 | 3081 | 86223 | 2557 | 49838 |
| 5E | | MI | 32776 | 8971 | 52590 | 6595 | 56886 | 5364 | 58141 | 4418 | 58261 | 3019 | 69346 | 2462 | 40541 |
| 16-#14 | 2.06 | MA | 39172 | 8971 | 62311 | 6679 | 67510 | 5433 | 68922 | 4477 | 68870 | 3096 | 82576 | 2476 | 48731 |
| 6L-4S | | MI | 33443 | 8971 | 53703 | 6600 | 58329 | 5346 | 59914 | 4403 | 60801 | 3031 | 72362 | 2519 | 40644 |
| 16-#14 | 2.06 | MA | 38411 | 8971 | 60895 | 6700 | 65803 | 5428 | 66822 | 4495 | 66053 | 3110 | 78687 | 2347 | 47949 |
| 7L-3S | | MI | 34187 | 8971 | 54988 | 6580 | 59967 | 5354 | 61904 | 4413 | 63336 | 3019 | 75219 | 2643 | 40677 |
| 16-#14 | 2.06 | MA | 37660 | 8971 | 59624 | 6697 | 64071 | 5448 | 64774 | 4513 | 63060 | 3100 | 75106 | 2276 | 46882 |
| 8L-2S | | MI | 35239 | 8971 | 56559 | 6585 | 61981 | 5336 | 64361 | 4397 | 66652 | 3006 | 79625 | 2768 | 40652 |
| 16-#18 | 3.66 | MA | 44473 | 9939 | 74294 | 7263 | 82791 | 5829 | 87498 | 4707 | 94344 | 3010 | 116035 | 2208 | 86231 |
| 4L-6S | | MI | 34065 | 9939 | 57336 | 7143 | 62547 | 5759 | 64951 | 4637 | 67337 | 2908 | 82194 | 1807 | 65418 |
| 16-#18 | 3.66 | MA | 43067 | 9939 | 71869 | 7256 | 79647 | 5862 | 83634 | 4736 | 88749 | 2989 | 109378 | 2104 | 83009 |
| 5E | | MI | 35151 | 9939 | 59170 | 7155 | 65083 | 5774 | 68050 | 4657 | 71316 | 2886 | 87076 | 1952 | 67023 |
| 16-#18 | 3.66 | MA | 41731 | 9939 | 69595 | 7248 | 76499 | 5851 | 79787 | 4722 | 83678 | 3011 | 103068 | 1960 | 81045 |
| 6L-4S | | MI | 36291 | 9939 | 61123 | 7166 | 67615 | 5746 | 71160 | 4633 | 75711 | 2908 | 92289 | 2050 | 69311 |
| 16-#18 | 3.66 | MA | 40429 | 9939 | 67105 | 7285 | 73494 | 5884 | 76093 | 4752 | 78723 | 3034 | 96333 | 1729 | 77733 |
| 7L-3S | | MI | 37564 | 9939 | 63375 | 7133 | 70484 | 5761 | 74646 | 4653 | 80093 | 2886 | 97189 | 2271 | 70062 |
| 16-#18 | 3.66 | MA | 39148 | 9939 | 64866 | 7278 | 70447 | 5873 | 72487 | 4781 | 73457 | 3012 | 90109 | 1606 | 74500 |
| 8L-2S | | MI | 39359 | 9939 | 66119 | 7144 | 74002 | 5732 | 78938 | 4629 | 85827 | 2864 | 104770 | 2492 | 70236 |
| 18-#11 | 1.61 | MA | 41472 | 8697 | 65073 | 6515 | 71319 | 5297 | 73627 | 4393 | 75210 | 3095 | 90019 | 2929 | 39510 |
| 2L-9S | | MI | 30555 | 8697 | 47999 | 6467 | 51091 | 5269 | 51094 | 4365 | 48841 | 3076 | 57134 | 2386 | 31057 |
| 18-#11 | 1.61 | MA | 40545 | 8697 | 63705 | 6513 | 69564 | 5293 | 71486 | 4406 | 72298 | 3106 | 86059 | 2843 | 39528 |
| 3L-8S | | MI | 30990 | 8697 | 48771 | 6453 | 52042 | 5256 | 52302 | 4371 | 50408 | 3067 | 59077 | 2440 | 31379 |
| 18-#11 | 1.61 | MA | 39897 | 8697 | 62592 | 6529 | 68147 | 5307 | 69763 | 4402 | 70080 | 3116 | 83475 | 2756 | 39515 |
| 4L-7S | | MI | 31420 | 8697 | 49489 | 6456 | 53018 | 5261 | 53458 | 4360 | 52088 | 3076 | 61059 | 2488 | 31658 |
| 18-#11 | 1.61 | MA | 39319 | 8697 | 61632 | 6527 | 66901 | 5304 | 68232 | 4415 | 67862 | 3110 | 80791 | 2714 | 39464 |
| 5L-6S | | MI | 31855 | 8697 | 50287 | 6442 | 53981 | 5248 | 54641 | 4349 | 53669 | 3067 | 63199 | 2578 | 32092 |
| 18-#11 | 1.61 | MA | 38769 | 8697 | 60732 | 6525 | 65654 | 5318 | 66707 | 4411 | 65852 | 3120 | 78228 | 2658 | 39353 |
| 6L-5S | | MI | 32302 | 8697 | 51016 | 6445 | 54990 | 5253 | 55874 | 4355 | 55287 | 3059 | 65203 | 2634 | 32162 |
| 18-#11 | 1.61 | MA | 38233 | 8697 | 59746 | 6540 | 64464 | 5315 | 65244 | 4423 | 63889 | 3131 | 75496 | 2568 | 38738 |
| 7L-4S | | MI | 32771 | 8697 | 51793 | 6448 | 55997 | 5241 | 57112 | 4344 | 57072 | 3067 | 67323 | 2674 | 32168 |
| 18-#11 | 1.61 | MA | 37706 | 8697 | 58860 | 6538 | 63257 | 5329 | 63817 | 4436 | 61803 | 3124 | 72986 | 2518 | 38327 |
| 8L-3S | | MI | 33295 | 8697 | 52690 | 6434 | 57141 | 5245 | 58502 | 4350 | 58854 | 3059 | 69339 | 2761 | 32147 |

## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

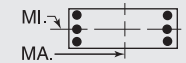
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.61 | MA | 37147 | 8697 | 57994 | 6536 | 62084 | 5326 | 62324 | 4432 | 59858 | 3135 | 70501 | 2465 | 37859 |
| 9L-2S | | MI | 34037 | 8697 | 53789 | 6438 | 58549 | 5233 | 60220 | 4339 | 61185 | 3050 | 72444 | 2847 | 32116 |
| 18-#14 | 2.32 | MA | 42610 | 9127 | 68535 | 6761 | 75633 | 5468 | 78842 | 4515 | 82285 | 3065 | 99366 | 2718 | 56219 |
| 3L-8S | | MI | 31647 | 9127 | 50943 | 6701 | 54675 | 5436 | 55479 | 4482 | 54636 | 3017 | 65056 | 2152 | 43024 |
| 18-#14 | 2.32 | MA | 41693 | 9127 | 66940 | 6783 | 73600 | 5488 | 76371 | 4508 | 79106 | 3079 | 95692 | 2594 | 56105 |
| 4L-7S | | MI | 32254 | 9127 | 51972 | 6706 | 56074 | 5444 | 57135 | 4466 | 57027 | 3029 | 67874 | 2219 | 43913 |
| 18-#14 | 2.32 | MA | 40876 | 9127 | 65562 | 6779 | 71812 | 5483 | 74174 | 4526 | 75923 | 3069 | 91862 | 2533 | 55881 |
| 5L-6S | | MI | 32870 | 9127 | 53116 | 6687 | 57454 | 5426 | 58831 | 4451 | 59276 | 3017 | 70911 | 2349 | 44433 |
| 18-#14 | 2.32 | MA | 40098 | 9127 | 64271 | 6776 | 70023 | 5503 | 71987 | 4519 | 73041 | 3083 | 88216 | 2452 | 54661 |
| 6L-5S | | MI | 33502 | 9127 | 54161 | 6692 | 58900 | 5434 | 60598 | 4461 | 61577 | 3005 | 73753 | 2431 | 45316 |
| 18-#14 | 2.32 | MA | 39340 | 9127 | 62855 | 6798 | 68316 | 5498 | 69888 | 4537 | 70224 | 3098 | 84327 | 2323 | 53905 |
| 7L-4S | | MI | 34166 | 9127 | 55274 | 6697 | 60343 | 5416 | 62371 | 4445 | 64117 | 3017 | 76769 | 2488 | 45519 |
| 18-#14 | 2.32 | MA | 38594 | 9127 | 61584 | 6794 | 66584 | 5517 | 67839 | 4555 | 67231 | 3087 | 80746 | 2252 | 52748 |
| 8L-3S | | MI | 34907 | 9127 | 56559 | 6677 | 61981 | 5424 | 64361 | 4455 | 66652 | 3005 | 79625 | 2612 | 45574 |
| 18-#14 | 2.32 | MA | 37813 | 9127 | 60340 | 6791 | 64900 | 5512 | 65696 | 4548 | 64440 | 3102 | 77210 | 2174 | 51584 |
| 9L-2S | | MI | 35955 | 9127 | 58130 | 6683 | 63995 | 5406 | 66818 | 4440 | 69969 | 2992 | 84032 | 2737 | 45574 |
| 18-#18 | 4.12 | MA | 44633 | 10216 | 75305 | 7429 | 84052 | 5986 | 89008 | 4812 | 96060 | 2967 | 119148 | 2055 | 93347 |
| 5L-6S | | MI | 35303 | 10216 | 60080 | 7316 | 66065 | 5883 | 69243 | 4713 | 73071 | 2880 | 89776 | 1744 | 73453 |
| 18-#18 | 4.12 | MA | 43307 | 10216 | 73031 | 7421 | 80903 | 5975 | 85160 | 4797 | 90989 | 2989 | 112838 | 1911 | 91187 |
| 6L-5S | | MI | 36381 | 10216 | 61914 | 7327 | 68601 | 5898 | 72342 | 4733 | 77050 | 2858 | 94658 | 1890 | 75251 |
| 18-#18 | 4.12 | MA | 42016 | 10216 | 70540 | 7458 | 77899 | 6008 | 81466 | 4827 | 86034 | 3012 | 106103 | 1680 | 87988 |
| 7L-4S | | MI | 37514 | 10216 | 63867 | 7339 | 71133 | 5870 | 75452 | 4708 | 81445 | 2880 | 99870 | 1987 | 77415 |
| 18-#18 | 4.12 | MA | 40745 | 10216 | 68302 | 7451 | 74851 | 5997 | 77860 | 4857 | 80768 | 2990 | 99879 | 1557 | 84639 |
| 8L-3S | | MI | 38778 | 10216 | 66119 | 7306 | 74002 | 5885 | 78938 | 4728 | 85827 | 2858 | 104770 | 2209 | 78536 |
| 20-#11 | 1.78 | MA | 42115 | 8805 | 66442 | 6583 | 73073 | 5345 | 75767 | 4423 | 78122 | 3087 | 93980 | 2913 | 43795 |
| 2L-10S | | MI | 30622 | 8805 | 48382 | 6531 | 51536 | 5313 | 51663 | 4406 | 49619 | 3075 | 58358 | 2305 | 33847 |
| 20-#11 | 1.78 | MA | 41191 | 8805 | 65073 | 6581 | 71319 | 5342 | 73627 | 4436 | 75210 | 3097 | 90019 | 2827 | 43800 |
| 3L-9S | | MI | 31076 | 8805 | 49098 | 6534 | 52500 | 5317 | 52812 | 4395 | 51172 | 3067 | 60239 | 2366 | 34348 |
| 20-#11 | 1.78 | MA | 40545 | 8805 | 63961 | 6596 | 69901 | 5356 | 71903 | 4431 | 72992 | 3108 | 87436 | 2741 | 43773 |
| 4L-8S | | MI | 31509 | 8805 | 49870 | 6520 | 53450 | 5305 | 54020 | 4401 | 52739 | 3058 | 62182 | 2420 | 34730 |
| 20-#11 | 1.78 | MA | 39969 | 8805 | 63000 | 6594 | 68655 | 5353 | 70372 | 4444 | 70774 | 3101 | 84751 | 2698 | 43708 |
| 5L-7S | | MI | 31936 | 8805 | 50588 | 6523 | 54427 | 5309 | 55176 | 4390 | 54419 | 3067 | 64164 | 2468 | 35000 |
| 20-#11 | 1.78 | MA | 39422 | 8805 | 62100 | 6592 | 67408 | 5367 | 68848 | 4440 | 68764 | 3112 | 82189 | 2642 | 43494 |
| 6E | | MI | 32370 | 8805 | 51386 | 6509 | 55390 | 5297 | 56360 | 4378 | 56000 | 3058 | 66304 | 2558 | 35414 |
| 20-#11 | 1.78 | MA | 38888 | 8805 | 61114 | 6607 | 66218 | 5364 | 67385 | 4453 | 66801 | 3122 | 79457 | 2553 | 42902 |
| 7L-5S | | MI | 32816 | 8805 | 52114 | 6513 | 56398 | 5301 | 57592 | 4385 | 57618 | 3049 | 68308 | 2614 | 35580 |
| 20-#11 | 1.78 | MA | 38363 | 8805 | 60229 | 6605 | 65012 | 5378 | 65957 | 4466 | 64715 | 3115 | 76947 | 2503 | 42502 |
| 8L-4S | | MI | 33283 | 8805 | 52891 | 6516 | 57406 | 5289 | 58830 | 4373 | 59403 | 3058 | 70428 | 2654 | 35604 |
| 20-#11 | 1.78 | MA | 37806 | 8805 | 59362 | 6603 | 63838 | 5375 | 64464 | 4461 | 62770 | 3126 | 74462 | 2449 | 41975 |
| 9L-3S | | MI | 33805 | 8805 | 53789 | 6502 | 58549 | 5294 | 60220 | 4380 | 61185 | 3049 | 72444 | 2741 | 35591 |
| 20-#11 | 1.78 | MA | 37226 | 8805 | 58392 | 6619 | 62648 | 5389 | 63044 | 4474 | 60842 | 3137 | 72054 | 2388 | 41280 |
| 10L-2S | | MI | 34545 | 8805 | 54888 | 6505 | 59958 | 5281 | 61938 | 4368 | 63516 | 3041 | 75549 | 2827 | 35567 |
| 20-#14 | 2.57 | MA | 42605 | 9282 | 68901 | 6880 | 76113 | 5558 | 79436 | 4550 | 83276 | 3067 | 101332 | 2570 | 62170 |
| 4L-8S | | MI | 32378 | 9282 | 52514 | 6798 | 56688 | 5506 | 57936 | 4524 | 57952 | 3003 | 69463 | 2121 | 47710 |
| 20-#14 | 2.57 | MA | 41792 | 9282 | 67522 | 6877 | 74325 | 5553 | 77240 | 4568 | 80094 | 3057 | 97502 | 2509 | 61792 |
| 5L-7S | | MI | 32982 | 9282 | 53543 | 6804 | 58088 | 5514 | 59592 | 4509 | 60343 | 3015 | 72281 | 2188 | 48682 |
| 20-#14 | 2.57 | MA | 41018 | 9282 | 66231 | 6873 | 72536 | 5573 | 75052 | 4562 | 77211 | 3071 | 93856 | 2429 | 60599 |
| 6E | | MI | 33595 | 9282 | 54687 | 6784 | 59468 | 5496 | 61288 | 4493 | 62592 | 3003 | 75318 | 2318 | 49185 |
| 20-#14 | 2.57 | MA | 40264 | 9282 | 64815 | 6895 | 70828 | 5568 | 72953 | 4579 | 74395 | 3085 | 89967 | 2299 | 59867 |
| 7L-5S | | MI | 34224 | 9282 | 55732 | 6789 | 60914 | 5503 | 63055 | 4503 | 64894 | 2990 | 78160 | 2400 | 50026 |
| 20-#14 | 2.57 | MA | 39522 | 9282 | 63544 | 6892 | 69097 | 5587 | 70904 | 4597 | 71401 | 3075 | 86386 | 2228 | 58625 |
| 8L-4S | | MI | 34885 | 9282 | 56845 | 6794 | 62357 | 5486 | 64828 | 4488 | 67434 | 3003 | 81175 | 2457 | 50388 |
| 20-#14 | 2.57 | MA | 38746 | 9282 | 62300 | 6888 | 67412 | 5582 | 68762 | 4591 | 68610 | 3089 | 82850 | 2150 | 57493 |
| 9L-3S | | MI | 35622 | 9282 | 58130 | 6775 | 63995 | 5493 | 66818 | 4497 | 69969 | 2990 | 84032 | 2581 | 50464 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis

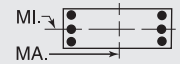


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.57 | MA | 37925 | 9282 | 60908 | 6910 | 65704 | 5602 | 66724 | 4609 | 65843 | 3103 | 79424 | 2062 | 55978 |
| 10L-2S | | MI | 36667 | 9282 | 59701 | 6780 | 66009 | 5476 | 69275 | 4482 | 73285 | 2978 | 88438 | 2706 | 50490 |
| 20-#18 | 4.58 | MA | 44871 | 10493 | 76467 | 7594 | 85308 | 6099 | 90533 | 4873 | 98300 | 2967 | 122608 | 1863 | 101354 |
| 6E | | MI | 36532 | 10493 | 62824 | 7489 | 69582 | 6007 | 73535 | 4788 | 78806 | 2851 | 97357 | 1682 | 81512 |
| 20-#18 | 4.58 | MA | 43589 | 10493 | 73976 | 7631 | 82303 | 6133 | 86839 | 4902 | 93344 | 2990 | 115873 | 1632 | 98261 |
| 7L-5S | | MI | 37603 | 10493 | 64658 | 7500 | 72119 | 6022 | 76634 | 4808 | 82785 | 2829 | 102239 | 1827 | 83496 |
| 20-#18 | 4.58 | MA | 42328 | 10493 | 71738 | 7624 | 79256 | 6122 | 83234 | 4932 | 88079 | 2968 | 109649 | 1509 | 94799 |
| 8L-4S | | MI | 38728 | 10493 | 66612 | 7511 | 74651 | 5994 | 79743 | 4784 | 87180 | 2851 | 107451 | 1925 | 85548 |
| 22-#11 | 1.96 | MA | 41834 | 8913 | 66442 | 6648 | 73073 | 5390 | 75767 | 4465 | 78122 | 3089 | 93980 | 2812 | 48065 |
| 3L-10S | | MI | 31142 | 8913 | 49481 | 6598 | 52945 | 5361 | 53381 | 4435 | 51950 | 3066 | 61463 | 2285 | 37159 |
| 22-#11 | 1.96 | MA | 41191 | 8913 | 65329 | 6663 | 71655 | 5404 | 74044 | 4461 | 75904 | 3099 | 91397 | 2725 | 48026 |
| 4L-9S | | MI | 31595 | 8913 | 50196 | 6602 | 53909 | 5366 | 54531 | 4424 | 53503 | 3058 | 63344 | 2346 | 37644 |
| 22-#11 | 1.96 | MA | 40617 | 8913 | 64369 | 6661 | 70410 | 5401 | 72512 | 4474 | 73686 | 3093 | 88712 | 2683 | 47948 |
| 5L-8S | | MI | 32025 | 8913 | 50969 | 6588 | 54859 | 5353 | 55739 | 4430 | 55070 | 3049 | 65287 | 2400 | 38083 |
| 22-#11 | 1.96 | MA | 40072 | 8913 | 63469 | 6659 | 69162 | 5415 | 70988 | 4469 | 71676 | 3103 | 86150 | 2627 | 47641 |
| 6L-7S | | MI | 32451 | 8913 | 51686 | 6591 | 55835 | 5358 | 56894 | 4419 | 56751 | 3058 | 67269 | 2448 | 38345 |
| 22-#11 | 1.96 | MA | 39540 | 8913 | 62483 | 6675 | 67973 | 5412 | 69525 | 4482 | 69713 | 3114 | 83418 | 2537 | 47071 |
| 7L-6S | | MI | 32883 | 8913 | 52485 | 6577 | 56798 | 5345 | 58078 | 4408 | 58331 | 3049 | 69409 | 2538 | 38742 |
| 22-#11 | 1.96 | MA | 39016 | 8913 | 61597 | 6673 | 66766 | 5426 | 68097 | 4495 | 67627 | 3107 | 80907 | 2487 | 46680 |
| 8L-5S | | MI | 33327 | 8913 | 53213 | 6580 | 57807 | 5350 | 59311 | 4414 | 59949 | 3040 | 71413 | 2594 | 38992 |
| 22-#11 | 1.96 | MA | 38463 | 8913 | 60731 | 6671 | 65593 | 5423 | 66604 | 4491 | 65682 | 3117 | 78423 | 2434 | 46096 |
| 9L-4S | | MI | 33793 | 8913 | 53990 | 6583 | 58814 | 5337 | 60548 | 4403 | 61734 | 3049 | 73533 | 2634 | 39027 |
| 22-#11 | 1.96 | MA | 37884 | 8913 | 59760 | 6686 | 64402 | 5437 | 65184 | 4504 | 63754 | 3128 | 76015 | 2373 | 45419 |
| 10L-3S | | MI | 34313 | 8913 | 54888 | 6569 | 59958 | 5342 | 61938 | 4409 | 63516 | 3040 | 75549 | 2721 | 39031 |
| 22-#11 | 1.96 | MA | 37319 | 8913 | 58892 | 6684 | 63235 | 5434 | 63710 | 4499 | 61698 | 3121 | 73566 | 2320 | 44737 |
| 11L-2S | | MI | 35051 | 8913 | 55986 | 6572 | 61367 | 5329 | 63657 | 4398 | 65847 | 3032 | 78654 | 2807 | 39013 |
| 22-#14 | 2.83 | MA | 42703 | 9438 | 69482 | 6974 | 76838 | 5623 | 80305 | 4611 | 84265 | 3044 | 103142 | 2485 | 67692 |
| 5L-8S | | MI | 33104 | 9438 | 54085 | 6896 | 58702 | 5576 | 60393 | 4566 | 61268 | 2989 | 73869 | 2090 | 52405 |
| 22-#14 | 2.83 | MA | 41933 | 9438 | 68191 | 6971 | 75048 | 5642 | 78118 | 4604 | 81382 | 3058 | 99496 | 2405 | 66545 |
| 6L-7S | | MI | 33706 | 9438 | 55114 | 6901 | 60102 | 5583 | 62049 | 4551 | 63660 | 3001 | 76688 | 2157 | 53456 |
| 22-#14 | 2.83 | MA | 41183 | 9438 | 66775 | 6992 | 73341 | 5637 | 76018 | 4622 | 78565 | 3073 | 95606 | 2275 | 65833 |
| 7L-6S | | MI | 34316 | 9438 | 56258 | 6881 | 61482 | 5566 | 63745 | 4536 | 65909 | 2989 | 79724 | 2287 | 53943 |
| 22-#14 | 2.83 | MA | 40444 | 9438 | 65504 | 6989 | 71609 | 5657 | 73970 | 4640 | 75572 | 3062 | 92026 | 2204 | 64511 |
| 8L-5S | | MI | 34943 | 9438 | 57303 | 6886 | 62928 | 5573 | 65512 | 4545 | 68210 | 2976 | 82566 | 2369 | 54746 |
| 22-#14 | 2.83 | MA | 39673 | 9438 | 64260 | 6986 | 69925 | 5652 | 71827 | 4633 | 72781 | 3077 | 88490 | 2127 | 63408 |
| 9L-4S | | MI | 35600 | 9438 | 58416 | 6892 | 64371 | 5556 | 67285 | 4530 | 70750 | 2989 | 85582 | 2426 | 55251 |
| 22-#14 | 2.83 | MA | 38855 | 9438 | 62868 | 7007 | 68217 | 5672 | 69789 | 4651 | 70014 | 3091 | 85063 | 2039 | 61836 |
| 10L-3S | | MI | 36335 | 9438 | 59701 | 6872 | 66009 | 5563 | 69275 | 4540 | 73285 | 2976 | 88438 | 2550 | 55346 |
| 22-#18 | 5.03 | MA | 45151 | 10769 | 77412 | 7804 | 86708 | 6257 | 92213 | 4978 | 100655 | 2967 | 125643 | 1584 | 108550 |
| 7L-6S | | MI | 37752 | 10769 | 65569 | 7662 | 73100 | 6131 | 77826 | 4864 | 84540 | 2822 | 104938 | 1620 | 89595 |
| 22-#18 | 5.03 | MA | 43899 | 10769 | 75174 | 7796 | 83660 | 6246 | 88607 | 5007 | 95389 | 2946 | 119419 | 1461 | 104977 |
| 8L-5S | | MI | 38817 | 10769 | 67403 | 7673 | 75637 | 6147 | 80925 | 4884 | 88519 | 2800 | 109820 | 1765 | 91754 |
| 24-#11 | 2.14 | MA | 41833 | 9021 | 66698 | 6731 | 73410 | 5453 | 76184 | 4490 | 78816 | 3091 | 95358 | 2710 | 52276 |
| 4L-10S | | MI | 31659 | 9021 | 50580 | 6666 | 54353 | 5409 | 55099 | 4464 | 54281 | 3057 | 64568 | 2265 | 40475 |
| 24-#11 | 2.14 | MA | 41262 | 9021 | 65737 | 6729 | 72164 | 5450 | 74653 | 4503 | 76597 | 3084 | 92673 | 2667 | 52185 |
| 5L-9S | | MI | 32112 | 9021 | 51295 | 6669 | 55317 | 5414 | 56249 | 4453 | 55835 | 3049 | 66449 | 2326 | 40946 |
| 24-#11 | 2.14 | MA | 40718 | 9021 | 64838 | 6727 | 70917 | 5464 | 73128 | 4499 | 74588 | 3094 | 90111 | 2612 | 51794 |
| 6L-8S | | MI | 32538 | 9021 | 52068 | 6655 | 56267 | 5402 | 57457 | 4459 | 57401 | 3040 | 68392 | 2380 | 41438 |
| 24-#11 | 2.14 | MA | 40189 | 9021 | 63851 | 6742 | 69727 | 5461 | 71665 | 4512 | 72625 | 3105 | 87379 | 2522 | 51242 |
| 7E | | MI | 32963 | 9021 | 52785 | 6658 | 57244 | 5406 | 58613 | 4448 | 59082 | 3049 | 70374 | 2428 | 41693 |
| 24-#11 | 2.14 | MA | 39667 | 9021 | 62966 | 6740 | 68520 | 5475 | 70237 | 4525 | 70539 | 3098 | 84868 | 2472 | 50861 |
| 8L-6S | | MI | 33394 | 9021 | 53583 | 6644 | 58207 | 5394 | 59796 | 4437 | 60663 | 3040 | 72514 | 2518 | 42074 |
| 24-#11 | 2.14 | MA | 39116 | 9021 | 62099 | 6738 | 67347 | 5471 | 68744 | 4520 | 68594 | 3109 | 82384 | 2418 | 50222 |
| 9L-5S | | MI | 33836 | 9021 | 54312 | 6647 | 59216 | 5398 | 61029 | 4443 | 62280 | 3031 | 74518 | 2574 | 42401 |
| 24-#11 | 2.14 | MA | 38539 | 9021 | 61129 | 6754 | 66157 | 5486 | 67324 | 4533 | 66666 | 3119 | 79975 | 2357 | 49562 |
| 10L-4S | | MI | 34301 | 9021 | 55089 | 6651 | 60223 | 5386 | 62267 | 4432 | 64065 | 3040 | 76638 | 2614 | 42447 |
| 24-#11 | 2.14 | MA | 37977 | 9021 | 60261 | 6752 | 64989 | 5482 | 65850 | 4529 | 64609 | 3113 | 77527 | 2305 | 48839 |
| 11L-3S | | MI | 34819 | 9021 | 55986 | 6637 | 61367 | 5390 | 63657 | 4438 | 65847 | 3031 | 78654 | 2701 | 42467 |

## RECTANGULAR TIED COLUMNS 38" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 2.14 | MA | 37424 | 9021 | 59308 | 6767 | 63807 | 5496 | 64433 | 4542 | 62682 | 3123 | 74769 | 2228 | 47991 |
| 12L-2S | | MI | 35555 | 9021 | 57085 | 6640 | 62775 | 5378 | 65375 | 4427 | 68179 | 3023 | 81759 | 2787 | 42455 |
| 24-#14 | 3.09 | MA | 42843 | 9593 | 70151 | 7068 | 77561 | 5712 | 81183 | 4646 | 85552 | 3046 | 105136 | 2381 | 72498 |
| 6L-8S | | MI | 33827 | 9593 | 55656 | 6993 | 60716 | 5646 | 62850 | 4609 | 64585 | 2975 | 78276 | 2059 | 57108 |
| 24-#14 | 3.09 | MA | 42096 | 9593 | 68735 | 7089 | 75854 | 5707 | 79084 | 4664 | 82736 | 3060 | 101246 | 2251 | 71803 |
| 7E | | MI | 34426 | 9593 | 56685 | 6998 | 62116 | 5653 | 64506 | 4594 | 66976 | 2987 | 81094 | 2126 | 58202 |
| 24-#14 | 3.09 | MA | 41361 | 9593 | 67464 | 7086 | 74122 | 5727 | 77035 | 4682 | 79743 | 3050 | 97666 | 2180 | 70405 |
| 8L-6S | | MI | 35034 | 9593 | 57829 | 6978 | 63496 | 5636 | 66202 | 4578 | 69225 | 2975 | 84131 | 2257 | 58706 |
| 24-#14 | 3.09 | MA | 40604 | 9593 | 66220 | 7083 | 72438 | 5722 | 74892 | 4675 | 76952 | 3064 | 94130 | 2103 | 69330 |
| 9L-5S | | MI | 35657 | 9593 | 58874 | 6984 | 64942 | 5643 | 67969 | 4588 | 71526 | 2962 | 86973 | 2338 | 59476 |
| 24-#14 | 3.09 | MA | 39780 | 9593 | 64828 | 7105 | 70729 | 5742 | 72854 | 4693 | 74185 | 3079 | 90703 | 2015 | 67702 |
| 10L-4S | | MI | 36312 | 9593 | 59987 | 6989 | 66385 | 5626 | 69742 | 4573 | 74067 | 2975 | 89988 | 2395 | 60110 |
| 24-#18 | 5.49 | MA | 45458 | 11046 | 78609 | 7969 | 88065 | 6370 | 93980 | 5083 | 102700 | 2924 | 129189 | 1412 | 115172 |
| 8L-6S | | MI | 38965 | 11046 | 68313 | 7835 | 76618 | 6255 | 82118 | 4939 | 90275 | 2794 | 112520 | 1557 | 97698 |

## RECTANGULAR TIED COLUMNS 38" x 48"

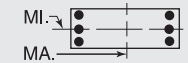
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.32 | MA | 43884 | 8892 | 68490 | 6642 | 74344 | 5410 | 76022 | 4505 | 76206 | 3222 | 89875 | 3043 | 35146 |
| 2L-3S | | MI | 32624 | 8892 | 51574 | 6519 | 54888 | 5346 | 55127 | 4451 | 53157 | 3164 | 61200 | 2713 | 27454 |
| 6-#18 | 1.32 | MA | 41431 | 8892 | 64881 | 6636 | 69718 | 5444 | 70378 | 4536 | 68527 | 3246 | 79557 | 2821 | 35233 |
| 3L-2S | | MI | 34480 | 8892 | 54319 | 6530 | 58406 | 5318 | 59419 | 4427 | 58892 | 3142 | 68781 | 2934 | 27319 |
| 8-#18 | 1.75 | MA | 45572 | 9169 | 72098 | 6815 | 78970 | 5534 | 81666 | 4581 | 83885 | 3200 | 100193 | 2997 | 46476 |
| 2L-4S | | MI | 32580 | 9169 | 52067 | 6725 | 55537 | 5455 | 55933 | 4506 | 54509 | 3158 | 63882 | 2429 | 36000 |
| 8-#18 | 1.75 | MA | 43138 | 9169 | 68490 | 6808 | 74344 | 5569 | 76022 | 4611 | 76206 | 3224 | 89875 | 2776 | 46477 |
| 3E | | MI | 33891 | 9169 | 54319 | 6692 | 58406 | 5471 | 59419 | 4526 | 58892 | 3136 | 68781 | 2650 | 36070 |
| 8-#18 | 1.75 | MA | 41430 | 9169 | 65549 | 6846 | 70597 | 5558 | 71468 | 4598 | 70345 | 3248 | 83161 | 2554 | 46197 |
| 4L-2S | | MI | 35735 | 9169 | 57063 | 6703 | 61924 | 5442 | 63710 | 4502 | 64626 | 3113 | 76363 | 2872 | 35984 |
| 10-#14 | 1.23 | MA | 43674 | 8840 | 67748 | 6648 | 73650 | 5419 | 75274 | 4518 | 75229 | 3247 | 88925 | 3087 | 33238 |
| 2L-5S | | MI | 31850 | 8840 | 49789 | 6555 | 52838 | 5362 | 52714 | 4467 | 50056 | 3196 | 58056 | 2686 | 26015 |
| 10-#14 | 1.23 | MA | 42271 | 8840 | 65690 | 6645 | 71013 | 5414 | 72056 | 4537 | 70852 | 3262 | 82976 | 2962 | 33287 |
| 3L-4S | | MI | 32527 | 8840 | 50902 | 6561 | 54282 | 5345 | 54487 | 4452 | 52596 | 3209 | 61071 | 2743 | 26001 |
| 10-#14 | 1.23 | MA | 41289 | 8840 | 64018 | 6667 | 68881 | 5434 | 69466 | 4530 | 67518 | 3277 | 79096 | 2838 | 33295 |
| 4L-3S | | MI | 33282 | 8840 | 52187 | 6541 | 55919 | 5352 | 56477 | 4462 | 55131 | 3196 | 63928 | 2867 | 25941 |
| 10-#14 | 1.23 | MA | 40414 | 8840 | 62574 | 6664 | 67008 | 5430 | 67163 | 4549 | 64181 | 3267 | 75063 | 2777 | 33200 |
| 5L-2S | | MI | 34349 | 8840 | 53759 | 6546 | 57933 | 5335 | 58934 | 4447 | 58447 | 3184 | 68335 | 2992 | 25872 |
| 10-#18 | 2.19 | MA | 47243 | 9445 | 75707 | 6988 | 83596 | 5659 | 87309 | 4656 | 91563 | 3178 | 110511 | 2951 | 57775 |
| 2L-5S | | MI | 32678 | 9445 | 52858 | 6886 | 56523 | 5608 | 57115 | 4606 | 55849 | 3107 | 66250 | 2269 | 42784 |
| 10-#18 | 2.19 | MA | 44827 | 9445 | 72098 | 6981 | 78970 | 5693 | 81666 | 4687 | 83885 | 3202 | 100193 | 2730 | 57685 |
| 3L-4S | | MI | 33845 | 9445 | 54811 | 6897 | 59055 | 5579 | 60224 | 4582 | 60244 | 3129 | 71463 | 2367 | 44475 |
| 10-#18 | 2.19 | MA | 43133 | 9445 | 69158 | 7019 | 75223 | 5683 | 77111 | 4673 | 78023 | 3226 | 93479 | 2509 | 57309 |
| 4L-3S | | MI | 35147 | 9445 | 57063 | 6864 | 61924 | 5595 | 63710 | 4602 | 64626 | 3107 | 76363 | 2588 | 44638 |
| 10-#18 | 2.19 | MA | 41621 | 9445 | 66616 | 7012 | 71926 | 5717 | 73060 | 4704 | 72155 | 3206 | 86460 | 2403 | 54936 |
| 5L-2S | | MI | 36979 | 9445 | 59807 | 6876 | 65442 | 5566 | 68002 | 4578 | 70361 | 3085 | 83944 | 2810 | 44611 |
| 12-#11 | 1.03 | MA | 42897 | 8709 | 65973 | 6586 | 71505 | 5376 | 72707 | 4496 | 71759 | 3268 | 84362 | 3122 | 27887 |
| 2L-6S | | MI | 31573 | 8709 | 48899 | 6493 | 51750 | 5312 | 51432 | 4438 | 48424 | 3230 | 55819 | 2770 | 21933 |
| 12-#11 | 1.03 | MA | 41913 | 8709 | 64537 | 6584 | 69665 | 5373 | 70462 | 4509 | 68704 | 3279 | 80187 | 3036 | 27927 |
| 3L-5S | | MI | 32025 | 8709 | 49628 | 6496 | 52759 | 5316 | 52665 | 4444 | 50041 | 3222 | 57823 | 2826 | 21909 |
| 12-#11 | 1.03 | MA | 41225 | 8709 | 63371 | 6600 | 68178 | 5387 | 68655 | 4505 | 66379 | 3290 | 77461 | 2950 | 27961 |
| 4E | | MI | 32499 | 8709 | 50405 | 6500 | 53766 | 5304 | 53902 | 4433 | 51827 | 3230 | 59943 | 2866 | 21863 |
| 12-#11 | 1.03 | MA | 40612 | 8709 | 62365 | 6598 | 66873 | 5385 | 67051 | 4518 | 64054 | 3284 | 74635 | 2907 | 27967 |
| 5L-3S | | MI | 33029 | 8709 | 51302 | 6486 | 54909 | 5308 | 55292 | 4439 | 53608 | 3222 | 61959 | 2952 | 21812 |
| 12-#11 | 1.03 | MA | 40029 | 8709 | 61422 | 6596 | 65566 | 5399 | 65453 | 4514 | 61948 | 3295 | 71933 | 2851 | 27919 |
| 6L-2S | | MI | 33778 | 8709 | 52401 | 6489 | 56318 | 5296 | 57011 | 4428 | 55940 | 3213 | 65064 | 3039 | 21763 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

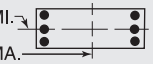



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#14 | 1.48 | MA | 44649 | 8996 | 69805 | 6746 | 76288 | 5488 | 78491 | 4560 | 79607 | 3235 | 94874 | 3064 | 39695 |
| 2L-6S | | MI | 31947 | 8996 | 50316 | 6647 | 53407 | 5424 | 53404 | 4500 | 51071 | 3195 | 59620 | 2573 | 30419 |
| 12-#14 | 1.48 | MA | 43252 | 8996 | 67748 | 6743 | 73650 | 5484 | 75274 | 4579 | 75229 | 3250 | 88925 | 2940 | 39730 |
| 3L-5S | | MI | 32589 | 8996 | 51360 | 6653 | 54852 | 5432 | 55171 | 4510 | 53372 | 3182 | 62462 | 2655 | 30898 |
| 12-#14 | 1.48 | MA | 42275 | 8996 | 66076 | 6765 | 71519 | 5504 | 72683 | 4573 | 71895 | 3265 | 85045 | 2815 | 39695 |
| 4E | | MI | 33263 | 8996 | 52473 | 6658 | 56296 | 5414 | 56944 | 4495 | 55912 | 3195 | 65478 | 2712 | 30924 |
| 12-#14 | 1.48 | MA | 41404 | 8996 | 64631 | 6762 | 69645 | 5499 | 70380 | 4591 | 68559 | 3255 | 81012 | 2754 | 39563 |
| 5L-3S | | MI | 34015 | 8996 | 53759 | 6638 | 57933 | 5422 | 58934 | 4504 | 58447 | 3182 | 68335 | 2836 | 30886 |
| 12-#14 | 1.48 | MA | 40575 | 8996 | 63278 | 6759 | 67770 | 5520 | 68088 | 4585 | 65538 | 3270 | 77164 | 2674 | 38800 |
| 6L-2S | | MI | 35077 | 8996 | 55330 | 6643 | 59947 | 5404 | 61391 | 4489 | 61764 | 3170 | 72741 | 2961 | 30830 |
| 12-#18 | 2.63 | MA | 48899 | 9722 | 79316 | 7161 | 88223 | 5783 | 92953 | 4731 | 99242 | 3156 | 120830 | 2906 | 69026 |
| 2L-6S | | MI | 32836 | 9722 | 53768 | 7048 | 57505 | 5716 | 58307 | 4662 | 57604 | 3100 | 68950 | 2061 | 49600 |
| 12-#18 | 2.63 | MA | 46499 | 9722 | 75707 | 7154 | 83596 | 5817 | 87309 | 4762 | 91563 | 3180 | 110511 | 2684 | 68870 |
| 3L-5S | | MI | 33940 | 9722 | 55602 | 7059 | 60041 | 5732 | 61406 | 4682 | 61583 | 3078 | 73832 | 2207 | 50933 |
| 12-#18 | 2.63 | MA | 44819 | 9722 | 72767 | 7192 | 79849 | 5807 | 82755 | 4749 | 85702 | 3204 | 103797 | 2463 | 68410 |
| 4E | | MI | 35099 | 9722 | 57555 | 7070 | 62573 | 5703 | 64516 | 4657 | 65978 | 3100 | 79044 | 2304 | 52930 |
| 12-#18 | 2.63 | MA | 43320 | 9722 | 70224 | 7185 | 76552 | 5841 | 78703 | 4779 | 79834 | 3184 | 96778 | 2357 | 65718 |
| 5L-3S | | MI | 36391 | 9722 | 59807 | 7037 | 65442 | 5719 | 68002 | 4677 | 70361 | 3078 | 83944 | 2526 | 53168 |
| 12-#18 | 2.63 | MA | 41893 | 9722 | 67841 | 7178 | 73251 | 5831 | 74668 | 4766 | 74516 | 3207 | 90110 | 2213 | 63686 |
| 6L-2S | | MI | 38212 | 9722 | 62551 | 7049 | 68960 | 5690 | 72294 | 4653 | 76095 | 3056 | 91525 | 2747 | 53210 |
| 14-#11 | 1.20 | MA | 43584 | 8817 | 67409 | 6653 | 73346 | 5424 | 74953 | 4525 | 74815 | 3259 | 88537 | 3108 | 32400 |
| 2L-7S | | MI | 31656 | 8817 | 49200 | 6575 | 52195 | 5373 | 51967 | 4479 | 49174 | 3230 | 56784 | 2659 | 25121 |
| 14-#11 | 1.20 | MA | 42603 | 8817 | 65973 | 6652 | 71505 | 5421 | 72707 | 4539 | 71759 | 3270 | 84362 | 3021 | 32433 |
| 3L-6S | | MI | 32095 | 8817 | 49998 | 6561 | 53158 | 5360 | 53150 | 4467 | 50755 | 3221 | 58924 | 2750 | 25361 |
| 14-#11 | 1.20 | MA | 41919 | 8817 | 64807 | 6667 | 70019 | 5436 | 70901 | 4535 | 69435 | 3281 | 81636 | 2935 | 32455 |
| 4L-5S | | MI | 32546 | 8817 | 50727 | 6564 | 54167 | 5365 | 54383 | 4474 | 52373 | 3213 | 60928 | 2806 | 25356 |
| 14-#11 | 1.20 | MA | 41308 | 8817 | 63800 | 6665 | 68714 | 5433 | 69296 | 4548 | 67109 | 3275 | 78810 | 2892 | 32437 |
| 5L-4S | | MI | 33018 | 8817 | 51504 | 6567 | 55174 | 5352 | 55621 | 4462 | 54158 | 3221 | 63048 | 2846 | 25324 |
| 14-#11 | 1.20 | MA | 40727 | 8817 | 62858 | 6664 | 67407 | 5447 | 67699 | 4544 | 65004 | 3286 | 76108 | 2836 | 32369 |
| 6L-3S | | MI | 33546 | 8817 | 52401 | 6553 | 56318 | 5357 | 57011 | 4469 | 55940 | 3213 | 65064 | 2932 | 25281 |
| 14-#11 | 1.20 | MA | 40161 | 8817 | 61824 | 6679 | 66161 | 5444 | 66166 | 4557 | 62947 | 3297 | 73228 | 2747 | 31945 |
| 7L-2S | | MI | 34293 | 8817 | 53500 | 6556 | 57727 | 5344 | 58729 | 4457 | 58271 | 3204 | 68169 | 3019 | 25237 |
| 14-#14 | 1.73 | MA | 45617 | 9151 | 71862 | 6843 | 78925 | 5558 | 81709 | 4603 | 83984 | 3222 | 100822 | 3042 | 46140 |
| 2L-7S | | MI | 32062 | 9151 | 50743 | 6764 | 54041 | 5512 | 54165 | 4558 | 52138 | 3193 | 60990 | 2412 | 34566 |
| 14-#14 | 1.73 | MA | 44226 | 9151 | 69805 | 6840 | 76288 | 5554 | 78491 | 4621 | 79607 | 3237 | 94874 | 2917 | 46147 |
| 3L-6S | | MI | 32685 | 9151 | 51887 | 6745 | 55421 | 5494 | 55861 | 4543 | 54387 | 3181 | 64027 | 2542 | 35140 |
| 14-#14 | 1.73 | MA | 43255 | 9151 | 68133 | 6862 | 74156 | 5574 | 75901 | 4615 | 76273 | 3252 | 90994 | 2793 | 46084 |
| 4L-5S | | MI | 33324 | 9151 | 52931 | 6750 | 56866 | 5502 | 57628 | 4552 | 56689 | 3168 | 66869 | 2624 | 35770 |
| 14-#14 | 1.73 | MA | 42388 | 9151 | 66688 | 6859 | 72283 | 5569 | 73598 | 4633 | 72937 | 3242 | 86961 | 2732 | 45918 |
| 5L-4S | | MI | 33995 | 9151 | 54044 | 6755 | 58310 | 5484 | 59401 | 4537 | 59229 | 3181 | 69885 | 2681 | 35828 |
| 14-#14 | 1.73 | MA | 41564 | 9151 | 65335 | 6856 | 70407 | 5589 | 71305 | 4627 | 69915 | 3258 | 83113 | 2651 | 45001 |
| 6L-3S | | MI | 34743 | 9151 | 55330 | 6735 | 59947 | 5492 | 61391 | 4547 | 61764 | 3168 | 72741 | 2805 | 35816 |
| 14-#14 | 1.73 | MA | 40760 | 9151 | 63852 | 6878 | 68618 | 5585 | 69105 | 4646 | 66964 | 3273 | 79010 | 2521 | 44118 |
| 7L-2S | | MI | 35801 | 9151 | 56901 | 6741 | 61961 | 5474 | 63848 | 4531 | 65080 | 3156 | 77148 | 2930 | 35773 |
| 14-#18 | 3.07 | MA | 48156 | 9999 | 79316 | 7327 | 88223 | 5941 | 92953 | 4838 | 99242 | 3158 | 120830 | 2639 | 80039 |
| 3L-6S | | MI | 34095 | 9999 | 56512 | 7221 | 61023 | 5841 | 62599 | 4737 | 63339 | 3072 | 76531 | 1999 | 57852 |
| 14-#18 | 3.07 | MA | 46489 | 9999 | 76375 | 7365 | 84475 | 5931 | 88398 | 4824 | 93381 | 3182 | 114115 | 2417 | 79504 |
| 4L-5S | | MI | 35191 | 9999 | 58346 | 7232 | 63559 | 5856 | 65698 | 4757 | 67318 | 3049 | 81413 | 2145 | 59115 |
| 14-#18 | 3.07 | MA | 45002 | 9999 | 73833 | 7358 | 81178 | 5965 | 84347 | 4855 | 87512 | 3161 | 107096 | 2311 | 76533 |
| 5L-4S | | MI | 36342 | 9999 | 60299 | 7243 | 66091 | 5827 | 68808 | 4733 | 71713 | 3072 | 86626 | 2242 | 61372 |
| 14-#18 | 3.07 | MA | 43587 | 9999 | 71450 | 7351 | 77877 | 5955 | 80312 | 4841 | 82195 | 3185 | 100429 | 2168 | 74588 |
| 6L-3S | | MI | 37626 | 9999 | 62551 | 7210 | 68960 | 5843 | 72294 | 4753 | 76095 | 3049 | 91525 | 2463 | 61676 |
| 14-#18 | 3.07 | MA | 42210 | 9999 | 68838 | 7389 | 74727 | 5989 | 76439 | 4872 | 76999 | 3209 | 93314 | 1937 | 71213 |
| 7L-2S | | MI | 39435 | 9999 | 65295 | 7221 | 72478 | 5814 | 76585 | 4728 | 81830 | 3027 | 99107 | 2685 | 61781 |
| 16-#11 | 1.37 | MA | 44269 | 8925 | 68845 | 6721 | 75187 | 5473 | 77199 | 4555 | 77870 | 3251 | 92712 | 3093 | 36906 |
| 2L-8S | | MI | 31746 | 8925 | 49581 | 6639 | 52627 | 5416 | 52530 | 4519 | 49825 | 3212 | 57907 | 2592 | 28162 |
| 16-#11 | 1.37 | MA | 43291 | 8925 | 67409 | 6719 | 73346 | 5470 | 74953 | 4568 | 74815 | 3262 | 88537 | 3007 | 36931 |
| 3L-7S | | MI | 32177 | 8925 | 50299 | 6642 | 53604 | 5421 | 53685 | 4508 | 51505 | 3221 | 59889 | 2639 | 28454 |

## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis



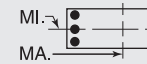

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.37 | MA | 42608 | 8925 | 66243 | 6735 | 71860 | 5484 | 73147 | 4564 | 72490 | 3273 | 85811 | 2921 | 36937 |
| 4L-6S | | MI | 32615 | 8925 | 51097 | 6628 | 54567 | 5409 | 54869 | 4497 | 53086 | 3212 | 62029 | 2730 | 28779 |
| 16-#11 | 1.37 | MA | 42000 | 8925 | 65236 | 6733 | 70555 | 5481 | 71542 | 4577 | 70165 | 3266 | 82985 | 2878 | 36901 |
| 5E | | MI | 33064 | 8925 | 51826 | 6631 | 55576 | 5413 | 56102 | 4503 | 54704 | 3204 | 64033 | 2786 | 28796 |
| 16-#11 | 1.37 | MA | 41421 | 8925 | 64294 | 6731 | 69248 | 5496 | 69945 | 4573 | 68059 | 3277 | 80283 | 2822 | 36814 |
| 6L-4S | | MI | 33535 | 8925 | 52602 | 6634 | 56583 | 5401 | 57339 | 4492 | 56489 | 3212 | 66153 | 2826 | 28775 |
| 16-#11 | 1.37 | MA | 40858 | 8925 | 63260 | 6747 | 68001 | 5493 | 68412 | 4586 | 66003 | 3288 | 77403 | 2732 | 36304 |
| 7L-3S | | MI | 34061 | 8925 | 53500 | 6620 | 57727 | 5405 | 58729 | 4498 | 58271 | 3204 | 68169 | 2912 | 28741 |
| 16-#11 | 1.37 | MA | 40293 | 8925 | 62333 | 6745 | 66737 | 5507 | 66916 | 4600 | 63817 | 3282 | 74760 | 2682 | 35841 |
| 8L-2S | | MI | 34806 | 8925 | 54599 | 6624 | 59135 | 5393 | 60447 | 4487 | 60602 | 3195 | 71274 | 2999 | 28703 |
| 16-#14 | 1.97 | MA | 46580 | 9307 | 73920 | 6940 | 81562 | 5628 | 84926 | 4645 | 88362 | 3210 | 106771 | 3019 | 52580 |
| 2L-8S | | MI | 32188 | 9307 | 51285 | 6856 | 54655 | 5574 | 54966 | 4616 | 53063 | 3167 | 62579 | 2314 | 38643 |
| 16-#14 | 1.97 | MA | 45195 | 9307 | 71862 | 6937 | 78925 | 5623 | 81709 | 4664 | 83984 | 3225 | 100822 | 2895 | 52554 |
| 3L-7S | | MI | 32799 | 9307 | 52314 | 6862 | 56055 | 5582 | 56622 | 4600 | 55455 | 3179 | 65397 | 2381 | 39327 |
| 16-#14 | 1.97 | MA | 44228 | 9307 | 70190 | 6959 | 76794 | 5644 | 79118 | 4657 | 80650 | 3240 | 96943 | 2770 | 52464 |
| 4L-6S | | MI | 33419 | 9307 | 53458 | 6842 | 57435 | 5564 | 58318 | 4585 | 57704 | 3167 | 68434 | 2511 | 39874 |
| 16-#14 | 1.97 | MA | 43366 | 9307 | 68746 | 6956 | 74920 | 5639 | 76815 | 4676 | 77314 | 3230 | 92910 | 2709 | 52268 |
| 5E | | MI | 34055 | 9307 | 54502 | 6847 | 58880 | 5572 | 60085 | 4595 | 60005 | 3154 | 71276 | 2593 | 40633 |
| 16-#14 | 1.97 | MA | 42546 | 9307 | 67392 | 6953 | 73044 | 5659 | 74523 | 4670 | 74293 | 3245 | 89062 | 2629 | 51216 |
| 6L-4S | | MI | 34723 | 9307 | 55615 | 6852 | 60323 | 5554 | 61858 | 4579 | 62545 | 3167 | 74291 | 2650 | 40717 |
| 16-#14 | 1.97 | MA | 41747 | 9307 | 65909 | 6975 | 71256 | 5655 | 72323 | 4688 | 71341 | 3260 | 84959 | 2499 | 50366 |
| 7L-3S | | MI | 35468 | 9307 | 56901 | 6833 | 61961 | 5561 | 63848 | 4589 | 65080 | 3154 | 77148 | 2774 | 40741 |
| 16-#14 | 1.97 | MA | 40960 | 9307 | 64577 | 6972 | 69441 | 5675 | 70176 | 4707 | 68204 | 3250 | 81187 | 2427 | 49375 |
| 8L-2S | | MI | 36522 | 9307 | 58472 | 6838 | 63975 | 5544 | 66305 | 4574 | 68397 | 3142 | 81554 | 2899 | 40706 |
| 16-#18 | 3.51 | MA | 48145 | 10275 | 79984 | 7538 | 89101 | 6055 | 94042 | 4900 | 101059 | 3160 | 124433 | 2372 | 90593 |
| 4L-6S | | MI | 35343 | 10275 | 59256 | 7394 | 64540 | 5965 | 66891 | 4812 | 69074 | 3043 | 84113 | 1937 | 65926 |
| 16-#18 | 3.51 | MA | 46669 | 10275 | 77442 | 7531 | 85804 | 6089 | 89991 | 4930 | 95191 | 3139 | 117414 | 2266 | 87374 |
| 5E | | MI | 36432 | 10275 | 61090 | 7405 | 67077 | 5980 | 69990 | 4832 | 73053 | 3021 | 88994 | 2082 | 67321 |
| 16-#18 | 3.51 | MA | 45266 | 10275 | 75058 | 7524 | 82503 | 6079 | 85956 | 4917 | 89874 | 3163 | 110747 | 2122 | 85506 |
| 6L-4S | | MI | 37575 | 10275 | 63044 | 7416 | 69609 | 5952 | 73099 | 4808 | 77448 | 3043 | 94207 | 2180 | 69671 |
| 16-#18 | 3.51 | MA | 43899 | 10275 | 72447 | 7562 | 79353 | 6113 | 82083 | 4948 | 84678 | 3187 | 103633 | 1891 | 81973 |
| 7L-3S | | MI | 38851 | 10275 | 65295 | 7383 | 72478 | 5967 | 76585 | 4828 | 81830 | 3021 | 99107 | 2401 | 70169 |
| 16-#18 | 3.51 | MA | 42554 | 10275 | 70101 | 7555 | 76158 | 6103 | 78303 | 4978 | 79156 | 3167 | 97070 | 1767 | 78787 |
| 8L-2S | | MI | 40650 | 10275 | 68040 | 7394 | 75995 | 5939 | 80877 | 4804 | 87564 | 2999 | 106688 | 2623 | 70323 |
| 18-#11 | 1.54 | MA | 44950 | 9033 | 70281 | 6788 | 77028 | 5521 | 79444 | 4584 | 80925 | 3242 | 96887 | 3079 | 41406 |
| 2L-9S | | MI | 31830 | 9033 | 49907 | 6720 | 53086 | 5477 | 53040 | 4542 | 50589 | 3212 | 59069 | 2518 | 31273 |
| 18-#11 | 1.54 | MA | 43975 | 9033 | 68845 | 6786 | 75187 | 5518 | 77199 | 4597 | 77870 | 3253 | 92712 | 2992 | 41423 |
| 3L-8S | | MI | 32267 | 9033 | 50680 | 6706 | 54036 | 5465 | 54248 | 4548 | 52156 | 3203 | 61012 | 2572 | 31511 |
| 18-#11 | 1.54 | MA | 43295 | 9033 | 67679 | 6802 | 73701 | 5533 | 75392 | 4593 | 75545 | 3264 | 89986 | 2906 | 41410 |
| 4L-7S | | MI | 32697 | 9033 | 51397 | 6709 | 55013 | 5470 | 55403 | 4537 | 53836 | 3212 | 62994 | 2619 | 31791 |
| 18-#11 | 1.54 | MA | 42689 | 9033 | 66672 | 6800 | 72395 | 5530 | 73788 | 4607 | 73220 | 3258 | 87160 | 2863 | 41359 |
| 5L-6S | | MI | 33133 | 9033 | 52196 | 6695 | 55975 | 5457 | 56587 | 4526 | 55417 | 3203 | 65134 | 2710 | 32192 |
| 18-#11 | 1.54 | MA | 42113 | 9033 | 65730 | 6799 | 71089 | 5544 | 72190 | 4603 | 71115 | 3269 | 84458 | 2807 | 41255 |
| 6L-5S | | MI | 33580 | 9033 | 52924 | 6699 | 56984 | 5462 | 57820 | 4532 | 57035 | 3195 | 67138 | 2766 | 32224 |
| 18-#11 | 1.54 | MA | 41551 | 9033 | 64696 | 6814 | 69842 | 5541 | 70658 | 4616 | 69058 | 3280 | 81578 | 2718 | 40668 |
| 7L-4S | | MI | 34050 | 9033 | 53701 | 6702 | 57992 | 5449 | 59058 | 4521 | 58820 | 3203 | 69258 | 2806 | 32219 |
| 18-#11 | 1.54 | MA | 40991 | 9033 | 63769 | 6812 | 68578 | 5556 | 69162 | 4629 | 66872 | 3273 | 78935 | 2667 | 40221 |
| 8L-3S | | MI | 34574 | 9033 | 54599 | 6688 | 59135 | 5454 | 60447 | 4527 | 60602 | 3195 | 71274 | 2892 | 32194 |
| 18-#11 | 1.54 | MA | 40403 | 9033 | 62861 | 6811 | 67349 | 5553 | 67598 | 4625 | 64835 | 3284 | 76315 | 2614 | 39821 |
| 9L-2S | | MI | 35317 | 9033 | 55697 | 6691 | 60544 | 5441 | 62166 | 4516 | 62933 | 3186 | 74379 | 2979 | 32161 |
| 18-#14 | 2.22 | MA | 46158 | 9463 | 73920 | 7034 | 81562 | 5693 | 84926 | 4706 | 88362 | 3212 | 106771 | 2872 | 58953 |
| 3L-8S | | MI | 32923 | 9463 | 52856 | 6954 | 56669 | 5644 | 57422 | 4658 | 56380 | 3153 | 66985 | 2283 | 43316 |
| 18-#14 | 2.22 | MA | 45196 | 9463 | 72247 | 7056 | 79431 | 5714 | 82335 | 4700 | 85028 | 3227 | 102892 | 2748 | 58838 |
| 4L-7S | | MI | 33531 | 9463 | 53885 | 6959 | 58069 | 5651 | 59079 | 4643 | 58771 | 3165 | 69804 | 2350 | 44093 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis

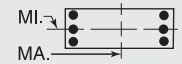


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.22 | MA | 44338 | 9463 | 70803 | 7053 | 77557 | 5709 | 80033 | 4718 | 81692 | 3218 | 98859 | 2687 | 58615 |
| 5L-6S | | MI | 34149 | 9463 | 55029 | 6939 | 59449 | 5634 | 60775 | 4627 | 61020 | 3153 | 72840 | 2480 | 44618 |
| 18-#14 | 2.22 | MA | 43522 | 9463 | 69450 | 7051 | 75682 | 5729 | 77740 | 4712 | 78670 | 3233 | 95010 | 2606 | 57442 |
| 6L-5S | | MI | 34782 | 9463 | 56073 | 6944 | 60894 | 5641 | 62541 | 4637 | 63321 | 3140 | 75682 | 2562 | 45489 |
| 18-#14 | 2.22 | MA | 42727 | 9463 | 67967 | 7073 | 73893 | 5725 | 75540 | 4730 | 75719 | 3248 | 90908 | 2476 | 56620 |
| 7L-4S | | MI | 35447 | 9463 | 57186 | 6950 | 62337 | 5624 | 64314 | 4622 | 65862 | 3153 | 78698 | 2619 | 45598 |
| 18-#14 | 2.22 | MA | 41944 | 9463 | 66635 | 7070 | 72078 | 5745 | 73393 | 4749 | 72581 | 3238 | 87136 | 2405 | 55537 |
| 8L-3S | | MI | 36189 | 9463 | 58472 | 6930 | 63975 | 5631 | 66305 | 4631 | 68397 | 3140 | 81554 | 2743 | 45642 |
| 18-#14 | 2.22 | MA | 41112 | 9463 | 65332 | 7067 | 70314 | 5740 | 71148 | 4743 | 69657 | 3253 | 83405 | 2327 | 54273 |
| 9L-2S | | MI | 37239 | 9463 | 60043 | 6935 | 65989 | 5614 | 68762 | 4616 | 71713 | 3128 | 85961 | 2868 | 45630 |
| 18-#18 | 3.95 | MA | 48322 | 10552 | 81050 | 7704 | 90431 | 6213 | 95634 | 5006 | 102870 | 3117 | 127732 | 2220 | 98237 |
| 5L-6S | | MI | 36583 | 10552 | 62000 | 7567 | 68058 | 6089 | 71182 | 4888 | 74808 | 3014 | 91694 | 1874 | 73954 |
| 18-#18 | 3.95 | MA | 46930 | 10552 | 78667 | 7697 | 87129 | 6203 | 91599 | 4992 | 97552 | 3141 | 121065 | 2076 | 96256 |
| 6L-5S | | MI | 37665 | 10552 | 63834 | 7578 | 70595 | 6104 | 74281 | 4908 | 78787 | 2992 | 96576 | 2020 | 75547 |
| 18-#18 | 3.95 | MA | 45574 | 10552 | 76056 | 7735 | 83979 | 6237 | 87727 | 5023 | 92356 | 3165 | 113951 | 1846 | 92753 |
| 7L-4S | | MI | 38800 | 10552 | 65788 | 7589 | 73126 | 6076 | 77391 | 4883 | 83182 | 3014 | 101788 | 2117 | 77770 |
| 18-#18 | 3.95 | MA | 44239 | 10552 | 73710 | 7728 | 80784 | 6227 | 83946 | 5054 | 86835 | 3145 | 107388 | 1721 | 89451 |
| 8L-3S | | MI | 40067 | 10552 | 68040 | 7556 | 75995 | 6091 | 80877 | 4903 | 87564 | 2992 | 106688 | 2339 | 78649 |
| 20-#11 | 1.71 | MA | 45628 | 9141 | 71716 | 6856 | 78869 | 5570 | 81690 | 4614 | 83981 | 3233 | 101062 | 3064 | 45901 |
| 2L-10S | | MI | 31898 | 9141 | 50291 | 6784 | 53531 | 5521 | 53608 | 4583 | 51367 | 3211 | 60293 | 2437 | 34053 |
| 20-#11 | 1.71 | MA | 44656 | 9141 | 70281 | 6854 | 77028 | 5567 | 79444 | 4627 | 80925 | 3244 | 96887 | 2978 | 45906 |
| 3L-9S | | MI | 32352 | 9141 | 51006 | 6788 | 54494 | 5526 | 54758 | 4572 | 52920 | 3203 | 62174 | 2498 | 34562 |
| 20-#11 | 1.71 | MA | 43979 | 9141 | 69115 | 6869 | 75542 | 5581 | 77638 | 4623 | 78601 | 3255 | 94161 | 2891 | 45879 |
| 4L-8S | | MI | 32786 | 9141 | 51779 | 6774 | 55445 | 5513 | 55966 | 4578 | 54487 | 3194 | 64117 | 2552 | 34863 |
| 20-#11 | 1.71 | MA | 43375 | 9141 | 68108 | 6868 | 74236 | 5578 | 76033 | 4636 | 76276 | 3249 | 91336 | 2849 | 45814 |
| 5L-7S | | MI | 33214 | 9141 | 52496 | 6777 | 56421 | 5518 | 57122 | 4567 | 56167 | 3203 | 66099 | 2599 | 35134 |
| 20-#11 | 1.71 | MA | 42801 | 9141 | 67166 | 6866 | 72929 | 5593 | 74436 | 4632 | 74170 | 3260 | 88633 | 2793 | 45689 |
| 6E | | MI | 33649 | 9141 | 53294 | 6763 | 57384 | 5505 | 58305 | 4556 | 57748 | 3194 | 68239 | 2689 | 35558 |
| 20-#11 | 1.71 | MA | 42241 | 9141 | 66132 | 6881 | 71683 | 5590 | 72903 | 4645 | 72114 | 3271 | 85753 | 2703 | 45039 |
| 7L-5S | | MI | 34095 | 9141 | 54023 | 6766 | 58393 | 5510 | 59538 | 4562 | 59366 | 3186 | 70243 | 2746 | 35645 |
| 20-#11 | 1.71 | MA | 41690 | 9141 | 65205 | 6880 | 70419 | 5604 | 71408 | 4659 | 69928 | 3265 | 83110 | 2653 | 44604 |
| 8L-4S | | MI | 34562 | 9141 | 54800 | 6769 | 59400 | 5497 | 60776 | 4551 | 61151 | 3194 | 72363 | 2786 | 35658 |
| 20-#11 | 1.71 | MA | 41098 | 9141 | 64297 | 6878 | 69190 | 5601 | 69843 | 4655 | 67890 | 3276 | 80490 | 2599 | 44142 |
| 9L-3S | | MI | 35085 | 9141 | 55697 | 6755 | 60544 | 5502 | 62166 | 4557 | 62933 | 3186 | 74379 | 2872 | 35641 |
| 20-#11 | 1.71 | MA | 40489 | 9141 | 63281 | 6894 | 67943 | 5616 | 68356 | 4668 | 65870 | 3287 | 77950 | 2538 | 43387 |
| 10L-2S | | MI | 35826 | 9141 | 56796 | 6758 | 61952 | 5490 | 63884 | 4546 | 65264 | 3177 | 77484 | 2959 | 35614 |
| 20-#14 | 2.47 | MA | 46158 | 9618 | 74305 | 7154 | 82068 | 5783 | 85553 | 4742 | 89406 | 3215 | 108840 | 2725 | 65207 |
| 4L-8S | | MI | 33655 | 9618 | 54427 | 7051 | 58683 | 5714 | 59879 | 4700 | 59696 | 3139 | 71392 | 2252 | 47999 |
| 20-#14 | 2.47 | MA | 45304 | 9618 | 72860 | 7151 | 80195 | 5779 | 83250 | 4761 | 86069 | 3205 | 104807 | 2664 | 64958 |
| 5L-7S | | MI | 34260 | 9618 | 55456 | 7056 | 60083 | 5721 | 61536 | 4685 | 62087 | 3151 | 74210 | 2319 | 48864 |
| 20-#14 | 2.47 | MA | 44492 | 9618 | 71507 | 7148 | 78319 | 5799 | 80958 | 4754 | 83048 | 3220 | 100959 | 2583 | 63677 |
| 6E | | MI | 34875 | 9618 | 56600 | 7036 | 61463 | 5704 | 63232 | 4670 | 64336 | 3139 | 77247 | 2450 | 49369 |
| 20-#14 | 2.47 | MA | 43701 | 9618 | 70024 | 7170 | 76530 | 5794 | 78758 | 4773 | 80096 | 3235 | 96857 | 2454 | 62881 |
| 7L-5S | | MI | 35505 | 9618 | 57644 | 7042 | 62908 | 5711 | 64998 | 4680 | 66638 | 3126 | 80089 | 2531 | 50232 |
| 20-#14 | 2.47 | MA | 42923 | 9618 | 68692 | 7167 | 74716 | 5815 | 76611 | 4791 | 76959 | 3225 | 93085 | 2382 | 61710 |
| 8L-4S | | MI | 36167 | 9618 | 58757 | 7047 | 64351 | 5694 | 66771 | 4664 | 69178 | 3139 | 83104 | 2588 | 50471 |
| 20-#14 | 2.47 | MA | 42095 | 9618 | 67389 | 7164 | 72951 | 5810 | 74366 | 4785 | 74034 | 3240 | 89353 | 2305 | 60479 |
| 9L-3S | | MI | 36906 | 9618 | 60043 | 7027 | 65989 | 5701 | 68762 | 4674 | 71713 | 3126 | 85961 | 2712 | 50534 |
| 20-#14 | 2.47 | MA | 41234 | 9618 | 65930 | 7186 | 71161 | 5830 | 72230 | 4804 | 71135 | 3256 | 85737 | 2217 | 59011 |
| 10L-2S | | MI | 37952 | 9618 | 61614 | 7032 | 68003 | 5684 | 71219 | 4659 | 75029 | 3114 | 90368 | 2837 | 50554 |
| 20-#18 | 4.39 | MA | 48581 | 10828 | 82276 | 7870 | 91755 | 6327 | 97243 | 5068 | 105231 | 3119 | 131383 | 2031 | 106945 |
| 6E | | MI | 37814 | 10828 | 64745 | 7740 | 71576 | 6213 | 75474 | 4963 | 80543 | 2986 | 99275 | 1812 | 82008 |
| 20-#18 | 4.39 | MA | 47235 | 10828 | 79664 | 7908 | 88606 | 6362 | 93370 | 5098 | 100035 | 3143 | 124269 | 1800 | 103553 |
| 7L-5S | | MI | 38888 | 10828 | 66579 | 7751 | 74113 | 6229 | 78573 | 4983 | 84522 | 2963 | 104157 | 1958 | 83790 |
| 20-#18 | 4.39 | MA | 45910 | 10828 | 77318 | 7901 | 85411 | 6351 | 89590 | 5129 | 94513 | 3123 | 117706 | 1676 | 100136 |
| 8L-4S | | MI | 40017 | 10828 | 68532 | 7762 | 76644 | 6200 | 81683 | 4959 | 88917 | 2986 | 109370 | 2055 | 85899 |
| 22-#11 | 1.88 | MA | 45335 | 9249 | 71716 | 6921 | 78869 | 5615 | 81690 | 4656 | 83981 | 3236 | 101062 | 2963 | 50382 |
| 3L-10S | | MI | 32418 | 9249 | 51390 | 6852 | 54939 | 5570 | 55327 | 4612 | 53698 | 3202 | 63398 | 2417 | 37364 |

## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

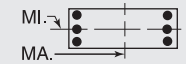
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.88 | MA | 44659 | 9249 | 70551 | 6937 | 77383 | 5629 | 79884 | 4652 | 81656 | 3247 | 98336 | 2877 | 50343 |
| 4L-9S | | MI | 32872 | 9249 | 52105 | 6855 | 55903 | 5574 | 56477 | 4601 | 55251 | 3194 | 65279 | 2478 | 37857 |
| 22-#11 | 1.88 | MA | 44058 | 9249 | 69544 | 6935 | 76077 | 5627 | 78279 | 4665 | 79331 | 3240 | 95511 | 2834 | 50264 |
| 5L-8S | | MI | 33302 | 9249 | 52877 | 6841 | 56853 | 5562 | 57685 | 4607 | 56818 | 3185 | 67222 | 2532 | 38218 |
| 22-#11 | 1.88 | MA | 43486 | 9249 | 68601 | 6933 | 74770 | 5641 | 76682 | 4661 | 77226 | 3251 | 92808 | 2778 | 50041 |
| 6L-7S | | MI | 33729 | 9249 | 53595 | 6844 | 57830 | 5566 | 58840 | 4596 | 58499 | 3194 | 69204 | 2579 | 38479 |
| 22-#11 | 1.88 | MA | 42928 | 9249 | 67568 | 6949 | 73524 | 5638 | 75149 | 4675 | 75169 | 3262 | 89928 | 2688 | 49413 |
| 7L-6S | | MI | 34162 | 9249 | 54393 | 6830 | 58793 | 5554 | 60024 | 4585 | 60080 | 3185 | 71344 | 2669 | 38885 |
| 22-#11 | 1.88 | MA | 42379 | 9249 | 66641 | 6947 | 72260 | 5653 | 73653 | 4688 | 72983 | 3256 | 87285 | 2638 | 48990 |
| 8L-5S | | MI | 34607 | 9249 | 55122 | 6833 | 59802 | 5558 | 61257 | 4591 | 61697 | 3177 | 73348 | 2726 | 39061 |
| 22-#11 | 1.88 | MA | 41790 | 9249 | 65733 | 6945 | 71031 | 5650 | 72089 | 4684 | 70945 | 3267 | 84665 | 2585 | 48468 |
| 9L-4S | | MI | 35073 | 9249 | 55899 | 6837 | 60809 | 5546 | 62494 | 4580 | 63482 | 3185 | 75468 | 2766 | 39088 |
| 22-#11 | 1.88 | MA | 41183 | 9249 | 64717 | 6961 | 69784 | 5664 | 70601 | 4697 | 68925 | 3278 | 82125 | 2524 | 47732 |
| 10L-3S | | MI | 35594 | 9249 | 56796 | 6823 | 61952 | 5551 | 63884 | 4586 | 65264 | 3177 | 77484 | 2852 | 39083 |
| 22-#11 | 1.88 | MA | 40591 | 9249 | 63808 | 6959 | 68561 | 5661 | 69057 | 4693 | 66771 | 3272 | 79547 | 2471 | 47108 |
| 11L-2S | | MI | 36333 | 9249 | 57895 | 6826 | 63361 | 5538 | 65603 | 4575 | 67595 | 3168 | 80589 | 2939 | 39062 |
| 22-#14 | 2.71 | MA | 46265 | 9774 | 74918 | 7248 | 82832 | 5849 | 86468 | 4803 | 90447 | 3193 | 110756 | 2641 | 71185 |
| 5L-8S | | MI | 34382 | 9774 | 55998 | 7148 | 60697 | 5784 | 62336 | 4743 | 63013 | 3124 | 75799 | 2221 | 52692 |
| 22-#14 | 2.71 | MA | 45457 | 9774 | 73564 | 7245 | 80957 | 5869 | 84175 | 4797 | 87426 | 3208 | 106908 | 2561 | 69920 |
| 6L-7S | | MI | 34985 | 9774 | 57027 | 7153 | 62097 | 5791 | 63993 | 4728 | 65404 | 3137 | 78617 | 2288 | 53639 |
| 22-#14 | 2.71 | MA | 44670 | 9774 | 72081 | 7267 | 79168 | 5864 | 81975 | 4815 | 84474 | 3223 | 102805 | 2431 | 69146 |
| 7L-6S | | MI | 35597 | 9774 | 58171 | 7134 | 63477 | 5774 | 65689 | 4712 | 67653 | 3124 | 81654 | 2419 | 54127 |
| 22-#14 | 2.71 | MA | 43895 | 9774 | 70749 | 7264 | 77353 | 5884 | 79828 | 4834 | 81337 | 3213 | 99034 | 2360 | 67891 |
| 8L-5S | | MI | 36225 | 9774 | 59215 | 7139 | 64922 | 5781 | 67455 | 4722 | 69954 | 3112 | 84496 | 2500 | 54951 |
| 22-#14 | 2.71 | MA | 43073 | 9774 | 69446 | 7261 | 75588 | 5880 | 77583 | 4827 | 78412 | 3228 | 95302 | 2282 | 66693 |
| 9L-4S | | MI | 36884 | 9774 | 60329 | 7144 | 66365 | 5764 | 69228 | 4707 | 72495 | 3124 | 87511 | 2557 | 55338 |
| 22-#14 | 2.71 | MA | 42215 | 9774 | 67987 | 7283 | 73798 | 5900 | 75447 | 4846 | 75512 | 3243 | 91686 | 2194 | 65165 |
| 10L-3S | | MI | 37619 | 9774 | 61614 | 7124 | 68003 | 5771 | 71219 | 4716 | 75029 | 3112 | 90368 | 2681 | 55420 |
| 22-#18 | 4.82 | MA | 48884 | 11105 | 83273 | 8080 | 93232 | 6486 | 99014 | 5174 | 107714 | 3121 | 134587 | 1754 | 114369 |
| 7L-6S | | MI | 39037 | 11105 | 67489 | 7912 | 75094 | 6337 | 79766 | 5039 | 86277 | 2957 | 106857 | 1750 | 90085 |
| 22-#18 | 4.82 | MA | 47569 | 11105 | 80927 | 8074 | 90037 | 6476 | 95234 | 5204 | 102192 | 3101 | 128024 | 1630 | 110839 |
| 8L-5S | | MI | 40104 | 11105 | 69323 | 7924 | 77631 | 6353 | 82865 | 5059 | 90256 | 2935 | 111738 | 1895 | 92047 |
| 24-#11 | 2.05 | MA | 45337 | 9357 | 71987 | 7004 | 79223 | 5678 | 82130 | 4682 | 84712 | 3238 | 102512 | 2862 | 54803 |
| 4L-10S | | MI | 32935 | 9357 | 52488 | 6919 | 56348 | 5618 | 57045 | 4642 | 56029 | 3193 | 66503 | 2396 | 40679 |
| 24-#11 | 2.05 | MA | 44738 | 9357 | 70980 | 7003 | 77918 | 5675 | 80525 | 4695 | 82386 | 3232 | 99686 | 2819 | 54712 |
| 5L-9S | | MI | 33389 | 9357 | 53204 | 6923 | 57312 | 5623 | 58195 | 4631 | 57583 | 3185 | 68384 | 2458 | 41158 |
| 24-#11 | 2.05 | MA | 44168 | 9357 | 70037 | 7001 | 76611 | 5689 | 78927 | 4691 | 80281 | 3243 | 96983 | 2764 | 54399 |
| 6L-8S | | MI | 33816 | 9357 | 53976 | 6909 | 58262 | 5610 | 59403 | 4637 | 59149 | 3176 | 70327 | 2512 | 41573 |
| 24-#11 | 2.05 | MA | 43612 | 9357 | 69004 | 7016 | 75365 | 5687 | 77395 | 4704 | 78224 | 3254 | 94104 | 2674 | 53792 |
| 7E | | MI | 34242 | 9357 | 54694 | 6912 | 59238 | 5615 | 60559 | 4626 | 60830 | 3185 | 72309 | 2559 | 41828 |
| 24-#11 | 2.05 | MA | 43066 | 9357 | 68077 | 7015 | 74101 | 5701 | 75899 | 4717 | 76038 | 3248 | 91461 | 2624 | 53378 |
| 8L-6S | | MI | 34674 | 9357 | 55492 | 6898 | 60201 | 5602 | 61742 | 4614 | 62411 | 3176 | 74449 | 2649 | 42218 |
| 24-#11 | 2.05 | MA | 42479 | 9357 | 67169 | 7013 | 72871 | 5698 | 74335 | 4713 | 74001 | 3259 | 88840 | 2570 | 52800 |
| 9L-5S | | MI | 35117 | 9357 | 56221 | 6901 | 61210 | 5607 | 62975 | 4621 | 64028 | 3168 | 76453 | 2706 | 42474 |
| 24-#11 | 2.05 | MA | 41874 | 9357 | 66153 | 7028 | 71624 | 5712 | 72847 | 4727 | 71981 | 3269 | 86300 | 2509 | 52081 |
| 10L-4S | | MI | 35582 | 9357 | 56998 | 6904 | 62217 | 5594 | 64213 | 4609 | 65813 | 3176 | 78573 | 2746 | 42510 |
| 24-#11 | 2.05 | MA | 41283 | 9357 | 65243 | 7027 | 70402 | 5710 | 71303 | 4723 | 69826 | 3263 | 83723 | 2456 | 51415 |
| 11L-3S | | MI | 36101 | 9357 | 57895 | 6890 | 63361 | 5599 | 65603 | 4616 | 67595 | 3168 | 80589 | 2832 | 42521 |
| 24-#11 | 2.05 | MA | 40704 | 9357 | 64245 | 7042 | 69164 | 5724 | 69818 | 4736 | 67807 | 3274 | 80815 | 2379 | 50495 |
| 12L-2S | | MI | 36838 | 9357 | 58994 | 6893 | 64770 | 5586 | 67321 | 4604 | 69927 | 3159 | 83694 | 2918 | 42506 |
| 24-#14 | 2.96 | MA | 46417 | 9929 | 75622 | 7342 | 83594 | 5939 | 87393 | 4839 | 91803 | 3195 | 112857 | 2538 | 76170 |
| 6L-8S | | MI | 35106 | 9929 | 57569 | 7245 | 62711 | 5854 | 64793 | 4785 | 66329 | 3110 | 80205 | 2190 | 57393 |
| 24-#14 | 2.96 | MA | 45634 | 9929 | 74139 | 7364 | 81805 | 5934 | 85193 | 4858 | 88851 | 3210 | 108754 | 2409 | 75416 |
| 7E | | MI | 35706 | 9929 | 58598 | 7251 | 64111 | 5861 | 66449 | 4770 | 68720 | 3123 | 83023 | 2257 | 58417 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 38" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#14 | 2.96 | MA | 44863 | 9929 | 72807 | 7361 | 79991 | 5954 | 83046 | 4876 | 85714 | 3201 | 104982 | 2337 | 74081 |
| 8L-6S | | MI | 36316 | 9929 | 59742 | 7231 | 65491 | 5843 | 68146 | 4755 | 70969 | 3110 | 86060 | 2388 | 58891 |
| 24-#14 | 2.96 | MA | 44045 | 9929 | 71504 | 7358 | 78226 | 5950 | 80800 | 4870 | 82790 | 3216 | 101251 | 2260 | 72912 |
| 9L-5S | | MI | 36941 | 9929 | 60786 | 7236 | 66936 | 5851 | 69912 | 4764 | 73271 | 3098 | 88902 | 2469 | 59680 |
| 24-#14 | 2.96 | MA | 43191 | 9929 | 70044 | 7380 | 76436 | 5970 | 78665 | 4888 | 79890 | 3231 | 97635 | 2172 | 71328 |
| 10L-4S | | MI | 37597 | 9929 | 61900 | 7241 | 68379 | 5833 | 71685 | 4749 | 75811 | 3110 | 91918 | 2526 | 60201 |
| 24-#18 | 5.26 | MA | 49215 | 11382 | 84536 | 8247 | 94663 | 6600 | 100877 | 5280 | 109871 | 3079 | 138343 | 1584 | 121559 |
| 8L-6S | | MI | 40252 | 11382 | 70233 | 8085 | 78612 | 6461 | 84057 | 5114 | 92012 | 2928 | 114438 | 1688 | 98183 |

## RECTANGULAR TIED COLUMNS 40" x 40"

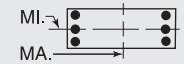
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.50 | MA | 32390 | 7902 | 51213 | 5815 | 55410 | 4730 | 56717 | 3927 | 56975 | 2765 | 67027 | 2575 | 28723 |
| 2L-3S | | MI | 30421 | 7902 | 48296 | 5805 | 51670 | 4760 | 52155 | 3953 | 50845 | 2787 | 58900 | 2354 | 28822 |
| 8-#14 | 1.13 | MA | 31464 | 7694 | 48970 | 5726 | 52753 | 4670 | 53558 | 3899 | 52896 | 2814 | 61734 | 2656 | 21947 |
| 2L-4S | | MI | 29527 | 7694 | 45939 | 5742 | 48878 | 4682 | 48838 | 3906 | 46651 | 2839 | 53958 | 2406 | 22074 |
| 8-#18 | 2.00 | MA | 33725 | 8179 | 54130 | 5988 | 59149 | 4854 | 61279 | 4003 | 63106 | 2738 | 75155 | 2517 | 37900 |
| 2L-4S | | MI | 30387 | 8179 | 48823 | 6012 | 52365 | 4870 | 53017 | 4010 | 52290 | 2782 | 61765 | 2074 | 37695 |
| 10-#14 | 1.41 | MA | 32244 | 7850 | 50639 | 5823 | 54891 | 4740 | 56167 | 3942 | 56435 | 2801 | 66448 | 2627 | 27210 |
| 2L-5S | | MI | 29602 | 7850 | 46428 | 5834 | 49487 | 4770 | 49568 | 3965 | 47480 | 2813 | 55454 | 2320 | 27219 |
| 10-#14 | 1.41 | MA | 31113 | 7850 | 48970 | 5819 | 52753 | 4758 | 53558 | 3958 | 52896 | 2813 | 61734 | 2502 | 27265 |
| 3L-4S | | MI | 30316 | 7850 | 47608 | 5839 | 51016 | 4751 | 51447 | 3949 | 50190 | 2826 | 58673 | 2378 | 27289 |
| 10-#18 | 2.50 | MA | 35047 | 8455 | 57047 | 6161 | 62889 | 4978 | 65841 | 4078 | 69236 | 2711 | 83283 | 2459 | 47042 |
| 2L-5S | | MI | 30506 | 8455 | 49669 | 6175 | 53420 | 5024 | 54281 | 4112 | 53724 | 2733 | 64320 | 1916 | 44242 |
| 10-#18 | 2.50 | MA | 33107 | 8455 | 54130 | 6151 | 59149 | 5008 | 61279 | 4104 | 63106 | 2733 | 75155 | 2237 | 46983 |
| 3L-4S | | MI | 31735 | 8455 | 51740 | 6185 | 56105 | 4994 | 57579 | 4086 | 58420 | 2755 | 69893 | 2016 | 46660 |

## RECTANGULAR TIED COLUMNS 40" x 42"

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.43 | MA | 35561 | 8256 | 55989 | 6103 | 60609 | 4966 | 61992 | 4128 | 62209 | 2924 | 73174 | 2735 | 30343 |
| 2L-3S | | MI | 31837 | 8256 | 50419 | 6070 | 53880 | 4978 | 54307 | 4138 | 52774 | 2929 | 61032 | 2491 | 28889 |
| 6-#18 | 1.43 | MA | 33470 | 8256 | 52899 | 6093 | 56648 | 4997 | 57160 | 4155 | 55682 | 2946 | 64499 | 2514 | 30442 |
| 3L-2S | | MI | 33808 | 8256 | 53336 | 6080 | 57619 | 4948 | 58869 | 4112 | 58904 | 2907 | 69160 | 2713 | 28779 |
| 8-#14 | 1.07 | MA | 34569 | 8048 | 53605 | 6013 | 57783 | 4907 | 58632 | 4100 | 57816 | 2971 | 67483 | 2812 | 23162 |
| 2L-4S | | MI | 30941 | 8048 | 48054 | 6009 | 51088 | 4901 | 50994 | 4093 | 48588 | 2982 | 56102 | 2545 | 22128 |
| 8-#14 | 1.07 | MA | 33364 | 8048 | 51839 | 6009 | 55520 | 4925 | 55871 | 4117 | 54060 | 2984 | 62460 | 2688 | 23233 |
| 3E | | MI | 31744 | 8048 | 49417 | 5988 | 52824 | 4908 | 53105 | 4102 | 51293 | 2970 | 59163 | 2670 | 22063 |
| 8-#14 | 1.07 | MA | 32516 | 8048 | 50399 | 6030 | 53685 | 4919 | 53641 | 4109 | 51189 | 2996 | 59195 | 2563 | 23289 |
| 4L-2S | | MI | 32881 | 8048 | 51085 | 5993 | 54963 | 4890 | 55714 | 4086 | 54833 | 2957 | 63877 | 2794 | 21990 |
| 8-#18 | 1.90 | MA | 36984 | 8532 | 59079 | 6275 | 64570 | 5090 | 66825 | 4204 | 68735 | 2900 | 81848 | 2681 | 40060 |
| 2L-4S | | MI | 31802 | 8532 | 50946 | 6277 | 54575 | 5088 | 55169 | 4195 | 54219 | 2924 | 63898 | 2212 | 37823 |
| 8-#18 | 1.90 | MA | 34910 | 8532 | 55989 | 6266 | 60609 | 5122 | 61992 | 4231 | 62209 | 2922 | 73174 | 2459 | 40084 |
| 3E | | MI | 33189 | 8532 | 53336 | 6243 | 57619 | 5102 | 58869 | 4214 | 58904 | 2902 | 69160 | 2433 | 38007 |
| 8-#18 | 1.90 | MA | 33444 | 8532 | 53462 | 6301 | 57389 | 5109 | 58079 | 4214 | 57220 | 2944 | 67549 | 2238 | 39855 |
| 4L-2S | | MI | 35146 | 8532 | 56253 | 6253 | 61359 | 5072 | 63431 | 4188 | 65035 | 2880 | 77287 | 2655 | 37963 |
| 10-#14 | 1.34 | MA | 35398 | 8204 | 55370 | 6111 | 60047 | 4976 | 61394 | 4142 | 61573 | 2958 | 72506 | 2785 | 28729 |
| 2L-5S | | MI | 31016 | 8204 | 48543 | 6101 | 51697 | 4989 | 51724 | 4151 | 49417 | 2957 | 57598 | 2458 | 27306 |
| 10-#14 | 1.34 | MA | 34200 | 8204 | 53605 | 6107 | 57783 | 4995 | 58632 | 4159 | 57816 | 2971 | 67483 | 2660 | 28784 |
| 3L-4S | | MI | 31731 | 8204 | 49723 | 6106 | 53226 | 4971 | 53603 | 4135 | 52127 | 2969 | 60817 | 2516 | 27353 |
| 10-#14 | 1.34 | MA | 33356 | 8204 | 52165 | 6127 | 55948 | 4989 | 56402 | 4151 | 54946 | 2984 | 64218 | 2536 | 28807 |
| 4L-3S | | MI | 32530 | 8204 | 51085 | 6086 | 54963 | 4978 | 55714 | 4144 | 54833 | 2957 | 63877 | 2641 | 27316 |
| 10-#14 | 1.34 | MA | 32601 | 8204 | 50919 | 6123 | 54333 | 5008 | 54417 | 4168 | 52071 | 2972 | 60796 | 2477 | 28738 |
| 5L-2S | | MI | 33661 | 8204 | 52753 | 6090 | 57101 | 4960 | 58323 | 4128 | 58372 | 2944 | 68592 | 2765 | 27257 |
| 10-#18 | 2.38 | MA | 38393 | 8809 | 62169 | 6448 | 68532 | 5215 | 71657 | 4279 | 75262 | 2875 | 90523 | 2626 | 49742 |
| 2L-5S | | MI | 31920 | 8809 | 51792 | 6440 | 55630 | 5242 | 56433 | 4297 | 55653 | 2876 | 66452 | 2054 | 44595 |
| 10-#18 | 2.38 | MA | 36334 | 8809 | 59079 | 6439 | 64570 | 5246 | 66825 | 4306 | 68735 | 2897 | 81848 | 2405 | 49683 |
| 3L-4S | | MI | 33151 | 8809 | 53863 | 6450 | 58314 | 5212 | 59731 | 4271 | 60350 | 2898 | 72025 | 2154 | 46801 |

## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

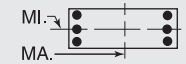
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#18 | 2.38 | MA | 34881 | 8809 | 56552 | 6474 | 61350 | 5233 | 62911 | 4289 | 63747 | 2919 | 76224 | 2183 | 49360 |
| 4L-3S | | MI | 34527 | 8809 | 56253 | 6416 | 61359 | 5226 | 63431 | 4289 | 65035 | 2876 | 77287 | 2375 | 47077 |
| 10-#18 | 2.38 | MA | 33581 | 8809 | 54363 | 6465 | 58512 | 5264 | 59425 | 4317 | 58748 | 2897 | 70289 | 2082 | 46999 |
| 5L-2S | | MI | 36470 | 8809 | 59170 | 6426 | 65099 | 5196 | 67993 | 4263 | 71165 | 2853 | 85415 | 2596 | 47111 |
| 12-#11 | 1.11 | MA | 34747 | 8073 | 53853 | 6049 | 58219 | 4934 | 59209 | 4121 | 58619 | 2980 | 68708 | 2826 | 24136 |
| 2L-6S | | MI | 30718 | 8073 | 47608 | 6036 | 50537 | 4936 | 50353 | 4119 | 47647 | 2988 | 55172 | 2539 | 23012 |
| 12-#11 | 1.11 | MA | 33905 | 8073 | 52619 | 6047 | 56638 | 4931 | 57280 | 4133 | 55994 | 2989 | 65176 | 2740 | 24179 |
| 3L-5S | | MI | 31195 | 8073 | 48380 | 6039 | 51606 | 4940 | 51659 | 4125 | 49368 | 2979 | 57315 | 2595 | 23027 |
| 12-#11 | 1.11 | MA | 33314 | 8073 | 51615 | 6062 | 55357 | 4944 | 55723 | 4128 | 53991 | 2999 | 62876 | 2653 | 24218 |
| 4E | | MI | 31696 | 8073 | 49202 | 6041 | 52673 | 4927 | 52970 | 4113 | 51267 | 2987 | 59576 | 2636 | 23000 |
| 12-#11 | 1.11 | MA | 32785 | 8073 | 50746 | 6059 | 54231 | 4940 | 54339 | 4140 | 51986 | 2991 | 60474 | 2612 | 24237 |
| 5L-3S | | MI | 32256 | 8073 | 50154 | 6027 | 53885 | 4931 | 54443 | 4119 | 53163 | 2978 | 61734 | 2722 | 22957 |
| 12-#11 | 1.11 | MA | 32282 | 8073 | 49932 | 6056 | 53103 | 4954 | 52960 | 4135 | 50169 | 3000 | 58191 | 2556 | 24205 |
| 6L-2S | | MI | 33051 | 8073 | 51320 | 6030 | 55380 | 4918 | 56267 | 4107 | 55644 | 2969 | 65053 | 2809 | 22912 |
| 12-#14 | 1.61 | MA | 36223 | 8359 | 57136 | 6208 | 62310 | 5046 | 64155 | 4185 | 65330 | 2946 | 77529 | 2758 | 34279 |
| 2L-6S | | MI | 31127 | 8359 | 49105 | 6194 | 52304 | 5052 | 52462 | 4185 | 50500 | 2956 | 59270 | 2348 | 31719 |
| 12-#14 | 1.61 | MA | 35029 | 8359 | 55370 | 6204 | 60047 | 5065 | 61394 | 4202 | 61573 | 2959 | 72506 | 2633 | 34317 |
| 3L-5S | | MI | 31804 | 8359 | 50211 | 6198 | 53836 | 5059 | 54333 | 4194 | 52956 | 2944 | 62312 | 2429 | 32470 |
| 12-#14 | 1.61 | MA | 34190 | 8359 | 53930 | 6225 | 58212 | 5059 | 59163 | 4193 | 58703 | 2971 | 69241 | 2509 | 34303 |
| 4E | | MI | 32515 | 8359 | 51391 | 6203 | 55365 | 5041 | 56212 | 4178 | 55667 | 2956 | 65531 | 2487 | 32553 |
| 12-#14 | 1.61 | MA | 33439 | 8359 | 52684 | 6220 | 56596 | 5078 | 57178 | 4210 | 55828 | 2959 | 65818 | 2450 | 34197 |
| 5L-3S | | MI | 33310 | 8359 | 52753 | 6183 | 57101 | 5047 | 58323 | 4187 | 58372 | 2944 | 68592 | 2612 | 32550 |
| 12-#14 | 1.61 | MA | 32725 | 8359 | 51516 | 6216 | 54978 | 5071 | 55201 | 4202 | 53223 | 2972 | 62575 | 2369 | 33380 |
| 6L-2S | | MI | 34437 | 8359 | 54422 | 6187 | 59240 | 5029 | 60932 | 4170 | 61912 | 2931 | 73307 | 2736 | 32507 |
| 12-#18 | 2.86 | MA | 39789 | 9085 | 65259 | 6621 | 72493 | 5339 | 76490 | 4354 | 81789 | 2850 | 99197 | 2572 | 59389 |
| 2L-6S | | MI | 32103 | 9085 | 52765 | 6603 | 56679 | 5352 | 57709 | 4354 | 57529 | 2871 | 69341 | 1851 | 51787 |
| 12-#18 | 2.86 | MA | 37745 | 9085 | 62169 | 6612 | 68532 | 5370 | 71657 | 4382 | 75262 | 2872 | 90523 | 2350 | 59257 |
| 3L-5S | | MI | 33266 | 9085 | 54709 | 6613 | 59369 | 5366 | 60995 | 4372 | 61783 | 2849 | 74580 | 1996 | 53278 |
| 12-#18 | 2.86 | MA | 36303 | 9085 | 59642 | 6647 | 65311 | 5357 | 67744 | 4365 | 70274 | 2894 | 84898 | 2129 | 58852 |
| 4E | | MI | 34488 | 9085 | 56780 | 6623 | 62054 | 5336 | 64293 | 4346 | 66480 | 2871 | 80153 | 2095 | 55764 |
| 12-#18 | 2.86 | MA | 35013 | 9085 | 57453 | 6638 | 62473 | 5388 | 64257 | 4392 | 65275 | 2872 | 78964 | 2027 | 56208 |
| 5L-3S | | MI | 35852 | 9085 | 59170 | 6589 | 65099 | 5350 | 67993 | 4365 | 71165 | 2849 | 85415 | 2317 | 56120 |
| 12-#18 | 2.86 | MA | 33786 | 9085 | 55399 | 6629 | 59631 | 5375 | 60783 | 4375 | 60745 | 2894 | 73369 | 1883 | 54615 |
| 6L-2S | | MI | 37782 | 9085 | 62087 | 6599 | 68838 | 5320 | 72555 | 4339 | 77296 | 2827 | 93542 | 2538 | 56229 |
| 14-#11 | 1.30 | MA | 35330 | 8181 | 55087 | 6117 | 59801 | 4983 | 61138 | 4150 | 61244 | 2971 | 72241 | 2808 | 28021 |
| 2L-7S | | MI | 30811 | 8181 | 47929 | 6118 | 51013 | 4997 | 50923 | 4160 | 48447 | 2988 | 56203 | 2430 | 26219 |
| 14-#11 | 1.30 | MA | 34490 | 8181 | 53853 | 6114 | 58219 | 4979 | 59209 | 4162 | 58619 | 2981 | 68708 | 2722 | 28057 |
| 3L-6S | | MI | 31274 | 8181 | 48774 | 6103 | 52032 | 4984 | 52177 | 4149 | 50129 | 2979 | 58491 | 2520 | 26632 |
| 14-#11 | 1.30 | MA | 33901 | 8181 | 52848 | 6129 | 56939 | 4992 | 57652 | 4157 | 56616 | 2990 | 66409 | 2636 | 28084 |
| 4L-5S | | MI | 31750 | 8181 | 49546 | 6106 | 53101 | 4989 | 53482 | 4154 | 51850 | 2970 | 60634 | 2576 | 26669 |
| 14-#11 | 1.30 | MA | 33375 | 8181 | 51980 | 6126 | 55812 | 4989 | 56268 | 4169 | 54611 | 2982 | 64007 | 2594 | 28081 |
| 5L-4S | | MI | 32249 | 8181 | 50369 | 6109 | 54168 | 4976 | 54794 | 4143 | 53748 | 2978 | 62895 | 2617 | 26659 |
| 14-#11 | 1.30 | MA | 32873 | 8181 | 51165 | 6124 | 54684 | 5002 | 54889 | 4164 | 52794 | 2992 | 61724 | 2538 | 28029 |
| 6L-3S | | MI | 32807 | 8181 | 51320 | 6094 | 55380 | 4980 | 56267 | 4148 | 55644 | 2970 | 65053 | 2704 | 26628 |
| 14-#11 | 1.30 | MA | 32384 | 8181 | 50273 | 6139 | 53608 | 4998 | 53566 | 4176 | 51018 | 3001 | 59288 | 2448 | 27573 |
| 7L-2S | | MI | 33599 | 8181 | 52486 | 6097 | 56875 | 4967 | 58091 | 4137 | 58126 | 2961 | 68371 | 2790 | 26589 |
| 14-#14 | 1.88 | MA | 37042 | 8515 | 58901 | 6305 | 64573 | 5116 | 66916 | 4227 | 69087 | 2933 | 82551 | 2731 | 39817 |
| 2L-7S | | MI | 31256 | 8515 | 49561 | 6311 | 52981 | 5140 | 53274 | 4243 | 51639 | 2956 | 60734 | 2189 | 36116 |
| 14-#14 | 1.88 | MA | 35854 | 8515 | 57136 | 6301 | 62310 | 5135 | 64155 | 4244 | 65330 | 2946 | 77529 | 2606 | 39835 |
| 3L-6S | | MI | 31913 | 8515 | 50773 | 6291 | 54443 | 5122 | 55071 | 4227 | 54040 | 2943 | 63984 | 2319 | 36738 |
| 14-#14 | 1.88 | MA | 35019 | 8515 | 55696 | 6322 | 60475 | 5129 | 61924 | 4236 | 62459 | 2959 | 74263 | 2482 | 39787 |
| 4L-5S | | MI | 32587 | 8515 | 51880 | 6296 | 55974 | 5129 | 56942 | 4236 | 56496 | 2931 | 67027 | 2400 | 37624 |
| 14-#14 | 1.88 | MA | 34272 | 8515 | 54450 | 6318 | 58860 | 5147 | 59939 | 4253 | 59585 | 2947 | 70841 | 2423 | 39649 |
| 5L-4S | | MI | 33295 | 8515 | 53059 | 6300 | 57504 | 5111 | 58821 | 4220 | 59206 | 2943 | 70246 | 2458 | 37740 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

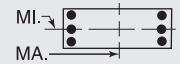


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#14 | 1.88 | MA | 33561 | 8515 | 53282 | 6314 | 57242 | 5141 | 57962 | 4244 | 56979 | 2960 | 67597 | 2342 | 38695 |
| 6L-3S | | MI | 34086 | 8515 | 54422 | 6280 | 59240 | 5117 | 60932 | 4229 | 61912 | 2931 | 73307 | 2583 | 37774 |
| 14-#14 | 1.88 | MA | 32868 | 8515 | 52002 | 6334 | 55698 | 5160 | 56064 | 4261 | 54433 | 2972 | 64135 | 2212 | 38012 |
| 7L-2S | | MI | 35207 | 8515 | 56090 | 6285 | 61379 | 5099 | 63541 | 4213 | 65451 | 2918 | 78021 | 2707 | 37744 |
| 14-#18 | 3.33 | MA | 39143 | 9362 | 65259 | 6785 | 72493 | 5494 | 76490 | 4457 | 81789 | 2847 | 99197 | 2296 | 68815 |
| 3L-6S | | MI | 33445 | 9362 | 55682 | 6776 | 60419 | 5476 | 62271 | 4429 | 63660 | 2844 | 77469 | 1792 | 60293 |
| 14-#18 | 3.33 | MA | 37712 | 9362 | 62732 | 6820 | 69272 | 5481 | 72576 | 4440 | 76800 | 2869 | 93573 | 2074 | 68277 |
| 4L-5S | | MI | 34599 | 9362 | 57626 | 6786 | 63109 | 5490 | 65557 | 4447 | 67914 | 2822 | 82707 | 1937 | 61990 |
| 14-#18 | 3.33 | MA | 36433 | 9362 | 60543 | 6811 | 66435 | 5512 | 69089 | 4467 | 71801 | 2847 | 87638 | 1973 | 65447 |
| 5L-4S | | MI | 35812 | 9362 | 59698 | 6796 | 65793 | 5460 | 68855 | 4422 | 72611 | 2844 | 88280 | 2037 | 64587 |
| 14-#18 | 3.33 | MA | 35215 | 9362 | 58489 | 6802 | 63592 | 5499 | 65616 | 4450 | 67272 | 2869 | 82043 | 1828 | 63648 |
| 6L-3S | | MI | 37166 | 9362 | 62087 | 6762 | 68838 | 5474 | 72555 | 4440 | 77296 | 2822 | 93542 | 2258 | 65146 |
| 14-#18 | 3.33 | MA | 34029 | 9362 | 56239 | 6837 | 60878 | 5530 | 62280 | 4478 | 62846 | 2891 | 76065 | 1597 | 60736 |
| 7L-2S | | MI | 39083 | 9362 | 65004 | 6772 | 72578 | 5444 | 77117 | 4414 | 83426 | 2800 | 101670 | 2480 | 65312 |
| 16-#11 | 1.49 | MA | 35909 | 8289 | 56320 | 6184 | 61382 | 5031 | 63068 | 4180 | 63869 | 2962 | 75774 | 2791 | 31897 |
| 2L-8S | | MI | 30912 | 8289 | 48336 | 6182 | 51474 | 5042 | 51523 | 4201 | 49142 | 2971 | 57408 | 2363 | 29434 |
| 16-#11 | 1.49 | MA | 35073 | 8289 | 55087 | 6182 | 59801 | 5027 | 61138 | 4192 | 61244 | 2972 | 72241 | 2705 | 31926 |
| 3L-7S | | MI | 31367 | 8289 | 49095 | 6185 | 52508 | 5046 | 52747 | 4190 | 50929 | 2979 | 59522 | 2411 | 29755 |
| 16-#11 | 1.49 | MA | 34486 | 8289 | 54082 | 6196 | 58520 | 5041 | 59582 | 4187 | 59241 | 2981 | 69942 | 2618 | 31942 |
| 4L-6S | | MI | 31828 | 8289 | 49940 | 6171 | 53527 | 5033 | 54001 | 4178 | 52610 | 2970 | 61809 | 2501 | 30246 |
| 16-#11 | 1.49 | MA | 33961 | 8289 | 53213 | 6194 | 57394 | 5037 | 58197 | 4199 | 57236 | 2974 | 67540 | 2577 | 31918 |
| 5E | | MI | 32302 | 8289 | 50712 | 6173 | 54596 | 5037 | 55306 | 4184 | 54331 | 2961 | 63953 | 2558 | 30300 |
| 16-#11 | 1.49 | MA | 33462 | 8289 | 52399 | 6191 | 56266 | 5050 | 56818 | 4194 | 55419 | 2983 | 65257 | 2521 | 31848 |
| 6L-4S | | MI | 32799 | 8289 | 51535 | 6176 | 55663 | 5024 | 56617 | 4172 | 56230 | 2970 | 66214 | 2598 | 30311 |
| 16-#11 | 1.49 | MA | 32975 | 8289 | 51507 | 6206 | 55189 | 5047 | 55495 | 4206 | 53643 | 2993 | 62821 | 2431 | 31315 |
| 7L-3S | | MI | 33355 | 8289 | 52486 | 6162 | 56875 | 5028 | 58091 | 4178 | 58126 | 2961 | 68371 | 2685 | 30289 |
| 16-#11 | 1.49 | MA | 32495 | 8289 | 50705 | 6204 | 54098 | 5060 | 54204 | 4218 | 51756 | 2985 | 60575 | 2382 | 30960 |
| 8L-2S | | MI | 34145 | 8289 | 53652 | 6165 | 58370 | 5015 | 59914 | 4166 | 60607 | 2952 | 71690 | 2771 | 30258 |
| 16-#14 | 2.14 | MA | 37856 | 8670 | 60667 | 6402 | 66837 | 5186 | 69677 | 4270 | 72843 | 2921 | 87574 | 2704 | 45345 |
| 2L-8S | | MI | 31398 | 8670 | 50140 | 6404 | 53637 | 5203 | 54128 | 4302 | 52627 | 2930 | 62440 | 2092 | 40197 |
| 16-#14 | 2.14 | MA | 36673 | 8670 | 58901 | 6398 | 64573 | 5205 | 66916 | 4286 | 69087 | 2934 | 82551 | 2579 | 45336 |
| 3L-7S | | MI | 32041 | 8670 | 51230 | 6409 | 55119 | 5210 | 55883 | 4286 | 55179 | 2943 | 65449 | 2160 | 41172 |
| 16-#14 | 2.14 | MA | 35842 | 8670 | 57461 | 6419 | 62738 | 5198 | 64685 | 4278 | 66216 | 2947 | 79286 | 2455 | 45262 |
| 4L-6S | | MI | 32695 | 8670 | 52442 | 6388 | 56581 | 5192 | 57680 | 4270 | 57579 | 2930 | 68699 | 2290 | 41769 |
| 16-#14 | 2.14 | MA | 35099 | 8670 | 56216 | 6415 | 61123 | 5217 | 62700 | 4295 | 63342 | 2934 | 75864 | 2396 | 45094 |
| 5E | | MI | 33365 | 8670 | 53548 | 6393 | 58113 | 5199 | 59551 | 4279 | 60035 | 2918 | 71741 | 2371 | 42765 |
| 16-#14 | 2.14 | MA | 34392 | 8670 | 55047 | 6411 | 59505 | 5211 | 60723 | 4287 | 60736 | 2947 | 72620 | 2315 | 44022 |
| 6L-4S | | MI | 34070 | 8670 | 54727 | 6398 | 59642 | 5180 | 61431 | 4263 | 62746 | 2930 | 74960 | 2429 | 42916 |
| 16-#14 | 2.14 | MA | 33703 | 8670 | 53768 | 6432 | 57962 | 5230 | 58826 | 4304 | 58190 | 2960 | 69157 | 2185 | 43365 |
| 7L-3S | | MI | 34857 | 8670 | 56090 | 6377 | 61379 | 5187 | 63541 | 4271 | 65451 | 2918 | 78021 | 2554 | 42975 |
| 16-#14 | 2.14 | MA | 33024 | 8670 | 52618 | 6427 | 56396 | 5224 | 56973 | 4320 | 55485 | 2948 | 65958 | 2116 | 42319 |
| 8L-2S | | MI | 35974 | 8670 | 57758 | 6382 | 63517 | 5169 | 66150 | 4255 | 68991 | 2905 | 82736 | 2678 | 42972 |
| 16-#18 | 3.81 | MA | 39109 | 9639 | 65822 | 6993 | 73234 | 5605 | 77408 | 4515 | 83327 | 2845 | 102247 | 2020 | 77394 |
| 4L-6S | | MI | 34776 | 9639 | 58600 | 6948 | 64159 | 5600 | 66833 | 4504 | 69790 | 2818 | 85597 | 1734 | 68830 |
| 16-#18 | 3.81 | MA | 37839 | 9639 | 63633 | 6984 | 70396 | 5636 | 73922 | 4543 | 78328 | 2822 | 96313 | 1918 | 74710 |
| 5E | | MI | 35921 | 9639 | 60543 | 6959 | 66848 | 5614 | 70119 | 4523 | 74044 | 2796 | 90835 | 1879 | 70726 |
| 16-#18 | 3.81 | MA | 36631 | 9639 | 61579 | 6975 | 67553 | 5623 | 70448 | 4526 | 73799 | 2845 | 90718 | 1774 | 72712 |
| 6L-4S | | MI | 37125 | 9639 | 62615 | 6969 | 69533 | 5584 | 73417 | 4497 | 78741 | 2818 | 96408 | 1979 | 73183 |
| 16-#18 | 3.81 | MA | 35455 | 9639 | 59329 | 7010 | 64840 | 5654 | 67113 | 4553 | 69373 | 2867 | 84740 | 1542 | 69913 |
| 7L-3S | | MI | 38470 | 9639 | 65004 | 6935 | 72578 | 5599 | 77117 | 4515 | 83426 | 2796 | 101670 | 2200 | 74158 |
| 18-#11 | 1.67 | MA | 36486 | 8397 | 57554 | 6252 | 62964 | 5080 | 64997 | 4209 | 66494 | 2954 | 79306 | 2773 | 35768 |
| 2L-9S | | MI | 31005 | 8397 | 48684 | 6264 | 51963 | 5103 | 52068 | 4225 | 49957 | 2971 | 58648 | 2291 | 32550 |
| 18-#11 | 1.67 | MA | 35653 | 8397 | 56320 | 6249 | 61382 | 5076 | 63068 | 4221 | 63869 | 2963 | 75774 | 2687 | 35789 |
| 3L-8S | | MI | 31467 | 8397 | 49502 | 6250 | 52969 | 5090 | 53347 | 4231 | 51623 | 2962 | 60727 | 2345 | 32987 |
| 18-#11 | 1.67 | MA | 35068 | 8397 | 55316 | 6264 | 60102 | 5089 | 61511 | 4216 | 61866 | 2973 | 73474 | 2601 | 35788 |
| 4L-7S | | MI | 31920 | 8397 | 50261 | 6252 | 54003 | 5094 | 54571 | 4219 | 53410 | 2971 | 62840 | 2393 | 33297 |
| 18-#11 | 1.67 | MA | 34545 | 8397 | 54447 | 6261 | 58975 | 5085 | 60127 | 4228 | 59861 | 2965 | 71072 | 2559 | 35749 |
| 5L-6S | | MI | 32380 | 8397 | 51107 | 6238 | 55022 | 5081 | 55824 | 4208 | 55092 | 2962 | 65128 | 2483 | 33766 |

## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis

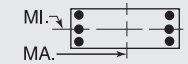



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.67 | MA | 34048 | 8397 | 53632 | 6259 | 57847 | 5099 | 58748 | 4223 | 58044 | 2975 | 68789 | 2503 | 35576 |
| 6L-5S | | MI | 32851 | 8397 | 51878 | 6241 | 56091 | 5085 | 57130 | 4213 | 56813 | 2953 | 67272 | 2539 | 33925 |
| 18-#11 | 1.67 | MA | 33563 | 8397 | 52740 | 6273 | 56771 | 5095 | 57424 | 4235 | 56268 | 2984 | 66353 | 2413 | 35062 |
| 7L-4S | | MI | 33347 | 8397 | 52701 | 6244 | 57158 | 5072 | 58441 | 4202 | 58711 | 2961 | 69533 | 2580 | 33956 |
| 18-#11 | 1.67 | MA | 33085 | 8397 | 51939 | 6271 | 55679 | 5108 | 56133 | 4247 | 54381 | 2976 | 64107 | 2365 | 34719 |
| 8L-3S | | MI | 33901 | 8397 | 53652 | 6229 | 58370 | 5077 | 59914 | 4207 | 60607 | 2952 | 71690 | 2666 | 33945 |
| 18-#11 | 1.67 | MA | 32597 | 8397 | 51075 | 6286 | 54617 | 5105 | 54782 | 4242 | 52622 | 2986 | 61894 | 2311 | 34242 |
| 9L-2S | | MI | 34688 | 8397 | 54818 | 6232 | 59865 | 5064 | 61738 | 4196 | 63089 | 2943 | 75009 | 2752 | 33920 |
| 18-#14 | 2.41 | MA | 38666 | 8826 | 62432 | 6500 | 69100 | 5256 | 72438 | 4312 | 76600 | 2909 | 92597 | 2677 | 50863 |
| 2L-9S | | MI | 31547 | 8826 | 50636 | 6521 | 54333 | 5291 | 54903 | 4335 | 53788 | 2930 | 64205 | 1985 | 44262 |
| 18-#14 | 2.41 | MA | 37488 | 8826 | 60667 | 6496 | 66837 | 5274 | 69677 | 4329 | 72843 | 2921 | 87574 | 2552 | 50828 |
| 3L-8S | | MI | 32181 | 8826 | 51809 | 6501 | 55775 | 5273 | 56737 | 4344 | 56167 | 2917 | 67155 | 2063 | 45172 |
| 18-#14 | 2.41 | MA | 36661 | 8826 | 59227 | 6516 | 65002 | 5268 | 67446 | 4321 | 69973 | 2934 | 84309 | 2428 | 50731 |
| 4L-7S | | MI | 32821 | 8826 | 52898 | 6506 | 57258 | 5280 | 58492 | 4328 | 58718 | 2930 | 70164 | 2131 | 46233 |
| 18-#14 | 2.41 | MA | 35922 | 8826 | 57981 | 6512 | 63386 | 5287 | 65462 | 4337 | 67098 | 2922 | 80887 | 2369 | 50395 |
| 5L-6S | | MI | 33472 | 8826 | 54110 | 6486 | 58720 | 5262 | 60289 | 4312 | 61119 | 2917 | 73413 | 2261 | 46809 |
| 18-#14 | 2.41 | MA | 35218 | 8826 | 56813 | 6508 | 61769 | 5281 | 63485 | 4329 | 64493 | 2935 | 77643 | 2288 | 49358 |
| 6L-5S | | MI | 34139 | 8826 | 55216 | 6490 | 60252 | 5268 | 62161 | 4321 | 63575 | 2905 | 76456 | 2343 | 47758 |
| 18-#14 | 2.41 | MA | 34533 | 8826 | 55533 | 6529 | 60225 | 5300 | 61587 | 4346 | 61947 | 2948 | 74180 | 2158 | 48725 |
| 7L-4S | | MI | 34840 | 8826 | 56396 | 6495 | 61781 | 5250 | 64040 | 4305 | 66285 | 2917 | 79675 | 2401 | 48086 |
| 18-#14 | 2.41 | MA | 33857 | 8826 | 54383 | 6525 | 58659 | 5294 | 59734 | 4363 | 59241 | 2935 | 70981 | 2089 | 47591 |
| 8L-3S | | MI | 35623 | 8826 | 57758 | 6475 | 63517 | 5257 | 66150 | 4314 | 68991 | 2905 | 82736 | 2525 | 48168 |
| 18-#14 | 2.41 | MA | 33171 | 8826 | 53145 | 6545 | 57136 | 5312 | 57797 | 4355 | 56718 | 2948 | 67836 | 2011 | 46601 |
| 9L-2S | | MI | 36735 | 8826 | 59427 | 6479 | 65656 | 5239 | 68759 | 4298 | 72530 | 2892 | 87450 | 2650 | 48194 |
| 18-#18 | 4.29 | MA | 39235 | 9915 | 66723 | 7157 | 74357 | 5761 | 78754 | 4618 | 84855 | 2798 | 104987 | 1864 | 83994 |
| 5L-6S | | MI | 36096 | 9915 | 61517 | 7121 | 67898 | 5724 | 71395 | 4580 | 75921 | 2791 | 93724 | 1676 | 77396 |
| 18-#18 | 4.29 | MA | 38036 | 9915 | 64669 | 7148 | 71514 | 5747 | 75281 | 4601 | 80326 | 2820 | 99392 | 1719 | 81805 |
| 6L-5S | | MI | 37233 | 9915 | 63460 | 7131 | 70588 | 5738 | 74681 | 4598 | 80175 | 2769 | 98962 | 1821 | 79483 |
| 18-#18 | 4.29 | MA | 36868 | 9915 | 62419 | 7183 | 68801 | 5779 | 71945 | 4628 | 75900 | 2842 | 93414 | 1488 | 79110 |
| 7L-4S | | MI | 38428 | 9915 | 65532 | 7142 | 73272 | 5708 | 77979 | 4572 | 84871 | 2791 | 104536 | 1920 | 81812 |
| 20-#11 | 1.86 | MA | 37061 | 8504 | 58788 | 6319 | 64545 | 5128 | 66926 | 4239 | 69119 | 2945 | 82839 | 2756 | 39633 |
| 2L-10S | | MI | 31071 | 8504 | 49093 | 6329 | 52437 | 5147 | 52674 | 4266 | 50786 | 2971 | 59954 | 2211 | 35506 |
| 20-#11 | 1.86 | MA | 36230 | 8504 | 57554 | 6317 | 62964 | 5124 | 64997 | 4251 | 66494 | 2955 | 79306 | 2669 | 39647 |
| 3L-9S | | MI | 31561 | 8504 | 49850 | 6331 | 53458 | 5151 | 53892 | 4255 | 52438 | 2962 | 61967 | 2272 | 36047 |
| 20-#11 | 1.86 | MA | 35647 | 8504 | 56549 | 6331 | 61683 | 5138 | 63440 | 4246 | 64491 | 2964 | 77007 | 2583 | 39628 |
| 4L-8S | | MI | 32019 | 8504 | 50668 | 6317 | 54464 | 5138 | 55171 | 4260 | 54105 | 2954 | 64045 | 2326 | 36542 |
| 20-#11 | 1.86 | MA | 35126 | 8504 | 55680 | 6329 | 60557 | 5134 | 62056 | 4258 | 62486 | 2956 | 74605 | 2542 | 39575 |
| 5L-7S | | MI | 32470 | 8504 | 51428 | 6320 | 55498 | 5143 | 56395 | 4249 | 55892 | 2962 | 66159 | 2374 | 36844 |
| 20-#11 | 1.86 | MA | 34631 | 8504 | 54866 | 6326 | 59428 | 5147 | 60677 | 4252 | 60669 | 2966 | 72322 | 2486 | 39307 |
| 6E | | MI | 32928 | 8504 | 52273 | 6305 | 56517 | 5130 | 57648 | 4237 | 57573 | 2953 | 68447 | 2464 | 37293 |
| 20-#11 | 1.86 | MA | 34148 | 8504 | 53974 | 6341 | 58352 | 5143 | 59354 | 4265 | 58893 | 2975 | 69886 | 2396 | 38814 |
| 7L-5S | | MI | 33399 | 8504 | 53044 | 6308 | 57586 | 5134 | 58954 | 4243 | 59294 | 2944 | 70590 | 2520 | 37545 |
| 20-#11 | 1.86 | MA | 33672 | 8504 | 53172 | 6338 | 57261 | 5157 | 58062 | 4277 | 57006 | 2968 | 67640 | 2347 | 38480 |
| 8L-4S | | MI | 33892 | 8504 | 53867 | 6311 | 58653 | 5121 | 60265 | 4231 | 61193 | 2953 | 72851 | 2561 | 37586 |
| 20-#11 | 1.86 | MA | 33186 | 8504 | 52309 | 6353 | 56199 | 5153 | 56711 | 4272 | 55247 | 2977 | 65426 | 2293 | 37946 |
| 9L-3S | | MI | 34444 | 8504 | 54818 | 6297 | 59865 | 5125 | 61738 | 4237 | 63089 | 2944 | 75009 | 2647 | 37595 |
| 20-#11 | 1.86 | MA | 32662 | 8504 | 51510 | 6351 | 55122 | 5166 | 55427 | 4284 | 53503 | 2987 | 63282 | 2232 | 37356 |
| 10L-2S | | MI | 35229 | 8504 | 55985 | 6300 | 61360 | 5112 | 63562 | 4225 | 65570 | 2935 | 78328 | 2734 | 37577 |
| 20-#14 | 2.68 | MA | 38298 | 8982 | 62432 | 6593 | 69100 | 5344 | 72438 | 4371 | 76600 | 2909 | 92597 | 2525 | 56313 |
| 3L-9S | | MI | 32329 | 8982 | 52304 | 6619 | 56471 | 5361 | 57512 | 4378 | 57327 | 2916 | 68919 | 1956 | 49275 |
| 20-#14 | 2.68 | MA | 37475 | 8982 | 60992 | 6614 | 67265 | 5338 | 70208 | 4363 | 73730 | 2922 | 89332 | 2401 | 56193 |
| 4L-8S | | MI | 32960 | 8982 | 53477 | 6598 | 57914 | 5343 | 59346 | 4387 | 59706 | 2904 | 71869 | 2034 | 50158 |
| 20-#14 | 2.68 | MA | 36739 | 8982 | 59747 | 6609 | 65650 | 5357 | 68223 | 4380 | 70855 | 2910 | 85910 | 2342 | 55695 |
| 5L-7S | | MI | 33597 | 8982 | 54566 | 6603 | 59397 | 5350 | 61101 | 4371 | 62258 | 2916 | 74878 | 2102 | 51299 |
| 20-#14 | 2.68 | MA | 36039 | 8982 | 58578 | 6605 | 64032 | 5351 | 66246 | 4372 | 68250 | 2922 | 82666 | 2261 | 54703 |
| 6E | | MI | 34244 | 8982 | 55778 | 6583 | 60859 | 5331 | 62898 | 4355 | 64658 | 2904 | 78128 | 2233 | 51856 |
| 20-#14 | 2.68 | MA | 35357 | 8982 | 57299 | 6626 | 62488 | 5369 | 64348 | 4388 | 65704 | 2935 | 79203 | 2131 | 54089 |
| 7L-5S | | MI | 34908 | 8982 | 56884 | 6587 | 62390 | 5338 | 64770 | 4363 | 67114 | 2892 | 81171 | 2314 | 52763 |
| 20-#14 | 2.68 | MA | 34685 | 8982 | 56149 | 6622 | 60922 | 5363 | 62495 | 4405 | 62998 | 2923 | 76004 | 2062 | 52874 |
| 8L-4S | | MI | 35606 | 8982 | 58064 | 6592 | 63920 | 5320 | 66649 | 4347 | 69825 | 2904 | 84389 | 2372 | 53249 |


## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

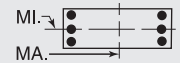

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.68 | MA | 34020 | 8982 | 54910 | 6643 | 59399 | 5382 | 60558 | 4397 | 60475 | 2936 | 72858 | 1984 | 51913 |
| 9L-3S | | MI | 36385 | 8982 | 59427 | 6572 | 65656 | 5327 | 68759 | 4356 | 72530 | 2892 | 87450 | 2496 | 53353 |
| 20-#18 | 4.76 | MA | 39430 | 10192 | 67759 | 7321 | 75475 | 5872 | 80113 | 4677 | 86852 | 2795 | 108067 | 1664 | 90922 |
| 6E | | MI | 37406 | 10192 | 64434 | 7294 | 71638 | 5848 | 75957 | 4655 | 82051 | 2765 | 101852 | 1618 | 85986 |
| 20-#18 | 4.76 | MA | 38271 | 10192 | 65509 | 7356 | 72762 | 5903 | 76778 | 4704 | 82426 | 2817 | 102089 | 1433 | 88325 |
| 7L-5S | | MI | 38535 | 10192 | 66378 | 7304 | 74327 | 5863 | 79243 | 4674 | 86305 | 2742 | 107090 | 1763 | 88256 |
| 22-#11 | 2.04 | MA | 36805 | 8612 | 58788 | 6384 | 64545 | 5173 | 66926 | 4280 | 69119 | 2946 | 82839 | 2652 | 43494 |
| 3L-10S | | MI | 31625 | 8612 | 50259 | 6396 | 53932 | 5196 | 54498 | 4296 | 53267 | 2963 | 63273 | 2192 | 39025 |
| 22-#11 | 2.04 | MA | 36224 | 8612 | 57783 | 6399 | 63265 | 5186 | 65370 | 4275 | 67116 | 2956 | 80539 | 2566 | 43464 |
| 4L-9S | | MI | 32114 | 8612 | 51016 | 6399 | 54953 | 5200 | 55716 | 4284 | 54920 | 2954 | 65286 | 2253 | 39551 |
| 22-#11 | 2.04 | MA | 35705 | 8612 | 56914 | 6396 | 62138 | 5182 | 63985 | 4287 | 65111 | 2948 | 78137 | 2524 | 43398 |
| 5L-8S | | MI | 32569 | 8612 | 51834 | 6384 | 55959 | 5187 | 56995 | 4290 | 56586 | 2945 | 67364 | 2307 | 40100 |
| 22-#11 | 2.04 | MA | 35211 | 8612 | 56100 | 6394 | 61010 | 5196 | 62606 | 4282 | 63294 | 2957 | 75854 | 2468 | 43044 |
| 6L-7S | | MI | 33018 | 8612 | 52594 | 6387 | 56993 | 5191 | 58219 | 4278 | 58373 | 2953 | 69478 | 2355 | 40394 |
| 22-#11 | 2.04 | MA | 34730 | 8612 | 55208 | 6408 | 59934 | 5192 | 61283 | 4294 | 61518 | 2967 | 73419 | 2378 | 42570 |
| 7L-6S | | MI | 33475 | 8612 | 53439 | 6373 | 58012 | 5178 | 59472 | 4266 | 60055 | 2944 | 71766 | 2445 | 40825 |
| 22-#11 | 2.04 | MA | 34256 | 8612 | 54406 | 6406 | 58842 | 5205 | 59991 | 4306 | 59631 | 2959 | 71173 | 2330 | 42244 |
| 8L-5S | | MI | 33943 | 8612 | 54211 | 6376 | 59081 | 5182 | 60778 | 4272 | 61776 | 2936 | 73909 | 2501 | 41161 |
| 22-#11 | 2.04 | MA | 33773 | 8612 | 53543 | 6421 | 57780 | 5201 | 58641 | 4301 | 57872 | 2968 | 68959 | 2276 | 41655 |
| 9L-4S | | MI | 34435 | 8612 | 55033 | 6379 | 60148 | 5169 | 62089 | 4260 | 63674 | 2944 | 76170 | 2542 | 41215 |
| 22-#11 | 2.04 | MA | 33250 | 8612 | 52744 | 6418 | 56703 | 5215 | 57356 | 4313 | 56128 | 2978 | 66814 | 2215 | 41082 |
| 10L-3S | | MI | 34985 | 8612 | 55985 | 6364 | 61360 | 5174 | 63562 | 4266 | 65570 | 2935 | 78328 | 2629 | 41241 |
| 22-#11 | 2.04 | MA | 32739 | 8612 | 51958 | 6415 | 55647 | 5211 | 56022 | 4308 | 54268 | 2970 | 64625 | 2163 | 40408 |
| 11L-2S | | MI | 35768 | 8612 | 57151 | 6367 | 62855 | 5161 | 65386 | 4254 | 68052 | 2926 | 81646 | 2715 | 41230 |
| 22-#14 | 2.95 | MA | 38285 | 9137 | 62758 | 6711 | 69528 | 5408 | 72969 | 4405 | 77486 | 2909 | 94354 | 2374 | 61651 |
| 4L-9S | | MI | 33107 | 9137 | 53972 | 6716 | 58610 | 5431 | 60121 | 4420 | 60867 | 2903 | 73634 | 1927 | 54231 |
| 22-#14 | 2.95 | MA | 37553 | 9137 | 61512 | 6707 | 67913 | 5427 | 70984 | 4422 | 74612 | 2897 | 90932 | 2315 | 61006 |
| 5L-8S | | MI | 33734 | 9137 | 55145 | 6696 | 60053 | 5413 | 61955 | 4429 | 63246 | 2891 | 76584 | 2005 | 55151 |
| 22-#14 | 2.95 | MA | 36856 | 9137 | 60344 | 6703 | 66295 | 5421 | 69007 | 4414 | 72006 | 2910 | 87688 | 2234 | 60054 |
| 6L-7S | | MI | 34369 | 9137 | 56234 | 6700 | 61535 | 5419 | 63710 | 4413 | 65797 | 2903 | 79593 | 2074 | 56362 |
| 22-#14 | 2.95 | MA | 36177 | 9137 | 59064 | 6723 | 64752 | 5439 | 67109 | 4431 | 69460 | 2923 | 84226 | 2104 | 59457 |
| 7L-6S | | MI | 35013 | 9137 | 57446 | 6680 | 62997 | 5401 | 65507 | 4397 | 68198 | 2891 | 82842 | 2204 | 56911 |
| 22-#14 | 2.95 | MA | 35509 | 9137 | 57914 | 6719 | 63186 | 5433 | 65256 | 4448 | 66755 | 2911 | 81026 | 2035 | 58166 |
| 8L-5S | | MI | 35674 | 9137 | 58553 | 6685 | 64529 | 5408 | 67379 | 4406 | 70654 | 2879 | 85885 | 2285 | 57779 |
| 22-#14 | 2.95 | MA | 34846 | 9137 | 56676 | 6740 | 61663 | 5452 | 63319 | 4439 | 64232 | 2923 | 77881 | 1957 | 57188 |
| 9L-4S | | MI | 36368 | 9137 | 59732 | 6689 | 66058 | 5390 | 69258 | 4390 | 73364 | 2891 | 89104 | 2343 | 58408 |
| 22-#18 | 5.24 | MA | 39663 | 10469 | 68599 | 7529 | 76723 | 6027 | 81610 | 4779 | 88953 | 2792 | 110763 | 1378 | 97557 |
| 7L-6S | | MI | 38707 | 10469 | 67351 | 7467 | 75377 | 5972 | 80519 | 4731 | 88182 | 2738 | 109979 | 1559 | 94600 |
| 24-#11 | 2.23 | MA | 36798 | 8720 | 59017 | 6466 | 64846 | 5234 | 67299 | 4304 | 69741 | 2947 | 84072 | 2548 | 47296 |
| 4L-10S | | MI | 32176 | 8720 | 51425 | 6463 | 55427 | 5244 | 56322 | 4325 | 55749 | 2954 | 66592 | 2173 | 42547 |
| 24-#11 | 2.23 | MA | 36281 | 8720 | 58148 | 6464 | 63720 | 5231 | 65914 | 4316 | 67736 | 2939 | 81670 | 2507 | 47218 |
| 5L-9S | | MI | 32665 | 8720 | 52183 | 6466 | 56448 | 5248 | 57539 | 4314 | 57401 | 2945 | 68604 | 2235 | 43059 |
| 24-#11 | 2.23 | MA | 35789 | 8720 | 57333 | 6461 | 62591 | 5244 | 64536 | 4311 | 65919 | 2949 | 79387 | 2451 | 46786 |
| 6L-8S | | MI | 33116 | 8720 | 53001 | 6452 | 57454 | 5235 | 58819 | 4319 | 59068 | 2936 | 70683 | 2289 | 43659 |
| 24-#11 | 2.23 | MA | 35310 | 8720 | 56441 | 6476 | 61515 | 5240 | 63212 | 4323 | 64143 | 2958 | 76951 | 2361 | 46329 |
| 7E | | MI | 33564 | 8720 | 53760 | 6455 | 58488 | 5239 | 60043 | 4307 | 60855 | 2945 | 72796 | 2337 | 43947 |
| 24-#11 | 2.23 | MA | 34838 | 8720 | 55640 | 6473 | 60424 | 5254 | 61921 | 4335 | 62256 | 2950 | 74705 | 2312 | 46010 |
| 8L-6S | | MI | 34019 | 8720 | 54605 | 6440 | 59507 | 5226 | 61296 | 4296 | 62536 | 2936 | 75084 | 2427 | 44362 |
| 24-#11 | 2.23 | MA | 34357 | 8720 | 54776 | 6488 | 59362 | 5250 | 60570 | 4330 | 60497 | 2960 | 72492 | 2258 | 45369 |
| 9L-5S | | MI | 34486 | 8720 | 55377 | 6443 | 60576 | 5231 | 62602 | 4301 | 64257 | 2927 | 77228 | 2483 | 44774 |
| 24-#11 | 2.23 | MA | 33835 | 8720 | 53977 | 6485 | 58285 | 5263 | 59285 | 4342 | 58753 | 2969 | 70347 | 2197 | 44811 |
| 10L-4S | | MI | 34976 | 8720 | 56200 | 6446 | 61643 | 5218 | 63913 | 4290 | 66156 | 2935 | 79489 | 2524 | 44839 |
| 24-#11 | 2.23 | MA | 33327 | 8720 | 53191 | 6483 | 57228 | 5259 | 57952 | 4337 | 56893 | 2962 | 68157 | 2146 | 44097 |
| 11L-3S | | MI | 35524 | 8720 | 57151 | 6432 | 62855 | 5222 | 65386 | 4295 | 68052 | 2926 | 81646 | 2610 | 44872 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 42"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#14 | 3.21 | MA | 38362 | 9293 | 63278 | 6804 | 70176 | 5497 | 73745 | 4465 | 78369 | 2885 | 95955 | 2288 | 66327 |
| 5L-9S | | MI | 33880 | 9293 | 55641 | 6813 | 60749 | 5501 | 62730 | 4463 | 64406 | 2890 | 78348 | 1898 | 59168 |
| 24-#14 | 3.21 | MA | 37668 | 9293 | 62110 | 6800 | 68559 | 5490 | 71768 | 4457 | 75763 | 2898 | 92711 | 2207 | 65411 |
| 6L-8S | | MI | 34505 | 9293 | 56813 | 6793 | 62191 | 5483 | 64564 | 4471 | 66785 | 2878 | 81298 | 1976 | 60153 |
| 24-#14 | 3.21 | MA | 36993 | 9293 | 60830 | 6821 | 67015 | 5509 | 69870 | 4473 | 73217 | 2910 | 89248 | 2077 | 64740 |
| 7E | | MI | 35136 | 9293 | 57903 | 6798 | 63674 | 5489 | 66319 | 4455 | 69337 | 2890 | 84307 | 2045 | 61325 |
| 24-#14 | 3.21 | MA | 36328 | 9293 | 59680 | 6816 | 65449 | 5503 | 68018 | 4490 | 70512 | 2898 | 86049 | 2007 | 63465 |
| 8L-6S | | MI | 35777 | 9293 | 59115 | 6777 | 65136 | 5471 | 68116 | 4439 | 71737 | 2878 | 87557 | 2175 | 61971 |
| 24-#14 | 3.21 | MA | 35665 | 9293 | 58442 | 6837 | 63926 | 5522 | 66080 | 4482 | 67989 | 2911 | 82904 | 1930 | 62422 |
| 9L-5S | | MI | 36435 | 9293 | 60221 | 6782 | 66668 | 5478 | 69988 | 4448 | 74193 | 2866 | 90600 | 2256 | 62804 |

## RECTANGULAR TIED COLUMNS 40" x 44"

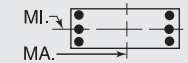
| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.36 | MA | 38873 | 8609 | 60966 | 6390 | 66028 | 5203 | 67486 | 4329 | 67644 | 3084 | 79548 | 2895 | 31963 |
| 2L-3S | | MI | 33252 | 8609 | 52542 | 6335 | 56089 | 5196 | 56458 | 4323 | 54703 | 3071 | 63164 | 2629 | 28953 |
| 6-#18 | 1.36 | MA | 36661 | 8609 | 57704 | 6382 | 61845 | 5235 | 62384 | 4357 | 60721 | 3106 | 70326 | 2673 | 32062 |
| 3L-2S | | MI | 35226 | 8609 | 55459 | 6345 | 59829 | 5166 | 61020 | 4298 | 60834 | 3049 | 71292 | 2850 | 28833 |
| 8-#14 | 1.02 | MA | 37815 | 8402 | 58440 | 6301 | 63034 | 5143 | 63926 | 4301 | 62896 | 3125 | 73459 | 2968 | 24377 |
| 2L-4S | | MI | 32356 | 8402 | 50169 | 6275 | 53297 | 5121 | 53150 | 4279 | 50525 | 3126 | 58246 | 2684 | 22179 |
| 8-#14 | 1.02 | MA | 36542 | 8402 | 56577 | 6297 | 60646 | 5137 | 61013 | 4318 | 58933 | 3139 | 68128 | 2843 | 24448 |
| 3E | | MI | 33160 | 8402 | 51532 | 6255 | 55034 | 5127 | 55261 | 4288 | 53230 | 3113 | 61307 | 2808 | 22107 |
| 8-#14 | 1.02 | MA | 35647 | 8402 | 55060 | 6318 | 58712 | 5157 | 58662 | 4311 | 55908 | 3152 | 64658 | 2719 | 24504 |
| 4L-2S | | MI | 34297 | 8402 | 53200 | 6260 | 57173 | 5109 | 57870 | 4272 | 56770 | 3101 | 66021 | 2933 | 22031 |
| 8-#18 | 1.82 | MA | 40386 | 8886 | 64229 | 6563 | 70211 | 5327 | 72589 | 4404 | 74567 | 3060 | 88770 | 2843 | 42220 |
| 2L-4S | | MI | 33217 | 8886 | 53069 | 6542 | 56784 | 5306 | 57320 | 4380 | 56148 | 3067 | 66030 | 2349 | 37942 |
| 8-#18 | 1.82 | MA | 38191 | 8886 | 60966 | 6555 | 66028 | 5359 | 67486 | 4433 | 67644 | 3083 | 79548 | 2622 | 42244 |
| 3E | | MI | 34606 | 8886 | 55459 | 6508 | 59829 | 5320 | 61020 | 4399 | 60834 | 3044 | 71292 | 2571 | 38087 |
| 8-#18 | 1.82 | MA | 36644 | 8886 | 58302 | 6591 | 62632 | 5347 | 63359 | 4417 | 62352 | 3105 | 73560 | 2400 | 42015 |
| 4L-2S | | MI | 36566 | 8886 | 58376 | 6518 | 63569 | 5290 | 65582 | 4373 | 66964 | 3022 | 79419 | 2792 | 38025 |
| 10-#14 | 1.28 | MA | 38695 | 8557 | 60303 | 6398 | 65422 | 5213 | 66839 | 4343 | 66860 | 3113 | 78790 | 2942 | 30248 |
| 2L-5S | | MI | 32430 | 8557 | 50658 | 6368 | 53907 | 5209 | 53880 | 4338 | 51354 | 3100 | 59742 | 2597 | 27387 |
| 10-#14 | 1.28 | MA | 37428 | 8557 | 58440 | 6394 | 63034 | 5207 | 63926 | 4361 | 62896 | 3126 | 73459 | 2818 | 30302 |
| 3L-4S | | MI | 33146 | 8557 | 51837 | 6373 | 55436 | 5190 | 55759 | 4322 | 54064 | 3113 | 62960 | 2655 | 27411 |
| 10-#14 | 1.28 | MA | 36538 | 8557 | 56923 | 6415 | 61100 | 5226 | 61576 | 4353 | 59871 | 3140 | 69989 | 2693 | 30326 |
| 4L-3S | | MI | 33946 | 8557 | 53200 | 6352 | 57173 | 5197 | 57870 | 4331 | 56770 | 3100 | 66021 | 2779 | 27365 |
| 10-#14 | 1.28 | MA | 35743 | 8557 | 55611 | 6412 | 59399 | 5221 | 59485 | 4370 | 56843 | 3129 | 66364 | 2634 | 30257 |
| 5L-2S | | MI | 35079 | 8557 | 54868 | 6357 | 59311 | 5179 | 60479 | 4315 | 60309 | 3088 | 70736 | 2904 | 27303 |
| 10-#18 | 2.27 | MA | 41883 | 9162 | 67492 | 6736 | 74394 | 5451 | 77692 | 4480 | 81490 | 3037 | 97991 | 2792 | 52442 |
| 2L-5S | | MI | 33334 | 9162 | 53915 | 6705 | 57839 | 5460 | 58584 | 4482 | 57582 | 3018 | 68584 | 2191 | 44939 |
| 10-#18 | 2.27 | MA | 39704 | 9162 | 64229 | 6727 | 70211 | 5483 | 72589 | 4508 | 74567 | 3059 | 88770 | 2570 | 52383 |
| 3L-4S | | MI | 34568 | 9162 | 55986 | 6715 | 60524 | 5430 | 61883 | 4456 | 62279 | 3040 | 74158 | 2291 | 46933 |
| 10-#18 | 2.27 | MA | 38169 | 9162 | 61564 | 6763 | 66815 | 5471 | 68462 | 4493 | 69275 | 3082 | 82782 | 2349 | 52060 |
| 4L-3S | | MI | 35946 | 9162 | 58376 | 6681 | 63569 | 5444 | 65582 | 4474 | 66964 | 3018 | 79419 | 2512 | 47167 |
| 10-#18 | 2.27 | MA | 36798 | 9162 | 59257 | 6755 | 63824 | 5504 | 64787 | 4521 | 63974 | 3059 | 76486 | 2246 | 49776 |
| 5L-2S | | MI | 37892 | 9162 | 61293 | 6691 | 67308 | 5414 | 70145 | 4448 | 73095 | 2996 | 87547 | 2734 | 47179 |
| 12-#11 | 1.06 | MA | 38002 | 8427 | 58698 | 6337 | 63489 | 5171 | 64528 | 4322 | 63736 | 3134 | 74740 | 2982 | 25400 |
| 2L-6S | | MI | 32132 | 8427 | 49719 | 6304 | 52747 | 5156 | 52511 | 4307 | 49588 | 3131 | 57322 | 2678 | 23078 |
| 12-#11 | 1.06 | MA | 37112 | 8427 | 57397 | 6334 | 61821 | 5167 | 62494 | 4334 | 60967 | 3144 | 70994 | 2895 | 25443 |
| 3L-5S | | MI | 32610 | 8427 | 50490 | 6306 | 53816 | 5161 | 53817 | 4312 | 51309 | 3123 | 59465 | 2734 | 23078 |
| 12-#11 | 1.06 | MA | 36489 | 8427 | 56339 | 6349 | 60472 | 5181 | 60854 | 4330 | 58857 | 3154 | 68552 | 2809 | 25481 |
| 4E | | MI | 33112 | 8427 | 51313 | 6309 | 54883 | 5148 | 55128 | 4301 | 53207 | 3131 | 61726 | 2775 | 23044 |
| 12-#11 | 1.06 | MA | 35932 | 8427 | 55424 | 6347 | 59285 | 5178 | 59396 | 4342 | 56745 | 3147 | 66009 | 2767 | 25501 |
| 5L-3S | | MI | 33672 | 8427 | 52264 | 6295 | 56095 | 5152 | 56601 | 4306 | 55103 | 3122 | 63884 | 2861 | 22998 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#11 | 1.06 | MA | 35401 | 8427 | 54567 | 6345 | 58098 | 5191 | 57944 | 4337 | 54832 | 3157 | 63586 | 2711 | 25468 |
| 6L-2S | | MI | 34468 | 8427 | 53430 | 6298 | 57590 | 5139 | 58425 | 4295 | 57585 | 3113 | 67202 | 2948 | 22951 |
| 12-#14 | 1.53 | MA | 39570 | 8713 | 62166 | 6495 | 67810 | 5283 | 69753 | 4386 | 70824 | 3100 | 84122 | 2917 | 36101 |
| 2L-6S | | MI | 32541 | 8713 | 51220 | 6461 | 54514 | 5272 | 54618 | 4371 | 52437 | 3100 | 61413 | 2487 | 31928 |
| 12-#14 | 1.53 | MA | 38309 | 8713 | 60303 | 6492 | 65422 | 5277 | 66839 | 4403 | 66860 | 3114 | 78790 | 2793 | 36139 |
| 3L-5S | | MI | 33219 | 8713 | 52326 | 6465 | 56045 | 5278 | 56489 | 4380 | 54893 | 3087 | 64456 | 2568 | 32559 |
| 12-#14 | 1.53 | MA | 37423 | 8713 | 58786 | 6513 | 63488 | 5296 | 64489 | 4395 | 63835 | 3127 | 75321 | 2668 | 36126 |
| 4E | | MI | 33932 | 8713 | 53506 | 6470 | 57575 | 5260 | 58368 | 4364 | 57604 | 3100 | 67675 | 2626 | 32622 |
| 12-#14 | 1.53 | MA | 36632 | 8713 | 57474 | 6509 | 61787 | 5291 | 62398 | 4413 | 60807 | 3116 | 71695 | 2608 | 36020 |
| 5L-3S | | MI | 34728 | 8713 | 54868 | 6450 | 59311 | 5267 | 60479 | 4373 | 60309 | 3087 | 70736 | 2750 | 32604 |
| 12-#14 | 1.53 | MA | 35879 | 8713 | 56244 | 6505 | 60083 | 5310 | 60316 | 4405 | 58063 | 3130 | 68250 | 2528 | 35267 |
| 6L-2S | | MI | 35856 | 8713 | 56537 | 6454 | 61450 | 5249 | 63088 | 4357 | 63849 | 3075 | 75450 | 2875 | 32556 |
| 12-#18 | 2.73 | MA | 43367 | 9439 | 70755 | 6909 | 78577 | 5575 | 82795 | 4555 | 88414 | 3014 | 107213 | 2741 | 62629 |
| 2L-6S | | MI | 33515 | 9439 | 54888 | 6867 | 58889 | 5570 | 59860 | 4539 | 59458 | 3013 | 71474 | 1988 | 52160 |
| 12-#18 | 2.73 | MA | 41202 | 9439 | 67492 | 6900 | 74394 | 5607 | 77692 | 4584 | 81490 | 3036 | 97991 | 2519 | 62497 |
| 3L-5S | | MI | 34682 | 9439 | 56832 | 6878 | 61579 | 5584 | 63147 | 4557 | 63712 | 2991 | 76712 | 2133 | 53617 |
| 12-#18 | 2.73 | MA | 39680 | 9439 | 64827 | 6936 | 70998 | 5595 | 73565 | 4568 | 76198 | 3058 | 92004 | 2298 | 62092 |
| 4E | | MI | 35906 | 9439 | 58904 | 6888 | 64263 | 5554 | 66445 | 4531 | 68409 | 3013 | 82285 | 2233 | 55907 |
| 12-#18 | 2.73 | MA | 38320 | 9439 | 62520 | 6928 | 68007 | 5628 | 69890 | 4597 | 70897 | 3036 | 85708 | 2195 | 59507 |
| 5L-3S | | MI | 37274 | 9439 | 61293 | 6854 | 67308 | 5568 | 70145 | 4550 | 73095 | 2991 | 87547 | 2454 | 56220 |
| 12-#18 | 2.73 | MA | 37025 | 9439 | 60357 | 6920 | 65011 | 5616 | 66229 | 4581 | 66093 | 3058 | 79756 | 2050 | 57774 |
| 6L-2S | | MI | 39207 | 9439 | 64210 | 6864 | 71048 | 5538 | 74707 | 4524 | 79225 | 2969 | 95675 | 2676 | 56308 |
| 14-#11 | 1.24 | MA | 38620 | 8534 | 59999 | 6404 | 65157 | 5219 | 66563 | 4351 | 66504 | 3125 | 78487 | 2965 | 29495 |
| 2L-7S | | MI | 32225 | 8534 | 50040 | 6385 | 53223 | 5218 | 53081 | 4348 | 50388 | 3132 | 58352 | 2569 | 26367 |
| 14-#11 | 1.24 | MA | 37733 | 8534 | 58698 | 6402 | 63489 | 5216 | 64528 | 4364 | 63736 | 3135 | 74740 | 2879 | 29531 |
| 3L-6S | | MI | 32689 | 8534 | 50885 | 6371 | 54242 | 5205 | 54335 | 4336 | 52069 | 3123 | 60640 | 2659 | 26704 |
| 14-#11 | 1.24 | MA | 37112 | 8534 | 57640 | 6417 | 62140 | 5229 | 62889 | 4359 | 61625 | 3145 | 72299 | 2792 | 29558 |
| 4L-5S | | MI | 33165 | 8534 | 51656 | 6374 | 55311 | 5209 | 55641 | 4342 | 53790 | 3114 | 62784 | 2715 | 26727 |
| 14-#11 | 1.24 | MA | 36557 | 8534 | 56725 | 6415 | 60953 | 5226 | 61431 | 4371 | 59513 | 3138 | 69756 | 2750 | 29555 |
| 5L-4S | | MI | 33665 | 8534 | 52479 | 6377 | 56378 | 5196 | 56952 | 4330 | 55689 | 3122 | 65045 | 2756 | 26707 |
| 14-#11 | 1.24 | MA | 36029 | 8534 | 55868 | 6412 | 59766 | 5240 | 59979 | 4367 | 57600 | 3148 | 67333 | 2695 | 29503 |
| 6L-3S | | MI | 34224 | 8534 | 53430 | 6362 | 57590 | 5200 | 58425 | 4336 | 57585 | 3113 | 67202 | 2843 | 26671 |
| 14-#11 | 1.24 | MA | 35514 | 8534 | 54929 | 6427 | 58633 | 5236 | 58586 | 4379 | 55731 | 3158 | 64749 | 2605 | 29088 |
| 7L-2S | | MI | 35017 | 8534 | 54597 | 6365 | 59085 | 5187 | 60249 | 4324 | 60066 | 3105 | 70521 | 2929 | 26631 |
| 14-#14 | 1.79 | MA | 40440 | 8868 | 64029 | 6592 | 70198 | 5352 | 72666 | 4428 | 74788 | 3088 | 89453 | 2892 | 41943 |
| 2L-7S | | MI | 32670 | 8868 | 51676 | 6578 | 55191 | 5360 | 55430 | 4430 | 53576 | 3099 | 62878 | 2328 | 36317 |
| 14-#14 | 1.79 | MA | 39183 | 8868 | 62166 | 6589 | 67810 | 5347 | 69753 | 4445 | 70824 | 3101 | 84122 | 2767 | 41962 |
| 3L-6S | | MI | 33328 | 8868 | 52888 | 6558 | 56652 | 5342 | 57227 | 4414 | 55976 | 3086 | 66128 | 2458 | 36946 |
| 14-#14 | 1.79 | MA | 38302 | 8868 | 60648 | 6610 | 65876 | 5366 | 67402 | 4438 | 67799 | 3115 | 80652 | 2643 | 41914 |
| 4L-5S | | MI | 34003 | 8868 | 53994 | 6563 | 58184 | 5348 | 59099 | 4423 | 58433 | 3074 | 69171 | 2539 | 37720 |
| 14-#14 | 1.79 | MA | 37515 | 8868 | 59336 | 6606 | 64175 | 5360 | 65311 | 4455 | 64770 | 3104 | 77026 | 2583 | 41775 |
| 5L-4S | | MI | 34712 | 8868 | 55174 | 6567 | 59713 | 5330 | 60978 | 4407 | 61143 | 3086 | 72389 | 2597 | 37814 |
| 14-#14 | 1.79 | MA | 36766 | 8868 | 58107 | 6603 | 62471 | 5380 | 63229 | 4448 | 62026 | 3117 | 73581 | 2502 | 40876 |
| 6L-3S | | MI | 35504 | 8868 | 56537 | 6547 | 61450 | 5337 | 63088 | 4415 | 63849 | 3074 | 75450 | 2721 | 37830 |
| 14-#14 | 1.79 | MA | 36036 | 8868 | 56759 | 6624 | 60846 | 5374 | 61231 | 4465 | 59345 | 3131 | 69905 | 2372 | 40125 |
| 7L-2S | | MI | 36628 | 8868 | 58205 | 6552 | 63589 | 5319 | 65697 | 4399 | 67388 | 3062 | 80165 | 2846 | 37797 |
| 14-#18 | 3.18 | MA | 42688 | 9716 | 70755 | 7073 | 78577 | 5732 | 82795 | 4659 | 88414 | 3013 | 107213 | 2468 | 72595 |
| 3L-6S | | MI | 34860 | 9716 | 57805 | 7040 | 62629 | 5694 | 64422 | 4614 | 65589 | 2987 | 79601 | 1930 | 60870 |
| 14-#18 | 3.18 | MA | 41177 | 9716 | 68090 | 7109 | 75181 | 5720 | 78668 | 4643 | 83122 | 3035 | 101226 | 2246 | 72117 |
| 4L-5S | | MI | 36017 | 9716 | 59749 | 7050 | 65318 | 5708 | 67709 | 4632 | 69843 | 2965 | 84839 | 2075 | 62325 |
| 14-#18 | 3.18 | MA | 39827 | 9716 | 65783 | 7101 | 72190 | 5752 | 74993 | 4672 | 77820 | 3013 | 94930 | 2143 | 69268 |
| 5L-4S | | MI | 37233 | 9716 | 61821 | 7061 | 68003 | 5678 | 71007 | 4607 | 74540 | 2987 | 90413 | 2175 | 64871 |
| 14-#18 | 3.18 | MA | 38543 | 9716 | 63620 | 7093 | 69194 | 5740 | 71332 | 4656 | 73016 | 3035 | 88978 | 1999 | 67614 |
| 6L-3S | | MI | 38591 | 9716 | 64210 | 7026 | 71048 | 5692 | 74707 | 4625 | 79225 | 2965 | 95675 | 2396 | 65253 |
| 14-#18 | 3.18 | MA | 37292 | 9716 | 61249 | 7129 | 66335 | 5772 | 67817 | 4685 | 68321 | 3057 | 82622 | 1768 | 64425 |
| 7L-2S | | MI | 40512 | 9716 | 67127 | 7037 | 74787 | 5662 | 79269 | 4599 | 85356 | 2942 | 103802 | 2617 | 65397 |
| 16-#11 | 1.42 | MA | 39234 | 8642 | 61300 | 6471 | 66825 | 5268 | 68598 | 4381 | 69272 | 3117 | 82234 | 2949 | 33582 |
| 2L-8S | | MI | 32326 | 8642 | 50446 | 6450 | 53684 | 5262 | 53682 | 4389 | 51082 | 3115 | 59557 | 2502 | 29581 |

## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

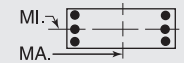
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.42 | MA | 38351 | 8642 | 59999 | 6469 | 65157 | 5264 | 66563 | 4393 | 66504 | 3127 | 78487 | 2862 | 33611 |
| 3L-7S | | MI | 32781 | 8642 | 51206 | 6453 | 54718 | 5266 | 54905 | 4377 | 52869 | 3123 | 61671 | 2550 | 29904 |
| 16-#11 | 1.42 | MA | 37732 | 8642 | 58941 | 6484 | 63808 | 5278 | 64923 | 4388 | 64394 | 3137 | 76046 | 2776 | 33627 |
| 4L-6S | | MI | 33244 | 8642 | 52051 | 6438 | 55737 | 5253 | 56159 | 4365 | 54551 | 3114 | 63959 | 2641 | 30323 |
| 16-#11 | 1.42 | MA | 37179 | 8642 | 58026 | 6482 | 62621 | 5274 | 63465 | 4401 | 62282 | 3130 | 73502 | 2734 | 33602 |
| 5E | | MI | 33718 | 8642 | 52823 | 6441 | 56806 | 5257 | 57465 | 4371 | 56272 | 3105 | 66102 | 2697 | 30363 |
| 16-#11 | 1.42 | MA | 36653 | 8642 | 57169 | 6480 | 61434 | 5288 | 62014 | 4396 | 60369 | 3140 | 71080 | 2678 | 33533 |
| 6L-4S | | MI | 34216 | 8642 | 53645 | 6444 | 57873 | 5244 | 58776 | 4359 | 58170 | 3114 | 68363 | 2738 | 30362 |
| 16-#11 | 1.42 | MA | 36140 | 8642 | 56230 | 6495 | 60301 | 5285 | 60621 | 4409 | 58499 | 3150 | 68496 | 2588 | 33035 |
| 7L-3S | | MI | 34773 | 8642 | 54597 | 6430 | 59085 | 5249 | 60249 | 4365 | 60066 | 3105 | 70521 | 2824 | 30336 |
| 16-#11 | 1.42 | MA | 35635 | 8642 | 55386 | 6493 | 59152 | 5298 | 59261 | 4421 | 56513 | 3142 | 66118 | 2539 | 32644 |
| 8L-2S | | MI | 35563 | 8642 | 55763 | 6433 | 60580 | 5236 | 62073 | 4353 | 62548 | 3096 | 73840 | 2910 | 30302 |
| 16-#14 | 2.05 | MA | 41304 | 9024 | 65891 | 6690 | 72586 | 5422 | 75579 | 4470 | 78751 | 3075 | 94784 | 2866 | 47775 |
| 2L-8S | | MI | 32811 | 9024 | 52255 | 6671 | 55846 | 5423 | 56284 | 4488 | 54564 | 3073 | 64584 | 2231 | 40527 |
| 16-#14 | 2.05 | MA | 40053 | 9024 | 64029 | 6686 | 70198 | 5417 | 72666 | 4488 | 74788 | 3089 | 89453 | 2742 | 47766 |
| 3L-7S | | MI | 33456 | 9024 | 53344 | 6675 | 57329 | 5429 | 58039 | 4472 | 57116 | 3086 | 67593 | 2299 | 41374 |
| 16-#14 | 2.05 | MA | 39176 | 9024 | 62511 | 6707 | 68264 | 5436 | 70315 | 4480 | 71763 | 3103 | 85983 | 2617 | 47692 |
| 4L-6S | | MI | 34111 | 9024 | 54556 | 6655 | 58791 | 5411 | 59836 | 4456 | 59516 | 3073 | 70842 | 2429 | 41975 |
| 16-#14 | 2.05 | MA | 38393 | 9024 | 61199 | 6704 | 66563 | 5430 | 68225 | 4498 | 68734 | 3091 | 82357 | 2558 | 47524 |
| 5E | | MI | 34783 | 9024 | 55663 | 6660 | 60323 | 5418 | 61708 | 4465 | 61972 | 3061 | 73885 | 2510 | 42875 |
| 16-#14 | 2.05 | MA | 37648 | 9024 | 59969 | 6700 | 64859 | 5450 | 66142 | 4490 | 65990 | 3105 | 78912 | 2477 | 46498 |
| 6L-4S | | MI | 35488 | 9024 | 56842 | 6664 | 61852 | 5400 | 63587 | 4449 | 64683 | 3073 | 77104 | 2568 | 42997 |
| 16-#14 | 2.05 | MA | 36921 | 9024 | 58622 | 6721 | 63234 | 5444 | 64144 | 4508 | 63309 | 3118 | 75236 | 2347 | 45777 |
| 7L-3S | | MI | 36277 | 9024 | 58205 | 6644 | 63589 | 5407 | 65697 | 4458 | 67388 | 3061 | 80165 | 2693 | 43042 |
| 16-#14 | 2.05 | MA | 36206 | 9024 | 57411 | 6717 | 61585 | 5463 | 62193 | 4525 | 60459 | 3107 | 71846 | 2277 | 44798 |
| 8L-2S | | MI | 37395 | 9024 | 59873 | 6649 | 65727 | 5389 | 68306 | 4442 | 70928 | 3049 | 84879 | 2817 | 43028 |
| 16-#18 | 3.64 | MA | 42661 | 9992 | 71353 | 7282 | 79364 | 5844 | 83770 | 4719 | 90045 | 3012 | 110448 | 2195 | 82051 |
| 4L-6S | | MI | 36193 | 9992 | 60723 | 7213 | 66368 | 5818 | 68984 | 4689 | 71719 | 2960 | 87729 | 1872 | 69400 |
| 16-#18 | 3.64 | MA | 41321 | 9992 | 69046 | 7274 | 76373 | 5876 | 80096 | 4747 | 84743 | 2990 | 104152 | 2092 | 79055 |
| 5E | | MI | 37342 | 9992 | 62666 | 7223 | 69058 | 5832 | 72271 | 4708 | 75973 | 2938 | 92967 | 2017 | 71058 |
| 16-#18 | 3.64 | MA | 40047 | 9992 | 66882 | 7266 | 73377 | 5864 | 76435 | 4732 | 79939 | 3012 | 98200 | 1948 | 77221 |
| 6L-4S | | MI | 38549 | 9992 | 64738 | 7233 | 71742 | 5802 | 75569 | 4682 | 80670 | 2960 | 98540 | 2116 | 73585 |
| 16-#18 | 3.64 | MA | 38806 | 9992 | 64512 | 7302 | 70518 | 5896 | 72920 | 4760 | 75244 | 3034 | 91844 | 1717 | 74126 |
| 7L-3S | | MI | 39897 | 9992 | 67127 | 7199 | 74787 | 5816 | 79269 | 4700 | 85356 | 2938 | 103802 | 2338 | 74272 |
| 18-#11 | 1.60 | MA | 39847 | 8750 | 62601 | 6539 | 68493 | 5316 | 70633 | 4410 | 72041 | 3108 | 85980 | 2932 | 37663 |
| 2L-9S | | MI | 32418 | 8750 | 50795 | 6532 | 54173 | 5323 | 54226 | 4412 | 51897 | 3115 | 60798 | 2430 | 32791 |
| 18-#11 | 1.60 | MA | 38966 | 8750 | 61300 | 6537 | 66825 | 5313 | 68598 | 4422 | 69272 | 3118 | 82234 | 2846 | 37685 |
| 3L-8S | | MI | 32881 | 8750 | 51612 | 6517 | 55179 | 5310 | 55506 | 4418 | 53564 | 3106 | 62876 | 2484 | 33135 |
| 18-#11 | 1.60 | MA | 38349 | 8750 | 60242 | 6552 | 65476 | 5326 | 66958 | 4418 | 67162 | 3128 | 79792 | 2760 | 37683 |
| 4L-7S | | MI | 33335 | 8750 | 52372 | 6520 | 56213 | 5315 | 56729 | 4406 | 55351 | 3114 | 64990 | 2532 | 33446 |
| 18-#11 | 1.60 | MA | 37798 | 8750 | 59327 | 6549 | 64289 | 5323 | 65500 | 4430 | 65050 | 3121 | 77249 | 2718 | 37644 |
| 5L-6S | | MI | 33796 | 8750 | 53217 | 6506 | 57232 | 5302 | 57983 | 4395 | 57032 | 3106 | 67278 | 2622 | 33926 |
| 18-#11 | 1.60 | MA | 37274 | 8750 | 58470 | 6547 | 63102 | 5337 | 64049 | 4426 | 63137 | 3131 | 74826 | 2662 | 37558 |
| 6L-5S | | MI | 34268 | 8750 | 53989 | 6509 | 58301 | 5306 | 59288 | 4400 | 58753 | 3097 | 69421 | 2678 | 33993 |
| 18-#11 | 1.60 | MA | 36763 | 8750 | 57531 | 6562 | 61969 | 5333 | 62655 | 4438 | 61268 | 3141 | 72243 | 2572 | 36988 |
| 7L-4S | | MI | 34764 | 8750 | 54812 | 6512 | 59368 | 5293 | 60600 | 4389 | 60652 | 3105 | 71682 | 2719 | 34011 |
| 18-#11 | 1.60 | MA | 36260 | 8750 | 56687 | 6560 | 60820 | 5347 | 61296 | 4451 | 59281 | 3134 | 69864 | 2523 | 36610 |
| 8L-3S | | MI | 35319 | 8750 | 55763 | 6497 | 60580 | 5297 | 62073 | 4394 | 62548 | 3096 | 73840 | 2805 | 33994 |
| 18-#11 | 1.60 | MA | 35736 | 8750 | 55862 | 6558 | 59702 | 5343 | 59874 | 4446 | 57429 | 3144 | 67515 | 2469 | 36195 |
| 9L-2S | | MI | 36108 | 8750 | 56929 | 6500 | 62075 | 5284 | 63897 | 4383 | 65029 | 3087 | 77158 | 2892 | 33966 |
| 18-#14 | 2.30 | MA | 42163 | 9180 | 67754 | 6787 | 74974 | 5492 | 78492 | 4513 | 82715 | 3063 | 100115 | 2841 | 53597 |
| 2L-9S | | MI | 32960 | 9180 | 52751 | 6788 | 56542 | 5511 | 57059 | 4522 | 55725 | 3073 | 66348 | 2124 | 44575 |
| 18-#14 | 2.30 | MA | 40918 | 9180 | 65891 | 6783 | 72586 | 5486 | 75579 | 4530 | 78751 | 3077 | 94784 | 2716 | 53562 |
| 3L-8S | | MI | 33595 | 9180 | 53923 | 6768 | 57985 | 5493 | 58893 | 4531 | 58104 | 3060 | 69299 | 2202 | 45499 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis

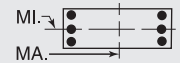



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 2.30 | MA | 40045 | 9180 | 64374 | 6805 | 70652 | 5506 | 73229 | 4523 | 75726 | 3090 | 91314 | 2592 | 53464 |
| 4L-7S | | MI | 34237 | 9180 | 55013 | 6773 | 59468 | 5499 | 60648 | 4515 | 60655 | 3073 | 72307 | 2270 | 46436 |
| 18-#14 | 2.30 | MA | 39266 | 9180 | 63062 | 6801 | 68951 | 5500 | 71138 | 4540 | 72698 | 3079 | 87689 | 2532 | 53269 |
| 5L-6S | | MI | 34889 | 9180 | 56225 | 6752 | 60930 | 5481 | 62445 | 4499 | 63055 | 3060 | 75557 | 2400 | 47014 |
| 18-#14 | 2.30 | MA | 38524 | 9180 | 61832 | 6797 | 67247 | 5519 | 69056 | 4533 | 69954 | 3092 | 84243 | 2451 | 52131 |
| 6L-5S | | MI | 35558 | 9180 | 57331 | 6757 | 62461 | 5488 | 64317 | 4507 | 65512 | 3048 | 78600 | 2481 | 47989 |
| 18-#14 | 2.30 | MA | 37801 | 9180 | 60485 | 6818 | 65622 | 5514 | 67057 | 4550 | 67272 | 3106 | 80568 | 2321 | 51434 |
| 7L-4S | | MI | 36260 | 9180 | 58511 | 6762 | 63991 | 5470 | 66196 | 4491 | 68222 | 3060 | 81819 | 2539 | 48171 |
| 18-#14 | 2.30 | MA | 37090 | 9180 | 59274 | 6815 | 63973 | 5533 | 65106 | 4567 | 64423 | 3095 | 77178 | 2251 | 50366 |
| 8L-3S | | MI | 37045 | 9180 | 59873 | 6741 | 65727 | 5477 | 68306 | 4500 | 70928 | 3048 | 84879 | 2664 | 48239 |
| 18-#14 | 2.30 | MA | 36359 | 9180 | 57970 | 6836 | 62369 | 5528 | 63066 | 4560 | 61766 | 3108 | 73837 | 2174 | 49280 |
| 9L-2S | | MI | 38159 | 9180 | 61541 | 6746 | 67866 | 5458 | 70915 | 4484 | 74467 | 3036 | 89594 | 2788 | 48257 |
| 18-#18 | 4.09 | MA | 42804 | 10269 | 72309 | 7447 | 80556 | 6000 | 85198 | 4823 | 91667 | 2967 | 113374 | 2041 | 88864 |
| 5L-6S | | MI | 37515 | 10269 | 63640 | 7386 | 70108 | 5942 | 73546 | 4765 | 77850 | 2933 | 95856 | 1813 | 77958 |
| 18-#18 | 4.09 | MA | 41539 | 10269 | 70145 | 7439 | 77560 | 5988 | 81538 | 4807 | 86862 | 2989 | 107422 | 1896 | 86833 |
| 6L-5S | | MI | 38656 | 10269 | 65584 | 7396 | 72797 | 5956 | 76833 | 4783 | 82104 | 2911 | 101095 | 1958 | 79812 |
| 18-#18 | 4.09 | MA | 40307 | 10269 | 67775 | 7475 | 74701 | 6020 | 78023 | 4836 | 82167 | 3011 | 101065 | 1665 | 83848 |
| 7L-4S | | MI | 39854 | 10269 | 67655 | 7406 | 75482 | 5926 | 80131 | 4757 | 86801 | 2933 | 106668 | 2058 | 82209 |
| 20-#11 | 1.77 | MA | 40456 | 8858 | 63902 | 6606 | 70161 | 5364 | 72668 | 4439 | 74809 | 3100 | 89727 | 2916 | 41739 |
| 2L-10S | | MI | 32485 | 8858 | 51204 | 6596 | 54647 | 5368 | 54833 | 4454 | 52726 | 3115 | 62104 | 2350 | 35737 |
| 20-#11 | 1.77 | MA | 39578 | 8858 | 62601 | 6604 | 68493 | 5361 | 70633 | 4452 | 72041 | 3110 | 85980 | 2830 | 41753 |
| 3L-9S | | MI | 32975 | 8858 | 51961 | 6599 | 55668 | 5372 | 56050 | 4442 | 54379 | 3106 | 64117 | 2411 | 36287 |
| 20-#11 | 1.77 | MA | 38963 | 8858 | 61543 | 6619 | 67143 | 5375 | 68993 | 4447 | 69931 | 3120 | 83539 | 2743 | 41734 |
| 4L-8S | | MI | 33434 | 8858 | 52779 | 6585 | 56674 | 5359 | 57329 | 4447 | 56045 | 3097 | 66195 | 2465 | 36692 |
| 20-#11 | 1.77 | MA | 38414 | 8858 | 60628 | 6617 | 65957 | 5371 | 67535 | 4460 | 67819 | 3112 | 80996 | 2701 | 41681 |
| 5L-7S | | MI | 33886 | 8858 | 53538 | 6588 | 57708 | 5363 | 58553 | 4436 | 57832 | 3106 | 68309 | 2513 | 36993 |
| 20-#11 | 1.77 | MA | 37892 | 8858 | 59771 | 6615 | 64770 | 5385 | 66083 | 4455 | 65905 | 3122 | 78573 | 2645 | 41494 |
| 6E | | MI | 34345 | 8858 | 54384 | 6573 | 58727 | 5350 | 59807 | 4424 | 59514 | 3097 | 70596 | 2603 | 37452 |
| 20-#11 | 1.77 | MA | 37383 | 8858 | 58832 | 6630 | 63637 | 5382 | 64690 | 4467 | 64036 | 3132 | 75989 | 2555 | 40946 |
| 7L-5S | | MI | 34816 | 8858 | 55155 | 6576 | 59796 | 5354 | 61112 | 4430 | 61235 | 3088 | 72740 | 2659 | 37617 |
| 20-#11 | 1.77 | MA | 36882 | 8858 | 57988 | 6627 | 62487 | 5395 | 63331 | 4480 | 62050 | 3125 | 73611 | 2506 | 40579 |
| 8L-4S | | MI | 35310 | 8858 | 55978 | 6579 | 60863 | 5341 | 62423 | 4418 | 63133 | 3096 | 75001 | 2700 | 37649 |
| 20-#11 | 1.77 | MA | 36361 | 8858 | 57163 | 6625 | 61370 | 5392 | 61909 | 4475 | 60198 | 3135 | 71262 | 2452 | 40103 |
| 9L-3S | | MI | 35863 | 8858 | 56929 | 6565 | 62075 | 5345 | 63897 | 4424 | 65029 | 3088 | 77158 | 2786 | 37647 |
| 20-#11 | 1.77 | MA | 35808 | 8858 | 56239 | 6640 | 60236 | 5406 | 60556 | 4488 | 58361 | 3145 | 68986 | 2391 | 39456 |
| 10L-2S | | MI | 36650 | 8858 | 58095 | 6567 | 63570 | 5332 | 65720 | 4412 | 67511 | 3079 | 80477 | 2873 | 37625 |
| 20-#14 | 2.56 | MA | 41778 | 9335 | 67754 | 6881 | 74974 | 5556 | 78492 | 4573 | 82715 | 3064 | 100115 | 2691 | 59350 |
| 3L-9S | | MI | 33743 | 9335 | 54419 | 6886 | 58681 | 5581 | 59668 | 4564 | 59264 | 3060 | 71063 | 2095 | 49586 |
| 20-#14 | 2.56 | MA | 40909 | 9335 | 66237 | 6902 | 73040 | 5576 | 76142 | 4565 | 79690 | 3078 | 96645 | 2566 | 59231 |
| 4L-8S | | MI | 34375 | 9335 | 55592 | 6865 | 60124 | 5562 | 61502 | 4573 | 61643 | 3047 | 74013 | 2173 | 50482 |
| 20-#14 | 2.56 | MA | 40133 | 9335 | 64925 | 6898 | 71339 | 5570 | 74051 | 4582 | 76661 | 3066 | 93020 | 2507 | 58878 |
| 5L-7S | | MI | 35014 | 9335 | 56681 | 6870 | 61607 | 5569 | 63257 | 4557 | 64195 | 3060 | 77022 | 2241 | 51503 |
| 20-#14 | 2.56 | MA | 39395 | 9335 | 63695 | 6894 | 69635 | 5589 | 71969 | 4575 | 73917 | 3080 | 89575 | 2426 | 57771 |
| 6E | | MI | 35662 | 9335 | 57893 | 6850 | 63068 | 5551 | 65054 | 4541 | 66595 | 3047 | 80271 | 2371 | 52062 |
| 20-#14 | 2.56 | MA | 38676 | 9335 | 62347 | 6916 | 68010 | 5584 | 69970 | 4592 | 71236 | 3094 | 85899 | 2296 | 57097 |
| 7L-5S | | MI | 36328 | 9335 | 58999 | 6854 | 64600 | 5558 | 66926 | 4550 | 69051 | 3035 | 83314 | 2452 | 52992 |
| 20-#14 | 2.56 | MA | 37968 | 9335 | 61137 | 6912 | 66361 | 5603 | 68020 | 4610 | 68387 | 3082 | 82509 | 2226 | 55943 |
| 8L-4S | | MI | 37027 | 9335 | 60179 | 6859 | 66129 | 5540 | 68805 | 4534 | 71762 | 3047 | 86533 | 2510 | 53339 |
| 20-#14 | 2.56 | MA | 37242 | 9335 | 59833 | 6933 | 64757 | 5597 | 65980 | 4602 | 65730 | 3096 | 79168 | 2148 | 54889 |
| 9L-3S | | MI | 37808 | 9335 | 61541 | 6839 | 67866 | 5546 | 70915 | 4543 | 74467 | 3035 | 89594 | 2635 | 53428 |
| 20-#18 | 4.55 | MA | 43019 | 10546 | 73408 | 7612 | 81743 | 6112 | 86641 | 4882 | 93785 | 2966 | 116644 | 1845 | 96471 |
| 6E | | MI | 38828 | 10546 | 66557 | 7559 | 73847 | 6066 | 78108 | 4840 | 83980 | 2907 | 103984 | 1755 | 86541 |
| 20-#18 | 4.55 | MA | 41796 | 10546 | 71038 | 7648 | 78884 | 6145 | 83126 | 4911 | 89090 | 2988 | 110287 | 1614 | 93589 |
| 7L-5S | | MI | 39961 | 10546 | 68501 | 7569 | 76537 | 6080 | 81395 | 4859 | 88234 | 2885 | 109222 | 1900 | 88583 |
| 22-#11 | 1.95 | MA | 40187 | 8966 | 63902 | 6672 | 70161 | 5409 | 72668 | 4481 | 74809 | 3101 | 89727 | 2813 | 45811 |
| 3L-10S | | MI | 33039 | 8966 | 52370 | 6664 | 56142 | 5416 | 56657 | 4483 | 55208 | 3107 | 65422 | 2331 | 39255 |
| 22-#11 | 1.95 | MA | 39575 | 8966 | 62844 | 6687 | 68811 | 5423 | 71028 | 4477 | 72699 | 3111 | 87285 | 2727 | 45780 |
| 4L-9S | | MI | 33528 | 8966 | 53127 | 6667 | 57163 | 5420 | 57874 | 4471 | 56860 | 3098 | 67435 | 2392 | 39789 |

## RECTANGULAR TIED COLUMNS 40" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

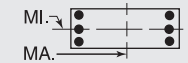
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.95 | MA | 39028 | 8966 | 61929 | 6684 | 67625 | 5420 | 69570 | 4489 | 70587 | 3104 | 84742 | 2685 | 45715 |
| 5L-8S | | MI | 33984 | 8966 | 53945 | 6652 | 58169 | 5407 | 59153 | 4477 | 58527 | 3089 | 69514 | 2446 | 40250 |
| 22-#11 | 1.95 | MA | 38508 | 8966 | 61072 | 6682 | 66437 | 5433 | 68118 | 4484 | 68674 | 3114 | 82320 | 2629 | 45436 |
| 6L-7S | | MI | 34435 | 8966 | 54705 | 6655 | 59203 | 5411 | 60377 | 4465 | 60314 | 3097 | 71627 | 2494 | 40544 |
| 22-#11 | 1.95 | MA | 38001 | 8966 | 60133 | 6697 | 65305 | 5430 | 66725 | 4497 | 66805 | 3124 | 79736 | 2539 | 44908 |
| 7L-6S | | MI | 34892 | 8966 | 55550 | 6641 | 60222 | 5398 | 61630 | 4454 | 61995 | 3088 | 73915 | 2584 | 40984 |
| 22-#11 | 1.95 | MA | 37501 | 8966 | 59289 | 6695 | 64155 | 5444 | 65365 | 4509 | 64818 | 3117 | 77358 | 2490 | 44551 |
| 8L-5S | | MI | 35362 | 8966 | 56321 | 6644 | 61291 | 5403 | 62936 | 4459 | 63716 | 3079 | 76059 | 2641 | 41237 |
| 22-#11 | 1.95 | MA | 36983 | 8966 | 58464 | 6693 | 63038 | 5440 | 63943 | 4505 | 62966 | 3127 | 75009 | 2436 | 44017 |
| 9L-4S | | MI | 35854 | 8966 | 57144 | 6646 | 62358 | 5390 | 64247 | 4448 | 65615 | 3088 | 78320 | 2681 | 41280 |
| 22-#11 | 1.95 | MA | 36431 | 8966 | 57540 | 6708 | 61904 | 5454 | 62591 | 4517 | 61130 | 3137 | 72732 | 2375 | 43388 |
| 10L-3S | | MI | 36405 | 8966 | 58095 | 6632 | 63570 | 5394 | 65720 | 4453 | 67511 | 3079 | 80477 | 2768 | 41295 |
| 22-#11 | 1.95 | MA | 35893 | 8966 | 56713 | 6705 | 60792 | 5451 | 61187 | 4512 | 59172 | 3129 | 70413 | 2323 | 42765 |
| 11L-2S | | MI | 37189 | 8966 | 59261 | 6635 | 65065 | 5381 | 67544 | 4442 | 69992 | 3070 | 83796 | 2854 | 41280 |
| 22-#14 | 2.81 | MA | 41768 | 9491 | 68100 | 6999 | 75428 | 5645 | 79055 | 4608 | 83654 | 3065 | 101977 | 2541 | 64992 |
| 4L-9S | | MI | 34521 | 9491 | 56087 | 6983 | 60820 | 5650 | 62277 | 4607 | 62804 | 3047 | 75777 | 2066 | 54605 |
| 22-#14 | 2.81 | MA | 40996 | 9491 | 66788 | 6995 | 73727 | 5640 | 76964 | 4625 | 80625 | 3054 | 98351 | 2481 | 64483 |
| 5L-8S | | MI | 35151 | 9491 | 57260 | 6963 | 62262 | 5632 | 64111 | 4615 | 65183 | 3034 | 78728 | 2144 | 55473 |
| 22-#14 | 2.81 | MA | 40262 | 9491 | 65558 | 6992 | 72023 | 5659 | 74882 | 4617 | 77881 | 3068 | 94906 | 2400 | 63420 |
| 6L-7S | | MI | 35786 | 9491 | 58349 | 6967 | 63745 | 5639 | 65866 | 4599 | 67734 | 3047 | 81736 | 2212 | 56574 |
| 22-#14 | 2.81 | MA | 39546 | 9491 | 64210 | 7013 | 70398 | 5654 | 72884 | 4635 | 75200 | 3081 | 91230 | 2271 | 62765 |
| 7L-6S | | MI | 36432 | 9491 | 59561 | 6947 | 65207 | 5621 | 67663 | 4583 | 70134 | 3034 | 84986 | 2342 | 57116 |
| 22-#14 | 2.81 | MA | 38842 | 9491 | 63000 | 7009 | 68749 | 5673 | 70933 | 4652 | 72350 | 3070 | 87840 | 2201 | 61530 |
| 8L-5S | | MI | 37095 | 9491 | 60668 | 6952 | 66739 | 5628 | 69535 | 4592 | 72591 | 3022 | 88029 | 2423 | 58007 |
| 22-#14 | 2.81 | MA | 38131 | 9491 | 61696 | 7030 | 67145 | 5667 | 68893 | 4645 | 69693 | 3083 | 84500 | 2123 | 60505 |
| 9L-4S | | MI | 37790 | 9491 | 61847 | 6956 | 68268 | 5609 | 71414 | 4576 | 75301 | 3034 | 91248 | 2481 | 58502 |
| 22-#18 | 5.00 | MA | 43275 | 10822 | 74301 | 7820 | 83067 | 6269 | 88229 | 4986 | 96013 | 2965 | 119509 | 1563 | 103346 |
| 7L-6S | | MI | 40131 | 10822 | 69474 | 7732 | 77587 | 6190 | 82670 | 4916 | 90111 | 2880 | 112112 | 1697 | 95148 |
| 24-#11 | 2.13 | MA | 40184 | 9074 | 64145 | 6754 | 70479 | 5472 | 73062 | 4506 | 75468 | 3102 | 91032 | 2710 | 49823 |
| 4L-10S | | MI | 33590 | 9074 | 53536 | 6731 | 57637 | 5464 | 58480 | 4512 | 57689 | 3098 | 68741 | 2312 | 42777 |
| 24-#11 | 2.13 | MA | 39639 | 9074 | 63230 | 6752 | 69293 | 5468 | 71605 | 4518 | 73356 | 3095 | 88489 | 2668 | 49745 |
| 5L-9S | | MI | 34080 | 9074 | 54293 | 6734 | 58658 | 5469 | 59698 | 4501 | 59342 | 3089 | 70754 | 2374 | 43296 |
| 24-#11 | 2.13 | MA | 39121 | 9074 | 62373 | 6750 | 68105 | 5482 | 70153 | 4514 | 71442 | 3105 | 86066 | 2612 | 49383 |
| 6L-8S | | MI | 34532 | 9074 | 55111 | 6720 | 59664 | 5456 | 60977 | 4506 | 61008 | 3080 | 72832 | 2428 | 43811 |
| 24-#11 | 2.13 | MA | 38616 | 9074 | 61434 | 6765 | 66972 | 5478 | 68760 | 4526 | 69573 | 3115 | 83483 | 2523 | 48873 |
| 7E | | MI | 34981 | 9074 | 55871 | 6723 | 60698 | 5460 | 62201 | 4495 | 62795 | 3089 | 74946 | 2476 | 44097 |
| 24-#11 | 2.13 | MA | 38118 | 9074 | 60590 | 6762 | 65823 | 5492 | 67400 | 4539 | 67587 | 3108 | 81104 | 2473 | 48524 |
| 8L-6S | | MI | 35437 | 9074 | 56716 | 6708 | 61717 | 5447 | 63454 | 4483 | 64477 | 3080 | 77234 | 2566 | 44521 |
| 24-#11 | 2.13 | MA | 37602 | 9074 | 59765 | 6760 | 64706 | 5489 | 65978 | 4534 | 65735 | 3118 | 78755 | 2420 | 47937 |
| 9L-5S | | MI | 35905 | 9074 | 57487 | 6711 | 62786 | 5451 | 64760 | 4489 | 66198 | 3071 | 79377 | 2622 | 44853 |
| 24-#11 | 2.13 | MA | 37052 | 9074 | 58841 | 6775 | 63572 | 5502 | 64626 | 4547 | 63898 | 3128 | 76479 | 2359 | 47323 |
| 10L-4S | | MI | 36396 | 9074 | 58310 | 6714 | 63853 | 5438 | 66071 | 4477 | 68096 | 3079 | 81638 | 2663 | 44908 |
| 24-#11 | 2.13 | MA | 36516 | 9074 | 58014 | 6773 | 62460 | 5499 | 63222 | 4542 | 61940 | 3121 | 74160 | 2306 | 46660 |
| 11L-3S | | MI | 36945 | 9074 | 59261 | 6699 | 65065 | 5442 | 67544 | 4483 | 69992 | 3070 | 83796 | 2749 | 44933 |
| 24-#14 | 3.07 | MA | 41855 | 9647 | 68650 | 7093 | 76115 | 5710 | 79878 | 4667 | 84589 | 3042 | 103682 | 2456 | 70098 |
| 5L-9S | | MI | 35296 | 9647 | 57755 | 7080 | 62958 | 5720 | 64886 | 4649 | 66343 | 3034 | 80492 | 2037 | 59621 |
| 24-#14 | 3.07 | MA | 41124 | 9647 | 67421 | 7089 | 74411 | 5729 | 77795 | 4660 | 81845 | 3055 | 100237 | 2375 | 69074 |
| 6L-8S | | MI | 35922 | 9647 | 58928 | 7060 | 64401 | 5702 | 66720 | 4658 | 68722 | 3021 | 83442 | 2115 | 60472 |
| 24-#14 | 3.07 | MA | 40412 | 9647 | 66073 | 7110 | 72786 | 5723 | 75797 | 4677 | 79163 | 3069 | 96561 | 2245 | 68436 |
| 7E | | MI | 36555 | 9647 | 60018 | 7064 | 65884 | 5709 | 68475 | 4642 | 71274 | 3034 | 86451 | 2183 | 61648 |
| 24-#14 | 3.07 | MA | 39711 | 9647 | 64862 | 7106 | 71137 | 5743 | 73846 | 4695 | 76314 | 3057 | 93171 | 2175 | 67125 |
| 8L-6S | | MI | 37198 | 9647 | 61230 | 7044 | 67346 | 5691 | 70272 | 4626 | 73674 | 3021 | 89701 | 2313 | 62176 |
| 24-#14 | 3.07 | MA | 39001 | 9647 | 63559 | 7128 | 69533 | 5737 | 71806 | 4687 | 73657 | 3071 | 89831 | 2097 | 66126 |
| 9L-5S | | MI | 37857 | 9647 | 62336 | 7049 | 68877 | 5697 | 72144 | 4635 | 76130 | 3009 | 92743 | 2394 | 63031 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

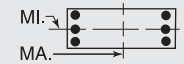



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.30 | MA | 42328 | 8963 | 66145 | 6677 | 71667 | 5439 | 73200 | 4530 | 73253 | 3241 | 86148 | 3053 | 33583 |
| 2L-3S | | MI | 34668 | 8963 | 54665 | 6600 | 58299 | 5414 | 58610 | 4508 | 56632 | 3213 | 65297 | 2766 | 29014 |
| 6-#18 | 1.30 | MA | 39995 | 8963 | 62709 | 6670 | 67263 | 5472 | 67826 | 4559 | 65943 | 3264 | 76379 | 2831 | 33682 |
| 3L-2S | | MI | 36643 | 8963 | 57582 | 6610 | 62039 | 5384 | 63172 | 4483 | 62763 | 3191 | 73424 | 2988 | 28887 |
| 8-#18 | 1.74 | MA | 43930 | 9239 | 69581 | 6850 | 76072 | 5563 | 78573 | 4605 | 80564 | 3219 | 95918 | 3004 | 44380 |
| 2L-4S | | MI | 34632 | 9239 | 55192 | 6807 | 58994 | 5523 | 59472 | 4565 | 58078 | 3209 | 68162 | 2487 | 38054 |
| 8-#18 | 1.74 | MA | 41614 | 9239 | 66145 | 6843 | 71667 | 5596 | 73200 | 4635 | 73253 | 3242 | 86148 | 2783 | 44404 |
| 3E | | MI | 36023 | 9239 | 57582 | 6773 | 62039 | 5538 | 63172 | 4584 | 62763 | 3187 | 73424 | 2708 | 38161 |
| 8-#18 | 1.74 | MA | 39985 | 9239 | 63342 | 6879 | 68096 | 5585 | 68859 | 4620 | 67667 | 3264 | 79798 | 2561 | 44175 |
| 4L-2S | | MI | 37985 | 9239 | 60499 | 6783 | 65778 | 5508 | 67734 | 4558 | 68893 | 3165 | 81552 | 2930 | 38085 |
| 10-#14 | 1.22 | MA | 42134 | 8911 | 65437 | 6685 | 71017 | 5449 | 72505 | 4544 | 72348 | 3267 | 85302 | 3099 | 31767 |
| 2L-5S | | MI | 33845 | 8911 | 52773 | 6635 | 56117 | 5428 | 56037 | 4524 | 53291 | 3243 | 61885 | 2735 | 27462 |
| 10-#14 | 1.22 | MA | 40798 | 8911 | 63477 | 6682 | 68505 | 5444 | 69439 | 4562 | 68177 | 3281 | 79662 | 2975 | 31821 |
| 3L-4S | | MI | 34562 | 8911 | 53952 | 6640 | 57646 | 5410 | 57916 | 4508 | 56001 | 3256 | 65104 | 2793 | 27466 |
| 10-#14 | 1.22 | MA | 39862 | 8911 | 61882 | 6704 | 66472 | 5464 | 66969 | 4555 | 64998 | 3296 | 75987 | 2850 | 31845 |
| 4L-3S | | MI | 35362 | 8911 | 55315 | 6619 | 59382 | 5417 | 60026 | 4517 | 58707 | 3243 | 68165 | 2918 | 27413 |
| 10-#14 | 1.22 | MA | 39026 | 8911 | 60504 | 6700 | 64684 | 5459 | 64772 | 4573 | 61815 | 3285 | 72158 | 2790 | 31775 |
| 5L-2S | | MI | 36496 | 8911 | 56983 | 6624 | 61521 | 5399 | 62635 | 4501 | 62246 | 3231 | 72880 | 3042 | 27347 |
| 10-#18 | 2.17 | MA | 45516 | 9516 | 73016 | 7023 | 80476 | 5687 | 83946 | 4681 | 87875 | 3197 | 105688 | 2956 | 55142 |
| 2L-5S | | MI | 34748 | 9516 | 56038 | 6970 | 60049 | 5678 | 60736 | 4667 | 59511 | 3160 | 70717 | 2329 | 45274 |
| 10-#18 | 2.17 | MA | 43216 | 9516 | 69581 | 7016 | 76072 | 5721 | 78573 | 4710 | 80564 | 3219 | 95918 | 2735 | 55083 |
| 3L-4S | | MI | 35985 | 9516 | 58110 | 6980 | 62733 | 5648 | 64034 | 4641 | 64208 | 3182 | 76290 | 2429 | 47057 |
| 10-#18 | 2.17 | MA | 41600 | 9516 | 66778 | 7052 | 72500 | 5710 | 74232 | 4696 | 74977 | 3242 | 89567 | 2513 | 54760 |
| 4L-3S | | MI | 37365 | 9516 | 60499 | 6945 | 65778 | 5662 | 67734 | 4659 | 68893 | 3160 | 81552 | 2650 | 47254 |
| 10-#18 | 2.17 | MA | 40157 | 9516 | 64353 | 7045 | 69356 | 5743 | 70369 | 4725 | 69383 | 3220 | 82910 | 2409 | 52574 |
| 5L-2S | | MI | 39314 | 9516 | 63416 | 6956 | 69518 | 5632 | 72296 | 4633 | 75024 | 3138 | 89679 | 2871 | 47245 |
| 12-#11 | 1.02 | MA | 41398 | 8780 | 63744 | 6624 | 68978 | 5407 | 70067 | 4522 | 69053 | 3288 | 80999 | 3137 | 26664 |
| 2L-6S | | MI | 33546 | 8780 | 51829 | 6571 | 54957 | 5377 | 54669 | 4494 | 51529 | 3275 | 59471 | 2817 | 23140 |
| 12-#11 | 1.02 | MA | 40461 | 8780 | 62376 | 6622 | 67224 | 5404 | 67927 | 4535 | 66141 | 3299 | 77038 | 3050 | 26707 |
| 3L-5S | | MI | 34025 | 8780 | 52601 | 6574 | 56026 | 5381 | 55975 | 4499 | 53250 | 3266 | 61615 | 2873 | 23126 |
| 12-#11 | 1.02 | MA | 39805 | 8780 | 61264 | 6637 | 65806 | 5418 | 66204 | 4531 | 63924 | 3309 | 74454 | 2964 | 26745 |
| 4E | | MI | 34527 | 8780 | 53424 | 6577 | 57093 | 5368 | 57286 | 4488 | 55148 | 3275 | 63875 | 2914 | 23086 |
| 12-#11 | 1.02 | MA | 39220 | 8780 | 60303 | 6635 | 64560 | 5415 | 64673 | 4544 | 61705 | 3303 | 71770 | 2921 | 26764 |
| 5L-3S | | MI | 35088 | 8780 | 54375 | 6563 | 58305 | 5372 | 58759 | 4493 | 57044 | 3266 | 66033 | 3000 | 23037 |
| 12-#11 | 1.02 | MA | 38663 | 8780 | 59403 | 6633 | 63313 | 5429 | 63148 | 4540 | 59696 | 3313 | 69207 | 2866 | 26732 |
| 6L-2S | | MI | 35884 | 8780 | 55541 | 6566 | 59800 | 5359 | 60583 | 4482 | 59526 | 3257 | 69352 | 3087 | 22989 |
| 12-#14 | 1.47 | MA | 43060 | 9066 | 67397 | 6783 | 73530 | 5519 | 75570 | 4586 | 76519 | 3255 | 90942 | 3075 | 37924 |
| 2L-6S | | MI | 33955 | 9066 | 53335 | 6728 | 56724 | 5491 | 56774 | 4558 | 54374 | 3243 | 63557 | 2625 | 32131 |
| 12-#14 | 1.47 | MA | 41730 | 9066 | 65437 | 6779 | 71017 | 5514 | 72505 | 4604 | 72348 | 3269 | 85302 | 2951 | 37962 |
| 3L-5S | | MI | 34635 | 9066 | 54441 | 6732 | 58255 | 5498 | 58646 | 4567 | 56830 | 3230 | 66600 | 2706 | 32642 |
| 12-#14 | 1.47 | MA | 40798 | 9066 | 63842 | 6801 | 68985 | 5534 | 70034 | 4597 | 69168 | 3283 | 81627 | 2826 | 37948 |
| 4E | | MI | 35348 | 9066 | 55621 | 6737 | 59785 | 5480 | 60525 | 4551 | 59541 | 3243 | 69819 | 2764 | 32687 |
| 12-#14 | 1.47 | MA | 39966 | 9066 | 62464 | 6798 | 67197 | 5529 | 67837 | 4615 | 65986 | 3273 | 77798 | 2766 | 37842 |
| 5L-3S | | MI | 36145 | 9066 | 56983 | 6717 | 61521 | 5487 | 62635 | 4559 | 62246 | 3230 | 72880 | 2889 | 32657 |
| 12-#14 | 1.47 | MA | 39174 | 9066 | 61172 | 6794 | 65407 | 5548 | 65650 | 4608 | 63103 | 3287 | 74151 | 2685 | 37164 |
| 6L-2S | | MI | 37274 | 9066 | 58651 | 6721 | 63660 | 5468 | 65244 | 4543 | 65786 | 3218 | 77594 | 3013 | 32605 |
| 12-#18 | 2.61 | MA | 47087 | 9793 | 76452 | 7196 | 84881 | 5811 | 89319 | 4756 | 95185 | 3175 | 115458 | 2908 | 65869 |
| 2L-6S | | MI | 34928 | 9793 | 57011 | 7132 | 61099 | 5787 | 62012 | 4724 | 61388 | 3156 | 73606 | 2126 | 52473 |
| 12-#18 | 2.61 | MA | 44803 | 9793 | 73016 | 7188 | 80476 | 5845 | 83946 | 4786 | 87875 | 3197 | 105688 | 2686 | 65737 |
| 3L-5S | | MI | 36097 | 9793 | 58955 | 7142 | 63788 | 5802 | 65298 | 4742 | 65642 | 3133 | 78844 | 2271 | 53946 |
| 12-#18 | 2.61 | MA | 43200 | 9793 | 70214 | 7225 | 76905 | 5834 | 79605 | 4771 | 82288 | 3220 | 99337 | 2465 | 65332 |
| 4E | | MI | 37325 | 9793 | 61027 | 7152 | 66473 | 5772 | 68596 | 4716 | 70339 | 3156 | 84417 | 2370 | 56042 |
| 12-#18 | 2.61 | MA | 41768 | 9793 | 67789 | 7218 | 73761 | 5867 | 75742 | 4801 | 76694 | 3198 | 92680 | 2360 | 62826 |
| 5L-3S | | MI | 38695 | 9793 | 63416 | 7118 | 69518 | 5786 | 72296 | 4735 | 75024 | 3133 | 89679 | 2592 | 56315 |
| 12-#18 | 2.61 | MA | 40406 | 9793 | 65516 | 7210 | 70612 | 5856 | 71894 | 4786 | 71623 | 3221 | 86370 | 2216 | 60932 |
| 6L-2S | | MI | 40632 | 9793 | 66333 | 7128 | 73257 | 5756 | 76858 | 4709 | 81154 | 3111 | 97807 | 2813 | 56385 |

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

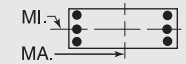



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.19 | MA | 42052 | 8888 | 65113 | 6691 | 70733 | 5456 | 72207 | 4552 | 71965 | 3280 | 84959 | 3121 | 30969 |
| 2L-7S | | MI | 33639 | 8888 | 52150 | 6653 | 55433 | 5438 | 55240 | 4535 | 52329 | 3275 | 60502 | 2708 | 26511 |
| 14-#11 | 1.19 | MA | 41117 | 8888 | 63744 | 6689 | 68978 | 5452 | 70067 | 4565 | 69053 | 3290 | 80999 | 3035 | 31005 |
| 3L-6S | | MI | 34104 | 8888 | 52995 | 6639 | 56452 | 5425 | 56493 | 4523 | 54010 | 3267 | 62790 | 2798 | 26771 |
| 14-#11 | 1.19 | MA | 40464 | 8888 | 62632 | 6705 | 67561 | 5466 | 68344 | 4560 | 66835 | 3301 | 78415 | 2949 | 31032 |
| 4L-5S | | MI | 34581 | 8888 | 53767 | 6642 | 57521 | 5429 | 57799 | 4529 | 55731 | 3258 | 64933 | 2854 | 26780 |
| 14-#11 | 1.19 | MA | 39881 | 8888 | 61672 | 6703 | 66315 | 5463 | 66813 | 4573 | 64617 | 3294 | 75731 | 2906 | 31029 |
| 5L-4S | | MI | 35081 | 8888 | 54590 | 6645 | 58588 | 5416 | 59110 | 4517 | 57630 | 3266 | 67194 | 2895 | 26753 |
| 14-#11 | 1.19 | MA | 39326 | 8888 | 60772 | 6701 | 65067 | 5477 | 65288 | 4569 | 62608 | 3305 | 73168 | 2850 | 30977 |
| 6L-3S | | MI | 35640 | 8888 | 55541 | 6630 | 59800 | 5421 | 60583 | 4523 | 59526 | 3257 | 69352 | 2982 | 26714 |
| 14-#11 | 1.19 | MA | 38785 | 8888 | 59785 | 6716 | 63878 | 5474 | 63825 | 4582 | 60645 | 3315 | 70436 | 2760 | 30609 |
| 7L-2S | | MI | 36434 | 8888 | 56707 | 6633 | 61295 | 5408 | 62407 | 4511 | 62007 | 3248 | 72671 | 3068 | 26671 |
| 14-#14 | 1.71 | MA | 43980 | 9222 | 69357 | 6880 | 76043 | 5589 | 78635 | 4629 | 80689 | 3242 | 96582 | 3051 | 44069 |
| 2L-7S | | MI | 34084 | 9222 | 53791 | 6845 | 57401 | 5579 | 57586 | 4616 | 55513 | 3242 | 65022 | 2466 | 36511 |
| 14-#14 | 1.71 | MA | 42655 | 9222 | 67397 | 6877 | 73530 | 5584 | 75570 | 4647 | 76519 | 3256 | 90942 | 2927 | 44088 |
| 3L-6S | | MI | 34743 | 9222 | 55003 | 6825 | 58862 | 5561 | 59383 | 4600 | 57913 | 3230 | 68272 | 2596 | 37147 |
| 14-#14 | 1.71 | MA | 41728 | 9222 | 65802 | 6898 | 71497 | 5603 | 73099 | 4640 | 73339 | 3271 | 87267 | 2802 | 44040 |
| 4L-5S | | MI | 35419 | 9222 | 56109 | 6829 | 60394 | 5568 | 61255 | 4609 | 60370 | 3217 | 71315 | 2678 | 37811 |
| 14-#14 | 1.71 | MA | 40900 | 9222 | 64424 | 6895 | 69710 | 5598 | 70903 | 4658 | 70157 | 3260 | 83438 | 2742 | 43901 |
| 5L-4S | | MI | 36129 | 9222 | 57289 | 6834 | 61923 | 5550 | 63134 | 4593 | 63080 | 3230 | 74533 | 2735 | 37886 |
| 14-#14 | 1.71 | MA | 40113 | 9222 | 63132 | 6892 | 67920 | 5618 | 68715 | 4651 | 67274 | 3275 | 79791 | 2661 | 43068 |
| 6L-3S | | MI | 36923 | 9222 | 58651 | 6814 | 63660 | 5556 | 65244 | 4602 | 65786 | 3217 | 77594 | 2860 | 37887 |
| 14-#14 | 1.71 | MA | 39345 | 9222 | 61717 | 6913 | 66213 | 5613 | 66616 | 4669 | 64457 | 3289 | 75902 | 2532 | 42246 |
| 7L-2S | | MI | 38047 | 9222 | 60320 | 6818 | 65798 | 5538 | 67853 | 4586 | 69325 | 3205 | 82309 | 2985 | 37849 |
| 14-#18 | 3.04 | MA | 46376 | 10069 | 76452 | 7361 | 84881 | 5969 | 89319 | 4861 | 95185 | 3175 | 115458 | 2638 | 76375 |
| 3L-6S | | MI | 36274 | 10069 | 59929 | 7305 | 64838 | 5912 | 66574 | 4799 | 67518 | 3129 | 81733 | 2067 | 61253 |
| 14-#18 | 3.04 | MA | 44785 | 10069 | 73650 | 7398 | 81309 | 5958 | 84978 | 4846 | 89599 | 3198 | 109107 | 2416 | 75897 |
| 4L-5S | | MI | 37435 | 10069 | 61872 | 7315 | 67528 | 5926 | 69860 | 4818 | 71772 | 3107 | 86972 | 2212 | 62651 |
| 14-#18 | 3.04 | MA | 43364 | 10069 | 71225 | 7391 | 78165 | 5991 | 81115 | 4876 | 84004 | 3176 | 102450 | 2312 | 73110 |
| 5L-4S | | MI | 38653 | 10069 | 63944 | 7325 | 70212 | 5896 | 73158 | 4792 | 76469 | 3129 | 92545 | 2312 | 65015 |
| 14-#18 | 3.04 | MA | 42013 | 10069 | 68951 | 7383 | 75017 | 5980 | 77267 | 4862 | 78934 | 3199 | 96140 | 2168 | 71302 |
| 6L-3S | | MI | 40014 | 10069 | 66333 | 7291 | 73257 | 5910 | 76858 | 4810 | 81154 | 3107 | 97807 | 2533 | 65356 |
| 14-#18 | 3.04 | MA | 40696 | 10069 | 66461 | 7420 | 72012 | 6013 | 73574 | 4891 | 73978 | 3221 | 89405 | 1937 | 68146 |
| 7L-2S | | MI | 41939 | 10069 | 69250 | 7301 | 76997 | 5880 | 81420 | 4784 | 87285 | 3085 | 105934 | 2755 | 65480 |
| 16-#11 | 1.36 | MA | 42702 | 8996 | 66481 | 6759 | 72487 | 5504 | 74348 | 4581 | 74877 | 3271 | 88920 | 3106 | 35267 |
| 2L-8S | | MI | 33740 | 8996 | 52557 | 6718 | 55894 | 5482 | 55840 | 4576 | 53023 | 3259 | 61707 | 2642 | 29722 |
| 16-#11 | 1.36 | MA | 41770 | 8996 | 65113 | 6757 | 70733 | 5501 | 72207 | 4594 | 71965 | 3282 | 84959 | 3019 | 35296 |
| 3L-7S | | MI | 34196 | 8996 | 53316 | 6721 | 56928 | 5487 | 57064 | 4564 | 54810 | 3267 | 63821 | 2690 | 30048 |
| 16-#11 | 1.36 | MA | 41119 | 8996 | 64001 | 6772 | 69315 | 5515 | 70484 | 4590 | 69747 | 3292 | 82376 | 2933 | 35312 |
| 4L-6S | | MI | 34659 | 8996 | 54162 | 6706 | 57947 | 5474 | 58317 | 4553 | 56492 | 3258 | 66109 | 2780 | 30396 |
| 16-#11 | 1.36 | MA | 40538 | 8996 | 63040 | 6770 | 68069 | 5512 | 68953 | 4603 | 67529 | 3285 | 79691 | 2891 | 35287 |
| 5E | | MI | 35134 | 8996 | 54933 | 6709 | 59016 | 5478 | 59623 | 4558 | 58213 | 3249 | 68252 | 2836 | 30426 |
| 16-#11 | 1.36 | MA | 39985 | 8996 | 62140 | 6768 | 66822 | 5526 | 67428 | 4598 | 65519 | 3296 | 77129 | 2835 | 35218 |
| 6L-4S | | MI | 35632 | 8996 | 55756 | 6712 | 60083 | 5465 | 60934 | 4547 | 60111 | 3258 | 70513 | 2877 | 30412 |
| 16-#11 | 1.36 | MA | 39447 | 8996 | 61154 | 6783 | 65632 | 5523 | 65965 | 4611 | 63557 | 3306 | 74397 | 2745 | 34761 |
| 7L-3S | | MI | 36190 | 8996 | 56707 | 6698 | 61295 | 5469 | 62407 | 4552 | 62007 | 3249 | 72671 | 2963 | 30382 |
| 16-#11 | 1.36 | MA | 38908 | 8996 | 60268 | 6781 | 64426 | 5537 | 64538 | 4624 | 61470 | 3300 | 71887 | 2695 | 34333 |
| 8L-2S | | MI | 36982 | 8996 | 57873 | 6700 | 62790 | 5456 | 64231 | 4541 | 64489 | 3240 | 75989 | 3049 | 30345 |
| 16-#14 | 1.96 | MA | 44894 | 9378 | 71317 | 6977 | 78555 | 5659 | 81701 | 4671 | 84860 | 3230 | 102221 | 3027 | 50205 |
| 2L-8S | | MI | 34224 | 9378 | 54370 | 6938 | 58056 | 5642 | 58440 | 4675 | 56501 | 3217 | 66728 | 2369 | 40848 |
| 16-#14 | 1.96 | MA | 43575 | 9378 | 69357 | 6974 | 76043 | 5653 | 78635 | 4689 | 80689 | 3244 | 96582 | 2903 | 50196 |
| 3L-7S | | MI | 34870 | 9378 | 55459 | 6942 | 59539 | 5649 | 60195 | 4659 | 59052 | 3229 | 69737 | 2437 | 41568 |
| 16-#14 | 1.96 | MA | 42652 | 9378 | 67762 | 6995 | 74010 | 5673 | 76165 | 4682 | 77510 | 3258 | 92907 | 2778 | 50122 |
| 4L-6S | | MI | 35526 | 9378 | 56671 | 6922 | 61001 | 5631 | 61992 | 4643 | 61453 | 3217 | 72986 | 2567 | 42175 |
| 16-#14 | 1.96 | MA | 41829 | 9378 | 66384 | 6992 | 72222 | 5668 | 73968 | 4700 | 74327 | 3248 | 89078 | 2718 | 49954 |
| 5E | | MI | 36200 | 9378 | 57778 | 6927 | 62533 | 5638 | 63864 | 4652 | 63909 | 3204 | 76029 | 2649 | 42971 |
| 16-#14 | 1.96 | MA | 41045 | 9378 | 65092 | 6989 | 70433 | 5688 | 71780 | 4693 | 71445 | 3262 | 85431 | 2637 | 48985 |
| 6L-4S | | MI | 36906 | 9378 | 58957 | 6931 | 64062 | 5620 | 65743 | 4635 | 66619 | 3217 | 79248 | 2707 | 43074 |
| 16-#14 | 1.96 | MA | 40282 | 9378 | 63677 | 7010 | 68726 | 5683 | 69681 | 4711 | 68628 | 3277 | 81542 | 2508 | 48195 |
| 7L-3S | | MI | 37696 | 9378 | 60320 | 6911 | 65798 | 5626 | 67853 | 4644 | 69325 | 3204 | 82309 | 2831 | 43107 |

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

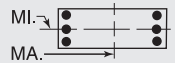
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 1.96 | MA | 39530 | 9378 | 62406 | 7007 | 66994 | 5703 | 67632 | 4729 | 65635 | 3266 | 77961 | 2437 | 47296 |
| 8L-2S | | MI | 38816 | 9378 | 61988 | 6916 | 67937 | 5608 | 70462 | 4628 | 72865 | 3192 | 87023 | 2956 | 43082 |
| 16-#18 | 3.48 | MA | 46357 | 10346 | 77085 | 7571 | 85714 | 6082 | 90352 | 4922 | 96910 | 3176 | 118877 | 2368 | 86454 |
| 4L-6S | | MI | 37609 | 10346 | 62846 | 7478 | 68578 | 6036 | 71136 | 4875 | 73649 | 3102 | 89861 | 2009 | 69957 |
| 16-#18 | 3.48 | MA | 44947 | 10346 | 74661 | 7564 | 82570 | 6115 | 86488 | 4952 | 91315 | 3154 | 112220 | 2264 | 83422 |
| 5E | | MI | 38762 | 10346 | 64790 | 7488 | 71267 | 6050 | 74422 | 4893 | 77903 | 3080 | 95099 | 2154 | 71381 |
| 16-#18 | 3.48 | MA | 43605 | 10346 | 72387 | 7556 | 79421 | 6104 | 82641 | 4937 | 86244 | 3177 | 105910 | 2120 | 81687 |
| 6L-4S | | MI | 39972 | 10346 | 66861 | 7498 | 73952 | 6020 | 77720 | 4867 | 82599 | 3102 | 100672 | 2254 | 73979 |
| 16-#18 | 3.48 | MA | 42299 | 10346 | 69897 | 7593 | 76417 | 6138 | 78947 | 4967 | 81289 | 3199 | 99175 | 1889 | 78372 |
| 7L-3S | | MI | 41324 | 10346 | 69250 | 7464 | 76997 | 6034 | 81420 | 4885 | 87285 | 3080 | 105934 | 2475 | 74382 |
| 16-#18 | 3.48 | MA | 41014 | 10346 | 67658 | 7586 | 73369 | 6127 | 75341 | 4996 | 76023 | 3178 | 92951 | 1766 | 75394 |
| 8L-2S | | MI | 43237 | 10346 | 72167 | 7474 | 80736 | 6004 | 85982 | 4860 | 93415 | 3058 | 114062 | 2697 | 74556 |
| 18-#11 | 1.53 | MA | 43349 | 9104 | 67850 | 6826 | 74241 | 5552 | 76488 | 4611 | 77789 | 3262 | 92881 | 3090 | 39559 |
| 2L-9S | | MI | 33832 | 9104 | 52905 | 6800 | 56383 | 5544 | 56384 | 4600 | 53838 | 3259 | 62947 | 2569 | 33026 |
| 18-#11 | 1.53 | MA | 42420 | 9104 | 66481 | 6824 | 72487 | 5549 | 74348 | 4624 | 74877 | 3273 | 88920 | 3004 | 39580 |
| 3L-8S | | MI | 34295 | 9104 | 53723 | 6785 | 57389 | 5531 | 57664 | 4605 | 55505 | 3250 | 65026 | 2623 | 33277 |
| 18-#11 | 1.53 | MA | 41771 | 9104 | 65369 | 6840 | 71069 | 5563 | 72625 | 4619 | 72659 | 3283 | 86337 | 2918 | 39578 |
| 4L-7S | | MI | 34750 | 9104 | 54483 | 6788 | 58423 | 5535 | 58887 | 4594 | 57292 | 3258 | 67139 | 2671 | 33590 |
| 18-#11 | 1.53 | MA | 41193 | 9104 | 64409 | 6838 | 69823 | 5560 | 71093 | 4632 | 70441 | 3277 | 83652 | 2875 | 39540 |
| 5L-6S | | MI | 35211 | 9104 | 55328 | 6774 | 59442 | 5522 | 60141 | 4582 | 58973 | 3249 | 69427 | 2761 | 34014 |
| 18-#11 | 1.53 | MA | 40642 | 9104 | 63509 | 6836 | 68576 | 5574 | 69569 | 4628 | 68431 | 3287 | 81090 | 2819 | 39454 |
| 6L-5S | | MI | 35685 | 9104 | 56099 | 6777 | 60511 | 5526 | 61447 | 4588 | 60694 | 3241 | 71571 | 2817 | 34058 |
| 18-#11 | 1.53 | MA | 40105 | 9104 | 62522 | 6851 | 67387 | 5571 | 68106 | 4641 | 66469 | 3298 | 78358 | 2730 | 38920 |
| 7L-4S | | MI | 36182 | 9104 | 56922 | 6779 | 61578 | 5513 | 62758 | 4576 | 62593 | 3249 | 73832 | 2858 | 34064 |
| 18-#11 | 1.53 | MA | 39577 | 9104 | 61637 | 6849 | 66180 | 5585 | 66678 | 4654 | 64382 | 3291 | 75847 | 2680 | 38506 |
| 8L-3S | | MI | 36737 | 9104 | 57873 | 6765 | 62790 | 5517 | 64231 | 4582 | 64489 | 3240 | 75989 | 2944 | 34042 |
| 18-#11 | 1.53 | MA | 39017 | 9104 | 60770 | 6847 | 65006 | 5582 | 65185 | 4649 | 62437 | 3302 | 73363 | 2626 | 38160 |
| 9L-2S | | MI | 37527 | 9104 | 59040 | 6768 | 64285 | 5504 | 66055 | 4570 | 66970 | 3231 | 79308 | 3031 | 34012 |
| 18-#14 | 2.20 | MA | 45803 | 9533 | 73277 | 7074 | 81068 | 5728 | 84766 | 4714 | 89031 | 3217 | 107861 | 3004 | 56331 |
| 2L-9S | | MI | 34357 | 9533 | 54865 | 7055 | 58752 | 5730 | 59215 | 4708 | 57662 | 3216 | 68492 | 2262 | 44878 |
| 18-#14 | 2.20 | MA | 44490 | 9533 | 71317 | 7071 | 78555 | 5723 | 81701 | 4732 | 84860 | 3232 | 102221 | 2879 | 56295 |
| 3L-8S | | MI | 35009 | 9533 | 56038 | 7035 | 60195 | 5712 | 61049 | 4717 | 60041 | 3204 | 71442 | 2340 | 45817 |
| 18-#14 | 2.20 | MA | 43571 | 9533 | 69722 | 7093 | 76523 | 5743 | 79230 | 4725 | 81680 | 3246 | 98547 | 2755 | 56198 |
| 4L-7S | | MI | 35652 | 9533 | 57128 | 7040 | 61678 | 5719 | 62804 | 4701 | 62592 | 3216 | 74451 | 2408 | 46631 |
| 18-#14 | 2.20 | MA | 42752 | 9533 | 68344 | 7089 | 74735 | 5738 | 77033 | 4743 | 78498 | 3235 | 94718 | 2694 | 56003 |
| 5L-6S | | MI | 36306 | 9533 | 58340 | 7019 | 63140 | 5701 | 64601 | 4685 | 64992 | 3204 | 77701 | 2539 | 47214 |
| 18-#14 | 2.20 | MA | 41972 | 9533 | 67052 | 7086 | 72946 | 5758 | 74846 | 4736 | 75615 | 3250 | 91071 | 2613 | 54913 |
| 6L-5S | | MI | 36976 | 9533 | 59446 | 7024 | 64671 | 5707 | 66473 | 4694 | 67449 | 3191 | 80744 | 2620 | 48125 |
| 18-#14 | 2.20 | MA | 41212 | 9533 | 65637 | 7108 | 71238 | 5753 | 72747 | 4754 | 72799 | 3264 | 87182 | 2484 | 54151 |
| 7L-4S | | MI | 37679 | 9533 | 60625 | 7029 | 66201 | 5689 | 68352 | 4678 | 70159 | 3204 | 83962 | 2678 | 48253 |
| 18-#14 | 2.20 | MA | 40464 | 9533 | 64366 | 7104 | 69507 | 5772 | 70698 | 4772 | 69805 | 3254 | 83601 | 2413 | 53158 |
| 8L-3S | | MI | 38465 | 9533 | 61988 | 7008 | 67937 | 5696 | 70462 | 4687 | 72865 | 3191 | 87023 | 2802 | 48308 |
| 18-#14 | 2.20 | MA | 39683 | 9533 | 63122 | 7101 | 67822 | 5767 | 68555 | 4765 | 67015 | 3268 | 80065 | 2335 | 51973 |
| 9L-2S | | MI | 39581 | 9533 | 63656 | 7013 | 70076 | 5678 | 73071 | 4671 | 76404 | 3179 | 91738 | 2927 | 48308 |
| 18-#18 | 3.91 | MA | 46516 | 10623 | 78097 | 7737 | 86974 | 6239 | 91862 | 5027 | 98626 | 3132 | 121990 | 2215 | 93755 |
| 5L-6S | | MI | 38934 | 10623 | 65763 | 7651 | 72317 | 6160 | 75698 | 4950 | 79779 | 3076 | 97989 | 1951 | 78508 |
| 18-#18 | 3.91 | MA | 45185 | 10623 | 75823 | 7729 | 83826 | 6228 | 88014 | 5012 | 93555 | 3154 | 115680 | 2071 | 91906 |
| 6L-5S | | MI | 40078 | 10623 | 67707 | 7661 | 75007 | 6174 | 78984 | 4968 | 84033 | 3053 | 103227 | 2096 | 80133 |
| 18-#18 | 3.91 | MA | 43889 | 10623 | 73332 | 7766 | 80821 | 6262 | 84320 | 5042 | 88600 | 3177 | 108945 | 1840 | 88619 |
| 7L-4S | | MI | 41280 | 10623 | 69778 | 7671 | 77692 | 6144 | 82282 | 4942 | 88730 | 3076 | 108800 | 2195 | 82597 |
| 18-#18 | 3.91 | MA | 42613 | 10623 | 71094 | 7759 | 77774 | 6251 | 80714 | 5072 | 83334 | 3155 | 102721 | 1717 | 85523 |
| 8L-3S | | MI | 42623 | 10623 | 72167 | 7637 | 80736 | 6158 | 85982 | 4961 | 93415 | 3053 | 114062 | 2417 | 83396 |
| 20-#11 | 1.70 | MA | 43993 | 9212 | 69218 | 6894 | 75996 | 5601 | 78628 | 4640 | 80701 | 3254 | 96842 | 3075 | 43845 |
| 2L-10S | | MI | 33899 | 9212 | 53314 | 6864 | 56857 | 5588 | 56991 | 4641 | 54667 | 3259 | 64253 | 2489 | 35960 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

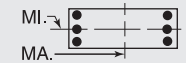
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.70 | MA | 43068 | 9212 | 67850 | 6892 | 74241 | 5598 | 76488 | 4653 | 77789 | 3264 | 92881 | 2989 | 43859 |
| 3L-9S | | MI | 34389 | 9212 | 54071 | 6867 | 57878 | 5592 | 58208 | 4629 | 56320 | 3250 | 66266 | 2550 | 36520 |
| 20-#11 | 1.70 | MA | 42421 | 9212 | 66738 | 6907 | 72824 | 5612 | 74765 | 4649 | 75571 | 3275 | 90298 | 2902 | 43840 |
| 4L-8S | | MI | 34849 | 9212 | 54889 | 6853 | 58884 | 5579 | 59488 | 4635 | 57986 | 3241 | 68344 | 2604 | 36835 |
| 20-#11 | 1.70 | MA | 41844 | 9212 | 65777 | 6905 | 71578 | 5609 | 73233 | 4662 | 73353 | 3268 | 87613 | 2860 | 43787 |
| 5L-7S | | MI | 35302 | 9212 | 55649 | 6856 | 59918 | 5583 | 60711 | 4623 | 59773 | 3250 | 70458 | 2652 | 37137 |
| 20-#11 | 1.70 | MA | 41295 | 9212 | 64877 | 6903 | 70331 | 5623 | 71709 | 4657 | 71343 | 3279 | 85051 | 2804 | 43686 |
| 6E | | MI | 35761 | 9212 | 56494 | 6841 | 60937 | 5570 | 61965 | 4611 | 61455 | 3241 | 72746 | 2742 | 37607 |
| 20-#11 | 1.70 | MA | 40761 | 9212 | 63891 | 6918 | 69141 | 5620 | 70246 | 4670 | 69380 | 3289 | 82319 | 2714 | 43083 |
| 7L-5S | | MI | 36233 | 9212 | 57266 | 6844 | 62006 | 5575 | 63271 | 4617 | 63176 | 3232 | 74889 | 2798 | 37686 |
| 20-#11 | 1.70 | MA | 40234 | 9212 | 63005 | 6916 | 67934 | 5634 | 68818 | 4683 | 67294 | 3282 | 79808 | 2664 | 42682 |
| 8L-4S | | MI | 36728 | 9212 | 58088 | 6847 | 63073 | 5562 | 64582 | 4605 | 65074 | 3240 | 77150 | 2839 | 37710 |
| 20-#11 | 1.70 | MA | 39677 | 9212 | 62139 | 6914 | 66761 | 5630 | 67325 | 4679 | 65349 | 3293 | 77324 | 2611 | 42273 |
| 9L-3S | | MI | 37282 | 9212 | 59040 | 6833 | 64285 | 5566 | 66055 | 4611 | 66970 | 3231 | 79308 | 2926 | 37697 |
| 20-#11 | 1.70 | MA | 39096 | 9212 | 61168 | 6930 | 65570 | 5645 | 65905 | 4692 | 63421 | 3304 | 74915 | 2550 | 41566 |
| 10L-2S | | MI | 38069 | 9212 | 60206 | 6835 | 65780 | 5553 | 67879 | 4599 | 69452 | 3223 | 82627 | 3012 | 37673 |
| 20-#14 | 2.45 | MA | 45400 | 9689 | 73277 | 7168 | 81068 | 5793 | 84766 | 4774 | 89031 | 3219 | 107861 | 2855 | 62388 |
| 3L-9S | | MI | 35156 | 9689 | 56534 | 7152 | 60891 | 5800 | 61824 | 4751 | 61201 | 3203 | 73207 | 2233 | 49888 |
| 20-#14 | 2.45 | MA | 44485 | 9689 | 71682 | 7190 | 79035 | 5813 | 82295 | 4767 | 85851 | 3233 | 104187 | 2731 | 62268 |
| 4L-8S | | MI | 35790 | 9689 | 57706 | 7132 | 62334 | 5782 | 63658 | 4760 | 63580 | 3191 | 76157 | 2311 | 50797 |
| 20-#14 | 2.45 | MA | 43670 | 9689 | 70304 | 7187 | 77248 | 5808 | 80099 | 4785 | 82669 | 3223 | 100357 | 2670 | 62048 |
| 5L-7S | | MI | 36430 | 9689 | 58796 | 7137 | 63817 | 5789 | 65413 | 4744 | 66131 | 3203 | 79166 | 2380 | 51699 |
| 20-#14 | 2.45 | MA | 42894 | 9689 | 69013 | 7183 | 75458 | 5828 | 77911 | 4778 | 79786 | 3237 | 96711 | 2590 | 60851 |
| 6E | | MI | 37080 | 9689 | 60008 | 7117 | 65278 | 5771 | 67210 | 4727 | 68532 | 3191 | 82415 | 2510 | 52261 |
| 20-#14 | 2.45 | MA | 42138 | 9689 | 67597 | 7205 | 73751 | 5823 | 75812 | 4796 | 76969 | 3252 | 92822 | 2460 | 60113 |
| 7L-5S | | MI | 37747 | 9689 | 61114 | 7121 | 66810 | 5777 | 69082 | 4736 | 70988 | 3178 | 85458 | 2591 | 53216 |
| 20-#14 | 2.45 | MA | 41393 | 9689 | 66326 | 7202 | 72019 | 5842 | 73763 | 4814 | 73976 | 3241 | 89241 | 2389 | 59031 |
| 8L-4S | | MI | 38448 | 9689 | 62294 | 7126 | 68339 | 5759 | 70961 | 4720 | 73698 | 3191 | 88677 | 2649 | 53425 |
| 20-#14 | 2.45 | MA | 40617 | 9689 | 65082 | 7198 | 70335 | 5837 | 71621 | 4807 | 71185 | 3256 | 85705 | 2311 | 57880 |
| 9L-3S | | MI | 39231 | 9689 | 63656 | 7106 | 70076 | 5766 | 73071 | 4729 | 76404 | 3178 | 91738 | 2773 | 53501 |
| 20-#14 | 2.45 | MA | 39793 | 9689 | 63689 | 7220 | 68627 | 5857 | 69582 | 4825 | 68418 | 3270 | 82279 | 2223 | 56519 |
| 10L-2S | | MI | 40343 | 9689 | 65325 | 7110 | 72214 | 5748 | 75680 | 4713 | 79943 | 3166 | 96452 | 2898 | 53528 |
| 20-#18 | 4.35 | MA | 46752 | 10899 | 79259 | 7902 | 88230 | 6353 | 93387 | 5088 | 100866 | 3132 | 125450 | 2023 | 102064 |
| 6E | | MI | 40249 | 10899 | 68680 | 7824 | 76057 | 6284 | 80260 | 5025 | 85909 | 3049 | 106116 | 1893 | 87085 |
| 20-#18 | 4.35 | MA | 45465 | 10899 | 76768 | 7939 | 85226 | 6386 | 89693 | 5118 | 95910 | 3155 | 118715 | 1792 | 98884 |
| 7L-5S | | MI | 41386 | 10899 | 70624 | 7834 | 78747 | 6298 | 83546 | 5044 | 90163 | 3027 | 111354 | 2038 | 88901 |
| 20-#18 | 4.35 | MA | 44199 | 10899 | 74530 | 7931 | 82178 | 6375 | 86088 | 5147 | 90645 | 3133 | 112491 | 1669 | 95672 |
| 8L-4S | | MI | 42580 | 10899 | 72695 | 7844 | 81431 | 6268 | 86844 | 5018 | 94860 | 3049 | 116928 | 2137 | 91245 |
| 22-#11 | 1.87 | MA | 43712 | 9320 | 69218 | 6959 | 75996 | 5646 | 78628 | 4682 | 80701 | 3256 | 96842 | 2973 | 48127 |
| 3L-10S | | MI | 34453 | 9320 | 54480 | 6932 | 58352 | 5636 | 58815 | 4670 | 57149 | 3250 | 67572 | 2470 | 39478 |
| 22-#11 | 1.87 | MA | 43068 | 9320 | 68106 | 6974 | 74578 | 5660 | 76905 | 4678 | 78483 | 3266 | 94258 | 2887 | 48097 |
| 4L-9S | | MI | 34943 | 9320 | 55238 | 6935 | 59373 | 5641 | 60032 | 4658 | 58801 | 3242 | 69585 | 2531 | 40020 |
| 22-#11 | 1.87 | MA | 42493 | 9320 | 67146 | 6972 | 73332 | 5657 | 75374 | 4691 | 76265 | 3260 | 91574 | 2844 | 48031 |
| 5L-8S | | MI | 35400 | 9320 | 56056 | 6920 | 60379 | 5628 | 61312 | 4664 | 60468 | 3233 | 71663 | 2585 | 40395 |
| 22-#11 | 1.87 | MA | 41946 | 9320 | 66246 | 6970 | 72085 | 5671 | 73849 | 4687 | 74255 | 3270 | 89011 | 2788 | 47836 |
| 6L-7S | | MI | 35851 | 9320 | 56815 | 6923 | 61413 | 5632 | 62535 | 4652 | 62255 | 3241 | 73777 | 2633 | 40688 |
| 22-#11 | 1.87 | MA | 41413 | 9320 | 65259 | 6986 | 70895 | 5668 | 72386 | 4700 | 72292 | 3281 | 86280 | 2699 | 47252 |
| 7L-6S | | MI | 36309 | 9320 | 57660 | 6909 | 62432 | 5619 | 63789 | 4641 | 63936 | 3232 | 76065 | 2724 | 41139 |
| 22-#11 | 1.87 | MA | 40889 | 9320 | 64374 | 6984 | 69689 | 5682 | 70959 | 4712 | 70206 | 3274 | 83769 | 2649 | 46861 |
| 8L-5S | | MI | 36780 | 9320 | 58432 | 6911 | 63501 | 5623 | 65094 | 4646 | 65657 | 3223 | 78208 | 2780 | 41309 |
| 22-#11 | 1.87 | MA | 40334 | 9320 | 63507 | 6982 | 68515 | 5679 | 69465 | 4708 | 68261 | 3284 | 81285 | 2595 | 46392 |
| 9L-4S | | MI | 37273 | 9320 | 59255 | 6914 | 64568 | 5610 | 66406 | 4635 | 67556 | 3232 | 80469 | 2820 | 41343 |
| 22-#11 | 1.87 | MA | 39755 | 9320 | 62537 | 6997 | 67325 | 5693 | 68045 | 4721 | 66333 | 3295 | 78876 | 2534 | 45704 |
| 10L-3S | | MI | 37825 | 9320 | 60206 | 6900 | 65780 | 5614 | 67879 | 4640 | 69452 | 3223 | 82627 | 2907 | 41348 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 46"

Short columns – no sidesway
Bending on major or minor axis

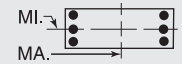



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.87 | MA | 39189 | 9320 | 61669 | 6995 | 66158 | 5690 | 66571 | 4717 | 64277 | 3288 | 76428 | 2482 | 45141 |
| 11L-2S | | MI | 38610 | 9320 | 61372 | 6903 | 67275 | 5601 | 69703 | 4629 | 71933 | 3214 | 85945 | 2993 | 41330 |
| 22-#14 | 2.69 | MA | 45394 | 9845 | 73642 | 7287 | 81548 | 5883 | 85361 | 4809 | 90022 | 3221 | 109827 | 2707 | 68333 |
| 4L-9S | | MI | 35936 | 9845 | 58202 | 7250 | 63030 | 5870 | 64433 | 4793 | 64741 | 3190 | 77921 | 2204 | 54905 |
| 22-#14 | 2.69 | MA | 44583 | 9845 | 72264 | 7284 | 79761 | 5878 | 83164 | 4827 | 86839 | 3211 | 105997 | 2646 | 67975 |
| 5L-8S | | MI | 36567 | 9845 | 59375 | 7229 | 64472 | 5852 | 66268 | 4802 | 67120 | 3178 | 80871 | 2282 | 55786 |
| 22-#14 | 2.69 | MA | 43810 | 9845 | 70973 | 7281 | 77971 | 5897 | 80976 | 4821 | 83957 | 3225 | 102351 | 2566 | 66796 |
| 6L-7S | | MI | 37204 | 9845 | 60464 | 7234 | 65955 | 5859 | 68022 | 4786 | 69671 | 3190 | 83880 | 2351 | 56771 |
| 22-#14 | 2.69 | MA | 43058 | 9845 | 69557 | 7302 | 76264 | 5892 | 78877 | 4838 | 81140 | 3239 | 98462 | 2436 | 66080 |
| 7L-6S | | MI | 37851 | 9845 | 61676 | 7214 | 67417 | 5840 | 69819 | 4770 | 72071 | 3178 | 87130 | 2481 | 57315 |
| 22-#14 | 2.69 | MA | 42317 | 9845 | 68286 | 7299 | 74532 | 5912 | 76828 | 4856 | 78147 | 3229 | 94881 | 2365 | 64913 |
| 8L-5S | | MI | 38515 | 9845 | 62782 | 7218 | 68949 | 5847 | 71691 | 4779 | 74528 | 3165 | 90173 | 2562 | 58229 |
| 22-#14 | 2.69 | MA | 41545 | 9845 | 67042 | 7296 | 72848 | 5907 | 74686 | 4850 | 75356 | 3243 | 91345 | 2287 | 63793 |
| 9L-4S | | MI | 39213 | 9845 | 63962 | 7223 | 70478 | 5829 | 73570 | 4763 | 77238 | 3178 | 93391 | 2620 | 58592 |
| 22-#14 | 2.69 | MA | 40725 | 9845 | 65649 | 7317 | 71139 | 5927 | 72648 | 4868 | 72589 | 3257 | 87919 | 2200 | 62373 |
| 10L-3S | | MI | 39992 | 9845 | 65325 | 7203 | 72214 | 5836 | 75680 | 4772 | 79943 | 3165 | 96452 | 2744 | 58687 |
| 22-#18 | 4.78 | MA | 47031 | 11176 | 80204 | 8112 | 89630 | 6510 | 95067 | 5193 | 103221 | 3133 | 128485 | 1744 | 109167 |
| 7L-6S | | MI | 41555 | 11176 | 71597 | 7997 | 79796 | 6408 | 84822 | 5101 | 92040 | 3022 | 114244 | 1834 | 95685 |
| 22-#18 | 4.78 | MA | 45773 | 11176 | 77965 | 8104 | 86583 | 6499 | 91461 | 5223 | 97955 | 3111 | 122261 | 1621 | 105841 |
| 8L-5S | | MI | 42685 | 11176 | 73541 | 8007 | 82486 | 6422 | 88108 | 5119 | 96294 | 3000 | 119482 | 1979 | 97685 |
| 24-#11 | 2.03 | MA | 43712 | 9427 | 69475 | 7042 | 76332 | 5709 | 79045 | 4707 | 81395 | 3258 | 98219 | 2871 | 52350 |
| 4L-10S | | MI | 35005 | 9427 | 55647 | 6999 | 59847 | 5685 | 60639 | 4700 | 59630 | 3242 | 70891 | 2452 | 42999 |
| 24-#11 | 2.03 | MA | 43139 | 9427 | 68514 | 7040 | 75086 | 5705 | 77514 | 4720 | 79177 | 3251 | 95535 | 2829 | 52272 |
| 5L-9S | | MI | 35495 | 9427 | 56404 | 7002 | 60868 | 5689 | 61856 | 4688 | 61283 | 3233 | 72904 | 2513 | 43526 |
| 24-#11 | 2.03 | MA | 42594 | 9427 | 67614 | 7038 | 73839 | 5720 | 75989 | 4716 | 77167 | 3261 | 92972 | 2773 | 51988 |
| 6L-8S | | MI | 35949 | 9427 | 57222 | 6988 | 61874 | 5676 | 63135 | 4693 | 62949 | 3224 | 74982 | 2567 | 43957 |
| 24-#11 | 2.03 | MA | 42064 | 9427 | 66628 | 7053 | 72650 | 5716 | 74526 | 4729 | 75204 | 3272 | 90241 | 2683 | 51424 |
| 7E | | MI | 36398 | 9427 | 57981 | 6990 | 62908 | 5680 | 64359 | 4682 | 64736 | 3232 | 77096 | 2615 | 44242 |
| 24-#11 | 2.03 | MA | 41541 | 9427 | 65742 | 7051 | 71443 | 5730 | 73099 | 4742 | 73118 | 3265 | 87730 | 2633 | 51043 |
| 8L-6S | | MI | 36855 | 9427 | 58827 | 6976 | 63927 | 5667 | 65613 | 4670 | 66418 | 3224 | 79383 | 2705 | 44676 |
| 24-#11 | 2.03 | MA | 40989 | 9427 | 64876 | 7049 | 70270 | 5727 | 71606 | 4737 | 71173 | 3276 | 85245 | 2580 | 50517 |
| 9L-5S | | MI | 37324 | 9427 | 59598 | 6979 | 64996 | 5671 | 66918 | 4676 | 68139 | 3215 | 81527 | 2761 | 44928 |
| 24-#11 | 2.03 | MA | 40411 | 9427 | 63906 | 7065 | 69079 | 5741 | 70186 | 4750 | 69245 | 3286 | 82837 | 2519 | 49845 |
| 10L-4S | | MI | 37816 | 9427 | 60421 | 6982 | 66063 | 5658 | 68229 | 4664 | 70037 | 3223 | 83788 | 2802 | 44974 |
| 24-#11 | 2.03 | MA | 39847 | 9427 | 63037 | 7063 | 67912 | 5738 | 68712 | 4746 | 67189 | 3280 | 80389 | 2466 | 49240 |
| 11L-3S | | MI | 38366 | 9427 | 61372 | 6967 | 67275 | 5663 | 69703 | 4670 | 71933 | 3214 | 85945 | 2888 | 44994 |
| 24-#11 | 2.03 | MA | 39293 | 9427 | 62085 | 7078 | 66730 | 5752 | 67294 | 4759 | 65261 | 3290 | 77630 | 2389 | 48375 |
| 12L-2S | | MI | 39149 | 9427 | 62538 | 6970 | 68770 | 5650 | 71526 | 4658 | 74415 | 3205 | 89264 | 2974 | 44982 |
| 24-#14 | 2.93 | MA | 45491 | 10000 | 74224 | 7381 | 82273 | 5948 | 86229 | 4870 | 91010 | 3198 | 111637 | 2622 | 73884 |
| 5L-9S | | MI | 36711 | 10000 | 59870 | 7347 | 65168 | 5940 | 67042 | 4836 | 68280 | 3177 | 82636 | 2175 | 59928 |
| 24-#14 | 2.93 | MA | 44722 | 10000 | 72933 | 7378 | 80484 | 5967 | 84042 | 4863 | 88127 | 3212 | 107991 | 2542 | 72747 |
| 6L-8S | | MI | 37339 | 10000 | 61043 | 7327 | 66611 | 5922 | 68877 | 4844 | 70659 | 3165 | 85586 | 2254 | 60783 |
| 24-#14 | 2.93 | MA | 43974 | 10000 | 71517 | 7399 | 78777 | 5962 | 81943 | 4881 | 85311 | 3227 | 104101 | 2412 | 72050 |
| 7E | | MI | 37974 | 10000 | 62132 | 7331 | 68094 | 5928 | 70631 | 4828 | 73210 | 3177 | 88595 | 2322 | 61846 |
| 24-#14 | 2.93 | MA | 43236 | 10000 | 70246 | 7396 | 77045 | 5982 | 79894 | 4899 | 82317 | 3216 | 100521 | 2341 | 70804 |
| 8L-6S | | MI | 38618 | 10000 | 63344 | 7311 | 69556 | 5910 | 72428 | 4812 | 75611 | 3165 | 91844 | 2452 | 62375 |
| 24-#14 | 2.93 | MA | 42468 | 10000 | 69002 | 7393 | 75361 | 5977 | 77751 | 4892 | 79527 | 3231 | 96985 | 2264 | 69712 |
| 9L-5S | | MI | 39280 | 10000 | 64451 | 7316 | 71087 | 5917 | 74300 | 4821 | 78067 | 3152 | 94887 | 2533 | 63252 |
| 24-#14 | 2.93 | MA | 41652 | 10000 | 67610 | 7414 | 73652 | 5997 | 75713 | 4910 | 76759 | 3245 | 93559 | 2176 | 68234 |
| 10L-4S | | MI | 39974 | 10000 | 65630 | 7320 | 72617 | 5899 | 76179 | 4805 | 80777 | 3165 | 98106 | 2591 | 63755 |
| 24-#18 | 5.22 | MA | 47336 | 11452 | 81401 | 8277 | 90987 | 6623 | 96834 | 5298 | 105266 | 3089 | 132031 | 1572 | 116027 |
| 8L-6S | | MI | 42853 | 11452 | 74514 | 8170 | 83536 | 6532 | 89384 | 5176 | 98170 | 2996 | 122371 | 1776 | 104306 |

## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

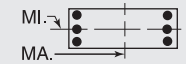
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.25 | MA | 45925 | 9316 | 71525 | 6964 | 77527 | 5675 | 79132 | 4730 | 79004 | 3395 | 92976 | 3210 | 35203 |
| 2L-3S | | MI | 36083 | 9316 | 56788 | 6865 | 60509 | 5631 | 60761 | 4694 | 58562 | 3356 | 67429 | 2904 | 29074 |
| 6-#18 | 1.25 | MA | 43469 | 9316 | 67916 | 6958 | 72900 | 5709 | 73488 | 4761 | 71326 | 3419 | 82658 | 2989 | 35302 |
| 3L-2S | | MI | 38061 | 9316 | 59705 | 6875 | 64248 | 5601 | 65324 | 4668 | 64692 | 3333 | 75556 | 3125 | 28939 |
| 8-#18 | 1.67 | MA | 47617 | 9593 | 75133 | 7137 | 82153 | 5800 | 84776 | 4806 | 86683 | 3373 | 103294 | 3164 | 46540 |
| 2L-4S | | MI | 36047 | 9593 | 57316 | 7072 | 61203 | 5741 | 61624 | 4751 | 60007 | 3351 | 70294 | 2624 | 38160 |
| 8-#18 | 1.67 | MA | 45179 | 9593 | 71525 | 7131 | 77527 | 5834 | 79132 | 4837 | 79004 | 3397 | 92976 | 2943 | 46564 |
| 3E | | MI | 37440 | 9593 | 59705 | 7037 | 64248 | 5756 | 65324 | 4769 | 64692 | 3329 | 75556 | 2846 | 38230 |
| 8-#18 | 1.67 | MA | 43468 | 9593 | 68584 | 7168 | 73779 | 5824 | 74578 | 4823 | 73143 | 3421 | 86262 | 2722 | 46335 |
| 4L-2S | | MI | 39404 | 9593 | 62622 | 7048 | 67988 | 5726 | 69886 | 4743 | 70823 | 3307 | 83684 | 3067 | 38144 |
| 10-#14 | 1.17 | MA | 45715 | 9264 | 70772 | 6973 | 76833 | 5685 | 78389 | 4745 | 78037 | 3421 | 92040 | 3255 | 33285 |
| 2L-5S | | MI | 35259 | 9264 | 54888 | 6902 | 58327 | 5648 | 58193 | 4711 | 55228 | 3387 | 64029 | 2874 | 27533 |
| 10-#14 | 1.17 | MA | 44311 | 9264 | 68715 | 6970 | 74195 | 5681 | 75171 | 4763 | 73659 | 3436 | 86091 | 3131 | 33340 |
| 3L-4S | | MI | 35977 | 9264 | 56067 | 6906 | 59856 | 5630 | 60072 | 4695 | 57938 | 3399 | 67248 | 2932 | 27519 |
| 10-#14 | 1.17 | MA | 43328 | 9264 | 67043 | 6992 | 72064 | 5701 | 72581 | 4757 | 70325 | 3451 | 82211 | 3006 | 33364 |
| 4L-3S | | MI | 36778 | 9264 | 57430 | 6886 | 61592 | 5636 | 62182 | 4704 | 60643 | 3387 | 70309 | 3056 | 27460 |
| 10-#14 | 1.17 | MA | 42451 | 9264 | 65598 | 6989 | 70190 | 5696 | 70278 | 4775 | 66989 | 3442 | 78178 | 2945 | 33294 |
| 5L-2S | | MI | 37913 | 9264 | 59098 | 6891 | 63731 | 5618 | 64791 | 4688 | 64183 | 3374 | 75023 | 3181 | 27391 |
| 10-#18 | 2.08 | MA | 49291 | 9870 | 78742 | 7310 | 86779 | 5924 | 90419 | 4881 | 94362 | 3351 | 113613 | 3119 | 57842 |
| 2L-5S | | MI | 36162 | 9870 | 58161 | 7234 | 62258 | 5895 | 62888 | 4852 | 61440 | 3302 | 72849 | 2466 | 45600 |
| 10-#18 | 2.08 | MA | 46871 | 9870 | 75133 | 7304 | 82153 | 5958 | 84776 | 4912 | 86683 | 3375 | 103294 | 2897 | 57783 |
| 3L-4S | | MI | 37401 | 9870 | 60233 | 7244 | 64943 | 5865 | 66186 | 4826 | 66137 | 3324 | 78422 | 2566 | 47175 |
| 10-#18 | 2.08 | MA | 45173 | 9870 | 72193 | 7341 | 78405 | 5948 | 80221 | 4899 | 80822 | 3399 | 96580 | 2676 | 57460 |
| 4L-3S | | MI | 38784 | 9870 | 62622 | 7210 | 67988 | 5880 | 69886 | 4844 | 70823 | 3302 | 83684 | 2787 | 47338 |
| 10-#18 | 2.08 | MA | 43658 | 9870 | 69651 | 7334 | 75108 | 5982 | 76170 | 4929 | 74954 | 3379 | 89561 | 2570 | 55390 |
| 5L-2S | | MI | 40736 | 9870 | 65539 | 7220 | 71727 | 5850 | 74448 | 4818 | 76953 | 3280 | 91811 | 3009 | 47311 |
| 12-#14 | 1.41 | MA | 46692 | 9420 | 72829 | 7070 | 79470 | 5755 | 81606 | 4787 | 82414 | 3409 | 97988 | 3233 | 39746 |
| 2L-6S | | MI | 35369 | 9420 | 55450 | 6994 | 58934 | 5711 | 58930 | 4744 | 56311 | 3386 | 65701 | 2764 | 32328 |
| 12-#14 | 1.41 | MA | 45293 | 9420 | 70772 | 7067 | 76833 | 5751 | 78389 | 4806 | 78037 | 3424 | 92040 | 3108 | 39784 |
| 3L-5S | | MI | 36050 | 9420 | 56556 | 6999 | 60465 | 5718 | 60802 | 4753 | 58767 | 3374 | 68744 | 2845 | 32721 |
| 12-#14 | 1.41 | MA | 44315 | 9420 | 69100 | 7089 | 74701 | 5771 | 75798 | 4799 | 74703 | 3439 | 88160 | 2984 | 39771 |
| 4E | | MI | 36764 | 9420 | 57735 | 7004 | 61995 | 5699 | 62681 | 4737 | 61477 | 3386 | 71962 | 2903 | 32746 |
| 12-#14 | 1.41 | MA | 43442 | 9420 | 67655 | 7086 | 72827 | 5766 | 73496 | 4818 | 71367 | 3429 | 84127 | 2923 | 39665 |
| 5L-3S | | MI | 37562 | 9420 | 59098 | 6983 | 63731 | 5706 | 64791 | 4746 | 64183 | 3374 | 75023 | 3027 | 32708 |
| 12-#14 | 1.41 | MA | 42612 | 9420 | 66302 | 7083 | 70952 | 5786 | 71203 | 4811 | 68345 | 3444 | 80279 | 2842 | 39072 |
| 6L-2S | | MI | 38692 | 9420 | 60766 | 6988 | 65870 | 5688 | 67400 | 4730 | 67722 | 3361 | 79738 | 3152 | 32652 |
| 12-#18 | 2.50 | MA | 50951 | 10146 | 82351 | 7483 | 91405 | 6048 | 96063 | 4957 | 102040 | 3329 | 123931 | 3073 | 69109 |
| 2L-6S | | MI | 36342 | 10146 | 59135 | 7397 | 63308 | 6005 | 64163 | 4909 | 63317 | 3298 | 75738 | 2263 | 52776 |
| 12-#18 | 2.50 | MA | 48546 | 10146 | 78742 | 7477 | 86779 | 6082 | 90419 | 4987 | 94362 | 3353 | 113613 | 2852 | 68977 |
| 3L-5S | | MI | 37513 | 10146 | 61078 | 7407 | 65998 | 6020 | 67450 | 4927 | 67571 | 3276 | 80976 | 2408 | 54268 |
| 12-#18 | 2.50 | MA | 46862 | 10146 | 75802 | 7514 | 83031 | 6072 | 85865 | 4974 | 88500 | 3377 | 106898 | 2630 | 68572 |
| 4E | | MI | 38743 | 10146 | 63150 | 7417 | 68682 | 5990 | 70748 | 4901 | 72268 | 3298 | 86550 | 2508 | 56170 |
| 12-#18 | 2.50 | MA | 45359 | 10146 | 73259 | 7507 | 79735 | 6106 | 81813 | 5005 | 82632 | 3357 | 99879 | 2524 | 66165 |
| 5L-3S | | MI | 40116 | 10146 | 65539 | 7383 | 71727 | 6004 | 74448 | 4920 | 76953 | 3276 | 91811 | 2729 | 56408 |
| 12-#18 | 2.50 | MA | 43929 | 10146 | 70876 | 7501 | 76433 | 6096 | 77778 | 4991 | 77315 | 3381 | 93212 | 2381 | 64103 |
| 6L-2S | | MI | 42056 | 10146 | 68456 | 7393 | 75467 | 5974 | 79010 | 4894 | 83083 | 3254 | 99939 | 2951 | 56450 |
| 14-#11 | 1.14 | MA | 45625 | 9242 | 70427 | 6979 | 76528 | 5692 | 78071 | 4753 | 77626 | 3434 | 91658 | 3277 | 32443 |
| 2L-7S | | MI | 35053 | 9242 | 54261 | 6921 | 57643 | 5659 | 57398 | 4722 | 54269 | 3419 | 62651 | 2847 | 26651 |
| 14-#11 | 1.14 | MA | 44643 | 9242 | 68991 | 6977 | 74687 | 5689 | 75825 | 4766 | 74571 | 3445 | 87483 | 3190 | 32479 |
| 3L-6S | | MI | 35519 | 9242 | 55106 | 6907 | 58662 | 5646 | 58651 | 4710 | 55951 | 3410 | 64939 | 2937 | 26835 |
| 14-#11 | 1.14 | MA | 43958 | 9242 | 67826 | 6992 | 73201 | 5703 | 74019 | 4762 | 72247 | 3456 | 84758 | 3104 | 32506 |
| 4L-5S | | MI | 35996 | 9242 | 55878 | 6910 | 59731 | 5650 | 59957 | 4716 | 57672 | 3402 | 67083 | 2994 | 26830 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis

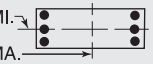



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.14 | MA | 43346 | 9242 | 66819 | 6991 | 71896 | 5701 | 72414 | 4775 | 69921 | 3450 | 81932 | 3061 | 32503 |
| 5L-4S | | MI | 36497 | 9242 | 56700 | 6912 | 60798 | 5637 | 61268 | 4704 | 59570 | 3410 | 69344 | 3034 | 26798 |
| 14-#11 | 1.14 | MA | 42764 | 9242 | 65877 | 6989 | 70589 | 5715 | 70816 | 4771 | 67816 | 3461 | 79229 | 3005 | 32452 |
| 6L-3S | | MI | 37056 | 9242 | 57652 | 6898 | 62010 | 5641 | 62742 | 4710 | 61466 | 3401 | 71501 | 3121 | 26756 |
| 14-#11 | 1.14 | MA | 42198 | 9242 | 64843 | 7005 | 69343 | 5712 | 69284 | 4784 | 65759 | 3472 | 76350 | 2916 | 32136 |
| 7L-2S | | MI | 37851 | 9242 | 58818 | 6901 | 63505 | 5628 | 64565 | 4698 | 63948 | 3392 | 74820 | 3207 | 26711 |
| 14-#14 | 1.64 | MA | 47662 | 9576 | 74887 | 7167 | 82107 | 5825 | 84824 | 4829 | 86792 | 3396 | 103937 | 3210 | 46195 |
| 2L-7S | | MI | 35498 | 9576 | 55906 | 7112 | 59610 | 5799 | 59742 | 4803 | 57450 | 3386 | 67166 | 2605 | 36698 |
| 14-#14 | 1.64 | MA | 46269 | 9576 | 72829 | 7164 | 79470 | 5820 | 81606 | 4848 | 82414 | 3411 | 97988 | 3086 | 46214 |
| 3L-6S | | MI | 36158 | 9576 | 57118 | 7092 | 61072 | 5781 | 61539 | 4787 | 59850 | 3373 | 70415 | 2735 | 37343 |
| 14-#14 | 1.64 | MA | 45296 | 9576 | 71157 | 7186 | 77338 | 5841 | 79016 | 4842 | 79080 | 3426 | 94109 | 2961 | 46166 |
| 4L-5S | | MI | 36835 | 9576 | 58224 | 7096 | 62604 | 5787 | 63411 | 4796 | 62307 | 3361 | 73458 | 2816 | 37896 |
| 14-#14 | 1.64 | MA | 44427 | 9576 | 69713 | 7183 | 75465 | 5836 | 76713 | 4860 | 75744 | 3417 | 90076 | 2900 | 46027 |
| 5L-4S | | MI | 37546 | 9576 | 59404 | 7101 | 64133 | 5769 | 65290 | 4780 | 65017 | 3373 | 76677 | 2874 | 37954 |
| 14-#14 | 1.64 | MA | 43601 | 9576 | 68359 | 7180 | 73589 | 5856 | 74420 | 4854 | 72723 | 3432 | 86228 | 2819 | 45270 |
| 6L-3S | | MI | 38341 | 9576 | 60766 | 7081 | 65870 | 5776 | 67400 | 4788 | 67722 | 3361 | 79738 | 2999 | 37942 |
| 14-#14 | 1.64 | MA | 42797 | 9576 | 66876 | 7202 | 71800 | 5852 | 72220 | 4872 | 69771 | 3447 | 82125 | 2690 | 44374 |
| 7L-2S | | MI | 39467 | 9576 | 62435 | 7085 | 68008 | 5758 | 70009 | 4772 | 71262 | 3348 | 84452 | 3123 | 37900 |
| 14-#18 | 2.92 | MA | 50208 | 10423 | 82351 | 7649 | 91405 | 6206 | 96063 | 5063 | 102040 | 3331 | 123931 | 2806 | 80155 |
| 3L-6S | | MI | 37689 | 10423 | 62052 | 7570 | 67048 | 6130 | 68725 | 4984 | 69447 | 3271 | 83866 | 2205 | 61555 |
| 14-#18 | 2.92 | MA | 48536 | 10423 | 79410 | 7687 | 87658 | 6196 | 91509 | 5049 | 96179 | 3355 | 117216 | 2585 | 79677 |
| 4L-5S | | MI | 38852 | 10423 | 63996 | 7580 | 69737 | 6144 | 72012 | 5003 | 73701 | 3249 | 89104 | 2350 | 62969 |
| 14-#18 | 2.92 | MA | 47044 | 10423 | 76868 | 7680 | 84361 | 6230 | 87457 | 5080 | 90311 | 3335 | 110197 | 2479 | 76972 |
| 5L-4S | | MI | 40074 | 10423 | 66067 | 7590 | 72422 | 6114 | 75310 | 4977 | 78398 | 3271 | 94677 | 2450 | 65152 |
| 14-#18 | 2.92 | MA | 45625 | 10423 | 74485 | 7674 | 81059 | 6220 | 83422 | 5067 | 84993 | 3358 | 103530 | 2335 | 75003 |
| 6L-3S | | MI | 41438 | 10423 | 68456 | 7556 | 75467 | 6128 | 79010 | 4995 | 83083 | 3249 | 99939 | 2671 | 65456 |
| 14-#18 | 2.92 | MA | 44244 | 10423 | 71873 | 7711 | 77909 | 6254 | 79549 | 5097 | 79798 | 3382 | 96416 | 2104 | 71897 |
| 7L-2S | | MI | 43366 | 10423 | 71373 | 7566 | 79206 | 6098 | 83572 | 4969 | 89214 | 3227 | 108067 | 2892 | 65561 |
| 16-#11 | 1.30 | MA | 46311 | 9350 | 71863 | 7046 | 78369 | 5740 | 80316 | 4782 | 80682 | 3425 | 95834 | 3262 | 36952 |
| 2L-8S | | MI | 35154 | 9350 | 54667 | 6986 | 58104 | 5703 | 57998 | 4763 | 54964 | 3402 | 63856 | 2781 | 29858 |
| 16-#11 | 1.30 | MA | 45332 | 9350 | 70427 | 7044 | 76528 | 5737 | 78071 | 4795 | 77626 | 3436 | 91658 | 3176 | 36980 |
| 3L-7S | | MI | 35610 | 9350 | 55427 | 6989 | 59138 | 5707 | 59222 | 4751 | 56751 | 3411 | 65970 | 2829 | 30187 |
| 16-#11 | 1.30 | MA | 44648 | 9350 | 69262 | 7060 | 75042 | 5752 | 76264 | 4791 | 75302 | 3447 | 88933 | 3089 | 36997 |
| 4L-6S | | MI | 36074 | 9350 | 56272 | 6974 | 60157 | 5694 | 60475 | 4740 | 58432 | 3402 | 68258 | 2919 | 30464 |
| 16-#11 | 1.30 | MA | 44039 | 9350 | 68255 | 7058 | 73737 | 5749 | 74660 | 4805 | 72977 | 3441 | 86107 | 3047 | 36972 |
| 5E | | MI | 36550 | 9350 | 57044 | 6977 | 61226 | 5698 | 61781 | 4745 | 60153 | 3393 | 70402 | 2975 | 30480 |
| 16-#11 | 1.30 | MA | 43460 | 9350 | 67312 | 7056 | 72430 | 5763 | 73062 | 4801 | 70871 | 3452 | 83405 | 2991 | 36902 |
| 6L-4S | | MI | 37049 | 9350 | 57867 | 6980 | 62293 | 5685 | 63092 | 4734 | 62052 | 3401 | 72662 | 3016 | 30460 |
| 16-#11 | 1.30 | MA | 42895 | 9350 | 66279 | 7072 | 71184 | 5761 | 71529 | 4814 | 68815 | 3463 | 80525 | 2901 | 36493 |
| 7L-3S | | MI | 37607 | 9350 | 58818 | 6966 | 63505 | 5689 | 64565 | 4739 | 63948 | 3392 | 74820 | 3102 | 30426 |
| 16-#11 | 1.30 | MA | 42329 | 9350 | 65352 | 7070 | 69920 | 5775 | 70034 | 4827 | 66629 | 3457 | 77882 | 2851 | 36027 |
| 8L-2S | | MI | 38399 | 9350 | 59984 | 6968 | 65000 | 5676 | 66389 | 4728 | 66429 | 3384 | 78139 | 3188 | 30387 |
| 16-#14 | 1.88 | MA | 48627 | 9731 | 76944 | 7264 | 84745 | 5895 | 88041 | 4872 | 91169 | 3384 | 109886 | 3188 | 52635 |
| 2L-8S | | MI | 35637 | 9731 | 56485 | 7205 | 60266 | 5862 | 60596 | 4861 | 58438 | 3360 | 68872 | 2508 | 41161 |
| 16-#14 | 1.88 | MA | 47239 | 9731 | 74887 | 7261 | 82107 | 5890 | 84824 | 4890 | 86792 | 3399 | 103937 | 3063 | 52626 |
| 3L-7S | | MI | 36285 | 9731 | 57574 | 7209 | 61749 | 5869 | 62351 | 4845 | 60989 | 3372 | 71880 | 2576 | 41755 |
| 16-#14 | 1.88 | MA | 46271 | 9731 | 73214 | 7283 | 79976 | 5911 | 82233 | 4884 | 83458 | 3414 | 100058 | 2939 | 52552 |
| 4L-6S | | MI | 36942 | 9731 | 58786 | 7189 | 63211 | 5850 | 64148 | 4829 | 63390 | 3360 | 75130 | 2706 | 42370 |
| 16-#14 | 1.88 | MA | 45407 | 9731 | 71770 | 7281 | 78102 | 5906 | 79930 | 4903 | 80122 | 3404 | 96025 | 2877 | 52384 |
| 5E | | MI | 37617 | 9731 | 59892 | 7194 | 64743 | 5857 | 66020 | 4838 | 65846 | 3348 | 78173 | 2787 | 43063 |
| 16-#14 | 1.88 | MA | 44585 | 9731 | 70417 | 7278 | 76227 | 5926 | 77638 | 4896 | 77100 | 3419 | 92176 | 2797 | 51483 |
| 6L-4S | | MI | 38324 | 9731 | 61072 | 7198 | 66272 | 5839 | 67899 | 4822 | 68556 | 3360 | 81392 | 2845 | 43147 |
| 16-#14 | 1.88 | MA | 43784 | 9731 | 68934 | 7300 | 74438 | 5921 | 75438 | 4915 | 74149 | 3434 | 88074 | 2667 | 50621 |
| 7L-3S | | MI | 39115 | 9731 | 62435 | 7178 | 68008 | 5846 | 70009 | 4831 | 71262 | 3348 | 84452 | 2970 | 43171 |
| 16-#14 | 1.88 | MA | 42995 | 9731 | 67602 | 7297 | 72623 | 5942 | 73291 | 4933 | 71011 | 3424 | 84302 | 2596 | 49812 |
| 8L-2S | | MI | 40237 | 9731 | 64103 | 7183 | 70147 | 5828 | 72618 | 4815 | 74801 | 3335 | 89167 | 3094 | 43136 |
| 16-#18 | 3.33 | MA | 50195 | 10700 | 83019 | 7860 | 92284 | 6320 | 97152 | 5125 | 103858 | 3333 | 127534 | 2539 | 90774 |
| 4L-6S | | MI | 39026 | 10700 | 64969 | 7743 | 70787 | 6254 | 73287 | 5060 | 75578 | 3244 | 91993 | 2147 | 70349 |
| 16-#18 | 3.33 | MA | 48715 | 10700 | 80477 | 7853 | 88987 | 6354 | 93101 | 5155 | 97989 | 3312 | 120515 | 2433 | 87808 |
| 5E | | MI | 40181 | 10700 | 66913 | 7753 | 73477 | 6268 | 76574 | 5078 | 79832 | 3222 | 97231 | 2292 | 71696 |

## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis



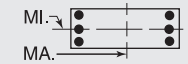

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 3.33 | MA | 47307 | 10700 | 78093 | 7847 | 85685 | 6344 | 89066 | 5142 | 92672 | 3336 | 113848 | 2289 | 85918 |
| 6L-4S | | MI | 41394 | 10700 | 68984 | 7763 | 76162 | 6238 | 79872 | 5052 | 84529 | 3244 | 102805 | 2391 | 74124 |
| 16-#18 | 3.33 | MA | 45936 | 10700 | 75482 | 7884 | 82536 | 6378 | 85193 | 5173 | 87476 | 3360 | 106734 | 2059 | 82648 |
| 7L-3S | | MI | 42749 | 10700 | 71373 | 7729 | 79206 | 6252 | 83572 | 5071 | 89214 | 3222 | 108067 | 2613 | 74489 |
| 16-#18 | 3.33 | MA | 44586 | 10700 | 73136 | 7877 | 79341 | 6368 | 81413 | 5203 | 81955 | 3340 | 100171 | 1934 | 79738 |
| 8L-2S | | MI | 44666 | 10700 | 74290 | 7739 | 82946 | 6222 | 88134 | 5045 | 95344 | 3200 | 116194 | 2834 | 74643 |
| 18-#11 | 1.46 | MA | 46993 | 9457 | 73299 | 7114 | 80210 | 5789 | 82562 | 4811 | 83737 | 3417 | 100009 | 3248 | 41454 |
| 2L-9S | | MI | 35246 | 9457 | 55016 | 7068 | 58593 | 5764 | 58543 | 4787 | 55779 | 3403 | 65097 | 2708 | 33175 |
| 18-#11 | 1.46 | MA | 46017 | 9457 | 71863 | 7112 | 78369 | 5786 | 80316 | 4825 | 80682 | 3428 | 95834 | 3161 | 41475 |
| 3L-8S | | MI | 35710 | 9457 | 55834 | 7053 | 59599 | 5751 | 59822 | 4792 | 57445 | 3394 | 67175 | 2762 | 33414 |
| 18-#11 | 1.46 | MA | 45336 | 9457 | 70698 | 7127 | 76883 | 5800 | 78510 | 4821 | 78357 | 3439 | 93108 | 3075 | 41474 |
| 4L-7S | | MI | 36165 | 9457 | 56593 | 7056 | 60633 | 5755 | 61046 | 4781 | 59232 | 3402 | 69289 | 2810 | 33730 |
| 18-#11 | 1.46 | MA | 44729 | 9457 | 69691 | 7126 | 75577 | 5797 | 76905 | 4834 | 76032 | 3432 | 90282 | 3032 | 41435 |
| 5L-6S | | MI | 36627 | 9457 | 57438 | 7042 | 61652 | 5742 | 62299 | 4769 | 60914 | 3393 | 71577 | 2900 | 34087 |
| 18-#11 | 1.46 | MA | 44152 | 9457 | 68748 | 7124 | 74271 | 5812 | 75308 | 4830 | 73927 | 3443 | 87580 | 2976 | 41349 |
| 6L-5S | | MI | 37101 | 9457 | 58210 | 7044 | 62721 | 5747 | 63605 | 4775 | 62635 | 3384 | 73720 | 2956 | 34120 |
| 18-#11 | 1.46 | MA | 43589 | 9457 | 67715 | 7139 | 73024 | 5809 | 73775 | 4843 | 71870 | 3454 | 84700 | 2886 | 40857 |
| 7L-4S | | MI | 37599 | 9457 | 59033 | 7047 | 63788 | 5734 | 64916 | 4763 | 64533 | 3393 | 75981 | 2997 | 34115 |
| 18-#11 | 1.46 | MA | 43028 | 9457 | 66788 | 7138 | 71760 | 5823 | 72279 | 4856 | 69684 | 3448 | 82057 | 2836 | 40407 |
| 8L-3S | | MI | 38155 | 9457 | 59984 | 7033 | 65000 | 5738 | 66389 | 4769 | 66429 | 3384 | 78139 | 3083 | 34089 |
| 18-#11 | 1.46 | MA | 42440 | 9457 | 65880 | 7136 | 70531 | 5820 | 70715 | 4852 | 67647 | 3459 | 79437 | 2783 | 40050 |
| 9L-2S | | MI | 38945 | 9457 | 61150 | 7036 | 66495 | 5725 | 68213 | 4757 | 68911 | 3375 | 81458 | 3170 | 34057 |
| 18-#14 | 2.11 | MA | 49586 | 9887 | 79001 | 7362 | 87382 | 5965 | 91259 | 4914 | 95547 | 3372 | 115835 | 3165 | 59065 |
| 2L-9S | | MI | 35770 | 9887 | 56980 | 7322 | 60962 | 5950 | 61371 | 4895 | 59599 | 3359 | 70636 | 2401 | 45172 |
| 18-#14 | 2.11 | MA | 48205 | 9887 | 76944 | 7359 | 84745 | 5960 | 88041 | 4933 | 91169 | 3387 | 109886 | 3041 | 59029 |
| 3L-8S | | MI | 36423 | 9887 | 58153 | 7302 | 62405 | 5932 | 63205 | 4904 | 61978 | 3347 | 73586 | 2479 | 46127 |
| 18-#14 | 2.11 | MA | 47240 | 9887 | 75272 | 7381 | 82613 | 5980 | 85450 | 4926 | 87835 | 3402 | 106006 | 2916 | 58932 |
| 4L-7S | | MI | 37068 | 9887 | 59242 | 7306 | 63888 | 5938 | 64960 | 4888 | 64529 | 3359 | 76595 | 2547 | 46819 |
| 18-#14 | 2.11 | MA | 46380 | 9887 | 73827 | 7378 | 80740 | 5976 | 83148 | 4945 | 84499 | 3392 | 101973 | 2855 | 58736 |
| 5L-6S | | MI | 37722 | 9887 | 60454 | 7286 | 65350 | 5920 | 66757 | 4872 | 66929 | 3347 | 79845 | 2677 | 47408 |
| 18-#14 | 2.11 | MA | 45562 | 9887 | 72474 | 7375 | 78864 | 5996 | 80855 | 4939 | 81478 | 3407 | 98125 | 2774 | 57706 |
| 6L-5S | | MI | 38393 | 9887 | 61561 | 7291 | 66881 | 5927 | 68629 | 4880 | 69386 | 3335 | 82887 | 2758 | 48222 |
| 18-#14 | 2.11 | MA | 44766 | 9887 | 70991 | 7397 | 77075 | 5991 | 78655 | 4957 | 78526 | 3422 | 94023 | 2645 | 56876 |
| 7L-4S | | MI | 39098 | 9887 | 62740 | 7295 | 68411 | 5909 | 70508 | 4864 | 72096 | 3347 | 86106 | 2816 | 48332 |
| 18-#14 | 2.11 | MA | 43981 | 9887 | 69659 | 7394 | 75261 | 6012 | 76508 | 4976 | 75389 | 3412 | 90251 | 2573 | 55969 |
| 8L-3S | | MI | 39886 | 9887 | 64103 | 7275 | 70147 | 5916 | 72618 | 4873 | 74801 | 3335 | 89167 | 2941 | 48375 |
| 18-#14 | 2.11 | MA | 43148 | 9887 | 68356 | 7391 | 73496 | 6007 | 74263 | 4969 | 72464 | 3427 | 86519 | 2496 | 54681 |
| 9L-2S | | MI | 41003 | 9887 | 65771 | 7280 | 72286 | 5897 | 75227 | 4857 | 78341 | 3322 | 93882 | 3065 | 48364 |
| 18-#18 | 3.75 | MA | 50372 | 10976 | 84085 | 8026 | 93613 | 6478 | 98744 | 5231 | 105668 | 3290 | 130834 | 2387 | 98667 |
| 5L-6S | | MI | 40352 | 10976 | 67886 | 7916 | 74527 | 6378 | 77849 | 5135 | 81708 | 3218 | 100121 | 2088 | 79047 |
| 18-#18 | 3.75 | MA | 48974 | 10976 | 81702 | 8019 | 90312 | 6468 | 94709 | 5217 | 100351 | 3314 | 124166 | 2244 | 96848 |
| 6L-5S | | MI | 41500 | 10976 | 69830 | 7926 | 77217 | 6392 | 81136 | 5153 | 85962 | 3196 | 105359 | 2233 | 80445 |
| 18-#18 | 3.75 | MA | 47613 | 10976 | 79091 | 8057 | 87162 | 6503 | 90837 | 5248 | 95155 | 3338 | 117052 | 2013 | 93420 |
| 7L-4S | | MI | 42705 | 10976 | 71901 | 7936 | 79901 | 6362 | 84434 | 5128 | 90659 | 3218 | 110932 | 2333 | 82977 |
| 18-#18 | 3.75 | MA | 46274 | 10976 | 76744 | 8050 | 83967 | 6492 | 87056 | 5279 | 89633 | 3318 | 110489 | 1889 | 90391 |
| 8L-3S | | MI | 44052 | 10976 | 74290 | 7902 | 82946 | 6376 | 88134 | 5146 | 95344 | 3196 | 116194 | 2554 | 83509 |
| 20-#11 | 1.63 | MA | 47673 | 9565 | 74735 | 7181 | 82051 | 5837 | 84808 | 4841 | 86793 | 3408 | 104184 | 3233 | 45951 |
| 2L-10S | | MI | 35312 | 9565 | 55425 | 7132 | 59067 | 5808 | 59149 | 4828 | 56608 | 3403 | 66403 | 2628 | 36177 |
| 20-#11 | 1.63 | MA | 46700 | 9565 | 73299 | 7179 | 80210 | 5834 | 82562 | 4854 | 83737 | 3419 | 100009 | 3147 | 45965 |
| 3L-9S | | MI | 35803 | 9565 | 56182 | 7135 | 60088 | 5813 | 60367 | 4816 | 58260 | 3394 | 68416 | 2689 | 36737 |
| 20-#11 | 1.63 | MA | 46021 | 9565 | 72134 | 7195 | 78724 | 5849 | 80756 | 4850 | 81413 | 3430 | 97283 | 3060 | 45946 |
| 4L-8S | | MI | 36264 | 9565 | 57000 | 7121 | 61094 | 5800 | 61646 | 4822 | 59927 | 3385 | 70494 | 2743 | 36973 |
| 20-#11 | 1.63 | MA | 45416 | 9565 | 71127 | 7193 | 77418 | 5846 | 79151 | 4863 | 79088 | 3424 | 94457 | 3017 | 45893 |
| 5L-7S | | MI | 36717 | 9565 | 57759 | 7123 | 62128 | 5804 | 62870 | 4810 | 61714 | 3393 | 72608 | 2791 | 37277 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis

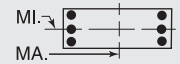



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.63 | MA | 44841 | 9565 | 70184 | 7191 | 76111 | 5860 | 77554 | 4859 | 76982 | 3435 | 91755 | 2962 | 45792 |
| 6E | | MI | 37178 | 9565 | 58605 | 7109 | 63147 | 5791 | 64123 | 4799 | 63395 | 3385 | 74896 | 2881 | 37705 |
| 20-#11 | 1.63 | MA | 44280 | 9565 | 69151 | 7207 | 74865 | 5857 | 76021 | 4873 | 74926 | 3446 | 88875 | 2872 | 45227 |
| 7L-5S | | MI | 37650 | 9565 | 59376 | 7112 | 64216 | 5795 | 65429 | 4804 | 65116 | 3376 | 77039 | 2937 | 37751 |
| 20-#11 | 1.63 | MA | 43723 | 9565 | 68224 | 7205 | 73601 | 5872 | 74525 | 4886 | 72739 | 3439 | 86232 | 2822 | 44790 |
| 8L-4S | | MI | 38146 | 9565 | 60199 | 7115 | 65283 | 5782 | 66740 | 4793 | 67015 | 3384 | 79300 | 2978 | 37764 |
| 20-#11 | 1.63 | MA | 43135 | 9565 | 67316 | 7203 | 72372 | 5869 | 72961 | 4882 | 70702 | 3450 | 83612 | 2768 | 44439 |
| 9L-3S | | MI | 38701 | 9565 | 61150 | 7100 | 66495 | 5786 | 68213 | 4798 | 68911 | 3375 | 81458 | 3065 | 37747 |
| 20-#11 | 1.63 | MA | 42526 | 9565 | 66300 | 7219 | 71125 | 5883 | 71473 | 4895 | 68682 | 3461 | 81072 | 2707 | 43686 |
| 10L-2S | | MI | 39489 | 9565 | 62316 | 7103 | 67990 | 5773 | 70037 | 4787 | 71392 | 3366 | 84776 | 3151 | 37720 |
| 20-#14 | 2.34 | MA | 49164 | 10043 | 79001 | 7456 | 87382 | 6030 | 91259 | 4975 | 95547 | 3374 | 115835 | 3018 | 65425 |
| 3L-9S | | MI | 36570 | 10042 | 58649 | 7419 | 63101 | 6020 | 63980 | 4937 | 63138 | 3346 | 75350 | 2372 | 50180 |
| 20-#14 | 2.34 | MA | 48204 | 10043 | 77329 | 7478 | 85251 | 6050 | 88668 | 4969 | 92213 | 3389 | 111955 | 2894 | 65306 |
| 4L-8S | | MI | 37205 | 10042 | 59821 | 7399 | 64544 | 6002 | 65815 | 4946 | 65517 | 3334 | 78301 | 2450 | 51104 |
| 20-#14 | 2.34 | MA | 47349 | 10042 | 75885 | 7475 | 83377 | 6046 | 86365 | 4987 | 88877 | 3379 | 107922 | 2832 | 65085 |
| 5L-7S | | MI | 37847 | 10042 | 60911 | 7404 | 66026 | 6008 | 67569 | 4930 | 68068 | 3346 | 81309 | 2518 | 51888 |
| 20-#14 | 2.34 | MA | 46535 | 10042 | 74531 | 7472 | 81501 | 6066 | 84073 | 4981 | 85855 | 3394 | 104074 | 2752 | 63940 |
| 6E | | MI | 38498 | 10043 | 62123 | 7383 | 67488 | 5990 | 69366 | 4914 | 70469 | 3334 | 84559 | 2648 | 52455 |
| 20-#14 | 2.34 | MA | 45742 | 10042 | 73048 | 7494 | 79713 | 6061 | 81873 | 5000 | 82904 | 3409 | 99971 | 2622 | 63136 |
| 7L-5S | | MI | 39166 | 10043 | 63229 | 7388 | 69020 | 5997 | 71238 | 4923 | 72925 | 3322 | 87602 | 2729 | 53377 |
| 20-#14 | 2.34 | MA | 44961 | 10043 | 71716 | 7491 | 77898 | 6081 | 79726 | 5018 | 79766 | 3400 | 96200 | 2551 | 62137 |
| 8L-4S | | MI | 39868 | 10043 | 64409 | 7393 | 70549 | 5979 | 73117 | 4907 | 75635 | 3334 | 90821 | 2787 | 53508 |
| 20-#14 | 2.34 | MA | 44133 | 10042 | 70413 | 7488 | 76133 | 6077 | 77481 | 5012 | 76842 | 3415 | 92468 | 2473 | 60884 |
| 9L-3S | | MI | 40653 | 10043 | 65771 | 7372 | 72286 | 5985 | 75227 | 4916 | 78341 | 3322 | 93882 | 2912 | 53572 |
| 20-#14 | 2.34 | MA | 43269 | 10043 | 68954 | 7510 | 74343 | 6097 | 75345 | 5030 | 73942 | 3430 | 88852 | 2385 | 59582 |
| 10L-2S | | MI | 41766 | 10043 | 67439 | 7377 | 74424 | 5967 | 77836 | 4900 | 81880 | 3309 | 98596 | 3036 | 53591 |
| 20-#18 | 4.17 | MA | 50629 | 11253 | 85311 | 8192 | 94938 | 6593 | 100353 | 5293 | 108029 | 3292 | 134484 | 2198 | 107699 |
| 6E | | MI | 41670 | 11253 | 70803 | 8089 | 78266 | 6502 | 82411 | 5210 | 87839 | 3191 | 108248 | 2030 | 87617 |
| 20-#18 | 4.17 | MA | 49278 | 11253 | 82699 | 8230 | 91788 | 6627 | 96480 | 5324 | 102833 | 3316 | 127370 | 1967 | 104212 |
| 7L-5S | | MI | 42810 | 11253 | 72747 | 8099 | 80956 | 6516 | 85698 | 5229 | 92093 | 3169 | 113487 | 2175 | 89212 |
| 20-#18 | 4.17 | MA | 47948 | 11253 | 80353 | 8223 | 88593 | 6617 | 92700 | 5354 | 97312 | 3296 | 120807 | 1843 | 101065 |
| 8L-4S | | MI | 44008 | 11253 | 74818 | 8109 | 83641 | 6486 | 88996 | 5203 | 96790 | 3191 | 119060 | 2275 | 91620 |
| 22-#11 | 1.79 | MA | 47379 | 9673 | 74735 | 7247 | 82051 | 5883 | 84808 | 4884 | 86793 | 3410 | 104184 | 3132 | 50444 |
| 3L-10S | | MI | 35867 | 9673 | 56591 | 7200 | 60562 | 5857 | 60973 | 4857 | 59089 | 3394 | 69721 | 2609 | 39693 |
| 22-#11 | 1.79 | MA | 46703 | 9673 | 73569 | 7262 | 80565 | 5897 | 83001 | 4880 | 84468 | 3421 | 101458 | 3046 | 50413 |
| 4L-9S | | MI | 36357 | 9673 | 57348 | 7202 | 61583 | 5861 | 62190 | 4846 | 60742 | 3385 | 71734 | 2671 | 40245 |
| 22-#11 | 1.79 | MA | 46100 | 9673 | 72563 | 7260 | 79259 | 5894 | 81397 | 4893 | 82143 | 3415 | 98632 | 3003 | 50348 |
| 5L-8S | | MI | 36815 | 9673 | 58166 | 7188 | 62589 | 5848 | 63470 | 4851 | 62408 | 3377 | 73813 | 2724 | 40534 |
| 22-#11 | 1.79 | MA | 45527 | 9673 | 71620 | 7259 | 77952 | 5909 | 79799 | 4889 | 80038 | 3426 | 95930 | 2947 | 50233 |
| 6L-7S | | MI | 37267 | 9673 | 58926 | 7191 | 63623 | 5852 | 64693 | 4840 | 64195 | 3385 | 75926 | 2773 | 40828 |
| 22-#11 | 1.79 | MA | 44968 | 9673 | 70587 | 7274 | 76706 | 5906 | 78267 | 4902 | 77981 | 3437 | 93050 | 2857 | 49602 |
| 7L-6S | | MI | 37726 | 9673 | 59771 | 7176 | 64642 | 5839 | 65947 | 4828 | 65877 | 3376 | 78214 | 2863 | 41290 |
| 22-#11 | 1.79 | MA | 44418 | 9673 | 69659 | 7273 | 75442 | 5920 | 76771 | 4915 | 75795 | 3431 | 90407 | 2807 | 49176 |
| 8L-5S | | MI | 38197 | 9673 | 60542 | 7179 | 65711 | 5843 | 67253 | 4834 | 67598 | 3367 | 80358 | 2919 | 41378 |
| 22-#11 | 1.79 | MA | 43828 | 9673 | 68752 | 7271 | 74213 | 5917 | 75207 | 4911 | 73757 | 3442 | 87787 | 2754 | 48779 |
| 9L-4S | | MI | 38692 | 9673 | 61365 | 7182 | 66778 | 5830 | 68564 | 4822 | 69496 | 3375 | 82619 | 2960 | 41404 |
| 22-#11 | 1.79 | MA | 43220 | 9673 | 67736 | 7286 | 72966 | 5932 | 73719 | 4925 | 71737 | 3453 | 85247 | 2693 | 48029 |
| 10L-3S | | MI | 39245 | 9673 | 62316 | 7168 | 67990 | 5835 | 70037 | 4828 | 71392 | 3367 | 84776 | 3046 | 41399 |
| 22-#11 | 1.79 | MA | 42626 | 9673 | 66826 | 7285 | 71743 | 5929 | 72175 | 4921 | 69583 | 3447 | 82669 | 2640 | 47433 |
| 11L-2S | | MI | 40030 | 9673 | 63483 | 7171 | 69485 | 5822 | 71861 | 4816 | 73874 | 3358 | 88095 | 3132 | 41378 |
| 22-#14 | 2.58 | MA | 49163 | 10198 | 79386 | 7575 | 87888 | 6120 | 91885 | 5011 | 96591 | 3377 | 117904 | 2871 | 71675 |
| 4L-9S | | MI | 37350 | 10198 | 60317 | 7517 | 65240 | 6089 | 66589 | 4980 | 66678 | 3333 | 80065 | 2343 | 55196 |
| 22-#14 | 2.58 | MA | 48312 | 10198 | 77942 | 7572 | 86014 | 6115 | 89583 | 5030 | 93254 | 3367 | 113871 | 2810 | 71431 |
| 5L-8S | | MI | 37983 | 10198 | 61490 | 7496 | 66682 | 6071 | 68424 | 4988 | 69057 | 3321 | 83015 | 2421 | 56091 |
| 22-#14 | 2.58 | MA | 47501 | 10198 | 76589 | 7569 | 84139 | 6136 | 87290 | 5023 | 90233 | 3382 | 110023 | 2729 | 70182 |
| 6L-7S | | MI | 38621 | 10198 | 62579 | 7501 | 68165 | 6078 | 70178 | 4972 | 71608 | 3333 | 86024 | 2489 | 56961 |
| 22-#14 | 2.58 | MA | 46712 | 10198 | 75105 | 7591 | 82350 | 6131 | 85090 | 5042 | 87281 | 3397 | 105920 | 2600 | 69402 |
| 7L-6S | | MI | 39270 | 10198 | 63791 | 7481 | 69627 | 6060 | 71975 | 4956 | 74008 | 3321 | 89274 | 2619 | 57509 |
| 22-#14 | 2.58 | MA | 45935 | 10198 | 73774 | 7588 | 80535 | 6151 | 82943 | 5060 | 84144 | 3387 | 102148 | 2528 | 68315 |
| 8L-5S | | MI | 39936 | 10198 | 64897 | 7485 | 71159 | 6067 | 73847 | 4965 | 76465 | 3309 | 92316 | 2700 | 58446 |

## RECTANGULAR TIED COLUMNS 40" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

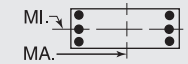
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 2.58 | MA | 45112 | 10198 | 72471 | 7586 | 78771 | 6147 | 80698 | 5054 | 81219 | 3402 | 98417 | 2451 | 67095 |
| 9L-4S | | MI | 40634 | 10198 | 66077 | 7490 | 72688 | 6049 | 75726 | 4949 | 79175 | 3321 | 95535 | 2758 | 58680 |
| 22-#14 | 2.58 | MA | 44251 | 10198 | 71011 | 7607 | 76981 | 6167 | 78563 | 5073 | 78320 | 3417 | 94801 | 2363 | 65732 |
| 10L-3S | | MI | 41416 | 10198 | 67439 | 7470 | 74424 | 6055 | 77836 | 4958 | 81880 | 3309 | 98596 | 2883 | 58762 |
| 22-#18 | 4.58 | MA | 50930 | 11529 | 86308 | 8403 | 96414 | 6751 | 102124 | 5399 | 110512 | 3294 | 137688 | 1922 | 115021 |
| 7L-6S | | MI | 42978 | 11529 | 73720 | 8262 | 82006 | 6626 | 86974 | 5286 | 93969 | 3165 | 116376 | 1972 | 96211 |
| 22-#18 | 4.58 | MA | 49610 | 11529 | 83962 | 8396 | 93219 | 6741 | 98344 | 5430 | 104990 | 3274 | 131126 | 1797 | 111758 |
| 8L-5S | | MI | 44112 | 11529 | 75664 | 8272 | 84696 | 6640 | 90260 | 5304 | 98223 | 3142 | 121614 | 2117 | 97994 |
| 24-#11 | 1.95 | MA | 47382 | 9781 | 75005 | 7330 | 82405 | 5946 | 85247 | 4909 | 87524 | 3413 | 105633 | 3031 | 54877 |
| 4L-10S | | MI | 36420 | 9781 | 57757 | 7267 | 62057 | 5905 | 62797 | 4887 | 61571 | 3386 | 73040 | 2591 | 43214 |
| 24-#11 | 1.95 | MA | 46781 | 9781 | 73999 | 7328 | 81100 | 5943 | 83642 | 4922 | 85198 | 3407 | 102807 | 2988 | 54799 |
| 5L-9S | | MI | 36910 | 9781 | 58514 | 7270 | 63078 | 5909 | 64014 | 4875 | 63223 | 3377 | 75053 | 2652 | 43749 |
| 24-#11 | 1.95 | MA | 46210 | 9781 | 73056 | 7326 | 79793 | 5957 | 82045 | 4918 | 83093 | 3418 | 100105 | 2933 | 54602 |
| 6L-8S | | MI | 37365 | 9781 | 59332 | 7255 | 64084 | 5896 | 65294 | 4881 | 64890 | 3368 | 77131 | 2706 | 44097 |
| 24-#11 | 1.95 | MA | 45653 | 9781 | 72023 | 7342 | 78547 | 5954 | 80512 | 4931 | 81036 | 3429 | 97225 | 2843 | 53980 |
| 7E | | MI | 37815 | 9781 | 60092 | 7258 | 65118 | 5901 | 66517 | 4869 | 66677 | 3376 | 79245 | 2754 | 44383 |
| 24-#11 | 1.95 | MA | 45105 | 9781 | 71095 | 7340 | 77283 | 5969 | 79017 | 4945 | 78850 | 3422 | 94582 | 2793 | 53565 |
| 8L-6S | | MI | 38273 | 9781 | 60937 | 7244 | 66137 | 5888 | 67771 | 4857 | 68358 | 3367 | 81533 | 2844 | 44826 |
| 24-#11 | 1.95 | MA | 44518 | 9781 | 70188 | 7338 | 76053 | 5966 | 77452 | 4941 | 76813 | 3433 | 91962 | 2739 | 53109 |
| 9L-5S | | MI | 38742 | 9781 | 61709 | 7247 | 67206 | 5892 | 69077 | 4863 | 70079 | 3359 | 83676 | 2900 | 45001 |
| 24-#11 | 1.95 | MA | 43911 | 9781 | 69171 | 7354 | 74806 | 5980 | 75965 | 4954 | 74793 | 3444 | 89422 | 2678 | 52377 |
| 10L-4S | | MI | 39235 | 9781 | 62531 | 7250 | 68273 | 5879 | 70388 | 4851 | 71978 | 3367 | 85937 | 2941 | 45038 |
| 24-#11 | 1.95 | MA | 43320 | 9781 | 68262 | 7352 | 73584 | 5977 | 74420 | 4950 | 72638 | 3438 | 86844 | 2625 | 51792 |
| 11L-3S | | MI | 39786 | 9781 | 63483 | 7235 | 69485 | 5883 | 71861 | 4857 | 73874 | 3358 | 88095 | 3027 | 45048 |
| 24-#11 | 1.95 | MA | 42739 | 9781 | 67264 | 7368 | 72346 | 5992 | 72935 | 4963 | 70619 | 3449 | 83937 | 2548 | 50898 |
| 12L-2S | | MI | 40570 | 9781 | 64649 | 7238 | 70980 | 5870 | 73685 | 4845 | 76355 | 3349 | 91414 | 3114 | 45033 |
| 24-#14 | 2.81 | MA | 49270 | 10354 | 79999 | 7670 | 88652 | 6185 | 92800 | 5072 | 97632 | 3354 | 119820 | 2787 | 77686 |
| 5L-9S | | MI | 38127 | 10354 | 61985 | 7614 | 67378 | 6159 | 69198 | 5022 | 70217 | 3320 | 84780 | 2314 | 60217 |
| 24-#14 | 2.81 | MA | 48463 | 10354 | 78646 | 7667 | 86776 | 6205 | 90508 | 5066 | 94611 | 3370 | 115972 | 2707 | 76431 |
| 6L-8S | | MI | 38756 | 10354 | 63158 | 7594 | 68821 | 6141 | 71033 | 5031 | 72596 | 3308 | 87730 | 2392 | 61086 |
| 24-#14 | 2.81 | MA | 47678 | 10354 | 77163 | 7689 | 84987 | 6201 | 88308 | 5084 | 91659 | 3385 | 111869 | 2577 | 75672 |
| 7E | | MI | 39393 | 10354 | 64247 | 7598 | 70304 | 6148 | 72787 | 5015 | 75147 | 3320 | 90738 | 2460 | 62037 |
| 24-#14 | 2.81 | MA | 46904 | 10354 | 75831 | 7686 | 83173 | 6221 | 86161 | 5103 | 88522 | 3375 | 108097 | 2506 | 74501 |
| 8L-6S | | MI | 40038 | 10354 | 65459 | 7578 | 71766 | 6130 | 74584 | 4999 | 77548 | 3308 | 93988 | 2590 | 62569 |
| 24-#14 | 2.81 | MA | 46085 | 10354 | 74528 | 7683 | 81408 | 6216 | 83916 | 5096 | 85597 | 3390 | 104366 | 2428 | 73312 |
| 9L-5S | | MI | 40701 | 10354 | 66566 | 7583 | 73297 | 6137 | 76456 | 5008 | 80004 | 3295 | 97031 | 2672 | 63467 |
| 24-#14 | 2.81 | MA | 45228 | 10354 | 73069 | 7705 | 79618 | 6237 | 81780 | 5115 | 82697 | 3405 | 100749 | 2340 | 71889 |
| 10L-4S | | MI | 41397 | 10354 | 67745 | 7587 | 74827 | 6118 | 78335 | 4992 | 82714 | 3308 | 100250 | 2729 | 63846 |
| 24-#18 | 5.00 | MA | 51260 | 11806 | 87571 | 8569 | 97845 | 6865 | 103987 | 5505 | 112669 | 3252 | 141444 | 1752 | 122469 |
| 8L-6S | | MI | 44279 | 11806 | 76637 | 8435 | 85746 | 6750 | 91536 | 5361 | 100100 | 3138 | 124504 | 1914 | 104827 |

## RECTANGULAR TIED COLUMNS 42" x 42"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.36 | MA | 37124 | 8627 | 58325 | 6382 | 63045 | 5196 | 64367 | 4323 | 64340 | 3074 | 75531 | 2880 | 30399 |
| 2L-3S | | MI | 35031 | 8627 | 55235 | 6373 | 59084 | 5227 | 59535 | 4351 | 57814 | 3096 | 66857 | 2659 | 30509 |
| 8-#14 | 1.02 | MA | 36130 | 8419 | 55932 | 6295 | 60220 | 5138 | 61012 | 4296 | 59956 | 3122 | 69853 | 2958 | 23205 |
| 2L-4S | | MI | 34076 | 8419 | 52726 | 6311 | 56121 | 5150 | 56020 | 4305 | 53329 | 3147 | 61565 | 2709 | 23343 |
| 8-#18 | 1.81 | MA | 38550 | 8903 | 61415 | 6555 | 67007 | 5320 | 69199 | 4399 | 70867 | 3049 | 84206 | 2826 | 40123 |
| 2L-4S | | MI | 35005 | 8903 | 55798 | 6581 | 59825 | 5338 | 60453 | 4409 | 59352 | 3094 | 69907 | 2383 | 39983 |
| 10-#14 | 1.28 | MA | 36961 | 8575 | 57697 | 6392 | 62483 | 5208 | 63773 | 4339 | 63713 | 3109 | 74876 | 2931 | 28776 |
| 2L-5S | | MI | 34161 | 8575 | 53246 | 6404 | 56769 | 5239 | 56796 | 4364 | 54211 | 3123 | 63165 | 2623 | 28825 |
| 10-#14 | 1.28 | MA | 35761 | 8575 | 55932 | 6388 | 60220 | 5226 | 61012 | 4356 | 59956 | 3122 | 69853 | 2807 | 28835 |
| 3L-4S | | MI | 34916 | 8575 | 54492 | 6409 | 58385 | 5220 | 58781 | 4348 | 57085 | 3135 | 66587 | 2682 | 28872 |
| 10-#18 | 2.27 | MA | 39962 | 9180 | 64505 | 6728 | 70968 | 5444 | 74032 | 4474 | 77394 | 3025 | 92880 | 2771 | 49811 |
| 2L-5S | | MI | 35140 | 9180 | 56699 | 6744 | 60948 | 5494 | 61799 | 4512 | 60879 | 3047 | 72647 | 2227 | 47374 |
| 10-#18 | 2.27 | MA | 37899 | 9180 | 61415 | 6718 | 67007 | 5475 | 69199 | 4501 | 70867 | 3047 | 84206 | 2550 | 49777 |
| 3L-4S | | MI | 36443 | 9180 | 58888 | 6754 | 63786 | 5462 | 65286 | 4484 | 65878 | 3069 | 78581 | 2328 | 49501 |

## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

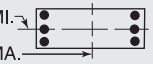
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.30 | MA | 40589 | 8998 | 63525 | 6683 | 68702 | 5444 | 70095 | 4534 | 69988 | 3241 | 82142 | 3047 | 32019 |
| 2L-3S | | MI | 36592 | 8998 | 57571 | 6652 | 61520 | 5457 | 61909 | 4546 | 59945 | 3246 | 69214 | 2804 | 30573 |
| 6-#18 | 1.30 | MA | 38374 | 8998 | 60262 | 6675 | 64519 | 5476 | 64992 | 4563 | 63065 | 3263 | 72920 | 2826 | 32129 |
| 3L-2S | | MI | 38687 | 8998 | 60661 | 6661 | 65482 | 5426 | 66742 | 4518 | 66472 | 3224 | 77889 | 3025 | 30453 |
| 8-#18 | 1.73 | MA | 42104 | 9275 | 66788 | 6856 | 72885 | 5568 | 75198 | 4609 | 76911 | 3218 | 91364 | 2996 | 42283 |
| 2L-4S | | MI | 36565 | 9275 | 58134 | 6860 | 62261 | 5568 | 62828 | 4604 | 61483 | 3244 | 72264 | 2528 | 40102 |
| 8-#18 | 1.73 | MA | 39905 | 9275 | 63525 | 6848 | 68702 | 5601 | 70095 | 4638 | 69988 | 3240 | 82142 | 2774 | 42327 |
| 3E | | MI | 38035 | 9275 | 60661 | 6825 | 65482 | 5581 | 66742 | 4621 | 66472 | 3222 | 77889 | 2749 | 40247 |
| 8-#18 | 1.73 | MA | 38356 | 9275 | 60860 | 6884 | 65306 | 5589 | 65968 | 4622 | 64696 | 3262 | 76154 | 2553 | 42143 |
| 4L-2S | | MI | 40115 | 9275 | 63751 | 6834 | 69443 | 5550 | 71574 | 4594 | 72998 | 3199 | 86563 | 2971 | 40185 |
| 10-#14 | 1.22 | MA | 40411 | 8946 | 62853 | 6694 | 68096 | 5456 | 69453 | 4550 | 69212 | 3271 | 81397 | 3096 | 30294 |
| 2L-5S | | MI | 35720 | 8946 | 55573 | 6686 | 59206 | 5470 | 59176 | 4561 | 56350 | 3274 | 65535 | 2769 | 28906 |
| 10-#14 | 1.22 | MA | 39142 | 8946 | 60990 | 6690 | 65708 | 5450 | 66540 | 4567 | 65249 | 3285 | 76066 | 2971 | 30353 |
| 3L-4S | | MI | 36477 | 8946 | 56819 | 6690 | 60821 | 5452 | 61161 | 4544 | 59225 | 3286 | 68957 | 2828 | 28929 |
| 10-#14 | 1.22 | MA | 38251 | 8946 | 59472 | 6711 | 63774 | 5470 | 64189 | 4560 | 62223 | 3299 | 72596 | 2847 | 30391 |
| 4L-3S | | MI | 37323 | 8946 | 58259 | 6669 | 62656 | 5458 | 63391 | 4552 | 62095 | 3273 | 72222 | 2953 | 28884 |
| 10-#14 | 1.22 | MA | 37454 | 8946 | 58160 | 6707 | 62073 | 5464 | 62098 | 4577 | 59195 | 3287 | 68970 | 2787 | 30344 |
| 5L-2S | | MI | 38524 | 8946 | 60025 | 6673 | 64920 | 5439 | 66152 | 4535 | 65852 | 3260 | 77245 | 3077 | 28821 |
| 10-#18 | 2.16 | MA | 43604 | 9551 | 70051 | 7029 | 77068 | 5692 | 80301 | 4685 | 83834 | 3195 | 100586 | 2944 | 52511 |
| 2L-5S | | MI | 36699 | 9551 | 59035 | 7024 | 63385 | 5723 | 64174 | 4707 | 63011 | 3197 | 75005 | 2372 | 47738 |
| 10-#18 | 2.16 | MA | 41421 | 9551 | 66788 | 7021 | 72885 | 5725 | 75198 | 4713 | 76911 | 3217 | 91364 | 2723 | 52477 |
| 3L-4S | | MI | 38005 | 9551 | 61224 | 7033 | 66222 | 5692 | 67661 | 4679 | 68010 | 3219 | 80939 | 2473 | 49633 |
| 10-#18 | 2.16 | MA | 39884 | 9551 | 64123 | 7057 | 69489 | 5713 | 71071 | 4698 | 71619 | 3239 | 85376 | 2501 | 52201 |
| 4L-3S | | MI | 39464 | 9551 | 63751 | 6998 | 69443 | 5705 | 71574 | 4696 | 72998 | 3197 | 86563 | 2695 | 49867 |
| 10-#18 | 2.16 | MA | 38509 | 9551 | 61816 | 7049 | 66498 | 5745 | 67396 | 4726 | 66318 | 3217 | 79080 | 2398 | 50173 |
| 5L-2S | | MI | 41530 | 9551 | 66841 | 7007 | 73404 | 5674 | 76407 | 4669 | 79525 | 3175 | 95238 | 2916 | 49879 |
| 12-#11 | 1.01 | MA | 39716 | 8815 | 61243 | 6633 | 66163 | 5415 | 67144 | 4529 | 66092 | 3293 | 77353 | 3136 | 25440 |
| 2L-6S | | MI | 35400 | 8815 | 54577 | 6621 | 57976 | 5418 | 57723 | 4529 | 54456 | 3304 | 62943 | 2849 | 24342 |
| 12-#11 | 1.01 | MA | 38826 | 8815 | 59942 | 6631 | 64495 | 5411 | 65110 | 4541 | 63323 | 3303 | 73607 | 3049 | 25485 |
| 3L-5S | | MI | 35905 | 8815 | 55391 | 6623 | 59104 | 5405 | 59102 | 4534 | 56273 | 3294 | 65226 | 2905 | 24342 |
| 12-#11 | 1.01 | MA | 38201 | 8815 | 58883 | 6646 | 63146 | 5425 | 63470 | 4537 | 61213 | 3313 | 71165 | 2963 | 25527 |
| 4E | | MI | 36435 | 8815 | 56260 | 6626 | 60230 | 5408 | 60486 | 4522 | 58278 | 3302 | 67628 | 2946 | 24307 |
| 12-#11 | 1.01 | MA | 37644 | 8815 | 57968 | 6644 | 61960 | 5422 | 62012 | 4549 | 59101 | 3306 | 68622 | 2921 | 25554 |
| 5L-3S | | MI | 37027 | 8815 | 57265 | 6611 | 61511 | 5395 | 62043 | 4527 | 60281 | 3292 | 69927 | 3033 | 24261 |
| 12-#11 | 1.01 | MA | 37113 | 8815 | 57111 | 6642 | 60772 | 5435 | 60560 | 4545 | 57188 | 3316 | 66199 | 2865 | 25539 |
| 6L-2S | | MI | 37871 | 8815 | 58498 | 6614 | 63092 | 5399 | 63972 | 4515 | 62906 | 3283 | 73460 | 3119 | 24215 |
| 12-#14 | 1.46 | MA | 41287 | 9102 | 64715 | 6791 | 70484 | 5526 | 72366 | 4592 | 73176 | 3259 | 86728 | 3071 | 36152 |
| 2L-6S | | MI | 35843 | 9102 | 56171 | 6779 | 59851 | 5534 | 59960 | 4595 | 57502 | 3274 | 67314 | 2661 | 33828 |
| 12-#14 | 1.46 | MA | 40024 | 9102 | 62853 | 6787 | 68096 | 5520 | 69453 | 4609 | 69212 | 3273 | 81397 | 2946 | 36195 |
| 3L-5S | | MI | 36560 | 9102 | 57339 | 6783 | 61469 | 5540 | 61937 | 4603 | 60107 | 3261 | 70558 | 2742 | 34381 |
| 12-#14 | 1.46 | MA | 39137 | 9102 | 61335 | 6808 | 66162 | 5539 | 67103 | 4602 | 66187 | 3286 | 77927 | 2821 | 36198 |
| 4E | | MI | 37313 | 9102 | 58584 | 6787 | 63085 | 5522 | 63922 | 4586 | 62982 | 3273 | 73980 | 2801 | 34444 |
| 12-#14 | 1.46 | MA | 38344 | 9102 | 60023 | 6805 | 64461 | 5534 | 65012 | 4619 | 63159 | 3275 | 74302 | 2762 | 36115 |
| 5L-3S | | MI | 38155 | 9102 | 60025 | 6766 | 64920 | 5528 | 66152 | 4595 | 65852 | 3261 | 77245 | 2925 | 34427 |
| 12-#14 | 1.46 | MA | 37590 | 9102 | 58793 | 6801 | 62757 | 5553 | 62929 | 4612 | 60415 | 3288 | 70856 | 2681 | 35506 |
| 6L-2S | | MI | 39351 | 9102 | 61790 | 6770 | 67183 | 5509 | 68913 | 4578 | 69609 | 3248 | 82268 | 3050 | 34379 |
| 12-#18 | 2.60 | MA | 45091 | 9828 | 73314 | 7202 | 81251 | 5817 | 85404 | 4760 | 90757 | 3172 | 109807 | 2893 | 62709 |
| 2L-6S | | MI | 36902 | 9828 | 60071 | 7187 | 64503 | 5834 | 65533 | 4765 | 65008 | 3194 | 78084 | 2173 | 55322 |
| 12-#18 | 2.60 | MA | 42923 | 9828 | 70051 | 7194 | 77068 | 5849 | 80301 | 4789 | 83834 | 3194 | 100586 | 2672 | 62600 |
| 3L-5S | | MI | 38136 | 9828 | 62125 | 7197 | 67346 | 5847 | 69007 | 4782 | 69538 | 3172 | 83679 | 2317 | 56935 |
| 12-#18 | 2.60 | MA | 41397 | 9828 | 67386 | 7230 | 73672 | 5837 | 76174 | 4773 | 78542 | 3216 | 94598 | 2450 | 62244 |
| 4E | | MI | 39431 | 9828 | 64314 | 7206 | 70184 | 5816 | 72493 | 4755 | 74537 | 3194 | 89613 | 2419 | 59147 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

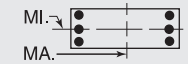
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 2.60 | MA | 40033 | 9828 | 65079 | 7222 | 70681 | 5869 | 72499 | 4802 | 73241 | 3194 | 88302 | 2347 | 59897 |
| 5L-3S | | MI | 40880 | 9828 | 66841 | 7171 | 73404 | 5829 | 76407 | 4772 | 79525 | 3172 | 95238 | 2640 | 59460 |
| 12-#18 | 2.60 | MA | 38735 | 9828 | 62916 | 7213 | 67685 | 5857 | 68838 | 4786 | 68436 | 3216 | 82350 | 2203 | 58142 |
| 6L-2S | | MI | 42932 | 9828 | 69931 | 7180 | 77365 | 5798 | 81239 | 4745 | 86052 | 3150 | 103912 | 2862 | 59548 |
| 14-#11 | 1.18 | MA | 40335 | 8923 | 62544 | 6701 | 67831 | 5463 | 69179 | 4558 | 68860 | 3285 | 81100 | 3119 | 29537 |
| 2L-7S | | MI | 35503 | 8923 | 54918 | 6703 | 58481 | 5463 | 58329 | 4571 | 55305 | 3304 | 64039 | 2741 | 27890 |
| 14-#11 | 1.18 | MA | 39447 | 8923 | 61243 | 6698 | 66163 | 5460 | 67144 | 4571 | 66092 | 3295 | 77353 | 3033 | 29576 |
| 3L-6S | | MI | 35993 | 8923 | 55810 | 6688 | 59557 | 5466 | 59652 | 4559 | 57081 | 3295 | 66475 | 2831 | 28178 |
| 14-#11 | 1.18 | MA | 38825 | 8923 | 60184 | 6713 | 64814 | 5473 | 65505 | 4566 | 63981 | 3305 | 74912 | 2946 | 29608 |
| 4L-5S | | MI | 36496 | 8923 | 56625 | 6691 | 60685 | 5453 | 61031 | 4564 | 58898 | 3285 | 68758 | 2887 | 28201 |
| 14-#11 | 1.18 | MA | 38269 | 8923 | 59270 | 6711 | 63627 | 5470 | 64047 | 4579 | 61869 | 3298 | 72369 | 2904 | 29617 |
| 5L-4S | | MI | 37024 | 8923 | 57493 | 6693 | 61812 | 5457 | 62416 | 4552 | 60903 | 3293 | 71160 | 2929 | 28181 |
| 14-#11 | 1.18 | MA | 37740 | 8923 | 58412 | 6709 | 62440 | 5484 | 62595 | 4574 | 59956 | 3308 | 69946 | 2849 | 29580 |
| 6L-3S | | MI | 37614 | 8923 | 58498 | 6679 | 63092 | 5443 | 63972 | 4557 | 62906 | 3284 | 73460 | 3015 | 28146 |
| 14-#11 | 1.18 | MA | 37225 | 8923 | 57473 | 6724 | 61307 | 5480 | 61202 | 4586 | 58087 | 3318 | 67362 | 2759 | 29257 |
| 7L-2S | | MI | 38455 | 8923 | 59732 | 6681 | 64674 | 5447 | 65902 | 4545 | 65531 | 3274 | 76992 | 3101 | 28105 |
| 14-#14 | 1.70 | MA | 42158 | 9257 | 66578 | 6888 | 72872 | 5596 | 75280 | 4635 | 77140 | 3247 | 92060 | 3045 | 41997 |
| 2L-7S | | MI | 35986 | 9257 | 56656 | 6897 | 60571 | 5623 | 60823 | 4654 | 58712 | 3274 | 68874 | 2504 | 38440 |
| 14-#14 | 1.70 | MA | 40900 | 9257 | 64715 | 6884 | 70484 | 5590 | 72366 | 4652 | 73176 | 3260 | 86728 | 2921 | 42026 |
| 3L-6S | | MI | 36681 | 9257 | 57936 | 6876 | 62115 | 5604 | 62721 | 4637 | 61258 | 3262 | 72337 | 2634 | 39139 |
| 14-#14 | 1.70 | MA | 40017 | 9257 | 63198 | 6906 | 68550 | 5609 | 70016 | 4644 | 70151 | 3274 | 83258 | 2796 | 41992 |
| 4L-5S | | MI | 37395 | 9257 | 59104 | 6880 | 63733 | 5610 | 64698 | 4646 | 63864 | 3249 | 75580 | 2715 | 39847 |
| 14-#14 | 1.70 | MA | 39229 | 9257 | 61886 | 6902 | 66849 | 5604 | 67925 | 4662 | 67122 | 3262 | 79633 | 2736 | 41877 |
| 5L-4S | | MI | 38144 | 9257 | 60350 | 6884 | 65348 | 5591 | 66683 | 4629 | 66738 | 3261 | 79003 | 2774 | 39940 |
| 14-#14 | 1.70 | MA | 38478 | 9257 | 60656 | 6898 | 65145 | 5623 | 65843 | 4654 | 64378 | 3276 | 76188 | 2656 | 41113 |
| 6L-3S | | MI | 38982 | 9257 | 61790 | 6864 | 67183 | 5597 | 68913 | 4637 | 69609 | 3248 | 82268 | 2898 | 39956 |
| 14-#14 | 1.70 | MA | 37747 | 9257 | 59308 | 6919 | 63520 | 5617 | 63844 | 4672 | 61697 | 3290 | 72512 | 2526 | 40353 |
| 7L-2S | | MI | 40173 | 9257 | 63556 | 6868 | 69446 | 5579 | 71675 | 4620 | 73366 | 3236 | 87291 | 3023 | 39923 |
| 14-#18 | 3.03 | MA | 46566 | 10105 | 76577 | 7375 | 85434 | 5941 | 90507 | 4836 | 97681 | 3149 | 119029 | 2842 | 72872 |
| 2L-7S | | MI | 37142 | 10105 | 60911 | 7395 | 65751 | 5990 | 67030 | 4868 | 67109 | 3191 | 80780 | 1887 | 61840 |
| 14-#18 | 3.03 | MA | 44411 | 10105 | 73314 | 7367 | 81251 | 5973 | 85404 | 4864 | 90757 | 3171 | 109807 | 2620 | 72706 |
| 3L-6S | | MI | 38335 | 10105 | 63161 | 7360 | 68464 | 5959 | 70365 | 4841 | 71535 | 3169 | 86759 | 2118 | 64630 |
| 14-#18 | 3.03 | MA | 42897 | 10105 | 70649 | 7403 | 77855 | 5961 | 81277 | 4849 | 85465 | 3193 | 103820 | 2399 | 72278 |
| 4L-5S | | MI | 39559 | 10105 | 65215 | 7369 | 71307 | 5972 | 73839 | 4858 | 76064 | 3147 | 92353 | 2263 | 66165 |
| 14-#18 | 3.03 | MA | 41543 | 10105 | 68342 | 7395 | 74864 | 5993 | 77602 | 4877 | 80164 | 3171 | 97524 | 2296 | 69653 |
| 5L-4S | | MI | 40846 | 10105 | 67404 | 7379 | 74145 | 5940 | 77325 | 4830 | 81063 | 3169 | 98288 | 2364 | 68651 |
| 14-#18 | 3.03 | MA | 40255 | 10105 | 66178 | 7386 | 71868 | 5981 | 73941 | 4861 | 75359 | 3193 | 91572 | 2152 | 67981 |
| 6L-3S | | MI | 42284 | 10105 | 69931 | 7343 | 77365 | 5953 | 81239 | 4847 | 86052 | 3147 | 103912 | 2586 | 69033 |
| 14-#18 | 3.03 | MA | 39000 | 10105 | 63808 | 7422 | 69009 | 6014 | 70426 | 4890 | 70664 | 3215 | 85216 | 1920 | 65019 |
| 7L-2S | | MI | 44323 | 10105 | 73021 | 7353 | 81327 | 5922 | 86072 | 4820 | 92578 | 3125 | 112587 | 2807 | 69177 |
| 16-#11 | 1.35 | MA | 40951 | 9031 | 63845 | 6768 | 69499 | 5512 | 71214 | 4588 | 71629 | 3276 | 84847 | 3103 | 33627 |
| 2L-8S | | MI | 35613 | 9031 | 55350 | 6768 | 58971 | 5524 | 58967 | 4612 | 56043 | 3288 | 65326 | 2675 | 31272 |
| 16-#11 | 1.35 | MA | 40066 | 9031 | 62544 | 6766 | 67831 | 5508 | 69179 | 4600 | 68860 | 3286 | 81100 | 3016 | 33659 |
| 3L-7S | | MI | 36094 | 9031 | 56152 | 6771 | 60062 | 5511 | 60258 | 4600 | 57930 | 3296 | 67572 | 2724 | 31632 |
| 16-#11 | 1.35 | MA | 39446 | 9031 | 61485 | 6781 | 66482 | 5522 | 67539 | 4596 | 66750 | 3296 | 78659 | 2930 | 33680 |
| 4L-6S | | MI | 36583 | 9031 | 57044 | 6756 | 61139 | 5515 | 61582 | 4588 | 59705 | 3286 | 70008 | 2814 | 32008 |
| 16-#11 | 1.35 | MA | 38892 | 9031 | 60571 | 6779 | 65295 | 5518 | 66081 | 4608 | 64638 | 3289 | 76115 | 2888 | 33669 |
| 5E | | MI | 37084 | 9031 | 57858 | 6758 | 62267 | 5501 | 62960 | 4593 | 61522 | 3277 | 72291 | 2870 | 32048 |
| 16-#11 | 1.35 | MA | 38365 | 9031 | 59713 | 6776 | 64108 | 5532 | 64630 | 4603 | 62725 | 3299 | 73693 | 2832 | 33615 |
| 6L-4S | | MI | 37610 | 9031 | 58727 | 6761 | 63393 | 5505 | 64345 | 4581 | 63528 | 3285 | 74693 | 2911 | 32047 |
| 16-#11 | 1.35 | MA | 37852 | 9031 | 58774 | 6791 | 62975 | 5529 | 63237 | 4616 | 60856 | 3309 | 71109 | 2742 | 33203 |
| 7L-3S | | MI | 38198 | 9031 | 59732 | 6746 | 64674 | 5492 | 65902 | 4586 | 65531 | 3275 | 76992 | 2998 | 32021 |
| 16-#11 | 1.35 | MA | 37346 | 9031 | 57931 | 6789 | 61826 | 5542 | 61877 | 4628 | 58869 | 3302 | 68731 | 2693 | 32810 |
| 8L-2S | | MI | 39037 | 9031 | 60965 | 6749 | 66255 | 5496 | 67831 | 4574 | 68156 | 3266 | 80525 | 3084 | 31987 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis

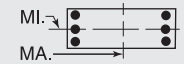


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#14 | 1.95 | MA | 43024 | 9413 | 68441 | 6985 | 75260 | 5665 | 78193 | 4677 | 81103 | 3234 | 97391 | 3020 | 47832 |
| 2L-8S | | MI | 36141 | 9413 | 57272 | 6990 | 61269 | 5686 | 61732 | 4713 | 59764 | 3250 | 70697 | 2408 | 43029 |
| 16-#14 | 1.95 | MA | 41771 | 9413 | 66578 | 6982 | 72872 | 5660 | 75280 | 4694 | 77140 | 3248 | 92060 | 2895 | 47835 |
| 3L-7S | | MI | 36822 | 9413 | 58422 | 6994 | 62835 | 5693 | 63584 | 4697 | 62469 | 3262 | 73897 | 2477 | 43794 |
| 16-#14 | 1.95 | MA | 40893 | 9413 | 65061 | 7003 | 70938 | 5679 | 72929 | 4687 | 74115 | 3261 | 88590 | 2771 | 47776 |
| 4L-6S | | MI | 37514 | 9413 | 59702 | 6973 | 64378 | 5674 | 65482 | 4680 | 65015 | 3249 | 77359 | 2607 | 44462 |
| 16-#14 | 1.95 | MA | 40108 | 9413 | 63749 | 6999 | 69237 | 5674 | 70838 | 4704 | 71086 | 3250 | 84964 | 2711 | 47633 |
| 5E | | MI | 38224 | 9413 | 60870 | 6977 | 65996 | 5680 | 67459 | 4688 | 67621 | 3237 | 80603 | 2688 | 45305 |
| 16-#14 | 1.95 | MA | 39361 | 9413 | 62519 | 6995 | 67533 | 5693 | 68756 | 4697 | 68342 | 3264 | 81519 | 2630 | 46733 |
| 6L-4S | | MI | 38970 | 9413 | 62116 | 6981 | 67611 | 5661 | 69444 | 4671 | 70495 | 3249 | 84025 | 2747 | 45427 |
| 16-#14 | 1.95 | MA | 38633 | 9413 | 61171 | 7017 | 65908 | 5687 | 66757 | 4714 | 65661 | 3277 | 77843 | 2500 | 46004 |
| 7L-3S | | MI | 39804 | 9413 | 63556 | 6961 | 69446 | 5667 | 71675 | 4679 | 73366 | 3236 | 87291 | 2871 | 45472 |
| 16-#14 | 1.95 | MA | 37916 | 9413 | 59961 | 7013 | 64259 | 5706 | 64807 | 4732 | 62811 | 3266 | 74453 | 2430 | 45179 |
| 8L-2S | | MI | 40991 | 9413 | 65321 | 6965 | 71710 | 5649 | 74436 | 4663 | 77122 | 3223 | 92313 | 2996 | 45458 |
| 16-#18 | 3.46 | MA | 45888 | 10381 | 76577 | 7540 | 85434 | 6097 | 90507 | 4940 | 97681 | 3148 | 119029 | 2569 | 82798 |
| 3L-7S | | MI | 38572 | 10381 | 64001 | 7568 | 69712 | 6114 | 71862 | 4943 | 73636 | 3167 | 89455 | 1832 | 71003 |
| 16-#18 | 3.46 | MA | 44384 | 10381 | 73912 | 7576 | 82038 | 6085 | 86379 | 4924 | 92388 | 3170 | 113042 | 2347 | 82305 |
| 4L-6S | | MI | 39756 | 10381 | 66251 | 7533 | 72426 | 6083 | 75198 | 4916 | 78062 | 3144 | 95433 | 2064 | 73947 |
| 16-#18 | 3.46 | MA | 43040 | 10381 | 71605 | 7568 | 79047 | 6117 | 82704 | 4952 | 87087 | 3148 | 106746 | 2244 | 79436 |
| 5E | | MI | 40971 | 10381 | 68305 | 7542 | 75268 | 6096 | 78671 | 4933 | 82591 | 3122 | 101028 | 2208 | 75421 |
| 16-#18 | 3.46 | MA | 41762 | 10381 | 69441 | 7559 | 76051 | 6106 | 79044 | 4937 | 82283 | 3170 | 100794 | 2100 | 77835 |
| 6L-4S | | MI | 42248 | 10381 | 70494 | 7551 | 78106 | 6065 | 82158 | 4906 | 87590 | 3144 | 106962 | 2310 | 78146 |
| 16-#18 | 3.46 | MA | 40517 | 10381 | 67071 | 7595 | 73192 | 6138 | 75529 | 4965 | 77588 | 3192 | 94438 | 1869 | 74713 |
| 7L-3S | | MI | 43677 | 10381 | 73021 | 7516 | 81327 | 6078 | 86072 | 4923 | 92578 | 3122 | 112587 | 2531 | 78592 |
| 18-#11 | 1.52 | MA | 41564 | 9139 | 65146 | 6836 | 71167 | 5560 | 73249 | 4617 | 74397 | 3267 | 88593 | 3086 | 37711 |
| 2L-9S | | MI | 35714 | 9139 | 55721 | 6850 | 59490 | 5569 | 59545 | 4637 | 56909 | 3289 | 66645 | 2604 | 34760 |
| 18-#11 | 1.52 | MA | 40682 | 9139 | 63845 | 6833 | 69499 | 5557 | 71214 | 4630 | 71629 | 3277 | 84847 | 3000 | 37735 |
| 3L-8S | | MI | 36204 | 9139 | 56584 | 6835 | 60552 | 5573 | 60896 | 4642 | 58668 | 3279 | 68859 | 2658 | 35033 |
| 18-#11 | 1.52 | MA | 40064 | 9139 | 62786 | 6848 | 68150 | 5570 | 69574 | 4625 | 69518 | 3287 | 82405 | 2914 | 37747 |
| 4L-7S | | MI | 36683 | 9139 | 57385 | 6838 | 61644 | 5559 | 62188 | 4630 | 60555 | 3287 | 71105 | 2706 | 35379 |
| 18-#11 | 1.52 | MA | 39512 | 9139 | 61872 | 6846 | 66963 | 5567 | 68116 | 4638 | 67406 | 3280 | 79862 | 2872 | 37716 |
| 5L-6S | | MI | 37170 | 9139 | 58278 | 6823 | 62720 | 5563 | 63511 | 4618 | 62330 | 3278 | 73540 | 2796 | 35832 |
| 18-#11 | 1.52 | MA | 38987 | 9139 | 61015 | 6844 | 65776 | 5581 | 66665 | 4633 | 65493 | 3290 | 77439 | 2816 | 37646 |
| 6L-5S | | MI | 37669 | 9139 | 59092 | 6826 | 63848 | 5550 | 64890 | 4623 | 64147 | 3268 | 75823 | 2852 | 35888 |
| 18-#11 | 1.52 | MA | 38475 | 9139 | 60075 | 6859 | 64643 | 5577 | 65271 | 4645 | 63624 | 3300 | 74856 | 2726 | 37156 |
| 7L-4S | | MI | 38193 | 9139 | 59961 | 6828 | 64975 | 5554 | 66274 | 4611 | 66153 | 3276 | 78225 | 2894 | 35906 |
| 18-#11 | 1.52 | MA | 37971 | 9139 | 59232 | 6857 | 63494 | 5591 | 63912 | 4658 | 61638 | 3293 | 72477 | 2677 | 36776 |
| 8L-3S | | MI | 38780 | 9139 | 60965 | 6814 | 66255 | 5540 | 67831 | 4616 | 68156 | 3266 | 80525 | 2980 | 35889 |
| 18-#11 | 1.52 | MA | 37447 | 9139 | 58406 | 6854 | 62376 | 5587 | 62490 | 4653 | 59786 | 3303 | 70128 | 2623 | 36472 |
| 9L-2S | | MI | 39616 | 9139 | 62199 | 6816 | 67837 | 5544 | 69760 | 4604 | 70781 | 3257 | 84058 | 3066 | 35862 |
| 18-#14 | 2.19 | MA | 43885 | 9569 | 70304 | 7083 | 77648 | 5735 | 81106 | 4719 | 85067 | 3222 | 102722 | 2994 | 53662 |
| 2L-9S | | MI | 36286 | 9569 | 57799 | 7108 | 62009 | 5775 | 62556 | 4748 | 60997 | 3250 | 72575 | 2303 | 47272 |
| 18-#14 | 2.19 | MA | 42637 | 9569 | 68441 | 7079 | 75260 | 5730 | 78193 | 4737 | 81103 | 3235 | 97391 | 2870 | 53635 |
| 3L-8S | | MI | 36976 | 9569 | 59037 | 7087 | 63532 | 5756 | 64493 | 4756 | 63520 | 3237 | 75720 | 2381 | 48294 |
| 18-#14 | 2.19 | MA | 41763 | 9569 | 66923 | 7100 | 73326 | 5749 | 75842 | 4729 | 78078 | 3249 | 93921 | 2745 | 53553 |
| 4L-7S | | MI | 37654 | 9569 | 60187 | 7091 | 65098 | 5762 | 66345 | 4739 | 66226 | 3250 | 78919 | 2450 | 49154 |
| 18-#14 | 2.19 | MA | 40982 | 9569 | 65611 | 7096 | 71625 | 5743 | 73751 | 4747 | 75050 | 3238 | 90295 | 2686 | 53383 |
| 5L-6S | | MI | 38343 | 9569 | 61467 | 7070 | 66642 | 5744 | 68243 | 4722 | 68772 | 3237 | 82382 | 2580 | 49797 |
| 18-#14 | 2.19 | MA | 40239 | 9569 | 64382 | 7093 | 69921 | 5763 | 71669 | 4739 | 72306 | 3251 | 86850 | 2605 | 52364 |
| 6L-5S | | MI | 39049 | 9569 | 62635 | 7075 | 68259 | 5750 | 70220 | 4730 | 71377 | 3224 | 85626 | 2661 | 50757 |
| 18-#14 | 2.19 | MA | 39514 | 9569 | 63034 | 7114 | 68296 | 5757 | 69671 | 4757 | 69624 | 3265 | 83174 | 2475 | 51662 |
| 7L-4S | | MI | 39792 | 9569 | 63881 | 7079 | 69875 | 5731 | 72205 | 4714 | 74252 | 3236 | 89048 | 2720 | 50905 |
| 18-#14 | 2.19 | MA | 38801 | 9569 | 61823 | 7110 | 66647 | 5776 | 67720 | 4774 | 66775 | 3253 | 79784 | 2405 | 50743 |
| 8L-3S | | MI | 40622 | 9569 | 65321 | 7058 | 71710 | 5737 | 74436 | 4722 | 77122 | 3223 | 92313 | 2844 | 50973 |
| 18-#14 | 2.19 | MA | 38070 | 9569 | 60520 | 7131 | 65043 | 5771 | 65680 | 4766 | 64118 | 3267 | 76444 | 2327 | 49638 |
| 9L-2S | | MI | 41804 | 9569 | 67087 | 7062 | 73973 | 5718 | 77197 | 4705 | 80879 | 3211 | 97336 | 2969 | 50991 |
| 18-#18 | 3.90 | MA | 45860 | 10658 | 77175 | 7749 | 86221 | 6209 | 91482 | 4999 | 99312 | 3147 | 122264 | 2296 | 92181 |
| 4L-7S | | MI | 39990 | 10658 | 67091 | 7741 | 73673 | 6238 | 76695 | 5019 | 80162 | 3142 | 98129 | 1777 | 80188 |
| 18-#18 | 3.90 | MA | 44526 | 10658 | 74868 | 7740 | 83230 | 6242 | 87807 | 5028 | 94010 | 3125 | 115968 | 2193 | 89241 |
| 5L-6S | | MI | 41165 | 10658 | 69341 | 7706 | 76387 | 6207 | 80030 | 4991 | 84588 | 3120 | 104107 | 2009 | 83023 |

## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

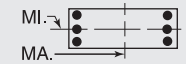
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 3.90 | MA | 43256 | 10658 | 72704 | 7732 | 80234 | 6230 | 84147 | 5012 | 89206 | 3147 | 110016 | 2049 | 87492 |
| 6L-5S | | MI | 42373 | 10658 | 71395 | 7715 | 79230 | 6220 | 83504 | 5008 | 89118 | 3098 | 109702 | 2153 | 84699 |
| 18-#18 | 3.90 | MA | 42020 | 10658 | 70334 | 7768 | 77375 | 6262 | 80632 | 5041 | 84511 | 3169 | 103660 | 1818 | 84428 |
| 7L-4S | | MI | 43641 | 10658 | 73584 | 7724 | 82067 | 6189 | 86990 | 4981 | 94117 | 3120 | 115637 | 2255 | 87402 |
| 20-#11 | 1.69 | MA | 42174 | 9247 | 66447 | 6903 | 72835 | 5608 | 75284 | 4647 | 77166 | 3259 | 92340 | 3070 | 41789 |
| 2L-10S | | MI | 35779 | 9247 | 56155 | 6915 | 59995 | 5631 | 60190 | 4678 | 57790 | 3290 | 68033 | 2525 | 37850 |
| 20-#11 | 1.69 | MA | 41295 | 9247 | 65146 | 6901 | 71167 | 5605 | 73249 | 4659 | 74397 | 3269 | 88593 | 2984 | 41807 |
| 3L-9S | | MI | 36305 | 9247 | 56954 | 6918 | 61072 | 5617 | 61475 | 4666 | 59534 | 3280 | 70178 | 2586 | 38459 |
| 20-#11 | 1.69 | MA | 40679 | 9247 | 64087 | 6916 | 69818 | 5619 | 71609 | 4654 | 72287 | 3279 | 86152 | 2897 | 41798 |
| 4L-8S | | MI | 36792 | 9247 | 57817 | 6903 | 62134 | 5621 | 62825 | 4671 | 61293 | 3271 | 72391 | 2640 | 38796 |
| 20-#11 | 1.69 | MA | 40129 | 9247 | 63173 | 6913 | 68631 | 5615 | 70151 | 4667 | 70175 | 3272 | 83609 | 2855 | 41757 |
| 5L-7S | | MI | 37270 | 9247 | 58619 | 6905 | 63225 | 5608 | 64117 | 4659 | 63180 | 3279 | 74637 | 2689 | 39131 |
| 20-#11 | 1.69 | MA | 39606 | 9247 | 62316 | 6911 | 67444 | 5629 | 68699 | 4662 | 68262 | 3282 | 81186 | 2799 | 41672 |
| 6E | | MI | 37754 | 9247 | 59511 | 6891 | 64302 | 5612 | 65440 | 4647 | 64955 | 3269 | 77073 | 2779 | 39647 |
| 20-#11 | 1.69 | MA | 39096 | 9247 | 61376 | 6926 | 66311 | 5626 | 67306 | 4675 | 66393 | 3292 | 78602 | 2709 | 41114 |
| 7L-5S | | MI | 38252 | 9247 | 60326 | 6893 | 65430 | 5598 | 66819 | 4652 | 66772 | 3260 | 79356 | 2835 | 39723 |
| 20-#11 | 1.69 | MA | 38594 | 9247 | 60533 | 6924 | 65162 | 5639 | 65947 | 4687 | 64406 | 3284 | 76224 | 2660 | 40746 |
| 8L-4S | | MI | 38774 | 9247 | 61194 | 6896 | 66556 | 5602 | 68204 | 4640 | 68778 | 3267 | 81758 | 2876 | 39755 |
| 20-#11 | 1.69 | MA | 38073 | 9247 | 59707 | 6922 | 64044 | 5636 | 64525 | 4683 | 62554 | 3295 | 73875 | 2606 | 40378 |
| 9L-3S | | MI | 39359 | 9247 | 62199 | 6881 | 67837 | 5589 | 69760 | 4645 | 70781 | 3258 | 84058 | 2963 | 39753 |
| 20-#11 | 1.69 | MA | 37519 | 9247 | 58783 | 6937 | 62910 | 5650 | 63172 | 4695 | 60718 | 3305 | 71599 | 2545 | 39720 |
| 10L-2S | | MI | 40193 | 9247 | 63433 | 6884 | 69418 | 5592 | 71689 | 4633 | 73406 | 3248 | 87590 | 3049 | 39731 |
| 20-#14 | 2.44 | MA | 43499 | 9724 | 70304 | 7176 | 77648 | 5799 | 81106 | 4779 | 85067 | 3223 | 102722 | 2844 | 59428 |
| 3L-9S | | MI | 37123 | 9724 | 59565 | 7205 | 64272 | 5845 | 65317 | 4790 | 64754 | 3238 | 77598 | 2276 | 52580 |
| 20-#14 | 2.44 | MA | 42629 | 9724 | 68786 | 7197 | 75714 | 5819 | 78756 | 4772 | 82042 | 3236 | 99252 | 2720 | 59324 |
| 4L-8S | | MI | 37806 | 9724 | 60803 | 7184 | 65795 | 5826 | 67254 | 4798 | 67277 | 3225 | 80743 | 2354 | 53571 |
| 20-#14 | 2.44 | MA | 41851 | 9724 | 67474 | 7194 | 74013 | 5813 | 76665 | 4789 | 79014 | 3225 | 95627 | 2660 | 59130 |
| 5L-7S | | MI | 38481 | 9724 | 61953 | 7188 | 67361 | 5832 | 69107 | 4781 | 69983 | 3237 | 83942 | 2423 | 54520 |
| 20-#14 | 2.44 | MA | 41111 | 9724 | 66244 | 7190 | 72309 | 5832 | 74582 | 4782 | 76269 | 3239 | 92181 | 2579 | 58004 |
| 6E | | MI | 39167 | 9724 | 63233 | 7168 | 68905 | 5813 | 71004 | 4765 | 72529 | 3224 | 87405 | 2553 | 55140 |
| 20-#14 | 2.44 | MA | 40391 | 9724 | 64897 | 7211 | 70684 | 5827 | 72584 | 4799 | 73588 | 3252 | 88505 | 2450 | 57325 |
| 7L-5S | | MI | 39870 | 9724 | 64401 | 7172 | 70523 | 5820 | 72981 | 4773 | 75134 | 3212 | 90649 | 2634 | 56187 |
| 20-#14 | 2.44 | MA | 39681 | 9724 | 63686 | 7207 | 69035 | 5846 | 70633 | 4816 | 70739 | 3241 | 85115 | 2379 | 56317 |
| 8L-4S | | MI | 40609 | 9724 | 65647 | 7176 | 72138 | 5801 | 74966 | 4756 | 78009 | 3224 | 94071 | 2693 | 56377 |
| 20-#14 | 2.44 | MA | 38954 | 9724 | 62382 | 7229 | 67431 | 5841 | 68593 | 4809 | 68082 | 3255 | 81775 | 2302 | 55245 |
| 9L-3S | | MI | 41436 | 9724 | 67087 | 7155 | 73973 | 5807 | 77197 | 4764 | 80879 | 3211 | 97336 | 2817 | 56466 |
| 20-#18 | 4.33 | MA | 46000 | 10935 | 78131 | 7913 | 87412 | 6366 | 92910 | 5103 | 100934 | 3101 | 125190 | 2142 | 99064 |
| 5L-7S | | MI | 41397 | 10935 | 70181 | 7914 | 77635 | 6362 | 81527 | 5094 | 86689 | 3117 | 106804 | 1723 | 89392 |
| 20-#18 | 4.33 | MA | 44740 | 10935 | 75967 | 7905 | 84417 | 6354 | 89249 | 5088 | 96129 | 3123 | 119238 | 1998 | 97121 |
| 6E | | MI | 42565 | 10935 | 72431 | 7879 | 80348 | 6331 | 84863 | 5067 | 91115 | 3095 | 112782 | 1954 | 92125 |
| 20-#18 | 4.33 | MA | 43512 | 10935 | 73597 | 7941 | 81558 | 6386 | 85735 | 5116 | 91434 | 3146 | 112881 | 1766 | 94162 |
| 7L-5S | | MI | 43764 | 10935 | 74485 | 7888 | 83191 | 6344 | 88336 | 5084 | 95644 | 3073 | 118377 | 2099 | 93994 |
| 22-#11 | 1.86 | MA | 42783 | 9355 | 67748 | 6970 | 74503 | 5657 | 77318 | 4676 | 79934 | 3250 | 96087 | 3053 | 45863 |
| 2L-11S | | MI | 35856 | 9355 | 56603 | 6980 | 60520 | 5675 | 60786 | 4702 | 58555 | 3273 | 69376 | 2456 | 41099 |
| 22-#11 | 1.86 | MA | 41906 | 9355 | 66447 | 6968 | 72835 | 5653 | 75284 | 4689 | 77166 | 3260 | 92340 | 2967 | 45874 |
| 3L-10S | | MI | 36369 | 9355 | 57389 | 6982 | 61576 | 5679 | 62119 | 4707 | 60415 | 3281 | 71566 | 2508 | 41574 |
| 22-#11 | 1.86 | MA | 41292 | 9355 | 65389 | 6983 | 71485 | 5667 | 73644 | 4684 | 75055 | 3270 | 89898 | 2881 | 45848 |
| 4L-9S | | MI | 36893 | 9355 | 58188 | 6985 | 62653 | 5666 | 63404 | 4695 | 62159 | 3272 | 73710 | 2569 | 42165 |
| 22-#11 | 1.86 | MA | 40744 | 9355 | 64474 | 6981 | 70299 | 5664 | 72186 | 4696 | 72943 | 3263 | 87355 | 2839 | 45794 |
| 5L-8S | | MI | 37378 | 9355 | 59051 | 6970 | 63715 | 5670 | 64755 | 4701 | 63918 | 3262 | 75924 | 2623 | 42562 |
| 22-#11 | 1.86 | MA | 40223 | 9355 | 63617 | 6979 | 69112 | 5677 | 70734 | 4692 | 71030 | 3273 | 84933 | 2783 | 45616 |
| 6L-7S | | MI | 37854 | 9355 | 59853 | 6973 | 64807 | 5656 | 66046 | 4688 | 65805 | 3270 | 78170 | 2671 | 42888 |
| 22-#11 | 1.86 | MA | 39715 | 9355 | 62677 | 6994 | 67979 | 5674 | 69341 | 4704 | 69161 | 3283 | 82349 | 2693 | 45076 |
| 7L-6S | | MI | 38337 | 9355 | 60745 | 6958 | 65883 | 5660 | 67370 | 4676 | 67580 | 3260 | 80606 | 2761 | 43383 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 42" x 44"

Short columns – no sidesway
Bending on major or minor axis

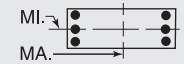



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.86 | MA | 39214 | 9355 | 61834 | 6991 | 66829 | 5688 | 67981 | 4717 | 67174 | 3276 | 79971 | 2644 | 44718 |
| 8L-5S | | MI | 38832 | 9355 | 61559 | 6961 | 67011 | 5647 | 68748 | 4681 | 69397 | 3251 | 82889 | 2817 | 43553 |
| 22-#11 | 1.86 | MA | 38695 | 9355 | 61008 | 6989 | 65712 | 5684 | 66559 | 4712 | 65322 | 3286 | 77622 | 2590 | 44290 |
| 9L-4S | | MI | 39353 | 9355 | 62428 | 6963 | 68138 | 5650 | 70133 | 4669 | 71403 | 3259 | 85291 | 2859 | 43597 |
| 22-#11 | 1.86 | MA | 38143 | 9355 | 60084 | 7004 | 64578 | 5698 | 65207 | 4724 | 63486 | 3296 | 75345 | 2529 | 43650 |
| 10L-3S | | MI | 39936 | 9355 | 63433 | 6948 | 69418 | 5637 | 71689 | 4675 | 73406 | 3249 | 87590 | 2945 | 43611 |
| 22-#11 | 1.86 | MA | 37604 | 9355 | 59257 | 7002 | 63466 | 5695 | 63803 | 4720 | 61528 | 3289 | 73026 | 2477 | 43136 |
| 11L-2S | | MI | 40767 | 9355 | 64666 | 6951 | 71000 | 5641 | 73619 | 4662 | 76031 | 3240 | 91123 | 3031 | 43597 |
| 22-#14 | 2.68 | MA | 43490 | 9880 | 70649 | 7295 | 78102 | 5889 | 81669 | 4814 | 86006 | 3224 | 104583 | 2694 | 65090 |
| 4L-9S | | MI | 37966 | 9880 | 61330 | 7302 | 66536 | 5915 | 68078 | 4832 | 68511 | 3225 | 82620 | 2249 | 57895 |
| 22-#14 | 2.68 | MA | 42716 | 9880 | 69337 | 7291 | 76401 | 5883 | 79578 | 4831 | 82977 | 3213 | 100958 | 2635 | 64744 |
| 5L-8S | | MI | 38632 | 9880 | 62569 | 7282 | 68059 | 5896 | 70015 | 4841 | 71034 | 3213 | 85766 | 2327 | 58857 |
| 22-#14 | 2.68 | MA | 41980 | 9880 | 68107 | 7287 | 74697 | 5902 | 77496 | 4824 | 80233 | 3226 | 97513 | 2554 | 63652 |
| 6L-7S | | MI | 39304 | 9880 | 63719 | 7286 | 69625 | 5902 | 71868 | 4824 | 73739 | 3225 | 88965 | 2396 | 59890 |
| 22-#14 | 2.68 | MA | 41262 | 9880 | 66760 | 7308 | 73072 | 5897 | 75497 | 4841 | 77552 | 3240 | 93837 | 2424 | 62993 |
| 7L-6S | | MI | 39986 | 9880 | 64998 | 7265 | 71168 | 5883 | 73766 | 4807 | 76285 | 3212 | 92428 | 2526 | 60491 |
| 22-#14 | 2.68 | MA | 40556 | 9880 | 65549 | 7305 | 71423 | 5916 | 73546 | 4859 | 74702 | 3229 | 90447 | 2354 | 61900 |
| 8L-5S | | MI | 40686 | 9880 | 66166 | 7269 | 72786 | 5889 | 75743 | 4815 | 78891 | 3199 | 95671 | 2607 | 61494 |
| 22-#14 | 2.68 | MA | 39833 | 9880 | 64245 | 7326 | 69819 | 5910 | 71507 | 4851 | 72045 | 3242 | 87106 | 2276 | 60859 |
| 9L-4S | | MI | 41422 | 9880 | 67412 | 7273 | 74401 | 5871 | 77728 | 4798 | 81765 | 3211 | 99094 | 2666 | 61843 |
| 22-#18 | 4.76 | MA | 46213 | 11211 | 79230 | 8078 | 88600 | 6478 | 94352 | 5163 | 103052 | 3100 | 128460 | 1946 | 106773 |
| 6L-7S | | MI | 42795 | 11211 | 73271 | 8087 | 81596 | 6486 | 86360 | 5169 | 93216 | 3092 | 115478 | 1668 | 98613 |
| 22-#18 | 4.76 | MA | 44994 | 11211 | 76860 | 8114 | 85741 | 6510 | 90838 | 5192 | 98357 | 3122 | 122103 | 1715 | 103913 |
| 7L-6S | | MI | 43955 | 11211 | 75521 | 8052 | 84309 | 6455 | 89695 | 5142 | 97642 | 3070 | 121456 | 1900 | 101250 |
| 24-#11 | 2.03 | MA | 42514 | 9463 | 67748 | 7036 | 74503 | 5702 | 77318 | 4718 | 79934 | 3252 | 96087 | 2951 | 49927 |
| 3L-11S | | MI | 36444 | 9463 | 57836 | 7047 | 62101 | 5724 | 62715 | 4732 | 61180 | 3265 | 72909 | 2439 | 44783 |
| 24-#11 | 2.03 | MA | 41902 | 9463 | 66690 | 7051 | 73153 | 5716 | 75678 | 4713 | 77824 | 3262 | 93645 | 2864 | 49894 |
| 4L-10S | | MI | 36955 | 9463 | 58622 | 7050 | 63158 | 5728 | 64048 | 4737 | 63040 | 3272 | 75098 | 2490 | 45301 |
| 24-#11 | 2.03 | MA | 41356 | 9463 | 65775 | 7048 | 71967 | 5712 | 74221 | 4726 | 75712 | 3254 | 91102 | 2822 | 49828 |
| 5L-9S | | MI | 37479 | 9463 | 59421 | 7052 | 64235 | 5714 | 65333 | 4725 | 64784 | 3263 | 77243 | 2551 | 45877 |
| 24-#11 | 2.03 | MA | 40837 | 9463 | 64918 | 7046 | 70779 | 5726 | 72769 | 4721 | 73799 | 3264 | 88679 | 2766 | 49563 |
| 6L-8S | | MI | 37961 | 9463 | 60285 | 7038 | 65297 | 5718 | 66684 | 4730 | 66543 | 3254 | 79457 | 2605 | 46330 |
| 24-#11 | 2.03 | MA | 40331 | 9463 | 63979 | 7061 | 69647 | 5722 | 71376 | 4734 | 71930 | 3274 | 86096 | 2677 | 49042 |
| 7E | | MI | 38435 | 9463 | 61086 | 7040 | 66388 | 5705 | 67976 | 4718 | 68430 | 3261 | 81703 | 2654 | 46647 |
| 24-#11 | 2.03 | MA | 39832 | 9463 | 63135 | 7059 | 68497 | 5736 | 70016 | 4746 | 69943 | 3267 | 83717 | 2627 | 48693 |
| 8L-6S | | MI | 38917 | 9463 | 61979 | 7026 | 67464 | 5708 | 69299 | 4706 | 70205 | 3252 | 84138 | 2744 | 47124 |
| 24-#11 | 2.03 | MA | 39315 | 9463 | 62309 | 7057 | 67380 | 5733 | 68594 | 4741 | 68091 | 3277 | 81368 | 2574 | 48208 |
| 9L-5S | | MI | 39411 | 9463 | 62793 | 7028 | 68593 | 5695 | 70678 | 4711 | 72022 | 3242 | 86421 | 2800 | 47380 |
| 24-#11 | 2.03 | MA | 38764 | 9463 | 61385 | 7072 | 66246 | 5746 | 67242 | 4754 | 66255 | 3287 | 79092 | 2513 | 47584 |
| 10L-4S | | MI | 39930 | 9463 | 63662 | 7031 | 69719 | 5699 | 72062 | 4699 | 74028 | 3250 | 88823 | 2841 | 47435 |
| 24-#11 | 2.03 | MA | 38227 | 9463 | 60558 | 7069 | 65134 | 5743 | 65838 | 4749 | 64296 | 3280 | 76773 | 2460 | 47028 |
| 11L-3S | | MI | 40511 | 9463 | 64666 | 7016 | 71000 | 5685 | 73619 | 4704 | 76031 | 3241 | 91123 | 2928 | 47461 |
| 24-#14 | 2.92 | MA | 43576 | 10035 | 71200 | 7388 | 78789 | 5953 | 82491 | 4874 | 86941 | 3200 | 106289 | 2609 | 70357 |
| 5L-9S | | MI | 38790 | 10035 | 63096 | 7400 | 68799 | 5984 | 70839 | 4875 | 72267 | 3213 | 87643 | 2222 | 63216 |
| 24-#14 | 2.92 | MA | 42843 | 10035 | 69970 | 7384 | 77085 | 5972 | 80409 | 4866 | 84197 | 3214 | 102844 | 2529 | 69305 |
| 6L-8S | | MI | 39453 | 10035 | 64334 | 7379 | 70322 | 5966 | 72776 | 4883 | 74791 | 3200 | 90788 | 2300 | 64151 |
| 24-#14 | 2.92 | MA | 42129 | 10035 | 68622 | 7406 | 75460 | 5967 | 78410 | 4884 | 81516 | 3227 | 99168 | 2399 | 68665 |
| 7E | | MI | 40122 | 10035 | 65484 | 7383 | 71888 | 5972 | 74629 | 4866 | 77496 | 3212 | 93988 | 2369 | 65263 |
| 24-#14 | 2.92 | MA | 41426 | 10035 | 67412 | 7402 | 73811 | 5986 | 76460 | 4901 | 78666 | 3216 | 95778 | 2329 | 67492 |
| 8L-6S | | MI | 40801 | 10035 | 66764 | 7362 | 73432 | 5953 | 76527 | 4850 | 80042 | 3200 | 97450 | 2499 | 65847 |
| 24-#14 | 2.92 | MA | 40716 | 10035 | 66108 | 7423 | 72207 | 5980 | 74420 | 4894 | 76009 | 3230 | 92437 | 2251 | 66479 |
| 9L-5S | | MI | 41499 | 10035 | 67932 | 7366 | 75049 | 5959 | 78504 | 4858 | 82648 | 3187 | 100694 | 2580 | 66812 |
| 24-#18 | 5.19 | MA | 46465 | 11488 | 80123 | 8287 | 89924 | 6634 | 95940 | 5267 | 105280 | 3099 | 131325 | 1664 | 113680 |
| 7E | | MI | 44183 | 11488 | 76361 | 8260 | 85557 | 6610 | 91192 | 5245 | 99743 | 3067 | 124153 | 1614 | 107849 |

## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

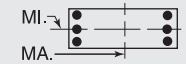
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.24 | MA | 44203 | 9369 | 68937 | 6985 | 74590 | 5692 | 76054 | 4745 | 75819 | 3406 | 88990 | 3213 | 33639 |
| 2L-3S | | MI | 38152 | 9369 | 59907 | 6931 | 63957 | 5687 | 64284 | 4741 | 62076 | 3396 | 71572 | 2949 | 30634 |
| 6-#18 | 1.24 | MA | 41867 | 9369 | 65501 | 6978 | 70186 | 5726 | 70680 | 4775 | 68509 | 3429 | 79221 | 2991 | 33749 |
| 3L-2S | | MI | 40249 | 9369 | 62997 | 6940 | 67918 | 5655 | 69117 | 4713 | 68603 | 3374 | 80246 | 3170 | 30507 |
| 8-#18 | 1.66 | MA | 45807 | 9646 | 72373 | 7158 | 78995 | 5816 | 81427 | 4820 | 83130 | 3384 | 98760 | 3164 | 44443 |
| 2L-4S | | MI | 38125 | 9646 | 60470 | 7139 | 64697 | 5798 | 65203 | 4799 | 63615 | 3394 | 74622 | 2673 | 40214 |
| 8-#18 | 1.66 | MA | 43488 | 9646 | 68937 | 7151 | 74590 | 5850 | 76054 | 4850 | 75819 | 3407 | 88990 | 2943 | 44487 |
| 3E | | MI | 39597 | 9646 | 62997 | 7104 | 67918 | 5811 | 69117 | 4816 | 68603 | 3371 | 80246 | 2894 | 40321 |
| 8-#18 | 1.66 | MA | 41856 | 9646 | 66134 | 7187 | 71018 | 5839 | 71713 | 4835 | 70233 | 3429 | 82640 | 2721 | 44303 |
| 4L-2S | | MI | 41680 | 9646 | 66087 | 7113 | 71879 | 5780 | 73949 | 4789 | 75130 | 3349 | 88921 | 3116 | 40245 |
| 10-#14 | 1.16 | MA | 44009 | 9317 | 68219 | 6995 | 73940 | 5704 | 75364 | 4760 | 74923 | 3433 | 88157 | 3260 | 31813 |
| 2L-5S | | MI | 37280 | 9317 | 57900 | 6967 | 61642 | 5702 | 61555 | 4757 | 58490 | 3425 | 67905 | 2915 | 28981 |
| 10-#14 | 1.16 | MA | 42671 | 9317 | 66259 | 6992 | 71427 | 5699 | 72298 | 4778 | 70752 | 3448 | 82517 | 3136 | 31872 |
| 3L-4S | | MI | 38037 | 9317 | 59146 | 6971 | 63258 | 5683 | 63540 | 4741 | 61364 | 3437 | 71327 | 2974 | 28985 |
| 10-#14 | 1.16 | MA | 41734 | 9317 | 64664 | 7014 | 69395 | 5719 | 69827 | 4772 | 67573 | 3462 | 78842 | 3011 | 31910 |
| 4L-3S | | MI | 38884 | 9317 | 60586 | 6950 | 65093 | 5689 | 65771 | 4749 | 64235 | 3424 | 74592 | 3099 | 28932 |
| 10-#14 | 1.16 | MA | 40897 | 9317 | 63286 | 7010 | 67607 | 5714 | 67631 | 4790 | 64390 | 3452 | 75013 | 2951 | 31862 |
| 5L-2S | | MI | 40087 | 9317 | 62352 | 6954 | 67356 | 5670 | 68532 | 4732 | 67992 | 3411 | 79615 | 3223 | 28866 |
| 10-#18 | 2.07 | MA | 47397 | 9923 | 75808 | 7331 | 83399 | 5941 | 86800 | 4896 | 90441 | 3362 | 108530 | 3116 | 55211 |
| 2L-5S | | MI | 38258 | 9923 | 61371 | 7303 | 65821 | 5953 | 66549 | 4902 | 65142 | 3347 | 77362 | 2517 | 48093 |
| 10-#18 | 2.07 | MA | 45093 | 9923 | 72373 | 7324 | 78995 | 5974 | 81427 | 4925 | 83130 | 3385 | 98760 | 2894 | 55177 |
| 3L-4S | | MI | 39566 | 9923 | 63560 | 7312 | 68659 | 5922 | 70035 | 4875 | 70141 | 3369 | 83296 | 2618 | 49757 |
| 10-#18 | 2.07 | MA | 43474 | 9923 | 69570 | 7360 | 75423 | 5963 | 77086 | 4911 | 77544 | 3407 | 92409 | 2673 | 54901 |
| 4L-3S | | MI | 41028 | 9923 | 66087 | 7277 | 71879 | 5935 | 73949 | 4892 | 75130 | 3347 | 88921 | 2840 | 49954 |
| 10-#18 | 2.07 | MA | 42028 | 9923 | 67145 | 7353 | 72279 | 5996 | 73223 | 4941 | 71949 | 3386 | 85752 | 2568 | 52992 |
| 5L-2S | | MI | 43097 | 9923 | 69177 | 7286 | 75840 | 5904 | 78781 | 4864 | 81656 | 3325 | 97595 | 3061 | 49945 |
| 12-#14 | 1.40 | MA | 44936 | 9473 | 70179 | 7092 | 76453 | 5774 | 78429 | 4803 | 79093 | 3421 | 93797 | 3236 | 37974 |
| 2L-6S | | MI | 37402 | 9473 | 58498 | 7060 | 62288 | 5765 | 62339 | 4792 | 59641 | 3425 | 69683 | 2807 | 34041 |
| 12-#14 | 1.40 | MA | 43604 | 9473 | 68219 | 7089 | 73940 | 5769 | 75364 | 4821 | 74923 | 3435 | 88157 | 3112 | 38018 |
| 3L-5S | | MI | 38120 | 9473 | 59666 | 7064 | 63906 | 5772 | 64316 | 4800 | 62247 | 3412 | 72927 | 2888 | 34465 |
| 12-#14 | 1.40 | MA | 42671 | 9473 | 66624 | 7111 | 71907 | 5789 | 72893 | 4814 | 71743 | 3450 | 84482 | 2987 | 38020 |
| 4E | | MI | 38874 | 9473 | 60912 | 7068 | 65521 | 5753 | 66301 | 4783 | 65121 | 3425 | 76349 | 2947 | 34510 |
| 12-#14 | 1.40 | MA | 41838 | 9473 | 65246 | 7108 | 70120 | 5784 | 70696 | 4832 | 68561 | 3439 | 80653 | 2927 | 37937 |
| 5L-3S | | MI | 39717 | 9473 | 62352 | 7047 | 67356 | 5759 | 68532 | 4791 | 67992 | 3412 | 79615 | 3071 | 34479 |
| 12-#14 | 1.40 | MA | 41045 | 9473 | 63954 | 7104 | 68330 | 5803 | 68509 | 4825 | 65678 | 3454 | 77006 | 2846 | 37415 |
| 6L-2S | | MI | 40915 | 9473 | 64117 | 7052 | 69620 | 5740 | 71293 | 4774 | 71748 | 3399 | 84637 | 3196 | 34427 |
| 12-#18 | 2.48 | MA | 48972 | 10199 | 79244 | 7504 | 87804 | 6065 | 92173 | 4971 | 97751 | 3340 | 118300 | 3067 | 65949 |
| 2L-6S | | MI | 38460 | 10199 | 62407 | 7467 | 66939 | 6064 | 67908 | 4960 | 67140 | 3344 | 80442 | 2318 | 55650 |
| 12-#18 | 2.48 | MA | 46683 | 10199 | 75808 | 7496 | 83399 | 6098 | 86800 | 5001 | 90441 | 3363 | 108530 | 2846 | 65840 |
| 3L-5S | | MI | 39697 | 10199 | 64461 | 7476 | 69782 | 6077 | 71381 | 4977 | 71669 | 3322 | 86037 | 2462 | 57285 |
| 12-#18 | 2.48 | MA | 45076 | 10199 | 73006 | 7533 | 79827 | 6087 | 82459 | 4986 | 84854 | 3385 | 102179 | 2625 | 65484 |
| 4E | | MI | 40995 | 10199 | 66650 | 7485 | 72620 | 6046 | 74868 | 4950 | 76668 | 3344 | 91971 | 2564 | 59282 |
| 12-#18 | 2.48 | MA | 43641 | 10199 | 70581 | 7526 | 76683 | 6120 | 78596 | 5016 | 79260 | 3364 | 95522 | 2520 | 63237 |
| 5L-3S | | MI | 42446 | 10199 | 69177 | 7450 | 75840 | 6059 | 78781 | 4967 | 81656 | 3322 | 97595 | 2785 | 59555 |
| 12-#18 | 2.48 | MA | 42275 | 10199 | 68308 | 7518 | 73535 | 6109 | 74748 | 5001 | 74189 | 3386 | 89212 | 2376 | 61317 |
| 6L-2S | | MI | 44503 | 10199 | 72267 | 7459 | 79802 | 6028 | 83614 | 4940 | 88183 | 3300 | 106270 | 3007 | 59625 |
| 14-#11 | 1.13 | MA | 43926 | 9295 | 67889 | 7002 | 73655 | 5711 | 75069 | 4769 | 74544 | 3447 | 87821 | 3283 | 31012 |
| 2L-7S | | MI | 37062 | 9295 | 57241 | 6985 | 60917 | 5695 | 60711 | 4768 | 57449 | 3456 | 66415 | 2888 | 28041 |
| 14-#11 | 1.13 | MA | 42991 | 9295 | 66521 | 7000 | 71901 | 5708 | 72928 | 4782 | 71632 | 3457 | 83860 | 3196 | 31050 |
| 3L-6S | | MI | 37553 | 9295 | 58133 | 6971 | 61994 | 5699 | 62034 | 4756 | 59224 | 3446 | 68851 | 2978 | 28246 |
| 14-#11 | 1.13 | MA | 42336 | 9295 | 65409 | 7016 | 70483 | 5722 | 71205 | 4778 | 69415 | 3468 | 81277 | 3110 | 31082 |
| 4L-5S | | MI | 38056 | 9295 | 58947 | 6973 | 63122 | 5685 | 63413 | 4761 | 61041 | 3437 | 71134 | 3034 | 28254 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

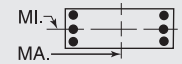


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.13 | MA | 41752 | 9295 | 64448 | 7014 | 69237 | 5719 | 69674 | 4791 | 67196 | 3461 | 78592 | 3068 | 31091 |
| 5L-4S | | MI | 38584 | 9295 | 59816 | 6976 | 64248 | 5689 | 64797 | 4749 | 63046 | 3445 | 73536 | 3075 | 28228 |
| 14-#11 | 1.13 | MA | 41197 | 9295 | 63548 | 7012 | 67990 | 5733 | 68149 | 4786 | 65187 | 3472 | 76030 | 3012 | 31055 |
| 6L-3S | | MI | 39176 | 9295 | 60821 | 6961 | 65529 | 5676 | 66354 | 4754 | 65049 | 3435 | 75835 | 3162 | 28188 |
| 14-#11 | 1.13 | MA | 40655 | 9295 | 62562 | 7027 | 66800 | 5730 | 66687 | 4799 | 63224 | 3482 | 73298 | 2922 | 30786 |
| 7L-2S | | MI | 40017 | 9295 | 62054 | 6963 | 67110 | 5679 | 68283 | 4742 | 67674 | 3426 | 79368 | 3248 | 28146 |
| 14-#14 | 1.63 | MA | 45857 | 9629 | 72139 | 7190 | 78965 | 5844 | 81494 | 4845 | 83264 | 3409 | 99437 | 3212 | 44123 |
| 2L-7S | | MI | 37544 | 9629 | 58984 | 7178 | 63008 | 5854 | 63203 | 4851 | 60852 | 3425 | 71243 | 2650 | 38643 |
| 14-#14 | 1.63 | MA | 44531 | 9629 | 70179 | 7186 | 76453 | 5839 | 78429 | 4863 | 79093 | 3423 | 93797 | 3088 | 44152 |
| 3L-6S | | MI | 38241 | 9629 | 60263 | 7157 | 64551 | 5835 | 65100 | 4834 | 63398 | 3413 | 74706 | 2780 | 39350 |
| 14-#14 | 1.63 | MA | 43602 | 9629 | 68584 | 7208 | 74420 | 5858 | 75958 | 4856 | 75914 | 3437 | 90122 | 2963 | 44118 |
| 4L-5S | | MI | 38956 | 9629 | 61431 | 7161 | 66169 | 5841 | 67077 | 4842 | 66003 | 3400 | 77950 | 2861 | 39937 |
| 14-#14 | 1.63 | MA | 42773 | 9629 | 67206 | 7205 | 72632 | 5853 | 73761 | 4874 | 72732 | 3427 | 86293 | 2903 | 44003 |
| 5L-4S | | MI | 39706 | 9629 | 62677 | 7165 | 67784 | 5823 | 69062 | 4825 | 68878 | 3412 | 81372 | 2920 | 40012 |
| 14-#14 | 1.63 | MA | 41984 | 9629 | 65914 | 7202 | 70843 | 5873 | 71574 | 4867 | 69849 | 3441 | 82646 | 2822 | 43317 |
| 6L-3S | | MI | 40545 | 9629 | 64117 | 7145 | 69620 | 5829 | 71293 | 4833 | 71748 | 3399 | 84637 | 3044 | 40013 |
| 14-#14 | 1.63 | MA | 41215 | 9629 | 64499 | 7223 | 69136 | 5868 | 69475 | 4885 | 67032 | 3455 | 78757 | 2692 | 42482 |
| 7L-2S | | MI | 41738 | 9629 | 65883 | 7149 | 71883 | 5810 | 74054 | 4817 | 75505 | 3387 | 89660 | 3169 | 39975 |
| 14-#18 | 2.90 | MA | 50534 | 10476 | 82680 | 7677 | 92208 | 6189 | 97547 | 5046 | 105062 | 3318 | 128070 | 3019 | 76652 |
| 2L-7S | | MI | 38699 | 10476 | 63247 | 7675 | 68187 | 6219 | 69405 | 5063 | 69241 | 3341 | 83138 | 2032 | 62371 |
| 14-#18 | 2.90 | MA | 48260 | 10476 | 79244 | 7669 | 87804 | 6222 | 92173 | 5076 | 97751 | 3341 | 118300 | 2798 | 76486 |
| 3L-6S | | MI | 39895 | 10476 | 65497 | 7640 | 70901 | 6188 | 72740 | 5036 | 73666 | 3319 | 89116 | 2263 | 64957 |
| 14-#18 | 2.90 | MA | 46664 | 10476 | 76442 | 7706 | 84232 | 6211 | 87832 | 5062 | 92165 | 3363 | 111949 | 2576 | 76058 |
| 4L-5S | | MI | 41122 | 10476 | 67551 | 7649 | 73743 | 6201 | 76214 | 5053 | 78196 | 3297 | 94711 | 2408 | 66510 |
| 14-#18 | 2.90 | MA | 45240 | 10476 | 74017 | 7699 | 81088 | 6244 | 83969 | 5091 | 86570 | 3341 | 105292 | 2472 | 73516 |
| 5L-4S | | MI | 42412 | 10476 | 69740 | 7658 | 76581 | 6170 | 79700 | 5025 | 83195 | 3319 | 100645 | 2509 | 68795 |
| 14-#18 | 2.90 | MA | 43884 | 10476 | 71743 | 7691 | 77939 | 6233 | 80121 | 5077 | 81500 | 3364 | 98982 | 2328 | 71684 |
| 6L-3S | | MI | 43853 | 10476 | 72267 | 7623 | 79802 | 6183 | 83614 | 5042 | 88183 | 3297 | 106270 | 2730 | 69136 |
| 14-#18 | 2.90 | MA | 42564 | 10476 | 69253 | 7728 | 74935 | 6267 | 76428 | 5106 | 76544 | 3387 | 92247 | 2097 | 68775 |
| 7L-2S | | MI | 45897 | 10476 | 75357 | 7632 | 83763 | 6152 | 88446 | 5015 | 94710 | 3275 | 114944 | 2952 | 69260 |
| 16-#11 | 1.29 | MA | 44577 | 9403 | 69258 | 7070 | 75410 | 5760 | 77209 | 4799 | 77456 | 3438 | 91782 | 3267 | 35312 |
| 2L-8S | | MI | 37172 | 9403 | 57673 | 7050 | 61407 | 5757 | 61348 | 4810 | 58187 | 3440 | 67702 | 2822 | 31419 |
| 16-#11 | 1.29 | MA | 43645 | 9403 | 67889 | 7068 | 73655 | 5757 | 75069 | 4811 | 74544 | 3449 | 87821 | 3181 | 35344 |
| 3L-7S | | MI | 37654 | 9403 | 58474 | 7053 | 62499 | 5743 | 62640 | 4797 | 60074 | 3447 | 69948 | 2870 | 31782 |
| 16-#11 | 1.29 | MA | 42992 | 9403 | 66777 | 7083 | 72238 | 5771 | 73346 | 4807 | 72326 | 3459 | 85238 | 3095 | 35365 |
| 4L-6S | | MI | 38143 | 9403 | 59366 | 7038 | 63575 | 5747 | 63963 | 4785 | 61849 | 3438 | 72383 | 2960 | 32080 |
| 16-#11 | 1.29 | MA | 42411 | 9403 | 65817 | 7081 | 70992 | 5768 | 71814 | 4820 | 70108 | 3452 | 82553 | 3052 | 35354 |
| 5E | | MI | 38645 | 9403 | 60181 | 7041 | 64703 | 5734 | 65342 | 4790 | 63666 | 3428 | 74667 | 3016 | 32111 |
| 16-#11 | 1.29 | MA | 41857 | 9403 | 64917 | 7079 | 69744 | 5782 | 70290 | 4816 | 68099 | 3463 | 79991 | 2996 | 35300 |
| 6L-4S | | MI | 39171 | 9403 | 61050 | 7043 | 65830 | 5737 | 66727 | 4778 | 65671 | 3436 | 77069 | 3058 | 32097 |
| 16-#11 | 1.29 | MA | 41317 | 9403 | 63931 | 7094 | 68555 | 5779 | 68827 | 4829 | 66136 | 3473 | 77259 | 2906 | 34937 |
| 7L-3S | | MI | 39761 | 9403 | 62054 | 7028 | 67110 | 5724 | 68283 | 4784 | 67674 | 3427 | 79368 | 3144 | 32066 |
| 16-#11 | 1.29 | MA | 40778 | 9403 | 63045 | 7092 | 67348 | 5793 | 67399 | 4842 | 64049 | 3467 | 74748 | 2857 | 34505 |
| 8L-2S | | MI | 40600 | 9403 | 63288 | 7031 | 68692 | 5728 | 70212 | 4771 | 70299 | 3417 | 82901 | 3230 | 32030 |
| 16-#14 | 1.86 | MA | 46774 | 9784 | 74099 | 7287 | 81478 | 5914 | 84560 | 4888 | 87435 | 3396 | 105077 | 3188 | 50262 |
| 2L-8S | | MI | 37699 | 9784 | 59599 | 7271 | 63705 | 5918 | 64111 | 4910 | 61903 | 3401 | 73067 | 2554 | 43369 |
| 16-#14 | 1.86 | MA | 45453 | 9784 | 72139 | 7284 | 78965 | 5908 | 81494 | 4906 | 83264 | 3410 | 99437 | 3064 | 50265 |
| 3L-7S | | MI | 38382 | 9784 | 60749 | 7275 | 65271 | 5924 | 65964 | 4893 | 64609 | 3413 | 76266 | 2623 | 43997 |
| 16-#14 | 1.86 | MA | 44528 | 9784 | 70544 | 7305 | 76933 | 5928 | 79024 | 4899 | 80084 | 3425 | 95762 | 2939 | 50206 |
| 4L-6S | | MI | 39075 | 9784 | 62029 | 7254 | 66815 | 5905 | 67862 | 4876 | 67155 | 3400 | 79729 | 2753 | 44673 |
| 16-#14 | 1.86 | MA | 43703 | 9784 | 69166 | 7302 | 75145 | 5923 | 76827 | 4917 | 76902 | 3414 | 91933 | 2879 | 50063 |
| 5E | | MI | 39787 | 9784 | 63197 | 7259 | 68432 | 5911 | 69839 | 4885 | 69760 | 3388 | 82973 | 2834 | 45401 |
| 16-#14 | 1.86 | MA | 42918 | 9784 | 67874 | 7299 | 73356 | 5943 | 74639 | 4910 | 74019 | 3429 | 88286 | 2798 | 49232 |
| 6L-4S | | MI | 40534 | 9784 | 64443 | 7263 | 70048 | 5893 | 71824 | 4868 | 72635 | 3400 | 86395 | 2893 | 45504 |
| 16-#14 | 1.86 | MA | 42153 | 9784 | 66459 | 7320 | 71648 | 5938 | 72540 | 4928 | 71203 | 3443 | 84397 | 2669 | 48431 |
| 7L-3S | | MI | 41369 | 9784 | 65883 | 7242 | 71883 | 5899 | 74054 | 4876 | 75505 | 3387 | 89660 | 3017 | 45537 |
| 16-#14 | 1.86 | MA | 41399 | 9784 | 65188 | 7317 | 69917 | 5958 | 70491 | 4946 | 68209 | 3432 | 80816 | 2598 | 47698 |
| 8L-2S | | MI | 42557 | 9784 | 67648 | 7246 | 74146 | 5880 | 76815 | 4859 | 79262 | 3374 | 94683 | 3142 | 45512 |
| 16-#18 | 3.31 | MA | 49824 | 10753 | 82680 | 7842 | 92208 | 6346 | 97547 | 5152 | 105062 | 3318 | 128070 | 2749 | 87118 |
| 3L-7S | | MI | 40131 | 10753 | 66337 | 7848 | 72148 | 6344 | 74237 | 5138 | 75767 | 3316 | 91812 | 1977 | 71528 |

## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

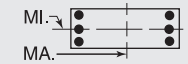
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 3.31 | MA | 48239 | 10753 | 79877 | 7879 | 88636 | 6335 | 93206 | 5137 | 99476 | 3341 | 121719 | 2528 | 86625 |
| 4L-6S | | MI | 41318 | 10753 | 68587 | 7812 | 74862 | 6312 | 77573 | 5111 | 80193 | 3294 | 97791 | 2208 | 74280 |
| 16-#18 | 3.31 | MA | 46825 | 10753 | 77453 | 7872 | 85492 | 6369 | 89342 | 5167 | 93881 | 3319 | 115062 | 2423 | 83822 |
| 5E | | MI | 42537 | 10753 | 70640 | 7822 | 77705 | 6325 | 81046 | 5128 | 84722 | 3272 | 103385 | 2353 | 75763 |
| 16-#18 | 3.31 | MA | 45480 | 10753 | 75179 | 7864 | 82344 | 6358 | 85495 | 5152 | 88810 | 3342 | 108752 | 2279 | 82068 |
| 6L-4S | | MI | 43817 | 10753 | 72830 | 7831 | 80542 | 6294 | 84533 | 5101 | 89721 | 3294 | 109320 | 2454 | 78299 |
| 16-#18 | 3.31 | MA | 44170 | 10753 | 72688 | 7901 | 79340 | 6391 | 81801 | 5182 | 83855 | 3365 | 102017 | 2048 | 78993 |
| 7L-3S | | MI | 45249 | 10753 | 75357 | 7796 | 83763 | 6307 | 88446 | 5118 | 94710 | 3272 | 114944 | 2676 | 78702 |
| 16-#18 | 3.31 | MA | 42880 | 10753 | 70450 | 7894 | 76292 | 6380 | 78195 | 5212 | 78589 | 3343 | 95793 | 1926 | 76267 |
| 8L-2S | | MI | 47281 | 10753 | 78447 | 7805 | 87724 | 6276 | 93279 | 5090 | 101237 | 3250 | 123619 | 2897 | 78876 |
| 18-#11 | 1.45 | MA | 45226 | 9510 | 70626 | 7137 | 77164 | 5808 | 79349 | 4828 | 80368 | 3429 | 95743 | 3252 | 39606 |
| 2L-9S | | MI | 37272 | 9510 | 58043 | 7132 | 61927 | 5801 | 61927 | 4834 | 59052 | 3440 | 69021 | 2750 | 34913 |
| 18-#11 | 1.45 | MA | 44296 | 9510 | 69258 | 7135 | 75410 | 5805 | 77209 | 4841 | 77456 | 3440 | 91782 | 3165 | 39631 |
| 3L-8S | | MI | 37763 | 9510 | 58906 | 7118 | 62989 | 5805 | 63278 | 4839 | 60812 | 3431 | 71234 | 2804 | 35180 |
| 18-#11 | 1.45 | MA | 43646 | 9510 | 68146 | 7150 | 73992 | 5819 | 75486 | 4837 | 75238 | 3450 | 89198 | 3079 | 39643 |
| 4L-7S | | MI | 38243 | 9510 | 59708 | 7120 | 64080 | 5792 | 64569 | 4827 | 62699 | 3439 | 73480 | 2853 | 35529 |
| 18-#11 | 1.45 | MA | 43066 | 9510 | 67185 | 7149 | 72746 | 5816 | 73954 | 4849 | 73020 | 3444 | 86514 | 3037 | 39611 |
| 5L-6S | | MI | 38731 | 9510 | 60600 | 7105 | 65157 | 5795 | 65893 | 4815 | 64474 | 3429 | 75916 | 2943 | 35910 |
| 18-#11 | 1.45 | MA | 42514 | 9510 | 66285 | 7147 | 71499 | 5830 | 72430 | 4845 | 71010 | 3454 | 83952 | 2981 | 39541 |
| 6L-5S | | MI | 39231 | 9510 | 61414 | 7108 | 66285 | 5782 | 67271 | 4820 | 66291 | 3420 | 78199 | 2999 | 35953 |
| 18-#11 | 1.45 | MA | 41977 | 9510 | 65299 | 7162 | 70309 | 5827 | 70967 | 4858 | 69048 | 3465 | 81220 | 2891 | 39095 |
| 7L-4S | | MI | 39756 | 9510 | 62283 | 7111 | 67411 | 5786 | 68656 | 4808 | 68296 | 3428 | 80601 | 3040 | 35959 |
| 18-#11 | 1.45 | MA | 41441 | 9510 | 64413 | 7160 | 69103 | 5841 | 69539 | 4871 | 66961 | 3458 | 78709 | 2841 | 38678 |
| 8L-3S | | MI | 40343 | 9510 | 63288 | 7096 | 68692 | 5772 | 70212 | 4813 | 70299 | 3418 | 82901 | 3127 | 35938 |
| 18-#11 | 1.45 | MA | 40887 | 9510 | 63547 | 7158 | 67929 | 5838 | 68046 | 4867 | 65016 | 3469 | 76225 | 2788 | 38352 |
| 9L-2S | | MI | 41180 | 9510 | 64522 | 7098 | 70273 | 5776 | 72142 | 4801 | 72924 | 3409 | 86433 | 3213 | 35907 |
| 18-#14 | 2.10 | MA | 47685 | 9940 | 76059 | 7384 | 83991 | 5983 | 87625 | 4930 | 91605 | 3384 | 110717 | 3165 | 56395 |
| 2L-9S | | MI | 37844 | 9940 | 60126 | 7389 | 64445 | 6006 | 64935 | 4944 | 63137 | 3401 | 74944 | 2449 | 47591 |
| 18-#14 | 2.10 | MA | 46369 | 9940 | 74099 | 7381 | 81478 | 5978 | 84560 | 4948 | 87435 | 3398 | 105077 | 3040 | 56369 |
| 3L-8S | | MI | 38535 | 9940 | 61365 | 7368 | 65969 | 5988 | 66872 | 4952 | 65660 | 3389 | 78090 | 2527 | 48632 |
| 18-#14 | 2.10 | MA | 45449 | 9940 | 72504 | 7403 | 79445 | 5998 | 82089 | 4941 | 84255 | 3412 | 101402 | 2915 | 56287 |
| 4L-7S | | MI | 39214 | 9940 | 62515 | 7372 | 67534 | 5994 | 68725 | 4936 | 68365 | 3401 | 81289 | 2596 | 49357 |
| 18-#14 | 2.10 | MA | 44628 | 9940 | 71126 | 7399 | 77658 | 5993 | 79892 | 4959 | 81073 | 3402 | 97573 | 2855 | 56117 |
| 5L-6S | | MI | 39905 | 9940 | 63794 | 7352 | 69078 | 5975 | 70623 | 4919 | 70911 | 3388 | 84752 | 2726 | 50007 |
| 18-#14 | 2.10 | MA | 43846 | 9940 | 69834 | 7396 | 75868 | 6013 | 77705 | 4952 | 78190 | 3416 | 93926 | 2774 | 55158 |
| 6L-5S | | MI | 40613 | 9940 | 64962 | 7356 | 70696 | 5981 | 72600 | 4927 | 73517 | 3375 | 87996 | 2807 | 50859 |
| 18-#14 | 2.10 | MA | 43085 | 9940 | 68419 | 7418 | 74161 | 6008 | 75605 | 4970 | 75374 | 3431 | 90037 | 2645 | 54387 |
| 7L-4S | | MI | 41356 | 9940 | 66208 | 7360 | 72311 | 5962 | 74585 | 4910 | 76391 | 3387 | 91418 | 2866 | 50987 |
| 18-#14 | 2.10 | MA | 42335 | 9940 | 67148 | 7414 | 72429 | 6027 | 73557 | 4988 | 72380 | 3420 | 86456 | 2574 | 53556 |
| 8L-3S | | MI | 42188 | 9940 | 67648 | 7339 | 74146 | 5968 | 76815 | 4918 | 79262 | 3374 | 94683 | 2990 | 51042 |
| 18-#14 | 2.10 | MA | 41552 | 9940 | 65904 | 7411 | 70745 | 6022 | 71414 | 4981 | 69589 | 3434 | 82920 | 2496 | 52349 |
| 9L-2S | | MI | 43372 | 9940 | 69414 | 7343 | 76410 | 5950 | 79576 | 4902 | 83019 | 3362 | 99706 | 3115 | 51041 |
| 18-#18 | 3.73 | MA | 49802 | 11029 | 83313 | 8052 | 93041 | 6460 | 98579 | 5212 | 106786 | 3319 | 131489 | 2480 | 97186 |
| 4L-7S | | MI | 41551 | 11029 | 69427 | 8020 | 76110 | 6468 | 79070 | 5214 | 82294 | 3292 | 100487 | 1922 | 80707 |
| 18-#18 | 3.73 | MA | 48398 | 11029 | 80888 | 8044 | 89897 | 6493 | 94716 | 5242 | 101192 | 3297 | 124832 | 2375 | 94152 |
| 5L-6S | | MI | 42730 | 11029 | 71677 | 7985 | 78823 | 6437 | 82405 | 5186 | 86720 | 3270 | 106465 | 2154 | 83612 |
| 18-#18 | 3.73 | MA | 47062 | 11029 | 78615 | 8037 | 86748 | 6482 | 90868 | 5228 | 96121 | 3320 | 118522 | 2231 | 92466 |
| 6L-5S | | MI | 43940 | 11029 | 73730 | 7994 | 81666 | 6450 | 85879 | 5203 | 91249 | 3247 | 112060 | 2298 | 85037 |
| 18-#18 | 3.73 | MA | 45762 | 11029 | 76124 | 8074 | 83744 | 6515 | 87174 | 5257 | 91166 | 3342 | 111787 | 2000 | 89232 |
| 7L-4S | | MI | 45212 | 11029 | 75920 | 8004 | 84504 | 6418 | 89365 | 5176 | 96248 | 3270 | 117994 | 2400 | 87795 |
| 18-#18 | 3.73 | MA | 44481 | 11029 | 73886 | 8066 | 80697 | 6504 | 83568 | 5287 | 85900 | 3321 | 105563 | 1877 | 86386 |
| 8L-3S | | MI | 46635 | 11029 | 78447 | 7968 | 87724 | 6431 | 93279 | 5193 | 101237 | 3247 | 123619 | 2621 | 88256 |
| 20-#11 | 1.61 | MA | 45871 | 9618 | 71995 | 7205 | 78918 | 5857 | 81489 | 4857 | 83280 | 3421 | 99704 | 3236 | 43895 |
| 2L-10S | | MI | 37338 | 9618 | 58478 | 7197 | 62431 | 5863 | 62572 | 4875 | 59933 | 3441 | 70409 | 2672 | 38085 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

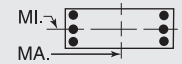


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.61 | MA | 44944 | 9618 | 70626 | 7203 | 77164 | 5853 | 79349 | 4870 | 80368 | 3431 | 95743 | 3150 | 43913 |
| 3L-9S | | MI | 37864 | 9618 | 59277 | 7200 | 63508 | 5850 | 63856 | 4863 | 61677 | 3432 | 72553 | 2733 | 38682 |
| 20-#11 | 1.61 | MA | 44296 | 9618 | 69514 | 7218 | 75746 | 5868 | 77626 | 4866 | 78150 | 3442 | 93159 | 3064 | 43904 |
| 4L-8S | | MI | 38352 | 9618 | 60140 | 7185 | 64570 | 5853 | 65207 | 4868 | 63437 | 3422 | 74767 | 2787 | 38945 |
| 20-#11 | 1.61 | MA | 43719 | 9618 | 68554 | 7216 | 74500 | 5864 | 76095 | 4879 | 75932 | 3435 | 90475 | 3021 | 43863 |
| 5L-7S | | MI | 38830 | 9618 | 60942 | 7188 | 65662 | 5840 | 66499 | 4856 | 65324 | 3430 | 77013 | 2835 | 39282 |
| 20-#11 | 1.61 | MA | 43169 | 9618 | 67654 | 7214 | 73253 | 5878 | 74570 | 4875 | 73922 | 3446 | 87912 | 2965 | 43778 |
| 6E | | MI | 39316 | 9618 | 61834 | 7173 | 66738 | 5844 | 67822 | 4844 | 67099 | 3421 | 79449 | 2925 | 39734 |
| 20-#11 | 1.61 | MA | 42633 | 9618 | 66668 | 7229 | 72064 | 5875 | 73107 | 4887 | 71960 | 3456 | 85181 | 2876 | 43258 |
| 7L-5S | | MI | 39814 | 9618 | 62648 | 7175 | 67866 | 5830 | 69201 | 4849 | 68916 | 3411 | 81732 | 2981 | 39792 |
| 20-#11 | 1.61 | MA | 42106 | 9618 | 65782 | 7227 | 70857 | 5889 | 71680 | 4900 | 69873 | 3449 | 82670 | 2826 | 42855 |
| 8L-4S | | MI | 40338 | 9618 | 63517 | 7178 | 68993 | 5834 | 70585 | 4837 | 70921 | 3419 | 84134 | 3023 | 39816 |
| 20-#11 | 1.61 | MA | 41548 | 9618 | 64915 | 7225 | 69683 | 5886 | 70186 | 4896 | 67928 | 3460 | 80185 | 2772 | 42534 |
| 9L-3S | | MI | 40923 | 9618 | 64522 | 7163 | 70273 | 5821 | 72142 | 4842 | 72924 | 3409 | 86433 | 3109 | 39803 |
| 20-#11 | 1.61 | MA | 40966 | 9618 | 63945 | 7241 | 68493 | 5900 | 68766 | 4909 | 66000 | 3471 | 77777 | 2711 | 41842 |
| 10L-2S | | MI | 41758 | 9618 | 65755 | 7166 | 71855 | 5825 | 74071 | 4830 | 75549 | 3400 | 89966 | 3195 | 39779 |
| 20-#14 | 2.33 | MA | 47281 | 10096 | 76059 | 7478 | 83991 | 6048 | 87625 | 4991 | 91605 | 3386 | 110717 | 3016 | 62465 |
| 3L-9S | | MI | 38681 | 10096 | 61892 | 7486 | 66709 | 6076 | 67696 | 4987 | 66893 | 3389 | 79967 | 2422 | 52897 |
| 20-#14 | 2.33 | MA | 46365 | 10096 | 74464 | 7500 | 81958 | 6068 | 85154 | 4984 | 88426 | 3400 | 107042 | 2892 | 62362 |
| 4L-8S | | MI | 39366 | 10096 | 63130 | 7466 | 68232 | 6057 | 69633 | 4995 | 69417 | 3376 | 83112 | 2500 | 53905 |
| 20-#14 | 2.33 | MA | 45547 | 10096 | 73086 | 7497 | 80171 | 6063 | 82957 | 5002 | 85243 | 3389 | 103213 | 2831 | 62167 |
| 5L-7S | | MI | 40043 | 10096 | 64280 | 7470 | 69798 | 6064 | 71486 | 4978 | 72122 | 3388 | 86312 | 2569 | 54723 |
| 20-#14 | 2.33 | MA | 44769 | 10096 | 71794 | 7493 | 78381 | 6083 | 80770 | 4995 | 82361 | 3404 | 99566 | 2750 | 61094 |
| 6E | | MI | 40730 | 10096 | 65560 | 7449 | 71341 | 6045 | 73384 | 4961 | 74668 | 3375 | 89774 | 2699 | 55349 |
| 20-#14 | 2.33 | MA | 44011 | 10096 | 70379 | 7515 | 76674 | 6078 | 78671 | 5013 | 79544 | 3418 | 95677 | 2621 | 60349 |
| 7L-5S | | MI | 41435 | 10096 | 66728 | 7453 | 72959 | 6051 | 75361 | 4969 | 77274 | 3363 | 93018 | 2780 | 56312 |
| 20-#14 | 2.33 | MA | 43265 | 10096 | 69108 | 7512 | 74942 | 6097 | 76622 | 5031 | 76551 | 3408 | 92096 | 2550 | 59425 |
| 8L-4S | | MI | 42175 | 10096 | 67974 | 7457 | 74574 | 6032 | 77346 | 4953 | 80148 | 3375 | 96440 | 2839 | 56463 |
| 20-#14 | 2.33 | MA | 42487 | 10096 | 67864 | 7508 | 73258 | 6092 | 74479 | 5024 | 73760 | 3422 | 88560 | 2472 | 58253 |
| 9L-3S | | MI | 43004 | 10096 | 69414 | 7436 | 76410 | 6038 | 79576 | 4961 | 83019 | 3362 | 99706 | 2963 | 56539 |
| 20-#14 | 2.33 | MA | 41663 | 10096 | 66471 | 7530 | 71549 | 6112 | 72441 | 5042 | 70993 | 3436 | 85134 | 2384 | 57044 |
| 10L-2S | | MI | 44183 | 10096 | 71179 | 7441 | 78673 | 6020 | 82337 | 4944 | 86775 | 3349 | 104729 | 3088 | 56565 |
| 20-#18 | 4.14 | MA | 49960 | 11306 | 84324 | 8217 | 94302 | 6617 | 100089 | 5318 | 108503 | 3275 | 134601 | 2327 | 104501 |
| 5L-7S | | MI | 42960 | 11306 | 72517 | 8193 | 80071 | 6592 | 83902 | 5289 | 88821 | 3267 | 109161 | 1868 | 89905 |
| 20-#18 | 4.14 | MA | 48633 | 11306 | 82051 | 8210 | 91153 | 6606 | 96241 | 5303 | 103432 | 3298 | 128292 | 2183 | 102756 |
| 6E | | MI | 44132 | 11306 | 74767 | 8158 | 82784 | 6561 | 87237 | 5262 | 93247 | 3245 | 115139 | 2099 | 92707 |
| 20-#18 | 4.14 | MA | 47341 | 11306 | 79560 | 8247 | 88149 | 6639 | 92547 | 5333 | 98476 | 3320 | 121557 | 1952 | 99491 |
| 7L-5S | | MI | 45334 | 11306 | 76820 | 8167 | 85627 | 6574 | 90711 | 5279 | 97776 | 3223 | 120734 | 2244 | 94330 |
| 20-#18 | 4.14 | MA | 46070 | 11306 | 77322 | 8239 | 85101 | 6628 | 88942 | 5362 | 93211 | 3299 | 115333 | 1829 | 96526 |
| 8L-4S | | MI | 46598 | 11306 | 79010 | 8176 | 88465 | 6543 | 94198 | 5252 | 102775 | 3245 | 126669 | 2345 | 96980 |
| 22-#11 | 1.78 | MA | 46514 | 9726 | 73363 | 7272 | 80673 | 5905 | 83630 | 4887 | 86192 | 3412 | 103664 | 3221 | 48179 |
| 2L-11S | | MI | 37415 | 9726 | 58925 | 7262 | 62956 | 5908 | 63167 | 4900 | 60698 | 3425 | 71752 | 2603 | 41335 |
| 22-#11 | 1.78 | MA | 45590 | 9726 | 71995 | 7270 | 78918 | 5902 | 81489 | 4900 | 83280 | 3423 | 99704 | 3135 | 48190 |
| 3L-10S | | MI | 37928 | 9726 | 59711 | 7265 | 64013 | 5911 | 64501 | 4905 | 62558 | 3433 | 73941 | 2654 | 41807 |
| 22-#11 | 1.78 | MA | 44944 | 9726 | 70883 | 7285 | 77501 | 5916 | 79766 | 4895 | 81062 | 3433 | 97120 | 3048 | 48165 |
| 4L-9S | | MI | 38453 | 9726 | 60510 | 7267 | 65090 | 5898 | 65786 | 4893 | 64302 | 3423 | 76086 | 2715 | 42409 |
| 22-#11 | 1.78 | MA | 44368 | 9726 | 69922 | 7283 | 76255 | 5913 | 78235 | 4908 | 78844 | 3427 | 94436 | 3006 | 48111 |
| 5L-8S | | MI | 38938 | 9726 | 61374 | 7253 | 66152 | 5902 | 67136 | 4898 | 66062 | 3414 | 78300 | 2769 | 42712 |
| 22-#11 | 1.78 | MA | 43821 | 9726 | 69022 | 7281 | 75007 | 5927 | 76710 | 4904 | 76834 | 3437 | 91873 | 2950 | 48012 |
| 6L-7S | | MI | 39415 | 9726 | 62175 | 7255 | 67243 | 5888 | 68428 | 4886 | 67949 | 3421 | 80546 | 2818 | 43038 |
| 22-#11 | 1.78 | MA | 43287 | 9726 | 68036 | 7297 | 73818 | 5924 | 75247 | 4917 | 74871 | 3448 | 89141 | 2860 | 47426 |
| 7L-6S | | MI | 39899 | 9726 | 63067 | 7240 | 68320 | 5892 | 69751 | 4874 | 69724 | 3412 | 82981 | 2908 | 43546 |
| 22-#11 | 1.78 | MA | 42761 | 9726 | 67150 | 7295 | 72611 | 5938 | 73820 | 4930 | 72785 | 3441 | 86631 | 2810 | 47034 |
| 8L-5S | | MI | 40396 | 9726 | 63882 | 7243 | 69448 | 5879 | 71130 | 4879 | 71541 | 3403 | 85264 | 2964 | 43625 |
| 22-#11 | 1.78 | MA | 42206 | 9726 | 66284 | 7293 | 71438 | 5935 | 72327 | 4925 | 70840 | 3451 | 84146 | 2757 | 46679 |
| 9L-4S | | MI | 40917 | 9726 | 64751 | 7245 | 70574 | 5883 | 72515 | 4867 | 73546 | 3410 | 87666 | 3005 | 43660 |
| 22-#11 | 1.78 | MA | 41625 | 9726 | 65314 | 7308 | 70247 | 5949 | 70907 | 4938 | 68912 | 3462 | 81738 | 2696 | 45978 |
| 10L-3S | | MI | 41501 | 9726 | 65755 | 7231 | 71855 | 5869 | 74071 | 4872 | 75549 | 3401 | 89966 | 3092 | 43664 |
| 22-#11 | 1.78 | MA | 41059 | 9726 | 64446 | 7306 | 69080 | 5946 | 69433 | 4934 | 66856 | 3455 | 79290 | 2643 | 45423 |
| 11L-2S | | MI | 42333 | 9726 | 66989 | 7233 | 73436 | 5873 | 76000 | 4860 | 78174 | 3391 | 93498 | 3178 | 43646 |

## RECTANGULAR TIED COLUMNS 42" x 46"

Short columns – no sidesway
Bending on major or minor axis

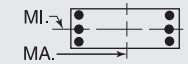



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 2.56 | MA | 47276 | 10251 | 76424 | 7597 | 84471 | 6138 | 88220 | 5026 | 92596 | 3388 | 112682 | 2868 | 68432 |
| 4L-9S | | MI | 39526 | 10251 | 63657 | 7584 | 68972 | 6146 | 70457 | 5029 | 70650 | 3376 | 84990 | 2395 | 58210 |
| 22-#14 | 2.56 | MA | 46462 | 10251 | 75046 | 7594 | 82683 | 6133 | 86023 | 5044 | 89414 | 3377 | 108853 | 2807 | 68214 |
| 5L-8S | | MI | 40193 | 10251 | 64896 | 7563 | 70495 | 6127 | 72395 | 5037 | 73173 | 3364 | 88135 | 2473 | 59188 |
| 22-#14 | 2.56 | MA | 45688 | 10251 | 73754 | 7591 | 80894 | 6152 | 83835 | 5037 | 86531 | 3391 | 105206 | 2727 | 67038 |
| 6L-7S | | MI | 40867 | 10251 | 66046 | 7567 | 72061 | 6133 | 74247 | 5020 | 75879 | 3376 | 91334 | 2542 | 60094 |
| 22-#14 | 2.56 | MA | 44933 | 10251 | 72339 | 7612 | 79186 | 6147 | 81736 | 5055 | 83715 | 3406 | 101317 | 2597 | 66316 |
| 7L-6S | | MI | 41551 | 10251 | 67325 | 7546 | 73605 | 6115 | 76145 | 5004 | 78425 | 3363 | 94797 | 2672 | 60699 |
| 22-#14 | 2.56 | MA | 44191 | 10251 | 71068 | 7609 | 77455 | 6167 | 79687 | 5073 | 80721 | 3395 | 97736 | 2526 | 65304 |
| 8L-5S | | MI | 42252 | 10251 | 68494 | 7550 | 75222 | 6121 | 78122 | 5012 | 81030 | 3350 | 98041 | 2753 | 61729 |
| 22-#14 | 2.56 | MA | 43417 | 10251 | 69824 | 7606 | 75771 | 6162 | 77545 | 5066 | 77931 | 3410 | 94200 | 2448 | 64163 |
| 9L-4S | | MI | 42990 | 10251 | 69739 | 7554 | 76838 | 6102 | 80107 | 4995 | 83905 | 3362 | 101463 | 2812 | 61934 |
| 22-#14 | 2.56 | MA | 42595 | 10251 | 68431 | 7627 | 74062 | 6182 | 75507 | 5084 | 75164 | 3424 | 90774 | 2360 | 62894 |
| 10L-3S | | MI | 43815 | 10251 | 71179 | 7534 | 78673 | 6108 | 82337 | 5003 | 86775 | 3350 | 104729 | 2936 | 62029 |
| 22-#18 | 4.55 | MA | 50193 | 11582 | 85486 | 8383 | 95558 | 6730 | 101614 | 5378 | 110742 | 3276 | 138062 | 2134 | 112929 |
| 6L-7S | | MI | 44360 | 11582 | 75607 | 8366 | 84032 | 6716 | 88734 | 5365 | 95347 | 3242 | 117836 | 1813 | 99121 |
| 22-#18 | 4.55 | MA | 48910 | 11582 | 82996 | 8420 | 92553 | 6763 | 97921 | 5408 | 105787 | 3298 | 131326 | 1903 | 109768 |
| 7L-6S | | MI | 45524 | 11582 | 77857 | 8331 | 86746 | 6685 | 92070 | 5337 | 99773 | 3220 | 123814 | 2045 | 101825 |
| 22-#18 | 4.55 | MA | 47647 | 11582 | 80757 | 8412 | 89506 | 6752 | 94315 | 5438 | 100521 | 3277 | 125103 | 1780 | 106685 |
| 8L-5S | | MI | 46719 | 11582 | 79910 | 8340 | 89588 | 6698 | 95544 | 5354 | 104302 | 3198 | 129409 | 2189 | 103639 |
| 24-#11 | 1.94 | MA | 46233 | 9834 | 73363 | 7338 | 80673 | 5950 | 83630 | 4929 | 86192 | 3414 | 103664 | 3119 | 52454 |
| 3L-11S | | MI | 38004 | 9834 | 60159 | 7330 | 64538 | 5956 | 65097 | 4929 | 63323 | 3416 | 75284 | 2585 | 45072 |
| 24-#11 | 1.94 | MA | 45590 | 9834 | 72251 | 7353 | 79255 | 5964 | 81906 | 4925 | 83974 | 3425 | 101081 | 3033 | 52421 |
| 4L-10S | | MI | 38515 | 9834 | 60945 | 7332 | 65594 | 5960 | 66430 | 4934 | 65183 | 3424 | 77474 | 2637 | 45534 |
| 24-#11 | 1.94 | MA | 45016 | 9834 | 71291 | 7351 | 78009 | 5961 | 80375 | 4938 | 81756 | 3418 | 98396 | 2990 | 52355 |
| 5L-9S | | MI | 39039 | 9834 | 61744 | 7335 | 66671 | 5946 | 67715 | 4922 | 66927 | 3415 | 79619 | 2698 | 46119 |
| 24-#11 | 1.94 | MA | 44470 | 9834 | 70391 | 7349 | 76762 | 5975 | 78851 | 4933 | 79746 | 3428 | 95834 | 2935 | 52176 |
| 6L-8S | | MI | 39522 | 9834 | 62607 | 7320 | 67733 | 5950 | 69066 | 4927 | 68687 | 3405 | 81832 | 2752 | 46481 |
| 24-#11 | 1.94 | MA | 43938 | 9834 | 69405 | 7364 | 75572 | 5972 | 77388 | 4946 | 77783 | 3439 | 93102 | 2845 | 51599 |
| 7E | | MI | 39997 | 9834 | 63409 | 7322 | 68825 | 5937 | 70357 | 4915 | 70573 | 3413 | 84078 | 2800 | 46799 |
| 24-#11 | 1.94 | MA | 43414 | 9834 | 68519 | 7362 | 74366 | 5986 | 75960 | 4959 | 75697 | 3432 | 90592 | 2795 | 51217 |
| 8L-6S | | MI | 40480 | 9834 | 64301 | 7308 | 69901 | 5941 | 71681 | 4903 | 72349 | 3403 | 86514 | 2890 | 47287 |
| 24-#11 | 1.94 | MA | 42861 | 9834 | 67652 | 7360 | 73192 | 5983 | 74467 | 4955 | 73752 | 3443 | 88107 | 2741 | 50802 |
| 9L-5S | | MI | 40975 | 9834 | 65115 | 7310 | 71029 | 5927 | 73059 | 4908 | 74166 | 3394 | 88797 | 2946 | 47455 |
| 24-#11 | 1.94 | MA | 42282 | 9834 | 66682 | 7375 | 72002 | 5997 | 73047 | 4968 | 71824 | 3453 | 85699 | 2680 | 50118 |
| 10L-4S | | MI | 41495 | 9834 | 65984 | 7313 | 72156 | 5931 | 74444 | 4896 | 76171 | 3402 | 91199 | 2988 | 47501 |
| 24-#11 | 1.94 | MA | 41717 | 9834 | 65814 | 7374 | 70835 | 5994 | 71573 | 4963 | 69768 | 3447 | 83251 | 2628 | 49575 |
| 11L-3S | | MI | 42077 | 9834 | 66989 | 7298 | 73436 | 5918 | 76000 | 4901 | 78174 | 3392 | 93498 | 3074 | 47521 |
| 24-#11 | 1.94 | MA | 41162 | 9834 | 64861 | 7389 | 69653 | 6008 | 70155 | 4976 | 67840 | 3457 | 80492 | 2551 | 48746 |
| 12L-2S | | MI | 42907 | 9834 | 68223 | 7301 | 75018 | 5921 | 77930 | 4889 | 80799 | 3383 | 97031 | 3160 | 47510 |
| 24-#14 | 2.80 | MA | 47372 | 10407 | 77006 | 7691 | 85196 | 6203 | 89088 | 5086 | 93585 | 3365 | 114492 | 2783 | 74157 |
| 5L-9S | | MI | 40352 | 10407 | 65423 | 7681 | 71235 | 6216 | 73219 | 5071 | 74407 | 3364 | 90013 | 2368 | 63530 |
| 24-#14 | 2.80 | MA | 46601 | 10407 | 75714 | 7688 | 83406 | 6222 | 86901 | 5080 | 90702 | 3379 | 110846 | 2703 | 72989 |
| 6L-8S | | MI | 41016 | 10407 | 66661 | 7660 | 72759 | 6197 | 75156 | 5080 | 76930 | 3351 | 93158 | 2446 | 64480 |
| 24-#14 | 2.80 | MA | 45850 | 10407 | 74299 | 7709 | 81699 | 6217 | 84802 | 5098 | 87885 | 3393 | 106957 | 2573 | 72287 |
| 7E | | MI | 41686 | 10407 | 67811 | 7664 | 74324 | 6203 | 77008 | 5063 | 79636 | 3363 | 96357 | 2515 | 65468 |
| 24-#14 | 2.80 | MA | 45111 | 10407 | 73028 | 7706 | 79968 | 6237 | 82753 | 5115 | 84892 | 3383 | 103376 | 2502 | 71191 |
| 8L-6S | | MI | 42367 | 10407 | 69091 | 7643 | 75868 | 6184 | 78906 | 5046 | 82182 | 3351 | 99820 | 2645 | 66056 |
| 24-#14 | 2.80 | MA | 44342 | 10407 | 71784 | 7703 | 78283 | 6232 | 80610 | 5109 | 82101 | 3397 | 99840 | 2425 | 70081 |
| 9L-5S | | MI | 43066 | 10407 | 70259 | 7648 | 77486 | 6191 | 80883 | 5054 | 84787 | 3338 | 103064 | 2726 | 67045 |
| 24-#14 | 2.80 | MA | 43523 | 10407 | 70391 | 7724 | 76575 | 6252 | 78572 | 5127 | 79334 | 3411 | 96414 | 2337 | 68751 |
| 10L-4S | | MI | 43800 | 10407 | 71505 | 7652 | 79101 | 6172 | 82868 | 5037 | 87662 | 3350 | 106486 | 2785 | 67400 |
| 24-#18 | 4.97 | MA | 50468 | 11859 | 86432 | 8593 | 96958 | 6887 | 103294 | 5483 | 113098 | 3276 | 141096 | 1855 | 120060 |
| 7E | | MI | 45751 | 11859 | 78697 | 8539 | 87993 | 6840 | 93567 | 5440 | 101874 | 3217 | 126510 | 1759 | 108353 |
| 24-#18 | 4.97 | MA | 49214 | 11859 | 84193 | 8585 | 93910 | 6877 | 99688 | 5513 | 107832 | 3254 | 134872 | 1732 | 116863 |
| 8L-6S | | MI | 46908 | 11859 | 80947 | 8504 | 90707 | 6809 | 96902 | 5413 | 106300 | 3195 | 132488 | 1990 | 110966 |

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

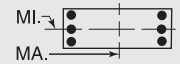
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.19 | MA | 47966 | 9741 | 74559 | 7287 | 80709 | 5941 | 82242 | 4956 | 81803 | 3568 | 96077 | 3377 | 35259 |
| 2L-3S | | MI | 39713 | 9741 | 62243 | 7210 | 66393 | 5916 | 66659 | 4936 | 64208 | 3546 | 73929 | 3094 | 30694 |
| 6-#18 | 1.19 | MA | 45508 | 9741 | 70951 | 7280 | 76083 | 5975 | 76598 | 4986 | 74124 | 3592 | 85759 | 3156 | 35369 |
| 3L-2S | | MI | 41812 | 9741 | 65333 | 7219 | 70354 | 5885 | 71491 | 4909 | 70735 | 3524 | 82604 | 3315 | 30559 |
| 8-#18 | 1.59 | MA | 49660 | 10017 | 78168 | 7460 | 85335 | 6065 | 87886 | 5031 | 89481 | 3546 | 106395 | 3332 | 46603 |
| 2L-4S | | MI | 39685 | 10017 | 62806 | 7418 | 67134 | 6027 | 67578 | 4994 | 65746 | 3544 | 76979 | 2818 | 40320 |
| 8-#18 | 1.59 | MA | 47219 | 10017 | 74559 | 7453 | 80709 | 6099 | 82242 | 5062 | 81803 | 3570 | 96077 | 3110 | 46647 |
| 3E | | MI | 41159 | 10017 | 65333 | 7383 | 70354 | 6040 | 71491 | 5011 | 70735 | 3521 | 82604 | 3039 | 40390 |
| 8-#18 | 1.59 | MA | 45506 | 10017 | 71619 | 7491 | 76962 | 6089 | 77688 | 5048 | 75942 | 3594 | 89363 | 2889 | 46463 |
| 4L-2S | | MI | 43244 | 10017 | 68423 | 7392 | 74315 | 6009 | 76324 | 4984 | 77261 | 3499 | 91278 | 3261 | 40304 |
| 10-#14 | 1.12 | MA | 47756 | 9689 | 73796 | 7297 | 80015 | 5952 | 81504 | 4971 | 80844 | 3595 | 95154 | 3424 | 33332 |
| 2L-5S | | MI | 38839 | 9689 | 60227 | 7248 | 64079 | 5933 | 63934 | 4954 | 60629 | 3576 | 70274 | 3061 | 29052 |
| 10-#14 | 1.12 | MA | 46350 | 9689 | 71739 | 7294 | 77377 | 5948 | 78287 | 4990 | 76467 | 3610 | 89206 | 3299 | 33391 |
| 3L-4S | | MI | 39598 | 9689 | 61473 | 7252 | 65694 | 5914 | 65919 | 4937 | 63504 | 3588 | 73696 | 3120 | 29038 |
| 10-#14 | 1.12 | MA | 45366 | 9689 | 70067 | 7316 | 75246 | 5968 | 75696 | 4983 | 73133 | 3625 | 85326 | 3175 | 33428 |
| 4L-3S | | MI | 40445 | 9689 | 62913 | 7231 | 67529 | 5921 | 68150 | 4945 | 66374 | 3575 | 76962 | 3245 | 28978 |
| 10-#14 | 1.12 | MA | 44488 | 9689 | 68622 | 7313 | 73372 | 5963 | 73393 | 5002 | 69796 | 3616 | 81293 | 3113 | 33381 |
| 5L-2S | | MI | 41649 | 9689 | 64679 | 7236 | 69793 | 5902 | 70911 | 4928 | 70131 | 3562 | 81984 | 3369 | 28910 |
| 10-#18 | 1.98 | MA | 51339 | 10294 | 81777 | 7633 | 89961 | 6189 | 93529 | 5107 | 97160 | 3524 | 116714 | 3286 | 57911 |
| 2L-5S | | MI | 39818 | 10294 | 63706 | 7582 | 68257 | 6183 | 68924 | 5097 | 67274 | 3497 | 79720 | 2662 | 48439 |
| 10-#18 | 1.98 | MA | 48914 | 10294 | 78168 | 7626 | 85335 | 6223 | 87886 | 5137 | 89481 | 3548 | 106395 | 3065 | 57877 |
| 3L-4S | | MI | 41128 | 10294 | 65896 | 7591 | 71095 | 6151 | 72410 | 5070 | 72273 | 3519 | 85654 | 2763 | 49875 |
| 10-#18 | 1.98 | MA | 47214 | 10294 | 75228 | 7663 | 81588 | 6213 | 83331 | 5124 | 83620 | 3572 | 99681 | 2843 | 57601 |
| 4L-3S | | MI | 42592 | 10294 | 68423 | 7556 | 74315 | 6165 | 76324 | 5087 | 77261 | 3497 | 91278 | 2985 | 50038 |
| 10-#18 | 1.98 | MA | 45695 | 10294 | 72685 | 7657 | 78291 | 6247 | 79280 | 5154 | 77752 | 3552 | 92662 | 2737 | 55832 |
| 5L-2S | | MI | 44664 | 10294 | 71513 | 7565 | 78277 | 6133 | 81156 | 5059 | 83788 | 3475 | 99953 | 3206 | 50011 |
| 12-#14 | 1.34 | MA | 48734 | 9844 | 75854 | 7394 | 82652 | 6022 | 84721 | 5014 | 85222 | 3583 | 101103 | 3401 | 39797 |
| 2L-6S | | MI | 38961 | 9844 | 60825 | 7341 | 64724 | 5997 | 64719 | 4988 | 61781 | 3576 | 72053 | 2953 | 34249 |
| 12-#14 | 1.34 | MA | 47333 | 9844 | 73796 | 7391 | 80015 | 6017 | 81504 | 5032 | 80844 | 3598 | 95154 | 3277 | 39840 |
| 3L-5S | | MI | 39680 | 9844 | 61993 | 7345 | 66342 | 6003 | 66696 | 4996 | 64386 | 3563 | 75297 | 3034 | 34543 |
| 12-#14 | 1.34 | MA | 46354 | 9844 | 72124 | 7413 | 77883 | 6038 | 78913 | 5026 | 77510 | 3613 | 91275 | 3152 | 39843 |
| 4E | | MI | 40435 | 9844 | 63239 | 7349 | 67958 | 5984 | 68681 | 4979 | 67261 | 3576 | 78719 | 3093 | 34569 |
| 12-#14 | 1.34 | MA | 45480 | 9844 | 70680 | 7410 | 76010 | 6033 | 76611 | 5044 | 74174 | 3603 | 87242 | 3091 | 39760 |
| 5L-3S | | MI | 41279 | 9844 | 64679 | 7329 | 69793 | 5990 | 70911 | 4988 | 70131 | 3563 | 81984 | 3217 | 34531 |
| 12-#14 | 1.34 | MA | 44649 | 9844 | 69326 | 7407 | 74134 | 6053 | 74318 | 5038 | 71153 | 3618 | 83394 | 3010 | 39335 |
| 6L-2S | | MI | 42478 | 9844 | 66444 | 7333 | 72056 | 5972 | 73672 | 4971 | 73888 | 3550 | 87007 | 3342 | 34475 |
| 12-#18 | 2.38 | MA | 53002 | 10571 | 85386 | 7805 | 94587 | 6313 | 99173 | 5182 | 104839 | 3502 | 127032 | 3240 | 69189 |
| 2L-6S | | MI | 40019 | 10571 | 64743 | 7746 | 69376 | 6294 | 70282 | 5155 | 69271 | 3494 | 82799 | 2463 | 55967 |
| 12-#18 | 2.38 | MA | 50593 | 10571 | 81777 | 7799 | 89961 | 6347 | 93529 | 5213 | 97160 | 3526 | 116714 | 3019 | 69080 |
| 3L-5S | | MI | 41257 | 10571 | 66796 | 7755 | 72218 | 6307 | 73756 | 5172 | 73800 | 3472 | 88394 | 2607 | 57626 |
| 12-#18 | 2.38 | MA | 48905 | 10571 | 78837 | 7836 | 86214 | 6337 | 88975 | 5199 | 91299 | 3550 | 109999 | 2798 | 68724 |
| 4E | | MI | 42559 | 10571 | 68986 | 7764 | 75056 | 6276 | 77243 | 5145 | 78799 | 3494 | 94328 | 2709 | 59410 |
| 12-#18 | 2.38 | MA | 47398 | 10571 | 76294 | 7830 | 82917 | 6371 | 84923 | 5230 | 85431 | 3530 | 102980 | 2692 | 66598 |
| 5L-3S | | MI | 44012 | 10571 | 71513 | 7729 | 78277 | 6289 | 81156 | 5162 | 83788 | 3472 | 99953 | 2930 | 59648 |
| 12-#18 | 2.38 | MA | 45965 | 10571 | 73911 | 7823 | 79616 | 6361 | 80888 | 5216 | 80113 | 3554 | 96313 | 2548 | 64504 |
| 6L-2S | | MI | 46072 | 10571 | 74603 | 7738 | 82238 | 6258 | 85989 | 5135 | 90315 | 3450 | 108627 | 3151 | 59690 |
| 14-#11 | 1.08 | MA | 47666 | 9666 | 73446 | 7304 | 79710 | 5960 | 81188 | 4980 | 80438 | 3609 | 94780 | 3446 | 32486 |
| 2L-7S | | MI | 38621 | 9666 | 59563 | 7268 | 63354 | 5927 | 63092 | 4965 | 59592 | 3608 | 68791 | 3034 | 28188 |
| 14-#11 | 1.08 | MA | 46683 | 9666 | 72010 | 7302 | 77870 | 5957 | 78942 | 4993 | 77383 | 3620 | 90605 | 3359 | 32524 |
| 3L-6S | | MI | 39112 | 9666 | 60455 | 7253 | 64430 | 5931 | 64416 | 4953 | 61367 | 3598 | 71227 | 3124 | 28309 |
| 14-#11 | 1.08 | MA | 45996 | 9666 | 70844 | 7318 | 76384 | 5971 | 77136 | 4989 | 75058 | 3631 | 87879 | 3273 | 32556 |
| 4L-5S | | MI | 39616 | 9666 | 61270 | 7255 | 65558 | 5917 | 65794 | 4958 | 63184 | 3589 | 73510 | 3180 | 28305 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

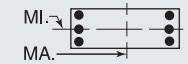



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 14-#11 | 1.08 | MA | 45384 | 9666 | 69838 | 7316 | 75078 | 5968 | 75531 | 5002 | 72733 | 3624 | 85053 | 3230 | 32565 |
| 5L-4S | | MI | 40145 | 9666 | 62138 | 7258 | 66685 | 5921 | 67179 | 4946 | 65190 | 3596 | 75912 | 3222 | 28272 |
| 14-#11 | 1.08 | MA | 44802 | 9666 | 68895 | 7314 | 73771 | 5983 | 73934 | 4998 | 70628 | 3635 | 82351 | 3174 | 32529 |
| 6L-3S | | MI | 40737 | 9666 | 63143 | 7243 | 67965 | 5908 | 68735 | 4951 | 67193 | 3587 | 78211 | 3308 | 28230 |
| 14-#11 | 1.08 | MA | 44234 | 9666 | 67862 | 7330 | 72525 | 5980 | 72401 | 5012 | 68571 | 3646 | 79471 | 3084 | 32320 |
| 7L-2S | | MI | 41580 | 9666 | 64377 | 7246 | 69547 | 5912 | 70665 | 4939 | 69818 | 3577 | 81744 | 3395 | 28186 |
| 14-#14 | 1.56 | MA | 49706 | 10000 | 77911 | 7491 | 85290 | 6092 | 87939 | 5056 | 89599 | 3571 | 107052 | 3379 | 46249 |
| 2L-7S | | MI | 39103 | 10000 | 61311 | 7459 | 65444 | 6085 | 65582 | 5047 | 62991 | 3577 | 73613 | 2796 | 38838 |
| 14-#14 | 1.56 | MA | 48311 | 10000 | 75854 | 7489 | 82652 | 6087 | 84721 | 5075 | 85222 | 3586 | 101103 | 3254 | 46279 |
| 3L-6S | | MI | 39801 | 10000 | 62590 | 7438 | 66988 | 6067 | 67480 | 5031 | 65537 | 3564 | 77076 | 2926 | 39557 |
| 14-#14 | 1.56 | MA | 47336 | 10000 | 74181 | 7510 | 80521 | 6108 | 82131 | 5068 | 81888 | 3601 | 97224 | 3130 | 46245 |
| 4L-5S | | MI | 40517 | 10000 | 63758 | 7443 | 68606 | 6073 | 69457 | 5039 | 68143 | 3551 | 80320 | 3007 | 40022 |
| 14-#14 | 1.56 | MA | 46467 | 10000 | 72737 | 7508 | 78647 | 6103 | 79828 | 5087 | 78552 | 3591 | 93191 | 3068 | 46129 |
| 5L-4S | | MI | 41268 | 10000 | 65004 | 7447 | 70221 | 6054 | 71442 | 5022 | 71017 | 3563 | 83742 | 3066 | 40081 |
| 14-#14 | 1.56 | MA | 45639 | 10000 | 71384 | 7505 | 76772 | 6123 | 77535 | 5080 | 75530 | 3606 | 89342 | 2988 | 45530 |
| 6L-3S | | MI | 42109 | 10000 | 66444 | 7426 | 72056 | 6060 | 73672 | 5030 | 73888 | 3550 | 87007 | 3190 | 40068 |
| 14-#14 | 1.56 | MA | 44833 | 10000 | 69901 | 7527 | 74983 | 6118 | 75336 | 5099 | 72578 | 3621 | 85240 | 2858 | 44619 |
| 7L-2S | | MI | 43303 | 10000 | 68210 | 7430 | 74319 | 6041 | 76433 | 5013 | 77645 | 3538 | 92030 | 3315 | 40026 |
| 14-#18 | 2.78 | MA | 54652 | 10847 | 88994 | 7978 | 99214 | 6437 | 104817 | 5257 | 112517 | 3480 | 137350 | 3195 | 80432 |
| 2L-7S | | MI | 40256 | 10847 | 65583 | 7954 | 70623 | 6449 | 71779 | 5258 | 71372 | 3491 | 85495 | 2177 | 62890 |
| 14-#18 | 2.78 | MA | 52258 | 10847 | 85386 | 7972 | 94587 | 6471 | 99173 | 5288 | 104839 | 3504 | 127032 | 2973 | 80266 |
| 3L-6S | | MI | 41455 | 10847 | 67833 | 7919 | 73337 | 6418 | 75115 | 5231 | 75798 | 3469 | 91474 | 2408 | 65273 |
| 14-#18 | 2.78 | MA | 50582 | 10847 | 82445 | 8009 | 90840 | 6461 | 94619 | 5275 | 98977 | 3528 | 120317 | 2752 | 79838 |
| 4L-5S | | MI | 42685 | 10847 | 69886 | 7928 | 76180 | 6431 | 78588 | 5248 | 80327 | 3447 | 97069 | 2553 | 66847 |
| 14-#18 | 2.78 | MA | 49086 | 10847 | 79903 | 8003 | 87543 | 6495 | 90567 | 5305 | 93109 | 3508 | 113298 | 2646 | 77400 |
| 5L-4S | | MI | 43977 | 10847 | 72076 | 7937 | 79017 | 6400 | 82075 | 5220 | 85326 | 3469 | 103003 | 2654 | 68932 |
| 14-#18 | 2.78 | MA | 47664 | 10847 | 77520 | 7996 | 84242 | 6485 | 86532 | 5292 | 87792 | 3532 | 106631 | 2502 | 75401 |
| 6L-3S | | MI | 45422 | 10847 | 74603 | 7902 | 82238 | 6413 | 85989 | 5237 | 90315 | 3447 | 108627 | 2875 | 69236 |
| 14-#18 | 2.78 | MA | 46278 | 10847 | 74908 | 8033 | 81092 | 6519 | 82659 | 5323 | 82596 | 3555 | 99517 | 2272 | 72563 |
| 7L-2S | | MI | 47469 | 10847 | 77693 | 7911 | 86199 | 6382 | 90821 | 5210 | 96841 | 3425 | 117302 | 3097 | 69341 |
| 16-#11 | 1.24 | MA | 48353 | 9774 | 74882 | 7371 | 81551 | 6008 | 83434 | 5009 | 83494 | 3600 | 98955 | 3431 | 36997 |
| 2L-8S | | MI | 38731 | 9774 | 59995 | 7332 | 63844 | 5989 | 63730 | 5007 | 60330 | 3591 | 70077 | 2968 | 31560 |
| 16-#11 | 1.24 | MA | 47372 | 9774 | 73446 | 7370 | 79710 | 6005 | 81188 | 5023 | 80438 | 3611 | 94780 | 3345 | 37028 |
| 3L-7S | | MI | 39213 | 9774 | 60797 | 7335 | 64935 | 5975 | 65022 | 4995 | 62217 | 3599 | 72323 | 3017 | 31928 |
| 16-#11 | 1.24 | MA | 46688 | 9774 | 72280 | 7385 | 78224 | 6019 | 79382 | 5019 | 78114 | 3622 | 92054 | 3258 | 37050 |
| 4L-6S | | MI | 39703 | 9774 | 61689 | 7320 | 66012 | 5979 | 66345 | 4983 | 63992 | 3589 | 74759 | 3107 | 32149 |
| 16-#11 | 1.24 | MA | 46078 | 9774 | 71274 | 7383 | 76919 | 6017 | 77777 | 5032 | 75789 | 3616 | 89228 | 3215 | 37039 |
| 5E | | MI | 40205 | 9774 | 62503 | 7323 | 67140 | 5966 | 67724 | 4988 | 65809 | 3580 | 77042 | 3163 | 32165 |
| 16-#11 | 1.24 | MA | 45498 | 9774 | 70331 | 7382 | 75612 | 6031 | 76180 | 5028 | 73683 | 3627 | 86526 | 3160 | 36985 |
| 6L-4S | | MI | 40733 | 9774 | 63372 | 7325 | 68266 | 5970 | 69108 | 4976 | 67815 | 3588 | 79444 | 3204 | 32145 |
| 16-#11 | 1.24 | MA | 44932 | 9774 | 69298 | 7397 | 74366 | 6028 | 74647 | 5041 | 71627 | 3638 | 83646 | 3070 | 36676 |
| 7L-3S | | MI | 41323 | 9774 | 64377 | 7311 | 69547 | 5956 | 70665 | 4981 | 69818 | 3578 | 81744 | 3291 | 32111 |
| 16-#11 | 1.24 | MA | 44365 | 9774 | 68370 | 7396 | 73102 | 6043 | 73151 | 5054 | 69441 | 3631 | 81003 | 3020 | 36204 |
| 8L-2S | | MI | 42163 | 9774 | 65611 | 7313 | 71128 | 5960 | 72594 | 4969 | 72443 | 3569 | 85276 | 3377 | 32072 |
| 16-#14 | 1.79 | MA | 50673 | 10156 | 79968 | 7589 | 87927 | 6162 | 91156 | 5099 | 93977 | 3558 | 113001 | 3356 | 52692 |
| 2L-8S | | MI | 39257 | 10156 | 61926 | 7552 | 66142 | 6149 | 66491 | 5106 | 64043 | 3552 | 75437 | 2700 | 43697 |
| 16-#14 | 1.79 | MA | 49283 | 10156 | 77911 | 7586 | 85290 | 6157 | 87939 | 5117 | 89599 | 3573 | 107052 | 3232 | 52695 |
| 3L-7S | | MI | 39941 | 10156 | 63076 | 7556 | 67708 | 6155 | 68343 | 5090 | 66748 | 3564 | 78636 | 2769 | 44192 |
| 16-#14 | 1.79 | MA | 48313 | 10156 | 76239 | 7608 | 83158 | 6177 | 85348 | 5111 | 86265 | 3588 | 103172 | 3107 | 52636 |
| 4L-6S | | MI | 40636 | 10156 | 64356 | 7536 | 69251 | 6136 | 70241 | 5073 | 69294 | 3551 | 82098 | 2899 | 44878 |
| 16-#14 | 1.79 | MA | 47447 | 10156 | 74794 | 7605 | 81285 | 6173 | 83045 | 5129 | 82929 | 3578 | 99139 | 3046 | 52493 |
| 5E | | MI | 41348 | 10156 | 65524 | 7540 | 70869 | 6143 | 72218 | 5081 | 71899 | 3539 | 85342 | 2980 | 45493 |
| 16-#14 | 1.79 | MA | 46624 | 10156 | 73441 | 7602 | 79409 | 6193 | 80753 | 5123 | 79908 | 3593 | 95291 | 2965 | 51740 |
| 6L-4S | | MI | 42097 | 10156 | 66770 | 7544 | 72484 | 6124 | 74203 | 5064 | 74774 | 3551 | 88765 | 3039 | 45577 |
| 16-#14 | 1.79 | MA | 45821 | 10156 | 71958 | 7624 | 77620 | 6188 | 78553 | 5141 | 76956 | 3608 | 91188 | 2836 | 50866 |
| 7L-3S | | MI | 42934 | 10156 | 68210 | 7523 | 74319 | 6130 | 76433 | 5072 | 77645 | 3538 | 92030 | 3163 | 45601 |
| 16-#14 | 1.79 | MA | 45031 | 10156 | 70626 | 7621 | 75806 | 6209 | 76406 | 5160 | 73819 | 3599 | 87417 | 2764 | 50221 |
| 8L-2S | | MI | 44123 | 10156 | 69975 | 7527 | 76583 | 6111 | 79194 | 5056 | 81401 | 3525 | 97053 | 3288 | 45566 |
| 16-#18 | 3.17 | MA | 53910 | 11124 | 88994 | 8145 | 99214 | 6595 | 104817 | 5363 | 112517 | 3482 | 137350 | 2928 | 91438 |
| 3L-7S | | MI | 41689 | 11124 | 68673 | 8127 | 74585 | 6573 | 76612 | 5333 | 77899 | 3466 | 94170 | 2122 | 72040 |

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

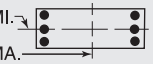
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#18 | 3.17 | MA | 52245 | 11124 | 86054 | 8182 | 95466 | 6585 | 100262 | 5350 | 106656 | 3506 | 130636 | 2706 | 90945 |
| 4L-6S | | MI | 42880 | 11124 | 70923 | 8092 | 77298 | 6542 | 79947 | 5306 | 82325 | 3444 | 100148 | 2353 | 74596 |
| 16-#18 | 3.17 | MA | 50760 | 11124 | 83512 | 8175 | 92169 | 6619 | 96211 | 5381 | 100788 | 3486 | 123616 | 2600 | 88230 |
| 5E | | MI | 44102 | 11124 | 72976 | 8101 | 80141 | 6555 | 83421 | 5323 | 86854 | 3422 | 105743 | 2498 | 76096 |
| 16-#18 | 3.17 | MA | 49348 | 11124 | 81128 | 8169 | 88868 | 6609 | 92176 | 5367 | 95470 | 3509 | 116949 | 2457 | 86315 |
| 6L-4S | | MI | 45385 | 11124 | 75166 | 8110 | 82979 | 6524 | 86907 | 5296 | 91853 | 3444 | 111677 | 2599 | 78444 |
| 16-#18 | 3.17 | MA | 47972 | 11124 | 78517 | 8206 | 85718 | 6644 | 88303 | 5398 | 90275 | 3533 | 109835 | 2226 | 83305 |
| 7L-3S | | MI | 46820 | 11124 | 77693 | 8075 | 86199 | 6537 | 90821 | 5313 | 96841 | 3422 | 117302 | 2821 | 78809 |
| 16-#18 | 3.17 | MA | 46618 | 11124 | 76171 | 8200 | 82523 | 6633 | 84523 | 5429 | 84753 | 3513 | 103272 | 2102 | 80666 |
| 8L-2S | | MI | 48856 | 11124 | 80783 | 8084 | 90160 | 6506 | 95654 | 5286 | 103368 | 3400 | 125976 | 3042 | 78963 |
| 18-#11 | 1.39 | MA | 49036 | 9882 | 76318 | 7439 | 83392 | 6056 | 85680 | 5039 | 86549 | 3591 | 103130 | 3417 | 41501 |
| 2L-9S | | MI | 38831 | 9882 | 60366 | 7415 | 64363 | 6033 | 64309 | 5031 | 61196 | 3592 | 71396 | 2897 | 35059 |
| 18-#11 | 1.39 | MA | 48059 | 9882 | 74882 | 7437 | 81551 | 6054 | 83434 | 5052 | 83494 | 3602 | 98955 | 3330 | 41526 |
| 3L-8S | | MI | 39323 | 9882 | 61229 | 7400 | 65425 | 6037 | 65659 | 5036 | 62955 | 3583 | 73610 | 2951 | 35322 |
| 18-#11 | 1.39 | MA | 47377 | 9882 | 73716 | 7453 | 80065 | 6068 | 81628 | 5048 | 81169 | 3613 | 96229 | 3244 | 41538 |
| 4L-7S | | MI | 39803 | 9882 | 62030 | 7402 | 66517 | 6024 | 66951 | 5024 | 64842 | 3590 | 75856 | 2999 | 35675 |
| 18-#11 | 1.39 | MA | 46769 | 9882 | 72710 | 7451 | 78760 | 6065 | 80023 | 5061 | 78844 | 3607 | 93404 | 3201 | 41506 |
| 5L-6S | | MI | 40291 | 9882 | 62923 | 7388 | 67593 | 6028 | 68274 | 5012 | 66617 | 3581 | 78292 | 3089 | 35983 |
| 18-#11 | 1.39 | MA | 46190 | 9882 | 71767 | 7449 | 77453 | 6079 | 78425 | 5057 | 76739 | 3618 | 90701 | 3145 | 41436 |
| 6L-5S | | MI | 40792 | 9882 | 63737 | 7390 | 68721 | 6014 | 69653 | 5017 | 68434 | 3571 | 80575 | 3145 | 36015 |
| 18-#11 | 1.39 | MA | 45627 | 9882 | 70734 | 7465 | 76207 | 6077 | 76893 | 5071 | 74682 | 3629 | 87821 | 3055 | 41040 |
| 7L-4S | | MI | 41318 | 9882 | 64606 | 7393 | 69848 | 6018 | 71038 | 5005 | 70440 | 3579 | 82977 | 3187 | 36010 |
| 18-#11 | 1.39 | MA | 45064 | 9882 | 69806 | 7463 | 74942 | 6091 | 75397 | 5084 | 72496 | 3623 | 85178 | 3005 | 40584 |
| 8L-3S | | MI | 41906 | 9882 | 65611 | 7378 | 71128 | 6005 | 72594 | 5010 | 72443 | 3570 | 85276 | 3273 | 35985 |
| 18-#11 | 1.39 | MA | 44476 | 9882 | 68899 | 7461 | 73713 | 6088 | 73833 | 5080 | 70458 | 3634 | 82558 | 2952 | 40234 |
| 9L-2S | | MI | 42744 | 9882 | 66844 | 7381 | 72710 | 6008 | 74523 | 4998 | 75068 | 3560 | 88809 | 3360 | 35952 |
| 18-#14 | 2.01 | MA | 51634 | 10311 | 82026 | 7686 | 90564 | 6232 | 94374 | 5141 | 98355 | 3546 | 118950 | 3334 | 59129 |
| 2L-9S | | MI | 39401 | 10311 | 62453 | 7670 | 66882 | 6238 | 67315 | 5141 | 65276 | 3552 | 77314 | 2595 | 47901 |
| 18-#14 | 2.01 | MA | 50250 | 10311 | 79968 | 7683 | 87927 | 6227 | 91156 | 5159 | 93977 | 3561 | 113001 | 3209 | 59103 |
| 3L-8S | | MI | 40094 | 10311 | 63692 | 7650 | 68405 | 6219 | 69252 | 5149 | 67799 | 3540 | 80459 | 2673 | 48960 |
| 18-#14 | 2.01 | MA | 49284 | 10311 | 78296 | 7705 | 85795 | 6247 | 88566 | 5153 | 90643 | 3576 | 109121 | 3084 | 59021 |
| 4L-7S | | MI | 40775 | 10311 | 64842 | 7654 | 69971 | 6225 | 71104 | 5132 | 70505 | 3552 | 83659 | 2742 | 49553 |
| 18-#14 | 2.01 | MA | 48422 | 10311 | 76852 | 7702 | 83922 | 6243 | 86263 | 5172 | 87307 | 3566 | 105088 | 3023 | 58851 |
| 5L-6S | | MI | 41466 | 10311 | 66121 | 7633 | 71515 | 6206 | 73002 | 5115 | 73051 | 3539 | 87121 | 2872 | 50210 |
| 18-#14 | 2.01 | MA | 47603 | 10311 | 75498 | 7699 | 82046 | 6263 | 83970 | 5165 | 84285 | 3581 | 101240 | 2943 | 57962 |
| 6L-5S | | MI | 42176 | 10311 | 67290 | 7637 | 73132 | 6212 | 74979 | 5123 | 75656 | 3526 | 90365 | 2953 | 50956 |
| 18-#14 | 2.01 | MA | 46804 | 10311 | 74015 | 7721 | 80257 | 6258 | 81770 | 5184 | 81334 | 3596 | 97137 | 2813 | 57120 |
| 7L-4S | | MI | 42921 | 10311 | 68535 | 7641 | 74748 | 6194 | 76964 | 5107 | 78531 | 3538 | 93787 | 3012 | 51065 |
| 18-#14 | 2.01 | MA | 46018 | 10311 | 72683 | 7718 | 78443 | 6278 | 79624 | 5202 | 78196 | 3586 | 93366 | 2742 | 56389 |
| 8L-3S | | MI | 43754 | 10311 | 69975 | 7620 | 76583 | 6200 | 79194 | 5115 | 81401 | 3525 | 97053 | 3136 | 51109 |
| 18-#14 | 2.01 | MA | 45184 | 10311 | 71380 | 7715 | 76678 | 6274 | 77378 | 5196 | 75272 | 3601 | 89634 | 2664 | 55075 |
| 9L-2S | | MI | 44940 | 10311 | 71741 | 7625 | 78846 | 6181 | 81956 | 5098 | 85158 | 3513 | 102075 | 3261 | 51098 |
| 18-#18 | 3.57 | MA | 53895 | 11400 | 89663 | 8355 | 100092 | 6709 | 105906 | 5425 | 114335 | 3484 | 140954 | 2661 | 102046 |
| 4L-7S | | MI | 43112 | 11400 | 71763 | 8300 | 78546 | 6697 | 81444 | 5409 | 84425 | 3442 | 102844 | 2067 | 81213 |
| 18-#18 | 3.57 | MA | 52421 | 11400 | 87120 | 8348 | 96795 | 6744 | 101854 | 5456 | 108466 | 3463 | 133935 | 2555 | 99084 |
| 5L-6S | | MI | 44294 | 11400 | 74013 | 8265 | 81259 | 6666 | 84780 | 5382 | 88851 | 3420 | 108823 | 2299 | 83932 |
| 18-#18 | 3.57 | MA | 51019 | 11400 | 84737 | 8342 | 93494 | 6734 | 97819 | 5443 | 103149 | 3487 | 127267 | 2411 | 97243 |
| 6L-5S | | MI | 45508 | 11400 | 76066 | 8274 | 84102 | 6679 | 88253 | 5399 | 93380 | 3397 | 114417 | 2443 | 85367 |
| 18-#18 | 3.57 | MA | 49653 | 11400 | 82126 | 8379 | 90344 | 6768 | 93947 | 5473 | 97953 | 3511 | 120153 | 2180 | 94069 |
| 7L-4S | | MI | 46783 | 11400 | 78256 | 8283 | 86940 | 6648 | 91740 | 5371 | 98379 | 3420 | 120352 | 2545 | 87948 |
| 18-#18 | 3.57 | MA | 48309 | 11400 | 79779 | 8373 | 87149 | 6758 | 90166 | 5504 | 92432 | 3491 | 113590 | 2056 | 91309 |
| 8L-3S | | MI | 48209 | 11400 | 80783 | 8248 | 90160 | 6661 | 95654 | 5388 | 103368 | 3397 | 125976 | 2766 | 88369 |
| 20-#11 | 1.55 | MA | 49717 | 9990 | 77754 | 7506 | 85233 | 6105 | 87925 | 5068 | 89605 | 3583 | 107305 | 3402 | 46001 |
| 2L-10S | | MI | 38897 | 9990 | 60800 | 7480 | 64868 | 6095 | 64953 | 5073 | 62077 | 3593 | 72784 | 2818 | 38312 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

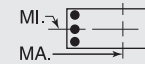



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#11 | 1.55 | MA | 48743 | 9990 | 76318 | 7505 | 83392 | 6102 | 85680 | 5081 | 86549 | 3594 | 103130 | 3316 | 46019 |
| 3L-9S | | MI | 39424 | 9990 | 61599 | 7482 | 65945 | 6082 | 66238 | 5060 | 63821 | 3583 | 74929 | 2879 | 38830 |
| 20-#11 | 1.55 | MA | 48063 | 9990 | 75152 | 7520 | 81906 | 6116 | 83873 | 5077 | 84225 | 3605 | 100405 | 3229 | 46010 |
| 4L-8S | | MI | 39912 | 9990 | 62462 | 7467 | 67007 | 6086 | 67589 | 5066 | 65580 | 3574 | 77143 | 2933 | 39088 |
| 20-#11 | 1.55 | MA | 47457 | 9990 | 74146 | 7518 | 80600 | 6113 | 82269 | 5091 | 81899 | 3599 | 97579 | 3186 | 45969 |
| 5L-7S | | MI | 40391 | 9990 | 63264 | 7470 | 68098 | 6072 | 68880 | 5053 | 67467 | 3582 | 79389 | 2982 | 39428 |
| 20-#11 | 1.55 | MA | 46880 | 9990 | 73203 | 7517 | 79294 | 6128 | 80671 | 5087 | 79794 | 3609 | 94876 | 3131 | 45884 |
| 6E | | MI | 40877 | 9990 | 64156 | 7455 | 69175 | 6076 | 70204 | 5041 | 69242 | 3572 | 81824 | 3072 | 39811 |
| 20-#11 | 1.55 | MA | 46319 | 9990 | 72170 | 7532 | 78047 | 6125 | 79138 | 5100 | 77737 | 3620 | 91997 | 3041 | 45409 |
| 7L-5S | | MI | 41376 | 9990 | 64971 | 7458 | 70303 | 6063 | 71582 | 5047 | 71059 | 3563 | 84107 | 3128 | 39857 |
| 20-#11 | 1.55 | MA | 45760 | 9990 | 71242 | 7530 | 76783 | 6139 | 77643 | 5113 | 75551 | 3614 | 89354 | 2991 | 44968 |
| 8L-4S | | MI | 41901 | 9990 | 65839 | 7460 | 71429 | 6066 | 72967 | 5034 | 73065 | 3570 | 86509 | 3169 | 39870 |
| 20-#11 | 1.55 | MA | 45172 | 9990 | 70335 | 7529 | 75554 | 6137 | 76078 | 5109 | 73514 | 3625 | 86733 | 2937 | 44624 |
| 9L-3S | | MI | 42487 | 9990 | 66844 | 7445 | 72710 | 6053 | 74523 | 5040 | 75068 | 3561 | 88809 | 3256 | 39853 |
| 20-#11 | 1.55 | MA | 44562 | 9990 | 69318 | 7544 | 74307 | 6151 | 74591 | 5122 | 71494 | 3636 | 84193 | 2876 | 43974 |
| 10L-2S | | MI | 43322 | 9990 | 68078 | 7448 | 74291 | 6057 | 76453 | 5027 | 77693 | 3552 | 92341 | 3342 | 39826 |
| 20-#14 | 2.23 | MA | 51212 | 10467 | 82026 | 7780 | 90564 | 6297 | 94374 | 5202 | 98355 | 3548 | 118950 | 3186 | 65503 |
| 3L-9S | | MI | 40240 | 10467 | 64219 | 7768 | 69145 | 6308 | 70076 | 5183 | 69033 | 3540 | 82337 | 2568 | 53205 |
| 20-#14 | 2.23 | MA | 50250 | 10467 | 80353 | 7802 | 88433 | 6317 | 91783 | 5195 | 95020 | 3563 | 115070 | 3062 | 65399 |
| 4L-8S | | MI | 40926 | 10467 | 65457 | 7747 | 70668 | 6289 | 72013 | 5191 | 71556 | 3527 | 85482 | 2646 | 54231 |
| 20-#14 | 2.23 | MA | 49392 | 10467 | 78909 | 7799 | 86559 | 6312 | 89480 | 5214 | 91684 | 3554 | 111037 | 3001 | 65205 |
| 5L-7S | | MI | 41604 | 10467 | 66607 | 7751 | 72234 | 6295 | 73865 | 5174 | 74262 | 3539 | 88681 | 2715 | 54919 |
| 20-#14 | 2.23 | MA | 48577 | 10467 | 77556 | 7796 | 84684 | 6333 | 87188 | 5208 | 88663 | 3569 | 107189 | 2920 | 64194 |
| 6E | | MI | 42293 | 10467 | 67887 | 7730 | 73778 | 6276 | 75763 | 5158 | 76808 | 3526 | 92144 | 2845 | 55552 |
| 20-#14 | 2.23 | MA | 47782 | 10467 | 76072 | 7818 | 82895 | 6328 | 84988 | 5226 | 85711 | 3584 | 103086 | 2791 | 63381 |
| 7L-5S | | MI | 42999 | 10467 | 69055 | 7734 | 75396 | 6282 | 77740 | 5166 | 79413 | 3514 | 95388 | 2926 | 56414 |
| 20-#14 | 2.23 | MA | 46999 | 10467 | 74741 | 7815 | 81080 | 6348 | 82841 | 5245 | 82574 | 3574 | 99314 | 2719 | 62553 |
| 8L-4S | | MI | 43741 | 10467 | 70301 | 7738 | 77011 | 6264 | 79725 | 5149 | 82288 | 3526 | 98810 | 2985 | 56546 |
| 20-#14 | 2.23 | MA | 46170 | 10467 | 73438 | 7813 | 79316 | 6344 | 80596 | 5238 | 79649 | 3589 | 95583 | 2642 | 61275 |
| 9L-3S | | MI | 44571 | 10467 | 71741 | 7718 | 78846 | 6270 | 81956 | 5157 | 85158 | 3513 | 102075 | 3109 | 56609 |
| 20-#14 | 2.23 | MA | 45304 | 10467 | 71978 | 7835 | 77525 | 6364 | 78460 | 5257 | 76750 | 3604 | 91967 | 2554 | 60138 |
| 10L-2S | | MI | 45752 | 10467 | 73506 | 7722 | 81110 | 6251 | 84717 | 5140 | 88915 | 3500 | 107098 | 3234 | 56629 |
| 20-#18 | 3.97 | MA | 54070 | 11677 | 90729 | 8521 | 101422 | 6868 | 107498 | 5531 | 116145 | 3441 | 144253 | 2509 | 109958 |
| 5L-7S | | MI | 44523 | 11677 | 74853 | 8473 | 82507 | 6822 | 86277 | 5484 | 90952 | 3417 | 111519 | 2013 | 90406 |
| 20-#18 | 3.97 | MA | 52677 | 11677 | 88346 | 8515 | 98120 | 6858 | 103463 | 5518 | 110828 | 3465 | 137585 | 2365 | 108183 |
| 6E | | MI | 45698 | 11677 | 77103 | 8437 | 85221 | 6790 | 89612 | 5457 | 95378 | 3395 | 117497 | 2244 | 93277 |
| 20-#18 | 3.97 | MA | 51321 | 11677 | 85734 | 8552 | 94970 | 6892 | 99590 | 5549 | 105632 | 3489 | 130471 | 2135 | 104853 |
| 7L-5S | | MI | 46904 | 11677 | 79156 | 8447 | 88063 | 6803 | 93086 | 5474 | 99907 | 3373 | 123092 | 2389 | 94658 |
| 20-#18 | 3.97 | MA | 49986 | 11677 | 83388 | 8545 | 91775 | 6882 | 95810 | 5579 | 100110 | 3469 | 123908 | 2010 | 101973 |
| 8L-4S | | MI | 48172 | 11677 | 81345 | 8456 | 90901 | 6772 | 96572 | 5447 | 104906 | 3395 | 129026 | 2490 | 97382 |
| 22-#11 | 1.70 | MA | 50395 | 10098 | 79190 | 7574 | 87074 | 6153 | 90171 | 5098 | 92660 | 3574 | 111481 | 3387 | 50496 |
| 2L-11S | | MI | 38973 | 10098 | 61248 | 7544 | 65393 | 6140 | 65549 | 5097 | 62841 | 3577 | 74127 | 2749 | 41559 |
| 22-#11 | 1.70 | MA | 49423 | 10098 | 77754 | 7572 | 85233 | 6150 | 87925 | 5111 | 89605 | 3585 | 107305 | 3301 | 50507 |
| 3L-10S | | MI | 39487 | 10098 | 62034 | 7547 | 66449 | 6144 | 66882 | 5102 | 64702 | 3584 | 76317 | 2801 | 42034 |
| 22-#11 | 1.70 | MA | 48746 | 10098 | 76588 | 7587 | 83747 | 6165 | 86119 | 5107 | 87280 | 3596 | 104580 | 3215 | 50481 |
| 4L-9S | | MI | 40014 | 10098 | 62833 | 7549 | 67526 | 6130 | 68167 | 5090 | 66446 | 3575 | 78462 | 2862 | 42601 |
| 22-#11 | 1.70 | MA | 48142 | 10098 | 75582 | 7586 | 82441 | 6162 | 84514 | 5120 | 84955 | 3590 | 101754 | 3172 | 50427 |
| 5L-8S | | MI | 40499 | 10098 | 63696 | 7535 | 68588 | 6134 | 69518 | 5095 | 68205 | 3565 | 80675 | 2916 | 42856 |
| 22-#11 | 1.70 | MA | 47567 | 10098 | 74639 | 7584 | 81134 | 6176 | 82917 | 5116 | 82849 | 3601 | 99052 | 3116 | 50329 |
| 6L-7S | | MI | 40976 | 10098 | 64498 | 7537 | 69680 | 6121 | 70810 | 5083 | 70092 | 3573 | 82921 | 2964 | 43185 |
| 22-#11 | 1.70 | MA | 47008 | 10098 | 73606 | 7600 | 79888 | 6173 | 81384 | 5129 | 80793 | 3612 | 96172 | 3026 | 49783 |
| 7L-6S | | MI | 41461 | 10098 | 65390 | 7523 | 70756 | 6124 | 72133 | 5071 | 71867 | 3564 | 85357 | 3054 | 43636 |
| 22-#11 | 1.70 | MA | 46457 | 10098 | 72678 | 7598 | 78624 | 6188 | 79888 | 5143 | 78607 | 3606 | 93529 | 2976 | 49355 |
| 8L-5S | | MI | 41959 | 10098 | 66204 | 7525 | 71884 | 6111 | 73512 | 5076 | 73684 | 3554 | 87640 | 3110 | 43695 |
| 22-#11 | 1.70 | MA | 45866 | 10098 | 71771 | 7596 | 77395 | 6185 | 78324 | 5139 | 76569 | 3617 | 90908 | 2923 | 49016 |
| 9L-4S | | MI | 42481 | 10098 | 67073 | 7528 | 73011 | 6115 | 74896 | 5064 | 75690 | 3562 | 90042 | 3152 | 43721 |
| 22-#11 | 1.70 | MA | 45257 | 10098 | 70754 | 7612 | 76148 | 6199 | 76836 | 5152 | 74549 | 3628 | 88368 | 2862 | 48316 |
| 10L-3S | | MI | 43066 | 10098 | 68078 | 7513 | 74291 | 6101 | 76453 | 5069 | 77693 | 3552 | 92341 | 3238 | 43716 |
| 22-#11 | 1.70 | MA | 44662 | 10098 | 69845 | 7610 | 74925 | 6196 | 75292 | 5148 | 72395 | 3621 | 85791 | 2809 | 47716 |
| 11L-2S | | MI | 43899 | 10098 | 69312 | 7515 | 75873 | 6105 | 78382 | 5057 | 80318 | 3543 | 95874 | 3325 | 43695 |

## RECTANGULAR TIED COLUMNS 42" x 48"

Short columns – no sidesway
Bending on major or minor axis

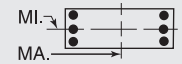



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#14 | 2.46 | MA | 51211 | 10622 | 82411 | 7899 | 91070 | 6387 | 95000 | 5238 | 99398 | 3551 | 121019 | 3039 | 71773 |
| 4L-9S | | MI | 41073 | 10622 | 65985 | 7865 | 71409 | 6377 | 72837 | 5226 | 72790 | 3527 | 87360 | 2541 | 58516 |
| 22-#14 | 2.46 | MA | 50357 | 10622 | 80966 | 7897 | 89197 | 6382 | 92698 | 5256 | 96062 | 3541 | 116986 | 2978 | 71555 |
| 5L-8S | | MI | 41754 | 10622 | 67223 | 7844 | 72932 | 6359 | 74774 | 5234 | 75313 | 3515 | 90505 | 2619 | 59511 |
| 22-#14 | 2.46 | MA | 49545 | 10622 | 79613 | 7894 | 87321 | 6402 | 90405 | 5250 | 93040 | 3556 | 113138 | 2898 | 70435 |
| 6L-7S | | MI | 42429 | 10622 | 68373 | 7848 | 74498 | 6365 | 76627 | 5217 | 78018 | 3527 | 93704 | 2688 | 60291 |
| 22-#14 | 2.46 | MA | 48754 | 10622 | 78130 | 7916 | 85532 | 6398 | 88205 | 5269 | 90089 | 3571 | 109035 | 2768 | 69647 |
| 7L-6S | | MI | 43115 | 10622 | 69653 | 7827 | 76041 | 6346 | 78524 | 5200 | 80564 | 3514 | 97167 | 2818 | 60902 |
| 22-#14 | 2.46 | MA | 47975 | 10622 | 76798 | 7913 | 83718 | 6418 | 86058 | 5287 | 86951 | 3561 | 105263 | 2697 | 68726 |
| 8L-5S | | MI | 43818 | 10622 | 70821 | 7832 | 77659 | 6352 | 80501 | 5208 | 83170 | 3501 | 100411 | 2899 | 61868 |
| 22-#14 | 2.46 | MA | 47150 | 10622 | 75495 | 7910 | 81953 | 6413 | 83813 | 5281 | 84027 | 3576 | 101532 | 2619 | 67483 |
| 9L-4S | | MI | 44557 | 10622 | 72066 | 7836 | 79274 | 6333 | 82486 | 5192 | 86044 | 3513 | 103833 | 2958 | 62021 |
| 22-#14 | 2.46 | MA | 46288 | 10622 | 74036 | 7932 | 80163 | 6434 | 81678 | 5299 | 81127 | 3591 | 97915 | 2531 | 66282 |
| 10L-3S | | MI | 45383 | 10622 | 73506 | 7815 | 81110 | 6340 | 84717 | 5200 | 88915 | 3501 | 107098 | 3082 | 62103 |
| 22-#18 | 4.37 | MA | 54324 | 11954 | 91954 | 8687 | 102746 | 6982 | 109107 | 5593 | 118506 | 3443 | 147904 | 2320 | 119130 |
| 6L-7S | | MI | 45926 | 11954 | 77943 | 8645 | 86468 | 6946 | 91109 | 5560 | 97479 | 3392 | 120193 | 1958 | 99618 |
| 22-#18 | 4.37 | MA | 52977 | 11954 | 89343 | 8725 | 99597 | 7016 | 105234 | 5624 | 113311 | 3467 | 140789 | 2089 | 115655 |
| 7L-6S | | MI | 47093 | 11954 | 80193 | 8610 | 89182 | 6915 | 94445 | 5532 | 101905 | 3370 | 126171 | 2190 | 102389 |
| 22-#18 | 4.37 | MA | 51651 | 11954 | 86997 | 8718 | 96402 | 7006 | 101454 | 5655 | 107789 | 3447 | 134227 | 1965 | 112656 |
| 8L-5S | | MI | 48292 | 11954 | 82246 | 8619 | 92024 | 6928 | 97918 | 5549 | 106434 | 3348 | 131766 | 2334 | 103965 |
| 24-#11 | 1.86 | MA | 50102 | 10205 | 79190 | 7639 | 87074 | 6199 | 90171 | 5140 | 92660 | 3577 | 111481 | 3287 | 54981 |
| 3L-11S | | MI | 39563 | 10205 | 62482 | 7612 | 66974 | 6188 | 67478 | 5126 | 65466 | 3568 | 77660 | 2732 | 45296 |
| 24-#11 | 1.86 | MA | 49426 | 10205 | 78024 | 7655 | 85588 | 6213 | 88365 | 5136 | 90336 | 3588 | 108755 | 3200 | 54948 |
| 4L-10S | | MI | 40075 | 10205 | 63267 | 7614 | 68031 | 6192 | 68812 | 5131 | 67327 | 3576 | 79850 | 2783 | 45760 |
| 24-#11 | 1.86 | MA | 48824 | 10205 | 77018 | 7653 | 84282 | 6210 | 86760 | 5150 | 88010 | 3581 | 105929 | 3157 | 54882 |
| 5L-9S | | MI | 40600 | 10205 | 64067 | 7617 | 69108 | 6179 | 70097 | 5119 | 69071 | 3566 | 81994 | 2844 | 46355 |
| 24-#11 | 1.86 | MA | 48252 | 10205 | 76075 | 7651 | 82975 | 6225 | 85162 | 5146 | 85905 | 3592 | 103227 | 3102 | 54771 |
| 6L-8S | | MI | 41083 | 10205 | 64930 | 7602 | 70170 | 6182 | 71447 | 5124 | 70830 | 3557 | 84208 | 2898 | 46626 |
| 24-#11 | 1.86 | MA | 47694 | 10205 | 75042 | 7667 | 81729 | 6222 | 83630 | 5159 | 83848 | 3603 | 100347 | 3012 | 54162 |
| 7E | | MI | 41559 | 10205 | 65731 | 7605 | 71261 | 6169 | 72739 | 5112 | 72717 | 3564 | 86454 | 2947 | 46945 |
| 24-#11 | 1.86 | MA | 47145 | 10205 | 74114 | 7665 | 80465 | 6236 | 82134 | 5172 | 81662 | 3597 | 97704 | 2962 | 53745 |
| 8L-6S | | MI | 42043 | 10205 | 66624 | 7590 | 72338 | 6173 | 74062 | 5100 | 74492 | 3555 | 88890 | 3037 | 47445 |
| 24-#11 | 1.86 | MA | 46556 | 10205 | 73207 | 7664 | 79236 | 6233 | 80570 | 5168 | 79625 | 3608 | 95084 | 2908 | 53408 |
| 9L-5S | | MI | 42539 | 10205 | 67438 | 7593 | 73466 | 6159 | 75441 | 5105 | 76309 | 3545 | 91173 | 3093 | 47528 |
| 24-#11 | 1.86 | MA | 45949 | 10205 | 72190 | 7679 | 77989 | 6248 | 79082 | 5181 | 77605 | 3619 | 92543 | 2847 | 52662 |
| 10L-4S | | MI | 43059 | 10205 | 68307 | 7595 | 74592 | 6163 | 76826 | 5093 | 78315 | 3553 | 93575 | 3134 | 47565 |
| 24-#11 | 1.86 | MA | 45356 | 10205 | 71281 | 7677 | 76766 | 6245 | 77538 | 5177 | 75450 | 3613 | 89966 | 2794 | 52075 |
| 11L-3S | | MI | 43642 | 10205 | 69312 | 7580 | 75873 | 6150 | 78382 | 5098 | 80318 | 3544 | 95874 | 3221 | 47575 |
| 24-#11 | 1.86 | MA | 44774 | 10205 | 70283 | 7693 | 75528 | 6259 | 76053 | 5191 | 73431 | 3624 | 87058 | 2717 | 51288 |
| 12L-2S | | MI | 44473 | 10205 | 70545 | 7583 | 77454 | 6154 | 80311 | 5086 | 82943 | 3534 | 99407 | 3307 | 47560 |
| 24-#14 | 2.68 | MA | 51317 | 10778 | 83024 | 7994 | 91834 | 6452 | 95915 | 5299 | 100439 | 3529 | 122935 | 2956 | 77903 |
| 5L-9S | | MI | 41912 | 10778 | 67750 | 7962 | 73672 | 6447 | 75598 | 5268 | 76546 | 3515 | 92382 | 2514 | 63834 |
| 24-#14 | 2.68 | MA | 50509 | 10778 | 81670 | 7991 | 89958 | 6472 | 93623 | 5292 | 97418 | 3544 | 119086 | 2875 | 76683 |
| 6L-8S | | MI | 42578 | 10778 | 68988 | 7941 | 75195 | 6428 | 77535 | 5276 | 79070 | 3502 | 95528 | 2592 | 64800 |
| 24-#14 | 2.68 | MA | 49721 | 10778 | 80187 | 8013 | 88170 | 6468 | 91423 | 5311 | 94466 | 3559 | 114984 | 2746 | 75917 |
| 7E | | MI | 43250 | 10778 | 70138 | 7945 | 76761 | 6435 | 79388 | 5259 | 81775 | 3514 | 98727 | 2661 | 65666 |
| 24-#14 | 2.68 | MA | 48946 | 10778 | 78855 | 8010 | 86355 | 6488 | 89276 | 5329 | 91329 | 3549 | 111212 | 2674 | 74909 |
| 8L-6S | | MI | 43933 | 10778 | 71418 | 7925 | 78305 | 6416 | 81286 | 5243 | 84321 | 3502 | 102190 | 2791 | 66258 |
| 24-#14 | 2.68 | MA | 48125 | 10778 | 77552 | 8007 | 84590 | 6483 | 87031 | 5323 | 88404 | 3564 | 107481 | 2597 | 73697 |
| 9L-5S | | MI | 44633 | 10778 | 72586 | 7929 | 79922 | 6422 | 83263 | 5251 | 86927 | 3489 | 105433 | 2872 | 67273 |
| 24-#14 | 2.68 | MA | 47266 | 10778 | 76093 | 8029 | 82800 | 6503 | 84895 | 5342 | 85505 | 3579 | 103864 | 2509 | 72435 |
| 10L-4S | | MI | 45369 | 10778 | 73832 | 7933 | 81538 | 6403 | 85247 | 5234 | 89801 | 3501 | 108856 | 2931 | 67491 |
| 24-#18 | 4.76 | MA | 54621 | 12230 | 92952 | 8898 | 104223 | 7140 | 110878 | 5700 | 120989 | 3445 | 151108 | 2043 | 126474 |
| 7E | | MI | 47319 | 12230 | 81033 | 8818 | 90429 | 7070 | 95942 | 5635 | 104005 | 3367 | 128868 | 1904 | 108845 |
| 24-#18 | 4.76 | MA | 53304 | 12230 | 90605 | 8891 | 101028 | 7130 | 107097 | 5730 | 115467 | 3425 | 144545 | 1919 | 123358 |
| 8L-6S | | MI | 48480 | 12230 | 83283 | 8783 | 93143 | 7039 | 99277 | 5608 | 108431 | 3345 | 134846 | 2135 | 111523 |

## RECTANGULAR TIED COLUMNS 44" x 44"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.24 | MA | 42304 | 9387 | 66084 | 6977 | 71376 | 5686 | 72704 | 4739 | 72331 | 3399 | 84736 | 3199 | 32073 |
| 2L-3S | | MI | 40087 | 9387 | 62821 | 6969 | 67193 | 5718 | 67601 | 4768 | 65408 | 3421 | 75514 | 2978 | 32193 |
| 8-#18 | 1.65 | MA | 43821 | 9664 | 69347 | 7150 | 75559 | 5810 | 77807 | 4815 | 79255 | 3376 | 93958 | 3148 | 42345 |
| 2L-4S | | MI | 40068 | 9664 | 63419 | 7178 | 67980 | 5830 | 68577 | 4827 | 67039 | 3420 | 78748 | 2705 | 42262 |
| 10-#14 | 1.16 | MA | 42125 | 9335 | 65402 | 6989 | 70770 | 5699 | 72067 | 4756 | 71564 | 3430 | 84004 | 3249 | 30340 |
| 2L-5S | | MI | 39166 | 9335 | 60710 | 7003 | 64747 | 5707 | 64712 | 4784 | 61547 | 3446 | 71577 | 2941 | 30424 |
| 10-#14 | 1.16 | MA | 40855 | 9335 | 63539 | 6985 | 68382 | 5693 | 69154 | 4774 | 67601 | 3444 | 78673 | 3125 | 30403 |
| 3L-4S | | MI | 39963 | 9335 | 62022 | 7007 | 66448 | 5713 | 66803 | 4766 | 64576 | 3457 | 75203 | 3000 | 30448 |
| 10-#18 | 2.07 | MA | 45325 | 9940 | 72610 | 7323 | 79742 | 5934 | 82910 | 4890 | 86178 | 3353 | 103180 | 3097 | 52579 |
| 2L-5S | | MI | 40221 | 9940 | 64375 | 7342 | 69172 | 5987 | 70005 | 4931 | 68661 | 3375 | 81675 | 2551 | 50558 |
| 10-#18 | 2.07 | MA | 43138 | 9940 | 69347 | 7315 | 75559 | 5966 | 77807 | 4919 | 79255 | 3375 | 93958 | 2875 | 52567 |
| 3L-4S | | MI | 41598 | 9940 | 66682 | 7351 | 72163 | 5954 | 73680 | 4903 | 73963 | 3397 | 87970 | 2654 | 52333 |

## RECTANGULAR TIED COLUMNS 44" x 46"

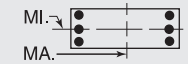
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.19 | MA | 46077 | 9776 | 71729 | 7293 | 77513 | 5946 | 78908 | 4960 | 78385 | 3572 | 91832 | 3372 | 33693 |
| 2L-3S | | MI | 41800 | 9776 | 65380 | 7262 | 69867 | 5959 | 70210 | 4973 | 67752 | 3579 | 78108 | 3130 | 32254 |
| 6-#18 | 1.19 | MA | 43739 | 9776 | 68293 | 7286 | 73108 | 5979 | 73534 | 4990 | 71075 | 3594 | 82062 | 3151 | 33813 |
| 3L-2S | | MI | 44019 | 9776 | 68643 | 7271 | 74050 | 5927 | 75313 | 4944 | 74675 | 3557 | 87330 | 3352 | 32127 |
| 8-#18 | 1.58 | MA | 47684 | 10053 | 75164 | 7466 | 81917 | 6070 | 84281 | 5035 | 85696 | 3550 | 101602 | 3324 | 44505 |
| 2L-4S | | MI | 41780 | 10053 | 65978 | 7471 | 70654 | 6072 | 71186 | 5033 | 69383 | 3578 | 81342 | 2858 | 42374 |
| 8-#18 | 1.58 | MA | 45362 | 10053 | 71729 | 7459 | 77513 | 6103 | 78908 | 5065 | 78385 | 3572 | 91832 | 3103 | 44567 |
| 3E | | MI | 43334 | 10053 | 68643 | 7435 | 74050 | 6084 | 75313 | 5048 | 74675 | 3556 | 87330 | 3079 | 42481 |
| 8-#18 | 1.58 | MA | 43728 | 10053 | 68926 | 7495 | 73941 | 6092 | 74567 | 5051 | 72799 | 3595 | 85481 | 2881 | 44422 |
| 4L-2S | | MI | 45539 | 10053 | 71906 | 7443 | 78233 | 6051 | 80416 | 5020 | 81598 | 3533 | 96552 | 3300 | 42405 |
| 10-#14 | 1.11 | MA | 45883 | 9724 | 71001 | 7305 | 76863 | 5959 | 78222 | 4977 | 77497 | 3600 | 91012 | 3421 | 31859 |
| 2L-5S | | MI | 40877 | 9724 | 63259 | 7299 | 67421 | 5950 | 67326 | 4990 | 63899 | 3605 | 74184 | 3094 | 30500 |
| 10-#14 | 1.11 | MA | 44544 | 9724 | 69041 | 7302 | 74350 | 5954 | 75157 | 4995 | 73327 | 3614 | 85372 | 3297 | 31921 |
| 3L-4S | | MI | 41676 | 9724 | 64571 | 7302 | 69122 | 5956 | 69417 | 4973 | 66928 | 3616 | 77809 | 3154 | 30504 |
| 10-#14 | 1.11 | MA | 43606 | 9724 | 67446 | 7323 | 72317 | 5974 | 72686 | 4988 | 70147 | 3629 | 81697 | 3172 | 31967 |
| 4L-3S | | MI | 42569 | 9724 | 66089 | 7281 | 71056 | 5937 | 71767 | 4980 | 69953 | 3602 | 81279 | 3278 | 30450 |
| 10-#14 | 1.11 | MA | 42767 | 9724 | 66068 | 7320 | 70530 | 5969 | 70490 | 5006 | 66965 | 3618 | 77868 | 3112 | 31943 |
| 5L-2S | | MI | 43840 | 9724 | 67951 | 7285 | 73444 | 5942 | 74680 | 4963 | 73916 | 3589 | 86611 | 3403 | 30385 |
| 10-#18 | 1.98 | MA | 49277 | 10329 | 78600 | 7639 | 86322 | 6194 | 89654 | 5111 | 93007 | 3528 | 111372 | 3276 | 55279 |
| 2L-5S | | MI | 41932 | 10329 | 66934 | 7636 | 71846 | 6228 | 72614 | 5137 | 71005 | 3532 | 84269 | 2703 | 50934 |
| 10-#18 | 1.98 | MA | 46969 | 10329 | 75164 | 7631 | 81917 | 6227 | 84281 | 5141 | 85696 | 3550 | 101602 | 3054 | 55267 |
| 3L-4S | | MI | 43312 | 10329 | 69241 | 7644 | 74837 | 6196 | 76289 | 5108 | 76306 | 3555 | 90564 | 2806 | 52457 |
| 10-#18 | 1.98 | MA | 45347 | 10329 | 72362 | 7668 | 78346 | 6216 | 79940 | 5126 | 80110 | 3573 | 95251 | 2833 | 55033 |
| 4L-3S | | MI | 44855 | 10329 | 71906 | 7608 | 78233 | 6208 | 80416 | 5124 | 81598 | 3532 | 96552 | 3028 | 52654 |
| 10-#18 | 1.98 | MA | 43898 | 10329 | 69937 | 7661 | 75202 | 6249 | 76077 | 5156 | 74515 | 3551 | 88594 | 2728 | 53399 |
| 5L-2S | | MI | 47045 | 10329 | 75169 | 7616 | 82416 | 6175 | 85519 | 5095 | 88522 | 3510 | 105774 | 3249 | 52645 |
| 12-#14 | 1.33 | MA | 46811 | 9880 | 72961 | 7402 | 79375 | 6029 | 81288 | 5019 | 81668 | 3587 | 96652 | 3397 | 38024 |
| 2L-6S | | MI | 41012 | 9880 | 63892 | 7392 | 68105 | 6039 | 68157 | 5025 | 65119 | 3606 | 76070 | 2988 | 35963 |
| 12-#14 | 1.33 | MA | 45478 | 9880 | 71001 | 7399 | 76863 | 6024 | 78222 | 5037 | 77497 | 3602 | 91012 | 3273 | 38072 |
| 3L-5S | | MI | 41769 | 9880 | 65122 | 7396 | 69809 | 6020 | 70239 | 5033 | 67863 | 3592 | 79515 | 3069 | 36287 |
| 12-#14 | 1.33 | MA | 44544 | 9880 | 69406 | 7421 | 74830 | 6044 | 75752 | 5031 | 74318 | 3616 | 87337 | 3148 | 38089 |
| 4E | | MI | 42564 | 9880 | 66434 | 7399 | 71510 | 6026 | 72330 | 5015 | 70891 | 3604 | 83141 | 3128 | 36332 |
| 12-#14 | 1.33 | MA | 43709 | 9880 | 68028 | 7417 | 73042 | 6038 | 73555 | 5049 | 71136 | 3606 | 83508 | 3088 | 38026 |
| 5L-3S | | MI | 43453 | 9880 | 67951 | 7378 | 73444 | 6006 | 74680 | 5023 | 73916 | 3590 | 86611 | 3253 | 36302 |
| 12-#14 | 1.33 | MA | 42915 | 9880 | 66736 | 7414 | 71253 | 6058 | 71368 | 5042 | 68253 | 3620 | 79861 | 3007 | 37659 |
| 6L-2S | | MI | 44719 | 9880 | 69814 | 7382 | 75832 | 6012 | 77594 | 5005 | 77880 | 3576 | 91942 | 3378 | 36250 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

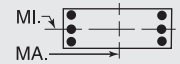



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 2.37 | MA | 50855 | 10606 | 82036 | 7812 | 90726 | 6318 | 95027 | 5186 | 100318 | 3505 | 121142 | 3227 | 66028 |
| 2L-6S | | MI | 42156 | 10606 | 68033 | 7801 | 73033 | 6340 | 74056 | 5196 | 73124 | 3531 | 87538 | 2508 | 58841 |
| 12-#18 | 2.37 | MA | 48562 | 10606 | 78600 | 7804 | 86322 | 6351 | 89654 | 5216 | 93007 | 3528 | 111372 | 3006 | 65940 |
| 3L-5S | | MI | 43460 | 10606 | 70197 | 7809 | 76029 | 6352 | 77717 | 5212 | 77928 | 3509 | 93491 | 2652 | 60646 |
| 12-#18 | 2.37 | MA | 46952 | 10606 | 75798 | 7841 | 82750 | 6340 | 85313 | 5201 | 87420 | 3551 | 105021 | 2785 | 65627 |
| 4E | | MI | 44829 | 10606 | 72504 | 7817 | 79020 | 6320 | 81391 | 5183 | 83230 | 3531 | 99786 | 2755 | 62522 |
| 12-#18 | 2.37 | MA | 45514 | 10606 | 73373 | 7834 | 79606 | 6374 | 81450 | 5231 | 81826 | 3529 | 98364 | 2680 | 63638 |
| 5L-3S | | MI | 46362 | 10606 | 75169 | 7781 | 82416 | 6332 | 85519 | 5199 | 88522 | 3509 | 105774 | 2976 | 62795 |
| 12-#18 | 2.37 | MA | 44145 | 10606 | 71099 | 7826 | 76458 | 6363 | 77602 | 5217 | 76755 | 3552 | 92054 | 2536 | 61688 |
| 6L-2S | | MI | 48538 | 10606 | 78432 | 7789 | 86599 | 6300 | 90622 | 5171 | 95445 | 3487 | 114996 | 3198 | 62865 |
| 14-#11 | 1.08 | MA | 45800 | 9701 | 70666 | 7313 | 76578 | 5967 | 77930 | 4986 | 77123 | 3614 | 90683 | 3444 | 31053 |
| 2L-7S | | MI | 40647 | 9701 | 62562 | 7317 | 66655 | 5968 | 66434 | 5001 | 62800 | 3636 | 72588 | 3067 | 29578 |
| 14-#11 | 1.08 | MA | 44864 | 9701 | 69298 | 7311 | 74823 | 5964 | 75790 | 4999 | 74211 | 3624 | 86722 | 3358 | 31094 |
| 3L-6S | | MI | 41164 | 9701 | 63502 | 7302 | 67788 | 5972 | 67827 | 4988 | 64669 | 3626 | 75172 | 3157 | 29720 |
| 14-#11 | 1.08 | MA | 44209 | 9701 | 68185 | 7327 | 73406 | 5978 | 74067 | 4995 | 71994 | 3635 | 84138 | 3271 | 31130 |
| 4L-5S | | MI | 41694 | 9701 | 64359 | 7304 | 68976 | 5958 | 69279 | 4993 | 66582 | 3616 | 77595 | 3212 | 29728 |
| 14-#11 | 1.08 | MA | 43624 | 9701 | 67225 | 7325 | 72160 | 5975 | 72535 | 5008 | 69775 | 3628 | 81454 | 3229 | 31150 |
| 5L-4S | | MI | 42251 | 9701 | 65273 | 7307 | 70162 | 5962 | 70737 | 4981 | 68694 | 3623 | 80138 | 3254 | 29702 |
| 14-#11 | 1.08 | MA | 43068 | 9701 | 66325 | 7323 | 70913 | 5989 | 71011 | 5004 | 67766 | 3639 | 78892 | 3173 | 31127 |
| 6L-3S | | MI | 42875 | 9701 | 66332 | 7292 | 71511 | 5948 | 72376 | 4985 | 70804 | 3613 | 82579 | 3341 | 29662 |
| 14-#11 | 1.08 | MA | 42526 | 9701 | 65339 | 7338 | 69723 | 5986 | 69548 | 5017 | 65803 | 3649 | 76160 | 3083 | 30956 |
| 7L-2S | | MI | 43764 | 9701 | 67633 | 7294 | 73179 | 5951 | 74411 | 4973 | 73573 | 3603 | 86326 | 3427 | 29620 |
| 14-#14 | 1.56 | MA | 47734 | 10035 | 74921 | 7500 | 81888 | 6099 | 84353 | 5062 | 85839 | 3575 | 102292 | 3373 | 44176 |
| 2L-7S | | MI | 41168 | 10035 | 64407 | 7511 | 68868 | 6104 | 69072 | 5085 | 66401 | 3607 | 77725 | 2833 | 40782 |
| 14-#14 | 1.56 | MA | 46406 | 10035 | 72961 | 7496 | 79375 | 6094 | 81288 | 5080 | 81668 | 3589 | 96652 | 3249 | 44209 |
| 3L-6S | | MI | 41902 | 10035 | 65755 | 7489 | 70493 | 6109 | 71070 | 5067 | 69083 | 3594 | 81401 | 2963 | 41565 |
| 14-#14 | 1.56 | MA | 45476 | 10035 | 71366 | 7518 | 77343 | 6113 | 78817 | 5073 | 78489 | 3604 | 92977 | 3124 | 44193 |
| 4L-5S | | MI | 42655 | 10035 | 66985 | 7493 | 72197 | 6090 | 73152 | 5075 | 71827 | 3580 | 84846 | 3043 | 42063 |
| 14-#14 | 1.56 | MA | 44646 | 10035 | 69988 | 7515 | 75555 | 6108 | 76620 | 5091 | 75306 | 3593 | 89148 | 3064 | 44099 |
| 5L-4S | | MI | 43446 | 10035 | 68297 | 7497 | 73898 | 6096 | 75243 | 5058 | 74855 | 3591 | 88472 | 3103 | 42138 |
| 14-#14 | 1.56 | MA | 43855 | 10035 | 68696 | 7511 | 73766 | 6128 | 74433 | 5084 | 72423 | 3608 | 85501 | 2983 | 43557 |
| 6L-3S | | MI | 44332 | 10035 | 69814 | 7476 | 75832 | 6076 | 77594 | 5065 | 77880 | 3578 | 91942 | 3228 | 42139 |
| 14-#14 | 1.56 | MA | 43085 | 10035 | 67281 | 7533 | 72058 | 6123 | 72334 | 5102 | 69607 | 3622 | 81612 | 2853 | 42710 |
| 7L-2S | | MI | 45593 | 10035 | 71677 | 7479 | 78220 | 6082 | 80507 | 5048 | 81844 | 3564 | 97273 | 3352 | 42101 |
| 14-#18 | 2.77 | MA | 52421 | 10883 | 85472 | 7985 | 95131 | 6442 | 100401 | 5262 | 107628 | 3483 | 130912 | 3179 | 76737 |
| 2L-7S | | MI | 42418 | 10883 | 68926 | 8009 | 74357 | 6497 | 75644 | 5300 | 75352 | 3530 | 90404 | 2225 | 66162 |
| 14-#18 | 2.77 | MA | 50142 | 10883 | 82036 | 7977 | 90726 | 6476 | 95027 | 5291 | 100318 | 3506 | 121142 | 2958 | 76593 |
| 3L-6S | | MI | 43679 | 10883 | 71296 | 7974 | 77216 | 6464 | 79159 | 5272 | 80047 | 3508 | 96760 | 2456 | 68676 |
| 14-#18 | 2.77 | MA | 48543 | 10883 | 79233 | 8014 | 87155 | 6465 | 90686 | 5277 | 94731 | 3528 | 114791 | 2736 | 76211 |
| 4L-5S | | MI | 44974 | 10883 | 73460 | 7982 | 80212 | 6476 | 82819 | 5287 | 84851 | 3486 | 102712 | 2601 | 70392 |
| 14-#18 | 2.77 | MA | 47115 | 10883 | 76809 | 8007 | 84011 | 6498 | 86823 | 5307 | 89136 | 3507 | 108134 | 2632 | 73911 |
| 5L-4S | | MI | 46334 | 10883 | 75767 | 7990 | 83203 | 6444 | 86494 | 5259 | 90153 | 3508 | 109008 | 2704 | 72575 |
| 14-#18 | 2.77 | MA | 45756 | 10883 | 74535 | 7999 | 80862 | 6487 | 82975 | 5292 | 84066 | 3529 | 101824 | 2488 | 72053 |
| 6L-3S | | MI | 47856 | 10883 | 78432 | 7954 | 86599 | 6456 | 90622 | 5274 | 95445 | 3486 | 114996 | 2925 | 72916 |
| 14-#18 | 2.77 | MA | 44433 | 10883 | 72044 | 8036 | 77858 | 6520 | 79282 | 5322 | 79110 | 3552 | 95089 | 2257 | 69389 |
| 7L-2S | | MI | 50019 | 10883 | 81695 | 7962 | 90782 | 6424 | 95724 | 5246 | 102368 | 3464 | 124218 | 3146 | 73040 |
| 16-#11 | 1.23 | MA | 46452 | 9809 | 72035 | 7381 | 78332 | 6016 | 80070 | 5016 | 80035 | 3605 | 94644 | 3429 | 35356 |
| 2L-8S | | MI | 40768 | 9809 | 63020 | 7382 | 67174 | 6030 | 67109 | 5043 | 63582 | 3620 | 73957 | 3001 | 33120 |
| 16-#11 | 1.23 | MA | 45519 | 9809 | 70666 | 7379 | 76578 | 6012 | 77930 | 5029 | 77123 | 3616 | 90683 | 3342 | 35390 |
| 3L-7S | | MI | 41275 | 9809 | 63863 | 7385 | 68323 | 6017 | 68469 | 5030 | 65568 | 3628 | 76335 | 3050 | 33523 |
| 16-#11 | 1.23 | MA | 44866 | 9809 | 69554 | 7394 | 75160 | 6027 | 76207 | 5024 | 74906 | 3626 | 88099 | 3256 | 35417 |
| 4L-6S | | MI | 41790 | 9809 | 64803 | 7370 | 69456 | 6020 | 69862 | 5018 | 67437 | 3617 | 78919 | 3140 | 33765 |
| 16-#11 | 1.23 | MA | 44283 | 9809 | 68593 | 7392 | 73914 | 6023 | 74676 | 5037 | 72687 | 3619 | 85415 | 3214 | 35418 |
| 5E | | MI | 42318 | 9809 | 65660 | 7372 | 70644 | 6006 | 71313 | 5023 | 69350 | 3607 | 81341 | 3196 | 33796 |
| 16-#11 | 1.23 | MA | 43729 | 9809 | 67693 | 7390 | 72667 | 6037 | 73151 | 5033 | 70678 | 3630 | 82852 | 3158 | 35377 |
| 6L-4S | | MI | 42873 | 9809 | 66574 | 7374 | 71830 | 6010 | 72771 | 5010 | 71462 | 3615 | 83885 | 3238 | 33782 |
| 16-#11 | 1.23 | MA | 43188 | 9809 | 66707 | 7405 | 71477 | 6034 | 71688 | 5046 | 68715 | 3640 | 80121 | 3068 | 35106 |
| 7L-3S | | MI | 43495 | 9809 | 67633 | 7359 | 73179 | 5996 | 74411 | 5015 | 73573 | 3605 | 86326 | 3324 | 33751 |

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

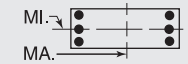



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.23 | MA | 42648 | 9809 | 65822 | 7403 | 70271 | 6048 | 70260 | 5059 | 66628 | 3634 | 77610 | 3018 | 34669 |
| 8L-2S | | MI | 44382 | 9809 | 68934 | 7361 | 74847 | 6000 | 76446 | 5002 | 76341 | 3595 | 90073 | 3411 | 33715 |
| 16-#14 | 1.78 | MA | 48652 | 10191 | 76881 | 7597 | 84401 | 6169 | 87418 | 5104 | 90009 | 3563 | 107932 | 3349 | 50318 |
| 2L-8S | | MI | 41337 | 10191 | 65059 | 7604 | 69607 | 6193 | 70034 | 5145 | 67515 | 3583 | 79666 | 2737 | 45889 |
| 16-#14 | 1.78 | MA | 47330 | 10191 | 74921 | 7594 | 81888 | 6163 | 84353 | 5122 | 85839 | 3577 | 102292 | 3225 | 50332 |
| 3L-7S | | MI | 42057 | 10191 | 66270 | 7608 | 71256 | 6174 | 71985 | 5127 | 70365 | 3595 | 83056 | 2807 | 46433 |
| 16-#14 | 1.78 | MA | 46403 | 10191 | 73326 | 7615 | 79855 | 6183 | 81882 | 5115 | 82659 | 3591 | 98617 | 3100 | 50287 |
| 4L-6S | | MI | 42787 | 10191 | 67618 | 7587 | 72881 | 6179 | 73983 | 5110 | 73046 | 3581 | 86732 | 2937 | 47182 |
| 16-#14 | 1.78 | MA | 45577 | 10191 | 71948 | 7612 | 78068 | 6178 | 79686 | 5133 | 79477 | 3581 | 94788 | 3040 | 50165 |
| 5E | | MI | 43537 | 10191 | 68848 | 7590 | 74585 | 6160 | 76066 | 5117 | 75790 | 3567 | 90178 | 3018 | 47831 |
| 16-#14 | 1.78 | MA | 44790 | 10191 | 70656 | 7609 | 76278 | 6198 | 77498 | 5126 | 76594 | 3595 | 91141 | 2959 | 49470 |
| 6L-4S | | MI | 44324 | 10191 | 70160 | 7594 | 76286 | 6165 | 78156 | 5100 | 78819 | 3579 | 93803 | 3078 | 47934 |
| 16-#14 | 1.78 | MA | 44024 | 10191 | 69241 | 7630 | 74571 | 6193 | 75399 | 5144 | 73778 | 3609 | 87252 | 2829 | 48659 |
| 7L-3S | | MI | 45206 | 10191 | 71677 | 7573 | 78220 | 6146 | 80507 | 5107 | 81844 | 3565 | 97273 | 3202 | 47967 |
| 16-#14 | 1.78 | MA | 43269 | 10191 | 67969 | 7627 | 72839 | 6213 | 73350 | 5162 | 70784 | 3599 | 83671 | 2759 | 48064 |
| 8L-2S | | MI | 46462 | 10191 | 73540 | 7577 | 80608 | 6152 | 83420 | 5090 | 85807 | 3552 | 102604 | 3327 | 47942 |
| 16-#18 | 3.16 | MA | 51710 | 11159 | 85472 | 8150 | 95131 | 6600 | 100401 | 5367 | 107628 | 3484 | 130912 | 2909 | 87232 |
| 3L-7S | | MI | 43939 | 11159 | 72189 | 8182 | 78540 | 6621 | 80747 | 5376 | 82275 | 3507 | 99626 | 2174 | 75841 |
| 16-#18 | 3.16 | MA | 50121 | 11159 | 82669 | 8187 | 91559 | 6589 | 96060 | 5352 | 102042 | 3506 | 124561 | 2688 | 86786 |
| 4L-6S | | MI | 45191 | 11159 | 74559 | 8146 | 81399 | 6589 | 84262 | 5347 | 86970 | 3485 | 105982 | 2405 | 78528 |
| 16-#18 | 3.16 | MA | 48703 | 11159 | 80245 | 8180 | 88415 | 6622 | 92196 | 5382 | 96447 | 3485 | 117904 | 2583 | 84212 |
| 5E | | MI | 46477 | 11159 | 76723 | 8155 | 84395 | 6600 | 87922 | 5363 | 91775 | 3463 | 111934 | 2549 | 80166 |
| 16-#18 | 3.16 | MA | 47354 | 11159 | 77971 | 8172 | 85267 | 6611 | 88349 | 5367 | 91376 | 3507 | 111594 | 2439 | 82436 |
| 6L-4S | | MI | 47828 | 11159 | 79030 | 8163 | 87386 | 6568 | 91597 | 5334 | 97076 | 3485 | 118230 | 2652 | 82619 |
| 16-#18 | 3.16 | MA | 46040 | 11159 | 75480 | 8209 | 82262 | 6644 | 84655 | 5397 | 86421 | 3530 | 104859 | 2208 | 79598 |
| 7L-3S | | MI | 49339 | 11159 | 81695 | 8127 | 90782 | 6580 | 95724 | 5350 | 102368 | 3463 | 124218 | 2874 | 83022 |
| 16-#18 | 3.16 | MA | 44746 | 11159 | 73242 | 8201 | 79215 | 6633 | 81049 | 5427 | 81155 | 3508 | 98635 | 2085 | 77120 |
| 8L-2S | | MI | 51490 | 11159 | 84958 | 8135 | 94965 | 6548 | 100827 | 5321 | 109291 | 3441 | 133440 | 3095 | 83196 |
| 18-#11 | 1.39 | MA | 47102 | 9917 | 73403 | 7448 | 80086 | 6064 | 82210 | 5045 | 82947 | 3596 | 98605 | 3413 | 39653 |
| 2L-9S | | MI | 40870 | 9917 | 63495 | 7448 | 67724 | 6075 | 67722 | 5068 | 64498 | 3622 | 75354 | 2931 | 36797 |
| 18-#11 | 1.39 | MA | 46171 | 9917 | 72035 | 7446 | 78332 | 6061 | 80070 | 5058 | 80035 | 3607 | 94644 | 3327 | 39680 |
| 3L-8S | | MI | 41395 | 9917 | 64321 | 7450 | 68842 | 6079 | 69144 | 5072 | 66350 | 3612 | 77703 | 2985 | 37088 |
| 18-#11 | 1.39 | MA | 45520 | 9917 | 70922 | 7461 | 76915 | 6075 | 78347 | 5054 | 77817 | 3617 | 92060 | 3241 | 39697 |
| 4L-7S | | MI | 41900 | 9917 | 65164 | 7452 | 69991 | 6065 | 70503 | 5060 | 68337 | 3619 | 80082 | 3034 | 37475 |
| 18-#11 | 1.39 | MA | 44939 | 9917 | 69962 | 7459 | 75669 | 6072 | 76816 | 5067 | 75599 | 3611 | 89376 | 3198 | 39679 |
| 5L-6S | | MI | 42413 | 9917 | 66104 | 7437 | 71124 | 6069 | 71897 | 5047 | 70206 | 3609 | 82665 | 3124 | 37805 |
| 18-#11 | 1.39 | MA | 44387 | 9917 | 69062 | 7458 | 74421 | 6086 | 75291 | 5062 | 73590 | 3621 | 86813 | 3142 | 39623 |
| 6L-5S | | MI | 42940 | 9917 | 66961 | 7439 | 72311 | 6055 | 73348 | 5052 | 72119 | 3599 | 85088 | 3180 | 37848 |
| 18-#11 | 1.39 | MA | 43848 | 9917 | 68076 | 7473 | 73232 | 6083 | 73828 | 5075 | 71627 | 3632 | 84081 | 3052 | 39264 |
| 7L-4S | | MI | 43493 | 9917 | 67876 | 7441 | 73498 | 6058 | 74806 | 5040 | 74231 | 3606 | 87631 | 3222 | 37855 |
| 18-#11 | 1.39 | MA | 43312 | 9917 | 67190 | 7471 | 72025 | 6097 | 72401 | 5088 | 69540 | 3625 | 81571 | 3003 | 38843 |
| 8L-3S | | MI | 44113 | 9917 | 68934 | 7426 | 74847 | 6045 | 76446 | 5044 | 76341 | 3596 | 90073 | 3308 | 37833 |
| 18-#11 | 1.39 | MA | 42758 | 9917 | 66324 | 7469 | 70852 | 6094 | 70908 | 5084 | 67596 | 3636 | 79086 | 2949 | 38522 |
| 9L-2S | | MI | 44997 | 9917 | 70235 | 7429 | 76515 | 6048 | 78481 | 5032 | 79110 | 3586 | 93819 | 3394 | 37803 |
| 18-#14 | 2.00 | MA | 49566 | 10347 | 78841 | 7694 | 86914 | 6238 | 90484 | 5147 | 94180 | 3550 | 113572 | 3325 | 56458 |
| 2L-9S | | MI | 41491 | 10347 | 65619 | 7723 | 70391 | 6257 | 70907 | 5180 | 68822 | 3585 | 81657 | 2634 | 50320 |
| 18-#14 | 2.00 | MA | 48248 | 10347 | 76881 | 7691 | 84401 | 6233 | 87418 | 5165 | 90009 | 3564 | 107932 | 3201 | 56440 |
| 3L-8S | | MI | 42224 | 10347 | 66922 | 7701 | 71995 | 6263 | 72947 | 5187 | 71479 | 3571 | 84998 | 2712 | 51466 |
| 18-#14 | 2.00 | MA | 47326 | 10347 | 75286 | 7713 | 82368 | 6253 | 84948 | 5158 | 86830 | 3579 | 104257 | 3076 | 56372 |
| 4L-7S | | MI | 42940 | 10347 | 68133 | 7705 | 73644 | 6243 | 74898 | 5170 | 74329 | 3582 | 88388 | 2782 | 52091 |
| 18-#14 | 2.00 | MA | 46503 | 10347 | 73908 | 7709 | 80581 | 6248 | 82751 | 5176 | 83648 | 3568 | 100428 | 3016 | 56225 |
| 5L-6S | | MI | 43667 | 10347 | 69480 | 7684 | 75269 | 6249 | 76897 | 5152 | 77010 | 3569 | 92064 | 2912 | 52810 |
| 18-#14 | 2.00 | MA | 45720 | 10347 | 72616 | 7706 | 78791 | 6268 | 80564 | 5169 | 80765 | 3583 | 96781 | 2935 | 55395 |
| 6L-5S | | MI | 44413 | 10347 | 70710 | 7688 | 76973 | 6230 | 78979 | 5160 | 79754 | 3555 | 95509 | 2993 | 53593 |
| 18-#14 | 2.00 | MA | 44957 | 10347 | 71201 | 7728 | 77084 | 6263 | 78464 | 5187 | 77948 | 3597 | 92892 | 2806 | 54615 |
| 7L-4S | | MI | 45197 | 10347 | 72022 | 7691 | 78674 | 6235 | 81070 | 5142 | 82782 | 3566 | 99134 | 3052 | 53720 |
| 18-#14 | 2.00 | MA | 44206 | 10347 | 69930 | 7724 | 75352 | 6282 | 76416 | 5205 | 74955 | 3587 | 89311 | 2735 | 53943 |
| 8L-3S | | MI | 46075 | 10347 | 73540 | 7670 | 80608 | 6216 | 83420 | 5150 | 85807 | 3553 | 102604 | 3177 | 53776 |
| 18-#14 | 2.00 | MA | 43422 | 10347 | 68686 | 7721 | 73668 | 6277 | 74273 | 5198 | 72164 | 3601 | 85775 | 2657 | 52713 |
| 9L-2S | | MI | 47327 | 10347 | 75403 | 7674 | 82996 | 6222 | 86333 | 5132 | 89771 | 3539 | 107936 | 3301 | 53775 |


## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

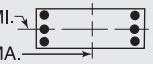

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#18 | 3.56 | MA | 51688 | 11436 | 86105 | 8360 | 95964 | 6713 | 101433 | 5428 | 109352 | 3484 | 134331 | 2640 | 97355 |
| 4L-7S | | MI | 45447 | 11436 | 75452 | 8355 | 82723 | 6745 | 85850 | 5451 | 89198 | 3484 | 108848 | 2123 | 85543 |
| 18-#18 | 3.56 | MA | 50279 | 11436 | 83680 | 8352 | 92820 | 6746 | 97570 | 5457 | 103758 | 3463 | 127673 | 2535 | 94538 |
| 5L-6S | | MI | 46691 | 11436 | 77822 | 8319 | 85582 | 6713 | 89364 | 5422 | 93893 | 3462 | 115204 | 2354 | 88394 |
| 18-#18 | 3.56 | MA | 48939 | 11436 | 81407 | 8345 | 89671 | 6735 | 93722 | 5443 | 98687 | 3485 | 121364 | 2391 | 92832 |
| 6L-5S | | MI | 47968 | 11436 | 79986 | 8328 | 88578 | 6725 | 93025 | 5438 | 98698 | 3440 | 121156 | 2498 | 89964 |
| 18-#18 | 3.56 | MA | 47635 | 11436 | 78916 | 8382 | 86667 | 6768 | 90028 | 5472 | 93732 | 3508 | 114629 | 2160 | 89831 |
| 7L-4S | | MI | 49310 | 11436 | 82293 | 8336 | 91568 | 6692 | 96700 | 5410 | 103999 | 3462 | 127452 | 2601 | 92655 |
| 18-#18 | 3.56 | MA | 46350 | 11436 | 76678 | 8374 | 83619 | 6757 | 86422 | 5502 | 88466 | 3486 | 108405 | 2037 | 87230 |
| 8L-3S | | MI | 50812 | 11436 | 84958 | 8300 | 94965 | 6704 | 100827 | 5425 | 109291 | 3440 | 133440 | 2822 | 93116 |
| 20-#11 | 1.54 | MA | 47748 | 10025 | 74772 | 7516 | 81841 | 6112 | 84351 | 5075 | 85859 | 3588 | 102565 | 3398 | 43943 |
| 2L-10S | | MI | 40940 | 10025 | 63872 | 7530 | 68258 | 6138 | 68404 | 5110 | 65430 | 3623 | 76825 | 2853 | 40220 |
| 20-#11 | 1.54 | MA | 46820 | 10025 | 73403 | 7514 | 80086 | 6109 | 82210 | 5088 | 82947 | 3598 | 98605 | 3311 | 43965 |
| 3L-9S | | MI | 41496 | 10025 | 64796 | 7515 | 69392 | 6124 | 69757 | 5097 | 67266 | 3613 | 79101 | 2914 | 40773 |
| 20-#11 | 1.54 | MA | 46171 | 10025 | 72291 | 7529 | 78669 | 6123 | 80487 | 5083 | 80729 | 3609 | 96021 | 3225 | 43967 |
| 4L-8S | | MI | 42019 | 10025 | 65622 | 7517 | 70510 | 6127 | 71179 | 5102 | 69118 | 3603 | 81450 | 2968 | 41059 |
| 20-#11 | 1.54 | MA | 45593 | 10025 | 71330 | 7527 | 77423 | 6120 | 78956 | 5096 | 78511 | 3602 | 93336 | 3183 | 43935 |
| 5L-7S | | MI | 42522 | 10025 | 66466 | 7519 | 71659 | 6114 | 72538 | 5089 | 71105 | 3610 | 83828 | 3017 | 41433 |
| 20-#11 | 1.54 | MA | 45042 | 10025 | 70430 | 7525 | 76176 | 6134 | 77431 | 5092 | 76501 | 3613 | 90774 | 3127 | 43865 |
| 6E | | MI | 43034 | 10025 | 67405 | 7504 | 72792 | 6117 | 73931 | 5077 | 72974 | 3600 | 86412 | 3107 | 41840 |
| 20-#11 | 1.54 | MA | 44505 | 10025 | 69444 | 7540 | 74986 | 6131 | 75969 | 5105 | 74539 | 3623 | 88042 | 3037 | 43427 |
| 7L-5S | | MI | 43559 | 10025 | 68262 | 7507 | 73979 | 6103 | 75383 | 5081 | 74887 | 3590 | 88835 | 3163 | 41898 |
| 20-#11 | 1.54 | MA | 43977 | 10025 | 68559 | 7538 | 73779 | 6145 | 74541 | 5118 | 72452 | 3616 | 85532 | 2987 | 43020 |
| 8L-4S | | MI | 44110 | 10025 | 69177 | 7509 | 75166 | 6107 | 76841 | 5069 | 76999 | 3597 | 91378 | 3205 | 41922 |
| 20-#11 | 1.54 | MA | 43419 | 10025 | 67692 | 7536 | 72606 | 6142 | 73048 | 5113 | 70507 | 3627 | 83047 | 2934 | 42705 |
| 9L-3S | | MI | 44728 | 10025 | 70235 | 7494 | 76515 | 6093 | 78481 | 5074 | 79110 | 3587 | 93819 | 3292 | 41909 |
| 20-#11 | 1.54 | MA | 42836 | 10025 | 66722 | 7552 | 71416 | 6156 | 71628 | 5126 | 68579 | 3638 | 80639 | 2873 | 42108 |
| 10L-2S | | MI | 45610 | 10025 | 71536 | 7496 | 78183 | 6096 | 80515 | 5061 | 81878 | 3577 | 97566 | 3378 | 41885 |
| 20-#14 | 2.22 | MA | 49161 | 10502 | 78841 | 7788 | 86914 | 6303 | 90484 | 5207 | 94180 | 3552 | 113572 | 3177 | 62541 |
| 3L-9S | | MI | 42377 | 10502 | 67481 | 7820 | 72779 | 6327 | 73821 | 5222 | 72786 | 3572 | 86988 | 2609 | 55923 |
| 20-#14 | 2.22 | MA | 48243 | 10502 | 77246 | 7810 | 84881 | 6323 | 88013 | 5200 | 91000 | 3566 | 109897 | 3052 | 62452 |
| 4L-8S | | MI | 43106 | 10502 | 68785 | 7799 | 74383 | 6333 | 75861 | 5229 | 75443 | 3559 | 90329 | 2686 | 57033 |
| 20-#14 | 2.22 | MA | 47424 | 10502 | 75868 | 7807 | 83093 | 6318 | 85816 | 5218 | 87818 | 3556 | 106068 | 2992 | 62280 |
| 5L-7S | | MI | 43819 | 10502 | 69996 | 7802 | 76032 | 6313 | 77811 | 5212 | 78292 | 3570 | 93719 | 2757 | 57755 |
| 20-#14 | 2.22 | MA | 46644 | 10502 | 74576 | 7803 | 81304 | 6338 | 83629 | 5211 | 84935 | 3570 | 102421 | 2911 | 61330 |
| 6E | | MI | 44543 | 10502 | 71343 | 7781 | 77657 | 6319 | 79810 | 5195 | 80974 | 3556 | 97395 | 2886 | 58448 |
| 20-#14 | 2.22 | MA | 45885 | 10502 | 73161 | 7825 | 79596 | 6333 | 81530 | 5229 | 82119 | 3585 | 98532 | 2782 | 60577 |
| 7L-5S | | MI | 45286 | 10502 | 72573 | 7785 | 79361 | 6300 | 81892 | 5202 | 83718 | 3543 | 100840 | 2967 | 59350 |
| 20-#14 | 2.22 | MA | 45137 | 10502 | 71890 | 7822 | 77865 | 6352 | 79481 | 5247 | 79125 | 3574 | 94951 | 2711 | 59809 |
| 8L-4S | | MI | 46066 | 10502 | 73885 | 7789 | 81062 | 6305 | 83983 | 5185 | 86746 | 3554 | 104466 | 3027 | 59500 |
| 20-#14 | 2.22 | MA | 44358 | 10502 | 70646 | 7818 | 76181 | 6347 | 77338 | 5240 | 76335 | 3588 | 91415 | 2633 | 58614 |
| 9L-3S | | MI | 46940 | 10502 | 75403 | 7767 | 82996 | 6286 | 86333 | 5192 | 89771 | 3540 | 107936 | 3151 | 59576 |
| 20-#14 | 2.22 | MA | 43532 | 10502 | 69253 | 7840 | 74472 | 6367 | 75300 | 5258 | 73568 | 3603 | 87989 | 2545 | 57556 |
| 10L-2S | | MI | 48187 | 10502 | 77265 | 7771 | 85385 | 6291 | 89247 | 5175 | 93735 | 3527 | 113267 | 3276 | 59603 |
| 20-#18 | 3.95 | MA | 51844 | 11712 | 87116 | 8525 | 97224 | 6870 | 102943 | 5533 | 111069 | 3441 | 137443 | 2487 | 104883 |
| 5L-7S | | MI | 46944 | 11712 | 78715 | 8528 | 86906 | 6869 | 90953 | 5526 | 96121 | 3461 | 118070 | 2071 | 95265 |
| 20-#18 | 3.95 | MA | 50513 | 11712 | 84843 | 8518 | 94076 | 6859 | 99095 | 5518 | 105998 | 3463 | 131134 | 2343 | 103240 |
| 6E | | MI | 48180 | 11712 | 81085 | 8492 | 89765 | 6837 | 94467 | 5498 | 100816 | 3439 | 124426 | 2302 | 98271 |
| 20-#18 | 3.95 | MA | 49217 | 11712 | 82352 | 8555 | 91071 | 6892 | 95401 | 5548 | 101042 | 3486 | 124399 | 2112 | 100083 |
| 7L-5S | | MI | 49448 | 11712 | 83249 | 8500 | 92760 | 6849 | 98128 | 5514 | 105621 | 3417 | 130378 | 2447 | 99782 |
| 20-#18 | 3.95 | MA | 47941 | 11712 | 80113 | 8547 | 88024 | 6882 | 91796 | 5578 | 95777 | 3464 | 118175 | 1989 | 97361 |
| 8L-4S | | MI | 50782 | 11712 | 85555 | 8509 | 95751 | 6817 | 101803 | 5485 | 110922 | 3439 | 136674 | 2550 | 102686 |
| 22-#11 | 1.70 | MA | 48393 | 10133 | 76140 | 7583 | 83595 | 6161 | 86491 | 5104 | 88771 | 3579 | 106526 | 3382 | 48230 |
| 2L-11S | | MI | 41025 | 10133 | 64346 | 7595 | 68814 | 6183 | 69035 | 5134 | 66240 | 3607 | 78252 | 2785 | 43631 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis

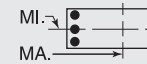



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.70 | MA | 47467 | 10133 | 74772 | 7581 | 81841 | 6158 | 84351 | 5117 | 85859 | 3590 | 102565 | 3296 | 48245 |
| 3L-10S | | MI | 41566 | 10133 | 65173 | 7597 | 69926 | 6186 | 70439 | 5139 | 68199 | 3615 | 80571 | 2837 | 44148 |
| 22-#11 | 1.70 | MA | 46820 | 10133 | 73659 | 7596 | 80423 | 6172 | 82628 | 5113 | 83641 | 3600 | 99982 | 3210 | 48230 |
| 4L-9S | | MI | 42120 | 10133 | 66098 | 7582 | 71060 | 6172 | 71791 | 5126 | 70035 | 3604 | 82848 | 2898 | 44752 |
| 22-#11 | 1.70 | MA | 46243 | 10133 | 72699 | 7594 | 79177 | 6169 | 81096 | 5126 | 81423 | 3594 | 97297 | 3167 | 48186 |
| 5L-8S | | MI | 42640 | 10133 | 66923 | 7585 | 72178 | 6176 | 73213 | 5131 | 71887 | 3594 | 85197 | 2952 | 45033 |
| 22-#11 | 1.70 | MA | 45695 | 10133 | 71799 | 7592 | 77930 | 6183 | 79572 | 5121 | 79413 | 3604 | 94735 | 3111 | 48103 |
| 6L-7S | | MI | 43142 | 10133 | 67767 | 7587 | 73327 | 6162 | 74573 | 5119 | 73874 | 3602 | 87575 | 3001 | 45395 |
| 22-#11 | 1.70 | MA | 45160 | 10133 | 70813 | 7608 | 76740 | 6180 | 78109 | 5134 | 77451 | 3615 | 92003 | 3022 | 47595 |
| 7L-6S | | MI | 43652 | 10133 | 68706 | 7572 | 74460 | 6165 | 75966 | 5106 | 75743 | 3592 | 90159 | 3091 | 45872 |
| 22-#11 | 1.70 | MA | 44633 | 10133 | 69927 | 7606 | 75534 | 6194 | 76681 | 5147 | 75364 | 3608 | 89492 | 2972 | 47200 |
| 8L-5S | | MI | 44175 | 10133 | 69563 | 7574 | 75647 | 6152 | 77418 | 5111 | 77656 | 3582 | 92581 | 3147 | 45942 |
| 22-#11 | 1.70 | MA | 44078 | 10133 | 69061 | 7604 | 74360 | 6191 | 75188 | 5143 | 73419 | 3618 | 87008 | 2918 | 46891 |
| 9L-4S | | MI | 44725 | 10133 | 70478 | 7576 | 76834 | 6155 | 78876 | 5098 | 79768 | 3589 | 95125 | 3189 | 45977 |
| 22-#11 | 1.70 | MA | 43496 | 10133 | 68090 | 7619 | 73170 | 6205 | 73768 | 5156 | 71491 | 3629 | 84600 | 2857 | 46243 |
| 10L-3S | | MI | 45341 | 10133 | 71536 | 7561 | 78183 | 6141 | 80515 | 5103 | 81878 | 3579 | 97566 | 3275 | 45981 |
| 22-#11 | 1.70 | MA | 42928 | 10133 | 67222 | 7617 | 72003 | 6201 | 72294 | 5151 | 69435 | 3622 | 82151 | 2805 | 45685 |
| 11L-2S | | MI | 46220 | 10133 | 72837 | 7564 | 79851 | 6145 | 82550 | 5091 | 84647 | 3569 | 101313 | 3361 | 45963 |
| 22-#14 | 2.45 | MA | 49156 | 10658 | 79206 | 7907 | 87393 | 6393 | 91078 | 5243 | 95171 | 3554 | 115537 | 3029 | 68526 |
| 4L-9S | | MI | 43258 | 10658 | 69344 | 7917 | 75167 | 6397 | 76734 | 5264 | 76750 | 3560 | 92320 | 2583 | 61532 |
| 22-#14 | 2.45 | MA | 48340 | 10658 | 77828 | 7904 | 85606 | 6388 | 88882 | 5261 | 91989 | 3543 | 111708 | 2968 | 68332 |
| 5L-8S | | MI | 43983 | 10658 | 70648 | 7896 | 76771 | 6402 | 78774 | 5272 | 79407 | 3546 | 95660 | 2661 | 62611 |
| 22-#14 | 2.45 | MA | 47564 | 10658 | 76536 | 7900 | 83816 | 6407 | 86694 | 5254 | 89106 | 3558 | 108061 | 2887 | 67273 |
| 6L-7S | | MI | 44693 | 10658 | 71859 | 7900 | 78420 | 6383 | 80725 | 5254 | 82256 | 3557 | 99050 | 2731 | 63425 |
| 22-#14 | 2.45 | MA | 46808 | 10658 | 75121 | 7922 | 82109 | 6402 | 84595 | 5272 | 86290 | 3572 | 104172 | 2758 | 66544 |
| 7L-6S | | MI | 45414 | 10658 | 73206 | 7878 | 80045 | 6389 | 82723 | 5237 | 84937 | 3544 | 102726 | 2861 | 64094 |
| 22-#14 | 2.45 | MA | 46064 | 10658 | 73850 | 7919 | 80378 | 6422 | 82546 | 5290 | 83296 | 3562 | 100591 | 2687 | 65684 |
| 8L-5S | | MI | 46153 | 10658 | 74436 | 7882 | 81749 | 6369 | 84805 | 5245 | 87681 | 3530 | 106171 | 2942 | 65102 |
| 22-#14 | 2.45 | MA | 45289 | 10658 | 72606 | 7916 | 78693 | 6417 | 80404 | 5283 | 80505 | 3576 | 97055 | 2609 | 64522 |
| 9L-4S | | MI | 46931 | 10658 | 75748 | 7886 | 83451 | 6375 | 86896 | 5227 | 90710 | 3541 | 109797 | 3001 | 65275 |
| 22-#14 | 2.45 | MA | 44466 | 10658 | 71213 | 7937 | 76985 | 6437 | 78366 | 5301 | 77738 | 3590 | 93629 | 2521 | 63401 |
| 10L-3S | | MI | 47801 | 10658 | 77265 | 7865 | 85385 | 6356 | 89247 | 5235 | 93735 | 3528 | 113267 | 3126 | 65370 |
| 22-#18 | 4.35 | MA | 52076 | 11989 | 88278 | 8691 | 98480 | 6983 | 104468 | 5594 | 113309 | 3441 | 140904 | 2294 | 113598 |
| 6L-7S | | MI | 48431 | 11989 | 81978 | 8701 | 91089 | 6993 | 96055 | 5602 | 103045 | 3438 | 127292 | 2020 | 105005 |
| 22-#18 | 4.35 | MA | 50789 | 11989 | 85788 | 8728 | 95476 | 7017 | 100775 | 5623 | 108353 | 3464 | 134168 | 2063 | 110353 |
| 7L-6S | | MI | 49659 | 11989 | 84348 | 8665 | 93948 | 6961 | 99570 | 5573 | 107740 | 3416 | 133648 | 2251 | 108015 |
| 22-#18 | 4.35 | MA | 49521 | 11989 | 83549 | 8720 | 92428 | 7006 | 97169 | 5653 | 103087 | 3442 | 127945 | 1940 | 107511 |
| 8L-5S | | MI | 50919 | 11989 | 86511 | 8673 | 96943 | 6973 | 103231 | 5589 | 112544 | 3394 | 139600 | 2395 | 109616 |
| 24-#11 | 1.85 | MA | 48111 | 10241 | 76140 | 7648 | 83595 | 6206 | 86491 | 5146 | 88771 | 3581 | 106526 | 3281 | 52515 |
| 3L-11S | | MI | 41649 | 10241 | 65647 | 7663 | 70482 | 6231 | 71070 | 5164 | 69009 | 3599 | 81999 | 2768 | 47575 |
| 24-#11 | 1.85 | MA | 47467 | 10241 | 75028 | 7664 | 82178 | 6220 | 84768 | 5142 | 86553 | 3592 | 103943 | 3194 | 52489 |
| 4L-10S | | MI | 42189 | 10241 | 66474 | 7665 | 71594 | 6234 | 72474 | 5168 | 70967 | 3606 | 84318 | 2821 | 48080 |
| 24-#11 | 1.85 | MA | 46892 | 10241 | 74067 | 7662 | 80932 | 6217 | 83236 | 5155 | 84335 | 3585 | 101258 | 3152 | 52434 |
| 5L-9S | | MI | 42741 | 10241 | 67399 | 7650 | 72728 | 6221 | 73826 | 5156 | 72803 | 3596 | 86594 | 2882 | 48727 |
| 24-#11 | 1.85 | MA | 46345 | 10241 | 73167 | 7660 | 79684 | 6231 | 81712 | 5151 | 82325 | 3595 | 98696 | 3096 | 52338 |
| 6L-8S | | MI | 43259 | 10241 | 68224 | 7652 | 73845 | 6224 | 75248 | 5161 | 74655 | 3586 | 88943 | 2935 | 49010 |
| 24-#11 | 1.85 | MA | 45812 | 10241 | 72181 | 7675 | 78495 | 6228 | 80249 | 5164 | 80362 | 3606 | 95964 | 3006 | 51767 |
| 7E | | MI | 43760 | 10241 | 69068 | 7654 | 74995 | 6210 | 76608 | 5148 | 76642 | 3593 | 91322 | 2985 | 49361 |
| 24-#11 | 1.85 | MA | 45287 | 10241 | 71296 | 7673 | 77288 | 6242 | 78821 | 5176 | 78276 | 3599 | 93453 | 2956 | 51383 |
| 8L-6S | | MI | 44268 | 10241 | 70007 | 7639 | 76128 | 6214 | 78001 | 5136 | 78511 | 3583 | 93905 | 3074 | 49900 |
| 24-#11 | 1.85 | MA | 44733 | 10241 | 70429 | 7671 | 76115 | 6239 | 77328 | 5172 | 76331 | 3610 | 90969 | 2903 | 51077 |
| 9L-5S | | MI | 44789 | 10241 | 70864 | 7642 | 77315 | 6200 | 79453 | 5140 | 80424 | 3573 | 96328 | 3130 | 49983 |
| 24-#11 | 1.85 | MA | 44154 | 10241 | 69459 | 7686 | 74924 | 6253 | 75908 | 5185 | 74403 | 3620 | 88560 | 2842 | 50382 |
| 10L-4S | | MI | 45337 | 10241 | 71779 | 7644 | 78501 | 6204 | 80910 | 5128 | 82536 | 3580 | 98871 | 3172 | 50028 |
| 24-#11 | 1.85 | MA | 43588 | 10241 | 68591 | 7684 | 73757 | 6250 | 74434 | 5181 | 72347 | 3614 | 86112 | 2789 | 49836 |
| 11L-3S | | MI | 45951 | 10241 | 72837 | 7629 | 79851 | 6190 | 82550 | 5132 | 84647 | 3570 | 101313 | 3259 | 50049 |
| 24-#11 | 1.85 | MA | 43032 | 10241 | 67638 | 7700 | 72575 | 6264 | 73016 | 5194 | 70419 | 3624 | 83354 | 2712 | 49106 |
| 12L-2S | | MI | 46828 | 10241 | 74138 | 7631 | 81519 | 6193 | 84585 | 5120 | 87415 | 3560 | 105059 | 3345 | 50037 |
| 24-#14 | 2.67 | MA | 49252 | 10813 | 79788 | 8001 | 88119 | 6458 | 91947 | 5303 | 96159 | 3531 | 117348 | 2944 | 74381 |
| 5L-9S | | MI | 44135 | 10813 | 71207 | 8014 | 77556 | 6467 | 79647 | 5307 | 80713 | 3547 | 97651 | 2558 | 67148 |

## RECTANGULAR TIED COLUMNS 44" x 46"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#14 | 2.67 | MA | 48480 | 10813 | 78496 | 7998 | 86329 | 6477 | 89760 | 5296 | 93277 | 3545 | 113701 | 2864 | 73223 |
| 6L-8S | | MI | 44856 | 10813 | 72511 | 7993 | 79159 | 6472 | 81687 | 5314 | 83370 | 3534 | 100991 | 2636 | 68197 |
| 24-#14 | 2.67 | MA | 47727 | 10813 | 77081 | 8019 | 84622 | 6472 | 87660 | 5314 | 90460 | 3560 | 109812 | 2734 | 72515 |
| 7E | | MI | 45563 | 10813 | 73721 | 7997 | 80808 | 6453 | 83638 | 5297 | 86220 | 3545 | 104381 | 2706 | 69098 |
| 24-#14 | 2.67 | MA | 46986 | 10813 | 75810 | 8016 | 82890 | 6492 | 85612 | 5332 | 87467 | 3549 | 106231 | 2663 | 71568 |
| 8L-6S | | MI | 46280 | 10813 | 75069 | 7976 | 82433 | 6458 | 85636 | 5280 | 88901 | 3531 | 108057 | 2836 | 69747 |
| 24-#14 | 2.67 | MA | 46215 | 10813 | 74566 | 8013 | 81206 | 6487 | 83469 | 5325 | 84676 | 3564 | 102695 | 2585 | 70437 |
| 9L-5S | | MI | 47017 | 10813 | 76299 | 7979 | 84137 | 6439 | 87719 | 5287 | 91645 | 3518 | 111502 | 2916 | 70852 |
| 24-#14 | 2.67 | MA | 45395 | 10813 | 73173 | 8034 | 79498 | 6507 | 81431 | 5343 | 81909 | 3578 | 99269 | 2497 | 69254 |
| 10L-4S | | MI | 47791 | 10813 | 77611 | 7983 | 85839 | 6445 | 89809 | 5270 | 94674 | 3529 | 115128 | 2976 | 71045 |
| 24-#18 | 4.74 | MA | 52350 | 12266 | 89223 | 8901 | 99880 | 7141 | 106148 | 5699 | 115664 | 3441 | 143938 | 2015 | 120640 |
| 7E | | MI | 49909 | 12266 | 85240 | 8874 | 95272 | 7117 | 101158 | 5677 | 109968 | 3415 | 136514 | 1969 | 114761 |
| 24-#18 | 4.74 | MA | 51091 | 12266 | 86985 | 8893 | 96833 | 7130 | 102542 | 5728 | 110398 | 3420 | 137714 | 1892 | 117680 |
| 8L-6S | | MI | 51128 | 12266 | 87611 | 8838 | 98131 | 7085 | 104673 | 5649 | 114663 | 3393 | 142870 | 2200 | 117675 |

## RECTANGULAR TIED COLUMNS 44" x 48"

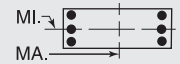
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.14 | MA | 50007 | 10165 | 77594 | 7609 | 83891 | 6206 | 85352 | 5181 | 84601 | 3741 | 99178 | 3545 | 35313 |
| 2L-3S | | MI | 43512 | 10165 | 67939 | 7556 | 72541 | 6201 | 72819 | 5178 | 70096 | 3736 | 80702 | 3283 | 32314 |
| 6-#18 | 1.14 | MA | 47546 | 10165 | 73986 | 7602 | 79265 | 6240 | 79708 | 5212 | 76923 | 3765 | 88860 | 3323 | 35433 |
| 3L-2S | | MI | 45733 | 10165 | 71202 | 7564 | 76724 | 6169 | 77922 | 5150 | 77019 | 3714 | 89924 | 3504 | 32179 |
| 8-#18 | 1.52 | MA | 51704 | 10442 | 81203 | 7782 | 88517 | 6330 | 90996 | 5256 | 92280 | 3719 | 109497 | 3499 | 46665 |
| 2L-4S | | MI | 43493 | 10442 | 68537 | 7765 | 73328 | 6313 | 73795 | 5238 | 71727 | 3735 | 83936 | 3010 | 42480 |
| 8-#18 | 1.52 | MA | 49260 | 10442 | 77594 | 7775 | 83891 | 6364 | 85352 | 5287 | 84601 | 3743 | 99178 | 3278 | 46727 |
| 3E | | MI | 45049 | 10442 | 71202 | 7729 | 76724 | 6325 | 77922 | 5253 | 77019 | 3713 | 89924 | 3231 | 42550 |
| 8-#18 | 1.52 | MA | 47544 | 10442 | 74654 | 7813 | 80144 | 6354 | 80798 | 5274 | 78740 | 3767 | 92464 | 3056 | 46582 |
| 4L-2S | | MI | 47255 | 10442 | 74465 | 7737 | 80907 | 6293 | 83025 | 5225 | 83942 | 3691 | 99146 | 3453 | 42464 |
| 10-#14 | 1.07 | MA | 49796 | 10113 | 76821 | 7621 | 83197 | 6219 | 84619 | 5198 | 83652 | 3770 | 98269 | 3592 | 33378 |
| 2L-5S | | MI | 42589 | 10113 | 65809 | 7594 | 70095 | 6194 | 69939 | 5197 | 66251 | 3764 | 76791 | 3248 | 30571 |
| 10-#14 | 1.07 | MA | 48389 | 10113 | 74763 | 7618 | 80560 | 6214 | 81402 | 5216 | 79274 | 3785 | 92320 | 3467 | 33440 |
| 3L-4S | | MI | 43388 | 10113 | 67121 | 7598 | 71796 | 6199 | 72030 | 5179 | 69280 | 3775 | 80416 | 3307 | 30557 |
| 10-#14 | 1.07 | MA | 47404 | 10113 | 73091 | 7640 | 78428 | 6235 | 78811 | 5210 | 75940 | 3800 | 88441 | 3343 | 33486 |
| 4L-3S | | MI | 44282 | 10113 | 68638 | 7577 | 73730 | 6180 | 74381 | 5187 | 72305 | 3761 | 83886 | 3432 | 30497 |
| 10-#14 | 1.07 | MA | 46525 | 10113 | 71647 | 7637 | 76555 | 6230 | 76508 | 5229 | 72604 | 3790 | 84408 | 3282 | 33462 |
| 5L-2S | | MI | 45554 | 10113 | 70501 | 7580 | 76119 | 6185 | 77294 | 5169 | 76268 | 3748 | 89217 | 3556 | 30429 |
| 10-#18 | 1.89 | MA | 53385 | 10718 | 84812 | 7955 | 93144 | 6454 | 96639 | 5332 | 99958 | 3697 | 119815 | 3453 | 57979 |
| 2L-5S | | MI | 43643 | 10718 | 69493 | 7929 | 74520 | 6470 | 75223 | 5342 | 73349 | 3690 | 86863 | 2856 | 51300 |
| 10-#18 | 1.89 | MA | 50957 | 10718 | 81203 | 7948 | 88517 | 6488 | 90996 | 5362 | 92280 | 3721 | 109497 | 3232 | 57967 |
| 3L-4S | | MI | 45026 | 10718 | 71800 | 7938 | 77511 | 6437 | 78897 | 5313 | 78650 | 3712 | 93158 | 2959 | 52575 |
| 10-#18 | 1.89 | MA | 49253 | 10718 | 78263 | 7986 | 84770 | 6478 | 86441 | 5349 | 86419 | 3745 | 102782 | 3011 | 57733 |
| 4L-3S | | MI | 46571 | 10718 | 74465 | 7902 | 80907 | 6449 | 83025 | 5329 | 83942 | 3690 | 99146 | 3180 | 52738 |
| 10-#18 | 1.89 | MA | 47732 | 10718 | 75720 | 7979 | 81473 | 6512 | 82390 | 5380 | 80550 | 3725 | 95763 | 2905 | 56261 |
| 5L-2S | | MI | 48764 | 10718 | 77728 | 7910 | 85090 | 6417 | 88128 | 5300 | 90865 | 3668 | 108368 | 3402 | 52711 |
| 12-#14 | 1.28 | MA | 50776 | 10269 | 78878 | 7718 | 85834 | 6289 | 87837 | 5240 | 88029 | 3757 | 104218 | 3570 | 39846 |
| 2L-6S | | MI | 42724 | 10269 | 66442 | 7688 | 70779 | 6283 | 70770 | 5232 | 67471 | 3765 | 78677 | 3141 | 36182 |
| 12-#14 | 1.28 | MA | 49374 | 10269 | 76821 | 7716 | 83197 | 6284 | 84619 | 5259 | 83652 | 3772 | 98269 | 3445 | 39894 |
| 3L-5S | | MI | 43481 | 10269 | 67671 | 7691 | 72483 | 6263 | 72853 | 5239 | 70215 | 3751 | 82122 | 3222 | 36366 |
| 12-#14 | 1.28 | MA | 48393 | 10269 | 75148 | 7738 | 81066 | 6304 | 82028 | 5252 | 80318 | 3787 | 94390 | 3320 | 39912 |
| 4E | | MI | 44277 | 10269 | 68983 | 7695 | 74185 | 6269 | 74944 | 5222 | 73243 | 3762 | 85747 | 3282 | 36391 |
| 12-#14 | 1.28 | MA | 47518 | 10269 | 73704 | 7735 | 79192 | 6300 | 79726 | 5271 | 76981 | 3777 | 90357 | 3259 | 39849 |
| 5L-3S | | MI | 45167 | 10269 | 70501 | 7674 | 76119 | 6250 | 77294 | 5229 | 76268 | 3749 | 89217 | 3406 | 36353 |
| 12-#14 | 1.28 | MA | 46685 | 10269 | 72351 | 7732 | 77317 | 6320 | 77433 | 5265 | 73960 | 3792 | 86508 | 3179 | 39590 |
| 6L-2S | | MI | 46434 | 10269 | 72364 | 7678 | 78507 | 6255 | 80207 | 5212 | 80232 | 3735 | 94549 | 3531 | 36297 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

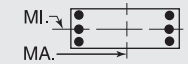
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#18 | 2.27 | MA | 55052 | 10995 | 88420 | 8128 | 97770 | 6578 | 102283 | 5407 | 107637 | 3675 | 130133 | 3408 | 69268 |
| 2L-6S | | MI | 43866 | 10995 | 70592 | 8094 | 75707 | 6582 | 76665 | 5401 | 75467 | 3689 | 90133 | 2660 | 59173 |
| 12-#18 | 2.27 | MA | 52639 | 10995 | 84812 | 8121 | 93144 | 6612 | 96639 | 5438 | 99958 | 3699 | 119815 | 3186 | 69180 |
| 3L-5S | | MI | 45173 | 10995 | 72756 | 8102 | 78703 | 6594 | 80325 | 5417 | 80272 | 3667 | 96085 | 2804 | 61006 |
| 12-#18 | 2.27 | MA | 50947 | 10995 | 81872 | 8159 | 89396 | 6602 | 92085 | 5424 | 94097 | 3723 | 113100 | 2965 | 68867 |
| 4E | | MI | 46545 | 10995 | 75063 | 8111 | 81694 | 6561 | 84000 | 5389 | 85573 | 3689 | 102380 | 2907 | 62650 |
| 12-#18 | 2.27 | MA | 49437 | 10995 | 79329 | 8152 | 86099 | 6636 | 88033 | 5455 | 88229 | 3703 | 106081 | 2859 | 67020 |
| 5L-3S | | MI | 48080 | 10995 | 77728 | 8075 | 85090 | 6573 | 88128 | 5404 | 90865 | 3667 | 108368 | 3129 | 62888 |
| 12-#18 | 2.27 | MA | 48001 | 10995 | 76946 | 8145 | 82798 | 6626 | 83999 | 5442 | 82912 | 3727 | 99414 | 2715 | 64892 |
| 6L-2S | | MI | 50260 | 10995 | 80991 | 8083 | 89273 | 6541 | 93231 | 5376 | 97788 | 3645 | 117590 | 3350 | 62930 |
| 14-#11 | 1.03 | MA | 49706 | 10090 | 76465 | 7629 | 82893 | 6227 | 84306 | 5207 | 83250 | 3783 | 97902 | 3615 | 32527 |
| 2L-7S | | MI | 42359 | 10090 | 65107 | 7614 | 69329 | 6212 | 69050 | 5208 | 65156 | 3795 | 75201 | 3221 | 29732 |
| 14-#11 | 1.03 | MA | 48722 | 10090 | 75029 | 7628 | 81052 | 6224 | 82060 | 5221 | 80195 | 3794 | 93727 | 3528 | 32568 |
| 3L-6S | | MI | 42876 | 10090 | 66046 | 7599 | 70462 | 6216 | 70443 | 5196 | 67025 | 3785 | 77785 | 3311 | 29783 |
| 14-#11 | 1.03 | MA | 48035 | 10090 | 73863 | 7643 | 79566 | 6239 | 80254 | 5217 | 77870 | 3805 | 91001 | 3442 | 32604 |
| 4L-5S | | MI | 43407 | 10090 | 66903 | 7601 | 71650 | 6202 | 71895 | 5200 | 68938 | 3775 | 80208 | 3366 | 29779 |
| 14-#11 | 1.03 | MA | 47422 | 10090 | 72857 | 7641 | 78260 | 6236 | 78649 | 5230 | 75545 | 3799 | 88175 | 3399 | 32624 |
| 5L-4S | | MI | 43964 | 10090 | 67818 | 7603 | 72836 | 6206 | 73353 | 5188 | 71050 | 3783 | 82751 | 3408 | 29747 |
| 14-#11 | 1.03 | MA | 46839 | 10090 | 71914 | 7640 | 76953 | 6250 | 77052 | 5226 | 73440 | 3810 | 85473 | 3343 | 32601 |
| 6L-3S | | MI | 44588 | 10090 | 68876 | 7588 | 74185 | 6192 | 74992 | 5193 | 73160 | 3773 | 85192 | 3495 | 29704 |
| 14-#11 | 1.03 | MA | 46271 | 10090 | 70881 | 7655 | 75707 | 6247 | 75519 | 5239 | 71383 | 3821 | 82593 | 3253 | 32499 |
| 7L-2S | | MI | 45478 | 10090 | 70177 | 7590 | 75853 | 6195 | 77027 | 5180 | 75929 | 3763 | 88939 | 3581 | 29660 |
| 14-#14 | 1.49 | MA | 51750 | 10424 | 80935 | 7816 | 88472 | 6359 | 91054 | 5283 | 92407 | 3745 | 110167 | 3547 | 46302 |
| 2L-7S | | MI | 42879 | 10424 | 66957 | 7806 | 71542 | 6347 | 71685 | 5291 | 68753 | 3766 | 80332 | 2986 | 40986 |
| 14-#14 | 1.49 | MA | 50353 | 10424 | 78878 | 7813 | 85834 | 6354 | 87837 | 5301 | 88029 | 3760 | 104218 | 3422 | 46335 |
| 3L-6S | | MI | 43614 | 10424 | 68304 | 7785 | 73167 | 6352 | 73684 | 5274 | 71435 | 3752 | 84008 | 3116 | 41782 |
| 14-#14 | 1.49 | MA | 49377 | 10424 | 77206 | 7835 | 83703 | 6374 | 85246 | 5295 | 84695 | 3775 | 100338 | 3298 | 46319 |
| 4L-5S | | MI | 44369 | 10424 | 69534 | 7789 | 74871 | 6333 | 75766 | 5281 | 74179 | 3739 | 87453 | 3197 | 42149 |
| 14-#14 | 1.49 | MA | 48505 | 10424 | 75761 | 7832 | 81829 | 6370 | 82943 | 5313 | 81359 | 3765 | 96305 | 3237 | 46225 |
| 5L-4S | | MI | 45161 | 10424 | 70846 | 7792 | 76573 | 6339 | 77857 | 5264 | 77207 | 3750 | 91079 | 3257 | 42207 |
| 14-#14 | 1.49 | MA | 47677 | 10424 | 74408 | 7829 | 79954 | 6390 | 80651 | 5307 | 78338 | 3780 | 92457 | 3156 | 45783 |
| 6L-3S | | MI | 46047 | 10424 | 72364 | 7771 | 78507 | 6319 | 80207 | 5272 | 80232 | 3736 | 94549 | 3381 | 42195 |
| 14-#14 | 1.49 | MA | 46869 | 10424 | 72925 | 7851 | 78165 | 6385 | 78451 | 5326 | 75386 | 3795 | 88354 | 3027 | 44856 |
| 7L-2S | | MI | 47310 | 10424 | 74226 | 7775 | 80895 | 6325 | 83121 | 5254 | 84196 | 3723 | 99880 | 3506 | 42152 |
| 14-#18 | 2.65 | MA | 56706 | 11272 | 92029 | 8301 | 102396 | 6702 | 107927 | 5483 | 115316 | 3653 | 140451 | 3362 | 80517 |
| 2L-7S | | MI | 44128 | 11272 | 71485 | 8303 | 77031 | 6738 | 78253 | 5505 | 77696 | 3688 | 92998 | 2378 | 66714 |
| 14-#18 | 2.65 | MA | 54307 | 11272 | 88420 | 8294 | 97770 | 6736 | 102283 | 5513 | 107637 | 3677 | 130133 | 3141 | 80373 |
| 3L-6S | | MI | 45392 | 11272 | 73855 | 8267 | 79890 | 6706 | 81768 | 5477 | 82391 | 3666 | 99354 | 2609 | 69006 |
| 14-#18 | 2.65 | MA | 52627 | 11272 | 85480 | 8332 | 94022 | 6726 | 97729 | 5500 | 101776 | 3701 | 123418 | 2919 | 79991 |
| 4L-5S | | MI | 46689 | 11272 | 76019 | 8275 | 82886 | 6718 | 85428 | 5492 | 87195 | 3644 | 105307 | 2753 | 70747 |
| 14-#18 | 2.65 | MA | 51128 | 11272 | 82938 | 8325 | 90725 | 6760 | 93677 | 5531 | 95908 | 3681 | 116399 | 2813 | 77815 |
| 5L-4S | | MI | 48053 | 11272 | 78326 | 8283 | 85877 | 6686 | 89103 | 5464 | 92496 | 3666 | 111602 | 2856 | 72712 |
| 14-#18 | 2.65 | MA | 49702 | 11272 | 80554 | 8318 | 87424 | 6750 | 89642 | 5517 | 90590 | 3705 | 109732 | 2670 | 75786 |
| 6L-3S | | MI | 49577 | 11272 | 80991 | 8248 | 89273 | 6698 | 93231 | 5480 | 97788 | 3644 | 117590 | 3077 | 73016 |
| 14-#18 | 2.65 | MA | 48312 | 11272 | 77943 | 8356 | 84274 | 6785 | 85769 | 5548 | 85394 | 3729 | 102618 | 2439 | 73211 |
| 7L-2S | | MI | 51744 | 11272 | 84254 | 8256 | 93456 | 6665 | 98333 | 5451 | 104712 | 3622 | 126812 | 3299 | 73121 |
| 16-#11 | 1.18 | MA | 50394 | 10198 | 77901 | 7697 | 84733 | 6276 | 86551 | 5237 | 86306 | 3775 | 102077 | 3600 | 37041 |
| 2L-8S | | MI | 42472 | 10198 | 65564 | 7679 | 69848 | 6275 | 69725 | 5250 | 65938 | 3780 | 76570 | 3155 | 33267 |
| 16-#11 | 1.18 | MA | 49413 | 10198 | 76465 | 7695 | 82893 | 6273 | 84306 | 5250 | 83250 | 3786 | 97902 | 3514 | 37075 |
| 3L-7S | | MI | 42987 | 10198 | 66408 | 7681 | 70997 | 6261 | 71085 | 5238 | 67924 | 3787 | 78948 | 3204 | 33676 |
| 16-#11 | 1.18 | MA | 48728 | 10198 | 75299 | 7711 | 81406 | 6287 | 82499 | 5246 | 80926 | 3797 | 95176 | 3427 | 37101 |
| 4L-6S | | MI | 43502 | 10198 | 67347 | 7666 | 72130 | 6264 | 72478 | 5225 | 69793 | 3777 | 81532 | 3294 | 33834 |
| 16-#11 | 1.18 | MA | 48117 | 10198 | 74293 | 7709 | 80101 | 6284 | 80895 | 5259 | 78600 | 3790 | 92350 | 3384 | 37103 |
| 5E | | MI | 44031 | 10198 | 68204 | 7668 | 73318 | 6250 | 73929 | 5230 | 71707 | 3767 | 83954 | 3350 | 33850 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

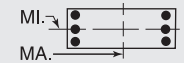



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.18 | MA | 47536 | 10198 | 73350 | 7707 | 78794 | 6299 | 79297 | 5255 | 76495 | 3801 | 89648 | 3329 | 37062 |
| 6L-4S | | MI | 44587 | 10198 | 69119 | 7671 | 74504 | 6254 | 75387 | 5217 | 73819 | 3774 | 86498 | 3392 | 33830 |
| 16-#11 | 1.18 | MA | 46969 | 10198 | 72317 | 7723 | 77548 | 6296 | 77765 | 5268 | 74439 | 3812 | 86768 | 3239 | 36854 |
| 7L-3S | | MI | 45209 | 10198 | 70177 | 7656 | 75853 | 6240 | 77027 | 5222 | 75929 | 3764 | 88939 | 3478 | 33796 |
| 16-#11 | 1.18 | MA | 46402 | 10198 | 71389 | 7721 | 76284 | 6310 | 76269 | 5282 | 72252 | 3806 | 84125 | 3189 | 36374 |
| 8L-2S | | MI | 46097 | 10198 | 71479 | 7658 | 77521 | 6244 | 79062 | 5210 | 78697 | 3754 | 92686 | 3565 | 33757 |
| 16-#14 | 1.70 | MA | 52718 | 10580 | 82993 | 7913 | 91109 | 6429 | 94271 | 5325 | 96784 | 3732 | 116116 | 3524 | 52748 |
| 2L-8S | | MI | 43048 | 10580 | 67609 | 7900 | 72281 | 6436 | 72648 | 5351 | 69868 | 3742 | 82273 | 2891 | 46098 |
| 16-#14 | 1.70 | MA | 51327 | 10580 | 80935 | 7910 | 88472 | 6424 | 91054 | 5344 | 92407 | 3747 | 110167 | 3400 | 52762 |
| 3L-7S | | MI | 43768 | 10580 | 68820 | 7903 | 73930 | 6417 | 74598 | 5334 | 72717 | 3753 | 85663 | 2961 | 46637 |
| 16-#14 | 1.70 | MA | 50355 | 10580 | 79263 | 7932 | 86340 | 6444 | 88463 | 5337 | 89073 | 3762 | 106287 | 3275 | 52717 |
| 4L-6S | | MI | 44500 | 10580 | 70167 | 7882 | 75555 | 6422 | 76597 | 5316 | 75398 | 3740 | 89339 | 3091 | 47397 |
| 16-#14 | 1.70 | MA | 49487 | 10580 | 77819 | 7929 | 84467 | 6440 | 86161 | 5356 | 85737 | 3753 | 102254 | 3214 | 52595 |
| 5E | | MI | 45251 | 10580 | 71397 | 7886 | 77259 | 6403 | 78679 | 5324 | 78142 | 3726 | 92784 | 3171 | 47923 |
| 16-#14 | 1.70 | MA | 48662 | 10580 | 76465 | 7926 | 82591 | 6460 | 83868 | 5349 | 82715 | 3768 | 98406 | 3134 | 51990 |
| 6L-4S | | MI | 46040 | 10580 | 72709 | 7890 | 78961 | 6409 | 80770 | 5306 | 81171 | 3737 | 96410 | 3231 | 48007 |
| 16-#14 | 1.70 | MA | 47859 | 10580 | 74982 | 7948 | 80802 | 6455 | 81668 | 5368 | 79763 | 3783 | 94303 | 3004 | 51102 |
| 7L-3S | | MI | 46922 | 10580 | 74226 | 7868 | 80895 | 6389 | 83121 | 5314 | 84196 | 3724 | 99880 | 3356 | 48031 |
| 16-#14 | 1.70 | MA | 47067 | 10580 | 73650 | 7945 | 78988 | 6475 | 79521 | 5386 | 76626 | 3773 | 90531 | 2932 | 50463 |
| 8L-2S | | MI | 48180 | 10580 | 76089 | 7872 | 83283 | 6395 | 86034 | 5297 | 88160 | 3710 | 105211 | 3480 | 47996 |
| 16-#18 | 3.03 | MA | 55963 | 11548 | 92029 | 8467 | 102396 | 6861 | 107927 | 5589 | 115316 | 3655 | 140451 | 3095 | 91552 |
| 3L-7S | | MI | 45650 | 11548 | 74748 | 8476 | 81214 | 6862 | 83356 | 5581 | 84619 | 3665 | 102220 | 2326 | 76386 |
| 16-#18 | 3.03 | MA | 54294 | 11548 | 89089 | 8504 | 98649 | 6850 | 103372 | 5575 | 109454 | 3679 | 133737 | 2874 | 91106 |
| 4L-6S | | MI | 46905 | 11548 | 77118 | 8440 | 84073 | 6830 | 86870 | 5552 | 89314 | 3643 | 108576 | 2557 | 78857 |
| 16-#18 | 3.03 | MA | 52805 | 11548 | 86546 | 8498 | 95352 | 6885 | 99321 | 5606 | 103586 | 3659 | 126717 | 2768 | 88640 |
| 5E | | MI | 48194 | 11548 | 79282 | 8448 | 87069 | 6842 | 90531 | 5568 | 94118 | 3621 | 114528 | 2702 | 80518 |
| 16-#18 | 3.03 | MA | 51389 | 11548 | 84163 | 8491 | 92050 | 6875 | 95286 | 5592 | 98269 | 3683 | 120050 | 2624 | 86697 |
| 6L-4S | | MI | 49548 | 11548 | 81589 | 8456 | 90060 | 6810 | 94206 | 5539 | 99420 | 3643 | 120824 | 2805 | 82764 |
| 16-#18 | 3.03 | MA | 50009 | 11548 | 81552 | 8529 | 88900 | 6909 | 91413 | 5623 | 93073 | 3706 | 112936 | 2393 | 83945 |
| 7L-3S | | MI | 51063 | 11548 | 84254 | 8420 | 93456 | 6822 | 98333 | 5555 | 104712 | 3621 | 126812 | 3026 | 83129 |
| 16-#18 | 3.03 | MA | 48651 | 11548 | 79206 | 8522 | 85705 | 6899 | 87633 | 5654 | 87551 | 3686 | 106373 | 2269 | 81370 |
| 8L-2S | | MI | 53218 | 11548 | 87516 | 8429 | 97639 | 6789 | 103436 | 5527 | 111635 | 3599 | 136034 | 3248 | 83283 |
| 18-#11 | 1.33 | MA | 51079 | 10306 | 79337 | 7764 | 86574 | 6324 | 88797 | 5266 | 89361 | 3766 | 106252 | 3585 | 41548 |
| 2L-9S | | MI | 42581 | 10306 | 66040 | 7744 | 70398 | 6319 | 70338 | 5275 | 66854 | 3781 | 77967 | 3085 | 36948 |
| 18-#11 | 1.33 | MA | 50100 | 10306 | 77901 | 7762 | 84733 | 6321 | 86551 | 5279 | 86306 | 3777 | 102077 | 3499 | 41576 |
| 3L-8S | | MI | 43106 | 10306 | 66865 | 7746 | 71516 | 6323 | 71760 | 5280 | 68706 | 3771 | 80316 | 3139 | 37235 |
| 18-#11 | 1.33 | MA | 49417 | 10306 | 76735 | 7778 | 83247 | 6336 | 84745 | 5275 | 83981 | 3788 | 99351 | 3413 | 41593 |
| 4L-7S | | MI | 43612 | 10306 | 67709 | 7749 | 72665 | 6309 | 73119 | 5267 | 70693 | 3778 | 82695 | 3188 | 37628 |
| 18-#11 | 1.33 | MA | 48808 | 10306 | 75729 | 7776 | 81942 | 6333 | 83140 | 5289 | 81656 | 3782 | 96525 | 3370 | 41574 |
| 5L-6S | | MI | 44126 | 10306 | 68648 | 7734 | 73798 | 6313 | 74513 | 5255 | 72562 | 3768 | 85278 | 3278 | 37878 |
| 18-#11 | 1.33 | MA | 48229 | 10306 | 74786 | 7775 | 80635 | 6347 | 81543 | 5285 | 79551 | 3793 | 93823 | 3314 | 41518 |
| 6L-5S | | MI | 44653 | 10306 | 69505 | 7736 | 74985 | 6299 | 75964 | 5259 | 74475 | 3758 | 87701 | 3334 | 37910 |
| 18-#11 | 1.33 | MA | 47665 | 10306 | 73753 | 7790 | 79389 | 6344 | 80010 | 5298 | 77494 | 3804 | 90943 | 3224 | 41216 |
| 7L-4S | | MI | 45207 | 10306 | 70420 | 7738 | 76172 | 6302 | 77422 | 5247 | 76587 | 3765 | 90244 | 3376 | 37906 |
| 18-#11 | 1.33 | MA | 47101 | 10306 | 72825 | 7788 | 78125 | 6359 | 78515 | 5311 | 75308 | 3798 | 88300 | 3174 | 40755 |
| 8L-3S | | MI | 45828 | 10306 | 71479 | 7723 | 77521 | 6289 | 79062 | 5251 | 78697 | 3755 | 92686 | 3462 | 37880 |
| 18-#11 | 1.33 | MA | 46513 | 10306 | 71918 | 7787 | 76895 | 6356 | 76950 | 5307 | 73270 | 3809 | 85680 | 3121 | 40409 |
| 9L-2S | | MI | 46713 | 10306 | 72780 | 7725 | 79189 | 6292 | 81097 | 5239 | 81466 | 3745 | 96432 | 3548 | 37847 |
| 18-#14 | 1.92 | MA | 53682 | 10736 | 85050 | 8010 | 93747 | 6498 | 97489 | 5368 | 101162 | 3720 | 122064 | 3502 | 59192 |
| 2L-9S | | MI | 43202 | 10736 | 68168 | 8018 | 73066 | 6500 | 73521 | 5386 | 71174 | 3743 | 84264 | 2788 | 50646 |
| 18-#14 | 1.92 | MA | 52295 | 10736 | 82993 | 8007 | 91109 | 6494 | 94271 | 5386 | 96784 | 3735 | 116116 | 3377 | 59174 |
| 3L-8S | | MI | 43935 | 10736 | 69472 | 7997 | 74669 | 6506 | 75561 | 5394 | 73831 | 3730 | 87604 | 2865 | 51769 |
| 18-#14 | 1.92 | MA | 51327 | 10736 | 81320 | 8029 | 88978 | 6514 | 91681 | 5380 | 93450 | 3750 | 112236 | 3253 | 59106 |
| 4L-7S | | MI | 44653 | 10736 | 70682 | 8001 | 76318 | 6487 | 77512 | 5376 | 76681 | 3741 | 90994 | 2935 | 52295 |
| 18-#14 | 1.92 | MA | 50464 | 10736 | 79876 | 8026 | 87104 | 6509 | 89378 | 5398 | 90114 | 3740 | 108203 | 3192 | 58958 |
| 5L-6S | | MI | 45381 | 10736 | 72030 | 7979 | 77943 | 6492 | 79510 | 5359 | 79362 | 3727 | 94670 | 3065 | 53024 |
| 18-#14 | 1.92 | MA | 49643 | 10736 | 78522 | 8023 | 85229 | 6530 | 87085 | 5392 | 87093 | 3755 | 104355 | 3111 | 58210 |
| 6L-5S | | MI | 46129 | 10736 | 73260 | 7983 | 79647 | 6473 | 81592 | 5366 | 82106 | 3714 | 98115 | 3146 | 53690 |
| 18-#14 | 1.92 | MA | 48843 | 10736 | 77039 | 8045 | 83440 | 6525 | 84886 | 5410 | 84141 | 3770 | 100252 | 2982 | 57356 |
| 7L-4S | | MI | 46914 | 10736 | 74572 | 7987 | 81349 | 6478 | 83683 | 5349 | 85135 | 3725 | 101741 | 3206 | 53799 |

## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

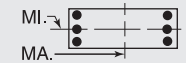
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#14 | 1.92 | MA | 48055 | 10736 | 75708 | 8043 | 81625 | 6545 | 82739 | 5429 | 81004 | 3760 | 96480 | 2910 | 56732 |
| 8L-3S | | MI | 47793 | 10736 | 76089 | 7966 | 83283 | 6459 | 86034 | 5356 | 88160 | 3711 | 105211 | 3330 | 53843 |
| 18-#14 | 1.92 | MA | 47220 | 10736 | 74404 | 8040 | 79860 | 6541 | 80493 | 5422 | 78079 | 3775 | 92749 | 2833 | 55456 |
| 9L-2S | | MI | 49047 | 10736 | 77952 | 7969 | 85671 | 6465 | 88947 | 5339 | 92123 | 3698 | 110542 | 3455 | 53832 |
| 18-#18 | 3.41 | MA | 55948 | 11825 | 92698 | 8677 | 103275 | 6975 | 109016 | 5651 | 117133 | 3657 | 144055 | 2828 | 102215 |
| 4L-7S | | MI | 47160 | 11825 | 78011 | 8649 | 85397 | 6986 | 88459 | 5656 | 91542 | 3642 | 111442 | 2275 | 86081 |
| 18-#18 | 3.41 | MA | 54469 | 11825 | 90155 | 8671 | 99978 | 7009 | 104964 | 5681 | 111265 | 3636 | 137036 | 2722 | 99490 |
| 5L-6S | | MI | 48407 | 11825 | 80381 | 8613 | 88256 | 6954 | 91973 | 5628 | 96237 | 3620 | 117798 | 2506 | 88722 |
| 18-#18 | 3.41 | MA | 53062 | 11825 | 87772 | 8664 | 96676 | 6999 | 100929 | 5668 | 105947 | 3660 | 130368 | 2578 | 97624 |
| 6L-5S | | MI | 49688 | 11825 | 82545 | 8621 | 91252 | 6966 | 95634 | 5643 | 101042 | 3597 | 123750 | 2650 | 90312 |
| 18-#18 | 3.41 | MA | 51693 | 11825 | 85161 | 8702 | 93527 | 7033 | 97057 | 5699 | 100752 | 3684 | 123254 | 2348 | 94702 |
| 7L-4S | | MI | 51033 | 11825 | 84851 | 8629 | 94242 | 6934 | 99309 | 5615 | 106343 | 3620 | 130046 | 2753 | 92808 |
| 18-#18 | 3.41 | MA | 50344 | 11825 | 82814 | 8695 | 90332 | 7023 | 93276 | 5729 | 95230 | 3664 | 116691 | 2223 | 92206 |
| 8L-3S | | MI | 52539 | 11825 | 87516 | 8593 | 97639 | 6946 | 103436 | 5630 | 111635 | 3597 | 136034 | 2975 | 93229 |
| 20-#11 | 1.48 | MA | 51761 | 10414 | 80773 | 7832 | 88415 | 6372 | 91043 | 5296 | 92417 | 3758 | 110427 | 3571 | 46049 |
| 2L-10S | | MI | 42651 | 10414 | 66417 | 7827 | 70932 | 6382 | 71020 | 5317 | 67786 | 3782 | 79438 | 3007 | 40459 |
| 20-#11 | 1.48 | MA | 50785 | 10414 | 79337 | 7830 | 86574 | 6370 | 88797 | 5309 | 89361 | 3769 | 106252 | 3485 | 46071 |
| 3L-9S | | MI | 43208 | 10414 | 67341 | 7812 | 72066 | 6368 | 72373 | 5304 | 69623 | 3772 | 81714 | 3068 | 40926 |
| 20-#11 | 1.48 | MA | 50104 | 10414 | 78171 | 7845 | 85088 | 6384 | 86991 | 5305 | 87037 | 3779 | 103526 | 3398 | 46073 |
| 4L-8S | | MI | 43731 | 10414 | 68167 | 7814 | 73184 | 6371 | 73795 | 5309 | 71475 | 3762 | 84063 | 3122 | 41207 |
| 20-#11 | 1.48 | MA | 49497 | 10414 | 77165 | 7844 | 83783 | 6381 | 85386 | 5318 | 84711 | 3773 | 100700 | 3355 | 46041 |
| 5L-7S | | MI | 44235 | 10414 | 69010 | 7816 | 74333 | 6358 | 75154 | 5296 | 73461 | 3770 | 86441 | 3171 | 41585 |
| 20-#11 | 1.48 | MA | 48920 | 10414 | 76222 | 7842 | 82476 | 6396 | 83789 | 5314 | 82606 | 3784 | 97998 | 3300 | 45971 |
| 6E | | MI | 44747 | 10414 | 69949 | 7801 | 75466 | 6361 | 76547 | 5284 | 75330 | 3760 | 89025 | 3261 | 41917 |
| 20-#11 | 1.48 | MA | 48357 | 10414 | 75189 | 7857 | 81229 | 6393 | 82256 | 5327 | 80549 | 3795 | 95118 | 3210 | 45585 |
| 7L-5S | | MI | 45273 | 10414 | 70807 | 7803 | 76653 | 6347 | 77999 | 5289 | 77244 | 3750 | 91448 | 3317 | 41963 |
| 20-#11 | 1.48 | MA | 47797 | 10414 | 74261 | 7856 | 79965 | 6407 | 80760 | 5341 | 78363 | 3789 | 92475 | 3160 | 45139 |
| 8L-4S | | MI | 45825 | 10414 | 71721 | 7806 | 77840 | 6351 | 79457 | 5276 | 79356 | 3757 | 93991 | 3359 | 41976 |
| 20-#11 | 1.48 | MA | 47210 | 10414 | 73354 | 7854 | 78736 | 6404 | 79196 | 5337 | 76326 | 3800 | 89855 | 3106 | 44800 |
| 9L-3S | | MI | 46444 | 10414 | 72780 | 7791 | 79189 | 6337 | 81097 | 5281 | 81466 | 3747 | 96432 | 3446 | 41959 |
| 20-#11 | 1.48 | MA | 46598 | 10414 | 72337 | 7870 | 77489 | 6419 | 77708 | 5350 | 74306 | 3811 | 87315 | 3045 | 44253 |
| 10L-2S | | MI | 47327 | 10414 | 74081 | 7793 | 80857 | 6340 | 83131 | 5268 | 84234 | 3737 | 100179 | 3532 | 41932 |
| 20-#14 | 2.13 | MA | 53259 | 10891 | 85050 | 8105 | 93747 | 6564 | 97489 | 5428 | 101162 | 3722 | 122064 | 3355 | 65578 |
| 3L-9S | | MI | 44089 | 10891 | 70031 | 8115 | 75454 | 6570 | 76434 | 5429 | 75138 | 3731 | 89595 | 2762 | 56246 |
| 20-#14 | 2.13 | MA | 52295 | 10891 | 83378 | 8127 | 91615 | 6584 | 94898 | 5422 | 97828 | 3737 | 118185 | 3230 | 65489 |
| 4L-8S | | MI | 44818 | 10891 | 71335 | 8094 | 77057 | 6576 | 78474 | 5436 | 77795 | 3717 | 92936 | 2840 | 57378 |
| 20-#14 | 2.13 | MA | 51436 | 10891 | 81933 | 8124 | 89742 | 6579 | 92595 | 5441 | 94492 | 3728 | 114152 | 3169 | 65318 |
| 5L-7S | | MI | 45532 | 10891 | 72545 | 8098 | 78706 | 6556 | 80425 | 5419 | 80644 | 3729 | 96326 | 2910 | 57959 |
| 20-#14 | 2.13 | MA | 50618 | 10891 | 80580 | 8121 | 87866 | 6599 | 90303 | 5434 | 91470 | 3743 | 110304 | 3089 | 64441 |
| 6E | | MI | 46258 | 10891 | 73893 | 8077 | 80331 | 6562 | 82423 | 5401 | 83326 | 3715 | 100001 | 3040 | 58661 |
| 20-#14 | 2.13 | MA | 49822 | 10891 | 79097 | 8143 | 86077 | 6595 | 88103 | 5453 | 88519 | 3758 | 106201 | 2959 | 63616 |
| 7L-5S | | MI | 47002 | 10891 | 75123 | 8080 | 82035 | 6543 | 84506 | 5409 | 86070 | 3701 | 103447 | 3121 | 59452 |
| 20-#14 | 2.13 | MA | 49037 | 10891 | 77765 | 8140 | 84263 | 6615 | 85956 | 5471 | 85381 | 3748 | 102429 | 2887 | 62956 |
| 8L-4S | | MI | 47784 | 10891 | 76435 | 8084 | 83737 | 6548 | 86597 | 5391 | 89098 | 3713 | 107072 | 3180 | 59583 |
| 20-#14 | 2.13 | MA | 48207 | 10891 | 76462 | 8137 | 82498 | 6610 | 83711 | 5465 | 82457 | 3763 | 98698 | 2810 | 61653 |
| 9L-3S | | MI | 48660 | 10891 | 77952 | 8063 | 85671 | 6529 | 88947 | 5399 | 92123 | 3699 | 110542 | 3305 | 59647 |
| 20-#14 | 2.13 | MA | 47340 | 10891 | 75003 | 8159 | 80708 | 6631 | 81575 | 5483 | 79557 | 3778 | 95081 | 2722 | 60657 |
| 10L-2S | | MI | 49909 | 10891 | 79815 | 8067 | 88059 | 6535 | 91860 | 5381 | 96087 | 3685 | 115873 | 3429 | 59666 |
| 20-#18 | 3.79 | MA | 56121 | 12101 | 93764 | 8844 | 104604 | 7133 | 110608 | 5757 | 118944 | 3614 | 147354 | 2677 | 110360 |
| 5L-7S | | MI | 48660 | 12101 | 81274 | 8822 | 89580 | 7111 | 93561 | 5732 | 98465 | 3619 | 120664 | 2224 | 95797 |
| 20-#18 | 3.79 | MA | 54724 | 12101 | 91380 | 8837 | 101303 | 7123 | 106573 | 5743 | 113626 | 3638 | 140687 | 2533 | 108562 |
| 6E | | MI | 49899 | 12101 | 83644 | 8786 | 92439 | 7078 | 97076 | 5703 | 103160 | 3596 | 127020 | 2455 | 98599 |
| 20-#18 | 3.79 | MA | 53363 | 12101 | 88769 | 8874 | 98153 | 7157 | 102700 | 5774 | 108430 | 3662 | 133572 | 2302 | 105479 |
| 7L-5S | | MI | 51171 | 12101 | 85807 | 8794 | 95434 | 7090 | 100737 | 5719 | 107965 | 3574 | 132972 | 2599 | 100127 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.


## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis

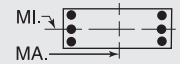


$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips


| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#18 | 3.79 | MA | 52024 | 12101 | 86423 | 8868 | 94958 | 7147 | 98920 | 5805 | 102909 | 3642 | 127009 | 2178 | 102861 |
| 8L-4S | | MI | 52508 | 12101 | 88114 | 8802 | 98425 | 7058 | 104412 | 5690 | 113266 | 3596 | 139268 | 2702 | 102845 |
| 22-#11 | 1.63 | MA | 52440 | 10522 | 82209 | 7899 | 90256 | 6421 | 93288 | 5325 | 95472 | 3749 | 114602 | 3556 | 50547 |
| 2L-11S | | MI | 42736 | 10522 | 66891 | 7892 | 71488 | 6427 | 71651 | 5341 | 68597 | 3767 | 80865 | 2939 | 43865 |
| 22-#11 | 1.63 | MA | 51467 | 10522 | 80773 | 7897 | 88415 | 6418 | 91043 | 5338 | 92417 | 3760 | 110427 | 3470 | 50561 |
| 3L-10S | | MI | 43277 | 10522 | 67718 | 7894 | 72600 | 6430 | 73055 | 5346 | 70555 | 3774 | 83184 | 2991 | 44385 |
| 22-#11 | 1.63 | MA | 50788 | 10522 | 79607 | 7913 | 86929 | 6432 | 89236 | 5334 | 90092 | 3771 | 107701 | 3384 | 50547 |
| 4L-9S | | MI | 43832 | 10522 | 68642 | 7879 | 73734 | 6416 | 74407 | 5334 | 72391 | 3764 | 85461 | 3052 | 44905 |
| 22-#11 | 1.63 | MA | 50183 | 10522 | 78601 | 7911 | 85623 | 6430 | 87632 | 5347 | 87767 | 3765 | 104876 | 3341 | 50503 |
| 5L-8S | | MI | 44353 | 10522 | 69468 | 7881 | 74852 | 6420 | 75829 | 5338 | 74243 | 3754 | 87810 | 3106 | 45182 |
| 22-#11 | 1.63 | MA | 49608 | 10522 | 77658 | 7909 | 84317 | 6444 | 86034 | 5343 | 85661 | 3776 | 102173 | 3285 | 50419 |
| 6L-7S | | MI | 44856 | 10522 | 70311 | 7884 | 76001 | 6406 | 77189 | 5326 | 76230 | 3761 | 90188 | 3155 | 45548 |
| 22-#11 | 1.63 | MA | 49047 | 10522 | 76625 | 7925 | 83070 | 6441 | 84502 | 5357 | 83605 | 3787 | 99293 | 3195 | 49959 |
| 7L-6S | | MI | 45366 | 10522 | 71250 | 7868 | 77134 | 6409 | 78582 | 5313 | 78099 | 3751 | 92772 | 3245 | 45953 |
| 22-#11 | 1.63 | MA | 48491 | 10522 | 75697 | 7923 | 81806 | 6455 | 83006 | 5370 | 81419 | 3780 | 96650 | 3145 | 49526 |
| 8L-5S | | MI | 45890 | 10522 | 72108 | 7871 | 78321 | 6396 | 80034 | 5318 | 80012 | 3741 | 95194 | 3301 | 46011 |
| 22-#11 | 1.63 | MA | 47904 | 10522 | 74790 | 7921 | 80577 | 6453 | 81442 | 5366 | 79381 | 3791 | 94030 | 3091 | 49193 |
| 9L-4S | | MI | 46441 | 10522 | 73022 | 7873 | 79508 | 6399 | 81492 | 5306 | 82124 | 3748 | 97738 | 3343 | 46038 |
| 22-#11 | 1.63 | MA | 47294 | 10522 | 73773 | 7937 | 79330 | 6467 | 79954 | 5379 | 77361 | 3802 | 91490 | 3031 | 48593 |
| 10L-3S | | MI | 47057 | 10522 | 74081 | 7858 | 80857 | 6385 | 83131 | 5310 | 84234 | 3738 | 100179 | 3429 | 46033 |
| 22-#11 | 1.63 | MA | 46698 | 10522 | 72864 | 7935 | 78107 | 6464 | 78410 | 5375 | 75206 | 3796 | 88912 | 2978 | 47988 |
| 11L-2S | | MI | 47938 | 10522 | 75382 | 7860 | 82525 | 6389 | 85166 | 5298 | 87003 | 3728 | 103926 | 3515 | 46012 |
| 22-#14 | 2.34 | MA | 53258 | 11047 | 85435 | 8224 | 94252 | 6654 | 98116 | 5465 | 102205 | 3725 | 124134 | 3208 | 71867 |
| 4L-9S | | MI | 44971 | 11047 | 71894 | 8213 | 77842 | 6640 | 79348 | 5471 | 79102 | 3718 | 94926 | 2737 | 61854 |
| 22-#14 | 2.34 | MA | 52402 | 11047 | 83990 | 8221 | 92379 | 6649 | 95813 | 5483 | 98869 | 3715 | 120101 | 3147 | 71673 |
| 5L-8S | | MI | 45696 | 11047 | 73197 | 8191 | 79445 | 6646 | 81387 | 5478 | 81759 | 3705 | 98267 | 2814 | 62952 |
| 22-#14 | 2.34 | MA | 51588 | 11047 | 82637 | 8218 | 90503 | 6669 | 93520 | 5477 | 95848 | 3730 | 116252 | 3066 | 70680 |
| 6L-7S | | MI | 46408 | 11047 | 74408 | 8195 | 81094 | 6626 | 83338 | 5461 | 84608 | 3716 | 101657 | 2885 | 63629 |
| 22-#14 | 2.34 | MA | 50795 | 11047 | 81154 | 8240 | 88714 | 6665 | 91320 | 5495 | 92896 | 3745 | 112150 | 2937 | 69882 |
| 7L-6S | | MI | 47130 | 11047 | 75756 | 8174 | 82719 | 6632 | 85337 | 5444 | 87289 | 3703 | 105333 | 3014 | 64307 |
| 22-#14 | 2.34 | MA | 50014 | 11047 | 79822 | 8237 | 86900 | 6685 | 89174 | 5514 | 89759 | 3736 | 108378 | 2865 | 69126 |
| 8L-5S | | MI | 47871 | 11047 | 76985 | 8178 | 84423 | 6613 | 87419 | 5451 | 90033 | 3689 | 108778 | 3095 | 65209 |
| 22-#14 | 2.34 | MA | 49188 | 11047 | 78519 | 8234 | 85135 | 6680 | 86928 | 5507 | 86834 | 3751 | 104647 | 2788 | 67859 |
| 9L-4S | | MI | 48650 | 11047 | 78297 | 8181 | 86125 | 6618 | 89510 | 5434 | 93062 | 3700 | 112404 | 3155 | 65362 |
| 22-#14 | 2.34 | MA | 48324 | 11047 | 77060 | 8256 | 83345 | 6700 | 84793 | 5526 | 83935 | 3766 | 101030 | 2700 | 66818 |
| 10L-3S | | MI | 49522 | 11047 | 79815 | 8160 | 88059 | 6599 | 91860 | 5441 | 96087 | 3687 | 115873 | 3279 | 65444 |
| 22-#18 | 4.17 | MA | 56374 | 12378 | 94989 | 9010 | 105929 | 7247 | 112217 | 5819 | 121305 | 3616 | 151005 | 2487 | 119512 |
| 6L-7S | | MI | 50149 | 12378 | 84536 | 8995 | 93763 | 7235 | 98664 | 5807 | 105388 | 3595 | 129886 | 2172 | 105532 |
| 22-#18 | 4.17 | MA | 55022 | 12378 | 92378 | 9047 | 102779 | 7281 | 108344 | 5849 | 116109 | 3640 | 143891 | 2256 | 116274 |
| 7L-6S | | MI | 51381 | 12378 | 86907 | 8959 | 96622 | 7203 | 102179 | 5778 | 110083 | 3573 | 136242 | 2403 | 108486 |
| 22-#18 | 4.17 | MA | 53692 | 12378 | 90032 | 9041 | 99584 | 7271 | 104564 | 5880 | 110587 | 3620 | 137328 | 2132 | 113535 |
| 8L-5S | | MI | 52645 | 12378 | 89070 | 8967 | 99617 | 7214 | 105840 | 5794 | 114888 | 3551 | 142194 | 2548 | 109959 |
| 24-#11 | 1.77 | MA | 52146 | 10630 | 82209 | 7965 | 90256 | 6466 | 93288 | 5368 | 95472 | 3751 | 114602 | 3455 | 55042 |
| 3L-11S | | MI | 43360 | 10630 | 68192 | 7959 | 73156 | 6475 | 73686 | 5371 | 71365 | 3758 | 84612 | 2922 | 47808 |
| 24-#11 | 1.77 | MA | 51470 | 10630 | 81043 | 7980 | 88770 | 6481 | 91482 | 5364 | 93148 | 3762 | 111876 | 3369 | 55017 |
| 4L-10S | | MI | 43901 | 10630 | 69019 | 7961 | 74268 | 6478 | 75090 | 5376 | 73323 | 3765 | 86931 | 2975 | 48317 |
| 24-#11 | 1.77 | MA | 50867 | 10630 | 80037 | 7979 | 87464 | 6478 | 89877 | 5377 | 90822 | 3756 | 109051 | 3326 | 54961 |
| 5L-9S | | MI | 44454 | 10630 | 69943 | 7946 | 75402 | 6465 | 76442 | 5363 | 75160 | 3755 | 89207 | 3036 | 48887 |
| 24-#11 | 1.77 | MA | 50293 | 10630 | 79094 | 7977 | 86157 | 6492 | 88280 | 5373 | 88717 | 3767 | 106348 | 3270 | 54865 |
| 6L-8S | | MI | 44973 | 10630 | 70769 | 7949 | 76520 | 6468 | 77864 | 5368 | 77012 | 3745 | 91556 | 3089 | 49160 |
| 24-#11 | 1.77 | MA | 49735 | 10630 | 78061 | 7992 | 84911 | 6489 | 86747 | 5386 | 86660 | 3778 | 103468 | 3181 | 54337 |
| 7E | | MI | 45474 | 10630 | 71612 | 7951 | 77669 | 6454 | 79224 | 5355 | 78998 | 3752 | 93935 | 3139 | 49514 |
| 24-#11 | 1.77 | MA | 49184 | 10630 | 77133 | 7991 | 83647 | 6504 | 85252 | 5399 | 84474 | 3772 | 100825 | 3130 | 53917 |
| 8L-6S | | MI | 45983 | 10630 | 72552 | 7936 | 78802 | 6458 | 80617 | 5343 | 80867 | 3742 | 96518 | 3228 | 49985 |
| 24-#11 | 1.77 | MA | 48595 | 10630 | 76225 | 7989 | 82418 | 6501 | 83687 | 5395 | 82437 | 3783 | 98205 | 3077 | 53588 |
| 9L-5S | | MI | 46505 | 10630 | 73409 | 7938 | 79989 | 6444 | 82069 | 5348 | 82781 | 3732 | 98941 | 3284 | 50055 |
| 24-#11 | 1.77 | MA | 47987 | 10630 | 75209 | 8004 | 81171 | 6515 | 82200 | 5409 | 80417 | 3794 | 95665 | 3016 | 52938 |
| 10L-4S | | MI | 47054 | 10630 | 74323 | 7940 | 81176 | 6448 | 83526 | 5335 | 84893 | 3739 | 101484 | 3326 | 50092 |

## RECTANGULAR TIED COLUMNS 44" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 24-#11 | 1.77 | MA | 47393 | 10630 | 74300 | 8003 | 79948 | 6513 | 80656 | 5405 | 78262 | 3787 | 93087 | 2963 | 52346 |
| 11L-3S | | MI | 47669 | 10630 | 75382 | 7925 | 82525 | 6434 | 85166 | 5340 | 87003 | 3729 | 103926 | 3413 | 50102 |
| 24-#11 | 1.77 | MA | 46810 | 10630 | 73302 | 8018 | 78710 | 6527 | 79170 | 5418 | 76243 | 3798 | 90180 | 2886 | 51665 |
| 12L-2S | | MI | 48547 | 10630 | 76683 | 7928 | 84193 | 6437 | 87201 | 5327 | 89771 | 3719 | 107672 | 3499 | 50087 |
| 24-#14 | 2.56 | MA | 53364 | 11202 | 86048 | 8318 | 95016 | 6719 | 99030 | 5525 | 103247 | 3703 | 126049 | 3124 | 78026 |
| 5L-9S | | MI | 45849 | 11202 | 73756 | 8310 | 80230 | 6710 | 82261 | 5513 | 83065 | 3706 | 100258 | 2711 | 67468 |
| 24-#14 | 2.56 | MA | 52554 | 11202 | 84694 | 8315 | 93141 | 6739 | 96738 | 5519 | 100225 | 3718 | 122201 | 3044 | 76927 |
| 6L-8S | | MI | 46571 | 11202 | 75060 | 8289 | 81833 | 6715 | 84301 | 5521 | 85722 | 3692 | 103598 | 2789 | 68536 |
| 24-#14 | 2.56 | MA | 51764 | 11202 | 83211 | 8337 | 91352 | 6734 | 94538 | 5538 | 97274 | 3733 | 118098 | 2914 | 76153 |
| 7E | | MI | 47279 | 11202 | 76271 | 8292 | 83482 | 6696 | 86251 | 5503 | 88572 | 3704 | 106988 | 2859 | 69303 |
| 24-#14 | 2.56 | MA | 50987 | 11202 | 81879 | 8334 | 89537 | 6755 | 92391 | 5556 | 94136 | 3723 | 114327 | 2842 | 75306 |
| 8L-6S | | MI | 47998 | 11202 | 77618 | 8271 | 85108 | 6702 | 88250 | 5486 | 91253 | 3690 | 110664 | 2989 | 69959 |
| 24-#14 | 2.56 | MA | 50165 | 11202 | 80576 | 8331 | 87773 | 6750 | 90146 | 5550 | 91212 | 3738 | 110595 | 2765 | 74071 |
| 9L-5S | | MI | 48737 | 11202 | 78848 | 8275 | 86811 | 6682 | 90332 | 5494 | 93997 | 3677 | 114109 | 3070 | 70962 |
| 24-#14 | 2.56 | MA | 49304 | 11202 | 79117 | 8353 | 85982 | 6770 | 88010 | 5568 | 88312 | 3753 | 106979 | 2677 | 72966 |
| 10L-4S | | MI | 49512 | 11202 | 80160 | 8279 | 88513 | 6688 | 92423 | 5476 | 97026 | 3688 | 117735 | 3129 | 71136 |
| 24-#18 | 4.55 | MA | 56671 | 12655 | 95987 | 9220 | 107405 | 7405 | 113988 | 5925 | 123788 | 3618 | 154209 | 2211 | 127086 |
| 7E | | MI | 51629 | 12655 | 87799 | 9168 | 97946 | 7359 | 103767 | 5882 | 112311 | 3572 | 139108 | 2121 | 115283 |
| 24-#18 | 4.55 | MA | 55349 | 12655 | 93640 | 9214 | 104210 | 7395 | 110207 | 5956 | 118266 | 3598 | 147646 | 2086 | 124227 |
| 8L-6S | | MI | 52853 | 12655 | 90170 | 9132 | 100805 | 7327 | 107282 | 5854 | 117007 | 3550 | 145464 | 2352 | 118270 |

## RECTANGULAR TIED COLUMNS 46" x 46"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.13 | MA | 47951 | 10183 | 74521 | 7601 | 80436 | 6199 | 81762 | 5175 | 80951 | 3737 | 94674 | 3532 | 33747 |
| 2L-3S | | MI | 45610 | 10183 | 71085 | 7594 | 76031 | 6232 | 76388 | 5205 | 73641 | 3760 | 84904 | 3311 | 33874 |
| 8-#18 | 1.51 | MA | 49561 | 10459 | 77956 | 7774 | 84840 | 6323 | 87135 | 5251 | 88262 | 3715 | 104444 | 3484 | 44565 |
| 2L-4S | | MI | 45599 | 10459 | 71718 | 7803 | 76864 | 6345 | 77421 | 5266 | 75365 | 3760 | 88323 | 3041 | 44534 |
| 10-#14 | 1.06 | MA | 47757 | 10131 | 73783 | 7615 | 79785 | 6214 | 81081 | 5194 | 80072 | 3766 | 93867 | 3582 | 31904 |
| 2L-5S | | MI | 44638 | 10131 | 68849 | 7630 | 73452 | 6224 | 73349 | 5223 | 69540 | 3784 | 80723 | 3272 | 32019 |
| 10-#14 | 1.06 | MA | 46417 | 10131 | 71822 | 7612 | 77273 | 6209 | 78016 | 5212 | 75902 | 3781 | 88227 | 3457 | 31969 |
| 3L-4S | | MI | 45477 | 10131 | 70228 | 7633 | 75240 | 6229 | 75545 | 5205 | 72722 | 3795 | 84552 | 3333 | 32022 |
| 10-#18 | 1.89 | MA | 51156 | 10736 | 81392 | 7947 | 89245 | 6447 | 92508 | 5326 | 95573 | 3693 | 114214 | 3436 | 55345 |
| 2L-5S | | MI | 45769 | 10736 | 72729 | 7969 | 78124 | 6503 | 78931 | 5371 | 77081 | 3716 | 91436 | 2888 | 53796 |
| 10-#18 | 1.89 | MA | 48845 | 10736 | 77956 | 7939 | 84840 | 6481 | 87135 | 5356 | 88262 | 3716 | 104444 | 3214 | 55354 |
| 3L-4S | | MI | 47221 | 10736 | 75154 | 7976 | 81268 | 6470 | 82794 | 5341 | 82676 | 3738 | 98093 | 2993 | 55157 |

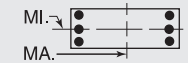
## RECTANGULAR TIED COLUMNS 46" x 48"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.09 | MA | 52047 | 10589 | 80629 | 7931 | 87074 | 6471 | 88462 | 5406 | 87400 | 3915 | 102279 | 3712 | 35367 |
| 2L-3S | | MI | 47482 | 10589 | 73877 | 7901 | 78954 | 6486 | 79242 | 5420 | 76207 | 3925 | 87746 | 3471 | 33934 |
| 6-#18 | 1.09 | MA | 49584 | 10589 | 77021 | 7925 | 82448 | 6505 | 82819 | 5437 | 79721 | 3939 | 91961 | 3491 | 35494 |
| 3L-2S | | MI | 49825 | 10589 | 77312 | 7909 | 83358 | 6452 | 84616 | 5390 | 83517 | 3903 | 97516 | 3692 | 33799 |
| 8-#18 | 1.45 | MA | 53747 | 10866 | 84238 | 8104 | 91700 | 6595 | 94106 | 5482 | 95078 | 3892 | 112598 | 3666 | 46725 |
| 2L-4S | | MI | 47471 | 10866 | 74510 | 8111 | 79786 | 6599 | 80275 | 5481 | 77931 | 3926 | 91165 | 3201 | 44640 |
| 8-#18 | 1.45 | MA | 51300 | 10866 | 80629 | 8098 | 87074 | 6629 | 88462 | 5512 | 87400 | 3916 | 102279 | 3445 | 46801 |
| 3E | | MI | 49109 | 10866 | 77312 | 8074 | 83358 | 6610 | 84616 | 5496 | 83517 | 3903 | 97516 | 3422 | 44710 |
| 8-#18 | 1.45 | MA | 49581 | 10866 | 77689 | 8135 | 83326 | 6619 | 83908 | 5499 | 81538 | 3940 | 95565 | 3224 | 46694 |
| 4L-2S | | MI | 51437 | 10866 | 80748 | 8082 | 87763 | 6576 | 89989 | 5466 | 90828 | 3880 | 107286 | 3644 | 44624 |
| 10-#14 | 1.02 | MA | 51837 | 10537 | 79845 | 7946 | 86379 | 6486 | 87734 | 5425 | 86459 | 3944 | 101384 | 3760 | 33422 |
| 2L-5S | | MI | 46509 | 10537 | 71631 | 7940 | 76375 | 6479 | 76207 | 5439 | 72114 | 3951 | 83578 | 3433 | 32090 |
| 10-#14 | 1.02 | MA | 50428 | 10537 | 77788 | 7943 | 83742 | 6481 | 84517 | 5443 | 82081 | 3959 | 95435 | 3636 | 33488 |
| 3L-4S | | MI | 47349 | 10537 | 73009 | 7943 | 78163 | 6484 | 78404 | 5421 | 75297 | 3961 | 87408 | 3494 | 32076 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.
(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

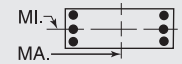



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 10-#14 | 1.02 | MA | 49442 | 10537 | 76115 | 7965 | 81611 | 6501 | 81926 | 5437 | 78747 | 3974 | 91555 | 3511 | 33541 |
| 4L-3S | | MI | 48289 | 10537 | 74604 | 7922 | 80195 | 6464 | 80875 | 5428 | 78476 | 3947 | 91082 | 3618 | 32016 |
| 10-#14 | 1.02 | MA | 48562 | 10537 | 74671 | 7962 | 79737 | 6497 | 79623 | 5455 | 75411 | 3964 | 87523 | 3450 | 33537 |
| 5L-2S | | MI | 49630 | 10537 | 76564 | 7925 | 82708 | 6469 | 83940 | 5410 | 82647 | 3933 | 96722 | 3743 | 31947 |
| 10-#18 | 1.81 | MA | 55431 | 11143 | 87847 | 8277 | 96326 | 6719 | 99750 | 5557 | 102757 | 3870 | 122916 | 3621 | 58045 |
| 2L-5S | | MI | 47640 | 11143 | 75521 | 8277 | 81047 | 6756 | 81785 | 5586 | 79647 | 3882 | 94278 | 3048 | 54183 |
| 10-#18 | 1.81 | MA | 52999 | 11143 | 84238 | 8270 | 91700 | 6753 | 94106 | 5588 | 95078 | 3894 | 112598 | 3399 | 58054 |
| 3L-4S | | MI | 49094 | 11143 | 77946 | 8284 | 84191 | 6723 | 85648 | 5556 | 85242 | 3903 | 100935 | 3153 | 55275 |
| 10-#18 | 1.81 | MA | 51293 | 11143 | 81298 | 8308 | 87953 | 6743 | 89551 | 5574 | 89217 | 3918 | 105883 | 3178 | 57857 |
| 4L-3S | | MI | 50721 | 11143 | 80748 | 8247 | 87763 | 6734 | 89989 | 5571 | 90828 | 3881 | 107286 | 3374 | 55438 |
| 10-#18 | 1.81 | MA | 49769 | 11143 | 78755 | 8301 | 84656 | 6777 | 85500 | 5605 | 83349 | 3898 | 98864 | 3072 | 56680 |
| 5L-2S | | MI | 53035 | 11143 | 84184 | 8255 | 92167 | 6701 | 95362 | 5541 | 98139 | 3858 | 117056 | 3595 | 55411 |
| 12-#14 | 1.22 | MA | 52817 | 10693 | 81902 | 8043 | 89017 | 6556 | 90952 | 5467 | 90837 | 3931 | 107333 | 3738 | 39895 |
| 2L-6S | | MI | 46656 | 10693 | 72300 | 8034 | 77098 | 6568 | 77085 | 5475 | 73402 | 3953 | 85572 | 3329 | 38069 |
| 12-#14 | 1.22 | MA | 51414 | 10693 | 79845 | 8040 | 86379 | 6551 | 87734 | 5485 | 86459 | 3946 | 101384 | 3613 | 39947 |
| 3L-5S | | MI | 47452 | 10693 | 73591 | 8037 | 78888 | 6548 | 79273 | 5482 | 76285 | 3939 | 89218 | 3410 | 38188 |
| 12-#14 | 1.22 | MA | 50432 | 10693 | 78173 | 8062 | 84248 | 6571 | 85143 | 5479 | 83125 | 3961 | 97504 | 3489 | 39977 |
| 4E | | MI | 48289 | 10693 | 74970 | 8041 | 80675 | 6554 | 81470 | 5464 | 79467 | 3949 | 93047 | 3470 | 38214 |
| 12-#14 | 1.22 | MA | 49556 | 10693 | 76728 | 8059 | 82374 | 6567 | 82841 | 5498 | 79789 | 3952 | 93471 | 3428 | 39932 |
| 5L-3S | | MI | 49225 | 10693 | 76564 | 8019 | 82708 | 6534 | 83940 | 5471 | 82647 | 3935 | 96722 | 3595 | 38176 |
| 12-#14 | 1.22 | MA | 48722 | 10693 | 75375 | 8056 | 80499 | 6587 | 80548 | 5491 | 76767 | 3967 | 89623 | 3347 | 39787 |
| 6L-2S | | MI | 50561 | 10693 | 78524 | 8022 | 85221 | 6539 | 87006 | 5453 | 86818 | 3920 | 102362 | 3719 | 38120 |
| 12-#18 | 2.17 | MA | 57101 | 11419 | 91455 | 8450 | 100952 | 6843 | 105393 | 5632 | 110436 | 3848 | 133234 | 3575 | 69345 |
| 2L-6S | | MI | 47884 | 11419 | 76683 | 8442 | 82303 | 6869 | 83310 | 5647 | 81887 | 3882 | 97738 | 2856 | 62393 |
| 12-#18 | 2.17 | MA | 54684 | 11419 | 87847 | 8443 | 96326 | 6877 | 99750 | 5663 | 102757 | 3872 | 122916 | 3354 | 69275 |
| 3L-5S | | MI | 49259 | 11419 | 78957 | 8450 | 85452 | 6880 | 87158 | 5661 | 86958 | 3860 | 104048 | 3000 | 64409 |
| 12-#18 | 2.17 | MA | 52989 | 11419 | 84906 | 8481 | 92579 | 6867 | 95195 | 5650 | 96896 | 3896 | 116201 | 3132 | 69002 |
| 4E | | MI | 50703 | 11419 | 81381 | 8457 | 88596 | 6847 | 91021 | 5632 | 92552 | 3881 | 110705 | 3104 | 65890 |
| 12-#18 | 2.17 | MA | 51476 | 11419 | 82364 | 8474 | 89282 | 6901 | 91143 | 5680 | 91027 | 3876 | 109182 | 3026 | 67432 |
| 5L-3S | | MI | 52319 | 11419 | 84184 | 8420 | 92167 | 6858 | 95362 | 5646 | 98139 | 3859 | 117056 | 3326 | 66128 |
| 12-#18 | 2.17 | MA | 50037 | 11419 | 79981 | 8468 | 85980 | 6891 | 87109 | 5667 | 85710 | 3900 | 102515 | 2883 | 65266 |
| 6L-2S | | MI | 54619 | 11419 | 87620 | 8428 | 96572 | 6825 | 100735 | 5617 | 105450 | 3836 | 126826 | 3547 | 66170 |
| 14-#14 | 1.43 | MA | 53793 | 10849 | 83959 | 8140 | 91654 | 6626 | 94169 | 5509 | 95214 | 3919 | 113282 | 3715 | 46354 |
| 2L-7S | | MI | 46826 | 10849 | 72844 | 8153 | 77904 | 6633 | 78051 | 5535 | 74756 | 3955 | 87322 | 3175 | 43141 |
| 14-#14 | 1.43 | MA | 52394 | 10849 | 81902 | 8137 | 89017 | 6621 | 90952 | 5528 | 90837 | 3934 | 107333 | 3591 | 46392 |
| 3L-6S | | MI | 47598 | 10849 | 74260 | 8131 | 79611 | 6638 | 80151 | 5517 | 77573 | 3940 | 91211 | 3305 | 44019 |
| 14-#14 | 1.43 | MA | 51417 | 10849 | 80230 | 8159 | 86885 | 6641 | 88361 | 5522 | 87503 | 3949 | 103453 | 3466 | 46391 |
| 4L-5S | | MI | 48391 | 10849 | 75551 | 8135 | 81401 | 6618 | 82338 | 5524 | 80456 | 3926 | 94858 | 3386 | 44275 |
| 14-#14 | 1.43 | MA | 50544 | 10849 | 78786 | 8156 | 85012 | 6636 | 86058 | 5540 | 84166 | 3939 | 99420 | 3405 | 46316 |
| 5L-4S | | MI | 49223 | 10849 | 76930 | 8138 | 83188 | 6623 | 84535 | 5506 | 83638 | 3937 | 98687 | 3446 | 44333 |
| 14-#14 | 1.43 | MA | 49714 | 10849 | 77432 | 8153 | 83136 | 6657 | 83766 | 5534 | 81145 | 3954 | 95572 | 3325 | 46028 |
| 6L-3S | | MI | 50156 | 10849 | 78524 | 8116 | 85221 | 6604 | 87006 | 5513 | 86818 | 3922 | 102362 | 3571 | 44321 |
| 14-#14 | 1.43 | MA | 48906 | 10849 | 75949 | 8175 | 81347 | 6652 | 81566 | 5552 | 78193 | 3969 | 91469 | 3195 | 45084 |
| 7L-2S | | MI | 51487 | 10849 | 80484 | 8120 | 87734 | 6609 | 90071 | 5495 | 90988 | 3908 | 108002 | 3695 | 44278 |
| 14-#18 | 2.54 | MA | 58759 | 11696 | 95064 | 8623 | 105578 | 6967 | 111037 | 5708 | 118114 | 3826 | 143552 | 3529 | 80600 |
| 2L-7S | | MI | 48170 | 11696 | 77628 | 8652 | 83703 | 7027 | 84990 | 5752 | 84242 | 3883 | 100773 | 2576 | 70571 |
| 14-#18 | 2.54 | MA | 56356 | 11696 | 91455 | 8616 | 100952 | 7002 | 105393 | 5738 | 110436 | 3850 | 133234 | 3308 | 80476 |
| 3L-6S | | MI | 49499 | 11696 | 80119 | 8615 | 86708 | 6993 | 88683 | 5722 | 89198 | 3860 | 107508 | 2807 | 72754 |
| 14-#18 | 2.54 | MA | 54672 | 11696 | 88515 | 8654 | 97205 | 6991 | 100839 | 5725 | 104574 | 3874 | 126519 | 3087 | 80135 |
| 4L-5S | | MI | 50865 | 11696 | 82393 | 8622 | 89856 | 7004 | 92531 | 5737 | 94269 | 3838 | 113818 | 2951 | 74671 |
| 14-#18 | 2.54 | MA | 53169 | 11696 | 85973 | 8647 | 93908 | 7026 | 96787 | 5756 | 98706 | 3854 | 119500 | 2981 | 78221 |
| 5L-4S | | MI | 52299 | 11696 | 84817 | 8630 | 93000 | 6971 | 96394 | 5707 | 99863 | 3859 | 120475 | 3056 | 76492 |
| 14-#18 | 2.54 | MA | 51740 | 11696 | 83589 | 8640 | 90606 | 7016 | 92752 | 5742 | 93389 | 3878 | 112833 | 2837 | 76157 |
| 6L-3S | | MI | 53905 | 11696 | 87620 | 8593 | 96572 | 6982 | 100735 | 5722 | 105450 | 3837 | 126826 | 3277 | 76796 |
| 14-#18 | 2.54 | MA | 50347 | 11696 | 80978 | 8678 | 87457 | 7050 | 88879 | 5773 | 88193 | 3902 | 105719 | 2606 | 73844 |
| 7L-2S | | MI | 56192 | 11696 | 91056 | 8600 | 100976 | 6949 | 106109 | 5692 | 112760 | 3814 | 136596 | 3499 | 76901 |
| 16-#11 | 1.13 | MA | 52435 | 10622 | 80920 | 8022 | 87915 | 6543 | 89669 | 5464 | 89118 | 3949 | 105198 | 3769 | 37084 |
| 2L-8S | | MI | 46388 | 10622 | 71375 | 8025 | 76116 | 6560 | 75983 | 5493 | 71786 | 3968 | 83333 | 3341 | 34979 |

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

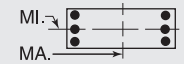
| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 16-#11 | 1.13 | MA | 51453 | 10622 | 79484 | 8020 | 86075 | 6540 | 87423 | 5477 | 86062 | 3960 | 101023 | 3683 | 37121 |
| 3L-7S | | MI | 46930 | 10622 | 72260 | 8027 | 77323 | 6546 | 77411 | 5481 | 73873 | 3974 | 85844 | 3391 | 35431 |
| 16-#11 | 1.13 | MA | 50767 | 10622 | 78318 | 8036 | 84589 | 6555 | 85617 | 5473 | 83738 | 3971 | 98298 | 3596 | 37151 |
| 4L-6S | | MI | 47472 | 10622 | 73247 | 8012 | 78512 | 6549 | 78874 | 5468 | 75836 | 3964 | 88576 | 3481 | 35519 |
| 16-#11 | 1.13 | MA | 50155 | 10622 | 77312 | 8034 | 83283 | 6552 | 84012 | 5487 | 81412 | 3965 | 95472 | 3553 | 37165 |
| 5E | | MI | 48027 | 10622 | 74147 | 8014 | 79759 | 6535 | 80398 | 5472 | 77845 | 3953 | 91138 | 3536 | 35535 |
| 16-#11 | 1.13 | MA | 49573 | 10622 | 76369 | 8032 | 81976 | 6566 | 82415 | 5483 | 79307 | 3976 | 92769 | 3498 | 37135 |
| 6L-4S | | MI | 48611 | 10622 | 75107 | 8016 | 81005 | 6538 | 81929 | 5459 | 80064 | 3960 | 93823 | 3579 | 35514 |
| 16-#11 | 1.13 | MA | 49006 | 10622 | 75336 | 8048 | 80730 | 6563 | 80882 | 5496 | 77250 | 3987 | 89890 | 3408 | 37025 |
| 7L-3S | | MI | 49266 | 10622 | 76219 | 8001 | 82423 | 6524 | 83652 | 5463 | 82281 | 3950 | 96406 | 3665 | 35481 |
| 16-#11 | 1.13 | MA | 48438 | 10622 | 74408 | 8046 | 79466 | 6578 | 79386 | 5509 | 75064 | 3981 | 87247 | 3358 | 36538 |
| 8L-2S | | MI | 50201 | 10622 | 77588 | 8003 | 84177 | 6527 | 85793 | 5450 | 85193 | 3939 | 100367 | 3752 | 35442 |
| 16-#14 | 1.63 | MA | 54763 | 11004 | 86017 | 8237 | 94292 | 6695 | 97387 | 5552 | 99592 | 3906 | 119230 | 3693 | 52802 |
| 2L-8S | | MI | 47008 | 11004 | 73533 | 8247 | 78685 | 6723 | 79068 | 5596 | 75934 | 3932 | 89381 | 3080 | 48505 |
| 16-#14 | 1.63 | MA | 53370 | 11004 | 83959 | 8234 | 91654 | 6691 | 94169 | 5570 | 95214 | 3921 | 113282 | 3568 | 52827 |
| 3L-7S | | MI | 47766 | 11004 | 74804 | 8250 | 80416 | 6703 | 81117 | 5578 | 78927 | 3942 | 92962 | 3151 | 49089 |
| 16-#14 | 1.63 | MA | 52396 | 11004 | 82287 | 8256 | 89523 | 6711 | 91578 | 5564 | 91880 | 3937 | 109402 | 3444 | 52794 |
| 4L-6S | | MI | 48535 | 11004 | 76220 | 8229 | 82124 | 6708 | 83216 | 5560 | 81744 | 3928 | 96851 | 3281 | 49928 |
| 16-#14 | 1.63 | MA | 51527 | 11004 | 80843 | 8253 | 87649 | 6706 | 89276 | 5582 | 88544 | 3927 | 105369 | 3383 | 52691 |
| 5E | | MI | 49324 | 11004 | 77511 | 8232 | 83913 | 6688 | 85403 | 5567 | 84626 | 3914 | 100498 | 3362 | 50353 |
| 16-#14 | 1.63 | MA | 50701 | 11004 | 79489 | 8251 | 85774 | 6727 | 86983 | 5576 | 85523 | 3942 | 101521 | 3302 | 52233 |
| 6L-4S | | MI | 50153 | 11004 | 78890 | 8235 | 85701 | 6693 | 87600 | 5549 | 87809 | 3924 | 104327 | 3422 | 50437 |
| 16-#14 | 1.63 | MA | 49896 | 11004 | 78006 | 8273 | 83985 | 6722 | 84783 | 5595 | 82571 | 3957 | 97418 | 3172 | 51330 |
| 7L-3S | | MI | 51082 | 11004 | 80484 | 8214 | 87734 | 6673 | 90071 | 5555 | 90988 | 3910 | 108002 | 3547 | 50461 |
| 16-#14 | 1.63 | MA | 49103 | 11004 | 76674 | 8270 | 82170 | 6742 | 82636 | 5613 | 79434 | 3947 | 93646 | 3101 | 50695 |
| 8L-2S | | MI | 52408 | 11004 | 82445 | 8217 | 90246 | 6679 | 93136 | 5537 | 95159 | 3895 | 113642 | 3671 | 50426 |
| 16-#18 | 2.90 | MA | 60404 | 11972 | 98673 | 8796 | 110205 | 7092 | 116680 | 5783 | 125793 | 3804 | 153870 | 3484 | 91836 |
| 2L-8S | | MI | 48481 | 11972 | 78826 | 8817 | 85060 | 7140 | 86757 | 5857 | 86287 | 3839 | 104319 | 2405 | 78320 |
| 16-#18 | 2.90 | MA | 58014 | 11972 | 95064 | 8789 | 105578 | 7126 | 111037 | 5814 | 118114 | 3828 | 143552 | 3262 | 91662 |
| 3L-7S | | MI | 49781 | 11972 | 81064 | 8825 | 88108 | 7151 | 90363 | 5827 | 91553 | 3861 | 110543 | 2528 | 80766 |
| 16-#18 | 2.90 | MA | 56342 | 11972 | 92124 | 8827 | 101831 | 7116 | 106482 | 5800 | 112253 | 3852 | 136838 | 3041 | 91259 |
| 4L-6S | | MI | 51102 | 11972 | 83555 | 8788 | 91112 | 7118 | 94057 | 5798 | 96508 | 3838 | 117278 | 2759 | 83133 |
| 16-#18 | 2.90 | MA | 54849 | 11972 | 89581 | 8820 | 98534 | 7150 | 102431 | 5831 | 106385 | 3832 | 129819 | 2935 | 89040 |
| 5E | | MI | 52458 | 11972 | 85828 | 8795 | 94261 | 7129 | 97904 | 5812 | 101579 | 3815 | 123587 | 2903 | 84963 |
| 16-#18 | 2.90 | MA | 53429 | 11972 | 87198 | 8813 | 95233 | 7140 | 98396 | 5818 | 101067 | 3856 | 123151 | 2791 | 87067 |
| 6L-4S | | MI | 53883 | 11972 | 88253 | 8803 | 97405 | 7095 | 101768 | 5783 | 107174 | 3837 | 130245 | 3008 | 87084 |
| 16-#18 | 2.90 | MA | 52046 | 11972 | 84587 | 8851 | 92083 | 7174 | 94523 | 5848 | 95871 | 3880 | 116037 | 2561 | 84570 |
| 7L-3S | | MI | 55479 | 11972 | 91056 | 8766 | 100976 | 7106 | 106109 | 5797 | 112760 | 3815 | 136596 | 3229 | 87449 |
| 16-#18 | 2.90 | MA | 50685 | 11972 | 82241 | 8844 | 88888 | 7164 | 90743 | 5879 | 90350 | 3859 | 109474 | 2436 | 81951 |
| 8L-2S | | MI | 57753 | 11972 | 94491 | 8773 | 105381 | 7073 | 111482 | 5767 | 120071 | 3792 | 146366 | 3450 | 87603 |
| 18-#11 | 1.27 | MA | 53121 | 10730 | 82356 | 8089 | 89756 | 6592 | 91915 | 5493 | 92173 | 3941 | 109374 | 3754 | 41593 |
| 2L-9S | | MI | 46498 | 10730 | 71877 | 8091 | 76697 | 6605 | 76630 | 5518 | 72754 | 3970 | 84810 | 3272 | 38840 |
| 18-#11 | 1.27 | MA | 52141 | 10730 | 80920 | 8088 | 87915 | 6589 | 89669 | 5507 | 89118 | 3952 | 105198 | 3668 | 41624 |
| 3L-8S | | MI | 47053 | 10730 | 72743 | 8093 | 77870 | 6609 | 78123 | 5523 | 74698 | 3959 | 87294 | 3326 | 39154 |
| 18-#11 | 1.27 | MA | 51457 | 10730 | 79754 | 8103 | 86429 | 6603 | 87863 | 5503 | 86793 | 3963 | 102473 | 3582 | 41645 |
| 4L-7S | | MI | 47591 | 10730 | 73629 | 8095 | 79077 | 6594 | 79551 | 5510 | 76785 | 3966 | 89805 | 3375 | 39587 |
| 18-#11 | 1.27 | MA | 50848 | 10730 | 78748 | 8102 | 85124 | 6600 | 86258 | 5516 | 84468 | 3957 | 99647 | 3539 | 41639 |
| 5L-6S | | MI | 48131 | 10730 | 74615 | 8079 | 80267 | 6598 | 81014 | 5497 | 78748 | 3955 | 92537 | 3465 | 39773 |
| 18-#11 | 1.27 | MA | 50268 | 10730 | 77805 | 8100 | 83817 | 6615 | 84660 | 5512 | 82362 | 3968 | 96945 | 3483 | 41596 |
| 6L-5S | | MI | 48685 | 10730 | 75515 | 8081 | 81514 | 6583 | 82538 | 5501 | 80757 | 3945 | 95099 | 3521 | 39806 |
| 18-#11 | 1.27 | MA | 49702 | 10730 | 76772 | 8115 | 82571 | 6612 | 83128 | 5525 | 80306 | 3979 | 94065 | 3393 | 41387 |
| 7L-4S | | MI | 49267 | 10730 | 76476 | 8083 | 82760 | 6587 | 84070 | 5488 | 82976 | 3951 | 97783 | 3563 | 39801 |
| 18-#11 | 1.27 | MA | 49138 | 10730 | 75844 | 8114 | 81307 | 6626 | 81632 | 5538 | 78120 | 3972 | 91422 | 3343 | 40919 |
| 8L-3S | | MI | 49919 | 10730 | 77588 | 8068 | 84177 | 6573 | 85793 | 5493 | 85193 | 3941 | 100367 | 3650 | 39776 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

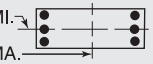



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#11 | 1.27 | MA | 48549 | 10730 | 74936 | 8112 | 80077 | 6623 | 80068 | 5534 | 76082 | 3983 | 88801 | 3289 | 40576 |
| 9L-2S | | MI | 50852 | 10730 | 78956 | 8070 | 85932 | 6576 | 87933 | 5480 | 88105 | 3930 | 104328 | 3736 | 39743 |
| 18-#14 | 1.83 | MA | 55728 | 11160 | 88074 | 8335 | 96929 | 6765 | 100604 | 5594 | 103969 | 3894 | 125179 | 3670 | 59243 |
| 2L-9S | | MI | 47162 | 11160 | 74249 | 8341 | 79513 | 6787 | 79991 | 5631 | 77314 | 3934 | 91485 | 2979 | 53408 |
| 18-#14 | 1.83 | MA | 54340 | 11160 | 86017 | 8332 | 94292 | 6761 | 97387 | 5613 | 99592 | 3909 | 119230 | 3546 | 59243 |
| 3L-8S | | MI | 47947 | 11160 | 75493 | 8344 | 81198 | 6792 | 82133 | 5638 | 80104 | 3919 | 95021 | 3057 | 54475 |
| 18-#14 | 1.83 | MA | 53370 | 11160 | 84345 | 8354 | 92160 | 6781 | 94796 | 5606 | 96258 | 3924 | 115351 | 3421 | 59188 |
| 4L-7S | | MI | 48701 | 11160 | 76764 | 8347 | 82929 | 6773 | 84182 | 5620 | 83098 | 3930 | 98602 | 3127 | 55045 |
| 18-#14 | 1.83 | MA | 52505 | 11160 | 82900 | 8351 | 90286 | 6776 | 92493 | 5625 | 92922 | 3914 | 111318 | 3360 | 59060 |
| 5L-6S | | MI | 49467 | 11160 | 78180 | 8326 | 84636 | 6778 | 86281 | 5602 | 85914 | 3916 | 102491 | 3257 | 55850 |
| 18-#14 | 1.83 | MA | 51683 | 11160 | 81547 | 8348 | 88411 | 6796 | 90201 | 5618 | 89900 | 3929 | 107470 | 3280 | 58451 |
| 6L-5S | | MI | 50252 | 11160 | 79471 | 8329 | 86426 | 6758 | 88469 | 5609 | 88797 | 3901 | 106138 | 3338 | 56424 |
| 18-#14 | 1.83 | MA | 50881 | 11160 | 80064 | 8370 | 86622 | 6792 | 88001 | 5637 | 86948 | 3944 | 103367 | 3150 | 57583 |
| 7L-4S | | MI | 51078 | 11160 | 80850 | 8332 | 88213 | 6763 | 90666 | 5591 | 91979 | 3912 | 109967 | 3398 | 56533 |
| 18-#14 | 1.83 | MA | 50092 | 11160 | 78732 | 8367 | 84808 | 6812 | 85854 | 5655 | 83811 | 3935 | 99595 | 3078 | 56964 |
| 8L-3S | | MI | 52003 | 11160 | 82445 | 8311 | 90246 | 6743 | 93136 | 5598 | 95159 | 3897 | 113642 | 3523 | 56577 |
| 18-#14 | 1.83 | MA | 49256 | 11160 | 77429 | 8364 | 83043 | 6807 | 83608 | 5649 | 80887 | 3950 | 95864 | 3001 | 55826 |
| 9L-2S | | MI | 53325 | 11160 | 84405 | 8314 | 92759 | 6748 | 96202 | 5580 | 99330 | 3883 | 119282 | 3647 | 56565 |
| 18-#18 | 3.26 | MA | 59661 | 12249 | 98673 | 8962 | 110205 | 7250 | 116680 | 5889 | 125793 | 3806 | 153870 | 3217 | 102836 |
| 3L-8S | | MI | 50088 | 12249 | 82261 | 8990 | 89465 | 7264 | 92130 | 5932 | 93598 | 3817 | 114089 | 2357 | 88618 |
| 18-#18 | 3.26 | MA | 57999 | 12249 | 95733 | 9000 | 106457 | 7240 | 112126 | 5876 | 119932 | 3830 | 147156 | 2995 | 102375 |
| 4L-7S | | MI | 51380 | 12249 | 84500 | 8998 | 92512 | 7275 | 95736 | 5903 | 98864 | 3839 | 120313 | 2480 | 90984 |
| 18-#18 | 3.26 | MA | 56516 | 12249 | 93190 | 8993 | 103160 | 7274 | 108074 | 5907 | 114063 | 3810 | 140137 | 2890 | 99885 |
| 5L-6S | | MI | 52692 | 12249 | 86991 | 8961 | 95517 | 7242 | 99430 | 5873 | 103819 | 3816 | 127048 | 2711 | 93527 |
| 18-#18 | 3.26 | MA | 55106 | 12249 | 90807 | 8986 | 99859 | 7264 | 104040 | 5893 | 108746 | 3834 | 133469 | 2746 | 97991 |
| 6L-5S | | MI | 54040 | 12249 | 89264 | 8968 | 98665 | 7253 | 103278 | 5888 | 108890 | 3793 | 133357 | 2855 | 95280 |
| 18-#18 | 3.26 | MA | 53732 | 12249 | 88195 | 9024 | 96709 | 7298 | 100167 | 5924 | 103550 | 3857 | 126355 | 2515 | 95318 |
| 7L-4S | | MI | 55456 | 12249 | 91689 | 8976 | 101809 | 7219 | 107141 | 5858 | 114485 | 3815 | 140015 | 2959 | 97668 |
| 18-#18 | 3.26 | MA | 52380 | 12249 | 85849 | 9017 | 93514 | 7288 | 96387 | 5955 | 98028 | 3837 | 119792 | 2391 | 92782 |
| 8L-3S | | MI | 57042 | 12249 | 94491 | 8939 | 105381 | 7230 | 111482 | 5873 | 120071 | 3792 | 146366 | 3181 | 98089 |
| 20-#11 | 1.41 | MA | 53804 | 10838 | 83792 | 8157 | 91597 | 6640 | 94160 | 5523 | 95229 | 3932 | 113549 | 3740 | 46097 |
| 2L-10S | | MI | 46576 | 10838 | 72275 | 8174 | 77261 | 6668 | 77350 | 5561 | 73737 | 3972 | 86362 | 3196 | 42616 |
| 20-#11 | 1.41 | MA | 52827 | 10838 | 82356 | 8155 | 89756 | 6637 | 91915 | 5536 | 92173 | 3943 | 109374 | 3653 | 46121 |
| 3L-9S | | MI | 47161 | 10838 | 73245 | 8158 | 78451 | 6654 | 78770 | 5548 | 75666 | 3961 | 88770 | 3257 | 43025 |
| 20-#11 | 1.41 | MA | 52145 | 10838 | 81190 | 8171 | 88270 | 6652 | 90108 | 5532 | 89849 | 3954 | 106648 | 3567 | 46134 |
| 4L-8S | | MI | 47715 | 10838 | 74112 | 8160 | 79625 | 6657 | 80263 | 5552 | 77610 | 3950 | 91255 | 3310 | 43332 |
| 20-#11 | 1.41 | MA | 51537 | 10838 | 80183 | 8169 | 86965 | 6649 | 88504 | 5545 | 87523 | 3948 | 103822 | 3524 | 46110 |
| 5L-7S | | MI | 48250 | 10838 | 74998 | 8162 | 80831 | 6643 | 81691 | 5539 | 79697 | 3957 | 93766 | 3360 | 43750 |
| 20-#11 | 1.41 | MA | 50959 | 10838 | 79241 | 8167 | 85658 | 6663 | 86906 | 5541 | 85418 | 3959 | 101120 | 3468 | 46052 |
| 6E | | MI | 48788 | 10838 | 75984 | 8147 | 82021 | 6646 | 83154 | 5526 | 81660 | 3947 | 96497 | 3450 | 44023 |
| 20-#11 | 1.41 | MA | 50396 | 10838 | 78207 | 8183 | 84412 | 6660 | 85373 | 5555 | 83361 | 3970 | 98240 | 3379 | 45755 |
| 7L-5S | | MI | 49340 | 10838 | 76884 | 8149 | 83268 | 6632 | 84679 | 5531 | 83669 | 3936 | 99060 | 3506 | 44069 |
| 20-#11 | 1.41 | MA | 49835 | 10838 | 77280 | 8181 | 83148 | 6675 | 83878 | 5568 | 81175 | 3964 | 95597 | 3328 | 45303 |
| 8L-4S | | MI | 49920 | 10838 | 77844 | 8151 | 84514 | 6635 | 86210 | 5518 | 85888 | 3943 | 101744 | 3548 | 44082 |
| 20-#11 | 1.41 | MA | 49247 | 10838 | 76372 | 8179 | 81918 | 6672 | 82314 | 5564 | 79138 | 3975 | 92977 | 3275 | 44968 |
| 9L-3S | | MI | 50571 | 10838 | 78956 | 8136 | 85932 | 6621 | 87933 | 5522 | 88105 | 3932 | 104328 | 3634 | 44065 |
| 20-#11 | 1.41 | MA | 48634 | 10838 | 75356 | 8195 | 80671 | 6686 | 80826 | 5577 | 77118 | 3986 | 90436 | 3214 | 44523 |
| 10L-2S | | MI | 51501 | 10838 | 80325 | 8138 | 87686 | 6624 | 90073 | 5509 | 91017 | 3922 | 108289 | 3721 | 44038 |
| 20-#14 | 2.04 | MA | 56689 | 11315 | 90131 | 8432 | 99566 | 6835 | 103821 | 5637 | 108347 | 3882 | 131128 | 3648 | 65678 |
| 2L-10S | | MI | 47270 | 11315 | 74817 | 8460 | 80318 | 6877 | 81018 | 5692 | 78717 | 3936 | 93699 | 2867 | 58368 |
| 20-#14 | 2.04 | MA | 55306 | 11315 | 88074 | 8429 | 96929 | 6830 | 100604 | 5655 | 103969 | 3897 | 125179 | 3523 | 65651 |
| 3L-9S | | MI | 48100 | 11315 | 76209 | 8438 | 82026 | 6857 | 83056 | 5674 | 81484 | 3921 | 97125 | 2955 | 59303 |
| 20-#14 | 2.04 | MA | 54340 | 11315 | 86402 | 8451 | 94797 | 6851 | 98013 | 5649 | 100635 | 3912 | 121300 | 3399 | 65575 |
| 4L-8S | | MI | 48880 | 11315 | 77453 | 8441 | 83710 | 6862 | 85199 | 5680 | 84275 | 3907 | 100661 | 3033 | 60450 |
| 20-#14 | 2.04 | MA | 53479 | 11315 | 84957 | 8448 | 92924 | 6846 | 95711 | 5667 | 97299 | 3902 | 117267 | 3338 | 65425 |
| 5L-7S | | MI | 49631 | 11315 | 78725 | 8445 | 85442 | 6843 | 87248 | 5662 | 87268 | 3918 | 104242 | 3104 | 61007 |
| 20-#14 | 2.04 | MA | 52659 | 11315 | 83604 | 8445 | 91048 | 6866 | 93418 | 5661 | 94278 | 3917 | 113418 | 3257 | 64680 |
| 6E | | MI | 50394 | 11315 | 80140 | 8423 | 87149 | 6848 | 89347 | 5644 | 90085 | 3903 | 108131 | 3233 | 61782 |
| 20-#14 | 2.04 | MA | 51861 | 11315 | 82121 | 8467 | 89259 | 6862 | 91218 | 5679 | 91326 | 3932 | 109316 | 3127 | 63843 |
| 7L-5S | | MI | 51176 | 11315 | 81431 | 8426 | 88939 | 6828 | 91534 | 5651 | 92968 | 3889 | 111778 | 3314 | 62489 |

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis

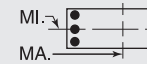



$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 20-#14 | 2.04 | MA | 51075 | 11315 | 80789 | 8464 | 87445 | 6882 | 89071 | 5698 | 88189 | 3922 | 105544 | 3056 | 63238 |
| 8L-4S | | MI | 51999 | 11315 | 82810 | 8430 | 90726 | 6833 | 93731 | 5633 | 96150 | 3899 | 115607 | 3374 | 62621 |
| 20-#14 | 2.04 | MA | 50244 | 11315 | 79486 | 8461 | 85680 | 6877 | 86826 | 5692 | 85264 | 3937 | 101813 | 2978 | 62020 |
| 9L-3S | | MI | 52920 | 11315 | 84405 | 8408 | 92759 | 6813 | 96202 | 5640 | 99330 | 3885 | 119282 | 3499 | 62684 |
| 20-#14 | 2.04 | MA | 49375 | 11315 | 78027 | 8483 | 83890 | 6897 | 84690 | 5710 | 82365 | 3952 | 98196 | 2891 | 61016 |
| 10L-2S | | MI | 54237 | 11315 | 86365 | 8411 | 95272 | 6818 | 99267 | 5622 | 103500 | 3871 | 124922 | 3623 | 62704 |
| 20-#18 | 3.62 | MA | 59645 | 12526 | 99341 | 9173 | 111083 | 7364 | 117770 | 5951 | 127610 | 3808 | 157474 | 2950 | 113486 |
| 4L-8S | | MI | 51684 | 12526 | 85697 | 9163 | 93869 | 7388 | 97504 | 6008 | 100909 | 3795 | 123859 | 2308 | 98932 |
| 20-#18 | 3.62 | MA | 58172 | 12526 | 96799 | 9166 | 107786 | 7398 | 113718 | 5982 | 121742 | 3787 | 150455 | 2844 | 110752 |
| 5L-7S | | MI | 52968 | 12526 | 87936 | 9171 | 96917 | 7399 | 101109 | 5978 | 106175 | 3816 | 130082 | 2431 | 101223 |
| 20-#18 | 3.62 | MA | 56771 | 12526 | 94415 | 9159 | 104485 | 7388 | 109683 | 5968 | 116425 | 3811 | 143788 | 2700 | 108929 |
| 6E | | MI | 54272 | 12526 | 90426 | 9134 | 99921 | 7366 | 104803 | 5949 | 111130 | 3794 | 136818 | 2662 | 103934 |
| 20-#18 | 3.62 | MA | 55406 | 12526 | 91804 | 9197 | 101335 | 7422 | 105810 | 5999 | 111229 | 3835 | 136673 | 2469 | 106088 |
| 7L-5S | | MI | 55611 | 12526 | 92700 | 9141 | 103070 | 7377 | 108651 | 5963 | 116201 | 3771 | 143127 | 2806 | 105619 |
| 20-#18 | 3.62 | MA | 54062 | 12526 | 89458 | 9190 | 98140 | 7412 | 102030 | 6030 | 105707 | 3815 | 130111 | 2345 | 103629 |
| 8L-4S | | MI | 57018 | 12526 | 95125 | 9149 | 106214 | 7344 | 112514 | 5933 | 121795 | 3793 | 149785 | 2911 | 108245 |
| 22-#11 | 1.55 | MA | 54485 | 10946 | 85228 | 8224 | 93438 | 6689 | 96406 | 5552 | 98284 | 3924 | 117724 | 3725 | 50596 |
| 2L-11S | | MI | 46668 | 10946 | 72776 | 8239 | 77848 | 6713 | 78017 | 5586 | 74593 | 3956 | 87875 | 3128 | 46180 |
| 22-#11 | 1.55 | MA | 53510 | 10946 | 83792 | 8223 | 91597 | 6686 | 94160 | 5566 | 95229 | 3935 | 113549 | 3639 | 50614 |
| 3L-10S | | MI | 47237 | 10946 | 73644 | 8241 | 79015 | 6716 | 79490 | 5590 | 76649 | 3963 | 90323 | 3180 | 46748 |
| 22-#11 | 1.55 | MA | 52830 | 10946 | 82626 | 8238 | 90111 | 6700 | 92354 | 5562 | 92904 | 3946 | 110823 | 3553 | 50610 |
| 4L-9S | | MI | 47820 | 10946 | 74614 | 8226 | 80206 | 6702 | 80911 | 5577 | 78578 | 3952 | 92731 | 3241 | 47213 |
| 22-#11 | 1.55 | MA | 52224 | 10946 | 81619 | 8236 | 88805 | 6697 | 90749 | 5575 | 90579 | 3939 | 107997 | 3510 | 50575 |
| 5L-8S | | MI | 48377 | 10946 | 75480 | 8228 | 81379 | 6705 | 82404 | 5582 | 80522 | 3942 | 95216 | 3295 | 47514 |
| 22-#11 | 1.55 | MA | 51648 | 10946 | 80677 | 8235 | 87499 | 6712 | 89152 | 5571 | 88473 | 3950 | 105295 | 3454 | 50505 |
| 6L-7S | | MI | 48906 | 10946 | 76366 | 8230 | 82586 | 6691 | 83831 | 5569 | 82609 | 3949 | 97726 | 3344 | 47917 |
| 22-#11 | 1.55 | MA | 51087 | 10946 | 79643 | 8250 | 86252 | 6709 | 87619 | 5584 | 86417 | 3961 | 102415 | 3364 | 50129 |
| 7L-6S | | MI | 49442 | 10946 | 77352 | 8214 | 83775 | 6694 | 85294 | 5556 | 84572 | 3938 | 100458 | 3434 | 48269 |
| 22-#11 | 1.55 | MA | 50529 | 10946 | 78716 | 8249 | 84988 | 6723 | 86123 | 5597 | 84231 | 3955 | 99772 | 3314 | 49691 |
| 8L-5S | | MI | 49993 | 10946 | 78252 | 8216 | 85023 | 6680 | 86819 | 5560 | 86581 | 3928 | 103021 | 3490 | 48328 |
| 22-#11 | 1.55 | MA | 49941 | 10946 | 77808 | 8247 | 83759 | 6720 | 84559 | 5593 | 82193 | 3966 | 97152 | 3260 | 49363 |
| 9L-4S | | MI | 50571 | 10946 | 79213 | 8218 | 86268 | 6683 | 88350 | 5547 | 88799 | 3934 | 105705 | 3533 | 48354 |
| 22-#11 | 1.55 | MA | 49331 | 10946 | 76792 | 8262 | 82512 | 6735 | 83072 | 5607 | 80173 | 3977 | 94612 | 3200 | 48861 |
| 10L-3S | | MI | 51220 | 10946 | 80325 | 8203 | 87686 | 6669 | 90073 | 5552 | 91017 | 3924 | 108289 | 3619 | 48349 |
| 22-#11 | 1.55 | MA | 48734 | 10946 | 75883 | 8261 | 81289 | 6732 | 81527 | 5603 | 78018 | 3971 | 92034 | 3146 | 48250 |
| 11L-2S | | MI | 52148 | 10946 | 81693 | 8205 | 89440 | 6673 | 92213 | 5539 | 93929 | 3913 | 112250 | 3705 | 48328 |
| 22-#14 | 2.24 | MA | 56267 | 11471 | 90131 | 8526 | 99566 | 6900 | 103821 | 5698 | 108347 | 3884 | 131128 | 3501 | 72052 |
| 3L-10S | | MI | 48206 | 11471 | 76777 | 8557 | 82830 | 6947 | 84083 | 5734 | 82888 | 3923 | 99339 | 2843 | 64295 |
| 22-#14 | 2.24 | MA | 55305 | 11471 | 88459 | 8548 | 97435 | 6920 | 101231 | 5691 | 105013 | 3899 | 127248 | 3376 | 71957 |
| 4L-9S | | MI | 49033 | 11471 | 78169 | 8535 | 84539 | 6927 | 86121 | 5716 | 85655 | 3909 | 102765 | 2931 | 65207 |
| 22-#14 | 2.24 | MA | 54447 | 11471 | 87015 | 8545 | 95561 | 6916 | 98928 | 5710 | 101677 | 3889 | 123215 | 3315 | 71785 |
| 5L-8S | | MI | 49809 | 11471 | 79413 | 8539 | 86223 | 6932 | 88264 | 5723 | 88446 | 3895 | 106301 | 3009 | 66414 |
| 22-#14 | 2.24 | MA | 53631 | 11471 | 85661 | 8542 | 93686 | 6936 | 96635 | 5703 | 98655 | 3904 | 119367 | 3235 | 70919 |
| 6L-7S | | MI | 50557 | 11471 | 80685 | 8542 | 87955 | 6912 | 90313 | 5705 | 91439 | 3905 | 109882 | 3080 | 66975 |
| 22-#14 | 2.24 | MA | 52836 | 11471 | 84178 | 8564 | 91897 | 6931 | 94436 | 5722 | 95704 | 3920 | 115264 | 3105 | 70109 |
| 7L-6S | | MI | 51316 | 11471 | 82100 | 8520 | 89662 | 6917 | 92412 | 5687 | 94256 | 3891 | 113771 | 3209 | 67723 |
| 22-#14 | 2.24 | MA | 52054 | 11471 | 82846 | 8561 | 90082 | 6952 | 92289 | 5740 | 92566 | 3910 | 111493 | 3033 | 69515 |
| 8L-5S | | MI | 52096 | 11471 | 83392 | 8524 | 91451 | 6898 | 94599 | 5694 | 97138 | 3876 | 117418 | 3290 | 68550 |
| 22-#14 | 2.24 | MA | 51227 | 11471 | 81543 | 8558 | 88317 | 6947 | 90043 | 5734 | 89642 | 3925 | 107761 | 2956 | 68223 |
| 9L-4S | | MI | 52915 | 11471 | 84770 | 8527 | 93239 | 6903 | 96796 | 5676 | 100321 | 3887 | 121247 | 3350 | 68703 |
| 22-#14 | 2.24 | MA | 50361 | 11471 | 80084 | 8580 | 86527 | 6967 | 87908 | 5752 | 86742 | 3940 | 104145 | 2868 | 67242 |
| 10L-3S | | MI | 53833 | 11471 | 86365 | 8505 | 95272 | 6883 | 99267 | 5683 | 103500 | 3873 | 124922 | 3475 | 68785 |
| 22-#18 | 3.99 | MA | 59817 | 12802 | 100407 | 9339 | 112413 | 7522 | 119362 | 6057 | 129421 | 3765 | 160773 | 2798 | 121637 |
| 5L-8S | | MI | 53269 | 12802 | 89133 | 9336 | 98274 | 7512 | 102877 | 6083 | 108220 | 3773 | 133628 | 2260 | 109112 |
| 22-#18 | 3.99 | MA | 58424 | 12802 | 98024 | 9332 | 109111 | 7512 | 115327 | 6044 | 124103 | 3789 | 154106 | 2655 | 119878 |
| 6L-7S | | MI | 54545 | 12802 | 91371 | 9343 | 101321 | 7523 | 106483 | 6054 | 113485 | 3794 | 139852 | 2383 | 111482 |
| 22-#18 | 3.99 | MA | 57068 | 12802 | 95413 | 9370 | 105961 | 7546 | 111454 | 6075 | 118907 | 3813 | 146992 | 2424 | 116877 |
| 7L-6S | | MI | 55841 | 12802 | 93862 | 9307 | 104326 | 7490 | 110176 | 6024 | 118441 | 3772 | 146587 | 2614 | 114352 |
| 22-#18 | 3.99 | MA | 55733 | 12802 | 93067 | 9363 | 102766 | 7536 | 107674 | 6105 | 113386 | 3793 | 140429 | 2299 | 114394 |
| 8L-5S | | MI | 57171 | 12802 | 96136 | 9314 | 107474 | 7501 | 114024 | 6038 | 123511 | 3749 | 152897 | 2758 | 115976 |

## RECTANGULAR TIED COLUMNS 46" x 48"

Short columns – no sidesway
Bending on major or minor axis




$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | AXIS | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 24-#11 | 1.70 | MA | 55163 | 11054 | 86663 | 8292 | 95279 | 6737 | 98652 | 5582 | 101339 | 3915 | 121899 | 3711 | 55091 |
| 2L-12S | | MI | 46771 | 11054 | 73191 | 8322 | 78420 | 6776 | 78739 | 5628 | 75578 | 3958 | 89077 | 3035 | 49794 |
| 24-#11 | 1.70 | MA | 54191 | 11054 | 85228 | 8290 | 93438 | 6734 | 96406 | 5595 | 98284 | 3926 | 117724 | 3624 | 55103 |
| 3L-11S | | MI | 47328 | 11054 | 74144 | 8306 | 79602 | 6762 | 80157 | 5615 | 77505 | 3948 | 91836 | 3112 | 50330 |
| 24-#11 | 1.70 | MA | 53513 | 11054 | 84062 | 8306 | 91952 | 6748 | 94600 | 5591 | 95959 | 3937 | 114998 | 3538 | 55083 |
| 4L-10S | | MI | 47896 | 11054 | 75012 | 8308 | 80770 | 6765 | 81631 | 5620 | 79561 | 3954 | 94284 | 3165 | 50885 |
| 24-#11 | 1.70 | MA | 52909 | 11054 | 83055 | 8304 | 90646 | 6746 | 92995 | 5604 | 93634 | 3931 | 112172 | 3495 | 55037 |
| 5L-9S | | MI | 48478 | 11054 | 75982 | 8293 | 81960 | 6751 | 83051 | 5607 | 81489 | 3944 | 96692 | 3226 | 51403 |
| 24-#11 | 1.70 | MA | 52334 | 11054 | 82113 | 8302 | 89339 | 6760 | 91398 | 5600 | 91529 | 3942 | 109470 | 3439 | 54954 |
| 6L-8S | | MI | 49032 | 11054 | 76849 | 8295 | 83133 | 6754 | 84544 | 5611 | 83434 | 3933 | 99177 | 3279 | 51698 |
| 24-#11 | 1.70 | MA | 51775 | 11054 | 81079 | 8318 | 88093 | 6757 | 89865 | 5613 | 89472 | 3953 | 106590 | 3350 | 54507 |
| 7E | | MI | 49559 | 11054 | 77735 | 8297 | 84340 | 6740 | 85972 | 5598 | 85521 | 3940 | 101687 | 3329 | 52090 |
| 24-#11 | 1.70 | MA | 51223 | 11054 | 80152 | 8316 | 86829 | 6772 | 88369 | 5627 | 87286 | 3946 | 103947 | 3299 | 54082 |
| 8L-6S | | MI | 50094 | 11054 | 78721 | 8282 | 85530 | 6743 | 87434 | 5585 | 87483 | 3929 | 104419 | 3419 | 52512 |
| 24-#11 | 1.70 | MA | 50633 | 11054 | 79244 | 8314 | 85600 | 6769 | 86805 | 5623 | 85249 | 3957 | 101327 | 3246 | 53759 |
| 9L-5S | | MI | 50643 | 11054 | 79621 | 8284 | 86777 | 6729 | 88959 | 5590 | 89493 | 3919 | 106981 | 3475 | 52582 |
| 24-#11 | 1.70 | MA | 50024 | 11054 | 78228 | 8330 | 84353 | 6783 | 85317 | 5636 | 83229 | 3968 | 98787 | 3185 | 53205 |
| 10L-4S | | MI | 51220 | 11054 | 80581 | 8286 | 88023 | 6732 | 90490 | 5577 | 91711 | 3926 | 109666 | 3517 | 52619 |
| 24-#11 | 1.70 | MA | 49430 | 11054 | 77319 | 8328 | 83130 | 6780 | 83773 | 5632 | 81074 | 3962 | 96209 | 3132 | 52607 |
| 11L-3S | | MI | 51866 | 11054 | 81693 | 8270 | 89440 | 6718 | 92213 | 5581 | 93929 | 3915 | 112250 | 3604 | 52630 |
| 24-#11 | 1.70 | MA | 48846 | 11054 | 76321 | 8344 | 81892 | 6795 | 82288 | 5645 | 79055 | 3973 | 93302 | 3055 | 52032 |
| 12L-2S | | MI | 52792 | 11054 | 83062 | 8272 | 91195 | 6721 | 94354 | 5568 | 96841 | 3905 | 116210 | 3690 | 52615 |
| 24-#14 | 2.45 | MA | 56265 | 11627 | 90517 | 8645 | 100072 | 6990 | 104448 | 5734 | 109390 | 3887 | 133197 | 3354 | 78335 |
| 4L-10S | | MI | 49138 | 11627 | 78737 | 8654 | 85343 | 7017 | 87149 | 5776 | 87058 | 3911 | 104979 | 2819 | 70222 |
| 24-#14 | 2.45 | MA | 55411 | 11627 | 89072 | 8642 | 98199 | 6986 | 102145 | 5752 | 106054 | 3877 | 129164 | 3293 | 78142 |
| 5L-9S | | MI | 49961 | 11627 | 80129 | 8633 | 87051 | 6997 | 89187 | 5758 | 89825 | 3896 | 108405 | 2907 | 71118 |
| 24-#14 | 2.45 | MA | 54598 | 11627 | 87719 | 8640 | 96323 | 7006 | 99853 | 5746 | 103033 | 3892 | 125316 | 3212 | 77164 |
| 6L-8S | | MI | 50734 | 11627 | 81373 | 8636 | 88736 | 7002 | 91329 | 5765 | 92616 | 3882 | 111941 | 2985 | 72292 |
| 24-#14 | 2.45 | MA | 53807 | 11627 | 86236 | 8662 | 94534 | 7001 | 97653 | 5764 | 100081 | 3907 | 121213 | 3082 | 76380 |
| 7E | | MI | 51479 | 11627 | 82645 | 8639 | 90467 | 6982 | 93378 | 5747 | 95610 | 3893 | 115522 | 3056 | 72948 |
| 24-#14 | 2.45 | MA | 53028 | 11627 | 84904 | 8659 | 92720 | 7021 | 95506 | 5783 | 96944 | 3897 | 117441 | 3011 | 75692 |
| 8L-6S | | MI | 52235 | 11627 | 84060 | 8618 | 92174 | 6987 | 95477 | 5729 | 98426 | 3878 | 119411 | 3185 | 73672 |
| 24-#14 | 2.45 | MA | 52205 | 11627 | 83601 | 8656 | 90955 | 7017 | 93261 | 5776 | 94019 | 3912 | 113710 | 2933 | 74433 |
| 9L-5S | | MI | 53011 | 11627 | 85352 | 8621 | 93964 | 6967 | 97665 | 5736 | 101309 | 3864 | 123058 | 3266 | 74607 |
| 24-#14 | 2.45 | MA | 51342 | 11627 | 82141 | 8678 | 89165 | 7037 | 91125 | 5795 | 91120 | 3927 | 110094 | 2846 | 73474 |
| 10L-4S | | MI | 53827 | 11627 | 86730 | 8624 | 95752 | 6973 | 99862 | 5718 | 104491 | 3874 | 126887 | 3327 | 74781 |
| 24-#18 | 4.35 | MA | 60067 | 13079 | 101633 | 9505 | 113737 | 7636 | 120970 | 6119 | 131782 | 3767 | 164424 | 2609 | 130836 |
| 6L-8S | | MI | 54844 | 13079 | 92569 | 9509 | 102678 | 7636 | 108250 | 6159 | 115530 | 3751 | 143398 | 2212 | 119264 |
| 24-#18 | 4.35 | MA | 58719 | 13079 | 99021 | 9543 | 110588 | 7670 | 117098 | 6150 | 126586 | 3791 | 157310 | 2378 | 127683 |
| 7E | | MI | 56112 | 13079 | 94807 | 9516 | 105726 | 7647 | 111856 | 6129 | 120796 | 3772 | 149622 | 2335 | 121757 |
| 24-#18 | 4.35 | MA | 57393 | 13079 | 96675 | 9536 | 107393 | 7660 | 113318 | 6181 | 121064 | 3771 | 150747 | 2254 | 125078 |
| 8L-6S | | MI | 57400 | 13079 | 97298 | 9480 | 108730 | 7614 | 115550 | 6099 | 125751 | 3750 | 156357 | 2566 | 124778 |

## RECTANGULAR TIED COLUMNS 48" x 48"

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#18 | 1.04 | MA | 54087 | 11014 | 83664 | 8254 | 90256 | 6736 | 91572 | 5631 | 90198 | 4088 | 105380 | 3879 | 35419 |
| 2L-3S | | MI | 51622 | 11014 | 80056 | 8247 | 85630 | 6770 | 85929 | 5662 | 82519 | 4112 | 95062 | 3658 | 35554 |
| 8-#18 | 1.39 | MA | 55789 | 11290 | 87273 | 8427 | 94882 | 6860 | 97216 | 5707 | 97877 | 4066 | 115699 | 3834 | 46784 |
| 2L-4S | | MI | 51619 | 11290 | 80724 | 8457 | 86509 | 6884 | 87018 | 5724 | 84337 | 4113 | 98666 | 3391 | 46800 |
| 10-#18 | 1.74 | MA | 57476 | 11567 | 90882 | 8599 | 99508 | 6984 | 102860 | 5782 | 105555 | 4043 | 126017 | 3788 | 58111 |
| 2L-5S | | MI | 51806 | 11567 | 81790 | 8624 | 87838 | 7042 | 88610 | 5830 | 86147 | 4071 | 101965 | 3239 | 57088 |
| 10-#18 | 1.74 | MA | 55041 | 11567 | 87273 | 8593 | 94882 | 7018 | 97216 | 5813 | 97877 | 4067 | 115699 | 3567 | 58138 |
| 3L-4S | | MI | 53332 | 11567 | 84333 | 8630 | 91135 | 7008 | 92661 | 5799 | 92015 | 4091 | 108984 | 3345 | 57975 |

(1) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

(2) L = long face, S = short face, E = each face; 3E = 3 bars each face; 2L-3S = 2 bars each long face and 3 short face.

## ROUND SPIRAL COLUMNS 12" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.64 | 201 | 312 | 400 | 241 | 465 | 193 | 489 | 155 | 496 | 92 | 423 | 9 | 396 |
| 6-#6 | 2.33 | 203 | 340 | 437 | 255 | 506 | 202 | 536 | 159 | 517 | 79 | 473 | -18 | 485 |
| 6-#7 | 3.18 | 206 | 375 | 481 | 274 | 554 | 214 | 590 | 164 | 622 | 75 | 531 | -50 | 559 |
| 6-#8 | 4.19 | 210 | 416 | 530 | 296 | 609 | 226 | 653 | 170 | 701 | 64 | 595 | -90 | 640 |
| 6-#9 | 5.31 | 216 | 462 | 580 | 319 | 667 | 240 | 718 | 175 | 730 | 47 | 679 | -129 | 721 |
| 6-#10 | 6.74 | 224 | 520 | 641 | 348 | 737 | 257 | 798 | 181 | 883 | 32 | 761 | -187 | 819 |
| 7-#5 | 1.92 | 205 | 323 | 387 | 260 | 466 | 211 | 503 | 169 | 521 | 102 | 467 | 12 | 438 |
| 7-#6 | 2.72 | 209 | 356 | 427 | 279 | 512 | 224 | 555 | 176 | 546 | 90 | 528 | -16 | 540 |
| 7-#7 | 3.71 | 214 | 397 | 474 | 301 | 566 | 240 | 616 | 184 | 662 | 88 | 604 | -49 | 633 |
| 7-#8 | 4.89 | 221 | 445 | 528 | 328 | 629 | 258 | 686 | 192 | 699 | 73 | 685 | -92 | 728 |
| 7-#9 | 6.19 | 231 | 498 | 585 | 358 | 694 | 278 | 758 | 204 | 785 | 62 | 767 | -141 | 818 |
| 8-#5 | 2.19 | 208 | 335 | 392 | 271 | 478 | 219 | 520 | 175 | 509 | 97 | 500 | 5 | 490 |
| 8-#6 | 3.11 | 212 | 372 | 437 | 293 | 530 | 234 | 579 | 183 | 619 | 98 | 571 | -27 | 581 |
| 8-#7 | 4.24 | 218 | 418 | 489 | 320 | 591 | 252 | 649 | 193 | 706 | 91 | 655 | -67 | 681 |
| 8-#8 | 5.59 | 227 | 473 | 549 | 351 | 661 | 274 | 728 | 203 | 805 | 81 | 749 | -115 | 789 |

## ROUND SPIRAL COLUMNS 14" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.21 | 323 | 401 | 585 | 323 | 701 | 264 | 746 | 214 | 755 | 139 | 659 | 42 | 497 |
| 6-#6 | 1.71 | 327 | 429 | 633 | 338 | 758 | 274 | 809 | 219 | 779 | 124 | 732 | 18 | 667 |
| 6-#7 | 2.34 | 332 | 464 | 690 | 357 | 826 | 287 | 884 | 228 | 929 | 126 | 817 | -13 | 825 |
| 6-#8 | 3.08 | 338 | 505 | 756 | 379 | 902 | 302 | 971 | 235 | 968 | 109 | 914 | -49 | 940 |
| 6-#9 | 3.90 | 345 | 550 | 826 | 404 | 983 | 318 | 1063 | 243 | 1152 | 107 | 1015 | -90 | 1057 |
| 6-#10 | 4.95 | 356 | 609 | 914 | 436 | 1083 | 338 | 1177 | 253 | 1208 | 87 | 1138 | -144 | 1198 |
| 6-#11 | 6.08 | 361 | 671 | 998 | 466 | 1159 | 351 | 1259 | 255 | 1396 | 68 | 1202 | -213 | 1295 |
| 7-#5 | 1.41 | 329 | 412 | 556 | 348 | 693 | 286 | 756 | 234 | 790 | 153 | 723 | 49 | 560 |
| 7-#6 | 2.00 | 335 | 445 | 609 | 367 | 754 | 300 | 827 | 242 | 877 | 149 | 812 | 25 | 739 |
| 7-#7 | 2.73 | 344 | 485 | 672 | 390 | 827 | 317 | 911 | 251 | 917 | 134 | 916 | -6 | 921 |
| 7-#8 | 3.59 | 354 | 533 | 745 | 419 | 911 | 337 | 1008 | 263 | 1103 | 137 | 1035 | -43 | 1065 |
| 7-#9 | 4.55 | 367 | 586 | 822 | 450 | 1000 | 358 | 1112 | 275 | 1232 | 129 | 1159 | -86 | 1211 |
| 7-#10 | 5.78 | 385 | 654 | 919 | 489 | 1112 | 386 | 1242 | 290 | 1391 | 118 | 1310 | -142 | 1374 |
| 7-#11 | 7.09 | 395 | 728 | 1007 | 525 | 1206 | 408 | 1336 | 296 | 1505 | 95 | 1407 | -216 | 1475 |
| 8-#5 | 1.61 | 332 | 423 | 563 | 361 | 708 | 295 | 777 | 241 | 767 | 146 | 762 | 42 | 627 |
| 8-#6 | 2.29 | 339 | 461 | 623 | 383 | 776 | 311 | 856 | 250 | 860 | 142 | 863 | 14 | 833 |
| 8-#7 | 3.12 | 348 | 507 | 693 | 411 | 858 | 331 | 951 | 262 | 1041 | 148 | 983 | -21 | 995 |
| 8-#8 | 4.11 | 360 | 562 | 773 | 445 | 953 | 354 | 1060 | 275 | 1178 | 142 | 1134 | -60 | 1150 |
| 8-#9 | 5.20 | 373 | 622 | 858 | 481 | 1053 | 380 | 1177 | 290 | 1324 | 135 | 1280 | -108 | 1308 |
| 8-#10 | 6.60 | 394 | 700 | 964 | 528 | 1178 | 412 | 1323 | 308 | 1404 | 116 | 1458 | -172 | 1500 |

## ROUND SPIRAL COLUMNS 16" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#6 | 1.31 | 490 | 531 | 876 | 434 | 1065 | 355 | 1153 | 290 | 1186 | 187 | 1055 | 58 | 809 |
| 6-#7 | 1.79 | 498 | 566 | 946 | 453 | 1150 | 368 | 1250 | 297 | 1220 | 170 | 1169 | 30 | 1054 |
| 6-#8 | 2.36 | 506 | 607 | 1027 | 476 | 1248 | 384 | 1362 | 305 | 1446 | 175 | 1300 | -3 | 1302 |
| 6-#9 | 2.98 | 516 | 652 | 1114 | 501 | 1354 | 401 | 1481 | 313 | 1595 | 167 | 1438 | -41 | 1459 |
| 6-#10 | 3.79 | 529 | 711 | 1224 | 533 | 1487 | 424 | 1630 | 324 | 1782 | 156 | 1609 | -92 | 1649 |
| 6-#11 | 4.66 | 536 | 774 | 1334 | 563 | 1606 | 442 | 1749 | 335 | 1927 | 136 | 1719 | -158 | 1787 |
| 6-#14 | 6.71 | 577 | 923 | 1589 | 645 | 1898 | 493 | 2081 | 360 | 2345 | 100 | 2079 | -295 | 2187 |
| 7-#5 | 1.08 | 492 | 514 | 763 | 449 | 978 | 372 | 1078 | 308 | 1128 | 209 | 1047 | 89 | 687 |
| 7-#6 | 1.53 | 501 | 547 | 829 | 469 | 1055 | 386 | 1165 | 316 | 1240 | 207 | 1164 | 68 | 910 |
| 7-#7 | 2.09 | 514 | 587 | 907 | 493 | 1147 | 404 | 1271 | 327 | 1283 | 190 | 1303 | 40 | 1169 |
| 7-#8 | 2.75 | 528 | 635 | 996 | 521 | 1252 | 425 | 1393 | 339 | 1531 | 200 | 1463 | 7 | 1443 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 16" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 7-#9 | 3.48 | 544 | 688 | 1093 | 553 | 1366 | 448 | 1524 | 353 | 1697 | 195 | 1632 | -31 | 1653 |
| 7-#10 | 4.42 | 566 | 757 | 1214 | 593 | 1508 | 478 | 1689 | 370 | 1904 | 187 | 1841 | -81 | 1888 |
| 7-#11 | 5.43 | 580 | 830 | 1336 | 631 | 1636 | 502 | 1832 | 382 | 1930 | 158 | 1978 | -150 | 2058 |
| 7-#14 | 7.83 | 645 | 1004 | 1618 | 733 | 1961 | 573 | 2211 | 421 | 2534 | 141 | 2421 | -294 | 2508 |
| 8-#5 | 1.23 | 495 | 525 | 765 | 463 | 995 | 383 | 1103 | 316 | 1088 | 200 | 1097 | 84 | 762 |
| 8-#6 | 1.75 | 505 | 563 | 839 | 486 | 1081 | 400 | 1202 | 326 | 1292 | 212 | 1230 | 59 | 1023 |
| 8-#7 | 2.39 | 518 | 609 | 927 | 515 | 1184 | 421 | 1320 | 339 | 1348 | 195 | 1389 | 28 | 1318 |
| 8-#8 | 3.14 | 533 | 664 | 1028 | 549 | 1303 | 445 | 1457 | 354 | 1513 | 192 | 1572 | -11 | 1578 |
| 8-#9 | 3.98 | 550 | 724 | 1138 | 587 | 1430 | 472 | 1605 | 370 | 1811 | 202 | 1765 | -55 | 1790 |
| 8-#10 | 5.05 | 574 | 802 | 1275 | 636 | 1590 | 507 | 1790 | 391 | 2049 | 196 | 2004 | -113 | 2046 |
| 8-#11 | 6.21 | 591 | 886 | 1408 | 681 | 1733 | 535 | 1951 | 405 | 2086 | 166 | 2199 | -183 | 2236 |
| 9-#10 | 5.68 | 601 | 848 | 1361 | 657 | 1695 | 525 | 1920 | 403 | 2205 | 186 | 2178 | -136 | 2216 |
| 9-#11 | 6.98 | 624 | 942 | 1508 | 707 | 1863 | 559 | 2101 | 418 | 2255 | 154 | 2360 | -222 | 2416 |
| 10-#10 | 6.32 | 622 | 894 | 1490 | 670 | 1817 | 531 | 2059 | 401 | 2375 | 170 | 2313 | -180 | 2358 |

## ROUND SPIRAL COLUMNS 18" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#6 | 1.04 | 698 | 647 | 1170 | 544 | 1445 | 447 | 1570 | 368 | 1619 | 248 | 1451 | 101 | 951 |
| 6-#7 | 1.41 | 708 | 681 | 1253 | 563 | 1545 | 460 | 1688 | 376 | 1766 | 244 | 1595 | 75 | 1245 |
| 6-#8 | 1.86 | 720 | 723 | 1350 | 585 | 1662 | 476 | 1826 | 385 | 1937 | 238 | 1760 | 44 | 1579 |
| 6-#9 | 2.36 | 733 | 768 | 1454 | 610 | 1788 | 494 | 1976 | 395 | 2121 | 232 | 1936 | 10 | 1911 |
| 6-#10 | 2.99 | 750 | 827 | 1586 | 643 | 1948 | 516 | 2165 | 408 | 2351 | 223 | 2156 | -36 | 2174 |
| 6-#11 | 3.68 | 759 | 889 | 1722 | 673 | 2103 | 536 | 2322 | 414 | 2543 | 206 | 2315 | -98 | 2360 |
| 6-#14 | 5.31 | 805 | 1039 | 2033 | 756 | 2483 | 594 | 2743 | 441 | 3072 | 177 | 2797 | -227 | 2876 |
| 7-#6 | 1.21 | 712 | 663 | 1090 | 585 | 1419 | 485 | 1582 | 401 | 1679 | 271 | 1593 | 114 | 1086 |
| 7-#7 | 1.65 | 728 | 703 | 1183 | 609 | 1529 | 503 | 1709 | 412 | 1841 | 269 | 1767 | 89 | 1398 |
| 7-#8 | 2.17 | 748 | 751 | 1291 | 637 | 1656 | 524 | 1856 | 425 | 1895 | 249 | 1969 | 58 | 1752 |
| 7-#9 | 2.75 | 769 | 804 | 1407 | 669 | 1793 | 548 | 2014 | 440 | 2235 | 263 | 2184 | 24 | 2107 |
| 7-#10 | 3.49 | 796 | 872 | 1552 | 710 | 1967 | 579 | 2215 | 459 | 2494 | 259 | 2452 | -22 | 2467 |
| 7-#11 | 4.29 | 813 | 946 | 1705 | 749 | 2134 | 605 | 2396 | 472 | 2717 | 246 | 2649 | -84 | 2701 |
| 7-#14 | 6.19 | 888 | 1120 | 2047 | 853 | 2536 | 681 | 2865 | 516 | 3085 | 211 | 3239 | -213 | 3325 |
| 8-#6 | 1.38 | 716 | 679 | 1095 | 603 | 1451 | 500 | 1624 | 412 | 1626 | 259 | 1676 | 107 | 1212 |
| 8-#7 | 1.89 | 733 | 725 | 1199 | 632 | 1575 | 522 | 1766 | 426 | 1925 | 276 | 1875 | 78 | 1579 |
| 8-#8 | 2.48 | 754 | 780 | 1320 | 666 | 1719 | 547 | 1932 | 442 | 2138 | 275 | 2105 | 43 | 1980 |
| 8-#9 | 3.14 | 775 | 840 | 1450 | 704 | 1874 | 575 | 2111 | 459 | 2368 | 272 | 2351 | 4 | 2341 |
| 8-#10 | 3.99 | 803 | 918 | 1614 | 754 | 2068 | 611 | 2337 | 482 | 2659 | 269 | 2656 | -49 | 2676 |
| 8-#11 | 4.90 | 823 | 1002 | 1788 | 801 | 2251 | 642 | 2541 | 498 | 2915 | 256 | 2883 | -121 | 2929 |
| 8-#14 | 7.07 | 904 | 1201 | 2177 | 926 | 2704 | 730 | 3068 | 550 | 3590 | 240 | 3558 | -271 | 3634 |
| 9-#10 | 4.49 | 835 | 964 | 1728 | 776 | 2187 | 627 | 2489 | 493 | 2855 | 261 | 2859 | -75 | 2898 |
| 9-#11 | 5.52 | 862 | 1058 | 1914 | 828 | 2396 | 663 | 2726 | 513 | 3144 | 246 | 3134 | -149 | 3176 |
| 10-#10 | 4.99 | 858 | 1010 | 1891 | 788 | 2339 | 633 | 2652 | 490 | 3075 | 247 | 3043 | -112 | 3059 |
| 10-#11 | 6.13 | 891 | 1114 | 2098 | 844 | 2570 | 672 | 2918 | 510 | 3387 | 227 | 3329 | -201 | 3373 |
| 11-#10 | 5.49 | 883 | 1056 | 1913 | 835 | 2426 | 673 | 2762 | 525 | 3219 | 262 | 3277 | -126 | 3300 |
| 11-#11 | 6.74 | 923 | 1171 | 2137 | 900 | 2677 | 718 | 3048 | 550 | 3570 | 245 | 3595 | -220 | 3631 |
| 12-#10 | 5.99 | 916 | 1101 | 1992 | 869 | 2518 | 701 | 2899 | 545 | 3392 | 268 | 3489 | -149 | 3508 |

## ROUND SPIRAL COLUMNS 20" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 1.15 | 969 | 811 | 1618 | 686 | 2020 | 563 | 2212 | 463 | 2163 | 291 | 2103 | 123 | 1437 |
| 6-#8 | 1.51 | 985 | 852 | 1730 | 708 | 2156 | 579 | 2371 | 473 | 2352 | 287 | 2304 | 95 | 1829 |
| 6-#9 | 1.91 | 1002 | 897 | 1852 | 733 | 2303 | 597 | 2545 | 483 | 2738 | 302 | 2519 | 62 | 2245 |
| 6-#10 | 2.43 | 1023 | 956 | 2006 | 766 | 2488 | 620 | 2766 | 497 | 3014 | 295 | 2788 | 20 | 2731 |
| 6-#11 | 2.98 | 1035 | 1019 | 2170 | 796 | 2674 | 640 | 2978 | 507 | 3035 | 261 | 2996 | -37 | 3015 |
| 6-#14 | 4.30 | 1088 | 1168 | 2535 | 880 | 3120 | 699 | 3499 | 539 | 3894 | 257 | 3603 | -156 | 3658 |
| 6-#18 | 7.64 | 1254 | 1547 | 3409 | 1092 | 4194 | 848 | 4696 | 610 | 5396 | 187 | 4977 | -482 | 5082 |
| 7-#7 | 1.34 | 993 | 832 | 1506 | 739 | 1985 | 613 | 2233 | 507 | 2400 | 342 | 2318 | 140 | 1635 |
| 7-#8 | 1.76 | 1017 | 880 | 1632 | 768 | 2133 | 635 | 2406 | 521 | 2621 | 340 | 2563 | 112 | 2051 |
| 7-#9 | 2.23 | 1042 | 934 | 1767 | 800 | 2293 | 659 | 2593 | 536 | 2670 | 315 | 2824 | 80 | 2493 |
| 7-#10 | 2.83 | 1078 | 1002 | 1938 | 841 | 2496 | 690 | 2828 | 556 | 3165 | 335 | 3152 | 38 | 3014 |
| 7-#11 | 3.48 | 1100 | 1075 | 2121 | 880 | 2699 | 717 | 3049 | 570 | 3212 | 303 | 3409 | -19 | 3422 |
| 7-#14 | 5.01 | 1186 | 1249 | 2526 | 985 | 3184 | 796 | 3608 | 618 | 4164 | 312 | 4150 | -137 | 4220 |
| 8-#7 | 1.53 | 999 | 854 | 1515 | 763 | 2035 | 634 | 2299 | 523 | 2331 | 327 | 2448 | 132 | 1832 |
| 8-#8 | 2.01 | 1023 | 909 | 1655 | 798 | 2205 | 660 | 2494 | 540 | 2747 | 350 | 2727 | 100 | 2322 |
| 8-#9 | 2.55 | 1049 | 970 | 1807 | 836 | 2390 | 689 | 2704 | 558 | 3017 | 348 | 3025 | 63 | 2823 |
| 8-#10 | 3.23 | 1085 | 1048 | 1998 | 886 | 2620 | 726 | 2970 | 582 | 3135 | 323 | 3399 | 15 | 3354 |
| 8-#11 | 3.97 | 1109 | 1131 | 2205 | 933 | 2843 | 758 | 3218 | 599 | 3425 | 314 | 3694 | -51 | 3715 |
| 8-#14 | 5.73 | 1198 | 1330 | 2662 | 1059 | 3384 | 850 | 3847 | 656 | 4183 | 305 | 4540 | -188 | 4588 |
| 9-#10 | 3.64 | 1122 | 1093 | 2137 | 908 | 2761 | 738 | 3140 | 591 | 3591 | 340 | 3643 | -11 | 3650 |
| 9-#11 | 4.47 | 1154 | 1188 | 2365 | 961 | 3005 | 778 | 3426 | 612 | 3943 | 328 | 3978 | -83 | 4023 |
| 9-#14 | 6.45 | 1272 | 1412 | 2873 | 1100 | 3614 | 881 | 4147 | 677 | 4865 | 314 | 4934 | -234 | 4983 |
| 10-#10 | 4.04 | 1149 | 1139 | 2343 | 920 | 2937 | 746 | 3334 | 587 | 3839 | 324 | 3862 | -45 | 3850 |
| 10-#11 | 4.97 | 1186 | 1244 | 2592 | 976 | 3216 | 785 | 3654 | 609 | 4250 | 311 | 4236 | -126 | 4248 |
| 10-#14 | 7.16 | 1318 | 1493 | 3172 | 1125 | 3900 | 895 | 4461 | 675 | 5290 | 291 | 5298 | -298 | 5319 |
| 11-#10 | 4.45 | 1177 | 1185 | 2351 | 969 | 3025 | 787 | 3460 | 625 | 4020 | 343 | 4147 | -57 | 4159 |
| 11-#11 | 5.46 | 1221 | 1300 | 2620 | 1034 | 3334 | 834 | 3805 | 653 | 4449 | 330 | 4563 | -143 | 4585 |
| 12-#10 | 4.85 | 1214 | 1231 | 2441 | 1003 | 3131 | 817 | 3610 | 645 | 3944 | 328 | 4402 | -77 | 4424 |
| 12-#11 | 5.96 | 1266 | 1356 | 2729 | 1075 | 3461 | 869 | 3992 | 677 | 4377 | 315 | 4859 | -171 | 4873 |
| 13-#10 | 5.26 | 1238 | 1277 | 2558 | 1032 | 3288 | 836 | 3782 | 659 | 4440 | 345 | 4632 | -108 | 4653 |
| 14-#10 | 5.66 | 1282 | 1322 | 2708 | 1051 | 3453 | 851 | 3979 | 664 | 4672 | 335 | 4848 | -139 | 4880 |

## ROUND SPIRAL COLUMNS 22" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.25 | 1303 | 995 | 2173 | 845 | 2738 | 694 | 3017 | 570 | 2990 | 358 | 2939 | 148 | 2079 |
| 6-#9 | 1.58 | 1326 | 1040 | 2313 | 870 | 2906 | 712 | 3214 | 581 | 3457 | 379 | 3193 | 117 | 2559 |
| 6-#10 | 2.00 | 1352 | 1099 | 2489 | 903 | 3118 | 735 | 3466 | 595 | 3778 | 373 | 3512 | 78 | 3155 |
| 6-#11 | 2.46 | 1369 | 1162 | 2681 | 933 | 3334 | 755 | 3712 | 605 | 3792 | 336 | 3771 | 25 | 3693 |
| 6-#14 | 3.55 | 1430 | 1311 | 3102 | 1017 | 3847 | 814 | 4322 | 639 | 4819 | 341 | 4504 | -87 | 4537 |
| 6-#18 | 6.31 | 1609 | 1690 | 4113 | 1230 | 5089 | 965 | 5784 | 724 | 6609 | 283 | 6195 | -389 | 6263 |
| 7-#7 | 1.10 | 1314 | 975 | 1879 | 883 | 2522 | 735 | 2850 | 611 | 3060 | 421 | 2965 | 196 | 1877 |
| 7-#8 | 1.45 | 1343 | 1023 | 2023 | 912 | 2691 | 757 | 3048 | 626 | 3093 | 392 | 3252 | 169 | 2356 |
| 7-#9 | 1.84 | 1374 | 1077 | 2179 | 944 | 2874 | 781 | 3263 | 642 | 3589 | 419 | 3561 | 140 | 2867 |
| 7-#10 | 2.34 | 1414 | 1145 | 2374 | 986 | 3106 | 813 | 3536 | 662 | 3938 | 417 | 3950 | 101 | 3501 |
| 7-#11 | 2.87 | 1445 | 1218 | 2590 | 1025 | 3344 | 841 | 3799 | 678 | 4263 | 408 | 4268 | 48 | 4080 |
| 7-#14 | 4.14 | 1544 | 1392 | 3056 | 1131 | 3902 | 921 | 4448 | 728 | 4761 | 373 | 5162 | -62 | 5197 |
| 7-#18 | 7.37 | 1810 | 1834 | 4174 | 1401 | 5249 | 1122 | 6003 | 850 | 7117 | 370 | 7227 | -362 | 7282 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 22" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#7 | 1.26 | 1320 | 997 | 1878 | 909 | 2572 | 758 | 2928 | 630 | 3173 | 432 | 3118 | 189 | 2089 |
| 8-#8 | 1.66 | 1350 | 1052 | 2038 | 944 | 2765 | 784 | 3151 | 647 | 3228 | 403 | 3445 | 159 | 2652 |
| 8-#9 | 2.10 | 1382 | 1113 | 2212 | 982 | 2976 | 813 | 3393 | 666 | 3518 | 403 | 3797 | 125 | 3255 |
| 8-#10 | 2.67 | 1421 | 1191 | 2430 | 1032 | 3243 | 851 | 3700 | 691 | 4162 | 431 | 4240 | 80 | 3960 |
| 8-#11 | 3.28 | 1454 | 1274 | 2672 | 1079 | 3516 | 886 | 3993 | 709 | 4528 | 423 | 4605 | 19 | 4541 |
| 8-#14 | 4.74 | 1554 | 1473 | 3197 | 1206 | 4147 | 980 | 4724 | 769 | 5471 | 417 | 5624 | -107 | 5651 |
| 9-#10 | 3.01 | 1468 | 1236 | 2595 | 1054 | 3409 | 863 | 3886 | 698 | 4135 | 396 | 4527 | 55 | 4302 |
| 9-#11 | 3.69 | 1506 | 1331 | 2861 | 1107 | 3706 | 899 | 4221 | 721 | 4845 | 414 | 4942 | -12 | 4949 |
| 9-#14 | 5.33 | 1637 | 1555 | 3451 | 1248 | 4416 | 1003 | 5053 | 788 | 5918 | 406 | 6095 | -152 | 6153 |
| 10-#10 | 3.34 | 1498 | 1282 | 2848 | 1065 | 3618 | 869 | 4113 | 693 | 4700 | 406 | 4741 | 14 | 4700 |
| 10-#11 | 4.10 | 1541 | 1387 | 3142 | 1122 | 3946 | 909 | 4487 | 716 | 4834 | 368 | 5242 | -53 | 5222 |
| 10-#14 | 5.92 | 1685 | 1636 | 3814 | 1273 | 4738 | 1022 | 5421 | 785 | 5979 | 357 | 6524 | -212 | 6510 |
| 11-#10 | 3.68 | 1530 | 1328 | 2839 | 1116 | 3705 | 913 | 4255 | 735 | 4583 | 400 | 5117 | 12 | 5070 |
| 11-#11 | 4.51 | 1581 | 1443 | 3153 | 1182 | 4065 | 961 | 4659 | 764 | 5427 | 419 | 5632 | -68 | 5643 |
| 11-#14 | 6.51 | 1754 | 1717 | 3866 | 1354 | 4929 | 1090 | 5669 | 848 | 6741 | 411 | 7054 | -237 | 7034 |
| 12-#10 | 4.01 | 1573 | 1374 | 2938 | 1152 | 3824 | 943 | 4416 | 754 | 5162 | 440 | 5415 | -5 | 5417 |
| 12-#11 | 4.92 | 1631 | 1499 | 3276 | 1224 | 4209 | 997 | 4861 | 787 | 5711 | 430 | 5980 | -92 | 6005 |
| 13-#10 | 4.34 | 1598 | 1420 | 3070 | 1180 | 4007 | 963 | 4615 | 769 | 5395 | 432 | 5686 | -36 | 5699 |
| 13-#11 | 5.33 | 1664 | 1556 | 3434 | 1260 | 4424 | 1021 | 5095 | 805 | 6000 | 422 | 6296 | -130 | 6317 |
| 14-#10 | 4.68 | 1648 | 1465 | 3248 | 1198 | 4193 | 976 | 4848 | 774 | 5661 | 422 | 5938 | -65 | 5953 |
| 14-#11 | 5.75 | 1724 | 1612 | 3638 | 1283 | 4647 | 1039 | 5368 | 812 | 6317 | 409 | 6593 | -167 | 6628 |
| 15-#10 | 5.01 | 1669 | 1511 | 3325 | 1241 | 4307 | 1012 | 4983 | 803 | 5492 | 408 | 6254 | -84 | 6262 |
| 16-#10 | 5.35 | 1711 | 1557 | 3412 | 1276 | 4451 | 1042 | 5156 | 822 | 6114 | 443 | 6547 | -101 | 6560 |

## ROUND SPIRAL COLUMNS 24" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.05 | 1683 | 1152 | 2685 | 995 | 3418 | 820 | 3771 | 678 | 3728 | 434 | 3675 | 205 | 2330 |
| 6-#9 | 1.33 | 1709 | 1197 | 2842 | 1020 | 3606 | 838 | 3993 | 688 | 4287 | 462 | 3968 | 176 | 2874 |
| 6-#10 | 1.68 | 1743 | 1256 | 3041 | 1053 | 3845 | 861 | 4275 | 702 | 4654 | 457 | 4338 | 138 | 3552 |
| 6-#11 | 2.07 | 1765 | 1318 | 3261 | 1082 | 4092 | 881 | 4555 | 712 | 4986 | 445 | 4648 | 88 | 4223 |
| 6-#14 | 2.98 | 1837 | 1468 | 3738 | 1167 | 4672 | 941 | 5244 | 747 | 5857 | 430 | 5509 | -17 | 5516 |
| 6-#18 | 5.31 | 2033 | 1847 | 4889 | 1382 | 6082 | 1093 | 6924 | 837 | 7408 | 356 | 7521 | -300 | 7565 |
| 7-#8 | 1.22 | 1730 | 1180 | 2469 | 1071 | 3338 | 892 | 3795 | 741 | 4119 | 508 | 4048 | 231 | 2671 |
| 7-#9 | 1.55 | 1767 | 1233 | 2645 | 1103 | 3545 | 916 | 4036 | 757 | 4429 | 507 | 4404 | 202 | 3250 |
| 7-#10 | 1.97 | 1814 | 1301 | 2866 | 1145 | 3806 | 948 | 4343 | 778 | 4824 | 506 | 4853 | 166 | 3972 |
| 7-#11 | 2.41 | 1849 | 1375 | 3114 | 1183 | 4079 | 975 | 4650 | 794 | 5197 | 498 | 5234 | 116 | 4682 |
| 7-#14 | 3.48 | 1967 | 1549 | 3644 | 1291 | 4711 | 1056 | 5396 | 847 | 5742 | 460 | 6283 | 13 | 6229 |
| 7-#18 | 6.19 | 2259 | 1991 | 4918 | 1563 | 6243 | 1261 | 7180 | 975 | 7898 | 440 | 8736 | -267 | 8811 |
| 8-#8 | 1.40 | 1739 | 1209 | 2472 | 1104 | 3412 | 920 | 3913 | 765 | 4283 | 522 | 4261 | 221 | 2986 |
| 8-#9 | 1.77 | 1776 | 1269 | 2668 | 1142 | 3649 | 949 | 4187 | 784 | 4633 | 522 | 4670 | 190 | 3668 |
| 8-#10 | 2.25 | 1823 | 1347 | 2913 | 1192 | 3948 | 987 | 4535 | 810 | 5079 | 523 | 5188 | 148 | 4519 |
| 8-#11 | 2.76 | 1858 | 1431 | 3191 | 1239 | 4263 | 1022 | 4873 | 829 | 5498 | 515 | 5625 | 91 | 5281 |
| 8-#14 | 3.98 | 1976 | 1630 | 3784 | 1366 | 4991 | 1119 | 5708 | 891 | 6135 | 479 | 6819 | -27 | 6826 |
| 8-#18 | 7.07 | 2300 | 2135 | 5218 | 1690 | 6728 | 1361 | 7718 | 1044 | 8559 | 466 | 9615 | -350 | 9618 |
| 9-#10 | 2.53 | 1873 | 1393 | 3126 | 1210 | 4146 | 999 | 4739 | 816 | 5375 | 515 | 5517 | 123 | 4926 |
| 9-#11 | 3.10 | 1922 | 1487 | 3436 | 1263 | 4488 | 1036 | 5122 | 839 | 5469 | 474 | 6013 | 60 | 5745 |
| 9-#14 | 4.48 | 2068 | 1711 | 4080 | 1408 | 5293 | 1141 | 6065 | 908 | 7084 | 503 | 7366 | -71 | 7395 |
| 9-#18 | 7.96 | 2499 | 2280 | 5693 | 1768 | 7210 | 1415 | 8352 | 1081 | 10037 | 481 | 10530 | -428 | 10472 |

## ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 10-#10 | 2.81 | 1912 | 1439 | 3408 | 1222 | 4392 | 1004 | 4999 | 809 | 5673 | 495 | 5760 | 83 | 5434 |
| 10-#11 | 3.45 | 1962 | 1543 | 3751 | 1280 | 4768 | 1045 | 5428 | 833 | 6221 | 485 | 6304 | 11 | 6262 |
| 10-#14 | 4.97 | 2120 | 1792 | 4516 | 1434 | 5669 | 1159 | 6488 | 904 | 7612 | 475 | 7859 | -128 | 7817 |
| 11-#10 | 3.09 | 1943 | 1485 | 3379 | 1277 | 4472 | 1050 | 5152 | 853 | 5913 | 520 | 6195 | 83 | 5818 |
| 11-#11 | 3.79 | 2006 | 1600 | 3741 | 1343 | 4884 | 1098 | 5620 | 884 | 6504 | 512 | 6810 | 8 | 6777 |
| 11-#14 | 5.47 | 2194 | 1874 | 4549 | 1517 | 5863 | 1229 | 6767 | 971 | 8004 | 509 | 8477 | -150 | 8462 |
| 12-#10 | 3.37 | 1996 | 1530 | 3487 | 1314 | 4604 | 1082 | 5328 | 873 | 6194 | 533 | 6537 | 68 | 6260 |
| 12-#11 | 4.14 | 2062 | 1656 | 3875 | 1387 | 5045 | 1136 | 5835 | 907 | 6845 | 527 | 7212 | -13 | 7215 |
| 12-#14 | 5.97 | 2271 | 1955 | 4749 | 1577 | 6096 | 1281 | 7083 | 1004 | 7904 | 491 | 9036 | -183 | 8986 |
| 13-#10 | 3.65 | 2024 | 1576 | 3635 | 1341 | 4814 | 1101 | 5554 | 888 | 6461 | 526 | 6848 | 37 | 6679 |
| 13-#11 | 4.48 | 2098 | 1712 | 4051 | 1421 | 5292 | 1160 | 6103 | 925 | 6679 | 483 | 7578 | -51 | 7595 |
| 13-#14 | 6.47 | 2337 | 2036 | 4995 | 1629 | 6439 | 1316 | 7458 | 1030 | 8923 | 514 | 9548 | -238 | 9491 |
| 14-#10 | 3.93 | 2081 | 1622 | 3844 | 1358 | 5023 | 1113 | 5812 | 892 | 6763 | 515 | 7135 | 10 | 7093 |
| 14-#11 | 4.83 | 2165 | 1769 | 4290 | 1444 | 5541 | 1176 | 6415 | 932 | 7516 | 505 | 7918 | -85 | 7937 |
| 15-#10 | 4.21 | 2101 | 1668 | 3918 | 1403 | 5146 | 1150 | 5970 | 924 | 6541 | 496 | 7501 | -8 | 7503 |
| 15-#11 | 5.17 | 2196 | 1825 | 4395 | 1497 | 5695 | 1220 | 6598 | 968 | 7295 | 488 | 8345 | -110 | 8348 |
| 16-#10 | 4.49 | 2147 | 1714 | 4013 | 1439 | 5302 | 1181 | 6165 | 944 | 7264 | 538 | 7837 | -23 | 7836 |
| 16-#11 | 5.52 | 2255 | 1881 | 4512 | 1540 | 5889 | 1257 | 6832 | 991 | 8124 | 530 | 8740 | -130 | 8748 |
| 17-#10 | 4.77 | 2172 | 1760 | 4180 | 1467 | 5500 | 1197 | 6374 | 958 | 7047 | 500 | 8173 | -50 | 8146 |
| 18-#10 | 5.05 | 2215 | 1805 | 4391 | 1485 | 5717 | 1212 | 6607 | 964 | 7861 | 530 | 8452 | -77 | 8457 |

## ROUND SPIRAL COLUMNS 26" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#9 | 1.13 | 2159 | 1367 | 3445 | 1183 | 4412 | 976 | 4890 | 805 | 4873 | 513 | 4853 | 238 | 3189 |
| 6-#10 | 1.44 | 2197 | 1426 | 3666 | 1216 | 4677 | 999 | 5203 | 819 | 5635 | 546 | 5274 | 202 | 3949 |
| 6-#11 | 1.76 | 2228 | 1489 | 3916 | 1245 | 4955 | 1018 | 5518 | 829 | 6031 | 537 | 5636 | 154 | 4708 |
| 6-#14 | 2.54 | 2312 | 1638 | 4450 | 1330 | 5603 | 1078 | 6285 | 865 | 6550 | 489 | 6625 | 55 | 6422 |
| 6-#18 | 4.52 | 2529 | 2017 | 5741 | 1546 | 7182 | 1232 | 8164 | 956 | 8764 | 451 | 8962 | -213 | 8990 |
| 7-#9 | 1.32 | 2227 | 1403 | 3170 | 1276 | 4312 | 1063 | 4925 | 882 | 5392 | 603 | 5362 | 269 | 3642 |
| 7-#10 | 1.67 | 2282 | 1472 | 3416 | 1318 | 4603 | 1094 | 5266 | 903 | 5444 | 562 | 5873 | 234 | 4452 |
| 7-#11 | 2.06 | 2323 | 1545 | 3699 | 1356 | 4911 | 1122 | 5611 | 920 | 6254 | 595 | 6317 | 187 | 5256 |
| 7-#14 | 2.97 | 2460 | 1719 | 4292 | 1464 | 5618 | 1204 | 6445 | 974 | 7325 | 592 | 7521 | 90 | 7102 |
| 7-#18 | 5.27 | 2783 | 2161 | 5723 | 1738 | 7336 | 1410 | 8474 | 1109 | 9268 | 539 | 10366 | -174 | 10415 |
| 8-#9 | 1.51 | 2237 | 1439 | 3179 | 1317 | 4416 | 1098 | 5096 | 913 | 5621 | 620 | 5644 | 256 | 4087 |
| 8-#10 | 1.91 | 2292 | 1517 | 3452 | 1367 | 4748 | 1136 | 5484 | 939 | 5710 | 580 | 6227 | 217 | 5042 |
| 8-#11 | 2.35 | 2334 | 1601 | 3766 | 1413 | 5102 | 1170 | 5868 | 958 | 6153 | 574 | 6761 | 165 | 5988 |
| 8-#14 | 3.39 | 2468 | 1800 | 4428 | 1541 | 5914 | 1268 | 6806 | 1023 | 7799 | 615 | 8132 | 54 | 7921 |
| 8-#18 | 6.03 | 2815 | 2305 | 6034 | 1866 | 7897 | 1517 | 9078 | 1181 | 10730 | 610 | 11373 | -249 | 11363 |
| 9-#10 | 2.15 | 2349 | 1563 | 3698 | 1384 | 4980 | 1148 | 5706 | 943 | 6437 | 612 | 6619 | 194 | 5529 |
| 9-#11 | 2.64 | 2401 | 1657 | 4048 | 1436 | 5366 | 1185 | 6138 | 966 | 6987 | 606 | 7201 | 135 | 6520 |
| 9-#14 | 3.81 | 2571 | 1881 | 4805 | 1577 | 6268 | 1291 | 7193 | 1038 | 8372 | 605 | 8755 | 11 | 8706 |
| 9-#18 | 6.78 | 3029 | 2450 | 6575 | 1944 | 8459 | 1559 | 9762 | 1215 | 10929 | 554 | 12425 | -325 | 12392 |
| 10-#10 | 2.39 | 2387 | 1609 | 4026 | 1393 | 5264 | 1150 | 6002 | 934 | 6318 | 551 | 6894 | 155 | 6102 |
| 10-#11 | 2.94 | 2452 | 1714 | 4417 | 1452 | 5690 | 1191 | 6485 | 958 | 6893 | 543 | 7527 | 86 | 7168 |
| 10-#14 | 4.24 | 2628 | 1963 | 5283 | 1607 | 6700 | 1307 | 7673 | 1032 | 8346 | 537 | 9229 | -58 | 9243 |
| 10-#18 | 7.53 | 3130 | 2594 | 7355 | 1997 | 9150 | 1598 | 10562 | 1215 | 11888 | 514 | 13388 | -424 | 13218 |

## ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 11-#10 | 2.63 | 2429 | 1655 | 3977 | 1452 | 5336 | 1199 | 6159 | 981 | 6569 | 578 | 7356 | 151 | 6569 |
| 11-#11 | 3.23 | 2501 | 1770 | 4386 | 1518 | 5800 | 1247 | 6689 | 1012 | 7190 | 572 | 8106 | 85 | 7688 |
| 11-#14 | 4.66 | 2708 | 2044 | 5290 | 1693 | 6894 | 1380 | 7981 | 1103 | 9384 | 612 | 10021 | -64 | 10001 |
| 12-#10 | 2.87 | 2484 | 1701 | 4091 | 1490 | 5480 | 1232 | 6353 | 1003 | 6852 | 589 | 7750 | 141 | 7123 |
| 12-#11 | 3.53 | 2565 | 1826 | 4530 | 1563 | 5977 | 1286 | 6924 | 1037 | 7539 | 586 | 8561 | 67 | 8267 |
| 12-#14 | 5.09 | 2792 | 2125 | 5509 | 1755 | 7152 | 1433 | 8317 | 1136 | 9923 | 633 | 10655 | -93 | 10658 |
| 13-#10 | 3.11 | 2515 | 1747 | 4256 | 1516 | 5711 | 1251 | 6607 | 1017 | 7651 | 626 | 8112 | 112 | 7559 |
| 13-#11 | 3.82 | 2603 | 1883 | 4726 | 1597 | 6256 | 1310 | 7225 | 1055 | 8436 | 620 | 8977 | 30 | 8833 |
| 13-#14 | 5.51 | 2860 | 2206 | 5781 | 1806 | 7539 | 1469 | 8740 | 1163 | 10416 | 621 | 11240 | -147 | 11224 |
| 14-#10 | 3.35 | 2584 | 1792 | 4498 | 1533 | 5949 | 1261 | 6891 | 1019 | 7456 | 574 | 8450 | 87 | 8050 |
| 14-#11 | 4.11 | 2678 | 1939 | 5002 | 1619 | 6532 | 1325 | 7568 | 1060 | 8839 | 607 | 9362 | -3 | 9363 |
| 14-#14 | 5.93 | 2962 | 2287 | 6145 | 1841 | 7923 | 1495 | 9227 | 1173 | 10988 | 604 | 11788 | -194 | 11782 |
| 15-#10 | 3.59 | 2604 | 1838 | 4567 | 1578 | 6080 | 1301 | 7064 | 1053 | 8250 | 631 | 8847 | 68 | 8518 |
| 15-#11 | 4.41 | 2709 | 1995 | 5104 | 1673 | 6698 | 1371 | 7780 | 1099 | 8552 | 584 | 9848 | -26 | 9854 |
| 16-#10 | 3.83 | 2654 | 1884 | 4670 | 1615 | 6273 | 1325 | 7289 | 1075 | 7967 | 597 | 9219 | 55 | 8976 |
| 16-#11 | 4.70 | 2772 | 2051 | 5232 | 1717 | 6906 | 1408 | 8041 | 1124 | 8871 | 592 | 10296 | -44 | 10288 |
| 17-#10 | 4.07 | 2682 | 1930 | 4858 | 1643 | 6469 | 1348 | 7515 | 1089 | 8857 | 637 | 9604 | 28 | 9469 |
| 17-#11 | 5.00 | 2806 | 2108 | 5453 | 1751 | 7170 | 1428 | 8319 | 1141 | 9887 | 631 | 10745 | -78 | 10696 |
| 18-#10 | 4.31 | 2727 | 1976 | 5095 | 1660 | 6721 | 1363 | 7777 | 1094 | 9192 | 631 | 9929 | 4 | 9913 |
| 18-#11 | 5.29 | 2864 | 2164 | 5733 | 1774 | 7459 | 1447 | 8629 | 1148 | 10301 | 625 | 11118 | -110 | 11110 |
| 19-#10 | 4.54 | 2766 | 2021 | 5169 | 1704 | 6843 | 1398 | 7979 | 1121 | 9466 | 643 | 10335 | -14 | 10330 |
| 20-#10 | 4.78 | 2808 | 2067 | 5313 | 1737 | 7023 | 1424 | 8184 | 1142 | 9116 | 607 | 10690 | -32 | 10682 |

## ROUND SPIRAL COLUMNS 28" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#10 | 1.24 | 2725 | 1610 | 4372 | 1393 | 5624 | 1148 | 6260 | 946 | 6740 | 642 | 6329 | 269 | 4347 |
| 6-#11 | 1.52 | 2759 | 1672 | 4652 | 1422 | 5934 | 1167 | 6609 | 955 | 7186 | 633 | 6743 | 224 | 5195 |
| 6-#14 | 2.19 | 2862 | 1822 | 5243 | 1507 | 6649 | 1227 | 7456 | 991 | 7756 | 583 | 7862 | 129 | 7183 |
| 6-#18 | 3.90 | 3102 | 2201 | 6675 | 1723 | 8397 | 1381 | 9534 | 1084 | 10244 | 551 | 10526 | -126 | 10543 |
| 7-#9 | 1.14 | 2759 | 1587 | 3757 | 1463 | 5183 | 1221 | 5938 | 1018 | 6055 | 659 | 6426 | 338 | 4043 |
| 7-#10 | 1.44 | 2822 | 1655 | 4030 | 1505 | 5504 | 1253 | 6313 | 1039 | 6974 | 707 | 7002 | 305 | 4942 |
| 7-#11 | 1.77 | 2871 | 1729 | 4347 | 1543 | 5848 | 1281 | 6697 | 1056 | 6947 | 653 | 7524 | 261 | 5841 |
| 7-#14 | 2.56 | 3018 | 1903 | 5005 | 1651 | 6630 | 1363 | 7618 | 1110 | 8632 | 698 | 8885 | 169 | 7963 |
| 7-#18 | 4.55 | 3387 | 2345 | 6595 | 1926 | 8536 | 1571 | 9874 | 1248 | 11532 | 689 | 12126 | -80 | 12150 |
| 8-#9 | 1.30 | 2771 | 1623 | 3749 | 1506 | 5284 | 1258 | 6123 | 1051 | 6741 | 725 | 6745 | 328 | 4509 |
| 8-#10 | 1.65 | 2834 | 1701 | 4050 | 1556 | 5650 | 1296 | 6556 | 1078 | 7289 | 727 | 7391 | 289 | 5567 |
| 8-#11 | 2.03 | 2884 | 1785 | 4401 | 1602 | 6044 | 1331 | 6986 | 1098 | 7819 | 722 | 7990 | 239 | 6628 |
| 8-#14 | 2.92 | 3027 | 1984 | 5133 | 1730 | 6940 | 1429 | 8029 | 1164 | 9158 | 724 | 9556 | 135 | 8977 |
| 8-#18 | 5.20 | 3412 | 2489 | 6911 | 2056 | 9132 | 1679 | 10563 | 1327 | 12423 | 725 | 13262 | -149 | 13251 |
| 9-#10 | 1.86 | 2898 | 1747 | 4331 | 1572 | 5914 | 1308 | 6797 | 1081 | 7123 | 669 | 7826 | 266 | 6145 |
| 9-#11 | 2.28 | 2959 | 1841 | 4722 | 1624 | 6348 | 1346 | 7279 | 1104 | 7693 | 664 | 8510 | 211 | 7256 |
| 9-#14 | 3.29 | 3150 | 2065 | 5559 | 1765 | 7348 | 1453 | 8446 | 1177 | 9122 | 665 | 10272 | 94 | 9787 |
| 9-#18 | 5.85 | 3641 | 2634 | 7593 | 2124 | 9782 | 1724 | 11298 | 1358 | 13518 | 710 | 14452 | -224 | 14464 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 28" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.06 | 2940 | 1793 | 4710 | 1578 | 6243 | 1308 | 7130 | 1069 | 7997 | 693 | 8152 | 229 | 6754 |
| 10-#11 | 2.53 | 3008 | 1898 | 5147 | 1636 | 6720 | 1350 | 7669 | 1094 | 8683 | 685 | 8876 | 164 | 8020 |
| 10-#14 | 3.65 | 3213 | 2146 | 6103 | 1792 | 7839 | 1467 | 8983 | 1169 | 10404 | 681 | 10800 | 27 | 10677 |
| 10-#18 | 6.50 | 3743 | 2778 | 8425 | 2187 | 10563 | 1761 | 12194 | 1357 | 14618 | 663 | 15377 | -342 | 15340 |
| 11-#10 | 2.27 | 2985 | 1839 | 4634 | 1641 | 6302 | 1360 | 7290 | 1119 | 8296 | 725 | 8649 | 226 | 7305 |
| 11-#11 | 2.79 | 3065 | 1954 | 5093 | 1707 | 6820 | 1408 | 7879 | 1151 | 9037 | 720 | 9484 | 159 | 8622 |
| 11-#14 | 4.02 | 3299 | 2228 | 6094 | 1883 | 8028 | 1542 | 9305 | 1242 | 10170 | 674 | 11651 | 17 | 11573 |
| 11-#18 | 7.15 | 3941 | 2922 | 8526 | 2328 | 10980 | 1879 | 12795 | 1472 | 15444 | 721 | 16842 | -360 | 16580 |
| 12-#10 | 2.48 | 3051 | 1885 | 4755 | 1680 | 6457 | 1394 | 7502 | 1142 | 8621 | 738 | 9089 | 217 | 7912 |
| 12-#11 | 3.04 | 3137 | 2010 | 5246 | 1753 | 7011 | 1449 | 8136 | 1177 | 9438 | 734 | 10005 | 146 | 9313 |
| 12-#14 | 4.38 | 3393 | 2309 | 6330 | 1947 | 8311 | 1597 | 9676 | 1277 | 11474 | 742 | 12387 | -4 | 12386 |
| 13-#10 | 2.68 | 3081 | 1930 | 4938 | 1706 | 6711 | 1412 | 7784 | 1156 | 8968 | 733 | 9493 | 188 | 8437 |
| 13-#11 | 3.29 | 3179 | 2066 | 5462 | 1786 | 7317 | 1472 | 8472 | 1195 | 9191 | 680 | 10484 | 110 | 9901 |
| 13-#14 | 4.75 | 3464 | 2390 | 6628 | 1996 | 8741 | 1633 | 10147 | 1304 | 12043 | 733 | 13062 | -55 | 13048 |
| 14-#10 | 2.89 | 3154 | 1976 | 5216 | 1721 | 6979 | 1421 | 8094 | 1156 | 9346 | 722 | 9860 | 164 | 9046 |
| 14-#11 | 3.55 | 3269 | 2123 | 5778 | 1807 | 7628 | 1485 | 8845 | 1197 | 9608 | 668 | 10932 | 81 | 10538 |
| 14-#14 | 5.12 | 3576 | 2471 | 7042 | 2030 | 9164 | 1656 | 10676 | 1313 | 12677 | 717 | 13674 | -101 | 13671 |
| 15-#10 | 3.09 | 3177 | 2022 | 5276 | 1768 | 7117 | 1463 | 8282 | 1193 | 9626 | 739 | 10313 | 146 | 9533 |
| 15-#11 | 3.80 | 3299 | 2179 | 5874 | 1862 | 7805 | 1533 | 9076 | 1239 | 9931 | 686 | 11455 | 57 | 11162 |
| 15-#14 | 5.48 | 3640 | 2552 | 7219 | 2105 | 9435 | 1720 | 11012 | 1368 | 13177 | 741 | 14428 | -135 | 14348 |
| 16-#10 | 3.30 | 3230 | 2068 | 5386 | 1806 | 7322 | 1487 | 8535 | 1216 | 9942 | 748 | 10728 | 135 | 10063 |
| 16-#11 | 4.05 | 3367 | 2235 | 6012 | 1907 | 8060 | 1563 | 9374 | 1266 | 11018 | 744 | 11947 | 40 | 11755 |
| 16-#14 | 5.85 | 3764 | 2634 | 7425 | 2168 | 9760 | 1773 | 11427 | 1403 | 13710 | 753 | 15116 | -161 | 15035 |
| 17-#10 | 3.51 | 3263 | 2114 | 5596 | 1833 | 7541 | 1510 | 8780 | 1229 | 10296 | 746 | 11131 | 104 | 10580 |
| 17-#11 | 4.31 | 3403 | 2292 | 6259 | 1942 | 8320 | 1591 | 9673 | 1282 | 11443 | 742 | 12456 | 8 | 12416 |
| 18-#10 | 3.71 | 3316 | 2159 | 5861 | 1849 | 7823 | 1525 | 9071 | 1234 | 9946 | 689 | 11492 | 83 | 11095 |
| 18-#11 | 4.56 | 3465 | 2348 | 6570 | 1963 | 8651 | 1610 | 10018 | 1289 | 11094 | 685 | 12887 | -22 | 12875 |
| 19-#10 | 3.92 | 3360 | 2205 | 5935 | 1894 | 7953 | 1561 | 9285 | 1261 | 10959 | 752 | 11958 | 68 | 11625 |
| 19-#11 | 4.81 | 3516 | 2404 | 6672 | 2016 | 8814 | 1652 | 10286 | 1322 | 12248 | 749 | 13423 | -44 | 13403 |
| 20-#10 | 4.13 | 3404 | 2251 | 6088 | 1928 | 8150 | 1588 | 9510 | 1283 | 11302 | 762 | 12368 | 51 | 12115 |
| 20-#11 | 5.07 | 3573 | 2460 | 6862 | 2058 | 9053 | 1684 | 10557 | 1348 | 12646 | 758 | 13892 | -67 | 13869 |
| 21-#10 | 4.33 | 3457 | 2297 | 6256 | 1959 | 8363 | 1611 | 9783 | 1297 | 11625 | 758 | 12767 | 27 | 12650 |
| 22-#10 | 4.54 | 3498 | 2343 | 6490 | 1983 | 8612 | 1626 | 10062 | 1308 | 11982 | 753 | 13130 | 0 | 13129 |

## ROUND SPIRAL COLUMNS 30" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 1.08 | 3330 | 1807 | 5162 | 1584 | 6693 | 1308 | 7456 | 1082 | 7453 | 695 | 7513 | 340 | 4745 |
| 6-#11 | 1.32 | 3370 | 1870 | 5473 | 1612 | 7034 | 1327 | 7839 | 1092 | 8475 | 736 | 7978 | 296 | 5683 |
| 6-#14 | 1.91 | 3490 | 2019 | 6121 | 1697 | 7817 | 1387 | 8765 | 1128 | 9055 | 679 | 9228 | 205 | 7878 |
| 6-#18 | 3.40 | 3759 | 2398 | 7696 | 1913 | 9736 | 1542 | 11043 | 1221 | 12705 | 703 | 12220 | -39 | 12226 |
| 7-#10 | 1.26 | 3439 | 1853 | 4711 | 1706 | 6517 | 1424 | 7494 | 1185 | 7708 | 763 | 8257 | 380 | 5441 |
| 7-#11 | 1.54 | 3497 | 1926 | 5063 | 1744 | 6898 | 1451 | 7917 | 1202 | 8191 | 757 | 8848 | 338 | 6438 |
| 7-#14 | 2.23 | 3663 | 2100 | 5786 | 1852 | 7755 | 1534 | 8925 | 1257 | 10081 | 811 | 10384 | 251 | 8780 |
| 7-#18 | 3.96 | 4074 | 2542 | 7536 | 2128 | 9849 | 1744 | 11400 | 1396 | 13277 | 806 | 14022 | 14 | 13953 |
| 8-#10 | 1.44 | 3453 | 1899 | 4711 | 1759 | 6661 | 1469 | 7748 | 1225 | 8604 | 841 | 8692 | 366 | 6098 |
| 8-#11 | 1.77 | 3511 | 1982 | 5100 | 1805 | 7096 | 1503 | 8237 | 1247 | 9189 | 836 | 9356 | 318 | 7271 |

## ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.55 | 3674 | 2182 | 5903 | 1933 | 8076 | 1602 | 9385 | 1315 | 9950 | 784 | 11085 | 217 | 10029 |
| 8-#18 | 4.53 | 4094 | 2687 | 7854 | 2260 | 10478 | 1852 | 12182 | 1482 | 13310 | 790 | 15290 | -50 | 15259 |
| 9-#10 | 1.62 | 3522 | 1945 | 5029 | 1774 | 6957 | 1480 | 8021 | 1228 | 8372 | 774 | 9169 | 343 | 6774 |
| 9-#11 | 1.99 | 3596 | 2039 | 5462 | 1826 | 7439 | 1518 | 8553 | 1252 | 9641 | 824 | 9929 | 290 | 8005 |
| 9-#14 | 2.86 | 3799 | 2263 | 6380 | 1967 | 8539 | 1626 | 9832 | 1325 | 11317 | 826 | 11903 | 178 | 10907 |
| 9-#18 | 5.09 | 4340 | 2831 | 8615 | 2328 | 11218 | 1900 | 12968 | 1510 | 14410 | 774 | 16618 | -124 | 16625 |
| 10-#10 | 1.80 | 3572 | 1990 | 5466 | 1777 | 7337 | 1478 | 8393 | 1215 | 8744 | 750 | 9543 | 308 | 7415 |
| 10-#11 | 2.21 | 3650 | 2095 | 5949 | 1835 | 7864 | 1519 | 8987 | 1240 | 9447 | 743 | 10359 | 245 | 8816 |
| 10-#14 | 3.18 | 3881 | 2344 | 6995 | 1991 | 9093 | 1637 | 10430 | 1316 | 12008 | 793 | 12505 | 114 | 11940 |
| 10-#18 | 5.66 | 4446 | 2975 | 9551 | 2388 | 12093 | 1935 | 13962 | 1508 | 15532 | 729 | 17645 | -238 | 17613 |
| 11-#10 | 1.98 | 3622 | 2036 | 5354 | 1843 | 7379 | 1533 | 8553 | 1267 | 9697 | 839 | 10078 | 304 | 8057 |
| 11-#11 | 2.43 | 3714 | 2151 | 5863 | 1910 | 7950 | 1581 | 9201 | 1299 | 9812 | 778 | 11009 | 240 | 9517 |
| 11-#14 | 3.50 | 3973 | 2425 | 6964 | 2087 | 9274 | 1716 | 10763 | 1392 | 12552 | 838 | 13420 | 103 | 12868 |
| 11-#18 | 6.22 | 4652 | 3120 | 9638 | 2534 | 12516 | 2056 | 14601 | 1625 | 17555 | 844 | 19282 | -252 | 19026 |
| 12-#10 | 2.16 | 3696 | 2082 | 5481 | 1885 | 7543 | 1568 | 8783 | 1291 | 10045 | 851 | 10516 | 290 | 8697 |
| 12-#11 | 2.65 | 3794 | 2208 | 6026 | 1958 | 8156 | 1623 | 9481 | 1326 | 10941 | 849 | 11585 | 229 | 10325 |
| 12-#14 | 3.82 | 4077 | 2506 | 7216 | 2152 | 9580 | 1772 | 11167 | 1428 | 12291 | 801 | 14225 | 85 | 13820 |
| 12-#18 | 6.79 | 4819 | 3264 | 10113 | 2643 | 13065 | 2150 | 15306 | 1683 | 17410 | 820 | 20609 | -301 | 20205 |
| 13-#10 | 2.34 | 3729 | 2128 | 5711 | 1906 | 7820 | 1585 | 9094 | 1305 | 9729 | 790 | 11009 | 268 | 9308 |
| 13-#11 | 2.87 | 3840 | 2264 | 6264 | 1990 | 8488 | 1645 | 9851 | 1344 | 10636 | 787 | 12115 | 193 | 10995 |
| 13-#14 | 4.14 | 4152 | 2588 | 7541 | 2200 | 10047 | 1807 | 11687 | 1455 | 13813 | 851 | 14977 | 34 | 14796 |
| 13-#18 | 7.36 | 5012 | 3408 | 10658 | 2735 | 13869 | 2216 | 16190 | 1733 | 19715 | 861 | 21851 | -395 | 21397 |
| 14-#10 | 2.52 | 3810 | 2174 | 6001 | 1923 | 8122 | 1593 | 9430 | 1304 | 10124 | 780 | 11388 | 242 | 9951 |
| 14-#11 | 3.09 | 3929 | 2320 | 6622 | 2009 | 8837 | 1658 | 10257 | 1345 | 11100 | 775 | 12602 | 164 | 11742 |
| 14-#14 | 4.46 | 4275 | 2669 | 8008 | 2233 | 10518 | 1830 | 12259 | 1462 | 14510 | 835 | 15698 | -6 | 15697 |
| 15-#10 | 2.70 | 3829 | 2219 | 6049 | 1972 | 8264 | 1637 | 9632 | 1342 | 10402 | 797 | 11906 | 228 | 10532 |
| 15-#11 | 3.31 | 3963 | 2376 | 6709 | 2066 | 9022 | 1708 | 10506 | 1389 | 12261 | 851 | 13191 | 142 | 12386 |
| 15-#14 | 4.77 | 4341 | 2750 | 8181 | 2310 | 10807 | 1896 | 12624 | 1519 | 14038 | 803 | 16490 | -43 | 16471 |
| 16-#10 | 2.87 | 3893 | 2265 | 6165 | 2010 | 8481 | 1662 | 9903 | 1366 | 11490 | 863 | 12373 | 218 | 11171 |
| 16-#11 | 3.53 | 4036 | 2433 | 6856 | 2112 | 9293 | 1738 | 10839 | 1417 | 12675 | 861 | 13735 | 127 | 13071 |
| 16-#14 | 5.09 | 4472 | 2831 | 8403 | 2374 | 11206 | 1938 | 13092 | 1557 | 14585 | 815 | 17253 | -66 | 17220 |
| 17-#10 | 3.05 | 3924 | 2311 | 6396 | 2038 | 8722 | 1685 | 10184 | 1376 | 11087 | 804 | 12794 | 187 | 11725 |
| 17-#11 | 3.75 | 4084 | 2489 | 7130 | 2146 | 9580 | 1766 | 11160 | 1433 | 12265 | 802 | 14268 | 90 | 13763 |
| 17-#14 | 5.41 | 4524 | 2912 | 8782 | 2425 | 11606 | 1979 | 13552 | 1582 | 15202 | 813 | 18006 | -120 | 17912 |
| 18-#10 | 3.23 | 3974 | 2357 | 6692 | 2053 | 9031 | 1698 | 10497 | 1383 | 11446 | 796 | 13191 | 165 | 12317 |
| 18-#11 | 3.97 | 4149 | 2545 | 7474 | 2166 | 9948 | 1784 | 11541 | 1440 | 13616 | 850 | 14743 | 64 | 14419 |
| 19-#10 | 3.41 | 4024 | 2403 | 6765 | 2099 | 9173 | 1736 | 10723 | 1412 | 12596 | 868 | 13707 | 152 | 12872 |
| 19-#11 | 4.19 | 4206 | 2602 | 7576 | 2221 | 10121 | 1828 | 11824 | 1473 | 13079 | 808 | 15354 | 45 | 15131 |
| 20-#10 | 3.59 | 4076 | 2449 | 6926 | 2133 | 9387 | 1763 | 10969 | 1434 | 12965 | 878 | 14165 | 136 | 13437 |
| 20-#11 | 4.41 | 4266 | 2658 | 7779 | 2262 | 10381 | 1861 | 12120 | 1500 | 14462 | 878 | 15888 | 24 | 15761 |
| 21-#10 | 3.77 | 4135 | 2494 | 7112 | 2164 | 9616 | 1786 | 11269 | 1448 | 12436 | 817 | 14599 | 112 | 14006 |
| 21-#11 | 4.63 | 4334 | 2714 | 7999 | 2301 | 10660 | 1889 | 12479 | 1517 | 14887 | 873 | 16415 | -6 | 16411 |
| 22-#10 | 3.95 | 4184 | 2540 | 7370 | 2187 | 9892 | 1801 | 11569 | 1458 | 13715 | 870 | 14999 | 86 | 14545 |
| 23-#10 | 4.13 | 4250 | 2586 | 7490 | 2226 | 10067 | 1837 | 11809 | 1484 | 14049 | 881 | 15495 | 73 | 15141 |
| 24-#10 | 4.31 | 4290 | 2632 | 7635 | 2263 | 10277 | 1862 | 12075 | 1507 | 14396 | 888 | 15933 | 52 | 15674 |

## ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.16 | 4064 | 2081 | 6385 | 1816 | 8266 | 1498 | 9218 | 1237 | 9915 | 845 | 9352 | 373 | 6171 |
| 6-#14 | 1.68 | 4202 | 2230 | 7092 | 1900 | 9117 | 1559 | 10222 | 1274 | 10496 | 781 | 10731 | 285 | 8574 |
| 6-#18 | 2.98 | 4502 | 2609 | 8810 | 2117 | 11206 | 1714 | 12701 | 1367 | 14539 | 817 | 14054 | 50 | 13834 |
| 7-#10 | 1.11 | 4139 | 2064 | 5463 | 1922 | 7650 | 1607 | 8817 | 1342 | 9049 | 875 | 9657 | 459 | 5954 |
| 7-#11 | 1.36 | 4206 | 2137 | 5852 | 1959 | 8068 | 1634 | 9279 | 1358 | 9578 | 869 | 10305 | 418 | 7045 |
| 7-#14 | 1.96 | 4392 | 2312 | 6640 | 2068 | 9000 | 1717 | 10375 | 1413 | 10905 | 869 | 11992 | 334 | 9611 |
| 7-#18 | 3.48 | 4850 | 2754 | 8552 | 2345 | 11283 | 1928 | 13070 | 1554 | 15176 | 931 | 16065 | 109 | 15452 |
| 8-#10 | 1.26 | 4155 | 2110 | 5439 | 1977 | 7789 | 1655 | 9083 | 1384 | 10072 | 962 | 10137 | 448 | 6634 |
| 8-#11 | 1.55 | 4223 | 2194 | 5867 | 2022 | 8265 | 1688 | 9617 | 1406 | 10713 | 958 | 10868 | 401 | 7919 |
| 8-#14 | 2.24 | 4405 | 2393 | 6740 | 2150 | 9329 | 1787 | 10880 | 1475 | 12316 | 964 | 12760 | 303 | 10942 |
| 8-#18 | 3.98 | 4867 | 2898 | 8866 | 2478 | 11942 | 2038 | 13945 | 1646 | 15169 | 909 | 17380 | 45 | 17187 |
| 9-#10 | 1.42 | 4231 | 2156 | 5797 | 1991 | 8117 | 1664 | 9387 | 1386 | 9763 | 885 | 10657 | 424 | 7417 |
| 9-#11 | 1.75 | 4313 | 2250 | 6273 | 2042 | 8645 | 1702 | 9969 | 1410 | 10446 | 881 | 11493 | 372 | 8769 |
| 9-#14 | 2.52 | 4543 | 2474 | 7273 | 2184 | 9844 | 1811 | 11361 | 1484 | 13014 | 948 | 13657 | 264 | 11957 |
| 9-#18 | 4.48 | 5129 | 3042 | 9708 | 2545 | 12774 | 2087 | 14781 | 1672 | 17506 | 955 | 18927 | -22 | 18916 |
| 10-#10 | 1.58 | 4286 | 2201 | 6298 | 1990 | 8552 | 1659 | 9800 | 1370 | 10892 | 921 | 11037 | 387 | 8084 |
| 10-#11 | 1.94 | 4376 | 2306 | 6827 | 2047 | 9131 | 1701 | 10451 | 1395 | 11715 | 914 | 11985 | 330 | 9621 |
| 10-#14 | 2.80 | 4618 | 2555 | 7964 | 2203 | 10471 | 1820 | 12021 | 1473 | 12848 | 852 | 14355 | 204 | 13254 |
| 10-#18 | 4.97 | 5243 | 3187 | 10747 | 2601 | 13748 | 2120 | 15876 | 1668 | 17563 | 845 | 20060 | -134 | 20041 |
| 11-#10 | 1.74 | 4342 | 2247 | 6142 | 2060 | 8573 | 1718 | 9959 | 1426 | 11252 | 960 | 11653 | 387 | 8826 |
| 11-#11 | 2.13 | 4442 | 2362 | 6701 | 2127 | 9199 | 1766 | 10666 | 1457 | 11333 | 892 | 12679 | 324 | 10430 |
| 11-#14 | 3.08 | 4723 | 2636 | 7899 | 2304 | 10639 | 1901 | 12363 | 1551 | 13404 | 898 | 15325 | 192 | 14203 |
| 11-#18 | 5.47 | 5457 | 3331 | 10821 | 2754 | 14171 | 2244 | 16542 | 1788 | 19820 | 973 | 21754 | -159 | 21641 |
| 12-#10 | 1.89 | 4419 | 2293 | 6275 | 2103 | 8746 | 1755 | 10205 | 1451 | 11621 | 973 | 12134 | 374 | 9493 |
| 12-#11 | 2.33 | 4537 | 2419 | 6873 | 2177 | 9417 | 1809 | 10968 | 1486 | 12597 | 971 | 13312 | 316 | 11281 |
| 12-#14 | 3.36 | 4838 | 2717 | 8169 | 2371 | 10966 | 1960 | 12800 | 1589 | 15017 | 982 | 16210 | 176 | 15286 |
| 12-#18 | 5.97 | 5635 | 3475 | 11332 | 2865 | 14766 | 2340 | 17310 | 1848 | 19588 | 939 | 23248 | -196 | 22909 |
| 13-#10 | 2.05 | 4461 | 2339 | 6527 | 2124 | 9047 | 1771 | 10545 | 1465 | 12033 | 968 | 12668 | 352 | 10200 |
| 13-#11 | 2.52 | 4581 | 2475 | 7169 | 2204 | 9777 | 1831 | 11373 | 1504 | 12220 | 901 | 13893 | 280 | 12052 |
| 13-#14 | 3.64 | 4918 | 2799 | 8523 | 2419 | 11471 | 1993 | 13369 | 1616 | 15722 | 975 | 17036 | 125 | 16301 |
| 13-#18 | 6.47 | 5828 | 3619 | 11920 | 2955 | 15635 | 2405 | 18278 | 1899 | 20704 | 928 | 24660 | -286 | 24264 |
| 14-#10 | 2.21 | 4551 | 2385 | 6857 | 2139 | 9384 | 1777 | 10910 | 1461 | 11668 | 894 | 13061 | 325 | 10871 |
| 14-#11 | 2.72 | 4685 | 2531 | 7539 | 2225 | 10165 | 1842 | 11811 | 1503 | 12735 | 889 | 14394 | 249 | 12905 |
| 14-#14 | 3.92 | 5065 | 2880 | 9046 | 2450 | 11992 | 2014 | 13986 | 1621 | 15397 | 896 | 17793 | 84 | 17364 |
| 14-#18 | 6.96 | 6049 | 3764 | 12733 | 3020 | 16484 | 2452 | 19348 | 1917 | 23498 | 969 | 25994 | -358 | 25424 |
| 15-#10 | 2.37 | 4571 | 2431 | 6889 | 2190 | 9527 | 1823 | 11124 | 1502 | 11962 | 911 | 13633 | 312 | 11537 |
| 15-#11 | 2.91 | 4714 | 2588 | 7612 | 2284 | 10357 | 1894 | 12077 | 1549 | 13099 | 909 | 15067 | 230 | 13636 |
| 15-#14 | 4.20 | 5133 | 2961 | 9213 | 2528 | 12297 | 2083 | 14379 | 1681 | 17057 | 986 | 18700 | 51 | 18400 |
| 16-#10 | 2.53 | 4630 | 2476 | 7010 | 2229 | 9756 | 1848 | 11411 | 1526 | 13192 | 987 | 14164 | 305 | 12208 |
| 16-#11 | 3.10 | 4798 | 2644 | 7767 | 2331 | 10643 | 1924 | 12433 | 1578 | 14485 | 985 | 15671 | 218 | 14430 |
| 16-#14 | 4.48 | 5267 | 3042 | 9449 | 2594 | 12720 | 2125 | 14895 | 1721 | 17696 | 1000 | 19538 | 30 | 19375 |
| 17-#10 | 2.68 | 4675 | 2522 | 7263 | 2256 | 10020 | 1871 | 11723 | 1536 | 12699 | 919 | 14603 | 273 | 12849 |
| 17-#11 | 3.30 | 4844 | 2700 | 8067 | 2365 | 10957 | 1952 | 12799 | 1590 | 13994 | 918 | 16225 | 179 | 15148 |
| 17-#14 | 4.76 | 5323 | 3123 | 9866 | 2644 | 13159 | 2167 | 15390 | 1745 | 17190 | 932 | 20357 | -23 | 20332 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.84 | 4730 | 2568 | 7593 | 2270 | 10358 | 1883 | 12067 | 1543 | 13089 | 910 | 15035 | 251 | 13534 |
| 18-#11 | 3.49 | 4905 | 2756 | 8448 | 2384 | 11358 | 1969 | 13207 | 1600 | 14465 | 908 | 16745 | 153 | 15895 |
| 18-#14 | 5.04 | 5437 | 3205 | 10376 | 2675 | 13715 | 2195 | 15974 | 1756 | 19150 | 987 | 21099 | -60 | 21046 |
| 19-#10 | 3.00 | 4785 | 2614 | 7662 | 2318 | 10507 | 1923 | 12303 | 1572 | 13426 | 925 | 15601 | 239 | 14146 |
| 19-#11 | 3.69 | 4976 | 2813 | 8549 | 2440 | 11546 | 2015 | 13504 | 1634 | 15931 | 991 | 17416 | 136 | 16638 |
| 19-#14 | 5.32 | 5519 | 3286 | 10555 | 2752 | 13996 | 2256 | 16414 | 1802 | 19761 | 1008 | 22036 | -88 | 21937 |
| 20-#10 | 3.16 | 4829 | 2660 | 7831 | 2352 | 10740 | 1951 | 12569 | 1596 | 14778 | 1001 | 16084 | 223 | 14800 |
| 20-#11 | 3.88 | 5047 | 2869 | 8762 | 2481 | 11827 | 2049 | 13825 | 1662 | 16415 | 1003 | 18017 | 117 | 17358 |
| 21-#10 | 3.32 | 4900 | 2706 | 8035 | 2383 | 10986 | 1973 | 12896 | 1610 | 14166 | 932 | 16578 | 201 | 15394 |
| 21-#11 | 4.07 | 5122 | 2925 | 9004 | 2520 | 12126 | 2077 | 14217 | 1679 | 16883 | 999 | 18580 | 87 | 18112 |
| 22-#10 | 3.47 | 4944 | 2751 | 8319 | 2405 | 11290 | 1987 | 13218 | 1619 | 15602 | 994 | 17015 | 175 | 16014 |
| 22-#11 | 4.27 | 5180 | 2982 | 9337 | 2549 | 12485 | 2095 | 14609 | 1692 | 16234 | 927 | 19103 | 55 | 18798 |
| 23-#10 | 3.63 | 5018 | 2797 | 8442 | 2445 | 11471 | 2024 | 13477 | 1645 | 14893 | 939 | 17542 | 162 | 16624 |
| 23-#11 | 4.46 | 5265 | 3038 | 9498 | 2596 | 12716 | 2139 | 14924 | 1723 | 16642 | 940 | 19749 | 38 | 19553 |
| 24-#10 | 3.79 | 5065 | 2843 | 8600 | 2482 | 11698 | 2050 | 13760 | 1669 | 16334 | 1013 | 18018 | 141 | 17230 |
| 25-#10 | 3.95 | 5133 | 2889 | 8817 | 2510 | 11973 | 2072 | 14069 | 1682 | 16744 | 1013 | 18537 | 126 | 17853 |
| 26-#10 | 4.11 | 5190 | 2935 | 9107 | 2530 | 12248 | 2091 | 14397 | 1695 | 16018 | 943 | 19038 | 105 | 18438 |

## ROUND SPIRAL COLUMNS 34" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.03 | 4846 | 2306 | 7394 | 2033 | 9638 | 1681 | 10754 | 1393 | 11517 | 962 | 10872 | 454 | 6660 |
| 6-#14 | 1.49 | 4989 | 2455 | 8159 | 2117 | 10557 | 1741 | 11838 | 1429 | 12951 | 954 | 12382 | 368 | 9272 |
| 6-#18 | 2.64 | 5337 | 2834 | 10021 | 2334 | 12817 | 1897 | 14517 | 1523 | 16507 | 935 | 16036 | 142 | 15359 |
| 7-#11 | 1.20 | 5003 | 2362 | 6716 | 2189 | 9364 | 1829 | 10795 | 1524 | 11117 | 987 | 11916 | 503 | 7662 |
| 7-#14 | 1.73 | 5210 | 2536 | 7571 | 2297 | 10373 | 1912 | 11978 | 1580 | 12554 | 989 | 13747 | 421 | 10456 |
| 7-#18 | 3.08 | 5702 | 2978 | 9645 | 2575 | 12846 | 2123 | 14894 | 1722 | 16090 | 991 | 18236 | 205 | 16999 |
| 8-#10 | 1.12 | 4945 | 2335 | 6237 | 2209 | 9040 | 1852 | 10567 | 1553 | 10924 | 1018 | 11739 | 534 | 7174 |
| 8-#11 | 1.37 | 5022 | 2418 | 6704 | 2254 | 9557 | 1885 | 11146 | 1574 | 11573 | 1015 | 12534 | 488 | 8573 |
| 8-#14 | 1.98 | 5227 | 2617 | 7649 | 2382 | 10707 | 1984 | 12508 | 1644 | 14136 | 1094 | 14590 | 393 | 11862 |
| 8-#18 | 3.52 | 5712 | 3123 | 9952 | 2710 | 13532 | 2236 | 15859 | 1820 | 17181 | 1035 | 19625 | 142 | 18955 |
| 9-#10 | 1.26 | 5028 | 2380 | 6638 | 2222 | 9404 | 1860 | 10905 | 1555 | 11307 | 1004 | 12299 | 510 | 8063 |
| 9-#11 | 1.55 | 5121 | 2475 | 7158 | 2273 | 9978 | 1897 | 11538 | 1578 | 12047 | 1000 | 13212 | 459 | 9548 |
| 9-#14 | 2.23 | 5377 | 2699 | 8239 | 2414 | 11272 | 2007 | 13043 | 1653 | 14875 | 1076 | 15566 | 354 | 13020 |
| 9-#18 | 3.97 | 6014 | 3267 | 10878 | 2776 | 14455 | 2285 | 16748 | 1843 | 18420 | 1014 | 21318 | 76 | 20883 |
| 10-#10 | 1.40 | 5090 | 2426 | 7209 | 2217 | 9898 | 1852 | 11361 | 1535 | 12579 | 1047 | 12683 | 470 | 8761 |
| 10-#11 | 1.72 | 5191 | 2531 | 7786 | 2274 | 10528 | 1894 | 12068 | 1560 | 13470 | 1040 | 13719 | 415 | 10436 |
| 10-#14 | 2.48 | 5459 | 2780 | 9015 | 2430 | 11979 | 2014 | 13766 | 1639 | 14641 | 970 | 16356 | 297 | 14386 |
| 10-#18 | 4.41 | 6138 | 3411 | 12025 | 2828 | 15534 | 2317 | 17945 | 1837 | 21158 | 1036 | 22631 | -28 | 22627 |
| 11-#10 | 1.54 | 5152 | 2472 | 7003 | 2292 | 9893 | 1915 | 11516 | 1595 | 12969 | 1088 | 13382 | 474 | 9610 |
| 11-#11 | 1.89 | 5264 | 2587 | 7612 | 2358 | 10573 | 1963 | 12283 | 1626 | 13935 | 1084 | 14504 | 413 | 11362 |
| 11-#14 | 2.73 | 5574 | 2861 | 8907 | 2535 | 12129 | 2099 | 14115 | 1721 | 15245 | 1020 | 17386 | 284 | 15498 |
| 11-#18 | 4.85 | 6361 | 3556 | 12078 | 2987 | 15954 | 2443 | 18636 | 1960 | 22248 | 1108 | 24412 | -57 | 24373 |
| 12-#10 | 1.68 | 5236 | 2518 | 7138 | 2336 | 10073 | 1953 | 11778 | 1621 | 12470 | 1029 | 13907 | 463 | 10301 |
| 12-#11 | 2.06 | 5363 | 2643 | 7791 | 2410 | 10802 | 2008 | 12606 | 1656 | 13456 | 1027 | 15126 | 397 | 12249 |
| 12-#14 | 2.97 | 5701 | 2942 | 9195 | 2605 | 12477 | 2159 | 14585 | 1760 | 17028 | 1113 | 18253 | 257 | 16801 |
| 12-#18 | 5.29 | 6553 | 3700 | 12623 | 3101 | 16592 | 2542 | 19464 | 2022 | 21919 | 1065 | 26044 | -89 | 25779 |

## ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 13-#10 | 1.82 | 5283 | 2564 | 7414 | 2356 | 10398 | 1968 | 12148 | 1635 | 12885 | 1024 | 14467 | 440 | 11108 |
| 13-#11 | 2.23 | 5417 | 2700 | 8114 | 2436 | 11191 | 2028 | 13046 | 1674 | 13956 | 1022 | 15826 | 370 | 13130 |
| 13-#14 | 3.22 | 5787 | 3023 | 9632 | 2645 | 13020 | 2191 | 15203 | 1788 | 17791 | 1106 | 19251 | 220 | 17848 |
| 13-#18 | 5.73 | 6748 | 3844 | 13257 | 3189 | 17524 | 2605 | 20518 | 2073 | 24804 | 1131 | 27590 | -178 | 27403 |
| 14-#10 | 1.96 | 5380 | 2609 | 7789 | 2370 | 10772 | 1973 | 12542 | 1629 | 14314 | 1086 | 14887 | 413 | 11804 |
| 14-#11 | 2.41 | 5531 | 2756 | 8531 | 2456 | 11621 | 2038 | 13519 | 1671 | 14523 | 1010 | 16341 | 338 | 14023 |
| 14-#14 | 3.47 | 5929 | 3105 | 10161 | 2681 | 13595 | 2211 | 15866 | 1789 | 17403 | 1019 | 20032 | 177 | 19046 |
| 14-#18 | 6.17 | 6983 | 3989 | 14154 | 3253 | 18454 | 2651 | 21663 | 2089 | 24493 | 1034 | 29069 | -245 | 28713 |
| 15-#10 | 2.10 | 5399 | 2655 | 7801 | 2422 | 10915 | 2022 | 12767 | 1672 | 14651 | 1106 | 15515 | 400 | 12562 |
| 15-#11 | 2.58 | 5561 | 2812 | 8587 | 2516 | 11816 | 2092 | 13800 | 1719 | 14907 | 1031 | 17079 | 320 | 14853 |
| 15-#14 | 3.72 | 6007 | 3186 | 10317 | 2761 | 13913 | 2282 | 16285 | 1852 | 19238 | 1118 | 21050 | 148 | 20123 |
| 15-#18 | 6.61 | 7169 | 4133 | 14560 | 3383 | 19074 | 2763 | 22417 | 2187 | 25478 | 1071 | 30683 | -312 | 30233 |
| 16-#10 | 2.24 | 5467 | 2701 | 7926 | 2462 | 11154 | 2047 | 13070 | 1696 | 14053 | 1043 | 16101 | 395 | 13262 |
| 16-#11 | 2.75 | 5639 | 2869 | 8749 | 2564 | 12117 | 2123 | 14176 | 1748 | 15362 | 1042 | 17762 | 311 | 15742 |
| 16-#14 | 3.97 | 6157 | 3267 | 10567 | 2827 | 14359 | 2325 | 16833 | 1892 | 19930 | 1134 | 21980 | 130 | 21225 |
| 17-#10 | 2.38 | 5512 | 2747 | 8200 | 2489 | 11443 | 2070 | 13413 | 1707 | 15497 | 1114 | 16567 | 363 | 13990 |
| 17-#11 | 2.92 | 5696 | 2925 | 9075 | 2597 | 12459 | 2151 | 14580 | 1761 | 17000 | 1114 | 18338 | 272 | 16547 |
| 17-#14 | 4.21 | 6217 | 3348 | 11019 | 2877 | 14836 | 2366 | 17394 | 1911 | 20711 | 1132 | 22830 | 75 | 22393 |
| 18-#10 | 2.52 | 5576 | 2793 | 8566 | 2502 | 11810 | 2080 | 13788 | 1713 | 15947 | 1105 | 17035 | 341 | 14707 |
| 18-#11 | 3.09 | 5768 | 2981 | 9496 | 2615 | 12895 | 2166 | 15024 | 1770 | 16374 | 1030 | 18902 | 245 | 17415 |
| 18-#14 | 4.46 | 6337 | 3429 | 11578 | 2907 | 15438 | 2393 | 18015 | 1928 | 21487 | 1119 | 23640 | 38 | 23423 |
| 19-#10 | 2.66 | 5633 | 2839 | 8629 | 2551 | 11964 | 2122 | 14034 | 1743 | 16338 | 1122 | 17651 | 331 | 15404 |
| 19-#11 | 3.26 | 5839 | 3037 | 9594 | 2673 | 13093 | 2214 | 15335 | 1806 | 16812 | 1047 | 19634 | 230 | 18184 |
| 19-#14 | 4.71 | 6425 | 3510 | 11761 | 2986 | 15742 | 2457 | 18477 | 1975 | 22150 | 1143 | 24661 | 13 | 24597 |
| 20-#10 | 2.80 | 5684 | 2884 | 8806 | 2585 | 12217 | 2151 | 14320 | 1767 | 15638 | 1056 | 18160 | 313 | 16126 |
| 20-#11 | 3.44 | 5912 | 3094 | 9817 | 2715 | 13397 | 2249 | 15682 | 1834 | 17291 | 1059 | 20265 | 210 | 19001 |
| 20-#14 | 4.96 | 6537 | 3592 | 12095 | 3045 | 16178 | 2505 | 18973 | 2014 | 22890 | 1160 | 25578 | -15 | 25557 |
| 21-#10 | 2.94 | 5757 | 2930 | 9029 | 2616 | 12480 | 2172 | 14670 | 1781 | 17188 | 1130 | 18695 | 293 | 16788 |
| 21-#11 | 3.61 | 5988 | 3150 | 10081 | 2753 | 13716 | 2276 | 16106 | 1851 | 17773 | 1056 | 20901 | 183 | 19783 |
| 22-#10 | 3.08 | 5809 | 2976 | 9340 | 2638 | 12813 | 2186 | 15019 | 1789 | 17652 | 1126 | 19186 | 267 | 17511 |
| 22-#11 | 3.78 | 6047 | 3206 | 10445 | 2781 | 14108 | 2294 | 16525 | 1863 | 19595 | 1126 | 21470 | 151 | 20572 |
| 23-#10 | 3.22 | 5882 | 3022 | 9465 | 2678 | 13019 | 2220 | 15296 | 1817 | 18027 | 1137 | 19741 | 254 | 18147 |
| 23-#11 | 3.95 | 6149 | 3263 | 10611 | 2829 | 14349 | 2339 | 16863 | 1895 | 20057 | 1140 | 22159 | 135 | 21384 |
| 24-#10 | 3.36 | 5927 | 3068 | 9634 | 2717 | 13242 | 2250 | 15596 | 1840 | 17206 | 1069 | 20259 | 234 | 18829 |
| 24-#11 | 4.12 | 6214 | 3319 | 10818 | 2875 | 14644 | 2370 | 17233 | 1923 | 19178 | 1072 | 22775 | 109 | 22144 |
| 25-#10 | 3.50 | 6005 | 3114 | 9868 | 2743 | 13540 | 2272 | 15930 | 1854 | 18878 | 1145 | 20794 | 216 | 19476 |
| 25-#11 | 4.30 | 6305 | 3375 | 11099 | 2908 | 15001 | 2397 | 17635 | 1940 | 21082 | 1148 | 23450 | 90 | 22952 |
| 26-#10 | 3.64 | 6060 | 3159 | 10187 | 2764 | 13837 | 2290 | 16290 | 1867 | 18034 | 1065 | 21346 | 197 | 20136 |
| 27-#10 | 3.78 | 6126 | 3205 | 10302 | 2805 | 14058 | 2322 | 16560 | 1890 | 18403 | 1075 | 21877 | 182 | 20793 |
| 28-#10 | 3.92 | 6197 | 3251 | 10498 | 2838 | 14299 | 2352 | 16857 | 1913 | 18803 | 1084 | 22429 | 163 | 21427 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.33 | 5881 | 2693 | 9328 | 2348 | 12145 | 1936 | 13622 | 1595 | 13839 | 1007 | 14190 | 455 | 9970 |
| 6-#18 | 2.36 | 6268 | 3072 | 11336 | 2564 | 14577 | 2091 | 16501 | 1689 | 18647 | 1060 | 18176 | 236 | 16695 |
| 7-#11 | 1.07 | 5893 | 2600 | 7661 | 2432 | 10796 | 2036 | 12472 | 1701 | 13734 | 1192 | 13691 | 593 | 8295 |
| 7-#14 | 1.55 | 6123 | 2775 | 8582 | 2541 | 11882 | 2119 | 13743 | 1757 | 14364 | 1115 | 15666 | 512 | 11313 |
| 7-#18 | 2.75 | 6665 | 3217 | 10820 | 2819 | 14545 | 2331 | 16880 | 1900 | 19476 | 1200 | 20523 | 302 | 18508 |
| 8-#11 | 1.23 | 5915 | 2657 | 7617 | 2501 | 10982 | 2095 | 12835 | 1754 | 14260 | 1224 | 14366 | 580 | 9232 |
| 8-#14 | 1.77 | 6143 | 2856 | 8634 | 2628 | 12216 | 2193 | 14296 | 1823 | 16129 | 1232 | 16586 | 487 | 12784 |
| 8-#18 | 3.14 | 6674 | 3361 | 11113 | 2956 | 15254 | 2446 | 17912 | 2001 | 19355 | 1167 | 22037 | 243 | 20786 |
| 9-#10 | 1.12 | 5919 | 2619 | 7556 | 2467 | 10823 | 2069 | 12584 | 1733 | 13942 | 1211 | 14106 | 601 | 8676 |
| 9-#11 | 1.38 | 6023 | 2713 | 8121 | 2518 | 11444 | 2106 | 13267 | 1757 | 13809 | 1126 | 15095 | 551 | 10340 |
| 9-#14 | 1.99 | 6299 | 2937 | 9285 | 2659 | 12835 | 2215 | 14886 | 1832 | 16909 | 1213 | 17639 | 448 | 14099 |
| 9-#18 | 3.54 | 6975 | 3505 | 12127 | 3021 | 16259 | 2494 | 18876 | 2024 | 20664 | 1144 | 23874 | 177 | 22772 |
| 10-#10 | 1.25 | 5986 | 2664 | 8204 | 2458 | 11381 | 2058 | 13085 | 1711 | 13476 | 1101 | 14491 | 558 | 9445 |
| 10-#11 | 1.53 | 6100 | 2769 | 8829 | 2515 | 12063 | 2099 | 13849 | 1736 | 15399 | 1173 | 15609 | 504 | 11259 |
| 10-#14 | 2.21 | 6396 | 3018 | 10151 | 2671 | 13625 | 2219 | 15675 | 1815 | 16595 | 1096 | 18448 | 388 | 15529 |
| 10-#18 | 3.93 | 7133 | 3650 | 13390 | 3069 | 17459 | 2524 | 20177 | 2015 | 23671 | 1174 | 25365 | 80 | 24911 |
| 11-#10 | 1.37 | 6055 | 2710 | 7940 | 2538 | 11345 | 2125 | 13233 | 1774 | 14860 | 1225 | 15277 | 566 | 10360 |
| 11-#11 | 1.69 | 6180 | 2825 | 8600 | 2603 | 12080 | 2173 | 14060 | 1805 | 15902 | 1221 | 16494 | 506 | 12311 |
| 11-#14 | 2.43 | 6513 | 3099 | 9993 | 2781 | 13753 | 2309 | 16028 | 1901 | 18480 | 1230 | 19611 | 380 | 16786 |
| 11-#18 | 4.32 | 7368 | 3794 | 13405 | 3233 | 17871 | 2655 | 20891 | 2141 | 23194 | 1167 | 27236 | 49 | 26931 |
| 12-#10 | 1.50 | 6146 | 2756 | 8071 | 2583 | 11531 | 2164 | 13511 | 1802 | 15274 | 1239 | 15846 | 556 | 11120 |
| 12-#11 | 1.84 | 6288 | 2882 | 8784 | 2657 | 12320 | 2219 | 14404 | 1837 | 16411 | 1237 | 17169 | 491 | 13231 |
| 12-#14 | 2.65 | 6661 | 3180 | 10296 | 2853 | 14121 | 2370 | 16530 | 1941 | 19213 | 1251 | 20553 | 355 | 18184 |
| 12-#18 | 4.72 | 7575 | 3938 | 13992 | 3350 | 18552 | 2755 | 21780 | 2206 | 24412 | 1198 | 29006 | 20 | 28894 |
| 13-#10 | 1.62 | 6196 | 2802 | 8378 | 2603 | 11881 | 2178 | 13911 | 1815 | 15751 | 1234 | 16430 | 531 | 12005 |
| 13-#11 | 1.99 | 6348 | 2938 | 9136 | 2682 | 12737 | 2238 | 14880 | 1854 | 15854 | 1149 | 17901 | 464 | 14232 |
| 13-#14 | 2.87 | 6743 | 3262 | 10769 | 2892 | 14702 | 2401 | 17198 | 1969 | 20035 | 1245 | 21629 | 319 | 19391 |
| 13-#18 | 5.11 | 7775 | 4083 | 14672 | 3437 | 19547 | 2817 | 22920 | 2257 | 27579 | 1274 | 30687 | -68 | 30627 |
| 14-#10 | 1.75 | 6303 | 2848 | 8800 | 2615 | 12295 | 2181 | 14335 | 1807 | 15204 | 1139 | 16878 | 504 | 12752 |
| 14-#11 | 2.15 | 6473 | 2994 | 9604 | 2700 | 13212 | 2245 | 15387 | 1849 | 17649 | 1219 | 18451 | 431 | 15156 |
| 14-#14 | 3.09 | 6907 | 3343 | 11357 | 2926 | 15332 | 2420 | 17907 | 1968 | 19572 | 1148 | 22435 | 274 | 20778 |
| 14-#18 | 5.50 | 8027 | 4227 | 15657 | 3500 | 20560 | 2862 | 24140 | 2270 | 29162 | 1253 | 32215 | -138 | 32013 |
| 15-#10 | 1.87 | 6325 | 2894 | 8788 | 2669 | 12435 | 2232 | 14570 | 1852 | 16660 | 1243 | 17563 | 493 | 13609 |
| 15-#11 | 2.30 | 6504 | 3051 | 9639 | 2763 | 13408 | 2303 | 15684 | 1900 | 16876 | 1159 | 19256 | 415 | 16094 |
| 15-#14 | 3.32 | 6991 | 3424 | 11498 | 3008 | 15662 | 2494 | 18352 | 2033 | 21592 | 1258 | 23544 | 246 | 21890 |
| 15-#18 | 5.89 | 8212 | 4371 | 16063 | 3631 | 21216 | 2977 | 24948 | 2371 | 30270 | 1293 | 34047 | -198 | 33713 |
| 16-#10 | 2.00 | 6398 | 2939 | 8916 | 2710 | 12684 | 2258 | 14889 | 1877 | 17096 | 1255 | 18179 | 488 | 14333 |
| 16-#11 | 2.45 | 6588 | 3107 | 9807 | 2811 | 13723 | 2334 | 16080 | 1929 | 18607 | 1255 | 20018 | 409 | 17021 |
| 16-#14 | 3.54 | 7130 | 3505 | 11761 | 3075 | 16130 | 2536 | 18930 | 2074 | 22337 | 1275 | 24588 | 233 | 23127 |
| 16-#18 | 6.29 | 8495 | 4516 | 16561 | 3745 | 22073 | 3049 | 25986 | 2440 | 29451 | 1230 | 35731 | -235 | 35457 |
| 17-#10 | 2.12 | 6449 | 2985 | 9213 | 2736 | 12997 | 2280 | 15259 | 1888 | 17561 | 1252 | 18697 | 458 | 15155 |
| 17-#11 | 2.61 | 6651 | 3163 | 10158 | 2844 | 14094 | 2362 | 16521 | 1942 | 17900 | 1169 | 20616 | 369 | 17928 |
| 17-#14 | 3.76 | 7198 | 3586 | 12246 | 3125 | 16647 | 2578 | 19545 | 2094 | 21619 | 1187 | 25470 | 177 | 24335 |
| 18-#10 | 2.25 | 6510 | 3031 | 9618 | 2748 | 13395 | 2289 | 15670 | 1893 | 18044 | 1242 | 19199 | 435 | 15904 |
| 18-#11 | 2.76 | 6728 | 3219 | 10622 | 2861 | 14564 | 2376 | 17003 | 1951 | 18445 | 1158 | 21224 | 342 | 18871 |
| 18-#14 | 3.98 | 7338 | 3668 | 12859 | 3154 | 17294 | 2603 | 20217 | 2110 | 23999 | 1259 | 26345 | 140 | 25489 |

## ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 4,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 19-#10 | 2.37 | 6580 | 3077 | 9672 | 2798 | 13552 | 2332 | 15925 | 1924 | 17234 | 1176 | 19830 | 422 | 16684 |
| 19-#11 | 2.91 | 6806 | 3276 | 10715 | 2920 | 14770 | 2425 | 17327 | 1987 | 18917 | 1177 | 22017 | 328 | 19737 |
| 19-#14 | 4.20 | 7434 | 3749 | 13043 | 3234 | 17617 | 2669 | 20701 | 2158 | 23065 | 1198 | 27452 | 116 | 26748 |
| 20-#10 | 2.50 | 6635 | 3123 | 9855 | 2833 | 13824 | 2363 | 16230 | 1949 | 18906 | 1270 | 20401 | 408 | 17433 |
| 20-#11 | 3.07 | 6868 | 3332 | 10947 | 2962 | 15098 | 2461 | 17698 | 2016 | 20811 | 1273 | 22680 | 307 | 20690 |
| 20-#14 | 4.42 | 7549 | 3830 | 13394 | 3293 | 18087 | 2718 | 21233 | 2197 | 25496 | 1301 | 28413 | 87 | 27897 |
| 21-#10 | 2.62 | 6715 | 3169 | 10097 | 2863 | 14105 | 2384 | 16603 | 1962 | 19371 | 1269 | 20977 | 388 | 18179 |
| 21-#11 | 3.22 | 6967 | 3388 | 11234 | 3000 | 15438 | 2488 | 18152 | 2033 | 19947 | 1187 | 23373 | 282 | 21501 |
| 21-#14 | 4.64 | 7666 | 3911 | 13789 | 3348 | 18571 | 2758 | 21880 | 2223 | 24535 | 1211 | 29392 | 49 | 29120 |
| 22-#10 | 2.74 | 6761 | 3214 | 10437 | 2884 | 14468 | 2397 | 16980 | 1970 | 19876 | 1264 | 21523 | 364 | 18933 |
| 22-#11 | 3.37 | 7029 | 3445 | 11630 | 3028 | 15865 | 2505 | 18602 | 2044 | 21970 | 1266 | 24003 | 250 | 22378 |
| 22-#14 | 4.86 | 7774 | 3992 | 14324 | 3391 | 19159 | 2786 | 22515 | 2242 | 27135 | 1291 | 30271 | 3 | 30253 |
| 23-#10 | 2.87 | 6849 | 3260 | 10562 | 2926 | 14680 | 2432 | 17274 | 1999 | 20272 | 1276 | 22106 | 351 | 19663 |
| 23-#11 | 3.52 | 7132 | 3501 | 11800 | 3077 | 16138 | 2546 | 18963 | 2077 | 22458 | 1280 | 24725 | 234 | 23220 |
| 24-#10 | 2.99 | 6899 | 3306 | 10739 | 2964 | 14918 | 2462 | 17591 | 2022 | 20709 | 1285 | 22667 | 331 | 20431 |
| 24-#11 | 3.68 | 7199 | 3557 | 12022 | 3123 | 16429 | 2582 | 19354 | 2106 | 22985 | 1289 | 25394 | 209 | 24070 |
| 25-#10 | 3.12 | 6974 | 3352 | 10994 | 2991 | 15239 | 2484 | 17951 | 2036 | 21182 | 1285 | 23242 | 314 | 21136 |
| 25-#11 | 3.83 | 7285 | 3613 | 12323 | 3156 | 16814 | 2609 | 19786 | 2123 | 21989 | 1203 | 26121 | 191 | 24929 |
| 26-#10 | 3.24 | 7031 | 3398 | 11342 | 3011 | 15558 | 2501 | 18344 | 2049 | 21655 | 1281 | 23819 | 293 | 21879 |
| 26-#11 | 3.98 | 7354 | 3670 | 12730 | 3182 | 17196 | 2633 | 20249 | 2139 | 22528 | 1200 | 26807 | 164 | 25763 |
| 27-#10 | 3.37 | 7105 | 3444 | 11457 | 3053 | 15791 | 2534 | 18626 | 2073 | 22080 | 1292 | 24398 | 279 | 22563 |
| 27-#11 | 4.14 | 7462 | 3726 | 12886 | 3232 | 17485 | 2671 | 20601 | 2167 | 24649 | 1298 | 27485 | 144 | 26623 |
| 28-#10 | 3.49 | 7175 | 3489 | 11665 | 3086 | 16045 | 2564 | 18945 | 2095 | 22534 | 1301 | 25008 | 262 | 23267 |
| 29-#10 | 3.62 | 7239 | 3535 | 11891 | 3118 | 16350 | 2586 | 19302 | 2110 | 22990 | 1300 | 25523 | 241 | 23980 |
| 30-#10 | 3.74 | 7323 | 3581 | 12181 | 3142 | 16677 | 2607 | 19667 | 2122 | 23472 | 1299 | 26077 | 216 | 24670 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 12" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.64 | 255 | 373 | 505 | 273 | 561 | 219 | 576 | 177 | 565 | 107 | 471 | 18 | 410 |
| 6-#6 | 2.33 | 258 | 400 | 542 | 287 | 602 | 228 | 621 | 180 | 580 | 93 | 520 | -8 | 528 |
| 6-#7 | 3.18 | 263 | 434 | 585 | 305 | 649 | 238 | 675 | 185 | 689 | 90 | 591 | -37 | 605 |
| 6-#8 | 4.19 | 268 | 475 | 633 | 326 | 703 | 250 | 736 | 190 | 766 | 78 | 658 | -76 | 688 |
| 6-#9 | 5.31 | 275 | 520 | 682 | 349 | 759 | 263 | 800 | 195 | 791 | 60 | 727 | -120 | 772 |
| 6-#10 | 6.74 | 284 | 577 | 742 | 377 | 828 | 280 | 878 | 201 | 946 | 46 | 808 | -177 | 871 |
| 7-#5 | 1.92 | 259 | 384 | 494 | 295 | 565 | 239 | 592 | 193 | 593 | 118 | 521 | 23 | 457 |
| 7-#6 | 2.72 | 265 | 416 | 533 | 312 | 610 | 251 | 643 | 199 | 613 | 104 | 583 | -5 | 587 |
| 7-#7 | 3.71 | 272 | 456 | 580 | 334 | 663 | 266 | 703 | 207 | 732 | 104 | 654 | -40 | 680 |
| 7-#8 | 4.89 | 281 | 503 | 633 | 360 | 724 | 284 | 771 | 216 | 763 | 87 | 734 | -82 | 783 |
| 7-#9 | 6.19 | 291 | 555 | 688 | 389 | 789 | 303 | 843 | 224 | 847 | 76 | 815 | -131 | 875 |
| 8-#5 | 2.19 | 262 | 395 | 499 | 306 | 577 | 247 | 610 | 200 | 577 | 113 | 551 | 15 | 514 |
| 8-#6 | 3.11 | 268 | 432 | 543 | 327 | 628 | 261 | 668 | 208 | 690 | 114 | 623 | -16 | 634 |
| 8-#7 | 4.24 | 276 | 477 | 594 | 353 | 688 | 279 | 737 | 218 | 776 | 106 | 706 | -57 | 730 |
| 8-#8 | 5.59 | 286 | 531 | 652 | 384 | 757 | 299 | 814 | 229 | 873 | 96 | 798 | -106 | 842 |

## ROUND SPIRAL COLUMNS 14" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.21 | 406 | 483 | 755 | 370 | 857 | 301 | 887 | 247 | 869 | 161 | 739 | 55 | 512 |
| 6-#6 | 1.71 | 412 | 511 | 802 | 384 | 913 | 310 | 949 | 252 | 883 | 144 | 810 | 31 | 689 |
| 6-#7 | 2.34 | 419 | 545 | 858 | 402 | 980 | 323 | 1023 | 258 | 1039 | 147 | 893 | 0 | 893 |
| 6-#8 | 3.08 | 427 | 586 | 922 | 424 | 1055 | 337 | 1108 | 265 | 1070 | 129 | 989 | -37 | 1013 |
| 6-#9 | 3.90 | 436 | 630 | 991 | 447 | 1135 | 352 | 1199 | 272 | 1260 | 127 | 1088 | -78 | 1134 |
| 6-#10 | 4.95 | 449 | 688 | 1078 | 478 | 1233 | 371 | 1310 | 281 | 1307 | 105 | 1209 | -132 | 1278 |
| 6-#11 | 6.08 | 455 | 750 | 1159 | 506 | 1306 | 383 | 1390 | 282 | 1499 | 87 | 1315 | -190 | 1377 |
| 7-#5 | 1.41 | 412 | 494 | 727 | 397 | 854 | 325 | 903 | 267 | 908 | 176 | 808 | 63 | 582 |
| 7-#6 | 2.00 | 422 | 527 | 780 | 415 | 914 | 338 | 971 | 275 | 994 | 172 | 895 | 39 | 768 |
| 7-#7 | 2.73 | 432 | 566 | 842 | 438 | 985 | 355 | 1054 | 284 | 1025 | 155 | 998 | 8 | 977 |
| 7-#8 | 3.59 | 445 | 614 | 913 | 465 | 1067 | 374 | 1149 | 296 | 1217 | 159 | 1115 | -30 | 1139 |
| 7-#9 | 4.55 | 460 | 666 | 989 | 495 | 1155 | 395 | 1251 | 308 | 1343 | 151 | 1250 | -69 | 1290 |
| 7-#10 | 5.78 | 479 | 733 | 1085 | 534 | 1264 | 421 | 1379 | 323 | 1500 | 139 | 1403 | -125 | 1466 |
| 7-#11 | 7.09 | 490 | 805 | 1171 | 567 | 1355 | 442 | 1469 | 328 | 1611 | 114 | 1484 | -203 | 1568 |
| 8-#5 | 1.61 | 415 | 505 | 733 | 411 | 869 | 335 | 925 | 273 | 879 | 168 | 854 | 59 | 649 |
| 8-#6 | 2.29 | 425 | 542 | 792 | 433 | 937 | 350 | 1002 | 285 | 970 | 164 | 957 | 32 | 867 |
| 8-#7 | 3.12 | 436 | 588 | 861 | 460 | 1017 | 369 | 1095 | 297 | 1157 | 171 | 1079 | -3 | 1081 |
| 8-#8 | 4.11 | 450 | 642 | 940 | 492 | 1109 | 392 | 1202 | 311 | 1292 | 164 | 1217 | -45 | 1228 |
| 8-#9 | 5.20 | 466 | 701 | 1024 | 527 | 1208 | 416 | 1317 | 326 | 1436 | 156 | 1362 | -94 | 1391 |
| 8-#10 | 6.60 | 487 | 778 | 1128 | 573 | 1331 | 447 | 1460 | 344 | 1506 | 135 | 1538 | -158 | 1586 |

## ROUND SPIRAL COLUMNS 16" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#6 | 1.31 | 614 | 639 | 1130 | 496 | 1302 | 404 | 1367 | 333 | 1358 | 217 | 1175 | 76 | 832 |
| 6-#7 | 1.79 | 624 | 673 | 1198 | 514 | 1385 | 417 | 1462 | 340 | 1378 | 197 | 1288 | 48 | 1086 |
| 6-#8 | 2.36 | 636 | 713 | 1278 | 536 | 1481 | 432 | 1572 | 349 | 1614 | 204 | 1417 | 14 | 1373 |
| 6-#9 | 2.98 | 648 | 758 | 1364 | 560 | 1585 | 448 | 1689 | 358 | 1762 | 195 | 1552 | -25 | 1569 |
| 6-#10 | 3.79 | 665 | 816 | 1472 | 591 | 1716 | 470 | 1835 | 369 | 1946 | 184 | 1721 | -76 | 1764 |
| 6-#11 | 4.66 | 674 | 877 | 1579 | 619 | 1831 | 486 | 1951 | 373 | 2087 | 162 | 1827 | -143 | 1906 |
| 6-#14 | 6.71 | 716 | 1025 | 1830 | 699 | 2118 | 535 | 2277 | 397 | 2499 | 126 | 2182 | -281 | 2313 |
| 7-#5 | 1.08 | 614 | 622 | 1020 | 516 | 1222 | 426 | 1301 | 352 | 1310 | 241 | 1177 | 109 | 712 |
| 7-#6 | 1.53 | 626 | 654 | 1084 | 535 | 1297 | 439 | 1387 | 360 | 1420 | 238 | 1292 | 87 | 943 |
| 7-#7 | 2.09 | 641 | 694 | 1161 | 558 | 1387 | 456 | 1490 | 369 | 1449 | 219 | 1429 | 59 | 1212 |
| 7-#8 | 2.75 | 660 | 741 | 1250 | 585 | 1491 | 477 | 1610 | 381 | 1706 | 230 | 1587 | 25 | 1510 |
| 7-#9 | 3.48 | 680 | 794 | 1345 | 616 | 1602 | 499 | 1738 | 397 | 1870 | 224 | 1754 | -13 | 1765 |
| 7-#10 | 4.42 | 705 | 861 | 1464 | 655 | 1741 | 527 | 1900 | 414 | 2075 | 216 | 1960 | -64 | 2007 |
| 7-#11 | 5.43 | 720 | 933 | 1585 | 690 | 1865 | 549 | 2039 | 425 | 2085 | 184 | 2093 | -133 | 2188 |
| 7-#14 | 7.83 | 784 | 1105 | 1861 | 790 | 2184 | 618 | 2412 | 464 | 2693 | 167 | 2564 | -270 | 2651 |

## ROUND SPIRAL COLUMNS 16" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#5 | 1.23 | 616 | 633 | 1021 | 531 | 1240 | 437 | 1328 | 360 | 1260 | 230 | 1228 | 104 | 786 |
| 8-#6 | 1.75 | 630 | 670 | 1094 | 553 | 1324 | 453 | 1424 | 370 | 1473 | 244 | 1359 | 78 | 1055 |
| 8-#7 | 2.39 | 645 | 715 | 1180 | 581 | 1425 | 473 | 1540 | 382 | 1515 | 225 | 1516 | 46 | 1371 |
| 8-#8 | 3.14 | 665 | 769 | 1280 | 614 | 1542 | 497 | 1675 | 396 | 1678 | 221 | 1696 | 7 | 1685 |
| 8-#9 | 3.98 | 685 | 829 | 1387 | 651 | 1667 | 523 | 1821 | 411 | 1986 | 232 | 1886 | -37 | 1908 |
| 8-#10 | 5.05 | 711 | 906 | 1523 | 698 | 1824 | 556 | 2003 | 431 | 2220 | 225 | 2159 | -86 | 2170 |
| 8-#11 | 6.21 | 729 | 988 | 1653 | 741 | 1963 | 583 | 2159 | 452 | 2242 | 192 | 2321 | -165 | 2364 |
| 9-#10 | 5.68 | 739 | 951 | 1608 | 718 | 1927 | 573 | 2130 | 446 | 2373 | 214 | 2297 | -119 | 2350 |
| 9-#11 | 6.98 | 763 | 1044 | 1753 | 766 | 2089 | 606 | 2306 | 461 | 2407 | 179 | 2475 | -206 | 2552 |
| 10-#10 | 6.32 | 759 | 996 | 1713 | 736 | 2045 | 578 | 2265 | 447 | 2539 | 198 | 2429 | -163 | 2485 |

## ROUND SPIRAL COLUMNS 18" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#6 | 1.04 | 870 | 783 | 1533 | 624 | 1786 | 511 | 1879 | 423 | 1869 | 286 | 1628 | 124 | 975 |
| 6-#7 | 1.41 | 885 | 817 | 1615 | 642 | 1884 | 523 | 1995 | 431 | 2014 | 282 | 1769 | 98 | 1279 |
| 6-#8 | 1.86 | 900 | 858 | 1710 | 664 | 1998 | 539 | 2131 | 441 | 2183 | 276 | 1932 | 67 | 1624 |
| 6-#9 | 2.36 | 917 | 903 | 1813 | 688 | 2122 | 555 | 2278 | 452 | 2364 | 269 | 2105 | 32 | 1989 |
| 6-#10 | 2.99 | 938 | 960 | 1942 | 720 | 2279 | 577 | 2464 | 466 | 2592 | 259 | 2322 | -15 | 2331 |
| 6-#11 | 3.68 | 951 | 1022 | 2076 | 748 | 2430 | 595 | 2616 | 472 | 2778 | 241 | 2476 | -77 | 2523 |
| 6-#14 | 5.31 | 1002 | 1169 | 2381 | 828 | 2804 | 651 | 3031 | 501 | 3301 | 211 | 2951 | -208 | 3050 |
| 7-#6 | 1.21 | 887 | 799 | 1455 | 671 | 1768 | 553 | 1902 | 457 | 1941 | 312 | 1780 | 139 | 1124 |
| 7-#7 | 1.65 | 907 | 839 | 1547 | 694 | 1875 | 571 | 2026 | 468 | 2100 | 310 | 1952 | 113 | 1446 |
| 7-#8 | 2.17 | 929 | 886 | 1653 | 722 | 2000 | 591 | 2171 | 480 | 2134 | 286 | 2152 | 83 | 1811 |
| 7-#9 | 2.75 | 954 | 938 | 1768 | 752 | 2135 | 614 | 2327 | 494 | 2489 | 302 | 2364 | 48 | 2197 |
| 7-#10 | 3.49 | 988 | 1005 | 1911 | 792 | 2306 | 644 | 2523 | 512 | 2744 | 297 | 2628 | 2 | 2623 |
| 7-#11 | 4.29 | 1009 | 1078 | 2062 | 828 | 2468 | 668 | 2700 | 523 | 2961 | 283 | 2820 | -61 | 2869 |
| 7-#14 | 6.19 | 1087 | 1249 | 2399 | 929 | 2863 | 741 | 3160 | 572 | 3306 | 244 | 3403 | -192 | 3526 |
| 8-#6 | 1.38 | 890 | 815 | 1458 | 691 | 1801 | 570 | 1946 | 470 | 1873 | 298 | 1864 | 132 | 1247 |
| 8-#7 | 1.89 | 911 | 860 | 1561 | 718 | 1923 | 590 | 2086 | 482 | 2186 | 317 | 2060 | 103 | 1625 |
| 8-#8 | 2.48 | 934 | 914 | 1680 | 752 | 2064 | 615 | 2249 | 497 | 2396 | 315 | 2287 | 68 | 2055 |
| 8-#9 | 3.14 | 959 | 974 | 1808 | 789 | 2216 | 642 | 2425 | 514 | 2623 | 312 | 2529 | 27 | 2449 |
| 8-#10 | 3.99 | 994 | 1051 | 1970 | 836 | 2408 | 676 | 2647 | 535 | 2910 | 307 | 2831 | -26 | 2846 |
| 8-#11 | 4.90 | 1017 | 1133 | 2141 | 881 | 2585 | 705 | 2845 | 549 | 3161 | 294 | 3052 | -99 | 3105 |
| 8-#14 | 7.07 | 1098 | 1329 | 2524 | 1003 | 3030 | 790 | 3364 | 598 | 3827 | 276 | 3792 | -234 | 3821 |
| 9-#10 | 4.49 | 1029 | 1096 | 2083 | 857 | 2523 | 692 | 2796 | 546 | 3103 | 299 | 3052 | -48 | 3069 |
| 9-#11 | 5.52 | 1059 | 1188 | 2266 | 906 | 2727 | 726 | 3027 | 563 | 3386 | 282 | 3306 | -126 | 3367 |
| 10-#10 | 4.99 | 1051 | 1141 | 2218 | 874 | 2671 | 696 | 2954 | 540 | 3318 | 284 | 3216 | -89 | 3264 |
| 10-#11 | 6.13 | 1085 | 1244 | 2416 | 928 | 2897 | 732 | 3214 | 569 | 3624 | 262 | 3497 | -179 | 3553 |
| 11-#10 | 5.49 | 1078 | 1186 | 2253 | 919 | 2753 | 741 | 3065 | 577 | 3464 | 299 | 3449 | -103 | 3503 |
| 11-#11 | 6.74 | 1118 | 1299 | 2471 | 982 | 2997 | 783 | 3345 | 600 | 3817 | 285 | 3761 | -198 | 3842 |
| 12-#10 | 5.99 | 1110 | 1231 | 2346 | 948 | 2850 | 765 | 3202 | 596 | 3637 | 305 | 3661 | -126 | 3717 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 20" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 1.15 | 1205 | 979 | 2116 | 786 | 2490 | 644 | 2639 | 533 | 2485 | 336 | 2347 | 153 | 1472 |
| 6-#8 | 1.51 | 1225 | 1020 | 2227 | 808 | 2623 | 659 | 2796 | 543 | 2672 | 331 | 2545 | 124 | 1876 |
| 6-#9 | 1.91 | 1249 | 1064 | 2347 | 832 | 2767 | 676 | 2966 | 554 | 3078 | 349 | 2757 | 91 | 2305 |
| 6-#10 | 2.43 | 1275 | 1122 | 2498 | 864 | 2950 | 698 | 3183 | 568 | 3350 | 341 | 3022 | 48 | 2837 |
| 6-#11 | 2.98 | 1293 | 1184 | 2659 | 892 | 3130 | 716 | 3390 | 578 | 3343 | 304 | 3225 | -10 | 3232 |
| 6-#14 | 4.30 | 1354 | 1331 | 3018 | 972 | 3569 | 772 | 3903 | 612 | 4217 | 301 | 3823 | -131 | 3891 |
| 6-#18 | 7.64 | 1519 | 1704 | 3877 | 1178 | 4626 | 914 | 5082 | 688 | 5701 | 228 | 5177 | -460 | 5334 |
| 7-#7 | 1.34 | 1234 | 1000 | 2006 | 847 | 2465 | 699 | 2675 | 578 | 2762 | 393 | 2578 | 172 | 1688 |
| 7-#8 | 1.76 | 1262 | 1048 | 2130 | 874 | 2610 | 720 | 2845 | 591 | 2980 | 390 | 2819 | 143 | 2118 |
| 7-#9 | 2.23 | 1293 | 1100 | 2264 | 905 | 2768 | 743 | 3028 | 605 | 3002 | 362 | 3077 | 111 | 2572 |
| 7-#10 | 2.83 | 1331 | 1167 | 2432 | 945 | 2966 | 773 | 3260 | 624 | 3516 | 384 | 3402 | 68 | 3135 |
| 7-#11 | 3.48 | 1363 | 1239 | 2614 | 981 | 3165 | 798 | 3474 | 636 | 3533 | 347 | 3653 | 11 | 3614 |
| 7-#14 | 5.01 | 1457 | 1411 | 3012 | 1083 | 3641 | 875 | 4023 | 681 | 4499 | 358 | 4385 | -109 | 4462 |
| 8-#7 | 1.53 | 1239 | 1022 | 2012 | 873 | 2517 | 721 | 2744 | 594 | 2672 | 375 | 2709 | 164 | 1882 |
| 8-#8 | 2.01 | 1268 | 1076 | 2150 | 906 | 2685 | 746 | 2935 | 610 | 3109 | 401 | 2983 | 131 | 2386 |
| 8-#9 | 2.55 | 1299 | 1136 | 2300 | 943 | 2866 | 774 | 3142 | 627 | 3375 | 399 | 3278 | 93 | 2922 |
| 8-#10 | 3.23 | 1337 | 1212 | 2488 | 991 | 3092 | 810 | 3404 | 650 | 3465 | 370 | 3647 | 44 | 3502 |
| 8-#11 | 3.97 | 1371 | 1295 | 2693 | 1036 | 3309 | 839 | 3645 | 665 | 3749 | 359 | 3935 | -22 | 3949 |
| 8-#14 | 5.73 | 1466 | 1491 | 3142 | 1159 | 3842 | 928 | 4264 | 719 | 4497 | 348 | 4770 | -161 | 4838 |
| 9-#10 | 3.64 | 1383 | 1257 | 2627 | 1012 | 3221 | 824 | 3568 | 658 | 3940 | 388 | 3889 | 19 | 3823 |
| 9-#11 | 4.47 | 1420 | 1350 | 2852 | 1062 | 3467 | 858 | 3848 | 678 | 4285 | 375 | 4245 | -49 | 4258 |
| 9-#14 | 6.45 | 1541 | 1571 | 3352 | 1197 | 4066 | 958 | 4557 | 740 | 5195 | 359 | 5200 | -199 | 5254 |
| 10-#10 | 4.04 | 1409 | 1303 | 2800 | 1028 | 3400 | 826 | 3756 | 652 | 4181 | 371 | 4107 | -16 | 4117 |
| 10-#11 | 4.97 | 1450 | 1406 | 3041 | 1083 | 3672 | 863 | 4069 | 672 | 4585 | 357 | 4475 | -98 | 4530 |
| 10-#14 | 7.16 | 1582 | 1651 | 3596 | 1232 | 4345 | 969 | 4865 | 749 | 5613 | 334 | 5528 | -270 | 5575 |
| 11-#10 | 4.45 | 1441 | 1348 | 2823 | 1075 | 3483 | 873 | 3886 | 692 | 4366 | 391 | 4392 | -28 | 4411 |
| 11-#11 | 5.46 | 1489 | 1461 | 3086 | 1138 | 3784 | 918 | 4223 | 717 | 4787 | 376 | 4801 | -115 | 4865 |
| 12-#10 | 4.85 | 1477 | 1393 | 2929 | 1106 | 3595 | 899 | 4035 | 712 | 4266 | 373 | 4648 | -47 | 4671 |
| 12-#11 | 5.96 | 1532 | 1516 | 3214 | 1174 | 3918 | 948 | 4409 | 741 | 4692 | 359 | 5097 | -142 | 5161 |
| 13-#10 | 5.26 | 1503 | 1438 | 3042 | 1134 | 3751 | 917 | 4204 | 725 | 4783 | 392 | 4872 | -80 | 4910 |
| 14-#10 | 5.66 | 1546 | 1483 | 3191 | 1151 | 3911 | 931 | 4397 | 729 | 5010 | 381 | 5084 | -111 | 5133 |

## ROUND SPIRAL COLUMNS 22" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.25 | 1620 | 1198 | 2837 | 968 | 3365 | 792 | 3587 | 656 | 3422 | 412 | 3266 | 184 | 2128 |
| 6-#9 | 1.58 | 1646 | 1243 | 2975 | 992 | 3530 | 809 | 3782 | 667 | 3917 | 437 | 3516 | 153 | 2622 |
| 6-#10 | 2.00 | 1682 | 1301 | 3147 | 1024 | 3738 | 831 | 4029 | 681 | 4233 | 431 | 3831 | 112 | 3235 |
| 6-#11 | 2.46 | 1705 | 1363 | 3336 | 1051 | 3948 | 849 | 4269 | 691 | 4211 | 388 | 4084 | 58 | 3840 |
| 6-#14 | 3.55 | 1778 | 1510 | 3750 | 1132 | 4453 | 906 | 4870 | 728 | 5259 | 396 | 4807 | -54 | 4838 |
| 6-#18 | 6.31 | 1968 | 1883 | 4746 | 1339 | 5675 | 1050 | 6311 | 818 | 7028 | 335 | 6475 | -360 | 6594 |
| 7-#7 | 1.10 | 1630 | 1179 | 2544 | 1016 | 3166 | 841 | 3444 | 699 | 3549 | 485 | 3317 | 235 | 1937 |
| 7-#8 | 1.45 | 1665 | 1226 | 2686 | 1044 | 3332 | 862 | 3638 | 712 | 3545 | 451 | 3600 | 208 | 2431 |
| 7-#9 | 1.84 | 1701 | 1279 | 2840 | 1075 | 3512 | 886 | 3850 | 727 | 4070 | 481 | 3905 | 178 | 2957 |
| 7-#10 | 2.34 | 1748 | 1346 | 3033 | 1115 | 3739 | 916 | 4118 | 747 | 4414 | 478 | 4289 | 138 | 3606 |
| 7-#11 | 2.87 | 1782 | 1418 | 3247 | 1151 | 3971 | 941 | 4374 | 760 | 4731 | 467 | 4601 | 84 | 4244 |
| 7-#14 | 4.14 | 1898 | 1590 | 3708 | 1254 | 4520 | 1019 | 5013 | 808 | 5188 | 426 | 5485 | -27 | 5506 |
| 7-#18 | 7.37 | 2161 | 2025 | 4810 | 1515 | 5843 | 1214 | 6542 | 924 | 7549 | 423 | 7525 | -331 | 7667 |
| 8-#7 | 1.26 | 1635 | 1201 | 2539 | 1044 | 3218 | 865 | 3526 | 718 | 3666 | 496 | 3472 | 229 | 2143 |
| 8-#8 | 1.66 | 1670 | 1255 | 2697 | 1078 | 3408 | 890 | 3745 | 734 | 3685 | 462 | 3795 | 198 | 2721 |
| 8-#9 | 2.10 | 1708 | 1314 | 2868 | 1115 | 3615 | 919 | 3984 | 752 | 3970 | 461 | 4142 | 163 | 3339 |
| 8-#10 | 2.67 | 1754 | 1391 | 3084 | 1163 | 3878 | 955 | 4285 | 776 | 4642 | 493 | 4579 | 117 | 4109 |

## ROUND SPIRAL COLUMNS 22" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 3.28 | 1790 | 1473 | 3323 | 1207 | 4145 | 987 | 4571 | 792 | 4999 | 483 | 4936 | 55 | 4739 |
| 8-#14 | 4.74 | 1907 | 1670 | 3840 | 1330 | 4765 | 1078 | 5291 | 849 | 5930 | 476 | 5942 | -73 | 5976 |
| 9-#10 | 3.01 | 1804 | 1436 | 3249 | 1183 | 4030 | 969 | 4466 | 783 | 4577 | 453 | 4862 | 92 | 4464 |
| 9-#11 | 3.69 | 1848 | 1529 | 3512 | 1233 | 4318 | 1004 | 4793 | 803 | 5310 | 473 | 5269 | 24 | 5177 |
| 9-#14 | 5.33 | 1994 | 1750 | 4094 | 1370 | 5011 | 1106 | 5611 | 867 | 6370 | 462 | 6454 | -110 | 6482 |
| 10-#10 | 3.34 | 1831 | 1481 | 3467 | 1197 | 4242 | 969 | 4685 | 775 | 5165 | 465 | 5114 | 59 | 4888 |
| 10-#11 | 4.10 | 1888 | 1584 | 3750 | 1253 | 4563 | 1007 | 5050 | 795 | 5260 | 422 | 5569 | -17 | 5580 |
| 10-#14 | 5.92 | 2039 | 1830 | 4395 | 1404 | 5342 | 1115 | 5970 | 861 | 6391 | 408 | 6840 | -177 | 6841 |
| 11-#10 | 3.68 | 1870 | 1526 | 3473 | 1248 | 4323 | 1018 | 4831 | 818 | 5022 | 456 | 5452 | 49 | 5243 |
| 11-#11 | 4.51 | 1932 | 1640 | 3781 | 1311 | 4674 | 1064 | 5226 | 845 | 5888 | 477 | 5959 | -33 | 5981 |
| 11-#14 | 6.51 | 2109 | 1910 | 4475 | 1481 | 5520 | 1192 | 6221 | 925 | 7186 | 466 | 7366 | -203 | 7390 |
| 12-#10 | 4.01 | 1912 | 1572 | 3589 | 1280 | 4450 | 1046 | 4993 | 838 | 5632 | 500 | 5752 | 32 | 5629 |
| 12-#11 | 4.92 | 1981 | 1695 | 3924 | 1348 | 4827 | 1096 | 5428 | 868 | 6171 | 488 | 6308 | -56 | 6336 |
| 13-#10 | 4.34 | 1947 | 1617 | 3717 | 1307 | 4631 | 1064 | 5187 | 852 | 5861 | 492 | 6015 | 0 | 6015 |
| 13-#11 | 5.33 | 2018 | 1751 | 4077 | 1384 | 5040 | 1119 | 5658 | 885 | 6456 | 479 | 6616 | -96 | 6661 |
| 14-#10 | 4.68 | 1995 | 1662 | 3895 | 1323 | 4812 | 1076 | 5415 | 855 | 6122 | 481 | 6263 | -29 | 6277 |
| 14-#11 | 5.75 | 2075 | 1806 | 4280 | 1404 | 5257 | 1136 | 5925 | 890 | 6767 | 466 | 6908 | -133 | 6965 |
| 15-#10 | 5.01 | 2021 | 1707 | 3951 | 1371 | 4927 | 1112 | 5551 | 886 | 5930 | 466 | 6602 | -45 | 6599 |
| 16-#10 | 5.35 | 2069 | 1752 | 4053 | 1403 | 5068 | 1143 | 5724 | 904 | 6576 | 501 | 6871 | -66 | 6895 |

## ROUND SPIRAL COLUMNS 24" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.05 | 2090 | 1394 | 3548 | 1144 | 4237 | 939 | 4519 | 775 | 4295 | 500 | 4106 | 248 | 2380 |
| 6-#9 | 1.33 | 2121 | 1439 | 3704 | 1168 | 4422 | 956 | 4737 | 785 | 4892 | 532 | 4395 | 219 | 2939 |
| 6-#10 | 1.68 | 2159 | 1497 | 3899 | 1199 | 4657 | 978 | 5015 | 798 | 5254 | 527 | 4760 | 180 | 3635 |
| 6-#11 | 2.07 | 2193 | 1558 | 4116 | 1226 | 4897 | 995 | 5287 | 815 | 5578 | 514 | 5063 | 129 | 4329 |
| 6-#14 | 2.98 | 2281 | 1705 | 4586 | 1308 | 5468 | 1052 | 5965 | 853 | 6439 | 497 | 5912 | 23 | 5830 |
| 6-#18 | 5.31 | 2497 | 2079 | 5718 | 1516 | 6855 | 1198 | 7622 | 947 | 7928 | 415 | 7898 | -264 | 7987 |
| 7-#8 | 1.22 | 2142 | 1422 | 3330 | 1230 | 4176 | 1019 | 4568 | 846 | 4756 | 584 | 4507 | 277 | 2752 |
| 7-#9 | 1.55 | 2186 | 1474 | 3504 | 1261 | 4378 | 1042 | 4806 | 861 | 5062 | 582 | 4859 | 249 | 3349 |
| 7-#10 | 1.97 | 2241 | 1542 | 3722 | 1302 | 4635 | 1073 | 5108 | 880 | 5451 | 580 | 5303 | 211 | 4088 |
| 7-#11 | 2.41 | 2283 | 1614 | 3970 | 1337 | 4901 | 1098 | 5406 | 895 | 5815 | 571 | 5676 | 160 | 4820 |
| 7-#14 | 3.48 | 2410 | 1785 | 4493 | 1441 | 5522 | 1176 | 6140 | 945 | 6307 | 525 | 6712 | 56 | 6463 |
| 7-#18 | 6.19 | 2717 | 2221 | 5750 | 1704 | 7028 | 1374 | 7896 | 1067 | 8436 | 501 | 9138 | -227 | 9254 |
| 8-#8 | 1.40 | 2149 | 1450 | 3328 | 1266 | 4252 | 1049 | 4692 | 871 | 4926 | 598 | 4722 | 268 | 3060 |
| 8-#9 | 1.77 | 2193 | 1510 | 3521 | 1303 | 4485 | 1077 | 4962 | 889 | 5272 | 598 | 5126 | 236 | 3759 |
| 8-#10 | 2.25 | 2248 | 1587 | 3764 | 1351 | 4779 | 1114 | 5303 | 913 | 5711 | 598 | 5638 | 193 | 4631 |
| 8-#11 | 2.76 | 2291 | 1669 | 4039 | 1395 | 5087 | 1146 | 5633 | 930 | 6121 | 589 | 6065 | 135 | 5497 |
| 8-#14 | 3.98 | 2418 | 1865 | 4623 | 1519 | 5804 | 1240 | 6455 | 989 | 6704 | 546 | 7244 | 15 | 7188 |
| 8-#18 | 7.07 | 2755 | 2363 | 6036 | 1834 | 7512 | 1473 | 8435 | 1134 | 9098 | 529 | 10006 | -313 | 10069 |
| 9-#10 | 2.53 | 2305 | 1632 | 3957 | 1370 | 4961 | 1128 | 5500 | 918 | 6000 | 589 | 5962 | 168 | 5069 |
| 9-#11 | 3.10 | 2359 | 1725 | 4260 | 1420 | 5293 | 1163 | 5875 | 939 | 6043 | 541 | 6448 | 104 | 5965 |
| 9-#14 | 4.48 | 2527 | 1945 | 4918 | 1558 | 6080 | 1266 | 6803 | 1005 | 7684 | 572 | 7786 | -29 | 7806 |
| 9-#18 | 7.96 | 2946 | 2505 | 6509 | 1908 | 7982 | 1526 | 9056 | 1170 | 10601 | 545 | 11001 | -376 | 10958 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.81 | 2336 | 1677 | 4219 | 1382 | 5210 | 1125 | 5751 | 908 | 6287 | 567 | 6245 | 136 | 5599 |
| 10-#11 | 3.45 | 2395 | 1780 | 4552 | 1439 | 5578 | 1164 | 6170 | 930 | 6825 | 555 | 6790 | 64 | 6523 |
| 10-#14 | 4.97 | 2576 | 2025 | 5287 | 1591 | 6464 | 1274 | 7215 | 998 | 8200 | 543 | 8280 | -85 | 8236 |
| 11-#10 | 3.09 | 2381 | 1722 | 4208 | 1437 | 5285 | 1178 | 5910 | 955 | 6534 | 593 | 6640 | 128 | 6015 |
| 11-#11 | 3.79 | 2449 | 1836 | 4562 | 1500 | 5687 | 1224 | 6367 | 983 | 7114 | 584 | 7245 | 51 | 7005 |
| 11-#14 | 5.47 | 2655 | 2105 | 5350 | 1671 | 6645 | 1353 | 7497 | 1067 | 8597 | 578 | 8896 | -109 | 8951 |
| 12-#10 | 3.37 | 2429 | 1767 | 4334 | 1470 | 5425 | 1207 | 6086 | 975 | 6816 | 606 | 6984 | 113 | 6490 |
| 12-#11 | 4.14 | 2504 | 1891 | 4720 | 1539 | 5857 | 1257 | 6583 | 1006 | 7456 | 599 | 7648 | 31 | 7518 |
| 12-#14 | 5.97 | 2728 | 2185 | 5584 | 1724 | 6891 | 1399 | 7813 | 1099 | 8457 | 555 | 9456 | -141 | 9498 |
| 13-#10 | 3.65 | 2463 | 1812 | 4478 | 1496 | 5632 | 1225 | 6308 | 989 | 7079 | 599 | 7287 | 82 | 6896 |
| 13-#11 | 4.48 | 2552 | 1946 | 4890 | 1573 | 6101 | 1280 | 6846 | 1024 | 7244 | 549 | 8005 | -8 | 8010 |
| 13-#14 | 6.47 | 2795 | 2265 | 5822 | 1775 | 7231 | 1432 | 8181 | 1125 | 9508 | 581 | 9955 | -197 | 9987 |
| 14-#10 | 3.93 | 2515 | 1858 | 4687 | 1511 | 5835 | 1235 | 6559 | 991 | 7374 | 587 | 7569 | 54 | 7332 |
| 14-#11 | 4.83 | 2617 | 2002 | 5129 | 1593 | 6343 | 1295 | 7151 | 1028 | 8114 | 575 | 8340 | -43 | 8361 |
| 15-#10 | 4.21 | 2548 | 1903 | 4737 | 1561 | 5960 | 1273 | 6719 | 1025 | 7113 | 563 | 7934 | 35 | 7771 |
| 15-#11 | 5.17 | 2652 | 2057 | 5205 | 1651 | 6499 | 1339 | 7335 | 1066 | 7864 | 558 | 8797 | -62 | 8791 |
| 16-#10 | 4.49 | 2599 | 1948 | 4849 | 1593 | 6113 | 1304 | 6914 | 1044 | 7876 | 610 | 8270 | 21 | 8179 |
| 16-#11 | 5.52 | 2719 | 2113 | 5343 | 1690 | 6689 | 1377 | 7568 | 1088 | 8722 | 600 | 9160 | -88 | 9191 |
| 17-#10 | 4.77 | 2624 | 1993 | 5016 | 1620 | 6298 | 1323 | 7119 | 1058 | 7622 | 570 | 8604 | -7 | 8607 |
| 18-#10 | 5.05 | 2675 | 2038 | 5183 | 1643 | 6500 | 1339 | 7347 | 1062 | 8464 | 601 | 8875 | -35 | 8887 |

## ROUND SPIRAL COLUMNS 26" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#9 | 1.13 | 2678 | 1652 | 4543 | 1359 | 5456 | 1116 | 5844 | 920 | 5597 | 592 | 5404 | 289 | 3257 |
| 6-#10 | 1.44 | 2723 | 1709 | 4760 | 1391 | 5717 | 1138 | 6152 | 933 | 6406 | 630 | 5819 | 253 | 4035 |
| 6-#11 | 1.76 | 2758 | 1771 | 5007 | 1417 | 5987 | 1155 | 6458 | 941 | 6793 | 619 | 6172 | 204 | 4819 |
| 6-#14 | 2.54 | 2867 | 1918 | 5532 | 1499 | 6624 | 1212 | 7213 | 988 | 7250 | 564 | 7149 | 103 | 6652 |
| 6-#18 | 4.52 | 3114 | 2291 | 6804 | 1707 | 8178 | 1359 | 9066 | 1084 | 9439 | 523 | 9456 | -169 | 9516 |
| 7-#9 | 1.32 | 2753 | 1687 | 4262 | 1465 | 5378 | 1213 | 5911 | 1006 | 6206 | 693 | 5948 | 324 | 3751 |
| 7-#10 | 1.67 | 2816 | 1754 | 4506 | 1505 | 5664 | 1244 | 6247 | 1026 | 6197 | 645 | 6454 | 289 | 4583 |
| 7-#11 | 2.06 | 2867 | 1827 | 4787 | 1540 | 5964 | 1269 | 6582 | 1040 | 7051 | 682 | 6888 | 240 | 5408 |
| 7-#14 | 2.97 | 3012 | 1998 | 5374 | 1644 | 6659 | 1347 | 7403 | 1091 | 8108 | 677 | 8078 | 142 | 7358 |
| 7-#18 | 5.27 | 3361 | 2434 | 6788 | 1909 | 8348 | 1547 | 9400 | 1220 | 9968 | 613 | 10893 | -125 | 10962 |
| 8-#9 | 1.51 | 2761 | 1723 | 4264 | 1509 | 5485 | 1250 | 6088 | 1038 | 6441 | 711 | 6234 | 312 | 4184 |
| 8-#10 | 1.91 | 2824 | 1800 | 4534 | 1557 | 5812 | 1287 | 6470 | 1062 | 6469 | 664 | 6810 | 271 | 5160 |
| 8-#11 | 2.35 | 2876 | 1882 | 4846 | 1600 | 6158 | 1318 | 6844 | 1080 | 6902 | 657 | 7332 | 218 | 6137 |
| 8-#14 | 3.39 | 3022 | 2078 | 5499 | 1724 | 6957 | 1413 | 7768 | 1141 | 8587 | 702 | 8686 | 105 | 8245 |
| 8-#18 | 6.03 | 3400 | 2576 | 7081 | 2040 | 8908 | 1653 | 10006 | 1292 | 11482 | 691 | 11888 | -203 | 11928 |
| 9-#10 | 2.15 | 2887 | 1845 | 4759 | 1575 | 6025 | 1300 | 6684 | 1066 | 7242 | 700 | 7195 | 248 | 5688 |
| 9-#11 | 2.64 | 2953 | 1937 | 5102 | 1624 | 6400 | 1336 | 7106 | 1086 | 7781 | 692 | 7767 | 187 | 6708 |
| 9-#14 | 3.81 | 3135 | 2158 | 5838 | 1762 | 7282 | 1440 | 8144 | 1154 | 9149 | 689 | 9303 | 61 | 9000 |
| 9-#18 | 6.78 | 3613 | 2718 | 7621 | 2114 | 9422 | 1704 | 10675 | 1324 | 11617 | 626 | 12933 | -280 | 13005 |
| 10-#10 | 2.39 | 2924 | 1890 | 5067 | 1583 | 6312 | 1295 | 6968 | 1053 | 7056 | 632 | 7453 | 206 | 6254 |
| 10-#11 | 2.94 | 2993 | 1993 | 5446 | 1640 | 6729 | 1334 | 7440 | 1075 | 7621 | 622 | 8147 | 148 | 7418 |
| 10-#14 | 4.24 | 3201 | 2238 | 6278 | 1795 | 7723 | 1446 | 8610 | 1145 | 9056 | 613 | 9859 | 7 | 9828 |
| 10-#18 | 7.53 | 3697 | 2860 | 8268 | 2183 | 10133 | 1727 | 11458 | 1319 | 12560 | 585 | 13903 | -376 | 13792 |

## ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 11-#10 | 2.63 | 2972 | 1935 | 5058 | 1638 | 6391 | 1347 | 7133 | 1103 | 7317 | 660 | 7955 | 209 | 6754 |
| 11-#11 | 3.23 | 3055 | 2048 | 5436 | 1706 | 6832 | 1398 | 7652 | 1132 | 7927 | 652 | 8671 | 138 | 7952 |
| 11-#14 | 4.66 | 3289 | 2318 | 6319 | 1877 | 7902 | 1528 | 8924 | 1219 | 10153 | 695 | 10567 | -13 | 10575 |
| 12-#10 | 2.87 | 3030 | 1980 | 5170 | 1677 | 6532 | 1381 | 7329 | 1125 | 7601 | 672 | 8330 | 196 | 7319 |
| 12-#11 | 3.53 | 3117 | 2104 | 5607 | 1746 | 7020 | 1433 | 7887 | 1156 | 8276 | 666 | 9128 | 120 | 8566 |
| 12-#14 | 5.09 | 3370 | 2398 | 6575 | 1932 | 8175 | 1575 | 9260 | 1251 | 10691 | 716 | 11204 | -42 | 11218 |
| 13-#10 | 3.11 | 3064 | 2025 | 5330 | 1702 | 6761 | 1399 | 7577 | 1139 | 8448 | 714 | 8682 | 165 | 7795 |
| 13-#11 | 3.82 | 3164 | 2159 | 5796 | 1779 | 7295 | 1455 | 8182 | 1174 | 9219 | 705 | 9534 | 82 | 9113 |
| 13-#14 | 5.51 | 3443 | 2478 | 6837 | 1982 | 8559 | 1609 | 9675 | 1277 | 11177 | 702 | 11775 | -98 | 11808 |
| 14-#10 | 3.35 | 3127 | 2070 | 5573 | 1716 | 6991 | 1407 | 7853 | 1138 | 8192 | 655 | 9013 | 140 | 8330 |
| 14-#11 | 4.11 | 3233 | 2215 | 6073 | 1797 | 7563 | 1468 | 8517 | 1176 | 9613 | 691 | 9911 | 48 | 9686 |
| 14-#14 | 5.93 | 3541 | 2558 | 7201 | 2014 | 8932 | 1633 | 10153 | 1285 | 11739 | 685 | 12315 | -146 | 12351 |
| 15-#10 | 3.59 | 3160 | 2116 | 5614 | 1767 | 7125 | 1448 | 8029 | 1174 | 9043 | 718 | 9410 | 120 | 8787 |
| 15-#11 | 4.41 | 3277 | 2270 | 6142 | 1858 | 7731 | 1514 | 8731 | 1217 | 9278 | 662 | 10396 | 25 | 10277 |
| 16-#10 | 3.83 | 3222 | 2161 | 5736 | 1800 | 7288 | 1479 | 8253 | 1196 | 8706 | 678 | 9783 | 107 | 9273 |
| 16-#11 | 4.70 | 3349 | 2326 | 6293 | 1898 | 7935 | 1553 | 8991 | 1241 | 9595 | 670 | 10844 | 7 | 10812 |
| 17-#10 | 4.07 | 3244 | 2206 | 5924 | 1827 | 7496 | 1498 | 8475 | 1209 | 9644 | 723 | 10165 | 81 | 9753 |
| 17-#11 | 5.00 | 3381 | 2381 | 6514 | 1931 | 8182 | 1575 | 9264 | 1258 | 10668 | 719 | 11291 | -27 | 11299 |
| 18-#10 | 4.31 | 3292 | 2251 | 6113 | 1849 | 7730 | 1515 | 8731 | 1212 | 9973 | 716 | 10480 | 55 | 10219 |
| 18-#11 | 5.29 | 3450 | 2436 | 6735 | 1960 | 8451 | 1596 | 9568 | 1263 | 11065 | 707 | 11653 | -61 | 11672 |
| 19-#10 | 4.54 | 3332 | 2296 | 6208 | 1890 | 7866 | 1547 | 8928 | 1244 | 10255 | 732 | 10889 | 37 | 10711 |
| 20-#10 | 4.78 | 3383 | 2341 | 6327 | 1928 | 8033 | 1576 | 9137 | 1261 | 9845 | 687 | 11239 | 18 | 11152 |

## ROUND SPIRAL COLUMNS 28" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#10 | 1.24 | 3375 | 1939 | 5741 | 1598 | 6929 | 1311 | 7454 | 1080 | 7712 | 739 | 7019 | 329 | 4436 |
| 6-#11 | 1.52 | 3417 | 2001 | 6017 | 1624 | 7230 | 1328 | 7793 | 1087 | 8149 | 730 | 7422 | 282 | 5309 |
| 6-#14 | 2.19 | 3534 | 2148 | 6599 | 1706 | 7934 | 1385 | 8626 | 1121 | 8641 | 671 | 8527 | 186 | 7352 |
| 6-#18 | 3.90 | 3825 | 2521 | 8010 | 1914 | 9654 | 1532 | 10675 | 1232 | 11101 | 636 | 11158 | -73 | 11187 |
| 7-#9 | 1.14 | 3408 | 1917 | 5121 | 1685 | 6521 | 1398 | 7178 | 1163 | 7012 | 758 | 7168 | 403 | 4161 |
| 7-#10 | 1.44 | 3482 | 1984 | 5392 | 1725 | 6836 | 1429 | 7547 | 1183 | 7993 | 811 | 7737 | 370 | 5085 |
| 7-#11 | 1.77 | 3541 | 2056 | 5708 | 1760 | 7172 | 1454 | 7920 | 1197 | 7887 | 749 | 8248 | 325 | 6008 |
| 7-#14 | 2.56 | 3705 | 2228 | 6358 | 1864 | 7940 | 1533 | 8826 | 1249 | 9622 | 798 | 9594 | 231 | 8181 |
| 7-#18 | 4.55 | 4101 | 2663 | 7930 | 2130 | 9813 | 1734 | 11046 | 1381 | 12486 | 784 | 12800 | -23 | 12814 |
| 8-#9 | 1.30 | 3418 | 1953 | 5103 | 1731 | 6626 | 1438 | 7371 | 1198 | 7776 | 832 | 7491 | 393 | 4613 |
| 8-#10 | 1.65 | 3491 | 2029 | 5402 | 1779 | 6986 | 1474 | 7797 | 1223 | 8317 | 833 | 8130 | 354 | 5695 |
| 8-#11 | 2.03 | 3551 | 2112 | 5751 | 1822 | 7371 | 1505 | 8217 | 1241 | 8834 | 826 | 8716 | 303 | 6784 |
| 8-#14 | 2.92 | 3717 | 2308 | 6473 | 1946 | 8252 | 1600 | 9243 | 1304 | 10156 | 826 | 10263 | 196 | 9350 |
| 8-#18 | 5.20 | 4141 | 2806 | 8226 | 2263 | 10410 | 1842 | 11739 | 1459 | 13382 | 822 | 13924 | -93 | 13943 |
| 9-#10 | 1.86 | 3561 | 2075 | 5660 | 1796 | 7229 | 1487 | 8029 | 1225 | 8072 | 766 | 8557 | 330 | 6320 |
| 9-#11 | 2.28 | 3635 | 2167 | 6044 | 1845 | 7651 | 1523 | 8499 | 1246 | 8630 | 759 | 9228 | 274 | 7461 |
| 9-#14 | 3.29 | 3844 | 2388 | 6859 | 1984 | 8628 | 1628 | 9647 | 1315 | 10041 | 758 | 10971 | 154 | 10140 |
| 9-#18 | 5.85 | 4375 | 2948 | 8836 | 2337 | 11006 | 1895 | 12457 | 1489 | 14459 | 804 | 15106 | -169 | 15167 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 28" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.06 | 3602 | 2120 | 6019 | 1800 | 7561 | 1479 | 8346 | 1210 | 8997 | 795 | 8862 | 291 | 6918 |
| 10-#11 | 2.53 | 3682 | 2223 | 6442 | 1856 | 8027 | 1518 | 8873 | 1232 | 9669 | 785 | 9572 | 224 | 8218 |
| 10-#14 | 3.65 | 3901 | 2468 | 7362 | 2011 | 9128 | 1631 | 10168 | 1303 | 11369 | 778 | 11587 | 102 | 11098 |
| 10-#18 | 6.50 | 4467 | 3090 | 9594 | 2406 | 11810 | 1916 | 13333 | 1482 | 15537 | 755 | 16193 | -261 | 16043 |
| 11-#10 | 2.27 | 3657 | 2165 | 5985 | 1860 | 7628 | 1535 | 8517 | 1263 | 9309 | 829 | 9405 | 293 | 7511 |
| 11-#11 | 2.79 | 3747 | 2278 | 6441 | 1923 | 8120 | 1585 | 9093 | 1292 | 10036 | 821 | 10231 | 226 | 8862 |
| 11-#14 | 4.02 | 4003 | 2548 | 7431 | 2093 | 9303 | 1716 | 10499 | 1380 | 11081 | 766 | 12390 | 84 | 11934 |
| 11-#18 | 7.15 | 4659 | 3232 | 9760 | 2538 | 12194 | 2049 | 13938 | 1600 | 16369 | 812 | 17492 | -304 | 17364 |
| 12-#10 | 2.48 | 3716 | 2210 | 6103 | 1900 | 7780 | 1570 | 8731 | 1286 | 9637 | 842 | 9824 | 282 | 8109 |
| 12-#11 | 3.04 | 3822 | 2334 | 6592 | 1970 | 8324 | 1622 | 9352 | 1318 | 10438 | 837 | 10726 | 209 | 9617 |
| 12-#14 | 4.38 | 4095 | 2628 | 7665 | 2157 | 9602 | 1765 | 10869 | 1414 | 12451 | 842 | 13088 | 57 | 12820 |
| 13-#10 | 2.68 | 3760 | 2255 | 6281 | 1925 | 8031 | 1586 | 9007 | 1300 | 9976 | 836 | 10217 | 251 | 8673 |
| 13-#11 | 3.29 | 3869 | 2389 | 6802 | 2001 | 8626 | 1643 | 9680 | 1335 | 10118 | 774 | 11193 | 172 | 10223 |
| 13-#14 | 4.75 | 4175 | 2708 | 7953 | 2206 | 10029 | 1799 | 11331 | 1441 | 13010 | 830 | 13746 | 4 | 13727 |
| 14-#10 | 2.89 | 3830 | 2300 | 6561 | 1937 | 8291 | 1594 | 9307 | 1297 | 10344 | 824 | 10575 | 226 | 9272 |
| 14-#11 | 3.55 | 3951 | 2445 | 7119 | 2018 | 8927 | 1654 | 10044 | 1335 | 10524 | 761 | 11633 | 141 | 10896 |
| 14-#14 | 5.12 | 4295 | 2788 | 8367 | 2236 | 10439 | 1820 | 11849 | 1446 | 13633 | 813 | 14349 | -43 | 14362 |
| 15-#10 | 3.09 | 3867 | 2345 | 6590 | 1990 | 8431 | 1637 | 9500 | 1336 | 10629 | 841 | 11029 | 209 | 9807 |
| 15-#11 | 3.80 | 3994 | 2500 | 7178 | 2081 | 9107 | 1704 | 10278 | 1379 | 10852 | 779 | 12155 | 117 | 11511 |
| 15-#14 | 5.48 | 4365 | 2868 | 8494 | 2319 | 10712 | 1885 | 12186 | 1503 | 14135 | 837 | 15099 | -78 | 15085 |
| 16-#10 | 3.30 | 3924 | 2390 | 6720 | 2024 | 8605 | 1668 | 9753 | 1359 | 10945 | 850 | 11445 | 197 | 10406 |
| 16-#11 | 4.05 | 4079 | 2555 | 7341 | 2121 | 9324 | 1742 | 10575 | 1405 | 12004 | 844 | 12648 | 101 | 12135 |
| 16-#14 | 5.85 | 4485 | 2948 | 8735 | 2376 | 11031 | 1939 | 12599 | 1537 | 14667 | 849 | 15787 | -104 | 15770 |
| 17-#10 | 3.51 | 3960 | 2436 | 6930 | 2051 | 8836 | 1687 | 9992 | 1371 | 11294 | 848 | 11870 | 171 | 10906 |
| 17-#11 | 4.31 | 4107 | 2611 | 7588 | 2154 | 9598 | 1765 | 10868 | 1421 | 12422 | 841 | 13154 | 68 | 12781 |
| 18-#10 | 3.71 | 4014 | 2481 | 7143 | 2071 | 9099 | 1703 | 10276 | 1374 | 10870 | 783 | 12195 | 144 | 11454 |
| 18-#11 | 4.56 | 4173 | 2666 | 7835 | 2182 | 9907 | 1786 | 11206 | 1426 | 12001 | 777 | 13571 | 37 | 13387 |
| 19-#10 | 3.92 | 4058 | 2526 | 7240 | 2114 | 9244 | 1737 | 10485 | 1406 | 11959 | 857 | 12665 | 129 | 11965 |
| 19-#11 | 4.81 | 4232 | 2722 | 7964 | 2232 | 10087 | 1825 | 11467 | 1464 | 13231 | 852 | 14111 | 15 | 14042 |
| 20-#10 | 4.13 | 4101 | 2571 | 7365 | 2152 | 9427 | 1767 | 10715 | 1424 | 12293 | 863 | 13069 | 112 | 12496 |
| 20-#11 | 5.07 | 4293 | 2777 | 8122 | 2278 | 10308 | 1861 | 11744 | 1485 | 13617 | 857 | 14573 | -8 | 14573 |
| 21-#10 | 4.33 | 4159 | 2616 | 7556 | 2178 | 9648 | 1786 | 10979 | 1441 | 12618 | 862 | 13466 | 87 | 13026 |
| 22-#10 | 4.54 | 4204 | 2661 | 7816 | 2196 | 9909 | 1795 | 11257 | 1447 | 12963 | 853 | 13879 | 69 | 13525 |

## ROUND SPIRAL COLUMNS 30" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#10 | 1.08 | 4123 | 2186 | 6848 | 1822 | 8305 | 1498 | 8933 | 1238 | 8579 | 800 | 8371 | 410 | 4838 |
| 6-#11 | 1.32 | 4172 | 2248 | 7155 | 1847 | 8638 | 1514 | 9305 | 1245 | 9669 | 848 | 8824 | 365 | 5800 |
| 6-#14 | 1.91 | 4305 | 2395 | 7795 | 1928 | 9408 | 1571 | 10216 | 1278 | 10156 | 782 | 10058 | 272 | 8052 |
| 6-#18 | 3.40 | 4635 | 2768 | 9346 | 2137 | 11295 | 1719 | 12461 | 1365 | 13850 | 809 | 13014 | 24 | 12910 |
| 7-#10 | 1.26 | 4241 | 2231 | 6385 | 1962 | 8162 | 1628 | 9021 | 1353 | 8887 | 876 | 9171 | 455 | 5597 |
| 7-#11 | 1.54 | 4312 | 2303 | 6737 | 1996 | 8534 | 1653 | 9432 | 1367 | 9358 | 869 | 9750 | 412 | 6624 |
| 7-#14 | 2.23 | 4495 | 2475 | 7452 | 2100 | 9376 | 1732 | 10423 | 1419 | 11314 | 928 | 11269 | 323 | 9018 |
| 7-#18 | 3.96 | 4923 | 2910 | 9183 | 2367 | 11435 | 1934 | 12860 | 1552 | 14469 | 918 | 14869 | 82 | 14422 |
| 8-#10 | 1.44 | 4253 | 2276 | 6373 | 2019 | 8311 | 1676 | 9285 | 1395 | 9879 | 964 | 9611 | 442 | 6234 |
| 8-#11 | 1.77 | 4323 | 2359 | 6761 | 2061 | 8736 | 1707 | 9762 | 1414 | 10450 | 957 | 10261 | 392 | 7437 |

## ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.55 | 4511 | 2555 | 7553 | 2185 | 9700 | 1801 | 10892 | 1478 | 11109 | 895 | 11969 | 289 | 10270 |
| 8-#18 | 4.53 | 4960 | 3052 | 9478 | 2502 | 12065 | 2044 | 13647 | 1637 | 14429 | 896 | 16125 | 17 | 16048 |
| 9-#10 | 1.62 | 4331 | 2321 | 6667 | 2034 | 8584 | 1687 | 9546 | 1396 | 9550 | 887 | 10079 | 417 | 6967 |
| 9-#11 | 1.99 | 4416 | 2414 | 7094 | 2083 | 9053 | 1723 | 10065 | 1417 | 10889 | 943 | 10825 | 363 | 8231 |
| 9-#14 | 2.86 | 4651 | 2635 | 7987 | 2221 | 10128 | 1830 | 11324 | 1487 | 12544 | 943 | 12778 | 249 | 11208 |
| 9-#18 | 5.09 | 5240 | 3195 | 10160 | 2575 | 12746 | 2099 | 14413 | 1664 | 15509 | 877 | 17443 | -58 | 17467 |
| 10-#10 | 1.80 | 4377 | 2367 | 7084 | 2034 | 8966 | 1677 | 9900 | 1378 | 9902 | 861 | 10429 | 379 | 7592 |
| 10-#11 | 2.21 | 4469 | 2470 | 7553 | 2090 | 9482 | 1715 | 10481 | 1400 | 10592 | 852 | 11229 | 315 | 9029 |
| 10-#14 | 3.18 | 4713 | 2715 | 8560 | 2245 | 10691 | 1829 | 11902 | 1473 | 13212 | 907 | 13351 | 182 | 12420 |
| 10-#18 | 5.66 | 5339 | 3337 | 11018 | 2641 | 13645 | 2118 | 15384 | 1656 | 16607 | 830 | 18645 | -146 | 18462 |
| 11-#10 | 1.98 | 4439 | 2412 | 7015 | 2099 | 9018 | 1736 | 10075 | 1435 | 10956 | 959 | 11016 | 383 | 8285 |
| 11-#11 | 2.43 | 4541 | 2525 | 7523 | 2161 | 9578 | 1781 | 10708 | 1464 | 10972 | 889 | 11937 | 318 | 9782 |
| 11-#14 | 3.50 | 4828 | 2795 | 8612 | 2333 | 10882 | 1911 | 12247 | 1553 | 13770 | 954 | 14339 | 181 | 13279 |
| 11-#18 | 6.22 | 5547 | 3479 | 11174 | 2780 | 14033 | 2253 | 16029 | 1777 | 18716 | 952 | 20103 | -186 | 19978 |
| 12-#10 | 2.16 | 4504 | 2457 | 7140 | 2141 | 9180 | 1773 | 10307 | 1459 | 11306 | 973 | 11480 | 373 | 8911 |
| 12-#11 | 2.65 | 4619 | 2580 | 7682 | 2210 | 9780 | 1825 | 10990 | 1491 | 12186 | 968 | 12485 | 303 | 10579 |
| 12-#14 | 3.82 | 4929 | 2875 | 8860 | 2398 | 11181 | 1969 | 12651 | 1589 | 13429 | 910 | 15102 | 156 | 14300 |
| 12-#18 | 6.79 | 5701 | 3621 | 11727 | 2876 | 14612 | 2336 | 16731 | 1833 | 18492 | 921 | 21433 | -235 | 21318 |
| 13-#10 | 2.34 | 4553 | 2502 | 7337 | 2165 | 9453 | 1788 | 10610 | 1473 | 10899 | 903 | 11913 | 342 | 9568 |
| 13-#11 | 2.87 | 4676 | 2636 | 7913 | 2241 | 10108 | 1845 | 11352 | 1508 | 11790 | 897 | 13002 | 266 | 11298 |
| 13-#14 | 4.14 | 5017 | 2955 | 9175 | 2446 | 11644 | 2002 | 13160 | 1615 | 15021 | 966 | 15836 | 103 | 15246 |
| 13-#18 | 7.36 | 5882 | 3763 | 12253 | 2966 | 15409 | 2399 | 17600 | 1883 | 20859 | 967 | 22646 | -332 | 22448 |
| 14-#10 | 2.52 | 4631 | 2547 | 7658 | 2174 | 9745 | 1794 | 10936 | 1468 | 11282 | 891 | 12281 | 315 | 10198 |
| 14-#11 | 3.09 | 4767 | 2691 | 8274 | 2256 | 10446 | 1855 | 11746 | 1506 | 12242 | 884 | 13478 | 235 | 12095 |
| 14-#14 | 4.46 | 5129 | 3035 | 9643 | 2474 | 12101 | 2022 | 13720 | 1618 | 15704 | 948 | 16546 | 62 | 16211 |
| 15-#10 | 2.70 | 4668 | 2592 | 7670 | 2230 | 9890 | 1840 | 11143 | 1509 | 11567 | 909 | 12802 | 301 | 10821 |
| 15-#11 | 3.31 | 4816 | 2747 | 8320 | 2320 | 10635 | 1906 | 11999 | 1552 | 13490 | 967 | 14068 | 213 | 12778 |
| 15-#14 | 4.77 | 5213 | 3115 | 9761 | 2559 | 12393 | 2089 | 14087 | 1678 | 15156 | 908 | 17335 | 25 | 17194 |
| 16-#10 | 2.87 | 4734 | 2637 | 7808 | 2265 | 10073 | 1872 | 11413 | 1532 | 12739 | 983 | 13270 | 291 | 11455 |
| 16-#11 | 3.53 | 4894 | 2802 | 8493 | 2362 | 10864 | 1945 | 12332 | 1580 | 13904 | 978 | 14613 | 199 | 13505 |
| 16-#14 | 5.09 | 5347 | 3195 | 10021 | 2617 | 12731 | 2143 | 14553 | 1715 | 15702 | 921 | 18099 | 2 | 18090 |
| 17-#10 | 3.05 | 4770 | 2682 | 8040 | 2291 | 10328 | 1890 | 11681 | 1545 | 12246 | 915 | 13713 | 264 | 12049 |
| 17-#11 | 3.75 | 4940 | 2858 | 8768 | 2395 | 11167 | 1968 | 12646 | 1596 | 13406 | 910 | 15173 | 166 | 14177 |
| 17-#14 | 5.41 | 5407 | 3275 | 10400 | 2666 | 13156 | 2177 | 15005 | 1739 | 16311 | 917 | 18891 | -45 | 18875 |
| 18-#10 | 3.23 | 4834 | 2728 | 8279 | 2310 | 10616 | 1905 | 11995 | 1547 | 12597 | 906 | 14071 | 237 | 12700 |
| 18-#11 | 3.97 | 5011 | 2913 | 9043 | 2421 | 11511 | 1989 | 13019 | 1600 | 14829 | 965 | 15602 | 133 | 14878 |
| 19-#10 | 3.41 | 4877 | 2773 | 8376 | 2355 | 10773 | 1941 | 12215 | 1580 | 13832 | 986 | 14592 | 224 | 13261 |
| 19-#11 | 4.19 | 5068 | 2969 | 9175 | 2473 | 11703 | 2029 | 13295 | 1639 | 14222 | 920 | 16218 | 115 | 15564 |
| 20-#10 | 3.59 | 4930 | 2818 | 8507 | 2393 | 10972 | 1972 | 12466 | 1599 | 14200 | 996 | 15044 | 208 | 13870 |
| 20-#11 | 4.41 | 5126 | 3024 | 9341 | 2519 | 11944 | 2066 | 13597 | 1661 | 15676 | 993 | 16745 | 93 | 16245 |
| 21-#10 | 3.77 | 4989 | 2863 | 8717 | 2419 | 11226 | 1986 | 12755 | 1616 | 13591 | 930 | 15476 | 183 | 14421 |
| 21-#11 | 4.63 | 5201 | 3079 | 9591 | 2551 | 12235 | 2089 | 13943 | 1682 | 16104 | 992 | 17269 | 63 | 16950 |
| 22-#10 | 3.95 | 5043 | 2908 | 9005 | 2436 | 11499 | 1999 | 13055 | 1621 | 14939 | 987 | 15930 | 165 | 14995 |
| 23-#10 | 4.13 | 5103 | 2953 | 9090 | 2479 | 11671 | 2036 | 13290 | 1651 | 15280 | 1002 | 16395 | 148 | 15566 |
| 24-#10 | 4.31 | 5147 | 2998 | 9259 | 2513 | 11879 | 2061 | 13560 | 1670 | 15619 | 1005 | 16856 | 131 | 16133 |

## ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.16 | 5030 | 2512 | 8430 | 2086 | 10221 | 1713 | 11007 | 1414 | 11376 | 974 | 10389 | 452 | 6293 |
| 6-#14 | 1.68 | 5179 | 2659 | 9127 | 2167 | 11057 | 1771 | 11996 | 1447 | 11844 | 900 | 11752 | 362 | 8753 |
| 6-#18 | 2.98 | 5551 | 3032 | 10820 | 2376 | 13113 | 1918 | 14438 | 1534 | 15946 | 940 | 15034 | 124 | 14449 |
| 7-#10 | 1.11 | 5103 | 2495 | 7494 | 2215 | 9653 | 1842 | 10681 | 1534 | 10491 | 1005 | 10777 | 546 | 6115 |
| 7-#11 | 1.36 | 5184 | 2567 | 7883 | 2249 | 10061 | 1866 | 11130 | 1548 | 11006 | 997 | 11412 | 503 | 7246 |
| 7-#14 | 1.96 | 5389 | 2739 | 8663 | 2353 | 10978 | 1945 | 12207 | 1600 | 12315 | 996 | 13079 | 417 | 9869 |
| 7-#18 | 3.48 | 5866 | 3174 | 10555 | 2621 | 13222 | 2148 | 14860 | 1734 | 16642 | 1060 | 17111 | 189 | 15984 |
| 8-#10 | 1.26 | 5119 | 2540 | 7454 | 2275 | 9798 | 1892 | 10958 | 1579 | 11631 | 1104 | 11265 | 535 | 6778 |
| 8-#11 | 1.55 | 5198 | 2623 | 7881 | 2317 | 10264 | 1922 | 11478 | 1598 | 12256 | 1097 | 11979 | 486 | 8095 |
| 8-#14 | 2.24 | 5408 | 2819 | 8744 | 2441 | 11311 | 2017 | 12722 | 1664 | 13839 | 1101 | 13848 | 386 | 11190 |
| 8-#18 | 3.98 | 5907 | 3316 | 10843 | 2758 | 13883 | 2260 | 15741 | 1827 | 16546 | 1033 | 18414 | 123 | 17842 |
| 9-#10 | 1.42 | 5204 | 2585 | 7788 | 2289 | 10102 | 1902 | 11250 | 1579 | 11204 | 1015 | 11773 | 510 | 7618 |
| 9-#11 | 1.75 | 5300 | 2678 | 8257 | 2337 | 10616 | 1938 | 11817 | 1600 | 11872 | 1009 | 12594 | 457 | 9016 |
| 9-#14 | 2.52 | 5556 | 2899 | 9231 | 2476 | 11787 | 2044 | 13187 | 1671 | 14519 | 1082 | 14734 | 346 | 12277 |
| 9-#18 | 4.48 | 6186 | 3458 | 11601 | 2830 | 14651 | 2316 | 16555 | 1850 | 18957 | 1083 | 19950 | 55 | 19625 |
| 10-#10 | 1.58 | 5255 | 2630 | 8269 | 2284 | 10538 | 1888 | 11640 | 1558 | 12410 | 1058 | 12124 | 469 | 8273 |
| 10-#11 | 1.94 | 5359 | 2733 | 8783 | 2340 | 11104 | 1927 | 12276 | 1580 | 13216 | 1049 | 13055 | 411 | 9849 |
| 10-#14 | 2.80 | 5631 | 2979 | 9879 | 2495 | 12423 | 2041 | 13822 | 1654 | 14227 | 975 | 15398 | 282 | 13562 |
| 10-#18 | 4.97 | 6322 | 3601 | 12556 | 2891 | 15649 | 2332 | 17622 | 1840 | 18889 | 962 | 21039 | -62 | 21051 |
| 11-#10 | 1.74 | 5323 | 2676 | 8158 | 2355 | 10571 | 1952 | 11817 | 1619 | 12792 | 1099 | 12763 | 472 | 9075 |
| 11-#11 | 2.13 | 5439 | 2789 | 8716 | 2416 | 11184 | 1997 | 12509 | 1647 | 12754 | 1019 | 13814 | 414 | 10721 |
| 11-#14 | 3.08 | 5748 | 3059 | 9902 | 2588 | 12603 | 2128 | 14180 | 1737 | 14800 | 1022 | 16451 | 281 | 14603 |
| 11-#18 | 5.47 | 6545 | 3743 | 12792 | 3025 | 16037 | 2472 | 18298 | 1964 | 21253 | 1099 | 22858 | -70 | 22837 |
| 12-#10 | 1.89 | 5394 | 2721 | 8286 | 2399 | 10741 | 1991 | 12067 | 1644 | 13165 | 1113 | 13310 | 469 | 9724 |
| 12-#11 | 2.33 | 5524 | 2844 | 8883 | 2467 | 11399 | 2042 | 12813 | 1676 | 14124 | 1108 | 14418 | 401 | 11555 |
| 12-#14 | 3.36 | 5870 | 3139 | 10168 | 2656 | 12923 | 2187 | 14618 | 1775 | 16515 | 1117 | 17291 | 259 | 15831 |
| 12-#18 | 5.97 | 6714 | 3885 | 13298 | 3136 | 16663 | 2557 | 19063 | 2023 | 20924 | 1058 | 24270 | -118 | 24214 |
| 13-#10 | 2.05 | 5448 | 2766 | 8505 | 2421 | 11038 | 2005 | 12398 | 1657 | 13568 | 1107 | 13777 | 438 | 10484 |
| 13-#11 | 2.52 | 5588 | 2900 | 9137 | 2497 | 11754 | 2061 | 13208 | 1693 | 13635 | 1028 | 14984 | 364 | 12384 |
| 13-#14 | 3.64 | 5955 | 3219 | 10510 | 2702 | 13423 | 2218 | 15175 | 1801 | 17207 | 1108 | 18097 | 206 | 16809 |
| 13-#18 | 6.47 | 6905 | 4027 | 13865 | 3224 | 17525 | 2618 | 20014 | 2073 | 22024 | 1043 | 25651 | -211 | 25511 |
| 14-#10 | 2.21 | 5536 | 2811 | 8869 | 2429 | 11363 | 2008 | 12750 | 1650 | 13087 | 1021 | 14158 | 410 | 11138 |
| 14-#11 | 2.72 | 5689 | 2955 | 9546 | 2510 | 12130 | 2069 | 13633 | 1689 | 14136 | 1015 | 15473 | 331 | 13221 |
| 14-#14 | 3.92 | 6088 | 3299 | 11036 | 2729 | 13929 | 2237 | 15777 | 1802 | 16768 | 1018 | 18841 | 164 | 17920 |
| 14-#18 | 6.96 | 7112 | 4169 | 14678 | 3284 | 18351 | 2662 | 21065 | 2087 | 24892 | 1091 | 26970 | -285 | 26776 |
| 15-#10 | 2.37 | 5577 | 2856 | 8862 | 2486 | 11512 | 2057 | 12971 | 1694 | 13390 | 1040 | 14734 | 396 | 11856 |
| 15-#11 | 2.91 | 5738 | 3011 | 9574 | 2577 | 12326 | 2124 | 13905 | 1738 | 14507 | 1035 | 16148 | 312 | 14008 |
| 15-#14 | 4.20 | 6169 | 3379 | 11141 | 2816 | 14237 | 2307 | 16174 | 1864 | 18532 | 1117 | 19746 | 131 | 18947 |
| 16-#10 | 2.53 | 5649 | 2901 | 9006 | 2523 | 11703 | 2089 | 13258 | 1717 | 14722 | 1125 | 15268 | 390 | 12518 |
| 16-#11 | 3.10 | 5826 | 3066 | 9757 | 2620 | 12567 | 2163 | 14260 | 1766 | 15994 | 1121 | 16753 | 300 | 14847 |
| 16-#14 | 4.48 | 6327 | 3458 | 11419 | 2875 | 14595 | 2361 | 16688 | 1904 | 19170 | 1132 | 20585 | 110 | 19958 |
| 17-#10 | 2.68 | 5689 | 2946 | 9259 | 2548 | 11982 | 2107 | 13556 | 1731 | 14121 | 1047 | 15730 | 361 | 13205 |
| 17-#11 | 3.30 | 5872 | 3122 | 10058 | 2652 | 12899 | 2185 | 14609 | 1782 | 15395 | 1043 | 17337 | 267 | 15597 |
| 17-#14 | 4.76 | 6375 | 3538 | 11835 | 2924 | 15059 | 2395 | 17174 | 1927 | 18556 | 1053 | 21447 | 63 | 21064 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.84 | 5750 | 2991 | 9529 | 2566 | 12297 | 2120 | 13898 | 1732 | 14501 | 1037 | 16119 | 334 | 13887 |
| 18-#11 | 3.49 | 5956 | 3177 | 10365 | 2677 | 13273 | 2204 | 15017 | 1785 | 15856 | 1033 | 17806 | 234 | 16414 |
| 18-#14 | 5.04 | 6494 | 3618 | 12239 | 2964 | 15579 | 2428 | 17747 | 1936 | 20601 | 1116 | 22120 | 17 | 22026 |
| 19-#10 | 3.00 | 5807 | 3037 | 9622 | 2612 | 12463 | 2158 | 14130 | 1766 | 14842 | 1052 | 16691 | 323 | 14527 |
| 19-#11 | 3.69 | 6011 | 3232 | 10498 | 2730 | 13481 | 2247 | 15308 | 1825 | 17425 | 1124 | 18483 | 217 | 17137 |
| 19-#14 | 5.32 | 6588 | 3698 | 12464 | 3036 | 15888 | 2484 | 18174 | 1989 | 21229 | 1144 | 23063 | -10 | 23055 |
| 20-#10 | 3.16 | 5864 | 3082 | 9759 | 2650 | 12679 | 2190 | 14402 | 1786 | 16295 | 1138 | 17169 | 306 | 15206 |
| 20-#11 | 3.88 | 6081 | 3288 | 10672 | 2776 | 13742 | 2285 | 15636 | 1848 | 17907 | 1136 | 19076 | 197 | 17904 |
| 21-#10 | 3.32 | 5929 | 3127 | 9990 | 2677 | 12952 | 2204 | 14717 | 1803 | 15583 | 1063 | 17659 | 284 | 15833 |
| 21-#11 | 4.07 | 6157 | 3343 | 10945 | 2809 | 14073 | 2303 | 16013 | 1869 | 18378 | 1136 | 19636 | 167 | 18637 |
| 22-#10 | 3.47 | 5976 | 3172 | 10306 | 2693 | 13252 | 2216 | 15039 | 1807 | 17104 | 1129 | 18084 | 256 | 16511 |
| 22-#11 | 4.27 | 6229 | 3399 | 11317 | 2831 | 14428 | 2319 | 16405 | 1876 | 17613 | 1050 | 20231 | 145 | 19366 |
| 23-#10 | 3.63 | 6049 | 3217 | 10391 | 2737 | 13431 | 2254 | 15292 | 1838 | 16303 | 1068 | 18648 | 248 | 17103 |
| 23-#11 | 4.46 | 6305 | 3454 | 11433 | 2883 | 14655 | 2364 | 16713 | 1912 | 18029 | 1067 | 20835 | 123 | 20127 |
| 24-#10 | 3.79 | 6102 | 3262 | 10575 | 2771 | 13656 | 2279 | 15579 | 1857 | 17836 | 1148 | 19150 | 231 | 17749 |
| 25-#10 | 3.95 | 6171 | 3307 | 10760 | 2801 | 13909 | 2304 | 15878 | 1874 | 18248 | 1151 | 19606 | 208 | 18356 |
| 26-#10 | 4.11 | 6220 | 3353 | 11019 | 2823 | 14197 | 2319 | 16205 | 1882 | 17410 | 1067 | 20102 | 186 | 18963 |

## ROUND SPIRAL COLUMNS 34" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.03 | 5997 | 2793 | 9849 | 2341 | 11991 | 1926 | 12912 | 1594 | 13280 | 1109 | 12128 | 543 | 6786 |
| 6-#14 | 1.49 | 6163 | 2940 | 10604 | 2421 | 12895 | 1983 | 13979 | 1628 | 14696 | 1099 | 13619 | 457 | 9456 |
| 6-#18 | 2.64 | 6579 | 3313 | 12440 | 2630 | 15119 | 2131 | 16617 | 1715 | 18212 | 1075 | 17229 | 226 | 15821 |
| 7-#11 | 1.20 | 6163 | 2848 | 9151 | 2519 | 11764 | 2093 | 13026 | 1741 | 12842 | 1133 | 13255 | 600 | 7879 |
| 7-#14 | 1.73 | 6393 | 3020 | 9998 | 2623 | 12756 | 2172 | 14189 | 1794 | 14258 | 1133 | 15066 | 516 | 10734 |
| 7-#18 | 3.08 | 6922 | 3455 | 12051 | 2891 | 15187 | 2376 | 17059 | 1929 | 17749 | 1130 | 19508 | 297 | 17523 |
| 8-#10 | 1.12 | 6094 | 2821 | 8652 | 2549 | 11457 | 2123 | 12827 | 1775 | 12680 | 1169 | 13103 | 633 | 7326 |
| 8-#11 | 1.37 | 6183 | 2903 | 9120 | 2590 | 11964 | 2153 | 13391 | 1794 | 13314 | 1163 | 13881 | 586 | 8759 |
| 8-#14 | 1.98 | 6417 | 3100 | 10054 | 2714 | 13094 | 2247 | 14732 | 1860 | 15978 | 1251 | 15912 | 488 | 12119 |
| 8-#18 | 3.52 | 6967 | 3597 | 12327 | 3031 | 15876 | 2490 | 18033 | 2027 | 18851 | 1176 | 20888 | 232 | 19698 |
| 9-#10 | 1.26 | 6187 | 2866 | 9029 | 2561 | 11795 | 2131 | 13151 | 1775 | 13047 | 1153 | 13651 | 608 | 8234 |
| 9-#11 | 1.55 | 6294 | 2959 | 9542 | 2608 | 12353 | 2166 | 13767 | 1795 | 13771 | 1146 | 14546 | 556 | 9816 |
| 9-#14 | 2.23 | 6577 | 3180 | 10596 | 2747 | 13618 | 2273 | 15248 | 1867 | 16697 | 1230 | 16874 | 448 | 13366 |
| 9-#18 | 3.97 | 7270 | 3739 | 13165 | 3102 | 16729 | 2547 | 18896 | 2048 | 20065 | 1152 | 22566 | 165 | 21547 |
| 10-#10 | 1.40 | 6243 | 2911 | 9581 | 2552 | 12288 | 2114 | 13580 | 1750 | 14412 | 1202 | 14000 | 565 | 8964 |
| 10-#11 | 1.72 | 6359 | 3014 | 10142 | 2606 | 12905 | 2152 | 14270 | 1772 | 15286 | 1193 | 15018 | 508 | 10679 |
| 10-#14 | 2.48 | 6660 | 3260 | 11327 | 2761 | 14333 | 2267 | 15943 | 1846 | 16311 | 1111 | 17625 | 387 | 14714 |
| 10-#18 | 4.41 | 7379 | 3882 | 14223 | 3157 | 17832 | 2560 | 20061 | 2035 | 22885 | 1180 | 23829 | 56 | 23592 |
| 11-#10 | 1.54 | 6318 | 2956 | 9420 | 2627 | 12297 | 2182 | 13756 | 1815 | 14830 | 1247 | 14728 | 572 | 9832 |
| 11-#11 | 1.89 | 6448 | 3070 | 10028 | 2689 | 12964 | 2227 | 14506 | 1843 | 15777 | 1241 | 15830 | 509 | 11679 |
| 11-#14 | 2.73 | 6788 | 3340 | 11311 | 2860 | 14497 | 2358 | 16311 | 1934 | 16936 | 1162 | 18747 | 385 | 15904 |
| 11-#18 | 4.85 | 7631 | 4024 | 14448 | 3299 | 18266 | 2691 | 20765 | 2163 | 23992 | 1254 | 25749 | 45 | 25472 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.68 | 6395 | 3002 | 9550 | 2673 | 12475 | 2222 | 14023 | 1842 | 14212 | 1178 | 15324 | 570 | 10550 |
| 12-#11 | 2.06 | 6539 | 3125 | 10202 | 2742 | 13190 | 2273 | 14832 | 1874 | 15179 | 1174 | 16536 | 504 | 12545 |
| 12-#14 | 2.97 | 6923 | 3419 | 11594 | 2931 | 14838 | 2419 | 16782 | 1973 | 18843 | 1267 | 19665 | 366 | 17237 |
| 12-#18 | 5.29 | 7818 | 4166 | 14988 | 3412 | 18889 | 2791 | 21592 | 2224 | 23546 | 1202 | 27293 | 1 | 27288 |
| 13-#10 | 1.82 | 6454 | 3047 | 9790 | 2694 | 12795 | 2235 | 14383 | 1854 | 14617 | 1172 | 15811 | 537 | 11387 |
| 13-#11 | 2.23 | 6608 | 3181 | 10481 | 2770 | 13574 | 2291 | 15262 | 1890 | 15669 | 1167 | 17150 | 466 | 13493 |
| 13-#14 | 3.22 | 7014 | 3499 | 11966 | 2975 | 15375 | 2449 | 17388 | 1999 | 19593 | 1258 | 20543 | 313 | 18374 |
| 13-#18 | 5.73 | 8047 | 4308 | 15600 | 3499 | 19813 | 2851 | 22627 | 2275 | 26528 | 1275 | 28806 | -92 | 28765 |
| 14-#10 | 1.96 | 6551 | 3092 | 10203 | 2700 | 13157 | 2237 | 14762 | 1845 | 16152 | 1242 | 16217 | 509 | 12094 |
| 14-#11 | 2.41 | 6722 | 3236 | 10941 | 2781 | 13990 | 2297 | 15719 | 1883 | 16218 | 1153 | 17650 | 432 | 14365 |
| 14-#14 | 3.47 | 7160 | 3579 | 12553 | 3000 | 15933 | 2466 | 18033 | 1997 | 19067 | 1159 | 21308 | 269 | 19683 |
| 14-#18 | 6.17 | 8272 | 4450 | 16498 | 3557 | 20718 | 2893 | 23750 | 2285 | 26080 | 1166 | 30267 | -160 | 30103 |
| 15-#10 | 2.10 | 6596 | 3137 | 10171 | 2760 | 13306 | 2288 | 14996 | 1891 | 16501 | 1264 | 16851 | 497 | 12912 |
| 15-#11 | 2.58 | 6775 | 3292 | 10947 | 2850 | 14190 | 2355 | 16009 | 1935 | 16612 | 1175 | 18392 | 415 | 15262 |
| 15-#14 | 3.72 | 7248 | 3659 | 12641 | 3090 | 16256 | 2539 | 18457 | 2063 | 21028 | 1269 | 22326 | 239 | 20735 |
| 15-#18 | 6.61 | 8454 | 4592 | 16793 | 3701 | 21340 | 3006 | 24504 | 2385 | 27067 | 1203 | 31868 | -229 | 31658 |
| 16-#10 | 2.24 | 6675 | 3182 | 10320 | 2797 | 13505 | 2321 | 15300 | 1915 | 15781 | 1190 | 17439 | 493 | 13606 |
| 16-#11 | 2.75 | 6871 | 3347 | 11139 | 2894 | 14443 | 2394 | 16385 | 1963 | 17068 | 1187 | 19077 | 406 | 16138 |
| 16-#14 | 3.97 | 7398 | 3739 | 12935 | 3150 | 16632 | 2594 | 19003 | 2102 | 21719 | 1285 | 23257 | 222 | 21882 |
| 17-#10 | 2.38 | 6718 | 3227 | 10595 | 2822 | 13809 | 2339 | 15627 | 1929 | 17340 | 1271 | 17894 | 459 | 14381 |
| 17-#11 | 2.92 | 6921 | 3402 | 11465 | 2925 | 14804 | 2416 | 16769 | 1980 | 18819 | 1268 | 19685 | 372 | 16992 |
| 17-#14 | 4.21 | 7470 | 3819 | 13386 | 3198 | 17136 | 2627 | 19540 | 2127 | 22489 | 1282 | 24154 | 174 | 23030 |
| 18-#10 | 2.52 | 6784 | 3272 | 10898 | 2839 | 14152 | 2350 | 16000 | 1929 | 17779 | 1260 | 18352 | 436 | 15089 |
| 18-#11 | 3.09 | 7002 | 3458 | 11808 | 2949 | 15210 | 2434 | 17213 | 1983 | 18060 | 1172 | 20193 | 338 | 17900 |
| 18-#14 | 4.46 | 7597 | 3899 | 13832 | 3237 | 17698 | 2658 | 20163 | 2135 | 23251 | 1268 | 24887 | 127 | 24117 |
| 19-#10 | 2.66 | 6844 | 3317 | 10987 | 2887 | 14324 | 2390 | 16242 | 1964 | 18175 | 1278 | 18976 | 427 | 15819 |
| 19-#11 | 3.26 | 7074 | 3513 | 11939 | 3004 | 15431 | 2479 | 17518 | 2023 | 18502 | 1190 | 20933 | 324 | 18705 |
| 19-#14 | 4.71 | 7685 | 3979 | 14064 | 3311 | 18032 | 2717 | 20612 | 2189 | 23916 | 1291 | 25916 | 103 | 25301 |
| 20-#10 | 2.80 | 6910 | 3363 | 11127 | 2925 | 14595 | 2415 | 16534 | 1984 | 17352 | 1202 | 19478 | 409 | 16526 |
| 20-#11 | 3.44 | 7149 | 3569 | 12120 | 3051 | 15712 | 2518 | 17871 | 2047 | 18980 | 1202 | 21556 | 303 | 19605 |
| 20-#14 | 4.96 | 7819 | 4059 | 14338 | 3376 | 18437 | 2771 | 21117 | 2221 | 24654 | 1308 | 26820 | 73 | 26385 |
| 21-#10 | 2.94 | 6976 | 3408 | 11380 | 2951 | 14851 | 2436 | 16871 | 2001 | 19018 | 1286 | 20010 | 388 | 17239 |
| 21-#11 | 3.61 | 7232 | 3624 | 12418 | 3083 | 16067 | 2535 | 18280 | 2068 | 19465 | 1203 | 22188 | 276 | 20368 |
| 22-#10 | 3.08 | 7032 | 3453 | 11726 | 2966 | 15179 | 2448 | 17219 | 2004 | 19473 | 1280 | 20487 | 361 | 17949 |
| 22-#11 | 3.78 | 7295 | 3680 | 12824 | 3104 | 16454 | 2551 | 18699 | 2074 | 21387 | 1278 | 22742 | 241 | 21194 |
| 23-#10 | 3.22 | 7112 | 3498 | 11810 | 3012 | 15364 | 2486 | 17491 | 2037 | 19858 | 1296 | 21083 | 353 | 18644 |
| 23-#11 | 3.95 | 7394 | 3735 | 12941 | 3158 | 16691 | 2597 | 19030 | 2111 | 21861 | 1296 | 23478 | 232 | 21984 |
| 24-#10 | 3.36 | 7161 | 3543 | 12007 | 3047 | 15605 | 2512 | 17795 | 2056 | 18905 | 1213 | 21629 | 337 | 19370 |
| 24-#11 | 4.12 | 7457 | 3791 | 13181 | 3199 | 16984 | 2628 | 19405 | 2135 | 20850 | 1213 | 24128 | 211 | 22793 |
| 25-#10 | 3.50 | 7243 | 3588 | 12207 | 3076 | 15879 | 2537 | 18118 | 2073 | 20701 | 1303 | 22123 | 314 | 20031 |
| 25-#11 | 4.30 | 7555 | 3846 | 13421 | 3236 | 17312 | 2658 | 19793 | 2155 | 22875 | 1303 | 24722 | 182 | 23597 |
| 26-#10 | 3.64 | 7297 | 3633 | 12492 | 3098 | 16189 | 2551 | 18477 | 2081 | 19721 | 1208 | 22643 | 291 | 20726 |
| 27-#10 | 3.78 | 7371 | 3679 | 12636 | 3136 | 16390 | 2587 | 18748 | 2104 | 20097 | 1222 | 23170 | 275 | 21378 |
| 28-#10 | 3.92 | 7429 | 3724 | 12795 | 3173 | 16646 | 2613 | 19042 | 2127 | 20489 | 1227 | 23721 | 256 | 22041 |

## ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi

$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.33 | 7263 | 3238 | 12235 | 2692 | 14930 | 2209 | 16176 | 1819 | 15786 | 1159 | 15671 | 555 | 10160 |
| 6-#18 | 2.36 | 7694 | 3611 | 14215 | 2900 | 17323 | 2357 | 19011 | 1906 | 20688 | 1219 | 19609 | 332 | 17052 |
| 7-#11 | 1.07 | 7260 | 3146 | 10550 | 2806 | 13653 | 2334 | 15133 | 1946 | 15941 | 1369 | 15293 | 703 | 8501 |
| 7-#14 | 1.55 | 7514 | 3318 | 11463 | 2910 | 14720 | 2413 | 16382 | 1999 | 16402 | 1278 | 17247 | 620 | 11613 |
| 7-#18 | 2.75 | 8097 | 3753 | 13680 | 3178 | 17339 | 2618 | 19469 | 2135 | 21606 | 1369 | 22053 | 406 | 18967 |
| 8-#11 | 1.23 | 7285 | 3201 | 10483 | 2880 | 13847 | 2397 | 15513 | 2002 | 16488 | 1404 | 15980 | 691 | 9428 |
| 8-#14 | 1.77 | 7542 | 3398 | 11489 | 3004 | 15061 | 2492 | 16951 | 2068 | 18332 | 1410 | 18172 | 595 | 13055 |
| 8-#18 | 3.14 | 8146 | 3895 | 13938 | 3321 | 18052 | 2735 | 20513 | 2237 | 21359 | 1328 | 23559 | 345 | 21622 |
| 9-#10 | 1.12 | 7286 | 3164 | 10397 | 2850 | 13671 | 2374 | 15261 | 1982 | 16169 | 1391 | 15723 | 712 | 8855 |
| 9-#11 | 1.38 | 7405 | 3257 | 10955 | 2897 | 14275 | 2409 | 15926 | 2003 | 15869 | 1292 | 16693 | 660 | 10599 |
| 9-#14 | 1.99 | 7716 | 3478 | 12090 | 3035 | 15634 | 2516 | 17519 | 2074 | 19089 | 1387 | 19209 | 555 | 14473 |
| 9-#18 | 3.54 | 8474 | 4037 | 14858 | 3391 | 18981 | 2791 | 21448 | 2258 | 22638 | 1301 | 25378 | 278 | 23520 |
| 10-#10 | 1.25 | 7347 | 3209 | 11027 | 2835 | 14227 | 2353 | 15731 | 1953 | 15520 | 1265 | 16068 | 666 | 9662 |
| 10-#11 | 1.53 | 7476 | 3312 | 11636 | 2890 | 14895 | 2391 | 16476 | 1975 | 17569 | 1346 | 17165 | 609 | 11519 |
| 10-#14 | 2.21 | 7807 | 3557 | 12910 | 3044 | 16432 | 2507 | 18275 | 2050 | 18594 | 1255 | 19972 | 490 | 15879 |
| 10-#18 | 3.93 | 8592 | 4179 | 16028 | 3441 | 20207 | 2801 | 22712 | 2241 | 25745 | 1338 | 26813 | 176 | 25823 |
| 11-#10 | 1.37 | 7429 | 3254 | 10808 | 2917 | 14207 | 2427 | 15905 | 2023 | 17084 | 1404 | 16888 | 677 | 10588 |
| 11-#11 | 1.69 | 7573 | 3368 | 11468 | 2978 | 14929 | 2471 | 16714 | 2051 | 18103 | 1398 | 18084 | 615 | 12645 |
| 11-#14 | 2.43 | 7946 | 3637 | 12848 | 3149 | 16577 | 2602 | 18652 | 2142 | 20650 | 1404 | 21168 | 486 | 17229 |
| 11-#18 | 4.32 | 8864 | 4322 | 16225 | 3588 | 20634 | 2937 | 23443 | 2373 | 25150 | 1322 | 28836 | 163 | 27748 |
| 12-#10 | 1.50 | 7513 | 3299 | 10932 | 2964 | 14391 | 2468 | 16189 | 2051 | 17504 | 1420 | 17535 | 676 | 11387 |
| 12-#11 | 1.84 | 7672 | 3423 | 11645 | 3033 | 15164 | 2519 | 17061 | 2083 | 18618 | 1415 | 18850 | 611 | 13548 |
| 12-#14 | 2.65 | 8079 | 3717 | 13144 | 3222 | 16937 | 2666 | 19155 | 2183 | 21387 | 1426 | 22235 | 477 | 18620 |
| 12-#18 | 4.72 | 9068 | 4464 | 16805 | 3705 | 21299 | 3039 | 24331 | 2436 | 26368 | 1354 | 30514 | 123 | 29785 |
| 13-#10 | 1.62 | 7577 | 3345 | 11201 | 2985 | 14736 | 2480 | 16578 | 2063 | 17969 | 1413 | 18041 | 642 | 12276 |
| 13-#11 | 1.99 | 7748 | 3479 | 11950 | 3060 | 15577 | 2536 | 17526 | 2099 | 17903 | 1314 | 19490 | 572 | 14624 |
| 13-#14 | 2.87 | 8193 | 3797 | 13548 | 3266 | 17512 | 2694 | 19810 | 2209 | 22194 | 1417 | 23182 | 424 | 19914 |
| 13-#18 | 5.11 | 9283 | 4606 | 17462 | 3790 | 22285 | 3097 | 25450 | 2487 | 29654 | 1438 | 32158 | 31 | 31951 |
| 14-#10 | 1.75 | 7681 | 3390 | 11665 | 2988 | 15136 | 2480 | 16984 | 2052 | 17255 | 1304 | 18471 | 613 | 13065 |
| 14-#11 | 2.15 | 7872 | 3534 | 12466 | 3069 | 16036 | 2540 | 18015 | 2090 | 19822 | 1393 | 20021 | 538 | 15525 |
| 14-#14 | 3.09 | 8352 | 3877 | 14200 | 3288 | 18123 | 2709 | 20499 | 2204 | 21566 | 1308 | 23970 | 378 | 21329 |
| 14-#18 | 5.50 | 9558 | 4748 | 18450 | 3846 | 23271 | 3138 | 26646 | 2495 | 31209 | 1414 | 33665 | -41 | 33625 |
| 15-#10 | 1.87 | 7732 | 3435 | 11605 | 3051 | 15283 | 2533 | 17230 | 2100 | 18872 | 1422 | 19164 | 603 | 13930 |
| 15-#11 | 2.30 | 7930 | 3589 | 12446 | 3140 | 16239 | 2600 | 18321 | 2144 | 18918 | 1323 | 20833 | 522 | 16540 |
| 15-#14 | 3.32 | 8447 | 3957 | 14267 | 3381 | 18458 | 2785 | 20951 | 2273 | 23739 | 1430 | 25080 | 350 | 22528 |
| 15-#18 | 5.89 | 9749 | 4890 | 18736 | 3992 | 23930 | 3254 | 27455 | 2598 | 32322 | 1455 | 35485 | -102 | 35375 |
| 16-#10 | 2.00 | 7817 | 3480 | 11758 | 3089 | 15490 | 2567 | 17550 | 2125 | 19310 | 1434 | 19784 | 599 | 14704 |
| 16-#11 | 2.45 | 8034 | 3645 | 12645 | 3185 | 16501 | 2640 | 18718 | 2173 | 20795 | 1432 | 21597 | 517 | 17448 |
| 16-#14 | 3.54 | 8606 | 4037 | 14576 | 3442 | 18852 | 2840 | 21528 | 2312 | 24483 | 1447 | 26126 | 337 | 23863 |
| 16-#18 | 6.29 | 10021 | 5032 | 19316 | 4095 | 24656 | 3348 | 28488 | 2666 | 31362 | 1381 | 37169 | -138 | 37070 |
| 17-#10 | 2.12 | 7866 | 3525 | 12056 | 3113 | 15818 | 2584 | 17902 | 2138 | 19766 | 1430 | 20289 | 567 | 15547 |
| 17-#11 | 2.61 | 8089 | 3700 | 12997 | 3216 | 16892 | 2662 | 19139 | 2190 | 19933 | 1332 | 22180 | 475 | 18422 |
| 17-#14 | 3.76 | 8674 | 4117 | 15062 | 3489 | 19398 | 2874 | 22115 | 2338 | 23611 | 1346 | 27057 | 288 | 25046 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 5,000 psi $f_y$ = 60,000 psi

$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.25 | 7937 | 3570 | 12395 | 3128 | 16191 | 2595 | 18311 | 2138 | 20235 | 1418 | 20779 | 543 | 16312 |
| 18-#11 | 2.76 | 8175 | 3756 | 13379 | 3238 | 17331 | 2678 | 19619 | 2192 | 20465 | 1320 | 22776 | 448 | 19358 |
| 18-#14 | 3.98 | 8821 | 4197 | 15554 | 3527 | 20002 | 2902 | 22789 | 2345 | 26116 | 1428 | 27850 | 242 | 26266 |
| 19-#10 | 2.37 | 8002 | 3615 | 12475 | 3178 | 16367 | 2636 | 18562 | 2174 | 19285 | 1342 | 21448 | 535 | 17135 |
| 19-#11 | 2.91 | 8255 | 3811 | 13505 | 3295 | 17561 | 2725 | 19937 | 2234 | 20942 | 1340 | 23579 | 435 | 20268 |
| 19-#14 | 4.20 | 8906 | 4277 | 15789 | 3602 | 20358 | 2964 | 23259 | 2400 | 25045 | 1356 | 28966 | 219 | 27493 |
| 20-#10 | 2.50 | 8074 | 3661 | 12619 | 3217 | 16660 | 2662 | 18875 | 2195 | 21103 | 1448 | 21984 | 517 | 17868 |
| 20-#11 | 3.07 | 8336 | 3867 | 13692 | 3342 | 17866 | 2765 | 20316 | 2258 | 22979 | 1448 | 24233 | 413 | 21205 |
| 20-#14 | 4.42 | 9028 | 4357 | 16075 | 3668 | 20794 | 3019 | 23802 | 2433 | 27614 | 1470 | 29913 | 188 | 28712 |
| 21-#10 | 2.62 | 8146 | 3706 | 12929 | 3239 | 16933 | 2683 | 19233 | 2211 | 21561 | 1445 | 22556 | 496 | 18674 |
| 21-#11 | 3.22 | 8420 | 3922 | 14016 | 3374 | 18244 | 2781 | 20753 | 2279 | 21963 | 1348 | 24922 | 387 | 22088 |
| 21-#14 | 4.64 | 9146 | 4437 | 16523 | 3716 | 21332 | 3044 | 24426 | 2465 | 26518 | 1374 | 30887 | 150 | 29950 |
| 22-#10 | 2.74 | 8206 | 3751 | 13271 | 3257 | 17290 | 2693 | 19609 | 2214 | 22056 | 1440 | 23087 | 471 | 19410 |
| 22-#11 | 3.37 | 8493 | 3978 | 14457 | 3394 | 18665 | 2796 | 21202 | 2284 | 24119 | 1438 | 25534 | 354 | 23029 |
| 22-#14 | 4.86 | 9274 | 4517 | 17122 | 3748 | 21913 | 3069 | 25063 | 2475 | 29230 | 1458 | 31744 | 102 | 31104 |
| 23-#10 | 2.87 | 8293 | 3796 | 13352 | 3304 | 17479 | 2733 | 19898 | 2247 | 22463 | 1456 | 23675 | 458 | 20192 |
| 23-#11 | 3.52 | 8595 | 4033 | 14574 | 3449 | 18909 | 2843 | 21556 | 2322 | 24619 | 1457 | 26309 | 344 | 23886 |
| 24-#10 | 2.99 | 8345 | 3841 | 13558 | 3339 | 17736 | 2759 | 20220 | 2267 | 22891 | 1461 | 24305 | 447 | 20948 |
| 24-#11 | 3.68 | 8670 | 4088 | 14832 | 3491 | 19223 | 2875 | 21952 | 2346 | 25134 | 1462 | 27013 | 324 | 24794 |
| 25-#10 | 3.12 | 8434 | 3886 | 13777 | 3368 | 18032 | 2784 | 20568 | 2284 | 23365 | 1464 | 24837 | 425 | 21692 |
| 25-#11 | 3.83 | 8767 | 4144 | 15088 | 3528 | 19577 | 2905 | 22370 | 2367 | 23996 | 1368 | 27653 | 296 | 25635 |
| 26-#10 | 3.24 | 8494 | 3931 | 14089 | 3389 | 18365 | 2797 | 20959 | 2292 | 23822 | 1455 | 25379 | 400 | 22448 |
| 26-#11 | 3.98 | 8835 | 4199 | 15452 | 3555 | 19977 | 2923 | 22832 | 2377 | 24518 | 1359 | 28333 | 268 | 26494 |
| 27-#10 | 3.37 | 8568 | 3976 | 14235 | 3428 | 18577 | 2834 | 21243 | 2316 | 24255 | 1470 | 25953 | 386 | 23178 |
| 27-#11 | 4.14 | 8932 | 4255 | 15646 | 3601 | 20240 | 2966 | 23185 | 2405 | 26790 | 1473 | 29005 | 247 | 27358 |
| 28-#10 | 3.49 | 8637 | 4022 | 14403 | 3465 | 18846 | 2860 | 21558 | 2339 | 24699 | 1475 | 26563 | 369 | 23939 |
| 29-#10 | 3.62 | 8709 | 4067 | 14660 | 3493 | 19129 | 2885 | 21910 | 2352 | 25157 | 1478 | 27068 | 346 | 24652 |
| 30-#10 | 3.74 | 8791 | 4112 | 14917 | 3519 | 19468 | 2901 | 22267 | 2364 | 25624 | 1472 | 27617 | 321 | 25399 |

## ROUND SPIRAL COLUMNS 12" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.64 | 308 | 433 | 613 | 298 | 654 | 241 | 655 | 193 | 625 | 119 | 519 | 28 | 422 |
| 6-#6 | 2.33 | 313 | 460 | 649 | 312 | 693 | 250 | 700 | 196 | 635 | 103 | 570 | 2 | 563 |
| 6-#7 | 3.18 | 320 | 494 | 690 | 329 | 739 | 261 | 752 | 201 | 747 | 101 | 630 | -30 | 641 |
| 6-#8 | 4.19 | 327 | 534 | 738 | 350 | 792 | 274 | 812 | 205 | 823 | 89 | 697 | -69 | 727 |
| 6-#9 | 5.31 | 336 | 578 | 785 | 371 | 847 | 288 | 875 | 210 | 842 | 70 | 765 | -113 | 812 |
| 6-#10 | 6.74 | 347 | 634 | 844 | 399 | 914 | 306 | 951 | 215 | 1000 | 55 | 847 | -170 | 914 |
| 7-#5 | 1.92 | 314 | 444 | 604 | 323 | 661 | 260 | 676 | 210 | 658 | 131 | 563 | 30 | 472 |
| 7-#6 | 2.72 | 321 | 476 | 641 | 340 | 705 | 272 | 725 | 216 | 673 | 117 | 623 | 2 | 618 |
| 7-#7 | 3.71 | 331 | 515 | 686 | 362 | 757 | 286 | 784 | 223 | 796 | 117 | 694 | -33 | 722 |
| 7-#8 | 4.89 | 342 | 561 | 736 | 388 | 817 | 303 | 851 | 231 | 823 | 100 | 773 | -75 | 824 |
| 7-#9 | 6.19 | 354 | 613 | 789 | 416 | 879 | 321 | 920 | 240 | 906 | 89 | 853 | -125 | 922 |
| 8-#5 | 2.19 | 316 | 455 | 611 | 333 | 675 | 268 | 694 | 217 | 636 | 124 | 594 | 23 | 529 |
| 8-#6 | 3.11 | 324 | 491 | 654 | 354 | 724 | 282 | 751 | 225 | 753 | 126 | 664 | -9 | 671 |
| 8-#7 | 4.24 | 334 | 536 | 703 | 379 | 783 | 298 | 818 | 234 | 837 | 118 | 746 | -49 | 779 |
| 8-#8 | 5.59 | 346 | 589 | 760 | 409 | 850 | 318 | 894 | 245 | 933 | 107 | 838 | -99 | 897 |

## ROUND SPIRAL COLUMNS 14" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.21 | 488 | 566 | 931 | 406 | 1010 | 329 | 1018 | 270 | 968 | 177 | 803 | 65 | 524 |
| 6-#6 | 1.71 | 496 | 593 | 976 | 420 | 1064 | 338 | 1079 | 275 | 975 | 160 | 872 | 40 | 707 |
| 6-#7 | 2.34 | 506 | 626 | 1031 | 437 | 1129 | 350 | 1151 | 280 | 1136 | 163 | 955 | 9 | 919 |
| 6-#8 | 3.08 | 517 | 666 | 1093 | 458 | 1203 | 363 | 1235 | 287 | 1159 | 143 | 1049 | -28 | 1070 |
| 6-#9 | 3.90 | 529 | 710 | 1161 | 481 | 1280 | 377 | 1323 | 294 | 1353 | 143 | 1146 | -70 | 1194 |
| 6-#10 | 4.95 | 544 | 767 | 1245 | 511 | 1376 | 405 | 1433 | 303 | 1392 | 119 | 1311 | -113 | 1342 |
| 6-#11 | 6.08 | 553 | 828 | 1324 | 537 | 1446 | 418 | 1509 | 302 | 1587 | 101 | 1377 | -180 | 1443 |
| 7-#5 | 1.41 | 496 | 576 | 907 | 437 | 1013 | 356 | 1040 | 292 | 1013 | 193 | 876 | 74 | 600 |
| 7-#6 | 2.00 | 507 | 608 | 957 | 455 | 1071 | 368 | 1107 | 299 | 1098 | 189 | 969 | 51 | 791 |
| 7-#7 | 2.73 | 522 | 647 | 1016 | 478 | 1140 | 384 | 1188 | 308 | 1119 | 171 | 1073 | 21 | 1013 |
| 7-#8 | 3.59 | 538 | 694 | 1084 | 505 | 1221 | 402 | 1281 | 319 | 1317 | 175 | 1192 | -17 | 1198 |
| 7-#9 | 4.55 | 555 | 745 | 1157 | 534 | 1306 | 422 | 1381 | 330 | 1441 | 166 | 1315 | -59 | 1353 |
| 7-#10 | 5.78 | 578 | 812 | 1249 | 573 | 1413 | 448 | 1506 | 345 | 1605 | 159 | 1466 | -115 | 1537 |
| 7-#11 | 7.09 | 591 | 883 | 1330 | 605 | 1500 | 467 | 1593 | 349 | 1714 | 134 | 1545 | -194 | 1644 |
| 8-#5 | 1.61 | 498 | 587 | 916 | 450 | 1030 | 366 | 1064 | 300 | 978 | 184 | 924 | 70 | 666 |
| 8-#6 | 2.29 | 509 | 624 | 973 | 471 | 1095 | 380 | 1139 | 310 | 1068 | 180 | 1026 | 42 | 890 |
| 8-#7 | 3.12 | 524 | 668 | 1040 | 498 | 1173 | 399 | 1230 | 321 | 1260 | 188 | 1147 | 7 | 1129 |
| 8-#8 | 4.11 | 541 | 722 | 1117 | 529 | 1264 | 420 | 1336 | 334 | 1393 | 181 | 1284 | -35 | 1309 |
| 8-#9 | 5.20 | 560 | 780 | 1199 | 563 | 1360 | 444 | 1448 | 349 | 1534 | 172 | 1427 | -84 | 1479 |
| 8-#10 | 6.60 | 584 | 856 | 1300 | 607 | 1480 | 474 | 1589 | 367 | 1596 | 149 | 1603 | -149 | 1655 |

## ROUND SPIRAL COLUMNS 16" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#6 | 1.31 | 737 | 746 | 1395 | 545 | 1533 | 442 | 1566 | 364 | 1509 | 239 | 1273 | 89 | 850 |
| 6-#7 | 1.79 | 750 | 780 | 1462 | 562 | 1613 | 454 | 1659 | 371 | 1518 | 217 | 1383 | 61 | 1112 |
| 6-#8 | 2.36 | 765 | 820 | 1540 | 583 | 1707 | 468 | 1767 | 379 | 1762 | 225 | 1510 | 26 | 1408 |
| 6-#9 | 2.98 | 781 | 864 | 1623 | 606 | 1809 | 484 | 1882 | 388 | 1907 | 216 | 1644 | -13 | 1654 |
| 6-#10 | 3.79 | 801 | 920 | 1729 | 636 | 1938 | 504 | 2025 | 398 | 2088 | 204 | 1810 | -64 | 1854 |
| 6-#11 | 4.66 | 815 | 981 | 1832 | 663 | 2048 | 519 | 2136 | 401 | 2226 | 182 | 1913 | -132 | 2000 |
| 6-#14 | 6.71 | 863 | 1126 | 2077 | 740 | 2329 | 584 | 2457 | 424 | 2633 | 144 | 2354 | -251 | 2414 |
| 7-#5 | 1.08 | 736 | 730 | 1292 | 570 | 1465 | 467 | 1512 | 386 | 1471 | 265 | 1283 | 123 | 728 |
| 7-#6 | 1.53 | 751 | 761 | 1354 | 588 | 1538 | 480 | 1596 | 394 | 1579 | 262 | 1396 | 101 | 969 |
| 7-#7 | 2.09 | 769 | 801 | 1428 | 611 | 1625 | 496 | 1697 | 404 | 1596 | 240 | 1532 | 73 | 1245 |
| 7-#8 | 2.75 | 791 | 847 | 1513 | 638 | 1727 | 516 | 1814 | 416 | 1861 | 253 | 1687 | 39 | 1556 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 16" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 7-#9 | 3.48 | 813 | 899 | 1604 | 669 | 1835 | 537 | 1940 | 429 | 2023 | 246 | 1852 | 0 | 1852 |
| 7-#10 | 4.42 | 845 | 965 | 1718 | 708 | 1971 | 564 | 2099 | 445 | 2224 | 237 | 2055 | -51 | 2101 |
| 7-#11 | 5.43 | 865 | 1036 | 1833 | 742 | 2090 | 585 | 2233 | 454 | 2220 | 203 | 2215 | -114 | 2287 |
| 7-#14 | 7.83 | 934 | 1205 | 2098 | 841 | 2402 | 652 | 2599 | 492 | 2831 | 186 | 2657 | -258 | 2767 |
| 8-#5 | 1.23 | 738 | 740 | 1298 | 585 | 1485 | 479 | 1541 | 397 | 1412 | 252 | 1346 | 121 | 805 |
| 8-#6 | 1.75 | 753 | 777 | 1368 | 606 | 1567 | 494 | 1635 | 407 | 1635 | 267 | 1480 | 96 | 1081 |
| 8-#7 | 2.39 | 772 | 822 | 1453 | 633 | 1666 | 513 | 1749 | 419 | 1663 | 246 | 1640 | 65 | 1405 |
| 8-#8 | 3.14 | 794 | 875 | 1550 | 665 | 1780 | 536 | 1882 | 434 | 1824 | 242 | 1824 | 28 | 1747 |
| 8-#9 | 3.98 | 818 | 934 | 1655 | 701 | 1902 | 561 | 2024 | 450 | 2139 | 254 | 2019 | -16 | 2030 |
| 8-#10 | 5.05 | 850 | 1009 | 1787 | 747 | 2055 | 593 | 2203 | 470 | 2371 | 247 | 2260 | -73 | 2268 |
| 8-#11 | 6.21 | 872 | 1090 | 1913 | 788 | 2190 | 618 | 2354 | 482 | 2378 | 211 | 2419 | -152 | 2466 |
| 9-#10 | 5.68 | 883 | 1054 | 1871 | 765 | 2155 | 610 | 2327 | 476 | 2529 | 240 | 2393 | -106 | 2474 |
| 9-#11 | 6.98 | 910 | 1145 | 2011 | 811 | 2312 | 641 | 2497 | 490 | 2550 | 202 | 2567 | -194 | 2662 |
| 10-#10 | 6.32 | 901 | 1098 | 1971 | 782 | 2269 | 614 | 2458 | 477 | 2683 | 218 | 2523 | -150 | 2614 |

## ROUND SPIRAL COLUMNS 18" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#6 | 1.04 | 1042 | 920 | 1916 | 688 | 2120 | 560 | 2169 | 464 | 2090 | 315 | 1771 | 141 | 994 |
| 6-#7 | 1.41 | 1059 | 953 | 1996 | 705 | 2216 | 572 | 2282 | 472 | 2232 | 310 | 1910 | 115 | 1305 |
| 6-#8 | 1.86 | 1080 | 993 | 2089 | 726 | 2328 | 587 | 2415 | 481 | 2398 | 304 | 2070 | 84 | 1660 |
| 6-#9 | 2.36 | 1100 | 1037 | 2189 | 749 | 2449 | 603 | 2560 | 491 | 2577 | 296 | 2241 | 48 | 2036 |
| 6-#10 | 2.99 | 1126 | 1094 | 2315 | 779 | 2603 | 623 | 2743 | 504 | 2802 | 286 | 2455 | 1 | 2452 |
| 6-#11 | 3.68 | 1144 | 1155 | 2444 | 806 | 2749 | 640 | 2890 | 509 | 2983 | 267 | 2605 | -62 | 2651 |
| 6-#14 | 5.31 | 1205 | 1300 | 2742 | 883 | 3115 | 693 | 3298 | 537 | 3499 | 236 | 3072 | -194 | 3189 |
| 7-#6 | 1.21 | 1061 | 935 | 1845 | 740 | 2118 | 607 | 2207 | 502 | 2174 | 343 | 1933 | 157 | 1153 |
| 7-#7 | 1.65 | 1084 | 974 | 1933 | 763 | 2222 | 623 | 2328 | 513 | 2331 | 340 | 2103 | 132 | 1484 |
| 7-#8 | 2.17 | 1111 | 1021 | 2035 | 791 | 2344 | 643 | 2469 | 525 | 2347 | 314 | 2300 | 100 | 1859 |
| 7-#9 | 2.75 | 1139 | 1072 | 2145 | 821 | 2476 | 665 | 2622 | 539 | 2713 | 332 | 2510 | 65 | 2256 |
| 7-#10 | 3.49 | 1175 | 1138 | 2283 | 861 | 2642 | 694 | 2815 | 557 | 2965 | 326 | 2771 | 18 | 2707 |
| 7-#11 | 4.29 | 1206 | 1210 | 2426 | 895 | 2799 | 717 | 2985 | 567 | 3176 | 310 | 2958 | -45 | 3002 |
| 7-#14 | 6.19 | 1289 | 1379 | 2750 | 996 | 3185 | 787 | 3437 | 610 | 3499 | 268 | 3533 | -177 | 3672 |
| 8-#6 | 1.38 | 1064 | 951 | 1854 | 760 | 2154 | 624 | 2254 | 517 | 2093 | 327 | 2018 | 151 | 1275 |
| 8-#7 | 1.89 | 1087 | 995 | 1955 | 787 | 2273 | 643 | 2391 | 530 | 2419 | 348 | 2211 | 121 | 1662 |
| 8-#8 | 2.48 | 1115 | 1049 | 2071 | 819 | 2411 | 667 | 2551 | 545 | 2626 | 345 | 2435 | 85 | 2102 |
| 8-#9 | 3.14 | 1144 | 1107 | 2196 | 855 | 2559 | 693 | 2723 | 563 | 2850 | 341 | 2674 | 44 | 2550 |
| 8-#10 | 3.99 | 1181 | 1183 | 2354 | 901 | 2746 | 726 | 2941 | 585 | 3133 | 336 | 3025 | 2 | 3020 |
| 8-#11 | 4.90 | 1214 | 1264 | 2520 | 944 | 2918 | 753 | 3133 | 599 | 3378 | 322 | 3251 | -70 | 3244 |
| 8-#14 | 7.07 | 1305 | 1457 | 2894 | 1062 | 3354 | 835 | 3642 | 651 | 4035 | 302 | 3932 | -217 | 3970 |
| 9-#10 | 4.49 | 1222 | 1227 | 2466 | 921 | 2858 | 741 | 3085 | 590 | 3322 | 326 | 3194 | -31 | 3222 |
| 9-#11 | 5.52 | 1261 | 1319 | 2643 | 967 | 3055 | 773 | 3310 | 607 | 3611 | 315 | 3444 | -110 | 3535 |
| 10-#10 | 4.99 | 1246 | 1272 | 2594 | 936 | 2999 | 743 | 3238 | 588 | 3532 | 311 | 3355 | -72 | 3405 |
| 10-#11 | 6.13 | 1286 | 1373 | 2786 | 988 | 3218 | 777 | 3490 | 606 | 3831 | 288 | 3632 | -163 | 3737 |
| 11-#10 | 5.49 | 1278 | 1316 | 2632 | 982 | 3085 | 789 | 3352 | 621 | 3689 | 331 | 3587 | -87 | 3653 |
| 11-#11 | 6.74 | 1324 | 1428 | 2845 | 1042 | 3321 | 830 | 3624 | 643 | 4028 | 312 | 3894 | -183 | 3997 |
| 12-#10 | 5.99 | 1307 | 1361 | 2697 | 1019 | 3182 | 813 | 3490 | 644 | 3853 | 333 | 3800 | -110 | 3865 |

## ROUND SPIRAL COLUMNS 20" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 1.15 | 1442 | 1147 | 2645 | 866 | 2952 | 705 | 3039 | 584 | 2770 | 369 | 2545 | 174 | 1499 |
| 6-#8 | 1.51 | 1465 | 1187 | 2753 | 887 | 3082 | 720 | 3193 | 593 | 2954 | 364 | 2740 | 145 | 1912 |
| 6-#9 | 1.91 | 1491 | 1231 | 2870 | 910 | 3223 | 736 | 3361 | 604 | 3378 | 384 | 2949 | 111 | 2353 |
| 6-#10 | 2.43 | 1526 | 1288 | 3017 | 940 | 3402 | 757 | 3574 | 617 | 3646 | 376 | 3211 | 68 | 2899 |
| 6-#11 | 2.98 | 1550 | 1349 | 3172 | 966 | 3576 | 773 | 3774 | 626 | 3614 | 335 | 3409 | 9 | 3379 |
| 6-#14 | 4.30 | 1624 | 1494 | 3524 | 1044 | 4007 | 827 | 4279 | 659 | 4499 | 333 | 3998 | -113 | 4074 |
| 6-#18 | 7.64 | 1808 | 1861 | 4364 | 1244 | 5044 | 964 | 5438 | 732 | 5965 | 257 | 5333 | -445 | 5536 |
| 7-#7 | 1.34 | 1473 | 1168 | 2542 | 934 | 2948 | 766 | 3096 | 634 | 3085 | 431 | 2790 | 195 | 1730 |
| 7-#8 | 1.76 | 1505 | 1215 | 2661 | 962 | 3090 | 786 | 3263 | 647 | 3299 | 428 | 3028 | 166 | 2170 |
| 7-#9 | 2.23 | 1539 | 1266 | 2790 | 992 | 3243 | 808 | 3442 | 662 | 3297 | 396 | 3284 | 133 | 2636 |
| 7-#10 | 2.83 | 1582 | 1333 | 2952 | 1032 | 3438 | 837 | 3669 | 680 | 3828 | 420 | 3604 | 90 | 3212 |
| 7-#11 | 3.48 | 1617 | 1404 | 3125 | 1067 | 3629 | 861 | 3876 | 692 | 3818 | 380 | 3849 | 31 | 3727 |
| 7-#14 | 5.01 | 1722 | 1573 | 3508 | 1168 | 4095 | 934 | 4415 | 737 | 4794 | 392 | 4573 | -90 | 4652 |
| 8-#7 | 1.53 | 1477 | 1189 | 2557 | 960 | 3004 | 788 | 3170 | 653 | 2977 | 412 | 2922 | 187 | 1922 |
| 8-#8 | 2.01 | 1510 | 1243 | 2693 | 992 | 3168 | 813 | 3357 | 670 | 3432 | 439 | 3193 | 153 | 2437 |
| 8-#9 | 2.55 | 1546 | 1301 | 2839 | 1028 | 3346 | 840 | 3560 | 688 | 3695 | 437 | 3483 | 115 | 2986 |
| 8-#10 | 3.23 | 1591 | 1377 | 3023 | 1074 | 3567 | 874 | 3817 | 711 | 3759 | 405 | 3848 | 66 | 3641 |
| 8-#11 | 3.97 | 1627 | 1458 | 3221 | 1117 | 3776 | 902 | 4051 | 727 | 4036 | 393 | 4129 | -2 | 4131 |
| 8-#14 | 5.73 | 1741 | 1651 | 3661 | 1236 | 4298 | 987 | 4659 | 783 | 4774 | 380 | 5057 | -122 | 5036 |
| 9-#10 | 3.64 | 1639 | 1421 | 3159 | 1093 | 3690 | 887 | 3976 | 714 | 4250 | 424 | 4115 | 45 | 3934 |
| 9-#11 | 4.47 | 1683 | 1513 | 3378 | 1141 | 3928 | 920 | 4248 | 733 | 4587 | 409 | 4442 | -27 | 4468 |
| 9-#14 | 6.45 | 1824 | 1730 | 3868 | 1273 | 4515 | 1016 | 4944 | 795 | 5486 | 391 | 5389 | -179 | 5468 |
| 10-#10 | 4.04 | 1661 | 1466 | 3325 | 1107 | 3861 | 887 | 4156 | 711 | 4483 | 406 | 4306 | 6 | 4285 |
| 10-#11 | 4.97 | 1717 | 1567 | 3558 | 1160 | 4125 | 922 | 4460 | 731 | 4879 | 391 | 4667 | -77 | 4724 |
| 10-#14 | 7.16 | 1861 | 1809 | 4101 | 1305 | 4786 | 1025 | 5243 | 795 | 5895 | 366 | 5711 | -251 | 5848 |
| 11-#10 | 4.45 | 1701 | 1510 | 3352 | 1156 | 3949 | 936 | 4291 | 748 | 4683 | 431 | 4590 | -7 | 4596 |
| 11-#11 | 5.46 | 1762 | 1622 | 3608 | 1216 | 4241 | 979 | 4619 | 772 | 5097 | 416 | 4991 | -95 | 5068 |
| 12-#10 | 4.85 | 1735 | 1555 | 3425 | 1195 | 4062 | 961 | 4441 | 771 | 4553 | 406 | 4846 | -26 | 4864 |
| 12-#11 | 5.96 | 1802 | 1677 | 3697 | 1263 | 4375 | 1008 | 4805 | 800 | 4970 | 390 | 5289 | -122 | 5364 |
| 13-#10 | 5.26 | 1767 | 1599 | 3553 | 1219 | 4206 | 983 | 4605 | 780 | 5095 | 432 | 5093 | -54 | 5109 |
| 14-#10 | 5.66 | 1812 | 1644 | 3684 | 1239 | 4369 | 992 | 4793 | 787 | 5309 | 415 | 5274 | -91 | 5330 |

## ROUND SPIRAL COLUMNS 22" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.25 | 1935 | 1402 | 3544 | 1065 | 3985 | 868 | 4125 | 718 | 3805 | 453 | 3532 | 210 | 2165 |
| 6-#9 | 1.58 | 1965 | 1446 | 3678 | 1088 | 4146 | 884 | 4316 | 729 | 4323 | 480 | 3779 | 179 | 2672 |
| 6-#10 | 2.00 | 2003 | 1503 | 3847 | 1118 | 4350 | 905 | 4559 | 742 | 4636 | 474 | 4090 | 137 | 3300 |
| 6-#11 | 2.46 | 2039 | 1563 | 4028 | 1144 | 4552 | 921 | 4790 | 751 | 4579 | 428 | 4336 | 83 | 3924 |
| 6-#14 | 3.55 | 2127 | 1708 | 4433 | 1222 | 5047 | 975 | 5381 | 786 | 5644 | 436 | 5049 | -31 | 5073 |
| 6-#18 | 6.31 | 2344 | 2076 | 5407 | 1423 | 6246 | 1113 | 6800 | 873 | 7392 | 372 | 6695 | -340 | 6856 |
| 7-#7 | 1.10 | 1943 | 1383 | 3266 | 1124 | 3817 | 924 | 4014 | 768 | 3987 | 532 | 3605 | 264 | 1973 |
| 7-#8 | 1.45 | 1981 | 1429 | 3402 | 1151 | 3979 | 944 | 4204 | 781 | 3950 | 494 | 3885 | 236 | 2489 |
| 7-#9 | 1.84 | 2022 | 1481 | 3550 | 1182 | 4154 | 966 | 4411 | 796 | 4499 | 527 | 4187 | 206 | 3026 |
| 7-#10 | 2.34 | 2072 | 1547 | 3736 | 1222 | 4377 | 996 | 4674 | 816 | 4839 | 523 | 4566 | 165 | 3694 |
| 7-#11 | 2.87 | 2115 | 1618 | 3940 | 1256 | 4600 | 1019 | 4921 | 829 | 5147 | 512 | 4871 | 110 | 4346 |
| 7-#14 | 4.14 | 2233 | 1787 | 4382 | 1358 | 5137 | 1094 | 5547 | 876 | 5566 | 466 | 5745 | -2 | 5747 |
| 7-#18 | 7.37 | 2528 | 2216 | 5442 | 1619 | 6433 | 1282 | 7050 | 993 | 7928 | 461 | 7762 | -309 | 7966 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 22" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#7 | 1.26 | 1948 | 1404 | 3271 | 1152 | 3875 | 949 | 4101 | 790 | 4109 | 544 | 3763 | 257 | 2185 |
| 8-#8 | 1.66 | 1988 | 1457 | 3426 | 1184 | 4060 | 973 | 4316 | 807 | 4094 | 507 | 4081 | 226 | 2776 |
| 8-#9 | 2.10 | 2031 | 1516 | 3593 | 1220 | 4263 | 1000 | 4550 | 826 | 4376 | 505 | 4424 | 191 | 3407 |
| 8-#10 | 2.67 | 2084 | 1591 | 3803 | 1266 | 4520 | 1035 | 4846 | 850 | 5071 | 539 | 4855 | 144 | 4192 |
| 8-#11 | 3.28 | 2127 | 1673 | 4036 | 1308 | 4778 | 1065 | 5122 | 867 | 5419 | 528 | 5204 | 81 | 4926 |
| 8-#14 | 4.74 | 2252 | 1866 | 4541 | 1428 | 5386 | 1153 | 5829 | 926 | 6339 | 519 | 6197 | -50 | 6229 |
| 9-#10 | 3.01 | 2141 | 1636 | 3966 | 1285 | 4666 | 1048 | 5020 | 851 | 4972 | 495 | 5167 | 124 | 4568 |
| 9-#11 | 3.69 | 2194 | 1727 | 4222 | 1332 | 4944 | 1081 | 5337 | 871 | 5723 | 517 | 5572 | 56 | 5324 |
| 9-#14 | 5.33 | 2349 | 1945 | 4792 | 1465 | 5623 | 1180 | 6141 | 935 | 6769 | 504 | 6714 | -85 | 6738 |
| 10-#10 | 3.34 | 2164 | 1680 | 4174 | 1297 | 4868 | 1046 | 5228 | 846 | 5578 | 509 | 5385 | 86 | 5038 |
| 10-#11 | 4.10 | 2223 | 1782 | 4449 | 1349 | 5178 | 1081 | 5583 | 867 | 5636 | 462 | 5834 | 9 | 5801 |
| 10-#14 | 5.92 | 2400 | 2023 | 5080 | 1497 | 5942 | 1186 | 6488 | 934 | 6755 | 446 | 7094 | -153 | 7184 |
| 11-#10 | 3.68 | 2208 | 1725 | 4186 | 1349 | 4956 | 1097 | 5382 | 887 | 5413 | 497 | 5725 | 75 | 5384 |
| 11-#11 | 4.51 | 2279 | 1836 | 4485 | 1409 | 5296 | 1141 | 5766 | 912 | 6311 | 526 | 6222 | -7 | 6229 |
| 11-#14 | 6.51 | 2479 | 2102 | 5166 | 1575 | 6126 | 1265 | 6744 | 992 | 7599 | 515 | 7616 | -180 | 7712 |
| 12-#10 | 4.01 | 2251 | 1769 | 4266 | 1390 | 5083 | 1124 | 5544 | 910 | 6052 | 545 | 6025 | 59 | 5786 |
| 12-#11 | 4.92 | 2324 | 1891 | 4585 | 1457 | 5449 | 1172 | 5968 | 941 | 6581 | 531 | 6573 | -30 | 6594 |
| 13-#10 | 4.34 | 2284 | 1814 | 4410 | 1412 | 5251 | 1146 | 5735 | 919 | 6286 | 540 | 6282 | 25 | 6174 |
| 13-#11 | 5.33 | 2369 | 1946 | 4757 | 1486 | 5647 | 1199 | 6193 | 951 | 6873 | 527 | 6912 | -64 | 6928 |
| 14-#10 | 4.68 | 2330 | 1858 | 4567 | 1430 | 5434 | 1152 | 5956 | 926 | 6532 | 524 | 6525 | -4 | 6528 |
| 14-#11 | 5.75 | 2419 | 2000 | 4937 | 1511 | 5867 | 1210 | 6453 | 960 | 7166 | 507 | 7161 | -109 | 7230 |
| 15-#10 | 5.01 | 2363 | 1903 | 4658 | 1470 | 5544 | 1194 | 6094 | 952 | 6316 | 507 | 6868 | -19 | 6881 |
| 16-#10 | 5.35 | 2418 | 1947 | 4760 | 1501 | 5692 | 1220 | 6266 | 975 | 6987 | 545 | 7132 | -41 | 7156 |

## ROUND SPIRAL COLUMNS 24" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.05 | 2495 | 1637 | 4472 | 1261 | 5050 | 1031 | 5225 | 856 | 4799 | 550 | 4458 | 280 | 2419 |
| 6-#9 | 1.33 | 2530 | 1681 | 4624 | 1284 | 5231 | 1047 | 5439 | 866 | 5427 | 585 | 4743 | 250 | 2990 |
| 6-#10 | 1.68 | 2575 | 1738 | 4815 | 1314 | 5461 | 1068 | 5712 | 880 | 5784 | 579 | 5103 | 211 | 3702 |
| 6-#11 | 2.07 | 2611 | 1798 | 5024 | 1339 | 5692 | 1083 | 5975 | 888 | 6100 | 565 | 5398 | 159 | 4415 |
| 6-#14 | 2.98 | 2723 | 1943 | 5483 | 1418 | 6251 | 1138 | 6642 | 924 | 6950 | 546 | 6237 | 52 | 6040 |
| 6-#18 | 5.31 | 2974 | 2311 | 6592 | 1619 | 7613 | 1277 | 8272 | 1015 | 8383 | 459 | 8197 | -238 | 8318 |
| 7-#8 | 1.22 | 2547 | 1664 | 4267 | 1360 | 5024 | 1118 | 5312 | 929 | 5328 | 641 | 4884 | 312 | 2816 |
| 7-#9 | 1.55 | 2595 | 1716 | 4435 | 1391 | 5222 | 1141 | 5544 | 944 | 5629 | 639 | 5232 | 283 | 3426 |
| 7-#10 | 1.97 | 2654 | 1782 | 4645 | 1430 | 5473 | 1170 | 5840 | 964 | 6013 | 636 | 5671 | 245 | 4184 |
| 7-#11 | 2.41 | 2704 | 1853 | 4881 | 1464 | 5729 | 1193 | 6128 | 977 | 6367 | 625 | 6036 | 193 | 4936 |
| 7-#14 | 3.48 | 2841 | 2022 | 5384 | 1567 | 6337 | 1268 | 6848 | 1028 | 6810 | 574 | 7061 | 87 | 6652 |
| 7-#18 | 6.19 | 3183 | 2451 | 6593 | 1829 | 7812 | 1460 | 8573 | 1150 | 8910 | 546 | 9460 | -200 | 9603 |
| 8-#8 | 1.40 | 2557 | 1692 | 4280 | 1395 | 5108 | 1150 | 5443 | 952 | 5505 | 656 | 5102 | 303 | 3118 |
| 8-#9 | 1.77 | 2606 | 1751 | 4468 | 1431 | 5335 | 1176 | 5708 | 969 | 5845 | 656 | 5500 | 270 | 3831 |
| 8-#10 | 2.25 | 2668 | 1826 | 4706 | 1477 | 5624 | 1212 | 6043 | 1002 | 6278 | 654 | 6006 | 226 | 4722 |
| 8-#11 | 2.76 | 2720 | 1908 | 4973 | 1519 | 5921 | 1241 | 6361 | 1019 | 6679 | 644 | 6423 | 167 | 5609 |
| 8-#14 | 3.98 | 2865 | 2101 | 5545 | 1639 | 6623 | 1332 | 7169 | 1080 | 7211 | 596 | 7588 | 45 | 7409 |
| 8-#18 | 7.07 | 3239 | 2591 | 6928 | 1946 | 8299 | 1558 | 9115 | 1231 | 9575 | 574 | 10315 | -287 | 10425 |
| 9-#10 | 2.53 | 2730 | 1871 | 4896 | 1494 | 5798 | 1224 | 6231 | 1001 | 6560 | 644 | 6326 | 201 | 5184 |
| 9-#11 | 3.10 | 2798 | 1962 | 5191 | 1541 | 6118 | 1258 | 6594 | 1021 | 6556 | 591 | 6845 | 143 | 6107 |
| 9-#14 | 4.48 | 2976 | 2180 | 5836 | 1675 | 6889 | 1358 | 7506 | 1087 | 8217 | 624 | 8186 | 11 | 8136 |
| 9-#18 | 7.96 | 3441 | 2731 | 7396 | 2016 | 8755 | 1610 | 9722 | 1251 | 11098 | 590 | 11323 | -348 | 11342 |

## ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.81 | 2759 | 1915 | 5146 | 1503 | 6033 | 1219 | 6468 | 993 | 6834 | 621 | 6606 | 169 | 5713 |
| 10-#11 | 3.45 | 2828 | 2017 | 5469 | 1557 | 6390 | 1255 | 6875 | 1015 | 7361 | 608 | 7142 | 96 | 6720 |
| 10-#14 | 4.97 | 3018 | 2258 | 6189 | 1706 | 7259 | 1362 | 7903 | 1085 | 8720 | 594 | 8621 | -55 | 8657 |
| 11-#10 | 3.09 | 2810 | 1960 | 5142 | 1560 | 6118 | 1274 | 6637 | 1038 | 7090 | 648 | 7003 | 160 | 6151 |
| 11-#11 | 3.79 | 2888 | 2071 | 5487 | 1621 | 6508 | 1318 | 7082 | 1064 | 7659 | 637 | 7598 | 83 | 7190 |
| 11-#14 | 5.47 | 3112 | 2337 | 6259 | 1787 | 7447 | 1443 | 8194 | 1147 | 9146 | 636 | 9234 | -79 | 9292 |
| 12-#10 | 3.37 | 2859 | 2004 | 5228 | 1602 | 6260 | 1303 | 6816 | 1062 | 7373 | 661 | 7349 | 146 | 6675 |
| 12-#11 | 4.14 | 2945 | 2126 | 5596 | 1670 | 6679 | 1351 | 7299 | 1093 | 8001 | 652 | 8003 | 63 | 7724 |
| 12-#14 | 5.97 | 3182 | 2416 | 6423 | 1855 | 7694 | 1488 | 8509 | 1187 | 8948 | 602 | 9794 | -111 | 9851 |
| 13-#10 | 3.65 | 2897 | 2049 | 5389 | 1624 | 6452 | 1324 | 7032 | 1071 | 7642 | 657 | 7644 | 113 | 7078 |
| 13-#11 | 4.48 | 2990 | 2181 | 5788 | 1698 | 6906 | 1378 | 7556 | 1104 | 7760 | 603 | 8350 | 22 | 8241 |
| 13-#14 | 6.47 | 3258 | 2495 | 6692 | 1897 | 8010 | 1528 | 8870 | 1204 | 10046 | 639 | 10282 | -169 | 10351 |
| 14-#10 | 3.93 | 2949 | 2093 | 5576 | 1641 | 6656 | 1329 | 7275 | 1076 | 7918 | 640 | 7920 | 85 | 7526 |
| 14-#11 | 4.83 | 3052 | 2235 | 6000 | 1721 | 7151 | 1386 | 7853 | 1113 | 8646 | 626 | 8681 | -13 | 8690 |
| 15-#10 | 4.21 | 2986 | 2138 | 5665 | 1682 | 6777 | 1372 | 7439 | 1106 | 7633 | 617 | 8316 | 72 | 7957 |
| 15-#11 | 5.17 | 3096 | 2290 | 6122 | 1769 | 7300 | 1436 | 8040 | 1145 | 8364 | 606 | 9141 | -32 | 9165 |
| 16-#10 | 4.49 | 3041 | 2182 | 5777 | 1715 | 6937 | 1399 | 7633 | 1129 | 8423 | 663 | 8621 | 52 | 8381 |
| 16-#11 | 5.52 | 3171 | 2344 | 6260 | 1808 | 7498 | 1469 | 8272 | 1173 | 9256 | 651 | 9498 | -58 | 9532 |
| 17-#10 | 4.77 | 3076 | 2226 | 5918 | 1745 | 7111 | 1421 | 7834 | 1138 | 8130 | 619 | 8953 | 24 | 8834 |
| 18-#10 | 5.05 | 3126 | 2271 | 6102 | 1763 | 7314 | 1432 | 8056 | 1146 | 9002 | 653 | 9215 | -5 | 9218 |

## ROUND SPIRAL COLUMNS 26" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#9 | 1.13 | 3194 | 1936 | 5720 | 1498 | 6494 | 1224 | 6746 | 1016 | 6241 | 650 | 5853 | 327 | 3308 |
| 6-#10 | 1.44 | 3245 | 1993 | 5933 | 1528 | 6749 | 1245 | 7048 | 1029 | 7090 | 692 | 6263 | 290 | 4104 |
| 6-#11 | 1.76 | 3288 | 2054 | 6171 | 1553 | 7009 | 1260 | 7344 | 1038 | 7467 | 680 | 6607 | 240 | 4907 |
| 6-#14 | 2.54 | 3406 | 2199 | 6685 | 1631 | 7633 | 1315 | 8086 | 1073 | 7868 | 620 | 7572 | 138 | 6785 |
| 6-#18 | 4.52 | 3706 | 2566 | 7929 | 1833 | 9157 | 1455 | 9909 | 1166 | 10031 | 576 | 9850 | -137 | 9927 |
| 7-#9 | 1.32 | 3265 | 1971 | 5455 | 1618 | 6461 | 1331 | 6861 | 1105 | 6937 | 760 | 6430 | 365 | 3835 |
| 7-#10 | 1.67 | 3334 | 2037 | 5690 | 1658 | 6740 | 1360 | 7189 | 1125 | 6873 | 707 | 6930 | 329 | 4684 |
| 7-#11 | 2.06 | 3393 | 2108 | 5958 | 1691 | 7029 | 1383 | 7513 | 1138 | 7764 | 747 | 7355 | 279 | 5534 |
| 7-#14 | 2.97 | 3550 | 2277 | 6522 | 1794 | 7709 | 1458 | 8318 | 1189 | 8806 | 740 | 8532 | 179 | 7522 |
| 7-#18 | 5.27 | 3923 | 2706 | 7882 | 2058 | 9363 | 1652 | 10280 | 1318 | 10588 | 668 | 11317 | -91 | 11389 |
| 8-#9 | 1.51 | 3280 | 2006 | 5475 | 1661 | 6577 | 1369 | 7048 | 1134 | 7181 | 779 | 6718 | 353 | 4261 |
| 8-#10 | 1.91 | 3351 | 2082 | 5740 | 1708 | 6897 | 1404 | 7422 | 1157 | 7153 | 727 | 7287 | 311 | 5257 |
| 8-#11 | 2.35 | 3412 | 2163 | 6043 | 1748 | 7231 | 1433 | 7784 | 1184 | 7575 | 718 | 7798 | 257 | 6257 |
| 8-#14 | 3.39 | 3578 | 2356 | 6682 | 1868 | 8014 | 1524 | 8691 | 1247 | 9292 | 766 | 9136 | 142 | 8503 |
| 8-#18 | 6.03 | 3980 | 2846 | 8231 | 2176 | 9928 | 1757 | 10891 | 1404 | 12151 | 751 | 12299 | -171 | 12369 |
| 9-#10 | 2.15 | 3422 | 2126 | 5960 | 1723 | 7100 | 1416 | 7625 | 1159 | 7965 | 767 | 7667 | 287 | 5815 |
| 9-#11 | 2.64 | 3496 | 2218 | 6294 | 1770 | 7463 | 1450 | 8034 | 1184 | 8491 | 757 | 8228 | 225 | 6858 |
| 9-#14 | 3.81 | 3705 | 2435 | 7016 | 1904 | 8326 | 1551 | 9055 | 1251 | 9842 | 752 | 9815 | 108 | 9253 |
| 9-#18 | 6.78 | 4231 | 2986 | 8765 | 2246 | 10425 | 1807 | 11543 | 1421 | 12226 | 679 | 13454 | -230 | 13479 |
| 10-#10 | 2.39 | 3454 | 2171 | 6254 | 1728 | 7371 | 1408 | 7892 | 1153 | 7716 | 692 | 7980 | 256 | 6377 |
| 10-#11 | 2.94 | 3534 | 2272 | 6623 | 1782 | 7775 | 1444 | 8351 | 1175 | 8269 | 681 | 8605 | 187 | 7568 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 4.24 | 3749 | 2514 | 7438 | 1932 | 8750 | 1552 | 9502 | 1247 | 9687 | 670 | 10303 | 44 | 10101 |
| 10-#18 | 7.53 | 4308 | 3126 | 9388 | 2312 | 11116 | 1825 | 12305 | 1426 | 13151 | 637 | 14316 | -342 | 14241 |
| 11-#10 | 2.63 | 3512 | 2215 | 6232 | 1790 | 7451 | 1467 | 8072 | 1196 | 7988 | 721 | 8426 | 249 | 6904 |
| 11-#11 | 3.23 | 3602 | 2327 | 6623 | 1850 | 7890 | 1511 | 8576 | 1229 | 8586 | 711 | 9131 | 176 | 8139 |
| 11-#14 | 4.66 | 3857 | 2592 | 7488 | 2018 | 8940 | 1637 | 9827 | 1314 | 10838 | 756 | 11010 | 23 | 10891 |
| 12-#10 | 2.87 | 3560 | 2260 | 6322 | 1834 | 7606 | 1497 | 8269 | 1218 | 8275 | 734 | 8803 | 235 | 7466 |
| 12-#11 | 3.53 | 3667 | 2381 | 6739 | 1902 | 8079 | 1545 | 8813 | 1259 | 8937 | 726 | 9591 | 159 | 8805 |
| 12-#14 | 5.09 | 3934 | 2671 | 7667 | 2088 | 9213 | 1684 | 10164 | 1354 | 11377 | 778 | 11648 | -5 | 11651 |
| 13-#10 | 3.11 | 3609 | 2304 | 6502 | 1854 | 7819 | 1518 | 8511 | 1231 | 9176 | 783 | 9147 | 204 | 7967 |
| 13-#11 | 3.82 | 3717 | 2436 | 6953 | 1928 | 8336 | 1572 | 9101 | 1270 | 9934 | 774 | 9986 | 119 | 9351 |
| 13-#14 | 5.51 | 4020 | 2750 | 7963 | 2129 | 9571 | 1724 | 10570 | 1372 | 11875 | 770 | 12205 | -63 | 12246 |
| 14-#10 | 3.35 | 3668 | 2348 | 6720 | 1869 | 8049 | 1520 | 8777 | 1238 | 8850 | 715 | 9472 | 178 | 8531 |
| 14-#11 | 4.11 | 3787 | 2491 | 7199 | 1950 | 8606 | 1578 | 9425 | 1276 | 10304 | 753 | 10357 | 85 | 9937 |
| 14-#14 | 5.93 | 4104 | 2829 | 8286 | 2165 | 9950 | 1738 | 11036 | 1386 | 12405 | 744 | 12738 | -112 | 12793 |
| 15-#10 | 3.59 | 3707 | 2393 | 6804 | 1913 | 8179 | 1566 | 8959 | 1266 | 9764 | 787 | 9904 | 164 | 9001 |
| 15-#11 | 4.41 | 3837 | 2545 | 7320 | 2000 | 8768 | 1631 | 9644 | 1312 | 9938 | 726 | 10883 | 68 | 10519 |
| 16-#10 | 3.83 | 3771 | 2437 | 6926 | 1946 | 8351 | 1593 | 9183 | 1287 | 9369 | 738 | 10241 | 145 | 9508 |
| 16-#11 | 4.70 | 3910 | 2600 | 7471 | 2040 | 8982 | 1663 | 9904 | 1341 | 10243 | 729 | 11288 | 43 | 11074 |
| 17-#10 | 4.07 | 3806 | 2482 | 7086 | 1977 | 8556 | 1610 | 9400 | 1300 | 10359 | 791 | 10622 | 118 | 9980 |
| 17-#11 | 5.00 | 3958 | 2654 | 7658 | 2077 | 9213 | 1691 | 10171 | 1352 | 11359 | 781 | 11733 | 9 | 11683 |
| 18-#10 | 4.31 | 3867 | 2526 | 7293 | 1993 | 8782 | 1627 | 9649 | 1302 | 10672 | 779 | 10926 | 91 | 10482 |
| 18-#11 | 5.29 | 4025 | 2709 | 7902 | 2099 | 9484 | 1705 | 10467 | 1362 | 11747 | 768 | 12083 | -26 | 12099 |
| 19-#10 | 4.54 | 3898 | 2571 | 7366 | 2039 | 8920 | 1659 | 9848 | 1334 | 10957 | 795 | 11338 | 74 | 10960 |
| 20-#10 | 4.78 | 3949 | 2615 | 7505 | 2072 | 9085 | 1689 | 10056 | 1351 | 10498 | 746 | 11754 | 66 | 11425 |

## ROUND SPIRAL COLUMNS 28" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 1.24 | 4021 | 2269 | 7214 | 1760 | 8229 | 1437 | 8584 | 1192 | 8576 | 813 | 7581 | 373 | 4506 |
| 6-#11 | 1.52 | 4071 | 2330 | 7481 | 1784 | 8518 | 1452 | 8911 | 1199 | 9002 | 802 | 7975 | 325 | 5401 |
| 6-#14 | 2.19 | 4205 | 2474 | 8050 | 1862 | 9207 | 1506 | 9730 | 1235 | 9425 | 737 | 9066 | 227 | 7488 |
| 6-#18 | 3.90 | 4548 | 2842 | 9430 | 2064 | 10895 | 1647 | 11746 | 1329 | 11855 | 699 | 11664 | -35 | 11686 |
| 7-#9 | 1.14 | 4043 | 2247 | 6620 | 1865 | 7884 | 1536 | 8375 | 1275 | 7874 | 832 | 7778 | 451 | 4236 |
| 7-#10 | 1.44 | 4119 | 2313 | 6880 | 1904 | 8192 | 1566 | 8737 | 1294 | 8909 | 889 | 8341 | 417 | 5196 |
| 7-#11 | 1.77 | 4189 | 2384 | 7183 | 1937 | 8515 | 1588 | 9096 | 1312 | 8730 | 821 | 8842 | 371 | 6144 |
| 7-#14 | 2.56 | 4366 | 2553 | 7809 | 2040 | 9266 | 1664 | 9985 | 1363 | 10509 | 873 | 10172 | 275 | 8359 |
| 7-#18 | 4.55 | 4788 | 2982 | 9321 | 2304 | 11101 | 1859 | 12166 | 1495 | 13334 | 854 | 13345 | 19 | 13246 |
| 8-#9 | 1.30 | 4061 | 2282 | 6623 | 1911 | 8001 | 1577 | 8581 | 1311 | 8710 | 913 | 8105 | 441 | 4695 |
| 8-#10 | 1.65 | 4142 | 2358 | 6916 | 1957 | 8353 | 1612 | 8999 | 1335 | 9243 | 913 | 8736 | 401 | 5796 |
| 8-#11 | 2.03 | 4212 | 2439 | 7255 | 1997 | 8725 | 1641 | 9404 | 1350 | 9748 | 904 | 9310 | 348 | 6911 |
| 8-#14 | 2.92 | 4399 | 2632 | 7963 | 2117 | 9588 | 1732 | 10412 | 1410 | 11052 | 903 | 10838 | 240 | 9531 |
| 8-#18 | 5.20 | 4851 | 3122 | 9679 | 2425 | 11704 | 1966 | 12866 | 1588 | 14237 | 894 | 14456 | -54 | 14481 |
| 9-#10 | 1.86 | 4220 | 2402 | 7169 | 1971 | 8584 | 1624 | 9218 | 1335 | 8926 | 839 | 9157 | 377 | 6460 |
| 9-#11 | 2.28 | 4305 | 2493 | 7543 | 2017 | 8992 | 1657 | 9673 | 1354 | 9471 | 830 | 9815 | 319 | 7627 |
| 9-#14 | 3.29 | 4534 | 2711 | 8342 | 2151 | 9949 | 1759 | 10801 | 1429 | 10863 | 827 | 11539 | 198 | 10374 |
| 9-#18 | 5.85 | 5104 | 3262 | 10282 | 2495 | 12281 | 2018 | 13563 | 1602 | 15294 | 872 | 15758 | -112 | 15713 |
| 10-#10 | 2.06 | 4256 | 2446 | 7512 | 1971 | 8896 | 1612 | 9514 | 1327 | 9892 | 872 | 9521 | 347 | 7051 |
| 10-#11 | 2.53 | 4347 | 2548 | 7924 | 2024 | 9347 | 1648 | 10025 | 1348 | 10550 | 860 | 10234 | 281 | 8379 |

## ROUND SPIRAL COLUMNS 28" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#14 | 3.65 | 4589 | 2789 | 8825 | 2175 | 10428 | 1757 | 11299 | 1422 | 12230 | 850 | 12154 | 146 | 11413 |
| 10-#18 | 6.50 | 5216 | 3402 | 11012 | 2560 | 13060 | 2034 | 14414 | 1605 | 16349 | 821 | 16725 | -220 | 16803 |
| 11-#10 | 2.27 | 4321 | 2491 | 7463 | 2039 | 8967 | 1675 | 9703 | 1373 | 10221 | 906 | 10004 | 340 | 7682 |
| 11-#11 | 2.79 | 4425 | 2603 | 7903 | 2099 | 9456 | 1719 | 10263 | 1399 | 10932 | 897 | 10818 | 272 | 9057 |
| 11-#14 | 4.02 | 4701 | 2868 | 8862 | 2267 | 10617 | 1846 | 11645 | 1492 | 11897 | 834 | 12957 | 128 | 12228 |
| 11-#18 | 7.15 | 5397 | 3542 | 11188 | 2694 | 13454 | 2169 | 15029 | 1711 | 17189 | 878 | 18013 | -265 | 18078 |
| 12-#10 | 2.48 | 4374 | 2535 | 7558 | 2085 | 9135 | 1707 | 9921 | 1396 | 10551 | 920 | 10427 | 329 | 8268 |
| 12-#11 | 3.04 | 4488 | 2657 | 8025 | 2152 | 9662 | 1755 | 10525 | 1425 | 11337 | 913 | 11316 | 255 | 9809 |
| 12-#14 | 4.38 | 4797 | 2947 | 9053 | 2340 | 10917 | 1895 | 12017 | 1517 | 13326 | 915 | 13657 | 101 | 13148 |
| 13-#10 | 2.68 | 4427 | 2580 | 7758 | 2104 | 9367 | 1726 | 10189 | 1409 | 10883 | 913 | 10809 | 297 | 8860 |
| 13-#11 | 3.29 | 4553 | 2712 | 8262 | 2177 | 9943 | 1781 | 10845 | 1442 | 10964 | 849 | 11771 | 217 | 10454 |
| 13-#14 | 4.75 | 4881 | 3026 | 9379 | 2379 | 11314 | 1935 | 12469 | 1552 | 13898 | 910 | 14300 | 45 | 14042 |
| 14-#10 | 2.89 | 4495 | 2624 | 8009 | 2117 | 9626 | 1727 | 10477 | 1404 | 11240 | 900 | 11160 | 271 | 9456 |
| 14-#11 | 3.55 | 4630 | 2766 | 8545 | 2197 | 10246 | 1785 | 11196 | 1452 | 11344 | 830 | 12202 | 185 | 11183 |
| 14-#14 | 5.12 | 4985 | 3104 | 9748 | 2414 | 11730 | 1946 | 12973 | 1563 | 14485 | 883 | 14894 | -1 | 14895 |
| 15-#10 | 3.09 | 4538 | 2669 | 8086 | 2163 | 9764 | 1776 | 10676 | 1444 | 11543 | 923 | 11653 | 260 | 10016 |
| 15-#11 | 3.80 | 4681 | 2821 | 8662 | 2250 | 10420 | 1841 | 11436 | 1485 | 11690 | 854 | 12772 | 168 | 11786 |
| 15-#14 | 5.48 | 5068 | 3183 | 9954 | 2482 | 11990 | 2019 | 13315 | 1613 | 15010 | 916 | 15707 | -27 | 15714 |
| 16-#10 | 3.30 | 4610 | 2713 | 8217 | 2197 | 9948 | 1803 | 10930 | 1467 | 11847 | 927 | 12031 | 243 | 10621 |
| 16-#11 | 4.05 | 4766 | 2876 | 8824 | 2290 | 10648 | 1874 | 11733 | 1510 | 12888 | 919 | 13217 | 145 | 12441 |
| 16-#14 | 5.85 | 5196 | 3262 | 10195 | 2538 | 12324 | 2065 | 13726 | 1638 | 15520 | 920 | 16327 | -63 | 16335 |
| 17-#10 | 3.51 | 4649 | 2758 | 8396 | 2227 | 10175 | 1820 | 11163 | 1479 | 12201 | 928 | 12453 | 216 | 11157 |
| 17-#11 | 4.31 | 4814 | 2930 | 9035 | 2328 | 10918 | 1895 | 12020 | 1526 | 13313 | 920 | 13721 | 112 | 13077 |
| 18-#10 | 3.71 | 4708 | 2802 | 8629 | 2242 | 10428 | 1836 | 11439 | 1480 | 11700 | 853 | 12766 | 187 | 11753 |
| 18-#11 | 4.56 | 4896 | 2985 | 9306 | 2348 | 11216 | 1915 | 12349 | 1529 | 12812 | 844 | 14125 | 79 | 13726 |
| 19-#10 | 3.92 | 4752 | 2846 | 8701 | 2290 | 10577 | 1870 | 11651 | 1513 | 12852 | 932 | 13241 | 173 | 12247 |
| 19-#11 | 4.81 | 4936 | 3039 | 9406 | 2404 | 11400 | 1954 | 12612 | 1568 | 14103 | 925 | 14668 | 57 | 14364 |
| 20-#10 | 4.13 | 4808 | 2891 | 8848 | 2323 | 10757 | 1900 | 11881 | 1531 | 13184 | 938 | 13718 | 167 | 12792 |
| 20-#11 | 5.07 | 5004 | 3094 | 9590 | 2444 | 11618 | 1991 | 12887 | 1589 | 14487 | 929 | 15218 | 47 | 14966 |
| 21-#10 | 4.33 | 4854 | 2935 | 9037 | 2348 | 10976 | 1918 | 12139 | 1548 | 13505 | 937 | 14071 | 136 | 13314 |
| 22-#10 | 4.54 | 4906 | 2980 | 9240 | 2374 | 11202 | 1935 | 12411 | 1552 | 13842 | 926 | 14449 | 113 | 13836 |

## ROUND SPIRAL COLUMNS 30" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#10 | 1.08 | 4912 | 2565 | 8669 | 2010 | 9915 | 1645 | 10335 | 1366 | 9580 | 880 | 9071 | 461 | 4910 |
| 6-#11 | 1.32 | 4969 | 2626 | 8965 | 2032 | 10235 | 1659 | 10694 | 1374 | 10730 | 932 | 9514 | 415 | 5894 |
| 6-#14 | 1.91 | 5120 | 2771 | 9590 | 2110 | 10988 | 1713 | 11589 | 1410 | 11132 | 859 | 10732 | 320 | 8192 |
| 6-#18 | 3.40 | 5482 | 3138 | 11109 | 2312 | 12839 | 1854 | 13797 | 1503 | 14861 | 888 | 13652 | 69 | 13334 |
| 7-#10 | 1.26 | 5020 | 2609 | 8227 | 2170 | 9842 | 1787 | 10497 | 1481 | 9950 | 962 | 9924 | 510 | 5717 |
| 7-#11 | 1.54 | 5098 | 2680 | 8564 | 2202 | 10199 | 1809 | 10893 | 1493 | 10407 | 953 | 10490 | 466 | 6766 |
| 7-#14 | 2.23 | 5299 | 2849 | 9253 | 2305 | 11023 | 1885 | 11865 | 1551 | 12419 | 1016 | 11993 | 376 | 9210 |
| 7-#18 | 3.96 | 5770 | 3278 | 10918 | 2570 | 13038 | 2081 | 14257 | 1684 | 15532 | 1001 | 15555 | 131 | 14801 |
| 8-#10 | 1.44 | 5047 | 2654 | 8243 | 2226 | 10005 | 1837 | 10776 | 1525 | 11031 | 1057 | 10367 | 497 | 6341 |
| 8-#11 | 1.77 | 5127 | 2735 | 8620 | 2265 | 10415 | 1865 | 11237 | 1542 | 11588 | 1049 | 11004 | 446 | 7570 |
| 8-#14 | 2.55 | 5337 | 2928 | 9396 | 2385 | 11359 | 1956 | 12346 | 1602 | 12152 | 979 | 12691 | 341 | 10456 |
| 8-#18 | 4.53 | 5841 | 3418 | 11282 | 2693 | 13678 | 2190 | 15055 | 1785 | 15429 | 975 | 16799 | 64 | 16490 |

## ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 9-#10 | 1.62 | 5133 | 2698 | 8532 | 2238 | 10264 | 1847 | 11023 | 1525 | 10612 | 972 | 10827 | 472 | 7119 |
| 9-#11 | 1.99 | 5230 | 2790 | 8947 | 2283 | 10717 | 1880 | 11524 | 1543 | 12011 | 1032 | 11559 | 416 | 8411 |
| 9-#14 | 2.86 | 5486 | 3007 | 9824 | 2417 | 11770 | 1983 | 12761 | 1610 | 13644 | 1030 | 13491 | 300 | 11444 |
| 9-#18 | 5.09 | 6121 | 3558 | 11956 | 2761 | 14336 | 2244 | 15797 | 1795 | 16489 | 953 | 18107 | -11 | 18115 |
| 10-#10 | 1.80 | 5173 | 2743 | 8930 | 2233 | 10621 | 1831 | 11350 | 1512 | 10942 | 944 | 11239 | 443 | 7733 |
| 10-#11 | 2.21 | 5276 | 2844 | 9386 | 2285 | 11121 | 1867 | 11914 | 1534 | 11617 | 933 | 12042 | 380 | 9201 |
| 10-#14 | 3.18 | 5547 | 3086 | 10373 | 2436 | 12307 | 1977 | 13311 | 1609 | 14287 | 992 | 14184 | 251 | 12658 |
| 10-#18 | 5.66 | 6200 | 3698 | 12781 | 2822 | 15206 | 2257 | 16738 | 1796 | 17561 | 903 | 19316 | -98 | 19355 |
| 11-#10 | 1.98 | 5246 | 2787 | 8847 | 2307 | 10680 | 1899 | 11548 | 1563 | 12091 | 1050 | 11764 | 437 | 8471 |
| 11-#11 | 2.43 | 5363 | 2899 | 9336 | 2366 | 11220 | 1943 | 12163 | 1589 | 12015 | 972 | 12671 | 371 | 9995 |
| 11-#14 | 3.50 | 5671 | 3164 | 10391 | 2535 | 12491 | 2071 | 13676 | 1675 | 14863 | 1040 | 15051 | 232 | 13601 |
| 11-#18 | 6.22 | 6442 | 3838 | 12950 | 2964 | 15608 | 2396 | 17398 | 1906 | 19749 | 1031 | 20764 | -140 | 20810 |
| 12-#10 | 2.16 | 5303 | 2832 | 8946 | 2355 | 10860 | 1933 | 11784 | 1587 | 12445 | 1064 | 12233 | 428 | 9082 |
| 12-#11 | 2.65 | 5432 | 2953 | 9464 | 2422 | 11443 | 1981 | 12449 | 1617 | 13307 | 1057 | 13223 | 357 | 10786 |
| 12-#14 | 3.82 | 5765 | 3243 | 10594 | 2610 | 12817 | 2121 | 14082 | 1710 | 14450 | 991 | 15818 | 208 | 14681 |
| 12-#18 | 6.79 | 6590 | 3978 | 13340 | 3087 | 16185 | 2478 | 18099 | 1976 | 19455 | 995 | 22095 | -188 | 22057 |
| 13-#10 | 2.34 | 5363 | 2876 | 9166 | 2372 | 11113 | 1951 | 12079 | 1600 | 11954 | 987 | 12653 | 396 | 9774 |
| 13-#11 | 2.87 | 5502 | 3008 | 9724 | 2445 | 11747 | 2005 | 12801 | 1633 | 12828 | 979 | 13726 | 318 | 11539 |
| 13-#14 | 4.14 | 5869 | 3322 | 10950 | 2647 | 13248 | 2160 | 14580 | 1736 | 16130 | 1059 | 16534 | 153 | 15605 |
| 13-#18 | 7.36 | 6787 | 4118 | 13939 | 3161 | 16930 | 2552 | 18951 | 2009 | 21918 | 1059 | 23281 | -289 | 23202 |
| 14-#10 | 2.52 | 5439 | 2920 | 9455 | 2383 | 11403 | 1950 | 12390 | 1593 | 12324 | 974 | 13012 | 369 | 10397 |
| 14-#11 | 3.09 | 5590 | 3063 | 10048 | 2463 | 12085 | 2007 | 13179 | 1629 | 13266 | 965 | 14193 | 287 | 12333 |
| 14-#14 | 4.46 | 5984 | 3401 | 11367 | 2680 | 13709 | 2169 | 15123 | 1753 | 16772 | 1031 | 17233 | 111 | 16602 |
| 15-#10 | 2.70 | 5485 | 2965 | 9521 | 2432 | 11546 | 2002 | 12606 | 1636 | 12628 | 996 | 13534 | 354 | 11050 |
| 15-#11 | 3.31 | 5646 | 3117 | 10157 | 2518 | 12269 | 2066 | 13442 | 1677 | 14611 | 1060 | 14834 | 271 | 13046 |
| 15-#14 | 4.77 | 6076 | 3479 | 11573 | 2751 | 13989 | 2246 | 15497 | 1798 | 16178 | 994 | 18093 | 83 | 17593 |
| 16-#10 | 2.87 | 5564 | 3009 | 9659 | 2467 | 11740 | 2029 | 12878 | 1659 | 13864 | 1073 | 14004 | 345 | 11691 |
| 16-#11 | 3.53 | 5740 | 3172 | 10331 | 2560 | 12511 | 2099 | 13775 | 1704 | 15009 | 1066 | 15329 | 250 | 13849 |
| 16-#14 | 5.09 | 6196 | 3558 | 11832 | 2808 | 14345 | 2292 | 15962 | 1834 | 16702 | 999 | 18782 | 50 | 18506 |
| 17-#10 | 3.05 | 5608 | 3054 | 9857 | 2496 | 11991 | 2046 | 13139 | 1671 | 13301 | 1002 | 14444 | 317 | 12309 |
| 17-#11 | 3.75 | 5793 | 3226 | 10564 | 2597 | 12809 | 2121 | 14082 | 1719 | 14443 | 996 | 15886 | 217 | 14511 |
| 17-#14 | 5.41 | 6286 | 3637 | 12153 | 2864 | 14763 | 2324 | 16405 | 1857 | 17320 | 1001 | 19572 | 3 | 19554 |
| 18-#10 | 3.23 | 5673 | 3098 | 10118 | 2509 | 12267 | 2060 | 13442 | 1672 | 13633 | 988 | 14789 | 288 | 12950 |
| 18-#11 | 3.97 | 5871 | 3281 | 10866 | 2615 | 13140 | 2140 | 14444 | 1721 | 15916 | 1051 | 16300 | 183 | 15265 |
| 19-#10 | 3.41 | 5718 | 3143 | 10189 | 2560 | 12430 | 2096 | 13667 | 1706 | 14955 | 1079 | 15314 | 276 | 13537 |
| 19-#11 | 4.19 | 5928 | 3336 | 10966 | 2674 | 13337 | 2181 | 14723 | 1761 | 15242 | 1001 | 16920 | 165 | 15924 |
| 20-#10 | 3.59 | 5784 | 3187 | 10343 | 2593 | 12626 | 2128 | 13918 | 1724 | 15313 | 1084 | 15761 | 259 | 14181 |
| 20-#11 | 4.41 | 6003 | 3390 | 11161 | 2714 | 13575 | 2218 | 15025 | 1782 | 16765 | 1079 | 17543 | 157 | 16621 |
| 21-#10 | 3.77 | 5834 | 3232 | 10552 | 2618 | 12862 | 2145 | 14201 | 1741 | 14626 | 1012 | 16231 | 240 | 14746 |
| 21-#11 | 4.63 | 6068 | 3445 | 11408 | 2746 | 13861 | 2240 | 15364 | 1803 | 17189 | 1078 | 18010 | 119 | 17321 |
| 22-#10 | 3.95 | 5891 | 3276 | 10776 | 2643 | 13112 | 2161 | 14493 | 1745 | 16038 | 1074 | 16647 | 217 | 15347 |
| 23-#10 | 4.13 | 5953 | 3320 | 10892 | 2682 | 13301 | 2194 | 14730 | 1775 | 16382 | 1089 | 17107 | 199 | 15918 |
| 24-#10 | 4.31 | 6004 | 3365 | 11031 | 2719 | 13494 | 2223 | 14999 | 1794 | 16718 | 1091 | 17568 | 182 | 16496 |

## ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.16 | 5990 | 2942 | 10637 | 2299 | 12172 | 1880 | 12706 | 1561 | 12675 | 1071 | 11236 | 509 | 6388 |
| 6-#14 | 1.68 | 6158 | 3087 | 11318 | 2377 | 12991 | 1934 | 13677 | 1597 | 13041 | 988 | 12581 | 418 | 8898 |
| 6-#18 | 2.98 | 6559 | 3455 | 12975 | 2578 | 15006 | 2075 | 16078 | 1691 | 17189 | 1031 | 15824 | 177 | 14868 |
| 7-#10 | 1.11 | 6044 | 2926 | 9769 | 2449 | 11705 | 2024 | 12486 | 1682 | 11792 | 1103 | 11700 | 609 | 6211 |
| 7-#11 | 1.36 | 6131 | 2997 | 10113 | 2485 | 12096 | 2046 | 12917 | 1694 | 12292 | 1094 | 12321 | 566 | 7400 |
| 7-#14 | 1.96 | 6355 | 3166 | 10865 | 2588 | 12993 | 2122 | 13973 | 1743 | 13582 | 1090 | 13971 | 478 | 10084 |
| 7-#18 | 3.48 | 6879 | 3595 | 12685 | 2853 | 15190 | 2318 | 16578 | 1886 | 17953 | 1157 | 17961 | 246 | 16410 |
| 8-#10 | 1.26 | 6075 | 2970 | 9732 | 2513 | 11867 | 2078 | 12781 | 1729 | 13043 | 1211 | 12194 | 598 | 6891 |
| 8-#11 | 1.55 | 6165 | 3052 | 10148 | 2552 | 12315 | 2105 | 13284 | 1745 | 13651 | 1203 | 12893 | 548 | 8235 |
| 8-#14 | 2.24 | 6399 | 3245 | 10993 | 2672 | 13341 | 2196 | 14505 | 1808 | 15212 | 1204 | 14740 | 446 | 11388 |
| 8-#18 | 3.98 | 6957 | 3735 | 13049 | 2980 | 15863 | 2430 | 17472 | 1963 | 17780 | 1124 | 19253 | 178 | 18359 |
| 9-#10 | 1.42 | 6170 | 3015 | 10059 | 2523 | 12154 | 2085 | 13056 | 1728 | 12506 | 1114 | 12692 | 573 | 7748 |
| 9-#11 | 1.75 | 6278 | 3106 | 10517 | 2568 | 12650 | 2118 | 13604 | 1746 | 13158 | 1105 | 13498 | 518 | 9211 |
| 9-#14 | 2.52 | 6562 | 3324 | 11472 | 2702 | 13797 | 2221 | 14949 | 1814 | 15872 | 1183 | 15615 | 406 | 12533 |
| 9-#18 | 4.48 | 7264 | 3875 | 13797 | 3047 | 16605 | 2485 | 18260 | 2000 | 20254 | 1178 | 20776 | 110 | 20128 |
| 10-#10 | 1.58 | 6213 | 3059 | 10519 | 2513 | 12561 | 2066 | 13415 | 1702 | 13776 | 1160 | 13015 | 530 | 8424 |
| 10-#11 | 1.94 | 6329 | 3161 | 11020 | 2565 | 13109 | 2102 | 14031 | 1733 | 14564 | 1149 | 14042 | 484 | 10032 |
| 10-#14 | 2.80 | 6628 | 3402 | 12093 | 2716 | 14401 | 2213 | 15551 | 1809 | 15462 | 1067 | 16406 | 360 | 13813 |
| 10-#18 | 4.97 | 7348 | 4015 | 14716 | 3102 | 17568 | 2494 | 19291 | 1999 | 20069 | 1048 | 22102 | 25 | 21963 |
| 11-#10 | 1.74 | 6294 | 3104 | 10394 | 2593 | 12605 | 2139 | 13620 | 1767 | 14184 | 1203 | 13719 | 540 | 9244 |
| 11-#11 | 2.13 | 6425 | 3215 | 10932 | 2652 | 13196 | 2182 | 14291 | 1793 | 14035 | 1115 | 14718 | 476 | 10961 |
| 11-#14 | 3.08 | 6765 | 3481 | 12081 | 2821 | 14578 | 2311 | 15934 | 1879 | 16055 | 1115 | 17331 | 341 | 14904 |
| 11-#18 | 5.47 | 7614 | 4155 | 14879 | 3252 | 17974 | 2639 | 19986 | 2097 | 22533 | 1192 | 23682 | -15 | 23683 |
| 12-#10 | 1.89 | 6356 | 3148 | 10495 | 2643 | 12795 | 2174 | 13876 | 1793 | 14562 | 1218 | 14235 | 532 | 9909 |
| 12-#11 | 2.33 | 6499 | 3270 | 11066 | 2710 | 13433 | 2222 | 14601 | 1822 | 15501 | 1212 | 15327 | 463 | 11777 |
| 12-#14 | 3.36 | 6867 | 3560 | 12297 | 2898 | 14928 | 2363 | 16376 | 1916 | 17862 | 1217 | 18175 | 319 | 16178 |
| 12-#18 | 5.97 | 7776 | 4295 | 15296 | 3378 | 18600 | 2722 | 20751 | 2154 | 22118 | 1145 | 25096 | -63 | 25086 |
| 13-#10 | 2.05 | 6422 | 3193 | 10738 | 2660 | 13069 | 2192 | 14197 | 1805 | 14955 | 1211 | 14689 | 500 | 10701 |
| 13-#11 | 2.52 | 6577 | 3325 | 11351 | 2732 | 13762 | 2245 | 14985 | 1838 | 14910 | 1123 | 15878 | 424 | 12648 |
| 13-#14 | 3.64 | 6983 | 3639 | 12685 | 2934 | 15392 | 2401 | 16920 | 1942 | 18542 | 1206 | 18962 | 264 | 17226 |
| 13-#18 | 6.47 | 7989 | 4435 | 15944 | 3449 | 19404 | 2795 | 21683 | 2204 | 23245 | 1142 | 26446 | -159 | 26408 |
| 14-#10 | 2.21 | 6502 | 3237 | 11125 | 2659 | 13391 | 2188 | 14531 | 1795 | 14366 | 1117 | 15057 | 471 | 11354 |
| 14-#11 | 2.72 | 6675 | 3379 | 11719 | 2748 | 14136 | 2245 | 15391 | 1831 | 15395 | 1108 | 16355 | 391 | 13479 |
| 14-#14 | 3.92 | 7109 | 3717 | 13155 | 2965 | 15902 | 2408 | 17502 | 1939 | 17996 | 1109 | 19693 | 222 | 18361 |
| 14-#18 | 6.96 | 8165 | 4575 | 16666 | 3519 | 20247 | 2822 | 22711 | 2244 | 26131 | 1180 | 27751 | -233 | 27686 |
| 15-#10 | 2.37 | 6557 | 3282 | 11118 | 2720 | 13552 | 2238 | 14764 | 1841 | 14692 | 1141 | 15638 | 458 | 12116 |
| 15-#11 | 2.91 | 6736 | 3434 | 11816 | 2806 | 14329 | 2307 | 15675 | 1881 | 15791 | 1135 | 17031 | 372 | 14302 |
| 15-#14 | 4.20 | 7201 | 3796 | 13355 | 3039 | 16199 | 2488 | 17908 | 2004 | 19880 | 1223 | 20675 | 198 | 19379 |
| 16-#10 | 2.53 | 6643 | 3326 | 11263 | 2756 | 13743 | 2271 | 15053 | 1864 | 16105 | 1229 | 16173 | 452 | 12773 |
| 16-#11 | 3.10 | 6839 | 3488 | 11999 | 2848 | 14584 | 2341 | 16031 | 1909 | 17354 | 1222 | 17637 | 360 | 15142 |
| 16-#14 | 4.48 | 7340 | 3875 | 13632 | 3097 | 16576 | 2535 | 18422 | 2042 | 20493 | 1229 | 21434 | 167 | 20428 |
| 17-#10 | 2.68 | 6689 | 3370 | 11479 | 2785 | 14017 | 2288 | 15343 | 1877 | 15416 | 1147 | 16631 | 423 | 13486 |
| 17-#11 | 3.30 | 6897 | 3543 | 12256 | 2885 | 14910 | 2362 | 16372 | 1925 | 16670 | 1142 | 18218 | 326 | 15931 |
| 17-#14 | 4.76 | 7429 | 3954 | 13987 | 3152 | 17033 | 2566 | 18897 | 2065 | 19801 | 1150 | 22293 | 120 | 21520 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.84 | 6762 | 3415 | 11772 | 2796 | 14318 | 2300 | 15673 | 1876 | 15774 | 1132 | 17006 | 394 | 14154 |
| 18-#11 | 3.49 | 6982 | 3598 | 12591 | 2902 | 15270 | 2380 | 16767 | 1926 | 17106 | 1125 | 18670 | 292 | 16787 |
| 18-#14 | 5.04 | 7582 | 4032 | 14433 | 3182 | 17536 | 2597 | 19455 | 2071 | 21900 | 1211 | 22945 | 72 | 22524 |
| 19-#10 | 3.00 | 6812 | 3459 | 11838 | 2848 | 14491 | 2338 | 15911 | 1912 | 16130 | 1152 | 17584 | 384 | 14830 |
| 19-#11 | 3.69 | 7040 | 3652 | 12690 | 2962 | 15485 | 2423 | 17062 | 1967 | 18782 | 1229 | 19353 | 276 | 17524 |
| 19-#14 | 5.32 | 7644 | 4111 | 14608 | 3263 | 17850 | 2653 | 19886 | 2126 | 22534 | 1240 | 23892 | 45 | 23648 |
| 20-#10 | 3.16 | 6885 | 3504 | 12000 | 2882 | 14705 | 2371 | 16183 | 1931 | 17663 | 1240 | 18055 | 365 | 15502 |
| 20-#11 | 3.88 | 7127 | 3707 | 12895 | 3003 | 15742 | 2462 | 17390 | 1989 | 19250 | 1236 | 19938 | 255 | 18328 |
| 21-#10 | 3.32 | 6939 | 3548 | 12229 | 2907 | 14958 | 2387 | 16491 | 1947 | 16856 | 1158 | 18586 | 349 | 16166 |
| 21-#11 | 4.07 | 7191 | 3761 | 13166 | 3034 | 16049 | 2483 | 17760 | 2010 | 19716 | 1236 | 20548 | 232 | 19053 |
| 22-#10 | 3.47 | 7001 | 3593 | 12477 | 2930 | 15233 | 2402 | 16804 | 1950 | 18458 | 1230 | 19040 | 326 | 16838 |
| 22-#11 | 4.27 | 7266 | 3816 | 13455 | 3065 | 16374 | 2503 | 18142 | 2015 | 18851 | 1142 | 21093 | 204 | 19811 |
| 23-#10 | 3.63 | 7070 | 3637 | 12595 | 2971 | 15431 | 2437 | 17060 | 1982 | 17570 | 1163 | 19529 | 308 | 17475 |
| 23-#11 | 4.46 | 7347 | 3871 | 13610 | 3112 | 16624 | 2543 | 18451 | 2052 | 19270 | 1159 | 21691 | 181 | 20574 |
| 24-#10 | 3.79 | 7124 | 3682 | 12747 | 3009 | 15639 | 2466 | 17346 | 2001 | 19191 | 1249 | 20031 | 291 | 18159 |
| 25-#10 | 3.95 | 7199 | 3726 | 12958 | 3034 | 15903 | 2486 | 17639 | 2017 | 19599 | 1251 | 20478 | 267 | 18754 |
| 26-#10 | 4.11 | 7258 | 3770 | 13184 | 3059 | 16170 | 2504 | 17958 | 2024 | 18662 | 1160 | 20969 | 244 | 19385 |

## ROUND SPIRAL COLUMNS 34" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#11 | 1.03 | 7143 | 3279 | 12507 | 2584 | 14344 | 2116 | 14963 | 1760 | 14851 | 1219 | 13155 | 609 | 6883 |
| 6-#14 | 1.49 | 7327 | 3424 | 13245 | 2661 | 15229 | 2170 | 16010 | 1796 | 16249 | 1207 | 14627 | 521 | 9604 |
| 6-#18 | 2.64 | 7770 | 3792 | 15041 | 2862 | 17409 | 2311 | 18604 | 1890 | 19722 | 1180 | 18193 | 287 | 16104 |
| 7-#11 | 1.20 | 7295 | 3334 | 11877 | 2782 | 14220 | 2298 | 15185 | 1908 | 14398 | 1244 | 14358 | 672 | 8039 |
| 7-#14 | 1.73 | 7540 | 3503 | 12655 | 2891 | 15189 | 2374 | 16325 | 1957 | 15794 | 1241 | 16149 | 586 | 10964 |
| 7-#18 | 3.08 | 8120 | 3932 | 14632 | 3156 | 17569 | 2571 | 19142 | 2086 | 19237 | 1234 | 20546 | 363 | 17872 |
| 8-#10 | 1.12 | 7235 | 3307 | 11392 | 2821 | 13952 | 2334 | 15029 | 1946 | 14273 | 1283 | 14230 | 706 | 7447 |
| 8-#11 | 1.37 | 7335 | 3389 | 11848 | 2858 | 14440 | 2361 | 15573 | 1962 | 14889 | 1276 | 14991 | 657 | 8906 |
| 8-#14 | 1.98 | 7593 | 3582 | 12763 | 2978 | 15546 | 2452 | 16889 | 2025 | 17642 | 1369 | 16997 | 557 | 12327 |
| 8-#18 | 3.52 | 8207 | 4072 | 14990 | 3286 | 18273 | 2686 | 20134 | 2184 | 20353 | 1282 | 21915 | 296 | 20284 |
| 9-#10 | 1.26 | 7338 | 3352 | 11761 | 2828 | 14270 | 2340 | 15331 | 1944 | 14622 | 1265 | 14765 | 680 | 8369 |
| 9-#11 | 1.55 | 7458 | 3443 | 12262 | 2872 | 14809 | 2372 | 15927 | 1962 | 15327 | 1256 | 15643 | 626 | 10017 |
| 9-#14 | 2.23 | 7770 | 3661 | 13296 | 3006 | 16047 | 2476 | 17381 | 2030 | 18338 | 1346 | 17946 | 516 | 13643 |
| 9-#18 | 3.97 | 8523 | 4212 | 15817 | 3351 | 19097 | 2741 | 20967 | 2204 | 21540 | 1254 | 23580 | 228 | 22105 |
| 10-#10 | 1.40 | 7385 | 3396 | 12289 | 2813 | 14728 | 2317 | 15723 | 1914 | 16065 | 1319 | 15082 | 634 | 9125 |
| 10-#11 | 1.72 | 7513 | 3498 | 12836 | 2864 | 15325 | 2352 | 16392 | 1933 | 16918 | 1308 | 16081 | 575 | 10874 |
| 10-#14 | 2.48 | 7843 | 3739 | 13996 | 3014 | 16725 | 2463 | 18036 | 2021 | 17809 | 1216 | 18831 | 473 | 14981 |
| 10-#18 | 4.41 | 8632 | 4352 | 16836 | 3400 | 20160 | 2747 | 22089 | 2214 | 24425 | 1287 | 25094 | 151 | 24192 |
| 11-#10 | 1.54 | 7471 | 3441 | 12115 | 2899 | 14753 | 2395 | 15935 | 1984 | 16515 | 1366 | 15882 | 649 | 10001 |
| 11-#11 | 1.89 | 7618 | 3552 | 12702 | 2957 | 15396 | 2438 | 16662 | 2009 | 17440 | 1358 | 16974 | 585 | 11938 |
| 11-#14 | 2.73 | 7992 | 3818 | 13944 | 3126 | 16890 | 2567 | 18436 | 2096 | 18460 | 1269 | 19818 | 454 | 16231 |
| 11-#18 | 4.85 | 8898 | 4492 | 16982 | 3559 | 20566 | 2896 | 22818 | 2316 | 25554 | 1361 | 26759 | 109 | 26050 |
| 12-#10 | 1.68 | 7540 | 3485 | 12215 | 2951 | 14954 | 2432 | 16209 | 2011 | 15790 | 1290 | 16446 | 643 | 10748 |
| 12-#11 | 2.06 | 7699 | 3607 | 12840 | 3017 | 15647 | 2480 | 16995 | 2040 | 16737 | 1284 | 17640 | 575 | 12782 |
| 12-#14 | 2.97 | 8102 | 3897 | 14174 | 3206 | 17264 | 2621 | 18912 | 2135 | 20480 | 1382 | 20742 | 435 | 17565 |
| 12-#18 | 5.29 | 9099 | 4632 | 17427 | 3687 | 21240 | 2982 | 23645 | 2376 | 25004 | 1303 | 28307 | 65 | 27928 |

## ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 13-#10 | 1.82 | 7613 | 3530 | 12482 | 2966 | 15249 | 2448 | 16557 | 2023 | 16185 | 1283 | 16918 | 609 | 11591 |
| 13-#11 | 2.23 | 7784 | 3662 | 13151 | 3038 | 16001 | 2502 | 17412 | 2056 | 17215 | 1276 | 18237 | 536 | 13780 |
| 13-#14 | 3.22 | 8224 | 3976 | 14594 | 3241 | 17762 | 2657 | 19503 | 2161 | 21215 | 1372 | 21598 | 381 | 18763 |
| 13-#18 | 5.73 | 9302 | 4772 | 18125 | 3757 | 22101 | 3053 | 24660 | 2426 | 28121 | 1395 | 29785 | -31 | 29784 |
| 14-#10 | 1.96 | 7699 | 3574 | 12918 | 2963 | 15605 | 2442 | 16915 | 2011 | 17812 | 1359 | 17310 | 579 | 12327 |
| 14-#11 | 2.41 | 7891 | 3716 | 13641 | 3039 | 16414 | 2499 | 17847 | 2046 | 17745 | 1261 | 18723 | 501 | 14641 |
| 14-#14 | 3.47 | 8368 | 4054 | 15121 | 3269 | 18322 | 2663 | 20124 | 2155 | 20561 | 1263 | 22349 | 335 | 20100 |
| 14-#18 | 6.17 | 9519 | 4912 | 18925 | 3824 | 23022 | 3078 | 25756 | 2432 | 27496 | 1263 | 31230 | -100 | 31165 |
| 15-#10 | 2.10 | 7760 | 3619 | 12888 | 3027 | 15770 | 2495 | 17164 | 2059 | 18190 | 1387 | 17949 | 568 | 13150 |
| 15-#11 | 2.58 | 7958 | 3771 | 13648 | 3112 | 16613 | 2564 | 18151 | 2100 | 18168 | 1289 | 19468 | 484 | 15583 |
| 15-#14 | 3.72 | 8467 | 4133 | 15312 | 3346 | 18634 | 2746 | 20561 | 2223 | 22664 | 1390 | 23364 | 305 | 21216 |
| 15-#18 | 6.61 | 9722 | 5052 | 19392 | 3941 | 23612 | 3207 | 26516 | 2534 | 28528 | 1313 | 32968 | -152 | 32735 |
| 16-#10 | 2.24 | 7854 | 3663 | 13038 | 3064 | 15969 | 2529 | 17471 | 2083 | 17345 | 1301 | 18539 | 563 | 13873 |
| 16-#11 | 2.75 | 8070 | 3825 | 13840 | 3156 | 16881 | 2599 | 18529 | 2128 | 18608 | 1296 | 20155 | 475 | 16466 |
| 16-#14 | 3.97 | 8618 | 4212 | 15606 | 3405 | 19031 | 2793 | 21107 | 2261 | 23329 | 1398 | 24296 | 288 | 22409 |
| 17-#10 | 2.38 | 7904 | 3707 | 13273 | 3092 | 16266 | 2545 | 17789 | 2096 | 19020 | 1394 | 19027 | 535 | 14673 |
| 17-#11 | 2.92 | 8134 | 3880 | 14119 | 3192 | 17236 | 2619 | 18904 | 2144 | 20476 | 1389 | 20758 | 440 | 17356 |
| 17-#14 | 4.21 | 8715 | 4291 | 15990 | 3460 | 19528 | 2824 | 21632 | 2285 | 24111 | 1401 | 25189 | 239 | 23538 |
| 18-#10 | 2.52 | 7983 | 3752 | 13601 | 3102 | 16594 | 2555 | 18147 | 2094 | 19432 | 1377 | 19431 | 505 | 15379 |
| 18-#11 | 3.09 | 8226 | 3935 | 14492 | 3207 | 17625 | 2635 | 19333 | 2144 | 19579 | 1279 | 21248 | 405 | 18249 |
| 18-#14 | 4.46 | 8858 | 4369 | 16481 | 3488 | 20070 | 2853 | 22238 | 2291 | 24835 | 1377 | 25899 | 191 | 24675 |
| 19-#10 | 2.66 | 8038 | 3796 | 13660 | 3156 | 16775 | 2596 | 18397 | 2131 | 19847 | 1400 | 20062 | 496 | 16151 |
| 19-#11 | 3.26 | 8289 | 3989 | 14587 | 3270 | 17854 | 2681 | 19644 | 2186 | 20039 | 1302 | 21994 | 392 | 19090 |
| 19-#14 | 4.71 | 8948 | 4448 | 16659 | 3571 | 20411 | 2913 | 22692 | 2346 | 25523 | 1409 | 26934 | 167 | 25862 |
| 20-#10 | 2.80 | 8110 | 3841 | 13828 | 3190 | 17007 | 2629 | 18690 | 2151 | 18902 | 1312 | 20558 | 478 | 16847 |
| 20-#11 | 3.44 | 8385 | 4044 | 14801 | 3311 | 18133 | 2720 | 19998 | 2209 | 20503 | 1309 | 22610 | 369 | 19983 |
| 20-#14 | 4.96 | 9080 | 4527 | 16980 | 3628 | 20810 | 2967 | 23195 | 2377 | 26238 | 1417 | 27825 | 136 | 26990 |
| 21-#10 | 2.94 | 8177 | 3885 | 14078 | 3215 | 17277 | 2645 | 19020 | 2167 | 20682 | 1406 | 21087 | 457 | 17604 |
| 21-#11 | 3.61 | 8454 | 4098 | 15096 | 3342 | 18461 | 2741 | 20399 | 2230 | 20983 | 1309 | 23296 | 349 | 20806 |
| 22-#10 | 3.08 | 8245 | 3930 | 14351 | 3237 | 17578 | 2660 | 19357 | 2169 | 21116 | 1396 | 21641 | 440 | 18302 |
| 22-#11 | 3.78 | 8536 | 4153 | 15414 | 3371 | 18816 | 2760 | 20806 | 2234 | 23001 | 1390 | 23887 | 321 | 21690 |
| 23-#10 | 3.22 | 8315 | 3974 | 14470 | 3279 | 17784 | 2695 | 19632 | 2202 | 21506 | 1412 | 22157 | 422 | 19026 |
| 23-#11 | 3.95 | 8624 | 4208 | 15573 | 3420 | 19077 | 2802 | 21139 | 2272 | 23478 | 1409 | 24525 | 299 | 22479 |
| 24-#10 | 3.36 | 8378 | 4019 | 14633 | 3318 | 18008 | 2725 | 19936 | 2221 | 20441 | 1321 | 22703 | 406 | 19748 |
| 24-#11 | 4.12 | 8695 | 4262 | 15771 | 3467 | 19350 | 2838 | 21513 | 2295 | 22356 | 1318 | 25175 | 278 | 23312 |
| 25-#10 | 3.50 | 8459 | 4063 | 14861 | 3343 | 18293 | 2745 | 20253 | 2237 | 22342 | 1418 | 23188 | 382 | 20436 |
| 25-#11 | 4.30 | 8791 | 4317 | 16045 | 3497 | 19691 | 2862 | 21894 | 2316 | 24484 | 1416 | 25756 | 247 | 24108 |
| 26-#10 | 3.64 | 8516 | 4108 | 15111 | 3367 | 18580 | 2762 | 20603 | 2244 | 21244 | 1315 | 23701 | 358 | 21158 |
| 27-#10 | 3.78 | 8601 | 4152 | 15283 | 3401 | 18798 | 2794 | 20868 | 2272 | 21622 | 1329 | 24270 | 348 | 21842 |
| 28-#10 | 3.92 | 8660 | 4196 | 15474 | 3433 | 19038 | 2824 | 21167 | 2290 | 22011 | 1333 | 24775 | 323 | 22555 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.33 | 8636 | 3782 | 15382 | 2963 | 17717 | 2421 | 18603 | 2007 | 17520 | 1274 | 16881 | 629 | 10312 |
| 6-#18 | 2.36 | 9120 | 4149 | 17319 | 3164 | 20062 | 2562 | 21390 | 2102 | 22500 | 1338 | 20771 | 402 | 17341 |
| 7-#11 | 1.07 | 8598 | 3692 | 13794 | 3103 | 16583 | 2567 | 17712 | 2135 | 17935 | 1503 | 16614 | 783 | 8631 |
| 7-#14 | 1.55 | 8865 | 3861 | 14691 | 3203 | 17626 | 2643 | 18936 | 2184 | 18241 | 1401 | 18546 | 700 | 11858 |
| 7-#18 | 2.75 | 9503 | 4289 | 16769 | 3477 | 20189 | 2840 | 21965 | 2313 | 23521 | 1496 | 23303 | 481 | 19340 |
| 8-#11 | 1.23 | 8644 | 3746 | 13730 | 3184 | 16801 | 2633 | 18119 | 2193 | 18507 | 1540 | 17310 | 772 | 9583 |
| 8-#14 | 1.77 | 8926 | 3939 | 14716 | 3303 | 17990 | 2724 | 19530 | 2255 | 20325 | 1544 | 19475 | 674 | 13273 |
| 8-#18 | 3.14 | 9598 | 4429 | 17116 | 3610 | 20921 | 2958 | 23030 | 2417 | 23163 | 1448 | 24800 | 419 | 22114 |
| 9-#10 | 1.12 | 8645 | 3709 | 13648 | 3152 | 16624 | 2611 | 17865 | 2174 | 18186 | 1527 | 17058 | 793 | 8995 |
| 9-#11 | 1.38 | 8777 | 3801 | 14193 | 3196 | 17207 | 2642 | 18508 | 2191 | 17732 | 1417 | 18009 | 740 | 10776 |
| 9-#14 | 1.99 | 9118 | 4018 | 15307 | 3329 | 18537 | 2746 | 20071 | 2260 | 21055 | 1518 | 20498 | 633 | 14771 |
| 9-#18 | 3.54 | 9939 | 4569 | 18024 | 3674 | 21817 | 3012 | 23932 | 2435 | 24412 | 1417 | 26604 | 351 | 24077 |
| 10-#10 | 1.25 | 8696 | 3754 | 14252 | 3131 | 17138 | 2583 | 18290 | 2139 | 17364 | 1388 | 17365 | 744 | 9834 |
| 10-#11 | 1.53 | 8837 | 3855 | 14846 | 3181 | 17785 | 2618 | 19012 | 2158 | 19523 | 1477 | 18442 | 686 | 11726 |
| 10-#14 | 2.21 | 9197 | 4097 | 16094 | 3331 | 19292 | 2729 | 20781 | 2230 | 20390 | 1374 | 21217 | 565 | 16161 |
| 10-#18 | 3.93 | 10057 | 4709 | 19150 | 3717 | 22996 | 3014 | 25146 | 2442 | 27599 | 1460 | 28305 | 281 | 26495 |
| 11-#10 | 1.37 | 8789 | 3798 | 14019 | 3224 | 17140 | 2667 | 18508 | 2214 | 19099 | 1539 | 18266 | 763 | 10766 |
| 11-#11 | 1.69 | 8949 | 3910 | 14657 | 3282 | 17834 | 2709 | 19292 | 2240 | 20095 | 1531 | 19450 | 701 | 12865 |
| 11-#14 | 2.43 | 9360 | 4176 | 15994 | 3450 | 19441 | 2838 | 21196 | 2327 | 22609 | 1534 | 22527 | 573 | 17582 |
| 11-#18 | 4.32 | 10345 | 4849 | 19265 | 3883 | 23398 | 3169 | 25908 | 2549 | 26907 | 1437 | 30058 | 236 | 28389 |
| 12-#10 | 1.50 | 8864 | 3843 | 14112 | 3278 | 17349 | 2706 | 18800 | 2243 | 19527 | 1556 | 18879 | 759 | 11599 |
| 12-#11 | 1.84 | 9038 | 3965 | 14796 | 3344 | 18099 | 2753 | 19648 | 2272 | 20617 | 1550 | 20175 | 693 | 13801 |
| 12-#14 | 2.65 | 9478 | 4254 | 16234 | 3533 | 19837 | 2895 | 21706 | 2368 | 23352 | 1557 | 23531 | 556 | 18969 |
| 12-#18 | 4.72 | 10566 | 4989 | 19743 | 4015 | 24118 | 3257 | 26798 | 2611 | 28126 | 1469 | 31741 | 197 | 30502 |
| 13-#10 | 1.62 | 8943 | 3887 | 14410 | 3292 | 17667 | 2720 | 19176 | 2254 | 19979 | 1548 | 19369 | 723 | 12492 |
| 13-#11 | 1.99 | 9131 | 4019 | 15136 | 3364 | 18479 | 2773 | 20098 | 2287 | 19755 | 1438 | 20796 | 652 | 14900 |
| 13-#14 | 2.87 | 9611 | 4333 | 16689 | 3566 | 20370 | 2929 | 22343 | 2393 | 24141 | 1546 | 24454 | 501 | 20325 |
| 13-#18 | 5.11 | 10782 | 5129 | 20492 | 4083 | 25036 | 3327 | 27894 | 2660 | 31514 | 1558 | 33347 | 102 | 32634 |
| 14-#10 | 1.75 | 9036 | 3932 | 14899 | 3285 | 18059 | 2712 | 19557 | 2239 | 19109 | 1428 | 19782 | 694 | 13327 |
| 14-#11 | 2.15 | 9243 | 4074 | 15683 | 3362 | 18933 | 2769 | 20561 | 2274 | 21783 | 1524 | 21311 | 617 | 15821 |
| 14-#14 | 3.09 | 9768 | 4412 | 17389 | 3574 | 20981 | 2932 | 23005 | 2384 | 23360 | 1426 | 25224 | 454 | 21722 |
| 14-#18 | 5.50 | 11018 | 5269 | 21374 | 4148 | 26038 | 3350 | 29059 | 2663 | 33040 | 1533 | 34835 | 29 | 34658 |
| 15-#10 | 1.87 | 9103 | 3976 | 14840 | 3353 | 18225 | 2768 | 19822 | 2290 | 20876 | 1556 | 20483 | 683 | 14183 |
| 15-#11 | 2.30 | 9320 | 4128 | 15664 | 3437 | 19154 | 2831 | 20885 | 2331 | 20781 | 1452 | 22127 | 601 | 16898 |
| 15-#14 | 3.32 | 9874 | 4491 | 17453 | 3671 | 21335 | 3011 | 23473 | 2455 | 25702 | 1566 | 26334 | 426 | 22984 |
| 15-#18 | 5.89 | 11235 | 5409 | 21845 | 4268 | 26665 | 3482 | 29877 | 2769 | 34207 | 1588 | 36804 | -16 | 36637 |
| 16-#10 | 2.00 | 9205 | 4021 | 14994 | 3391 | 18431 | 2803 | 20146 | 2315 | 21317 | 1569 | 21105 | 679 | 14990 |
| 16-#11 | 2.45 | 9441 | 4183 | 15864 | 3482 | 19416 | 2872 | 21284 | 2360 | 22774 | 1564 | 22894 | 596 | 17800 |
| 16-#14 | 3.54 | 10039 | 4569 | 17762 | 3732 | 21724 | 3067 | 24050 | 2494 | 26419 | 1575 | 27381 | 413 | 24384 |
| 16-#18 | 6.29 | 11484 | 5549 | 22423 | 4369 | 27425 | 3562 | 30906 | 2835 | 33073 | 1492 | 38326 | -71 | 38303 |
| 17-#10 | 2.12 | 9259 | 4065 | 15250 | 3418 | 18753 | 2819 | 20488 | 2328 | 21777 | 1568 | 21645 | 652 | 15835 |
| 17-#11 | 2.61 | 9507 | 4238 | 16165 | 3517 | 19799 | 2892 | 21695 | 2376 | 21787 | 1460 | 23521 | 560 | 18809 |
| 17-#14 | 3.76 | 10143 | 4648 | 18176 | 3786 | 22261 | 3098 | 24625 | 2519 | 25429 | 1472 | 28307 | 363 | 25607 |
| 18-#10 | 2.25 | 9345 | 4109 | 15615 | 3426 | 19108 | 2827 | 20879 | 2325 | 22217 | 1551 | 22077 | 622 | 16625 |
| 18-#11 | 2.76 | 9610 | 4292 | 16579 | 3531 | 20220 | 2906 | 22157 | 2376 | 22287 | 1441 | 24047 | 524 | 19734 |
| 18-#14 | 3.98 | 10296 | 4727 | 18717 | 3812 | 22843 | 3125 | 25279 | 2523 | 28021 | 1553 | 29074 | 315 | 26943 |

## ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 19-#10 | 2.37 | 9404 | 4154 | 15664 | 3483 | 19295 | 2869 | 21141 | 2363 | 21154 | 1470 | 22755 | 614 | 17460 |
| 19-#11 | 2.91 | 9679 | 4347 | 16667 | 3596 | 20459 | 2954 | 22484 | 2419 | 22785 | 1466 | 24858 | 512 | 20687 |
| 19-#14 | 4.20 | 10395 | 4806 | 18894 | 3898 | 23207 | 3187 | 25756 | 2580 | 26848 | 1481 | 30198 | 293 | 28112 |
| 20-#10 | 2.50 | 9481 | 4198 | 15838 | 3517 | 19547 | 2904 | 21454 | 2384 | 23094 | 1581 | 23284 | 595 | 18216 |
| 20-#11 | 3.07 | 9773 | 4401 | 16889 | 3637 | 20761 | 2995 | 22863 | 2443 | 24939 | 1578 | 25504 | 489 | 21614 |
| 20-#14 | 4.42 | 10536 | 4884 | 19231 | 3956 | 23638 | 3243 | 26297 | 2612 | 29522 | 1595 | 31131 | 260 | 29382 |
| 21-#10 | 2.62 | 9552 | 4243 | 16109 | 3542 | 19834 | 2919 | 21805 | 2399 | 23556 | 1582 | 23852 | 575 | 19055 |
| 21-#11 | 3.22 | 9858 | 4456 | 17210 | 3668 | 21110 | 3015 | 23291 | 2463 | 23797 | 1474 | 26250 | 471 | 22554 |
| 21-#14 | 4.64 | 10637 | 4963 | 19675 | 4001 | 24136 | 3273 | 26910 | 2643 | 28292 | 1491 | 32189 | 232 | 30577 |
| 22-#10 | 2.74 | 9628 | 4287 | 16408 | 3562 | 20161 | 2933 | 22168 | 2400 | 24027 | 1571 | 24465 | 559 | 19791 |
| 22-#11 | 3.37 | 9946 | 4511 | 17557 | 3696 | 21496 | 3034 | 23727 | 2466 | 26057 | 1566 | 26902 | 443 | 23476 |
| 22-#14 | 4.86 | 10767 | 5042 | 20139 | 4047 | 24670 | 3304 | 27531 | 2651 | 31113 | 1581 | 33105 | 192 | 31770 |
| 23-#10 | 2.87 | 9705 | 4332 | 16526 | 3606 | 20374 | 2969 | 22462 | 2435 | 24441 | 1588 | 25008 | 541 | 20610 |
| 23-#11 | 3.52 | 10037 | 4565 | 17718 | 3747 | 21768 | 3076 | 24085 | 2506 | 26563 | 1586 | 27572 | 421 | 24378 |
| 24-#10 | 2.99 | 9772 | 4376 | 16697 | 3646 | 20613 | 3000 | 22783 | 2454 | 24866 | 1592 | 25599 | 526 | 21356 |
| 24-#11 | 3.68 | 10118 | 4620 | 17932 | 3795 | 22059 | 3113 | 24480 | 2529 | 27074 | 1590 | 28277 | 400 | 25333 |
| 25-#10 | 3.12 | 9860 | 4421 | 16945 | 3670 | 20921 | 3020 | 23124 | 2470 | 25334 | 1595 | 26120 | 502 | 22142 |
| 25-#11 | 3.83 | 10222 | 4674 | 18225 | 3825 | 22428 | 3137 | 24890 | 2549 | 25802 | 1487 | 28904 | 371 | 26189 |
| 26-#10 | 3.24 | 9921 | 4465 | 17220 | 3694 | 21228 | 3035 | 23506 | 2477 | 25780 | 1585 | 26655 | 477 | 22893 |
| 26-#11 | 3.98 | 10306 | 4729 | 18544 | 3856 | 22798 | 3158 | 25341 | 2558 | 26312 | 1477 | 29577 | 342 | 27082 |
| 27-#10 | 3.37 | 10010 | 4509 | 17396 | 3729 | 21459 | 3069 | 23784 | 2506 | 26217 | 1601 | 27275 | 468 | 23652 |
| 27-#11 | 4.14 | 10407 | 4784 | 18774 | 3896 | 23083 | 3197 | 25687 | 2592 | 28715 | 1600 | 30303 | 328 | 27940 |
| 28-#10 | 3.49 | 10078 | 4554 | 17598 | 3761 | 21712 | 3099 | 24105 | 2524 | 26658 | 1605 | 27835 | 445 | 24410 |
| 29-#10 | 3.62 | 10158 | 4598 | 17815 | 3792 | 22020 | 3114 | 24445 | 2541 | 27111 | 1607 | 28376 | 428 | 25145 |
| 30-#10 | 3.74 | 10229 | 4643 | 18100 | 3813 | 22352 | 3129 | 24800 | 2547 | 27568 | 1600 | 28873 | 396 | 25925 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 12" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.64 | 414 | 553 | 816 | 327 | 813 | 263 | 783 | 210 | 712 | 130 | 570 | 35 | 438 |
| 6-#6 | 2.33 | 423 | 580 | 848 | 340 | 850 | 272 | 825 | 213 | 715 | 114 | 621 | 9 | 587 |
| 6-#7 | 3.18 | 434 | 612 | 887 | 362 | 894 | 282 | 876 | 217 | 831 | 112 | 680 | -23 | 703 |
| 6-#8 | 4.19 | 446 | 651 | 931 | 383 | 943 | 295 | 933 | 221 | 904 | 99 | 746 | -62 | 797 |
| 6-#9 | 5.31 | 459 | 694 | 976 | 405 | 995 | 308 | 993 | 225 | 916 | 78 | 814 | -106 | 891 |
| 6-#10 | 6.74 | 476 | 749 | 1030 | 434 | 1058 | 324 | 1066 | 229 | 1076 | 64 | 895 | -164 | 970 |
| 7-#5 | 1.92 | 420 | 564 | 818 | 354 | 831 | 285 | 812 | 229 | 752 | 144 | 616 | 37 | 494 |
| 7-#6 | 2.72 | 432 | 595 | 853 | 370 | 872 | 296 | 859 | 234 | 759 | 128 | 675 | 9 | 649 |
| 7-#7 | 3.71 | 446 | 633 | 894 | 391 | 921 | 310 | 915 | 240 | 886 | 129 | 757 | -22 | 771 |
| 7-#8 | 4.89 | 462 | 678 | 940 | 415 | 977 | 327 | 978 | 247 | 904 | 111 | 839 | -64 | 885 |
| 7-#9 | 6.19 | 479 | 728 | 990 | 442 | 1036 | 345 | 1045 | 255 | 986 | 99 | 921 | -113 | 995 |
| 8-#5 | 2.19 | 423 | 574 | 829 | 365 | 847 | 294 | 832 | 236 | 724 | 136 | 647 | 30 | 552 |
| 8-#6 | 3.11 | 435 | 610 | 868 | 384 | 893 | 308 | 887 | 243 | 845 | 138 | 716 | -2 | 718 |
| 8-#7 | 4.24 | 450 | 653 | 914 | 408 | 948 | 325 | 950 | 252 | 926 | 129 | 797 | -43 | 832 |
| 8-#8 | 5.59 | 468 | 705 | 967 | 436 | 1012 | 346 | 1023 | 261 | 1019 | 117 | 905 | -87 | 954 |

## ROUND SPIRAL COLUMNS 14" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#5 | 1.21 | 652 | 730 | 1267 | 448 | 1275 | 363 | 1232 | 295 | 1115 | 194 | 899 | 78 | 541 |
| 6-#6 | 1.71 | 664 | 757 | 1309 | 460 | 1326 | 373 | 1290 | 299 | 1109 | 175 | 973 | 55 | 731 |
| 6-#7 | 2.34 | 678 | 789 | 1359 | 477 | 1388 | 385 | 1359 | 304 | 1277 | 179 | 1060 | 25 | 953 |
| 6-#8 | 3.08 | 695 | 828 | 1418 | 496 | 1458 | 399 | 1439 | 310 | 1288 | 158 | 1160 | -11 | 1170 |
| 6-#9 | 3.90 | 713 | 871 | 1481 | 518 | 1531 | 414 | 1524 | 317 | 1488 | 157 | 1264 | -50 | 1306 |
| 6-#10 | 4.95 | 736 | 926 | 1560 | 546 | 1623 | 433 | 1629 | 324 | 1515 | 132 | 1392 | -103 | 1423 |
| 6-#11 | 6.08 | 753 | 985 | 1629 | 585 | 1683 | 445 | 1698 | 323 | 1712 | 114 | 1456 | -171 | 1529 |
| 7-#5 | 1.41 | 659 | 741 | 1264 | 483 | 1297 | 391 | 1270 | 319 | 1174 | 213 | 970 | 86 | 624 |
| 7-#6 | 2.00 | 674 | 772 | 1309 | 500 | 1351 | 404 | 1333 | 325 | 1257 | 208 | 1056 | 61 | 825 |
| 7-#7 | 2.73 | 692 | 810 | 1364 | 521 | 1416 | 419 | 1410 | 334 | 1266 | 189 | 1159 | 31 | 1055 |
| 7-#8 | 3.59 | 713 | 855 | 1428 | 546 | 1492 | 437 | 1499 | 343 | 1472 | 195 | 1275 | -7 | 1283 |
| 7-#9 | 4.55 | 735 | 905 | 1496 | 575 | 1572 | 457 | 1594 | 354 | 1594 | 186 | 1397 | -50 | 1448 |
| 7-#10 | 5.78 | 766 | 969 | 1581 | 611 | 1673 | 482 | 1714 | 367 | 1747 | 174 | 1545 | -107 | 1643 |
| 7-#11 | 7.09 | 789 | 1038 | 1651 | 641 | 1751 | 500 | 1792 | 369 | 1849 | 148 | 1660 | -176 | 1767 |
| 8-#5 | 1.61 | 663 | 751 | 1277 | 496 | 1317 | 403 | 1296 | 328 | 1127 | 202 | 1015 | 81 | 691 |
| 8-#6 | 2.29 | 679 | 787 | 1330 | 516 | 1379 | 418 | 1368 | 336 | 1214 | 197 | 1115 | 53 | 924 |
| 8-#7 | 3.12 | 698 | 830 | 1393 | 541 | 1453 | 436 | 1455 | 347 | 1413 | 205 | 1234 | 18 | 1187 |
| 8-#8 | 4.11 | 721 | 882 | 1464 | 571 | 1538 | 458 | 1556 | 359 | 1542 | 197 | 1369 | -25 | 1391 |
| 8-#9 | 5.20 | 745 | 939 | 1541 | 603 | 1629 | 482 | 1663 | 372 | 1679 | 187 | 1510 | -75 | 1568 |
| 8-#10 | 6.60 | 779 | 1012 | 1636 | 645 | 1744 | 513 | 1798 | 389 | 1726 | 162 | 1682 | -140 | 1779 |

## ROUND SPIRAL COLUMNS 16" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#6 | 1.31 | 981 | 961 | 1908 | 601 | 1939 | 488 | 1893 | 398 | 1734 | 262 | 1396 | 101 | 876 |
| 6-#7 | 1.79 | 999 | 994 | 1970 | 617 | 2015 | 501 | 1982 | 404 | 1724 | 238 | 1503 | 72 | 1147 |
| 6-#8 | 2.36 | 1020 | 1032 | 2042 | 637 | 2104 | 516 | 2085 | 411 | 1979 | 247 | 1626 | 38 | 1457 |
| 6-#9 | 2.98 | 1044 | 1075 | 2121 | 658 | 2201 | 532 | 2196 | 419 | 2120 | 237 | 1815 | 10 | 1786 |
| 6-#10 | 3.79 | 1073 | 1130 | 2219 | 687 | 2323 | 554 | 2334 | 429 | 2296 | 224 | 1991 | -39 | 1966 |
| 6-#11 | 4.66 | 1096 | 1189 | 2310 | 710 | 2423 | 569 | 2435 | 431 | 2427 | 201 | 2102 | -104 | 2119 |
| 6-#14 | 6.71 | 1164 | 1329 | 2542 | 783 | 2690 | 619 | 2744 | 451 | 2822 | 161 | 2475 | -238 | 2543 |
| 7-#5 | 1.08 | 975 | 945 | 1843 | 633 | 1905 | 515 | 1868 | 423 | 1720 | 291 | 1428 | 139 | 749 |
| 7-#6 | 1.53 | 994 | 976 | 1899 | 650 | 1972 | 528 | 1947 | 430 | 1826 | 288 | 1541 | 117 | 1007 |
| 7-#7 | 2.09 | 1016 | 1014 | 1967 | 671 | 2055 | 544 | 2043 | 439 | 1824 | 265 | 1678 | 90 | 1292 |
| 7-#8 | 2.75 | 1042 | 1059 | 2046 | 697 | 2150 | 563 | 2155 | 450 | 2104 | 279 | 1835 | 56 | 1616 |
| 7-#9 | 3.48 | 1070 | 1109 | 2131 | 726 | 2253 | 584 | 2275 | 462 | 2262 | 273 | 2001 | 18 | 1942 |
| 7-#10 | 4.42 | 1105 | 1173 | 2238 | 763 | 2381 | 611 | 2427 | 477 | 2461 | 264 | 2206 | -33 | 2242 |
| 7-#11 | 5.43 | 1136 | 1242 | 2338 | 794 | 2488 | 630 | 2550 | 484 | 2435 | 227 | 2335 | -103 | 2441 |
| 7-#14 | 7.83 | 1224 | 1406 | 2587 | 888 | 2784 | 696 | 2901 | 519 | 3056 | 213 | 2770 | -247 | 2914 |

## ROUND SPIRAL COLUMNS 16" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#5 | 1.23 | 979 | 956 | 1855 | 648 | 1931 | 529 | 1902 | 434 | 1645 | 276 | 1487 | 136 | 831 |
| 8-#6 | 1.75 | 1000 | 991 | 1920 | 668 | 2008 | 545 | 1992 | 443 | 1880 | 292 | 1619 | 111 | 1118 |
| 8-#7 | 2.39 | 1024 | 1034 | 1998 | 694 | 2101 | 564 | 2100 | 455 | 1888 | 269 | 1776 | 80 | 1454 |
| 8-#8 | 3.14 | 1052 | 1086 | 2089 | 724 | 2209 | 587 | 2227 | 469 | 2044 | 264 | 1958 | 41 | 1832 |
| 8-#9 | 3.98 | 1083 | 1143 | 2188 | 758 | 2325 | 613 | 2363 | 484 | 2369 | 276 | 2150 | -2 | 2152 |
| 8-#10 | 5.05 | 1122 | 1216 | 2312 | 802 | 2470 | 645 | 2535 | 502 | 2594 | 267 | 2387 | -60 | 2436 |
| 8-#11 | 6.21 | 1155 | 1295 | 2423 | 839 | 2591 | 670 | 2674 | 513 | 2577 | 229 | 2541 | -140 | 2648 |
| 9-#10 | 5.68 | 1161 | 1259 | 2378 | 824 | 2562 | 655 | 2651 | 507 | 2750 | 260 | 2510 | -95 | 2604 |
| 9-#11 | 6.98 | 1202 | 1348 | 2502 | 867 | 2705 | 685 | 2809 | 518 | 2746 | 220 | 2721 | -175 | 2826 |
| 10-#10 | 6.32 | 1176 | 1302 | 2475 | 833 | 2665 | 662 | 2773 | 506 | 2893 | 236 | 2636 | -140 | 2748 |

## ROUND SPIRAL COLUMNS 18" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#6 | 1.04 | 1385 | 1193 | 2665 | 762 | 2715 | 620 | 2648 | 508 | 2419 | 345 | 1953 | 158 | 1021 |
| 6-#7 | 1.41 | 1407 | 1225 | 2739 | 778 | 2805 | 632 | 2757 | 515 | 2558 | 339 | 2088 | 131 | 1342 |
| 6-#8 | 1.86 | 1432 | 1264 | 2825 | 797 | 2911 | 647 | 2884 | 524 | 2719 | 332 | 2244 | 99 | 1710 |
| 6-#9 | 2.36 | 1459 | 1307 | 2918 | 819 | 3026 | 664 | 3023 | 533 | 2893 | 324 | 2410 | 62 | 2103 |
| 6-#10 | 2.99 | 1494 | 1362 | 3037 | 847 | 3172 | 686 | 3199 | 545 | 3112 | 314 | 2618 | 15 | 2572 |
| 6-#11 | 3.68 | 1529 | 1421 | 3150 | 870 | 3304 | 703 | 3334 | 549 | 3284 | 293 | 2864 | -31 | 2809 |
| 6-#14 | 5.31 | 1612 | 1561 | 3431 | 944 | 3654 | 759 | 3727 | 574 | 3786 | 260 | 3361 | -157 | 3362 |
| 7-#6 | 1.21 | 1400 | 1208 | 2641 | 822 | 2755 | 669 | 2723 | 550 | 2536 | 377 | 2130 | 175 | 1188 |
| 7-#7 | 1.65 | 1427 | 1246 | 2722 | 843 | 2853 | 685 | 2838 | 559 | 2690 | 374 | 2296 | 149 | 1536 |
| 7-#8 | 2.17 | 1459 | 1291 | 2817 | 869 | 2968 | 705 | 2973 | 571 | 2680 | 346 | 2514 | 122 | 1925 |
| 7-#9 | 2.75 | 1493 | 1341 | 2919 | 898 | 3092 | 726 | 3119 | 584 | 3067 | 366 | 2725 | 87 | 2337 |
| 7-#10 | 3.49 | 1536 | 1405 | 3047 | 935 | 3250 | 754 | 3303 | 600 | 3314 | 360 | 2988 | 41 | 2832 |
| 7-#11 | 4.29 | 1573 | 1473 | 3173 | 966 | 3390 | 776 | 3459 | 608 | 3518 | 344 | 3174 | -22 | 3201 |
| 7-#14 | 6.19 | 1675 | 1637 | 3476 | 1062 | 3757 | 845 | 3893 | 647 | 3811 | 300 | 3755 | -152 | 3858 |
| 8-#6 | 1.38 | 1408 | 1223 | 2660 | 842 | 2801 | 689 | 2778 | 565 | 2430 | 357 | 2242 | 174 | 1314 |
| 8-#7 | 1.89 | 1438 | 1266 | 2753 | 867 | 2912 | 709 | 2909 | 577 | 2775 | 380 | 2439 | 145 | 1715 |
| 8-#8 | 2.48 | 1472 | 1317 | 2862 | 898 | 3043 | 733 | 3061 | 592 | 2976 | 376 | 2668 | 111 | 2172 |
| 8-#9 | 3.14 | 1509 | 1374 | 2979 | 932 | 3184 | 759 | 3226 | 608 | 3193 | 371 | 2912 | 71 | 2659 |
| 8-#10 | 3.99 | 1557 | 1448 | 3127 | 976 | 3361 | 793 | 3435 | 628 | 3468 | 365 | 3216 | 19 | 3154 |
| 8-#11 | 4.90 | 1597 | 1526 | 3275 | 1014 | 3516 | 819 | 3612 | 641 | 3701 | 348 | 3435 | -53 | 3482 |
| 8-#14 | 7.07 | 1710 | 1714 | 3627 | 1127 | 3931 | 903 | 4102 | 689 | 4341 | 325 | 4107 | -202 | 4250 |
| 9-#10 | 4.49 | 1601 | 1491 | 3217 | 999 | 3462 | 801 | 3570 | 632 | 3663 | 359 | 3373 | -16 | 3391 |
| 9-#11 | 5.52 | 1653 | 1579 | 3373 | 1043 | 3642 | 831 | 3779 | 646 | 3930 | 341 | 3613 | -96 | 3717 |
| 10-#10 | 4.99 | 1620 | 1534 | 3339 | 1006 | 3588 | 806 | 3709 | 629 | 3848 | 337 | 3528 | -57 | 3582 |
| 10-#11 | 6.13 | 1673 | 1632 | 3512 | 1054 | 3789 | 840 | 3945 | 645 | 4134 | 312 | 3796 | -149 | 3926 |
| 11-#10 | 5.49 | 1663 | 1577 | 3381 | 1059 | 3685 | 848 | 3832 | 661 | 4013 | 358 | 3794 | -66 | 3861 |
| 11-#11 | 6.74 | 1728 | 1685 | 3571 | 1116 | 3902 | 886 | 4087 | 681 | 4339 | 336 | 4097 | -162 | 4193 |
| 12-#10 | 5.99 | 1691 | 1620 | 3456 | 1090 | 3783 | 877 | 3970 | 685 | 4174 | 358 | 3969 | -97 | 4050 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 20" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#7 | 1.15 | 1913 | 1484 | 3684 | 958 | 3779 | 781 | 3707 | 640 | 3199 | 404 | 2798 | 195 | 1538 |
| 6-#8 | 1.51 | 1943 | 1523 | 3784 | 978 | 3902 | 796 | 3854 | 648 | 3377 | 399 | 2987 | 165 | 1964 |
| 6-#9 | 1.91 | 1975 | 1565 | 3893 | 999 | 4035 | 812 | 4015 | 658 | 3825 | 420 | 3191 | 131 | 2422 |
| 6-#10 | 2.43 | 2016 | 1620 | 4031 | 1028 | 4205 | 834 | 4220 | 670 | 4086 | 411 | 3446 | 86 | 2992 |
| 6-#11 | 2.98 | 2053 | 1679 | 4168 | 1050 | 4362 | 851 | 4405 | 677 | 4014 | 367 | 3634 | 26 | 3542 |
| 6-#14 | 4.30 | 2150 | 1820 | 4498 | 1124 | 4773 | 907 | 4892 | 708 | 4911 | 365 | 4208 | -98 | 4298 |
| 6-#18 | 7.64 | 2400 | 2176 | 5293 | 1312 | 5767 | 1051 | 6010 | 774 | 6341 | 283 | 5798 | -388 | 5790 |
| 7-#7 | 1.34 | 1937 | 1504 | 3647 | 1036 | 3835 | 844 | 3815 | 694 | 3580 | 471 | 3065 | 217 | 1788 |
| 7-#8 | 1.76 | 1974 | 1549 | 3758 | 1062 | 3968 | 864 | 3973 | 706 | 3788 | 467 | 3297 | 188 | 2242 |
| 7-#9 | 2.23 | 2015 | 1599 | 3877 | 1091 | 4113 | 886 | 4145 | 719 | 3762 | 437 | 3547 | 154 | 2725 |
| 7-#10 | 2.83 | 2065 | 1663 | 4027 | 1128 | 4296 | 914 | 4362 | 736 | 4321 | 463 | 3860 | 110 | 3324 |
| 7-#11 | 3.48 | 2110 | 1732 | 4180 | 1159 | 4468 | 936 | 4551 | 746 | 4269 | 420 | 4150 | 60 | 3897 |
| 7-#14 | 5.01 | 2231 | 1896 | 4538 | 1256 | 4910 | 1009 | 5068 | 788 | 5269 | 435 | 4879 | -60 | 4948 |
| 8-#7 | 1.53 | 1950 | 1525 | 3676 | 1063 | 3904 | 871 | 3900 | 714 | 3447 | 450 | 3237 | 216 | 1978 |
| 8-#8 | 2.01 | 1990 | 1576 | 3802 | 1093 | 4059 | 896 | 4079 | 730 | 3928 | 479 | 3513 | 184 | 2511 |
| 8-#9 | 2.55 | 2035 | 1633 | 3939 | 1127 | 4227 | 923 | 4273 | 746 | 4183 | 476 | 3810 | 147 | 3080 |
| 8-#10 | 3.23 | 2090 | 1706 | 4111 | 1171 | 4437 | 958 | 4519 | 768 | 4206 | 439 | 4182 | 100 | 3788 |
| 8-#11 | 3.97 | 2140 | 1785 | 4288 | 1209 | 4626 | 985 | 4734 | 782 | 4468 | 426 | 4467 | 34 | 4346 |
| 8-#14 | 5.73 | 2273 | 1972 | 4702 | 1323 | 5122 | 1071 | 5318 | 834 | 5187 | 410 | 5310 | -102 | 5392 |
| 9-#10 | 3.64 | 2141 | 1750 | 4221 | 1194 | 4546 | 963 | 4665 | 769 | 4735 | 466 | 4372 | 65 | 4086 |
| 9-#11 | 4.47 | 2201 | 1838 | 4415 | 1239 | 4763 | 994 | 4918 | 785 | 5059 | 450 | 4688 | -9 | 4699 |
| 9-#14 | 6.45 | 2362 | 2049 | 4871 | 1367 | 5322 | 1089 | 5589 | 842 | 5942 | 432 | 5618 | -163 | 5781 |
| 10-#10 | 4.04 | 2163 | 1793 | 4375 | 1198 | 4695 | 966 | 4826 | 764 | 4937 | 441 | 4555 | 25 | 4456 |
| 10-#11 | 4.97 | 2227 | 1891 | 4586 | 1247 | 4938 | 1000 | 5111 | 781 | 5316 | 423 | 4906 | -59 | 4965 |
| 10-#14 | 7.16 | 2397 | 2125 | 5100 | 1385 | 5570 | 1104 | 5866 | 842 | 6307 | 394 | 5933 | -235 | 6117 |
| 11-#10 | 4.45 | 2215 | 1836 | 4411 | 1255 | 4800 | 1011 | 4975 | 801 | 5148 | 467 | 4880 | 19 | 4797 |
| 11-#11 | 5.46 | 2288 | 1944 | 4641 | 1312 | 5069 | 1051 | 5282 | 822 | 5546 | 449 | 5277 | -69 | 5353 |
| 12-#10 | 4.85 | 2241 | 1879 | 4497 | 1289 | 4915 | 1041 | 5126 | 825 | 4984 | 438 | 5093 | -8 | 5101 |
| 12-#11 | 5.96 | 2326 | 1997 | 4745 | 1351 | 5206 | 1088 | 5469 | 851 | 5385 | 420 | 5523 | -105 | 5617 |
| 13-#10 | 5.26 | 2286 | 1922 | 4607 | 1316 | 5052 | 1056 | 5283 | 832 | 5553 | 466 | 5339 | -36 | 5377 |
| 14-#10 | 5.66 | 2319 | 1965 | 4734 | 1328 | 5201 | 1069 | 5459 | 838 | 5797 | 460 | 5505 | -75 | 5573 |

## ROUND SPIRAL COLUMNS 22" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.25 | 2562 | 1809 | 4940 | 1179 | 5097 | 960 | 5023 | 786 | 4381 | 496 | 3871 | 235 | 2219 |
| 6-#9 | 1.58 | 2600 | 1851 | 5064 | 1200 | 5249 | 977 | 5206 | 796 | 4934 | 526 | 4111 | 203 | 2741 |
| 6-#10 | 2.00 | 2647 | 1906 | 5222 | 1228 | 5443 | 999 | 5439 | 808 | 5238 | 518 | 4414 | 161 | 3394 |
| 6-#11 | 2.46 | 2691 | 1965 | 5382 | 1250 | 5625 | 1015 | 5652 | 815 | 5128 | 467 | 4649 | 105 | 4049 |
| 6-#14 | 3.55 | 2804 | 2106 | 5763 | 1324 | 6096 | 1072 | 6222 | 848 | 6213 | 477 | 5345 | -12 | 5357 |
| 6-#18 | 6.31 | 3100 | 2462 | 6682 | 1513 | 7244 | 1217 | 7593 | 928 | 7919 | 407 | 6948 | -327 | 7180 |
| 7-#7 | 1.10 | 2556 | 1790 | 4761 | 1251 | 5020 | 1021 | 4990 | 842 | 4661 | 582 | 3981 | 292 | 2024 |
| 7-#8 | 1.45 | 2598 | 1835 | 4887 | 1276 | 5172 | 1041 | 5171 | 855 | 4572 | 540 | 4254 | 264 | 2568 |
| 7-#9 | 1.84 | 2645 | 1885 | 5024 | 1305 | 5337 | 1063 | 5368 | 868 | 5158 | 575 | 4549 | 232 | 3124 |
| 7-#10 | 2.34 | 2704 | 1949 | 5196 | 1343 | 5547 | 1091 | 5620 | 886 | 5487 | 570 | 4921 | 191 | 3813 |
| 7-#11 | 2.87 | 2758 | 2018 | 5376 | 1373 | 5747 | 1113 | 5846 | 897 | 5807 | 564 | 5213 | 135 | 4496 |
| 7-#14 | 4.14 | 2897 | 2182 | 5790 | 1470 | 6256 | 1186 | 6446 | 941 | 6172 | 515 | 6155 | 33 | 6004 |
| 7-#18 | 7.37 | 3235 | 2597 | 6786 | 1718 | 7491 | 1373 | 7891 | 1049 | 8554 | 515 | 8191 | -269 | 8319 |
| 8-#7 | 1.26 | 2571 | 1811 | 4785 | 1280 | 5096 | 1050 | 5094 | 866 | 4795 | 595 | 4185 | 292 | 2245 |
| 8-#8 | 1.66 | 2618 | 1862 | 4929 | 1311 | 5271 | 1075 | 5299 | 882 | 4726 | 553 | 4509 | 262 | 2854 |
| 8-#9 | 2.10 | 2669 | 1919 | 5085 | 1344 | 5462 | 1102 | 5522 | 899 | 4999 | 551 | 4858 | 228 | 3505 |
| 8-#10 | 2.67 | 2734 | 1992 | 5282 | 1388 | 5706 | 1138 | 5805 | 922 | 5728 | 587 | 5298 | 184 | 4319 |

## ROUND SPIRAL COLUMNS 22" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#11 | 3.28 | 2792 | 2071 | 5489 | 1426 | 5940 | 1167 | 6060 | 936 | 6059 | 574 | 5652 | 122 | 5126 |
| 8-#14 | 4.74 | 2947 | 2258 | 5964 | 1540 | 6518 | 1256 | 6739 | 991 | 6953 | 561 | 6667 | -3 | 6670 |
| 9-#10 | 3.01 | 2790 | 2036 | 5412 | 1410 | 5834 | 1143 | 5963 | 921 | 5590 | 543 | 5522 | 150 | 4718 |
| 9-#11 | 3.69 | 2861 | 2124 | 5639 | 1454 | 6088 | 1174 | 6258 | 937 | 6371 | 568 | 5914 | 81 | 5527 |
| 9-#14 | 5.33 | 3044 | 2335 | 6168 | 1584 | 6734 | 1270 | 7031 | 997 | 7399 | 554 | 7037 | -63 | 7109 |
| 10-#10 | 3.34 | 2817 | 2079 | 5603 | 1412 | 6007 | 1143 | 6146 | 913 | 6202 | 553 | 5730 | 111 | 5216 |
| 10-#11 | 4.10 | 2892 | 2177 | 5851 | 1460 | 6292 | 1177 | 6478 | 931 | 6201 | 501 | 6167 | 32 | 6029 |
| 10-#14 | 5.92 | 3088 | 2411 | 6448 | 1601 | 7023 | 1283 | 7352 | 995 | 7293 | 481 | 7406 | -131 | 7522 |
| 11-#10 | 3.68 | 2877 | 2122 | 5629 | 1473 | 6119 | 1191 | 6320 | 955 | 6023 | 544 | 6068 | 99 | 5591 |
| 11-#11 | 4.51 | 2963 | 2230 | 5899 | 1530 | 6433 | 1232 | 6680 | 977 | 6932 | 569 | 6611 | 25 | 6494 |
| 11-#14 | 6.51 | 3189 | 2487 | 6536 | 1691 | 7226 | 1353 | 7623 | 1051 | 8191 | 554 | 8003 | -147 | 8064 |
| 12-#10 | 4.01 | 2905 | 2165 | 5726 | 1508 | 6251 | 1223 | 6486 | 979 | 6692 | 589 | 6370 | 83 | 6001 |
| 12-#11 | 4.92 | 2997 | 2283 | 6016 | 1571 | 6589 | 1270 | 6884 | 1006 | 7198 | 573 | 6902 | -8 | 6911 |
| 13-#10 | 4.34 | 2956 | 2208 | 5849 | 1535 | 6409 | 1238 | 6666 | 986 | 6920 | 584 | 6657 | 55 | 6387 |
| 13-#11 | 5.33 | 3060 | 2336 | 6164 | 1605 | 6776 | 1288 | 7098 | 1015 | 7485 | 568 | 7239 | -42 | 7286 |
| 14-#10 | 4.68 | 2996 | 2251 | 5998 | 1545 | 6574 | 1248 | 6872 | 991 | 7150 | 565 | 6850 | 18 | 6771 |
| 14-#11 | 5.75 | 3104 | 2389 | 6337 | 1620 | 6978 | 1303 | 7342 | 1023 | 7818 | 562 | 7468 | -89 | 7554 |
| 15-#10 | 5.01 | 3039 | 2294 | 6075 | 1596 | 6694 | 1284 | 7018 | 1017 | 6920 | 552 | 7198 | 3 | 7181 |
| 16-#10 | 5.35 | 3081 | 2337 | 6171 | 1627 | 6843 | 1316 | 7190 | 1040 | 7650 | 598 | 7545 | -5 | 7550 |

## ROUND SPIRAL COLUMNS 24" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#8 | 1.05 | 3302 | 2122 | 6310 | 1400 | 6517 | 1142 | 6411 | 938 | 5561 | 602 | 4908 | 311 | 2475 |
| 6-#9 | 1.33 | 3345 | 2165 | 6451 | 1421 | 6687 | 1158 | 6615 | 948 | 6236 | 640 | 5186 | 280 | 3062 |
| 6-#10 | 1.68 | 3399 | 2220 | 6628 | 1449 | 6905 | 1180 | 6877 | 960 | 6583 | 633 | 5537 | 240 | 3797 |
| 6-#11 | 2.07 | 3449 | 2279 | 6812 | 1470 | 7112 | 1196 | 7119 | 967 | 6882 | 617 | 5819 | 187 | 4542 |
| 6-#14 | 2.98 | 3579 | 2419 | 7243 | 1543 | 7644 | 1252 | 7761 | 1000 | 7711 | 597 | 6637 | 77 | 6281 |
| 6-#18 | 5.31 | 3894 | 2775 | 8289 | 1733 | 8947 | 1399 | 9336 | 1085 | 9047 | 500 | 8548 | -219 | 8723 |
| 7-#8 | 1.22 | 3343 | 2149 | 6222 | 1512 | 6599 | 1235 | 6591 | 1018 | 6211 | 701 | 5375 | 346 | 2891 |
| 7-#9 | 1.55 | 3395 | 2199 | 6377 | 1541 | 6785 | 1257 | 6812 | 1032 | 6503 | 697 | 5715 | 316 | 3531 |
| 7-#10 | 1.97 | 3462 | 2263 | 6572 | 1579 | 7021 | 1286 | 7094 | 1050 | 6875 | 693 | 6145 | 276 | 4313 |
| 7-#11 | 2.41 | 3525 | 2331 | 6780 | 1608 | 7250 | 1307 | 7358 | 1061 | 7209 | 680 | 6495 | 223 | 5094 |
| 7-#14 | 3.48 | 3685 | 2495 | 7250 | 1706 | 7826 | 1381 | 8048 | 1108 | 7571 | 623 | 7498 | 115 | 6928 |
| 7-#18 | 6.19 | 4072 | 2911 | 8385 | 1955 | 9230 | 1570 | 9705 | 1221 | 9689 | 606 | 10017 | -153 | 10035 |
| 8-#8 | 1.40 | 3366 | 2175 | 6259 | 1550 | 6707 | 1272 | 6743 | 1049 | 6403 | 717 | 5594 | 336 | 3201 |
| 8-#9 | 1.77 | 3424 | 2232 | 6435 | 1583 | 6921 | 1299 | 6995 | 1067 | 6733 | 715 | 5983 | 302 | 3936 |
| 8-#10 | 2.25 | 3498 | 2306 | 6657 | 1627 | 7194 | 1335 | 7316 | 1090 | 7153 | 713 | 6581 | 273 | 4855 |
| 8-#11 | 2.76 | 3566 | 2384 | 6895 | 1664 | 7463 | 1364 | 7609 | 1104 | 7533 | 701 | 7003 | 215 | 5777 |
| 8-#14 | 3.98 | 3743 | 2572 | 7432 | 1778 | 8132 | 1456 | 8384 | 1162 | 7981 | 645 | 8192 | 97 | 7765 |
| 8-#18 | 7.07 | 4172 | 3046 | 8736 | 2070 | 9731 | 1685 | 10258 | 1305 | 10285 | 616 | 10982 | -222 | 11120 |
| 9-#10 | 2.53 | 3561 | 2349 | 6809 | 1647 | 7346 | 1340 | 7484 | 1087 | 7439 | 706 | 6837 | 239 | 5348 |
| 9-#11 | 3.10 | 3641 | 2437 | 7069 | 1691 | 7637 | 1370 | 7820 | 1103 | 7360 | 649 | 7306 | 173 | 6305 |
| 9-#14 | 4.48 | 3850 | 2648 | 7669 | 1821 | 8371 | 1468 | 8697 | 1165 | 9058 | 685 | 8624 | 39 | 8427 |
| 9-#18 | 7.96 | 4366 | 3182 | 9123 | 2153 | 10153 | 1716 | 10833 | 1318 | 11892 | 650 | 11708 | -326 | 11939 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 10-#10 | 2.81 | 3591 | 2392 | 7034 | 1645 | 7543 | 1336 | 7688 | 1076 | 7667 | 675 | 7068 | 200 | 5881 |
| 10-#11 | 3.45 | 3677 | 2490 | 7326 | 1694 | 7871 | 1371 | 8068 | 1095 | 8172 | 660 | 7590 | 126 | 6976 |
| 10-#14 | 4.97 | 3901 | 2724 | 8006 | 1836 | 8701 | 1478 | 9059 | 1161 | 9497 | 642 | 9046 | -27 | 9073 |
| 11-#10 | 3.09 | 3660 | 2435 | 7053 | 1712 | 7662 | 1388 | 7885 | 1122 | 7960 | 709 | 7466 | 191 | 6349 |
| 11-#11 | 3.79 | 3759 | 2543 | 7362 | 1768 | 8020 | 1429 | 8301 | 1145 | 8507 | 697 | 8043 | 111 | 7463 |
| 11-#14 | 5.47 | 4017 | 2801 | 8085 | 1930 | 8917 | 1552 | 9373 | 1223 | 9944 | 686 | 9649 | -54 | 9709 |
| 12-#10 | 3.37 | 3690 | 2478 | 7159 | 1749 | 7810 | 1423 | 8069 | 1147 | 8228 | 716 | 7814 | 177 | 6879 |
| 12-#11 | 4.14 | 3795 | 2596 | 7493 | 1812 | 8197 | 1469 | 8522 | 1175 | 8831 | 704 | 8450 | 92 | 8007 |
| 12-#14 | 5.97 | 4069 | 2877 | 8275 | 1989 | 9167 | 1606 | 9690 | 1263 | 9686 | 646 | 10210 | -86 | 10284 |
| 13-#10 | 3.65 | 3749 | 2521 | 7295 | 1774 | 7989 | 1437 | 8272 | 1154 | 8489 | 712 | 8143 | 150 | 7316 |
| 13-#11 | 4.48 | 3865 | 2649 | 7657 | 1844 | 8410 | 1488 | 8765 | 1183 | 8527 | 652 | 8839 | 58 | 8531 |
| 13-#14 | 6.47 | 4173 | 2953 | 8508 | 2038 | 9466 | 1634 | 10035 | 1277 | 10828 | 686 | 10757 | -134 | 10868 |
| 14-#10 | 3.93 | 3794 | 2564 | 7470 | 1782 | 8171 | 1444 | 8495 | 1157 | 8746 | 693 | 8362 | 113 | 7790 |
| 14-#11 | 4.83 | 3919 | 2702 | 7858 | 1857 | 8631 | 1500 | 9042 | 1190 | 9447 | 675 | 9101 | 13 | 9040 |
| 15-#10 | 4.21 | 3843 | 2607 | 7546 | 1836 | 8306 | 1483 | 8671 | 1187 | 8416 | 666 | 8764 | 100 | 8232 |
| 15-#11 | 5.17 | 3977 | 2755 | 7961 | 1920 | 8793 | 1544 | 9240 | 1222 | 9149 | 661 | 9568 | -5 | 9574 |
| 16-#10 | 4.49 | 3889 | 2650 | 7653 | 1867 | 8468 | 1515 | 8866 | 1211 | 9305 | 728 | 9162 | 94 | 8689 |
| 16-#11 | 5.52 | 4033 | 2808 | 8091 | 1957 | 8992 | 1583 | 9471 | 1251 | 10118 | 716 | 10037 | -15 | 10051 |
| 17-#10 | 4.77 | 3940 | 2693 | 7805 | 1891 | 8632 | 1531 | 9058 | 1218 | 8925 | 674 | 9437 | 58 | 9123 |
| 18-#10 | 5.05 | 3988 | 2736 | 7956 | 1912 | 8819 | 1546 | 9266 | 1225 | 9859 | 715 | 9727 | 35 | 9553 |

## ROUND SPIRAL COLUMNS 26" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#9 | 1.13 | 4221 | 2505 | 8071 | 1662 | 8371 | 1356 | 8264 | 1113 | 7217 | 712 | 6428 | 363 | 3383 |
| 6-#10 | 1.44 | 4281 | 2560 | 8269 | 1690 | 8612 | 1378 | 8554 | 1126 | 8125 | 757 | 6828 | 325 | 4201 |
| 6-#11 | 1.76 | 4338 | 2619 | 8477 | 1710 | 8845 | 1393 | 8825 | 1132 | 8483 | 743 | 7157 | 274 | 5035 |
| 6-#14 | 2.54 | 4484 | 2759 | 8959 | 1783 | 9438 | 1449 | 9539 | 1165 | 8793 | 677 | 8098 | 169 | 6988 |
| 6-#18 | 4.52 | 4840 | 3116 | 10132 | 1973 | 10895 | 1596 | 11299 | 1251 | 10903 | 627 | 10322 | -112 | 10422 |
| 7-#9 | 1.32 | 4277 | 2539 | 7955 | 1799 | 8478 | 1469 | 8499 | 1210 | 8068 | 830 | 7058 | 405 | 3949 |
| 7-#10 | 1.67 | 4352 | 2603 | 8173 | 1836 | 8740 | 1498 | 8812 | 1228 | 7917 | 772 | 7547 | 367 | 4824 |
| 7-#11 | 2.06 | 4422 | 2672 | 8409 | 1865 | 8998 | 1519 | 9107 | 1239 | 8859 | 814 | 7956 | 317 | 5705 |
| 7-#14 | 2.97 | 4605 | 2836 | 8935 | 1962 | 9641 | 1593 | 9878 | 1287 | 9871 | 803 | 9109 | 214 | 7766 |
| 7-#18 | 5.27 | 5041 | 3251 | 10212 | 2213 | 11214 | 1783 | 11764 | 1407 | 11600 | 739 | 11836 | -62 | 11910 |
| 8-#9 | 1.51 | 4311 | 2573 | 8007 | 1844 | 8624 | 1504 | 8712 | 1249 | 8331 | 851 | 7348 | 391 | 4371 |
| 8-#10 | 1.91 | 4394 | 2646 | 8254 | 1888 | 8926 | 1537 | 9070 | 1272 | 8213 | 793 | 7903 | 349 | 5396 |
| 8-#11 | 2.35 | 4471 | 2725 | 8523 | 1924 | 9228 | 1578 | 9402 | 1287 | 8613 | 782 | 8534 | 312 | 6433 |
| 8-#14 | 3.39 | 4670 | 2912 | 9123 | 2037 | 9972 | 1670 | 10273 | 1347 | 10371 | 831 | 9899 | 201 | 8869 |
| 8-#18 | 6.03 | 5156 | 3387 | 10583 | 2330 | 11799 | 1907 | 12390 | 1495 | 13156 | 807 | 13131 | -99 | 13200 |
| 9-#10 | 2.15 | 4462 | 2689 | 8429 | 1906 | 9103 | 1554 | 9249 | 1267 | 9104 | 841 | 8326 | 332 | 5993 |
| 9-#11 | 2.64 | 4553 | 2778 | 8724 | 1949 | 9431 | 1585 | 9627 | 1284 | 9609 | 831 | 8878 | 270 | 7074 |
| 9-#14 | 3.81 | 4788 | 2988 | 9394 | 2079 | 10252 | 1683 | 10607 | 1347 | 10936 | 824 | 10392 | 143 | 9582 |
| 9-#18 | 6.78 | 5358 | 3523 | 11024 | 2413 | 12255 | 1934 | 13005 | 1505 | 13197 | 746 | 13971 | -201 | 14159 |
| 10-#10 | 2.39 | 4497 | 2732 | 8689 | 1899 | 9325 | 1546 | 9472 | 1254 | 8727 | 754 | 8583 | 294 | 6556 |
| 10-#11 | 2.94 | 4595 | 2831 | 9023 | 1948 | 9694 | 1581 | 9900 | 1272 | 9256 | 740 | 9191 | 223 | 7790 |
| 10-#14 | 4.24 | 4846 | 3065 | 9793 | 2091 | 10625 | 1690 | 11009 | 1340 | 10639 | 725 | 10863 | 78 | 10472 |
| 10-#18 | 7.53 | 5461 | 3658 | 11641 | 2454 | 12893 | 1964 | 13718 | 1508 | 14022 | 683 | 14815 | -315 | 15023 |

## ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 11-#10 | 2.63 | 4575 | 2775 | 8699 | 1972 | 9449 | 1603 | 9690 | 1303 | 9041 | 789 | 9032 | 286 | 7121 |
| 11-#11 | 3.23 | 4687 | 2884 | 9050 | 2028 | 9851 | 1644 | 10160 | 1327 | 9616 | 778 | 9717 | 211 | 8400 |
| 11-#14 | 4.66 | 4977 | 3141 | 9859 | 2191 | 10853 | 1768 | 11366 | 1407 | 11911 | 826 | 11562 | 55 | 11254 |
| 12-#10 | 2.87 | 4606 | 2818 | 8814 | 2011 | 9613 | 1626 | 9895 | 1330 | 9313 | 796 | 9413 | 273 | 7682 |
| 12-#11 | 3.53 | 4726 | 2936 | 9192 | 2073 | 10049 | 1686 | 10404 | 1358 | 9949 | 786 | 10179 | 194 | 9110 |
| 12-#14 | 5.09 | 5033 | 3217 | 10069 | 2252 | 11133 | 1824 | 11707 | 1448 | 12418 | 837 | 12202 | 27 | 12067 |
| 13-#10 | 3.11 | 4673 | 2862 | 8965 | 2035 | 9810 | 1653 | 10122 | 1336 | 10280 | 850 | 9793 | 247 | 8209 |
| 13-#11 | 3.82 | 4805 | 2989 | 9374 | 2104 | 10288 | 1704 | 10676 | 1366 | 11009 | 838 | 10620 | 161 | 9668 |
| 13-#14 | 5.51 | 5145 | 3294 | 10324 | 2299 | 11470 | 1852 | 12094 | 1462 | 12905 | 829 | 12824 | -21 | 12846 |
| 14-#10 | 3.35 | 4720 | 2905 | 9166 | 2041 | 10012 | 1658 | 10362 | 1337 | 9859 | 775 | 10053 | 213 | 8790 |
| 14-#11 | 4.11 | 4865 | 3042 | 9605 | 2115 | 10529 | 1714 | 10974 | 1371 | 11354 | 814 | 10915 | 117 | 10281 |
| 14-#14 | 5.93 | 5228 | 3370 | 10635 | 2322 | 11818 | 1872 | 12532 | 1474 | 13406 | 799 | 13253 | -84 | 13327 |
| 15-#10 | 3.59 | 4778 | 2948 | 9254 | 2091 | 10161 | 1700 | 10561 | 1370 | 10858 | 852 | 10494 | 199 | 9282 |
| 15-#11 | 4.41 | 4930 | 3095 | 9707 | 2181 | 10709 | 1761 | 11207 | 1407 | 10931 | 784 | 11449 | 101 | 10878 |
| 16-#10 | 3.83 | 4830 | 2991 | 9357 | 2130 | 10336 | 1720 | 10787 | 1396 | 10388 | 798 | 10819 | 179 | 9856 |
| 16-#11 | 4.70 | 4992 | 3148 | 9850 | 2219 | 10925 | 1800 | 11468 | 1437 | 11289 | 800 | 11978 | 93 | 11475 |
| 17-#10 | 4.07 | 4883 | 3034 | 9528 | 2153 | 10520 | 1748 | 10992 | 1402 | 11468 | 861 | 11252 | 159 | 10306 |
| 17-#11 | 5.00 | 5059 | 3201 | 10053 | 2248 | 11143 | 1819 | 11723 | 1445 | 12439 | 849 | 12347 | 49 | 12060 |
| 18-#10 | 4.31 | 4939 | 3077 | 9696 | 2172 | 10736 | 1763 | 11224 | 1408 | 11786 | 853 | 11587 | 138 | 10820 |
| 18-#11 | 5.29 | 5123 | 3254 | 10253 | 2274 | 11394 | 1838 | 12001 | 1454 | 12835 | 842 | 12736 | 21 | 12624 |
| 19-#10 | 4.54 | 4991 | 3120 | 9800 | 2214 | 10875 | 1788 | 11430 | 1435 | 12053 | 864 | 11948 | 113 | 11312 |
| 20-#10 | 4.78 | 5050 | 3163 | 9921 | 2252 | 11048 | 1812 | 11638 | 1457 | 11535 | 814 | 12327 | 99 | 11783 |

## ROUND SPIRAL COLUMNS 28" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#10 | 1.24 | 5306 | 2928 | 10163 | 1951 | 10585 | 1592 | 10490 | 1305 | 9888 | 889 | 8301 | 415 | 4606 |
| 6-#11 | 1.52 | 5369 | 2987 | 10396 | 1970 | 10843 | 1606 | 10789 | 1311 | 10292 | 877 | 8678 | 366 | 5530 |
| 6-#14 | 2.19 | 5533 | 3127 | 10929 | 2043 | 11497 | 1663 | 11576 | 1344 | 10603 | 805 | 9743 | 265 | 7696 |
| 6-#18 | 3.90 | 5930 | 3483 | 12229 | 2232 | 13108 | 1810 | 13520 | 1431 | 12975 | 761 | 12280 | -3 | 12283 |
| 7-#9 | 1.14 | 5300 | 2907 | 9775 | 2078 | 10434 | 1694 | 10449 | 1403 | 9213 | 909 | 8576 | 498 | 4335 |
| 7-#10 | 1.44 | 5383 | 2971 | 10016 | 2115 | 10723 | 1728 | 10793 | 1422 | 10328 | 971 | 9127 | 463 | 5346 |
| 7-#11 | 1.77 | 5462 | 3040 | 10281 | 2143 | 11010 | 1748 | 11120 | 1432 | 10031 | 895 | 9609 | 415 | 6328 |
| 7-#14 | 2.56 | 5664 | 3203 | 10865 | 2240 | 11720 | 1822 | 11970 | 1480 | 11869 | 950 | 10913 | 317 | 8619 |
| 7-#18 | 4.55 | 6155 | 3619 | 12283 | 2491 | 13463 | 2014 | 14065 | 1602 | 14617 | 923 | 14021 | 55 | 13709 |
| 8-#9 | 1.30 | 5339 | 2941 | 9818 | 2127 | 10589 | 1737 | 10689 | 1446 | 10169 | 998 | 8908 | 488 | 4811 |
| 8-#10 | 1.65 | 5431 | 3014 | 10090 | 2171 | 10922 | 1770 | 11088 | 1470 | 10686 | 997 | 9523 | 446 | 5943 |
| 8-#11 | 2.03 | 5518 | 3093 | 10392 | 2205 | 11256 | 1794 | 11459 | 1485 | 11163 | 986 | 10075 | 392 | 7095 |
| 8-#14 | 2.92 | 5741 | 3280 | 11055 | 2319 | 12076 | 1902 | 12426 | 1546 | 12430 | 981 | 11568 | 280 | 9798 |
| 8-#18 | 5.20 | 6283 | 3755 | 12672 | 2611 | 14094 | 2140 | 14787 | 1698 | 15532 | 963 | 15480 | 25 | 15359 |
| 9-#10 | 1.86 | 5505 | 3057 | 10291 | 2186 | 11120 | 1779 | 11277 | 1462 | 10274 | 921 | 9990 | 429 | 6663 |
| 9-#11 | 2.28 | 5608 | 3145 | 10621 | 2228 | 11489 | 1816 | 11696 | 1479 | 10796 | 911 | 10638 | 371 | 7859 |
| 9-#14 | 3.29 | 5869 | 3356 | 11362 | 2359 | 12398 | 1916 | 12780 | 1543 | 12164 | 907 | 12356 | 251 | 10689 |
| 9-#18 | 5.85 | 6503 | 3890 | 13168 | 2693 | 14623 | 2169 | 15440 | 1705 | 16627 | 956 | 16434 | -76 | 16514 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 28" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 10-#10 | 2.06 | 5545 | 3100 | 10590 | 2174 | 11371 | 1774 | 11519 | 1445 | 11270 | 950 | 10289 | 392 | 7240 |
| 10-#11 | 2.53 | 5654 | 3198 | 10961 | 2222 | 11783 | 1809 | 11995 | 1464 | 11898 | 936 | 10984 | 325 | 8615 |
| 10-#14 | 3.65 | 5935 | 3432 | 11812 | 2365 | 12814 | 1918 | 13222 | 1533 | 13536 | 922 | 12874 | 187 | 11834 |
| 10-#18 | 6.50 | 6619 | 4026 | 13885 | 2732 | 15335 | 2196 | 16231 | 1705 | 17559 | 883 | 17377 | -185 | 17514 |
| 11-#10 | 2.27 | 5629 | 3143 | 10585 | 2254 | 11499 | 1830 | 11758 | 1499 | 11654 | 993 | 10780 | 385 | 7911 |
| 11-#11 | 2.79 | 5757 | 3251 | 10980 | 2310 | 11947 | 1877 | 12279 | 1523 | 12338 | 982 | 11571 | 315 | 9340 |
| 11-#14 | 4.02 | 6080 | 3509 | 11876 | 2473 | 13054 | 2001 | 13610 | 1604 | 13175 | 911 | 13672 | 167 | 12666 |
| 11-#18 | 7.15 | 6864 | 4162 | 14058 | 2889 | 15769 | 2316 | 16878 | 1809 | 18478 | 958 | 18638 | -235 | 18811 |
| 12-#10 | 2.48 | 5665 | 3186 | 10708 | 2295 | 11680 | 1861 | 11985 | 1528 | 11969 | 1001 | 11207 | 374 | 8498 |
| 12-#11 | 3.04 | 5799 | 3304 | 11132 | 2357 | 12164 | 1905 | 12550 | 1556 | 12722 | 991 | 12073 | 298 | 10091 |
| 12-#14 | 4.38 | 6140 | 3585 | 12103 | 2536 | 13362 | 2059 | 13988 | 1647 | 14662 | 987 | 14375 | 141 | 13596 |
| 13-#10 | 2.68 | 5739 | 3229 | 10875 | 2317 | 11893 | 1880 | 12236 | 1534 | 12304 | 998 | 11629 | 348 | 9124 |
| 13-#11 | 3.29 | 5887 | 3357 | 11331 | 2386 | 12424 | 1937 | 12851 | 1564 | 12247 | 921 | 12576 | 267 | 10769 |
| 13-#14 | 4.75 | 6266 | 3661 | 12381 | 2582 | 13736 | 2087 | 14418 | 1661 | 15222 | 982 | 15089 | 95 | 14504 |
| 14-#10 | 2.89 | 5790 | 3272 | 11105 | 2321 | 12117 | 1889 | 12492 | 1532 | 12619 | 977 | 11907 | 314 | 9734 |
| 14-#11 | 3.55 | 5949 | 3410 | 11594 | 2395 | 12692 | 1945 | 13170 | 1566 | 12599 | 899 | 12923 | 225 | 11532 |
| 14-#14 | 5.12 | 6358 | 3738 | 12734 | 2602 | 14114 | 2105 | 14888 | 1671 | 15774 | 951 | 15567 | 34 | 15377 |
| 15-#10 | 3.09 | 5856 | 3315 | 11189 | 2374 | 12281 | 1928 | 12714 | 1567 | 12940 | 1001 | 12412 | 302 | 10318 |
| 15-#11 | 3.80 | 6026 | 3463 | 11714 | 2455 | 12889 | 1995 | 13431 | 1605 | 12961 | 924 | 13503 | 208 | 12179 |
| 15-#14 | 5.48 | 6462 | 3814 | 12903 | 2692 | 14394 | 2169 | 15246 | 1720 | 16315 | 985 | 16390 | 9 | 16339 |
| 16-#10 | 3.30 | 5913 | 3358 | 11300 | 2414 | 12468 | 1954 | 12971 | 1595 | 13241 | 1004 | 12777 | 284 | 10925 |
| 16-#11 | 4.05 | 6094 | 3516 | 11851 | 2503 | 13121 | 2019 | 13729 | 1637 | 14244 | 992 | 13932 | 183 | 12892 |
| 16-#14 | 5.85 | 6557 | 3890 | 13130 | 2746 | 14729 | 2224 | 15656 | 1762 | 16913 | 1010 | 16986 | -31 | 17005 |
| 17-#10 | 3.51 | 5971 | 3402 | 11491 | 2437 | 12671 | 1976 | 13191 | 1601 | 13614 | 1011 | 13255 | 264 | 11482 |
| 17-#11 | 4.31 | 6165 | 3569 | 12077 | 2531 | 13363 | 2054 | 14002 | 1644 | 14693 | 1001 | 14505 | 159 | 13498 |
| 18-#10 | 3.71 | 6033 | 3445 | 11679 | 2454 | 12911 | 1983 | 13445 | 1606 | 13022 | 935 | 13602 | 242 | 12096 |
| 18-#11 | 4.56 | 6239 | 3622 | 12298 | 2556 | 13649 | 2073 | 14309 | 1652 | 14107 | 925 | 14950 | 133 | 14162 |
| 19-#10 | 3.92 | 6091 | 3488 | 11788 | 2498 | 13064 | 2023 | 13668 | 1633 | 14251 | 1014 | 14021 | 220 | 12638 |
| 19-#11 | 4.81 | 6308 | 3675 | 12437 | 2606 | 13834 | 2103 | 14581 | 1684 | 15466 | 1004 | 15426 | 103 | 14803 |
| 20-#10 | 4.13 | 6155 | 3531 | 11916 | 2537 | 13254 | 2048 | 13897 | 1656 | 14600 | 1025 | 14458 | 208 | 13196 |
| 20-#11 | 5.07 | 6386 | 3727 | 12597 | 2653 | 14062 | 2132 | 14855 | 1711 | 15870 | 1014 | 15927 | 85 | 15428 |
| 21-#10 | 4.33 | 6209 | 3574 | 12090 | 2560 | 13452 | 2070 | 14145 | 1666 | 14891 | 1017 | 14794 | 175 | 13727 |
| 22-#10 | 4.54 | 6281 | 3617 | 12281 | 2584 | 13669 | 2079 | 14401 | 1675 | 15231 | 1011 | 15166 | 152 | 14262 |

## ROUND SPIRAL COLUMNS 30" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#10 | 1.08 | 6483 | 3323 | 12329 | 2232 | 12844 | 1823 | 12706 | 1499 | 11106 | 963 | 9972 | 510 | 5012 |
| 6-#11 | 1.32 | 6553 | 3382 | 12588 | 2251 | 13128 | 1836 | 13033 | 1504 | 12340 | 1019 | 10396 | 463 | 6026 |
| 6-#14 | 1.91 | 6734 | 3522 | 13172 | 2323 | 13843 | 1893 | 13892 | 1537 | 12605 | 938 | 11584 | 366 | 8402 |
| 6-#18 | 3.40 | 7173 | 3878 | 14600 | 2512 | 15608 | 2040 | 16021 | 1624 | 16370 | 968 | 14436 | 109 | 13886 |
| 7-#10 | 1.26 | 6567 | 3366 | 12120 | 2415 | 12991 | 1969 | 13058 | 1630 | 11602 | 1051 | 10907 | 564 | 5864 |
| 7-#11 | 1.54 | 6655 | 3435 | 12415 | 2443 | 13307 | 1995 | 13417 | 1639 | 12032 | 1040 | 11453 | 518 | 6963 |
| 7-#14 | 2.23 | 6877 | 3598 | 13057 | 2540 | 14084 | 2069 | 14345 | 1688 | 14123 | 1106 | 12926 | 426 | 9488 |
| 7-#18 | 3.96 | 7422 | 4014 | 14618 | 2791 | 15997 | 2262 | 16642 | 1811 | 17150 | 1083 | 16416 | 174 | 15319 |
| 8-#10 | 1.44 | 6621 | 3409 | 12185 | 2475 | 13201 | 2021 | 13379 | 1681 | 12832 | 1155 | 11355 | 550 | 6495 |
| 8-#11 | 1.77 | 6718 | 3487 | 12519 | 2509 | 13568 | 2045 | 13801 | 1697 | 13357 | 1144 | 11967 | 497 | 7763 |

## ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 8-#14 | 2.55 | 6965 | 3675 | 13245 | 2622 | 14464 | 2130 | 14864 | 1759 | 13765 | 1065 | 13615 | 388 | 10734 |
| 8-#18 | 4.53 | 7564 | 4150 | 15020 | 2914 | 16673 | 2390 | 17469 | 1915 | 16956 | 1053 | 18042 | 151 | 17236 |
| 9-#10 | 1.62 | 6702 | 3452 | 12412 | 2489 | 13420 | 2028 | 13589 | 1672 | 12291 | 1066 | 11863 | 532 | 7313 |
| 9-#11 | 1.99 | 6815 | 3540 | 12778 | 2530 | 13829 | 2057 | 14050 | 1689 | 13783 | 1133 | 12584 | 476 | 8661 |
| 9-#14 | 2.86 | 7103 | 3751 | 13591 | 2660 | 14829 | 2166 | 15237 | 1754 | 15386 | 1129 | 14508 | 361 | 11783 |
| 9-#18 | 5.09 | 7804 | 4285 | 15575 | 2995 | 17276 | 2421 | 18160 | 1918 | 18051 | 1044 | 19109 | 51 | 18790 |
| 10-#10 | 1.80 | 6746 | 3495 | 12754 | 2470 | 13702 | 2019 | 13849 | 1651 | 12548 | 1030 | 12200 | 496 | 7934 |
| 10-#11 | 2.21 | 6867 | 3593 | 13164 | 2517 | 14157 | 2054 | 14373 | 1670 | 13192 | 1017 | 12983 | 432 | 9449 |
| 10-#14 | 3.18 | 7177 | 3827 | 14095 | 2660 | 15289 | 2164 | 15718 | 1740 | 15929 | 1078 | 15092 | 300 | 13009 |
| 10-#18 | 5.66 | 7932 | 4421 | 16377 | 3028 | 18063 | 2444 | 19027 | 1916 | 18992 | 974 | 20149 | -56 | 20195 |
| 11-#10 | 1.98 | 6837 | 3538 | 12729 | 2557 | 13834 | 2080 | 14110 | 1710 | 13879 | 1150 | 12738 | 490 | 8715 |
| 11-#11 | 2.43 | 6978 | 3646 | 13167 | 2612 | 14327 | 2119 | 14682 | 1734 | 13655 | 1064 | 13619 | 422 | 10300 |
| 11-#14 | 3.50 | 7335 | 3904 | 14152 | 2776 | 15538 | 2252 | 16138 | 1816 | 16580 | 1137 | 15957 | 279 | 14016 |
| 11-#18 | 6.22 | 8200 | 4556 | 16552 | 3194 | 18518 | 2569 | 19730 | 2025 | 21376 | 1124 | 21571 | -102 | 21667 |
| 12-#10 | 2.16 | 6877 | 3581 | 12861 | 2601 | 14030 | 2114 | 14360 | 1740 | 14219 | 1159 | 13212 | 481 | 9328 |
| 12-#11 | 2.65 | 7026 | 3699 | 13331 | 2662 | 14564 | 2157 | 14980 | 1768 | 15044 | 1149 | 14177 | 408 | 11086 |
| 12-#14 | 3.82 | 7402 | 3980 | 14397 | 2841 | 15876 | 2289 | 16554 | 1861 | 16021 | 1071 | 16729 | 256 | 15185 |
| 12-#18 | 6.79 | 8322 | 4692 | 16998 | 3298 | 19100 | 2667 | 20434 | 2096 | 20908 | 1064 | 22904 | -149 | 22943 |
| 13-#10 | 2.34 | 6959 | 3624 | 13044 | 2622 | 14259 | 2131 | 14634 | 1746 | 13611 | 1079 | 13675 | 455 | 10073 |
| 13-#11 | 2.87 | 7123 | 3752 | 13548 | 2690 | 14844 | 2180 | 15310 | 1776 | 14453 | 1070 | 14732 | 376 | 11881 |
| 13-#14 | 4.14 | 7540 | 4056 | 14699 | 2886 | 16278 | 2327 | 17025 | 1875 | 17797 | 1145 | 17521 | 210 | 16118 |
| 13-#18 | 7.36 | 8563 | 4828 | 17516 | 3385 | 19808 | 2720 | 21249 | 2123 | 23456 | 1131 | 24228 | -232 | 24285 |
| 14-#10 | 2.52 | 7013 | 3667 | 13304 | 2622 | 14507 | 2125 | 14906 | 1741 | 13936 | 1059 | 13953 | 419 | 10694 |
| 14-#11 | 3.09 | 7189 | 3805 | 13846 | 2696 | 15139 | 2193 | 15650 | 1775 | 14841 | 1047 | 15104 | 335 | 12697 |
| 14-#14 | 4.46 | 7634 | 4133 | 15095 | 2904 | 16695 | 2354 | 17528 | 1881 | 18399 | 1113 | 18092 | 154 | 17138 |
| 15-#10 | 2.70 | 7085 | 3710 | 13383 | 2678 | 14684 | 2180 | 15151 | 1780 | 14261 | 1083 | 14533 | 410 | 11379 |
| 15-#11 | 3.31 | 7276 | 3858 | 13962 | 2759 | 15354 | 2239 | 15938 | 1817 | 16320 | 1150 | 15760 | 320 | 13439 |
| 15-#14 | 4.77 | 7756 | 4209 | 15293 | 2984 | 17001 | 2410 | 17923 | 1933 | 17715 | 1072 | 18965 | 127 | 18132 |
| 16-#10 | 2.87 | 7149 | 3753 | 13501 | 2720 | 14884 | 2207 | 15427 | 1808 | 15612 | 1164 | 14946 | 394 | 12011 |
| 16-#11 | 3.53 | 7350 | 3911 | 14109 | 2808 | 15601 | 2271 | 16275 | 1851 | 16715 | 1153 | 16238 | 297 | 14249 |
| 16-#14 | 5.09 | 7860 | 4285 | 15510 | 3052 | 17358 | 2454 | 18388 | 1979 | 18230 | 1074 | 19629 | 91 | 19152 |
| 17-#10 | 3.05 | 7213 | 3796 | 13711 | 2742 | 15106 | 2228 | 15674 | 1814 | 14923 | 1087 | 15382 | 366 | 12663 |
| 17-#11 | 3.75 | 7427 | 3964 | 14359 | 2836 | 15867 | 2298 | 16565 | 1858 | 16058 | 1085 | 16869 | 273 | 14957 |
| 17-#14 | 5.41 | 7972 | 4361 | 15858 | 3094 | 17736 | 2494 | 18811 | 1990 | 18884 | 1087 | 20525 | 57 | 20153 |
| 18-#10 | 3.23 | 7280 | 3840 | 13920 | 2757 | 15366 | 2234 | 15951 | 1818 | 15284 | 1083 | 15827 | 350 | 13304 |
| 18-#11 | 3.97 | 7508 | 4017 | 14603 | 2858 | 16183 | 2308 | 16900 | 1865 | 17652 | 1151 | 17327 | 245 | 15753 |
| 19-#10 | 3.41 | 7344 | 3883 | 14034 | 2804 | 15536 | 2277 | 16190 | 1847 | 16708 | 1175 | 16294 | 331 | 13935 |
| 19-#11 | 4.19 | 7584 | 4069 | 14749 | 2911 | 16383 | 2356 | 17192 | 1898 | 16840 | 1088 | 17875 | 218 | 16432 |
| 20-#10 | 3.59 | 7414 | 3926 | 14169 | 2842 | 15744 | 2302 | 16441 | 1870 | 17085 | 1185 | 16783 | 320 | 14573 |
| 20-#11 | 4.41 | 7669 | 4122 | 14919 | 2958 | 16633 | 2386 | 17493 | 1926 | 18499 | 1178 | 18444 | 203 | 17138 |
| 21-#10 | 3.77 | 7473 | 3969 | 14361 | 2865 | 15957 | 2324 | 16713 | 1880 | 16248 | 1100 | 17148 | 288 | 15177 |
| 21-#11 | 4.63 | 7740 | 4175 | 15147 | 2987 | 16894 | 2414 | 17819 | 1938 | 18883 | 1169 | 18888 | 163 | 17851 |
| 22-#10 | 3.95 | 7550 | 4012 | 14571 | 2888 | 16195 | 2332 | 16985 | 1888 | 17779 | 1172 | 17556 | 264 | 15824 |
| 23-#10 | 4.13 | 7606 | 4055 | 14692 | 2928 | 16385 | 2371 | 17240 | 1919 | 18105 | 1182 | 18067 | 252 | 16408 |
| 24-#10 | 4.31 | 7680 | 4098 | 14837 | 2966 | 16586 | 2394 | 17496 | 1937 | 18456 | 1189 | 18466 | 227 | 17024 |

## ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.16 | 7901 | 3804 | 15071 | 2551 | 15718 | 2083 | 15577 | 1711 | 14653 | 1172 | 12324 | 565 | 6523 |
| 6-#14 | 1.68 | 8098 | 3944 | 15707 | 2623 | 16494 | 2140 | 16508 | 1744 | 14855 | 1081 | 13637 | 472 | 9109 |
| 6-#18 | 2.98 | 8581 | 4300 | 17264 | 2812 | 18414 | 2286 | 18820 | 1831 | 19055 | 1124 | 16805 | 224 | 15293 |
| 7-#10 | 1.11 | 7915 | 3788 | 14503 | 2737 | 15563 | 2234 | 15627 | 1853 | 13822 | 1206 | 12911 | 672 | 6349 |
| 7-#11 | 1.36 | 8011 | 3857 | 14828 | 2764 | 15908 | 2252 | 16017 | 1862 | 14291 | 1195 | 13509 | 627 | 7609 |
| 7-#14 | 1.96 | 8254 | 4021 | 15528 | 2861 | 16753 | 2334 | 17025 | 1910 | 15542 | 1188 | 15125 | 537 | 10371 |
| 7-#18 | 3.48 | 8847 | 4436 | 17233 | 3112 | 18837 | 2527 | 19522 | 2035 | 19958 | 1254 | 19037 | 298 | 16907 |
| 8-#10 | 1.26 | 7975 | 3831 | 14554 | 2802 | 15784 | 2290 | 15974 | 1907 | 15255 | 1324 | 13412 | 660 | 7052 |
| 8-#11 | 1.55 | 8082 | 3910 | 14922 | 2835 | 16185 | 2313 | 16433 | 1923 | 15828 | 1313 | 14084 | 608 | 8436 |
| 8-#14 | 2.24 | 8352 | 4097 | 15712 | 2947 | 17156 | 2398 | 17603 | 1987 | 17344 | 1311 | 15888 | 502 | 11678 |
| 8-#18 | 3.98 | 9011 | 4572 | 17646 | 3239 | 19557 | 2618 | 20456 | 2146 | 19675 | 1216 | 20300 | 225 | 19190 |
| 9-#10 | 1.42 | 8061 | 3874 | 14810 | 2813 | 16024 | 2296 | 16205 | 1898 | 14567 | 1222 | 13961 | 642 | 7936 |
| 9-#11 | 1.75 | 8187 | 3963 | 15213 | 2853 | 16470 | 2324 | 16708 | 1914 | 15190 | 1213 | 14753 | 587 | 9494 |
| 9-#14 | 2.52 | 8502 | 4173 | 16098 | 2983 | 17558 | 2421 | 17998 | 1979 | 18016 | 1297 | 16862 | 475 | 12896 |
| 9-#18 | 4.48 | 9269 | 4707 | 18261 | 3318 | 20234 | 2690 | 21184 | 2146 | 22322 | 1290 | 22006 | 180 | 20775 |
| 10-#10 | 1.58 | 8110 | 3917 | 15199 | 2787 | 16338 | 2282 | 16483 | 1872 | 15892 | 1267 | 14292 | 603 | 8637 |
| 10-#11 | 1.94 | 8244 | 4015 | 15649 | 2834 | 16836 | 2316 | 17054 | 1890 | 16644 | 1254 | 15203 | 544 | 10295 |
| 10-#14 | 2.80 | 8583 | 4250 | 16661 | 2976 | 18069 | 2426 | 18517 | 1961 | 17354 | 1160 | 17531 | 417 | 14183 |
| 10-#18 | 4.97 | 9411 | 4843 | 19144 | 3344 | 21098 | 2709 | 22126 | 2140 | 21851 | 1132 | 23145 | 76 | 22688 |
| 11-#10 | 1.74 | 8208 | 3960 | 15148 | 2882 | 16472 | 2349 | 16767 | 1936 | 16380 | 1319 | 14921 | 602 | 9475 |
| 11-#11 | 2.13 | 8364 | 4068 | 15629 | 2936 | 17011 | 2387 | 17390 | 1959 | 16053 | 1221 | 15892 | 535 | 11281 |
| 11-#14 | 3.08 | 8756 | 4326 | 16702 | 3100 | 18328 | 2508 | 18970 | 2042 | 18032 | 1220 | 18458 | 397 | 15349 |
| 11-#18 | 5.47 | 9703 | 4979 | 19325 | 3519 | 21573 | 2839 | 22878 | 2253 | 24551 | 1300 | 24701 | 32 | 24494 |
| 12-#10 | 1.89 | 8253 | 4003 | 15288 | 2928 | 16684 | 2384 | 17040 | 1968 | 16746 | 1328 | 15445 | 594 | 10170 |
| 12-#11 | 2.33 | 8416 | 4121 | 15805 | 2989 | 17267 | 2427 | 17715 | 1995 | 17643 | 1318 | 16508 | 523 | 12096 |
| 12-#14 | 3.36 | 8827 | 4402 | 16967 | 3168 | 18694 | 2560 | 19424 | 2089 | 19945 | 1318 | 19309 | 375 | 16623 |
| 12-#18 | 5.97 | 9834 | 5114 | 19807 | 3627 | 22207 | 2899 | 23648 | 2327 | 23933 | 1228 | 26118 | -16 | 26124 |
| 13-#10 | 2.05 | 8342 | 4046 | 15488 | 2948 | 16930 | 2400 | 17336 | 1973 | 17139 | 1325 | 15874 | 560 | 10982 |
| 13-#11 | 2.52 | 8523 | 4174 | 16042 | 3015 | 17568 | 2449 | 18073 | 2003 | 16913 | 1228 | 17114 | 491 | 13017 |
| 13-#14 | 3.64 | 8979 | 4478 | 17294 | 3211 | 19125 | 2596 | 19938 | 2103 | 20635 | 1316 | 20178 | 331 | 17717 |
| 13-#18 | 6.47 | 10098 | 5250 | 20363 | 3712 | 22968 | 2992 | 24540 | 2355 | 25040 | 1224 | 27617 | -94 | 27655 |
| 14-#10 | 2.21 | 8400 | 4089 | 15782 | 2945 | 17201 | 2392 | 17624 | 1965 | 16351 | 1216 | 16223 | 530 | 11670 |
| 14-#11 | 2.72 | 8594 | 4227 | 16376 | 3018 | 17890 | 2443 | 18433 | 1999 | 17340 | 1204 | 17487 | 448 | 13864 |
| 14-#14 | 3.92 | 9080 | 4555 | 17736 | 3226 | 19580 | 2620 | 20471 | 2106 | 19879 | 1199 | 20768 | 273 | 18959 |
| 14-#18 | 6.96 | 10283 | 5386 | 21070 | 3757 | 23750 | 3031 | 25512 | 2377 | 27993 | 1262 | 28689 | -193 | 28751 |
| 15-#10 | 2.37 | 8479 | 4132 | 15853 | 3005 | 17391 | 2450 | 17893 | 2007 | 16704 | 1241 | 16867 | 523 | 12447 |
| 15-#11 | 2.91 | 8690 | 4280 | 16487 | 3085 | 18122 | 2509 | 18750 | 2044 | 17762 | 1232 | 18236 | 436 | 14725 |
| 15-#14 | 4.20 | 9215 | 4631 | 17934 | 3310 | 19912 | 2681 | 20906 | 2162 | 21923 | 1321 | 21766 | 250 | 19976 |
| 16-#10 | 2.53 | 8550 | 4176 | 15978 | 3047 | 17603 | 2478 | 18189 | 2036 | 18260 | 1335 | 17342 | 510 | 13115 |
| 16-#11 | 3.10 | 8771 | 4333 | 16643 | 3135 | 18384 | 2542 | 19111 | 2079 | 19462 | 1325 | 18770 | 415 | 15569 |
| 16-#14 | 4.48 | 9328 | 4707 | 18167 | 3379 | 20292 | 2725 | 21422 | 2209 | 22527 | 1325 | 22499 | 216 | 21144 |
| 17-#10 | 2.68 | 8618 | 4219 | 16205 | 3068 | 17846 | 2498 | 18461 | 2042 | 17417 | 1246 | 17795 | 481 | 13870 |
| 17-#11 | 3.30 | 8854 | 4386 | 16916 | 3162 | 18675 | 2568 | 19432 | 2086 | 18626 | 1238 | 19344 | 381 | 16389 |
| 17-#14 | 4.76 | 9449 | 4784 | 18549 | 3421 | 20704 | 2765 | 21873 | 2220 | 21737 | 1250 | 23472 | 183 | 22182 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.84 | 8691 | 4262 | 16439 | 3082 | 18125 | 2502 | 18761 | 2045 | 17804 | 1241 | 18277 | 465 | 14535 |
| 18-#11 | 3.49 | 8942 | 4439 | 17186 | 3183 | 19015 | 2576 | 19796 | 2092 | 19102 | 1233 | 19928 | 363 | 17245 |
| 18-#14 | 5.04 | 9571 | 4860 | 18913 | 3457 | 21190 | 2782 | 22397 | 2233 | 23988 | 1325 | 24195 | 144 | 23263 |
| 19-#10 | 3.00 | 8761 | 4305 | 16555 | 3131 | 18310 | 2547 | 19017 | 2075 | 18146 | 1256 | 18794 | 447 | 15262 |
| 19-#11 | 3.69 | 9025 | 4492 | 17338 | 3238 | 19236 | 2627 | 20108 | 2126 | 20896 | 1338 | 20534 | 338 | 18037 |
| 19-#14 | 5.32 | 9691 | 4936 | 19151 | 3529 | 21501 | 2849 | 22840 | 2278 | 24579 | 1344 | 25028 | 104 | 24349 |
| 20-#10 | 3.16 | 8837 | 4348 | 16697 | 3170 | 18537 | 2574 | 19290 | 2099 | 19845 | 1356 | 19310 | 435 | 15924 |
| 20-#11 | 3.88 | 9116 | 4545 | 17516 | 3286 | 19508 | 2658 | 20436 | 2155 | 21389 | 1351 | 21174 | 324 | 18885 |
| 21-#10 | 3.32 | 8902 | 4391 | 16907 | 3193 | 18765 | 2595 | 19585 | 2109 | 18857 | 1260 | 19728 | 405 | 16621 |
| 21-#11 | 4.07 | 9194 | 4597 | 17766 | 3314 | 19787 | 2685 | 20790 | 2167 | 21811 | 1342 | 21647 | 285 | 19637 |
| 22-#10 | 3.47 | 8984 | 4434 | 17137 | 3214 | 19025 | 2602 | 19874 | 2116 | 20604 | 1344 | 20172 | 382 | 17321 |
| 22-#11 | 4.27 | 9298 | 4650 | 18038 | 3343 | 20098 | 2696 | 21149 | 2178 | 20811 | 1246 | 22182 | 256 | 20417 |
| 23-#10 | 3.63 | 9046 | 4477 | 17263 | 3255 | 19226 | 2643 | 20140 | 2142 | 19556 | 1264 | 20718 | 370 | 17977 |
| 23-#11 | 4.46 | 9367 | 4703 | 18199 | 3390 | 20347 | 2743 | 21480 | 2215 | 21208 | 1256 | 22847 | 240 | 21177 |
| 24-#10 | 3.79 | 9127 | 4520 | 17422 | 3294 | 19443 | 2666 | 20426 | 2166 | 21335 | 1362 | 21153 | 345 | 18671 |
| 25-#10 | 3.95 | 9183 | 4563 | 17616 | 3317 | 19686 | 2690 | 20718 | 2182 | 21711 | 1358 | 21643 | 326 | 19301 |
| 26-#10 | 4.11 | 9257 | 4606 | 17829 | 3341 | 19941 | 2701 | 21008 | 2186 | 20636 | 1263 | 22065 | 296 | 19990 |

## ROUND SPIRAL COLUMNS 34" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.03 | 9423 | 4253 | 17866 | 2872 | 18636 | 2347 | 18439 | 1931 | 17249 | 1335 | 14477 | 673 | 7022 |
| 6-#14 | 1.49 | 9638 | 4394 | 18553 | 2944 | 19473 | 2403 | 19442 | 1964 | 18609 | 1321 | 15915 | 583 | 9818 |
| 6-#18 | 2.64 | 10163 | 4750 | 20240 | 3131 | 21547 | 2549 | 21939 | 2052 | 21997 | 1287 | 19399 | 343 | 16537 |
| 7-#11 | 1.20 | 9542 | 4306 | 17539 | 3106 | 18835 | 2534 | 18941 | 2099 | 16824 | 1360 | 15803 | 742 | 8222 |
| 7-#14 | 1.73 | 9806 | 4470 | 18297 | 3203 | 19747 | 2605 | 20028 | 2147 | 18177 | 1354 | 17557 | 654 | 11269 |
| 7-#18 | 3.08 | 10451 | 4885 | 20147 | 3454 | 22002 | 2809 | 22727 | 2273 | 21522 | 1338 | 21869 | 424 | 18404 |
| 8-#10 | 1.12 | 9501 | 4280 | 17216 | 3150 | 18690 | 2578 | 18895 | 2149 | 16776 | 1404 | 15712 | 777 | 7615 |
| 8-#11 | 1.37 | 9620 | 4359 | 17618 | 3182 | 19125 | 2600 | 19390 | 2164 | 17355 | 1394 | 16442 | 726 | 9116 |
| 8-#14 | 1.98 | 9915 | 4546 | 18474 | 3294 | 20172 | 2684 | 20650 | 2227 | 20236 | 1493 | 18402 | 623 | 12629 |
| 8-#18 | 3.52 | 10634 | 5021 | 20567 | 3585 | 22765 | 2904 | 23769 | 2391 | 22669 | 1389 | 23210 | 353 | 21057 |
| 9-#10 | 1.26 | 9596 | 4323 | 17504 | 3158 | 18952 | 2581 | 19146 | 2138 | 17117 | 1389 | 16299 | 758 | 8563 |
| 9-#11 | 1.55 | 9732 | 4412 | 17944 | 3198 | 19435 | 2608 | 19691 | 2153 | 17790 | 1379 | 17162 | 704 | 10265 |
| 9-#14 | 2.23 | 10075 | 4623 | 18901 | 3327 | 20610 | 2705 | 21084 | 2219 | 20940 | 1476 | 19455 | 595 | 14030 |
| 9-#18 | 3.97 | 10911 | 5157 | 21244 | 3662 | 23514 | 2976 | 24532 | 2387 | 23891 | 1374 | 25069 | 308 | 22819 |
| 10-#10 | 1.40 | 9649 | 4367 | 17945 | 3126 | 19300 | 2549 | 19439 | 2107 | 18632 | 1442 | 16620 | 716 | 9349 |
| 10-#11 | 1.72 | 9795 | 4465 | 18435 | 3171 | 19842 | 2595 | 20058 | 2125 | 19445 | 1428 | 17614 | 658 | 11150 |
| 10-#14 | 2.48 | 10164 | 4699 | 19528 | 3314 | 21175 | 2706 | 21640 | 2197 | 20114 | 1324 | 20205 | 539 | 15369 |
| 10-#18 | 4.41 | 11065 | 5292 | 22214 | 3681 | 24459 | 2991 | 25549 | 2378 | 26766 | 1392 | 26378 | 211 | 25002 |
| 11-#10 | 1.54 | 9754 | 4410 | 17863 | 3229 | 19435 | 2635 | 19748 | 2176 | 19178 | 1498 | 17345 | 719 | 10242 |
| 11-#11 | 1.89 | 9923 | 4518 | 18387 | 3282 | 20019 | 2673 | 20422 | 2199 | 20064 | 1488 | 18406 | 654 | 12244 |
| 11-#14 | 2.73 | 10347 | 4775 | 19546 | 3446 | 21441 | 2794 | 22127 | 2283 | 20865 | 1389 | 21200 | 519 | 16707 |
| 11-#18 | 4.85 | 11382 | 5428 | 22393 | 3866 | 24953 | 3106 | 26351 | 2496 | 28021 | 1485 | 28022 | 164 | 26847 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 12-#10 | 1.68 | 9803 | 4453 | 18008 | 3277 | 19661 | 2672 | 20044 | 2210 | 18265 | 1408 | 17919 | 714 | 11025 |
| 12-#11 | 2.06 | 9981 | 4571 | 18573 | 3337 | 20295 | 2715 | 20775 | 2238 | 19169 | 1399 | 19081 | 644 | 13120 |
| 12-#14 | 2.97 | 10428 | 4852 | 19831 | 3517 | 21836 | 2848 | 22620 | 2332 | 23021 | 1500 | 22131 | 501 | 18036 |
| 12-#18 | 5.29 | 11522 | 5564 | 22910 | 3976 | 25639 | 3189 | 27187 | 2572 | 27233 | 1400 | 29575 | 122 | 28799 |
| 13-#10 | 1.82 | 9900 | 4496 | 18227 | 3295 | 19925 | 2687 | 20363 | 2214 | 18658 | 1404 | 18364 | 678 | 11886 |
| 13-#11 | 2.23 | 10097 | 4624 | 18831 | 3362 | 20616 | 2735 | 21162 | 2244 | 19648 | 1395 | 19646 | 602 | 14183 |
| 13-#14 | 3.22 | 10594 | 4928 | 20184 | 3558 | 22296 | 2882 | 23175 | 2345 | 23764 | 1497 | 23075 | 456 | 19290 |
| 13-#18 | 5.73 | 11810 | 5699 | 23507 | 4060 | 26450 | 3259 | 28155 | 2600 | 30485 | 1499 | 31212 | 44 | 30902 |
| 14-#10 | 1.96 | 9962 | 4539 | 18557 | 3290 | 20220 | 2676 | 20666 | 2204 | 20397 | 1481 | 18731 | 647 | 12662 |
| 14-#11 | 2.41 | 10173 | 4677 | 19204 | 3362 | 20967 | 2727 | 21540 | 2238 | 20113 | 1372 | 20108 | 567 | 15050 |
| 14-#14 | 3.47 | 10701 | 5004 | 20674 | 3570 | 22791 | 2882 | 23738 | 2345 | 22861 | 1368 | 23671 | 396 | 20642 |
| 14-#18 | 6.17 | 12012 | 5835 | 24285 | 4102 | 27300 | 3317 | 29186 | 2619 | 29637 | 1353 | 32404 | -51 | 32401 |
| 15-#10 | 2.10 | 10048 | 4582 | 18616 | 3353 | 20422 | 2738 | 20960 | 2249 | 20811 | 1511 | 19442 | 642 | 13485 |
| 15-#11 | 2.58 | 10275 | 4729 | 19306 | 3432 | 21215 | 2796 | 21887 | 2286 | 20568 | 1401 | 20935 | 557 | 16038 |
| 15-#14 | 3.72 | 10849 | 5080 | 20870 | 3658 | 23148 | 2969 | 24213 | 2405 | 25160 | 1504 | 24793 | 377 | 21834 |
| 15-#18 | 6.61 | 12250 | 5971 | 24714 | 4234 | 27922 | 3408 | 29971 | 2704 | 30693 | 1405 | 34160 | -102 | 34176 |
| 16-#10 | 2.24 | 10125 | 4625 | 18747 | 3397 | 20646 | 2766 | 21275 | 2279 | 19791 | 1416 | 19969 | 631 | 14239 |
| 16-#11 | 2.75 | 10366 | 4782 | 19471 | 3484 | 21492 | 2830 | 22272 | 2321 | 21006 | 1407 | 21544 | 540 | 16911 |
| 16-#14 | 3.97 | 10972 | 5157 | 21117 | 3728 | 23550 | 3014 | 24762 | 2453 | 25817 | 1510 | 25611 | 346 | 23189 |
| 17-#10 | 2.38 | 10199 | 4668 | 18993 | 3417 | 20909 | 2786 | 21573 | 2285 | 21628 | 1516 | 20450 | 602 | 15061 |
| 17-#11 | 2.92 | 10456 | 4835 | 19766 | 3510 | 21807 | 2855 | 22625 | 2329 | 23031 | 1508 | 22140 | 505 | 17852 |
| 17-#14 | 4.21 | 11102 | 5233 | 21530 | 3769 | 23997 | 3053 | 25260 | 2464 | 26582 | 1512 | 26496 | 298 | 24264 |
| 18-#10 | 2.52 | 10278 | 4711 | 19254 | 3429 | 21209 | 2788 | 21895 | 2286 | 22071 | 1510 | 20967 | 585 | 15787 |
| 18-#11 | 3.09 | 10550 | 4888 | 20065 | 3528 | 22171 | 2861 | 23016 | 2334 | 22003 | 1402 | 22770 | 486 | 18739 |
| 18-#14 | 4.46 | 11234 | 5309 | 21930 | 3803 | 24517 | 3069 | 25826 | 2477 | 27377 | 1508 | 27411 | 273 | 25490 |
| 19-#10 | 2.66 | 10352 | 4754 | 19369 | 3480 | 21406 | 2835 | 22169 | 2318 | 22472 | 1527 | 21535 | 569 | 16596 |
| 19-#11 | 3.26 | 10642 | 4941 | 20221 | 3586 | 22412 | 2915 | 23349 | 2370 | 22442 | 1419 | 23435 | 463 | 19643 |
| 19-#14 | 4.71 | 11364 | 5386 | 22179 | 3878 | 24859 | 3139 | 26297 | 2523 | 28023 | 1529 | 28325 | 235 | 26614 |
| 20-#10 | 2.80 | 10434 | 4797 | 19517 | 3520 | 21655 | 2863 | 22464 | 2343 | 21374 | 1436 | 22080 | 556 | 17300 |
| 20-#11 | 3.44 | 10739 | 4994 | 20408 | 3634 | 22707 | 2947 | 23704 | 2399 | 22932 | 1431 | 24110 | 448 | 20526 |
| 20-#14 | 4.96 | 11503 | 5462 | 22457 | 3945 | 25277 | 3182 | 26798 | 2563 | 28774 | 1547 | 29299 | 215 | 27777 |
| 21-#10 | 2.94 | 10505 | 4840 | 19746 | 3542 | 21897 | 2884 | 22778 | 2353 | 23290 | 1532 | 22534 | 528 | 18096 |
| 21-#11 | 3.61 | 10824 | 5047 | 20679 | 3663 | 23004 | 2973 | 24087 | 2411 | 23367 | 1424 | 24648 | 411 | 21397 |
| 22-#10 | 3.08 | 10594 | 4883 | 19997 | 3562 | 22178 | 2890 | 23088 | 2358 | 23724 | 1526 | 23030 | 505 | 18819 |
| 22-#11 | 3.78 | 10931 | 5100 | 20976 | 3690 | 23341 | 2983 | 24466 | 2420 | 25558 | 1518 | 25228 | 382 | 22295 |
| 23-#10 | 3.22 | 10661 | 4926 | 20128 | 3605 | 22391 | 2932 | 23377 | 2386 | 24097 | 1536 | 23607 | 493 | 19569 |
| 23-#11 | 3.95 | 11011 | 5153 | 21144 | 3739 | 23604 | 3032 | 24811 | 2452 | 26012 | 1530 | 25938 | 368 | 23144 |
| 24-#10 | 3.36 | 10750 | 4970 | 20299 | 3645 | 22625 | 2956 | 23680 | 2410 | 22877 | 1442 | 24082 | 469 | 20289 |
| 24-#11 | 4.12 | 11117 | 5206 | 21350 | 3787 | 23887 | 3061 | 25183 | 2481 | 24740 | 1437 | 26502 | 337 | 24058 |
| 25-#10 | 3.50 | 10809 | 5013 | 20508 | 3667 | 22887 | 2980 | 23984 | 2420 | 24917 | 1541 | 24612 | 451 | 21008 |
| 25-#11 | 4.30 | 11190 | 5259 | 21603 | 3815 | 24202 | 3091 | 25563 | 2501 | 26997 | 1534 | 27139 | 314 | 24821 |
| 26-#10 | 3.64 | 10890 | 5056 | 20742 | 3690 | 23159 | 2989 | 24313 | 2430 | 23648 | 1434 | 25051 | 419 | 21734 |
| 27-#10 | 3.78 | 10960 | 5099 | 20910 | 3722 | 23379 | 3027 | 24596 | 2460 | 24010 | 1442 | 25696 | 417 | 22451 |
| 28-#10 | 3.92 | 11035 | 5142 | 21095 | 3753 | 23625 | 3052 | 24882 | 2476 | 24411 | 1451 | 26252 | 398 | 23174 |

## ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.33 | 11362 | 4870 | 21730 | 3284 | 22799 | 2682 | 22717 | 2199 | 20163 | 1394 | 18432 | 699 | 10529 |
| 6-#18 | 2.36 | 11932 | 5226 | 23547 | 3471 | 25028 | 2828 | 25396 | 2286 | 25238 | 1461 | 22234 | 466 | 17782 |
| 7-#11 | 1.07 | 11258 | 4783 | 20565 | 3471 | 22106 | 2835 | 22210 | 2352 | 21052 | 1645 | 18351 | 863 | 8817 |
| 7-#14 | 1.55 | 11543 | 4947 | 21382 | 3567 | 23086 | 2905 | 23376 | 2400 | 21103 | 1530 | 20243 | 777 | 12182 |
| 7-#18 | 2.75 | 12242 | 5362 | 23378 | 3817 | 25512 | 3089 | 26276 | 2525 | 26473 | 1625 | 24907 | 552 | 19901 |
| 8-#11 | 1.23 | 11342 | 4836 | 20626 | 3551 | 22409 | 2905 | 22692 | 2420 | 21677 | 1685 | 19058 | 851 | 9802 |
| 8-#14 | 1.77 | 11663 | 5023 | 21546 | 3663 | 23532 | 2989 | 24041 | 2483 | 23442 | 1685 | 21172 | 749 | 13587 |
| 8-#18 | 3.14 | 12443 | 5498 | 23800 | 3953 | 26317 | 3208 | 27404 | 2648 | 25957 | 1571 | 26377 | 485 | 22690 |
| 9-#10 | 1.12 | 11315 | 4800 | 20511 | 3526 | 22224 | 2884 | 22432 | 2393 | 21352 | 1670 | 18815 | 873 | 9195 |
| 9-#11 | 1.38 | 11464 | 4889 | 20989 | 3564 | 22746 | 2910 | 23019 | 2408 | 20683 | 1555 | 19827 | 828 | 11031 |
| 9-#14 | 1.99 | 11834 | 5099 | 22019 | 3693 | 24006 | 3007 | 24515 | 2474 | 24177 | 1666 | 22304 | 721 | 15184 |
| 9-#18 | 3.54 | 12739 | 5633 | 24543 | 4028 | 27127 | 3258 | 28226 | 2644 | 27241 | 1553 | 28387 | 441 | 24743 |
| 10-#10 | 1.25 | 11373 | 4843 | 21008 | 3486 | 22607 | 2846 | 22740 | 2357 | 20237 | 1519 | 19198 | 836 | 10070 |
| 10-#11 | 1.53 | 11532 | 4942 | 21540 | 3531 | 23192 | 2876 | 23407 | 2375 | 22556 | 1613 | 20269 | 779 | 12016 |
| 10-#14 | 2.21 | 11931 | 5176 | 22714 | 3673 | 24627 | 3003 | 25106 | 2447 | 23163 | 1498 | 23057 | 661 | 16568 |
| 10-#18 | 3.93 | 12907 | 5769 | 25603 | 4040 | 28166 | 3289 | 29315 | 2630 | 30430 | 1581 | 29863 | 350 | 27391 |
| 11-#10 | 1.37 | 11485 | 4886 | 20889 | 3597 | 22742 | 2940 | 23075 | 2432 | 22289 | 1688 | 20025 | 844 | 11017 |
| 11-#11 | 1.69 | 11669 | 4994 | 21458 | 3650 | 23372 | 2976 | 23799 | 2455 | 23243 | 1678 | 21175 | 780 | 13179 |
| 11-#14 | 2.43 | 12126 | 5252 | 22704 | 3813 | 24899 | 3098 | 25628 | 2539 | 25704 | 1680 | 24197 | 648 | 18090 |
| 11-#18 | 4.32 | 13248 | 5905 | 25767 | 4233 | 28677 | 3411 | 30169 | 2753 | 29684 | 1568 | 31600 | 302 | 29264 |
| 12-#10 | 1.50 | 11538 | 4929 | 21034 | 3648 | 22983 | 2979 | 23394 | 2468 | 22708 | 1700 | 20650 | 840 | 11914 |
| 12-#11 | 1.84 | 11732 | 5047 | 21652 | 3708 | 23666 | 3020 | 24180 | 2495 | 23747 | 1690 | 21911 | 772 | 14158 |
| 12-#14 | 2.65 | 12215 | 5328 | 23007 | 3887 | 25322 | 3154 | 26160 | 2590 | 26411 | 1692 | 25211 | 632 | 19466 |
| 12-#18 | 4.72 | 13398 | 6040 | 26327 | 4347 | 29415 | 3497 | 31072 | 2832 | 30827 | 1583 | 33289 | 263 | 31468 |
| 13-#10 | 1.62 | 11644 | 4972 | 21278 | 3665 | 23264 | 2992 | 23736 | 2471 | 23157 | 1695 | 21109 | 802 | 12801 |
| 13-#11 | 1.99 | 11857 | 5100 | 21932 | 3731 | 24008 | 3039 | 24595 | 2501 | 22677 | 1574 | 22496 | 728 | 15284 |
| 13-#14 | 2.87 | 12394 | 5405 | 23388 | 3927 | 25811 | 3187 | 26757 | 2602 | 27208 | 1689 | 26088 | 573 | 20892 |
| 13-#18 | 5.11 | 13710 | 6176 | 26966 | 4429 | 30277 | 3565 | 32116 | 2860 | 34435 | 1694 | 35065 | 186 | 33639 |
| 14-#10 | 1.75 | 11709 | 5016 | 21647 | 3656 | 23583 | 2978 | 24053 | 2458 | 22006 | 1558 | 21494 | 771 | 13669 |
| 14-#11 | 2.15 | 11938 | 5153 | 22347 | 3727 | 24388 | 3028 | 24993 | 2491 | 24834 | 1659 | 22983 | 692 | 16254 |
| 14-#14 | 3.09 | 12508 | 5481 | 23929 | 3935 | 26347 | 3183 | 27351 | 2599 | 26134 | 1547 | 26829 | 525 | 22296 |
| 14-#18 | 5.50 | 13907 | 6312 | 27817 | 4468 | 31195 | 3579 | 33205 | 2875 | 35827 | 1647 | 36279 | 87 | 35689 |
| 15-#10 | 1.87 | 11802 | 5059 | 21691 | 3723 | 23797 | 3043 | 24372 | 2506 | 24039 | 1702 | 22274 | 768 | 14536 |
| 15-#11 | 2.30 | 12049 | 5206 | 22438 | 3801 | 24652 | 3101 | 25369 | 2543 | 23667 | 1580 | 23890 | 684 | 17331 |
| 15-#14 | 3.32 | 12666 | 5557 | 24118 | 4027 | 26728 | 3274 | 27865 | 2662 | 28713 | 1697 | 28056 | 507 | 23647 |
| 15-#18 | 5.89 | 14183 | 6447 | 28255 | 4604 | 31864 | 3715 | 34056 | 2964 | 37027 | 1704 | 38270 | 44 | 37936 |
| 16-#10 | 2.00 | 11885 | 5102 | 21826 | 3768 | 24033 | 3073 | 24707 | 2537 | 24465 | 1710 | 22830 | 756 | 15382 |
| 16-#11 | 2.45 | 12147 | 5259 | 22610 | 3854 | 24944 | 3136 | 25778 | 2579 | 25865 | 1700 | 24574 | 670 | 18274 |
| 16-#14 | 3.54 | 12802 | 5633 | 24380 | 4098 | 27152 | 3320 | 28448 | 2711 | 29422 | 1704 | 28982 | 481 | 25056 |
| 16-#18 | 6.29 | 14404 | 6583 | 28735 | 4722 | 32624 | 3791 | 35082 | 3046 | 35683 | 1596 | 39735 | -17 | 39740 |
| 17-#10 | 2.12 | 11965 | 5145 | 22092 | 3787 | 24316 | 3092 | 25026 | 2542 | 24910 | 1708 | 23362 | 729 | 16244 |
| 17-#11 | 2.61 | 12244 | 5312 | 22928 | 3880 | 25284 | 3161 | 26163 | 2587 | 24656 | 1586 | 25192 | 634 | 19340 |
| 17-#14 | 3.76 | 12941 | 5710 | 24823 | 4139 | 27634 | 3359 | 28993 | 2723 | 28214 | 1592 | 29898 | 432 | 26325 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 60,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 18-#10 | 2.25 | 12050 | 5188 | 22381 | 3797 | 24637 | 3092 | 25375 | 2543 | 25312 | 1688 | 23759 | 697 | 17061 |
| 18-#11 | 2.76 | 12345 | 5365 | 23258 | 3896 | 25672 | 3164 | 26582 | 2590 | 25197 | 1580 | 25867 | 614 | 20257 |
| 18-#14 | 3.98 | 13083 | 5786 | 25261 | 4170 | 28189 | 3372 | 29600 | 2734 | 31079 | 1701 | 30884 | 406 | 27757 |
| 19-#10 | 2.37 | 12129 | 5231 | 22495 | 3851 | 24846 | 3142 | 25666 | 2576 | 24096 | 1605 | 24525 | 697 | 17909 |
| 19-#11 | 2.91 | 12441 | 5418 | 23415 | 3957 | 25929 | 3221 | 26936 | 2628 | 25675 | 1599 | 26594 | 593 | 21282 |
| 19-#14 | 4.20 | 13224 | 5862 | 25520 | 4248 | 28558 | 3445 | 30099 | 2782 | 29662 | 1609 | 31879 | 371 | 28934 |
| 20-#10 | 2.50 | 12218 | 5274 | 22649 | 3891 | 25116 | 3171 | 25984 | 2602 | 26272 | 1731 | 25107 | 684 | 18700 |
| 20-#11 | 3.07 | 12548 | 5471 | 23610 | 4005 | 26250 | 3255 | 27317 | 2658 | 28066 | 1726 | 27303 | 578 | 22194 |
| 20-#14 | 4.42 | 13372 | 5939 | 25811 | 4316 | 29010 | 3490 | 30639 | 2823 | 32577 | 1742 | 32902 | 349 | 30248 |
| 21-#10 | 2.62 | 12294 | 5317 | 22896 | 3913 | 25373 | 3190 | 26316 | 2611 | 26689 | 1725 | 25595 | 656 | 19557 |
| 21-#11 | 3.22 | 12640 | 5524 | 23904 | 4033 | 26565 | 3280 | 27726 | 2670 | 26667 | 1605 | 27891 | 542 | 23180 |
| 21-#14 | 4.64 | 13503 | 6015 | 26222 | 4358 | 29463 | 3529 | 31227 | 2842 | 31075 | 1617 | 33735 | 297 | 31476 |
| 22-#10 | 2.74 | 12389 | 5360 | 23170 | 3931 | 25676 | 3196 | 26648 | 2615 | 27159 | 1719 | 26144 | 634 | 20344 |
| 22-#11 | 3.37 | 12754 | 5576 | 24226 | 4058 | 26928 | 3289 | 28129 | 2677 | 29133 | 1712 | 28530 | 514 | 24140 |
| 22-#14 | 4.86 | 13672 | 6091 | 26662 | 4401 | 29978 | 3547 | 31812 | 2857 | 34106 | 1723 | 34637 | 257 | 32685 |
| 23-#10 | 2.87 | 12461 | 5403 | 23303 | 3976 | 25899 | 3239 | 26959 | 2645 | 27556 | 1730 | 26753 | 622 | 21170 |
| 23-#11 | 3.52 | 12842 | 5629 | 24400 | 4110 | 27206 | 3339 | 28501 | 2710 | 29616 | 1724 | 29278 | 499 | 25070 |
| 24-#10 | 2.99 | 12559 | 5446 | 23483 | 4016 | 26150 | 3263 | 27281 | 2669 | 28002 | 1739 | 27269 | 599 | 21936 |
| 24-#11 | 3.68 | 12957 | 5682 | 24623 | 4158 | 27509 | 3368 | 28895 | 2740 | 30150 | 1734 | 29890 | 470 | 26031 |
| 25-#10 | 3.12 | 12622 | 5489 | 23711 | 4038 | 26432 | 3287 | 27606 | 2679 | 28433 | 1735 | 27839 | 581 | 22751 |
| 25-#11 | 3.83 | 13034 | 5735 | 24893 | 4186 | 27848 | 3398 | 29304 | 2760 | 28631 | 1614 | 30577 | 447 | 26919 |
| 26-#10 | 3.24 | 12709 | 5532 | 23967 | 4060 | 26722 | 3295 | 27963 | 2689 | 28878 | 1729 | 28293 | 548 | 23500 |
| 26-#11 | 3.98 | 13138 | 5788 | 25192 | 4215 | 28202 | 3410 | 29713 | 2766 | 29144 | 1609 | 31153 | 409 | 27883 |
| 27-#10 | 3.37 | 12784 | 5575 | 24139 | 4094 | 26956 | 3335 | 28263 | 2719 | 29298 | 1739 | 28919 | 539 | 24310 |
| 27-#11 | 4.14 | 13228 | 5841 | 25414 | 4254 | 28486 | 3456 | 30081 | 2801 | 31725 | 1734 | 31978 | 405 | 28750 |
| 28-#10 | 3.49 | 12865 | 5619 | 24337 | 4125 | 27217 | 3359 | 28571 | 2736 | 29754 | 1749 | 29611 | 530 | 25058 |
| 29-#10 | 3.62 | 12944 | 5662 | 24546 | 4156 | 27487 | 3383 | 28907 | 2753 | 30207 | 1751 | 30070 | 505 | 25838 |
| 30-#10 | 3.74 | 13025 | 5705 | 24806 | 4173 | 27790 | 3396 | 29231 | 2757 | 30632 | 1741 | 30611 | 479 | 26604 |

## ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 2.07 | 2461 | 1888 | 5210 | 1362 | 5903 | 1042 | 6092 | 804 | 5668 | 401 | 5737 | 117 | 5246 |
| 6-#14 | 2.98 | 2475 | 2072 | 5730 | 1449 | 6517 | 1094 | 6809 | 827 | 6546 | 358 | 6718 | -9 | 6718 |
| 6-#18 | 5.31 | 2499 | 2540 | 6957 | 1667 | 7976 | 1223 | 8522 | 880 | 9262 | 256 | 9027 | -346 | 8874 |
| 7-#11 | 2.41 | 2419 | 1957 | 5102 | 1491 | 6016 | 1152 | 6334 | 891 | 6021 | 453 | 6464 | 130 | 5816 |
| 7-#14 | 3.48 | 2425 | 2173 | 5680 | 1603 | 6697 | 1226 | 7129 | 929 | 7493 | 447 | 7670 | -4 | 7669 |
| 7-#18 | 6.19 | 2443 | 2719 | 7045 | 1885 | 8316 | 1408 | 9028 | 1019 | 9319 | 314 | 10509 | -362 | 10165 |
| 8-#11 | 2.76 | 2421 | 2027 | 5210 | 1547 | 6221 | 1196 | 6604 | 928 | 6822 | 497 | 6896 | 104 | 6480 |
| 8-#14 | 3.98 | 2430 | 2273 | 5870 | 1678 | 6993 | 1283 | 7507 | 977 | 7470 | 428 | 8259 | -46 | 8241 |
| 8-#18 | 7.07 | 2506 | 2897 | 7417 | 2006 | 8829 | 1498 | 9661 | 1092 | 10830 | 347 | 11471 | -449 | 11128 |
| 9-#11 | 3.10 | 2457 | 2096 | 5468 | 1574 | 6472 | 1216 | 6888 | 930 | 7208 | 481 | 7400 | 58 | 7113 |
| 9-#14 | 4.48 | 2473 | 2373 | 6211 | 1720 | 7342 | 1315 | 7908 | 982 | 8554 | 436 | 8974 | -111 | 8823 |
| 9-#18 | 7.96 | 2700 | 3075 | 7959 | 2084 | 9411 | 1558 | 10342 | 1104 | 10987 | 287 | 12681 | -564 | 11831 |
| 10-#11 | 3.45 | 2450 | 2166 | 5755 | 1589 | 6767 | 1214 | 7202 | 922 | 7581 | 442 | 7745 | 12 | 7693 |
| 10-#14 | 4.97 | 2466 | 2473 | 6575 | 1750 | 7747 | 1319 | 8354 | 976 | 9095 | 384 | 9477 | -176 | 9376 |
| 11-#11 | 3.79 | 2471 | 2236 | 5826 | 1660 | 6933 | 1278 | 7442 | 967 | 7939 | 468 | 8272 | -19 | 8258 |
| 11-#14 | 5.47 | 2503 | 2574 | 6723 | 1842 | 7992 | 1401 | 8687 | 1032 | 9581 | 414 | 10193 | -228 | 9973 |
| 12-#11 | 4.14 | 2506 | 2305 | 5963 | 1713 | 7152 | 1313 | 7713 | 995 | 8287 | 465 | 8734 | -42 | 8713 |
| 12-#14 | 5.97 | 2556 | 2674 | 6929 | 1915 | 8303 | 1448 | 9067 | 1070 | 9394 | 381 | 10832 | -263 | 10552 |
| 13-#11 | 4.48 | 2502 | 2375 | 6191 | 1745 | 7396 | 1338 | 7997 | 1002 | 8671 | 453 | 9136 | -95 | 9064 |
| 13-#14 | 6.47 | 2577 | 2774 | 7242 | 1963 | 8644 | 1486 | 9467 | 1081 | 10609 | 391 | 11401 | -340 | 10988 |
| 14-#11 | 4.83 | 2516 | 2444 | 6442 | 1773 | 7671 | 1347 | 8304 | 1004 | 8447 | 396 | 9538 | -139 | 9436 |
| 15-#11 | 5.17 | 2536 | 2514 | 6583 | 1824 | 7860 | 1398 | 8551 | 1037 | 8776 | 409 | 10046 | -165 | 9834 |
| 16-#11 | 5.52 | 2547 | 2583 | 6760 | 1867 | 8084 | 1429 | 8823 | 1062 | 9753 | 433 | 10482 | -206 | 10237 |

## ROUND SPIRAL COLUMNS 26" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.76 | 3156 | 2143 | 6396 | 1578 | 7277 | 1214 | 7496 | 946 | 7403 | 532 | 6983 | 198 | 5991 |
| 6-#14 | 2.54 | 3189 | 2328 | 6987 | 1665 | 7974 | 1268 | 8309 | 971 | 8468 | 488 | 8106 | 77 | 7775 |
| 6-#18 | 4.52 | 3244 | 2796 | 8392 | 1887 | 9640 | 1401 | 10264 | 1030 | 11032 | 370 | 10773 | -245 | 10652 |
| 7-#11 | 2.06 | 3102 | 2213 | 6213 | 1719 | 7387 | 1336 | 7771 | 1043 | 7846 | 596 | 7830 | 216 | 6621 |
| 7-#14 | 2.97 | 3125 | 2428 | 6877 | 1833 | 8160 | 1412 | 8672 | 1083 | 8423 | 523 | 9208 | 88 | 8748 |
| 7-#18 | 5.27 | 3152 | 2974 | 8442 | 2120 | 10008 | 1600 | 10837 | 1181 | 11864 | 461 | 12484 | -253 | 12248 |
| 8-#11 | 2.35 | 3110 | 2282 | 6320 | 1779 | 7612 | 1384 | 8074 | 1083 | 8266 | 611 | 8322 | 194 | 7417 |
| 8-#14 | 3.39 | 3136 | 2528 | 7064 | 1911 | 8488 | 1473 | 9096 | 1134 | 9603 | 576 | 9881 | 50 | 9656 |
| 8-#18 | 6.03 | 3196 | 3152 | 8847 | 2246 | 10583 | 1695 | 11552 | 1258 | 12822 | 476 | 13586 | -333 | 13299 |
| 9-#11 | 2.64 | 3143 | 2352 | 6617 | 1804 | 7898 | 1403 | 8393 | 1084 | 8696 | 594 | 8842 | 141 | 8072 |
| 9-#14 | 3.81 | 3178 | 2629 | 7461 | 1952 | 8884 | 1504 | 9548 | 1140 | 10219 | 554 | 10689 | -14 | 10612 |
| 9-#18 | 6.78 | 3295 | 3330 | 9471 | 2324 | 11245 | 1756 | 12323 | 1271 | 13885 | 439 | 14965 | -446 | 14240 |
| 10-#11 | 2.94 | 3146 | 2421 | 6968 | 1817 | 8234 | 1397 | 8745 | 1074 | 9111 | 554 | 9272 | 103 | 8768 |
| 10-#14 | 4.24 | 3172 | 2729 | 7900 | 1980 | 9346 | 1505 | 10050 | 1132 | 10102 | 468 | 11253 | -77 | 11207 |
| 10-#18 | 7.53 | 3425 | 3509 | 10118 | 2390 | 12009 | 1772 | 13186 | 1270 | 14944 | 352 | 15957 | -558 | 14941 |
| 11-#11 | 3.23 | 3166 | 2491 | 7016 | 1892 | 8414 | 1466 | 9015 | 1123 | 9518 | 583 | 9873 | 75 | 9500 |
| 11-#14 | 4.66 | 3215 | 2829 | 8031 | 2076 | 9614 | 1593 | 10425 | 1193 | 11376 | 535 | 12069 | -124 | 11938 |
| 12-#11 | 3.53 | 3210 | 2560 | 7165 | 1947 | 8657 | 1503 | 9318 | 1153 | 9909 | 583 | 10401 | 54 | 10137 |
| 12-#14 | 5.09 | 3265 | 2929 | 8256 | 2151 | 9962 | 1642 | 10852 | 1233 | 11922 | 532 | 12799 | -157 | 12660 |

## ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 13-#11 | 3.82 | 3214 | 2630 | 7424 | 1979 | 8933 | 1528 | 9637 | 1160 | 10339 | 571 | 10853 | 3 | 10841 |
| 13-#14 | 5.51 | 3288 | 3030 | 8612 | 2199 | 10348 | 1680 | 11302 | 1244 | 12533 | 516 | 13441 | -231 | 13156 |
| 14-#11 | 4.11 | 3232 | 2699 | 7708 | 2004 | 9245 | 1536 | 9982 | 1162 | 10763 | 542 | 11307 | -42 | 11280 |
| 14-#14 | 5.93 | 3327 | 3130 | 8995 | 2242 | 10780 | 1696 | 11791 | 1250 | 12265 | 444 | 14089 | -294 | 13686 |
| 15-#11 | 4.41 | 3249 | 2769 | 7863 | 2058 | 9453 | 1589 | 10259 | 1197 | 11161 | 559 | 11882 | -64 | 11822 |
| 16-#11 | 4.70 | 3260 | 2838 | 8059 | 2103 | 9703 | 1622 | 10564 | 1223 | 11555 | 555 | 12379 | -104 | 12263 |
| 17-#11 | 5.00 | 3292 | 2908 | 8273 | 2143 | 9975 | 1650 | 10882 | 1233 | 11982 | 546 | 12867 | -140 | 12694 |
| 18-#11 | 5.29 | 3315 | 2977 | 8547 | 2168 | 10274 | 1663 | 11221 | 1240 | 12450 | 534 | 13313 | -195 | 13042 |

## ROUND SPIRAL COLUMNS 28" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.52 | 3936 | 2419 | 7745 | 1811 | 8847 | 1400 | 9099 | 1098 | 8911 | 641 | 8387 | 283 | 6606 |
| 6-#14 | 2.19 | 3996 | 2604 | 8410 | 1899 | 9627 | 1455 | 10008 | 1124 | 10101 | 600 | 9653 | 166 | 8853 |
| 6-#18 | 3.90 | 4083 | 3071 | 9993 | 2123 | 11502 | 1592 | 12206 | 1188 | 12116 | 456 | 12681 | -143 | 12606 |
| 7-#11 | 1.77 | 3894 | 2489 | 7469 | 1965 | 8949 | 1535 | 9408 | 1206 | 8796 | 667 | 9363 | 308 | 7358 |
| 7-#14 | 2.56 | 3923 | 2704 | 8209 | 2080 | 9814 | 1612 | 10415 | 1249 | 10741 | 682 | 10915 | 184 | 9848 |
| 7-#18 | 4.55 | 3985 | 3250 | 9989 | 2372 | 11894 | 1806 | 12848 | 1352 | 13928 | 591 | 14631 | -143 | 14533 |
| 8-#11 | 2.03 | 3908 | 2558 | 7572 | 2029 | 9184 | 1585 | 9744 | 1250 | 9235 | 683 | 9919 | 288 | 8398 |
| 8-#14 | 2.92 | 3940 | 2804 | 8401 | 2162 | 10172 | 1677 | 10886 | 1303 | 11388 | 700 | 11673 | 151 | 10924 |
| 8-#18 | 5.20 | 4028 | 3428 | 10395 | 2500 | 12529 | 1904 | 13645 | 1435 | 14002 | 570 | 15874 | -216 | 15671 |
| 9-#11 | 2.28 | 3943 | 2628 | 7911 | 2053 | 9513 | 1604 | 10098 | 1250 | 9678 | 667 | 10496 | 236 | 9066 |
| 9-#14 | 3.29 | 3997 | 2904 | 8853 | 2202 | 10616 | 1707 | 11389 | 1308 | 11265 | 633 | 12500 | 76 | 12078 |
| 9-#18 | 5.85 | 4109 | 3606 | 11119 | 2579 | 13272 | 1965 | 14507 | 1448 | 16185 | 575 | 17423 | -328 | 16794 |
| 10-#11 | 2.53 | 3936 | 2697 | 8318 | 2062 | 9894 | 1595 | 10488 | 1237 | 10823 | 673 | 10966 | 197 | 9889 |
| 10-#14 | 3.65 | 3994 | 3005 | 9377 | 2228 | 11138 | 1705 | 11947 | 1298 | 12736 | 624 | 13196 | 24 | 13073 |
| 10-#18 | 6.50 | 4148 | 3784 | 11876 | 2643 | 14133 | 1980 | 15471 | 1445 | 17363 | 488 | 18531 | -436 | 17725 |
| 11-#11 | 2.79 | 3977 | 2767 | 8351 | 2143 | 10083 | 1669 | 10787 | 1291 | 11282 | 706 | 11645 | 173 | 10651 |
| 11-#14 | 4.02 | 4045 | 3105 | 9483 | 2328 | 11427 | 1798 | 12363 | 1364 | 13356 | 663 | 14115 | -18 | 14095 |
| 11-#18 | 7.15 | 4319 | 3963 | 12209 | 2797 | 14660 | 2120 | 16168 | 1540 | 18374 | 539 | 20031 | -528 | 18972 |
| 12-#11 | 3.04 | 4015 | 2836 | 8510 | 2199 | 10343 | 1707 | 11124 | 1322 | 10937 | 660 | 12238 | 153 | 11402 |
| 12-#14 | 4.38 | 4094 | 3205 | 9726 | 2405 | 11810 | 1850 | 12838 | 1406 | 13965 | 661 | 14938 | -49 | 14893 |
| 13-#11 | 3.29 | 4030 | 2906 | 8801 | 2230 | 10656 | 1732 | 11478 | 1329 | 12193 | 696 | 12740 | 104 | 12226 |
| 13-#14 | 4.75 | 4126 | 3305 | 10127 | 2453 | 12242 | 1888 | 13338 | 1417 | 14642 | 646 | 15653 | -121 | 15505 |
| 14-#11 | 3.55 | 4062 | 2975 | 9118 | 2253 | 11010 | 1739 | 11860 | 1330 | 11816 | 622 | 13245 | 59 | 12923 |
| 14-#14 | 5.12 | 4165 | 3406 | 10549 | 2493 | 12727 | 1902 | 13882 | 1423 | 15316 | 607 | 16379 | -184 | 16157 |
| 15-#11 | 3.80 | 4077 | 3045 | 9278 | 2310 | 11231 | 1794 | 12168 | 1367 | 12231 | 640 | 13889 | 39 | 13700 |
| 15-#14 | 5.48 | 4189 | 3506 | 10812 | 2567 | 13059 | 1976 | 14314 | 1470 | 15930 | 629 | 17269 | -217 | 16855 |
| 16-#11 | 4.05 | 4091 | 3114 | 9501 | 2357 | 11504 | 1828 | 12506 | 1395 | 12640 | 637 | 14447 | 0 | 14445 |
| 16-#14 | 5.85 | 4224 | 3606 | 11128 | 2631 | 13451 | 2022 | 14791 | 1508 | 16545 | 623 | 18047 | -274 | 17565 |
| 17-#11 | 4.31 | 4128 | 3184 | 9731 | 2396 | 11809 | 1856 | 12859 | 1405 | 14016 | 674 | 14990 | -34 | 14952 |
| 18-#11 | 4.56 | 4148 | 3253 | 10043 | 2421 | 12149 | 1870 | 13235 | 1412 | 13564 | 618 | 15487 | -89 | 15364 |
| 19-#11 | 4.81 | 4178 | 3323 | 10189 | 2481 | 12387 | 1918 | 13549 | 1442 | 14949 | 669 | 16093 | -109 | 15933 |
| 20-#11 | 5.07 | 4226 | 3392 | 10411 | 2525 | 12665 | 1949 | 13889 | 1468 | 14382 | 626 | 16739 | -135 | 16400 |

## ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.32 | 4833 | 2715 | 9270 | 2061 | 10628 | 1599 | 10916 | 1261 | 10610 | 759 | 9962 | 372 | 7221 |
| 6-#14 | 1.91 | 4903 | 2900 | 10008 | 2150 | 11491 | 1655 | 11922 | 1289 | 11925 | 719 | 11371 | 260 | 9984 |
| 6-#18 | 3.40 | 5031 | 3368 | 11772 | 2377 | 13577 | 1796 | 14363 | 1357 | 15123 | 614 | 14762 | -39 | 14742 |
| 7-#11 | 1.54 | 4802 | 2785 | 8883 | 2231 | 10713 | 1748 | 11259 | 1382 | 11202 | 841 | 11076 | 404 | 8101 |
| 7-#14 | 2.23 | 4849 | 3000 | 9700 | 2346 | 11673 | 1827 | 12373 | 1426 | 12656 | 811 | 12802 | 285 | 10988 |
| 7-#18 | 3.96 | 4945 | 3546 | 11670 | 2639 | 13985 | 2024 | 15075 | 1534 | 16192 | 726 | 16960 | -31 | 16938 |
| 8-#11 | 1.77 | 4822 | 2854 | 8976 | 2299 | 10954 | 1801 | 11628 | 1428 | 11724 | 861 | 11698 | 388 | 9207 |
| 8-#14 | 2.55 | 4873 | 3100 | 9892 | 2432 | 12042 | 1894 | 12891 | 1484 | 12481 | 776 | 13648 | 255 | 12246 |
| 8-#18 | 4.53 | 4994 | 3724 | 12099 | 2772 | 14680 | 2128 | 15955 | 1621 | 17382 | 751 | 18347 | -98 | 18250 |
| 9-#11 | 1.99 | 4855 | 2924 | 9361 | 2321 | 11322 | 1819 | 12017 | 1428 | 12217 | 838 | 12332 | 335 | 10045 |
| 9-#14 | 2.86 | 4920 | 3201 | 10400 | 2470 | 12552 | 1925 | 13445 | 1488 | 14084 | 802 | 14560 | 181 | 13440 |
| 9-#18 | 5.09 | 5066 | 3902 | 12909 | 2850 | 15506 | 2188 | 16907 | 1635 | 17440 | 668 | 19925 | -227 | 19576 |
| 10-#11 | 2.21 | 4855 | 2993 | 9825 | 2324 | 11760 | 1807 | 12447 | 1412 | 12733 | 800 | 12839 | 296 | 11056 |
| 10-#14 | 3.18 | 4937 | 3301 | 10988 | 2491 | 13137 | 1919 | 14060 | 1475 | 13856 | 704 | 15320 | 129 | 14598 |
| 10-#18 | 5.66 | 5092 | 4081 | 13798 | 2913 | 16465 | 2200 | 17973 | 1630 | 19982 | 629 | 21289 | -314 | 20611 |
| 11-#11 | 2.43 | 4900 | 3063 | 9840 | 2412 | 11945 | 1885 | 12775 | 1470 | 13245 | 837 | 13599 | 276 | 11839 |
| 11-#14 | 3.50 | 4983 | 3401 | 11090 | 2599 | 13437 | 2017 | 14517 | 1546 | 15536 | 798 | 16345 | 91 | 15854 |
| 11-#18 | 6.22 | 5228 | 4259 | 14110 | 3071 | 17038 | 2347 | 18742 | 1730 | 21104 | 686 | 22958 | -399 | 22112 |
| 12-#11 | 2.65 | 4947 | 3132 | 10007 | 2470 | 12228 | 1925 | 13145 | 1503 | 13727 | 839 | 14259 | 257 | 12714 |
| 12-#14 | 3.82 | 5048 | 3501 | 11351 | 2678 | 13846 | 2070 | 15039 | 1590 | 15128 | 745 | 17262 | 62 | 16917 |
| 12-#18 | 6.79 | 5348 | 4437 | 14597 | 3202 | 17769 | 2433 | 19634 | 1800 | 22241 | 679 | 24488 | -458 | 23589 |
| 13-#11 | 2.87 | 4965 | 3202 | 10324 | 2500 | 12574 | 1950 | 13534 | 1510 | 14247 | 829 | 14810 | 209 | 13582 |
| 13-#14 | 4.14 | 5086 | 3602 | 11791 | 2724 | 14330 | 2108 | 15590 | 1602 | 16953 | 783 | 18049 | -8 | 18038 |
| 13-#18 | 7.36 | 5565 | 4615 | 15331 | 3290 | 18575 | 2503 | 20579 | 1824 | 23526 | 653 | 25844 | -586 | 24626 |
| 14-#11 | 3.09 | 4991 | 3271 | 10686 | 2521 | 12975 | 1955 | 13954 | 1509 | 14757 | 798 | 15364 | 164 | 14382 |
| 14-#14 | 4.46 | 5134 | 3702 | 12262 | 2762 | 14880 | 2122 | 16189 | 1606 | 17690 | 743 | 18851 | -71 | 18771 |
| 15-#11 | 3.31 | 5016 | 3341 | 10847 | 2581 | 13206 | 2013 | 14292 | 1549 | 15249 | 819 | 16080 | 146 | 15295 |
| 15-#14 | 4.77 | 5154 | 3802 | 12536 | 2839 | 15226 | 2198 | 16664 | 1656 | 18369 | 768 | 19838 | -101 | 19606 |
| 16-#11 | 3.53 | 5034 | 3410 | 11085 | 2629 | 13504 | 2048 | 14664 | 1578 | 15731 | 818 | 16700 | 108 | 16053 |
| 16-#14 | 5.09 | 5188 | 3902 | 12893 | 2906 | 15652 | 2245 | 17189 | 1695 | 17778 | 713 | 20704 | -157 | 20429 |
| 17-#11 | 3.75 | 5076 | 3480 | 11344 | 2667 | 13840 | 2076 | 15051 | 1588 | 16250 | 810 | 17296 | 75 | 16890 |
| 17-#14 | 5.41 | 5258 | 4003 | 13243 | 2963 | 16125 | 2287 | 17738 | 1711 | 19786 | 752 | 21552 | -206 | 21179 |
| 18-#11 | 3.97 | 5107 | 3549 | 11694 | 2691 | 14209 | 2088 | 15465 | 1595 | 16765 | 786 | 17845 | 21 | 17722 |
| 19-#11 | 4.19 | 5140 | 3619 | 11845 | 2754 | 14475 | 2139 | 15810 | 1627 | 17275 | 806 | 18513 | 3 | 18499 |
| 20-#11 | 4.41 | 5191 | 3688 | 12078 | 2798 | 14780 | 2171 | 16183 | 1653 | 17781 | 808 | 19224 | -21 | 19059 |
| 21-#11 | 4.63 | 5203 | 3758 | 12375 | 2833 | 15107 | 2201 | 16569 | 1665 | 18275 | 796 | 19768 | -58 | 19673 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.16 | 5853 | 3032 | 10982 | 2329 | 12634 | 1813 | 12962 | 1436 | 11681 | 824 | 11721 | 467 | 7837 |
| 6-#14 | 1.68 | 5939 | 3216 | 11793 | 2419 | 13581 | 1869 | 14065 | 1465 | 13025 | 789 | 13273 | 358 | 10885 |
| 6-#18 | 2.98 | 6107 | 3684 | 13741 | 2647 | 15878 | 2013 | 16750 | 1536 | 17471 | 745 | 17028 | 69 | 16681 |
| 7-#11 | 1.36 | 5833 | 3101 | 10464 | 2515 | 12687 | 1976 | 13341 | 1569 | 13191 | 976 | 12983 | 506 | 8851 |
| 7-#14 | 1.96 | 5899 | 3317 | 11358 | 2630 | 13744 | 2055 | 14562 | 1614 | 14783 | 947 | 14884 | 390 | 12090 |
| 7-#18 | 3.48 | 6037 | 3863 | 13519 | 2925 | 16298 | 2257 | 17534 | 1727 | 18670 | 869 | 19484 | 84 | 18958 |
| 8-#11 | 1.55 | 5861 | 3171 | 10544 | 2587 | 12942 | 2033 | 13735 | 1618 | 13767 | 998 | 13673 | 493 | 10021 |
| 8-#14 | 2.24 | 5933 | 3417 | 11546 | 2721 | 14130 | 2126 | 15127 | 1676 | 15571 | 972 | 15820 | 364 | 13689 |
| 8-#18 | 3.98 | 6095 | 4041 | 13967 | 3062 | 17030 | 2363 | 18496 | 1818 | 19977 | 897 | 21017 | 23 | 20898 |
| 9-#11 | 1.75 | 5894 | 3240 | 10977 | 2607 | 13349 | 2049 | 14168 | 1617 | 14300 | 974 | 14362 | 439 | 10989 |
| 9-#14 | 2.52 | 5982 | 3517 | 12114 | 2757 | 14691 | 2155 | 15732 | 1679 | 16345 | 941 | 16816 | 289 | 14844 |
| 9-#18 | 4.48 | 6163 | 4219 | 14867 | 3139 | 17959 | 2424 | 19539 | 1832 | 21401 | 863 | 22752 | -106 | 22592 |
| 10-#11 | 1.94 | 5899 | 3310 | 11503 | 2605 | 13847 | 2034 | 14635 | 1598 | 14854 | 934 | 14904 | 400 | 12137 |
| 10-#14 | 2.80 | 5980 | 3617 | 12772 | 2772 | 15357 | 2148 | 16403 | 1663 | 17168 | 892 | 17636 | 238 | 16178 |
| 10-#18 | 4.97 | 6186 | 4397 | 15864 | 3198 | 19020 | 2433 | 20706 | 1824 | 22813 | 775 | 24241 | -191 | 23678 |
| 11-#11 | 2.13 | 5953 | 3379 | 11490 | 2699 | 14026 | 2116 | 14994 | 1661 | 15422 | 975 | 15748 | 383 | 13052 |
| 11-#14 | 3.08 | 6061 | 3718 | 12864 | 2887 | 15656 | 2250 | 16902 | 1739 | 17930 | 939 | 18770 | 204 | 17481 |
| 11-#18 | 5.47 | 6325 | 4576 | 16178 | 3363 | 19635 | 2586 | 21548 | 1931 | 24049 | 837 | 26084 | -270 | 25582 |
| 12-#11 | 2.33 | 6004 | 3449 | 11668 | 2760 | 14331 | 2158 | 15389 | 1695 | 15949 | 979 | 16476 | 366 | 14072 |
| 12-#14 | 3.36 | 6114 | 3818 | 13139 | 2968 | 16098 | 2304 | 17471 | 1785 | 18667 | 942 | 19782 | 176 | 18703 |
| 12-#18 | 5.97 | 6421 | 4754 | 16703 | 3497 | 20411 | 2673 | 22523 | 2004 | 25296 | 833 | 27776 | -326 | 27199 |
| 13-#11 | 2.52 | 6029 | 3519 | 12011 | 2788 | 14710 | 2182 | 15819 | 1703 | 15414 | 904 | 17076 | 318 | 14967 |
| 13-#14 | 3.64 | 6161 | 3918 | 13613 | 3013 | 16630 | 2342 | 18073 | 1797 | 19477 | 927 | 20641 | 108 | 20068 |
| 13-#18 | 6.47 | 6546 | 4932 | 17512 | 3585 | 21311 | 2745 | 23559 | 2027 | 26701 | 809 | 29264 | -450 | 28287 |
| 14-#11 | 2.72 | 6065 | 3588 | 12421 | 2807 | 15142 | 2185 | 16279 | 1700 | 17066 | 937 | 17678 | 273 | 15890 |
| 14-#14 | 3.92 | 6238 | 4018 | 14142 | 3049 | 17238 | 2355 | 18728 | 1800 | 20278 | 887 | 21518 | 45 | 21241 |
| 14-#18 | 6.96 | 6765 | 5110 | 18333 | 3662 | 22310 | 2778 | 24689 | 2043 | 28110 | 743 | 30796 | -557 | 29486 |
| 15-#11 | 2.91 | 6081 | 3658 | 12579 | 2870 | 15399 | 2247 | 16644 | 1743 | 17607 | 961 | 18410 | 250 | 16840 |
| 15-#14 | 4.20 | 6254 | 4119 | 14425 | 3130 | 17608 | 2434 | 19245 | 1853 | 19622 | 853 | 22604 | 18 | 22507 |
| 16-#11 | 3.10 | 6114 | 3727 | 12826 | 2918 | 15721 | 2283 | 17044 | 1772 | 18134 | 960 | 19149 | 221 | 17710 |
| 16-#14 | 4.48 | 6291 | 4219 | 14801 | 3197 | 18070 | 2483 | 19819 | 1894 | 21765 | 911 | 23559 | -37 | 23506 |
| 17-#11 | 3.30 | 6153 | 3797 | 13120 | 2957 | 16084 | 2310 | 17470 | 1783 | 17452 | 889 | 19799 | 188 | 18681 |
| 17-#14 | 4.76 | 6365 | 4319 | 15195 | 3255 | 18588 | 2524 | 20418 | 1909 | 22571 | 901 | 24485 | -84 | 24335 |
| 18-#11 | 3.49 | 6173 | 3866 | 13511 | 2980 | 16484 | 2321 | 17925 | 1789 | 19257 | 929 | 20398 | 134 | 19529 |
| 18-#14 | 5.04 | 6392 | 4420 | 15718 | 3292 | 19150 | 2544 | 21060 | 1921 | 23375 | 868 | 25346 | -161 | 25012 |
| 19-#11 | 3.69 | 6223 | 3936 | 13658 | 3044 | 16770 | 2373 | 18297 | 1822 | 19790 | 944 | 21129 | 119 | 20446 |
| 19-#14 | 5.32 | 6457 | 4520 | 15969 | 3379 | 19567 | 2614 | 21591 | 1965 | 24155 | 895 | 26367 | -187 | 25979 |
| 20-#11 | 3.88 | 6276 | 4005 | 13908 | 3089 | 17112 | 2407 | 18699 | 1849 | 20368 | 954 | 21794 | 82 | 21365 |
| 21-#11 | 4.07 | 6305 | 4075 | 14234 | 3124 | 17471 | 2430 | 19123 | 1861 | 20906 | 941 | 22503 | 60 | 22200 |
| 22-#11 | 4.27 | 6338 | 4144 | 14571 | 3158 | 17849 | 2452 | 19574 | 1872 | 21488 | 927 | 23151 | 19 | 23062 |
| 23-#11 | 4.46 | 6372 | 4214 | 14778 | 3211 | 18161 | 2493 | 19950 | 1900 | 20529 | 870 | 23826 | -8 | 23811 |

## ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#11 | 1.03 | 7004 | 3369 | 12893 | 2615 | 14879 | 2040 | 15253 | 1621 | 14640 | 1016 | 13676 | 567 | 8454 |
| 6-#14 | 1.49 | 7106 | 3553 | 13778 | 2705 | 15911 | 2097 | 16453 | 1651 | 16206 | 979 | 15372 | 460 | 11766 |
| 6-#18 | 2.64 | 7319 | 4021 | 15910 | 2934 | 18420 | 2243 | 19383 | 1726 | 20039 | 884 | 19491 | 179 | 18496 |
| 7-#11 | 1.20 | 6996 | 3438 | 12260 | 2812 | 14894 | 2218 | 15669 | 1769 | 15407 | 1119 | 15097 | 614 | 9612 |
| 7-#14 | 1.73 | 7082 | 3654 | 13195 | 2933 | 16040 | 2298 | 16996 | 1815 | 17137 | 1092 | 17172 | 501 | 13138 |
| 7-#18 | 3.08 | 7237 | 4200 | 15548 | 3229 | 18845 | 2503 | 20239 | 1931 | 21374 | 1019 | 22215 | 203 | 20833 |
| 8-#11 | 1.37 | 7032 | 3508 | 12284 | 2894 | 15161 | 2279 | 16083 | 1821 | 16038 | 1144 | 15857 | 604 | 10839 |
| 8-#14 | 1.98 | 7126 | 3754 | 13374 | 3028 | 16448 | 2373 | 17593 | 1879 | 17999 | 1119 | 18201 | 478 | 14997 |
| 8-#18 | 3.52 | 7302 | 4378 | 16011 | 3371 | 19600 | 2612 | 21284 | 2026 | 22802 | 1051 | 23898 | 147 | 23049 |
| 9-#11 | 1.55 | 7065 | 3578 | 12768 | 2912 | 15607 | 2293 | 16559 | 1819 | 16611 | 1119 | 16599 | 549 | 11949 |
| 9-#14 | 2.23 | 7177 | 3854 | 14005 | 3063 | 17063 | 2401 | 18264 | 1882 | 18833 | 1088 | 19280 | 403 | 16290 |
| 9-#18 | 3.97 | 7402 | 4556 | 17003 | 3447 | 20627 | 2673 | 22418 | 2039 | 22654 | 935 | 25789 | 18 | 25665 |
| 10-#11 | 1.72 | 7075 | 3647 | 13364 | 2905 | 16162 | 2274 | 17070 | 1796 | 16054 | 1005 | 17053 | 494 | 13155 |
| 10-#14 | 2.48 | 7179 | 3955 | 14740 | 3072 | 17812 | 2390 | 18992 | 1863 | 18401 | 968 | 20156 | 351 | 17813 |
| 10-#18 | 4.41 | 7428 | 4734 | 18097 | 3499 | 21812 | 2680 | 23687 | 2029 | 25870 | 928 | 27399 | -65 | 27313 |
| 11-#11 | 1.89 | 7139 | 3717 | 13311 | 3005 | 16338 | 2363 | 17448 | 1863 | 16639 | 1047 | 18105 | 496 | 14201 |
| 11-#14 | 2.73 | 7264 | 4055 | 14803 | 3194 | 18108 | 2497 | 19533 | 1944 | 20553 | 1089 | 21404 | 322 | 19152 |
| 11-#18 | 4.85 | 7577 | 4913 | 18424 | 3673 | 22436 | 2837 | 24601 | 2142 | 25409 | 929 | 29420 | -138 | 29150 |
| 12-#11 | 2.06 | 7182 | 3786 | 13501 | 3068 | 16664 | 2406 | 17873 | 1899 | 18401 | 1127 | 18903 | 479 | 15403 |
| 12-#14 | 2.97 | 7331 | 4155 | 15101 | 3278 | 18583 | 2554 | 20135 | 1991 | 21354 | 1093 | 22512 | 295 | 20545 |
| 12-#18 | 5.29 | 7666 | 5091 | 18985 | 3809 | 23275 | 2927 | 25660 | 2217 | 28580 | 994 | 31276 | -192 | 30937 |
| 13-#11 | 2.23 | 7224 | 3856 | 13872 | 3095 | 17078 | 2429 | 18339 | 1906 | 19011 | 1116 | 19550 | 433 | 16390 |
| 13-#14 | 3.22 | 7386 | 4255 | 15611 | 3321 | 19162 | 2591 | 20798 | 2003 | 22230 | 1079 | 23443 | 228 | 22000 |
| 13-#18 | 5.73 | 7783 | 5269 | 19848 | 3895 | 24257 | 2999 | 26786 | 2242 | 30105 | 971 | 32896 | -313 | 32226 |
| 14-#11 | 2.41 | 7273 | 3925 | 14408 | 3099 | 17543 | 2429 | 18849 | 1903 | 19603 | 1084 | 20199 | 386 | 17444 |
| 14-#14 | 3.47 | 7446 | 4356 | 16202 | 3354 | 19812 | 2600 | 21512 | 2005 | 23094 | 1037 | 24393 | 165 | 23294 |
| 14-#18 | 6.17 | 7982 | 5447 | 20757 | 3971 | 25380 | 3032 | 28015 | 2256 | 31632 | 905 | 34568 | -420 | 33570 |
| 15-#11 | 2.58 | 7290 | 3995 | 14485 | 3178 | 17816 | 2494 | 19232 | 1947 | 20193 | 1110 | 21002 | 367 | 18424 |
| 15-#14 | 3.72 | 7477 | 4456 | 16488 | 3439 | 20221 | 2684 | 22066 | 2061 | 22313 | 996 | 25495 | 130 | 24747 |
| 15-#18 | 6.61 | 8045 | 5626 | 21371 | 4100 | 26085 | 3159 | 28973 | 2340 | 32989 | 945 | 36547 | -476 | 35149 |
| 16-#11 | 2.75 | 7310 | 4064 | 14740 | 3227 | 18169 | 2532 | 19665 | 1978 | 20766 | 1111 | 21808 | 338 | 19416 |
| 16-#14 | 3.97 | 7517 | 4556 | 16879 | 3507 | 20720 | 2734 | 22679 | 2102 | 24712 | 1066 | 26624 | 87 | 26048 |
| 17-#11 | 2.92 | 7374 | 4134 | 15065 | 3266 | 18554 | 2559 | 20126 | 1988 | 21376 | 1103 | 22512 | 306 | 20445 |
| 17-#14 | 4.21 | 7614 | 4656 | 17322 | 3565 | 21273 | 2775 | 23335 | 2118 | 25584 | 1056 | 27629 | 41 | 27383 |
| 18-#11 | 3.09 | 7395 | 4203 | 15504 | 3287 | 18992 | 2568 | 20622 | 1993 | 21977 | 1078 | 23160 | 251 | 21417 |
| 18-#14 | 4.46 | 7642 | 4757 | 17899 | 3601 | 21881 | 2794 | 24040 | 2130 | 26453 | 1023 | 28565 | -36 | 28501 |
| 19-#11 | 3.26 | 7440 | 4273 | 15644 | 3353 | 19297 | 2623 | 21021 | 2029 | 22558 | 1096 | 23955 | 239 | 22438 |
| 19-#14 | 4.71 | 7712 | 4857 | 18149 | 3689 | 22329 | 2866 | 24605 | 2175 | 27261 | 1043 | 29673 | -58 | 29547 |
| 20-#11 | 3.44 | 7489 | 4342 | 15911 | 3398 | 19660 | 2657 | 21457 | 2057 | 23131 | 1094 | 24677 | 204 | 23374 |
| 20-#14 | 4.96 | 7787 | 4957 | 18542 | 3753 | 22858 | 2915 | 25224 | 2214 | 28146 | 1057 | 30690 | -112 | 30426 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 21-#11 | 3.61 | 7521 | 4412 | 16267 | 3434 | 20056 | 2680 | 21916 | 2069 | 22181 | 1021 | 25449 | 181 | 24336 |
| 22-#11 | 3.78 | 7558 | 4481 | 16632 | 3466 | 20467 | 2701 | 22397 | 2078 | 22767 | 1008 | 26149 | 142 | 25329 |
| 23-#11 | 3.95 | 7606 | 4551 | 16855 | 3521 | 20801 | 2744 | 22811 | 2109 | 24945 | 1086 | 26887 | 115 | 26237 |
| 24-#11 | 4.12 | 7636 | 4620 | 17102 | 3571 | 21143 | 2782 | 23250 | 2135 | 25541 | 1089 | 27642 | 89 | 27173 |
| 25-#11 | 4.30 | 7701 | 4690 | 17438 | 3607 | 21542 | 2807 | 23704 | 2148 | 26126 | 1079 | 28331 | 48 | 28057 |

## ROUND SPIRAL COLUMNS 36" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#14 | 1.33 | 8414 | 3911 | 15974 | 3008 | 18496 | 2340 | 19100 | 1849 | 18689 | 1121 | 17678 | 568 | 12649 |
| 6-#18 | 2.36 | 8672 | 4379 | 18291 | 3239 | 21218 | 2487 | 22276 | 1926 | 22841 | 1029 | 22162 | 294 | 20383 |
| 7-#11 | 1.07 | 8295 | 3796 | 14210 | 3134 | 17349 | 2476 | 18251 | 1980 | 16674 | 1185 | 17429 | 728 | 10384 |
| 7-#14 | 1.55 | 8406 | 4011 | 15278 | 3247 | 18584 | 2556 | 19691 | 2027 | 19732 | 1245 | 19679 | 617 | 14199 |
| 7-#18 | 2.75 | 8605 | 4557 | 17768 | 3552 | 21614 | 2763 | 23205 | 2147 | 24320 | 1176 | 25167 | 326 | 22763 |
| 8-#11 | 1.23 | 8342 | 3865 | 14207 | 3221 | 17624 | 2541 | 18691 | 2035 | 18552 | 1298 | 18263 | 720 | 11664 |
| 8-#14 | 1.77 | 8460 | 4111 | 15384 | 3355 | 19013 | 2635 | 20317 | 2095 | 20669 | 1275 | 20804 | 597 | 16158 |
| 8-#18 | 3.14 | 8684 | 4735 | 18239 | 3699 | 22417 | 2876 | 24326 | 2246 | 24145 | 1131 | 27002 | 275 | 25273 |
| 9-#11 | 1.38 | 8375 | 3935 | 14745 | 3236 | 18111 | 2553 | 19203 | 2032 | 19164 | 1273 | 19058 | 665 | 12924 |
| 9-#14 | 1.99 | 8504 | 4212 | 16082 | 3387 | 19682 | 2661 | 21048 | 2097 | 21563 | 1243 | 21964 | 522 | 17651 |
| 9-#18 | 3.54 | 8758 | 4914 | 19328 | 3773 | 23533 | 2936 | 25558 | 2258 | 27452 | 1163 | 29047 | 147 | 27979 |
| 10-#11 | 1.53 | 8392 | 4005 | 15418 | 3223 | 18713 | 2529 | 19765 | 2005 | 19786 | 1227 | 19531 | 609 | 14182 |
| 10-#14 | 2.21 | 8520 | 4312 | 16901 | 3390 | 20503 | 2646 | 21842 | 2074 | 21002 | 1111 | 22711 | 449 | 19502 |
| 10-#18 | 3.93 | 8822 | 5092 | 20525 | 3819 | 24855 | 2940 | 26929 | 2245 | 29168 | 1087 | 30777 | 65 | 30361 |
| 11-#11 | 1.69 | 8465 | 4074 | 15317 | 3330 | 18897 | 2624 | 20160 | 2078 | 20474 | 1277 | 20684 | 614 | 15378 |
| 11-#14 | 2.43 | 8618 | 4412 | 16926 | 3519 | 20805 | 2759 | 22407 | 2160 | 23417 | 1246 | 24260 | 444 | 20868 |
| 11-#18 | 4.32 | 8985 | 5270 | 20853 | 4001 | 25484 | 3103 | 27916 | 2364 | 30641 | 1160 | 32979 | -3 | 32972 |
| 12-#11 | 1.84 | 8510 | 4144 | 15517 | 3396 | 19243 | 2669 | 20617 | 2115 | 21095 | 1284 | 21552 | 599 | 16626 |
| 12-#14 | 2.65 | 8691 | 4513 | 17246 | 3606 | 21313 | 2818 | 23055 | 2208 | 24284 | 1252 | 25466 | 419 | 22443 |
| 12-#18 | 4.72 | 9071 | 5448 | 21451 | 4140 | 26386 | 3195 | 29052 | 2441 | 29968 | 1084 | 35001 | -55 | 34901 |
| 13-#11 | 1.99 | 8561 | 4213 | 15918 | 3421 | 19688 | 2692 | 21120 | 2121 | 20299 | 1188 | 22246 | 552 | 17748 |
| 13-#14 | 2.87 | 8740 | 4613 | 17793 | 3648 | 21940 | 2855 | 23771 | 2220 | 25225 | 1238 | 26468 | 353 | 23943 |
| 13-#18 | 5.11 | 9191 | 5627 | 22371 | 4224 | 27449 | 3266 | 30275 | 2466 | 33753 | 1139 | 36751 | -174 | 36369 |
| 14-#11 | 2.15 | 8623 | 4283 | 16515 | 3422 | 20191 | 2689 | 21670 | 2116 | 20888 | 1156 | 22941 | 505 | 19007 |
| 14-#14 | 3.09 | 8829 | 4713 | 18563 | 3661 | 22635 | 2861 | 24558 | 2222 | 26151 | 1195 | 27489 | 289 | 25405 |
| 14-#18 | 5.50 | 9399 | 5805 | 23372 | 4298 | 28646 | 3297 | 31603 | 2480 | 35397 | 1073 | 38563 | -281 | 37948 |
| 15-#11 | 2.30 | 8633 | 4352 | 16575 | 3505 | 20476 | 2757 | 22081 | 2164 | 23023 | 1267 | 23816 | 488 | 20048 |
| 15-#14 | 3.32 | 8845 | 4813 | 18736 | 3767 | 23068 | 2948 | 25137 | 2280 | 25231 | 1146 | 28687 | 257 | 27010 |
| 15-#18 | 5.89 | 9431 | 5983 | 24013 | 4431 | 29423 | 3429 | 32637 | 2567 | 34410 | 1042 | 40710 | -332 | 39637 |
| 16-#11 | 2.45 | 8665 | 4422 | 16836 | 3554 | 20863 | 2797 | 22546 | 2196 | 23640 | 1269 | 24690 | 460 | 21171 |
| 16-#14 | 3.54 | 8909 | 4914 | 19140 | 3835 | 23616 | 3000 | 25797 | 2322 | 27902 | 1228 | 29913 | 215 | 28372 |
| 16-#18 | 6.29 | 9567 | 6161 | 24783 | 4547 | 30360 | 3513 | 33783 | 2636 | 35797 | 1036 | 42627 | -431 | 41364 |
| 17-#11 | 2.61 | 8730 | 4491 | 17192 | 3593 | 21270 | 2822 | 23043 | 2206 | 24295 | 1261 | 25447 | 429 | 22245 |
| 17-#14 | 3.76 | 8992 | 5014 | 19625 | 3893 | 24200 | 3040 | 26504 | 2338 | 28840 | 1218 | 30996 | 170 | 29890 |
| 18-#11 | 2.76 | 8760 | 4561 | 17683 | 3613 | 21746 | 2830 | 23566 | 2209 | 24940 | 1236 | 26144 | 374 | 23326 |
| 18-#14 | 3.98 | 9044 | 5114 | 20267 | 3928 | 24860 | 3058 | 27263 | 2349 | 29773 | 1185 | 32006 | 93 | 31339 |

## ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sideway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 19-#11 | 2.91 | 8803 | 4630 | 17813 | 3681 | 22070 | 2887 | 24004 | 2247 | 23864 | 1171 | 27004 | 364 | 24409 |
| 19-#14 | 4.20 | 9119 | 5214 | 20513 | 4018 | 25337 | 3132 | 27873 | 2396 | 30648 | 1207 | 33203 | 74 | 32752 |
| 20-#11 | 3.07 | 8863 | 4700 | 18097 | 3727 | 22449 | 2922 | 24476 | 2276 | 26186 | 1254 | 27784 | 330 | 25436 |
| 20-#14 | 4.42 | 9197 | 5315 | 20932 | 4082 | 25893 | 3181 | 28539 | 2436 | 31521 | 1204 | 34303 | 22 | 34195 |
| 21-#11 | 3.22 | 8894 | 4769 | 18483 | 3762 | 22885 | 2945 | 24962 | 2287 | 25076 | 1171 | 28617 | 308 | 26530 |
| 21-#14 | 4.64 | 9258 | 5415 | 21468 | 4135 | 26498 | 3215 | 29242 | 2454 | 30328 | 1125 | 35488 | -9 | 35466 |
| 22-#11 | 3.37 | 8947 | 4839 | 18877 | 3793 | 23332 | 2965 | 25476 | 2296 | 27541 | 1240 | 29368 | 268 | 27544 |
| 22-#14 | 4.86 | 9328 | 5515 | 22004 | 4185 | 27121 | 3248 | 29977 | 2470 | 33463 | 1186 | 36571 | -65 | 36406 |
| 23-#11 | 3.52 | 8974 | 4908 | 19109 | 3849 | 23679 | 3009 | 25922 | 2328 | 26262 | 1165 | 30171 | 243 | 28581 |
| 24-#11 | 3.68 | 9007 | 4978 | 19379 | 3901 | 24045 | 3048 | 26405 | 2356 | 28780 | 1252 | 30986 | 218 | 29647 |
| 25-#11 | 3.83 | 9075 | 5047 | 19736 | 3936 | 24476 | 3073 | 26883 | 2368 | 29408 | 1241 | 31731 | 177 | 30651 |
| 26-#11 | 3.98 | 9112 | 5117 | 20108 | 3971 | 24925 | 3097 | 27393 | 2380 | 28075 | 1147 | 32478 | 143 | 31645 |
| 27-#11 | 4.14 | 9161 | 5186 | 20409 | 4017 | 25277 | 3136 | 27844 | 2409 | 28634 | 1152 | 33355 | 117 | 32621 |

## ROUND SPIRAL COLUMNS 38" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.19 | 9868 | 4289 | 18393 | 3330 | 21351 | 2596 | 22023 | 2058 | 21419 | 1270 | 20205 | 681 | 13532 |
| 6-#18 | 2.12 | 10147 | 4757 | 20896 | 3561 | 24286 | 2744 | 25445 | 2137 | 24164 | 1102 | 25055 | 413 | 22342 |
| 7-#14 | 1.39 | 9878 | 4389 | 17507 | 3587 | 21389 | 2829 | 22653 | 2252 | 22583 | 1406 | 22420 | 738 | 15284 |
| 7-#18 | 2.47 | 10125 | 4935 | 20188 | 3893 | 24644 | 3037 | 26448 | 2374 | 25687 | 1251 | 28352 | 455 | 24746 |
| 8-#11 | 1.10 | 9800 | 4243 | 16322 | 3566 | 20347 | 2818 | 21574 | 2262 | 21323 | 1461 | 20904 | 842 | 12493 |
| 8-#14 | 1.59 | 9943 | 4489 | 17589 | 3700 | 21836 | 2913 | 23316 | 2322 | 22023 | 1344 | 23643 | 722 | 17324 |
| 8-#18 | 2.82 | 10219 | 5113 | 20662 | 4045 | 25493 | 3155 | 27619 | 2475 | 27248 | 1289 | 30342 | 408 | 27570 |
| 9-#11 | 1.24 | 9834 | 4313 | 16919 | 3580 | 20877 | 2828 | 22124 | 2257 | 21972 | 1435 | 21750 | 787 | 13915 |
| 9-#14 | 1.79 | 9987 | 4590 | 18356 | 3731 | 22562 | 2937 | 24101 | 2323 | 24549 | 1407 | 24883 | 646 | 19006 |
| 9-#18 | 3.17 | 10295 | 5291 | 21851 | 4117 | 26701 | 3213 | 28975 | 2489 | 28830 | 1243 | 32541 | 279 | 30393 |
| 10-#11 | 1.38 | 9856 | 4382 | 17676 | 3560 | 21529 | 2798 | 22736 | 2227 | 21118 | 1294 | 22239 | 729 | 15219 |
| 10-#14 | 1.98 | 10011 | 4690 | 19267 | 3727 | 23445 | 2915 | 24968 | 2297 | 23841 | 1261 | 25667 | 572 | 21007 |
| 10-#18 | 3.53 | 10372 | 5470 | 23158 | 4156 | 28162 | 3215 | 30448 | 2472 | 30538 | 1170 | 34385 | 198 | 33016 |
| 11-#11 | 1.51 | 9940 | 4452 | 17518 | 3674 | 21715 | 2900 | 23148 | 2304 | 21819 | 1344 | 23497 | 737 | 16566 |
| 11-#14 | 2.18 | 10122 | 4790 | 19245 | 3863 | 23763 | 3037 | 25558 | 2388 | 26539 | 1411 | 27351 | 572 | 22600 |
| 11-#18 | 3.88 | 10515 | 5648 | 23463 | 4347 | 28793 | 3382 | 31498 | 2596 | 32027 | 1243 | 36773 | 135 | 35953 |
| 12-#11 | 1.65 | 9986 | 4521 | 17725 | 3742 | 22080 | 2947 | 23637 | 2344 | 24047 | 1448 | 24437 | 723 | 17861 |
| 12-#14 | 2.38 | 10182 | 4890 | 19585 | 3953 | 24302 | 3097 | 26252 | 2438 | 25640 | 1324 | 28655 | 548 | 24397 |
| 12-#18 | 4.23 | 10638 | 5826 | 24113 | 4489 | 29757 | 3477 | 32695 | 2675 | 33502 | 1246 | 38963 | 85 | 38372 |
| 13-#11 | 1.79 | 10042 | 4591 | 18158 | 3766 | 22553 | 2969 | 24176 | 2349 | 24744 | 1437 | 25178 | 677 | 19124 |
| 13-#14 | 2.58 | 10258 | 4991 | 20170 | 3993 | 24973 | 3133 | 27019 | 2450 | 26579 | 1311 | 29727 | 482 | 25955 |
| 13-#18 | 4.59 | 10767 | 6004 | 25090 | 4571 | 30903 | 3548 | 34024 | 2701 | 35148 | 1226 | 40843 | -32 | 40772 |
| 14-#11 | 1.93 | 10122 | 4661 | 18820 | 3765 | 23100 | 2963 | 24755 | 2341 | 25414 | 1402 | 25915 | 629 | 20436 |
| 14-#14 | 2.78 | 10364 | 5091 | 21018 | 4004 | 25719 | 3136 | 27861 | 2449 | 29463 | 1361 | 30819 | 418 | 27573 |
| 14-#18 | 4.94 | 10991 | 6183 | 26187 | 4642 | 32171 | 3575 | 35468 | 2714 | 36791 | 1164 | 42793 | -138 | 42499 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 38" DIA.

Short columns – no sideway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 15-#11 | 2.06 | 10131 | 4730 | 18859 | 3851 | 23396 | 3035 | 25206 | 2393 | 26109 | 1433 | 26865 | 614 | 21627 |
| 15-#14 | 2.98 | 10380 | 5191 | 21178 | 4113 | 26174 | 3227 | 28484 | 2510 | 30416 | 1397 | 32116 | 389 | 29229 |
| 15-#18 | 5.29 | 11008 | 6361 | 26850 | 4780 | 33016 | 3712 | 36555 | 2803 | 41005 | 1293 | 44940 | -204 | 44422 |
| 16-#11 | 2.20 | 10169 | 4800 | 19125 | 3901 | 23810 | 3076 | 25703 | 2425 | 26772 | 1435 | 27808 | 587 | 22955 |
| 16-#14 | 3.17 | 10423 | 5291 | 21594 | 4182 | 26771 | 3281 | 29191 | 2554 | 29260 | 1305 | 33438 | 347 | 30756 |
| 16-#18 | 5.64 | 11134 | 6539 | 27651 | 4896 | 34026 | 3799 | 37777 | 2874 | 39762 | 1203 | 47184 | -283 | 46340 |
| 17-#11 | 2.34 | 10240 | 4869 | 19511 | 3939 | 24246 | 3101 | 26232 | 2435 | 27472 | 1428 | 28617 | 557 | 24072 |
| 17-#14 | 3.37 | 10523 | 5392 | 22121 | 4240 | 27386 | 3320 | 29950 | 2570 | 30197 | 1295 | 34598 | 304 | 32468 |
| 17-#18 | 6.00 | 11287 | 6717 | 28521 | 5003 | 35116 | 3874 | 39090 | 2905 | 44352 | 1273 | 49204 | -363 | 48120 |
| 18-#11 | 2.48 | 10262 | 4939 | 20059 | 3958 | 24761 | 3107 | 26786 | 2437 | 28159 | 1402 | 29362 | 501 | 25285 |
| 18-#14 | 3.57 | 10558 | 5492 | 22833 | 4274 | 28100 | 3336 | 30748 | 2579 | 33350 | 1355 | 35682 | 227 | 33939 |
| 19-#11 | 2.61 | 10324 | 5008 | 20176 | 4027 | 25118 | 3160 | 27255 | 2476 | 26913 | 1328 | 30288 | 494 | 26398 |
| 19-#14 | 3.77 | 10642 | 5592 | 23071 | 4366 | 28605 | 3413 | 31413 | 2629 | 34292 | 1379 | 36970 | 210 | 35531 |
| 20-#11 | 2.75 | 10389 | 5078 | 20475 | 4074 | 25498 | 3201 | 27770 | 2507 | 29499 | 1422 | 31127 | 460 | 27550 |
| 20-#14 | 3.97 | 10744 | 5693 | 23515 | 4431 | 29187 | 3462 | 32131 | 2670 | 32881 | 1285 | 38152 | 160 | 37155 |
| 21-#11 | 2.89 | 10428 | 5147 | 20892 | 4109 | 25966 | 3225 | 28281 | 2518 | 30199 | 1417 | 31956 | 431 | 28712 |
| 21-#14 | 4.17 | 10810 | 5793 | 24094 | 4483 | 29848 | 3497 | 32872 | 2687 | 36271 | 1378 | 39427 | 129 | 38634 |
| 22-#11 | 3.03 | 10468 | 5217 | 21318 | 4139 | 26457 | 3244 | 28831 | 2526 | 28883 | 1314 | 32823 | 399 | 29812 |
| 22-#14 | 4.36 | 10910 | 5893 | 24668 | 4531 | 30521 | 3529 | 33657 | 2702 | 37307 | 1359 | 40586 | 74 | 40180 |
| 23-#11 | 3.16 | 10516 | 5286 | 21556 | 4197 | 26816 | 3289 | 29309 | 2559 | 29482 | 1323 | 33692 | 375 | 31000 |
| 23-#14 | 4.56 | 10958 | 5993 | 25049 | 4609 | 31058 | 3589 | 34334 | 2746 | 38206 | 1368 | 41795 | 35 | 41579 |
| 24-#11 | 3.30 | 10554 | 5356 | 21848 | 4249 | 27207 | 3328 | 29818 | 2587 | 32277 | 1422 | 34567 | 351 | 32069 |
| 25-#11 | 3.44 | 10617 | 5425 | 22226 | 4284 | 27670 | 3353 | 30338 | 2600 | 32949 | 1411 | 35368 | 311 | 33198 |
| 26-#11 | 3.58 | 10669 | 5495 | 22632 | 4318 | 28145 | 3376 | 30885 | 2612 | 33667 | 1399 | 36167 | 277 | 34321 |
| 27-#11 | 3.71 | 10709 | 5564 | 22947 | 4365 | 28527 | 3418 | 31367 | 2641 | 34310 | 1405 | 37110 | 253 | 35400 |
| 28-#11 | 3.85 | 10777 | 5634 | 23271 | 4409 | 28928 | 3456 | 31866 | 2668 | 34997 | 1409 | 37906 | 223 | 36481 |

## ROUND SPIRAL COLUMNS 40" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.07 | 11479 | 4687 | 21046 | 3669 | 24490 | 2866 | 25236 | 2279 | 22783 | 1332 | 22965 | 799 | 14416 |
| 6-#18 | 1.91 | 11799 | 5155 | 23738 | 3901 | 27640 | 3015 | 28904 | 2360 | 29200 | 1341 | 28180 | 536 | 24234 |
| 7-#14 | 1.25 | 11500 | 4787 | 19945 | 3947 | 24470 | 3118 | 25900 | 2488 | 23990 | 1470 | 25406 | 866 | 16372 |
| 7-#18 | 2.23 | 11803 | 5333 | 22931 | 4237 | 27950 | 3325 | 29982 | 2613 | 30993 | 1514 | 31783 | 588 | 26783 |
| 8-#14 | 1.43 | 11582 | 4888 | 19996 | 4065 | 24933 | 3206 | 26606 | 2562 | 25009 | 1505 | 26730 | 853 | 18498 |
| 8-#18 | 2.55 | 11914 | 5512 | 23290 | 4410 | 28844 | 3449 | 31203 | 2717 | 32790 | 1557 | 33931 | 545 | 29939 |
| 9-#11 | 1.12 | 11448 | 4711 | 19295 | 3942 | 23916 | 3119 | 25335 | 2495 | 25051 | 1605 | 24689 | 914 | 14921 |
| 9-#14 | 1.61 | 11626 | 4988 | 20837 | 4093 | 25716 | 3227 | 27445 | 2561 | 27805 | 1579 | 28048 | 776 | 20379 |
| 9-#18 | 2.86 | 11992 | 5690 | 24583 | 4480 | 30144 | 3505 | 32660 | 2730 | 32290 | 1407 | 36282 | 416 | 32822 |
| 10-#11 | 1.24 | 11476 | 4781 | 20148 | 3915 | 24622 | 3082 | 25998 | 2461 | 25734 | 1553 | 25191 | 854 | 16265 |
| 10-#14 | 1.79 | 11658 | 5088 | 21848 | 4083 | 26664 | 3200 | 28386 | 2532 | 28853 | 1519 | 28867 | 700 | 22465 |
| 10-#18 | 3.18 | 12018 | 5868 | 26009 | 4512 | 31711 | 3501 | 34259 | 2710 | 36540 | 1427 | 37874 | 298 | 35744 |

## ROUND SPIRAL COLUMNS 40" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 11-#11 | 1.37 | 11570 | 4850 | 19924 | 4037 | 24808 | 3192 | 26428 | 2544 | 26552 | 1612 | 26558 | 867 | 17772 |
| 11-#14 | 1.97 | 11783 | 5189 | 21769 | 4227 | 26996 | 3329 | 28999 | 2627 | 29931 | 1585 | 30689 | 704 | 24246 |
| 11-#18 | 3.50 | 12242 | 6046 | 26281 | 4711 | 32378 | 3677 | 35350 | 2839 | 38260 | 1511 | 40816 | 277 | 38773 |
| 12-#11 | 1.49 | 11618 | 4920 | 20126 | 4107 | 25191 | 3241 | 26949 | 2585 | 27264 | 1621 | 27570 | 854 | 19111 |
| 12-#14 | 2.15 | 11846 | 5289 | 22127 | 4319 | 27565 | 3391 | 29740 | 2680 | 28869 | 1488 | 32093 | 682 | 26323 |
| 12-#18 | 3.82 | 12331 | 6225 | 26979 | 4857 | 33402 | 3774 | 36629 | 2920 | 39954 | 1516 | 43174 | 229 | 41462 |
| 13-#11 | 1.61 | 11682 | 4989 | 20602 | 4130 | 25692 | 3261 | 27523 | 2589 | 26143 | 1502 | 28357 | 808 | 20523 |
| 13-#14 | 2.33 | 11934 | 5389 | 22752 | 4358 | 28273 | 3426 | 30559 | 2691 | 32001 | 1580 | 33235 | 617 | 27991 |
| 13-#18 | 4.14 | 12512 | 6403 | 28015 | 4937 | 34632 | 3845 | 38051 | 2946 | 41836 | 1495 | 45184 | 114 | 44451 |
| 14-#11 | 1.74 | 11779 | 5059 | 21333 | 4125 | 26284 | 3252 | 28131 | 2579 | 28717 | 1573 | 29136 | 759 | 21881 |
| 14-#14 | 2.51 | 12059 | 5489 | 23683 | 4365 | 29079 | 3426 | 31443 | 2687 | 30843 | 1433 | 34395 | 552 | 29798 |
| 14-#18 | 4.46 | 12754 | 6581 | 29438 | 4975 | 35973 | 3868 | 39626 | 2959 | 43711 | 1428 | 47270 | 7 | 47215 |
| 15-#11 | 1.86 | 11786 | 5128 | 21343 | 4215 | 26589 | 3328 | 28619 | 2633 | 27502 | 1499 | 30163 | 746 | 23212 |
| 15-#14 | 2.69 | 12075 | 5590 | 23825 | 4478 | 29554 | 3521 | 32122 | 2753 | 34070 | 1573 | 35793 | 525 | 31496 |
| 15-#18 | 4.77 | 12766 | 6759 | 29894 | 5147 | 36866 | 4009 | 40757 | 3051 | 45413 | 1478 | 49580 | -55 | 49441 |
| 16-#11 | 1.99 | 11831 | 5198 | 21616 | 4267 | 27020 | 3369 | 29152 | 2667 | 30171 | 1610 | 31175 | 720 | 24599 |
| 16-#14 | 2.86 | 12123 | 5690 | 24252 | 4548 | 30191 | 3577 | 32876 | 2798 | 32732 | 1470 | 37212 | 485 | 33199 |
| 16-#18 | 5.09 | 12891 | 6938 | 30724 | 5264 | 37966 | 4099 | 42062 | 3123 | 47123 | 1475 | 51993 | -132 | 51630 |
| 17-#11 | 2.11 | 11906 | 5267 | 22034 | 4304 | 27495 | 3394 | 29706 | 2676 | 28859 | 1496 | 32037 | 690 | 25858 |
| 17-#14 | 3.04 | 12232 | 5790 | 24820 | 4605 | 30847 | 3615 | 33680 | 2813 | 36139 | 1566 | 38450 | 442 | 34980 |
| 17-#18 | 5.41 | 13039 | 7116 | 31661 | 5371 | 39110 | 4172 | 43466 | 3154 | 48992 | 1460 | 54153 | -210 | 53511 |
| 18-#11 | 2.23 | 11932 | 5337 | 22633 | 4321 | 28051 | 3399 | 30296 | 2677 | 31648 | 1576 | 32828 | 634 | 27247 |
| 18-#14 | 3.22 | 12273 | 5890 | 25605 | 4638 | 31614 | 3630 | 34523 | 2820 | 37198 | 1532 | 39606 | 365 | 36601 |
| 18-#18 | 5.73 | 13149 | 7294 | 32872 | 5442 | 40399 | 4211 | 44969 | 3180 | 47475 | 1313 | 56194 | -342 | 55047 |
| 19-#11 | 2.36 | 12004 | 5406 | 22742 | 4393 | 28421 | 3454 | 30797 | 2718 | 32375 | 1598 | 33821 | 629 | 28432 |
| 19-#14 | 3.40 | 12366 | 5991 | 25833 | 4732 | 32172 | 3700 | 35233 | 2873 | 38208 | 1558 | 40985 | 351 | 38411 |
| 20-#11 | 2.48 | 12073 | 5476 | 23056 | 4441 | 28820 | 3496 | 31350 | 2750 | 33079 | 1598 | 34719 | 596 | 29714 |
| 20-#14 | 3.58 | 12438 | 6091 | 26302 | 4798 | 32754 | 3758 | 36014 | 2915 | 36596 | 1453 | 42251 | 302 | 40034 |
| 21-#11 | 2.61 | 12114 | 5545 | 23500 | 4475 | 29321 | 3519 | 31891 | 2760 | 33828 | 1593 | 35605 | 568 | 30908 |
| 21-#14 | 3.76 | 12526 | 6191 | 26923 | 4850 | 33461 | 3793 | 36790 | 2932 | 40276 | 1550 | 43516 | 261 | 41690 |
| 22-#11 | 2.73 | 12167 | 5615 | 23964 | 4504 | 29856 | 3538 | 32478 | 2767 | 34623 | 1584 | 36526 | 536 | 32132 |
| 22-#14 | 3.94 | 12611 | 6291 | 27539 | 4897 | 34196 | 3825 | 37628 | 2946 | 41423 | 1539 | 44850 | 217 | 43409 |
| 23-#11 | 2.86 | 12209 | 5684 | 24205 | 4563 | 30227 | 3584 | 32986 | 2802 | 35309 | 1594 | 37461 | 512 | 33382 |
| 23-#14 | 4.12 | 12662 | 6392 | 27933 | 4976 | 34752 | 3885 | 38351 | 2991 | 42385 | 1550 | 46151 | 180 | 44973 |
| 24-#11 | 2.98 | 12262 | 5754 | 24510 | 4616 | 30643 | 3624 | 33520 | 2831 | 36040 | 1599 | 38397 | 489 | 34545 |
| 24-#14 | 4.30 | 12750 | 6492 | 28387 | 5050 | 35350 | 3941 | 39124 | 3031 | 40532 | 1452 | 47474 | 145 | 46591 |
| 25-#11 | 3.10 | 12321 | 5824 | 24920 | 4651 | 31137 | 3649 | 34081 | 2844 | 34309 | 1483 | 39254 | 449 | 35807 |
| 25-#14 | 4.48 | 12873 | 6592 | 28952 | 5102 | 36049 | 3978 | 39913 | 3051 | 44451 | 1541 | 48695 | 87 | 48120 |
| 26-#11 | 3.23 | 12362 | 5893 | 25361 | 4684 | 31639 | 3671 | 34667 | 2855 | 35023 | 1472 | 40104 | 416 | 36952 |
| 27-#11 | 3.35 | 12421 | 5963 | 25683 | 4732 | 32045 | 3713 | 35172 | 2885 | 38211 | 1584 | 41114 | 393 | 38157 |
| 28-#11 | 3.48 | 12504 | 6032 | 26025 | 4777 | 32477 | 3753 | 35704 | 2912 | 38941 | 1588 | 41968 | 364 | 39353 |
| 29-#11 | 3.60 | 12543 | 6102 | 26393 | 4820 | 32951 | 3778 | 36264 | 2926 | 39663 | 1579 | 42891 | 331 | 40526 |
| 30-#11 | 3.72 | 12583 | 6171 | 26868 | 4850 | 33441 | 3802 | 36857 | 2941 | 37732 | 1464 | 43702 | 291 | 41729 |

## ROUND SPIRAL COLUMNS 42" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.73 | 13615 | 5574 | 26826 | 4258 | 31293 | 3301 | 32669 | 2593 | 30600 | 1408 | 31551 | 665 | 25789 |
| 7-#14 | 1.14 | 13291 | 5206 | 22602 | 4326 | 27841 | 3421 | 29453 | 2736 | 29107 | 1753 | 28650 | 999 | 17475 |
| 7-#18 | 2.02 | 13648 | 5752 | 25790 | 4616 | 31547 | 3629 | 33802 | 2862 | 34748 | 1694 | 35473 | 726 | 28660 |
| 8-#14 | 1.30 | 13386 | 5307 | 22616 | 4449 | 28318 | 3514 | 30203 | 2815 | 30273 | 1794 | 30079 | 990 | 19677 |
| 8-#18 | 2.31 | 13776 | 5930 | 26132 | 4794 | 32483 | 3757 | 35093 | 2971 | 36673 | 1742 | 37782 | 688 | 32379 |
| 9-#11 | 1.01 | 13226 | 5130 | 21885 | 4322 | 27245 | 3424 | 28852 | 2745 | 28415 | 1784 | 27889 | 1047 | 15940 |
| 9-#14 | 1.46 | 13430 | 5407 | 23531 | 4474 | 29160 | 3533 | 31095 | 2812 | 29257 | 1642 | 31474 | 912 | 21772 |
| 9-#18 | 2.60 | 13858 | 6109 | 27533 | 4862 | 33877 | 3812 | 36645 | 2982 | 38589 | 1692 | 40283 | 559 | 35309 |
| 10-#11 | 1.13 | 13261 | 5200 | 22845 | 4290 | 28007 | 3382 | 29553 | 2706 | 29124 | 1729 | 28399 | 985 | 17320 |
| 10-#14 | 1.62 | 13471 | 5507 | 24655 | 4457 | 30176 | 3499 | 32110 | 2779 | 32444 | 1696 | 32323 | 834 | 23934 |
| 10-#18 | 2.89 | 13890 | 6287 | 29086 | 4887 | 35542 | 3801 | 38377 | 2960 | 40643 | 1609 | 41961 | 440 | 38545 |
| 11-#11 | 1.24 | 13365 | 5269 | 22545 | 4420 | 28184 | 3499 | 30013 | 2795 | 28010 | 1672 | 29879 | 1002 | 18997 |
| 11-#14 | 1.79 | 13610 | 5607 | 24509 | 4609 | 30517 | 3636 | 32747 | 2880 | 33608 | 1767 | 34288 | 843 | 25915 |
| 11-#18 | 3.18 | 14139 | 6465 | 29315 | 5094 | 36253 | 3986 | 39509 | 3094 | 39658 | 1584 | 45121 | 424 | 41654 |
| 12-#11 | 1.35 | 13415 | 5339 | 22737 | 4491 | 28589 | 3550 | 30566 | 2838 | 28710 | 1682 | 30966 | 991 | 20373 |
| 12-#14 | 1.95 | 13674 | 5708 | 24867 | 4703 | 31116 | 3701 | 33534 | 2934 | 34669 | 1777 | 35793 | 821 | 28072 |
| 12-#18 | 3.46 | 14232 | 6643 | 30061 | 5244 | 37336 | 4085 | 40871 | 3177 | 44299 | 1705 | 47649 | 378 | 44628 |
| 13-#11 | 1.46 | 13487 | 5408 | 23260 | 4513 | 29118 | 3568 | 31177 | 2842 | 31557 | 1791 | 31798 | 945 | 21943 |
| 13-#14 | 2.11 | 13776 | 5808 | 25550 | 4741 | 31861 | 3734 | 34405 | 2944 | 33423 | 1645 | 37004 | 757 | 29952 |
| 13-#18 | 3.75 | 14388 | 6822 | 31157 | 5322 | 38636 | 4155 | 42384 | 3203 | 43212 | 1572 | 49788 | 264 | 47964 |
| 14-#11 | 1.58 | 13600 | 5478 | 24066 | 4505 | 29759 | 3557 | 31814 | 2828 | 30151 | 1636 | 32616 | 894 | 23343 |
| 14-#14 | 2.27 | 13921 | 5908 | 26567 | 4745 | 32729 | 3731 | 35331 | 2937 | 36913 | 1717 | 38230 | 691 | 32079 |
| 14-#18 | 4.04 | 14688 | 7000 | 32699 | 5356 | 40065 | 4175 | 44048 | 3213 | 48288 | 1616 | 52007 | 157 | 50750 |
| 15-#11 | 1.69 | 13607 | 5547 | 24038 | 4599 | 30070 | 3636 | 32332 | 2886 | 33101 | 1788 | 33722 | 884 | 24834 |
| 15-#14 | 2.44 | 13924 | 6008 | 26681 | 4862 | 33222 | 3829 | 36064 | 3007 | 38011 | 1758 | 39732 | 667 | 33811 |
| 15-#18 | 4.33 | 14704 | 7178 | 33154 | 5533 | 41005 | 4320 | 45265 | 3309 | 50108 | 1669 | 54483 | 98 | 53789 |
| 16-#11 | 1.80 | 13658 | 5617 | 24319 | 4651 | 30517 | 3678 | 32906 | 2922 | 31591 | 1673 | 34805 | 858 | 26252 |
| 16-#14 | 2.60 | 13991 | 6109 | 27122 | 4933 | 33885 | 3886 | 36868 | 3053 | 39068 | 1761 | 41250 | 627 | 35700 |
| 16-#18 | 4.62 | 14835 | 7356 | 34011 | 5651 | 42196 | 4413 | 46654 | 3383 | 51931 | 1669 | 57065 | 23 | 56885 |
| 17-#11 | 1.91 | 13738 | 5686 | 24771 | 4688 | 31032 | 3703 | 33486 | 2930 | 34644 | 1785 | 35718 | 829 | 27652 |
| 17-#14 | 2.76 | 14093 | 6209 | 27734 | 4990 | 34596 | 3925 | 37708 | 3068 | 40210 | 1751 | 42564 | 585 | 37528 |
| 17-#18 | 4.91 | 14983 | 7535 | 35016 | 5757 | 43394 | 4485 | 48150 | 3415 | 50324 | 1543 | 59366 | -53 | 59213 |
| 18-#11 | 2.03 | 13768 | 5756 | 25420 | 4703 | 31629 | 3706 | 34114 | 2929 | 35423 | 1758 | 36554 | 772 | 29088 |
| 18-#14 | 2.92 | 14156 | 6309 | 28585 | 5021 | 35418 | 3938 | 38605 | 3074 | 38576 | 1602 | 43790 | 507 | 39377 |
| 18-#18 | 5.20 | 15089 | 7713 | 36340 | 5828 | 44772 | 4523 | 49722 | 3438 | 55909 | 1600 | 61542 | -186 | 60900 |
| 19-#11 | 2.14 | 13843 | 5825 | 25521 | 4778 | 32007 | 3763 | 34645 | 2972 | 36188 | 1781 | 37617 | 769 | 30427 |
| 19-#14 | 3.09 | 14242 | 6409 | 28809 | 5117 | 35999 | 4010 | 39359 | 3128 | 42409 | 1745 | 45263 | 497 | 41240 |
| 19-#18 | 5.49 | 15292 | 7891 | 36892 | 5981 | 45839 | 4635 | 51026 | 3519 | 53881 | 1528 | 64030 | -219 | 63285 |
| 20-#11 | 2.25 | 13924 | 5895 | 25848 | 4826 | 32429 | 3806 | 35223 | 3004 | 34474 | 1664 | 38574 | 738 | 31879 |
| 20-#14 | 3.25 | 14334 | 6510 | 29302 | 5185 | 36609 | 4069 | 40196 | 3172 | 43469 | 1744 | 46613 | 449 | 42975 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 42" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 21-#11 | 2.36 | 13973 | 5964 | 26319 | 4860 | 32963 | 3829 | 35807 | 3015 | 37731 | 1777 | 39517 | 709 | 33166 |
| 21-#14 | 3.41 | 14415 | 6610 | 29960 | 5236 | 37362 | 4104 | 41015 | 3189 | 44609 | 1738 | 47961 | 408 | 44819 |
| 22-#11 | 2.48 | 14032 | 6034 | 26825 | 4887 | 33536 | 3847 | 36431 | 3021 | 36011 | 1650 | 40491 | 677 | 34505 |
| 22-#14 | 3.57 | 14529 | 6710 | 30624 | 5281 | 38160 | 4135 | 41906 | 3202 | 45824 | 1727 | 49375 | 364 | 46569 |
| 23-#11 | 2.59 | 14078 | 6103 | 27068 | 4948 | 33925 | 3894 | 36969 | 3058 | 39304 | 1779 | 41493 | 655 | 35787 |
| 23-#14 | 3.74 | 14563 | 6810 | 31030 | 5362 | 38734 | 4197 | 42673 | 3249 | 46849 | 1739 | 50769 | 329 | 48320 |
| 24-#11 | 2.70 | 14121 | 6173 | 27382 | 5001 | 34365 | 3935 | 37529 | 3086 | 37410 | 1665 | 42490 | 633 | 37075 |
| 24-#14 | 3.90 | 14632 | 6911 | 31504 | 5437 | 39368 | 4253 | 43482 | 3289 | 47952 | 1745 | 52179 | 295 | 50157 |
| 25-#11 | 2.81 | 14202 | 6242 | 27826 | 5036 | 34891 | 3960 | 38124 | 3099 | 38122 | 1656 | 43403 | 592 | 38394 |
| 25-#14 | 4.06 | 14758 | 7011 | 32114 | 5488 | 40113 | 4290 | 44331 | 3309 | 49044 | 1731 | 53482 | 237 | 51794 |
| 26-#11 | 2.93 | 14246 | 6312 | 28303 | 5069 | 35421 | 3980 | 38756 | 3110 | 41657 | 1762 | 44303 | 560 | 39639 |
| 26-#14 | 4.22 | 14816 | 7111 | 32753 | 5539 | 40864 | 4325 | 45219 | 3327 | 46864 | 1601 | 54782 | 191 | 53509 |
| 27-#11 | 3.04 | 14311 | 6381 | 28630 | 5118 | 35848 | 4024 | 39283 | 3141 | 39561 | 1652 | 45309 | 530 | 40978 |
| 28-#11 | 3.15 | 14379 | 6451 | 28991 | 5163 | 36313 | 4065 | 39848 | 3169 | 40286 | 1656 | 46293 | 509 | 42227 |
| 29-#11 | 3.27 | 14432 | 6520 | 29385 | 5206 | 36810 | 4089 | 40443 | 3183 | 41000 | 1648 | 47274 | 477 | 43496 |
| 30-#11 | 3.38 | 14490 | 6590 | 29890 | 5236 | 37334 | 4113 | 41064 | 3196 | 44735 | 1755 | 48136 | 437 | 44770 |
| 31-#11 | 3.49 | 14544 | 6659 | 30146 | 5294 | 37776 | 4154 | 41606 | 3225 | 42440 | 1643 | 49174 | 416 | 45995 |
| 32-#11 | 3.60 | 14608 | 6729 | 30519 | 5338 | 38230 | 4192 | 42175 | 3252 | 43164 | 1647 | 50118 | 382 | 47292 |

## ROUND SPIRAL COLUMNS 44" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.58 | 15605 | 6013 | 30174 | 4633 | 35261 | 3600 | 36755 | 2837 | 36659 | 1683 | 35180 | 798 | 27344 |
| 7-#14 | 1.04 | 15253 | 5645 | 25490 | 4723 | 31516 | 3739 | 33327 | 2996 | 32809 | 1940 | 32167 | 1138 | 18591 |
| 7-#18 | 1.84 | 15667 | 6191 | 28880 | 5014 | 35449 | 3948 | 37937 | 3123 | 36214 | 1758 | 39435 | 870 | 30503 |
| 8-#14 | 1.18 | 15362 | 5746 | 25459 | 4852 | 32003 | 3837 | 34121 | 3080 | 34039 | 1983 | 33703 | 1132 | 20863 |
| 8-#18 | 2.10 | 15813 | 6370 | 29199 | 5198 | 36425 | 4081 | 39305 | 3237 | 40855 | 1935 | 41908 | 836 | 34889 |
| 9-#14 | 1.33 | 15407 | 5846 | 26448 | 4873 | 32907 | 3854 | 35066 | 3074 | 32841 | 1818 | 35173 | 1053 | 23183 |
| 9-#18 | 2.37 | 15876 | 6548 | 30712 | 5262 | 37913 | 4134 | 40953 | 3246 | 42880 | 1884 | 44558 | 706 | 37851 |
| 10-#11 | 1.03 | 15217 | 5639 | 25779 | 4683 | 31698 | 3696 | 33425 | 2963 | 32810 | 1912 | 31875 | 1123 | 18385 |
| 10-#14 | 1.48 | 15456 | 5946 | 27698 | 4850 | 33995 | 3814 | 36138 | 3036 | 33909 | 1756 | 36049 | 974 | 25415 |
| 10-#18 | 2.63 | 15938 | 6726 | 32401 | 5280 | 39680 | 4116 | 42817 | 3221 | 45042 | 1798 | 46319 | 586 | 41419 |
| 11-#11 | 1.13 | 15329 | 5708 | 25391 | 4821 | 31860 | 3820 | 33920 | 3059 | 33758 | 1980 | 33475 | 1144 | 20180 |
| 11-#14 | 1.63 | 15610 | 6047 | 27475 | 5010 | 34336 | 3958 | 36817 | 3144 | 37585 | 1957 | 38161 | 986 | 27607 |
| 11-#18 | 2.89 | 16183 | 6904 | 32577 | 5495 | 40431 | 4310 | 43991 | 3361 | 47021 | 1892 | 49700 | 576 | 44594 |
| 12-#11 | 1.23 | 15383 | 5778 | 25570 | 4895 | 32288 | 3874 | 34505 | 3104 | 32253 | 1859 | 34637 | 1133 | 21648 |
| 12-#14 | 1.78 | 15676 | 6147 | 27828 | 5106 | 34968 | 4026 | 37649 | 3201 | 38695 | 1968 | 39769 | 967 | 29836 |
| 12-#18 | 3.16 | 16311 | 7083 | 33367 | 5649 | 41573 | 4412 | 45434 | 3446 | 48944 | 1902 | 52399 | 531 | 47869 |
| 13-#11 | 1.33 | 15465 | 5847 | 26142 | 4916 | 32847 | 3891 | 35151 | 3107 | 35396 | 1980 | 35513 | 1087 | 23383 |
| 13-#14 | 1.92 | 15783 | 6247 | 28572 | 5143 | 35752 | 4057 | 38573 | 3210 | 39913 | 1954 | 41048 | 902 | 31912 |
| 13-#18 | 3.42 | 16450 | 7261 | 34526 | 5725 | 42936 | 4479 | 47040 | 3471 | 51062 | 1881 | 54666 | 419 | 51310 |
| 14-#11 | 1.44 | 15583 | 5917 | 27028 | 4904 | 33537 | 3876 | 35818 | 3090 | 36190 | 1941 | 36368 | 1035 | 24821 |
| 14-#14 | 2.07 | 15956 | 6347 | 29681 | 5144 | 36683 | 4051 | 39541 | 3200 | 41078 | 1907 | 42338 | 835 | 34150 |
| 14-#18 | 3.68 | 16722 | 7439 | 36191 | 5756 | 44463 | 4497 | 48779 | 3478 | 49620 | 1691 | 57018 | 311 | 54363 |

## ROUND SPIRAL COLUMNS 44" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 15-#11 | 1.54 | 15599 | 5986 | 26958 | 5001 | 33853 | 3960 | 36366 | 3151 | 37031 | 1978 | 37556 | 1028 | 26468 |
| 15-#14 | 2.22 | 15958 | 6448 | 29758 | 5265 | 37193 | 4153 | 40316 | 3273 | 39424 | 1820 | 43946 | 814 | 36112 |
| 15-#18 | 3.95 | 16780 | 7617 | 36641 | 5938 | 45447 | 4646 | 50096 | 3580 | 51429 | 1744 | 59662 | 256 | 57796 |
| 16-#11 | 1.64 | 15658 | 6056 | 27244 | 5055 | 34315 | 4003 | 36982 | 3189 | 35303 | 1851 | 38710 | 1003 | 27925 |
| 16-#14 | 2.37 | 16034 | 6548 | 30216 | 5337 | 37880 | 4211 | 41181 | 3321 | 43356 | 1954 | 45562 | 775 | 38259 |
| 16-#18 | 4.21 | 16917 | 7796 | 37523 | 6056 | 46708 | 4741 | 51569 | 3655 | 57040 | 1869 | 62413 | 181 | 60872 |
| 17-#11 | 1.74 | 15738 | 6125 | 27731 | 5091 | 34870 | 4027 | 37587 | 3195 | 38666 | 1976 | 39674 | 973 | 29473 |
| 17-#14 | 2.52 | 16143 | 6648 | 30872 | 5393 | 38647 | 4249 | 42058 | 3335 | 44567 | 1945 | 46954 | 734 | 40125 |
| 17-#18 | 4.47 | 17120 | 7974 | 38597 | 6162 | 47980 | 4813 | 53142 | 3686 | 59145 | 1855 | 64854 | 107 | 64034 |
| 18-#11 | 1.85 | 15778 | 6195 | 28433 | 5104 | 35510 | 4029 | 38252 | 3193 | 36857 | 1818 | 40550 | 916 | 30951 |
| 18-#14 | 2.66 | 16190 | 6748 | 31785 | 5422 | 39526 | 4261 | 43009 | 3339 | 42713 | 1783 | 48249 | 656 | 42159 |
| 18-#18 | 4.74 | 17227 | 8152 | 40037 | 6232 | 49449 | 4849 | 54798 | 3707 | 61252 | 1801 | 67165 | -26 | 67084 |
| 19-#11 | 1.95 | 15860 | 6264 | 28523 | 5181 | 35895 | 4088 | 38814 | 3239 | 40300 | 1973 | 41687 | 915 | 32431 |
| 19-#14 | 2.81 | 16309 | 6849 | 32009 | 5521 | 40122 | 4335 | 43807 | 3396 | 43769 | 1809 | 49817 | 647 | 44069 |
| 19-#18 | 5.00 | 17435 | 8330 | 40585 | 6387 | 50573 | 4964 | 56180 | 3791 | 58976 | 1717 | 69809 | -55 | 69617 |
| 20-#11 | 2.05 | 15948 | 6334 | 28863 | 5231 | 36339 | 4131 | 39418 | 3271 | 38355 | 1843 | 42705 | 884 | 33929 |
| 20-#14 | 2.96 | 16407 | 6949 | 32524 | 5590 | 40765 | 4395 | 44681 | 3440 | 48018 | 1939 | 51251 | 601 | 45979 |
| 20-#18 | 5.26 | 17585 | 8509 | 41533 | 6501 | 51722 | 5063 | 57706 | 3865 | 65138 | 1836 | 72269 | -143 | 71733 |
| 21-#11 | 2.15 | 16003 | 6403 | 29362 | 5264 | 36906 | 4153 | 40044 | 3282 | 41934 | 1969 | 43704 | 856 | 35360 |
| 21-#14 | 3.11 | 16496 | 7049 | 33219 | 5640 | 41565 | 4429 | 45561 | 3457 | 49223 | 1933 | 52682 | 560 | 47967 |
| 22-#11 | 2.26 | 16072 | 6473 | 29910 | 5290 | 37511 | 4170 | 40705 | 3287 | 42821 | 1959 | 44730 | 824 | 36866 |
| 22-#14 | 3.26 | 16589 | 7149 | 33936 | 5684 | 42416 | 4460 | 46505 | 3470 | 50525 | 1922 | 54176 | 517 | 49793 |
| 23-#11 | 2.36 | 16121 | 6542 | 30153 | 5353 | 37924 | 4219 | 41266 | 3325 | 43600 | 1972 | 45801 | 803 | 38238 |
| 23-#14 | 3.40 | 16659 | 7250 | 34352 | 5767 | 43018 | 4523 | 47317 | 3518 | 51596 | 1935 | 55664 | 482 | 51730 |
| 24-#11 | 2.46 | 16168 | 6612 | 30477 | 5406 | 38389 | 4261 | 41858 | 3354 | 41462 | 1846 | 46859 | 782 | 39658 |
| 24-#14 | 3.55 | 16736 | 7350 | 34841 | 5842 | 43688 | 4581 | 48161 | 3558 | 52766 | 1942 | 57161 | 450 | 53602 |
| 25-#11 | 2.56 | 16259 | 6682 | 30956 | 5441 | 38940 | 4285 | 42489 | 3367 | 45231 | 1968 | 47827 | 741 | 41010 |
| 25-#14 | 3.70 | 16848 | 7450 | 35499 | 5894 | 44478 | 4618 | 49061 | 3578 | 53922 | 1928 | 58544 | 392 | 55477 |
| 26-#11 | 2.67 | 16306 | 6751 | 31471 | 5472 | 39505 | 4305 | 43166 | 3378 | 46076 | 1955 | 48777 | 709 | 42381 |
| 26-#14 | 3.85 | 16932 | 7550 | 36186 | 5944 | 45267 | 4651 | 50015 | 3597 | 55161 | 1913 | 59920 | 346 | 57402 |
| 27-#11 | 2.77 | 16369 | 6821 | 31801 | 5523 | 39953 | 4350 | 43715 | 3409 | 46859 | 1964 | 49847 | 681 | 43782 |
| 27-#14 | 4.00 | 17013 | 7651 | 36715 | 6011 | 45924 | 4711 | 50809 | 3638 | 52499 | 1793 | 61420 | 302 | 59152 |
| 28-#11 | 2.87 | 16449 | 6890 | 32179 | 5568 | 40444 | 4391 | 44313 | 3437 | 44507 | 1838 | 50895 | 660 | 45127 |
| 28-#14 | 4.14 | 17116 | 7751 | 37270 | 6075 | 46629 | 4768 | 51662 | 3677 | 57417 | 1927 | 62900 | 271 | 60938 |
| 29-#11 | 2.98 | 16501 | 6960 | 32599 | 5611 | 40971 | 4415 | 44944 | 3452 | 48488 | 1960 | 51932 | 628 | 46524 |
| 30-#11 | 3.08 | 16574 | 7029 | 33136 | 5640 | 41529 | 4439 | 45593 | 3464 | 49335 | 1950 | 52845 | 588 | 47826 |
| 31-#11 | 3.18 | 16621 | 7099 | 33402 | 5699 | 41993 | 4481 | 46170 | 3494 | 50118 | 1956 | 53949 | 568 | 49180 |
| 32-#11 | 3.28 | 16675 | 7168 | 33796 | 5744 | 42467 | 4519 | 46777 | 3521 | 47554 | 1830 | 54952 | 535 | 50519 |
| 33-#11 | 3.39 | 16751 | 7238 | 34252 | 5781 | 43007 | 4545 | 47393 | 3536 | 51749 | 1952 | 55971 | 507 | 51830 |
| 34-#11 | 3.49 | 16819 | 7307 | 34707 | 5817 | 43572 | 4572 | 48036 | 3550 | 52596 | 1943 | 57069 | 478 | 53206 |

## ROUND SPIRAL COLUMNS 46" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.44 | 17775 | 6473 | 33793 | 5026 | 39558 | 3913 | 41177 | 3093 | 40835 | 1866 | 39079 | 936 | 28901 |
| 7-#18 | 1.68 | 17867 | 6651 | 32212 | 5430 | 39670 | 4282 | 42409 | 3397 | 43167 | 2081 | 43682 | 1019 | 32364 |
| 8-#14 | 1.08 | 17518 | 6205 | 28535 | 5274 | 36005 | 4176 | 38375 | 3357 | 38119 | 2181 | 37616 | 1281 | 22056 |
| 8-#18 | 1.93 | 18032 | 6829 | 32500 | 5620 | 40682 | 4421 | 43854 | 3515 | 45341 | 2136 | 46323 | 989 | 36946 |
| 9-#14 | 1.22 | 17563 | 6306 | 29602 | 5292 | 36971 | 4190 | 39375 | 3350 | 39338 | 2145 | 39156 | 1201 | 24612 |
| 9-#18 | 2.17 | 18095 | 7007 | 34121 | 5681 | 42268 | 4471 | 45597 | 3523 | 47485 | 2084 | 49119 | 859 | 40301 |
| 10-#14 | 1.35 | 17622 | 6406 | 30989 | 5262 | 38134 | 4143 | 40495 | 3305 | 37827 | 1936 | 40056 | 1119 | 26907 |
| 10-#18 | 2.41 | 18169 | 7186 | 35965 | 5691 | 44140 | 4446 | 47595 | 3494 | 46435 | 1862 | 50958 | 737 | 44365 |
| 11-#11 | 1.03 | 17475 | 6168 | 28472 | 5241 | 35852 | 4158 | 38163 | 3335 | 35265 | 2026 | 37280 | 1284 | 21343 |
| 11-#14 | 1.49 | 17791 | 6506 | 30677 | 5430 | 38467 | 4295 | 41223 | 3421 | 41859 | 2155 | 42322 | 1136 | 29338 |
| 11-#18 | 2.65 | 18437 | 7364 | 36077 | 5916 | 44926 | 4649 | 48809 | 3639 | 48408 | 1955 | 54566 | 733 | 47594 |
| 12-#11 | 1.13 | 17532 | 6237 | 28636 | 5317 | 36303 | 4214 | 38780 | 3382 | 38667 | 2191 | 38597 | 1282 | 22937 |
| 12-#14 | 1.62 | 17859 | 6606 | 31022 | 5529 | 39135 | 4366 | 42101 | 3480 | 43036 | 2168 | 44034 | 1118 | 31617 |
| 12-#18 | 2.89 | 18576 | 7542 | 36881 | 6072 | 46126 | 4753 | 50334 | 3727 | 53894 | 2107 | 57438 | 690 | 51184 |
| 13-#11 | 1.22 | 17622 | 6307 | 29259 | 5337 | 36892 | 4229 | 39455 | 3384 | 39549 | 2178 | 39516 | 1236 | 24753 |
| 13-#14 | 1.76 | 17978 | 6707 | 31829 | 5565 | 39960 | 4395 | 43078 | 3488 | 44318 | 2153 | 45379 | 1054 | 33900 |
| 13-#18 | 3.13 | 18727 | 7720 | 38131 | 6147 | 47552 | 4819 | 52033 | 3752 | 56139 | 2086 | 59833 | 579 | 54711 |
| 14-#11 | 1.31 | 17755 | 6376 | 30230 | 5322 | 37634 | 4211 | 40159 | 3364 | 40389 | 2137 | 40406 | 1183 | 26316 |
| 14-#14 | 1.90 | 18174 | 6807 | 33036 | 5562 | 40956 | 4386 | 44088 | 3474 | 45557 | 2105 | 46731 | 985 | 36209 |
| 14-#18 | 3.37 | 19016 | 7899 | 39926 | 6175 | 49180 | 4833 | 53847 | 3755 | 58352 | 2015 | 62314 | 470 | 58053 |
| 15-#11 | 1.41 | 17773 | 6446 | 30111 | 5423 | 37952 | 4298 | 40736 | 3429 | 41276 | 2177 | 41678 | 1177 | 28090 |
| 15-#14 | 2.03 | 18174 | 6907 | 33070 | 5687 | 41479 | 4493 | 44906 | 3551 | 46776 | 2150 | 48448 | 967 | 38365 |
| 15-#18 | 3.61 | 19048 | 8077 | 40352 | 6361 | 50206 | 4987 | 55260 | 3862 | 60413 | 2075 | 65129 | 418 | 61822 |
| 16-#11 | 1.50 | 17839 | 6516 | 30402 | 5479 | 38429 | 4342 | 41395 | 3468 | 42117 | 2183 | 42904 | 1153 | 29618 |
| 16-#14 | 2.17 | 18260 | 7007 | 33542 | 5761 | 42191 | 4551 | 45831 | 3602 | 47958 | 2155 | 50164 | 929 | 40704 |
| 16-#18 | 3.85 | 19237 | 8255 | 41270 | 6480 | 51515 | 5083 | 56820 | 3939 | 62453 | 2077 | 68051 | 345 | 64939 |
| 17-#11 | 1.60 | 17923 | 6585 | 30924 | 5514 | 39021 | 4367 | 42026 | 3474 | 40135 | 2030 | 43919 | 1124 | 31321 |
| 17-#14 | 2.30 | 18375 | 7108 | 34244 | 5816 | 43014 | 4589 | 46745 | 3614 | 45952 | 2003 | 51631 | 888 | 42766 |
| 17-#18 | 4.09 | 19400 | 8433 | 42414 | 6586 | 52883 | 5155 | 58459 | 3969 | 64687 | 2063 | 70632 | 272 | 68418 |
| 18-#11 | 1.69 | 17969 | 6655 | 31682 | 5523 | 39708 | 4366 | 42728 | 3469 | 40930 | 2003 | 44833 | 1067 | 32837 |
| 18-#14 | 2.44 | 18428 | 7208 | 35223 | 5842 | 43950 | 4599 | 47750 | 3617 | 50505 | 2111 | 52991 | 810 | 45001 |
| 18-#18 | 4.33 | 19468 | 8612 | 43956 | 6654 | 54445 | 5190 | 60210 | 3989 | 66910 | 2009 | 73076 | 139 | 71827 |
| 19-#11 | 1.78 | 18060 | 6724 | 31759 | 5604 | 40099 | 4427 | 43320 | 3518 | 44727 | 2173 | 46046 | 1066 | 34465 |
| 19-#14 | 2.57 | 18560 | 7308 | 35443 | 5945 | 44560 | 4676 | 48592 | 3676 | 48247 | 1998 | 54659 | 803 | 46952 |
| 19-#18 | 4.57 | 19781 | 8790 | 44514 | 6811 | 55616 | 5307 | 61671 | 4075 | 68962 | 2050 | 75877 | 113 | 75073 |
| 20-#11 | 1.88 | 18141 | 6794 | 32111 | 5655 | 40565 | 4471 | 43949 | 3550 | 45567 | 2176 | 47124 | 1037 | 36004 |
| 20-#14 | 2.71 | 18665 | 7409 | 35980 | 6014 | 45237 | 4736 | 49502 | 3721 | 52881 | 2142 | 56178 | 758 | 49043 |
| 20-#18 | 4.81 | 19932 | 8968 | 45509 | 6927 | 56815 | 5407 | 63299 | 4150 | 71014 | 2047 | 78484 | 27 | 78321 |
| 21-#11 | 1.97 | 18215 | 6863 | 32637 | 5687 | 41165 | 4494 | 44614 | 3561 | 46452 | 2170 | 48179 | 1008 | 37575 |
| 21-#14 | 2.84 | 18763 | 7509 | 36711 | 6064 | 46084 | 4770 | 50444 | 3738 | 54152 | 2136 | 57692 | 718 | 51082 |
| 21-#18 | 5.05 | 20117 | 9146 | 46761 | 7021 | 58271 | 5472 | 64891 | 4182 | 73239 | 2037 | 81121 | -44 | 80957 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 46" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.07 | 18294 | 6933 | 33231 | 5711 | 41804 | 4508 | 45316 | 3566 | 44150 | 2004 | 49100 | 962 | 39126 |
| 22-#14 | 2.98 | 18866 | 7609 | 37484 | 6106 | 46979 | 4799 | 51441 | 3750 | 55507 | 2124 | 59264 | 674 | 53081 |
| 22-#18 | 5.30 | 20378 | 9325 | 47976 | 7111 | 59796 | 5536 | 66628 | 4212 | 70589 | 1888 | 83913 | -118 | 82910 |
| 23-#11 | 2.16 | 18346 | 7002 | 33472 | 5776 | 42239 | 4560 | 45900 | 3604 | 48203 | 2173 | 50398 | 956 | 40635 |
| 23-#14 | 3.11 | 18926 | 7709 | 37907 | 6191 | 47618 | 4865 | 52286 | 3799 | 56659 | 2139 | 60847 | 641 | 55191 |
| 24-#11 | 2.25 | 18399 | 7072 | 33804 | 5830 | 42728 | 4602 | 46524 | 3634 | 49081 | 2180 | 51517 | 936 | 42209 |
| 24-#14 | 3.25 | 19026 | 7810 | 38412 | 6266 | 48323 | 4923 | 53177 | 3840 | 57894 | 2147 | 62432 | 609 | 57112 |
| 25-#11 | 2.35 | 18490 | 7141 | 34313 | 5865 | 43305 | 4625 | 47190 | 3647 | 49920 | 2170 | 52541 | 895 | 43664 |
| 25-#14 | 3.38 | 19128 | 7910 | 39117 | 6318 | 49150 | 4959 | 54127 | 3860 | 59115 | 2133 | 63896 | 552 | 59172 |
| 26-#11 | 2.44 | 18549 | 7211 | 34872 | 5895 | 43905 | 4645 | 47897 | 3657 | 50810 | 2156 | 53540 | 863 | 45218 |
| 26-#14 | 3.52 | 19194 | 8010 | 39854 | 6368 | 49987 | 4992 | 55148 | 3879 | 60403 | 2117 | 65346 | 506 | 61135 |
| 27-#11 | 2.53 | 18617 | 7280 | 35204 | 5947 | 44373 | 4691 | 48484 | 3690 | 51638 | 2166 | 54675 | 836 | 46610 |
| 27-#14 | 3.66 | 19324 | 8110 | 40393 | 6436 | 50676 | 5053 | 55973 | 3921 | 61566 | 2127 | 66936 | 464 | 63104 |
| 28-#11 | 2.63 | 18703 | 7350 | 35600 | 5993 | 44884 | 4732 | 49116 | 3718 | 52524 | 2172 | 55785 | 816 | 48083 |
| 28-#14 | 3.79 | 19433 | 8211 | 40975 | 6500 | 51421 | 5111 | 56874 | 3960 | 62806 | 2134 | 68506 | 433 | 65148 |
| 29-#11 | 2.72 | 18763 | 7419 | 36046 | 6035 | 45448 | 4757 | 49780 | 3733 | 53358 | 2163 | 56879 | 785 | 49516 |
| 29-#14 | 3.93 | 19528 | 8311 | 41596 | 6563 | 52210 | 5147 | 57823 | 3982 | 64019 | 2121 | 70073 | 388 | 66983 |
| 30-#11 | 2.82 | 18824 | 7489 | 36616 | 6063 | 46040 | 4780 | 50458 | 3744 | 54250 | 2152 | 57843 | 744 | 50941 |
| 31-#11 | 2.91 | 18893 | 7558 | 36888 | 6123 | 46520 | 4822 | 51067 | 3775 | 55078 | 2159 | 59012 | 725 | 52409 |
| 32-#11 | 3.00 | 18952 | 7628 | 37306 | 6169 | 47018 | 4861 | 51716 | 3803 | 55949 | 2164 | 60076 | 692 | 53792 |
| 33-#11 | 3.10 | 19035 | 7697 | 37784 | 6205 | 47589 | 4887 | 52358 | 3817 | 56799 | 2155 | 61152 | 665 | 55251 |
| 34-#11 | 3.19 | 19084 | 7767 | 38271 | 6241 | 48187 | 4913 | 53036 | 3831 | 53846 | 2004 | 62310 | 636 | 56636 |
| 35-#11 | 3.29 | 19167 | 7836 | 38630 | 6293 | 48685 | 4947 | 53651 | 3860 | 58553 | 2158 | 63365 | 612 | 58048 |
| 36-#11 | 3.38 | 19253 | 7906 | 38988 | 6343 | 49213 | 4979 | 54290 | 3887 | 59381 | 2156 | 64494 | 586 | 59473 |

## ROUND SPIRAL COLUMNS 48" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.33 | 20133 | 6953 | 37695 | 5436 | 44199 | 4240 | 45951 | 3361 | 42305 | 1920 | 43261 | 1080 | 30458 |
| 7-#18 | 1.55 | 20257 | 7131 | 35795 | 5865 | 44224 | 4630 | 47233 | 3683 | 47859 | 2286 | 48227 | 1174 | 34245 |
| 8-#18 | 1.77 | 20441 | 7309 | 36045 | 6061 | 45270 | 4775 | 48755 | 3806 | 50134 | 2344 | 51039 | 1148 | 38997 |
| 9-#14 | 1.12 | 19909 | 6786 | 33004 | 5730 | 41367 | 4541 | 44035 | 3638 | 43802 | 2350 | 43438 | 1355 | 26060 |
| 9-#18 | 1.99 | 20504 | 7488 | 37773 | 6119 | 46955 | 4822 | 50594 | 3812 | 52418 | 2293 | 53980 | 1017 | 42669 |
| 10-#14 | 1.24 | 19976 | 6886 | 34537 | 5692 | 42609 | 4487 | 45204 | 3587 | 45052 | 2276 | 44358 | 1270 | 28411 |
| 10-#18 | 2.21 | 20592 | 7666 | 39788 | 6122 | 48935 | 4790 | 52700 | 3777 | 54786 | 2200 | 55893 | 894 | 47296 |
| 11-#14 | 1.37 | 20160 | 6986 | 34124 | 5870 | 42928 | 4648 | 45981 | 3710 | 46409 | 2353 | 46665 | 1282 | 31075 |
| 11-#18 | 2.43 | 20884 | 7844 | 39823 | 6355 | 49746 | 5002 | 53980 | 3930 | 57038 | 2305 | 59733 | 894 | 50653 |
| 12-#11 | 1.03 | 19869 | 6718 | 31944 | 5759 | 40647 | 4569 | 43407 | 3673 | 43107 | 2398 | 42859 | 1437 | 24238 |
| 12-#14 | 1.49 | 20231 | 7086 | 34458 | 5970 | 43633 | 4721 | 46905 | 3771 | 47707 | 2376 | 48600 | 1275 | 33414 |
| 12-#18 | 2.65 | 20987 | 8022 | 40636 | 6513 | 51009 | 5110 | 55586 | 4020 | 59149 | 2318 | 62779 | 853 | 54574 |
| 13-#11 | 1.12 | 19968 | 6787 | 32621 | 5777 | 41266 | 4582 | 44111 | 3673 | 44030 | 2384 | 43820 | 1390 | 26133 |
| 13-#14 | 1.62 | 20362 | 7187 | 35331 | 6005 | 44498 | 4748 | 47923 | 3778 | 49052 | 2361 | 50012 | 1211 | 35914 |
| 13-#18 | 2.87 | 21198 | 8201 | 41983 | 6588 | 52500 | 5174 | 57378 | 4044 | 61538 | 2298 | 65300 | 743 | 58174 |
| 14-#11 | 1.21 | 20115 | 6857 | 33681 | 5758 | 42063 | 4561 | 44852 | 3650 | 44901 | 2342 | 44742 | 1336 | 27845 |
| 14-#14 | 1.74 | 20576 | 7287 | 36641 | 5998 | 45562 | 4736 | 48987 | 3761 | 47004 | 2157 | 51422 | 1141 | 38288 |
| 14-#18 | 3.09 | 21503 | 8379 | 43912 | 6612 | 54230 | 5185 | 59268 | 4044 | 63868 | 2226 | 67910 | 633 | 61820 |
| 15-#11 | 1.29 | 20135 | 6926 | 33508 | 5864 | 42381 | 4652 | 45459 | 3719 | 42793 | 2225 | 46102 | 1333 | 29673 |
| 15-#14 | 1.87 | 20580 | 7387 | 36627 | 6128 | 46096 | 4847 | 49848 | 3842 | 51641 | 2359 | 53251 | 1126 | 40648 |
| 15-#18 | 3.32 | 21548 | 8557 | 44305 | 6802 | 55296 | 5343 | 60757 | 4154 | 66035 | 2289 | 70898 | 585 | 65686 |
| 16-#11 | 1.38 | 20209 | 6996 | 33802 | 5921 | 42872 | 4697 | 46154 | 3759 | 46738 | 2391 | 47400 | 1309 | 31330 |
| 16-#14 | 1.99 | 20676 | 7488 | 37112 | 6203 | 46831 | 4906 | 50834 | 3894 | 52889 | 2365 | 55068 | 1088 | 43077 |
| 16-#18 | 3.54 | 21680 | 8735 | 45260 | 6923 | 56653 | 5439 | 62424 | 4235 | 68172 | 2291 | 73991 | 513 | 69086 |
| 17-#11 | 1.47 | 20297 | 7065 | 34361 | 5955 | 43499 | 4721 | 46816 | 3764 | 47667 | 2383 | 48465 | 1280 | 33135 |
| 17-#14 | 2.11 | 20798 | 7588 | 37860 | 6257 | 47707 | 4944 | 51785 | 3906 | 54231 | 2356 | 56611 | 1048 | 45311 |
| 17-#18 | 3.76 | 21881 | 8913 | 46476 | 7028 | 58117 | 5513 | 64129 | 4263 | 65833 | 2127 | 76711 | 441 | 72897 |
| 18-#11 | 1.55 | 20349 | 7135 | 35179 | 5962 | 44238 | 4719 | 47556 | 3758 | 48546 | 2352 | 49415 | 1223 | 34746 |
| 18-#14 | 2.24 | 20857 | 7688 | 38908 | 6281 | 48707 | 4952 | 52843 | 3907 | 55545 | 2319 | 58030 | 969 | 47742 |
| 18-#18 | 3.98 | 21997 | 9092 | 48111 | 7094 | 59772 | 5545 | 65975 | 4282 | 72895 | 2224 | 79288 | 308 | 76354 |
| 19-#11 | 1.64 | 20448 | 7204 | 35235 | 6046 | 44632 | 4782 | 48178 | 3809 | 46184 | 2223 | 50707 | 1224 | 36543 |
| 19-#14 | 2.36 | 20991 | 7788 | 39121 | 6387 | 49329 | 5031 | 53729 | 3969 | 56821 | 2352 | 59803 | 965 | 49884 |
| 19-#18 | 4.20 | 22229 | 9270 | 48688 | 7255 | 60979 | 5665 | 67514 | 4371 | 75039 | 2267 | 82248 | 286 | 79906 |
| 20-#11 | 1.72 | 20534 | 7274 | 35600 | 6098 | 45119 | 4827 | 48832 | 3842 | 50370 | 2385 | 51846 | 1196 | 38104 |
| 20-#14 | 2.49 | 21114 | 7889 | 39679 | 6457 | 50039 | 5092 | 54675 | 4013 | 58073 | 2354 | 61407 | 921 | 52169 |
| 20-#18 | 4.42 | 22434 | 9448 | 49729 | 7372 | 62240 | 5766 | 69208 | 4446 | 77198 | 2265 | 85002 | 202 | 83616 |
| 21-#11 | 1.81 | 20616 | 7343 | 36156 | 6129 | 45754 | 4849 | 49533 | 3853 | 47870 | 2220 | 52957 | 1167 | 39822 |
| 21-#14 | 2.61 | 21206 | 7989 | 40448 | 6506 | 50933 | 5126 | 55676 | 4031 | 55450 | 2191 | 63004 | 880 | 54251 |
| 21-#18 | 4.64 | 22680 | 9626 | 51041 | 7465 | 63776 | 5831 | 70909 | 4479 | 79544 | 2256 | 87789 | 131 | 86835 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 48" DIA.

Short columns – no sidesway

$f'_c$ = 6,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.90 | 20707 | 7413 | 36798 | 6152 | 46426 | 4862 | 50280 | 3856 | 52180 | 2355 | 53920 | 1120 | 41413 |
| 22-#14 | 2.74 | 21337 | 8089 | 41278 | 6547 | 51872 | 5153 | 56730 | 4042 | 60714 | 2317 | 64418 | 816 | 56432 |
| 22-#18 | 4.86 | 22950 | 9805 | 52338 | 7553 | 65395 | 5893 | 72741 | 4509 | 82091 | 2242 | 90728 | 57 | 90345 |
| 23-#11 | 1.98 | 20754 | 7482 | 37033 | 6218 | 46882 | 4916 | 50885 | 3896 | 53132 | 2382 | 55296 | 1115 | 43063 |
| 23-#14 | 2.86 | 21400 | 8189 | 41705 | 6634 | 52548 | 5222 | 57607 | 4092 | 57907 | 2194 | 66333 | 804 | 58616 |
| 23-#18 | 5.08 | 23056 | 9983 | 53240 | 7690 | 66591 | 5997 | 74310 | 4587 | 78527 | 2108 | 93557 | -9 | 93521 |
| 24-#11 | 2.07 | 20819 | 7552 | 37372 | 6273 | 47396 | 4958 | 51542 | 3926 | 54068 | 2390 | 56477 | 1096 | 44681 |
| 24-#14 | 2.98 | 21511 | 8290 | 42225 | 6709 | 53289 | 5280 | 58545 | 4134 | 63352 | 2360 | 68005 | 774 | 60687 |
| 25-#11 | 2.16 | 20918 | 7621 | 37913 | 6307 | 47999 | 4981 | 52244 | 3939 | 54939 | 2379 | 57556 | 1055 | 46283 |
| 25-#14 | 3.11 | 21617 | 8390 | 42974 | 6761 | 54152 | 5316 | 59546 | 4154 | 64621 | 2346 | 69550 | 717 | 62929 |
| 26-#11 | 2.24 | 20968 | 7691 | 38518 | 6337 | 48635 | 5000 | 52981 | 3948 | 55871 | 2366 | 58604 | 1023 | 47925 |
| 26-#14 | 3.23 | 21690 | 8490 | 43767 | 6810 | 55038 | 5348 | 60612 | 4171 | 65973 | 2329 | 71074 | 672 | 64934 |
| 27-#11 | 2.33 | 21057 | 7760 | 38850 | 6390 | 49123 | 5047 | 53605 | 3983 | 56747 | 2377 | 59804 | 997 | 49457 |
| 27-#14 | 3.36 | 21809 | 8590 | 44314 | 6880 | 55758 | 5410 | 61490 | 4215 | 67202 | 2341 | 72755 | 631 | 67088 |
| 28-#11 | 2.41 | 21148 | 7830 | 39262 | 6436 | 49653 | 5089 | 54270 | 4012 | 57671 | 2383 | 60978 | 977 | 51094 |
| 28-#14 | 3.48 | 21946 | 8691 | 44923 | 6944 | 56532 | 5468 | 62438 | 4255 | 68524 | 2349 | 74414 | 600 | 69170 |
| 29-#11 | 2.50 | 21216 | 7899 | 39735 | 6478 | 50254 | 5113 | 54961 | 4025 | 58557 | 2374 | 62129 | 946 | 52558 |
| 29-#14 | 3.61 | 22026 | 8791 | 45581 | 7007 | 57373 | 5505 | 63438 | 4277 | 69785 | 2335 | 76065 | 556 | 71238 |
| 30-#11 | 2.59 | 21282 | 7969 | 40340 | 6505 | 50880 | 5136 | 55676 | 4037 | 55527 | 2205 | 63143 | 906 | 54112 |
| 30-#14 | 3.73 | 22141 | 8891 | 46406 | 7050 | 58251 | 5541 | 64459 | 4296 | 71136 | 2322 | 77529 | 499 | 73440 |
| 31-#11 | 2.67 | 21348 | 8038 | 40616 | 6567 | 51376 | 5179 | 56316 | 4068 | 60368 | 2371 | 64378 | 888 | 55632 |
| 31-#14 | 3.85 | 22220 | 8991 | 46849 | 7134 | 58986 | 5599 | 65372 | 4337 | 72369 | 2330 | 79267 | 470 | 75358 |
| 32-#11 | 2.76 | 21421 | 8108 | 41058 | 6613 | 51899 | 5218 | 57001 | 4097 | 61275 | 2375 | 65502 | 855 | 57123 |
| 33-#11 | 2.84 | 21501 | 8177 | 41559 | 6649 | 52501 | 5244 | 57674 | 4111 | 58030 | 2210 | 66634 | 828 | 58673 |
| 34-#11 | 2.93 | 21563 | 8247 | 42079 | 6685 | 53127 | 5270 | 58389 | 4125 | 63117 | 2359 | 67853 | 799 | 60126 |
| 35-#11 | 3.02 | 21642 | 8316 | 42448 | 6737 | 53654 | 5304 | 59036 | 4154 | 59748 | 2212 | 68966 | 776 | 61670 |
| 36-#11 | 3.10 | 21745 | 8386 | 42819 | 6787 | 54209 | 5337 | 59700 | 4181 | 64887 | 2368 | 70156 | 751 | 63122 |
| 37-#11 | 3.19 | 21793 | 8455 | 43329 | 6825 | 54779 | 5369 | 60392 | 4196 | 65822 | 2367 | 71207 | 718 | 64619 |

## ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#11 | 2.07 | 3337 | 2368 | 6998 | 1493 | 7247 | 1148 | 7125 | 875 | 6286 | 442 | 6158 | 145 | 5485 |
| 6-#14 | 2.98 | 3414 | 2548 | 7490 | 1575 | 7834 | 1203 | 7819 | 895 | 7145 | 397 | 7118 | 16 | 7049 |
| 6-#18 | 5.31 | 3557 | 3005 | 8654 | 1780 | 9235 | 1338 | 9479 | 942 | 9858 | 293 | 9378 | -327 | 9332 |
| 7-#11 | 2.41 | 3330 | 2436 | 7001 | 1635 | 7456 | 1259 | 7446 | 966 | 6716 | 504 | 6924 | 160 | 6064 |
| 7-#14 | 3.48 | 3390 | 2646 | 7547 | 1741 | 8106 | 1331 | 8212 | 1000 | 8226 | 501 | 8107 | 24 | 7985 |
| 7-#18 | 6.19 | 3533 | 3178 | 8837 | 2011 | 9655 | 1512 | 10046 | 1082 | 9980 | 366 | 11066 | -315 | 10691 |
| 8-#11 | 2.76 | 3355 | 2504 | 7132 | 1693 | 7682 | 1311 | 7732 | 1004 | 7544 | 544 | 7475 | 152 | 6752 |
| 8-#14 | 3.98 | 3423 | 2744 | 7757 | 1817 | 8420 | 1400 | 8604 | 1049 | 8119 | 469 | 8863 | 6 | 8835 |
| 8-#18 | 7.07 | 3594 | 3352 | 9226 | 2130 | 10180 | 1619 | 10688 | 1156 | 11463 | 383 | 12138 | -384 | 11641 |
| 9-#11 | 3.10 | 3388 | 2572 | 7347 | 1723 | 7911 | 1322 | 7996 | 1003 | 7920 | 527 | 7861 | 89 | 7380 |
| 9-#14 | 4.48 | 3469 | 2842 | 8044 | 1865 | 8744 | 1419 | 8982 | 1051 | 9238 | 479 | 9412 | -83 | 9387 |
| 9-#18 | 7.96 | 3672 | 3526 | 9686 | 2222 | 10730 | 1657 | 11338 | 1162 | 11567 | 320 | 13066 | -542 | 12381 |
| 10-#11 | 3.45 | 3397 | 2639 | 7612 | 1726 | 8168 | 1323 | 8278 | 993 | 8264 | 485 | 8193 | 42 | 7991 |
| 10-#14 | 4.97 | 3503 | 2939 | 8393 | 1880 | 9110 | 1428 | 9395 | 1043 | 9746 | 423 | 9901 | -149 | 9871 |
| 11-#11 | 3.79 | 3445 | 2707 | 7701 | 1808 | 8364 | 1382 | 8542 | 1038 | 8641 | 512 | 8717 | 9 | 8680 |
| 11-#14 | 5.47 | 3561 | 3037 | 8549 | 1986 | 9381 | 1502 | 9748 | 1098 | 10250 | 455 | 10608 | -203 | 10482 |
| 12-#11 | 4.14 | 3480 | 2775 | 7860 | 1854 | 8588 | 1424 | 8817 | 1067 | 8984 | 508 | 9181 | -14 | 9180 |
| 12-#14 | 5.97 | 3610 | 3135 | 8781 | 2049 | 9695 | 1559 | 10130 | 1137 | 10109 | 438 | 11248 | -238 | 11104 |
| 13-#11 | 4.48 | 3511 | 2843 | 8060 | 1892 | 8818 | 1440 | 9105 | 1080 | 9396 | 504 | 9624 | -59 | 9601 |
| 13-#14 | 6.47 | 3654 | 3233 | 9057 | 2104 | 10020 | 1585 | 10539 | 1156 | 11311 | 440 | 11876 | -304 | 11517 |
| 14-#11 | 4.83 | 3537 | 2911 | 8300 | 1909 | 9071 | 1454 | 9375 | 1073 | 9134 | 449 | 9959 | -114 | 9933 |
| 15-#11 | 5.17 | 3566 | 2978 | 8421 | 1974 | 9272 | 1498 | 9647 | 1113 | 9438 | 455 | 10473 | -139 | 10390 |
| 16-#11 | 5.52 | 3592 | 3046 | 8591 | 2016 | 9496 | 1536 | 9903 | 1130 | 10483 | 488 | 11021 | -163 | 10750 |

## ROUND SPIRAL COLUMNS 26" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#11 | 1.76 | 4225 | 2709 | 8702 | 1735 | 9015 | 1339 | 8835 | 1030 | 8263 | 585 | 7533 | 232 | 6173 |
| 6-#14 | 2.54 | 4310 | 2889 | 9262 | 1818 | 9681 | 1395 | 9621 | 1053 | 9305 | 539 | 8633 | 109 | 8116 |
| 6-#18 | 4.52 | 4501 | 3345 | 10595 | 2027 | 11281 | 1535 | 11515 | 1106 | 11816 | 416 | 11245 | -220 | 11213 |
| 7-#11 | 2.06 | 4232 | 2776 | 8663 | 1892 | 9252 | 1464 | 9214 | 1133 | 8809 | 661 | 8431 | 253 | 6848 |
| 7-#14 | 2.97 | 4311 | 2986 | 9290 | 2001 | 9989 | 1538 | 10082 | 1170 | 9309 | 583 | 9784 | 123 | 9080 |
| 7-#18 | 5.27 | 4501 | 3519 | 10771 | 2275 | 11757 | 1724 | 12173 | 1259 | 12785 | 526 | 13003 | -224 | 12902 |
| 8-#11 | 2.35 | 4264 | 2844 | 8800 | 1954 | 9504 | 1520 | 9538 | 1175 | 9207 | 668 | 9058 | 248 | 7726 |
| 8-#14 | 3.39 | 4354 | 3084 | 9504 | 2080 | 10341 | 1610 | 10525 | 1223 | 10513 | 630 | 10643 | 110 | 10100 |
| 8-#18 | 6.03 | 4577 | 3693 | 11199 | 2399 | 12351 | 1836 | 12901 | 1338 | 13662 | 523 | 14418 | -261 | 13927 |
| 9-#11 | 2.64 | 4292 | 2912 | 9047 | 1983 | 9762 | 1529 | 9833 | 1173 | 9625 | 651 | 9493 | 186 | 8370 |
| 9-#14 | 3.81 | 4401 | 3182 | 9839 | 2127 | 10706 | 1629 | 10949 | 1224 | 11116 | 607 | 11267 | 21 | 11146 |
| 9-#18 | 6.78 | 4653 | 3867 | 11729 | 2491 | 12974 | 1875 | 13636 | 1345 | 14710 | 484 | 15483 | -417 | 15068 |
| 10-#11 | 2.94 | 4310 | 2980 | 9367 | 1983 | 10051 | 1527 | 10145 | 1160 | 10003 | 607 | 9858 | 139 | 9106 |
| 10-#14 | 4.24 | 4418 | 3280 | 10255 | 2139 | 11119 | 1635 | 11410 | 1214 | 10901 | 513 | 11813 | -43 | 11805 |
| 10-#18 | 7.53 | 4705 | 4041 | 12371 | 2531 | 13684 | 1904 | 14453 | 1341 | 15717 | 391 | 16456 | -531 | 15969 |
| 11-#11 | 3.23 | 4361 | 3048 | 9443 | 2070 | 10271 | 1591 | 10447 | 1210 | 10436 | 638 | 10459 | 110 | 9856 |
| 11-#14 | 4.66 | 4499 | 3378 | 10402 | 2250 | 11424 | 1715 | 11812 | 1275 | 12256 | 586 | 12621 | -92 | 12560 |
| 12-#11 | 3.53 | 4406 | 3115 | 9618 | 2118 | 10522 | 1635 | 10756 | 1241 | 10823 | 636 | 10990 | 89 | 10507 |
| 12-#14 | 5.09 | 4549 | 3475 | 10658 | 2315 | 11777 | 1774 | 12243 | 1315 | 12794 | 580 | 13353 | -125 | 13298 |

## ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 13-#11 | 3.82 | 4436 | 3183 | 9845 | 2155 | 10781 | 1652 | 11059 | 1246 | 11283 | 632 | 11487 | 45 | 11271 |
| 13-#14 | 5.51 | 4603 | 3573 | 10972 | 2370 | 12143 | 1800 | 12702 | 1335 | 13449 | 575 | 14060 | -189 | 13915 |
| 14-#11 | 4.11 | 4482 | 3251 | 10113 | 2170 | 11065 | 1663 | 11380 | 1246 | 11717 | 608 | 11865 | -9 | 11863 |
| 14-#14 | 5.93 | 4691 | 3671 | 11345 | 2399 | 12546 | 1822 | 13137 | 1328 | 13139 | 507 | 14604 | -266 | 14358 |
| 15-#11 | 4.41 | 4503 | 3319 | 10250 | 2239 | 11291 | 1711 | 11687 | 1288 | 12087 | 618 | 12448 | -31 | 12433 |
| 16-#11 | 4.70 | 4545 | 3387 | 10438 | 2283 | 11542 | 1750 | 11975 | 1307 | 12505 | 620 | 13069 | -54 | 12897 |
| 17-#11 | 5.00 | 4583 | 3455 | 10667 | 2314 | 11801 | 1770 | 12296 | 1323 | 12892 | 603 | 13481 | -100 | 13403 |
| 18-#11 | 5.29 | 4608 | 3522 | 10898 | 2344 | 12080 | 1788 | 12603 | 1321 | 13327 | 585 | 13966 | -148 | 13819 |

## ROUND SPIRAL COLUMNS 28" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#11 | 1.52 | 5254 | 3076 | 10661 | 1997 | 11048 | 1545 | 10798 | 1198 | 10005 | 705 | 9090 | 324 | 6789 |
| 6-#14 | 2.19 | 5355 | 3256 | 11288 | 2080 | 11793 | 1602 | 11676 | 1222 | 11169 | 661 | 10330 | 205 | 9238 |
| 6-#18 | 3.90 | 5591 | 3713 | 12792 | 2292 | 13594 | 1746 | 13805 | 1280 | 13057 | 508 | 13297 | -111 | 13283 |
| 7-#11 | 1.77 | 5276 | 3144 | 10568 | 2171 | 11314 | 1685 | 11240 | 1313 | 9935 | 737 | 10131 | 352 | 7588 |
| 7-#14 | 2.56 | 5375 | 3354 | 11266 | 2280 | 12138 | 1761 | 12210 | 1352 | 11946 | 757 | 11655 | 226 | 10250 |
| 7-#18 | 4.55 | 5586 | 3887 | 12952 | 2559 | 14128 | 1951 | 14560 | 1447 | 15101 | 667 | 15307 | -107 | 15287 |
| 8-#11 | 2.03 | 5316 | 3212 | 10708 | 2238 | 11584 | 1744 | 11605 | 1359 | 10355 | 747 | 10684 | 331 | 8644 |
| 8-#14 | 2.92 | 5429 | 3452 | 11493 | 2364 | 12529 | 1837 | 12707 | 1409 | 12553 | 765 | 12403 | 190 | 11422 |
| 8-#18 | 5.20 | 5673 | 4061 | 13388 | 2686 | 14790 | 2068 | 15377 | 1531 | 15015 | 623 | 16897 | -137 | 16428 |
| 9-#11 | 2.28 | 5343 | 3280 | 10989 | 2265 | 11879 | 1753 | 11929 | 1356 | 10783 | 731 | 11320 | 288 | 9397 |
| 9-#14 | 3.29 | 5469 | 3550 | 11873 | 2410 | 12936 | 1854 | 13177 | 1410 | 12337 | 693 | 13317 | 129 | 12507 |
| 9-#18 | 5.85 | 5784 | 4234 | 14005 | 2778 | 15486 | 2107 | 16196 | 1539 | 17253 | 631 | 18098 | -292 | 17788 |
| 10-#11 | 2.53 | 5367 | 3348 | 11356 | 2259 | 12201 | 1746 | 12269 | 1340 | 11963 | 737 | 11716 | 241 | 10268 |
| 10-#14 | 3.65 | 5499 | 3648 | 12364 | 2418 | 13396 | 1857 | 13683 | 1397 | 13836 | 684 | 13917 | 65 | 13552 |
| 10-#18 | 6.50 | 5846 | 4408 | 14748 | 2816 | 16281 | 2133 | 17103 | 1533 | 18370 | 538 | 19184 | -401 | 18879 |
| 11-#11 | 2.79 | 5428 | 3415 | 11427 | 2353 | 12442 | 1817 | 12611 | 1395 | 12455 | 772 | 12398 | 216 | 11043 |
| 11-#14 | 4.02 | 5584 | 3745 | 12497 | 2534 | 13734 | 1943 | 14137 | 1463 | 14487 | 725 | 14830 | 21 | 14730 |
| 11-#18 | 7.15 | 5989 | 4582 | 15079 | 2992 | 16846 | 2258 | 17828 | 1626 | 19408 | 591 | 20656 | -498 | 19991 |
| 12-#11 | 3.04 | 5464 | 3483 | 11616 | 2404 | 12713 | 1862 | 12956 | 1428 | 12029 | 720 | 12995 | 196 | 11816 |
| 12-#14 | 4.38 | 5648 | 3843 | 12776 | 2601 | 14125 | 2004 | 14617 | 1506 | 15088 | 721 | 15656 | -10 | 15652 |
| 13-#11 | 3.29 | 5512 | 3551 | 11870 | 2439 | 13006 | 1878 | 13291 | 1432 | 13353 | 760 | 13546 | 154 | 12653 |
| 13-#14 | 4.75 | 5699 | 3941 | 13129 | 2656 | 14533 | 2030 | 15096 | 1514 | 15814 | 717 | 16442 | -72 | 16386 |
| 14-#11 | 3.55 | 5573 | 3619 | 12167 | 2451 | 13326 | 1889 | 13644 | 1431 | 12946 | 694 | 13965 | 99 | 13373 |
| 14-#14 | 5.12 | 5785 | 4039 | 13536 | 2682 | 14981 | 2051 | 15608 | 1518 | 16506 | 685 | 17052 | -148 | 16962 |
| 15-#11 | 3.80 | 5594 | 3687 | 12330 | 2516 | 13570 | 1939 | 13988 | 1476 | 13335 | 705 | 14621 | 80 | 14192 |
| 15-#14 | 5.48 | 5813 | 4137 | 13761 | 2777 | 15332 | 2115 | 16080 | 1576 | 17074 | 697 | 17952 | -181 | 17764 |
| 16-#11 | 4.05 | 5624 | 3754 | 12527 | 2570 | 13845 | 1979 | 14309 | 1497 | 13769 | 709 | 15163 | 39 | 14932 |
| 16-#14 | 5.85 | 5884 | 4234 | 14063 | 2839 | 15725 | 2171 | 16529 | 1602 | 17724 | 700 | 18706 | -242 | 18392 |
| 17-#11 | 4.31 | 5683 | 3822 | 12773 | 2600 | 14135 | 1999 | 14664 | 1512 | 15181 | 743 | 15774 | 13 | 15701 |
| 18-#11 | 4.56 | 5713 | 3890 | 13034 | 2628 | 14452 | 2017 | 15003 | 1510 | 14617 | 676 | 16313 | -34 | 16293 |
| 19-#11 | 4.81 | 5755 | 3958 | 13220 | 2683 | 14701 | 2058 | 15340 | 1547 | 16076 | 729 | 16851 | -63 | 16786 |
| 20-#11 | 5.07 | 5803 | 4026 | 13418 | 2734 | 14977 | 2096 | 15663 | 1565 | 15433 | 682 | 17448 | -97 | 17329 |

## ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.32 | 6436 | 3471 | 12892 | 2279 | 13367 | 1767 | 13033 | 1378 | 11977 | 833 | 10844 | 421 | 7405 |
| 6-#14 | 1.91 | 6553 | 3651 | 13589 | 2363 | 14192 | 1825 | 14005 | 1403 | 13263 | 791 | 12224 | 305 | 10299 |
| 6-#18 | 3.40 | 6837 | 4108 | 15264 | 2577 | 16194 | 1972 | 16369 | 1465 | 16394 | 680 | 15547 | 1 | 15542 |
| 7-#11 | 1.54 | 6470 | 3539 | 12734 | 2471 | 13659 | 1923 | 13546 | 1507 | 12722 | 928 | 12039 | 457 | 8339 |
| 7-#14 | 2.23 | 6594 | 3749 | 13504 | 2581 | 14574 | 2000 | 14618 | 1547 | 14158 | 898 | 13735 | 335 | 11407 |
| 7-#18 | 3.96 | 6854 | 4282 | 15369 | 2861 | 16786 | 2194 | 17227 | 1647 | 17658 | 814 | 17821 | 12 | 17742 |
| 8-#11 | 1.77 | 6522 | 3607 | 12875 | 2543 | 13945 | 1985 | 13952 | 1556 | 13225 | 941 | 12661 | 439 | 9460 |
| 8-#14 | 2.55 | 6659 | 3847 | 13741 | 2669 | 14985 | 2079 | 15170 | 1608 | 13846 | 849 | 14572 | 302 | 12800 |
| 8-#18 | 4.53 | 6957 | 4456 | 15837 | 2993 | 17515 | 2316 | 18134 | 1736 | 18757 | 820 | 19589 | -11 | 19149 |
| 9-#11 | 1.99 | 6547 | 3675 | 13192 | 2568 | 14273 | 1993 | 14305 | 1552 | 13724 | 923 | 13356 | 395 | 10351 |
| 9-#14 | 2.86 | 6697 | 3945 | 14167 | 2713 | 15450 | 2096 | 15684 | 1608 | 15563 | 886 | 15577 | 241 | 13912 |
| 9-#18 | 5.09 | 7039 | 4629 | 16528 | 3084 | 18286 | 2354 | 19036 | 1743 | 18703 | 732 | 20927 | -165 | 20753 |
| 10-#11 | 2.21 | 6577 | 3742 | 13603 | 2556 | 14637 | 1982 | 14672 | 1533 | 14162 | 875 | 13780 | 348 | 11454 |
| 10-#14 | 3.18 | 6736 | 4042 | 14710 | 2715 | 15960 | 2095 | 16235 | 1592 | 15149 | 771 | 16228 | 178 | 15132 |
| 10-#18 | 5.66 | 7149 | 4803 | 17393 | 3120 | 19165 | 2377 | 20032 | 1735 | 21263 | 690 | 22122 | -272 | 21909 |
| 11-#11 | 2.43 | 6649 | 3810 | 13671 | 2658 | 14890 | 2058 | 15056 | 1593 | 14716 | 915 | 14547 | 327 | 12269 |
| 11-#14 | 3.50 | 6834 | 4140 | 14852 | 2839 | 16323 | 2187 | 16742 | 1663 | 16960 | 871 | 17251 | 138 | 16389 |
| 11-#18 | 6.22 | 7275 | 4977 | 17712 | 3301 | 19789 | 2508 | 20840 | 1834 | 22420 | 749 | 23765 | -361 | 23294 |
| 12-#11 | 2.65 | 6685 | 3878 | 13874 | 2710 | 15187 | 2105 | 15436 | 1627 | 15196 | 916 | 15213 | 308 | 13173 |
| 12-#14 | 3.82 | 6903 | 4238 | 15154 | 2909 | 16743 | 2249 | 17272 | 1708 | 16451 | 811 | 18172 | 109 | 17499 |
| 12-#18 | 6.79 | 7400 | 5151 | 18255 | 3413 | 20524 | 2611 | 21732 | 1906 | 23535 | 738 | 25297 | -419 | 24699 |
| 13-#11 | 2.87 | 6743 | 3946 | 14148 | 2744 | 15509 | 2121 | 15803 | 1632 | 15704 | 905 | 15816 | 267 | 14040 |
| 13-#14 | 4.14 | 6962 | 4336 | 15540 | 2963 | 17199 | 2275 | 17798 | 1717 | 18356 | 854 | 19036 | 49 | 18772 |
| 13-#18 | 7.36 | 7531 | 5325 | 18908 | 3515 | 21293 | 2660 | 22643 | 1923 | 24916 | 732 | 26791 | -529 | 25685 |
| 14-#11 | 3.09 | 6820 | 4014 | 14483 | 2753 | 15868 | 2130 | 16188 | 1629 | 16266 | 887 | 16276 | 211 | 14881 |
| 14-#14 | 4.46 | 7070 | 4434 | 15989 | 2985 | 17705 | 2295 | 18358 | 1719 | 19177 | 833 | 19710 | -28 | 19694 |
| 15-#11 | 3.31 | 6832 | 4082 | 14652 | 2822 | 16129 | 2182 | 16569 | 1677 | 16731 | 902 | 17005 | 195 | 15800 |
| 15-#14 | 4.77 | 7096 | 4532 | 16257 | 3073 | 18077 | 2362 | 18881 | 1780 | 19808 | 848 | 20710 | -57 | 20657 |
| 16-#11 | 3.53 | 6874 | 4149 | 14864 | 2877 | 16431 | 2224 | 16923 | 1699 | 17243 | 906 | 17608 | 155 | 16632 |
| 16-#14 | 5.09 | 7148 | 4629 | 16571 | 3149 | 18503 | 2419 | 19377 | 1808 | 19158 | 796 | 21550 | -117 | 21425 |
| 17-#11 | 3.75 | 6929 | 4217 | 15138 | 2907 | 16750 | 2244 | 17312 | 1714 | 17713 | 890 | 18279 | 131 | 17495 |
| 17-#14 | 5.41 | 7233 | 4727 | 16948 | 3194 | 18956 | 2449 | 19932 | 1832 | 21197 | 829 | 22505 | -152 | 22177 |
| 18-#11 | 3.97 | 6975 | 4285 | 15431 | 2934 | 17090 | 2260 | 17683 | 1711 | 18236 | 872 | 18872 | 83 | 18328 |
| 19-#11 | 4.19 | 7023 | 4353 | 15628 | 2991 | 17371 | 2304 | 18055 | 1751 | 18696 | 878 | 19468 | 57 | 19132 |
| 20-#11 | 4.41 | 7074 | 4421 | 15836 | 3042 | 17675 | 2343 | 18411 | 1770 | 19202 | 881 | 20125 | 25 | 20006 |
| 21-#11 | 4.63 | 7124 | 4489 | 16114 | 3075 | 17989 | 2364 | 18798 | 1787 | 19722 | 874 | 20646 | -14 | 20630 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.16 | 7782 | 3893 | 15416 | 2581 | 15993 | 2004 | 15561 | 1570 | 13249 | 904 | 12809 | 523 | 8022 |
| 6-#14 | 1.68 | 7915 | 4073 | 16182 | 2665 | 16898 | 2063 | 16626 | 1597 | 14563 | 867 | 14329 | 411 | 11184 |
| 6-#18 | 2.98 | 8216 | 4530 | 18030 | 2880 | 19101 | 2212 | 19226 | 1662 | 19045 | 823 | 18009 | 116 | 17358 |
| 7-#11 | 1.36 | 7829 | 3961 | 15179 | 2793 | 16302 | 2176 | 16151 | 1714 | 15056 | 1075 | 14171 | 567 | 9101 |
| 7-#14 | 1.96 | 7977 | 4171 | 16022 | 2902 | 17309 | 2254 | 17325 | 1756 | 16628 | 1047 | 16038 | 449 | 12458 |
| 7-#18 | 3.48 | 8289 | 4704 | 18067 | 3183 | 19751 | 2452 | 20194 | 1859 | 20473 | 969 | 20560 | 136 | 19624 |
| 8-#11 | 1.55 | 7891 | 4029 | 15318 | 2869 | 16613 | 2243 | 16591 | 1767 | 15616 | 1092 | 14864 | 553 | 10282 |
| 8-#14 | 2.24 | 8054 | 4269 | 16265 | 2996 | 17747 | 2338 | 17933 | 1821 | 17378 | 1062 | 16968 | 420 | 14234 |
| 8-#18 | 3.98 | 8410 | 4878 | 18564 | 3321 | 20528 | 2578 | 21191 | 1953 | 21687 | 979 | 22064 | 70 | 21813 |
| 9-#11 | 1.75 | 7916 | 4097 | 15673 | 2892 | 16971 | 2249 | 16981 | 1762 | 16153 | 1073 | 15617 | 508 | 11314 |
| 9-#14 | 2.52 | 8090 | 4367 | 16740 | 3038 | 18256 | 2353 | 18491 | 1819 | 18166 | 1039 | 18063 | 359 | 15362 |
| 9-#18 | 4.48 | 8493 | 5052 | 19330 | 3410 | 21394 | 2617 | 22176 | 1960 | 23084 | 944 | 23982 | -35 | 23962 |
| 10-#11 | 1.94 | 7952 | 4165 | 16132 | 2874 | 17380 | 2234 | 17372 | 1738 | 16616 | 1022 | 16065 | 460 | 12476 |
| 10-#14 | 2.80 | 8138 | 4465 | 17340 | 3033 | 18830 | 2348 | 19084 | 1799 | 18881 | 976 | 18761 | 295 | 16770 |
| 10-#18 | 4.97 | 8554 | 5226 | 20292 | 3440 | 22358 | 2635 | 23261 | 1949 | 24412 | 849 | 25284 | -140 | 25174 |
| 11-#11 | 2.13 | 8034 | 4232 | 16187 | 2983 | 17644 | 2316 | 17800 | 1804 | 17236 | 1066 | 16921 | 443 | 13453 |
| 11-#14 | 3.08 | 8250 | 4562 | 17485 | 3166 | 19209 | 2446 | 19647 | 1877 | 19693 | 1026 | 19898 | 260 | 18066 |
| 11-#18 | 5.47 | 8764 | 5399 | 20624 | 3630 | 23039 | 2774 | 24153 | 2055 | 25694 | 913 | 27103 | -223 | 26798 |
| 12-#11 | 2.33 | 8070 | 4300 | 16407 | 3038 | 17967 | 2364 | 18209 | 1840 | 17764 | 1069 | 17657 | 426 | 14579 |
| 12-#14 | 3.36 | 8302 | 4660 | 17809 | 3238 | 19666 | 2510 | 20228 | 1924 | 20424 | 1026 | 20916 | 232 | 19347 |
| 12-#18 | 5.97 | 8854 | 5573 | 21214 | 3746 | 23823 | 2878 | 25132 | 2129 | 26918 | 905 | 28798 | -279 | 28476 |
| 13-#11 | 2.52 | 8132 | 4368 | 16702 | 3071 | 18319 | 2380 | 18615 | 1844 | 17094 | 987 | 18312 | 385 | 15466 |
| 13-#14 | 3.64 | 8392 | 4758 | 18223 | 3290 | 20166 | 2536 | 20800 | 1932 | 21218 | 1011 | 21858 | 174 | 20776 |
| 13-#18 | 6.47 | 9003 | 5747 | 21932 | 3847 | 24680 | 2928 | 26128 | 2147 | 28304 | 880 | 30435 | -385 | 29553 |
| 14-#11 | 2.72 | 8223 | 4436 | 17078 | 3077 | 18700 | 2385 | 19031 | 1840 | 18919 | 1039 | 18810 | 329 | 16439 |
| 14-#14 | 3.92 | 8508 | 4856 | 18723 | 3310 | 20720 | 2554 | 21409 | 1933 | 22107 | 989 | 22593 | 97 | 21941 |
| 14-#18 | 6.96 | 9234 | 5921 | 22737 | 3900 | 25620 | 2974 | 27205 | 2160 | 29883 | 849 | 31734 | -517 | 30778 |
| 15-#11 | 2.91 | 8241 | 4504 | 17250 | 3149 | 18995 | 2443 | 19427 | 1883 | 19435 | 1056 | 19616 | 315 | 17409 |
| 15-#14 | 4.20 | 8547 | 4954 | 19003 | 3401 | 21124 | 2624 | 21983 | 1997 | 21283 | 940 | 23696 | 70 | 23271 |
| 16-#11 | 3.10 | 8291 | 4572 | 17471 | 3205 | 19323 | 2485 | 19830 | 1913 | 19995 | 1062 | 20281 | 276 | 18345 |
| 16-#14 | 4.48 | 8605 | 5052 | 19335 | 3478 | 21589 | 2683 | 22526 | 2027 | 23589 | 1013 | 24623 | 12 | 24540 |
| 17-#11 | 3.30 | 8349 | 4639 | 17780 | 3235 | 19666 | 2504 | 20257 | 1929 | 19139 | 976 | 20925 | 243 | 19313 |
| 17-#14 | 4.76 | 8684 | 5149 | 19757 | 3523 | 22083 | 2712 | 23131 | 2050 | 24320 | 990 | 25665 | -21 | 25505 |
| 18-#11 | 3.49 | 8386 | 4707 | 18106 | 3260 | 20032 | 2519 | 20663 | 1925 | 21071 | 1027 | 21656 | 205 | 20194 |
| 18-#14 | 5.04 | 8757 | 5247 | 20198 | 3567 | 22608 | 2739 | 23712 | 2049 | 25140 | 966 | 26596 | -88 | 26466 |
| 19-#11 | 3.69 | 8457 | 4775 | 18306 | 3320 | 20338 | 2565 | 21067 | 1966 | 21578 | 1035 | 22311 | 181 | 21129 |
| 19-#14 | 5.32 | 8835 | 5345 | 20513 | 3645 | 23039 | 2800 | 24278 | 2103 | 25839 | 974 | 27503 | -128 | 27302 |
| 20-#11 | 3.88 | 8511 | 4843 | 18530 | 3371 | 20680 | 2606 | 21452 | 1986 | 22130 | 1039 | 23030 | 152 | 22041 |
| 21-#11 | 4.07 | 8560 | 4911 | 18835 | 3404 | 21011 | 2627 | 21876 | 2003 | 22696 | 1033 | 23602 | 112 | 22944 |
| 22-#11 | 4.27 | 8628 | 4979 | 19154 | 3436 | 21375 | 2647 | 22289 | 2005 | 23217 | 1010 | 24241 | 71 | 23865 |
| 23-#11 | 4.46 | 8666 | 5046 | 19367 | 3489 | 21686 | 2687 | 22686 | 2040 | 22180 | 954 | 24982 | 51 | 24685 |

## ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.03 | 9303 | 4343 | 18251 | 2903 | 18945 | 2257 | 18402 | 1775 | 16678 | 1114 | 14998 | 631 | 8639 |
| 6-#14 | 1.49 | 9452 | 4523 | 19087 | 2987 | 19930 | 2316 | 19559 | 1802 | 18208 | 1075 | 16659 | 522 | 12070 |
| 6-#18 | 2.64 | 9792 | 4979 | 21108 | 3204 | 22335 | 2468 | 22395 | 1870 | 21961 | 973 | 20697 | 235 | 19250 |
| 7-#11 | 1.20 | 9362 | 4411 | 17922 | 3136 | 19272 | 2447 | 19075 | 1935 | 17617 | 1224 | 16542 | 684 | 9876 |
| 7-#14 | 1.73 | 9530 | 4621 | 18838 | 3245 | 20363 | 2525 | 20351 | 1977 | 19374 | 1205 | 18580 | 568 | 13523 |
| 7-#18 | 3.08 | 9901 | 5153 | 21063 | 3527 | 23044 | 2727 | 23480 | 2084 | 23564 | 1133 | 23538 | 264 | 21562 |
| 8-#11 | 1.37 | 9436 | 4478 | 18055 | 3218 | 19607 | 2519 | 19545 | 1990 | 18284 | 1251 | 17309 | 673 | 11109 |
| 8-#14 | 1.98 | 9625 | 4718 | 19084 | 3345 | 20836 | 2613 | 21002 | 2045 | 20199 | 1223 | 19606 | 543 | 15404 |
| 8-#18 | 3.52 | 10041 | 5327 | 21587 | 3671 | 23856 | 2855 | 24570 | 2183 | 24895 | 1146 | 25193 | 203 | 24056 |
| 9-#11 | 1.55 | 9459 | 4546 | 18450 | 3238 | 19996 | 2522 | 19971 | 1984 | 18858 | 1231 | 18119 | 627 | 12293 |
| 9-#14 | 2.23 | 9659 | 4816 | 19610 | 3384 | 21389 | 2627 | 21618 | 2043 | 21045 | 1199 | 20789 | 481 | 16797 |
| 9-#18 | 3.97 | 10125 | 5501 | 22431 | 3758 | 24810 | 2893 | 25637 | 2189 | 24646 | 1037 | 27278 | 98 | 26550 |
| 10-#11 | 1.72 | 9502 | 4614 | 18962 | 3213 | 20443 | 2502 | 20391 | 1957 | 18054 | 1099 | 18586 | 578 | 13507 |
| 10-#14 | 2.48 | 9716 | 4914 | 20271 | 3372 | 22028 | 2618 | 22252 | 2019 | 20351 | 1058 | 21530 | 418 | 18464 |
| 10-#18 | 4.41 | 10194 | 5675 | 23475 | 3780 | 25879 | 2909 | 26808 | 2174 | 27835 | 1014 | 28683 | -5 | 28680 |
| 11-#11 | 1.89 | 9595 | 4682 | 18996 | 3330 | 20724 | 2590 | 20854 | 2028 | 18698 | 1145 | 19537 | 564 | 14626 |
| 11-#14 | 2.73 | 9843 | 5012 | 20405 | 3513 | 22422 | 2721 | 22873 | 2103 | 22703 | 1189 | 22786 | 387 | 19825 |
| 11-#18 | 4.85 | 10404 | 5849 | 23834 | 3980 | 26587 | 3053 | 27787 | 2287 | 27295 | 1012 | 30683 | -82 | 30567 |
| 12-#11 | 2.06 | 9631 | 4750 | 19234 | 3388 | 21073 | 2641 | 21298 | 2065 | 20610 | 1231 | 20344 | 549 | 15835 |
| 12-#14 | 2.97 | 9894 | 5110 | 20758 | 3588 | 22917 | 2788 | 23490 | 2151 | 23500 | 1191 | 23902 | 361 | 21253 |
| 12-#18 | 5.29 | 10525 | 6023 | 24468 | 4099 | 27438 | 3160 | 28853 | 2363 | 30580 | 1079 | 32544 | -136 | 32387 |
| 13-#11 | 2.23 | 9702 | 4818 | 19552 | 3419 | 21455 | 2656 | 21735 | 2069 | 21203 | 1219 | 20959 | 499 | 16880 |
| 13-#14 | 3.22 | 9999 | 5208 | 21201 | 3638 | 23459 | 2813 | 24120 | 2159 | 24358 | 1176 | 24921 | 303 | 22729 |
| 13-#18 | 5.73 | 10693 | 6197 | 25231 | 4198 | 28371 | 3210 | 29934 | 2382 | 32083 | 1055 | 34323 | -239 | 33690 |
| 14-#11 | 2.41 | 9800 | 4885 | 19971 | 3422 | 21859 | 2658 | 22193 | 2063 | 21750 | 1183 | 21585 | 452 | 18046 |
| 14-#14 | 3.47 | 10123 | 5305 | 21755 | 3655 | 24046 | 2827 | 24778 | 2159 | 25312 | 1153 | 25716 | 225 | 24062 |
| 14-#18 | 6.17 | 10863 | 6371 | 26117 | 4249 | 29424 | 3256 | 31101 | 2394 | 33790 | 1024 | 35742 | -371 | 35098 |
| 15-#11 | 2.58 | 9827 | 4953 | 20144 | 3498 | 22179 | 2719 | 22615 | 2109 | 22416 | 1219 | 22469 | 440 | 19041 |
| 15-#14 | 3.72 | 10162 | 5403 | 22046 | 3751 | 24498 | 2903 | 25366 | 2215 | 24338 | 1096 | 26924 | 202 | 25593 |
| 15-#18 | 6.61 | 10998 | 6544 | 26694 | 4393 | 30159 | 3365 | 32139 | 2495 | 35037 | 1045 | 37739 | -426 | 36883 |
| 16-#11 | 2.75 | 9884 | 5021 | 20371 | 3555 | 22542 | 2763 | 23053 | 2140 | 23025 | 1226 | 23197 | 402 | 20109 |
| 16-#14 | 3.97 | 10241 | 5501 | 22390 | 3829 | 25002 | 2963 | 25981 | 2257 | 26930 | 1181 | 27939 | 145 | 26878 |
| 17-#11 | 2.92 | 9946 | 5089 | 20712 | 3584 | 22904 | 2781 | 23514 | 2155 | 23576 | 1210 | 23893 | 370 | 21107 |
| 17-#14 | 4.21 | 10324 | 5599 | 22862 | 3874 | 25527 | 2992 | 26642 | 2281 | 27721 | 1159 | 28936 | 99 | 28317 |
| 18-#11 | 3.09 | 9987 | 5157 | 21077 | 3608 | 23301 | 2795 | 23954 | 2151 | 24183 | 1191 | 24682 | 332 | 22112 |
| 18-#14 | 4.46 | 10408 | 5697 | 23347 | 3916 | 26092 | 3017 | 27279 | 2280 | 28605 | 1134 | 30078 | 46 | 29743 |
| 19-#11 | 3.26 | 10061 | 5225 | 21278 | 3670 | 23631 | 2843 | 24391 | 2194 | 24737 | 1201 | 25396 | 311 | 23162 |
| 19-#14 | 4.71 | 10495 | 5794 | 23669 | 3996 | 26559 | 3080 | 27885 | 2335 | 29368 | 1144 | 31065 | 10 | 31008 |
| 20-#11 | 3.44 | 10126 | 5292 | 21518 | 3722 | 23996 | 2885 | 24809 | 2215 | 25337 | 1205 | 26177 | 282 | 24114 |
| 20-#14 | 4.96 | 10572 | 5892 | 24019 | 4069 | 27088 | 3138 | 28474 | 2362 | 30213 | 1149 | 32165 | -33 | 32104 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 21-#11 | 3.61 | 10181 | 5360 | 21850 | 3755 | 24360 | 2905 | 25268 | 2232 | 24171 | 1112 | 26801 | 243 | 25150 |
| 22-#11 | 3.78 | 10261 | 5428 | 22194 | 3785 | 24755 | 2925 | 25705 | 2233 | 24741 | 1098 | 27490 | 203 | 26114 |
| 23-#11 | 3.95 | 10300 | 5496 | 22426 | 3840 | 25090 | 2967 | 26144 | 2270 | 27105 | 1190 | 28300 | 184 | 27089 |
| 24-#11 | 4.12 | 10351 | 5564 | 22682 | 3891 | 25442 | 3005 | 26565 | 2289 | 27655 | 1185 | 28968 | 149 | 28092 |
| 25-#11 | 4.30 | 10423 | 5631 | 22996 | 3924 | 25815 | 3028 | 27018 | 2308 | 28264 | 1180 | 29714 | 114 | 28986 |

## ROUND SPIRAL COLUMNS 36" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.33 | 11175 | 4999 | 22322 | 3330 | 23309 | 2585 | 22824 | 2021 | 21093 | 1230 | 19229 | 638 | 12956 |
| 6-#18 | 2.36 | 11555 | 5456 | 24519 | 3547 | 25917 | 2738 | 25896 | 2091 | 25157 | 1132 | 23624 | 358 | 21216 |
| 7-#11 | 1.07 | 11076 | 4887 | 20981 | 3501 | 22589 | 2735 | 22332 | 2169 | 19148 | 1297 | 19166 | 807 | 10662 |
| 7-#14 | 1.55 | 11265 | 5097 | 21970 | 3610 | 23764 | 2813 | 23717 | 2212 | 22336 | 1361 | 21376 | 694 | 14603 |
| 7-#18 | 2.75 | 11696 | 5630 | 24377 | 3892 | 26659 | 3016 | 27105 | 2322 | 26947 | 1304 | 26770 | 397 | 23557 |
| 8-#11 | 1.23 | 11166 | 4955 | 21103 | 3588 | 22948 | 2811 | 22840 | 2228 | 21248 | 1420 | 20010 | 799 | 11942 |
| 8-#14 | 1.77 | 11382 | 5195 | 22215 | 3715 | 24272 | 2906 | 24407 | 2283 | 23314 | 1394 | 22501 | 673 | 16576 |
| 8-#18 | 3.14 | 11861 | 5804 | 24923 | 4042 | 27532 | 3149 | 28283 | 2425 | 26505 | 1234 | 28579 | 341 | 26374 |
| 9-#11 | 1.38 | 11188 | 5023 | 21541 | 3605 | 23368 | 2812 | 23294 | 2220 | 21857 | 1399 | 20875 | 753 | 13287 |
| 9-#14 | 1.99 | 11414 | 5293 | 22794 | 3751 | 24869 | 2917 | 25075 | 2280 | 24218 | 1369 | 23770 | 610 | 18159 |
| 9-#18 | 3.54 | 11921 | 5978 | 25847 | 4126 | 28563 | 3186 | 29439 | 2430 | 30022 | 1287 | 30831 | 236 | 28939 |
| 10-#11 | 1.53 | 11238 | 5091 | 22111 | 3573 | 23842 | 2786 | 23747 | 2189 | 22361 | 1343 | 21358 | 701 | 14548 |
| 10-#14 | 2.21 | 11480 | 5391 | 23521 | 3732 | 25560 | 2903 | 25758 | 2253 | 23351 | 1214 | 24551 | 545 | 20099 |
| 10-#18 | 3.93 | 12024 | 6152 | 26978 | 4141 | 29749 | 3199 | 30693 | 2412 | 31549 | 1188 | 32335 | 134 | 31387 |
| 11-#11 | 1.69 | 11339 | 5159 | 22118 | 3698 | 24151 | 2882 | 24247 | 2265 | 23125 | 1396 | 22408 | 692 | 15819 |
| 11-#14 | 2.43 | 11623 | 5489 | 23637 | 3882 | 25982 | 3013 | 26421 | 2341 | 26008 | 1361 | 25930 | 519 | 21596 |
| 11-#18 | 4.32 | 12258 | 6326 | 27355 | 4351 | 30483 | 3348 | 31762 | 2531 | 33090 | 1264 | 34520 | 62 | 34153 |
| 12-#11 | 1.84 | 11377 | 5226 | 22373 | 3759 | 24526 | 2935 | 24727 | 2304 | 23751 | 1402 | 23288 | 678 | 17077 |
| 12-#14 | 2.65 | 11673 | 5586 | 24020 | 3960 | 26514 | 3083 | 27089 | 2391 | 26872 | 1364 | 27146 | 494 | 23217 |
| 12-#18 | 4.72 | 12388 | 6499 | 28036 | 4473 | 31401 | 3458 | 32909 | 2610 | 32236 | 1177 | 36549 | 11 | 36473 |
| 13-#11 | 1.99 | 11458 | 5294 | 22714 | 3788 | 24934 | 2948 | 25196 | 2307 | 22760 | 1297 | 23947 | 628 | 18263 |
| 13-#14 | 2.87 | 11783 | 5684 | 24492 | 4008 | 27099 | 3107 | 27765 | 2399 | 27792 | 1350 | 28102 | 424 | 24732 |
| 13-#18 | 5.11 | 12537 | 6673 | 28845 | 4570 | 32410 | 3508 | 34082 | 2629 | 36157 | 1238 | 38469 | -90 | 38047 |
| 14-#11 | 2.15 | 11555 | 5362 | 23179 | 3788 | 25365 | 2947 | 25684 | 2299 | 23300 | 1263 | 24613 | 580 | 19556 |
| 14-#14 | 3.09 | 11925 | 5782 | 25103 | 4022 | 27719 | 3118 | 28488 | 2398 | 28659 | 1303 | 29094 | 359 | 26243 |
| 14-#18 | 5.50 | 12752 | 6847 | 29815 | 4617 | 33524 | 3549 | 35337 | 2640 | 37990 | 1206 | 40007 | -222 | 39692 |
| 15-#11 | 2.30 | 11599 | 5430 | 23349 | 3869 | 25708 | 3012 | 26143 | 2348 | 25692 | 1391 | 25579 | 571 | 20664 |
| 15-#14 | 3.32 | 11976 | 5880 | 25401 | 4122 | 28206 | 3197 | 29109 | 2456 | 27668 | 1259 | 30409 | 339 | 27853 |
| 15-#18 | 5.89 | 12871 | 7021 | 30423 | 4767 | 34341 | 3665 | 36463 | 2745 | 36724 | 1149 | 42177 | -273 | 41641 |
| 16-#11 | 2.45 | 11664 | 5498 | 23583 | 3926 | 26107 | 3058 | 26616 | 2380 | 26350 | 1399 | 26370 | 534 | 21923 |
| 16-#14 | 3.54 | 12065 | 5978 | 25757 | 4201 | 28761 | 3259 | 29774 | 2499 | 30567 | 1358 | 31513 | 283 | 29354 |
| 16-#18 | 6.29 | 13075 | 7195 | 31095 | 4900 | 35277 | 3766 | 37542 | 2795 | 38189 | 1158 | 44036 | -377 | 43155 |
| 17-#11 | 2.61 | 11723 | 5566 | 23954 | 3955 | 26488 | 3075 | 27112 | 2396 | 26942 | 1383 | 27118 | 503 | 22945 |
| 17-#14 | 3.76 | 12153 | 6076 | 26272 | 4246 | 29314 | 3287 | 30484 | 2524 | 31418 | 1336 | 32587 | 238 | 30913 |
| 18-#11 | 2.76 | 11775 | 5633 | 24362 | 3978 | 26916 | 3087 | 27571 | 2389 | 27588 | 1363 | 27964 | 464 | 24082 |
| 18-#14 | 3.98 | 12219 | 6173 | 26812 | 4286 | 29924 | 3311 | 31167 | 2521 | 32364 | 1311 | 33816 | 185 | 32362 |

## ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 19-#11 | 2.91 | 11858 | 5701 | 24562 | 4041 | 27271 | 3138 | 28054 | 2435 | 26312 | 1283 | 28739 | 445 | 25186 |
| 19-#14 | 4.20 | 12344 | 6271 | 27139 | 4368 | 30427 | 3376 | 31824 | 2579 | 33192 | 1323 | 34885 | 152 | 33816 |
| 20-#11 | 3.07 | 11917 | 5769 | 24818 | 4095 | 27654 | 3180 | 28507 | 2457 | 28839 | 1380 | 29583 | 418 | 26240 |
| 20-#14 | 4.42 | 12425 | 6369 | 27513 | 4443 | 30983 | 3434 | 32460 | 2607 | 34105 | 1329 | 36074 | 111 | 35371 |
| 21-#11 | 3.22 | 11989 | 5837 | 25177 | 4127 | 28055 | 3201 | 28992 | 2474 | 27479 | 1275 | 30258 | 379 | 27386 |
| 21-#14 | 4.64 | 12527 | 6467 | 28015 | 4491 | 31542 | 3465 | 33165 | 2634 | 32637 | 1222 | 37034 | 55 | 36692 |
| 22-#11 | 3.37 | 12078 | 5905 | 25547 | 4155 | 28481 | 3219 | 29457 | 2473 | 30095 | 1351 | 30996 | 339 | 28396 |
| 22-#14 | 4.86 | 12635 | 6565 | 28527 | 4539 | 32147 | 3496 | 33840 | 2637 | 35915 | 1289 | 38103 | -1 | 38100 |
| 23-#11 | 3.52 | 12123 | 5972 | 25791 | 4212 | 28833 | 3262 | 29932 | 2512 | 28692 | 1275 | 31877 | 322 | 29505 |
| 24-#11 | 3.68 | 12179 | 6040 | 26070 | 4264 | 29211 | 3302 | 30398 | 2533 | 31334 | 1362 | 32600 | 287 | 30548 |
| 25-#11 | 3.83 | 12248 | 6108 | 26404 | 4297 | 29613 | 3324 | 30873 | 2551 | 31988 | 1357 | 33404 | 253 | 31625 |
| 26-#11 | 3.98 | 12314 | 6176 | 26756 | 4330 | 30045 | 3347 | 31344 | 2554 | 30426 | 1248 | 34055 | 210 | 32731 |
| 27-#11 | 4.14 | 12380 | 6244 | 27049 | 4374 | 30396 | 3386 | 31815 | 2589 | 31021 | 1258 | 35031 | 194 | 33683 |

## ROUND SPIRAL COLUMNS 38" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.19 | 13094 | 5503 | 25907 | 3692 | 27055 | 2870 | 26440 | 2251 | 24275 | 1393 | 22052 | 761 | 13840 |
| 6-#18 | 2.12 | 13515 | 5960 | 28280 | 3909 | 29867 | 3024 | 29749 | 2323 | 26740 | 1211 | 26806 | 486 | 23257 |
| 7-#14 | 1.39 | 13196 | 5601 | 25435 | 3996 | 27532 | 3118 | 27432 | 2460 | 25679 | 1537 | 24440 | 826 | 15697 |
| 7-#18 | 2.47 | 13680 | 6134 | 28026 | 4278 | 30639 | 3321 | 31090 | 2573 | 28598 | 1385 | 30272 | 535 | 25607 |
| 8-#11 | 1.10 | 13093 | 5459 | 24480 | 3980 | 26655 | 3121 | 26496 | 2479 | 24525 | 1599 | 22985 | 932 | 12780 |
| 8-#14 | 1.59 | 13336 | 5699 | 25676 | 4107 | 28074 | 3216 | 28173 | 2535 | 24960 | 1469 | 25668 | 808 | 17754 |
| 8-#18 | 2.82 | 13880 | 6308 | 28590 | 4434 | 31574 | 3460 | 32330 | 2679 | 30067 | 1406 | 32238 | 484 | 28768 |
| 9-#11 | 1.24 | 13113 | 5527 | 24964 | 3994 | 27107 | 3119 | 26977 | 2469 | 25167 | 1576 | 23802 | 875 | 14298 |
| 9-#14 | 1.79 | 13366 | 5797 | 26311 | 4140 | 28716 | 3224 | 28884 | 2530 | 27702 | 1548 | 27022 | 745 | 19541 |
| 9-#18 | 3.17 | 13936 | 6482 | 29597 | 4516 | 32685 | 3494 | 33600 | 2684 | 31686 | 1373 | 34655 | 379 | 31387 |
| 10-#11 | 1.38 | 13171 | 5595 | 25598 | 3954 | 27608 | 3087 | 27461 | 2434 | 23974 | 1415 | 24396 | 831 | 15599 |
| 10-#14 | 1.98 | 13442 | 5895 | 27110 | 4113 | 29446 | 3204 | 29621 | 2499 | 26638 | 1378 | 27837 | 678 | 21565 |
| 10-#18 | 3.53 | 14054 | 6655 | 30820 | 4523 | 33987 | 3504 | 34936 | 2662 | 33199 | 1278 | 36253 | 277 | 34137 |
| 11-#11 | 1.51 | 13281 | 5662 | 25571 | 4089 | 27946 | 3190 | 27999 | 2516 | 24760 | 1469 | 25551 | 826 | 17031 |
| 11-#14 | 2.18 | 13600 | 5992 | 27200 | 4272 | 29909 | 3323 | 30329 | 2593 | 29624 | 1541 | 29346 | 657 | 23265 |
| 11-#18 | 3.88 | 14313 | 6829 | 31193 | 4742 | 34746 | 3660 | 36088 | 2788 | 34764 | 1354 | 38630 | 211 | 37076 |
| 12-#11 | 1.65 | 13321 | 5730 | 25840 | 4152 | 28346 | 3245 | 28516 | 2557 | 27206 | 1582 | 26505 | 813 | 18332 |
| 12-#14 | 2.38 | 13650 | 6090 | 27611 | 4354 | 30479 | 3394 | 31048 | 2645 | 28520 | 1444 | 30663 | 633 | 25239 |
| 12-#18 | 4.23 | 14403 | 7003 | 31935 | 4868 | 35731 | 3772 | 37300 | 2868 | 36222 | 1354 | 40828 | 161 | 39589 |
| 13-#11 | 1.79 | 13410 | 5798 | 26206 | 4180 | 28775 | 3257 | 29016 | 2559 | 27880 | 1570 | 27207 | 764 | 19669 |
| 13-#14 | 2.58 | 13773 | 6188 | 28114 | 4400 | 31101 | 3417 | 31771 | 2653 | 29436 | 1430 | 31685 | 564 | 26783 |
| 13-#18 | 4.59 | 14614 | 7177 | 32791 | 4963 | 36816 | 3821 | 38572 | 2887 | 37840 | 1333 | 42889 | 63 | 42473 |
| 14-#11 | 1.93 | 13512 | 5866 | 26721 | 4175 | 29238 | 3253 | 29523 | 2548 | 28490 | 1531 | 27911 | 715 | 21008 |
| 14-#14 | 2.78 | 13926 | 6286 | 28785 | 4410 | 31760 | 3424 | 32538 | 2649 | 32458 | 1484 | 32742 | 498 | 28484 |
| 14-#18 | 4.94 | 14842 | 7351 | 33848 | 5007 | 37989 | 3859 | 39933 | 2897 | 39668 | 1302 | 44542 | -70 | 44445 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 38" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 15-#11 | 2.06 | 13568 | 5934 | 26885 | 4261 | 29605 | 3322 | 30032 | 2601 | 29281 | 1572 | 28961 | 708 | 22258 |
| 15-#14 | 2.98 | 13989 | 6384 | 29086 | 4515 | 32280 | 3508 | 33213 | 2711 | 33526 | 1533 | 34167 | 481 | 30137 |
| 15-#18 | 5.29 | 14985 | 7525 | 34484 | 5162 | 38885 | 3981 | 41058 | 2985 | 43971 | 1423 | 46888 | -116 | 46676 |
| 16-#11 | 2.20 | 13641 | 6002 | 27124 | 4319 | 30033 | 3370 | 30540 | 2635 | 29989 | 1581 | 29817 | 672 | 23595 |
| 16-#14 | 3.17 | 14088 | 6482 | 29454 | 4594 | 32888 | 3573 | 33927 | 2755 | 32216 | 1440 | 35361 | 426 | 31818 |
| 16-#18 | 5.64 | 15129 | 7699 | 35182 | 5296 | 39895 | 4084 | 42277 | 3057 | 42615 | 1339 | 48901 | -219 | 48413 |
| 17-#11 | 2.34 | 13702 | 6069 | 27525 | 4348 | 30439 | 3386 | 31065 | 2649 | 30620 | 1565 | 30616 | 641 | 24784 |
| 17-#14 | 3.37 | 14181 | 6579 | 30010 | 4639 | 33468 | 3599 | 34687 | 2779 | 33065 | 1420 | 36511 | 382 | 33497 |
| 17-#18 | 6.00 | 15306 | 7873 | 36117 | 5380 | 40938 | 4137 | 43605 | 3103 | 47253 | 1398 | 50908 | -299 | 50205 |
| 18-#11 | 2.48 | 13761 | 6137 | 27979 | 4368 | 30899 | 3396 | 31547 | 2641 | 31306 | 1544 | 31317 | 582 | 26103 |
| 18-#14 | 3.57 | 14254 | 6677 | 30608 | 4678 | 34123 | 3621 | 35400 | 2775 | 36435 | 1496 | 37825 | 328 | 35046 |
| 19-#11 | 2.61 | 13853 | 6205 | 28176 | 4434 | 31278 | 3450 | 32068 | 2689 | 29829 | 1454 | 32355 | 585 | 27234 |
| 19-#14 | 3.77 | 14381 | 6775 | 30938 | 4762 | 34661 | 3689 | 36120 | 2836 | 37330 | 1510 | 38979 | 299 | 36690 |
| 20-#11 | 2.75 | 13913 | 6273 | 28447 | 4489 | 31680 | 3492 | 32565 | 2712 | 32655 | 1564 | 33262 | 559 | 28420 |
| 20-#14 | 3.97 | 14479 | 6873 | 31336 | 4837 | 35244 | 3747 | 36807 | 2865 | 35756 | 1415 | 40257 | 259 | 38274 |
| 21-#11 | 2.89 | 13995 | 6341 | 28834 | 4521 | 32110 | 3512 | 33074 | 2728 | 33299 | 1550 | 33987 | 521 | 29598 |
| 21-#14 | 4.17 | 14575 | 6971 | 31877 | 4886 | 35856 | 3779 | 37550 | 2891 | 39234 | 1497 | 41291 | 204 | 39822 |
| 22-#11 | 3.03 | 14090 | 6409 | 29231 | 4547 | 32575 | 3530 | 33569 | 2727 | 31728 | 1432 | 34774 | 481 | 30734 |
| 22-#14 | 4.36 | 14704 | 7069 | 32423 | 4931 | 36506 | 3809 | 38267 | 2893 | 40245 | 1478 | 42434 | 148 | 41499 |
| 23-#11 | 3.16 | 14137 | 6476 | 29485 | 4606 | 32942 | 3575 | 34081 | 2768 | 32378 | 1447 | 35727 | 464 | 31950 |
| 23-#14 | 4.56 | 14784 | 7166 | 32812 | 5008 | 37040 | 3868 | 38981 | 2947 | 41213 | 1496 | 43758 | 121 | 42937 |
| 24-#11 | 3.30 | 14206 | 6544 | 29788 | 4659 | 33348 | 3615 | 34572 | 2789 | 35327 | 1547 | 36505 | 431 | 33093 |
| 25-#11 | 3.44 | 14279 | 6612 | 30141 | 4691 | 33778 | 3637 | 35089 | 2807 | 36026 | 1543 | 37369 | 397 | 34254 |
| 26-#11 | 3.58 | 14337 | 6680 | 30524 | 4723 | 34234 | 3659 | 35592 | 2809 | 36677 | 1522 | 38063 | 354 | 35384 |
| 27-#11 | 3.71 | 14426 | 6748 | 30832 | 4769 | 34616 | 3700 | 36097 | 2846 | 37364 | 1535 | 39013 | 330 | 36496 |
| 28-#11 | 3.85 | 14494 | 6815 | 31150 | 4811 | 35026 | 3739 | 36579 | 2865 | 38004 | 1530 | 39980 | 318 | 37672 |

## ROUND SPIRAL COLUMNS 40" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#14 | 1.07 | 15219 | 6034 | 29861 | 4074 | 31190 | 3171 | 30427 | 2495 | 25919 | 1461 | 25143 | 889 | 14725 |
| 6-#18 | 1.91 | 15683 | 6491 | 32410 | 4292 | 34205 | 3326 | 33973 | 2568 | 32457 | 1473 | 30256 | 620 | 24886 |
| 7-#14 | 1.25 | 15334 | 6132 | 29253 | 4404 | 31687 | 3439 | 31519 | 2721 | 27392 | 1608 | 27789 | 964 | 16805 |
| 7-#18 | 2.23 | 15863 | 6665 | 32028 | 4686 | 35007 | 3643 | 35454 | 2836 | 34512 | 1652 | 34058 | 679 | 27601 |
| 8-#14 | 1.43 | 15497 | 6230 | 29484 | 4521 | 32263 | 3542 | 32319 | 2801 | 28469 | 1646 | 29123 | 950 | 18939 |
| 8-#18 | 2.55 | 16107 | 6839 | 32606 | 4848 | 36004 | 3788 | 36758 | 2946 | 36361 | 1699 | 36186 | 633 | 31235 |
| 9-#11 | 1.12 | 15246 | 6058 | 28733 | 4405 | 31233 | 3443 | 31040 | 2732 | 28806 | 1763 | 27109 | 1013 | 15342 |
| 9-#14 | 1.61 | 15525 | 6328 | 30178 | 4551 | 32951 | 3549 | 33074 | 2794 | 31515 | 1736 | 30407 | 872 | 20941 |
| 9-#18 | 2.86 | 16160 | 7013 | 33698 | 4927 | 37194 | 3820 | 38116 | 2950 | 35659 | 1552 | 38765 | 527 | 33895 |
| 10-#11 | 1.24 | 15310 | 6126 | 29440 | 4357 | 31762 | 3404 | 31552 | 2692 | 29336 | 1699 | 27714 | 968 | 16660 |
| 10-#14 | 1.79 | 15612 | 6426 | 31054 | 4516 | 33720 | 3521 | 33862 | 2758 | 32386 | 1661 | 31405 | 817 | 23042 |
| 10-#18 | 3.18 | 16294 | 7187 | 35019 | 4925 | 38575 | 3822 | 39557 | 2925 | 39916 | 1559 | 40453 | 425 | 36964 |

## ROUND SPIRAL COLUMNS 40" DIA.

Short columns – no sidesway $f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 11-#11 | 1.37 | 15430 | 6194 | 29372 | 4501 | 32127 | 3516 | 32131 | 2780 | 30262 | 1762 | 28980 | 967 | 18263 |
| 11-#14 | 1.97 | 15785 | 6524 | 31112 | 4684 | 34224 | 3649 | 34618 | 2858 | 33570 | 1731 | 33048 | 800 | 24944 |
| 11-#18 | 3.50 | 16579 | 7361 | 35382 | 5154 | 39397 | 3988 | 40772 | 3056 | 41735 | 1646 | 43027 | 364 | 39982 |
| 12-#11 | 1.49 | 15471 | 6261 | 29645 | 4567 | 32553 | 3573 | 32687 | 2823 | 30986 | 1771 | 30009 | 955 | 19602 |
| 12-#14 | 2.15 | 15835 | 6621 | 31550 | 4769 | 34830 | 3723 | 35388 | 2913 | 32268 | 1623 | 34468 | 778 | 27030 |
| 12-#18 | 3.82 | 16668 | 7534 | 36182 | 5285 | 40449 | 4103 | 42072 | 3138 | 43411 | 1648 | 45396 | 317 | 42785 |
| 13-#11 | 1.61 | 15570 | 6329 | 30080 | 4585 | 33004 | 3583 | 33217 | 2825 | 29592 | 1642 | 30754 | 906 | 21098 |
| 13-#14 | 2.33 | 15971 | 6719 | 32085 | 4813 | 35483 | 3743 | 36158 | 2919 | 35615 | 1724 | 35555 | 710 | 28812 |
| 13-#18 | 4.14 | 16904 | 7708 | 37087 | 5377 | 41610 | 4151 | 43430 | 3158 | 45260 | 1626 | 47322 | 195 | 46023 |
| 14-#11 | 1.74 | 15676 | 6397 | 30614 | 4584 | 33498 | 3576 | 33741 | 2811 | 32343 | 1718 | 31494 | 855 | 22478 |
| 14-#14 | 2.51 | 16121 | 6817 | 32819 | 4819 | 36188 | 3748 | 36955 | 2912 | 34145 | 1562 | 36674 | 643 | 30783 |
| 14-#18 | 4.46 | 17145 | 7882 | 38234 | 5418 | 42841 | 4185 | 44909 | 3168 | 47042 | 1552 | 49364 | 87 | 48648 |
| 15-#11 | 1.86 | 15745 | 6465 | 30765 | 4674 | 33888 | 3649 | 34298 | 2867 | 30934 | 1637 | 32630 | 851 | 23878 |
| 15-#14 | 2.69 | 16210 | 6915 | 33121 | 4929 | 36742 | 3836 | 37697 | 2979 | 37737 | 1726 | 38212 | 629 | 32511 |
| 15-#18 | 4.77 | 17312 | 8056 | 38895 | 5578 | 43798 | 4311 | 46088 | 3258 | 48925 | 1624 | 51889 | 44 | 51565 |
| 16-#11 | 1.99 | 15826 | 6533 | 31012 | 4734 | 34337 | 3698 | 34845 | 2902 | 33953 | 1772 | 33551 | 816 | 25259 |
| 16-#14 | 2.86 | 16321 | 7013 | 33498 | 5009 | 37392 | 3902 | 38461 | 3025 | 36212 | 1622 | 39497 | 575 | 34343 |
| 16-#18 | 5.09 | 17467 | 8230 | 39618 | 5712 | 44902 | 4417 | 47393 | 3331 | 50733 | 1638 | 54057 | -57 | 53957 |
| 17-#11 | 2.11 | 15889 | 6601 | 31444 | 4762 | 34778 | 3714 | 35368 | 2908 | 32320 | 1639 | 34402 | 785 | 26590 |
| 17-#14 | 3.04 | 16418 | 7111 | 34096 | 5053 | 38010 | 3928 | 39264 | 3048 | 39767 | 1716 | 40723 | 532 | 36066 |
| 17-#18 | 5.41 | 17623 | 8404 | 40622 | 5797 | 45993 | 4470 | 48811 | 3377 | 52434 | 1601 | 56203 | -135 | 55893 |
| 18-#11 | 2.23 | 15955 | 6668 | 31939 | 4780 | 35270 | 3722 | 35904 | 2906 | 35353 | 1734 | 35144 | 726 | 27988 |
| 18-#14 | 3.22 | 16498 | 7208 | 34756 | 5091 | 38709 | 3948 | 40013 | 3041 | 40836 | 1689 | 41818 | 450 | 37792 |
| 18-#18 | 5.73 | 17818 | 8578 | 41655 | 5879 | 47205 | 4521 | 50182 | 3380 | 50726 | 1458 | 58685 | -226 | 57415 |
| 19-#11 | 2.36 | 16056 | 6736 | 32137 | 4849 | 35669 | 3778 | 36464 | 2956 | 36057 | 1750 | 36259 | 731 | 29273 |
| 19-#14 | 3.40 | 16638 | 7306 | 35086 | 5178 | 39283 | 4019 | 40786 | 3105 | 41799 | 1705 | 43360 | 451 | 39605 |
| 20-#11 | 2.48 | 16118 | 6804 | 32423 | 4904 | 36092 | 3821 | 36999 | 2981 | 36796 | 1757 | 37230 | 706 | 30652 |
| 20-#14 | 3.58 | 16744 | 7404 | 35507 | 5254 | 39892 | 4078 | 41535 | 3137 | 39990 | 1599 | 44729 | 413 | 41242 |
| 21-#11 | 2.61 | 16204 | 6872 | 32834 | 4936 | 36551 | 3841 | 37536 | 2997 | 37486 | 1743 | 38005 | 668 | 31857 |
| 21-#14 | 3.76 | 16848 | 7502 | 36088 | 5302 | 40546 | 4109 | 42312 | 3161 | 43831 | 1694 | 45837 | 358 | 43024 |
| 22-#11 | 2.73 | 16311 | 6940 | 33263 | 4961 | 37056 | 3858 | 38062 | 2994 | 38223 | 1727 | 38839 | 628 | 33126 |
| 22-#14 | 3.94 | 16984 | 7600 | 36669 | 5345 | 41253 | 4139 | 43075 | 3163 | 44905 | 1674 | 47052 | 302 | 44689 |
| 23-#11 | 2.86 | 16365 | 7007 | 33526 | 5021 | 37439 | 3904 | 38610 | 3037 | 38969 | 1744 | 39866 | 613 | 34399 |
| 23-#14 | 4.12 | 17077 | 7697 | 37076 | 5425 | 41810 | 4199 | 43840 | 3218 | 45943 | 1694 | 48478 | 276 | 46370 |
| 24-#11 | 2.98 | 16442 | 7075 | 33843 | 5075 | 37871 | 3945 | 39125 | 3057 | 39646 | 1741 | 40698 | 580 | 35645 |
| 24-#14 | 4.30 | 17174 | 7795 | 37544 | 5500 | 42425 | 4255 | 44582 | 3247 | 43777 | 1576 | 49651 | 228 | 48093 |
| 25-#11 | 3.10 | 16519 | 7143 | 34225 | 5107 | 38330 | 3967 | 39683 | 3076 | 37701 | 1621 | 41622 | 547 | 36898 |
| 25-#14 | 4.48 | 17291 | 7893 | 38073 | 5548 | 43079 | 4289 | 45370 | 3274 | 47971 | 1683 | 50969 | 180 | 49640 |
| 26-#11 | 3.23 | 16583 | 7211 | 34705 | 5122 | 38809 | 3987 | 40220 | 3078 | 38347 | 1602 | 42360 | 504 | 38095 |
| 27-#11 | 3.35 | 16681 | 7279 | 34957 | 5185 | 39219 | 4030 | 40751 | 3116 | 41819 | 1730 | 43378 | 481 | 39341 |
| 28-#11 | 3.48 | 16753 | 7347 | 35293 | 5228 | 39661 | 4069 | 41265 | 3135 | 42501 | 1726 | 44414 | 469 | 40540 |
| 29-#11 | 3.60 | 16828 | 7414 | 35651 | 5271 | 40105 | 4092 | 41822 | 3155 | 43246 | 1723 | 45225 | 427 | 41765 |
| 30-#11 | 3.72 | 16923 | 7482 | 36092 | 5298 | 40577 | 4115 | 42373 | 3160 | 41018 | 1591 | 46095 | 393 | 42980 |

## ROUND SPIRAL COLUMNS 42" DIA.

Short columns – no sidesway $f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.73 | 18070 | 7049 | 36928 | 4695 | 38951 | 3643 | 38587 | 2826 | 34155 | 1545 | 33988 | 759 | 26448 |
| 7-#14 | 1.14 | 17690 | 6691 | 33440 | 4833 | 36251 | 3778 | 36006 | 2996 | 33364 | 1918 | 31437 | 1109 | 17927 |
| 7-#18 | 2.02 | 18270 | 7223 | 36401 | 5114 | 39784 | 3981 | 40196 | 3112 | 38868 | 1850 | 38144 | 829 | 29479 |
| 8-#14 | 1.30 | 17877 | 6788 | 33657 | 4956 | 36860 | 3887 | 36866 | 3080 | 34602 | 1961 | 32881 | 1098 | 20131 |
| 8-#18 | 2.31 | 18555 | 7397 | 36988 | 5283 | 40842 | 4132 | 41587 | 3226 | 40855 | 1901 | 40436 | 787 | 33744 |
| 9-#11 | 1.01 | 17596 | 6616 | 32867 | 4837 | 35766 | 3784 | 35502 | 3009 | 32792 | 1959 | 30716 | 1158 | 16303 |
| 9-#14 | 1.46 | 17903 | 6886 | 34408 | 4983 | 37593 | 3890 | 37662 | 3071 | 33296 | 1804 | 34237 | 1019 | 22362 |
| 9-#18 | 2.60 | 18603 | 7571 | 38168 | 5359 | 42111 | 4162 | 43027 | 3229 | 42808 | 1864 | 43176 | 681 | 36460 |
| 10-#11 | 1.13 | 17668 | 6684 | 33655 | 4781 | 36324 | 3738 | 36028 | 2963 | 33328 | 1892 | 31329 | 1110 | 17730 |
| 10-#14 | 1.62 | 18000 | 6984 | 35372 | 4939 | 38402 | 3855 | 38501 | 3031 | 36574 | 1855 | 35268 | 963 | 24531 |
| 10-#18 | 2.89 | 18754 | 7745 | 39593 | 5349 | 43562 | 4157 | 44576 | 3200 | 44604 | 1756 | 44949 | 577 | 39866 |
| 11-#11 | 1.24 | 17793 | 6752 | 33540 | 4934 | 36712 | 3858 | 36664 | 3059 | 32052 | 1829 | 32711 | 1114 | 19476 |
| 11-#14 | 1.79 | 18178 | 7082 | 35391 | 5117 | 38946 | 3992 | 39306 | 3137 | 37863 | 1930 | 37053 | 950 | 26647 |
| 11-#18 | 3.18 | 19061 | 7919 | 39938 | 5588 | 44457 | 4332 | 45857 | 3337 | 43464 | 1727 | 47726 | 522 | 42952 |
| 12-#11 | 1.35 | 17840 | 6820 | 33813 | 5003 | 37166 | 3902 | 37258 | 3104 | 32766 | 1839 | 33818 | 1103 | 20884 |
| 12-#14 | 1.95 | 18239 | 7180 | 35839 | 5205 | 39590 | 4068 | 40129 | 3194 | 38930 | 1939 | 38576 | 930 | 28806 |
| 12-#18 | 3.46 | 19153 | 8093 | 40797 | 5723 | 45575 | 4450 | 47244 | 3422 | 48362 | 1854 | 50268 | 477 | 46060 |
| 13-#11 | 1.46 | 17948 | 6888 | 34288 | 5019 | 37639 | 3927 | 37819 | 3104 | 35872 | 1957 | 34603 | 1054 | 22569 |
| 13-#14 | 2.11 | 18387 | 7278 | 36472 | 5236 | 40273 | 4087 | 40944 | 3200 | 37370 | 1796 | 39728 | 861 | 30788 |
| 13-#18 | 3.75 | 19416 | 8267 | 41750 | 5813 | 46798 | 4497 | 48688 | 3441 | 46969 | 1710 | 52316 | 357 | 49471 |
| 14-#11 | 1.58 | 18059 | 6955 | 34877 | 5015 | 38167 | 3916 | 38359 | 3087 | 34105 | 1787 | 35376 | 1002 | 23965 |
| 14-#14 | 2.27 | 18544 | 7375 | 37223 | 5250 | 41025 | 4088 | 41770 | 3189 | 41056 | 1873 | 40907 | 793 | 32977 |
| 14-#18 | 4.04 | 19670 | 8441 | 42992 | 5850 | 48102 | 4527 | 50242 | 3448 | 52209 | 1757 | 54486 | 248 | 52299 |
| 15-#11 | 1.69 | 18137 | 7023 | 35008 | 5110 | 38578 | 3993 | 38959 | 3147 | 37398 | 1953 | 36603 | 1001 | 25524 |
| 15-#14 | 2.44 | 18651 | 7473 | 37515 | 5364 | 41611 | 4181 | 42578 | 3260 | 42211 | 1916 | 42561 | 782 | 34863 |
| 15-#18 | 4.33 | 19828 | 8615 | 43673 | 6015 | 49119 | 4658 | 51519 | 3543 | 54226 | 1833 | 57193 | 209 | 55552 |
| 16-#11 | 1.80 | 18230 | 7091 | 35264 | 5171 | 39047 | 4027 | 39550 | 3184 | 35707 | 1840 | 37590 | 966 | 26943 |
| 16-#14 | 2.60 | 18773 | 7571 | 37908 | 5446 | 42291 | 4247 | 43395 | 3308 | 43421 | 1940 | 43937 | 729 | 36928 |
| 16-#18 | 4.62 | 20030 | 8788 | 44420 | 6150 | 50316 | 4768 | 52910 | 3618 | 56155 | 1848 | 59517 | 109 | 58556 |
| 17-#11 | 1.91 | 18295 | 7159 | 35729 | 5198 | 39524 | 4059 | 40096 | 3189 | 38974 | 1956 | 38491 | 936 | 28424 |
| 17-#14 | 2.76 | 18864 | 7669 | 38548 | 5489 | 42959 | 4273 | 44196 | 3318 | 44455 | 1919 | 45238 | 687 | 38688 |
| 17-#18 | 4.91 | 20192 | 8962 | 45494 | 6234 | 51456 | 4818 | 54418 | 3664 | 54100 | 1691 | 61802 | 33 | 61537 |
| 18-#11 | 2.03 | 18367 | 7227 | 36262 | 5213 | 40047 | 4065 | 40660 | 3185 | 39746 | 1933 | 39272 | 876 | 29865 |
| 18-#14 | 2.92 | 18962 | 7767 | 39261 | 5524 | 43704 | 4292 | 45025 | 3322 | 42544 | 1765 | 46398 | 604 | 40601 |
| 18-#18 | 5.20 | 20408 | 9136 | 46624 | 6315 | 52748 | 4868 | 55846 | 3665 | 59995 | 1772 | 64443 | -58 | 63598 |
| 19-#11 | 2.14 | 18478 | 7295 | 36464 | 5285 | 40463 | 4123 | 41260 | 3238 | 40491 | 1950 | 40466 | 883 | 31293 |
| 19-#14 | 3.09 | 19115 | 7865 | 39600 | 5615 | 44307 | 4365 | 45852 | 3387 | 46615 | 1909 | 48046 | 608 | 42461 |
| 19-#18 | 5.49 | 20626 | 9310 | 47325 | 6453 | 53804 | 4978 | 57233 | 3764 | 57591 | 1671 | 66655 | -114 | 66344 |
| 20-#11 | 2.25 | 18542 | 7362 | 36763 | 5342 | 40912 | 4151 | 41821 | 3262 | 38526 | 1827 | 41502 | 859 | 32741 |
| 20-#14 | 3.25 | 19205 | 7962 | 40043 | 5692 | 44948 | 4424 | 46657 | 3421 | 47725 | 1918 | 49505 | 571 | 44275 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 42" DIA.

Short columns – no sideway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 21-#11 | 2.36 | 18636 | 7430 | 37198 | 5372 | 41400 | 4187 | 42399 | 3278 | 42009 | 1944 | 42327 | 821 | 34104 |
| 21-#14 | 3.41 | 19341 | 8060 | 40657 | 5739 | 45643 | 4456 | 47474 | 3445 | 48776 | 1899 | 50687 | 517 | 46245 |
| 22-#11 | 2.48 | 18750 | 7498 | 37662 | 5396 | 41937 | 4202 | 42955 | 3275 | 39944 | 1800 | 43207 | 781 | 35571 |
| 22-#14 | 3.57 | 19486 | 8158 | 41282 | 5781 | 46407 | 4485 | 48283 | 3446 | 49912 | 1879 | 51974 | 462 | 47945 |
| 23-#11 | 2.59 | 18814 | 7566 | 37932 | 5459 | 42343 | 4250 | 43539 | 3319 | 43585 | 1946 | 44198 | 757 | 36873 |
| 23-#14 | 3.74 | 19592 | 8256 | 41706 | 5862 | 46987 | 4546 | 49099 | 3502 | 51020 | 1901 | 53501 | 437 | 49815 |
| 24-#11 | 2.70 | 18898 | 7634 | 38261 | 5513 | 42802 | 4276 | 44079 | 3340 | 41352 | 1814 | 45196 | 736 | 38253 |
| 24-#14 | 3.90 | 19697 | 8354 | 42194 | 5938 | 47640 | 4603 | 49876 | 3531 | 52039 | 1896 | 54753 | 390 | 51610 |
| 25-#11 | 2.81 | 18979 | 7702 | 38675 | 5545 | 43290 | 4314 | 44671 | 3359 | 42092 | 1811 | 46179 | 702 | 39537 |
| 25-#14 | 4.06 | 19806 | 8452 | 42765 | 5986 | 48336 | 4637 | 50723 | 3560 | 53175 | 1890 | 56158 | 342 | 53385 |
| 26-#11 | 2.93 | 19048 | 7769 | 39190 | 5559 | 43792 | 4333 | 45248 | 3361 | 45832 | 1919 | 46960 | 659 | 40863 |
| 26-#14 | 4.22 | 19929 | 8549 | 43474 | 6012 | 49061 | 4670 | 51544 | 3565 | 50622 | 1739 | 57292 | 281 | 55319 |
| 27-#11 | 3.04 | 19148 | 7837 | 39446 | 5623 | 44226 | 4376 | 45806 | 3399 | 43505 | 1804 | 48047 | 638 | 42190 |
| 28-#11 | 3.15 | 19233 | 7905 | 39801 | 5666 | 44703 | 4401 | 46352 | 3419 | 44182 | 1801 | 49152 | 626 | 43468 |
| 29-#11 | 3.27 | 19313 | 7973 | 40183 | 5709 | 45167 | 4439 | 46944 | 3439 | 44920 | 1798 | 50013 | 585 | 44829 |
| 30-#11 | 3.38 | 19414 | 8041 | 40650 | 5735 | 45669 | 4462 | 47519 | 3443 | 48867 | 1908 | 50938 | 551 | 46066 |
| 31-#11 | 3.49 | 19488 | 8108 | 40927 | 5795 | 46112 | 4494 | 48083 | 3479 | 46389 | 1800 | 51876 | 521 | 47374 |
| 32-#11 | 3.60 | 19564 | 8176 | 41291 | 5837 | 46574 | 4525 | 48633 | 3498 | 47119 | 1803 | 52890 | 495 | 48659 |

## ROUND SPIRAL COLUMNS 44" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.58 | 20686 | 7635 | 41855 | 5117 | 44126 | 3975 | 43612 | 3096 | 41078 | 1847 | 38016 | 903 | 28010 |
| 7-#14 | 1.04 | 20274 | 7276 | 38016 | 5284 | 41243 | 4133 | 40911 | 3284 | 37741 | 2122 | 35400 | 1260 | 19064 |
| 7-#18 | 1.84 | 20907 | 7809 | 41163 | 5565 | 44989 | 4337 | 45350 | 3401 | 40681 | 1920 | 42543 | 985 | 31353 |
| 8-#14 | 1.18 | 20485 | 7374 | 38213 | 5414 | 41884 | 4225 | 41834 | 3374 | 39056 | 2169 | 36958 | 1253 | 21329 |
| 8-#18 | 2.10 | 21232 | 7983 | 41754 | 5741 | 46108 | 4494 | 46836 | 3521 | 45715 | 2113 | 45005 | 947 | 35797 |
| 9-#14 | 1.33 | 20510 | 7472 | 39020 | 5436 | 42664 | 4248 | 42671 | 3362 | 37517 | 1997 | 38383 | 1173 | 23801 |
| 9-#18 | 2.37 | 21277 | 8157 | 43026 | 5813 | 47456 | 4521 | 48358 | 3521 | 47773 | 2074 | 47606 | 816 | 39011 |
| 10-#11 | 1.03 | 20254 | 7270 | 38262 | 5226 | 41314 | 4088 | 40917 | 3247 | 37679 | 2093 | 35255 | 1259 | 18811 |
| 10-#14 | 1.48 | 20617 | 7570 | 40082 | 5384 | 43513 | 4206 | 43539 | 3316 | 38380 | 1920 | 39442 | 1114 | 26032 |
| 10-#18 | 2.63 | 21445 | 8331 | 44560 | 5794 | 48977 | 4508 | 50012 | 3488 | 49651 | 1963 | 49756 | 736 | 42844 |
| 11-#11 | 1.13 | 20385 | 7338 | 38092 | 5390 | 41721 | 4218 | 41616 | 3351 | 38774 | 2166 | 36760 | 1267 | 20645 |
| 11-#14 | 1.63 | 20803 | 7668 | 40056 | 5573 | 44091 | 4351 | 44414 | 3430 | 42520 | 2139 | 41374 | 1106 | 28374 |
| 11-#18 | 2.89 | 21768 | 8505 | 44881 | 6043 | 49945 | 4694 | 51362 | 3632 | 51767 | 2063 | 52743 | 686 | 45983 |
| 12-#11 | 1.23 | 20438 | 7405 | 38363 | 5461 | 42208 | 4265 | 42249 | 3398 | 36953 | 2033 | 37945 | 1258 | 22181 |
| 12-#14 | 1.78 | 20872 | 7765 | 40509 | 5663 | 44776 | 4408 | 45290 | 3489 | 43641 | 2149 | 43003 | 1087 | 30599 |
| 12-#18 | 3.16 | 21870 | 8678 | 45795 | 6182 | 51129 | 4814 | 52837 | 3720 | 53678 | 2069 | 55459 | 642 | 49412 |
| 13-#11 | 1.33 | 20556 | 7473 | 38880 | 5476 | 42703 | 4279 | 42840 | 3397 | 40397 | 2165 | 38771 | 1209 | 23957 |
| 13-#14 | 1.92 | 21034 | 7863 | 41196 | 5693 | 45491 | 4448 | 46152 | 3494 | 44821 | 2134 | 44218 | 1019 | 32791 |
| 13-#18 | 3.42 | 22135 | 8852 | 46800 | 6270 | 52407 | 4859 | 54366 | 3738 | 55753 | 2047 | 57629 | 523 | 52909 |
| 14-#11 | 1.44 | 20671 | 7541 | 39526 | 5467 | 43263 | 4273 | 43395 | 3376 | 41102 | 2121 | 39574 | 1155 | 25468 |
| 14-#14 | 2.07 | 21197 | 7961 | 42015 | 5702 | 46289 | 4445 | 47005 | 3479 | 45890 | 2080 | 45454 | 950 | 35052 |
| 14-#18 | 3.68 | 22428 | 9026 | 48138 | 6303 | 53792 | 4886 | 55981 | 3741 | 53890 | 1839 | 59923 | 414 | 56031 |

## ROUND SPIRAL COLUMNS 44" DIA.

Short columns – no sideway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 15-#11 | 1.54 | 20760 | 7609 | 39635 | 5567 | 43696 | 4346 | 44040 | 3440 | 42014 | 2161 | 40893 | 1156 | 27181 |
| 15-#14 | 2.22 | 21322 | 8059 | 42291 | 5821 | 46908 | 4542 | 47870 | 3554 | 43977 | 1985 | 47228 | 941 | 37134 |
| 15-#18 | 3.95 | 22605 | 9200 | 48836 | 6473 | 54869 | 5022 | 57370 | 3842 | 55901 | 1913 | 62816 | 379 | 59638 |
| 16-#11 | 1.64 | 20863 | 7677 | 39899 | 5630 | 44185 | 4389 | 44677 | 3479 | 40067 | 2036 | 41948 | 1122 | 28647 |
| 16-#14 | 2.37 | 21455 | 8157 | 42700 | 5905 | 47617 | 4587 | 48751 | 3604 | 48398 | 2151 | 48696 | 889 | 39418 |
| 16-#18 | 4.21 | 22826 | 9374 | 49606 | 6610 | 56139 | 5133 | 58848 | 3919 | 61943 | 2067 | 65296 | 280 | 62670 |
| 17-#11 | 1.74 | 20930 | 7745 | 40396 | 5655 | 44697 | 4413 | 45244 | 3483 | 43684 | 2165 | 42898 | 1093 | 30309 |
| 17-#14 | 2.52 | 21548 | 8255 | 43384 | 5947 | 48336 | 4636 | 49584 | 3613 | 49494 | 2130 | 50072 | 847 | 41362 |
| 17-#18 | 4.47 | 22996 | 9548 | 50750 | 6693 | 57348 | 5183 | 60432 | 3964 | 63859 | 2031 | 67720 | 206 | 65973 |
| 18-#11 | 1.85 | 21010 | 7812 | 40970 | 5668 | 45253 | 4424 | 45836 | 3478 | 41530 | 1999 | 43714 | 1032 | 31765 |
| 18-#14 | 2.66 | 21657 | 8352 | 44145 | 5979 | 49126 | 4652 | 50458 | 3615 | 47314 | 1962 | 51295 | 764 | 43471 |
| 18-#18 | 4.74 | 23165 | 9722 | 51980 | 6773 | 58719 | 5231 | 61930 | 3962 | 66004 | 1991 | 69926 | 66 | 69448 |
| 19-#11 | 1.95 | 21130 | 7880 | 41173 | 5744 | 45684 | 4477 | 46476 | 3532 | 45291 | 2160 | 44992 | 1041 | 33343 |
| 19-#14 | 2.81 | 21823 | 8450 | 44497 | 6073 | 49754 | 4728 | 51339 | 3684 | 48329 | 1980 | 53050 | 771 | 45372 |
| 19-#18 | 5.00 | 23463 | 9896 | 52692 | 6913 | 59838 | 5345 | 63406 | 4064 | 63306 | 1878 | 72874 | 62 | 72440 |
| 20-#11 | 2.05 | 21196 | 7948 | 41485 | 5801 | 46159 | 4514 | 47063 | 3558 | 43051 | 2024 | 46093 | 1019 | 34831 |
| 20-#14 | 2.96 | 21916 | 8548 | 44962 | 6152 | 50432 | 4765 | 52180 | 3717 | 52957 | 2131 | 54600 | 736 | 47371 |
| 20-#18 | 5.26 | 23621 | 10070 | 53535 | 7044 | 61029 | 5445 | 64861 | 4118 | 69861 | 2024 | 75530 | -7 | 75507 |
| 21-#11 | 2.15 | 21299 | 8016 | 41944 | 5831 | 46677 | 4541 | 47683 | 3574 | 46897 | 2155 | 46967 | 980 | 36338 |
| 21-#14 | 3.11 | 22065 | 8646 | 45608 | 6198 | 51169 | 4819 | 53058 | 3742 | 54069 | 2113 | 55856 | 681 | 49392 |
| 22-#11 | 2.26 | 21411 | 8084 | 42446 | 5852 | 47239 | 4563 | 48268 | 3569 | 47714 | 2137 | 47893 | 941 | 37884 |
| 22-#14 | 3.26 | 22218 | 8744 | 46279 | 6238 | 51979 | 4847 | 53911 | 3742 | 55284 | 2093 | 57214 | 626 | 51268 |
| 23-#11 | 2.36 | 21492 | 8151 | 42721 | 5917 | 47675 | 4605 | 48881 | 3615 | 48505 | 2149 | 48953 | 917 | 39315 |
| 23-#14 | 3.40 | 22324 | 8841 | 46718 | 6322 | 52592 | 4911 | 54778 | 3800 | 56446 | 2115 | 58678 | 589 | 53338 |
| 24-#11 | 2.46 | 21584 | 8219 | 43061 | 5972 | 48160 | 4640 | 49454 | 3636 | 46043 | 2012 | 50013 | 897 | 40858 |
| 24-#14 | 3.55 | 22451 | 8939 | 47225 | 6398 | 53284 | 4946 | 55590 | 3829 | 57527 | 2111 | 60175 | 557 | 55159 |
| 25-#11 | 2.56 | 21664 | 8287 | 43545 | 5996 | 48670 | 4669 | 50080 | 3655 | 50168 | 2152 | 51055 | 863 | 42226 |
| 25-#14 | 3.70 | 22566 | 9037 | 47840 | 6446 | 54021 | 5002 | 56486 | 3857 | 58729 | 2106 | 61665 | 509 | 57169 |
| 26-#11 | 2.67 | 21744 | 8355 | 44060 | 6017 | 49202 | 4679 | 50696 | 3657 | 50929 | 2130 | 51878 | 820 | 43688 |
| 26-#14 | 3.85 | 22673 | 9135 | 48598 | 6471 | 54780 | 5033 | 57367 | 3863 | 59857 | 2078 | 62865 | 449 | 59112 |
| 27-#11 | 2.77 | 21852 | 8423 | 44318 | 6082 | 49662 | 4732 | 51282 | 3695 | 51767 | 2146 | 53035 | 800 | 45073 |
| 27-#14 | 4.00 | 22834 | 9233 | 49007 | 6558 | 55435 | 5092 | 58199 | 3915 | 56947 | 1956 | 64484 | 416 | 60951 |
| 28-#11 | 2.87 | 21929 | 8491 | 44691 | 6126 | 50166 | 4766 | 51861 | 3716 | 49039 | 2000 | 53980 | 770 | 46453 |
| 28-#14 | 4.14 | 22940 | 9331 | 49550 | 6619 | 56155 | 5127 | 59021 | 3943 | 62104 | 2090 | 66145 | 399 | 62923 |
| 29-#11 | 2.98 | 22030 | 8558 | 45098 | 6168 | 50658 | 4796 | 52486 | 3736 | 53369 | 2140 | 55121 | 748 | 47874 |
| 30-#11 | 3.08 | 22136 | 8626 | 45593 | 6193 | 51190 | 4810 | 53084 | 3739 | 54144 | 2121 | 56100 | 714 | 49213 |
| 31-#11 | 3.18 | 22212 | 8694 | 45882 | 6255 | 51657 | 4859 | 53688 | 3776 | 54971 | 2134 | 57099 | 685 | 50658 |
| 32-#11 | 3.28 | 22301 | 8762 | 46269 | 6298 | 52140 | 4890 | 54275 | 3796 | 52147 | 2003 | 58176 | 659 | 51966 |
| 33-#11 | 3.39 | 22388 | 8830 | 46660 | 6340 | 52648 | 4922 | 54886 | 3816 | 56632 | 2135 | 59197 | 631 | 53388 |
| 34-#11 | 3.49 | 22467 | 8898 | 47131 | 6367 | 53192 | 4939 | 55485 | 3822 | 57469 | 2126 | 60093 | 585 | 54760 |

## ROUND SPIRAL COLUMNS 46" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.44 | 23541 | 8248 | 47207 | 5560 | 49749 | 4323 | 49066 | 3378 | 45926 | 2047 | 42356 | 1053 | 29574 |
| 7-#18 | 1.68 | 23784 | 8422 | 46331 | 6037 | 50642 | 4709 | 50942 | 3704 | 48685 | 2273 | 47272 | 1146 | 33246 |
| 8-#14 | 1.08 | 23334 | 7987 | 43169 | 5894 | 47356 | 4604 | 47243 | 3681 | 43893 | 2386 | 41369 | 1414 | 22534 |
| 8-#18 | 1.93 | 24150 | 8596 | 46922 | 6220 | 51822 | 4873 | 52526 | 3829 | 50948 | 2332 | 49908 | 1113 | 37858 |
| 9-#14 | 1.22 | 23357 | 8085 | 44036 | 5911 | 48182 | 4624 | 48119 | 3667 | 45098 | 2356 | 42858 | 1333 | 25259 |
| 9-#18 | 2.17 | 24192 | 8770 | 48280 | 6288 | 53250 | 4897 | 54129 | 3827 | 53120 | 2293 | 52649 | 981 | 41399 |
| 10-#14 | 1.35 | 23474 | 8183 | 45203 | 5850 | 49072 | 4573 | 49006 | 3614 | 42976 | 2118 | 43942 | 1272 | 27545 |
| 10-#18 | 2.41 | 24377 | 8943 | 49939 | 6260 | 54841 | 4875 | 55887 | 3790 | 51403 | 2033 | 54889 | 899 | 45896 |
| 11-#11 | 1.03 | 23217 | 7950 | 43047 | 5867 | 47178 | 4586 | 47009 | 3657 | 40683 | 2224 | 41141 | 1427 | 21821 |
| 11-#14 | 1.49 | 23667 | 8280 | 45123 | 6050 | 49679 | 4728 | 49963 | 3736 | 47542 | 2356 | 46028 | 1269 | 30125 |
| 11-#18 | 2.65 | 24717 | 9117 | 50227 | 6520 | 55881 | 5072 | 57308 | 3940 | 53524 | 2132 | 58092 | 855 | 49075 |
| 12-#11 | 1.13 | 23275 | 8018 | 43312 | 5941 | 47697 | 4644 | 47682 | 3706 | 44462 | 2396 | 42407 | 1419 | 23490 |
| 12-#14 | 1.62 | 23745 | 8378 | 45580 | 6142 | 50411 | 4787 | 50893 | 3798 | 48735 | 2367 | 47765 | 1251 | 32408 |
| 12-#18 | 2.89 | 24829 | 9291 | 51170 | 6661 | 57131 | 5195 | 58872 | 4030 | 59366 | 2293 | 60984 | 814 | 52842 |
| 13-#11 | 1.22 | 23403 | 8086 | 43874 | 5954 | 48214 | 4657 | 48294 | 3704 | 45305 | 2382 | 43271 | 1370 | 25344 |
| 13-#14 | 1.76 | 23920 | 8476 | 46323 | 6171 | 51157 | 4826 | 51799 | 3801 | 49975 | 2352 | 49041 | 1183 | 34822 |
| 13-#18 | 3.13 | 25116 | 9465 | 52349 | 6728 | 58464 | 5238 | 60485 | 4048 | 61565 | 2271 | 63274 | 696 | 56412 |
| 14-#11 | 1.31 | 23523 | 8154 | 44582 | 5941 | 48808 | 4646 | 48871 | 3680 | 46044 | 2336 | 44101 | 1315 | 26989 |
| 14-#14 | 1.90 | 24091 | 8574 | 47213 | 6175 | 52002 | 4819 | 52679 | 3783 | 51104 | 2297 | 50332 | 1112 | 37179 |
| 14-#18 | 3.37 | 25428 | 9639 | 53691 | 6777 | 59930 | 5261 | 62159 | 4047 | 63648 | 2192 | 65691 | 585 | 59844 |
| 15-#11 | 1.41 | 23621 | 8222 | 44663 | 6046 | 49263 | 4725 | 49561 | 3748 | 47013 | 2379 | 45517 | 1319 | 28774 |
| 15-#14 | 2.03 | 24229 | 8672 | 47469 | 6300 | 52653 | 4910 | 53603 | 3862 | 52402 | 2346 | 52228 | 1107 | 39437 |
| 15-#18 | 3.61 | 25618 | 9813 | 54392 | 6953 | 61067 | 5402 | 63659 | 4153 | 65778 | 2255 | 68773 | 554 | 63625 |
| 16-#11 | 1.50 | 23736 | 8290 | 44933 | 6110 | 49771 | 4769 | 50245 | 3788 | 47983 | 2400 | 46640 | 1286 | 30372 |
| 16-#14 | 2.17 | 24378 | 8770 | 47893 | 6385 | 53391 | 4967 | 54548 | 3914 | 53758 | 2372 | 53790 | 1056 | 41788 |
| 16-#18 | 3.85 | 25866 | 9987 | 55194 | 7091 | 62390 | 5514 | 65227 | 4232 | 68104 | 2294 | 71411 | 456 | 66868 |
| 17-#11 | 1.60 | 23804 | 8357 | 45465 | 6135 | 50315 | 4792 | 50833 | 3791 | 45524 | 2225 | 47639 | 1256 | 32148 |
| 17-#14 | 2.30 | 24474 | 8867 | 48621 | 6427 | 54160 | 5004 | 55413 | 3922 | 51251 | 2194 | 55240 | 1014 | 43938 |
| 17-#18 | 4.09 | 26044 | 10161 | 56410 | 7173 | 63688 | 5565 | 66801 | 4255 | 70137 | 2259 | 73972 | 383 | 70616 |
| 18-#11 | 1.69 | 23892 | 8425 | 46081 | 6144 | 50907 | 4801 | 51452 | 3784 | 46304 | 2201 | 48487 | 1195 | 33688 |
| 18-#14 | 2.44 | 24593 | 8965 | 49434 | 6455 | 54997 | 5030 | 56330 | 3922 | 56180 | 2322 | 56520 | 931 | 46317 |
| 18-#18 | 4.33 | 26224 | 10335 | 57723 | 7251 | 65139 | 5611 | 68454 | 4273 | 72396 | 2218 | 76303 | 243 | 74034 |
| 19-#11 | 1.78 | 24017 | 8493 | 46283 | 6224 | 51354 | 4856 | 52134 | 3841 | 50473 | 2379 | 49733 | 1196 | 35424 |
| 19-#14 | 2.57 | 24772 | 9063 | 49795 | 6553 | 55648 | 5096 | 57267 | 3993 | 53506 | 2187 | 58388 | 940 | 48381 |
| 19-#18 | 4.57 | 26542 | 10509 | 58461 | 7394 | 66313 | 5727 | 70020 | 4378 | 74335 | 2241 | 79428 | 243 | 77351 |
| 20-#11 | 1.88 | 24090 | 8561 | 46608 | 6282 | 51854 | 4894 | 52747 | 3867 | 51358 | 2389 | 51018 | 1184 | 36948 |
| 20-#14 | 2.71 | 24868 | 9161 | 50282 | 6633 | 56364 | 5146 | 58144 | 4027 | 58573 | 2353 | 60030 | 906 | 50532 |
| 20-#18 | 4.81 | 26713 | 10683 | 59348 | 7527 | 67560 | 5829 | 71576 | 4433 | 76476 | 2254 | 82242 | 176 | 81005 |
| 21-#11 | 1.97 | 24201 | 8629 | 47091 | 6311 | 52401 | 4921 | 53404 | 3883 | 52169 | 2375 | 51942 | 1146 | 38605 |
| 21-#14 | 2.84 | 25021 | 9259 | 50960 | 6678 | 57142 | 5188 | 59082 | 4053 | 59745 | 2335 | 61359 | 851 | 52596 |
| 21-#18 | 5.05 | 26945 | 10856 | 60524 | 7615 | 68912 | 5887 | 73174 | 4479 | 78535 | 2223 | 84561 | 80 | 83949 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 46" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.07 | 24318 | 8696 | 47632 | 6331 | 52989 | 4925 | 54022 | 3877 | 49479 | 2199 | 52911 | 1106 | 40190 |
| 22-#14 | 2.98 | 25193 | 9356 | 51680 | 6717 | 57990 | 5226 | 59980 | 4051 | 61006 | 2314 | 62786 | 797 | 54657 |
| 22-#18 | 5.30 | 27203 | 11030 | 61689 | 7700 | 70398 | 5948 | 74774 | 4487 | 75403 | 2046 | 87115 | -14 | 87071 |
| 23-#11 | 2.16 | 24411 | 8764 | 47911 | 6398 | 53455 | 4986 | 54664 | 3924 | 53860 | 2370 | 54043 | 1084 | 41765 |
| 23-#14 | 3.11 | 25310 | 9454 | 52132 | 6803 | 58645 | 5280 | 60887 | 4111 | 62163 | 2327 | 64346 | 760 | 56791 |
| 24-#11 | 2.25 | 24511 | 8832 | 48261 | 6453 | 53966 | 5021 | 55271 | 3946 | 54741 | 2377 | 55165 | 1064 | 43350 |
| 24-#14 | 3.25 | 25448 | 9552 | 52657 | 6880 | 59375 | 5328 | 61745 | 4141 | 63399 | 2335 | 65931 | 729 | 58775 |
| 25-#11 | 2.35 | 24593 | 8900 | 48775 | 6477 | 54498 | 5049 | 55930 | 3965 | 55610 | 2372 | 56265 | 1030 | 44871 |
| 25-#14 | 3.38 | 25569 | 9650 | 53374 | 6916 | 60145 | 5372 | 62691 | 4169 | 64667 | 2330 | 67508 | 682 | 60985 |
| 26-#11 | 2.44 | 24681 | 8968 | 49330 | 6497 | 55061 | 5059 | 56570 | 3965 | 56409 | 2350 | 57129 | 988 | 46477 |
| 26-#14 | 3.52 | 25683 | 9748 | 54123 | 6951 | 60946 | 5414 | 63631 | 4175 | 65835 | 2301 | 68771 | 622 | 62956 |
| 27-#11 | 2.53 | 24798 | 9036 | 49590 | 6563 | 55545 | 5113 | 57198 | 4006 | 57299 | 2367 | 58358 | 969 | 47968 |
| 27-#14 | 3.66 | 25858 | 9846 | 54540 | 7040 | 61638 | 5463 | 64500 | 4227 | 67076 | 2321 | 70488 | 591 | 64982 |
| 28-#11 | 2.63 | 24878 | 9103 | 49981 | 6608 | 56070 | 5147 | 57810 | 4027 | 58129 | 2366 | 59361 | 939 | 49497 |
| 28-#14 | 3.79 | 25970 | 9943 | 55111 | 7102 | 62399 | 5510 | 65368 | 4255 | 68232 | 2316 | 71902 | 546 | 67037 |
| 29-#11 | 2.72 | 24987 | 9171 | 50413 | 6650 | 56596 | 5177 | 58468 | 4047 | 58989 | 2362 | 60564 | 917 | 50948 |
| 29-#14 | 3.93 | 26104 | 10041 | 55716 | 7164 | 63138 | 5554 | 66313 | 4285 | 69486 | 2312 | 73627 | 515 | 68986 |
| 30-#11 | 2.82 | 25100 | 9239 | 50936 | 6674 | 57158 | 5190 | 59091 | 4049 | 59803 | 2342 | 61596 | 883 | 52419 |
| 31-#11 | 2.91 | 25183 | 9307 | 51235 | 6736 | 57644 | 5240 | 59730 | 4087 | 60681 | 2356 | 62656 | 855 | 53905 |
| 32-#11 | 3.00 | 25280 | 9375 | 51646 | 6780 | 58153 | 5272 | 60359 | 4108 | 61624 | 2369 | 63798 | 830 | 55393 |
| 33-#11 | 3.10 | 25371 | 9443 | 52056 | 6822 | 58690 | 5303 | 60995 | 4127 | 62433 | 2358 | 64754 | 793 | 56872 |
| 34-#11 | 3.19 | 25456 | 9510 | 52558 | 6849 | 59264 | 5320 | 61625 | 4133 | 59093 | 2193 | 65821 | 756 | 58289 |
| 35-#11 | 3.29 | 25574 | 9578 | 52883 | 6908 | 59740 | 5367 | 62263 | 4168 | 64123 | 2353 | 66968 | 739 | 59745 |
| 36-#11 | 3.38 | 25659 | 9646 | 53285 | 6951 | 60255 | 5398 | 62881 | 4187 | 64990 | 2357 | 67981 | 704 | 61179 |

## ROUND SPIRAL COLUMNS 48" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.33 | 26648 | 8888 | 53005 | 6023 | 55843 | 4687 | 54970 | 3673 | 47744 | 2105 | 47020 | 1209 | 31139 |
| 7-#18 | 1.55 | 26912 | 9062 | 51925 | 6530 | 56765 | 5099 | 56994 | 4020 | 54180 | 2498 | 52346 | 1315 | 35159 |
| 8-#18 | 1.77 | 27320 | 9236 | 52508 | 6721 | 58004 | 5269 | 58676 | 4151 | 56558 | 2561 | 55160 | 1286 | 39929 |
| 9-#14 | 1.12 | 26454 | 8725 | 49474 | 6408 | 54169 | 5016 | 54028 | 3985 | 50385 | 2581 | 47679 | 1500 | 26736 |
| 9-#18 | 1.99 | 27358 | 9410 | 53950 | 6785 | 59513 | 5290 | 60359 | 4147 | 58865 | 2522 | 58039 | 1152 | 43813 |
| 10-#14 | 1.24 | 26582 | 8823 | 50753 | 6338 | 55101 | 4957 | 54931 | 3925 | 51364 | 2490 | 48783 | 1436 | 29070 |
| 10-#18 | 2.21 | 27561 | 9584 | 55748 | 6747 | 61175 | 5260 | 62192 | 4103 | 60892 | 2402 | 60363 | 1069 | 48502 |
| 11-#14 | 1.37 | 26783 | 8921 | 50610 | 6548 | 55735 | 5110 | 55972 | 4057 | 52964 | 2582 | 51029 | 1438 | 31899 |
| 11-#18 | 2.43 | 27919 | 9757 | 55995 | 7019 | 62279 | 5466 | 63713 | 4262 | 63327 | 2515 | 63788 | 1031 | 52190 |
| 12-#11 | 1.03 | 26363 | 8658 | 48680 | 6443 | 53654 | 5041 | 53576 | 4029 | 49733 | 2623 | 47218 | 1588 | 24814 |
| 12-#14 | 1.49 | 26869 | 9018 | 51068 | 6644 | 56514 | 5184 | 56956 | 4120 | 54230 | 2596 | 52876 | 1422 | 34234 |
| 12-#18 | 2.65 | 28040 | 9931 | 56959 | 7162 | 63602 | 5593 | 65367 | 4355 | 65433 | 2524 | 66859 | 991 | 56348 |
| 13-#11 | 1.12 | 26500 | 8726 | 49287 | 6455 | 54193 | 5052 | 54209 | 4024 | 50612 | 2608 | 48120 | 1538 | 26742 |
| 13-#14 | 1.62 | 27058 | 9116 | 51869 | 6671 | 57291 | 5209 | 57897 | 4122 | 55528 | 2579 | 54213 | 1354 | 36880 |
| 13-#18 | 2.87 | 28350 | 10105 | 58227 | 7228 | 64990 | 5634 | 67065 | 4371 | 67769 | 2503 | 69269 | 873 | 59980 |
| 14-#11 | 1.21 | 26625 | 8794 | 50060 | 6436 | 54822 | 5037 | 54806 | 3997 | 51369 | 2560 | 48974 | 1481 | 28526 |
| 14-#14 | 1.74 | 27235 | 9214 | 52834 | 6671 | 58184 | 5210 | 58812 | 4100 | 52935 | 2355 | 55555 | 1281 | 39294 |
| 14-#18 | 3.09 | 28682 | 10279 | 59670 | 7272 | 66538 | 5653 | 68796 | 4366 | 69956 | 2423 | 71805 | 761 | 63736 |
| 15-#11 | 1.29 | 26731 | 8862 | 50110 | 6546 | 55297 | 5121 | 55543 | 4069 | 48918 | 2433 | 50490 | 1488 | 30381 |
| 15-#14 | 1.87 | 27380 | 9312 | 53066 | 6801 | 58867 | 5305 | 59796 | 4184 | 58087 | 2575 | 57577 | 1279 | 41771 |
| 15-#18 | 3.32 | 28885 | 10453 | 60364 | 7453 | 67733 | 5799 | 70388 | 4477 | 72204 | 2489 | 75079 | 734 | 67602 |
| 16-#11 | 1.38 | 26860 | 8930 | 50385 | 6612 | 55824 | 5166 | 56268 | 4111 | 53439 | 2629 | 51682 | 1455 | 32116 |
| 16-#14 | 1.99 | 27553 | 9410 | 53504 | 6888 | 59633 | 5364 | 60806 | 4238 | 59519 | 2602 | 59233 | 1229 | 44183 |
| 16-#18 | 3.54 | 29161 | 10627 | 61201 | 7593 | 69109 | 5912 | 72068 | 4559 | 74644 | 2528 | 77876 | 638 | 71148 |
| 17-#11 | 1.47 | 26930 | 8997 | 50952 | 6636 | 56398 | 5187 | 56882 | 4113 | 54269 | 2612 | 52729 | 1426 | 33959 |
| 17-#14 | 2.11 | 27651 | 9507 | 54277 | 6928 | 60450 | 5401 | 61703 | 4245 | 60730 | 2580 | 60756 | 1188 | 46540 |
| 17-#18 | 3.76 | 29346 | 10801 | 62489 | 7675 | 70496 | 5964 | 73701 | 4581 | 71674 | 2328 | 80574 | 566 | 75254 |
| 18-#11 | 1.55 | 27025 | 9065 | 51614 | 6642 | 57030 | 5179 | 57529 | 4104 | 55127 | 2585 | 53607 | 1365 | 35633 |
| 18-#14 | 2.24 | 27781 | 9605 | 55144 | 6953 | 61337 | 5424 | 62663 | 4243 | 62038 | 2550 | 62090 | 1104 | 48985 |
| 18-#18 | 3.98 | 29539 | 10975 | 63877 | 7749 | 72028 | 6007 | 75438 | 4596 | 79186 | 2453 | 83028 | 425 | 78705 |
| 19-#11 | 1.64 | 27157 | 9133 | 51809 | 6725 | 57491 | 5253 | 58224 | 4156 | 52319 | 2434 | 54936 | 1367 | 37457 |
| 19-#14 | 2.36 | 27970 | 9703 | 55512 | 7055 | 62011 | 5493 | 63655 | 4317 | 63275 | 2574 | 64076 | 1115 | 51266 |
| 19-#18 | 4.20 | 29846 | 11149 | 64651 | 7897 | 73245 | 6126 | 77095 | 4704 | 81216 | 2478 | 86332 | 429 | 82349 |
| 20-#11 | 1.72 | 27235 | 9201 | 52148 | 6785 | 58017 | 5291 | 58892 | 4190 | 56991 | 2618 | 56294 | 1356 | 39091 |
| 20-#14 | 2.49 | 28071 | 9801 | 56019 | 7136 | 62763 | 5544 | 64570 | 4351 | 64590 | 2585 | 65810 | 1082 | 53715 |
| 20-#18 | 4.42 | 30062 | 11323 | 65580 | 8031 | 74558 | 6229 | 78714 | 4760 | 83469 | 2492 | 89305 | 363 | 86063 |
| 21-#11 | 1.81 | 27355 | 9269 | 52657 | 6813 | 58593 | 5318 | 59581 | 4206 | 53977 | 2430 | 57266 | 1317 | 40916 |
| 21-#14 | 2.61 | 28237 | 9899 | 56731 | 7180 | 63584 | 5586 | 65564 | 4377 | 61433 | 2395 | 67212 | 1027 | 55856 |
| 21-#18 | 4.64 | 30308 | 11497 | 66810 | 8118 | 75985 | 6287 | 80420 | 4807 | 85642 | 2461 | 91757 | 268 | 89500 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 48" DIA.

Short columns – no sidesway

$f'_c$ = 8,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.90 | 27477 | 9337 | 53237 | 6831 | 59208 | 5320 | 60236 | 4199 | 58712 | 2584 | 58278 | 1277 | 42525 |
| 22-#14 | 2.74 | 28419 | 9997 | 57501 | 7217 | 64469 | 5598 | 66510 | 4374 | 67125 | 2544 | 68707 | 973 | 58110 |
| 22-#18 | 4.86 | 30579 | 11670 | 68049 | 8201 | 77558 | 6347 | 82104 | 4815 | 88040 | 2431 | 94444 | 175 | 93122 |
| 23-#11 | 1.98 | 27581 | 9404 | 53518 | 6901 | 59700 | 5383 | 60909 | 4247 | 59611 | 2599 | 59482 | 1256 | 44251 |
| 23-#14 | 2.86 | 28547 | 10094 | 57965 | 7306 | 65167 | 5678 | 67457 | 4435 | 63804 | 2388 | 70365 | 937 | 60290 |
| 23-#18 | 5.08 | 30826 | 11844 | 68963 | 8338 | 78740 | 6449 | 83752 | 4910 | 84224 | 2300 | 97214 | 104 | 96470 |
| 24-#11 | 2.07 | 27689 | 9472 | 53879 | 6956 | 60240 | 5419 | 61548 | 4270 | 60552 | 2608 | 60667 | 1237 | 45873 |
| 24-#14 | 2.98 | 28698 | 10192 | 58506 | 7383 | 65935 | 5727 | 68361 | 4466 | 69672 | 2568 | 72038 | 907 | 62554 |
| 25-#11 | 2.16 | 27774 | 9540 | 54423 | 6980 | 60794 | 5447 | 62241 | 4288 | 61454 | 2602 | 61826 | 1204 | 47539 |
| 25-#14 | 3.11 | 28824 | 10290 | 59267 | 7419 | 66737 | 5770 | 69357 | 4494 | 70990 | 2562 | 73700 | 860 | 64737 |
| 26-#11 | 2.24 | 27869 | 9608 | 55020 | 6998 | 61388 | 5455 | 62904 | 4288 | 62289 | 2580 | 62730 | 1161 | 49185 |
| 26-#14 | 3.23 | 28947 | 10388 | 60069 | 7453 | 67581 | 5788 | 70335 | 4498 | 72214 | 2533 | 75026 | 801 | 66870 |
| 27-#11 | 2.33 | 27995 | 9676 | 55280 | 7066 | 61896 | 5511 | 63576 | 4330 | 63232 | 2598 | 64030 | 1143 | 50816 |
| 27-#14 | 3.36 | 29120 | 10486 | 60492 | 7543 | 68309 | 5861 | 71262 | 4553 | 73526 | 2554 | 76842 | 771 | 69092 |
| 28-#11 | 2.41 | 28078 | 9744 | 55689 | 7112 | 62443 | 5545 | 64221 | 4351 | 64098 | 2596 | 65092 | 1114 | 52465 |
| 28-#14 | 3.48 | 29254 | 10584 | 61090 | 7606 | 69101 | 5909 | 72177 | 4582 | 74762 | 2551 | 78339 | 727 | 71178 |
| 29-#11 | 2.50 | 28190 | 9811 | 56146 | 7153 | 63002 | 5575 | 64905 | 4371 | 65011 | 2593 | 66357 | 1092 | 54042 |
| 29-#14 | 3.61 | 29396 | 10681 | 61730 | 7668 | 69888 | 5953 | 73171 | 4611 | 76064 | 2546 | 80155 | 696 | 73314 |
| 30-#11 | 2.59 | 28315 | 9879 | 56698 | 7176 | 63595 | 5588 | 65559 | 4373 | 61473 | 2402 | 67441 | 1058 | 55684 |
| 30-#14 | 3.73 | 29555 | 10779 | 62494 | 7706 | 70732 | 5976 | 74118 | 4618 | 77305 | 2521 | 81724 | 649 | 75478 |
| 31-#11 | 2.67 | 28407 | 9947 | 57006 | 7240 | 64100 | 5639 | 66233 | 4411 | 66791 | 2588 | 68563 | 1031 | 57229 |
| 31-#14 | 3.85 | 29700 | 10877 | 62968 | 7792 | 71465 | 6044 | 75066 | 4669 | 78604 | 2538 | 83294 | 606 | 77581 |
| 32-#11 | 2.76 | 28512 | 10015 | 57442 | 7285 | 64635 | 5671 | 66899 | 4433 | 67775 | 2601 | 69769 | 1006 | 58822 |
| 33-#11 | 2.84 | 28608 | 10083 | 57870 | 7326 | 65200 | 5702 | 67565 | 4452 | 64056 | 2418 | 70776 | 969 | 60335 |
| 34-#11 | 2.93 | 28698 | 10150 | 58403 | 7352 | 65798 | 5718 | 68227 | 4457 | 69560 | 2581 | 71898 | 933 | 61881 |
| 35-#11 | 3.02 | 28817 | 10218 | 58739 | 7412 | 66305 | 5766 | 68899 | 4493 | 65712 | 2413 | 73108 | 917 | 63429 |
| 36-#11 | 3.10 | 28915 | 10286 | 59157 | 7455 | 66847 | 5797 | 69543 | 4513 | 71318 | 2589 | 74177 | 883 | 64933 |
| 37-#11 | 3.19 | 29016 | 10354 | 59643 | 7490 | 67406 | 5829 | 70228 | 4534 | 72181 | 2580 | 75307 | 857 | 66514 |

## ROUND SPIRAL COLUMNS 24" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#11 | 2.07 | 4106 | 2848 | 8418 | 1805 | 8659 | 1393 | 8436 | 1071 | 7286 | 569 | 7040 | 241 | 5680 |
| 6-#14 | 2.98 | 4181 | 3024 | 8899 | 1881 | 9230 | 1444 | 9112 | 1089 | 8127 | 521 | 7978 | 110 | 7487 |
| 6-#18 | 5.31 | 4307 | 3469 | 10035 | 2073 | 10592 | 1571 | 10728 | 1128 | 10864 | 419 | 10186 | -241 | 10210 |
| 7-#11 | 2.41 | 4095 | 2914 | 8385 | 1967 | 8876 | 1519 | 8785 | 1174 | 7760 | 640 | 7857 | 264 | 6309 |
| 7-#14 | 3.48 | 4145 | 3119 | 8919 | 2067 | 9507 | 1586 | 9529 | 1204 | 9324 | 644 | 9017 | 124 | 8385 |
| 7-#18 | 6.19 | 4261 | 3638 | 10176 | 2322 | 11011 | 1756 | 11312 | 1275 | 10962 | 493 | 11964 | -216 | 11717 |
| 8-#11 | 2.76 | 4116 | 2980 | 8504 | 2027 | 9100 | 1575 | 9074 | 1216 | 8661 | 691 | 8437 | 259 | 7137 |
| 8-#14 | 3.98 | 4172 | 3214 | 9116 | 2145 | 9818 | 1658 | 9922 | 1257 | 9138 | 601 | 9808 | 112 | 9291 |
| 8-#18 | 7.07 | 4309 | 3808 | 10548 | 2441 | 11529 | 1866 | 11951 | 1353 | 12496 | 516 | 13047 | -283 | 12602 |
| 9-#11 | 3.10 | 4144 | 3047 | 8717 | 2055 | 9320 | 1581 | 9326 | 1211 | 9029 | 672 | 8797 | 193 | 7711 |
| 9-#14 | 4.48 | 4218 | 3310 | 9396 | 2190 | 10129 | 1672 | 10285 | 1253 | 10322 | 620 | 10324 | 19 | 10227 |
| 9-#18 | 7.96 | 4382 | 3978 | 10994 | 2530 | 12057 | 1897 | 12578 | 1352 | 12522 | 443 | 13922 | -448 | 13639 |
| 10-#11 | 3.45 | 4152 | 3113 | 8987 | 2050 | 9568 | 1577 | 9593 | 1197 | 9348 | 625 | 9111 | 144 | 8386 |
| 10-#14 | 4.97 | 4223 | 3405 | 9748 | 2196 | 10485 | 1677 | 10682 | 1241 | 10800 | 558 | 10796 | -50 | 10800 |
| 11-#11 | 3.79 | 4191 | 3179 | 9057 | 2139 | 9762 | 1640 | 9862 | 1245 | 9740 | 656 | 9637 | 111 | 9062 |
| 11-#14 | 5.47 | 4284 | 3501 | 9883 | 2308 | 10751 | 1754 | 11036 | 1299 | 11317 | 593 | 11497 | -105 | 11461 |
| 12-#11 | 4.14 | 4234 | 3245 | 9209 | 2185 | 9982 | 1683 | 10134 | 1275 | 10077 | 651 | 10104 | 89 | 9653 |
| 12-#14 | 5.97 | 4332 | 3596 | 10106 | 2370 | 11059 | 1812 | 11414 | 1338 | 11120 | 571 | 12139 | -139 | 12120 |
| 13-#11 | 4.48 | 4251 | 3311 | 9404 | 2221 | 10204 | 1697 | 10418 | 1287 | 10492 | 648 | 10544 | 43 | 10350 |
| 13-#14 | 6.47 | 4370 | 3691 | 10373 | 2424 | 11372 | 1834 | 11817 | 1357 | 12373 | 579 | 12763 | -206 | 12673 |
| 14-#11 | 4.83 | 4277 | 3377 | 9644 | 2233 | 10450 | 1708 | 10673 | 1276 | 10148 | 581 | 10853 | -15 | 10855 |
| 15-#11 | 5.17 | 4299 | 3443 | 9752 | 2302 | 10647 | 1753 | 10948 | 1318 | 10449 | 587 | 11375 | -39 | 11368 |
| 16-#11 | 5.52 | 4331 | 3510 | 9915 | 2343 | 10866 | 1792 | 11197 | 1334 | 11566 | 631 | 11941 | -60 | 11934 |

## ROUND SPIRAL COLUMNS 26" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#11 | 1.76 | 5204 | 3274 | 10509 | 2107 | 10819 | 1631 | 10515 | 1265 | 9641 | 748 | 8673 | 347 | 6299 |
| 6-#14 | 2.54 | 5284 | 3449 | 11056 | 2183 | 11468 | 1683 | 11281 | 1283 | 10662 | 699 | 9747 | 221 | 8632 |
| 6-#18 | 4.52 | 5464 | 3894 | 12358 | 2378 | 13025 | 1815 | 13126 | 1328 | 13122 | 568 | 12301 | -114 | 12317 |
| 7-#11 | 2.06 | 5207 | 3340 | 10421 | 2288 | 11067 | 1773 | 10931 | 1382 | 10248 | 835 | 9637 | 378 | 7056 |
| 7-#14 | 2.97 | 5276 | 3545 | 11035 | 2390 | 11783 | 1843 | 11775 | 1414 | 10631 | 743 | 10964 | 244 | 9543 |
| 7-#18 | 5.27 | 5411 | 4064 | 12480 | 2649 | 13501 | 2017 | 13808 | 1492 | 14149 | 690 | 14122 | -111 | 14136 |
| 8-#11 | 2.35 | 5237 | 3406 | 10542 | 2354 | 11317 | 1834 | 11260 | 1428 | 10646 | 843 | 10298 | 377 | 8017 |
| 8-#14 | 3.39 | 5314 | 3640 | 11232 | 2472 | 12132 | 1920 | 12221 | 1471 | 11924 | 801 | 11864 | 237 | 10636 |
| 8-#18 | 6.03 | 5468 | 4234 | 12887 | 2774 | 14087 | 2134 | 14535 | 1576 | 15007 | 684 | 15597 | -139 | 15135 |
| 9-#11 | 2.64 | 5262 | 3472 | 10788 | 2379 | 11565 | 1839 | 11540 | 1422 | 11054 | 824 | 10703 | 311 | 8734 |
| 9-#14 | 3.81 | 5361 | 3735 | 11561 | 2516 | 12483 | 1932 | 12627 | 1467 | 12517 | 776 | 12449 | 143 | 11607 |
| 9-#18 | 6.78 | 5579 | 4403 | 13402 | 2862 | 14686 | 2165 | 15243 | 1575 | 16043 | 644 | 16602 | -303 | 16399 |
| 10-#11 | 2.94 | 5276 | 3538 | 11118 | 2370 | 11844 | 1830 | 11834 | 1404 | 11402 | 775 | 11046 | 261 | 9568 |
| 10-#14 | 4.24 | 5369 | 3831 | 11983 | 2517 | 12884 | 1933 | 13067 | 1452 | 12175 | 665 | 12973 | 76 | 12575 |
| 10-#18 | 7.53 | 5615 | 4573 | 14044 | 2891 | 15379 | 2188 | 16035 | 1566 | 17002 | 542 | 17552 | -419 | 17380 |
| 11-#11 | 3.23 | 5324 | 3604 | 11168 | 2465 | 12062 | 1900 | 12143 | 1458 | 11853 | 810 | 11652 | 233 | 10267 |
| 11-#14 | 4.66 | 5435 | 3926 | 12104 | 2636 | 13183 | 2017 | 13473 | 1515 | 13639 | 753 | 13778 | 27 | 13659 |
| 12-#11 | 3.53 | 5359 | 3671 | 11333 | 2514 | 12308 | 1946 | 12451 | 1490 | 12236 | 807 | 12187 | 213 | 10983 |
| 12-#14 | 5.09 | 5497 | 4022 | 12348 | 2701 | 13530 | 2078 | 13900 | 1558 | 14166 | 745 | 14514 | -5 | 14513 |

## ROUND SPIRAL COLUMNS 26" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 13-#11 | 3.82 | 5395 | 3737 | 11556 | 2549 | 12558 | 1959 | 12743 | 1492 | 12698 | 805 | 12679 | 169 | 11741 |
| 13-#14 | 5.51 | 5531 | 4117 | 12653 | 2754 | 13883 | 2099 | 14352 | 1576 | 14827 | 743 | 15216 | -70 | 15185 |
| 14-#11 | 4.11 | 5434 | 3803 | 11827 | 2558 | 12835 | 1967 | 13052 | 1489 | 13120 | 779 | 13027 | 110 | 12407 |
| 14-#14 | 5.93 | 5585 | 4212 | 13026 | 2777 | 14276 | 2118 | 14766 | 1564 | 14413 | 661 | 15722 | -152 | 15684 |
| 15-#11 | 4.41 | 5455 | 3869 | 11947 | 2631 | 13055 | 2016 | 13363 | 1534 | 13488 | 788 | 13622 | 90 | 13166 |
| 16-#11 | 4.70 | 5474 | 3935 | 12127 | 2674 | 13302 | 2057 | 13644 | 1552 | 13906 | 791 | 14263 | 70 | 13873 |
| 17-#11 | 5.00 | 5528 | 4001 | 12355 | 2702 | 13552 | 2073 | 13959 | 1567 | 14279 | 772 | 14653 | 21 | 14545 |
| 18-#11 | 5.29 | 5551 | 4067 | 12581 | 2730 | 13825 | 2090 | 14252 | 1562 | 14706 | 752 | 15130 | -27 | 15124 |

## ROUND SPIRAL COLUMNS 28" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#11 | 1.52 | 6479 | 3733 | 12916 | 2434 | 13312 | 1888 | 12911 | 1473 | 11743 | 896 | 10533 | 460 | 6919 |
| 6-#14 | 2.19 | 6574 | 3909 | 13532 | 2511 | 14038 | 1941 | 13767 | 1493 | 12883 | 849 | 11744 | 338 | 9615 |
| 6-#18 | 3.90 | 6802 | 4354 | 15002 | 2708 | 15791 | 2076 | 15842 | 1543 | 14604 | 677 | 14645 | 15 | 14573 |
| 7-#11 | 1.77 | 6498 | 3800 | 12760 | 2636 | 13590 | 2049 | 13400 | 1606 | 11630 | 929 | 11657 | 499 | 7817 |
| 7-#14 | 2.56 | 6587 | 4004 | 13445 | 2738 | 14392 | 2120 | 14344 | 1640 | 13736 | 959 | 13152 | 370 | 10667 |
| 7-#18 | 4.55 | 6768 | 4524 | 15092 | 3002 | 16326 | 2298 | 16630 | 1724 | 16833 | 861 | 16736 | 28 | 16568 |
| 8-#11 | 2.03 | 6535 | 3866 | 12881 | 2707 | 13858 | 2114 | 13772 | 1657 | 12051 | 939 | 12213 | 478 | 8841 |
| 8-#14 | 2.92 | 6636 | 4100 | 13650 | 2826 | 14779 | 2202 | 14845 | 1702 | 14339 | 967 | 13894 | 332 | 12044 |
| 8-#18 | 5.20 | 6841 | 4693 | 15503 | 3130 | 16979 | 2421 | 17446 | 1813 | 16613 | 802 | 18395 | 7 | 18358 |
| 9-#11 | 2.28 | 6558 | 3932 | 13162 | 2730 | 14142 | 2118 | 14079 | 1649 | 12468 | 921 | 12851 | 435 | 9693 |
| 9-#14 | 3.29 | 6672 | 4195 | 14025 | 2867 | 15170 | 2213 | 15294 | 1697 | 13993 | 880 | 14818 | 273 | 13037 |
| 9-#18 | 5.85 | 6922 | 4863 | 16105 | 3218 | 17650 | 2451 | 18234 | 1812 | 18951 | 821 | 19528 | -155 | 19435 |
| 10-#11 | 2.53 | 6578 | 3998 | 13542 | 2714 | 14453 | 2104 | 14398 | 1627 | 13732 | 935 | 13220 | 385 | 10701 |
| 10-#14 | 3.65 | 6696 | 4290 | 14527 | 2864 | 15617 | 2208 | 15776 | 1678 | 15567 | 877 | 15390 | 207 | 14185 |
| 10-#18 | 6.50 | 7007 | 5032 | 16851 | 3243 | 18425 | 2470 | 19112 | 1801 | 20012 | 719 | 20585 | -268 | 20474 |
| 11-#11 | 2.79 | 6637 | 4064 | 13582 | 2818 | 14692 | 2180 | 14749 | 1687 | 14248 | 975 | 13912 | 362 | 11505 |
| 11-#14 | 4.02 | 6775 | 4386 | 14626 | 2990 | 15949 | 2300 | 16236 | 1748 | 16241 | 923 | 16304 | 163 | 15322 |
| 11-#18 | 7.15 | 7096 | 5202 | 17141 | 3428 | 18975 | 2598 | 19833 | 1895 | 21070 | 777 | 22036 | -367 | 21707 |
| 12-#11 | 3.04 | 6671 | 4130 | 13759 | 2869 | 14958 | 2227 | 15093 | 1721 | 13698 | 909 | 14515 | 343 | 12366 |
| 12-#14 | 4.38 | 6843 | 4481 | 14892 | 3057 | 16333 | 2363 | 16713 | 1793 | 16832 | 917 | 17135 | 133 | 16361 |
| 13-#11 | 3.29 | 6717 | 4196 | 14009 | 2903 | 15241 | 2240 | 15416 | 1723 | 15133 | 962 | 15059 | 300 | 13151 |
| 13-#14 | 4.75 | 6883 | 4577 | 15236 | 3110 | 16727 | 2384 | 17175 | 1797 | 17563 | 915 | 17915 | 70 | 17555 |
| 14-#11 | 3.55 | 6771 | 4262 | 14311 | 2908 | 15553 | 2247 | 15755 | 1718 | 14604 | 882 | 15444 | 241 | 13942 |
| 14-#14 | 5.12 | 6957 | 4672 | 15645 | 3128 | 17165 | 2401 | 17671 | 1797 | 18240 | 881 | 18481 | -12 | 18479 |
| 15-#11 | 3.80 | 6783 | 4329 | 14458 | 2976 | 15791 | 2299 | 16104 | 1767 | 14992 | 894 | 16114 | 223 | 14798 |
| 15-#14 | 5.48 | 6985 | 4767 | 15847 | 3228 | 17506 | 2467 | 18147 | 1859 | 18801 | 892 | 19395 | -43 | 19372 |
| 16-#11 | 4.05 | 6815 | 4395 | 14641 | 3031 | 16060 | 2341 | 16417 | 1786 | 15427 | 898 | 16641 | 181 | 15562 |
| 16-#14 | 5.85 | 7019 | 4863 | 16137 | 3289 | 17891 | 2524 | 18583 | 1883 | 19451 | 896 | 20126 | -106 | 20071 |
| 17-#11 | 4.31 | 6866 | 4461 | 14886 | 3058 | 16342 | 2358 | 16765 | 1801 | 16941 | 942 | 17265 | 157 | 16370 |
| 18-#11 | 4.56 | 6903 | 4527 | 15143 | 3084 | 16651 | 2373 | 17089 | 1795 | 16249 | 861 | 17795 | 109 | 17124 |
| 19-#11 | 4.81 | 6937 | 4593 | 15317 | 3140 | 16893 | 2415 | 17427 | 1834 | 17821 | 927 | 18321 | 78 | 17875 |
| 20-#11 | 5.07 | 6985 | 4659 | 15503 | 3191 | 17164 | 2454 | 17741 | 1851 | 17061 | 867 | 18919 | 45 | 18684 |

## ROUND SPIRAL COLUMNS 30" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.32 | 7946 | 4227 | 15666 | 2786 | 16162 | 2164 | 15648 | 1697 | 14133 | 1054 | 12638 | 579 | 7540 |
| 6-#14 | 1.91 | 8055 | 4403 | 16349 | 2863 | 16966 | 2218 | 16594 | 1719 | 15392 | 1010 | 13987 | 461 | 10506 |
| 6-#18 | 3.40 | 8299 | 4848 | 17989 | 3062 | 18916 | 2356 | 18899 | 1772 | 18460 | 891 | 17237 | 149 | 16434 |
| 7-#11 | 1.54 | 7975 | 4293 | 15426 | 3011 | 16468 | 2345 | 16219 | 1848 | 14973 | 1166 | 13938 | 628 | 8591 |
| 7-#14 | 2.23 | 8090 | 4498 | 16182 | 3113 | 17359 | 2417 | 17262 | 1883 | 16382 | 1132 | 15601 | 502 | 11731 |
| 7-#18 | 3.96 | 8319 | 5017 | 18007 | 3378 | 19510 | 2599 | 19801 | 1971 | 19817 | 1041 | 19611 | 172 | 18486 |
| 8-#11 | 1.77 | 8025 | 4359 | 15542 | 3088 | 16752 | 2415 | 16633 | 1902 | 15482 | 1181 | 14565 | 610 | 9670 |
| 8-#14 | 2.55 | 8150 | 4593 | 16392 | 3206 | 17765 | 2503 | 17820 | 1949 | 15920 | 1069 | 16435 | 469 | 13369 |
| 8-#18 | 4.53 | 8410 | 5187 | 18444 | 3512 | 20230 | 2727 | 20708 | 2065 | 20897 | 1045 | 21458 | 158 | 20572 |
| 9-#11 | 1.99 | 8046 | 4425 | 15861 | 3108 | 17067 | 2416 | 16967 | 1893 | 15965 | 1161 | 15262 | 567 | 10670 |
| 9-#14 | 2.86 | 8183 | 4689 | 16815 | 3246 | 18213 | 2513 | 18310 | 1942 | 17769 | 1120 | 17449 | 410 | 14515 |
| 9-#18 | 5.09 | 8491 | 5356 | 19120 | 3598 | 20973 | 2757 | 21576 | 2064 | 20685 | 940 | 22720 | -4 | 22719 |
| 10-#11 | 2.21 | 8072 | 4492 | 16291 | 3084 | 17421 | 2397 | 17309 | 1866 | 16361 | 1106 | 15651 | 516 | 11733 |
| 10-#14 | 3.18 | 8215 | 4784 | 17374 | 3235 | 18709 | 2503 | 18833 | 1919 | 17162 | 981 | 18066 | 343 | 15859 |
| 10-#18 | 5.66 | 8524 | 5526 | 19992 | 3619 | 21831 | 2771 | 22538 | 2049 | 23322 | 903 | 23880 | -115 | 23835 |
| 11-#11 | 2.43 | 8141 | 4558 | 16320 | 3198 | 17669 | 2480 | 17705 | 1933 | 16945 | 1151 | 16434 | 497 | 12675 |
| 11-#14 | 3.50 | 8308 | 4880 | 17474 | 3371 | 19065 | 2602 | 19349 | 1996 | 19146 | 1103 | 19094 | 304 | 17066 |
| 11-#18 | 6.22 | 8700 | 5696 | 20261 | 3812 | 22437 | 2907 | 23344 | 2151 | 24505 | 968 | 25504 | -206 | 25311 |
| 12-#11 | 2.65 | 8174 | 4624 | 16508 | 3251 | 17961 | 2530 | 18085 | 1969 | 17420 | 1152 | 17107 | 479 | 13733 |
| 12-#14 | 3.82 | 8357 | 4975 | 17760 | 3440 | 19477 | 2667 | 19876 | 2043 | 18481 | 1026 | 20022 | 276 | 18246 |
| 12-#18 | 6.79 | 8786 | 5865 | 20783 | 3922 | 23159 | 3012 | 24227 | 2224 | 25596 | 953 | 27040 | -263 | 26852 |
| 13-#11 | 2.87 | 8224 | 4690 | 16779 | 3283 | 18273 | 2542 | 18439 | 1970 | 17919 | 1140 | 17703 | 437 | 14605 |
| 13-#14 | 4.14 | 8430 | 5070 | 18138 | 3492 | 19919 | 2688 | 20384 | 2047 | 20521 | 1083 | 20878 | 215 | 19550 |
| 13-#18 | 7.36 | 8903 | 6035 | 21417 | 4022 | 23904 | 3054 | 25110 | 2235 | 26990 | 951 | 28526 | -374 | 27820 |
| 14-#11 | 3.09 | 8302 | 4756 | 17122 | 3285 | 18623 | 2546 | 18807 | 1963 | 18475 | 1122 | 18123 | 377 | 15532 |
| 14-#14 | 4.46 | 8526 | 5166 | 18591 | 3506 | 20413 | 2704 | 20925 | 2046 | 21340 | 1062 | 21502 | 133 | 20650 |
| 15-#11 | 3.31 | 8310 | 4822 | 17271 | 3357 | 18878 | 2602 | 19195 | 2016 | 18941 | 1137 | 18870 | 363 | 16417 |
| 15-#14 | 4.77 | 8552 | 5261 | 18838 | 3597 | 20775 | 2773 | 21453 | 2111 | 21965 | 1077 | 22520 | 105 | 21912 |
| 16-#11 | 3.53 | 8348 | 4888 | 17467 | 3414 | 19173 | 2645 | 19540 | 2036 | 19455 | 1143 | 19458 | 321 | 17309 |
| 16-#14 | 5.09 | 8592 | 5356 | 19131 | 3675 | 21192 | 2831 | 21936 | 2138 | 21171 | 1010 | 23336 | 43 | 23059 |
| 17-#11 | 3.75 | 8403 | 4955 | 17741 | 3440 | 19483 | 2662 | 19923 | 2051 | 19907 | 1124 | 20142 | 299 | 18187 |
| 17-#14 | 5.41 | 8666 | 5452 | 19505 | 3715 | 21631 | 2857 | 22482 | 2160 | 23331 | 1056 | 24312 | 11 | 24249 |
| 18-#11 | 3.97 | 8429 | 5021 | 18030 | 3464 | 19815 | 2675 | 20276 | 2044 | 20417 | 1103 | 20723 | 250 | 19024 |
| 19-#11 | 4.19 | 8488 | 5087 | 18214 | 3523 | 20088 | 2721 | 20650 | 2086 | 20873 | 1110 | 21308 | 223 | 19912 |
| 20-#11 | 4.41 | 8539 | 5153 | 18408 | 3575 | 20387 | 2760 | 20996 | 2103 | 21379 | 1113 | 21967 | 192 | 20738 |
| 21-#11 | 4.63 | 8576 | 5219 | 18683 | 3605 | 20691 | 2779 | 21377 | 2120 | 21894 | 1106 | 22464 | 150 | 21596 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 32" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#11 | 1.16 | 9617 | 4755 | 18780 | 3163 | 19395 | 2460 | 18750 | 1937 | 15709 | 1142 | 15007 | 706 | 8161 |
| 6-#14 | 1.68 | 9741 | 4930 | 19532 | 3240 | 20277 | 2515 | 19787 | 1960 | 16995 | 1102 | 16493 | 590 | 11393 |
| 6-#18 | 2.98 | 10022 | 5375 | 21343 | 3440 | 22424 | 2655 | 22323 | 2016 | 21582 | 1067 | 20093 | 287 | 18379 |
| 7-#11 | 1.36 | 9659 | 4821 | 18441 | 3413 | 19721 | 2662 | 19411 | 2106 | 17808 | 1349 | 16498 | 764 | 9378 |
| 7-#14 | 1.96 | 9791 | 5026 | 19269 | 3515 | 20701 | 2735 | 20553 | 2142 | 19350 | 1317 | 18329 | 642 | 12812 |
| 7-#18 | 3.48 | 10078 | 5545 | 21272 | 3780 | 23078 | 2920 | 23346 | 2234 | 23124 | 1232 | 22767 | 321 | 20468 |
| 8-#11 | 1.55 | 9719 | 4887 | 18549 | 3495 | 20029 | 2737 | 19862 | 2164 | 18376 | 1368 | 17200 | 750 | 10506 |
| 8-#14 | 2.24 | 9869 | 5121 | 19480 | 3614 | 21134 | 2825 | 21170 | 2213 | 20100 | 1334 | 19259 | 613 | 14545 |
| 8-#18 | 3.98 | 10187 | 5715 | 21732 | 3921 | 23845 | 3053 | 24346 | 2334 | 24320 | 1241 | 24249 | 252 | 22871 |
| 9-#11 | 1.75 | 9739 | 4953 | 18909 | 3513 | 20374 | 2736 | 20230 | 2154 | 18895 | 1346 | 17953 | 706 | 11681 |
| 9-#14 | 2.52 | 9900 | 5216 | 19954 | 3650 | 21625 | 2833 | 21701 | 2205 | 20869 | 1308 | 20361 | 553 | 15900 |
| 9-#18 | 4.48 | 10249 | 5884 | 22484 | 4005 | 24680 | 3082 | 25293 | 2332 | 25697 | 1203 | 26194 | 151 | 25124 |
| 10-#11 | 1.94 | 9772 | 5019 | 19393 | 3481 | 20771 | 2711 | 20592 | 2122 | 19308 | 1288 | 18359 | 653 | 12777 |
| 10-#14 | 2.80 | 9941 | 5312 | 20576 | 3631 | 22184 | 2819 | 22262 | 2177 | 21528 | 1236 | 21018 | 485 | 17596 |
| 10-#18 | 4.97 | 10308 | 6054 | 23459 | 4018 | 25621 | 3091 | 26337 | 2313 | 26951 | 1097 | 27453 | 43 | 27186 |
| 11-#11 | 2.13 | 9851 | 5085 | 19400 | 3604 | 21030 | 2802 | 21036 | 2195 | 19965 | 1339 | 19237 | 639 | 13867 |
| 11-#14 | 3.08 | 10049 | 5407 | 20669 | 3778 | 22555 | 2924 | 22837 | 2261 | 22376 | 1293 | 22166 | 452 | 18828 |
| 11-#18 | 5.47 | 10482 | 6223 | 23732 | 4221 | 26284 | 3236 | 27231 | 2422 | 28265 | 1168 | 29257 | -42 | 29217 |
| 12-#11 | 2.33 | 9883 | 5152 | 19603 | 3660 | 21348 | 2854 | 21445 | 2233 | 20489 | 1341 | 19983 | 623 | 14977 |
| 12-#14 | 3.36 | 10096 | 5503 | 20974 | 3850 | 23004 | 2992 | 23415 | 2310 | 23096 | 1292 | 23192 | 425 | 20196 |
| 12-#18 | 5.97 | 10603 | 6393 | 24295 | 4335 | 27053 | 3342 | 28200 | 2499 | 29465 | 1156 | 30958 | -97 | 30891 |
| 13-#11 | 2.52 | 9942 | 5218 | 19896 | 3690 | 21688 | 2865 | 21836 | 2234 | 19627 | 1240 | 20629 | 581 | 15991 |
| 13-#14 | 3.64 | 10184 | 5598 | 21380 | 3900 | 23487 | 3012 | 23968 | 2314 | 23878 | 1276 | 24124 | 366 | 21542 |
| 13-#18 | 6.47 | 10702 | 6562 | 24995 | 4434 | 27884 | 3385 | 29166 | 2510 | 30833 | 1130 | 32585 | -204 | 32358 |
| 14-#11 | 2.72 | 10035 | 5284 | 20283 | 3688 | 22060 | 2865 | 22233 | 2225 | 21625 | 1309 | 21082 | 521 | 17134 |
| 14-#14 | 3.92 | 10299 | 5693 | 21888 | 3910 | 24029 | 3025 | 24554 | 2310 | 24762 | 1254 | 24804 | 283 | 22817 |
| 14-#18 | 6.96 | 10892 | 6732 | 25798 | 4476 | 28803 | 3426 | 30213 | 2519 | 32419 | 1101 | 33804 | -345 | 33419 |
| 15-#11 | 2.91 | 10043 | 5350 | 20430 | 3765 | 22348 | 2926 | 22632 | 2271 | 22144 | 1327 | 21909 | 509 | 18077 |
| 15-#14 | 4.20 | 10311 | 5789 | 22143 | 4006 | 24422 | 3099 | 25136 | 2379 | 23758 | 1187 | 25928 | 259 | 24243 |
| 16-#11 | 3.10 | 10089 | 5416 | 20632 | 3823 | 22669 | 2971 | 23032 | 2302 | 22706 | 1334 | 22559 | 469 | 19113 |
| 16-#14 | 4.48 | 10373 | 5884 | 22451 | 4085 | 24878 | 3159 | 25664 | 2407 | 26241 | 1279 | 26830 | 199 | 25522 |
| 17-#11 | 3.30 | 10147 | 5482 | 20942 | 3850 | 23002 | 2986 | 23451 | 2317 | 21651 | 1228 | 23195 | 435 | 20016 |
| 17-#14 | 4.76 | 10452 | 5980 | 22870 | 4126 | 25357 | 3184 | 26259 | 2430 | 26946 | 1253 | 27894 | 168 | 26825 |
| 18-#11 | 3.49 | 10176 | 5548 | 21266 | 3871 | 23360 | 2998 | 23838 | 2309 | 23748 | 1295 | 23933 | 398 | 20983 |
| 18-#14 | 5.04 | 10523 | 6075 | 23304 | 4165 | 25870 | 3208 | 26816 | 2424 | 27750 | 1226 | 28811 | 99 | 28121 |
| 19-#11 | 3.69 | 10238 | 5615 | 21449 | 3933 | 23657 | 3046 | 24244 | 2353 | 24252 | 1303 | 24578 | 374 | 21963 |
| 19-#14 | 5.32 | 10588 | 6170 | 23601 | 4245 | 26290 | 3269 | 27382 | 2480 | 28439 | 1233 | 29697 | 58 | 29335 |
| 20-#11 | 3.88 | 10300 | 5681 | 21658 | 3985 | 23992 | 3087 | 24619 | 2371 | 24804 | 1308 | 25299 | 344 | 22853 |
| 21-#11 | 4.07 | 10342 | 5747 | 21960 | 4015 | 24314 | 3105 | 25037 | 2388 | 25364 | 1301 | 25845 | 302 | 23850 |
| 22-#11 | 4.27 | 10401 | 5813 | 22275 | 4045 | 24669 | 3123 | 25433 | 2386 | 25862 | 1275 | 26473 | 260 | 24720 |
| 23-#11 | 4.46 | 10439 | 5879 | 22475 | 4098 | 24972 | 3164 | 25829 | 2423 | 24653 | 1202 | 27221 | 242 | 25657 |

## ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#11 | 1.03 | 11505 | 5317 | 22283 | 3565 | 23036 | 2776 | 22242 | 2193 | 19859 | 1404 | 17657 | 840 | 8785 |
| 6-#14 | 1.49 | 11646 | 5492 | 23105 | 3642 | 23996 | 2831 | 23370 | 2216 | 21356 | 1362 | 19280 | 727 | 12281 |
| 6-#18 | 2.64 | 11964 | 5937 | 25087 | 3842 | 26341 | 2972 | 26136 | 2275 | 25034 | 1252 | 23230 | 432 | 20408 |
| 7-#11 | 1.20 | 11561 | 5383 | 21828 | 3841 | 23382 | 3000 | 23002 | 2381 | 20926 | 1534 | 19356 | 909 | 10178 |
| 7-#14 | 1.73 | 11715 | 5587 | 22729 | 3943 | 24444 | 3073 | 24244 | 2418 | 22661 | 1513 | 21355 | 789 | 13909 |
| 7-#18 | 3.08 | 12058 | 6107 | 24911 | 4208 | 27055 | 3261 | 27290 | 2513 | 26774 | 1433 | 26222 | 477 | 22605 |
| 8-#11 | 1.37 | 11632 | 5449 | 21922 | 3931 | 23713 | 3080 | 23486 | 2443 | 21618 | 1566 | 20137 | 899 | 11348 |
| 8-#14 | 1.98 | 11808 | 5683 | 22935 | 4049 | 24912 | 3169 | 24905 | 2493 | 23491 | 1534 | 22385 | 765 | 15728 |
| 8-#18 | 3.52 | 12186 | 6276 | 25390 | 4356 | 27856 | 3398 | 28385 | 2618 | 28089 | 1446 | 27856 | 413 | 25255 |
| 9-#11 | 1.55 | 11650 | 5515 | 22326 | 3944 | 24088 | 3076 | 23888 | 2431 | 22170 | 1543 | 20944 | 853 | 12694 |
| 9-#14 | 2.23 | 11835 | 5778 | 23463 | 4082 | 25446 | 3174 | 25492 | 2483 | 24315 | 1507 | 23573 | 704 | 17284 |
| 9-#18 | 3.97 | 12242 | 6446 | 26221 | 4437 | 28777 | 3426 | 29410 | 2615 | 27605 | 1314 | 29968 | 312 | 27565 |
| 10-#11 | 1.72 | 11689 | 5581 | 22872 | 3904 | 24523 | 3046 | 24272 | 2394 | 21090 | 1383 | 21361 | 798 | 13831 |
| 10-#14 | 2.48 | 11886 | 5874 | 24153 | 4054 | 26069 | 3155 | 26088 | 2450 | 23342 | 1337 | 24265 | 635 | 19074 |
| 10-#18 | 4.41 | 12316 | 6616 | 27285 | 4442 | 29822 | 3431 | 30534 | 2591 | 30922 | 1300 | 31322 | 204 | 29925 |
| 11-#11 | 1.89 | 11779 | 5647 | 22847 | 4037 | 24799 | 3144 | 24757 | 2474 | 21777 | 1435 | 22342 | 789 | 15081 |
| 11-#14 | 2.73 | 12008 | 5969 | 24226 | 4211 | 26453 | 3268 | 26725 | 2542 | 25951 | 1495 | 25538 | 606 | 20552 |
| 11-#18 | 4.85 | 12514 | 6785 | 27574 | 4657 | 30510 | 3582 | 31518 | 2709 | 30213 | 1286 | 33312 | 126 | 32524 |
| 12-#11 | 2.06 | 11811 | 5713 | 23064 | 4097 | 25142 | 3198 | 25201 | 2514 | 23906 | 1542 | 23161 | 774 | 16236 |
| 12-#14 | 2.97 | 12055 | 6064 | 24556 | 4287 | 26939 | 3338 | 27339 | 2592 | 26739 | 1496 | 26665 | 582 | 22211 |
| 12-#18 | 5.29 | 12644 | 6955 | 28178 | 4774 | 31345 | 3692 | 32575 | 2788 | 33682 | 1369 | 35181 | 74 | 34671 |
| 13-#11 | 2.23 | 11879 | 5780 | 23380 | 4125 | 25512 | 3209 | 25621 | 2513 | 24486 | 1529 | 23743 | 721 | 17399 |
| 13-#14 | 3.22 | 12146 | 6160 | 24992 | 4334 | 27464 | 3357 | 27948 | 2596 | 27581 | 1480 | 27673 | 523 | 23589 |
| 13-#18 | 5.73 | 12755 | 7124 | 28922 | 4871 | 32249 | 3735 | 33622 | 2800 | 35165 | 1344 | 36948 | -30 | 36914 |
| 14-#11 | 2.41 | 11969 | 5846 | 23815 | 4119 | 25906 | 3205 | 26058 | 2503 | 24996 | 1488 | 24339 | 671 | 18589 |
| 14-#14 | 3.47 | 12281 | 6255 | 25557 | 4341 | 28038 | 3366 | 28582 | 2591 | 28528 | 1456 | 28406 | 439 | 25050 |
| 14-#18 | 6.17 | 12956 | 7294 | 29810 | 4909 | 33280 | 3775 | 34756 | 2807 | 36876 | 1314 | 38277 | -171 | 38125 |
| 15-#11 | 2.58 | 11996 | 5912 | 23958 | 4201 | 26218 | 3270 | 26484 | 2552 | 25693 | 1529 | 25250 | 663 | 19673 |
| 15-#14 | 3.72 | 12304 | 6351 | 25817 | 4442 | 28478 | 3445 | 29170 | 2649 | 27339 | 1379 | 29639 | 419 | 26523 |
| 15-#18 | 6.61 | 13023 | 7463 | 30352 | 5056 | 33993 | 3885 | 35798 | 2914 | 38103 | 1334 | 40297 | -223 | 40004 |
| 16-#11 | 2.75 | 12049 | 5978 | 24164 | 4259 | 26573 | 3317 | 26919 | 2585 | 26305 | 1537 | 25962 | 623 | 20858 |
| 16-#14 | 3.97 | 12375 | 6446 | 26135 | 4522 | 28971 | 3507 | 29778 | 2692 | 30147 | 1486 | 30627 | 360 | 27979 |
| 17-#11 | 2.92 | 12103 | 6044 | 24506 | 4286 | 26924 | 3331 | 27372 | 2599 | 26835 | 1518 | 26650 | 591 | 21887 |
| 17-#14 | 4.21 | 12458 | 6541 | 26605 | 4563 | 29481 | 3531 | 30428 | 2715 | 30909 | 1460 | 31615 | 313 | 29465 |
| 18-#11 | 3.09 | 12144 | 6110 | 24872 | 4305 | 27312 | 3341 | 27790 | 2590 | 27424 | 1497 | 27445 | 553 | 22999 |
| 18-#14 | 4.46 | 12508 | 6637 | 27085 | 4600 | 30033 | 3553 | 31038 | 2708 | 31774 | 1433 | 32772 | 262 | 30797 |
| 19-#11 | 3.26 | 12214 | 6176 | 25052 | 4369 | 27634 | 3392 | 28230 | 2636 | 27977 | 1507 | 28150 | 531 | 24007 |
| 19-#14 | 4.71 | 12615 | 6732 | 27385 | 4682 | 30488 | 3617 | 31645 | 2767 | 32528 | 1443 | 33739 | 224 | 32198 |
| 20-#11 | 3.44 | 12269 | 6242 | 25275 | 4423 | 27991 | 3434 | 28638 | 2655 | 28577 | 1513 | 28933 | 503 | 25027 |
| 20-#14 | 4.96 | 12692 | 6828 | 27712 | 4756 | 31005 | 3676 | 32219 | 2792 | 33371 | 1448 | 34841 | 182 | 33614 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 34" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 21-#11 | 3.61 | 12329 | 6309 | 25605 | 4453 | 28345 | 3452 | 29089 | 2672 | 27178 | 1396 | 29529 | 461 | 26077 |
| 22-#11 | 3.78 | 12400 | 6375 | 25945 | 4480 | 28730 | 3469 | 29508 | 2668 | 27735 | 1381 | 30205 | 420 | 27052 |
| 23-#11 | 3.95 | 12440 | 6441 | 26162 | 4536 | 29057 | 3512 | 29947 | 2708 | 30319 | 1494 | 31025 | 402 | 28128 |
| 24-#11 | 4.12 | 12483 | 6507 | 26402 | 4588 | 29401 | 3551 | 30358 | 2726 | 30856 | 1488 | 31671 | 365 | 29125 |
| 25-#11 | 4.30 | 12548 | 6573 | 26713 | 4618 | 29763 | 3571 | 30803 | 2744 | 31458 | 1483 | 32412 | 330 | 30118 |

## ROUND SPIRAL COLUMNS 36" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load $\phi M_n$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | |
| 6-#14 | 1.33 | 13782 | 6088 | 27091 | 4069 | 28148 | 3166 | 27367 | 2488 | 24854 | 1554 | 22367 | 871 | 13171 |
| 6-#18 | 2.36 | 14139 | 6533 | 29246 | 4270 | 30692 | 3309 | 30364 | 2549 | 28836 | 1448 | 26667 | 582 | 22187 |
| 7-#11 | 1.07 | 13689 | 5979 | 25609 | 4297 | 27476 | 3359 | 27011 | 2672 | 22835 | 1624 | 22532 | 1061 | 10990 |
| 7-#14 | 1.55 | 13867 | 6183 | 26583 | 4398 | 28621 | 3432 | 28358 | 2710 | 26244 | 1707 | 24698 | 944 | 15021 |
| 7-#18 | 2.75 | 14271 | 6703 | 28946 | 4663 | 31441 | 3621 | 31658 | 2808 | 30790 | 1644 | 29994 | 639 | 24599 |
| 8-#11 | 1.23 | 13777 | 6045 | 25685 | 4393 | 27831 | 3445 | 27535 | 2739 | 25228 | 1777 | 23395 | 1055 | 12195 |
| 8-#14 | 1.77 | 13979 | 6279 | 26781 | 4511 | 29122 | 3534 | 29062 | 2789 | 27250 | 1746 | 25831 | 924 | 16918 |
| 8-#18 | 3.14 | 14419 | 6872 | 29440 | 4819 | 32302 | 3764 | 32842 | 2918 | 30079 | 1552 | 31785 | 581 | 27722 |
| 9-#11 | 1.38 | 13793 | 6111 | 26135 | 4403 | 28237 | 3438 | 27962 | 2725 | 25812 | 1752 | 24254 | 1008 | 13725 |
| 9-#14 | 1.99 | 14003 | 6374 | 27365 | 4541 | 29699 | 3536 | 29698 | 2778 | 28127 | 1717 | 27104 | 862 | 18690 |
| 9-#18 | 3.54 | 14470 | 7042 | 30353 | 4897 | 33299 | 3789 | 33952 | 2914 | 33824 | 1624 | 34063 | 480 | 30074 |
| 10-#11 | 1.53 | 13839 | 6177 | 26748 | 4354 | 28697 | 3400 | 28375 | 2683 | 26248 | 1686 | 24677 | 951 | 14896 |
| 10-#14 | 2.21 | 14063 | 6469 | 28130 | 4504 | 30373 | 3510 | 30337 | 2740 | 26929 | 1529 | 27826 | 791 | 20557 |
| 10-#18 | 3.93 | 14558 | 7211 | 31511 | 4892 | 34457 | 3790 | 35154 | 2885 | 35256 | 1513 | 35505 | 372 | 32750 |
| 11-#11 | 1.69 | 13934 | 6243 | 26684 | 4497 | 29001 | 3508 | 28900 | 2769 | 27067 | 1748 | 25766 | 946 | 16317 |
| 11-#14 | 2.43 | 14201 | 6565 | 28172 | 4671 | 30785 | 3632 | 31021 | 2838 | 29894 | 1707 | 29231 | 768 | 22236 |
| 11-#18 | 4.32 | 14781 | 7381 | 31805 | 5119 | 35170 | 3949 | 36231 | 3011 | 36845 | 1597 | 37687 | 300 | 35431 |
| 12-#11 | 1.84 | 13970 | 6309 | 26915 | 4560 | 29369 | 3565 | 29382 | 2812 | 27691 | 1754 | 26660 | 934 | 17510 |
| 12-#14 | 2.65 | 14246 | 6660 | 28528 | 4751 | 31308 | 3705 | 31686 | 2892 | 30750 | 1710 | 30460 | 745 | 24091 |
| 12-#18 | 4.72 | 14865 | 7551 | 32452 | 5240 | 36071 | 4062 | 37369 | 3093 | 35717 | 1485 | 39726 | 251 | 37864 |
| 13-#11 | 1.99 | 14047 | 6375 | 27256 | 4586 | 29765 | 3573 | 29832 | 2810 | 26423 | 1625 | 27283 | 881 | 18851 |
| 13-#14 | 2.87 | 14350 | 6756 | 28995 | 4796 | 31875 | 3723 | 32340 | 2894 | 31653 | 1694 | 31368 | 670 | 25657 |
| 13-#18 | 5.11 | 15044 | 7720 | 33242 | 5333 | 37049 | 4104 | 38505 | 3105 | 39865 | 1567 | 41632 | 149 | 40669 |
| 14-#11 | 2.15 | 14142 | 6441 | 27742 | 4576 | 30185 | 3566 | 30296 | 2797 | 26925 | 1584 | 27915 | 829 | 20064 |
| 14-#14 | 3.09 | 14496 | 6851 | 29622 | 4798 | 32481 | 3727 | 33034 | 2887 | 32472 | 1640 | 32325 | 603 | 27350 |
| 14-#18 | 5.50 | 15258 | 7890 | 34218 | 5368 | 38140 | 4139 | 39723 | 3110 | 41700 | 1536 | 43070 | 7 | 43015 |
| 15-#11 | 2.30 | 14181 | 6508 | 27876 | 4663 | 30520 | 3636 | 30762 | 2850 | 29611 | 1742 | 28912 | 824 | 21297 |
| 15-#14 | 3.32 | 14530 | 6946 | 29882 | 4905 | 32954 | 3812 | 33657 | 2949 | 31264 | 1581 | 33671 | 586 | 28900 |
| 15-#18 | 5.89 | 15348 | 8059 | 34785 | 5521 | 38932 | 4257 | 40856 | 3222 | 40169 | 1456 | 45269 | -40 | 45218 |
| 16-#11 | 2.45 | 14241 | 6574 | 28086 | 4723 | 30911 | 3684 | 31232 | 2884 | 30274 | 1751 | 29687 | 785 | 22527 |
| 16-#14 | 3.54 | 14612 | 7042 | 30209 | 4986 | 33498 | 3876 | 34315 | 2994 | 34422 | 1704 | 34747 | 527 | 30505 |
| 16-#18 | 6.29 | 15455 | 8229 | 35413 | 5657 | 39849 | 4360 | 41903 | 3268 | 41633 | 1466 | 47073 | -149 | 46876 |
| 17-#11 | 2.61 | 14297 | 6640 | 28458 | 4748 | 31280 | 3698 | 31718 | 2898 | 30841 | 1733 | 30426 | 753 | 23697 |
| 17-#14 | 3.76 | 14700 | 7137 | 30723 | 5026 | 34034 | 3899 | 35014 | 3017 | 35241 | 1678 | 35811 | 482 | 32036 |
| 18-#11 | 2.76 | 14344 | 6706 | 28870 | 4766 | 31699 | 3705 | 32153 | 2886 | 31468 | 1710 | 31275 | 715 | 24944 |
| 18-#14 | 3.98 | 14755 | 7233 | 31259 | 5061 | 34631 | 3919 | 35666 | 3008 | 36166 | 1651 | 37054 | 430 | 33543 |

## ROUND SPIRAL COLUMNS 36" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 19-#11 | 2.91 | 14423 | 6772 | 29045 | 4833 | 32043 | 3759 | 32640 | 2935 | 29933 | 1608 | 32043 | 696 | 26074 |
| 19-#14 | 4.20 | 14863 | 7328 | 31560 | 5146 | 35119 | 3985 | 36326 | 3069 | 36986 | 1662 | 38104 | 396 | 35145 |
| 20-#11 | 3.07 | 14479 | 6838 | 29282 | 4888 | 32418 | 3802 | 33083 | 2956 | 32719 | 1729 | 32891 | 669 | 27260 |
| 20-#14 | 4.42 | 14959 | 7423 | 31909 | 5222 | 35664 | 4045 | 36946 | 3096 | 37897 | 1669 | 39295 | 355 | 36582 |
| 21-#11 | 3.22 | 14549 | 6904 | 29639 | 4917 | 32809 | 3820 | 33560 | 2972 | 31082 | 1598 | 33534 | 627 | 28338 |
| 21-#14 | 4.64 | 15034 | 7519 | 32407 | 5266 | 36208 | 4072 | 37639 | 3122 | 36151 | 1536 | 40213 | 296 | 38134 |
| 22-#11 | 3.37 | 14634 | 6971 | 30007 | 4942 | 33225 | 3835 | 34004 | 2967 | 33940 | 1695 | 34257 | 586 | 29446 |
| 22-#14 | 4.86 | 15152 | 7614 | 32911 | 5310 | 36799 | 4100 | 38288 | 3120 | 39662 | 1624 | 41265 | 238 | 39619 |
| 23-#11 | 3.52 | 14666 | 7037 | 30232 | 5000 | 33567 | 3880 | 34480 | 3009 | 32287 | 1598 | 35150 | 570 | 30587 |
| 24-#11 | 3.68 | 14723 | 7103 | 30495 | 5053 | 33937 | 3920 | 34935 | 3028 | 35173 | 1706 | 35850 | 534 | 31679 |
| 25-#11 | 3.83 | 14792 | 7169 | 30825 | 5083 | 34328 | 3940 | 35402 | 3046 | 35820 | 1701 | 36650 | 499 | 32793 |
| 26-#11 | 3.98 | 14838 | 7235 | 31174 | 5114 | 34751 | 3961 | 35855 | 3045 | 33979 | 1566 | 37265 | 452 | 33840 |
| 27-#11 | 4.14 | 14914 | 7301 | 31457 | 5157 | 35091 | 3999 | 36325 | 3082 | 34578 | 1577 | 38272 | 440 | 34923 |

## ROUND SPIRAL COLUMNS 38" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#14 | 1.19 | 16163 | 6718 | 31513 | 4521 | 32761 | 3522 | 31804 | 2776 | 28722 | 1757 | 25770 | 1022 | 14062 |
| 6-#18 | 2.12 | 16560 | 7163 | 33844 | 4722 | 35503 | 3665 | 35032 | 2838 | 30808 | 1544 | 30421 | 739 | 23758 |
| 7-#14 | 1.39 | 16260 | 6813 | 30855 | 4881 | 33256 | 3812 | 32911 | 3019 | 30302 | 1926 | 28378 | 1107 | 16149 |
| 7-#18 | 2.47 | 16721 | 7333 | 33400 | 5145 | 36284 | 4001 | 36475 | 3119 | 32847 | 1743 | 34102 | 808 | 26462 |
| 8-#11 | 1.10 | 16167 | 6675 | 29859 | 4883 | 32407 | 3832 | 32035 | 3053 | 29230 | 1999 | 26993 | 1219 | 13049 |
| 8-#14 | 1.59 | 16396 | 6909 | 31039 | 5001 | 33791 | 3920 | 33670 | 3103 | 29306 | 1838 | 29619 | 1091 | 18116 |
| 8-#18 | 2.82 | 16900 | 7502 | 33903 | 5308 | 37206 | 4151 | 37725 | 3234 | 34307 | 1764 | 36054 | 756 | 30265 |
| 9-#11 | 1.24 | 16181 | 6741 | 30360 | 4889 | 32843 | 3821 | 32487 | 3036 | 29844 | 1973 | 27777 | 1160 | 14688 |
| 9-#14 | 1.79 | 16417 | 7004 | 31683 | 5026 | 34412 | 3920 | 34345 | 3090 | 32329 | 1939 | 30973 | 1028 | 20116 |
| 9-#18 | 3.17 | 16945 | 7672 | 34902 | 5382 | 38280 | 4174 | 38943 | 3229 | 35896 | 1728 | 38495 | 654 | 32647 |
| 10-#11 | 1.38 | 16234 | 6807 | 31047 | 4830 | 33331 | 3775 | 32925 | 2988 | 28265 | 1775 | 28325 | 1112 | 15972 |
| 10-#14 | 1.98 | 16487 | 7099 | 32530 | 4980 | 35124 | 3885 | 35032 | 3047 | 30875 | 1733 | 31718 | 955 | 22054 |
| 10-#18 | 3.53 | 17049 | 7841 | 36160 | 5368 | 39554 | 4169 | 40220 | 3195 | 37309 | 1620 | 40022 | 545 | 35660 |
| 11-#11 | 1.51 | 16339 | 6873 | 30936 | 4984 | 33662 | 3893 | 33493 | 3082 | 29112 | 1839 | 29529 | 1112 | 17535 |
| 11-#14 | 2.18 | 16640 | 7195 | 32533 | 5158 | 35576 | 4017 | 35766 | 3152 | 34227 | 1931 | 33263 | 937 | 23947 |
| 11-#18 | 3.88 | 17297 | 8011 | 36437 | 5606 | 40290 | 4336 | 41385 | 3329 | 38929 | 1705 | 42402 | 480 | 38409 |
| 12-#11 | 1.65 | 16375 | 6939 | 31177 | 5051 | 34055 | 3952 | 34013 | 3127 | 31868 | 1978 | 30501 | 1101 | 18799 |
| 12-#14 | 2.38 | 16684 | 7290 | 32913 | 5242 | 36135 | 4093 | 36484 | 3208 | 32809 | 1808 | 34596 | 916 | 25875 |
| 12-#18 | 4.23 | 17379 | 8180 | 37140 | 5732 | 41256 | 4452 | 42588 | 3413 | 40362 | 1703 | 44613 | 433 | 41145 |
| 13-#11 | 1.79 | 16461 | 7005 | 31545 | 5075 | 34471 | 3959 | 34493 | 3124 | 32526 | 1964 | 31162 | 1048 | 20310 |
| 13-#14 | 2.58 | 16800 | 7386 | 33412 | 5284 | 36738 | 4110 | 37182 | 3210 | 33707 | 1792 | 35565 | 842 | 27641 |
| 13-#18 | 4.59 | 17584 | 8350 | 37978 | 5823 | 42309 | 4494 | 43821 | 3425 | 41958 | 1680 | 46657 | 333 | 44201 |
| 14-#11 | 1.93 | 16560 | 7071 | 32085 | 5059 | 34923 | 3948 | 34972 | 3107 | 33088 | 1919 | 31826 | 995 | 21557 |
| 14-#14 | 2.78 | 16942 | 7481 | 34104 | 5282 | 37383 | 4110 | 37916 | 3199 | 36980 | 1864 | 36581 | 773 | 29600 |
| 14-#18 | 4.94 | 17811 | 8520 | 39045 | 5854 | 43456 | 4524 | 45140 | 3429 | 43785 | 1650 | 48202 | 191 | 46673 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 38" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 15-#11 | 2.06 | 16612 | 7137 | 32206 | 5153 | 35280 | 4023 | 35490 | 3165 | 33920 | 1967 | 32914 | 992 | 22949 |
| 15-#14 | 2.98 | 17004 | 7576 | 34361 | 5394 | 37889 | 4199 | 38595 | 3265 | 38093 | 1921 | 38043 | 759 | 31277 |
| 15-#18 | 5.29 | 17892 | 8689 | 39633 | 6013 | 44326 | 4648 | 46257 | 3518 | 48364 | 1796 | 50582 | 148 | 49525 |
| 16-#11 | 2.20 | 16680 | 7204 | 32419 | 5214 | 35700 | 4073 | 35995 | 3200 | 34634 | 1977 | 33753 | 955 | 24218 |
| 16-#14 | 3.17 | 17096 | 7672 | 34696 | 5477 | 38484 | 4266 | 39303 | 3312 | 36482 | 1804 | 39208 | 702 | 33098 |
| 16-#18 | 5.64 | 18041 | 8859 | 40283 | 6149 | 45315 | 4754 | 47460 | 3592 | 46716 | 1688 | 52538 | 40 | 52216 |
| 17-#11 | 2.34 | 16737 | 7270 | 32823 | 5238 | 36094 | 4085 | 36510 | 3214 | 35239 | 1958 | 34542 | 923 | 25561 |
| 17-#14 | 3.37 | 17178 | 7767 | 35251 | 5516 | 39047 | 4287 | 40050 | 3334 | 37299 | 1780 | 40347 | 657 | 34666 |
| 17-#18 | 6.00 | 18190 | 9028 | 41211 | 6227 | 46328 | 4801 | 48768 | 3636 | 51591 | 1766 | 54530 | -40 | 54471 |
| 18-#11 | 2.48 | 16791 | 7336 | 33283 | 5253 | 36544 | 4090 | 36965 | 3200 | 35901 | 1934 | 35195 | 860 | 26828 |
| 18-#14 | 3.57 | 17250 | 7862 | 35849 | 5550 | 39687 | 4305 | 40729 | 3323 | 40947 | 1879 | 41674 | 605 | 36360 |
| 19-#11 | 2.61 | 16879 | 7402 | 33450 | 5323 | 36912 | 4147 | 37493 | 3252 | 34120 | 1819 | 36277 | 867 | 28101 |
| 19-#14 | 3.77 | 17370 | 7958 | 36148 | 5637 | 40210 | 4375 | 41454 | 3388 | 41836 | 1893 | 42809 | 574 | 38021 |
| 20-#11 | 2.75 | 16936 | 7468 | 33700 | 5379 | 37305 | 4191 | 37978 | 3274 | 37254 | 1956 | 37189 | 842 | 29395 |
| 20-#14 | 3.97 | 17452 | 8053 | 36518 | 5714 | 40780 | 4435 | 42123 | 3416 | 39960 | 1774 | 44090 | 535 | 39623 |
| 21-#11 | 2.89 | 17010 | 7534 | 34086 | 5408 | 37723 | 4208 | 38477 | 3289 | 37875 | 1940 | 37881 | 801 | 30608 |
| 21-#14 | 4.17 | 17556 | 8149 | 37055 | 5758 | 41375 | 4462 | 42853 | 3441 | 43709 | 1878 | 45080 | 476 | 41376 |
| 22-#11 | 3.03 | 17111 | 7600 | 34483 | 5431 | 38179 | 4223 | 38951 | 3283 | 35983 | 1794 | 38649 | 760 | 31956 |
| 22-#14 | 4.36 | 17685 | 8244 | 37595 | 5800 | 42012 | 4490 | 43543 | 3438 | 44700 | 1856 | 46203 | 419 | 42883 |
| 23-#11 | 3.16 | 17146 | 7667 | 34715 | 5492 | 38535 | 4269 | 39464 | 3327 | 36642 | 1811 | 39617 | 744 | 33069 |
| 23-#14 | 4.56 | 17750 | 8339 | 37959 | 5878 | 42530 | 4549 | 44255 | 3494 | 45676 | 1877 | 47541 | 393 | 44532 |
| 24-#11 | 3.30 | 17210 | 7733 | 35000 | 5546 | 38931 | 4310 | 39944 | 3346 | 39881 | 1936 | 40371 | 709 | 34295 |
| 25-#11 | 3.44 | 17283 | 7799 | 35349 | 5575 | 39350 | 4329 | 40451 | 3364 | 40573 | 1930 | 41229 | 675 | 35440 |
| 26-#11 | 3.58 | 17334 | 7865 | 35729 | 5604 | 39796 | 4349 | 40935 | 3363 | 41197 | 1907 | 41885 | 628 | 36616 |
| 27-#11 | 3.71 | 17412 | 7931 | 36026 | 5649 | 40168 | 4390 | 41439 | 3401 | 41888 | 1921 | 42844 | 606 | 37801 |
| 28-#11 | 3.85 | 17488 | 7997 | 36335 | 5690 | 40568 | 4430 | 41909 | 3419 | 42514 | 1915 | 43837 | 596 | 38932 |

## ROUND SPIRAL COLUMNS 40" DIA.

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6-#14 | 1.07 | 18803 | 7382 | 36396 | 4999 | 37857 | 3897 | 36704 | 3079 | 30784 | 1840 | 29508 | 1180 | 14955 |
| 6-#18 | 1.91 | 19240 | 7827 | 38902 | 5200 | 40799 | 4041 | 40162 | 3143 | 37574 | 1870 | 34509 | 903 | 25329 |
| 7-#14 | 1.25 | 18912 | 7477 | 35567 | 5390 | 38376 | 4213 | 37932 | 3345 | 32452 | 2013 | 32412 | 1279 | 17293 |
| 7-#18 | 2.23 | 19409 | 7996 | 38295 | 5653 | 41612 | 4403 | 41765 | 3447 | 39819 | 2076 | 38565 | 985 | 28347 |
| 8-#14 | 1.43 | 19071 | 7572 | 35731 | 5518 | 38944 | 4328 | 38753 | 3435 | 33565 | 2058 | 33766 | 1266 | 19321 |
| 8-#18 | 2.55 | 19641 | 8166 | 38801 | 5824 | 42595 | 4559 | 43083 | 3566 | 41699 | 2129 | 40683 | 937 | 32328 |
| 9-#11 | 1.12 | 18828 | 7405 | 35017 | 5402 | 37934 | 4226 | 37486 | 3364 | 34286 | 2205 | 31774 | 1331 | 15649 |
| 9-#14 | 1.61 | 19090 | 7668 | 36438 | 5539 | 39609 | 4324 | 39468 | 3419 | 36941 | 2173 | 35009 | 1185 | 21564 |
| 9-#18 | 2.86 | 19680 | 8336 | 39889 | 5895 | 43745 | 4579 | 44385 | 3560 | 40606 | 1950 | 43285 | 835 | 35220 |
| 10-#11 | 1.24 | 18888 | 7471 | 35789 | 5333 | 38449 | 4171 | 37946 | 3310 | 34725 | 2130 | 32324 | 1281 | 17059 |
| 10-#14 | 1.79 | 19169 | 7763 | 37374 | 5482 | 40360 | 4281 | 40200 | 3370 | 37714 | 2086 | 35962 | 1127 | 23563 |
| 10-#18 | 3.18 | 19800 | 8505 | 41256 | 5870 | 45097 | 4566 | 45759 | 3521 | 45098 | 1970 | 44889 | 725 | 38654 |

## ROUND SPIRAL COLUMNS 40" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 11-#11 | 1.37 | 19002 | 7537 | 35623 | 5499 | 38807 | 4299 | 38562 | 3412 | 35727 | 2204 | 33651 | 1286 | 18709 |
| 11-#14 | 1.97 | 19329 | 7859 | 37330 | 5672 | 40851 | 4424 | 40986 | 3482 | 38971 | 2167 | 37653 | 1114 | 25684 |
| 11-#18 | 3.50 | 20075 | 8675 | 41507 | 6120 | 45895 | 4744 | 46992 | 3662 | 46985 | 2068 | 47476 | 667 | 41455 |
| 12-#11 | 1.49 | 19040 | 7603 | 35863 | 5569 | 39224 | 4362 | 39121 | 3459 | 36453 | 2214 | 34701 | 1276 | 20103 |
| 12-#14 | 2.15 | 19381 | 7954 | 37732 | 5760 | 41446 | 4503 | 41757 | 3541 | 37304 | 2029 | 39091 | 1095 | 27678 |
| 12-#18 | 3.82 | 20154 | 8844 | 42264 | 6251 | 46926 | 4864 | 48282 | 3749 | 48636 | 2068 | 49861 | 621 | 44514 |
| 13-#11 | 1.61 | 19135 | 7669 | 36310 | 5580 | 39662 | 4366 | 39629 | 3456 | 34676 | 2053 | 35400 | 1223 | 21700 |
| 13-#14 | 2.33 | 19510 | 8049 | 38264 | 5800 | 42080 | 4517 | 42499 | 3542 | 40989 | 2157 | 40121 | 1021 | 29656 |
| 13-#18 | 4.14 | 20362 | 9014 | 43151 | 6339 | 48053 | 4904 | 49598 | 3760 | 50458 | 2044 | 51699 | 492 | 47655 |
| 14-#11 | 1.74 | 19238 | 7735 | 36868 | 5570 | 40146 | 4351 | 40122 | 3434 | 37737 | 2152 | 36094 | 1169 | 23069 |
| 14-#14 | 2.51 | 19658 | 8145 | 39025 | 5793 | 42769 | 4513 | 43260 | 3527 | 39104 | 1960 | 41193 | 950 | 31718 |
| 14-#18 | 4.46 | 20626 | 9183 | 44313 | 6365 | 49258 | 4929 | 51032 | 3763 | 52161 | 1959 | 53689 | 380 | 50422 |
| 15-#11 | 1.86 | 19297 | 7801 | 36967 | 5669 | 40524 | 4431 | 40691 | 3497 | 36000 | 2047 | 37275 | 1169 | 24607 |
| 15-#14 | 2.69 | 19737 | 8240 | 39275 | 5911 | 43307 | 4608 | 44008 | 3599 | 43101 | 2160 | 42775 | 940 | 33560 |
| 15-#18 | 4.77 | 20726 | 9353 | 44918 | 6531 | 50186 | 5059 | 52204 | 3856 | 54103 | 2042 | 56256 | 342 | 53627 |
| 16-#11 | 1.99 | 19378 | 7868 | 37185 | 5732 | 40964 | 4482 | 41235 | 3534 | 39402 | 2214 | 38180 | 1132 | 25932 |
| 16-#14 | 2.86 | 19841 | 8336 | 39617 | 5995 | 43945 | 4676 | 44766 | 3647 | 41224 | 2028 | 44030 | 884 | 35609 |
| 16-#18 | 5.09 | 20893 | 9523 | 45588 | 6668 | 51267 | 5168 | 53492 | 3932 | 55912 | 2057 | 58363 | 236 | 56348 |
| 17-#11 | 2.11 | 19437 | 7934 | 37621 | 5755 | 41392 | 4494 | 41740 | 3536 | 37379 | 2049 | 39017 | 1101 | 27435 |
| 17-#14 | 3.04 | 19924 | 8431 | 40215 | 6033 | 44543 | 4697 | 45555 | 3669 | 45099 | 2147 | 45242 | 840 | 37354 |
| 17-#18 | 5.41 | 21048 | 9692 | 46585 | 6745 | 52326 | 5214 | 54889 | 3976 | 57554 | 2015 | 60493 | 157 | 59274 |
| 18-#11 | 2.23 | 19497 | 8000 | 38126 | 5767 | 41873 | 4497 | 42252 | 3530 | 40746 | 2170 | 39706 | 1037 | 28738 |
| 18-#14 | 3.22 | 20005 | 8526 | 40877 | 6065 | 45228 | 4712 | 46267 | 3655 | 46139 | 2118 | 46272 | 753 | 39246 |
| 18-#18 | 5.73 | 21170 | 9862 | 47602 | 6822 | 53513 | 5260 | 56207 | 3969 | 55473 | 1841 | 63014 | 70 | 62417 |
| 19-#11 | 2.36 | 19594 | 8066 | 38290 | 5841 | 42261 | 4557 | 42820 | 3585 | 41456 | 2187 | 40871 | 1047 | 30163 |
| 19-#14 | 3.40 | 20138 | 8622 | 41171 | 6155 | 45785 | 4786 | 47046 | 3723 | 47098 | 2134 | 47874 | 760 | 40991 |
| 20-#11 | 2.48 | 19653 | 8132 | 38552 | 5898 | 42675 | 4601 | 43344 | 3608 | 42196 | 2195 | 41848 | 1023 | 31497 |
| 20-#14 | 3.58 | 20222 | 8717 | 41562 | 6234 | 46381 | 4846 | 47777 | 3753 | 44936 | 2000 | 49247 | 722 | 42735 |
| 21-#11 | 2.61 | 19734 | 8198 | 38963 | 5926 | 43122 | 4618 | 43871 | 3623 | 42862 | 2179 | 42587 | 981 | 32854 |
| 21-#14 | 3.76 | 20340 | 8813 | 42139 | 6277 | 47017 | 4873 | 48540 | 3777 | 49098 | 2120 | 50307 | 663 | 44551 |
| 22-#11 | 2.73 | 19843 | 8264 | 39394 | 5947 | 43616 | 4632 | 44373 | 3616 | 43578 | 2161 | 43400 | 940 | 34245 |
| 22-#14 | 3.94 | 20477 | 8908 | 42715 | 6317 | 47709 | 4900 | 49273 | 3773 | 50149 | 2098 | 51500 | 606 | 46222 |
| 23-#11 | 2.86 | 19886 | 8330 | 39631 | 6010 | 43988 | 4679 | 44923 | 3661 | 44336 | 2180 | 44444 | 926 | 35530 |
| 23-#14 | 4.12 | 20540 | 9003 | 43094 | 6397 | 48249 | 4960 | 50037 | 3831 | 51197 | 2121 | 52941 | 582 | 48070 |
| 24-#11 | 2.98 | 19958 | 8397 | 39928 | 6065 | 44410 | 4721 | 45427 | 3681 | 44999 | 2176 | 45252 | 892 | 36916 |
| 24-#14 | 4.30 | 20638 | 9099 | 43536 | 6474 | 48851 | 5018 | 50761 | 3858 | 48660 | 1972 | 54077 | 530 | 49703 |
| 25-#11 | 3.10 | 20035 | 8463 | 40307 | 6094 | 44857 | 4740 | 45974 | 3699 | 42689 | 2026 | 46168 | 858 | 38144 |
| 25-#14 | 4.48 | 20742 | 9194 | 44059 | 6518 | 49487 | 5048 | 51535 | 3884 | 53192 | 2106 | 55387 | 482 | 51504 |
| 26-#11 | 3.23 | 20090 | 8529 | 40802 | 6102 | 45325 | 4758 | 46490 | 3697 | 43307 | 2004 | 46865 | 812 | 39455 |
| 27-#11 | 3.35 | 20177 | 8595 | 41024 | 6168 | 45723 | 4801 | 47021 | 3737 | 47140 | 2162 | 47893 | 790 | 40700 |
| 28-#11 | 3.48 | 20259 | 8661 | 41350 | 6210 | 46156 | 4842 | 47522 | 3755 | 47806 | 2157 | 48958 | 781 | 41933 |
| 29-#11 | 3.60 | 20325 | 8727 | 41695 | 6252 | 46587 | 4862 | 48069 | 3774 | 48543 | 2153 | 49735 | 736 | 43209 |
| 30-#11 | 3.72 | 20420 | 8793 | 42138 | 6275 | 47049 | 4883 | 48602 | 3776 | 45938 | 1989 | 50593 | 702 | 44405 |

## ROUND SPIRAL COLUMNS 42" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi  $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips  $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.73 | 22193 | 8525 | 44447 | 5702 | 46605 | 4436 | 45781 | 3463 | 39715 | 1958 | 38950 | 1074 | 26901 |
| 7-#14 | 1.14 | 21836 | 8175 | 40741 | 5926 | 44006 | 4636 | 43452 | 3688 | 39668 | 2400 | 36820 | 1458 | 18452 |
| 7-#18 | 2.02 | 22383 | 8694 | 43654 | 6189 | 47451 | 4825 | 47533 | 3791 | 45051 | 2321 | 43402 | 1169 | 30253 |
| 8-#14 | 1.30 | 22020 | 8270 | 40879 | 6062 | 44606 | 4758 | 44337 | 3783 | 40954 | 2452 | 38291 | 1450 | 20533 |
| 8-#18 | 2.31 | 22656 | 8864 | 44158 | 6368 | 48493 | 4989 | 48941 | 3916 | 47076 | 2380 | 45690 | 1127 | 34401 |
| 9-#11 | 1.01 | 21747 | 8103 | 40132 | 5942 | 43535 | 4652 | 42985 | 3710 | 39161 | 2450 | 36148 | 1511 | 16615 |
| 9-#14 | 1.46 | 22036 | 8366 | 41649 | 6079 | 45316 | 4750 | 45090 | 3765 | 39187 | 2257 | 39600 | 1367 | 23034 |
| 9-#18 | 2.60 | 22690 | 9034 | 45338 | 6435 | 49721 | 5006 | 50321 | 3907 | 48986 | 2338 | 48451 | 1023 | 37624 |
| 10-#11 | 1.13 | 21814 | 8169 | 40999 | 5863 | 44078 | 4588 | 43452 | 3649 | 39594 | 2369 | 36693 | 1457 | 18156 |
| 10-#14 | 1.62 | 22125 | 8461 | 42685 | 6011 | 46106 | 4698 | 45864 | 3710 | 42775 | 2326 | 40575 | 1306 | 25086 |
| 10-#18 | 2.89 | 22826 | 9203 | 46821 | 6399 | 51141 | 4983 | 51796 | 3863 | 50648 | 2215 | 50127 | 912 | 41701 |
| 11-#11 | 1.24 | 21935 | 8235 | 40768 | 6041 | 44457 | 4727 | 44130 | 3759 | 37983 | 2287 | 38149 | 1468 | 19893 |
| 11-#14 | 1.79 | 22298 | 8557 | 42586 | 6214 | 46636 | 4852 | 46707 | 3830 | 44149 | 2414 | 42419 | 1299 | 27447 |
| 11-#18 | 3.18 | 23127 | 9373 | 47037 | 6662 | 52009 | 5173 | 53100 | 4012 | 49181 | 2166 | 52926 | 860 | 44570 |
| 12-#11 | 1.35 | 21976 | 8301 | 41003 | 6113 | 44902 | 4772 | 44729 | 3809 | 38701 | 2297 | 39280 | 1460 | 21456 |
| 12-#14 | 1.95 | 22351 | 8652 | 42993 | 6304 | 47267 | 4934 | 47531 | 3891 | 45213 | 2424 | 43966 | 1281 | 29499 |
| 12-#18 | 3.46 | 23204 | 9542 | 47846 | 6797 | 53106 | 5296 | 54478 | 4102 | 54462 | 2323 | 55487 | 817 | 47969 |
| 13-#11 | 1.46 | 22081 | 8367 | 41493 | 6123 | 45361 | 4795 | 45266 | 3804 | 42209 | 2446 | 40016 | 1406 | 23095 |
| 13-#14 | 2.11 | 22494 | 8747 | 43638 | 6329 | 47930 | 4946 | 48316 | 3891 | 43211 | 2246 | 45055 | 1208 | 31701 |
| 13-#18 | 3.75 | 23434 | 9712 | 48783 | 6882 | 54293 | 5335 | 55876 | 4112 | 52635 | 2145 | 57442 | 689 | 51182 |
| 14-#11 | 1.58 | 22188 | 8433 | 42112 | 6108 | 45878 | 4775 | 45771 | 3779 | 39963 | 2236 | 40736 | 1350 | 24600 |
| 14-#14 | 2.27 | 22647 | 8843 | 44409 | 6331 | 48666 | 4938 | 49102 | 3872 | 47246 | 2346 | 46179 | 1136 | 33825 |
| 14-#18 | 4.04 | 23718 | 9881 | 50045 | 6904 | 55569 | 5355 | 57380 | 4111 | 58192 | 2212 | 59552 | 576 | 54260 |
| 15-#11 | 1.69 | 22258 | 8499 | 42184 | 6213 | 46277 | 4860 | 46385 | 3846 | 43715 | 2440 | 42014 | 1354 | 26210 |
| 15-#14 | 2.44 | 22744 | 8938 | 44641 | 6455 | 49235 | 5038 | 49920 | 3949 | 48438 | 2396 | 47884 | 1129 | 35879 |
| 15-#18 | 4.33 | 23836 | 10051 | 50662 | 7076 | 56556 | 5491 | 58652 | 4210 | 60277 | 2299 | 62308 | 542 | 57667 |
| 16-#11 | 1.80 | 22349 | 8566 | 42407 | 6277 | 46736 | 4893 | 46975 | 3885 | 41625 | 2299 | 42986 | 1318 | 27668 |
| 16-#14 | 2.60 | 22859 | 9034 | 44994 | 6540 | 49901 | 5107 | 50730 | 3999 | 49676 | 2424 | 49231 | 1074 | 37994 |
| 16-#18 | 4.62 | 24021 | 10221 | 51351 | 7214 | 57729 | 5604 | 60026 | 4288 | 62207 | 2316 | 64569 | 437 | 60573 |
| 17-#11 | 1.91 | 22409 | 8632 | 42877 | 6300 | 47199 | 4924 | 47501 | 3886 | 45283 | 2444 | 43872 | 1287 | 29272 |
| 17-#14 | 2.76 | 22944 | 9129 | 45636 | 6578 | 50549 | 5128 | 51505 | 4005 | 50669 | 2399 | 50517 | 1030 | 39947 |
| 17-#18 | 4.91 | 24184 | 10390 | 52419 | 7291 | 58835 | 5647 | 61511 | 4332 | 59689 | 2122 | 66835 | 360 | 63953 |
| 18-#11 | 2.03 | 22476 | 8698 | 43424 | 6308 | 47712 | 4925 | 48039 | 3878 | 46024 | 2418 | 44595 | 1222 | 30674 |
| 18-#14 | 2.92 | 23035 | 9224 | 46354 | 6606 | 51279 | 5141 | 52305 | 4004 | 48313 | 2210 | 51605 | 942 | 42088 |
| 18-#18 | 5.20 | 24315 | 10560 | 53535 | 7365 | 60099 | 5691 | 62881 | 4322 | 65945 | 2231 | 69516 | 273 | 67031 |
| 19-#11 | 2.14 | 22583 | 8764 | 43586 | 6386 | 48115 | 4987 | 48649 | 3935 | 46777 | 2436 | 45844 | 1234 | 32258 |
| 19-#14 | 3.09 | 23181 | 9320 | 46651 | 6701 | 51865 | 5217 | 53138 | 4075 | 52796 | 2387 | 53319 | 952 | 43979 |
| 19-#18 | 5.49 | 24585 | 10729 | 54188 | 7505 | 61124 | 5802 | 64267 | 4426 | 63123 | 2098 | 71676 | 213 | 69989 |
| 20-#11 | 2.25 | 22643 | 8830 | 43859 | 6445 | 48554 | 5013 | 49198 | 3959 | 44395 | 2282 | 46886 | 1211 | 33628 |
| 20-#14 | 3.25 | 23266 | 9415 | 47062 | 6780 | 52491 | 5278 | 53925 | 4107 | 53905 | 2396 | 54783 | 916 | 45919 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 42" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 21-#11 | 2.36 | 22733 | 8896 | 44294 | 6471 | 49029 | 5049 | 49765 | 3974 | 48271 | 2429 | 47673 | 1170 | 35161 |
| 21-#14 | 3.41 | 23389 | 9510 | 47672 | 6823 | 53168 | 5305 | 54727 | 4130 | 54922 | 2374 | 55913 | 857 | 47777 |
| 22-#11 | 2.48 | 22838 | 8962 | 44764 | 6490 | 49555 | 5061 | 50295 | 3966 | 45767 | 2250 | 48529 | 1129 | 36566 |
| 22-#14 | 3.57 | 23543 | 9606 | 48295 | 6860 | 53916 | 5331 | 55503 | 4124 | 56033 | 2351 | 57175 | 801 | 49634 |
| 23-#11 | 2.59 | 22900 | 9028 | 45004 | 6556 | 49949 | 5111 | 50882 | 4013 | 49838 | 2431 | 49512 | 1104 | 37997 |
| 23-#14 | 3.74 | 23618 | 9701 | 48686 | 6943 | 54478 | 5393 | 56319 | 4184 | 57153 | 2376 | 58721 | 778 | 51557 |
| 24-#11 | 2.70 | 22980 | 9095 | 45311 | 6611 | 50397 | 5134 | 51410 | 4033 | 47174 | 2265 | 50512 | 1083 | 39424 |
| 24-#14 | 3.90 | 23726 | 9797 | 49146 | 7021 | 55117 | 5452 | 57077 | 4211 | 58147 | 2369 | 59934 | 728 | 53443 |
| 25-#11 | 2.81 | 23053 | 9161 | 45722 | 6640 | 50872 | 5173 | 51991 | 4051 | 47905 | 2261 | 51487 | 1049 | 40804 |
| 25-#14 | 4.06 | 23835 | 9892 | 49711 | 7064 | 55794 | 5481 | 57909 | 4239 | 59273 | 2362 | 61329 | 679 | 55345 |
| 26-#11 | 2.93 | 23121 | 9227 | 46255 | 6647 | 51364 | 5189 | 52546 | 4049 | 52028 | 2398 | 52223 | 1002 | 42250 |
| 26-#14 | 4.22 | 23922 | 9987 | 50437 | 7081 | 56504 | 5511 | 58701 | 4239 | 56275 | 2175 | 62406 | 614 | 57119 |
| 27-#11 | 3.04 | 23216 | 9293 | 46477 | 6715 | 51786 | 5234 | 53103 | 4089 | 49296 | 2253 | 53323 | 982 | 43605 |
| 28-#11 | 3.15 | 23287 | 9359 | 46821 | 6757 | 52252 | 5255 | 53637 | 4108 | 49958 | 2249 | 54458 | 973 | 44998 |
| 29-#11 | 3.27 | 23376 | 9425 | 47190 | 6798 | 52704 | 5295 | 54217 | 4127 | 50687 | 2245 | 55284 | 929 | 46305 |
| 30-#11 | 3.38 | 23476 | 9491 | 47661 | 6820 | 53195 | 5315 | 54772 | 4128 | 55018 | 2384 | 56194 | 894 | 47633 |
| 31-#11 | 3.49 | 23531 | 9558 | 47909 | 6883 | 53625 | 5346 | 55333 | 4165 | 52147 | 2247 | 57114 | 863 | 49002 |
| 32-#11 | 3.60 | 23608 | 9624 | 48262 | 6924 | 54076 | 5375 | 55871 | 4183 | 52875 | 2251 | 58128 | 837 | 50324 |

## ROUND SPIRAL COLUMNS 44" DIA.

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.58 | 25433 | 9257 | 50500 | 6230 | 52947 | 4850 | 51913 | 3799 | 47962 | 2335 | 43762 | 1252 | 28475 |
| 7-#14 | 1.04 | 25046 | 8907 | 46399 | 6489 | 50171 | 5080 | 49495 | 4048 | 45019 | 2655 | 41621 | 1646 | 19606 |
| 7-#18 | 1.84 | 25643 | 9426 | 49499 | 6751 | 53824 | 5269 | 53818 | 4151 | 47352 | 2406 | 48631 | 1361 | 32181 |
| 8-#14 | 1.18 | 25254 | 9002 | 46505 | 6633 | 50802 | 5180 | 50447 | 4150 | 46390 | 2710 | 43215 | 1642 | 21753 |
| 8-#18 | 2.10 | 25958 | 9596 | 49994 | 6939 | 54926 | 5440 | 55325 | 4283 | 52909 | 2642 | 51095 | 1324 | 36484 |
| 9-#14 | 1.33 | 25267 | 9098 | 47338 | 6645 | 51558 | 5198 | 51236 | 4128 | 44319 | 2498 | 44586 | 1557 | 24512 |
| 9-#18 | 2.37 | 25986 | 9766 | 51271 | 7001 | 56232 | 5453 | 56782 | 4271 | 54919 | 2598 | 53640 | 1189 | 40057 |
| 10-#11 | 1.03 | 25026 | 8901 | 46698 | 6419 | 50242 | 5026 | 49474 | 4004 | 44913 | 2620 | 41450 | 1643 | 19264 |
| 10-#14 | 1.48 | 25366 | 9193 | 48487 | 6567 | 52388 | 5136 | 52033 | 4065 | 45066 | 2407 | 45577 | 1493 | 26621 |
| 10-#18 | 2.63 | 26139 | 9935 | 52877 | 6954 | 57720 | 5421 | 58353 | 4222 | 56648 | 2470 | 55752 | 1106 | 44289 |
| 11-#11 | 1.13 | 25152 | 8967 | 46394 | 6610 | 50638 | 5176 | 50224 | 4124 | 46110 | 2707 | 43044 | 1658 | 21085 |
| 11-#14 | 1.63 | 25547 | 9289 | 48323 | 6782 | 52950 | 5301 | 52952 | 4195 | 49783 | 2673 | 47582 | 1492 | 29236 |
| 11-#18 | 2.89 | 26464 | 10105 | 53049 | 7230 | 58659 | 5624 | 59733 | 4379 | 58859 | 2583 | 58773 | 1060 | 47713 |
| 12-#11 | 1.23 | 25199 | 9033 | 46621 | 6686 | 51115 | 5225 | 50863 | 4176 | 43806 | 2539 | 44259 | 1652 | 22790 |
| 12-#14 | 1.78 | 25607 | 9384 | 48730 | 6876 | 53622 | 5357 | 53831 | 4259 | 50902 | 2684 | 49239 | 1476 | 31338 |
| 12-#18 | 3.16 | 26542 | 10274 | 53908 | 7370 | 59820 | 5750 | 61200 | 4472 | 60745 | 2588 | 61513 | 1019 | 51509 |
| 13-#11 | 1.33 | 25313 | 9099 | 47157 | 6694 | 51596 | 5235 | 51428 | 4170 | 47715 | 2705 | 45029 | 1598 | 24503 |
| 13-#14 | 1.92 | 25763 | 9479 | 49432 | 6899 | 54316 | 5396 | 54659 | 4257 | 52055 | 2666 | 50385 | 1402 | 33777 |
| 13-#18 | 3.42 | 26794 | 10444 | 54898 | 7453 | 61060 | 5786 | 62679 | 4481 | 62787 | 2564 | 63581 | 892 | 54781 |
| 14-#11 | 1.44 | 25424 | 9165 | 47840 | 6673 | 52145 | 5220 | 51944 | 4140 | 48352 | 2653 | 45771 | 1540 | 26150 |
| 14-#14 | 2.07 | 25922 | 9575 | 50278 | 6895 | 55097 | 5383 | 55469 | 4234 | 53048 | 2604 | 51559 | 1329 | 35956 |
| 14-#18 | 3.68 | 27098 | 10613 | 56263 | 7468 | 62417 | 5802 | 64239 | 4475 | 60364 | 2311 | 65808 | 778 | 58188 |

## ROUND SPIRAL COLUMNS 44" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 15-#11 | 1.54 | 25506 | 9231 | 47880 | 6784 | 52565 | 5301 | 52606 | 4212 | 49311 | 2700 | 47151 | 1547 | 27828 |
| 15-#14 | 2.22 | 26031 | 9670 | 50484 | 7025 | 55698 | 5489 | 56346 | 4316 | 50699 | 2480 | 53392 | 1325 | 38232 |
| 15-#18 | 3.95 | 27237 | 10783 | 56888 | 7647 | 63461 | 5944 | 65625 | 4581 | 62446 | 2396 | 68758 | 748 | 61677 |
| 16-#11 | 1.64 | 25606 | 9298 | 48107 | 6850 | 53043 | 5345 | 53241 | 4253 | 46901 | 2542 | 48190 | 1512 | 29427 |
| 16-#14 | 2.37 | 26164 | 9766 | 50849 | 7113 | 56392 | 5531 | 57221 | 4368 | 55630 | 2687 | 54831 | 1271 | 40407 |
| 16-#18 | 4.21 | 27439 | 10953 | 57594 | 7787 | 64706 | 6059 | 67086 | 4660 | 68959 | 2586 | 71173 | 645 | 65106 |
| 17-#11 | 1.74 | 25667 | 9364 | 48612 | 6871 | 53541 | 5366 | 53787 | 4253 | 50972 | 2704 | 49124 | 1481 | 31095 |
| 17-#14 | 2.52 | 26251 | 9861 | 51537 | 7149 | 57090 | 5580 | 58026 | 4373 | 56682 | 2661 | 56189 | 1228 | 42570 |
| 17-#18 | 4.47 | 27610 | 11122 | 58734 | 7863 | 65878 | 6101 | 68645 | 4703 | 70807 | 2544 | 73576 | 569 | 68610 |
| 18-#11 | 1.85 | 25742 | 9430 | 49203 | 6876 | 54086 | 5374 | 54351 | 4242 | 48300 | 2498 | 49875 | 1415 | 32635 |
| 18-#14 | 2.66 | 26352 | 9956 | 52308 | 7174 | 57865 | 5590 | 58867 | 4369 | 53988 | 2454 | 57334 | 1139 | 44776 |
| 18-#18 | 4.74 | 27752 | 11292 | 59952 | 7935 | 67222 | 6143 | 70081 | 4691 | 72910 | 2500 | 75671 | 420 | 71740 |
| 19-#11 | 1.95 | 25853 | 9496 | 49361 | 6958 | 54504 | 5429 | 55003 | 4303 | 52554 | 2697 | 51215 | 1430 | 34286 |
| 19-#14 | 2.81 | 26511 | 10052 | 52611 | 7273 | 58473 | 5670 | 59757 | 4444 | 55004 | 2473 | 59161 | 1152 | 46869 |
| 19-#18 | 5.00 | 28014 | 11461 | 60610 | 8078 | 68307 | 6258 | 71557 | 4799 | 69731 | 2352 | 78718 | 426 | 75028 |
| 20-#11 | 2.05 | 25919 | 9562 | 49644 | 7018 | 54968 | 5466 | 55578 | 4328 | 49834 | 2527 | 52324 | 1408 | 35788 |
| 20-#14 | 2.96 | 26598 | 10147 | 53041 | 7354 | 59136 | 5704 | 60579 | 4476 | 60110 | 2661 | 60718 | 1118 | 49077 |
| 20-#18 | 5.26 | 28203 | 11631 | 61399 | 8212 | 69472 | 6361 | 72976 | 4849 | 76739 | 2533 | 81377 | 357 | 78380 |
| 21-#11 | 2.15 | 26018 | 9628 | 50105 | 7044 | 55472 | 5492 | 56185 | 4343 | 54137 | 2690 | 53157 | 1366 | 37441 |
| 21-#14 | 3.11 | 26732 | 10242 | 53684 | 7395 | 59853 | 5759 | 61440 | 4499 | 61185 | 2638 | 61918 | 1059 | 51065 |
| 22-#11 | 2.26 | 26127 | 9694 | 50614 | 7060 | 56023 | 5511 | 56742 | 4333 | 54927 | 2670 | 54055 | 1325 | 38919 |
| 22-#14 | 3.26 | 26898 | 10338 | 54355 | 7430 | 60648 | 5782 | 62259 | 4492 | 62372 | 2616 | 63247 | 1002 | 53119 |
| 23-#11 | 2.36 | 26201 | 9760 | 50855 | 7129 | 56445 | 5554 | 57360 | 4382 | 55719 | 2683 | 55109 | 1301 | 40504 |
| 23-#14 | 3.40 | 26983 | 10433 | 54757 | 7517 | 61241 | 5847 | 63126 | 4555 | 63548 | 2641 | 64691 | 963 | 55134 |
| 24-#11 | 2.46 | 26288 | 9827 | 51171 | 7185 | 56919 | 5588 | 57920 | 4403 | 52776 | 2511 | 56172 | 1281 | 41966 |
| 24-#14 | 3.55 | 27102 | 10529 | 55233 | 7594 | 61917 | 5878 | 63918 | 4582 | 64604 | 2635 | 66190 | 932 | 57160 |
| 25-#11 | 2.56 | 26364 | 9893 | 51662 | 7204 | 57416 | 5616 | 58534 | 4420 | 57372 | 2686 | 57205 | 1247 | 43521 |
| 25-#14 | 3.70 | 27217 | 10624 | 55842 | 7638 | 62635 | 5936 | 64799 | 4609 | 65794 | 2629 | 67670 | 884 | 59122 |
| 26-#11 | 2.67 | 26439 | 9959 | 52187 | 7219 | 57937 | 5621 | 59126 | 4417 | 58098 | 2660 | 57979 | 1201 | 44979 |
| 26-#14 | 3.85 | 27311 | 10719 | 56620 | 7653 | 63378 | 5964 | 65649 | 4610 | 66877 | 2597 | 68807 | 819 | 61066 |
| 27-#11 | 2.77 | 26543 | 10025 | 52408 | 7288 | 58383 | 5677 | 59711 | 4459 | 58946 | 2678 | 59151 | 1182 | 46476 |
| 27-#14 | 4.00 | 27454 | 10815 | 56985 | 7745 | 64015 | 6024 | 66477 | 4664 | 63506 | 2442 | 70439 | 787 | 63084 |
| 28-#11 | 2.87 | 26616 | 10091 | 52769 | 7331 | 58876 | 5710 | 60278 | 4478 | 55724 | 2496 | 60071 | 1150 | 47963 |
| 28-#14 | 4.14 | 27575 | 10910 | 57512 | 7804 | 64718 | 6054 | 67279 | 4690 | 69107 | 2609 | 72144 | 774 | 64965 |
| 29-#11 | 2.98 | 26707 | 10157 | 53162 | 7372 | 59355 | 5739 | 60891 | 4497 | 60521 | 2670 | 61232 | 1130 | 49408 |
| 30-#11 | 3.08 | 26820 | 10223 | 53663 | 7392 | 59875 | 5749 | 61468 | 4497 | 61266 | 2647 | 62194 | 1095 | 50960 |
| 31-#11 | 3.18 | 26882 | 10290 | 53921 | 7457 | 60330 | 5800 | 62068 | 4536 | 62098 | 2662 | 63174 | 1064 | 52325 |
| 32-#11 | 3.28 | 26966 | 10356 | 54296 | 7499 | 60800 | 5830 | 62643 | 4554 | 58812 | 2499 | 64252 | 1039 | 53783 |
| 33-#11 | 3.39 | 27053 | 10422 | 54673 | 7540 | 61296 | 5861 | 63243 | 4574 | 63748 | 2663 | 65266 | 1011 | 55142 |
| 34-#11 | 3.49 | 27123 | 10488 | 55146 | 7563 | 61828 | 5875 | 63822 | 4576 | 64572 | 2653 | 66120 | 962 | 56555 |

## ROUND SPIRAL COLUMNS 46" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.44 | 28972 | 10023 | 57086 | 6782 | 59850 | 5285 | 58582 | 4151 | 53828 | 2584 | 48961 | 1437 | 30045 |
| 7-#18 | 1.68 | 29203 | 10192 | 55852 | 7340 | 60759 | 5734 | 60652 | 4529 | 56893 | 2846 | 54272 | 1561 | 34130 |
| 8-#14 | 1.08 | 28778 | 9769 | 52633 | 7232 | 57559 | 5653 | 57108 | 4533 | 52305 | 2981 | 48556 | 1842 | 22981 |
| 8-#18 | 1.93 | 29560 | 10362 | 56332 | 7537 | 61919 | 5913 | 62260 | 4667 | 59211 | 2915 | 56918 | 1529 | 38576 |
| 9-#14 | 1.22 | 28798 | 9864 | 53532 | 7239 | 58360 | 5666 | 57932 | 4508 | 53458 | 2945 | 49984 | 1757 | 25887 |
| 9-#18 | 2.17 | 29583 | 10532 | 57701 | 7594 | 63303 | 5922 | 63792 | 4652 | 61328 | 2870 | 59595 | 1392 | 42520 |
| 10-#14 | 1.35 | 28908 | 9959 | 54803 | 7150 | 59230 | 5594 | 58740 | 4437 | 50648 | 2653 | 50986 | 1689 | 28170 |
| 10-#18 | 2.41 | 29754 | 10701 | 59448 | 7535 | 64861 | 5880 | 65458 | 4597 | 58910 | 2555 | 61785 | 1307 | 46895 |
| 11-#11 | 1.03 | 28668 | 9733 | 52522 | 7206 | 57380 | 5636 | 56868 | 4506 | 48534 | 2778 | 48355 | 1857 | 22285 |
| 11-#14 | 1.49 | 29095 | 10055 | 54563 | 7378 | 59820 | 5771 | 59748 | 4577 | 55877 | 2944 | 53161 | 1694 | 30939 |
| 11-#18 | 2.65 | 30095 | 10871 | 59566 | 7825 | 65869 | 6095 | 66915 | 4763 | 61134 | 2667 | 65036 | 1268 | 50665 |
| 12-#11 | 1.13 | 28721 | 9799 | 52738 | 7285 | 57888 | 5699 | 57549 | 4561 | 52884 | 2992 | 49654 | 1852 | 24139 |
| 12-#14 | 1.62 | 29163 | 10150 | 54967 | 7475 | 60537 | 5831 | 60682 | 4644 | 57070 | 2956 | 54930 | 1679 | 33196 |
| 12-#18 | 2.89 | 30181 | 11040 | 60447 | 7968 | 67095 | 6225 | 68473 | 4858 | 67496 | 2865 | 67956 | 1229 | 54991 |
| 13-#11 | 1.22 | 28844 | 9865 | 53322 | 7291 | 58390 | 5707 | 58132 | 4553 | 53698 | 2975 | 50459 | 1799 | 25923 |
| 13-#14 | 1.76 | 29333 | 10245 | 55729 | 7496 | 61261 | 5868 | 61553 | 4641 | 58279 | 2938 | 56132 | 1605 | 35885 |
| 13-#18 | 3.13 | 30456 | 11210 | 61637 | 8024 | 68388 | 6258 | 70033 | 4867 | 69657 | 2841 | 70137 | 1103 | 58452 |
| 14-#11 | 1.31 | 28959 | 9931 | 54075 | 7264 | 58973 | 5687 | 58666 | 4519 | 54361 | 2921 | 51219 | 1738 | 27718 |
| 14-#14 | 1.90 | 29498 | 10341 | 56654 | 7487 | 62090 | 5850 | 62384 | 4613 | 59324 | 2874 | 57351 | 1530 | 38109 |
| 14-#18 | 3.37 | 30744 | 11379 | 62990 | 8060 | 69825 | 6270 | 71646 | 4856 | 71635 | 2750 | 72477 | 987 | 62203 |
| 15-#11 | 1.41 | 29052 | 9997 | 54077 | 7382 | 59412 | 5774 | 59377 | 4596 | 55385 | 2971 | 52705 | 1748 | 29462 |
| 15-#14 | 2.03 | 29622 | 10436 | 56830 | 7623 | 62720 | 5947 | 63323 | 4700 | 60674 | 2930 | 59316 | 1530 | 40620 |
| 15-#18 | 3.61 | 30939 | 11549 | 63606 | 8245 | 70926 | 6418 | 73146 | 4968 | 73808 | 2821 | 75625 | 962 | 65763 |
| 16-#11 | 1.50 | 29163 | 10064 | 54307 | 7451 | 59909 | 5819 | 60059 | 4639 | 56384 | 2996 | 53813 | 1714 | 31207 |
| 16-#14 | 2.17 | 29770 | 10532 | 57205 | 7713 | 63442 | 6005 | 64262 | 4755 | 62063 | 2961 | 60848 | 1477 | 42846 |
| 16-#18 | 3.85 | 31161 | 11719 | 64340 | 8387 | 72222 | 6534 | 74697 | 5050 | 76180 | 2866 | 78196 | 860 | 69520 |
| 17-#11 | 1.60 | 29226 | 10130 | 54847 | 7470 | 60439 | 5839 | 60625 | 4637 | 53330 | 2778 | 54793 | 1683 | 32938 |
| 17-#14 | 2.30 | 29858 | 10627 | 57939 | 7748 | 64190 | 6039 | 65098 | 4758 | 58958 | 2739 | 62278 | 1434 | 45231 |
| 17-#18 | 4.09 | 31339 | 11888 | 65552 | 8462 | 73482 | 6577 | 76225 | 5066 | 78140 | 2825 | 80734 | 786 | 73109 |
| 18-#11 | 1.69 | 29308 | 10196 | 55486 | 7471 | 61020 | 5844 | 61213 | 4624 | 54074 | 2750 | 55570 | 1617 | 34622 |
| 18-#14 | 2.44 | 29969 | 10722 | 58766 | 7768 | 65011 | 6061 | 65980 | 4752 | 64396 | 2903 | 63473 | 1344 | 47495 |
| 18-#18 | 4.33 | 31492 | 12058 | 66858 | 8531 | 74905 | 6616 | 77830 | 5077 | 80351 | 2780 | 82945 | 636 | 76544 |
| 19-#11 | 1.78 | 29426 | 10262 | 55636 | 7558 | 61452 | 5903 | 61908 | 4688 | 58811 | 2970 | 56854 | 1621 | 36333 |
| 19-#14 | 2.57 | 30142 | 10818 | 59072 | 7872 | 65641 | 6129 | 66926 | 4829 | 61178 | 2730 | 65421 | 1360 | 49798 |
| 19-#18 | 4.57 | 31776 | 12227 | 67534 | 8678 | 76043 | 6734 | 79398 | 5188 | 82270 | 2802 | 86178 | 646 | 80179 |
| 20-#11 | 1.88 | 29496 | 10328 | 55929 | 7619 | 61941 | 5940 | 62509 | 4713 | 59701 | 2981 | 58179 | 1612 | 38021 |
| 20-#14 | 2.71 | 30231 | 10913 | 59520 | 7955 | 66340 | 6179 | 67784 | 4862 | 66794 | 2937 | 67071 | 1326 | 52069 |
| 20-#18 | 4.81 | 31978 | 12397 | 68363 | 8814 | 77262 | 6838 | 80915 | 5241 | 84406 | 2816 | 88996 | 579 | 83574 |
| 21-#11 | 1.97 | 29602 | 10394 | 56415 | 7643 | 62473 | 5966 | 63153 | 4728 | 60482 | 2964 | 59058 | 1571 | 39688 |
| 21-#14 | 2.84 | 30377 | 11009 | 60197 | 7995 | 67099 | 6219 | 68705 | 4886 | 67927 | 2914 | 68340 | 1268 | 54266 |
| 21-#18 | 5.05 | 32179 | 12567 | 69528 | 8894 | 78578 | 6890 | 82487 | 5285 | 86404 | 2779 | 91218 | 476 | 86996 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.

(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 46" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 2.07 | 29716 | 10460 | 56966 | 7658 | 63050 | 5963 | 63740 | 4717 | 57210 | 2746 | 59996 | 1529 | 41303 |
| 22-#14 | 2.98 | 30554 | 11104 | 60919 | 8028 | 67930 | 6255 | 69565 | 4878 | 69156 | 2890 | 69735 | 1211 | 56581 |
| 22-#18 | 5.30 | 32437 | 12736 | 70675 | 8974 | 80034 | 6946 | 84029 | 5285 | 82710 | 2562 | 93736 | 381 | 90600 |
| 23-#11 | 2.16 | 29798 | 10527 | 57206 | 7729 | 63501 | 6029 | 64388 | 4767 | 62146 | 2957 | 61124 | 1507 | 42974 |
| 23-#14 | 3.11 | 30650 | 11199 | 61329 | 8117 | 68565 | 6308 | 70473 | 4942 | 70308 | 2903 | 71277 | 1174 | 58716 |
| 24-#11 | 2.25 | 29897 | 10593 | 57531 | 7786 | 64000 | 6063 | 64982 | 4789 | 63028 | 2965 | 62250 | 1487 | 44543 |
| 24-#14 | 3.25 | 30780 | 11295 | 61821 | 8195 | 69278 | 6354 | 71311 | 4970 | 71541 | 2912 | 72864 | 1143 | 60953 |
| 25-#11 | 2.35 | 29975 | 10659 | 58054 | 7804 | 64519 | 6091 | 65628 | 4806 | 63886 | 2960 | 63341 | 1453 | 46237 |
| 25-#14 | 3.38 | 30890 | 11390 | 62547 | 8225 | 70027 | 6397 | 72240 | 4997 | 72795 | 2907 | 74429 | 1095 | 62955 |
| 26-#11 | 2.44 | 30057 | 10725 | 58622 | 7818 | 65070 | 6094 | 66242 | 4802 | 64646 | 2934 | 64152 | 1407 | 47745 |
| 26-#14 | 3.52 | 31001 | 11485 | 63306 | 8253 | 70812 | 6439 | 73147 | 4997 | 73915 | 2873 | 75625 | 1030 | 65089 |
| 27-#11 | 2.53 | 30169 | 10791 | 58840 | 7889 | 65539 | 6152 | 66871 | 4846 | 65548 | 2953 | 65397 | 1389 | 49391 |
| 27-#14 | 3.66 | 31156 | 11581 | 63673 | 8346 | 71483 | 6485 | 74012 | 5052 | 75165 | 2895 | 77357 | 1001 | 67164 |
| 28-#11 | 2.63 | 30245 | 10857 | 59217 | 7933 | 66053 | 6185 | 67470 | 4866 | 66361 | 2950 | 66374 | 1357 | 50915 |
| 28-#14 | 3.79 | 31262 | 11676 | 64227 | 8406 | 72228 | 6530 | 74860 | 5079 | 76296 | 2888 | 78732 | 953 | 69218 |
| 29-#11 | 2.72 | 30344 | 10923 | 59636 | 7974 | 66565 | 6214 | 68115 | 4885 | 67211 | 2945 | 67598 | 1338 | 52504 |
| 29-#14 | 3.93 | 31405 | 11772 | 64810 | 8467 | 72947 | 6574 | 75788 | 5108 | 77536 | 2883 | 80488 | 925 | 71397 |
| 30-#11 | 2.82 | 30465 | 10989 | 60166 | 7992 | 67116 | 6223 | 68715 | 4883 | 67992 | 2922 | 68611 | 1303 | 54096 |
| 31-#11 | 2.91 | 30535 | 11056 | 60431 | 8058 | 67588 | 6276 | 69351 | 4923 | 68876 | 2938 | 69653 | 1274 | 55615 |
| 32-#11 | 3.00 | 30626 | 11122 | 60829 | 8101 | 68084 | 6306 | 69967 | 4943 | 69834 | 2953 | 70795 | 1249 | 57198 |
| 33-#11 | 3.10 | 30717 | 11188 | 61224 | 8142 | 68608 | 6337 | 70590 | 4961 | 70616 | 2940 | 71715 | 1209 | 58677 |
| 34-#11 | 3.19 | 30793 | 11254 | 61730 | 8164 | 69170 | 6350 | 71200 | 4963 | 66717 | 2735 | 72766 | 1171 | 60246 |
| 35-#11 | 3.29 | 30898 | 11320 | 62025 | 8226 | 69632 | 6399 | 71833 | 5000 | 72279 | 2933 | 73922 | 1155 | 61703 |
| 36-#11 | 3.38 | 30994 | 11386 | 62414 | 8268 | 70135 | 6428 | 72437 | 5018 | 73143 | 2937 | 74906 | 1118 | 63176 |

## ROUND SPIRAL COLUMNS 48" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 6-#18 | 1.33 | 32824 | 10823 | 64229 | 7360 | 67340 | 5738 | 65813 | 4519 | 56158 | 2654 | 54567 | 1630 | 31615 |
| 7-#18 | 1.55 | 33076 | 10993 | 62736 | 7957 | 68280 | 6220 | 68060 | 4923 | 63548 | 3126 | 60344 | 1769 | 36100 |
| 8-#18 | 1.77 | 33476 | 11162 | 63195 | 8163 | 69497 | 6407 | 69771 | 5068 | 65990 | 3199 | 63176 | 1742 | 40679 |
| 9-#14 | 1.12 | 32643 | 10664 | 60253 | 7860 | 65748 | 6157 | 65204 | 4906 | 59916 | 3226 | 55815 | 1964 | 27267 |
| 9-#18 | 1.99 | 33494 | 11332 | 64654 | 8214 | 70961 | 6412 | 71377 | 5050 | 68236 | 3154 | 65983 | 1604 | 45011 |
| 10-#14 | 1.24 | 32762 | 10759 | 61654 | 7759 | 66660 | 6074 | 66018 | 4826 | 60739 | 3118 | 56821 | 1892 | 29732 |
| 10-#18 | 2.21 | 33682 | 11501 | 66556 | 8143 | 72589 | 6359 | 73109 | 4987 | 70080 | 3015 | 68244 | 1516 | 49518 |
| 11-#14 | 1.37 | 32957 | 10855 | 61329 | 8001 | 67274 | 6248 | 67120 | 4977 | 62470 | 3226 | 59174 | 1903 | 32627 |
| 11-#18 | 2.43 | 34023 | 11671 | 66610 | 8447 | 73659 | 6587 | 74674 | 5163 | 72641 | 3144 | 71732 | 1484 | 53652 |
| 12-#11 | 1.03 | 32556 | 10599 | 59377 | 7912 | 65245 | 6194 | 64811 | 4963 | 59335 | 3276 | 55487 | 2062 | 25502 |
| 12-#14 | 1.49 | 33033 | 10950 | 61727 | 8102 | 68037 | 6327 | 68109 | 5047 | 63739 | 3241 | 61058 | 1890 | 35071 |
| 12-#18 | 2.65 | 34135 | 11840 | 67505 | 8594 | 74955 | 6721 | 76322 | 5262 | 74725 | 3152 | 74835 | 1447 | 58118 |
| 13-#11 | 1.12 | 32689 | 10665 | 60011 | 7916 | 65769 | 6200 | 65412 | 4953 | 60182 | 3258 | 56324 | 2007 | 27355 |
| 13-#14 | 1.62 | 33216 | 11046 | 62551 | 8120 | 68792 | 6346 | 69011 | 5041 | 65003 | 3221 | 62314 | 1816 | 37874 |
| 13-#18 | 2.87 | 34433 | 12010 | 68788 | 8648 | 76301 | 6751 | 77963 | 5270 | 77020 | 3128 | 77128 | 1321 | 61987 |
| 14-#11 | 1.21 | 32808 | 10731 | 60839 | 7883 | 66387 | 6175 | 65962 | 4915 | 60854 | 3200 | 57099 | 1945 | 29305 |
| 14-#14 | 1.74 | 33387 | 11141 | 63560 | 8105 | 69668 | 6338 | 69873 | 5009 | 61692 | 2945 | 63575 | 1739 | 40285 |
| 14-#18 | 3.09 | 34731 | 12180 | 70248 | 8678 | 77820 | 6758 | 79628 | 5254 | 79090 | 3036 | 79578 | 1204 | 66306 |
| 15-#11 | 1.29 | 32909 | 10798 | 60798 | 8008 | 66845 | 6268 | 66724 | 4997 | 57829 | 3038 | 58695 | 1958 | 31112 |
| 15-#14 | 1.87 | 33524 | 11236 | 63700 | 8249 | 70328 | 6441 | 70875 | 5102 | 67527 | 3215 | 65676 | 1742 | 42976 |
| 15-#18 | 3.32 | 34953 | 12349 | 70846 | 8870 | 78977 | 6913 | 81223 | 5371 | 81390 | 3110 | 82928 | 1183 | 69924 |
| 16-#11 | 1.38 | 33026 | 10864 | 61029 | 8078 | 67360 | 6315 | 67448 | 5042 | 63018 | 3281 | 59873 | 1925 | 33009 |
| 16-#14 | 1.99 | 33689 | 11332 | 64084 | 8340 | 71078 | 6501 | 71880 | 5159 | 68997 | 3247 | 67303 | 1690 | 45313 |
| 16-#18 | 3.54 | 35198 | 12519 | 71609 | 9015 | 80324 | 7030 | 82884 | 5456 | 83879 | 3157 | 85656 | 1082 | 74024 |
| 17-#11 | 1.47 | 33097 | 10930 | 61606 | 8097 | 67919 | 6334 | 68038 | 5039 | 63808 | 3260 | 60899 | 1894 | 34800 |
| 17-#14 | 2.11 | 33780 | 11427 | 64865 | 8374 | 71873 | 6534 | 72746 | 5160 | 70157 | 3221 | 68804 | 1648 | 47973 |
| 17-#18 | 3.76 | 35356 | 12688 | 72895 | 9088 | 81672 | 7073 | 84470 | 5470 | 80222 | 2908 | 88329 | 1009 | 77687 |
| 18-#11 | 1.55 | 33186 | 10996 | 62296 | 8094 | 68540 | 6316 | 68650 | 5024 | 64621 | 3229 | 61698 | 1827 | 36634 |
| 18-#14 | 2.24 | 33900 | 11522 | 65751 | 8390 | 72743 | 6553 | 73667 | 5152 | 71418 | 3186 | 70044 | 1558 | 50245 |
| 18-#18 | 3.98 | 35549 | 12858 | 74279 | 9153 | 83174 | 7110 | 86155 | 5480 | 88291 | 3070 | 90653 | 858 | 81441 |
| 19-#11 | 1.64 | 33313 | 11062 | 62432 | 8185 | 68985 | 6398 | 69355 | 5080 | 61197 | 3038 | 63072 | 1833 | 38402 |
| 19-#14 | 2.36 | 34087 | 11618 | 66057 | 8499 | 73394 | 6625 | 74671 | 5233 | 72663 | 3212 | 72118 | 1575 | 52769 |
| 19-#18 | 4.20 | 35855 | 13027 | 74983 | 9306 | 84353 | 7231 | 87815 | 5594 | 90303 | 3095 | 94074 | 872 | 85307 |
| 20-#11 | 1.72 | 33385 | 11128 | 62737 | 8247 | 69499 | 6437 | 70017 | 5116 | 66509 | 3267 | 64472 | 1825 | 40237 |
| 20-#14 | 2.49 | 34178 | 11713 | 66522 | 8583 | 74130 | 6675 | 75566 | 5266 | 73980 | 3224 | 73861 | 1543 | 55096 |
| 20-#18 | 4.42 | 36012 | 13197 | 75851 | 9443 | 85637 | 7336 | 89394 | 5647 | 92552 | 3110 | 97052 | 808 | 88865 |
| 21-#11 | 1.81 | 33501 | 11194 | 63249 | 8271 | 70060 | 6461 | 70693 | 5131 | 62831 | 3032 | 65396 | 1783 | 41959 |
| 21-#14 | 2.61 | 34336 | 11809 | 67233 | 8622 | 74929 | 6715 | 76542 | 5290 | 70158 | 2988 | 75199 | 1484 | 57502 |
| 21-#18 | 4.64 | 36285 | 13367 | 77070 | 9522 | 87025 | 7388 | 91072 | 5693 | 94658 | 3073 | 99402 | 705 | 92752 |

(1) See "Control Points for Interaction Curves – Round Columns"; Fig. 4-1.
(2) "0% $f_y$" indicates zero tension in bars on the tension side, "50% $f_y$" indicates 50% $f_y$ stress in bars on the tension side, and "100% $f_y$" indicates 100% $f_y$ stress (i.e., balance point) in bars on the tension side.

## ROUND SPIRAL COLUMNS 48" DIA.

Short columns – no sidesway

$f'_c$ = 10,000 psi $f_y$ = 75,000 psi
$\phi M_n$ in inch-kips $\phi P_n$ in kips

| BARS | RHO | Max Cap | | 0% $f_y$ | | 25% $f_y$ | | 50% $f_y$ | | 100% $f_y$ | | $\varepsilon_t$ = 0.005 | | Zero Axial Load |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ | $\phi P_n$ | $\phi M_n$ |
| 22-#11 | 1.90 | 33619 | 11260 | 63844 | 8282 | 70663 | 6456 | 71314 | 5118 | 68165 | 3226 | 66373 | 1741 | 43718 |
| 22-#14 | 2.74 | 34503 | 11904 | 68009 | 8652 | 75797 | 6720 | 77446 | 5280 | 76438 | 3176 | 76658 | 1428 | 59936 |
| 22-#18 | 4.86 | 36556 | 13536 | 78294 | 9599 | 88567 | 7443 | 92694 | 5691 | 97013 | 3040 | 102049 | 610 | 96285 |
| 23-#11 | 1.98 | 33711 | 11327 | 64081 | 8357 | 71140 | 6525 | 71993 | 5170 | 69070 | 3243 | 67576 | 1720 | 45444 |
| 23-#14 | 2.86 | 34632 | 11999 | 68425 | 8745 | 76473 | 6805 | 78396 | 5346 | 72493 | 2979 | 78299 | 1392 | 62214 |
| 23-#18 | 5.08 | 36787 | 13706 | 79153 | 9737 | 89713 | 7544 | 94335 | 5791 | 92614 | 2872 | 104764 | 535 | 99947 |
| 24-#11 | 2.07 | 33820 | 11393 | 64413 | 8414 | 71667 | 6560 | 72619 | 5193 | 70012 | 3252 | 68766 | 1702 | 47153 |
| 24-#14 | 2.98 | 34772 | 12095 | 68931 | 8824 | 77224 | 6852 | 79280 | 5375 | 78979 | 3202 | 79975 | 1362 | 64636 |
| 25-#11 | 2.16 | 33900 | 11459 | 64967 | 8432 | 72207 | 6587 | 73298 | 5210 | 70901 | 3246 | 69913 | 1668 | 48902 |
| 25-#14 | 3.11 | 34886 | 12190 | 69702 | 8853 | 78004 | 6894 | 80257 | 5402 | 80282 | 3195 | 81626 | 1314 | 66836 |
| 26-#11 | 2.24 | 33989 | 11525 | 65580 | 8444 | 72789 | 6589 | 73934 | 5204 | 71694 | 3219 | 70760 | 1621 | 50548 |
| 26-#14 | 3.23 | 35007 | 12286 | 70516 | 8879 | 78832 | 6905 | 81200 | 5401 | 81454 | 3161 | 82879 | 1250 | 69188 |
| 27-#11 | 2.33 | 34110 | 11591 | 65794 | 8517 | 73281 | 6649 | 74607 | 5250 | 72651 | 3239 | 72081 | 1605 | 52297 |
| 27-#14 | 3.36 | 35174 | 12381 | 70885 | 8974 | 79538 | 6983 | 82124 | 5458 | 82777 | 3184 | 84713 | 1221 | 71359 |
| 28-#11 | 2.41 | 34188 | 11657 | 66188 | 8562 | 73815 | 6682 | 75238 | 5270 | 73500 | 3237 | 73115 | 1573 | 53907 |
| 28-#14 | 3.48 | 35283 | 12476 | 71464 | 9035 | 80312 | 7028 | 83018 | 5485 | 83987 | 3179 | 86168 | 1175 | 73550 |
| 29-#11 | 2.50 | 34296 | 11723 | 66631 | 8602 | 74361 | 6711 | 75909 | 5289 | 74402 | 3233 | 74401 | 1554 | 55675 |
| 29-#14 | 3.61 | 35440 | 12572 | 72082 | 9096 | 81079 | 7072 | 83995 | 5514 | 85274 | 3173 | 88016 | 1147 | 75778 |
| 30-#11 | 2.59 | 34411 | 11790 | 67193 | 8619 | 74941 | 6719 | 76538 | 5286 | 70204 | 2995 | 75464 | 1519 | 57274 |
| 30-#14 | 3.73 | 35599 | 12667 | 72852 | 9128 | 81905 | 7089 | 84909 | 5515 | 86470 | 3143 | 89564 | 1098 | 77904 |
| 31-#11 | 2.67 | 34501 | 11856 | 67463 | 8686 | 75431 | 6773 | 77210 | 5328 | 76154 | 3226 | 76569 | 1491 | 58939 |
| 31-#14 | 3.85 | 35714 | 12763 | 73279 | 9217 | 82617 | 7160 | 85851 | 5569 | 87774 | 3162 | 91101 | 1054 | 80181 |
| 32-#11 | 2.76 | 34601 | 11922 | 67884 | 8731 | 75953 | 6804 | 77861 | 5348 | 77153 | 3241 | 77776 | 1466 | 60559 |
| 33-#11 | 2.84 | 34688 | 11988 | 68298 | 8771 | 76505 | 6835 | 78515 | 5366 | 72784 | 3013 | 78744 | 1426 | 62180 |
| 34-#11 | 2.93 | 34777 | 12054 | 68836 | 8792 | 77091 | 6847 | 79154 | 5367 | 78894 | 3218 | 79848 | 1389 | 63820 |
| 35-#11 | 3.02 | 34890 | 12120 | 69140 | 8856 | 77583 | 6897 | 79822 | 5405 | 74412 | 3006 | 81069 | 1374 | 65425 |
| 36-#11 | 3.10 | 34975 | 12186 | 69543 | 8897 | 78111 | 6927 | 80452 | 5424 | 80637 | 3226 | 82107 | 1338 | 67059 |
| 37-#11 | 3.19 | 35084 | 12253 | 70026 | 8930 | 78657 | 6958 | 81124 | 5444 | 81474 | 3214 | 83229 | 1311 | 68616 |